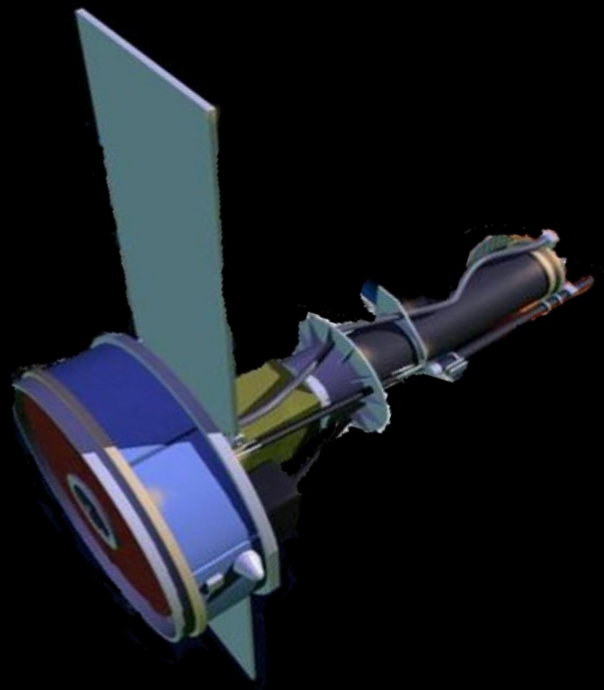
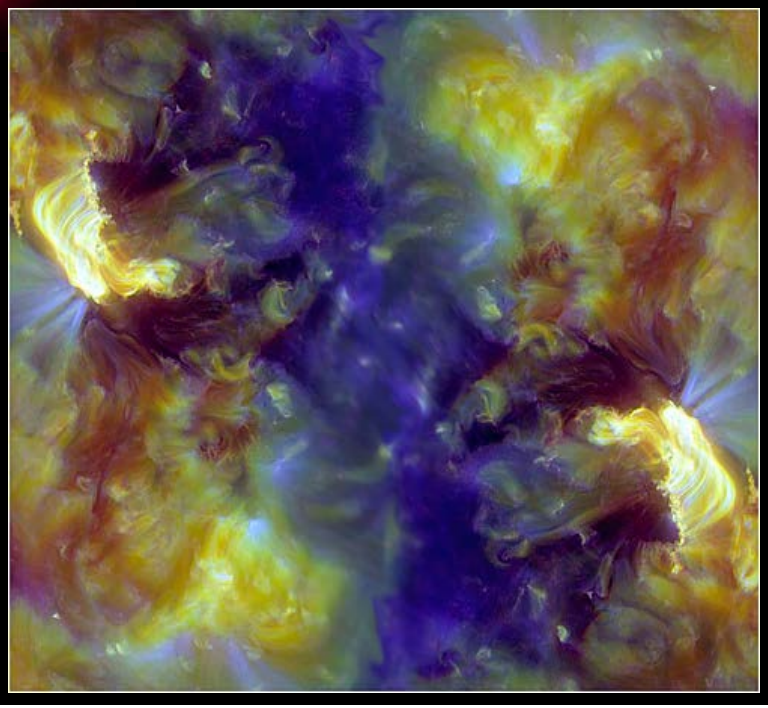




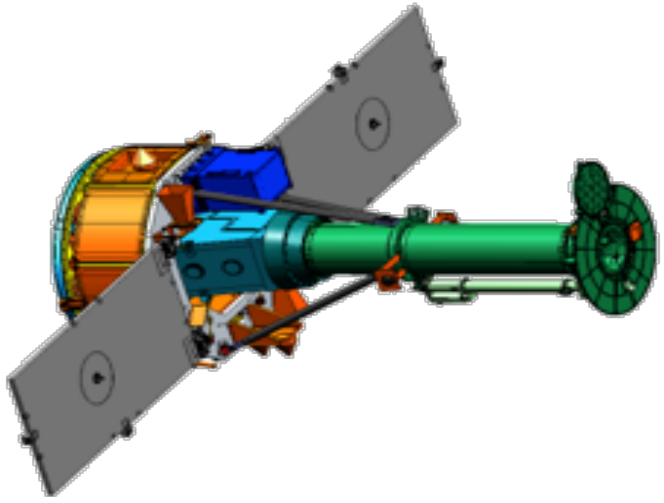
# IRIS

## Interface Region Imaging Spectrograph

Launched in 2013 for a 2+ year mission to investigate energy transport mechanisms on the sun

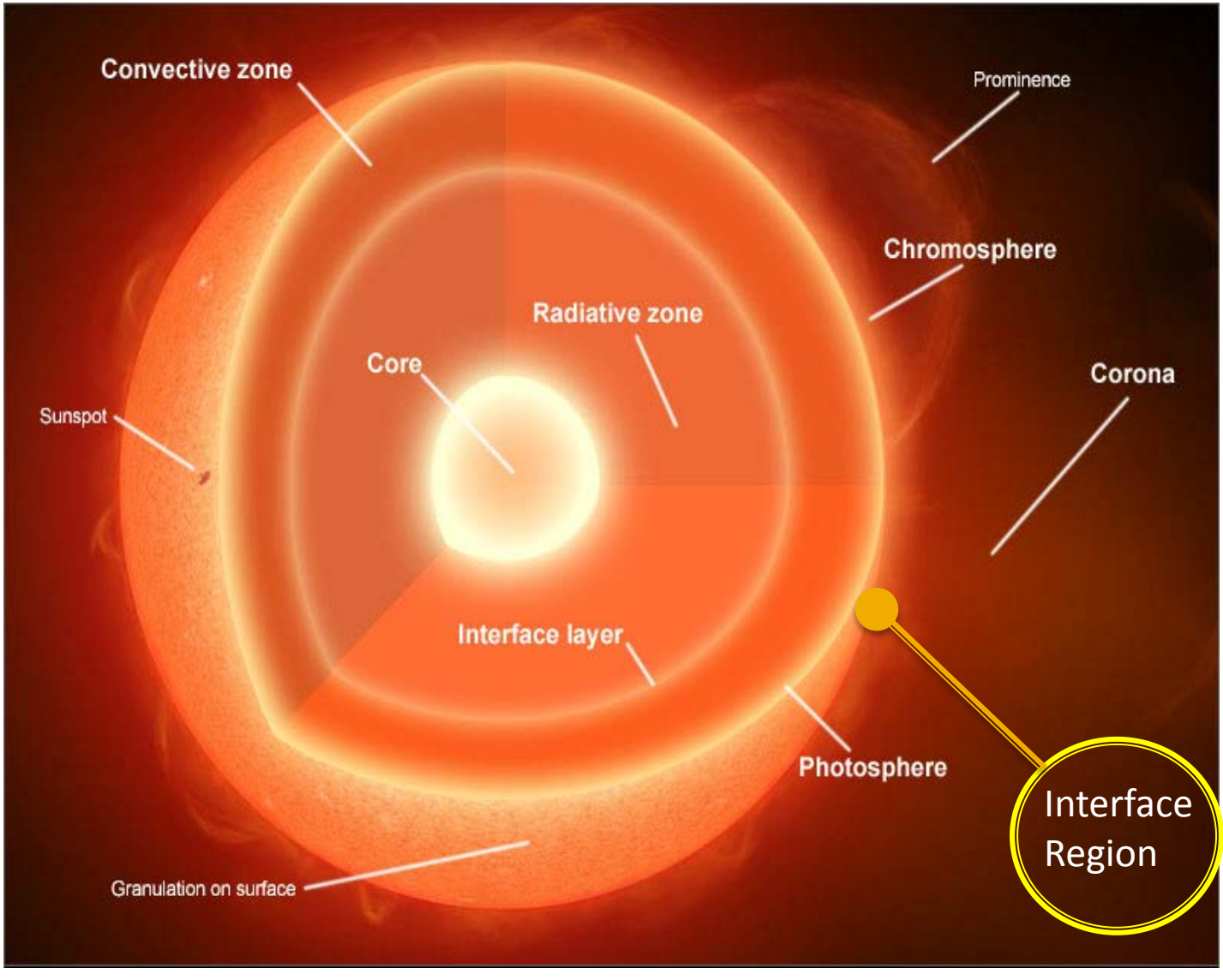
# IRIS Mission

- IRIS is a NASA Small EXplorer Mission developed to study the region of the sun between the photosphere (5000 K) and the corona (1.5M K)



- The Mission Includes
  - Instrument (telescope and imaging spectrograph)
  - Spacecraft (power, pointing, C&DH, comm)
  - Ground Data Systems
  - Mission Operations Center
  - Science and data analysis

# IRIS Mission Objectives




[Core ~ 16 million K]

