PandaX-I&II 电子学与数据获取系统

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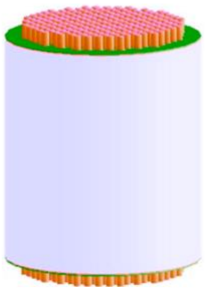
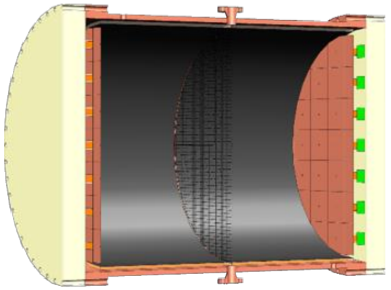
PandaX 探测器

PandaX＝Particle and Astrophysical Xenon Experiments

PandaX-I: 120 kg
DM experiment
2009-2014
Total channel: 180 PMT

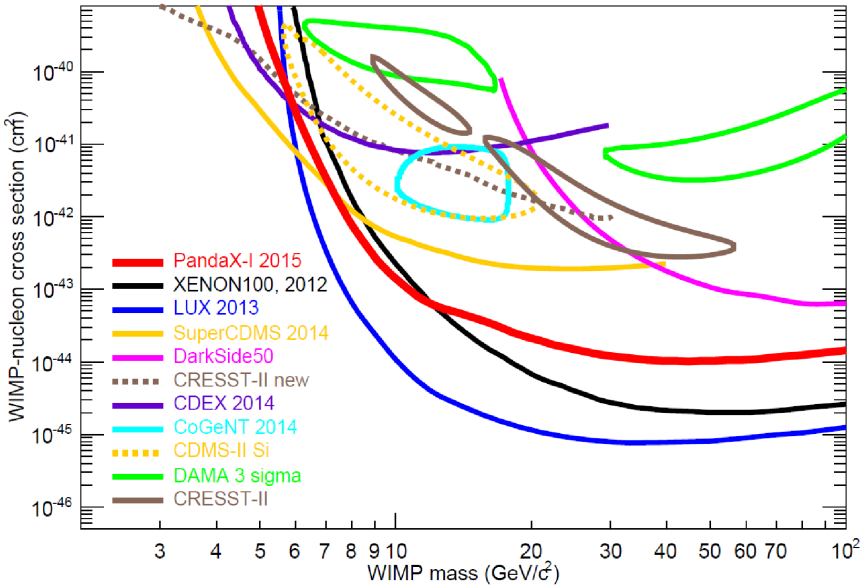
PandaX-II: 500 kg
DM experiment
2014-2017
Total channel: 158 PMT



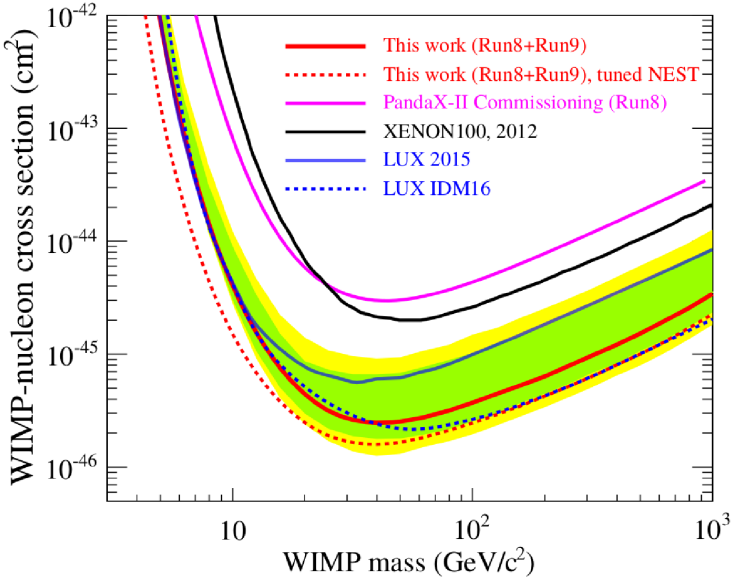


PandaX-xT: multi-ton
DM experiment
2016-
Total channel: >400 PMT

PandaX-III: 200 kg to 1 ton
136Xe 0vDBD experiment
2016-
Total channel: ~10k(per detector)



