India's involvement in Mega Projects in Physics & Astronomy

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Abstract

- India in recent years has entered into several mega projects (India's contribution will be approximately 300 Million US$ in each of these project) in the area of physics and astronomy where it has collaborations with various international communities in these areas
- The main seven of these are: ITER; LHC; INO; SKA; TMT; LIGO; ASTROSAT and ADITYA-L1
- The talk will highlight these mega projects and future prospects

Talk Outline

- **ITER**
- **LHC**
- **INO**
- **SKA**
- **TMT**
- **ASTROSAT**
- **INDIGO**
- **ADITYA-L1**

Mega Projects

- Most of these projects require approx. 70% amount to be spent (in kind) within India to develop infrastucture and industries catering to these projects and rest will be contribution to the International consortium in cash
- Most of these were sanctioned by the Indian Government in the past five-year plan and the current plan

ITER

- Website: https://www.iter-india.org/
- The international nuclear fusion project known as ITER, is based on the 'tokamak – a Russian concept' of magnetic confinement, in which the plasma is contained in a doughnut-shaped vacuum vessel
- Experimental Fusion Reactor in Cadarache, Southern France
- Lead by: Institute for Plasma Research, Gandhinagar, Gujrat, India
- Indian contribution is $\sim 9\%$ in the form of components made by the Indian industry

ITER

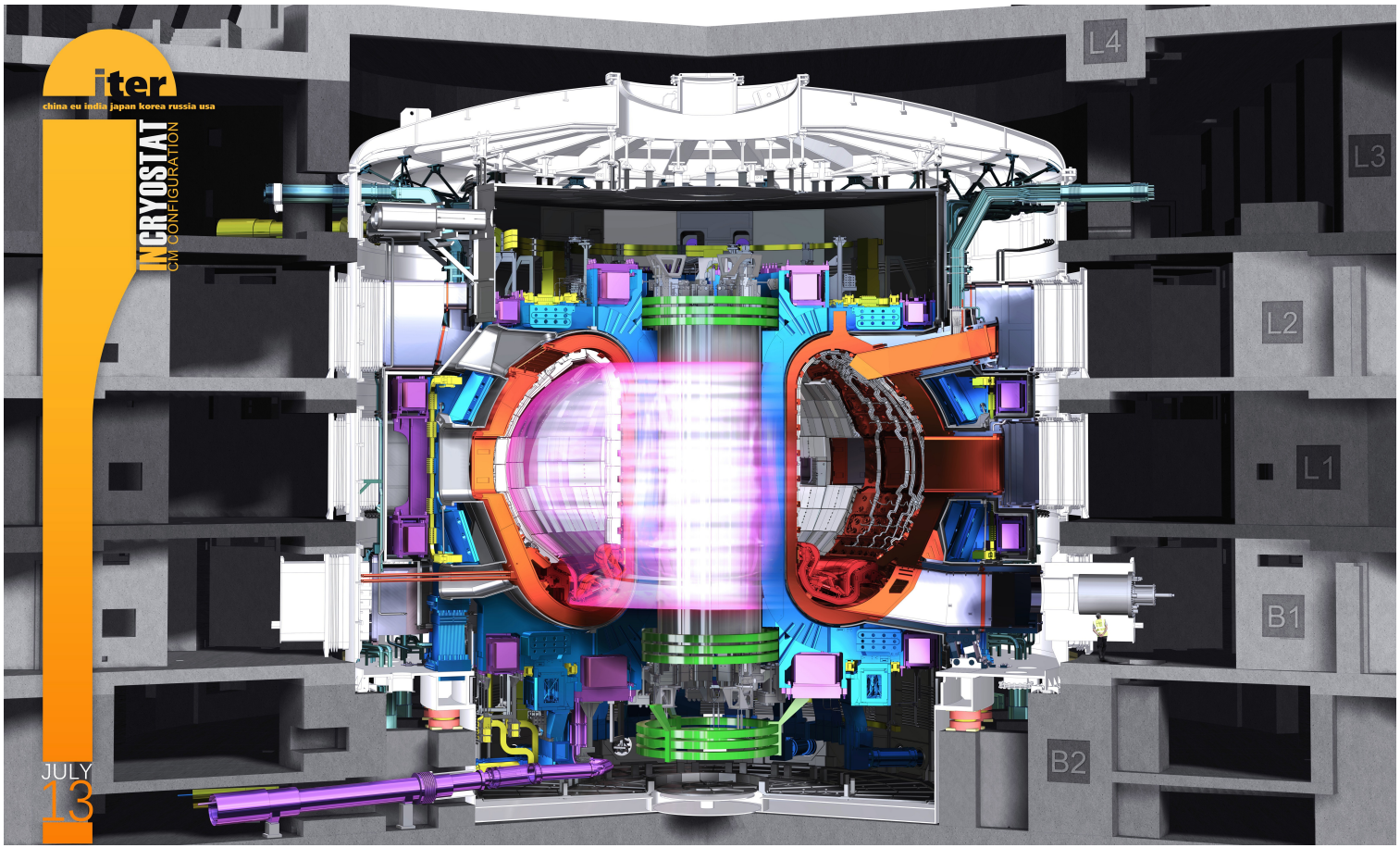

Figure 1: Cut-out schematic of ITER

LHC-Large Hadron Collider

- Website: http://india.web.cern.ch/india/
- India is involved in LHC; ALICE; CMS & WLCG
- For LHC India contributed to superconducting corrector magnets, precision magnetic positioning system jacks, accelerator protection systems, quench detection electronics, vacuum system design for long beam transport lines and cryogenic systems which were developed by scientists and engineers through Indian industries

LHC

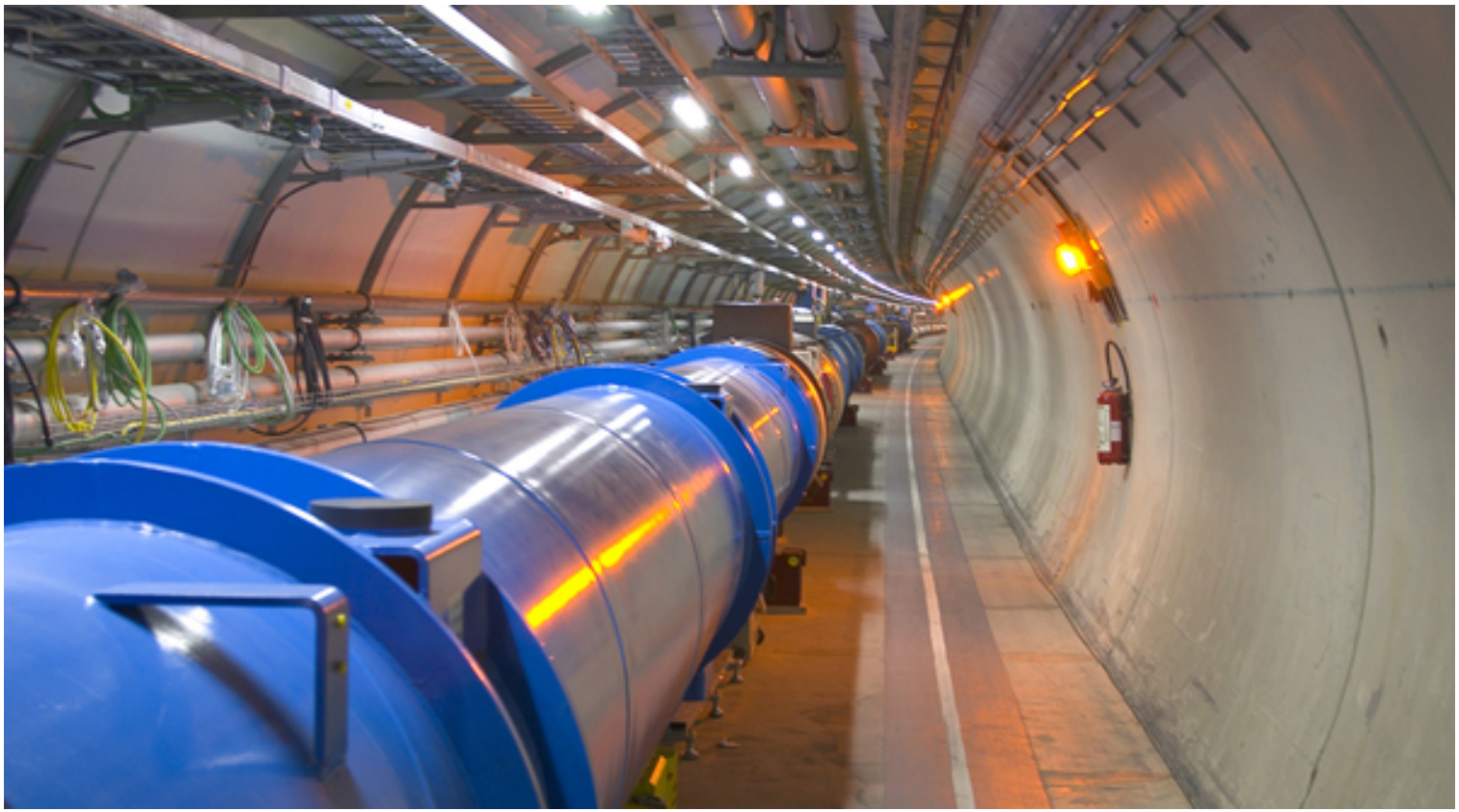

Figure 2: Cut-out schematic of LHC

INO-Indian Neutrino Observatory

- Website: http://www.ino.tifr.res.in/ino/
- India-based Neutrino Observatory (INO) is a particle physics research project under construction to primarily study atmospheric neutrinos in a 1,300 meters (4,300 ft) deep cave under Ino Peak near Theni, Tamil Nadu, India. Project will provide a precise measurement of neutrino mixing parameters.
- Participating Indian Institutions: TIFR, Mumbai; BARC, Mumbai; IMSc, Chennai; SINP, Kolkata; VECC, Kolkata; HRI, Allahbad; IOP, Bhubneshwar and several Indian Universities and Institutes

