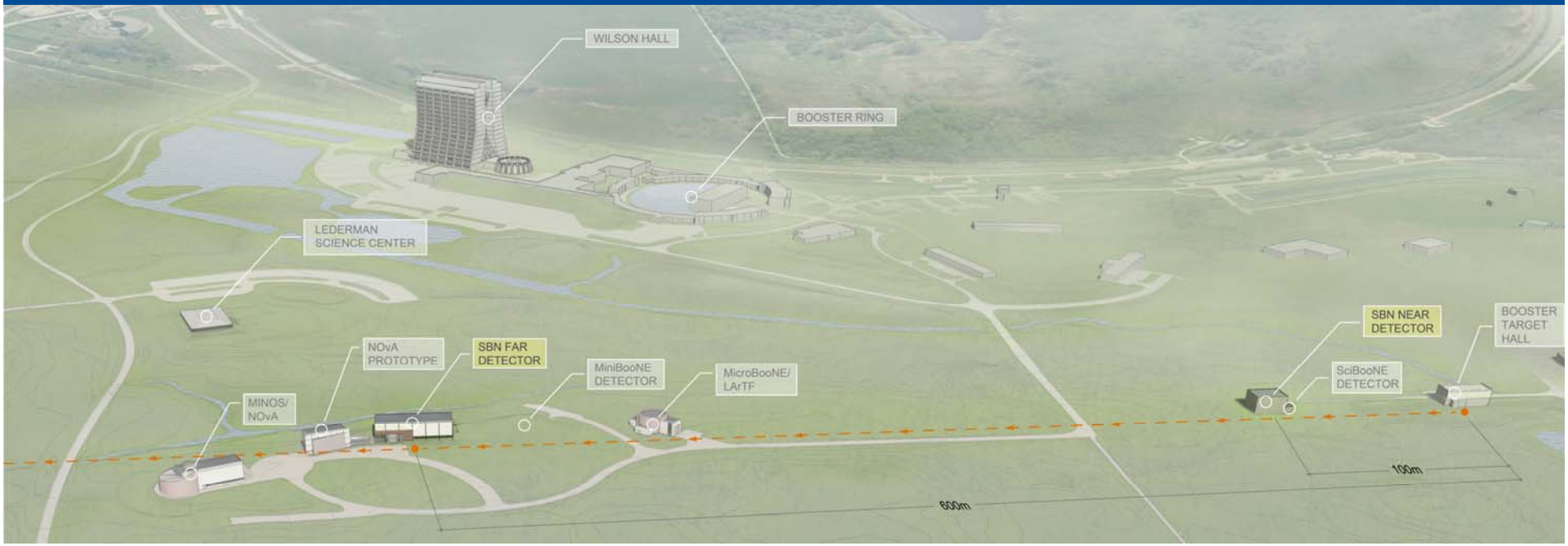


SBN Program Grounding

Linda Bagby - SBN Program Electrical Coordinator

Director's Progress Review of the SBN Program

16 December 2015

Outline

- Grounding Premise
- Far Detector Building
- Near Detector Building
- Grounding Options
- Summary

Grounding Premise

- Sensitive electronics experiments require dedicated attention to the grounding of the experiment from the building infrastructure to the subsystem integration.
- DocDB# 589 provides a detailed explanation of how the SBN Program addresses Grounding and Shielding.

  http://sbn-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=589

  – Based on the DUNE Grounding Committee's document.
    - Members include L. Bagby, P. Bauer, S. Chappa, M. Johnson, V. Radeka
- Effort began with the building infrastructure based on input from the detector groups.
- As subsystem designs mature, a committee will be formed to review specific grounding and shielding plans.

