STRAIGHT 30 SECTION IN-TUNNEL SHIELDING FINAL DESIGN

February 28, 2014

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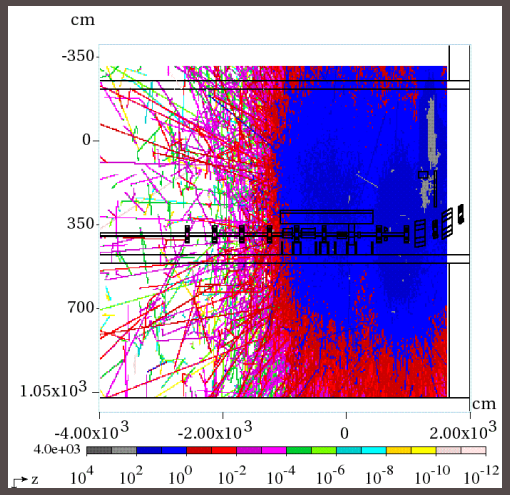
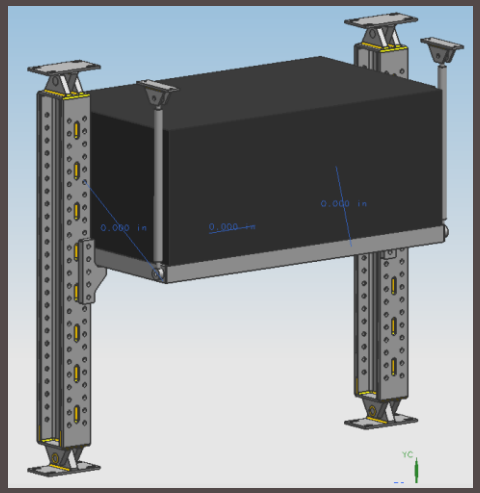
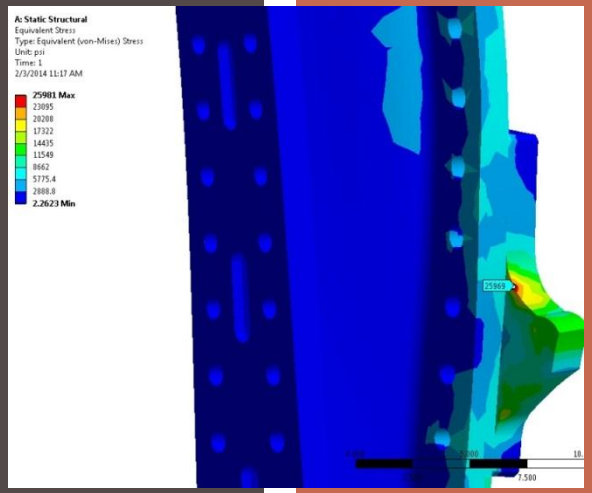


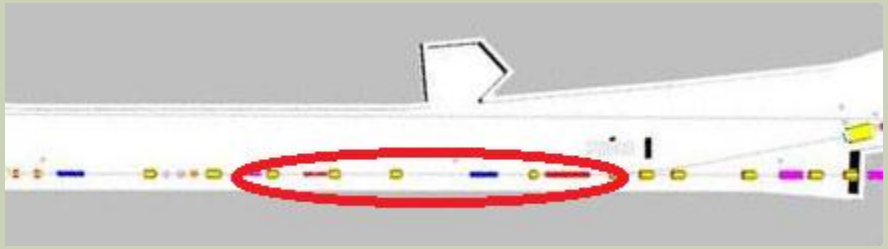




EXTRACTION LINE SHIELDING

- It was identified by the experiment that significant dose rate reduction would be needed during and after beam-on operation.

- Iterative MARS runs by Tony Leveling arrived at an appropriate amount of shielding for the straight 30 section for the problematic areas.



- These dose rate studies showed that approximately 3 feet of vertical steel shielding, with horizontal shielding consisting of 18 inches of concrete + 4” of marble gives sufficient protection for Mu2e operation. This shielding address 2 main issues:

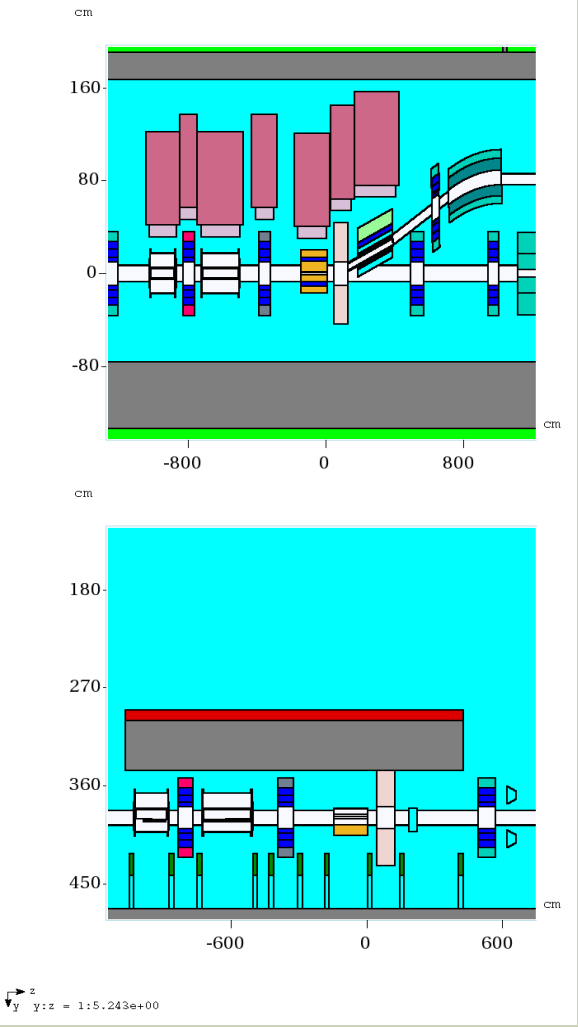
  - Sky shine to Wilson Hall and surrounding areas
  - Residual dose rate in tunnel for workers

