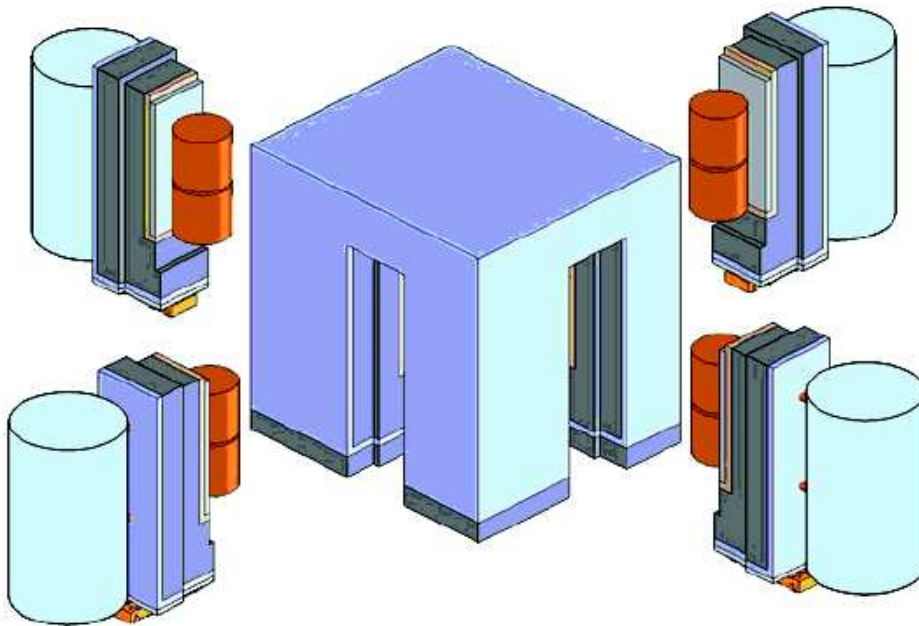




# Majorana Site Facilities



**Draft Revision 0** *November 6, 2005*

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# 1 Scope and Overview

This document describes the activities that are envisioned to be carried out at the site for the Majorana experiment. The necessary functionality, spaces and services required to perform these activities are described. There are two functionalities envisioned

## **Detector Assembly and Operation**

The assembly, operation and calibration of detector.

## **Copper Electroforming and Machining**

The electroforming and machining of the ultra pure copper components.

A third functionality that is not presently envisioned is the growing of detector crystals and the fabrication of detectors from the crystals underground This document describes the current understanding of the function and activities associated with each laboratory space and services required by Majorana. As well, there is an accompanying spread sheet

`majorana_site_infrastructure_rev_xx.xls`

which contains a space summary sheet and a room equipment list.

*The spaces discussed here are spaces that are specifically identified as required by the Majorana experiment. It is assumed for the purpose of this document that Majorana is going into a developed laboratory that provides some basic services. If Majorana was going into a virgin site then there are additional infrastructure requirements that would have to be developed.*

## 2 Site Activities

### Underground Activities

- Assembly of the detector multilith (detector blockhouse) and it's associated veto shielding.
- Characterization of the Ge detectors including:
  - Pulse shape characterization vs position.
- Testing of the bare Ge Detectors.
- Assembly of the Ge detectors into cryostats.
- Testing of the Ge detector strings
- Assembly of the Ge detector strings into cryostats.
- Assembly of the detector cryostat modules into monoliths.
- Assembly of monoliths into the multilith.
- Electroforming of the detector assembly and shielding copper components.
- Machining of the detector assembly and shielding copper components.
- Low background counting ( $\gamma$ ?  $\alpha$ ?) of components that must be done at the final underground site?
- Final QA of components before assembly into detector systems?
- Storage of components in a radon free environment.
- Calibration of:
  - Bare crystals
  - Fully assembled detector.

### Surface Activities

- Receiving of detector components to go underground.
- Surface control and monitoring of experiment.
- Data processing and data storage.
- Radon emanation of components?
- $\alpha$  counting of components?

## 2.1 Activity Sequences

This section should really be developed by the Final Assembly Working Group rather than Facilities. However, going through the exercise even with limited knowledge illuminates needs for the facility development. It is expected that these sequences will be corrected, modified and refined as a better understanding of the Majorana experimental sequence is achieved. This in turn will refine the site facility development..

### 2.1.1 Electroforming Copper Components

This is a proposed process sequence for the electroforming of copper parts for Majorana. It's purpose is to identify the facilities and equipment required for each step of the process.

1. Source copper for electroplating arrives on site.
2. Source chemicals for electrolytes arrive on site.
3. Copper stock is cleaned on surface and sealed in shipping containers to go underground.
4. Chemicals and copper stock shipped underground in clean sealed shipping containers.
5. Copper stock and reagents are unpacked inside the underground Facility. Stored in the Facility Clean Storage Area.
6. Move copper stock and reagents into electroforming lab as necessary for the electroforming program.
7. Prepare plating bath. Need:
  - UPW
  - electrolytes
  - copper stock.
8. Purge plating bath of Rn loaded air (covergas?)
9. Plating cycle:
  - (a) Plate for period of time.
  - (b) Remove part from bath, rinse and dry.
  - (c) Machine surface. (Rn Reduced?)
  - (d) Chemically remove surface layer of Rn daughters under covergas.
  - (e) Transfer part back to plating bath without exposure to air.
  - (f) Repeat until part formed.
10. Remove part from mandrill
11. After final machining of part, chemically remove Rn daughters under covergas.

12. Passivate surface under covergas.
13. Dry part under covergas
14. Transfer part to Rn Free storage under covergas.

### **2.1.2 Crystal Reception and Characterization**

This is a proposed process sequence for Ge crystals coming to site, going underground and being characterized, ready for installation in the detector assembly.

