CUORE at LNGS Clean Room

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Definitions:

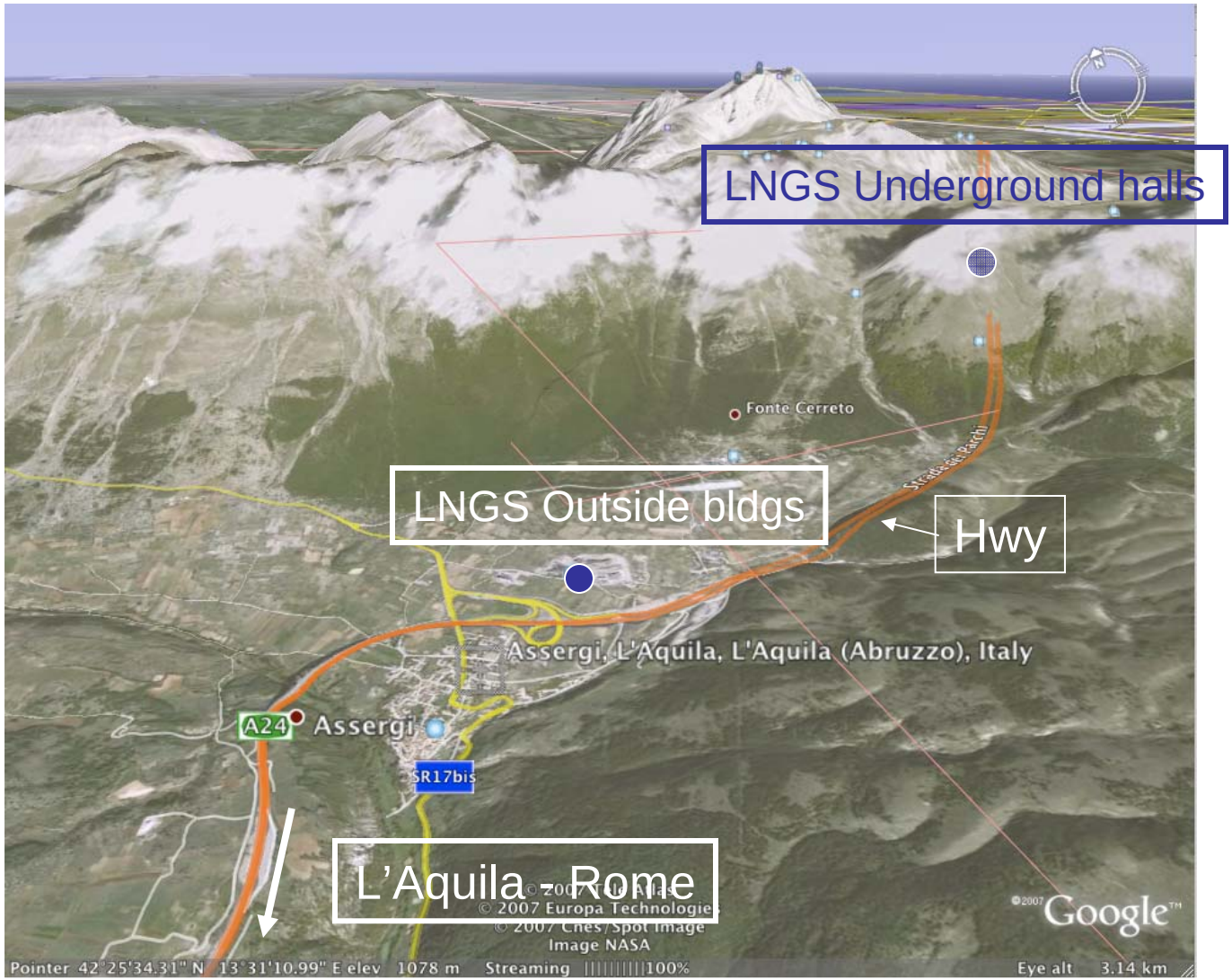
- LNGS: Labortori Nationali Gran Sasso
  (Gran Sasso National Laboratory)
  See next slides

- CUORE: Cryogenic Underground Observatory for Rare Events
  - “cuore” means “heart” in Italian
  - See Following slides

LNGS in Italy

- Located in the **Appennini** mountains, in the central part of Italy
- The closest town is **Assergi**, a little village 120 km far from Rome

LNGS in Italy



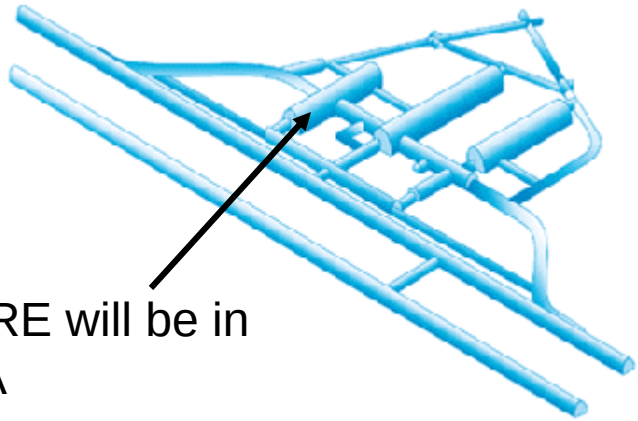
- <u>Access</u> to the Underground lab <u>through</u> the A24 <u>hwy</u>
- Shuttles running every 20 minutes from the outside bldgs to the underground lab for researchers
- Easy access for trucks

The Location: Gran Sasso

LNGS is located underground
In a traffic tunnel. Outside air is
Brought into tunnel, but has a high
Radon content.

