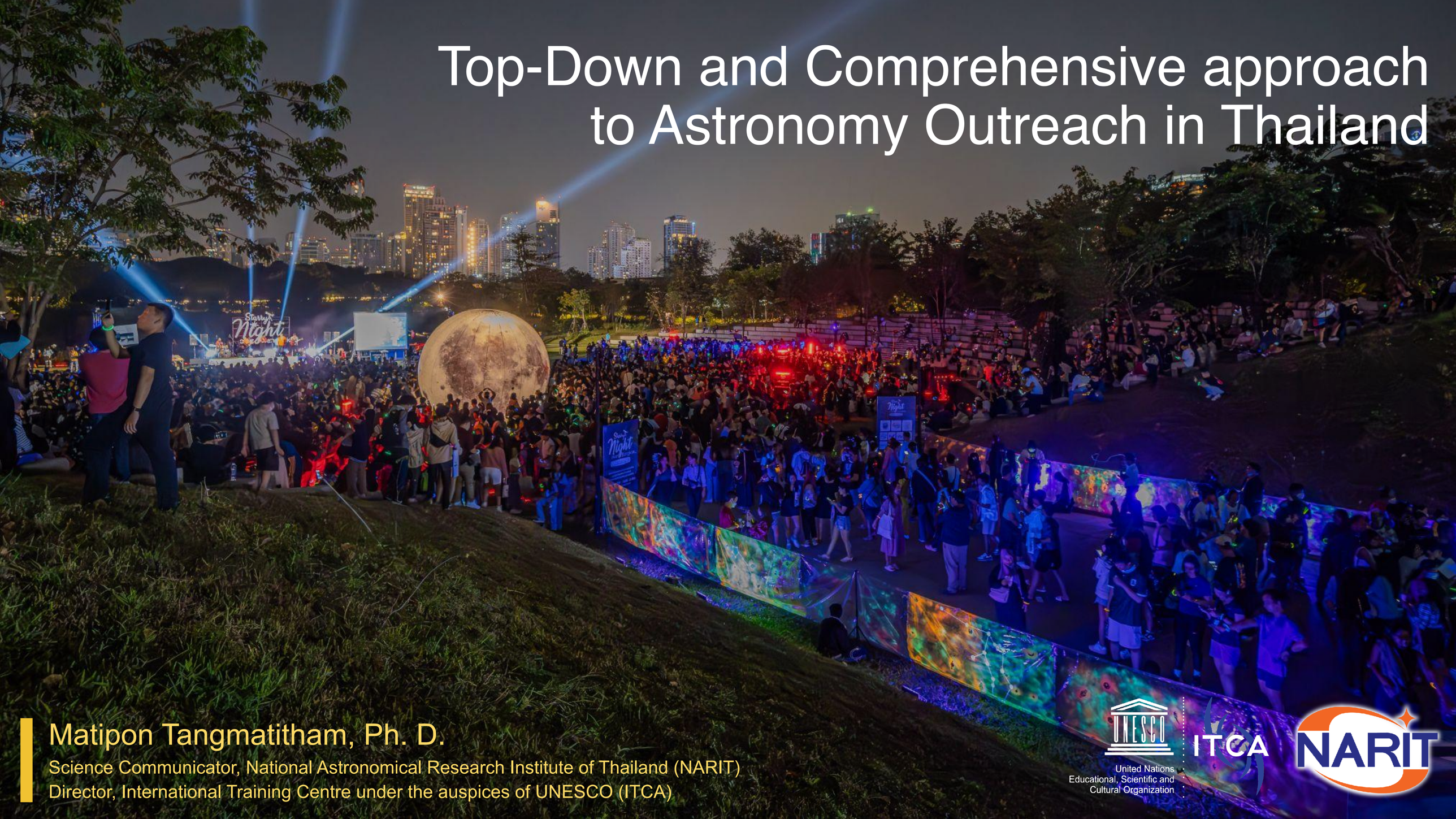
Top-Down and Comprehensive approach to Astronomy Outreach in Thailand



Matipon Tangmatitham, Ph. D.
Science Communicator, National Astronomical Research Institute of Thailand (NARIT)
Director, International Training Centre under the auspices of UNESCO (ITCA)

United Nations
Educational, Scientific and
Cultural Organization

ITCA

NARIT

ASTRONOMY

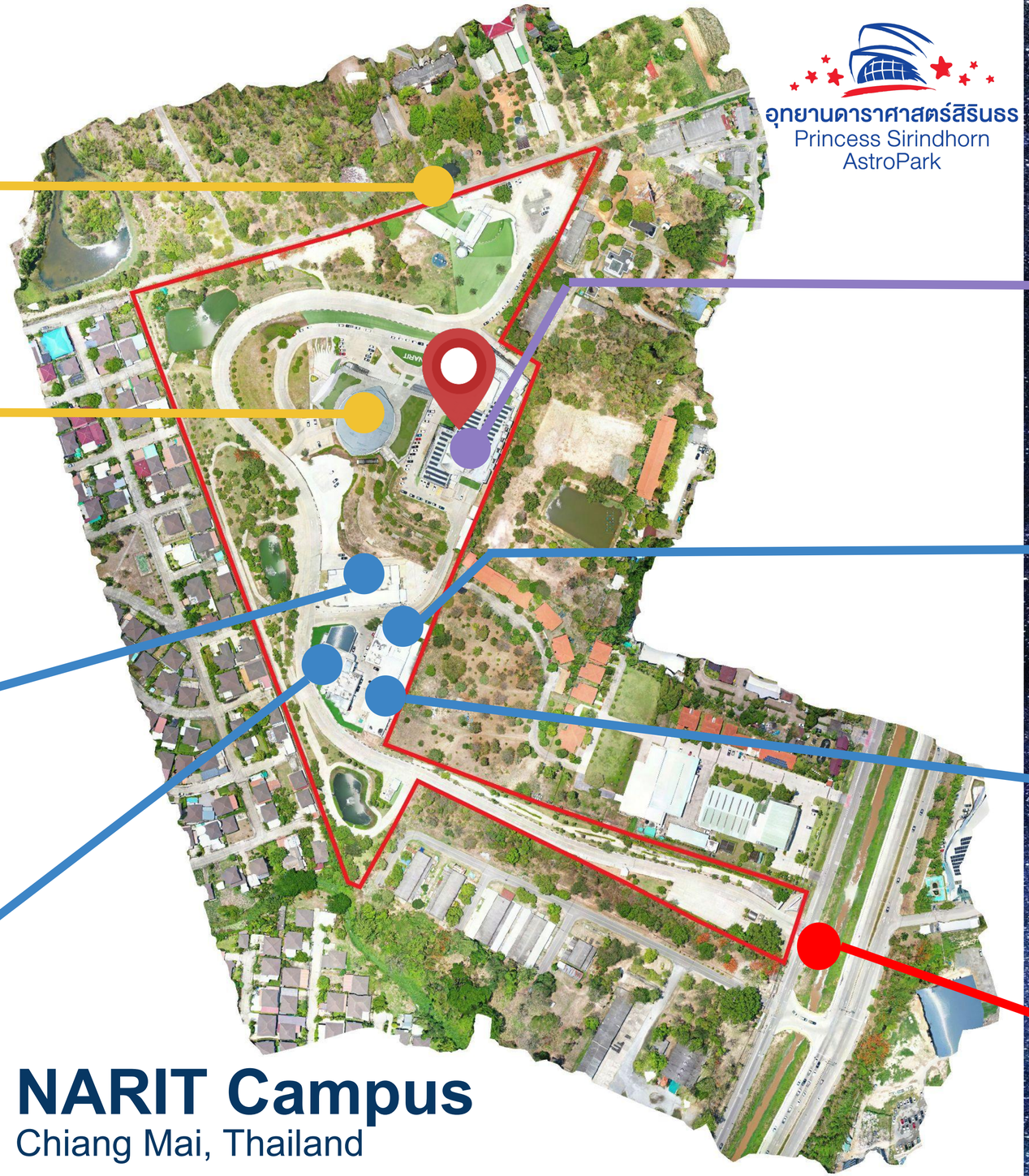
A challenge that drives human capacity and technology developments

Public Observatory

Planetarium and
Exhibition

Advanced Innovation Center

Prototype Incubator Center



อุทยานดาราศาสตร์สิรินธร
Princess Sirindhorn
AstroPark

NARIT Campus

Chiang Mai, Thailand

NARIT Headquarters

Fabrication Lab

Center of Observatory
Operations and Engineering

Entrance Gate

Cross-cutting infrastructures for space science and space technology development in Thailand

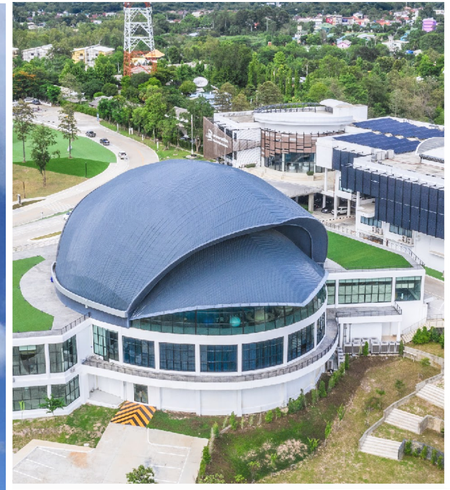
Astrophysics … and Space Situational Awareness

Thai National Observatory

($\lambda = 400 - 900$ nm)

Thai National Radio Observatory

($\lambda = 1 - 20$ cm)



Astronomical Infrastructures

Optical Telescopes

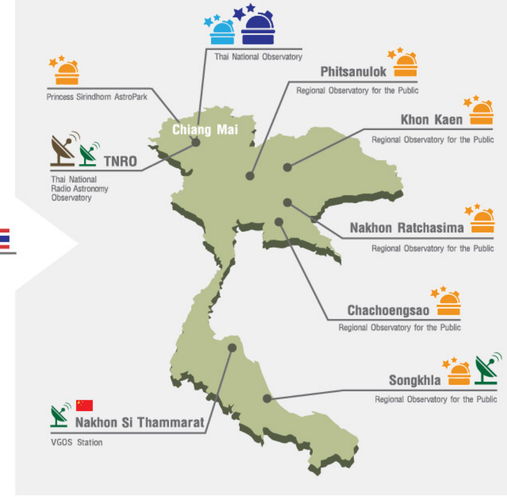
Existing: 2.4m, 1.0m, 0.7m x 10, 0.6m, 0.5m x 3

Planned: 0.8m (NARIT-made) and 0.5m planetary telescope

Radio Telescopes

Existing: 40m, 13m

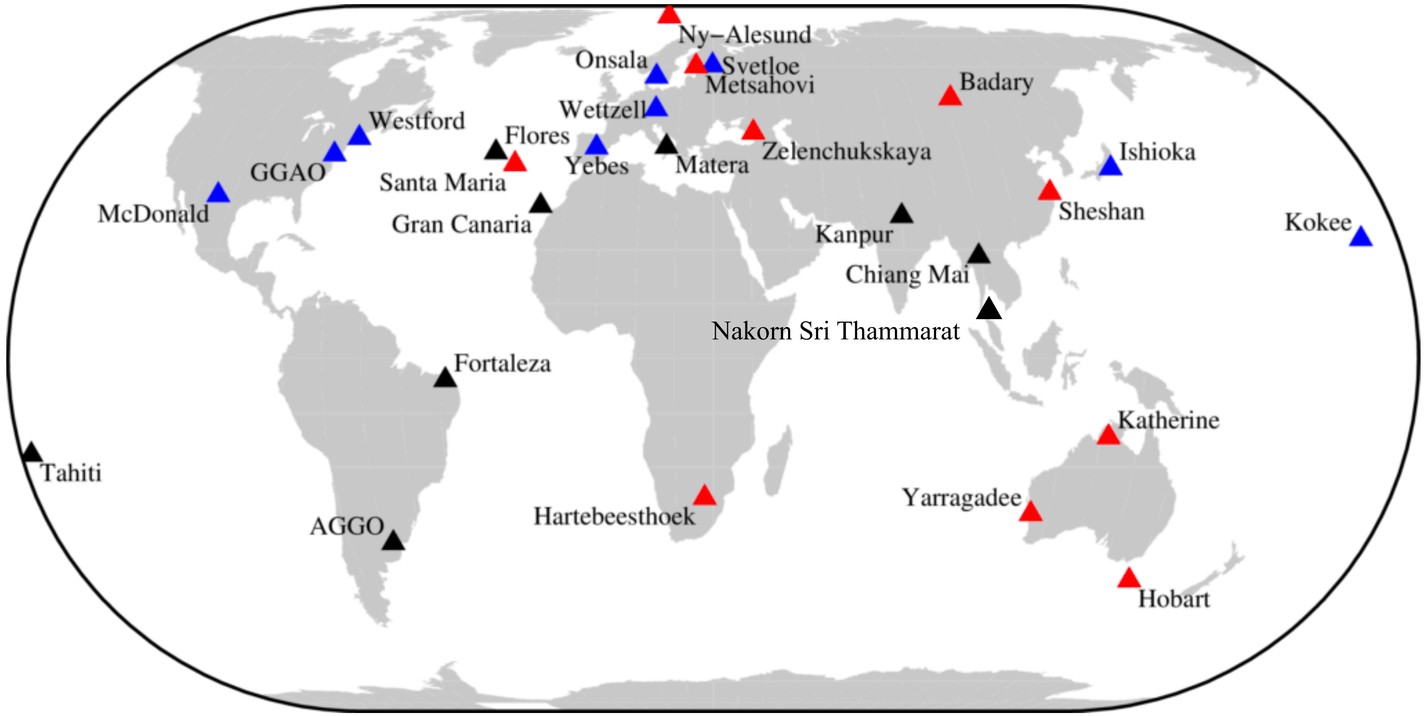
Under construction: 13m x 2 VGOS



⌀ 2.4 meters ⌀ 1 meters ⌀ 0.7 meters ⌀ 0.4 meters ⌀ 40 meters ⌀ 13 meters

International VLBI Service (IVS) for Geodesy and Astrometry

Tectonic motion at 0.1 mm/year accuracy using global VLBI quasar observations. Chiang Mai station is completed; Nakorn Sri Thammarat station completion in 2026.



