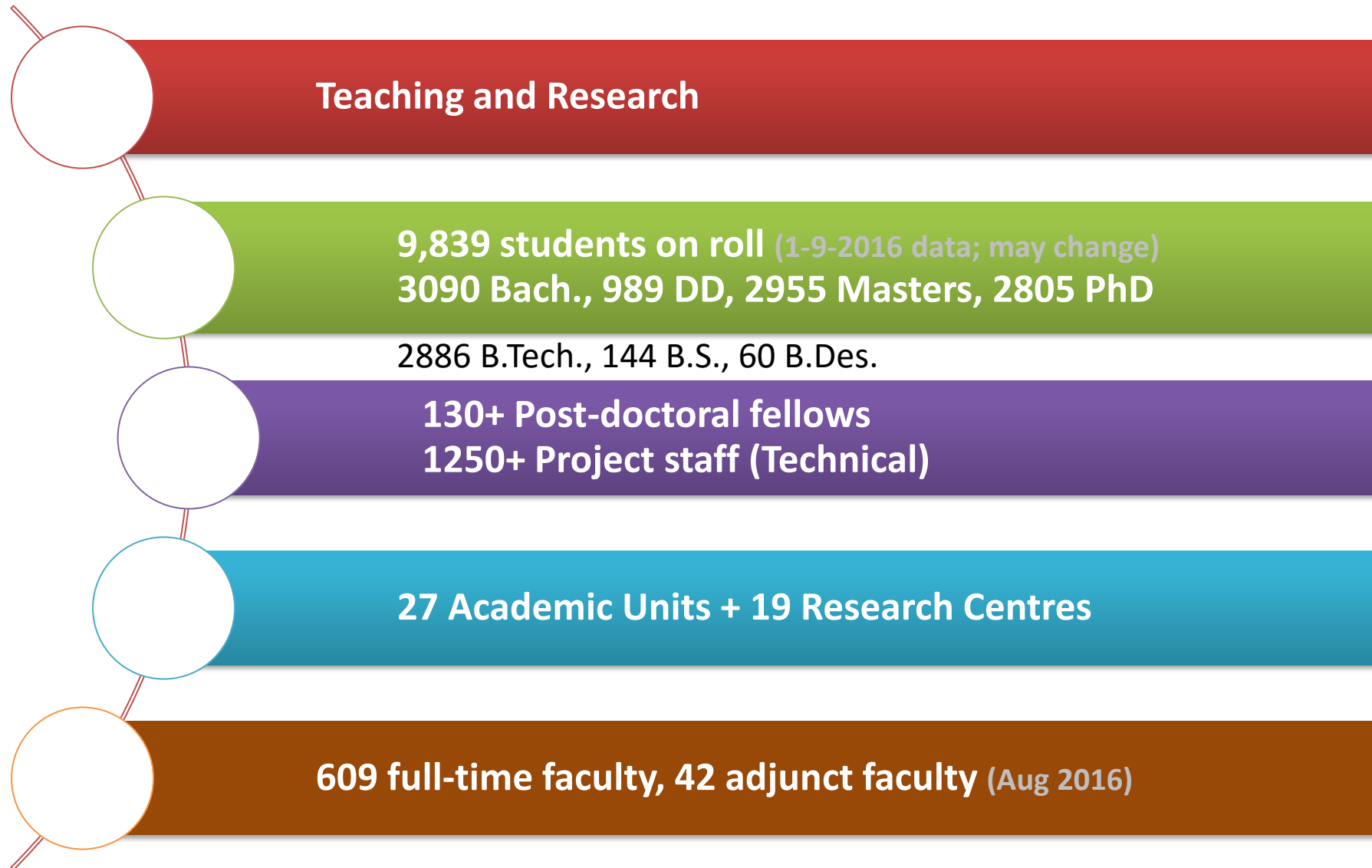




**Industrial Research and Consultancy Center  
Indian Institute of Technology Bombay  
October 2016**

# IIT Bombay at a glance



# **Academic units @ IIT Bombay**

- **Department of Aerospace Engineering**
- **Department of Biosciences & Bioengineering**
- **Department of Chemical Engineering**
- **Department of Chemistry**
- **Department of Civil Engineering**
- **Department of Computer Science & Engineering**
- **Department of Earth Sciences**
- **Department of Electrical Engineering**
- **Department of Energy Science and Engineering**
- **Department of Humanities and Social Sciences**
- **Department of Mathematics**
- **Department of Mechanical Engineering**
- **Department of Metallurgical Engg. & Materials Sci.**
- **Department of Physics**
- **Center for Environmental Science & Engineering**
- **Center for Policy Studies (IDP)**
- **Center for Research in Nanotechnology & Science**
- **Center for Technology Alternatives to Rural Areas**
- **Center for Urban Science and Engineering**
- **Center of Studies in Resources Engineering**
- **IDP in Climate Studies**
- **IDP in Education Technology**
- **IDP in Industrial Engg. & Operations Research**
- **IDP in Systems & Control Engineering**
- **IITB Desai Sethi Centre for Entrepreneurship (IDP)**
- **Industrial Design Center**
- **Shailesh J. Mehta School of Management**

# Academic programs and degrees

**Applied Statistics & Informatics**

**Chemistry**

**Geology**

**Geophysics**

**Mathematics**

**Physics**

**Aerospace Engineering**

**Chemical Engineering**

**Civil Engineering**

**Electrical Engineering**

**Mechanical Engineering**

**Design**

**Education Technology**

**Entrepreneurship (minor)**

**Humanities & Social Sciences**

**Management**

**Policy Studies**

**Biomedical Engineering**

**Biotechnology**

**Climate Studies**

**Computer Science & Engineering**

**Energy Science & Engineering**

**Environment Science & Engineering**

**Geoinformatics & Natural Resources Eng.**

**Industrial Eng & Operations Research**

**Metallurgical Eng & Material Science**

**Nanotechnology & Science**

**Systems and Control Engineering**

**Technology & Development**

**Urban Science & Engineering**

**BTech, BS, PhD, MTech, MSc, MDes, MMgmt, MPhil**

**Dual degree programs (BTech+MTech, MTech+PhD, MTech+MSc, MSc+PhD)**

**Minors and Honors for BTech students**

# Research Centers @ IIT Bombay

- Biomedical Engineering and Technology Incubation Centre [RGSTC, Maharashtra Govt + DST]
- Centre for Aerospace System Design & Engineering [ARDB + MoD]
- Centre for Formal Design and Verification of Software [DAE]
- **Centre for Computational Engineering and Science [DAE]**
- Centre of Excellence in Nanoelectronics [MCIT]
- Centre of Excellence in Steel Technology [MoSteel]
- **Centre of Propulsion Technology [DRDO]**
- **Forbes Marshall Energy Efficiency Laboratory [Industry]**
- Geospatial Information Science and Engineering (@CSE) [DST]
- National Centre for Aerospace Innovation and Research [DST, NAL, HAL, Boeing, DMG Mori, Sandvik, DelCam]
- National Centre for Mathematics (with TIFR) [NBHM, DAE]
- National Centre for Photovoltaic Research and Education [MNRE]
- National Centre of Excellence in Technology for Internal Security [MEITY]
- National Mission on Education through ICT [MHRD]
- National Solar Thermal Research, Testing and Simulation Facility [MNRE]
- Power Anser Laboratory [TCS + TCE]
- Tata Center for Technology Development [Tata Trusts]
- Tata Teleservices - IIT Bombay Centre of Excellence in Telecommunication [Tata Teleservices]
- Wadhvani Research Center for Bioengineering [Alumnus]