See:

http://www.lngs.infn.it/



CUORE will be in
Hall A

CUORE

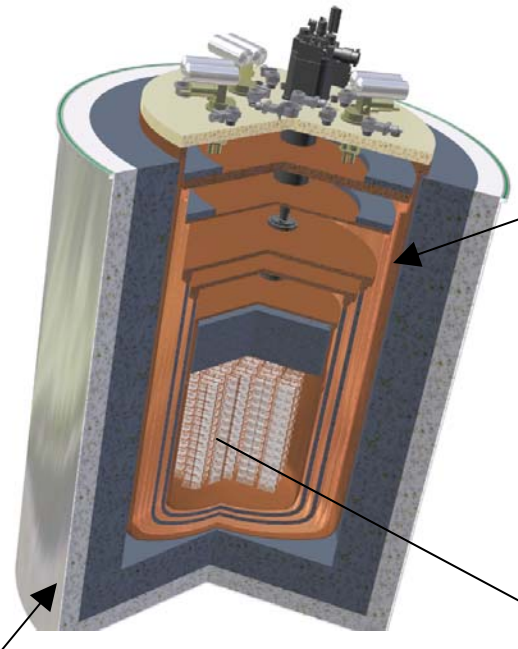
- Cryogenic Underground Observatory for Rare Events
- Purpose:
  - Measure as yet unknown properties of the “Neutrino”. Neutrino’s are generated in radioactive decay
  - We are looking for a very, very rare process (half life~ 10^{26} years!) to answer the two questions:

    1. Is the neutrino its own anti-particle?
    2. If Yes, what is its mass?

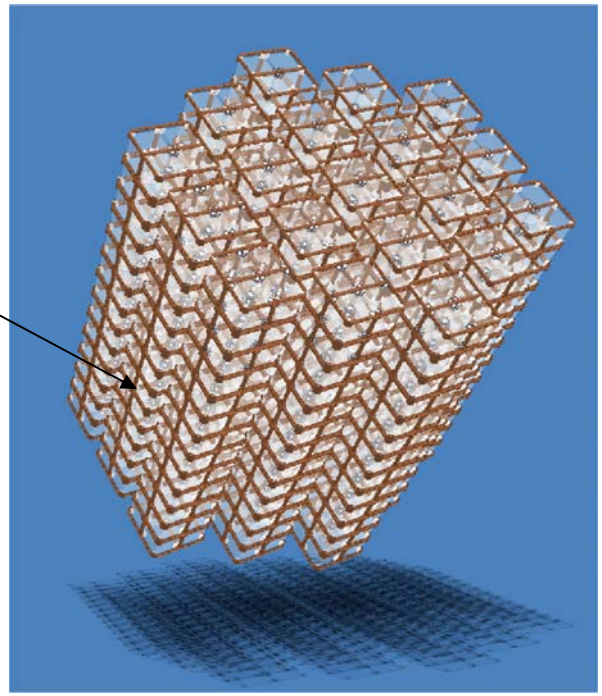
- ~ 1000 TeO_2 crystals (~ 1 Ton total) kept at 10m Kelvin.
- Extremely sensitive to radioactive backgrounds
  - Special materials (radio pure Cu & PTFE) and cleaning processes
  - Radon Control: air pumped from outside is 10Bq/m^3, need 0.1Bq/m^3
  - Clean room for final assembly and maintenance.

The Detector and Cryostat

- 988 TeO_2 crystals, each 5 x 5 x5 cm^3
- Multi-layer cryostat with Pb, Poly and copper shielding
- Cryostat is about 1m dia x 3 m tall.
- Show here with external Pb and Poly shield



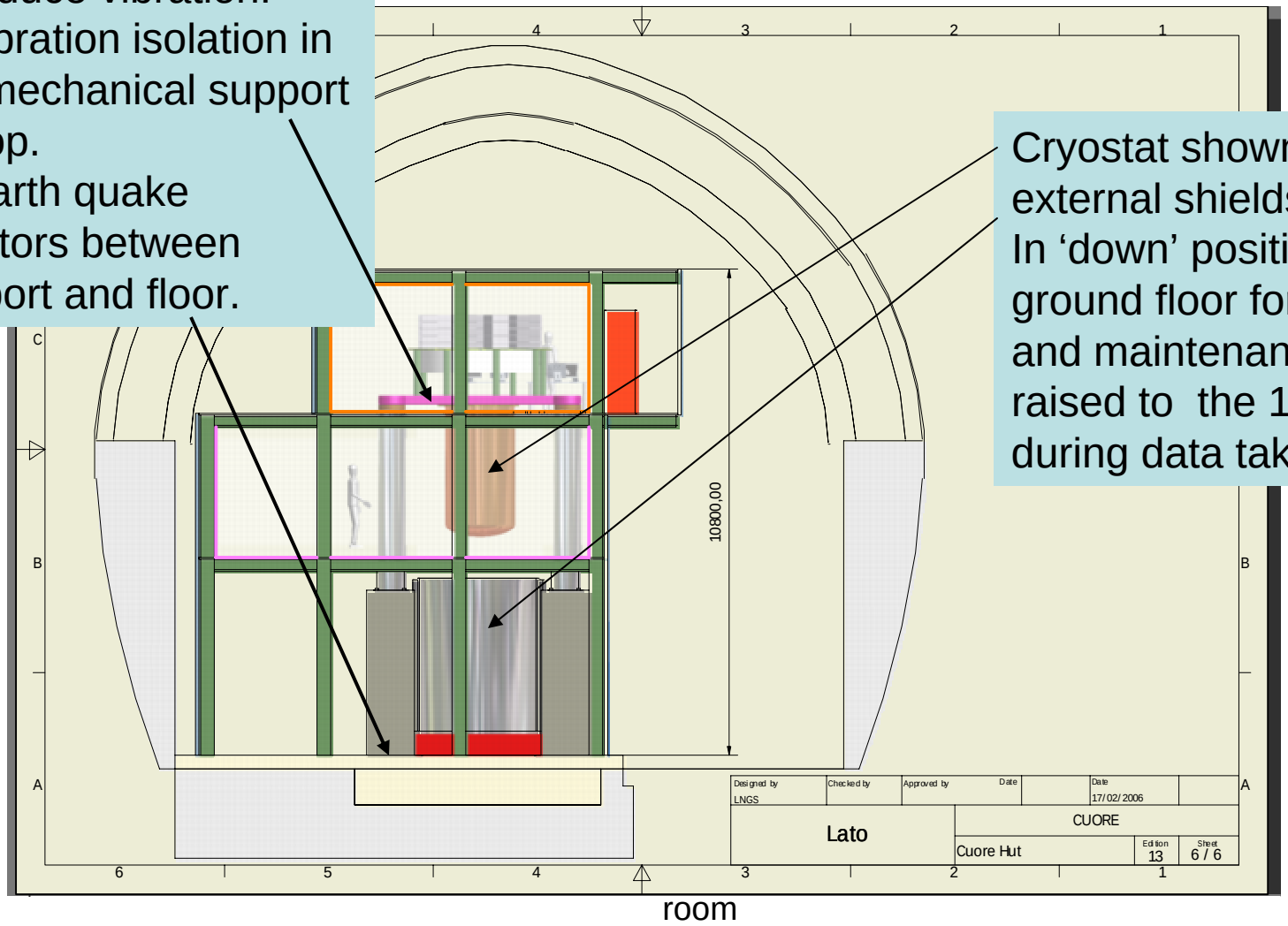
988 TeO_2 crystals Suspended above from cryostat cover, cooled to 10mdeg Kelvin