INO

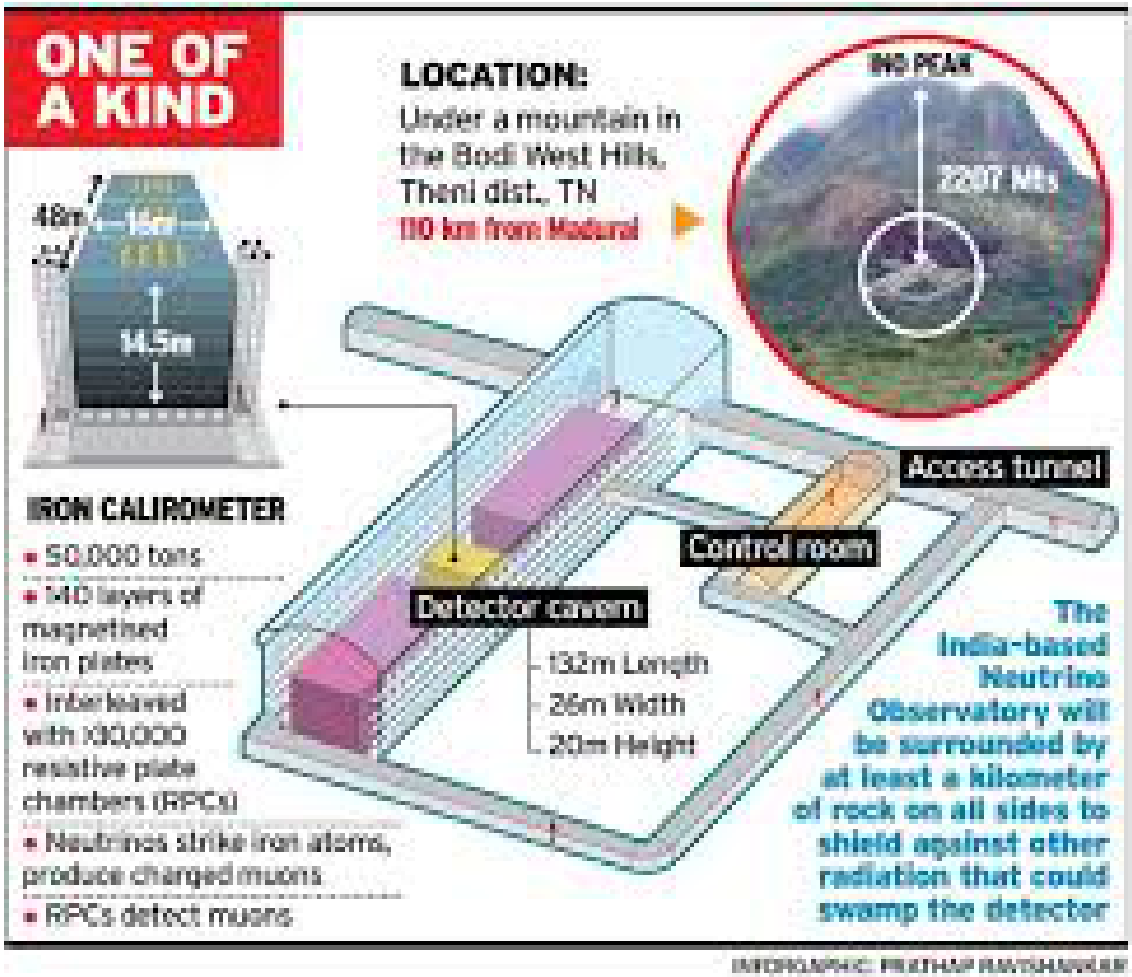

Figure 3: Schematic of INO

INO ...contd.

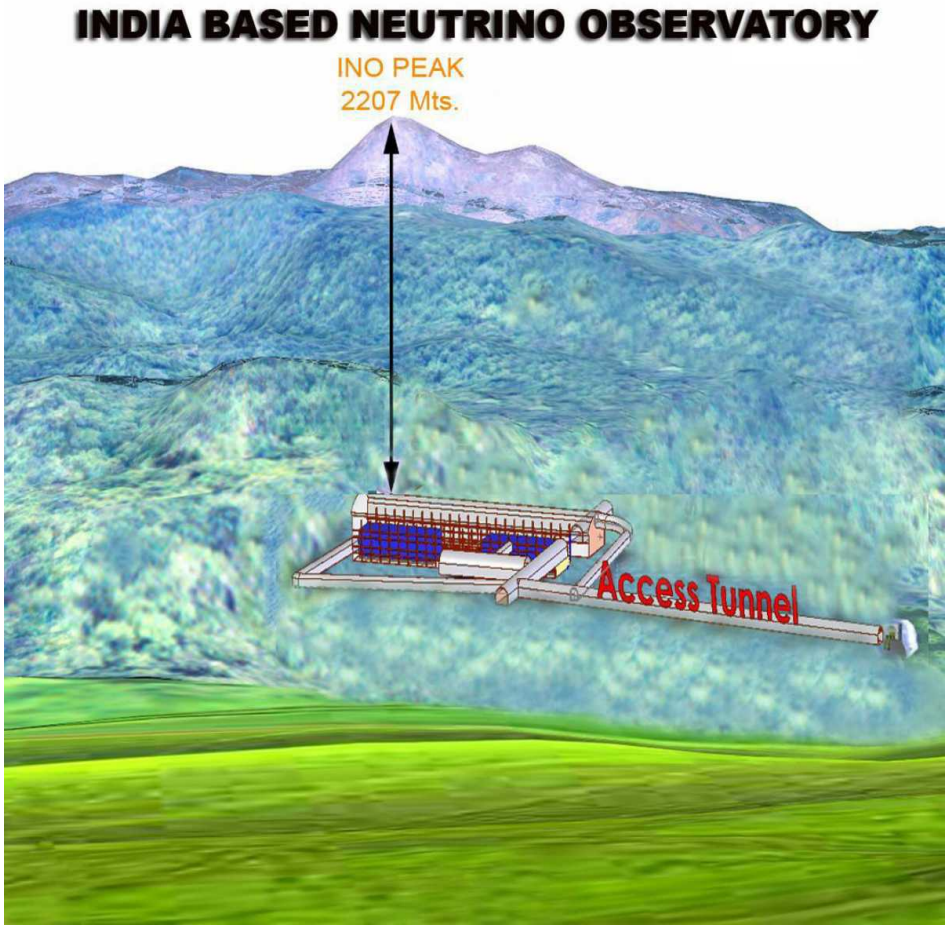

Figure 4: Location of INO

INO ...contd.

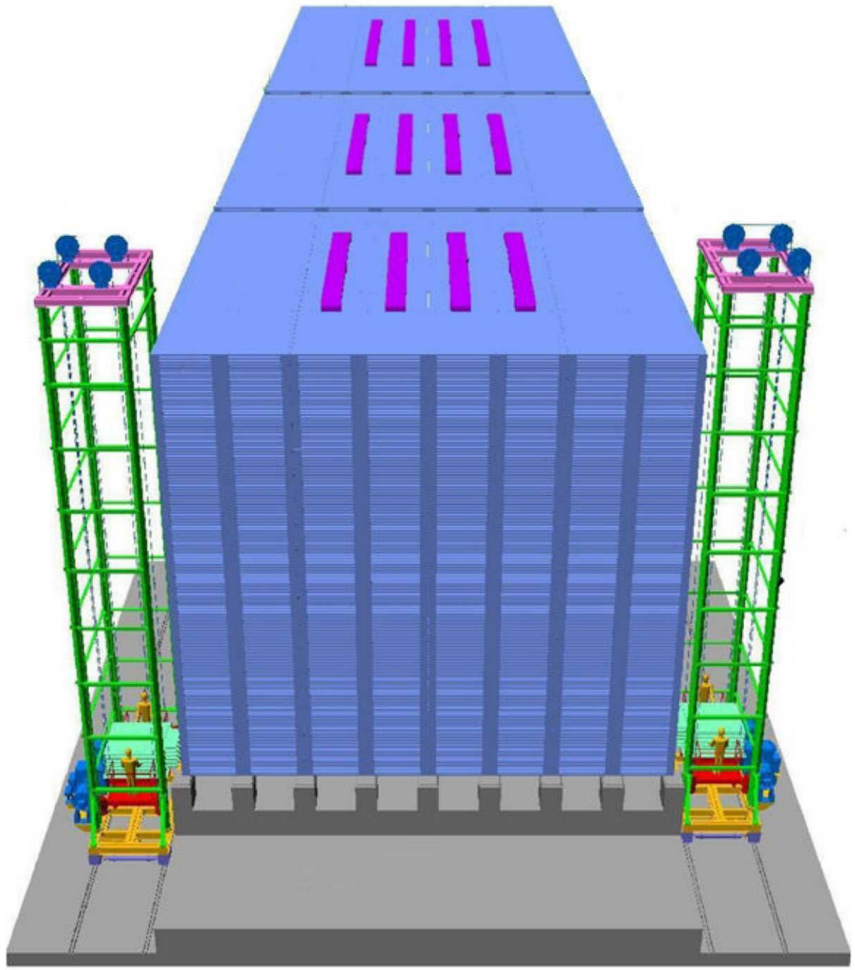

Figure 5: Schematic of INO Detector

SKA-Square Kilometer Array

- Website: http://www.ncra.tifr.res.in:8081/ tirth/SKA-India/index.html
- SKA will be located in Africa and Australia
- Primary Institute: NCRA, TIFR, Pune
- Bulk of the contribution from India will be in terms of services; materials & software etc.

