ISS/JEM

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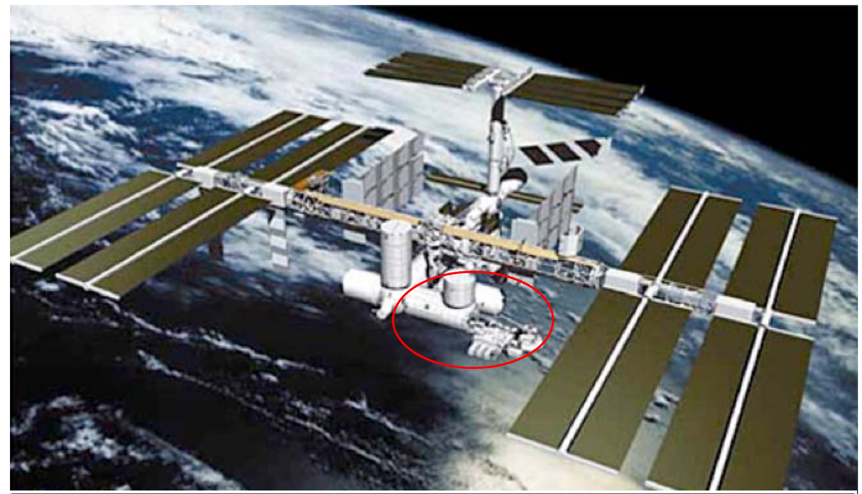
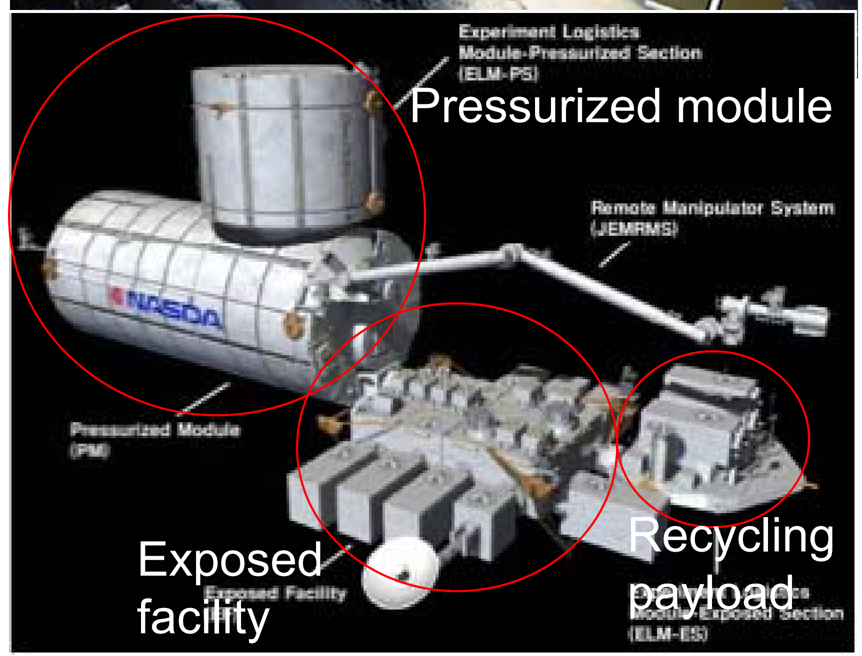
ISS dimension ~ football stadium
ISS mass ~ Jumbo jet
ISS space = 1.5 x Jumbo jet
ISS orbit ~ 400 km above ground
90 min per orbit

Japanese Experiment Module (JEM) :"KIBO (Hope)"

- Japan's unique exposed platform on the ISS (power, coolant and data lines are provided)
- Observations fit to the orbit (~400km, 90min/orbit) and characteristics of ISS
- Development of technologies in the exposed space



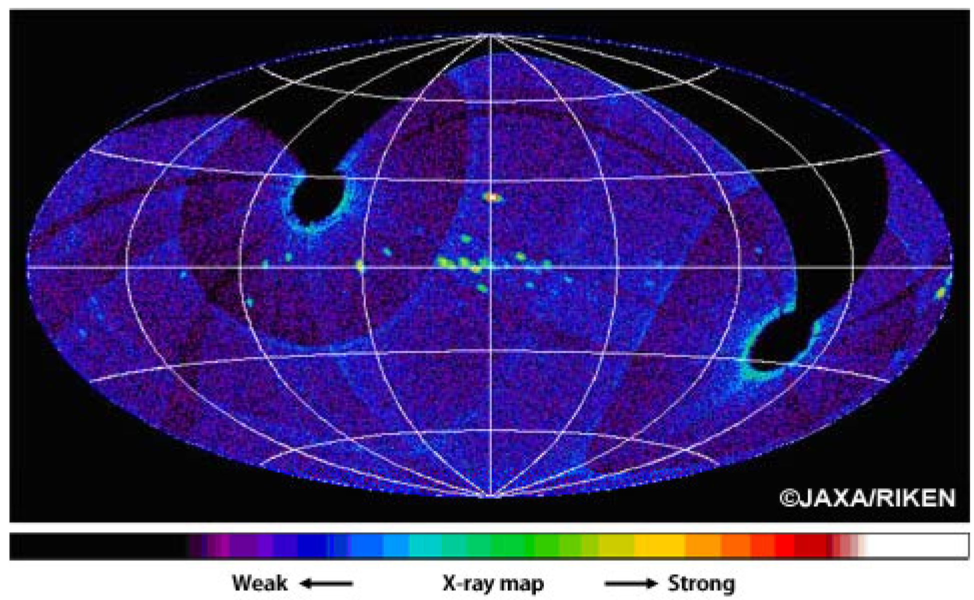


Early Phase JEM-EF Missions :Observatory Sciences

- MAXI (Monitor of All-sky X-ray Image)
  - P.I. : Dr. M. Matsuoka (RIKEN)
  - MAXI monitors X-ray objects in the whole sky with high sensitivity.
- SMILES (Superconducting Submillimeter-Wave Limb Emission Sounder)
  - P. I. : Dr. H. Mashiko (CRL)
  - SMILES observes and monitors very weak sub-millimeter wave emission lines
  - of trace gas molecules in the stratosphere for the first time.
- SEDA-AP (Space Environment Data Acquisition equipment - Attached Payload)
  - Not introduced here.
  - see http://kibo.jaxa.jp/en/experiment/ef/seda-ap/