Moveable (vertically) lead and plastic Shield, 120 Ton.

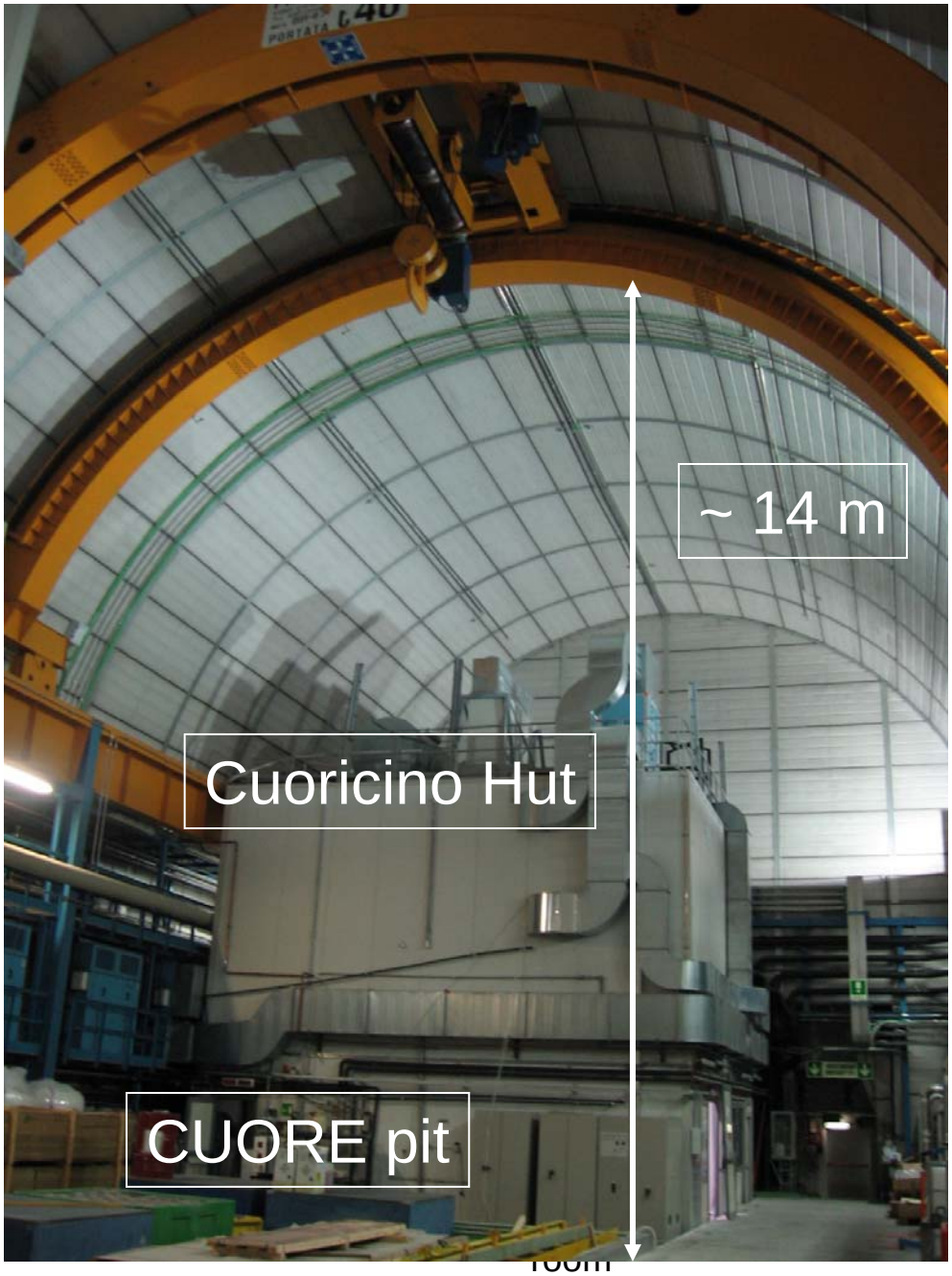
Cross-section of Hut inside Hall A (incl. curved crane)

Detector is supported independently from Hut to reduce vibration:
1) vibration isolation in the mechanical support on top.
2) Earth quake isolators between support and floor.



