

Indo-German Science & Technology Centre



Annual Report

2014-15 | 2015-16



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2014-15 | 2015-16



The Indo-German Science & Technology Centre (IGSTC) has been established to facilitate Indo-German R&D networking through substantive interactions among government, academia/research systems and industry to foster innovation and application for the overall economic and societal developments of both the countries. Both Governments currently contribute up to Euro 2 million (₹ 13 crore) every year for realizing the goals.

IGSTC aims to:

- Play a proactive role in facilitating participation of industry in joint R&D projects.
- Provide/assist in mobilizing resources to carry out industrial R&D projects.
- Promote electronic exchange and dissemination of information on opportunities in bilateral S&T cooperation. The Centre will also prepare/compile state-of-the-art reports on topics of interest with the help of highly qualified scientists and technologists, one from each country.
- Provide individual advice to institutes and industries from either country, the possibilities of Indo-German cooperation and help in the identification of suitable partners.
- Facilitate and promote Indo-German bilateral collaboration in basic and applied science, research and technology through substantive interaction among government, academia and industry.
- Encourage public-private partnerships (PPP) to foster elements of innovation and application and cultivate a culture of cooperation between science and industry.
- Nurture contacts between young and mid career scientists and technologists to develop a sense of mutual trust, leadership and entrepreneurship.
- Develop cooperation through the identification of scientists and scientific institutions of the two countries.
- Organize workshops, seminars, training programmes and other types of events on topics of mutual interest.

Governance

GOVERNING BODY



Arabinda Mitra

DST
Indian Co-chair



Christian Joergens

BMBF
German Co-chair



Anuradha Mitra*

DST
(Served till December 2014)



Gerold Heinrich

DLR-PT



Krishnan Balasubramaniam**

IIT Madras
(Served till September 2014)



Eberhard Abele

TU Darmstadt



Anjan Das

Confederation of Indian Industry



Clas Neumann

SAP India



Shailja Gupta

DBT



Philip Petit***

German Embassy in India
(Served till May 2014)



***J.B. Mohapatra**

DST, Joined GB in place of
Anuradha Mitra



*****Stephan Lanzinger**

German Embassy in India
Joined GB in place of Philip Petit



****Sandeep Verma**

IIT Kanpur
Joined GB in place of Krishnan
Balasubramanian

From the Director's Desk

Seeking new horizons, IGSTC strives to bring together the immense scientific talent in both countries, to work together and resolve immediate and future S&T challenges.

In terms of numbers there are 19 ongoing projects in 2+2 mode involving 76 partners across academia and industry from India and Germany with investment of about 14 million euros.



Seeing the trajectory of growth of Indo-German relationship, evolved over last 5 years, the years 2014 and 2015 are certainly significant especially when we talk about Indo-German strategic partnership which includes evolution of IGSTC.

Research partnership across the boundaries connecting academia and industry with a motto "invention to Innovation" is the model with which Indo-German Science & Technology centre (IGSTC) began its journey in 2011. The influence of WTO, globalisation of R&D and emergence of global challenges made us think of a partnership which invokes the power of collaboration and ethos of mutuality of interest and respect.

The Year of Germany in India in 2012 gave the slogan "Germany and India: Infinite Opportunities". Yes, the opportunities are unlimited and more so in the innovation space. Establishment of German House for Research and Innovation (DWHI) in New Delhi in the same year also signalled the era of strategic partnership between these two great nations.

The years 2014/2015 have been significant. These years not only have seen significant growth of

Indian researchers/students in Germany, they also witnessed IGSTC spreading its wings connecting more than 80 best research institutions and industry partners from both countries taking up real life challenges to find out the solutions which are relevant for socio-economic development. IGSTC call for proposals during this period in the areas of Medical Technology including Diagnostic tool, New Materials for energy efficiency and water & Wastewater Technology received overwhelming response – 10 projects in 2+2 mode engaging best brains from academia and industry made a beginning in a true partnership mode to find industry ready technological solutions. Investment of about 2 million euro committed to these projects (mostly TRL 5 and above) with flexible project funding model which they all need to succeed.

2014/2015 also took a review of IGSTC as a unique model of research partnership. It opened our eyes. To create level playing field, Indian side started offering grant to the Indian industry instead of loan. The recommendation emerged out of the IGSTC review committee, excellent outcomes of some of the ongoing projects and the growing expectations & aspirations of the

stakeholders made us to believe that (a) IGSTC is in right tract but can improve (b) IGSTC needs to expand and consolidate its gains and (c) make more investment in right instruments to attract more players and to drive innovation.

Hannover Fair (April 2015) provided an excellent platform, when IGSTC could showcase one of its projects on flexible electronics (FLEXIPRIDE) in the form of a solar tree with TU Chemnitz taking the lead. Indian Prime Minister (who was on a visit to Germany for the inauguration of Hannover Fair) and German Chancellor made a joint statement which also included in-principle decision for extension and expansion of IGSTC. This was formalised (October 2015) with signing of the Joint Declaration by both the Governments with enhanced annual commitment of 4 million euro by each side.

The report presented here is a testimony of IGSTC and its journey through its initial period.

Shall appreciate if you could find time to turn these pages and offer your considered views for us to improve. For IGSTC to fly high.

A. Chakraborty
Director

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A glance through the years.....

During the years 2014-15 and 2015-16, IGSTC continued its support to 19 joint projects in 2+2 mode in emerging areas of (a) sustainable energy (b) advanced manufacturing (c) biomedical devices and biotechnology (d) water and wastewater technologies (e) nanotechnology and (f) embedded system and ICT. There are 6 projects in the pipeline from the Call 2015 in the areas of energy materials, energy

76 (seventy six) project partners from academia and industry from India/Germany.

In conjunction with the 6th GB Meeting of IGSTC, Partners Meet was held in Bernried, Germany on 2-4 February 2015. Subsequently the 7th GB Meeting of IGSTC was held in New Delhi on 16th March 2016.



On 13 April 2015, Hannover Fair (Germany) with India as a partner country was inaugurated by the Indian Prime Minister. IGSTC was represented at the pavilion of the BMBF with one of its projects FLEXIPRIDE as a successful model of Indo-German partnership. It was showcased as a "Solar Tree" with each leaf acting as a solar panel in a flexible form using flexible/printable electronics technology, jointly being developed by IIT Kanpur and Technical University, Chemnitz.

storage and water biosensors/wastewater technologies. The total project investment (both Indian and German) can be estimated as Rs. 100 Cr. or 14 million Euros and is involving

During the period, 4 Indo-German Joint workshops were supported by IGSTC and 2 each were organized in India and Germany connecting more than 150 researchers from both the countries.

By the time, IGSTC has completed its First Phase, the Centre was recognized as a successful model and flagship initiative of Indo-German R&D partnership. Adding a feather to its cap, the tenure of IGSTC was extended to 2022 and beyond (Second Phase) with increase in annual investment from 2 to 4 million Euros by each side for expansion of its scope and horizon through a joint declaration signed between Govt. of India (DST) and Govt. of Germany (BMBF) at the ministerial level on 5 October 2015 in the presence of Hon'ble Prime



Minister of India and the visiting German Chancellor Dr. Angela Merkel.



sanitation, water and communication - safety - security. It is expected that approximately 80 participants will attend the workshop from India and Germany from both academia and industry.

In conjunction with the 7th Governing Board Meeting, IGSTC organised Project Partners Meeting on 15 March 2016 in New Delhi. Principal Investigators representing all IGSTC supported projects participated in the programme. There were presentations from selected projects and all the projects were exhibited as posters in the evening session. Hon'ble Minister of State for Science & Technology, Dr Harsh Vardhan inaugurated the poster session.

IGSTC continued shouldering the responsibility of implementation of the DST-Max Planck Programme on behalf of DST. This Programme has provided an excellent opportunity to the Indian young scientists to partner with the global leaders at the Max Planck Institutes in Germany through a networked model of cooperation. IGSTC has been administering 15 Partner Groups at newly established IISERs, IITs and Central Universities. As some of them already completed their project term, currently IGSTC is handling only 10 Partner groups. There are 19 ongoing Max Planck-India Visiting Fellowships (Mobility Grants) granted to young researchers from various universities / research institutes.

In a yet another endeavor to promote Indo-German Research partnership, IGSTC is organizing a Symposium on "Smart Cities: Challenges and Opportunities" during 27-29 April 2016 in Berlin, Germany in association with FICCI (India), Nexus Institute (Germany) and PTV AG (Germany). The symposium will be focusing on governance and integrative planning approaches. There will be presentations from eminent experts in various topics and also interactive part - working sessions at five "thematic roundtables": energy and buildings, mobility and management, waste management and

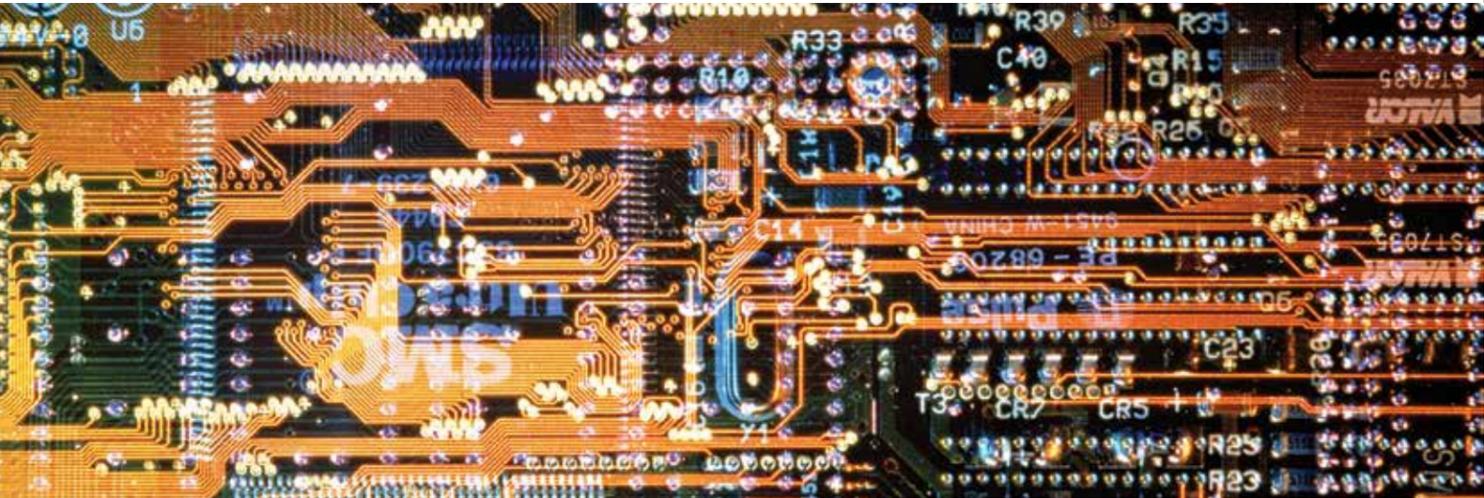
The detailed report on various activities are presented in the following pages.





Programme Activities
(2+2 Projects)

Microfluidic based detection of microbial communities and antibiotic responses in the management of diabetic foot ulcers



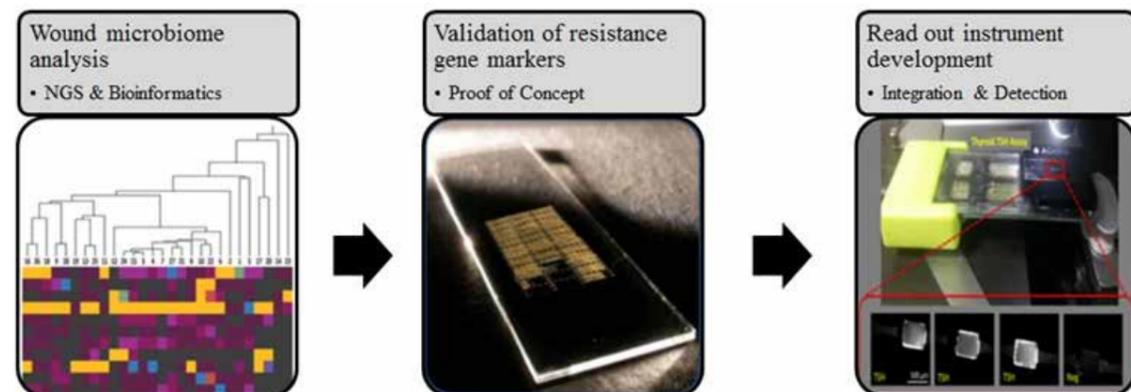
MIDARDI

The Project

Europe and India face an epidemic of obesity and Type 2 diabetes (T2D). Development of T2D strongly correlate and very often predisposes to increased risk of many disabling chronic diseases including Lower Extremity Amputations (LEA) such as foot infections. Bacterial communities in such foot infections show diverse morphological and physiological characteristics and their bioburden in diabetic foot ulcers (DFU) show a distinct pattern of antibiotic resistance which significantly delays wound healing. Though infected ulcers require proper antibiotic therapy, rapid and accurate detection of polymicrobial communities in wound environment is critical in proper wound management. In this polymicrobial setting, the project aims at developing a microfluidics-based lab-on-a-chip for rapid and accurate detection of different types of bacteria, their virulence/fitness factors and antibiotic resistant genes that may contribute to dominance of certain

types in DFU settings. The detection module would aid clinicians in decision-making process to improve specific outcomes that would concomitantly improve wound healing per se in DFU scenario.

- ❖ Assay development for species identification and antibiotic resistance testing based on gene and mutation detection
- ❖ Fully-integrated, disposable Lab-on-a-Chip System to perform DNA sequence detection assays
- ❖ Readout unit dedicated to local environment to demonstrate species and drug resistance testing of pathogenic bacteria
- ❖ Proof-of-concept of mutation detection for translation



Project Investigators Partnering Institutions



K Satyamoorthy
Manipal University
Manipal



Frank Bier
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leipzig



Thomas Geßner
Fraunhofer-ENAS
Chemnitz



Dhananjaya Dendukuri
Achira Labs Pvt. Ltd
Bangalore



Joerg Nestler
BiFlow Systems GmbH
Chemnitz

Progress Achieved

Different use case scenarios were evaluated and technical requirements and specifications were derived both from a user and a market perspective. Foot ulcer wound samples were collected from more than 100 patients both diabetic and non diabetic individuals. Based on the wound and severity, each sample was assigned a Wagner grade. A total of 201 strains have been isolated and the dominant microbes were identified. Of these, 121 isolates were processed for antibiotic sensitivity. Culture independent analysis was carried out for wound microbiomes by sequencing the 16S rDNA gene using the ION PGM platform. After quality filtering, we obtained 9 million reads with an average of 237,000 reads per library. A total of 237 genera were classified and of these, 11 species had a relative abundance of >0.01% in more than half of the samples. The dominant phyla across all grades were Proteobacteria and Firmicutes, consistent with the culture results.

Relevant genes for species identification and resistance detection were defined. An identification of Methicillin Resistant Staphylococcus aureus (MRSA) was established as most relevant. In order to identify bacterial species and further differentiate between Staphylococcus species a DNA microarray was developed. The microarray consists of specific probes for species identification as well as probes for relevant antibiotic resistance detection. To distinguish S. aureus from other Staphylococcus species, such as S. haemolyticus and S. epidermidis, the identification of single-nucleotide-polymorphisms (SNPs) was necessary, and successfully achieved, resulting in an array containing 10 non-SNP and 6 SNP probes.

On the instrumentation and hardware aspect of the Lab-on-a-Chip, user and technical requirements for the proposed product have been identified. A successful proof-of-concept for a technological merge between BiFlow's cartridge technology and Achira's sensing technology has been demonstrated. A Thyroid Stimulating Hormone (TSH) assay from Achira's Acix platform was run seamlessly on a BiFlowflex.flow cartridge. Control electronics has been developed being able to both control all the integrated heating and pumping steps required for both the species and drug resistance assay. A two-wavelength band detection system with a high dynamic range, low noise has been conceptualized. A monochromatic working prototype has already been setup.

Publications:

Apoorva J, Ramya V, Varghese VK, Chakrabarty S, Paul B, Nestler J, Harald P, Morschhauser A, Bier F, Dendukuri D Murali TS and Satyamoorthy K. 2016. Modelling the wound microbiome: Microbiological insights based on next generation sequencing. 2016 NextGen Genomics, Biology, Bioinformatics and Technologies Conference, Cochin, India (3-5 October 2016).

Any other relevant points:

Kavitha S, Spoorthi J, Deepika VB, Raviraj A, Ramachandra L, Satyamoorthy K, Murali TS. 2017. Virulence determinants in clinical Staphylococcus aureus from monomicrobial and polymicrobial infections of diabetic foot ulcers. Journal of Medical Microbiology (in press). DOI:10.1099/jmm.0.000370 ●

MIDARDI



Microfluidic based detection of microbial communities and antibiotic responses in the management of Diabetic Foot Ulcers (MIDARDI)

INTRODUCTION

- Chronic and non healing foot ulcers - common complication of diabetes
- A major healthcare burden and decrease the quality of life
- Microbes that colonize wounds play a major role in wound healing
- Current cultural techniques are time-consuming and not thorough
- Leads to indiscriminate antibiotic use increasing antibiotic resistance
- Imminent need for rapid, accurate profiling of microbial virulence

OBJECTIVES

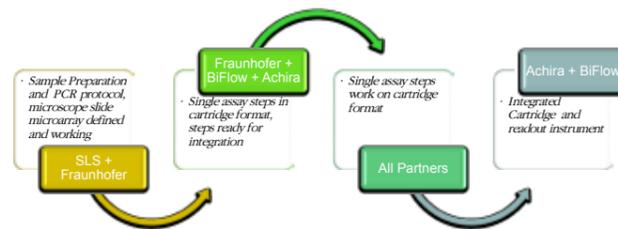
- Assay development for species identification and antibiotic resistance testing based on gene and mutation detection
- Fully-integrated, disposable Lab-on-a-Chip System to perform DNA sequence detection assays
- Proof-of-concept of mutation detection for translation
- Readout unit dedicated to local environment to demonstrate species and drug resistance testing of pathogenic bacteria

IMPROVED DIAGNOSTICS - SCENARIO

MIDARDI

High prevalence and debilitating
Current methods - Time consuming
Point-of-care needed in Primary Health Care
Accurate and Rapid - PCR based testing
Synergy of partners - DNA Diagnostic
Can be carried forward to other bacterial infections

MAJOR MILESTONES



CORE COMPETENCEIES AND SPECIFIC ROLE OF PARTNERS

<p>SLS MANIPAL UNIVERSITY</p> <p>Clinical and molecular diagnostics of foot ulcers.</p> <p>CONTRIBUTION: Clinical, molecular and biochemistry of foot ulcers. Molecular diagnostics and sample preparation based on magnetic particles.</p>	<p>ACHIRA LABS Pvt. Ltd</p> <p>Microfabrication, assay development and instrument development.</p> <p>CONTRIBUTION: Instrumentation and informatics. Large scale production of polymer parts. Testing and validation.</p>	<p>FRAUNHOFER ENAS ZUR ANGEWANDTEN FORSCHUNG</p> <p>ivD platform cartridge and drug resistance testing.</p> <p>CONTRIBUTION: Instrumentation. Assay and biosensor development. Assay miniaturization and integration. Sample preparation based on silica membrane.</p>	<p>BIFLOW SYSTEMS GmbH</p> <p>Assembly line for microfluidic cartridge and quality control.</p> <p>CONTRIBUTION: • Cartridges and evaluation kits for quick assay integration in a real lab on chip environment. • Assembly technologies for microfluidic cartridges. • Microfluidic cartridge development.</p>
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WORK DISTRIBUTION

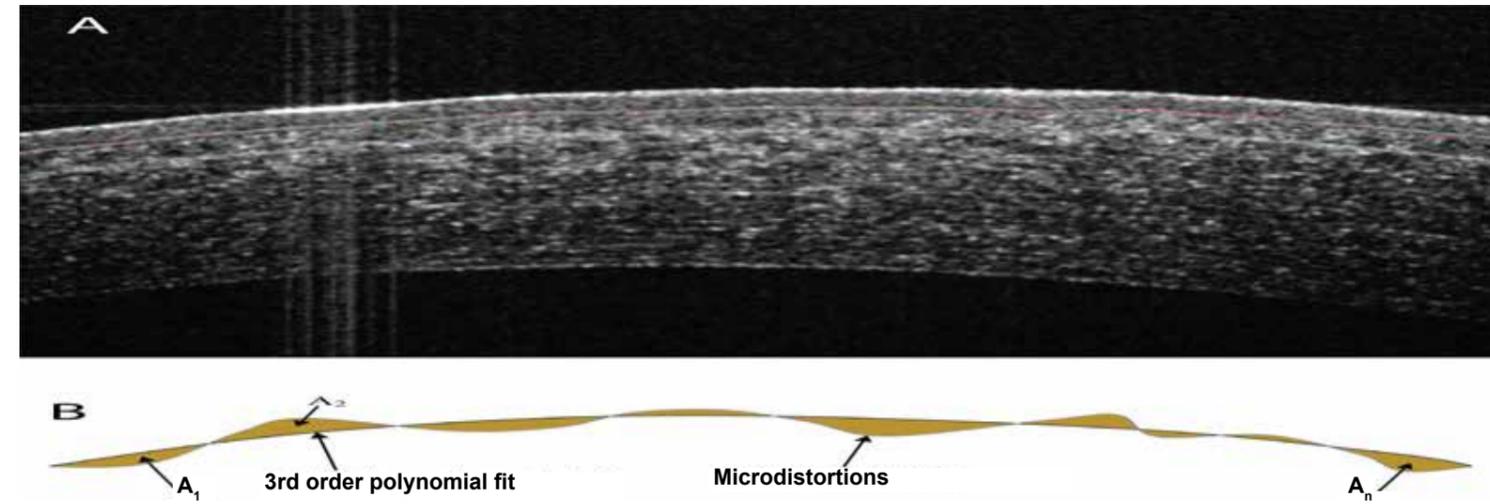
	MANIPAL UNIVERSITY	ACHIRA	Fraunhofer	bi.FLOW
Readout & Control Unit				(1)
Lab-on-Chip Hardware				
Lab-on-Chip Ware				
BioChemistry				
Fabrication				
Testing				
Dissemination				
Exploitation				

EXPECTED OUTCOMES

Application and Europe-Indian Use-Case	Readout & Control Unit • Portable and robust
Biochemistry • Identification and design of DNA signatures for Drug resistances • Assay simplification and miniaturization (for integration)	Lab-on-a-chip • Sample preparation • DNA amplification (multiplex) • Reagent & Storage stability

MIDARDI

Next-generation dynamic scheinpflug imaging and biomechanical analytics for in vivo quantification of corneal viscoelasticity



The Project

- ❖ Development of faster imaging sensor and location-specific measurement of corneal biomechanics using a non-contact air-puff technique
- ❖ Development of software package for real time parallel simulation using inverse finite element technique to estimate non-linear fiber dependent viscoelastic properties of the corneal tissue from deformation measurements of the cornea
- ❖ Combine the tools [aims (1) and (2)] into a clinical prototype that will be assessed in groups of patients with normal eyes (pre/post refractive surgery and ocular hypertension) and degenerative eye disease, namely keratoconus, and assess its sensitivity to treatments (collagen crosslinking).

Expected Outcome :

- ❖ First device with high definition imaging and location

specific quantification of corneal biomechanical response

- ❖ First clinical ocular device to use inverse finite element and continuum soft tissue mechanics
- ❖ First ocular device to quantify non-linear biomechanical properties of ocular tissues
- ❖ First ocular device to enable customization of treatments based on corneal biomechanics

Progress Achieved

The following are significant achievements made so far:

- ❖ First prototype of location specific biomechanical measurement of instrument built and undergoing design improvement. Preliminary testing on living human eyes performed to evaluate safety.
- ❖ Inverse finite element model (FEM) for LASIK and SMILE constructed. A prospective study on contra-

SBAC



Project Investigators Partnering Institutions



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Narayana Nethralaya
Bangalore



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OCULUS Optikgeräte GmbH
Wetzlar



Everette J Remington Nelson
VIT University
Vellore



Shyam Vasudevrao
Forus Health
Bangalore



Eberhard Spoerl
University Carl Gustav Carus
Dresden

lateral treatment was completed and data analyses are ongoing. The objective of this study was to develop the inverse finite element structure for future studies with new version of the biomechanical testing of the device. Biomechanical measurements were performed with the 1st generation of the instrument. A publication on some of the study results has also come out in Translational vision science and technology (doi:10.1167/tvst.5.5.12).

❖ State of the art image algorithms have been developed for 3-D reconstruction of topography of corneal layers from high resolution Optical coherence tomography (DRI Triton, Topcon Inc., Japan) device funded by SIBAC. This will be used for future FEM simulations.

Publications:

i. Shroff R, Francis M, Pahuja N, Veeboy L, Shetty R, Sinha Roy A. Quantitative Evaluation of Microdistortions in

Bowman's Layer and Corneal Deformation after Small Incision Lenticule Extraction. *Transl Vis Sci Technol.* 2016; 5(5): 12.

ii. Matalia H, Francis M, Gangil T, Chandapura RS, Kurian M, Shetty R, Nelson EJR, Sinha Roy A. Non-contact quantification of topography of anterior corneal surface and Bowman's layer with high speed OCT. Under final review in *Journal of Refractive Surgery*, November 2016.

iii. Francis M, Pahuja N, Shroff R, Gowda R, Matalia H, Shetty R, Nelson EJR, Sinha Roy. Waveform analyses of deformation amplitude and corneal deformation in normal, suspect and keratoconus eyes. Under final review in *Journal of Cataract and Refractive Surgery*, November 2016. ●



Next-generation dynamic Scheimpflug imaging and biomechanical analytics for in vivo quantification of corneal viscoelasticity

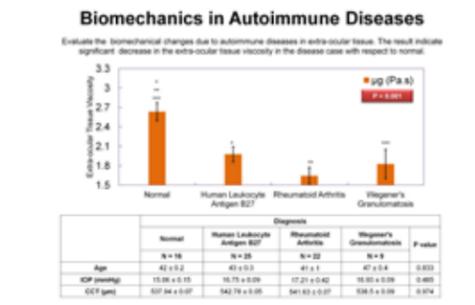
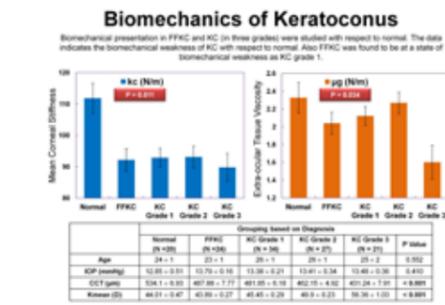
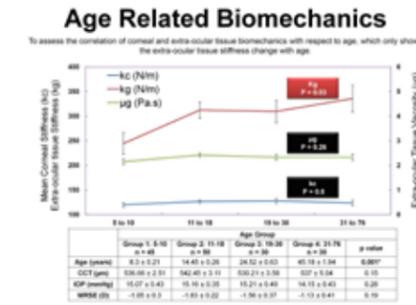
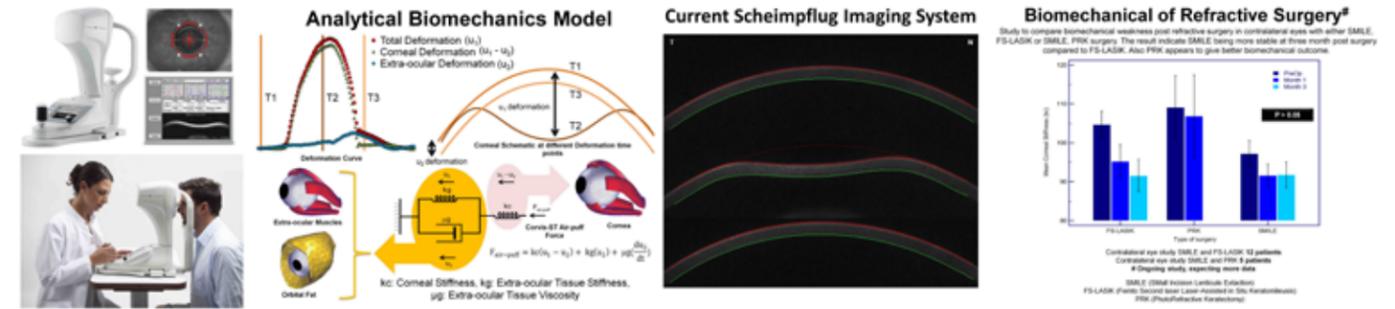


Dr. Abhijit Sinha Roy¹, Dr. Everette Jacob Remington Nelson², Mathew Francis³

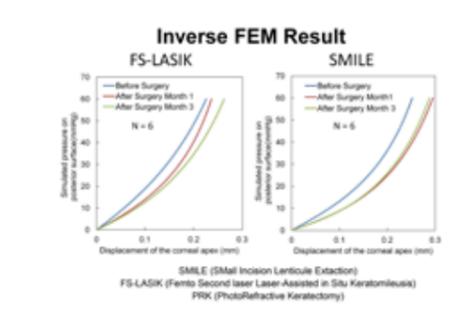
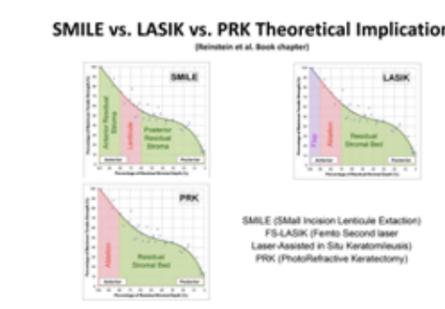
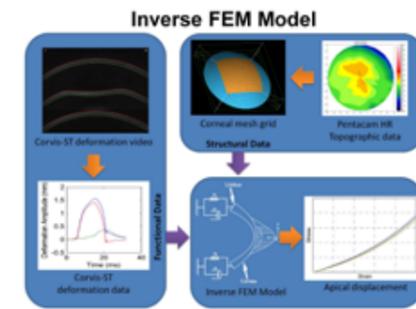
Universitätsklinikum Carl Gustav Carus

¹Chief Scientist, Imaging, Biomechanics and Mathematical Modeling Solutions Lab, Narayana Nethralaya Foundation; ²Associate Professor, School of Bio Sciences and Technology, VIT University; ³Research Engineer, Imaging Biomechanics and Mathematical Modeling Solutions Lab

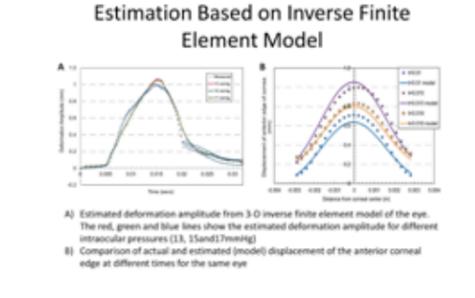
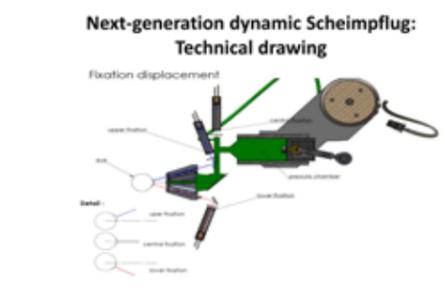
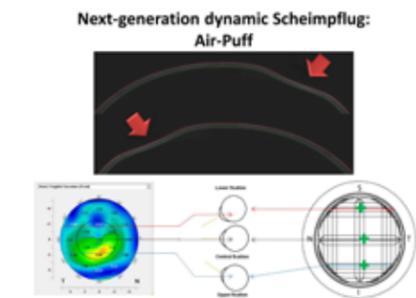
Analytical Model



Inverse Finite Element Model



Next-generation dynamic Scheimpflug imaging and biomechanics



Re-engineering high-end audiometric devices for robust and affordable audiological testing



Source : Shutterstock

SOUND4ALL

The Project

- Hearing impairment is one of the most common forms of disability and is widespread in countries like India. With regular screening, hearing impairment may be detected early and treated. Whilescreening of newborns for hearing loss is slowly gaining momentum in India, it needs to be more widespread. However, monitoring children and adults regularly is almost non-prevalent. Currently available audiometric screening equipment are too expensive and require trained specialists for administering tests. The problem of deafness is rampant and difficult to detect, but is mostly curable if detected early. This project aims to completely re-engineer such a screening device in order to (i) significantly bring down its cost, and (ii) enable it to be used by laypersons in the same manner that we use blood pressure monitors or thermometers.
- To reduce the cost of screening devices, a completely different hardware and software architecture need to be used, without sacrificing the quality. Developing such architectures and evaluating them are the main scientific goals of this project. In particular, two main techniques proposed: (i) offload the involved signal processing algorithms onto a mobile phone, and (ii)

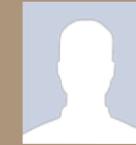
instead of using expensive and specialized probes, use commercially available off-the-shelf components. This will introduce significant measurement distortions, which will be corrected using suitable signal processing algorithms. Since the usage and penetration of mobile phones even in rural areas in India is relatively high, designs based on such solutions will bring down the manufacturing cost. This project aims

- to design new low-cost versions of such equipment, which at the same time be easily usable by laymen; three different classes of devices expected to design are
 - with a cost of < ₹100 (Rs. 8,000), schools and factories use;
 - with a cost of < ₹10 (Rs. 800), personal use;
 - with a cost of ≈ ₹1-2 (Rs. 80-160) to be donated or sponsored by aid/governmental organizations for individual use, particularly in rural areas.
- to develop an oto-acoustic emission device that will be robust, reliable and most importantly affordable for community based and individual hearing screening.

Project Investigators Partnering Institutions



Dinesh Kalyanasundaram
IIT Delhi



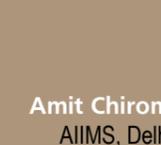
Suyash Ojha
Elkon India Pvt. Ltd.



Samarjit Chakraborty
TU Munich



Kapil Sikka
AIIMS, Delhi



Amit Chirrom
AIIMS, Delhi



Thomas Rosner
PATH Medical GmbH
Germering

Progress Achieved

- AIIMS Team has worked in evaluating the external canal volumes in 600 subjects of all ages, sex and ethnicity and data shared with other investigators.
- The work on probe design and printing is being carried out by IIT Delhi.

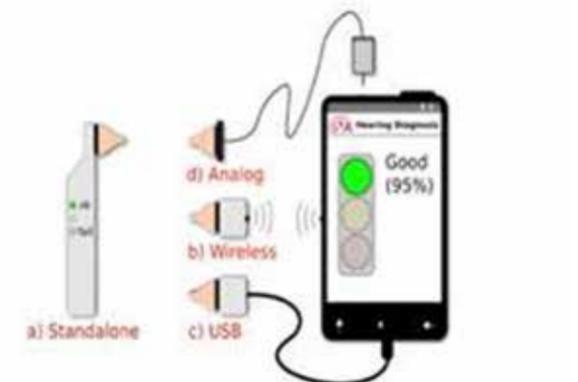
- Sound processing algorithms are being worked out by German partners.

Any other relevant points:

It is planned to host a Sound4All workshop in Delhi during December 2016 by AIIMS and IIT Delhi with an aim to disseminate the knowledge on subject of deafness and inspire young clinicians.



Currently available hearing screening device



Target hearing screening device with 4 different modes

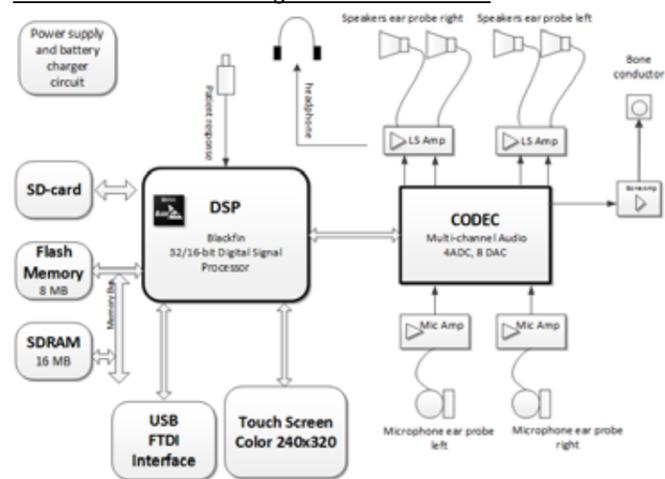
SOUND4ALL



Motivation

- Hearing impairment is one of the most common forms of disability and is widespread in countries like India.
- Currently available audiometric screening equipments are too expensive for widespread use in India and require trained specialists for administering tests using them.
- Goal of this project is to design new low-cost versions of such equipment, which at the same time can be used by laypersons.

Architecture of an existing audiometric device



Proposed solution/ methodology

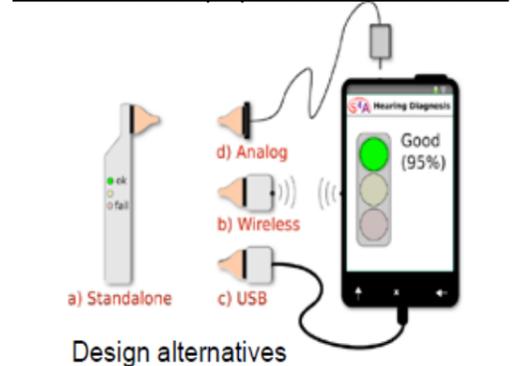
Re-engineer an audiometric screening device to:

- (i) Significantly bring down its cost.
- (ii) Enable it to be used by laypersons.
- This in turn will help with the detection of the onset of hearing impairment and the affected patients may be referred for treatment early on, thereby significantly improving their chances of recovery or to prevent further deterioration.
- Newly designed devices will need to use a completely different hardware and software architecture, without sacrificing the quality of the screening.
- Developing such architectures and evaluating them are the main scientific goals of this project.