Overview of MAXI

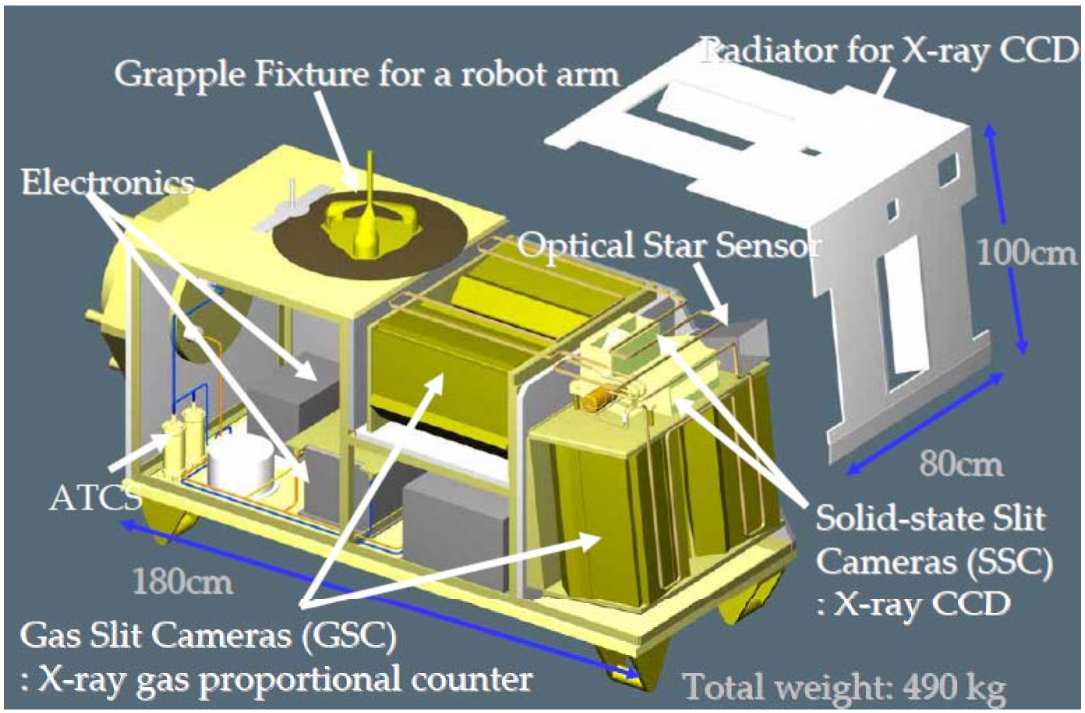
- MAXI (Monitor of All-sky X-ray Image)
  - MAXI monitors X-ray objects in the whole sky with high sensitivity.
  - The first light image captured in August 2009
  - Capture so-called "all-sky X-ray moving image" once per orbit



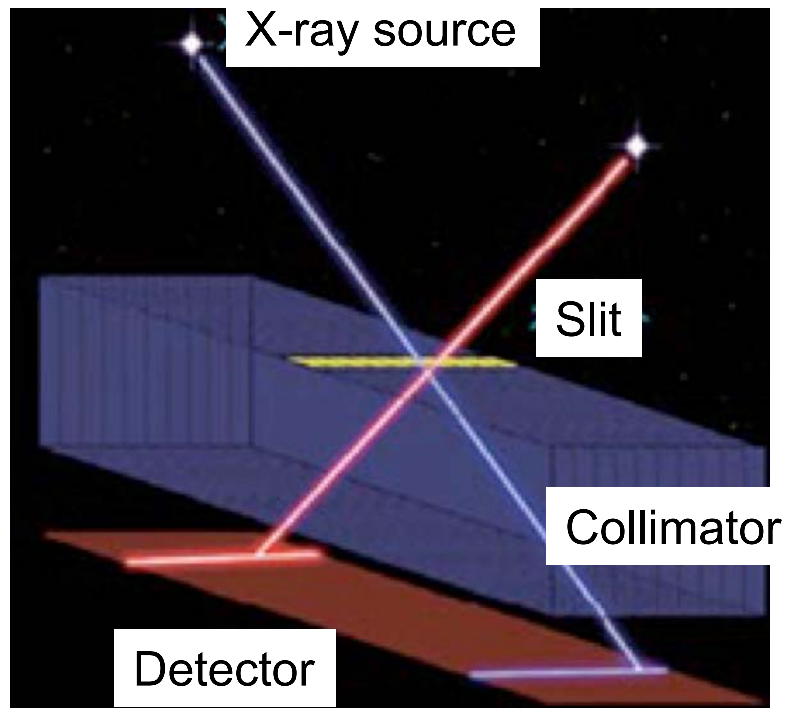
First light: August 15, 2009

Overview of MAXI

- Dimension: 100 * 80 * 180 (cm^3), Total weight: 490kg
- MAXI employs slit cameras. The slit is orthogonally oriented to a one-dimensional position-sensitive X-ray detector.



