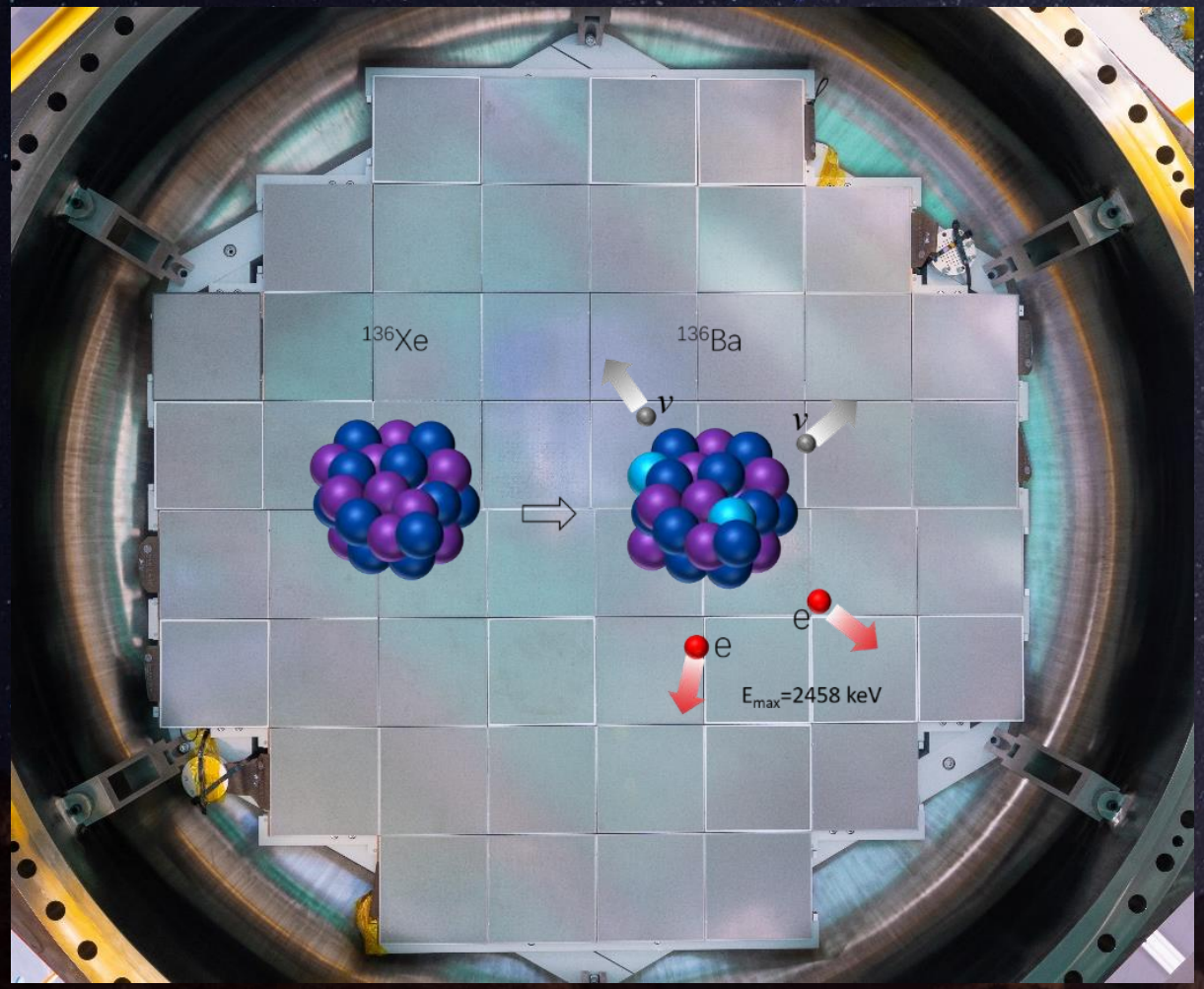
Status and Prospect for the PandaX-III Experiment



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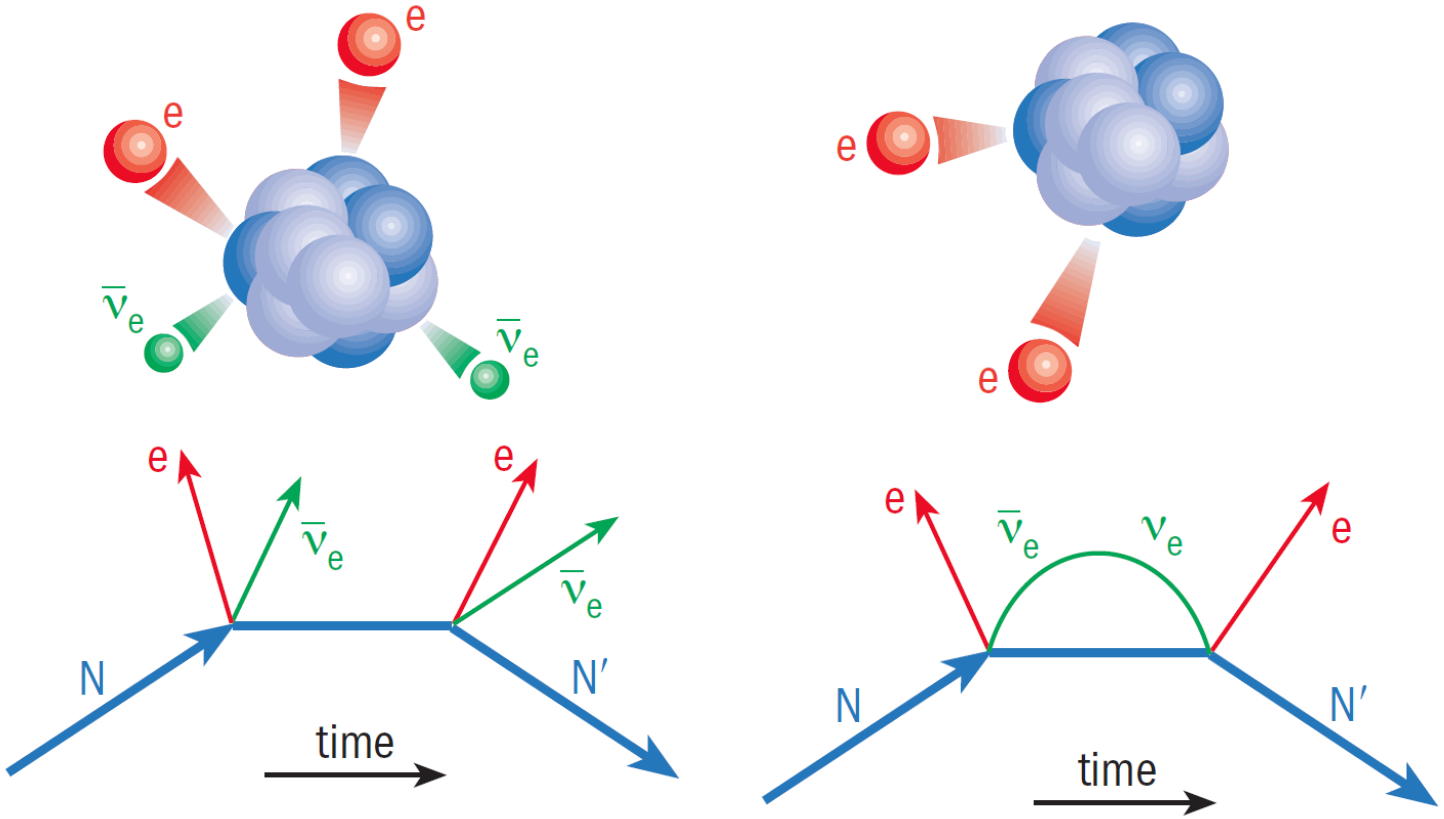
2023-09-28

On behalf of PandaX-III collaboration

Shanghai Jiao Tong University, China

16th Topical Seminar on Innovative Particle and Radiation Detectors(IPRD23)
25-29 September 2023 Siena, Italy

Neutrinoless double beta decay ($0\nu\beta\beta$)



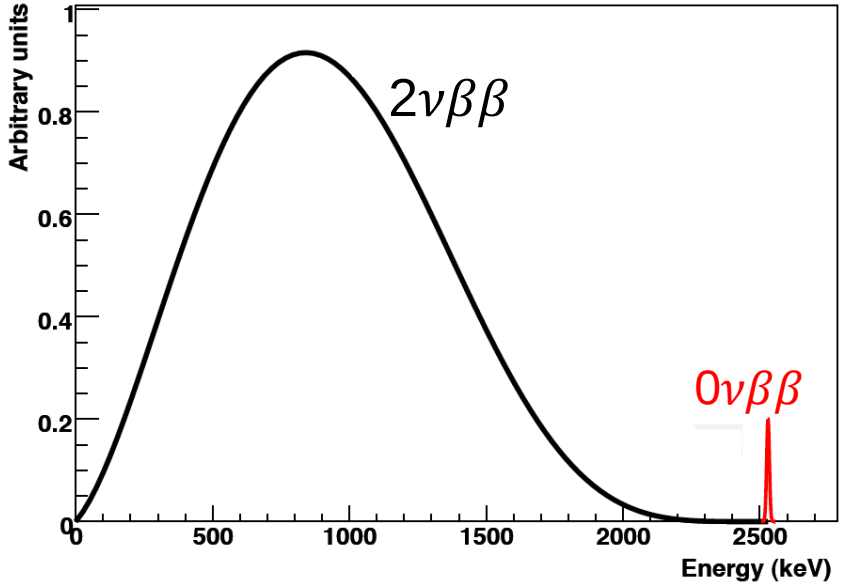
$\bar{\nu} = \nu$

- $2\nu\beta\beta$: 9 isotopes, including ^{136}Xe, ^{76}Ge, ^{130}Te, ^{82}Se and ^{100}Mo
- $0\nu\beta\beta$: Majorana Neutrino? Lepton number violation?
- Measures effective Majorana mass: relate $0\nu\beta\beta$ to the neutrino oscillation physics

