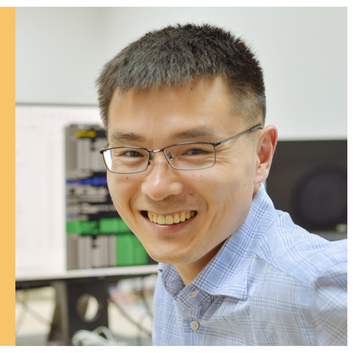
Poster #183

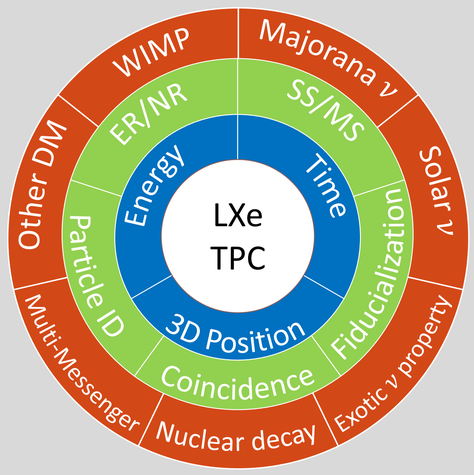
Multi-anode 2″ PMT for Future Liquid Xenon Detectors

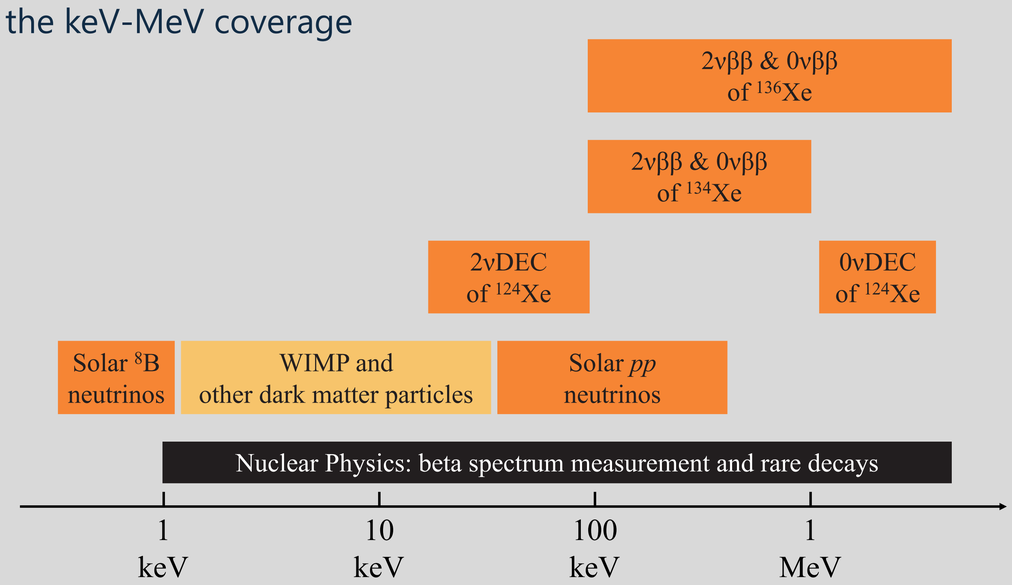
Ke Han (ke.han@sjtu.edu.cn) for the PandaX Collaboration



1. LXe TPCs for neutrino and dark matter physics

- A large liquid xenon (LXe) Time Projection Chamber (TPC) measures the energy, time, and 3D position of an event
- Powerful tool for neutrino physics, dark matter direction, and nuclear physics in a wide energy window
- Photomultiplier Tubes (PMTs) measure the light signals from LXe; Critical for the keV-MeV coverage





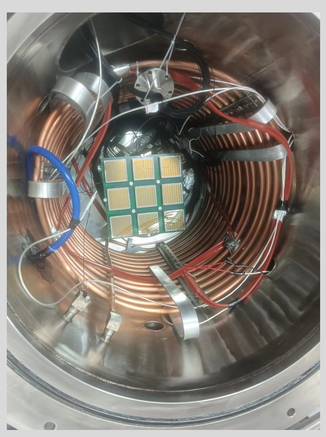
2. Hamamatsu R12699 multi-anode 2″ PMT

- 56-mm square effective photocathode with 2×2 individual anodes
- Special bialkalai photocathode and synthetic quartz window for UV
- Compact dynode construction to achieve fast time response
- Low-temperature operation down to -110°C

	R8520	R11410	R12699
Used in	PandaX-I	PandaX-II, -4T	future PandaX

3. R12699 specification

- PandaX purchased 350 Hamamatsu R12699 PMTs (v1)
- All PMTs tested at room temperature and -100°C
- Average gain is about 5×10^6 with 1000 V bias
- Average dark rate at -100°C is ~10 Hz per anode
- Average after-pulse is <1%



