实验物理中心

2024年度考核报告

王志民

中微子二组，副研

2024-11-22

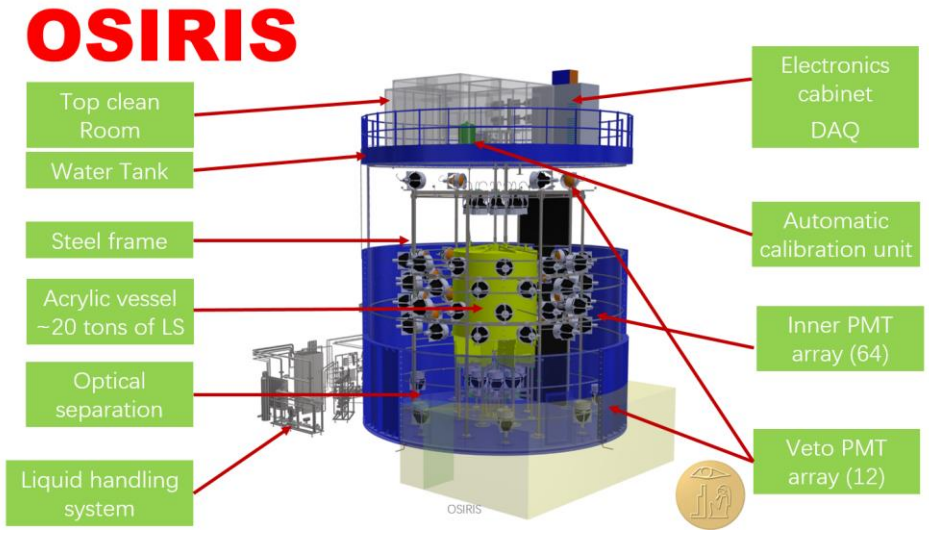
工作职责及报告摘要

- 工作职责：江门中微子实验（JUNO）
  - JUNO-OSIRIS探测器联调、运行与分析: 负责
  - JUNO-TAO VETO探测器系统：负责
  - JUNO 20” PMT分析
  - 其他
- 学术交流、学术发展规划
- 公共服务

JUNO OSIRIS

Online Scintillator Internal Radioactivity Investigation System

完成安装测试、集成测试（to 2024.3）
完成探测器dry run、探测器灌装、刻度 (to 2024.7)
完成探测器运行、分析、关键物理指标分析确认
实现液闪U/Th本底水平测量、探测器升级改造 (to 2024.11)
处理改进探测器氡气泄露问题 (to 2024.11)
实现宇宙线流强、中子本底等JUNO首次地下测量



LS 19.5ton+ Pure Water 550ton

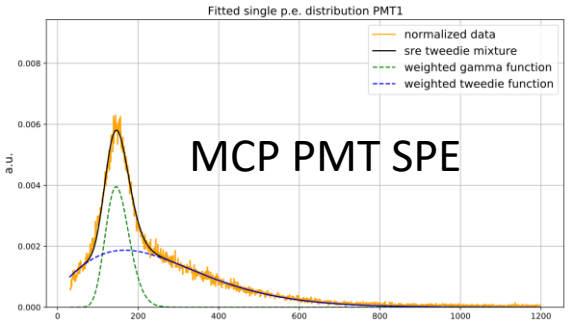
- **76 NNVT PMTs** installed with magnetic shielding and reflectors
  - 12 top LPMTs installed
    - 8 for LS
    - 4 for VETO
  - 48 side LPMTs installed for LS
  - 16 bottom LPMTs installed
    - 8 for LS
    - 8 for VETO
- 2 inside cameras installed/replacement
- 49 temperature sensor (in detector)
- 24 Laser capsule installed
- **26+1 GCUs + 2 LVPs + 1 BEC (+1 WR switch)**

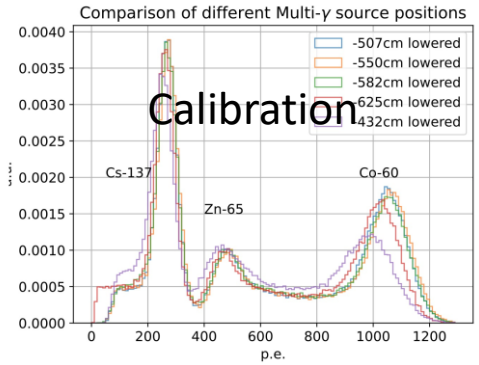
JUNO地下第一个实现运行的完整要素探测器物理测量系统

JUNO OSIRIS (pre-JUNO)

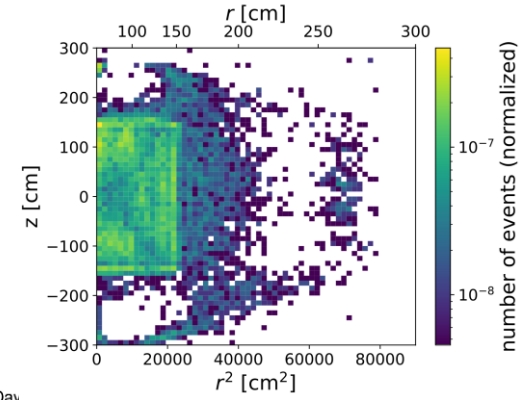
JUNO地下第一个完整要素运行的探测器物理测量系统

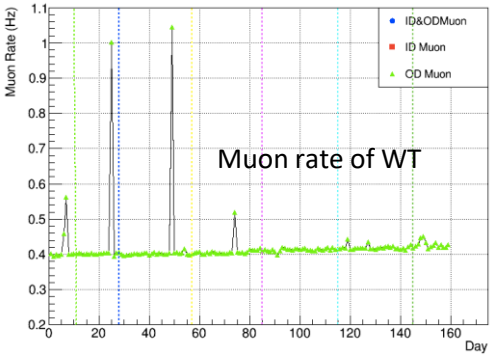
Abusleme, A., Adam, T., Ahmad, S. *et al.* The design and sensitivity of JUNO's scintillator radiopurity pre-detector OSIRIS. *Eur. Phys. J. C* **81**, 973 (2021). https://doi.org/10.1140/epjc/s10052-021-09544-4

