Mu2e experiment integration

Federico Crisci

Supervisor: George Ginther

Final report

21 September 2016

Overview

- Mu2e searches for neutrinoless conversion of muon to electron
- Stopping target monitor (STM) provides normalization (counting number of muons stopped in stopping target) by detecting photons resulting from muon stops
- Become familiar with the Mu2e experiment building
- Design of the STM (Stopping Target Monitor) infrastructure
- Refined the Teamcenter CAD model of the Mu2e experiment
- Added features in Teamcenter CAD model

Design of the assigned parts of the STM

The parts of the STM infrastructure that weren't in the 3D CAD model and that I had to model are:

Upstream elements:

- Shield for CRV
- Sweeper magnet
- STM field-of-view collimator
- Stand for the upstream components

Downstream elements:

- STM spot-size collimator
- STM shielding
- Two photon detectors
- Stand for the downstream components

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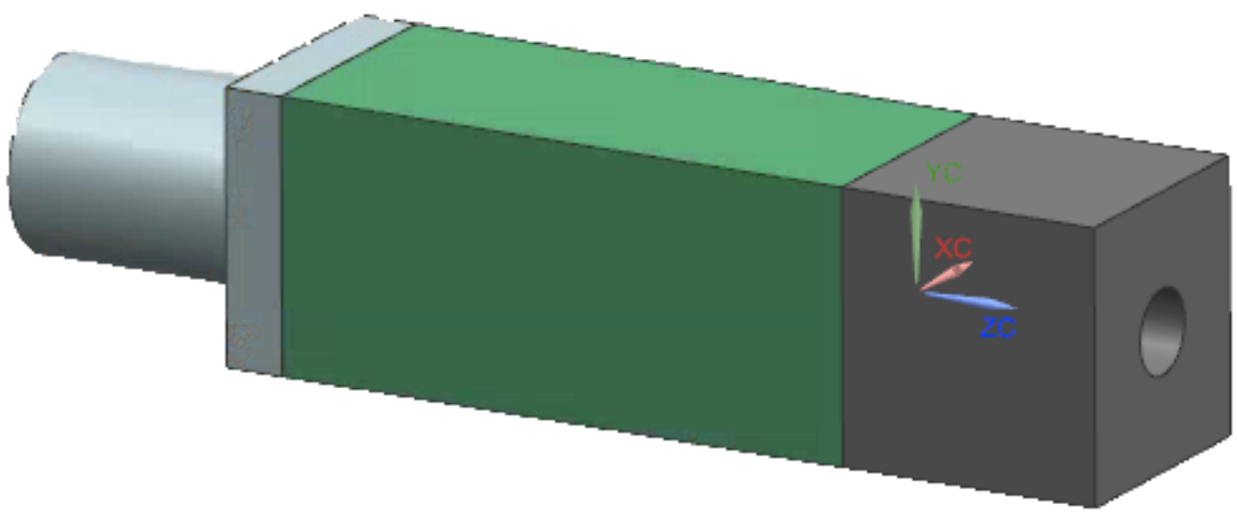

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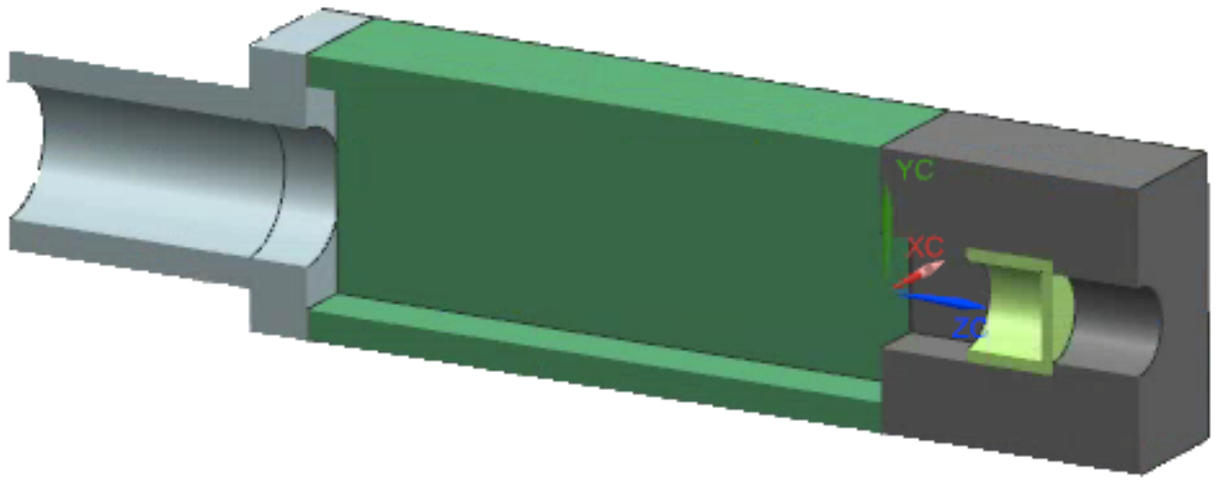

Total weight:
4811 lbs.

Requirements of the upstream STM stand

- Support the upstream STM components
- Move and reposition stand and mounted components readily and reliably to facilitate detector train access
- It has to be made out of non-magnetic material, because of the proximity with a strong magnetic field
- It has to facilitate the alignment of the components
- The legs of the stand rest on the two inner floor plates

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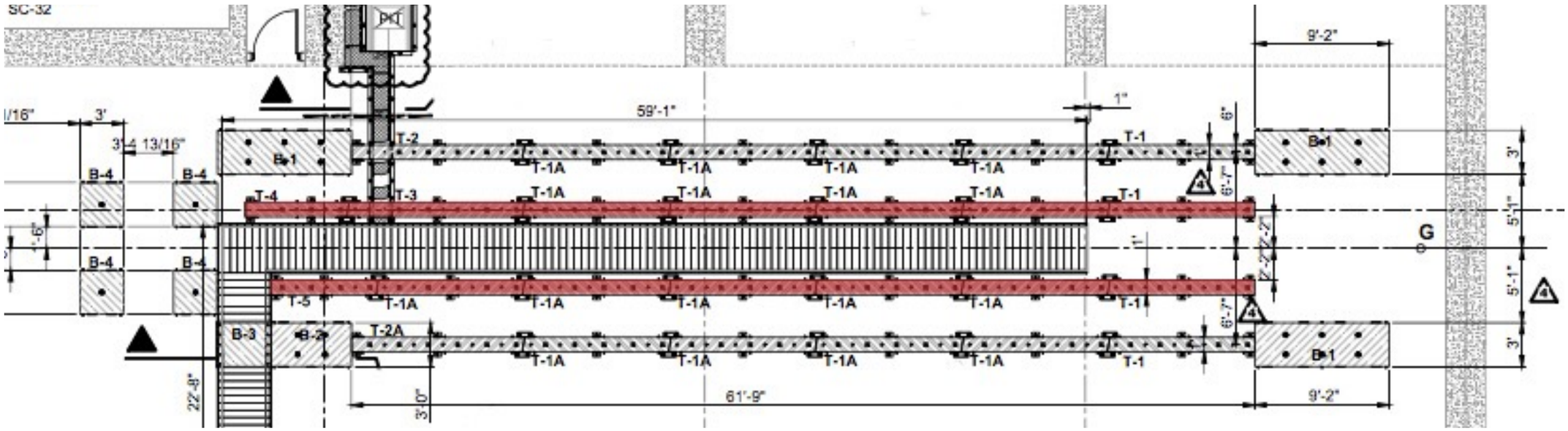

Fermilab

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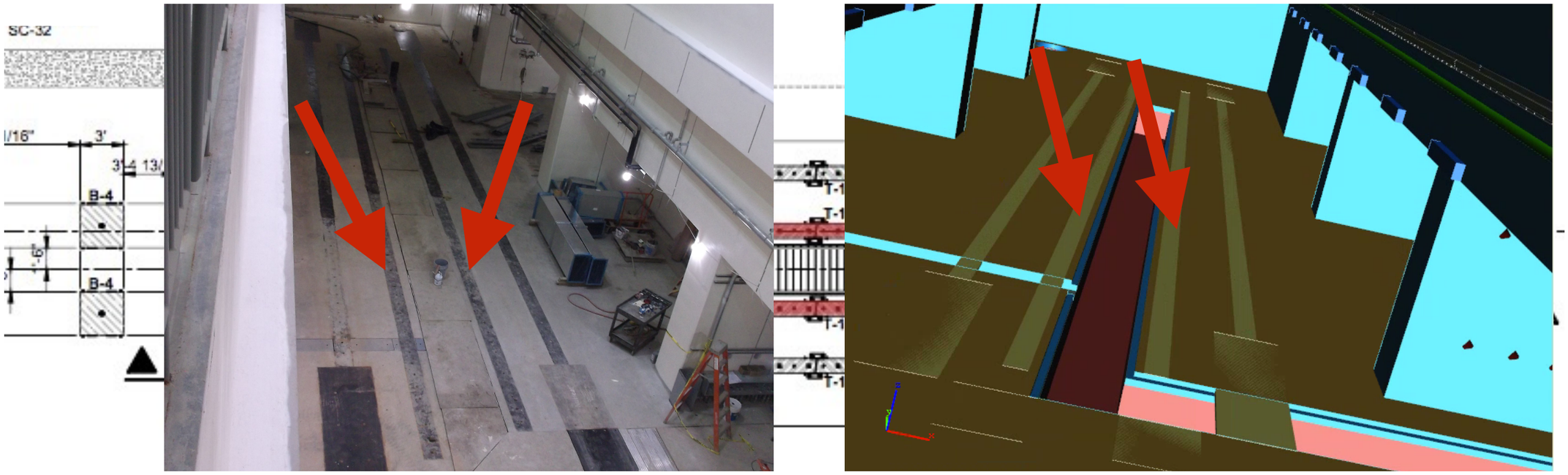


Solution realized for the Upstream STM infrastructure

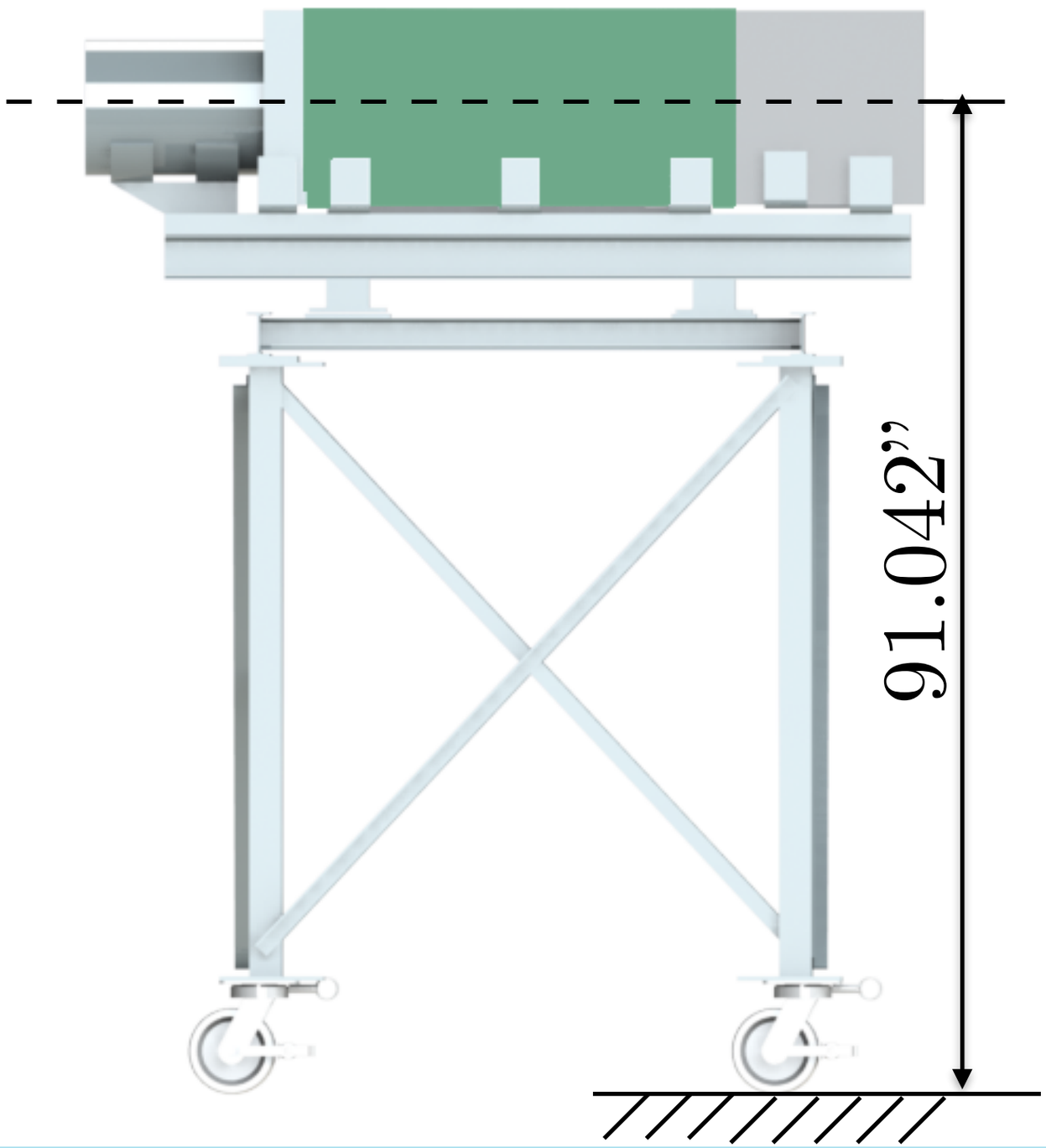
Solution realized for the Upstream STM infrastructure

Total weight of the stand:

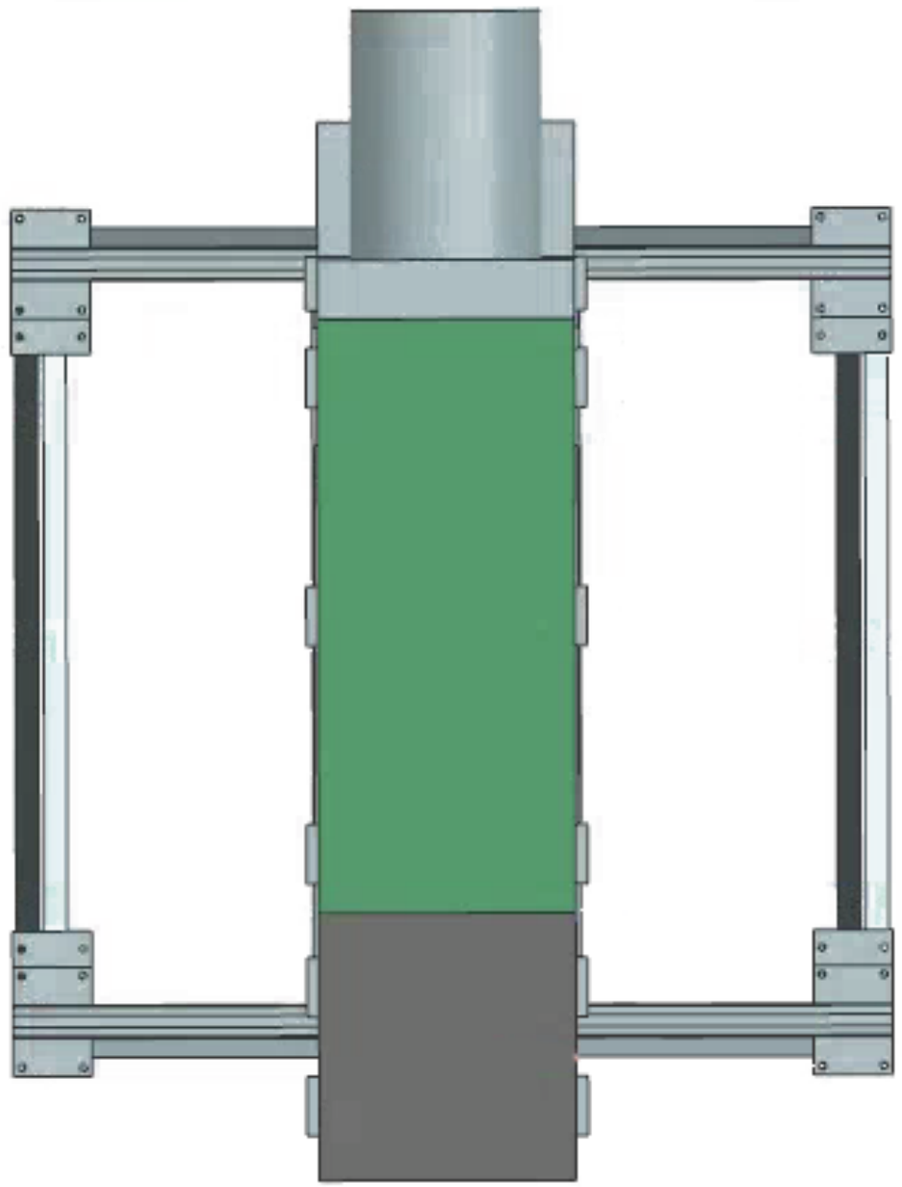
430 lbs

Solution realized for the Upstream STM infrastructure

Side view

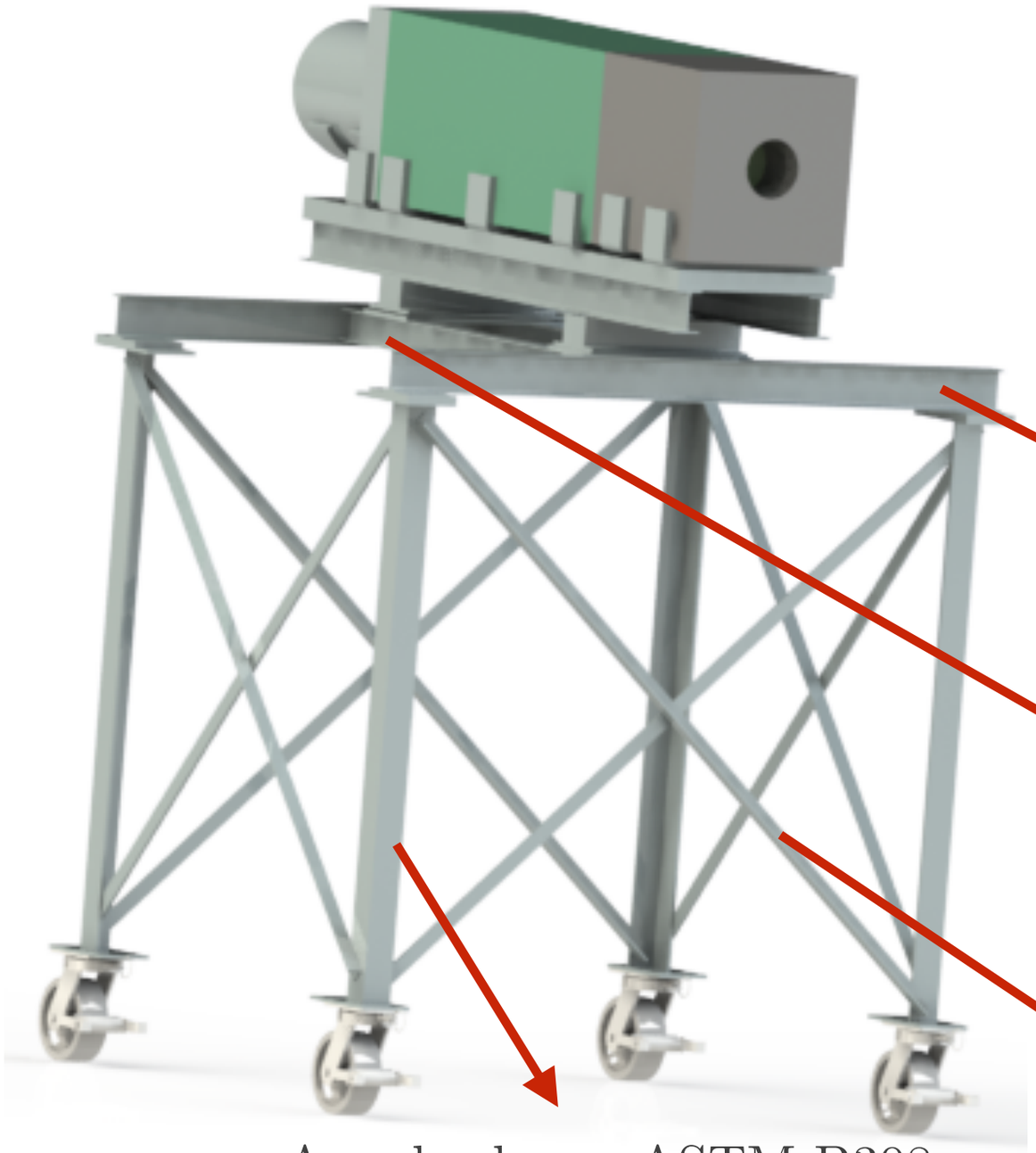


Top view



Fermilab

Used material and beams for the Upstream STM infrastructure



- Aluminum 6061
  - Modulus of elasticity: 68.9 GPa
  - Tensile yield strength: 276 MPa
  - Ultimate tensile strength: 310 MPa

I-BEAM ASTM B308

4” x 0.190” x 2.66”

I-BEAM ASTM B308

3” x 0.170” x 2.33”

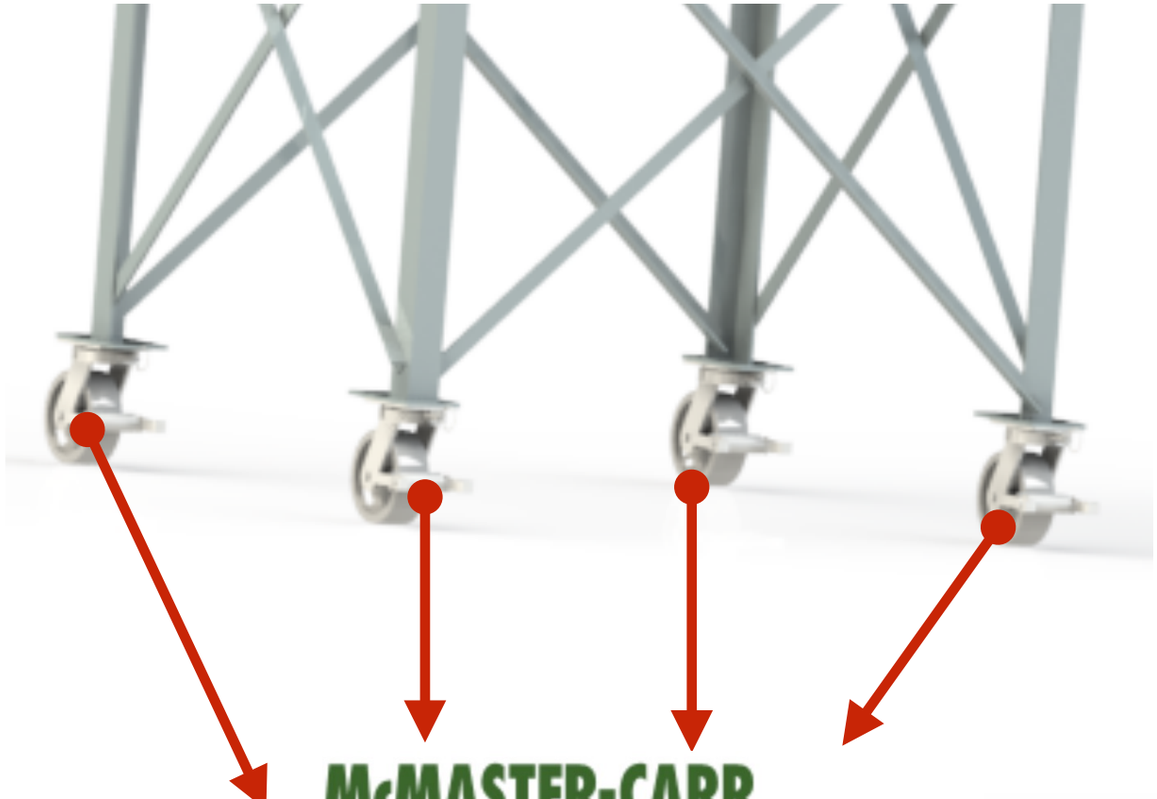
Angular beam ASTM B308

3” x 3” x 3/8”

Angular beam ASTM B308

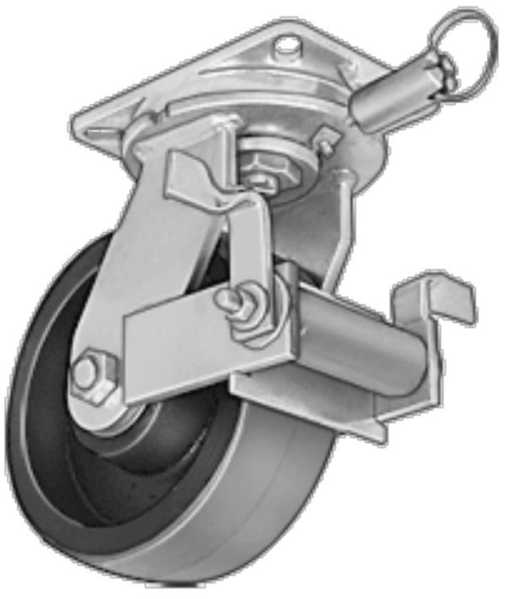
1 1/2” x 1 1/2” x 1/4”

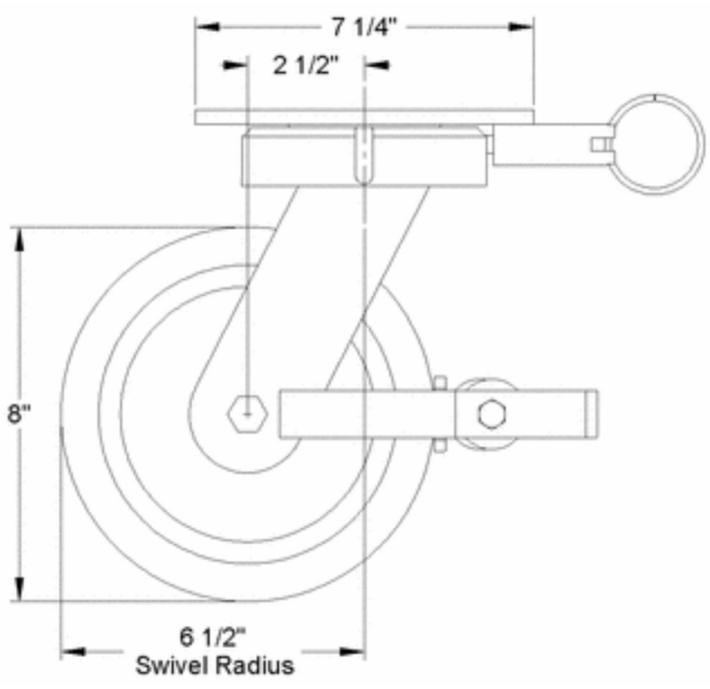
Selected wheels for the Upstream STM infrastructure

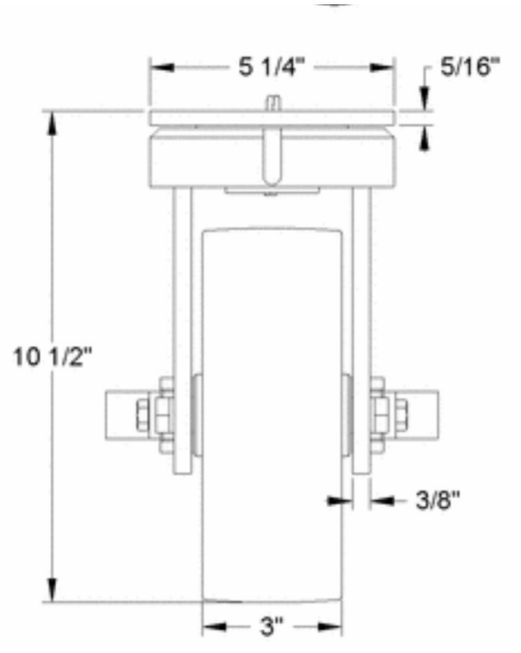


4 Stronghart Single Wheel Caster:

- Diameter: 8”
- Width: 3”
- Mount height: 10 1/2”
- Capacity: 2,520 lbs
- Swivel with Brake and Swivel Lock
- Abrasion-Resistant Green Polyurethane

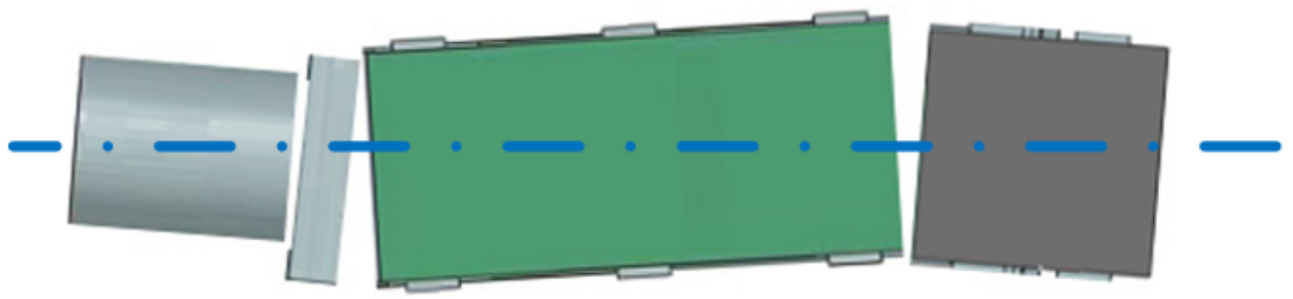






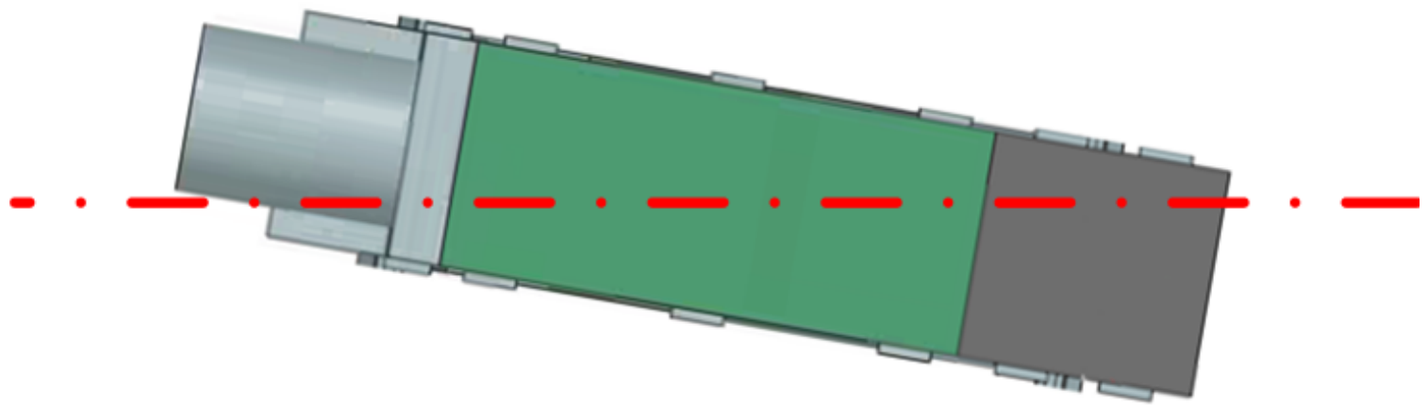
Relative alignment of the parts on the table

The system realized allows the relative alignment of the shield for CRV, sweeper magnet and the collimator, so that this internal alignment operation does not to be repeated every time the stand has to be moved.



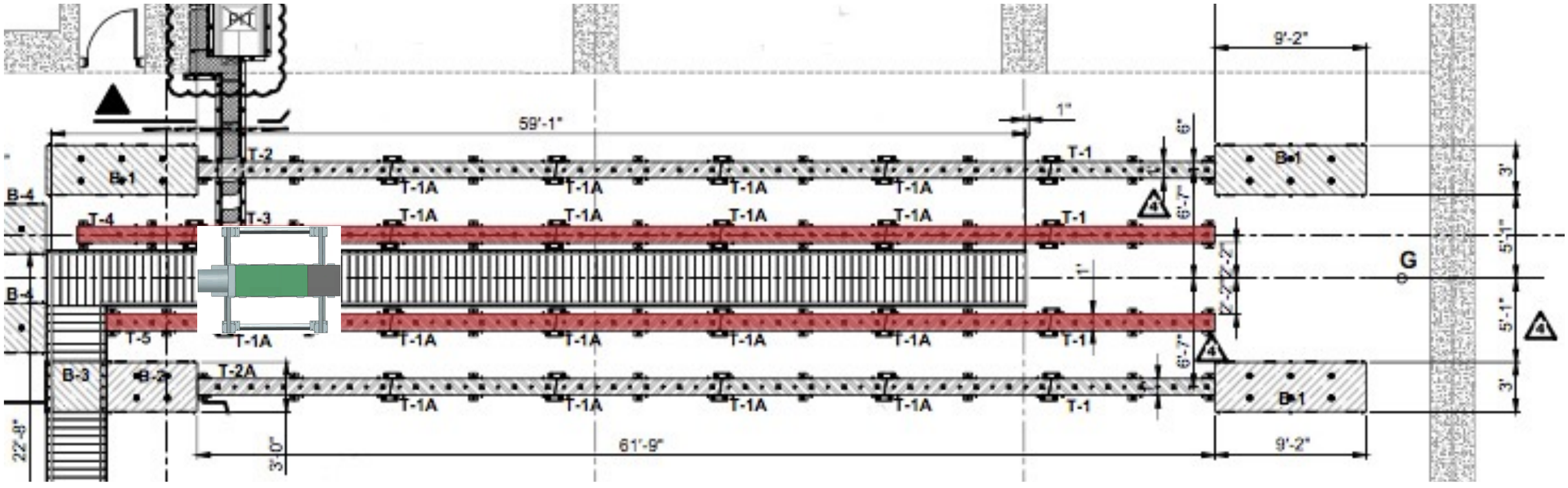
Alignment between the table and the beam line

Once realized the alignment of the individual elements on the table, this one can be mounted on the stand and aligned to the beam line through the alignment system mounted on the stand. This second alignment is faster than the one made before and this will reduce the time due to the realignment after the maintenance operation.



Moving operation for the Upstream STM components

The stand realized allows the table with the shield for CRV, the sweeper magnet and the collimator to be moved in the plane, to allow other maintenance operation. This will avoid the need to pick up the table when it is just sufficient remove it from the beam line.



