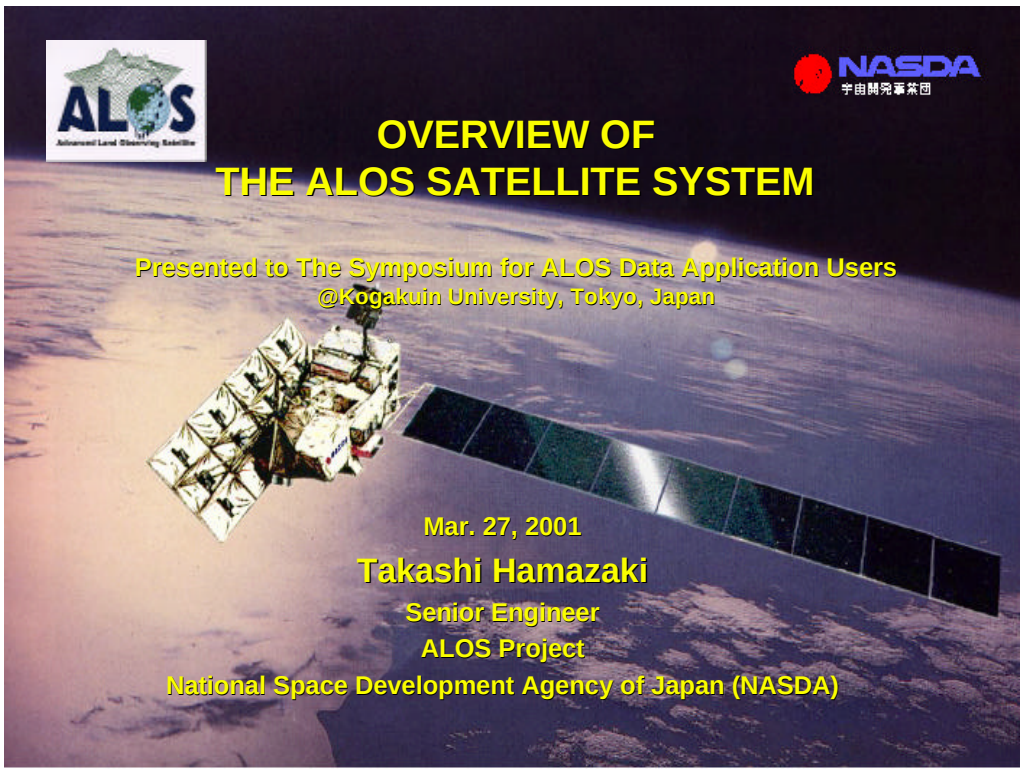


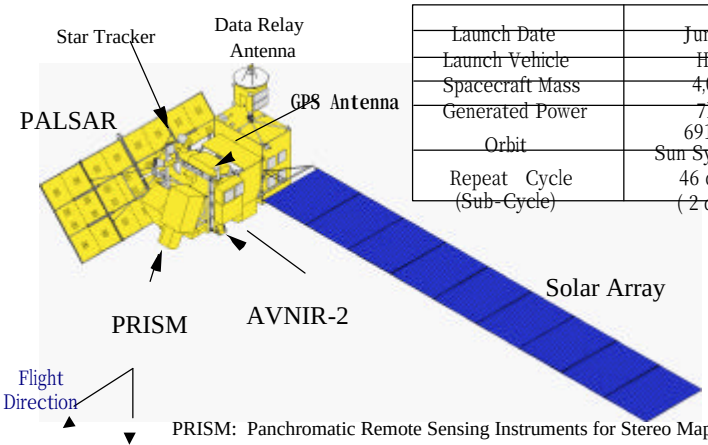
Agenda

- ALOS Mission Objectives
- ALOS Satellite System and Development Schedule
- ALOS Key Technology Development
- Conclusion

