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Advanced Technology Center

IRIS
Lessons Learned

NASA SMEX PI-Forum
September 20, 2017

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PM: SMEX 2008 – IRIS
PM: SMEX 2016 - MUSE

Agenda

- **IRIS Science**
- **Mission Overview**
- **Lessons Learned**

IRIS Partners

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NASA Goddard Space Flight Center

SAO

NASA Ames Research Center

Stanford University

UiO University of Oslo

Montana State University

Science & Technology Facilities Council Rutherford Appleton Laboratory

NSO

esa European Space Agency

国立天文台 NAOJ National Astronomical Observatory of Japan

NCAR National Center for Atmospheric Research

Berkeley University of California

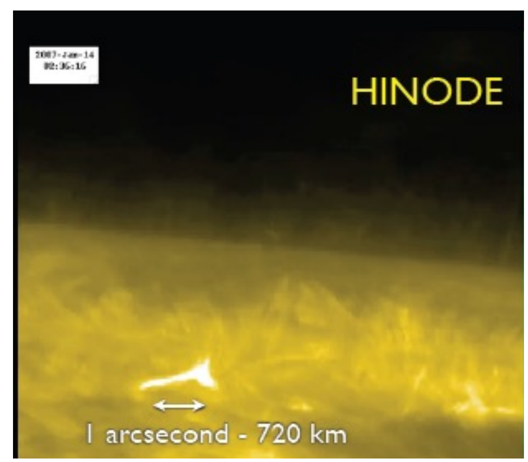
MPS Max-Planck-Institut für Sonnensystemforschung Max Planck Institute for Solar System Research

Most Compelling Science Driver

To discover how an outer stellar atmosphere is Energized

- The chromosphere is where most of the non-thermal energy that creates the Corona and Solar Wind is released.
- This critical region has long been neglected because of its complexity. But now modern computers and new instrument capabilities can uncover the fundamental physical processes that occur there.
- ***In particular how energy is generated and transmitted through the chromosphere and transition region into the corona*.**

HINODE has revealed a dynamic chromosphere (temporal scales of < 10 seconds) and highly structured (spatial scales < an arc second.)

