

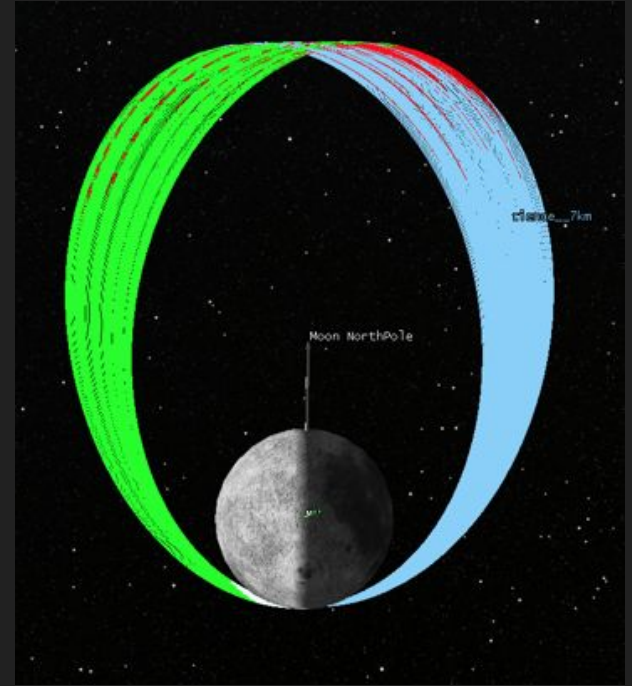
# The Lunar polar Hydrogen Mapper (LunaH-Map) CubeSat Mission

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Flight Software Lead



# Mission overview

- Selected by NASA for SIMPLEx program in November 2015 to fly a 6U cubesat carrying a planetary science payload on SLS EM-1 in 2018
- Led by ASU in collaboration with NASA centers, JPL, and commercial companies
- Will complete low perilune (10 km) passes over lunar south pole to map hydrogen abundance and distribution in PSRs

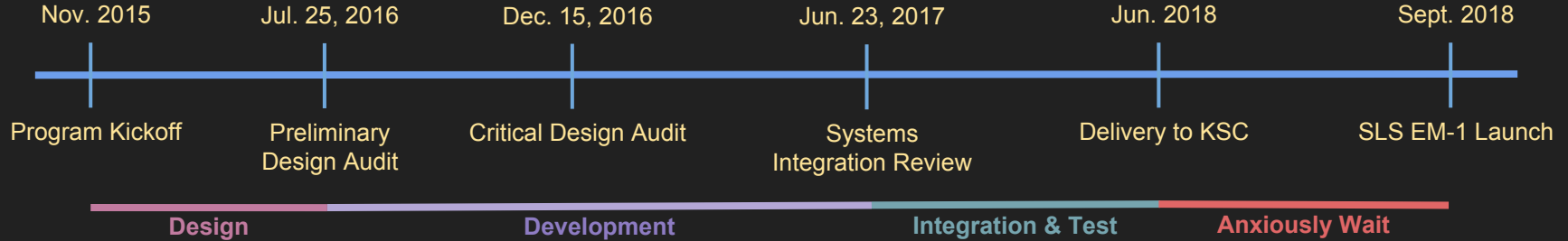


Lunar polar Hydrogen Mapper (LunaH-Map)

