An effective hands-on training framework under the THEOS-2 Small Satellite KHTT Program By Developing a Satellite Qualification Model

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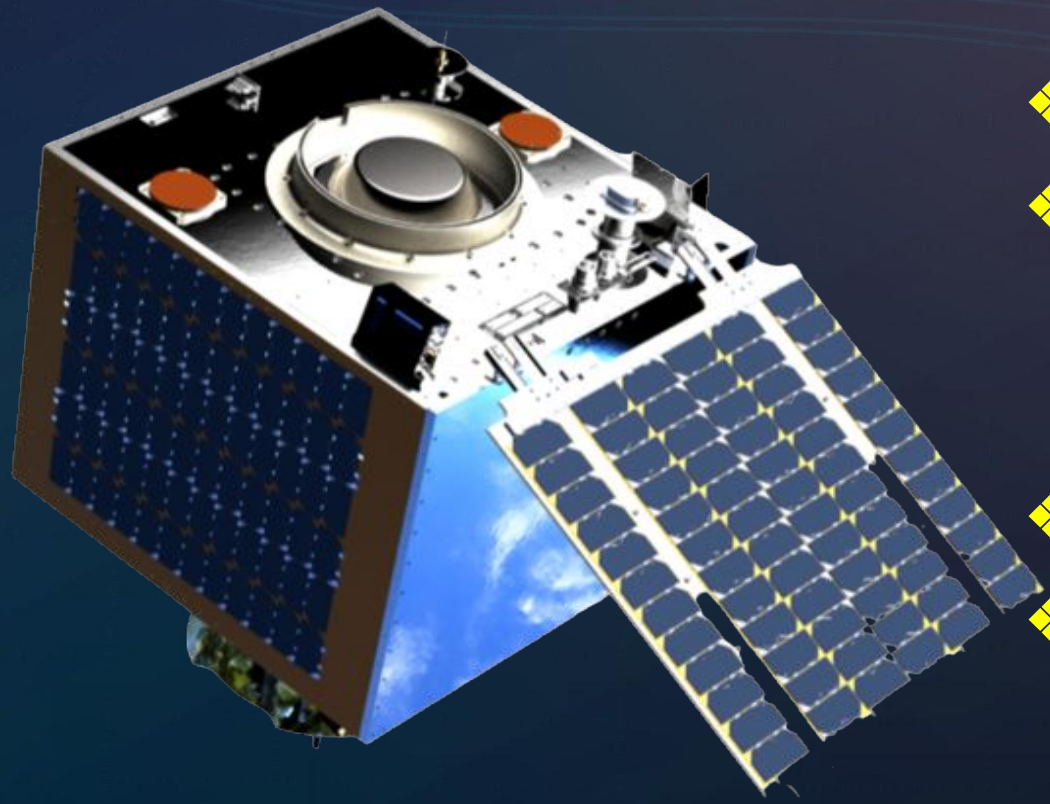
28TH APRSAF
ASIA-PACIFIC REGIONAL SPACE AGENCY FORUM
VIETNAM

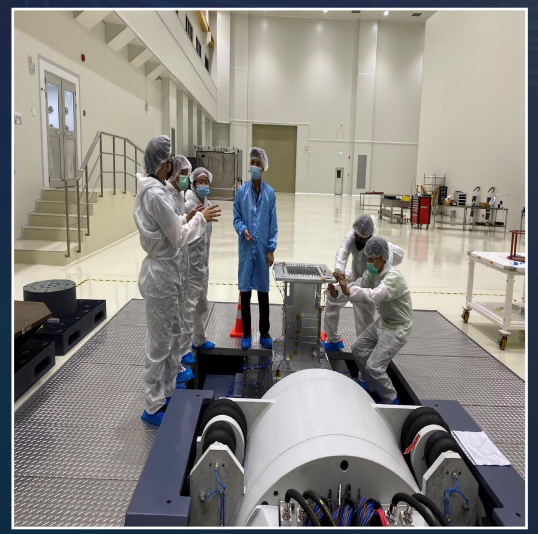
GISTDA

Outline



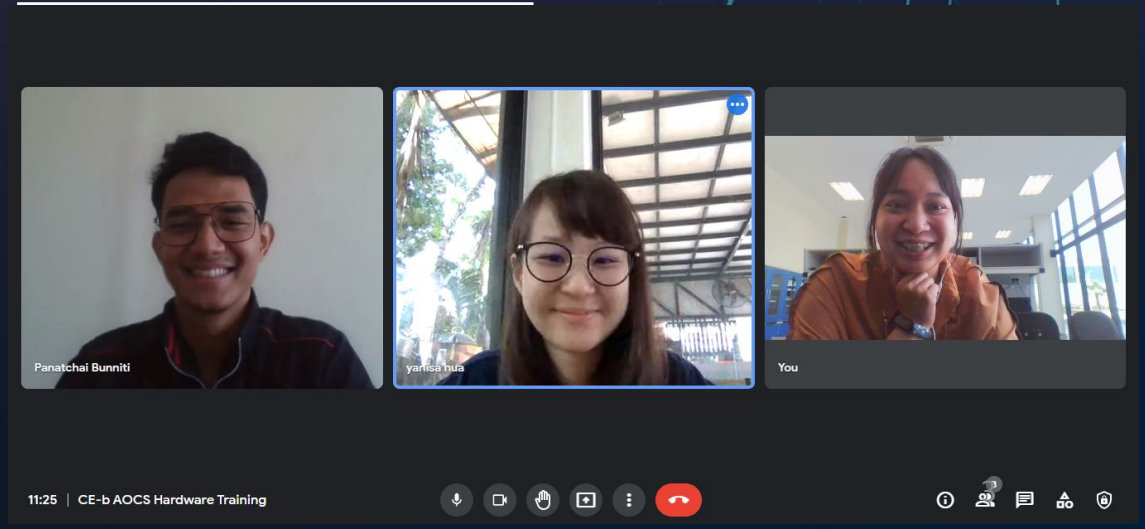
- The objective of hands-on training program
- Background
  - GISTDA satellites program
  - THEOS-2A Satellite
- THEOS-2A Satellite Qualification Model
- Know-how transfer and training framework
  - Selecting >> Training plan >> Monitoring
- Feedback and lesson learn