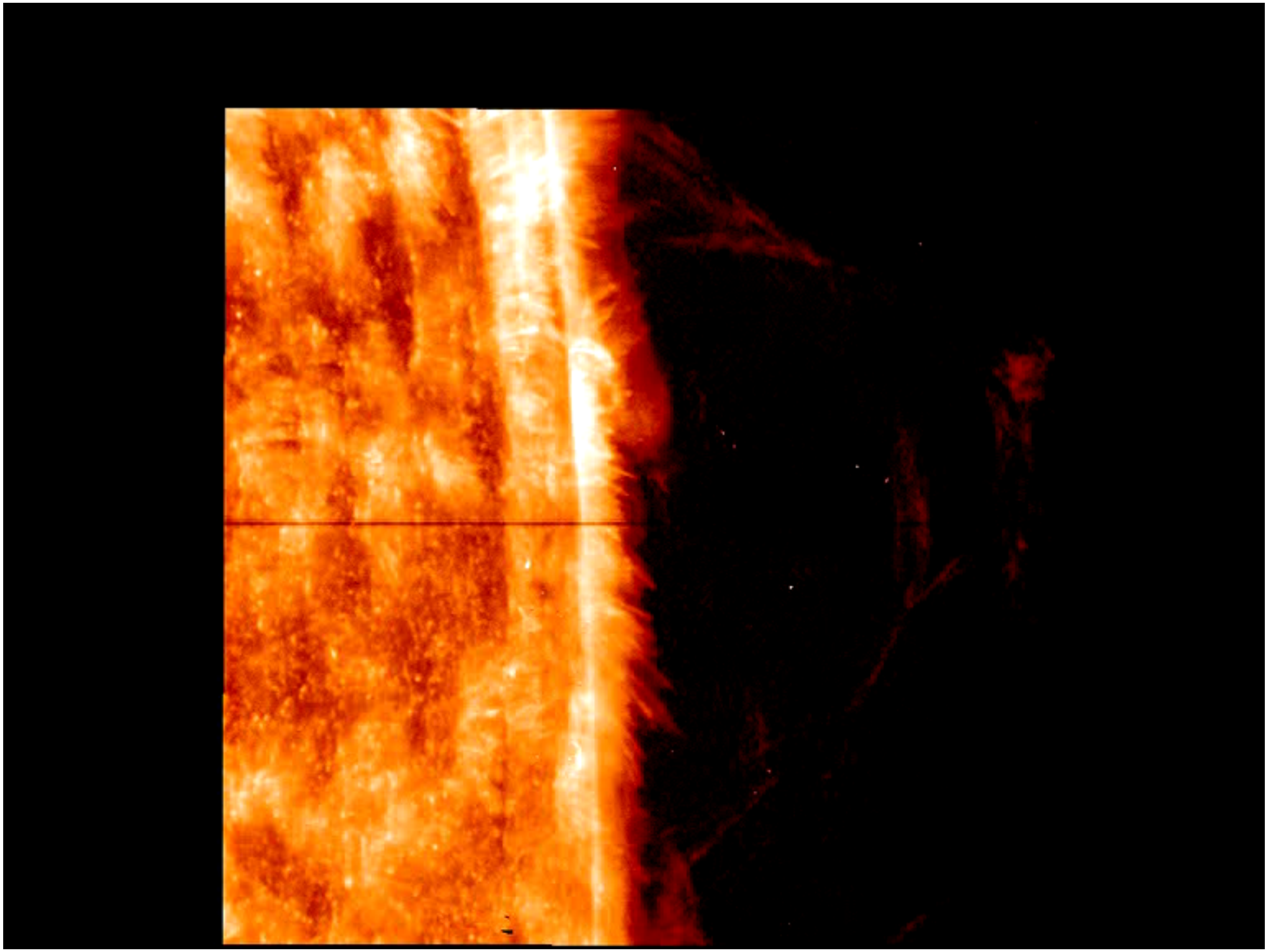


IRIS Science Summary

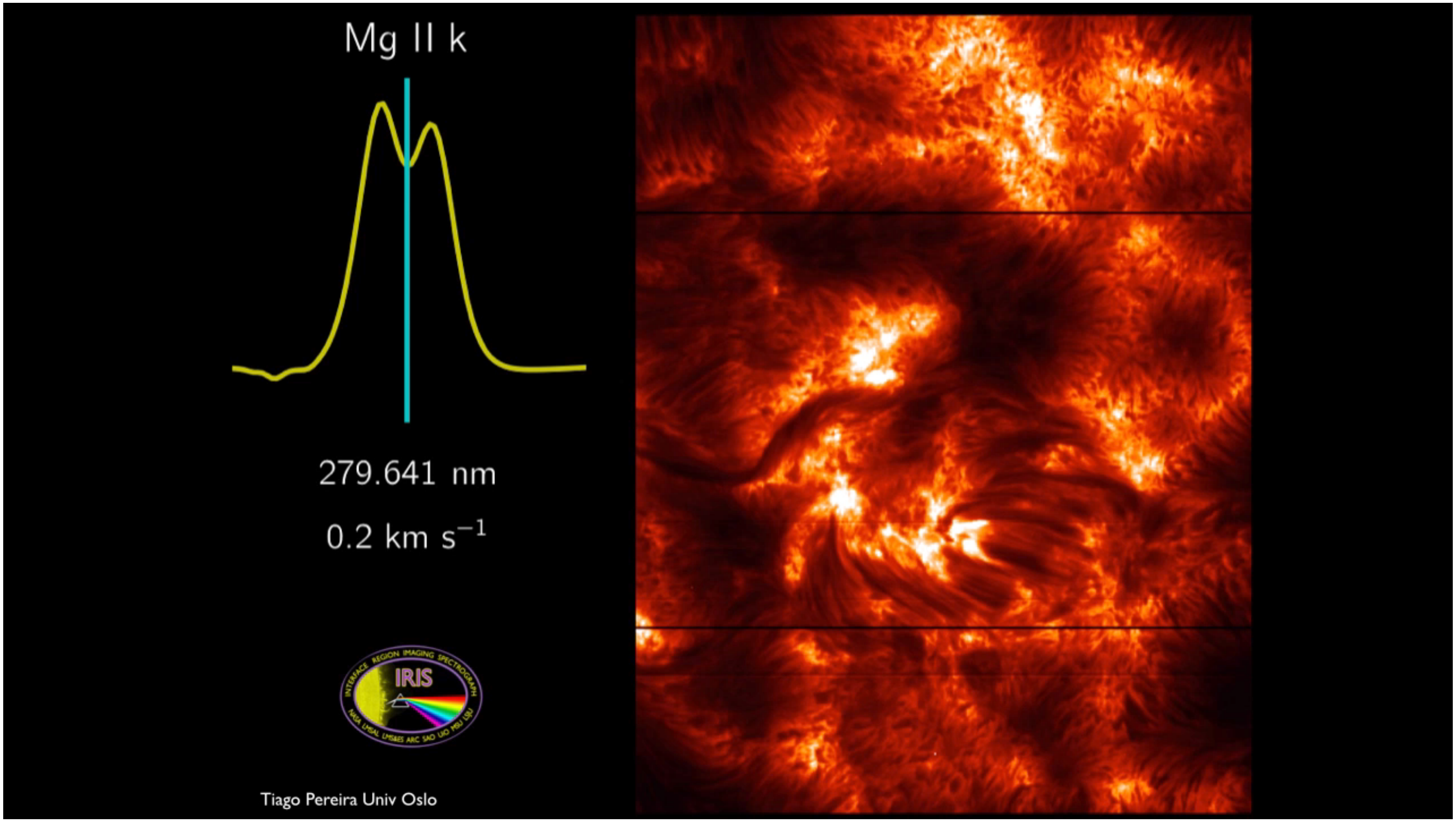
- **IRIS Functioning Well: high resolution spectra and images obtained daily**
- **IRIS data available at http://iris.lmsal.com/search**