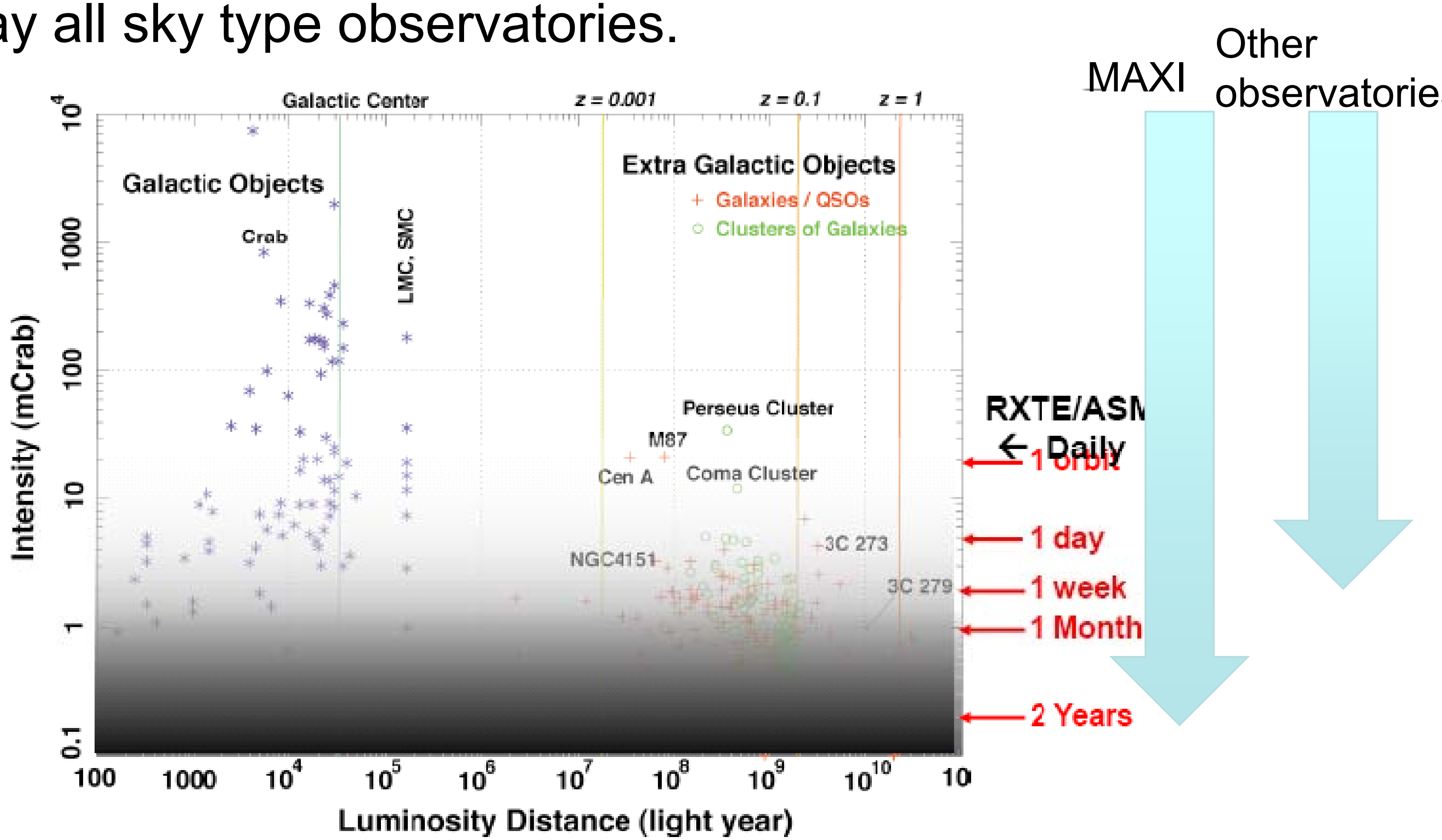
Conceptual diagram



Observation principle

X-ray sources detectability with MAXI

- 10 times more sensitive compared to that of the existing X-ray all sky type observatories.



2nd-phase observational sciences from JEM-EF

- 1^{st} phase: 2009-2011, 16 science themes (30 experiments in total)
- 2^{nd} phase: 2012-2015
  - a total of 11 candidate missions for conceptual study.
  - four candidates for port-sharing utilization missions were selected to move to the development phase.
    - IMAP（Ionosphere,Mesosphere,upper Atomosphere, and Plasmasphere mapping）
    - GLIMS（Global Lightning and Sprite Measurement Mission）
    - SIMPLE（Space Inflatable Membranes Pioneering Long-term Experiments）
    - REXJ（Robot Experiment on JEM）
- cf. 2^{nd} phase experiments for PM (Pressurized Module)
  - 14 among 18 space science programs are X ray sensor developments.

Summary of JEM-EF

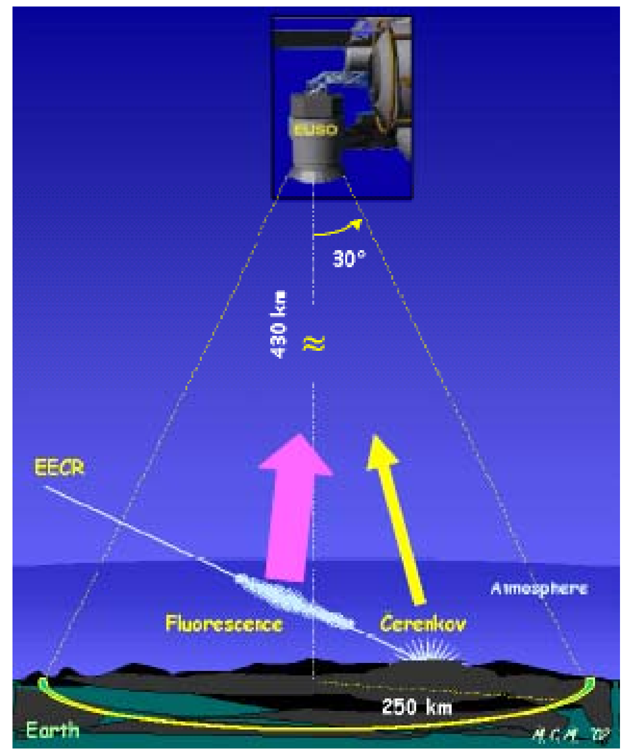
- Number of ports: 10
- Standard envelope: 1.85m * 1.0m * 0.8m
- Mass: less than 500kg
- Services by KIBO

- Electric power: max 10kW
- communication
  - slow: bass line
  - medium: Ethernet
  - fast: optical fiber
- Coolant: liquid only, controlled temperature 20 +/- 4 C

JEM-EUSO

(Extreme Universe Space Observatory onboard Japanese Experiment Module)

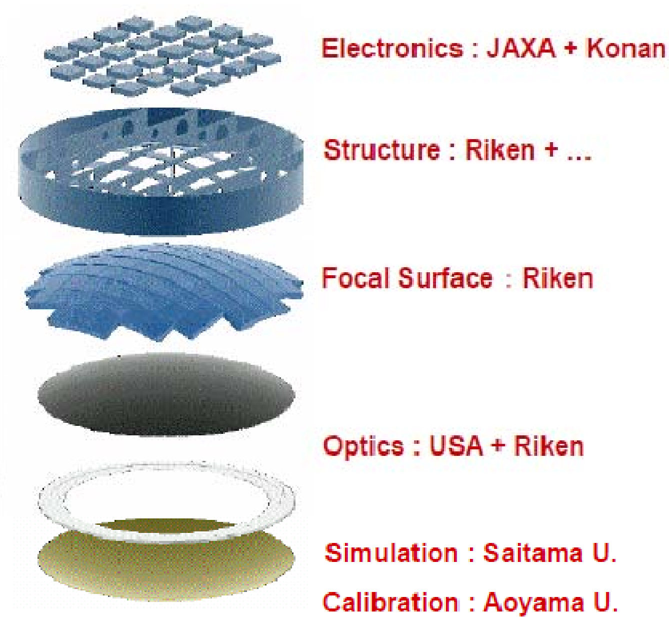
- Not suitable for the standard exposed facility but the mounting support enables it to be installed…
- candidate as a 2nd phase observatory
- to be launched in 2013 by the Japanese heavy lift rocket - the H2B, and then conveyed to ISS by HTV (H-II transfer Vehicle)..
- a very wide-field, large-lens telescope (~60 degrees, 2.5 m diameter)
- Observe extreme energy particles with energy above 10^20 eV and estimate arrival direction (air-shower observations from space, covering 500km area in once)



JEM-based exoplanet telescope?