VLBI Global Observing System Stations (based on IVS; September 2020)

NARIT Research in a Nutshell

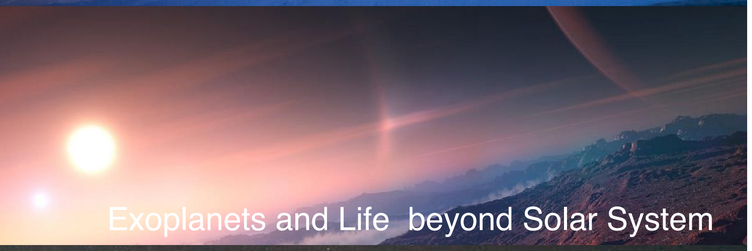
Frontier Research in the fields of astronomy, space and atmospheric science

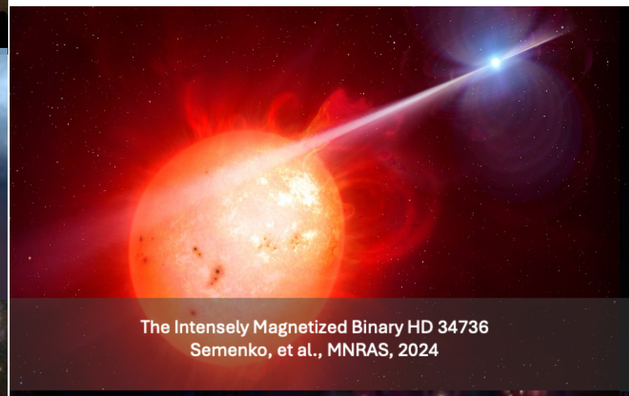
28 Researchers (FTE)

53.6%

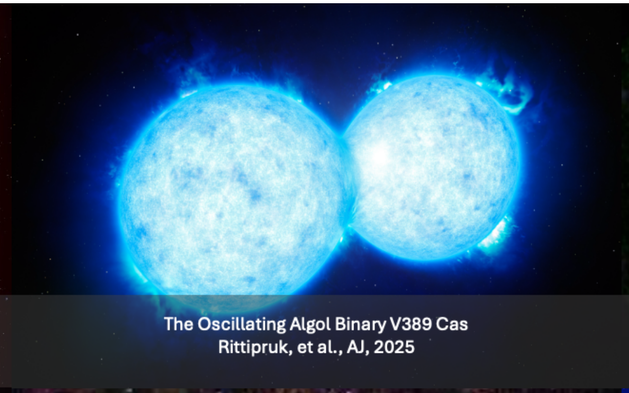
46.4%

36.9 Average Age (year)





The Intensely Magnetized Binary HD 34736
Semenko, et al., MNRAS, 2024

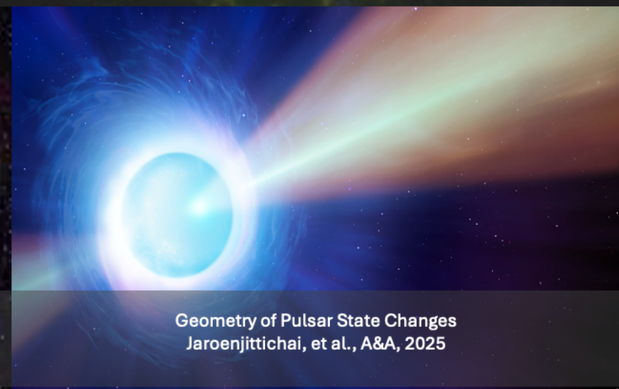


The Oscillating Algol Binary V389 Cas
Rittipruk, et al., AJ, 2025

JWST Reveals Cold Dust Reservoir in SN 2014C
Tiyanont, et al., ApJ, 2025

Proton-Mediated Sugar Formation in Space
Wongkummoon, et al., MNRAS, 2025

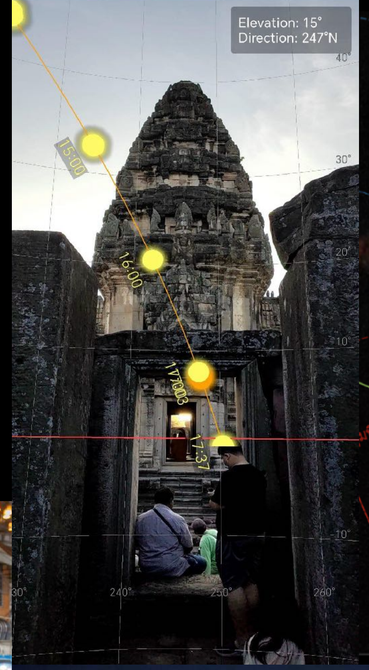
3D Simulation of SiO Maser Polarization in AGB Stars
Phetra, et al., MNRAS, 2025

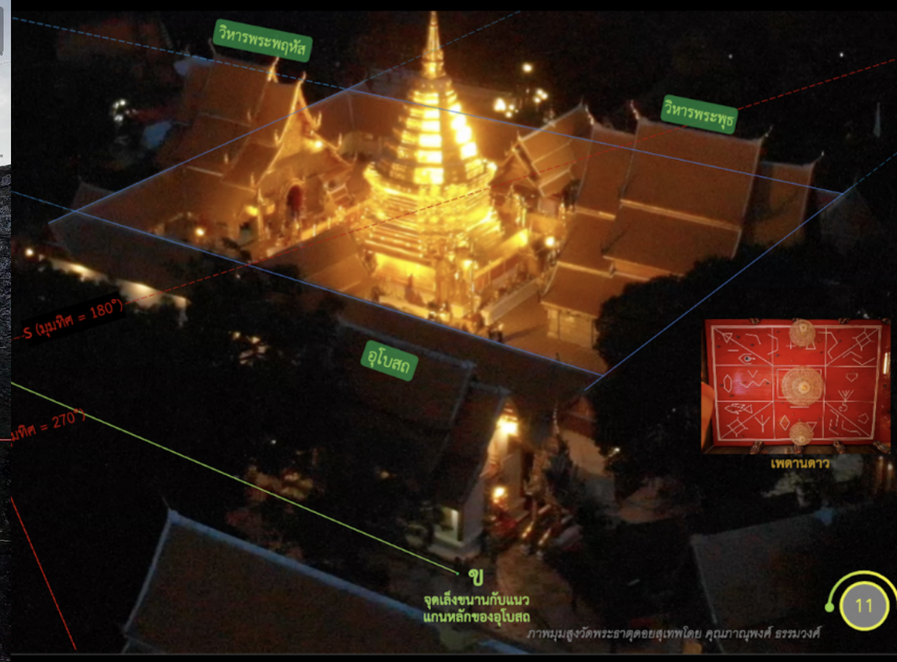


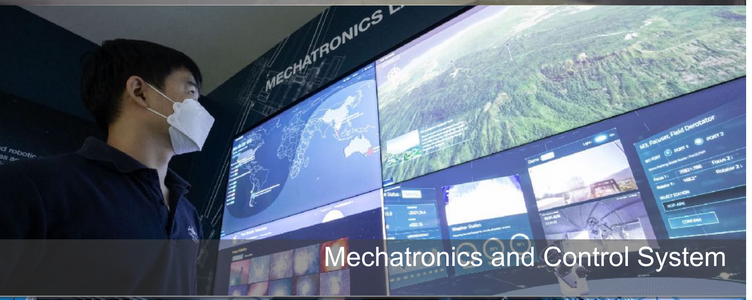
Geometry of Pulsar State Changes
Jaroenjittichai, et al., A&A, 2025

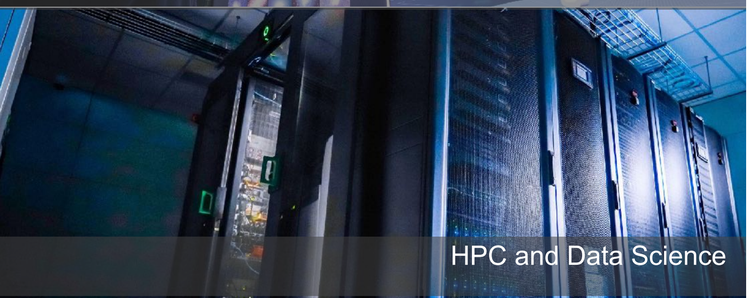
Multicultural Astronomy

Astronomy as a bridge for mutual understanding among Thailand’s multicultural populations









Astronomy as a challenge

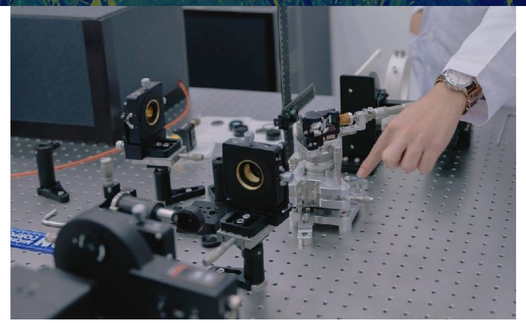
that drives advanced engineering capacities

Impacts on advanced technology sectors

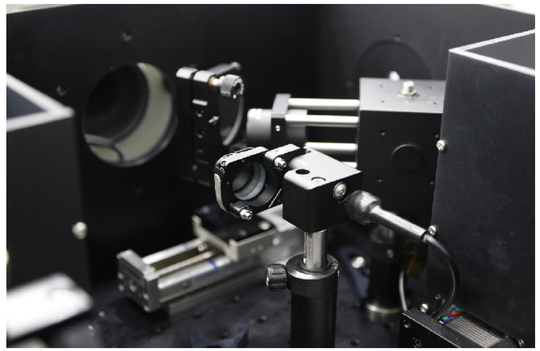
- Advanced Optics and Photonics
- Radio Frequency Technologies
- Advanced Mechanical Manufacturing
- Mechatronics and Control System
- HPC and Data Science
- Mirror Coating and Anodization
- Space Systems
- Astronomy Driven Technologies

NARIT Center for Optics and Photonics

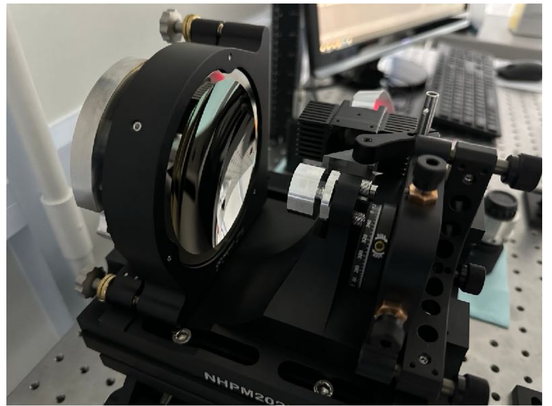
Spectrographs, Coronagraphs, Optical Design, Astrophotonics

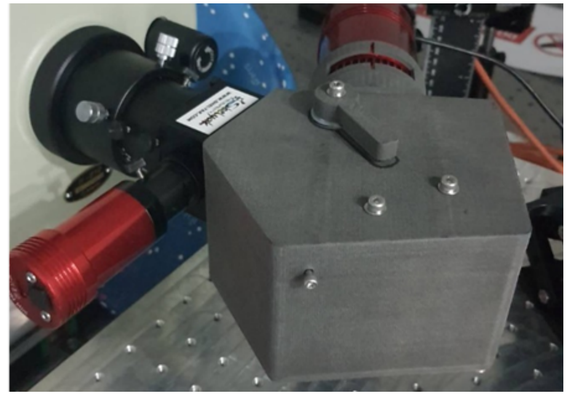


Evanescent wave coronagraph + AO

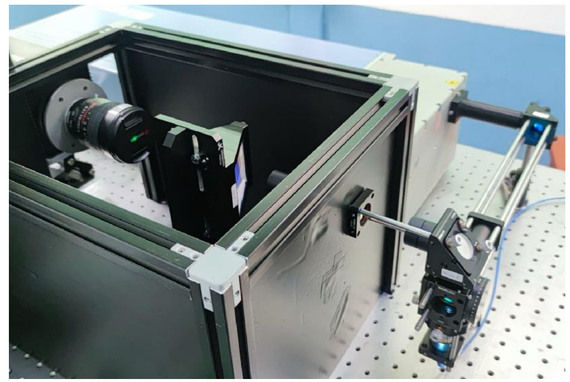


Low resolution spectrograph





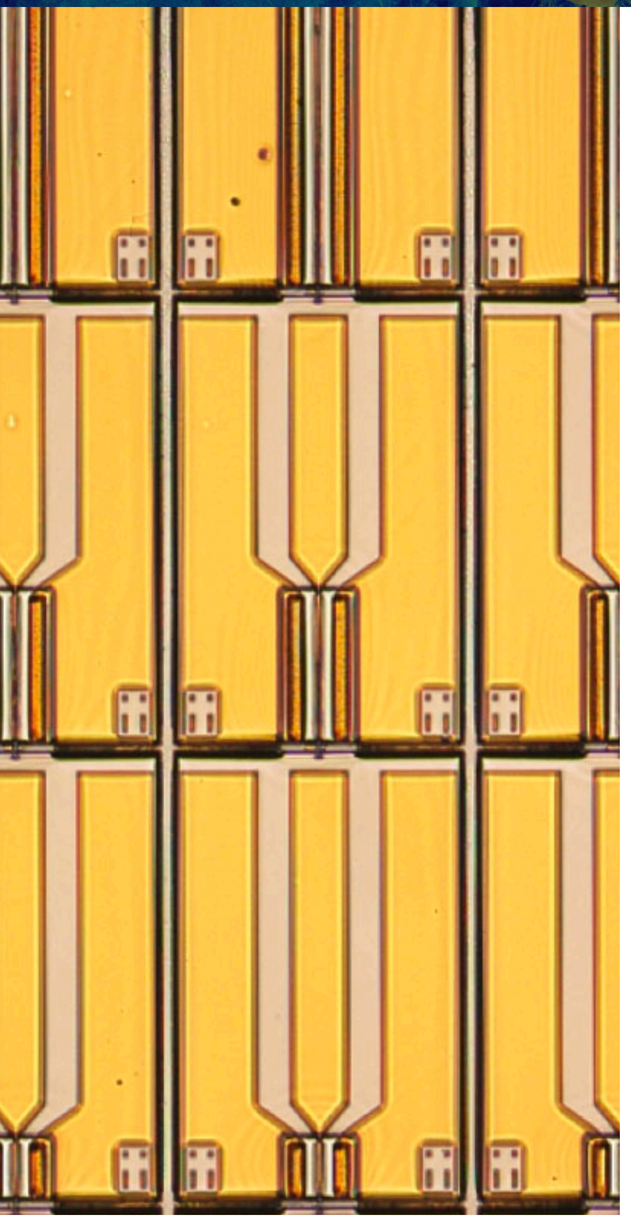
UV to Visible spectrograph
(for atmospheric physics)



Time-resolved Raman spectroscopy

Space Hyperspectral Imaging
Payload (Dispersive unit shown)

Photonic chips development for Astrophotonics Spectroscopy



Integrated-photonics concept for high-contrast imaging

Measurement and order-sorting is performed via an energy-resolving MKIDS detector.

This injects the light into a nulling chip.

A telescope pupil is injected into a pupil-remapping chip via an on-chip 3-D-printed microlens array.

The output is spectrally dispersed at high spectral resolution via an arrayed-waveguide-grating-based photonic spectrograph.

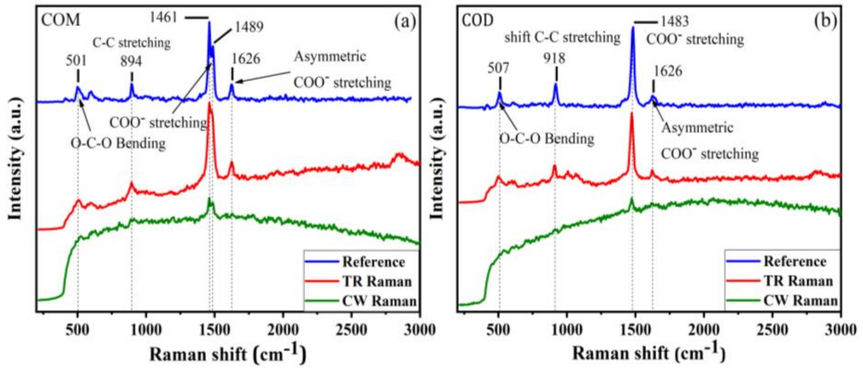
On-chip active modulation allows the null to be carefully tracked by dynamically adjusting optical path length.

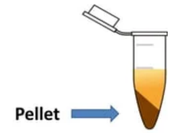
Review by Norris & Bland-Hawthorn 2019, OPN

Time-Resolved Raman Spectroscopy
Astronomical Technologies, Medical and Biosensor Applications

Low-resolution spectrometer — originally developed for the Thai National Observatory — repurposed into a time-resolved Raman spectrometer. By temporally resolving the signal, we can separate the Raman (short duration) and the subsequent fluorescence for accurate identification of other chemical species.

