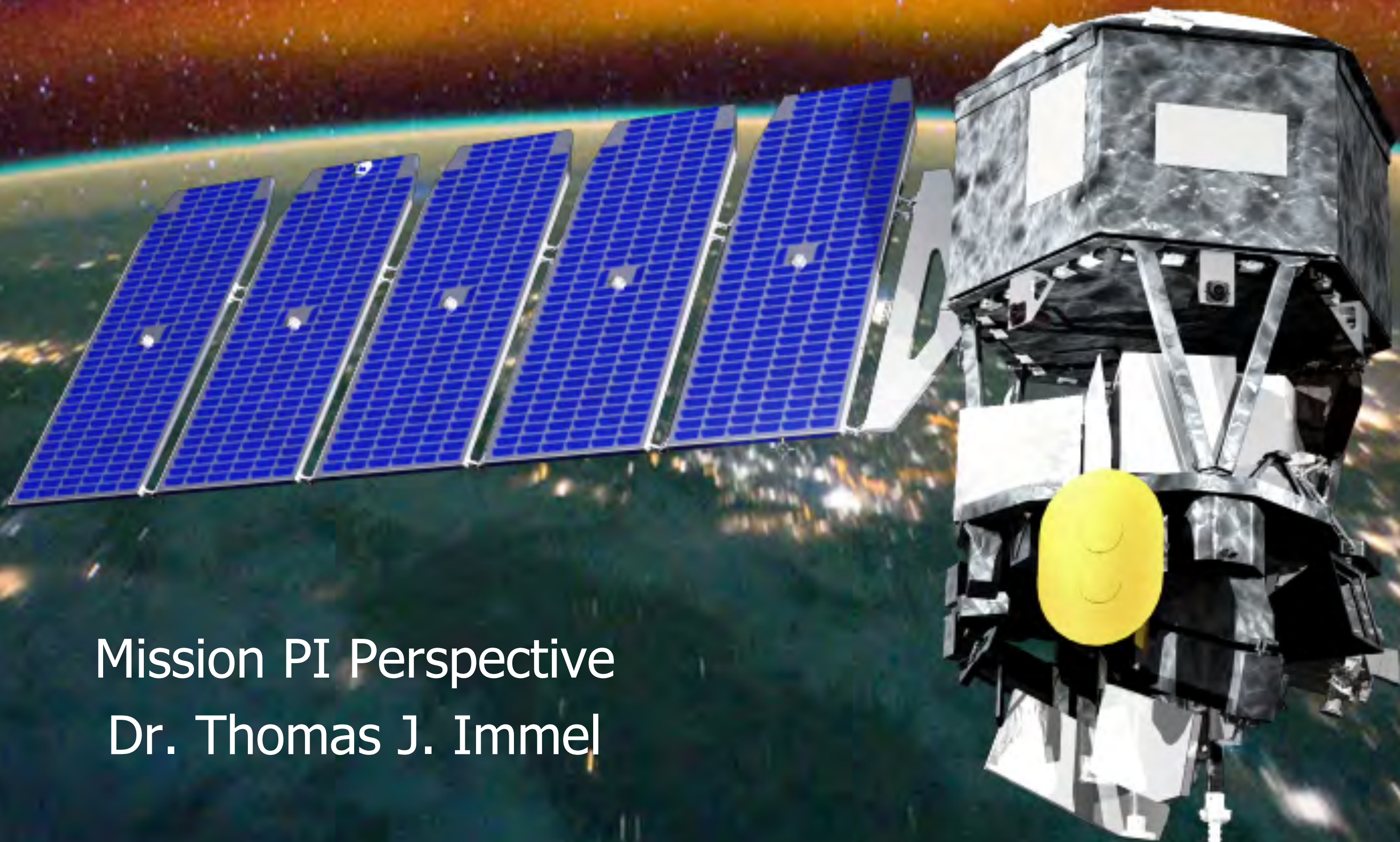
ICON

Ionospheric Connection Explorer



Mission PI Perspective

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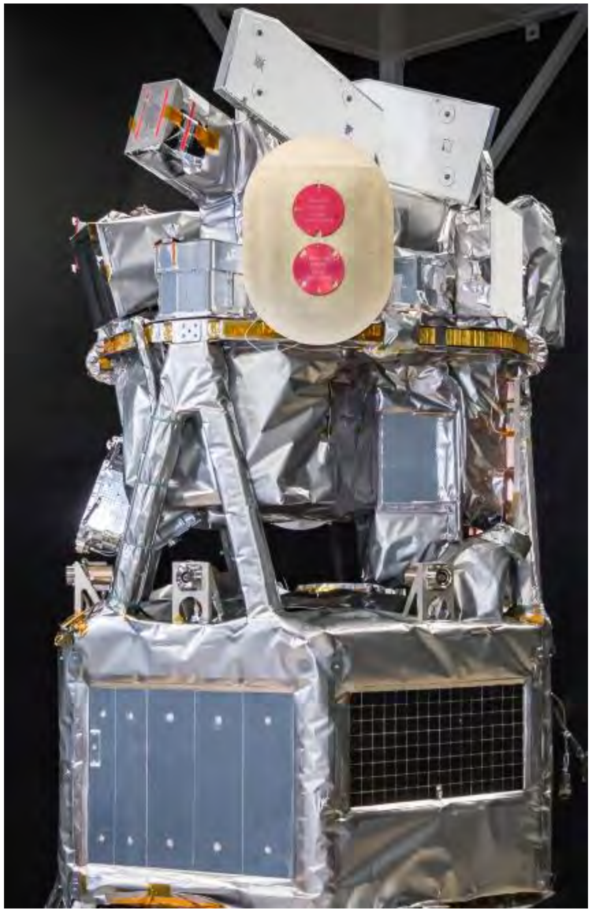
The Ionospheric Connection Explorer

ICON : NASA Explorer Mission Programmatics

Mission Summary	
Cost	$184.1 M (RY)
Launch vehicle	Pegasus XL RTS - Kwajalein
Spacecraft	LEOStar-2, 3-axis stabilized, no consumables
Launch	December 2017
Orbit	575 km circular, 27° inclination
Ground segment	Berkeley Ground Station, WGS, Santiago
Mission & Science Ops	24 months Phase E Operated from UCB

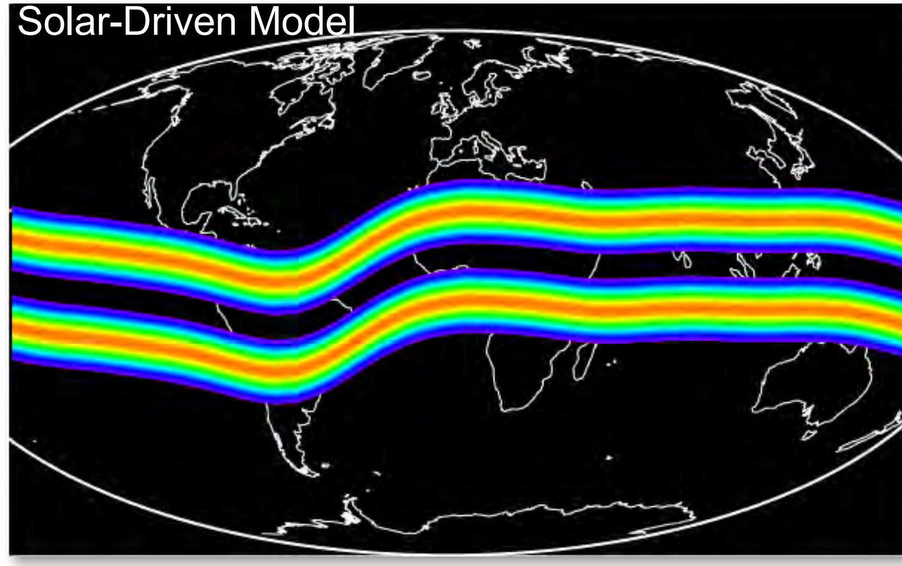