EXTRACTION LINE SHIELDING

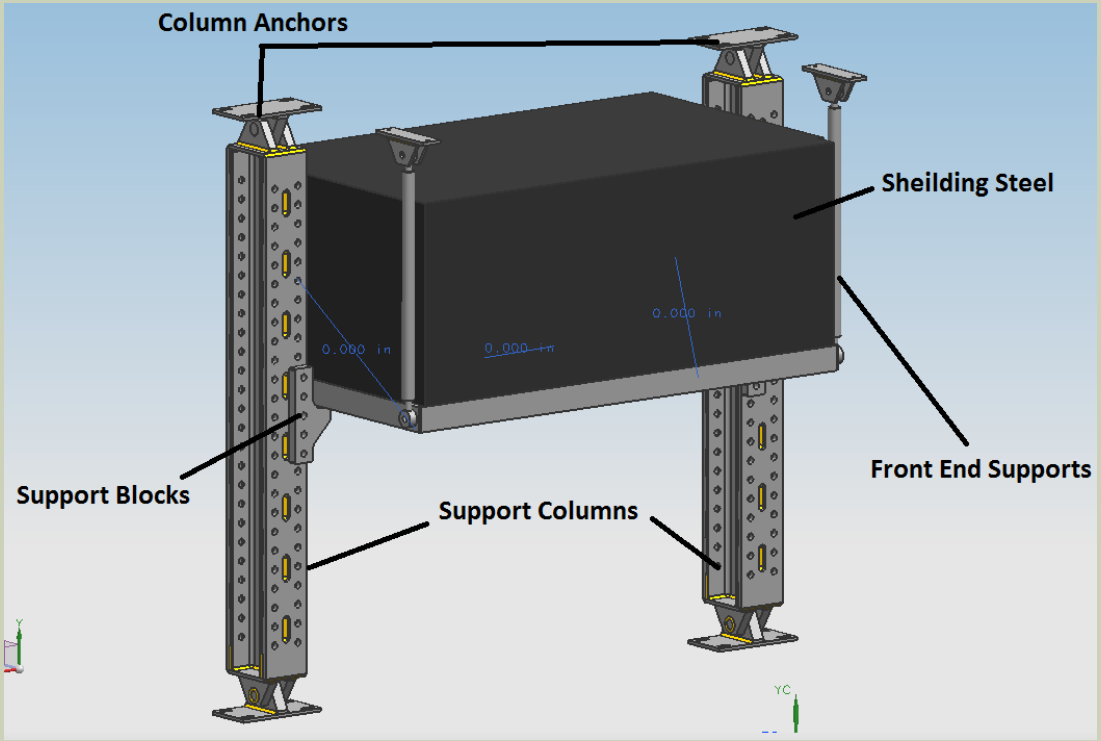
- Items to be shielded were identified as:
  1. C – Magnet
  2. D2Q5 Quad
  3. ELAM
  4. D2Q4 Quad
  5. D2Q3 Quad
  6. Extraction Septum (X 2)

- A need for an adaptable structure that can accommodate different magnet configurations was desired from a design and cost standpoint due to different heights and lengths associated with each device.

- Needed to allow for relatively quick magnet change outs due to dose rate concerns & ease of beam pipe welding or assembly



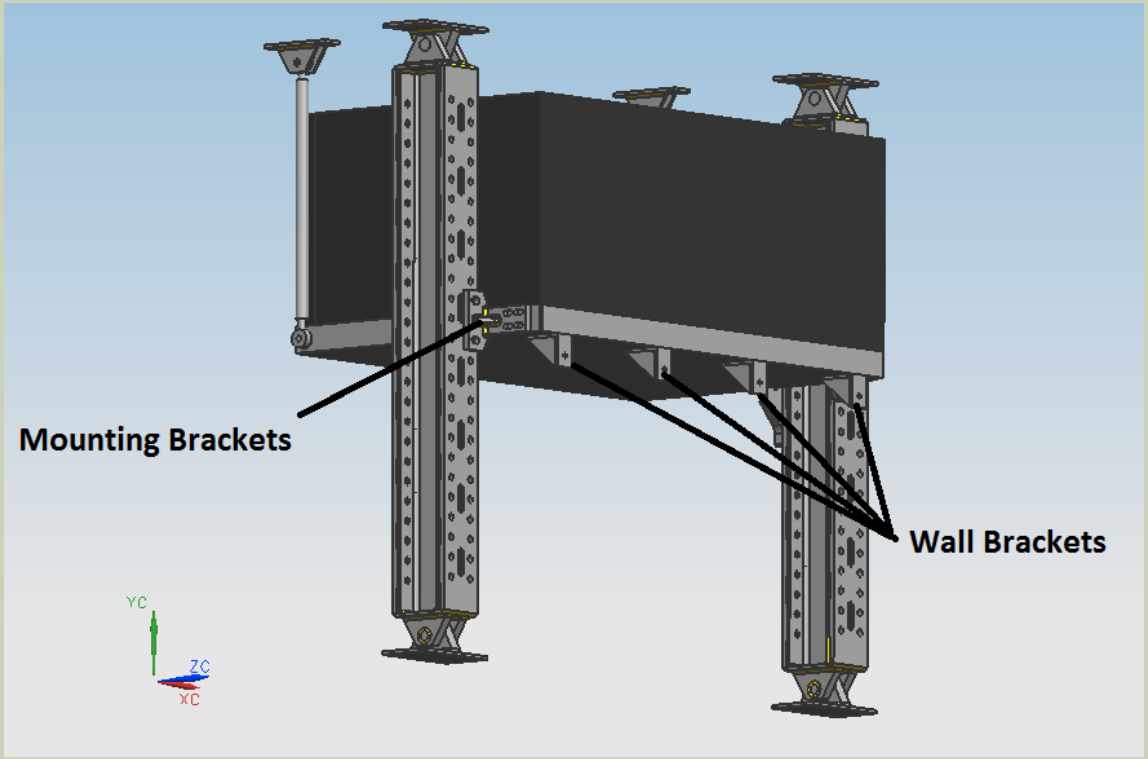
FINAL SUPPORT COLUMN / SHELF DESIGN



- Columns are modular and can be used in all shielding areas where space allows
- Support shelves consist of 4” thick steel with a max span of 96” (8ft).
- Shielding depth is 48”.
- Max steel height is 36” for full depth, or 45,000 lbs, whichever is greater.