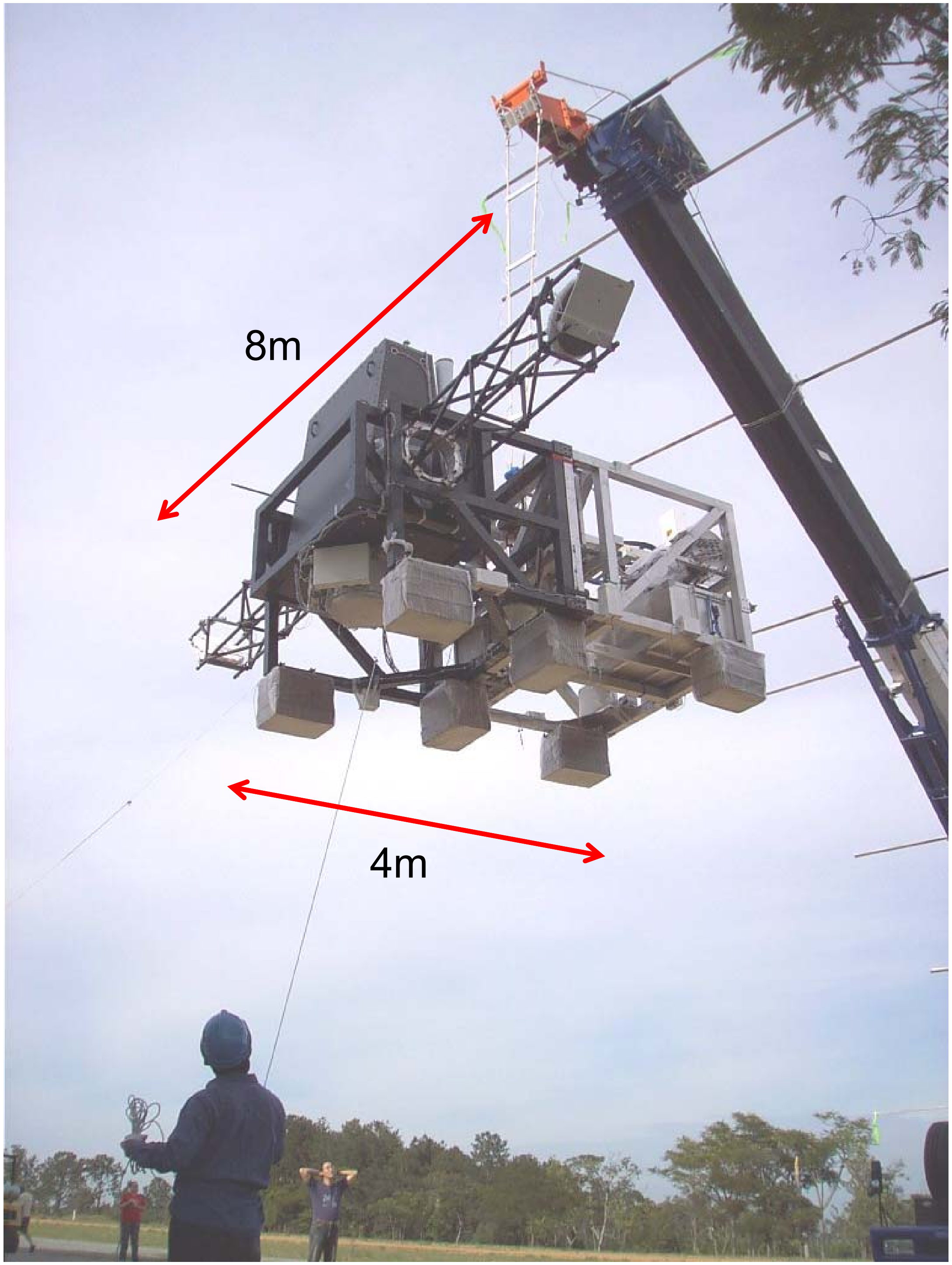
- JEM-EUSO can be a good baseline for possible future exoplanet telescope using JEM

- The telescope parameters for JEM-EUSO
  - telescope aperture: 2.5m
  - 330-400 nm
  - operation: 3 years
  - total weight: ~1.2 ton
  - dissipation power: 800W



JEM-based exoplanet telescope?

- JEM exoplanet telescope?
  - possible to propose it for 3rd call??
- Above 2m diameter, off-axis
- Vis-NIR
- several coronagraphs sharing focal plane
- tip/tilt and AO system (disturbance conditions unknown)
- Field of view unknown
- Also suitable for transit all-sky survey or gravitational lensing
  - note MAXI can scan all-sky in every 90 min
- Concern about the pointing (this is not a problem for MAXI and UESO)