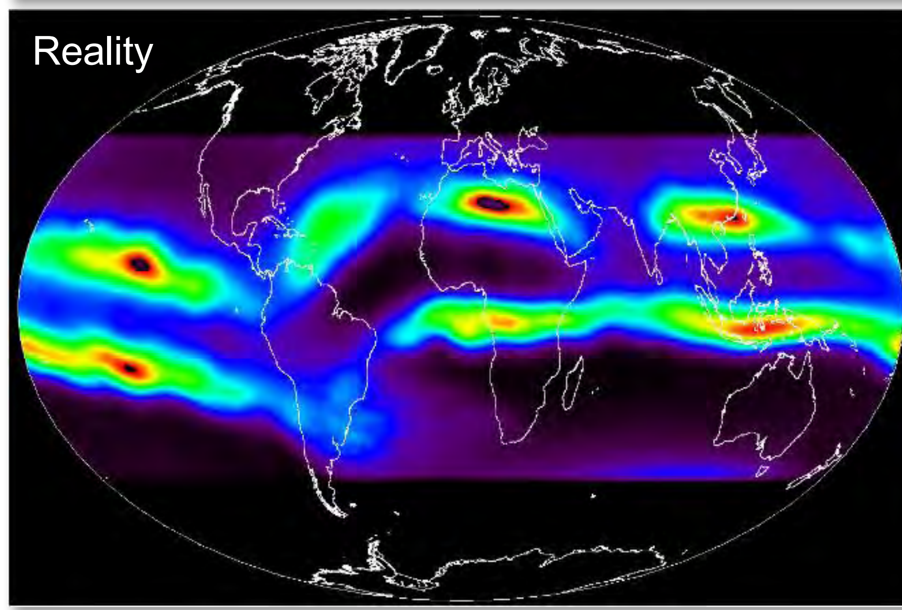
- Mishap during transport of launch vehicle motors caused shift of June launch

The ionosphere is structured and variable in ways that we cannot account for…

- Since the year 2000, there have been a number of discoveries showing the usual suspects (changes in solar wind and radiance) are insufficient to explain the ionospheric variability.
- It has been shown, for instance, that the ionosphere has large zonal variations in density, that vary temporal scales from months to days.
- There is apparently another influence that is large and controlling.