Photosphere + 500km @ 4,100 Deg K

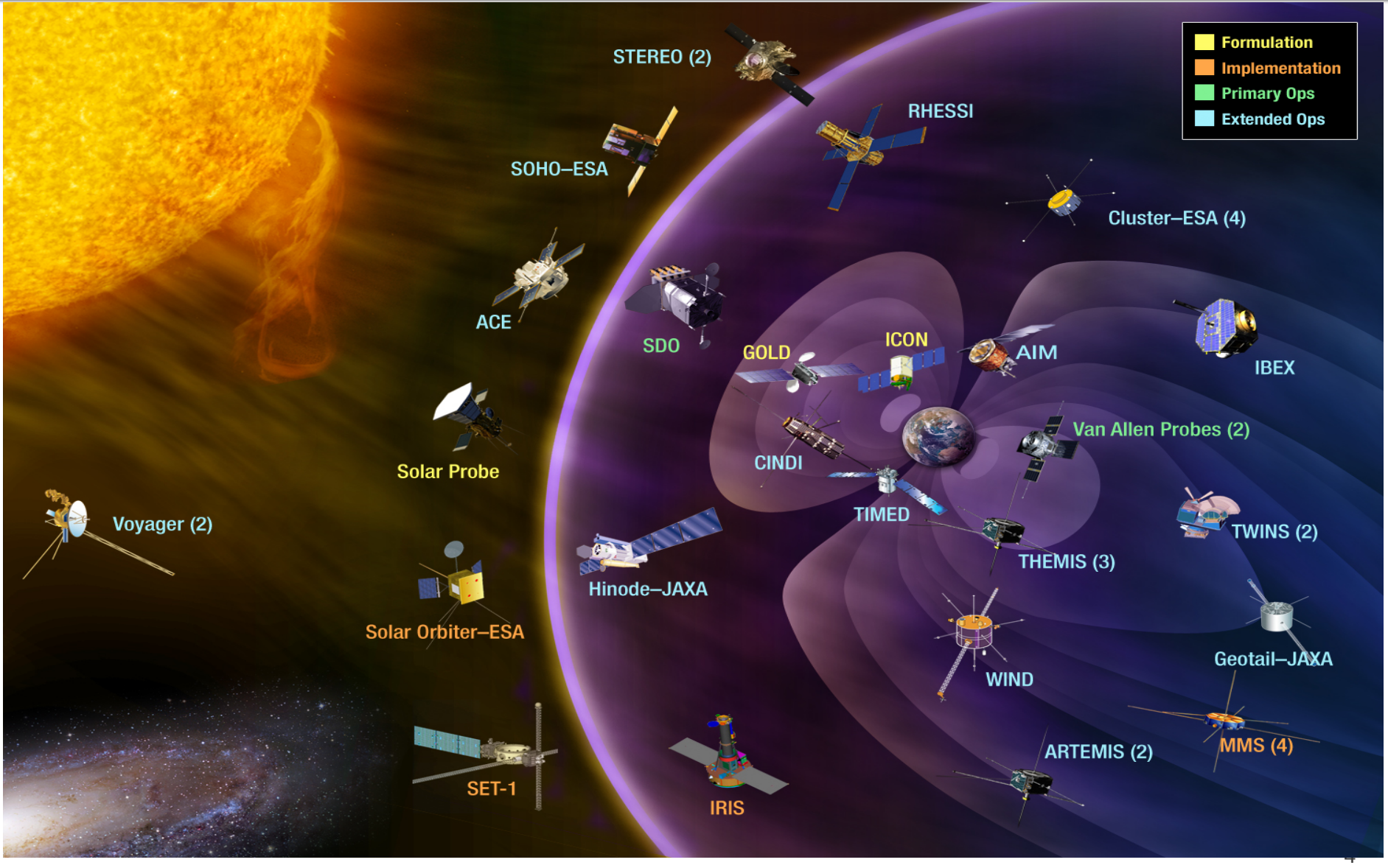
Chromosphere @ up to 20,000 Deg K

Corona @ 1–2,000,000 Deg K (& up to 20 million)

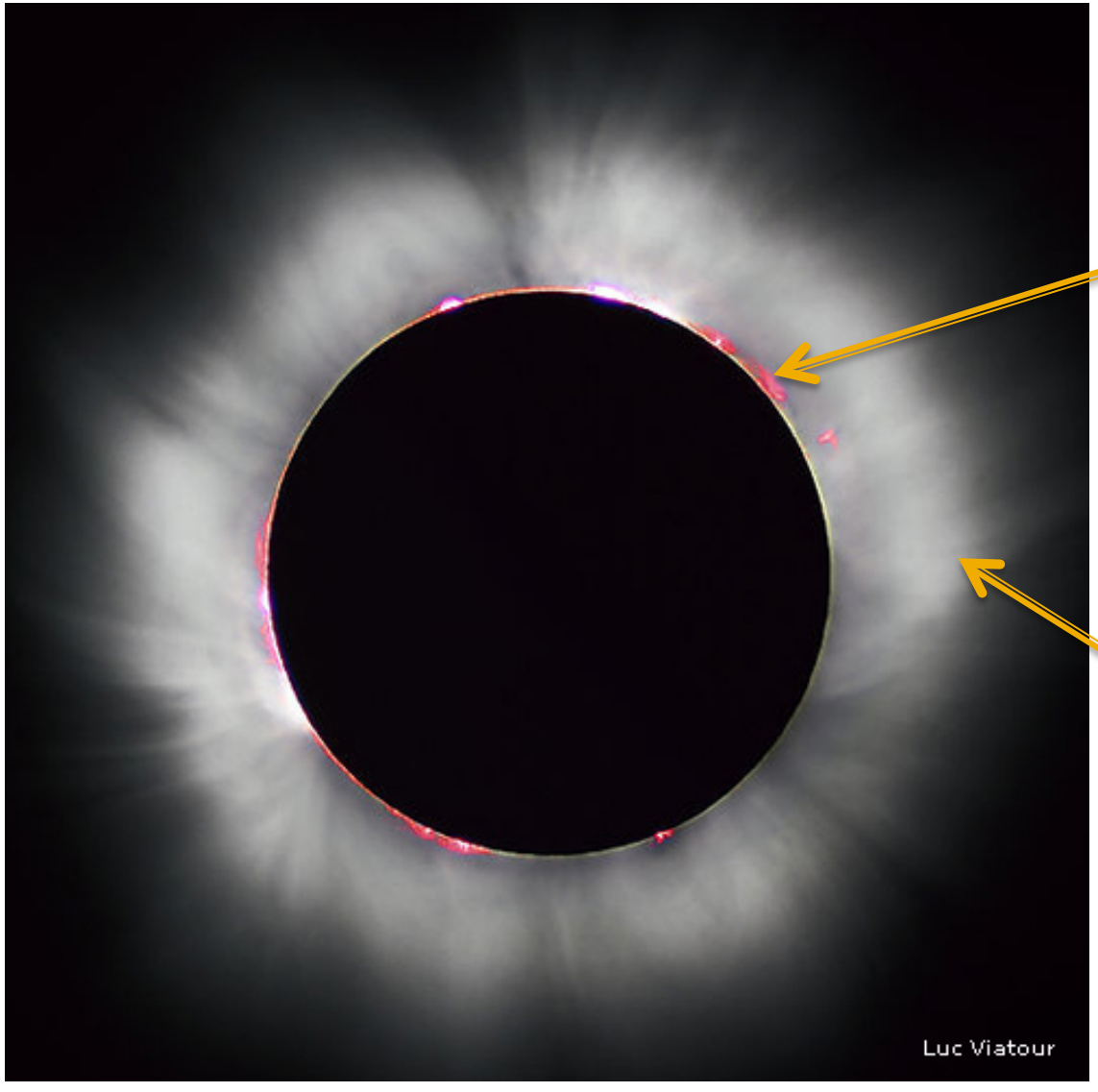
Why this increase?

And what is the energizing mechanism?

# NASA's Heliophysics Fleet



# Solar Eclipse

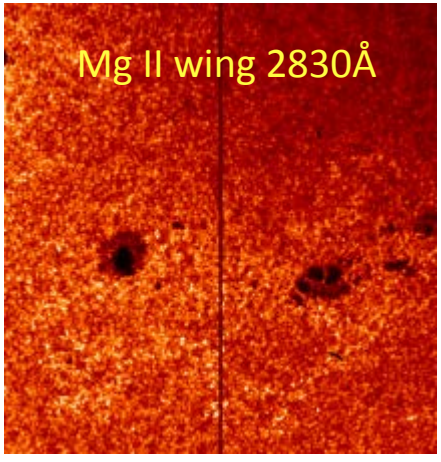



Chromosphere

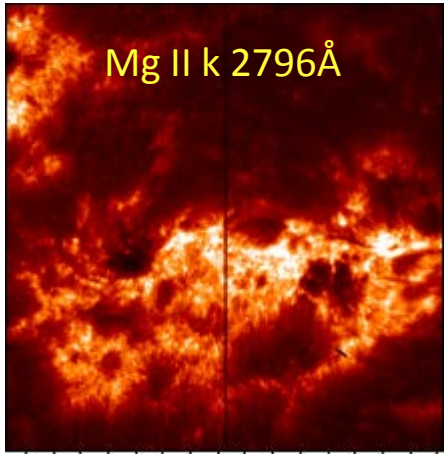
Corona

# What does IRIS really do?

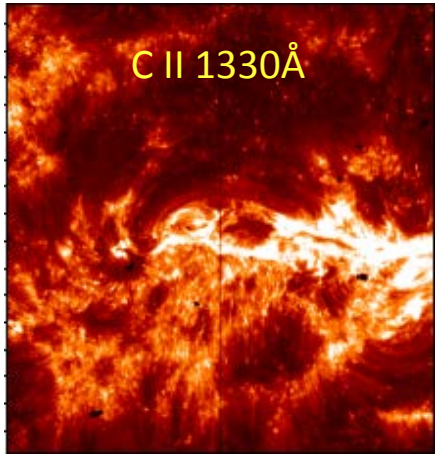
- IRIS records images AND spectra of the sun throughout the Interface Region – all ultraviolet spectrum.
- How does IRIS image different layers of the sun?



