WG2: Detector Technology Development

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on behalf of WG2 Speakers

Kyungpook National University

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WG2: Detector Technology Development

- *1□ talks*
- *Various detector R&D efforts*
  - *GEM*
  - *TPC*
  - *Calorimeter*
  - *Liquid scintillator for neutrino experiments*
  - □

GEM Production Machines

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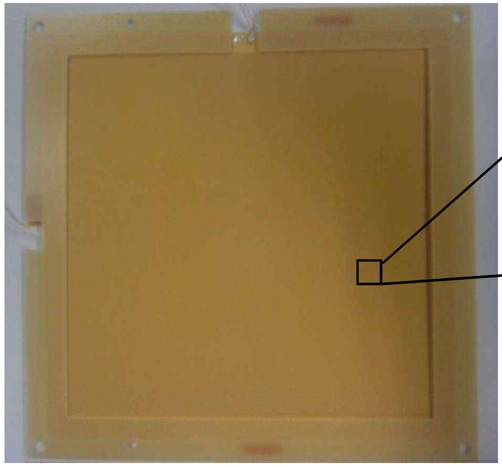
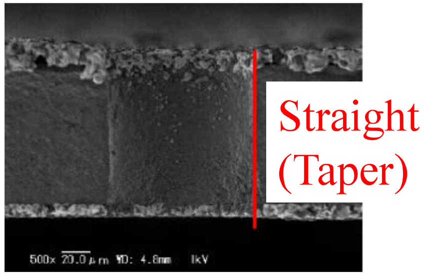
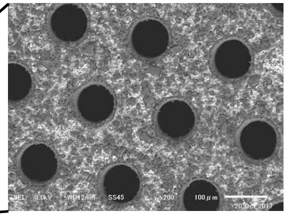
Jason Lee showed that Korea CMS and Mecaro Ltd. built the mass production system to produce GEM foil with a good quality control. GEM will be installed in the CMS detector at CERN.

Ceramic GEM

LTCC-GEM



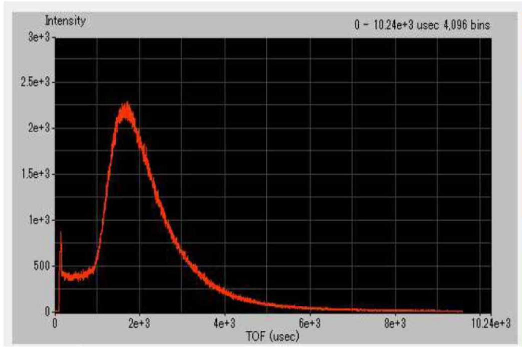




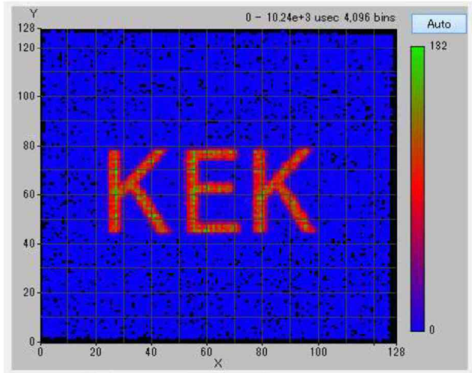
LTCC-GEM

- Size : 100 mm × 100 mm
- Hole diameter : 100 μm (70 μm)
- Hole pitch : 200 μm (140 μm)
- Thickness : 100 μm (50 μm)
- Material of Electrode : Au (Cu)

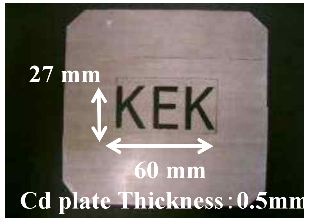
Results



Time of Flight distribution for 0-10 msec.
Flight length : ~4m
Thermal neutron peak : ~1.7msec



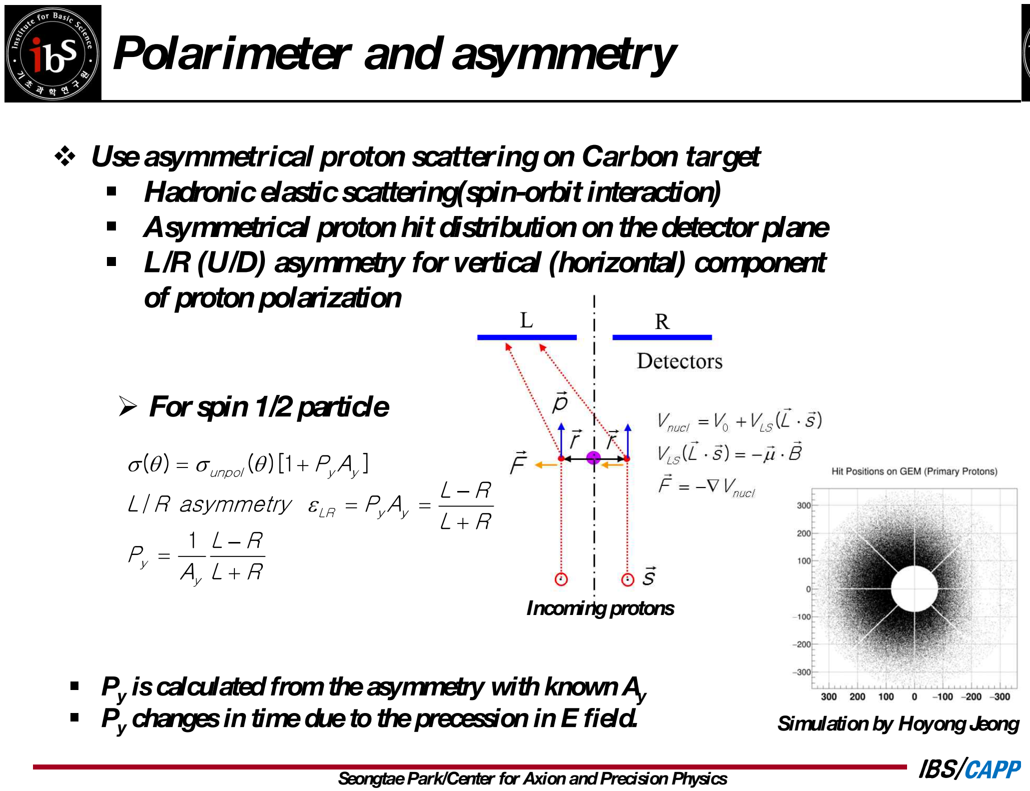
Two-dimensional image (10cmx10cm with ToF cut (Cd cut off)