**Exploratory, with seed funding**  
**Healthcare Research Consortium**  
**IITB + Hospitals + Corporates**



# Research Centers @ IIT Bombay



**Tata Centre**  
Technology and Design, IIT BOMBAY

**National Solar Thermal Research,  
Testing and Simulation Facility**

**GISE**  
Advanced Research Lab

**NCAIR** NATIONAL CENTRE FOR  
AEROSPACE INNOVATION AND RESEARCH

**Forbes Marshall Energy Efficiency Laboratory**

**National Centre for Mathematics**  
A joint center of TIFR and IIT Bombay

**WADHWANI  
FOUNDATION**

**IITB-TTSL**  
Center  
for  
Excellence in Telecom

**CA/DE**

**National Mission on Education  
Through ICT**

**PA**

**CoPT**

**CCES**

**CoEST**  
Centre of Excellence in Steel Technology

**Centre for Formal Design  
and  
Verification of Software**



**NCETIS**  
National Center of Excellence in  
Technology for Internal Security  
Indian Institute of Technology Bombay

# Research & Development @ IIT Bombay

**1200 (Journal) + 487 (Conference)**

- No. of Research Publications in 2015 (calendar year)

**82**

- No. of companies incubated so far

**130**

- No. of Indian patent applications filed in 2015 (calendar year)