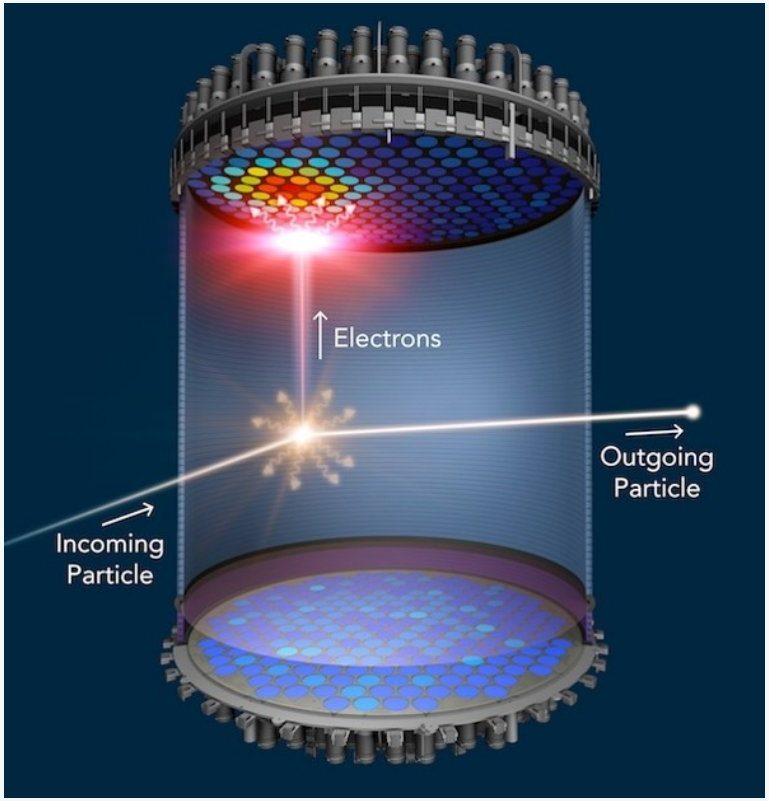
PandaX-I result

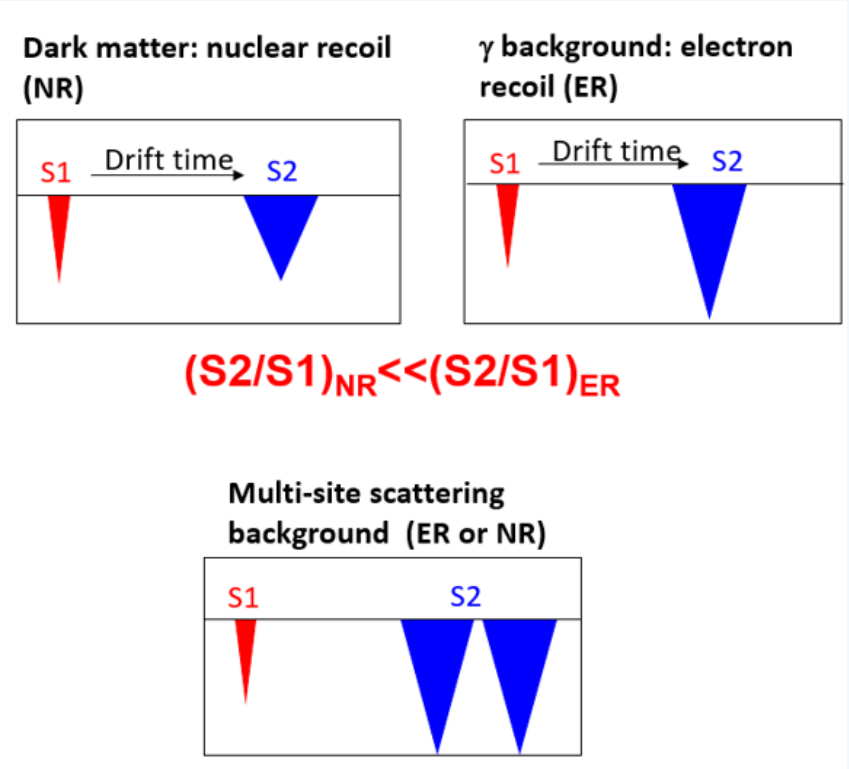


PandaX-II result

PandaX 暗物质探测器

- collect raw signals from top and bottom PMT arrays of TPC
- trigger on electronics system with <1keV$_{ee}$ threshold
- convert raw analog signals int to digital signals
- save triggered events into disk array for offline analysis





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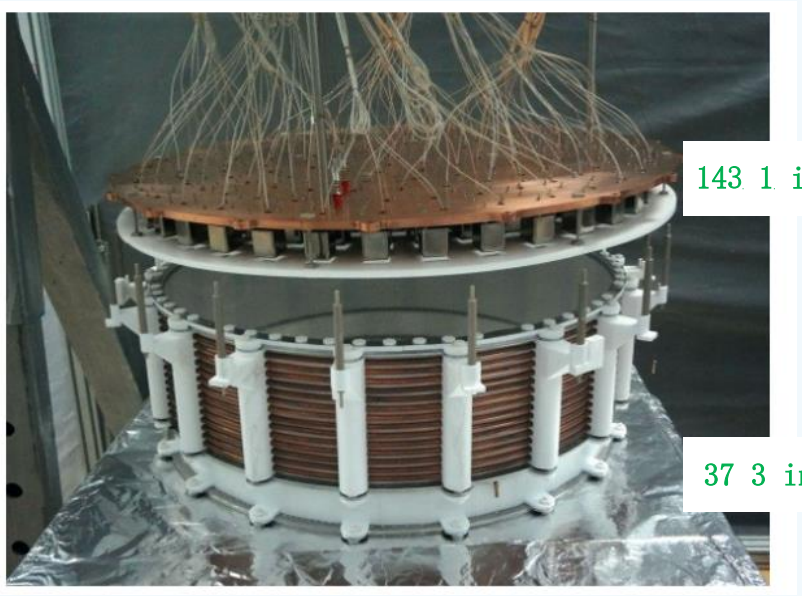
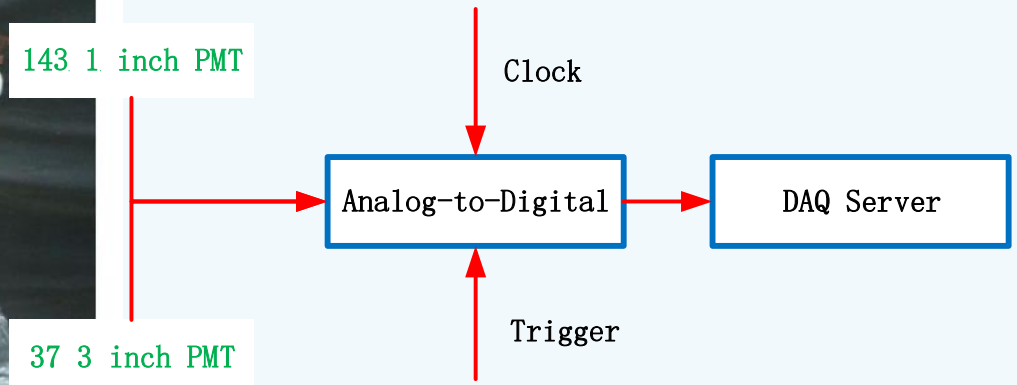
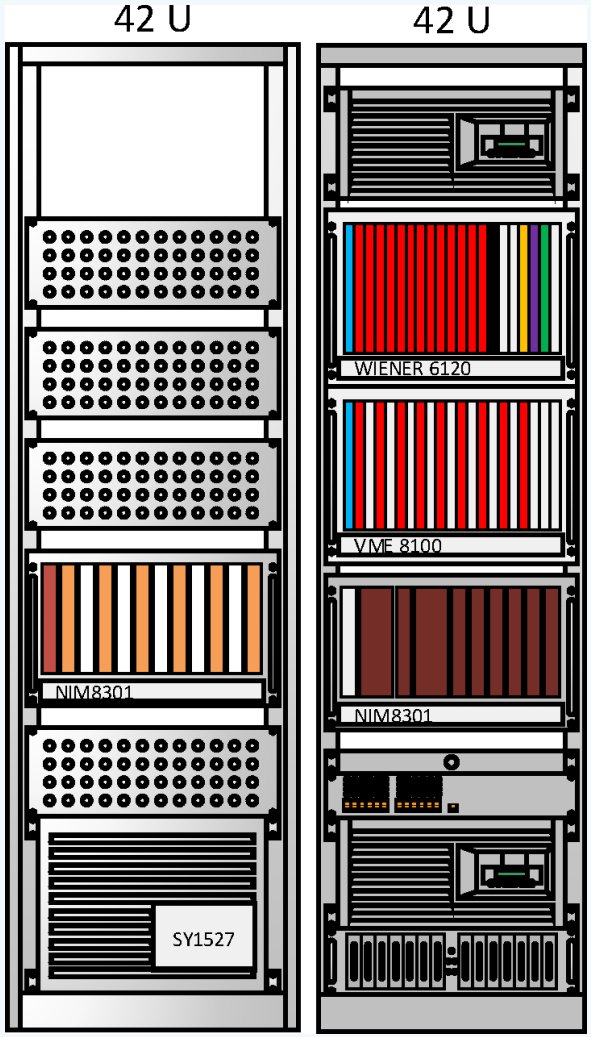
PandaX-I&II 电子学与数据获取系统：EnDAQ 总述