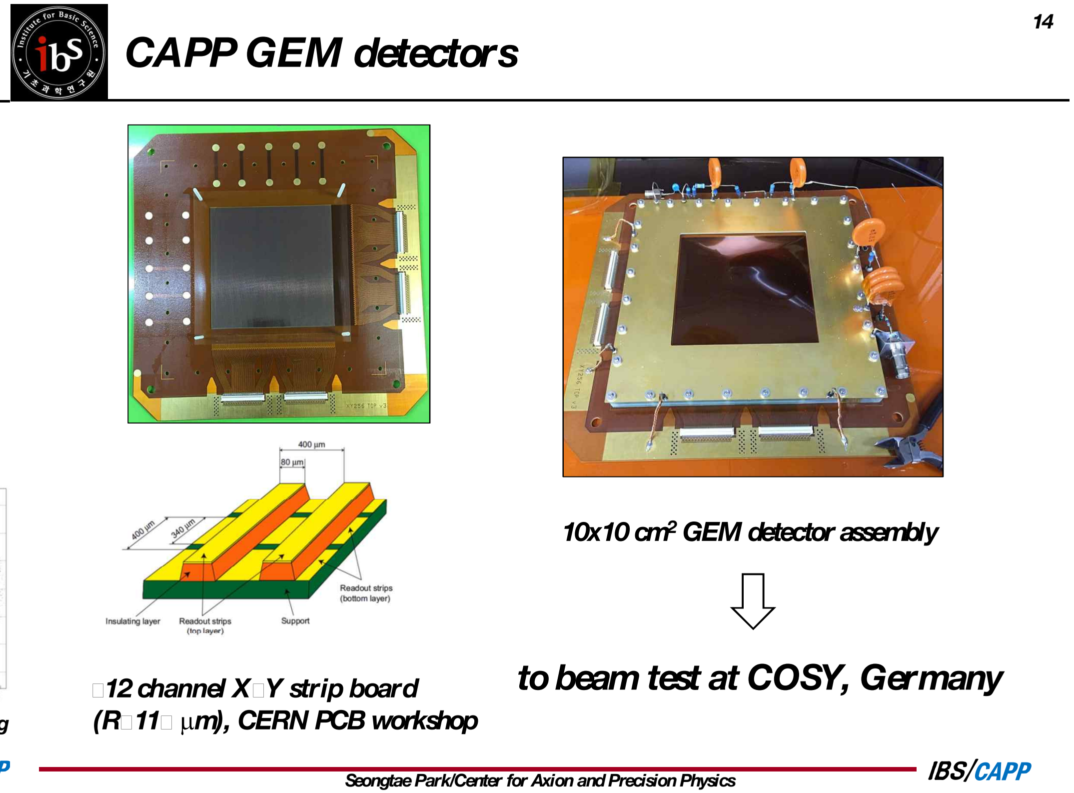


Shoji Uno (KEK)

Shoji Uno introduced Ceramic GEM which is an alternative way to resolve the serious damage (carbonization) by a large discharge. It is still under developing.

GEM for pEDM measurement

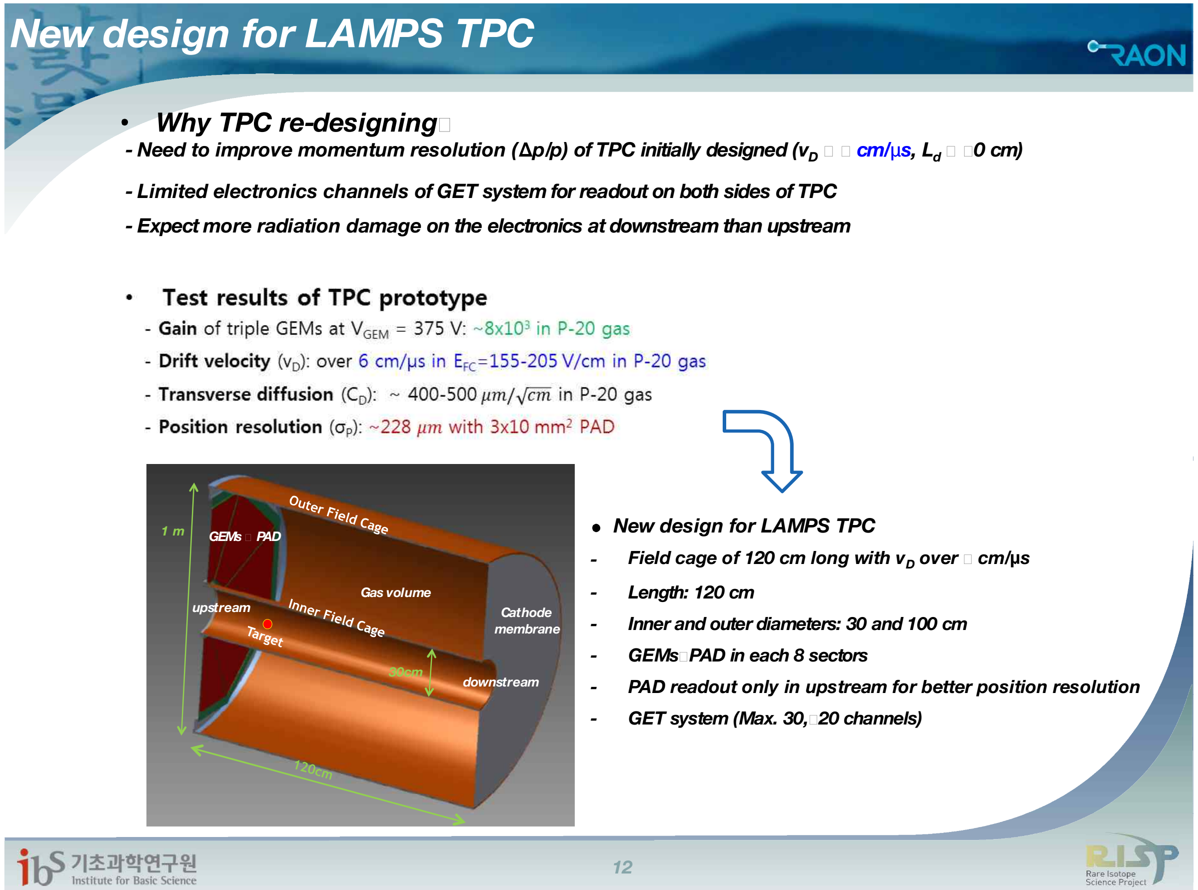




Seongtae Park (CAPP/IBS)

Seongtae Park is working on the proton EDM measurement. The main task is to detect asymmetrical protons scattering on Carbon target. In this experiment, GEM plays a main role to detect protons.