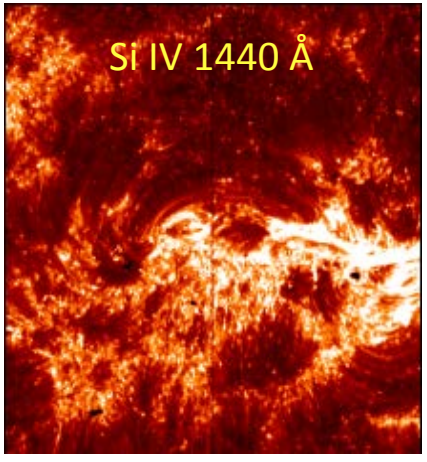

6000K




15,000K

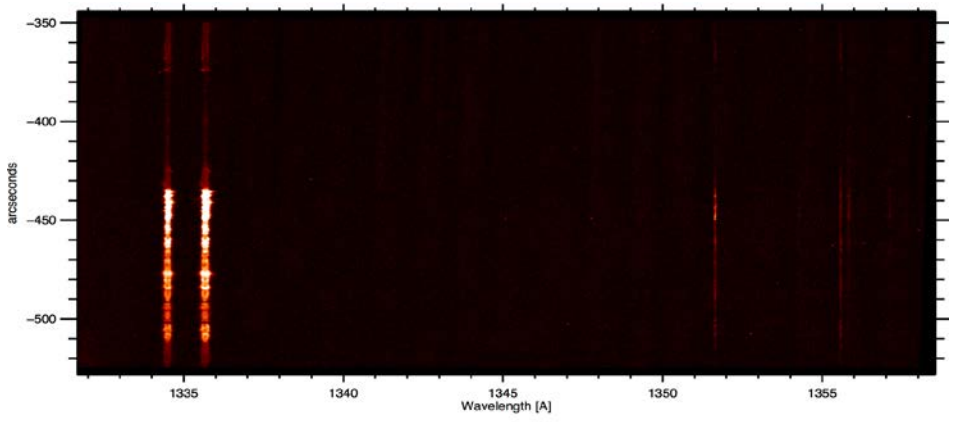



30,000K

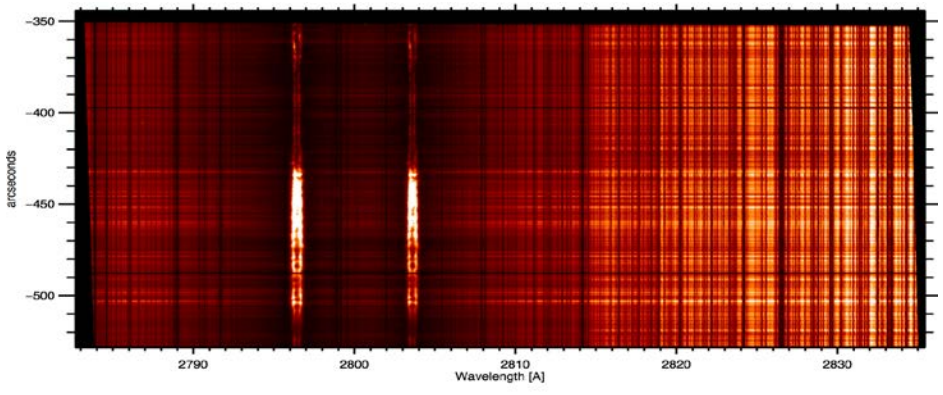



65,000K

# IRIS Spectra

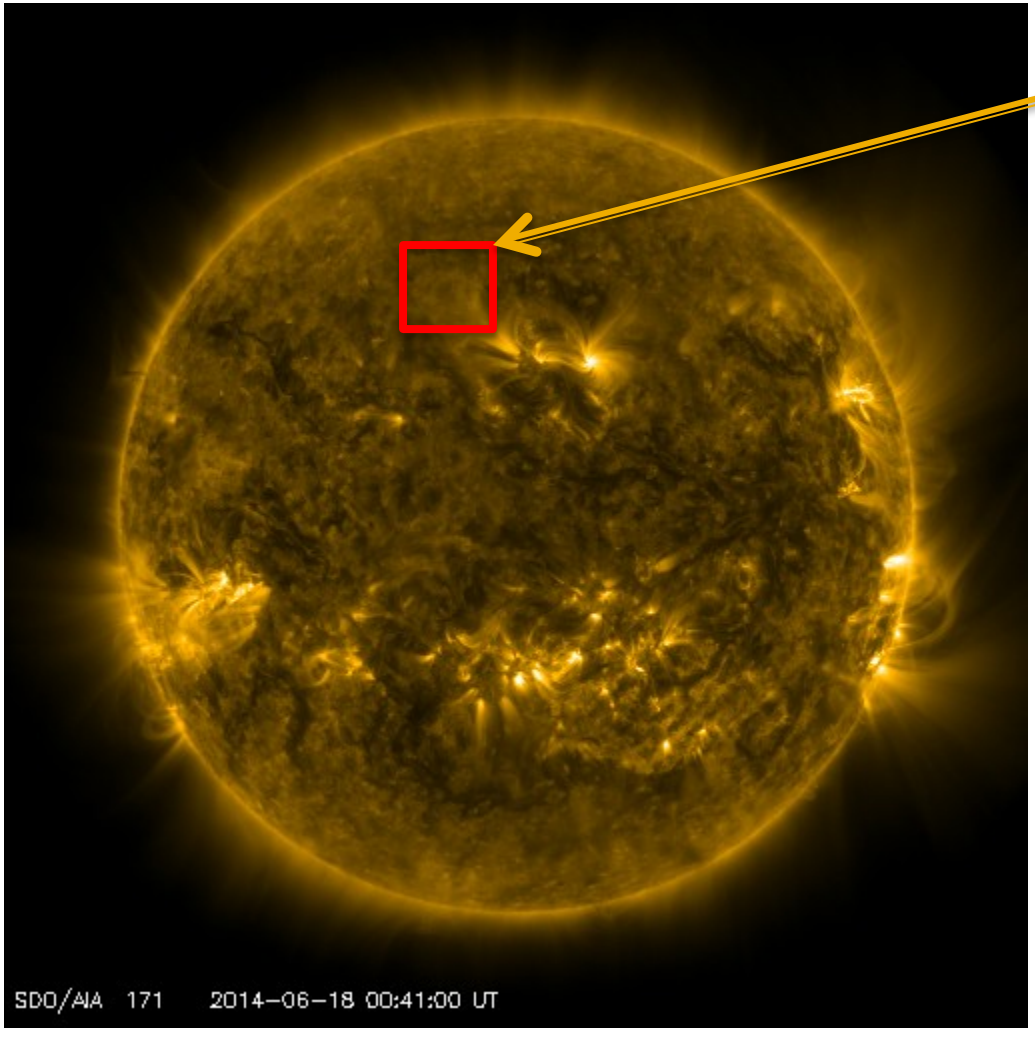



How do the scientists use spectra?




Good indications of:
-Velocity
-Density
-Temperature
-Magnetic Fields

# IRIS the Microscope?




IRIS has a FOV of 175x175 arc secs
Less than 5% of total solar disk

# Collaboration

IRIS science team regularly collaborates with various spacecraft and ground observatory teams

Swedish Solar Telescope (SST)

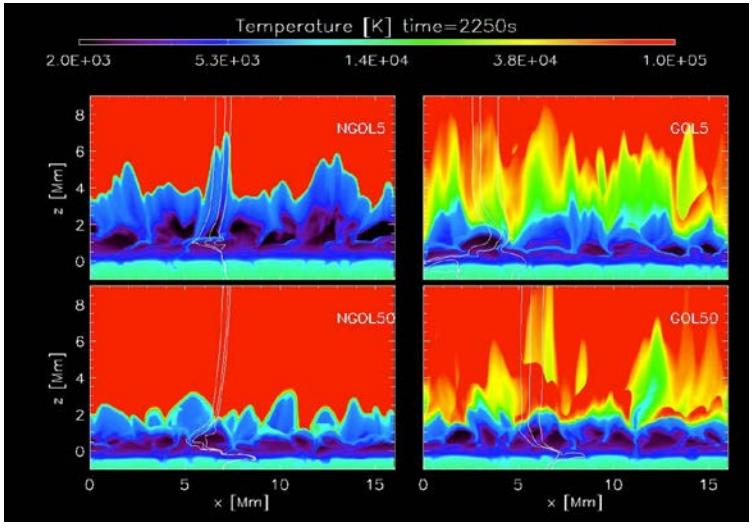
Dunn Solar Telescope (DST)

Hinode

Solar Dynamics Observatory (SDO)

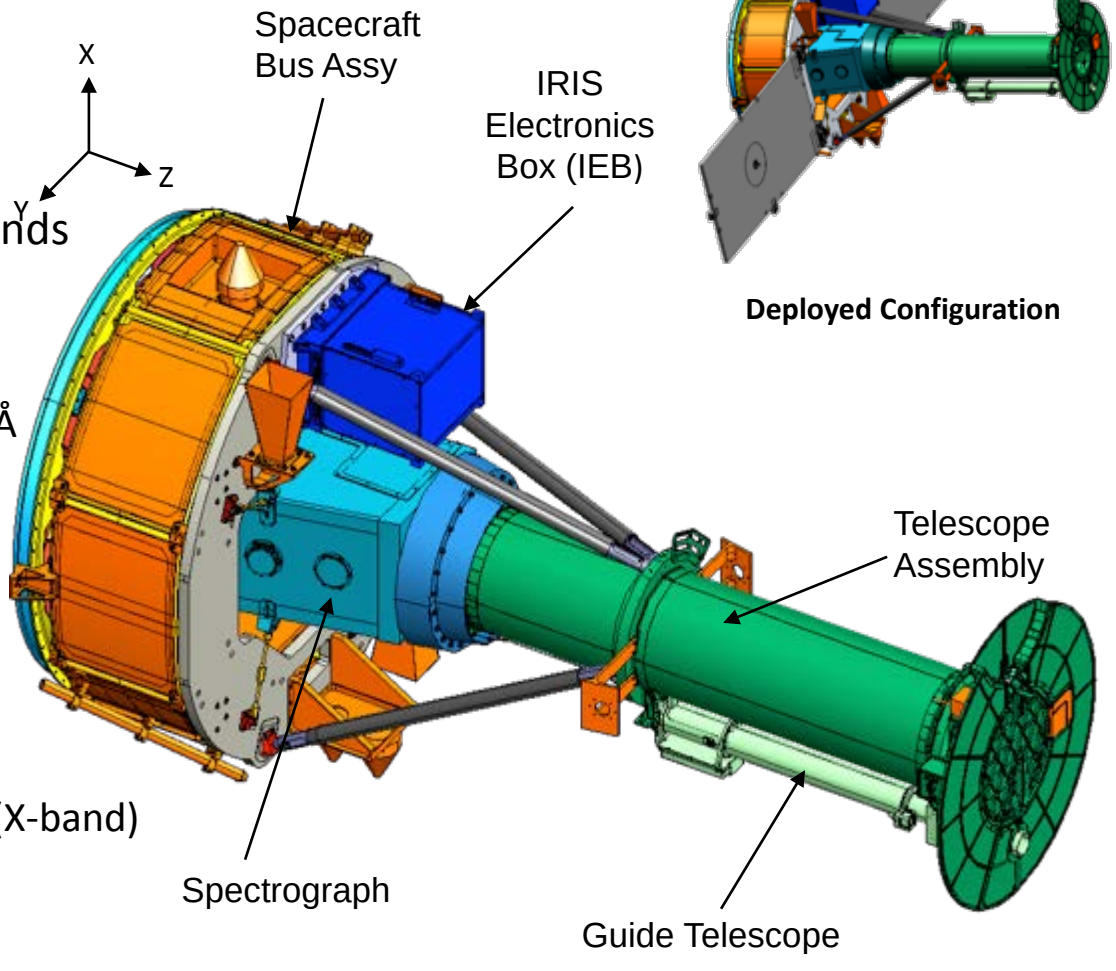
# Computation

- Simulation of Interface Region dynamics
- Over 30 MILLION CPU hours on Pleiades Supercomputer at NASA Ames.
- Other computing facilities used as well
- MHD equation simulations
- University of Oslo team
- Aids in interpretation of IRIS data and is crucial for the mission!