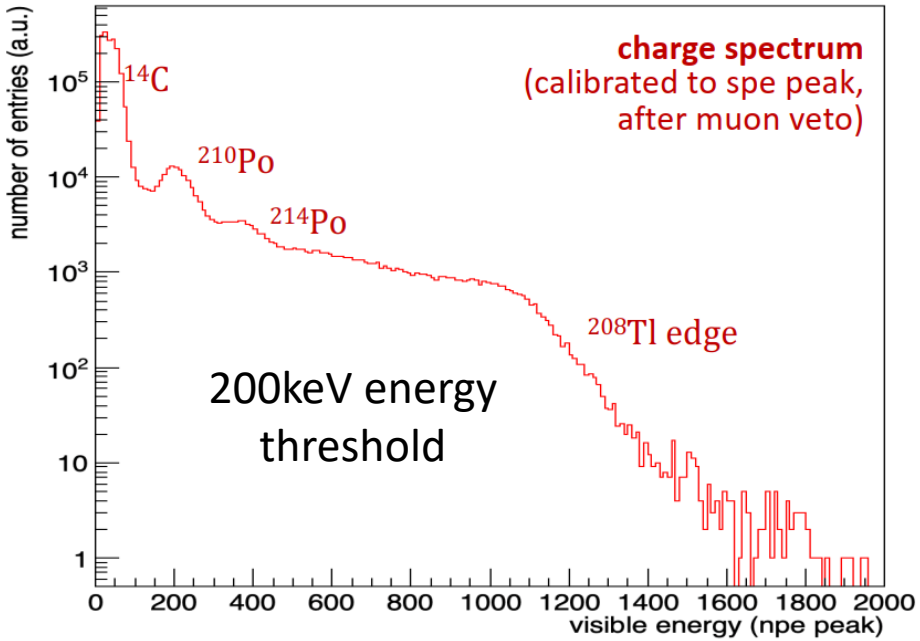


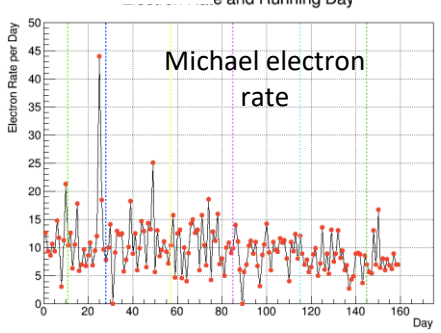


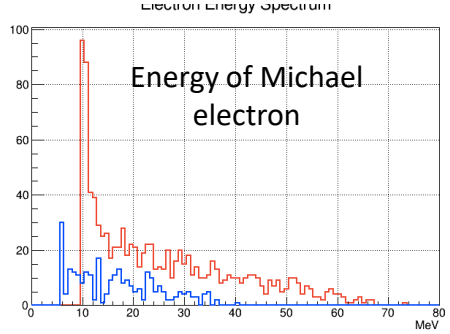
Vertex reconstruction

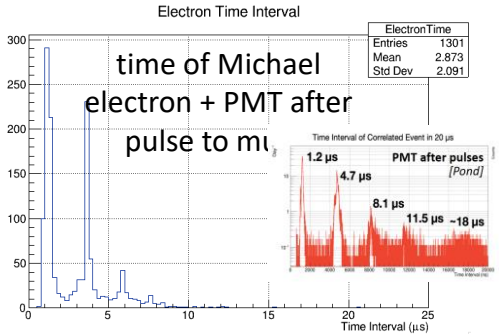


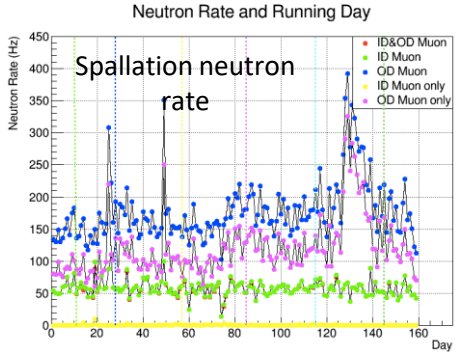


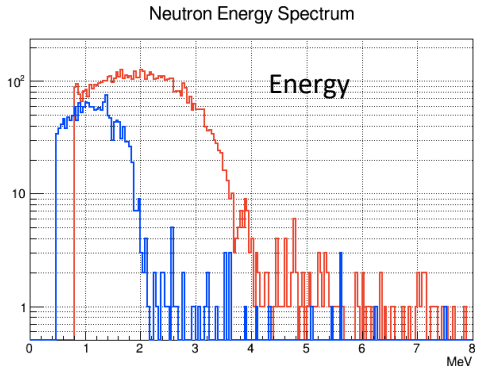


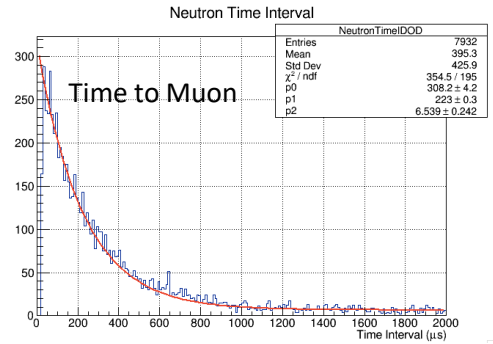






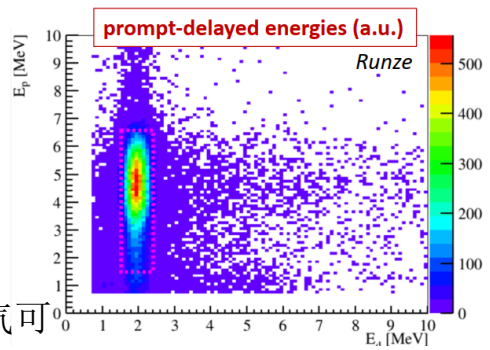


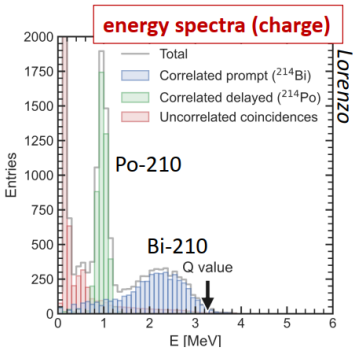


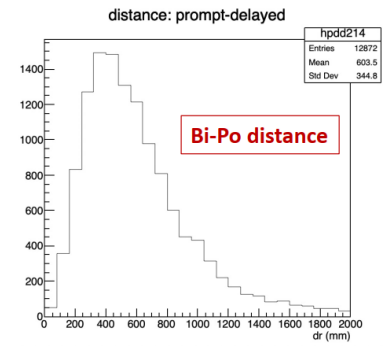


OSIRIS data taking & analysis continuing

- Keep data taking after detector filled
  - ~100keV energy threshold (~50keV, shortly),
  - ~7Hz trigger rates (~70Hz shortly)
  - radon decay, U/Th measurements
  - **Onsite** day shifters
  - **Remote** night shifters







LS置换策略下氡气可以被很好置换

JUNO-doc-11670

(Up to 04/27)

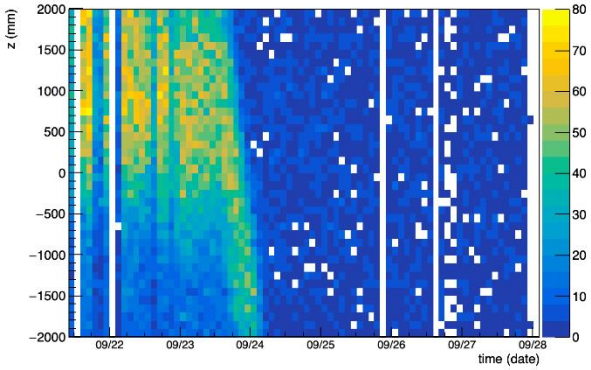
^{238}U in LS: **(1.29±0.03)x10^{-14} g/g**

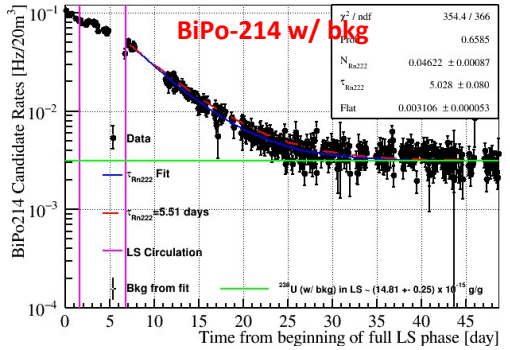
^{232}Th in LS: **(6.57±0.77)x10^{-15} g/g**

