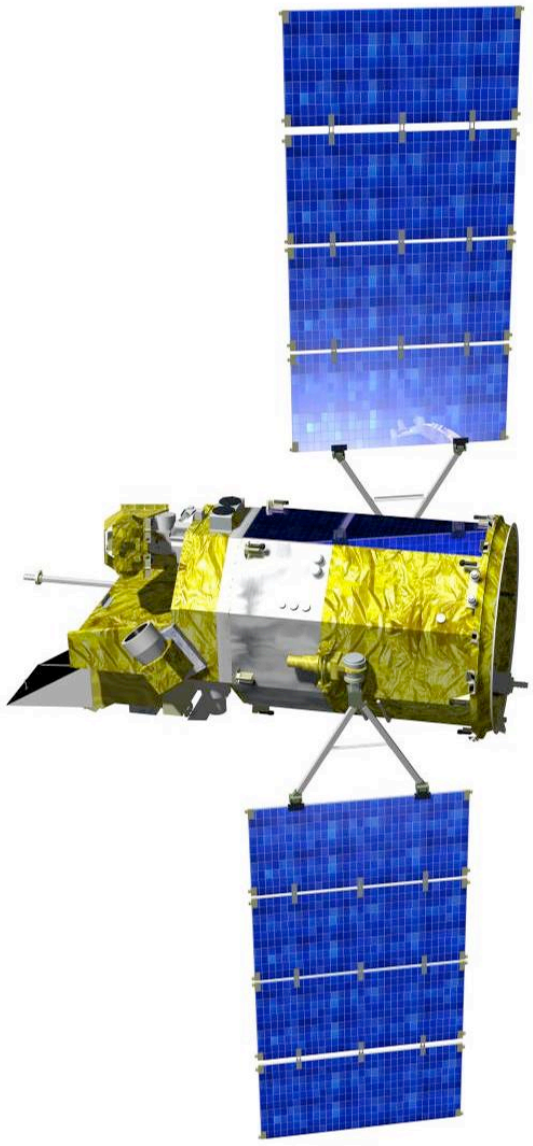
Glory Introduction Package

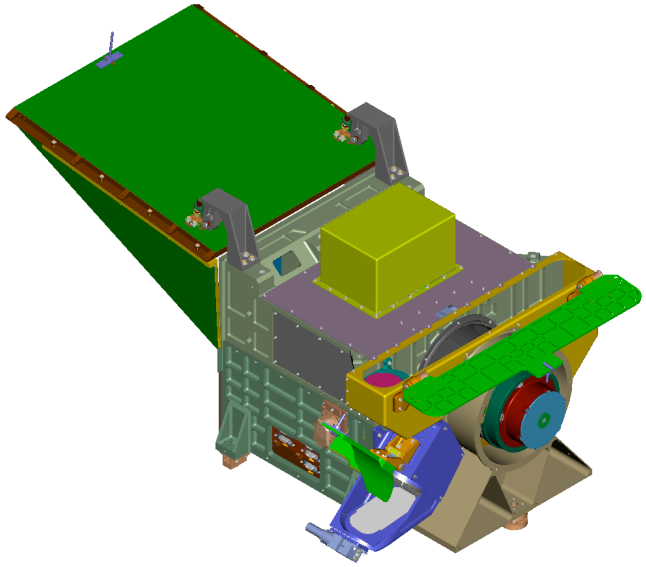
March 2008

Glory Mission Overview

- Mission Objectives
  - Increase our Understanding of Aerosols as Agents of Climate Change by Flying an Aerosol Polarimetry Sensor (APS), and
  - Continue Measuring the Sun's Direct and Indirect Effects on Climate by Flying a Total Solar Irradiance (TIM) Sensc
- Level 1 Requirements Baselined November 2005
  - Contains Full and Minimum Success Criteria
- Mission confirmed December 2005
  - Mission Risk Classification / Class C - in accordance with NPR 8705.4
  - Project Categorization / Mission Category II - in accordance with NPR 7120.5C
  - Launch Vehicle / Risk Category 2 - in accordance with NPR 8610.7C
- Mission Design
  - 3 years (5 year consumables)
  - 705 km Altitude, 98.2 degrees Inclination (Sun-Synchronous)
  - March 2009 Launch Readiness from the Vandenberg Air Force Base

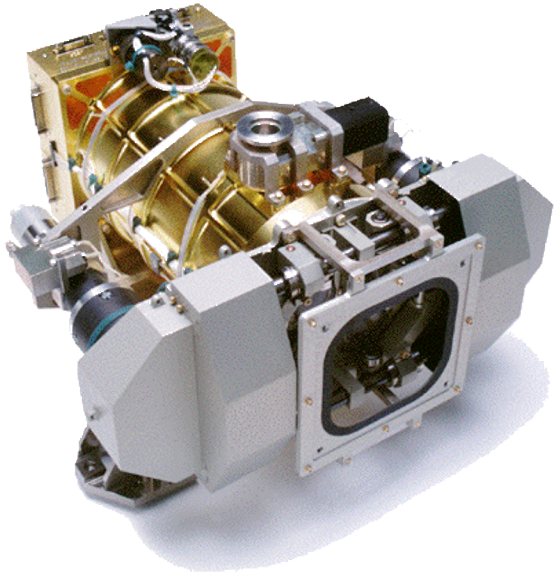


Glory Science Summary



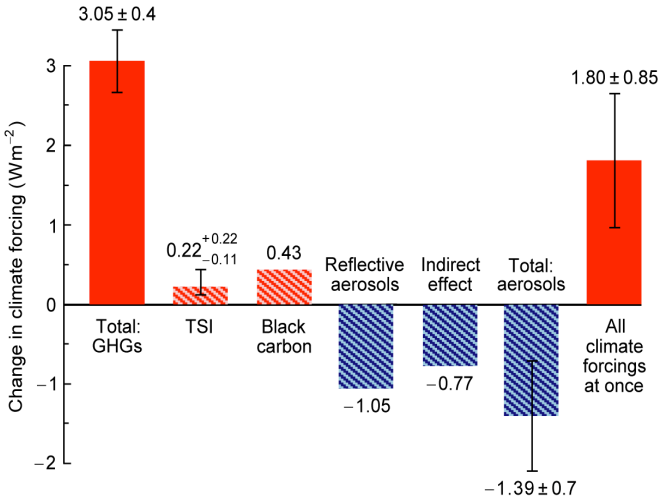
APS will help to quantify the role of aerosols as natural and anthropogenic agents of climate change with much better accuracy than existing instruments

TIM will continue measuring the 28-year record of total solar irradiance (TSI) with improved accuracy and stability to determine its direct and indirect effects on climate