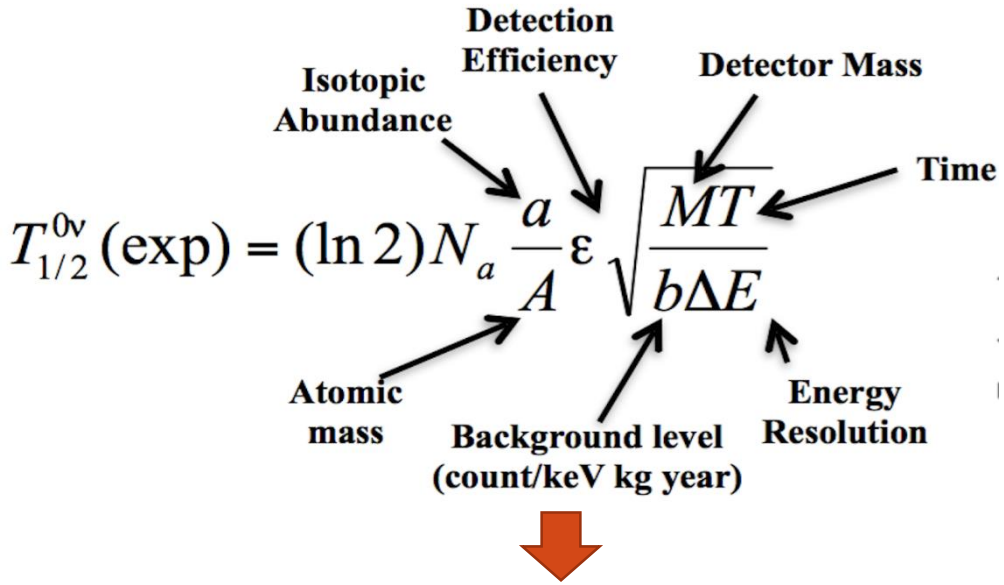
Detection of $0\nu\beta\beta$

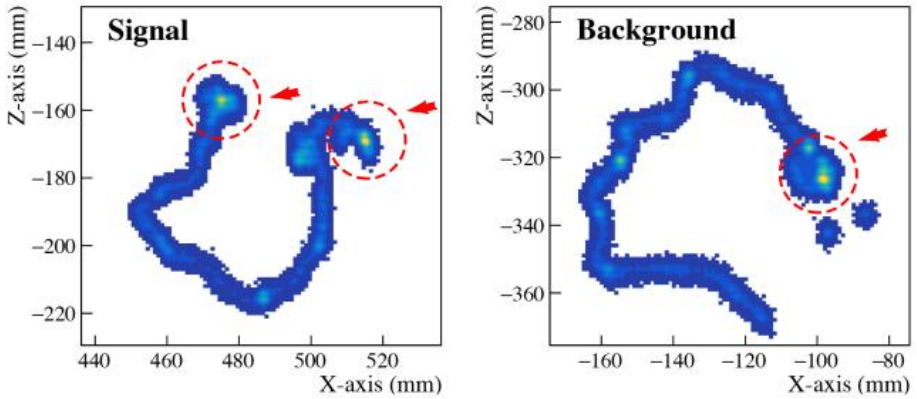
- Measure energies of emitted electrons
- Electron tracks are a huge plus
- Daughter nuclei identification

$$^{136}_{54}Xe \rightarrow {}^{136}_{56}Ba + 2e^- + (2\bar{\nu})$$



Sum of two electrons energy

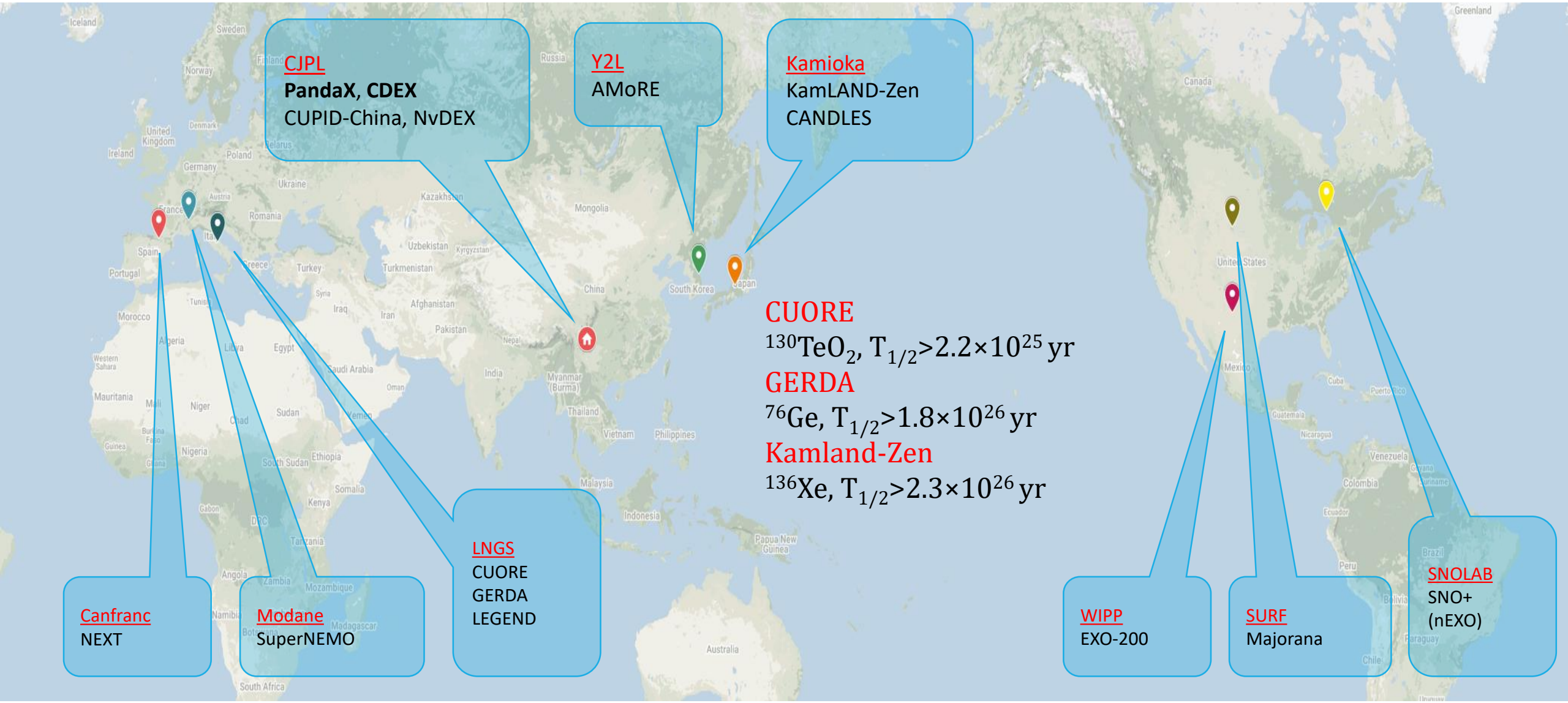




Simulated tracks in high pressure Xe

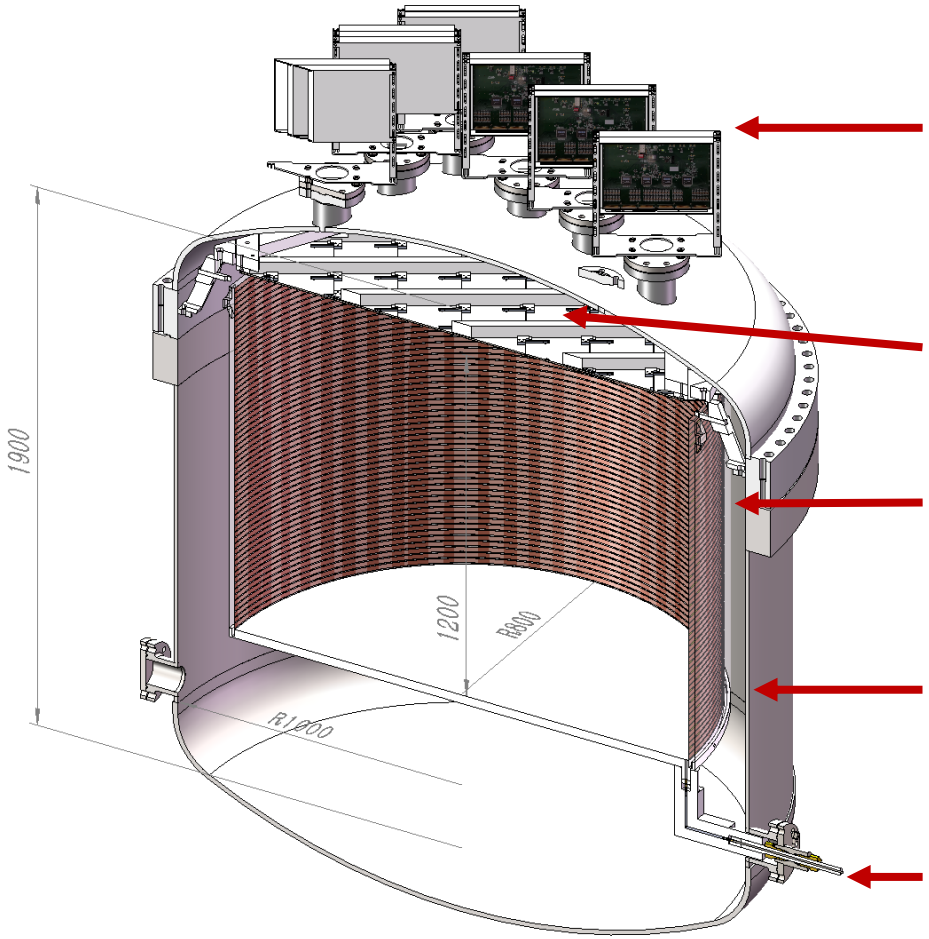
Experiment: large exposure, high energy resolution, low background level and signal-background discrimination

