Design and Lessons Learned on t e Development of a Cryogenic Pupil S lect Mechanism (PSM)

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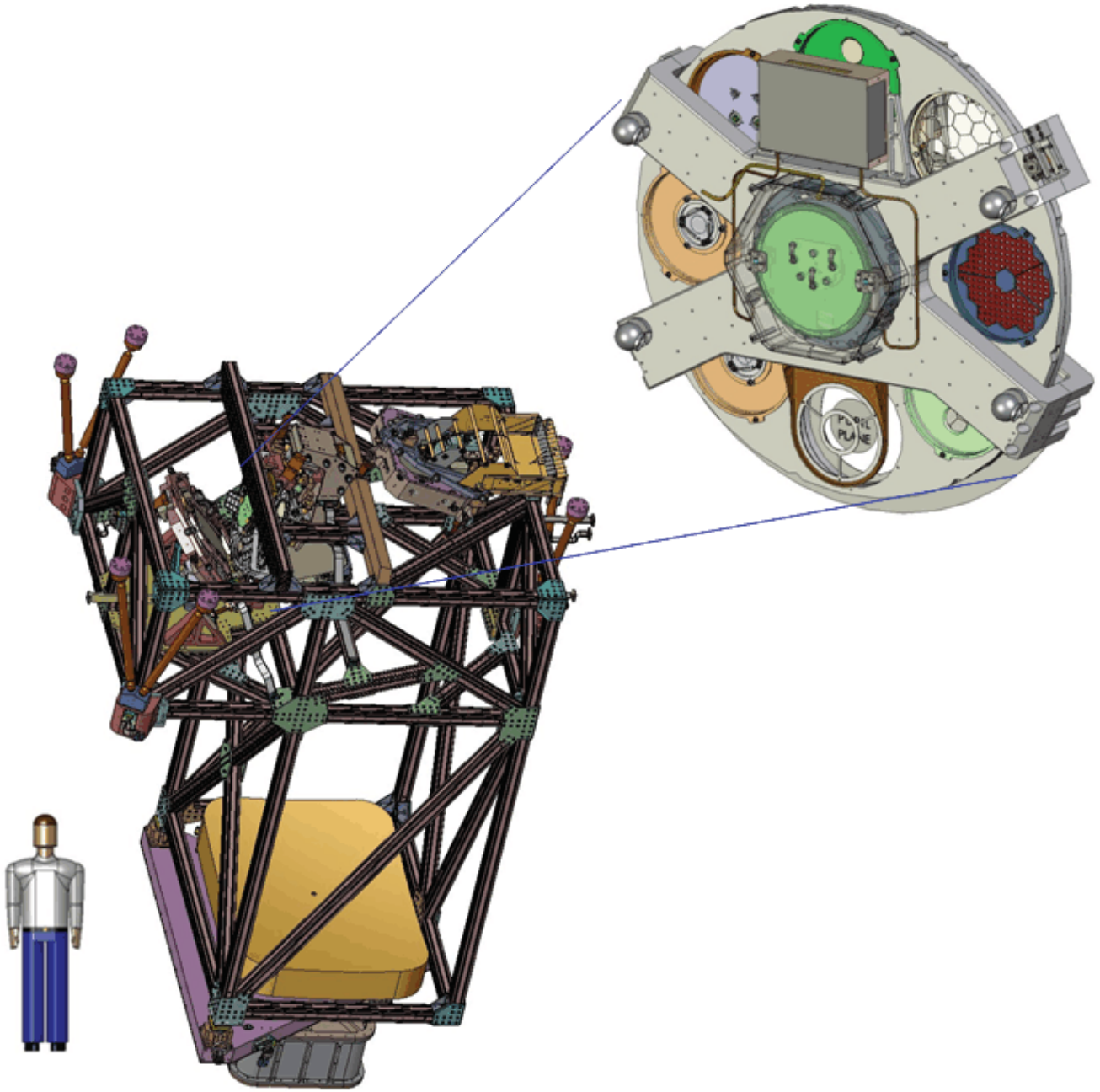
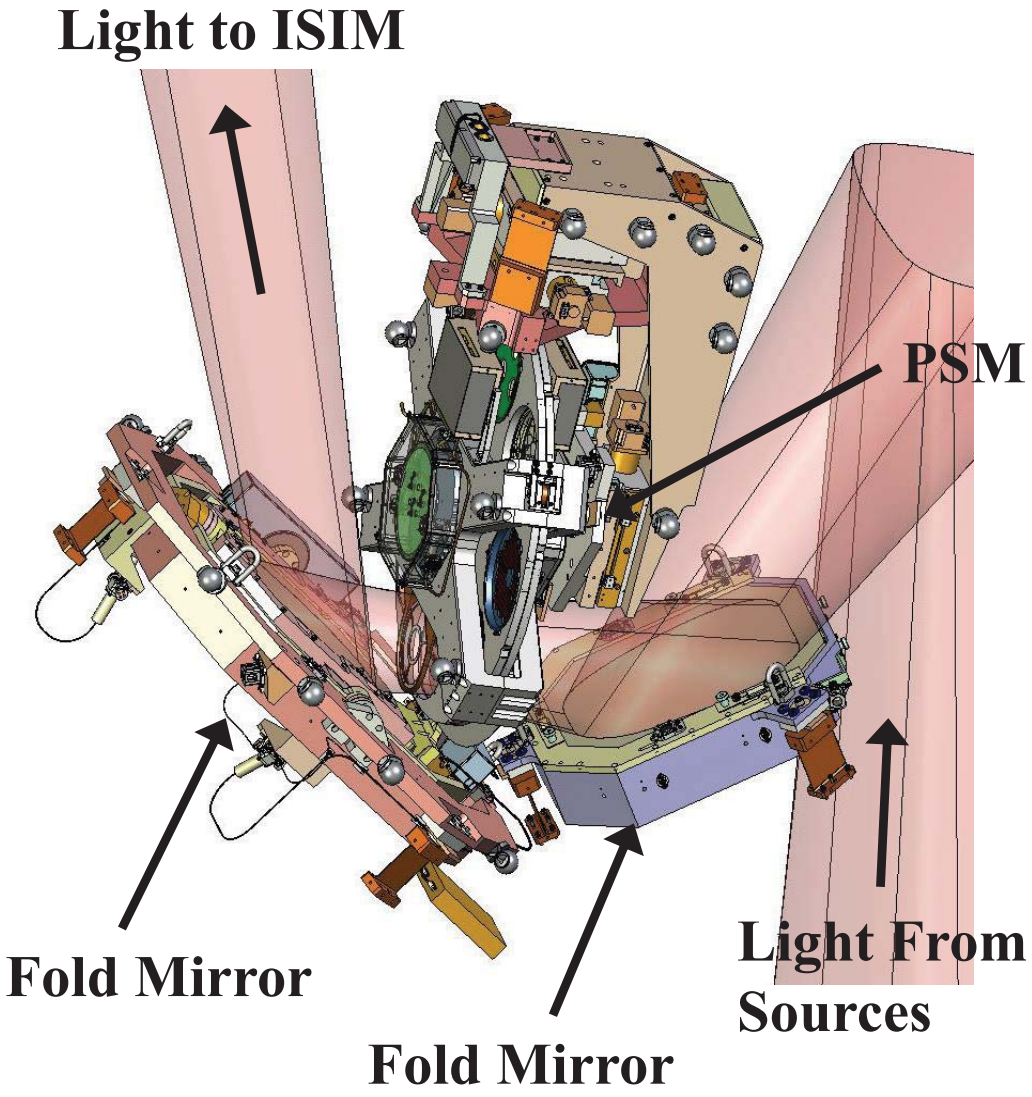
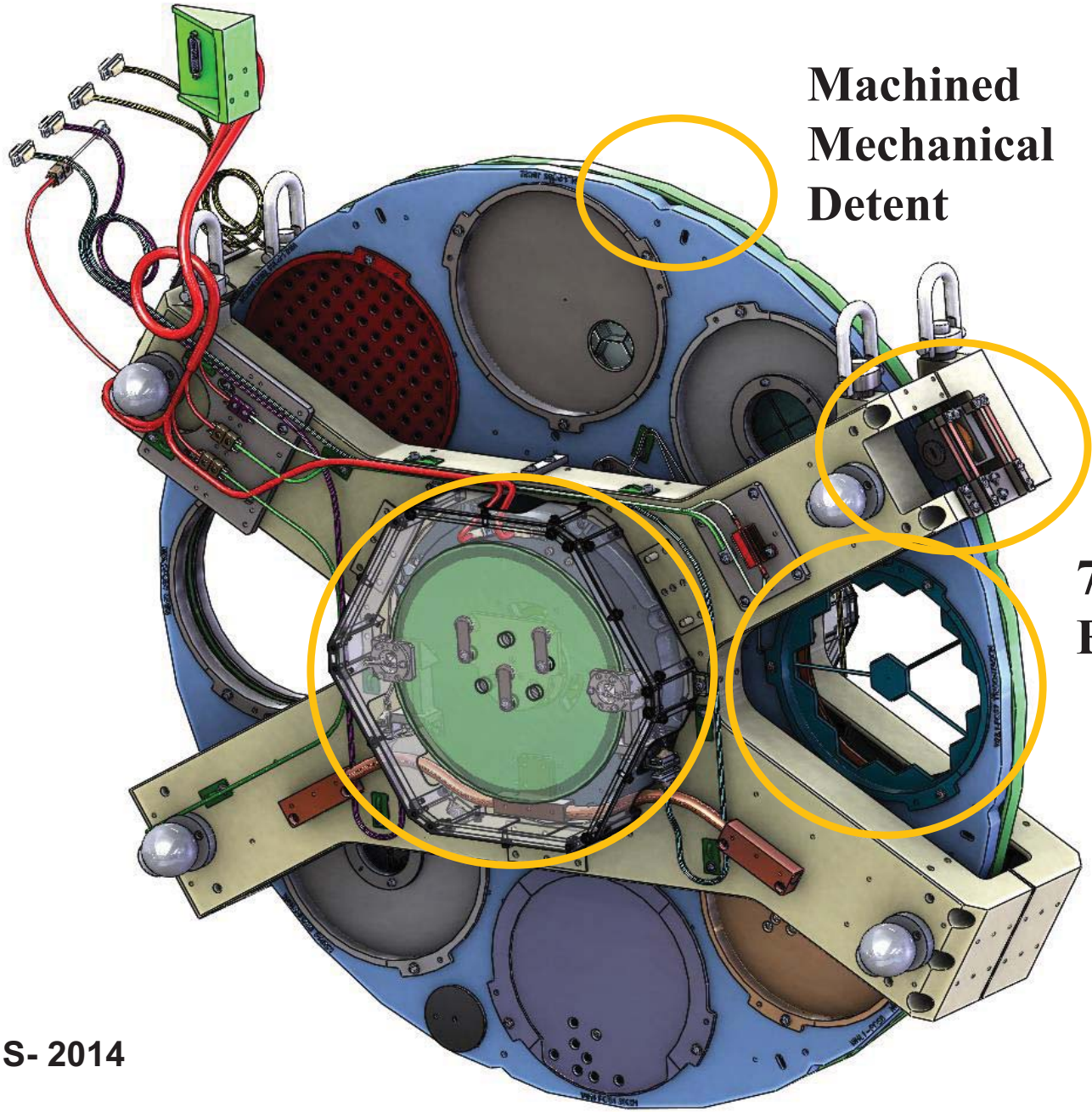
What is the PSM?



