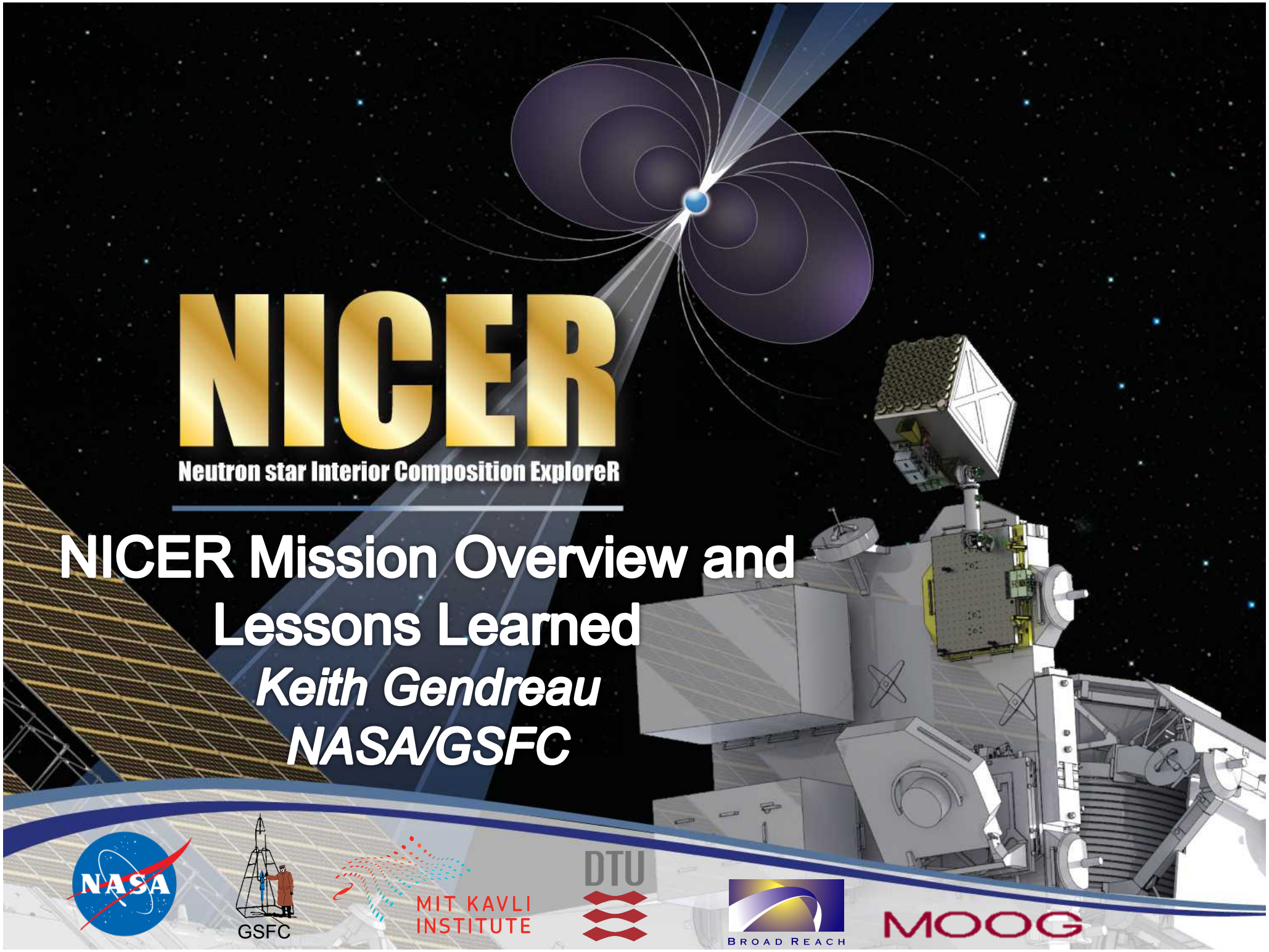
NICER
Neutron star Interior Composition ExploreR
NICER Mission Overview and Lessons Learned
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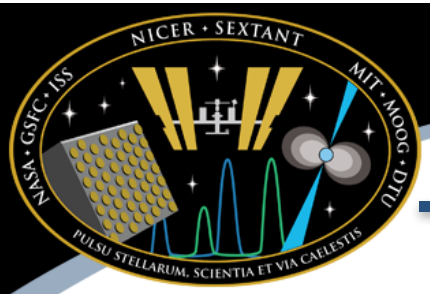
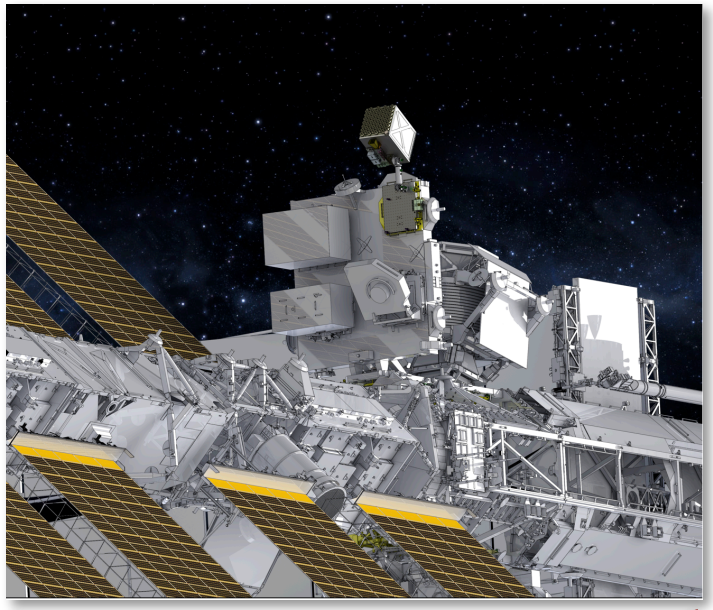