SKA

Figure 6: An Artist Concept of SKA

SKA ...contd.

Figure 7: An Artist Concept of SKA

SKA ...contd.

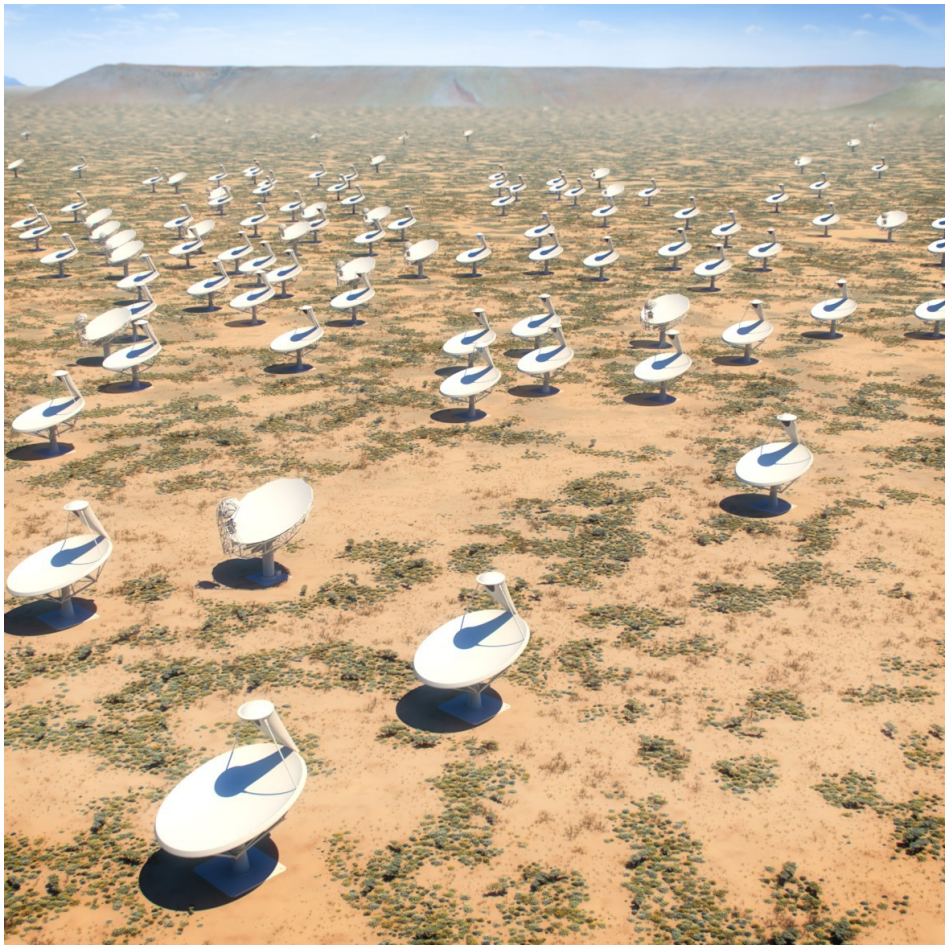

Figure 8: An Artist Concept of SKA

SKA Data

Figure 9: SKA data challenge

TMT-Thirty Meter Telescope

- Website: http://tmt.iiap.res.in/
- The Thirty Meter Telescope (TMT) will be the world's most advanced and capable ground-based optical, near-infrared, and mid-infrared observatory coming up at Hawaii, USA
- Participating Indian Institutions: IIA, Bangalore; ARIES, Nainital & IUCAA, Pune
- India's contribution is 10% of cost in cash and kind
- In kind contribution: Edge sensors; Actuators; Segment support assemblies; Segment polishing & Software

TMT

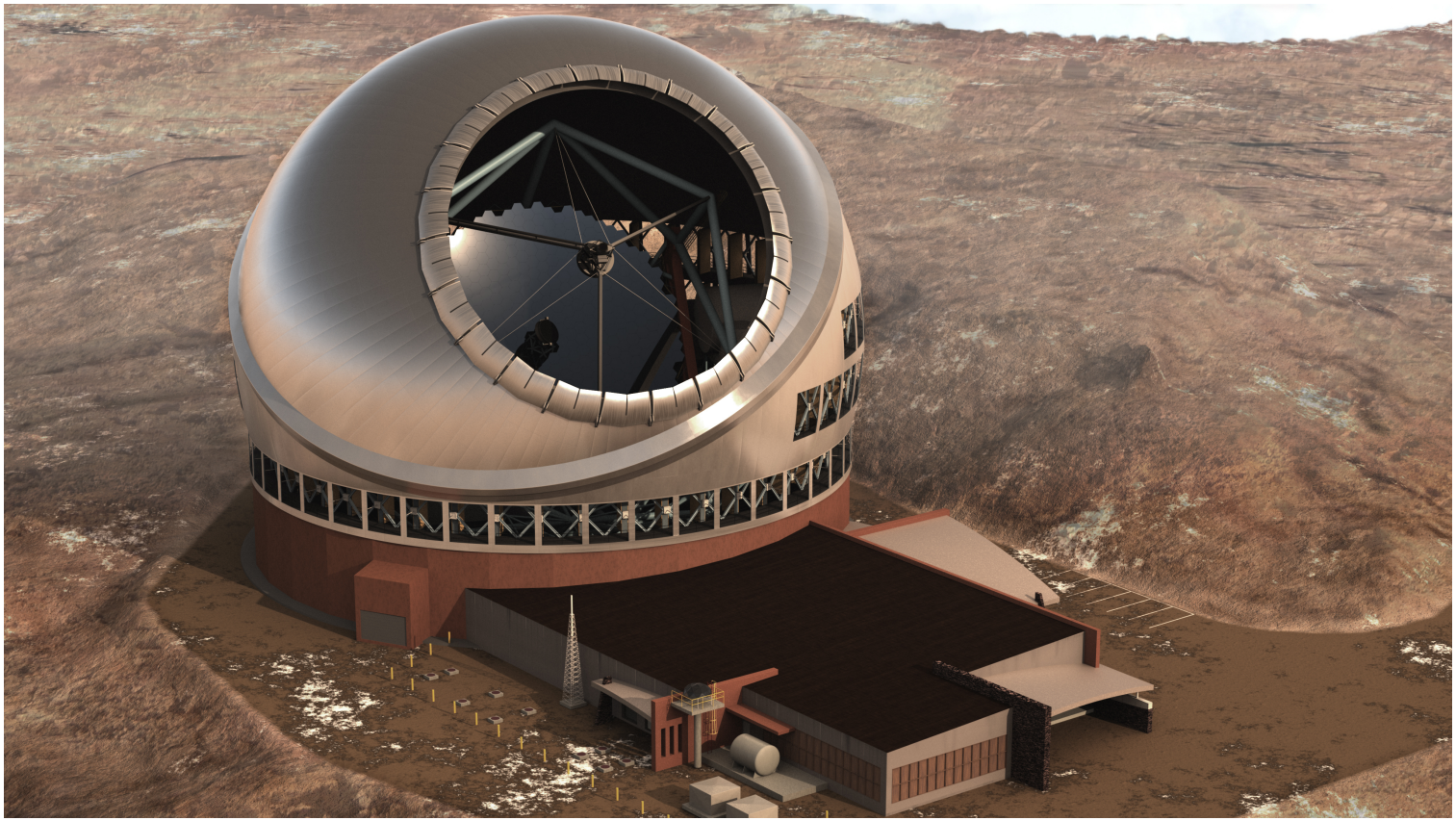

Figure 10: An Artist Concept of TMT

TMT ...contd.

