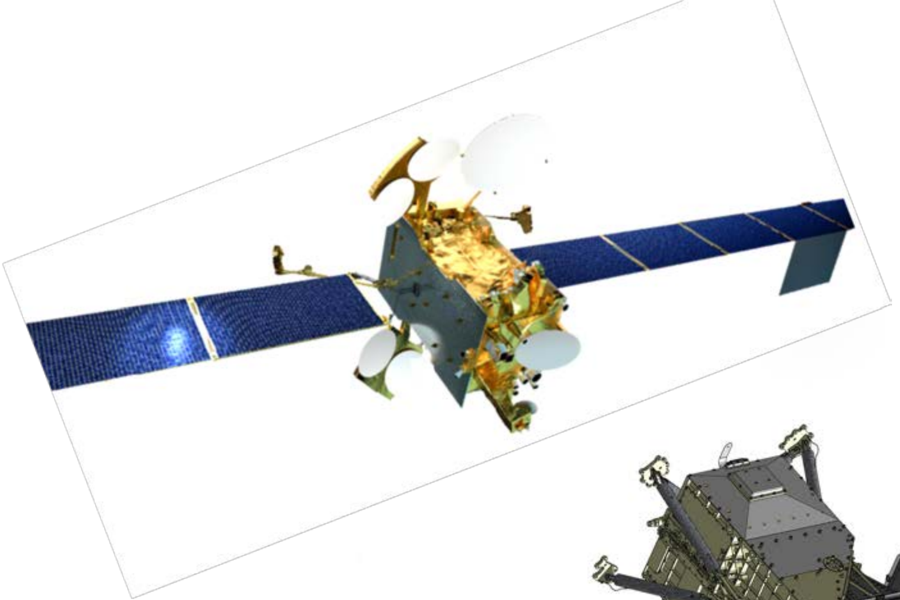
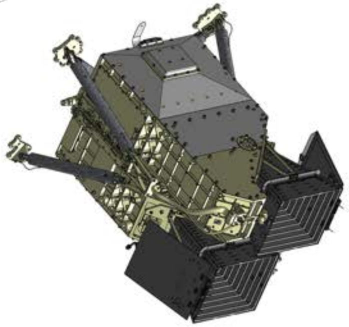
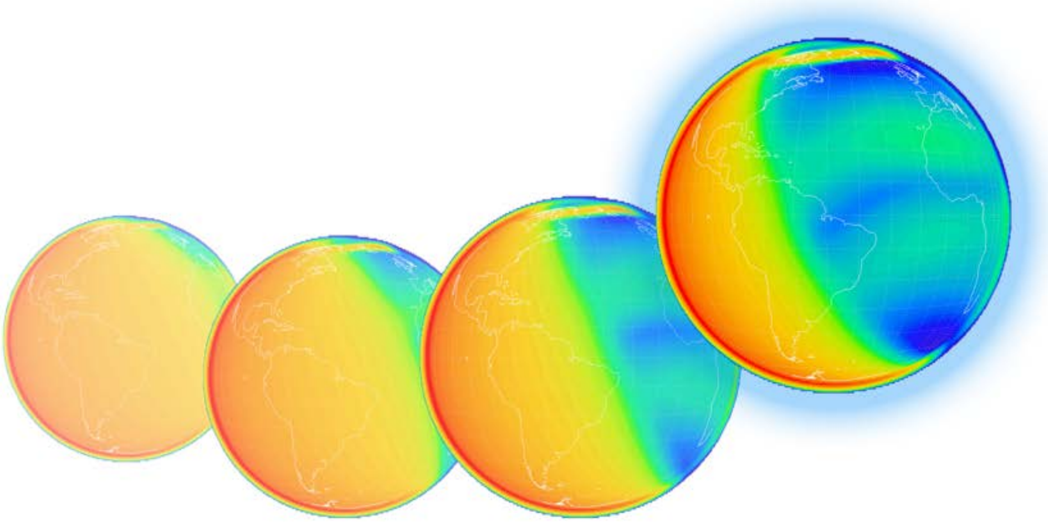




Recent Insights into the Thermosphere-Ionosphere Response to External Forcing from the Global-scale Observations of the Limb and Disk (GOLD) Mission