1. **Chromosphere is riddled with twist, associated with heating to transition region temperatures and propagating torsional Alfven waves**
2. **"Unresolved Fine Structures" (UFS) resolved as small-scale, ~100,000K loops**
3. **Evidence of electron beam heating in coronal nanoflares**
4. **First observations of heating to 100,000 K *in the photosphere***
5. **Chromospheric heating strongly impacted by ion-neutral collisions**
6. **Heating of chromospheric jets or spicules to transition region temperatures**
7. **Formation of recurrent coronal jets, supersonic down flows in sunspots, heating of prominences, etc…**

May 2014 CME

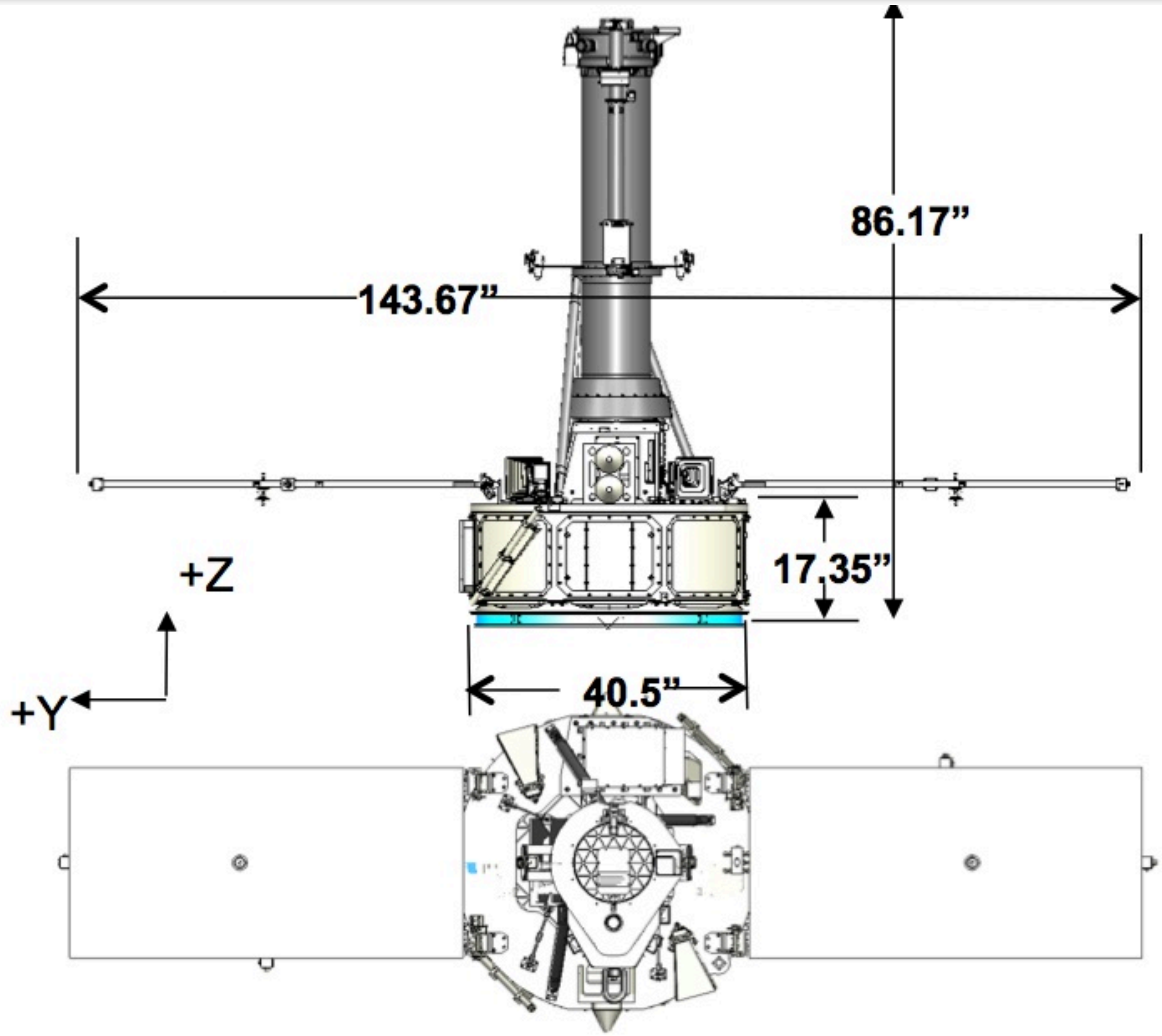


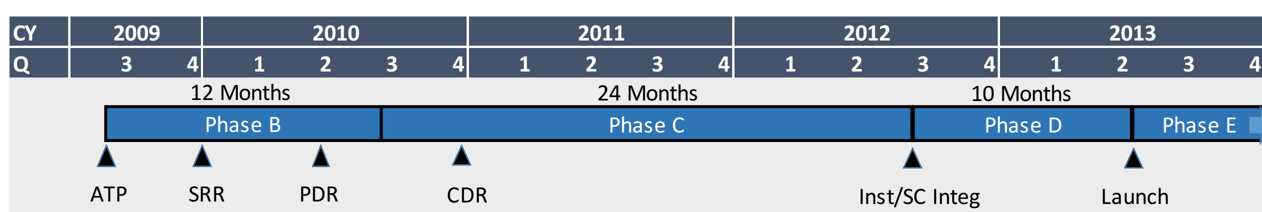
Science Data



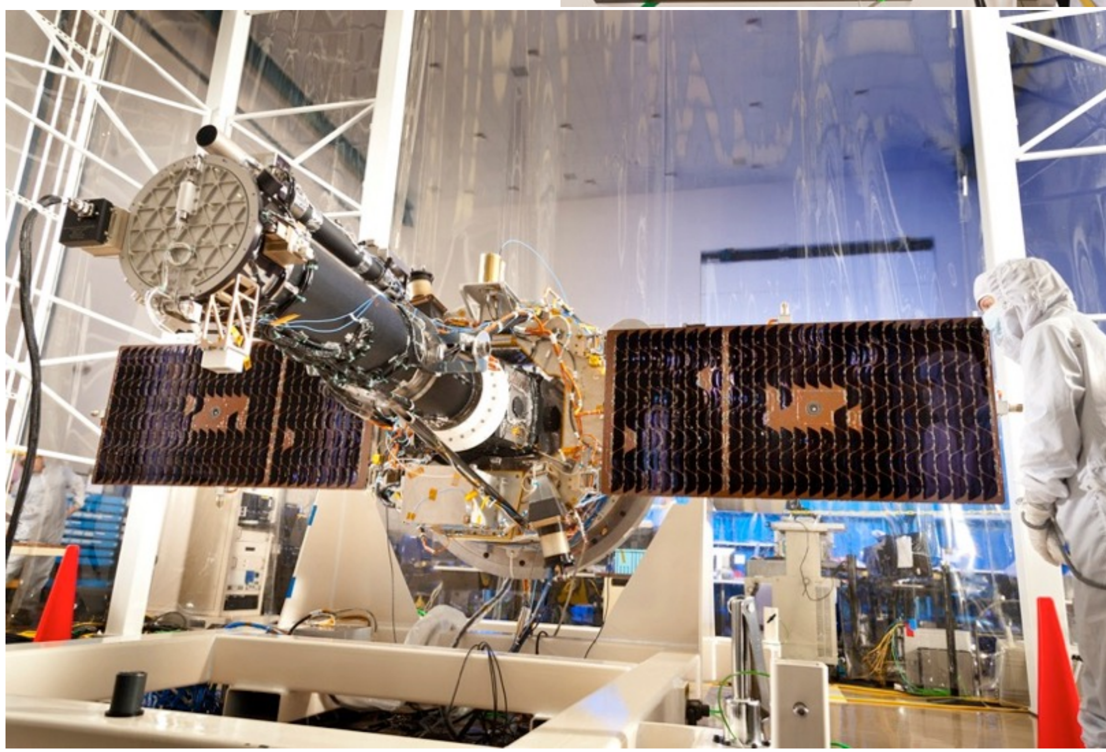
IRIS Mission

- **Launched June 27, 2013**
- **Launch Vehicle: Pegasus XL**
- **Solar Pointing**
- **Orbit: Sun synchronous, polar Orbit: 620kmx670km**
  - 7 months eclipse free viewing
  - Orbit Inclination: 97.89 deg MLT 6:00-6:05am
  - Orbit period: 97 min
- **Mass: 183 kg meas.**
- **Power: 342 W meas.**
- **Telemetry rate:**
  - 15 Mbps, 60Gb/day (X-band)
- **Recording capacity: 48 Gbits**
- **Mission Life: >2 Years**
- **Budget ~ $115M RY 2009**





IRIS Observatory



Contributions to Project Success

- **Co-location of team–(as much as possible); PI, PM, science team members critical**
  - If not, must over communicate and use excellent sharing tools
- **Excellent working relationship between PM and MM and Explorers office**
  - Bring up issues as soon as possible to minimize any surprises
  - Ability to share early information with time to follow up with details and resolution plans if needed
  - Explorers office treated as key and trusted member of Project Team {IRIS Example – comm box}
- **Team composition**
  - Small team, "many hats," cross-train, keep work in-house and in-team
  - Team agility – people with good judgment are as important as good processes
  - Designers, Architects – experience with build and test – design for X
  - Quality is part of team and solutions, not just monitor, audit, and enforce
- **Communication critical at all levels**
  - Visit subs, key team members, and hold more TIMs than planned
    - Prior to visits – "why am I doing all this travel for a 4 hour meeting"
    - After visit/TIM – "I can't believe how important that meeting was to clear up …"