We now believe that the lower atmosphere is the source of much of this variability.





TIMED-GUVI, England *et al.* (2009)

ICON's Science Objectives require measurements of both drivers and responses

The Ionospheric Dynamo, driven by the neutral atmosphere, governs the motion of the plasma:

- We need to measure the **drivers**:

Neutral winds that carry the energy and momentum that drives the dynamo.

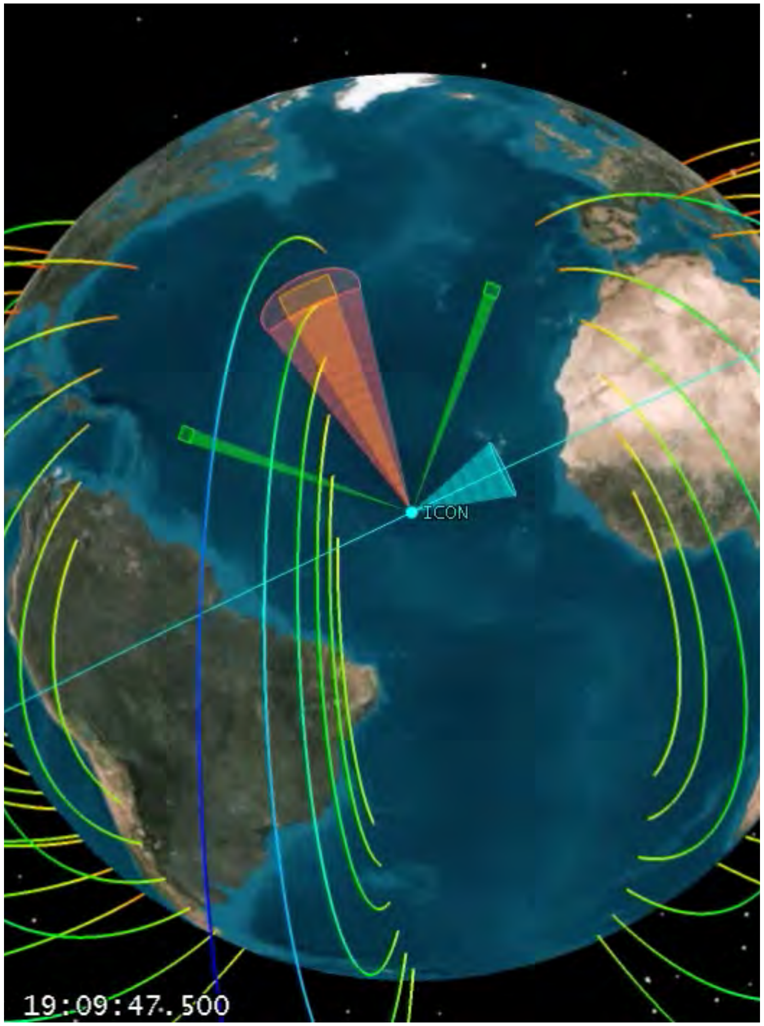
Composition of the atmosphere that controls the chemical production and loss rates of plasma.

Temperature of the atmosphere that reveals the atmospheric waves entering space from below.

- With the **responses**:

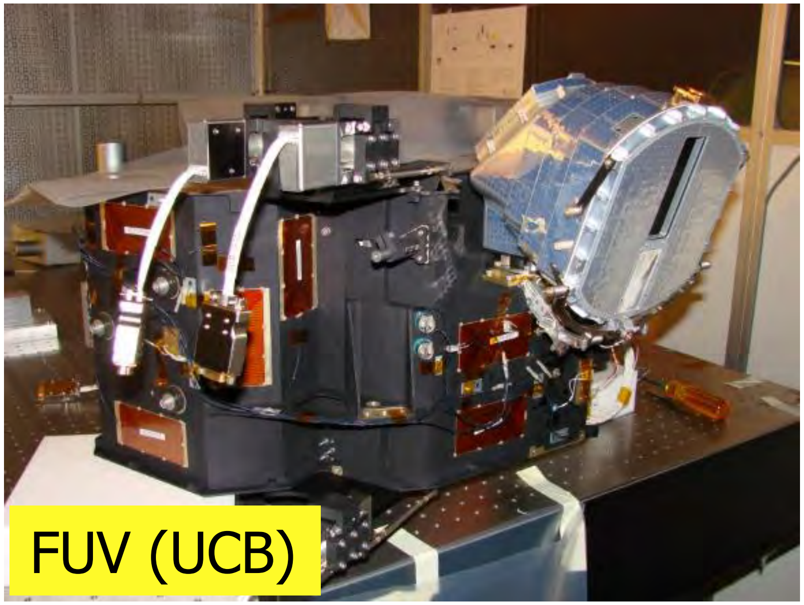
The electric field and **the plasma velocity distribution**, which are directly related.

