SiD Collaboration

Preliminary End Door Design Concept Support of Forward Systems

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SiD Engineering Team

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– RAL	
• Andy Nichols	Phil Burrows

Introductory Remarks

- SiD Engineering meetings began on July 25, 2007
  - Work presented today comprises a multi organizational effort
  - Work is very preliminary
    - Represents a first look at realistically building an end door
  - Manpower is increasing
    - Organizational responsibilities are solidifying
- Physical dimensions are very fluid
  - Dimensions WILL CHANGE
- Precise design requirements are somewhat vague

End Door Design Philosophy

- Initial Phase Design Goals
  - One piece end door?
    - Moves in Z 2 meters as one unit (normal access/beamline location)
    - Moves in Z 6 meters as one unit (rare but planned ocurrance/garage location)
    - Can be designed to split at midplane for disaster scenarios
  - Maintain magnetic field uniformity requirements in tracking region
  - 5mm maximum axial mechanical deflection due to magnetic pressure
  - Begin fringe field investigations
    - Determine requirements
    - Determine what it takes for a 5 gauss solution
      - Make a decision
  - Maintain ability to replace muon chambers (RPC baseline)
    - Off beamline
  - Determine appropriate design codes and standards

End Door Design Comments

- Dimensional constraints
  - Outer radial dimensions driven by barrel flux return design and fringe field considerations
  - Inner radial dimensions driven by forward support tube assembly
  - Z Thickness driven by:
    - Magnetic fringe field requirements
    - Muon detection requirements
- Present concept
  - Eleven 200mm thick steel plates with ten 40mm nominal gaps for detector planes
- Machined steel surfaces will be used
  - On mating surfaces transverse to the direction of the magnetic flux
  - To minimize the effects of dimensional tolerance stack-up

End Door Design Philosophy

- Second Phase Design Goals
  - Provide mechanical support for HCal and ECal
  - Maximize RPC coverage
  - Mechanical connection to barrel
    - Presently considering hydraulically driven taper pins
  - PacMan Shielding
    - Determine Interfaces
    - Determine design requirements
      - Technical
      - Access issues
      - Push-pull
  - Push-pull considerations
  - Transportation to site
    - Weights and physical sizes
  - Cost

End Door Interface Considerations

- Inner Support Tube
  - Provides structural support for
    - LumiCal
    - LHCal
    - BeamCal
    - QD0
  - Fixed Z location
    - End door exhibits 2 meters relative Z motion when opened on beamline
  - Alignment issues before, during, and after end door extraction
- Ecal and Hcal
  - Structural supports
  - Alignment issues. End door deflection due to magnetic pressure – how is this interface affected?
- Provide clearance of services for all of above
  - QD0 service cryostat
- Barrel flux return
  - Connection of end door to barrel
  - Routing of barrel detector services
- PacMan shielding

