Preliminary Design of a Magnetic Measurement System for the Detector and Production Solenoids of the Mu2e Experiment

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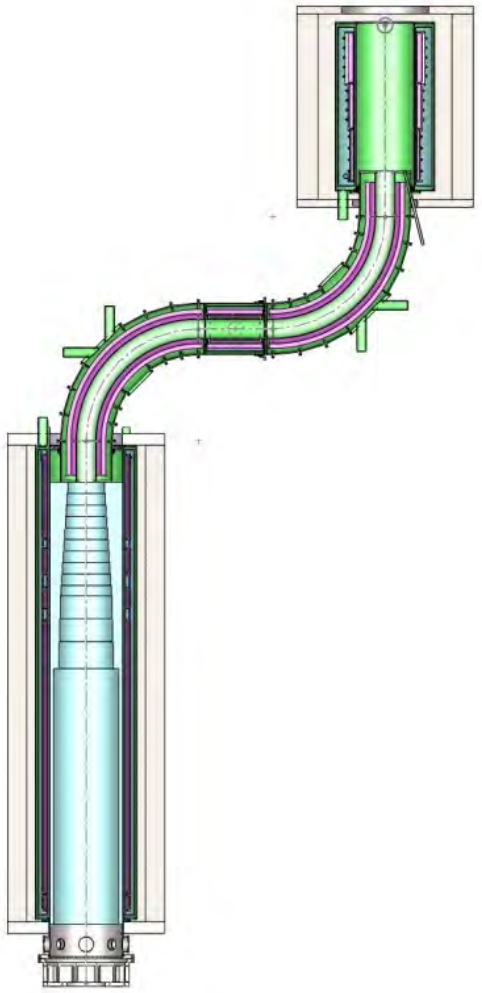
Introduction – Mu2e

- Conversion of muons to electrons
- Protons from the booster ring
- Three Solenoids
  - Production Solenoid
  - Transport Solenoid
  - Detector Solenoid



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The Problem

- Accurate data requires an accurate magnetic field map
- Locations within 50 micron
- Non-metallic materials
- Cannot touch the inside of the PS bore
- Must be adjustable

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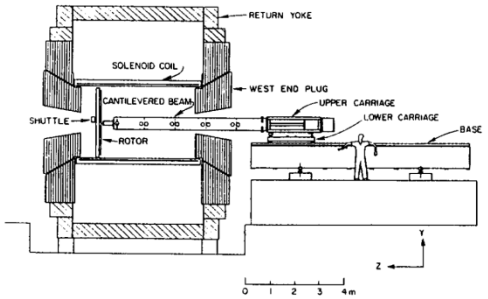
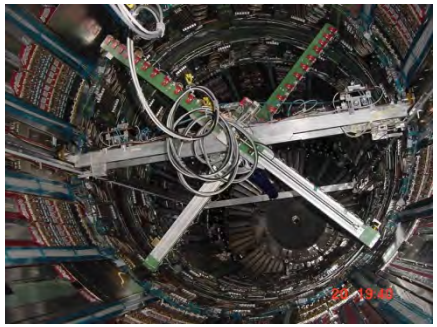
Previous Systems





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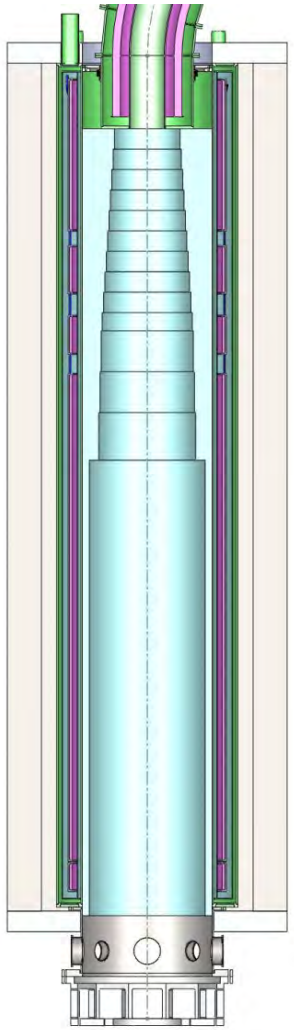
Detector Solenoid Requirements

- Carriage that rides on rails
- As little metal as possible
- Cable control
- Accuracy of 50 micron, 71 µrad
- Volume of 0.7m radially x 9.1m axially
- TS Volume of 0.15m radially x 1m axially