What Does the PSM Do?



As-Built Design Features



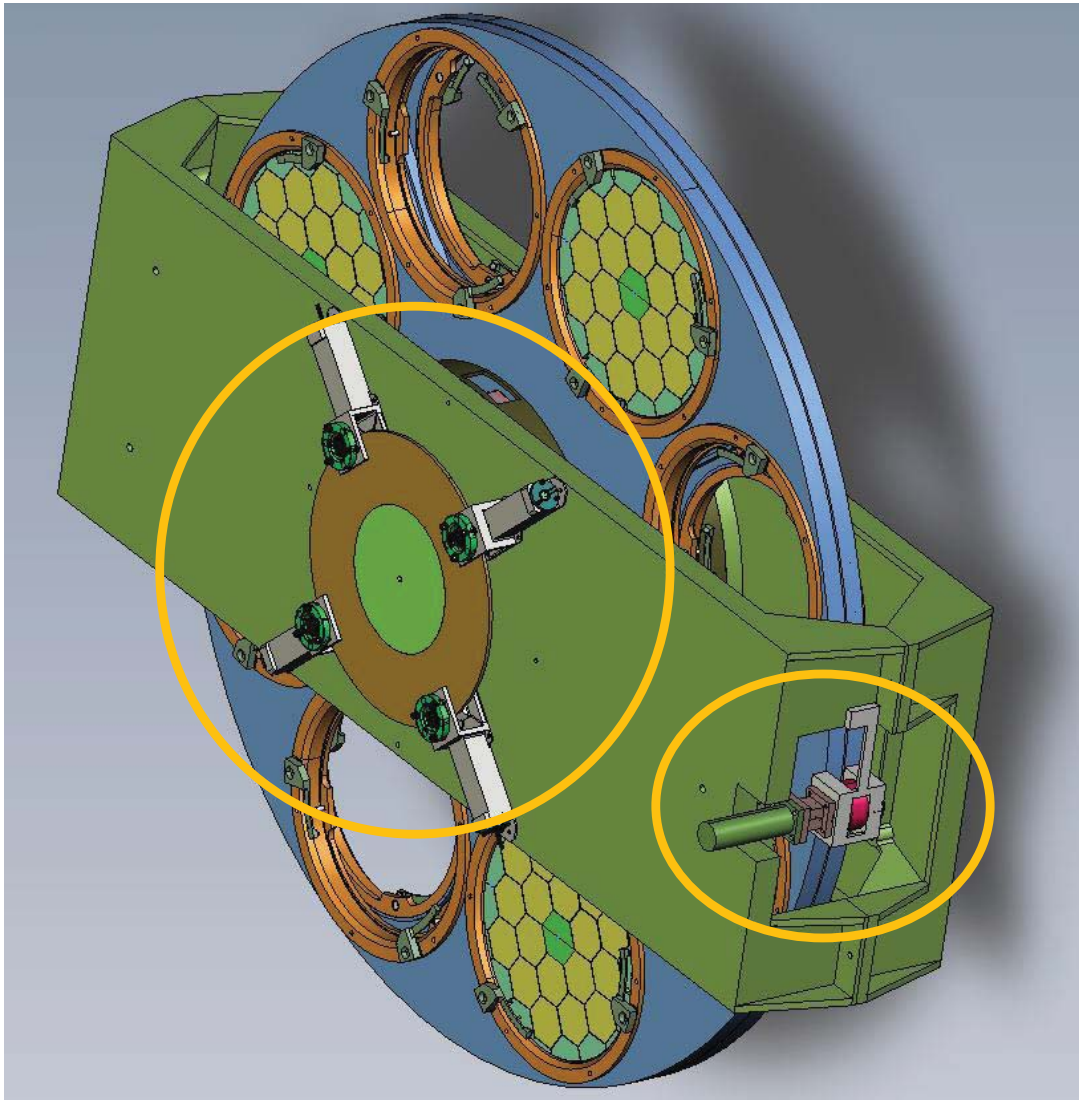
Machined Mechanical Detent

Detent Follower Assembly

7 Optical Elements in Each Wheel

- Direct Drive BDC Motor, Titanium Drive Housing, Encoder

PSM Design: Initial Concept



Absolute Encoder Provided High Knowledge Accuracy Information

Stepper Motor with High Gear Ratio Preloaded on Wheel, Driving through Friction

So, What Went Wrong?

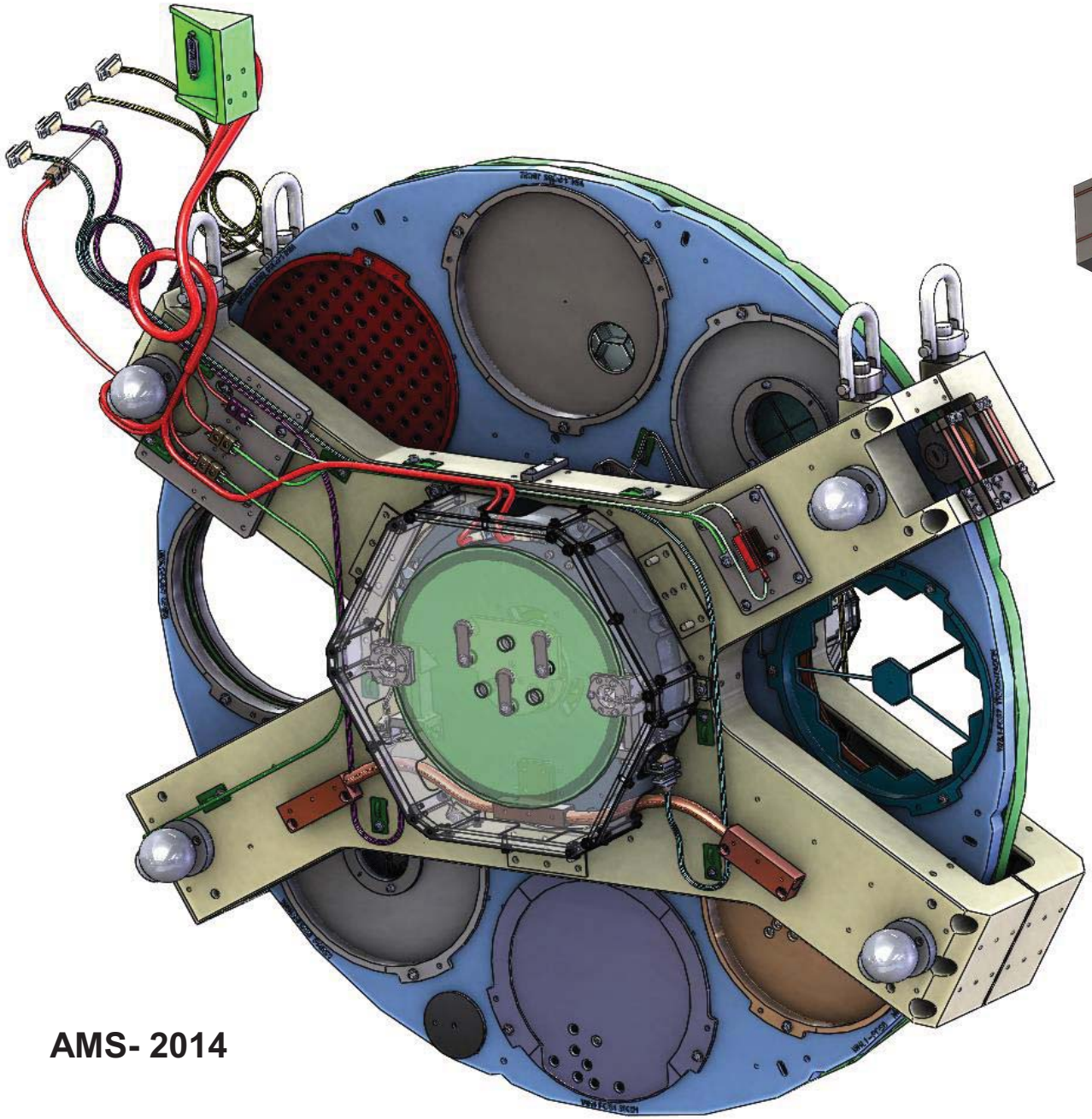
Several concerns led to changes in design from the initial concept

