GlueX DIRC Shipping and Installation Considerations

GlueX DIRC Technical Review
Jefferson Lab
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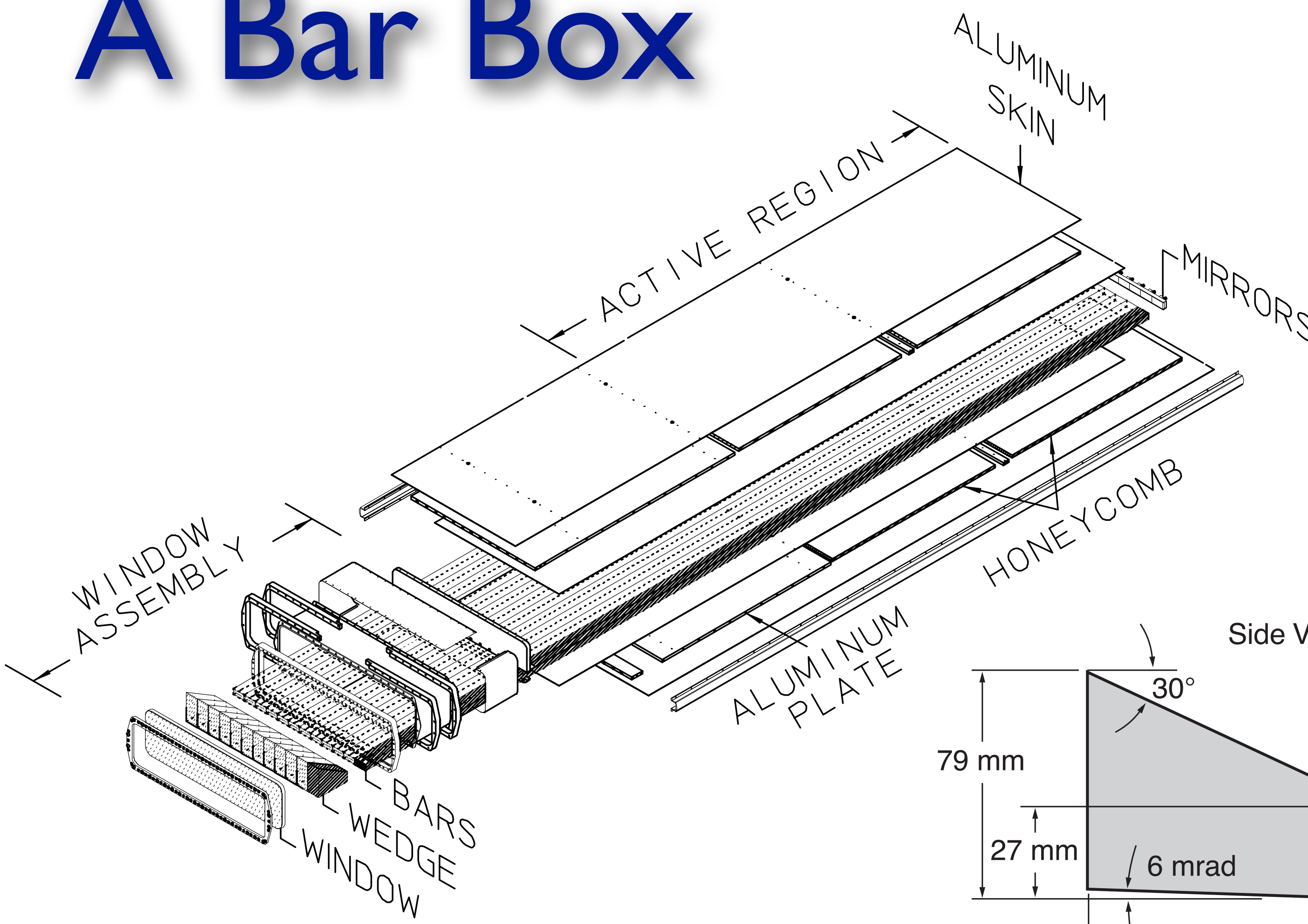
Matthew Shepherd and John Frye
Indiana University

Outline

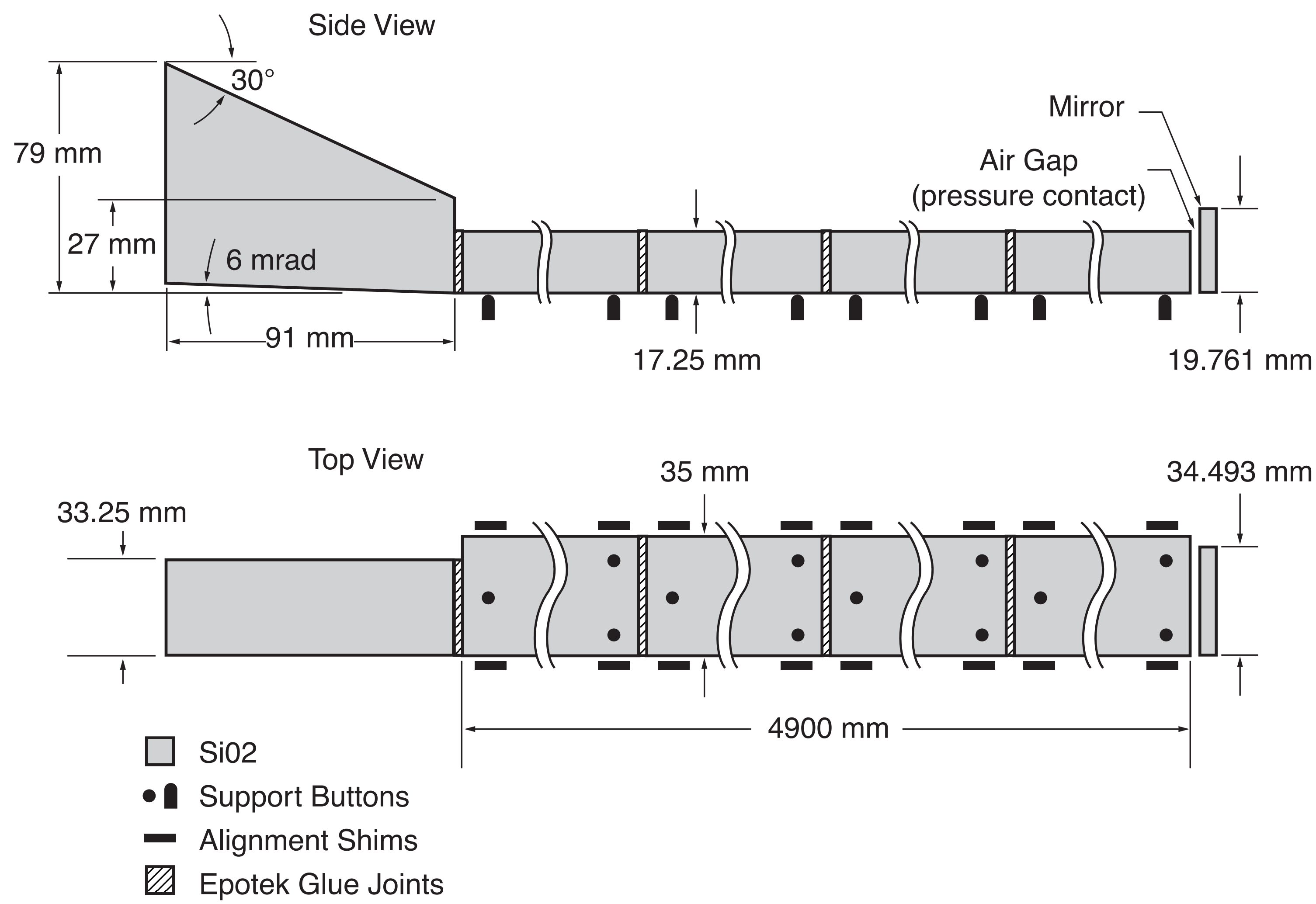
- Previous talks have addressed
  - why particle identification is essential to the GlueX physics program, and
  - how the GlueX DIRC design will achieve the stated particle identification goals.

- A few remaining details:
  - how to safely transport four priceless BaBar DIRC bar boxes from SLAC to Jefferson Lab without damage, and
  - how to install and integrate these elements into the existing GlueX detector.