# Mission objectives

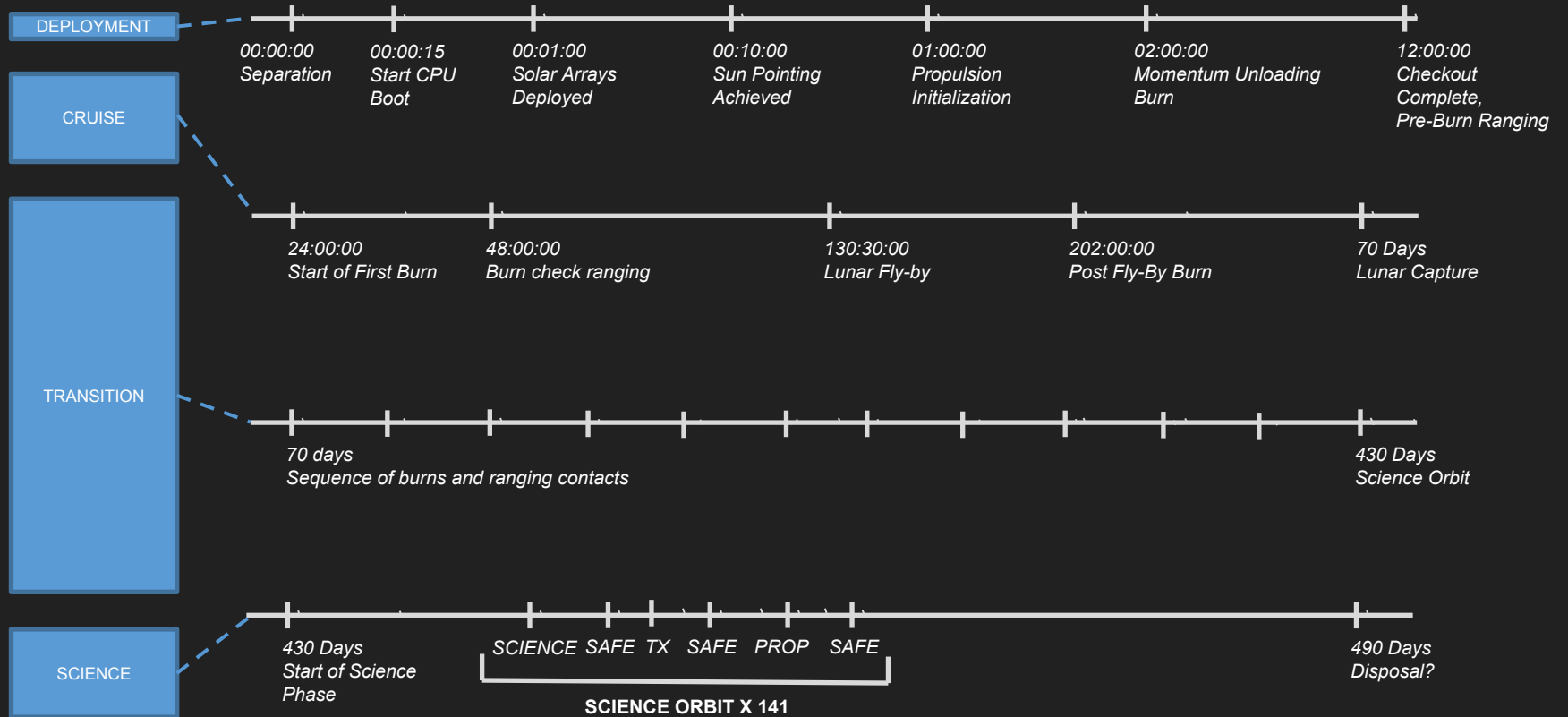
- Technology demonstration
  - Design, build, fly and acquire in-flight data with a CubeSat-sized neutron spectrometer
  - Demonstrate a modified eHaWK+ solar array design in-flight
  - Maneuver using a low-thrust ion propulsion system (for ~8 months) to enter a lunar polar orbit
  - Demonstrate scheduled communications, tracking, and spacecraft operations with an interplanetary CubeSat
- Science: evaluate uniformity of hydrogen across the lunar south pole
  - Map hydrogen abundances of no less than 0.6% WEH (600 ppm) +/- 120 ppm
  - Map hydrogen abundances at spatial scales of less than or equal to 15 km<sup>2</sup> in the top 1-m of lunar regolith

# Development timeline



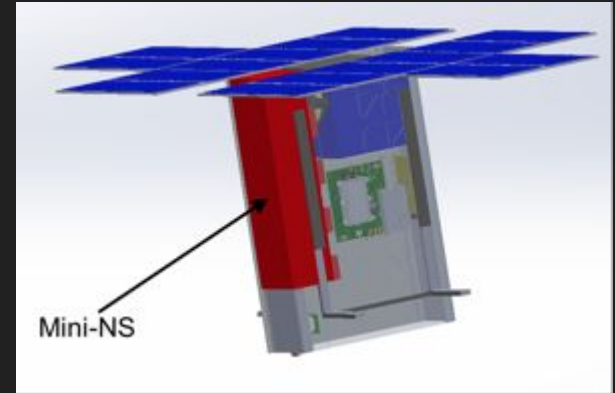
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# Mission timeline

