Status of EXO-200kg

Search for Double-Beta Decay in Liquid Xe

F. LePort

EXO-200kg Majorana mass sensitivity

Assumptions:

1) 200kg of Xe enriched to 80% in 136
2) $\sigma(E)/E$ = 1.4% obtained in EXO R&D, Conti et al Phys Rev B 68 (2003) 054201
3) Low but finite radioactive background:
   20 events/year in the $\pm 2\sigma$ interval centered around the 2.481MeV endpoint
4) Negligible background from $2\nu\beta\beta$ ($T_{1/2} > 1 \cdot 10^{22}$yr R.Bernabei et al. measurement)

Case	Mass (ton)	Eff. (%)	Run Time (yr)	σ_E/E @ 2.5MeV (%)	Radioactive Background (events)	$T_{1/2}^{0\nu}$ (yr, 90%CL)	Majorana mass (eV)	
							QRPA	NSM
Prototype	0.2	70	2	1.6	40	$6.4*10^{25}$	0.27	0.38

What if Klapdor's observation is correct ?

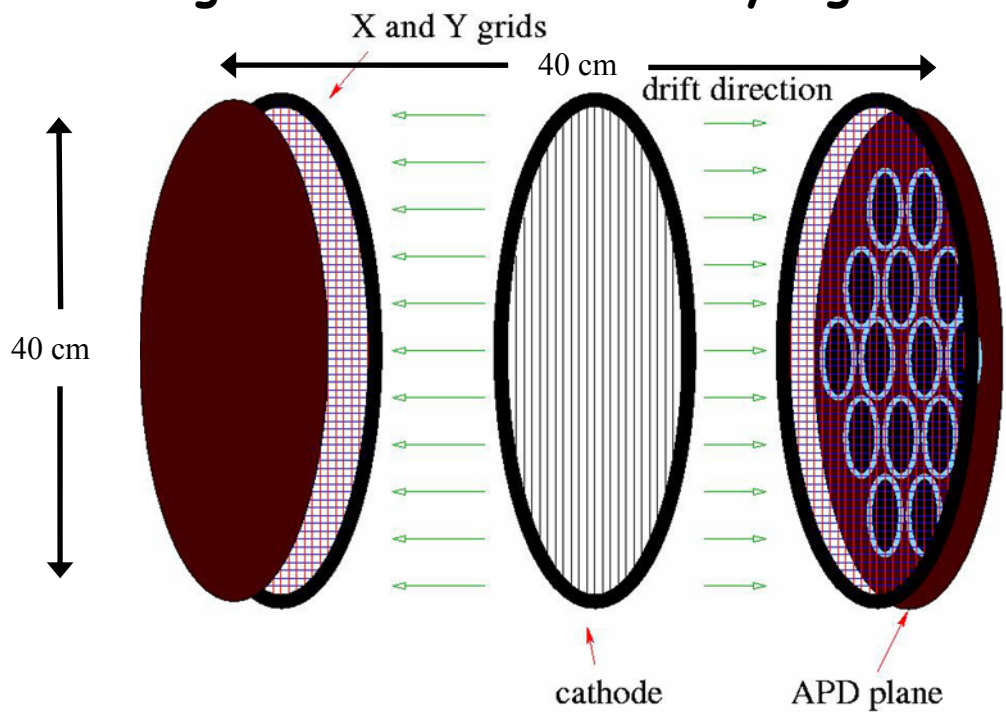
Central value $T_{1/2}$ (Ge) = $1.2^{+3}_{-0.5} \cdot 10^{25}$, ($\pm 3\sigma$)
(Phys. Lett. B 586 (2004) 198-212
consistently use Rodin's matrix elements for both Ge and Xe)