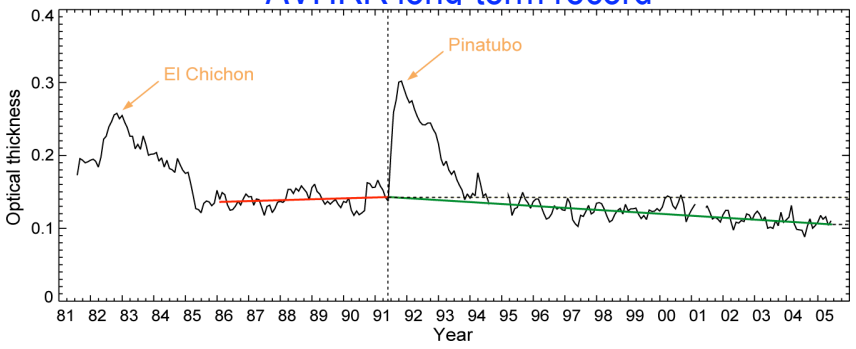


Uniqueness of Glory Science – Aerosols

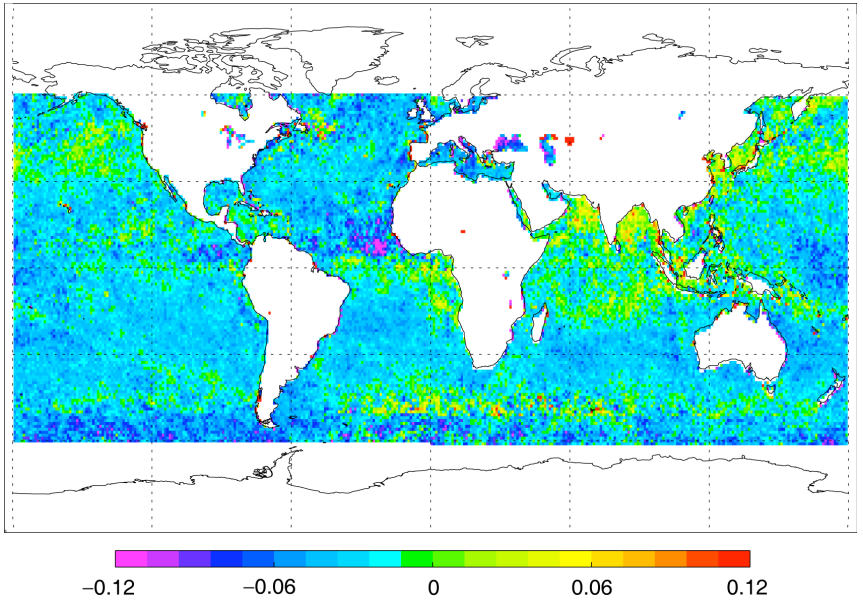
Aerosol radiative forcing must be constrained to _ W/m^2. This accuracy is at least 5 times better than what the existing instruments can yield but should be attainable with the Glory APS



AVHRR long-term record

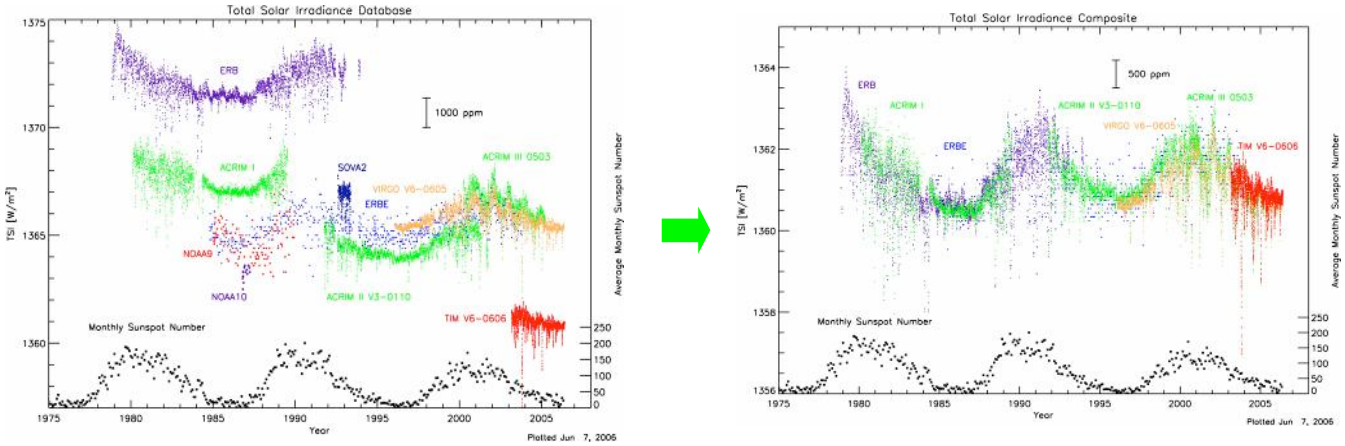


Aerosol optical thickness difference between the early 2000s and late 1980s

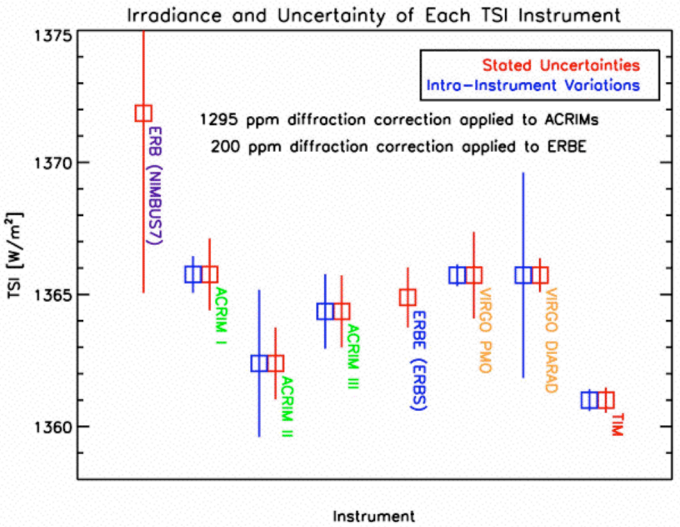


Uniqueness of Glory Science - TSI

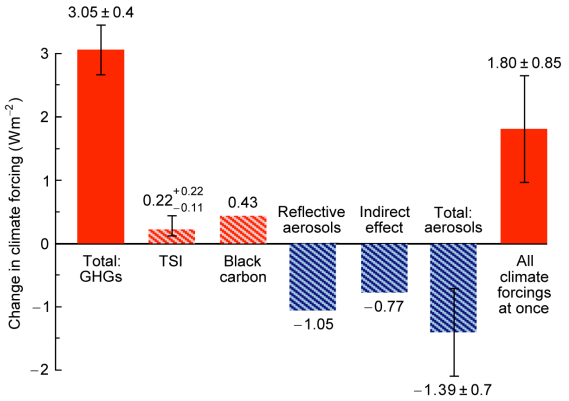
TSI measurements need to be accurate and well-connected to the existing 28-year record



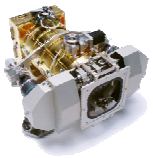
Existing TSI instruments have large uncertainties and intra-instrument variations. The Glory TIM will improve significantly the absolute accuracy of the TSI record

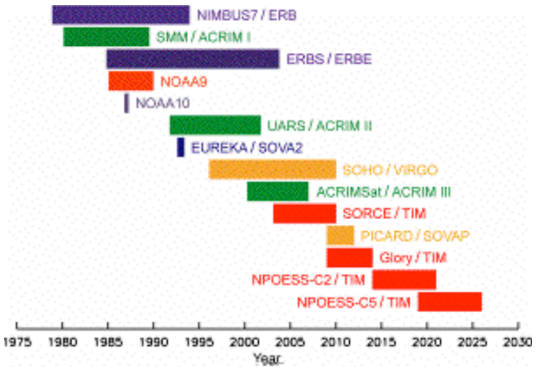


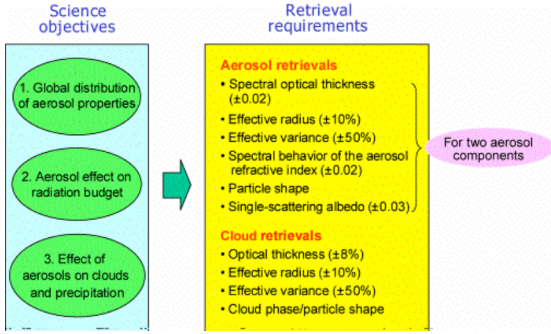
Glory Science Data Fills Critical Gap in Climate Model

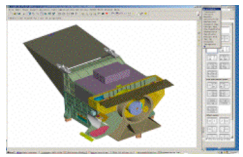


- ✓ Continuity of record
- ✓ Accuracy 100 ppm
- ✓ Stability 35 ppm/year









Critical Importance of APS Science

Glory APS will help answer one of the key science questions posed in the *U.S. Climate Change Science Program*:

"What are the climate-relevant chemical, microphysical, and optical properties, and spatial and temporal distributions, of human-caused and naturally occurring aerosols?"