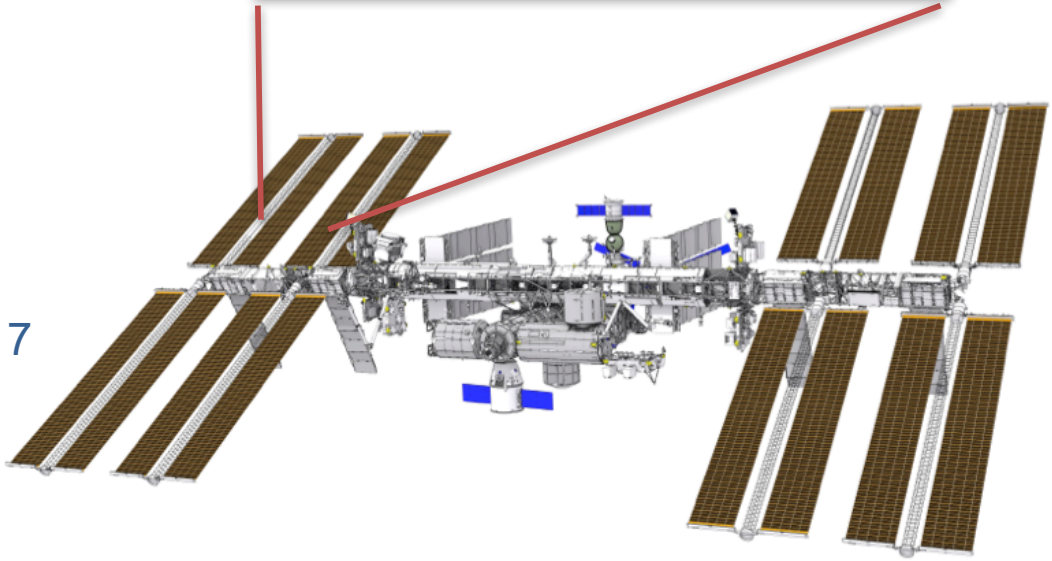
Agenda

- **Mission Overview**
- **A selection of Lessons Learned with NICER**
  - **Team dynamics**
  - **Testing vs Analysis**
  - **Maintaining Schedule**

An Astrophysics Mission of Opportunity on the International Space Station

- ***Science:*** **Understanding ultra-dense matter through observations of neutron stars in the soft X-ray band**
- ***Launch:*** **Completed on June 3, 2017, SpaceX-11**
- ***Platform:*** **ISS ExPRESS Logistics Carrier (ELC), with active pointing over nearly a full hemisphere**
- ***Duration:*** **24 months including Guest Observer program**
- ***Instrument:*** **X-ray (0.2–12 keV) "concentrator" optics and silicon-drift detectors. GPS position & absolute time reference**
- ***Enhancements:***
  - **Guest Observer program**
  - **Demonstration of pulsar-based spacecraft navigation**
- ***Status:***
  - NICER installed on ISS on June 13, 2017
  - Commissioning completed
  - Payload performing very well