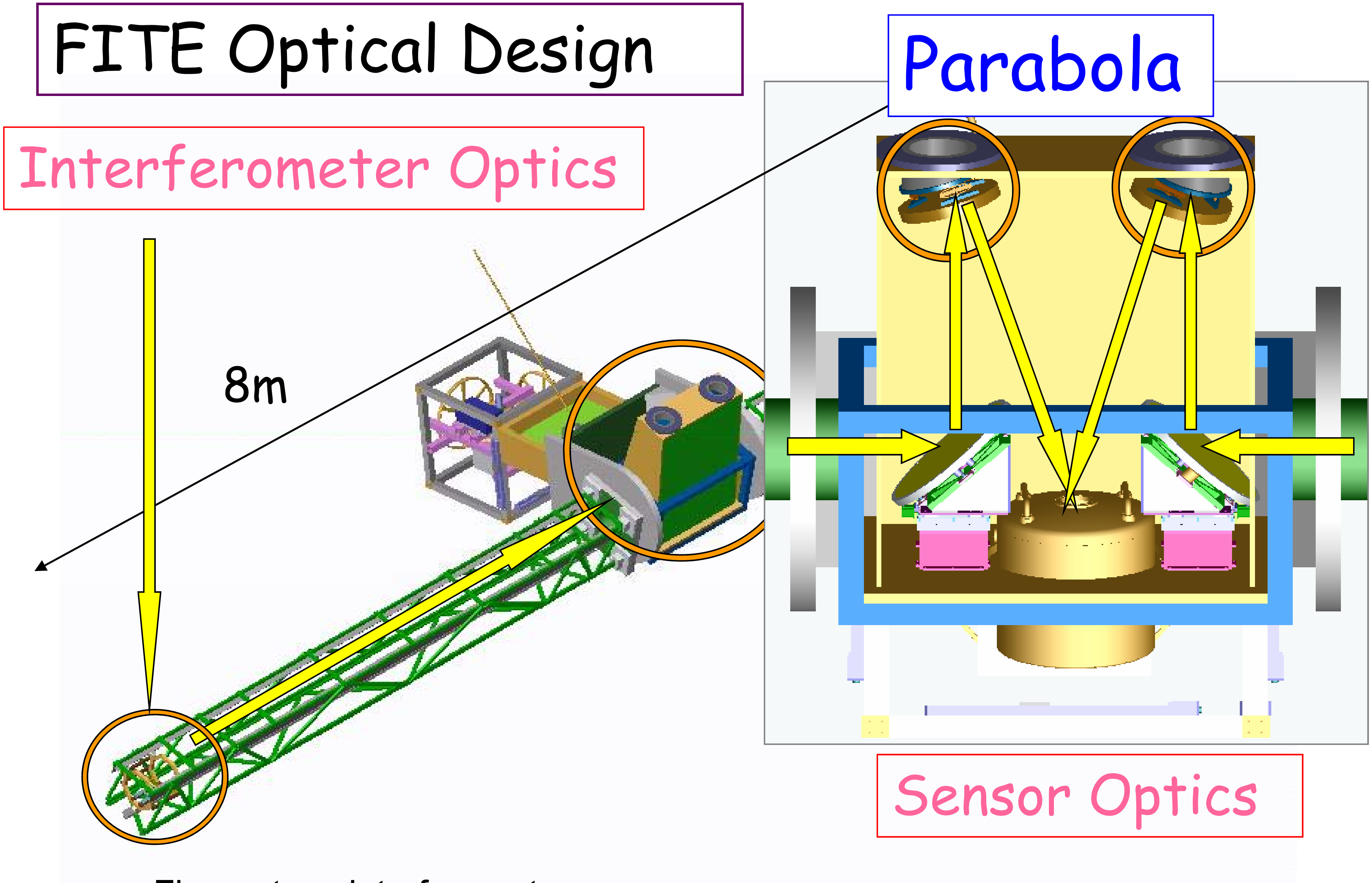
Far-Infrared Interferometric Telescope Experiment (FITE)

- PI H. Shibai (Osaka U.)

- Collaboration with Nagoya U., Tokyo U., JAXA, U. Sao Paulo, and INPE (20 members)

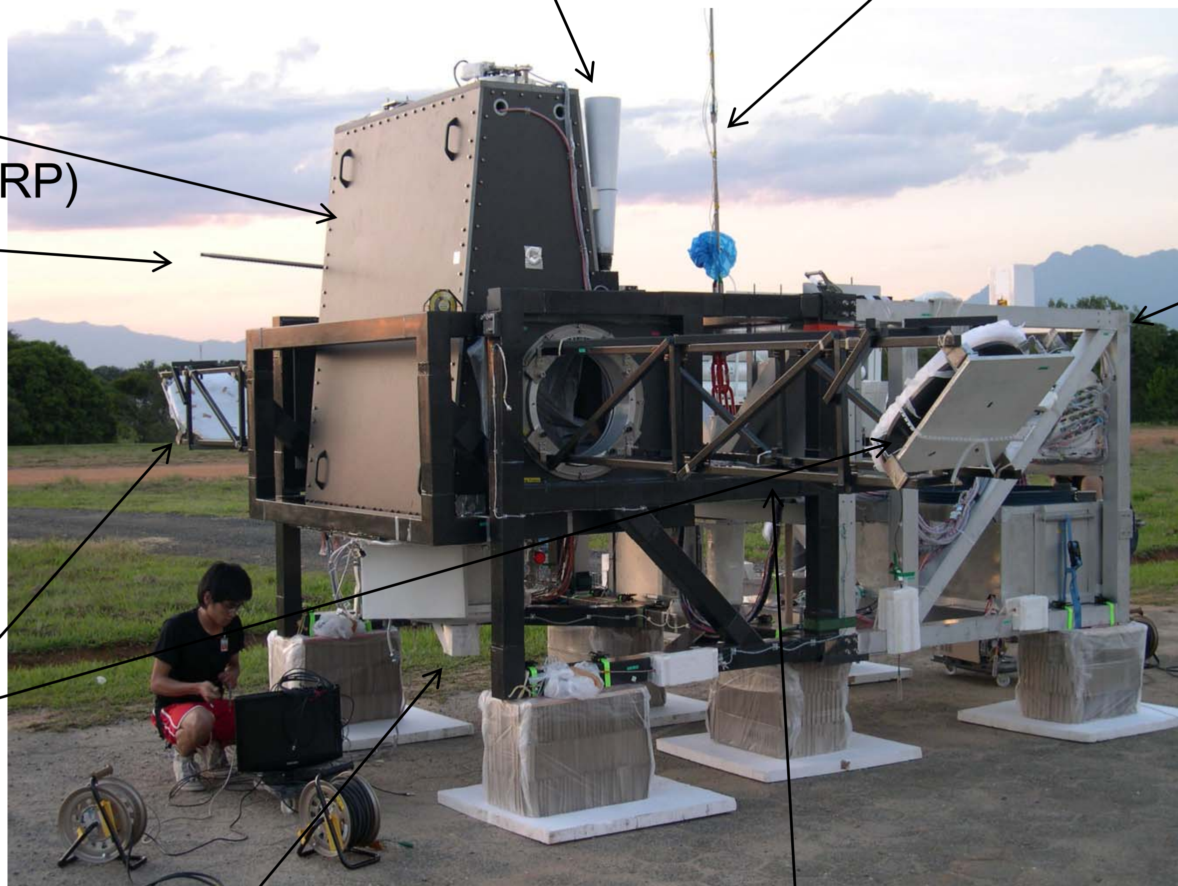
- Started from 2003
- Rehearsal already done in 2008
- First flight in Brazil in Autumn 2010

FITE Optical Design



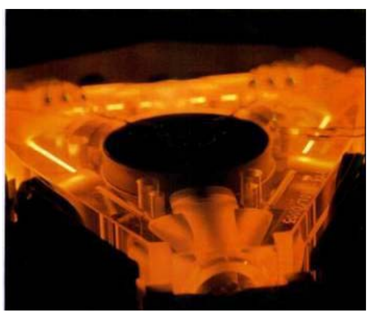
- Fizeau-type interferometer.
- First plane mirrors, secondary mirrors, off-axis parabola mirrors, sensor optics
- 40cm in diameter, baseline: 8m