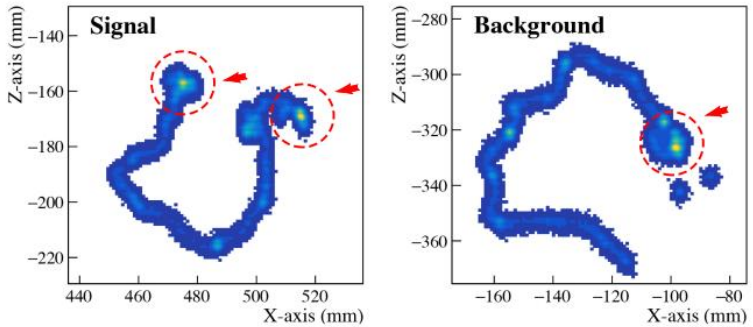
$0\nu\beta\beta$ experiments



PandaX-III detector: search for $0\nu\beta\beta$ of ^{136}Xe

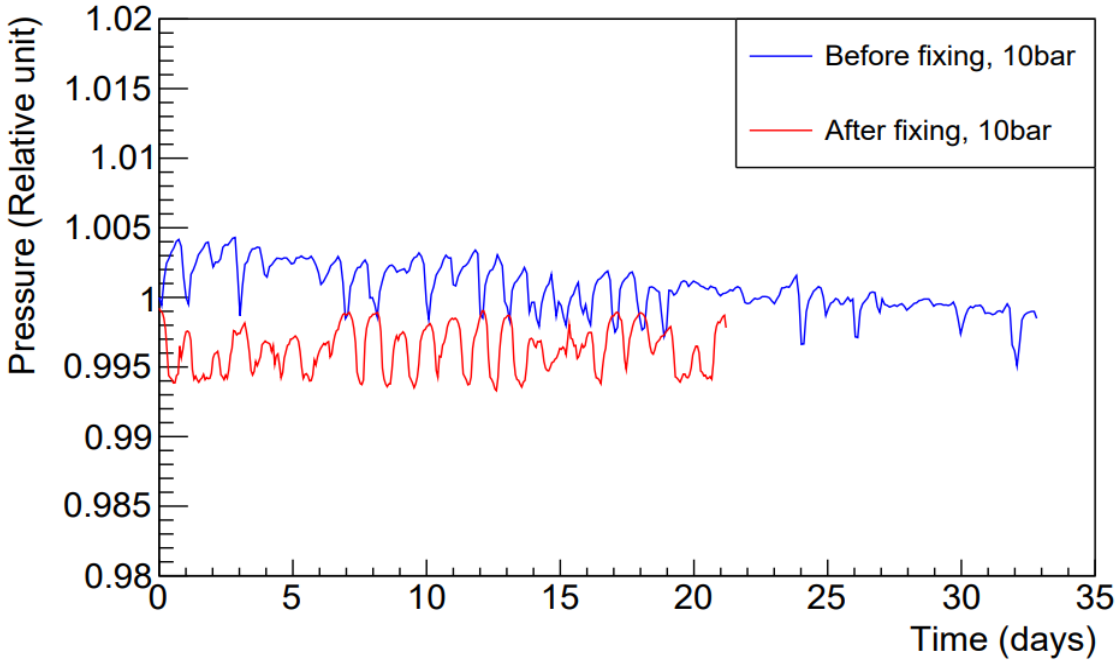
- 10 bar Xe-(1%)TMA (trimethylamine): 140 kg 90% ^{136}Xe
- TPC : Single-end charge readout on the upper side, the cathode on the bottom
- 52 20X20 cm^2 Micromegas for charge readout
- Readout: 2 series of strips (x, y) of 3 mm
- Energy resolution: 3% FWHM expected at 2.5 MeV (Q value of ^{136}Xe 0νββ)

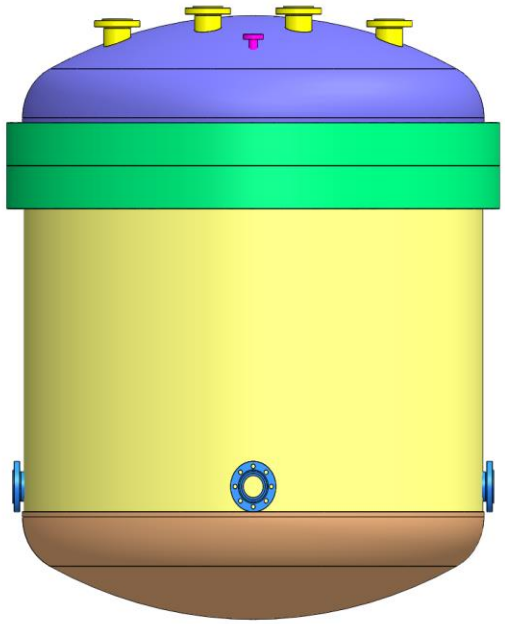


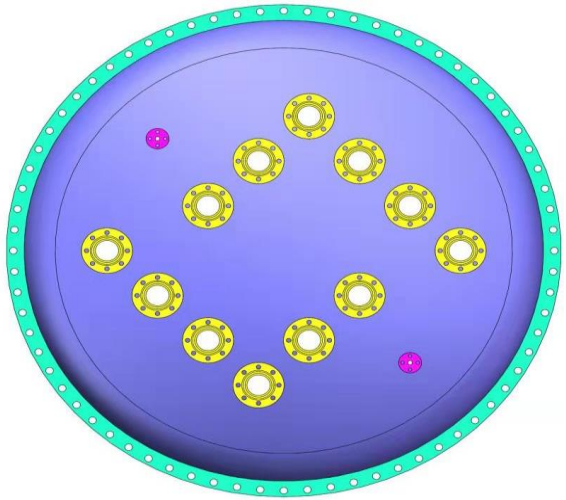


PandaX-III detector: SS vessel

- Vessel made of low background stainless steel with pressurization of 15 bar
- 20 flanges on the top flange and barrel for signal cables, HV feedthrough and gas circulation
- Leak check and longterm high pressure test

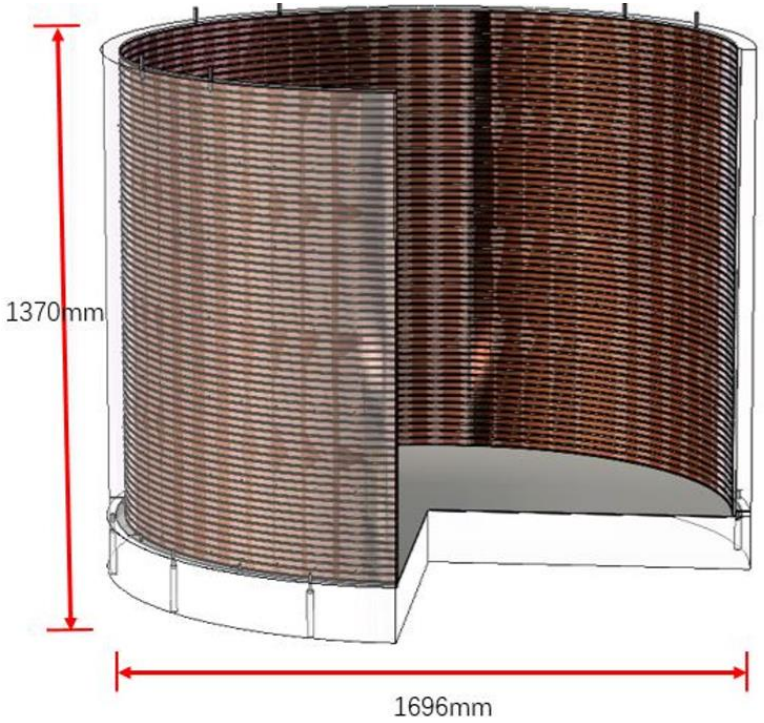


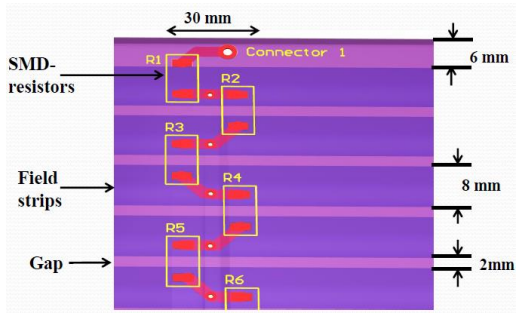


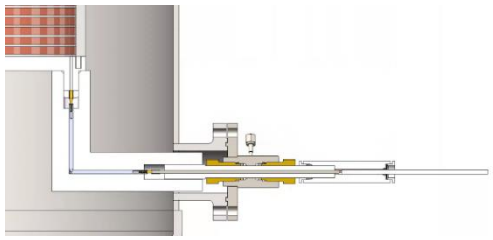


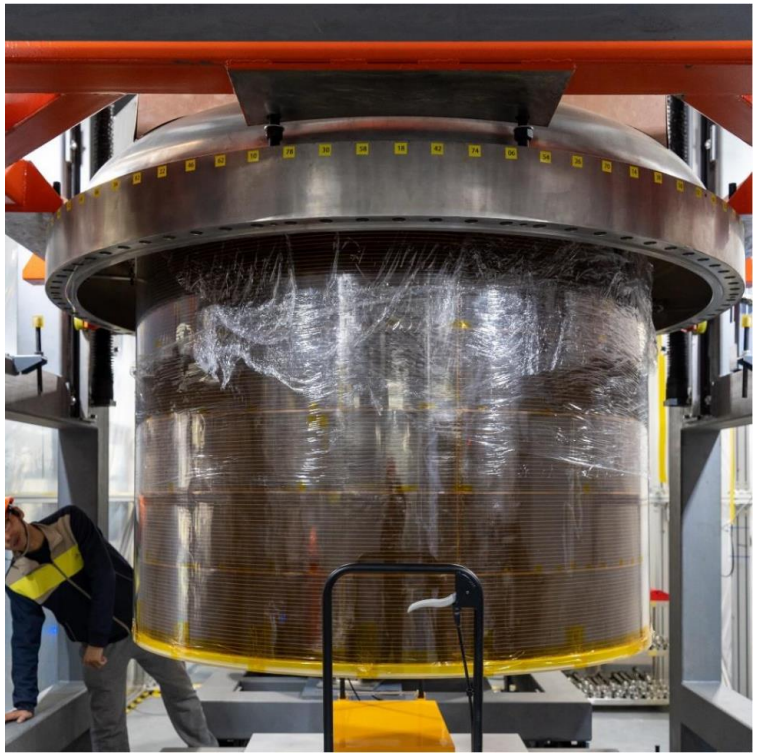
PandaX-III detector: TPC

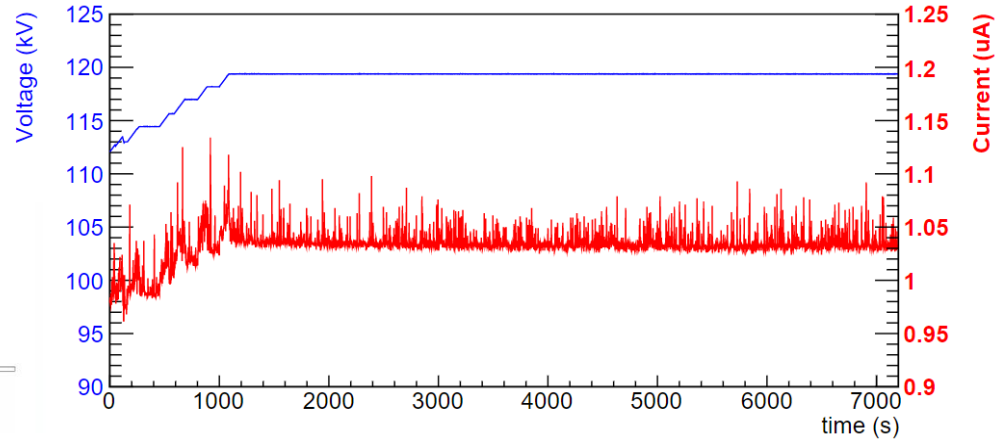
- Field cage : Flexible PCB + SMD resistors supported by a low background acrylic barrel
- L shape feedthrough to apply HV on the cathode
- Apply 120 kV at atmosphere steadily