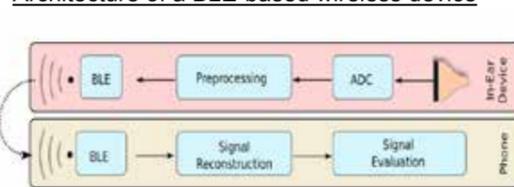
Objective assessment of hearing using otoacoustic emissions (OAE):

- Transiently evoked OAEs (TEOAE) elicited by clicks or tone bursts
- Distortion product OAEs (DPOAE) to obtain frequency specific information

Architecture of an proposed audiometric device



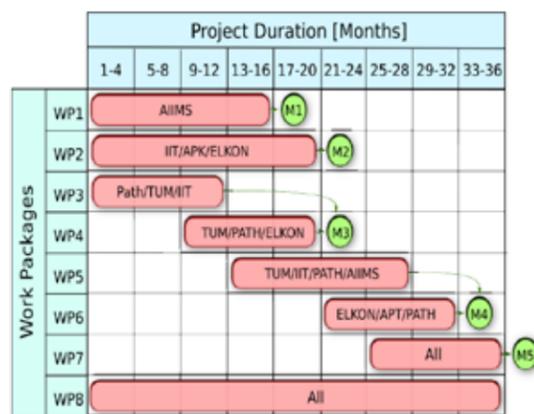
Architecture of a BLE-based wireless device



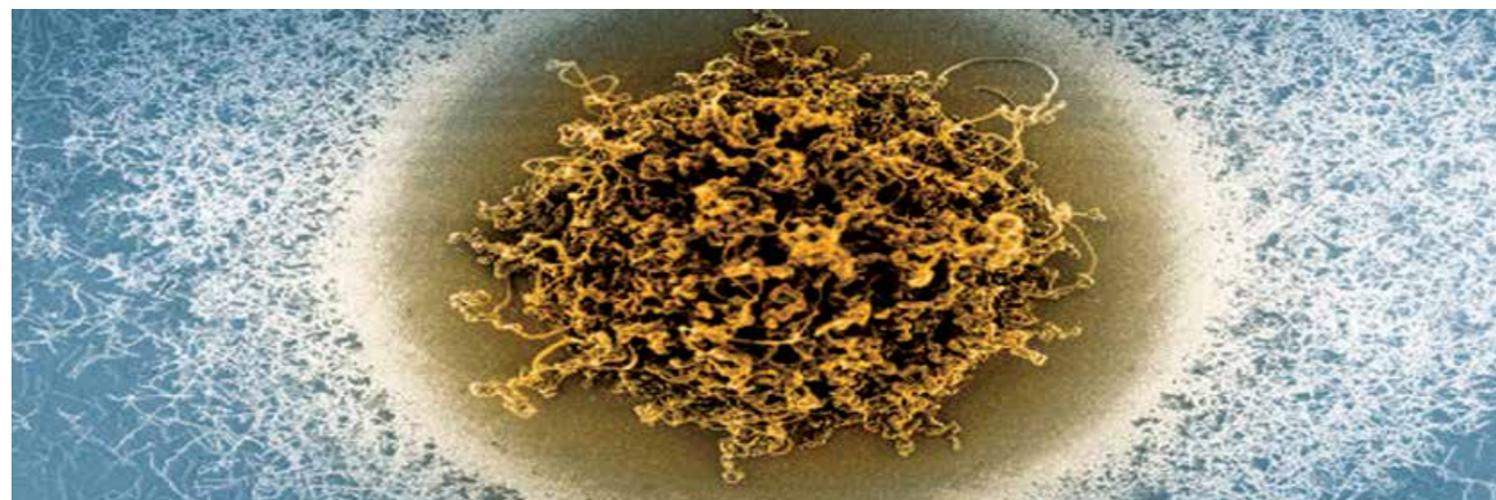
- Investigate the design of 3 different classes of devices:
- with a cost of < €100 (Rs. 8,000), schools and factories.
 - with a cost of < €10 (Rs. 800), personal.
 - with a cost of ≈ €1-2 (Rs. 80-160) to be donated or sponsored by aid/governmental organizations for individual use, particularly in rural areas.

Design Principle/ methodology

- Reduce the number of parts that are needed by incorporating multiple functions into single parts.
- Eliminate moving parts.
- Modularize multiple parts into single sub-assemblies.
- Use of standard off-the shelf components.
- Use of snap fits and elimination of fasteners
- Offload signal processing and GUI onto a mobile phone



On chemoenzymatic synthesis and development of biodegradable structurally persistent core-shell nano-architectures for drug delivery application



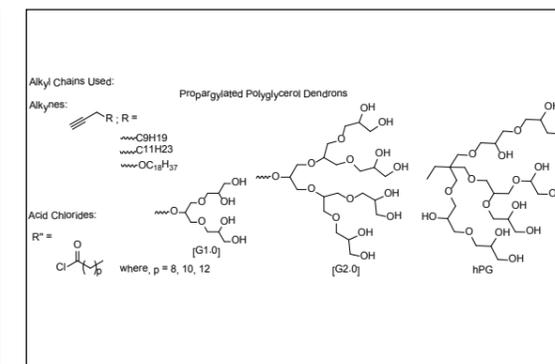
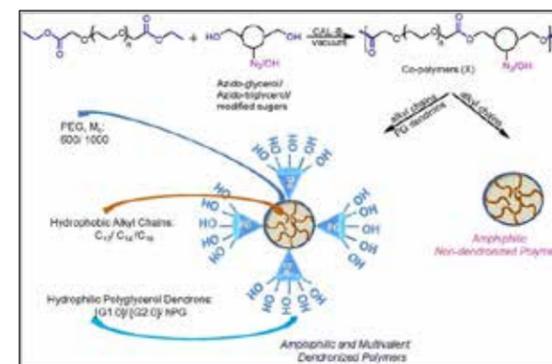
The Project

Despite incredible improvements in health in recent decades, there are still a number of challenges and unmet needs for curing or treating a myriad of diseases. This is attributed to insufficient drug doses, actually reaching the target site due to their partial degradation, and adverse side effects. To reduce doses required and the incidence of systemic complications, and to ensure appropriate drug dosing directly at the target site, drugs can be directly and continuously delivered to the tissue of interest by using delivery systems. Polymeric micelles have been used as a potential carrier for a wide variety of drugs, due to their solubilization, low toxicity, long circulation, targeting and nano-size. The team is working to design and develop novel nanomaterials based upon a combination of linear and dendritic architectures and to study the entrapment of the drug molecules in the nanoparticles and their biological response. Expected deliverables are

- To design and develop novel environmentally benign

biocatalytic routes to synthesize nanomaterials based upon amphiphilic copolymers

- To study the entrapment mechanisms of the drug molecules in the nanoparticles and their release inside the cell
- To study the structural properties of nanomaterials using state of art electron microscopy facilities to eventually standardize the method and allow control of the size and distribution of the particles entrapping biomolecules
- To analyze bio-distribution and pharmacokinetics in a mice model system
- To realize efficient delivery of drug and phenotypic expression in a mice model system
- To enhance the aqueous solubility and to study the pharmacokinetics (PK) and the pharmacodynamics (PD) of our 'new chemical entities (NCEs)' and other molecules of interest



Scheme 1: Synthesis of Amphiphilic Dendronized and Non-dendronized Polymers.

NANOTRANS

Project Investigators Partnering Institutions



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Progress Achieved

- ❖ Explored PEG (Mn: 600/ 1000 diethyl ester) and azido glycerol/ triglycerol/ modified sugar based dendronized/ non-dendronized polymers grafted with hydrophobic chains of varying lengths (C12/ C14/ C18) and hydrophilic polyglycerol based dendrons for their transport potential using Pyrene, Nile red, ICG, Dexamethasone, Curcumin and also studied for their cyto-toxicity profile.
- ❖ The dendronized polymers grafted with longer hydrophobic chains (C18) and [G2.0] generation regular and hyperbranched polyglyceroldendrons have shown superior encapsulation for Nile red and also found to be have better biocompatibility even up to the concentration of 500 µg/mL till 72 hr.
- ❖ The polyglycerol based dendrons were found to increase the biocompatibility of the polymers as it was found in the following order: Non-dendronized < [G1.0] dendronized < [G2.0] dendronized.

- ❖ The dendronized polymeric systems were observed to exhibit superior transport systems as compared to the respective low molecular weight amphiphile as shown by the cellular fluorescence microscopy and FACS measurements.
- ❖ The degree of polymerization (DOP) was increased from 9 to 20 (approx) for base co-polymer for the modified PEG diesters and azido glycerol as compared to the unmodified ones.

Publications:

- ❖ S. Gupta, R. Tyagi, V. S. Parmar, S. K. Sharma and R. Haag. *Polymer* 2012, 53, 3053-3078.
- ❖ S. Gupta, B. Schade, S. Kumar, C. Böttcher, S. K. Sharma, and R. Haag. *Small* 2013, 9(6), 894-904.
- ❖ M. Kumari, A. K. Singh, S. Kumar, K. Achazi, S. Gupta, R. Haag, S. K. Sharma. *Polymer Adv. Tech.* 2014, 25, 1208-1215.
- ❖ M. Kumari, S. Gupta, K. Achazi, R. Haag, S. K. Sharma. *Macromol. Rapid Commun.* 2015, 36, 254-261.



Chemoenzymatic Synthesis and Development of Biodegradable, Structurally Persistent Core-shell Nano-architectures for Drug Delivery Applications

(NANOTRANS)

Date of Start: 1st April 2012
Date of Completion: 31st December 2015

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Summary

➤ Despite incredible improvements in health in recent decades, there are still a number of challenges and unmet needs for curing or treating a myriad of diseases. This is attributed to insufficient drug doses, actually reaching the target site due to partial degradation, and also cause various undesired adverse side effects.

➤ Nanocarriers are aimed at delivering bioactive substances to target sites and eliciting their biological functions in a controlled manner, thereby achieving enhanced therapeutic efficacy with minimal side effects.

➤ We aim to design and develop novel nanomaterials based on a combination of linear and dendritic architectures and to study the entrapment of the drug molecules in the nanoparticles and their biological response.

Objectives

➤ To design and develop novel environmentally benign biocatalytic routes to synthesize nanomaterials based upon amphiphilic copolymers.

➤ To study the entrapment mechanisms of drug molecules in the nanoparticles and their release inside the cell.

➤ To study the structural properties of nanomaterials using electron microscopy facilities to eventually standardize the method and allow control of the size and distribution of particles entrapping biomolecules.

➤ To analyze bio-distribution and pharmacokinetics in a mice model system.

➤ To enhance the aqueous solubility and to study the pharmacokinetics (PK) and pharmacodynamics (PD) of our 'new chemical entities (NCEs)' and other molecules of interest.

Objectives Met

➤ Developed a biocatalytic method for the synthesis of amphiphilic dendronized and non-dendronized polymers.

➤ Comparative study of supramolecular organization behavior and cyto-toxicity profile of synthesized polymers.

➤ Compared the cellular uptake potential of dendronized polymers with respective low molecular weight amphiphile.

➤ Synthesized photoresponsive polymeric amphiphiles and studied their photoreponsive behavior using Nile red as a model guest.

➤ Synthesized triglycerol and PEG based, hyperbranched polyesters (HBPEs) and hyperbranched polyester - amphiphilic branched shell (HBPE-ABS) nanocarriers.

➤ Studied the transport potential of pyrene, Nile red, ICG, and Cy3 as model dyes and Dexamethasone, Curcumin and Finasteride as model drugs.

➤ Enzyme induced release of pyrene was studied from hyperbranched nanocarriers under physiological conditions.

Salient Research Achievements

Synthesis of Amphiphilic Dendritic and Polymeric Architectures

Cryo-TEM image

PEG-1000 and azido-glycerol based non-dendronized polymer (50% C₁₈ hydrophobic alkyl chain)

Wt% Encapsulation of Nile red

PEG-1000 and azido glycerol based amphiphilic copolymers having varying ratio of C₁₈ alkyl chain as hydrophobic fraction and [G1.0]/ [G2.0]/ hPG dendrons as hydrophilic fraction

Schematic representation of Core-shell HBPEs (Hyperbranched Polyesters)

Cellular Internalization of Cy3

Photoresponsive Polymeric Amphiphiles

Schematic representation of HBPEs-ABS (Hyperbranched Polyesters-Amphiphilic Branched Shell) Nanocarriers

Papers Presented and Published in Conferences

➤ 17 Invited talks by Prof. Sunil K. Sharma (Indian PI)

➤ 3 Oral presentations by Ph.D. students

➤ 10 Posters by Ph.D. students

Manpower Trained

➤ 8 Ph.D. Students

➤ 1 project assistant

Visits

India to Berlin	Berlin to India
Doctoral Visits - 9	Doctoral Visits - 9
Ph.D. Students - 6	Ph.D. Students - 3

Publications

2016, 7, 887
IF: 5.52

2015, 36, 254
IF: 4.60

2015, 69, 416 & 2016 (Communicated)
IF: 3.24

2012, 53, 3053
IF: 3.56

2013, 9, 894
IF: 8.37

2014, 25, 1208
IF: 1.78

2015, 5, 48301
IF: 3.84

Major equipment procured in the project

Cary 300 UV-Visible Spectrophotometer

Cary Eclipse Fluorescence Spectrophotometer

Rotavapor

Malvern Zetasizer

Activities Involved

❖ Two Indo-German workshops were organized in the Department of Chemistry, University of Delhi in January 2013 and March 2015.

Supported Publications

The research facilities generated in the project were utilized to pursue research in some other projects too, and the support from IGSTC has been duly acknowledged in the 3 such publications.

- ❖ *Med. Chem. Res.* 23, 4907-4914 (2014).
- ❖ *J. Photochem. Photobiol. A: Chemistry*, 280, 39-45 (2015).
- ❖ *J. Het. Chem.* 52, 562-572 (2015).

Project Sponsored by

Indo-German Science & Technology Centre

Development, characterization and validation of nanoparticles for the adsorption of uremic toxins in renal failure patients



Source : Shutterstock

Project Investigators Partnering Institutions



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Hyderabad



J Jankowski
RWTH Aachen University
Aachen



H D Lemke
Excorlab GmbH
Oberburg



Karl Kratz
Helmholtz Zentrum Geesthacht
Berlin

Progress Achieved

- ❖ First PEI particles are characterized regarding their ability to adsorb hydrophobic uremic-toxins.
- ❖ Adsorption of uremic toxins by the PEI particles developed within the NPore project are characterized.
- ❖ Techniques of quantification of adsorbed plasma proteins by the PEI particles are established. Amount of adsorbed plasma proteins are quantified.
- ❖ First quantification of adsorption capacity of the PEI-particles is done.
- ❖ Amount of adsorbed plasma proteins is quantified.
- ❖ MALDI-mass spectrometry is adapted to the necessities of the NPore project.
- ❖ PEI-particles are characterized based on MALDI-mass-spectrometric images.

Publications:

- i. Basu, S.; Heuchel, M.; Weigel, T.; Kratz, K.; Lendlein, A., Integrated process for preparing porous, surface functionalized polyetherimide microparticles. *Polymers for Advanced Technologies* 2015, 26 (12) 1447-1455.
- ii. Kumar, R. K.; Basu, S.; Lemke, H.-D.; Jankowski, J.; Kratz, K.; Lendlein, A.; Tetali, S. D., Effect of extracts of poly(ether imide) microparticles on cytotoxicity, ROS generation and proinflammatory effects on human monocytic (THP-1) cells. *Clinical Hemorheology and Microcirculation* 2015, 61 (4) 657-65.
- iii. Tetali, S. D.; Jankowski, V.; Luetzow, K.; Kratz, K.; Lendlein, A.; Jankowski, J. Adsorption capacity of poly(ether imide) microparticles to uremic toxins; *Clinical Hemorheology and Microcirculation* 2015, 61 (4) 667-80.
- iv. Reddi K. Kumar, Sayantani Basu, Horst-Dieter Lemke, Joachim Jankowski, Karl Kratz, Andreas Lendlein., Sarada D. Tetali. Influence of nanoporous poly (ether imide) particle extracts on

- v. Reddi K. Kumar, Sayantani Basu, Horst-Dieter Lemke, Joachim Jankowski, Karl Kratz, Andreas Lendlein, Sarada D. Tetali Effect of extracts of poly(ether imide) microparticles on cytotoxicity, ROS generation and proinflammatory effects on human monocytic (THP-1) cells; *Clinical Hemorheology and Microcirculation* 61 (2015) 667-680
- vi. Sarada D. Tetali, Vera Jankowski, Karola Luetzow, Karl Kratz, Andreas Lendlein, Joachim Jankowski; Adsorption capacity of poly(ether imide) microparticles to uremic toxins; *Clinical Hemorheology and Microcirculation* 61 (2015) 657-665
- vii. "Surface modification of porous polyetherimide microparticles prepared via a spraying/coagulation process", Basu, S.; Kratz, K.; Lendlein, A.; Annual Conference Advanced Functional Polymers in Medicine (AFPM) 2015, March 23-25., Galway, Ireland.
- viii. "Strategy for the hemocompatibility testing of polymer-based Microparticles", Braune, S.; Kratz, K.; Lendlein, A.; Jung, F. (oral presentation 7.2); 34. Jahrestagung der Deutsche Gesellschaft für Klinische Mikrozirkulation und Hämorheologie.V., November 27/28, 2015, Regensburg, Germany.
- ix. "Adsorption capacity of poly(etherimide) microparticles to uremic toxins", Tetali, S.D.; Jankowski, V.; F. Brettschneider, F.; Luetzow, K.; Kratz, K.; Lendlein, A.; Jankowski, J. (poster presentation P12); 34. Jahrestagung der Deutsche Gesellschaft für Klinische Mikrozirkulation und Hämorheologie.V., November 27/28, 2015, Regensburg, Germany.
- x. "Examining the influence of poly(etherimide) microparticles on cytotoxicity and proinflammatory effects on human monocytic cells as well as apoptosis of human aortic endothelial cells", Kumar, R. K.; Basu, S.; Kratz, K.; Lendlein, A.; Tetali, S.D. (poster presentation P12); 34. Jahrestagung der Deutsche Gesellschaft für Klinische Mikrozirkulation und Hämorheologie.V., November 27/28, 2015, Regensburg, Germany.

The Project

- ❖ The goal of the NPore project was the development and modification, characterization and validation of absorbing material to remove the uremic toxins (UTs) from serum of renal failure patients.
- ❖ The project was divided into five work packages (WPs) out of which the WP2 was prepared by Charite/IMCAR-Institute (University Hospital RWTH Aachen (Germany)). The objective of the WP2 was to assess and quantify the protein adsorption onto PEI-based microparticles, determination of the adsorption capacity of PEI-based microparticles by application of modern techniques such as reverse-phase chromatography (RP-HPLC) and matrix-assisted-laser-desorption-ionization-mass-spectrometry (MALDI-MS).
- ❖ Non cytotoxic and hemocompatible nanoporous spherical microparticles based on purified poly(ether imide) (PEI) and/or hydrophylically functionalized PEI surface were successfully engineered by the HZG partner of the NPore project. The porous microparticles exhibited the requested characteristics to remove the UTs.
- ❖ Initially, the adsorption capacity of non- and modified PEI microparticles for adsorption of UTs such as phenylacetic acid (PAA), indoxyl sulfate (IDS) and p-cresyl sulfate (p-CS) was assessed in human blood and plasma, respectively. The RP-HPLC results evidenced a significant binding affinity of pCRS and IDS to the PEI microparticles than that of PAA. The adsorption capacity of PEI microparticles was further investigated in the recirculation experiments.
- ❖ The experimental setup and analytical conditions for adsorption capacity assessment of PEI microparticles against UTs were established. Sampling was performed at two assembling points such as prior (sampling spot 1) and after solution passed through the PEI-filled cartridge

- (sampling spot 2). RP-HPLC data showed significant adsorbed amounts of IDS and pCRS in the sampling spot 2 compared to PAA sampling spots 1 and 2, respectively. Although previously designed PEI microparticles exhibited significant adsorption characteristics for the UTs, it has been demonstrated that they did not show significant bio- and hemocompatibility.
- ❖ Alternatively, new modified PEI-based particles with hemocompatibility properties were fabricated and their bulk morphology was assessed by means of cryo-SEM. The morphometric parameters such as full width at the height maximum (FWHM) of PEI-based microparticle size histograms revealed a higher distribution width for ET-modified PEI and a lower one for non-modified PEI microparticles.
- ❖ The quantification studies of adsorption capacity of newly designed PEI-based microparticles to IDS revealed that the smaller the FWHM the larger the binding affinity. Hence, larger amounts of IDS of 4.6 mg/g ± 0.08, 4.8 mg/g ± 0.02, and 2.5 mg/g ± 0.01, respectively were partially adsorbed to PEI-PVP-I, PEI-PVP-II, and PEI type microparticles, whereas PEI-ET, PEI-DET, and PEI-PEG showed a lower adsorption capacity to IDS: 0.50 mg/g ± 0.02, 2.55 mg/g ± 0.04, and 2.5 mg/g ± 0.01, respectively.
- ❖ Within the experimental design of the NPore project, it has been evidenced that PEI-PVP-II microparticles have high dewetting contact angle (47° ± 8), thus ensures a predominant antifouling character. Next to it, PEI-PVP-II microparticles present suitable hemocompatibility and cytotoxicity as well as physico-chemical characteristics requested for "in-situ" adsorption experiments of UTs. Based on the experimental feedback, PEI-PVP-II microparticles can confidently be considered as a good candidate for further recirculation adsorption experiments.



Development, characterisation and validation of nanoparticles for the adsorption of hydrophobic uremic toxins in renal failure patients (NPORE).

Reddi K. Kumar¹, Vamsy K. Damiseti¹, Sayantani Basu^{2,3}, Marieke R  th⁴, Christoph Sauvant⁴, Horst-Dieter Lemke⁴, Vera Jankowski⁵, Joachim Jankowski^{5,6}, Karl Kratz², Andreas Lendlein^{2,3}, Sarada D. Tetali^{1*}

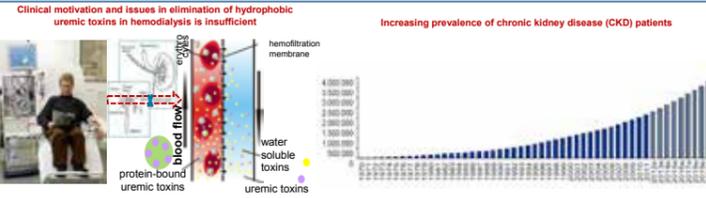


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Background

Chronic kidney disease (CKD), loss of kidney function over time, is a public health problem and its prevalence is estimated to be 8-16% worldwide¹. The burden of CKD is very high in India although the data on patient population is limited². Introduction of **The National Dialysis Program** into 2016 union budget of India is a huge relief to CKD patient families. As current haemodialysis techniques, which are operated under aqueous conditions, are not capable to remove low molecular weight hydrophobic uremic toxins from the blood of chronic renal failure patients³. With respect to the hydrophobic nature and the high level of protein binding of such uremic toxins, hydrophobic adsorbent materials are required i.e. apheresis particles. One candidate material are highly porous microparticles prepared from poly(ether imide) (PEI)⁴. In this work we explored the viability, the monocytic differentiation, the proinflammatory behaviour and the intracellular ROS levels of human monocytic cells as well as the proinflammatory and apoptotic behaviour of human aortic endothelial cells which were treated using PEI microparticles extracts.



Specific aims

Partnership

Synthesis

Poly(ether imide) microparticles

Capacity

Uremic toxin adsorption by PEI particles

Biocompatibility (in vitro) of PEI particles on blood and vascular cells

Methodology

Preparation of PEI particles

Preparation of PEI microparticle (unmodified) extracts for cellular treatments

Modification of PEI particles

Rewetting the dry modified-PEI particles for Cellular treatments

Results-

Effect of unmodified PEI particles on cultured monocytic and endothelial cells⁵

Toxicity of PEI particles on human monocytic (THP-1) and aortic endothelial cells (HAECs)

Effect of modified-PEI particles on cultured monocytic cells

Cytotoxicity test by Trypan blue exclusion method

Effect of unmodified, modified-I and modified-II PEI particles on blood factors

Intracellular ROS detection - Confocal microscopy

Effect of PEI particles on transcripts and protein levels of proinflammatory markers in THP-1 cells : RT-PCR and ELISA

Effect of modified PEI particles on transcripts and protein levels of proinflammatory markers in THP-1 cells : RT-PCR and ELISA

Summary and Future direction

- The obtained results showed that steam sterilized PEI microparticles (unmodified and modified-II) did not exhibit cytotoxic or proinflammatory effects on cultured monocytic (THP-1) and endothelial (HAECs) cells.
- Whereas unmodified and modified-I particles activated blood coagulation factors.
- Modified-II particles did not activate blood coagulation factors.
- Modified-II particles should be examined for their uremic toxin adsorption capacity and their cytotoxic, inflammatory and apoptotic effects on monocytic cells, HAECs and HSMCs and also using animal (in vivo) models.

Monocyte to macrophage differentiation

Effect of PEI particles on transcripts and protein levels of proinflammatory and apoptotic markers in HAECs: RT-PCR

References

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- U. Khanna (2009) Indian J Nephrol. 19(1): 1-4.
- S. Lekawanvijit, AR. Komp, BH. Wang, DJ. Kelly, H. Krum. (2012) Circ. Res. 111: 1470-1483.
- W. Albrecht, K. Lutzow, Th. Weigel, Th. Groth, M. Schossig, A. Lendlein. (2006) Journal of Membrane Science 273: 106-115.
- Kokkiriappi PK, Kamsala RV, Basihyam L, Manthapuram N, Bitta P, Peddada V, Raghavendra AS, Tetali SD. (2013) J. Ethnopharmacol. 146: 456-64

Publications

- Basu S, Huchella M, Weigel T, Kratz K and Lendlein A (2015) Integrated process for preparing porous, surface functionalized polyetherimide microparticles. *Polym Adv Technol* 26: 1447-55
- Tetali SD, Jankowski V, Lutzow K, Kratz K, Lendlein A, Jankowski J (2016) Adsorption capacity of poly(ether imide) microparticles to uremic toxins. *Clin Hemorheol Microcirc* 61(4):657-65
- Kumar RK, Basu S, Lemke HD, Jankowski J, Kratz K, Lendlein A, Tetali SD (2016) Effect of extracts of poly(ether imide) microparticles on cytotoxicity, ROS generation and proinflammatory effects on human monocytic (THP-1) cells. *Clin Hemorheol Microcirc* 61(4):667-80.
- Kumar RK, Basu S, Lemke HD, Jankowski J, Kratz K, Lendlein A, Tetali SD. Influence of nanoporous poly(ether imide) particle extracts on human aortic endothelial cells. (in preparation)

Imparting drought stress-tolerance to crop plants by heterologous transfer of high altitude plant protection mechanisms



The Project

In the upcoming years, crop production will be facing an increased demand by the growing and changing world population on the one hand and strong limitations by increasing abiotic stresses, like drought and temperature changes caused by the global climate change on the other hand. Thus, breeders and plant scientists have to provide crop varieties with higher yield, improved yield stability and stress tolerance traits to maintain and increase a sustainable crop production. In order to enable and maintain growth of plants in the future changing and more extreme environmental conditions, it is required to identify novel mechanisms to improve drought tolerance of crops.

To reach this, in this 2 + 2 project plants were modified to express stress-induced genes from plants growing at extremely high altitudes of India. Such genes have been identified by the Indian partner at IHBT and were transformed in the model plant *Arabidopsis thaliana* (CSIR-IHBT, India) and in crops (Oilseed rape (OSR), Deutsche Saatveredelung AG (DSV AG), Germany and corn, Krishidhan Research Foundation Private Limited, India).

In the end, nine different genes/gene combinations from plants growing in high altitude were transformed in 14 independent *Arabidopsis* lines, 6 genes in crops (OSR). Growth of these genetically modified plants in mild drought stress conditions was analysed with state-of-the-art plant phenotyping technologies at Forschungszentrum Juelich with image analysis methods to quantify a drought tolerance mediated by the transgene. All nine different genes or combinations of

genes were investigated in the model plant *Arabidopsis* for improvement of growth under mild drought stress; an improved drought tolerance could not be detected. Three lines expressing the transgenes in OSR have been characterised for growth under mild drought stress, also not showing significant changes indicating drought tolerance. To characterise the growth in extreme drought stress, novel technologies have been developed to quantify changes in morphology (*Arabidopsis*), or yellowing of the leaves (oilseed rape) in extreme drought stress, as it occurs especially in India.

The three transgenic rapeseed lines were investigated for changes in yellowing during drought stress, but no improvement of drought tolerance by the transgenes was observed. However, physiological and biochemical analyses showed that transgenic *Arabidopsis* overexpressing CsTLP improved drought tolerance.

Transgenic *Arabidopsis* overexpressing a transcription factor RaWRKY exhibited improvement in seed yield. Transgenic *Arabidopsis* co-over-expressing PaSOD and RaAPX showed improved lignification of the vascular tissue that was associated with improvement of stress tolerance. Transcriptome of *Potentilla aetnosa* was deciphered and also using the *Caraganajubata*, we solved a long standing question on the molecular mechanism of high altitude plants which makes them to thrive in cold desert at high altitude. Promoters of several stress responsive genes were cloned from *Rheum australe*.



Acknowledgements

Reddi Kiran Kumar (SRF) and Vamsy K. Damiseti (JRF) are recipients of fellowship from IGSTC funded project (Grant No. IGSTC/NPORE/SDT/2012). Indo-German Science and Technology Centre (Grant No. IGSTC/NPORE/SDT/2012) and German Federal Ministry for Education and Research (BMBF), (Grant No. s 01DQ13006A, 01DQ13006B and 01DQ13006C) are acknowledged for financial support. Funding bodies UGC-SAP, DBT-CREBB and UPE are thanked for providing central facilities required to carry out research work at University of Hyderabad in the Dept. of Plant Sciences and School of Life sciences.



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Krishidhan Research Foundation Pvt. Ltd
Maharashtra



Dieter Stelling
Deutsche Saatveredelung AG
Lippstadt

Progress Achieved

- ❖ Establishment of controlled field comparable stress conditions (FZJ) - A phenotyping protocol for the identification of mild drought tolerant growth has been established. Technologies for the phenotyping of extreme drought stress in Arabidopsis and OSR have been developed.
- ❖ Identification and isolation of stress specific promoters & genes and construction of expression constructs (IHBT, KRFPL) - High altitude plants *Caraganajubata* and *Potentillaatrosanguinea* were sequenced for expressed genes using SOLEXA sequencing; also, a suppression subtracted library was prepared, sequenced and analysed for *Caraganajubata*. (IHBT); -Stress induced genes of high altitude plants were identified (IHBT); -Putative Promoters of stress inducible genes were cloned from *Rheum australe* (IHBT); -Gene expression constructs for the identified stress induced genes from high altitude plants have been cloned into expression vectors for transformation in Arabidopsis and crop plants. KRFPL cloned SOD and Succinyl-CoA-ligase in marker free vector for transformation of maize (IHBT/KRFPL).
- ❖ Development of transgenic plants: Model and crop plants (IHBT, KRFPL, DSV, FZJ) -Six transgenes were transformed in oilseed rape (OSR) (DSV); -Homozygous lines were identified for one transgene (Succinyl-CoA-Ligase) (DSV/FZJ); -A 4th OSR line was genotyped and single insertion lines were identified for future drought stress phenotyping (WRKY) (DSV/FZJ); -Nine genes or combinations in the model plant *Arabidopsis thaliana* were provided for phenotyping (IHBT); -Arabidopsis expressing transgenes (CstLP, RaWKY, PaSOD, PaSOD+RaAPX) were evaluated

for their performance under abiotic stresses (IHBT).

- ❖ Phenotyping impact of high altitude plants genes on stress tolerance (FZJ, DSV, KRFPL) -Three OSR lines were characterized for growth in drought stress conditions (FZJ); -14 independent lines of transgenic Arabidopsis have been phenotyped for growth in mild stress (FZJ); -Phenotyping and quantification of the plants response to extreme stress has been performed to also identify and quantify tolerance against extreme drought, this is still under further development (FZJ); -Yield of transgenic OSR lines was quantified during seed production, deviation from standard yield was re-investigated for one line, but not confirmed in second yield quantification (FZJ/DSV).

Publications:

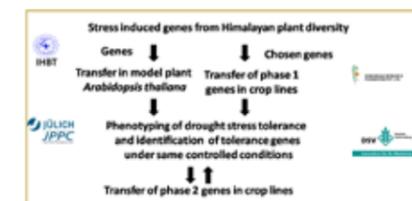
- ❖ Conference contribution (Poster): Jessica Knüfer, Christoph Briese, Marcus Jansen, Silke Kleinen, Alexander Putz, Sanjay Kumar, Dieter Stelling, Ulrich Schurr, Anika Wiese-Klinkenberg "A non-invasive imaging procedure to identify drought-stress tolerant oilseed rape plants expressing genes from high altitude plants" Interdrought IV, 2nd to 6th September 2013 in Crown Perth, Western Australia
- ❖ Conference contribution (Poster): Jessica Knüfer, Christoph Briese, Marcus Jansen, Silke Kleinen, Alexander Putz, Sanjay Kumar, Dieter Stelling, Ulrich Schurr, Anika Wiese-Klinkenberg "Imaging oilseed rape plants expressing genes from high altitude plants under severe drought conditions" 3rd International Plant Phenotyping Symposium 17th to 19th February 2014, Chennai, Indien
- ❖ Presentation of the Project with Deutsche Welle (DW) "Future now - Innovations shaping tomorrow" (2010): <http://futurenow.dw-world.de/english/category/gm-plants/>



Introduction

Crop production is facing an increased demand by the growing and changing world population on the one hand and strong limitations by increasing abiotic stresses, like drought and temperature changes caused by the global climate change on the other hand. To enable and maintain growth of plants in the changing and more extreme environmental conditions, it is required to identify novel genes and mechanisms to improve stress tolerance of crop plants. The present project was carried out to transfer the chosen stress-induced genes isolated from plants growing and surviving in high altitude stress experiencing extreme cold, drought and high light in the model plant *Arabidopsis thaliana* (CSIR-IHBT, Palampur). Transgenic plants were analyzed in the Juelich Plant Phenotyping Centre (Forschungszentrum Juelich, FZJ, Germany) for their growth under controlled and drought stress conditions in a most field-comparable environment. Finally, genes providing a stress tolerance to the model plants were transferred to high quality crop plants by Krishidhan Research Foundation Pvt. Ltd. (KRFPL, India) and Deutsche Saatveredelung AG (DSV, Germany). Transgenic crop plants were further characterized for drought tolerance in Forschungszentrum Juelich.

Project Planning



A typical niche (a) of *Rheum australe* (b) at Rohtang Pass (Western Himalaya, India)



A typical niche (a) of *Potentilla atrosanguinea* (b) at Kunzum Pass (Western Himalaya, India)

A glimpse of Himalayan plant species and their habitat.

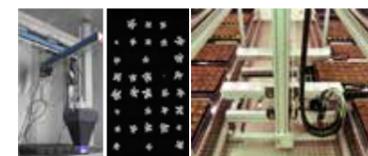
Planned activities by the four partners.

Planned exchange of various components between the partners.

Major Achievements

Established controlled field comparable stress conditions (FZJ)

- Established a phenotyping protocol for the identification of mild drought tolerant growth.
- Developed technologies for the phenotyping of extreme drought stress in Arabidopsis and OSR.



Arabidopsis Phenotyping: GROWSCREEN-Fluoro (left). Middle pictures masks for the quantification of rosette areas and growth, combined with fluorescence imaging to measure photosynthesis parameters. Pictures acquired with Maxi-PAM camera moving in x- and y-direction over 40 pots (left). Right: automated growth chamber with plant carrier system to automatically transfer plant trays to measurement in GROWSCREEN Fluoro.

Identified and isolated stress specific promoters & genes and constructed expression constructs (CSIR-IHBT, KRFPL)

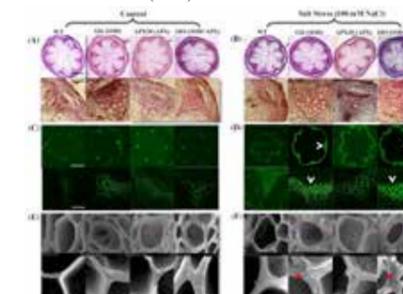
- High altitude plants *Caraganajubata* and *Potentilla atrosanguinea* were sequenced for expressed genes using SOLEXA sequencing.
- Stress induced genes and promoters were identified for generating transgenics (IHBT).
- KRFPL cloned SOD and Succinyl-CoA-ligase in marker free vector for transformation of maize (IHBT/KRFPL).



SCIENTIFIC REPORTS | 3 : 1022 | DOI: 10.1038/srep01022

Developed transgenic plants: Model and crop plants (IHBT, KRFPL, DSV, FZJ)

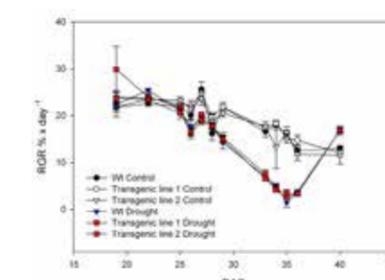
- Six transgenes were transformed in oilseed rape (OSR) (DSV)
- Homozygous lines were identified for one transgene (Succinyl-CoA-Ligase) (DSV/FZJ).
- A 4th OSR line was genotyped and single insertion lines were identified for future drought stress phenotyping (WRKY) (DSV/FZJ).
- Arabidopsis expressing transgenes (CstLP, RaWKY, PaSOD, PaSOD+RaAPX) were evaluated for their performance under abiotic stresses (IHBT).