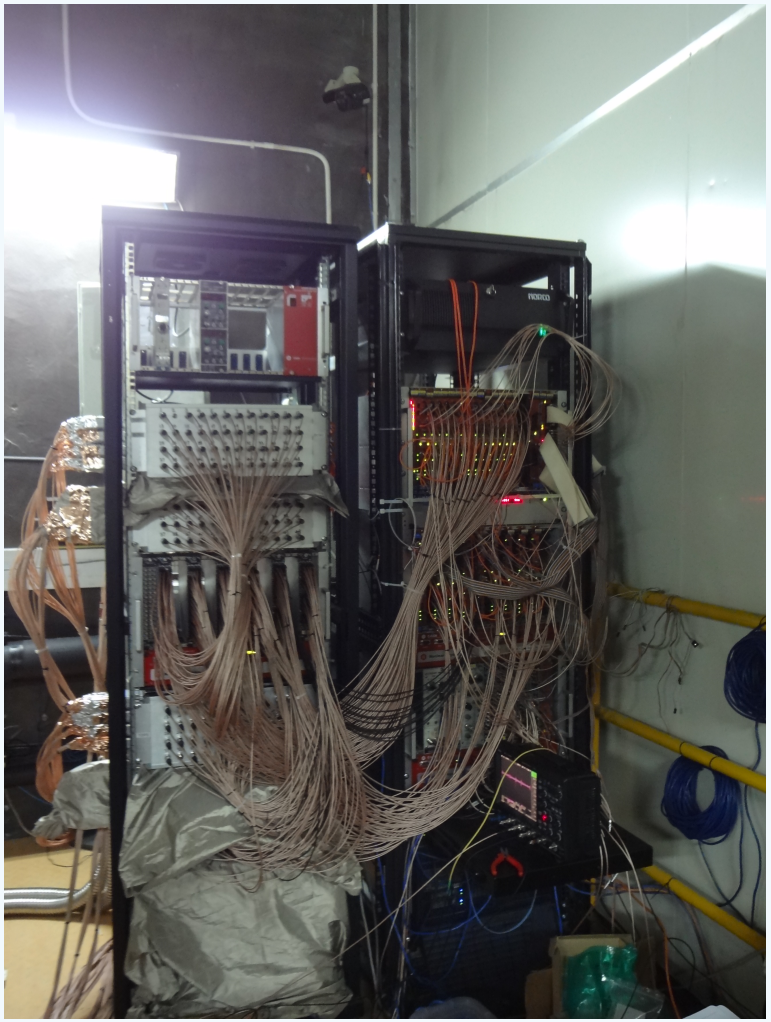
- The central components of the electronics hardware are 180 channels of commercial flash ADC waveform digitizers.
- The DAQ software is developed in house in C++, with external libraries from CAEN, as well as the XML and MySQL libraries.
- EnDAQ system runs with gain calibration, nuclear source calibration except no source physical run.