Kidney stone early detection:
Fluorescence-suppressed Raman spectroscopy enables quick and sensitive detection of urinary stone composition, e.g. COM (a) and COD, directly from urinary sediment



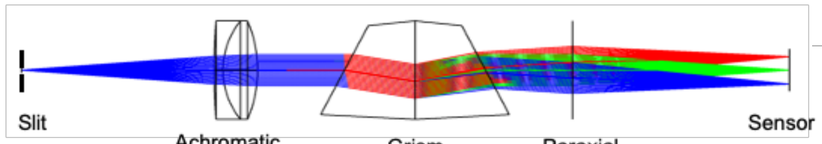


Urinary sediment

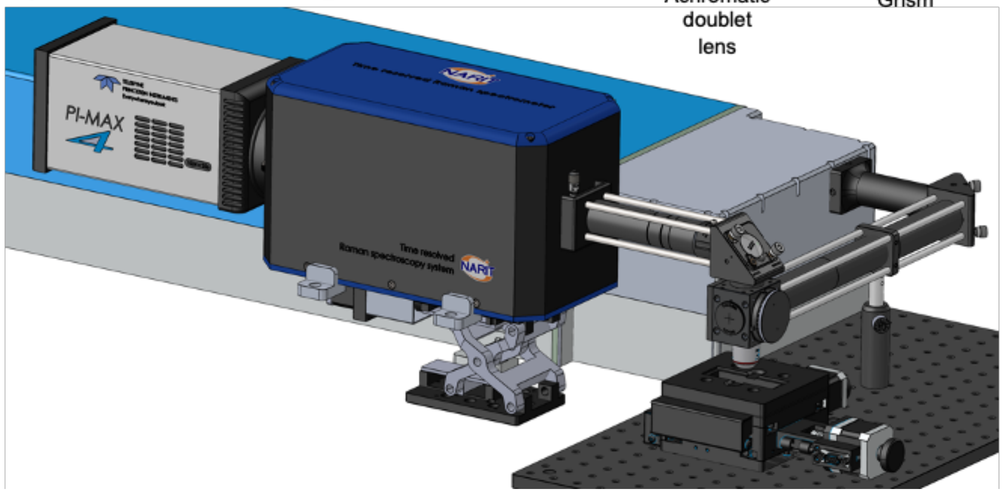
COM (calciumoxalate monohydrate)

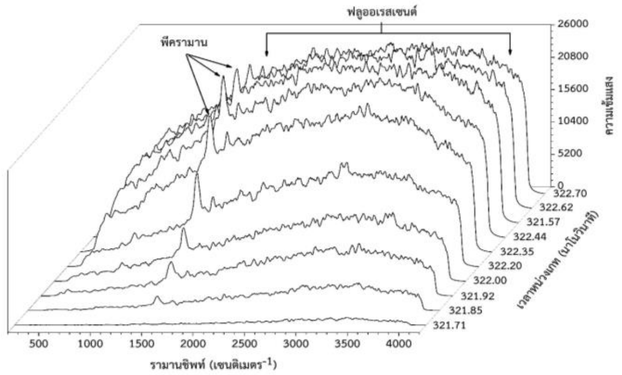
COD (calciumoxalate dihydrate)

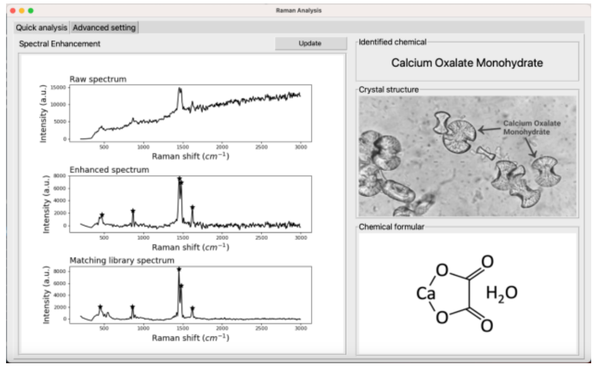
Optical Design



Opto-mechanical Design







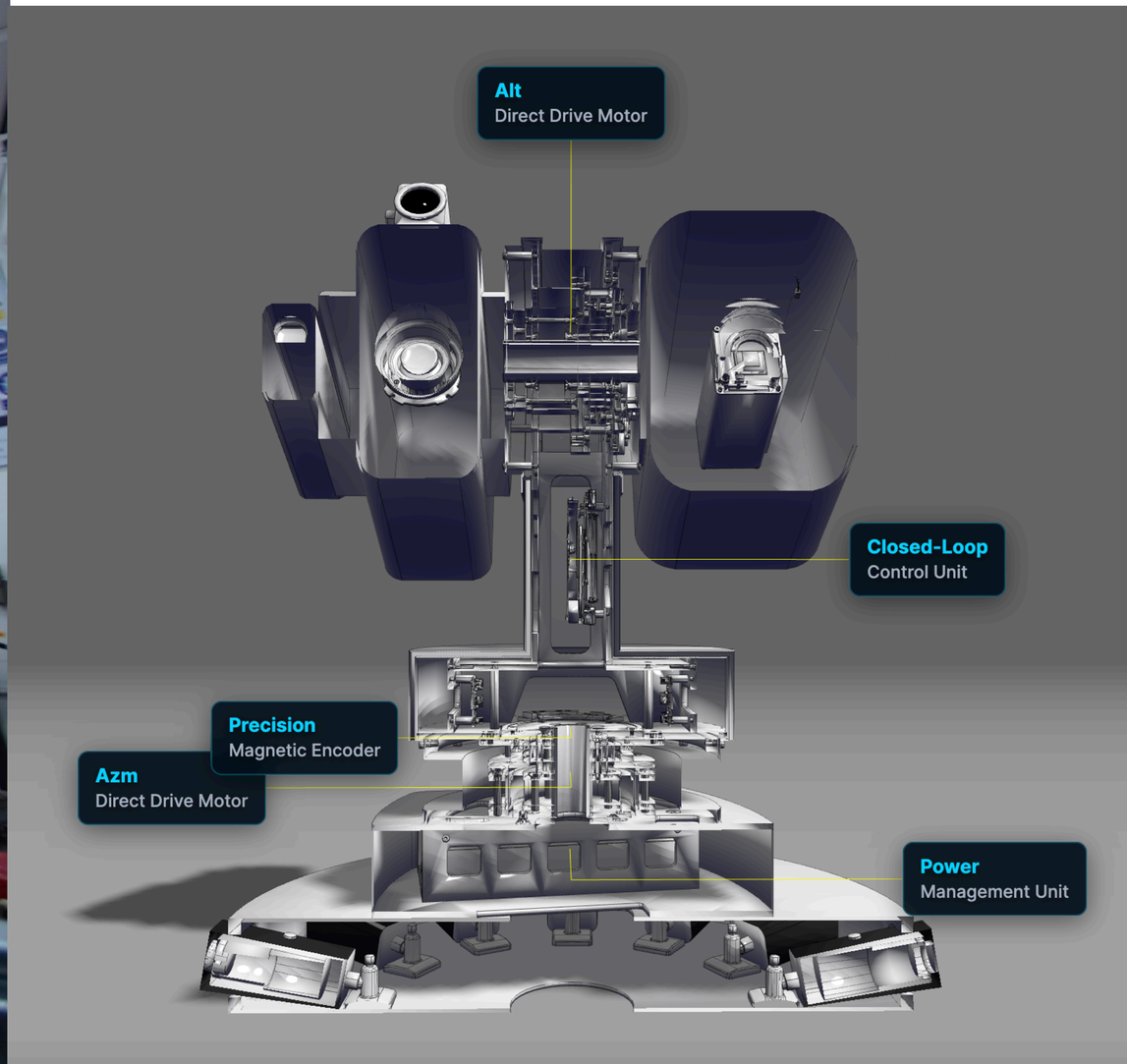
Actual measurements from NARIT-PSU prototype (2023)

NARIT

Automated 0.8-meter class robotic telescope

Automate multispectral UAV surveillance system

First Light expected: December 2026



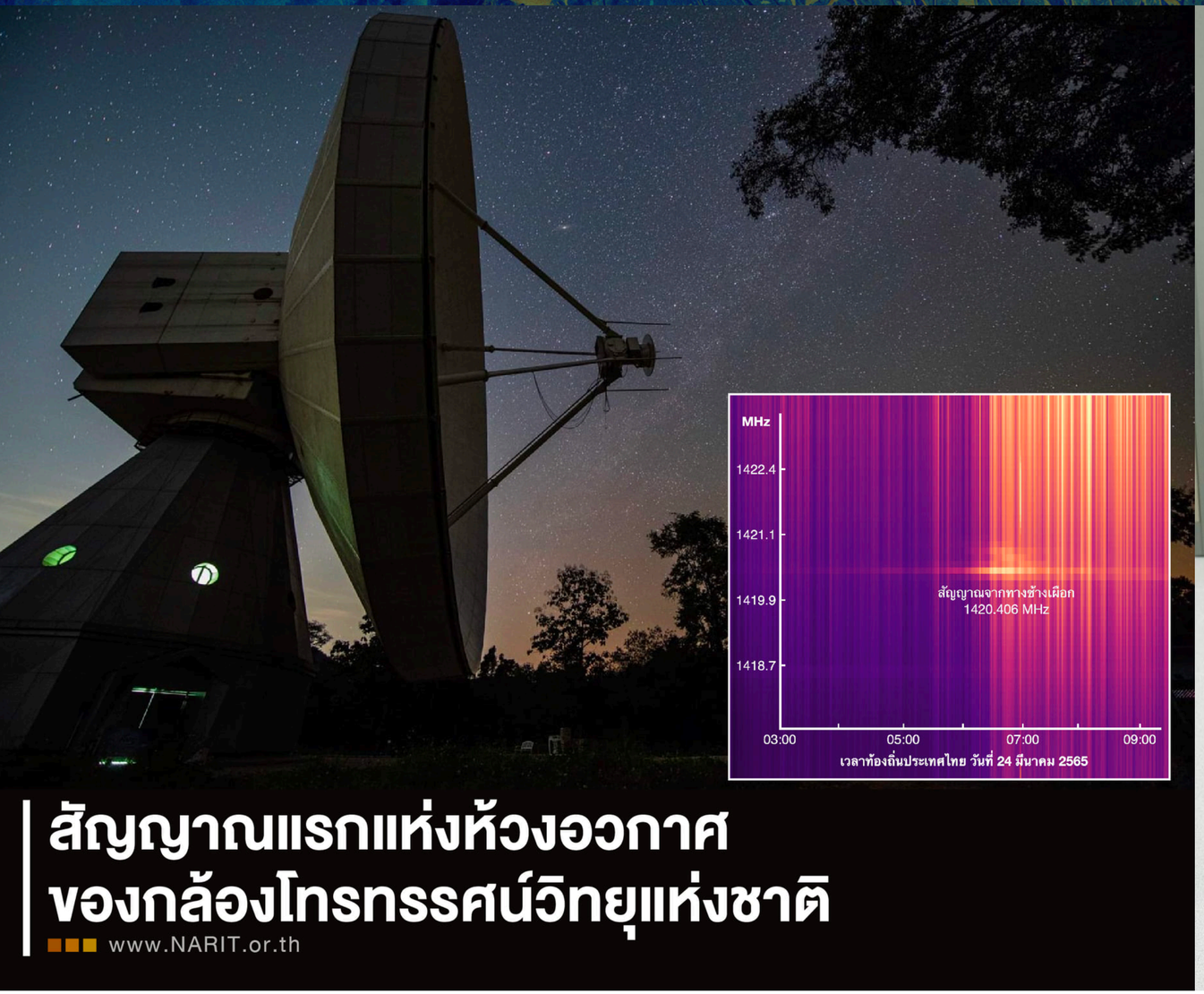
Astronomical observation in optical and radio underpins our Nation's infrastructures for Space Situational Awareness (SSA)

18 January 2024
01:50 ICT

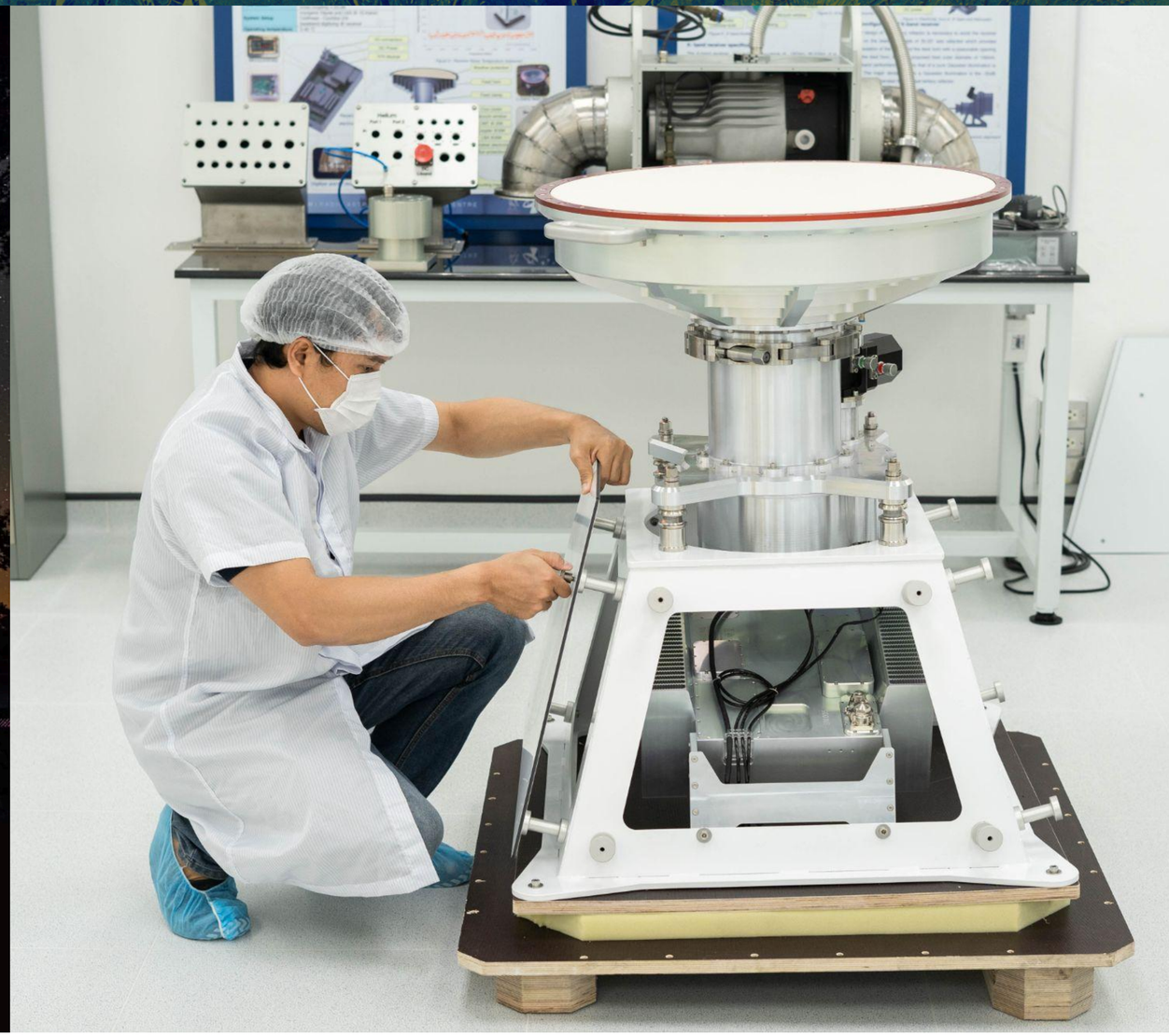
Final image of Peregrine Mission One before burning up in upper atmosphere above South Pacific Ocean