  - Perform vendor risk based assessment and allocate reserve funds as soon as needed
    - IRIS example: Identified less mature vendor, figured out areas where company could truly help, estimated cost and allocated cost reserves up front, worked with vendor throughout to provide assistance in board development and test
  - Tailoring of procedures and processes – breaks command and control structure and captures executing team's inputs

Key drivers (1 of 2)

- **Most important aspect of meeting the programmatic goals is maintaining the schedule**
  - Dealing with unknowns *inserted* into the program requires constant vigilance
  - There are many factors that can impact timely performance
- **Changing Rules at NASA:**
  - True Class D vs requirements and review creep - *GeoCarb CDRL tailoring*
  - Negotiate Mission Assurance Plan (MAP) and CDRLs at start of program – *IRIS PAIP example*
  - Increasing scope of Project Level reviews such as SRR, PDR, CDR - *IRIS and GeoCarb examples*
    - Reviews are useful and helpful as an exercise
    - Lose value when review involves 10's of NASA members
    - Moves from open, beneficial discussion to lots of presentations and message shaping
    - Should be able to review, approve, and close RFAs with PM and SRB Chair concurrence
- **Changing rules at performing institution**
    - Increased and changing processes
      - Usually not mutually agreed to between the organization that executes them and the organization that creates them. Also the "one size fits all" mentality can be detrimental to the executing group.
      - Tailored process captures the communication between executing and creating organization
    - At LM, developed tailored set of command media – required pre-work to address all requirements

Key Drivers (2 of 2)

- **Must have SRB team and chair that understand Class-D and SMEX scope**
- **Earned Value Management – low value for rapid development programs – NASA should implement tailored system to provide insight without all of ANSI-EIA-748**
- **Must have good rapport and close working relationship between the PM and the PI and Science team**
  - Understand relationship between instrument requirements (Level 2) and Level 1 requirements
  - Ability to balance trades between real instrument performance and science requirements
  - Able to make rapid decisions and determine “good enough” performance