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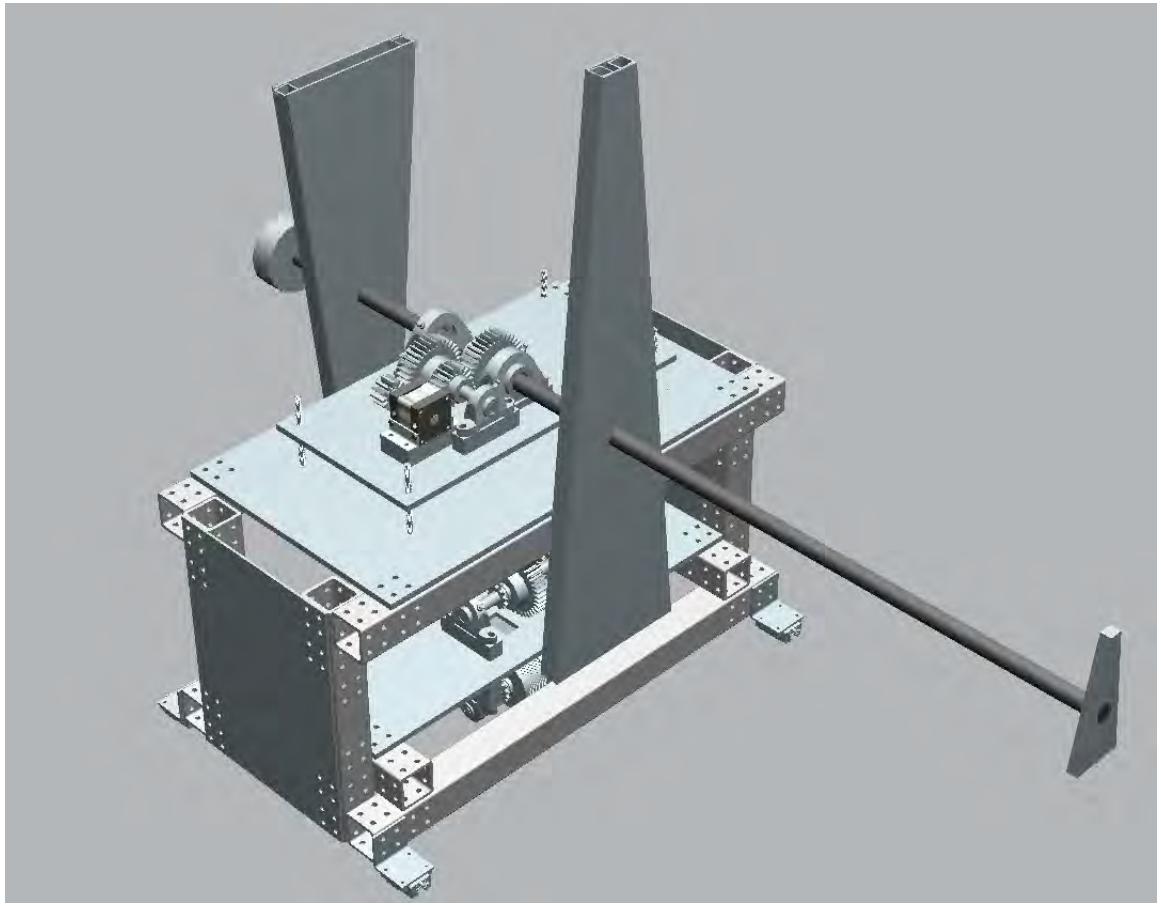
The Preliminary Design – DS