#### **Sequence**

1. Crystal arrives from off site.  
*This may be a commercial transport or it may be hand carried. Will it be in a large concrete shipping container or just a box? How often? 1 per week?*
2. Crystal is inspected on surface to verify that it survived transportation to site.  
*This presumably means a visual inspection and some kind of room temperature electrical test? If shipping container is opened, the crystal needs a Class 100 clean room. Probably needs either Rn free air or covergas.*
3. Crystal packed in container to take underground.  
*Because the crystal is small, the shipping container is probably hand held. Needs to be dust tight and able to withstand ug air pressure. Needs to be radon tight.*
4. Crystal is transported underground.  
*Because the crystal is small, probably carried by hand. Care is taken to minimize total time on surface at site. Care is taken during transportation that the temperature is acceptable. Possibly have shock indicators on the crystal transport containers.*
5. Crystal transportation container is cleaned to an acceptable level and brought into the UG facility.
6. Crystal transportation container is cleaned to an acceptable level and brought into the Crystal Prep Room.
7. Crystal is transferred from transport container to Rn free storage.  
*How will this be done? The transport box could be put into a glovebox and the glovebox flushed with cover gas. Then the box is opened and the crystal is moved to a Rn free storage box without exposure to Lab air.*
8. Crystal is transferred from Rn Free Storage to test cryostat  
*How could this be done in a Rn free manner? Perhaps the Rn free storage box connects to a glovebox and the glovebox connects to the cryostat.*
9. Crystal is tested cold.
10. Crystal is characterized.
11. Cryostat is warmed up and crystal is moved to Rn Free Storage.

### **2.1.3 Assembly of Detector String**

Assembly of 3 crystals into a detector string.

#### **Sequence**

1. 3 crystals are moved from RFS (Radon Free Storage) to glovebox.
2. The noncrystal components of the string (support rods, plates, rings, wiring, preamps etc) are moved from RFS to glovebox.
3. Components are assembled into string.
4. String is tested warm.
5. String is moved to cryostat.
6. Cryostat is cooled and string is tested cold.
7. Assuming that the string works, the string is left cold in the cryostat until it is ready to be moved into the detector monolith cryostat.

### **2.1.4 Assembly of Detector Blockhouse**

- Sequence for assembly the detector blockhouse or multilith.

### **2.1.5 Assembly of Monolith**

- Sequence for assembly monolith

### **2.1.6 Assembly of Monolith Cryostat**

- Sequence for assembly of detector strings into the final monolith cryostat.

### **2.1.7 Insertion of Monolith into Blockhouse**

- Sequence for moving a monolith from Detector Assembly Rm to into the Detector Blockhouse.

### **2.1.8 Extraction of Monolith from Blockhouse**

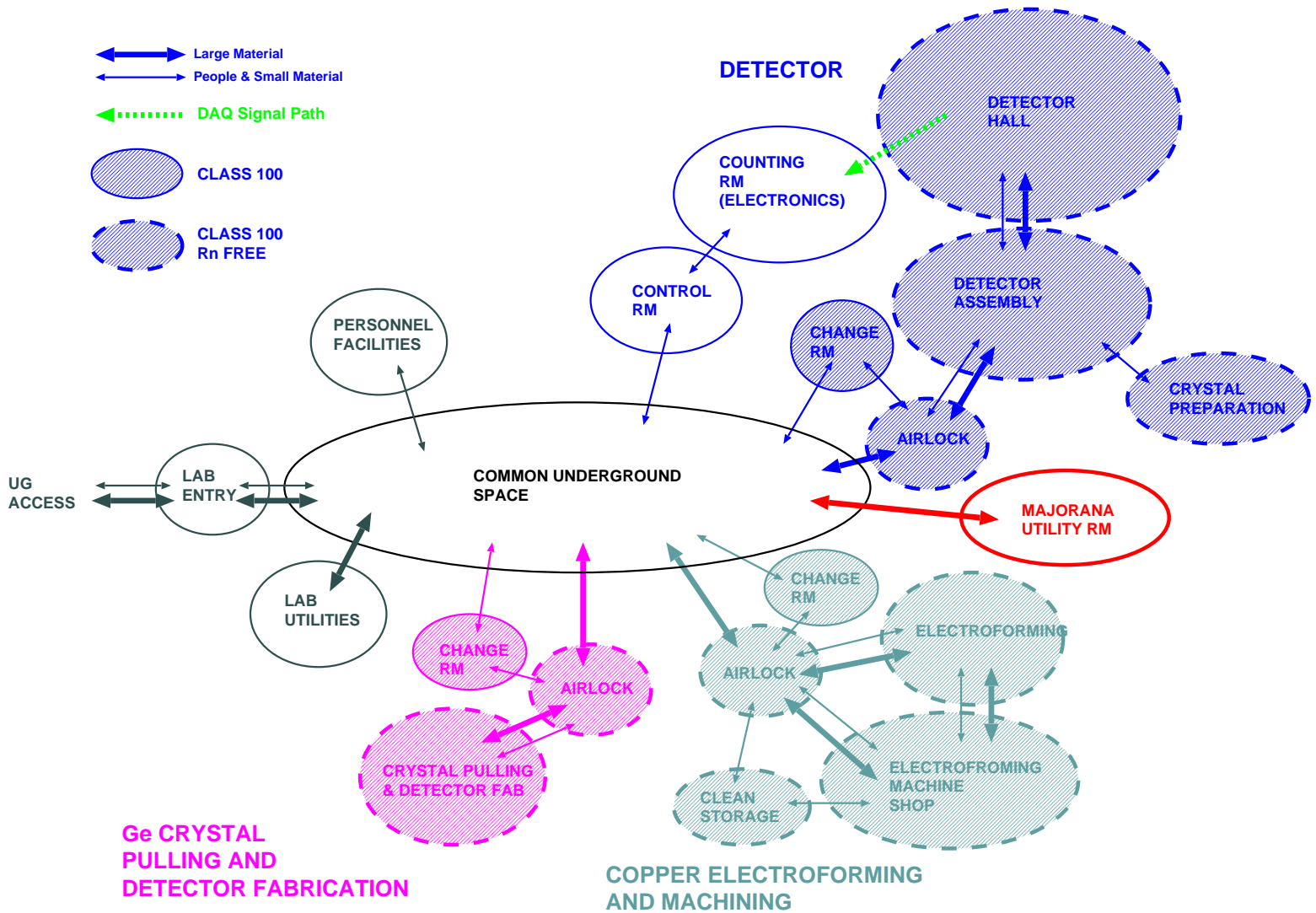
- Sequence for extracting monolith from blockhouse and moving it into Detector Assembly Rm.