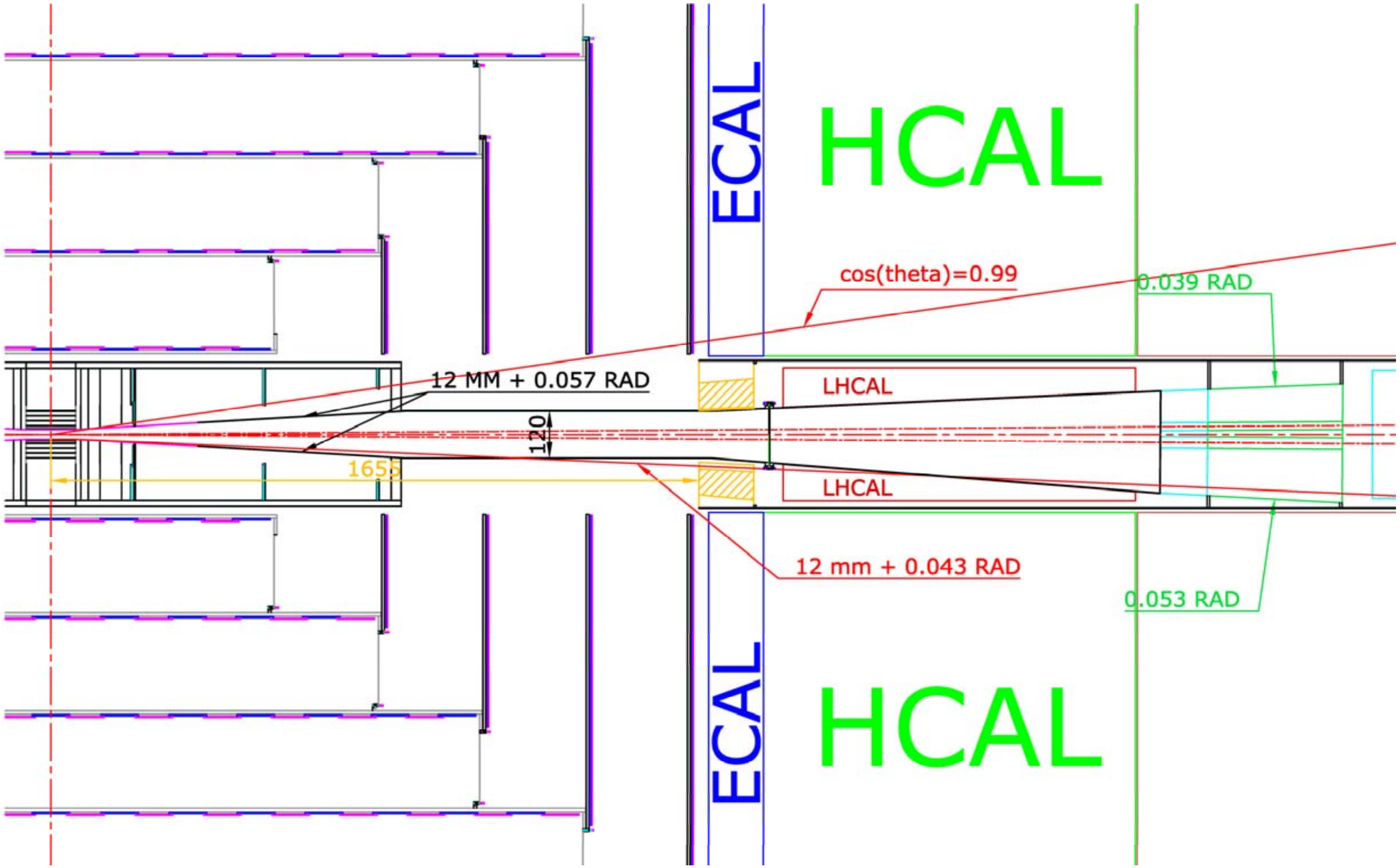
SiD Calorimeter Masses

Calorimeter	Mass
LumiCal	≈325 kg
LHCal	≈270 kg
BeamCal	≈130 kg

From Bill Morse's talk

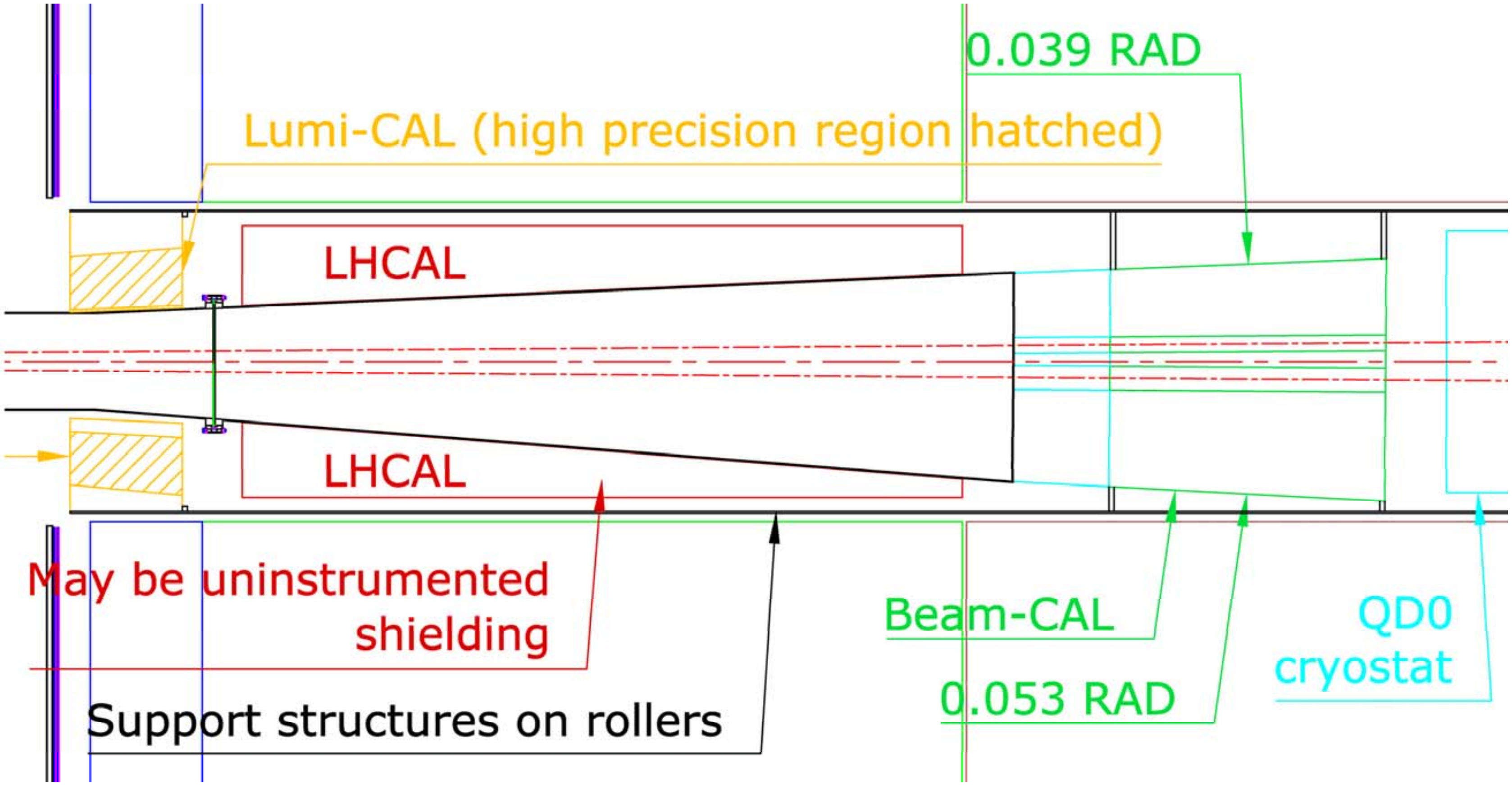
Beam Pipe

- The beam pipe shape in the forward region is shown below.



Support of Forward Calorimeters

- Deflection calculations have been made for two types of support:
  - Bars at 3, 6, 9, and 12 o'clock
  - Cylinders of stepped wall thickness



Deflections when Open 3m

- Support points with rollers were assumed at front and rear of HCAL
  (Z = 4820, 5770 mm).
- Forward calorimeters supported at their ends as dead weights
- QD0 weight ignored

4 - 20 mm x 20 mm bars

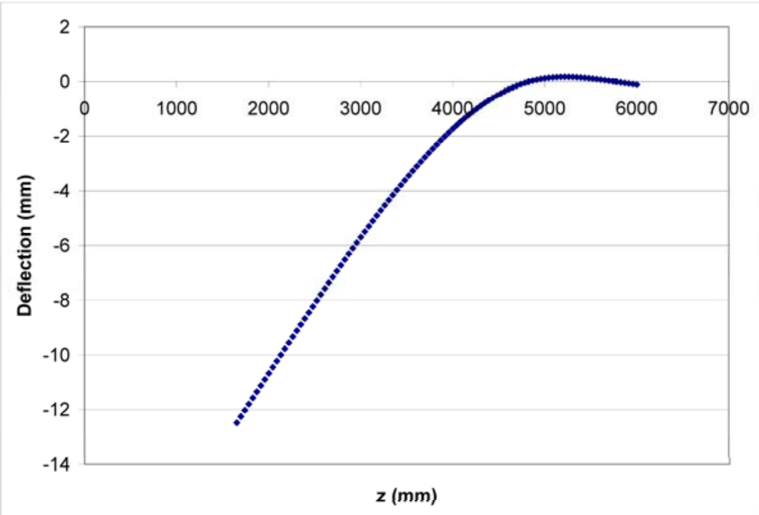
Deflection at front of Lumi-CAL = 12.5 mm

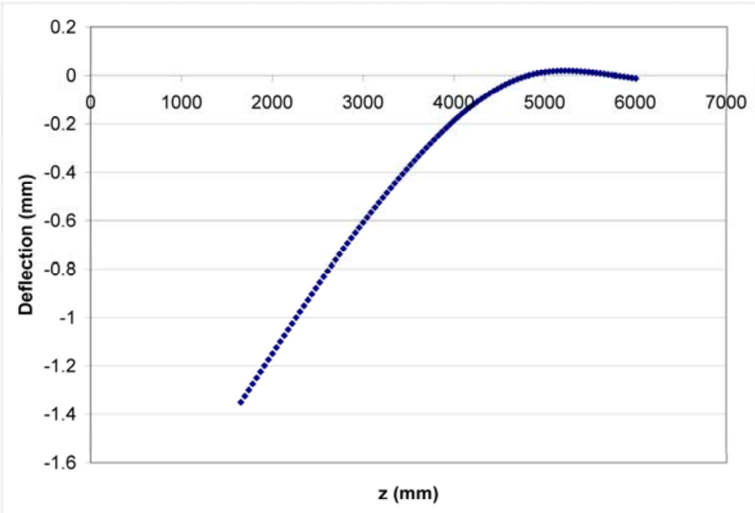
Stress in bars = 16.6 ksi

Stepped cylinders (3, 10, 20 mm walls)

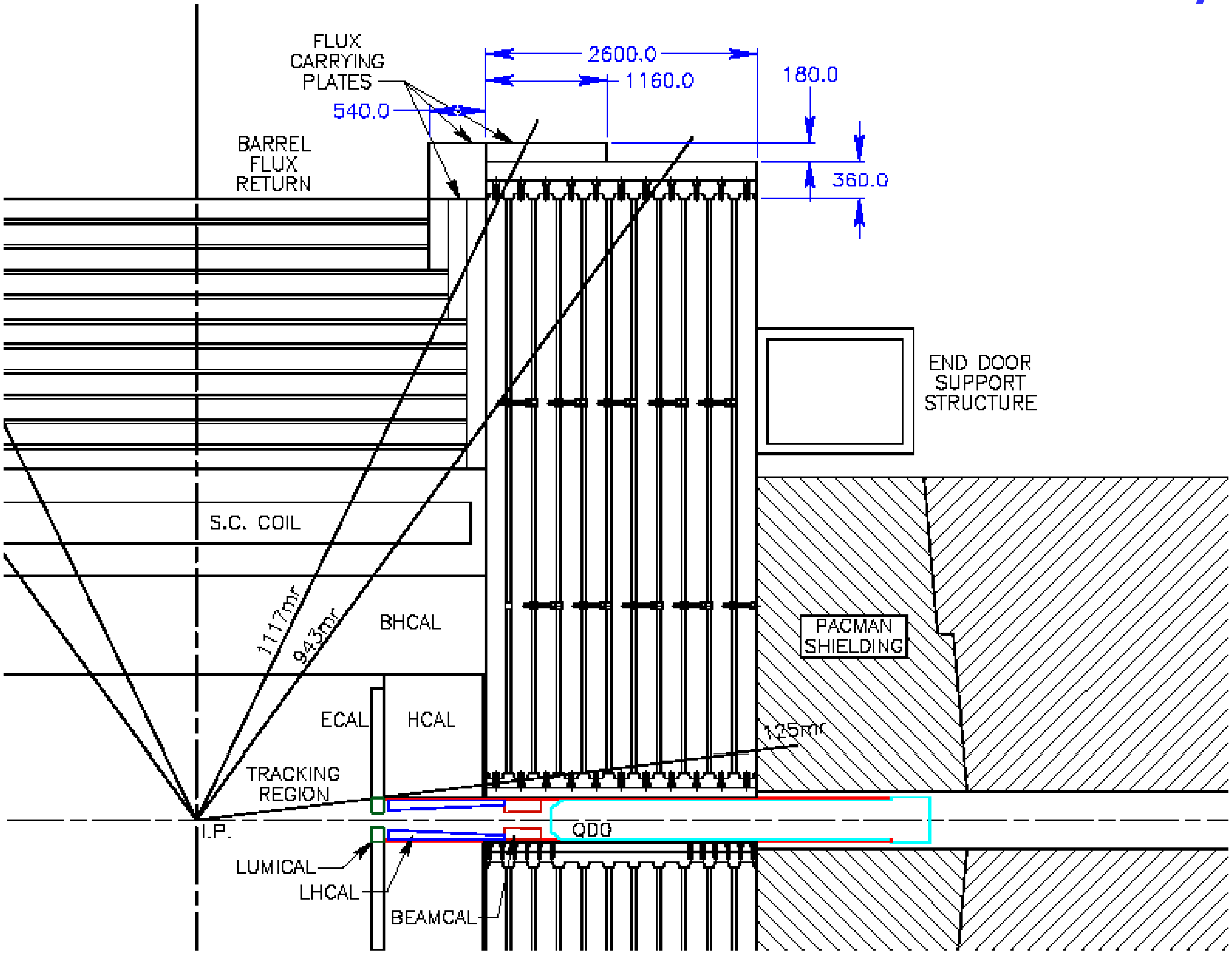
Deflection at front of Lumi-CAL = 1.4 mm