Overexpression of SOD and APX leads to enhanced lignin deposition in stem of Arabidopsis. a, b Transverse stem sections were stained with safranin-O for lignin. c, d Lignification pattern under control and salt stress. e, f Sections observed under scanning electron microscope.

Phenotyped impact of high altitude plants genes on stress tolerance (FZJ, DSV, KRFPL)

- Three OSR lines were characterized for growth in drought stress conditions (FZJ).
- Fourteen independent lines of transgenic Arabidopsis have been phenotyped for growth in mild stress (FZJ).
- Phenotyping and quantification of the plants response to extreme stress has been performed to also identify and quantify tolerance against extreme drought (FZJ).
- Yield of transgenic OSR lines was quantified during seed production, deviation from standard yield was re-investigated for one line, but not confirmed in second yield quantification (FZJ/DSV)



Drought stress growth response: Relative rosette area growth rates (RGR %/day) in control conditions and during emerging mild drought stress. Effect of a transgene in Arabidopsis, two independent transgenic lines 1 and 2. DAS = days after sowing.

Plant Molecular Biology: DOI 10.1007/s11103-015-0301-6

Partners of the project

CSIR Institute of Himalayan Bioresource Technology (CSIR-IHBT)
Dr. S. Kumar/Dr. P.S. Ahuja
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Deutsche Saatveredelung AG (DSV AG)
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Deutsche Saatveredelung AG
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59557 Lippstadt, Germany

Project Sponsored by



Indo-German Science & Technology Centre

IHBT

Biotechnological approaches to improve chickpea crop productivity for farming community and industry



Source : Project Archives

Project Investigators Partnering Institutions



Rajeev Varshney
ICRISAT, Hyderabad



Gunter Kahl
Goethe Universitat Frankfurtam Main, Frankfurt



Manash Chatterjee
BenchBio private Limited Vapi



Peter Winter
General Manager, GenXPro GmbH, Frankfurt

Progress Achieved

This project explored the resources developed (eg. in a different project, ICRISAT produced >400,000 ESTs from chickpea genotypes using next-generation sequencing (NGS) technologies), with the help of expertise available at University of Frankfurt / GenXPro in Germany and ICRISAT/ BenchBio in India to identify candidate genes for drought tolerance in chickpea. In this context, a transcriptome assembly (ca. 60,000 contigs) was generated and 3,000 dehydration stress-responsive genes involved in major drought-stress signalling cascades were identified. Robust drought-responsive candidate genes were identified from MACE libraries and 50 qRT-PCR assays for drought-responsive candidate genes were studied. Furthermore, KASPar assays were developed for 2,005 SNPs and a high-density molecular map of chickpea comprising 1,328 loci was developed. In addition, an Integrated SNP Mining and Utilization (ISMU) pipeline, a computational tool for identifying SNPs in NGS data sets was developed. This project eventually helped to enhance breeding efficiency for developing superior chickpea varieties with higher yield under rainfed conditions.

- ❖ ISMU pipeline, a computational tool for identifying SNPs in Next Generation Sequencing (NGS) data sets was developed.

Publications:

- ❖ Azam S, Rathore A, Shah TM, Telluri M, Amindala B, et al. (2014) An Integrated SNP Mining and Utilization (ISMU) Pipeline for Next Generation Sequencing Data. PLoS ONE 9 (7): e101754.
- ❖ Afonso-Grunz F, Molina C, Hoffmeier K, Rycak Lukas, Kudapa H, Varshney RK, Drevon J, Winter P, Kahl G. (2014) Genome-based analysis of the transcriptome from mature chickpea root nodules. Frontiers in Plant Science 5: 325.
- ❖ Varshney RK*, Song C, Saxena RK, Azam S, Yu S, Sharpe A, Cannon S, Baek J, Rosen BD, Tar'an B, Millan T, Zhang X, Ramsay LD, Iwata A, Wang Y, Nelson W, Farmer AD, Gaur PM, Soderlund C, Penmetsa RV, Xu C, Bharti AK, He W, Winter P, Zhao S, Hane JK, Garcia NC, Condie JA, Upadhyaya HD, Luo MC, Thudi M, Gowda CLL, Singh NP, Lichtenzveig J, Gali KK, Rubio J, Nadarajan N, Dolezel J, Bansal KC, Xu X, Edwards D, Zhang G, Kahl G, Gil J, Singh KB, Datta SK, Jackson SA, Wang J, Cook DR (2013) Draft genome sequence of chickpea (*Cicerarietinum*) provides a resource for trait improvement. Nature Biotechnology 31:240–246.
- ❖ Kudapa H, Ramalingam A, Nayakoti S, Chen X, Zhuang W, Liang X, Kahl G, Edwards D, Varshney RK (2013) Functional genomics to study stress responses in crop legumes: Progress and prospects. Functional Plant Biology 40(12): 1221-1233
- ❖ Hiremath PJ, Kumar A, Penmetsa RV, Farmer A, Schlueter JA, Chamarthi SK, Whaley AM, Carrasquilla-Garcia N, Gaur PM, Upadhyaya HD, KaviKishor PB, Shah TM, Cook DR and Varshney RK (2012). Large-scale development of cost-effective SNP marker assays for diversity assessment and genetic mapping in chickpea and comparative mapping in legumes. Plant Biotechnology Journal 10: 716–732. ●

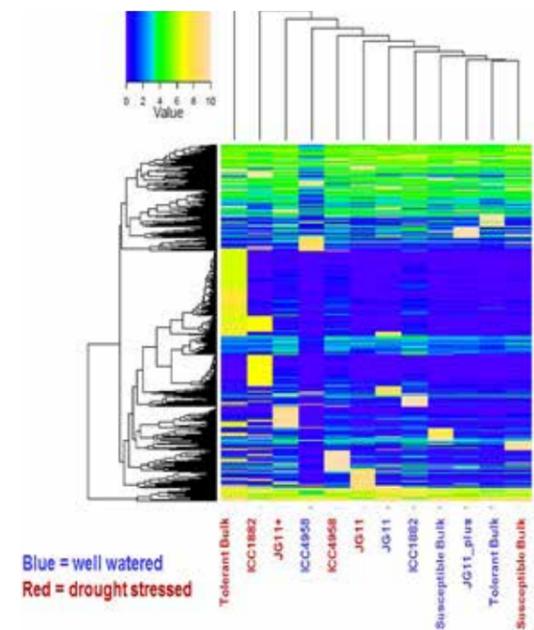
- ❖ A transcriptome assembly (ca. 60,000 contigs) has been generated and 3,000 dehydration stress-responsive genes involved in major drought-stress signalling cascades were identified (GXP and ICRISAT).
- ❖ Robust drought-responsive candidate genes identified from MACE libraries and 50 qRT-PCR assays for drought-responsive candidate genes designed (UF)
- ❖ KASPar assays were developed for 2,005 SNPs and 384 SNP genotyping data was generated on the reference set consisting of 301 accessions. High-density molecular map of chickpea comprising 1,328 loci was developed. high resolution gene expression profiles identified through MACE libraries

The Project

The basic objectives of the project are: Chickpea (*Cicerarietinum* L.), an important grain legume crop of high nutritive value is mostly grown in low-input and on residual moisture in Indian and semi-arid regions of Sub-Saharan Africa. India is the largest producer and largest consumer of chickpea. However India imports at least 40% of the international chickpea production. Due to insufficient rainfall in arid and semi-arid growing areas, the crop often suffers from drought. Terminal drought globally is the major constraint for chickpea production. In the past, breeding efforts to improve drought tolerance have been hindered due to its quantitative genetic basis and our poor understanding of the physiological basis of yield under water-limited conditions. Recent advances in chickpea genomics including the genome sequence, unraveled gene networks and genetic variation controlling valuable traits in elite breeding populations.

- ❖ Identification of candidate genes associated with drought tolerance in chickpea

- ❖ Quantitative real time PCR (qRT-PCR) assays for candidate drought-responsive genes in chickpea
- ❖ Perfect gene-based markers associated with drought tolerance in chickpea
- ❖ Relevant statistical packages and bioinformatics tools for data analysis



Massive Analysis of cDNA Ends (MACE) –Differential gene expression profiles



Biotechnological approaches to improve chickpea crop productivity for farming community and industry



Rajeev Varshney^{1,*}, Himabindu Kudapa¹, Mahendar Thudi¹, Pooran Gaur¹, Fabian Grunz², Günter Kahl², Björn Rotter³, Peter Winter³, Manash Chatterjee⁴

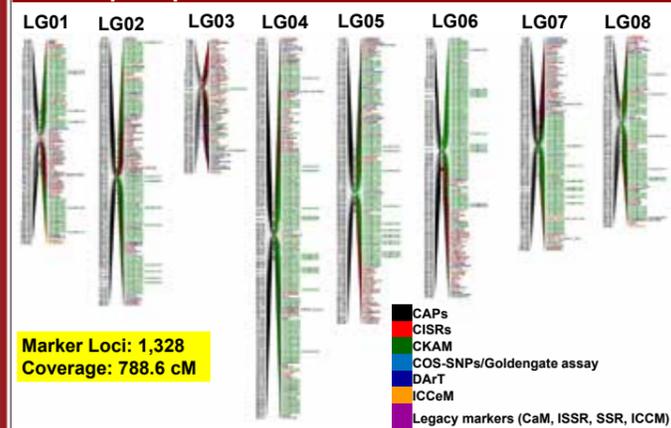
¹International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India; ²Goethe-Universität Frankfurt, Frankfurt am Main, Germany; ³GenXPro GmbH, Frankfurt am Main, Germany; ⁴BenchBio Private Limited, Gujarat, India
*Address for correspondence: r.k.varshney@cgiar.org

The Project Chickpea (*Cicer arietinum* L.), an important grain legume crop of high nutritive value is mostly grown in low-input and on residual moisture in Indian and semi-arid regions of Sub-Saharan Africa. India is the largest producer and consumer of chickpea. However India imports at least 40% of the international chickpea production. Terminal drought globally is the major constraint for chickpea production. In the past, breeding efforts to improve drought tolerance have been hindered due to its quantitative genetic basis and our poor understanding of the physiological basis of yield under water-limited conditions. Recent advances in chickpea genomics including the genome sequence, unraveled gene networks and genetic variation controlling valuable traits in elite breeding populations. This project explored the resources developed (eg. in a different project, ICRISAT produced >400,000 ESTs from chickpea genotypes using next-generation sequencing (NGS) technologies), with the help of expertise available at University of Frankfurt / GenXPro in Germany and ICRISAT/BenchBio in India to identify candidate genes for drought tolerance in chickpea. In this context, a transcriptome assembly (ca. 60,000 contigs) was generated and 3,000 dehydration stress-responsive genes involved in drought-stress signalling cascades were identified. Robust drought-responsive candidate genes were identified from Massive Analysis of cDNA Ends (MACE) libraries and 50 qRT-PCR assays for drought-responsive candidate genes were studied. Furthermore, KASPar assays were developed for 2,005 SNPs and a high-density molecular map comprising 1,328 loci was developed. In addition, an Integrated SNP Mining and Utilization (ISMU) pipeline, a computational tool for identifying SNPs in NGS data sets was developed. This project eventually helped to enhance breeding efficiency for developing superior chickpea varieties with higher yield under rainfed conditions.

Objectives

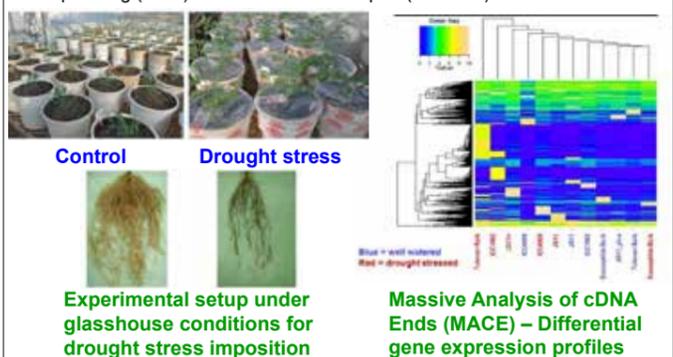
- ❖ Identification of candidate genes associated with drought tolerance in chickpea
- ❖ Quantitative real time PCR (qRT-PCR) assays for candidate drought-responsive genes in chickpea
- ❖ Perfect gene-based markers associated with drought tolerance in chickpea
- ❖ Relevant statistical packages and bioinformatics tools for data analysis

Transcript Map

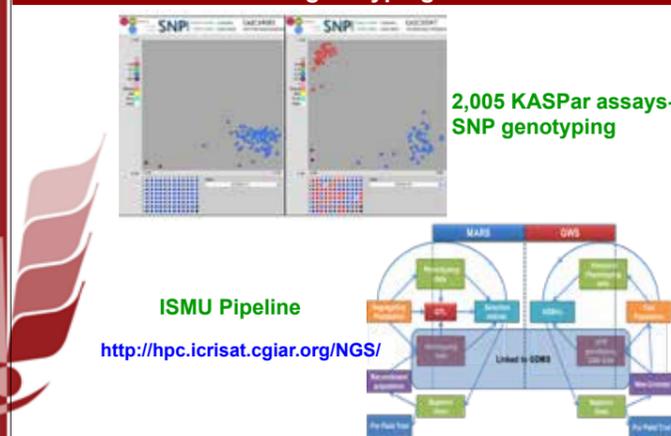


Progress Achieved

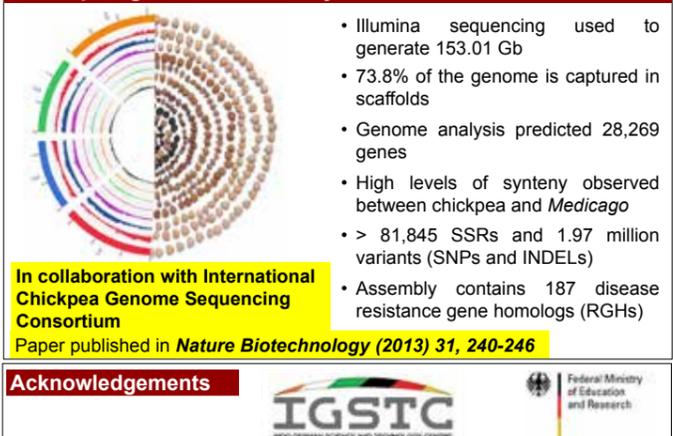
- ✓ A transcriptome assembly (ca. 60,000 contigs) was generated and 3,000 dehydration stress-responsive genes involved in major drought-stress signalling cascades were identified (GXP and ICRISAT)
- ✓ Robust drought-responsive candidate genes identified from MACE libraries and 50 qRT-PCR assays designed (UF)
- ✓ KASPar assays were developed for 2,005 SNPs and 384 SNP genotyping data was generated on the reference set consisting of 301 accessions. High-density molecular map of chickpea comprising 1,328 loci was developed (ICRISAT)
- ✓ ISMU pipeline, a computational tool for identifying SNPs in Next generation sequencing (NGS) data sets was developed (ICRISAT)



SNPs: Identification and genotyping



Chickpea genome assembly



Developing sustainable transgenic crop plants for drought or a combination of drought & heat stress by manipulating aba & ascorbate- gultathione pathways



Source : shutterstock

The Project

The basic objectives of the project were:

- ❖ In vitro gene pyramiding and construction of plant transformation vector with all the genes, i.e. Superoxide dismutase (SOD), Ascorbate peroxidase (Apx), Monodehydroascorbatereductase (MDHAR), Dehydroascorbatereductase (DHAR) and Glutathione reductase (GR), encoding for enzymes involved in ascorbate-glutathione pathway (at ICGEB).
- ❖ Preparation of constructs for manipulating ABA levels under drought using key genes of ABA metabolism and catabolism as well as alterations for ABA signaling to elevate hypersensitivity to ABA under drought (at IPK Germany).
- ❖ Transformation of selected maize lines through Agrobacterium- mediated transformation (at Nuziveedu Seeds (P) Ltd).
- ❖ Transformation and characterization of primary transgenic barley lines and double haploid transgenic plants and screening barley transgenic plants for terminal drought tolerance (at IPK and SURL, Germany).

- ❖ Molecular analysis of transgenic maize plants for stable integration of transgenes and their expression at both RNA and Protein levels (at both ICGEB and Nuziveedu Seeds (P) Ltd components).
- ❖ Validation of selected transgenic maize and barley events for their stress adaptation in the greenhouse under different stress conditions (at ICGEB, Nuziveedu Seeds (P) Ltd and IPK).
- ❖ The enhanced productions of Reactive Oxygen Species (ROS) in response to drought stress are effectively deactivated in multiple redox reactions by the ascorbate-glutathione pathway enzymes expressed in transgenic maize to combat drought stress induced cellular damage (at ICGEB and Nuziveedu Seeds (P) Ltd.).
- ❖ The genetic manipulation of drought stress responsive ABA levels in transgenic plants for subsequent expression of drought stress adaptive genes through ABA mediated signaling pathway to sustained plant growth and productivity under drought stressed agro-climatic condition (at IPK, ICGEB and Nuziveedu Seeds (P) Ltd.).

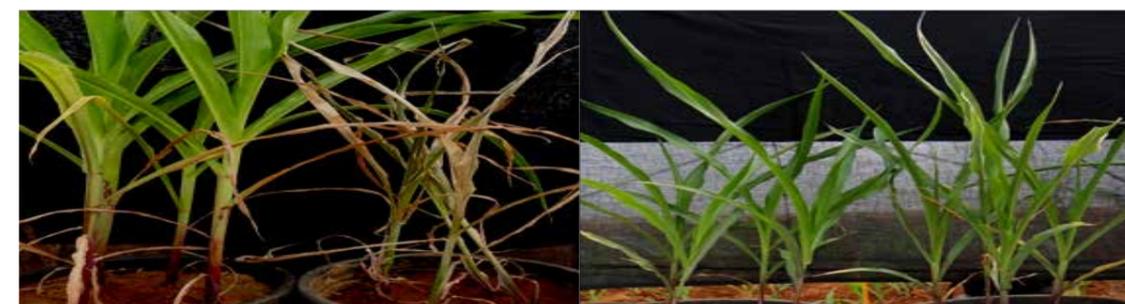


Figure - Tolerant green transgenic (left) and completely dried non-transgenic (right) maize plants under drought stress given in pot experiment

Project Investigators Partnering Institutions



M K Reddy
International Centre for Genetic Engineering and Bio Technology (ICGEB), New Delhi



N Sreenivasulu
Leibniz Institute for Plant Genetics and Cultivated Plant Research Gatersleben



P Sateesh Kumar
Nuziveedu Seeds (P) Ltd. Hyderabad



Jenes Weyen
Saaten-Union Resistenzlabor GmbH Leopoldshöhe

Progress Achieved

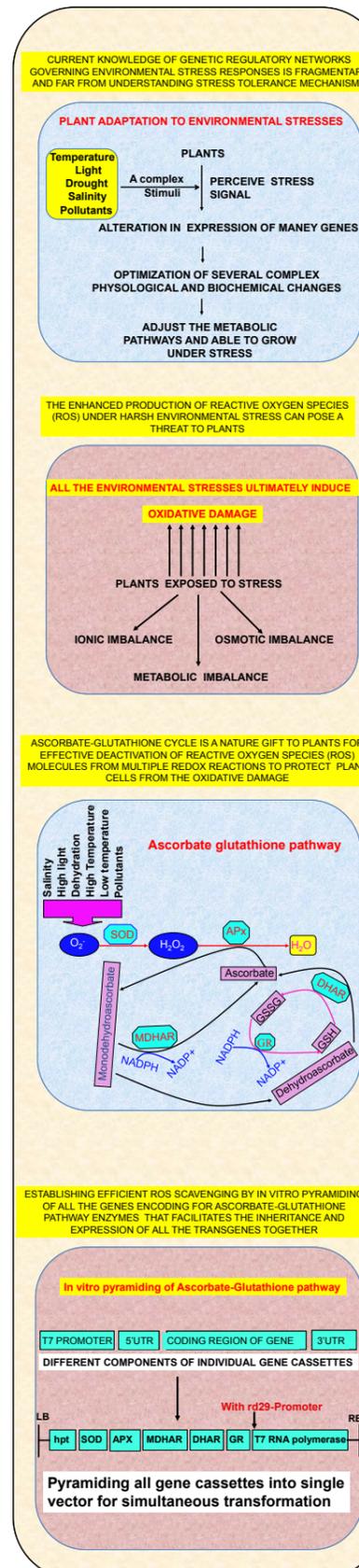
- The objective within this project was the combination and pyramiding of genes increasing tolerance against drought and heat stress in spring barley and maize. Therefore, transgenic lines with optimized biosynthesis pathway of the plant hormone abscisic acid (ABA, Figure 1), the ABA signaling pathway and the Glutathione-Ascorbate metabolism were generated (IPK, ICGEB and Nuziveedu Seeds).
- After initial characterization several lines were selected, grown in the greenhouse and crossed together (project partner Saatenunion). The progeny were raised as

donor plants for the production of doubled haploid (DH-) lines. DH-lines were produced via in vitro tissue culture. Doubled haploid plants have the advantage of being genetically stable. They do not segregate in the further generations and are completely homozygous. That makes them ideal tools for further investigation of genes of interest. Seeds were sown under greenhouse conditions at IPK Gatersleben for further analysis under control and defined drought stress settings. Selected Lines showed a stable yield under drought stress conditions.

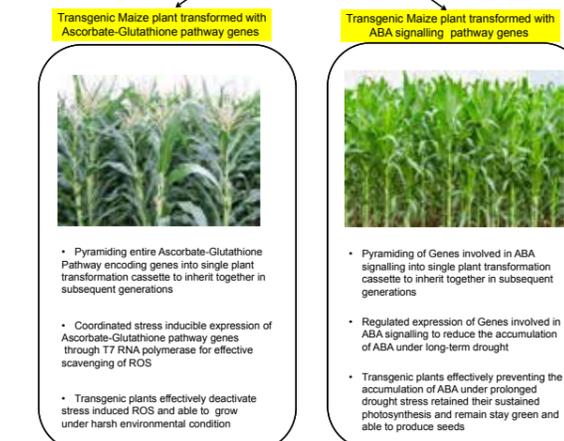
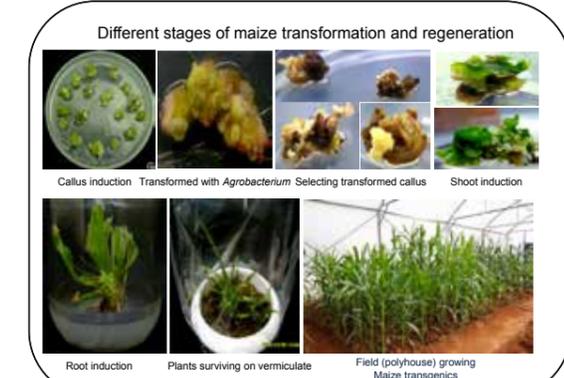
- The Indian component adopting Agrobacterium mediated transformation and transformed entire ascorbate-glutathione pathway encoding genes into maize plants for effective deactivation of reactive oxygen intermediate (ROI) molecules to protect the transgenic maize from the oxidative damage. In addition, modulated the expression levels of ABA, the major phytohormone and an essential messenger to trigger the expression of stress adaptive genes under drought stress by simultaneously over expressing NCED6 and a receptor protein kinase under appropriate promoters to enhance production of ABA at the same time to prevent the leaf senescence for improved seed setting and grain filling. Elite transgenic lines were selected after field and lab level screening with basta and methylviologen treatments respectively. In selected lines, morphological, physiological and biochemical characterization was done by doing pigment analyses, ion leakage, lipid peroxidation and enzyme assays under the induced oxidative stress condition with methyl viologen in lab and also by simulated drought stress experiments in poly house. Significant difference was observed between transgenics and control plants (Figure 2). Stable yields were observed in some lines and enhanced cob length and pigmentation were observed in others (Figure 3).



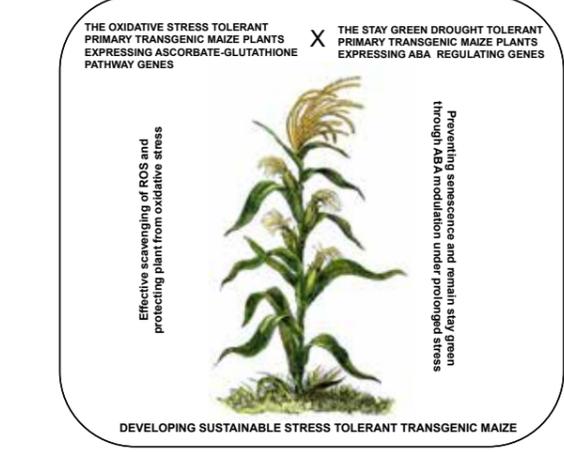
Figure – Cob size and pigmentation in transgenic (A-C) and non-transgenic (D) maize lines



AGROBACTERIUM MEDIATED MAIZE TRANSFORMATION AND REGENERATION

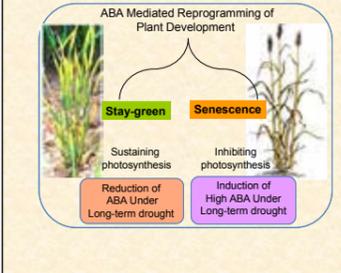


GENE PYRAMIDING BY CROSSING TWO TRANSGENIC LINES

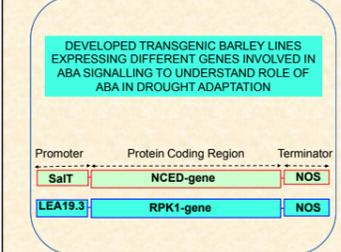


WORK DONE UNDER INDIAN COMPONENT

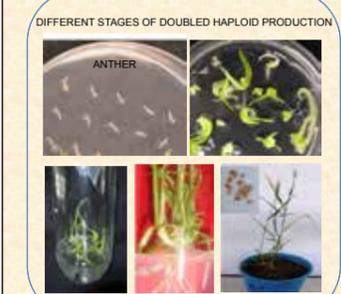
THE IMPACT OF PLANT HORMONE ABSICISCI ACID (ABA) AND ITS ROLE IN STRESS ADAPTATION



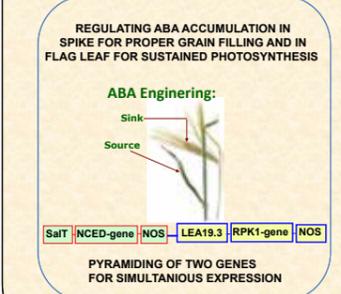
REGULATED EXPRESSION OF ABA TO UNDERSTAND PLANT GROWTH AND DEVELOPMENT UNDER DROUGHT



PYRAMIDING OF GENES INVOLVED IN ABA SIGNALLING AND GENERATED TRANSGENIC LINES THAT SHOWED STRESS TOLERANCE AND SUBSEQUENT DOUBLED HAPLOID LINES PRODUCED



IN VITRO PYRAMIDING OF SELECTED GENES FOR THE TISSUE SPECIFIC REGULATED EXPRESSION OF ABA FOR PROPER GRAIN FILLING AND SUSTAINED PHOTOSYNTHESIS DURING TERMINAL DROUGHT



Compact linear fresnel reflector technology (CLFR) for solar thermal power generation and process heat



Source : Getty Images

Project Investigators Partnering Institutions



P M Mujumdar
IIT Bombay
Mumbai



Werner Platzer
Fraunhofer ISE
Freiburg



R R Sonde
Thermax Global
Pune



Thomas Kuckelkorn Schott
Solar Cspgmbh
Mainz

- ❖ Engineering drawings were created in collaboration with and support of the Thermax team, for taking up the fabrication of the components and modules of the actual demonstration pilot plant through external vendors.
- ❖ The effect of possible springback and loading mechanisms to compensate for the same was studied through a nonlinear analysis.

Publications:

- ❖ This report gives a summary of the work done by the project team at IIT Bombay, and its contributions to the project along with Thermax and other partners towards successful implementation of

the demonstration pilot plant based on the CLFR concept for application of solar thermal power hybridization with conventional thermal power plant. All the objectives of the project have been successfully met. A new and novel conceptual and detailed design of the primary collector unit of the plant was evolved as a part of the project. The concept was successfully implemented and tested as a part of the actual demonstration plant, alongside another design from the Thermax team based on a more conventional approach. Both designs were supported by a detailed high fidelity analysis based on the finite element method.●



The Project

The objective of the project is to develop a low cost concentrating collector for production of medium temperature heat, designed for Indian climate, cost and production conditions.

Specifically this project envisages setting up of a CLFR based low cost high efficiency solar thermal rooftop collector demonstration plant and integrating the same with an existing thermal power unit. It involves

Expected deliverables:

- ❖ Design and development of all the critical components like primary mirror system, secondary concentrator, receiver mounting, tracking system, heat exchangers, evaporators etc.
- ❖ Design and analysis of structural system,
- ❖ Fabrication of the components of the system, assembly, erection and commissioning at site,
- ❖ Testing & integration of the system in the existing

thermal power plant at Manuguru, to address all the above aspects and quantify the efficiency and cost.

Progress Achieved

- ❖ Conceptual design to meet the requirements arrived at and frozen.
- ❖ Detailed configuration design and analysis carried out.
- ❖ No major or critical bottle necks in the design seen as per the analysis.
- ❖ Fabrications issues of the components were addressed.
- ❖ Mirror bending and bonding experiments were successful, validating the design concept
- ❖ A prototype of a single reflector was fabricated and tested for focussing accuracy.
- ❖ Detailed design drawings were created for discussions with Thermax on further work towards assembly and integration requirements between the different modules.

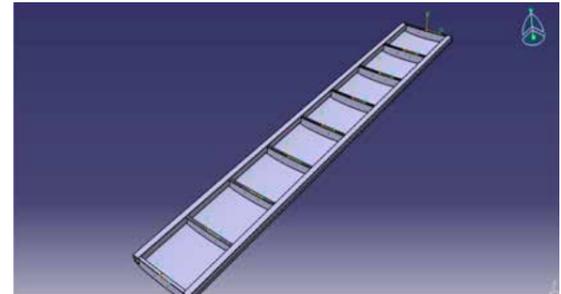


Fig 1: 3D model of primary reflector support structure without mirror

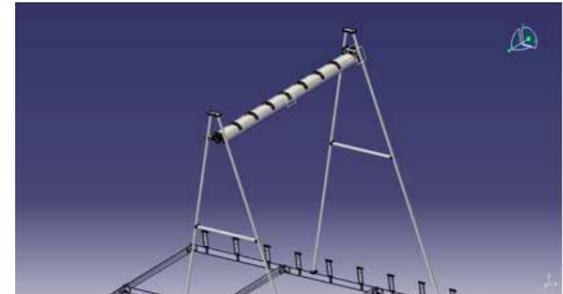
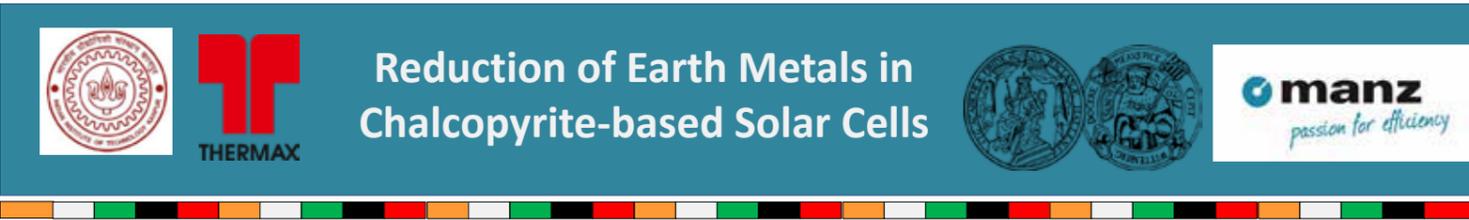


Fig 2: 3D model of Secondary reflector held on the A frame



Reduction of earth metals in chalcopyritebased solar cells



Project Investigators Partnering Institutions



Sarang Ingle
IIT Kanpur
Kanpur



Roland Scheer
Martin-Luther-University
Halle



Nagesh Kini
Thermax
Pune



Ralf Sorgenfrei
Manz CIGS technology GmBh
Schwabisch Hall

The Project

- ❖ Model process for CIGS growth with reduced layer thickness and preserved or improved photovoltaic properties
- ❖ Model process for Kesterite growth with reduced layer thickness and preserved or improved photovoltaic properties
- ❖ Report on scientific and economic potential of both approaches and benchmarkingProgress of the project.

Progress Achieved

CZTS thin films obtained through solution route have been successfully obtained over the molybdenum coated soda-lime glass substrate (1 inch-square surface area). Film deposition parameters have been optimized in order to obtain films that are free of macro-cracks, have minimal pin-holes, and have the desired stoichiometry, which is, copper poor and zinc rich.

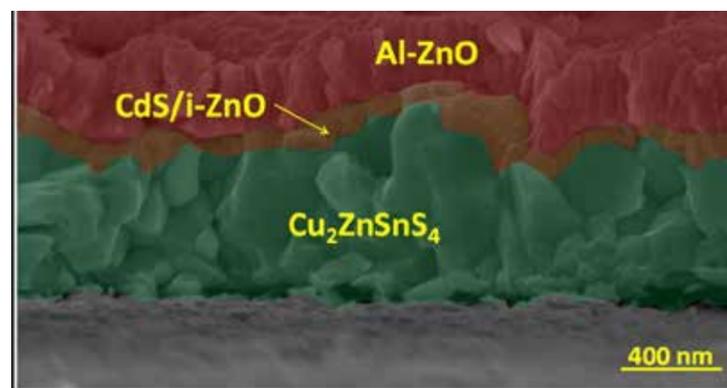
A complete photovoltaic device (area \square 0.25 cm²) has been fabricated by sputter deposition of intrinsic zinc oxide (i-ZnO), chemical-bath deposition

of cadmium-sulfide (CdS), and sputter deposition of aluminum doped zinc-oxide (AZO) in that order on the CZTS film.

The best cell fabricated so far shows open circuit voltage (Voc) of 0.47V and short-circuits current density (Jsc) of 1.38 mA/cm². In the efficiency table by M. A. Green et al. CZTS device1 with highest reported efficiency has Voc = 0.6585, Jsc = 20.43 mA/cm².

Any other relevant points:

- Sputtering system and IR furnace have been installed.



Cross Section of CZTS Solar Cell

MOTIVATION

Earth abundant metal chalcogenides material Cu₂ZnSnS₄(CZTS) based solar cell is considered to be an alternative to Cu(In,Ga)S₂ (CIGS) absorber material based solar cells. It uses Zinc and Tin in place of Gallium and Indium making it low cost material for solar cell application.

SOLAR CELL STRUCTURE

BAND DIAGRAM

CURRENT EFFICIENCY STATUS

- Highest Efficiency achieved with CZTSSe is 12.6% [1].
- Current highest achieved efficiency with CIGSe is 20% [2].
- The goal of present investigation is to understand the efficiency limiting factors in CZTSSe, and thus devise an approach for improving its efficiency.

METHODOLOGY & RESULTS

CZTS (ABSORBER LAYER) & OTHER LAYERS

Salt of copper, Zinc and Tin Thiourea (CSN2H4) as source Sulfur 2-methoxy ethanol as a solvent

Solution approach

Salt of cadmium Thiourea as source Sulfur Deionized water as a solvent

Chemical bath deposition

Sputtering approach

Layer-1: Cu₂ZnSnS₄ (Absorber Layer)

Three layers	Five layers	Ten layers

- Sol-gel coating with metal acetate salts gives smooth morphology
- Beyond 5-layer (500 nm) CZTS film starts to develop cracks

Layer-2: Cadmium Sulfide (CBD method)

- XRD and Raman spectroscopy confirm the formation of CdS
- SILAR gives 343 nm of CdS for 15 deposition cycle
- CBD gives 64 nm of CdS for 8 min of deposition

Layer-3: Zinc oxide (Sol-Gel method)

- ZnO film with Grain size of around 25 nm is achieved for 1-layer spin coating, sample was heated on hot plate at 300°C for 10 min
- XRD pattern confirms the formation of ZnO

TRANSPORT CHARACTERISTICS

- CZTS film on Mo coated substrate has been fabricated.
- CdS film via CBD and i-ZnO film via Sol-Gel has been fabricated

INDIAN-GERMAN COLLABORATIVE WORK

ACKNOWLEDGEMENT

• Authors would like to thank Indo-German Science and Technology Center (IGSTC) for the funding to carry out this work.

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- 1) Wei Wang et. al. Adv. Energy Mater. 2014, 4, 1301465
- 2) Philip Jackson et. al. prog. Photovolt: Res. Appl. 2011; 19:894-897



Project sponsored by Indo-German Science & technology Centre

Flexible printed integrated disposable electronics

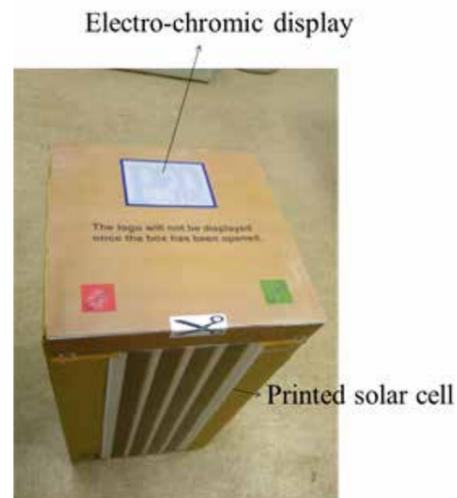


The Project

Printed electronics has developed as a promising research area, as it provides the possibility to produce large quantities of low-cost flexible electronic devices by means of conventional mass printing technologies. Production costs decrease and numerous applications, e.g. solar cells, antenna, sensors, etc., become possible. Even though remarkable progress has been made in research for printed electronic components in recent years, the integration of multiple electronic components into multifunctional systems is much less mature. The FLEXIPRIDE project, which is funded by BMBF within its initiative to strengthen international cooperation in education and research, aims at producing such multifunctional systems, which facilitate numerous novel applications. In particular, different application scenarios

are to be developed on the basis of mass printing technologies: solar-based energy sources and security seals.