A Bar Box



4 boxes needed for the GlueX FDIRC



key mechanical features

- size
- glue joints
- pristine bar surfaces
- sliding support buttons
- mirror pressure

Environmental Concerns

- Temperature variation
    - BaBar literature cites design tolerance of ±20°C
    - stuck buttons may inhibit smooth thermal response
- Shock/vibration
    - aged glue joints
    - window/bar breakage
    - resonant vibration
- Altitude variation
    - cannot contaminate bar surfaces
    - gas environment inside the box must be dry N_2
    - potential outgassing of materials

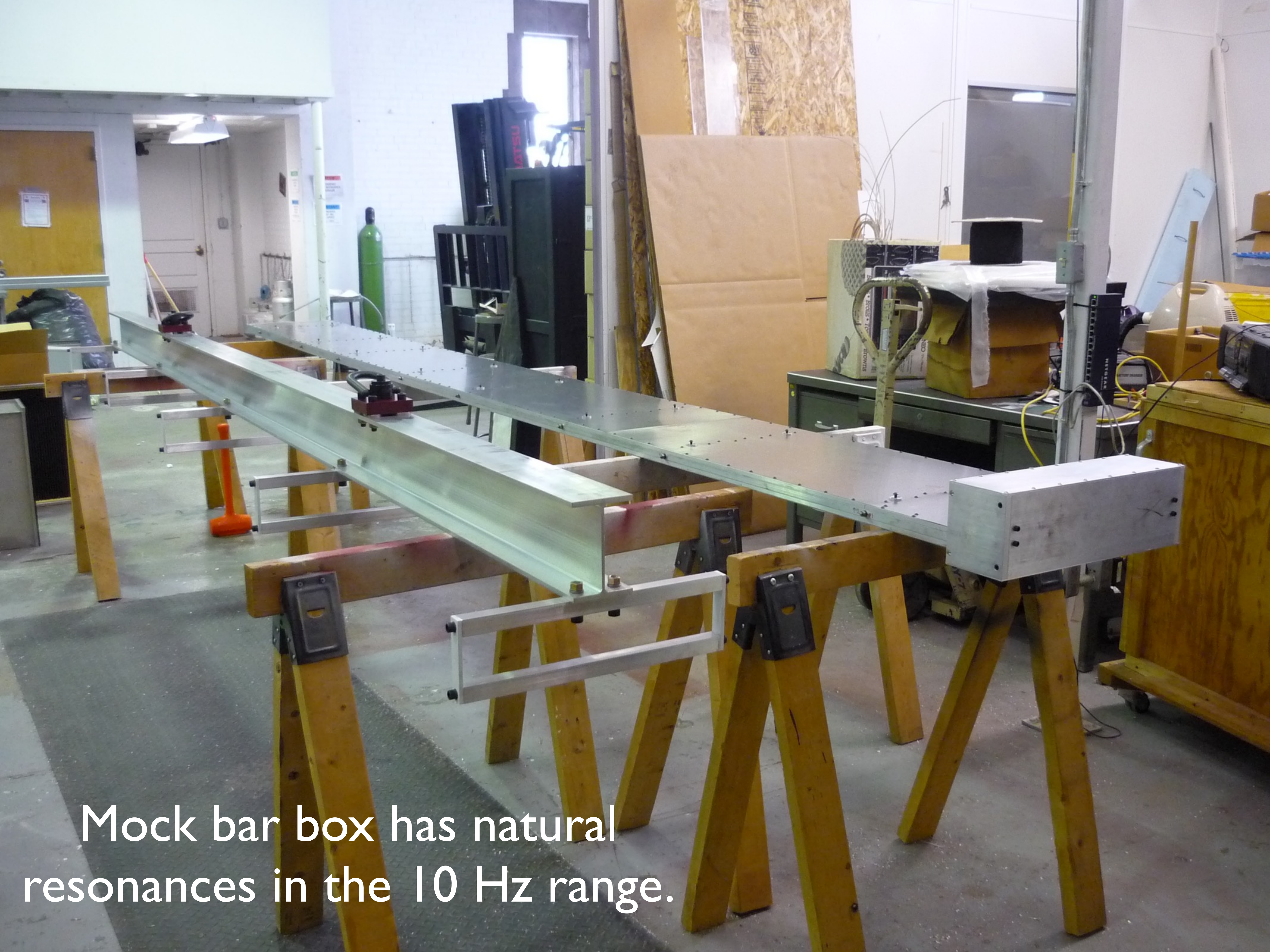
Precise limits
are difficult to define

Typical Tensile Strengths:

Fused Silica: 7000 psi
Epotek Glue: >1000 psi

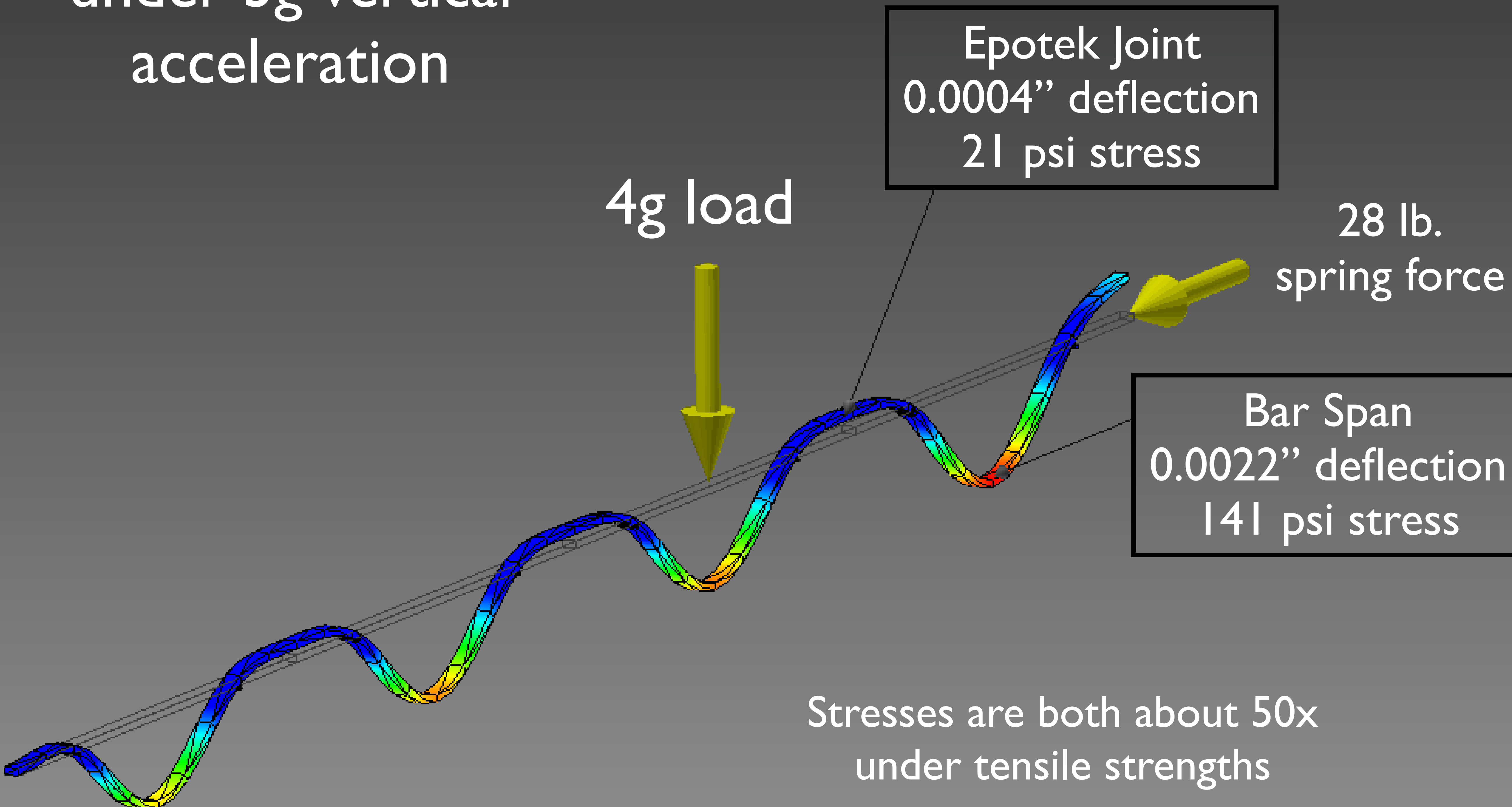
Design for at least 10x below these limits.