Stress in cylinders = 1.8 ksi

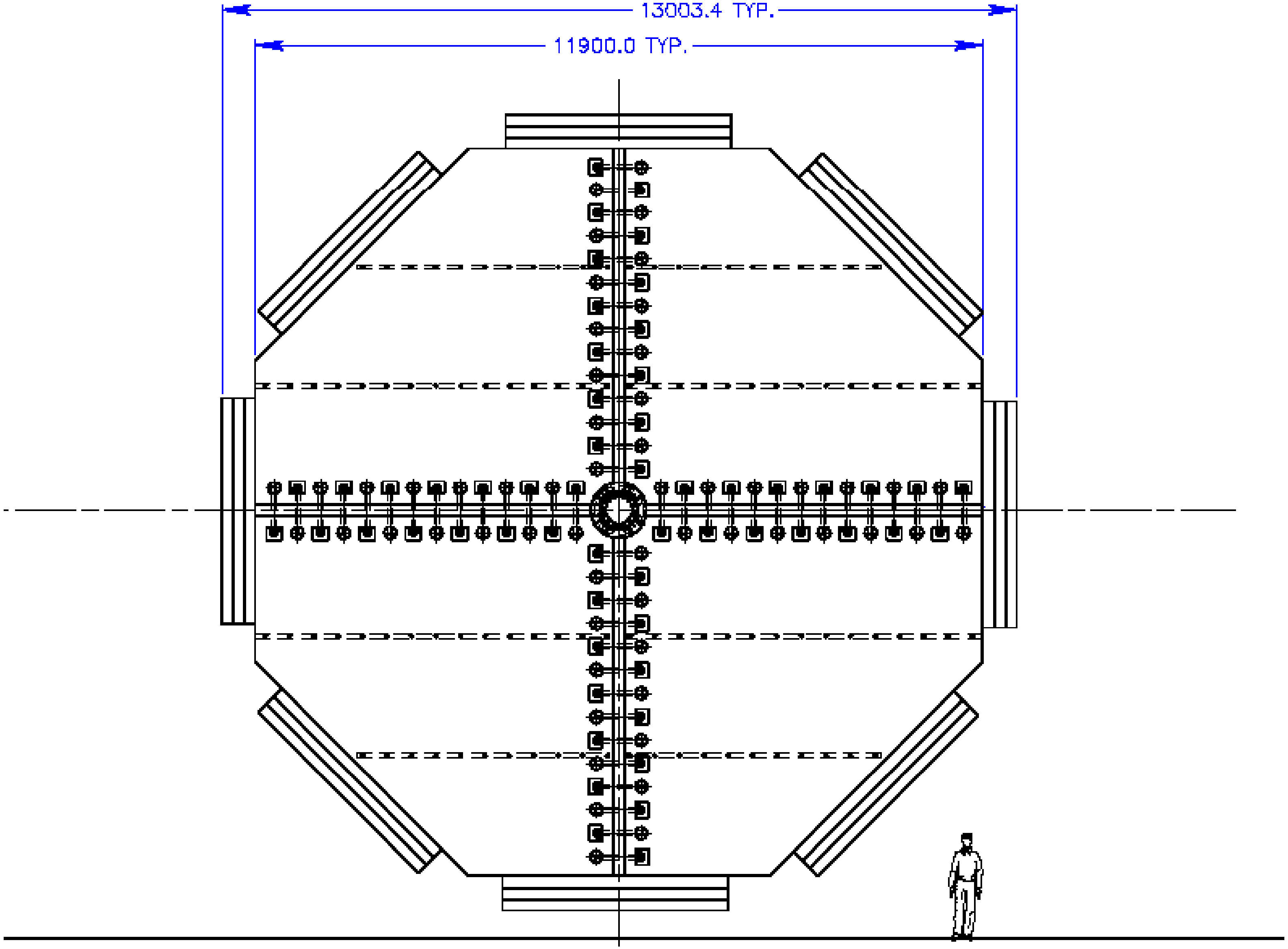




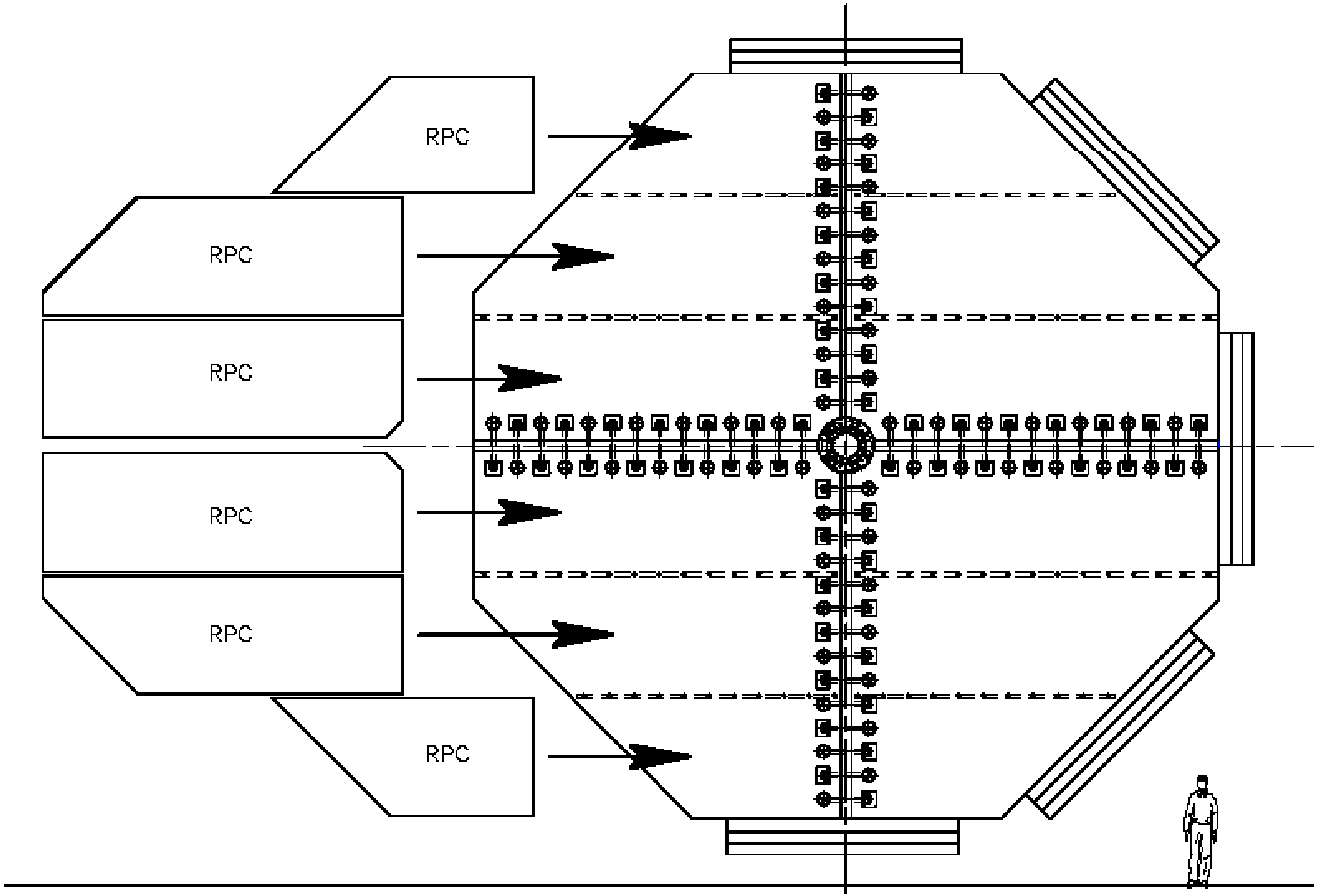
Elevation View of Detector Geometry