The objective of hands-on training program



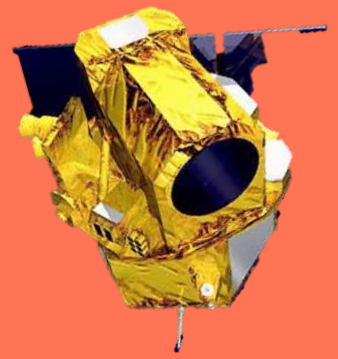
To increase the potential of personnel in the country through the transfer of knowledge of industrial-grade satellite development to have the ability to develop advanced technologies

To further develop the knowledge base in the field of industrial-grade satellite development, to be able to continually **support the growth of the space industry in the future**



GISTDA's SATELLITES

THEOS (THAICHOTE)



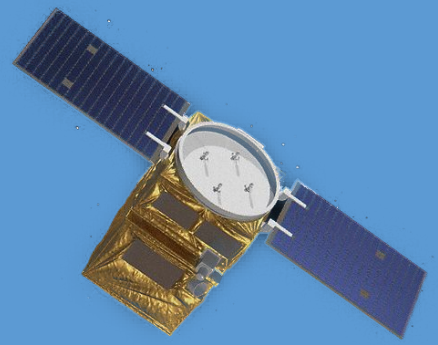
Launch date : Oct 1st 2008

Payload : Imager Full SiC (Silicon Carbide) telescope 2m (PAN), Refractive telescope 15m (MS)

Mass : ~750 kg
Dimensions : 2.1 m x 2.1 m x 2.4 m

Orbit : ~672 km Sun Synchronous - Low Earth Orbit

THEOS-2



Launch date :Q1 2023

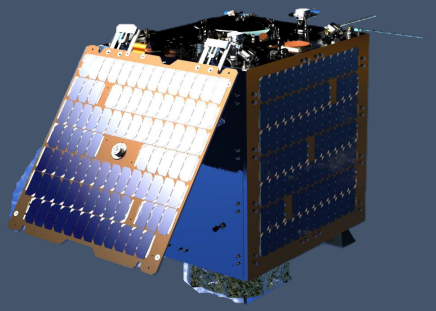
Payload : Very high-res imager (KORSCH Type with 3 SiC mirrors) 0.5m (PAN), 2m (MS)
Mass : ~425 kg

Dimensions : 1.4m x 1.2m x 1.8m

Orbit : ~621 km Sun Synchronous - Low Earth Orbit

THEOS-2A

Built by SSTL and GISTDA engineers



Launch date :Q2 2023

Main Payload : High-res imager with CMOS; 1.18m (RGB)

Mass : ~100 kg

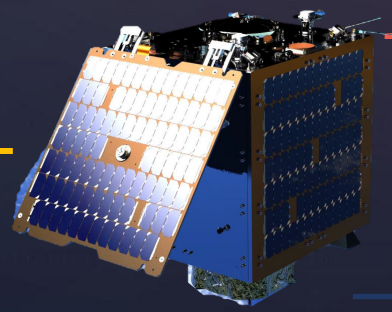
Dimensions : 0.62m x 0.72m x 0.95m

Orbit : ~500 km Sun Synchronous - Low Earth Orbit

What is THEOS-2A?

Technology Transfer

THEOS-2A isn't just a satellite program but a knowledge, technology transfer how to make a satellite and bring Thailand to satellite industry through 48 engineers.



THEOS-2A Satellite

An earth observation satellite capable of multiple imagine modes(primary payload), air and ship tracking(second payload) and experimental project for Thai's engineer(third payload).

Assembly Integration and Test (AIT)

AIT objective is to make satellite's components viable and work together. With GISTDA facility provide vibration, thermal and thermal vacuum including mass properties with clean rooms up to standard which crucial to satellites testing process.

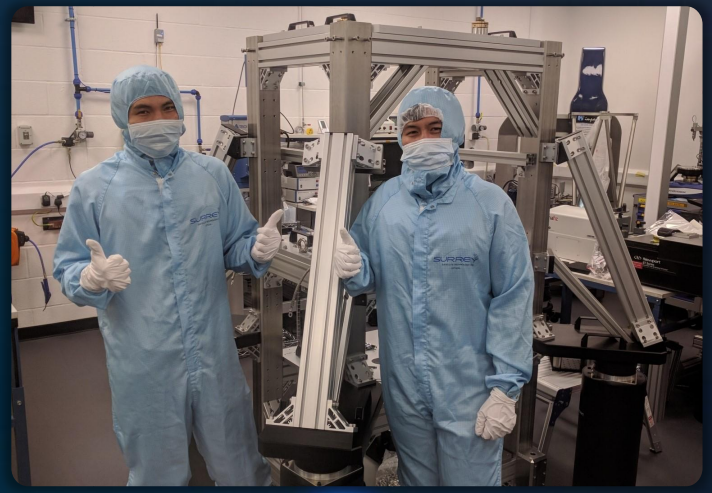
THEOS-2A Launch schedule

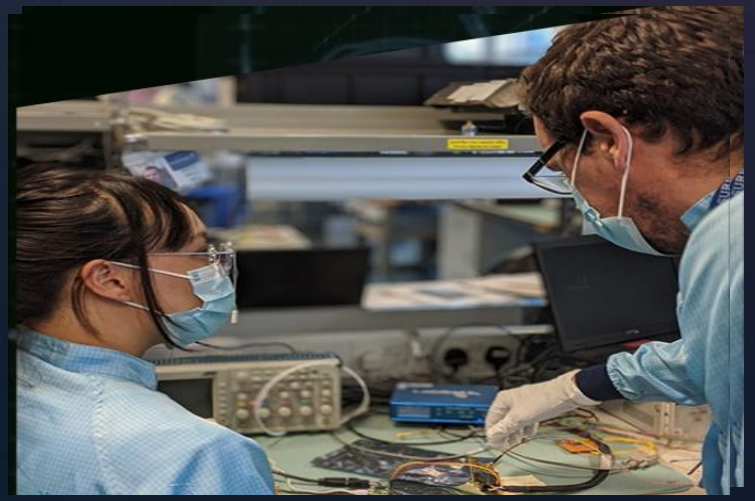
Launch proposed
- Polar Satellite Launch vehicle (PSLV) at Sriharikota, Tirupati district, Andhra Pradesh, India
- SSO orbit altitude 500-550km
- launch schedule Q1-Q2 2023