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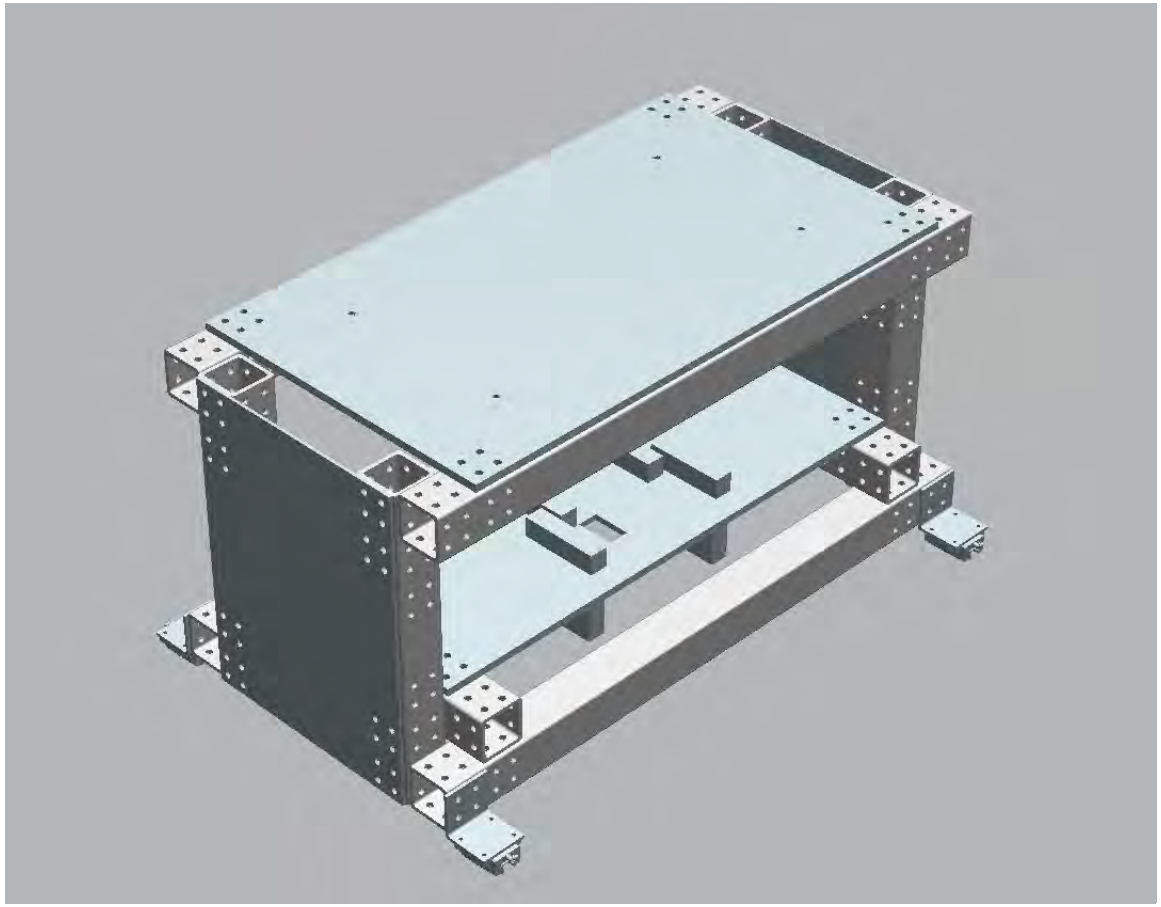
The Frame



