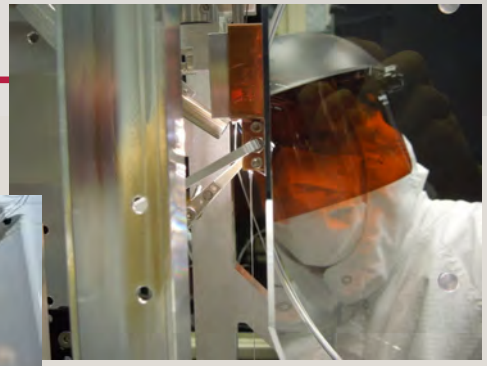
POTENTIAL ROLE FOR INDIA IN THE GLOBAL R&D

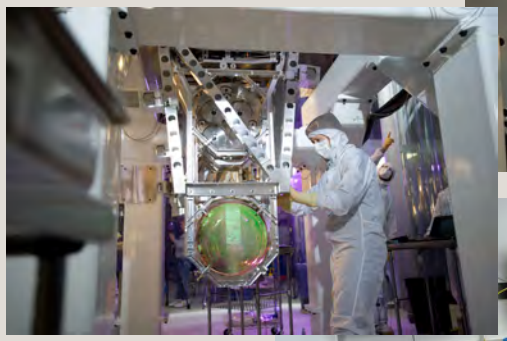
SURESH DORAVARI

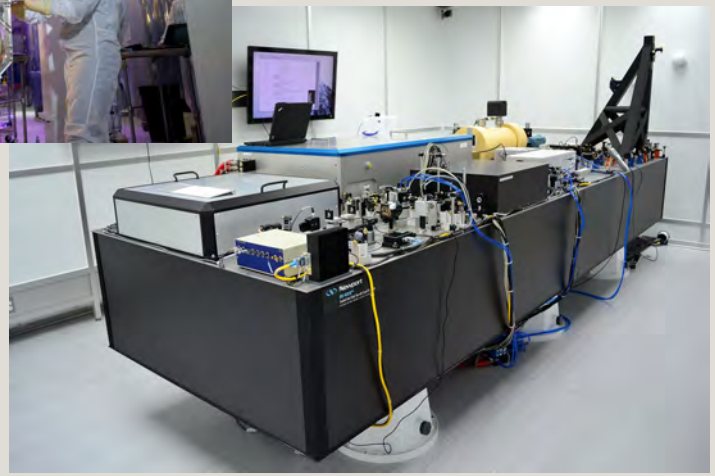
IUCAA

R&D FOR THIRD GENERATION DETECTORS

- Large mirrors and relevant metrology – *200 to 300 kg, 0.5-1.0 m dia*
- Silicon cryogenic suspension – *123 K for CE and 10 K for ET*
- Suspensions – *large mirrors + lower suspension modes*
- Newtonian noise – *seismometer arrays and active feedforward control*
- High power laser – *1060, 1550, 2000 nm lasers at ~ 100-200 W*
- Reducing technical noise – to enable observations in the < *10 Hz band*
- Coating Thermal Noise – *low loss at cryogenic temperatures*
- Quantum noise – f*req dependant squeezing with ~km long filter cavities*