Richard Eastes & the GOLD Science Team



Laboratory for Atmospheric and Space Physics
University of Colorado Boulder

UCF

SES
Government Solutions

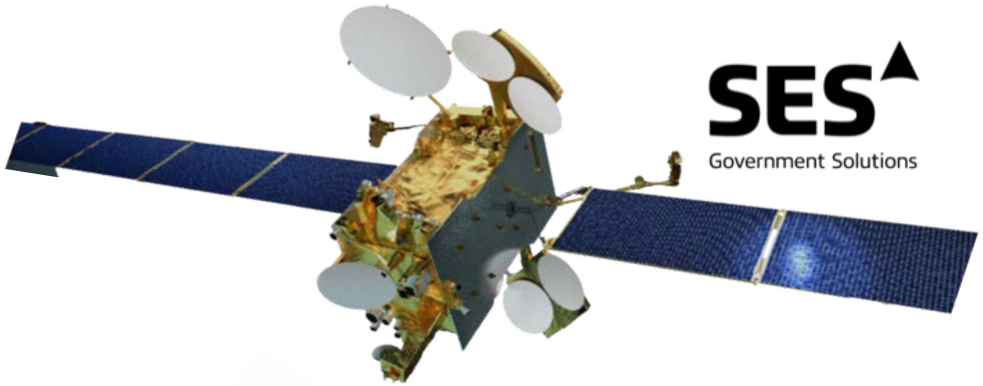
Scientific Motivation

- **GOLD is the next logical step in Ionosphere-Thermosphere studies**
  - Decades of research using observations from low earth orbiting (LEO) spacecraft and ground-based facilities
  - *Can not separate daily spatial - temporal variability*
  - Enabled the characterization of the I-T system **'climate'**

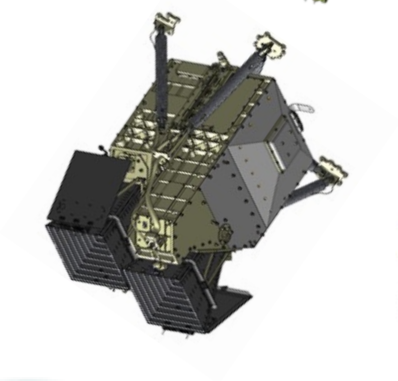
- **GOLD images the I-T system from geostationary orbit (GEO)**
  - NASA Explorers Mission of Opportunity
  - *Near-hemispherical measurements of dayside composition (O/N_2) and temperature with 30-minute cadence in near real-time*
  - Enables the first characterization of the I-T system **'weather'**

GOLD Mission Overview

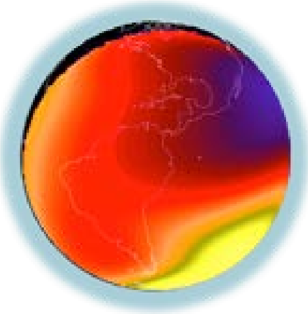
- **Host Mission**
  - SES-14, in geostationary orbit at 47.5° west (over mouth of the Amazon River)
- **GOLD Instrument**
  - Two identical, independent imaging spectrographs covering ~135-160 nm
- **Measurements**
  - Earth's disk
    - Tdisk & O/N_2 - Daytime: from spatial-spectral image cubes of O-135.6 nm and N_2-LBH emission
    - Nmax - Nighttime: from images of O-135.6 nm emission
  - Earth's limb
    - Texo - Altitude profiles of N_2-LBH emission
    - O_2 density profile - Stellar occultations



SES Government Solutions

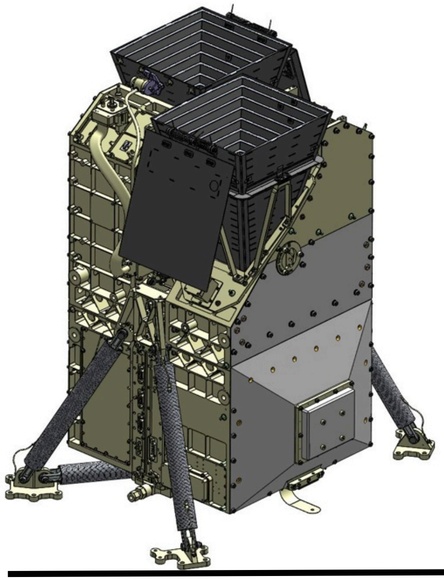


LASP Laboratory for Atmospheric and Space Physics
University of Colorado Boulder



UCF

GOLD Mission Summary



Instrument Summary	
Mass	**37.0**
Power	**75 W (avg)**
Size	**51 × 55 × 69 cm^3**
Data	**6 Mbps**