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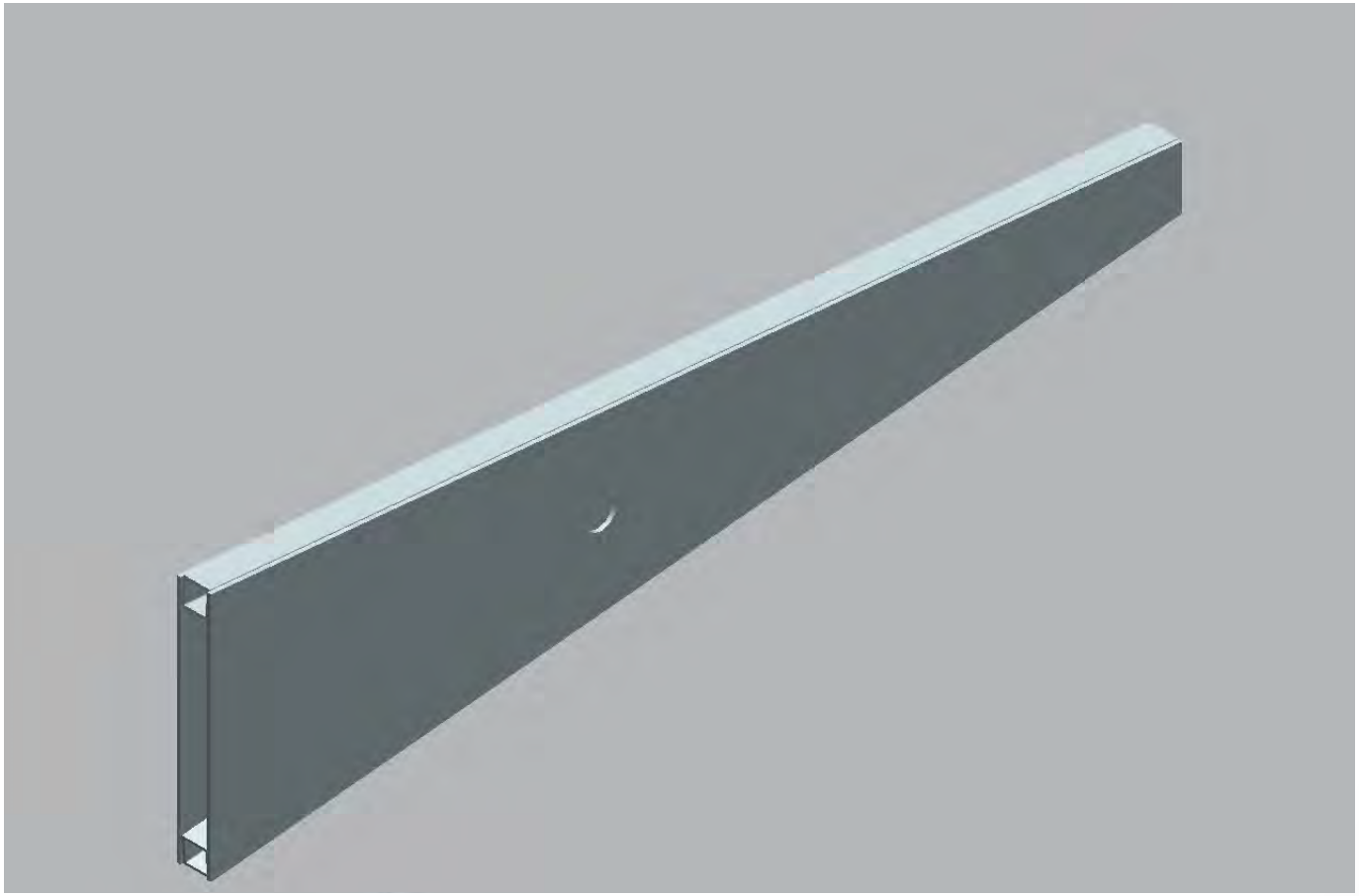
The Propellers



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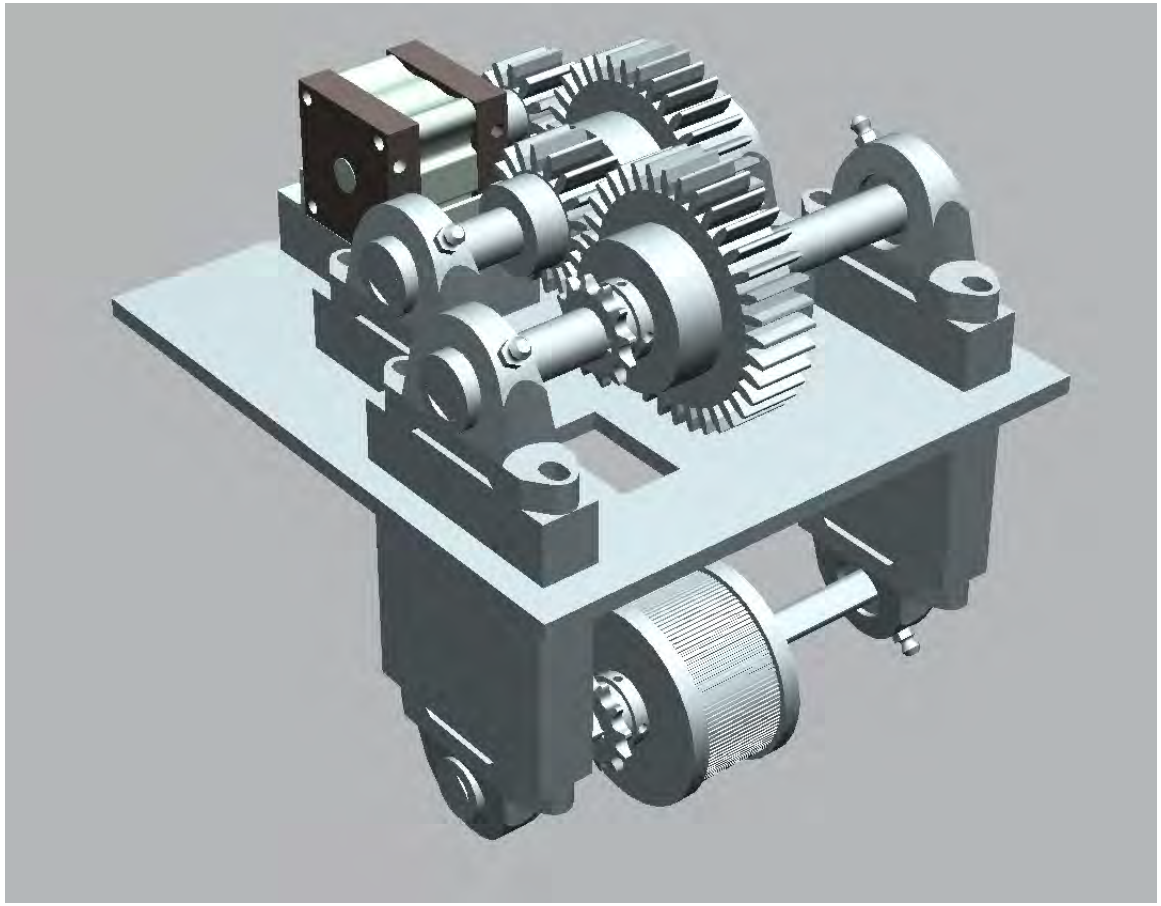
The Carriage Drive System



