Neutrino **E**xperiment for **O**scillation at **S**hort baseline

December 7 @ AAP 2015

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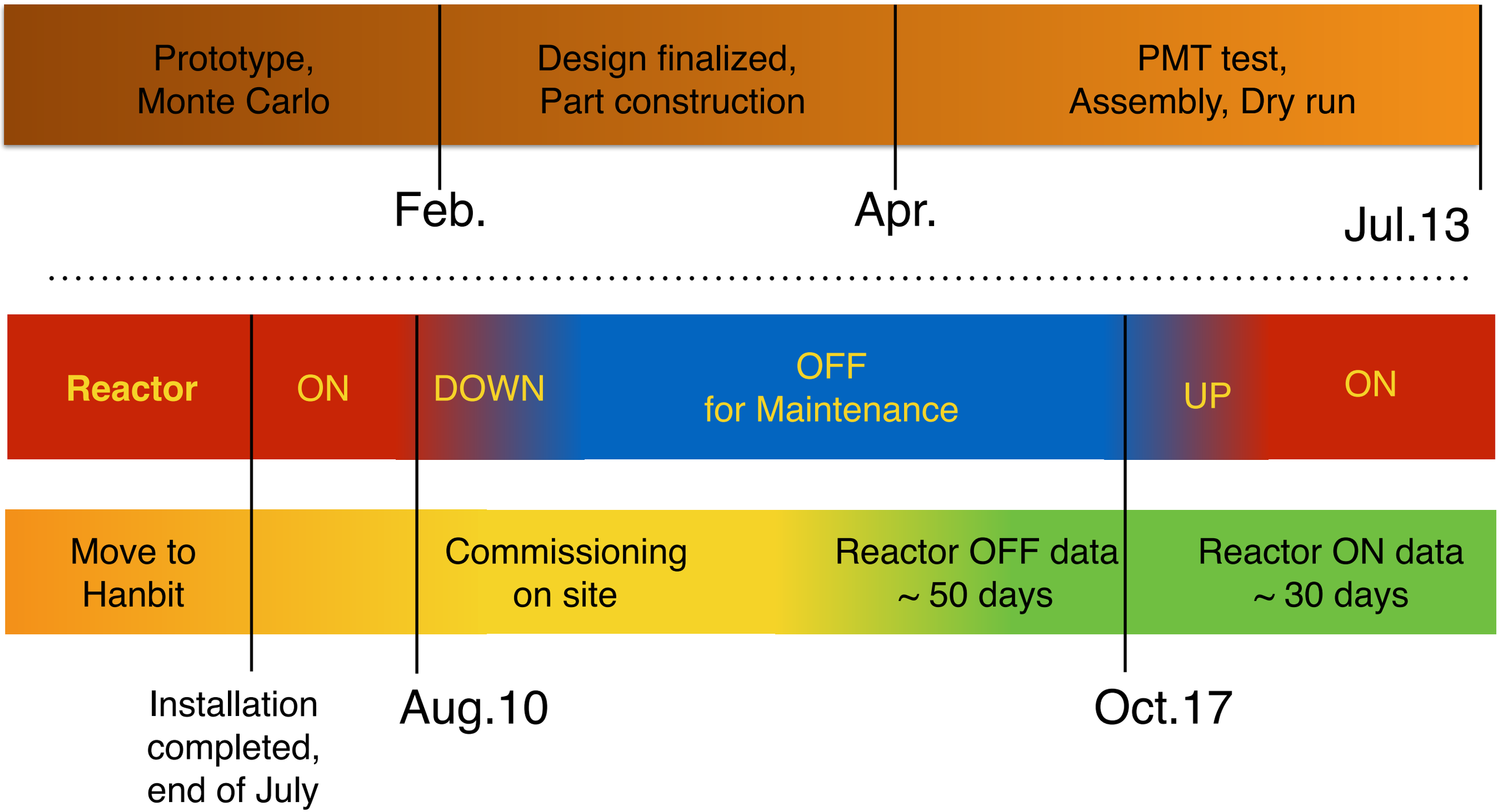
On behalf of NEOS Collaboration
Center for Underground Physics / Institute for Basic Science