Guidance Sources

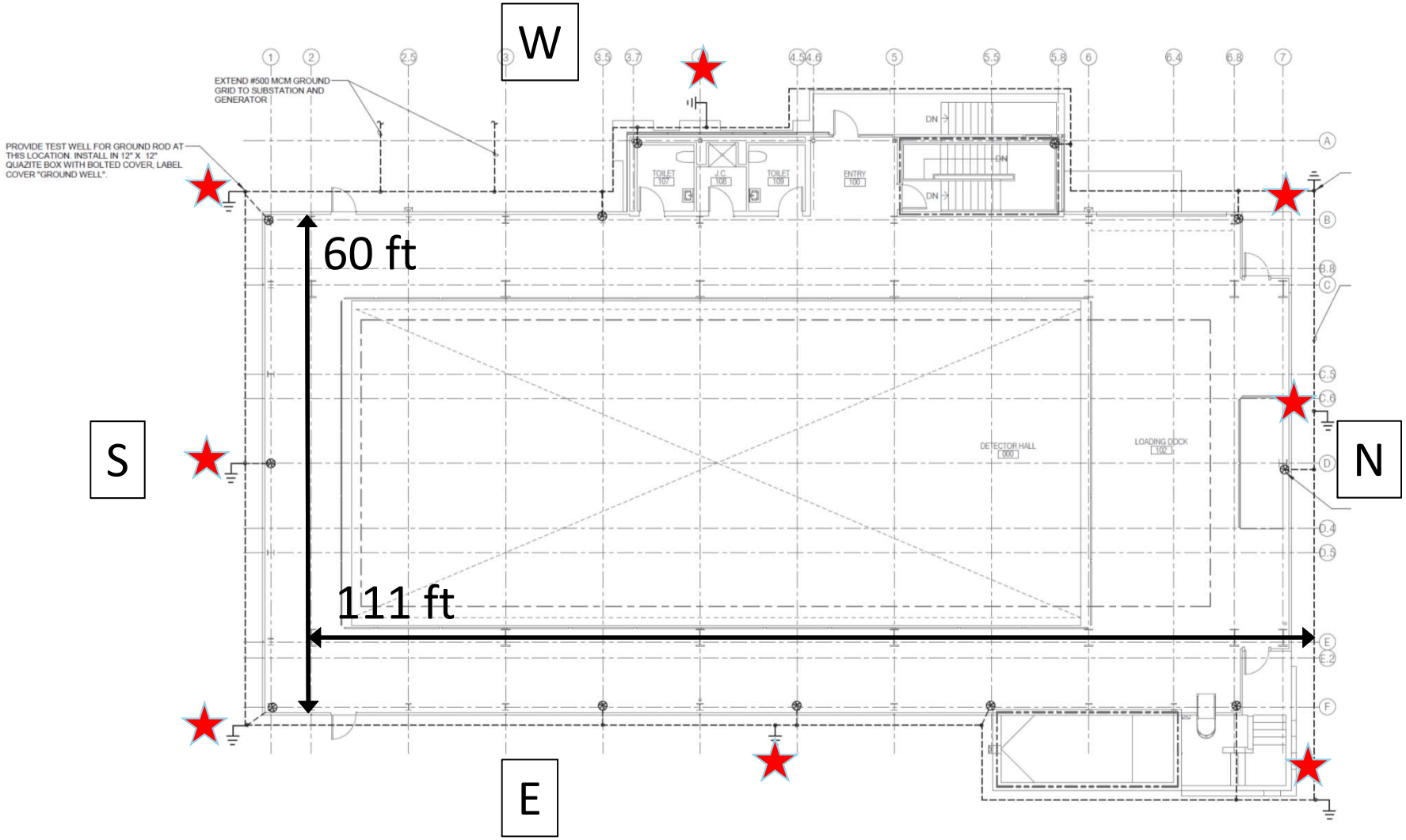
- The National Electrical Code 250.56: Resistance of Rod, Pipe, and Plate Electrodes states the building ground resistance must be at least 25 Ω for a single ground electrode.

- The IEEE Standard142-1991 (IEEE Green Book) offers recommended practices for grounding of industrial and commercial power systems. (IEEE: Institute of Electrical and Electronics Engineers)
  - 2-5 Ω generally suitable for industrial plant subsystems, buildings, and large commercial installations.
  - <1 Ω possible with parallel grounding electrodes, typically used for large substations and generator stations.
  - Our goal is <1 Ω.