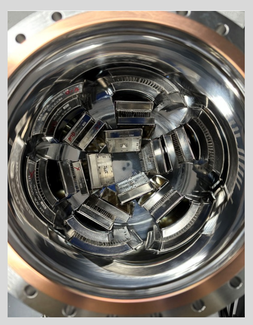
PMTs in a cryostat

4. Reduced radioactivity

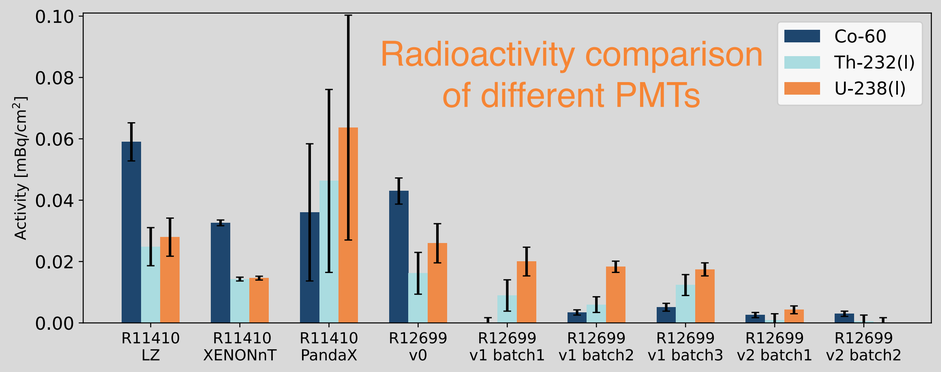
- The radioactivities of all PMT materials (aluminum, Kovar, SS, quartz window, ceramic, etc.) are assayed with HPGe underground
- Iterate with Hamamatsu to replace materials (for example, Kovar) with high radioactivities.
- Reduce ^{60}Co, ^{232}Th, and ^{238}U contaminations from batch to batch
- Radon emanation is on par with R11410 (LZ/XENONnT)

Quartz measured with HPGe

PMTs measured with HPGe

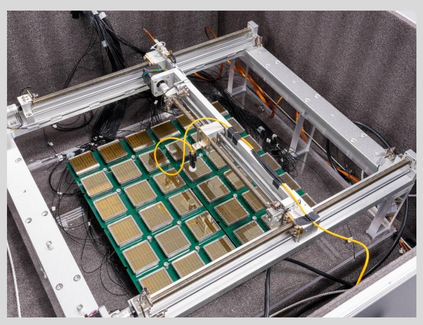


PMT radon emanation measurement

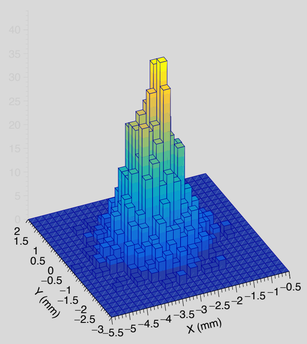


5. Performance of large arrays

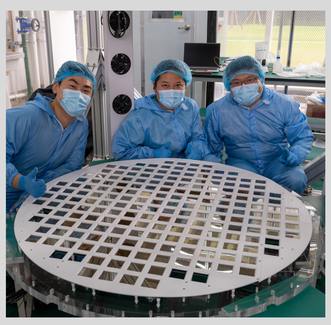
- An array of 36 PMTs (v1) is tested in a room-temperature dark box
- LED light source + position control to validate position reconstruction
- 0.5 mm position precision demonstrated with data
- 2 large 176-PMT arrays are ready for a test LXe TPC setup



36-PMT array



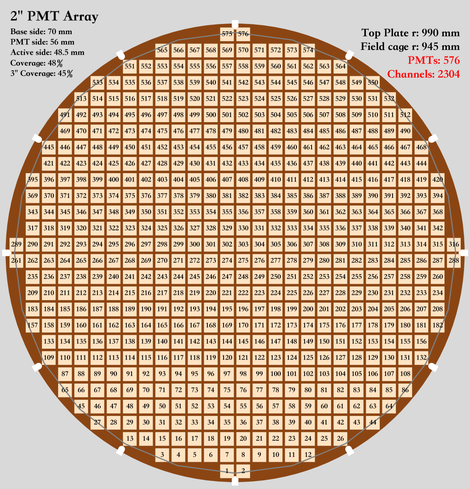
Position Precision



176-PMT array

6. Conclusion and outlook

- The next generation PandaX detector PandaX-xT aims to be an ultimate dark matter detector and a competitive double beta decay experiment
- The first phase, PandaX-20T, will have a 500-PMT top array for a wide dynamic range, precise position reconstruction, and fast timing
- 300 low-radioactivity v2 PMTs will be delivered within the year



Concept of PandaX-20T 2″ PMT top array