NEOS

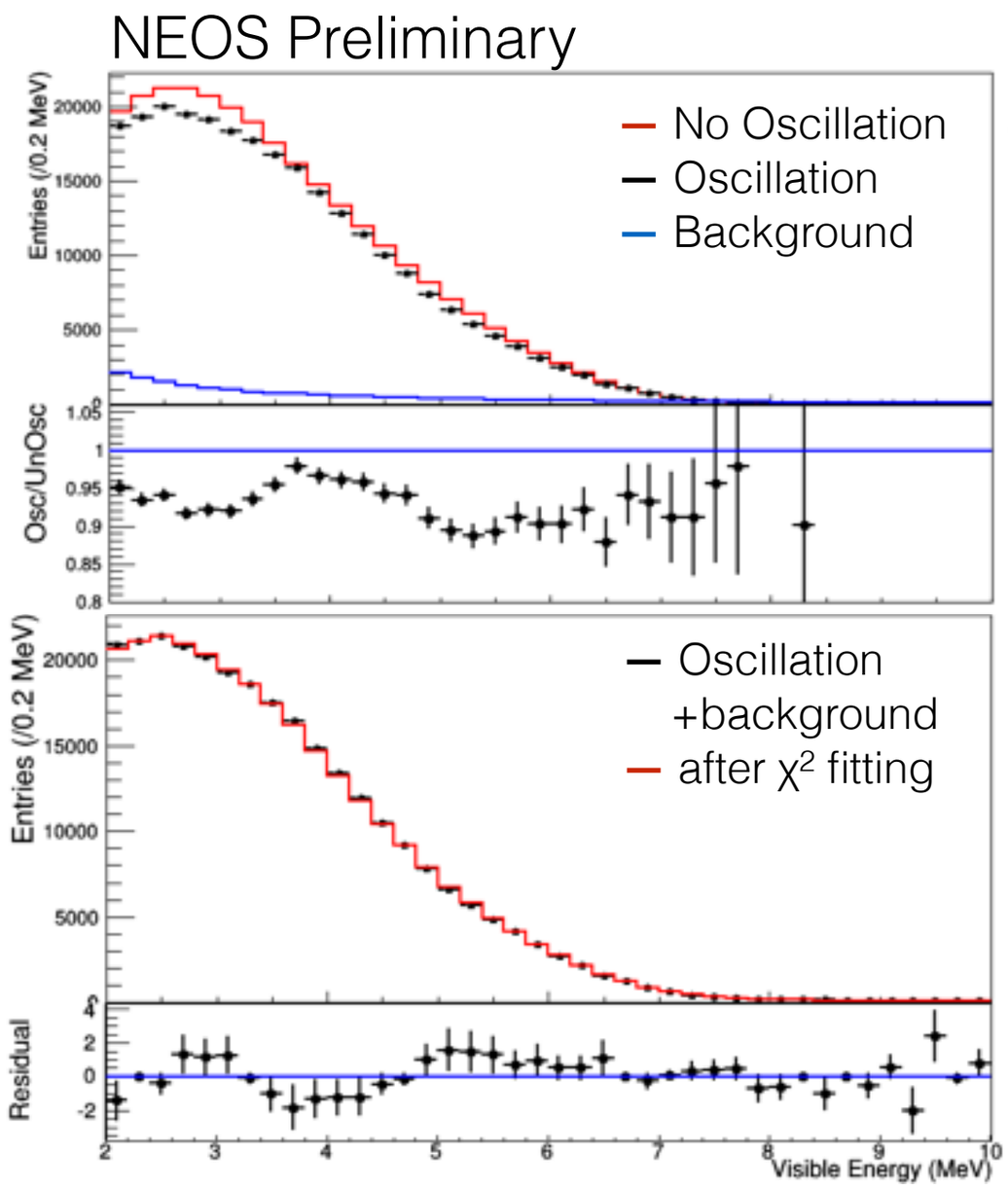
- Previously HANARO
- To verify short baseline ν oscillation
  — Tendon gallery (~25m baseline)
  — Focusing on neutrino energy spectrum analysis
- Newly developed liquid scintillator for better PSD
- Data taking starts from August 2015
  — Aiming at more than 6 months' reactor ON data

Boyoung Han, Eunju Jeon, Kyungkwang Joo, Yeongduk Kim, Baro Kim, Hongjoo Kim, Hyunsoo Kim, Jinyu Kim, Youngju Ko, Moo Hyun Lee, Jaison Lee, Jooyoung Lee, Kyungju Ma, Yoomin Oh, Hyangkyu Park, Kangsoon Park, Kyungmin Seo, Kim Siyeon, Gwang-Min Sun