The project deliverables have been based on a yearly basis. At the end of the project a demonstrator with printed solar cell and an active RFID with printed antenna with printed connectors will be presented. A device model will be developed to simulate the circuits and the individual components like solar cells, Transistors and electrochromic or light emitting displays in the circuit. An optical system using different sensors and methods for defect detection will be developed. Another optical system to measure the thickness of the printed layers will also be developed and effort will be made to combine defect detection and thickness measurement in one system to be mounted on the printing machine.



Project Investigators Partnering Institutions



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Progress Achieved

- ❖ First oscillating EC-display with simple astable multivibrator and conventional electronics components reached.
- ❖ Integrated security tag with EC-display, battery and switch button.
- ❖ Spin-off "Pakutronic" transferred in company saralon with six employees and first customised products.
- ❖ Integration of inline inspection system in R2R printing machine.
- ❖ Optical analyzing of defect positions in ground metal electrode.
- ❖ New 3PV solar cell layout (8 stripes, 4V) for HMI2015 is working.
- ❖ First connection technologies for full printing integration of demonstrator investigated.

Publications:

- ❖ Investigation of the degradation mechanisms of a variety of organic photovoltaic devices by combination of imaging techniques—the ISOS-3 inter-laboratory collaboration, Energy Environ. Sci., 2012, 5, 6521-6540
- ❖ Prof. Dr. Arved C. Hübler: Printed Solar Cells on Paper - Alternatives for the future, Bio Electronics 2014, Kirchberg/Kitzbühel, Austria
- ❖ Moazzam Ali, Deep Prakash, Tino Zillger, Pradeep Kumar Singh, and Arved Carl Hübler: Printed Piezoelectric Energy Harvesting Device. Advanced Energy Materials (2013)

General public relation activities:

- ❖ Roadshow "The DWIH New Delhi – Excellence on Tour!", New Delhi, India, 2013/2014

- ❖ Meeting, "Opportunities and Innovation in Electronics and IT", Dresden, September 2014
- ❖ Elektronik auf Papier (engineering people #8 2014) PMTUC 24.11.14
- ❖ Preparation of Industriemesse Hannover, April 2015

Another result of the project is the foundation of the company SARALON. It is a spin-off from the pmTUC. SARALON works on the development of electrochromic displays, circuitries and batteries by using conventional printing machines. With this strategy electronics can be produced in a simple and cost-effective way.



FLEXIPRIDE





Flexible Printed Integrated Disposable Electronics (FLEXIPRIDE)

Objective of the Project

The aim of this project is to combine the different printed electronic elements into a single functioning device. Existing Roll to Roll mass printing processes of Gravure and Flexography which are used for printing of labels, packages, plastic bags etc will be investigated and optimized for printing electronic elements. This will open up a whole new field of applications using different printed electronic components. This project aims at delivering a prototype for a security label which can be placed on a package.



Fig 1. Example of one area of application for a printed label as a security seal

Task of each partner

pmTUC – The objective of this project is to optimize the paper printed solar cell to achieve higher efficiencies and to improve the lifetime of the cells by encapsulating or laminating it with a protective coating against UV radiation, water vapor and oxygen.

Chromasens - will take up the task of development of an inline system to inspect and control the quality of roll-to-roll printed functional layers and printed electronic devices. The inline system will detect structural defects and inhomogeneity in layer thickness by optical methods.

Project Duration : 01.08.2012 - 31.07.2015

IIT Kanpur - Simulation of the paper printed solar cell from the pmTUC to evaluate the performance and suggest improvements in parameters like layer thickness, roughness and material properties for further improvement in the efficiency and to increase power output of the 3PV cells

Anil Printers – Anil printers with its expertise in Radio Frequency Identification Tags (RFID) will look into the printing of antennas for RFID tags by using inexpensive conductive inks. Antenna parameters like Antenna design, conductivity of the printed layers and Q value will be tested optimized.

Partner collaboration

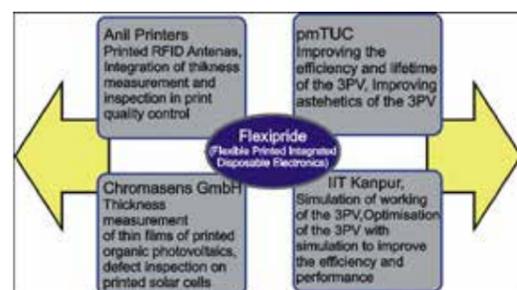


Fig 2. The collaboration between the partners and their work areas.

Partners

4 Partners - 2 Academic and 2 Industry partners

TU Chemnitz, Germany (Co-ordinator)

Chromasens GmbH, Germany

IIT Kanpur, India,

Anil Printers, India

Project supported by the

Indo-German Science & Technology Centre

Resource and energy reliability by co-digestion of veg-market and slaughterhouse waste



The Project

The project objectives are to demonstrate the feasibility of sustainable resource and energy reliability by co-digestion of veg-market and slaughterhouse waste in India and its potential for global realization. In a pilot project conducted in Chennai, Tamil Nadu, India on the premises of an existing biogas plant currently operated by the project partner RamkyEnviro Engineers Ltd. and in close vicinity to the Koyambedu Wholesale Market Complex, the German and Indian partners apply their common developed innovative approach with the following deliverables:

- ❖ Demonstration of the feasibility of recovery of bioenergy from slaughterhouse waste, fruit- and vegetable market waste and other organic wastes in urban areas in a sustainable way
- ❖ Integration of advanced anaerobic processes in the

economic, social and natural environment in context to India

- ❖ Establishment of a sustainable supply chain for the generation of energy through anaerobic treatment of slaughterhouse waste, fruit- and vegmarket waste and other organic wastes generated in Chennai City as substrates.
- ❖ Avoiding emission of Methane into environment by reducing the disposal of organic wastes in open dumps and also reducing the odour nuisance and other land and water pollution.
- ❖ Contribution to local energy supply through generation of bioenergy and also generation of bio-fertilisers/soil conditioner with rich nutrient contents (N, P, K) thus making this energy recovery as sustainable with generation of additional income.

RESERVES



Fig 1: Project Partners visiting a vegetable market for inspecting waste created



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Titus Lehmann
Lehmann - UMT GmbH
Pöhl

- ❖ Establishment of employment opportunities, both at the biogas plant as well as along the supply and product chain
- ❖ Supporting German companies in accessing the Indian market
- ❖ Economic assessment and construction of a prototype system
- ❖ Training of qualified staffs for operation and concepts for vocational training

Furthermore an objective is to evaluate the possibility of processing the produced digestate to fuel or fertilizer. The digestate residuals, which are produced in large amounts by high loading rates, can be dewatered with the LEHMANN-UMT solid separator (bio-extrusion system) and used directly as fertilizer or pelletized to renewable fuel.

Within this project, the project partners are ensuring a close knowledge transfer for the operational personnel during the pilot scale study. Sustainability assessment of the process and the marketable product qualities using Life Cycle Assessment (LCA) as well as carbon footprints investigations are carried out alongside the value added chain. Sustainable ways for biogas and digestate utilization are investigated. Herewith material and energy flows are optimized, as well as biogas upgrading and usage efficiency. To ensure the acceptance of this project among various stakeholders, and to confirm the exemplarity of this project, capacity building by demonstration workshops/ training programme is organised. The first meeting of all the project partners are being planned during the first week of May, 2016. ●

A joint study is conducted with various combinations of co-digestion of wastes from slaughterhouses and fruit- and veg-markets and, if available and required, supplemented by other organic wastes from hotels, food industry, etc. The investigation is performed by laboratory scale tests at CLRI accompanied by ISAH. Suitable combinations of substrate as well as available state-of-the-art technologies are evaluated and used as a data basis for the design of an adapted pilot plant. The pilot plant will include biogas production and the bio-extrusion process, which increases the bioavailability due to cell disruption by means of bio-extrusion (patented technology by LEHMANN-UMT).



Fig 2: Biogas production tests in batch reactor



Current Scenario



Urbanization



Municipal Solid Waste (MSW)



Current disposal



Urgent need for treatment of organic fractions of MSW (Vegetable market and slaughter house wastes)

Objectives

- Bilateral standardization of BMP evaluation methods (lab scale studies)
- Co-digestion of vegetable market, slaughter house and food wastes from canteens and hotels
- Design and implementation of pilot scale treatment at Chennai with innovative pre-treatment (bio-extrusion) at onsite circumstances
- Generation, purification and bottling of Biogas
- Potential utilization of digestate as nutrient
- Sustainability assessment of the process using LCA approach

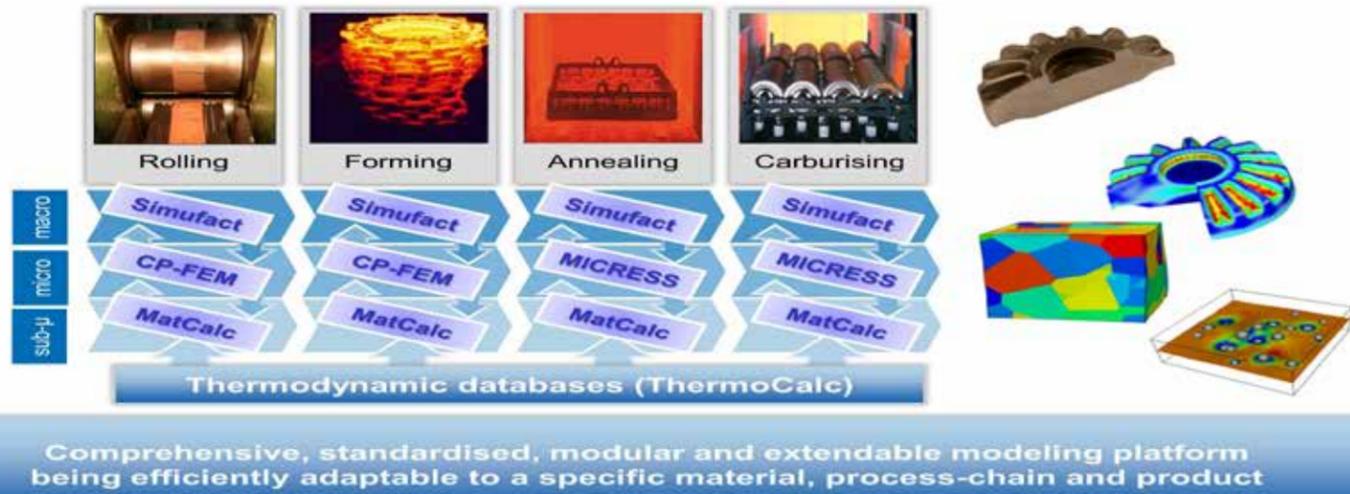
Expected outcome

- Address the growing energy demand and MSW treatment and disposal issues in India
- Identifies suitable substrate combinations for anaerobic co-digestion of slaughter house waste with veg-/fruit-market wastes in lab & pilot-scale
- Adaptation of appropriate German technology for sustainable energy production by co-digestion to Indian conditions with enhancement of biogas yield through pre-treatment with bio-extrusion
- Biogas upgrading technology for effective mobility and affordable utilisation
- To recover valuable products from the digested waste as nutrient rich bio-fertilizer
- Sustainability assessment by LCA
- Model concept for sustainable MSW management for Co-digestion of slaughterhouse and veg-market/other waste in India

Sustainable option for Smart Cities



Combined process and alloy design of a microalloyed DP forging steel based on integrative computational materials engineering



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Tata Consultancy Services
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Hamburg

Progress Achieved

Design of alloy composition completed; Identification of model data/ all tools have been started.

composition, so that the effect of the phase transformation on microstructure at various distances across the sample can be captured

❖ **Carburization experiment/simulation-** Vacuum carburizing has been gaining importance as a modern, environmentally-friendly and cost-effective method of surface hardening in the global machinery, automobile and aviation industry. The carburizing carrier gas is Acetylene (C₂H₂) and high pressure Nitrogen gas (N₂) is used as quenching medium. In order to simulate the carburization process, a series of boost-diffusion simulations have been conducted by means of a programmed Python code as an interface and DICTRA software package.

❖ **Simulation of the distortion in Macro-scale-** According to the experimentally obtained results, the carbon diffusion module has been successfully developed in Simufact. Further, the influence of

❖ **Microstructural design towards reduced distortion-** Usually, the final microstructure of the carburized and quenched components is comprised of almost Martensite plus Bainite. In the context of this project it has been proved that the evolution of ferrite can lead to a reduced heat-treatment distortion of the specimens which is an unavoidable phenomenon accompanied with hardened components. The microstructural evolution of the carburized specimens has been predicted through MICRESS®. A set of parametric study has been conducted by varying the carbon

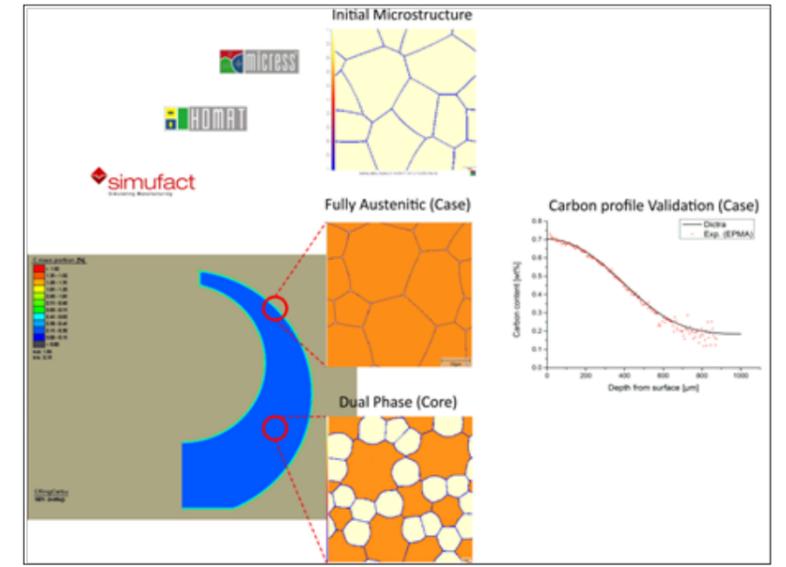


Figure 1. Microstructural evolution of the carburized component during cooling to hardening temperature

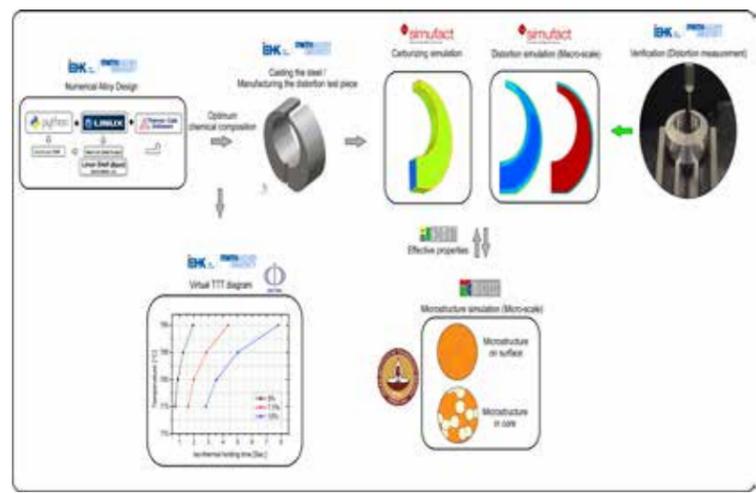
the enriched carbon layer on the subsequent phase transformation has been simulated and the effect of internal microstructure on the heat treatment-induced distortion has been demonstrated. ●

The Project

Because machinability is important simultaneously with strength in gears used in the transmissions and suspensions of automobiles and construction equipment, the majority of gears used in these applications are manufactured by a process of forging and machining followed by surface hardening by carburization, using case hardening steels. In recent years, higher strength in these gears has been strongly desired from the viewpoints of weight reduction and downsizing. In automotive applications, heat-treatment distortion of gears has also become a problem due to demand for reduced noise. This project aims at the development of an energetic production of forged gears with dual phase microstructure leading to reduced distortion.

The main goals of the project were:

- ❖ Numerical design of alloy composition
- ❖ Experiments on thermomechanical process simulation
- ❖ Microstructural phase and grain size characterization
- ❖ Precipitation characterization
- ❖ Precipitation modelling on Nano scale during hot forming



- ❖ Microstructure evolution modelling during thermomechanical processing
- ❖ Microstructure transformation modelling during cooling
- ❖ Model implementation and parallelization
- ❖ Link of models
- ❖ Multi scale modelling of hot forming process chain
- ❖ Benchmark and validation trials
- ❖ Management and reporting



DP-FORGE

DP-FORGE



TATA CONSULTANCY SERVICES
Experience century

Combined Process and Alloy Design of a Micro-alloyed DP Forging Steel based on Integrative Computational Materials Engineering (DP-Forge)



Introduction

Objective: ICME approach for the design of a microalloyed dual phase gear

Goals:

- Develop an ICME based simulation platform for design of gear material and processes
- Linking relevant simulation tools along the process chain & across the length scales
- Identification of parameters for all relevant models by means of tailored experiments
- Validation of the ICME platform concept by design of a new dual phase steel for forged and carburised gears with the potential of reduced distortion
- Validation of this new combined steel and carburising concept on laboratory scale

ICME approach-link across and along process chain
[Ref: Schmitz, G. and Prah, U., 2012, ICME: Concepts and Applications of a Modular Simulation Platform]

Microstructure Evolution

- Multi-Phase Field Modeling of microstructure evolution performed using Micress
- $\gamma - \alpha$ transformation during inter-critical annealing at 775°C simulated using Micress
- Microstructure(volume fraction of ferrite) studied across length from core to case
- Grain growth during carburization at 950°C simulated in Micress

Initial microstructure using voronoi tessellation and final micro-structure after annealing at 775 °C (Image courtesy: IEHK)

Grain growth at core during carburization at 950 °C for 2 hours

Microstructure(volume fraction of ferrite) from core to case-starting stage of inter-critical annealing at 775 °C.
i. C=0.18% ii. C=0.195% iii. C=0.197% iv. C=0.198% Image Courtesy:MME

Numerical Alloy Design

Selection of chemical composition with criteria

- Dual phase steel in core & martensite in case
- With highest ΔT (between A_{e3} and A_{c_m})
- Good Hardenability

Role of silicon in shifting the curves up & left
[Ref: Kazuaki et al. JFE 23 (2009), 24-29]

Effective Properties with Homogenization

- Effective properties of simulated microstructure(RVE) using Asymptotic Homogenization in HOMAT
- Thermo-elastic properties generated using HOMAT
- Flow curves to be obtained using Abaqus and Gleeble trials

Effective properties from core to case at start of inter-critical annealing:
i. Thermal conductivity ii. Specific heat capacity iii. Elastic moduli iv. Density Image Courtesy:MME

Heat Treatment Cycle

- Heat treatment cycle for forged & carburized gear
- Carburization depth targets: 0.3-0.5 mm
- Surface hardness targets: 57-63 HRC (C=0.7%)
- Modified Navy C Ring sample for macro scale experiments

Reference heat treatment cycle (time-temperature)

Modified Navy C Ring sample

Vacuum furnace

Macroscale Simulation Trials in Simufact

Dummy model with the initial distribution of C-atoms

Residual stresses after hardening (von Mises)

Distortion in a C Ring sample

Image Courtesy: Simufact

Simulations and Experiments at Sub-micro Scale

- MatCalc simulation to study the evolution of Aluminium Nitride(AIN) precipitates
- DICTRA based simulations for diffusion and phase transformation
 - Volume fraction of ferrite with time during inter-critical annealing at 775°C
 - Carbon content with depth during pulse carburizing at 950°C
- Experiments: dilatometry and EPMA
- LENP(Local Equilibrium Negligible Partitioning) aligns closely with experimental results

MatCalc simulation of AIN precipitates (phase fraction with time)

Pulse carburization: Carbon activity with time

Volume fraction of ferrite with time during inter-critical annealing at 775 °C: DICTRA and Dilatometry trials

Pulse carburization at 950 °C: Carbon content with depth from surface

Image Courtesy: IEHK

ICME Platform: TCS-PREMAP

Platform for Realization of Engineering Materials and Products(PREMAP)

Use of TCS PREMAP for integration of simulation tools and execution of simulation workflows for ICME based development

TCS PREMAP platform interface

Integrated gear design process

Recrystallized fraction after hot forging step

Martensite fraction distribution after heat treatment

Integrated gear design process workflow realized on TCS PREMAP platform

Image Courtesy: TRDDC(TCS)

Visualization of automated multi-sensor NDT assessment of concrete structures

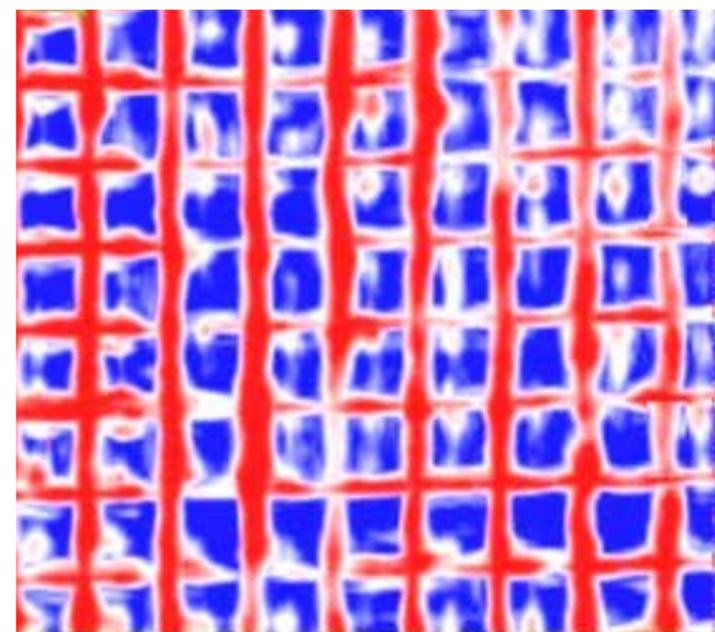


Source : Project Archives

The Project

The regular inspection of concrete structures is necessary to assess their condition and get data to serve as a base for planning maintenance and repair. Concrete inspection for structure (damages) and material properties (deterioration) is not possible with a single method approach. Effects of deterioration processes and structural changes are non-uniform in nature and must be addressed by a multi-method approach. Robot and scanner systems have facilitated the collection of high quality multi-sensory

data. Nevertheless, individual sensor data is often independently analyzed and compared against the data from other sensors at decision level. Thus, the potential of multi-sensory information is typically not fully realized. Fusing multi-sensory data can close this gap and pave the way for automated evaluation of multimodal data sets. Honeycombing defects (Honeycombs are porous volumes of coarse grain aggregates bonded together by cement) are formed when the fresh concrete ingredients segregate and also due to poor workmanship. Detection and characterization of honeycombs is a challenging inspection task due to their strong variability in size, shape, position, orientation and density. Moreover, unlike voids of the comparable size, honeycombs introduce a gradual and volumetrically distributed change in material properties



Top Reinforcements obtained with radar

The main goals of the project were:

- To develop and Implement automated scanner system for data collection using multi-sensor (Ground Penetrating Radar(GPR), Ultrasonic Pulse Echo (UPE), and Impact Echo (IE)).
- Development of software tool for visualization of data using data fusion technique by combining radar, ultrasonic pulse echo and impact echo.
- Evaluation of various inclusions, defects, thickness and voids in concrete structures using multi-sensor techniques.

NDT-DATA-FUSION



Project Investigators Partnering Institutions



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Progress Achieved

A systematic approach for fusion of multi-sensory nondestructive testing (NDT) data was developed to improve the detectability of honeycombs by fusing the information from the three different sensors. A prototype (demonstrator) was developed at BAM (GER) and was delivered to CSIR-SERC (IND). Tests in laboratory and preliminary field tests were carried out with this demonstrator. Data was collected on a number of large scale concrete specimens containing distinct built-in honeycombing defects and varying thickness. The description of the concept for software integration and outline of the visualization concept has just begun. A description of the technology, which enables the scanner to move in its foreseen grid and schedule, has already been made. The system is able to acquire data from commercially available sensors. The collected data is display to the operator immediately. Data Processing (filtering, noise removal etc.) has been implemented for UPE and GPR data. Fig. 1 shows the data collection using automated scanner with radar and UPE on a large concrete slab containing different sizes of honeycombs with two layers of reinforcement mesh. Field tests under consideration of typical practical problems were performed in diaphragm walls and parking garages. The evaluation of the performance of the approach will be conducted as soon as the experimental investigations are completely evaluated.

The automated scanner has been erected on the vertical face of a concrete wall in the laboratory using suction feet and trial runs were performed. Measurements are being planned on a large scale I-girder beam of 20 m span as part of the field studies. Investigations for the nondestructive testing of pitting corrosion have been initiated. The schedule for this experiment includes multi sensor reference measurements in the beginning. Afterwards the chloride is induced to the concrete and pitting corrosion is initiated on pre-defined locations. Afterwards new features indicating pitting corrosion are to be found. Corrosion data in field was already collected and will be evaluated after the laboratory investigations are completed.

Publications:

- ❖ P. Srinivasan, & S.G.N. Murthy, "State of the art in the automated scanning of NDT in concrete" CSIR-SERC Research Report No. R & D -02 CLP-004-RR-01, December 2013
- ❖ P. Srinivasan, & S.G.N. Murthy, "Evaluation of voids and reinforcement in thick concrete slabs using radar and ultrasonic pulse echo", CSIR-SERC Research Report No. R&D-02 CLP-0041, May 2014
- ❖ C.Völker and P.Shokouhi, "Multi sensor data fusion approach for automatic Honeycomb detection in concrete," NDT&E, Vol. no.71, pp .54-60, April 2015.
- ❖ P. Srinivasan, D. Ramakrishnan, S. Maruthi, "Determination of spacing and radius of rebar in concrete specimen", CSIR-SERC Research Report No. R&D-03, CLP-0041, May 2015
- ❖ C. Völker and P.Shokouhi, "Clustering Based Multi sensor data fusion for Honeycomb detection in concrete", Journal of NDE, 01/2016; 34(4):34:32 1-10, September 2015.
- ❖ P. Srinivasan, S.G.N Murthy, D. Ramakrishnan and K. Vasanth, "Evaluation of Thickness and Defects in Diaphragm Walls Using Impact Echo", International Journal of Applied Engineering Research (IJAER), Volume 10, Number 62(2015), Special Issues, pp.428-430.
- ❖ P. Srinivasan, S.G.N Murthy, D. Ramakrishnan and K. Vasanth, "Evaluation of Thickness and Defects in Diaphragm Walls Using Impact Echo", International Journal of Applied Engineering Research (IJAER), Volume 10, Number 62(2015), Special Issues, pp.428-430.
- ❖ Visualization of automated multi-sensor NDT assessment of concrete structures (NDT Data Fusion) - Poster presented at the IGSTC Annual Event, 2016. ●



VISUALIZATION OF AUTOMATED MULTI-SENSOR NDT ASSESSMENT OF CONCRETE STRUCTURES (NDT DATA FUSION)



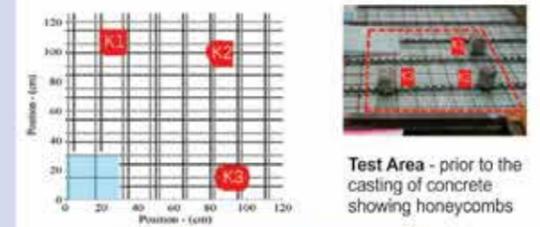
The project :

- Regular inspection of concrete structures is necessary to assess their condition and to get data to serve as a base for planning maintenance and repair.
- Concrete inspection for structure (damages) and material properties (deterioration) is not possible with a single method approach.
- Effects of deterioration processes and structural changes are non-uniform in nature and must be addressed by a multi-method approach.

Project goals:

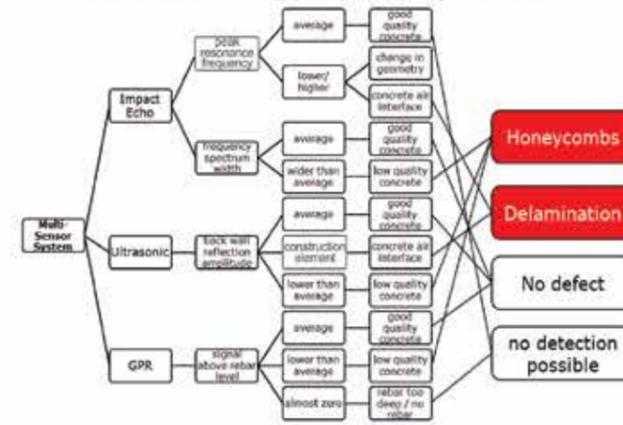
- Development and implementation of automated scanner system for multi sensor data collection
- Development of software tool for visualization using data fusion techniques
- Validation at laboratory level and application in field investigations

Laboratory Investigations

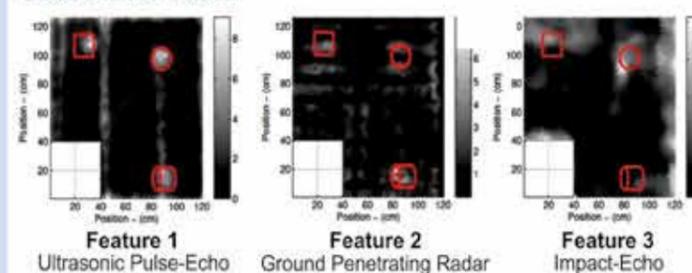


Field measurement using Automatic Scanner

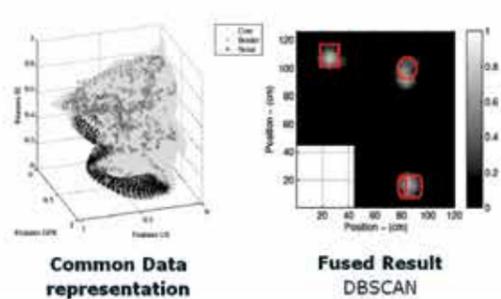
Fusion strategy for honeycombs



Data set for fusion



Fusion result with DBSCAN



Progress achieved:

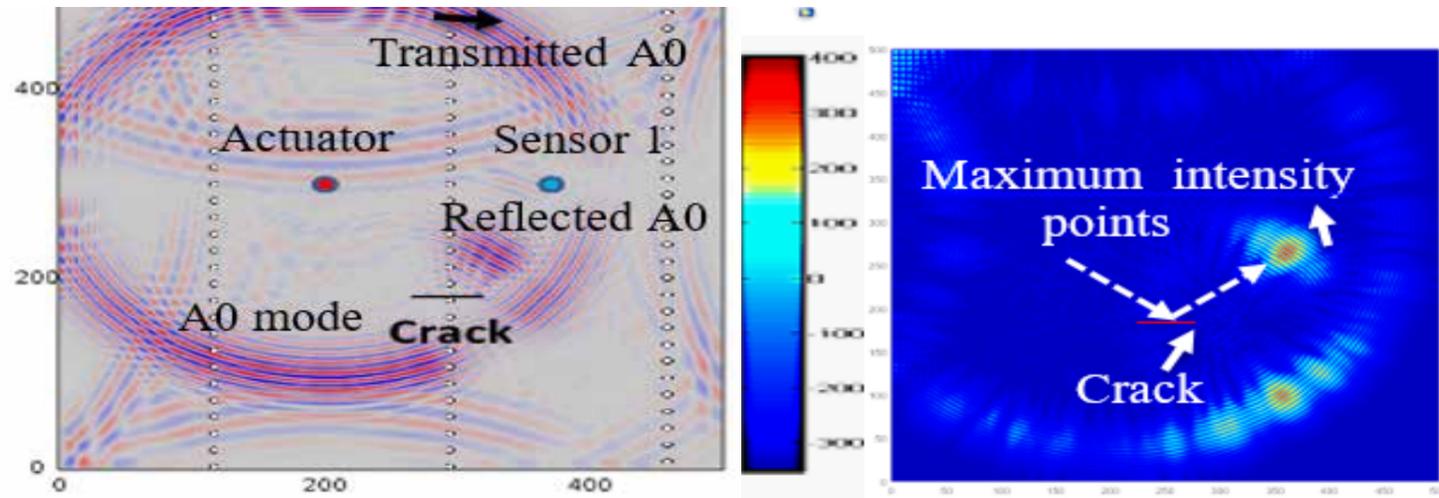
- Automatic scanner able to acquire data from commercially available sensors was developed at BAM (GERMANY) and installed at CSIR-SERC (INDIA). Data Processing (filtering, noise removal etc.) has been implemented
- Different voids (honeycombs and pitting corrosion) have been addressed in laboratory investigations
- Field tests under consideration of typical practical problems were performed in parking garages, diaphragm walls etc.
- Part of the work has been published in NDT&E International, Journal of Nondestructive Evaluation, International Journal of Forensic Engineering, International Journal of Applied Engineering Research and in conferences.

References :

- C. Völker, P. Shokouhi, "Multi sensor data fusion approach for automatic Honeycomb detection in concrete", NDT&E int. 71, 54-60 (2015).
- C. Völker, P. Shokouhi, "Clustering based multi sensor data fusion for honeycomb detection in concrete", Journal of Nondestructive Evaluation 34, 34:32 1-10 (2016).
- P. Srinivasan, K. Ravisankar, S. Thirugnanasambandam, "Forensic evaluation of a large reinforced concrete specimen using radar and ultrasonic pulse echo", International Journal of Engineering, USA, Volume 1, No. 3/4, pp.198 - 208 (2013).
- Srinivasan, P. Murthy S.G.N, Ramakrishnan, D, Vasanth, K. "Evaluation of Thickness and defects in diaphragm walls using Impact Echo", International journal of Applied Engineering Research, Volume 10, Number 62, Special Issues, pp.428-430 (2015).
- Srinivasan, P, Murthy S.G.N, Ramakrishnan, D, Vasanth, K. "Evaluation of Diaphragm walls With Ultrasonic Pulse Echo and Impact Echo -A Case Study".
- Srinivasan, P, Murthy S.G.N, Ramakrishnan, D, Wiggerhauser, H "Rapid NDT Assessment of Concrete Structures using Multi-sensor".



Integration of non-destructive evaluation based ultrasonic simulation



The Project

A means to optimize structural design and specifically the structural health monitoring (SHM) systems associated to those is achieved by simulation. Many of the simulation tools and algorithms for SHM have been developed at disparate locations and for specific applications. The wide field of SHM encompassing subjects such as materials, structures, fatigue and fracture, physical principles of non-destructive testing (NDT), and possibly much more requires a thorough configuration of networked simulation tools and algorithms leading to something being considered as an open platform for SHM systems simulation and configuration. The main objective of INDEUS is therefore to:

- ❖ establish a simulation platform in non-destructive evaluation (NDE) with an emphasis on SHM;
- ❖ facilitate the understanding of physical parameters travelling through arbitrary structures;
- ❖ identify an optimum transducer configuration for structures to become self-monitoring in the sense of SHM.

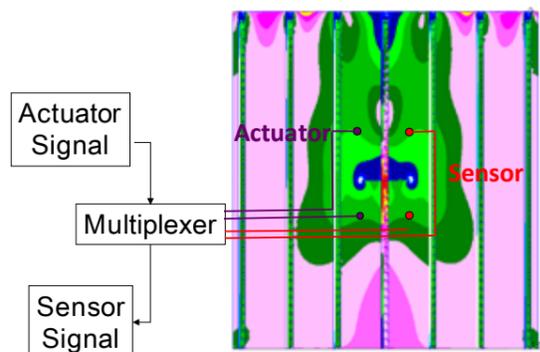


Fig. 1: Principle of a SHM system presented on the simulation result of the damage probability in a stiffened panel of an aircraft fuselage

Progress Achieved

- ❖ A simulation platform developed by integrating simulation data across various existing tools and analyzing the data through an SHM simulation software developed.
- ❖ Ultrasonic wave based techniques for inspection of defects in structural components were simulated and the simulation results were validated with prototypic testing in India and Germany.
- ❖ NDE inspection of various types component was successfully simulated using the simulation platform and process.
- ❖ Probabilistic approach for damage growth simulation due to fatigue loading was incorporated in the simulation platform
- ❖ SHM sensor system consisting of a network of piezoelectric transmitters and receivers integrated on the structure was optimized with the help of probabilistic damage information from simulation and ultrasonic simulation data as guiding information.
- ❖ Inspection of a repaired structure with composite material patch was simulated and the test results were validated through testing of a prototype stiffened panel of aircraft fuselage skin.
- ❖ The overall outcome from the project is the simulation platform and the demonstrated processes that will help to create SHM based concept of designing structures and develop necessary process for realizing such concept in actual hardware to meet emerging application needs in aerospace and infrastructure health monitoring.