TPC for LAMPS experiment at RAON

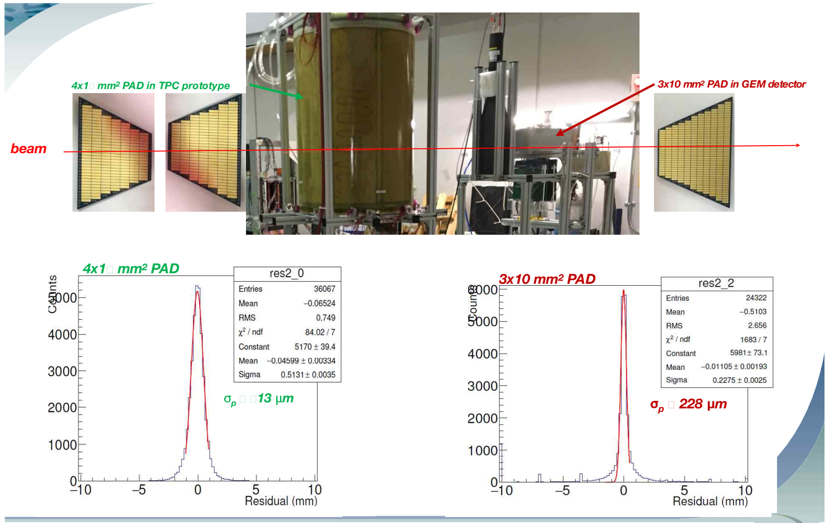


Disadvantages of wire method for TPC

- Difficult to handle thin wires & limited spacing in between wires
- Dead time for data taking due to gating grid
- limited operation with continuous wave (CW) beam

Advantages of GEM for TPC

- Physical strength better than wire
- Prevent positive ions in ion back flow (IBF)
- High gain and good radiation hardness
- Enable to be operated at high event rate and under CW beam



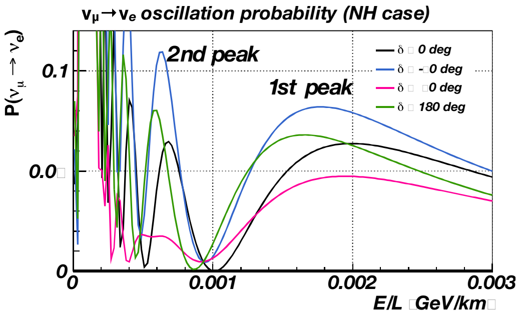
Min Sang Ryu (RISP/IBS)

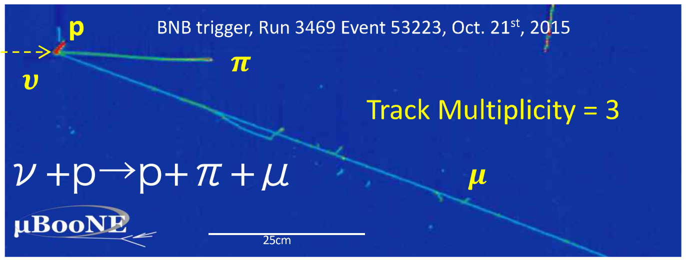
Main tracking system for LAMPS experiment at RAON is Time Projection Chamber. For the readout, this TPC uses GEM instead of the typical wire readout due to advantages of GEM for TPC. Minsang introduced the prototype TPC and the beam test results.

Liquid argon TPC for neutrino experiment

Why liquid argon TPC for ν experiment ?

- Liquid argon TPC (LArTPC) has a capability of good particle identification and good energy resolution up to several GeV
- One of ways to measure ν CPV is to measure "oscillation pattern" with wide energy region
- A large size LArTPC (>10kton) is a candidate of neutrino detector for long baseline ν oscillation experiment, nucleon decay search, SN neutrino observation, atmospheric neutrino measurements etc.





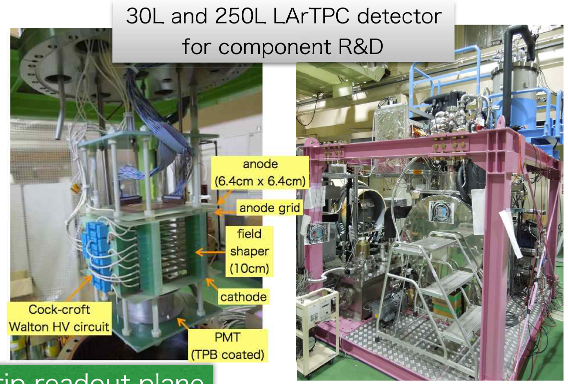
ν interactions at a few GeV : multiple track events are dominant

tector R&D at Japan

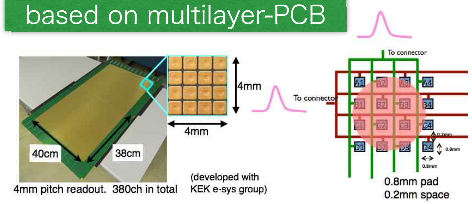
system

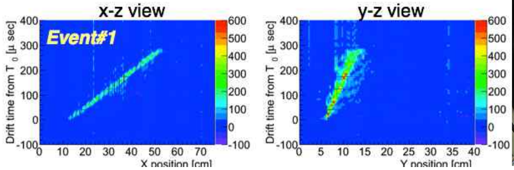
prototype

30L and 250L LArTPC detector for component R&D

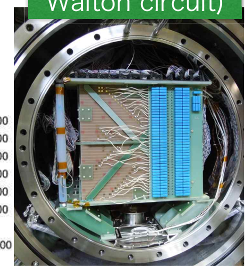


Anode strip readout plane based on multilayer-PCB





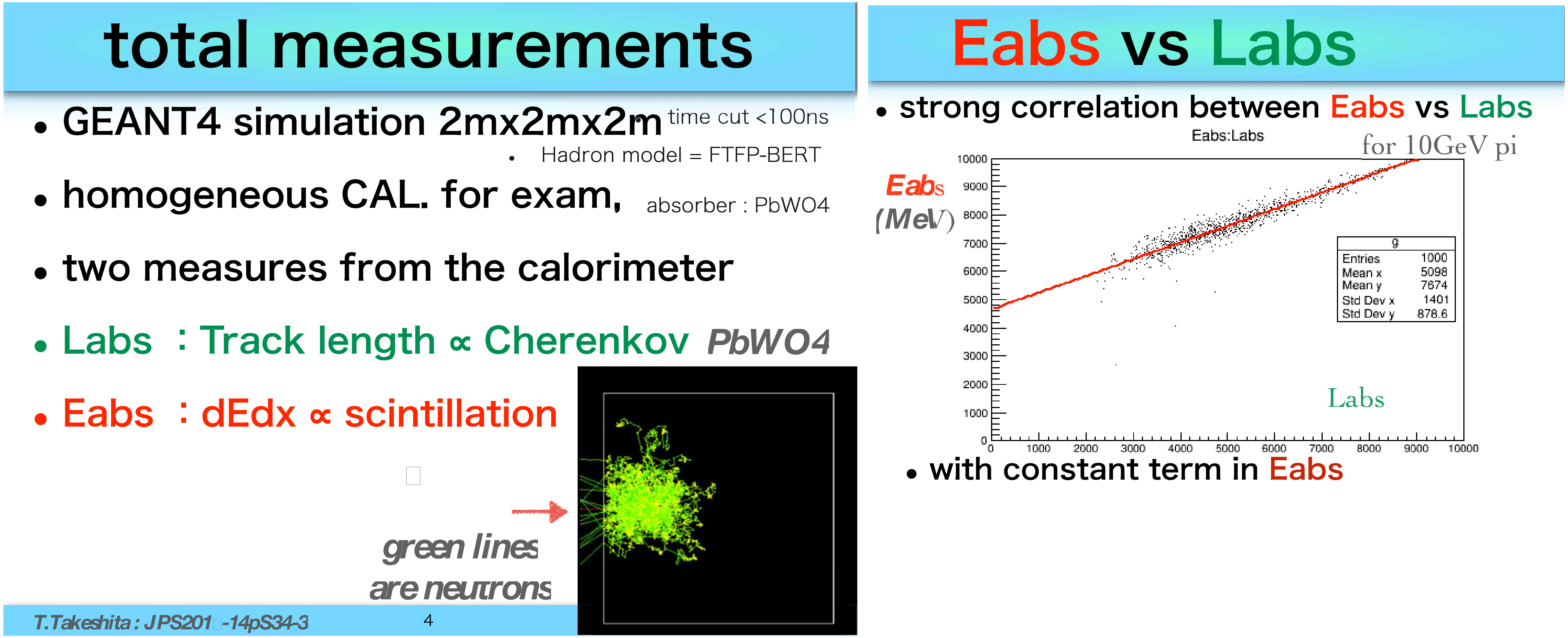
High voltage generator (Cockcroft-Walton circuit)



Ken Sakashita (KEK/J-PARC)

The liquid argon TPC has a good particle identification and energy resolution. This is a reasonable choice for neutrino experiment. Ken Sakashita presented the R&D efforts from a small LAr TPC to 1 kton prototype and the performance of LAr TPC.