ALOS Mission Objectives

- Land Observation Technology Development
- Contribution to the following fields of applications
  - Cartography
    - 1/25,000 scale map, 3 to 5m accuracy Digital Elevation Model(DEM)
    - High resolution (2.5m) and wide swath width (35 or 70km)
    - Mapping without any Ground Control Points
  - Regional Environmental Monitoring
    - Multi-Spectral & Multi-Polarization Observation
    - Same Area/ Simultaneous Observation with Optics & SAR
    - Wide Swath Width and Frequent Observation (Seasonal Changes)
  - Disaster Monitoring
    - Observation within 48 hours (on the equator) or 24 hours (at 60deg latitude)
  - Earth Resources Survey
    - JERS-1 Successor

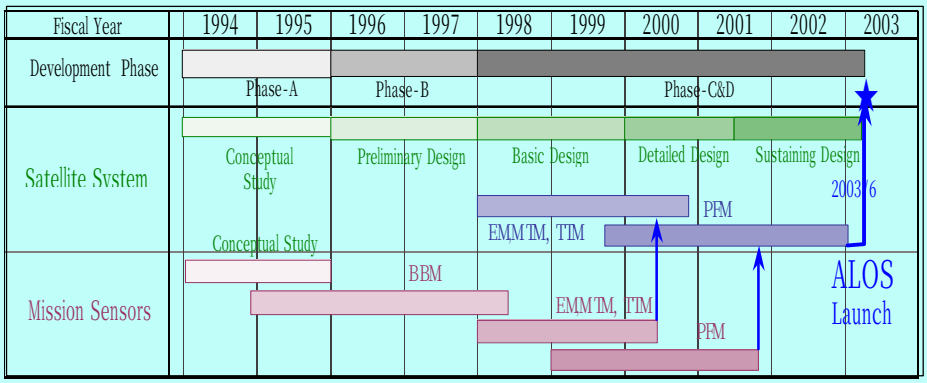
ALOS Satellite System



Launch Date	June 2003
Launch Vehicle	H-IIA
Spacecraft Mass	4,000kg
Generated Power	7kW
Orbit	691.65km Sun Synchronous
Repeat Cycle (Sub-Cycle)	46 days (2 days)

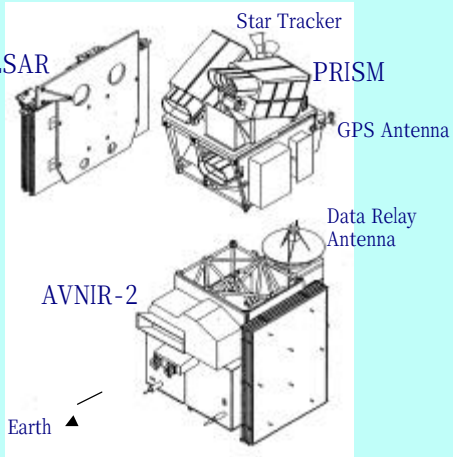
PRISM: Panchromatic Remote Sensing Instruments for Stereo Mapping
AVNIR-2: Advanced Visible and Near Infrared Radiometer type 2
PALSAR: Phased Array type L-band Synthetic Aperture Radar

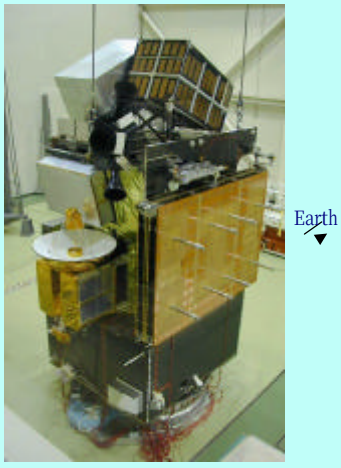
ALOS Development Schedule



BBM: Bread Board Model
EM: Engineering Model
MTM: Mechanical Test Model
TTM: Thermal Test Model
PFM: Proto Flight Model

ALOS Mechanical Test Model (MTM)





ALOS Mechanical Test Model

ALOS Thermal Test Model (TTM)

ALOS Thermal Test Model (TTM)

@13mΦ Space Chamber,
Tsukuba Space Center, NASDA

Mapping Requirements

1) Providing 3 to 5m altitude accuracy Digital Elevation Model.
   a) 2.5m resolution panchromatic image.
   b) Triplet stereoscopic images with nadir, forward, and backward sensors.
   c) Base to Height ratio between forward and backward sensor is equal to 1.0.