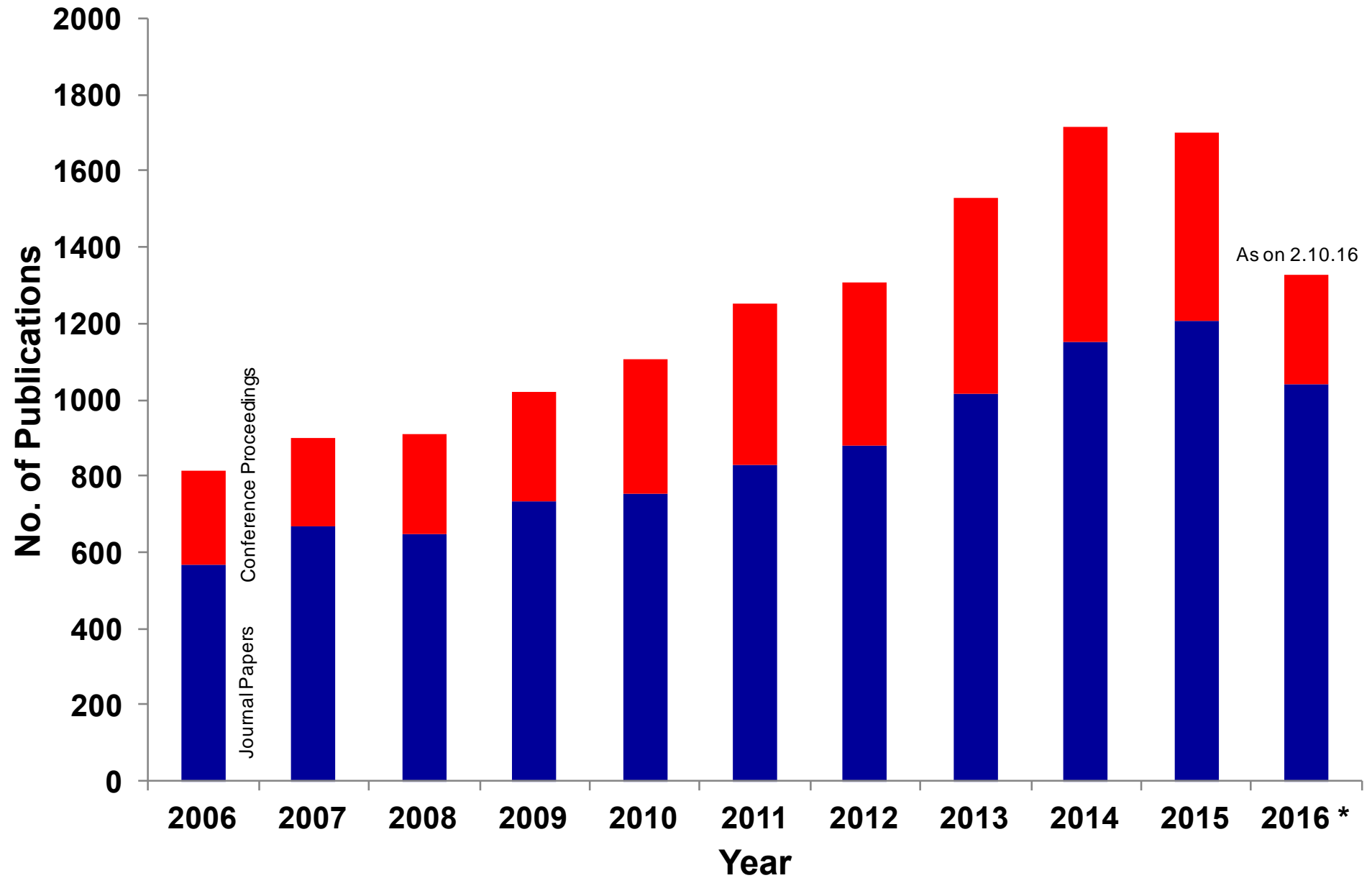
**325**

- Number of PhD degrees awarded in 2016 Convocation

**2190**

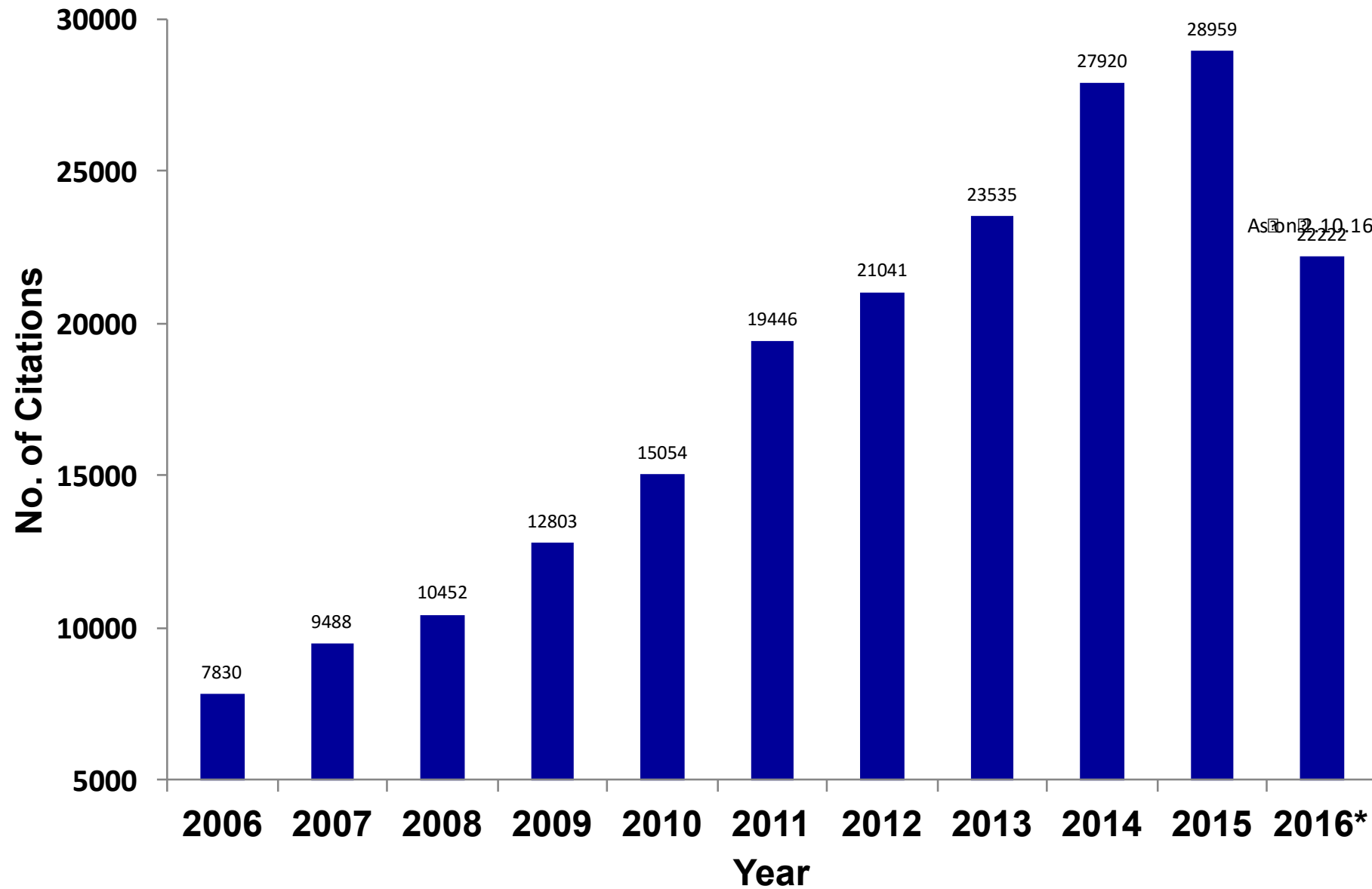
- UG and other PG degrees awarded in 2016 Convocation

# Research publications

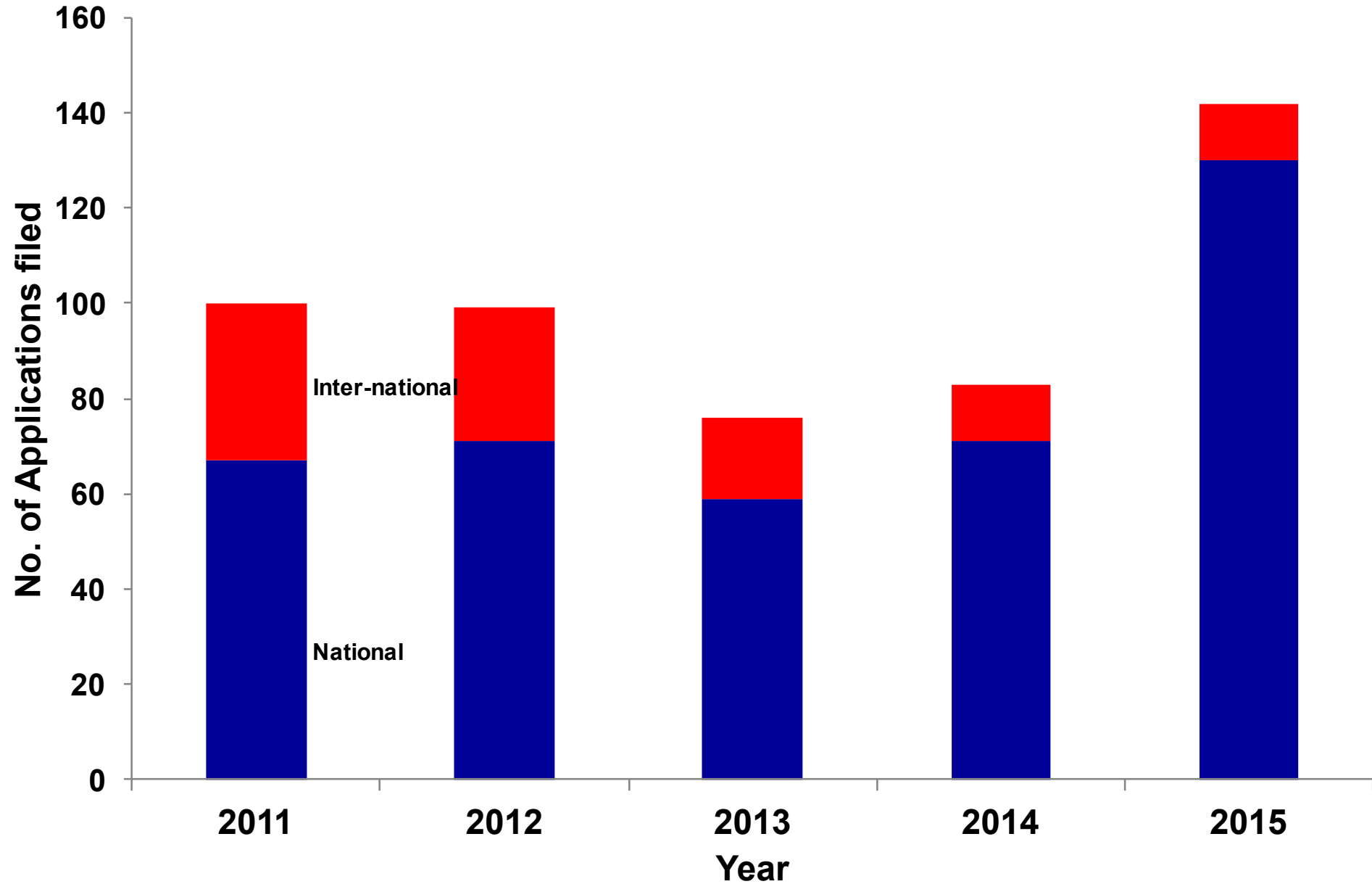




# Visibility of IITB Publications – citations



# Patent applications filed



## **Representative examples**

# Technology transferred

- Multi-utility heat pumps deployed as 3.52 kW Residential to 55 kW Industrial Heating
- SHR\_WH deployed on 1 TR to 270 TR Air Conditioning and Refrigeration Systems  
Proven reliability: working for the last 8+ years without a service call  
Installed @ McDonalds, hotels, hostels, Club Mahindra, Worli Dairy, M&M, ...
- Applications: Heating Air / Water / Process Fluid, Cooling Air / Water / Potable Water / Process Stream