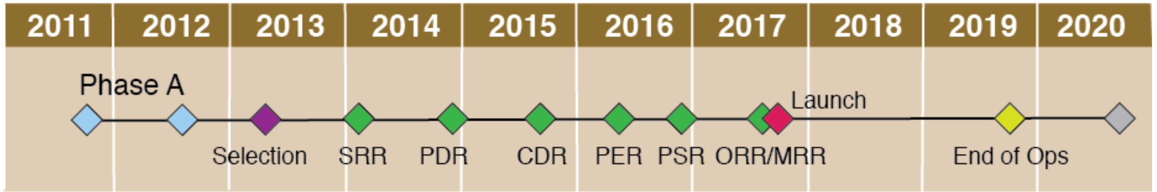
Imaging Spectrograph:

Two independent, identical channels

Wavelength range: 135 – 160 nm

Detectors: Microchannel plate, 2-D crossed delay line

Launch: Plan was late 2017; actual was Jan 2018



Science Questions:

- How do geomagnetic storms affect the thermosphere? *How does the thermosphere respond to solar ultraviolet variability?* How do atmospheric waves and tides affect the temperature of the thermosphere? *How does the nighttime equatorial ionosphere respond?*

How does the thermosphere-ionosphere system respond to external forcing from above and below

Laboratory for Atmospheric and Space Physics (LASP), University of Colorado

PI: Richard Eastes

Deputy PI: William McClintock

Project Manager: Rory Barrett

University of Central Florida

Science Data Center: Hassan Foroosh and Andrey Krywonos

$64M (RY) Mission of Opportunity, 2 year mission

What to plan for and do early-on to avoid problems later in project's development

To Win and Execute a Science Mission?

- **Great science - which you have or you wouldn't be here**
  - *World class question(s) that can be answered by the mission*
  - *Essential for selection to perform Phase A study*
  - *Fits in NASA's strategic plan*
- **Outstanding Implementation**
  - *Appropriate and low risk. Heritage and simplicity reduce risk*
    - Treat heritage with caution
  - *Achievable within resources (technical, cost, and schedule) with generous margins*
  - *Good implementation is critical in Phase A CSR, much more weight than in proposal evaluation*
- **Well developed and defined requirements**
  - *Requirements are necessary to keep everyone on track*
  - *Allows design to be optimized early and allows assessment of potential changes*

Phase A (B & C) Lesson – Traceability Matrix (Requirements)

- **An essential tool for communicating the relationship between the science questions, science requirements, measurement requirements and measurement capabilities**
- ***Enables you and others to see the flowdown from science questions to mission and instrument capabilities….and to allocate resources***
- **A key** reference for CSR and beyond (e.g., for Level 1's)

Science Traceability Matrix

Sci. Goal	Sci. Obj.	Scientific Measurement Requirements	Instrument Functional Requirements (Reqmts.)	Projected Performance	Mission Functional Reqmts.
Overarching	Q1	UV disk images of O and N_2 emissions ….	Spatial res.		1. Geostationary orbit 2. …….
			λ res.		
			…		