Other suggestions

- **On IRIS, we performed a lessons learned review (survey) with the team before they dispersed. Suggestions from the team:**
- **Areas to improve/watch**
  - More aggressive tailoring of institution's processes
  - Make tool decisions early, get templates, guidance out
  - Develop core team, keep as much cradle to grave as possible
  - Be agile with staffing – pro-active with bad fits, be selective, be clear with going outside, cross-train so can handle if key personnel leave
  - Early resource planning essential, but be willing to revisit at key program milestones
  - Continuously promote small team culture – especially with new members, over communicate if not co-located
  - Lack of resources early resulted in reactive not proactive responses
- **Other**
  - Co-location and almost daily communication
  - Drive schedule discipline early in program. Lock down design and hold to baseline
  - Emphasize early physical and mathematical models
  - Trade level of assembly for test (risk vs time vs resources)
  - Find out who in NASA community is using similar technology or same vendors
    - IRIS Examples: GRAIL, LADEE, MAVEN (battery, reaction wheels, comm system)
    - Lessons learned; available hardware to borrow; avoid vendor resource competition
  - Team also provided technical improvement ideas for hardware designs and test equipment

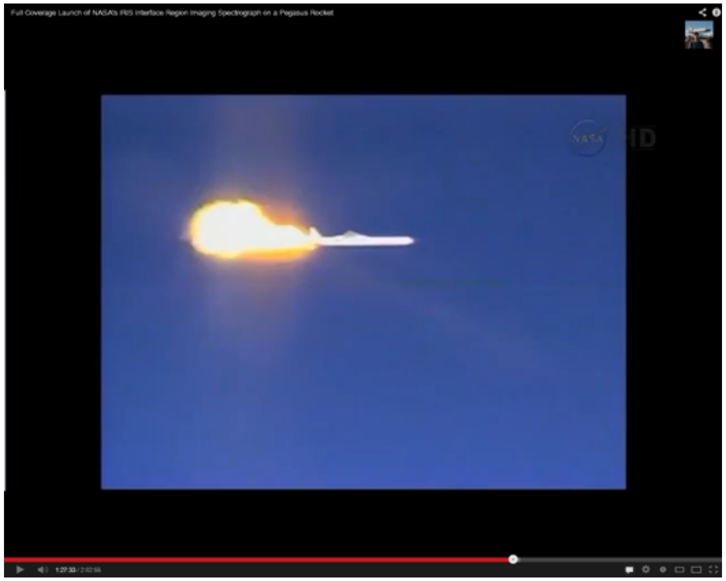
BACKUP

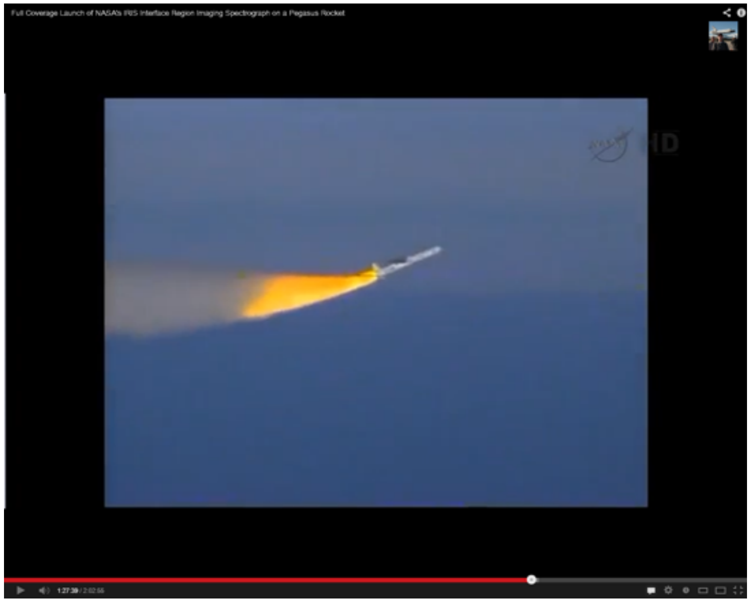
IRIS Mission Architecture

Launch Day

Plane and rocket preparing for takeoff

Longest 5 seconds ever





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Distribution of Lessons Learned Survey Categories