In particular, APS will directly contribute to addressing the CCSP calls for

- major advances in understanding of the factors that determine atmospheric concentrations of aerosols,
- an improved description of the global distributions of aerosols and their radiative properties,
- a reduced uncertainty regarding the direct and indirect effects of the changing distributions of aerosol, and
- a more definitive observational foundation to evaluate decadal- to century-scale variability and change.

Critical Importance of TIM Science

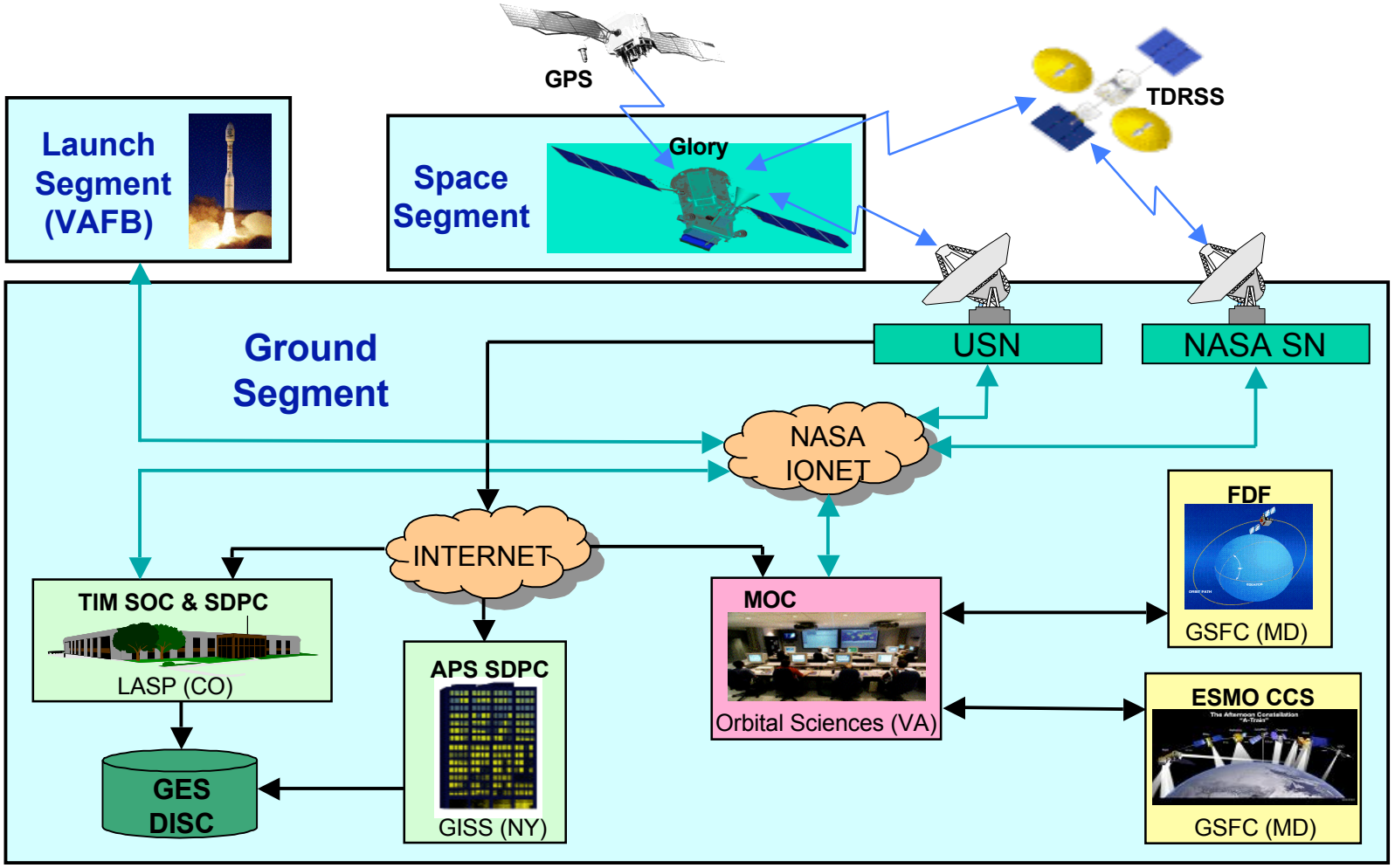
"One activity ranks above all others for determining solar influence on global change: Monitor the total and spectral irradiance from an uninterrupted series of spacecraft radiometers employing in-flight sensitivity tracking."

Solar Influence on Global Change
National Academy of Science Report

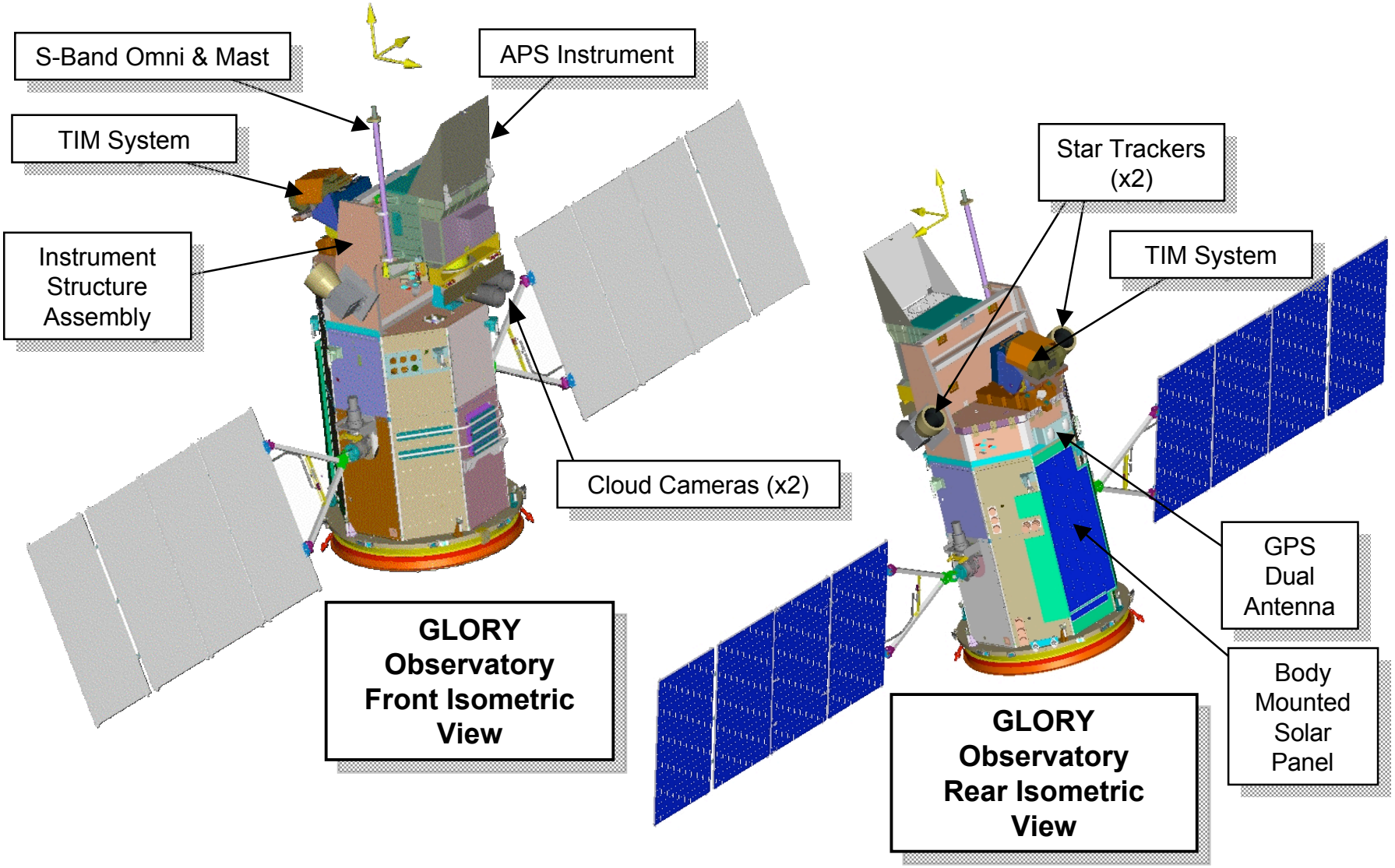
Key Baseline and Minimum Mission Requirements