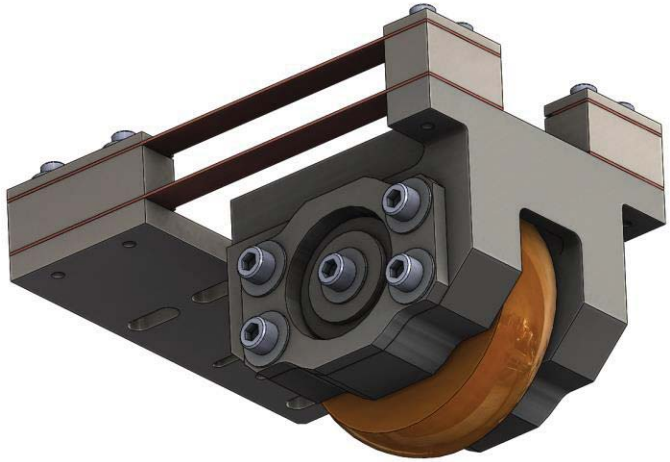
- **Motor Life**
- **Power Dissipation**
- **Variability of Friction at Cold Temperatures**
- **Potential Motor Drive Wheel Slip**

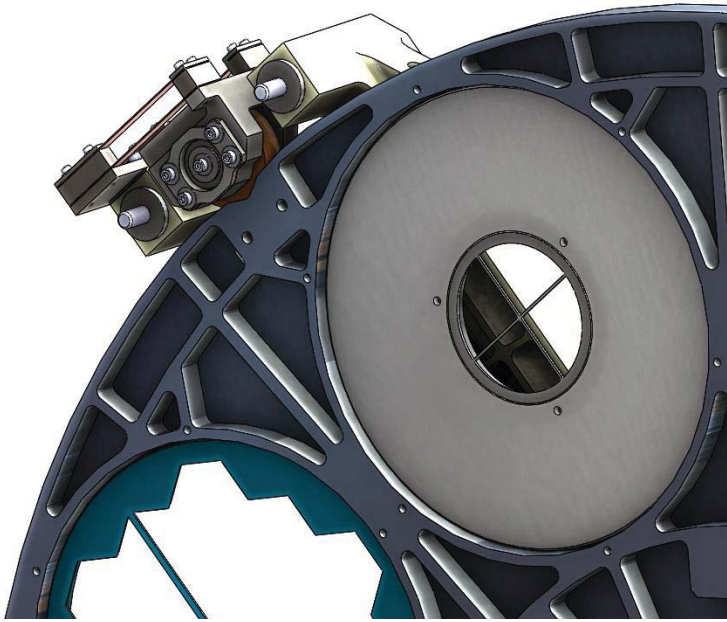
Design Modification Constraints

- Constrained Development Schedule
- Long Lead Item Fabrication Had Started
  - Bearing Procurement
  - GSFC Developed Cryogenic Encoder
- Minimal System Impact
  - Maintain Wire Count
  - Utilize Existing Motor Driver