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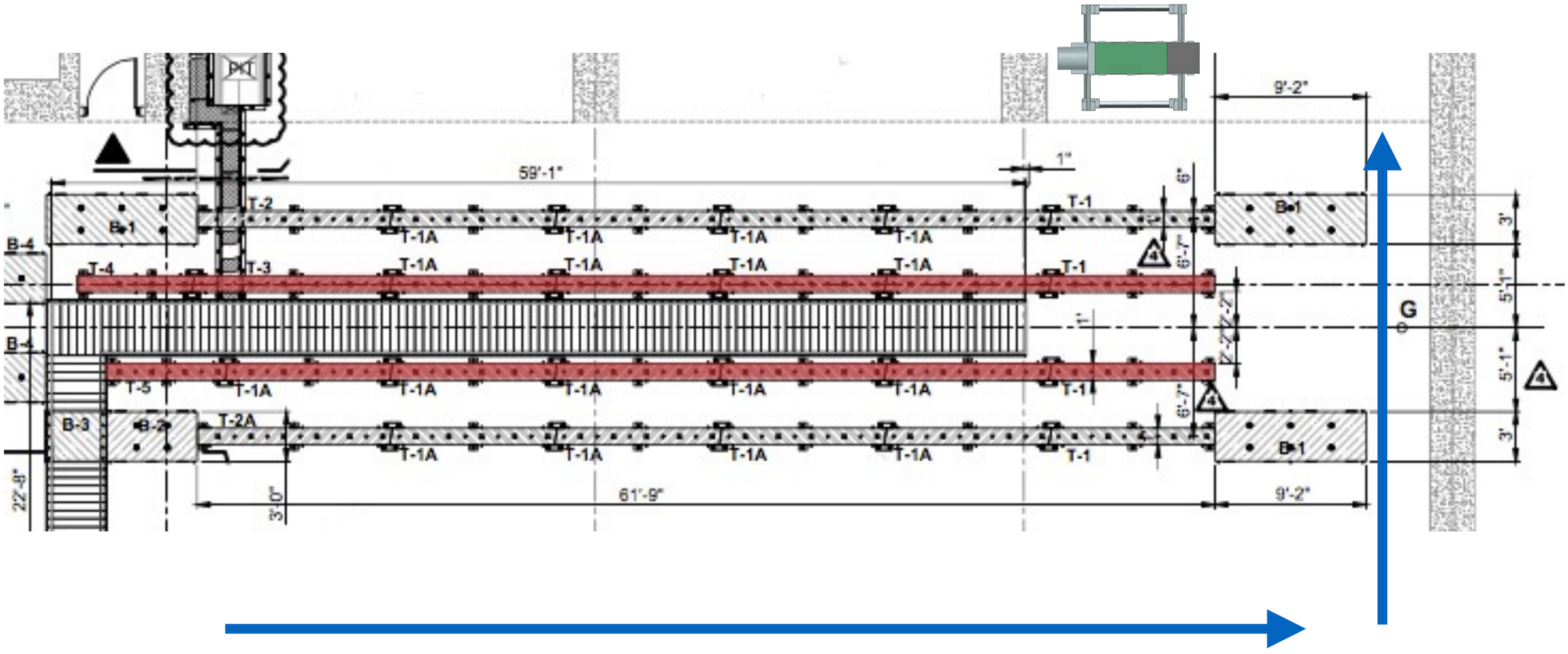
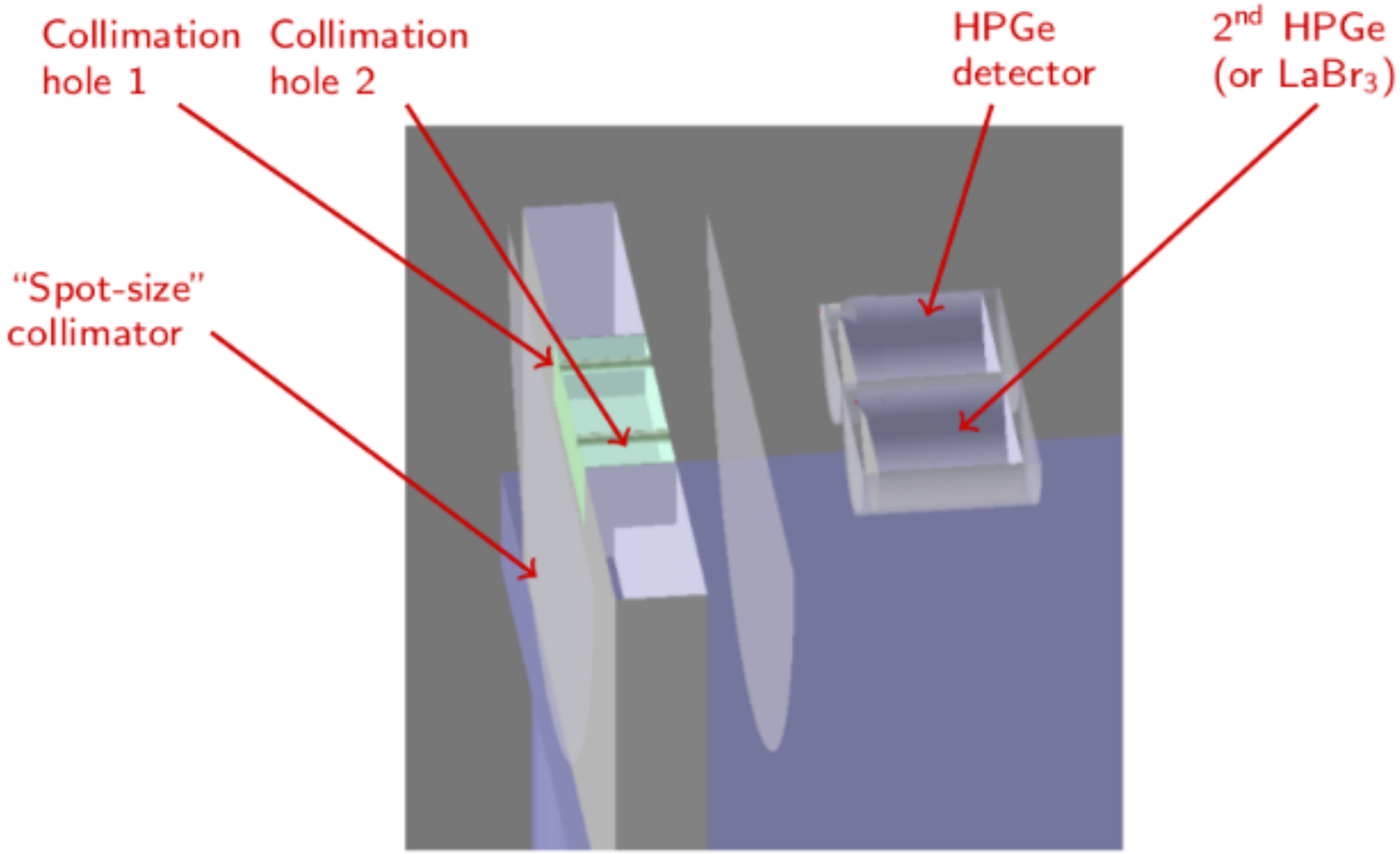


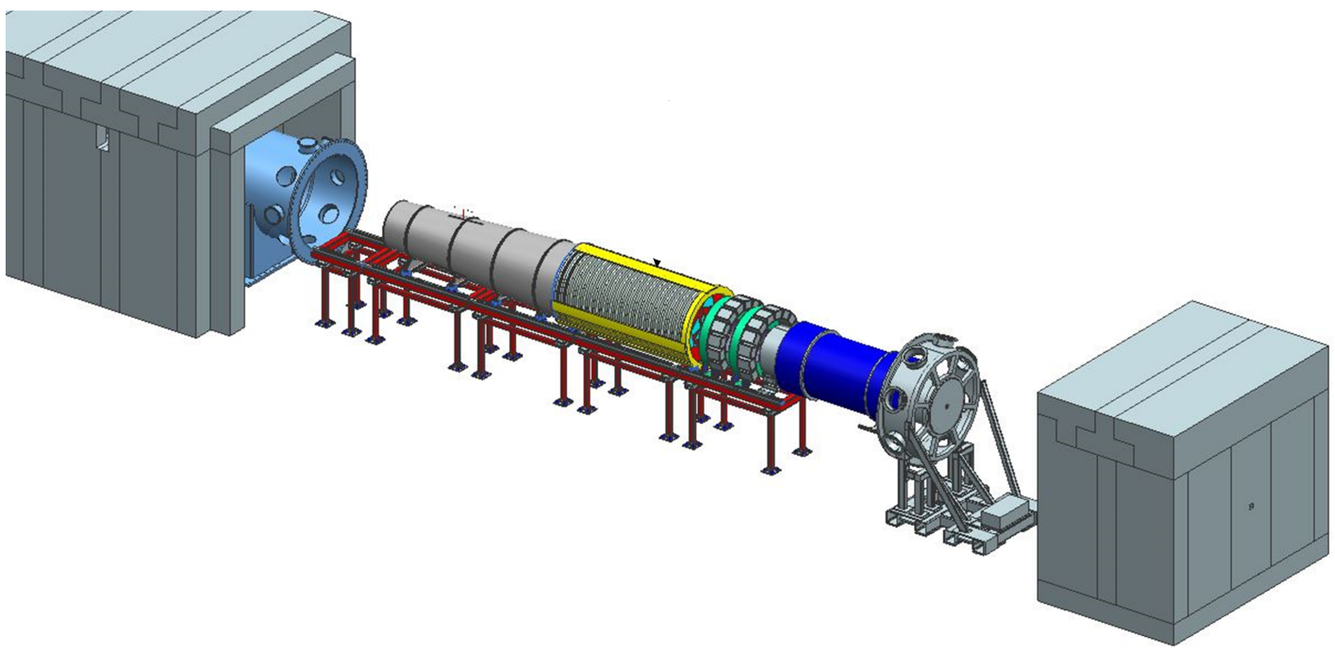
Downstream elements of STM

- Tungsten wall with the two collimation holes
- Two photon detectors (two HPGe or one HPGe and one $LaBr_3$)
- Room background shield made from lead
- Stand for downstream elements

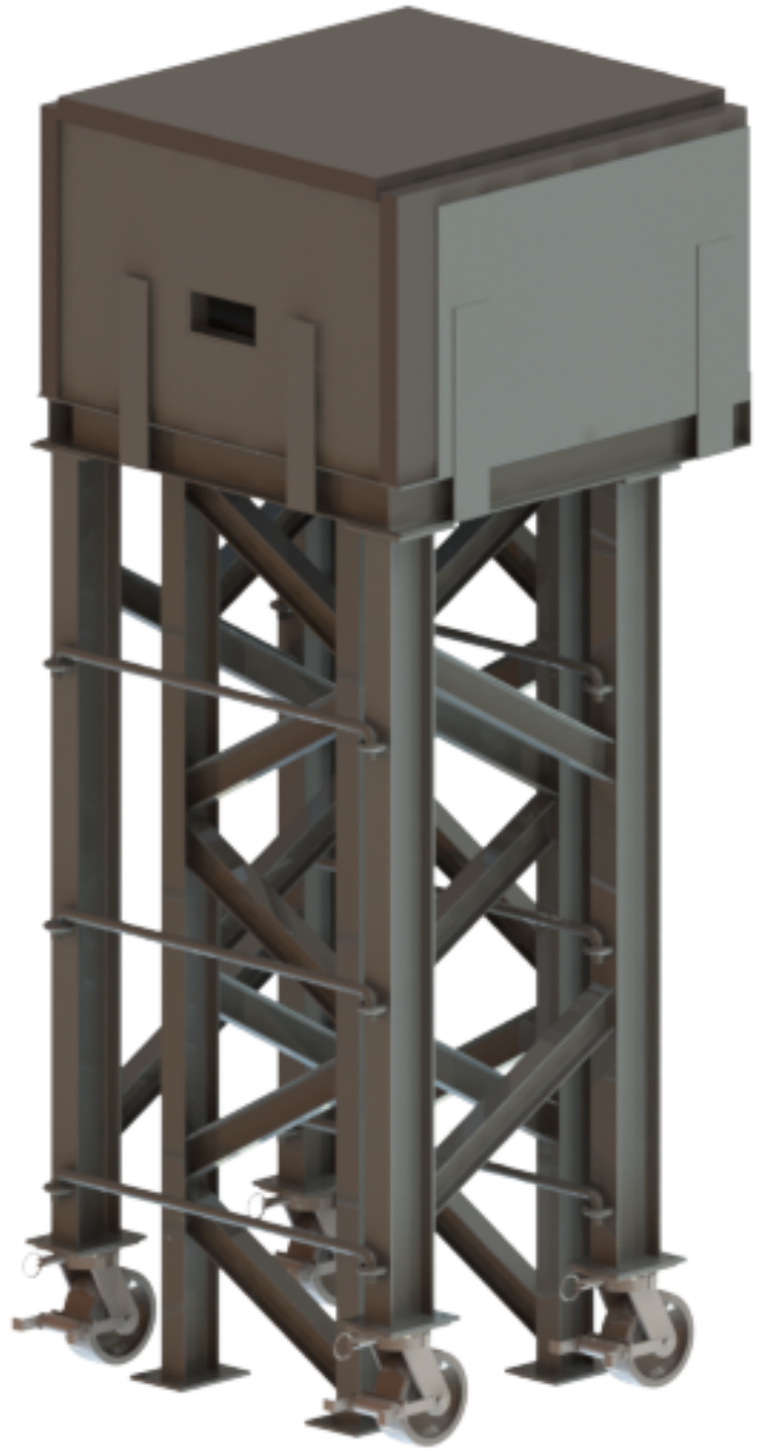


Requirements of the downstream STM stand

- It has to support the the tungsten wall with the two 5.642 mm radius collimation holes, the two photon detectors and the lead background shield.
- It has to allow to build the shielding with common 2” x 4” x 8” lead bricks
- It has to allow to remove the bricks for maintenance on the two detectors
- It can’t be too long, in z direction, because the space upstream the tungsten wall is necessary for the moving of the upstream train during the maintenance
- The stand has to be referred to the ground, so it cant be fixed to the east hall wall too
- It has to allow the operation of alignment



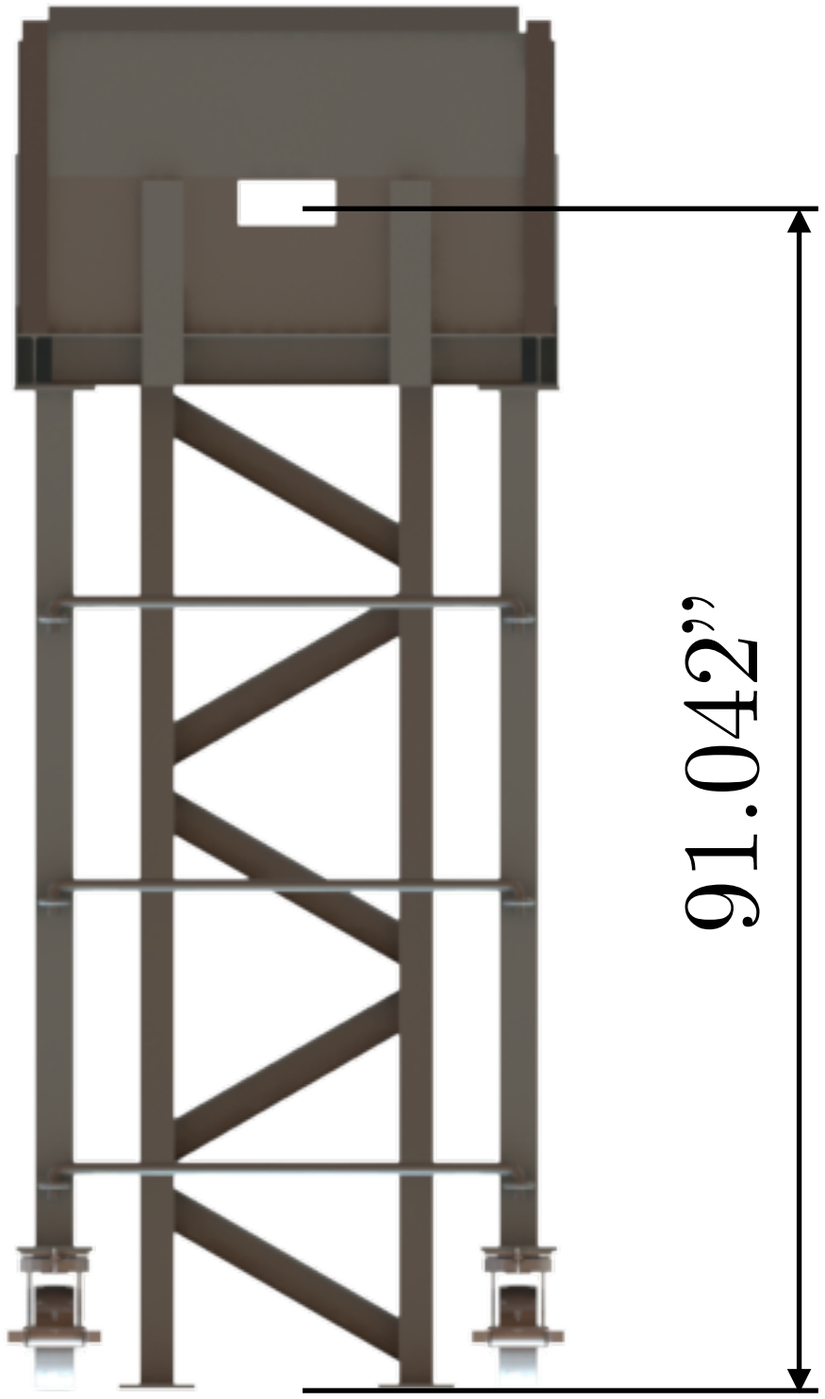
Solution realized for the Downstream STM infrastructure



Solution realized for the Downstream STM infrastructure

Side view

Front view



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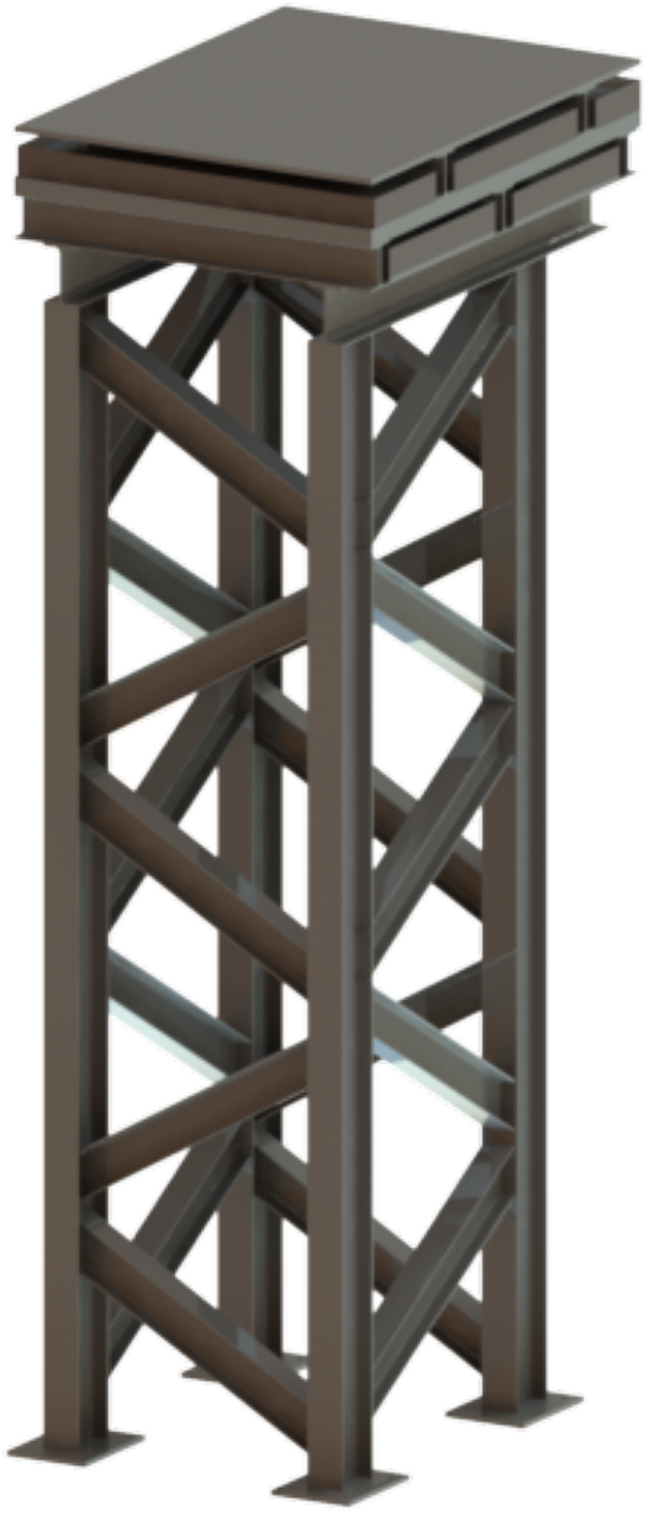
Solution realized - fixed part



Total weight of steel:

606 lbs

Total weight of lead:

980 lbs

Solution realized - mobile part

Total weight of steel:

712 lbs

Total weight of lead:

3350 lbs

Solution realized - mobile part

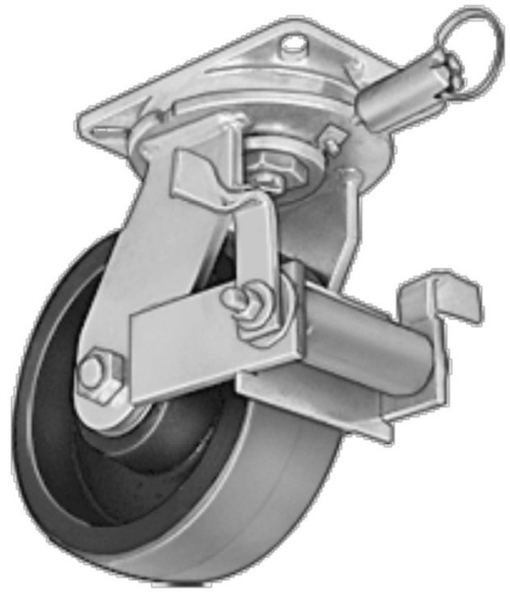
Total weight of steel:

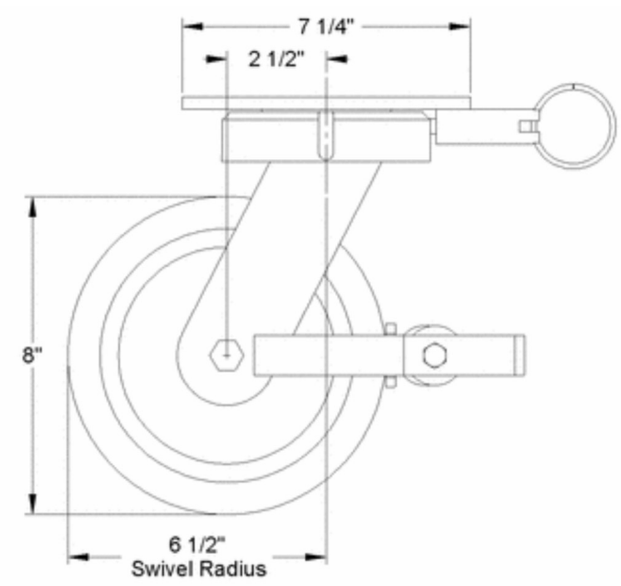
712 lbs

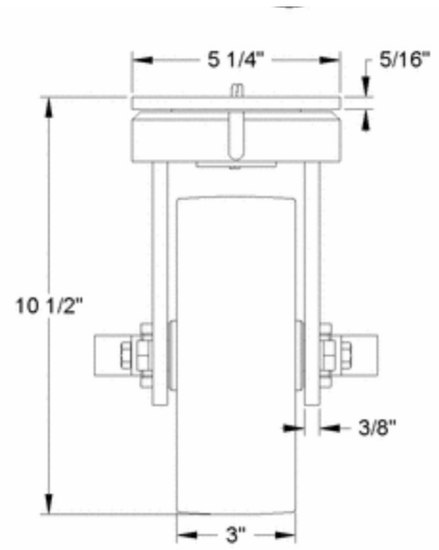
Total weight of lead:

3350 lbs

McMASTER-CARR







Fermilab

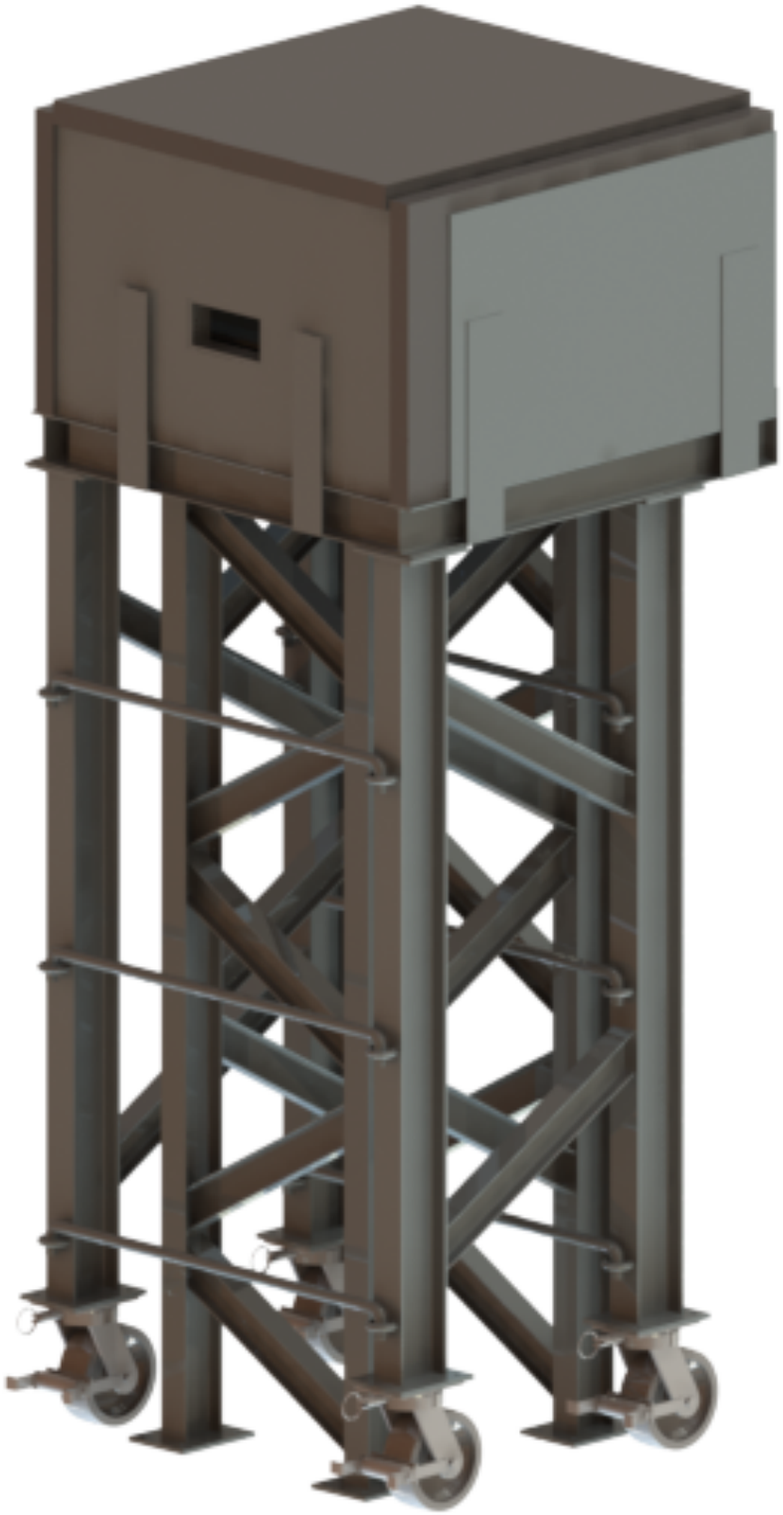
Advantages of the realized solution for the Upstream STM infrastructure

- **The fixed stand, which is the one that supports the tungsten wall and the two detectors includes few lead bricks.** This reduces the weight of this part of the stand so that it is subjected to less deformation, allowing a better alignment of the pieces on it.

- **The removable shield allows the maintenance access without removing the bricks one by one.** This operation in fact would be too long and it would be a waste of time. Furthermore, the placement of the bricks one by one, once the maintenance is finish, could affect the alignment of the holes in the tungsten wall and the photon detectors.

- The fact that the shield can be easily removed allows to **gain more space along z** during the upstream maintenance operation, which is important to allowed the parts to be extracted from the upstream shielding.

Used material and beams



- STRUCTURAL STEEL
  - Modulus of elasticity: 210 GPa
  - Tensile yield strength: 290 MPa
  - Ultimate tensile strength: 480

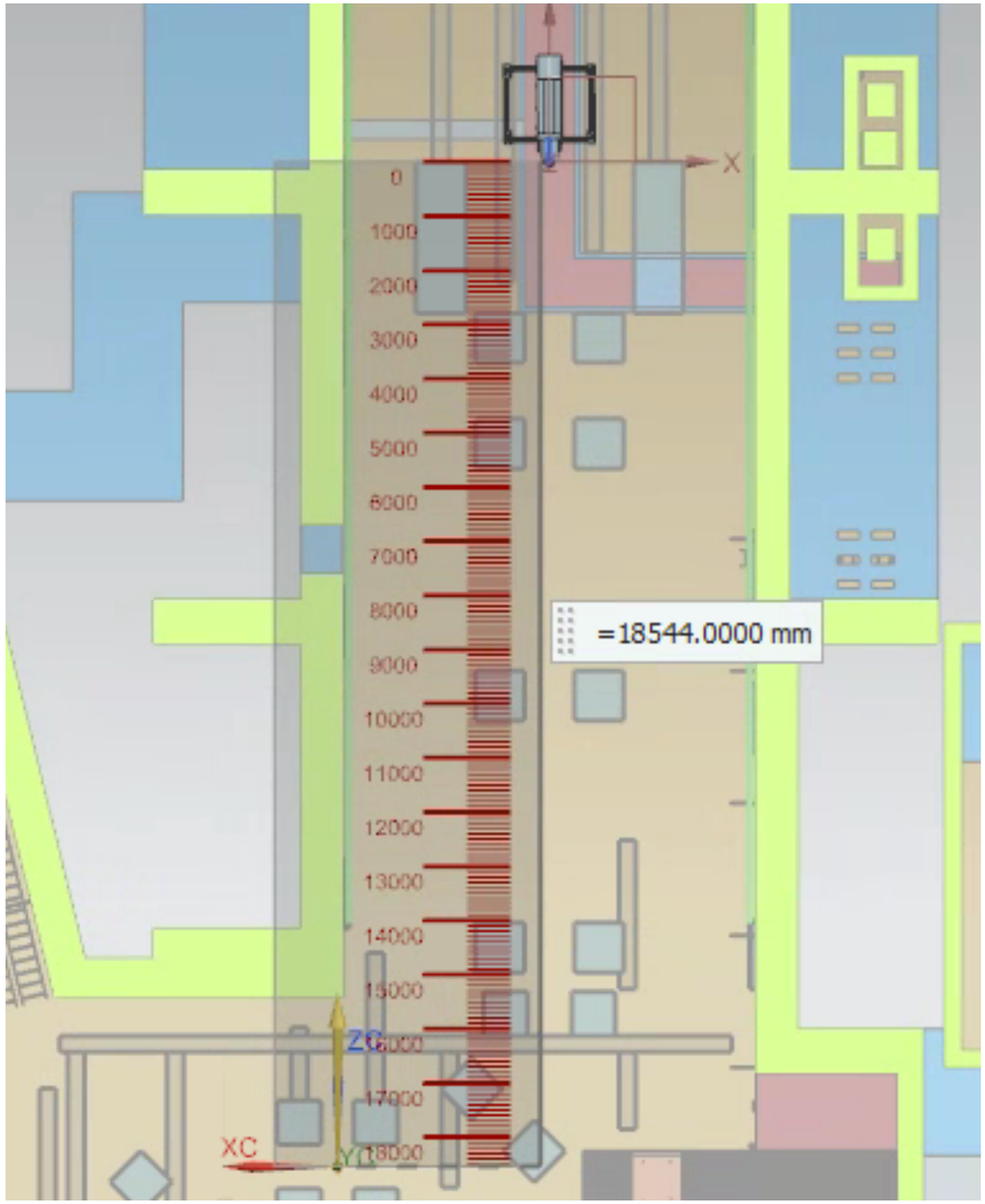
I shape beam ASTM A36

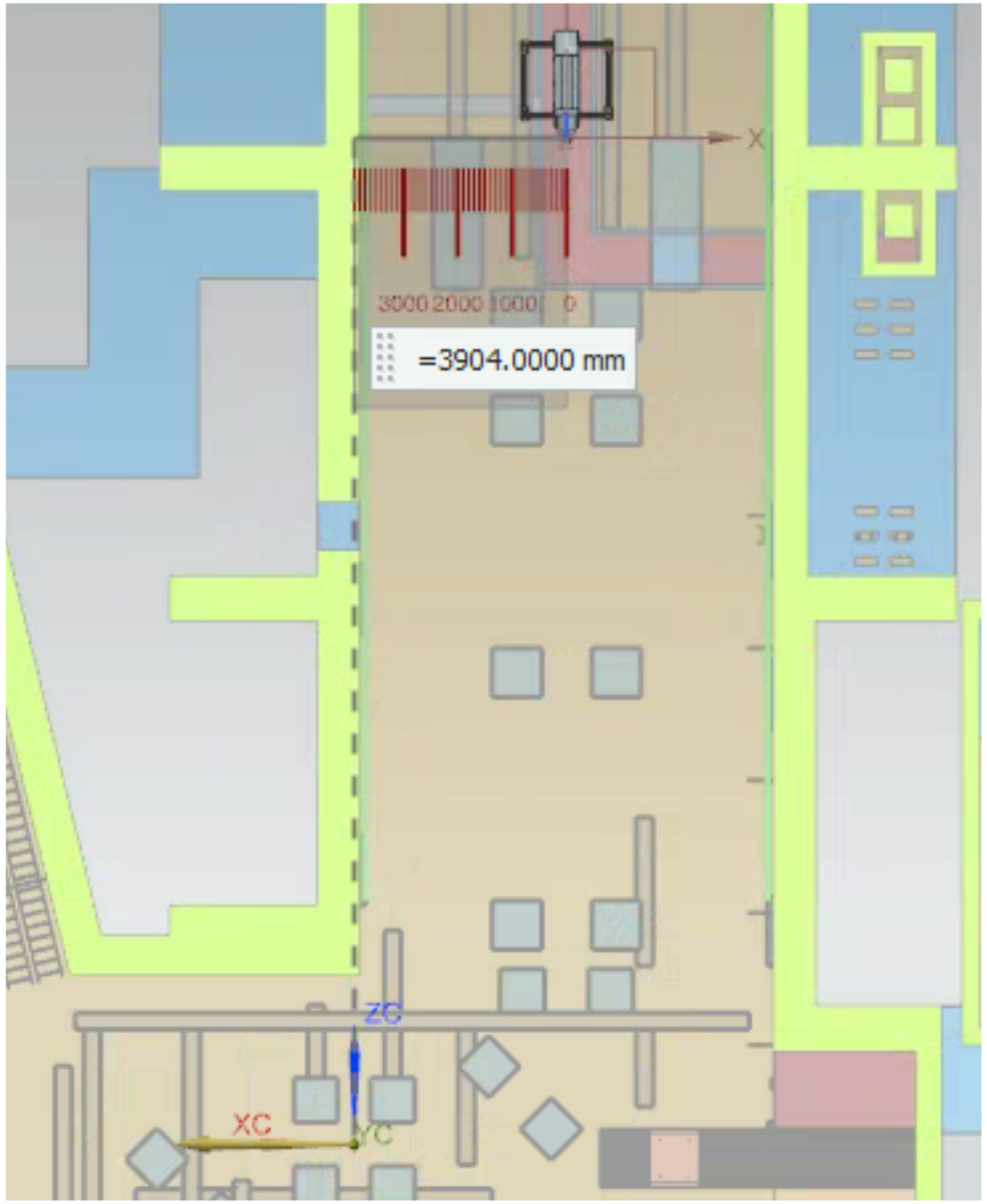
3” x 0.170” x 2,33”

I shape beam ASTM A36

4” x 0.193” x 2.663”

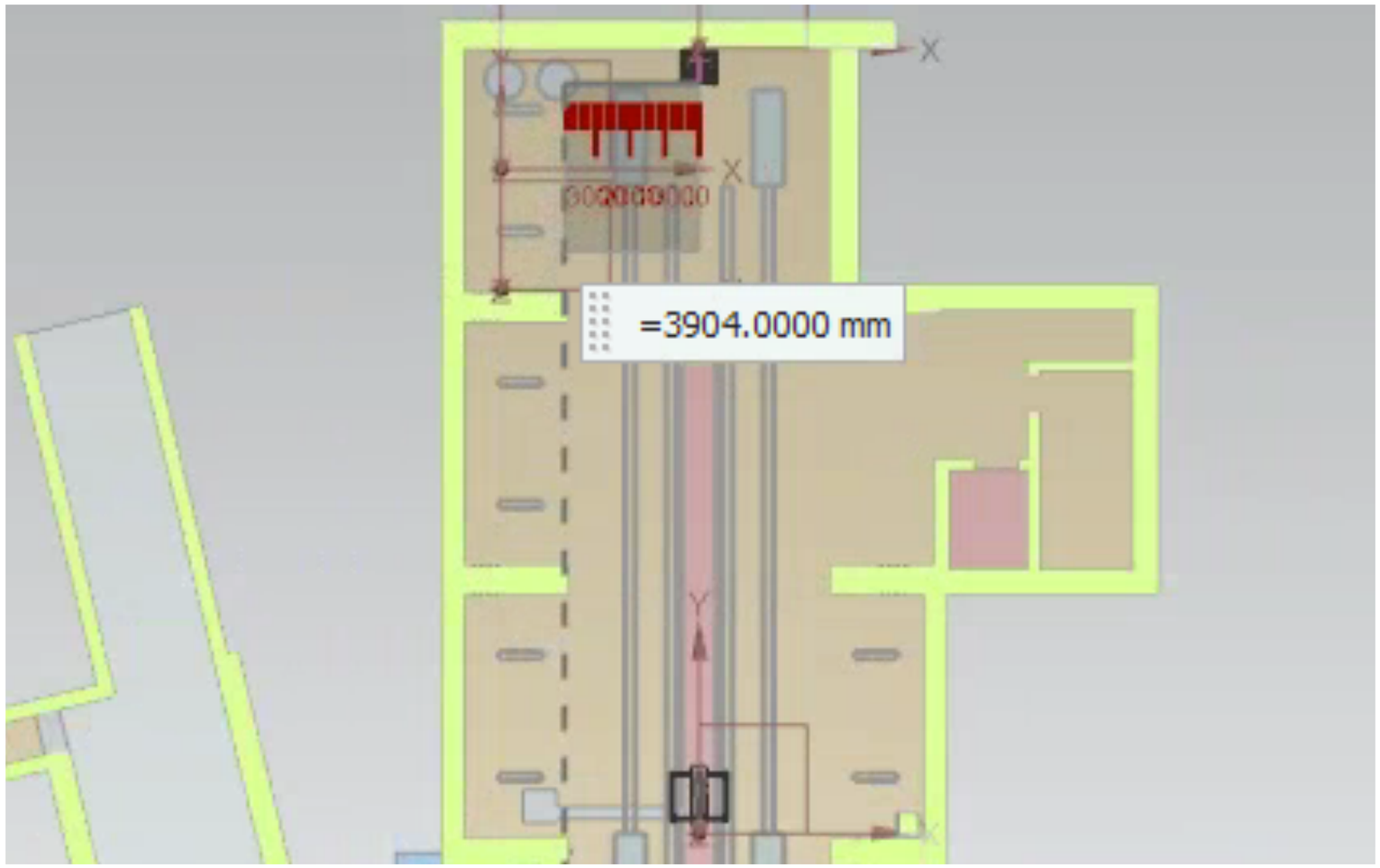
Insert the Upstream and Downstream components of STM in Teamcenter building model