# Rover – remotely operated vehicle



- Wireless control
- Climb steps
- Remote inspection and removal of suspicious objects
- Remote disposal of IEDs

# Biomedical Engineering and Technology (incubator) Center

- BETiC – started in 2014, a translational research center
- Catalyzes indigenous medical device innovation
- Brings together doctors, researchers and manufacturers.
- Develop a range of diagnostic devices, surgical instruments and patient aids covering medical specialties like orthopedics, internal medicine, cardiology and rehabilitation.
- Funding: RGSTC and DST
- Have developed over 100 medical devices, filed 20 Indian patents, and transferred 3 technologies to industry



# Biomedical Engineering and Technology (incubator) Center

Ideas  
room  
of  
BETiC



Surgeon  
testing  
laparoscopic  
device



Medical  
Device  
Innovation  
Conclave



Indian  
Medical  
Device  
Exhibition  
in Dervan



# Societal relevance



**Communicator for  
children with cerebral  
palsy**



**LPG Stove for  
Visually  
Impaired**



**Ascender:  
climbing wheel  
chair**



**Bed for the  
Elderly**



**Online Farmer  
Knowledge  
Exchange**



**Super Critical  
Fluid extraction**



**Riding Type  
Power Tiller**



**Education &  
Creativity  
based Board Games**



**Technologies and  
Tools for Cane and  
Bamboo Craft**



**Solar Urja Lamp**



**Indian Rupee symbol**



# Societal relevance

- Water treatment for removal of arsenic, pesticides, herbicides, etc.
- Hand-pump attachable filters developed using indigenous material
- Each unit caters to around 200 families

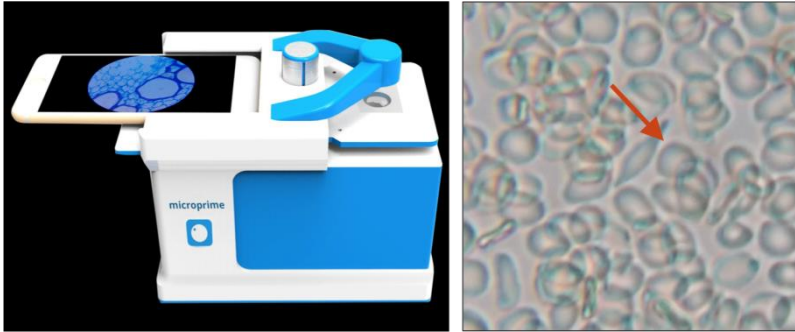


- 50+ units - Assam, Bihar, UP, West Bengal.
- Each unit costs around Rs. 70K.
- Low maintenance (Rs. 1000/year)



**Air quality monitoring, waste water treatment, solid and hazardous waste management, environmental system modeling, ...**

# Point of care diagnostics

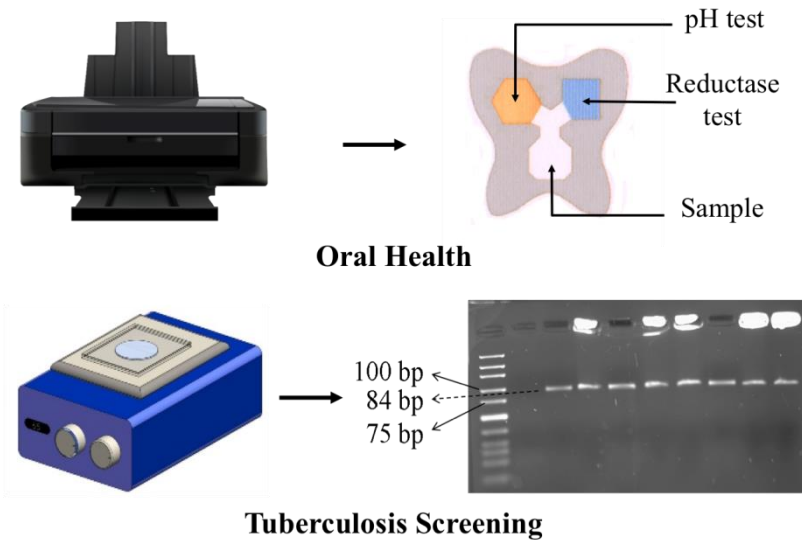


Detection of sickle cell disease by microscopy



## UCHEK

Mobile-based urine and blood glucose analyzer



Paperfluidics for affordable diagnostics



## SUCHEK

A low-cost glucometer (blood)

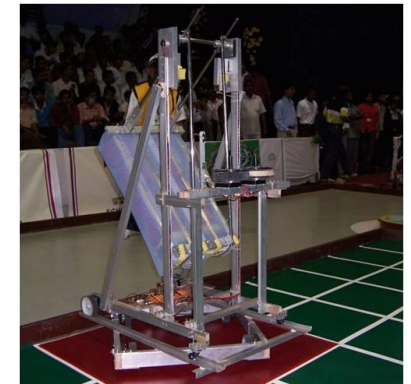
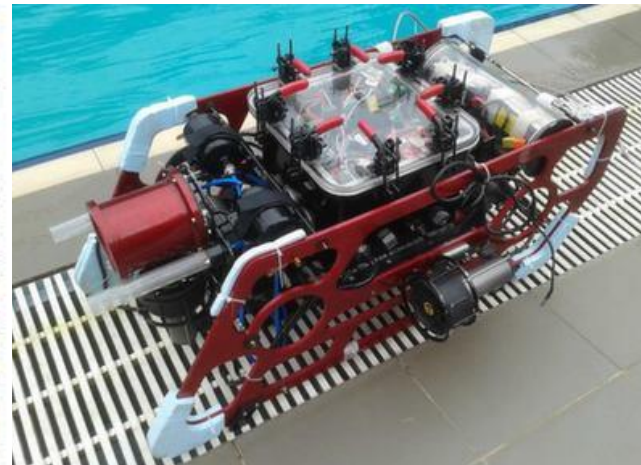
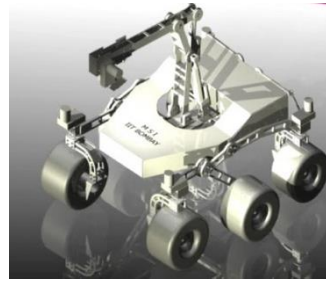
# Extra-mural funding for R&D activities

Financial Year	Research Funding (in Crores INR) (rounded off to the nearest integer)		
	National organizations	International organizations	Total Receipts
2011-12	181	9	190
2012-12	278	16	294
2013-14	199	15	214
2014-15	227	16	243
2015-16	236	16	252