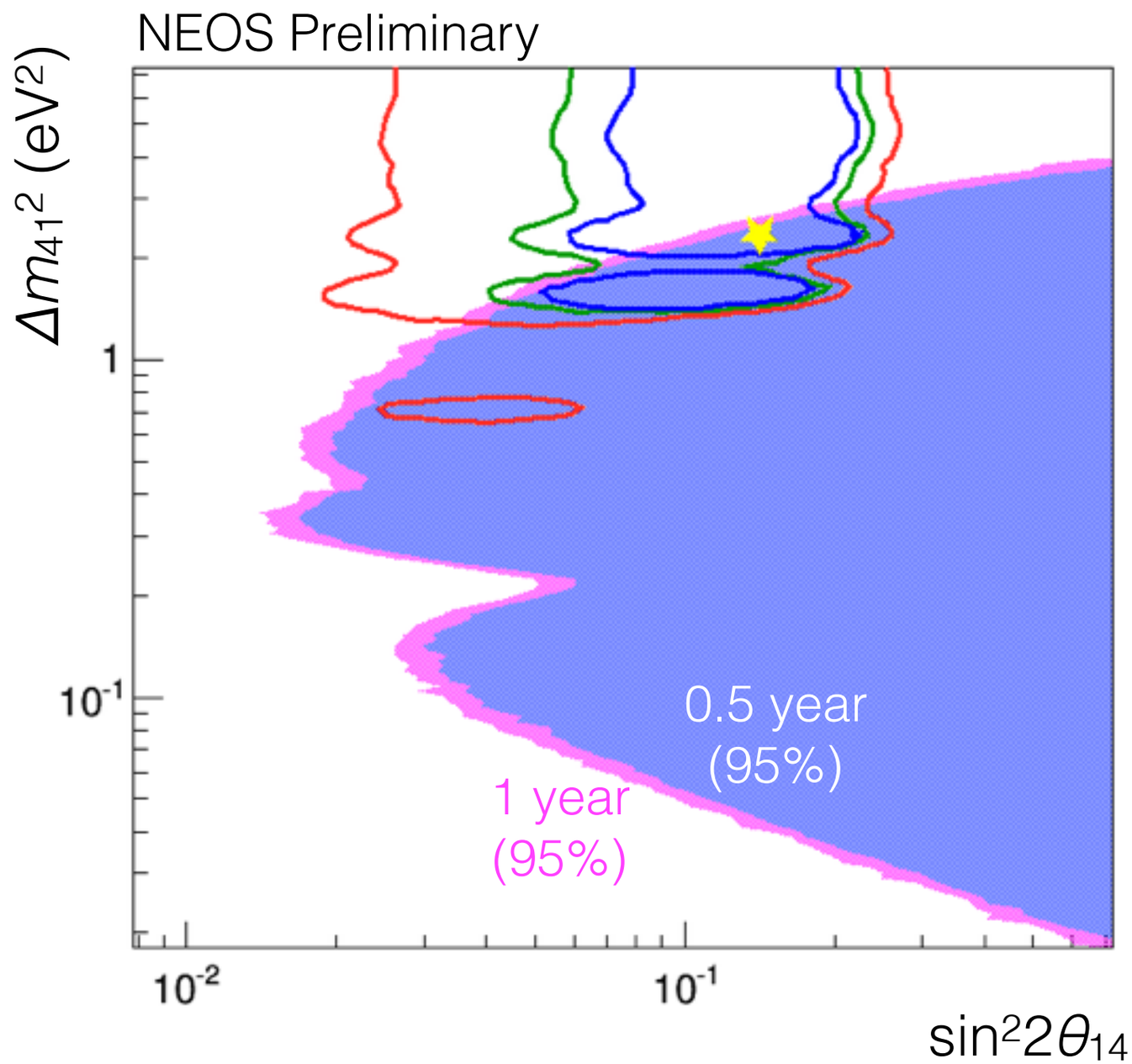
Timeline


Prototype,
Monte Carlo
Design finalized,
Part construction
PMT test,
Assembly, Dry run
Feb.
Apr.
Jul.13
Reactor
ON
DOWN
OFF
for Maintenance
UP
ON
Move to
Hanbit
Commissioning
on site
Reactor OFF data
~ 50 days
Reactor ON data
~ 30 days
Installation
completed,
end of July
Aug.10
Oct.17