### **3 Underground Facilities**

Table 1 summarizes the required underground spaces for the Majorana experiment. The necessary adjacencies between the spaces is shown in figure 1.

Both the detector area and the electroforming areas will likely require higher clean room conditions than the base laboratory and thus need air locks and change rooms to enter. However they do not necessarily have to be connected. Figure 1 reflects this and shows them separated. The eventual design for the Majorana laboratory may merge these air locks and change rooms. The advantage of merging the airlocks is that once inside the Class 100 cleanroom area, movement of personnel and materials is relatively easy. The advantage of leaving them separated is that it isolates the activities and lessens the possibility of contamination between these areas.

Figure 1: Bubble Diagram showing adjacencies of the Majorana Underground Spaces.



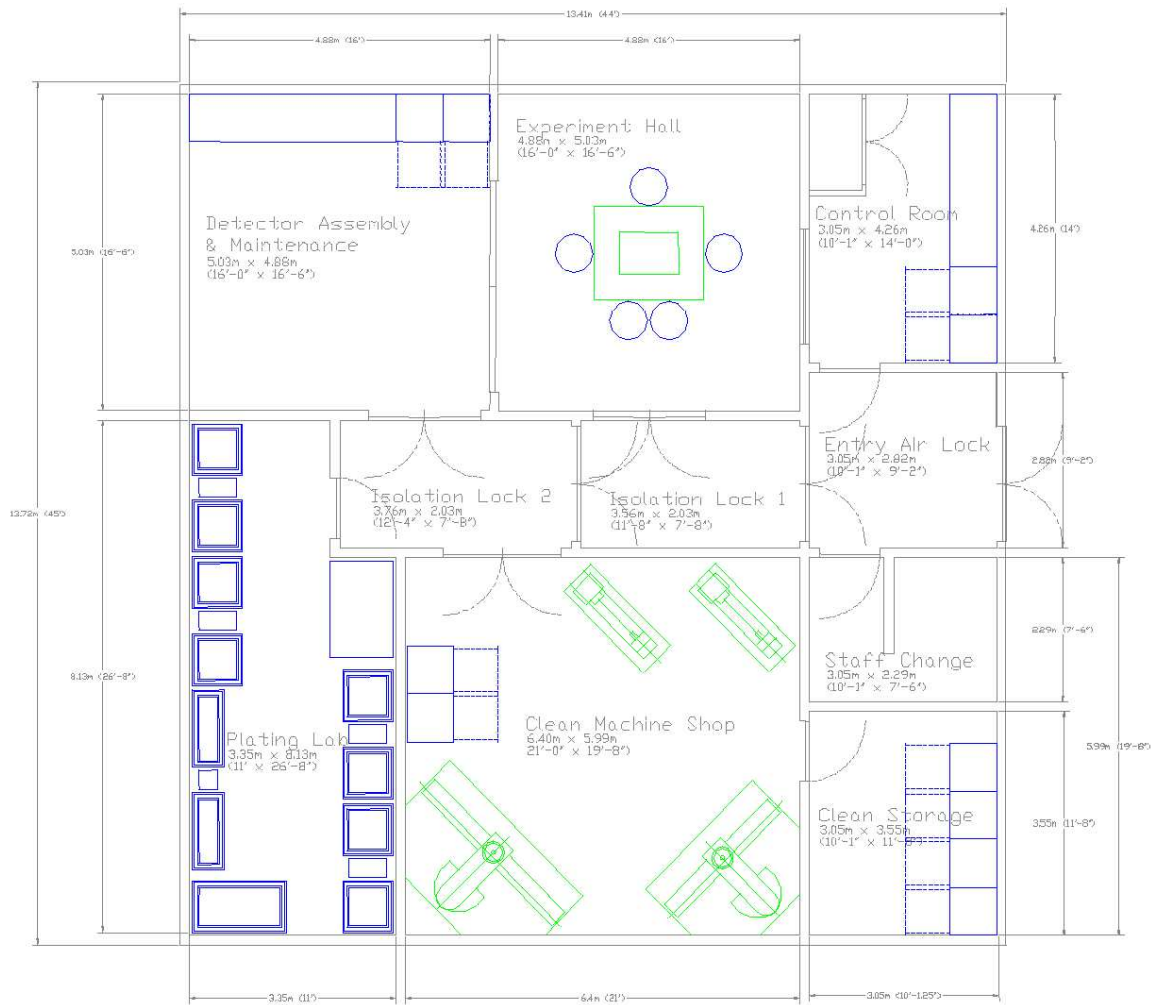


Figure 2: Whitebook Underground Facility Layout

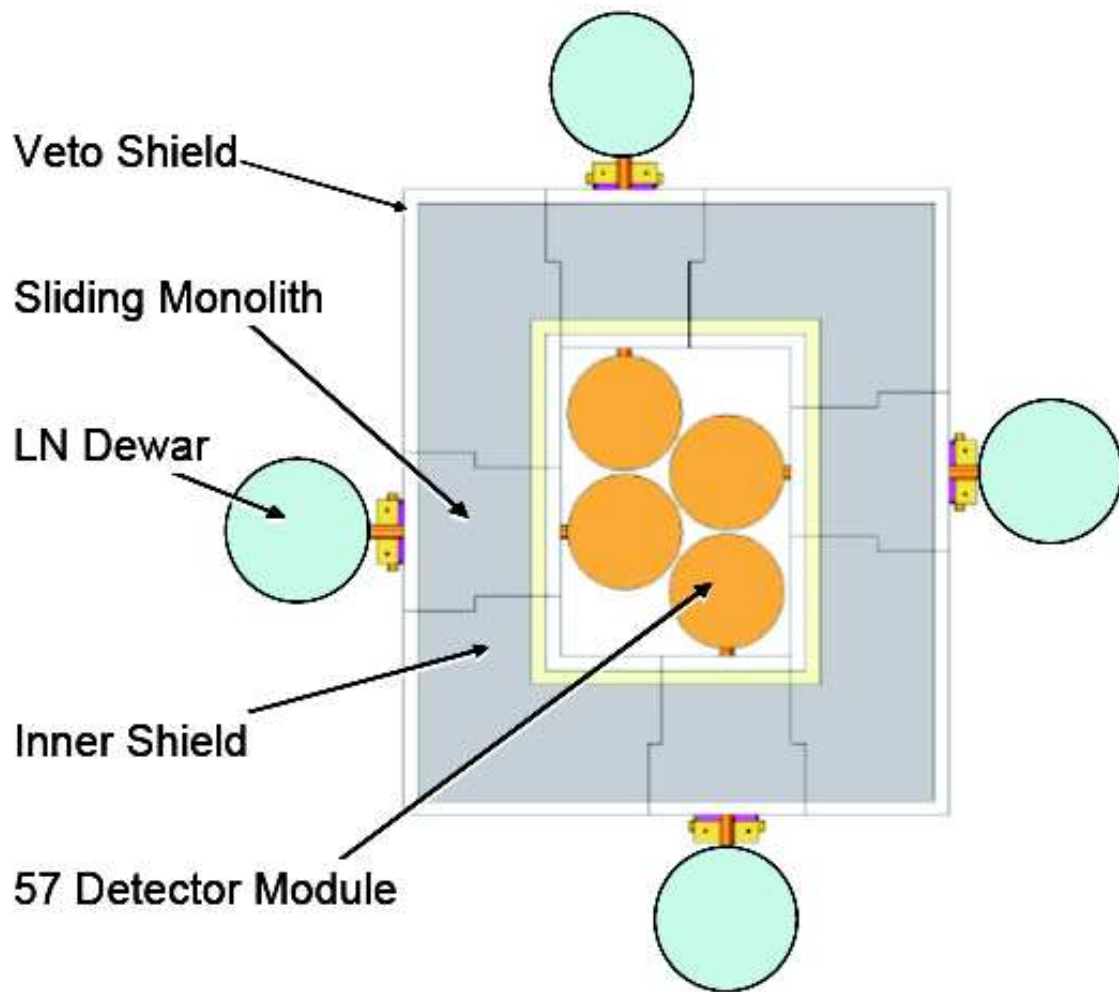


Figure 3: Reference Design, detector top view

Rm	Area	Size	CLASS	Rn Free
101	Detector Hall		100?	X
102	Assembly Room		100?	X
103	Crystal Preparation Room		100?	X
104	Detector Area Airlock			X
105	Detector Area Change Room		2000	
106	Underground Control Room		2000	
107	Counting Room		2000	
108	Electroforming Lab		100?	X
109	Electroforming Machine Shop		2000?	X
110	Rn Free Component Storage		100?	X
111	Electroforming Airlock			X
112	Electroforming Change Room		2000	
113	Low Background Counting		2000	X
114	Facility Clean Storage		2000	
115	Office			