# IRIS Spacecraft

- Launch Date: June 27, 2013
- Launch Vehicle: Pegasus XL
- Solar Pointing
- Telescope resolution: 0.33 arcseconds
- Observing wavelengths:
  - 1332-1406 Å & 2796 - 2803Å
  - Human eye detects ~ 3800 – 7500 Å
- Orbit: Polar & Sun synchronous
  - 620 x 670 km (385 – 416 miles)
- Orbit period: 97 min
- Mass: 183 kg
- Power: 342 W
- Telemetry rate: 15 Mbps, 60Gb/day (X-band)
- Recording capacity: 48 Gbits
- Mission Life: >2 Years

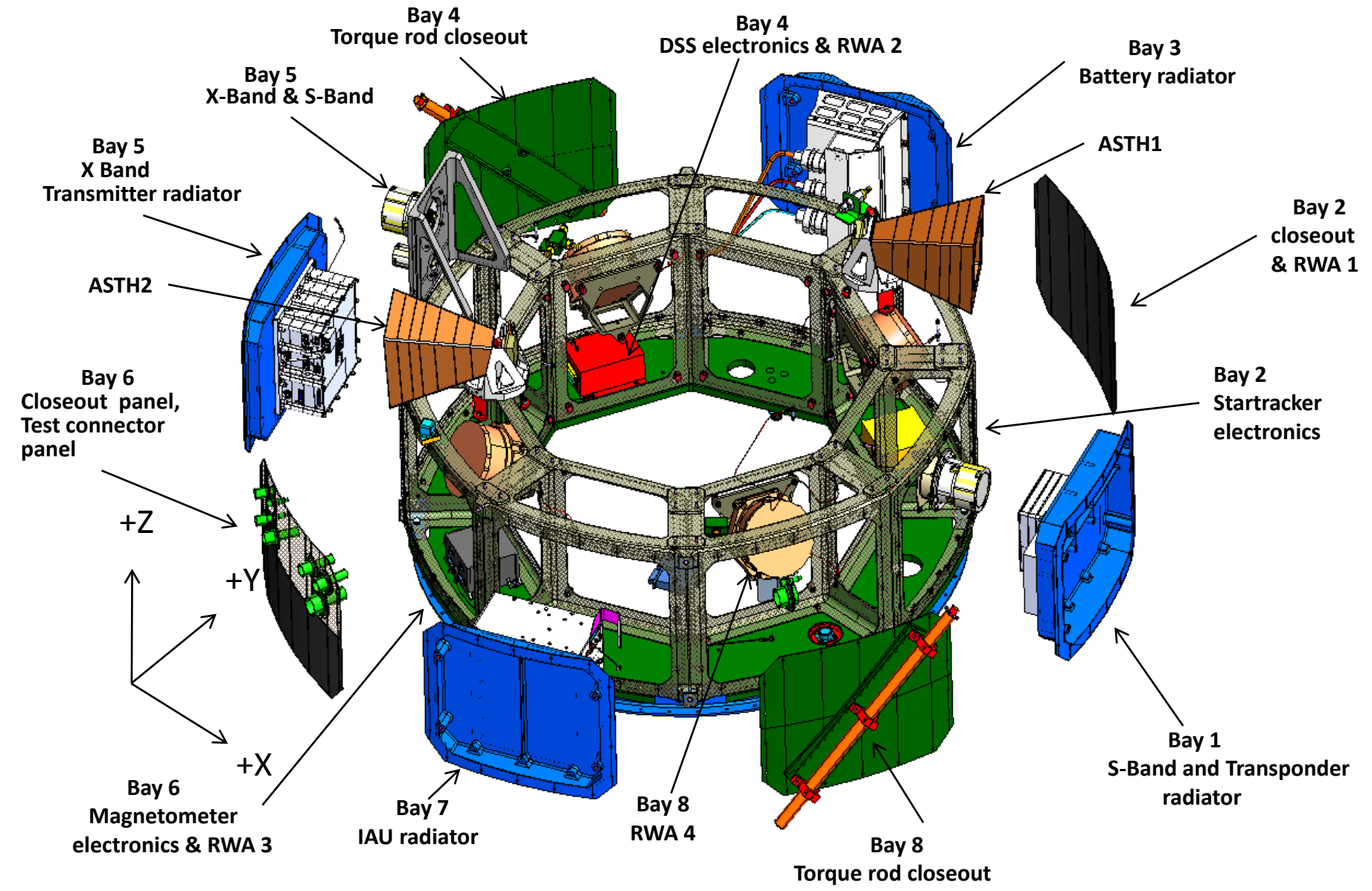




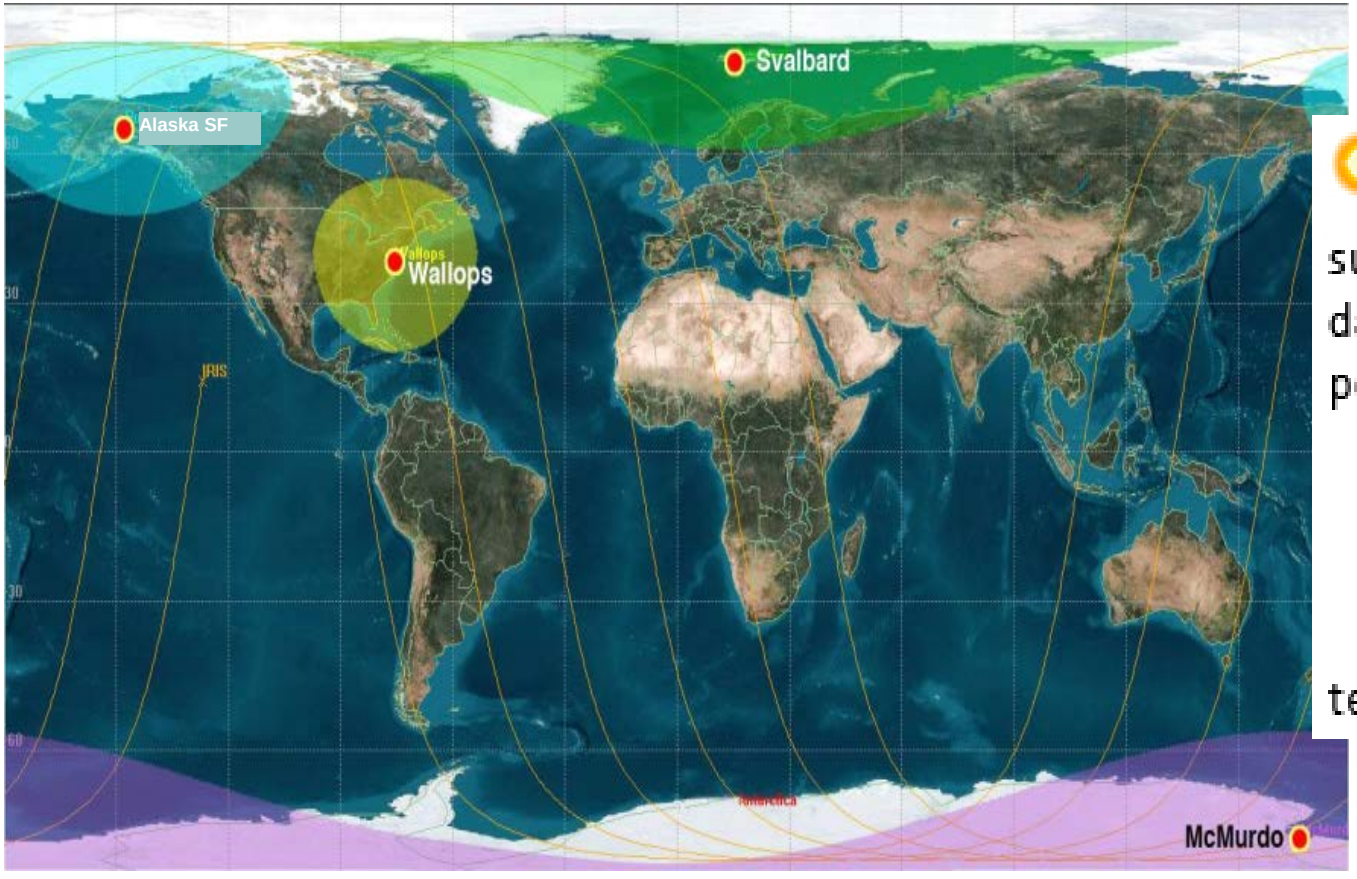

**Deployed Configuration**

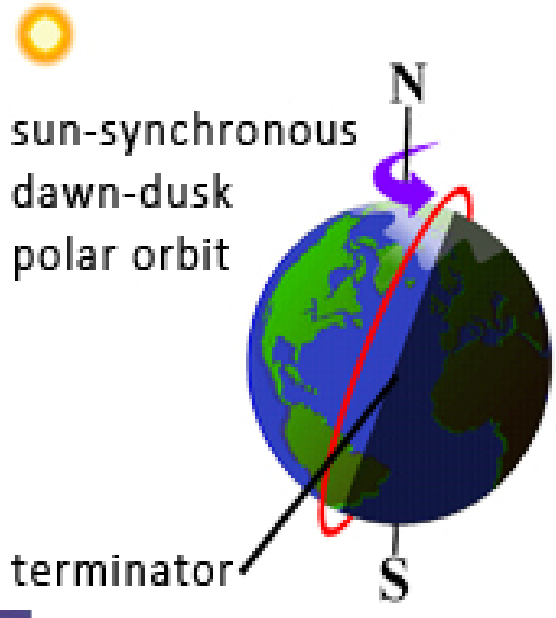
*IRIS is a sun-pointed spacecraft that images the Sun's chromosphere in ultraviolet light*