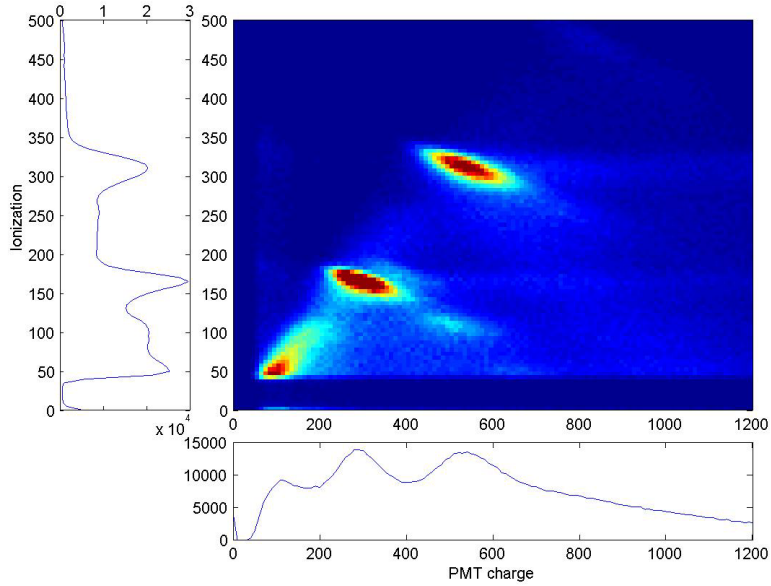
In 200kg EXO, 2yr:

- Worst case (QRPA, upper limit) 15 events on top of 40 events bkgd → 2σ
- Best case (NSM, lower limit) 162 events on top of 40 bkgd → 11σ

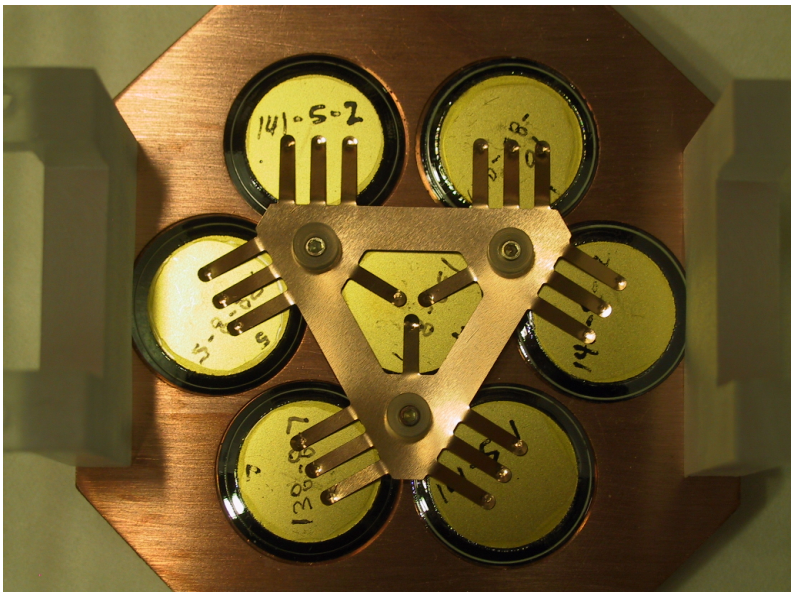
Detection Tools

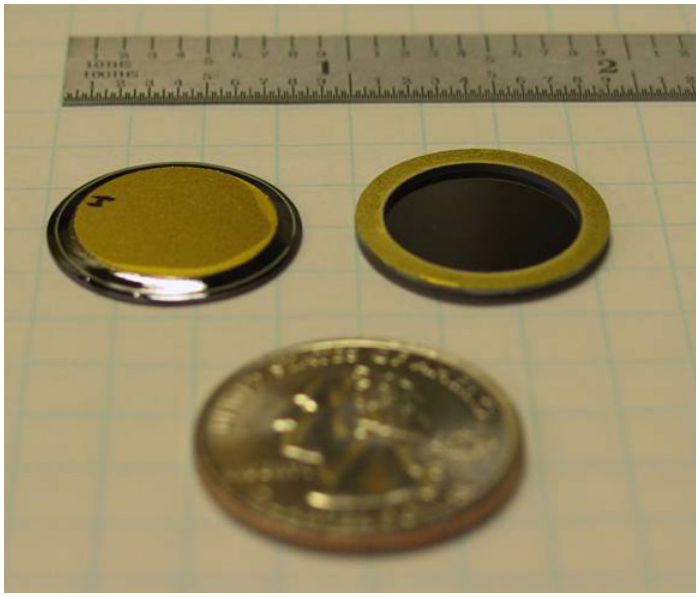
- Cylindrical detector split into two halves by HV plane (75 kV max, running potential to be optimized)
- Crossed wires, 100μm diameter, 3mm pitch, ganged in groups of 3 at either end (ionization, 48chx48ch => 1 cm^3 resolution)
- Avalanche Photodiodes, ganged in groups of 7, at either end (scintillation, 37ch, ~15% collection efficiency not including reflections)
- Low background flex cables carry signals out