116	Majorana Utility Room		2000	
117	Facility Dirty Storage			

Table 1: Majorana Underground Facility Space Summary

## **3.1 Detector Hall**

### **Function**

Contains the fully shielded detector. The standard reference model has the individual crystals assembled into cryostats containing up to 57 crystals. The 57 crystal cryostats are mounted on shielding “monoliths” which are moved into a common shielding structure (block house).

### **Activities**

- Insert/remove monolith from multilith
- Possibly fill LN2?
- Work on front end electronics in room?
- Move monolith to/from Detector Assembly
- Deploy calibration sources into the detector multilith.

### **Cleanliness and Radon Mitigation**

- CLASS 100
- Radon Free Air
- Covergas

### **Equipment**

- Crane for assembly of the detector block house.
- Blank shielding monolith to seal the detector block house when a detector monolith is being prepared.

### **Services**

- Radon free air
- Cover gas.
- Vacuum System
- Residue-less fire suppression.

### **Hazards**

- Fire
- ODH

### **Monitoring**

- Temperature
- Humidity
- Pressure
- O<sub>2</sub>

- Rn

Questions

- Size of Detector and shielding blockhouse (“Multilith”)?
- What capacity and motion required for the lifting device?  
I.e. How large and heavy will the shielding blocks be?  
What will be the sequence for assembling/disassembling the blockhouse be?
- How are monoliths moved?
- Will there be front end electronics in the detector room?
- Will LN<sub>2</sub> be brought into the detector room in dewars or transferred through a distribution system?
- Should the detector hall be a Faraday cage?