- We do this by:
  - Requesting UFER Ground construction in buildings.
  - Taking measurements of rebar planes and ground resistance when appropriate throughout the construction process.

Far Detector Building: Icarus

8 // 10ft grounding electrodes



Far Detector Building: Icarus

#10 rebar (d:1.25”, grade 60 Steel)
2 planes, 31.5” spacing
Top plane: 6” x 10” grid
Bottom plane: 18” x 10” grid

Fluke 1630 Earth Ground Clamp
10.29.15 UFER Ground measurements
SW: **.187** Ω, NE: **.240** Ω

SW

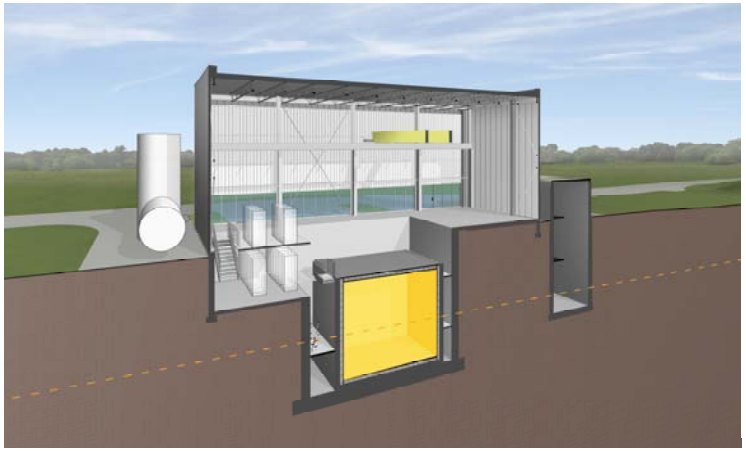
500 MCM cable

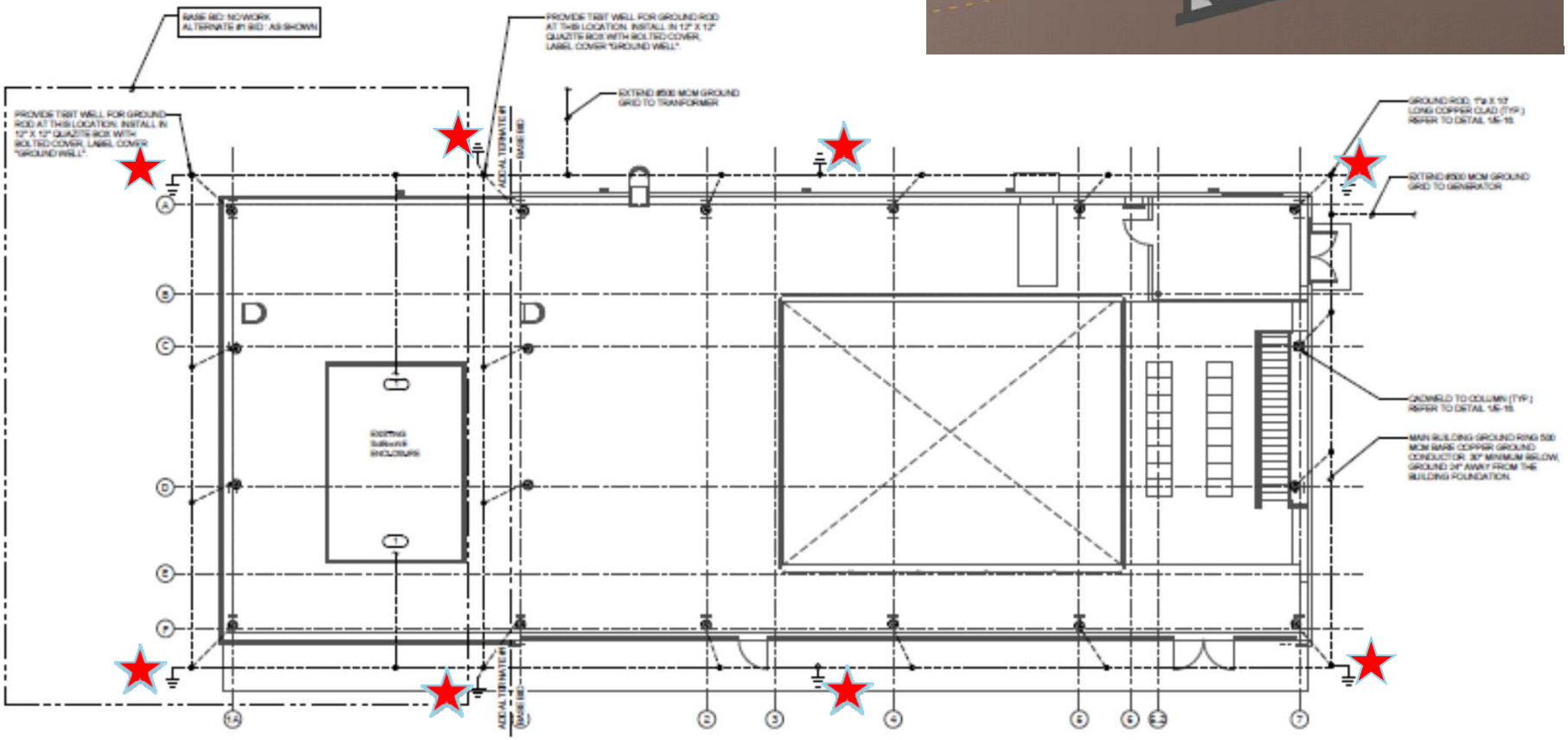
Far Detector Building: Icarus

Fluke 1630 Earth Ground Clamp
12.11.15 UFER Ground measurements
SE: **.08-.1** Ω, E: **.07-.14** Ω, NE: **.05-.19** Ω