Publications:

- Integration of Non-Destructive Evaluation based

Project Investigators Partnering Institutions



D Roy Mahapatra
Indian Institute of Science
Bangalore



Christian Boller
Universität des Saarlandes
Saarbrücken



Dwarakanath Krishnamurthy
Tech Mahindra
Bangalore



Rainer Franke
Materialforschung und Anwendungstechnik GmbH
Dresden

- Ultrasonic Simulation (INDEUS) – A Means for Simulation in SHM, Christian Boller, D. Roy Mahapatra, Ramanan Sridaran Venkat, Nitin Balajee Ravi, Nibir Chakraborty, Rakesh Shivamurthy, Keerthy M. Simon, SHM Journal (under review) Dec 2016.
- A Study of Effectiveness of an SHM Sensor System for Fatigue Damage Inspection, Nitin B Ravi, Nibir Chakraborty, Mirko Steckel, Punith Betagiri, Padmanaban Raghuraman, Rakesh Shivamurthy, Ramanan S Venkat, D Roy Mahapatra, Christian Boller, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.
- Simulation Based Optimization of Sensor Network for SHM of Complex Structures, Nitin B Ravi, Nibir Chakraborty, D Roy Mahapatra, 8th European

- Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.
- Ultrasonic Guided Wave Simulation Performance Evaluation for QNDE-SHM Processes Nitin B Ravi, Ramanan S Venkat, Nibir Chakraborty, D Roy Mahapatra, Christian Boller, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.
- Integration of Non-Destructive Evaluation based Ultrasonic Simulation (INDEUS) A Means for Simulation in SHM, Christian Boller, D Roy Mahapatra, Ramanan S Venkat, Nitin B Ravi, Nibir Chakraborty, Peter Starke, Mirko Steckel, Dwarakanath Krishnamurthy, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.
- Ultrasonic Guided Wave Sensor Network Optimization for Monitoring Rivet Line, Nitin B. Ravi, Nibir Chakraborty, D. Roy Mahapatra, 10th International Workshop on Structural Health Monitoring 2015 (IWSHM 2015), 1-3 September 2015, Stanford, USA
- Optimized Actuator/Sensor Combinations for Structural Health Monitoring: Simulation and Experimental Validation, 1-3 September 2015, Stanford, USA, C. Boller, N. B. Ravi, N. Chakraborty, G. S. Kamalakar, K. Ukirde and D. Roy Mahapatra, 10th International Workshop on Structural Health Monitoring 2015 (IWSHM 2015), 1-3 September 2015, Stanford, USA.
- Modeling ultrasonic NDE and guided-wave-based structural health monitoring, Nitin B Ravi, Vivek T Rathod, Nibir Chakraborty, D Roy Mahapatra, Ramanan Sridaran, Christian Boller, SPIE Smart Structures and Materials+ Nondestructive Evaluation and Health Monitoring, 2015, April 1, Proc. SPIE, 9437, Structural Health Monitoring and Inspection of Advanced Materials, Aerospace, and Civil Infrastructure 2015, 94371V.



Fig. 2: Experimental validation of crack propagation under fatigue stress in stiffened panels of an aircraft fuselage

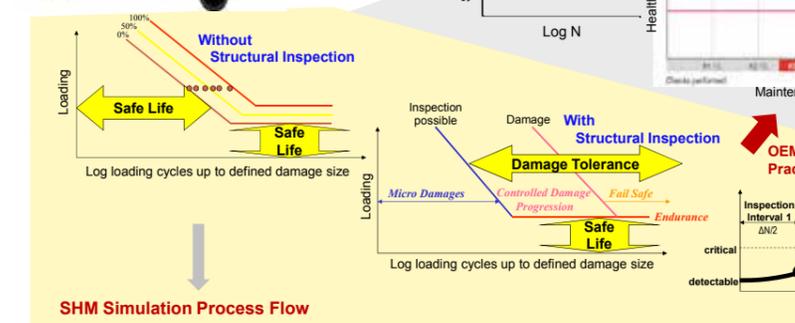
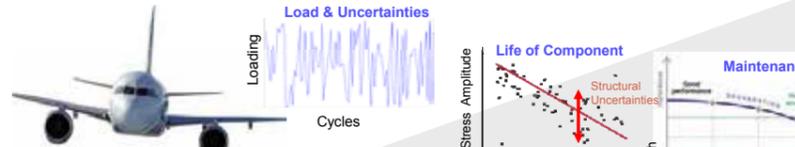


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UNIVERSITÄT DES SAARLANDES

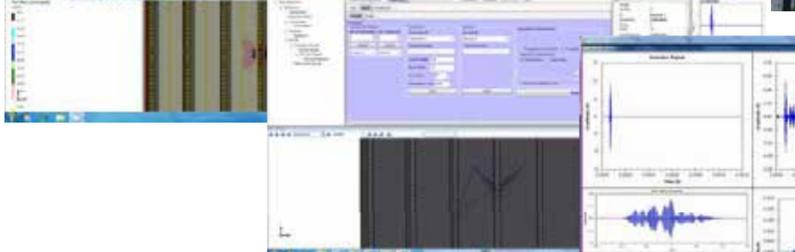
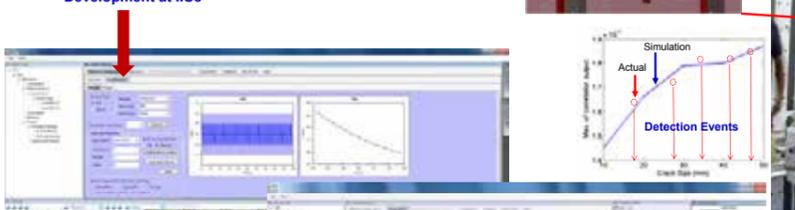
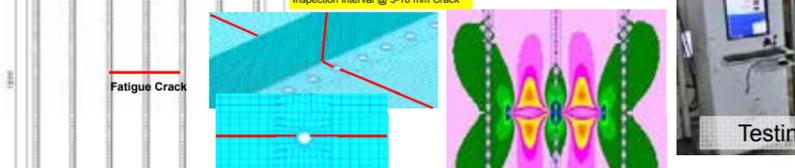
IMA DRESDEN

Structural Failure and Damage Tolerance



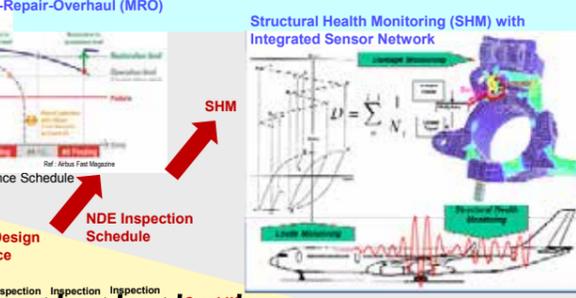
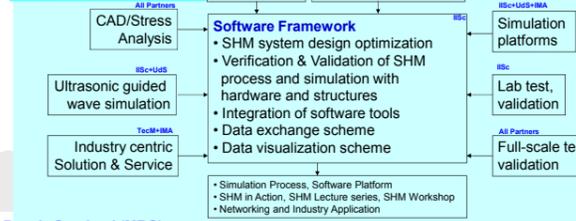
Loads → Geometry CAD/CAE → Stress & Strain (FE) → Damage Accumul. → NDT Simulation → SHM Simulation → Experimental Validation → SHM System Design/ Process Qualification

• Ultrasonic Guided Wave
• Optimal Sensor-Actuator
• Probable Damage Location
• Probability of Detection



Industry Centric SHM Simulation Workshop using INDEUS Platform
International Conference on NDT in Aerospace, 3-5 November, 2016, Bengaluru

Project at a Glance

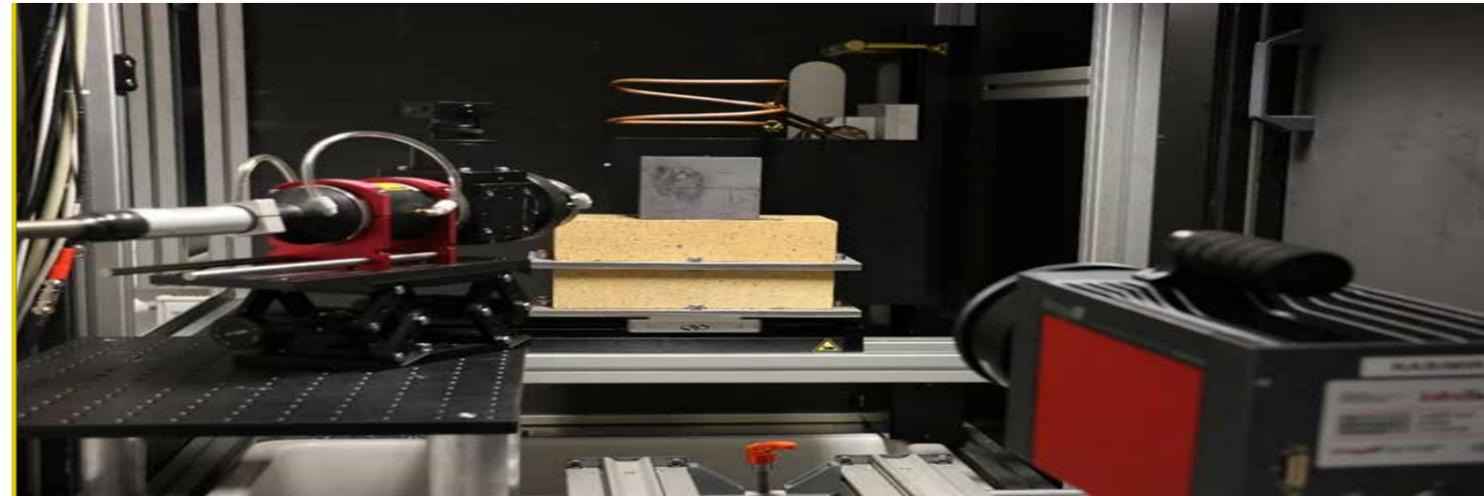


- ### NDE + SHM Goals
- Detect damages of specified size reliably using integrated sensors
 - Eliminate any need for scheduling manual inspection
 - Provide confidence in damage monitoring to determine when to discard components
 - Provide design input toward building lighter and safer structures



- ### SHM Simulation Output
- When to start monitoring damages
 - Where to monitor damages
 - How often to inspect
 - When to repair or discard the structure

Advanced manufacturing process monitoring using in-line laser thermography - AMPLAST



The Project

The project will deliver new and improved NDE measurement methodologies capable of providing measurements of the state of the process and the product, under hostile manufacturing conditions, that would otherwise be impossible. The technique to be developed in this proposed project involves the novel complementary utilization of laser based excitation and the spatially and temporally resolved detection of the transient thermal flux radiation from regions of interest and to consequently obtain key material and process related parameters that pertain to the state of the manufacturing process/product. Some of the measured parameters include surface and sub-surface cracks, surface and sub-surface temperatures, anisotropy, surface hardness, etc. The work will eventually lead to the creation of new sensing methodologies for the in-situ measurement of parameters that critically influence the performance of the manufacturing process and the manufactured product. The development of advanced process measurement and monitoring technologies will lead to cost savings by reducing rejects during production, improving the quality of the products through improved real-time process control, and assist in the efforts of core industries to improve productivity by reducing downtime. Plant and product safety and reliability will improve as measurement resolution and reliability improves, with improved procedures becoming integrated into relevant standards.

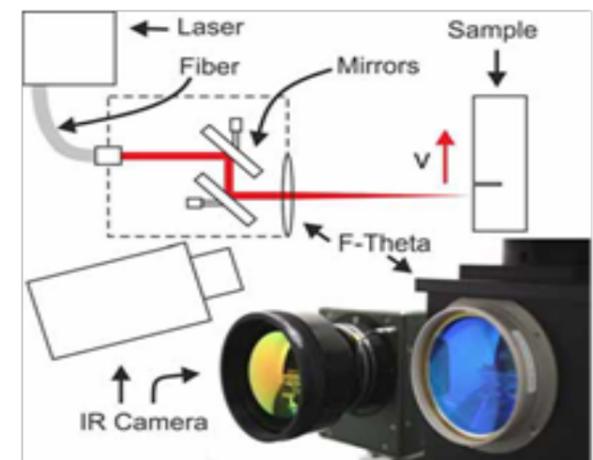


Fig. Experimental Schematic

AMPLAST

Project Investigators Partnering Institutions



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IIT Madras
Chennai



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IIT Madras
Chennai



Mathias Ziegler
BAM
Berlin



S Alavudeen
Dhvani Research and Development Solutions
Pvt Ltd, Chennai



Matthias Krauß
InfraTec GmbH
Dresden

Progress Achieved

- ❖ development of Laser-thermographic testing method for the detection of surface cracks at hostile environmental conditions as found in industrial steel production
- ❖ evaluation and characterization of the crack detection method
- ❖ optimization and characterization of the crack detection method
- ❖ optimization of the crack detection schemes (analysis algorithm, on-line capability)
- ❖ implementation of an on-site testing system; validation under industrial production environments (field study)
- ❖ development, validation and optimization of theoretical models and simulation themes for an enhanced understanding of the method
- ❖ development and evaluation of a Lab system allowing anisotropy measurements, accompanied by theoretical modelling and simulations for a validation of the experimental results
- ❖ Laser-thermographic testing setup was established and characterized allowing measurements under controlled conditions which match realistic production environments
- ❖ first experiments prove the general operability of the concept and allow preliminary estimations on performance and reliability
- ❖ algorithms for analyzing the acquired data were developed and tested
- ❖ FEM simulations were established for a comparison and evaluation of the experimental results
- ❖ a set of experimental data was acquired for a parametric evaluation of the method

Any other relevant points:

- i. Honorable Minister at Ministry of Science and

Technology Dr. Harsh Vardhan visited BAM (Germany) and witnessed AMPLAST research in August 2016.

- ii. Workshop + Project Meeting 21-22.6.2016 at BAM in Berlin; visit of company headquarter InfraTec GmbH in Dresden (Germany)

Publications:

- i. U. Sreedhar, C. V. Krishnamurthy, K. Balasubramaniam. Heat diffusion in Polycrystalline Materials- A microstructure based material model: Quantitative Infrared Thermography Conference QIRT-Asia, Mahabalipuram, India, July 6-10, 2015.
- ii. P. V. Nithin, U.Sreedhar, C. V. Krishnamurthy, M. Zeigler, P. Myrach and K. Balasubramaniam. In-line Laser Thermography for Crack Detection: A Numerical Approach: Quantitative Infrared Thermography Conference QIRT-Asia, Mahabalipuram, India, July 6-10, 2015.
- iii. Nithin Puthiyaveetil, Sruthi Krishna, Renil Kidangan, Sreedhar Unnikrishnakurup, C V Krishnamurthy, Mathias Zeigler, Philipp Myrach and Krishnan Balasubramaniam. In-line laser thermography for crack detection at elevated temperature: A Numerical modeling study, Quantitative Infrared Thermography Conference QIRT Gdańsk, Poland, July 4-8, 2016
- iv. Mathias Ziegler, Benjamin Polomski, Sreedhar Unnikrishnakurup, Nithin Puthiyaveetil, Krishnan Balasubramaniam, Philipp Myrach Thermographic Crack Detection in Hot Steel Surfaces, 19th World Conference on Non-Destructive Testing (WCNDT 2016), Munich, Germany, 13-17 June 2016.
- v. Nithin Puthiyaveetil, Renil Kidangan, Sreedhar Unnikrishnakurup, C V Krishnamurthy, Mathias Zeigler, Philipp Myrach and Krishnan Balasubramaniam, In-line laser thermography for fast detection of defects at elevated temperature, Non-Destructive Evaluation 2016, Thiruvananthapuram, India, Dec 15th to 17th 2016. ●



Advanced Manufacturing Process Monitoring using in-line Laser Thermography (AMPLAST)



MAIN GOAL OF AMPLAST

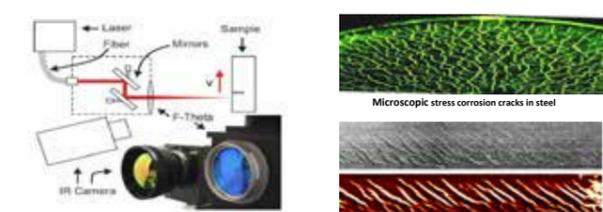
CREATE quantitative, rapid, and non-destructive laser thermographic testing techniques FOR in-line manufacturing process monitoring that can withstand difficult processing environments AND allow for reliable measurements adding value to industries

MOTIVATION FOR MAIN OBJECTIVE

- Manufacturing industries (primary and secondary stages) require process monitoring through measurement of critical product (materials) parameters
- Such measurements must be quantitative and are required to be performed at appropriate stages of manufacturing in order to reduce waste and to improve performance and production rates
- The measurements must be NON-INTRUSIVE, NON-CONTACT AND NON-DESTRUCTIVE and must be able to handle the speed of production
- The measurements must be tolerant to the hostile processing environment
- Capable for Defect detection, product + material properties determination, Application of different material system

PROCESS CAPABILITY OF LASER THERMOGRAPHY

CRACK DETECTION



- Surface scan with high-power laser beam
- Simultaneous detection of temperature inhomogeneity pointing towards the presence of surface breaking cracks
- Sensitivity is comparable to standard magnetic particle and dye penetration testing (performed off line and in contact)
- Non-contact & online/inline capabilities

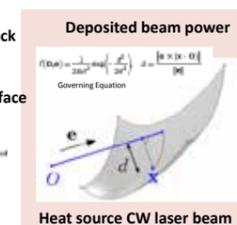
RESEARCH PLAN - MAJOR STRUCTURE

- WP 1: Study 1 - Detection of surface cracks in steel billets in hot
- WP 2: Study 2 - Anisotropy of Rolled Steel Sheets
- WP 3: Study 3 - Temperature measurements during heat treatment in Furnace
- WP 4: Implementation of the user friendly software system

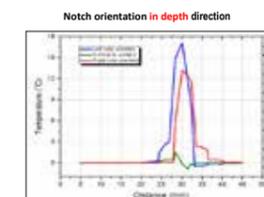
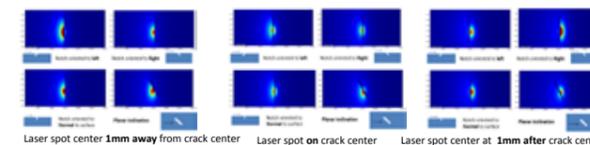
WP 1: DETECTION OF SURFACE CRACKS IN STEEL BILLETS IN HOT CONDITION

3D MODELING : EFFECT OF CRACK ORIENTATION IN CRACK DETECTION

- Model created in Comsol Multiphysics 5.1
- A notch is introduced perpendicular to the block surface
- Block material is Stainless steel
- A laser spot is used to scan over the metal surface
- Physics Used : Heat transfer in solids
- Heat conduction equation $\rho C_p \frac{\partial T}{\partial t} + \rho C_p \nabla \cdot \mathbf{q} = 0 + Q_{ext}$ where $\mathbf{q} = -k \nabla T$
- Initial surface temperature: 300K

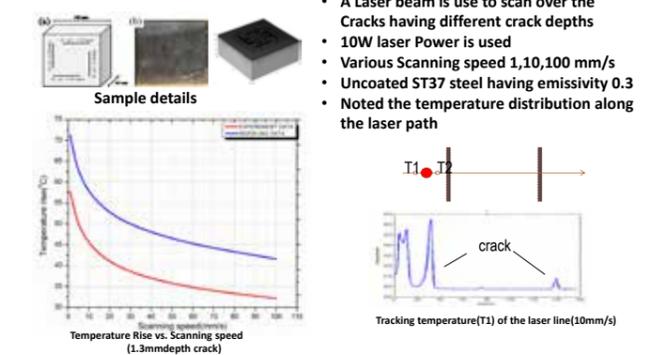


HEAT DISTRIBUTION PATTERN NEAR TO THE CRACK



- > Heat retentivity is more when the notch is oriented towards the scanning direction.
- > There is a marginal variation in temperature rise in the case of inclined cracks compared to normal

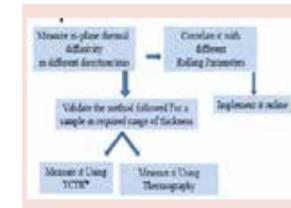
EXPERIMENTAL VALIDATION



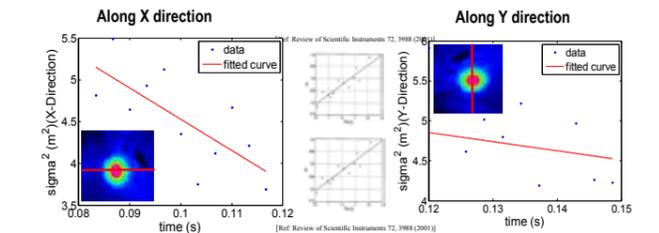
Both simulation and experimental data giving almost comparable results, there is some variation in temperature rise mainly due to the emissivity variation

WP 2: ANISOTROPY OF ROLLED STEEL SHEETS

THERMAL DIFFUSIVITY MEASUREMENTS

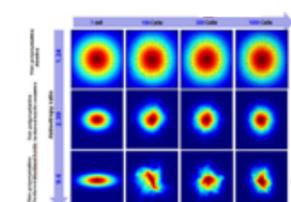


- Spatially Resolved method
- It is for in-plane thermal diffusivity measurement
- A sample of thickness L is heated using a Gaussian pulse
- The angular coefficient of the straight line describing the Gaussian widening as
- A function of time is eight times the thermal diffusivity of the material



- The slope will be negative as the reducing radius of the spot is taken for calculation
- Hence absolute value of the slope is taken for calculating thermal diffusivity
- Horizontal Diffusivity is 3.9891 m²/s Vertical Diffusivity is 2.4256 m²/s

2D FE MODELING TO STUDY THE ANISOTROPY FACTOR OF ROLLED METAL SHEETS



- As an initial step to study the anisotropy in rolled steel a microstructural based material model is developed. implemented using the commercial FEM software COMSOL Multiphysics.
- The first column results corresponds the single crystal domain and rest for different number of crystals.
- It is observed that the anisotropic effect is vanishing when the heat passes through different orientations. The averaging taking place and this effect increases with the increase in number of cells in the domain.

VISIBLE OUTPUTS

- P. V. Nithin, U. Sreedhar, C. V. Krishnamurthy, M. Zeigler, P. Myrach and K. Balasubramaniam. In-line Laser Thermography for Crack Detection: A Numerical Approach: *Quantitative Infrared Thermography Conference QIRT-Asia*, Mahabalipuram, India, July 6-10, 2015.
- U. Sreedhar, C. V. Krishnamurthy, K. Balasubramaniam. Heat diffusion in Polycrystalline Materials- A microstructure based material model: *Quantitative Infrared Thermography Conference QIRT-Asia*, Mahabalipuram, India, July 6-10, 2015.
- P. V. Nithin, U. Sreedhar, C. V. Krishnamurthy, M. Zeigler, P. Myrach and K. Balasubramaniam. The Effect of Surface Breaking Crack Orientation Detection Capability : A Laser Thermography Numerical Modeling Approach: NDE-2015, Hyderabad, India, November 26-27, 2015



Design and development of hollow crankshaft for automobiles



Fig : Shaft Prototype

The Project

The awareness of climate change and the limited availability of resources demands reconsideration of the resources used in vehicle production. Also according to the current scenario of automotive industries, designers are focusing on the development of lightweight, compact and high pressure engines. This demands downsizing of the engine components without compromising its strength. The consistent use of lightweight components in conventional automobile leads to a reduction in fuel consumption and also to a reduction in CO2 emissions.

The objective of the project is development of a new, innovative design for lightweight crankshaft (an automobile engine component) and efficient manufacturing process of the developed lightweight crankshaft. Real prototypes will be produced by appropriate and cost effective manufacturing technologies. With the help of the prototypes, achievable effects regarding lightweight design, increase of manufacturing efficiency, cost

minimization, its performance etc. will be validated and further potentials will be estimated.

Another objective of the project is strengthening of Scientific Cooperation between Indian and German Partners.

The main goals of the project were:

- ❖ Design - Definition of specifications, shaft design, design evaluation (simulation) / optimization (if required)
- ❖ Development of Process Chain - identification / evaluation of processes, feasibility studies / optimization, definition of appropriate process chain
- ❖ Realization of prototypes - Design / construction / testing of required tools / rigs, prototyping, optimization Loops (if required)
- ❖ Evaluation of Prototype Shafts - Prototype tests (test rigs, real cars), identification of optimization approaches, optimization loops (if required)

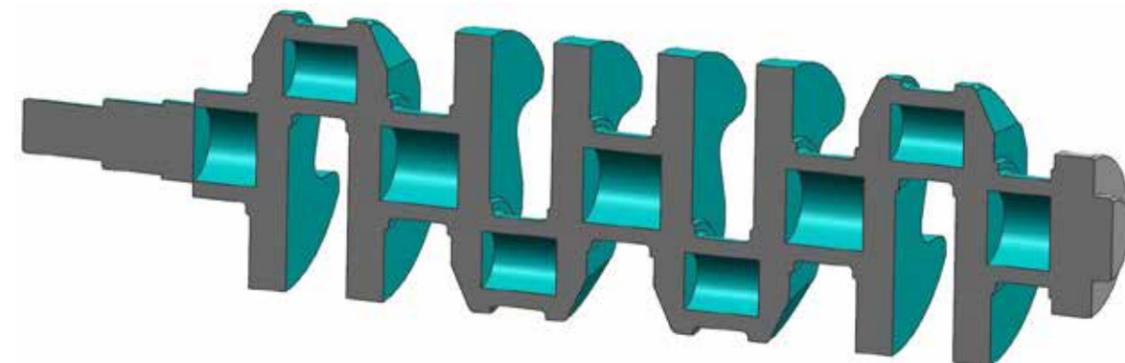


Fig. 1 Hollow Crankshaft

Project Investigators Partnering Institutions



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CSIR- CMERI
Durgapur

A Sterzing
Fraunhofer – IWU
Chemnitz



Rajkumar P Singh
Bharat Forge Ltd
Pune

I Seidel
Seidel Werkzeugbau GmbH
Erbisdorf



Progress Achieved

- ❖ Base Crankshaft Finalization –The crankshaft is selected based on its application, engine capacity, number of cylinders, annual production volume and possible weight reduction. The possible weight reduction for selected crankshaft is around 20 to 25%.
- ❖ Conceptual Design and Manufacturing Process - We did literature survey over patents, publication and published articles on Hollow crankshaft. Based on the literature survey, we have developed various conceptual designs. The finalized conceptual design was evaluated on the basis of manufacturing feasibility, strength, stiffness and cost etc. Along with the conceptual design the appropriate and feasible manufacturing process chain was also developed.
- ❖ **Crankshaft Material Selection**- The material selection for crankshaft was done based on manufacturing process (forging, machining and welding) involved and required metallurgical parameters. Micro-alloyed steel is suitable as it contains micro-alloying elements which precipitates at higher temperature and restricts uneven grain growth. The resulting grain structure achieved in finely distributed grains without external heat treatments. This resulted into better mechanical and fatigue properties.
- ❖ **Hollow Crankshaft Segment Dummies** – Using cutting technologies to prepare hollow rod bearing dummies and joining technology to realize 1-cylinder dummies out of selected material, two series of test specimen could be manufactured for testing of torsion and bending life-cycle-investigations. The

results can be compared to the done Finite Element Analysis and used to optimize whole process chain.

- ❖ **Crankshaft Geometrical Design** – Using 3D CAD modeling and Finite Element Analysis, the crankshaft geometrical design was finalized. Optimizing various geometrical parameters of crankshaft, the weight reduction (around 25%) is achieved without compromising its strength and stiffness. The finalized lightweight geometrical design was analyzed against various crankshaft design criteria's like bending & torsional stresses, bending and torsional rigidities, bearing reactions, balancing, deflection in bending etc. Residual stresses due to the joining process were realized by the Finite Element Simulation on the crankshaft model using Goldak's double ellipsoidal heat source model. Sequential thermal and mechanical analysis has been carried out to approximate the residual stresses. Transient thermal analysis for a duration of 370s (189s for moving the heat source and remaining time for cooling purpose) has been performed.
- ❖ **Prototype manufacturing** – The forging design of hollow crankshaft prototypes is in final steps. After finalizing the forging design, the tools and dies will be manufactured.
- ❖ **Testing of prototypes** – The bending and torsion fatigue testing of base crankshaft is running on the test rig. The results of this will help in comparing with the results of prototype fatigue testing and further optimization to the design based on the comparison. Along with fatigue testing the engine testing of full hollow crankshaft prototype is also planned. ●



Objective:

The aim of the project is to develop new innovative lightweight “Hollow Crankshaft Design” having better strength & stiffness characteristics.

KEY FEATURES

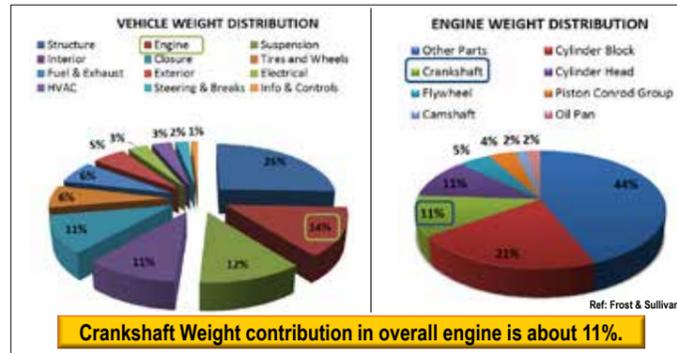
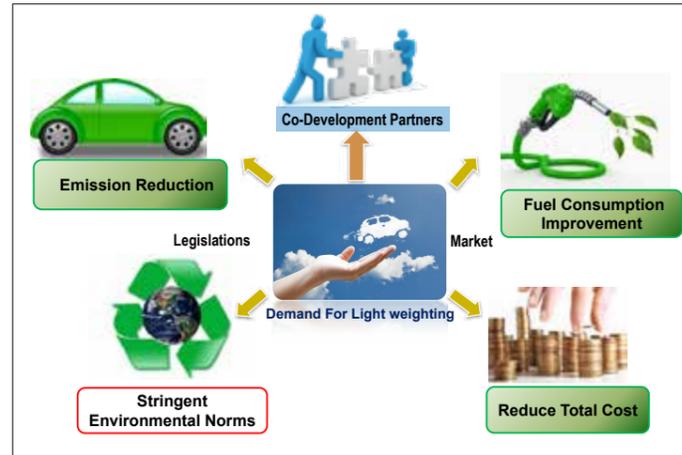
- Lightweight design keeping Strength & Rigidities intact.
- Minimization of Material & Energy inputs.
- Use of Innovative Technologies.
- Modified Prototype Design for Higher Series Flexibility.

APPROACH

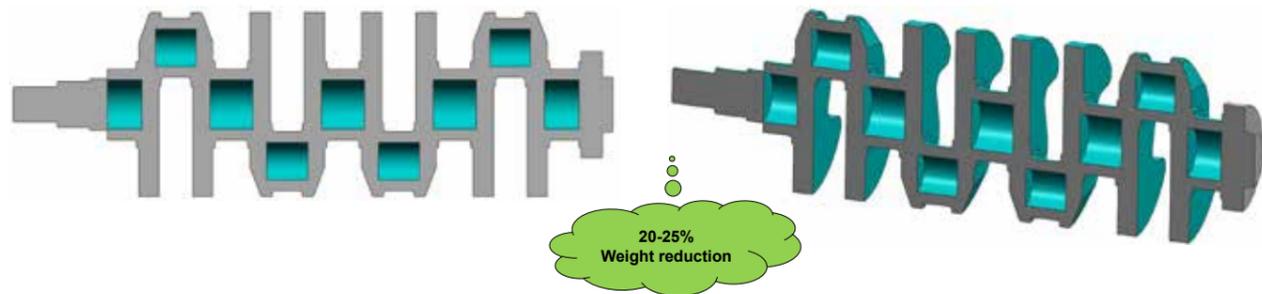
- Selection of relevant demonstrator shaft (Utility Vehicle).
- Conceptual design.
- Theoretical evaluation and optimization.
- Realization of prototype.
- Proof of required characteristics/function and effects.
- Fatigue & Engine Testing Validation.

BENEFITS

- Innovative Lightweight crankshaft Design.
- Engine Emission reduction.
- Better Engine Performace.
- Minimization of Fuel Consumption (Operation).



Crankshaft Weight contribution in overall engine is about 11%.



Manufacturing using Forging and Fabrication Process

BHARAT FORGE

- Crankshaft Conceptual design.
- Design Optimization.
- FE Analysis
- Prototype Testing
- Engine Testing

CNERI

- Testing of Virtual prototype.
- Welding simulation
- Design optimization

Fraunhofer IWU

- Process Development
- Design of process chains.
- Prototype Manufacturing

SWB SEIDEL WERKZEUGBAU GmbH

- Realization of tools.
- Realization of test jigs

Design of selective nanoporous membrane bioreactor for efficient production of bio-butanol from lignocellulosic sugars



Source : Shutterstock

The Project

Rising demand for fuels, increasing cost of production, dwindling supply of fossil resources, and negative impact of fossil fuels on the planet have led to massive efforts being launched across the globe for development of technologies that would provide sustainable alternative. Liquid biofuels are essential and the world has decided generally to move rapidly from the food-competing first generation bio-fuels to second generation alternatives viz. bio-ethanol, bio-butanol. The project focuses on designing bioreactor for efficient production of bio-butanol. The essential requisites for making bio-butanol cost competitive are access to cheaper cellulosic fermentable sugars as raw material and better cost of production through higher yield on sugars, higher volumetric rate of production and cheaper recovery/purification technologies. The objective of the project is to design a selective nanoporous membrane bioreactor for efficient production of bio-butanol from lignocellulosic sugars. Membranes, membrane process and fermentation will be adapted to each other and optimized before fermentation and membrane preparation will be scaled up to a semi technical scale. The integration of the novel membrane with high butanol/water selectivity and high butanol permeance with the bioreactor (fermenter) will

enable: (1) continuous recovery of butanol from bioreactor thereby giving butanol production at higher rate without inhibition or toxic effects on the metabolizing cells, and (2) continuous upgrading of butanol from low concentration broth of < 1 wt% to > 8 wt%. The direct combination of the new membrane technology with continuous FBR based fermentation is allowing energy and cost efficient butanol production. It opens the opportunity of using sugar derived from lignocellulosic agricultural residues for sustainable and economic 2nd generation bio fuels. Expected deliverables are.

- ❖ development of organophilic zeolite and mixed matrix membrane and membrane characterization by micro-characterization and separation tests in synthetic mixtures;
- ❖ building required membrane housing and basic engineering;
- ❖ fabrication of the membrane plant and integration with ICT fermenters;
- ❖ integrated fermentation-recovery runs process optimization at 5L scale;
- ❖ scale up to Pilot level at 500-5000L scale.

SENAMEB

Project Investigators Partnering Institutions



Arvind Mallinath Lali
Institute of Chemical Technology
Mumbai



H Richter
Fraunhofer - IKTS
Dresden



Sanjeev G Patil
Privi Biotechnologies Pvt. Ltd.
Navi Mumbai



P Mund
Atech Innovations GmbH
Gladback

Progress Achieved

❖ Hydrophobic zeolite membranes designed by seeding of tubular ceramic substances with small zeolite crystals (silicalite). Membrane is prepared by mixing small zeolite particles (which are produced by milling and followed by hydrothermal treatment) with PDMS. Characterization and testing of membranes has been done by SEM/FESEM, EDX, N₂-porosimetry. Based on dimensions and performance of membrane, biobutanol reactor has been designed and the corresponding

equipment has been acquired. Bioreactor is used for fermentative production of butanol. It serves as an experimental tool to test cell recycle and proposed membrane extractive fermentation. Pervaporation membrane assembly, automated heating, cooling and vacuum assembly, off-line gas analyzer, aseptic networking of reactor and membranes and micro filtration membrane assembly are the components of bioreactor which has been acquired and assembled for functional lab-scale prototype. Further milestones are on track and expected to be as per the timeline. ●



Design of Selective Nanoporous Membrane Bioreactor for Efficient Production of Bio-butanol from Lignocellulosic Sugars - SeNaMeB

Arvind Lali¹, Aruna Agrawal¹, Hannes Richter², Marc Villvock², Manish Petkar³, Peter Mundt⁴

¹DBT-ICT Centre for Energy Biosciences, Institute of Chemical Technology, Mumbai, India

²Fraunhofer Institute of Ceramic Technologies and Systems, Hermsdorf, Germany

³Privi Biotechnologies Pvt. Ltd. (A wholly owned business of Privi Organics Limited), Mumbai, India

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Privi Organics Limited



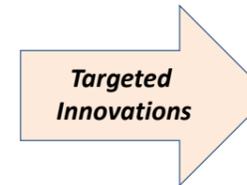
Genesis of the Proposal

1. N-Butanol: Potential Biofuel; Useful chemical and solvent
2. Current demand as Chemical > 1 million ton/year
3. All demand met through petro-source
4. Butanol derived from Renewable Feedstock preferred
5. Potential Route: Fermentation of Sugars to Butanol
6. Current Bio-Butanol Technology suffers from

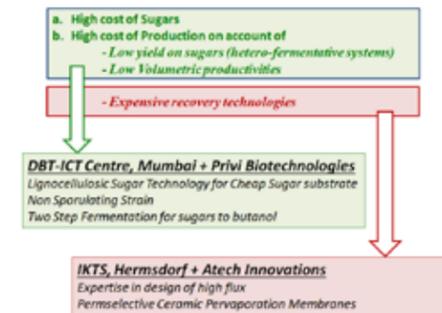
a. High cost of Sugars

b. High cost of Production on account of

- Low yield on sugars (hetero-fermentative system)
- Low Volumetric productivities
- Expensive recovery technologies



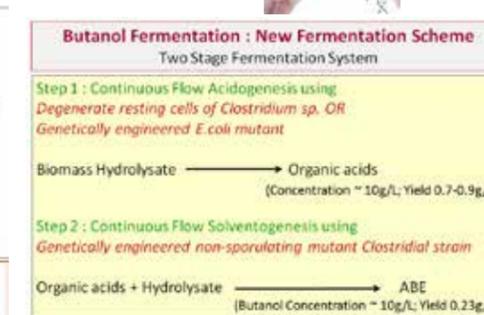
The IGSTC Project - SeNaMeB



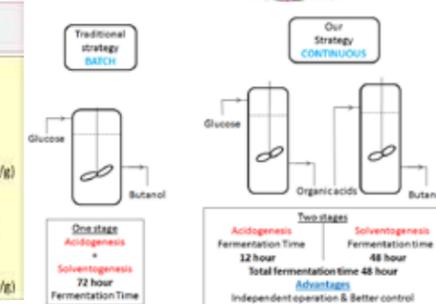
Chemical Processing Innovation



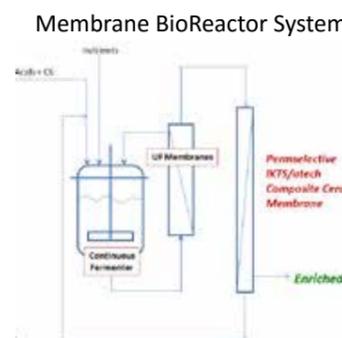
Biological Innovation



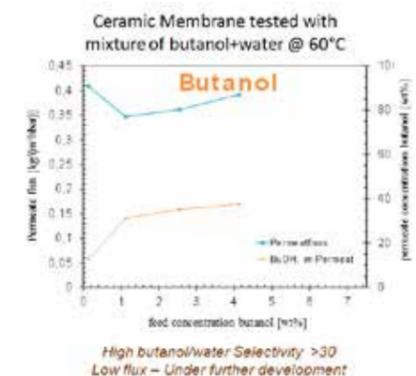
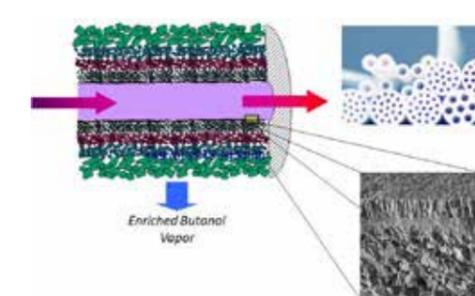
Technology Innovation



Separation Process Innovation



Innovation in Membrane Material Technology



Architecture-aware timing analysis and optimization of safety-critical automotive software



The Project

Automotive software development is concerned with careful translation of mathematically proven control laws into concurrent communicating software tasks running on complex networks of processors. With 50-100 computing elements, numerous sensors and actuators, kilometers of cabling, and more than 100 M lines of code, automotive control is one of the most complex cyber-physical systems in existence.

