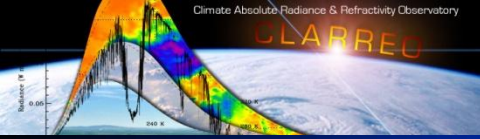


Climate Absolute Radiance and Refractivity Observatory (CLARREO)

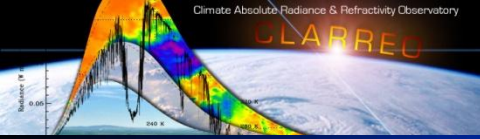
Extended Pre-Phase A Engineering Focus Areas

**Briefing to CLARREO Science Team
October 2011**



Overview

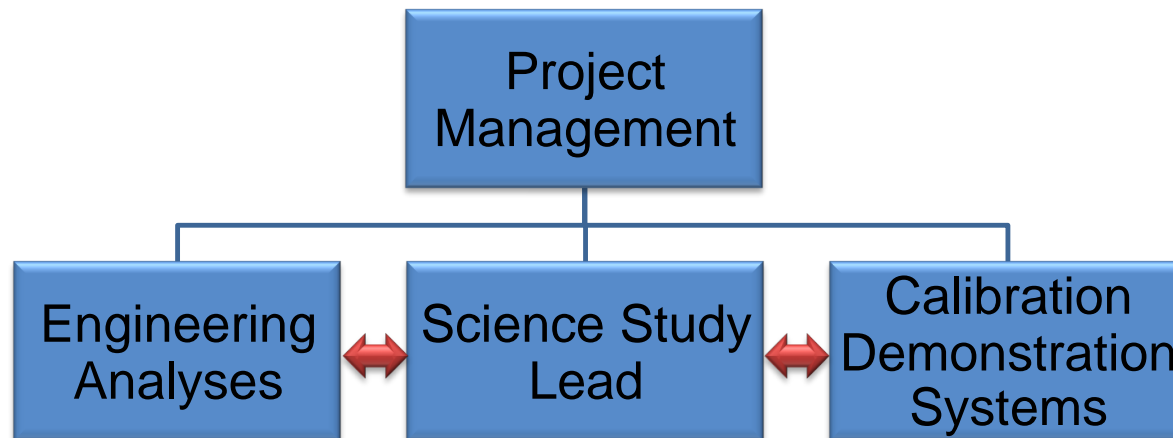
- **CLARREO Organization & Engineering Scope**
- **Identifying Alternative Opportunities**
- **Spacecraft Accommodations & Opportunities with Existing Projects**
 - Iridium Accommodation Study
 - FastSat Accommodation Study
- **Assessment Input to Science Studies**
- **Continued Support of Science Studies**

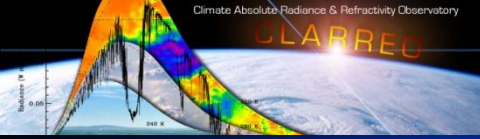


Extended Pre-Phase A Organization

- **Primary Objectives:**

- Identifies alternative means of achieving some of the CLARREO science objectives in a cost effective manner
- Identifies and pursues enabling work that will provide the agility, reduced risk and foundational science needed to capitalize on opportunities for implementing the alternative approaches

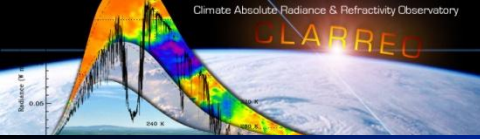




Engineering Scope

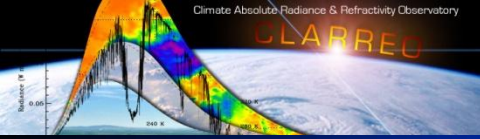
- **Develop and Evaluate Alternative Mission Concepts**
 - Engineering analysis of Missions of Opportunity concepts
 - Identify potential host spacecraft and mature vendor relationships
 - Access to Space Opportunities (Commercial, DoD, International)
 - Perform cost estimates for alternative instrument and mission concepts
- **Preliminary Instrument Accommodations Analyses**
 - Assessment of existing instrument synergy within established opportunities
 - Define compatibility targets for “out of scope” metrics
 - Update engineering portion of Science Value Matrix
- **Support Science Studies**
 - Orbital Sampling for Spectral Fingerprinting
 - Orbital Sampling for Reference Intercalibration

Alternative options will be considered primarily by the ratio, Science Value / Cost.