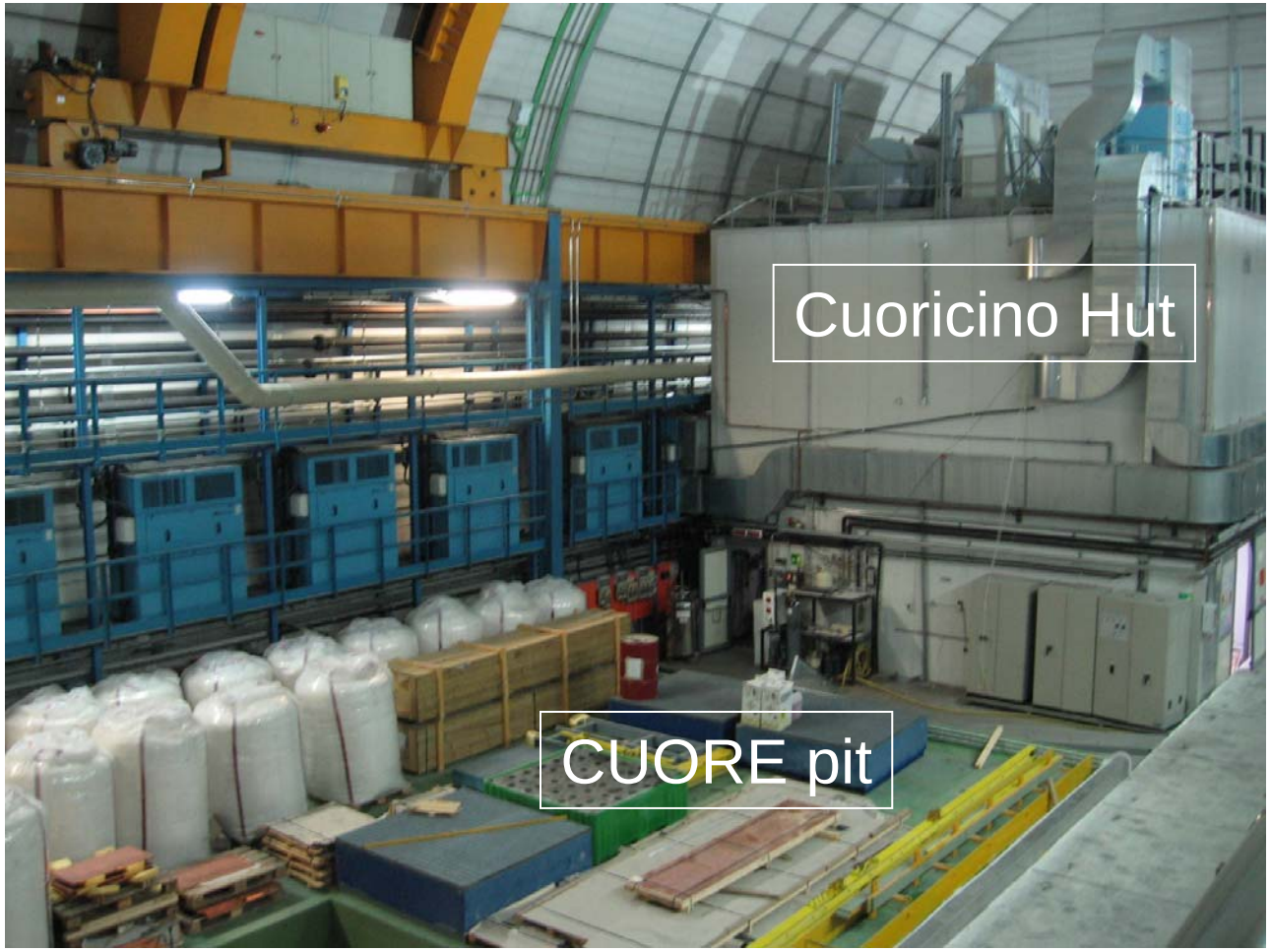
Cryostat shown with external shields withdrawn In ‘down’ position on ground floor for assembly and maintenance. They are raised to the 1st floor during data taking