# Student initiatives

- IITB Racing
- Pratham satellite
- Mars Rover, Land Robot
- Intelligent ground vehicle
- Shunya at Solar Decathlon
- Biosynth: a biodiesel plant
- Rakshak: Unmanned Aerial Vehicle
- Matsya: Autonomous Underwater Vehicle
- Drishti: auto-tunable lens for universal eye glasses





# Laboratory safety



Indian Institute of  
Technology Bombay

Laboratory Safety

[www.iitb.ac.in/safety](http://www.iitb.ac.in/safety)

Home

Emergency Response

Emergency Contact Numbers

Safety Policy

Safety Manuals and Videos

**Customized safety videos  
Available also on YouTube**

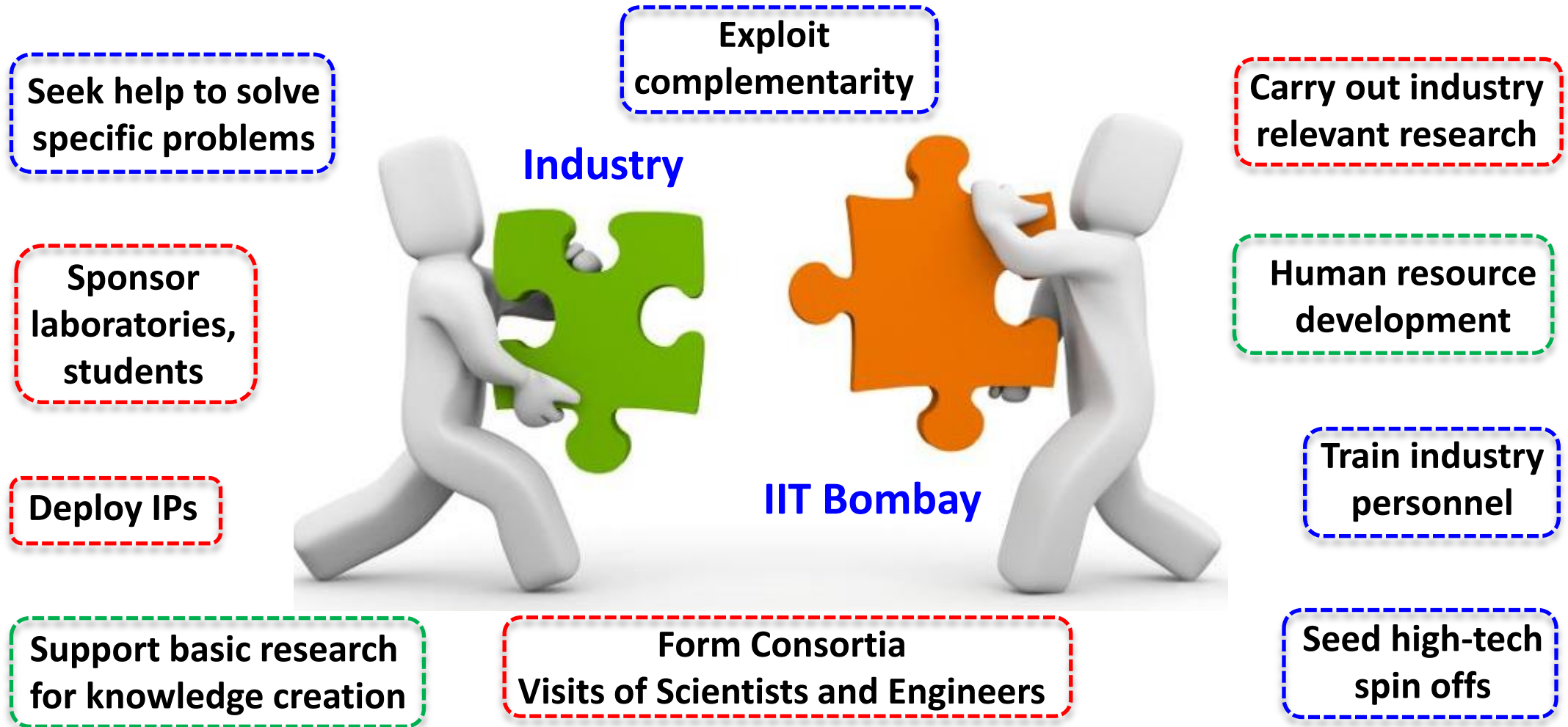
[www.iitb.ac.in/safety/en/safety-videos-0](http://www.iitb.ac.in/safety/en/safety-videos-0)

## Machine Safety



Unguarded moving parts of machines/equipment and the sudden or uncontrolled release of their power systems

# Partnership with Industry



# Strengthening partnership with industry

## Education Offerings

- Continuing Education Program
- Customized programs
- External Ph.D. student

## Students

- Promotion of manpower development
- Internships for "hands-on" exposure
- Support for student technical projects

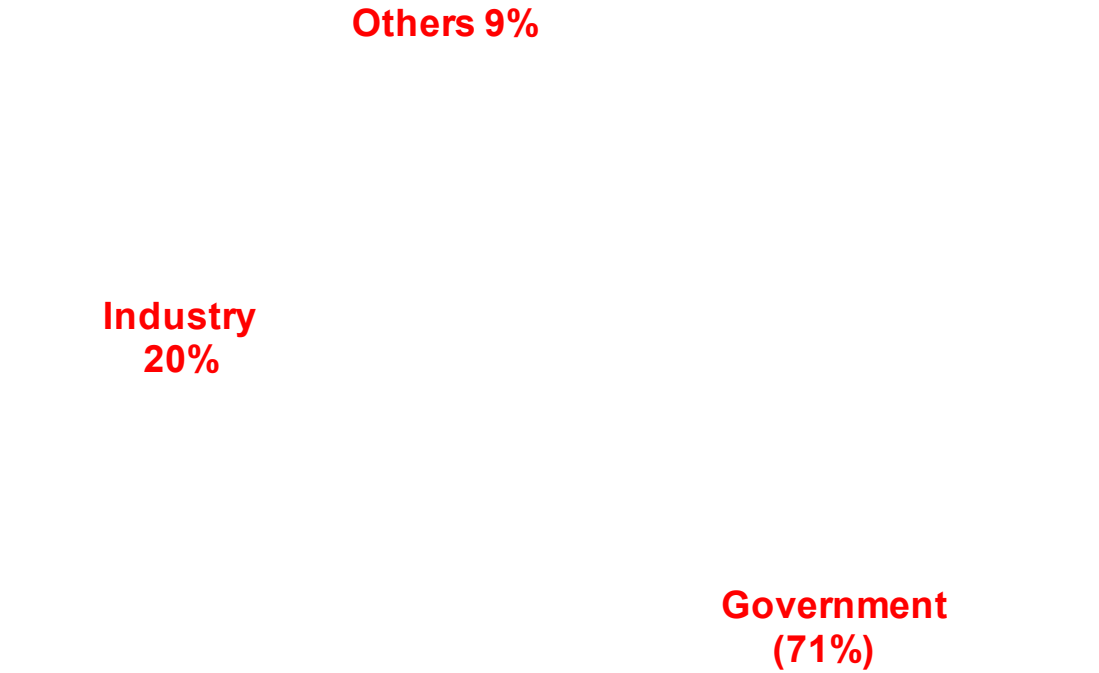
## Endowment

- Chair Professorship and R&D Support

## Building bridges

- Faculty as visiting scientists
- Industry scientist/engineer as visiting faculty