Plasma density of the ionosphere, the combined result of solar production and plasma motion.

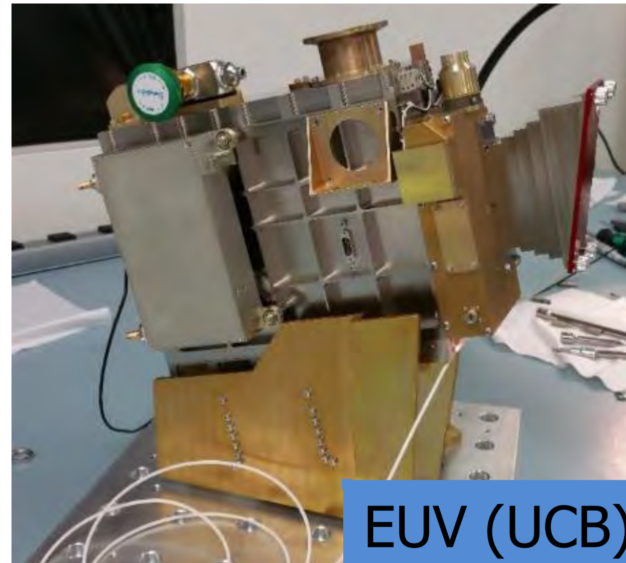


All baseline measurements being made. No science descopes exercised

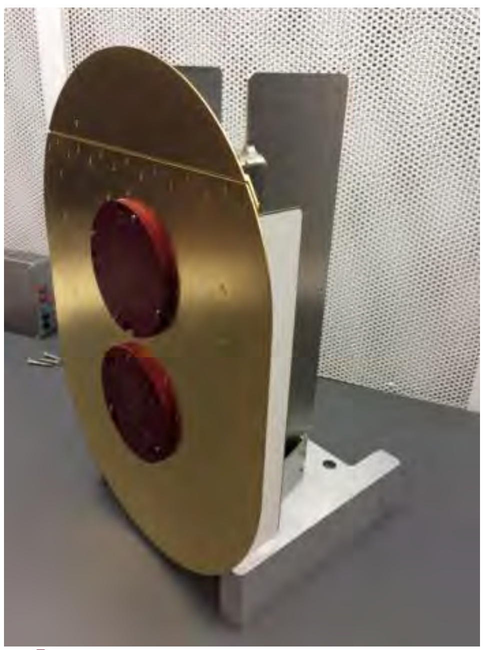
ICON carries a set of instruments to make all the necessary measurements.

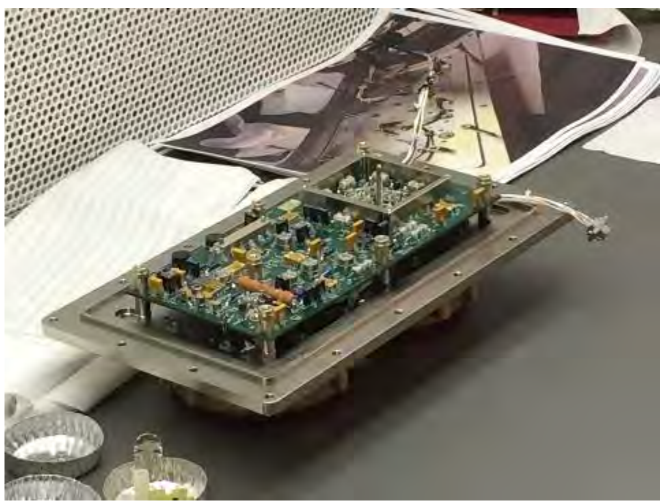


FUV (UCB)



EUV (UCB)