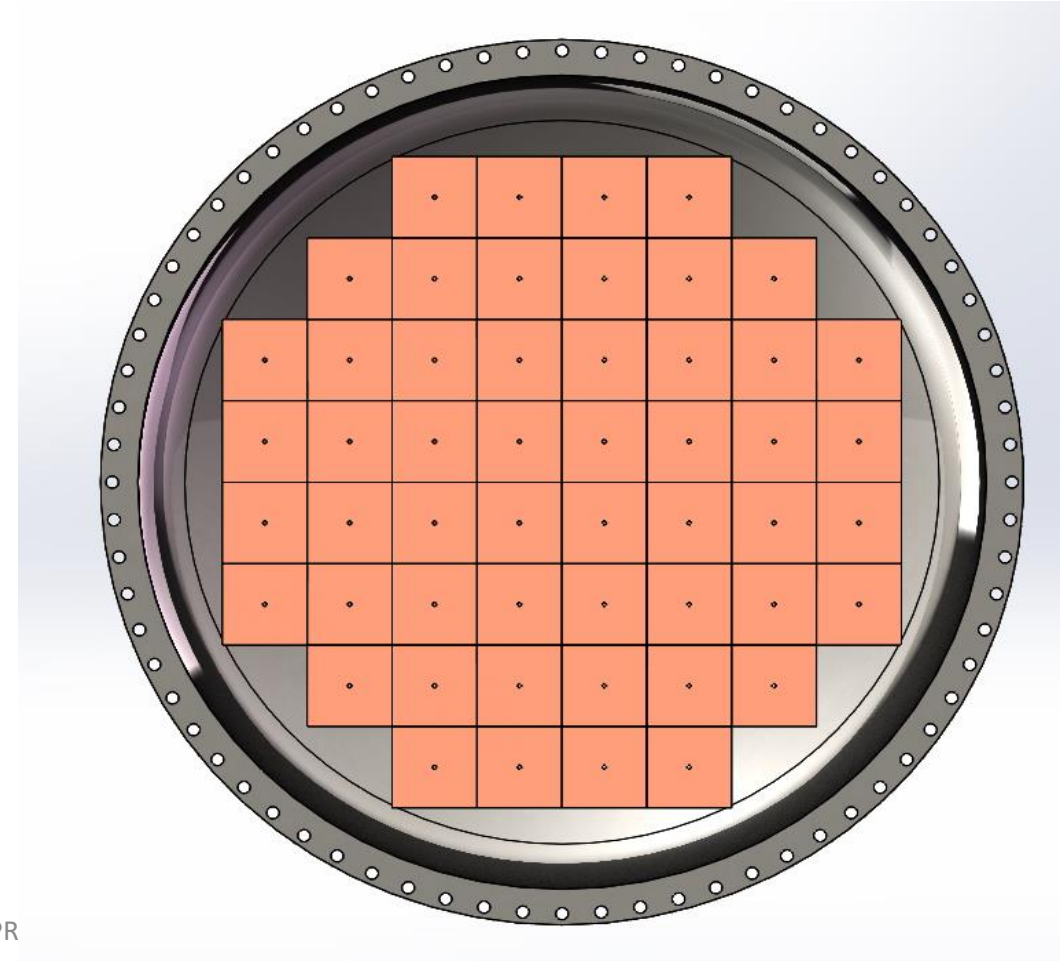


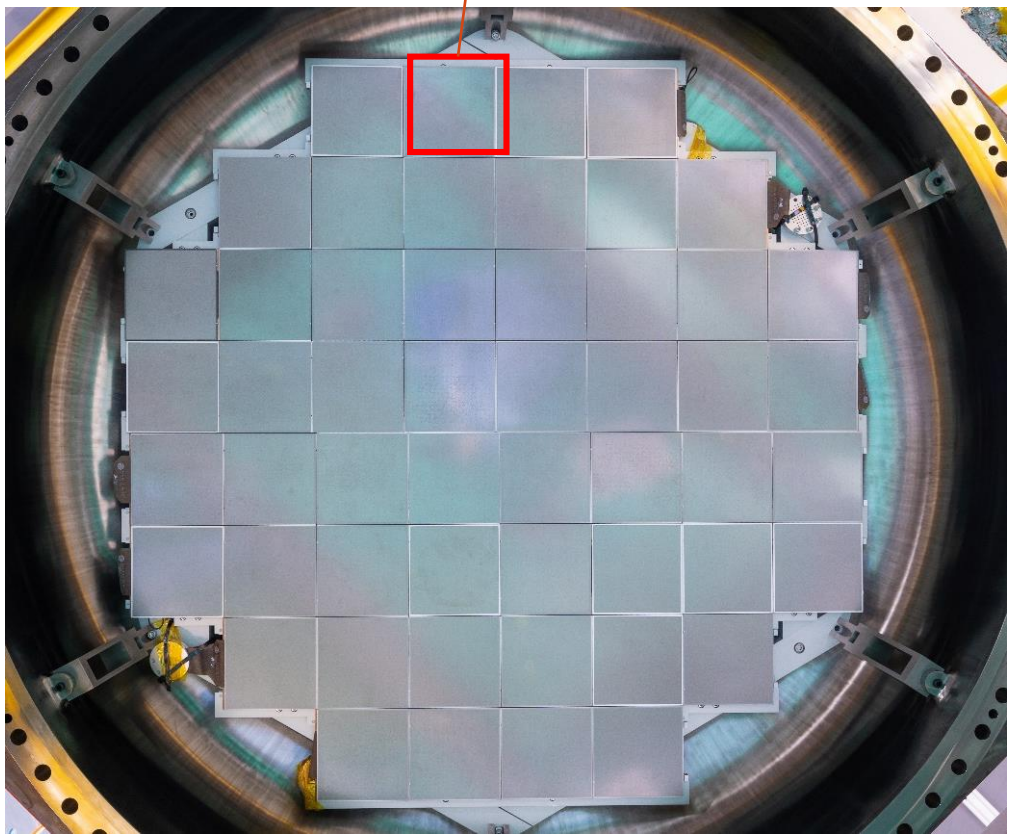




PandaX-III detector: TPC

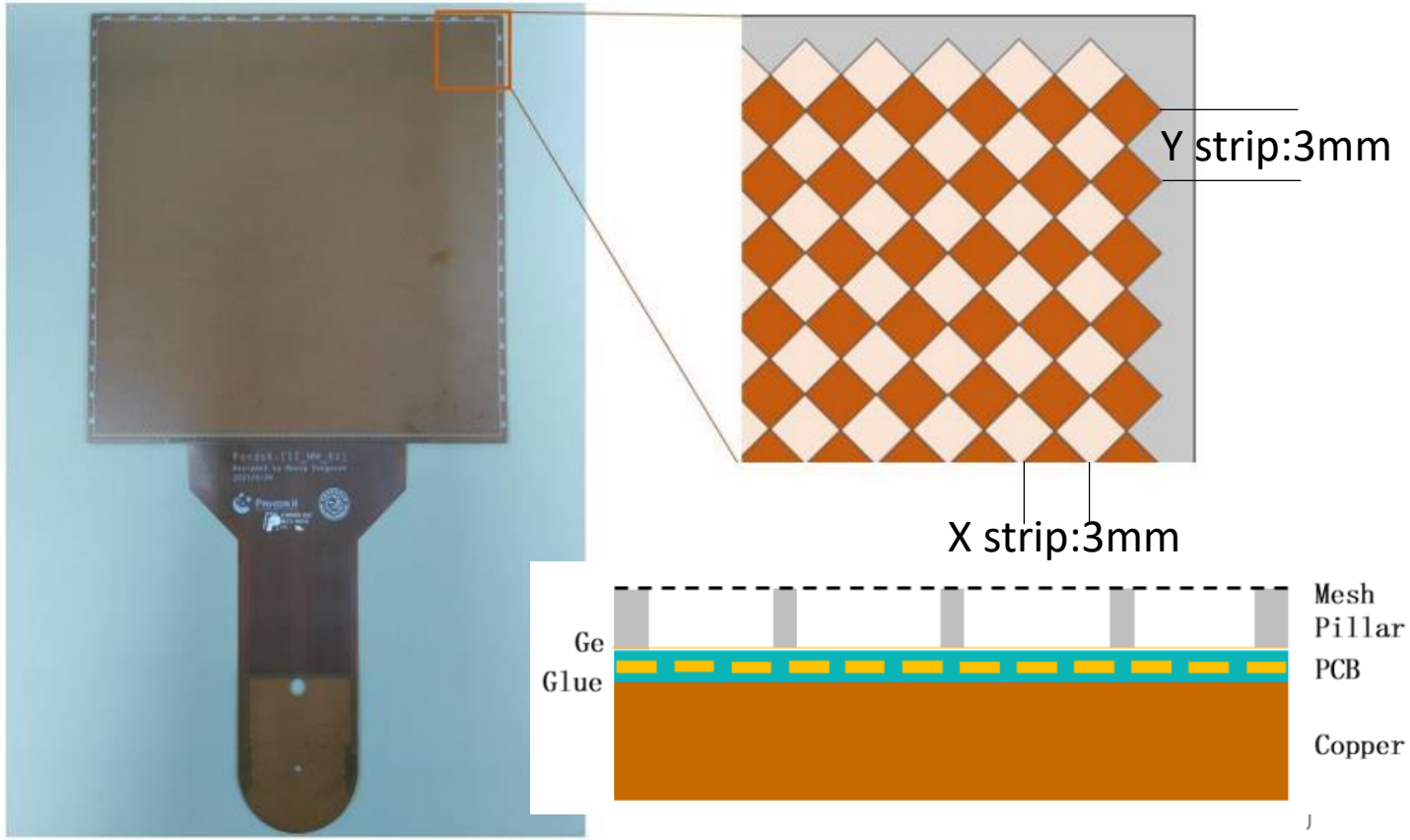
- Readout plane consists of 52 modular Micromegas
- Each module is 20×20 cm^2