NICER in SSPF
Prior to Dragon Trunk Integration

NICER in Dragon Trunk

NICER installed in the Dragon trunk along with companion payloads MUSES and ROSA

Launch and Extraction – 3 of 4

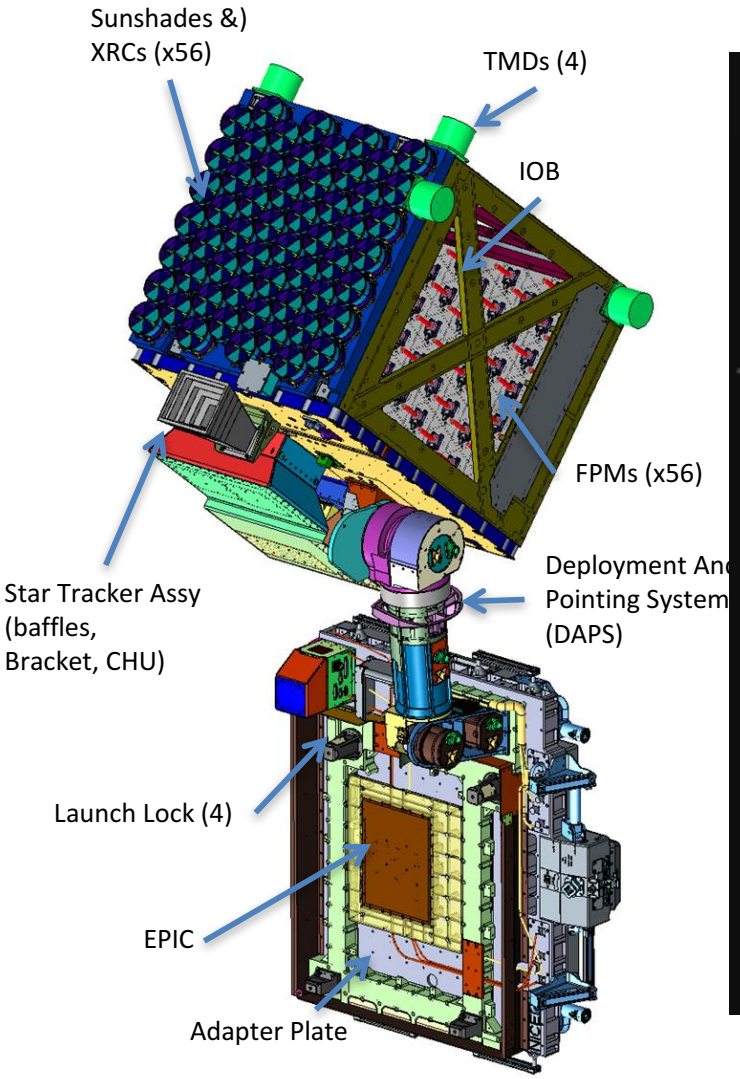
Time Lapse

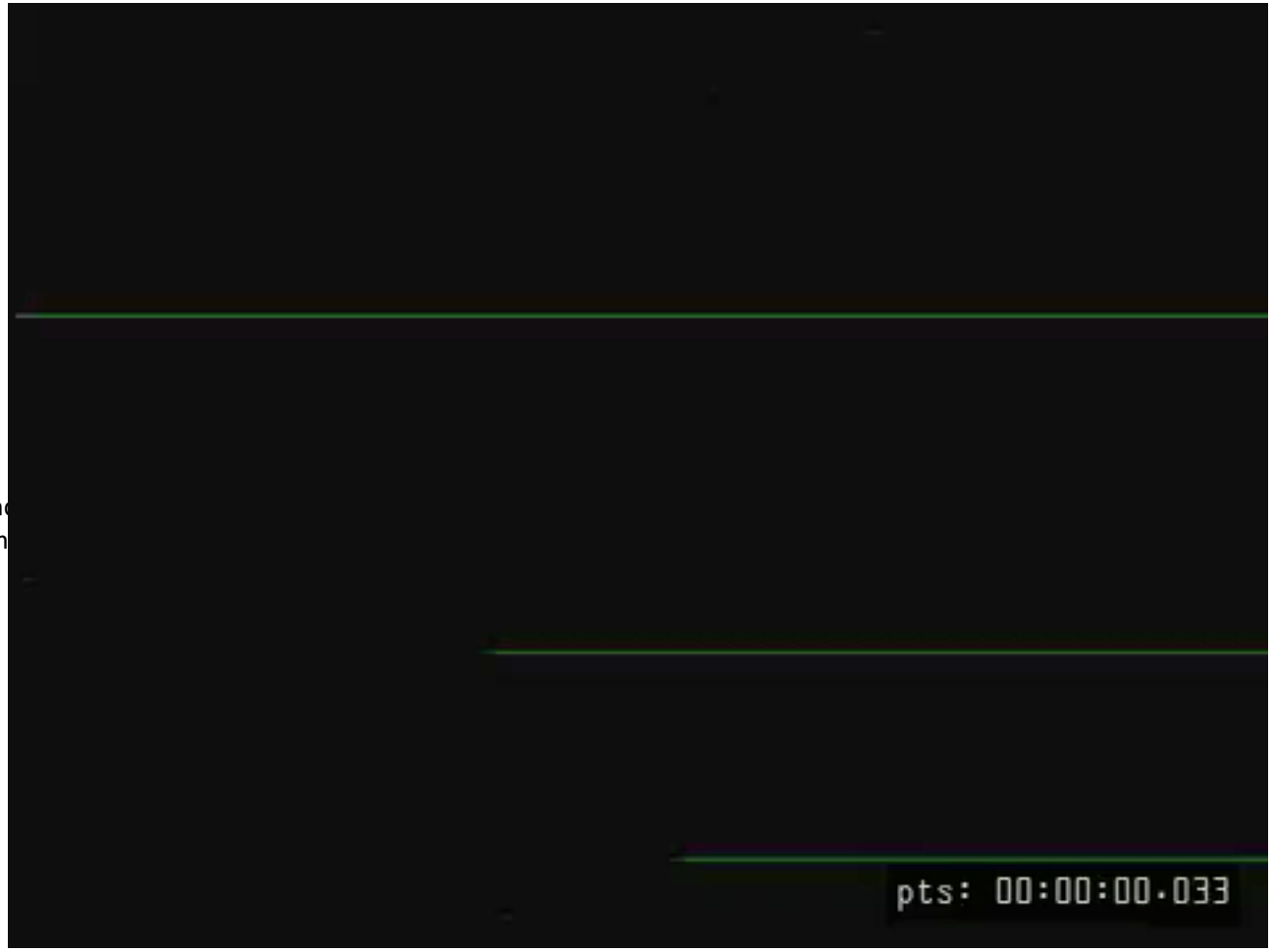
June 3, 2017

NICER in Space

Launch and Extraction – 4 of 4

The NICER Payload





NICER Team Dynamics

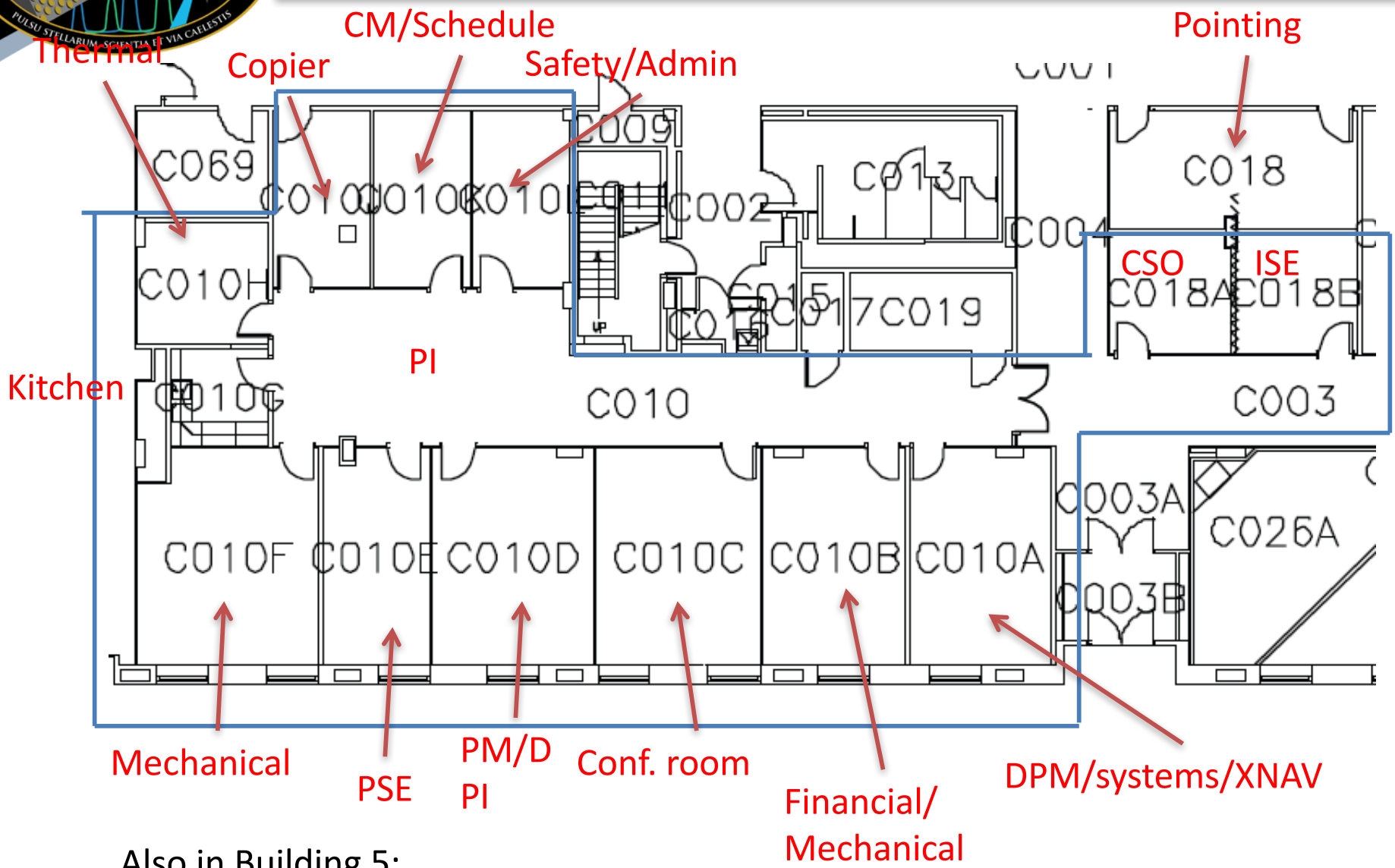
- PI picks a team which has diversity
  - A mix of conservative people and “cowboys”
  - People who can get along together or the PI can bridge
- PI is active in ALL aspects of NICER development
  - PI could be a technician, manager, or resource analyst
- PI makes decisions very quickly
  - Generally in less than 1 week and sometimes immediately, but only after considering all choices and hearing all the sides
  - There are risks associated with most decisions- Track and manage those risks
- NICER focuses on mitigations to risks and healthy risk processes
  - Entire team is involved
  - Risks are actively tracked and updated monthly
- Team is mostly co-located when possible
- Major re-direction is done in person