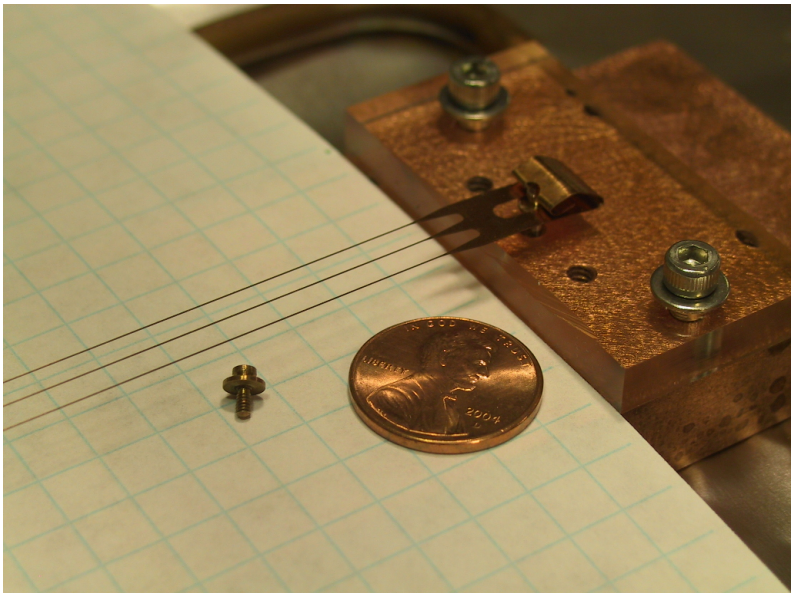


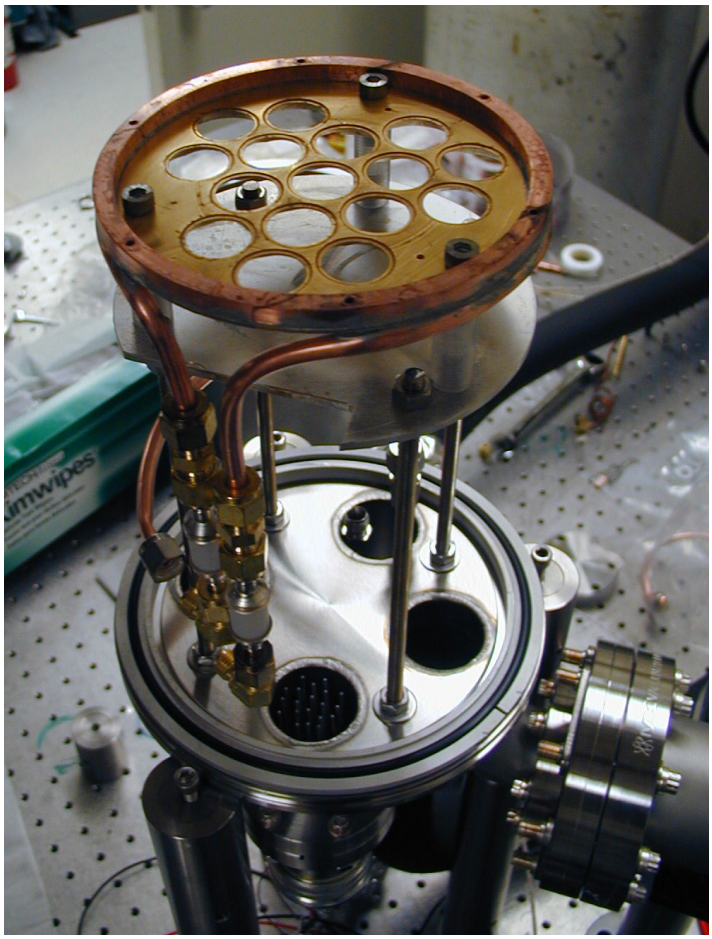


Detection Tools



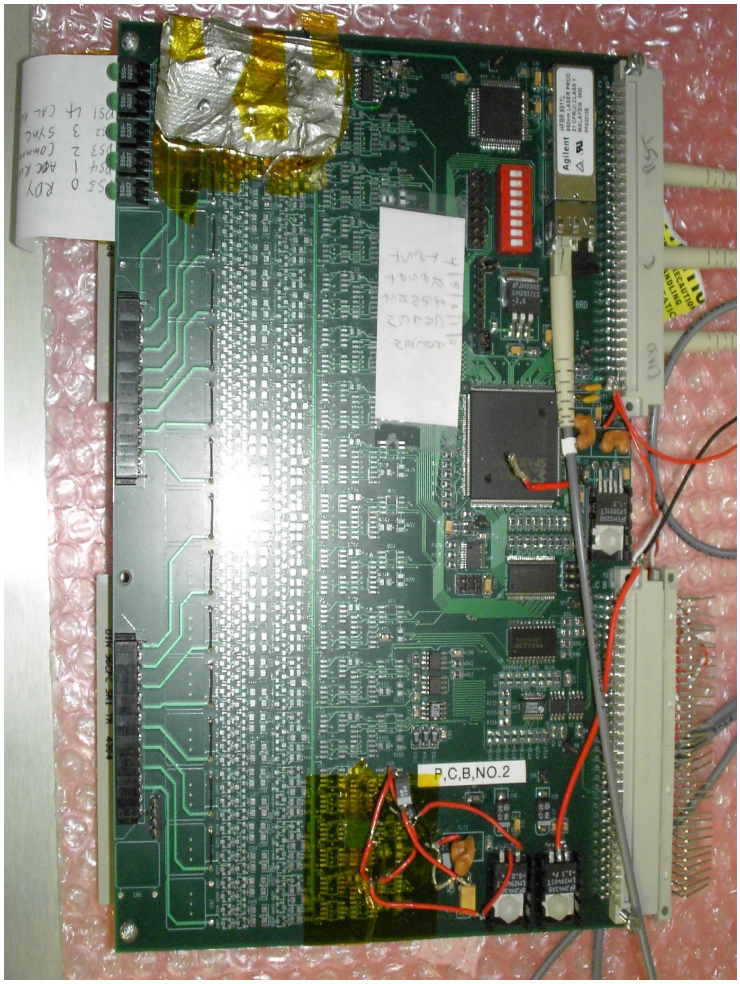


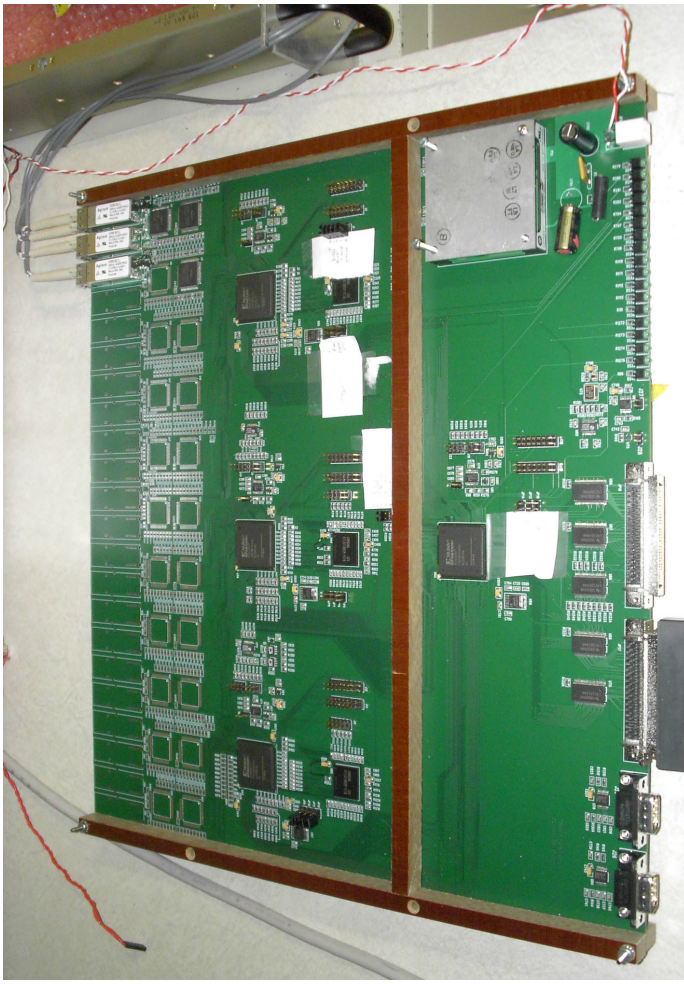