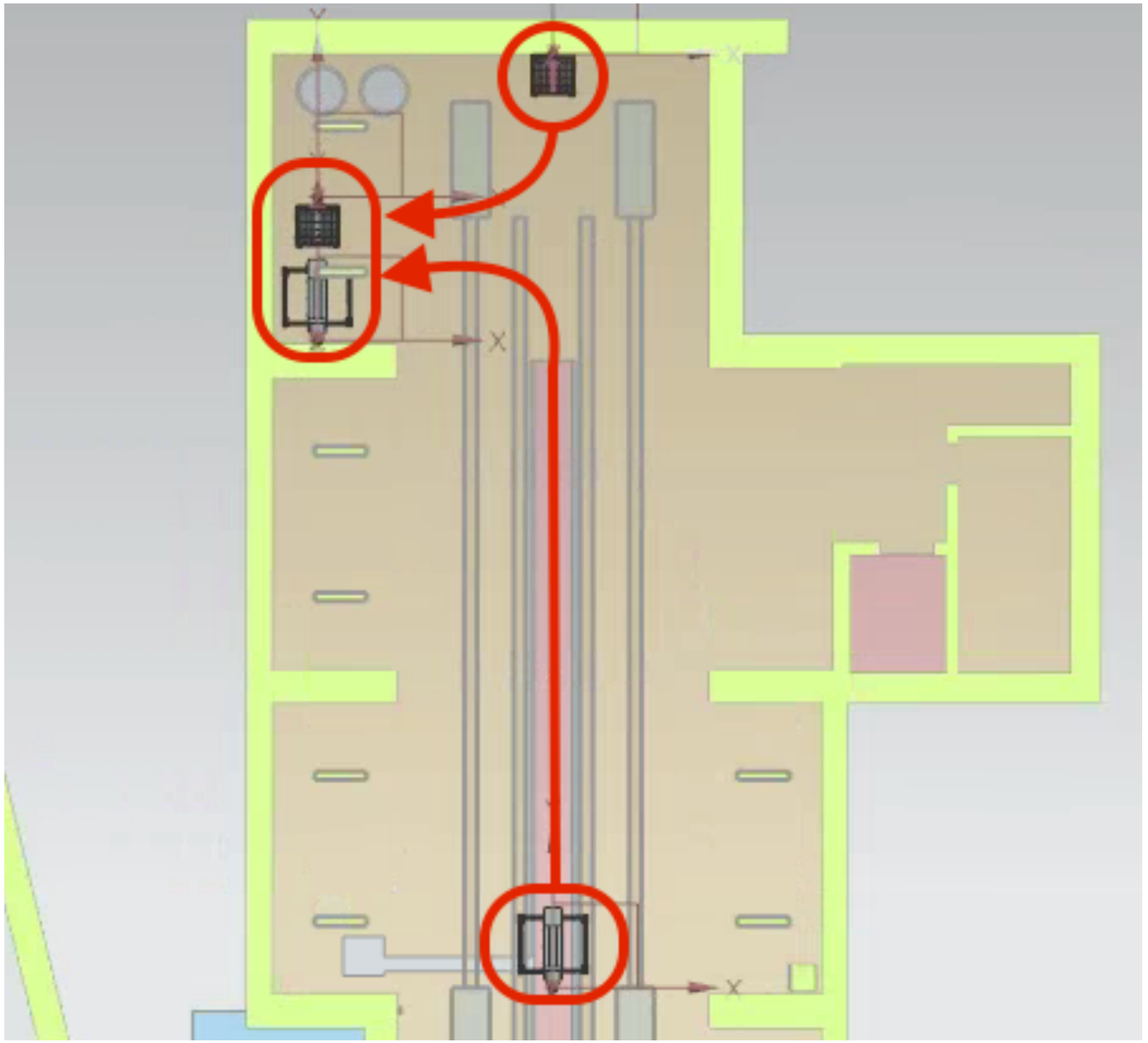


Fermilab

Insert the Upstream and Downstream components of STM in Teamcenter building model



Storage of the STM components during maintenance



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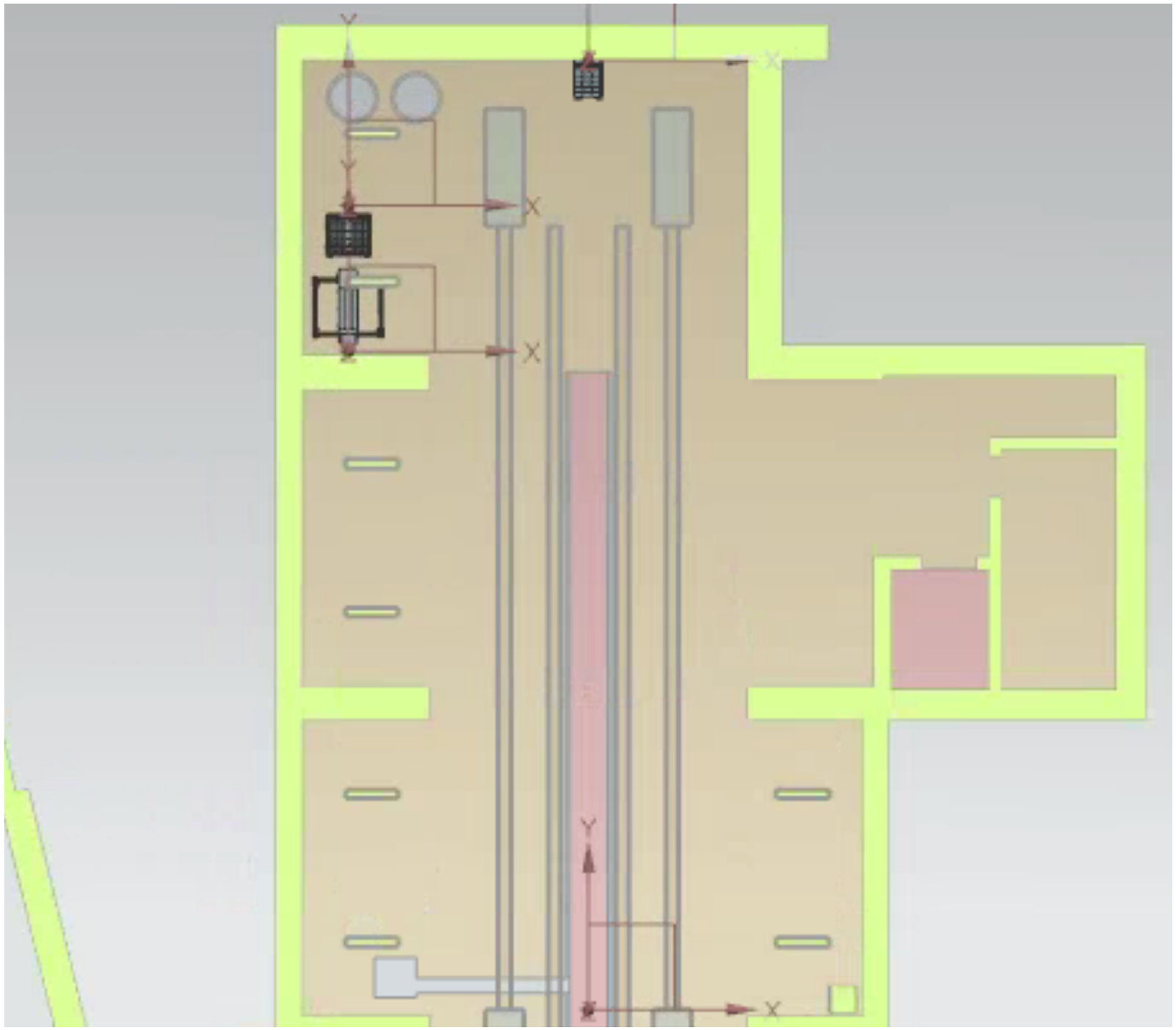
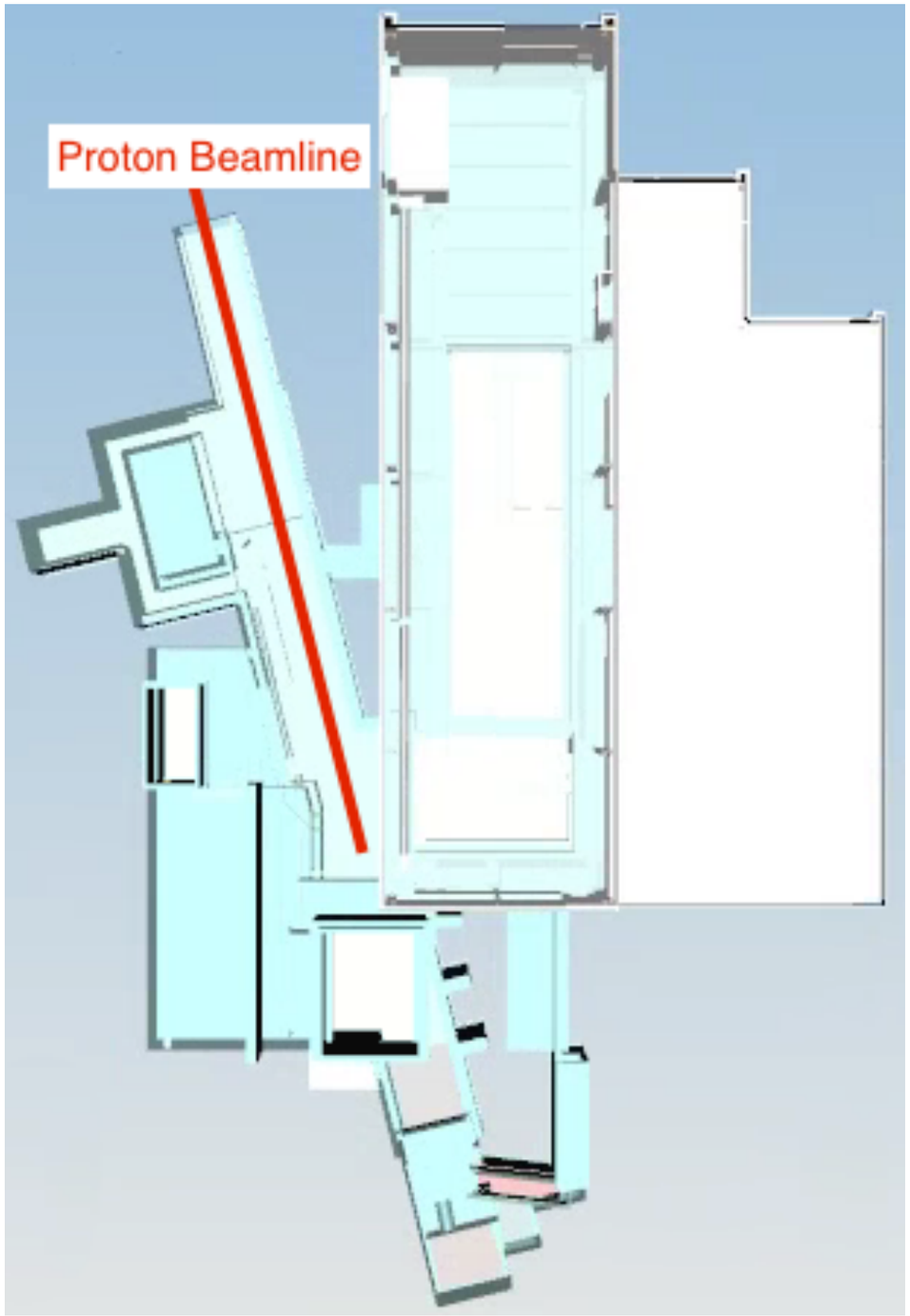
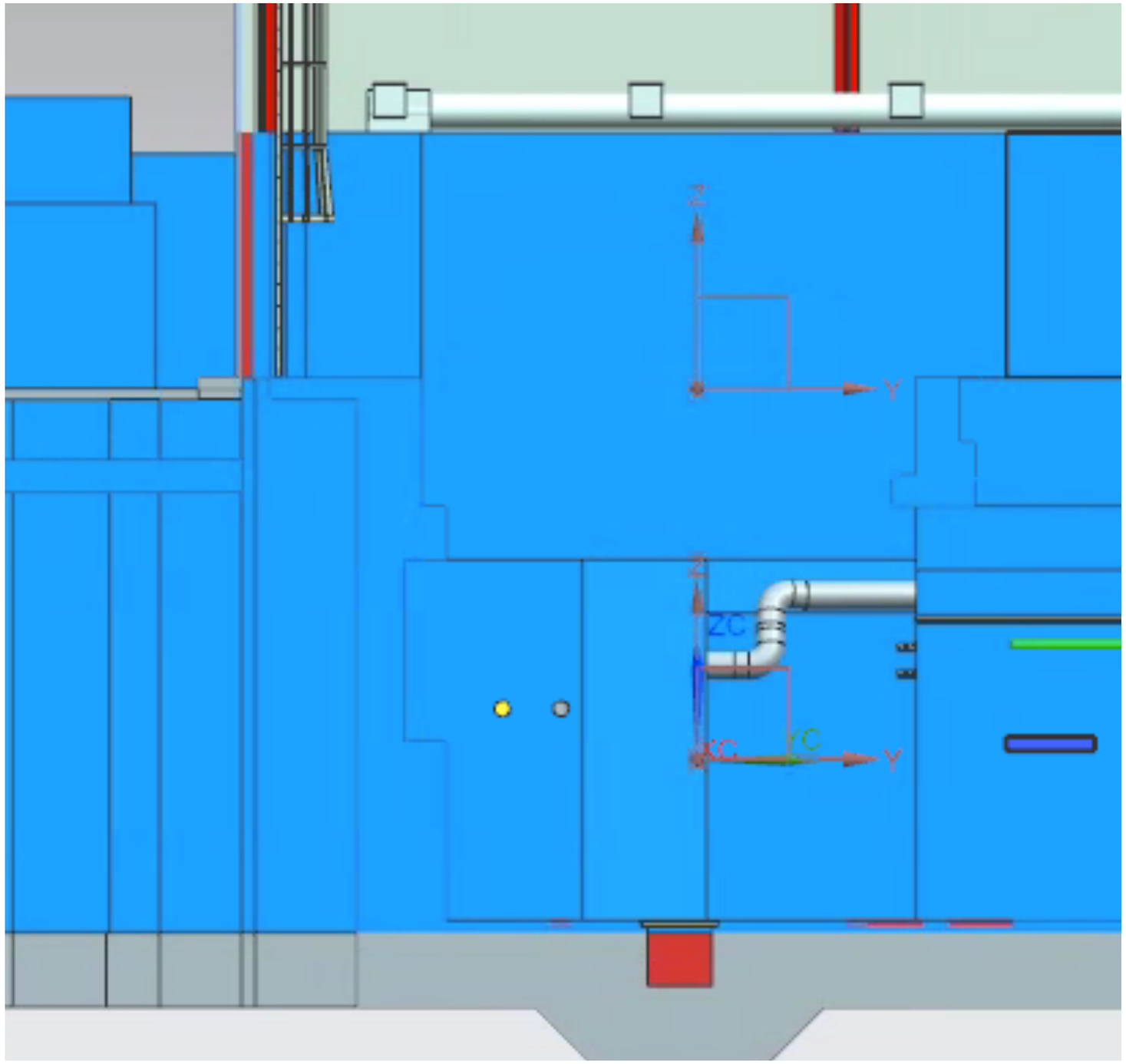


North West Shield Block Pile





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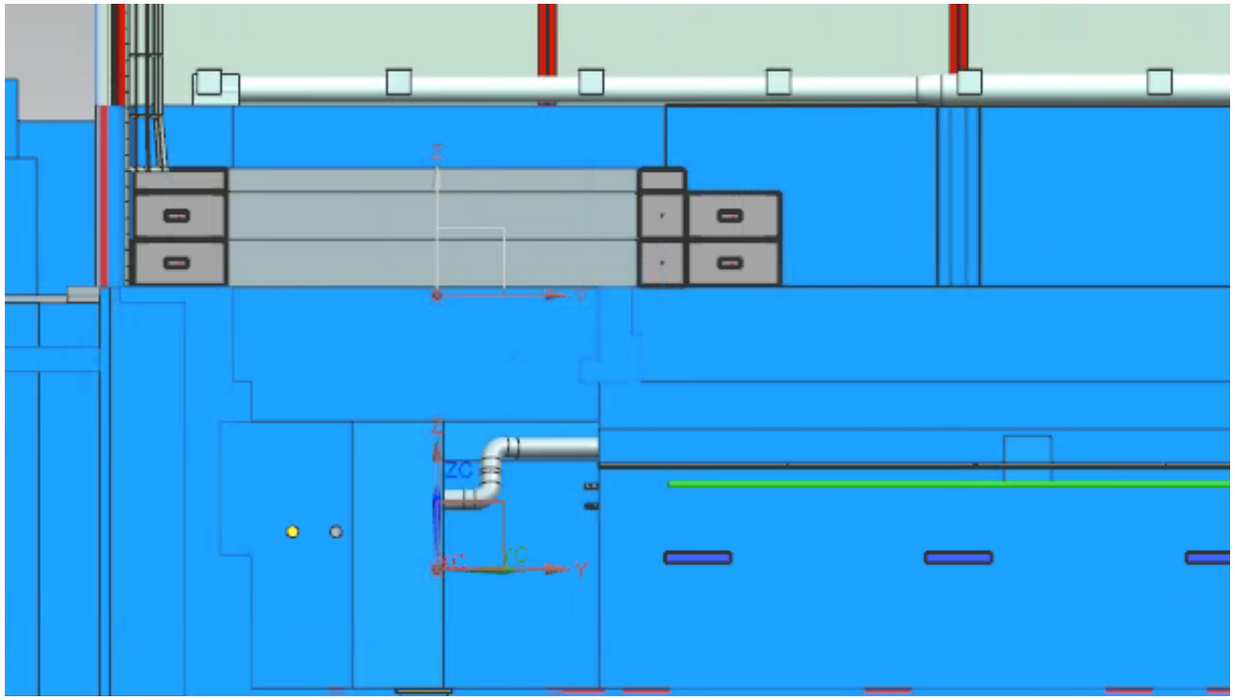
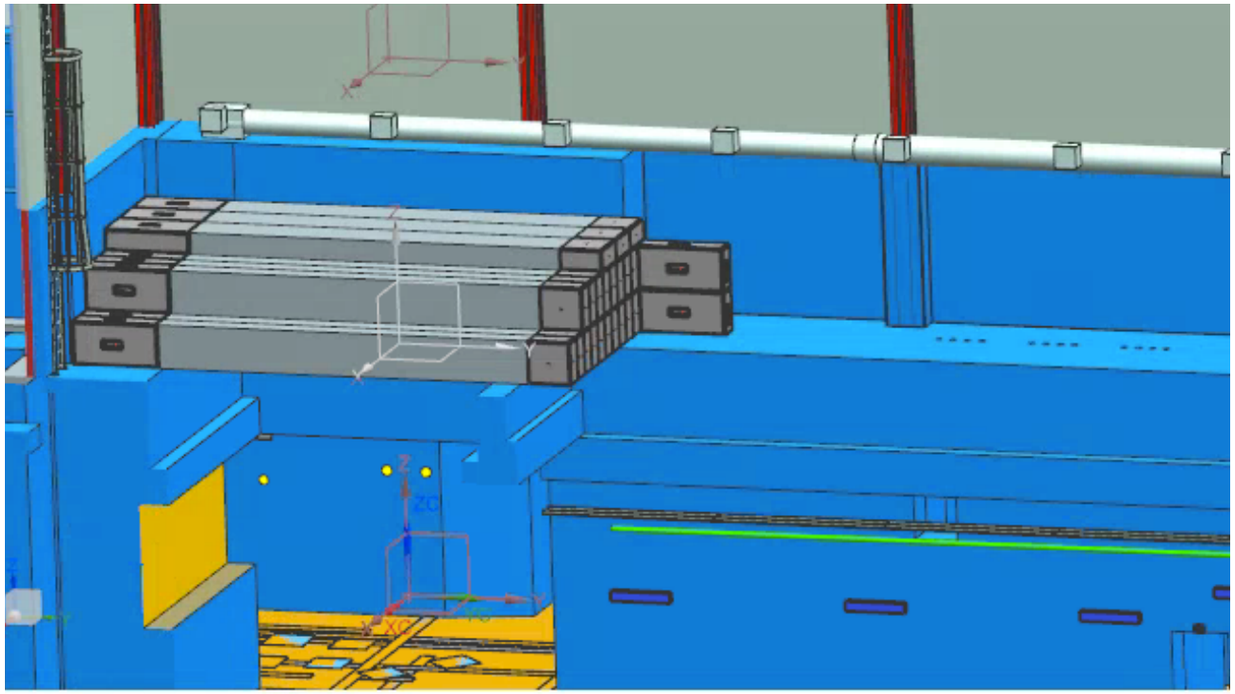
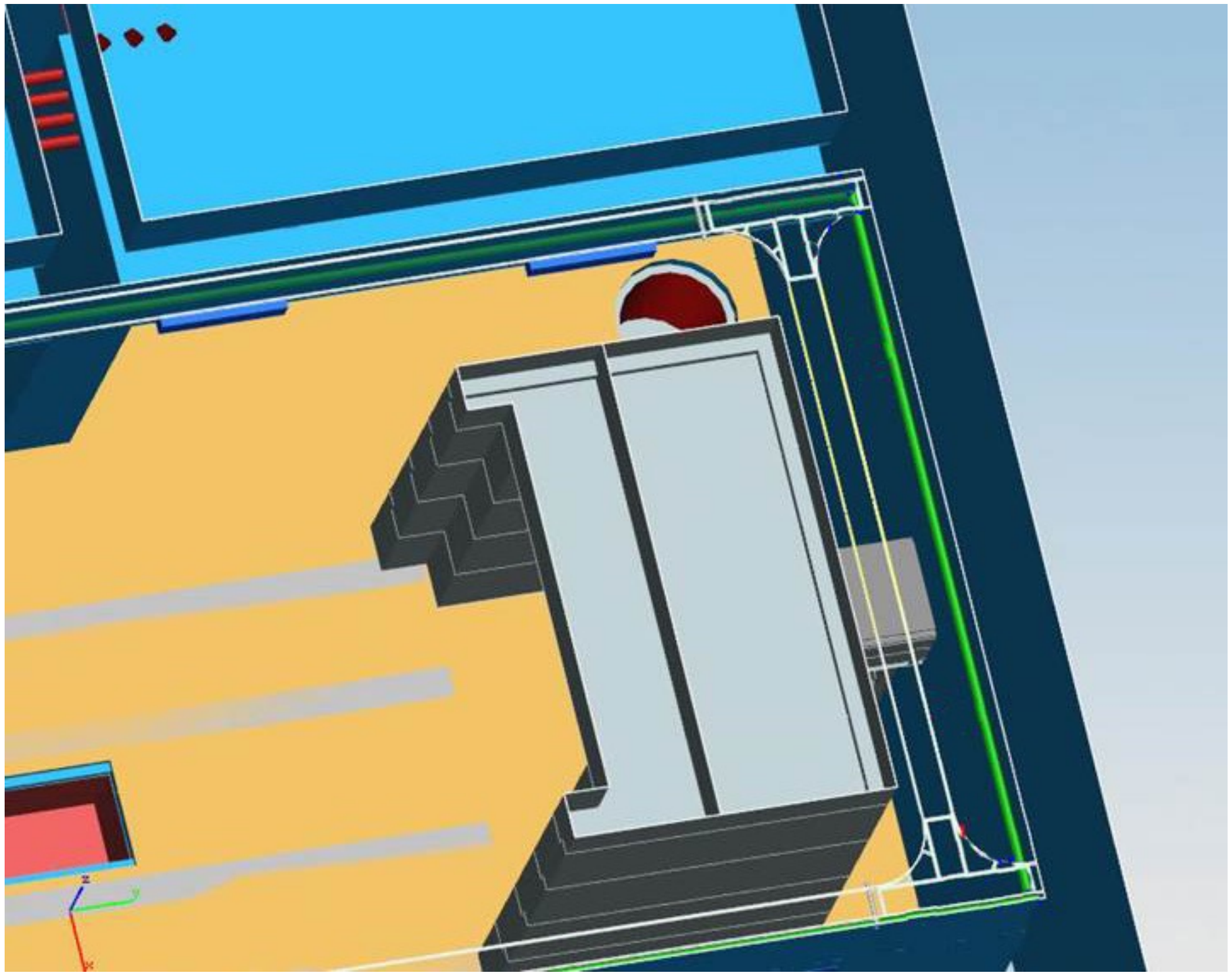




TS Hatch			
Bottom Layer	20	*SP23H*	1.5 x 3.0 x 23 w/ haunch
2nd layer	20	*SP23*	1.5 x 3.0 x 23
3rd, 4th & 5th layer TS Hatch	23	*SP26*	1.5 x 3.0 x 26
3rd, 4th & 5th layer West	23	*D*	1.5 x 3.0 x 6
3rd, 4th & 5th layer East	23	*E*	1.5 x 3.0 x 3
Far East	2	*D*	1.5 x 3.0 x 6

Cable trays around East end of detector hall



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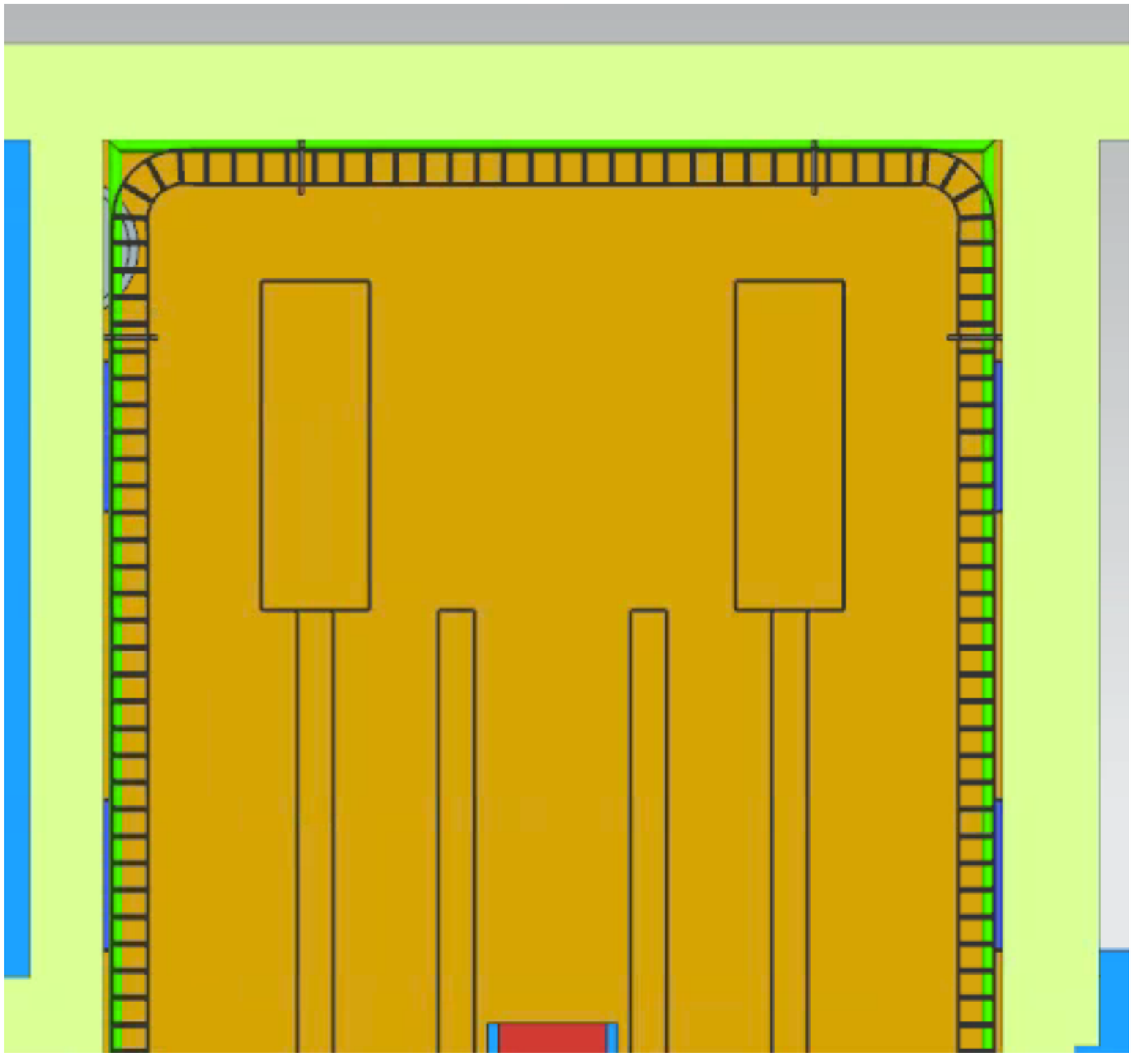
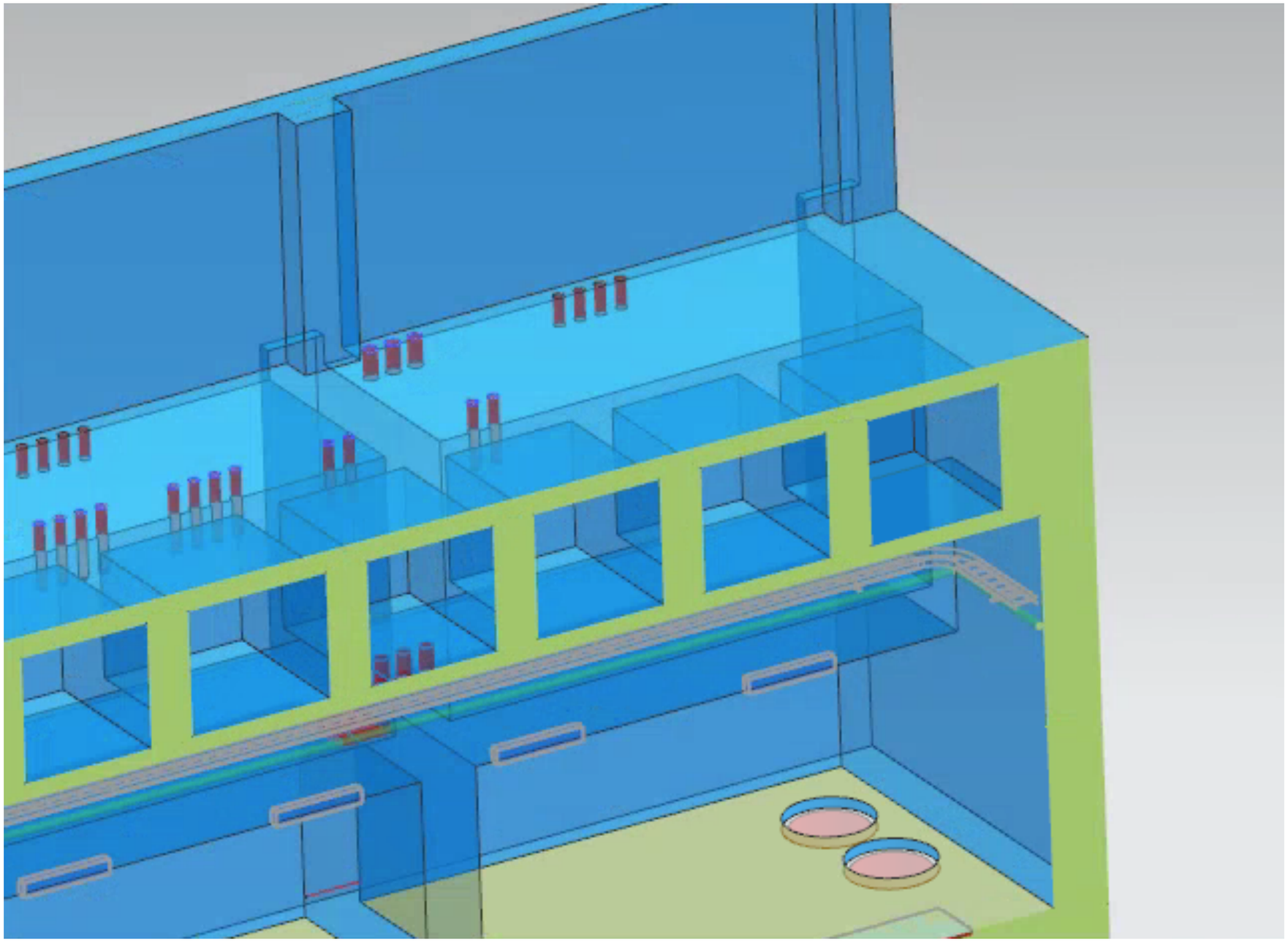


Penetrations



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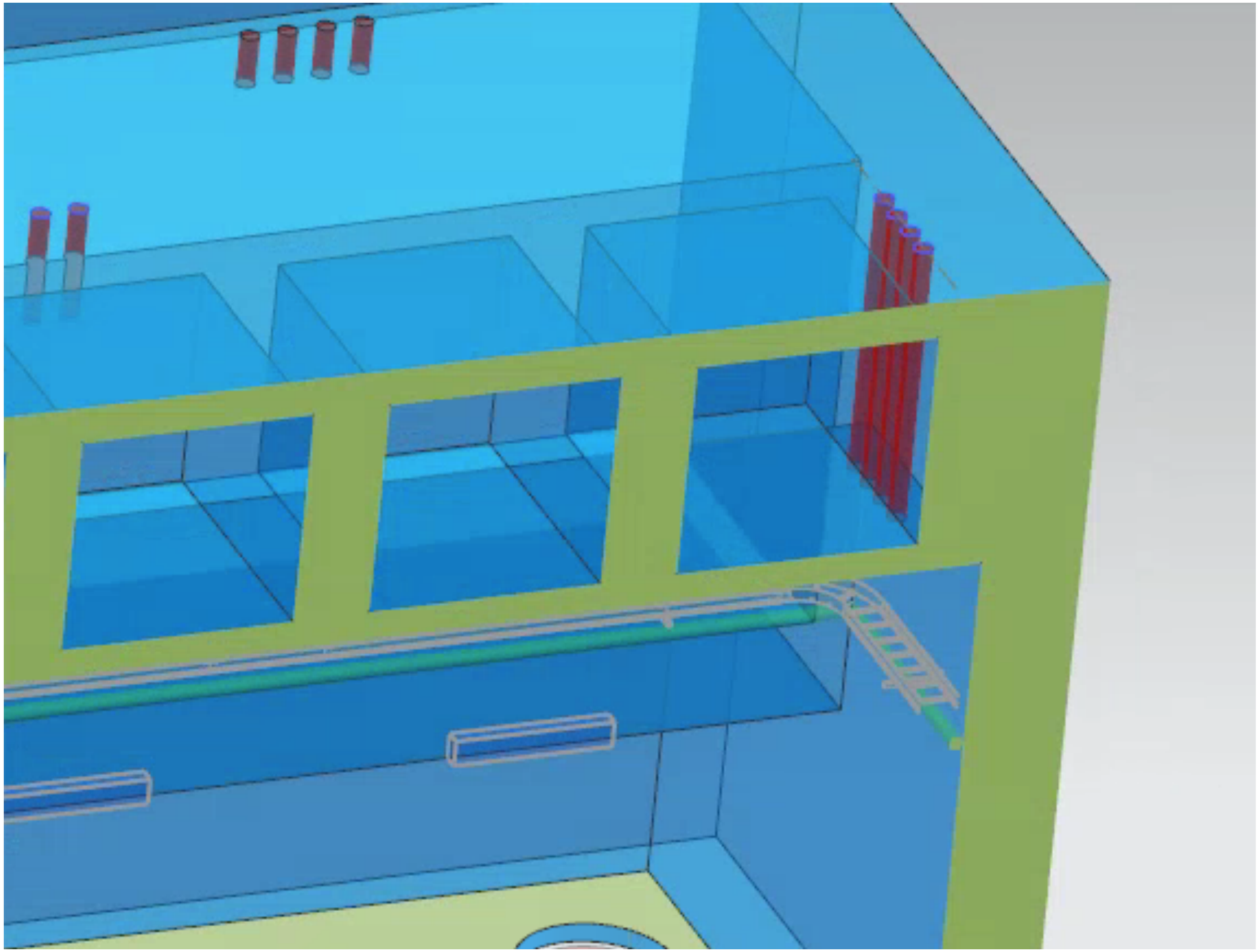