Near Detector Building: SBND

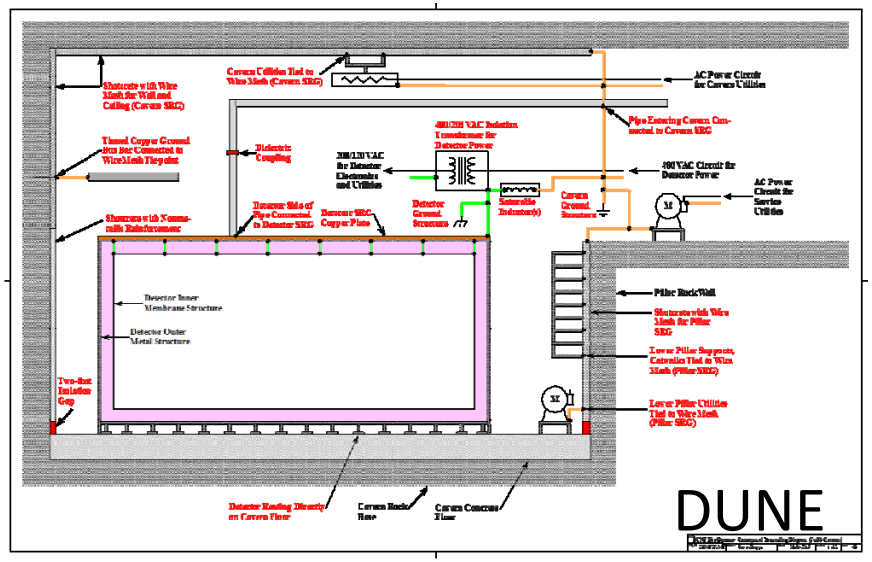
8 // 10ft grounding electrodes

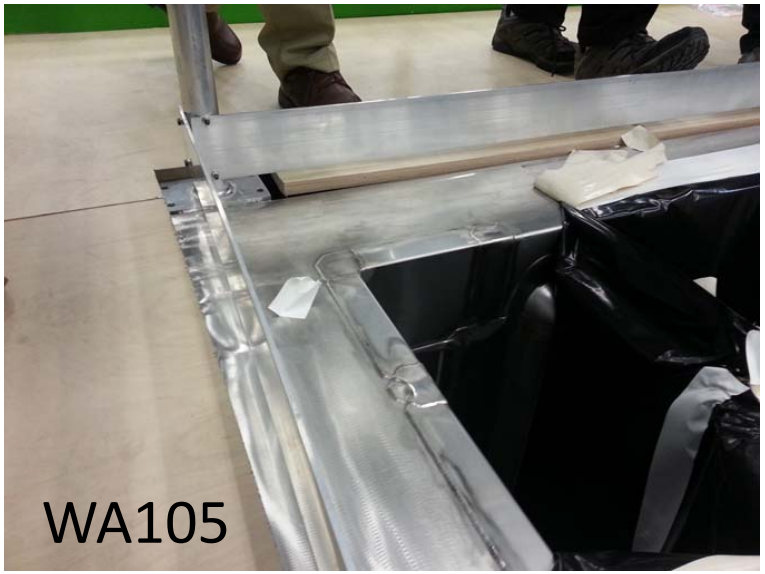


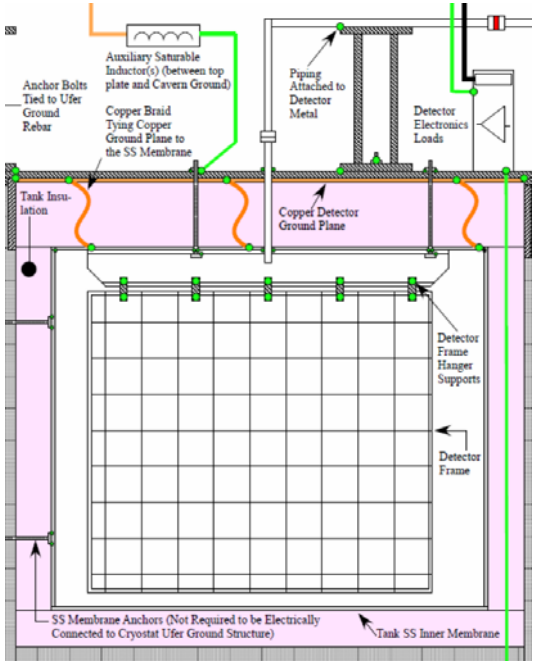


Grounding Options

- DocDB# 684: A survey of how various LAr experiments are grounding.
  http://sbn-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=684
- 2 approaches
  - Isolated
    - Can use a custom designed double shielded transformer with a saturable inductor linking building ground to detector ground.
  - ‘Quiet’ power
    - Utilizes standard double shielded transformers powering only sensitive electronics.