2) Providing "Mapping without any Ground Control Points" capability.
   d) Exact satellite position information within 2.5m accuracy.
   e) Exact satellite attitude information within 0.0002-degree accuracy.
   f) Absolute time information for each pixel within 0.00037sec accuracy.

3) Providing "Distortion free image".
   g) Long term attitude stability within 0.0002deg/5sec .

Requirement 1), 2), and3) ;
   h) Minimizing thermal distortion during orbital period (100minutes)
      - Among Sensor's optic axes.
      - Between Sensor's optic axis and attitude sensors.

ALOS Key Technology Development

(1) High Resolution Optics
- High Resolution (2.5m) & Wide Swath Width (35 or 70km)
- Triplet Stereo Optics (Base to Height ratio=1.0)

(2) L-band Synthetic Aperture Radar (SAR)
- Variable Off-Nadir angle, Full polarimetry
- Active Phased Array Antenna

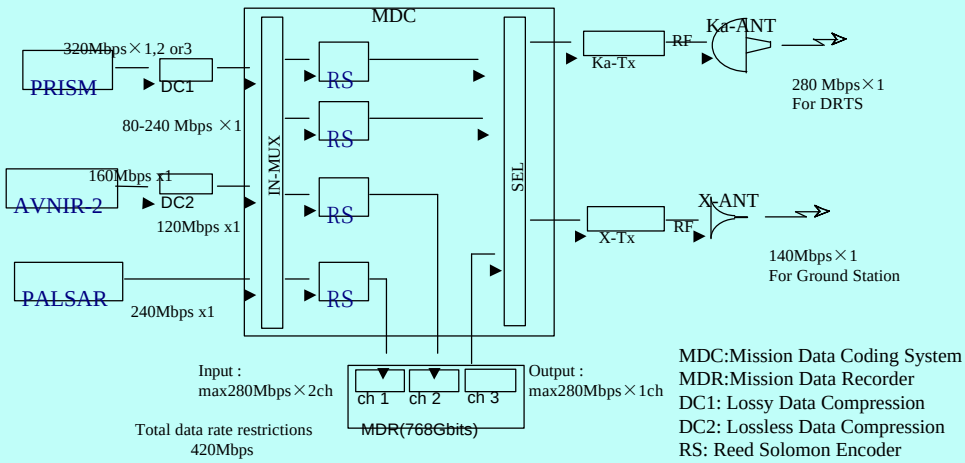
(3) High Speed Mission Data Handling System
- Over 1Gbps data handling, via Data Relay Satellites

(4) Precise Position and Attitude Determination System
- Mapping without any Ground Control Points

(5) Highly Stable Attitude Control System
- Distortion Free Image

(6) Low Thermal Distortion Structure

High Speed Mission Data Handling System



MDC:Mission Data Coding System
MDR:Mission Data Recorder
DC1: Lossy Data Compression
DC2: Lossless Data Compression
RS: Reed Solomon Encoder

High Speed Mission Data Handling System

- Over 1Gbps On-Board Data Handling
- High Speed Real Time Data Compression
  - 960Mbbps→240Mbps
- Solid State Mission Data Recorder
  - Speed:420Mbps, Capacity:768Gbits
- Reed Solomon Error Correction Coding
  - Bit Error Rate<10^{-16}
- CCSDS (Consultative Committee for Space Data Systems) Format
- Data Relay Satellite
  - 280Mbps @DRTS-W/-E , 140Mbps@ARTEMIS

Mission Data Transmission

- Data Relay Satellite
  - Primary path for ALOS mission data transmission
  - DRTS-W(2002), DRTS-E(TBD)
  - 280Mbps×1ch (Ka band)
  - TT&C (S band)
  - Receiving Stations: Tsukuba and Hatoyama.
  - Sharing with ADEOS-II and JEM
  - ESA/ARTEMIS available, TDRS Next compatible.