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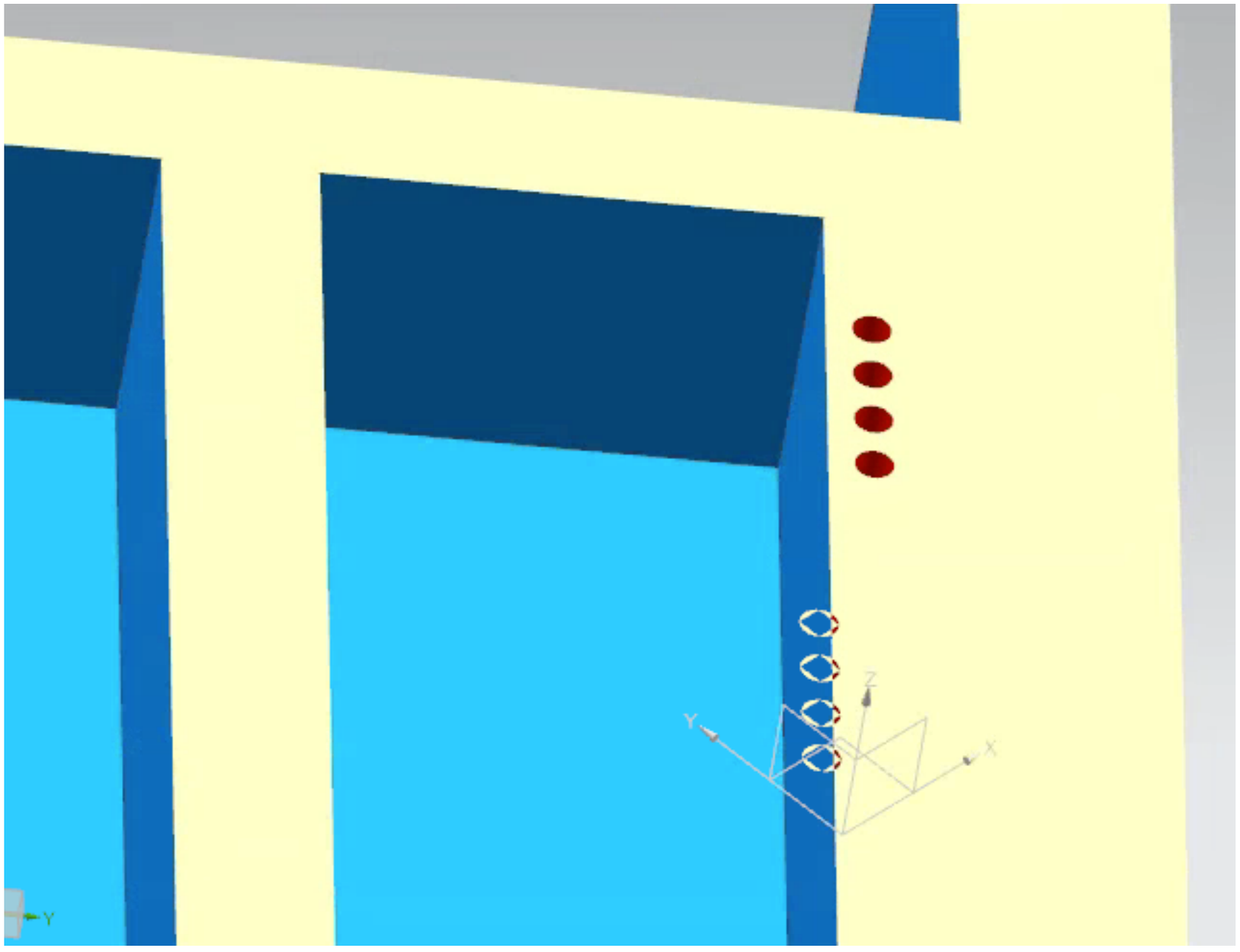
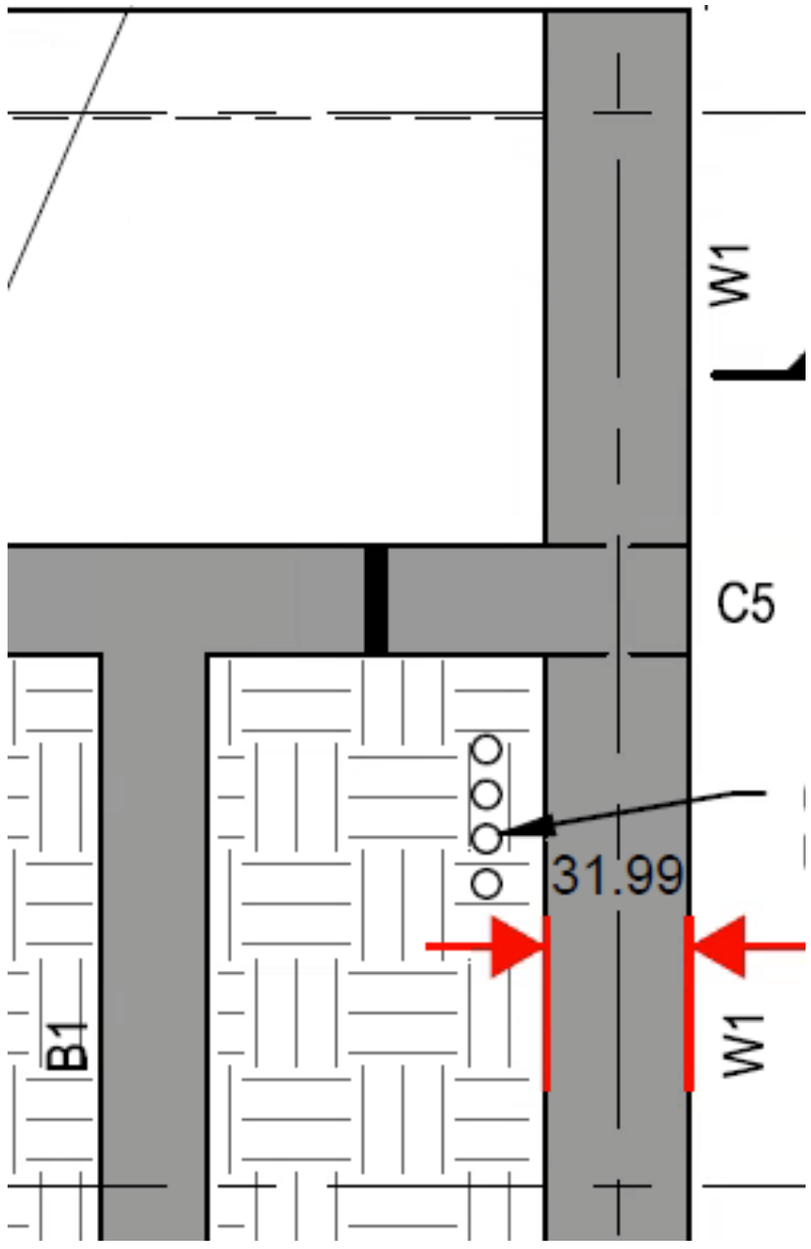
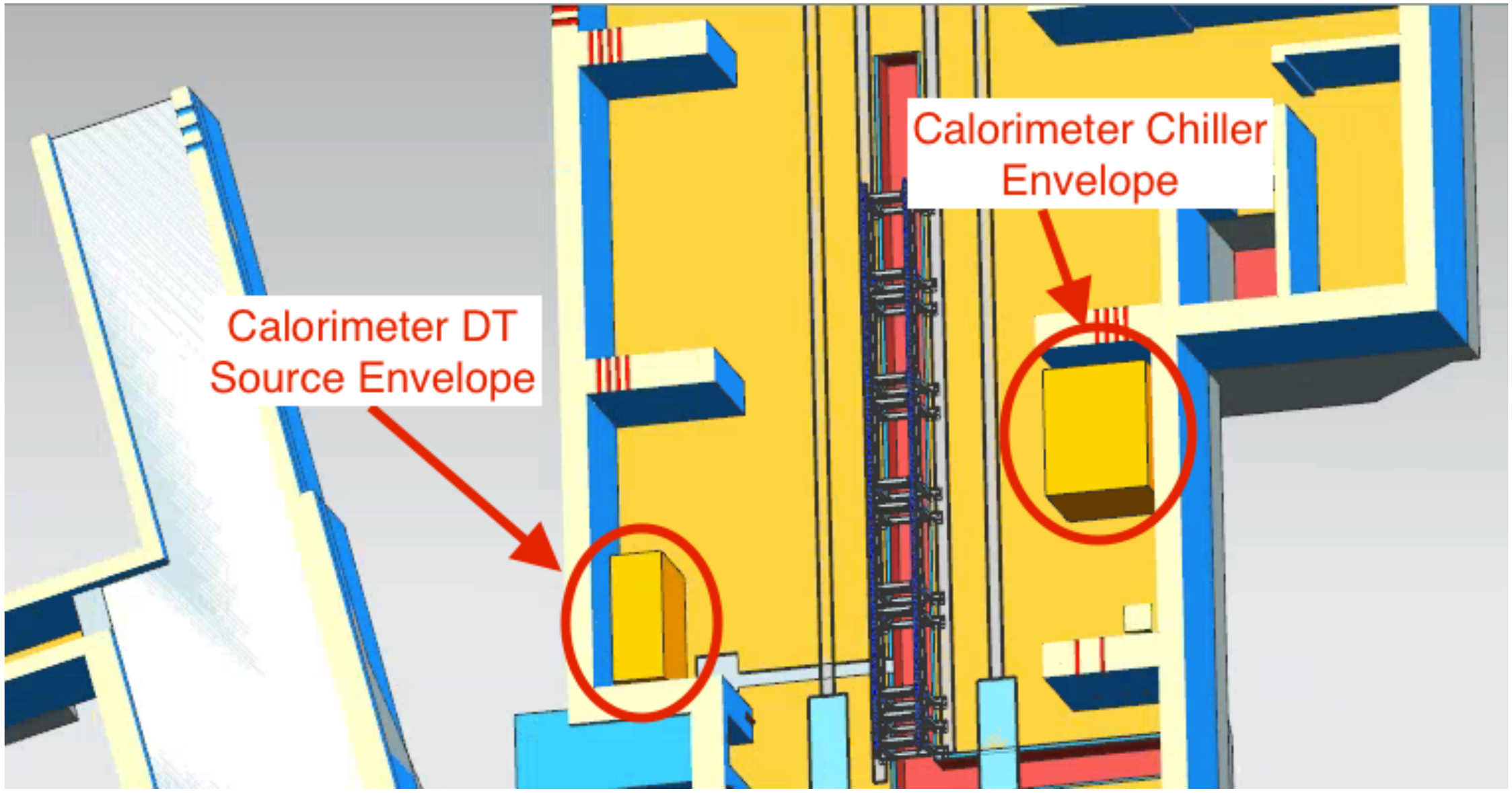




Placeholders for calorimeter infrastructures



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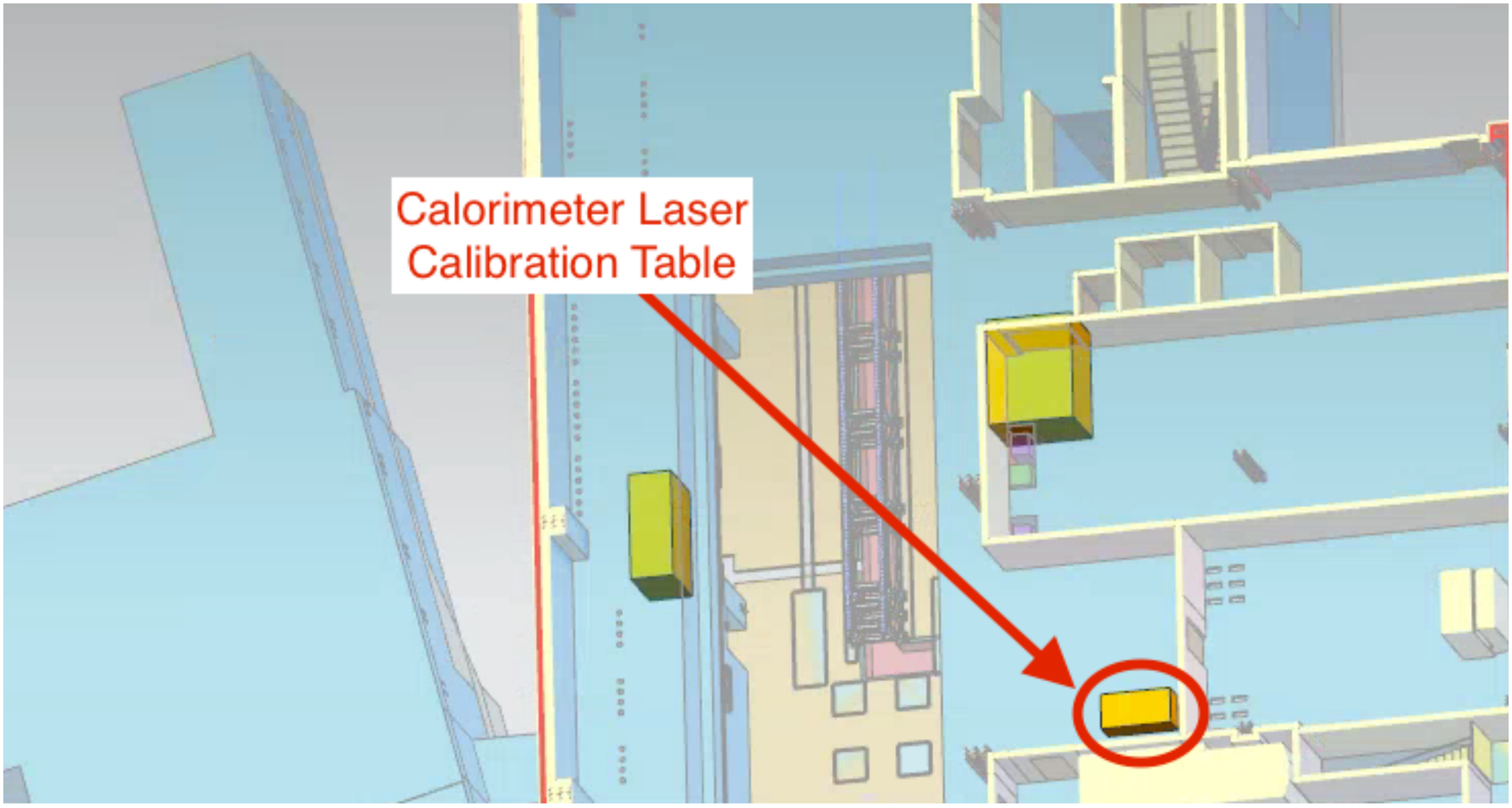
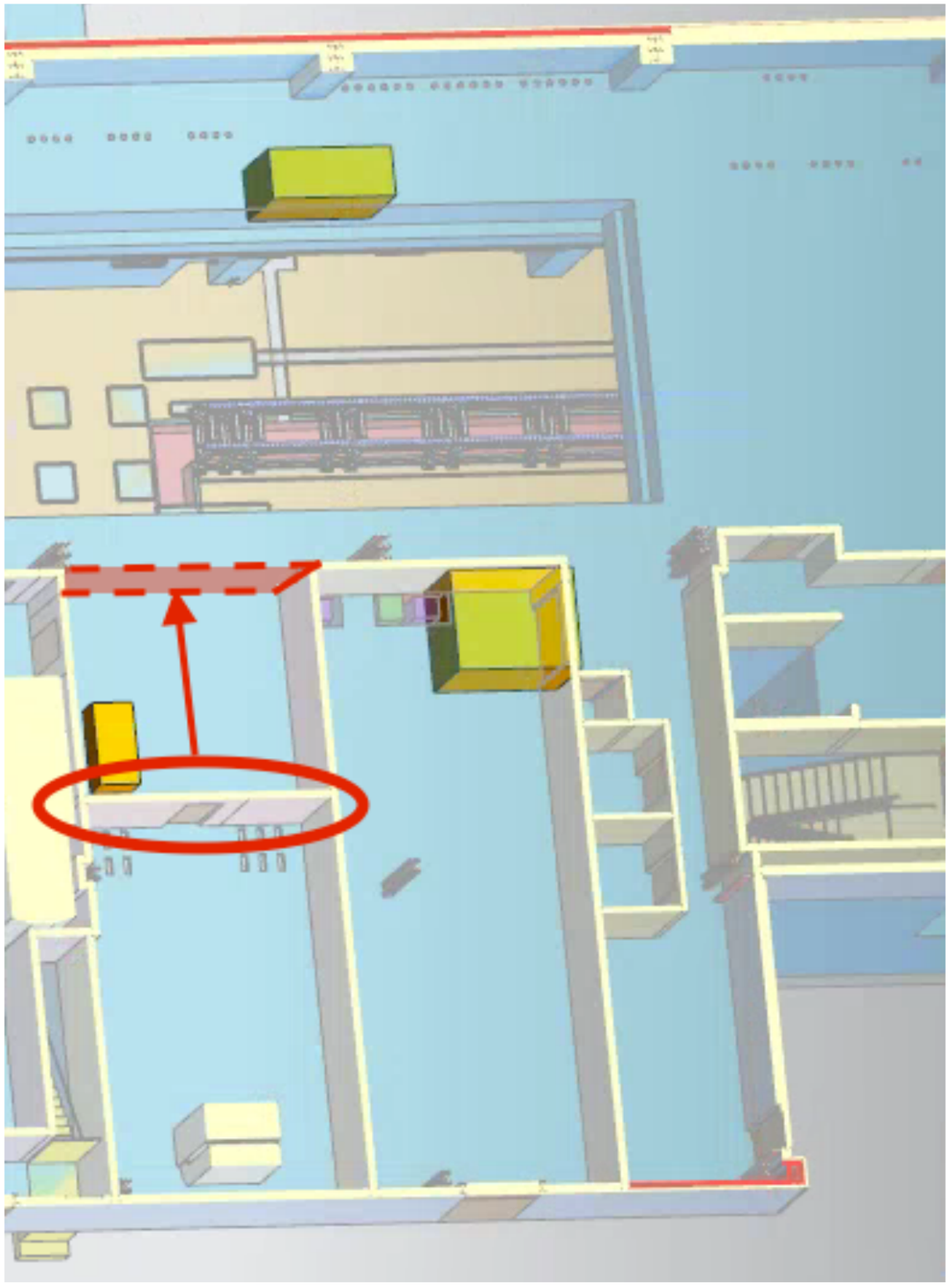
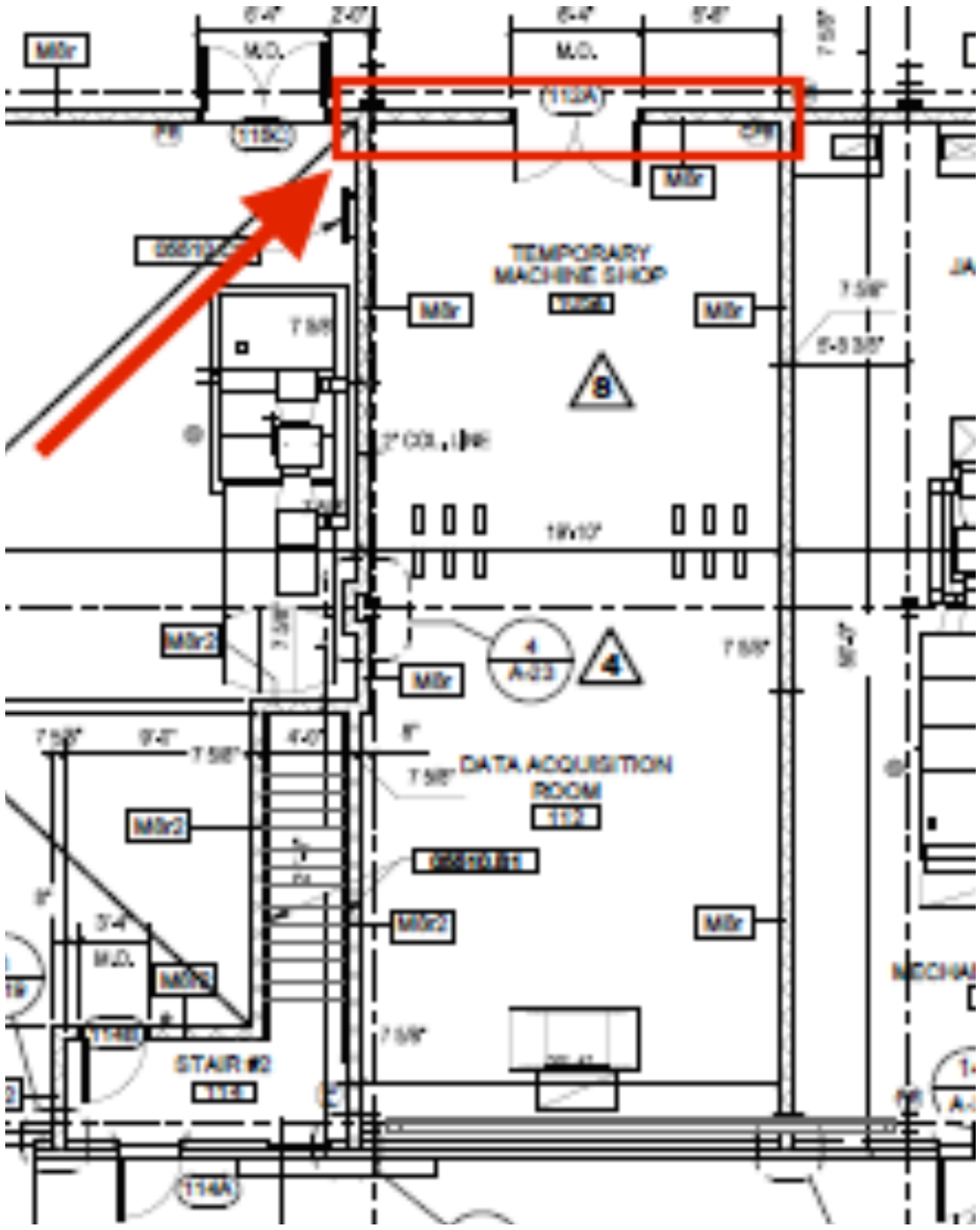


DAQ room wall

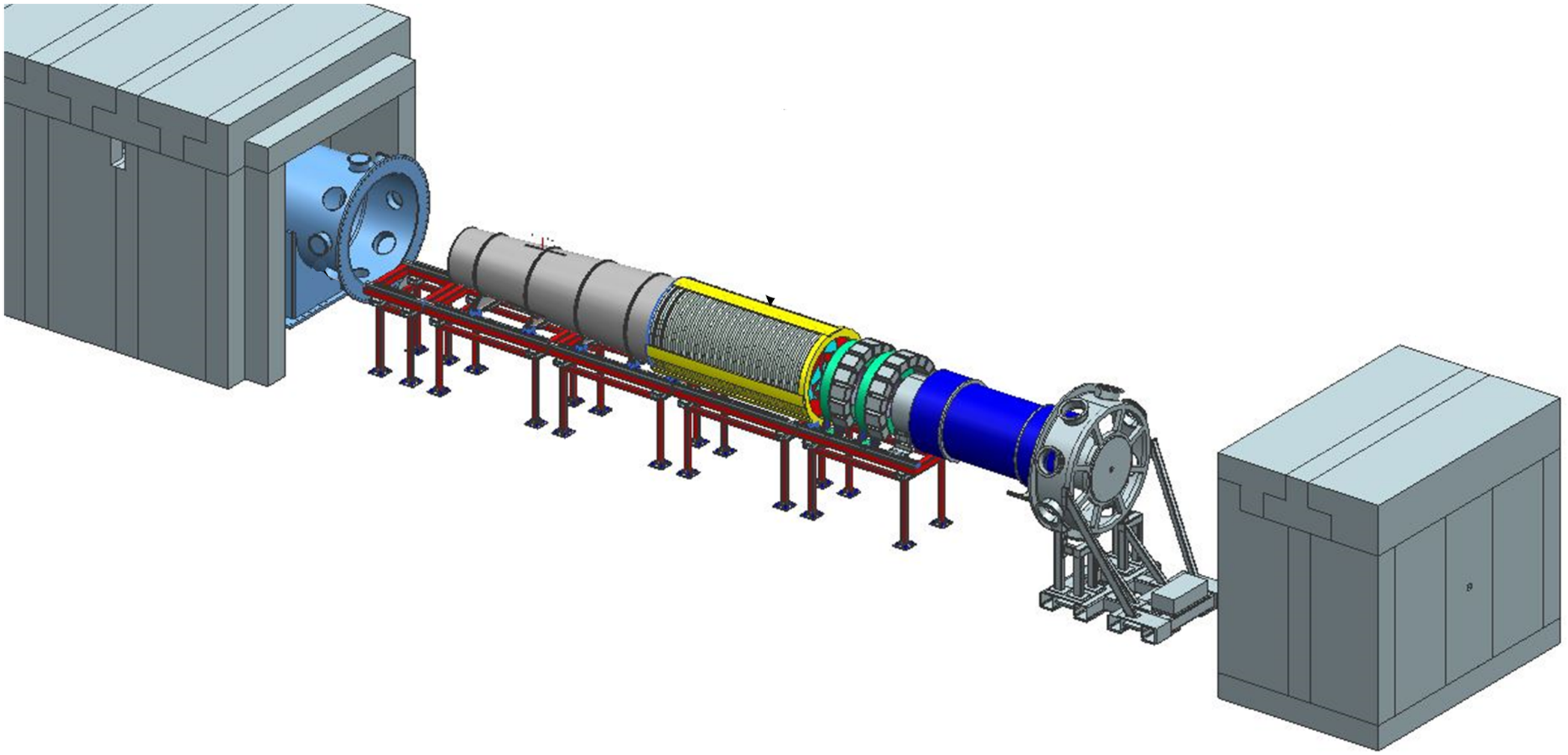




Fermilab

Detector train

Parking location for external rail stands



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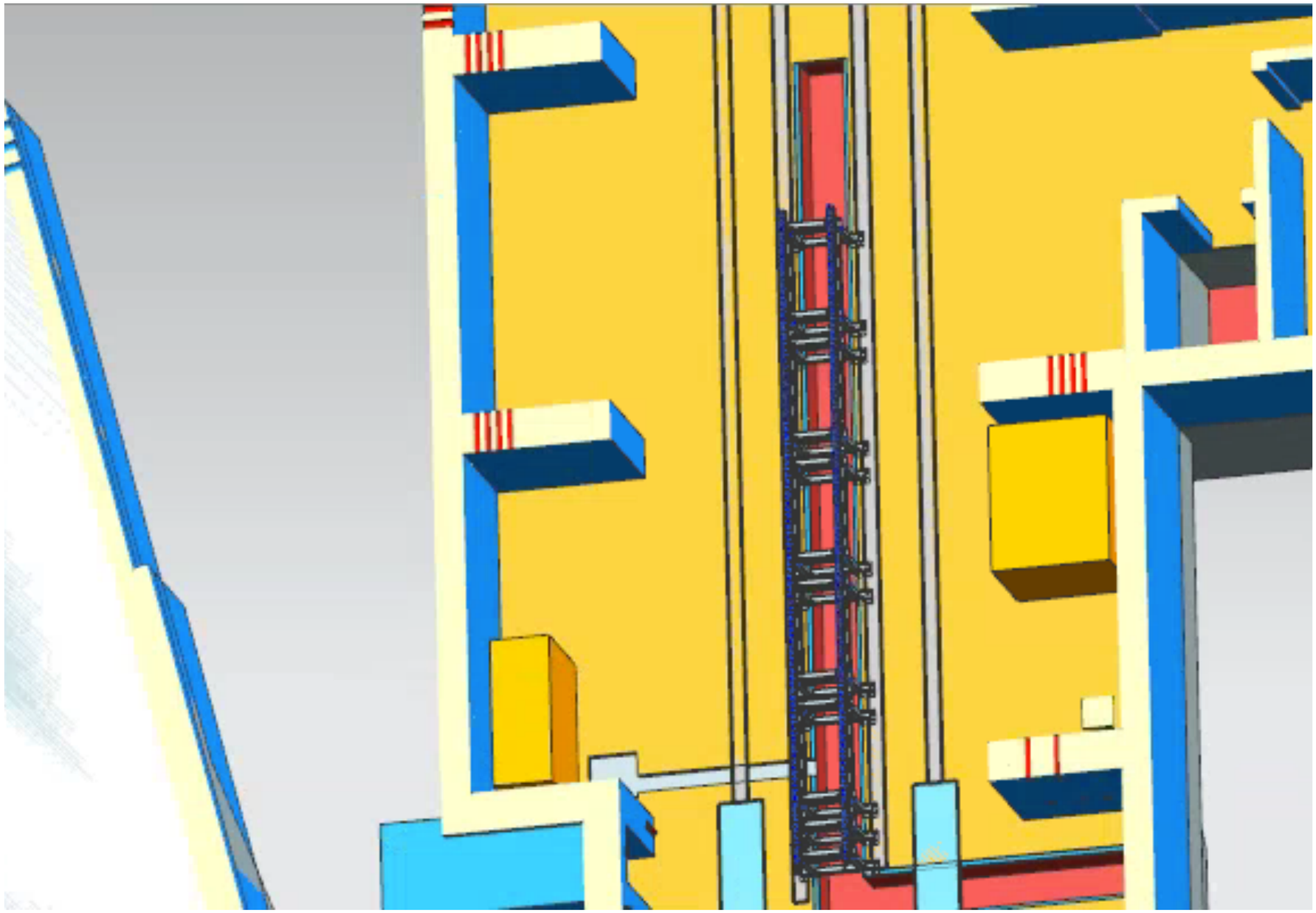

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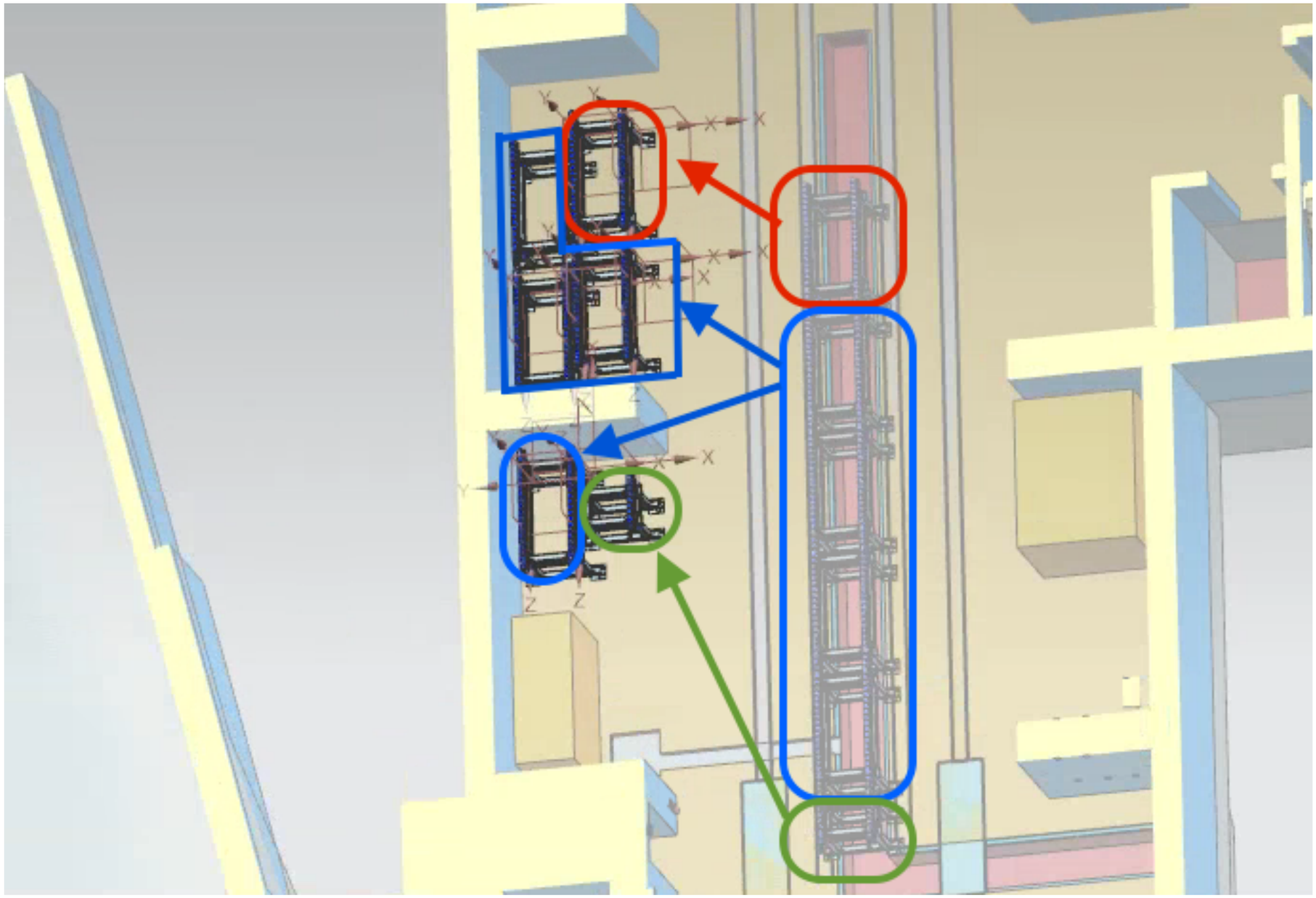
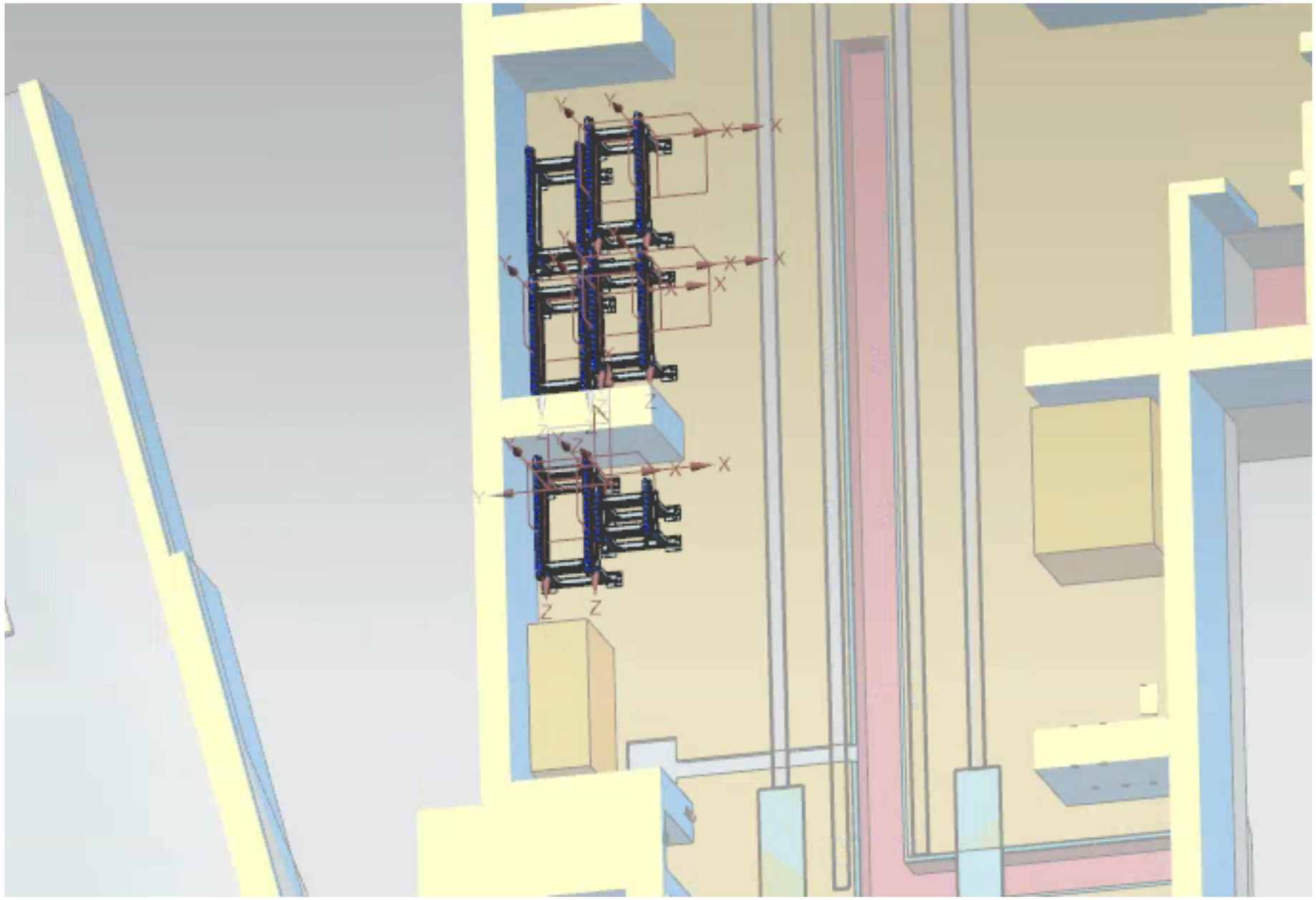
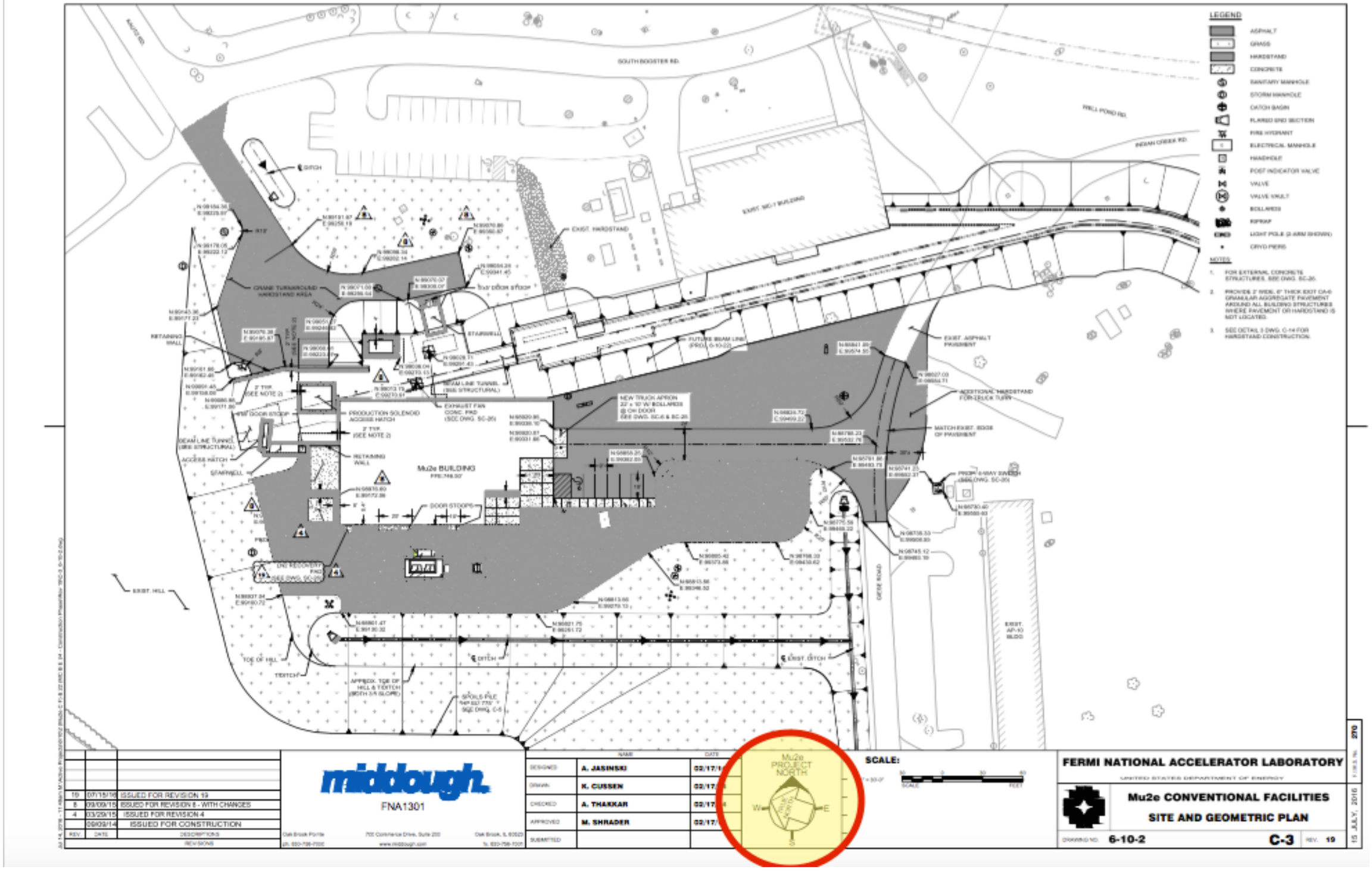