Alternative NASA Opportunities

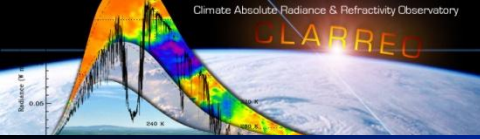
- **Earth System Science Pathfinder (ESSP) Program**
 - Earth Venture-2 solicitation (FIREX, Zeus proposals submitted: Sept 2011)
 - Earth Venture-Instruments (Draft AO released Sept. 29)
 - Common Instrument Interface (CII)
 - Continued interface with CII to understand guidelines for data, electrical power, mechanical, thermal, environmental, software, contamination.
 - Block-buy Affordability Study Kickoff set for next week
- **Stand Alone Missions of Opportunity (SALMON-2)**
 - Solicits proposals for Missions of Opportunity (MO) through NASA Mission Directorates (5 year cycle)
- **Earth Systematic Missions (ESM) Program**
 - Potential MOO with future Decadal Survey missions.



Hosting on Existing Platforms

- **International Space Station**
 - Offers large payload mass and volume allocations
 - Logistics, access to space, and attitude variations need to be considered
- **Iridium NEXT**
 - Has the advantage of numerous launch opportunities, but offers only small payload mass and volume allocations
- **Small Satellites: FASTSAT (MSFC)**
 - Initial studies of the MSFC FASTSAT satellite bus indicate that the CLARREO infrared and reflected solar instruments are too large for this platform
 - Future studies will investigate other existing small satellite opportunities
- **ESPA (DoD)**
 - Offers a well known interface for small spacecraft but poses some programmatic issues that need to be addressed
- **International & Inter-Agency Systems**
 - UK, EUMETSAT Polar System, Korean Meteorological Administration, NOAA

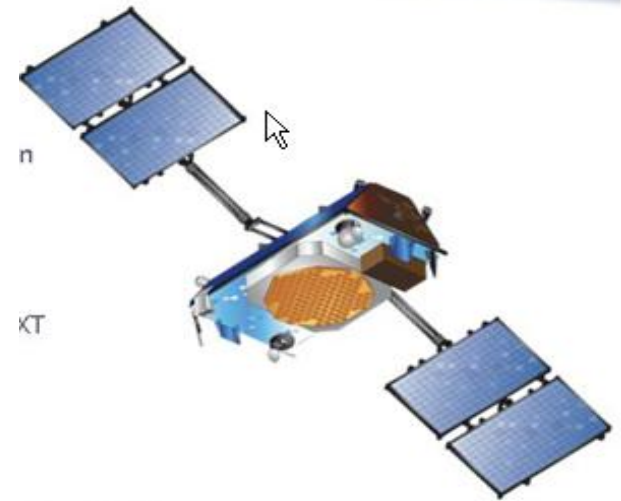




Iridium & FASTSAT

- **Iridium**

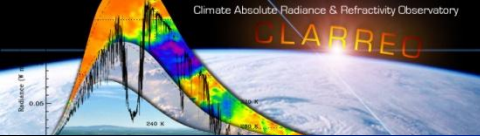
- Anticipated to begin launching in 2015
- 66 cross-linked satellites, 6 planes of 780 km, 86.4 deg. inclination
- 50 kg, 30 x 40 x 70 cm volume, 50 WOAP (200 W Peak), 1 Mbps
- Near-nadir observation



- **FASTSAT (NASA MSFC)**

- NASA/DoD microsat design supports standards of the ESPA ring
- 1 of 3 secondary microsat payloads launched Fall 2010 on Minotaur IV

