Navigation

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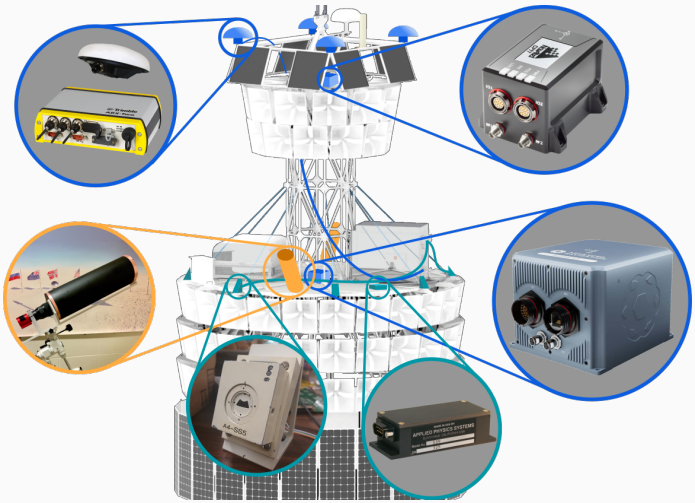
Overview of the navigation suite

1. Inertial navigation systems
   1.1 Boreas
   1.2 CPT7
2. Diff. GNSS – ABX-Two
3. Star Trackers x2
   - Dedicated talk from Windell later
4. Sun Sensor array (x8, every 45° in azimuth)
5. Magnetometer

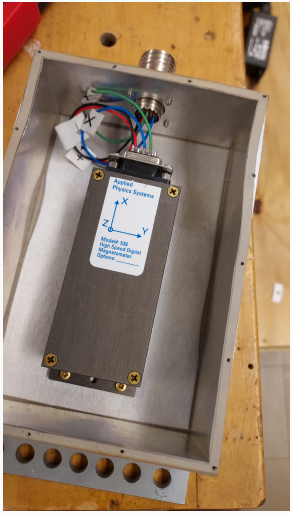


The Navigation Suite

Subsystem	Heading	Pitch/Roll	Observable	Notes
Boreas IMU	0.005°	0.006°	Accelerations and rotations, GNSS constellation	
CPT7 IMU	0.03°	0.01°	Accelerations and rotations, GNSS constellation	
Star trackers	0.001°	0.001°	Magnitude < 6 stars	
ABX-Two	0.02°	0.075°	GNSS constellation	
Sun sensors	0.17°	$\sim$0.3°	Sun	We think performance can be improved!
Magnetometers	$\sim$0.1°	$\sim$0.1° to 0.5°	Earth's magnetic field	

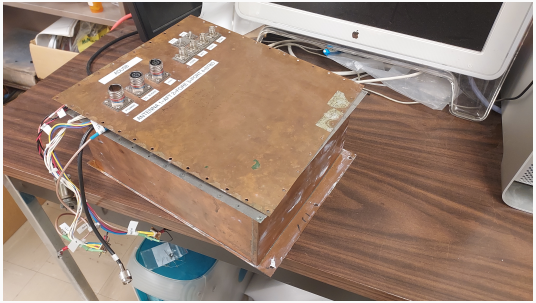
Magnetometer

- Programmable serial data stream, will be read out by housekeeping
- At some point TBD should be sent to OSU for compatibility testing



ABX-Two – within enclosure within the MIE

- UD machine shop is working on retrofitting old ADU5 enclosure
- This enclosure will also hold the sunsensor readout electronics board
- Basic machining (adding some bolts, connector holes), should be done soon