Detector train

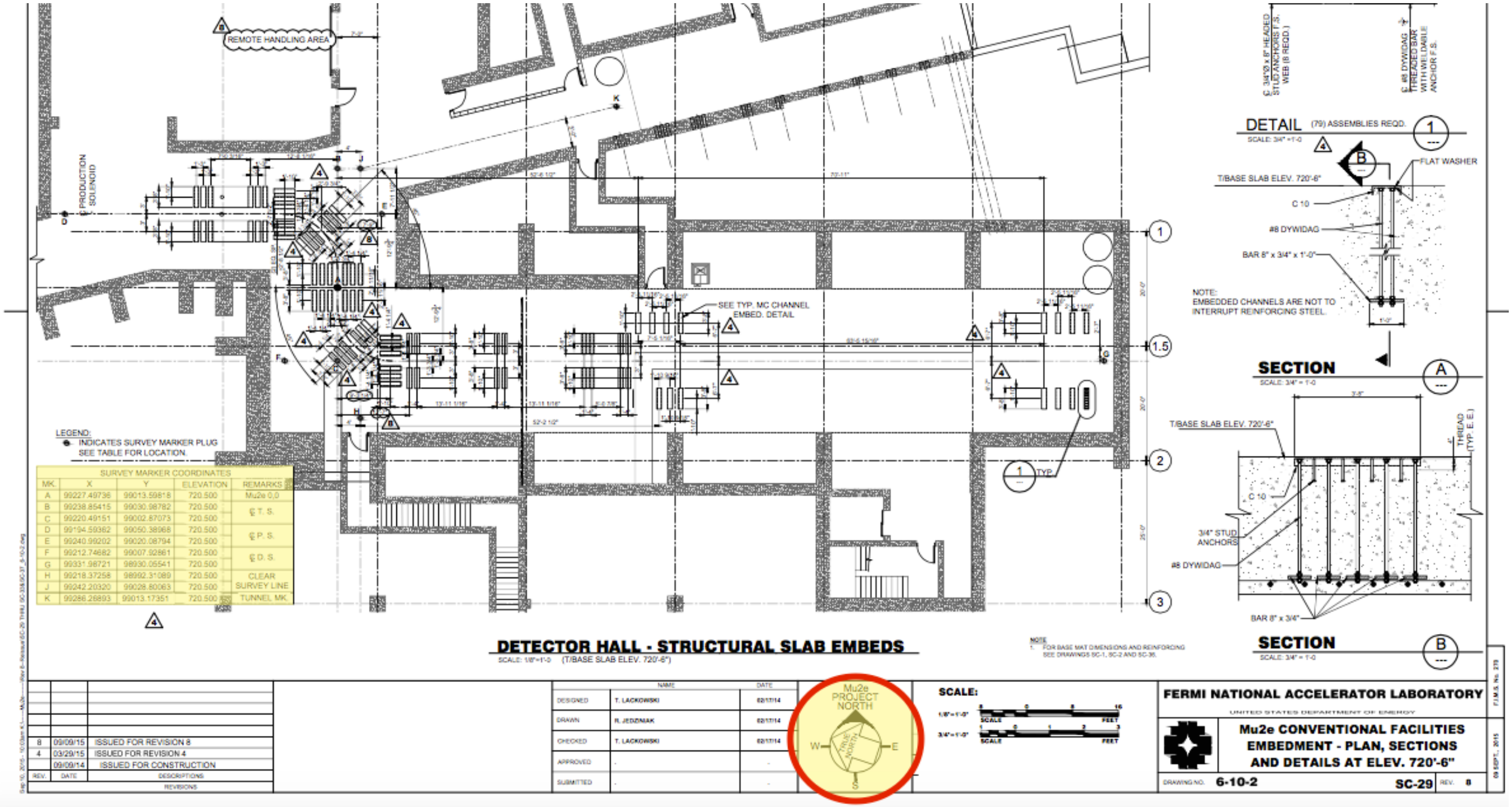
Parking location for external rail stands



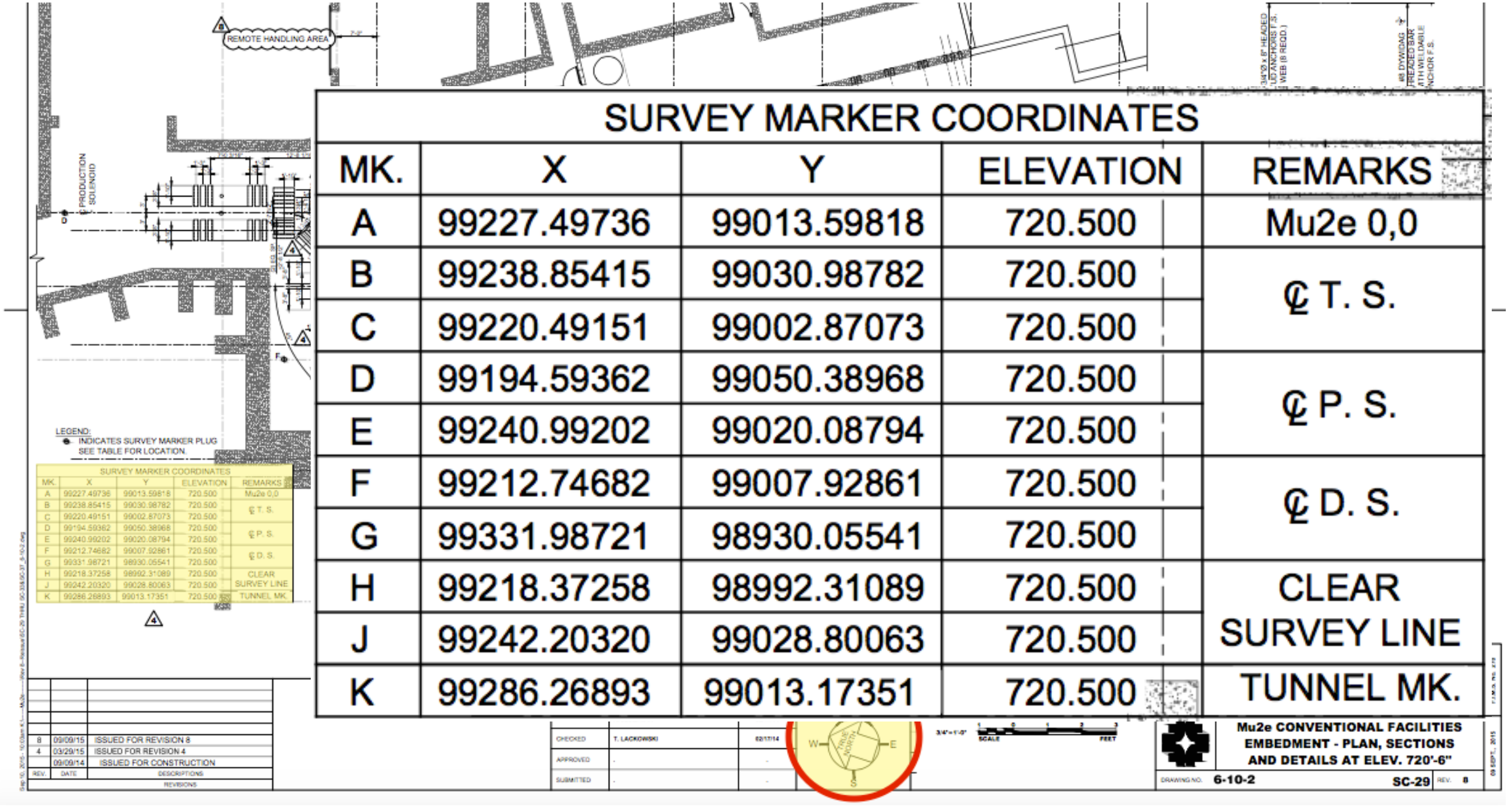
Outdoor features



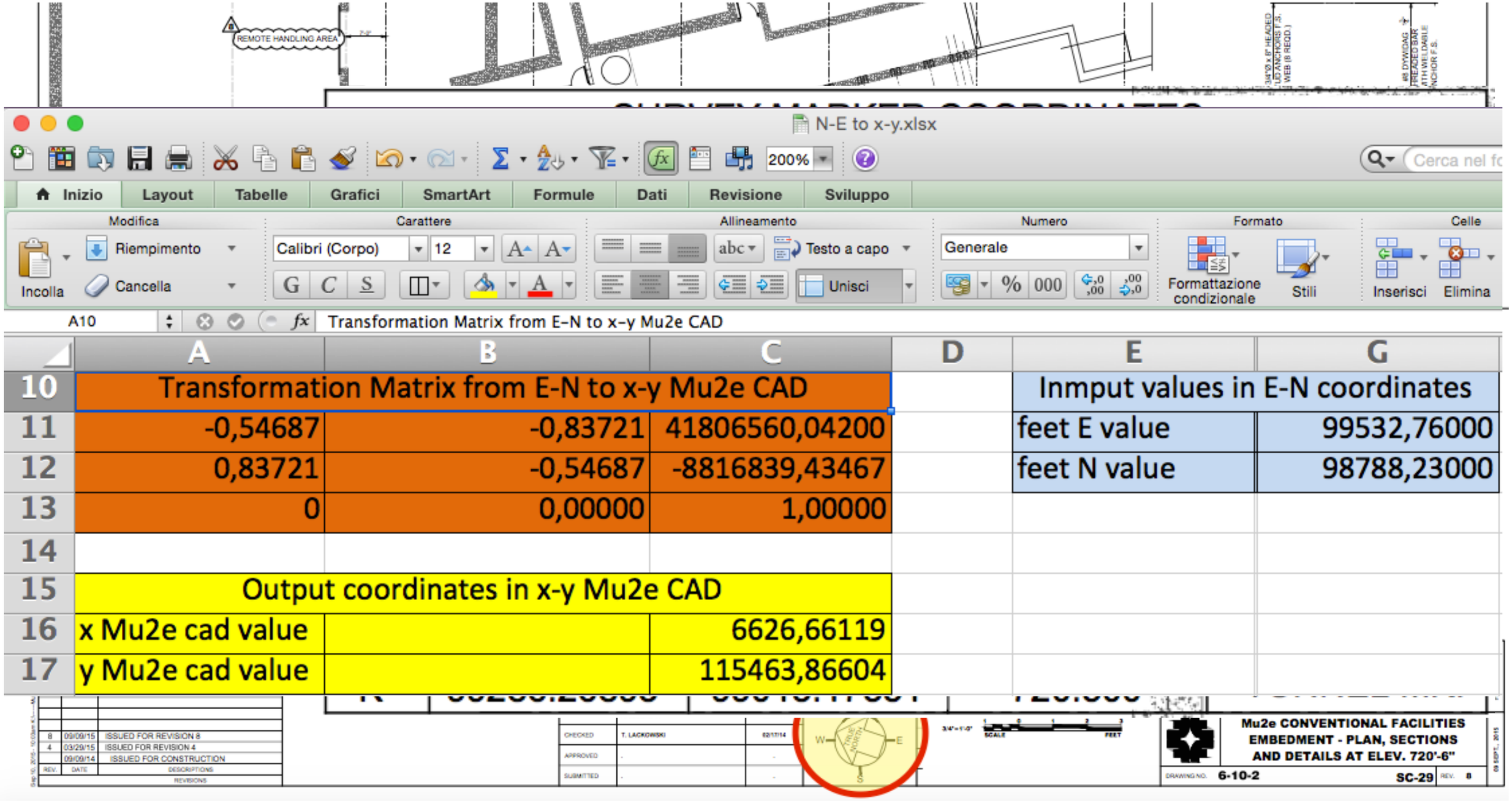
Outdoor features



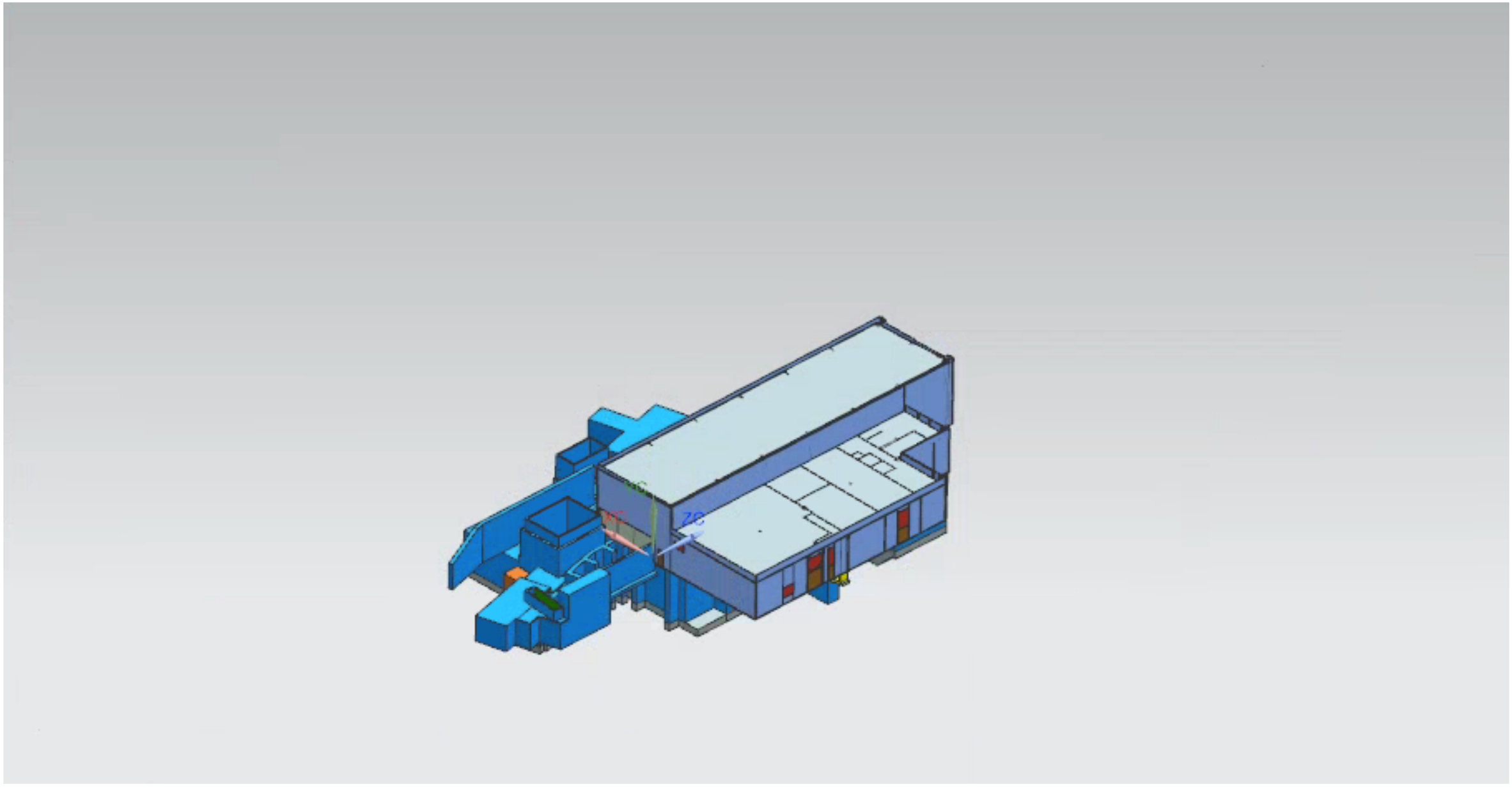
Outdoor features



Outdoor features

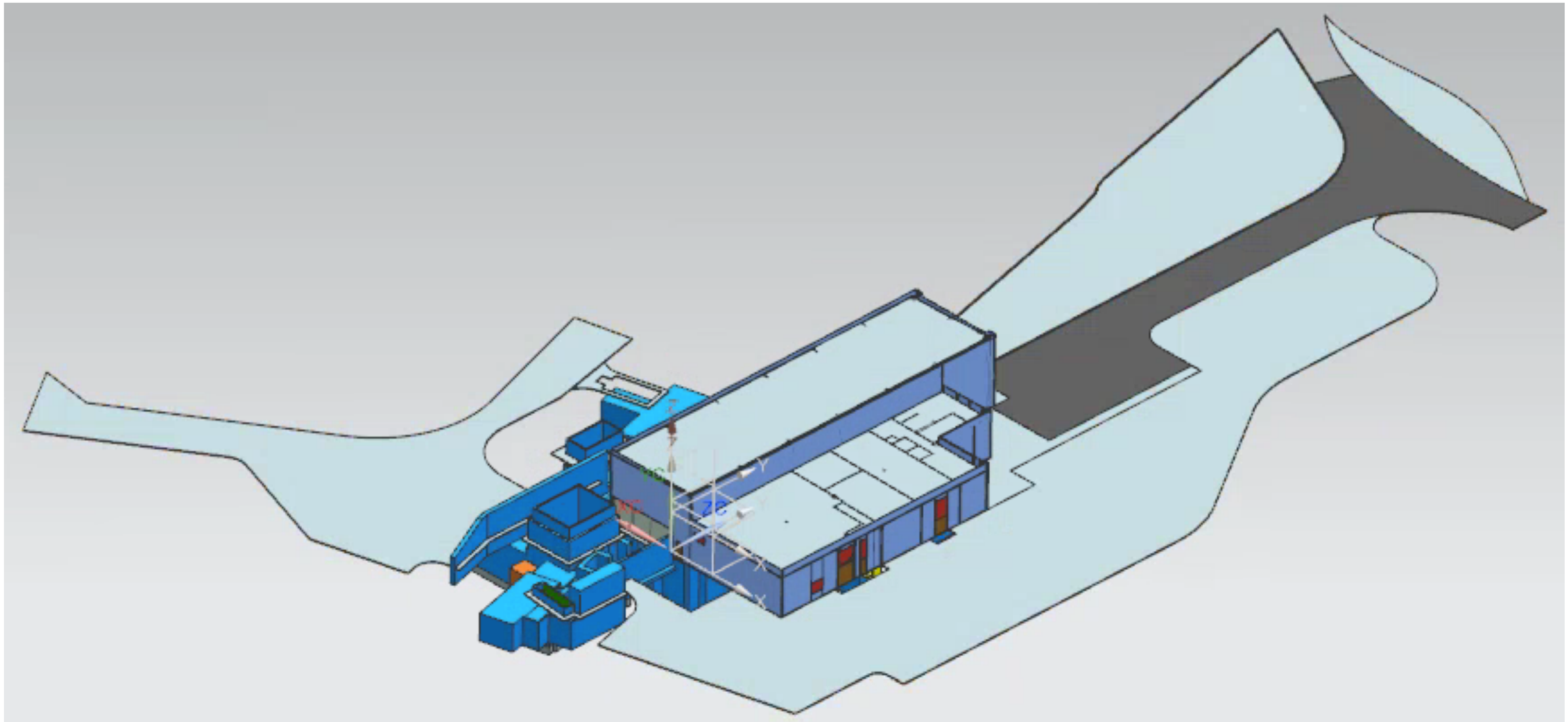


Outdoor features



Outdoor features

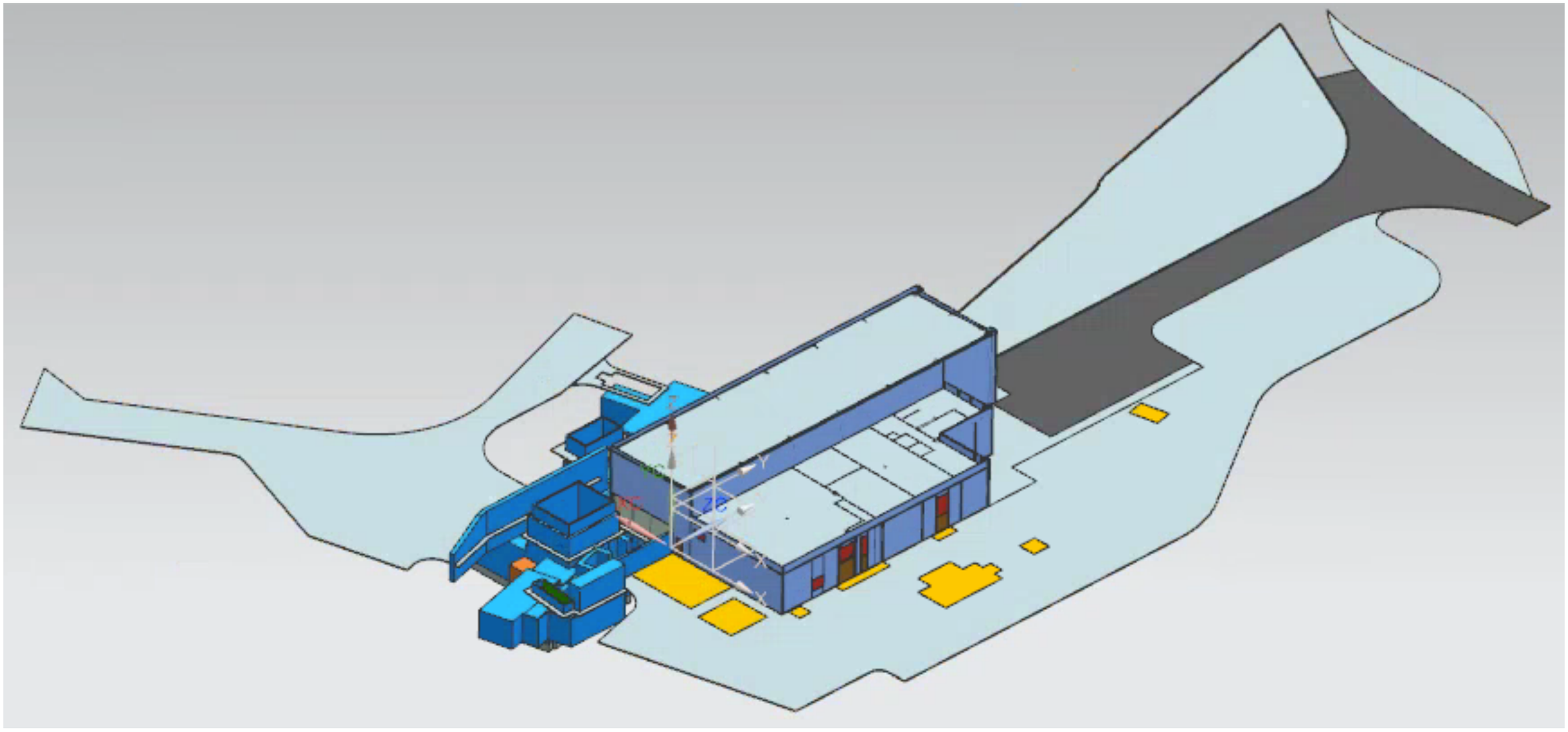
Hardstand and road



Outdoor features

Transformers

and generator pads



Outdoor features

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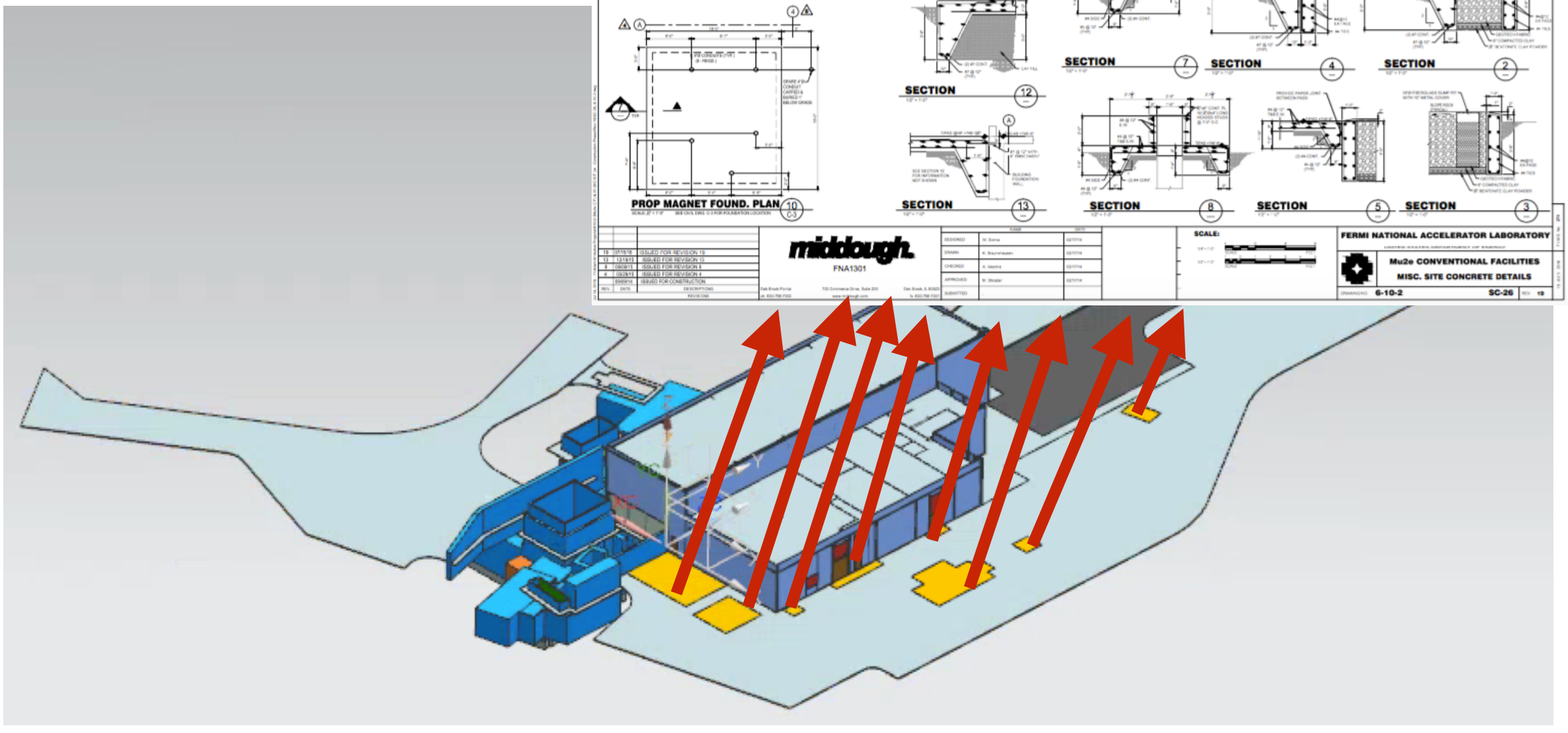
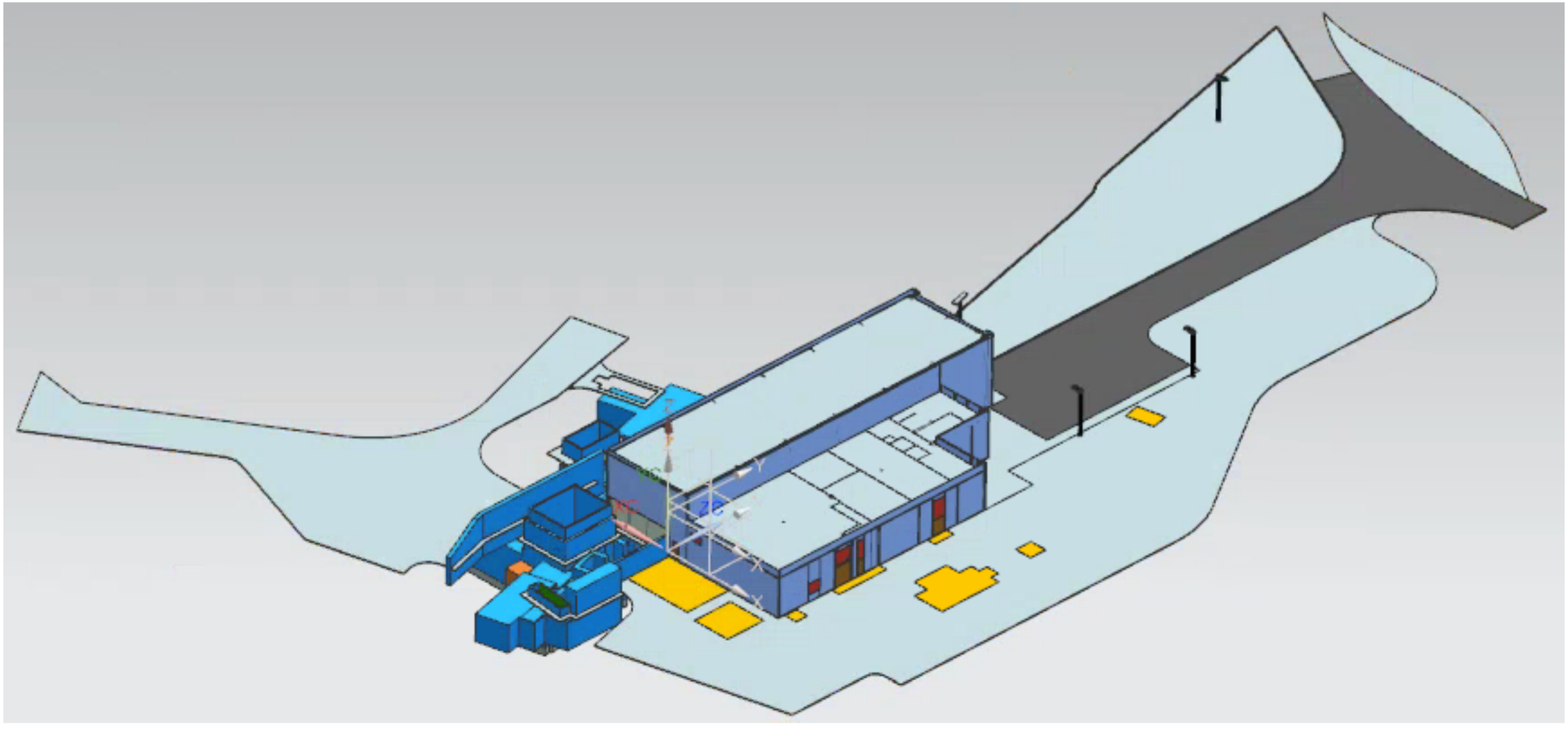


Fermilab

Outdoor features

Lights and drains



Outdoor features

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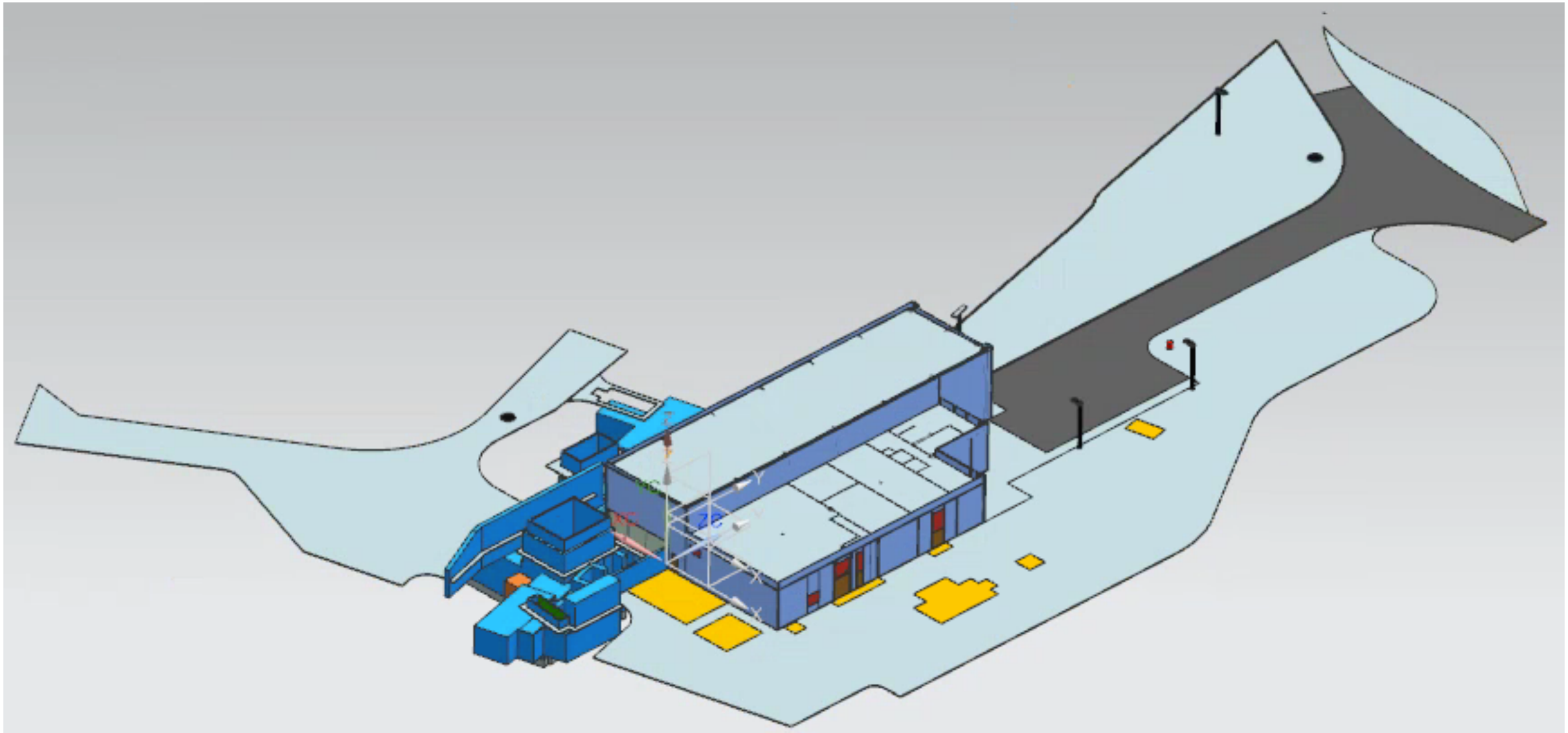
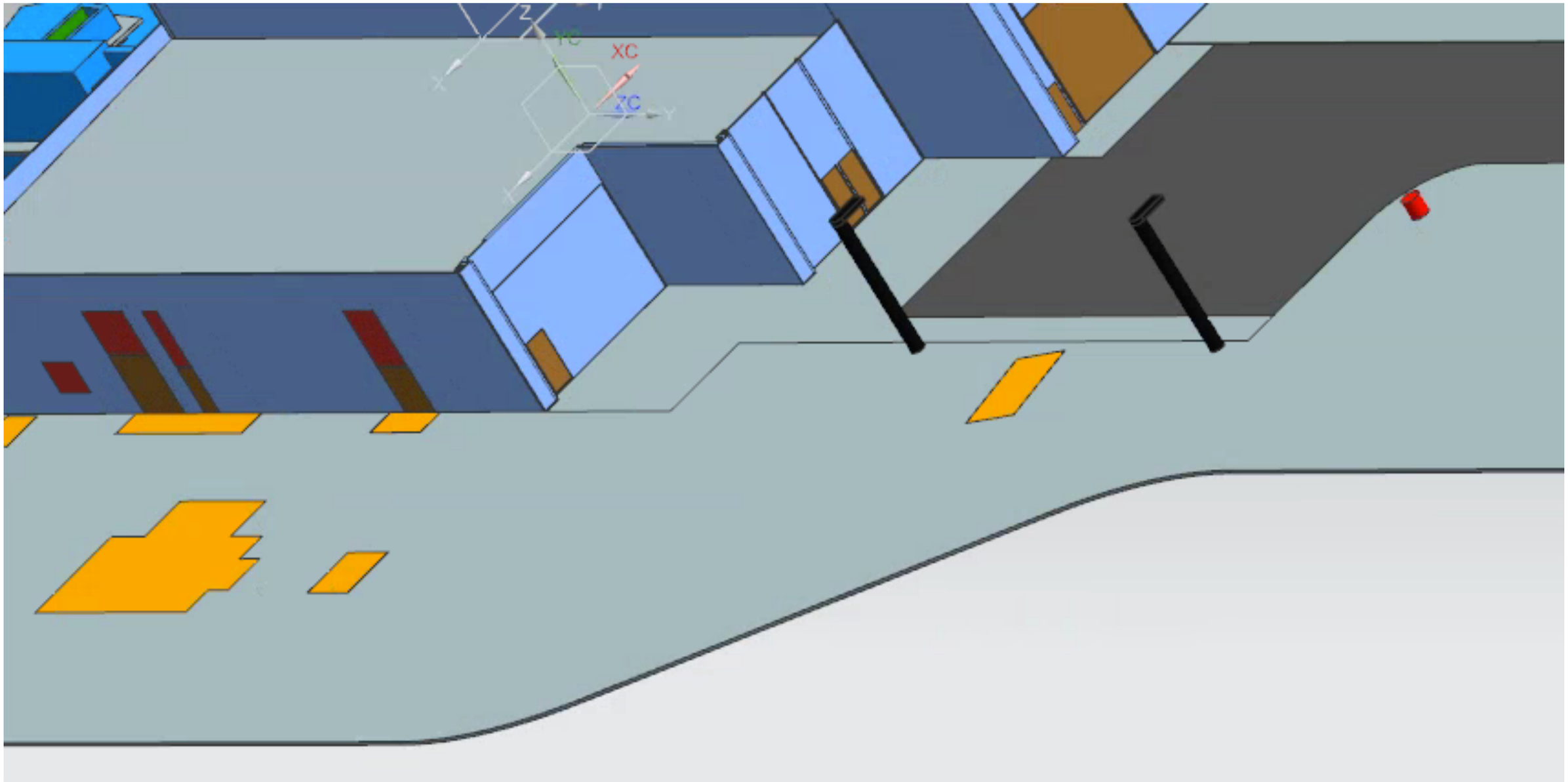