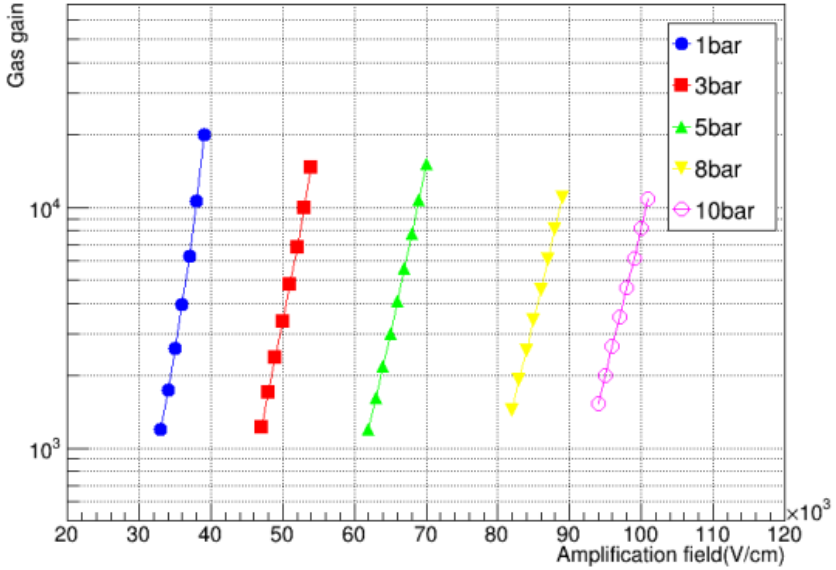


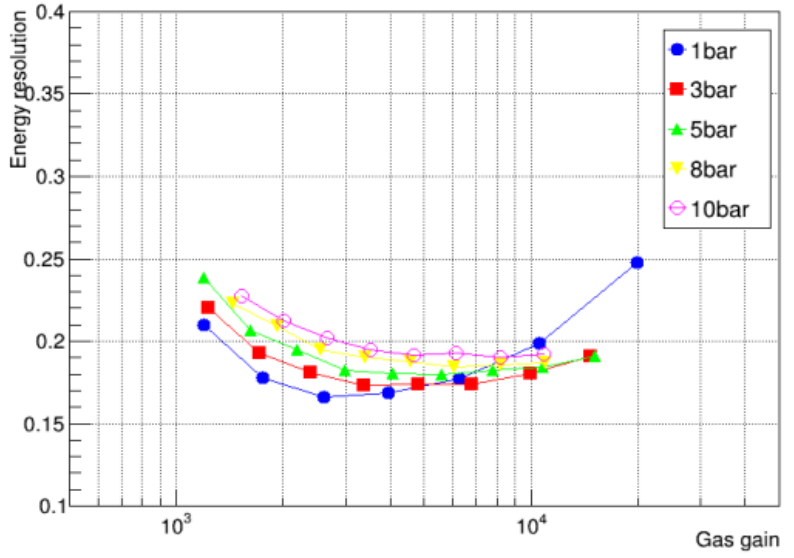


Micromegas

- Low background thermal banding Micromegas designed by USTC and SJT
- Micromegas made of flexible PCB and glued on a copper supporter
- ~10% uniformity and several thousand gain in high pressure



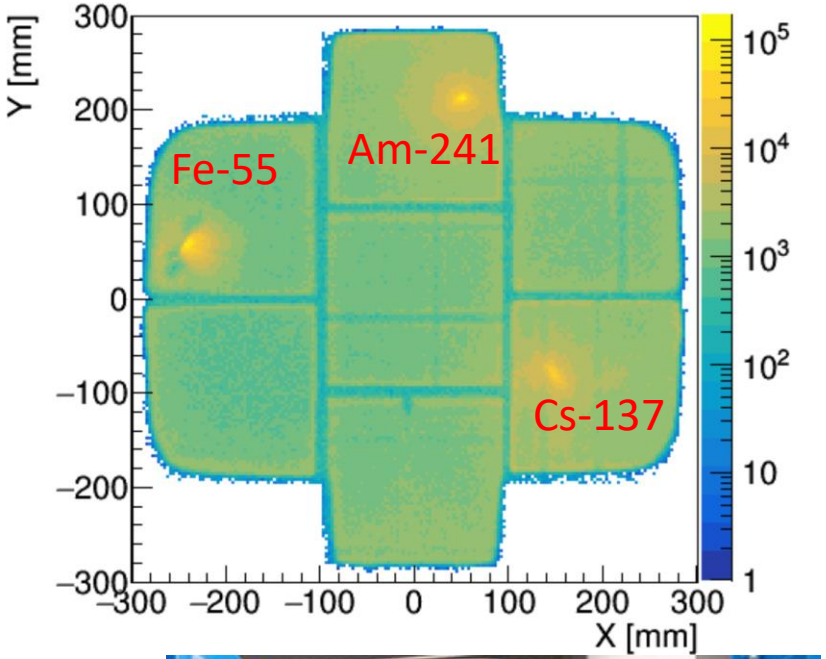


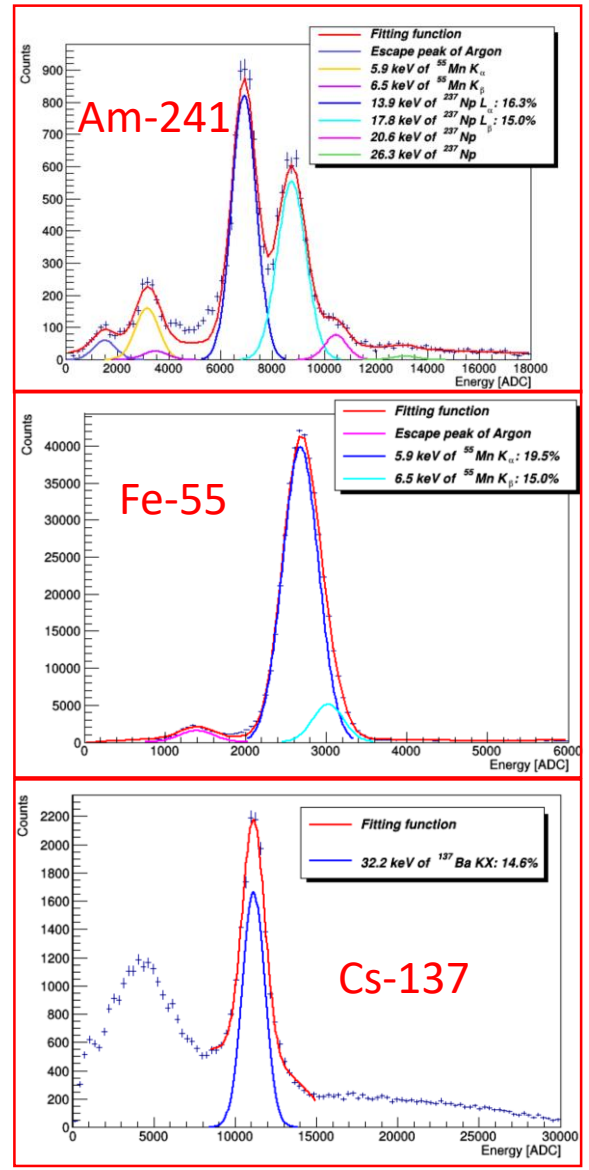


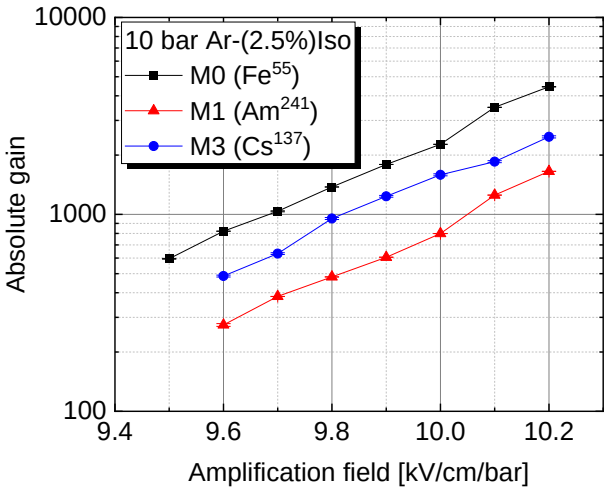
Micromegas test in prototype detector

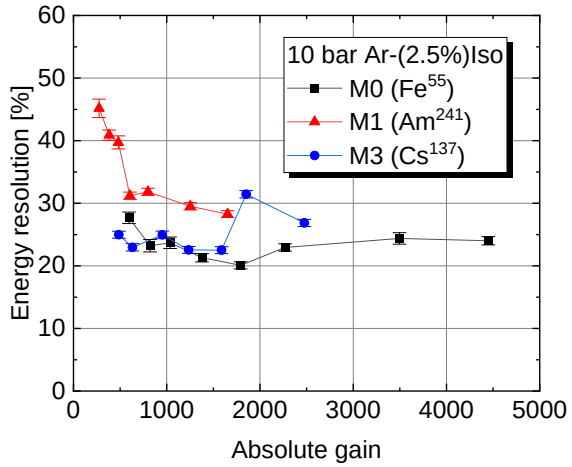
Prototype TPC test :

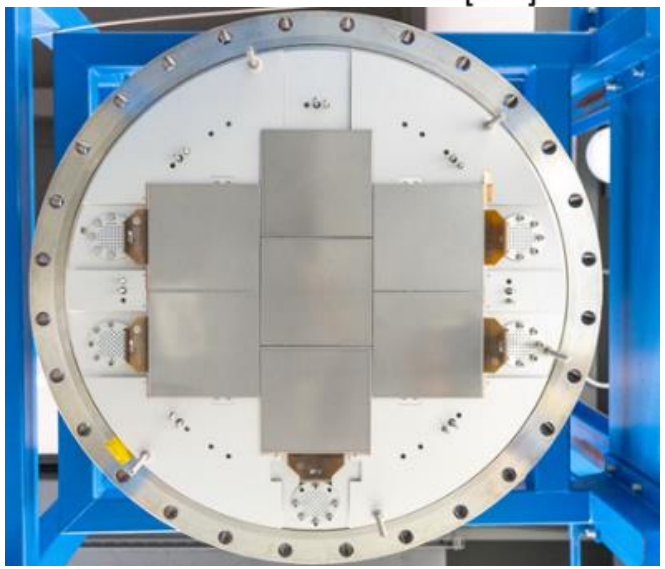
- 700 L volume and 78 cm drift distance
- Readout plane: 7 Micromegas
- Sources: ^{55}Fe, ^{241}Am and ^{137}Cs
- Gas: 1-10 bar Ar-iso