Electronics

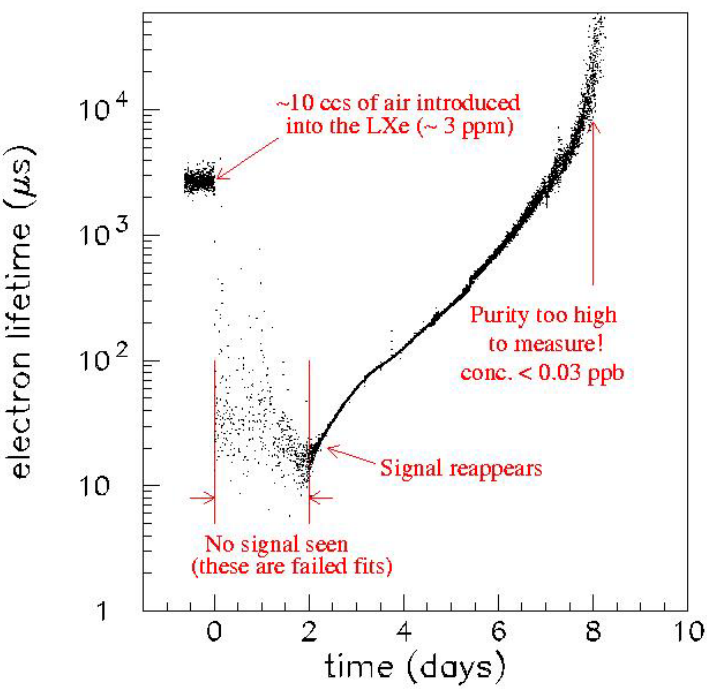
- Design finalized, in production
- 18 Front end cards, 16 channels each. Data will be digitized by 12-bit ADCs.
- 1 software controlled HV card will control all HV except 75 kV cathode.
- 6 front end cards each will service the X wires, Y wires, and APDs.
- DAQ software design well underway.
- Entire DAQ chain (only 1 FEC) has been tested.