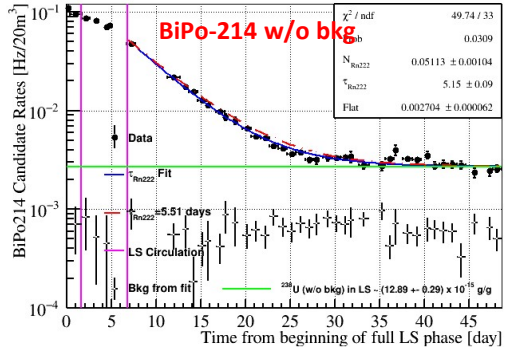
Preliminary:

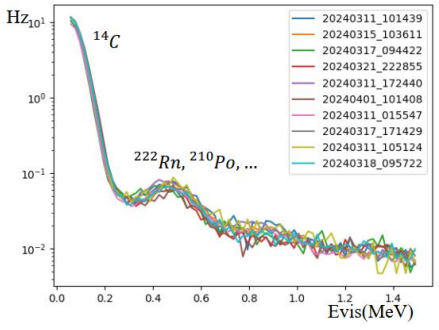
^{14}C: **~2.9 × 10^{-17} g/g**

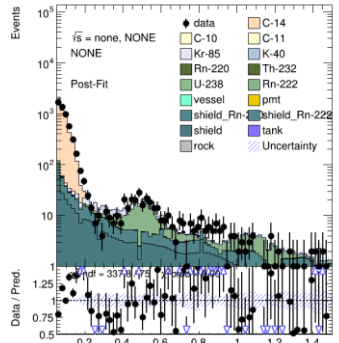
^{85}Kr: <4mBq/mm3 **(<~3e^{-22} g/g)** (Upper Limit @95% CL)

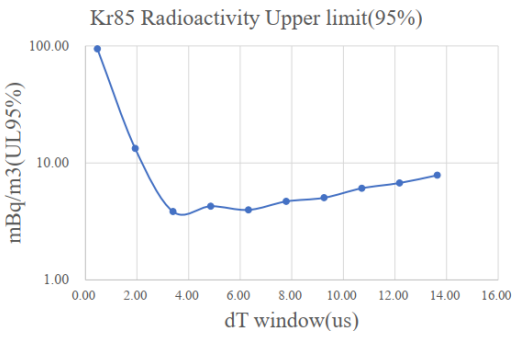


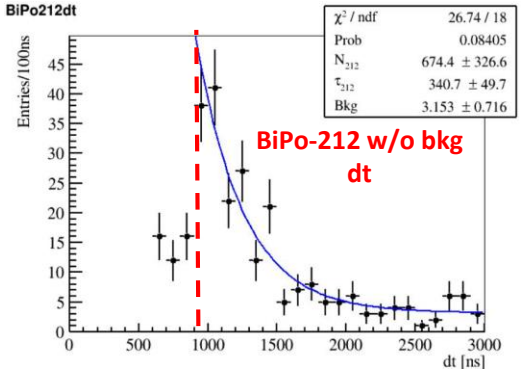


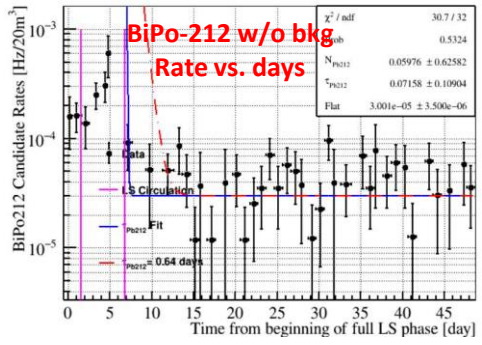










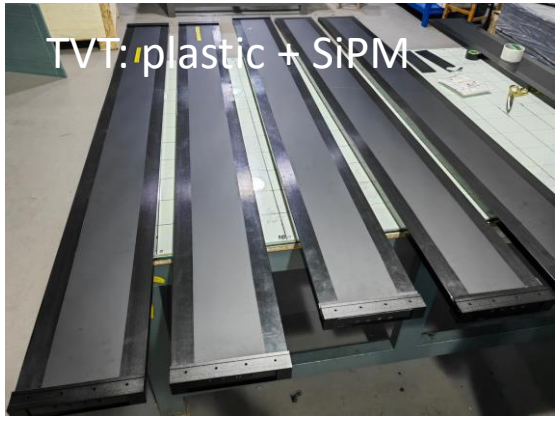


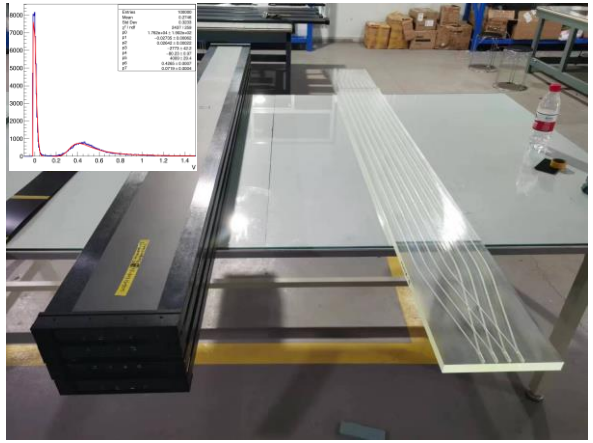
JUNO-TAO VETO

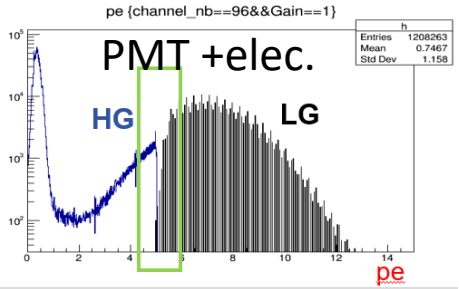
WT：生产评审完成，生产制造中， 模型及电子学测试、安装；
TVT：完成闪烁体生产，FEB+SiPM全部生产测试完成，准备电子学准备及物理测量；

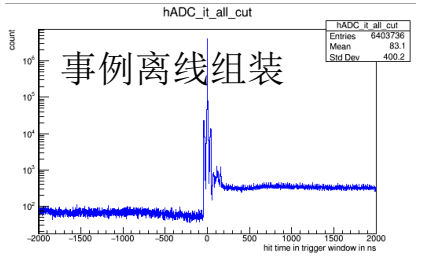
Water tank

- Finished the water quality sample monitoring at Kaiping:
  - no big change of water quality in ~5 months
- Finished the assembly of 4 sets of electronics with the help of JUNO SPMT group, now located at Kaiping SAB
- Quoting for the pure water system
- Quoting for the production and installation of the water tank
- Working on a small water tank + electronics +DAQ