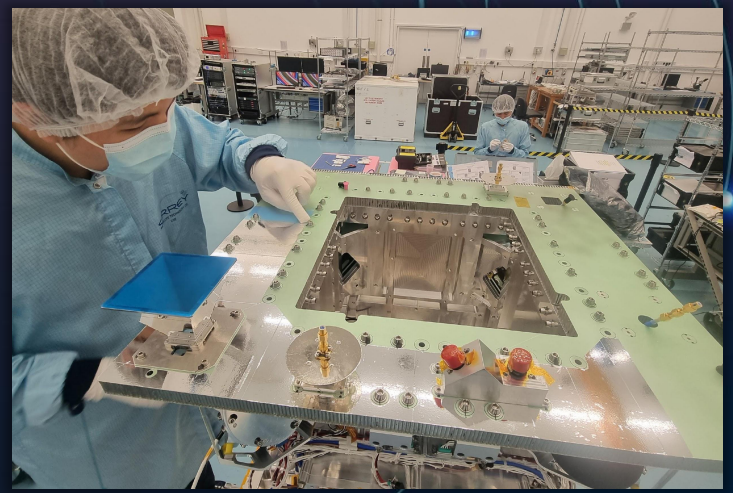
In-country Manufacturing

The program objective is to support Thailand manufacturers make satellite's grade components and up to worldwide standard which now Thai-built parts are onboard

Know-How Transfer and Training (KHTT) CE-A Program

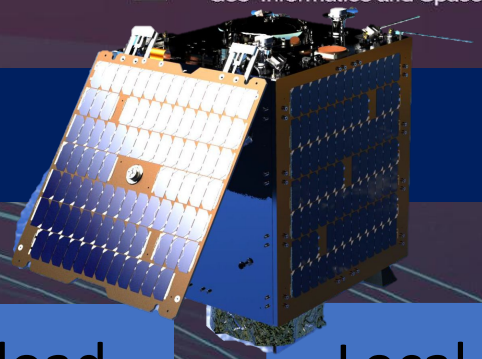




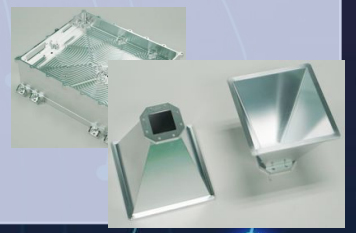


A team of 22 Thai engineers have been sent to the United Kingdom for two years to co-develop and build a 100 kg class Earth-observation satellite called THEOS-2 SmallSAT. This was carried out at the facilities of Surrey Satellite Technology Ltd. (SSTL)

THEOS-2A Program



Know-How Technology Transfer	Thai engineer's payload development	Local space component supply chain
• 22 engineers trained at SSTL • Train the trainer	• Build from the scratch • Flight acceptance test	• Variety of components and function • SMEs focus



The focus of this presentation

- Thai engineer trained 32 engineer by Developing a Satellite Qualification Model

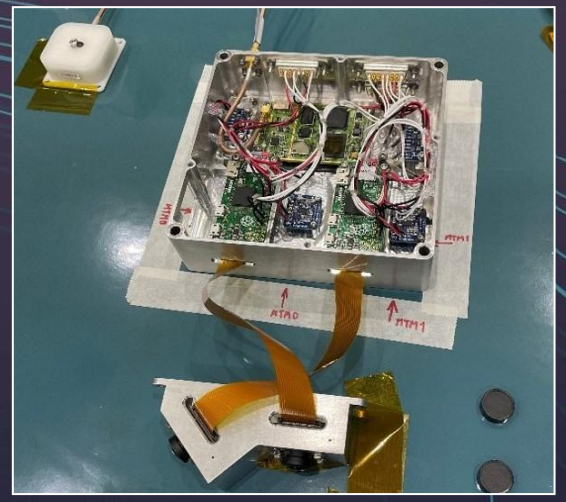
Ref: Building Comprehensive Thailand Space Capacity through THEOS-2 SmallSAT (IAC-21-B4.1.3)

THEOS-2A Satellite Qualification Model (SQM)

The crucial element of THEOS-2 program is that GISTDA has a license to rebuild a 100-kg class THEOS-2A spacecraft locally. Satellite Qualification Model uses the same blueprint as flight version. However, SQM components will undergo extensive qualification tests which are more severe than flight acceptance level.

Primary Structure

The backbone of the satellite, design to withstand most of forces that may affect satellite's components for the satellite as a whole



3PL Re-built

3rd Payload SQM has been rebuilt for electrical test for satellite qualification model, for every components are the same as 3rd payload flight model designed at SSTL the difference between the two are SQM is C++ based software.

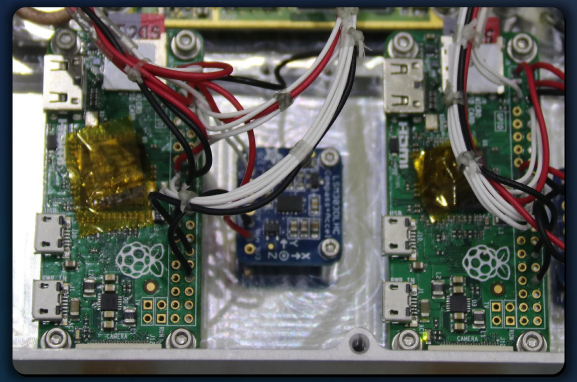
PDM and Battery

Another product from THEOS-2A program engineers is Power Distribution Module (PDM) electrical module for control and distribute power to each components in the satellite. Every step of development and create components are happen in Thailand capable of operate in space environment.