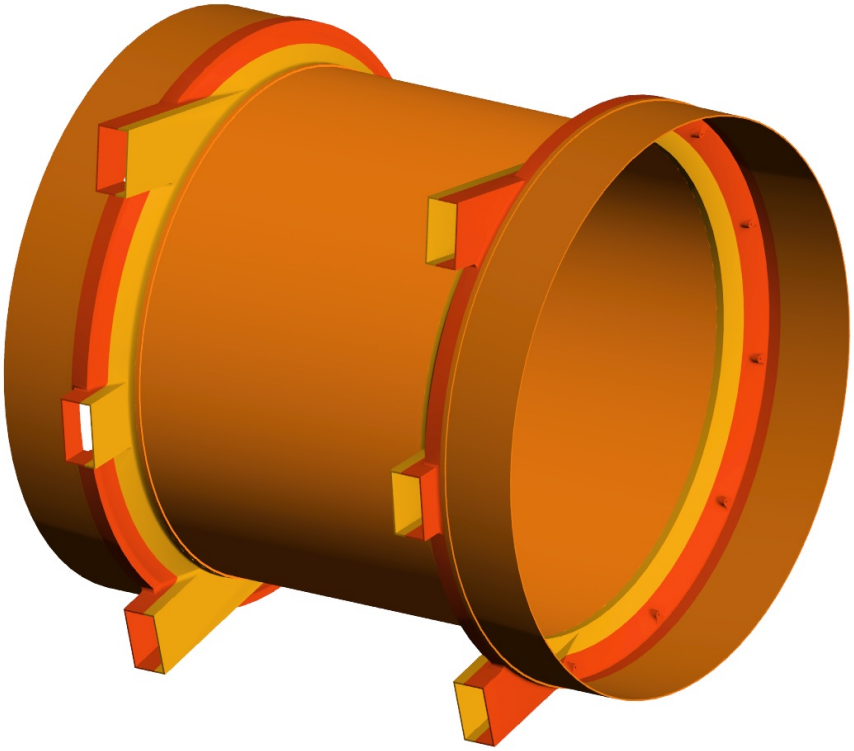
Xe handling and Refrigeration

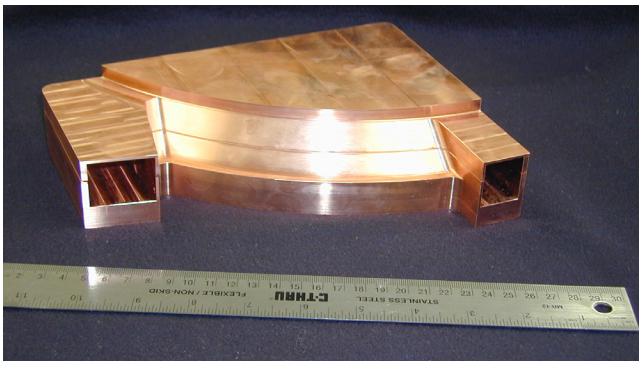
- Xe purification is essential to maintaining high electron lifetimes
- A Xe purification and chemical qualification system has been built and run at SLAC.
- Methods for Xe purification have been tested and proven
- Final Xe handling and purification system built and ready
- Refrigeration system has been designed and is in production



TPC Vessel

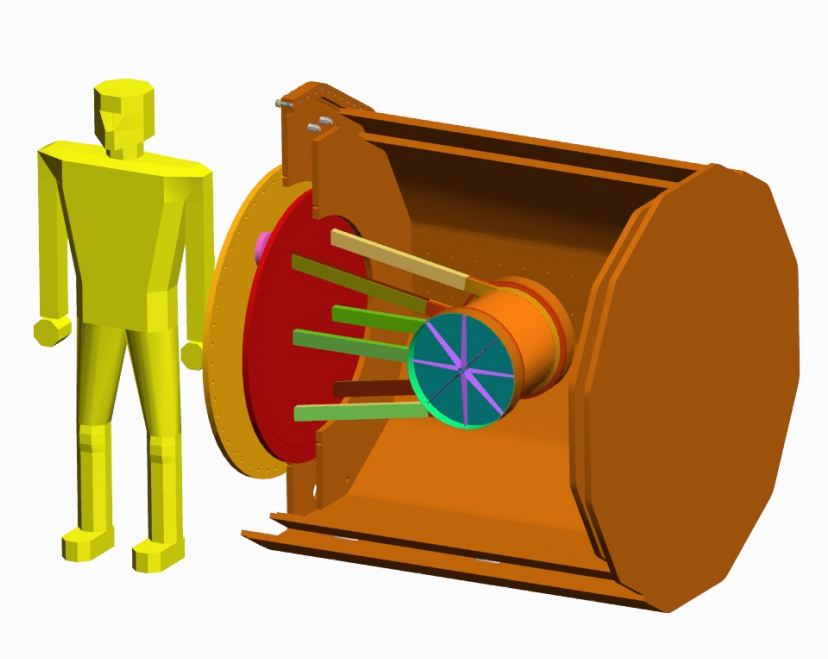
- Ultra-clean Cu vessel
  - Low background Cu on hand
  - 1.5 mm thick walls (15kg total mass)
  - e-beam welding will fuse most parts
  - TIG welding will seal the detector components inside
  - Full scale parts built and tested





Cu Cryostat

- The vessel sits in a Cu Cryostat made of the same ultra-low background Cu used for the chamber.
- Cryostat is built using e-beam welding
- Cryostat is filled with HFE7000, which serves as a heat transfer medium and shielding (high density, ultra clean)