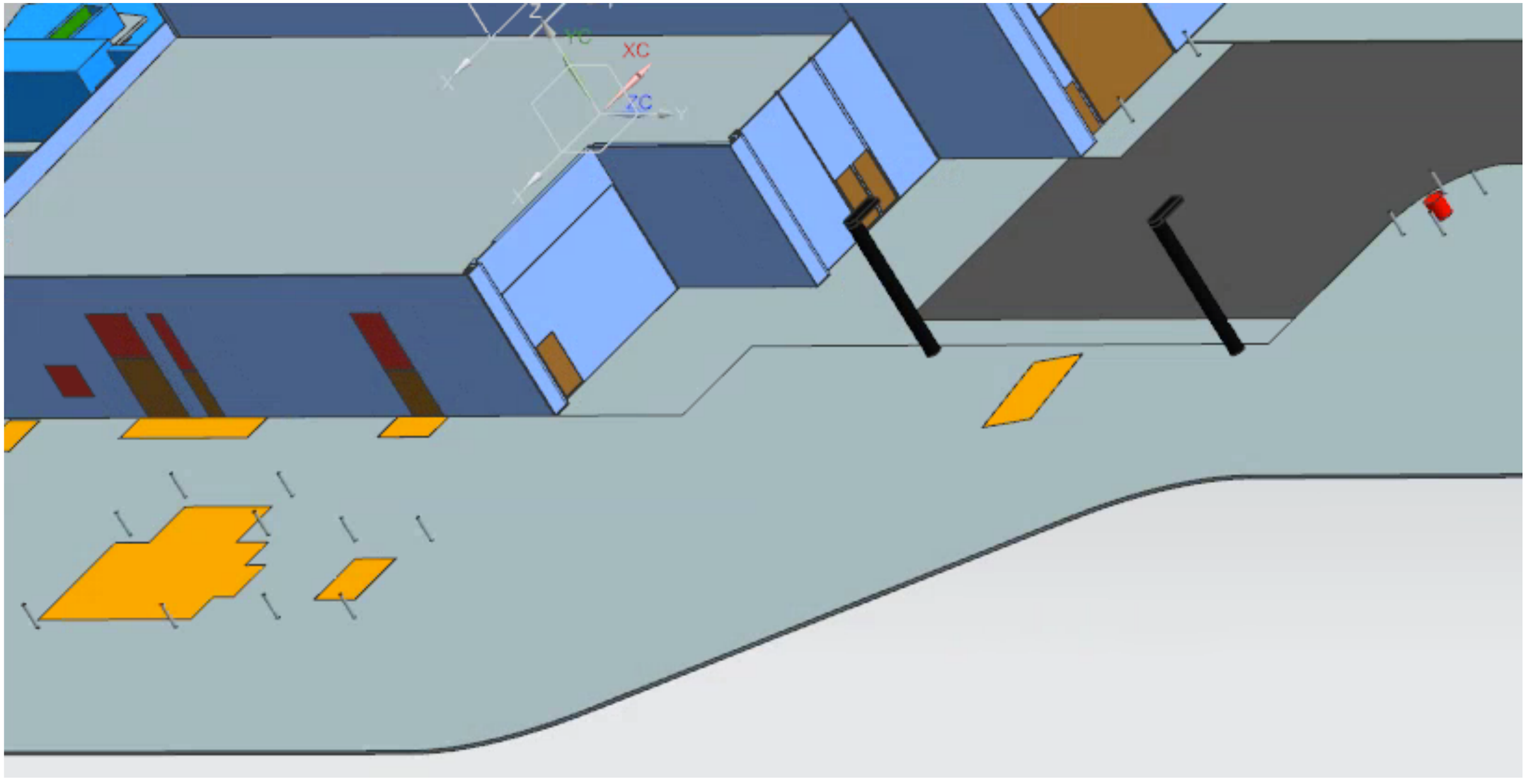
Outdoor features

Bollards



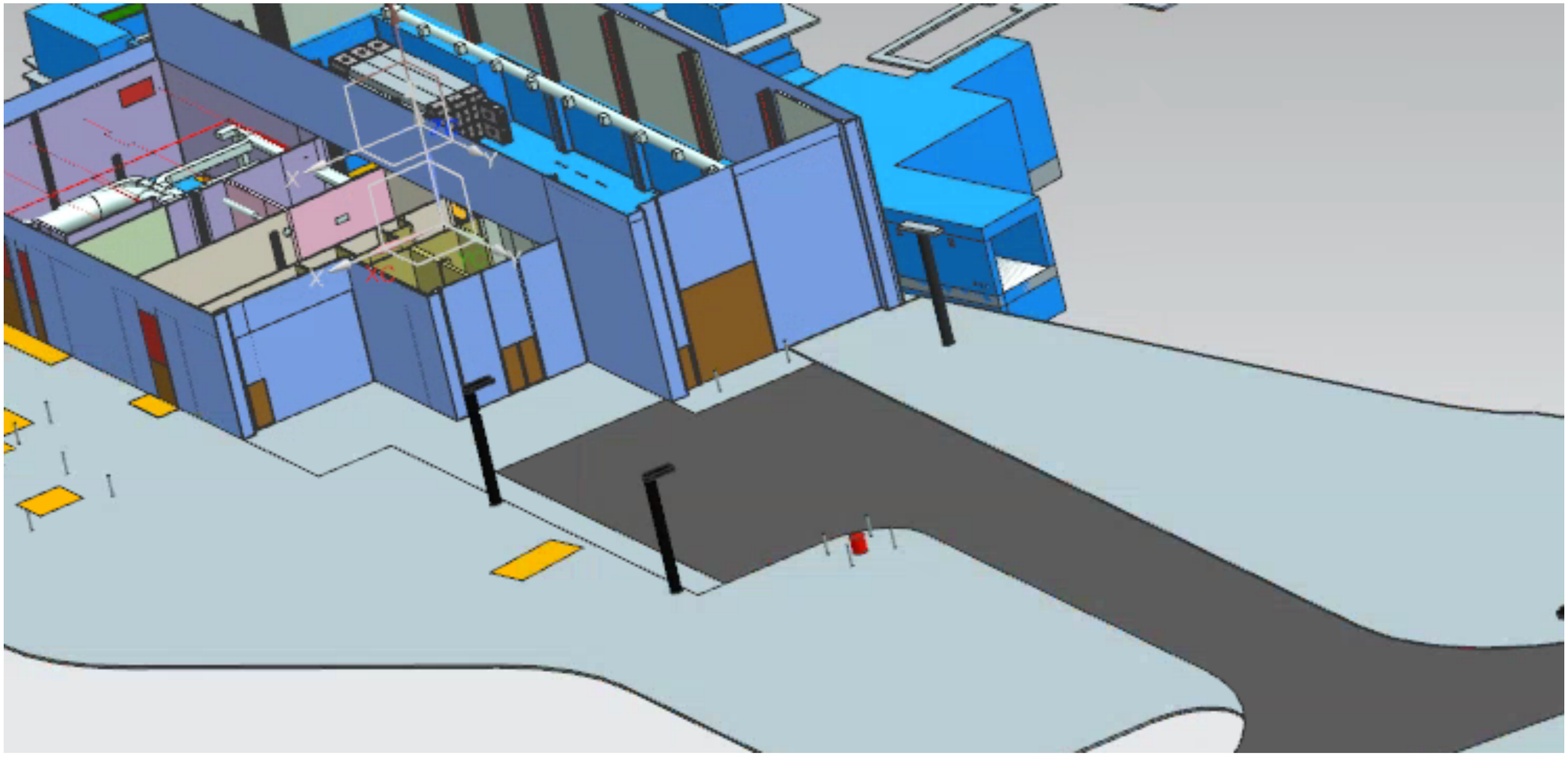
Outdoor features

Bollards



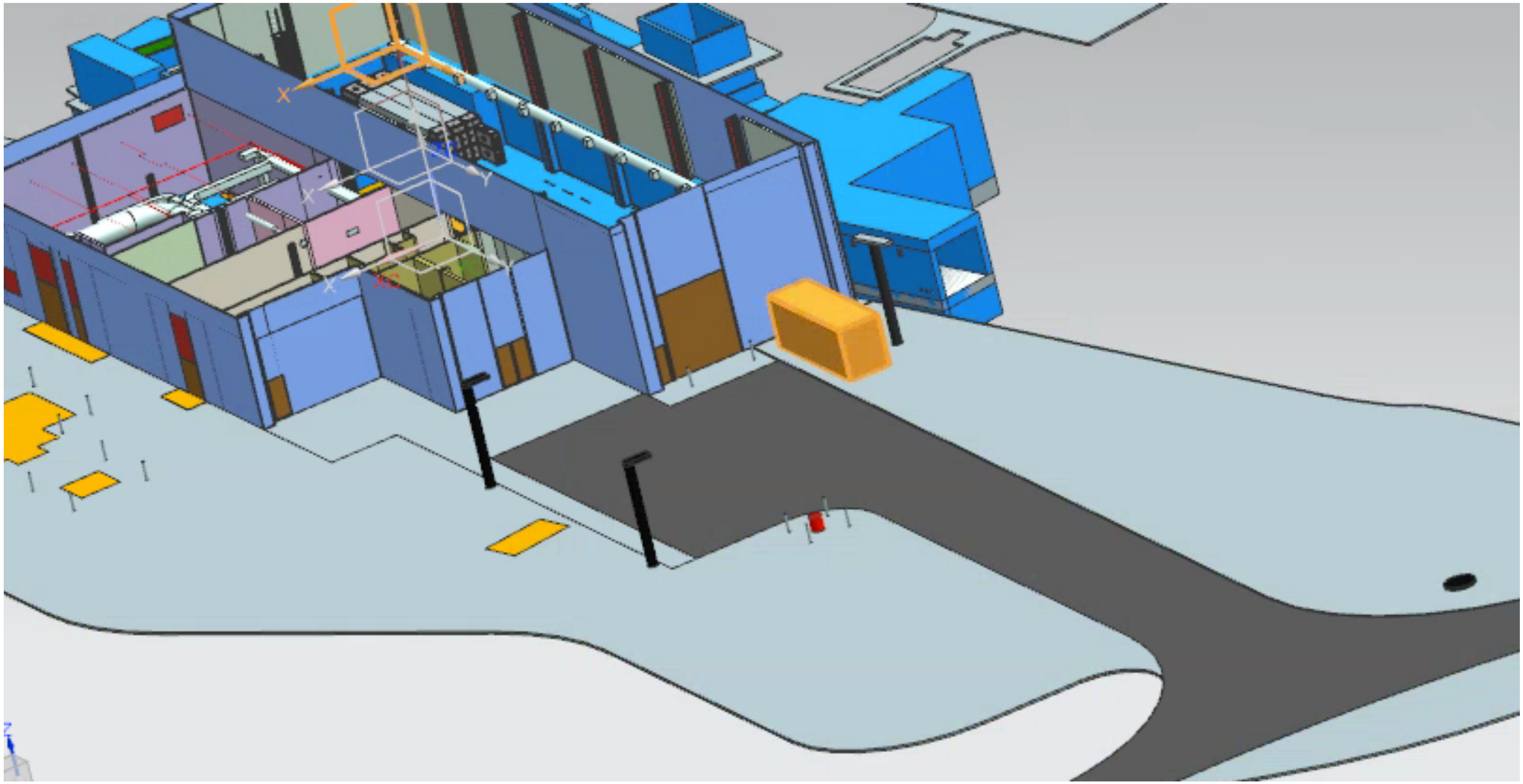
Outdoor features

Tube trailer

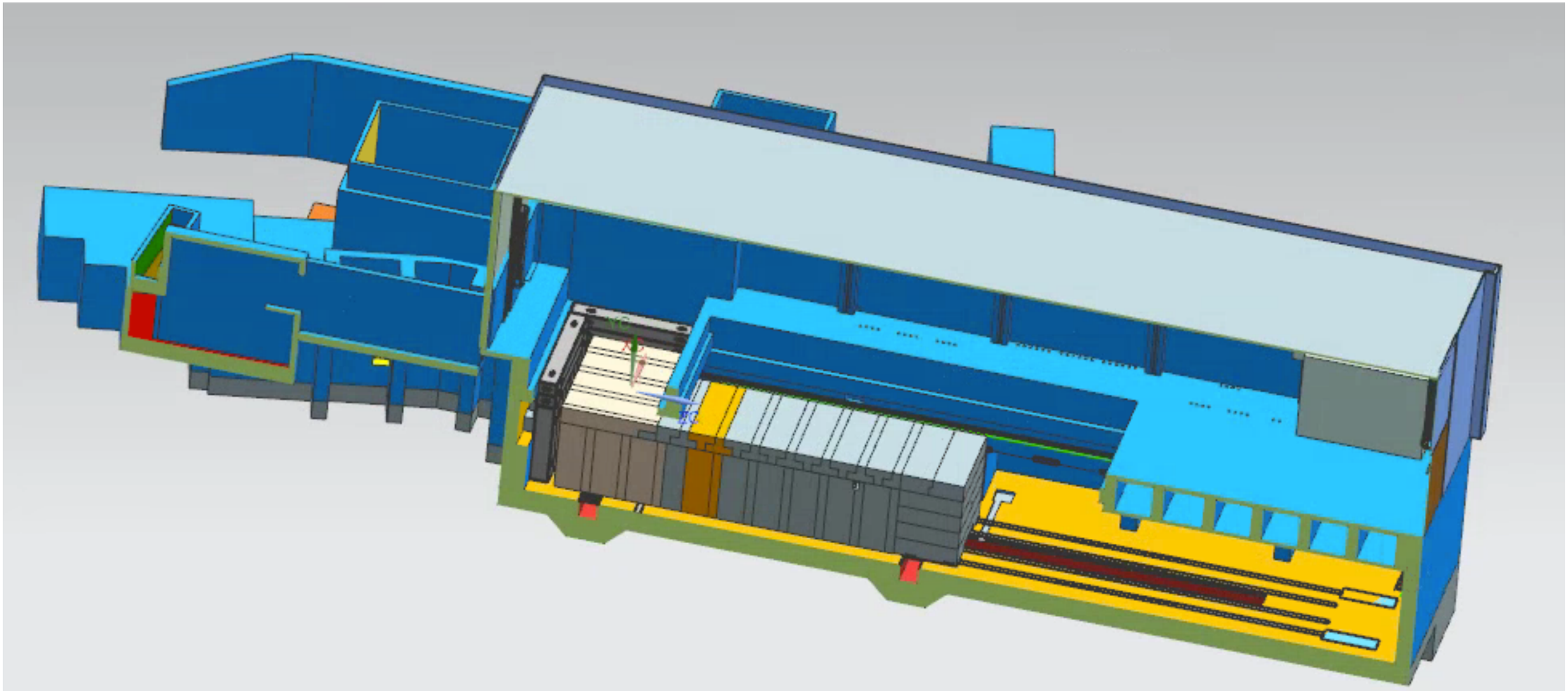


Outdoor features

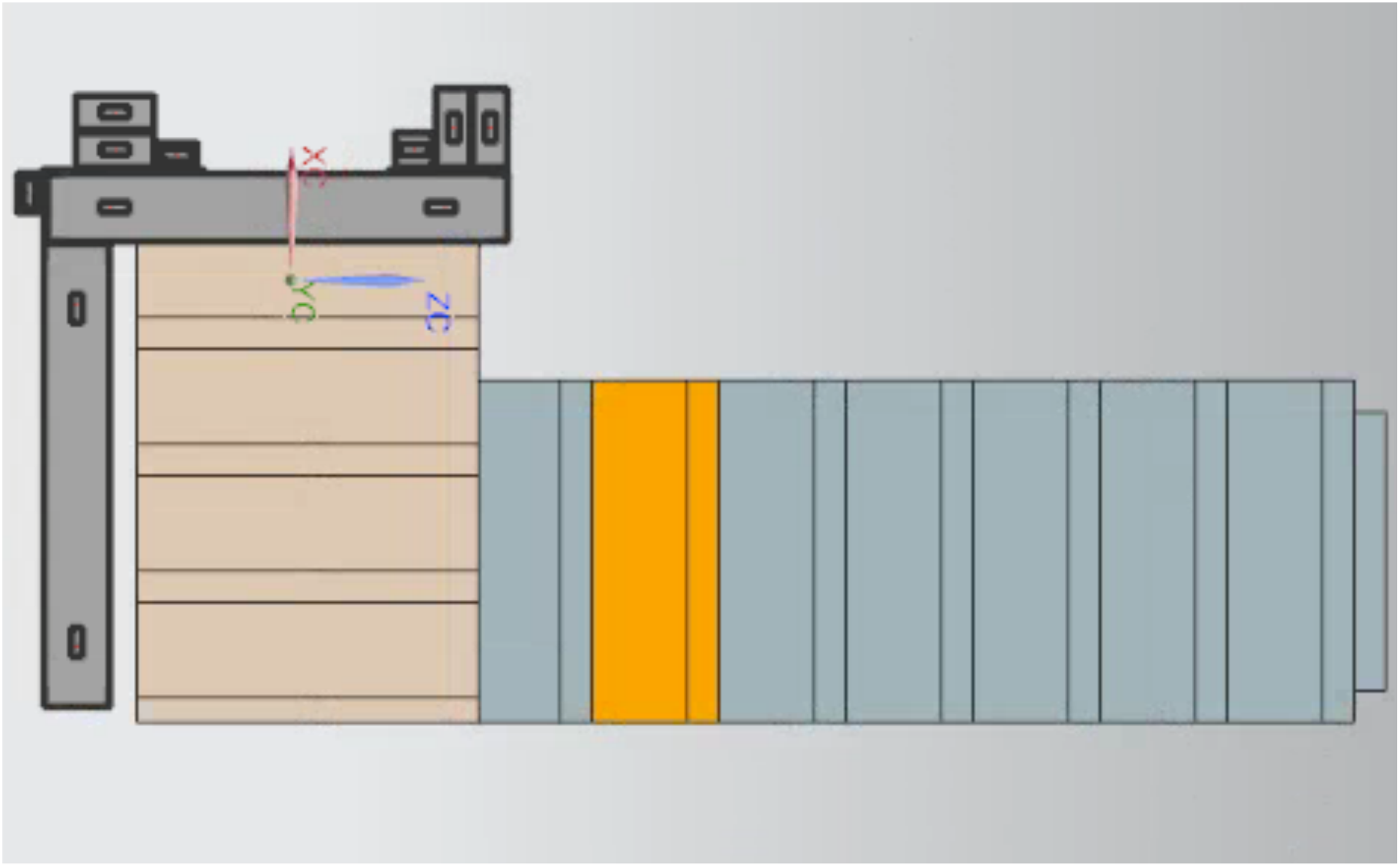
Tube trailer



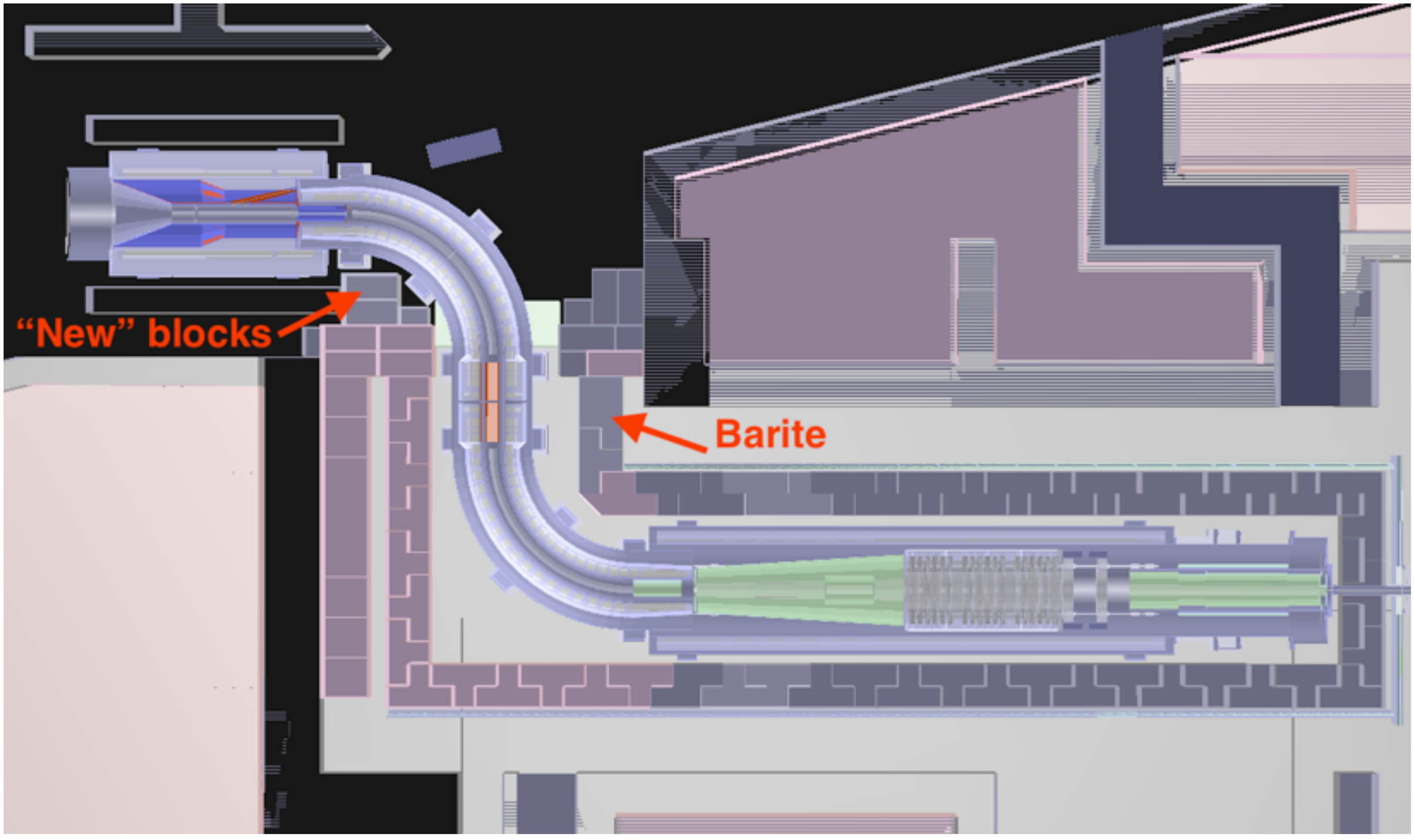
Plan Staging of shield blocks



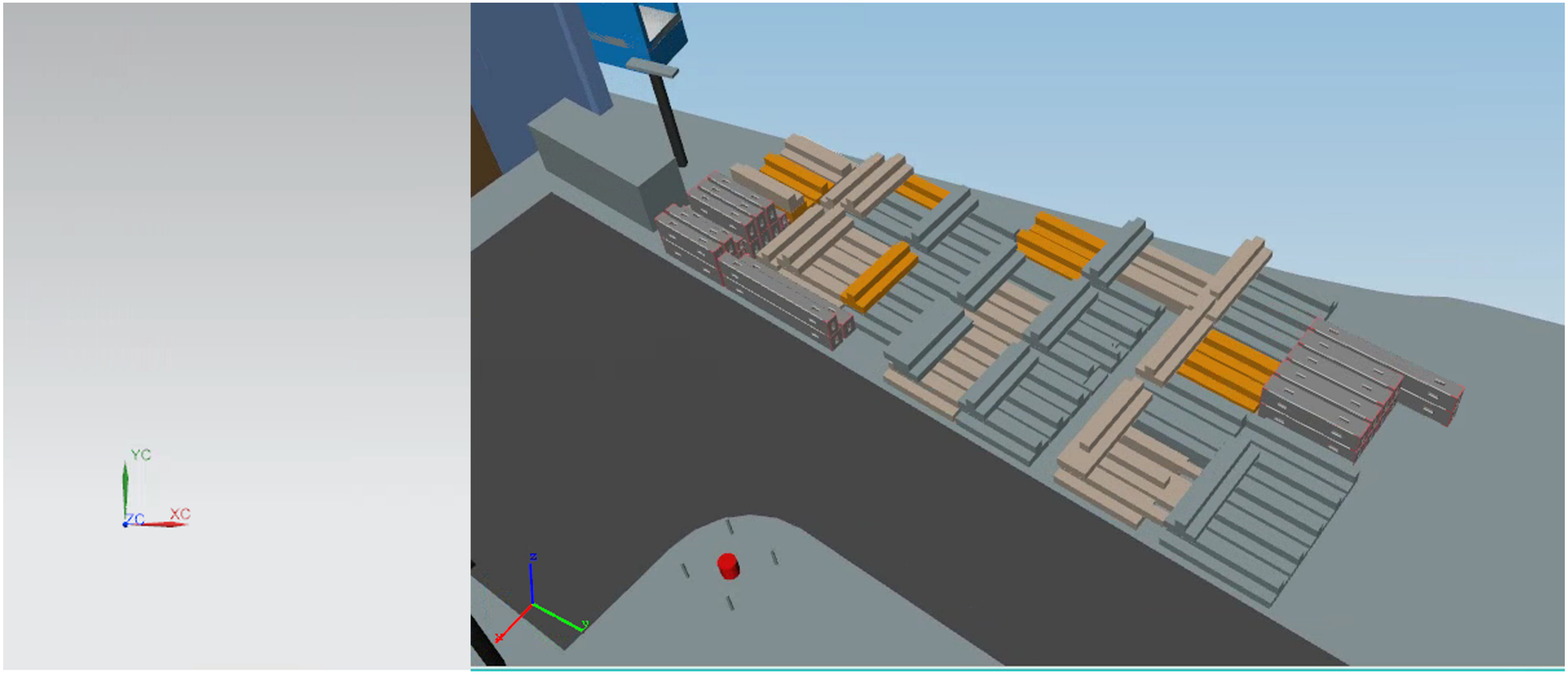
Plan Staging of shield blocks



Plan Staging of shield blocks



Plan Staging of shield blocks



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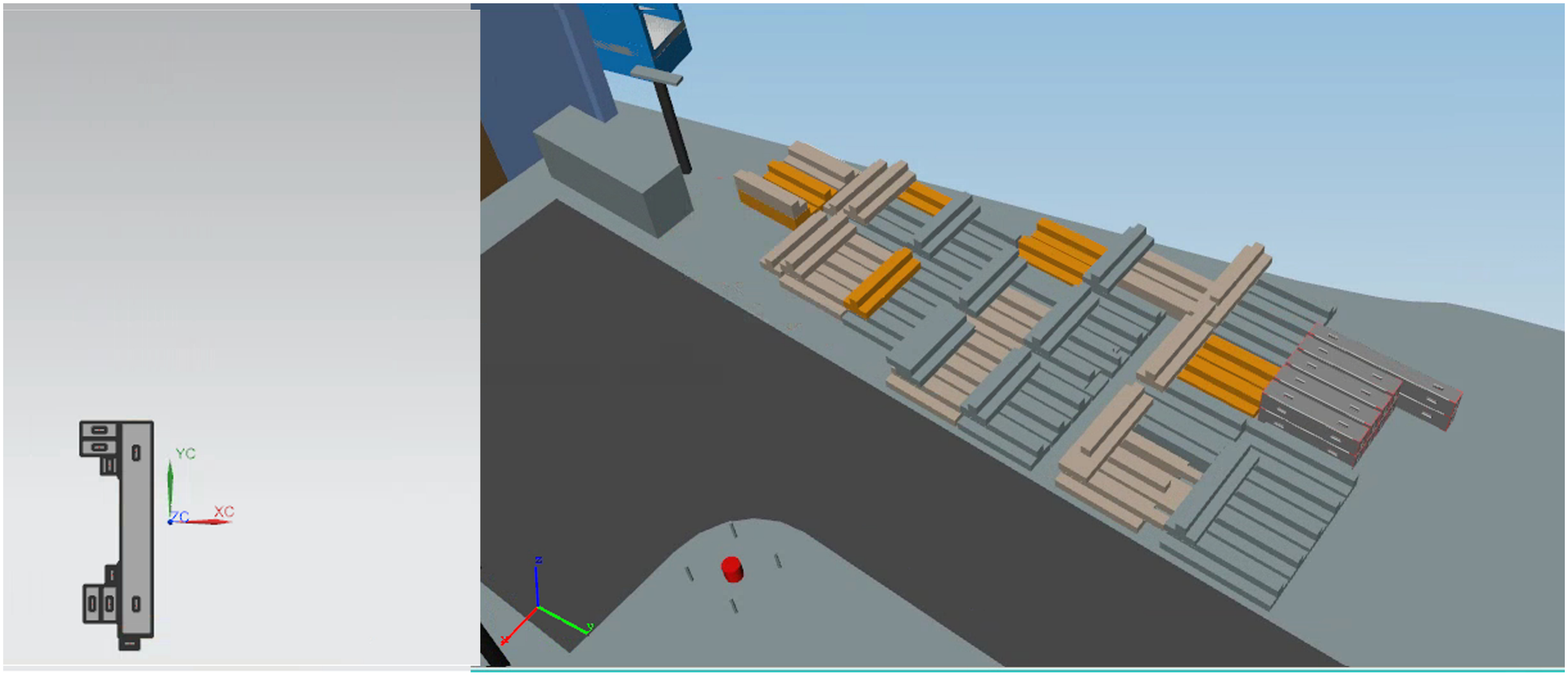
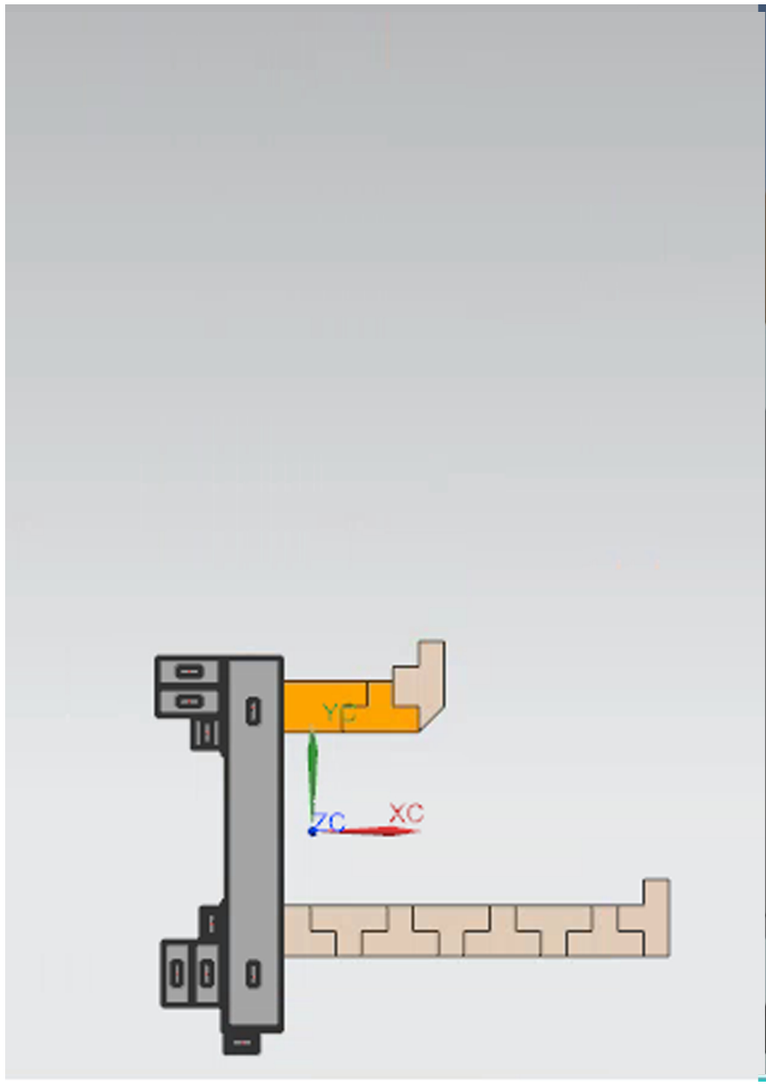
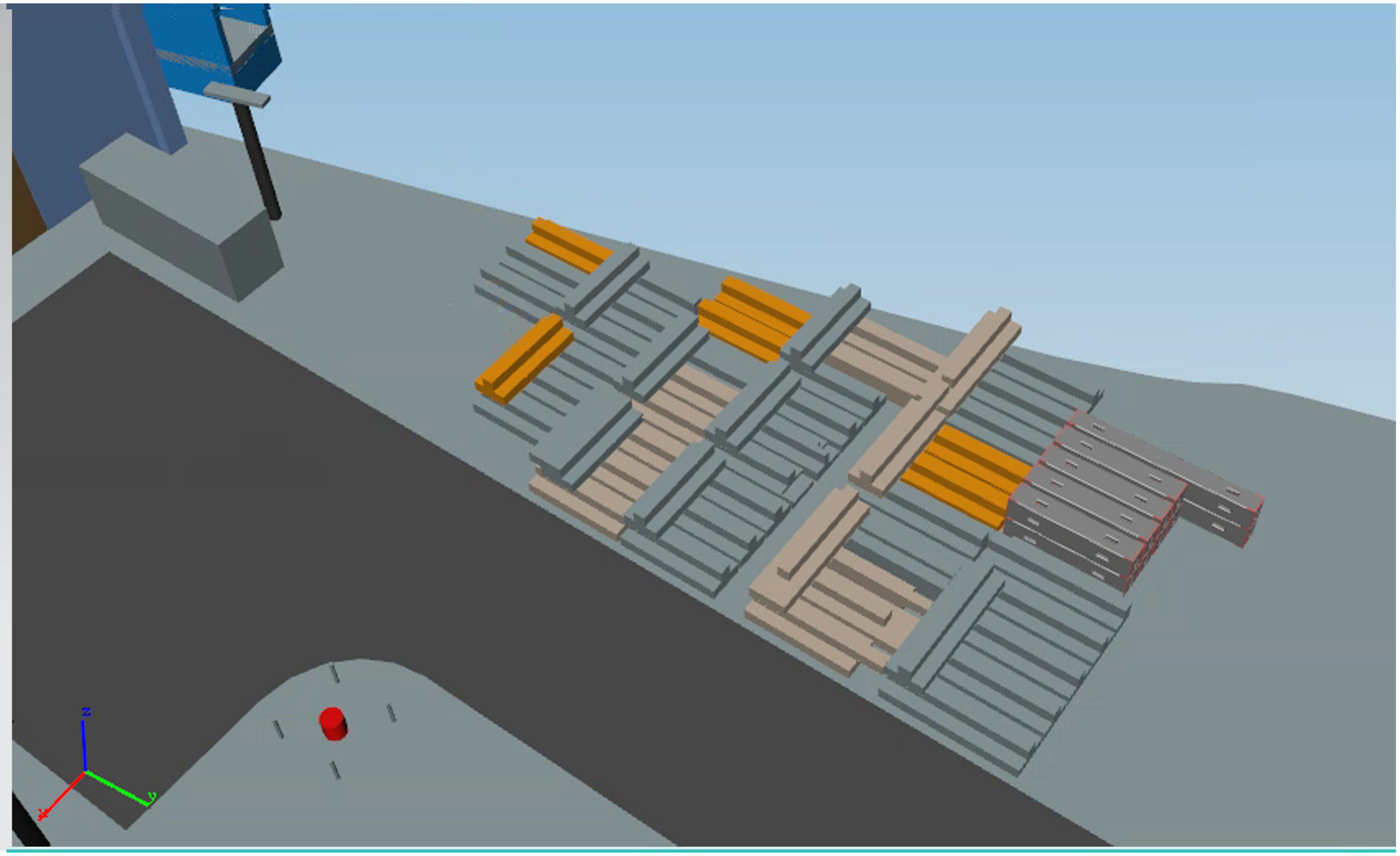
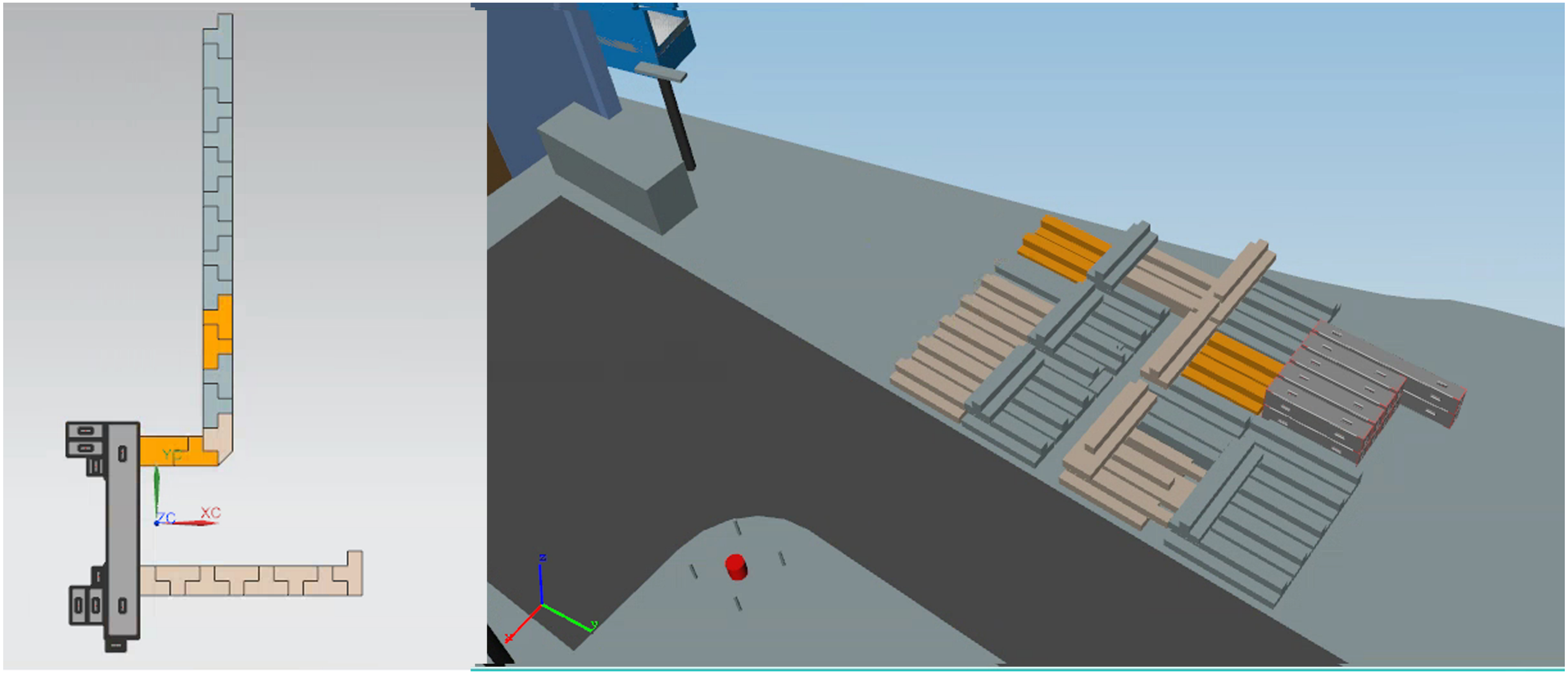