With our increased reliance on safety critical automotive features, the task of establishing the correctness of the implementation is a verification nightmare. While model based development practices have to some extent streamlined the reliable development of such

systems, guaranteeing timing correctness remains the biggest verification challenge, considering the stringent real time nature of automotive control.

This project brings together valuable expertise in automotive engineering from Germany with software development and verification expertise from India, towards a common goal, namely to come up with a methodology and tool flow for establishing timing convergence in automotive cyber-physical control. As we approach the completion of this challenging task, we present the forthcoming tool flow – the first of its kind – by integrating components developed by all four partners.

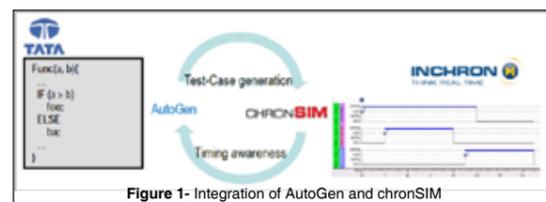


Figure 1- Integration of AutoGen and chronSIM

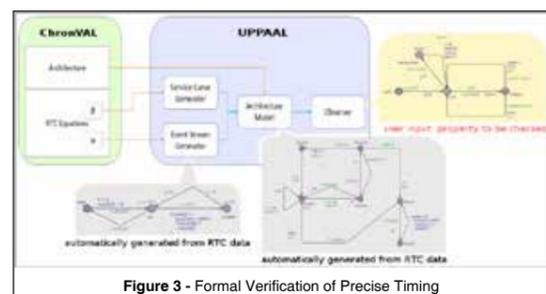


Figure 3 - Formal Verification of Precise Timing

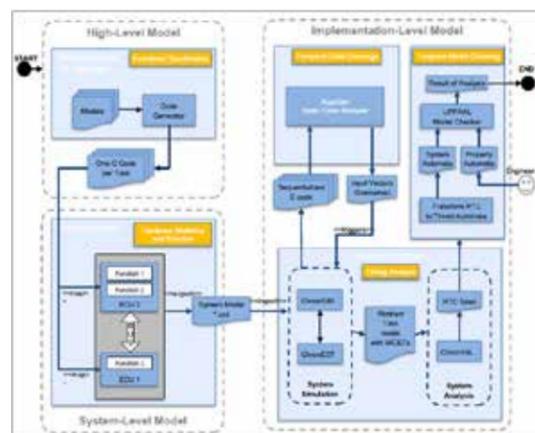


Figure 2 - AUTOSAFE Tool Chain

Project Investigators Partnering Institutions



Partha Chakrabarti
IIT Kharagpur



Pallab Dasgupta
IIT Kharagpur



Samarjit Chakraborty
TU Munich



Arun Bahulkar
Tata Research Development and Design Center
Pune



Karsten Albers
INCHRON GmbH
Postdam

Progress Achieved

In model driven development process for embedded control software, once model validation phase is over, code generated for each control task is mapped to a computational unit (ECU) on the platform on which it will execute. The code executes on the ECU at discrete intervals of time and – in each execution it analyses the data obtained from the sensors and determines the actuation levels to ensure that the plant remains within acceptable bounds of behaviour.

The modelling phase assumes the underlying computational environment to be ideal. In reality, with automotive platforms having 50-100 ECUs and complex networking, the sensor-control-actuation flow is far from ideal. One particularly annoying ramification of the non-ideal nature of the compute environment is in its inability to meet timing requirements, which has a direct impact on control performance and thereby the safety of critical control functionalities. Our goal is to develop a tool flow where the impact of the non-idealities of the compute platform on a control task can be predicted a-priori, leading to the automatic generation of a timed model of the control – the timed model can then be subjected to formal analysis to determine whether it guarantees acceptable control performance.

The overall tool flow relies on existing offerings from TRDDC and INCHRON combined with three important developments that have come out of this project. Figure 2 outlines the tool flow. The model development process is based on standard Matlab Simulink/SF platforms, as is prevalent in current industrial practice. This is followed by code generation. The generated code is passed on to the INCHRON tool suite along with a model of the platform developed in Enterprise Architect. The INCHRON tool suite is tailored towards evaluating the platform induced delay variations for the given platform and the controller code, which includes worst case execution time analysis of the

code and message passing delays, scheduler overheads, delays induced through pre-emption of tasks, etc. However, its analysis is statistical in nature and may not always hit the corner case scenarios of the code. This is where the combination of the TRDDC tool, AutGen with the INCHRON tool, chronSIM, provides some unique benefits

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- ii. Santhosh Prabhu M, AritraHazra and Pallab Dasgupta, Reliability Guarantees in Automata Based Scheduling for Embedded Control Software, IEEE Embedded Systems Letters (ESL), vol. 5, no. 2, pp. 17-20, 2013.
- iii. Kajori Banerjee, Pallab Dasgupta, Acceptance and Random Generation of Event Sequences under Real Time Calculus constraints, In Proc of of Design Automation and Test in Europe (DATE), Dresden, 2014.
- iv. Santhosh Prabhu M, Aritra Hazra, Pallab Dasgupta and P. P. Chakrabarti, Handling Fault Detection Latencies in Automata-based Scheduling for Embedded Control Software, In Proc. of IEEE Multi-Conference on Systems and Control (MSC), August 2013.
- v. Kajori Banerjee, Santhosh Prabhu M and Pallab Dasgupta, Debugging Assertion Failures in Software Controllers using a Reference Model, In Proc. of 6th India Software Engineering Conference (ISEC), 2013.
- vi. AritraHazra, PriyankarGhosh and PallabDasgupta, Reliability Annotations to Formal Specifications of Context-Sensitive Safety Properties in Embedded Systems, In the Forum on Specification and Design Languages (FDL), Vienna, Austria, September 2012



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vii. RajorsheeRaha, SoumyajitDey, P. P. Chakrabarti, PallabDasgupta, Multi-mode Sampling Period Selection for Embedded Real Time Control, Design Automation Conference (Poster), San Francisco, 2014.

viii. SumanaGhosh, PallabDasgupta, Formal Methods for Pattern Based Reliability Analysis in Embedded Systems, In Proc. of 28th Int. Conf. on VLSI Design and 14th Int. Conf. on Embedded Systems, Jan 2015.

ix. RajorsheeRaha, AritraHazra, AkashMondal, SoumyajitDey, P.P. Chakrabarti, PallabDasgupta. Synthesis of Sampling Modes for Adaptive Control, In Proc. of IEEE Int. Conf. on Control System, Computing and Engineering, Penang, Malaysia, Nov 2014.

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xii. AnandYeolekar, DivyeshUnadkat, VivekAgarwal, Shrawan Kumar, R. Venkatesh: Scaling Model Checking for Test Generation Using Dynamic Inference. ICST 2013: 184-191

xiii. Licong Zhang, Reinhard Schneider, Alejandro Masrur, Martin Becker, Martin Geier, SamarjitChakraborty: Timing challenges in automotive software architectures. 36th International Conference on Software Engineering (ICSE), 2014

xiv. Licong Zhang, Dip Goswami, Reinhard Schneider, SamarjitChakraborty: Task- and network-level schedule co-synthesis of Ethernet-based time-triggered systems. ASP-DAC 2014: 119-124

xv. Reinhard Schneider, Dip Goswami, SamarjitChakraborty, Unmesh D. Bordoloi, PetruEles, ZeboPeng: Quantifying Notions of Extensibility in FlexRay Schedule Synthesis. ACM Trans. Design Autom. Electr. Syst. 19(4): 32 (2014)

xvi. Dip Goswami, Reinhard Schneider, SamarjitChakraborty: Relaxing Signal Delay Constraints in Distributed Embedded Controllers. IEEE Trans. Contr. Sys. Techn. 22(6): 2337-2345 (2014)

xvii. Matthias Kauer, Sebastian Steinhorst, Dip Goswami, Reinhard Schneider, Martin Lukasiewicz, SamarjitChakraborty: Formal verification of distributed controllers using Time-Stamped Event Count Automata. ASP-DAC 2013: 411-416

xviii. Dip Goswami, SamarjitChakraborty, PurandarBhaduri, Sanjoy K. Mitter: Characterizing feedback signal drop patterns in formal verification of networked control systems. CACSD 2013: 13-18

xix. Dip Goswami, Martin Lukasiewicz, Matthias Kauer, Sebastian Steinhorst, Alejandro Masrur, SamarjitChakraborty, S. Ramesh: Model-based development and verification of control software for electric vehicles. DAC 2013: 96

xx. Georg Georgakos, Ulf Schlichtmann, Reinhard Schneider, SamarjitChakraborty: Reliability challenges for electric vehicles: from devices to architecture and systems software. DAC 2013: 98

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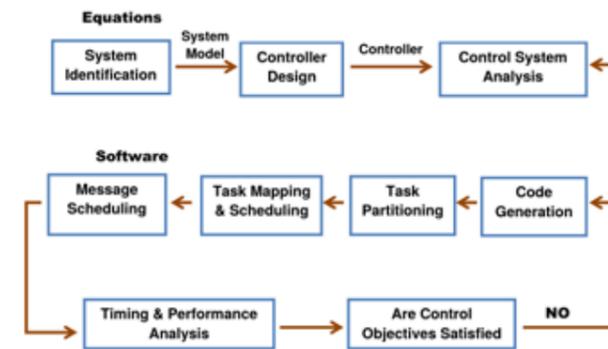
xxii. Reinhard Schneider, Licong Zhang, Dip Goswami, Alejandro Masrur, SamarjitChakraborty: Compositional analysis of switched Ethernet topologies. DATE 2013: 1099-1104

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Executive Summary

This project brings together valuable expertise in automotive engineering from Germany with software development and verification expertise from India, towards a common goal, namely to come up with a methodology and tool flow for establishing timing convergence in automotive cyber-physical control.

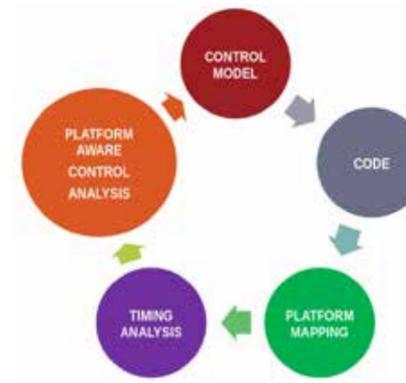
AUTOMOTIVE SOFTWARE DEVELOPMENT CYCLE



- Control Development Phase
- Software Development Phase

Why is the AUTOSAFE tool flow significant?

- AUTOSAFE develops the notion of platform aware control analysis.
- Built-in formal methods guarantee early resolution of timing issues.
- ISO-26262 recommends the use of formal methods to prove safety of critical systems.



CHALLENGE: Developing a cohesive formal verification tool chain

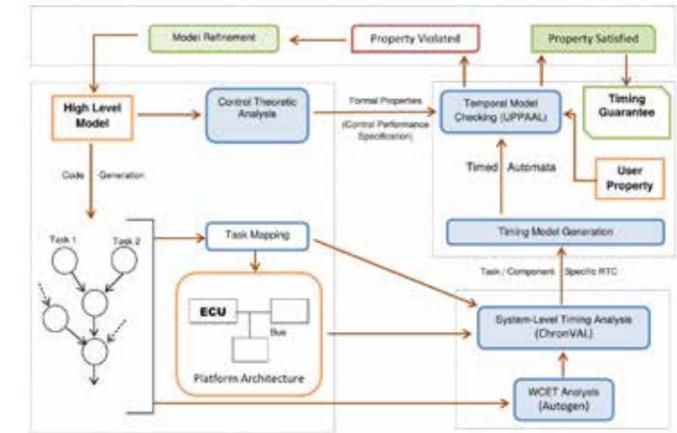
AUTOSAFE Goals

- Formalization of Bandwidth versus Control Performance Trade-offs
- Advanced Platform Modeling
- Formal Validation of Control
- Reliability of Control
- Synthesis of Automated Control

Publications

- DAC, DATE, ASPDAC, ICSE, ACM TODAES, IEEE Trans. Control Systems Technology, ASP-DAC, CACSD, ICCSCE, MSC, FDL, ESL, VLSID, etc.

The AUTOSAFE Methodology



APSEC 2015

Research Highlights

- TU Munich:
 - New Timing Analysis Techniques: ICSE 2014, DATE 2013 and ASPDAC 2014
 - New Scheduling Techniques: ACM TODAES 2014
 - Platform-timing-aware design of Control Software: IEEE Trans. Control Systems Technology 2014, ASP-DAC 2013, CACSD 2013 and DATE 2013
 - Exploratory Research: DAC 2013
- IIT Kharagpur:
 - Stimulus Generation using Real Time Calculus (RTC): DATE 2014
 - Multi-mode Sampling for Computationally Efficient Control: DAC 2014, ICCSCE 2014, MSC 2015
 - Incorporating Reliability in Control Design and Scheduling: FDL 2012, ESL 2013, MSC 2013, VLSID 2015

Joint Activities

AUTOSAFE Workshop 2013



TRDDC, Pune, India

AUTOSAFE Workshop 2014



TU Munich, Germany

Joint Tutorial at ESWEK 2014



New Delhi, India

AUTOSAFE Workshop 2015



IIT Kharagpur, India

AUTOSAFE: What next ?

- To prepare the blueprint for an "INDO-GERMAN CENTRE ON AUTOMOTIVE SOFTWARE AND CONTROL" for collaborative R & D between industry and academia

Upcoming IGSTC Projects

LOW-COST EMERGENCY POWER SYSTEM BASED ON PRINTED SMART SUPERCAPS (LOWCOSTEPS)



MULTIPLEXED, LABEL-FREE FIBER OPTIC BIOSENSOR ARRAY SYSTEM FOR WATERBORNE PATHOGEN DETECTION (MULTI-WAP)



ONLINE-INDICATION OF PATHOGEN-LIKE POLLUTION IN WATER BY FECAL PIGMENT ANALYSIS (FEC-ONLINE)



CLUSTER-COMPOSITE NANOFIBRE MEMBRANES FOR RAPID, ULTRA-TRACE DETECTION OF WATERBORNE CONTAMINANTS (CANDECT)



DNA BIOCHIP FOR ON-SITE WATER PATHOGEN DETECTION INCLUDING VIABILITY AND ANTIBIOTIC RESISTANCE TESTING (WATERCHIP)



NANOSTRUCTURED HYBRID TRANSPARENT NETWORK ELECTRODES FOR LARGE AREA VISIBLY TRANSPARENT SOLAR CELLS (METNETWORK)





Joint Workshops
Platform for Research Networking

Electrochemical storage systems: Synergy of material design and modeling

Kharagpur, India
17-20, February
2016

Recent advancement in online/remote water quality monitoring and management technologies

Chennai, India
2 - 4 February
2016



Workshop Coordinators



Amreesh Chandra
IIT Kharagpur



Ulrike Krewer
Technical University Braunschweig

Workshop Coordinators



T Subramani
Anna University



D Karunandidhi
SIET Coimbatore



H C Rafiq Azzam
RWTH Aachen

Background

The development of next generation supercapacitors and Li-ion batteries is now heavily dependent of the paradigm shift in conventional materials design and device fabrication strategies used to obtain such energy storage devices. The joint workshop aims to bring together the leading groups from the two countries to deliberate and put forward a clear road map for developing the next generation storage technologies.

Agenda, Participation and Deliberations

45 Indian and 8 German participants took part in vigorous discussions in the workshop held at Indian Institute of Technology Kharagpur. Participants were from premier research institutions like IITs, BARC, Central Universities and TU Braunschweig etc.

Academic highlights of the event:

- I. Highlights of scientific and technical presentations / deliberations:
 - ❖ Road map for development of new storage technologies was discussed.
 - ❖ More synergy between theory, simulation and experiments needs to be developed.
 - ❖ More open source documents need to be shared amongst the consortia members.
 - ❖ Efficient sharing and use of existing facilities need to be ensured.
- II. New developments presented at the event:
 - ❖ Most of the speakers shared their recent/ongoing work (unpublished) being pursued in their groups.
 - ❖ New ab-initio theoretical and simulation strategies being

investigated to understand the behavior of energy systems.

- ❖ The need and strategies that can be used to fabricate, tune and tailor nanoparticles ranging from hollow to hierarchical.
- III. Major recommendations of the event:
 - ❖ Each subgroup formed during the Programme should try to submit a joint proposal to initiate long term collaboration.
 - ❖ It is important to once again start focusing on basic research as a major breakthrough is required to bring quantum jump in the energy storage systems.
 - ❖ Simple material structures may have to be replaced by hierarchical structures for ensuring improvement in performance.
 - ❖ It would be useful if theoretical models can be developed, which can predict; to some extent, the type of materials that would be useful for different energy storage technologies. This will save time, cost and wastage of expensive raw materials.

Specific outcomes of the Workshop

The important and specific outcomes of the workshop:

- ❖ Preparation, submission and publication of "white paper" or "current opinion" on the topics discussed during the workshop.
- ❖ To explore the possibility of organizing the follow up workshop, where the core participants/ member remain the same.
- ❖ Submission of joint projects by forming consortia of sub teams that were formed during the workshop.
- ❖ Exchange visits of student and faculties.
- ❖ Sharing of resources and facilities.

Background

Indo-German Science and Technology Centre (IGSTC) workshop on "Recent advancement in online/remote water quality monitoring and management technologies" was conducted at Department of Mining Engineering, Anna University, Chennai, India during 2-4 February 2016, to provide a platform for the exchange of knowledge and experiences in water and waste water quality monitoring technologies with focus on online and remote methods in various spatial scales and for different contaminants and contaminant sources. Continuous monitoring of available sources in term of quantity and quality is the need of the hour for both Germany and India to provide safe drinking water. Therefore it is needed to develop new advanced remote technologies for the monitoring of water and waste water quality across different temporal and spatial scales.

Agenda, Participation and Deliberations

Discussions were made on the existing satellite and sensing systems, airborne and unmanned systems, and ground-based systems for the remote monitoring of water and waste water quality. Interactions were also made for the development of wireless based real-time water quality monitoring technologies. Hydrological modeling and remote sensing based discharge monitoring linking water quantity to contaminant loads and pathways were presented by the experts.

Remote sensing techniques for monitoring the variation of turbidity, temperature, nutrients, pathogens, dissolved oxygen and contaminants with respect to space and time were dealt in this workshop. Focus was given for the dispersion of industrial pollutants/effluents as well as diffused pollution. Discussions were made on water quality and proxies such as algae blooms, upwelling, fish dying etc.

Integrated remote and online water quality data, its transformation into information for decision-making and public participation were also included in the deliberations. Finally existing global and national online water quality monitoring platforms and data portals and look for the potential linkages between Germany and India as well as opportunities of downscaling to particular catchments or water bodies were discussed.

Conclusions and Recommendations

- ❖ Forming a core joint working group (Germany and India)
- ❖ Identifying strengths of each partners
- ❖ Determining direct and indirect, organic and inorganic dynamic and static, natural and artificial sources of pollution
- ❖ Formulating a multifaceted, in-situ, spaceborne and airborane, multi-sensor, multi-scale online monitoring mechanism
- ❖ Assigning different task to partners based on their strength
- ❖ Exchange of technology and sharing of knowledge

Decentralized approach for wastewater management & septic tank management reality - Solutions & innovation in the Indian water sector

Karlsruhe, Germany
22-24, February
2016

New generation sensors for unsaturated soils and water technology

Bochum, Germany
24-25 February
2016



Workshop Coordinators



Sreekrishnan Trichur Ramaswamy
IIT Delhi



Erhard Hoffmann
Karlsruhe Institute of Technology Karlsruhe

Workshop Coordinators



D N Singh
IIT Bombay



Tom Schanz
Ruhr-Universität Bochum

Background to the Workshop

Compact decentralized wastewater treatment units are the need of the hour in unplanned urban poor localities. Such plants, if based on treatment technology like Aerobic or Anaerobic Rotating Biological Contactors (RBCs) are best suited for this kind of localities. Research was carried out and presented in the workshop as well as river water management principles which are planned for future support (decentralized treatment units). Germany's technology development in this area would certainly assist Indian researchers and stakeholder to test such a plant at pilot scale. Delhi Jal Board can participate and provide material support at one of its existing treatment facility to test such a unit. A workshop was organised by XXXXX to

Agenda, Participation and Deliberations

During the course of the workshop, presentations were made and technical discussions and elaborations held on decentralized wastewater treatment processes and their relevance. It ensued that decentralized wastewater treatment plants are relevant both for isolated communities as well as for metros with unplanned growth.

It was agreed that any decentralized sewage treatment process would necessarily be of low energy and land requirements, easy to operate and resilient to fluctuations

in input sewage quality and, to a certain extent, quantity. The site visit carried out as part of the joint workshop also included visit two operating "Rotating Biological Contactor (RBC)" systems as well as one RBC design and fabrication facility. Discussions on possibility of using the RBC, with necessary design modifications to carry out the treatment through the anaerobic route. In addition to the inherent advantages of the RBC, this will also be energy positive, or, at least energy neutral. It is planned to communicate with the GIZ office in Delhi regarding the implementation of the RBC.

Outcomes of the Workshop

The bottleneck of success in wastewater-management in India is not the absence of appropriate process technology and civil constructions, neither the availability of sufficient investment finance but sustainable operations and maintenance. Research and development of technology based solutions to improve the situations should not be limited to natural sciences or process technology or civil engineering only. It should, wherever possible, go along with an applied research about the social-cultural conditions and applicable business-models including financing models to make sure that facilities, utilities which are installed will lead to the desired success in regular and long-term operations.

Background

The workshop provided a platform for bringing together scientists and industrial companies from both countries to enhance the transfer of knowledge, research and development (R&D) activities in the field of Water Technology and Unsaturated Soils.

Agenda, Participation and Deliberations

The workshop provided a platform for bringing together scientists and industrial companies from both countries to enhance the transfer of knowledge, research and development (R&D) activities in the field of Water Technology and Unsaturated Soils.

Apart from lectures the workshop consisted of a guided visit of the laboratory of the Chair of Foundation Engineering, Soil and Rock Mechanics. On the second day a common session providing a summary of the first workshop day was followed by parallel sessions of technical presentations. The workshop culminated with a common final discussion with all workshop participants.

New developments presented at the event

One of the new sensors for Unsaturated Soils applications presented was the fixed-matrix porous ceramic disc

sensor MPS 6 (Decagon devices) for measuring soil suction was presented. Another new development was in the use of numerical optimization tools for improvement of monitoring strategies. These tools are promising for better design and planning of monitoring concepts for any geotechnical and geo-environmental applications. Technology' developments presented at the workshop were simple and low-cost optical read out formats for biosensors for food, environmental and warfare contamination, the advanced water quality biosensors for arsenic **Specific Outcomes**

As a result from the discussions during the workshop, the idea of the establishment of an "Centre for Geoenvironmental Research and Innovation" was raised. Outcomes of the discussions of the 'Water Technology' group of the workshop led to immediate practical actions e.g. transfer of the AquacheckTestkit to Pune, Water Pollution Board, start of bilateral collaboration and plans for installation of a Aquacheck/LAVARIS office in Bangalore, export of water treatment units to Bangalore, joint proposal submission of German and Indian partners for Water Technology Initiative of Department of Science and Technology, ARSOLux measurements at TERI University in India etc.

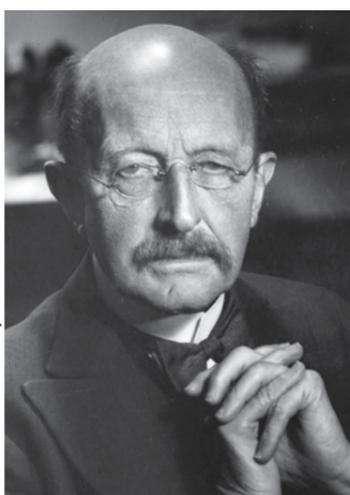


DST-Max Planck Programme
Connecting Excellence



DST–Max Planck Society Programme

Connecting Excellence



Source : Max Planck Society

The Department of Science & Technology (DST), Govt. of India and Max Planck Society (MPG), Germany have collaborated, through an agreement signed in 2004, to constitute and operationalise DST–Max Planck Society Programme.

Running since year 2004, the DST-Max Planck Society Programme has two flagship initiatives under its umbrella aimed at creating opportunities for collaboration and sustained interactions with S&T research priorities.

IGSTC has been entrusted with the responsibility of implementing the DST/ MPG Programme from Indian side.

Max Planck Partner Groups at Indian Institutes

The “Partner Group” is an instrument created by the Max Planck Society (MPG) for the purpose of strengthening the ties between Max Planck Institutes and research institutes from other countries. Partner Group is a mechanism to intensify cooperation between individual scientists through jointly conceptualized and implemented S&T research projects.

The “Max Planck Partner Group at Indian Partner Institute” has been developed as an instrument for supporting collaborative research in target areas prioritized on the basis of their relevance to immediate problems and interests of institutions involved from both sides.

Partner Groups are headed by Indian scientists who return to India after completing their extended research residency at a Max Planck Institute. Partner Groups allow the involved scientists to lead appropriately equipped research groups in order to continue their research activities in close co-operation with their former German hosts.

Each Partner Group is supported to the tune of €20000 per year by MPG with a matching contribution of equivalent ₹ amount by the DST. Grants are expected to be utilized, as far as possible, for the purpose of creating MPI like facilities at the respective Indian host institutions.

Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery that we are trying to solve.'

Max Planck

Structural Biology of vesicular trafficking: Screening of putative Rab5 GAPs for their role in Rab5 to Rab7 conversion



Sunando Datta
IISER Bhopal

Marino Zerial
MPI of Molecular Cell Biology and
Genetics, Dresden



Genetic Diversity Studies: Studies on human salivary microbiome in Indian populations and its implications in human genetic diversity studies, health sciences and evolutionary biology



Madhusudan Reddy
CDFD Hyderabad

Mark Stoneking
MPI for Evolutionary Anthropology,
Leipzig



Gravitational Wave Physics: Searching intermediate mass black holes in gravitational wave window



Archana Pai
IISER Trivandrum

Bernard Schutz
MPI for Gravitational Physics, Golm



Chemical Ecology: The role of small-RNA pathways in plant defense against insect herbivores



Shree Prakash Pandey
IISER Kolkata

Ian Thomas Baldwin
MPI for Chemical Ecology, Jena



Glyconano –technology: Carbohydrate capped nanoparticles as tumor specific drug delivery system



Raghavendra Kikkeri
IISER Pune

Peter H. Seeberger
MPI of Colloids and Interfaces, Potsdam



Centre for cosmology and gravity



S. Shankaranarayanan
IISER Trivandrum

Hermann Nicolai
MPI for Gravitational Physics, Potsdam



Atmospheric Chemistry and composition: Tropospheric OH reactivity and VOC measurements within India



Vinayak Sinha
IISER Chandigarh

Jos Lelieveld
MPI for Chemistry, Mainz



Polymer research: Developing new conjugated materials for optoelectronic devices



Parameswar K Iyer
IIT, Guwahati

Klaus Müllen
MPI for Polymer Research, Mainz



Data management and mining: Search and mining over large scale graphs



Srikanta Bedathur
Indraprastha Institute of
Information Technology, Delhi

Gerhard Weikum
MPI of Informatics, aarbrücken



Asymmetric organocatalysis: New aminocatalytic asymmetric transformations



Subhas C Pan
IIT Guwahati

Benjamin List
MPI for Kohlenforschung
Muelheim an der Ruhr



Atmospheric Sciences: Characterising the properties of biological aerosol particles under different environmental and seasonal conditions over the Indian tropical region : assessment for possible climatic & health impacts



Sachin S Gunthe
IIT Madras

Ulrich Pöschl
MPI for Chemistry, Mainz



Regulation of RNA splicing by a novel ubiquitin related protein



Shravan K. Mishra
IISER Mohali

Stefan Jentsch
MPI of Biochemistry
Martinsried



Coupling and dynamics of solar atmosphere



Durgesh Tripathi
Inter-Univ Centre for Astronomy and
Astrophysics, Pune



Sami K Solanki
MPI for Solar System
Research, Lindau

Role of cellular membranes in stress signalling and protein homeostasis maintenance



Swasti Raychaudhuri
CSIR- CCMB Hyderabad



F Ulrich Hartl
MPI of Biochemistry,
Martinsried

Multifunctional hybrid nanostructures for alternative energy systems



Amreesh Chandra
IIT Kharagpur



Katharina Landfester
MPI for Polymer Research Mainz

Max Planck - India Fellowship/Mobility Grant

Max Planck-India Visiting Fellowship is a distinction for highly qualified and talented scientists. The Fellowship is awarded to scientifically outstanding, promising young Indian scientists.

Individuals selected for the award get the opportunity to work with Scientists at the Max Planck Institute (MPI) relevant to their area of expertise for up to 2 months a year for four consecutive years.

Fellowship holders receive from MPG a sum of €3,000 per year, for up to four years, with Indian side providing travel support for each research stay.

S. No	Fellow	MPI Counterpart	Field of Research / Title
CALL 2011			
1	Dr Srinivasan Krishnamurthi Institute of Microbial Technology Chandigarh	Prof Bremen Rudolf Amann MPI for Marine Microbiology Bremen	Polyphasic taxonomic characterization of marine bacteria and analyses of the microbial diversity in Indian marine waters using culture-independent approaches
2	Dr Suneel Kateria Delhi University Delhi	Prof Wolfgang Gaertner MPI for Bioinorganic Chemistry Mülheim	Deciphering the role of the flanking N- and C-terminal regions in the modulation of photocycle kinetics of a LOV domain of a marine algal phototropin
3	Dr Sandeep Kaur Delhi University Delhi	Prof Matthias Stein MPI for Dynamics of complex technical systems, Magdeburg	Transition metal dithiolato complexes as functional models for hydrogenases
CALL 2012			
4	Dr Koushik Dutta IISER Bhopal	Dr Georg G Raffelt MPI for Physics München	Inflationary cosmology and its connection to particle physics
5	Dr Naveen Chandra Bisht NIPGR New Delhi	Prof Jonathan Gershenzon MPI for Chemical Ecology Jena	Investigating the role of glucosinolate content towards plant fitness in <i>Brassica juncea</i>
6	Dr Subbulakshmi Chidambaram Vision Research Foundation Chennai	Prof Reinhard Jahn MPI for Biophysical Chemistry Goettingen	Dissecting the regulatory role of Adiponectin signalling in human retinal synaptic vesicle trafficking under physiological and pathological conditions
CALL 2013			
7	Dr P Anil Kumar Institute of Microbial Technology Chandigarh	Prof Friedrich Widdel MPI for Marine Microbiology Bremen	Physiology of mixotrophic planktonic bacteria

8	Dr Satya Pal Nehra Deenbandhu Chhotu Ram Univ of Sci & Tech, Murthal	Prof Dwayne Miller MPI for Dynamics and Structure of Matters Hamburg	Preparation and Characterization of Semiconductor Photocatalysts for Surface Reaction Dynamics Study and their Applications
9	Dr Richa Rai Banaras Hindu University Varanasi	Prof Jonathan Gershenzon MPI for Chemical Ecology Jena	Application of metabolite, transcript and flux measurements to investigate the effect of elevated ozone and carbon dioxide on yield and pest protection of C3 and C4 crops
10	Dr Kamal P Singh IISER Mohali	Prof J M Rost MPI for Physik Komplexer Systeme, Dresden	Sub-fs control of photo- dynamics in atoms/molecules using shaped XUV pulses
CALL 2014			
11	Dr N Ramesh Kumar NIIST Thiruvananthapuram	Prof Ian Thomas Baldwin MPI for Chemical Ecology Jena	Identification and functional characterization of seed borne bacterial endophytes of <i>Nicotiana attenuata</i> and the elucidation of their transmission to the progeny using culture-dependent and- independent approaches
12	Dr Areejit Samal Institute of Mathematical Sciences, Chennai	Prof Jürgen Jost MPI for Mathematics Sciences Leipzig	Computational methods for identifying and analyzing design features of metabolic networks
13	Dr. Arjun Bagchi IISER Pune	Prof Stefan Theisen Gravitational Physics Golm	Minkowskian Holography
14	Dr V Pramitha IIT Madras	Prof Joachim P Spatz MPI for Intelligent Systems Stuttgart	Direct patterning of vortex generating diffractive optical elements on fibre tip using a focused ion beam
15	Dr Karthik V Raman IISc Bangalore	Prof Klaus Kern MPI for Solid State Research Stuttgart	Tailoring interface spin transport: towards molecular spintronics
16	Dr Srikant Sukumar IIT Bombay	Prof Peter Benner MPI for Dynamics of Complex Technical Systems, Magdeburg	Cooperative control and consensus, nonlinear control, adaptive control, time-varying systems
17	Dr K Sowjanya Sree Amity Univ, Noida	Prof David G Heckel MPI for Chemical Ecology Jena	Transcriptional responses of <i>Helicoverpa armigera</i> to the insecticidal mycotoxin, Destruxin
18	Dr Venkat Gundabala IIT Bombay	Prof Katharina Landfester MPI for Polymer Research Mainz	Water-based nanocomposite coatings
19	Dr Anshu Deenbandhu Chhotu Ram Univ Sci & Tech, Murthal, Sonapat	Prof R J Dwayne Miller MPI for the Structure and Dynamics of Matter, Hamburg	Structure and Dynamics of Functionalized and Catalysts Modified Carbon Nanotubes for Charge and Mass Transport Applications



Financial Statements Audit Report 2014-15

SSAS & ASSOCIATES**CHARTERED ACCOUNTANTS**

Branch- D/147, Pushpanjali Enclave; Pitampura, Delhi-110034
Tel: 91.11.27010841; 91.9868144009, email- sansaxonline@gmail.com

Date : 28.09.2015

INDEPENDENT AUDITOR'S REPORT

To the Governing Body of
Indo-German Science and Technology Centre (IGSTC)
New Delhi

Report on financial Statements

We have audited the accompanying financial statements Indo Indo-German Science and Technology Centre, New Delhi (a society registered under Societies Registration Act, 1860) which comprise the Balance Sheet as at March 31, 2015, the Income and Expenditure Account, the Receipts and Payments Account for the year then ended and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the Society. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.



H. O : U-52/62, DLF Phase III, Gurgaon – 122002, Haryana

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Society in preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on effectiveness of the society's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the accompanying financial statements give a true and fair view of the financial position of Indo- German Science and Technology Centre (IGSTC) for the year ended March 31, 2015 in conformity with the accounting principles generally accepted in India.

Emphasis of Matter

Without qualifying our opinion, we draw attention to:

Reference point B) Notes to Financial Statements

- **Note 2.** German expenditure towards research projects (Non- Shareable) amounting to Rs. 7,39,88,023/- are based on statement provided by Government of Germany (IB-BMBF).
- **Note 7.** German operational Expenditure amounting to Rs.34,88,870/- reflected in the financial statements are based on statement provided by Government of Germany (IB-BMBF) to the Centre.