Telescope Side

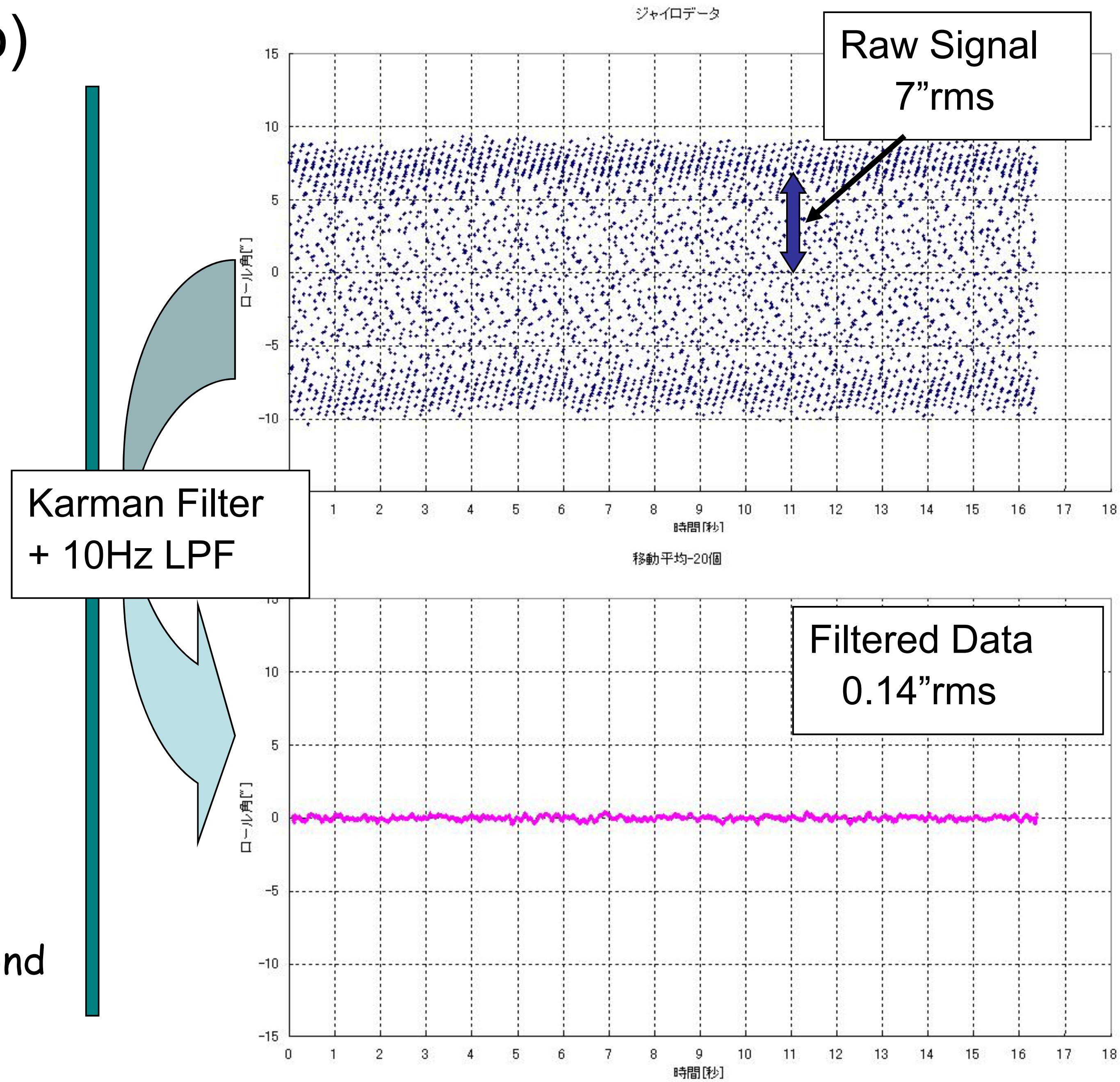


Control Gondola

Performance of Gyro
(Ring laser gyro)