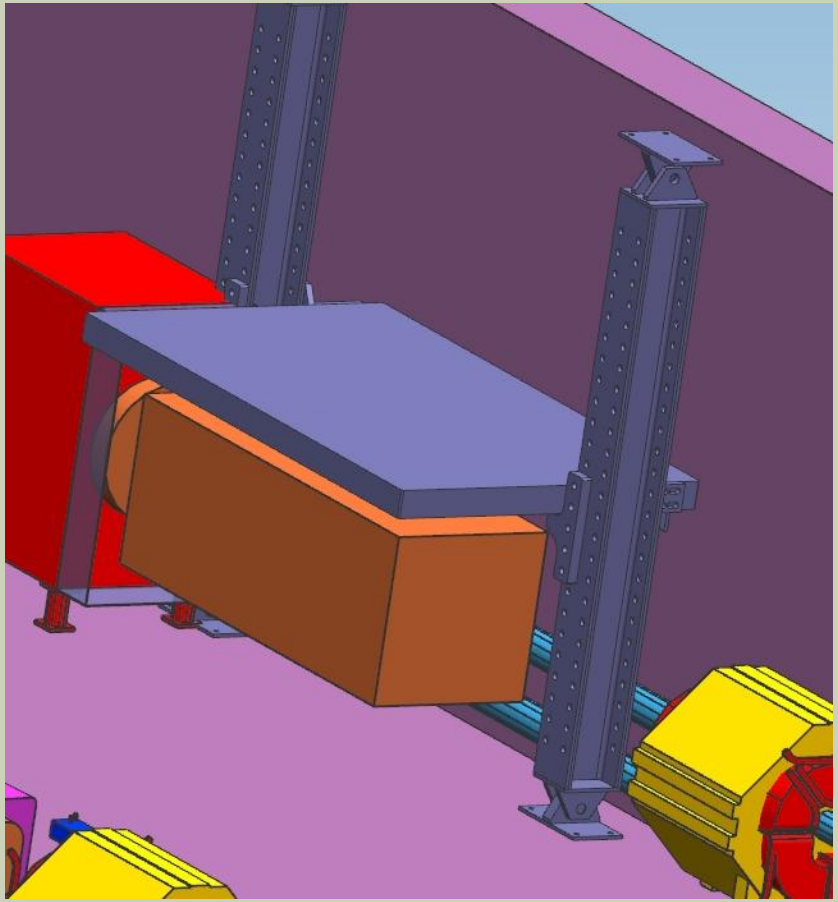
SUPPORT COLUMN / SHELF DESIGN

- 89% of load is taken by columns. Remaining 11% is on wall brackets. Column mounting brackets and front end supports are redundant & included for unknown seismic movement and settling. Also included to account for wall bracket slippage or poor fastener preloading.



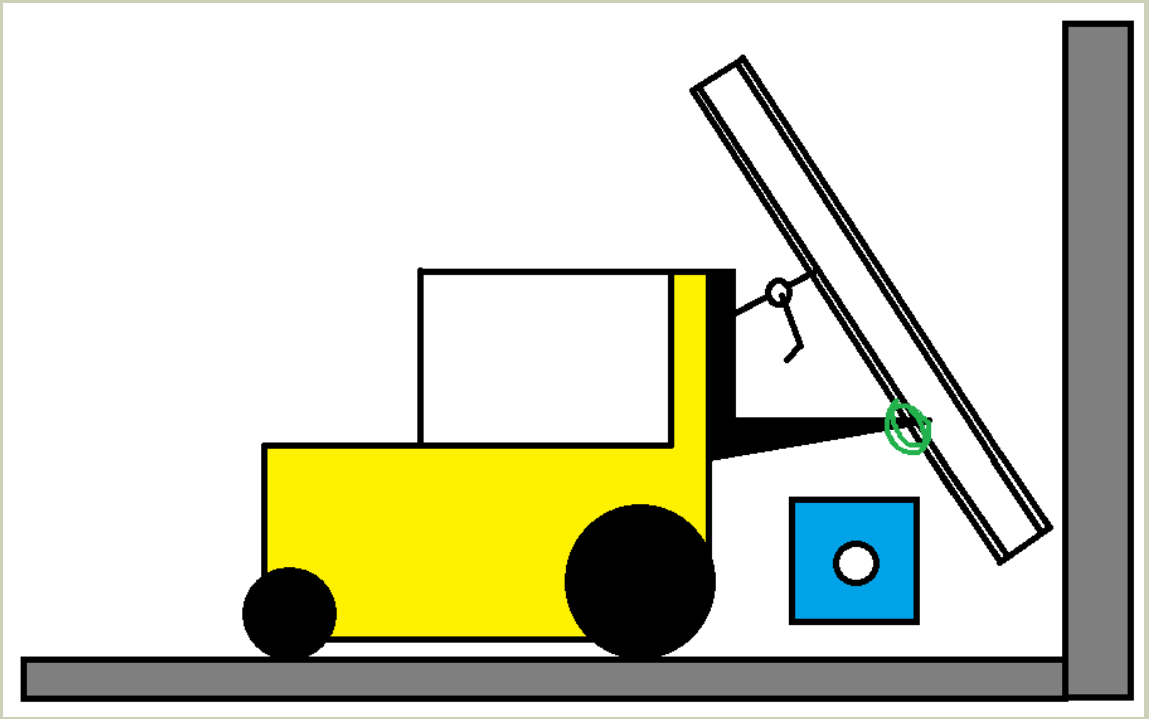
SUPPORT COLUMN / SHELF DESIGN

- Columns must be placed first. Their placement needs to be correct and well thought out for proper load distribution and to avoid interference.
- Shielding shelf length can be measured after placement, with fabrication and installation occurring as a separate activity.
- Support rods can be installed afterwards, as wall brackets and support blocks will take nearly all the load.