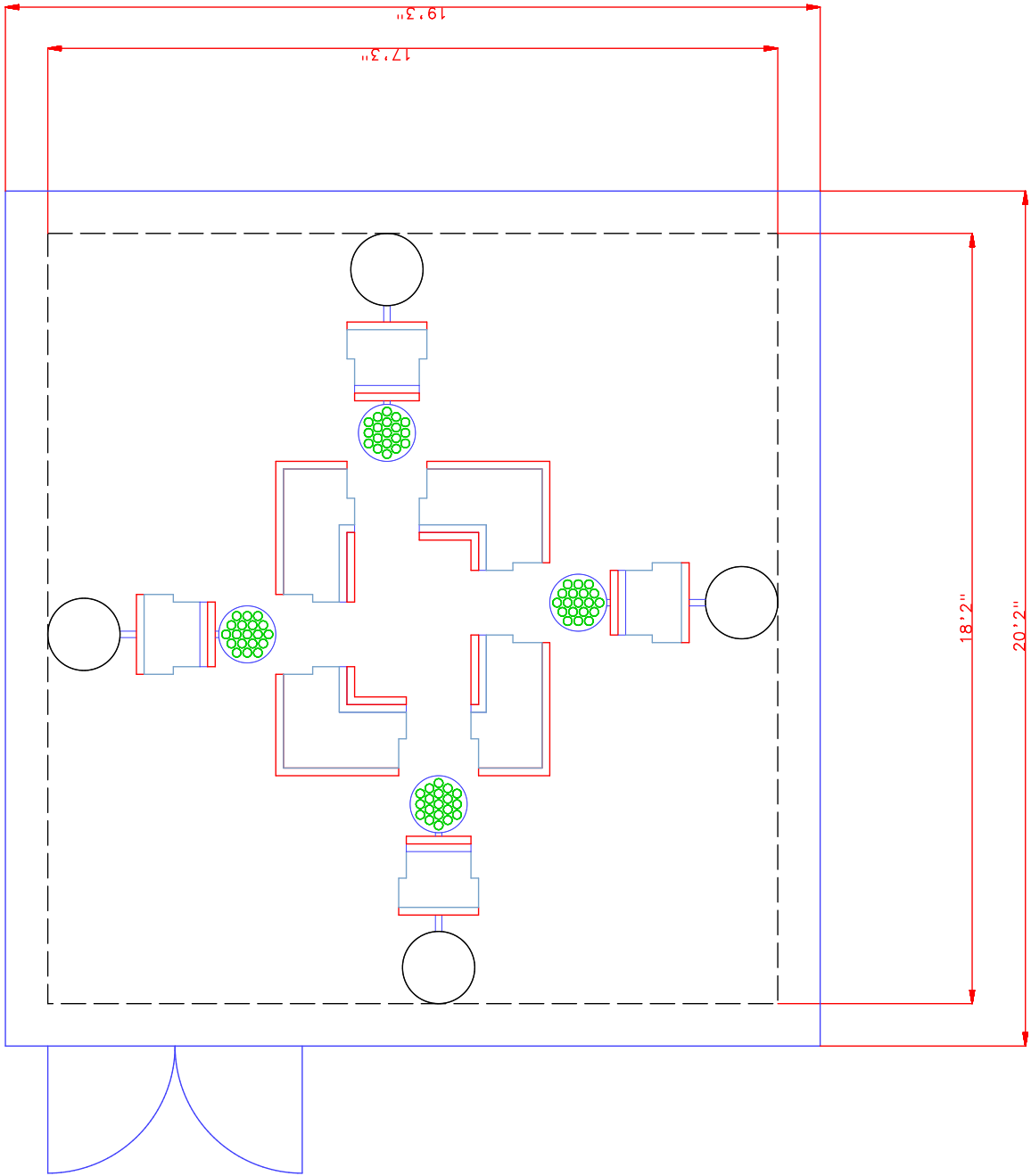


Figure 4: Detector Hall Plan View

## **3.2 Detector Assembly Room**

### **Function**

- Anti-room to the Detector Hall.
- Assembly of an individual cryostat monolith.
- Testing of assembled cryostat monoliths before insertion into the detector blockhouse.

### **Activities**

- Assemble detector string into cryostat
- Assemble cryostat
- Warm and cold test cryostat
- Mount cryostat on monolith
- Move monolith to Detector Hall

### **Cleanliness and Radon Mitigation**

- CLASS 100
- Radon Free Air
- Covergas

### **Equipment**

- Crane for assembly of a cryostat monolith.
- Test Cryostat?
- Test DAQ and electronics

### **Services**

- DAQ connection to all crystals in a monolith.
- LN2
- Cover gas
- Vacuum System
- Residue-less fire suppression.

### **Hazards**

- Fire
- ODH

### **Monitoring**

- Temperature
- Humidity

- Pressure
- O<sub>2</sub>

#### Questions

- Specifications of a monolith
  - dimensions
  - weight
  - Is it to be lifted?
- How are monoliths moved from the Detector Hall to Assembly Room?