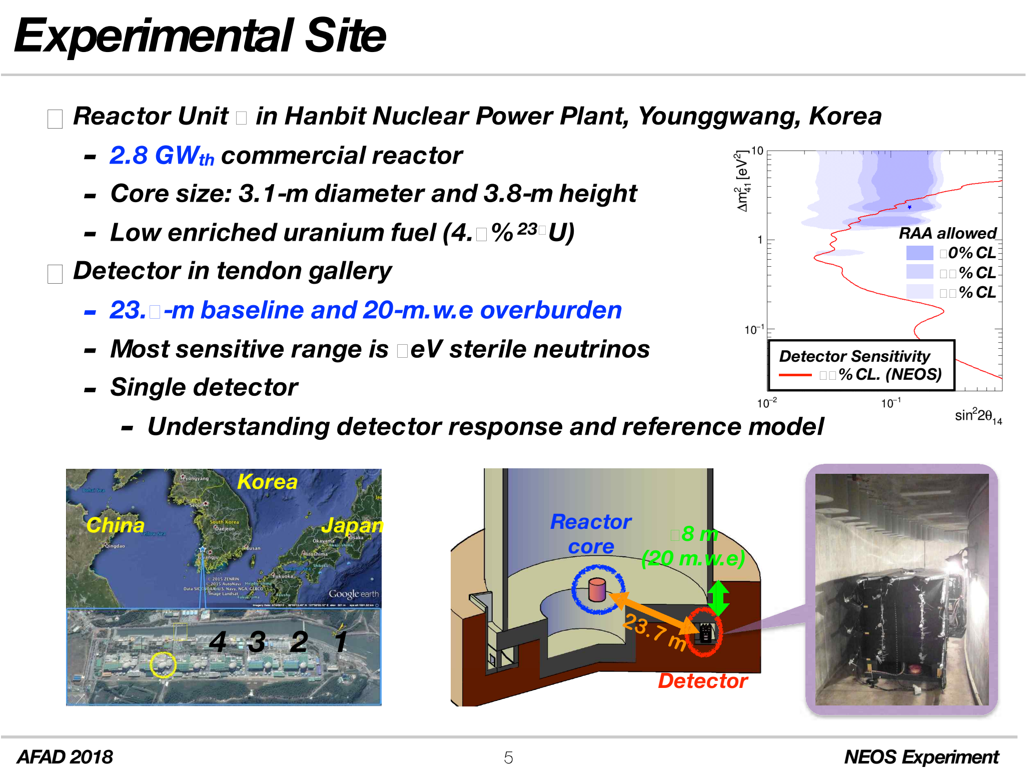
Dual-Readout Calorimeter

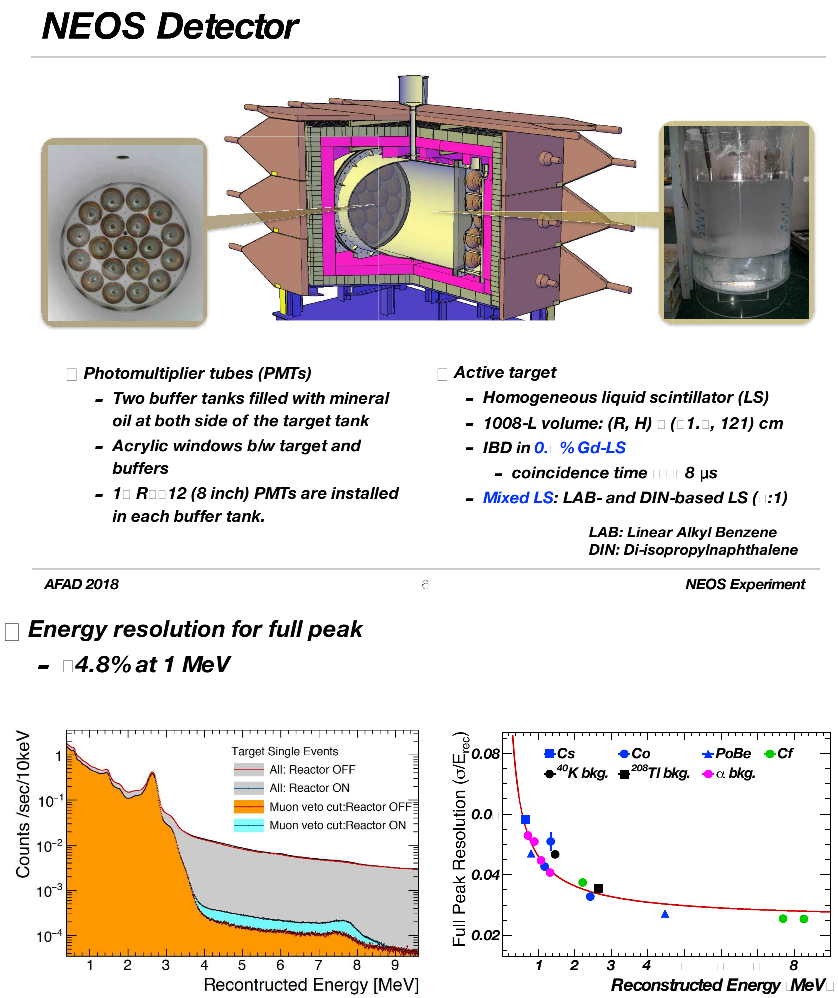


Tohru Takeshita (Shinshu Univ.)

Tohru Takeshita is working the dual-readout calorimeter using $PbWO_4$ crystal. He observed the correlation between scintillation and Cerenkov signal and try to achieve a good hadronic energy resolution using the dual-readout method.