For **SSAS & ASSOCIATES,**
Chartered Accountants
Firm Registration No: 08550N


ALPANA SAXENA
Partner, Membership No. 095837
Place : Delhi



SCHEDULE ANNEXED TO AND FORMING PART OF THE BALANCE SHEET, THE INCOME & EXPENDITURE ACCOUNT AND THE RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2015.

SCHEDULE- 'G'

ACCOUNTING POLICIES AND NOTES ON ACCOUNTS

Objectives of the Organisation

The Indo German Science and Technology Centre (Society) established in India by the Governments of India and Germany, to facilitate and promote the interaction, in India and in Germany, of governments, academia and industry in science and technology. It is to build and improve research and technology synergies between countries, focusing primarily on natural, life, and engineering sciences. The centre was registered in India on 14th June 2010 under Societies Registration Act, 1860.

A. SIGNIFICANT ACCOUNTING POLICIES

1. Accounting Period:

Financials are reported from 01st April of a year to 31st March of the following year.

2. Reporting currency and foreign currency transactions:

The accounting currency of the Society is Indian Rupee. Separate Receipts & payment account, Income & Expenditure Account and Balance Sheet is drawn in Euro at the rate of exchange as prescribed by RBI on the Balance Sheet date i.e. 31.03.2015.

3. Basis of preparation :

The financial statements are prepared under the historical cost convention and have been changed from cash basis to the mercantile system of accounting. In the absence of any authoritatively established accounting principles for the specialised aspects related to societies not having any commercial activity, these statements have been prepared in accordance with the significant accounting policies as prescribed by the Institute of Chartered Accountants of India.

4. Any surplus of Receipt over Payment is carried forward to next year for utilization as per objectives of the IGSTC.

5. **Method of Accounting:** Accounts are maintained on mercantile basis.

6. Grants Awarded:

Grants to an awardee are recognized on the recommendation of the Scientific Council, approval by the Governing Body and with the final approval of both Indian and German Governments. Based on the commitments made to awardees in a year, aggregate grants are recognized as expenditure to the extent of payment made to each awardee during the year. Grants released for various research projects have been shown under the head "Scientific Expenses" in the "Income &

1



Expenditure Account" on the basis of disbursements made by the Centre. First year releases are made only on the basis of the approved Budget in the letter of sanction to the project. However, subsequent releases are made on the basis of approved budget in the letter of sanction and the statement of expenditure and the utilization certificate of the last releases of the previous years furnished by the institutions.

7. Loans & Advances:

Till the year 2013-14 Loans granted to Industrial partners of the awardees are treated as utilization of fund of the Centre. The overhead charges on the loans become due from the date of release of funds. However, the overhead charges accrued during the implementation period get amortised and recovered in maximum ten instalments. The recovery of overhead charges shall be accounted for as income during the year of receipt. Consequent upon switching over to mercantile system of accounting, balance of loan will be reflected as Loan and Advances during the financial year.

8. Foreign Currency Transactions :

Transactions: Foreign exchange transactions are recorded at the rate prevailing on the date of transaction.

Translation to Euro: Indian currency assets and liabilities at the year-end are stated at the rate of foreign exchange (euro) at the closing of financial year (31.03.2015).

9. Grants Awarded - Recognition:

Grants to an awardee are recognised as commitments based on recommendation of the Scientific Council and final approval of the Governing Body. Based on the commitments made to awardees in a year, aggregate grants are recognised as expenditure to the extent of payment made to each awardee during the year.

10. Income Recognition:

Grants: Grants from the two governments are (Department of Science & Technology of the Govt. of India and the Govt. of Germany (BMBF)) recognised in the Income & Expenditure Statements as Grant in Aid only on receipt of the funds from either side under the head Income in the Receipts & Payments Account and the Income & Expenditure Account.

11. Fixed Assets:

All the assets acquired for research projects remain with the institution where the research work is carried on. The Centre has, however, retained the right to transfer these assets to other institutions, if so required, on completion of the projects for which these assets were purchased. The expenditure on these assets has been accounted for in the Income and Expenditure Account under the head "Scientific Expenses". Hence, these assets have not been taken in the Balance Sheet of the Centre.

Fixed assets acquired by the Centre are stated at cost of acquisition less accumulated depreciation. The cost of an asset comprises of its purchase price and directly attributable costs of bringing the asset to working condition for its intended use.

During the year, the Centre has carried out the exercise of the physical verification of assets and no major discrepancies have come to notice.

2



12. All operational expenditure pertaining to German Government incurred in Germany are reported on the basis of statement of expenses.

13. All direct grant awards towards scientific projects by the German Government are neither recorded as receipt nor expenditure of the Centre, since the same are not received/ paid in India. However, the same is included in the "Notes to Accounts" on the basis of Statement received from Government of Germany.

B. NOTES TO ACCOUNTS:

1. Both governments have considered the allocation of equivalent amount of funds up to 10 million euros each to meet the objectives of the Centre and its running expenditure for an initial period of five years. The annual expenditure may be enlarged by mutual agreement. Out of the said contribution :

a) The Capital and Operating expenditure of the Centre and expenses on account of workshops, seminars, symposiums, preparatory visits, exploratory missions, etc shall be shared equally by the two Governments.

b) Expenditure for joint research projects shall be shared by the two Governments according to the distribution of costs for the respective parts of the project in each country.

2. During the period under reporting, the total expenditure till the reporting date are as under:

S. No.	Nature of Expenditure	Amount (INR)	Amount (INR)
i	Establishment expenditure (Shareable)		1,81,86,528
	1) Capital Expenditure	1,02,390	
	2) Operational Expenditure	1,80,84,138	
	i) By IGSTC, Gurgaon : ₹ 1,45,95,267		
	ii) By IB-BMBF : 34,88,870*		
ii	Scientific Workshop expenditure (Shareable)		76,088
	1) By IGSTC, Gurgaon Rs. 12,96,895	76,088	
	Less: refund received Rs. 12,20,807		
	2) By IB-BMBF		
iii	Total Shareable expenditure (i + ii)		1,82,62,616
iv	Research Projects (Non-shareable)		11,56,16,471
	1) Paid by Indian Side to Indian Awardees	5,52,76,148	
	2) Paid by German Side to German Awardees	7,39,88,023	
	Total Expenditure (iii + iv)		13,38,79,087

(*)As reported through IB/BMBF.



3. Statement of Distribution of Shareable Expenses:

Amount in Rupees

S. No.	Expenditure	Total	Allocable to Indian Side	Allocable to German Side
1	Shareable expenditure	1,82,62,616	91,31,308	91,31,308
2	Balance of contribution as on 1.4.2014 carried forward		Nil	1,27,03,623
	Net shareable expenditure		91,31,308	(35,72,235)
3	Contribution received from IB-BMBF during 2014-15			Nil
	Balance of Contribution as on 31 st March, 2015		Nil	(35,72,235)

4. Status of Current Award Liabilities :

Amount in Rupees

Awarded in 2+2 mode	Number of awards committed during the year	Amount committed	Amount released up to 31.3.2015	Outstanding future commitments
Indian Side	10	6,08,65,955	5,52,76,148**	55,89,807
German Side	10	7,39,88,023	7,39,88,023***	-
	Total	13,90,93,226	12,92,64,171	55,89,807

(**) includes Rs. 79, 78,750/- as loans given to industrial partners as per the terms of the agreement.

(***) the project expense of the German side is for the period from 1.1.2014 to 31.12.2014

5. **Income Tax:** Income Tax Department [office of the Commissioner of Income Tax (E), New Delhi] has granted IGSTC registration under section 12A of the Income Tax Act, 1961 as General Public Utility vide their letter no CIT(E)/2014-15/DEL-IR24110-10122014/4089 dated 10/12/2014.

6. All expenditure and grant payment figures from the German Government side are reported in the Indian Currency at the exchange rates as per Reserve Bank of India as on the date of close of the financial year i.e. on 31st March, 2015 at Indian rupee at Euro 1 = Rupee 67.5104 .



7. All German expenditures reflected in the financial statements are based on the statements provided by the Govt. of Germany (IB-BMBF) to the Centre.

8. Employees Welfare and other benefits:

- i. **Gratuity:** as per the rules under the Payment of Gratuity Act 1972,
 ii. **Employee's Provident Fund:** Employees of Centre has been enrolled under the Employees Provident Fund Scheme of the Govt. of India (EPF). During the year 2014-15, IGSTC contributed Rs. 4,41,041 as employer's contribution to the EPF Account of the employees.

iii. **Leave Encashment:** As per the rule of Centre.

iv. As per the approval of Governing Body, all financial powers in respect of activities of the Centre is exercised by the Director after obtaining approval of the Governing Body.

v. There are no disputes / claims which are unsettled for a long time.

9. Related parties Disclosures:

During the year no trust funds were utilized for the benefits of the settlers or the trustees other than reimbursement of expenses incurred by them.

10. An Extra Mural Programme under India-German (DST-MPG) Science & Technology Cooperation Programme by IGSTC under an agreement with Department of Science and Technology is being administered and managed from Indian side as per the approved activities under DST-MPG MOU signed by the Governments of India and Germany. A separate bank account, Statement of Expenditure & Utilisation Certificate are prepared and rendered to DST. The financial statements (Receipts & Payments Accounts, Income & Expenditure Accounts and Balance Sheet) are prepared separately and annexed to the Centre's financial statements.

11. Previous years' figures are rearranged/ regrouped wherever necessary.

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE BALANCE SHEET AS AT 31ST MARCH 2015

Amount in INR

	Schedule	Amount as at March 31, 2015		Amount as at March 31, 2014	
SOURCE OF FUNDS					
Capital Fund					
Opening Balance		8,44,40,067		7,82,02,214	
Add : Surplus/(Deficit)		35,04,013	8,79,44,080	62,37,853	8,44,40,067
Current Liabilities					
	I		60,64,494		75,000
TOTAL			9,40,08,574		8,45,15,067
APPLICATION OF FUNDS					
Fixed Assets					
Gross Block	A	4,87,278		6,65,912	
Add: Addition during the year		1,02,390			
Total		5,89,668			
Less : Sale during the year		-			
Less: Depreciation		1,28,234		1,78,634	4,87,278
Net Block			4,61,435		
Cash and Bank Balances					
Cash in hand		2,146		2,512	
Balance with Bank	J	7,64,57,993	7,64,60,139	8,40,25,277	8,40,27,789
Loans and Advances					
	K		1,70,87,000		
TOTAL			9,40,08,574		8,45,15,067
Accounting policies and notes on accounts	L				

As per our report of even date.

For SSAS & ASSOCIATES
Firm Registration No. 08550N
Chartered Accountants

-sd-
Alpana Saxena
Partner
Membership No. 095837

-sd-
S. S. SENGUPTA
MANAGER ACCOUNTS & ADMIN.

-sd-
A. CHAKRABORTY
DIRECTOR

Place : New Delhi
Date : 28 Sep. 2015



INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2015

	Schedule	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
INCOME			
Grant-in-aid : Contribution from Department of Science and Technology, Govt. of India		6,00,00,000	3,00,00,000
Contribution from Govt. of Germany		-	2,19,39,015
Contribution (through expndiutre intimated by BMBF) from Govt. of Germany € 51678.62)		34,88,870	43,20,392
Interest from Bank Accounts Banks in India		23,79,869	43,31,062
Disposal of old newspaper		1,044	230
Unspent amount refunded from workshop		-	1,95,109
TOTAL		6,58,69,783	6,07,85,808
EXPENDITURE			
Scientific Project Expenses of the Centre	B	4,36,77,624	1,67,84,398
Governing Body/ Scientific Council Expenses	C	17,21,043	18,65,895
Travelling Expenses (National & International)	D	6,21,946	10,45,722
Office Expenses	E	1,04,88,603	1,03,95,512
Salaries	F	55,56,604	44,49,001
Scientific Workshop Expenses of the Centre	G	76,088	1,84,60,449
Other Meetings / Conference	H	95,628	13,68,344
Depreciation on Fixed Assets	A	1,28,234	1,78,634
TOTAL		6,23,65,770	5,45,47,955
Surplus/(Deficit) of Income over expenditure carried over to Balance Sheet		35,04,013	62,37,853
Accounting policies and notes on accounts	G		

As per our report of even date.

For SSAS & ASSOCIATES
 Firm Registration No. 08550N
 Chartered Accountants

-sd-
 Alpana Saxena
 Partner
 Membership No. 095837

-sd-
 S. S. SENGUPTA
 MANAGER ACCOUNTS &
 ADMIN.

-sd-
 A. CHAKRABORTY
 DIRECTOR

Place : New Delhi
 Date : 28 Sep. 2015

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH, 2015

	Schedule	Amount in INR	
		Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
A. Opening balance			
Cash in hand		2,512	4,490
Cash at Bank		8,40,25,277	7,75,58,802
B. Receipts			
Grant-in-aid : Contribution from Dept. of Science and Technology, Govt. of India		6,00,00,000	3,00,00,000
Contribution from Government of Germany (Interest from Bank Accounts		-	2,19,39,015
Amount of Tax Deducted at Source (TDS)		23,79,869	43,31,062
Amount of GPF, HBA ,RGIS recovered on behalf of CSIR for A. Chakraborty, Director		-	10,29,909
Amount wrongly received in main A/c		-	3,63,180
Disposal of old newspaper		-	75,000
Unspent amount refunded from workshop Call -2012 unspent amount refunded from ICGEB for IGSTC 2+2 Project		1,044	230
		12,20,807	1,95,109
		1,01,331	-
TOTAL		14,77,30,840	13,54,96,797
Payments			
C. Project Expense (Non -shareable)			
Scientific project expenses of the Centre		5,52,76,148	1,67,84,398
D. Scientific Expense (Shareable)			
Scientific Workshop		12,96,895	1,84,60,449
Other Meetings / Conference		95,628	13,68,344
E. Establishment Expense (Sharable)			
Governing Body/ Scientific Council Expenses		17,21,043	18,65,895
Travelling Expenses (National & International)		6,21,946	10,45,722
Office Expenses		65,36,205	60,75,119
Salaries		38,25,707	44,49,001
Purchase of Office Equipment		18,000	21,375
Purchase of Furniture & Fixtures		-	-
Purchase of Computer/Printer		84,390	5,199
D. Other Payments			
TDS Payments		12,06,558	10,29,909
Amount recovered on behalf of CSIR, Delhi		5,13,180	3,63,180
MPG fellowship amount refunded but credited erroneously		75,000	417
		17,94,738	13,93,506
E. Closing Balance			
Cash in hand		2,146	2,512
Bank Balances		7,64,57,993	8,40,25,277
TOTAL		14,77,30,840	13,54,96,797
Accounting policies and notes on accounts	G		

As per our report of even date.

For SSAS & ASSOCIATES
 Firm Registration No. 08550N
 Chartered Accountants

-sd-
 Alpana Saxena
 Partner
 Membership No. 095837

-sd-
 S. S. SENGUPTA
 MANAGER ACCOUNTS & ADMIN.

-sd-
 A. CHAKRABORTY
 DIRECTOR

Place : New Delhi
 Date : 28 Sep. 2015

**SCHEDULES FORMING PART OF THE BALANCE SHEET AND
THE INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2015**

**Schedule 'A'
Fixed Assets**

S.NO	PARTICULARS	Rate of Depreciation	GROSS BLOCK				DEPRECIATION FOR THE YEAR	Amount in INR	
			Balance as on 1-4-2014	Addition during the year		SOLD DURING THE YEAR		NET BLOCK BALANCE AS ON 31-3-2015	
				UPTO 30-09-14	AFTER 30-09-14				TOTAL
1	Computer and Peripherals	60%	79,920	-	84,390	-	1,64,310	73,269	91,041
2	Office Equipment	15%	2,30,574	18,000	-	-	2,48,574	37,286	2,11,288
3	Furniture & Fixture	10%	1,76,784	-	-	-	1,76,784	17,678	1,59,105
	TOTAL		4,87,278	18,000	84,390	-	5,89,668	1,28,234	4,61,435
	Perivous Year		6,39,338	8,699	17,875	-	6,65,912	1,78,634	4,87,278

Schedules	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Schedule 'B'		
Scientific Expenses of the centre (India Side)		
Research Projects - Grant		1,40,55,648
1 Compact Linear Fresnel Reflector (CLFR) for Solar Thermal Power and Process Heat -IIT Bombay	14,08,493	
2 Remsolar Project - IIT Kanpur	77,92,000	
3 IN-DUES Project - IISC Bangalore	41,00,000	
4 Nanotrans Project -University of Delhi	33,78,712	
5 NDT - DATA -SERC, Chennai	18,30,000	
6 Npore - Hyberabad	23,68,000	
7 AMPLAST Project - IIT Madras	1,16,00,000	
8 DNDHCSA Project - CSIR, CMERI	42,00,000	
9 DP- Forge Project - IIT Madras	82,30,000	
10 SeNaMeB Project - ICT Chennai	79,80,000	
	5,28,87,205	
Less : Unspent balance recived from ICGEB for IGSTC 2+ 2 Project	1,01,331	5,27,85,874
Loan Given to industrial partners for Scientific Projects		27,28,750
Less: Perivous Year releases of Loan	91,08,250	-91,08,250
	4,36,77,624	
	4,36,77,624	1,67,84,398

Schedule 'C'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Governing Body/ Scientific Council Expense		
Governing Body Meeting (VI GB in Germany , amount after adjustment of unspent of euro)	12,81,172	8,90,579
Scientific Council Meeting	4,39,871	9,75,316
	17,21,043	18,65,895

Schedule 'D'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Travelling Expenses		
Travel with in India	3,53,272	1,45,419
Travel Abroad	2,68,674	9,00,303
	6,21,946	10,45,722

Schedule 'E'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Office Expense		
Advertisement Expense	70,251	16,500
Transportation Expense	5,50,272	4,62,633
Telephone & Internet Expenses	2,44,417	2,18,452
Printing & Stationery	1,08,714	95,065
Postage and Courier Expenses	19,402	9,010
Office Rent	42,47,208	39,32,600
Staff Welfare Expense	25,009	17,679
Electricity, Water & Other Maintenance charges	7,01,127	7,24,721
Legal and Professional Expense	7,18,686	-
Miscellaneous Office Expenses	3,14,647	5,98,460
Operational Expenses by IB-BMBF, (₹ 51679)	34,88,870	43,20,393
	1,04,88,603	1,03,95,513

Schedule 'F'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Salaries		43,60,968
Salary including liability for Leave Salary contribution , Pension contribution , Rent and Licence fee for director, IGSTC	54,57,675	
Medical	98,929	55,56,604
	55,56,604	44,49,001

Schedule 'G'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Scientific Workshop		
Indo German Joint Workshop		
1 Strategies and Concepts for Advanced Manufacturing (INAE, Delhi)	2,01,588	
2 Microbial ecology and application of inoculants in bio-control (Ecology IARI)	36,212	
Surfactants and amphiphilic polymers in nanotechnology-On the way	3,82,789	
3 smarter formulations (Poly - PU)		
Diagnostics and translational Genome sequencing in clinical and public	1,06,782	
4 health microbiology (Health - THSTI)		
Advances in Medical Technology towards Current Health Care Necessities	3,60,008	
5 held in Manipal		
6 Water and Wastewater Management for Sustainable (Water -IITD)	2,09,516	12,96,895
Less: Unspent balance refunded		-12,20,807
	76,088	

Schedule 'H'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Other Meetings / Conference		
1 Scientific Committee Meeting	95,628	
	95,628	

Schedule 'I'	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Current Liabilities		
Current Period Liabilities		
1 Leave Salary Contribution , HRA and Licence	4,74,687	4,74,687
Fee in respect of Director , IGSTC		
Project Releases - Grants (instalments due in 2014-15)		
1 IN -DUES	6,48,806	
2 NANOTRANS	7,43,001	
3 NDT DATA FUSION	18,30,000	
4 NPORE	23,68,000	
	55,89,807	
	60,64,494	60,64,494

Schedule "J"	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
1 Axis Bank	5,30,66,250	
	3,00,000	5,33,66,250
2 Axis Bank		9,47,349
3 Union Bank of India		2,21,44,395
		7,64,57,993

Schedule "K"	Amount for the year ended March 31, 2015	Amount for the year ended March 31, 2014
Loans and Advances		
Nuziveedu Seeds Pvt Ltd	29,01,250	
Krishidhan Research Foundation	15,50,750	
Thermax Ltd	60,00,000	
Bharat Forge	60,75,000	
Dhvani Research Pvt Ltd	5,60,000	
	1,70,87,000	

SSAS & Associates

CHARTERED ACCOUNTANTS

D-147, Pushpanjali Enclave Pitampura, Delhi-110034

Tel: 91.11. 27010841; 91.9868144009, Email: sansaxonline@gmail.com

Date: 28.09.2015

INDEPENDENT AUDITOR'S REPORT

To the Governing Body of
Head, International Bilateral Cooperation Division (IBCD)
& Co- chair, Indo- German Science and Technology centre,
Department of Science & Technology, New Delhi

Report on financial Statements

We have audited the accompanying financial statements of **Indo Indo-German Science and Technology Centre, with respect to EMR Programme concerning management and administration of Indo- German (DST-MPG) Science and Technology Centre, New Delhi** which comprise the Balance Sheet as at March 31, 2015, the Income and Expenditure Account, the Receipts and Payments Account for the year then ended and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the Society. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

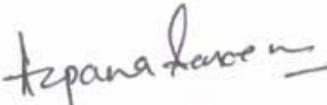
An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Society's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on effectiveness of the society's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the accompanying financial statements give a true and fair view of the financial position of **Indo Indo-German Science and Technology Centre, with respect to EMR Programme concerning management and administration of Indo- German (DST-MPG) Science and Technology Centre, New Delhi** for the year ended March 31, 2015 in conformity with the accounting principles generally accepted in India.

For SSAS & ASSOCIATES,
 Chartered Accountants
 Firm Registration No: 08550N


ALPANA SAXENA
 Partner
 Membership No. 095837
 Place : Delhi



**INDO - GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme**

BALANCE SHEET AS AT 31ST MARCH 2015

Amount in INR

	Schedule	Amount as at March 31, 2015		Amount as at March 31, 2014	
SOURCE OF FUNDS					
Operational Reserve Fund					
Opening Balance		1,043,633			
Add : Surplus/(Deficit)		1,271,279		1,043,633	
			2,314,912		1,043,633
Balance Funds of DST-MPG Programme					
Balance funds out of receipts from Department of Science and Technology, Govt. Of India	A		4,968,778		293,100
TOTAL			7,283,690		1,336,733
APPLICATION OF FUNDS					
Fixed Assets					
Gross Block	B	128,639		193,945	
Less: Depreciation to date		37,781		65,306	
Net Block			90,858		128,639
Current Assets					
Cash and Bank Balances					
Cash in hand		-		438	
Axis Bank Saving Bank Account		7,192,832	7,192,832	1,207,657	1,208,094
TOTAL			7,283,690		1,336,733
Accounting policies and notes on accounts	D				

As per our report of even date.

For SSAS & ASSOCIATES

Firm Registration No. 08550N

Chartered Accountants

-sd-
Alpana Saxena
Partner, Membership No. 095837

-sd-
S. S. SENGUPTA
MANAGER ACCOUNTS & ADMIN.

-sd-
A. CHAKRABORTY
DIRECTOR

Place : New Delhi

Date :

**INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2014**

Amount in INR

	Schedule	Amount for the year	
		ended March 31, 2015	ended March 31, 2014
INCOME			
Allocation expense		1,731,642	371,862
Unspent amount of project received		16,745	
Amount received from IGSTC main account for fellowship, which was wrongly credited .		75,000	
TOTAL		1,823,387	371,862
EXPENDITURE			
Meeting Expenses		5,599	4,975
Office Expenses		304,729	382,461
Salaries		204,000	396,250
Depreciation on Fixed Assets	B	37,781	65,306
TOTAL		552,109	848,992
Surplus/(Deficit) of Income over expenditure		1,271,278	-477,130
Balance brought forward from balance sheet			1,520,763
Balance carried over to balance sheet			
		1,271,278	1,043,633
Accounting policies and notes on accounts	E		

As per our report of even date.

For SSAS & ASSOCIATES

Firm Registration No. 08550N

Chartered Accountants

-sd-
Alpana Saxena
Partner, Membership No. 095837

-sd-
S. S. SENGUPTA
MANAGER ACCOUNTS & ADMIN.

-sd-
A. CHAKRABORTY
DIRECTOR

Place : New Delhi

Date :

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH, 2015

Amount in INR					
	Schedule	Amount for the year		Amount for the year	
		ended March 31, 2015		ended March 31, 2014	
A. Opening balance					
Cash in hand		438	-	-	-
Axis Bank Saving Bank Account		1,207,657	1,208,094	5,595,192	5,595,192
B. Receipts					
Fund received from Dept. of Science and Technology, Govt of India towards MPG Programme		23,538,812			
Interest on saving bank account		184,926			
Amount received from IGSTC main account for fellowship, which was wrongly credited		75,000			
Unspent amount of project received		16,745	23,815,483		
Total		25,023,577		5,595,192	
C. Payments					
Grants Sanctioned and released as per MPG	C	17,316,418		3,718,621	
Meeting Expenses		5,599		4,975	
Office Expenses	D	508,729		778,711	
Purchase of Office Equipment	B	-		5,900	
Purchase of Computer & Printer	B	-	17,830,746	14,990	4,523,197
D. Closing Balance					
Cash in hand		-		438	
Axis Bank Saving Bank Account		7,192,832	7,192,832	1,207,657	1,208,095
Total		25,023,577		5,731,291	
Accounting policies and notes on accounts	D				

As per our report of even date.

For SSAS & ASSOCIATES

Firm Registration No. 08550N
Chartered Accountants

-sd-
Alpana Saxena
 Partner, Membership No. 095837

-sd-
S. S. SENGUPTA
 MANAGER ACCOUNTS & ADMIN.

-sd-
A. CHAKRABORTY
 DIRECTOR

Place : New Delhi

Date :

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
EMR Programme - Indo German (DST-MPG) Science & Technology Co-operation
SCHEDULE FORMING PART OF BALANCE SHEET, INCOME & EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ON 31ST MARCH, 2015

	Amount for the year ended		Amount for the year ended	
	March 31, 2015		March 31, 2014	
Amount In INR				
Schedule - 'A'				
Balance Funds of DST-MPG Programme				
Opening Balance	2,93,100		42,47,484	
Receipts				
Fund received from Dept. of Science and Technology, Govt. of India towards MPG programme	2,35,38,812		-	
Interest on saving bank account	1,84,926	2,40,16,838	1,36,099	
		2,40,16,838		43,83,583
Utilisation				
Grant sanctioned and released as per MPG Programme	1,73,16,418		37,18,621	
Allocation of management expenses	17,31,642	1,90,48,060	3,71,862	40,90,483
Less: Excess of Management expense		49,68,778		2,93,100
		49,68,778		2,93,100

Schedule 'B'

Fixed Assets

S. No.	Particulars	GROSS BLOCK				DEPRECIATION	NET BLOCK			
		Balance as on 01.04.2014	Additions during the Year		Sold during the year			Total	For the Year	Balance as on 31.03.2015
			upto 30.09.2014	after 30.09.2014						
1	Computer & Monitor	41,079	-	-	-	41,079	24,647	16,432		
2	Office Equipment	87,560	-	-	-	87,560	13,134	74,426		
	Total	1,28,639	-	-	-	1,28,639	37,781	90,858		

Schedule - 'C'

Amount In INR

Partner Groups - PG		Amount In INR
1	Genetic Diversity studies - CDFD Hyderabad	12,03,161
2	Structural Biology of Vesicular Trafficking - IISER Bhopal	10,30,464
3	Chemical Ecology - IISER Kolkata	12,14,087
4	Tropospheric OH Reactivity - IISER Mohali	12,42,560
5	Glyconano Technology - IISER Pune	8,17,378
6	Gravitational Wave - IISER Thiruvananthapuram	10,57,798
7	Cosmology and Gravity - IISER Thiruvananthapuram	11,98,439
8	Polymer Research - IIT Guwahati	5,89,000
9	Regulation of RNA splicing - IISER Mohali	13,50,000
10	Asymmetric Organocatalysis - IIT Guwahati	13,35,681
11	Atmospheric Science - IIT Madras	12,49,189
12	Cellular Membranes in stress signalling and protein homeostasis maintenance - CSIR - CCMB	14,00,000
13	Multifunctional Hybrid Nanostructures for alternative energy	13,00,000
14	Coupling and Dynamics of solar atmosphere - IUCAA Pune	13,50,000
	A. Total	1,63,37,757

Fellowship		
1	Polyphasic taxonomic Characterization of marine bacteria and analyses of the microbial diversity - IMT Chandigarh	75,000
2	Transition metal dithiolato complexes as functional moieties for hydrogenases - University of Delhi	75,000
3	Deciphering the role of the flanking N- and C-terminal regions in the modulation of photocycle kinetics of a LOV domain of a marine algal phototropin - University of Delhi South Campus	73,421
4	Preparation and Characterization of Semiconductor Photo catalysts for surface Reaction Dynamics Study and their applications - DBCRUST	75,000
5	Physiology of Mixotrophic Planktonic Bacteria - IMT Chandigarh	75,000
6	Inflationary cosmology and its connection to particle physics - Saha Institute of Nuclear Physics, Kolkata	74,278
7	Investigating the role of glucosinolate content forwards plant fitness in Brassica juncea - NIPGR, New Delhi	75,000
8	Inflationary cosmology and its connection to particle physics - Saha Institute of Nuclear Physics, Kolkata	80,962
9	Sub-fs control of photo-dynamics in atoms using shaped XUV pulses - IISER Mohali	75,000
10	Applications of metabolite transcript and flux measurements to investigate the effect of elevated ozone and carbon dioxide on yield and pest protection of C3 and C4 crops - BHU, Banaras	75,000
11	Direct patterning of vortex generating diffractive optical elements on fibre tip using a focused ion beam	75,000
12	Cooperative control and consensus - IIT Bombay	75,000
13	Water based nanocomposite dispersions as antimicrobial coatings - IIT Bombay	75,000
B. Total		9,78,661
TOTAL (A+B)		1,73,16,418

Schedule -D'		Amount In INR
1	Salaries	2,04,000
2	Miscellaneous Expense	3,04,729
		<u>5,08,729</u>

Notes on Accounts

1. funds received under DST-MPG Programme vide MoU dated September, 2011 are being managed on behalf of DST as per the mandate given in the said MoU. Therefore the funds do not form part of grant/income of IGSTC

2. Status of Current Awards Liabilities

Particulars	No. of Awards Committed	Amount Committed	Amount In INR				Outstanding Commitments
			Amount Released 2011-12	Amount Released 2012-13	Amount Released 2013-14	Amount Released 2014-15	
Indian Principle Investigator	34	5,27,15,760	86,97,920	1,36,00,112	37,23,503	1,73,16,418	93,77,807



Financial Statements

Audit Report 2015-16



RAJEEV NEELAM & ASSOCIATES
Chartered Accountants

H.O. : D-2/16, Darya Ganj, New Delhi - 110002
Phone : +91 11 23282925, 23263436
E-mail : rajeevna@gmail.com

INDEPENDENT AUDITOR'S REPORT

TO,
THE MEMBERS OF GOVERNING BODY,
Indo-German Science and Technology Centre (IGSTC) - Core
New Delhi,

REPORT ON THE FINANCIAL STATEMENTS

We have audited the accompanying financial statements of **Indo German Science and Technology Centre, - Core, New Delhi**, (A society registered under Societies Registration Act, 1960) which comprise the Balance Sheet as at March 31, 2016, the Statement of Income and Expenditure and the Receipts and Payments for the year then ended, and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

The IGSTC management is responsible for the preparation and presentation of these financial statements that give a true and fair view of the financial position, financial performance and receipts and payment of the IGSTC in accordance with the accounting principles generally accepted in India, including the Accounting Standards issued by the Institute of Chartered Accountants of India. This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Indian Laws applicable to IGSTC for safeguarding its assets and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgements and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit.

We have taken into account the provisions of the Indian Laws applicable to IGSTC, the accounting and auditing standards and matters which are required to be included in the audit report under the provisions of the said the Indian Laws and the Rules made thereunder.

We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to IGSTC preparation of the financial statements that give a true and fair view in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the



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Phone : +91 0120 431 0582, E-mail : sanjeev.singhal@gmail.com

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the financial statements.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required by the Indian Law in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India,

- In the case of the Balance Sheet, of the state of affairs of the IGSTC as at March 31, 2016;
- In the case of Income and Expenditure Account of the deficit of Income over expenditure; and
- In the case of Receipts and Payments Account of the receipts and payments for the year ended on that date.

Qualification

- IGSTC has not provided for gratuity in accordance with the mercantile system of accounting which is against the accounting policy followed. The amount is not ascertained.
- Overhead charges recoverable on loans given to Industrial partner amounting to Rs. 1,56,780.00 relating to, for the period from the end of the moratorium period till the date of start of loan installment (a period of 6 months) has not been provided.

Emphasis of Matter

Without qualifying our report, we draw attention to:

- Refer to note number 3 of notes to account regarding German expenditure towards research projects (non-sharable) amounting to Rs. 8,40,18,873 (Euro 1,118,827) that are based on statement provided by IB-BMBF, Government of Germany to the Centre.
- German operational expenditure amounting to Rs.39,65,653 (Euro 52808.13) reflected in the financial statement are based on statement provided by IB-BMBF, Government of Germany to the Centre.

Other Matters

We did not audit the financial statement / information provided by IB-BMBF of Government of Germany. These information are unaudited and have been forming part of financial statement / notes to accounts.

Report on Other Legal and Regulatory Requirements

- we report that:
 - We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit.



- b) in our opinion proper books of account as required by law have been kept by the IGSTC so far as it appears from our examination of those books;
- c) the balance sheet, the income and expenditure account and receipts and payments account dealt with by this Report are in agreement with the books of account;
- d) in our opinion, the aforesaid Balance Sheet, Income and Expenditure Account and Receipts and Payments Account dealt with by this Report are prepared in accordance with the applicable Accounting Standards issued by the Institute of Chartered Accountants of India.

For **RAJEEV NEELAM & ASSOCIATES**
Firm Registration No. 013787N
Chartered Accountants

RAJEEV K. GUPTA
Partner
Membership No. 087128

Place : New Delhi
Dated : 30th September, 2016



INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE ACCOUNT
THE RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2016.

SCHEDULE- 'L'
ACCOUNTING POLICIES AND NOTES ON ACCOUNTS

Objectives of the Organisation

The Indo German Science and Technology Centre (Society) established in India by the Governments of India and Germany, to facilitate and promote the interaction, in India and Germany of government, academia and industry in science and technology. It is to build and improve research and technology synergies between countries, focusing primarily on natural, life, and engineering sciences. The centre was registered in India on 14th June 2010 under Societies Registration Act, 1860.

I. SIGNIFICANT ACCOUNTING POLICIES

1. **Accounting Period**
Financials are reported from 01st April of a year to 31st March of the following year.
2. **Reporting currency**
The functional currency of the Society is Indian Rupee. Separate Receipts & Payment account, Income & Expenditure Account and Balance Sheet are drawn in Euro at the rate of exchange as prescribed by RBI on the Balance Sheet date i.e. 31.03.2016.
3. **Basis of preparation**
Accounts have been prepared on accrual basis and accordingly income and expenditure are recognized as they are committed and relate to the accomplishments and efforts of the organization. All the transactions and other events are recorded in the period in which they occur as per accrual concept.
4. Any surplus / deficit arising in Income and Expenditure is carried forward to next year for utilization / recovery as per the objectives of IGSTC.
5. **Method of Accounting**
Accounts are maintained on mercantile basis.
6. **Grants Awarded**
Grants are recognized as commitments of expenditure after recommendation of the Scientific Council and approval by the Governing Body. Based on the commitments made to awardees in a year, aggregate grants are recognized as expenditure to the extent of payment due to be made to each awardee during the year. Grants are released on the basis of the approved sanctioned tranches. Release after first year is made on the basis of the utilization certificate received from year to year.
7. **Grants Awarded - Recognition**
Grants are recognised as expenses on the basis of commitments as per the approved sanction terms and timelines for each year.



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8. Loans & Advances

Balance of loans under the projects, including overhead charges due on such loans, are reflected as Loan and Advances.

9. Foreign Currency Transactions

Transactions: Foreign exchange transactions are recorded at the rate prevailing on the date of transaction.

Translation to Euro: Indian currency assets and liabilities at the year-end are stated at the rate of foreign exchange (euro) at the closing of financial year.

10. Income Recognition

Grants: Grants from the two governments are (Department of Science & Technology, Govt. of India and BMBF, Govt. of Germany) are recognised in the Income & Expenditure statements as Grant in Aid only on receipt of the funds from either side under the head Income in the Receipts & Payments Account and the Income & Expenditure account.

11. Fixed Assets:

All the assets acquired for research projects remain with the institution where the research work is carried on. The IGSTC has however retained the right to transfer these assets to other institutions, if so required, on completion of the projects for which these assets were purchased. The expenditure on these assets has been accounted for in the Income and Expenditure Account under the head "Scientific Expenses". Hence, these assets have not been taken in the Balance Sheet of the Centre.

12. Fixed assets acquired by the centre are stated at cost of acquisition less accumulated depreciation. The cost of an asset comprises of its purchase price and directly attributable costs of bringing the asset to working condition for its intended use. During the year, the Centre has carried out the exercise of the physical verification of assets and no major discrepancies have come to notice.

13. All operational expenditure pertaining to German Government incurred in Germany are reported on the basis of statement of expenses.

14. All direct grant awards towards scientific projects by the German Government are neither recorded as receipt nor expenditure of the Centre, since the same are not received/ paid in India. However the same is included in the "Notes to Accounts" on the basis of Statement received from BMBF, Government of Germany.