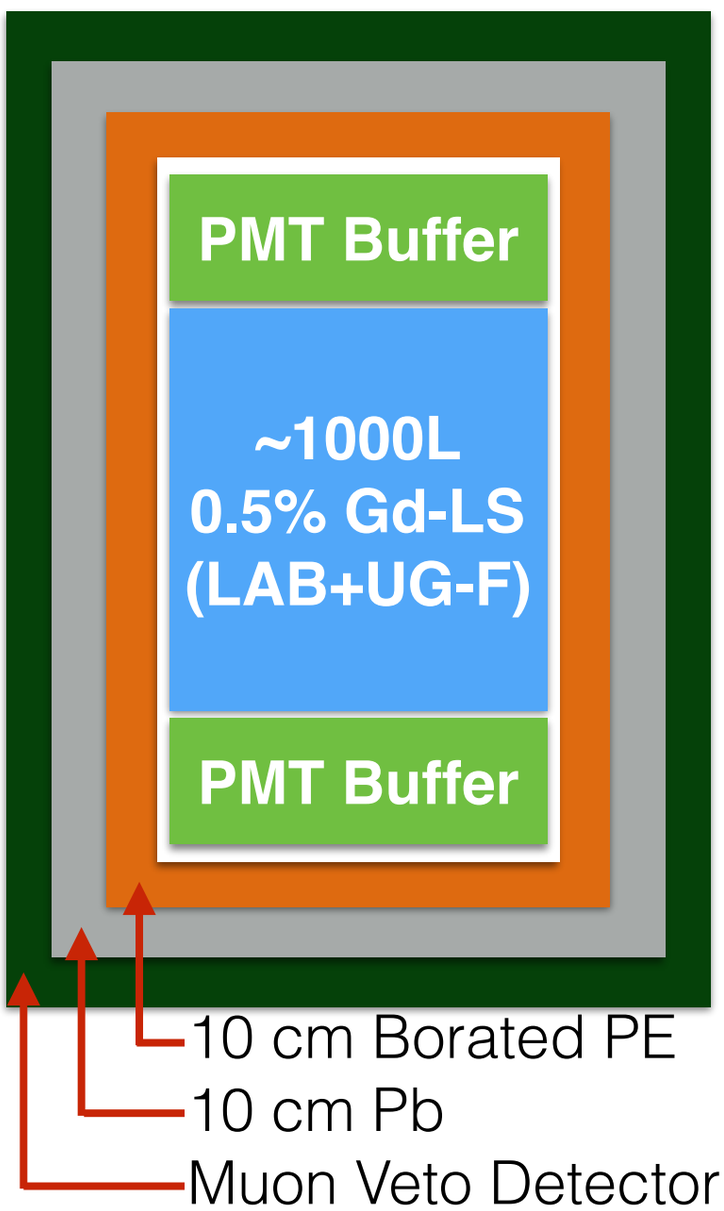
Sensitivity

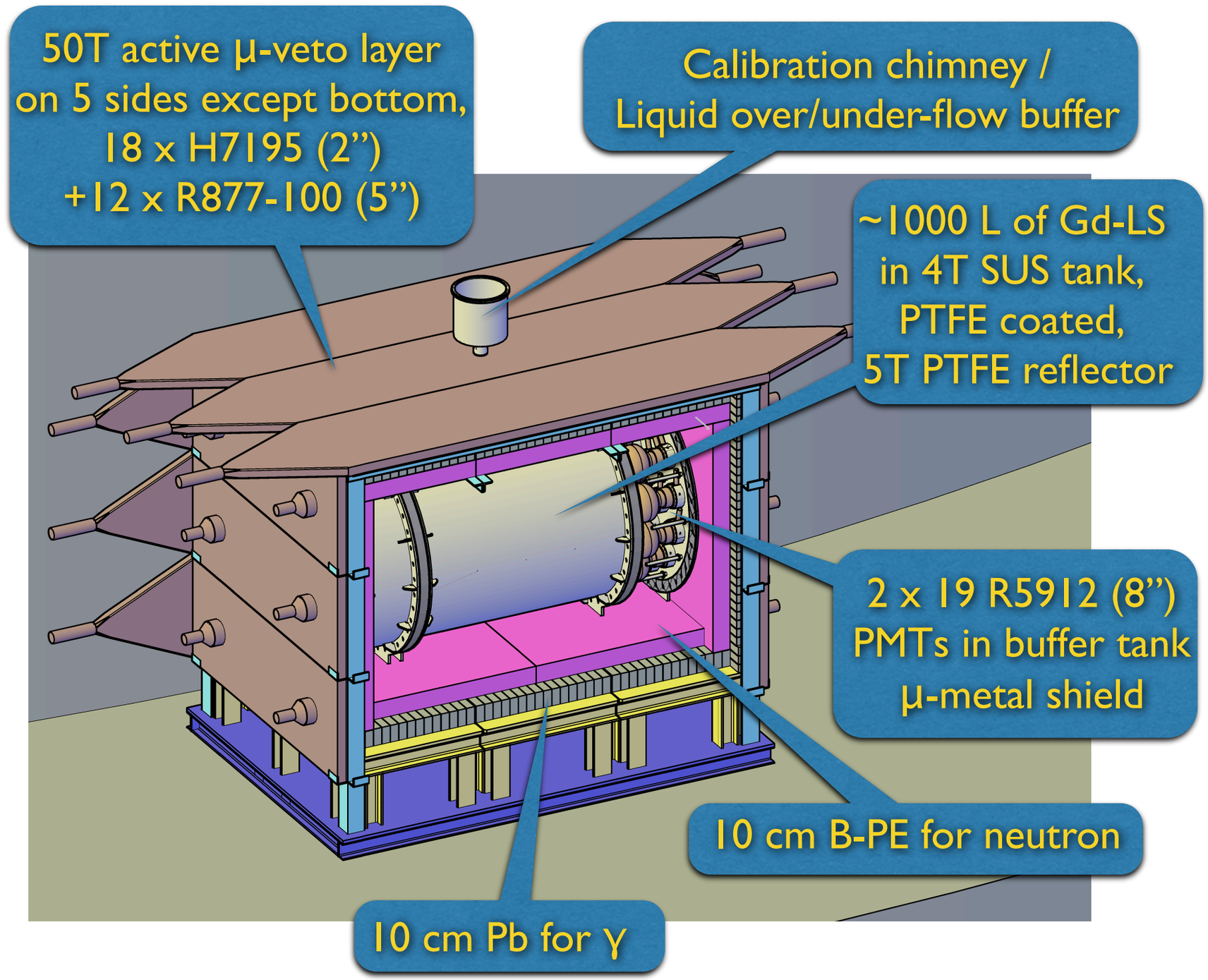


Δm_{41}^2=1.0 eV^2, $\sin^2 2\theta_{14}$ = 0.1