# Spacecraft Bus

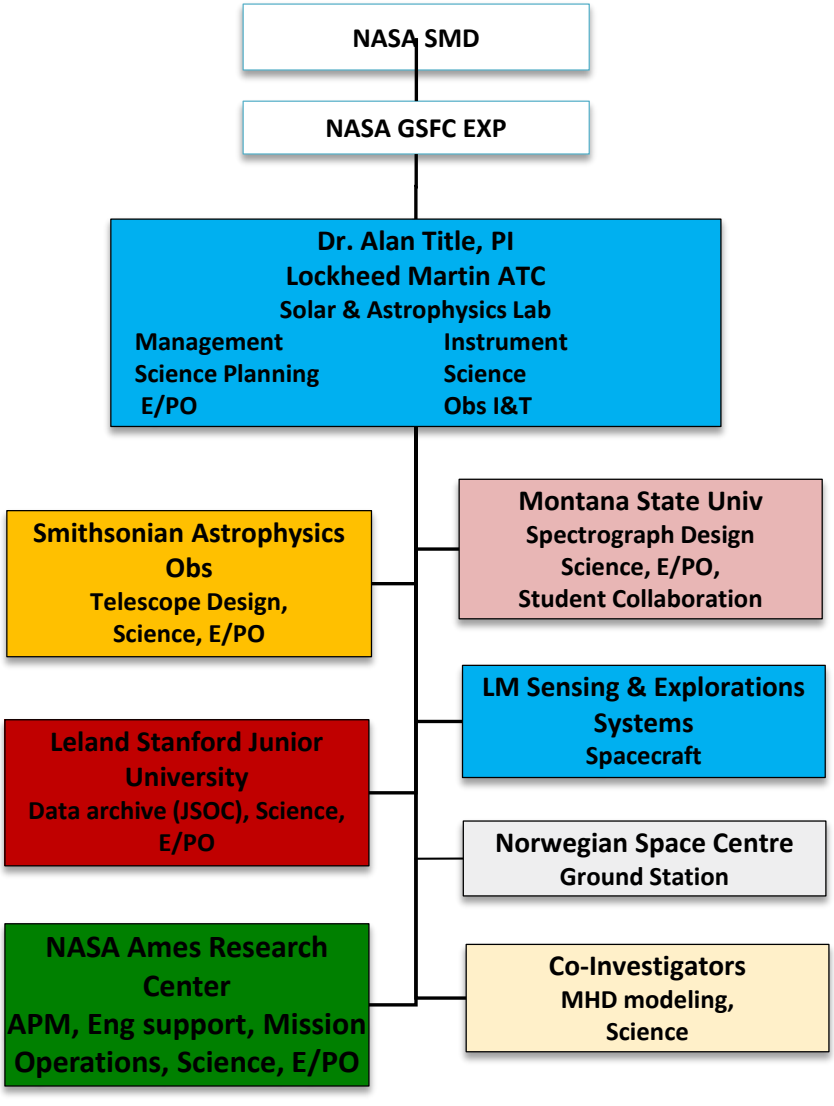


# Orbit and Ground Stations



# Ames on the IRIS Team

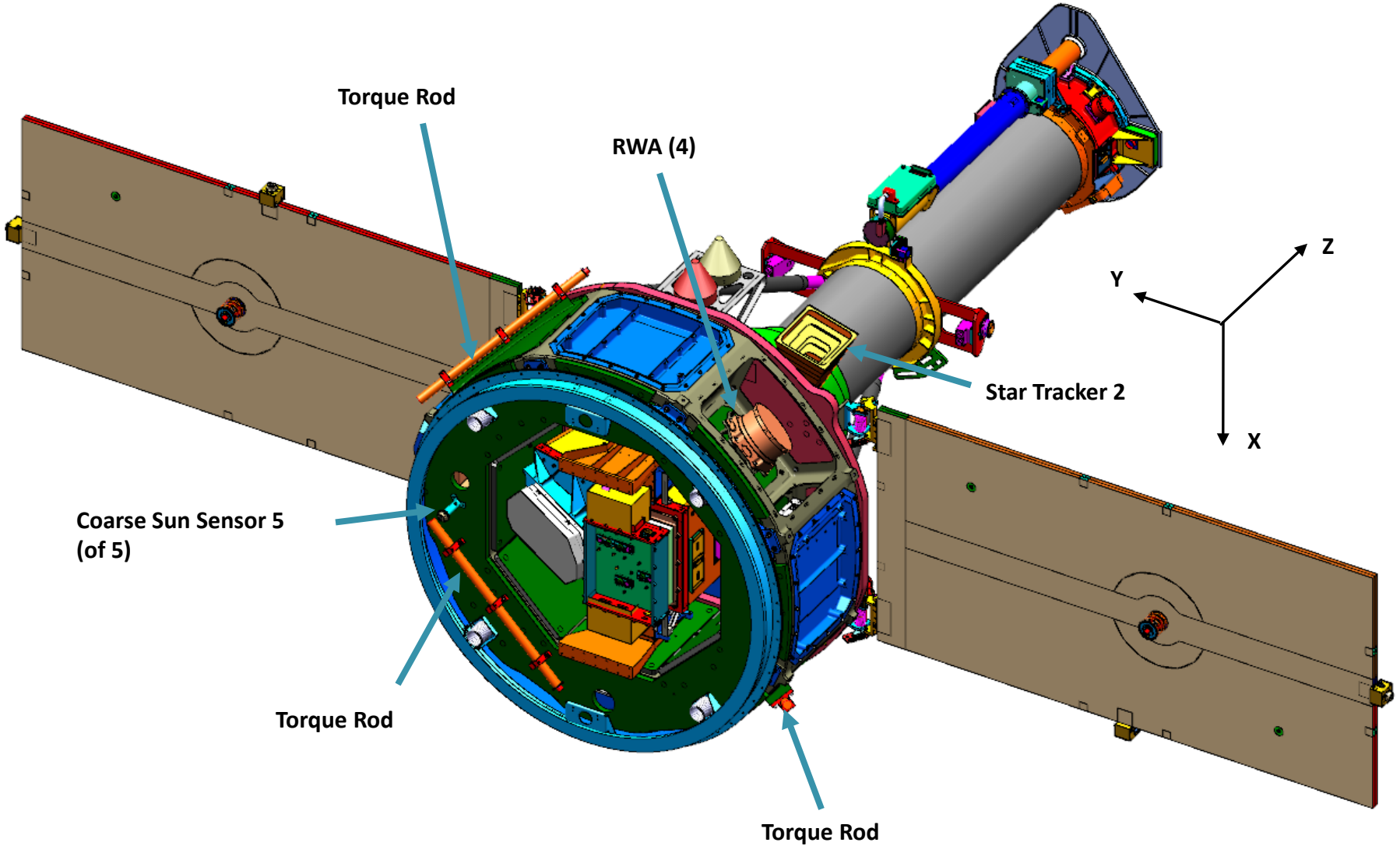



- Ames has been a critical partner on IRIS from the beginning
  - Assistant Project Manager - J. Marmie
  - Mission Operations
  - Ground Systems
  - E/PO
  - Science participation - P. Worden
  - Flight Software support
  - ACS support
  - Simulator support
  - Instrument FSW support
  - Thermal Engineering Support

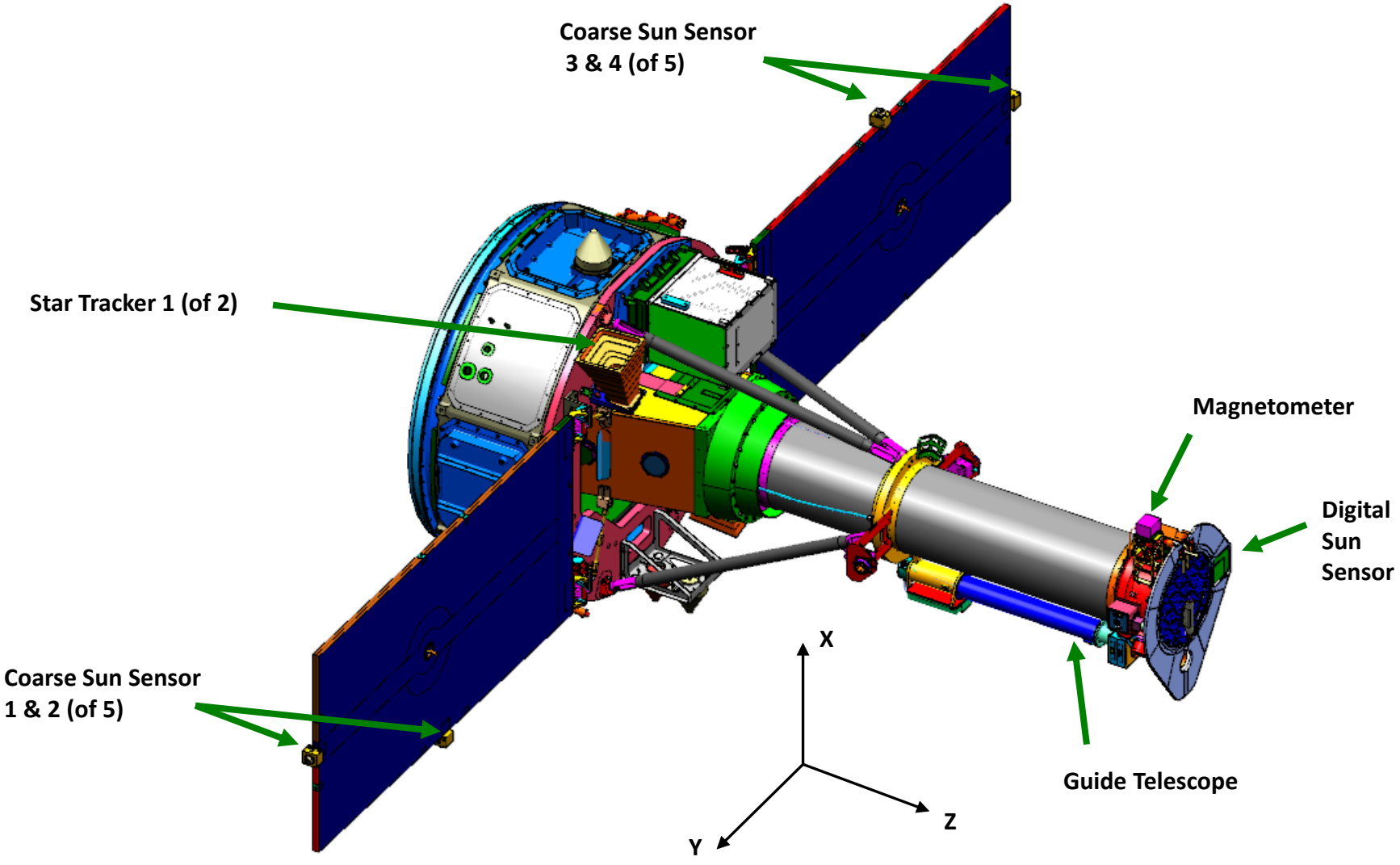
# Eddy Bio

- Started working at NASA in 2006 as an intern
- BS/MS at San Francisco State and Santa Clara
- Various Projects at NASA
  - Testing/Qualification of payload to ISS
  - Hardware/Software projects
  - Proposals
  - And IRIS – worked extensively at Lockheed Martin
  - Also supporting UAS effort at Ames
- Look forward to supporting future exciting projects!