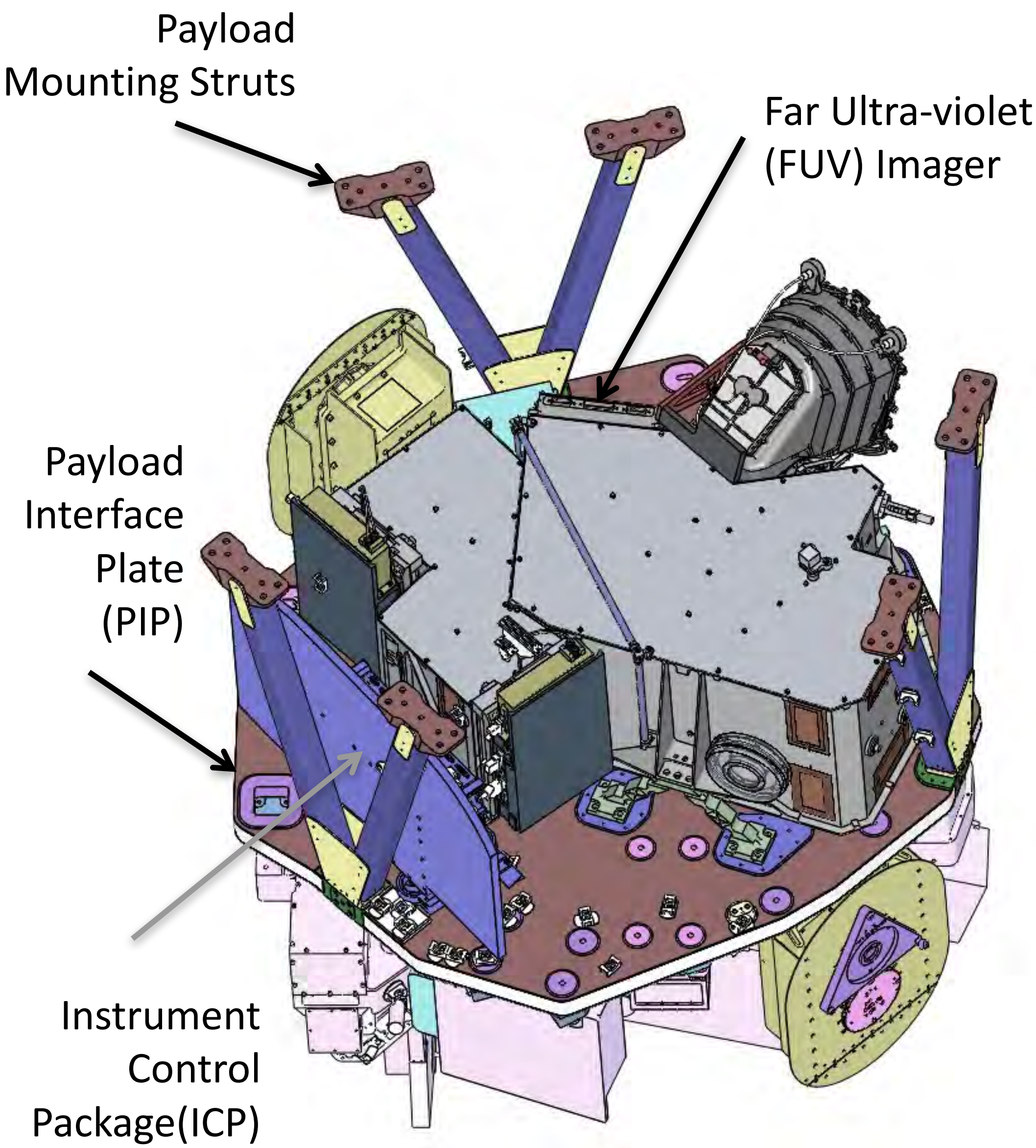


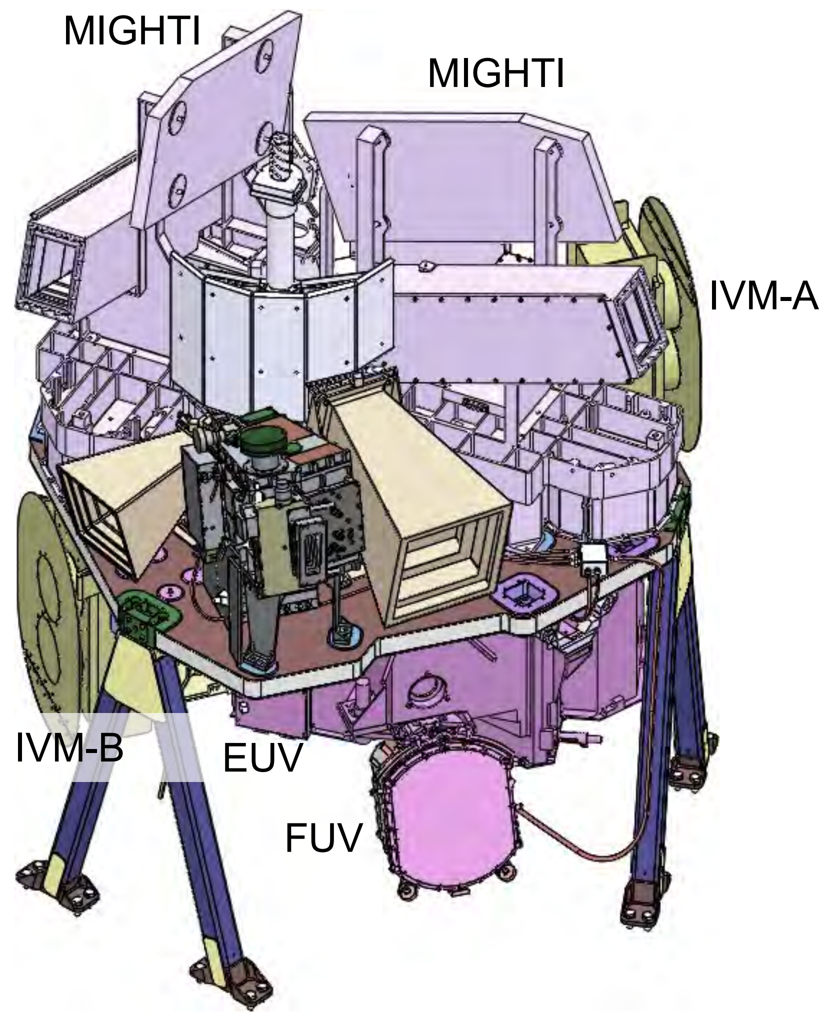


IVM (UTD)

MIGHTI (NRL)