Radio astronomy as a proving ground for RF technologies and Big Data

Radio Astronomy Center — NARIT



Thai National Radio Observatory, Chiang Mai

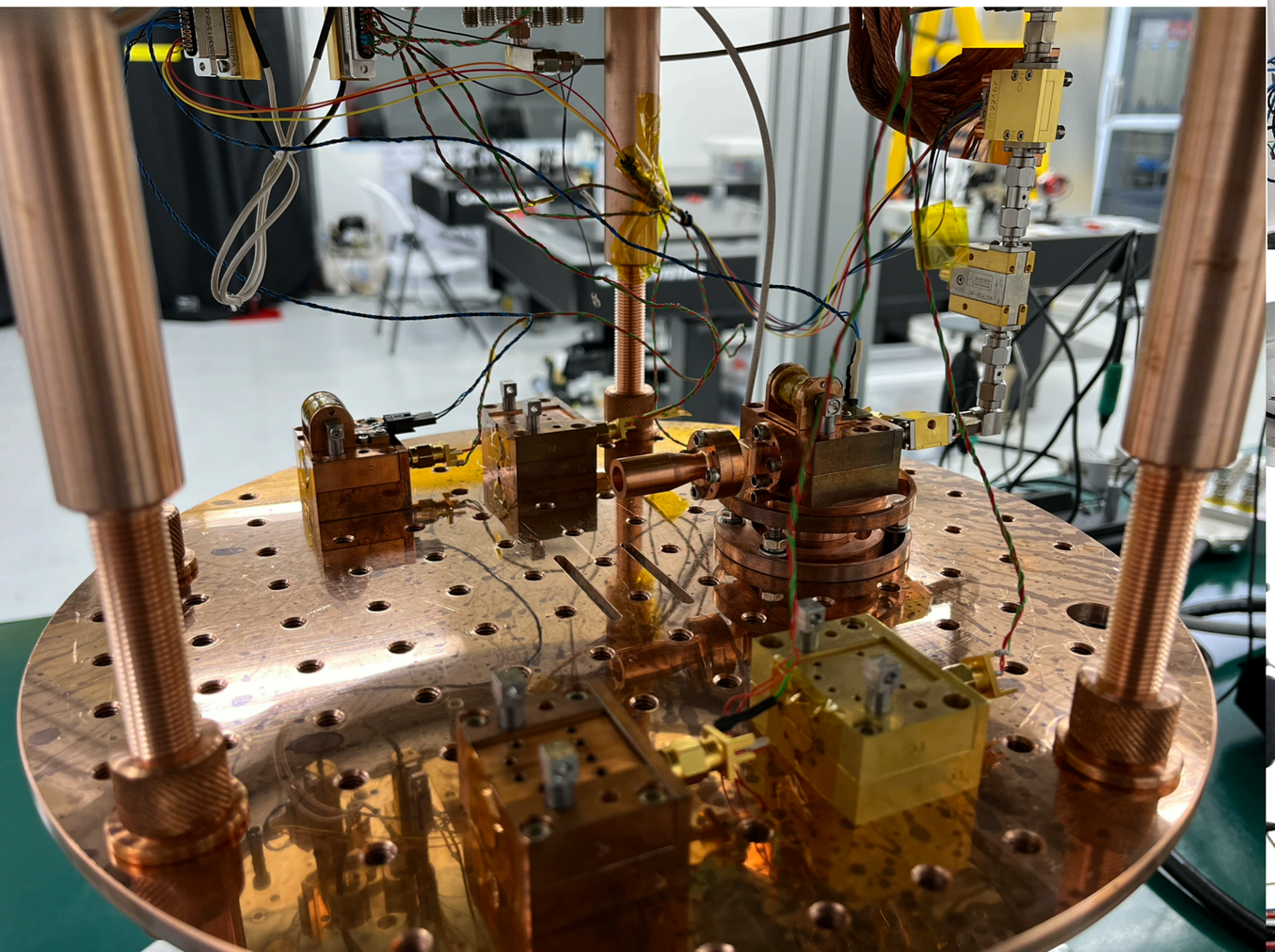


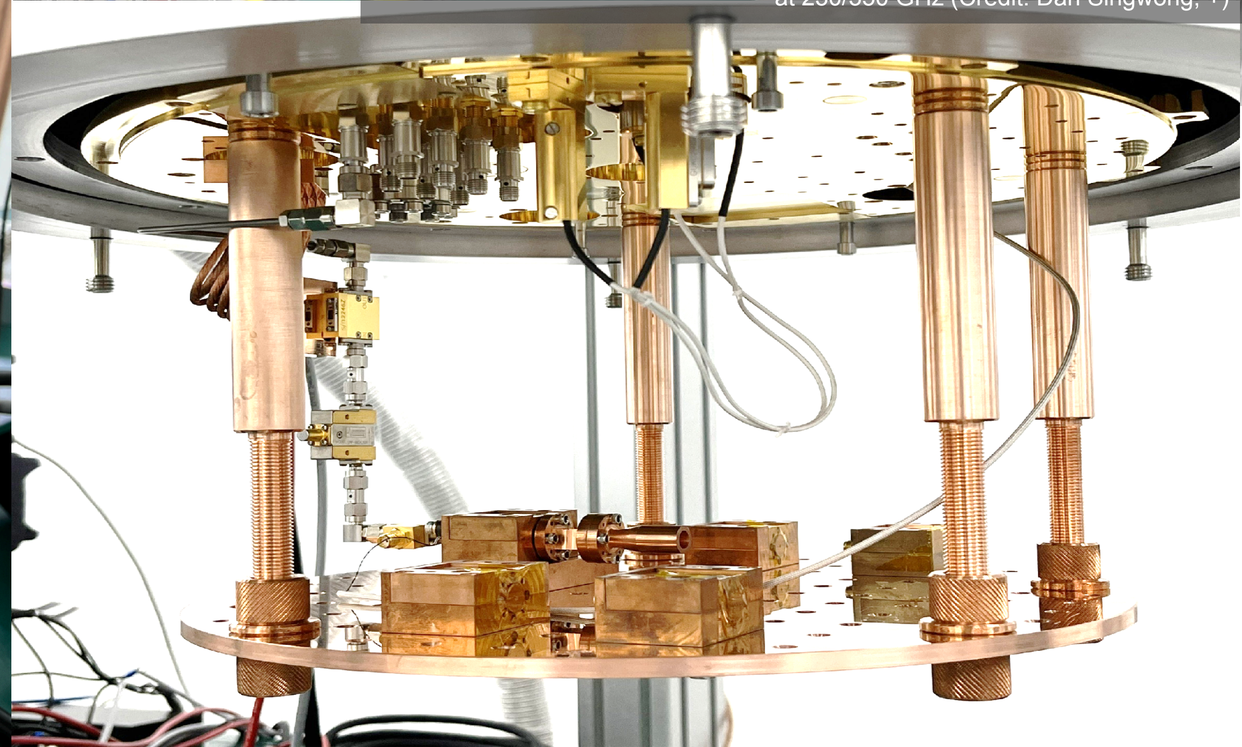
L-band Receiver at TNRO (2022)

SIS Mixer Development

Superconductor-Insulator-Superconductor Mixer receiver for next-generation THz astronomy

4K system for SIS mixer and its fabrication block at 230/350 GHz (Credit: Dan Singwong, +)



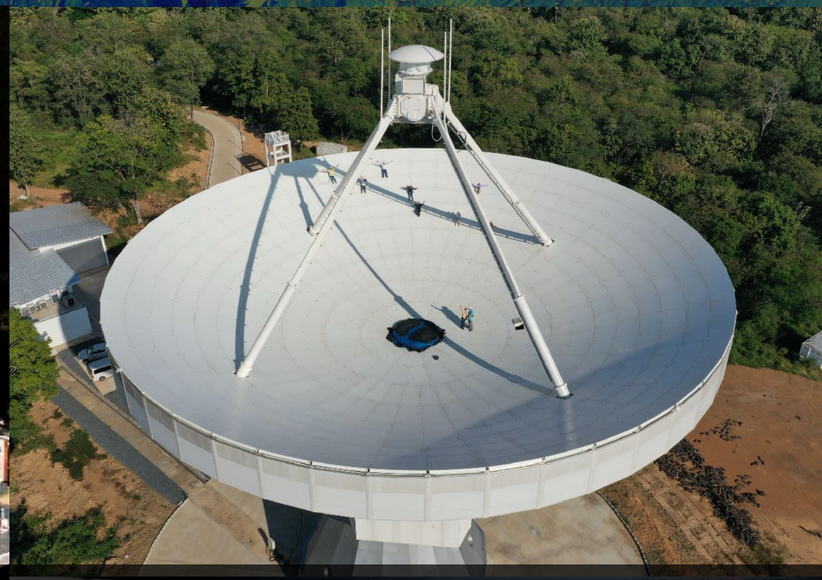


Space Technology

A natural extension of astronomical development

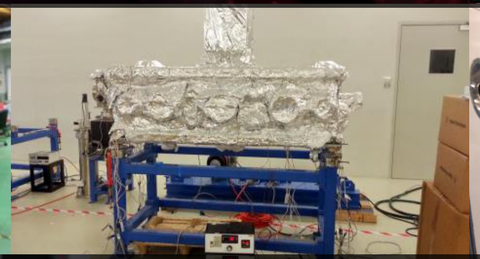
Advanced optics lab (NARIT)

Satellite AIT Facilities (GISTDA, NARIT)



40-m antenna for deep space comm and SSA (NARIT)

Thermal Vacuum Chamber



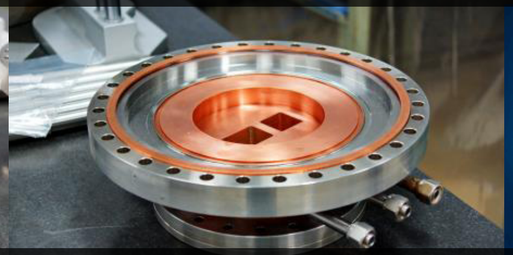
Vacuum Laboratory (SLRI)

Clean room (GISTDA/NARIT)

Ground station (GISTDA)

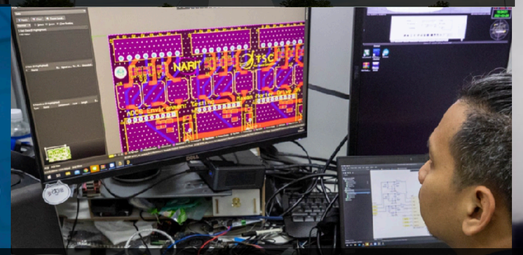
High-precision machining and 3D printing (NARIT/SLRI)

Ultra High-Vacuum Welding



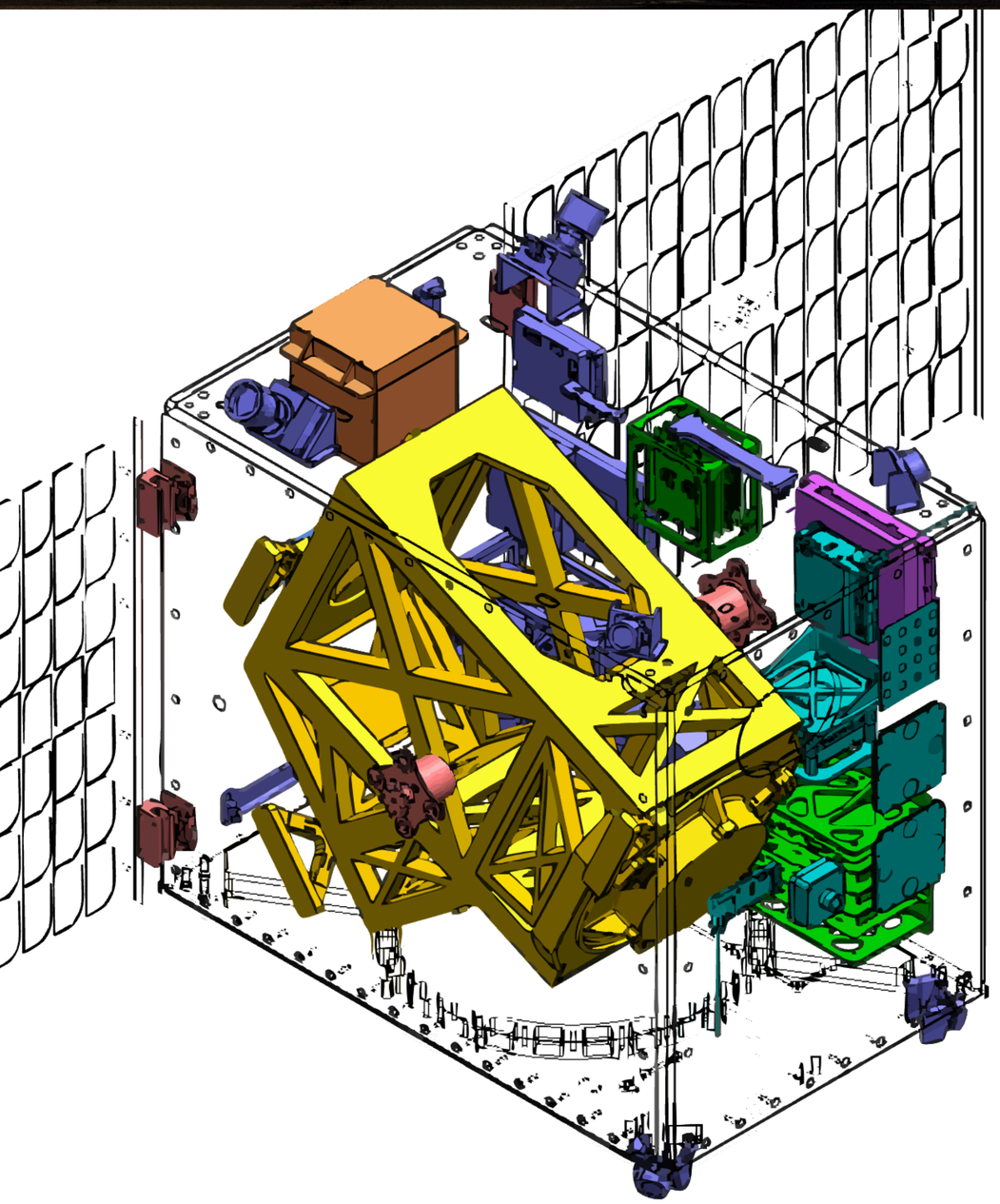
Ultra High-Vacuum Parts (SLRI)

High Performance Computers

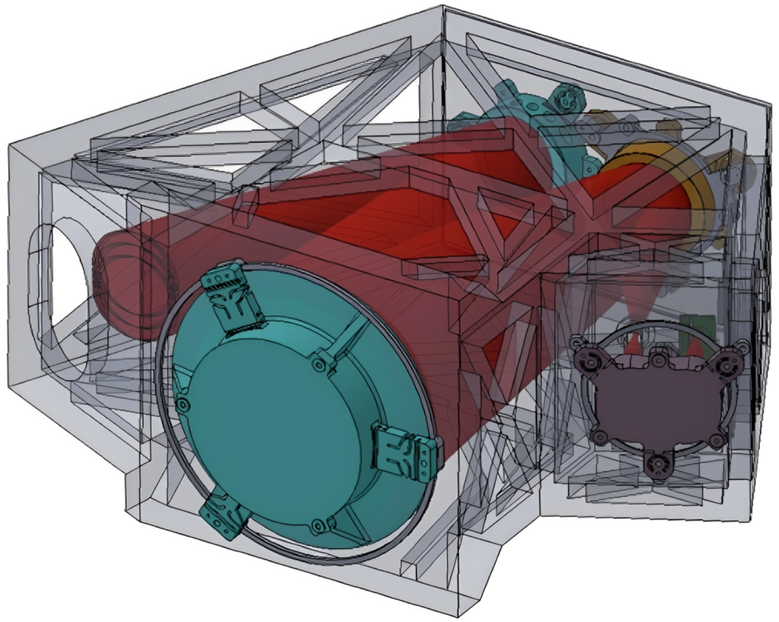


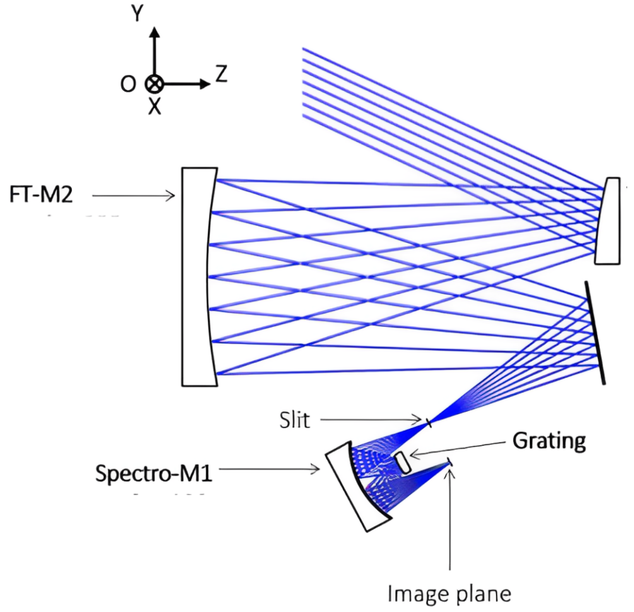
Electronics Lab (NARIT/SLRI)

First domestically-made microsatellite in Thailand, at NARIT



- Mass: ~100 kg
- SSO orbit at 500 - 600 km
- Main Payload: Hyperspectral Imaging Camera
- Science Payload: Space Weather
- Ground station in Chiang Mai
- Data transmission: X-band, S-band, UHF
- Data reception: S-band, VHF