Mission Objective	Baseline Mission Requirements	Minimum Success Criteria
Mission Level Requirements: Capture, process, calibrate, and validate aerosol, cloud and solar irradiance data		
Mission Duration	At least three years of continuous observations for seasonal and regional trends	Provide APS science data to enable a greater understanding of the seasonal variability of aerosol properties, i.e., data from four sequential seasonal periods. Provide TIM science data as a continuation from the SORCE mission
Initial Science Data Delivery	First release of validated data at launch readiness date plus six months	No time constraint specified
Total Solar Irradiance Data: Collect Total Solar Irradiance (TSI) measurements over the X-ray to microwave range consistent with the continuity of measurement with respect to the SORCE mission		
Total Solar Irradiance Measurements	The TIM instrument shall: • have the capability to continuously measure TSI data to an accuracy of ≤350 ppm (1σ) • with stability of ≤ 10 ppm (1σ)	Produce the following environmental data records: • Six-hourly average total solar irradiance [accuracy of ≤100 ppm (1σ) and stability of ≤ 35 ppm (1σ) or accuracy of ≤350 ppm (1σ) and stability of ≤ 10 ppm (1σ)] • Daily average irradiance
Aerosol Data: Collect aerosol optical thickness and microphysics data for two modes of the aerosol population, including spectral behavior of the aerosol refractive index and single-scattering albedo		
APS Wavelength & Angular Sampling	Observe each sub-satellite view of the Earth using multiple spectral bands, ***six*** spectral bands between 0.4 and 1.0 _m and ***three*** spectral bands between 1.0 and 2.4 _m, from multiple angles within its field of regard	Observe each sub-satellite view of the Earth using multiple spectral bands, ***four*** spectral bands between 0.4 and 1.0 _m and ***two*** spectral bands between 1.0 and 2.4 _m, from multiple angles within its field of regard
APS Instrument Accuracy	Radiometric accuracy of better than 8% and polarimetric accuracy of better than 1% in all bands used for the determination of aerosol and cloud properties at radiance levels typical of aerosols over the ocean and higher	Radiometric accuracy of better than 8% and a polarimetric accuracy of better than 1% in all bands used to determine aerosol and cloud properties
Cloud Screening in APS Field	Capable of creating an ancillary cloud mask from cloud camera measurements that is effective in screening of clouds for the purpose of producing aerosol retrievals	No equivalent minimum requirement defined. Implicit that APS will provide its own cloud-screening in the event that screening data from the Cloud Cameras is not available