Payload integrated completely before delivery to spacecraft





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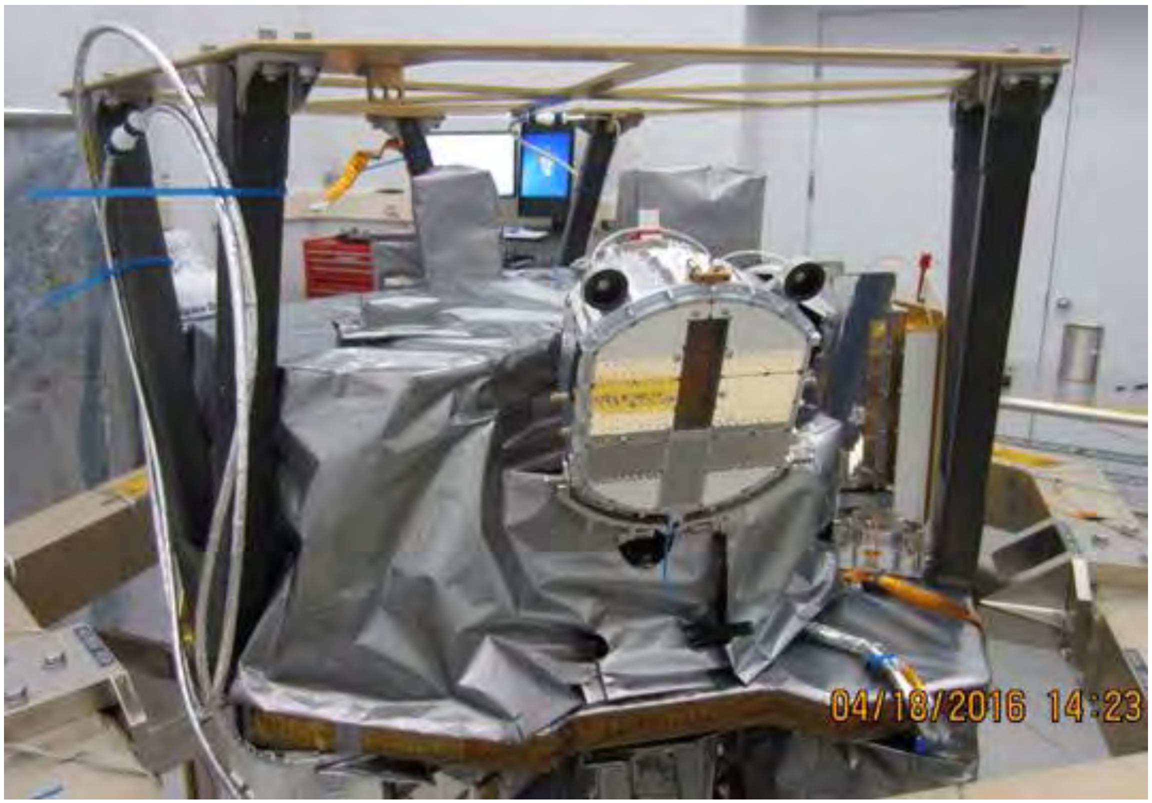
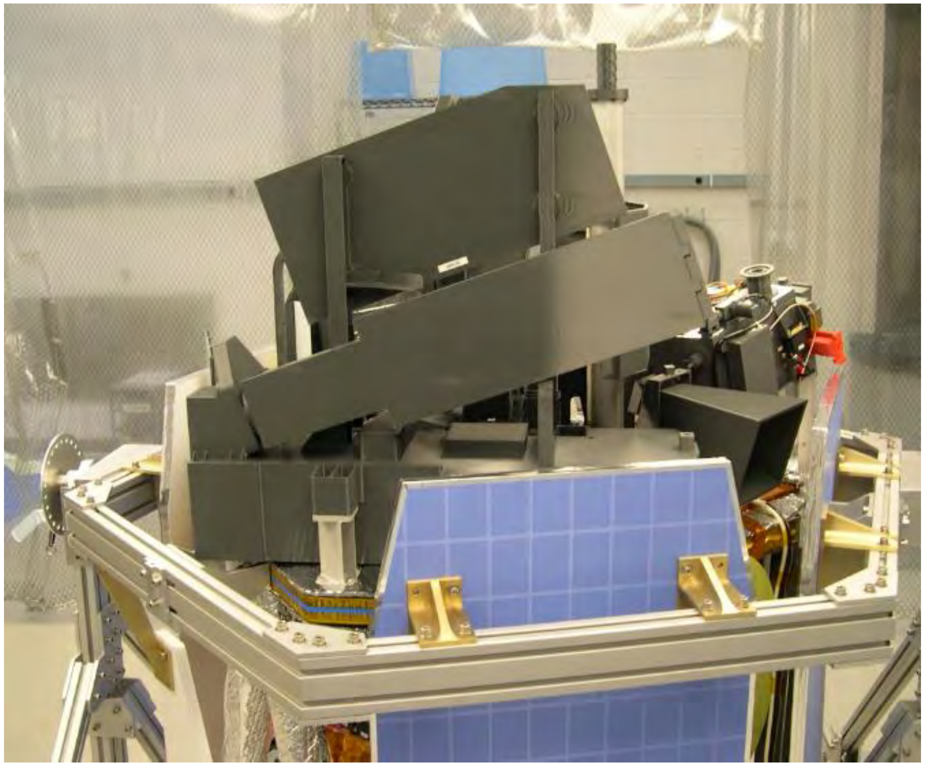
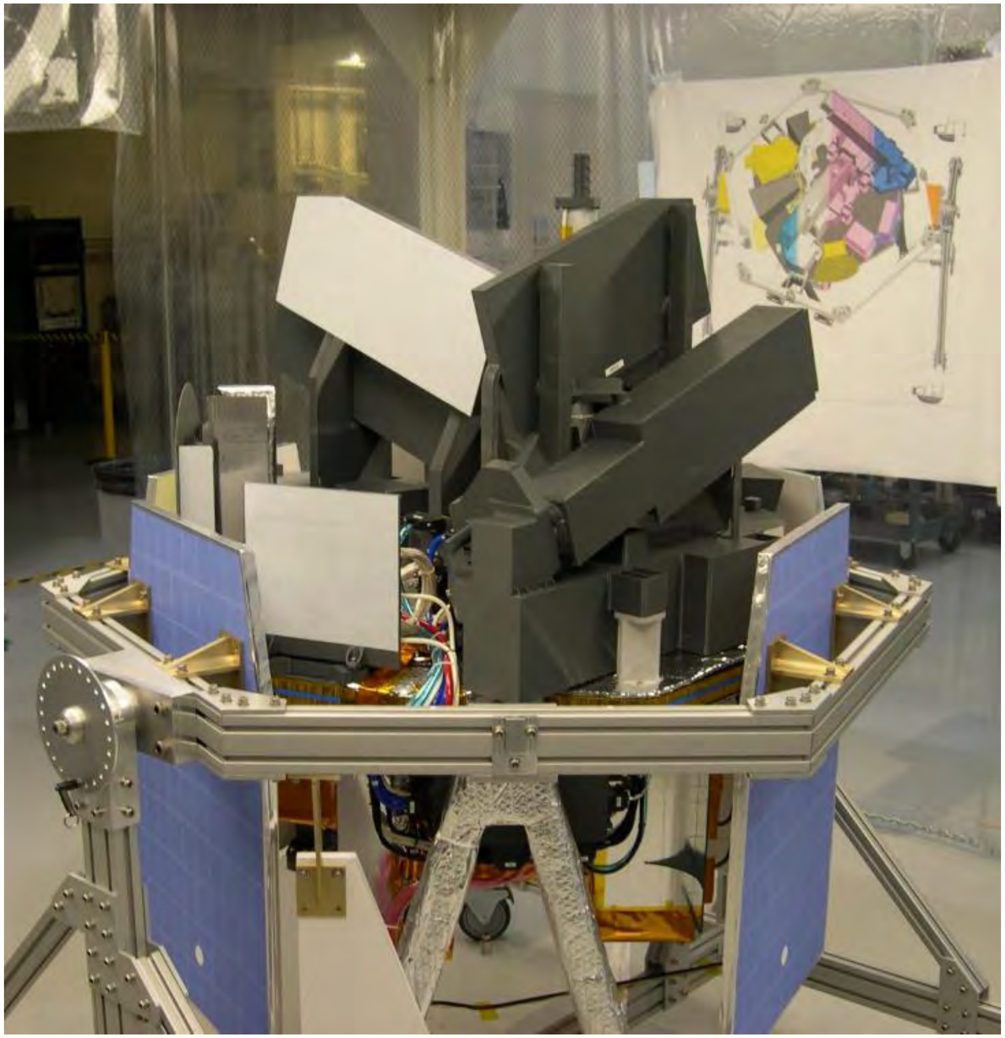