NEOS Detector for Reactor Neutrinos

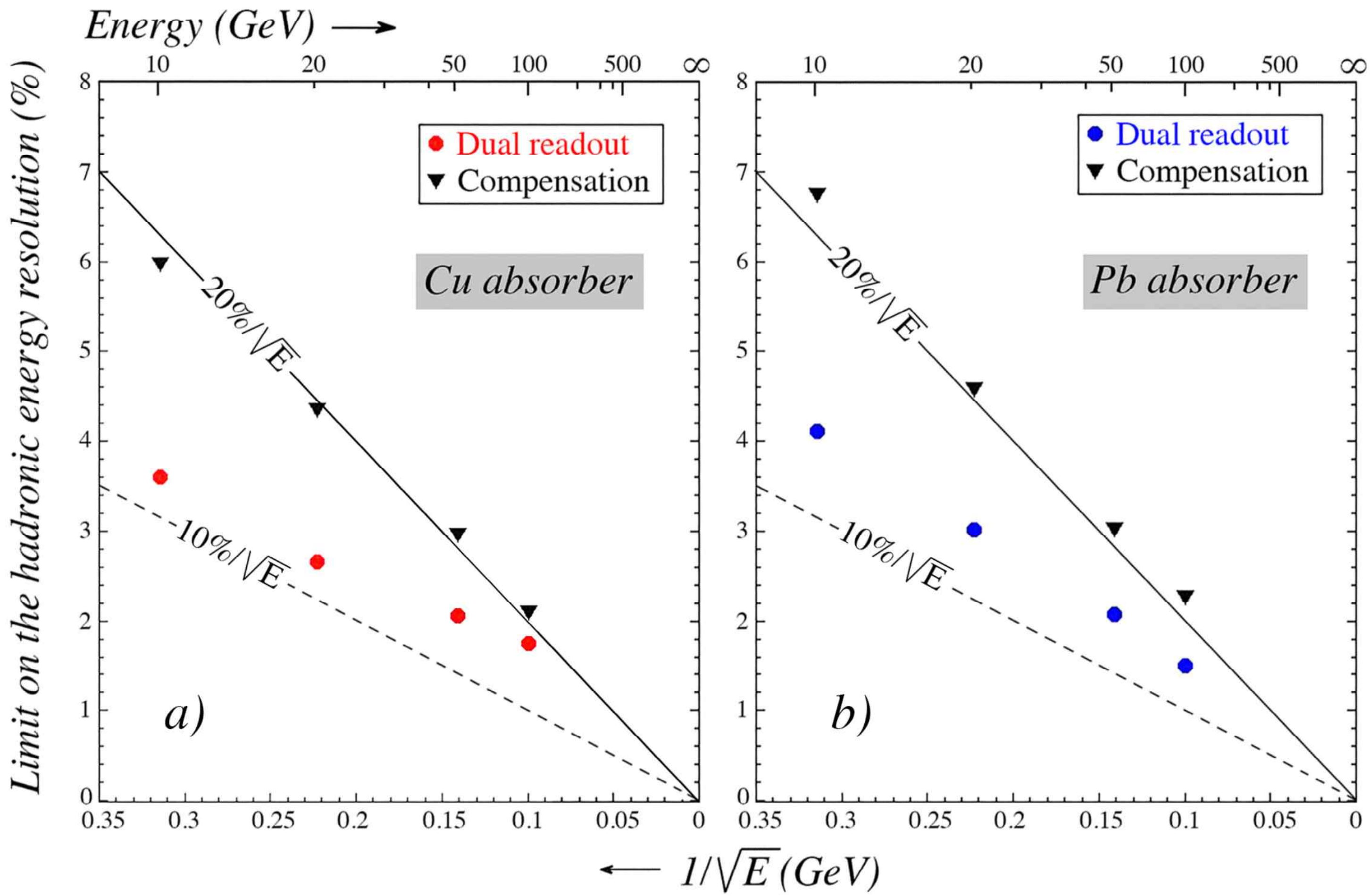




Young Ju Ko (CUP/IBS)

NEOS Detector is the detector for the short baseline neutrino experiment consisting PMT and liquid scintillator. It is installed in the Hanbit nuclear power plant and detects neutrinos. Young Ju Ko showed the energy resolution of this detector was 4.8% at 1 MeV and physics result on search for light sterile neutrino search.

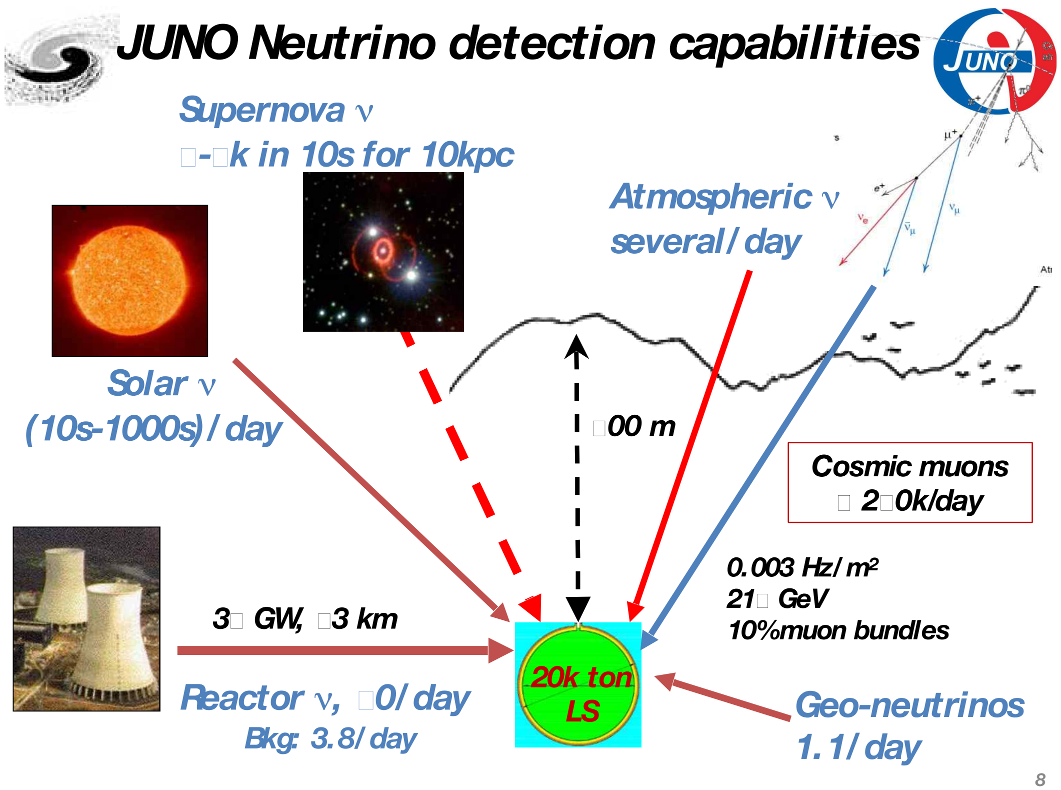
Limit on the ultimate hadronic energy resolution