# Attitude Control System (ACS)



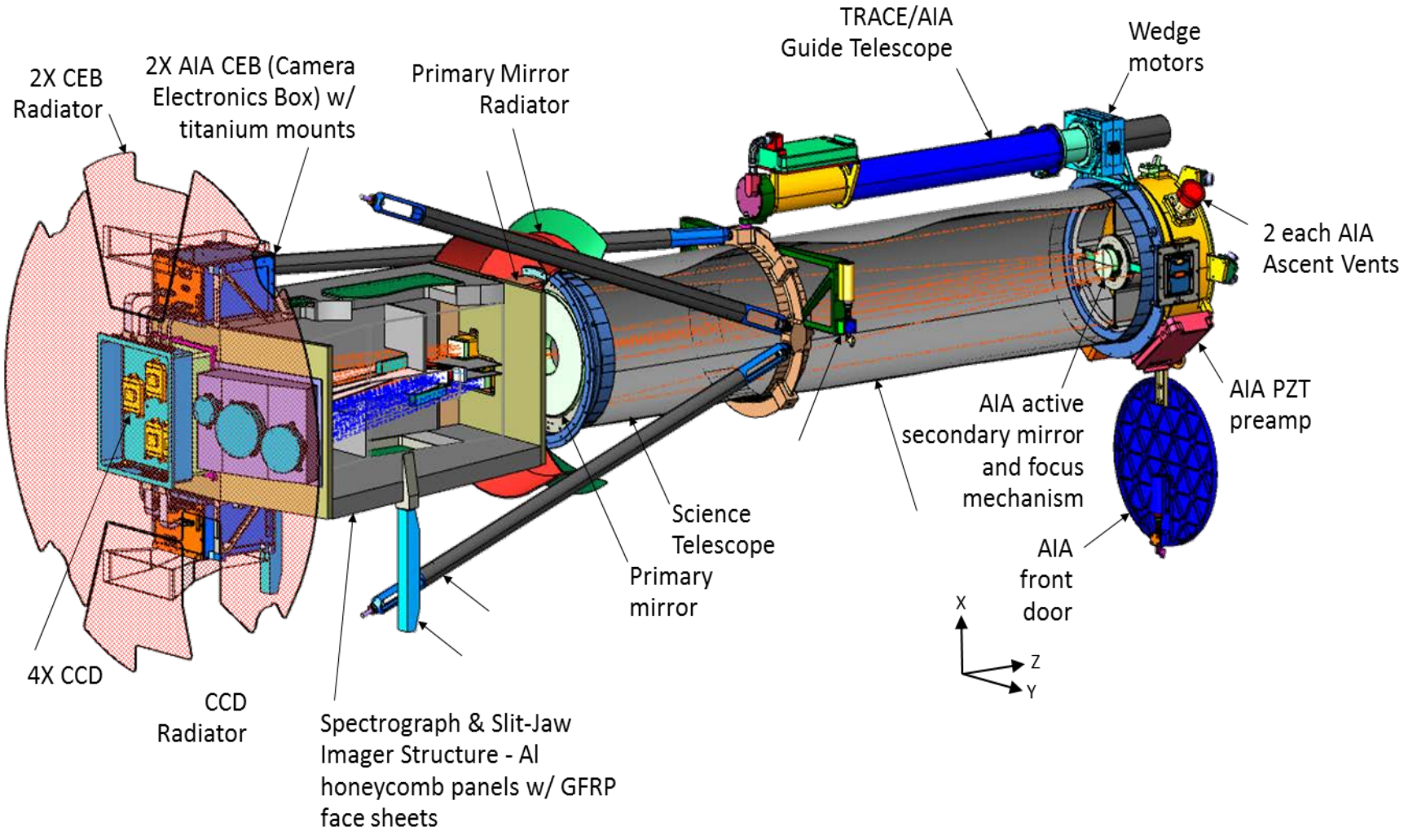
# Attitude Control System (ACS)



# ACS

- Several Different modes of Operation:
  - De-tumble
  - Sun Search
  - Coarse Control
  - Inertial Sun Point
  - Fine Sun Point
    - Spend ~99% of time in this mode during operations
    - Better than 0.5 arc-sec stability

# Instrument


2X CEB Radiator
2X AIA CEB (Camera Electronics Box) w/ titanium mounts
Primary Mirror Radiator
TRACE/AIA Guide Telescope
Wedge motors
2 each AIA Ascent Vents
AIA PZT preamp
AIA active secondary mirror and focus mechanism
AIA front door
Science Telescope
Primary mirror
4X CCD
CCD Radiator
Spectrograph & Slit-Jaw Imager Structure - Al honeycomb panels w/ GFRP face sheets
X
Z
Y

# Flight Software

- Separate CPU/Code for Spacecraft Bus and Instrument
- RAD750 and RAD6000 CPUs
- Coded in C/C++ with VxWorks OS
- Fault Management
  - Checks on various components and health
  - Responds to many potential anomalies

- Flight Software Loads
  - Sometimes things just aren't perfect!
  - Loaded FSW from the ground for Instrument, Spacecraft, AND Star Tracker!

# Robert Bio

- BS Computer Engineering Santa Clara University 1995
- Graduate Program Spacecraft Systems Engineering APEX/ Stevens Institute of Technology 2009
- Started as an intern at Ames in 1993
- Highlights of NASA career include:
  - Leading and supporting Ames mission proposals
  - Operations and Information Architecture for Constellation
  - Developing astronaut training management systems
  - Supporting the Columbia Accident Investigation Board
  - Developing Operations for upcoming Resource Prospector
- Robert has long been a space enthusiast, and looks forward to the exciting new things that NASA is doing

# Ground Data System

- The tools to support the operation of the mission
  - Building Command packages
  - Receiving and processing Telemetry
  - Communication Scheduling
- Systems Engineering
  - Requirements coverage
  - Architecture and Interface design
  - System design
  - Verification and Validation
- Tool Development

# Testing and Training

## Testing

- GDS Component
- GDS System
- Flight Software
  - Range of Simulators
- Interfaces
  - Flight Software
  - Ground Stations
  - Science Planning
  - Scheduling Systems

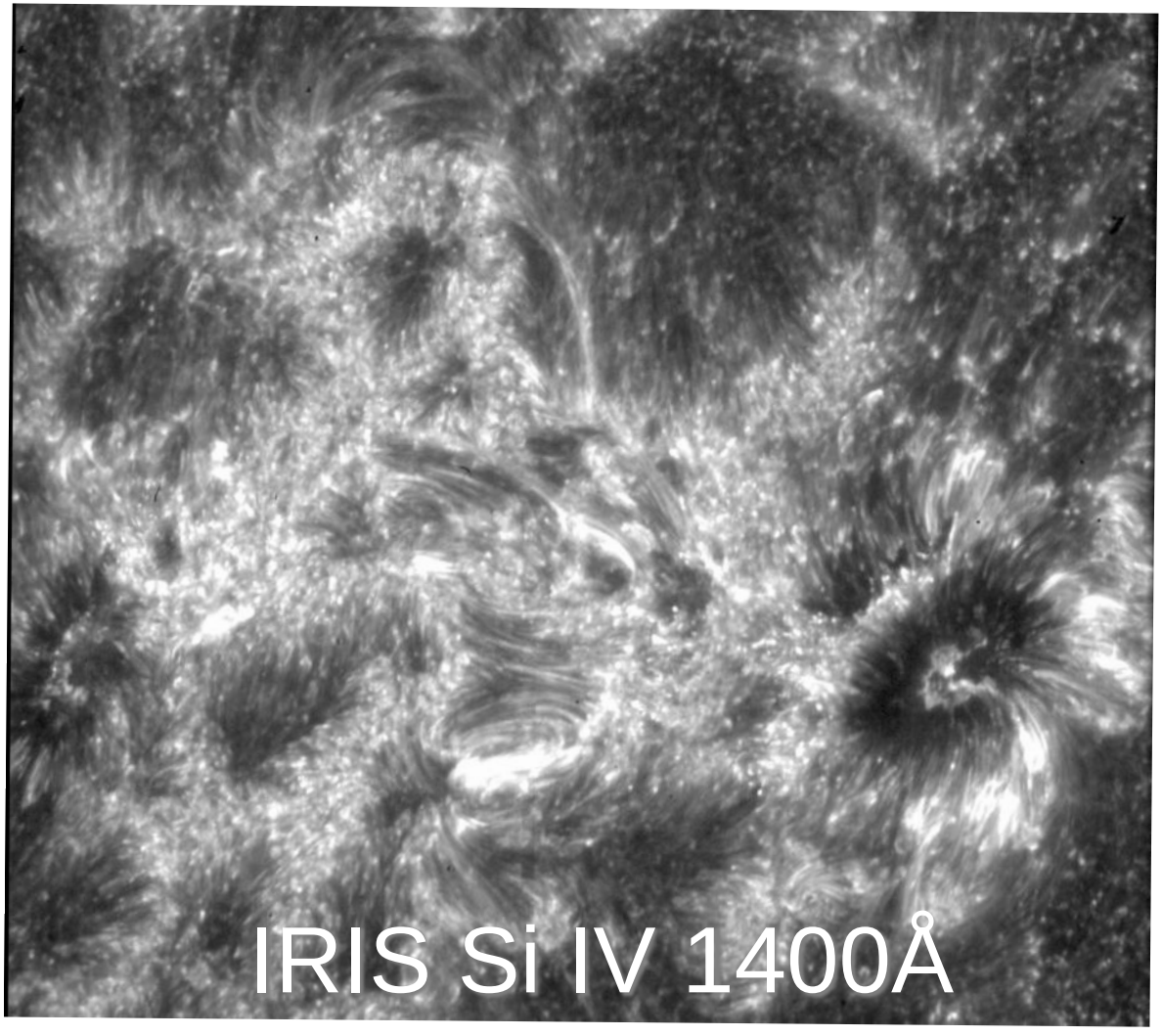
## Training

- Flight Software
- Spacecraft Systems
- Instrument Systems
- Ground Stations
- Voice Systems
- GDS Systems
- Mission Sims
  - Day in the Life
  - Launch and Early Ops
  - Comm Scheduling