Al Bars
KOMATSU
BT LIFTER
ULINE



Mock bar box has natural resonances in the 10 Hz range.

FEA of bar response under 3g vertical acceleration

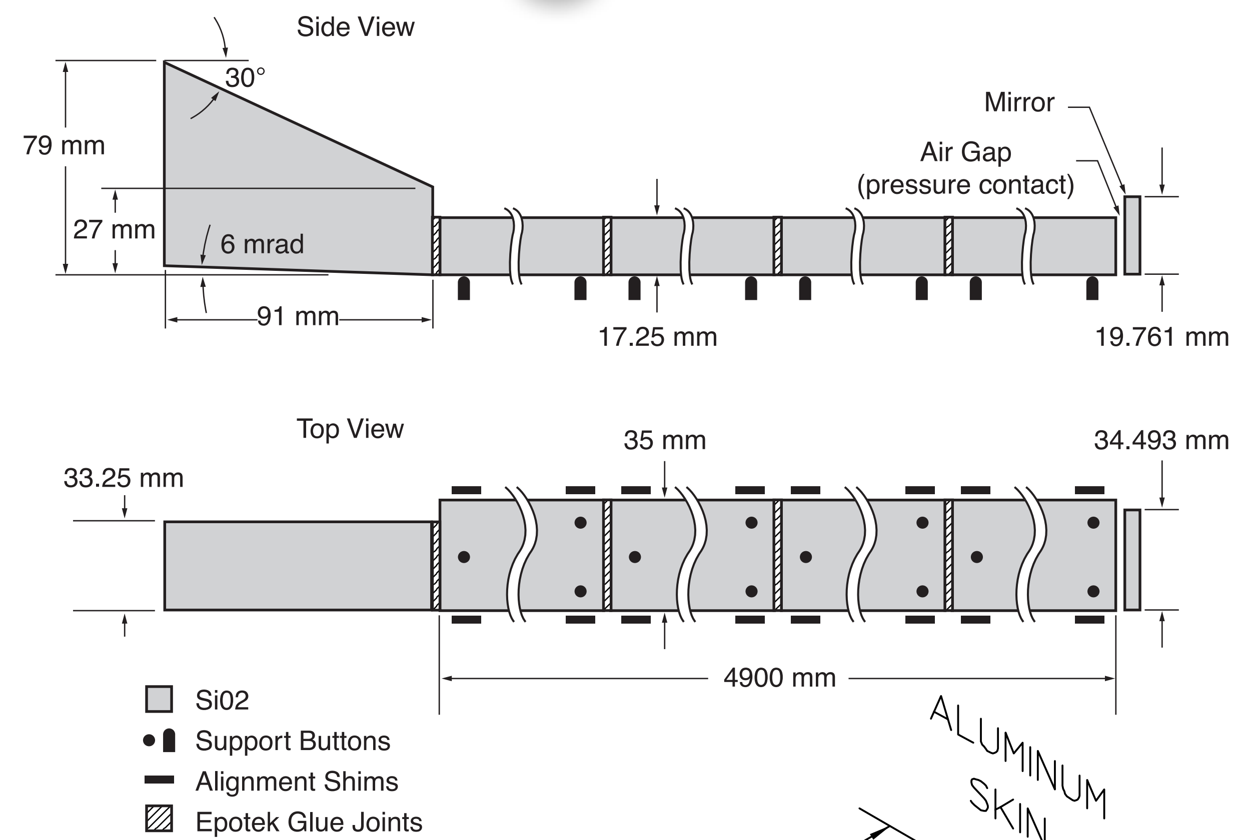


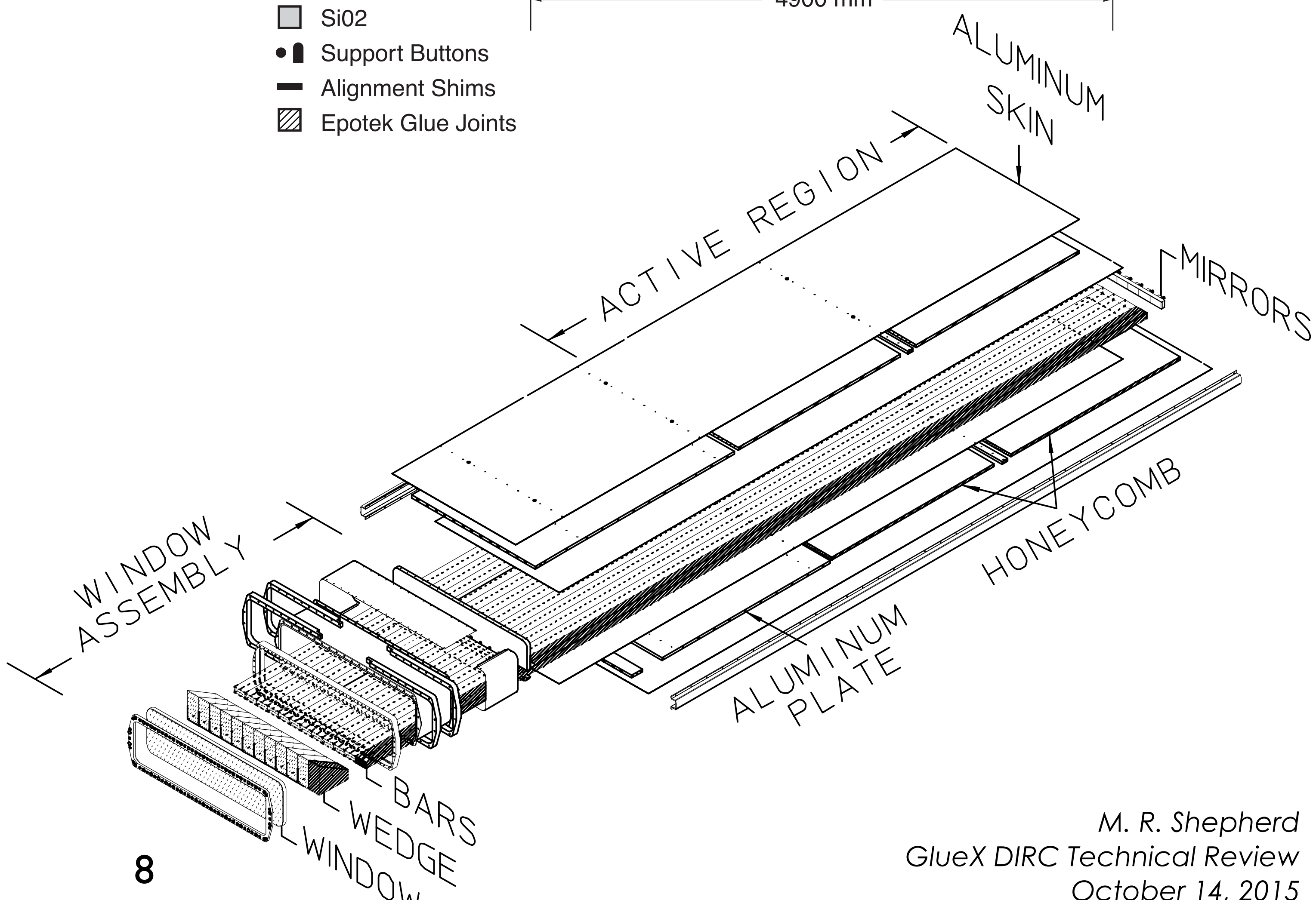
Stresses are both about 50x under tensile strengths

Adopt ALARA but 3g seems to be a safe transverse acceleration

Window Loading

- Net force applied by mirrors on the window: 340 lbs.
    - balances hydrostatic pressure in BaBar design
- Weight of bars: ≈ 200 lbs.
- **Proposed limit: 1.5 g acceleration**
    - keeps all glue joints in compression in one direction
    - loads the window with 640 lbs. of force in the other direction
- FEA with 1030 lbs. of force on window (3.5 g equiv. acceleration) gives safety factor of 11