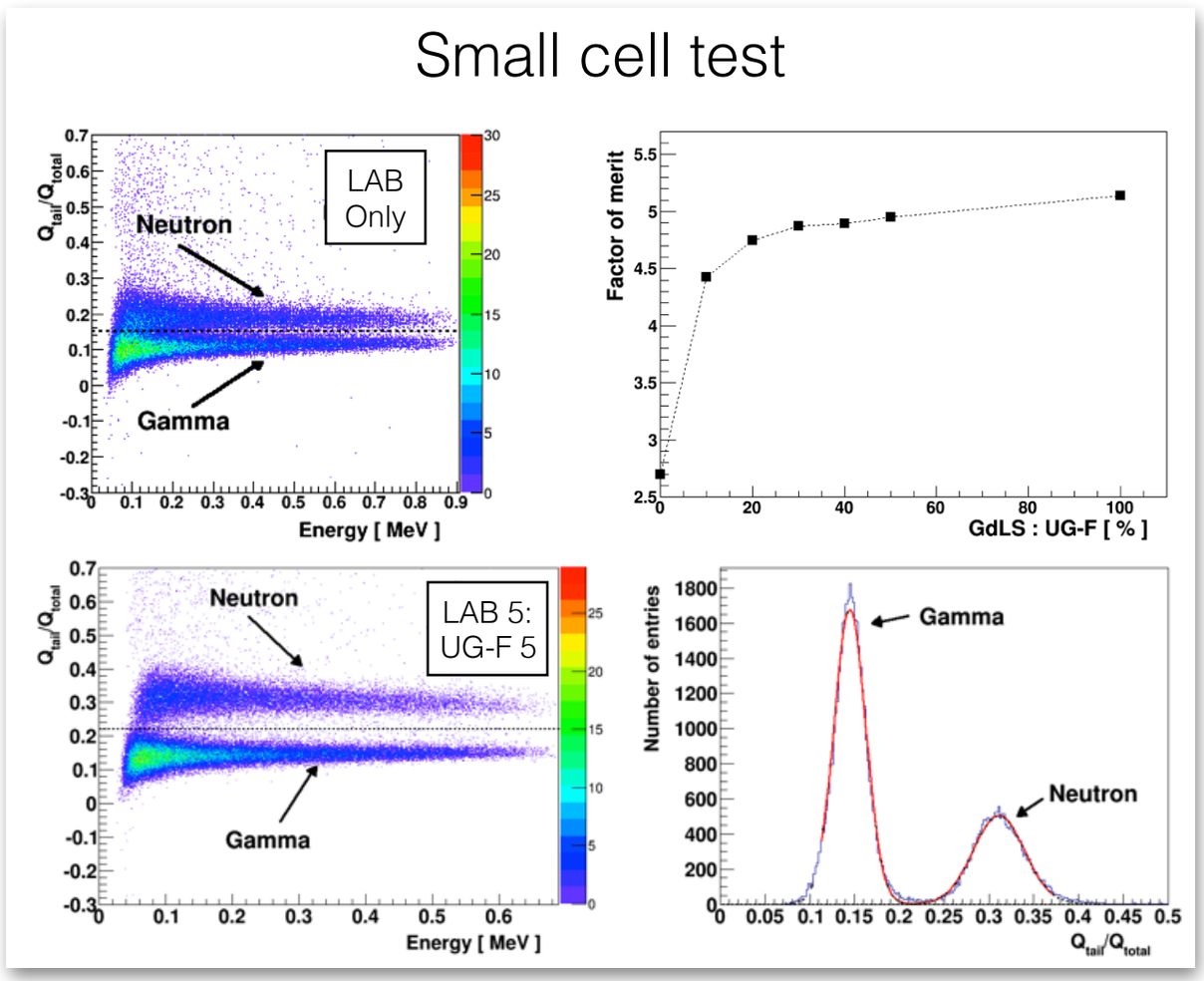
NEOS Detector

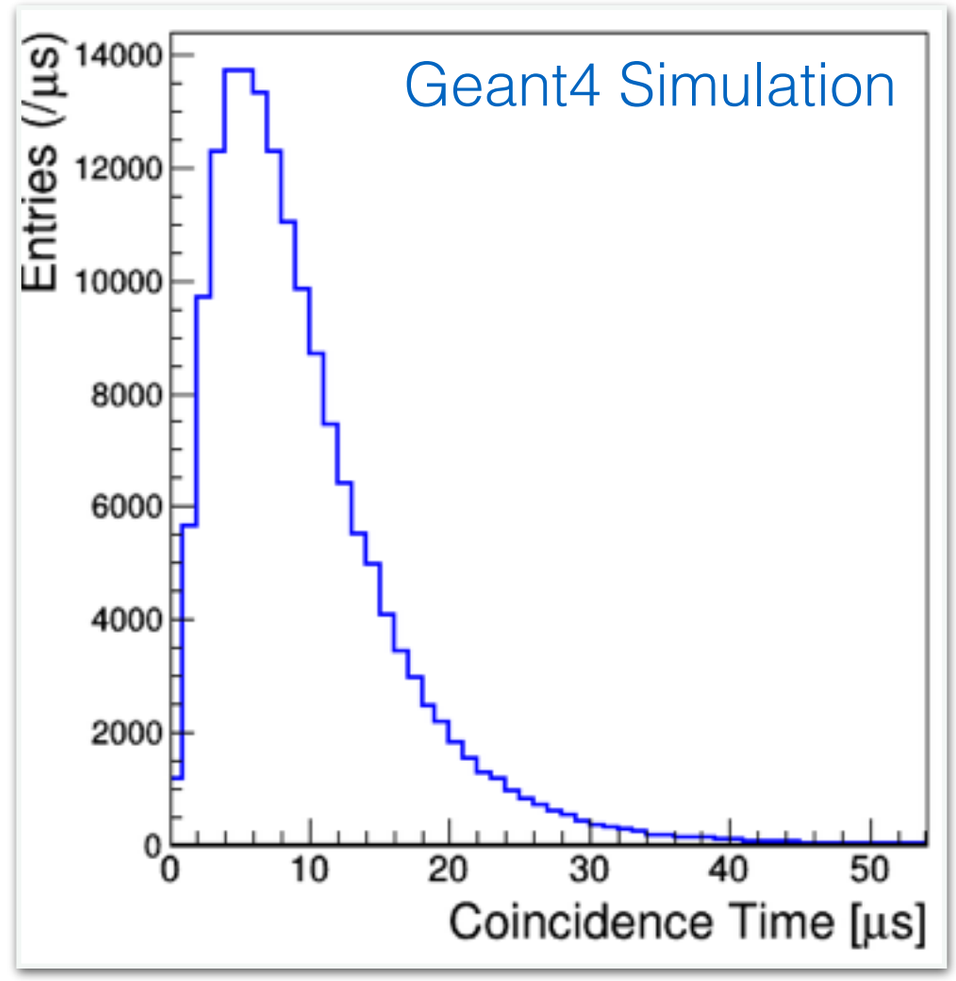




Liquid Scintillator

- LAB + Ultima Gold-F (DIN) 9:1
  — Better Pulse Shape Discrimination
- High Gd concentration — 0.54 (±0.03) %
  — ~7 μs neutron capture time expected.