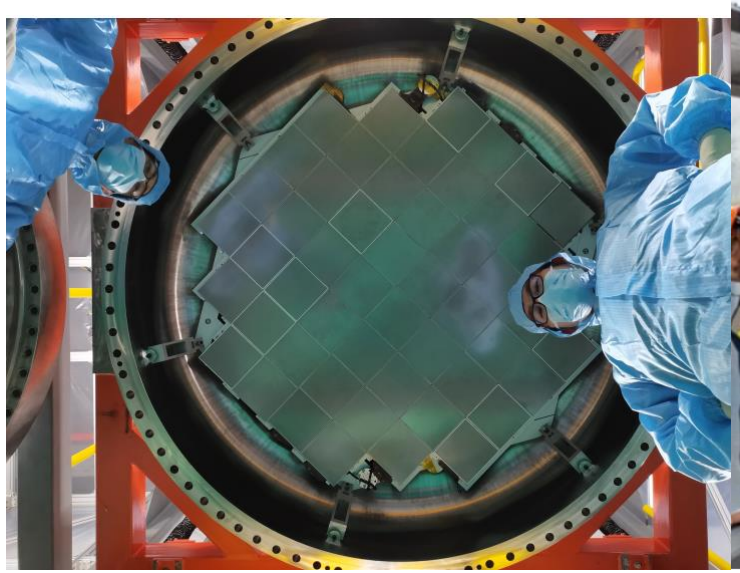


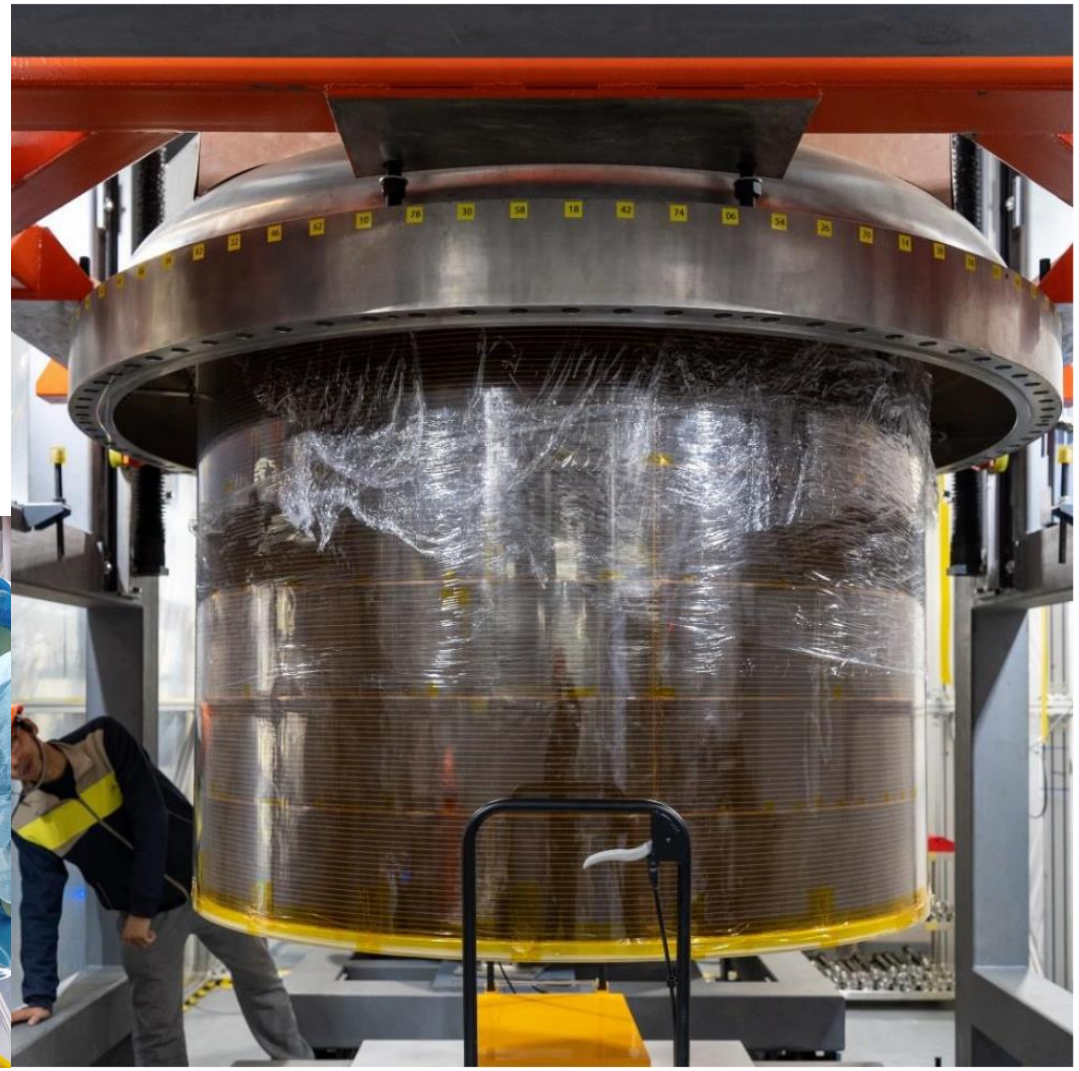




10 bar Ar-2.5%iso

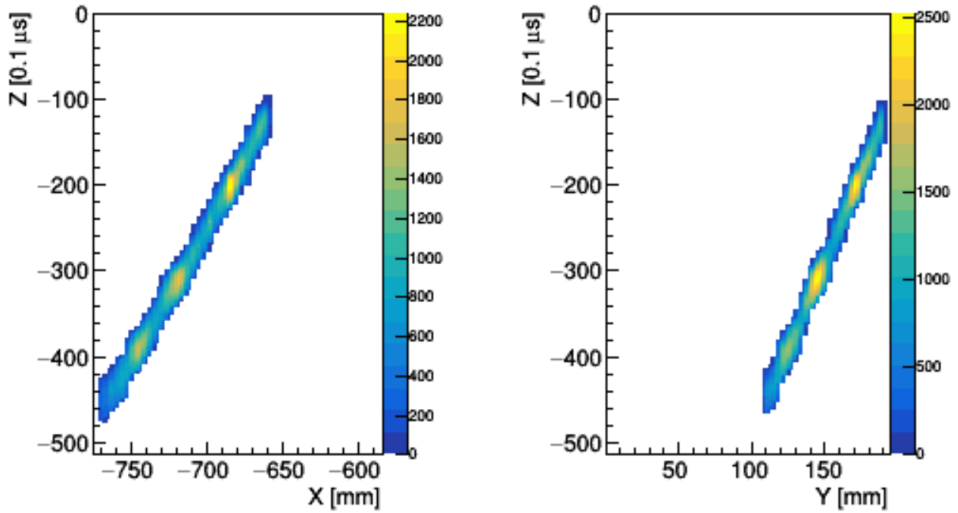
Detector assembling

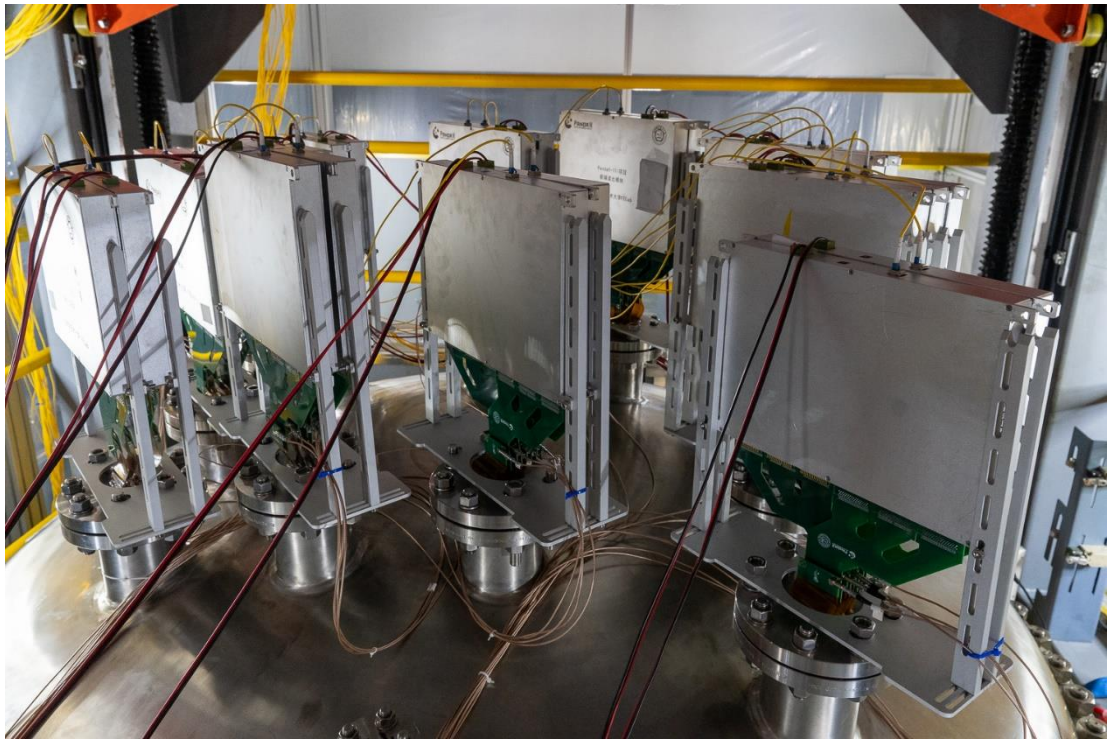




Detector assembling

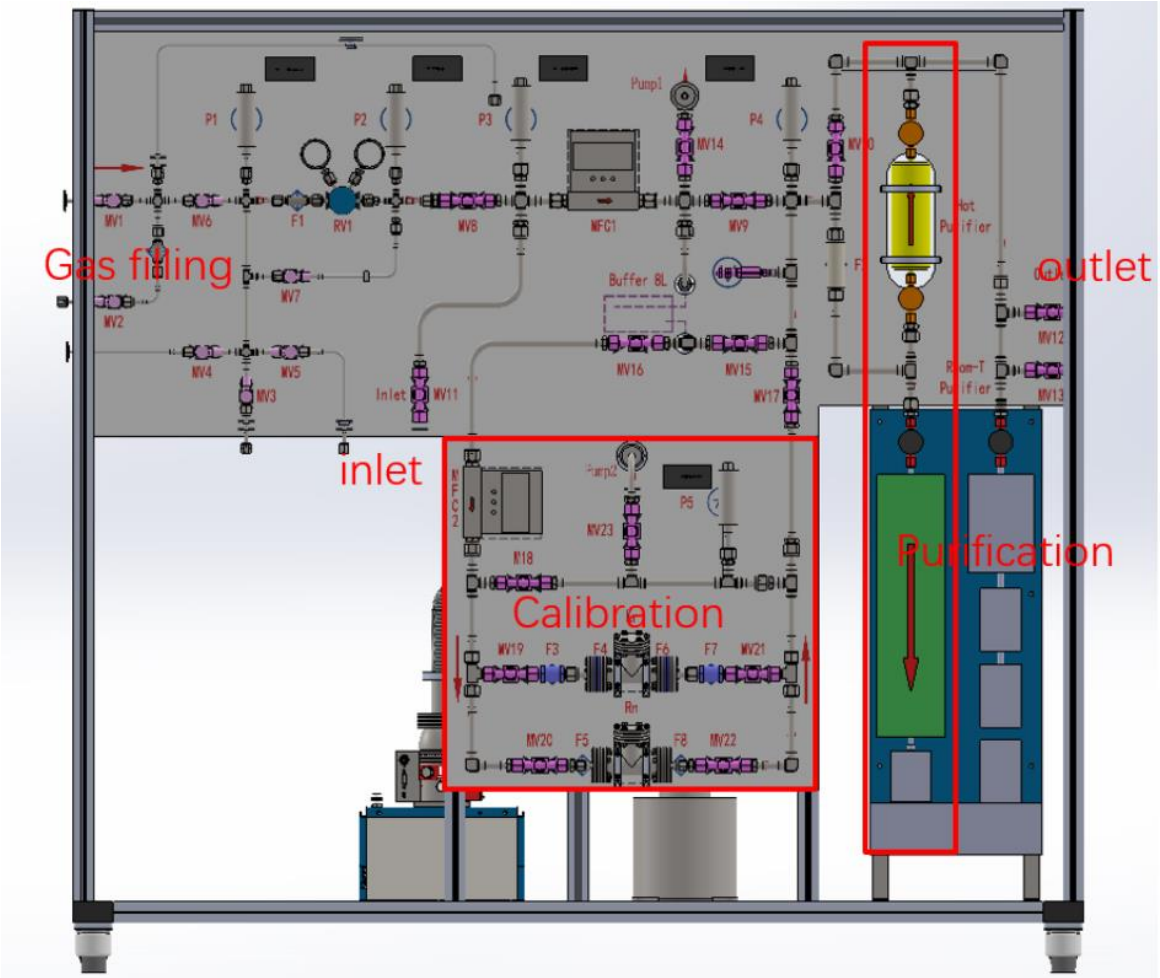
- The detector assembly was completed
- The subsystems were connected
- 1 bar Ar-2.5% iso was filled for muon calibration