GPS Simulator

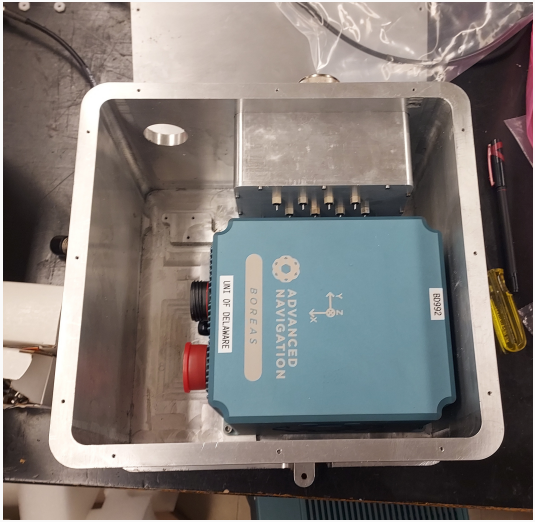
- Recently acquired CLAW GPS simulator from Jackson Labs/Viavi
- Very portable! Shown here next to my Blackwell room key
- Only simulates GPS constellation, but suitable for testing functionality, CoCom limits
  - Verified last week on the ABX-Two, which thought it was 120,000 feet above Newark, DE

Inertial Measurement Units

Two majors efforts right now:

1. Chace is developing his own Kalman filter, with the dynamics of the balloon payload in mind. Will utilize all available navigation data to provide the best possible attitude and position solution during post-flight analysis.
   - A realtime version of this may also run on the payload during flight, if processor bandwidth allows. If not, a simplified weighted averaging filter will run.
   - Chace will give more info in his work in a bit!
2. Completion and verification of the RF enclosure for the IMUs. Fabrication and plated is complete, and assembly will begin this week. So later this summer we can test it at KU.

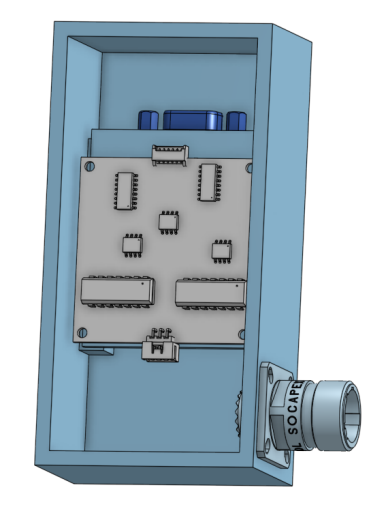
Boreas in RF Enclosure

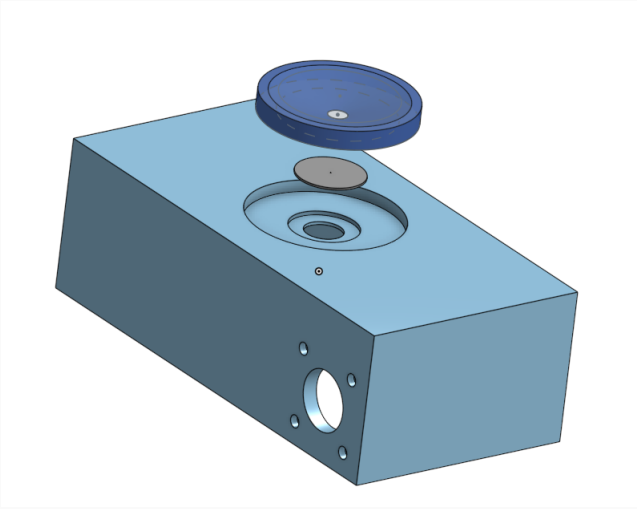


Sun Sensors

- Recent testing of the sun sensors has revealed issues – Sasha in the next talk will discuss these in more detail
- As part of the effort to resolve these, we've started a redesign of the sunsensor enclosures, which also allows us to improve the optical properties i.e. pinhole, stray light mask

Sun Sensors





Timeline

- ABX-Two plus Sun Sensor enclosure needs to be finished before MIE enclosure – should be done in the next week or two
  - If we make further changes to sun sensor electronics, may have to change out a board in the fall (but still before Bemco test)
- All other hardware deadlines are based on full instrument integration next year
- Kalman filter requirement is for analysis, so still plenty of time. Preliminary version can be put on flight CPU before flight (though not required)
- As hardware efforts are winding down over the next six months, navigation effort will focus on analysis and simulations – further development of Kalman filter, and cross-calibration of navigation instuments during flight with each other and pulsers