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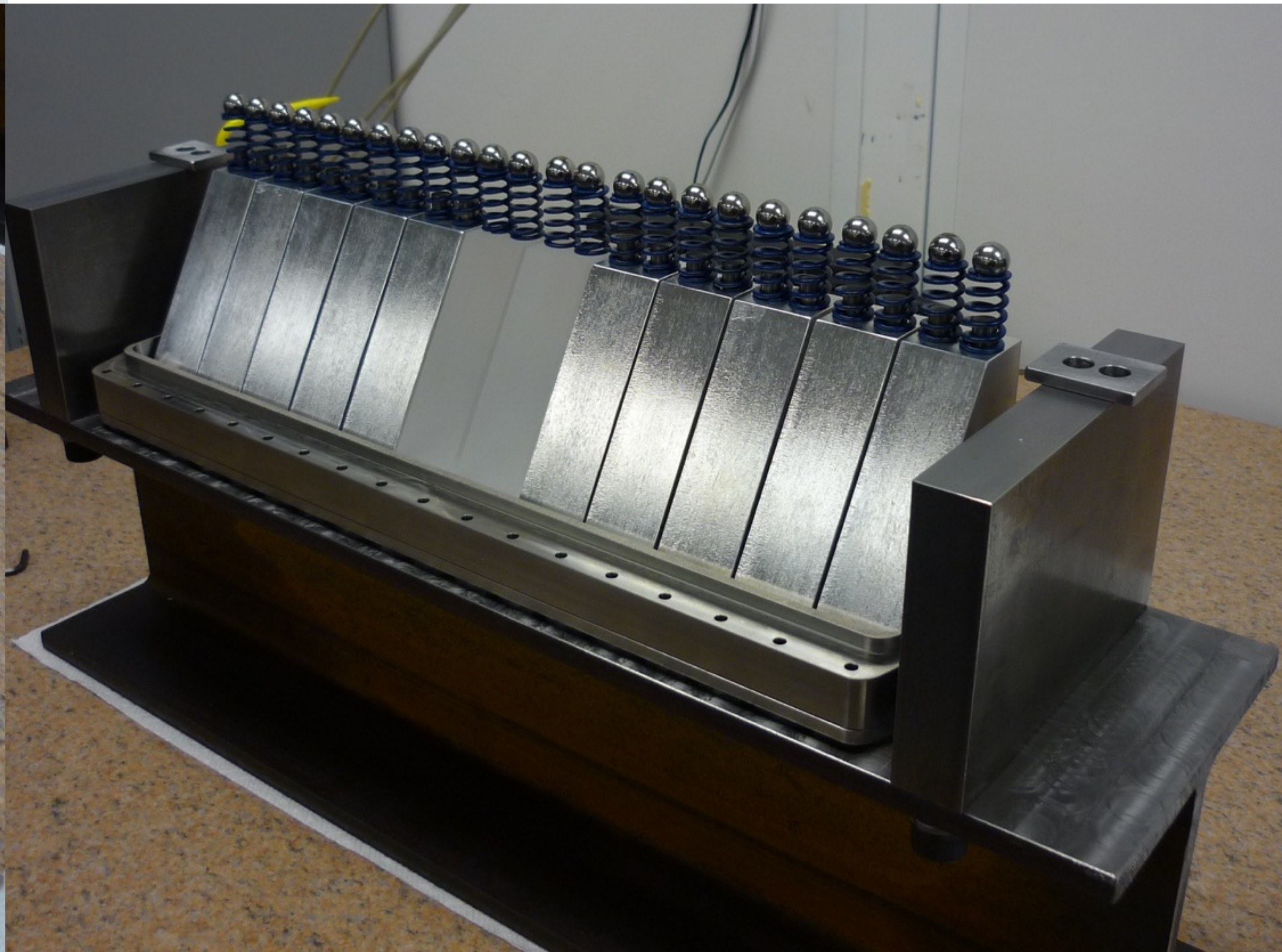
Window Load Testing

Actual fused silica window and replica flange loaded at 1030 lbs. (3.5 g equivalent) for two weeks.



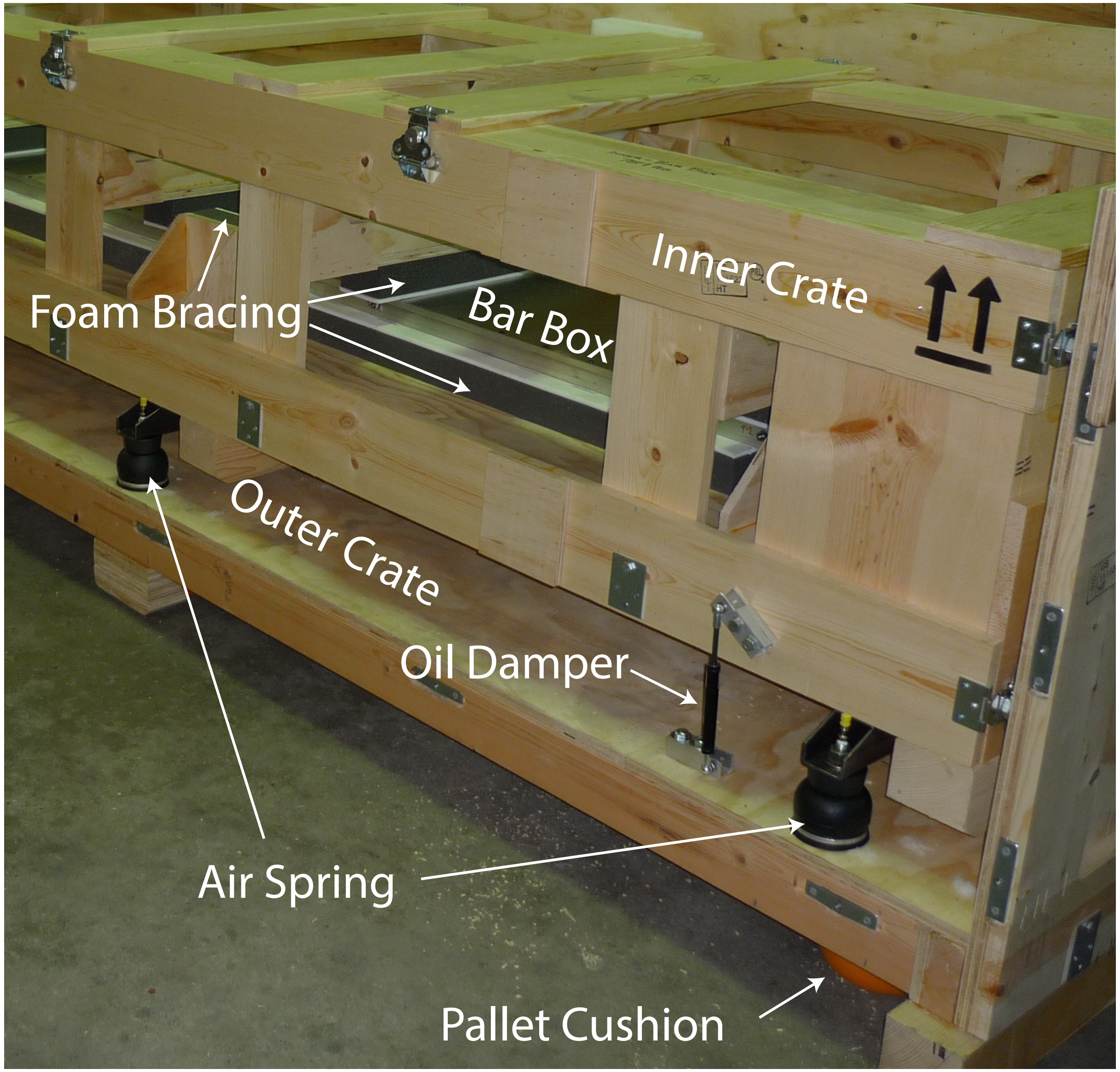
Crating Requirements

- Keep shock ALARA but use safe quantitative guidelines
  - 3 g transverse plane
  - 1.5 g longitudinally
- Brace box to avoid natural resonances in the 10 Hz range that can be driven by overland transit
- Need easy access for loading and unloading (most damage actually happens during this phase)
- Start by asking an expert for help:
  - contract with Art Crating Los Angeles (ACLA) who specializes in crating and shipping fine art
  - consultant visited IU to see the mock box and discuss design requirements
  - constructed a complete crate system for one box and shipped to IU

Shipping Crate Fabricated by ACLA
(≈ 1600 lbs. when loaded)