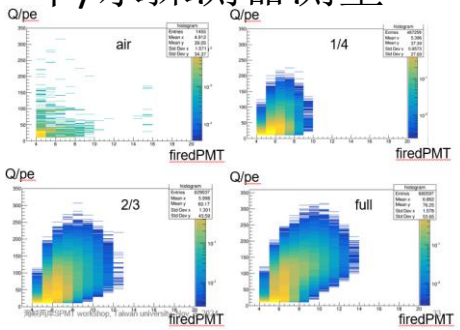




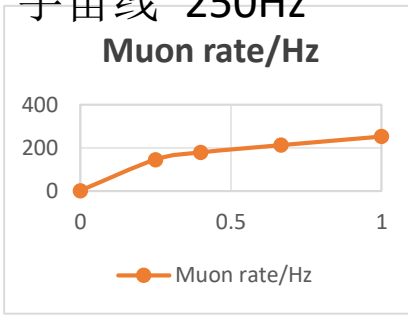


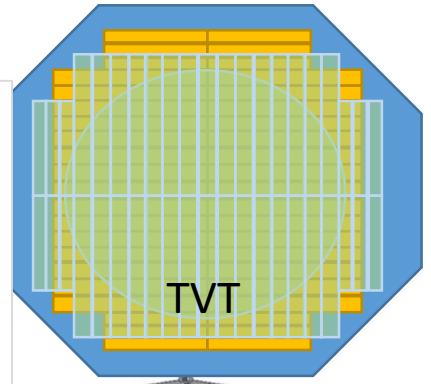


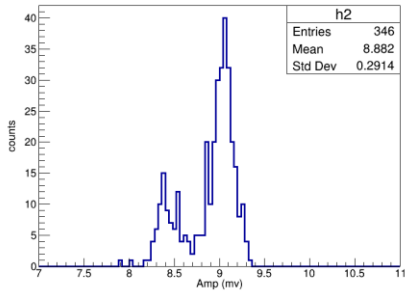
干/水探测器测量



宇宙线~250Hz







FEB+SiPM，室温
SPE幅度

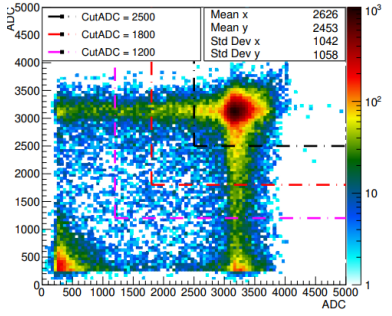


Fig. 8. Two-dimensional scatter diagrams of energy spectrum from two CR monitors.

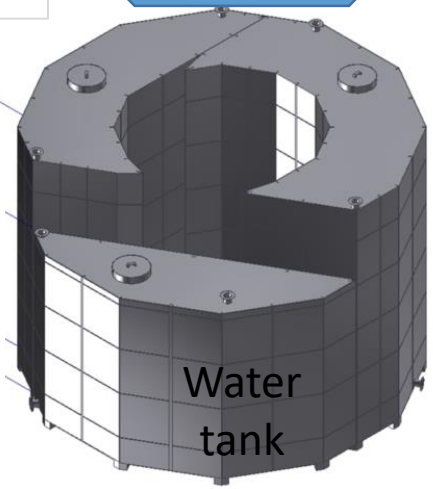


图 2.十二角水箱模型

项目及报告、文章、公共服务情况

文章发表 3+2 篇：（另JUNO合作组+3）

Accepted:

1. **Dark Count of 20-inch PMTs Generated by Natural Radioactivity, JINST 19 (2024) 02, P02026**
2. **Performance of the plastic scintillator module for the top veto tracker of the Taishan Antineutrino Observatory, NST, 2024, accepted, arXiv:2406.15973 [physics.ins-det]**
3. **A novel design for 100 meter-scale water attenuation length measurement and monitoring, Li Wang et al 2024 JINST 19 P05051**

Proceeding

1. **"Design and Integration of JUNO-OSIRIS." , Rodphai, Narongkiat and Zhimin Wang. (2024). NuPhy.**
2. **The high-precision detector of the JUNO-TAO experiment, NIMA, PISA 2024, accepted**

Drafted:

1. **PMT Charge Uncertainty with Artificial Correlated Pulses**
2. **Characteristic of JUNO 1F3 electronics prototype by 20-inch PMT self-generated large pulses**
3. **Non-cyclic prototype of JUNO-TAO VETO water tank with 3 inch PMTs**

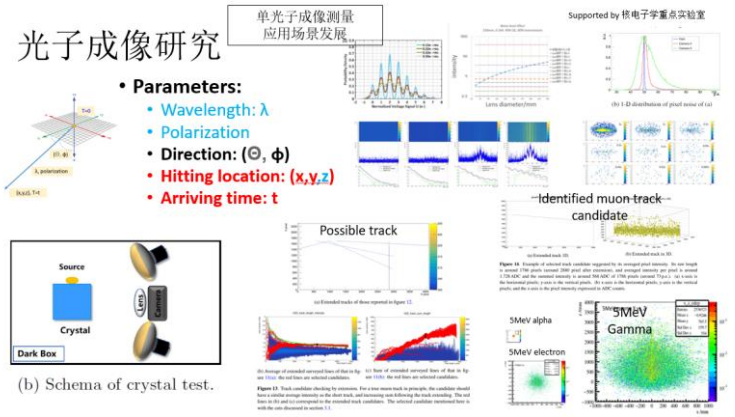
- **0. 负责：科技部中俄重点专项 子课题3**
  - **350万（2024.9-2028.8）**
- **1. 参与： JUNO-TAO 科技部重点专项**
  - **~200万**
- 2.主持：核探测与核电子学国家重点实验室自主研究课题
  - 15万元，1年（2024）单光子灵敏相机光学成像系统
- 3. 主持项目： 项目来源：国家自然科学基金面上：
  - 利用液闪探测器模型对新型MCP-PMT和高精度探测器标定及重建的研究
- 4. 参与项目:
  - 江门中微子实验(CD L3, PMT L3s, SPMT, JUNO-TAO L3, OSIRIS)
- 5. Committees
  - Dayabay speaker committee

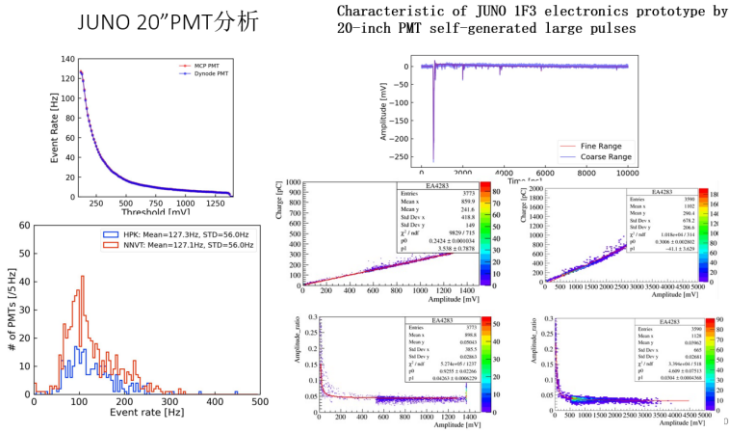
- 指导联培硕士研究生2+1名
- 协助指导博士研究生1+1名
- 实验物理党总支委员、第4支部书记
- 实验物理中心研究生管理小组成员，组织中微子1组/2组学生考核
- 杂志文章评审11篇：
  RDTM 4+JINST 2 + NIM 1 +核电子学 4

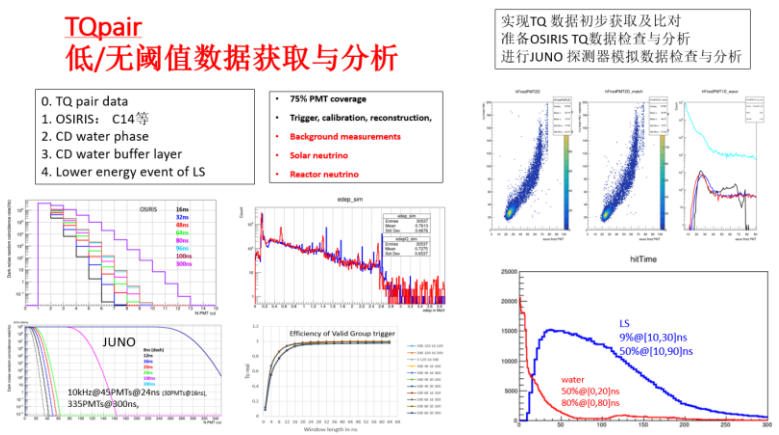
- 参加国际会议及报告
  - JUNO合作组会，review
  - NuDM-2024: talk+proceeding
  - PISA 2024: proceeding
  - TAIWAN workshop: TALK