room



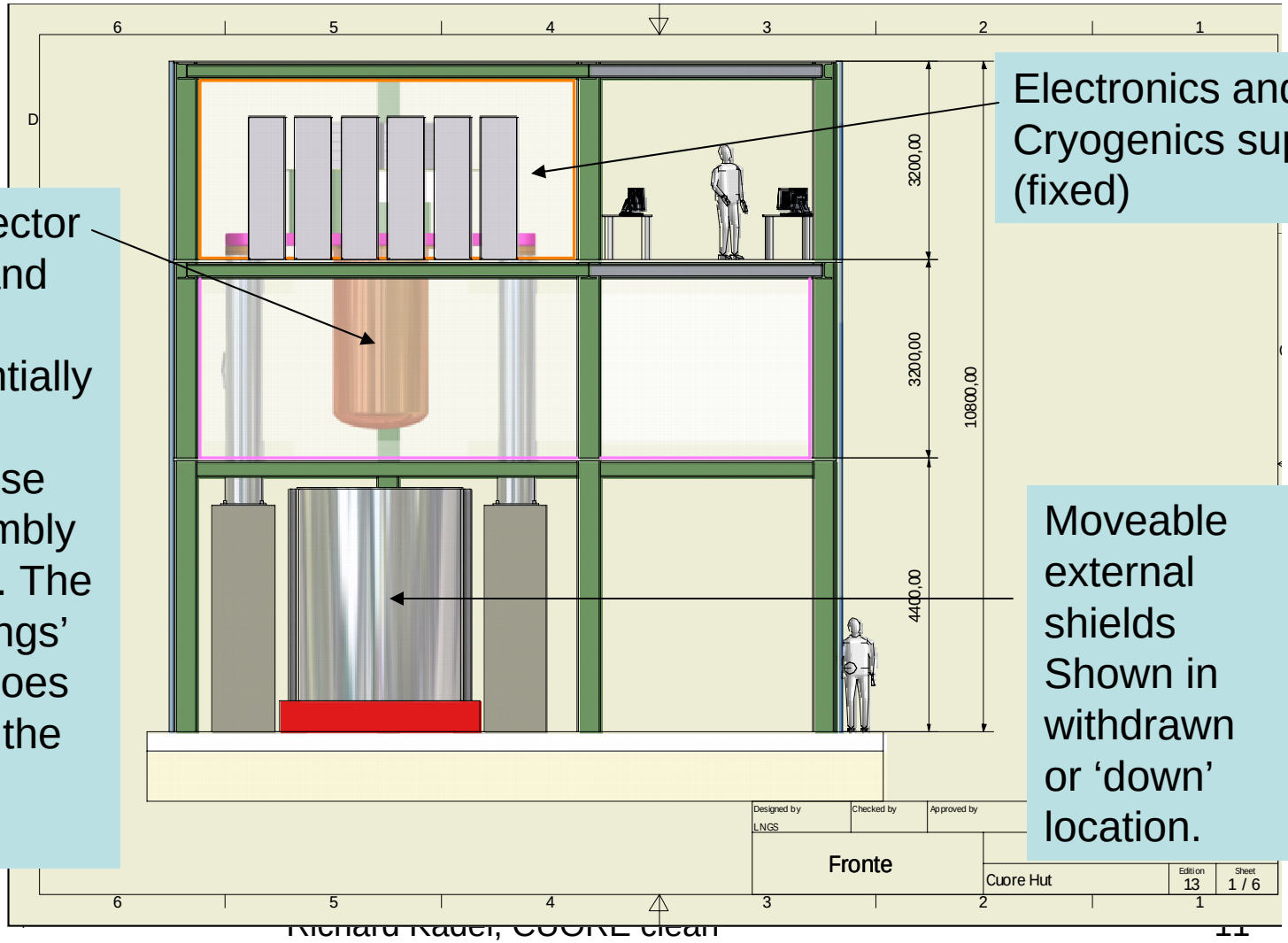
Hall A

CUORE pit



Richard Kadel, CUORE clean room

Cross-section thru ‘hut’

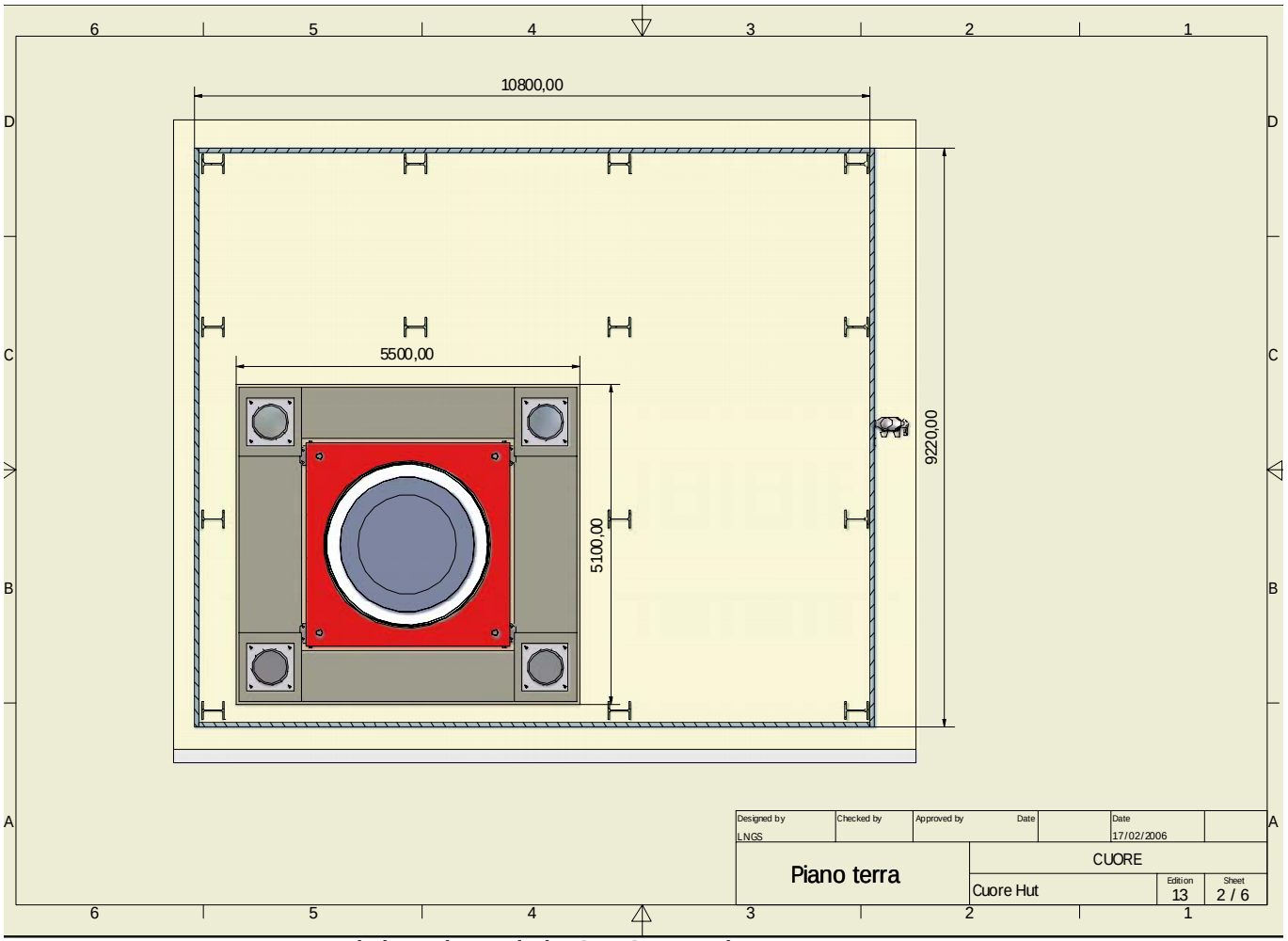


Electronics and Cryogenics suppo (fixed)