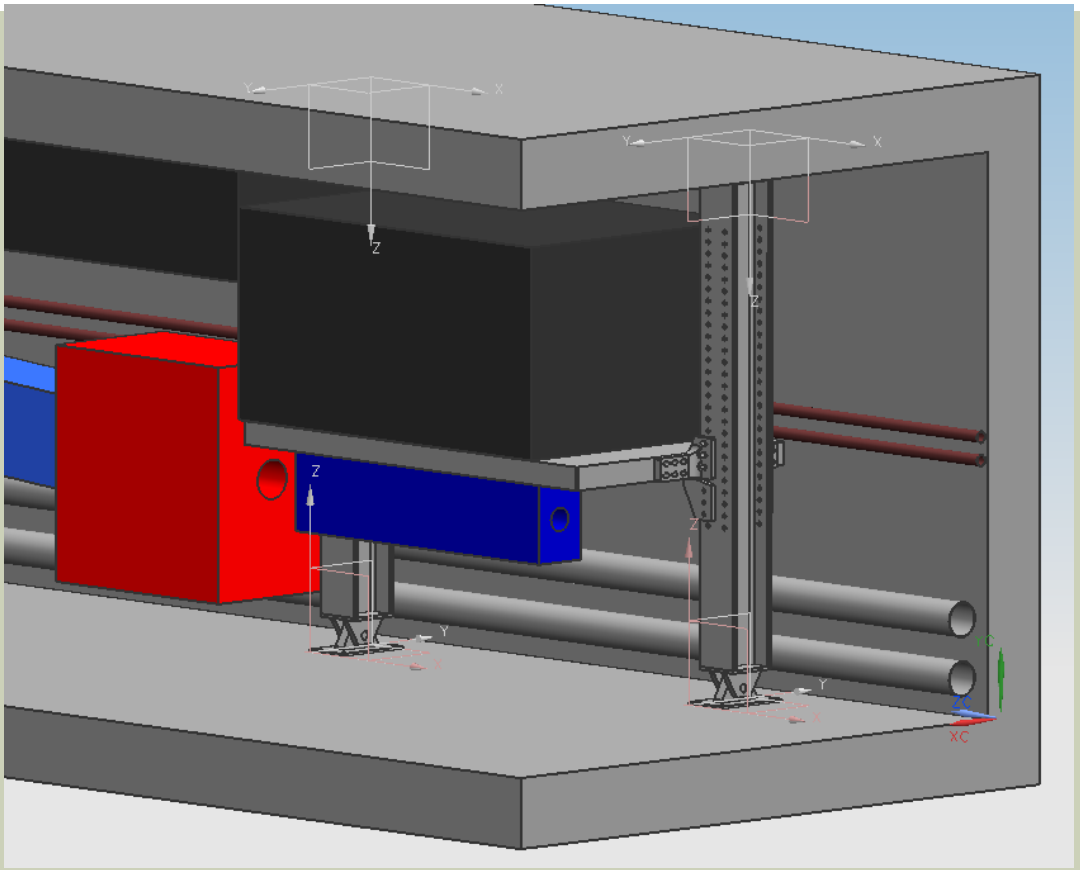
INSTALLATION STEPS

- Columns have many mounting points. Shackles can easily be attached and strapped to fork truck tines. Column position can be manipulated with come-a-long or screw jack attached to fork truck mast.
- This will only be needed if we have to position behind an existing magnet
- Column assemblies will weigh approximately 700 - 800 lbs. Will need to be well controlled during placement.



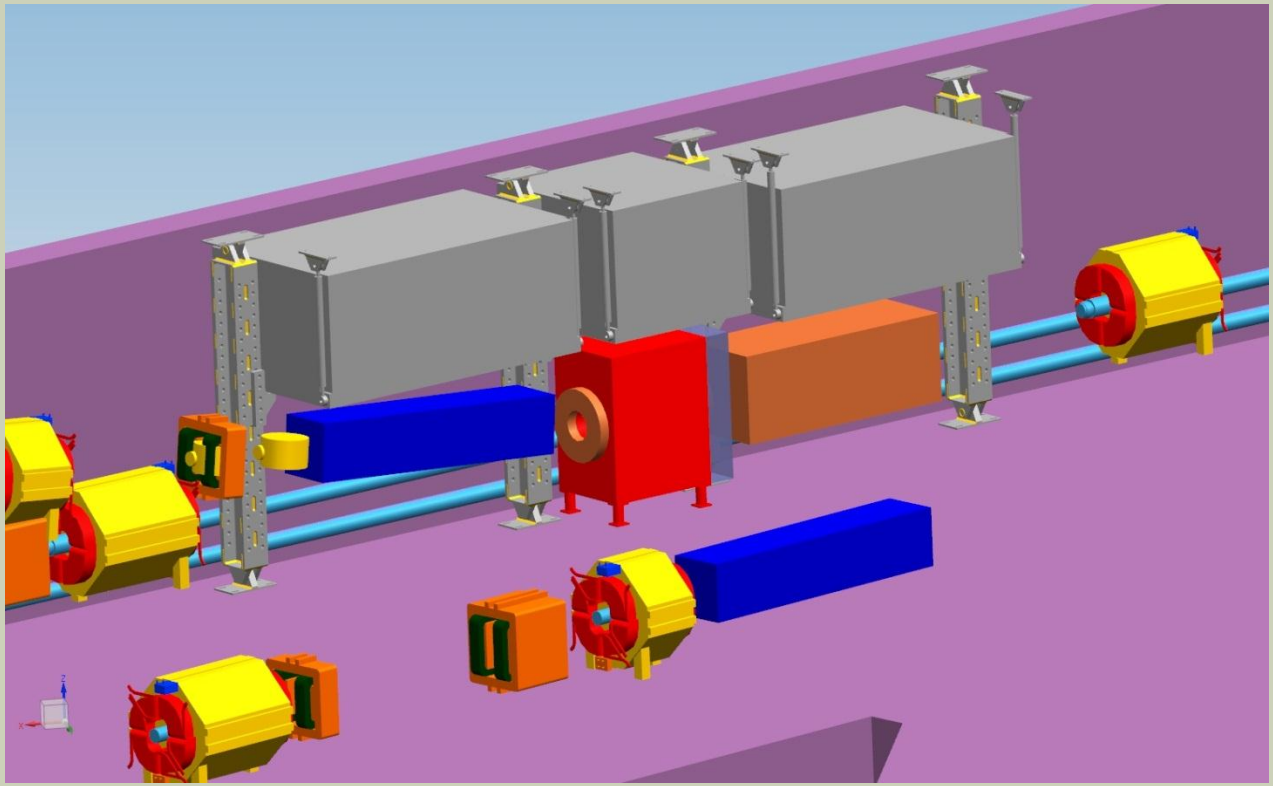
SUPPORT STAND PLACEMENT IN TUNNEL

- Stainless LCW lines do not need to be relocated.
- 2” Dia. Copper headers will need to be relocated in some places.
- It might be easier to raise or lower entire header length instead of select spots? – Need input on this.



