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EXO-200: status & prospects

Martin Auger on behalf of the EXO collaboration

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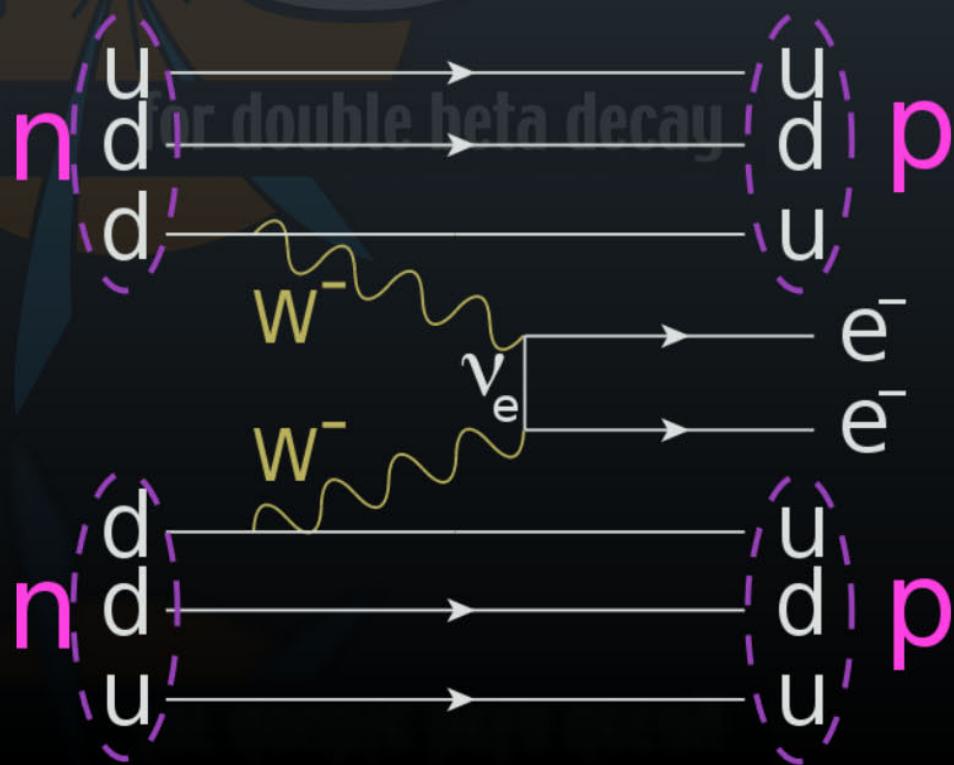
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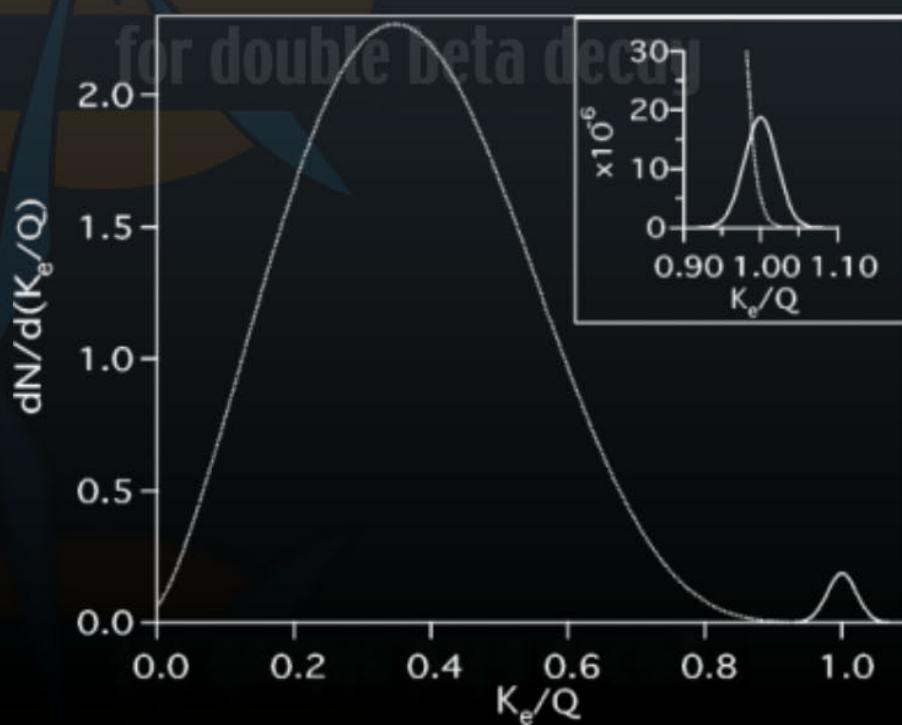
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The lepton-number-violating neutrinoless double β-decay requires, in addition to a non-vanishing neutrino mass, that neutrinos are Majorana particles.