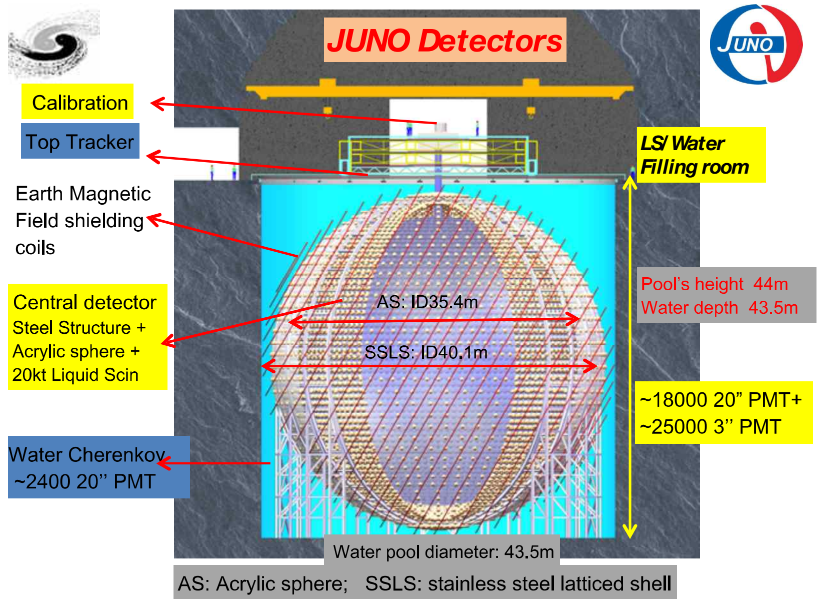


Sehwook Lee (Kyungpook Natl. Univ.)

Dual-readout method and compensating calorimeters improve the poor hadronic energy resolution. Their ultimate hadronic energy resolutions were predicted by GEANT 4 simulation. According to the results, 20%/√E can be achieved.

The Central Detector of Juno

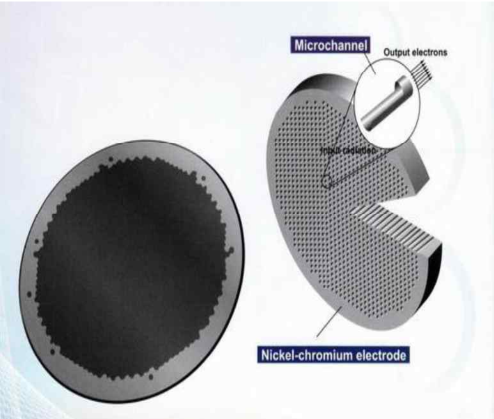


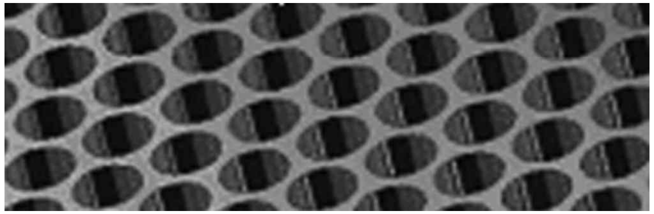


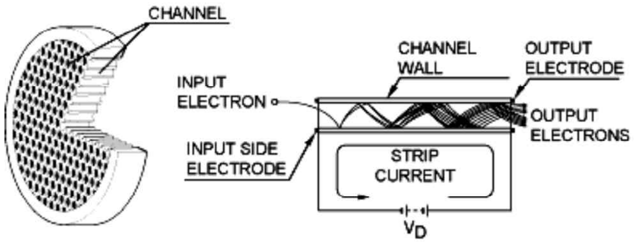
Yuekun Heng (JUNO coll.)

JUNO detector is designed to provide the capabilities for the detection of neutrinos from supernova, sun, air shower, and geo-neutrinos. The ultimate goal of this detector is to achieve 3% energy resolution.

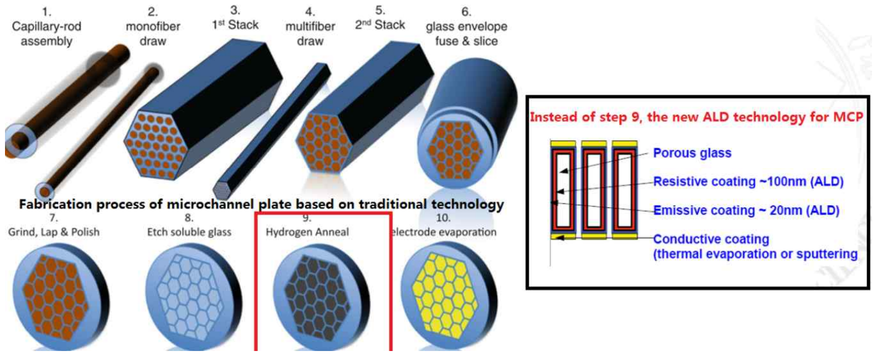
Microchannel Plate and its performance

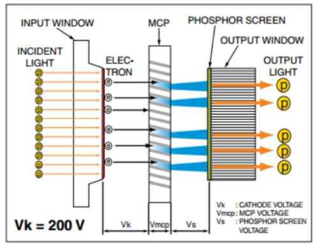


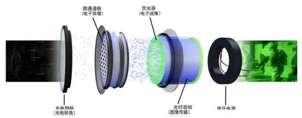


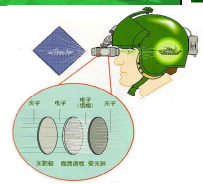


3. Making progress
(traditional technology and the new technology made of MCP)







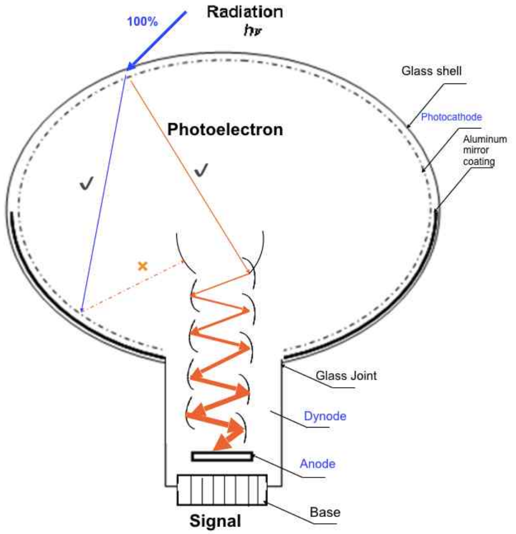


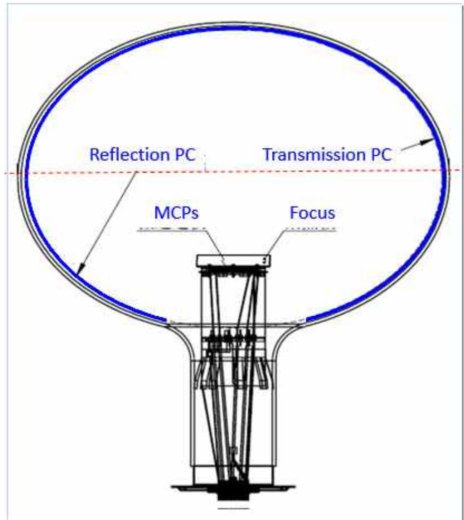
Shulin Liu

Each hole in the microchannel plate acts as one PMT dynode. It can be applied to the image intensifier, MCP-PMT and so on. Shulin Liu introduced the efforts of him and his collaborators to improve the performance of MCP PMT.