# IRIS is acquired by TDRSS!

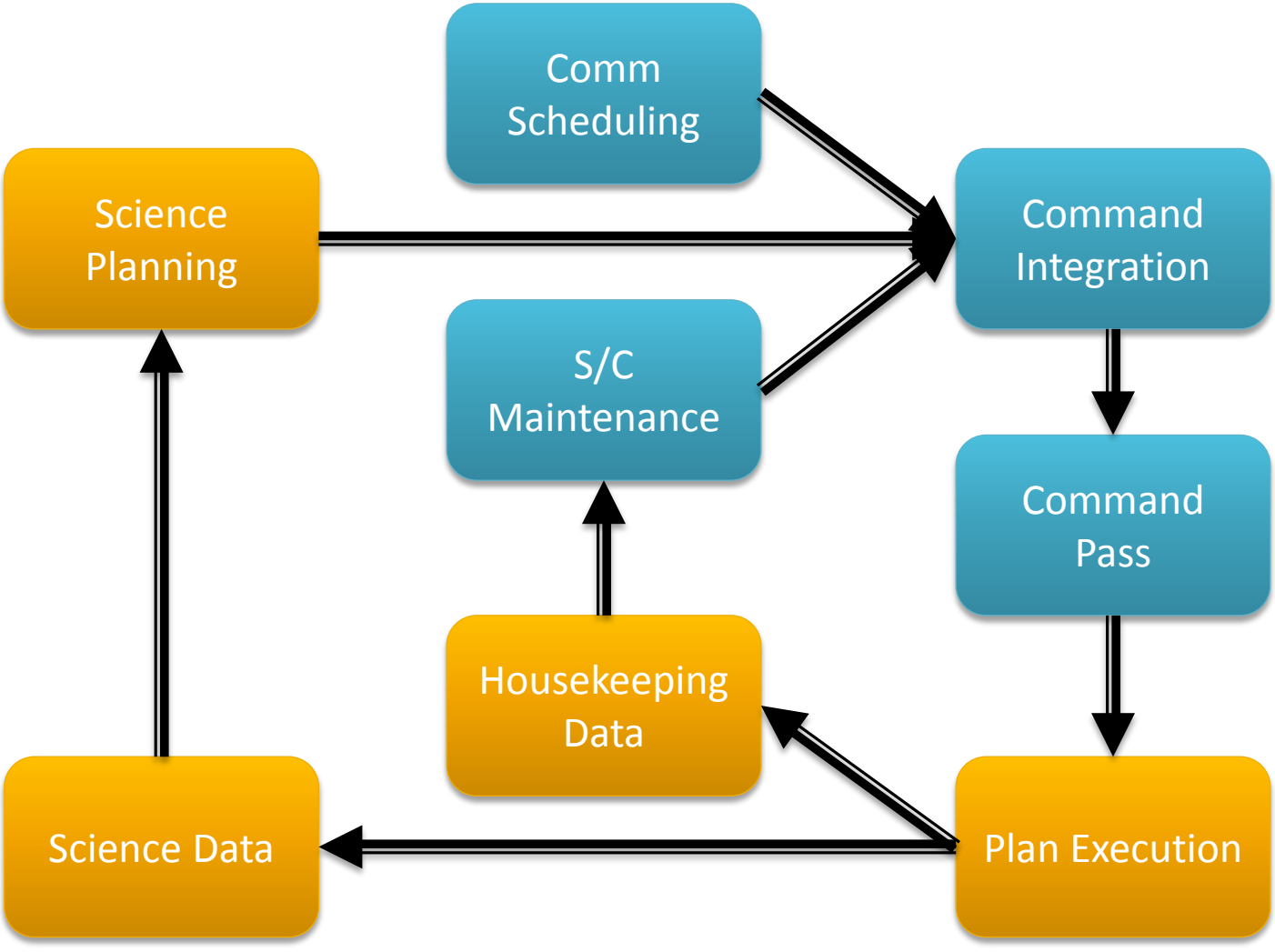

**Success! But you'd hardly know it**

# First Light

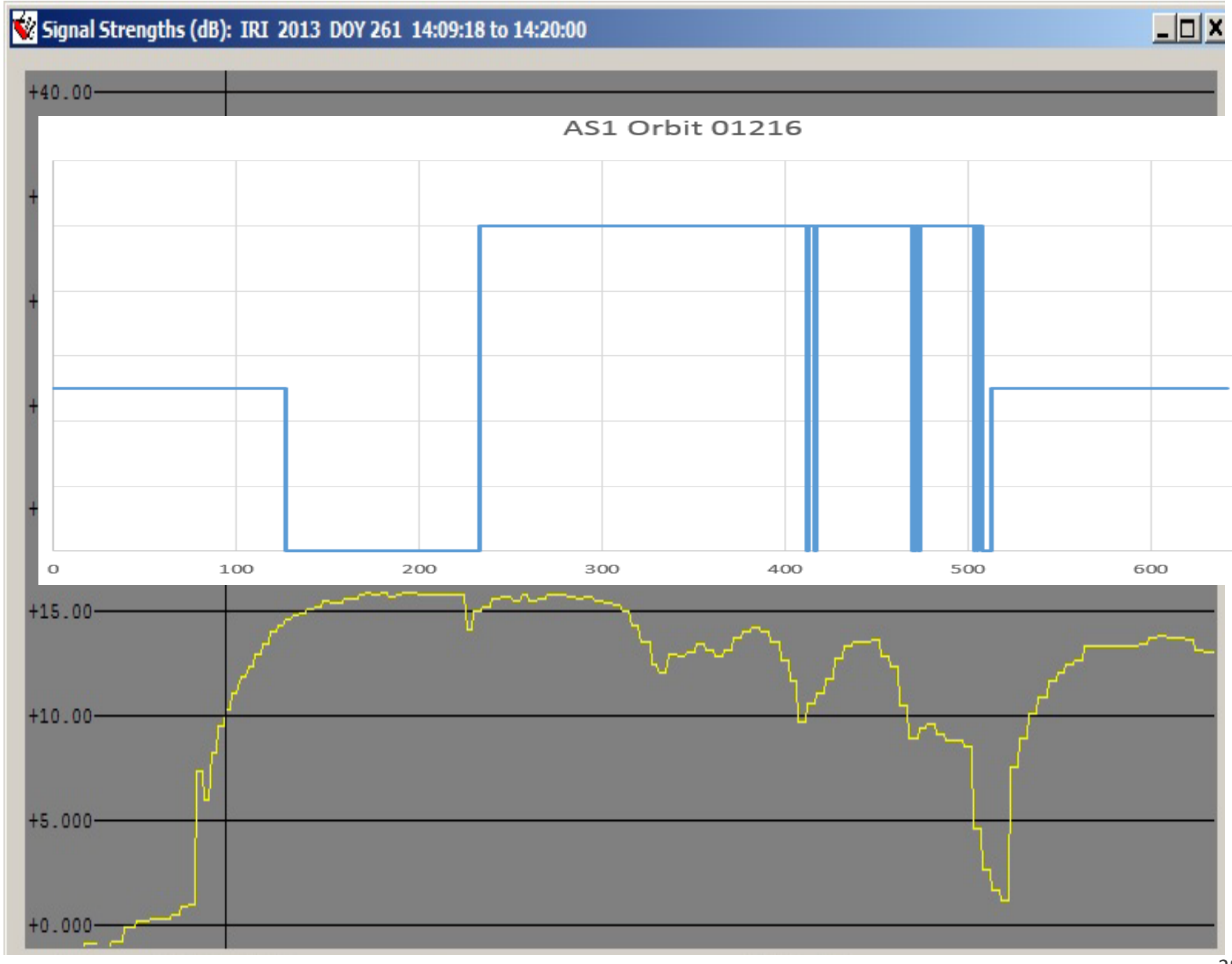


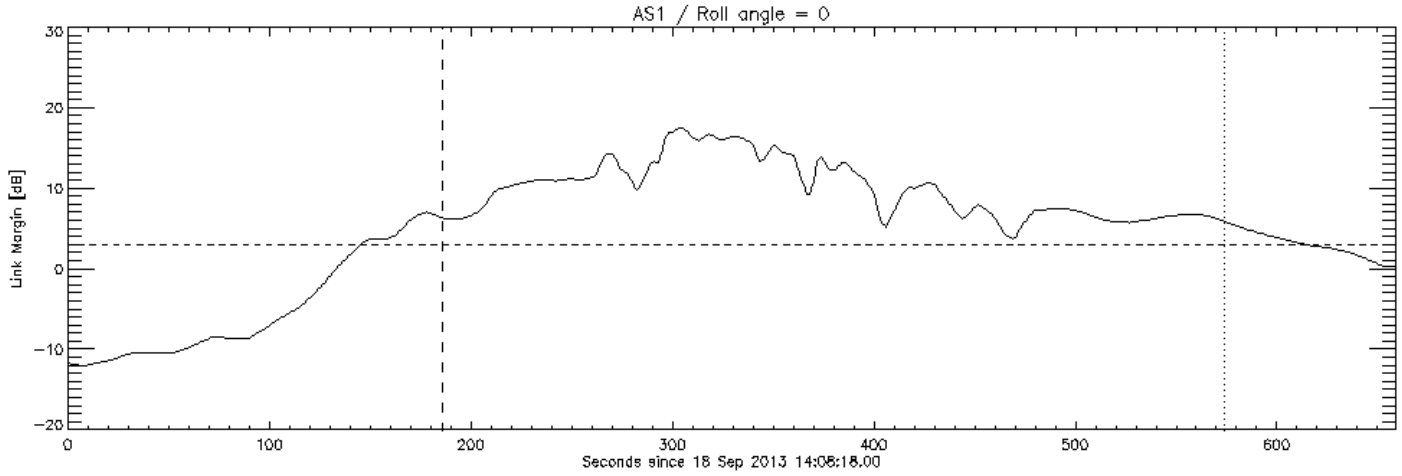

- First light announced July 25, 2013
- Nearly 1 year of successful on orbit operations
- Threshold mission requirements met
- Data available to public at: iris.lmsal.com/iristoday