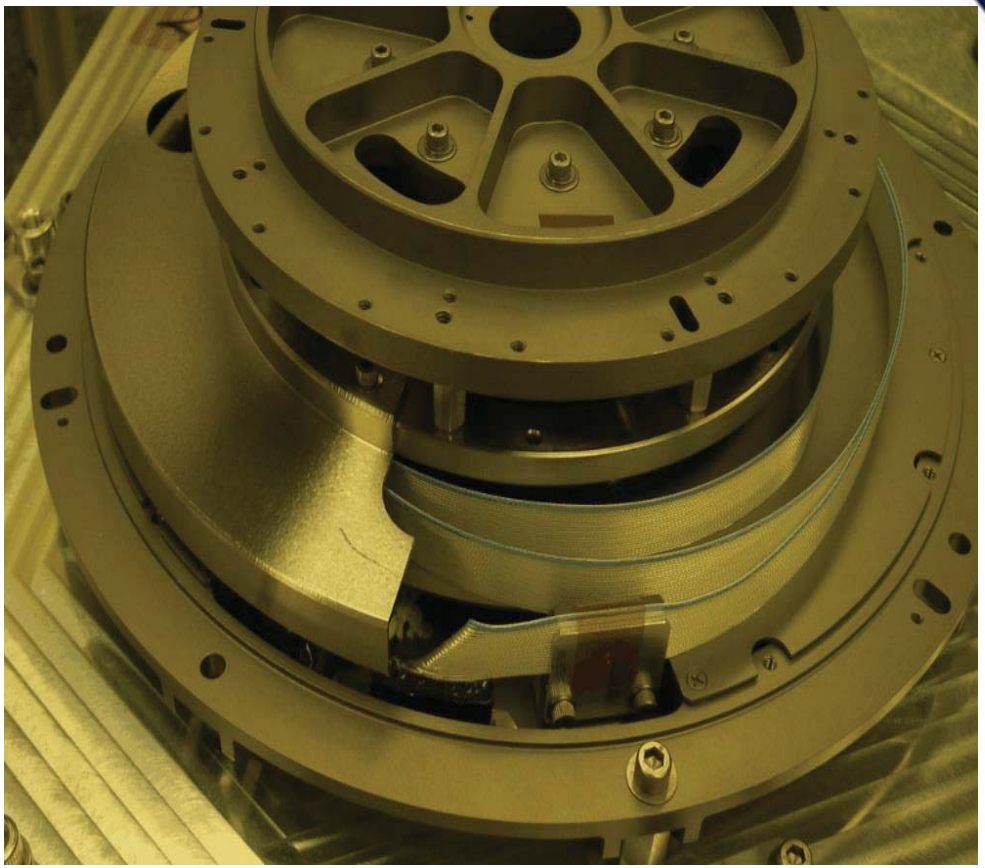
PSM Re-Design



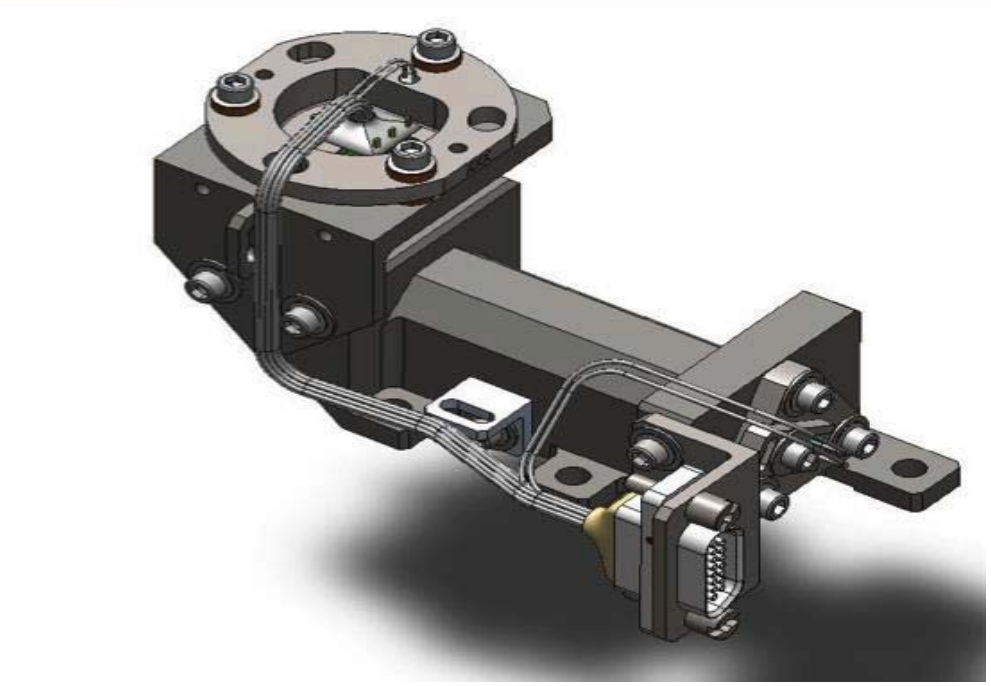


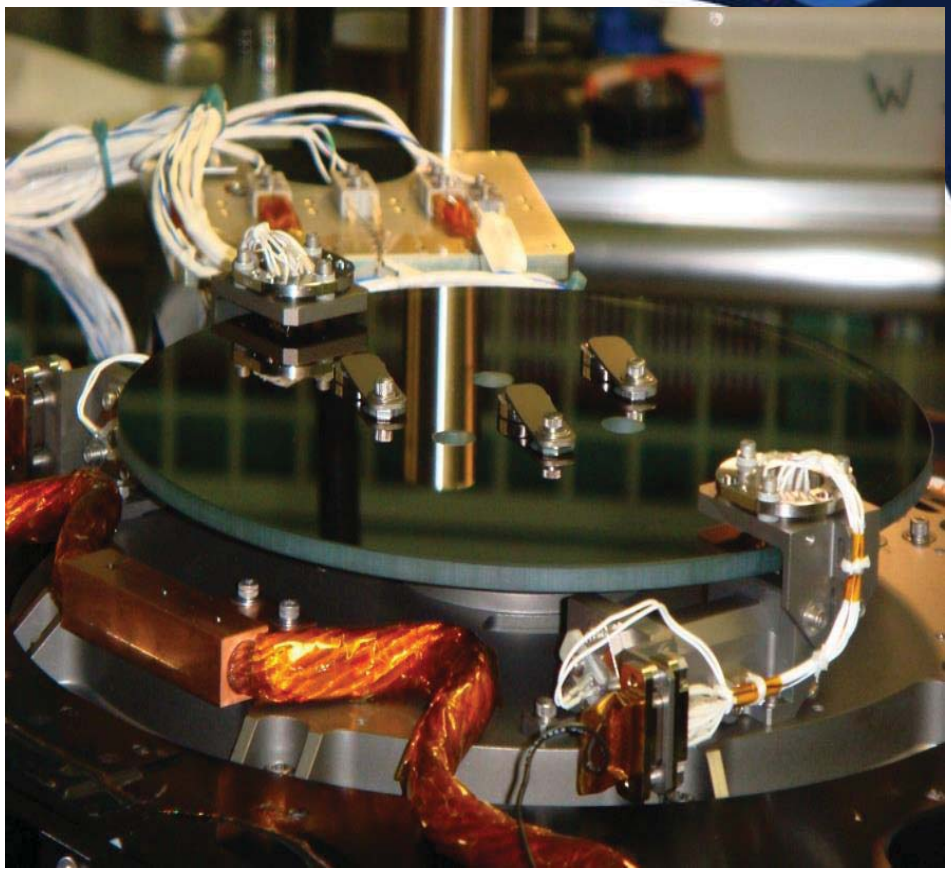


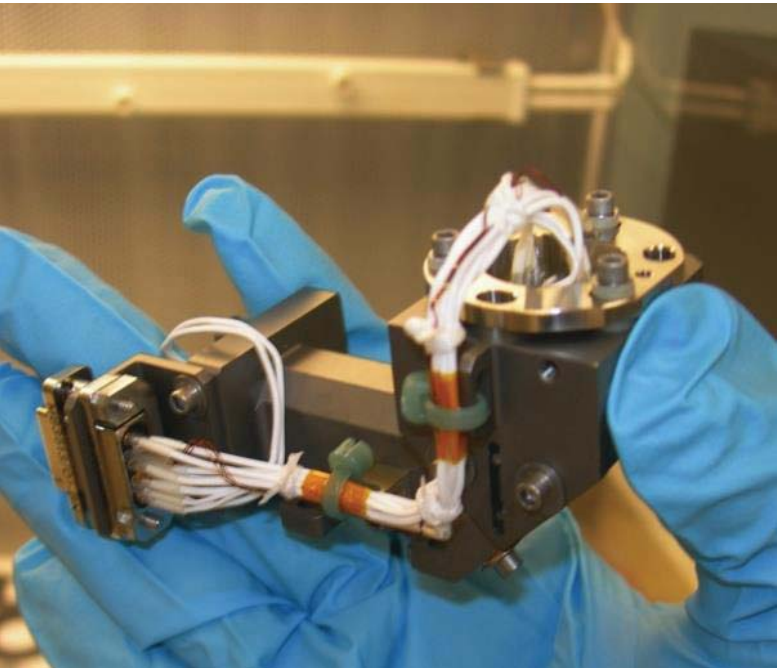
PSM Build: Motor Assembly/ Cable Drum