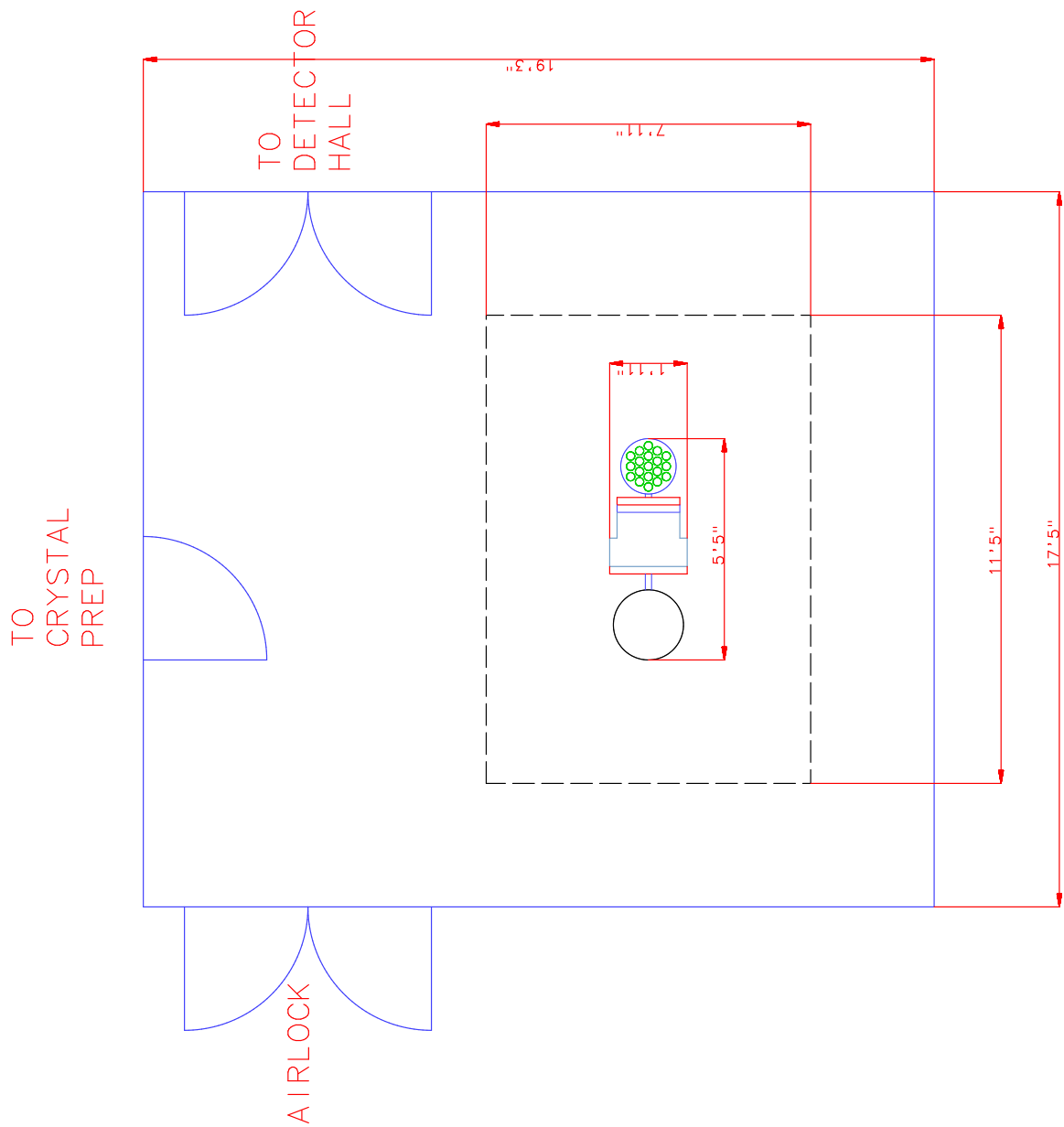


Figure 5: Detector Assembly Room Plan View

### **3.3 Crystal Preparation Room**

**Function** The Crystal Preparation Room is intended as a space adjacent to the Detector Assembly room in which bare crystals are manipulated for assembly into detector strings. Possibly the characterization of the crystals will be done here as well. The space is isolated from the detector assembly room to prevent interference between the more industrial type activity of handling the monoliths and the delicate work on the crystals. This room will also be used for the repair of the front end electronics of crystals and possibly bakeout of crystals in an oven.

- Testing and repair of individual crystals.
- Characterization of crystals prior to assembly into detector strings.

#### **Activities**

- Assemble crystals into detector string
- Repairs to front end electronics on crystals
- Test bare crystals, test bare strings.
- Characterization of crystals prior to assembly into detector strings.

#### **Cleanliness and Radon Mitigation**

- CLASS 100
- Radon Free Air
- Covergas

#### **Equipment**

- Work bench, chairs
- Micro-electronics work station
- Cryostat for characterization of the crystals.
- Bakeout oven

#### **Services**

- DAQ connection to all crystals in a monolith.
- Radon free air or reduced radon air.
- Cover gas.
- Vacuum System

#### **Hazards**

- ODH
- Crystal related chemicals (HF, . . .)

#### **Monitoring**

- Temperature
- Humidity
- O<sub>2</sub>

#### Questions

- What equipment is required to work on a crystal?
- Will chemical work be done on the crystal?

### **3.4 Detector Area Airlock**

#### **Function**

- Transition from main underground laboratory to the Detector Area.
- Personnel and Large equipment.

#### **Activities**

- Personnel moving from base laboratory to Detector Assembly via change rooms.
- Move large equipment from base laboratory to Detector Assembly.

#### **Cleanliness and Radon Mitigation**

- CLASS 100
- Radon Free Air

#### **Equipment**

- 

#### **Services**

- 

#### **Monitoring**

- Differential Pressure between exterior, airlock and Detector area.

Questions

-

### **3.5 Detector Area Change Room**

#### **Function**

- Change room for personnel working in the Class 100 clean areas associated with the detector.

#### **Activities**

- Change to/from base lab clothing from/to Class 100 cleanroom clothing.

#### **Cleanliness and Radon Mitigation**

- CLASS 2000

#### **Equipment**

- Bench
- Lockers
- Dirty Laundry hamper
- Fresh cleanroom clothing.

#### **Services**

- 

#### **Monitoring**

- Temperature
- Humidity

#### Questions

-

## **3.6 Underground Control Room**

### **Function**

- UG Monitoring and Control Computers. Expect up to 6 people present.
- Monitoring of Majorana environment (O<sub>2</sub>, CO, NO, Rn)
- Monitor Electroforming operations while underground.

### **Activities**

- Control and monitoring of detector while ug

### **Cleanliness and Radon Mitigation**

- CLASS 2000

### **Equipment**

- Computers
- Operator Stations
- Communications to surface (phone, video?)

### **Services**

- Normal Power (120VAC)
- UPS

### **Monitoring**

- Temperature
- Humidity

Questions

-

## 3.7 Electronics Room

### Function

- 

### Activities

- Install and operate DAQ electronics DAQ computer systems.

### Cleanliness and Radon Mitigation

- CLASS 2000

### Equipment

- Data Racks

### Services

- Normal Power
- Standby Power
- UPS
- Network

### Monitoring

- Temperature
- Humidity

#### Questions

- How many channels of DAQ?
- Number of racks?
- Power consumption?
- Heat load?
- Heat removal when on standby power?
- What systems will be on UPS?
- Location of UPS?

## 3.8 Electroforming Lab

### Function

- Electroplating of ultra pure copper for detector component fabrication.

### Activities

- 

### Cleanliness and Radon Mitigation

- CLASS 100
- Radon Free Air
- Covergas

### Equipment

- 

### Services

- Normal Power
- Standby Power
- UPS?
- UPW
- Isolated Sump
- Vacuum System

### Hazards

- Explosive gas ( $H_2$ )
- Chemical spills (acid)
- Fire
- Electrocutation
- ODH

### Monitoring

- Explosive Gas
- Temperature
- Humidity
- $O_2$

### Questions

-

### **3.9 Electroforming Machine Shop**

#### **Function**

- Machining of the electroformed copper pieces for the detector assemblies.

#### **Activities**

- 

#### **Cleanliness and Radon Mitigation**

- CLASS 100
- Radon Free Air
- Covergas?

#### **Equipment**

- 

#### **Services**

- Power (120, 208, 600?)
- UPW
- Covergas?
- Vacuum System

#### **Monitoring**

- Temperature
- Humidity

#### Questions

- Type, size, number of lathes?
- Type, size, number of mills?
- Drill Press?
- Hydraulic Press?
- Ban Saw?
- Hand tools?