Neutrinoless double β-decay is therefore an ideal way to probe the absolute mass of the neutrino in ways neutrino oscillations cannot.

$$(T_{1/2}^{0\nu})^{-1} = G^{0\nu}(Q, Z) |M_{GT}^{0\nu} - M_F^{0\nu}|^2 \left(\frac{\langle m_{\nu_e} \rangle}{m_e} \right)^2$$



EXO-200

An Overview

EXO-200 is the first phase of the EXO experiment realised using 200kg of 80% enriched Xenon

- Major R&D effort towards full EXO experiment.
- Allow observation of $\beta\beta\nu\nu$ disintegration in Xenon.
- No Barium tagging capabilities but, phenomenal efforts for background reduction and energy resolution improvements.
- Materials database, clean construction techniques and experience are easily scalable to future full EXO detector.

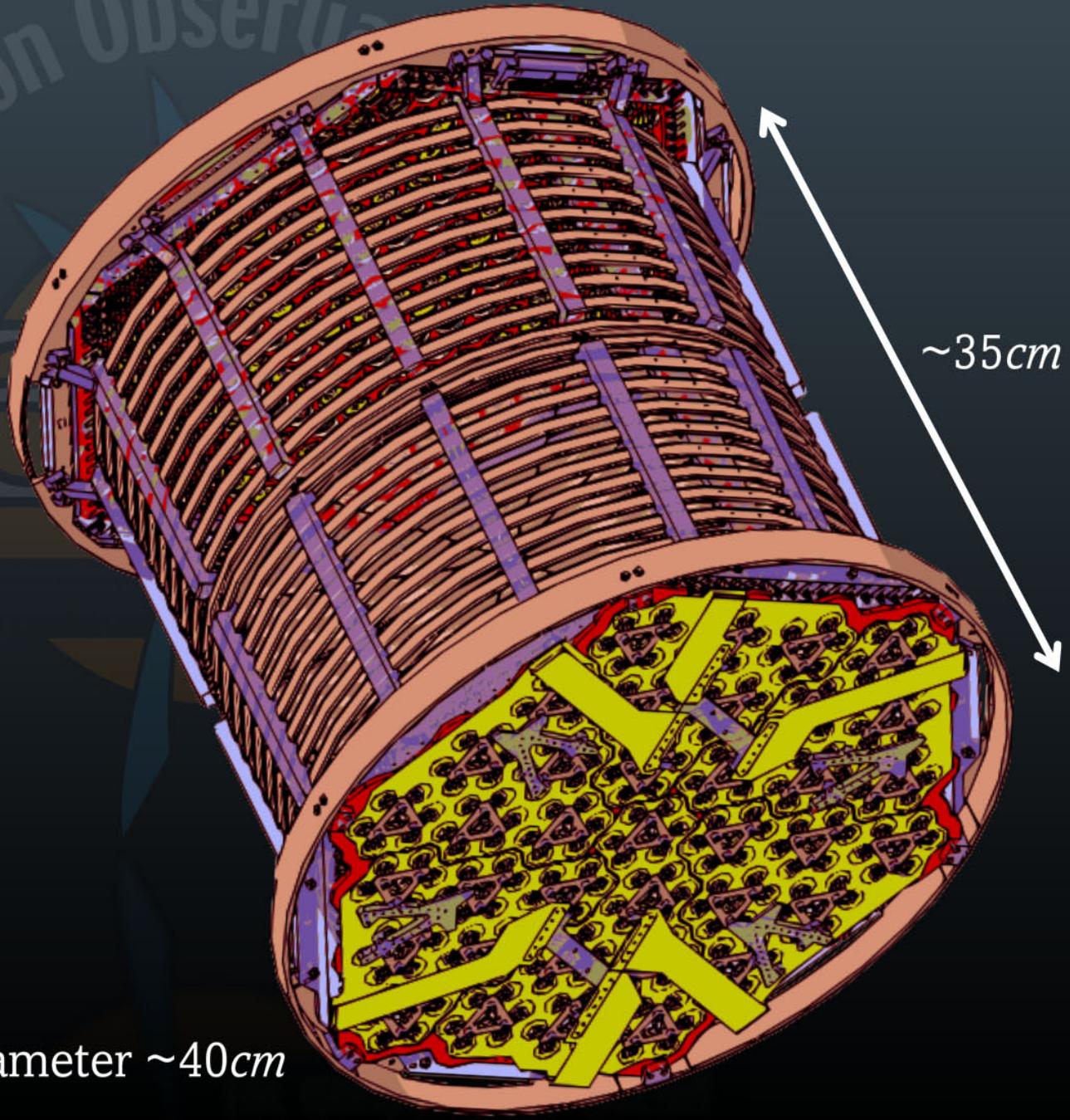
EXO-200

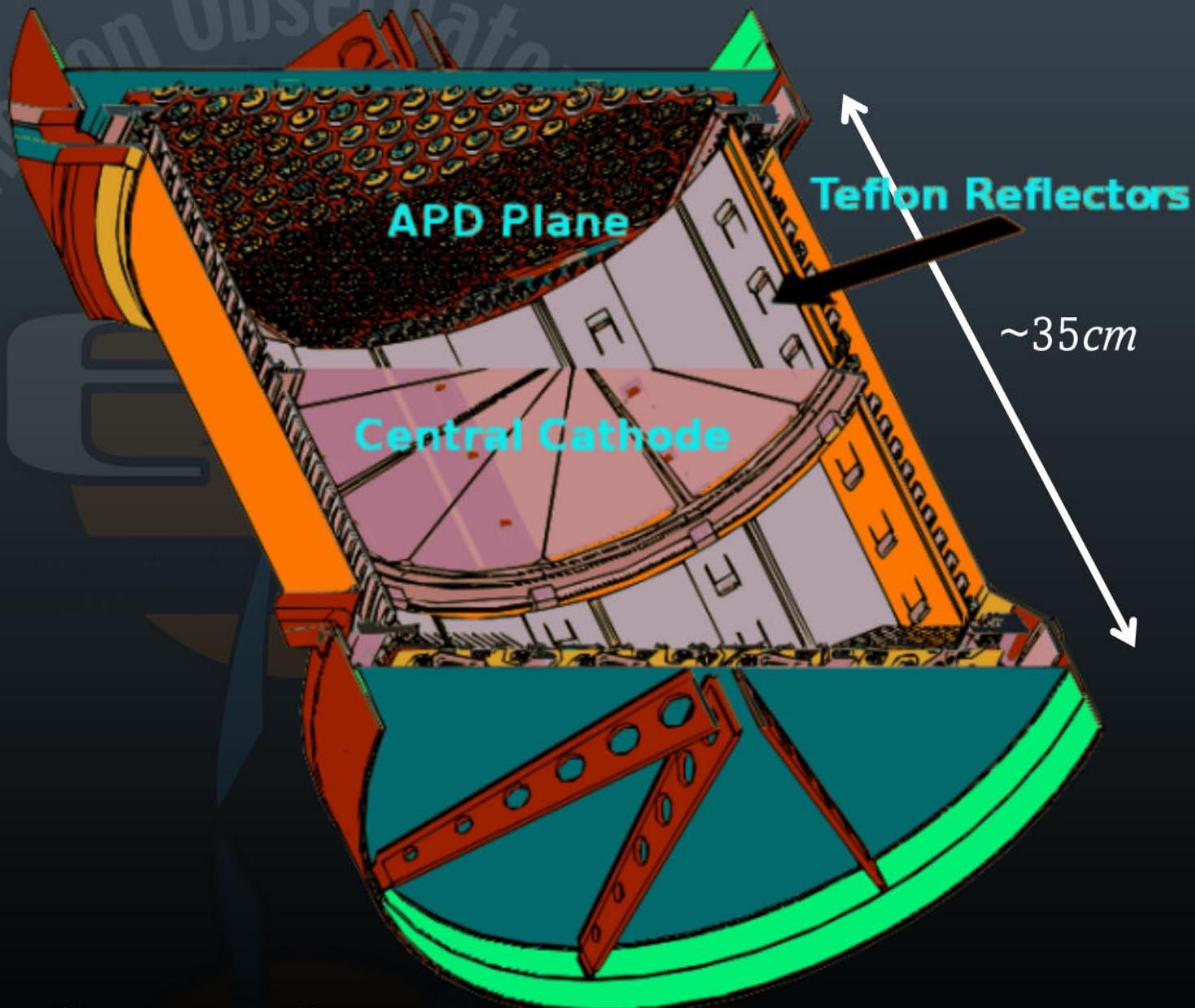
The Detector

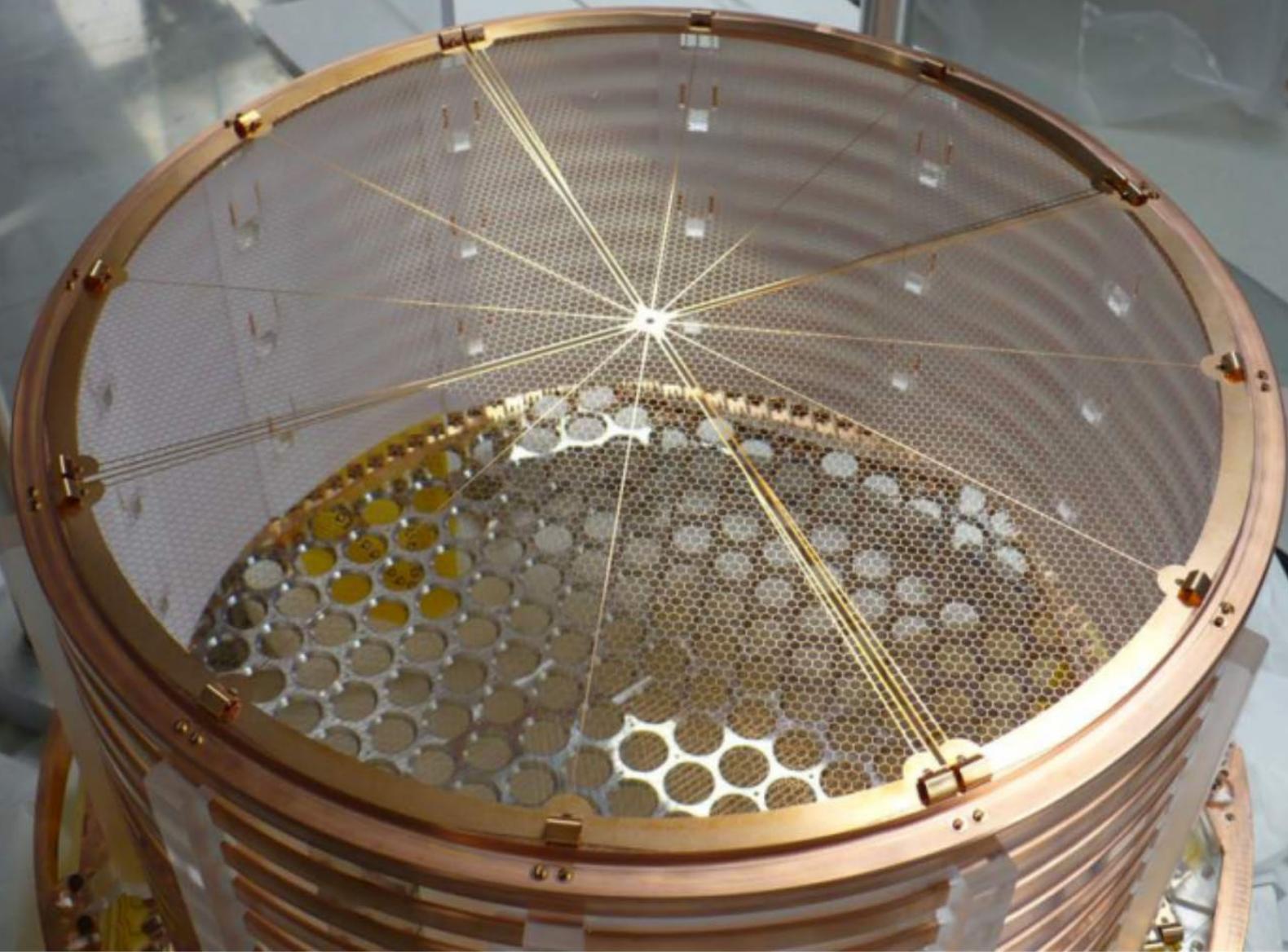
EXO-200 uses a liquid Xenon TPC with two cylindrical volumes.