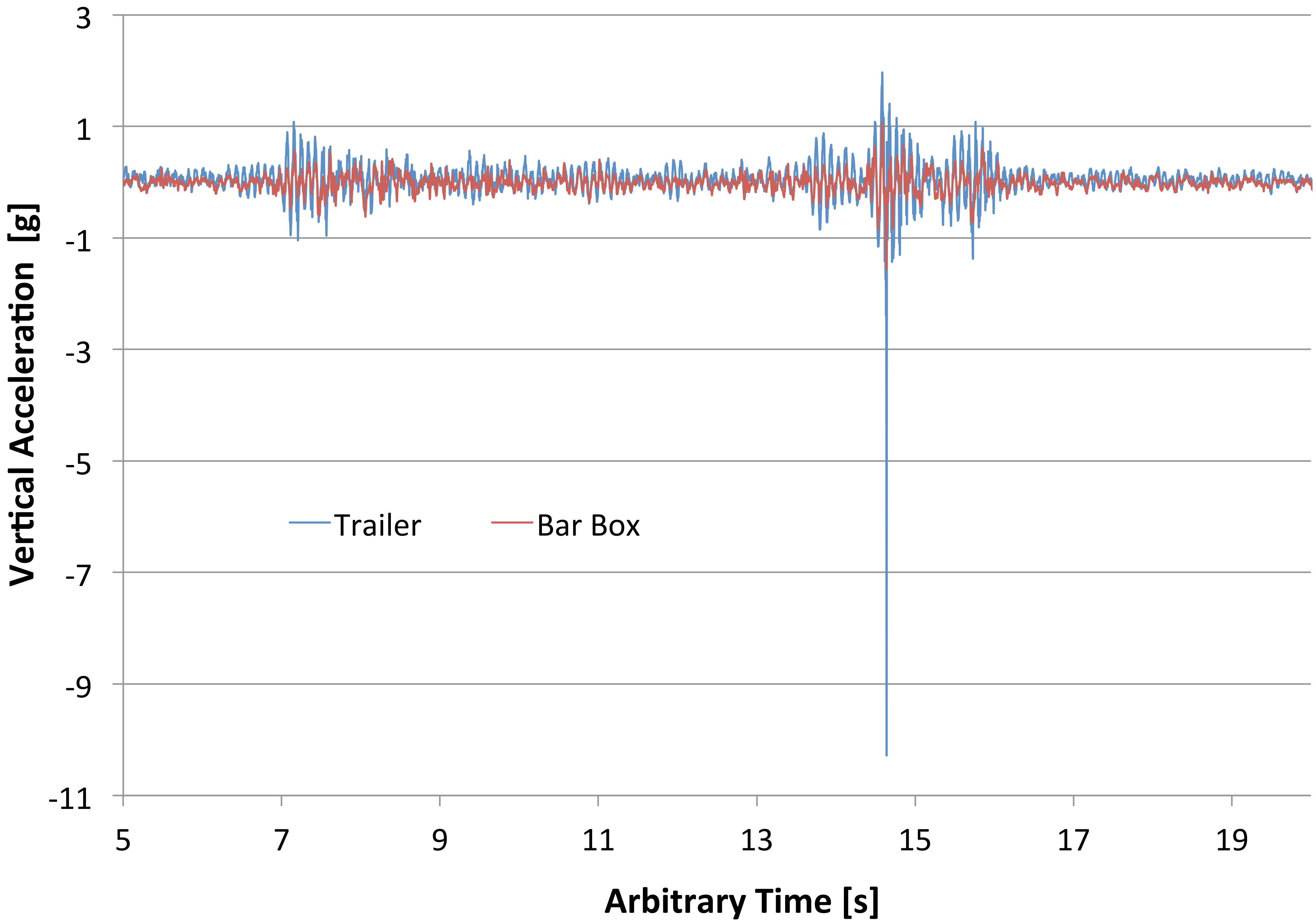
Shock Absorbing Features

- Instrument box, inner crate, and outer crate with three-axis accelerometers
- Optimize damping using series of "drop tests" onto concrete floor from a few inches
  - variable spring pressure
  - variable oil damping
- Propose to regulate air spring pressure in transit

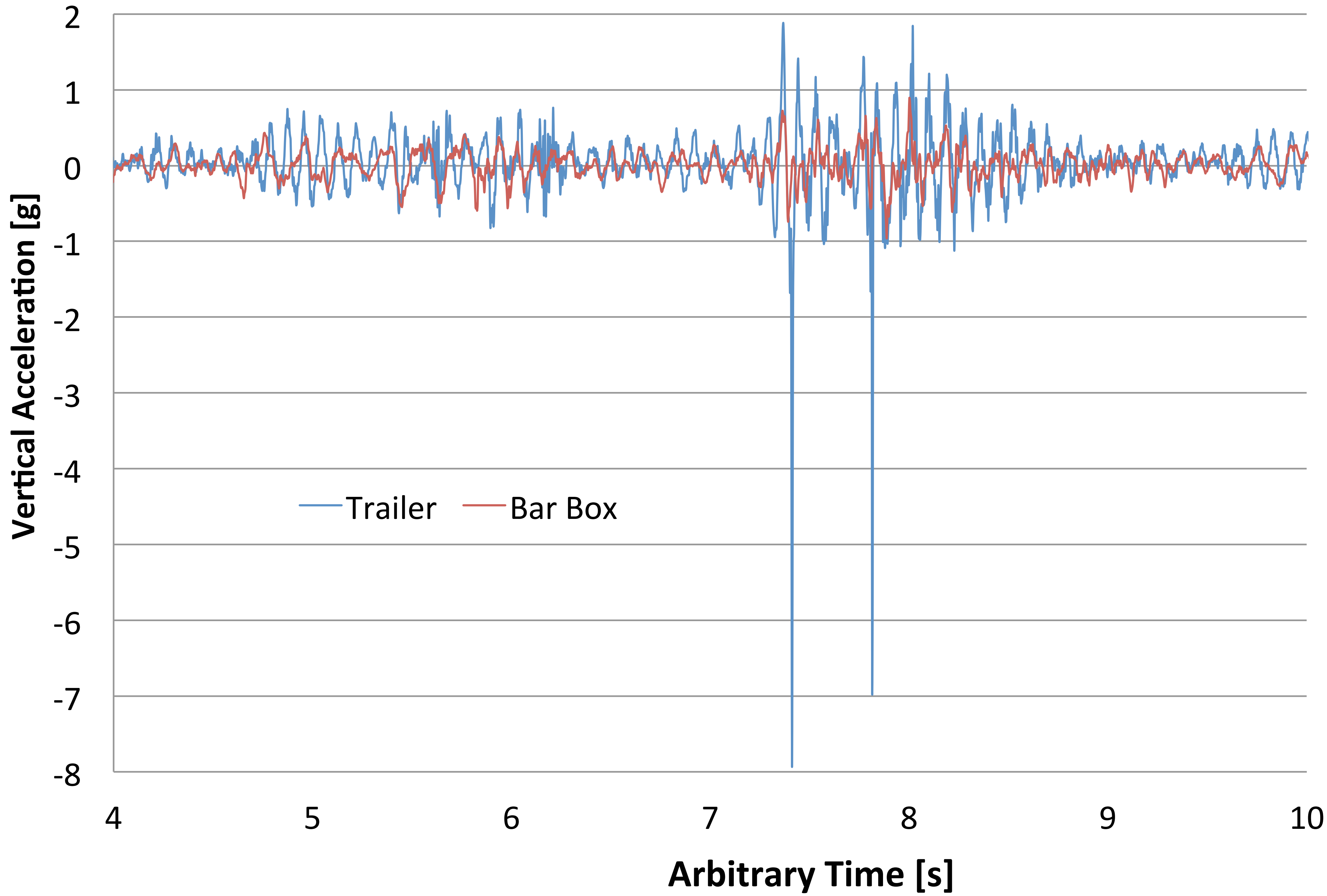


4 hour road test with accelerometers on the bed of the trailer as well as various positions on the bar box and crate