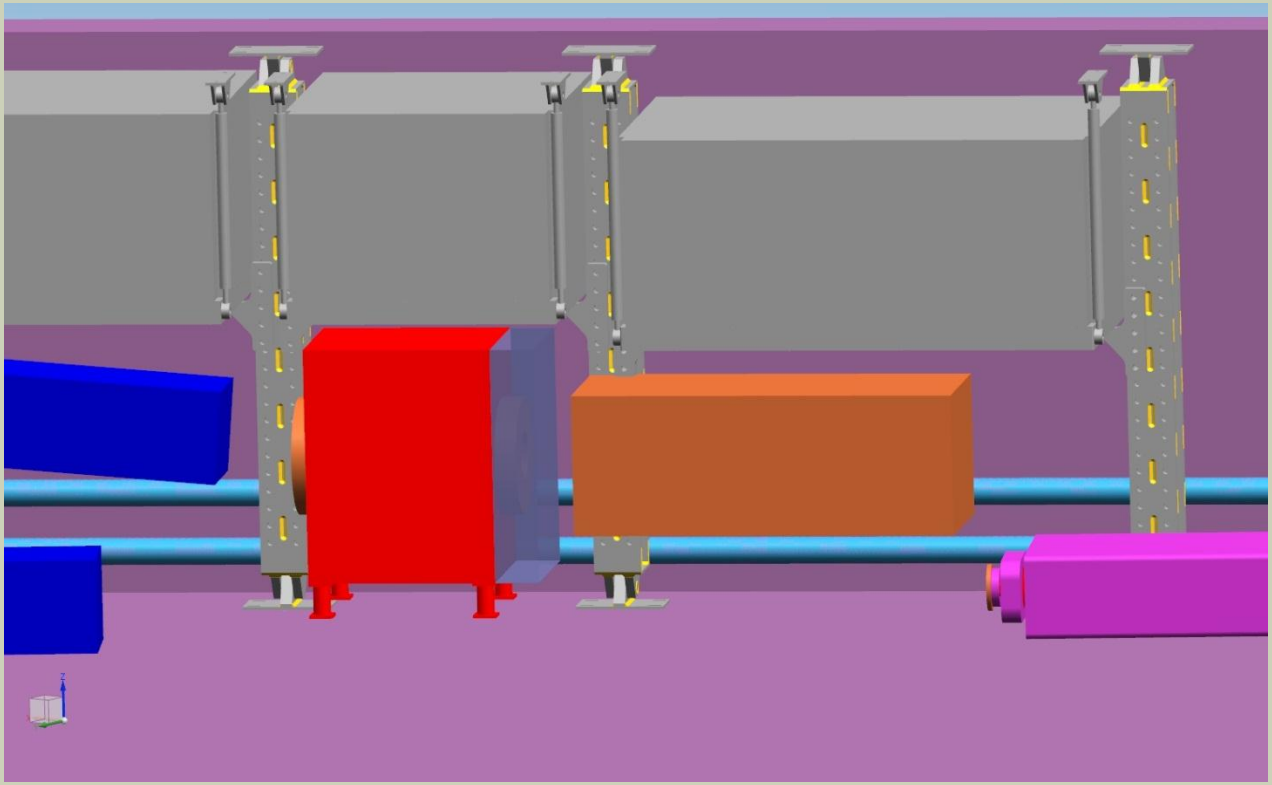
SUPPORT STAND PLACEMENT IN TUNNEL

- Shielding stacks can share adjacent columns.
- Access to front of beam line & associated components is retained.



SUPPORT STAND PLACEMENT IN TUNNEL

- Shielding can be positioned at any height on the columns after field measurements are taken.

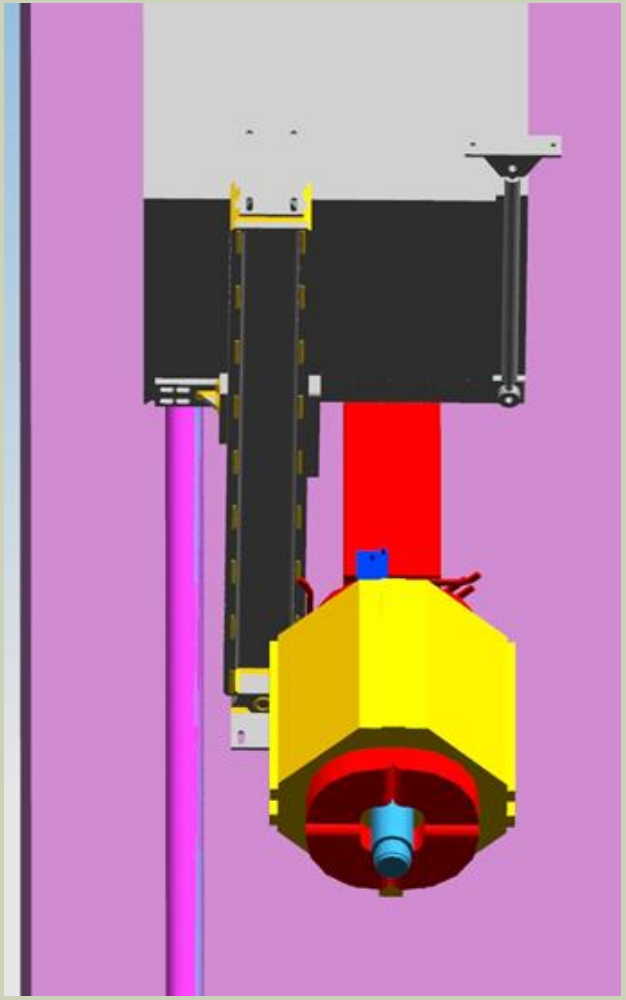


SUPPORT STAND PLACEMENT IN TUNNEL

- Enough clearance remains between columns, main LCW lines, and magnets.
- Some columns will need to be placed around large quads due to interference.
- Key issue to resolve is placement of magnet stands relative to column bases in model. These will be imported to check for interferences (WIP).
- Column placement is not set in stone; they can work around existing structures if necessary.

    - 8’ shelf length limitation must be considered.
    - Must meet distance requirements from wall.

- Water lines, cabling, and instrumentation should work around the columns however.

