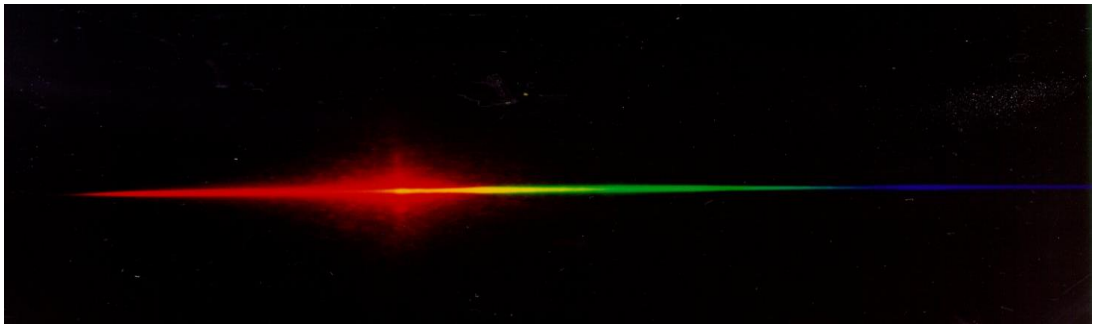
BRICS Photonics Working Group Meeting: 2020
Overview of Indian Experience

Ranjani Viswanatha

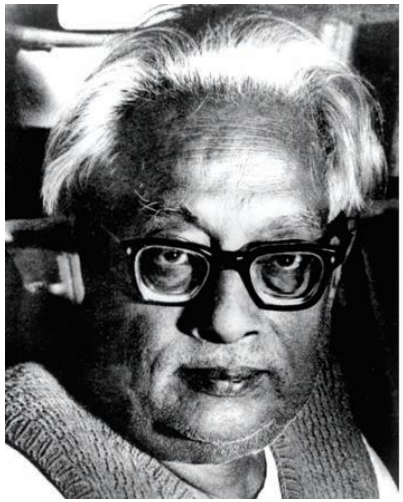


"Lighting the Way through Innovation"

Jawaharlal Nehru Centre for Advanced Scientific Centre rv@jncasr.ac.in

Photonics in India: Some History

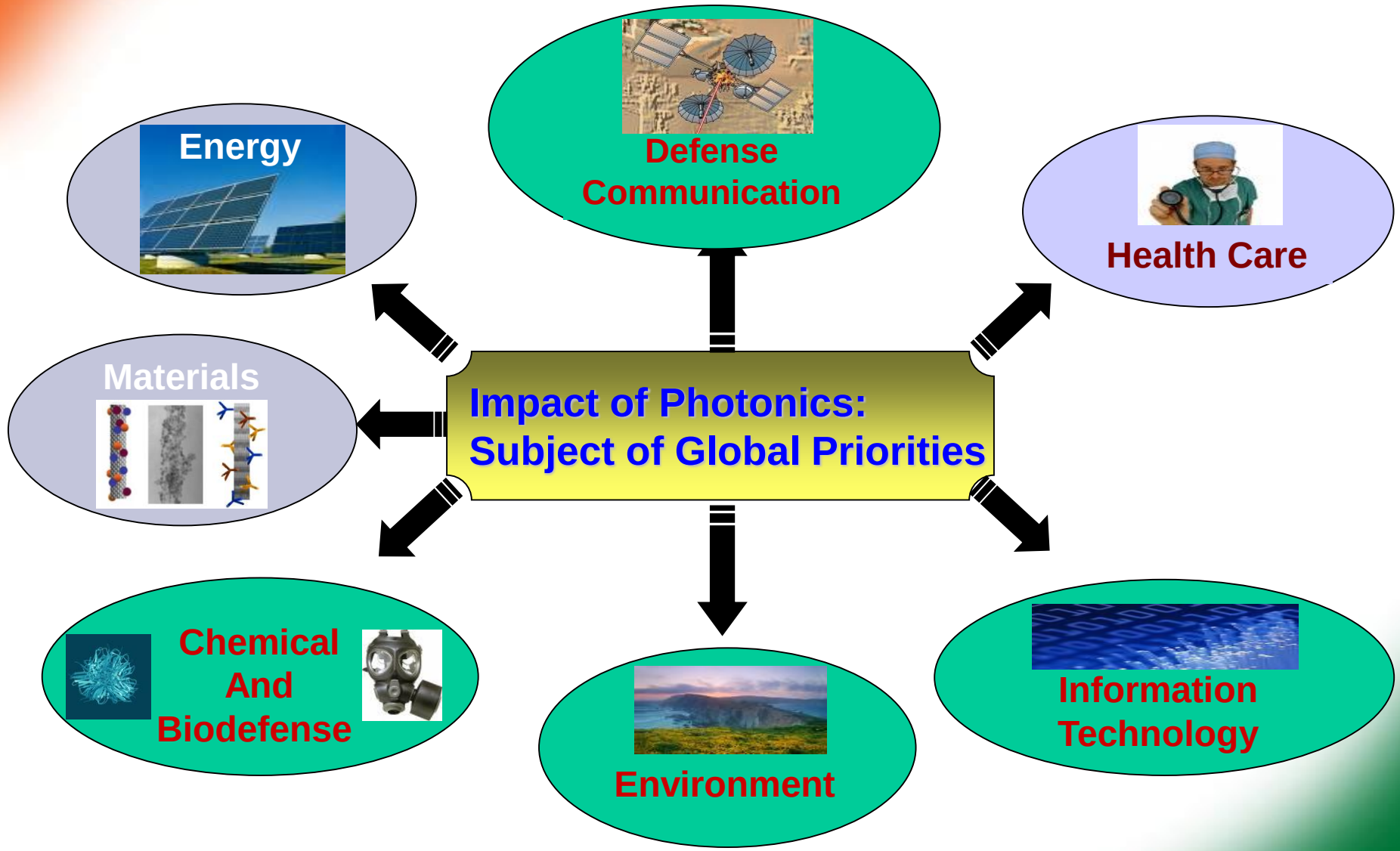
- **Rich History**
- **C. V. Raman and Satyendranath Bose**