Managing Partners, Managing Contingency, and Descope Philosophy/Approach

Descope Philsophy for MoO

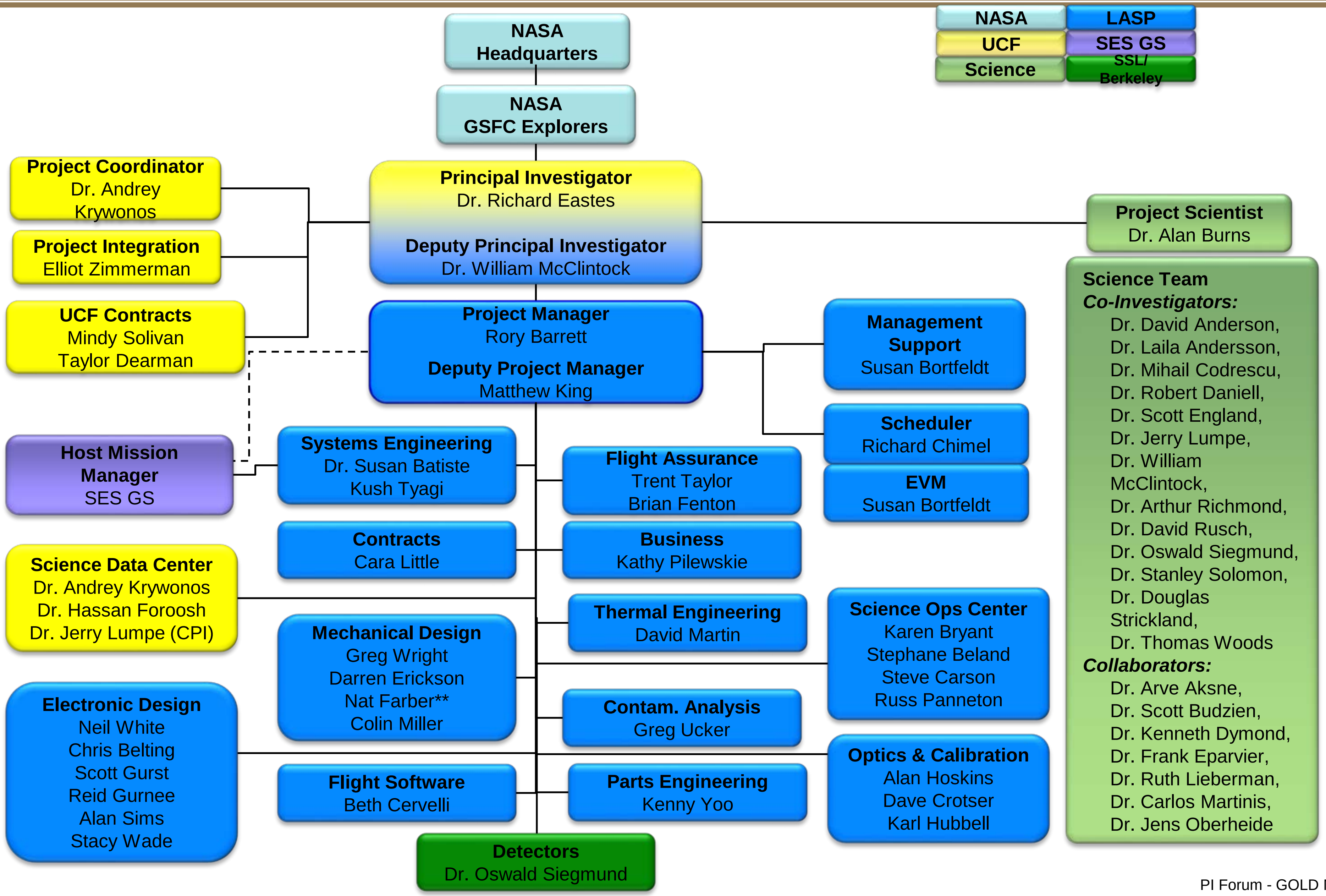
- **GOLD instrument design used two identical channels**

- ***Single channel was capable of productive measurements, but both needed for full capability needed to meet full science (Level 1) requirements proposed***

- **Capability to make productive (threshold) measurements with single channel also enhances reliability of the instrument**

Managing Partners, Managing Contingency, and Descope Philosophy/Approach

GOLD Project Organization



Hosting of Mission (1 of 2)

- **Proposed effort for GOLD included contracting with SES-GS for hosting of mission on an SES satellite**

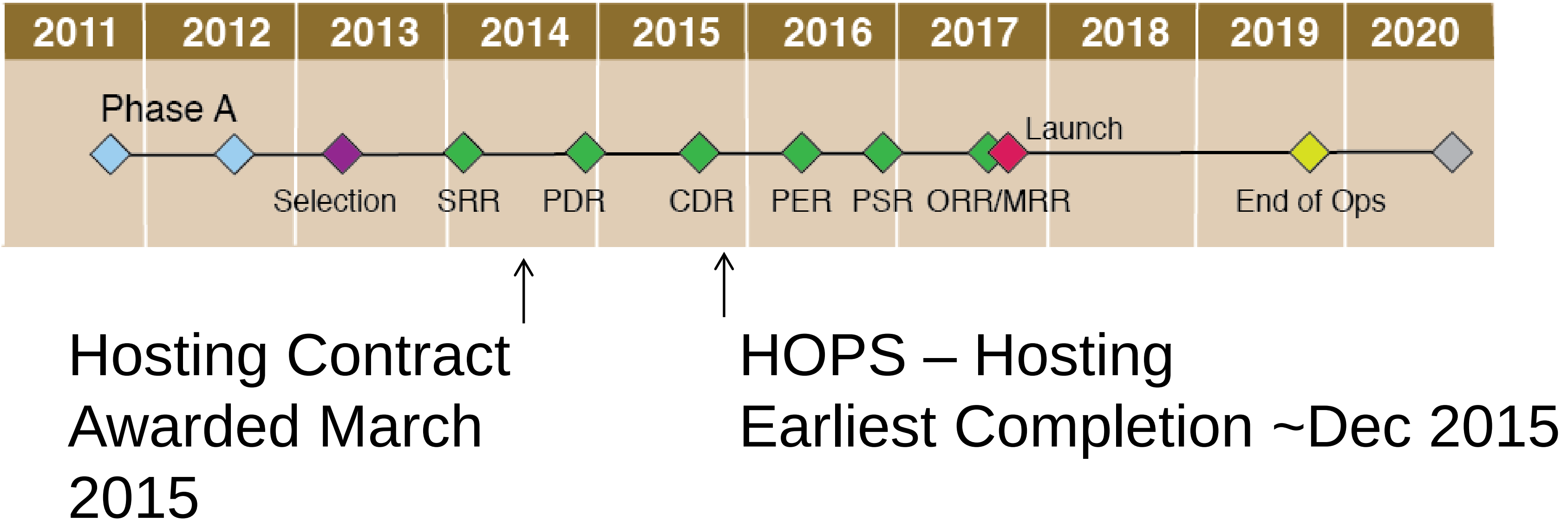
- ***In preparation for Preliminary Design Review, the need to update accommodation costs was recognized late***