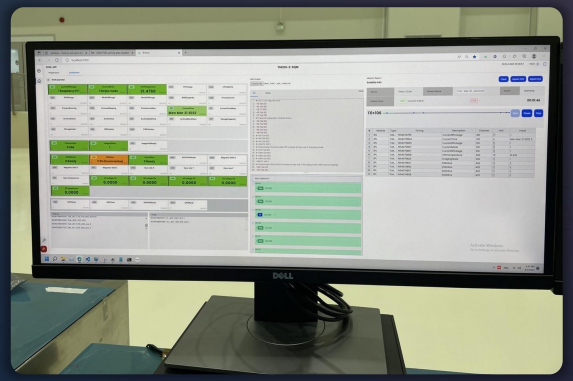
Rebuild 3rd Payload by Thai Engineers

Hardware & Software products

Raspberry PI



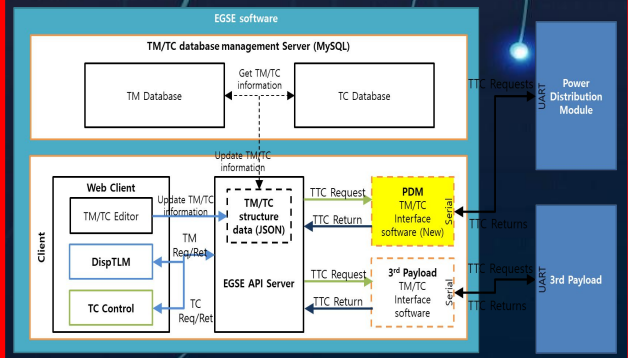
Flight Software and Module Software



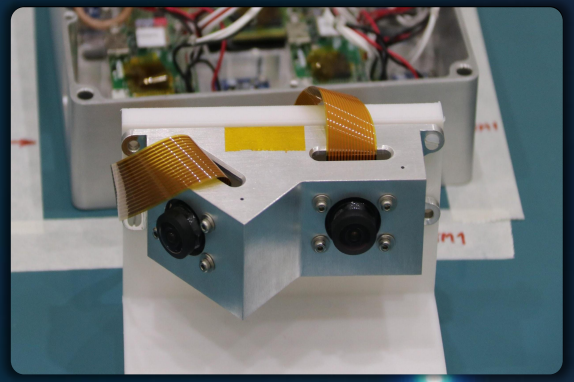
Module Box (Nano Tray)

New phase

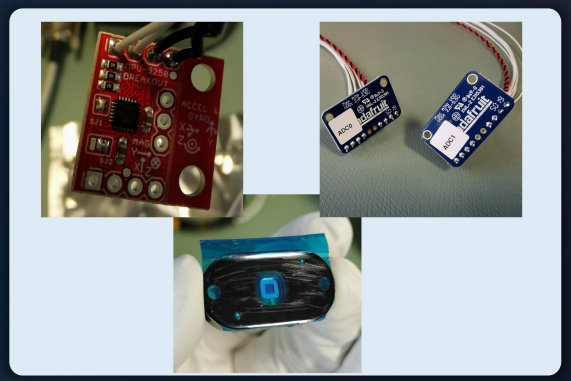
Electrical Ground Support Equipment



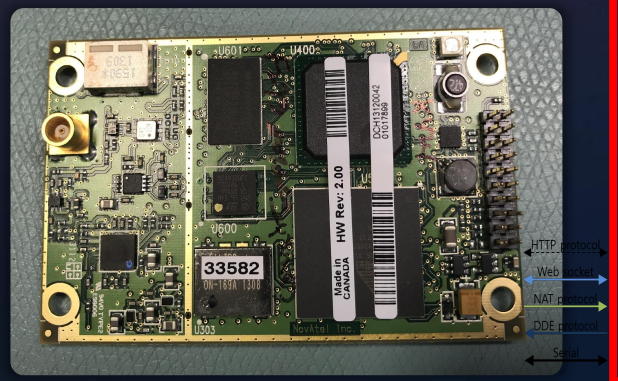
Camera



ADCS



GPS



Selecting Process

https://training.gistda.or.th/

Round 1

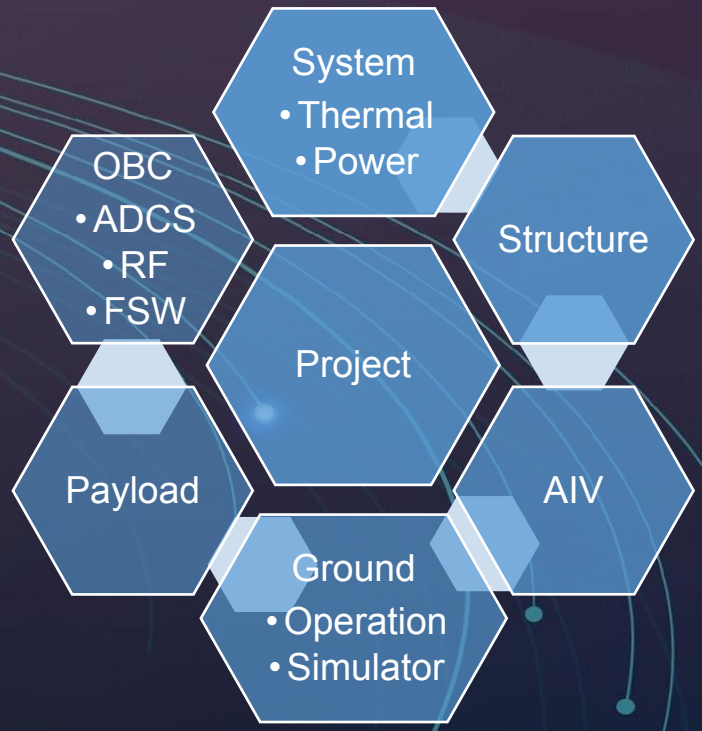
- Basic course 22 module (~200 participant)
  - Online course
- Selecting by examination (passed ~120)
  - multiple choice test
    subjective test

Round 2

- Advanced course: A1 10 Module (~120 participant)
  - Online course “Spacecraft Mission Design Workshop”
- Working Group (60)
  - Grouping in 6 groups by position (Management, EE, ME)
  - High level requirement, VCD
  - Advisor open to ask any question online meeting (once a week/group) and question via Email
- Selecting by presentation (passed 32) decided by mentor