# R&D Receipts (FY 2015-16)



# Entrepreneurship ecosystem

## IIT Bombay

- Desai Sethi Centre for Entrepreneurship
- Policy changes: deferred placement

## ECell

- Student body for entrepreneurial activities

## SINE

- SINE Labs (Elec, Mech, etc.)
- More industry & international tie-ups

## Alumni

- Mentor network (IASCEND)
- Funds for prototyping (IITB Innovate)

# IP protection



Controller General of Patents, Designs and Trademarks  
Department of Industrial Policy and Promotion  
Ministry of Commerce and Industry

- Online, streamlined processes for filing for IP protection
- Costs borne by IIT Bombay
- Can file as a single student inventor also!

Legal Status		Enforced	
Due date of next renewal		07/05/2017 16:02:27	
Patent Number	273155	Date of Patent	07/05/2010 16:02:27
Application Number	1451/MUM/2010	Date of Grant	20/May/2016
Type of Application	ORDINARY APPLICATION	Date of Recordal	20/May/2016
Parent Application Number	---	Appropriate Office	MUMBAI
PCT International Application Number	---	CT International Filing Date	---
Grant Title :DISTRIBUTED OSCILLATOR FOR GENERATING A HIGH FREQUENCY THIRD HARMONIC MICROWAVE SIGNAL HAVING HIGH POWER OUTPUT			
Serial No.	Name of Grantee	Grant Address	
---	INDIAN INSTITUTE OF TECHNOLOGY BOMBAY	POWAI, MUMBAI 400076, MAHARASHTRA, INDIA	
Serial No.	Name of Patentee	Address of Patentee	
---	INDIAN INSTITUTE OF TECHNOLOGY BOMBAY	POWAI, MUMBAI 400076, MAHARASHTRA, INDIA	
Address of Service :MR. M.A.JOSE, Khaitan & Co One Indiabulls Centre, 13th floor 841 Senapati Bapat Marg Elephinstone Road Mumbai 400 013 Maharashtra India			
Additional Address of Service : ---			



Research work  
Date: 10/1/15  
To report about my work properly prepared protein

Lysozyme 2L  
Time 12-11g  
NaCl 584g  
Glycine 100mg  
Protein purification is x.k. done

16/12/15  
WT & K FPLC fractions concentrated

To do:  
- CD study 2-3  $\mu$ M GSHCl denatured WT & ctrl  
- ANS binding study  
    o 6-10  $\mu$ M protein with ANS with or without substrate (GSHCl)  
GSH denatured WT as control  
- Trypophan fluorescence of WT & K, and NATA,  $\rightarrow$  NAD titration & quenching of CD fluorescence  
- GSD-PD assay with or without NAD both WT & K. ROOMAD  
- GSD-PD assay NAD titration  
- NAD, NATA to be freshly prepared  
- All reactions measurements to be done in triplicates  
- Check pH of acidified-quenched reaction mix to make sure that complete hydrolysis is taking place

Page 70

Research work  
Date: 16/12/15  
Concentration measurement at 280nm

WT  $\rightarrow$  0.4905 28.0  $\mu$ M 200nm 18.4  $\mu$ M  
K  $\rightarrow$  0.329 18.8  $\mu$ M 24nm 25.235  $\mu$ M  
25.230

CD - concentration  $\rightarrow$  2  $\mu$ M  
WT with 6M GSHCl. 100ul GSHCl + 100ul WT + 45ul buffer

data taken

Trypophan fluorescence done with 2  $\mu$ M protein at high sensitivity  
Fluorescence quenched by NAD

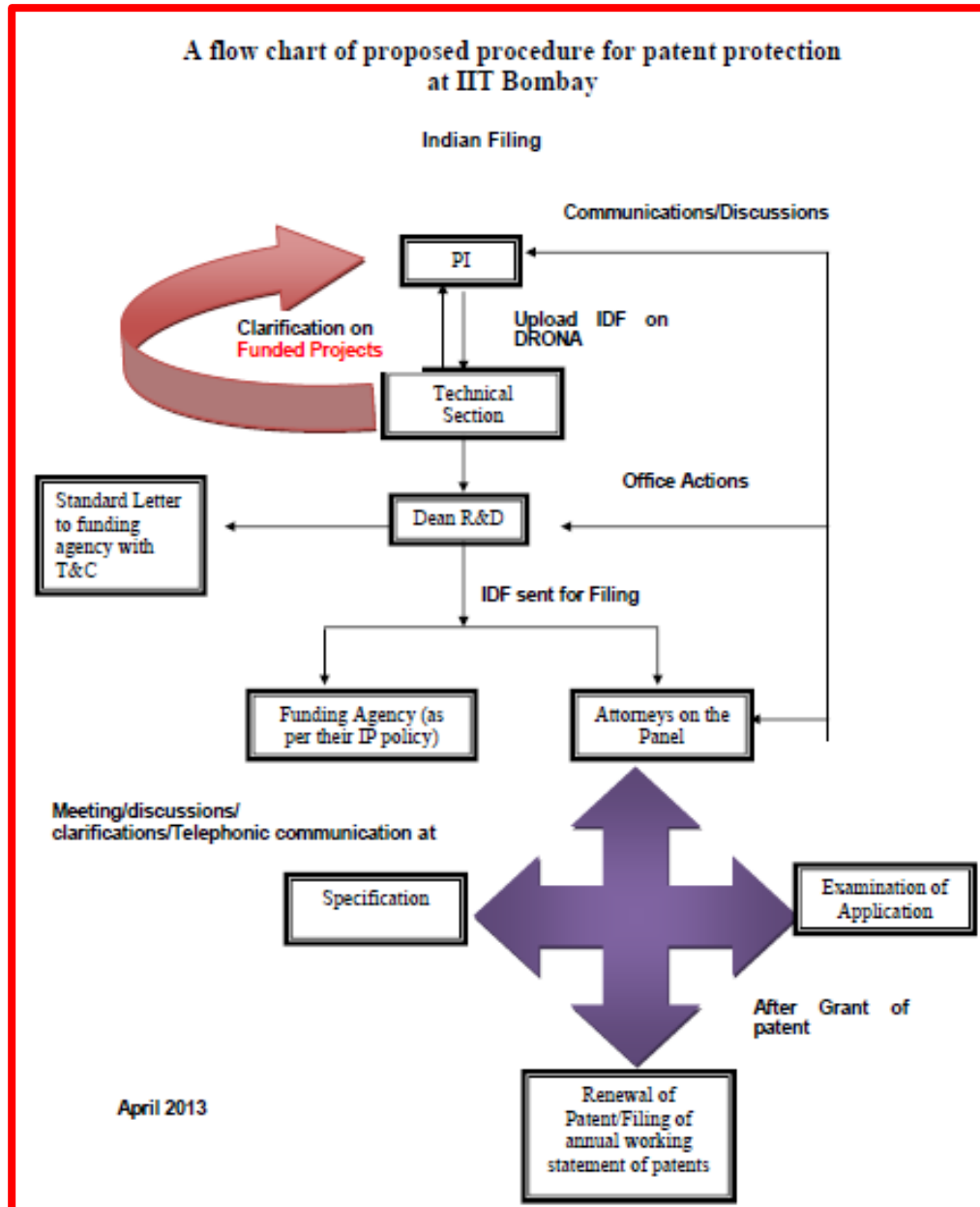
17/12/15  
ANS binding study  
buffer with ANS, WT & K with ANS, WT & K with ANS & substrate  
ANS stock 1mM  $\rightarrow$  2ul ANS stock in 100ul protein (5  $\mu$ M)  $\rightarrow$  20  $\mu$ M  
+3, +2, +2, +2  
0.5% NAC 100  $\mu$ M  $\rightarrow$  1ul in 100ul protein (5  $\mu$ M) + 2ul ANS  $\rightarrow$  10  $\mu$ M  
75ul + 34.5ul buffer  
WT 78  $\mu$ M  $\rightarrow$  5  $\mu$ M  $\rightarrow$  5.6kms ~~11.2ul in 40ul~~ 22.5ul  
K 18.8  $\mu$ M  $\rightarrow$  5  $\mu$ M  $\rightarrow$  3.76kms 110 + 413.4ul is 10 + 303.6ul buffer