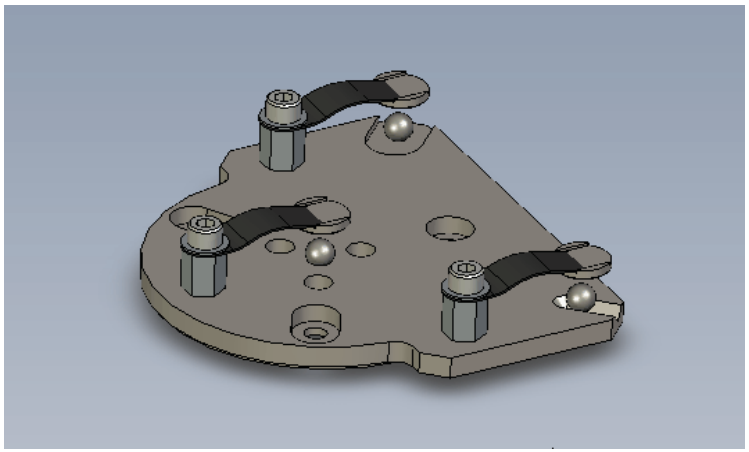


Encoder Assembly and Alignment





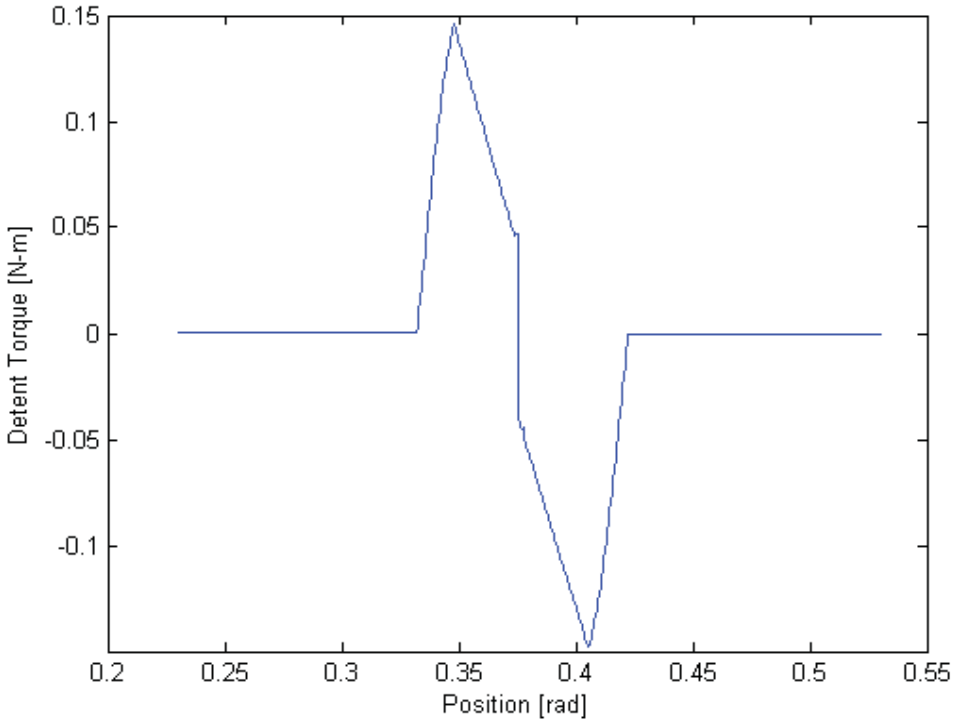




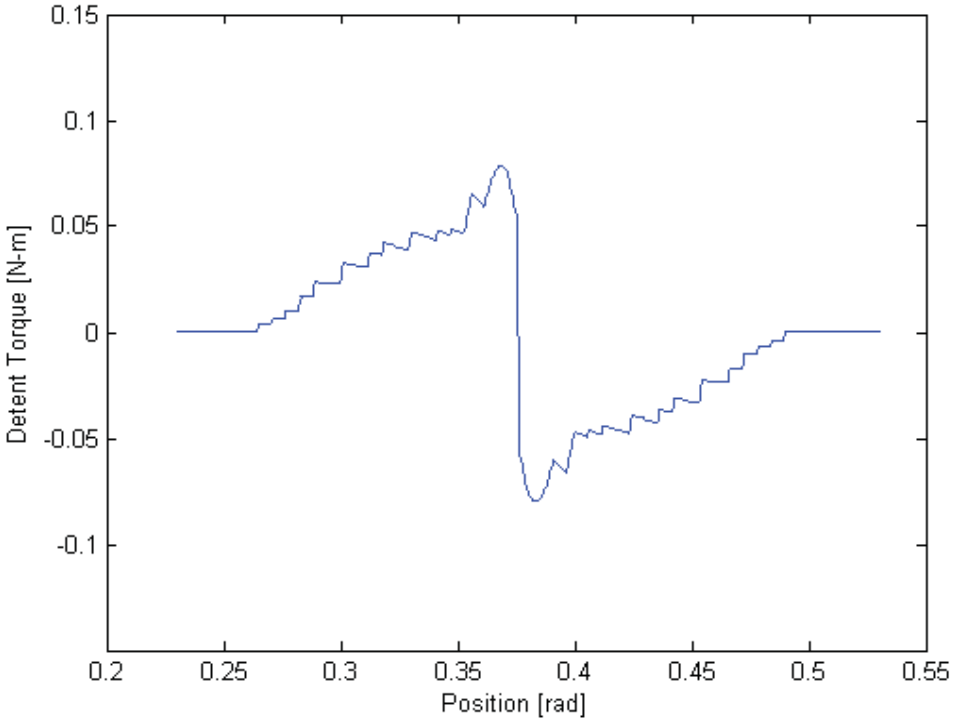
The Problem

Detent Modification

•Torque Profile, Original Detent