- **Shaped the growth of optics and photonics around the world.**

Raman won the Nobel Prize for Physics in 1930 for his discovery of the light scattering effect named after him. Bose, whose collaboration with Albert Einstein led to the development of Bose–Einstein statistics

Current Emphasis



Quantum Optics

* Light: quantum features at room temperature
* Energy of a photon : Large so that background black body radiation: negligible and small enough to be detected
* Quantum States of Light: Easy to achieve
* Adopt Components: Highly efficient detectors, integrated photonic circuits, and waveguide- or nanostructure-based nonlinear optical devices can be adopted
* Enabler for emerging new techniques: new modes of information processing, including sensing, imaging, communications, simulation, and computation
* Most Promising Platforms: India invests $ 1.2 billion in this area in 2019-2024

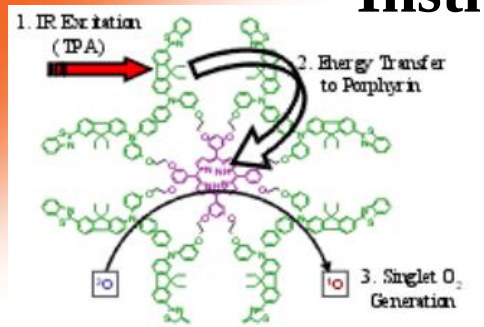
NANOPHOTONICS

Areas of work

- Nanoscale Optical Interactions and Excitation Dynamics: Manipulation and Manifestations
- Nano-optics and photonics
- Photonic devices and opto-mechanics
- Plasmonics
- Quantum Materials, 2D materials, Quantum Dots
- Biologically relevant materials
- Metamaterials