B. NOTES TO ACCOUNTS:

1. Both governments have considered the allocation of equivalent amount of funds up to 10 million euros each to meet the objectives of the Centre and its running expenditure for an initial period of five years. The annual expenditure may be enlarged by mutual agreement. Out of the said contribution :

a) The Capital and Operating expenditure of the Centre and expenses on account of workshops, seminars, symposiums, preparatory visits, exploratory missions, etc are shared equally by the two Governments.



Ramesh Weelam



Sh. H. S.

b) Expenditure for joint research projects are shared by the two Governments according to the distribution of costs for the respective parts of the project in each country.

2. Total contribution, utilisation of funds and allocation of shareable expense are as under

Contribution and Utilisation of funds to meet Shareable expenses	Upto 31/3/2015	During 2015-16	Total Contribution / Utilisation
1) German side			
a) Direct Expenses Incurred in Germany (##)	10,099,728	3,965,653	14,065,381
b) Funds Remitted to India for Expenses	40,376,460	11,638,658	52,015,118
	50,476,188	15,604,311	66,080,499
Less: Funds Utilised (Shareable)	43,649,955	14,579,856	58,229,811
Balance Carried Forward			7,850,689
2) Indian side			
a) Grant Contribution	245,000,000	50,000,000	295,000,000
b) Accrued as interest and other receipts	8,727,909	5,128,974	13,856,883
	253,727,909	55,128,974	308,856,883
Less: Funds Utilised (Shareable)	43,649,955	14,579,856	58,229,811
Project Utilisation (Non Shareable)	129,421,542	50,969,667	180,391,209
Balance Carried Forward			70,235,864
(##) Amounts as reported by BMBF			
Current year direct expense contribution of € 52808.13 by BMBF converted at @ Rs. 75.0955 per Euro			

3. Status of future commitments of Awards sanctioned

Awarded in 2+2 mode	Number of awards committed	Amount Sanctioned	Amount released up to 31.3.2015	Amount in INR		
				Amount committed in current year	Reversal of commitment due to short closure	Outstanding future commitments
Indian side	25	337,419,698	141,020,066	52,731,420 (**)	16,789,487	126,878,725
German Side (in INR) (***)	25	757,099,314	264,056,429	84,018,873	-	409,024,012
German Side (in Euro)	25	10,081,820	3,516,275	1,118,827	-	5,446,718
Total		1,094,519,012	405,076,495	136,750,293	16,789,487	535,902,737

(**) includes Rs. 59,25,000/- as loans given to industrial partners as per the terms of the agreement.

(***) Converted at a RBI reference rate of exchange at close of financial year at Euro 1 = Rupee 75.0955

4. Income Tax

Income Tax Department [office of the Commissioner of Income Tax (E), New Delhi] has granted IGSTC registration under section 12A of the Income Tax Act, 1961 as General Public Utility vide their letter no CIT(E)/2014-15/DEL-IR24110-10122014/4089 dated 10/12/2014.



Ramesh Weelam



Sh. H. S.

5. All German expenditure figures are reflected in the report as per information provided by IB-BMBF to IGSTC.
6. **Other disclosures**
- (i) **Gratuity:** Is payable as per the rules under the payment of Gratuity Act, 1972. However, no provision for the same has been made in the accounts as the same shall be accounted on actual payment.
- (ii) As per approval of Governing Body, all financial powers in respect of activities of the Centre are exercised by Director after obtaining approval of the Governing Body.
7. There are no disputes/claims which are unsettled for a long time.
8. **Related parties Disclosures:**
During the year no trust funds were utilized for the benefits of the settlers or the trustees other than reimbursement of expenses incurred by them.
9. **Prior Period Expenses/ Income**
Expenses due in previous year, but accounted for in the current year. Further overhead charges on loan relating to prior years were recognized as income during the current year in accordance with accrual system of account and recognition norms as per AS-9 of ICAI.

Expenses

S no.	Account head	Amount
1	Office expenses	2,27,838
2	Salaries	4,09,964
3	Communication	22,146
4	Project expenses	11,17,667
5	Scientific workshop	3,18,755
	Total	20,96,370
Income		
1	Overhead charges	8,14,807

10. The previous year figures have been regrouped / rearranged wherever necessary to make them comparable with the current year figures.
11. There are no contingent liabilities during the reporting period.

For RAJEEV NEELAM & ASSOCIATES
Firm Registration No. 013787N
Chartered Accountants

RAJEEV K. GUPTA
Partner
Membership No. 087128

Place : New Delhi
Dated: 30 SEP 2016




SUNIL KUKREJA
Manager (A/c & Admin.)


DR. CHADARAM SIVAJI
Director/ Scientist 'F', DST



INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
BALANCE SHEET AS AT 31ST MARCH 2016

Schedule	Amount in INR		
	As at March 31, 2016	As at March 31, 2015	
SOURCE OF FUNDS			
Reserve fund			
Opening Balance	8,79,44,080	8,44,40,067	
Add : Surplus/(Deficit)	(94,71,449)	35,04,013	
	7,84,72,631	8,79,44,080	
Current liabilities	A	1,16,74,336	60,64,494
TOTAL		9,01,46,967	9,40,08,574
APPLICATION OF FUNDS			
Fixed assets			
Gross block	B	4,61,434	4,87,278
Add: addition during the year		30,358	1,02,390
Total		4,91,792	5,89,668
Less: Depreciation		1,05,713	1,28,234
Net Block		3,86,079	4,61,435
Cash and Bank Balances			
Cash in hand		9,356	2,146
Balance with Bank	C	6,71,81,535	7,64,57,993
		6,71,90,891	7,64,60,139
Loans and Advances	D	2,25,44,624	1,70,87,000
Prepaid Expenses		25,373	-
TOTAL		9,01,46,967	9,40,08,574
Accounting policies and notes on accounts	L		

As per our report of even date.

For RAJEEV NEELAM & ASSOCIATES
Firm Registration No. 013787N
Chartered Accountants

-Sd-
RAJEEV K. GUPTA
Partner
Membership No. 087128

-Sd-
SUNIL KUKREJA
Manager (A/c & Admin.)

-Sd-
DR. CHADARAM SIVAJI
Director/ Scientist 'F', DST

Place : New Delhi
Date :

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2016

		Amount in INR		
Schedule	For the year ended March 31, 2016	For the year ended March 31, 2015		
INCOME				
Grant-in-aid :				
Contribution from Department of Science and Technology, Govt. of India	5,00,00,000	6,00,00,000		
Contribution from Govt. of Germany (through expenses intimated by BMBF) from Govt. of Germany (€ 52,808.13)	1,16,38,658	-		
	<u>39,65,653</u>	<u>6,56,04,311</u>	<u>34,88,870</u>	<u>6,34,88,870</u>
Interest Income				
Interest from Bank Accounts	39,05,164	23,79,869		
Interest on Income Tax Refunds	243	39,05,407	-	23,79,869
Overhead Charges on Loans		12,17,760		
Miscellaneous receipts		330		
Income Tax Refunds		5,477		
			<u>-</u>	<u>-</u>
TOTAL	<u>7,07,33,285</u>	<u>6,58,69,783</u>		
EXPENDITURE				
Scientific Project Expenses of the Centre	E	5,09,69,667	4,36,77,624	
Governing Body/ Scientific Council Expenses	F	29,42,418	17,21,043	
Travelling Expenses (National & International)	G	7,73,545	6,21,946	
Office Expenses	H	1,13,84,182	1,04,88,603	
Salaries	I	63,11,768	55,56,604	
Joint Scientific Workshop	J	73,62,181	76,088	
Other Meetings / Conference	K	3,55,260	95,628	
Depreciation on Fixed Assets	B	1,05,713	1,28,234	
			<u>-</u>	<u>-</u>
TOTAL		<u>8,02,04,734</u>	<u>6,23,65,770</u>	
Surplus/(Deficit) of Income over expenditure carried over to Balance Sheet		<u>(94,71,449)</u>	<u>35,04,013</u>	
Accounting policies and notes on accounts	L			
As per our report of even date.				
For RAJEEV NEELAM & ASSOCIATES				
Firm Registration No. 013787N Chartered Accountants				
-Sd-	-Sd-			
RAJEEV K. GUPTA	SUNIL KUKREJA	DR. CHADARAM SIVAJI		
Partner	Manager (A/c & Admin.)	Director/ Scientist 'F', DST		
Membership No. 087128				

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH, 2016

		Amount in INR			
Schedule	For the year ended March 31, 2016	For the year ended March 31, 2015			
Opening balance					
Cash in hand	2,146	2,512			
Cash at bank	7,64,57,993	7,64,60,139	8,40,25,277	8,40,27,789	
			<u>-</u>	<u>-</u>	
Receipts					
Grant-in-aid :					
Contribution from Department of Science and Technology, Govt. of India	5,00,00,000	6,00,00,000			
Contribution from Govt. of Germany	1,16,38,658	6,16,38,658	-	6,00,00,000	
			<u>-</u>	<u>-</u>	
Interest Received					
Interest from bank accounts	39,01,860	23,79,869			
Interest on income tax refunds	243	-			
Income tax refunds	5,477	39,07,580	-	23,79,869	
Overhead charges on loan		3,61,251			
			<u>-</u>	<u>-</u>	
Unspent amount refunded from :					
Workshop Call -2012	-	12,20,807			
ICGEB for IGSTC 2+2 Project	-	1,01,331	13,22,138		
			<u>-</u>	<u>-</u>	
Loans refunded		13,35,326			
Amount of tax deducted at source (TDS)		12,22,047			
Amount of GPF, HBA, RGIS recovered on behalf of CSIR		5,43,180			
Miscellaneous receipts		330			
Amount received from DST-MPG account		2,832			
			<u>-</u>	<u>-</u>	
TOTAL	<u>14,54,71,343</u>	<u>14,77,30,840</u>			
Payments					
Project Expense (Non-shareable)					
Scientific project expenses of the Centre		4,68,06,420	5,52,76,148		
Loan for projects		59,25,000			
Scientific Expense (Shareable)					
Joint scientific workshop	67,26,550	70,81,810	12,96,895		
Other meetings/conference	3,55,260	95,628	13,92,523		
			<u>-</u>	<u>-</u>	
Establishment Expense (Shareable)					
Governing body/ scientific council expenses	29,42,418	17,21,043			
Travelling expenses (national & international)	7,73,545	6,21,946			
Office expenses	72,08,578	65,36,205			
Salaries	57,47,096	38,25,708			
Purchase of office equipment	30,358	18,000			
Purchase of computer/printer	-	84,390	1,28,07,292		
			<u>-</u>	<u>-</u>	
		<u>1,67,01,995</u>	<u>84,390</u>	<u>1,28,07,292</u>	
		<u>7,65,15,225</u>	<u>6,94,75,963</u>		

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INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH, 2016

Schedule	Amount in INR	
	For the year ended March 31, 2016	For the year ended March 31, 2015
b/f	7,65,15,225	6,94,75,963
Other Payments		
TDS Payments	12,22,047	12,06,558
Amount recovered on behalf of CSIR, Delhi	5,43,180	5,13,180
MPG fellowship amount refunded but credited erroneously	-	75,000
	<u>17,65,227</u>	<u>17,94,738</u>
Closing Balance		
Cash in hand	9,356	2,146
Bank balances	6,71,81,535	7,64,57,993
	<u>6,71,90,891</u>	<u>7,64,60,139</u>
TOTAL	<u>14,54,71,343</u>	<u>14,77,30,840</u>

Accounting policies and notes on accounts L

As per our report of even date.

For RAJEEV NEELAM & ASSOCIATES

Firm Registration No. 013787N
Chartered Accountants

-Sd-
RAJEEV K. GUPTA
Partner
Membership No. 087128

Place : New Delhi
Date :

-Sd-
SUNIL KUKREJA
Manager (A/c & Admin.)

-Sd-
DR. CHADARAM SIVAJI
Director/ Scientist 'F', DST

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT FOR
THE YEAR ON 31ST MARCH, 2016

	Amount in INR	
	As at March 31, 2016	As at March 31, 2015
Schedule 'A'		
Current Liabilities		
TDS payable	83,900	-
Creditors for expenses	78,114	-
Project/ workshop commitments payable		
Project - grants	97,53,054	55,89,807
Workshops	6,35,631	-
	<u>1,03,88,685</u>	<u>55,89,807</u>
Other liabilities		
Staff salaries	3,14,948	-
Employee benefit expenses	6,74,108	4,74,687
IT admin charges	1,15,500	-
Payable to DST - MPG	2,832	-
Telephone expenses	16,249	4,74,687
	<u>11,23,637</u>	<u>4,74,687</u>
	<u>1,16,74,336</u>	<u>60,64,494</u>

Schedule 'B'

Fixed Assets

S. No.	Particulars	GROSS BLOCK			Total	DEPRECIATION For the Year	NET BLOCK Balance as on 31.03.2016
		Balance as on 01.04.2015	Additions during the Year				
			upto 30.09.2015	after 30.09.2015			
1	Computer & Printers	91,041	-	-	91,041	54,625	36,416
2	Office Equipment	2,11,287	16,090	14,268	2,41,645	35,177	2,06,468
3	Furniture & Fixture	1,59,106	-	-	1,59,106	15,911	1,43,195
	TOTAL	4,61,434	16,090	14,268	4,91,792	1,05,713	3,86,079
	Perivous Year	4,87,278	18,000	84,390	5,89,668	1,28,234	4,61,434

As at
March 31, 2016

As at
March 31, 2015

Schedule 'C'

Balances with Banks

Saving Bank Accounts		
Axis Bank A/c No. 910010034609799	3,42,77,936	5,30,66,250
Axis Bank A/c No. 911010026562072	86,22,781	9,47,349
Union Bank of India A/c No. 349902010043192	60,29,932	57,95,840
Fixed Deposits		
Axis Bank	4,08,116	3,00,000
Union Bank of India	1,78,42,770	1,63,48,554
	<u>6,71,81,535</u>	<u>7,64,57,993</u>

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT
FOR THE YEAR ON 31ST MARCH, 2016

	Amount in INR	
	As at March 31, 2016	As at March 31, 2015
Schedule 'D'		
Loans and Advances		
Loan to industries	2,16,76,675	1,70,87,000
Overhead charges receivables on loans	8,56,509	-
TDS Income Tax -A.Y 16-17	3,304	-
Recovery of expense from CSIR	8,136	-
	<u>2,25,44,624</u>	<u>1,70,87,000</u>
	For the year ended March 31, 2016	For the year ended March 31, 2015
Schedule 'E'		
Scientific expenses of the centre (India Side)		
Research Projects - Grant		
Call 2010		
CLFR	-	14,08,493
	-	14,08,493
Call 2011		
REMSOLAR	16,42,000	77,92,000
IN-DUES	42,00,000	41,00,000
NPORE	22,26,219	23,68,000
NANOTRANS	-	33,78,712
NDT DATA FUSION	3,91,448	18,30,000
	84,59,667	2,08,77,205
Call 2012		
AMPLAST	47,50,000	1,16,00,000
DNDHCSA	15,50,000	42,00,000
DP- Forge	18,80,000	82,30,000
SeNaMeB	25,80,000	79,80,000
RESERVES	43,90,000	-
	1,51,50,000	3,20,10,000
Call 2014		
MIRDI	77,50,000	-
SIBAC	94,50,000	-
SOUND4ALL	1,01,60,000	-
	2,73,60,000	-
	5,09,69,667	5,28,87,205
Less: Less unspent balance received from projects	-	1,01,331
	5,09,69,667	5,27,85,874
Less : Loans accounted as expenditure in earlier years	-	91,08,250
	<u>5,09,69,667</u>	<u>4,36,77,624</u>
Schedule 'F'		
Governing body/ Scientific council expense		
Governing body meeting	15,22,796	12,81,172
Scientific council meeting	14,19,622	4,39,871
	<u>29,42,418</u>	<u>17,21,043</u>

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE - CORE
SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT
FOR THE YEAR ON 31ST MARCH, 2016

	Amount in INR	
	For the year ended March 31, 2016	For the year ended March 31, 2015
Schedule 'G'		
Travelling Expenses		
Travel within India	2,48,322	3,53,272
Travel abroad	5,25,223	2,68,674
	<u>7,73,545</u>	<u>6,21,946</u>
Schedule 'H'		
Office Expense		
Office rent	43,18,650	42,47,208
Electricity, water & other maintenance charges	7,44,026	7,01,127
Transportation	5,81,764	5,50,272
Telephone and internet	3,02,553	2,44,417
Printing & stationery	3,51,740	1,08,714
Postage and courier	9,817	19,402
Staff welfare	27,278	25,009
Advertisement	56,112	70,251
Legal and professional	7,93,723	7,18,686
Miscellaneous	2,32,866	3,14,647
Operational Expenses by IB-BMBF * (€ 52,808.13)	39,65,653	34,88,870
	<u>1,13,84,182</u>	<u>1,04,88,603</u>
* Refer to note number '5' of the Schedule 'M(II)'		
Schedule 'I'		
Salaries		
Salaries and allowances	59,04,750	50,16,634
Contribution to employees provident fund	2,73,832	4,41,041
Medical reimbursement /medical insurance	1,33,186	98,929
	<u>63,11,768</u>	<u>55,56,604</u>
Schedule 'J'		
Joint Scientific Workshop		
Call -2012	3,18,755	-
Call-2014	70,43,426	12,96,895
	73,62,181	12,96,895
Less : Unspent balance received	-	12,20,807
	<u>73,62,181</u>	<u>76,088</u>
Schedule 'K'		
Other meetings / conference		
Due diligence meeting	3,33,121	-
Project promotion meeting	22,139	95,628
	<u>3,55,260</u>	<u>95,628</u>



RAJEEV NEELAM & ASSOCIATES
Chartered Accountants

H.O. : D-2/16, Darya Ganj, New Delhi - 110002
Phone : +91 11 23282925, 23263436
E-mail : rajeevna@gmail.com

INDEPENDENT AUDITOR'S REPORT

TO,
THE MEMBERS OF GOVERNING BODY,
Head, International Bilateral Cooperation Division (IBCD) &
Co-Chair, Indo-German Science and Technology Centre (IGSTC)
Department of Science & Technology,
New Delhi,

REPORT ON THE FINANCIAL STATEMENTS

We have audited the accompanying financial statements of Indo German Science and Technology Centre, New Delhi, with respect to EMR Programme concerning management and administration of Indo – German (DST – MPG) Science and Technology Centre, New Delhi which comprise the Balance Sheet as at March 31, 2016, the Statement of Income and Expenditure and the Receipts and Payments for the year then ended, and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

The IGSTC management is responsible for the preparation and presentation of these financial statements that give a true and fair view of the financial position, financial performance and receipts and payment of the IGSTC in accordance with the accounting principles generally accepted in India, including the Accounting Standards issued by the Institute of Chartered Accountants of India. This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Indian Laws applicable to IGSTC for safeguarding its assets and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgements and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit.

We have taken into account the provisions of the Indian Laws applicable to IGSTC, the accounting and auditing standards and matters which are required to be included in the audit report under the provisions of the said the Indian Laws and the Rules made thereunder.

We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to IGSTC preparation of the financial statements that give a true and fair view in order to design audit procedures



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that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the financial statements.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required by the Indian Law in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India,

- a) In the case of the Balance Sheet, of the state of affairs of the IGSTC as at March 31, 2016;
- b) In the case of Income and Expenditure Account of the deficit of income over expenditure; and
- c) In the case of Receipts and Payments Account of the receipts and payments for the year ended on that date.

Report on Other Legal and Regulatory Requirements

1. we report that:

- a) We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit.
- b) in our opinion proper books of account as required by law have been kept by the IGSTC so far as it appears from our examination of those books;
- c) the balance sheet, the income and expenditure account and receipts and payments account dealt with by this Report are in agreement with the books of account;
- d) in our opinion, the aforesaid Balance Sheet, Income and Expenditure Account and Receipts and Payments Account dealt with by this Report are prepared in accordance with the applicable Accounting Standards issued by the Institute of Chartered Accountants of India.

For RAJEEV NEELAM & ASSOCIATES
Firm Registration No. 013787N
Chartered Accountants



RAJEEV K. GUPTA
Partner
Membership No. 087128

Place : New Delhi
Dated : 30th September, 2016

INDO - GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme
BALANCE SHEET AS AT 31ST MARCH, 2016

Schedule	Amount in INR		
	As at March 31, 2016	As at March 31, 2015	
SOURCE OF FUNDS			
Operational Reserve Fund			
Opening balance	23,14,912	10,43,633	
Add : Surplus/(Deficit)	(14,41,252)	12,71,279	
	8,73,660	23,14,912	
Balance Funds of DST-MPG Programme			
Balance funds out of receipts from Department of Science and Technology, Govt. Of India	A	4,86,328	49,68,778
TOTAL		13,59,988	72,83,690
APPLICATION OF FUNDS			
Fixed Assets			
Gross block	B	1,38,858	1,28,639
Less: depreciation to date		35,423	37,781
Net block		1,03,435	90,858
Current Assets			
Due from IGSTC, Main Account		2,832	-
Cash and Bank Balances			
Cash in hand		-	-
Axis bank saving account (Reserve Fund A/c)		10,25,353	-
Axis bank saving account		2,28,367	71,92,832
TOTAL		13,59,988	72,83,690

Accounting policies and notes on accounts

E

As per our report of even date.

For RAJEEV NEELAM & ASSOCIATESFirm Registration No. 013787N
Chartered Accountants

-Sd-
RAJEEV K. GUPTA
 Partner
 Membership No. 087128

Place : New Delhi
Date :

-Sd-
SUNIL KUKREJA
 Manager (A/c & Admin.)

-Sd-
DR. CHADARAM SIVAJI
 Director/ Scientist 'F', DST

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2016

Schedule	Amount in INR		
	For the year ended March 31, 2016	For the year ended March 31, 2015	
INCOME			
Allocation expense	2,49,892	17,31,642	
Unspent amount of project received	-	16,745	
Amount received from IGSTC main account for fellowship, which was wrongly credited	-	75,000	
TOTAL	2,49,892	18,23,387	
EXPENDITURE			
Scientific committee meeting expenses	-	76,966	
Meeting expenses	-	5,599	
Office expenses	1,32,991	66,762	
Salaries	3,92,000	3,65,000	
Depreciation on fixed assets	B	35,423	37,781
TOTAL	5,60,414	5,52,108	
Surplus/(Deficit) of Income over expenditure	(3,10,522)	12,71,279	
Recovery of Excess Allocation of management expense in the year 2014-15	10,38,985	-	
Unspent balance received back wrongly treated as income in earlier year	91,745	11,30,730	
Balance carried over to balance sheet	(14,41,252)	12,71,279	
Accounting policies and notes on accounts	E		

As per our report of even date.

For RAJEEV NEELAM & ASSOCIATESFirm Registration No. 013787N
Chartered Accountants

-Sd-
RAJEEV K. GUPTA
 Partner
 Membership No. 087128

Place : New Delhi
Date :

-Sd-
SUNIL KUKREJA
 Manager (A/c & Admin.)

-Sd-
DR. CHADARAM SIVAJI
 Director/ Scientist 'F', DST

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH, 2016

	Schedule	Amount in INR	
		For the year ended March 31, 2016	For the year ended March 31, 2015
Opening balance			
Cash in hand		-	438
Axis bank saving account		<u>71,92,832</u>	<u>12,07,657</u>
		71,92,832	12,08,094
Receipts			
Fund received from Dept. of Science and Technology, Govt of India towards MPG Programme		-	2,35,38,812
Interest on saving bank account		1,87,242	1,84,926
Amount received from IGSTC main account for fellowship, which was wrongly credited		-	75,000
Unspent amount of project received		<u>6,96,760</u>	<u>16,745</u>
		8,84,002	2,38,15,483
TOTAL		<u>80,76,834</u>	<u>2,50,23,577</u>
Payments			
Advance to IGSTC main account		2,832	-
Grants sanctioned and released as per MPG	C	62,47,290	1,73,16,418
Scientific committee meeting expenses		-	76,966
Meeting expenses		-	5,599
Salaries		3,92,000	3,65,000
Office expenses	D	1,32,991	66,762
Purchase of computer & printer	B	<u>48,000</u>	<u>-</u>
		68,23,113	1,78,30,745
Closing Balance			
Cash in hand		-	-
Axis bank saving Account		<u>12,53,720</u>	<u>71,92,832</u>
		12,53,720	71,92,832
Total		<u>80,76,834</u>	<u>2,50,23,577</u>

Accounting policies and notes on accounts

As per our report of even date.

For RAJEEV NEELAM & ASSOCIATESFirm Registration No. 013787N
Chartered Accountants

-Sd-
RAJEEV K. GUPTA
 Partner
 Membership No. 087128

Place : New Delhi
Date :

-Sd-
SUNIL KUKREJA
 Manager (A/c & Admin.)

-Sd-
DR. CHADARAM SIVAJI
 Director/ Scientist 'F', DST

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme

SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT
FOR THE YEAR ON 31ST MARCH, 2016

	Amount In INR	
	As at March 31, 2016	As at March 31, 2015
Schedule - 'A'		
Balance Funds of DST-MPG Programme		
Opening Balance	49,68,778	2,93,100
Receipts		
Fund received from Dept. of Science and Technology, Govt. of India towards MPG programme	-	2,35,38,812
Interest on saving bank account	<u>1,87,242</u>	<u>1,84,926</u>
	51,56,020	2,40,16,838
	<u>51,56,020</u>	<u>2,40,16,838</u>
Utilisation		
Grant sanctioned and released as per MPG Programme	54,58,785	1,73,16,418
Allocation of management expenses	<u>2,49,892</u>	<u>17,31,642</u>
	57,08,677	1,90,48,060
Less: Excess of Management expense	<u>(10,38,985)</u>	<u>-</u>
	46,69,692	1,90,48,060
	<u>4,86,328</u>	<u>49,68,778</u>

Schedule 'B'

Fixed Assets

S. No.	Particulars	GROSS BLOCK			Total	DEPRECIATION For the Year	NET BLOCK Balance as on 31.03.2016
		Balance as on 01.04.2015	Additions during the Year				
			upto 30.09.2015	after 30.09.2015			
1	Computer & Printers	16,432	-	48,000	64,432	24,259	40,173
2	Office Equipment	74,426	-	-	74,426	11,164	63,262
	Total	<u>90,858</u>	<u>-</u>	<u>48,000</u>	<u>1,38,858</u>	<u>35,423</u>	<u>1,03,435</u>
	Previous Year	1,28,639	-	-	1,28,639	37,781	90,858

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme

SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT FOR
THE YEAR ON 31ST MARCH, 2016

	Amount In INR	
	For the year ended March 31, 2016	For the year ended March 31, 2015
Schedule -'C'		
Grants Sanctioned and released as per MPG		
Partner Groups		
1 Genetic Diversity studies - CDFD Hyderabad	6,00,000	12,03,161
2 Structural Biology of Vesicular Trafficking - IISER Bhopal	9,89,478	10,30,464
3 Chemical Ecology - IISER Kolkata	7,55,000	12,14,087
4 Tropospheric OH Reactivity -IISER Mohali	9,38,887	12,42,560
5 Glyconano Technology - IISER Pune	-	8,17,378
6 Gravitational Wave - IISER Thiruvananthapuram	3,87,723	10,57,798
7 Cosmology and Gravity - IISER Thiruvananthapuram	9,73,475	11,98,439
8 Polymer Research - IIT Guwahati	8,10,700	5,89,000
9 Regulation of RNA splicing - IISER Mohali	-	13,50,000
10 Asymmetric Organ catalysis - IIT Guwahati	-	13,35,681
11 Atmospheric Science -IIT Madras	-	12,49,189
12 Cellular Membranes in stress signalling and protein homeostasis maintenance - CSIR - CCMB	-	14,00,000
13 Multifunctional Hybrid Nanostructures for alternative energy systems - IIT Kharagpur	-	13,00,000
14 Coupling and Dynamics of solar atmosphere - IUCAA Pune	-	13,50,000
	<u>54,55,263</u>	<u>1,63,37,757</u>
Less: unspent amount refunded *	6,20,865	-
A. Total	<u>48,34,398</u>	<u>1,63,37,757</u>

* This includes Rs. 16,745 refund of unspent amount the projects in the earlier year, accounted as income in financial year 2014-15.

Fellowship

1 Deciphering the role of the flanking N- and C-terminal regions in the modulation of photocycle kinetics of a LOV domain of a marine algal phototropin	75,000	73,421
2 Transition metal dithioato complexes as functional models for hydrogenases	72,109	75,000
3 Dissecting the regulatory role of adiponectin signalling in human retinal synaptic vesicle trafficking under physiological and pathological conditions	75,000	-
4 Investigating the role of glucosinolate content towards plant fitness in Brassica juncea	75,000	75,000
5 Inflationary cosmology and its connection to particle physics	48,154	1,55,240
6 Physiology of mixotrophic planktonic bacteria	75,000	75,000
7 Application of metabolite, transcript and flux measurements to investigate the effect of elevated ozone and carbon dioxide on yield and pest protection of C3 and C4 crops	71,764	75,000
c/f	<u>4,92,027</u>	<u>5,28,661</u>

INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme

SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT
FOR THE YEAR ON 31ST MARCH, 2016

	Amount In INR	
	For the year ended March 31, 2016	For the year ended March 31, 2015
	b/f	4,92,027
8 Complex Networks and Systems Biology	75,000	-
9 Tailoring interface spin transport: towards molecular spintronics	75,000	-
10 Agricultural Microbiology	75,000	-
11 Transcriptional responses of Helicoverpa armigera to the insecticidal mycotoxin, Destruxin	75,000	-
12 Polyphasic taxonomic Characterization of marine bacteria and analyses of the microbial diversity	-	75,000
13 Preparation and Characterization of Semiconductor Photo catalysts for surface Reaction Dynamics Study and their applications	-	75,000
14 Sub-fs control of photo -synamics in atoms using shaped XUV pulseto	-	75,000
15 Direct patterning of vortex generating diffractive optical elements on fibre tip using a focused ion beam	-	75,000
16 Cooperative control and consensus	-	75,000
17 Water based nanocomposite dispersions as antimicrobial coatings	-	75,000
	Total	7,92,027
Less: unspent amount refunded *	1,67,640	-
B. Total	<u>6,24,387</u>	<u>9,78,661</u>
TOTAL (A+B)	<u>54,58,785</u>	<u>1,73,16,418</u>

* This includes Rs. 75,000 refunded unspent from the projects in the earlier year, wrongly taken into the income of financial year 2014-15.

Schedule -'D'**Office Expenses**

Communication Expenses	8,484	15,191
Tours & Travels	64,489	25,376
Printing & Stationery	17,850	5,758
Advertisement Expenses	-	20,000
Miscellaneous Expense	42,168	437
	<u>1,32,991</u>	<u>66,762</u>

Schedule -'E'**Accounting Policies and Notes to Accounts****A. Accounting Policies****Income recognition and Accounting for Expenditure**

1 Accounts have been prepared on accrual basis and accordingly incomes and expenditure are recognized as they are committed and relate to the accomplishments and efforts of the organization. All the transactions and other events are recorded in the period in which they occur as per accrual concept.

**INDO GERMAN SCIENCE & TECHNOLOGY CENTRE
INDIA GERMAN (DST - MPG) Science & Technology Co-operation Programme**

**SCHEDULE FORMING PART OF BALANCE SHEET, INCOME AND EXPENDITURE AND RECEIPT AND PAYMENT ACCOUNT
FOR THE YEAR ON 31ST MARCH, 2016**

- 2 Funds received under DST-MPG Programme vide MoU dated September, 2011 are being managed on behalf of DST as per the mandate given in the said MoU. Therefore the funds do not form part of grant/income of IGSTC. Considering the fact, all funds received on account for such activities are treated as advances for meeting the proposed activity and also to cover the related direct and indirect administrative costs. Therefore, the receipt and utilization against the respective programmes are not considered as Income or Expenditure of IGSTC. However, the costs of administration for running these extramural programmes are recovered from the fund so received, on the basis of approval given by DST at 4% of the total project amount released during the year. The residual programme grants not utilized during the year are carried forward as current liability for fulfilling commitments in coming financial year.
- 3 Interest income is recognized on accrual basis for all Deposits with the banks and is treated as part of contribution from DST for DST MPG Program.
- 4 Fixed Assets are stated at their original cost less accumulated depreciation but including freight, duties, taxes and other incidental expenses relating to acquisition and installation.
- 5 Depreciation of Fixed Assets has been provided on written down value method on a pro-rata basis at the rates as prescribed under the Income-tax Rules, 1962.

B. NOTES TO ACCOUNTS:

- 1 Commitments amounting to Rs. 1,93,16,885/- have been made under various undergoing programmes at the close of the Financial year, to that extent the current available funds are encumbered to meet the future commitments.

Total Future Commitments			
Heads	Partner Group	Fellowship /Mobility Grant	Total
Call 2010	77,50,364	-	77,50,364
Call 2011	-	1,58,909	1,58,909
Call 2012	41,65,130	2,64,246	44,29,376
Call 2013	40,50,000	7,53,236	48,03,236
Call 2014	-	21,75,000	21,75,000
Total Future Commitments			1,93,16,885

- 2 Prior Period Expenses / Income:

Expenses due in previous year but accounted for in the current year

Particulars	Amount
Salaries	1,93,000.00

- 3 There is no contingent liability as on 31st March, 2016

- 4 The previous year figures have been regrouped/ rearranged wherever necessary to conform to current year figures.

For RAJEEV NEELAM & ASSOCIATES

Firm Registration No. 013787N

Chartered Accountants

-Sd-
RAJEEV K. GUPTA
Partner
Membership No. 087128

-Sd-
SUNIL KUKREJA
Manager (A/c & Admin.)

-Sd-
DR. CHADARAM SIVAJI
Director/ Scientist 'F', DST

Place : New Delhi

Date :

Notes

Contact Points



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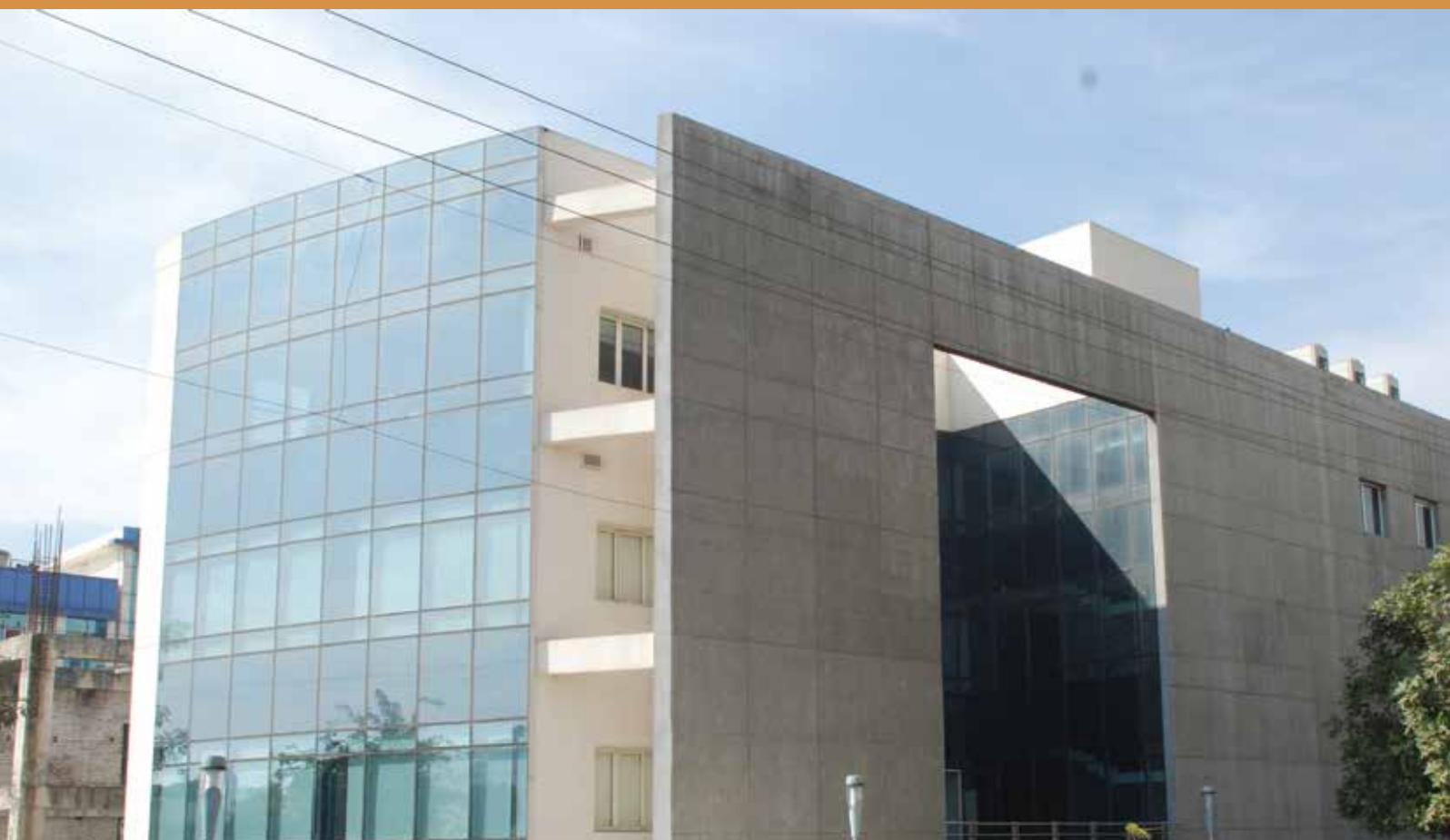
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IGSTC through the lens.....





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