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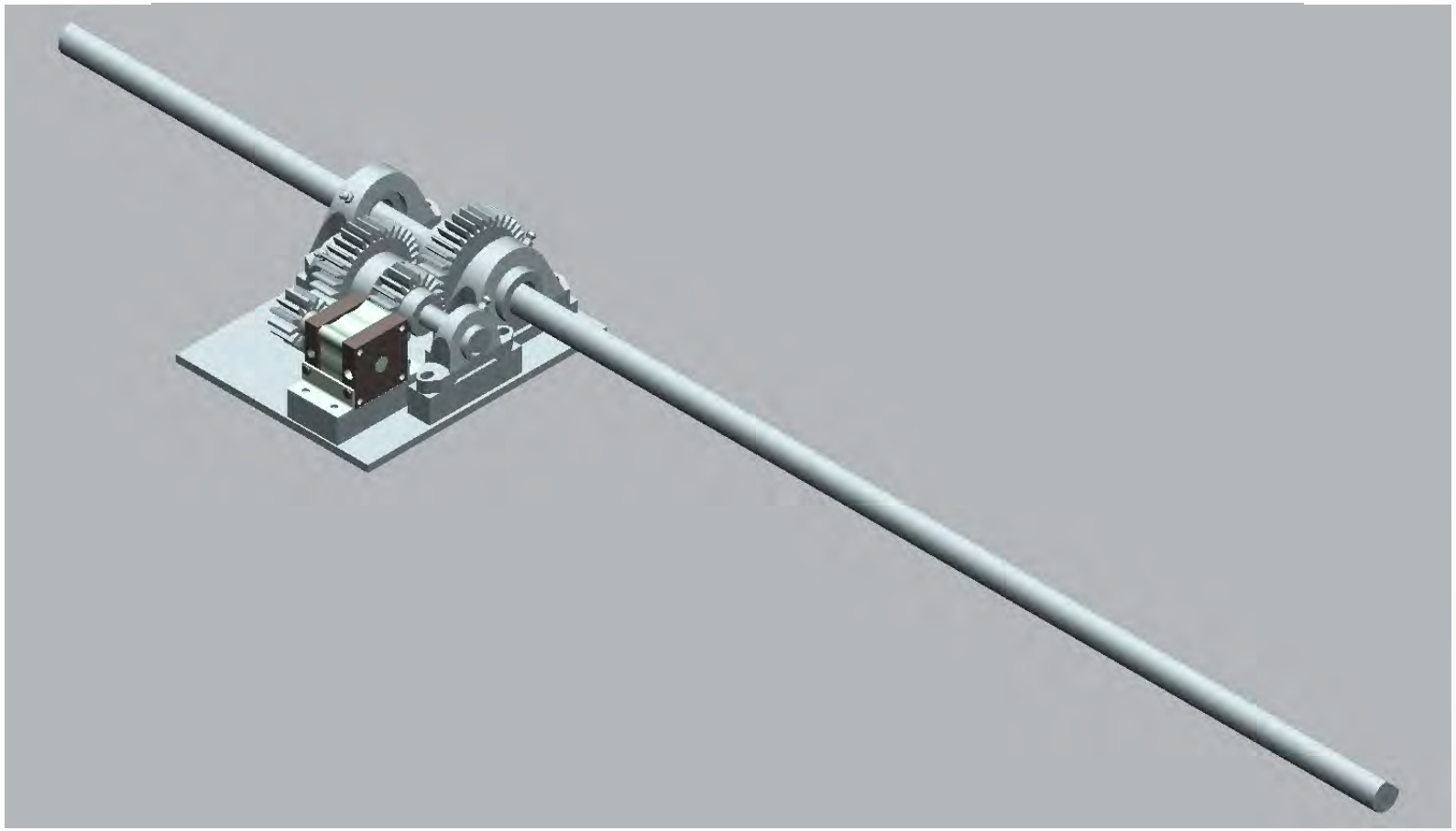
The Propeller Drive System