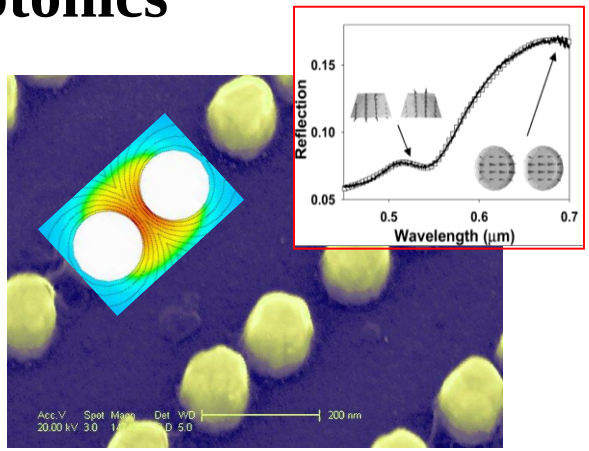
NANOPHOTONICS

Institutes carrying out in Nanophotonics

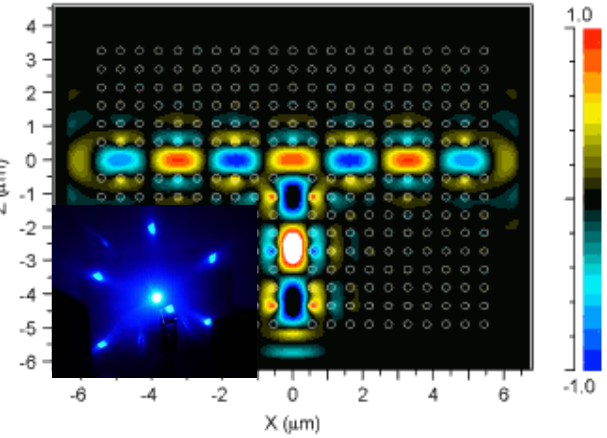


Dendrimers: Control of excitation dynamics

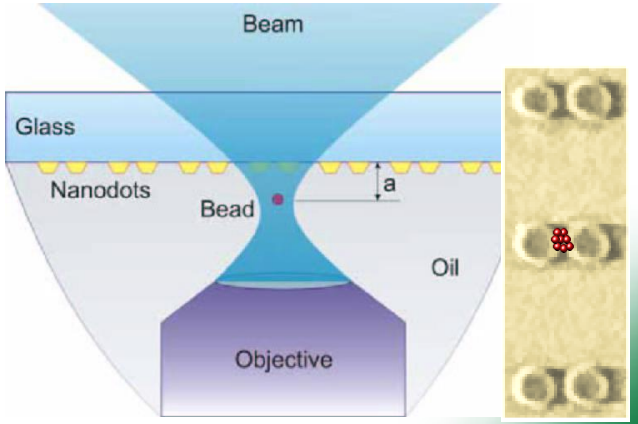
- IISc
- JNCASR
- IIT Bombay
- IIT Kharagpur
- IIT Kanpur
- IIT Guwahati
- IIT Ropar
- IIT Delhi
- TIFR
- IISER Tvm
- RRCAT
- University of Delhi
- CSIO
- IISER Pune
- IISER Mohali
- BITS