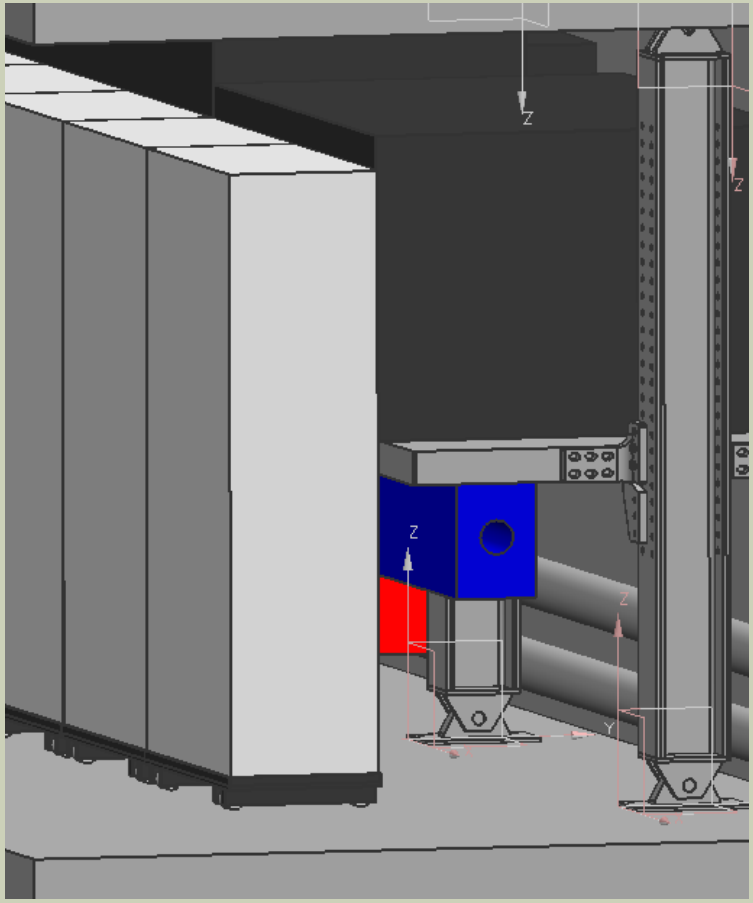


ADDITIONAL CONSIDERATIONS

- Efforts to design water line, electrical bus and instrumentation connections to the front (open tunnel side) of experimental devices would make maintenance and replacement many times easier do to inability to easily access the back side of devices.
- Worst case scenario, shielding can be removed. It will take time however to unstack shielding steel.
- Steel will become activated and work activities in the tunnel could involve significant dose over lengthy repair activities.
- After column and steel placement, there will be a significant load on the floor which will most likely create some settling / displacement.
- Additional surveying might be needed after floor is allowed to adjust to shielding load.

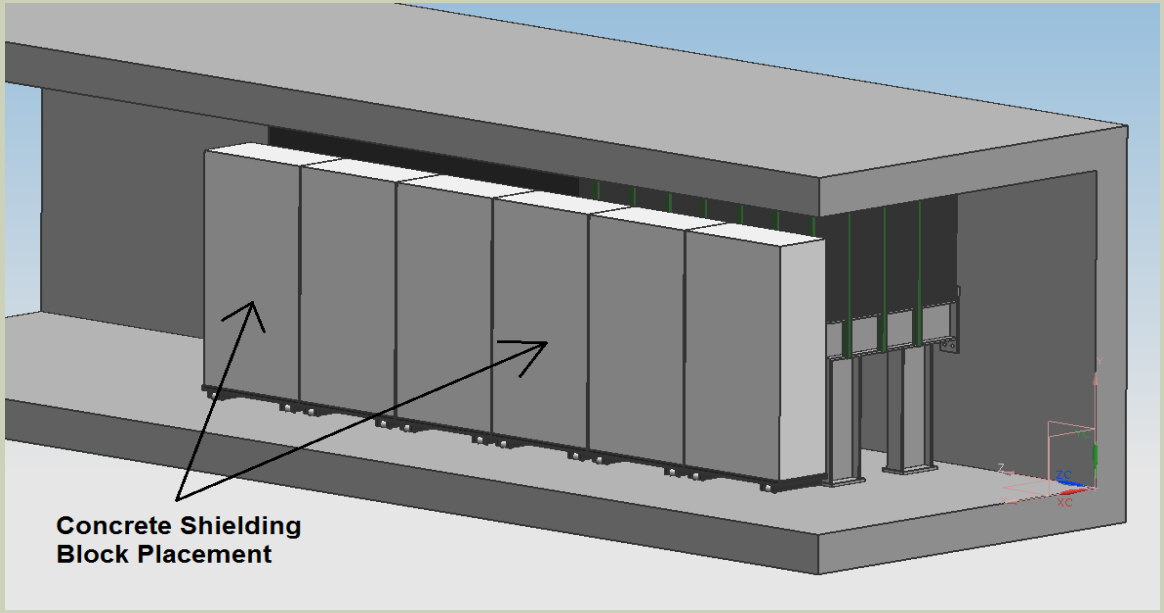
EXTERNAL SHIELDING

- D-Blocks (18” Thick Concrete) + 4” of marble shielding will be placed outside.
- Will remain on sliding trays / rails for removal into walkway when accessing components.
- Current concept uses movable baseplates, but possible design could use parallel support rails to beam line for side to side movement instead.
- These are a minor design task and will be finished up after main shielding is approved & drawings generated.



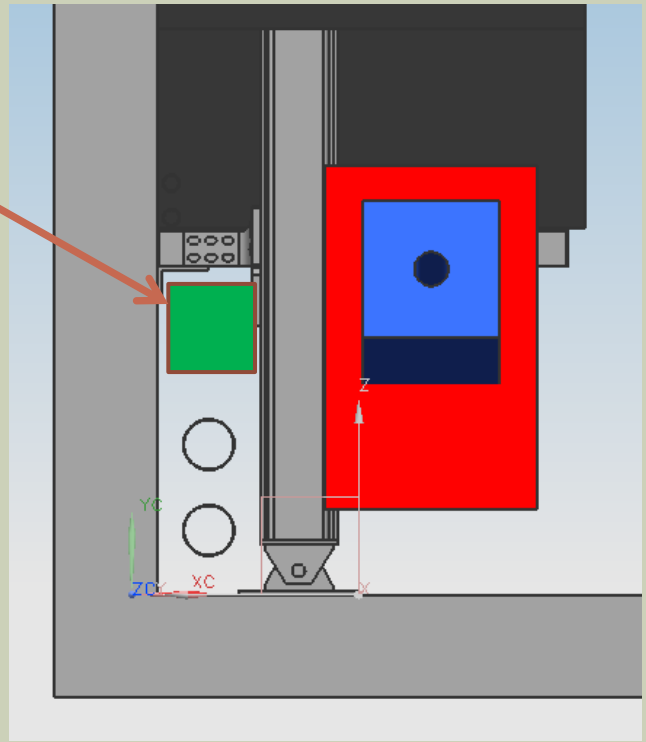
EXTERNAL SHIELDING

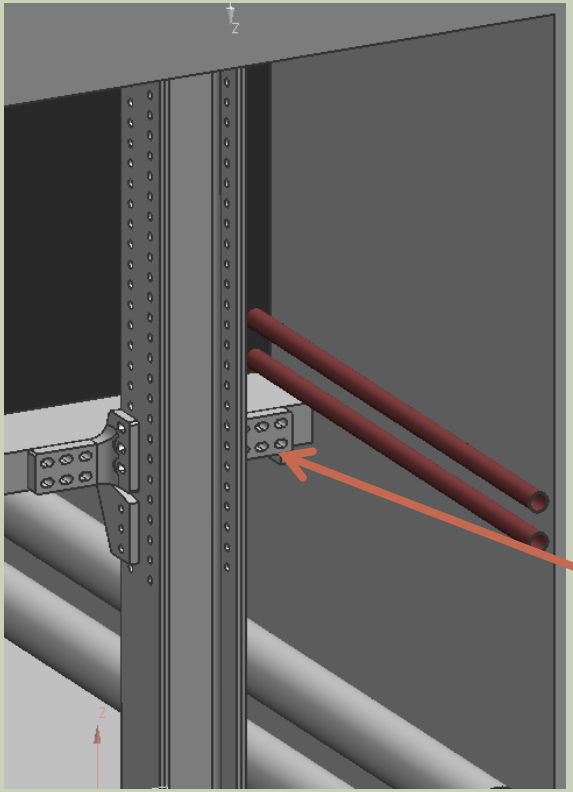
- Multiple blocks will extend to end of shielding
- There will be a hand-stacked steel shield 6” thick, consisting of ½” plate at the ends of the devices which is built around the beam pipe.
- The side shield, in conjunction with the steel above and concrete / marble in front should mostly encapsulate the problematic devices.