R&D for the 20 inch MCP-PMT

Photon Detection Efficiency (PE)□ QE_{Trans} □CE





Dynode:(PE)□ QE_{Trans} □CE

□ 20% □□0% □ 14% (200□)

□ 30% □□0% □ 2□% (201□)

Dynode:(PE)□ QE_{Trans} □CE

□ 2□% □100% □ 2□% (201□)

3.1 The 20 inch MCP□PMT production line (201□)

- 2 units were working already in 201□□ ★
- □ units were ready on the summer 201□□ ☆
- 14 units were ready on the winter 201□□ ★

One Unit could produce 3PMTs in Two days□

□ □ □ 22 Units for the mass production □

□ □ □ 33 PMTs / 1 day （1PMT need 2 days） □

The celebration for the 20 inch MCP□PMT production line (2016)

Aim:

1PMT need 2 days

total 33 pic/ day□

30 pic PMTs (OK□) /day

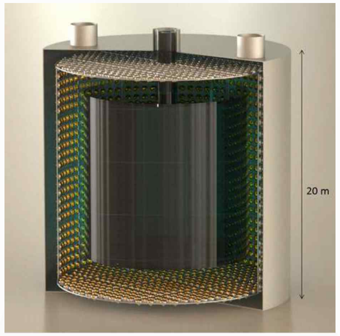
Sen Qian (IHEP)

JUNO experiment needs 20,000 of 20 inch PMT. For this experiment, MCP-PMT group replaced the dynode of PMT with the MCP. Mass production system is established which can produce 33 PMTs/day. Also, Sen Qian showed the test result of MCP-PMT such as Quantum Efficiency, TTS (Transfer Time spread) and so on.

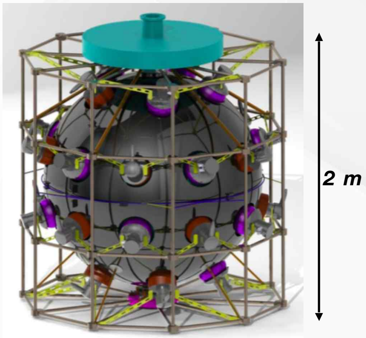
Liquid Scintillation Cerekov Detector for Neutrino Experiment

Jinping Neutrino Experiment

- *Total fiducial target mass of 2000 tons for solar neutrino physics*
- *Equivalently, 3000 tons for geo-neutrino and supernova neutrino physics*



The conceptual design for a cylindrical neutrino detector at Jinping. Spherical inner vessel is also an option.



One ton prototype detector design. This detector is running now.

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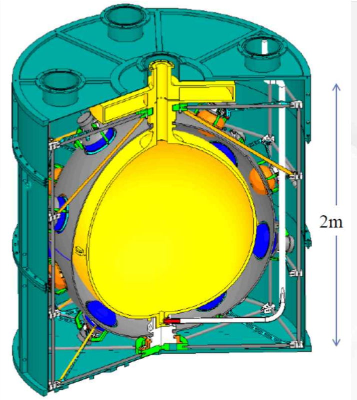
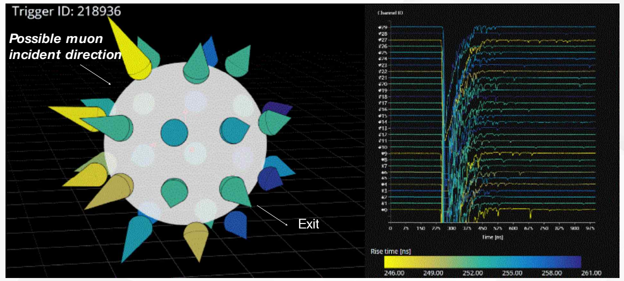


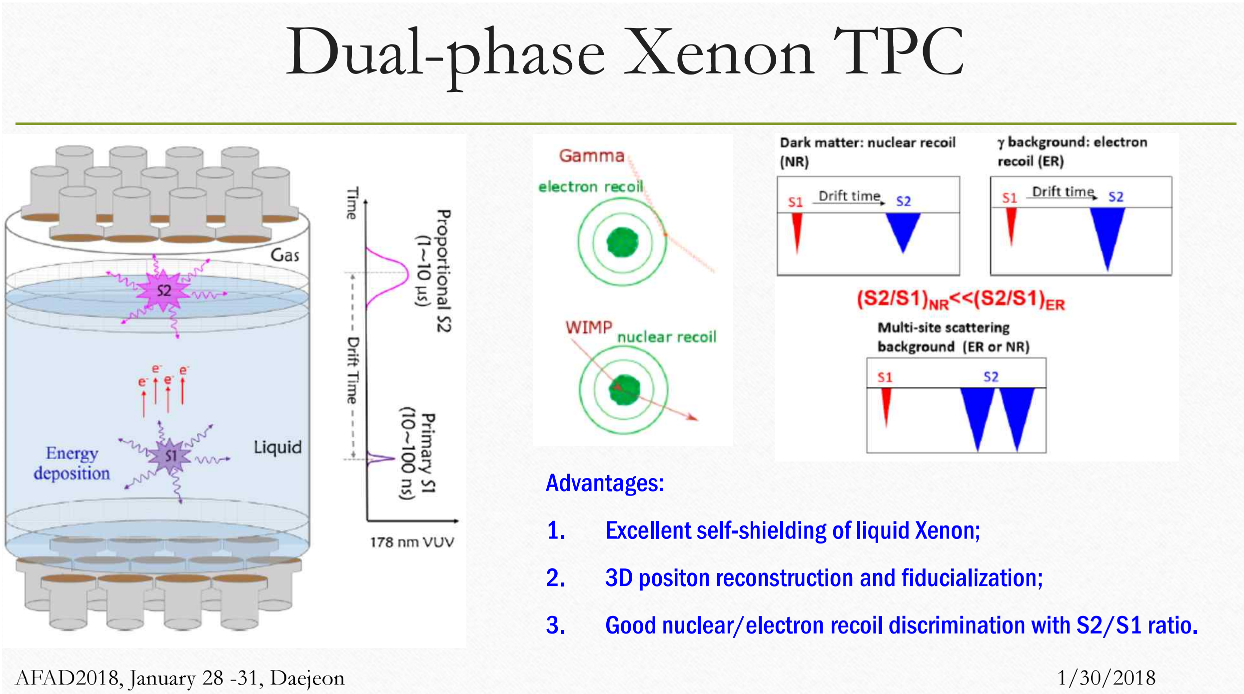
Online real time event display (animation)
A cosmic ray muon candidate event