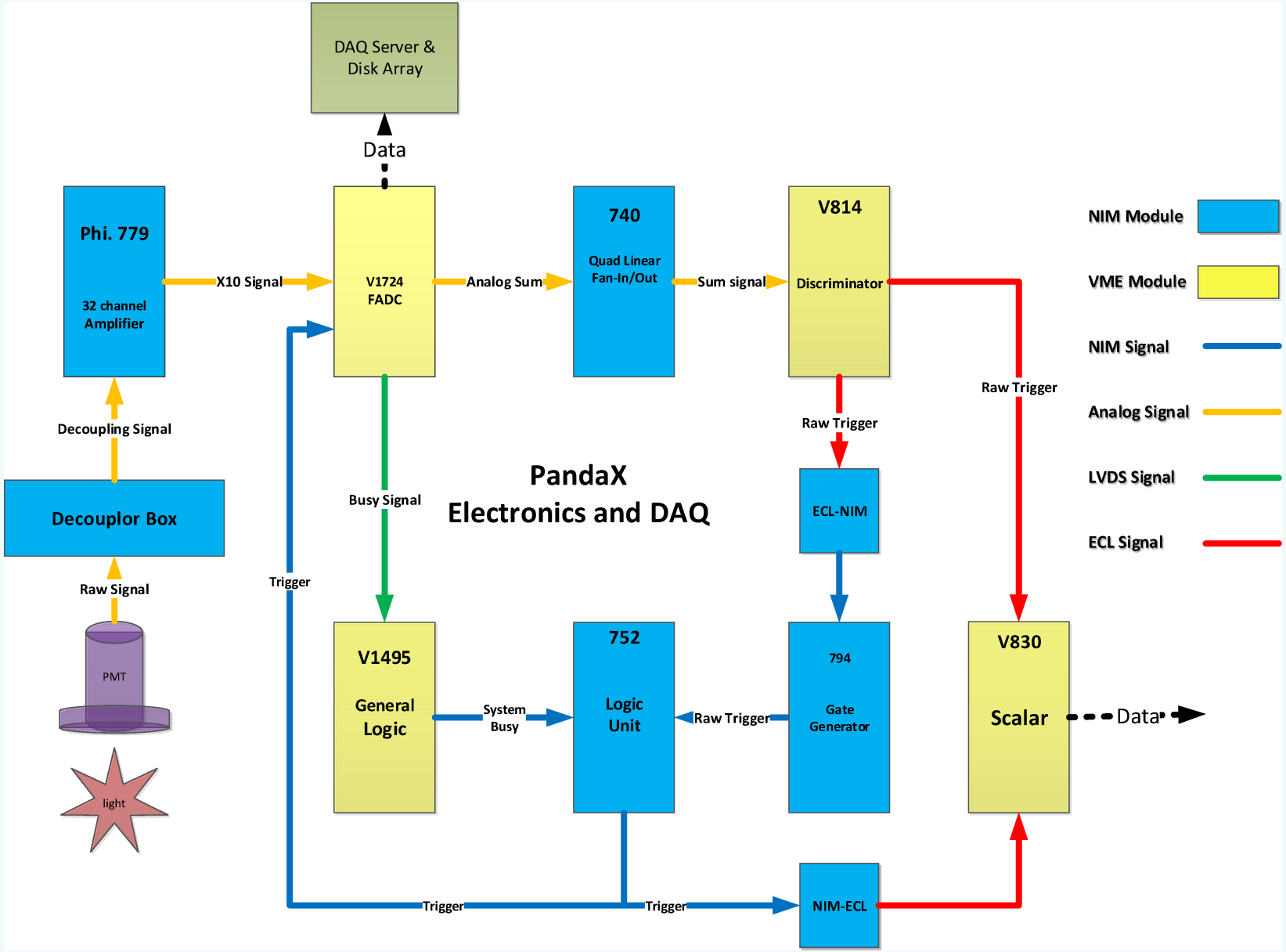


PandaX-I&II 电子学与数据获取系统：EnDAQ 总述



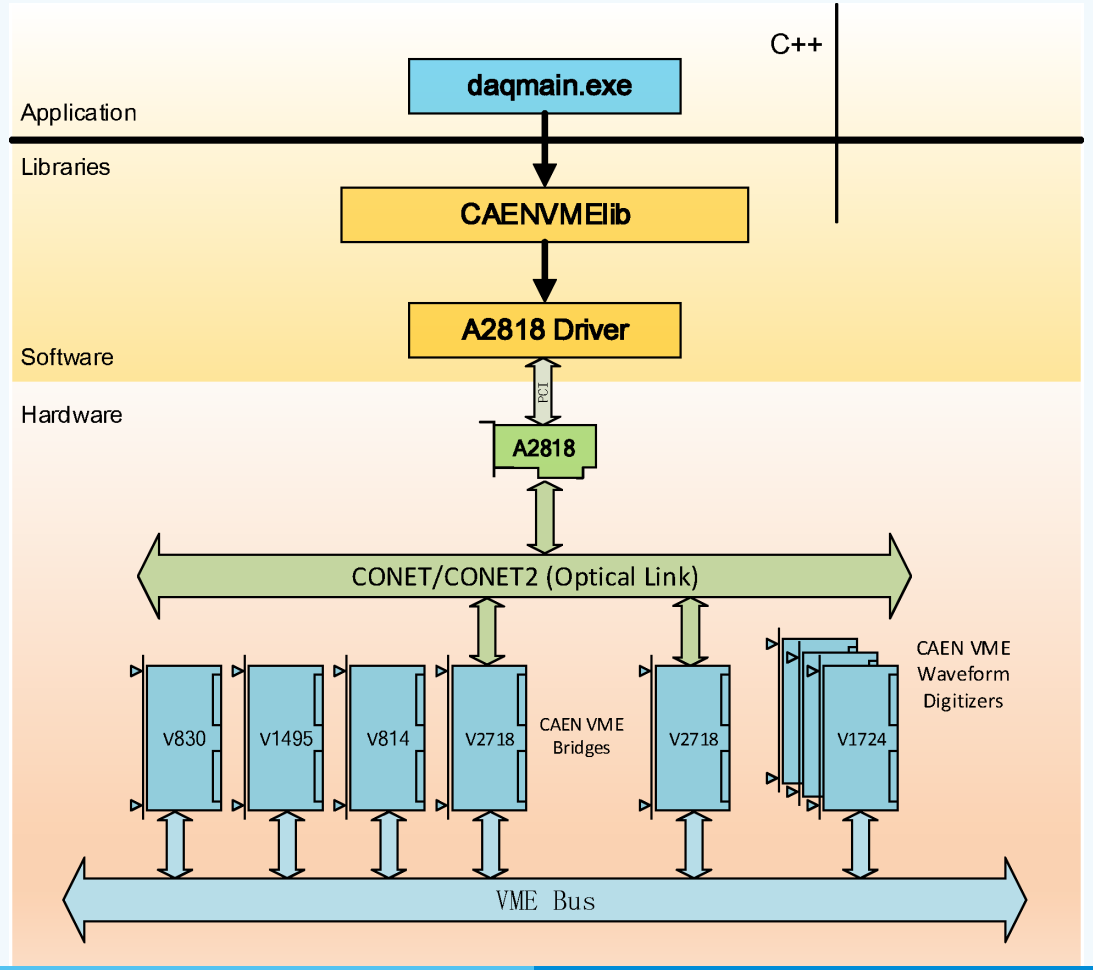


PandaX-I&II 电子学与数据获取系统：试运行硬件设计

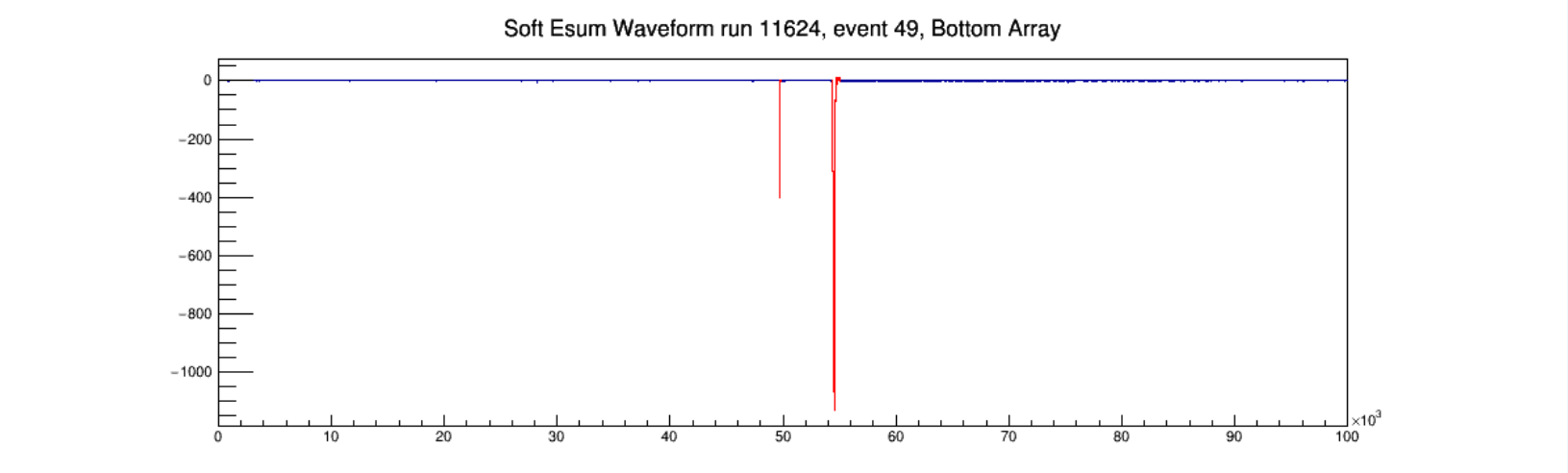


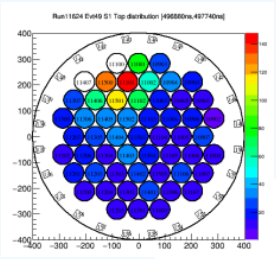
PandaX-I&II 电子学与数据获取系统：试运行软件设计

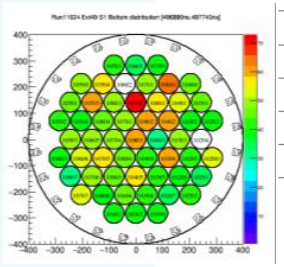
- Use A2818 PCI card to control VME modules and readout data
- Data readout upper limit 40MB/s
- Commissioning run readout window 80μs