Ref: LIGO-T1800133-v3
Instrument Science White Paper 2018

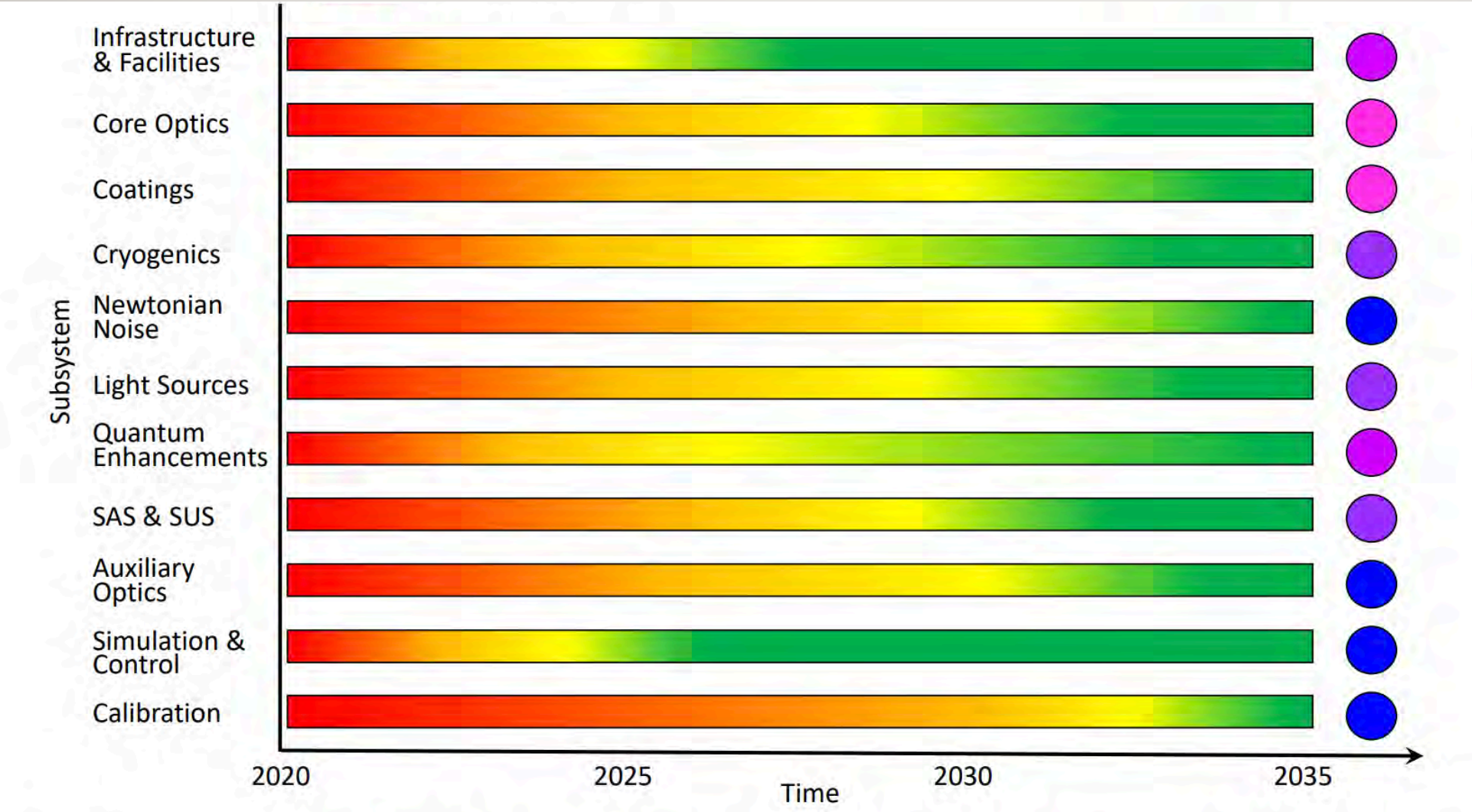
TOWARDS 3G OBSERVATORY FACILITIES

- Modelling and simulation of large detectors, underground facilities, and novel readout schemes.
- Studies on the scientific impact vs. cost of various design choices.
- Development of lower cost construction of large vacuum facilities (testing outgassing, vacuum tube materials and their optical properties, welding technology)
- Developing methods of atmospheric Newtonian noise cancellation and/or design of a low-noise infrastructure
- Site characterization and improving facility design to preserve site quality

- Building quantum back-action (QND) dominated prototype interferometers
- Developing methods of low-loss squeezing injection
- Novel squeezing generation concepts (e.g. ponderomotive squeezing)
- New techniques for frequency dependent squeezing without filter cavities.
- Development of 1 kW laser system.
- Angular sensing and Thermal Compensation Systems

Ref: LIGO-T1800133-v3
Instrument Science White Paper 2018

TIMELINES TO FOR VARIOUS 3G SUB-SYSTEMS TO REACH REQUIRED MATURITY LEVEL AND THE R&D INVESTMENT REQUIRED



Ref: GWIC 3G R&D Subcommittee report July 2019

INDIAN SCENARIO : PLAYING TO OUR TRADITIONAL STRENGTHS

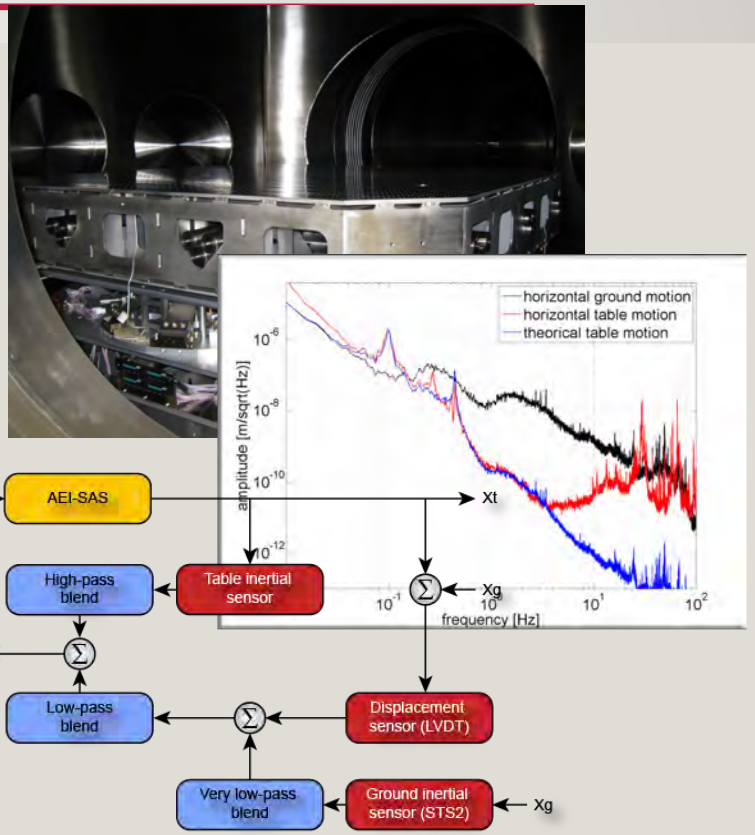
Analysis of available detector data

Interferometer modelling , System Identification , Control

a. "LIGO-In-a-Box" – a Neural Network to mimic the IFO response
b. Techniques based on Bayesian inference for sysID
c. Markov Chain Monte Carlo of Finesse and FFT methods
d. Nonlinear regression methods using Machine Learning
e. Control algorithms using ML, NN techniques