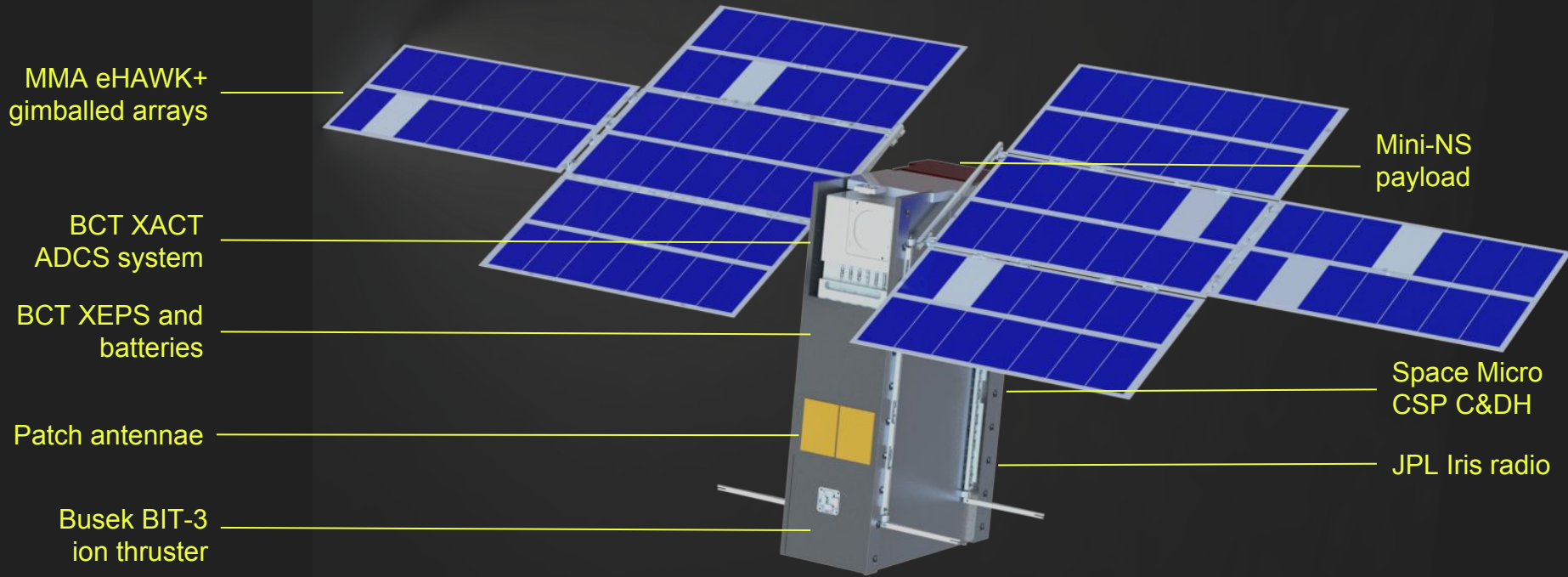


# Mini-NS Payload

- < 2.5U detector using  $\text{Cs}_2\text{YLiCl}_6:\text{Ce}$  (“CLYC”) scintillator material to detect epithermal neutrons
- Neutron spectroscopy is well suited for resource constrained missions
  - Low power, low mass, and low data volume
  - Challenge is to maximize surface area of detector for achieving statistically significant count rates compared to previous missions (e.g. LEND, LPNS)
- Need precise attitude determination, but not necessarily pointing control



# Spacecraft overview



Lunar polar Hydrogen Mapper (LunaH-Map)

# Challenges

1. Developing subsystems as spacecraft is being developed — must have a flexible schedule, design, and team
2. Small budget → small team... like a startup!
3. Many low TRL components flying for the first time on EM-1 or post-integration
4. More autonomy necessary when handling faults during cruise due to relatively infrequent contacts with ground





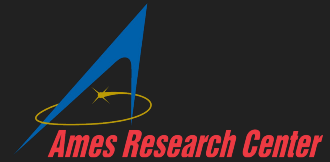
Dr. Craig Hardgrove (PI)  
Dr. Jim Bell (Deputy PI)  
Robert Amzler (Mechanical/Structures)\*  
Nathan Barba (Harnessing)\*  
Zach Burnham (Ground Ops)\*  
Tess Calvert (Project Manager)  
Jim Crowell (Thermal)\*\*  
Austin Godber (Science Ops)  
Savannah Puckett (Software)\*  
Dr. Mark Robinson (Science Co-I)  
Dr. Paul Scowen (Co-I, Instrument Integration)

### **AZ Space Technologies**

Igor Lazbin (Chief Engineer)  
Gates West (FPGA, EE)  
Dawn Gregory (Safety)  
Valentin Ivanitski (Mechanical/Structures, Thermal)



Alessandra Babuscia (Comms)  
Kar-Ming Cheung (Ground Ops)



Tony Colaprete (Science Co-I)  
Anthony Genova (Trajectory)



James Christian (Instrument Dev)  
Erik Johnson (Instrument Dev)



Mike Tsay (Propulsion)  
Lenny Paritsky (Propulsion)



Jeremy Bauman (Navigation)  
David Dunham (Navigation)  
Derek Nelson (Navigation)  
Bobby Williams (Navigation)

### **Other members**

Darrell Drake (Science Co-I, Consultant)  
Richard Starr (Science Co-I, Catholic Univ. of America)  
Matthew Beasley (Collaborator, Planetary Resources)