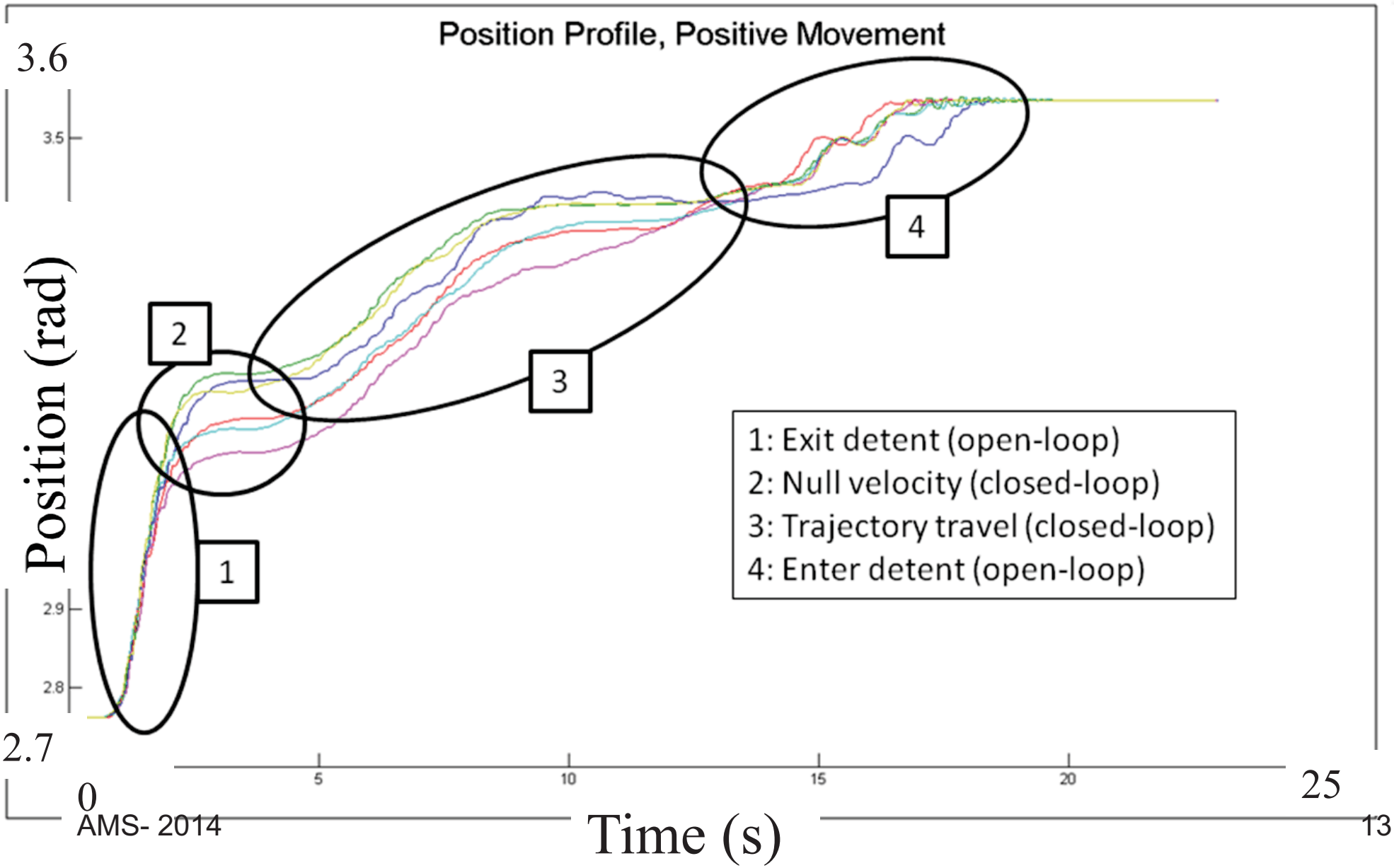


•Torque Profile, Modified Detent

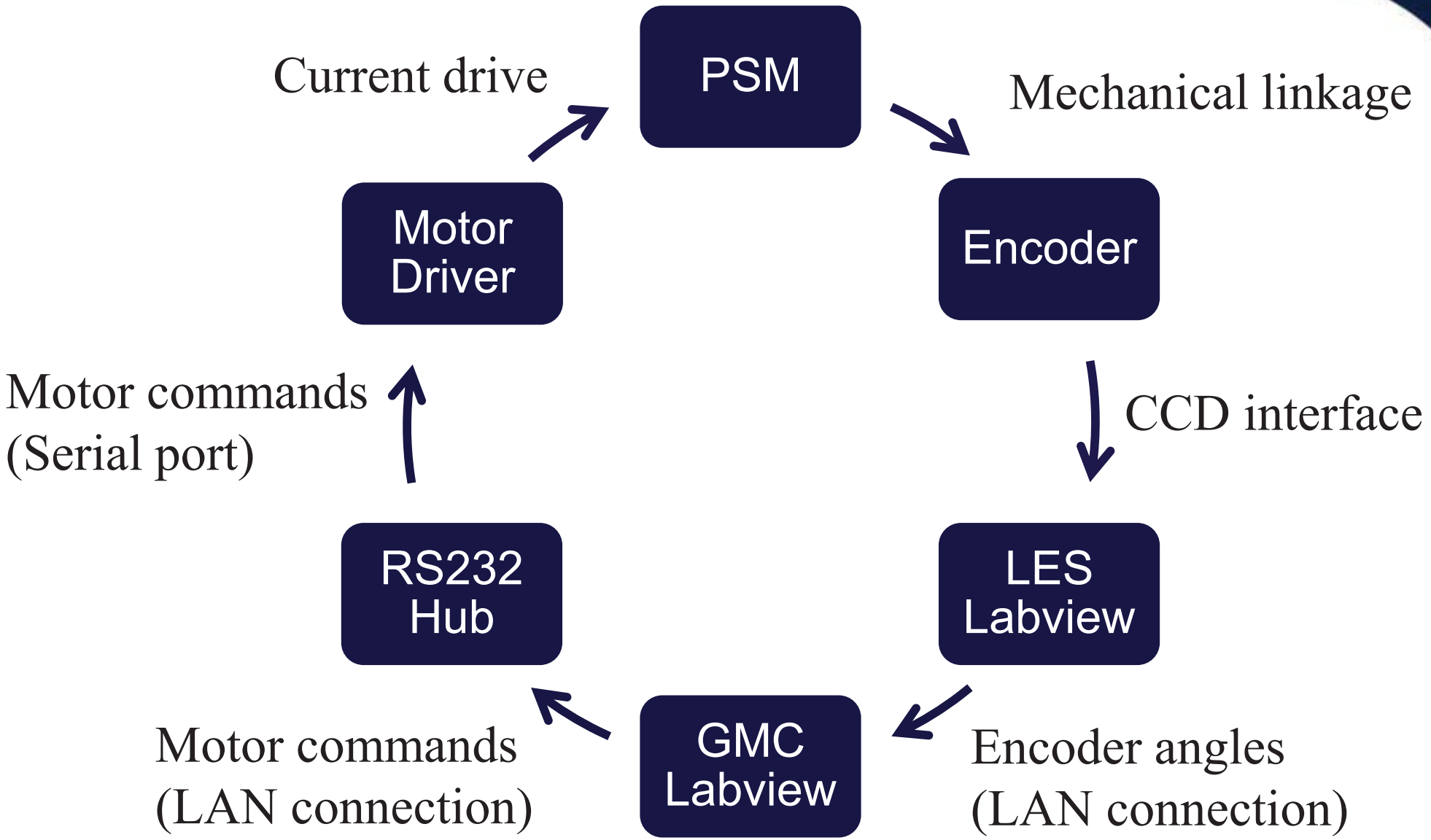


• Detent modification greatly reduced peak disturbance torque and reduced discontinuities.