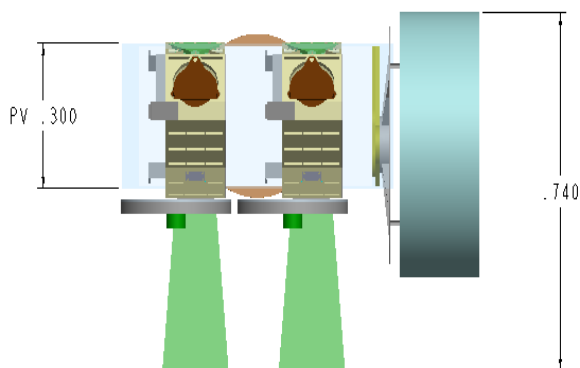




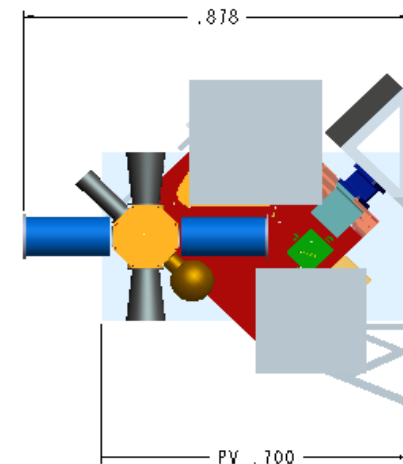
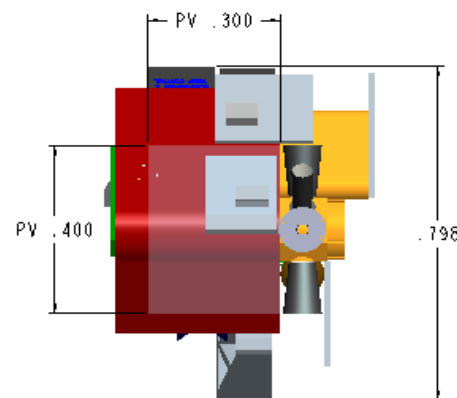
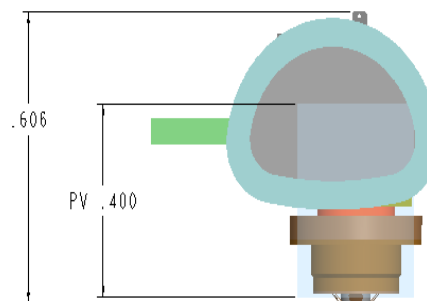
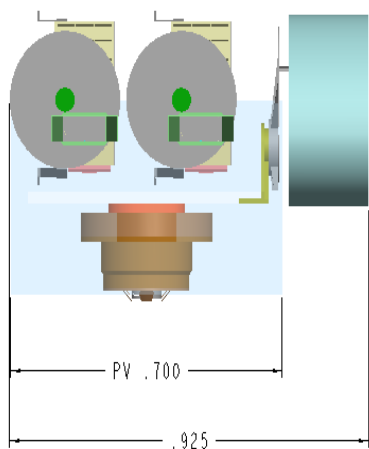
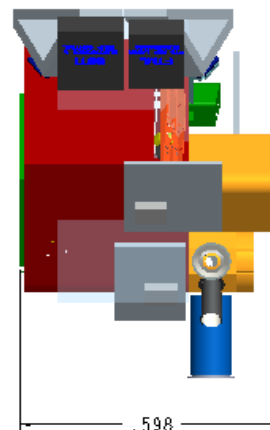
CLARREO Baseline IR & RS Instrument Configuration