Computing thermal noise in coatings using numerical methods

FEM analysis with adaptive mesh refinement with parallel computing



Picture Credits: Thesis of Gerald Bergmann

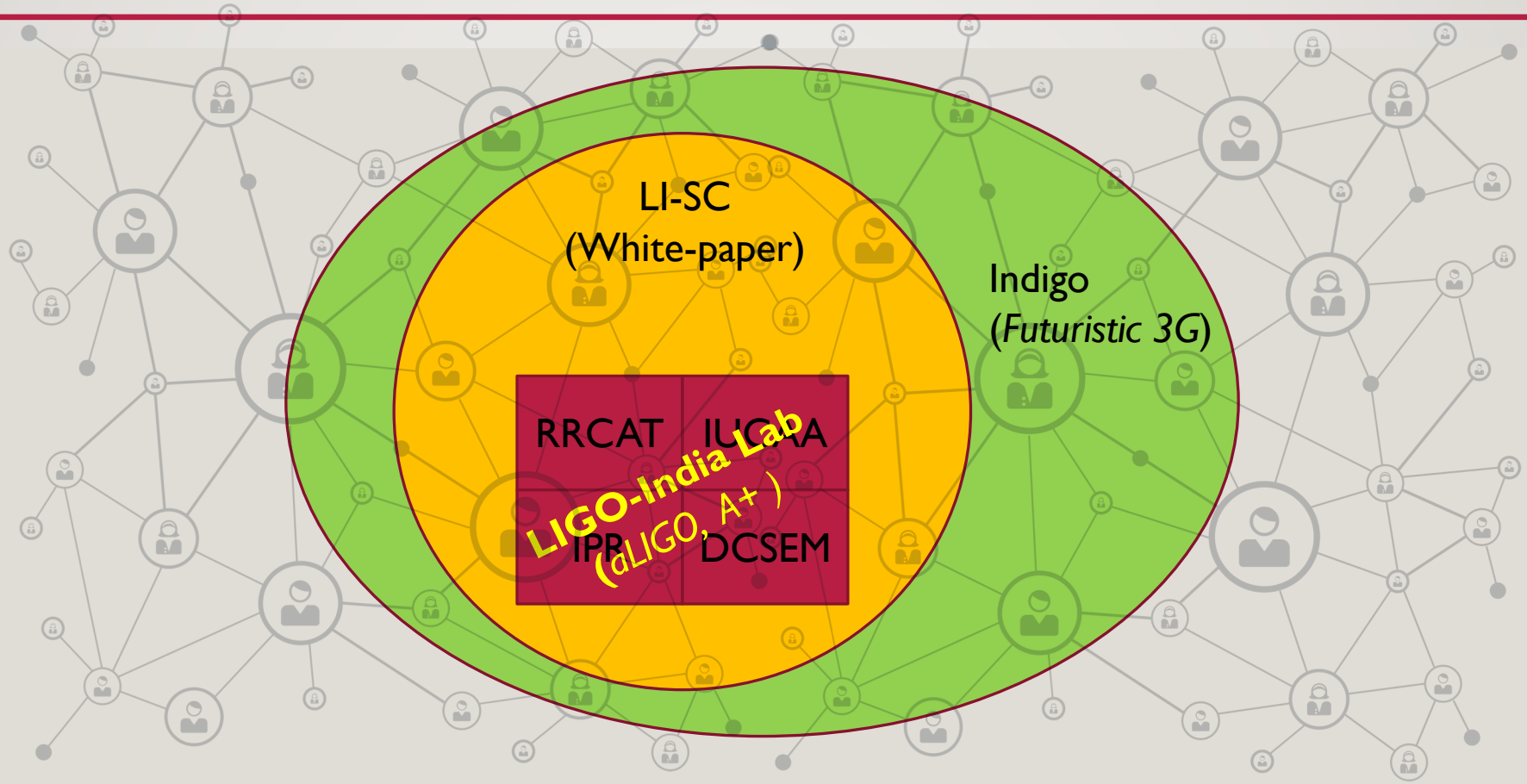
INDIAN SCENARIO : FORAYS INTO NEW TECHNOLOGY

Developent of Sensors, transducers, seismic isolation, suspensions, lasers

- R&D in nodal institutions
  - LIGO-India focused -- aLIGO and A+
- R&D labs in LI-SC institutions
  - Instrument Science While Paper road map – Voyager + Cosmic Explorer
- R&D in a network of partner institutions
  - long term 3G tech from related fields

    Atom interferometry, high precision metrology, high energy physics, solid state physics

NETWORKS / ORGANISATIONS / FOCUS AREAS FOR INSTITUTIONS IN INDIA



Thanks Bala!!

And

Thanks to all of you!