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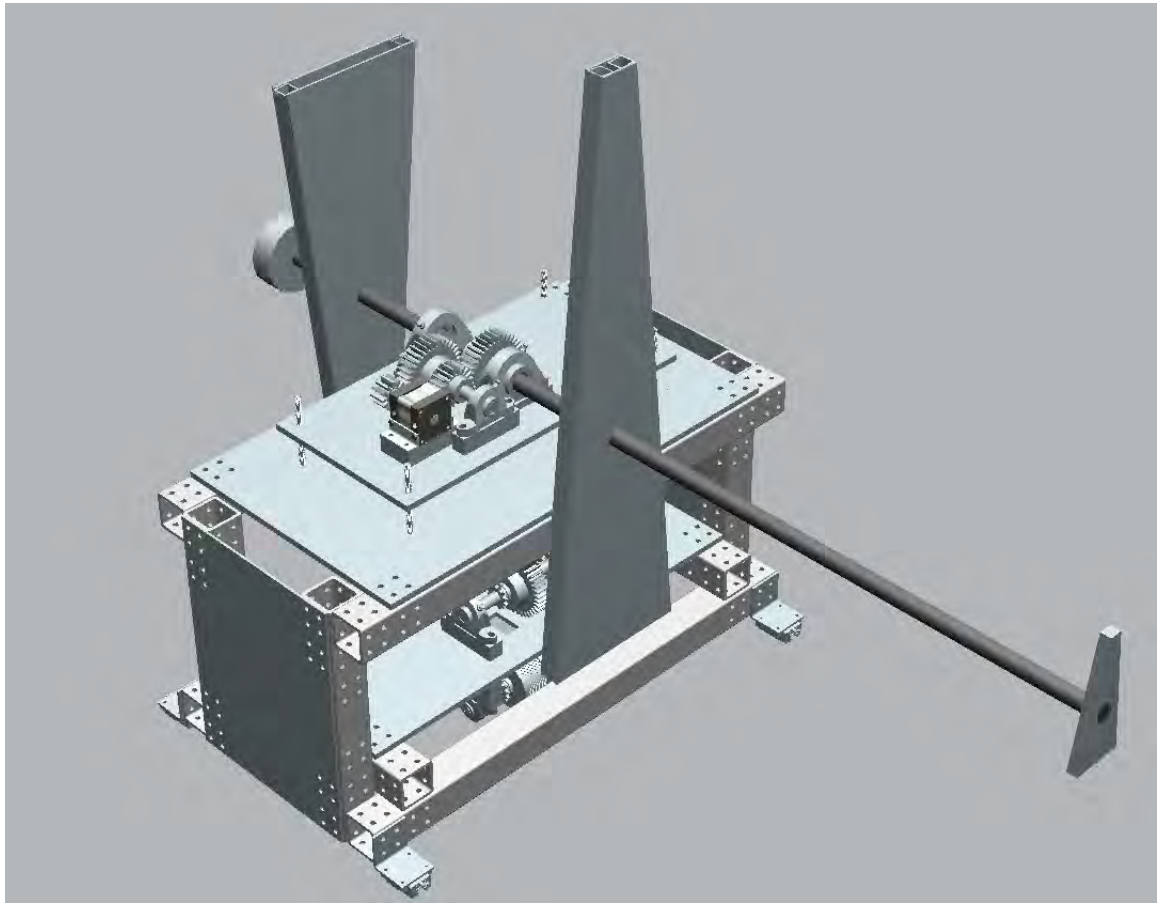
The Preliminary Design – DS



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Production Solenoid Requirements

- 300 micron precision, 1.2 mrad
- Cannot touch the interior of the bore
- Volume of 0.25m radially x 4m axially
- This may change
- TS Volume of 0.15m radially x 1m axially