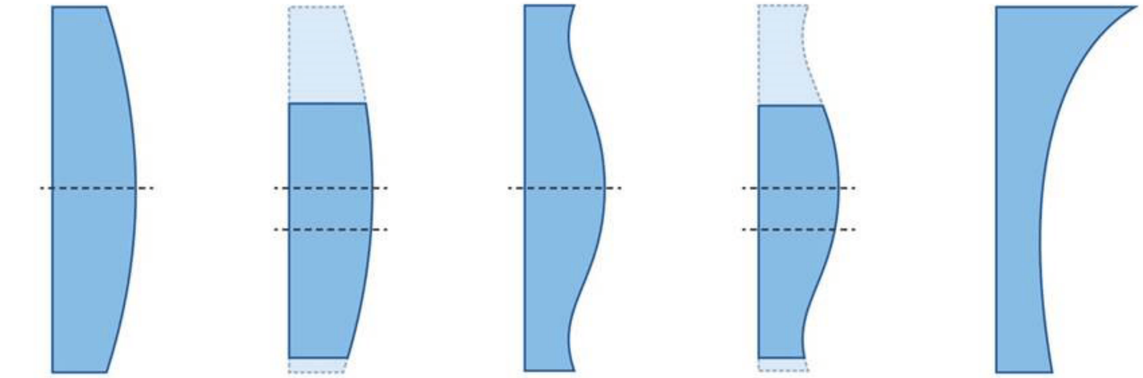


First domestically-made microsatellite in Thailand, at NARIT

Freeform Optics — a basis for space and astronomical optics

Single Point Diamond Turning - SPDT
Operational since August 2025

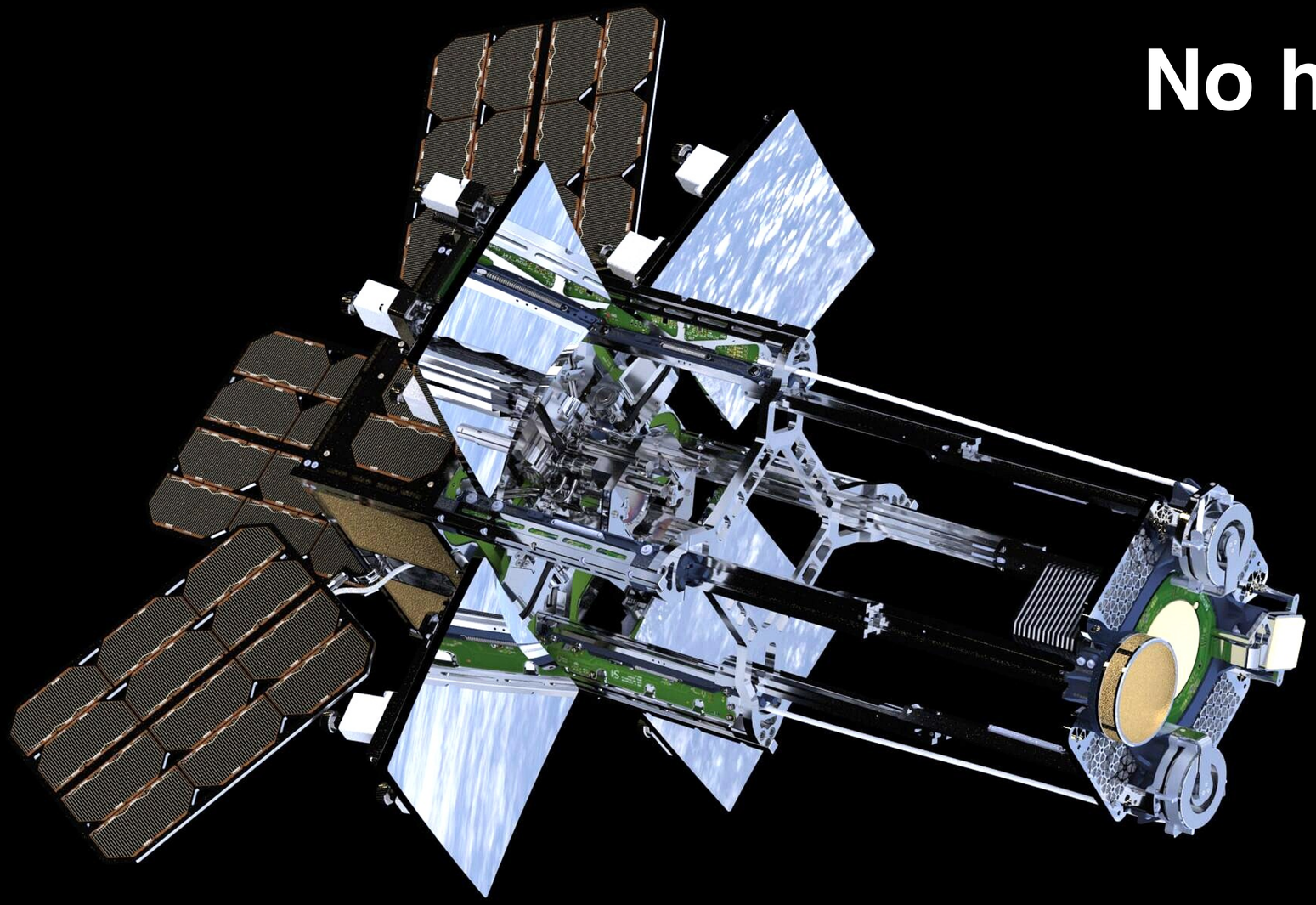
Types of Optical Surfaces
From classical (left) to the future (right)



Nanometer-precision, freeform optical surface gives rise to new era of optical manufacturing — leading to extreme compactness and performance.

Thailand will lead the SEA region in this technology with astronomical and space instrumentation as “anchor” customers. Technology transfer arrangements made with Durham University.

Ideas abound.
No heritage … yet.

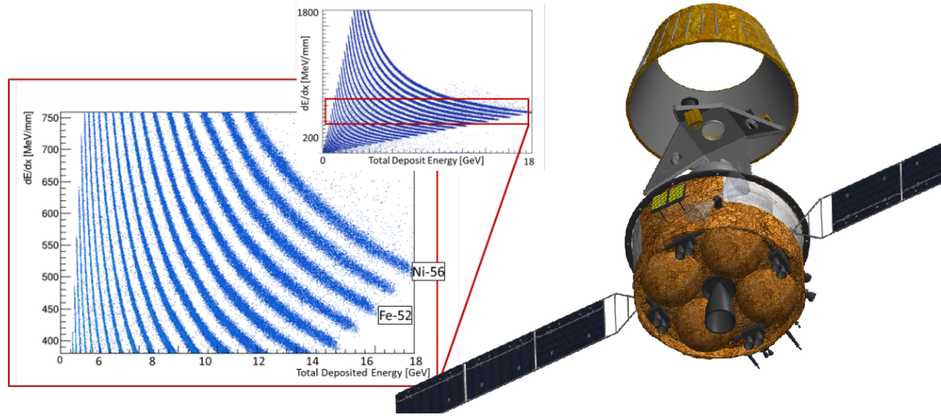


Courtesy: Supersharp (Cambridge/UK)

Sino-Thai Cooperation in Space Technology and Space Exploration

Chang'e 7 Orbiter Scientific Payload (2023 - present)

CE7 Thai Payload
Official Handover Ceremony
Beijing — 29 August 2025



Space Weather Payload sensitive to energy range of 15 MeV/nuc to 200 MeV/nuc and ion speciation from He to Ni (Z = 2 to 28)

Dr. Peerapong Torteeka
Project Manager
Control System Engineer

Prof. David John Ruffolo
Senior Payload Scientist

Shariff Manuthasna
Space System Eng.

Tanawish Masri
Aerospace Eng.

Dr. Kullapha C.
Payload Scientist

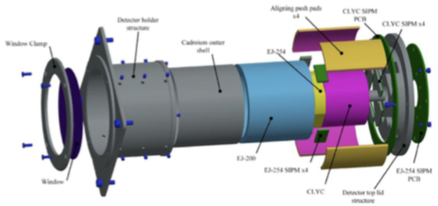
Thanayuth Panyalert
Mechanical and System Eng.

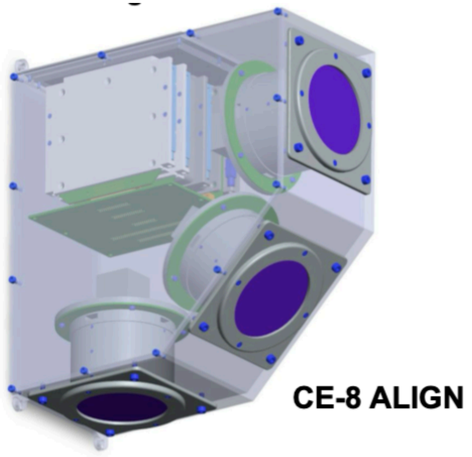
Prof. Dr Wu Yanhua
Deep Space Exploration (DSEL)

Prof. Dr Zhang Shenyi
National Space Science Center (NSSC), CAS

Sino-Thai Cooperation in Space Technology and Space Exploration

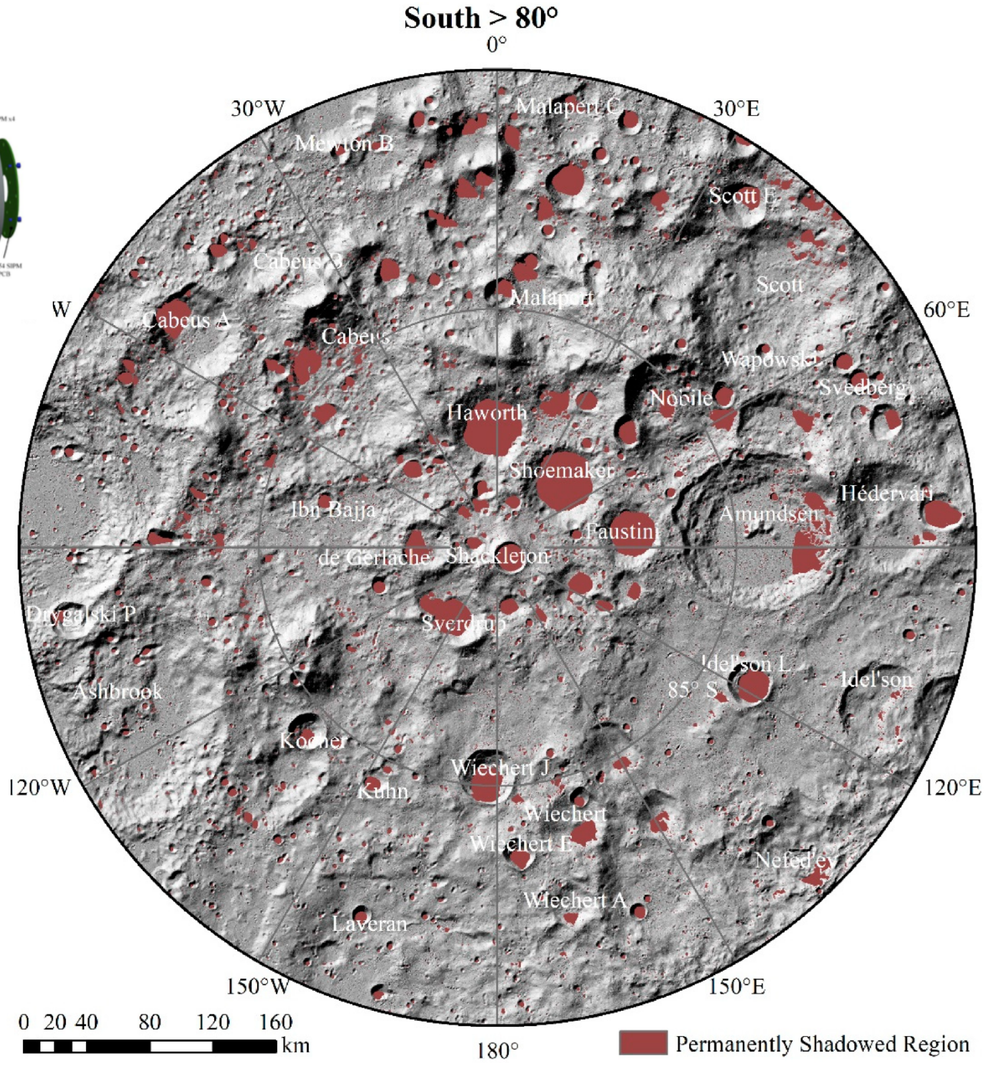
Chang'e 8 Lander Scientific Payload (2024 - present)





Chang'E 8 "ALIGN"

Thailand's scientific payload onboard the CE8 lander



Astronomy research goes hand-in-hand with localized technology development and capacity building

2009 — 2016 — 2025

RESEARCH FACILITIES AND INT'L INVOLVEMENT

Thai National telescope

Remote Robotic Telescopes

Thai robotic telescope network

The gravitational-wave optical transient observer: GOTO

Jiangmen underground neutrino observatory: JUNO

Cherenkov telescope array: CTA

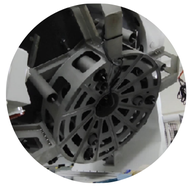
Thai National radio telescope

VLBI Global observing system: VGOS

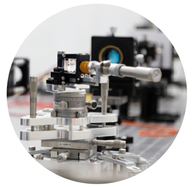
TECHNOLOGY DEVELOPMENT

Thai Robotic Telescope Network control system

Mirror coating machine

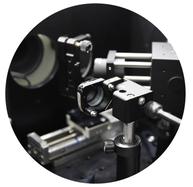


2.4 m Telescope control system



EvWaCo

EXOhSPEC



Low-resolution spectrograph

Radio Receivers

Investment in astronomy is an investment in technology.

Astronomy Outreach, Public Engagement and Communications

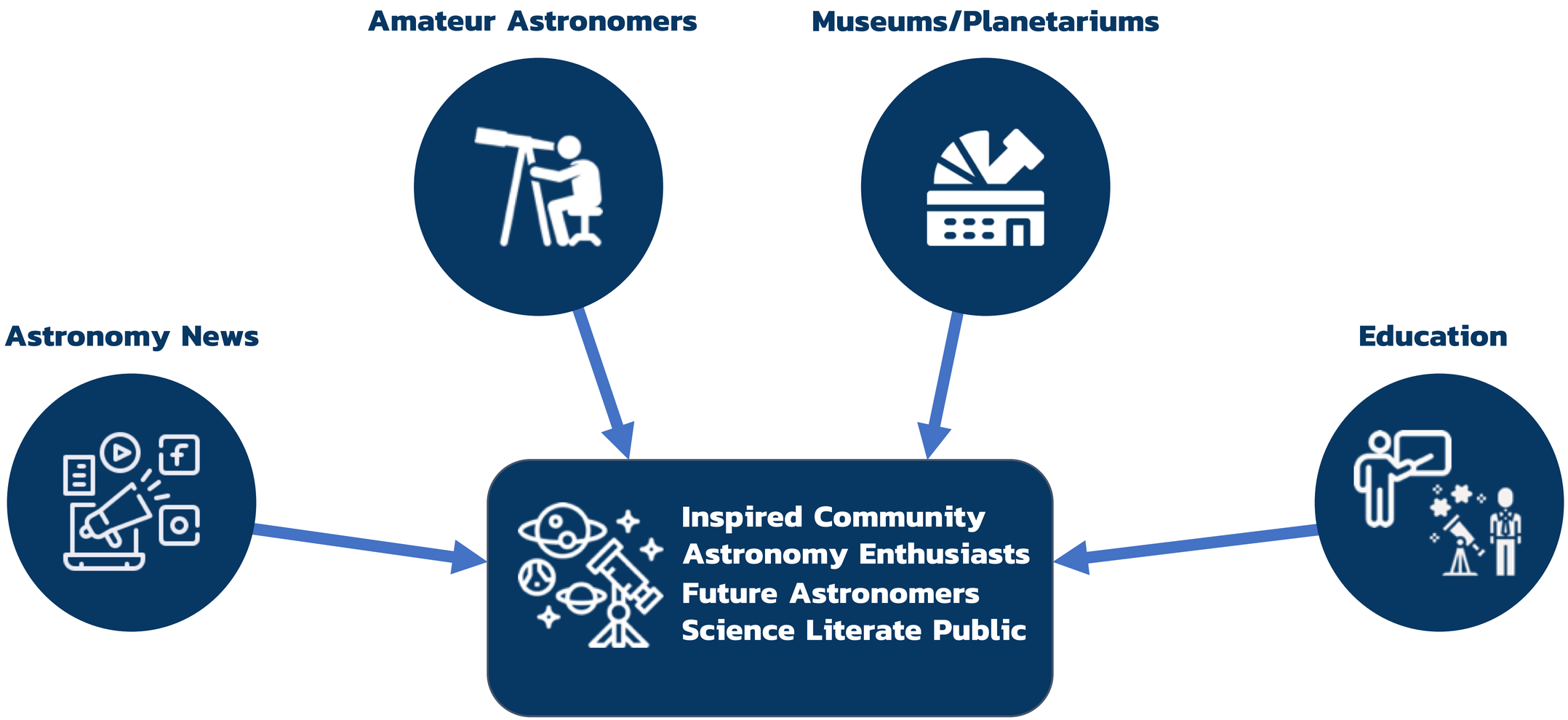
NATIONAL ASTRONOMICAL RESEARCH INSTITUTE OF THAILAND
(NARIT)