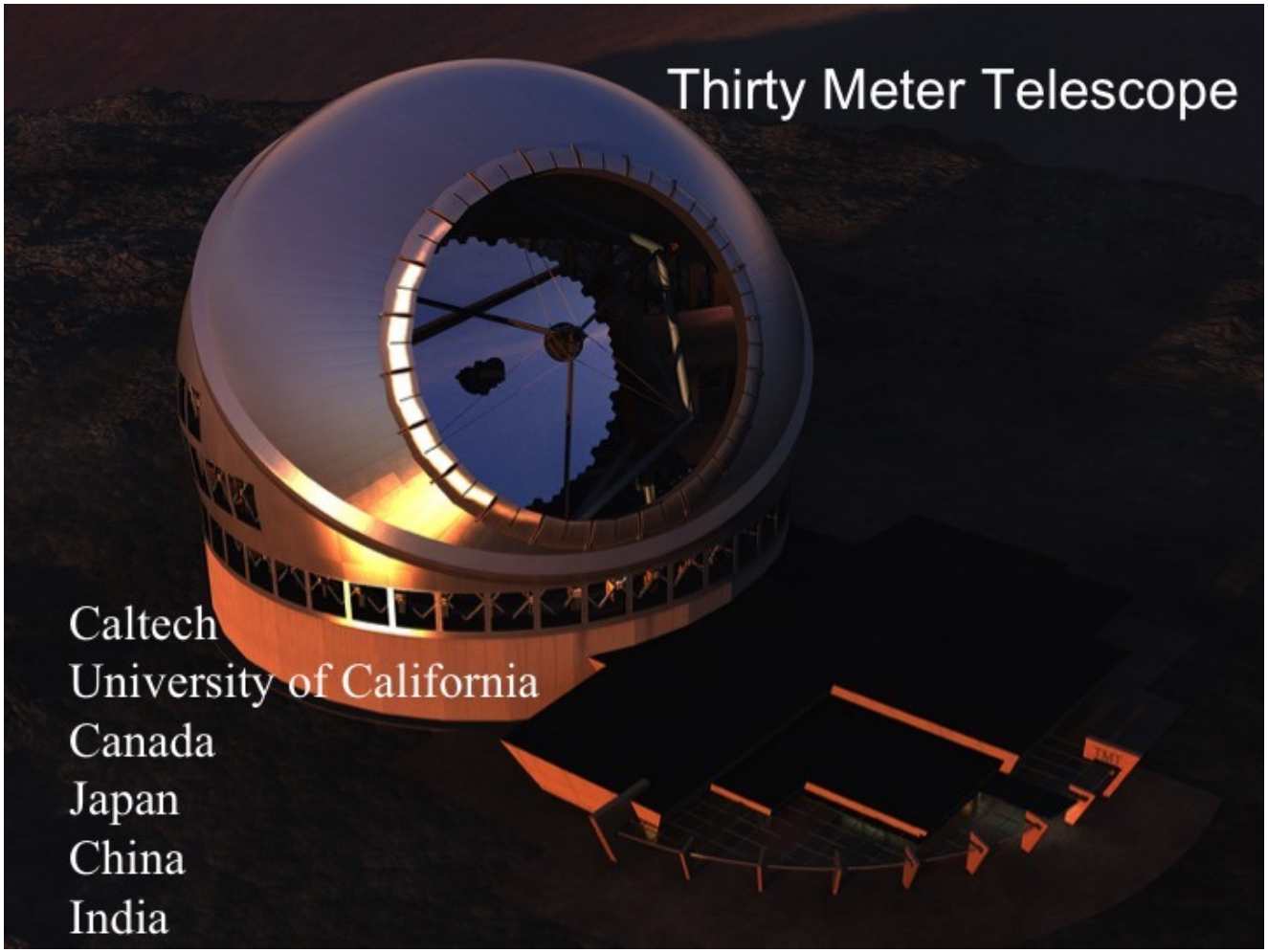

Figure 11: TMT Partner Countries

TMT ...contd.

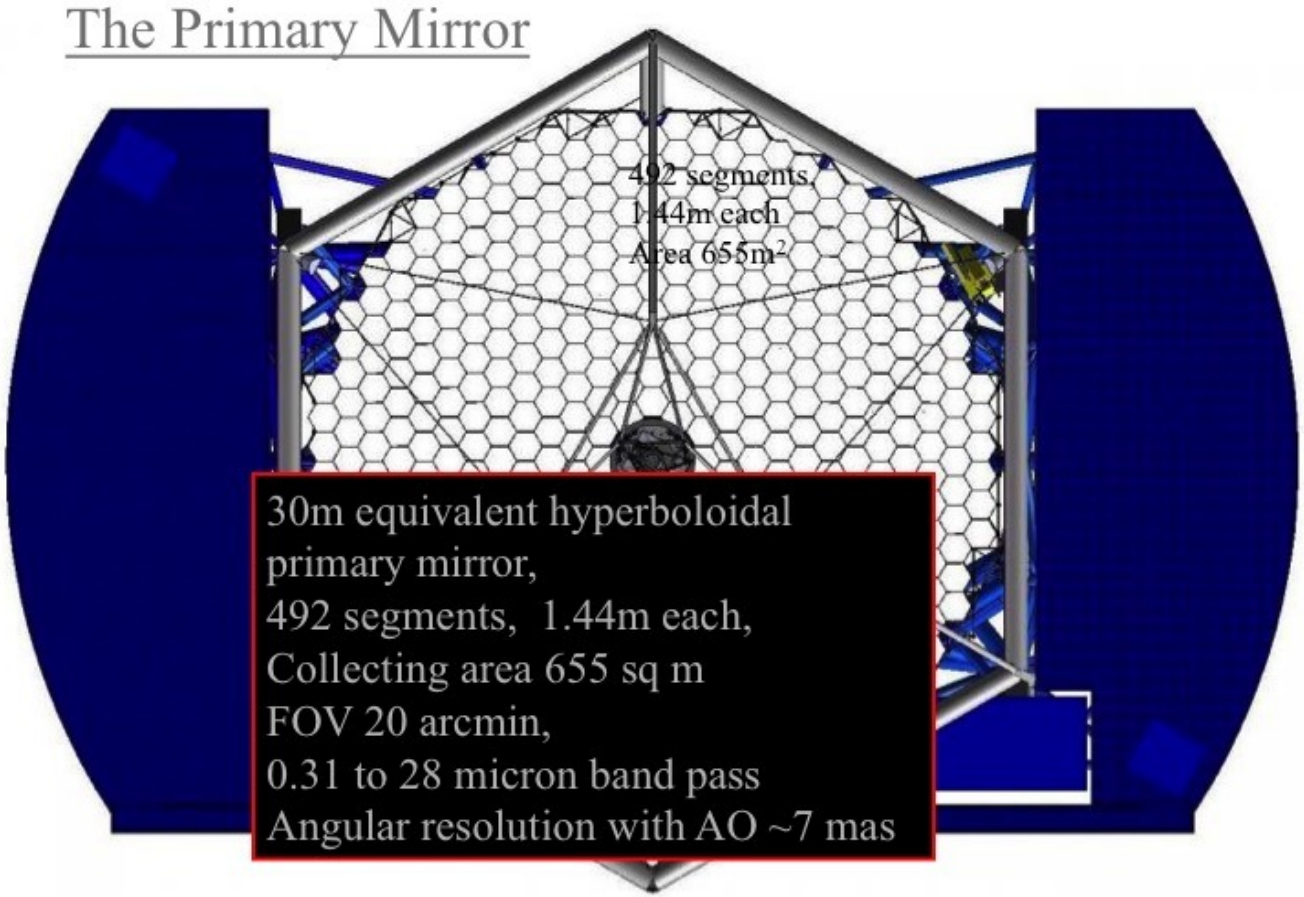

Figure 12: TMT M1 Mirror

TMT ...contd.

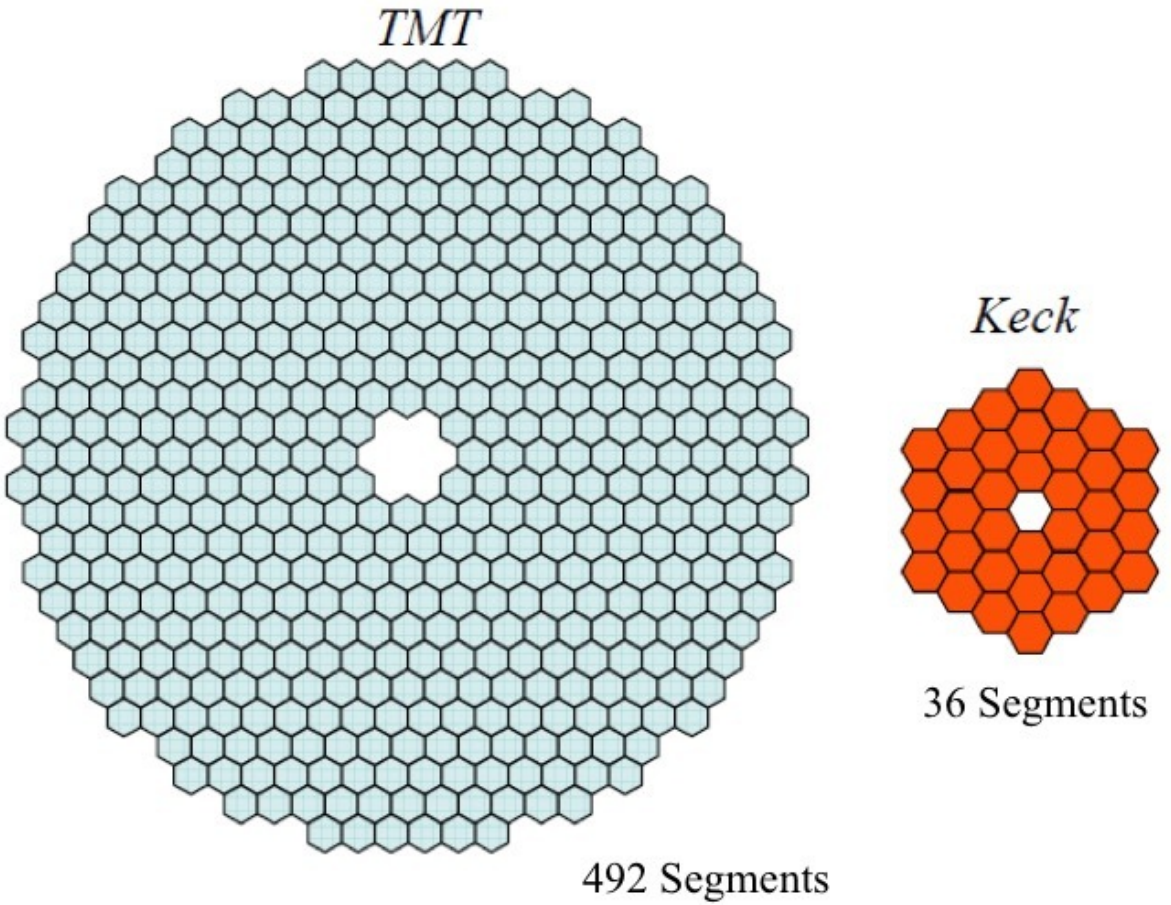

Figure 13: TMT and Keck Comparison

TMT ...contd.