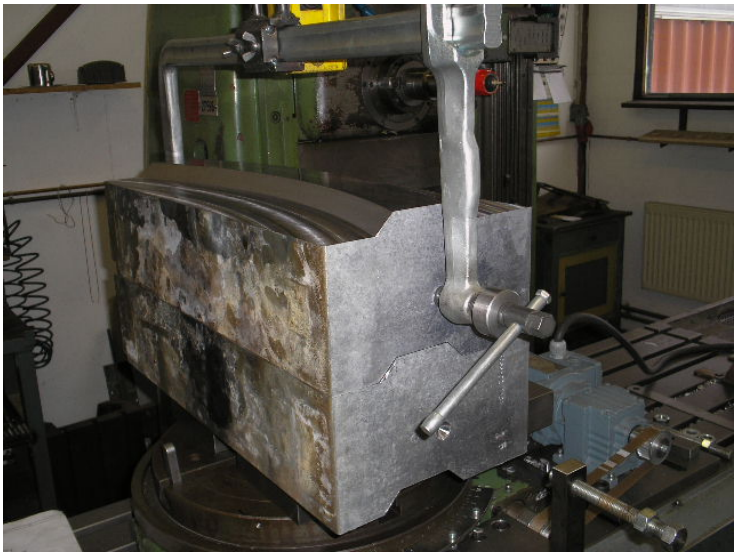


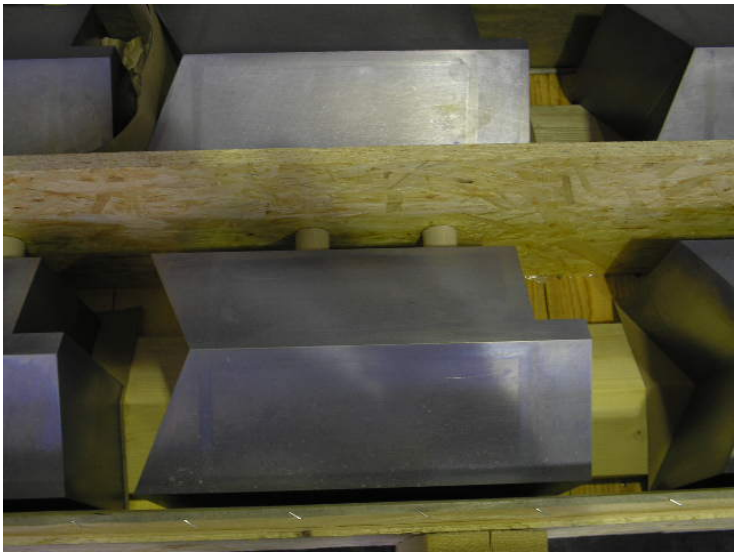
Status of the Cryostat

- Both inner and outer cryostats have been manufactured
- Entire assembly is on its way to Stanford by boat now

Lead Shielding

- The entire cryostat will be surrounded by 25 cm of low radioactivity lead (~70 tons total mass)
- A crane inside our clean rooms will be used to assemble the lead shield
- Lead bricks are interlocking to minimize gaps which point toward the detector
- Polyethylene foam will fill any gaps between the lead shield and cryostat to displace radon contaminated air
- The lead will arrive this coming week