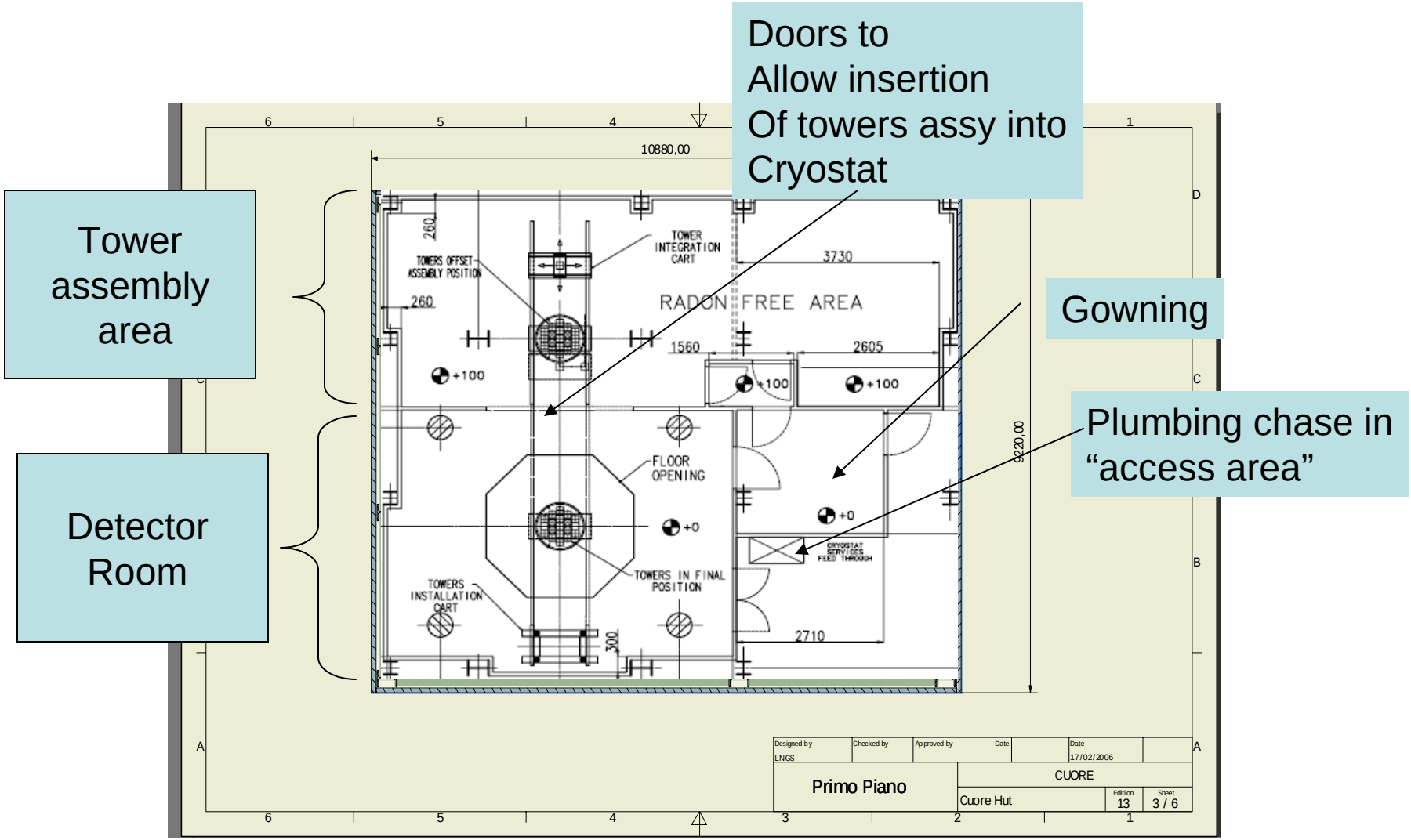
Cryostat with detector Inside. Cryostat and six thermo-shield layers are sequentially lowered towards ground floor expose detector for assembly and maintenance. The detector itself ‘hangs’ from above and does not move. This is the clean room area.

Moveable external shields Shown in withdrawn or ‘down’ location.

Ground Floor, showing External Shield



First floor (Clean room).