Take fluorescence before adding ANS also

Excitation at 310nm, emission 400-600nm

ANS 1M = 299.34 g in 1000ml 5mM = 14.95mg in 10ml  
= 299.34 mg in 1ml 1mM in 50ul  
1mM = 0.299 mg in 100ul  
= 0.299 mg in 100ul

# IP protection

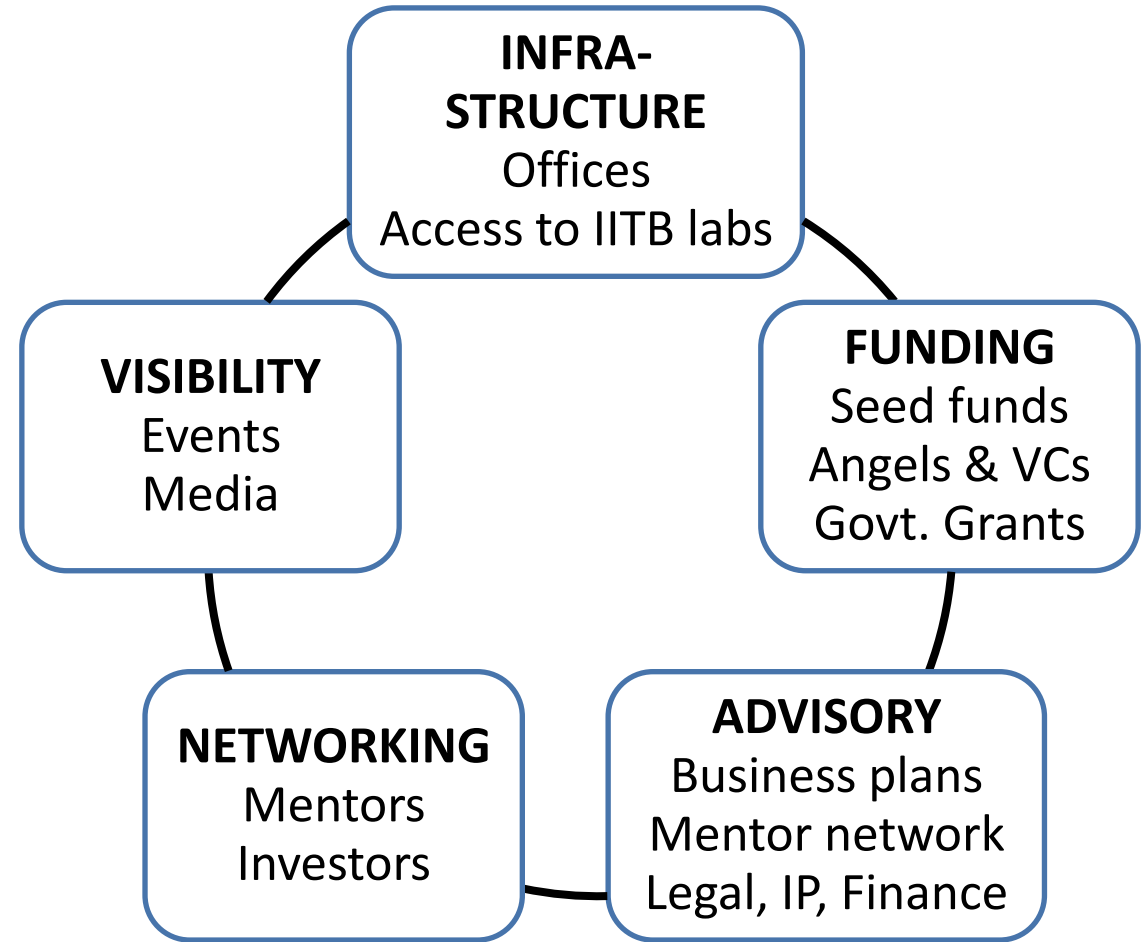
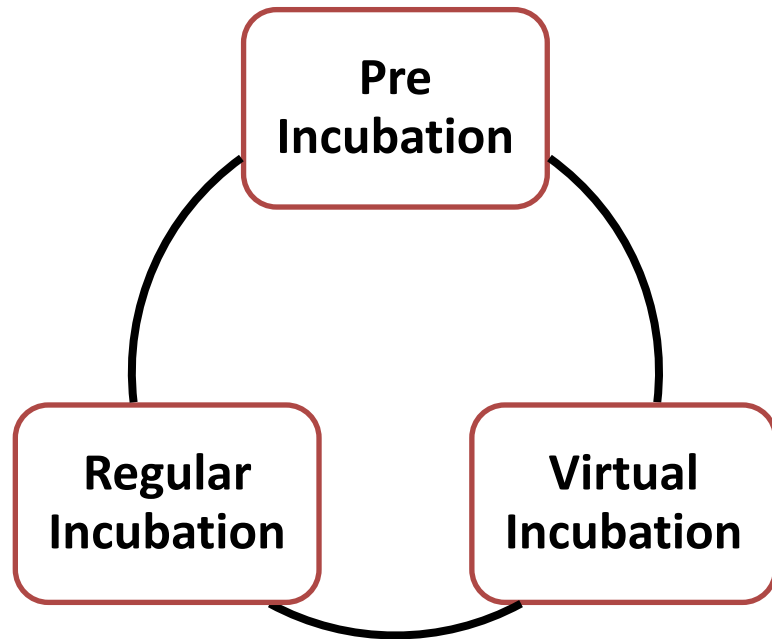