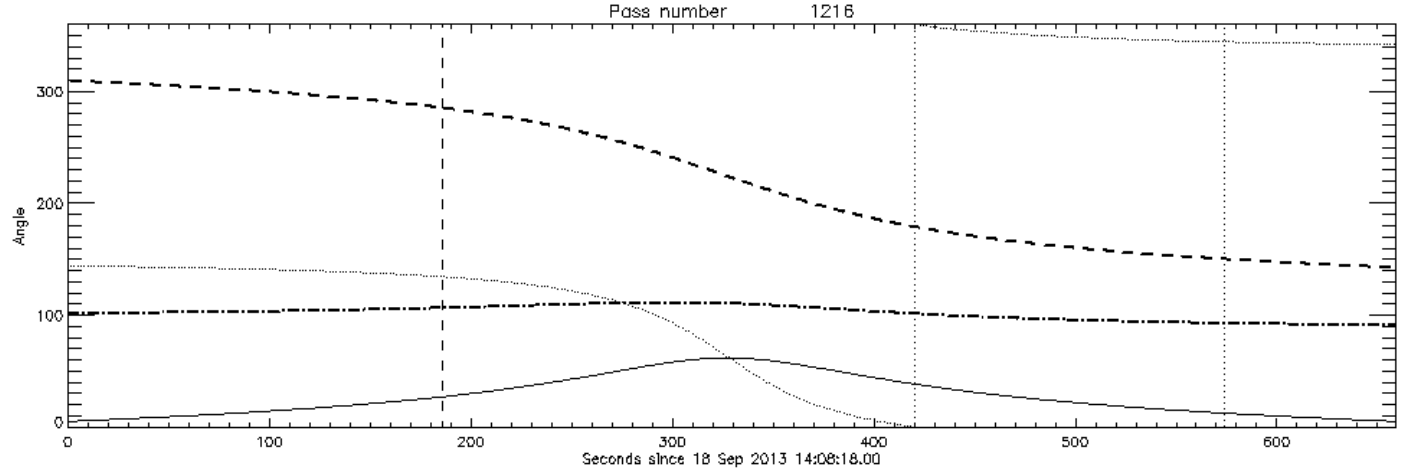
# IRIS Day in the Life

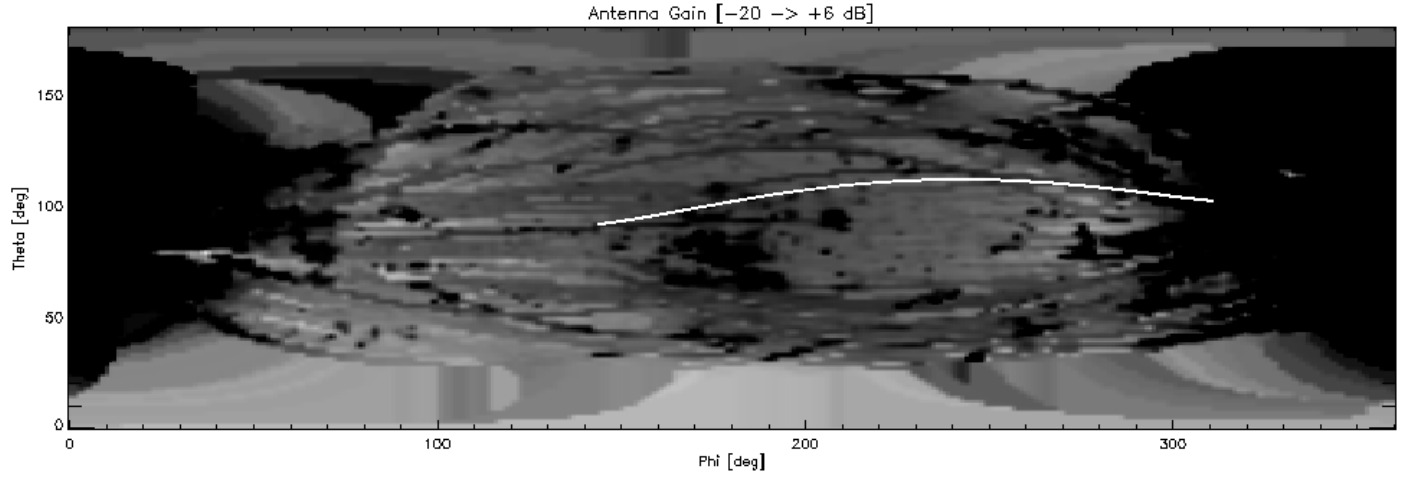


# Backup

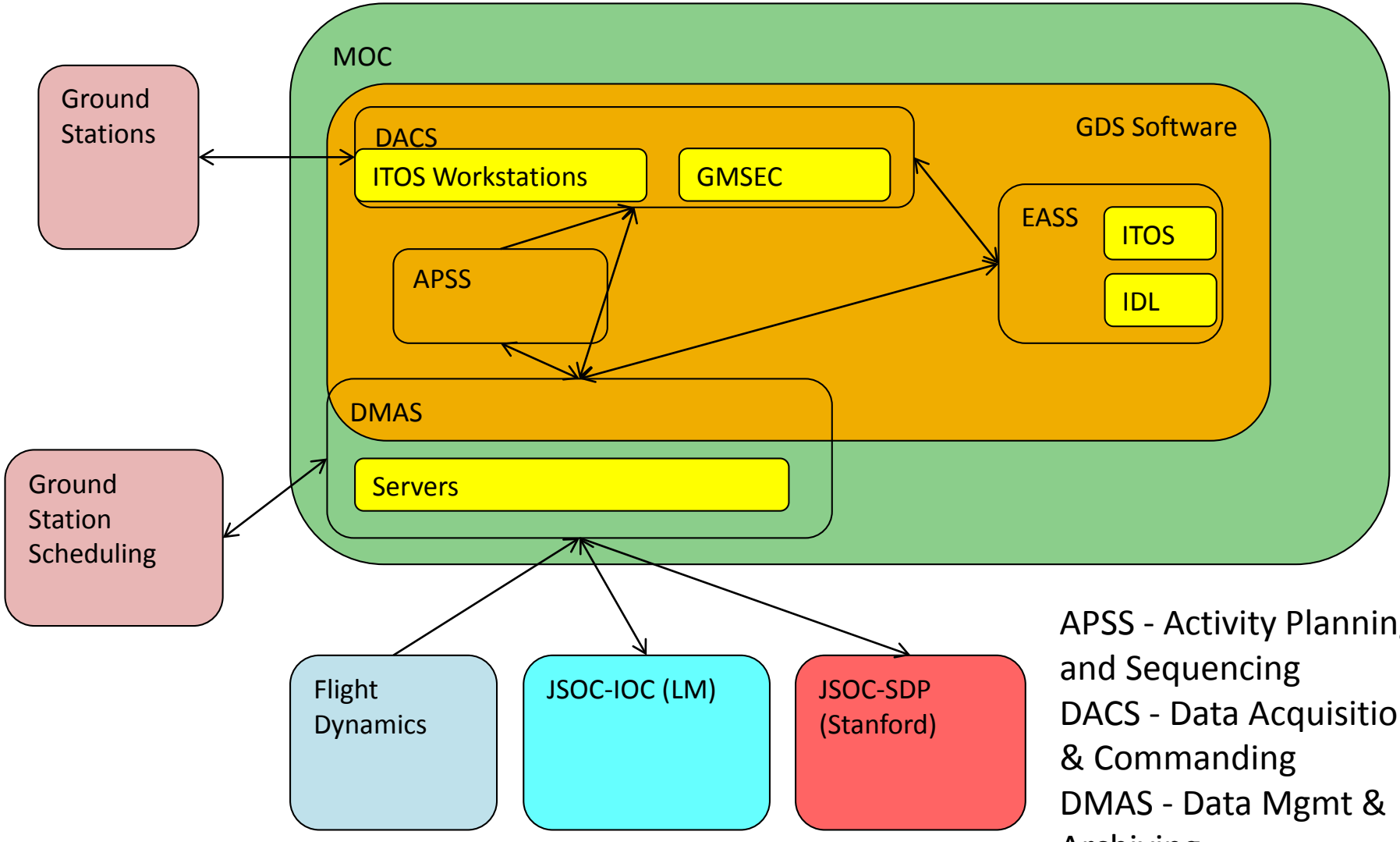

Signal Strengths (dB): IRI 2013 DOY 261 14:09:18 to 14:20:00
+40.00
AS1 Orbit 01216
0
100
200
300
400
500
600
+15.00
+10.00
+5.000
+0.000


AS1 / Roll angle = 0
Link Margin [dB]
30
20
10
0
−10
−20
0
100
200
300
400
500
600
Seconds since 18 Sep 2013 14:08:18.00


Pass number 1216
Angle
300
200
100
0
0
100
200
300
400
500
600
Seconds since 18 Sep 2013 14:08:18.00


Antenna Gain [−20 −> +6 dB]
Theta [deg]
150
100
50
0
0
100
200
300
Phi [deg]

# GDS Architecture Overview

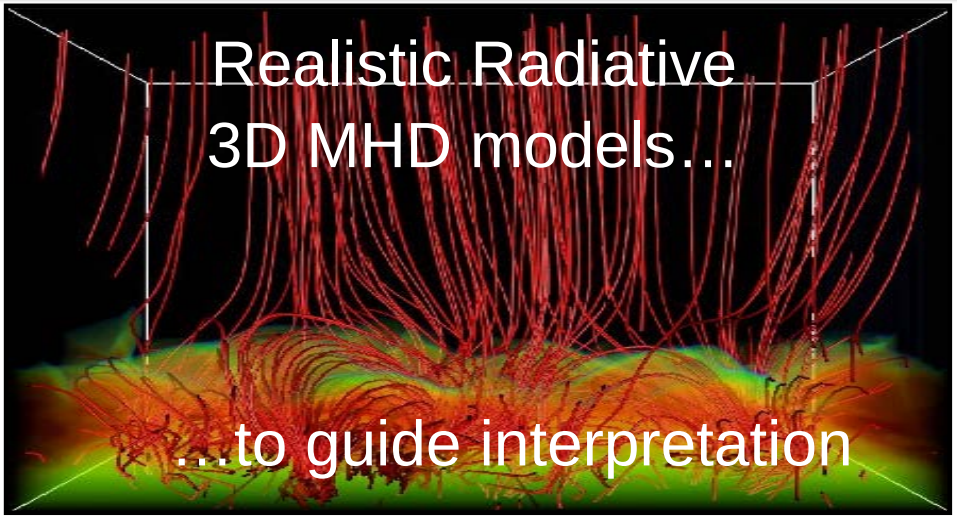


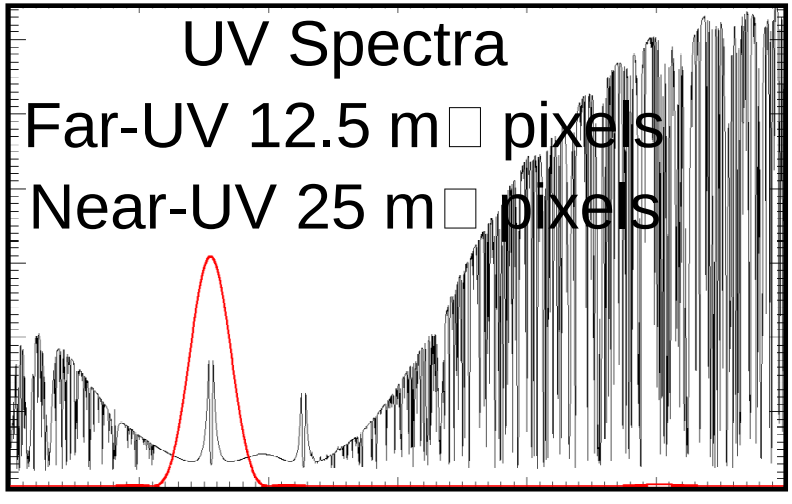

APSS - Activity Planning and Sequencing
DACS - Data Acquisition & Commanding
DMAS - Data Mgmt & Archiving
EASS - Engr Analysis & Support

# Science Implementation

UV slit-jaw Images
Si IV (65,000K)
C II (30,000K)

Mg II h/k (10,000K)
Mg II h/k wing (6,000K)




**20 cm UV telescope:**

1/6 arcsec pixels

***multi-channel spectrograph***

*far-UV* : 1332-1358 Å, 1390 -1406 Å,
40 mÅ resolution, effective area 2.8 $cm^2$

*near-UV* : 2785-2835 Å,
80 mÅ resolution, effective area 0.3 $cm^2$

***slit-jaw imaging***

1335 Å & 1400 Å with 40 Å bandpass each;
2796 Å & 2831 Å with 4 Å bandpass each.