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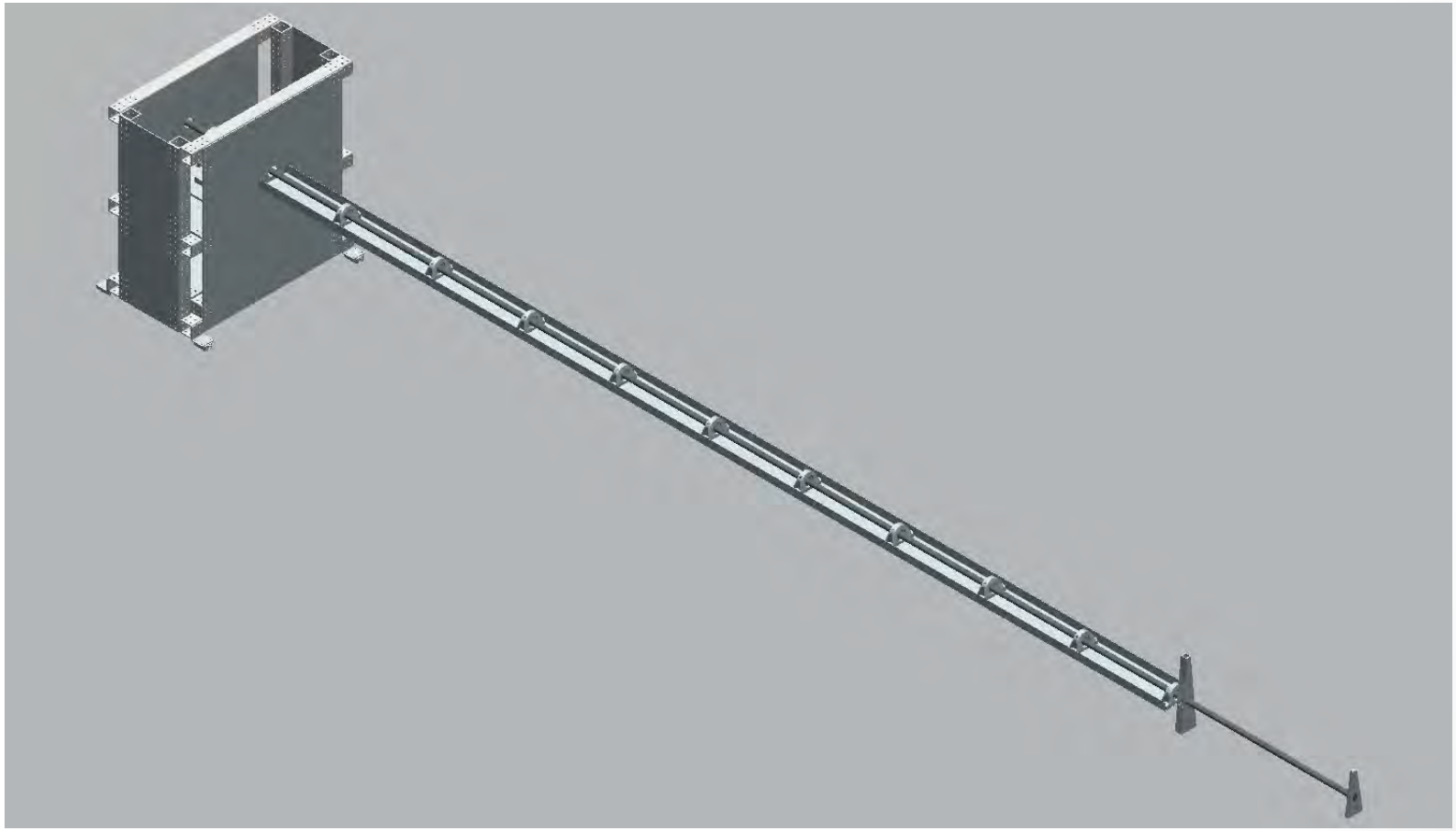
The Preliminary Design - PS