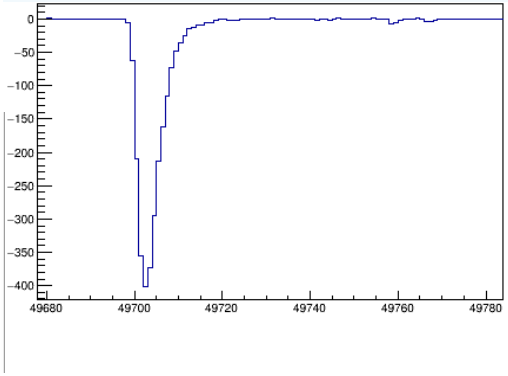


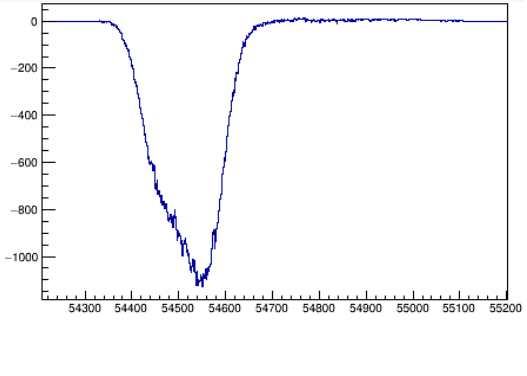
PandaX-I&II 电子学与数据获取系统：PandaX 反冲事例波形

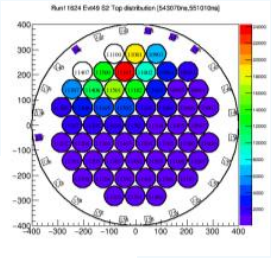


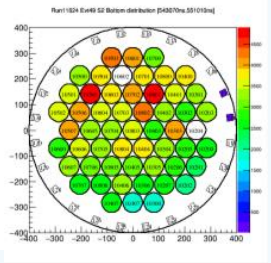






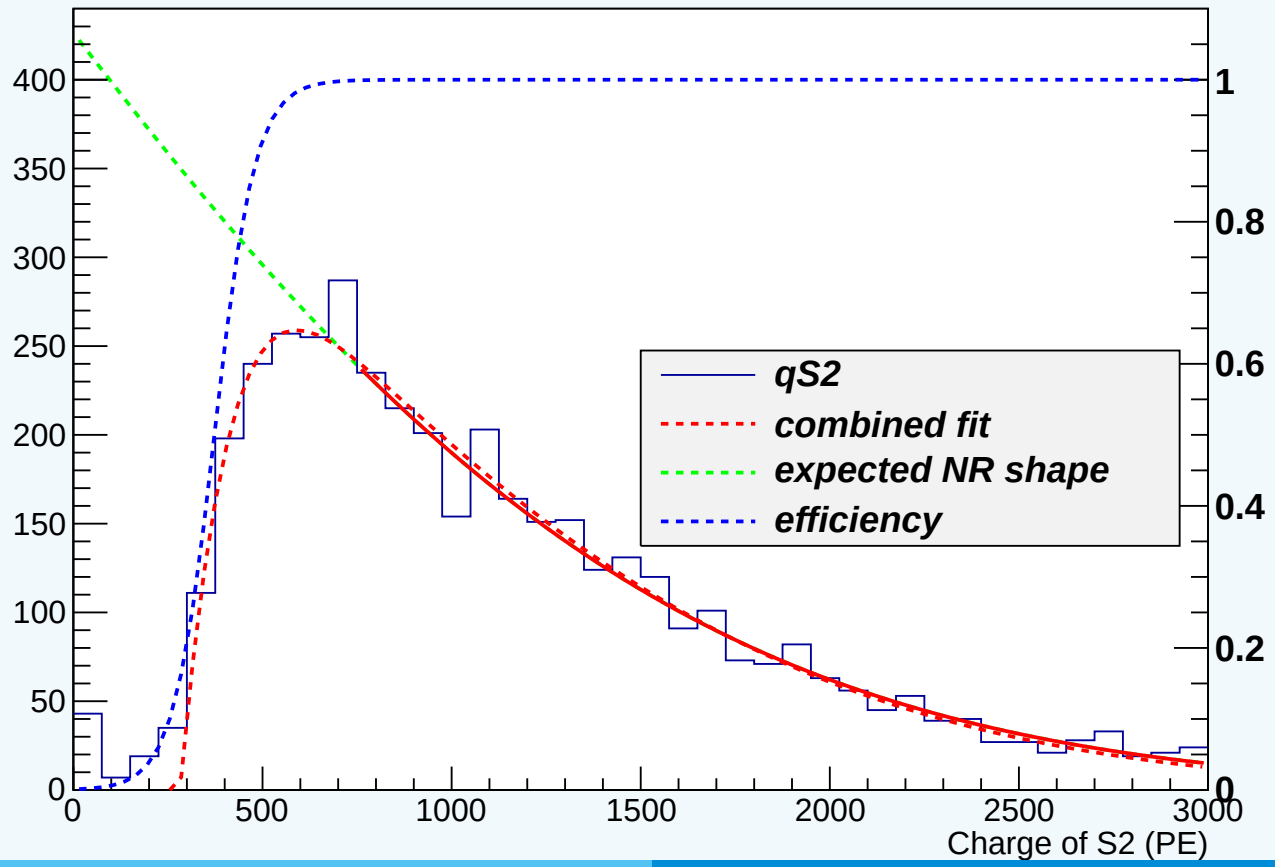






PandaX-I&II 电子学与数据获取系统：试运行触发效率

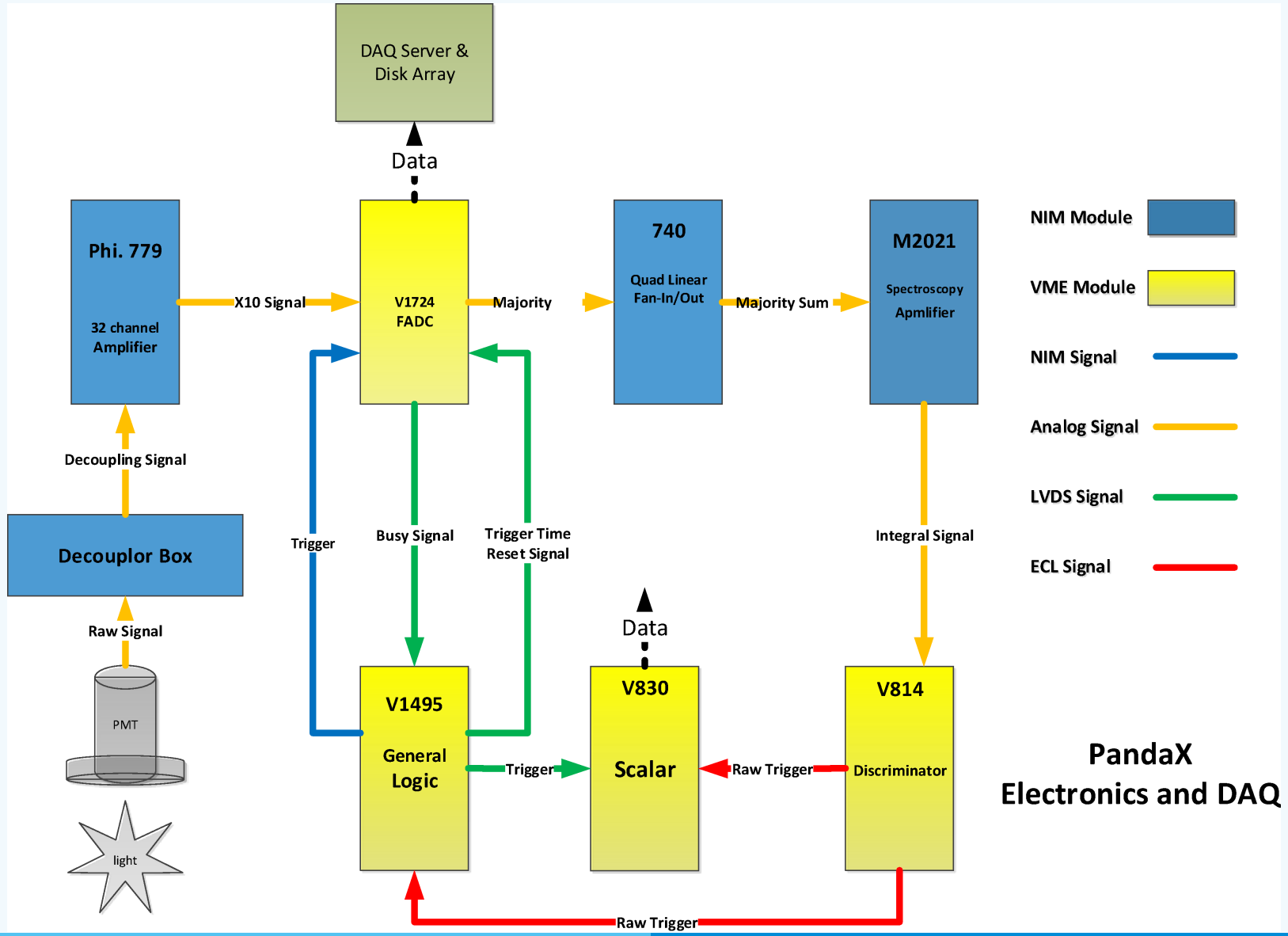
- The mean value of S2 for a 1 keV$_{ee}$ electron recoil and nuclear recoil events are 867 PE and 525 PE.
- The trigger threshold during the commissioning run was 372.77PE when the trigger efficiency was 50%.



PandaX-I&II 电子学与数据获取系统：升级总述

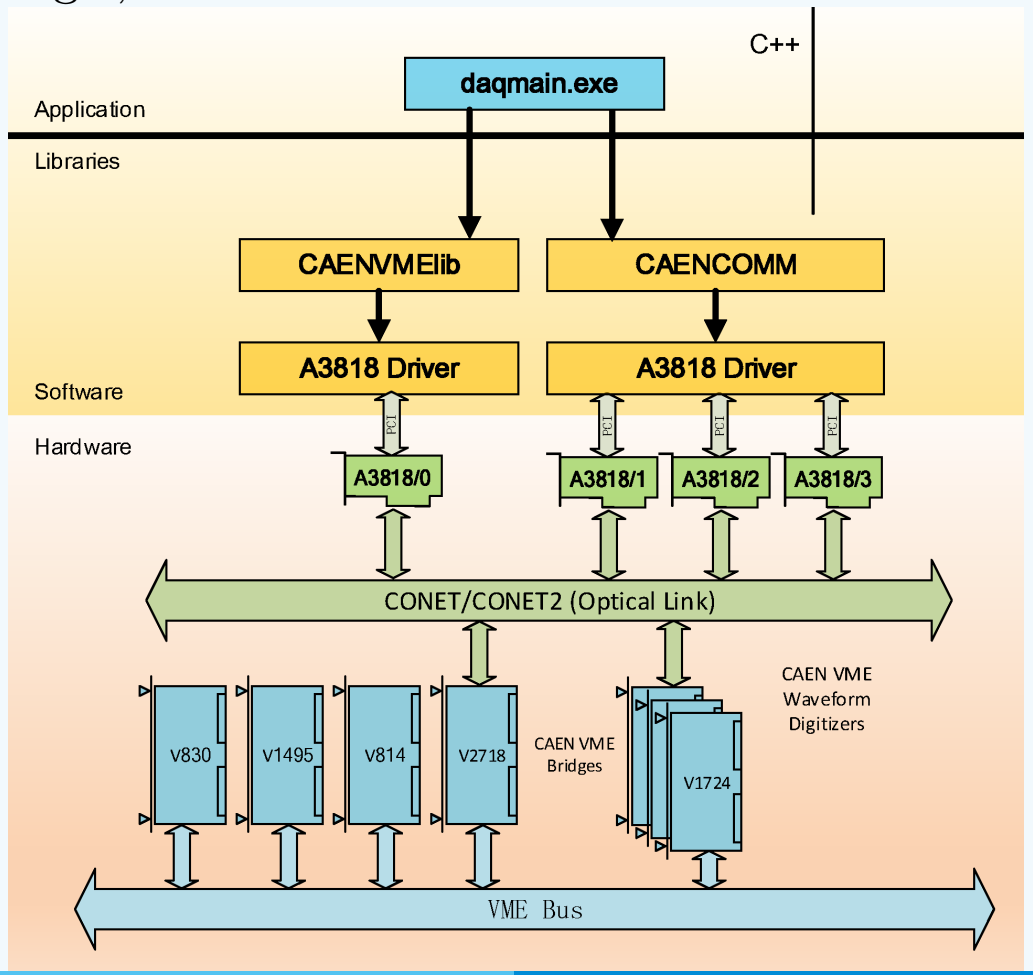
- Commissioning run behavior:
  - significant coherent HV power supply noise on PMT raw signal
  - 100% trigger efficiency threshold is higher than PandaX requirement 1keV$_{ee}$
  - system crash with zero suppression and >100μs data acquisition window
  - data readout upper limit 40MB/s which is less than system design (70MB/s)
- Upgrade method:
  - use time-over-threshold signal of FADC to avoid noise trigger
  - use spectroscopy amplifier to improve trigger efficiency on S2 signals
  - use CAEN local bus to instead VME Bus to improve the data readout
  - use FPGA to instead NIM modules for trigger logic