Maximum Acceleration



Vertical Oscillations

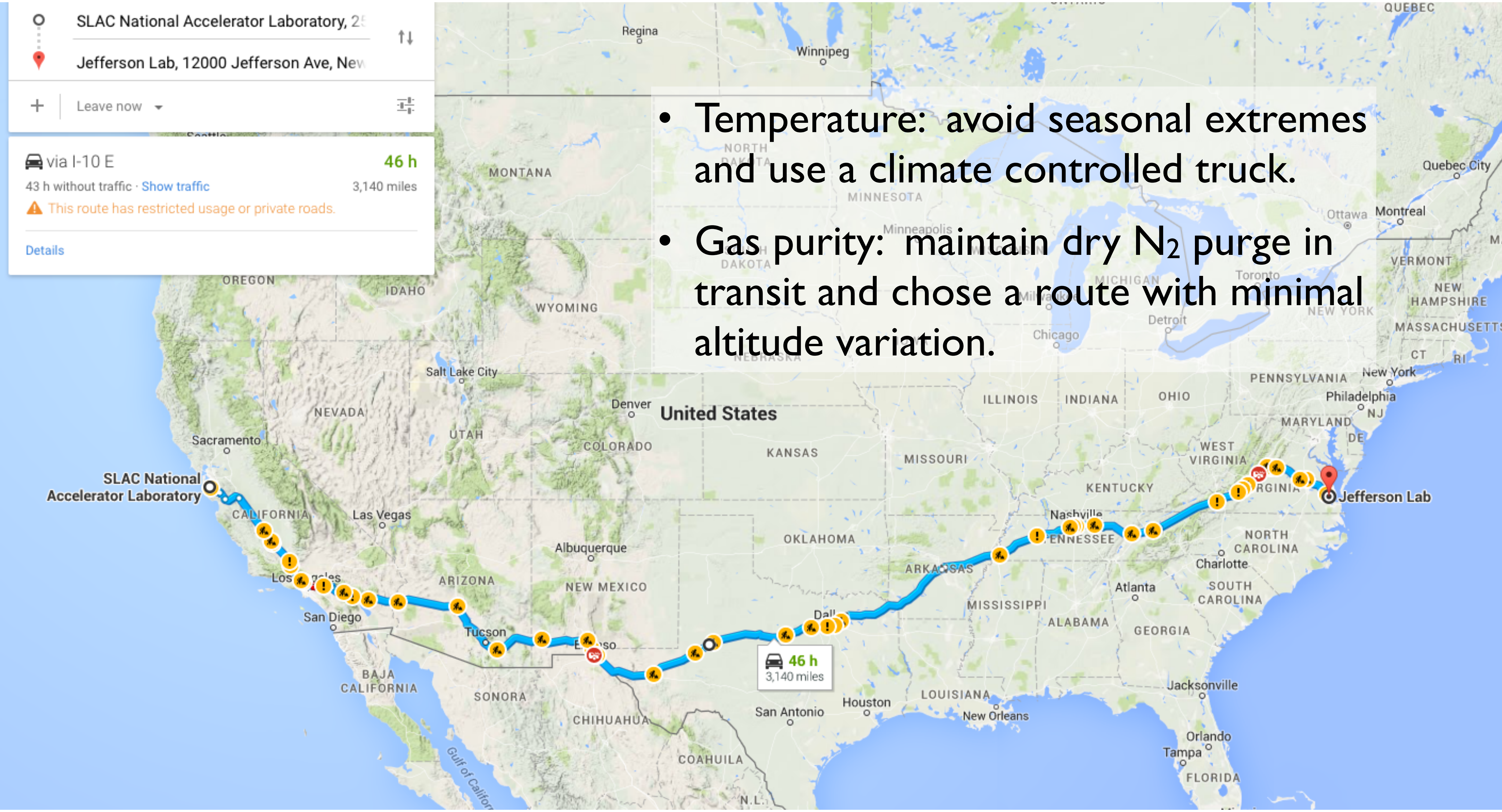


Road Test Observations

- Maximum vertical acceleration of the truck bed was
  - 10 g, during which
  - bar box acceleration remained less than 2 g.
- Maximum transverse acceleration of the bar box was 2.8 g,
  - under our design limit, but
  - will be reduced with addition of transverse air springs (not present during test).
- Maximum aft/fore acceleration was 0.6 g,
  - well under our design limit.
  - Propose to orient boxes with window towards the back of the truck to reduce potential damage in a hard stopping event.
- Oscillation in 10 Hz range evident: rely on stiff inner crate to prevent resonant flexing of the box.

Shipping Strategy

- Temperature: avoid seasonal extremes and use a climate controlled truck.
- Gas purity: maintain dry N_2 purge in transit and chose a route with minimal altitude variation.



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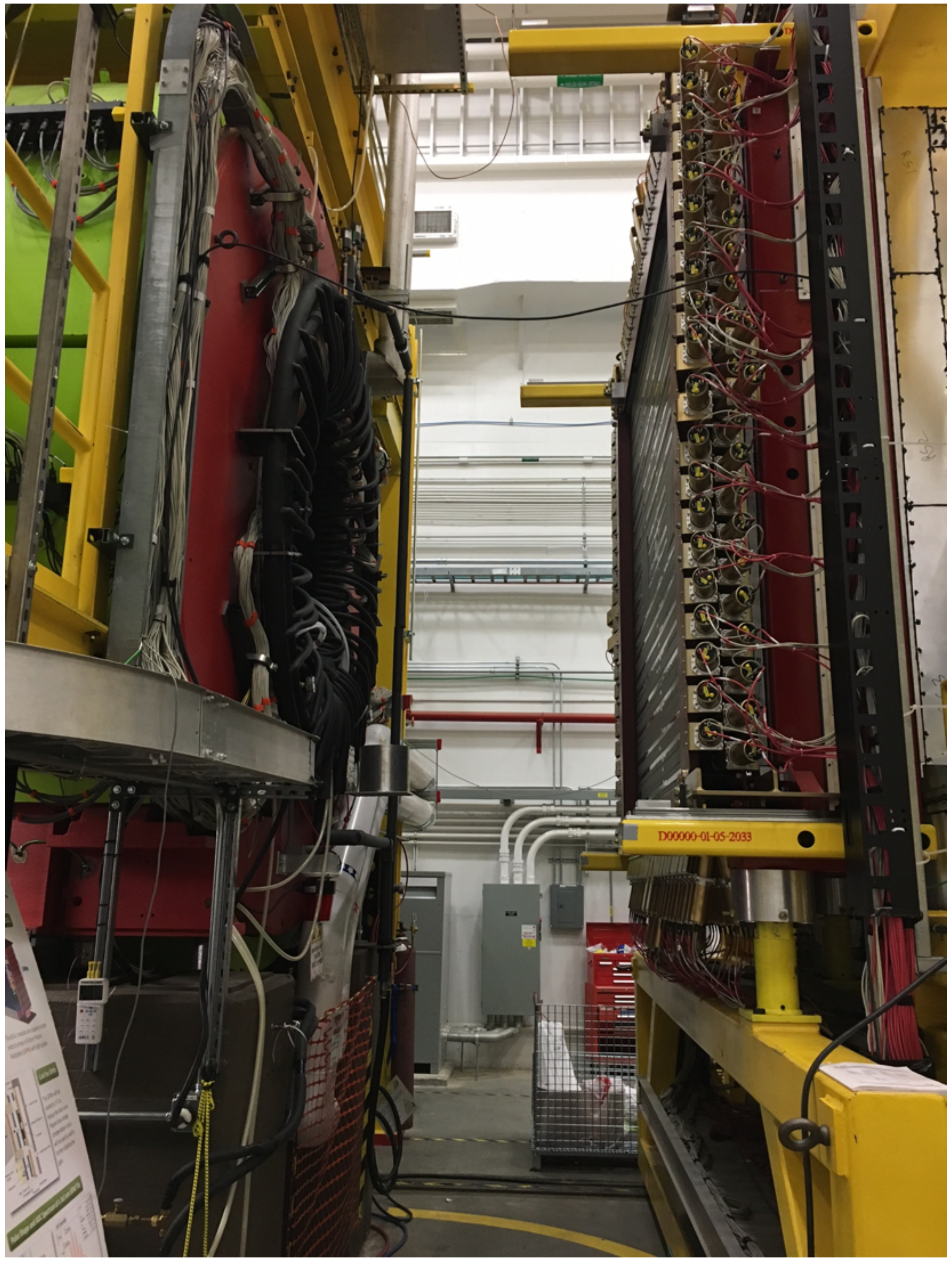
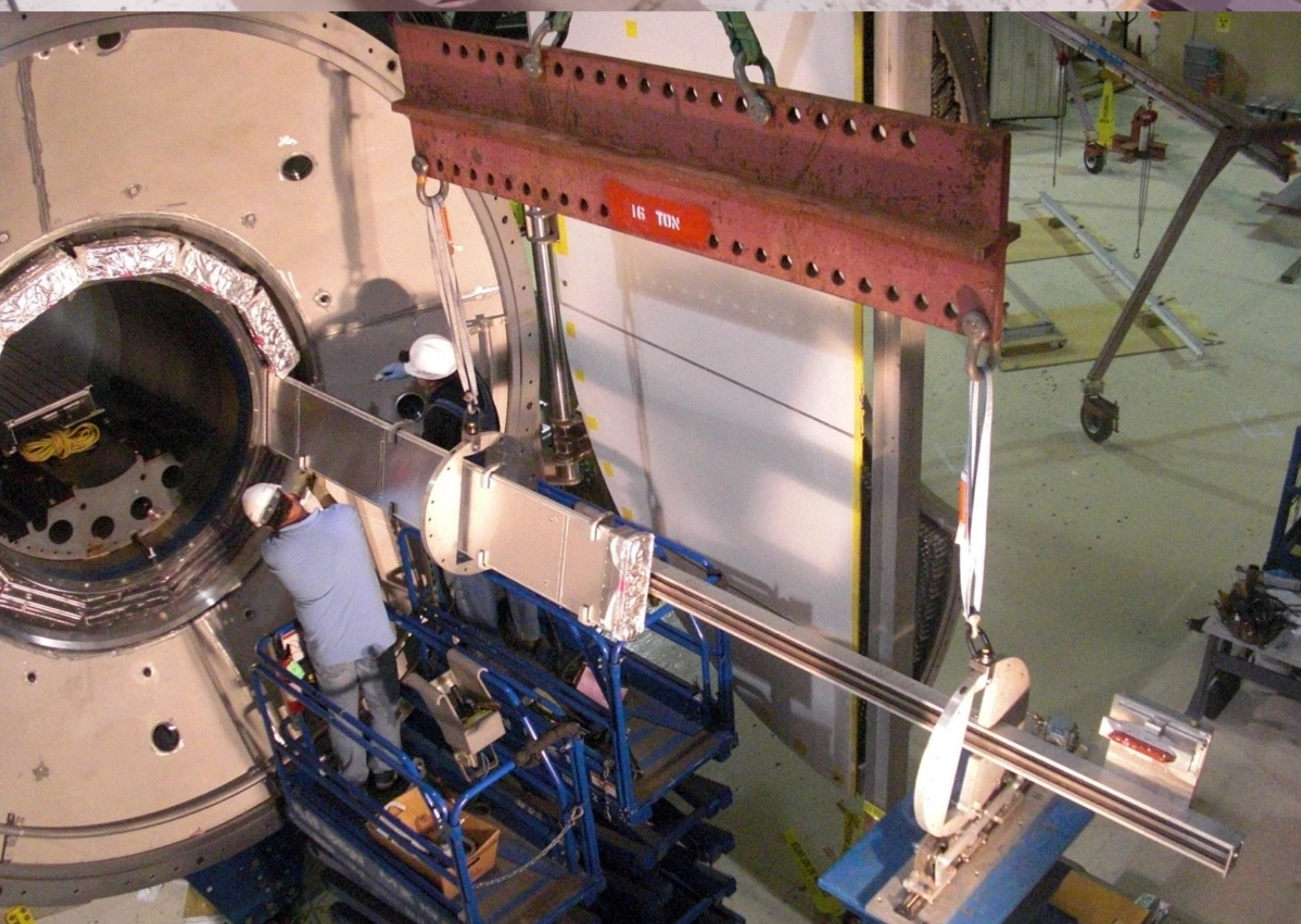
Bar Box Integration