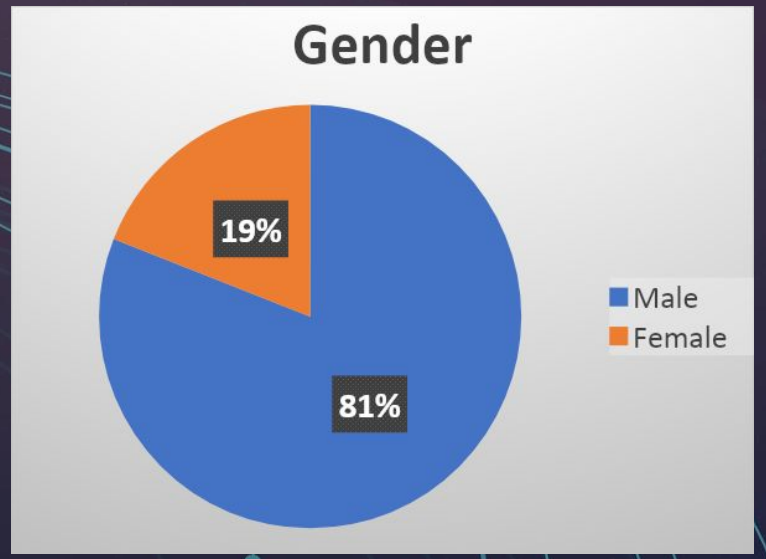
Round 3

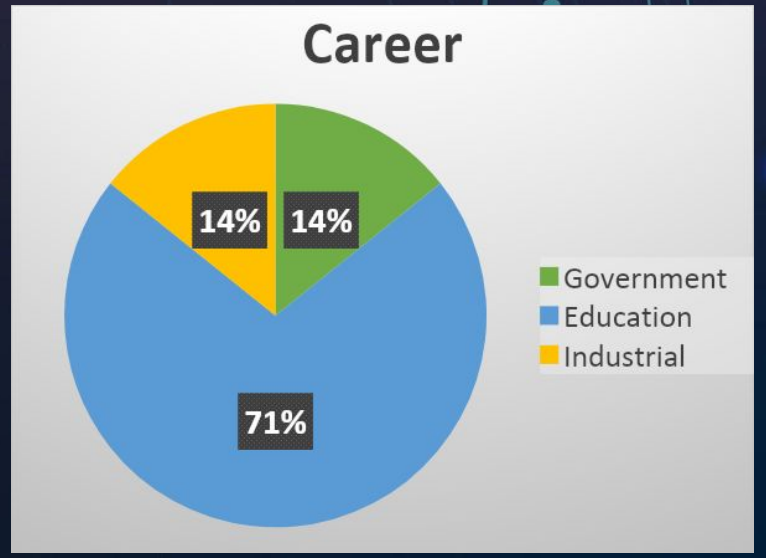
- Hands-on training: A2 5 months (32 participant)



Summary of Candidate

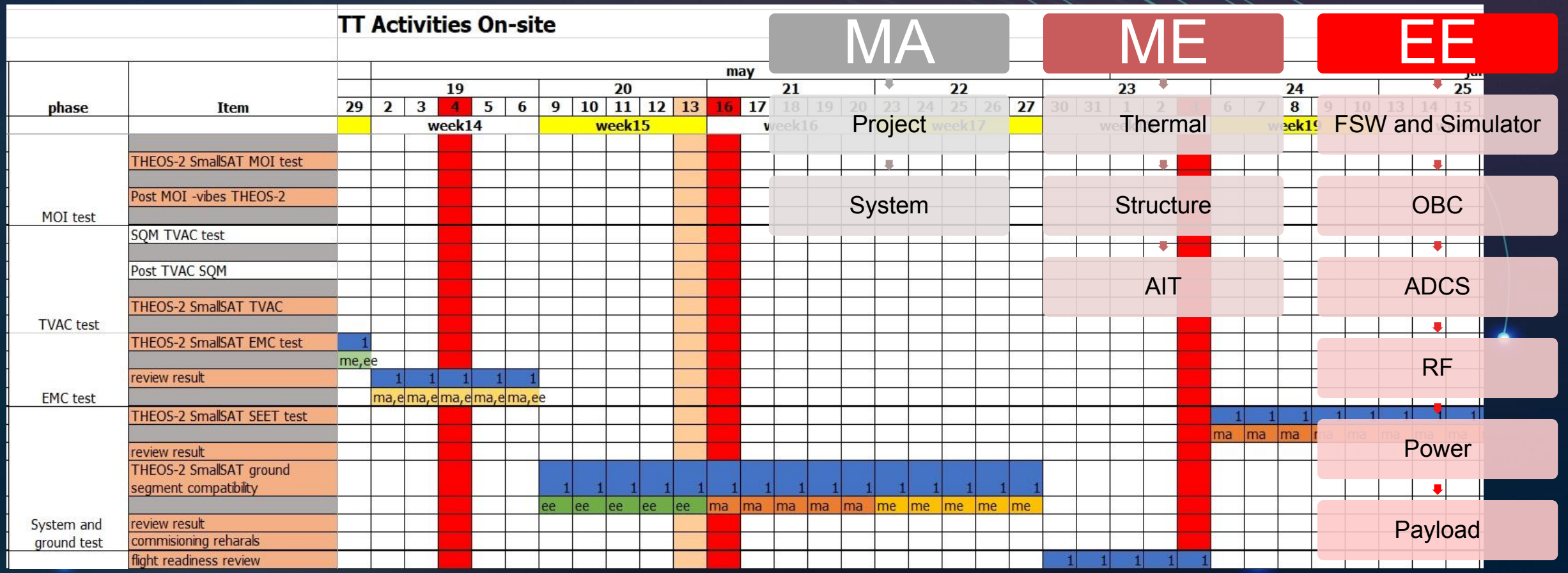
- Total participants is 32 Trainees (Gistda employee 11 people,10 male and 1 female)
- Focusing from outside Gistda is 21 people
  - Gender
    - 17 male 4 female
  - Occupation
    - Government agencies and state enterprises 3 people
    - A total of 15 educational institutions
      - 10 students
      - 5 teachers
    - Private sector 3 people