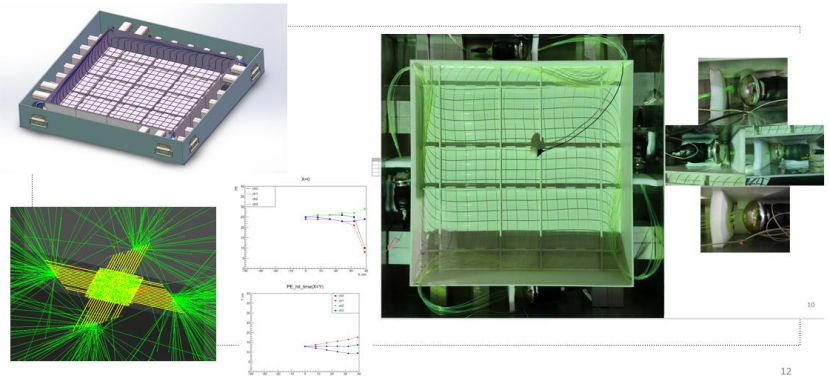
下年度工作及学术发展计划

- 实现JUNO-ORSIRIS 调试与测试，分析、运行
- 完成JUNO-TAO veto 建设\运行、分析
- 20” PMT分析
- JUNO PMT 刻度研究、探测器（TQpair）数据研究
- 其他





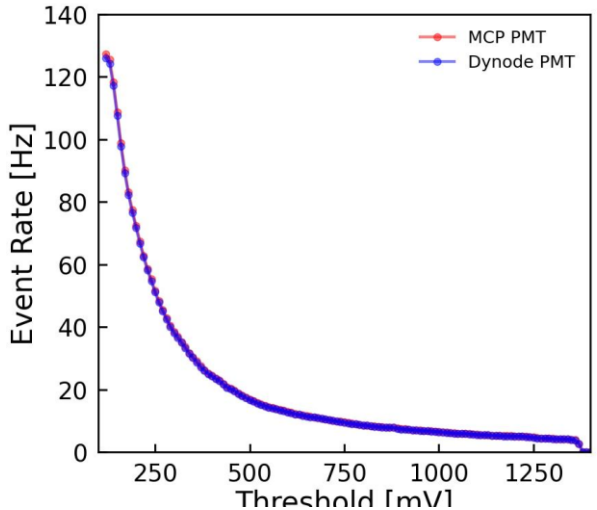


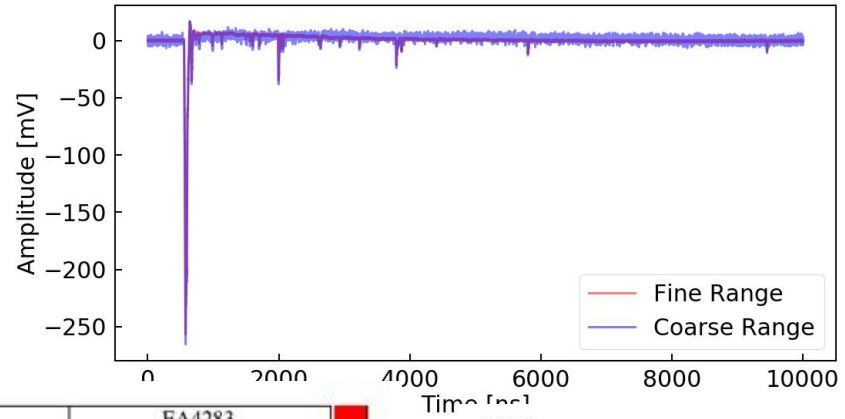


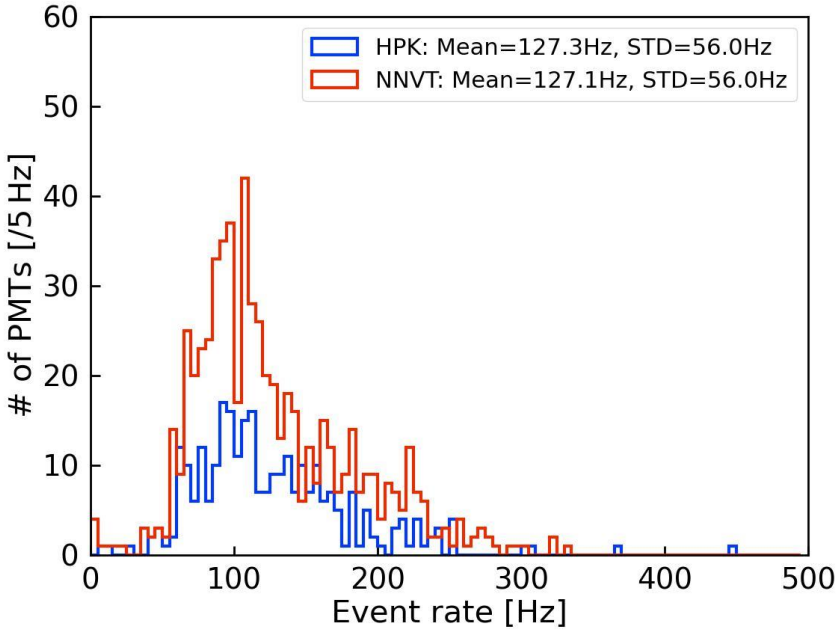
谢谢

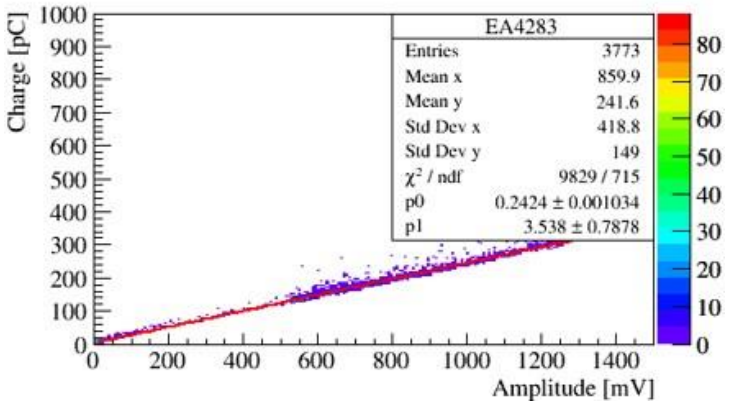
JUNO 20”PMT分析

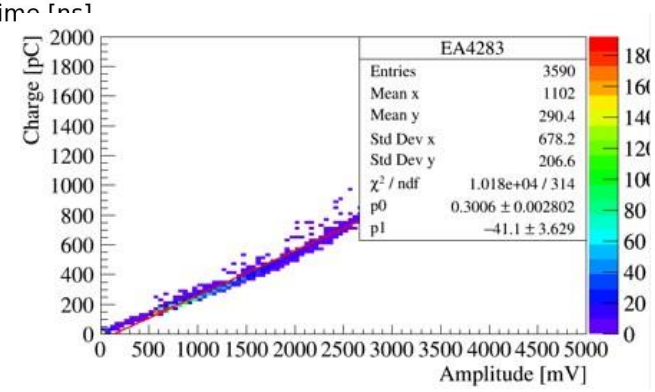
Characteristic of JUNO 1F3 electronics prototype by 20-inch PMT self-generated large pulses