Resolution < 1arcsecond
Negligible Drift Error

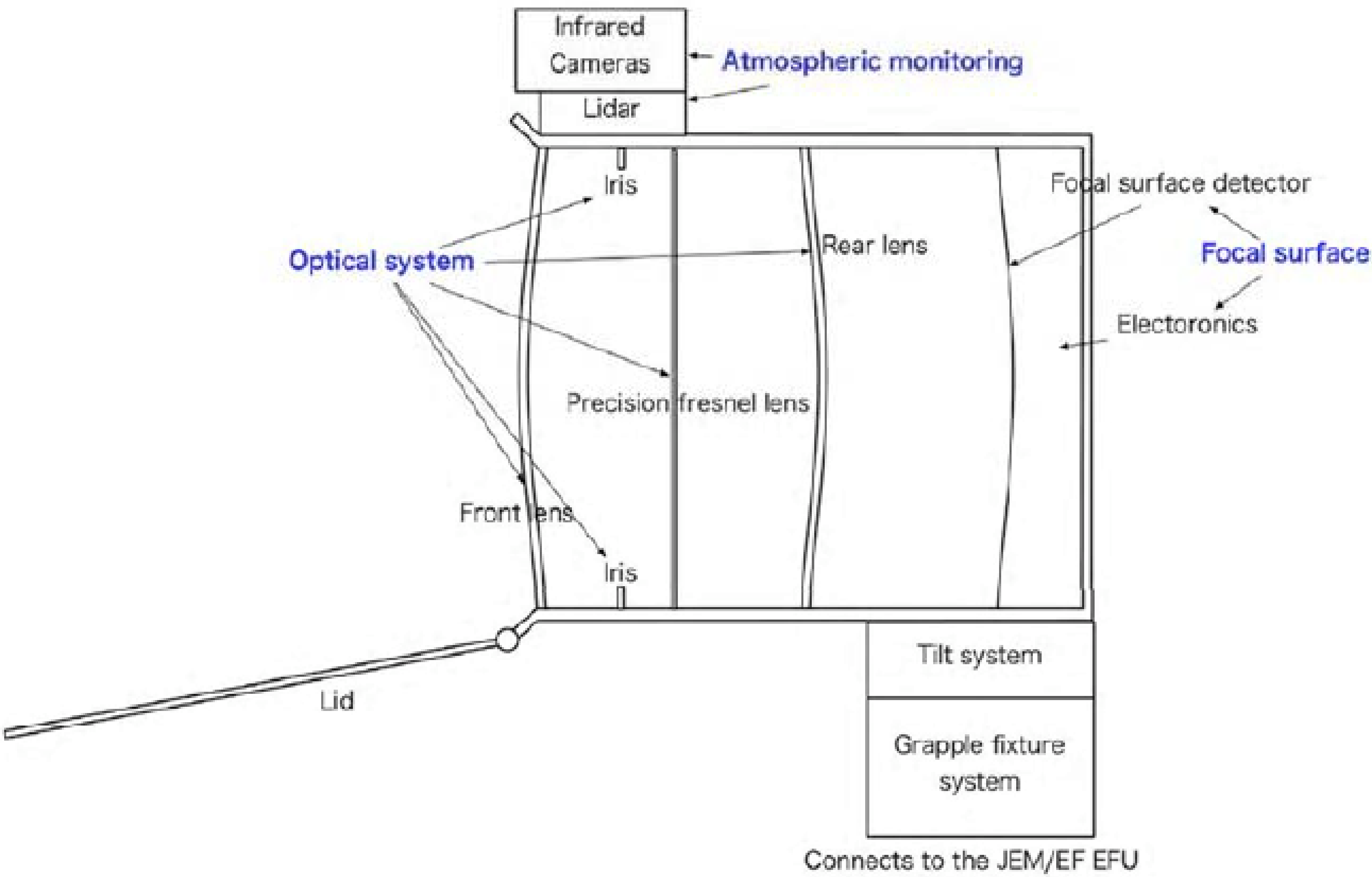


FITE Summary

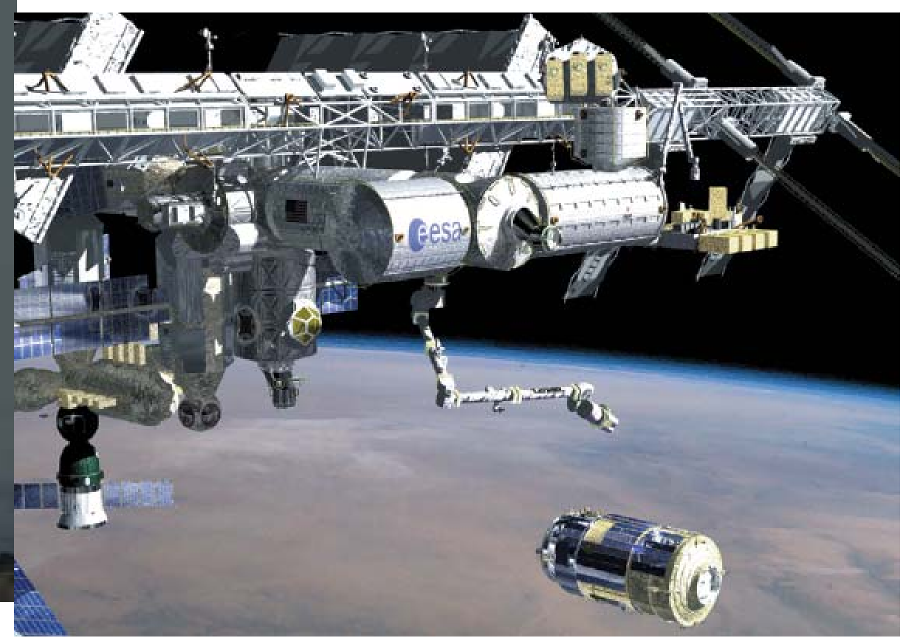
- Structure
  Dimension : 8.5m x 4m x 2.5m (H)
  Dry Weight : 1620 kg (without Ballast)
  Structure : CFRP Pipes + Aluminum Pipes
- Telescope/Interferometer
  Type : Two-Beam Fizeau-Type Interferometer
  Mirrors : Four Plane Mirrors (SiC)
  Two Off-Axis Parabolas (Zerodur)
  Aperture : 40 cm (dia)
- Sensors
  Far-Infrared : 15 pixel array (newly developed)
  Beam Monitors : MIR 320x240 array + 3 CCDs
  Cryostat : Super-fluid He (30 ltrs)
- Control System
  Onboard System : 6 CPUs + Functions
  Moving Part : 25 actuators
  Battery : 300 AH @ 24 volts (Li-Ion, rechargeable)
  Data Rate : 192 kbps
  Ground System : 8 QL Monitors + Video Camera Monitor

Backup slide

JEM-EUSO telescope



HII-B

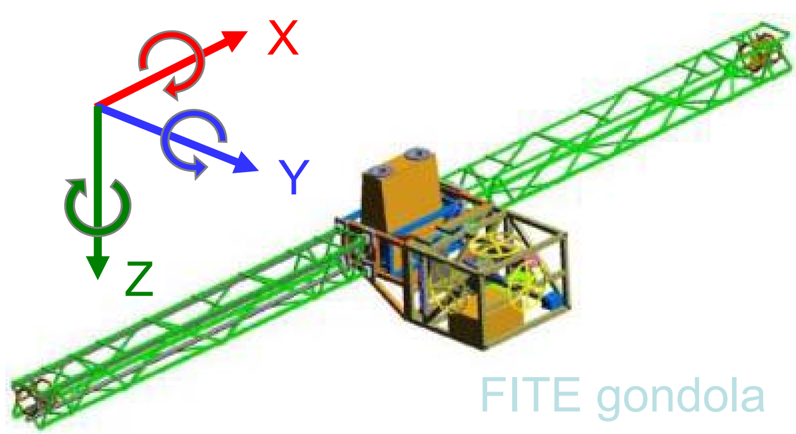


Attitude Control for FITE

- FITE project aims for a spatial resolution of 1” (4” for the first flight)

  → Attitude stabilizing accuracy required is 1” (4” for the first flight)

- Adopt <u>Three-axis Stabilized Attitude Control System</u>
  - Hang the gondola at its gravity center
  - Control its three-axis attitude
  - Second trial in the world for balloon-borne telescope