- **Updated cost was $2.5M larger than original ROM**

- ***Raised concerns within program of additional, future increases in costs and that such changes could push mission costs beyond cost cap of $65M for MoOs***

Hosting of Mission (2 of 2)

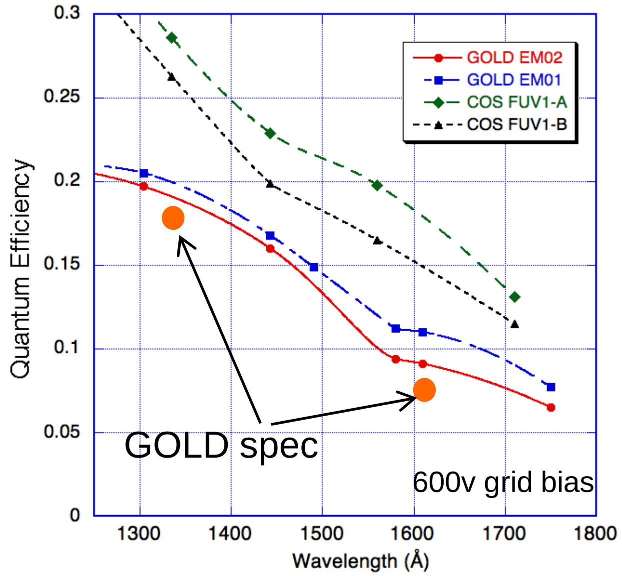
- **Viable plan for hosting and of cost needed before PDR**
- ***Consequently, suggestions that GOLD team consider hosting contract through Air Force HOPS program***
- **Months of digression before recognizing likely delays**
- ***Then resumed effort on hosting contract with SES-GS***



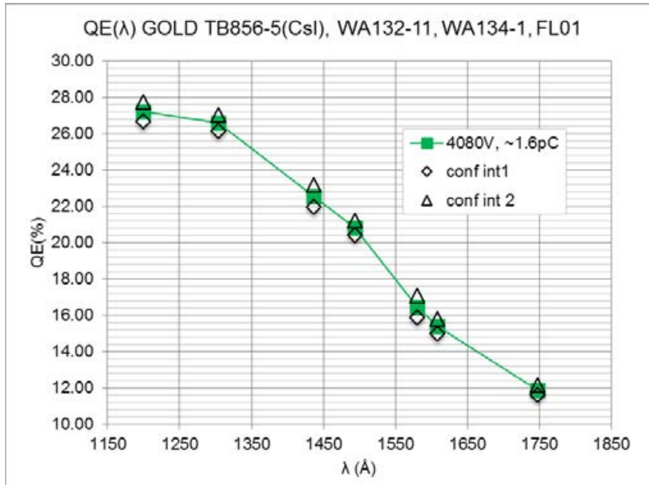
- **Key to successful resolution was clearer communication**

Example 2 – Low QE Detectors

- Detector QE on engineering model was lower than predicted
  - Reallocation of sensitivity budget would have eliminated margin on requirements
- *Were at point where impact to schedule reserve was small (~2 weeks) & repeating later steps in processing would have large schedule impact (next step would have been commitment to low sens)*
- Allowed time to explore reason for low sensitivity and options for sensitivity increase
- *Good communication enabled team to allow time needed for analysis*



Engineering Detector



Flight Detector

In Conclusion

- **Well developed requirements are a key to understanding and communicating how to best use resources**

- **Broad and effective communication benefits the mission in managing partners and managing contingency**