Plasmonic arrays: Field enhancement, Novel optical resonances

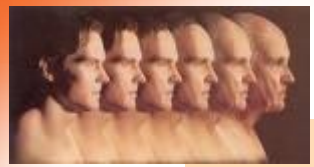


Photonic crystals: Manipulation of light propagation



Nanotrapping: Subwavelength control of field gradients

Biophotonics



Aging

Obesity

Current and Future Health Care Challenges

Genetic Disorders

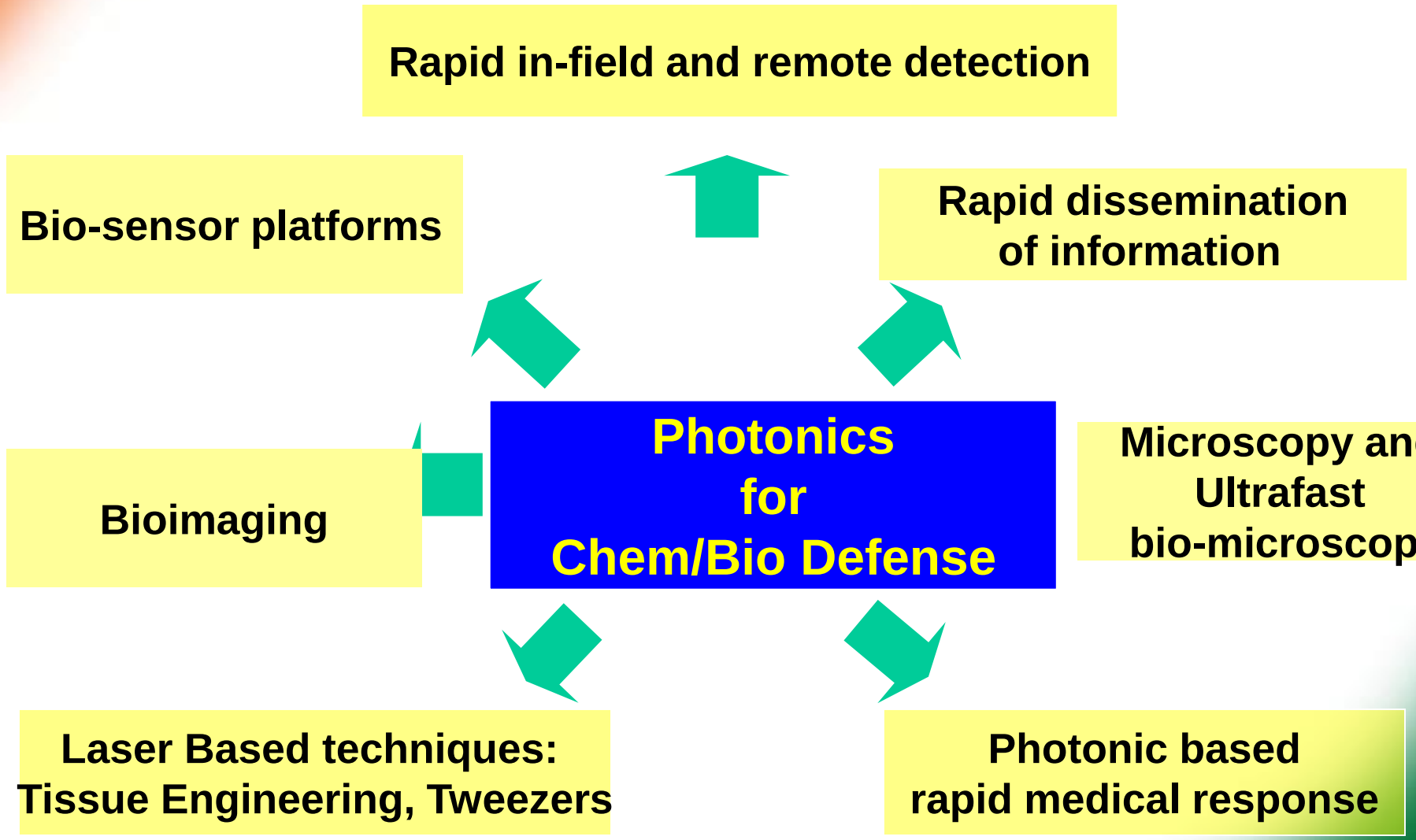
Infectious Diseases

Cancer

Addictions

BioPhotonics

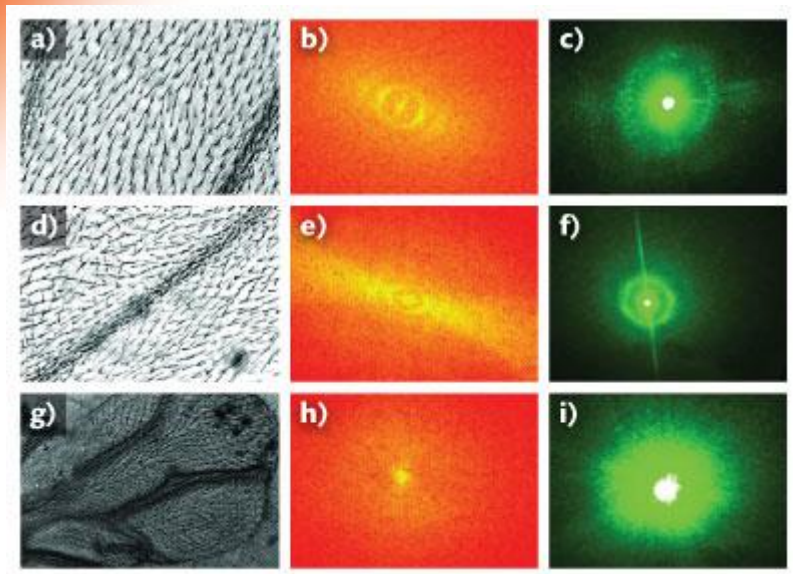
Areas of work



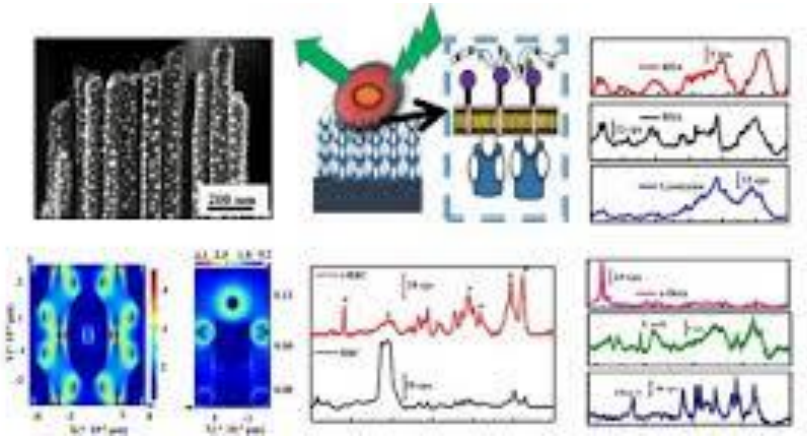
BioPhotonics

Institutes carrying out work in Biophotonics

JNCASR
TIFR
IIT Kanpur
Prantae Solutions
IISc
NCBS
SINP
RRCAT
IISER Kolkata
IIT Delhi
IIT Bombay
IISER Pune



Optical probe characterizes biophotonic insect-wing structures



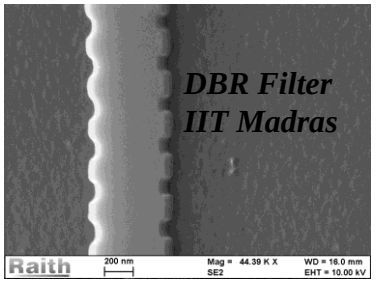
Highly sensitive Universal SERS Biosensing Platform

Microwave Photonics & Integrated Optics

Areas of work

- Optical generation of mm wave and transport for advanced wireless and radar systems
- Integrated Optic RF filters, Optical frequency combs
- SOI, SiN platforms
- Ring resonator, PIN modulators, switches, demux/mux
- Photonic & Electronic Integrated Circuits
- Photonic Analog to Digital Converters
- High speed detectors