Glory Mission Elements

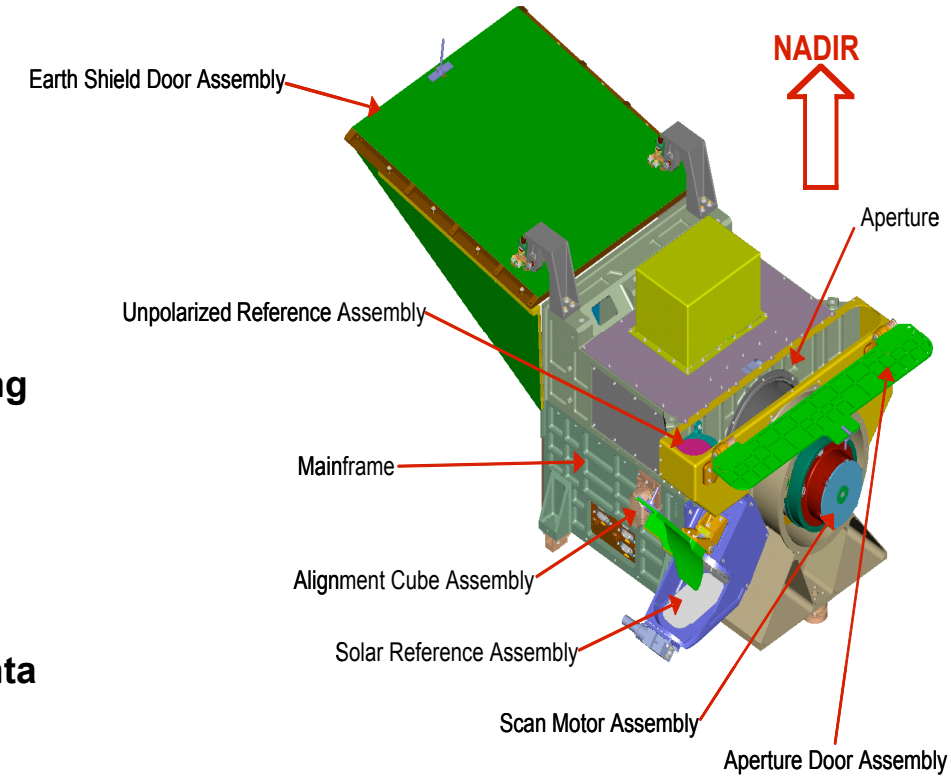


Glory Observatory Configuration

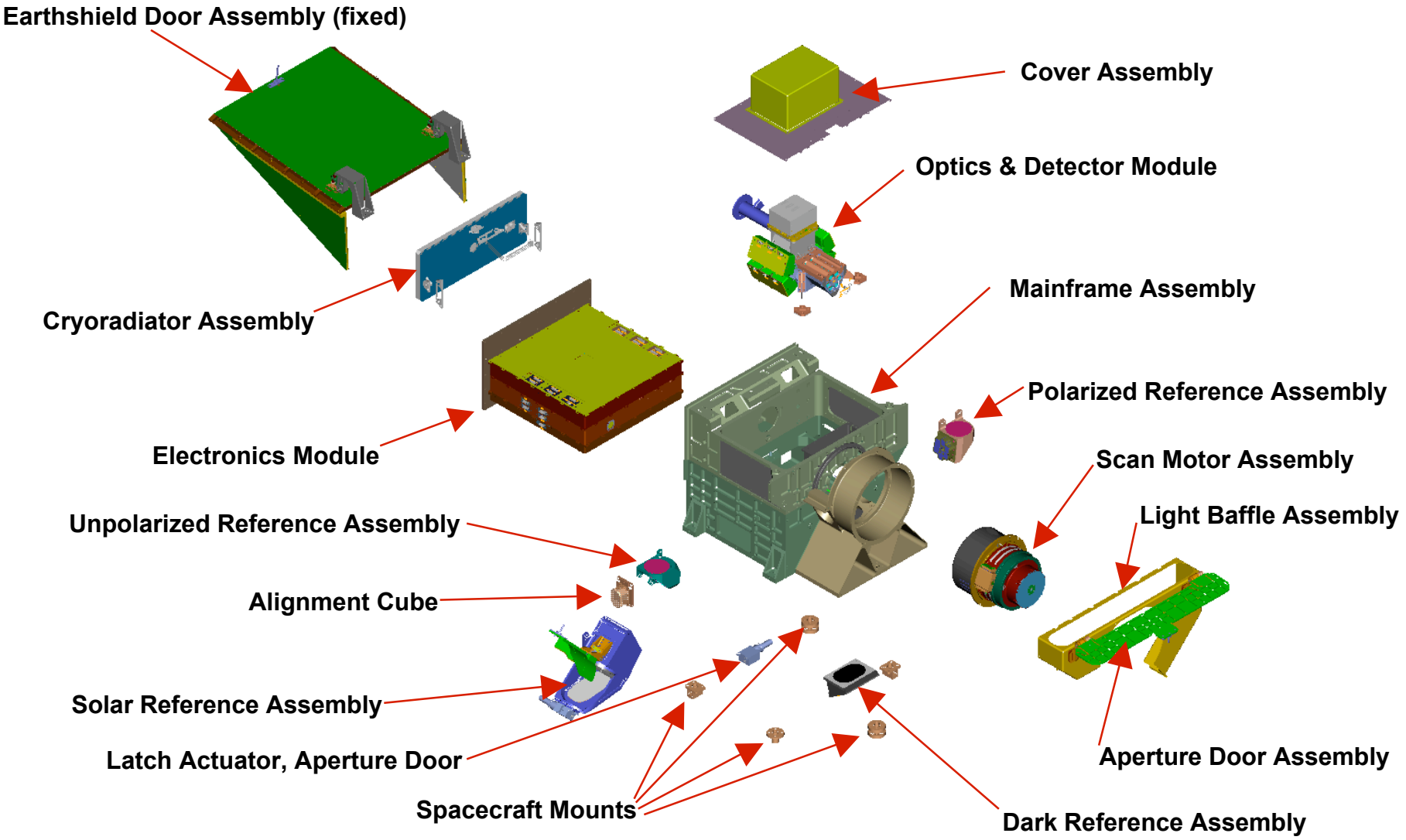


APS Instrument Overview

- **Along-track Scanning Polarimeter measuring polarized reflectance vs. angle for retrieval of aerosol and cloud properties**
- **9 spectral bands from 410 – 2250 nm**
- **Temporally and spatially simultaneous measurements obtained from 6 boresighted telescopes**
- **2 windows & 2 mirrors comprise rotating scan mirror assembly**
-
- **Calibration maintained by continuous views of on-board polarimetric and radiometric calibrators**
- **Instrument developed by Raytheon Santa Barbara remote sensing**
- **CDR successfully completed April 11 – 13, 2006**



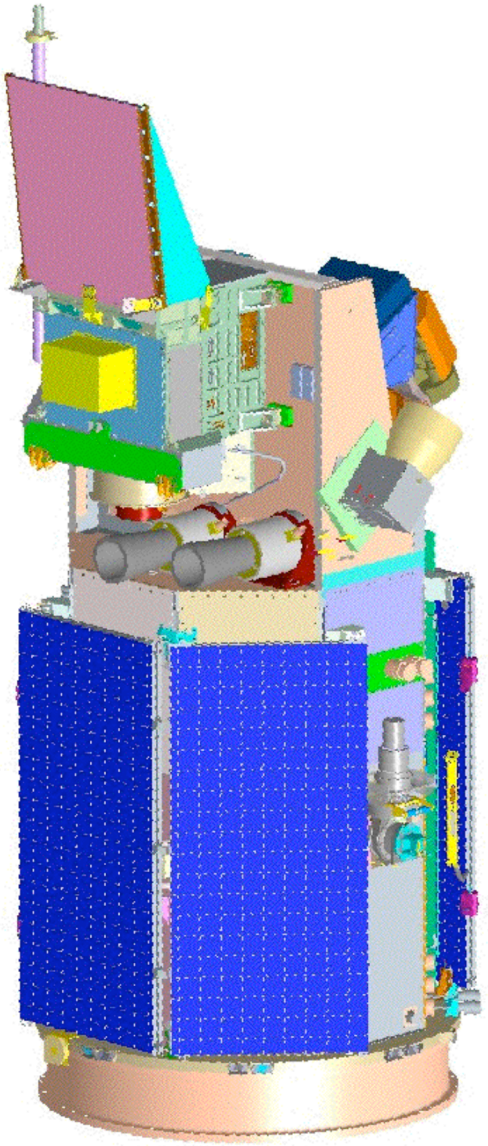
APS Expanded Physical Description



Spacecraft History

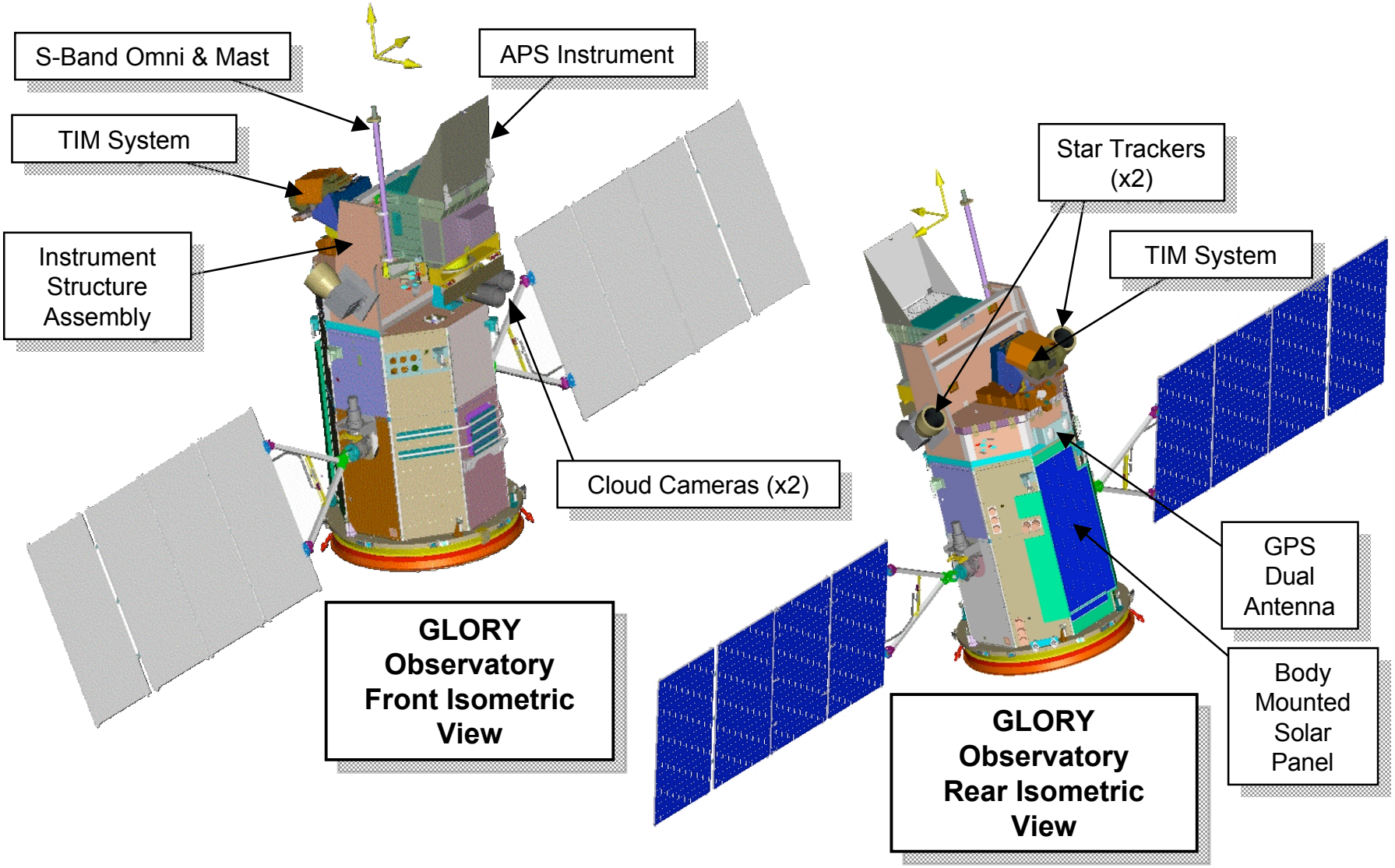
VCL	August 1998	• VCL Spacecraft Bus CDR
	December 2000	• VCL Spacecraft Bus Delta-Pre-Ship Review • Functional Performance Test Results By Subsystem and Open NCRs
	September 2001	• VCL Spacecraft Activity Terminated
Glory	Early 2004	• Glory letter contract awarded • VCL Spacecraft Re-Integrated w/GSE, SW and Ground System • Performed Evaluation Performance Test • Conducted Component Audit Review Of 58 VCL H/W Components & MRB
	June 2004	• Conducted Baseline Review
	February 2005	• Spacecraft Funding Suspended
	April 2005	• Spacecraft Funding Re-started
	June - July 2005	• PDR Subsystem Peer Reviews
	August 2005	• Spacecraft PDR
	April - May 2006	• CDR Subsystem Peer Reviews
	June 2006	• Spacecraft CDR