PandaX-I&II 电子学与数据获取系统：一期硬件设计



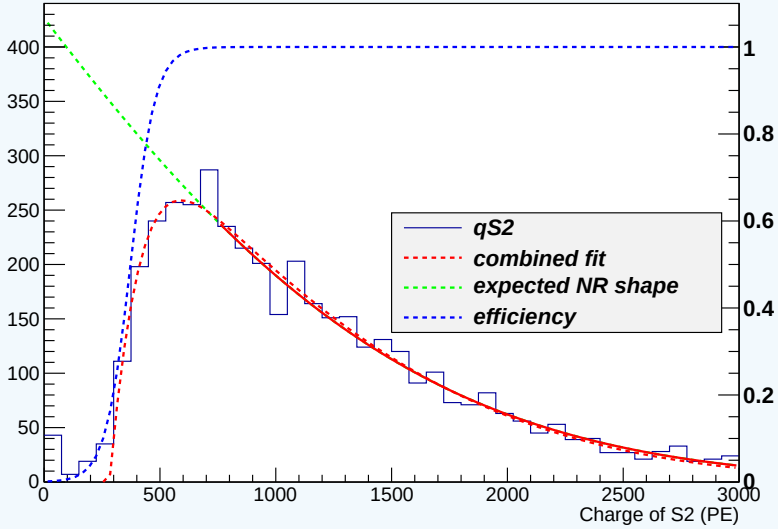
PandaX-I&II 电子学与数据获取系统：一期软件设计框架

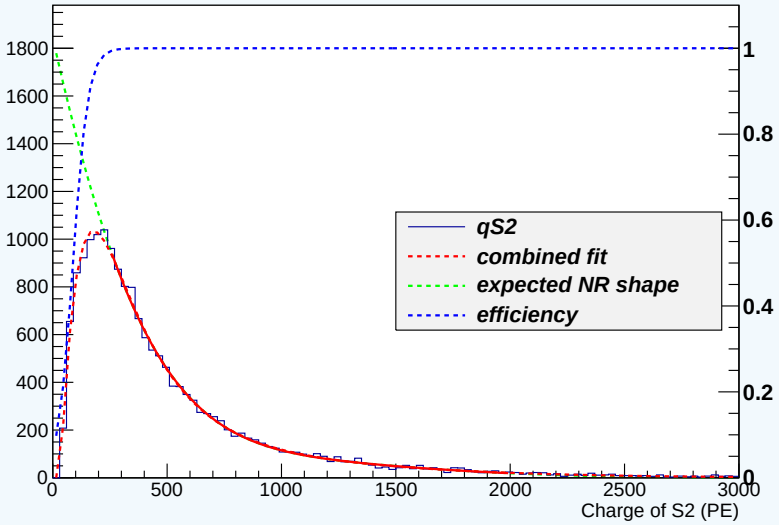
- one A3818 PCI controller for system initialize, CAEN local bus control and data readout
- improve software configuration on zero suppression, time-over-threshold logic, etc.



PandaX-I&II 电子学与数据获取系统：触发效率

- Commissioning run trigger threshold is 372.77PE with 50% trigger efficiency
- Physical run trigger threshold is 88.28PE with 50% trigger efficiency





PandaX-I&II 电子学与数据获取系统：系统性能统计

参数 \ 运行模式	^{137}Cs	^{60}Co	^{252}Cf	LED	Dark Matter
序列号	6306	6494	6493	6612	6511
时间窗口 (μs)	200	200	200	5.12	200
零压缩模式	YES	YES	YES	NO	YES
事例数	554699	593653	164040	26339	210885
运行时间 (s)	15266.84	23445.02	7270.03	251.14	63816.20
总数据量 (GB)	321.39	459.00	112.43	5.64	134.76
频率 (Hz)	36.33	25.32	22.56	104.88	3.30
平均大小 (KB)	607.53	810.73	718.61	224.58	670.07
平均传输速率 (MB/s)	21.56	20.05	15.83	23.00	2.16

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总结

- The system ran steadily for more than nine months and collected about 8 TB of dark matter data in PandaX-I
- The same system is used in the second phase 500-kg PandaX-II experiment
- data readout upper limit is 70MB/s
- Physical run trigger threshold is 88.28PE with 50% trigger efficiency

Q & A

Any questions?

Acknowledgments

Thank You For Your Attention!