Design Analysis Cycle 6, January 2011

Reflected Solar

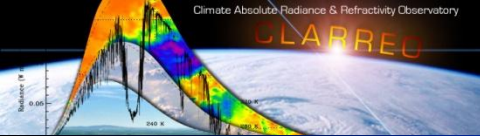


Infrared



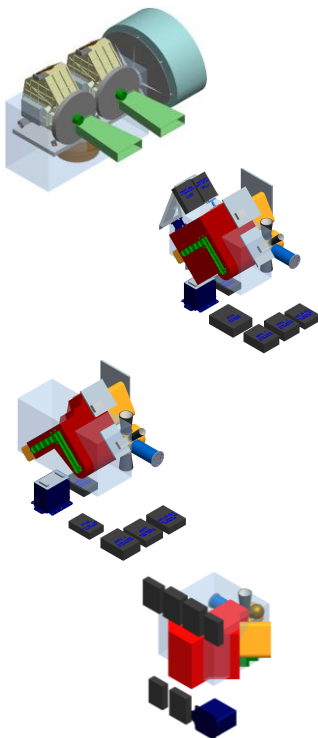
Instrument vs. Payload Volume Size (dimensions in m, electrical enclosures removed)

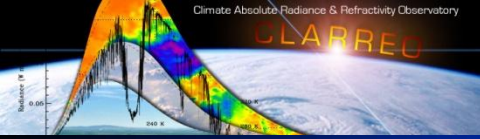




Iridium & FASTSAT Accommodation Studies

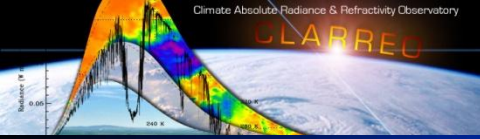
	IRIDIUM	FASTSAT HSV01	FASTSAT A110	FASTSAT A210
Reflected Solar (DAC-6)	Mass: No Volume: No	Mass: No Volume: No	Mass: No Volume: No	Mass: No Volume: No
Infrared Instrument (DAC-6)	Mass: No Volume: No	Mass: No Volume: No	Mass: No Volume: No	Mass: No Volume: No
Far IR	Mass: Yes Volume: No	Mass: No Volume: No	Mass: Yes Volume: No	Mass: Yes Volume: No
2-port IR	Mass: Yes Volume: No	Mass: No Volume: No	Mass: Yes Volume: No	Mass: Yes Volume: No





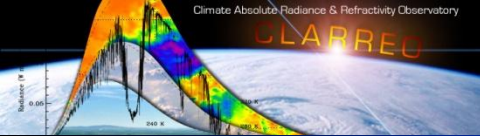
Access to Space Opportunities

- **Launch Affordability is dependent on our role as a:**
 - Hosted Payload: a payload manifested on a spacecraft bus flying on a primary space mission. (ESPA)
 - Secondary Payload: a small spacecraft flying on a primary science mission, paying only the additive costs of integration, and willing to be deployed into the prime payload's insertion orbit after its separation. (CALIPSO, CLOUDSAT)
 - Rideshare: a secondary spacecraft launched into space on a large launch vehicle and deployed after the primary spacecraft. (ESPA)
 - Hosted Payload Opportunity: a spacecraft bus flying on a primary space mission with surplus resources to accommodate a hosted payload. (IRIDIUM NEXT)
- **Orbit selection possibly not within our control**
 - Engineering studies will provide input to Science Studies to characterize impact to science value
 - Environmental impacts (thermal, power) to CLARREG instruments will be assessed.