Astronomy Outreach, Development and Education (ODE) Prizes

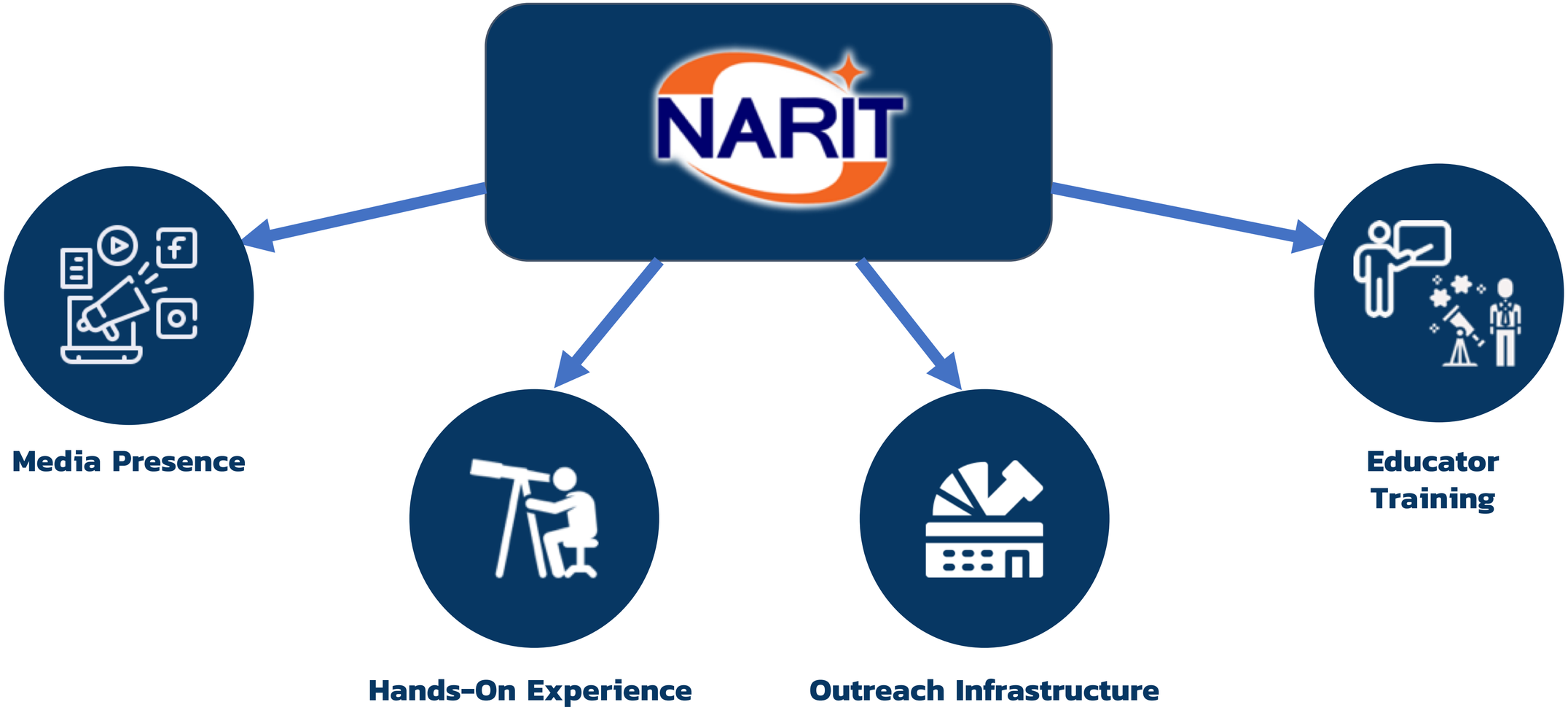
IAU XXXII General Assembly (IAUGA2024)
August 6, 2024, Cape Town, South Africa

2024 ODE Outreach Prize

“Bottoms-Up” Approach



“Top-Down” Approach



Credit: Jurik Peter
กล้องโทรทรรศน์อวกาศเจมส์ เว็บบ์
กับการค้นหาสิ่งมีชีวิตนอกโลก
www.NARIT.or.th

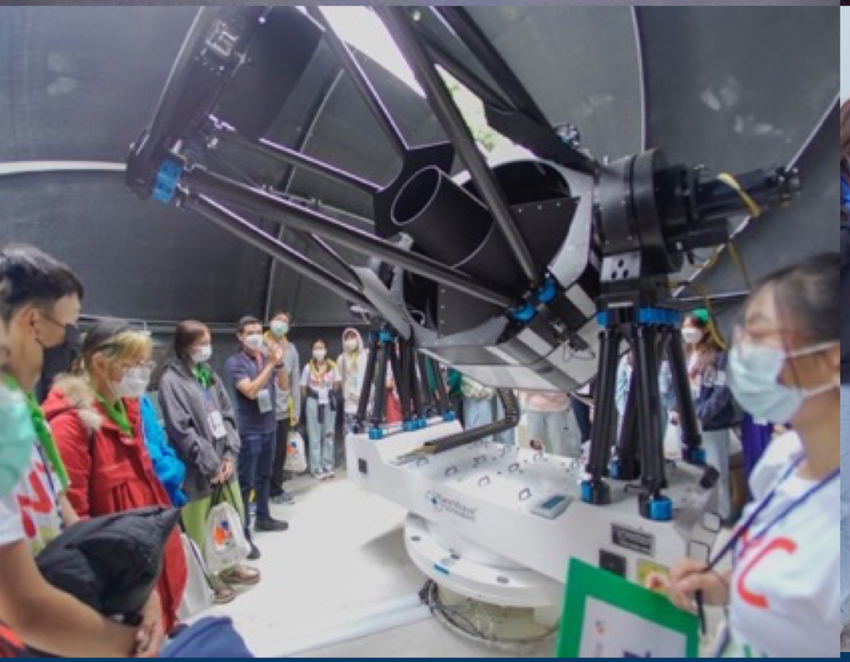
BREAKING NEWS
2 ทุ่ม คืนนี้! เกาะติดการแถลงข่าว
ผลงานการค้นพบสำคัญของเครือข่ายกล้องโทรทรรศน์ EHT
เกี่ยวกับกาแล็กซีทางช้างเผือก ที่นี่ NARITpage

ดาวเนปจูนกำลังเย็นลง
แม้จะย่างเข้าสู่ฤดูร้อน
www.NARIT.or.th
ภาพ : NASA/JPL-Caltech/Kevin M. Gill

เนบิวลาหัวม้าและเนบิวลาเปลวเพลิง
www.NARIT.or.th

สภาพของฝาหลังและร่มชูชีพที่นำยานเพอร์เซเวียแรนส์
ลงจอดบนดาวอังคารอย่างปลอดภัย
www.NARIT.or.th
ภาพ : NASA/JPL-Caltech

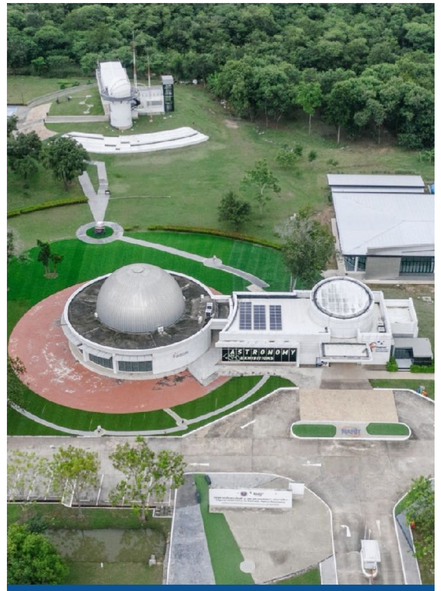
สุริยุปราคา
ปรากฏการณ์ความงามใต้เงาจันทร์
www.NARIT.or.th



Hands-On Experience

OUTREACH INFRASTRUCTURE

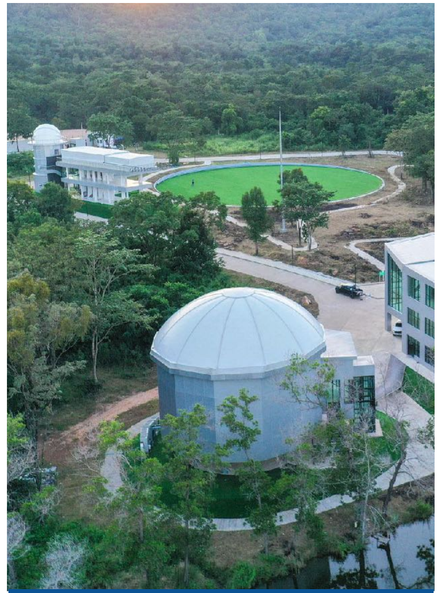
Princess Sirindhorn AstroPark
(2020)



ROP Nakhon Ratchasima
(2014)

ROP Chachoengsao
(2018)

ROP Songkhla
(2019)



ROP Khon Kaen
(2024)

~2027

Thai National Observatory

Phitsanulok
Regional Observatory for the Public

Princess Sirindhorn AstroPark

Khon Kaen
Regional Observatory for the Public

Chiang Mai

TNRO
Thai National
Radio Astronomy
Observatory

Nakhon Ratchasima
Regional Observatory for the Public

Chachoengsao
Regional Observatory for the Public

Songkhla
Regional Observatory for the Public

Nakhon Si Thammarat
VGOS Station

⌀ 2.4 meters ⌀ 1 meters ⌀ 0.7 meters ⌀ 0.4 meters ⌀ 40 meters ⌀ 13 meters

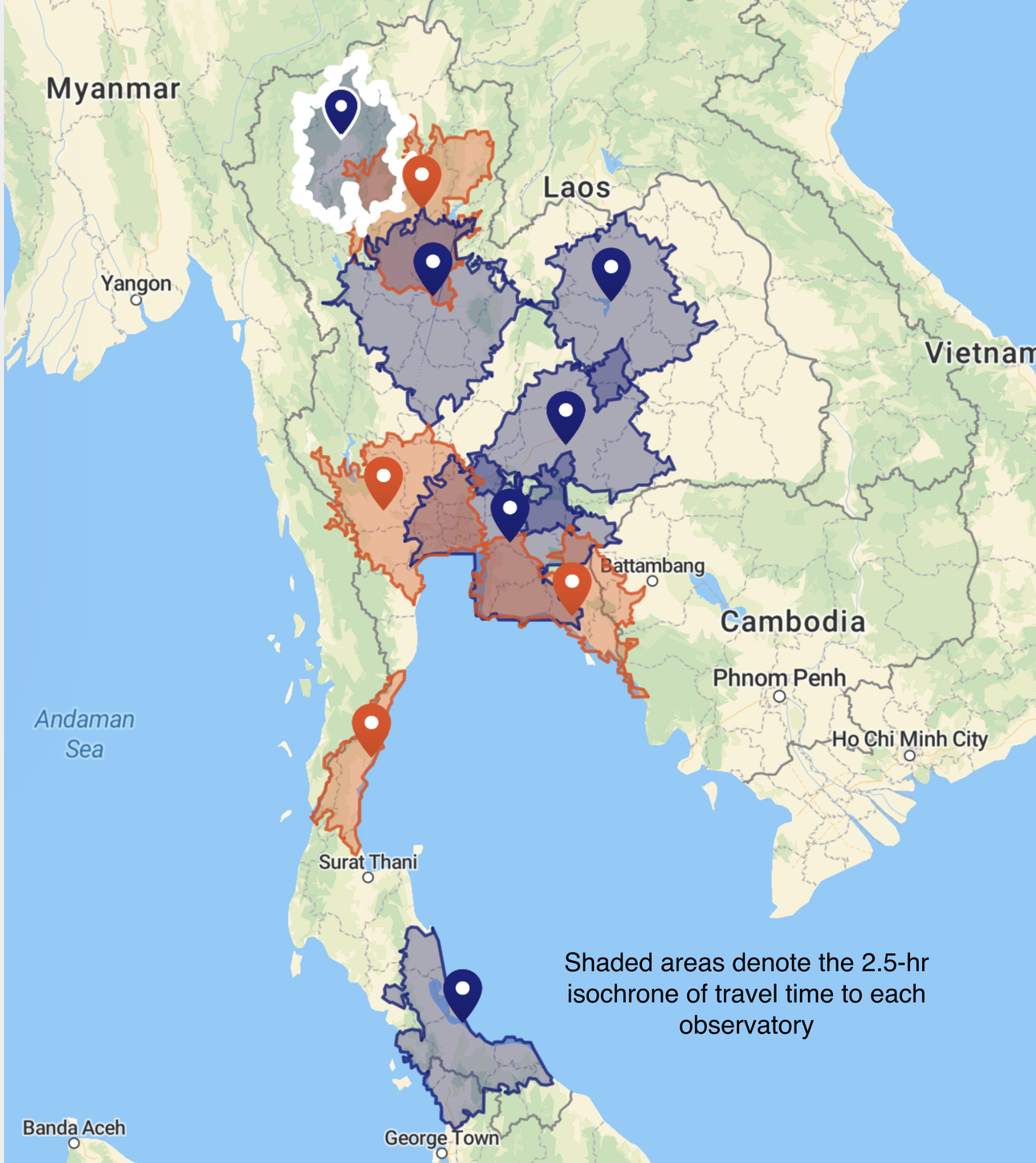
Regional Observatory for the public

Regional Observatories — Phase I

- Nakhon Ratchasima
- Chachoengsao
- Songkla
- Khon Khen
- Pitsanolok

Regional Observatories — Phase II
(Under Construction)

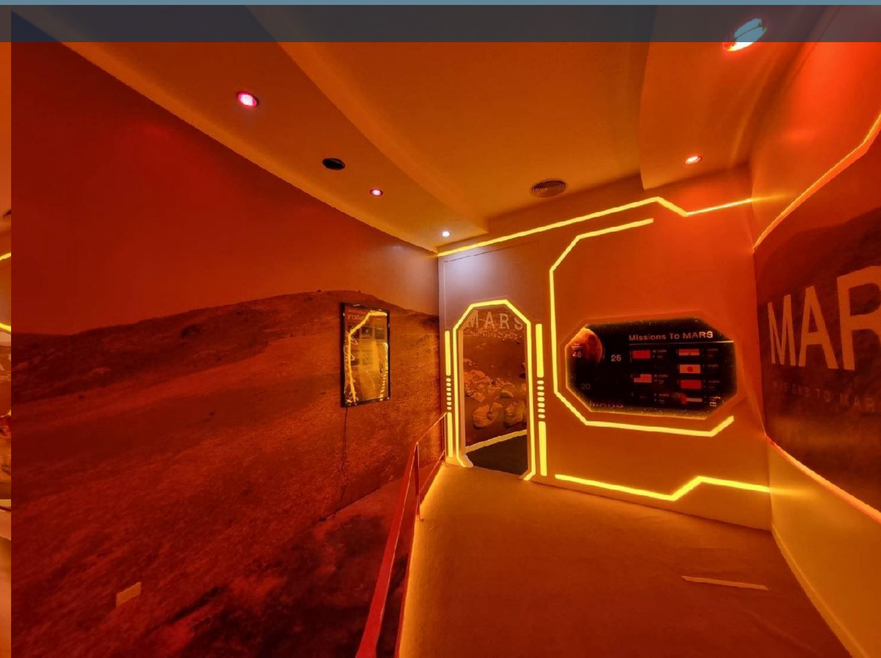
- Prae
- Kanchanaburi
- Chanthaburi
- Chumphon