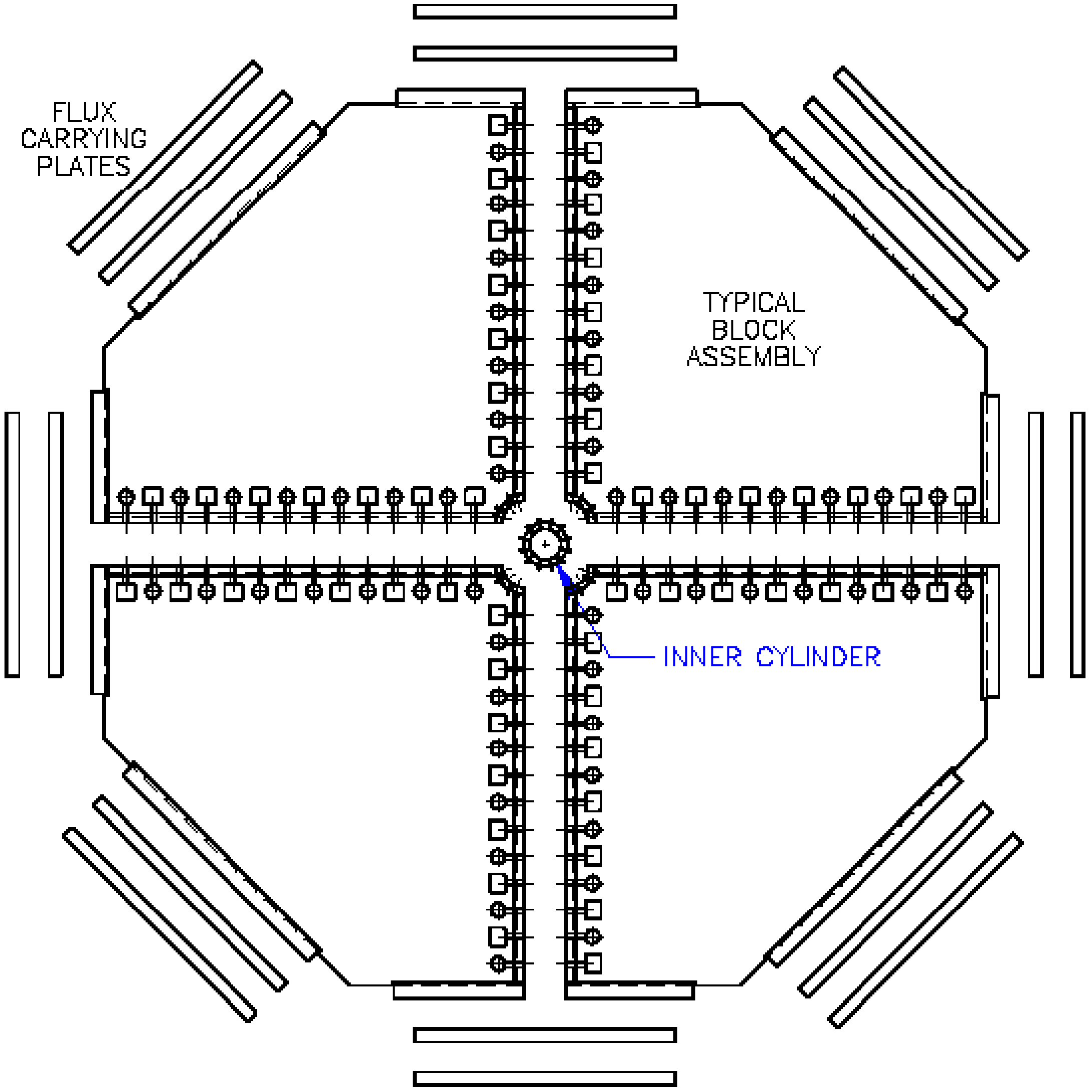
End Door Assembly



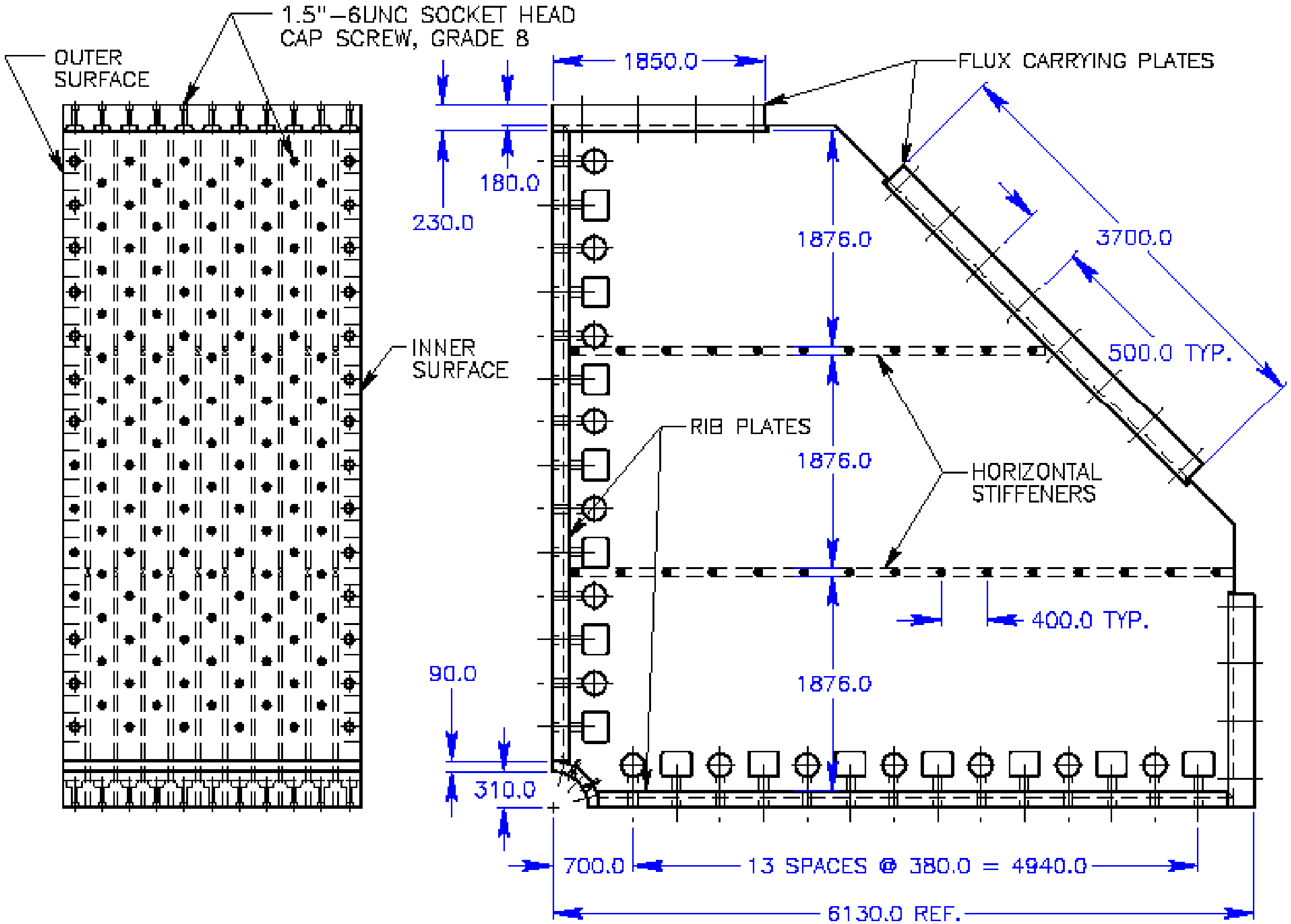
Muon Chamber Replacement (RPC Baseline)