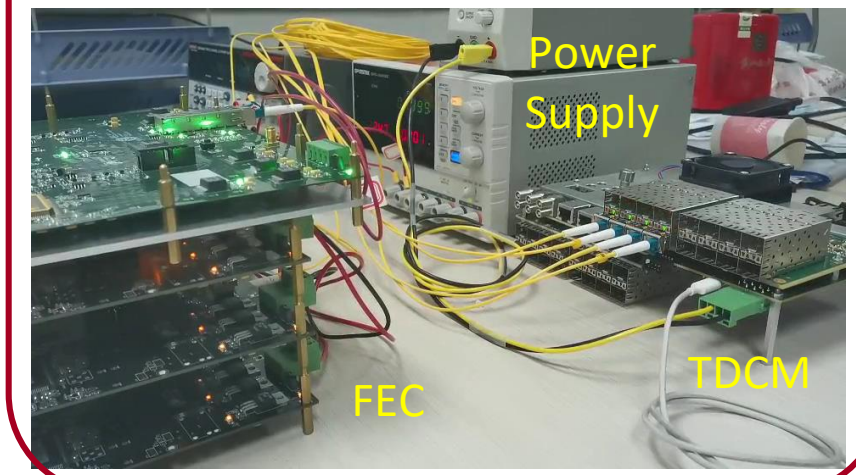
Gas handling and internal calibration system

- Gas filling and mixing , circulation and purification, emergency recovery and sampling
- Internal calibration (gas): $^{220}\mathrm{Rn}$ and $^{83\mathrm{m}}\mathrm{Kr}$

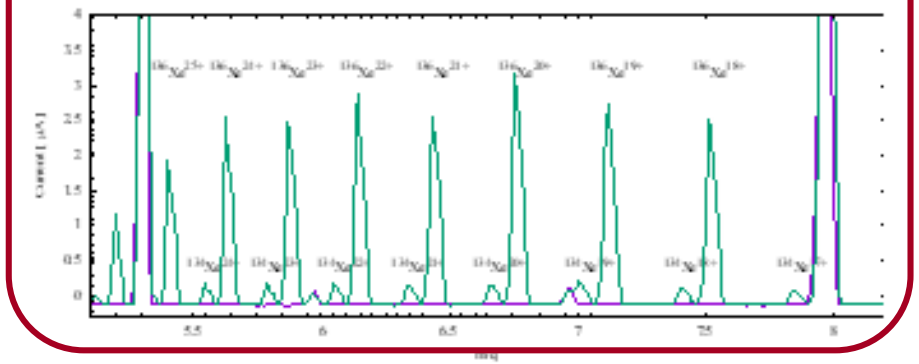


Status of the others

Electronics system

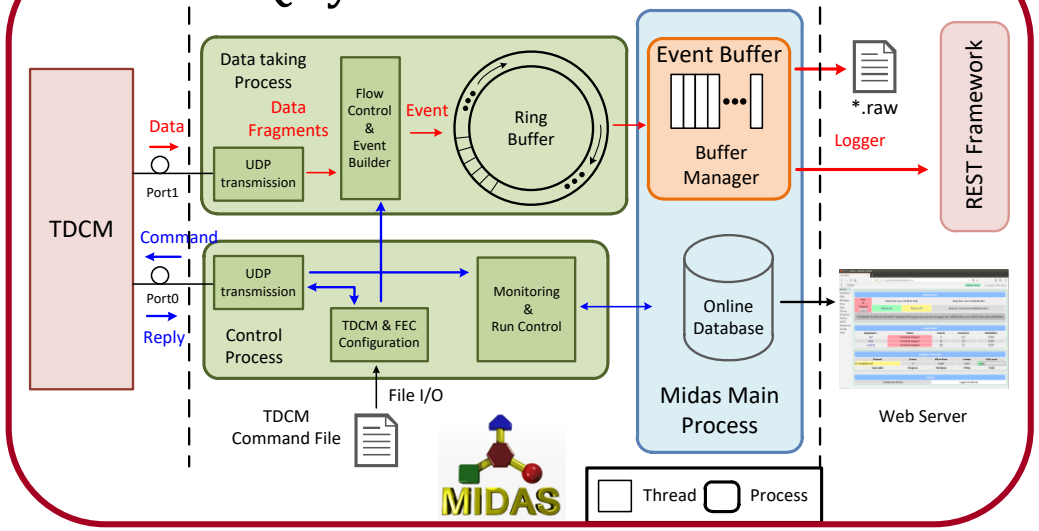


145 kg ^{136}Xe enriched at SJTU

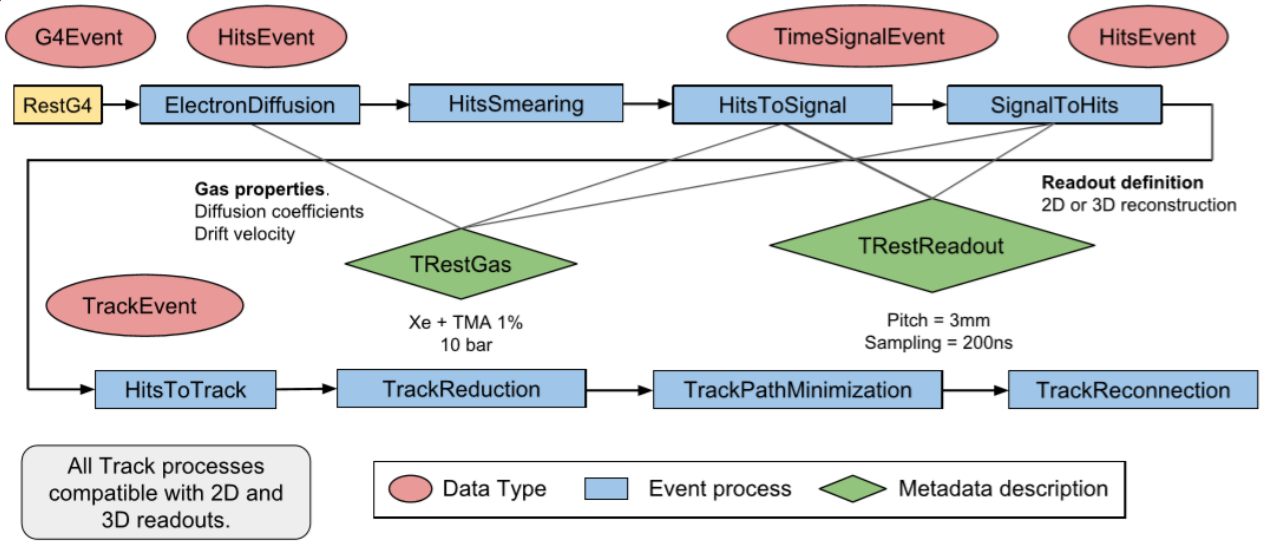


Slow control system

DAQ system

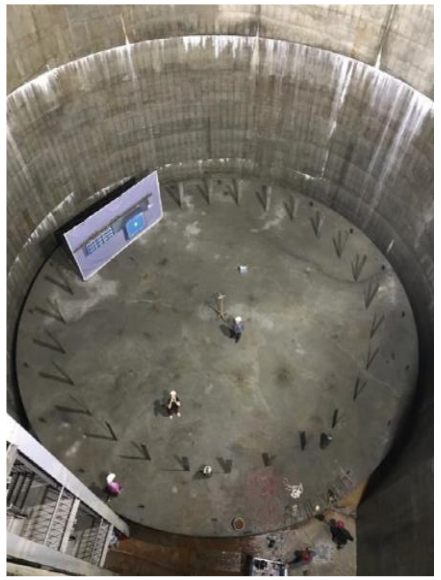


REST: Simulation and data analysis



PandaX-III will be installed in CJPL-II

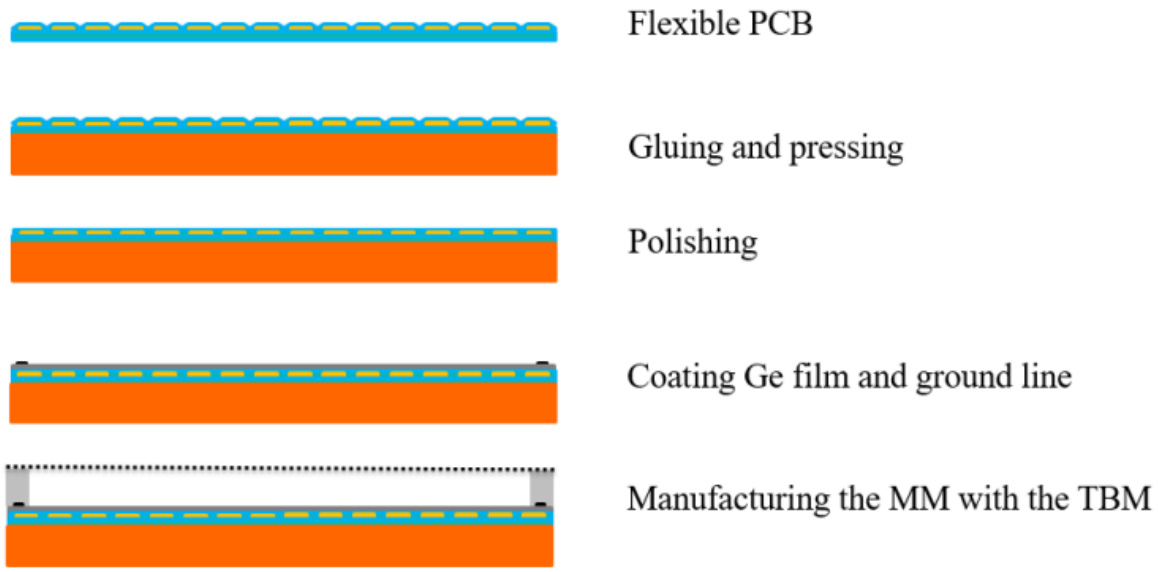
Thanks and welcome collaborators!