CABLE TRAY LOCATION ON WALL

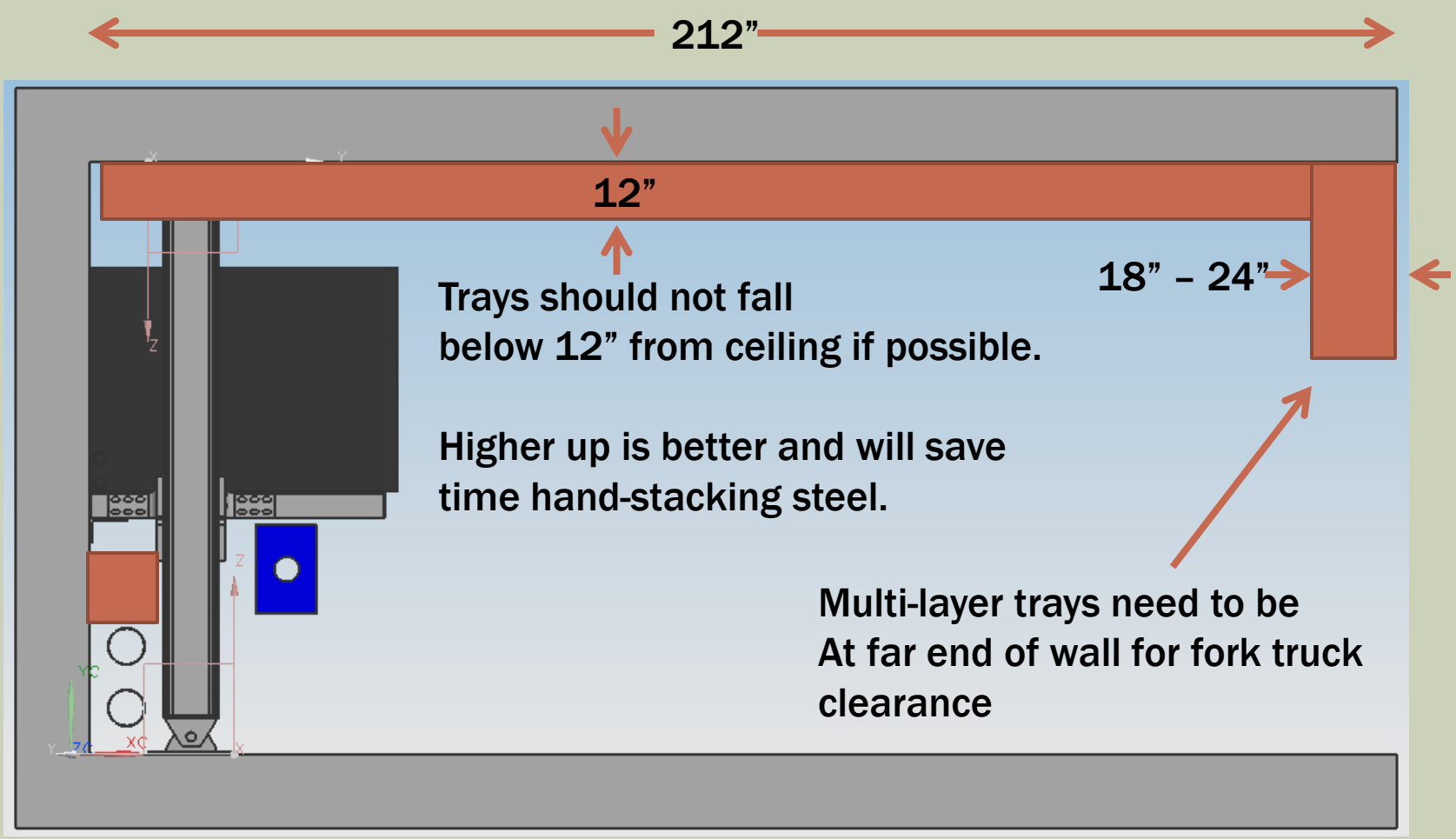
- Sufficient clearance on wall to accept a 12” W x 12 H cable tray.





- Space behind columns can be utilized for cabling & instrumentation runs if routed from top of the ceiling.