Payload Mockup Developed for Integration Planning





- High fidelity mockup of payload allowed for detailed planning of instrument integration.
- Addition of solar arrays allows assessment of any issues with late flow calibration and instrument access.

Current Events: ICON Observatory Pre-Ship Review complete

PI Tasks – Abbreviated list, temporal order

- Develop PLRA w/HQ and GSFC
- Review development of all requirements documents to L4
- Maintain L2 science requirements
- Drive agenda for all Science Team Calls and Meetings
  - Monthly calls, weekly working groups
- Lead project science validation/verification effort, w/peer reviews of algorithm performance
  - In concert w Project Scientist and Project Sys. Engineer.
- Participate in project weekly calls/mtgs – Management, Systems, Science Operations, Science Communications
- Participate in all SRB and GSFC project reviews, and all KDP reviews at HQ.
- As long as science descopes are still viable options, participate in Risk Management Board discussions.
- Present status of WBS 4 at Monthly Management Reviews.
- Manage/delegate development of Space Science Review issue and mission reports therein.
- Participate in SOC organization and development
  - Project Scientist leads

PI Tasks – Part 2

Science Communcations

- SMD Policy regarding science communications changed in 2015 has been guiding A/O language.
- It identifies the PI as the sole project contact for science communications; all efforts to be undertaken by the designated NASA center at the mission level on behalf of the project.
- The PI and project specifically have no budget to support this activity.
- If new missions are to have any support at the project level, it will probably be a significant ask. Until policy changes, the PI (or their designee) is solely responsible for science communications at the project level.

PI Lessons Learned

- You will repeatedly revisit your science requirements and the PI ultimately is called to explain every change
  - It is important enough to hold significant margins that the PI controls
    1. In the development of the Program Level Requirements, and Requirements Agreement, strive to maintain margins between the Program (Level 1) and the Project (Level 2) science requirements. Level 2 should not be a pass-through of the Program Requirements down to the mission elements.
    2. Payload and Spacecraft (Level 3) and Instrument (Level 4) requirements will be developed and reviewed after selection, and the systems engineering effort will expose performance hits that will put pressure on Project requirements. Only with margin to the Program requirements can the mission proceed.
    3. Strategy for achieving this can be agreed upon with mission (GSFC) and program (SMD) scientists. Your strategy will be discussed at length with your Standing Review Board.

    Recommendation: Upon selection, expand your Science Traceability Matrix to a Project Document (ICON: Science Rationale and Traceability Document) that explains the approach and defends the requirements in the PLRA.

PI Lessons Learned

- You have the responsibility to build and deliver the science mission you proposed to SMD.
  - NASA can be very helpful but:
    1. Should there be discussions needed regarding scope; be prepared to stake out your position and stick to it for as long as it takes. The easiest solution is always to tap your reserves; a very precious resource. This should be your last course of action!
    2. You manage, your NASA center provides oversight. Oversight can be very useful; take advantage of it where you can. Recognize, however, that you will need to manage the oversight as well to control cost and schedule.
    3. Even while "pushing back", it is vitally important to maintain a collegial, respectful, and open relationship with your NASA center and your SRB. Threats to this can come up on either side. Addressing them as early as possible will make your life easier.
    4. Your Mission Assurance Requirements document, MAR, can have significant cost implications (e.g. EEE parts). Be sure your project personnel understand the implications of each and every clause. It is much easier to negotiate in advance than it is to write waivers later.

Other Lessons

- Your PM defends your science budget from cost and schedule threats. For the PI to be able to trust the PM's choices and discretion implicitly is a great value to the mission.
- Your SE defends your science mission from technical threats. Again, trust is valuable. If the PM and SE understand the science mission and the risks, they can handle it!
- Earned Value Management will incur significant financial burdens to your project.
- Optional Enhancements are unlikely to be picked up without strong Program level support. This specifically goes to Student Experiments or Science Enhancements. You will have to fight to actually implement anything presented as optional.