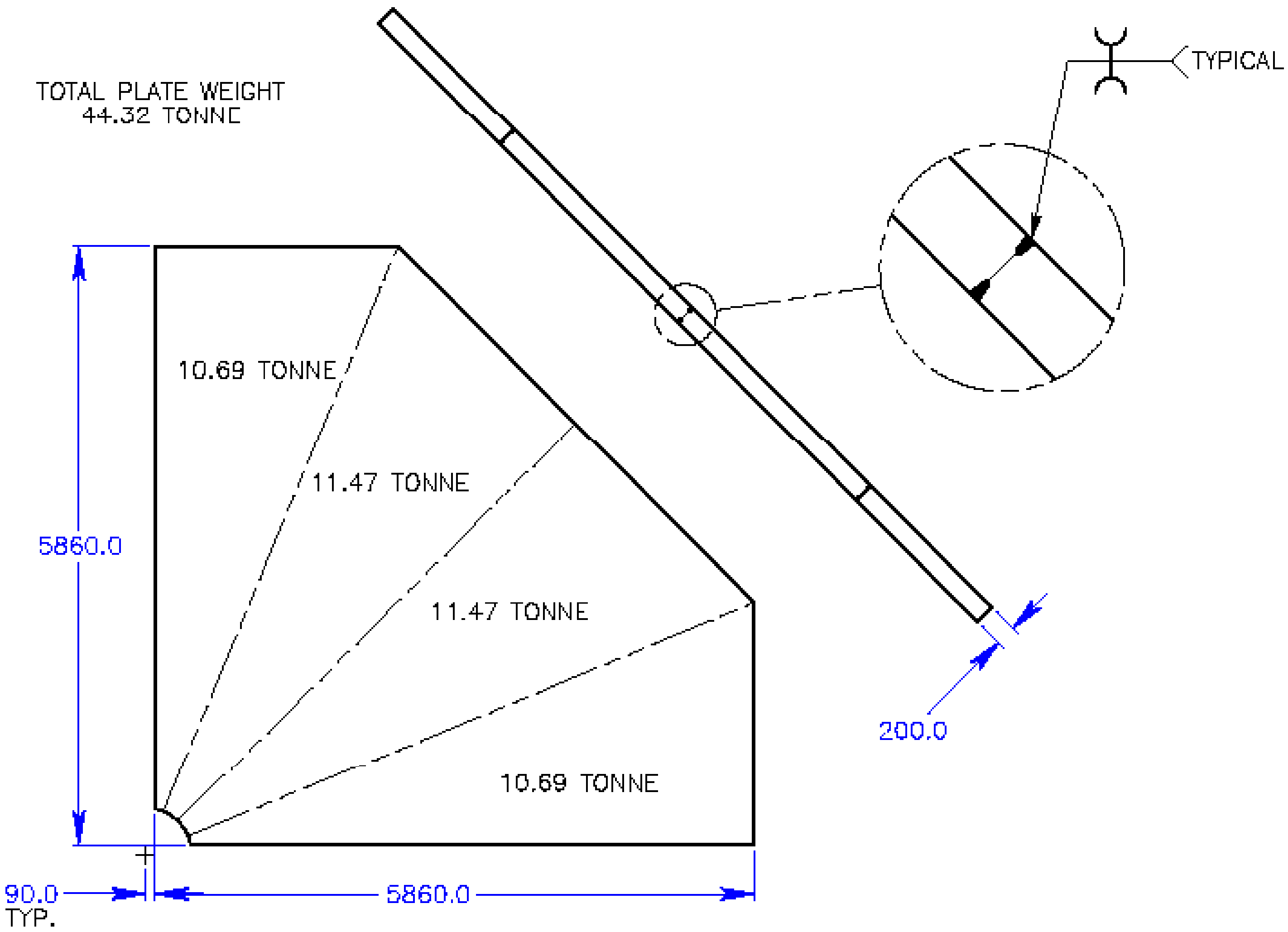
Exploded Assembly



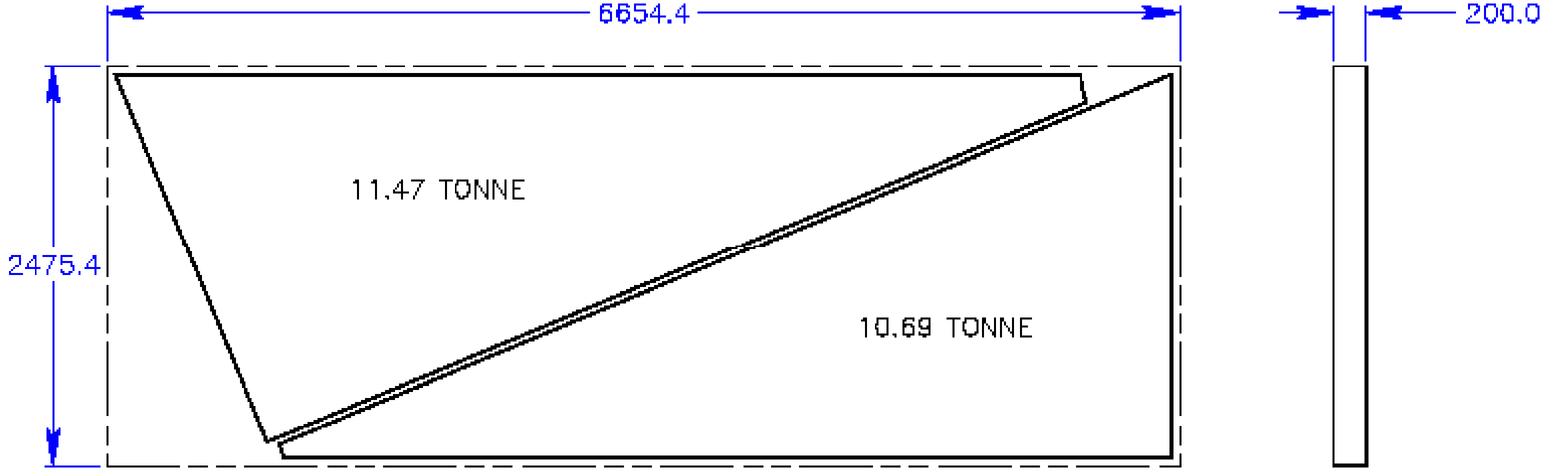
Typical Block Assembly (537 Tonne)