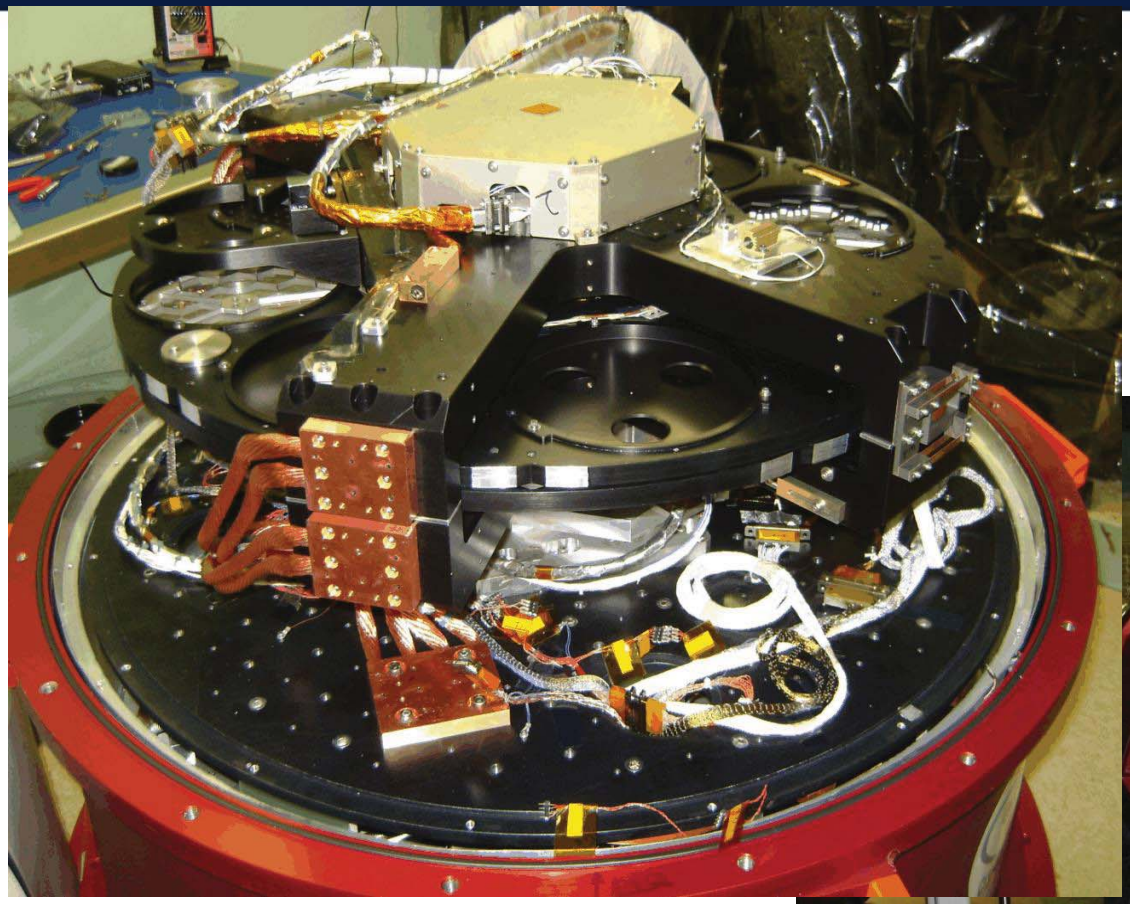
Mode-Switching Controller

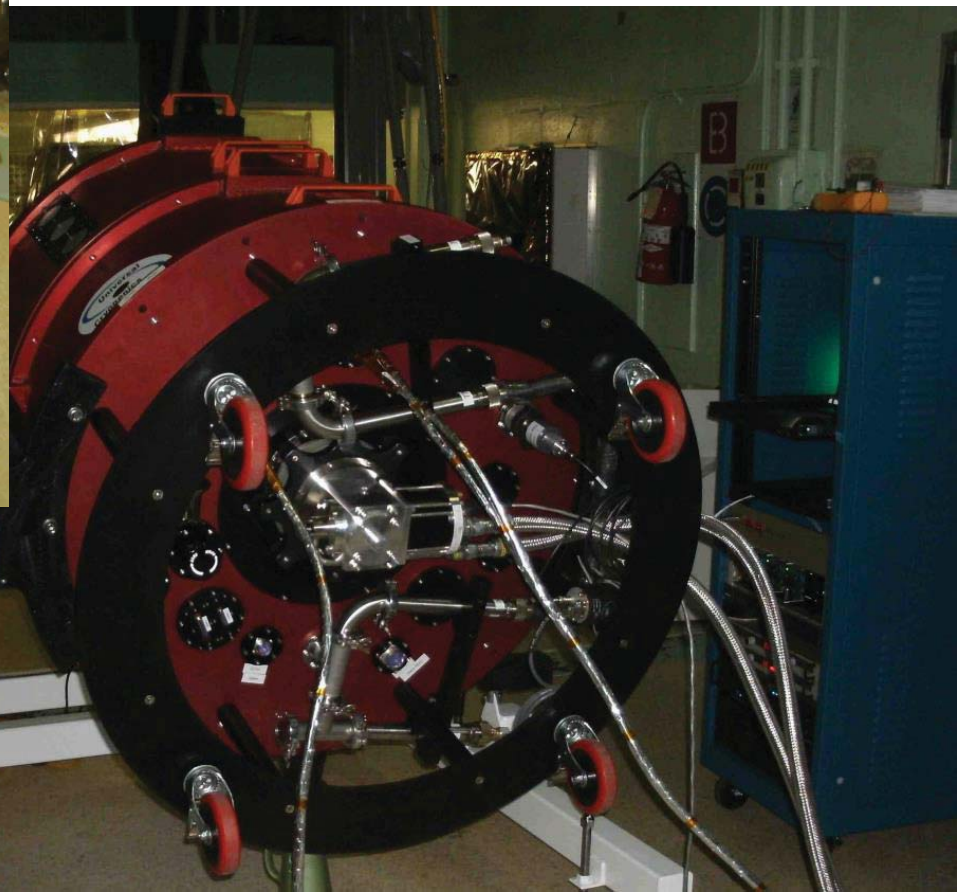


Control System Layout



Functional and Performance Testing





PSM Integration into OSIM

PSM Lessons Learned

- Motors and encoder/sensor selection are key decision points in an electromechanical system
- Cold treated hybrid bearings consisting of Si3N4 balls, Cronidur 30 races, and a PGM-HT retainer have been shown to be suitable for cryogenic operations
- When modeling a plant, ensure the plant is of a high enough fidelity to represent the dynamic response of the system accurately.
- Closed-loop control always needs a sensor with sufficient bandwidth and speed range.
- In a two-pole system, use high order compensator
- Automatic event logging is critical in systems with many operators

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