# Society for Innovation and Entrepreneurship (SINE)



- **Technology Business Incubator of IIT Bombay set up in 2004; a not-for-profit entity**
- **Facilitates conversion of IIT Bombay R&D into commercial entities**
- **Helps in building business models / plans, fund raising, approaching clients**
- **Governing Board members includes IIT Bombay faculty and industry experts**
- **Incubate companies that have a potential to create economic growth and/or have a strategic or social value**
- **Intellectual property created by IIT Bombay faculty, students, staff, alumnus**

# Facilities @ SINE



# Impact and outcome of SINE

<b>83</b> companies incubated so far	Current: 28
	Folded: 20
	Graduated / acquired: 35
<b>2,000+</b> jobs created during incubation	

<b>40</b> companies funded by Angels / VCs. US\$ 75k to >25mn	<b>18</b> companies funded by Banks / Govt.
--	--

<b>IITB IP commercialized</b>	<b>25</b>
<b>Faculty involved startups</b>	<b>21</b>
<b>Companies with social innovation</b>	<b>07</b>
<b>Equity returns (partial exits)</b>	<b>INR 3+ crores</b>

Policies and procedures emulated in many other colleges

# Spectrum of incubatee companies (05/2016)



ICT – Software - 30



Healthcare - 12



CleanTech/ Energy - 7



Mechatronics – 6



Media - 5



ICT – Hardware - 6



Education - 4



FinTech - 4



Big Data/ IoT - 2



Other - 6



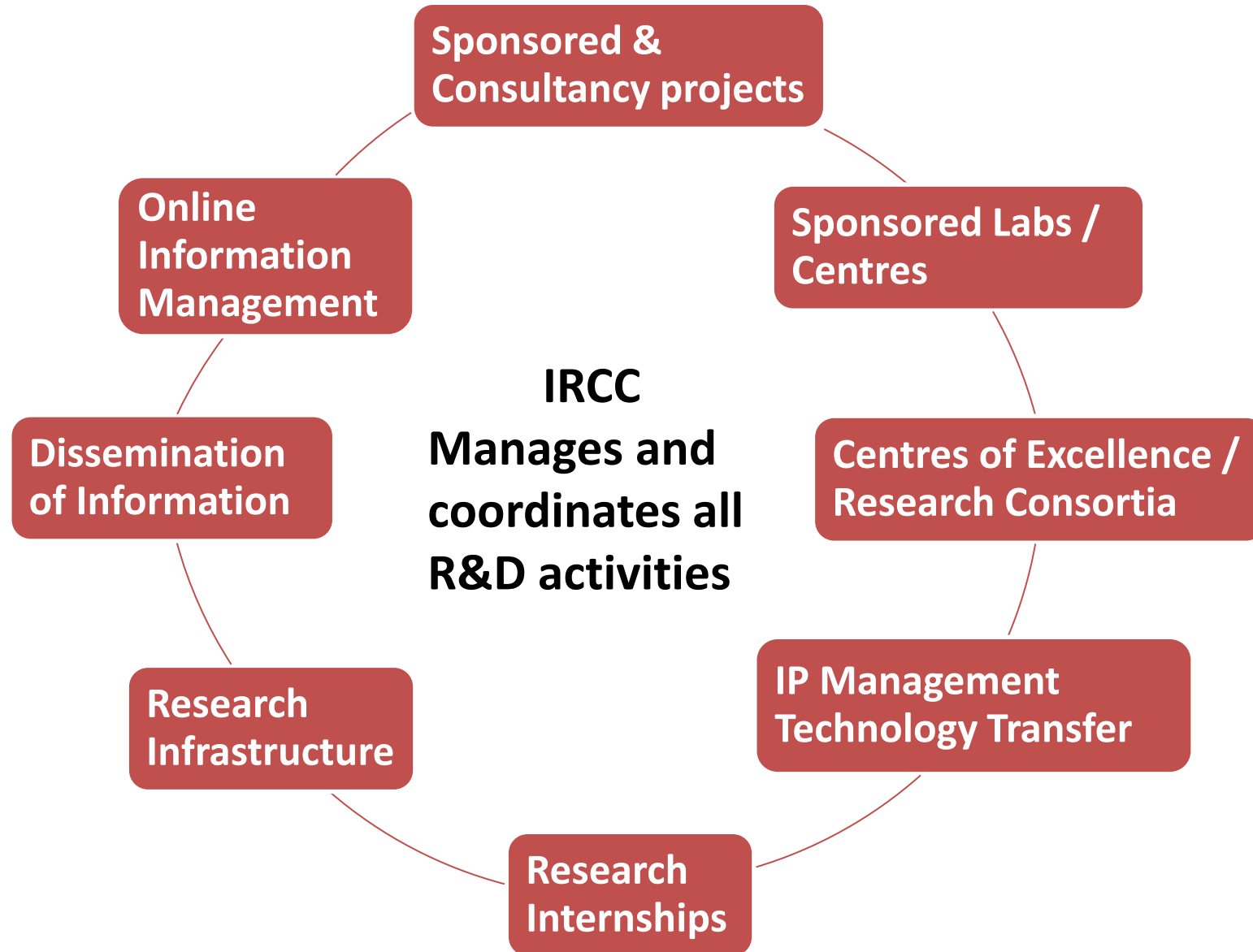
# SINE... success stories

- **Sedemac Mechatronics** – technology company – products focused on controls for small engines and powertrains; Turnover >100 crores; >200 employees
- **Seclore** – data security – one of 3 startups shortlisted for billion dollar project of Silicon Valley Chapter of TiE; > 300 employees; moved to the Silicon Valley
- **idea Forge** – technology company – empanelled supplier of UAV for Gol; >50 employees
- **Zeus Numerix** – CFD – enlisted vendor of Gol – software + services; >50 employees
- **Webaroo** – cloud and mobile messaging platform; Turnover: >200 Cr; > 200 employees
- **Purple Squirrel Eduventures** – education sector; >150 employees
- **Covacsis** – targets manufacturing industries – data analytics – 15+ clients; bn \$ revenue
- **Vegayan** – networking products

# **SINE... new developments and updates**

- SINE + DST + Intel India have launched Plugin, a hardware and system products accelerator program
- SINE will conduct an acceleration program for impact startups with SAP as CSR partner
- SINE applies to DST to be a Centre of Excellence (Incubation center) – application is only by invitation
- SINE + SBI MoU to support fintech startups – SBI will help test applications and products developed and promote the startups through its connect with the industry.
- SINE to set up a Bio/Med Tech incubator - funding from BIRAC (DBT, GoI)

# Industrial Research and Consutancy Center



*Thank You*