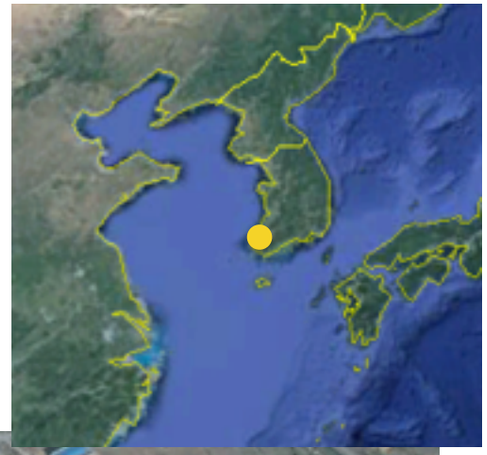


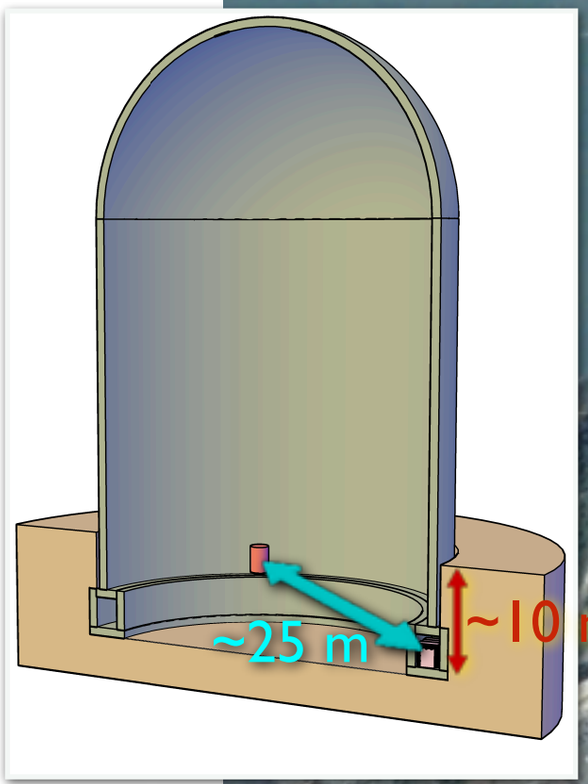


Experimental Site

Tendon Gallery of Hanbit Reactor 5

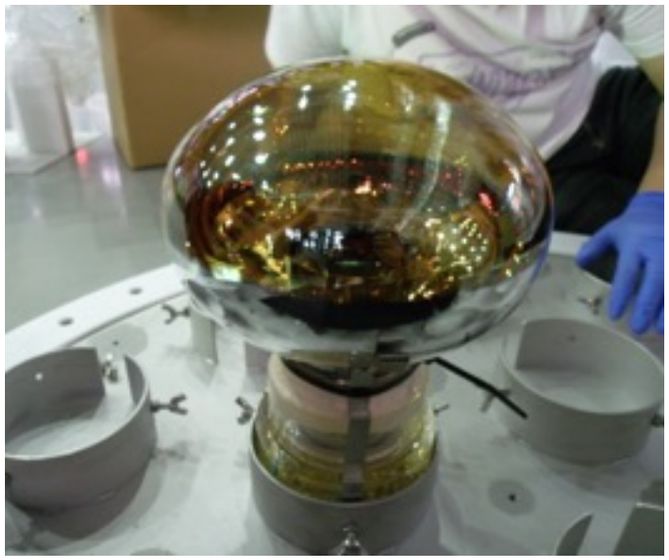
- 2.815 GW_{th} commercial reactor, with Φ 3 m x H 3.8 m core size
- Tendon gallery
  — overburden ~30 m.w.e (concrete)
  — baseline ~ 25 m
- Distance to nearest neighborhood reactors ~250m
  — 1% contribution from each of them