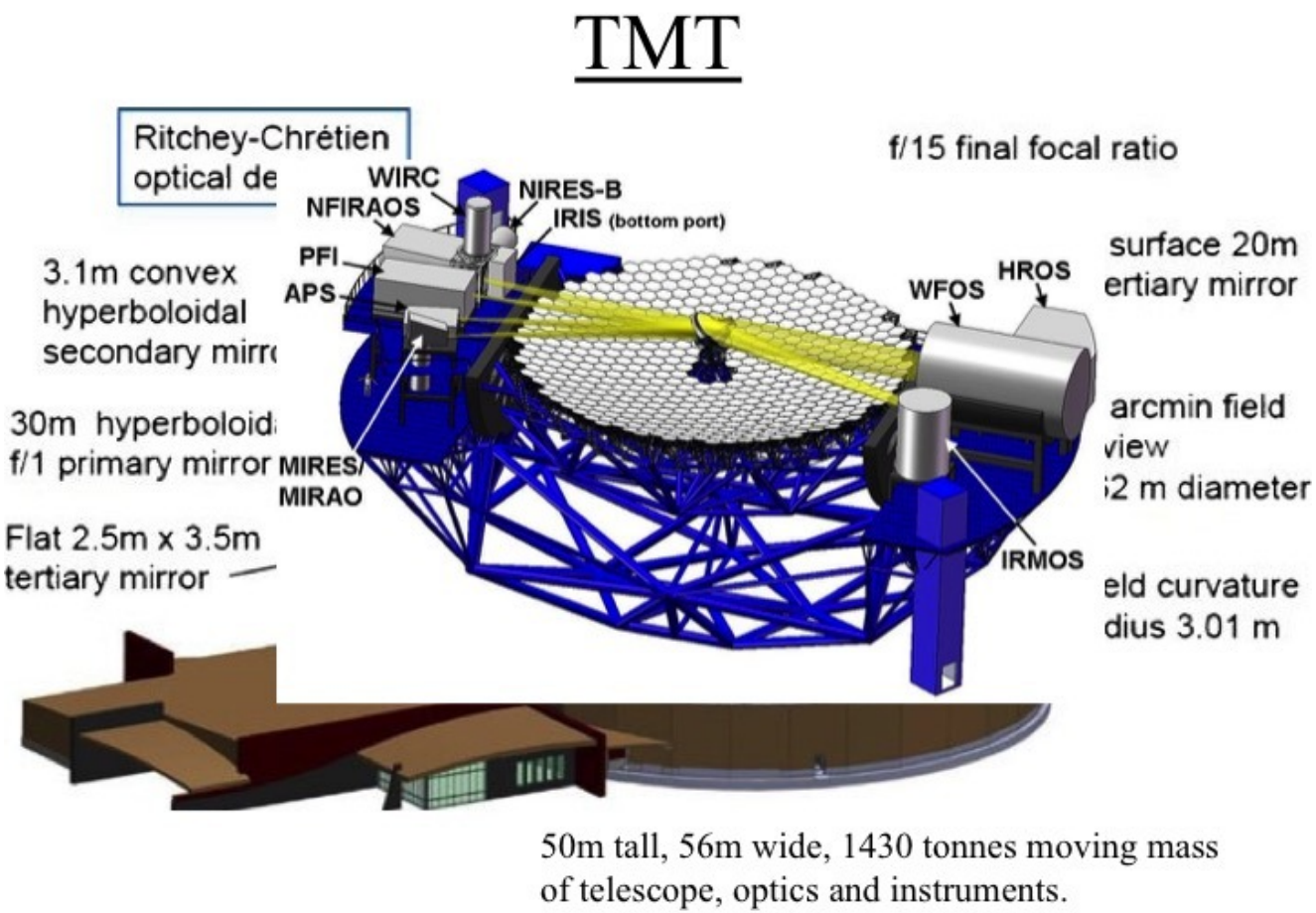

Figure 14: TMT Views

TMT ...contd.

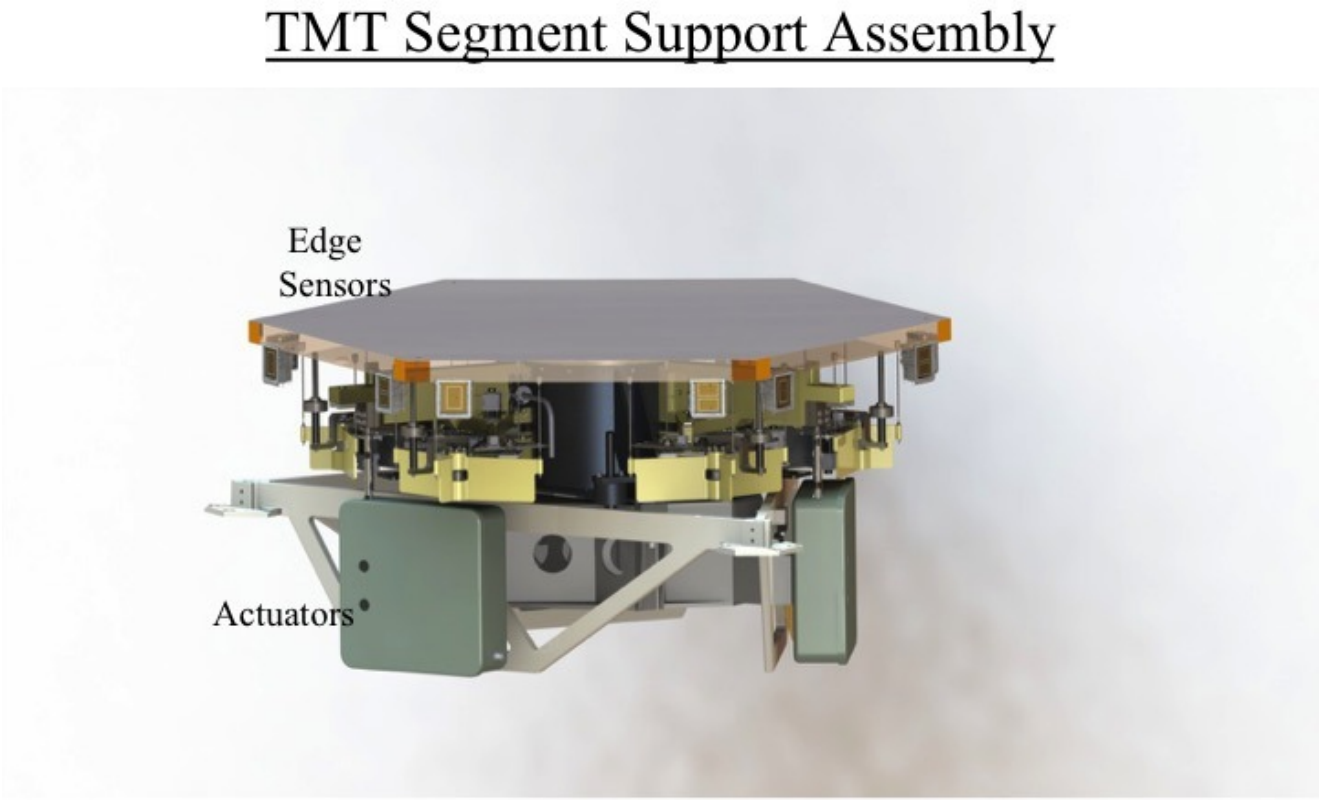

Figure 15: TMT Segment Support Assembly

TMT ...contd.

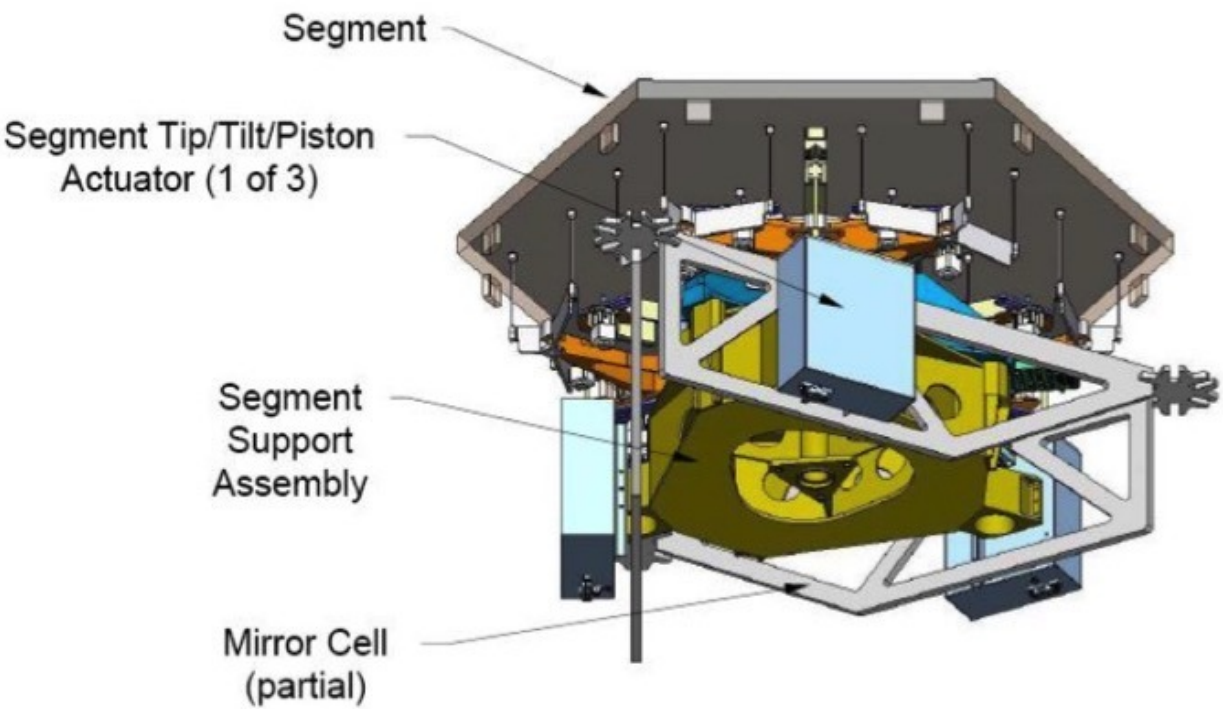

Figure 16: Segment Support Assembly bottom view

TMT ...contd.