Plan of onsite training

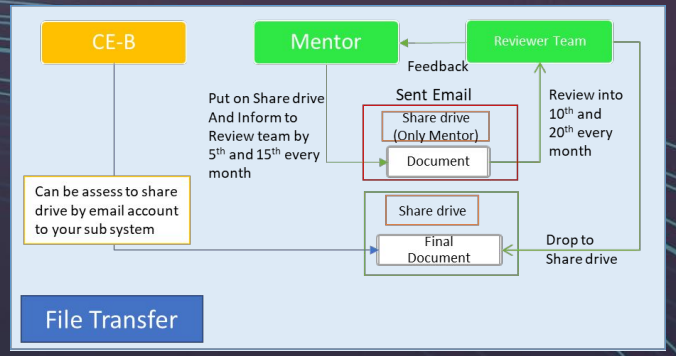
The candidates have learnt from the SQM development in parallel with the verification of THEOS-2A which is expected to launch during Quarter 2 of 2023

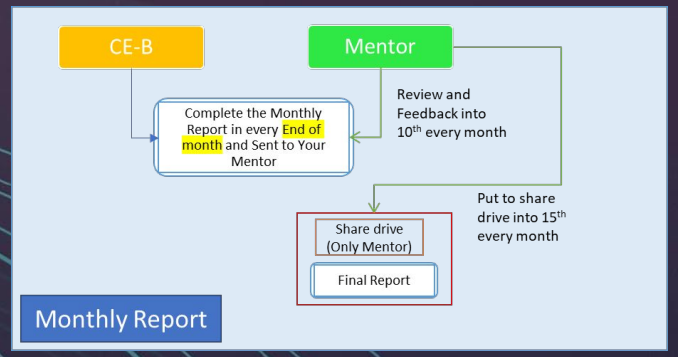


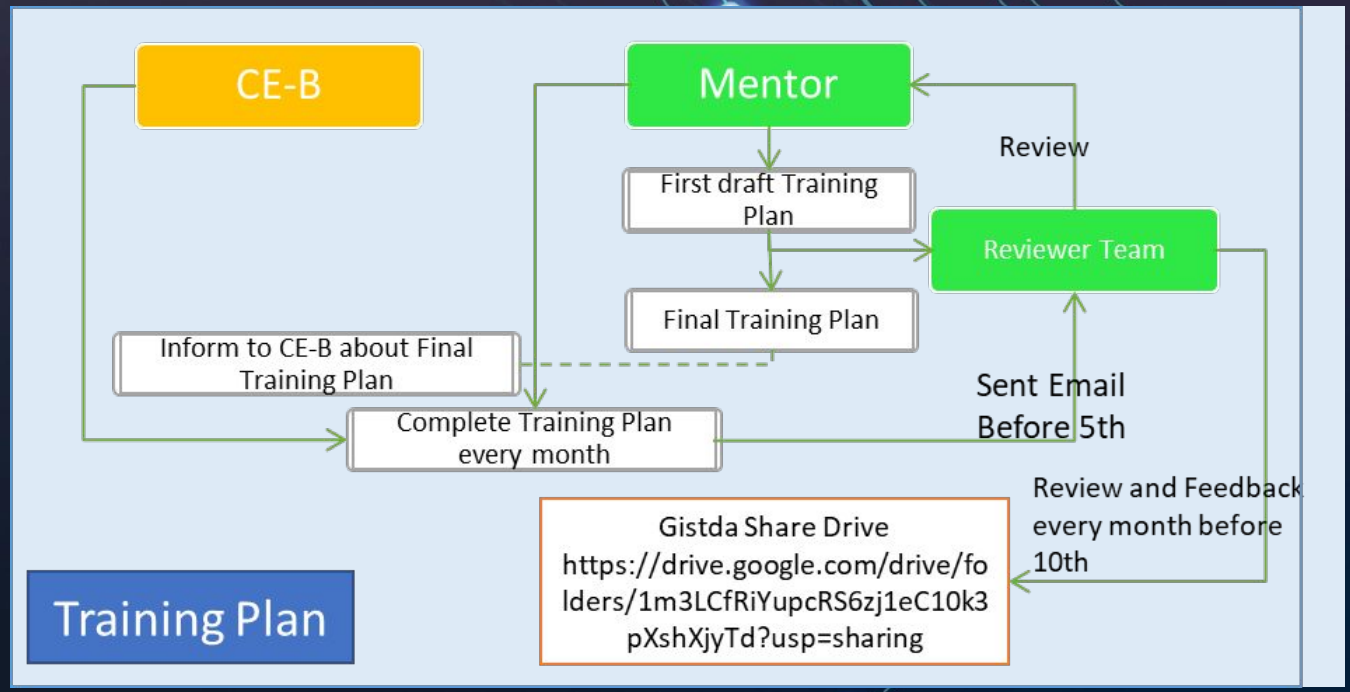
MA: Management, ME: Mechanical, EE: Electrical

Monitoring

- Review (by reviewer team)
  - Training plan
  - Monthly Report
  - Review Material
- Presentation
  - First presentation
  - 2nd (Midterm) catch up -> Interview
  - Final Presentation
- Mini project -> SchoolSAT







Presentation

- ✔ To set and match the objectives between trainees and trainers
- ✔ Review and summarize the training did meet your objective or not?

First Presentation (Onsite)

- Introduce yourself
- Expectation
- Personal Goal relate to Space and KHTT
- 5 Minute Presenter
- 5 Minute for Q&A

Final Presentation (Online)

- Evaluate the Training plan outcomes meet your expectation
- Summary all task you are done
- Suggestion or recommendation
- 5 Minute Presenter
- 5 Minute for Q&A