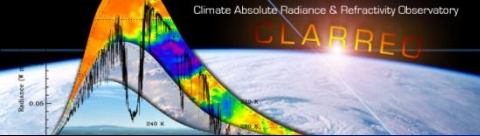


Supporting Science Studies

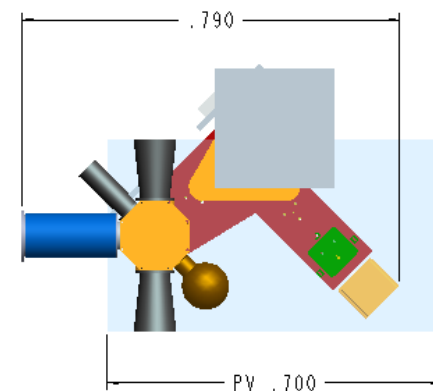
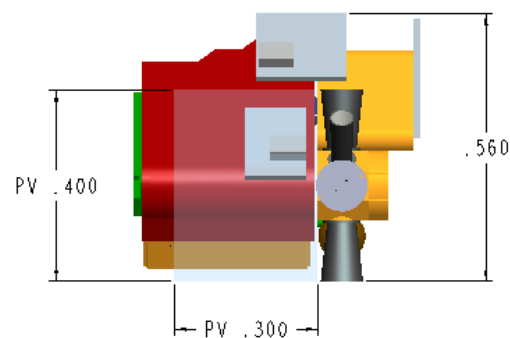
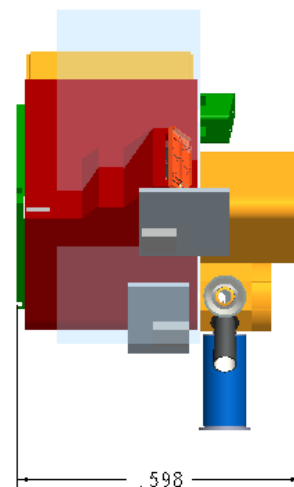
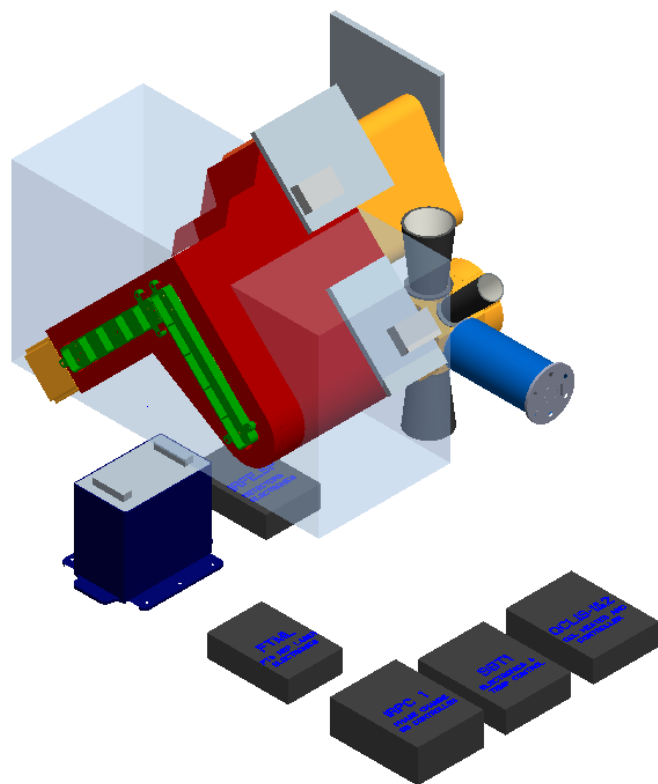
- **Provide targets for physical metrics to achieve compatibility**
 - Accommodation studies will characterize available mass, power consumption, volume, and data envelopes
 - These targets can be used for modified instrument designs
- **Provide cost estimation for instrument and mission concepts**
 - NASA Instrument Cost modeling and Mission & Operations Cost capability
 - Cost data will become input for updating Science Value assessment.
- **High Precession Orbit Propagation ephemeris for orbit sampling studies (Doelling)**
- **Provide simulation results of Reference Intercalibration with LEO and GEO assets (LEO & GEO; IR & RS) (Lukashin, etc.)**