Basic Astronomy

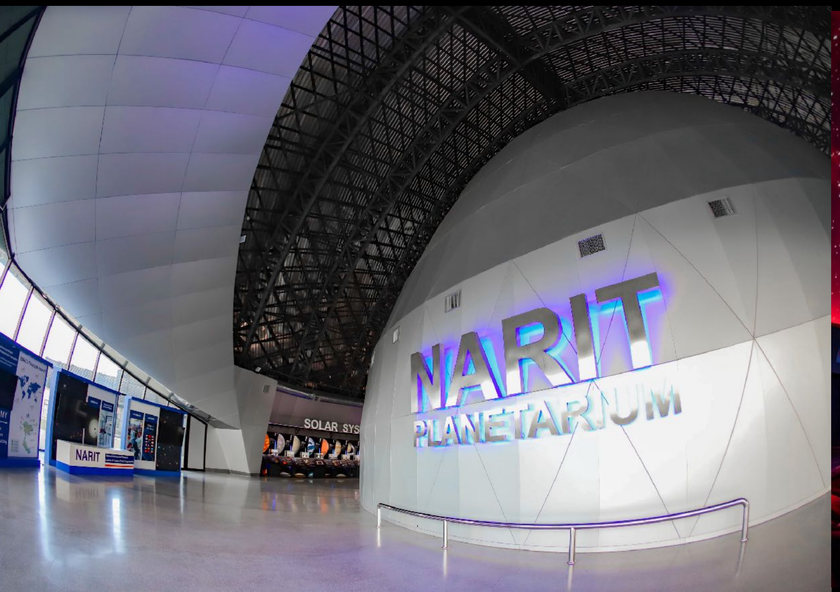
Astronomy Insight

Space Exploration



Planetarium

Fulldome digital: max 8K
Diameter: 10**, 12,** 17 m.
Seats: 49**-**161 + accessible seats



Public Night
Every Saturday Night
(Free of charge)

Planetarium & Exhibition

(October 2022 - September 2023)

PLANETARIUM

Total: **191,547**

Showtime: 3,654

Average per showtime: 106/ 31

Total income : 6,872,540

148,585

77.6%

42,962

22.4%

EXHIBITION

Total: 370,289

Day: 314

Average per day: 1,179

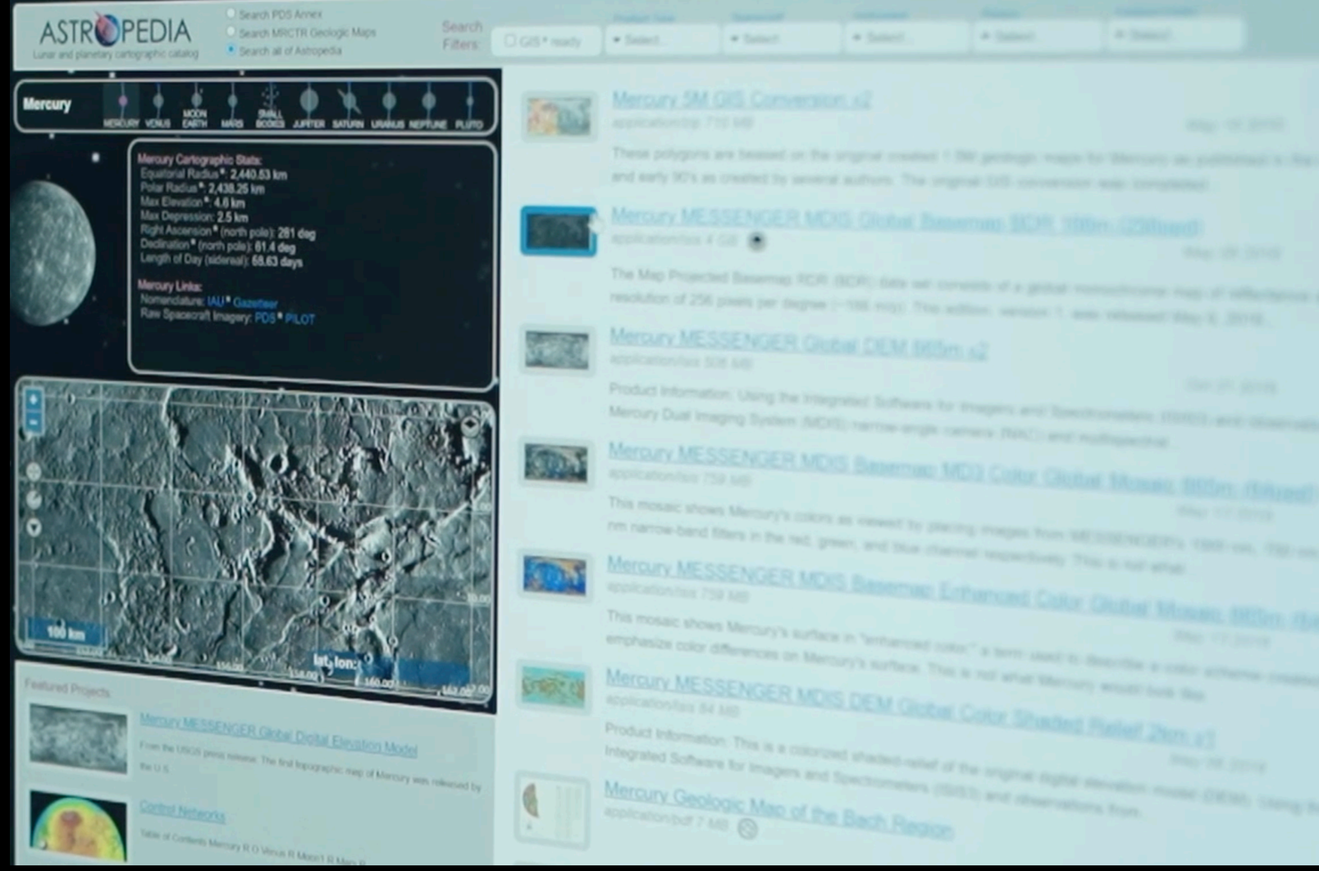
SCHOOL

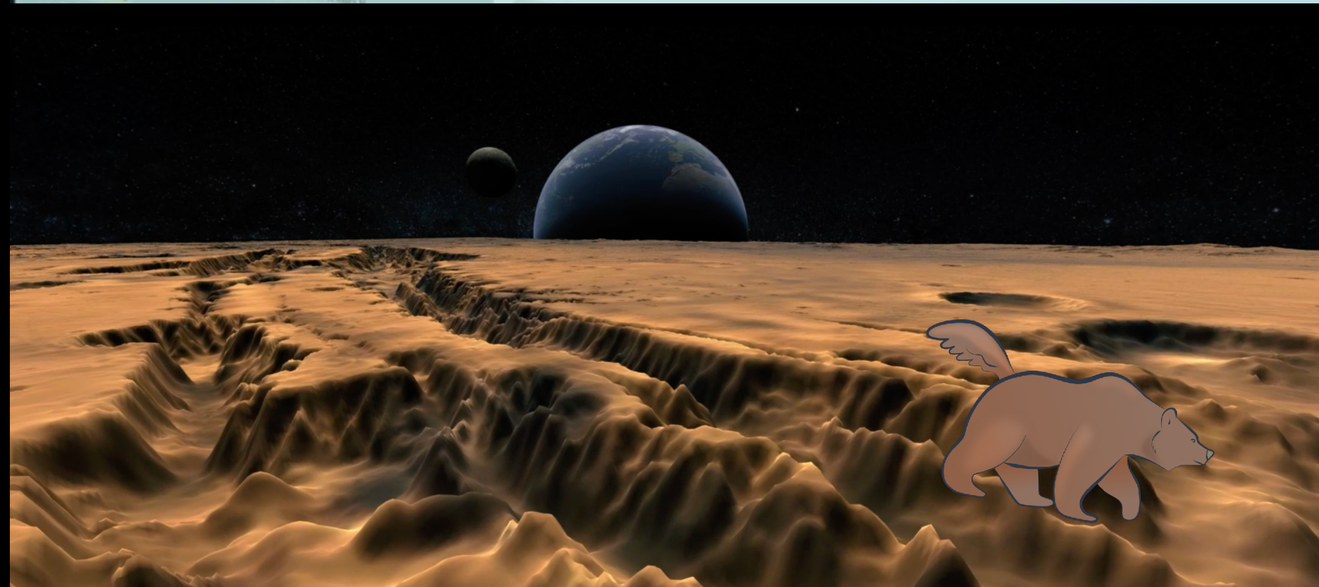
Total: 2,249

Average per day: 7

Planetarium Software Development

System: Unity Game Engine
Database: HIPPARCOS Catalog, NASA
Software development: In-house crafted by NARIT's astronomers and programmers
Deep Sky Objects: Taken from Thai Robotic Telescopes
Constellation Arts: Thai traditional constellations





Planetarium Software Development

System: Unity Game Engine
Database: HIPPARCOS Catalog, NASA
Deep Sky Objects: Taken from Thai Robotic Telescopes
Constellation Arts: Thai traditional constellations

NAPA - Star Map

Download on the App Store

GET IT ON Google Play

Public Night

(October 2023 - September 2024)

54,841 participants

231 nights

avg. **237** participants/ night

	CMI	NMA	CCO	SKA	KKN
Average/ day	**450**	**156**	**136**	**182**	**167**

Every Saturday Night 06:00 - 10:00 p.m
(CMI: November to May)

ASTRONOMY Outreach and Public Engagement

by the numbers

1,613,116

(> 50% girls!)

2024 participants

60

Full-time Outreach
+ support staffs

8%

Of NARIT's
annual budget

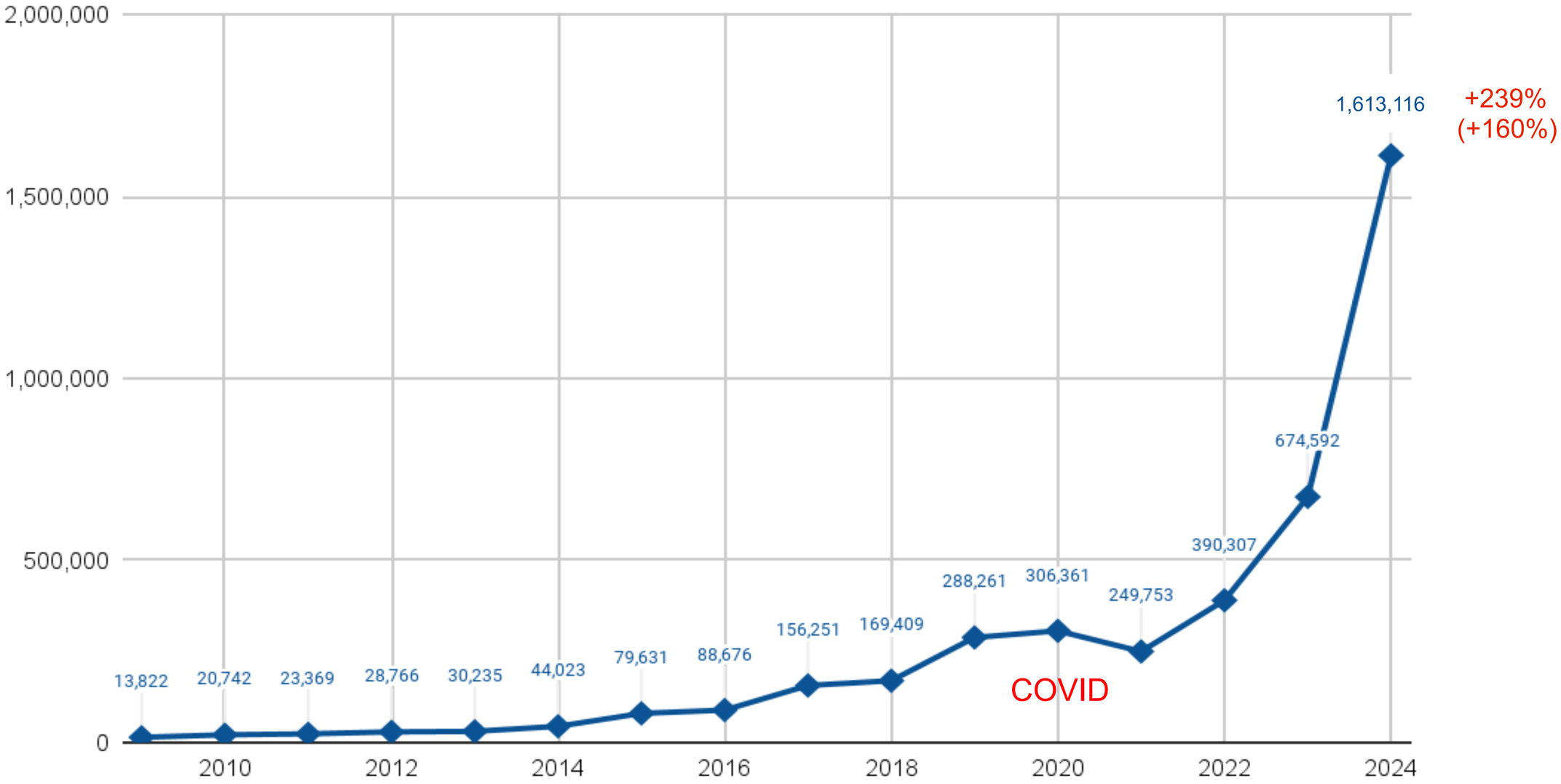
5

Regional
Observatories
For the public
+ Astropark

$1

Cost per capita

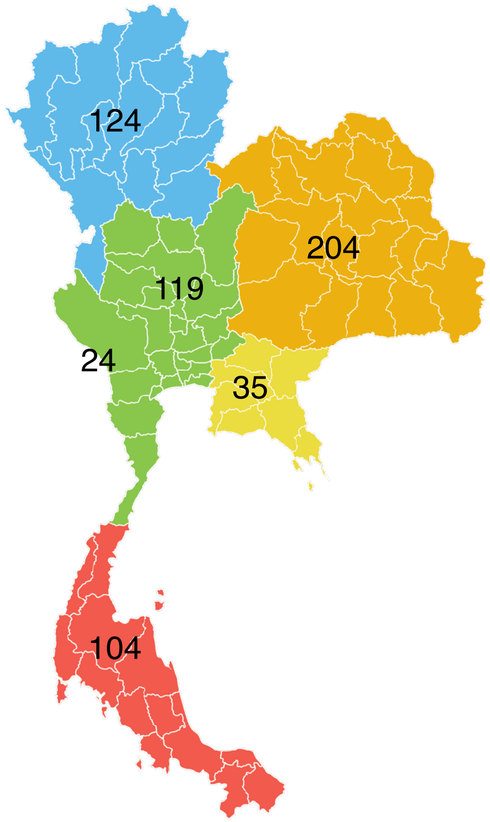
NARIT's overall Public Engagement across all activities