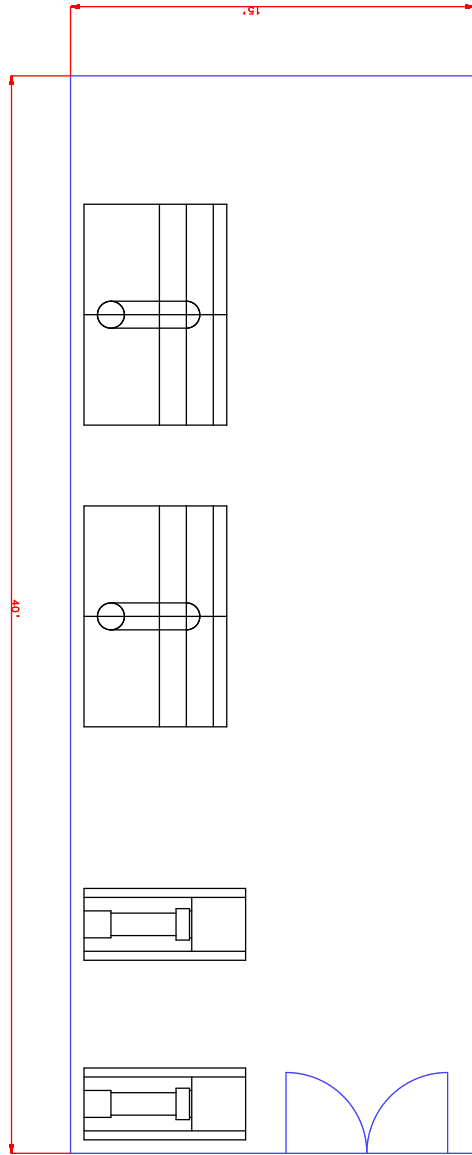


Figure 6: Electroforming Machine Shop Plan View

### 3.10 Rn Free Component Storage

#### Function

- Storing the machined, cleaned detector components (Cu and other) in a radon free environment until needed for the assembly of a detector module. The radon free environment could be either a covergas (eg. N<sub>2</sub>) or vacuum.
- Components need to be installed and removed from the radon free storage.

#### Activities

- 

#### Cleanliness and Radon Mitigation

- CLASS 100
- Radon Free Air
- Covergas

#### Equipment

- 

#### Services

- Covergas
- Radon free air?

#### Hazards

- ODH

#### Monitoring

- Temperature
- Humidity
- Pressure
- O<sub>2</sub>

#### Questions

- Covergas, vacuum or both?  
The advantage of using vacuum is that it is easy to monitor the quality of the radon isolation. I.e. just monitor the vacuum.
- What capacity?  
Conservatively, it should be able to hold the entire detector assembly in pieces. That may be too much space however. At least it should be able to hold an entire cryostat's worth of components.

### **3.11 Electroforming Airlock**

#### **Function**

- 

#### **Activities**

- 

#### **Cleanliness and Radon Mitigation**

- CLASS 100
- Radon Free Air

#### **Equipment**

- 

#### **Services**

- 

#### **Monitoring**

- Differential Pressure between exterior, airlock and Detector area.

#### Questions

-

## 3.12 Electroforming Change Room

### Function

- 

### Activities

- 

### Cleanliness and Radon Mitigation

- CLASS 2000

### Equipment

- 

### Services

- 

### Monitoring

- Temperature
- Humidity

### Questions

-

### **3.13 Low Background Counting**

#### **Function**

- 

#### **Activities**

- 

#### **Cleanliness and Radon Mitigation**

- CLASS 2000

#### **Equipment**

- 

#### **Services**

- 

#### **Monitoring**

- Temperature
- Humidity

#### Questions

-

### 3.14 Facility Clean Storage

#### Function

- Staging of detector components including Pb shielding.
- LN<sub>2</sub> dewars
- Spare electronics

#### Activities

- 

#### Cleanliness and Radon Mitigation

- CLASS 2000

#### Equipment

- 

#### Services

- 

#### Monitoring

- Temperature
- Humidity

#### Questions

-

### 3.15 Majorana Utility Room

The Majorana Utility Room contains specialized equipment for the Majorana experiment.

#### Function

- Class 100 AHUs
- Radon Free Air System
- LN<sub>2</sub> Storage, distribution
- LN<sub>2</sub> Production?
- Nitrogen Boil Off Cover Gas system?

#### Activities

- 

#### Cleanliness and Radon Mitigation

- CLASS 2000

#### Equipment

- 

#### Services

- 

#### Monitoring

- Temperature
- Humidity

#### Questions

-

### **3.16 Facility Dirty Storage**

#### **Function**

- Possible storage location for materials coming into the laboratory.

#### **Activities**

- 

#### **Cleanliness and Radon Mitigation**

- N/A

#### **Equipment**

- 

#### **Services**

- 

#### **Monitoring**

- 

#### Questions

- Is this required?

## 4 Infrastructure and Services

### 4.1 Power

#### Questions

- Normal Power
  - Detector DAQ
  - Electroforming
  - Radon Scrubbing?
  - LN<sub>2</sub> production?
- Standby Power
  - Cover gas must be preserved on Standby power.
- UPS

### 4.2 Cooling

#### Questions

- Normal
- Standby
- Ventilation air or chilled water?

### 4.3 Radon Mitigation

#### Questions

- Radon Free Air
- Cover gas
- Vacuum
- Radon barriers on cavern walls
- Store components under cover gas
- Only handle components under cover gas (gloveboxes)

## 4.4 Radon Free Air

### Questions

- Quantity
- Purity (Radon, Oxygen levels)
- Droughts (no access)
- Methods:
  - Scrub underground
  - Pipe from surface
  - Aged Air
  - Home Brew (mixed LN<sub>2</sub> and LO<sub>2</sub>)
- Is there a commercial option considered?

## 4.5 Liquid Nitrogen

The liquid nitrogen needs for Majorana include:

- Coolant for Detector Multilith
- Coolant for test cryostat(s) in Detector Assembly and possibly Crystal Prep.
- Covergas for plating baths, storage, etc.

It has been proposed the LN<sub>2</sub> for Majorana be brought to a central holding tank and then distributed to cryostats. This is presumably for cooling purposes. The pros and cons are:

**PROS** The system can be mostly automatic. It avoids bringing dewars into ultra clean areas which requires lots of handling and lots of cleaning.

**CONS** A distribution system is expensive (requires vacuum jacketed transfer lines). Also it will waste a lot of LN<sub>2</sub> that will boil off as the transfer lines cool down.