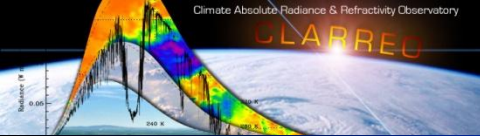
BACKUP



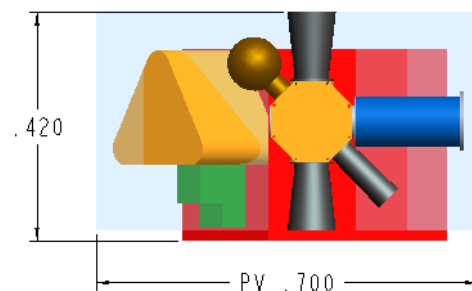
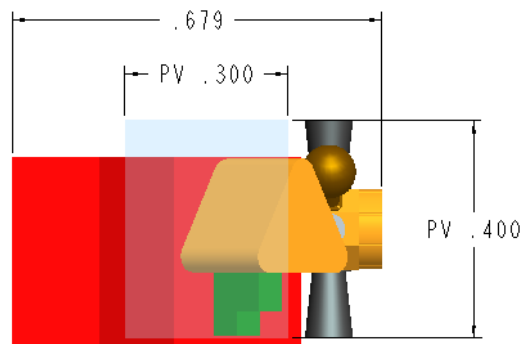
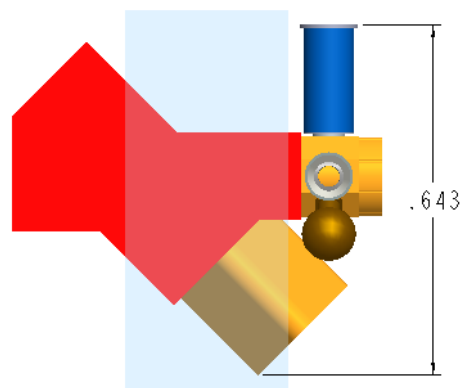
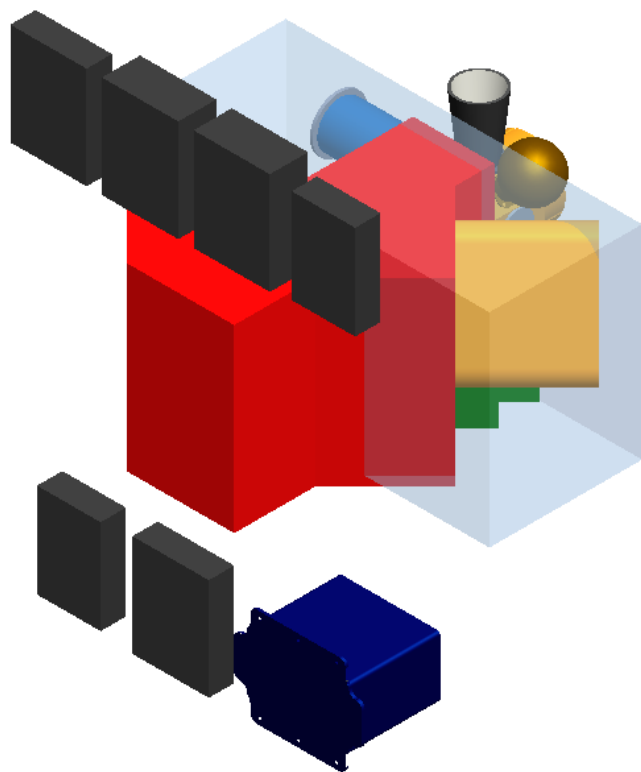
CLARREO Far-IR Instrument Configuration



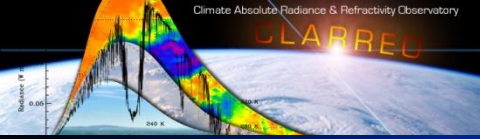
Instrument vs. Payload Volume Size (dimensions in m, electrical enclosures removed)



CLARREO Two Port Instrument Configuration



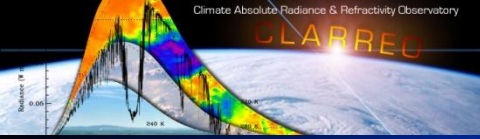
Instrument vs. Payload Volume Size (dimensions in m, electrical enclosures removed)



RS Instrument Configuration vs. Iridium Payload Mass and Volume Constraints

	Payload Mass – 50 kg Payload Volume – 84000 cm³, 70 x 30 x 40 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	85, No	463125, 75 x 95 x 65, No

* Volume accounts for instrument only. Electrical enclosures not included.