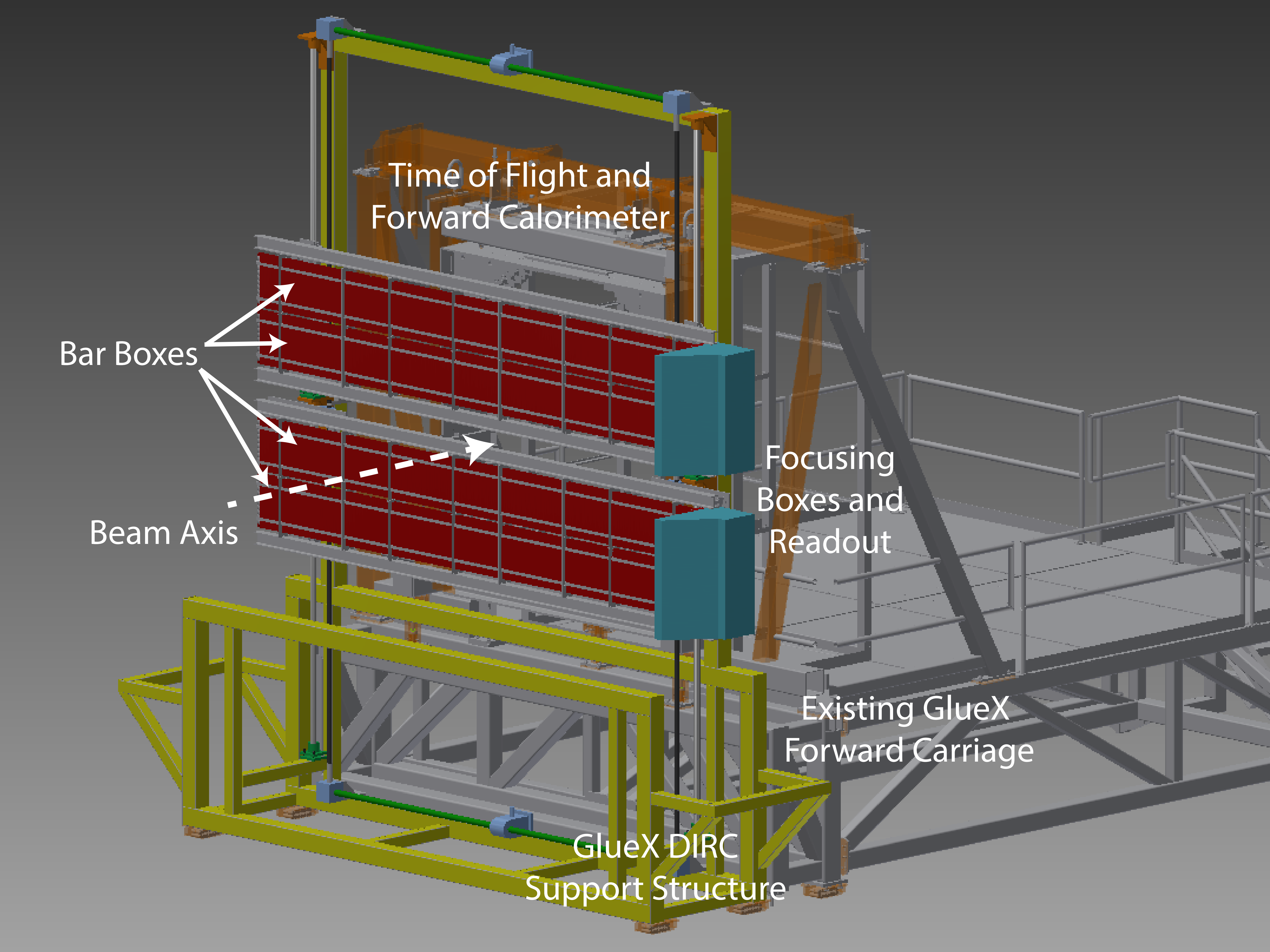
- Replicate many features, fixtures, and design elements successfully used in BaBar DIRC
  - lifting and installation jigs
  - roller tracks for positioning and alignment
  - bar box to focusing box flange and water seal
- Additional GlueX considerations
  - minimize material in front of the forward calorimeter
  - ability to (somewhat) easily remove from the beam line
- Design now at conceptual level