Know How Transfer and Training (KHTT) CE-B Program

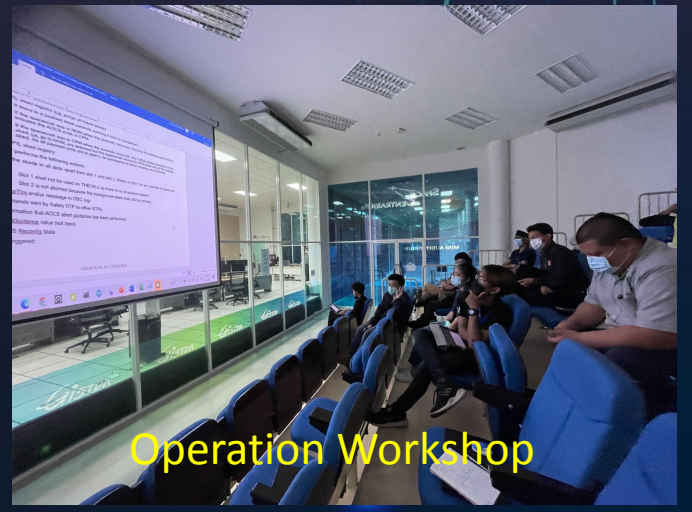

Orientation


Visit


Induction to vibration shaker


Raspberry pi camera testing


OBC training


Operation Workshop

SQM Activity

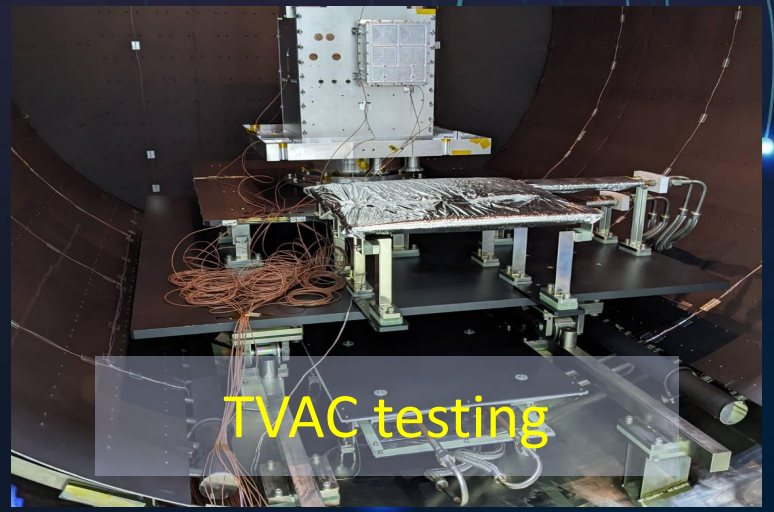

MOI Training

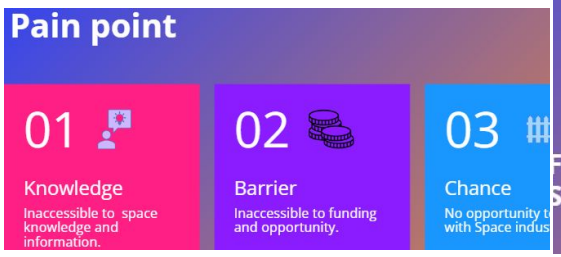

Vibration Training

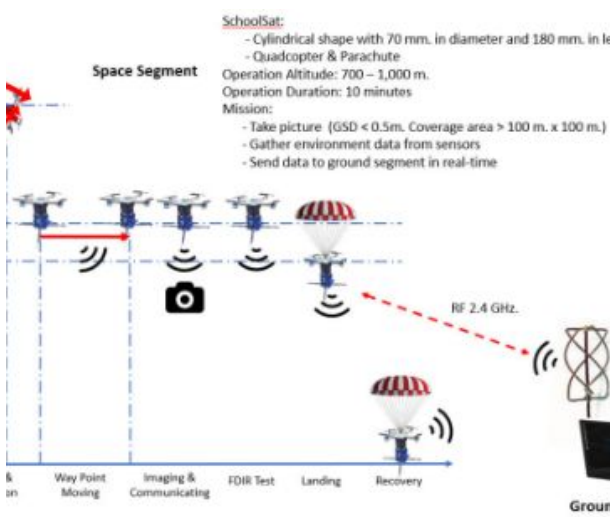

Wiring


Build structure


FSW and Third payload functional test


TVAC testing





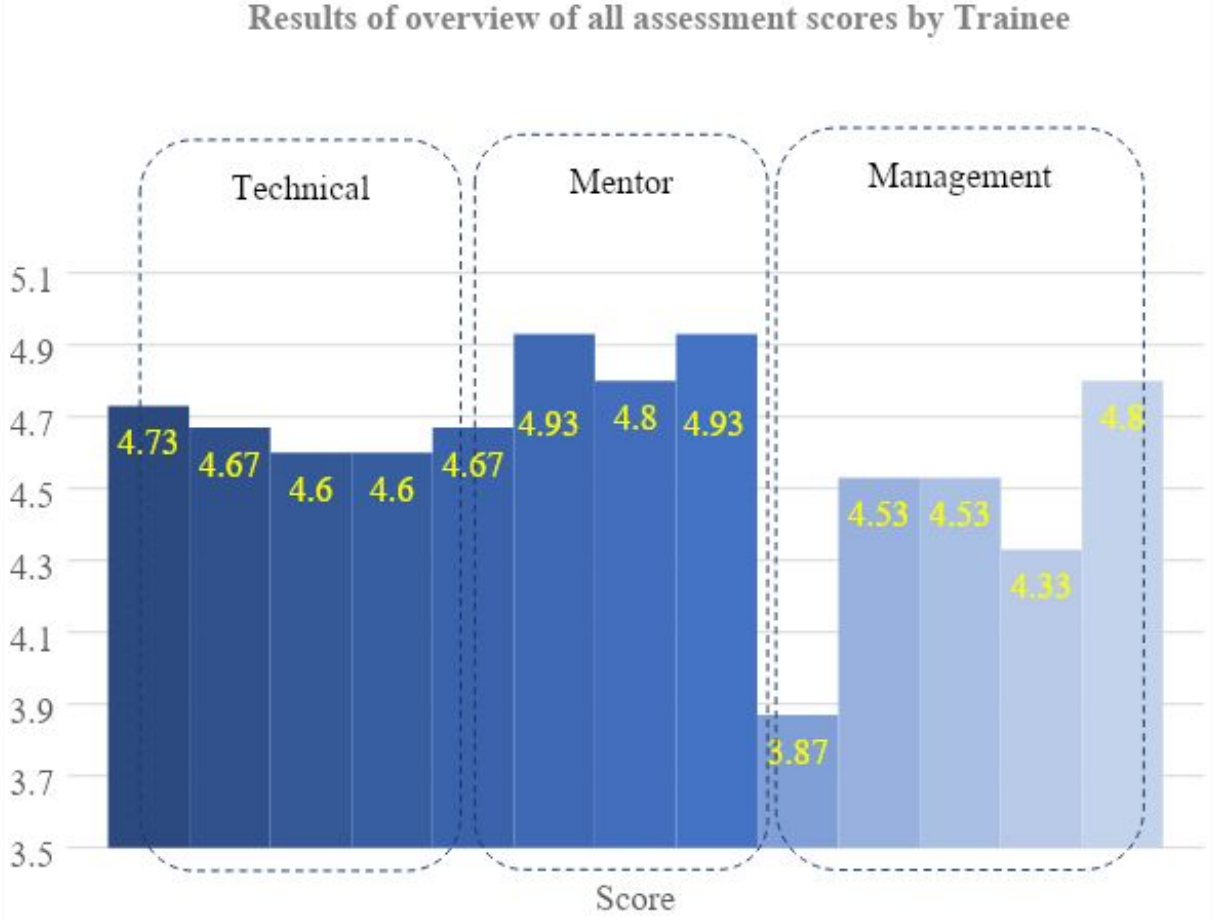
Mini project is SchoolSAT

- **In the Preliminary Design Review phase.**
- **There are register to pitch in the Space economy competition 2022 (National event)**
- **This competition is to find startups that use deep technology in the space economy**
- **To develop the capabilities of Startups to become products or services to bring to the market and be able to expand the business in Thailand and internationally.**

Feedback (By Trainees in blind test)

Assessment topic in rating score

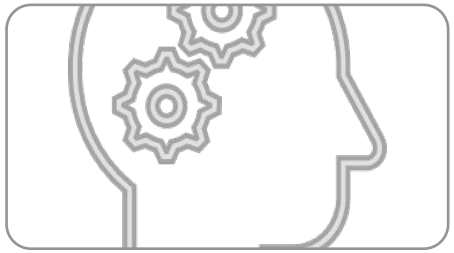
- Technical and Theory
  - ✔ The training content is consistent with the course objectives.
    The course contents in the curriculum are useful and can be applied in the work.
    New of knowledge, ideas, skills and experiences have you gained from the training
    Improve the knowledge after training
- Trainer
  - ✔ Methods and techniques of lecturers' transfer
    Opportunity to ask questions and express opinions
    Expertise and Appropriate
    Personality
- Management
  - ✔ Program duration, Facilitation of transportation, Accommodation facilities, Workplace and Coordination before-during training



Overall = 4.53 -> 90.6 percent

5= Absolutely agree to 0 = not agree

Suggestion from trainees to improve this program and Presentation Objective Highlight

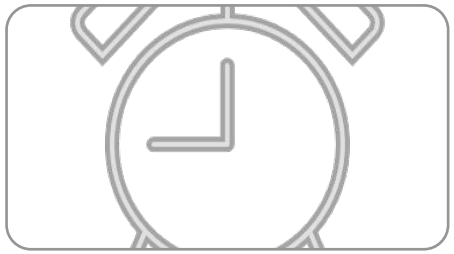


Technique

- More practice
- Deeping in theoretical
- Learn another sub system

Facility

- There should be equipment, tools, software, budgets that help support hands-on operations in a more concrete way
- There should be a document library included for each sub-system for the trainees to study.



Management

- There should be a longer period of time and extent program until the launch
- Would like more of all subsystems to join Onsite at the same time.
- Disclosure of technical documents after NDA

Suggestion from trainees for next program

Continue course online

- Virtual satellite development course , Although the technology has changed, the key features remain.
- Intensive satellite development courses go even further. (A3,A4,A5,..)