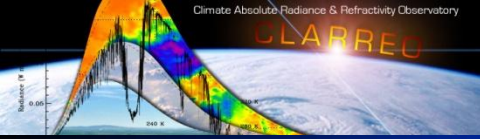


RS Instrument Configuration vs. HSV01

Payload Mass and Volume Constraints

	Payload Mass – 21 kg Payload Volume – 100000 cm³, 50 x 50 x 40 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	85, No	463125, 75 x 95 x 65, No

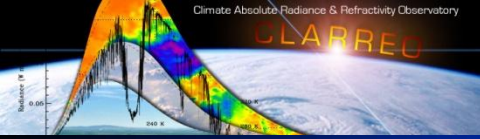
* Volume accounts for instrument only. Electrical enclosures not included.



RS Instrument Configuration vs. A110 Payload Mass and Volume Constraints

	Payload Mass – 70 kg Payload Volume – 125000 cm³, 50 x 50 x 50 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	85, No	463125, 75 x 95 x 65, No

* Volume accounts for instrument only. Electrical enclosures not included.

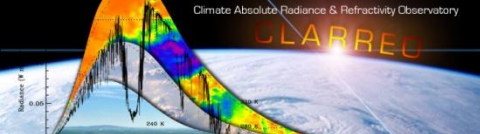


RS Instrument Configuration vs. A210

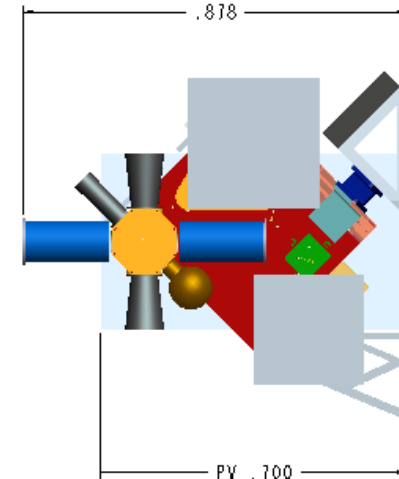
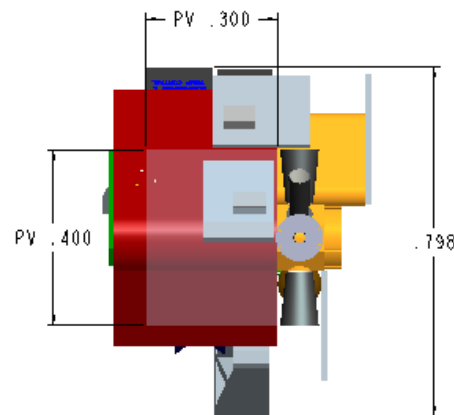
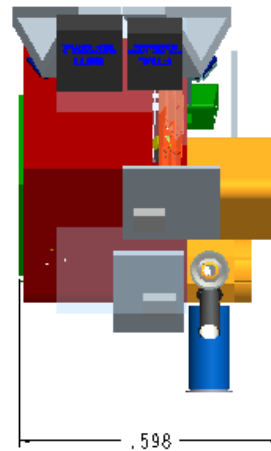
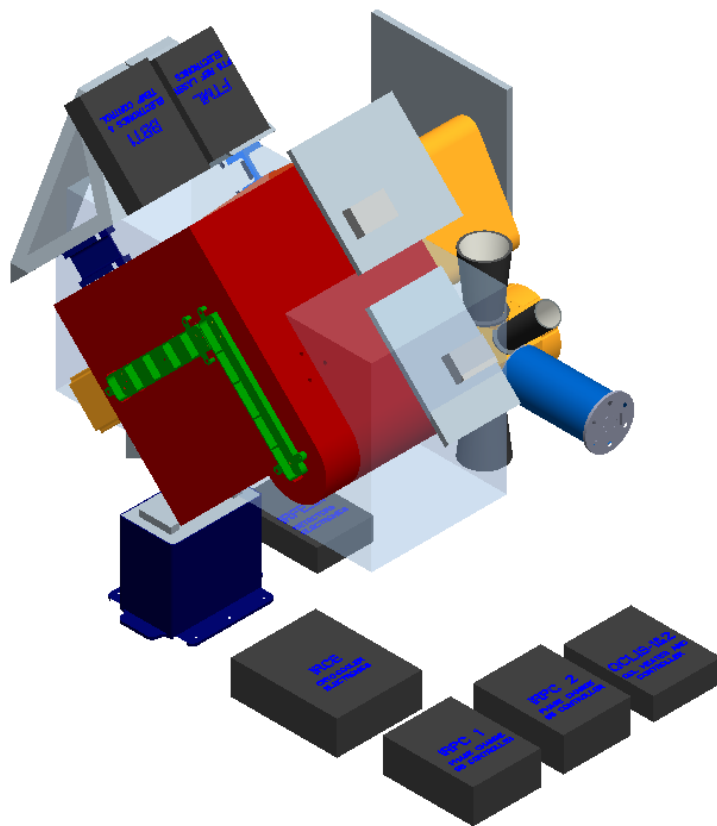
Payload Mass and Volume Constraints