Plan Staging of shield blocks

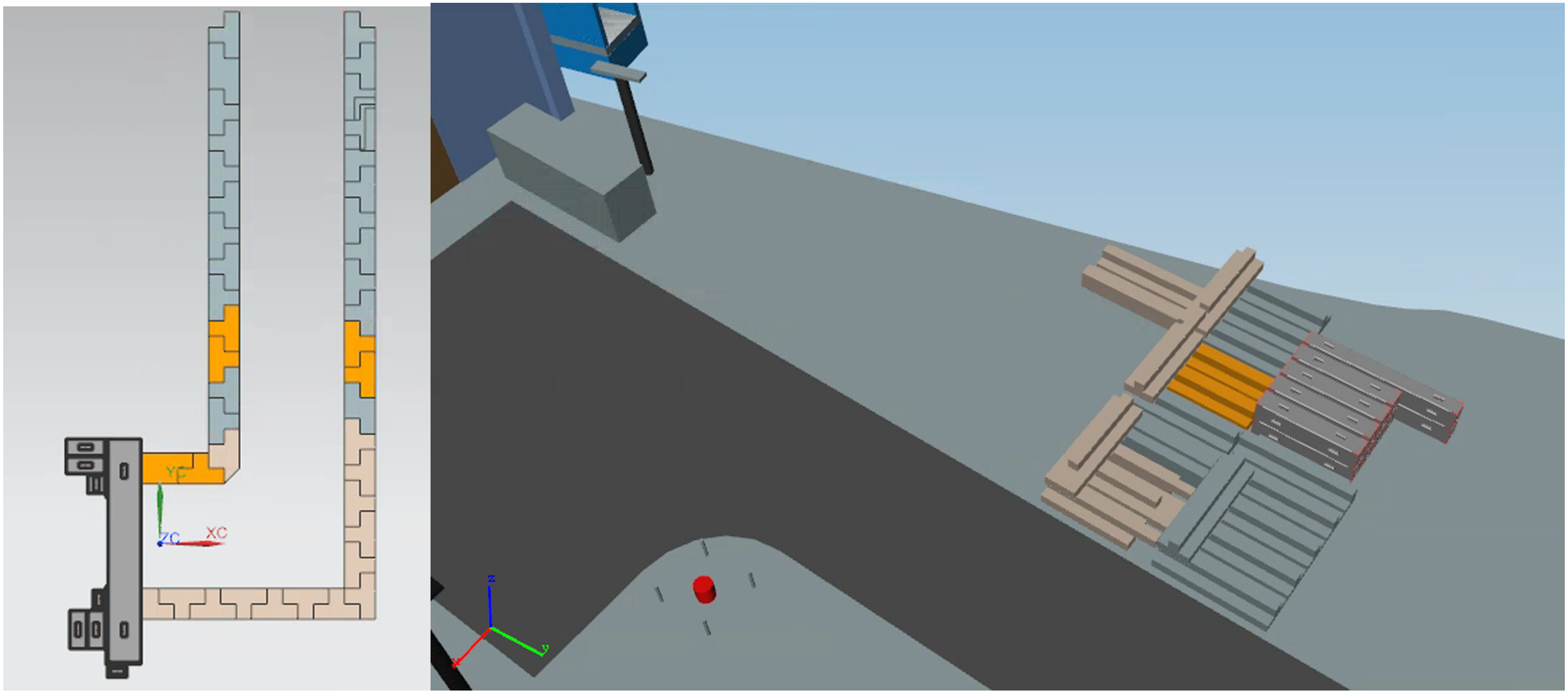




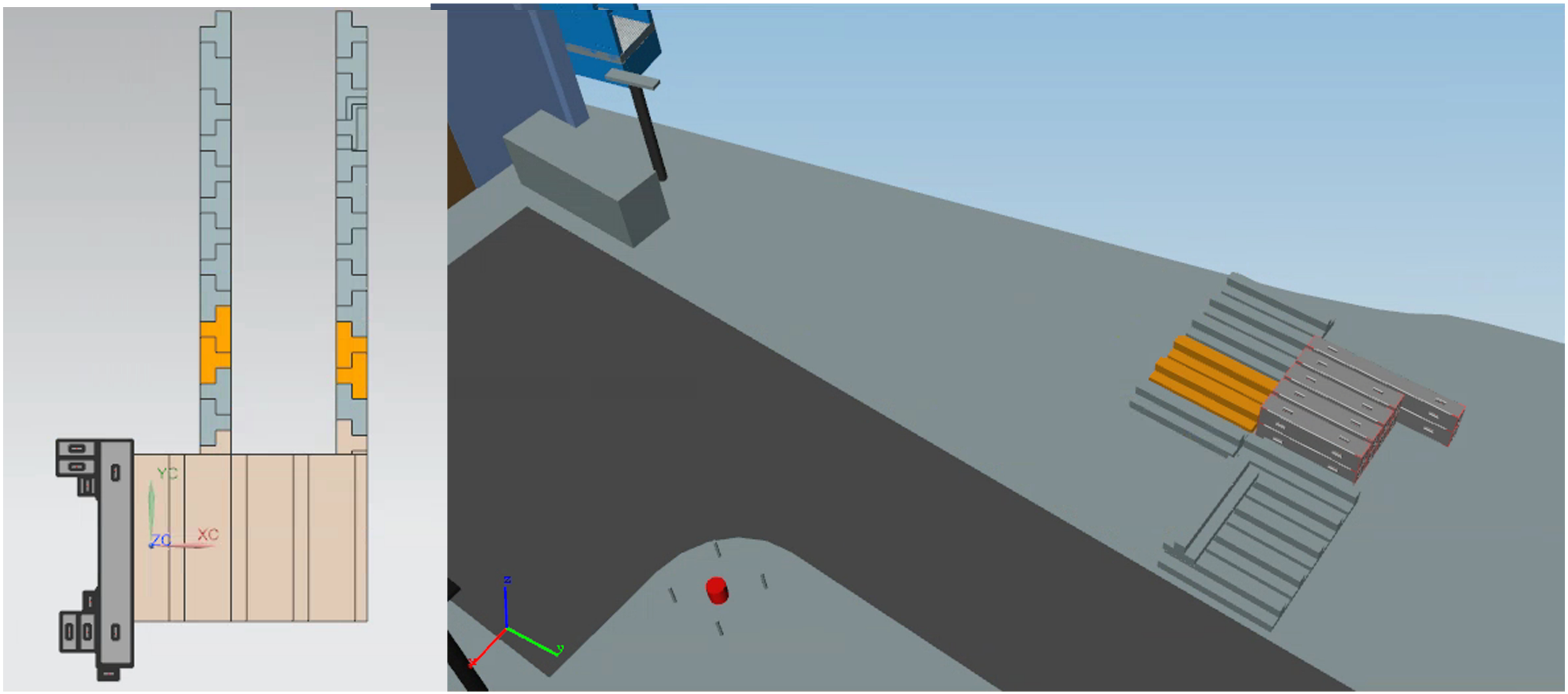
Plan Staging of shield blocks



Plan Staging of shield blocks



Plan Staging of shield blocks



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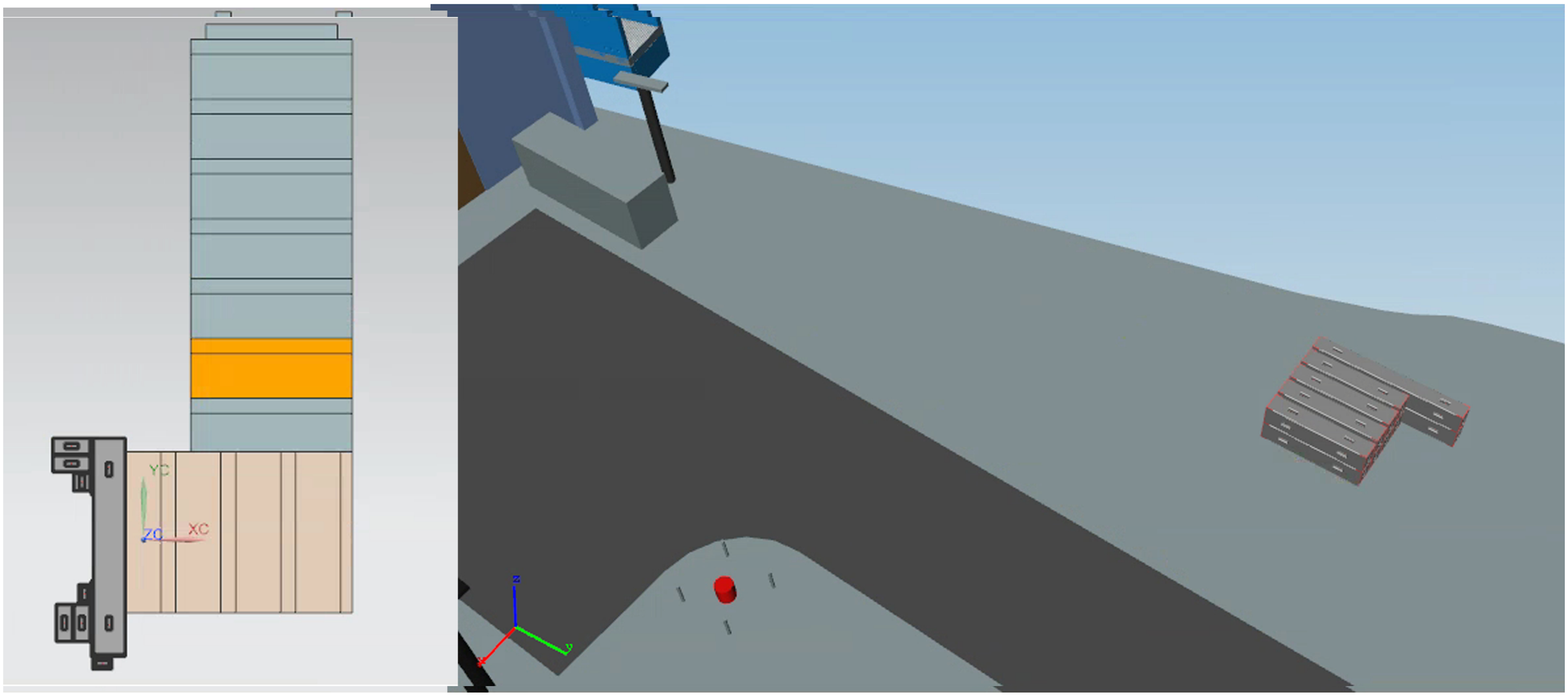

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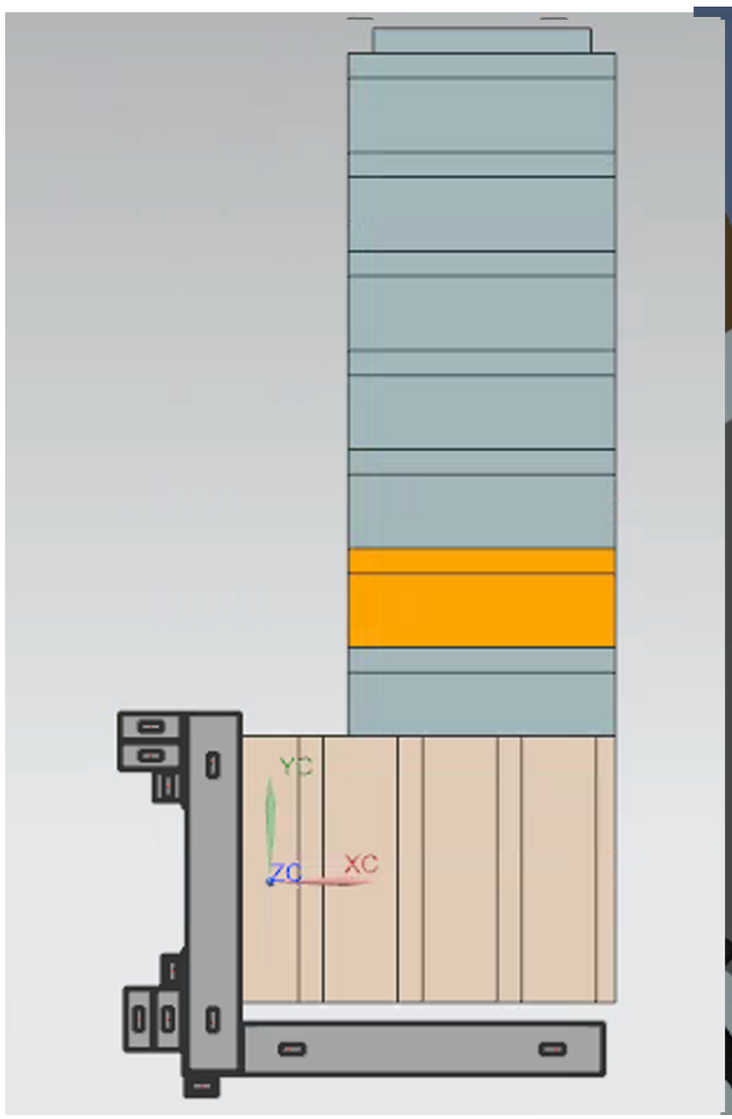

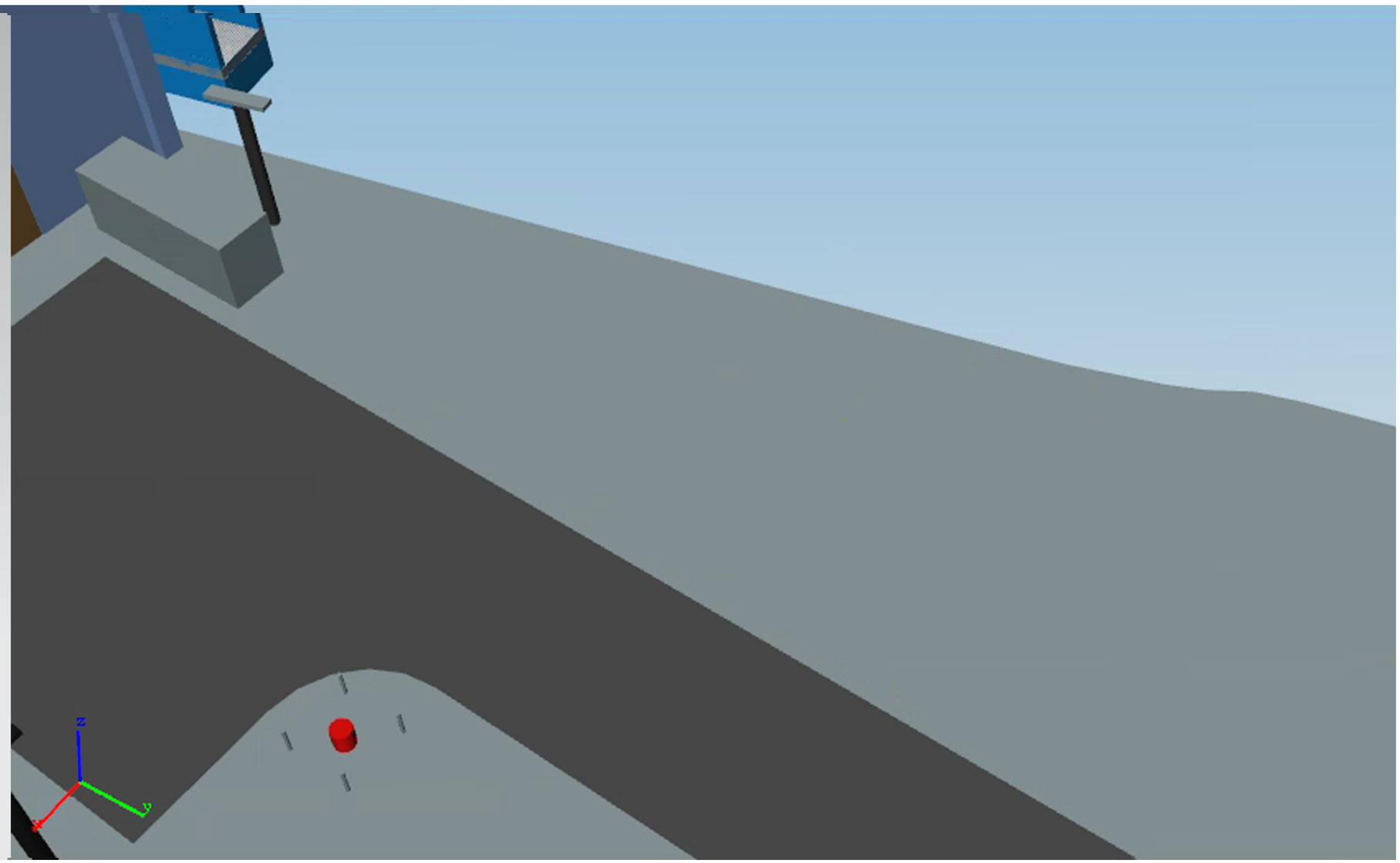

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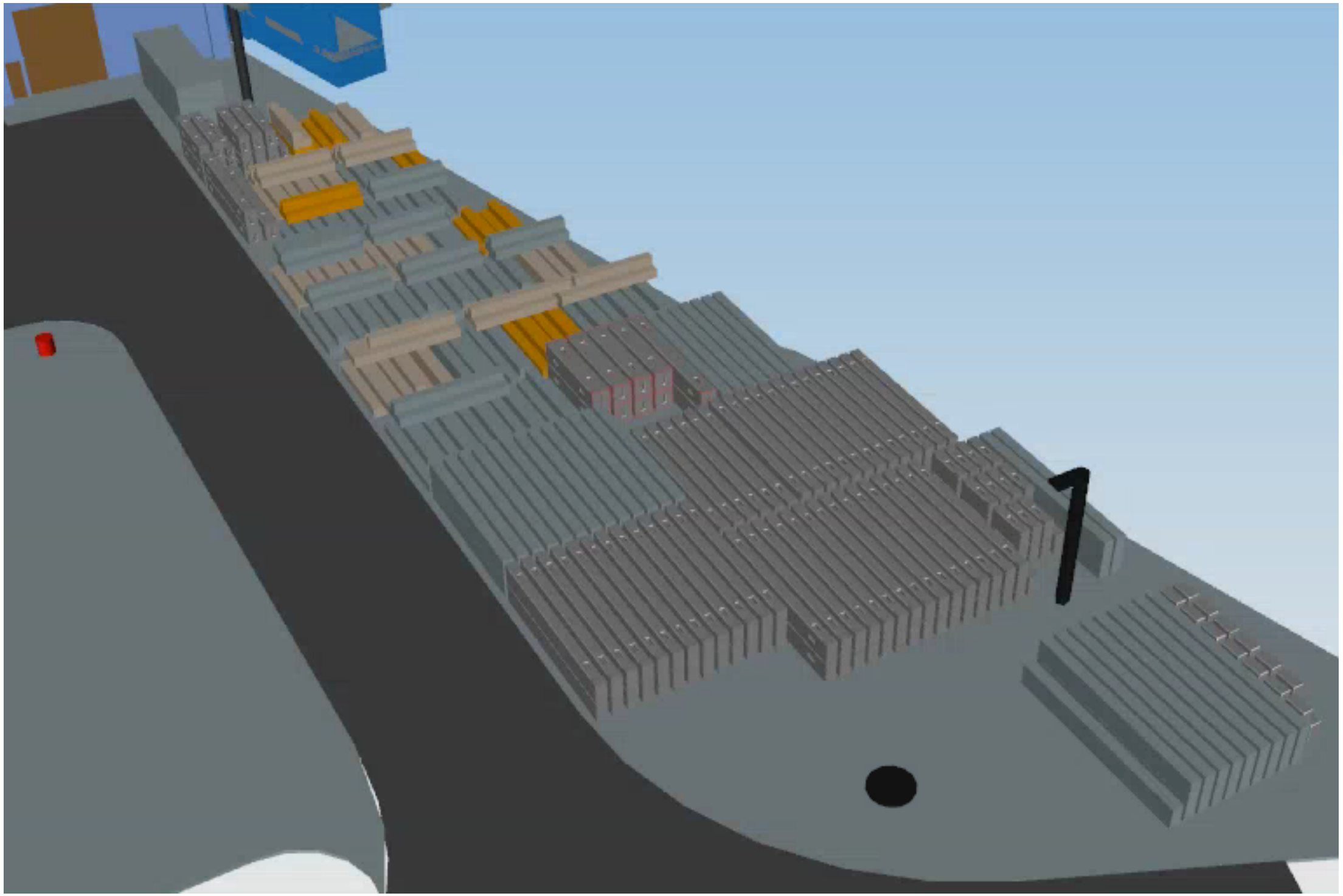
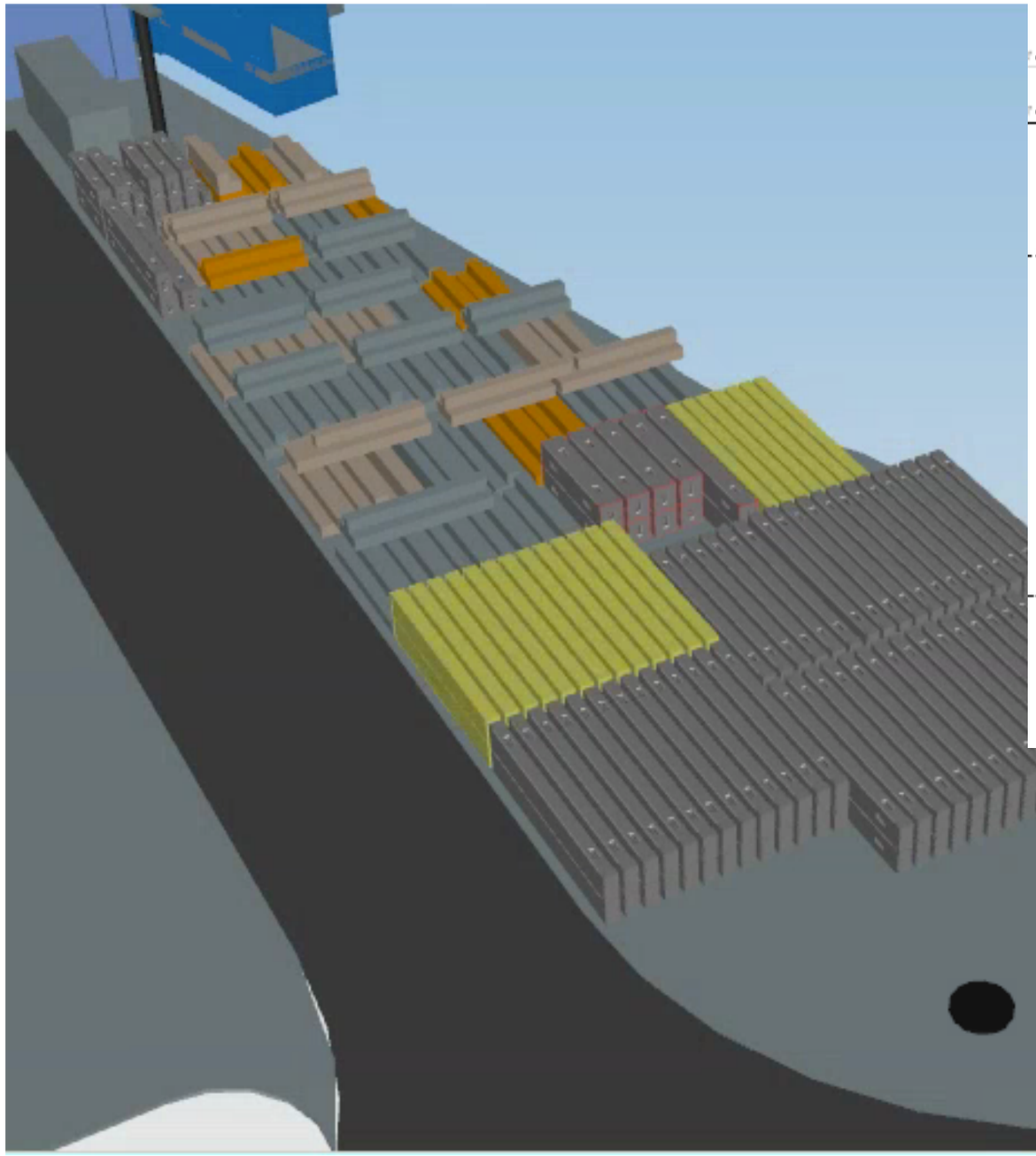
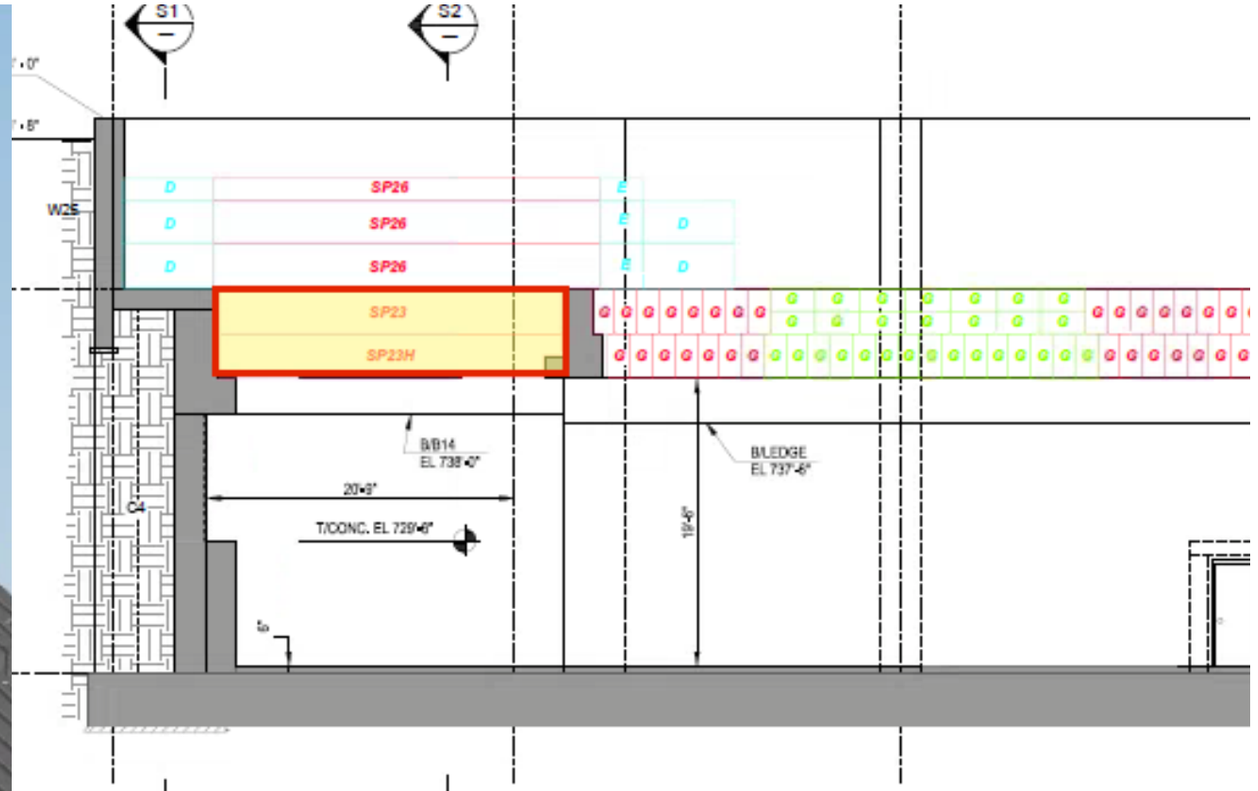