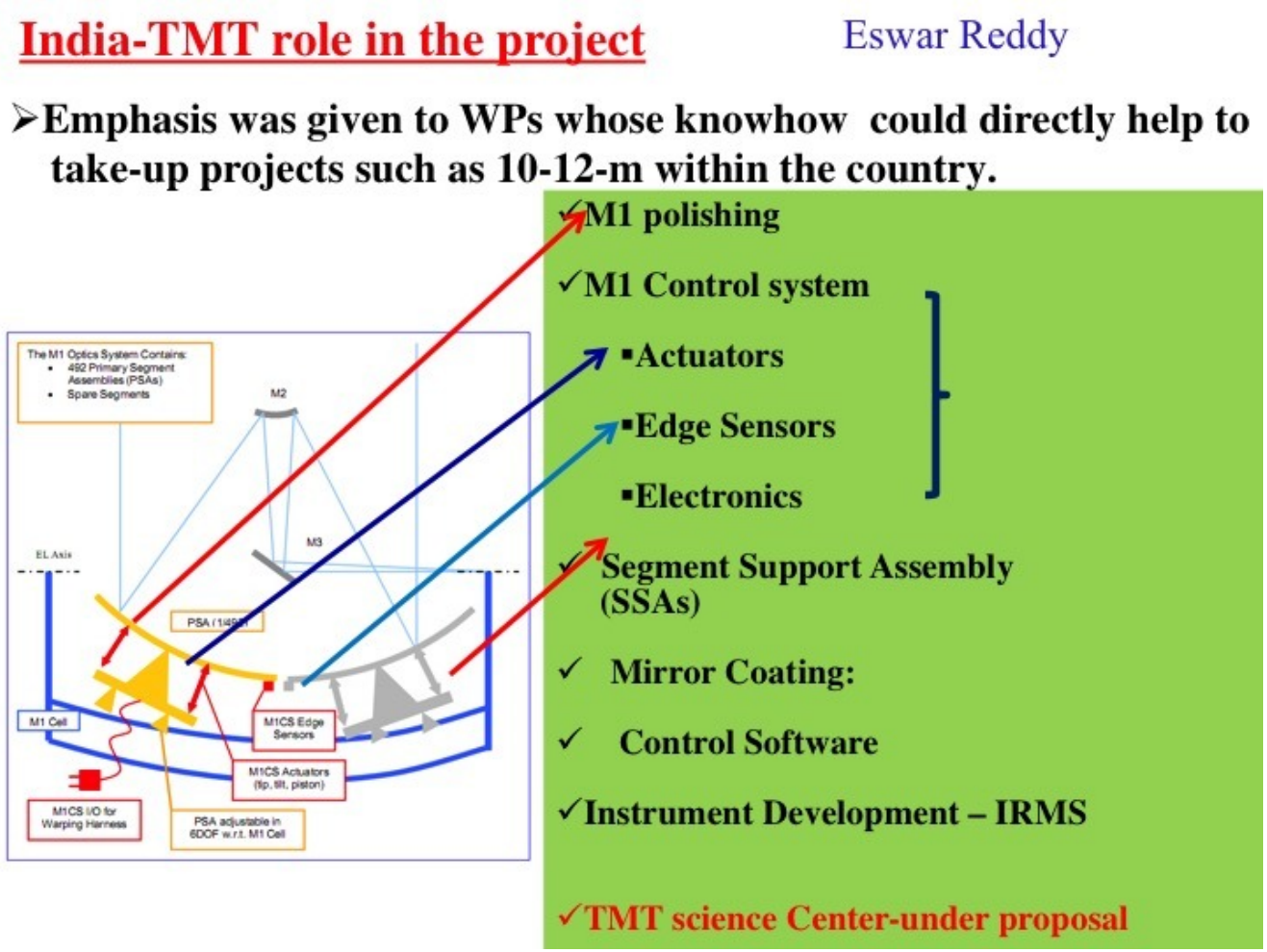

Figure 17: TMT-India Roles

ASTROSAT

- Website: http://astrosat.iucaa.in/
- ASTROSAT is a multi-wavelength astronomy mission on an IRS-class satellite in a 650-km, near-equatorial orbit launched by the Indian launch vehicle PSLV by ISRO on September 28, 2015
- Participating Institutes: ISRO, Bangalore;TIFR, Mumbai; IUCAA, Pune; IIA, Bangalore; RRI, Bangalore; SNBNCBS, Kolkata; BARC, Mumbai; Canadian Space Agency & University of Leicester, UK

ASTROSAT Instruments

- Ultra Violet Imaging Telescope (UVIT)
- Soft X-ray imaging Telescope (SXT)
- LAXPC Instrument
- Cadmium Zinc Telluride Imager (CZTI)
- Scanning Sky Monitor (SSM)
- Charged Particle Monitor (CPM)