	Payload Mass – 65 kg Payload Volume – 125000 cm³, 50 x 50 x 50 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	85, No	463125, 75 x 95 x 65, No

* Volume accounts for instrument only. Electrical enclosures not included.

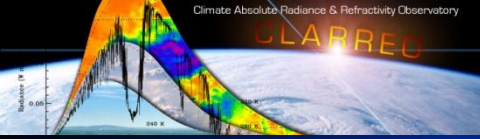


CLARREO Baseline IR Instrument – DAC6 Configuration



Instrument vs. Payload Volume Size (dimensions in m, electrical enclosures removed)

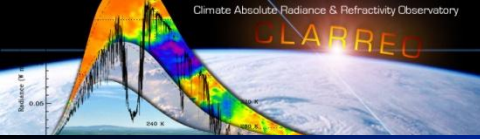




IR Instrument Configuration vs. Iridium Payload Mass and Volume Constraints

	Payload Mass – 50 kg Payload Volume – 84000 cm³, 70 x 30 x 40 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	74, No	432000, 90 x 60 x 80, No
Far-IR	45, Yes	288000, 80 x 60 x 60, No
Two Port	48, Yes	204750, 65 x 70 x 45, No

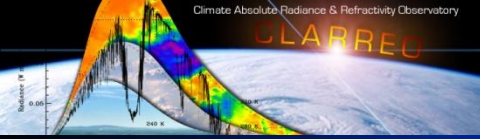
* Volume accounts for instrument only. Electrical enclosures not included.



IR Instrument Configuration vs. HSV01 Payload Mass and Volume Constraints

	Payload Mass – 21 kg Payload Volume – 100000 cm³, 50 x 50 x 40 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	74, No	432000, 90 x 60 x 80, No
Far-IR	45, No	288000, 80 x 60 x 60, No
Two Port	48, No	204750, 65 x 70 x 45, No

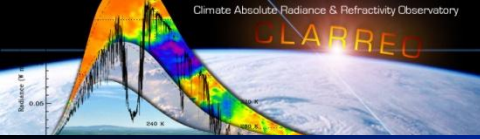
* Volume accounts for instrument only. Electrical enclosures not included.



IR Instrument Configuration vs. A110 Payload Mass and Volume Constraints

	Payload Mass – 70 kg Payload Volume – 125000 cm³, 50 x 50 x 50 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	74, No	432000, 90 x 60 x 80, No
Far-IR	45, Yes	288000, 80 x 60 x 60, No
Two Port	48, Yes	204750, 65 x 70 x 45, No

* Volume accounts for instrument only. Electrical enclosures not included.



IR Instrument Configuration vs. A210 Payload Mass and Volume Constraints

	Payload Mass – 65 kg Payload Volume – 125000 cm³, 50 x 50 x 50 (cm)	
	Instrument Mass (kg), Meets Constraint (Yes, No)	~ Required Instrument Payload Volume* (cm ³), Measurements L x W x H (cm) Meets Constraint (Yes, No)
CLARREO Baseline DAC-6	74, No	432000, 90 x 60 x 80, No
Far-IR	45, Yes	288000, 80 x 60 x 60, No
Two Port	48, Yes	204750, 65 x 70 x 45, No

* Volume accounts for instrument only. Electrical enclosures not included.