- Charge collection is achieved by using 144x144 wire plains at 60° angles.
- Scintillation light is readout using 258 bare Large Area Avalanche Photodiodes (LAAPD) at both end caps.
- The cryostats is made of high purity copper with an external refrigeration-based cooling system.
- It will yield a fuducial mass of ~115kg

Enriched Xenon Observatory











EXO-200

The Location

The EXO-200 detector is located in the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New-Mexico, USA.

- The salt mine offers a depth of 1600 meters water equivalent. This reduces the muon flux by roughly a factor of ten.
- Large experimental hall has been made available for EXO-200 to accomodate clean-room modules and all systems.
- Salt is "cleaner" than traditional hard-rock mines.

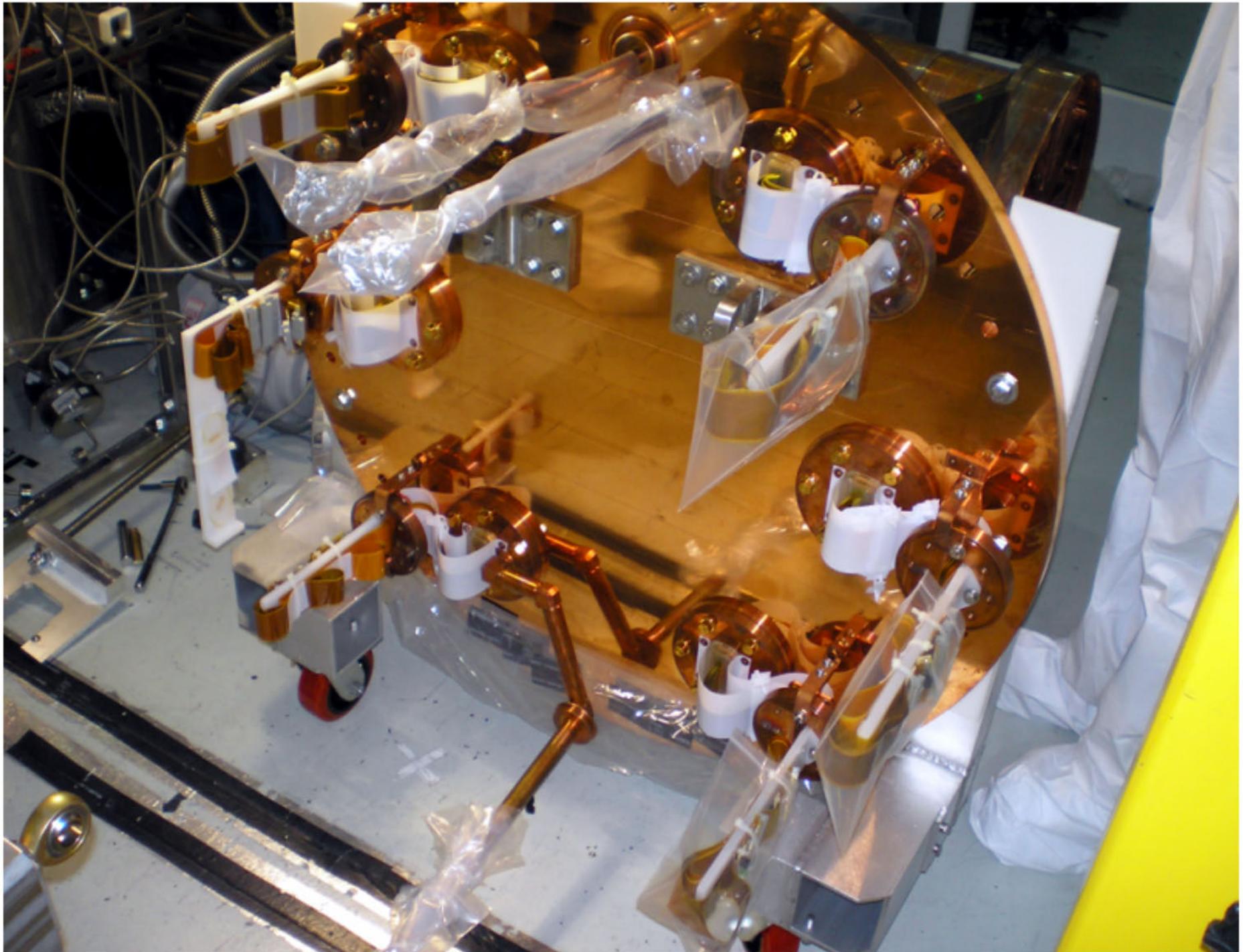