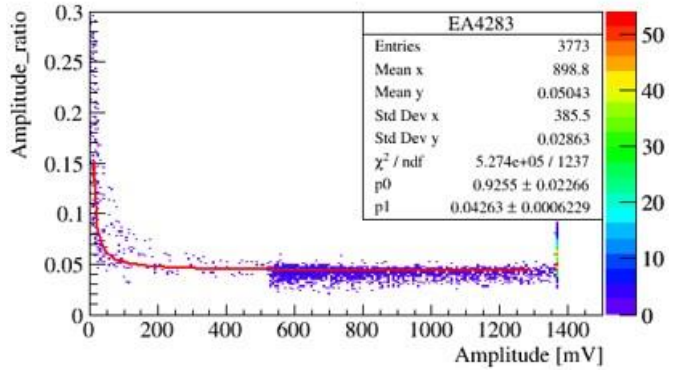


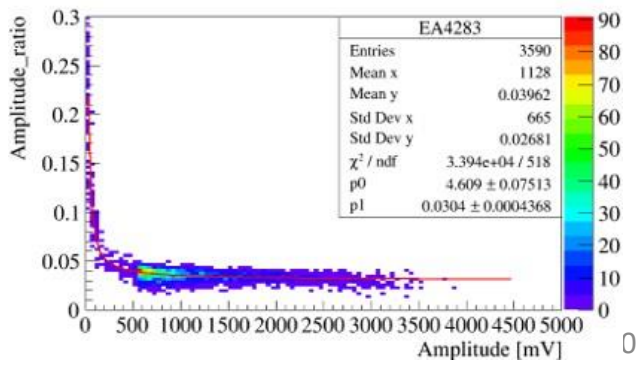










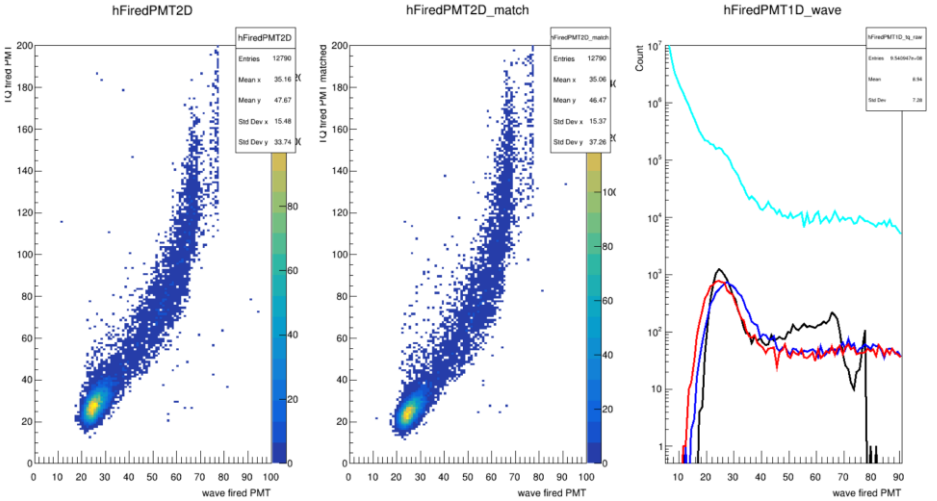


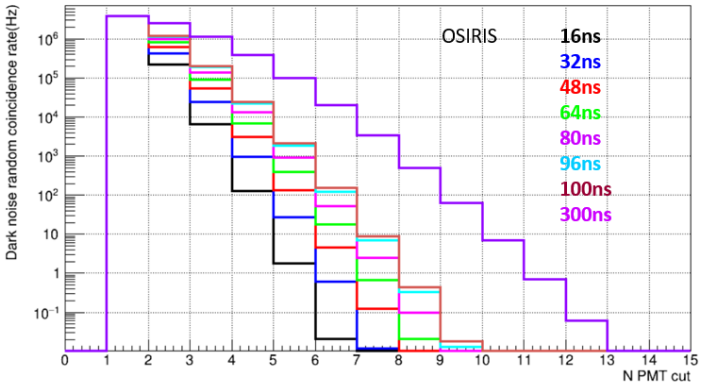
TQpair
低/无阈值数据获取与分析

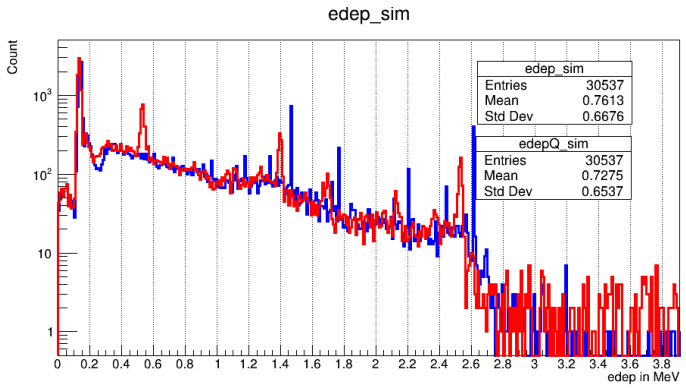
实现TQ 数据初步获取及比对
准备OSIRIS TQ数据检查与分析
进行JUNO 探测器模拟数据检查与分析

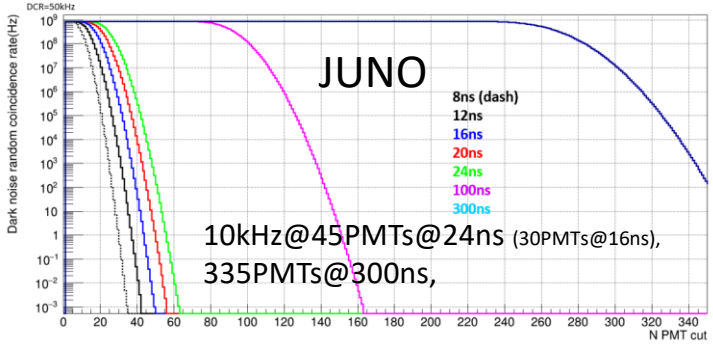
0. TQ pair data
1. OSIRIS： C14等
2. CD water phase
3. CD water buffer layer
4. Lower energy event of LS

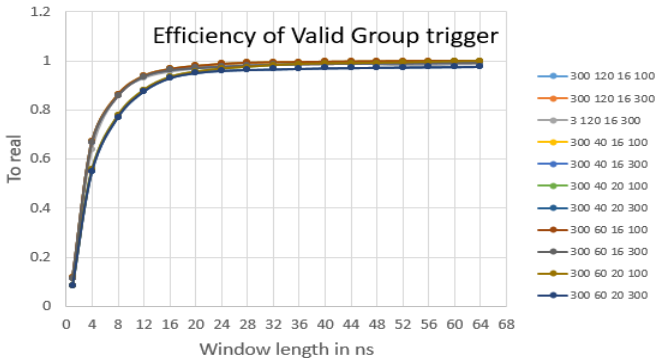
- **75% PMT coverage**
- **Trigger, calibration, reconstruction,**
- **Background measurements**
- **Solar neutrino**
- **Reactor neutrino**