Typical Block Plate

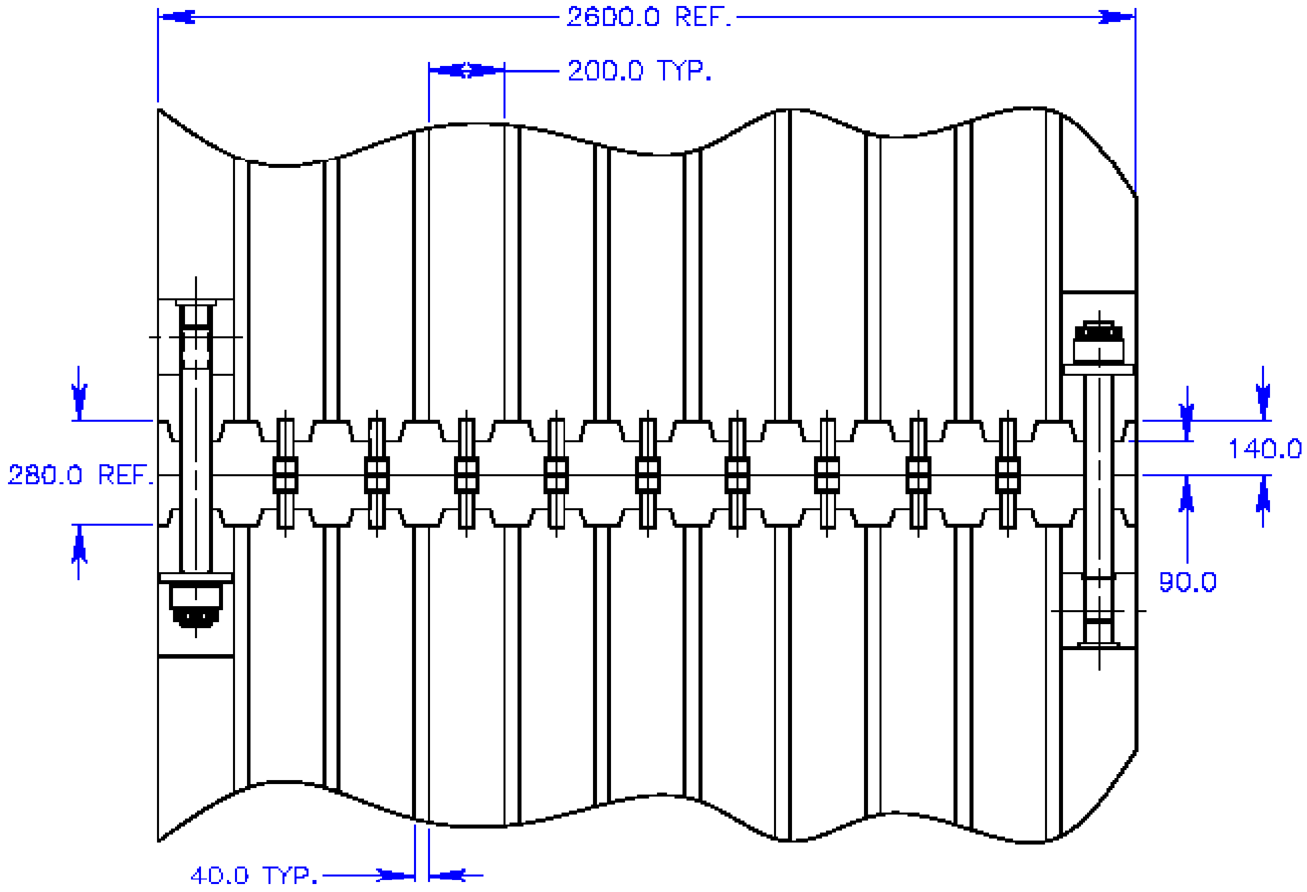


Continuous Cast Steel Slab

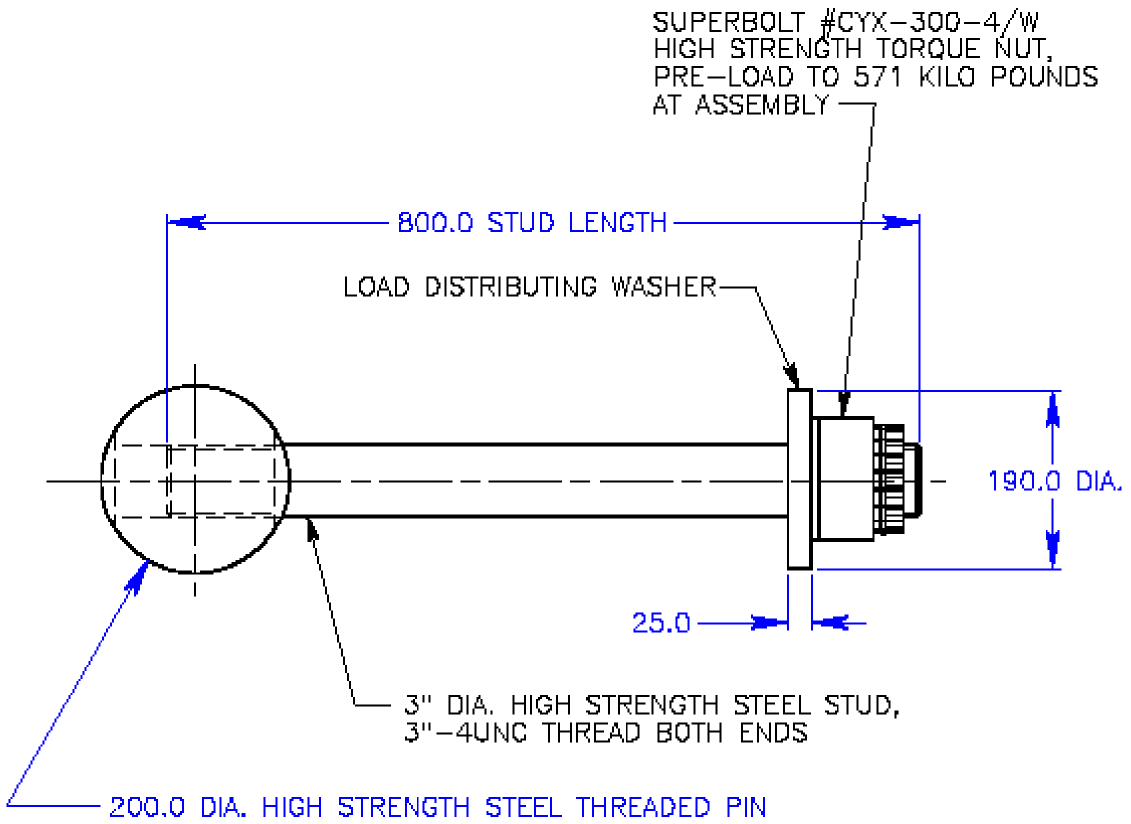


25.91 TONNE
CONTINUOUS CAST STEEL SLAB

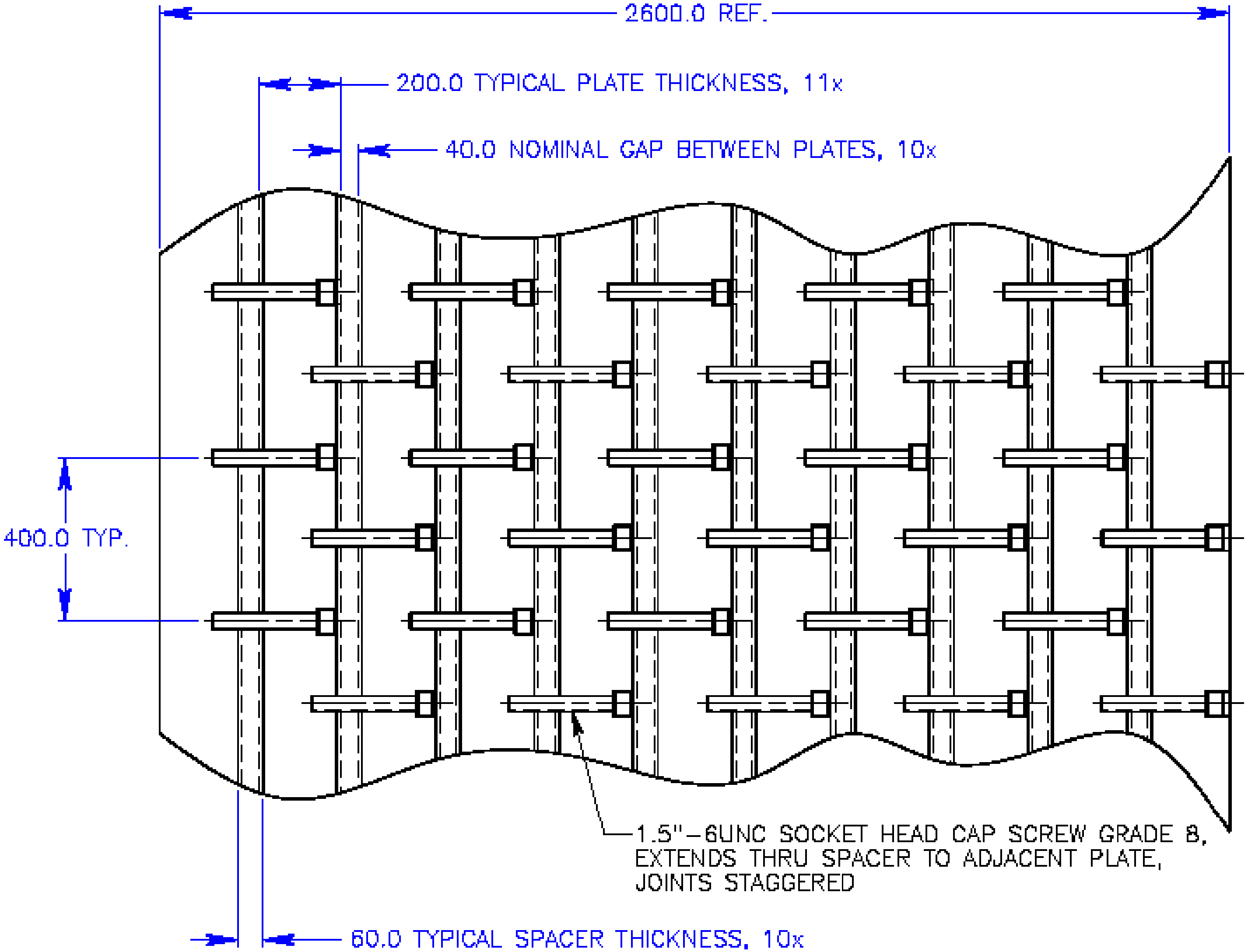
Block-to-Block Connection



Block-to-Block Fastener Assembly



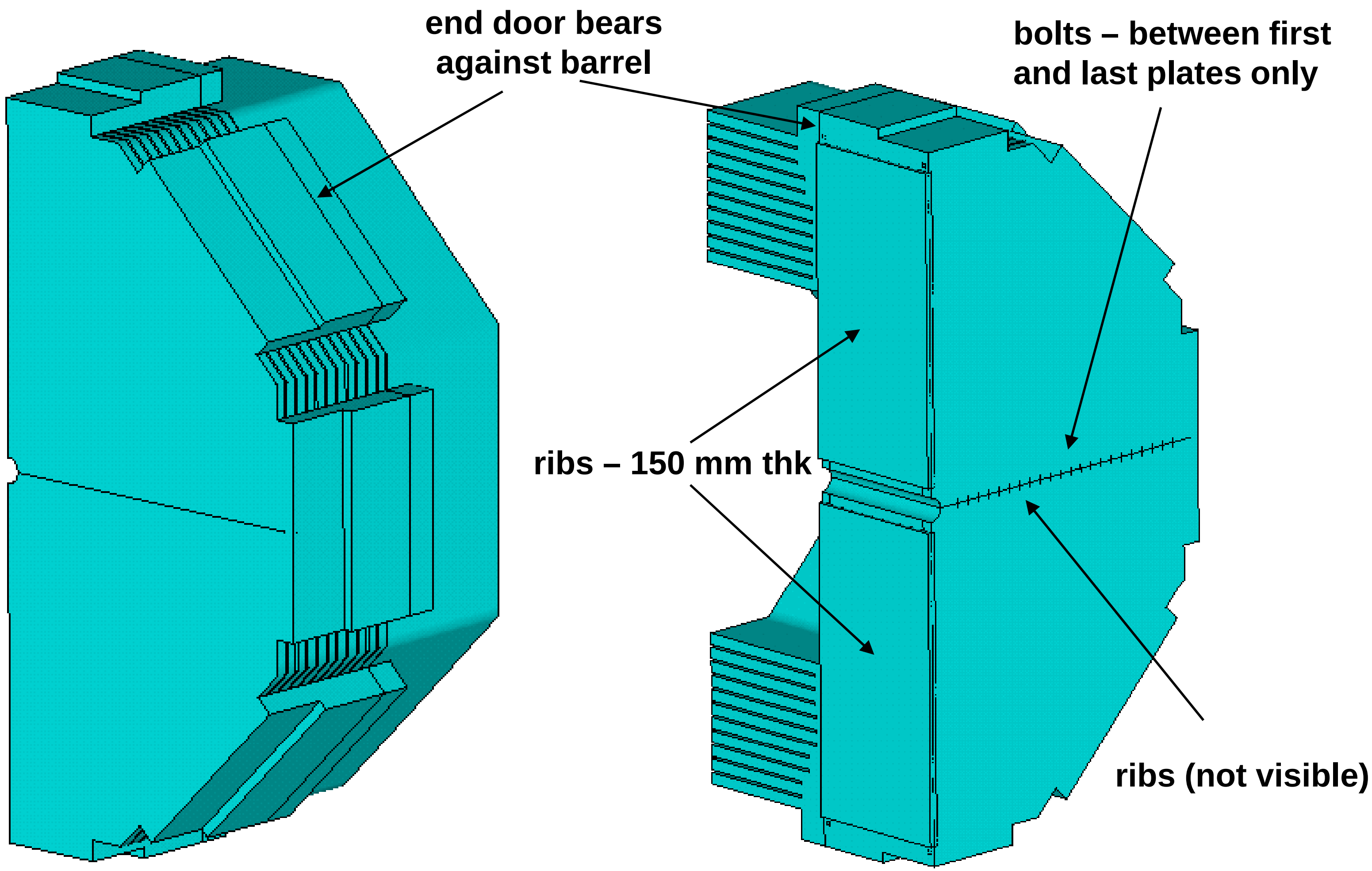
End Door Plan View Cross Section thru Horizontal Spacers