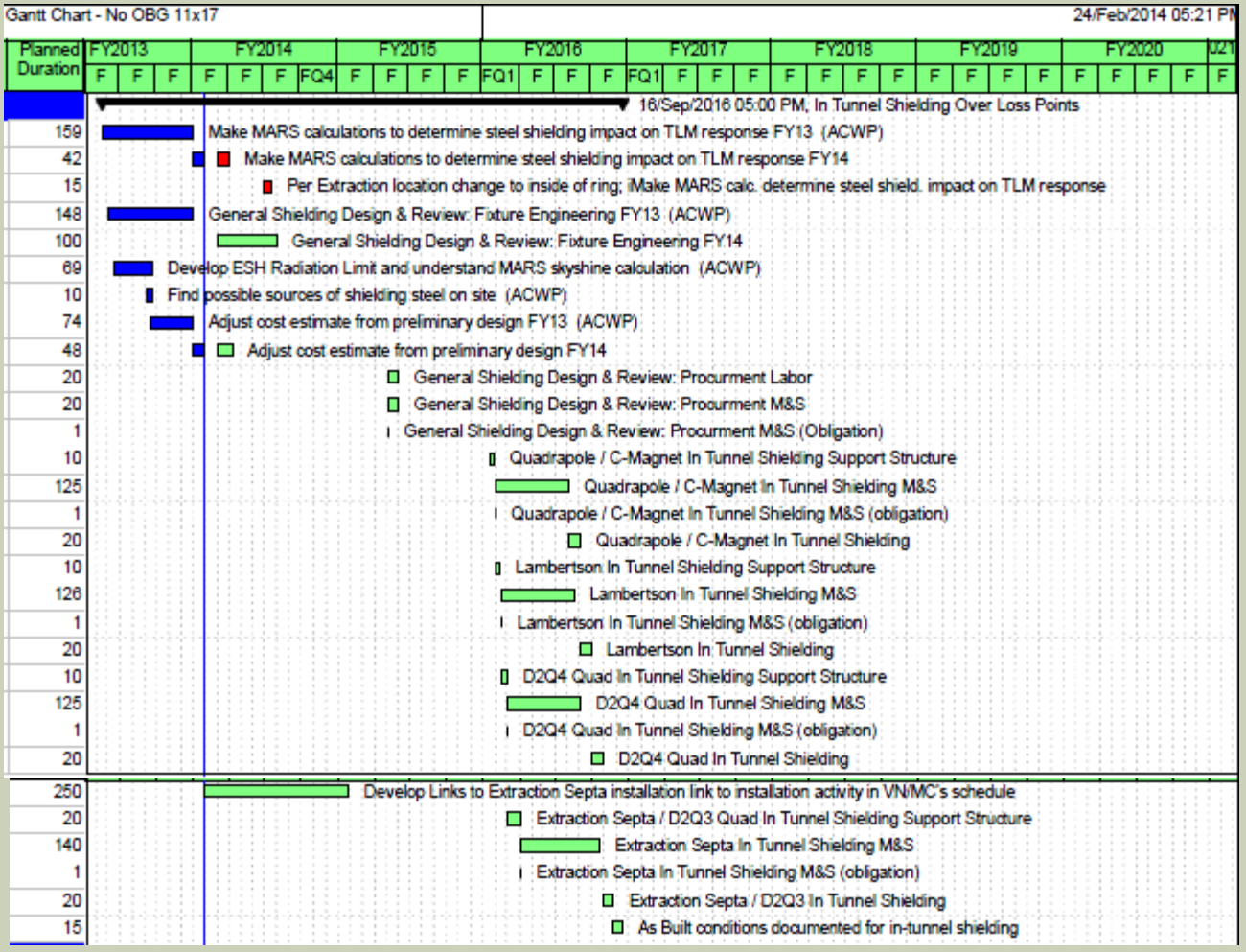
CABLE TRAY PLACEMENT IN TUNNEL



Proposed Installation Steps

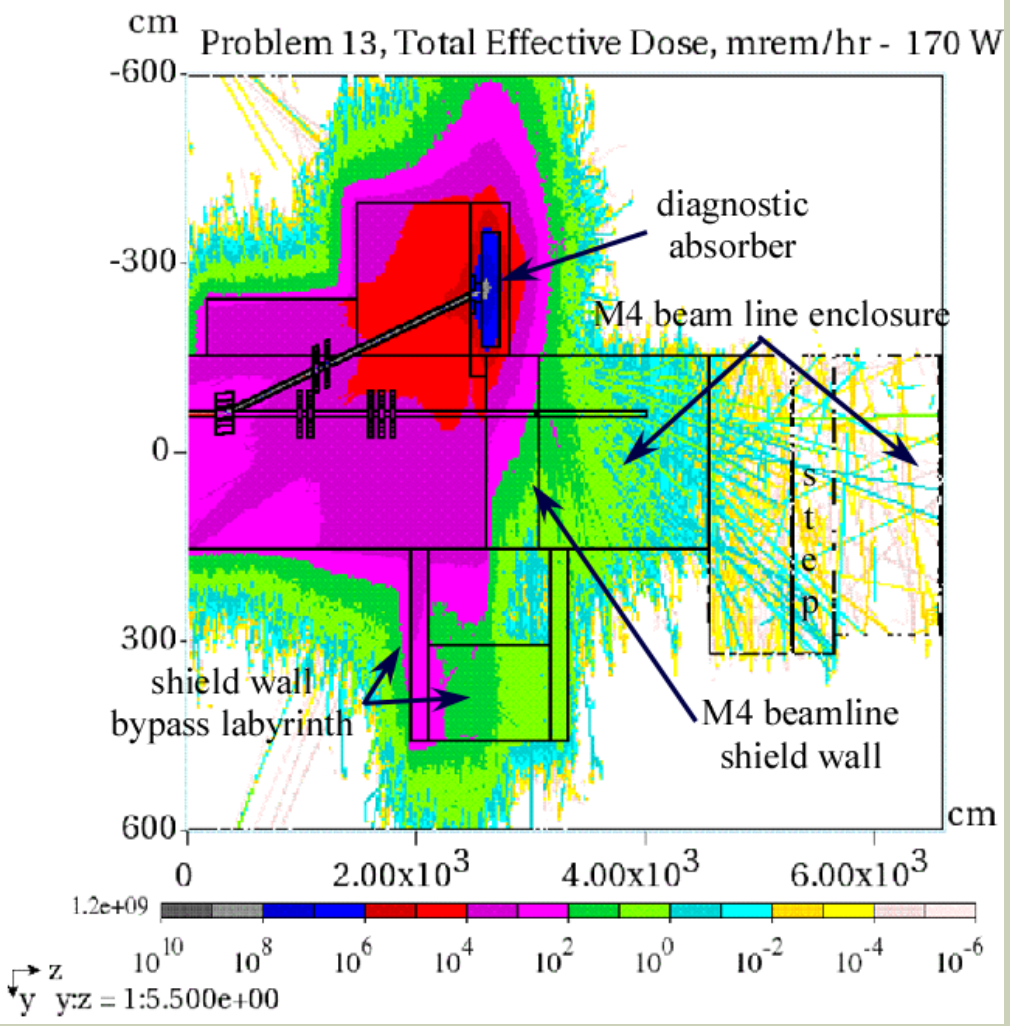
- M4 Line magnets, kickers, septa, etc… installed.
  - Decreases chances of misplaced support column.
  - Beam tube / connections cannot be installed at this point. Ideally they wait for support columns.
- Support columns placed.
  - Final device placement is known.
- Beam tube installed / welded.
- All cable trays installed.
- All water / electrical bus / instrumentation installed.
- Shielding shelves installed.
- Shielding steel put in place.
  - Will work around existing installations.
- Concrete / marble side shielding installed.

Proposed Installation Schedule



Shielding Walls For M4 / M5 Line Reconfiguration Work

- Will need to build multiple shield walls for the M4 and M5 beam line reconfigurations.
- Will involve heavy use of rigging equipment an fork truck to build wall.
- Wall depth is up to 14', stretching the width of the tunnel.



Shield Wall For M4 / M5 Reconfiguration Work

- Existing shielding from CDF will have to be dismantled and reconfigured for new installation.
- There are two walls that can be dismantled, with additional sand bags available for upper shielding.
- An interlocked gate will have to be installed at these locations.
- This wall will then be moved and reconfigured again, at a location down stream of the existing installation.

Shield Wall For M4 / M5 Reconfiguration Work