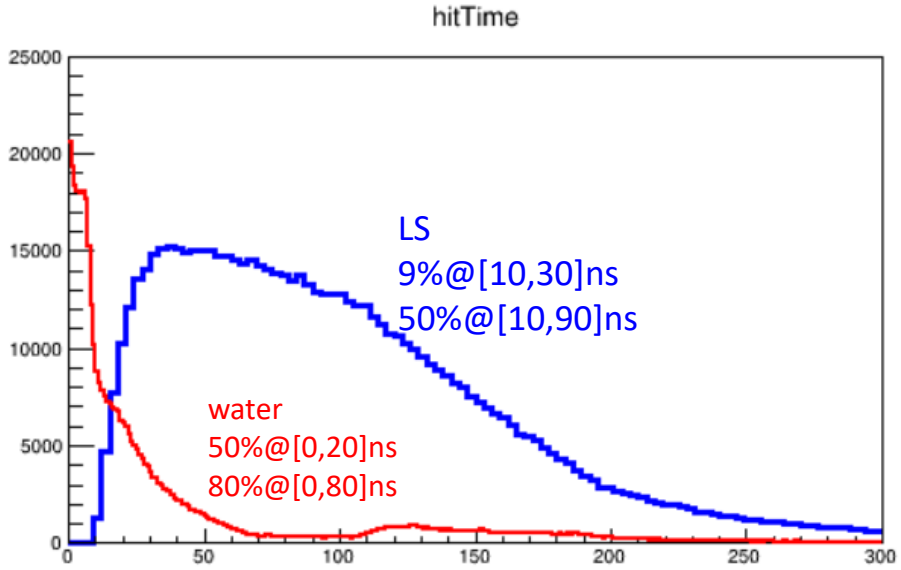




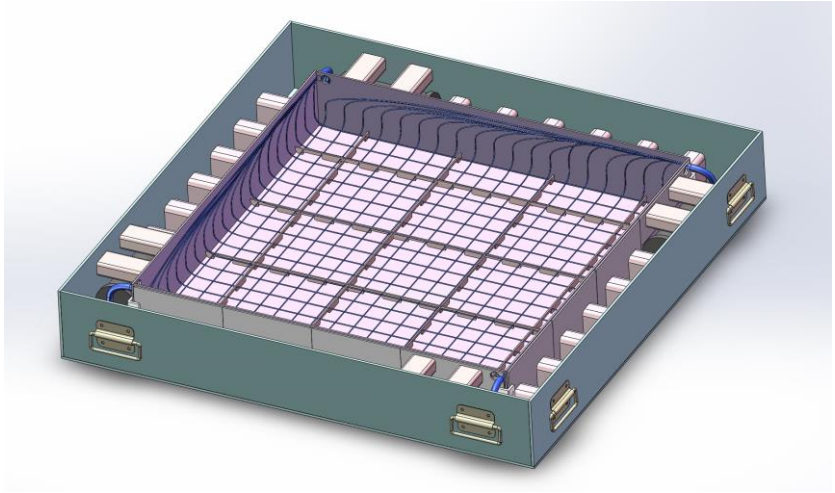


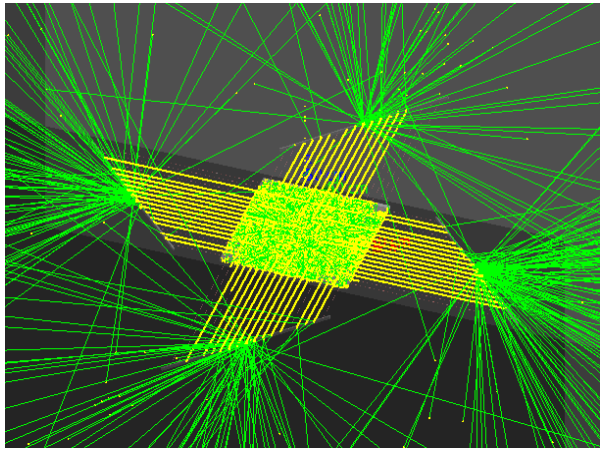


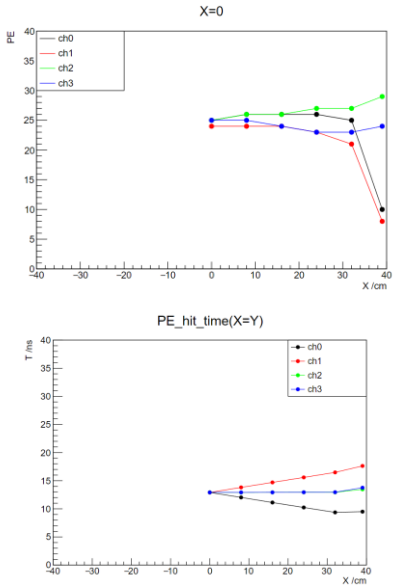


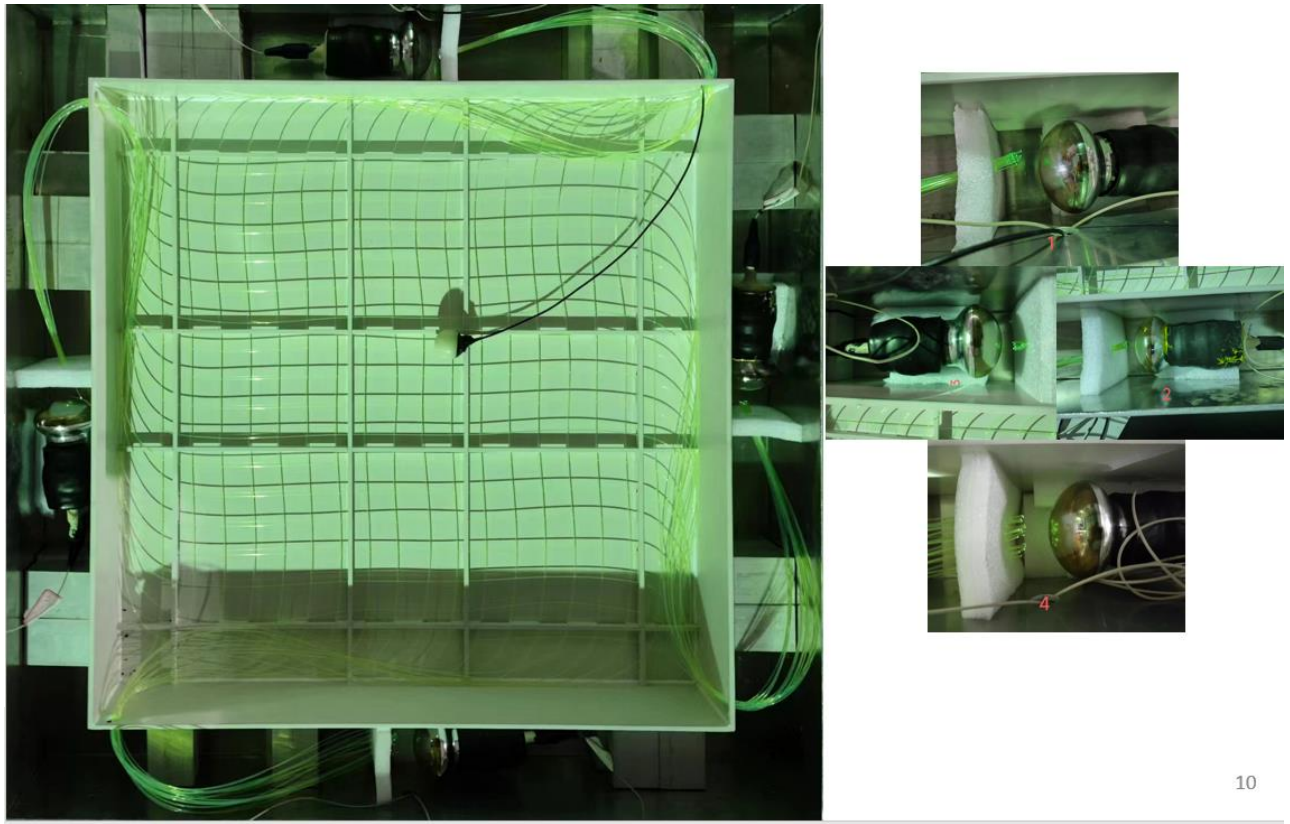


模块化液闪电磁粒子探测器









光子成像研究

单光子成像测量
应用场景发展

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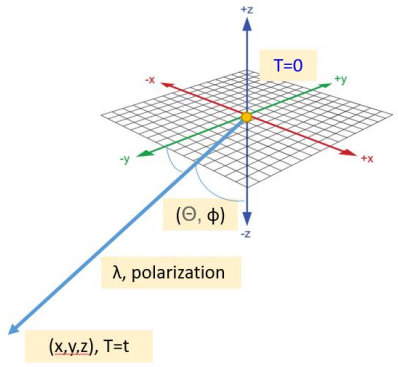
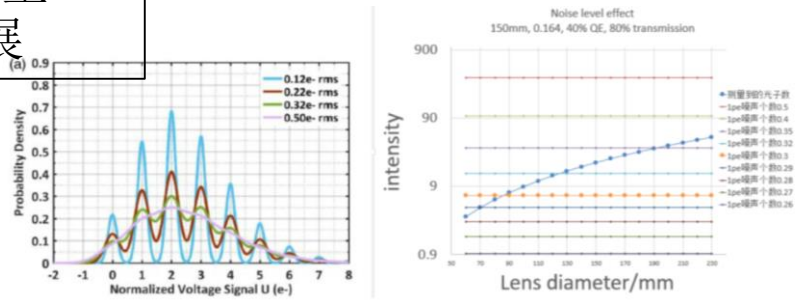
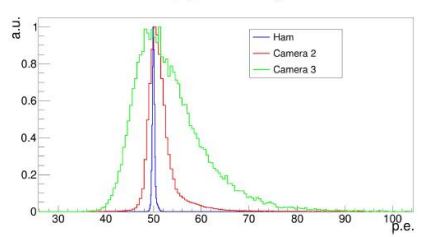
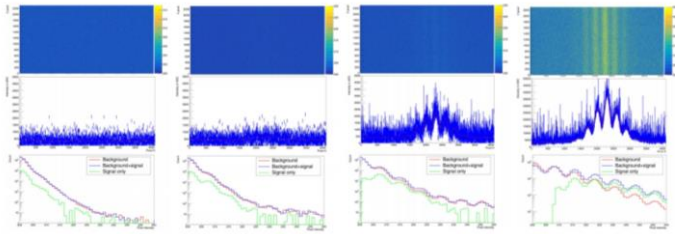


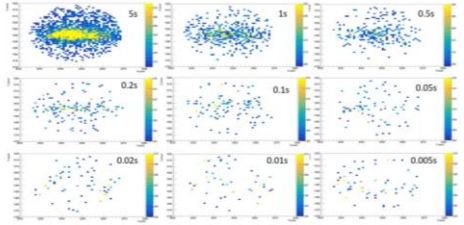
- **Parameters:**
  - Wavelength: λ
  - Polarization
  - **Direction: (Θ, ϕ)**
  - **Hitting location: (x,y,z)**
  - **Arriving time: t**

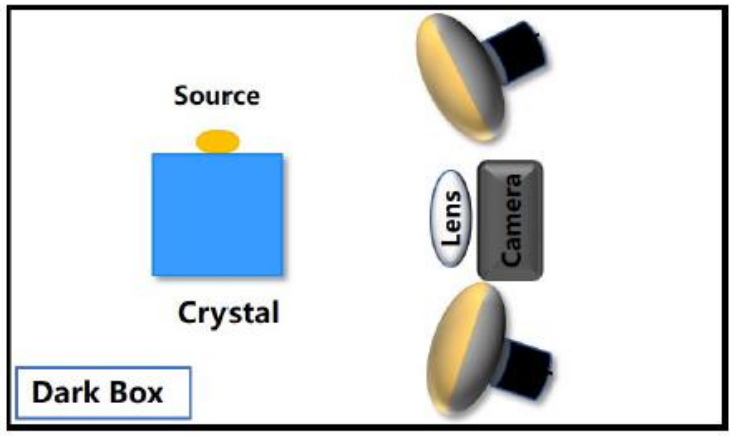




(b) 1-D distribution of pixel noise of (a)

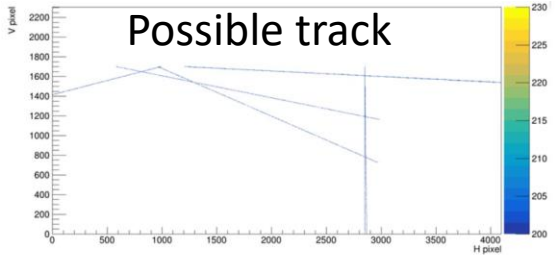




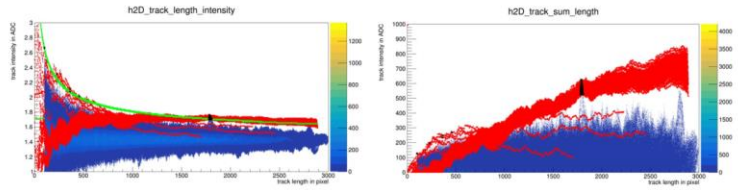


(b) Schema of crystal test.

Possible track



(a) Extended tracks of those reported in figure 12.

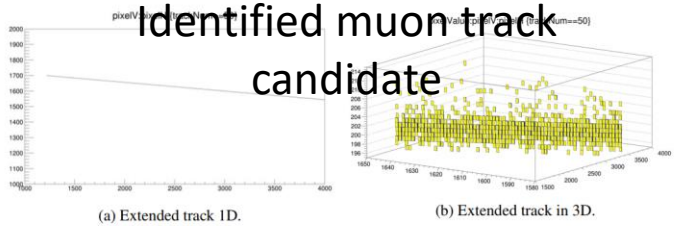


(b) Average of extended surveyed lines of that in figure 11(a): the red lines are selected candidates.

(c) Sum of extended surveyed lines of that in figure 11(b): the red lines are selected candidates.

Figure 13. Track candidate checking by extension. For a true muon track in principle, the candidate should have a similar average intensity as the short track, and increasing sum following the track extending. The red lines in (b) and (c) correspond to the extended track candidates. The selected candidate mentioned here is with the cuts discussed in section 3.1.

Identified muon track candidate



(a) Extended track 1D.

(b) Extended track in 3D.

Figure 14. Example of selected track candidate suggested by its averaged pixel intensity. Its raw length is around 1786 pixels (around 2880 pixel after extension), and averaged intensity per pixel is around 1.728 ADC and the summed intensity is around 568 ADC of 1786 pixels (around 73 p.e.). (a) x-axis is the horizontal pixels; y-axis is the vertical pixels. (b) x-axis is the horizontal pixels; y-axis is the vertical pixels; and the z-axis is the pixel intensity expressed in ADC counts.

5MeV alpha

5MeV electron