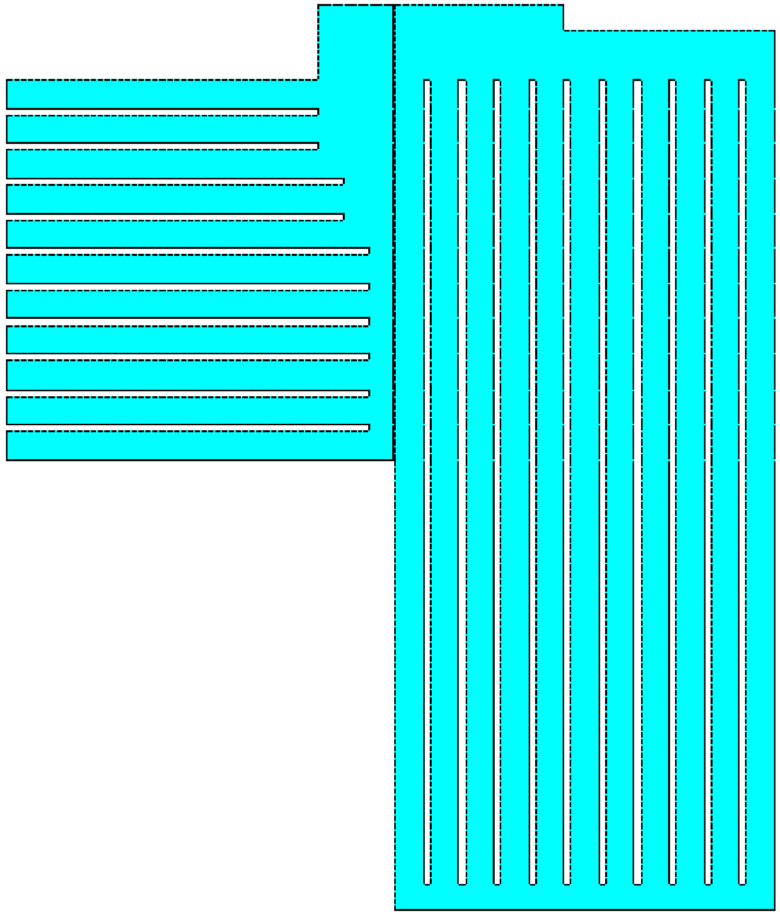
PacMan Shielding

- A major component of the SiD "Self-Shielding" concept
- Extends in Z from outer surface of the end door to the wall (tunnel opening) of the experimental hall
  - Approximately 8.6 meters
- Extends radially 3 meters
  - 1 meter of steel (328 tonne minimum per side)
  - 2 meters of concrete (592 tonne minimum per side)
  - Minimize clearance to inner support tube assembly
- Configuration is probably detector specific
  - Movable components must allow 2 meter end door extraction
  - Movable components must allow disconnection and clearance of beam pipe during push-pull
    - PacMan must be supported from and travel with detector during push-pull

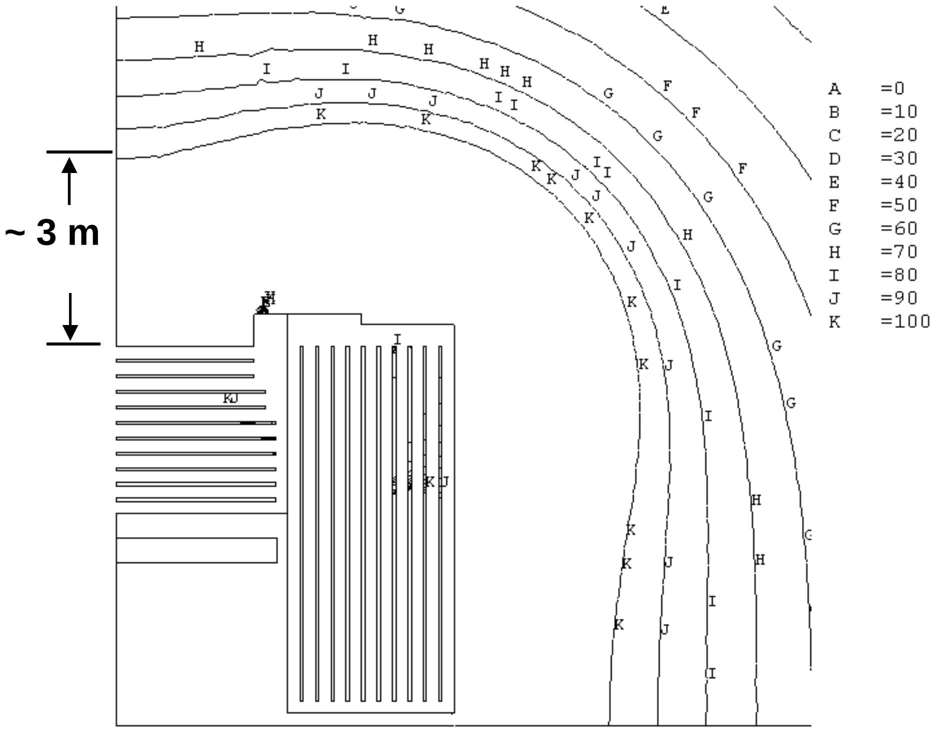
3D Structural FE Model (20 cm Plates)