Becoming NARIT STAFF & Astronomy path

Astronomy Teacher Training and Workshop

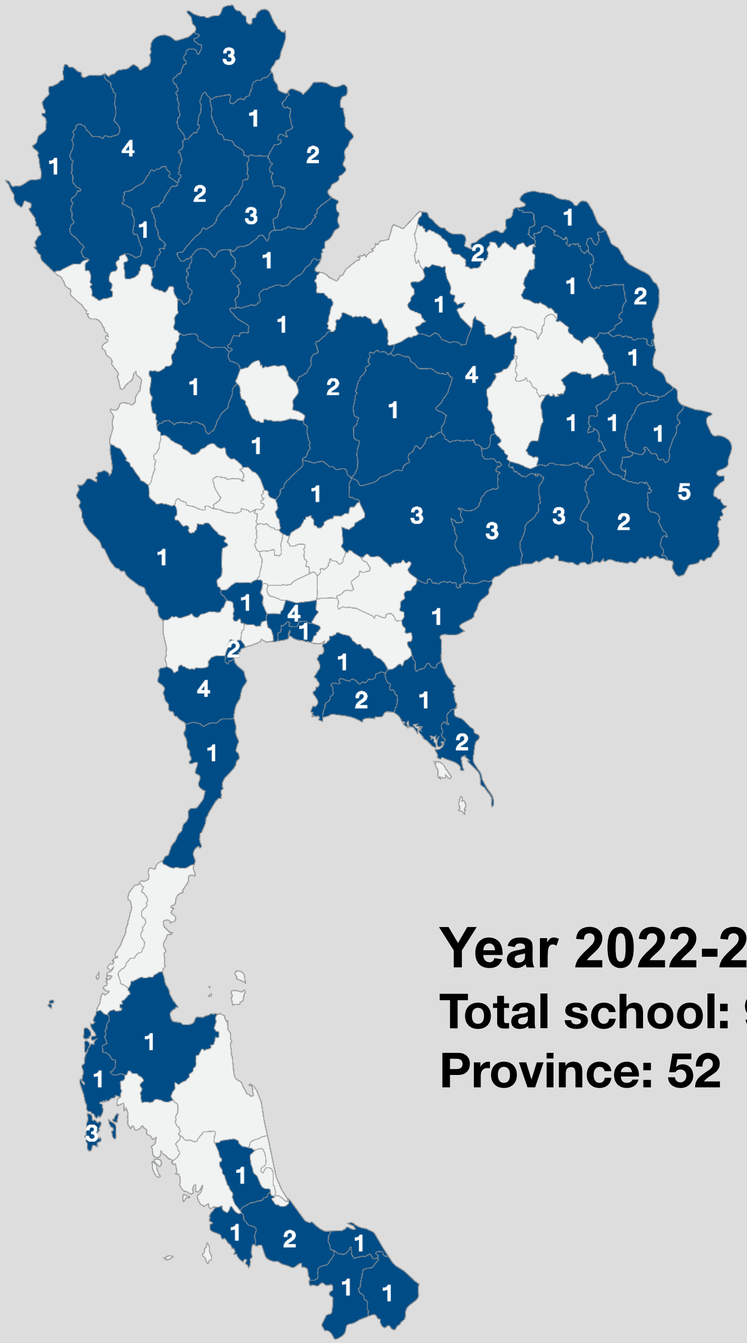
Astronomy Learning Opportunity Dobsonion School Project



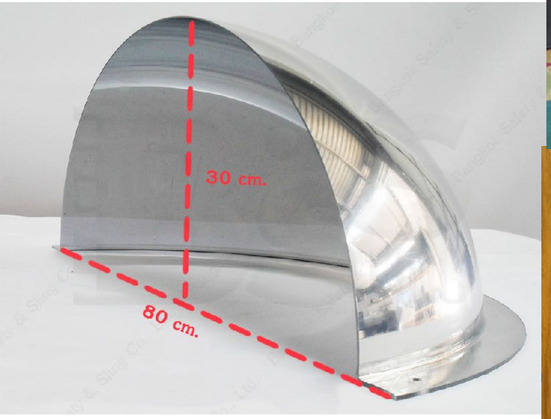
60 พรรษา
เจ้าฟ้านักดาราศาสตร์
Commemoration of the 60th Birthday of the Princess of Astronomy

Year 2015 — present
Total school: 710
Province: 77
Average per province: 8
Output: > 1,000 activities per year

DIY Planetarium Dome for school



Year 2022-2023:
Total school: 90
Province: 52



โดมท้องฟ้าจำลองที่ประกอบเสร็จแล้ว

Amazing Dark Sky in Thailand

Raises public awareness on the impact of light pollution and conserve the dark sky via establishing “Dark Sky Preserve” and public awareness campaign

Dark Sky Preserve

Dark Sky Community

Private Dark Sky Preserve

Suburban Dark Sky Preserve

64

Dark Sky Area
(2022-2025)

Starry
Night
over Bangkok
2024
ดูดาวกลางกรุง
07.12.2024
Participants
35,653

United Nations
Educational, Scientific and
Cultural Organization

ITCA

International Training
Centre in Astronomy
under the auspices of UNESCO

IAU

SEA-ROAD

International
Astronomical
Union

Southeast Asian
Regional Office of
Astronomy
for Development

SEA-PEO

2024

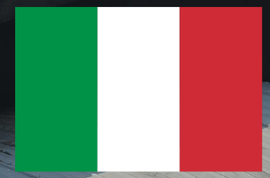
Southeast Asia Planetarium, Education and Outreach Conference

การประชุมแลกเปลี่ยนเรียนรู้ด้านดาราศาสตร์ ท้องฟ้าจำลอง การศึกษา และการสื่อสารดาราศาสตร์ ระดับนานาชาติ
ครั้งแรกในภูมิภาคเอเชียตะวันออกเฉียงใต้

25-28 November 2024

Princess Sirindhorn AstroPark, Chiang Mai, Thailand

Participants from over 24 Countries



Southeast Asia: 183 + 48

Outside Southeast Asia: 21

K-12 ASTRO ASIA 2025

K-12 ASTRONOMY EDUCATION CONFERENCE IN ASIA

1-4 SEPTEMBER 2025

VENUE: Princess Sirindhorn AstroPark, Chiang Mai, Thailand

CONFERENCE TOPICS

- Astronomy Curriculum
- Classroom Activities
- Informal Astronomy Education
- Accessibility, Diversity, Equity, and Inclusion in Astronomy Education
- Extracurricular Astronomy Activities
- Teacher Training

PARTICIPANTS

- Astronomy Teachers
- Astronomy Educators
- Public Outreach Personnels

ABSTRACT SUBMISSION PERIOD:
2 April - 31 May 2025

ANNOUNCEMENT OF ABSTRACT SELECTION:
1 July 2025

PARTICIPATION CONFIRMATION DEADLINE:
15 July 2025

REGISTRATION DEADLINE:
31 July 2025

FINAL PROGRAM ANNOUNCEMENT:
15 August 2025

CONFERENCE DATES:
1-4 September 2025

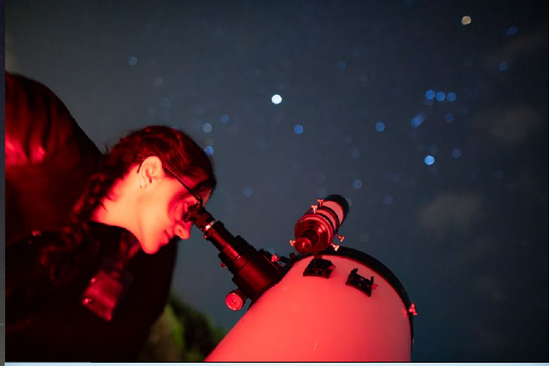
APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER

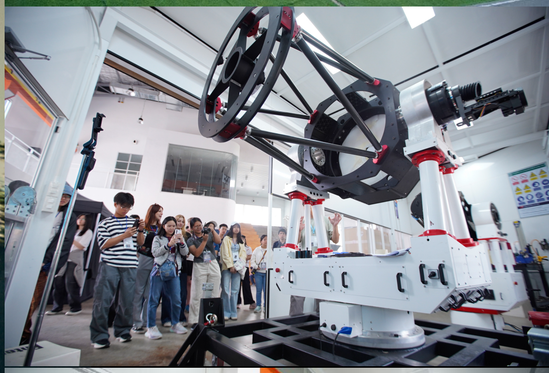
No Registration Fee Required

More details > https://indico.narit.or.th/e/K-12AstroAsia

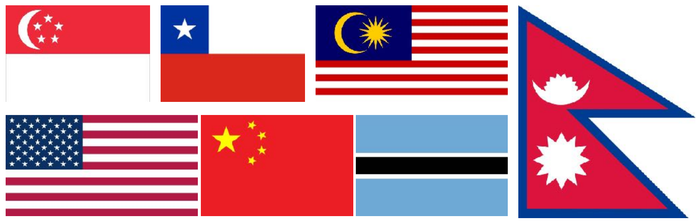
k-12astroasia@narit.or.th

ASEAN ASTRONOMY CAMP





Outreach: International Collaborations



14 organizations

Singapore
Science Center

Botswana

Singapore S&T
School

Malaysia

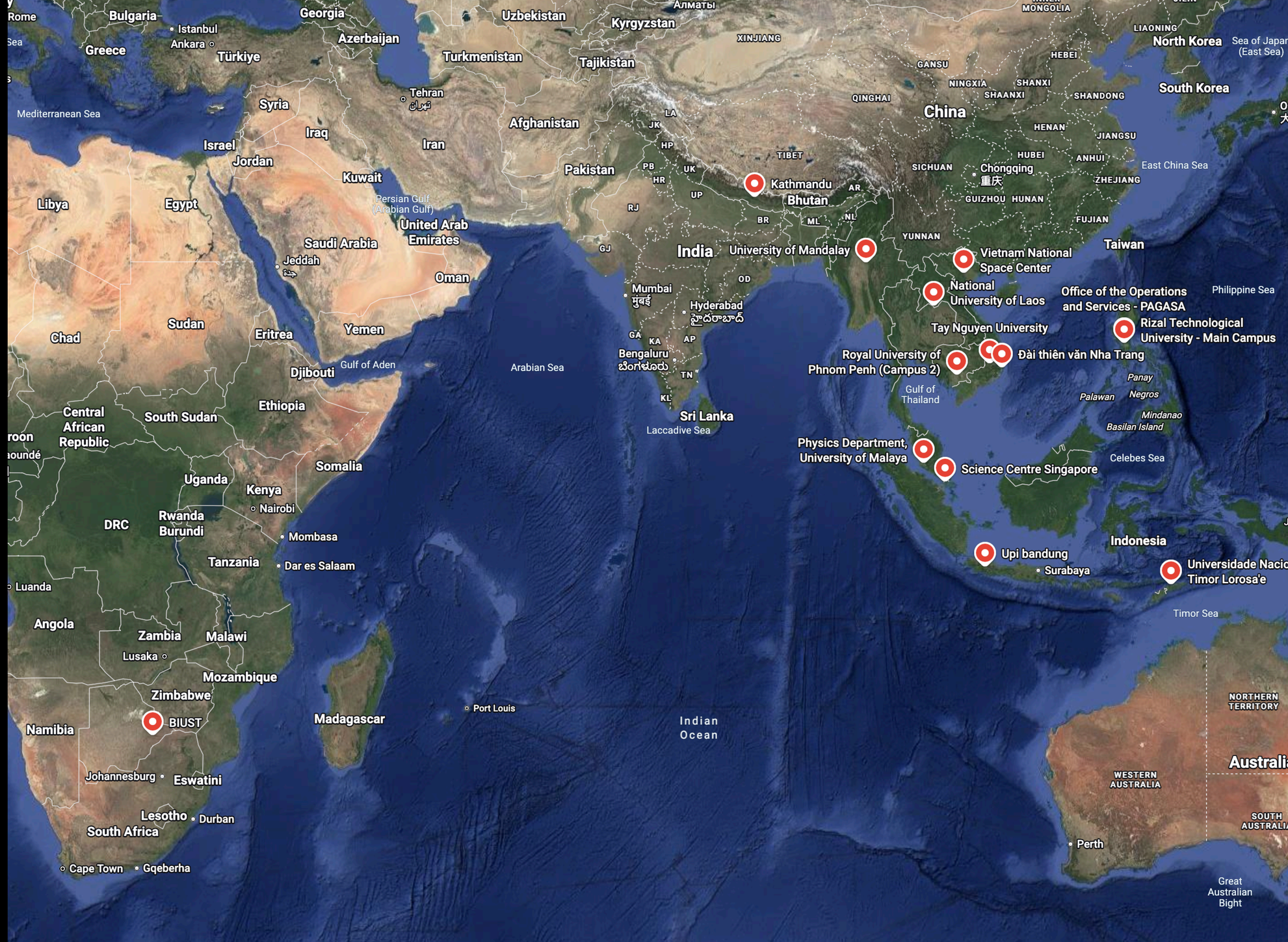
Fulbright USA

United Nations Educational, Scientific and Cultural Organization

ITCA

ITCA Teacher Training Workshop Series (2017 - 2025)

Visited



BIUST staff training
August 2024
Palapye, Botswana

Outreach at local school
August 2024
Gabarone, Botswana

Botswana World Space Week
Gabarone, Botswana
October 2025

- Visiting Institution: BIUST SKA/AVN Team
- Host: National Astronomical Research Institute of Thailand (NARIT)
- Duration: 1 Oct – 29 Dec 2025

Objectives of the Visit

- Observe radio observatory operations
- Learn radio telescope subsystems
- Understand science commissioning processes
- Observe scientific research activities
- Study inter-team coordination
- Gain outreach experience
- Identify transferable practices for BIUST

ITCA Internship

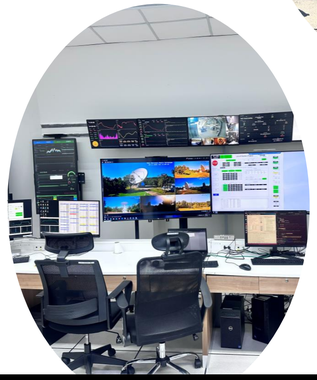
- ~ 3 months internship
- Researcher or engineer position

Public Stargazing Outreach

- Starry Night in Chiang Mai
- Telescope setup in public spaces
- Sky narration and public engagement
- Objects observed: Saturn, M15, M42, Betelgeuse, Galaxies

Radio Telescope Subsystems

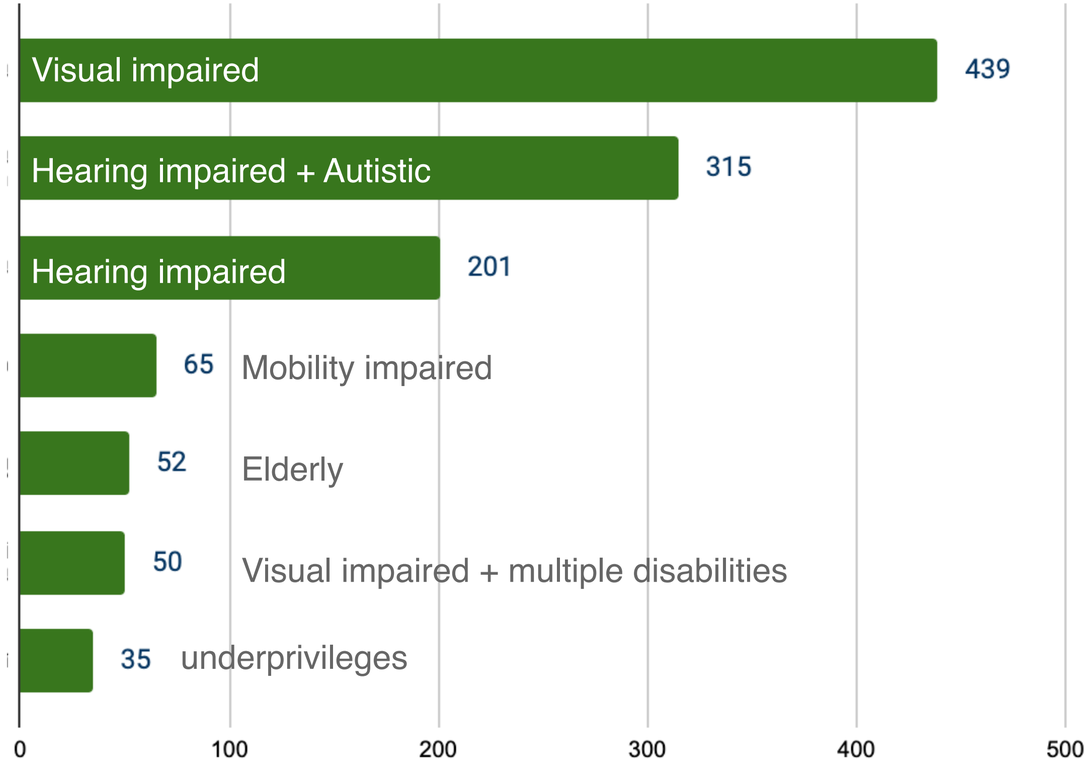
- Antenna & mechanical systems
- Receivers & front-end electronics
- Back-end signal chain
- Control software
- Data storage & processing
- RFI analysis and mitigation



Astrotourism Workshop
16-17 March 2026
Maun, Botswana

INCLUSIVE OUTREACH PROGRAM

19
Activities

1,157
Participants

“Astronomy Leaves No One Behind”