Reintegrated Glory Spacecraft

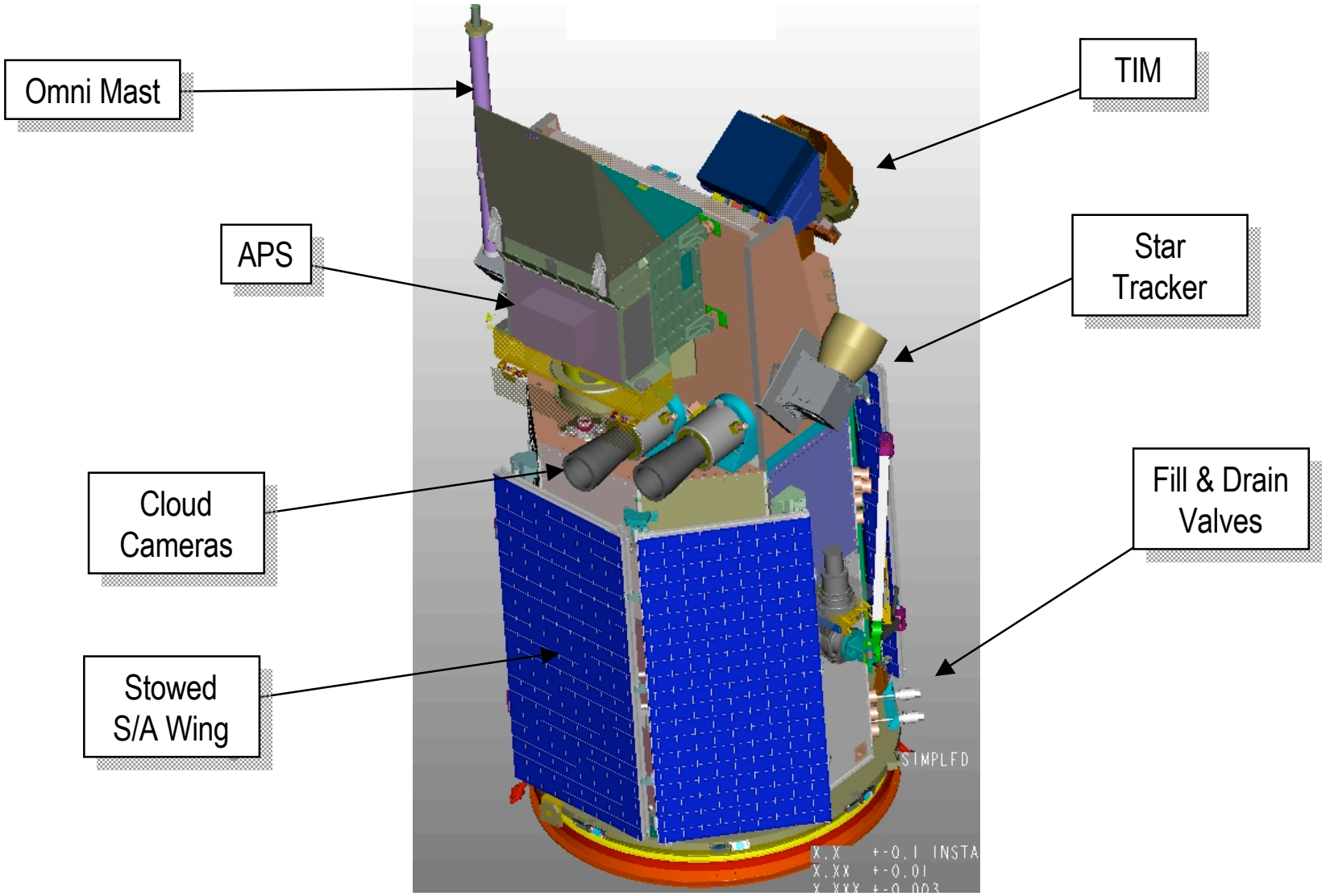


Weight	553 kg (Instruments + Spacecraft)
Power	335W Load (Solar Array Can Support 393W O.A. Load)
Comm.	X band: 40 Mbps downlink (5.7dB margin) S Band: 3.9kbps, 62.5kbps, or 2 Mbps downlink (all >3dB margin except TDRS uplink=+0.6dB)
Attitude control	150 arc sec roll; 1050 arc sec pitch; 450 arc sec control (74, 142, 96 arc sec. predicted); 120 arc sec per axis knowledge (34, 64, 44 arc sec predicted)
Reliability	0.85 for 3 yr. required; (0.86 for 3 yr. predicted)