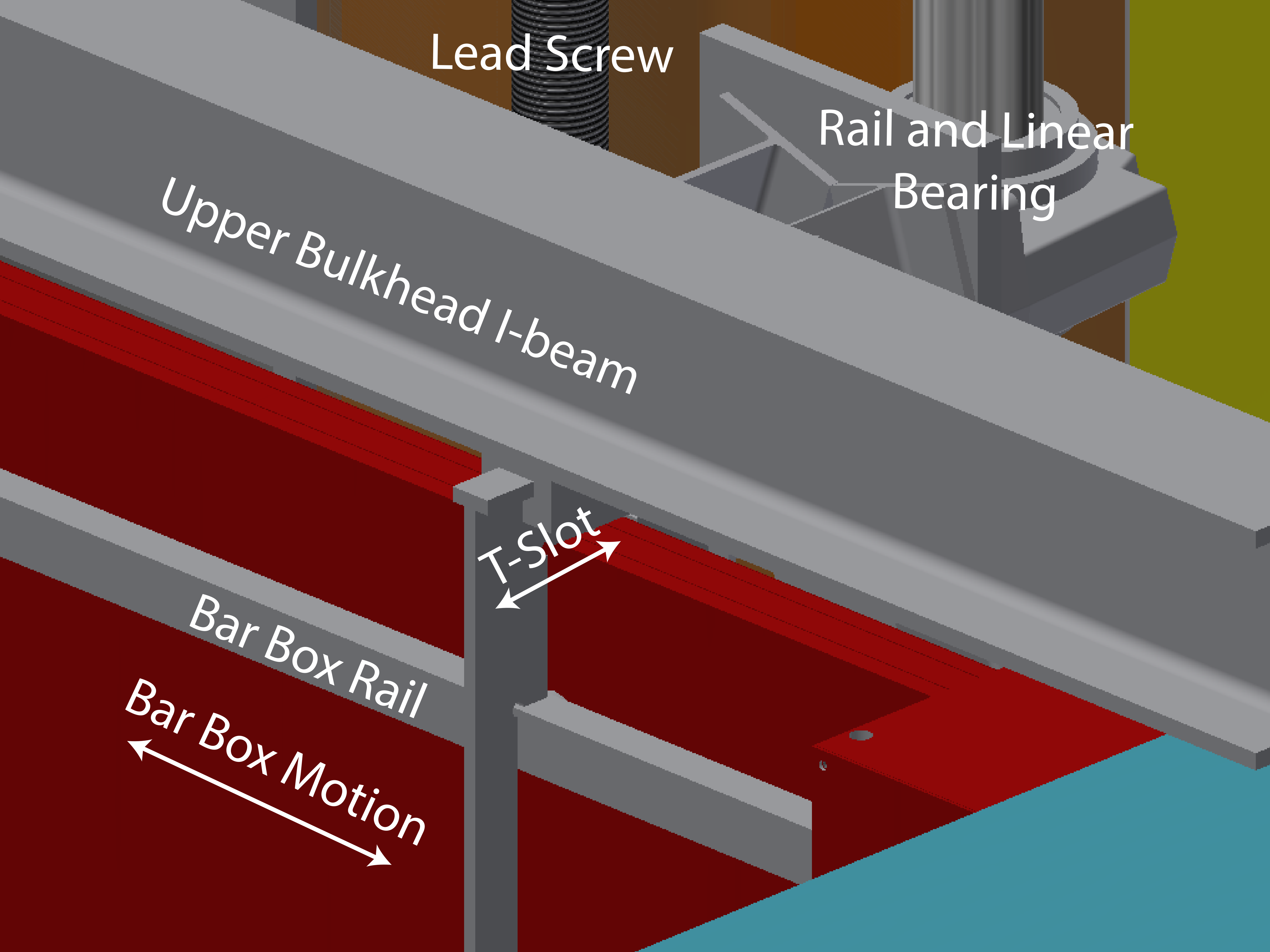

16 TON

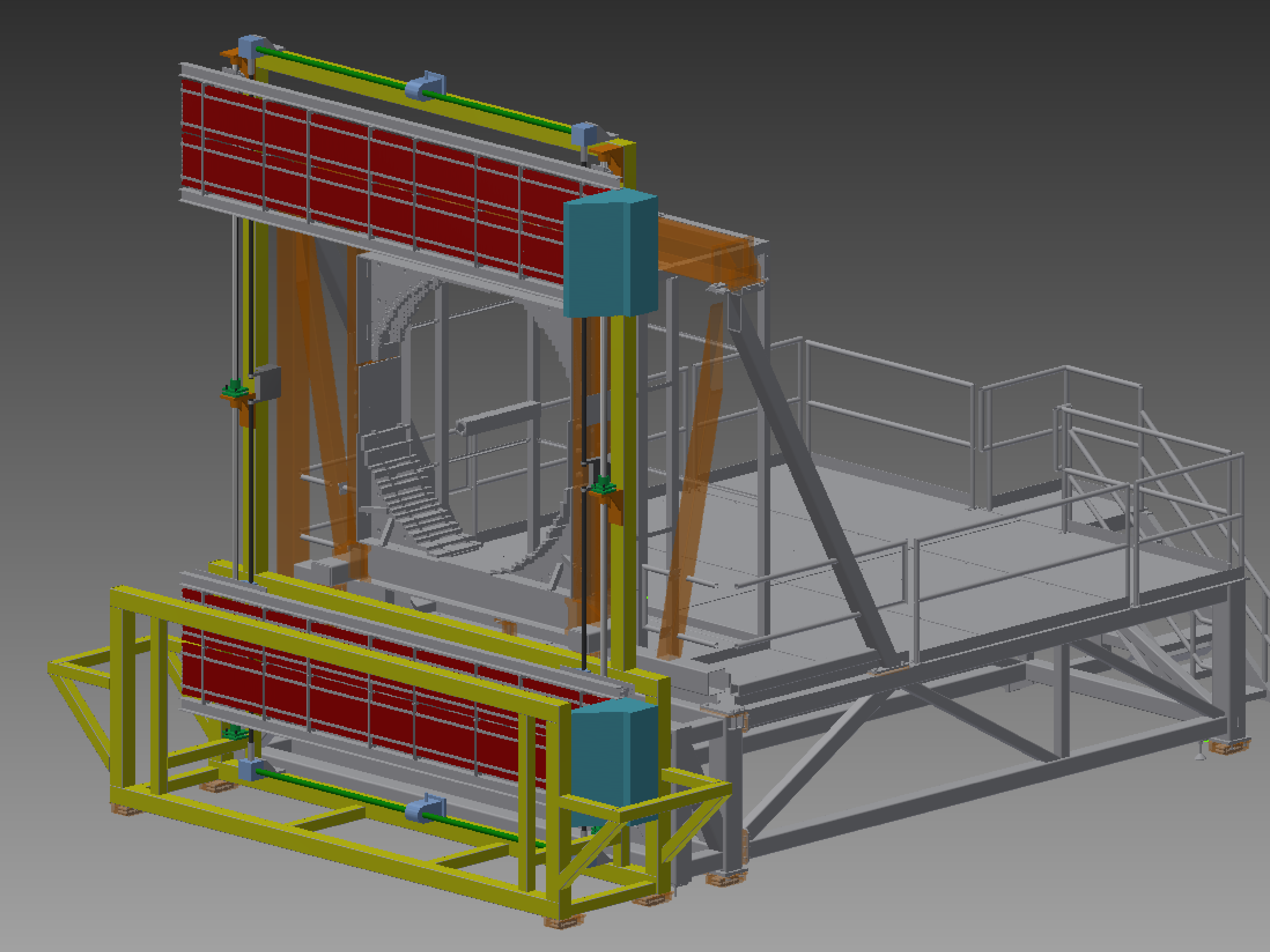

Cam Follower
(load bearing)


Roller
(guiding)



Time of Flight and
Forward Calorimeter
Bar Boxes
Beam Axis
Focusing
Boxes and
Readout
Existing GlueX
Forward Carriage
GlueX DIRC
Support Structure


Lead Screw
Rail and Linear Bearing
Upper Bulkhead I-beam
T-Slot
Bar Box Rail
Bar Box Motion



Summary

- We have developed a strategy for transporting bar boxes from SLAC to Jefferson Lab
    - keep temperature and altitude variation as well as shock as low as possible
    - field-tested crating system achieves what seems to be, based on analysis, reasonable design limits
- A plan for integrating the bar boxes within the spatial and operational constraints of Hall D exists
    - utilizes techniques developed for BaBar
    - retractable for experiments that would be sensitive to the material
    - conceptual at this stage: needs final design