Back up

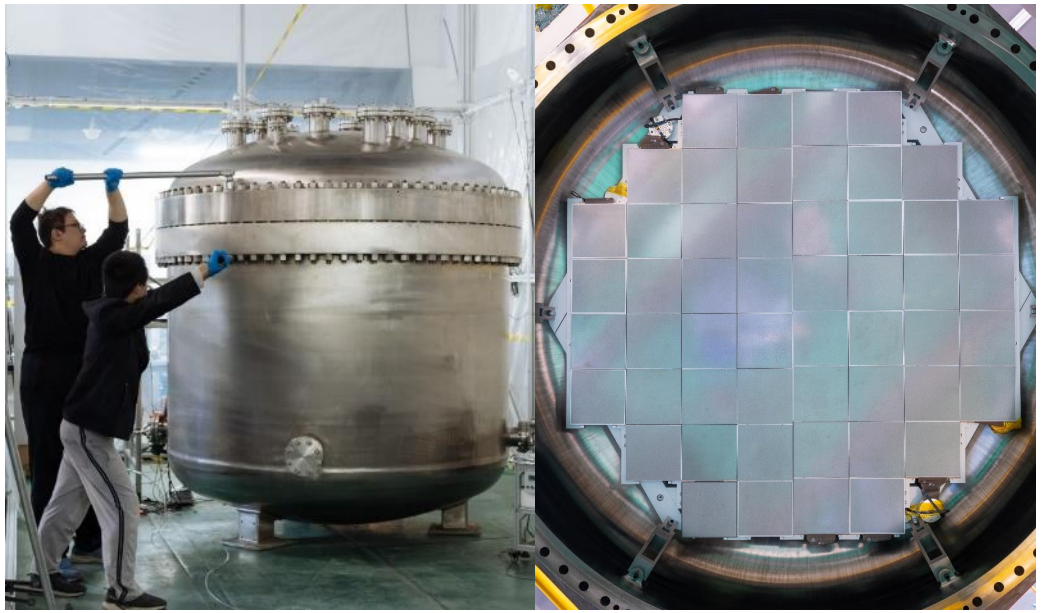
Micromegas

Sample	^{232}Th	^{235}U	^{238}U	^{40}K	^{60}Co
PCB	0.91±1.42	-	0.28±0.55	22.6±9.07	0.37±0.31
SS wire mesh	0.24±0.12	<0.01	0.08±0.04	0.69±0.58	<0.01
Thermal bonding Film	1.00±0.33	<0.01	11.57±1.57	1.67±1.28	-
Epoxy glue	1.40±0.75	-	0.05±0.25	-	-
Total	3.55±1.64	<0.01	11.98±1.68	24.96±9.18	0.37±0.31



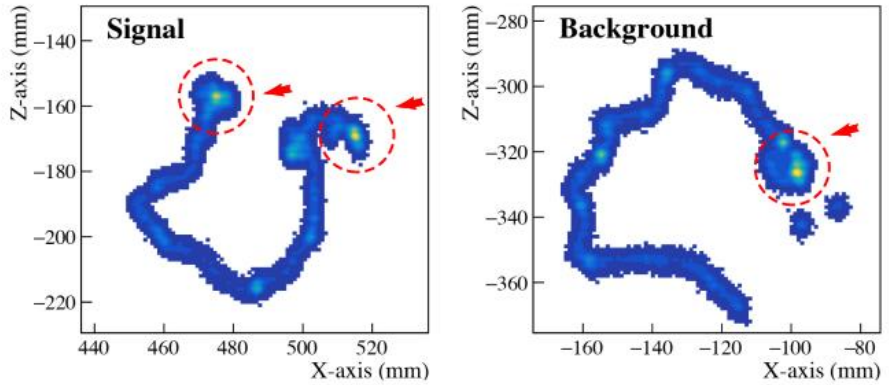
PandaX-III experiment

- PandaX-III: high pressure (10 bar) gaseous TPC (140 kg ^{136}Xe of 90%), 1.2m×1.6m active volume
- Readout plane: 52 20×20 cm^2 Micromegas modules of 3 mm strip (64 strips in each side)
- The topological information is powerful for signal and background discrimination
- Detection sensitivity: 2.7×10^{26} yr with 5-year live time



PandaX-III detector

Micromegas



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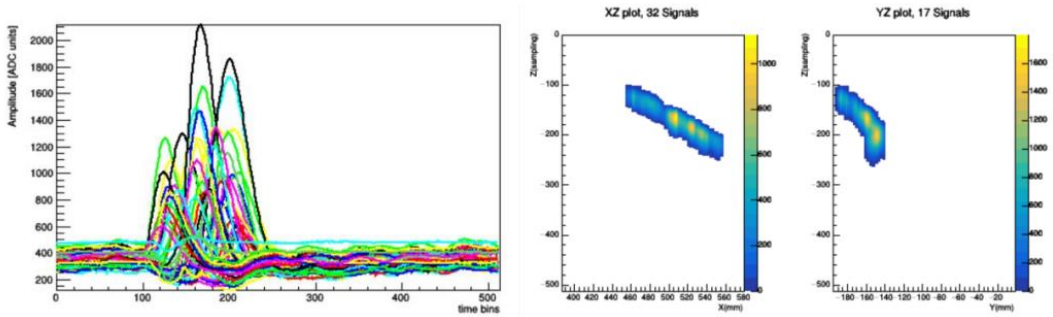
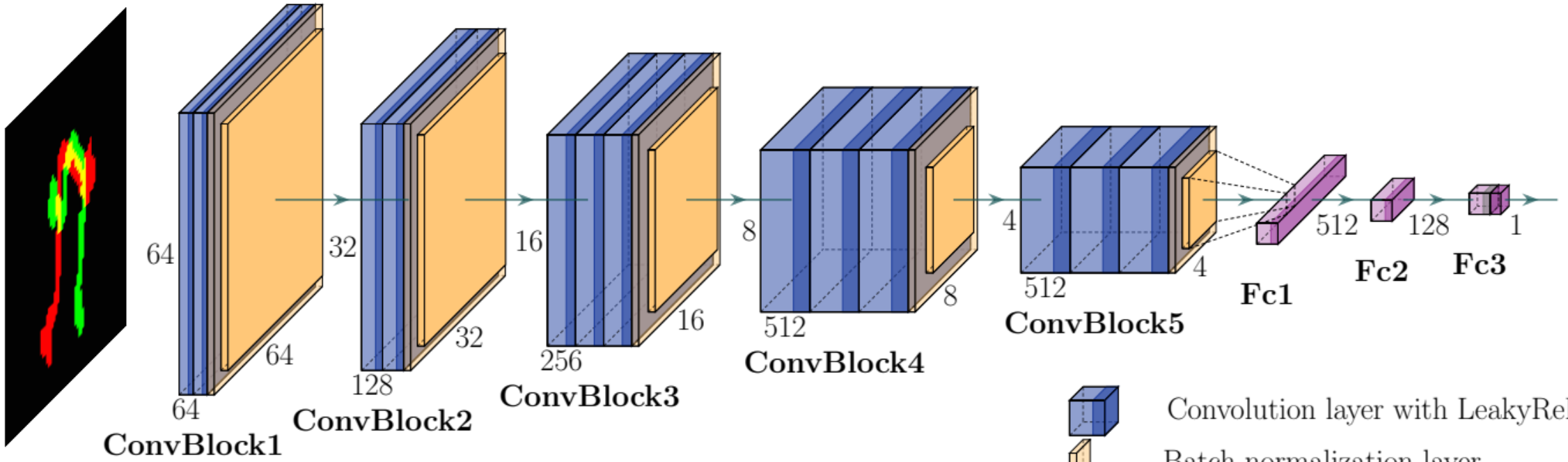
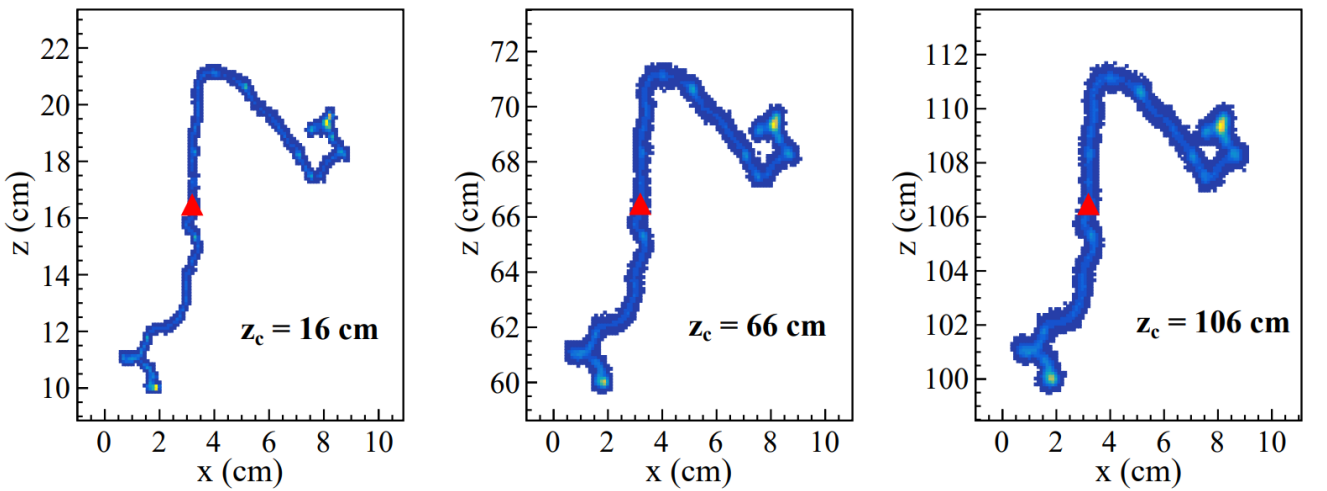



64
64
64
ConvBlock1
32
128
32
ConvBlock2
16
256
16
ConvBlock3
8
512
8
ConvBlock4
4
512
4
ConvBlock5
512
Fc1
128
Fc2
1
Fc3
Convolution layer with LeakyReLU
Batch normalization layer
Max Pooling layer
Full connection layer


z (cm)
x (cm)
z_c = 16 cm
z_c = 66 cm
z_c = 106 cm