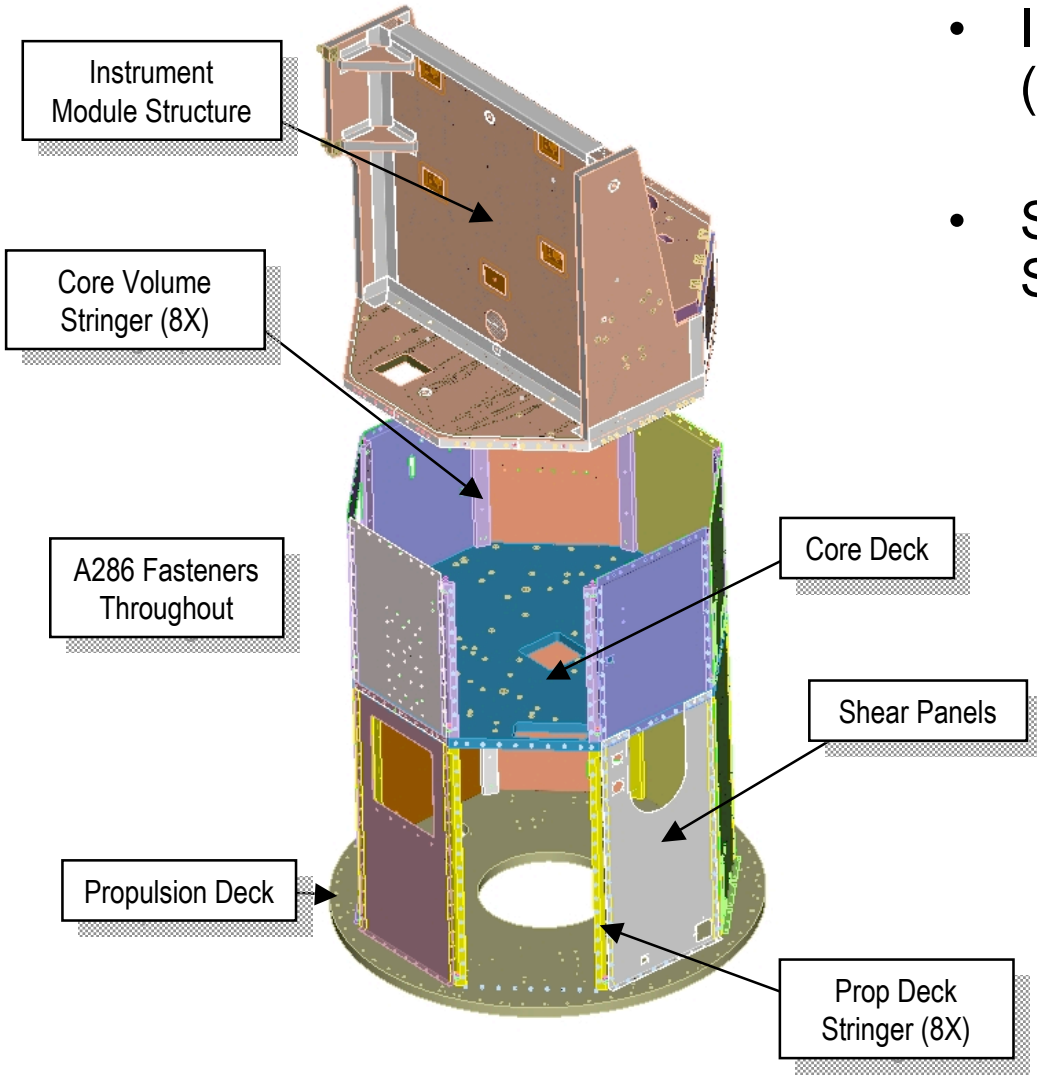
Glory Observatory Configuration



Observatory Configuration: Stowed

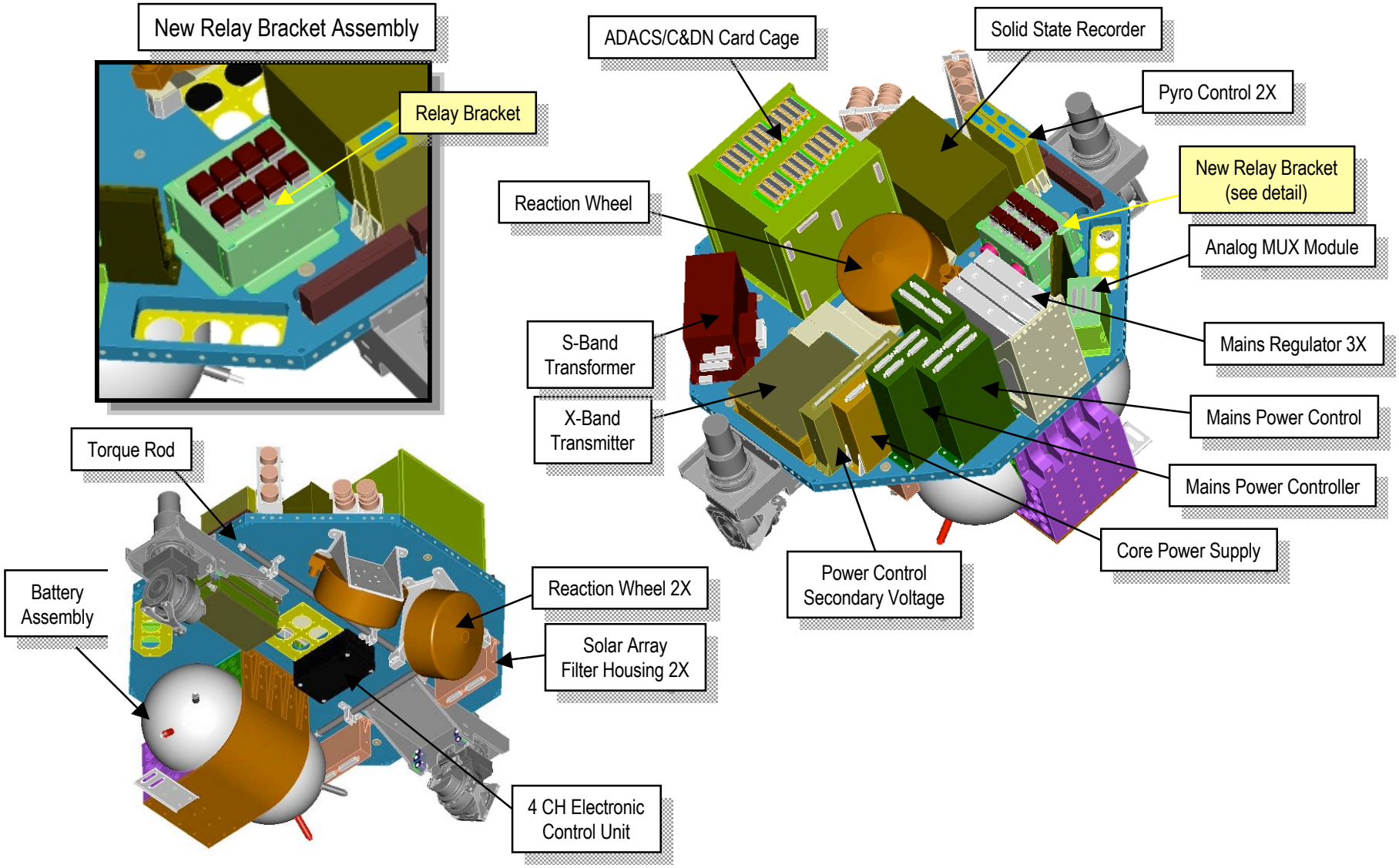


Primary Structure

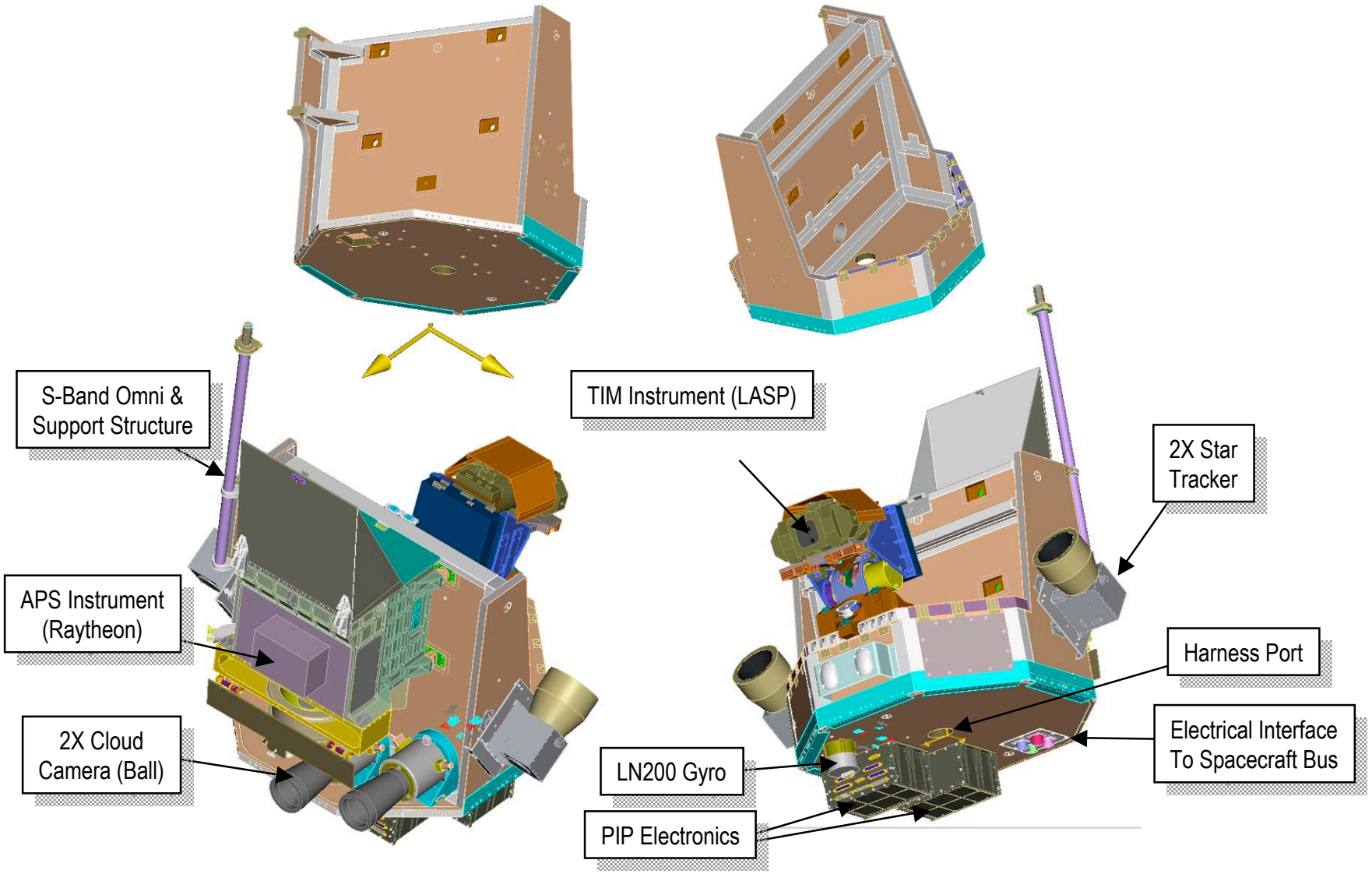


- Instrument Module Assembly (New)
  - Al Honeycomb panels
- Spacecraft Bus Primary Structure
  - Core Deck – Al Honeycomb (Existing)
  - Prop Deck – Solid Aluminum (New)
  - Stringers – Aluminum Bar (New)
  - Shear Panels – Sheet Aluminum (New)

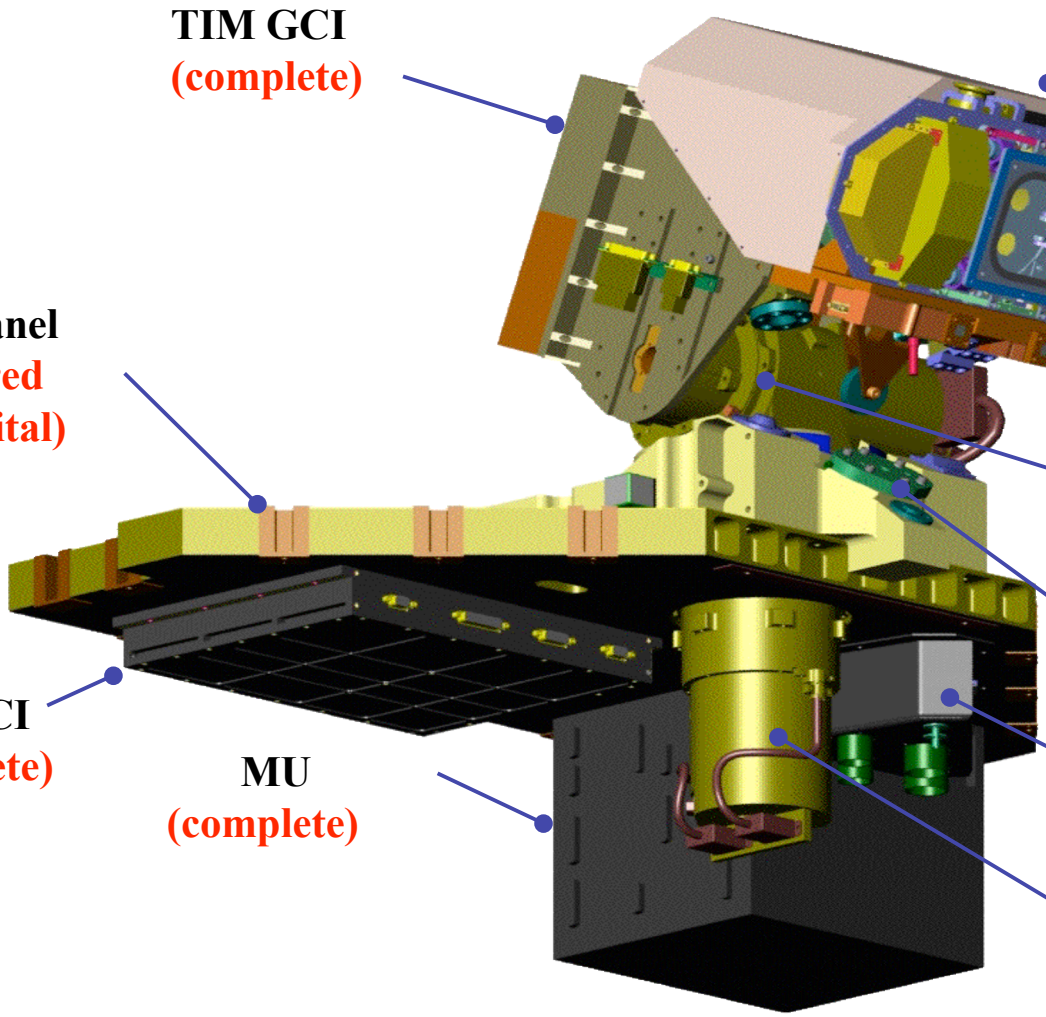
Core Deck—Existing Hardware



Instrument Module Assembly (IMA)—New Hardware



TIM Instrument System



TIM GCI
(complete)

Removable Radiator
(complete)

TIM Sensor
(complete)

TIM Panel
(delivered
by Orbital)

Fine Sun Sensors (2)