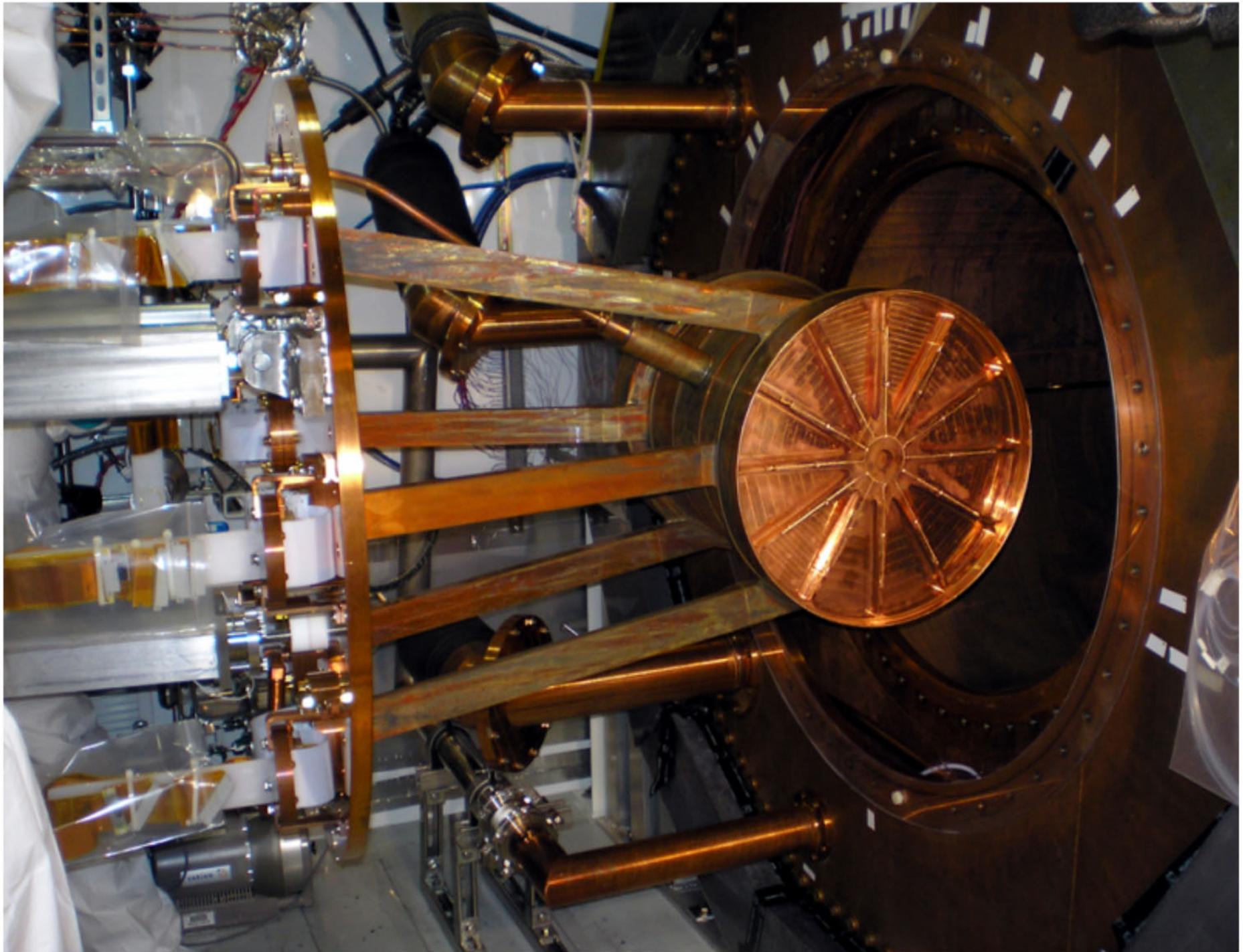


The TPC has been installed in the cryostat last week!

- The TPC is located inside a calibration tubing setup. It allows a calibration source to be positionned at critical points around the TPC.
- Thin copper walls keep mass at a minimum. All welded with e-beam and (Th-free) tig.
- Soon ready to cool down first natural Xe batch and switch to enriched Xe when appropriate.







- Selection of materials, optimized custom design and clean processes yield a very low radioactive background; 20 events per year within 2σ around the 2.458 MeV peak of the decay spectrum.
- Very good energy resolution; $\sigma(E)/E = 1.4\%$
- Negligible background from 2ν decay; $T_{1/2} > 10^{22}$ yrs.
- TPC is completed and electronics are connected at Stanford. Tests will be over soon and the chamber will be welded shut and shipped to WIPP. Installed before the end of 2009.
- Start with natural Xe and switch to enriched when appropriate

EXO-200

Performance

Limit on $\beta\beta v v$ in ^{136}Xe :

$$T_{1/2}^{2\nu} > 1.2 \times 10^{24} \text{ yr} @ 90\% \text{ C.L.}$$

Mass (ton)	Eff. (%)	Run Time (yrs.)	σ_E/E @ 2.5 MeV (%)	Radioactive Background (events)	$T_{1/2}^{0\nu}$ (yrs. 90 C.L.)	Majorana mass (meV) QRPA	Majorana mass (meV) NSM	
EXO-200	0.2	70	2	1.6	40	6.4×10^{25}	133 <small>Rodin et. al., Nucl. Phys. A 793 (2007) 213</small>	186 <small>Caurier et. al., arXiv:0709.2137v1</small>

Expected signal for Ge $\beta\beta 0\nu$ claim

QRPA: 46 events (5.0σ)

NSM: 170 events (11.7σ)

Conclusions

- Hardware is in place.
- Physics run begins in 2010.
- Ongoing R&D for EXO-Full.