ASTROSAT

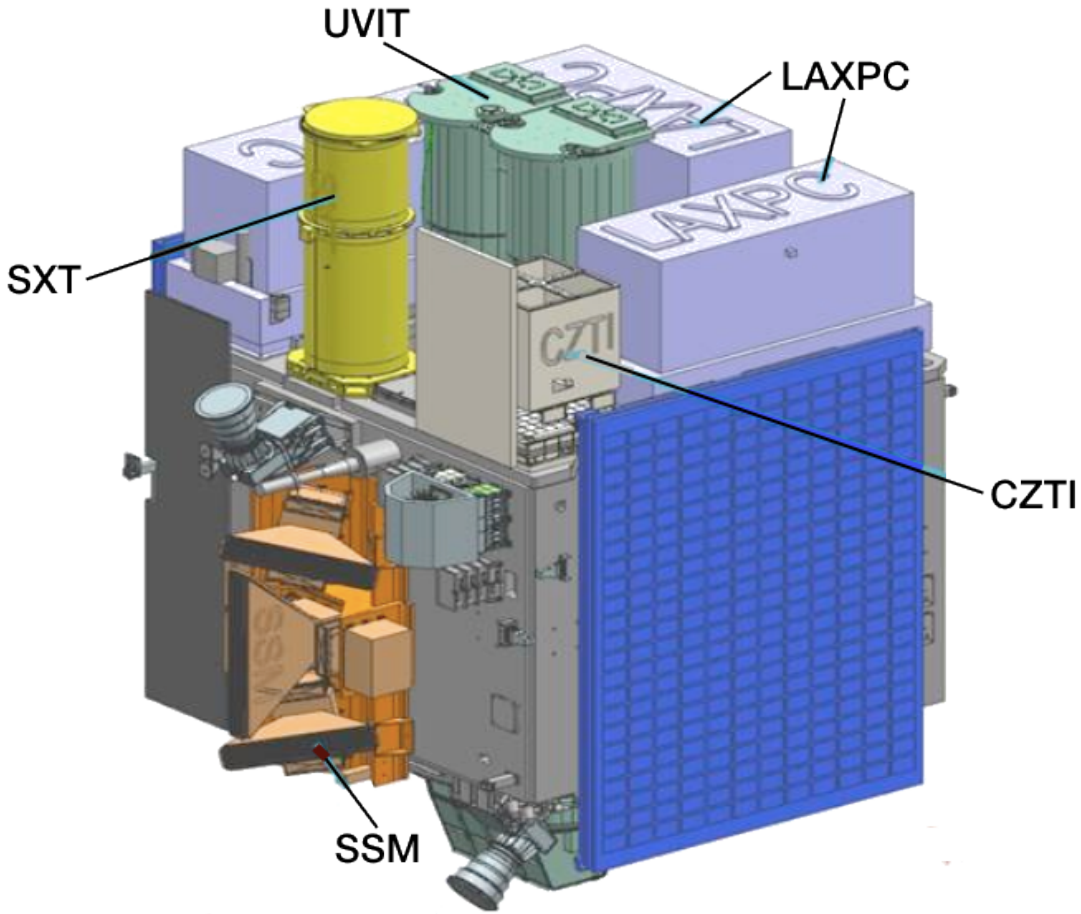

Figure 18: ASTROSAT Instruments

UVIT Image

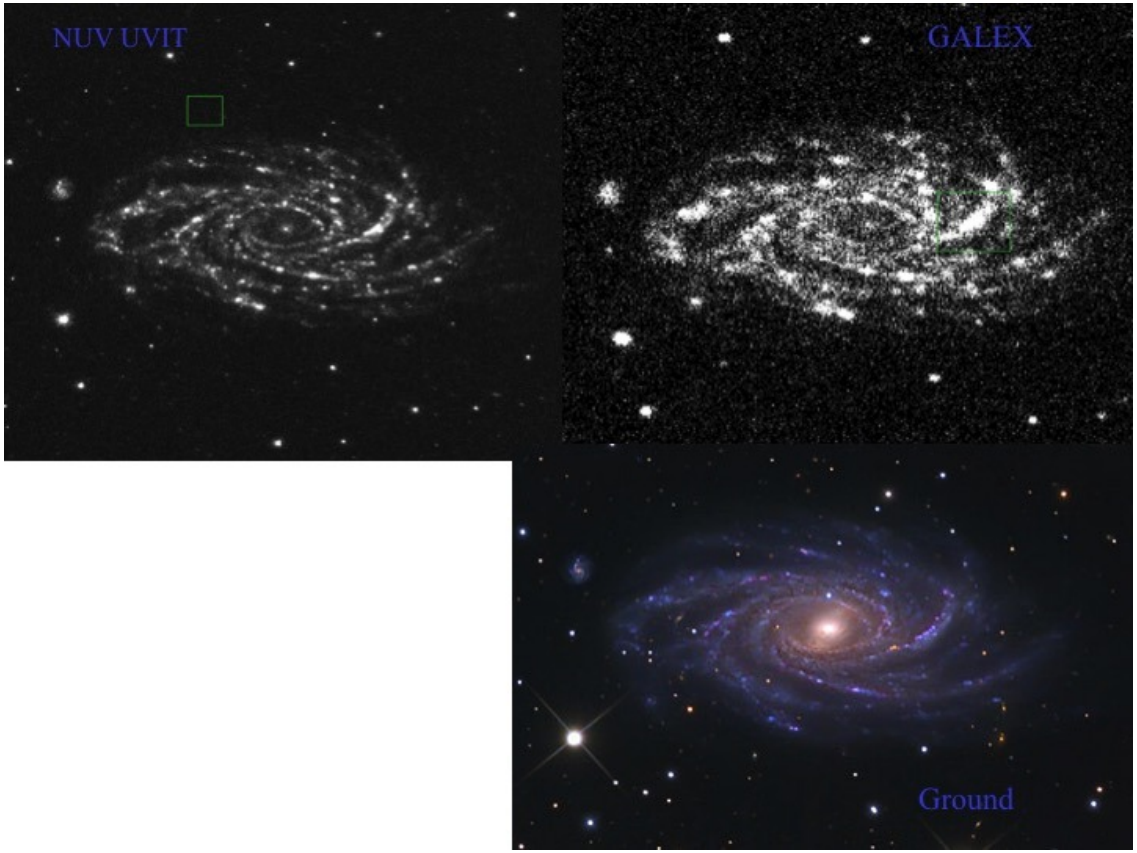

Figure 19: Image Comparison UVIT/GALEX/Ground

INDIGO–LIGO

- Website: http://gw-indigo.org/tiki-index.php?page=LIGO-India
- LIGO-India is a proposed advanced gravitational-wave observatory to be located in India as part of the worldwide network. A consortium of Indian research institutions and the LIGO Laboratory in USA, along with its international partners
- Participating Institutions: IUCAA, Pune, TIFR, Mumbai; IISERs, IITs, Chennai Mathematical Institute, Chennai; RRCAT, Indore; IPR, Gandhinagar and many Indian Universities

LIGO

Figure 20: Arial view of LIGO Livingstone, Lousiana, USA site

LIGO-India

Figure 21: Artist View of Indian LIGO site

Advance LIGO Detection

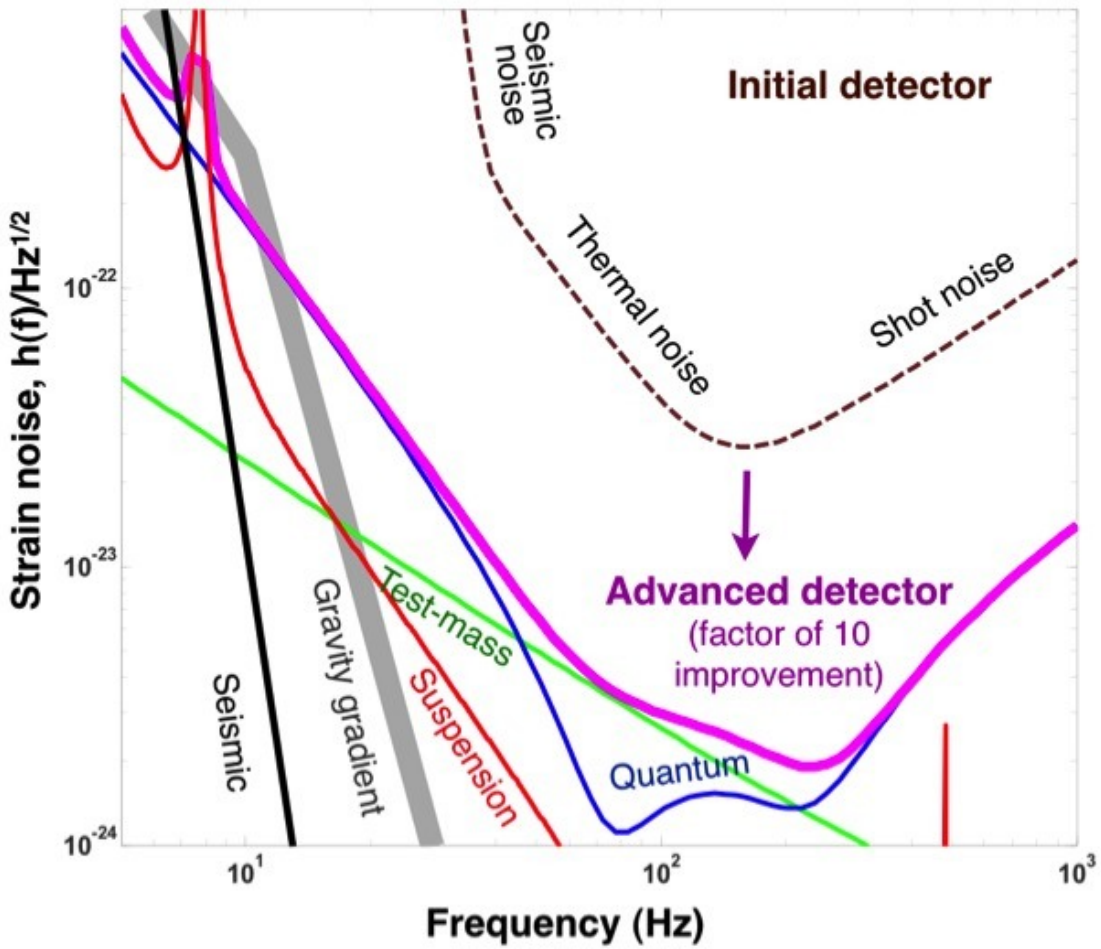

Figure 22: Advance LIGO Capabilities

ADITIYA-L1 Mission

- Website: http://www.isro.gov.in/aditya-l1-first-indian-mission-to-study-sun
- Aditya - L1 First Indian mission to study the Sun
- Aditya-1 was meant to observe only the solar corona but now with additional experiments can now provide observations of Sun's Photosphere (soft and hard X-ray), Chromosphere (UV) and corona (Visible and NIR)
- Visible Emission Line Coronagraph (VELC) - IIA
- Solar Ultraviolet Imaging Telescope (SUIT) - IUCAA
- Aditya Solar wind Particle Experiment (ASPEX) - PRL
- Plasma Analyser Package for Aditya (PAPA) - SPL, VSSC
- Solar Low Energy X-ray Spectrometer (SoLEXS) - ISAC
- High Energy L1 Orbiting X-ray Spectrometer (HEL1OS) - ISAC, USO-PRL
- Magnetometer - LEOS, ISAC

ADITYA-L1 Concept

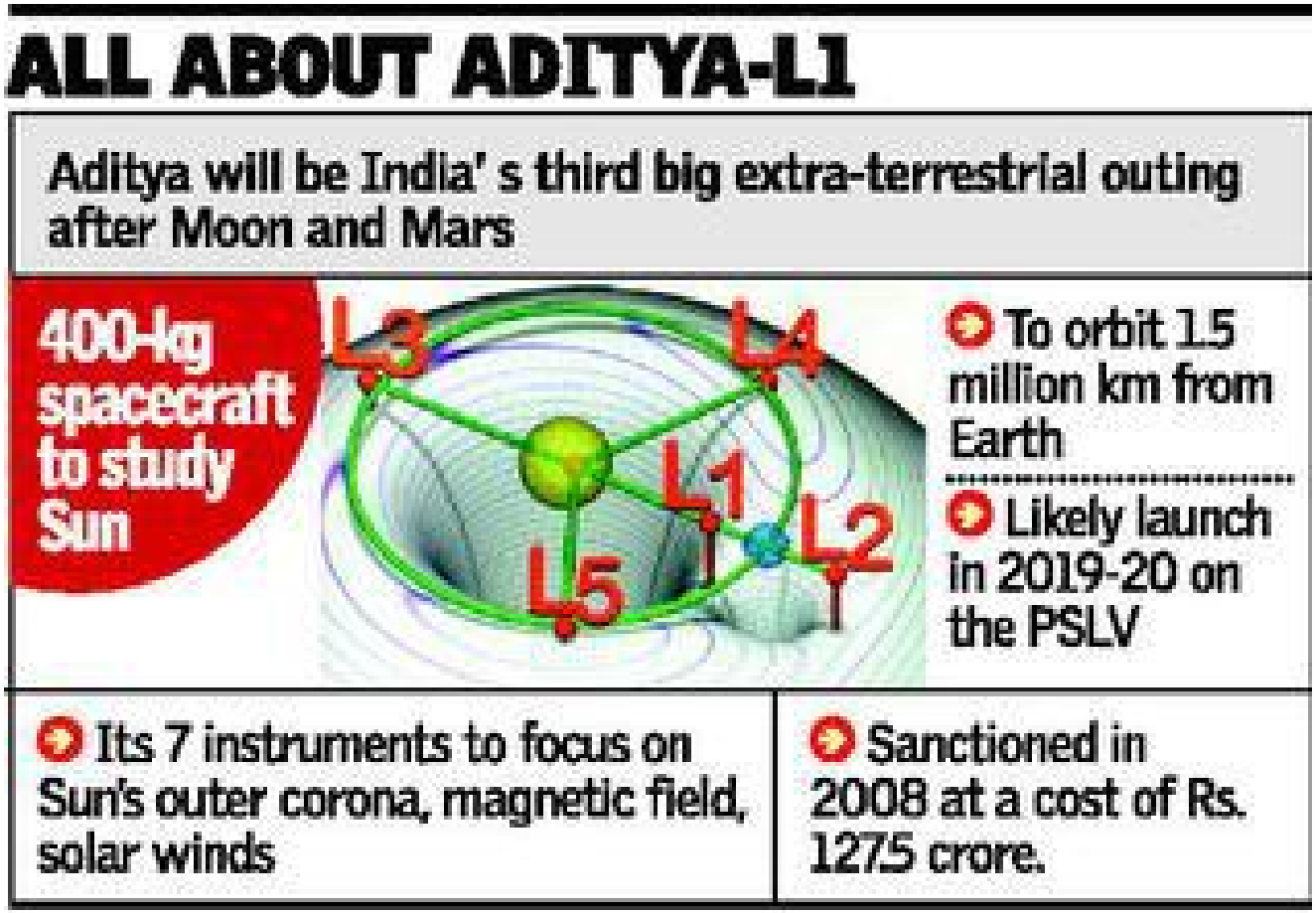

Figure 23: Concept of ADITYA-L1 Mission

ADITYA ...contd.