Plan Staging of shield blocks

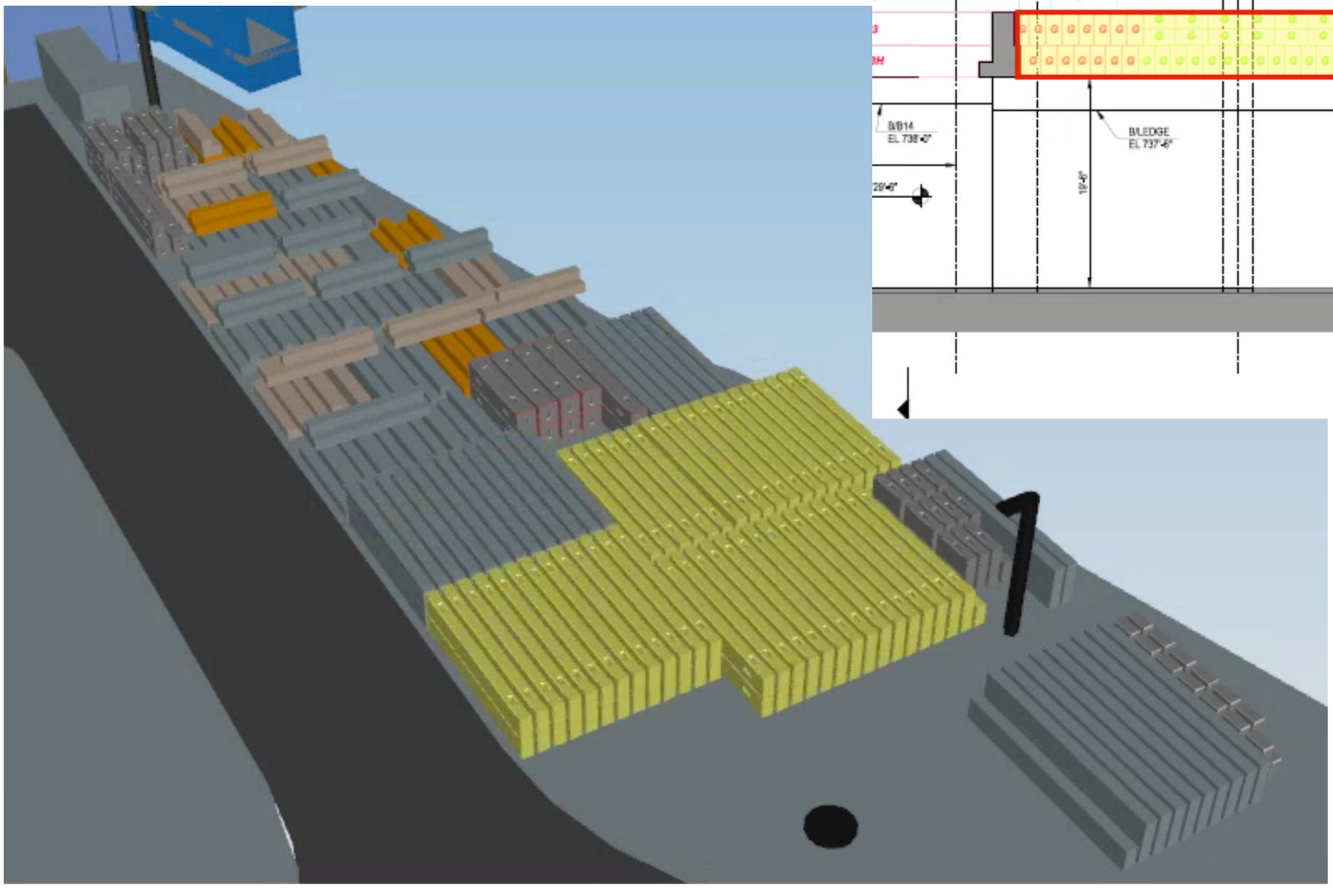
TS Hatch Blocks

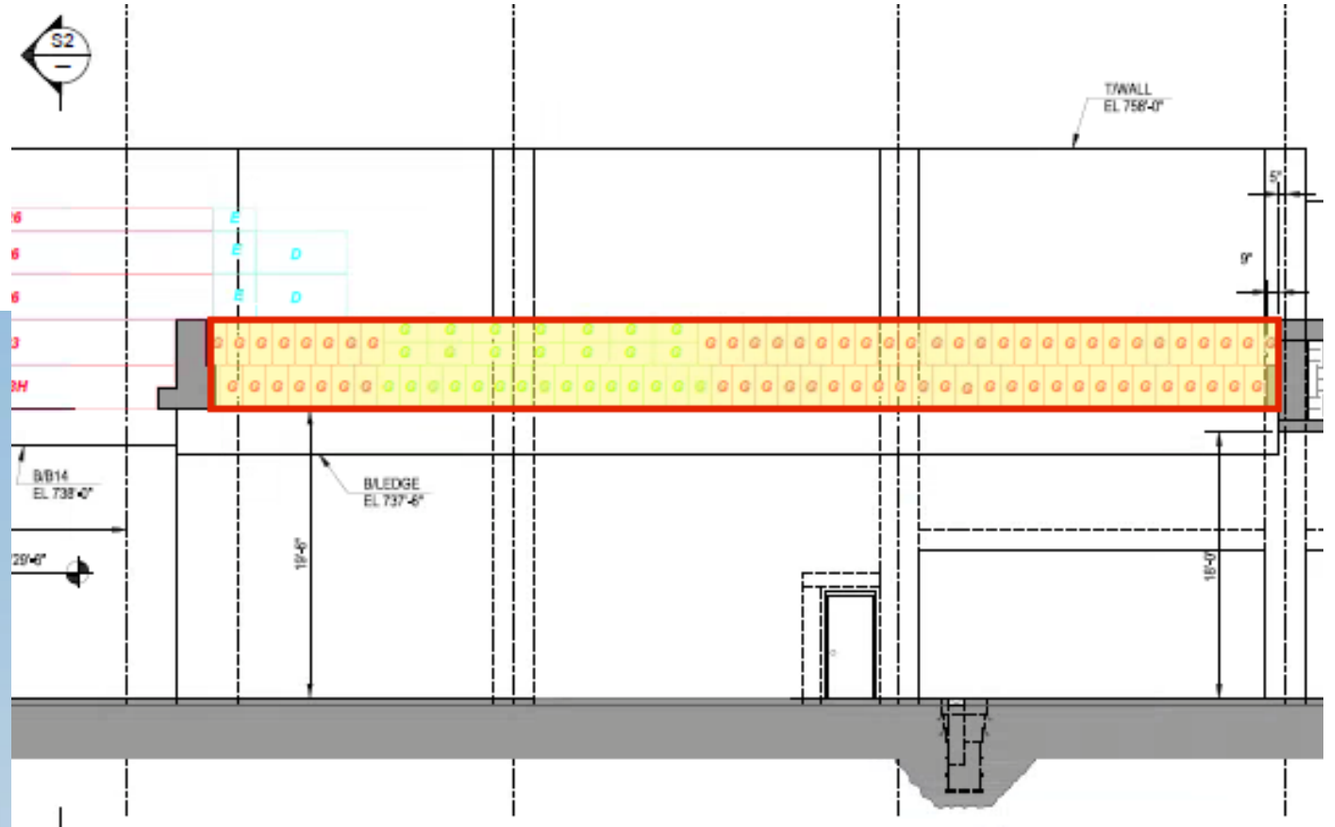




Plan Staging of shield blocks

DS Hatch Blocks

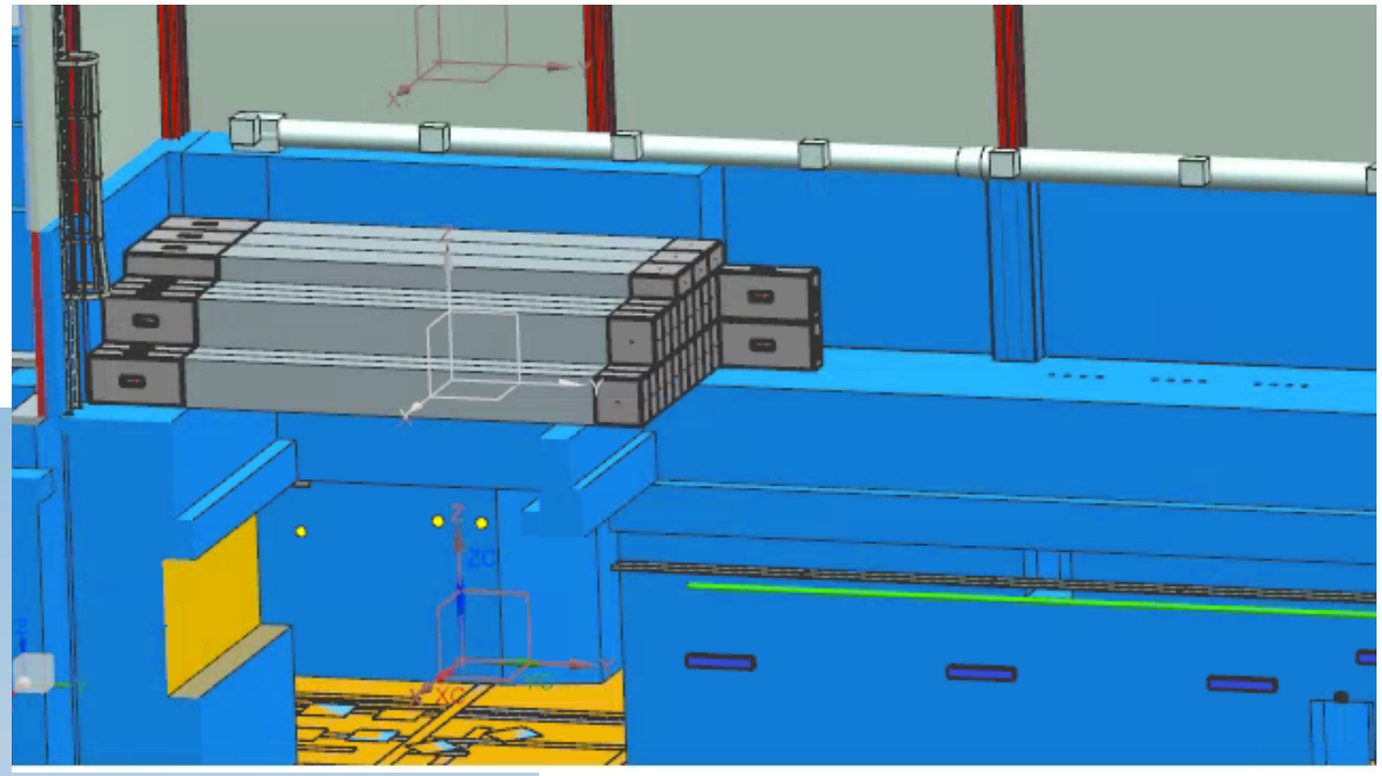


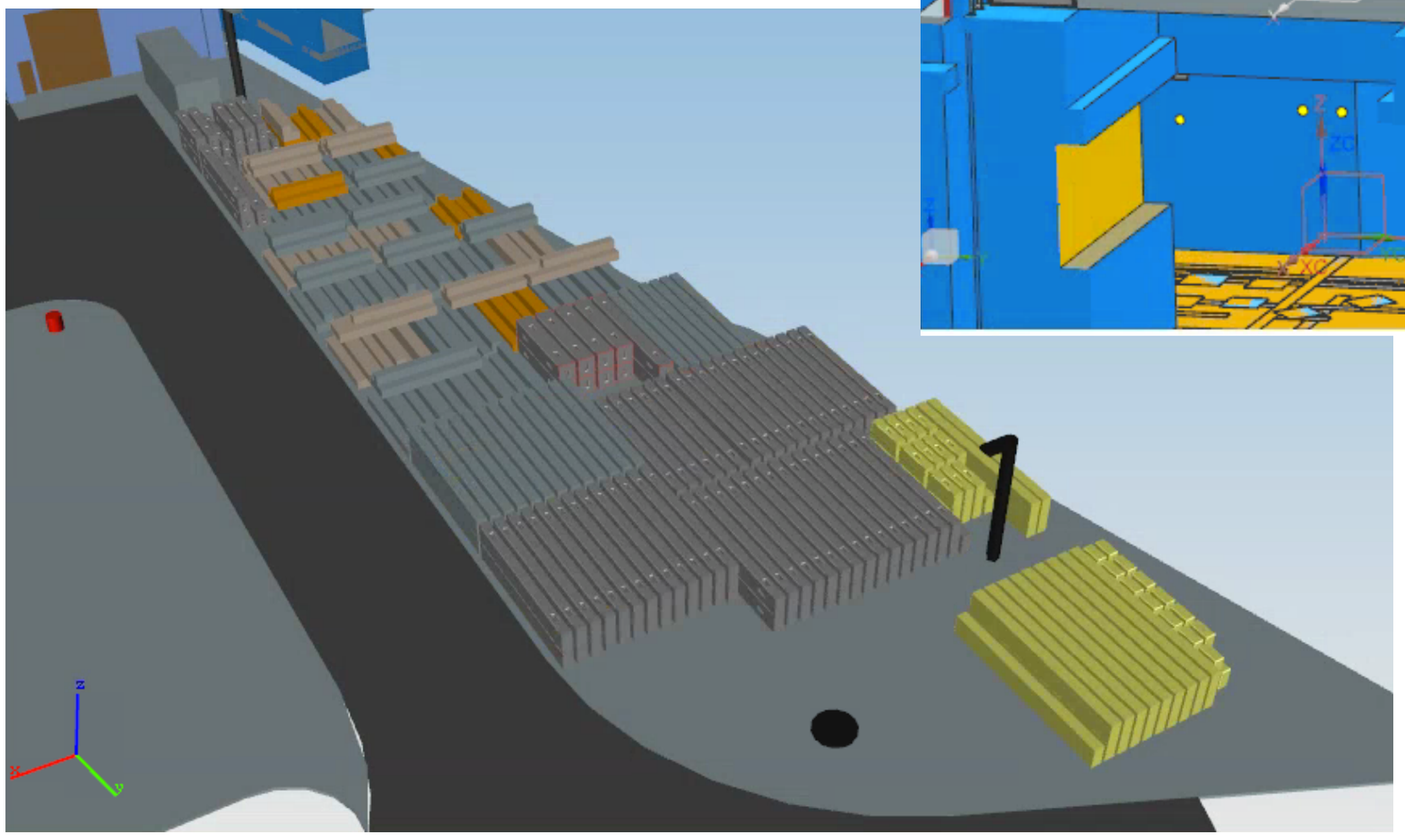


Fermilab

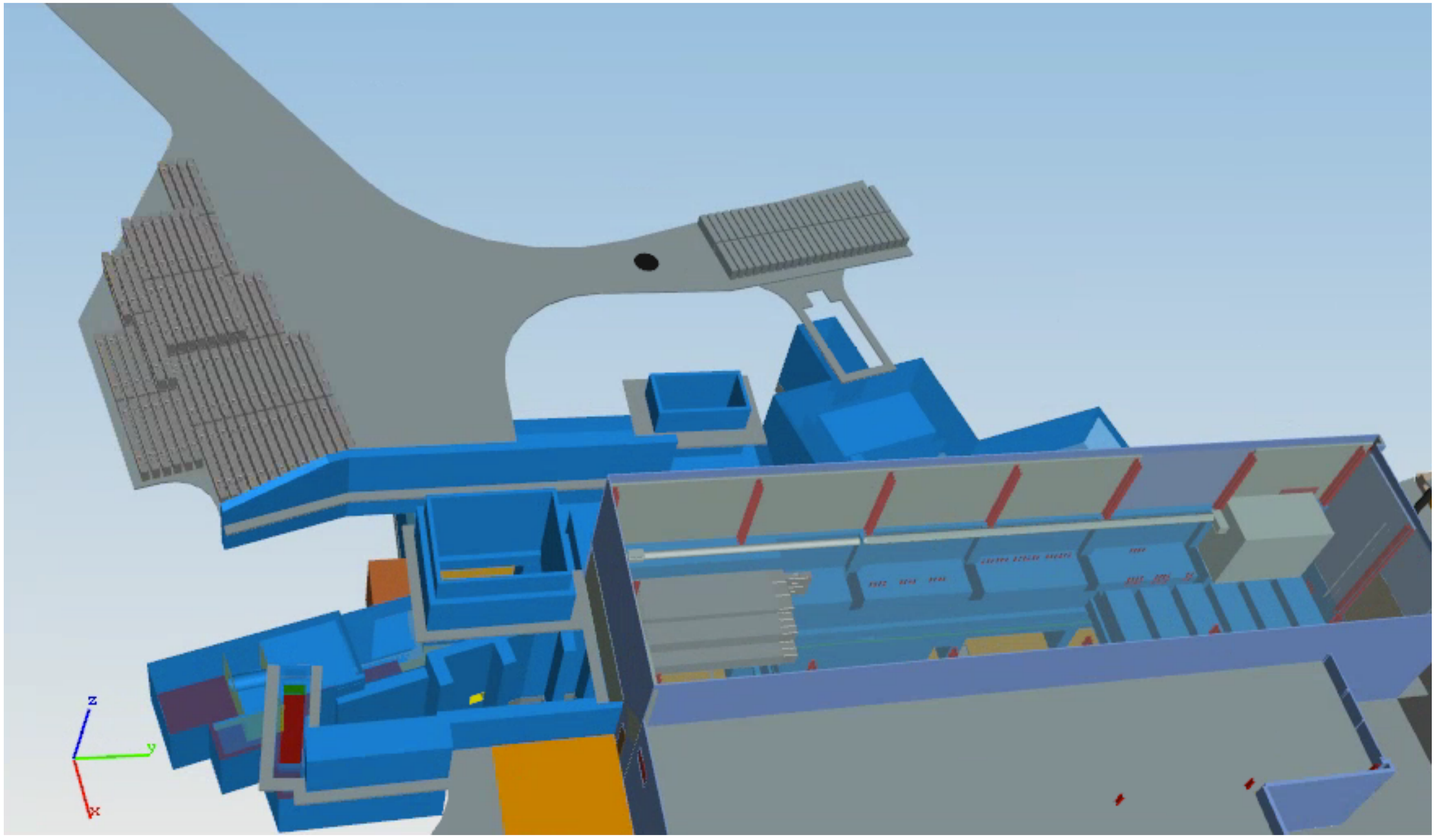
Plan Staging of shield blocks

North West Shield Block Pile



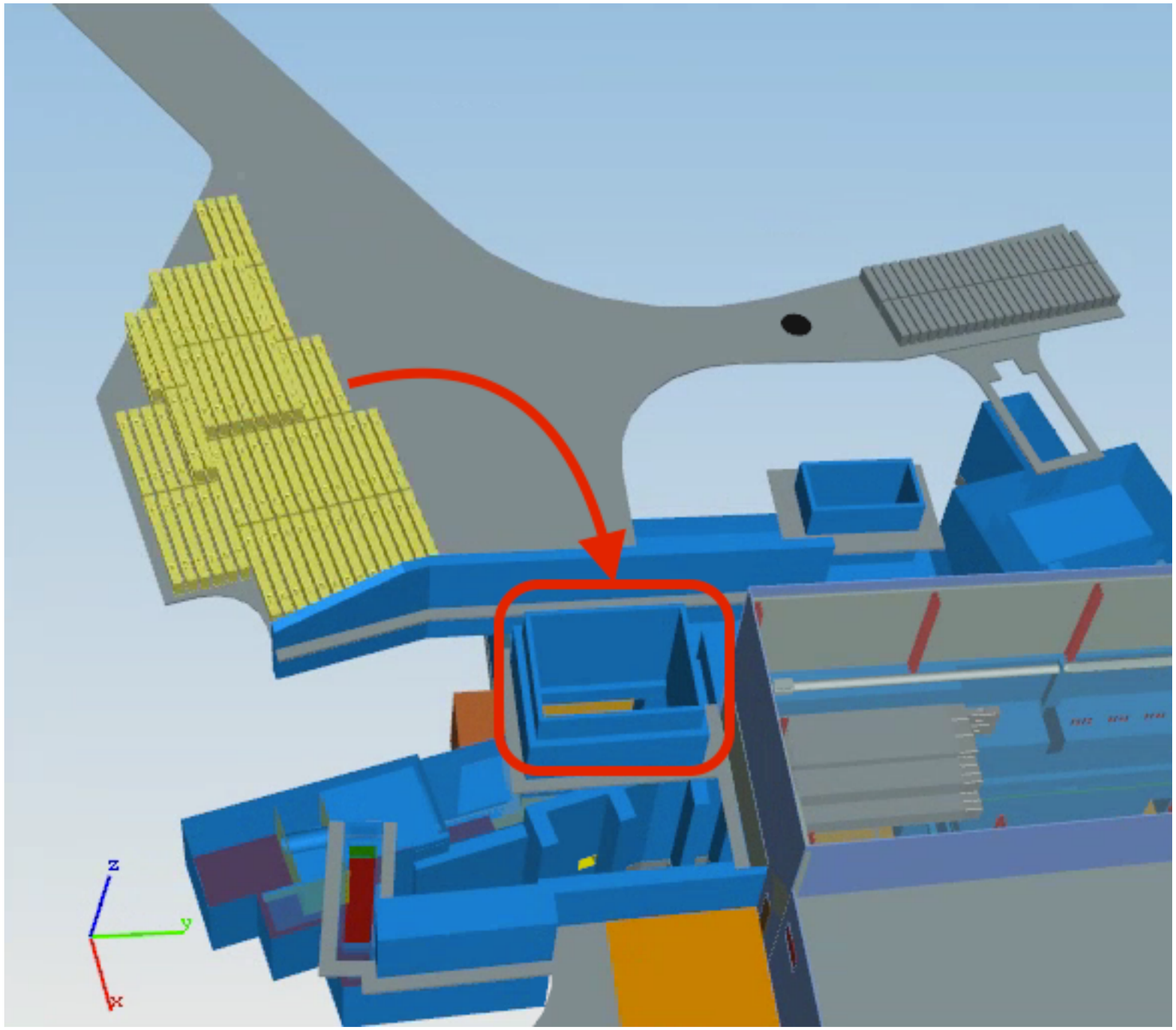


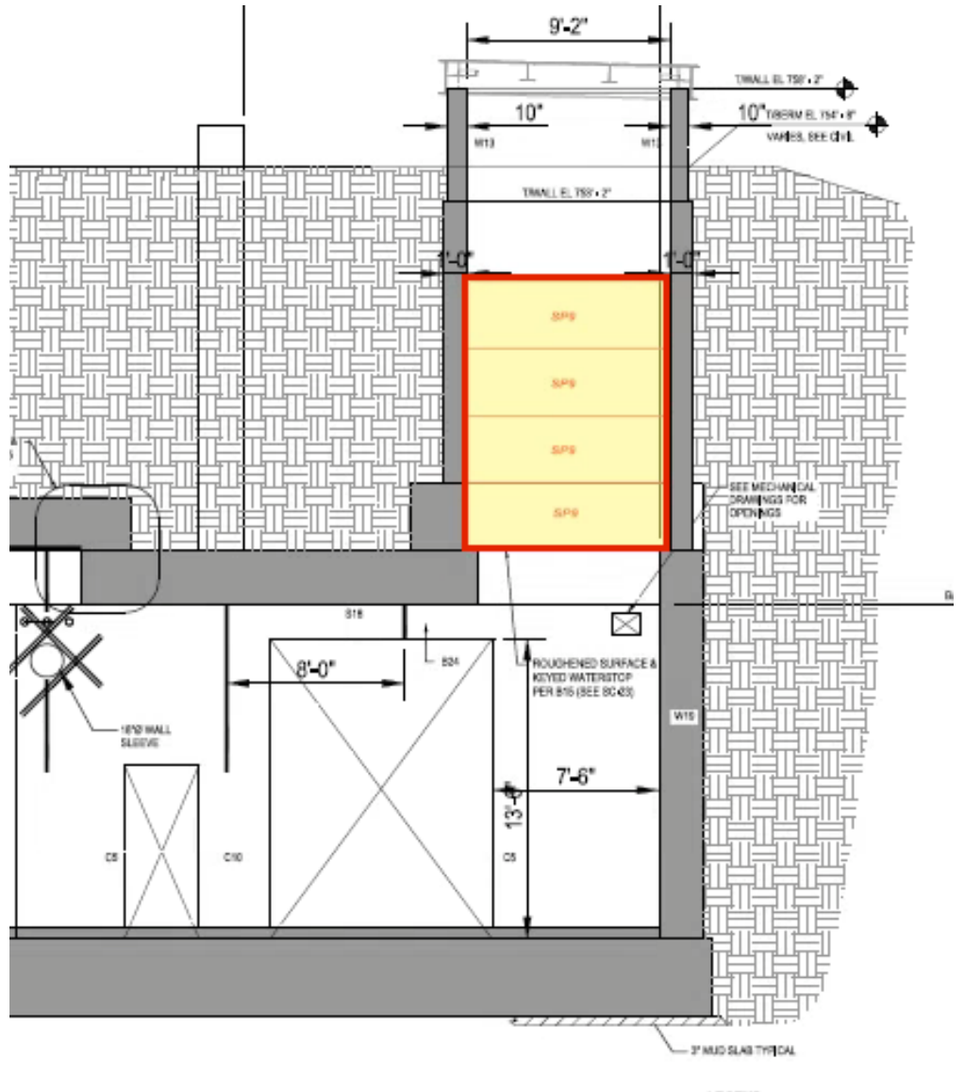
Plan Staging of shield blocks



Plan Staging of shield blocks

PS Hatch Blocks

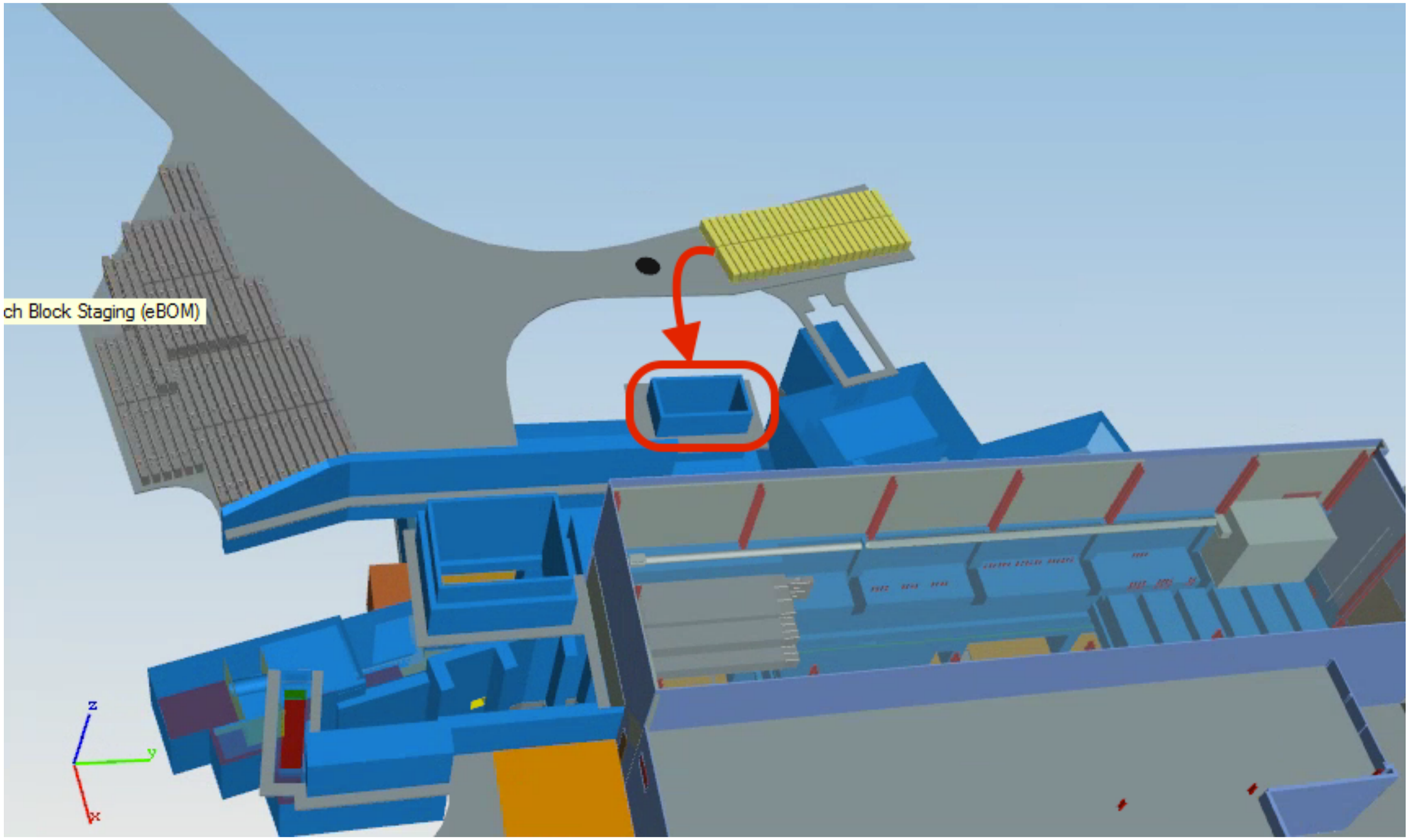




Fermilab

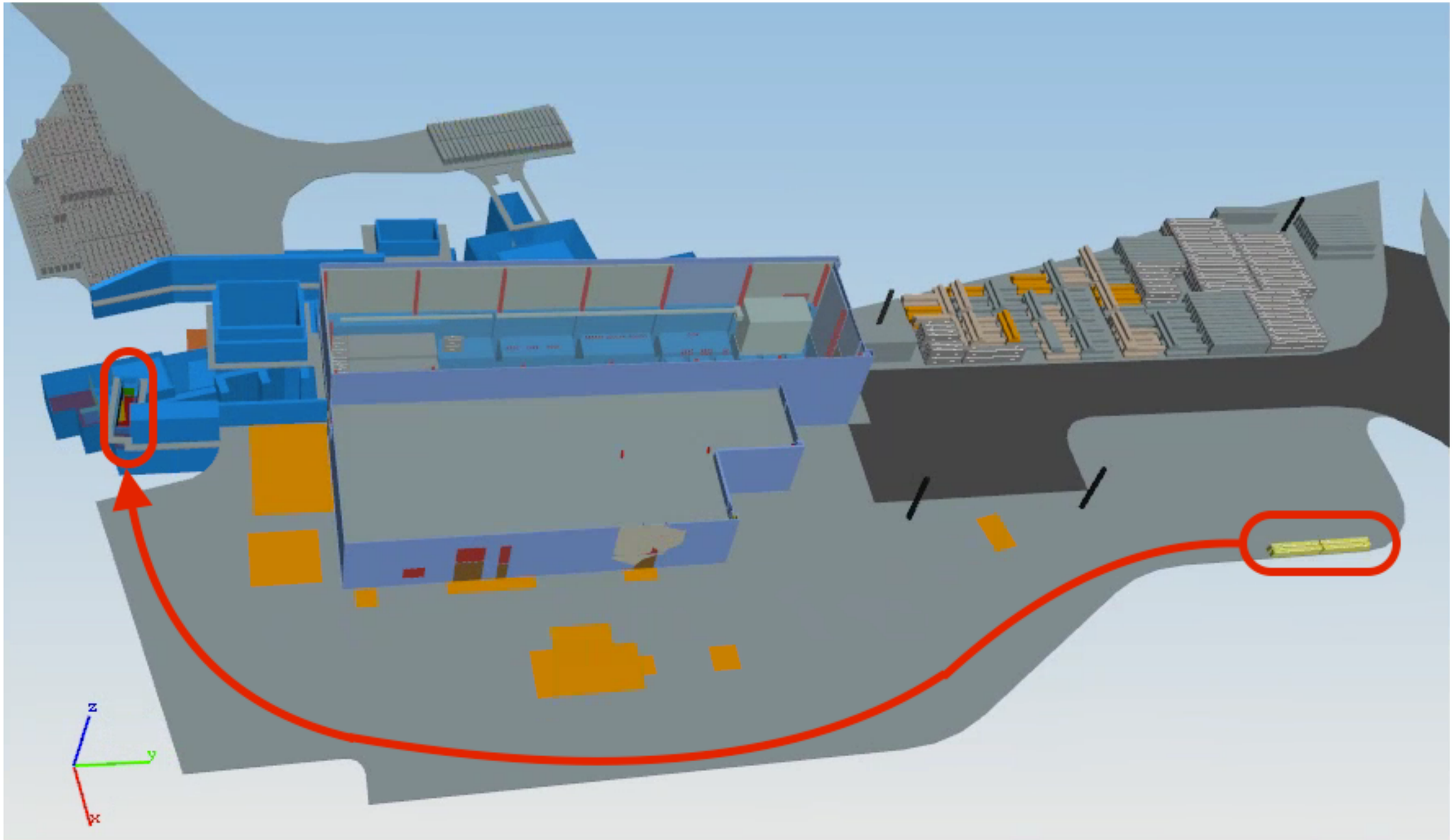
Plan Staging of shield blocks

Remote Handling Hatch

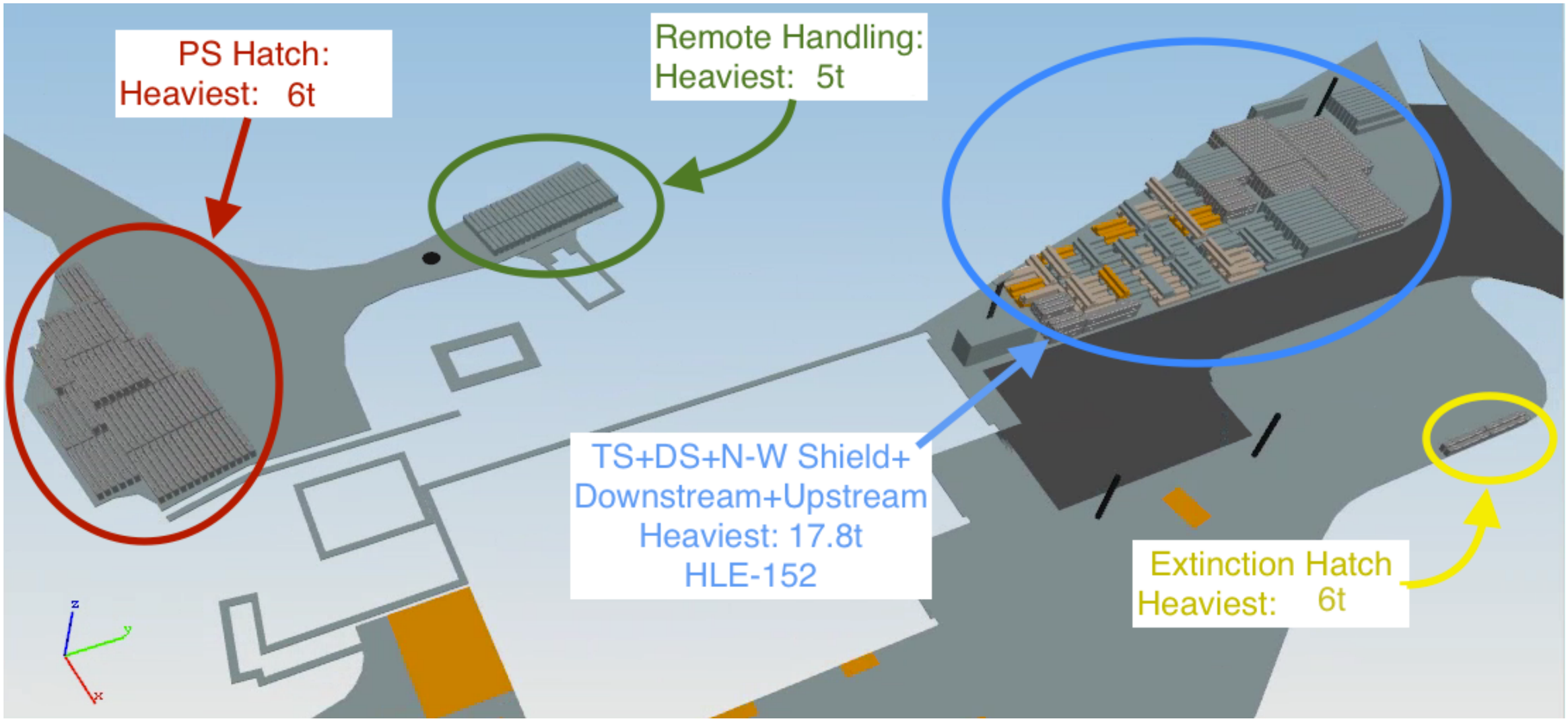


Plan Staging of shield blocks

Extinction Hatch



Blocks weight



Other features refined

- OPA and IPA locations
- Stopping Target Location
- Correct the calorimeter disks orientation
- Verify the calorimeter disks location

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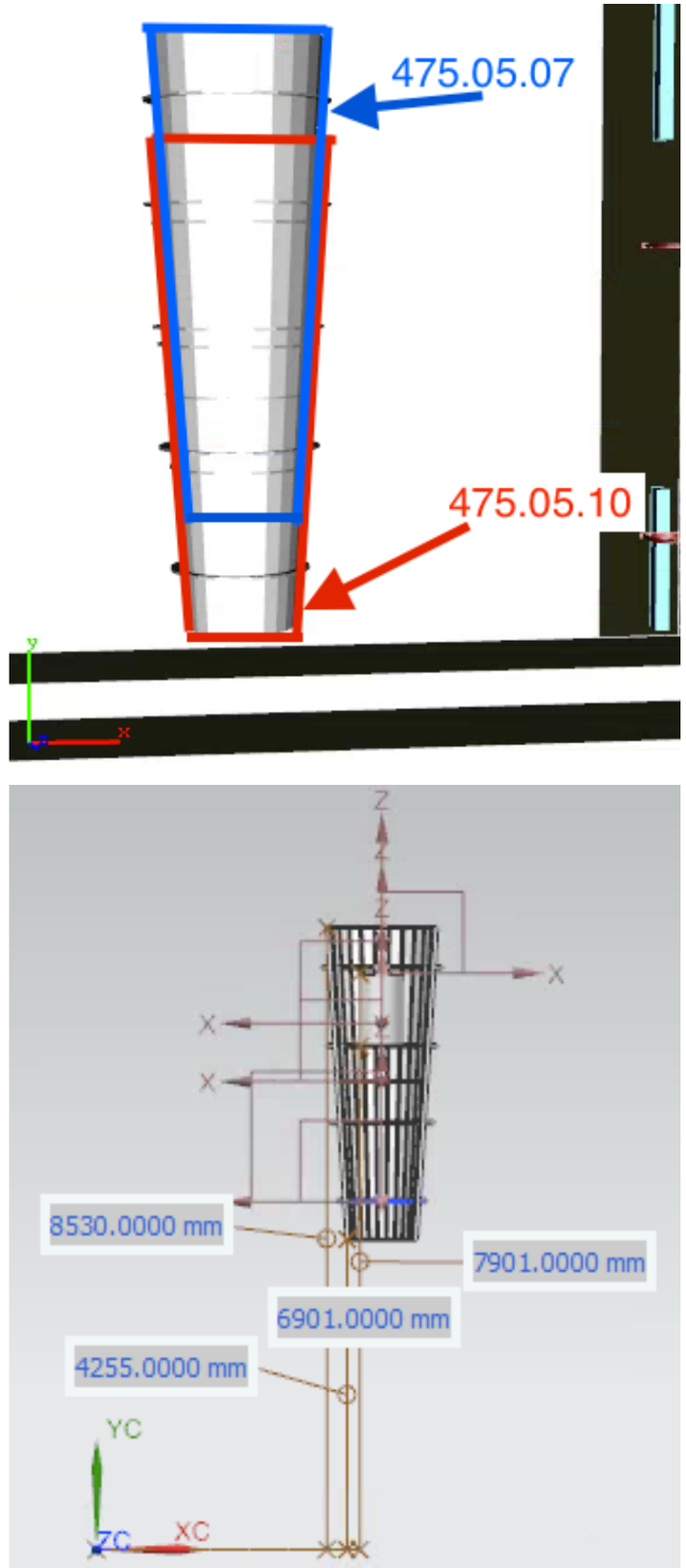

Fermilab

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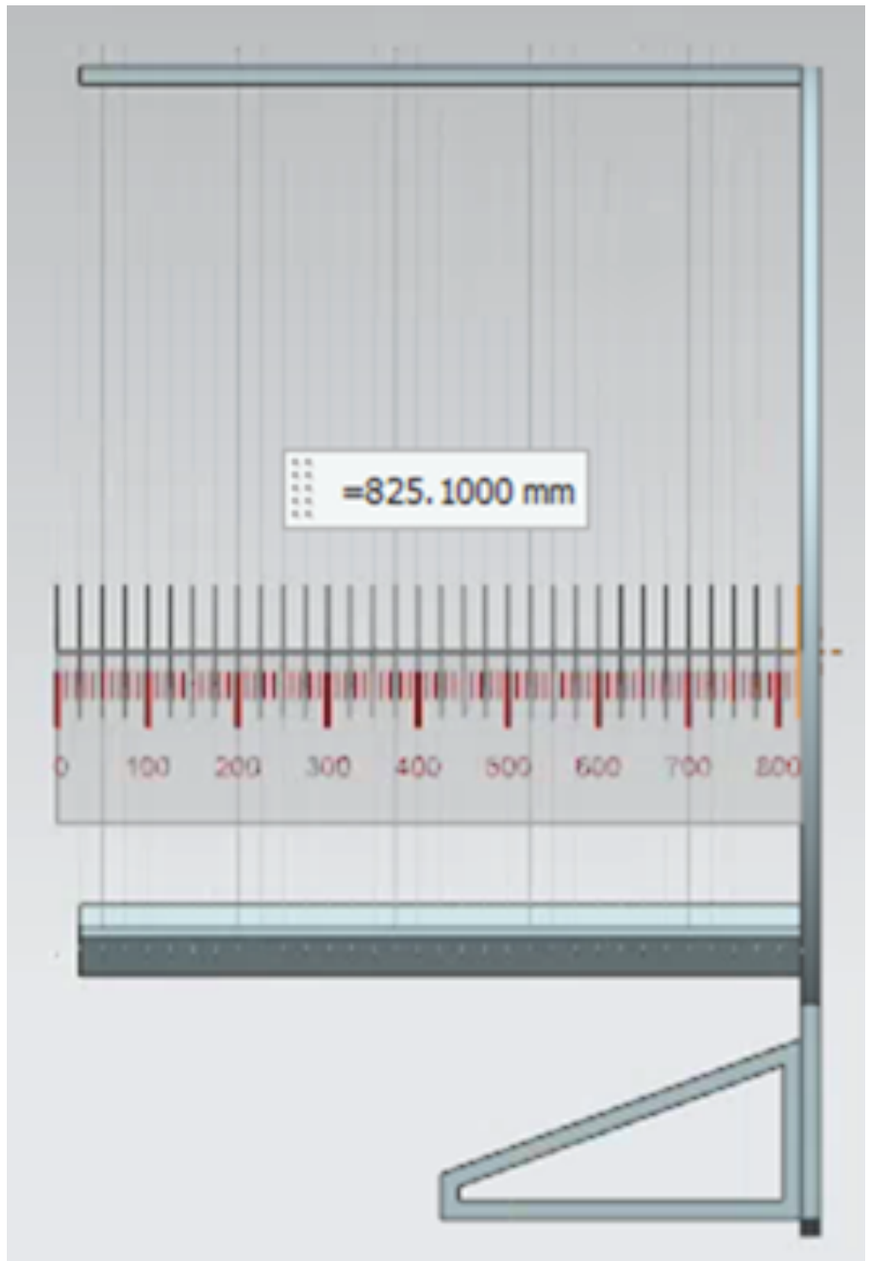

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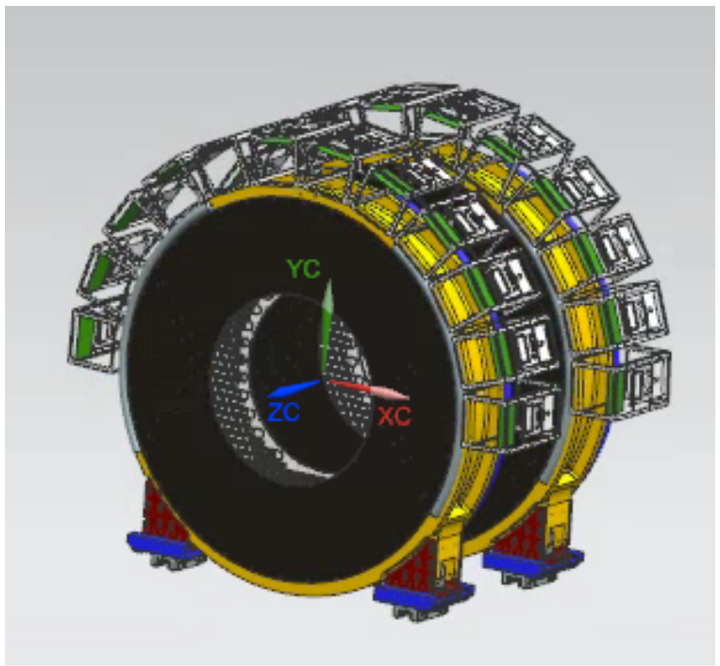

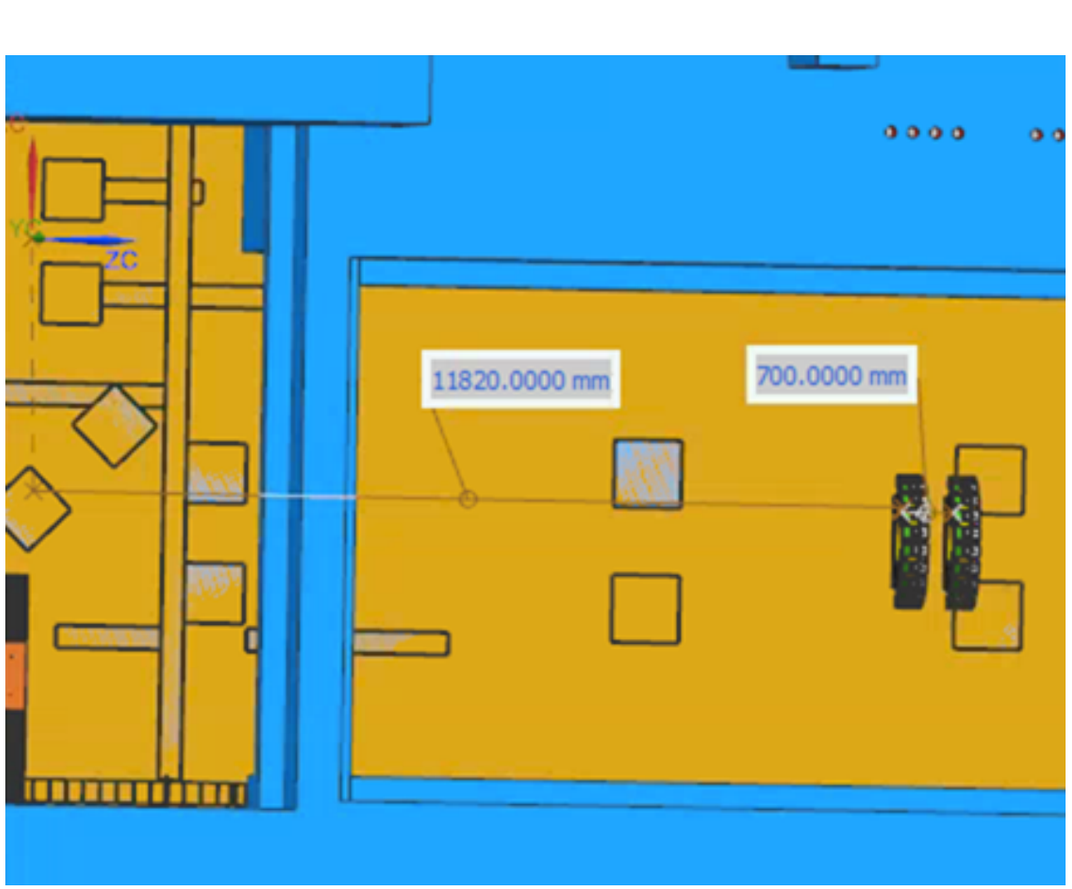

Still many things to do..

- Electrical services in the solenoid power supply room
- Sump equipment in neighboring alcove
- Services in mechanical room
- Services in electrical alcove
- Services in DAQ room
- Services in Cal DT source alcove
- Floor plates
- Trench cover plates
- Pipe chase features
- Air activation barrier
- Shield blocks in the hatches
- Trench planning
- DS VESDA line
- etc..