(complete)

Elevation Gimbal
(complete)

Launch Restraint System
(complete)

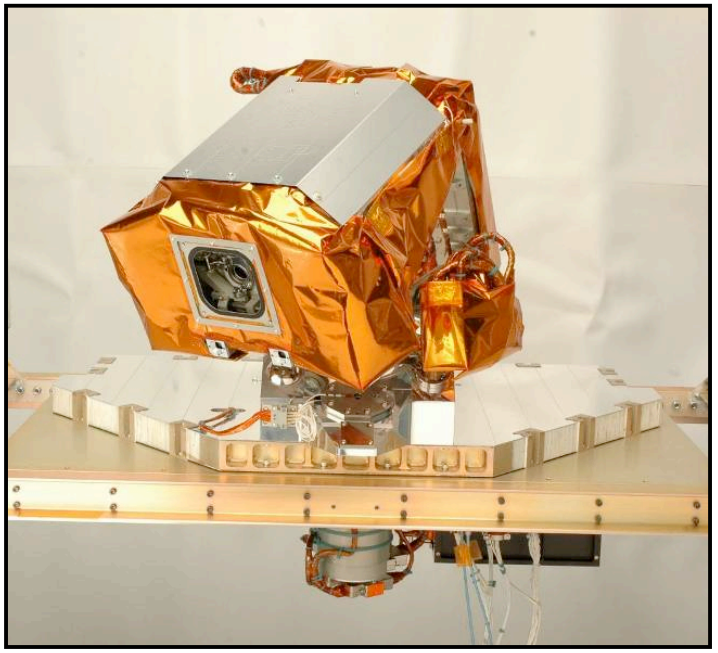
TPS GCI
(complete)

MU
(complete)

Connector Bracket
(complete)

Azimuth Gimbal
(complete)

Glory Total Irradiance Monitor (TIM)



- Req. unchanged from SORCE/TIM to Glory TIM CDR.
  - Performance
    - Accuracy 100 ppm (1s)
    - Stability 10 ppm/yr (1s)
    - Noise 1 ppm (1s)
  - Measure TSI for >3 yrs
  - Report four 6hourly and one daily average TSI measurement per day (Level 3 data products)

System Description (cont'd)

Total Mass: 3.1 kg each

Envelope: 5.25 in. diameter, 15 inch long

Power: 11.5 w each

Data Rate: 216 kbps total

Heritage:
CALIPSO Wide Field Camera
Ball CT-633 Star Tracker