Aditya-L1 Solar Space Mission

- First Indian space mission to study the Sun.
- The spacecraft will be in an halo orbit around the from an Halo orbit around the Sun-Earth Lagrangian Point L1, which is at a distance of ~1.5 million km from the Earth.
- The 1.5 ton satellite will carry seven payloads to observe the Solar photosphere, chromosphere and corona
- Launch by PSLV-XL is expected in 2019-20.

Figure 24: ADITYA Solar Space Mission

ADITYA ...contd.

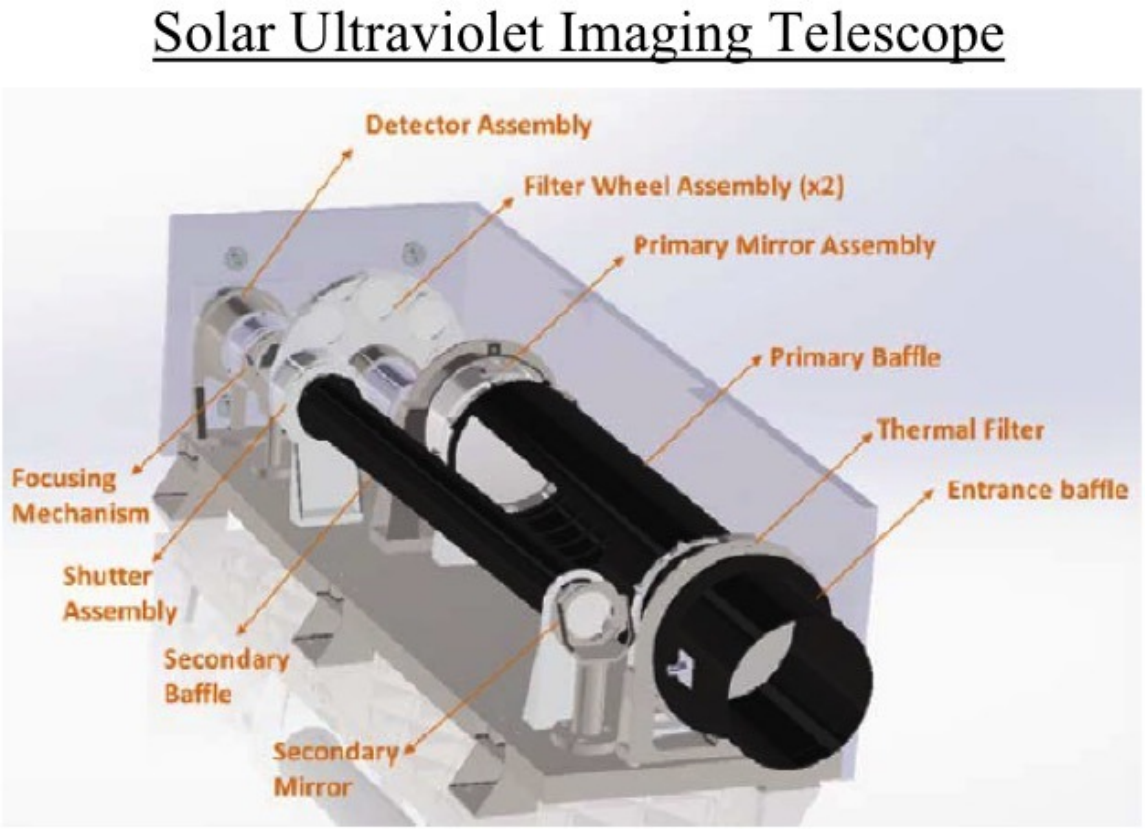

Figure 5. SUIT payload with all the subsystems.

Figure 25: SUIT

ADITYA ...contd.

Thermal filter transmits Angular resolution of 1.4

SUIT will for the first time provide full disk observations in the near-UV. It will

- Measure and monitor Solar radiation in NUV (200-400 nm)
- Simultaneously map the photosphere and chromosphere using 11 filters covering different heights in the Solar atmosphere.
- Measure and monitor spatially resolved Solar spectral irradiance that governs the chemistry of oxygen and ozone in the Earth's atmosphere.

IUCAA , IISER Kolkata,
IIA, ISRO Centres.

Figure 26: SUIT Details

ADITYA ...contd.

In Situ Experiments

- There are three *in situ* experiments: Aditya Solar wind Particle Experiment; Plasma Analyser Package for Aditya and a Magnetometer Package.
- The three payloads will sample heliospheric data at L1.
- A unique opportunity to get a better understanding of the inner heliosphere, and predict space weather more accurately.

PRL, IISER-Pune, Udaipur Solar Observatory, Space Physics Laboratory, Laboratory or Electro-Optical Systems

Figure 27: SUIT Measurments

ADITYA ...contd.

X-ray Spectrometers on Aditya-L1

- The mission will have two high spectral resolution X-ray spectrometers to study Solar flares.
- A soft X-ray spectrometer will cover the range 1-30 keV, while a hard spectrometer will cover 10-150 keV.
- The instruments together will enable the study of Solar flare plasma parameters and accelaration mechanism of energetic particles.

Figure 28: ADITYA X-Ray Instrument

ADITYA-L1

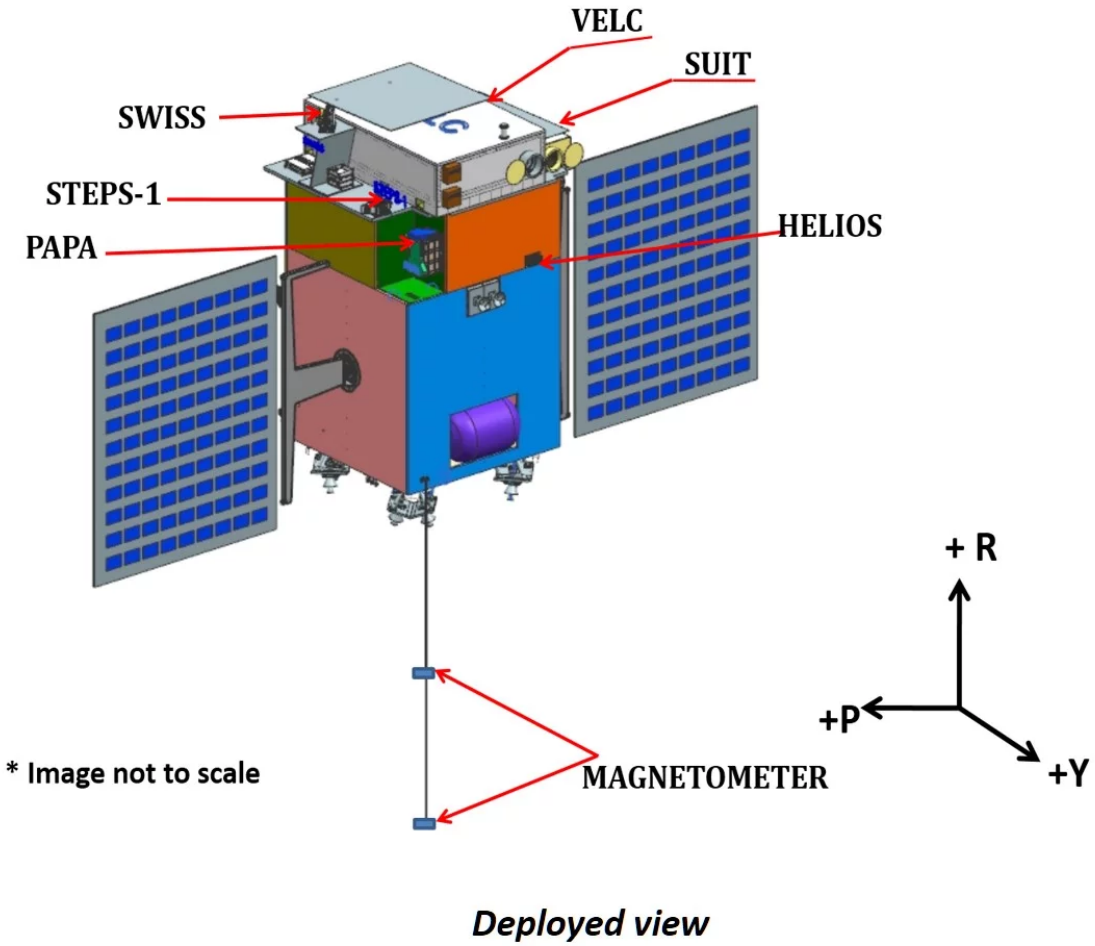

Figure 29: Schematic of ADITYA-L1 Satellite

Thanks