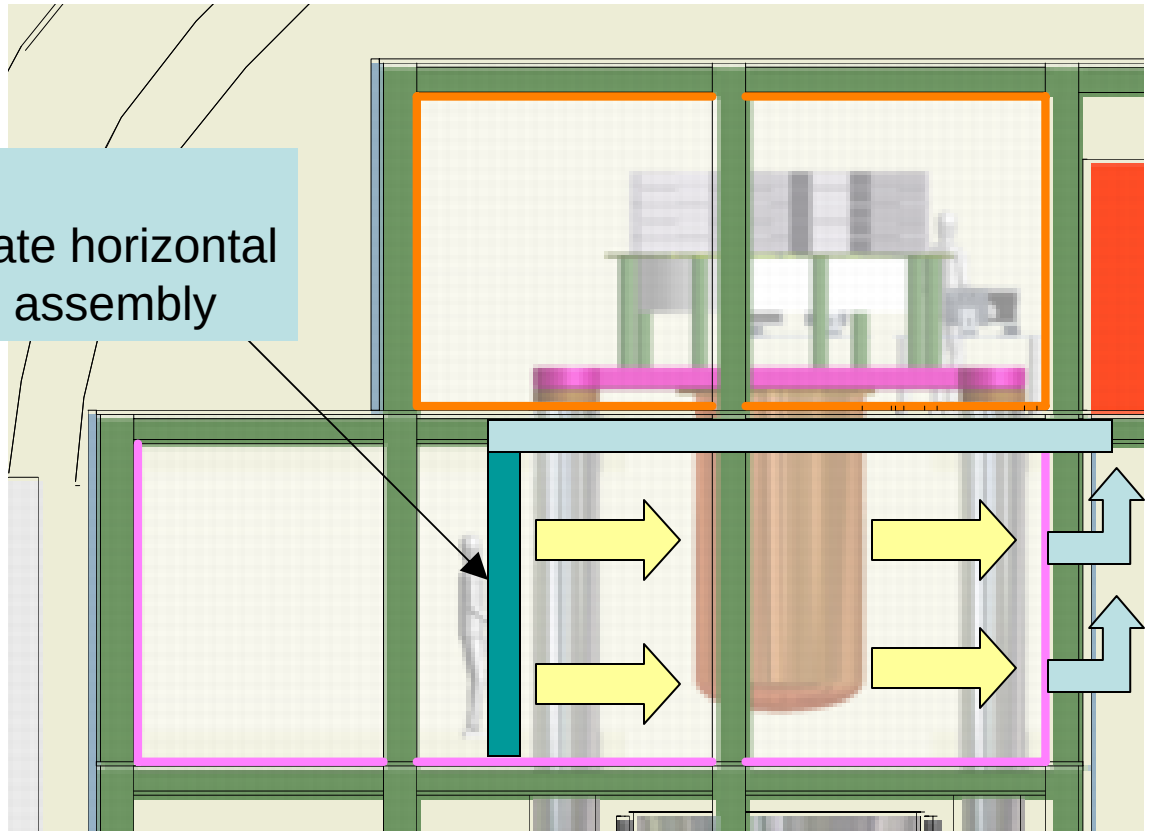


Air Supply

- We have to remove radon from the tunnel air (too radioactive)
- Expect makeup supply of order 150-300 m^3/hr.
- Most sensitive area for radon is tower assembly area.
- Downward air flow (if mechanically possible) in this area.
- Air return in “detector room” can be in walls.
- Modify air flow in this area during final assy (see next slide.)

Temporary Air flow pattern during tower insertion into cryostat

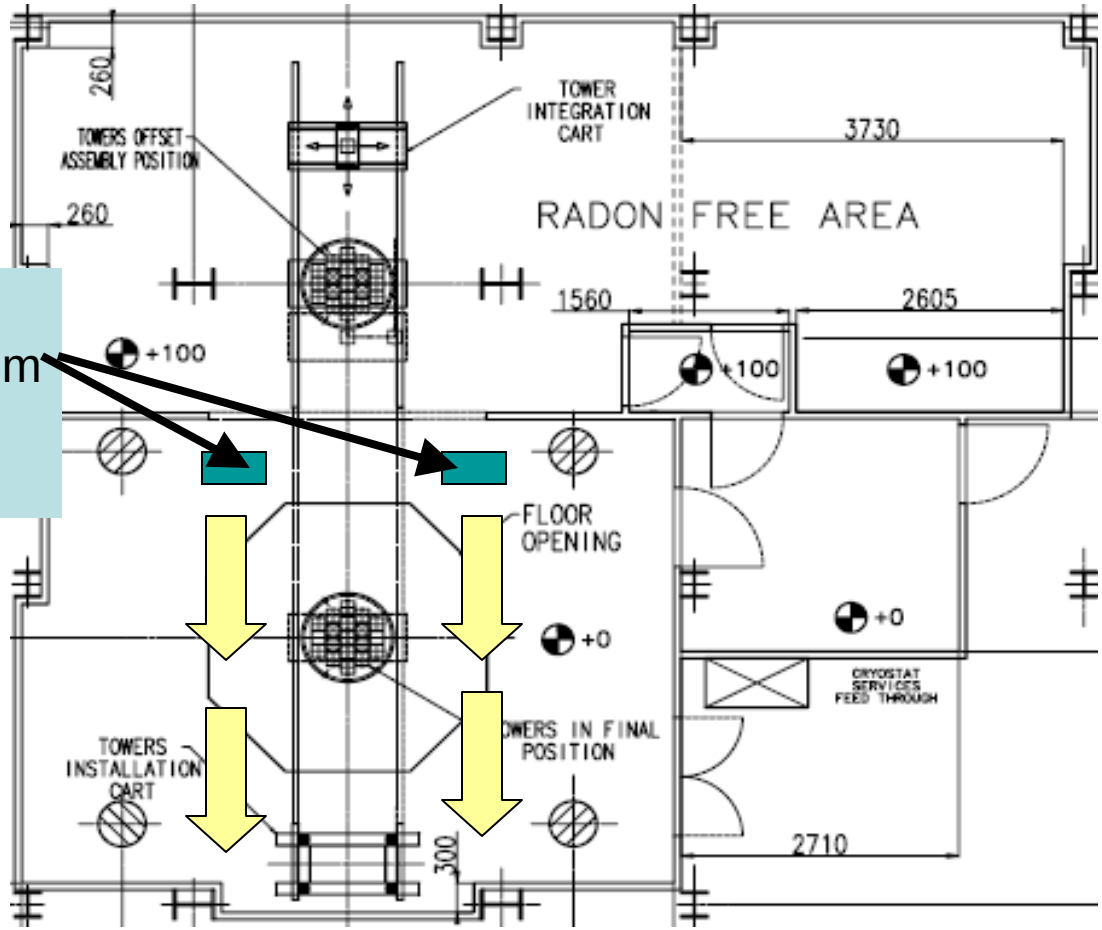
Temporary Duct
From ceiling to create horizontal
Air flow during final assembly