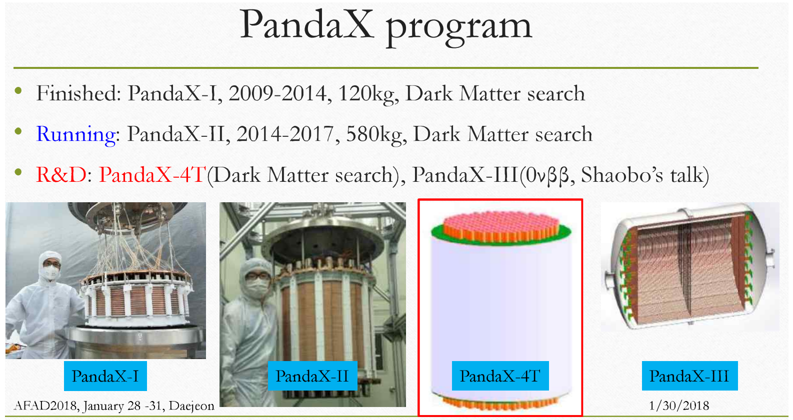


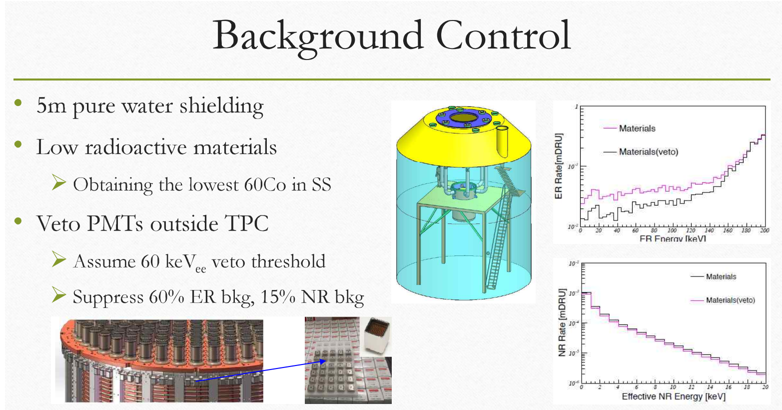
Guo Ziyi (Tsinghua Univ.)

Jinping Neutrino experiment is for the studies of solar, supernova, and geo-neutrinos. Due to the needs of high light yield and energy resolutions, they chose the liquid scintillation Cerenkov detector. Guo Ziyi showed the results of the 1-ton prototype detector before building the real experiment.

PandaX-4T Dark Matter Detector



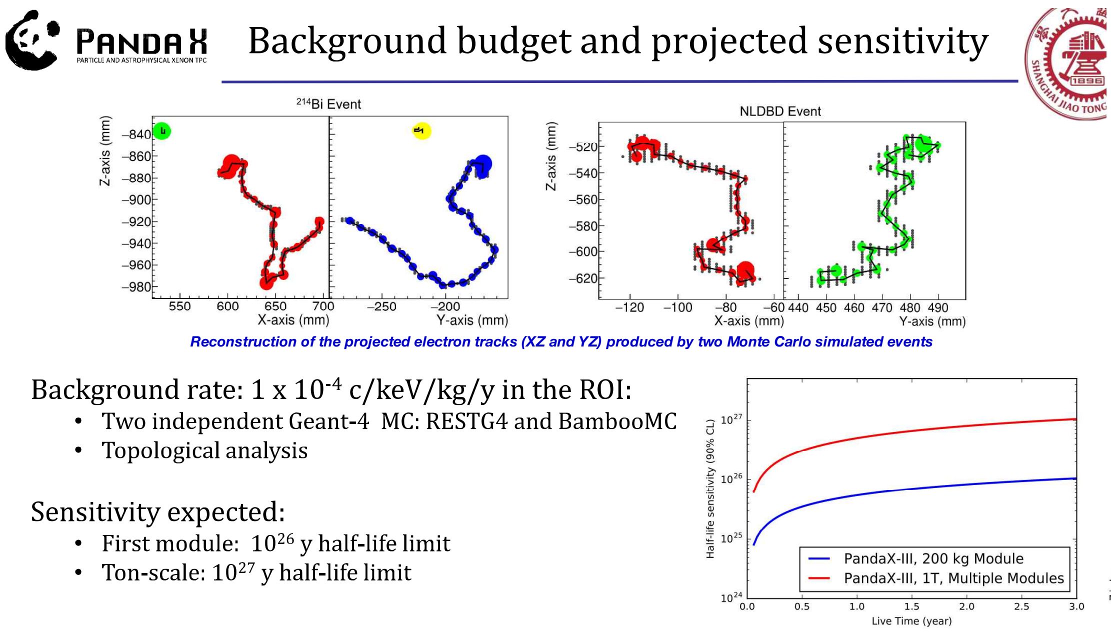


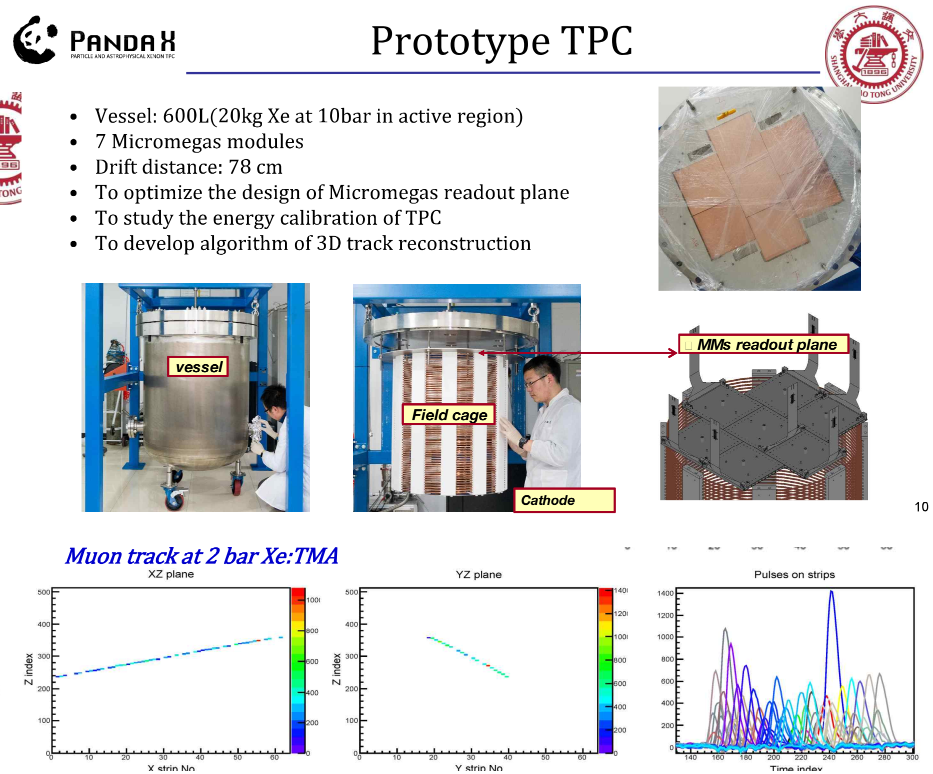


Jingkai Xia (Shanghai Jiao Tong University)

PandaX-4T is the one project of PandaX program which searches dark matter. This experiment uses Xenon TPC which can distinguish the signal of the nuclear recoil by dark matter and the background produced by the electron recoil energy when a gamma hit a atomic electron. Jingkai Xia explained their background control studies and the expected sensitivity. Now, PandaX-4T is under construction.

PandaX-III Xenon TPC for Neutrinoless Double Beta Decay





Shaobo Wang (Shanghai Jiao Tong University)

Xenon TPC for PandaX-III project is the detector for the neutrinoless double beta decay experiment. By measuring the trajectories of produced particle, the ultimately low background can be achieved. Shaobo Wang introduced his experience on the commissioning of the prototype TPC.