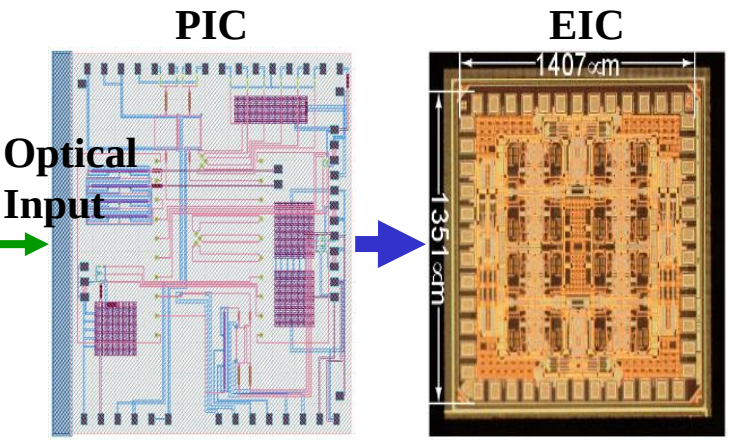
Microwave Photonics & Integrated Optics



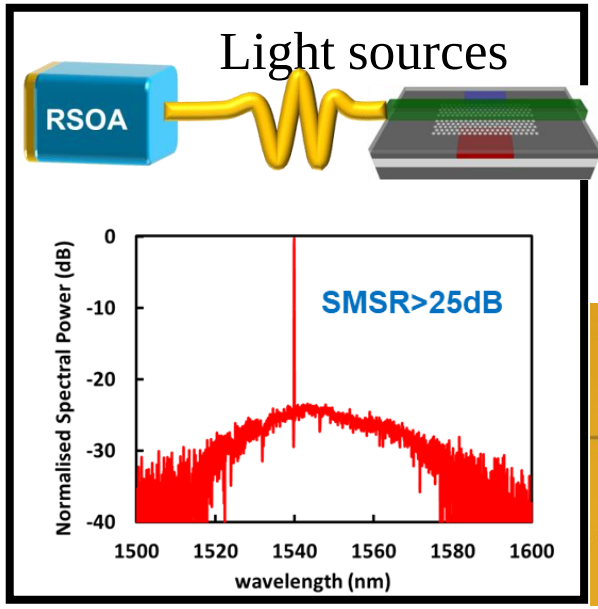
IITMadras & Lightmotif

Institutes carrying out Systems/Devices work

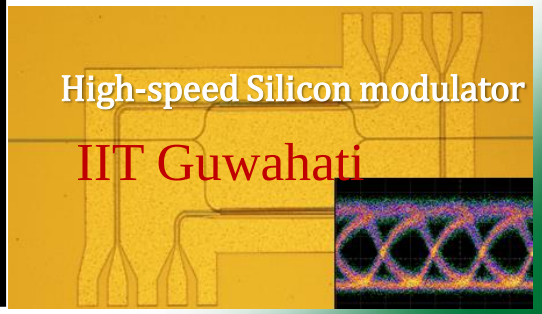
- IIT Madras
- IIT Bombay
- IISc
- IIT Kharagpur
- IIT Kanpur
- IIT Guwahati
- IIT Ropar
- IISER Tvm
- University of Calcutta
- IACS



IITBombay



IIT Guwahati



LIGO India Scientific Collaboration

The Indian Initiative in Gravitational-wave Observations (IndIGO) consortium was restructured as the LISC. The LIGO-India project is a mega-science project in Astronomy on Indian soil. It is intrinsically a multidisciplinary mega-science project that requires expertise from a variety of fields including photonics and provides cutting edge research opportunities.

Key Areas of work

- Development of a ultra-narrow line width (sub-100 Hz) laser oscillator
- Development of suspended mirror Fabry-Perot Cavity

Key Institutes involved

- RRCAT, Indore; IUCAA, Pune; IIA, Bangalore; IPR, Ghandhinagar along with several other institutes

Educational Institutes for various degrees in Optics & Photonics

Post-Doctoral Degrees

- ✓ University of Calcutta, *Kolkata (since 1953)*
- ✓ Indian Institute of Technology, *Delhi (since 1965)*
- ✓ Cochin University of Science & Technology, *Cochin*
- ✓ Kerala University, *Trivandrum*
- ✓ National Institute of Technology, *Warangal*
- ✓ Devi Ahalyabai University, *Indore*
- ✓ Guru Jambheswar University, *Hissar*
- ✓ Indian Institute of Space Science & Technology, *Trivandrum*

Doctoral programs

IITs at Mumbai, Chennai, Kanpur, Kharagpur, Guwahati, Roorkee, Patna, Bhubaneswar

IISc, RRI, JNCASR and IIA at Bangalore,

IACS, Kolkata, IUCAA Pune, PRL, Ahmedabad,

University of Hyderabad, Benaras Hindu University, Kerala University, Cochin University, Pune University, Jadavpur University, Burdwan University

NITs at Warangal, Trichy, Kozhikode, Bhubaneswar, Durgapur

A few other universities and R&D institutions

PHOTONICS in Industry: Where does India Stand

India Photonics Market estimated to reach $70 Million by 2025

* Aerospace technology
* Health Care: Laser technology for cancer monitoring, eye surgeries
* Environmental technology
* Consumer Electronics: photonics in sensors, solar power LED street lighting, mobile home theater headset
* Fibre Optics: Telecommunication sector, media & broadcasting, military and defence, Fast Internet
* Quantum Optics

PHOTONICS in Industry

Network Systems and Technologies' fibre-to-home components manufacturing facility in Kochi, South India

Photonics For Information

Communication:

- Reconfigurable Photonic Crystals
- 3D Plasmonic Guiding and Routing Network

Processing:

- Electro-optic Processing Using Supramolecular Structures and Nanocomposites
- Electrically and Optically Switchable Photonic Crystals

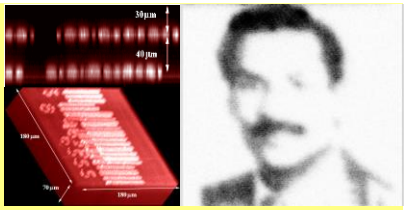
Quantum Photonics:

- Quantum well lasers
- Quantum cascade lasers

Materials:

- Sunscreen lotions
- Laser pointers, Laser printers, DVD players
- Solid State Lasers

Storage:



- 3D Two-Photon Storage
- Holographic Storage

Displays (Organic Displays: OLED, PLED)

Prominent Institutes in PHOTONICS in India