Co-Location of Core Team -> Success

- Early in Phase B, NICER was given the opportunity to co-locate all key players
- Building 5 at GSFC is centric to most NICER labs and already had a number of thermal/mechanical/I&T personnel located there
- Locating core team in B5 C010 and nearby offices has allowed for very clear communication
  - Minimizes misunderstandings, wasted effort
  - Reinforces "team" concept and an understanding of roles and responsibilities

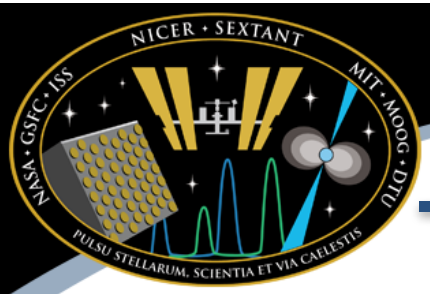
<u>Keeps costs down and ensures success</u>

NICER HQ in Building 5: Success through Communication



Also in Building 5:

XTI Integration tent, Mechanical analyst, Thermal Analyst, Additional Mechanical Design, I&T office



Analysis versus Test

- Often the cheapest way to meet/verify a requirement is to build an Engineering model or demonstration unit using inexpensive parts and to try and demonstrate meeting the requirement
  - NICER XRC alignment and mounting system was developed this way using MANY ETUs and vibration tests
- Performing extensive analysis on things that could be built and tested is often the most expensive and can lead you wrong
  - NICER use of Frangibolts went this way and cost us dearly by moving what should have been a simple and straightforward solution to the critical path
- Iterating on the engineering model and testing should arrive at the optimum solution and highest confidence of flight build success for the least money
- Build engineering models for all difficult analytical problems

Importance of Maintaining Schedule

- NICER strove to maintain its schedule presented in its step 1 proposal : Time is money
  - Develop “road to PDR / CDR” plan to ensure leads understand success criteria and provide appropriate analysis, testing and documentation to pass reviews
- Setup partnerships with all contractors in Phase A
- Plan extensively for long lead procurements
- Anticipate problems
  - Enabled contractors to work BEFORE government shutdown
- Be aggressive
  - NICER held an SRR in Phase A
  - NICER presented with real ISS problem and proceeded with an aggressive plan to overcome so that mission CDR was impacted