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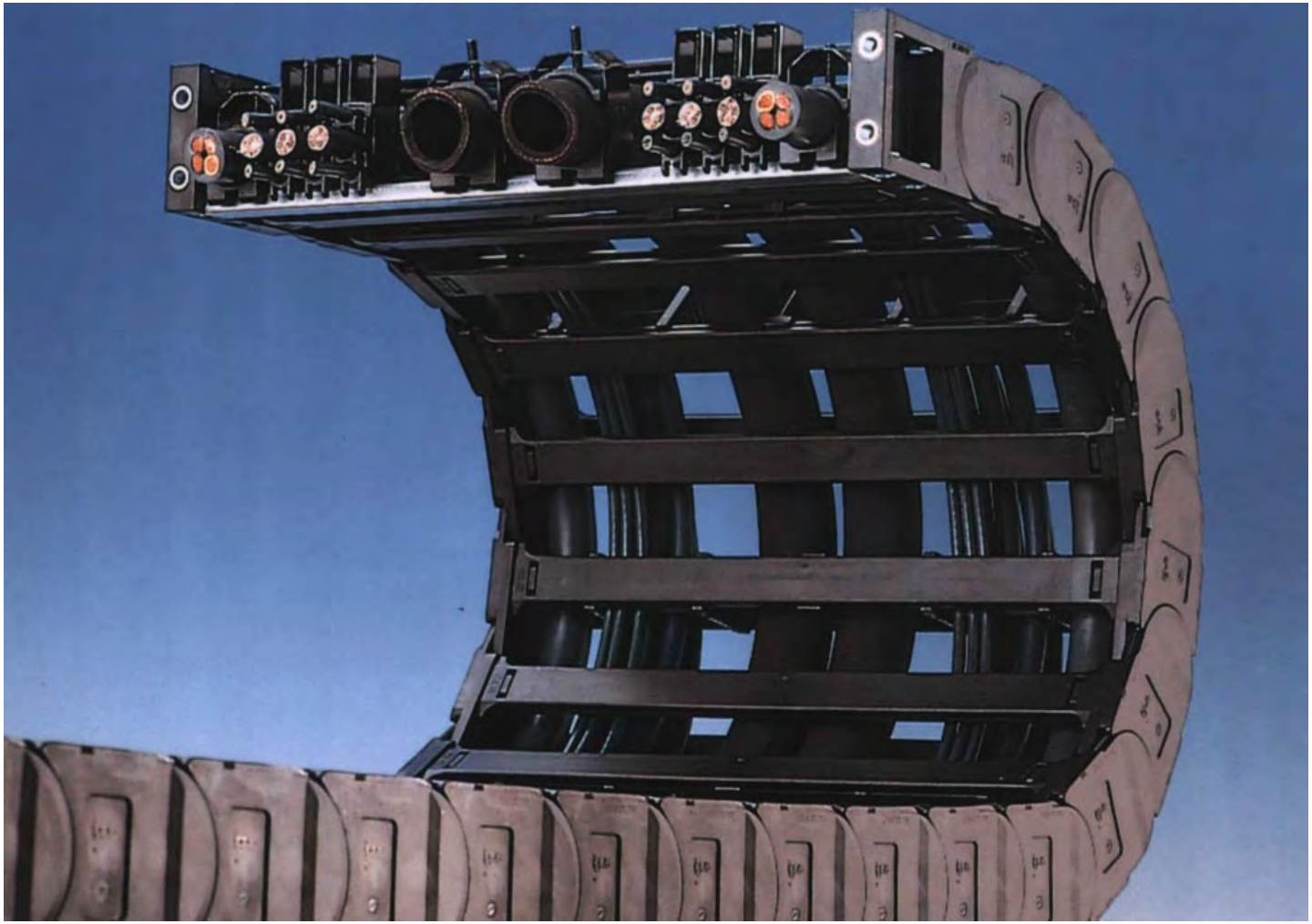
Cable Control



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Material Selection - Constraints

- DS system must minimize use of metal
- PS cantilevered beam must be light
  - Fiberglass
  - Carbon Fiber
- Gears may be nonmetallic
  - Nylon is available, but with drawbacks

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Materials

- Fiberglass frame and platforms
- Fiberglass propellers
- Carbon fiber axle and c-channel
- Nylon or stainless steel gears
- Any metal must be stainless steel or aluminum

Sources of Error

- Gear wear and backlash
  - Linear and angular encoders
  - Feedback control system
- The rails
  - Active actuators to correct the error
- Torque on the propellers
  - Axle through the center of gravity

Next Steps

- Find a suitable stage for minor adjustments
- Use wall-mounted ball bearings
- Air supply for the motors
- Improve the PS design (CDF design?)
- Vibration analysis
- Error/tolerance analysis

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Conclusions

- The DS preliminary design meets many of the requirements
  - Room for improvement
- The PS preliminary design meets some of the requirements
  - Needs to be retooled

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Questions?