- Direct Transmission
  - Secondary path for ALOS mission data transmission
  - 140Mbps×1ch(X band)
  - Receiving Station: Hatoyama and foreign ALOS data node stations (under negotiation).

Precise Position and Attitude Determination System

- Crucial for “Mapping without any Ground Control Points”
- Dual Frequency Carrier Phase Tracking type GPS Receiver
  - Position Accuracy 0.2~1.0m
- High Accuracy Star Trackers
  - Attitude Accuracy 0.0002 degree (2.5m nadir point uncertainty)
- Absolute Time Clock
  - Synchronized to GPS absolute time and UTC.
  - Accuracy 0.0000004sec (4 μ sec) to GPS absolute time.
  - No drifts and No calibration necessary.

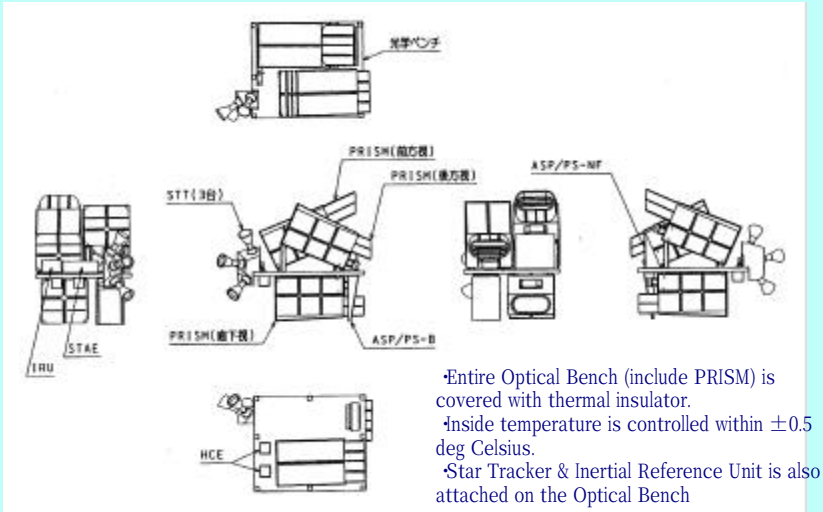
Highly Stable Attitude Control System

- Crucial for “Distortion Free Image”
- ALOS attitude stability
  - 0.0002 degree per 5sec.
  - Corresponds to 2.5m or one pixel distortion within 35km square scene.
- Attitude Disturbance from major vibration sources;
  - Data relay communication antenna pointing mechanics.
  - AVNIR-2 pointing mirror drive mechanics.
  - Solar array drive mechanics.
  - PALSAR antenna structural vibration.
- Required Technology
  - Feed-forward technique
  - On-board parameter tuning.
  - Solar Array Random Rotation

Low Thermal Distortion Structure

- Integrated Optical Bench Concept
- Thermally Insulated Truss-type Primary Structure
- Negative Thermal Expansion CFRP Truss
  - Cancellation of Metal Fitting's positive Thermal Expansion

Optical Bench Concept



•Entire Optical Bench (include PRISM) is covered with thermal insulator.
•Inside temperature is controlled within ±0.5 deg Celsius.
•Star Tracker & Inertial Reference Unit is also attached on the Optical Bench

Conclusion

- ALOS Development Status:
  - In the Final Stage of Technology Development.
  - Ready for System Critical Design Review and PFM Assembly.
- "Well-Balanced" and "Well-Integrated" Earth Observation Satellite System.
  - "Sensor's Performance is Important but not Everything."
- Close Communication/Interaction with User Community.
  - Flexible Operation and Minimum Operational Restrictions.
  - "Mapping without any Ground Control Points" capability
- User Community's Strong Support and More Involvement is Crucial for Mission Success.