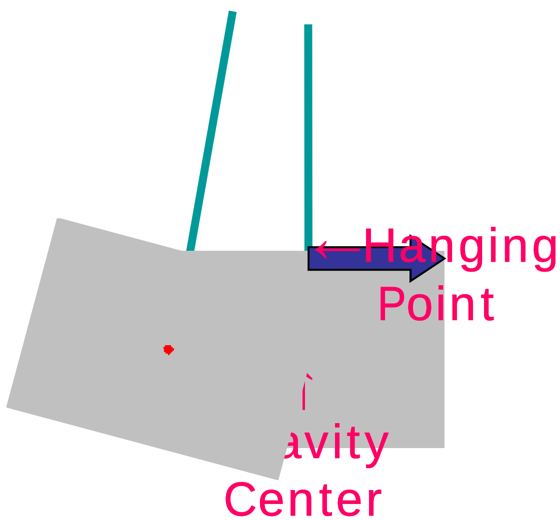


FITE gondola

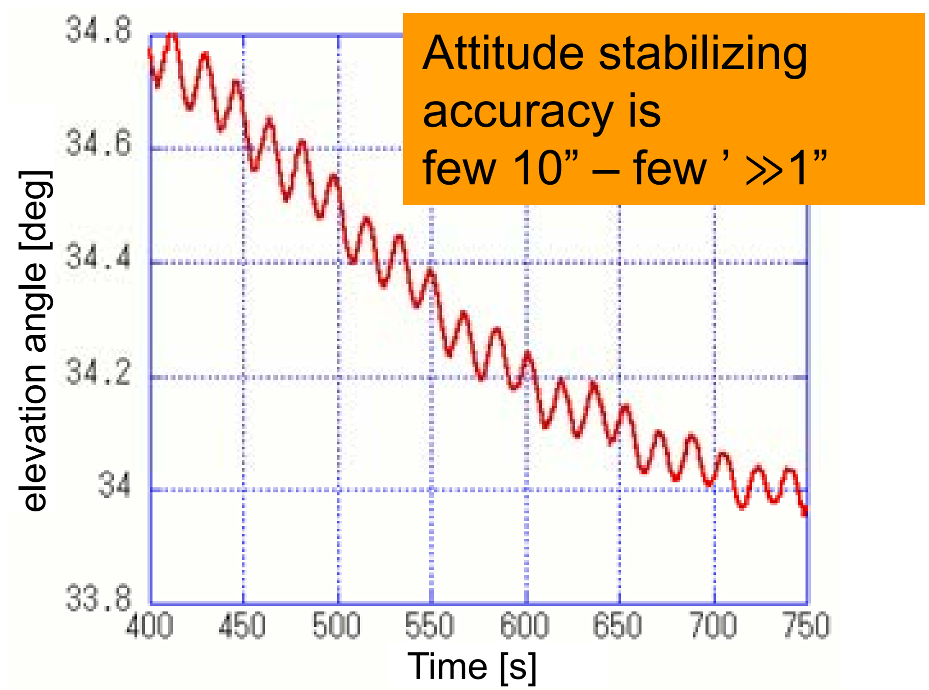
Alt-azimuth Pointing System

~ traditional control system for balloon-borne telescope

- Control elevation angle + azimuthal angle
- The gondola is stabilized by gravity

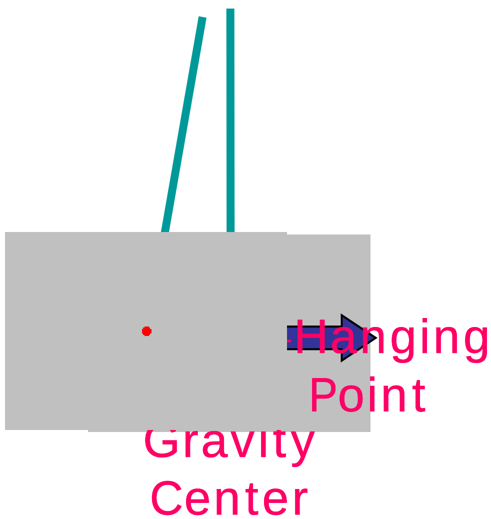


balloon-gondola pendulum motion



Pendulum motion of balloon-borne telescope (recorded at FIRBE observation, 2001)

When the gondola is hung at its gravity center, ...



Attitude of the gondola does not change!

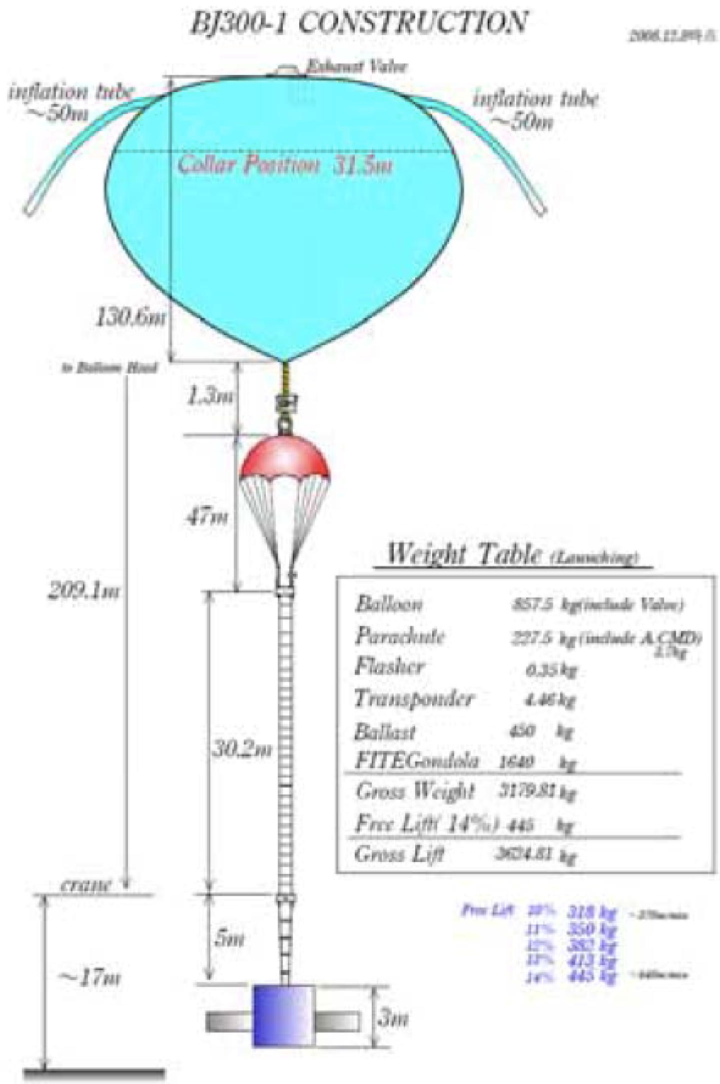
No couple of force

→ No pendulum motion

We can control its attitude with high accuracy

⇔ need to control its three-axis attitude

First Trial - December in 2008 in Brazil



Collaboration with Brazilian Institute for Space Science (INPE)