- Interested in participating in the training in the next satellite development course, such as satellite development, earth observation, outer space exploration

Extended

- Going into details of the sub-system AOCS, OBDH that can be extended in the application of Machine Learning, Artificial Intelligence, TinyML to control or enhance the capabilities of Spacecraft more,
- In the big picture of Thailand. in the promotion of the agricultural sector by applying space technology as an add-on to push forward agricultural technology in the country to be more advanced, such as IoT in a non-terrestrial format
- Channel or opportunity for startups, private organizations, entrepreneurs to have more access to space technology.
- Bringing images or satellite data to apply in the economy.
- Development of software for satellites.
- Interested in the topic of space economy

Lesson learnt

- Timeline
- Teaching operations must be continuous, will make more focus
- Limitations on facilities such as software being purchased
- Intellectual property is an issue for technology transfer forwarding.
- Relationship (GAP) between Team from age, culture, personality
  Between Trainer and Trainee
- Manhours of trainee and trainer
- Transferability: Knowledge transfer personnel have specialized knowledge.

Conclusion

THEOS-2A delivers key elements

Output

- 32 trainees have been completed
- Hands-on training framework

Consequence

- Trainee have been transferred of knowledge of industrial-grade satellite development to have the ability to develop advanced technologies
- The knowledge base in the field of satellite development can support the growth of the space industry in the future

Next step for space education

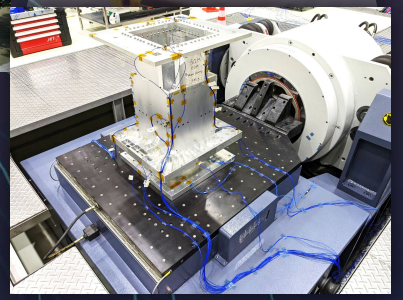
Continue

- Education technology platform will be launch at the end of this year (25Dec2022)-> Domestic
- SchoolSAT Project was started, this will be finished Q3 2023
- (future plan) CubeSAT Project will be continued later Q4 2023

Outreach

- Internship framework
- Knowledge transfer to Thai entrepreneurs who are interested in enhancing the competitiveness of the aerospace industry, such as manufacturing control through ECSS standards, etc.
- Asia pacific collaboration start from AIT facility e.g., vibration testing service

National Assembly Integration and Test facility



The AIT facility is the first space environment testing facility in Thailand. The equipment are:

- Integration bay
- Thermal cycling
- Thermal vacuum chamber
- Vibration shaker
- Mass properties measurement

Thank you