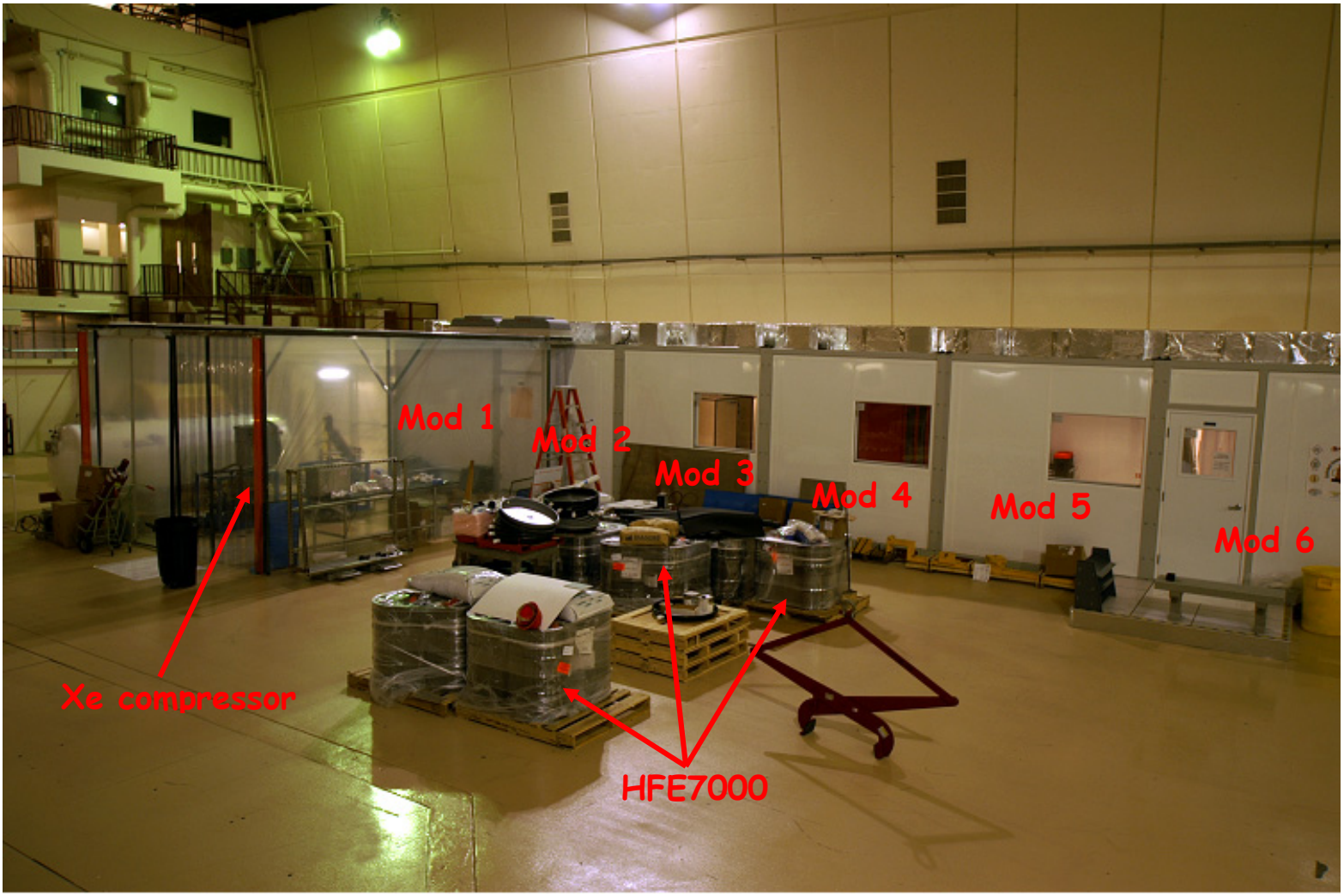


Ultra-low Background Experiment

- Massive effort on material radioactivity qualification
- Tools include
  - Neutron Activation Analysis (MIT/Alabama)
  - Low background γ-spectroscopy (Neuchatel, Alabama)
  - α-counting (Alabama, Stanford, SLAC, Carleton)
  - Radon counting (Laurentian)
  - High performance GD-MS and ICP-MS (Canadian Inst. Standards)
- Every material, from the contacts on APDs to the screws in Pb shielding is qualified
- Qualification standards are based on Monte-Carlo simulations, using Geant3/Geant4
- Over 100 materials have been qualified
- Results to be published in NIM

Summary

- EXO-200 will be assembled and tested using natural Xe at Stanford before moving to WIPP
- The clean rooms have been delivered and assembled
- Enriched Xe on hand since '03
- Chamber and internals and DAQ in production now
- Xe handling system ready
- The HFE7000 and its containment dewar is here
- Major refrigeration components on hand
- The Cryostat and Lead will arrive this week



WIPP & Future Milestones

- EXO-200 will be located in WIPP, near Carlsbad NM.
- ½ mile of Earth will provide ~2000m w.e. shielding

- Future Milestones
  - First full cooldown scheduled for Jun 15th
  - Finish full scale testing at Stanford by Oct 20th
  - Move to WIPP between Nov 20th and Dec 8th