### Questions

- Quantity
- Purity (Radon, Oxygen levels)
- Droughts (no access)

## 4.6 Nitrogen Boil Off Cover Gas

### Questions

- Quantity
- Purity (Radon, Oxygen levels)
- Droughts (no access)

## 4.7 Radon Free Compressed Gas

May need a compressed gas (ie. compressed air) for some activities such as in the machine shop and the plating shop. However, if the work area is a Radon reduced area, one does not want to just use regular compressed air (unless the compressor uses the same radon reduced air as the work space). Probably the solution is to use the cover gas at pressure (40 PSIG?). Will have to watch out for ODH.

## 4.8 Radon Free Storage

It is anticipated that Majorana will require a means of storing components in a Radon Free environment. The form that a Radon Free Storage (RFS) system could take could be a high purity cover gas such as from boil off nitrogen or it could be a vacuum. The problems are:

- Transferring components between one RFS location to another?
- Bringing components out of RFS to be worked on.
- Adding or removing components to a RFS without contaminating components already in the storage container.
- A RFS must be maintained and verifiable meaning that the system must always be kept radon free and it must be possible to verify that the system works. <sup>1</sup>

One possible solution is a modular system of storage boxes and gloveboxes that would look something like a “Habitrail” hamster habitat. Storage boxes would be gas tight. A storage box would be coupled to a glovebox, perhaps with a bellows. The coupling between the storage box and glovebox would be flushed or pumped to vacuum. A door on the glove box would be opened from within the glovebox by a gloved hand and then the door on the storage box opened as well from within the glovebox. Objects could then be transferred between storage box and glovebox. The design of access doors, couplings and glove ports would be standardized but the storage boxes and gloveboxes would come in a number of different sizes to accommodate the different components and activities. In principle, such a system would allow handling of all components without ever exposing them to air.

---

<sup>1</sup>If a vacuum system is used, it is relatively easy to verify that it is working properly (just by measuring the vacuum). A covergas system is harder to verify since radon is difficult to measure. One can measure oxygen but it does not always track radon and is not necessarily easy to measure to sufficient accuracy.

## 4.9 UPW

Ultra pure water is probably required for the Copper Electroforming Lab. It might also be required for the Machine shop and it might be required for the Crystal Prep Rm and the Detector Assembly Rm. In addition, it should be made available in small containers for various cleaning tasks.

### Questions

- Quantity
- Locations

## 4.10 Lifting Devices

### Questions

- Range/motion
- Capacity
- Cleanliness

## 4.11 Contamination Testing

### Questions

- Emanation Testing (Radon?)
- Swipes, tapelifts, XRF?
- Surface Alpha counting?

## 5 Consumables

- LN<sub>2</sub>
- old air?
- electroplating chemicals
- ...

## **6 Surface Facilities and Infrastructure**

### **6.1 Laboratory Space**

#### **Function**

#### **Activities**

- Inspection and acceptance of crystals arriving at site.
- Surface electronics repair.

#### **Cleanliness and Radon Mitigation**

- CLASS 100 for crystal handling (maybe glovebox?)

#### **Equipment**

- Computers
- Operator Stations
- Communications to surface (phone, video?)

#### **Services**

- Normal Power (120VAC)
- UPS
- Covergas

#### **Monitoring**

- Temperature
- Humidity

Questions

- 

### **6.2 Material Handling**

## 6.3 Surface Control Room

### Function

- Surface Monitoring and Control Computers. Expect up to 6 people present.
- Monitoring of Majorana environment (O<sub>2</sub>, CO, NO, Rn)
- Monitor Electroforming operations while on surface.

### Activities

- Control and monitoring of detector while ug

### Cleanliness and Radon Mitigation

- CLASS 2000

### Equipment

- Computers
- Operator Stations
- Communications to surface (phone, video?)

### Services

- Normal Power (120VAC)
- UPS

### Monitoring

- Temperature
- Humidity

Questions

- 

## 6.4 Office

## 7 Specialized Equipment

### 7.1 Component Storage Boxes

Because a large number of components for Majorana will need to be stored under a cover gas and ensured that they will not be exposed to radon loaded or moist air (in the case of the crystals), the possibility of specialized storage containers that are designed to prevent radon ingress should be considered. Options are:

- Vacuum Box  
Maintain the parts under vacuum.
- Cover Gas Box  
Maintain a covergas through the boxes.

The advantage of keeping parts under vacuum is that it is easy to monitor the quality of the vacuum to ensure that there is no air present. Using a covergas, it is easier to monitor oxygen content than to directly measure the Rn content. A covergas based system will also have to be designed to compensate for pressure changes. Boxes should have the following features:

- Either be large enough to contain the largest clean parts (of order 2'x2'x2') or come in several sizes.
- Be able to secure the components in place to prevent sliding around.
- Be fabricated from intrinsically clean materials.
- Probably have a window to view contents.
- Have a way to verify their integrity.  
In the case of a vacuum system, it could be by holding a vacuum.
- Have a means of being connected to glove boxes etc.  
This could be a mechanism of ports where a box is bolted to a port on a glove box, the inter-box space is pumped out or flushed and then the port is opened from the glovebox.

## **8 Hazards**

### **8.1 ODH**

- Cover gas?

### **8.2 Fire**

- Large volumes of plastic

### **8.3 Explosive Gas**

### **8.4 Chemicals**

- Electroforming chemicals (acids, copper sulphate, ...)
- Crystal Prep chemicals (HF, peroxides, ...)

## A Notes, Memos, Information

Aksel and Fraser,  
Craig and I were reviewing the Cu production in detail yesterday for the Ge Module Production task and came up with a production model which spells out the bath requirements more clearly. This is only a model, but it should give a sense of what we need.

Cryostat Cu Parts: 6 baths, ~27 calendar weeks per cryostat  
    Bath 1: cryo vessel main cylinder and IR shroud  
    Bath 2: cryo vessel lids  
    Bath 3: cryo vessel flanges and cold plates (main and per string parts)  
    Bath 4: cross arm tube and cold finger  
    Bath 5: small rods for detector strings and other small parts  
    Bath 6: "electro-welding" of vacuum vessel  
Inner Shield Cu: 10 baths, 80% duty factor, 50 calendar weeks.  
    Each bath produces a 10" x 30" x 1/2" plate (from a 10" diam. X 10" cylinder) in 2 weeks

This may be rather crowded in one room.

Jim

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