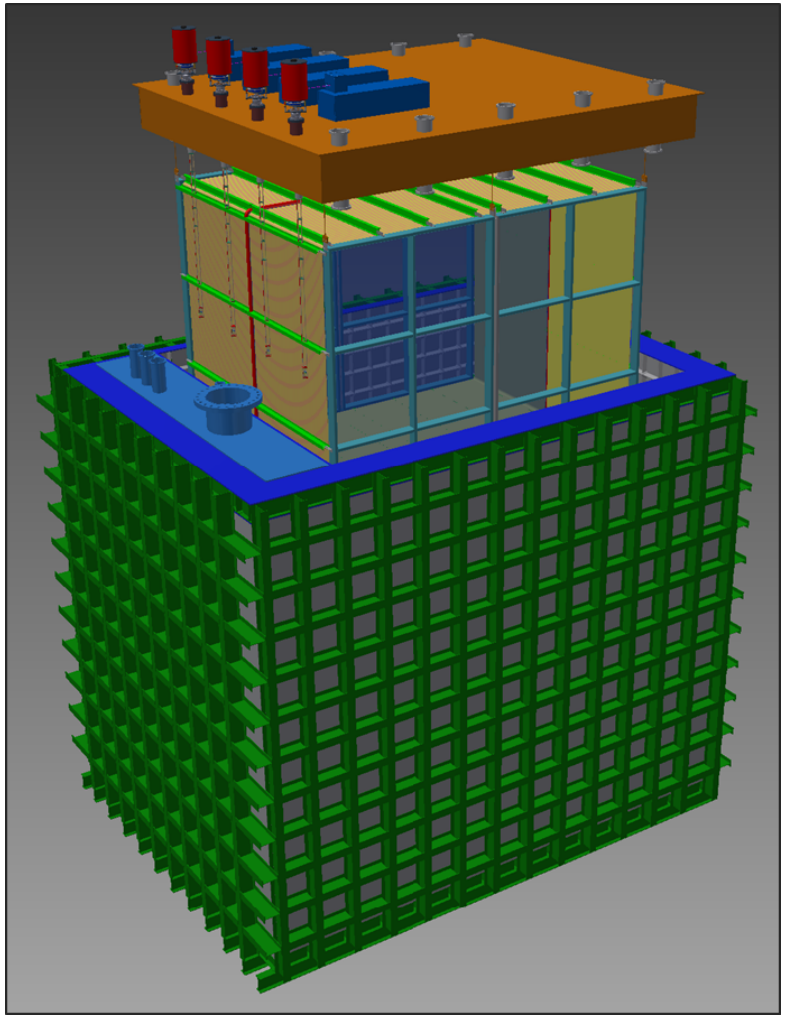






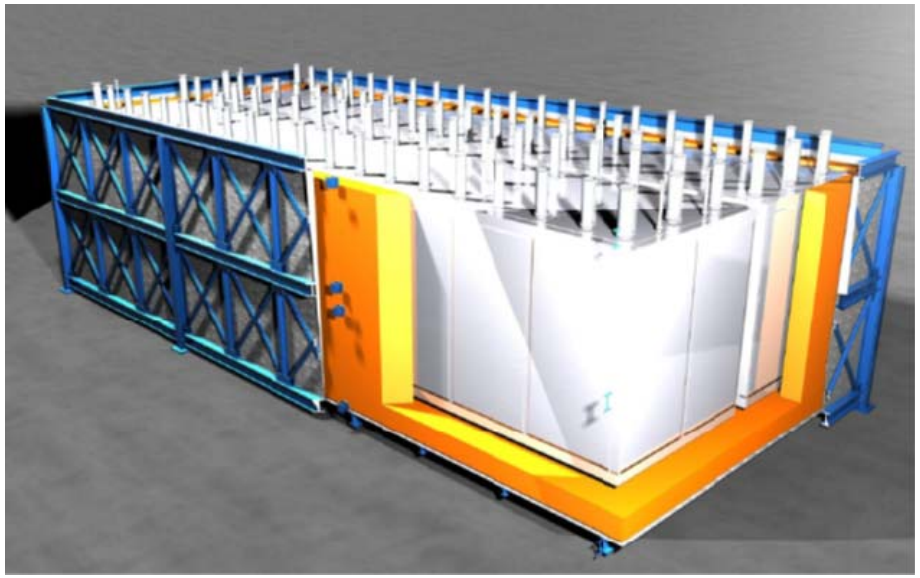
Grounding Options: SBND

- Conductive UFER ground.
- Outer I-beam frame similar to WA105.
- Need to pay attention to capacitive coupling.
- Anode frame difficult to isolate.
- WA105 approach probably the best solution utilizing ‘Quiet’ power.



Grounding Options: Icarus

- Conductive UFER ground.
- Warm Box (I-beam structure) sits on concrete floor.
- TPC sits on rubber feet inside inner cold box.
- Cold Box defined as Detector Ground.
- A clear division between building ground and detector ground.
- Can use ‘Isolated’ grounding approach.



Additional low noise design features and requirements

- Dielectric breaks on all cryogenic piping connected to cryostat.
- Keep motors, generators, VFDs, pumps off of sensitive equipment dedicated transformers.
- Use low noise VFDs.
- All metal features must be bonded to ground.
- Minimize/eliminate ground loops.
  - Require drawings for all cable connections from equipment to detector feedthroughs or crates.
  - Require drawings for crate electronics AC Distribution and signal grounding.

Summary

- Building UFER ground systems monitored as construction continues.
- Grounding options survey completed.
- Suggested grounding configurations cited for Icarus and SBND.
- Low noise integration features cited.