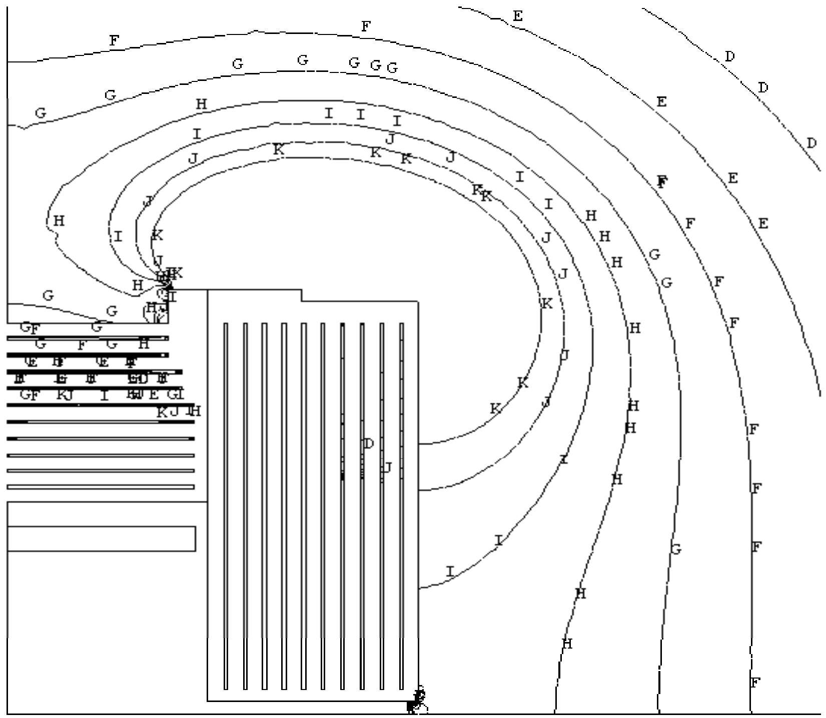
2D Axisymmetric Magnetic FE Model



Fringe Fields - Practical Design

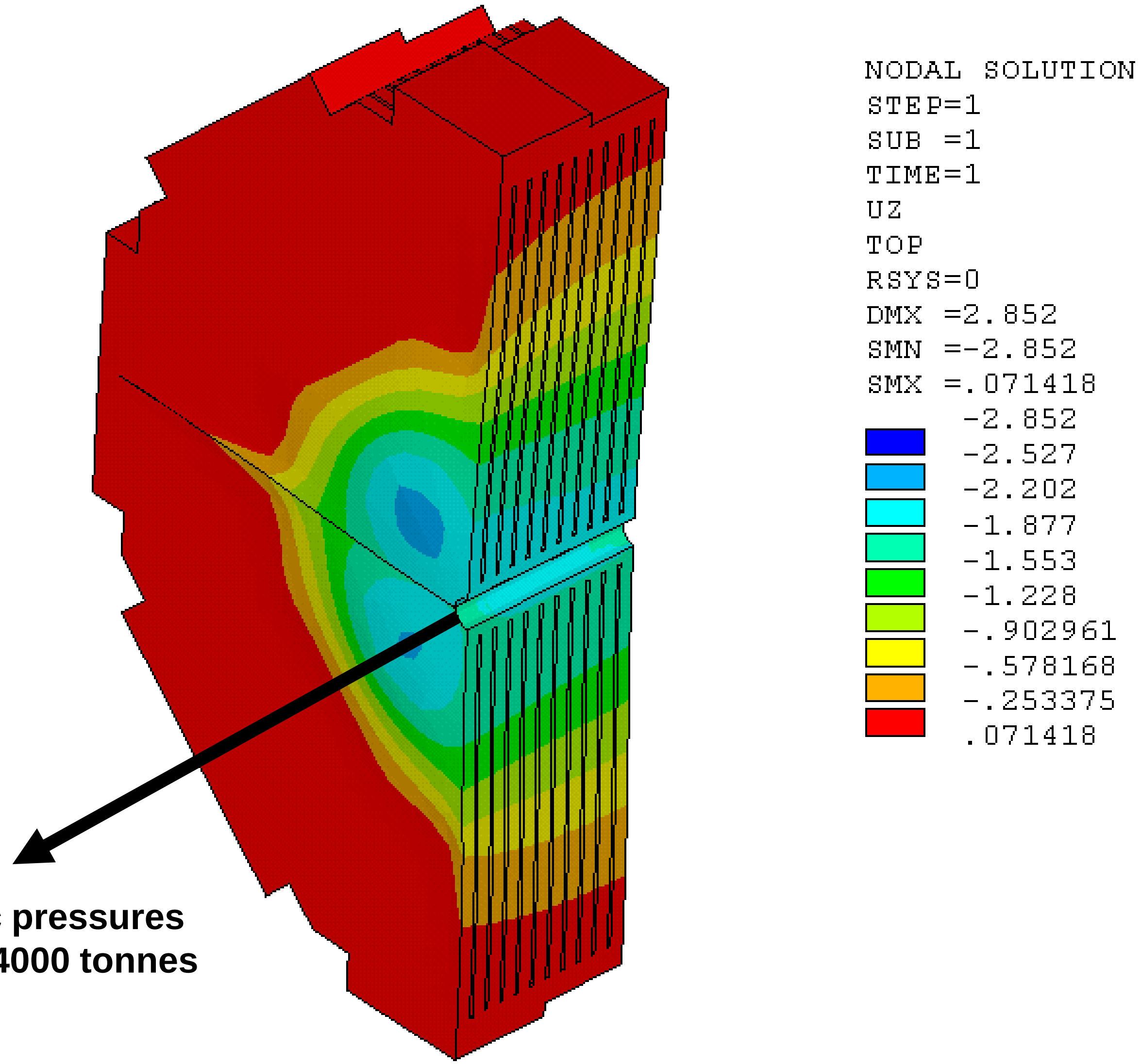


20 cm plates



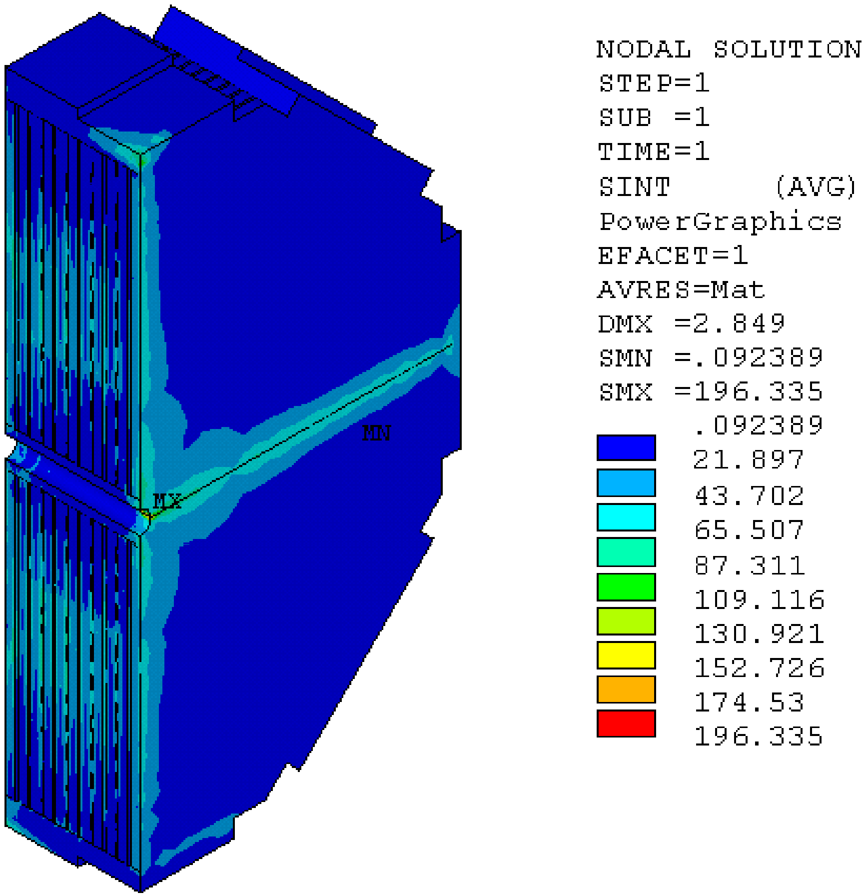
22 cm plates

Axial Deflection of End Door (mm)

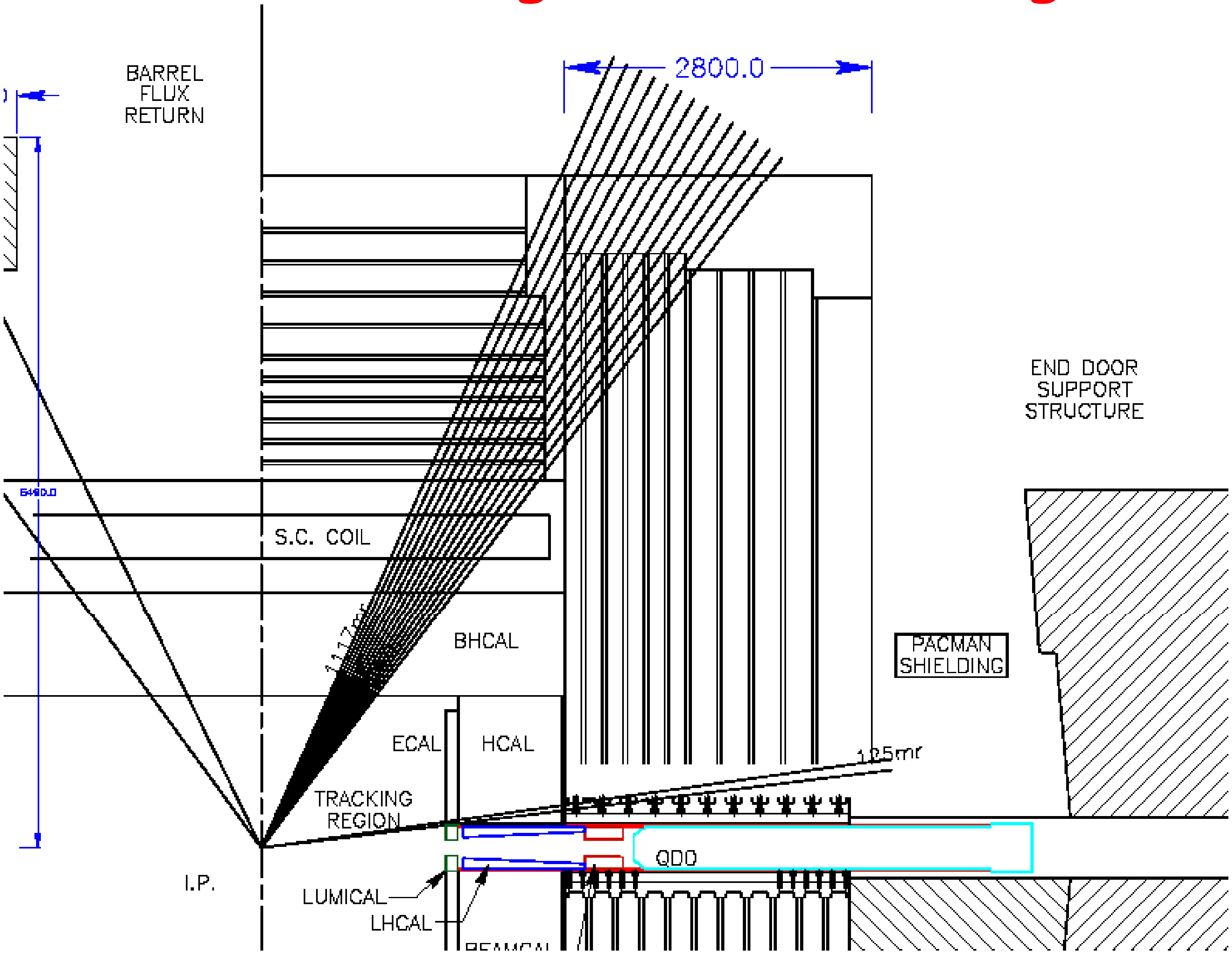


magnetic pressures totaling 14000 tonnes

End Door Stresses (MPa)



Next Phase Configuration Investigation



Conclusions

- A strong engineering team has been formed – and functioning
- We are evaluating and compiling design requirements
  - Technical performance requirements
  - Issues pertaining to fabrication, assembly, installation, and push-pull
  - Safety issues
- Need information from systems
  - i.e., Muon System
    - Thickness of steel absorber needed
    - Minimum preferred number of planes for any track
- We are evaluating and compiling information pertaining to the large steel fabricators
  - Four fabricators found thus far that can supply raw plates (continuous cast) of 27 tonne
- End door block design needs revising
  - 537 tonne is too heavy
    - Prefer assembly with 500 tonne capacity crane
- If very low fringe fields (~5 g) are required, then thicker iron plates may be called for, increasing weight and material cost
- Azimuthal detector gaps at 3,6,9 & 12 positions should be optimized
- Will determine floor space and crane requirements and forward to facilities team