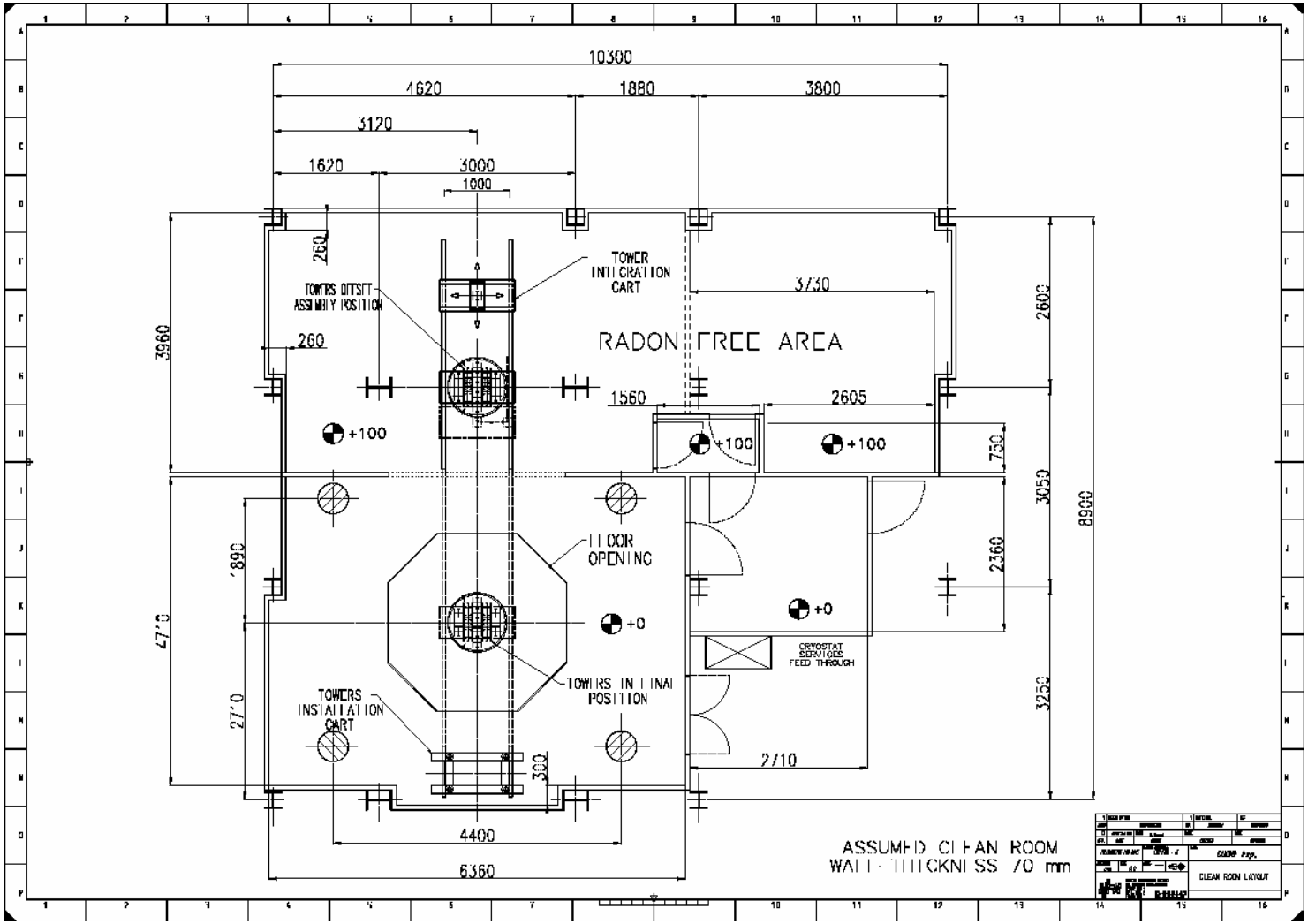
Return air flow ducts in walls and ceiling

Air flow during final Assembly

Temporary ducts
Divert air flow from
Ceiling ducts to
Horizontal flow.



Floor Plan Layout



More Information

- Class 100 near detector, Class 1000 elsewhere.
- Filter/ Blower issues
  - External blower and ‘plenum’ (i.e. ‘ducting’) is more energy efficient than fan/filter units. External fan makes for less noise and vibration.
  - Fan /Filter units are nosier, but can makes it easier to have ‘local clean spots’ in larger clean room.
  - Want to reduce radon infiltration from tunnels→ minimize low pressure areas in ducts, etc.
- Consider ‘Demand Controlled Filtration’ No ‘air showers’ to blow people off prior to entry into clean room.

Sealing holes in Clean Room

- Two sets of holes:
  - Detector support columns
  - Hole for moveable external shield.
- We have ideas on how to seal holes around experimental support posts: Custom rubber seals
- Also have ideas on how to seal floor around large opening for external shield.

Task

- The idea is to produce a “user specification” for the clean room that could be given to design(/build?) firm who would create construction drawings.
- LBNL can provide drawings of the space, and some of technical requirements unique to our application.
- Need help on incorporating this information into “standard” clean room specfications (ie HVAC, lighting, surfaces, N2 and compressed air supply, vacuum cleaning systems,etc)