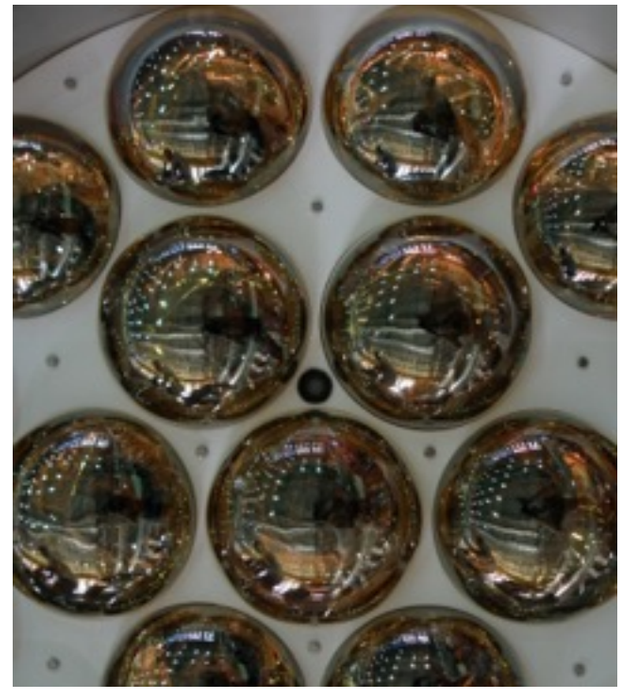


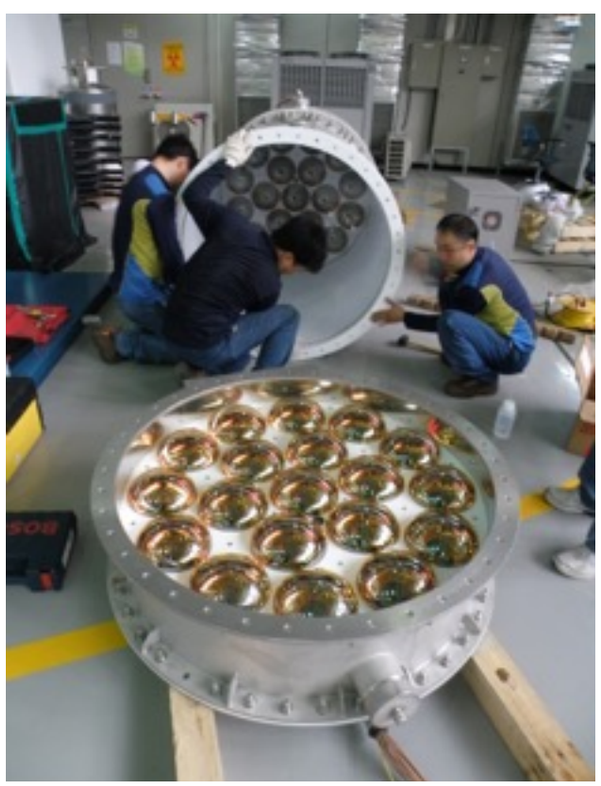


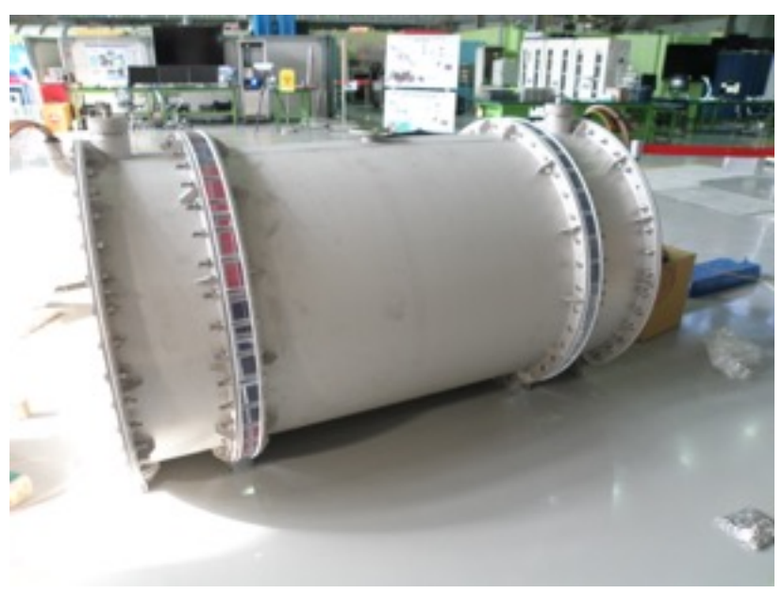
Construction & Test

April ~ July 2015 in Korea Atomic Energy Research Institute

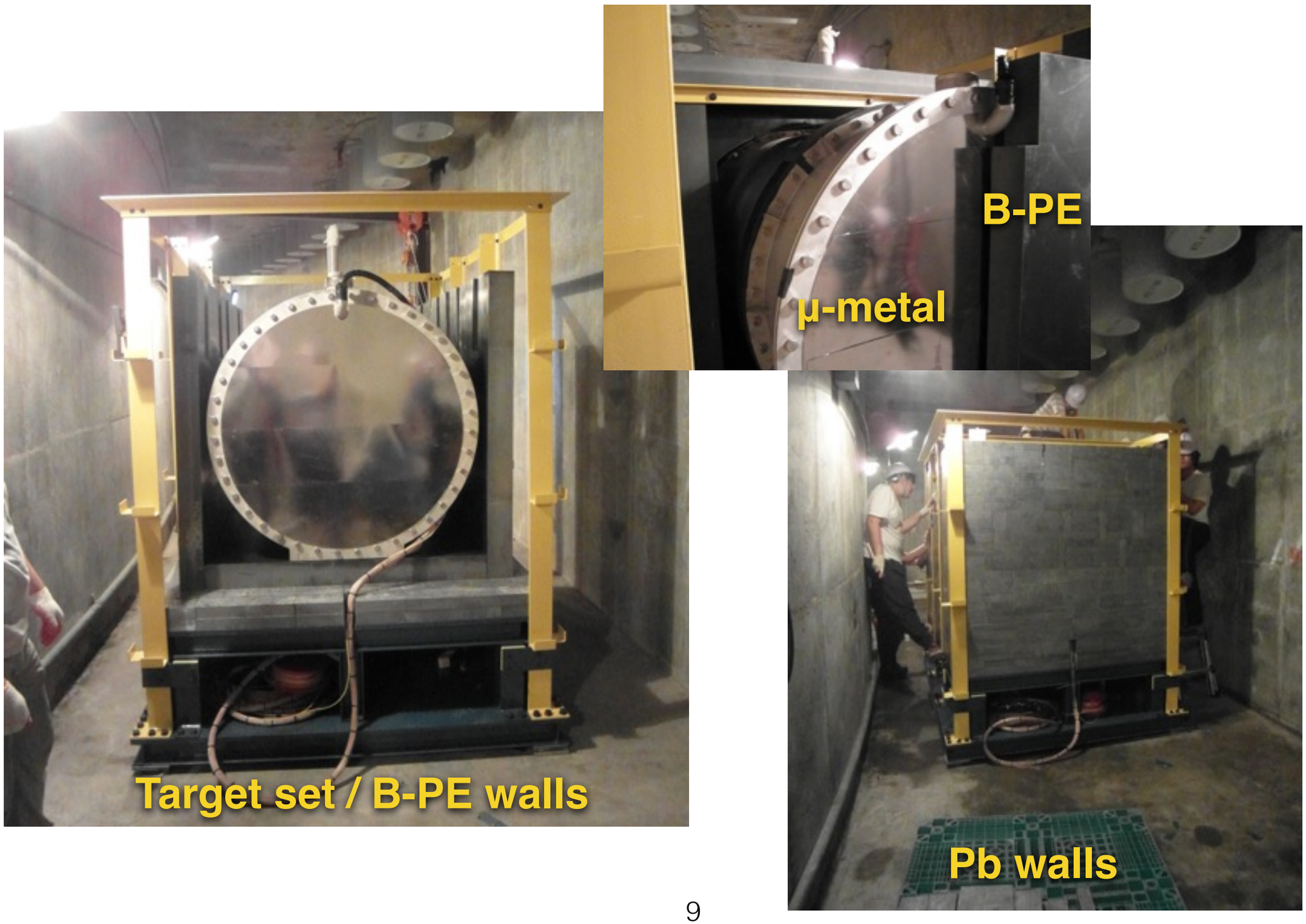




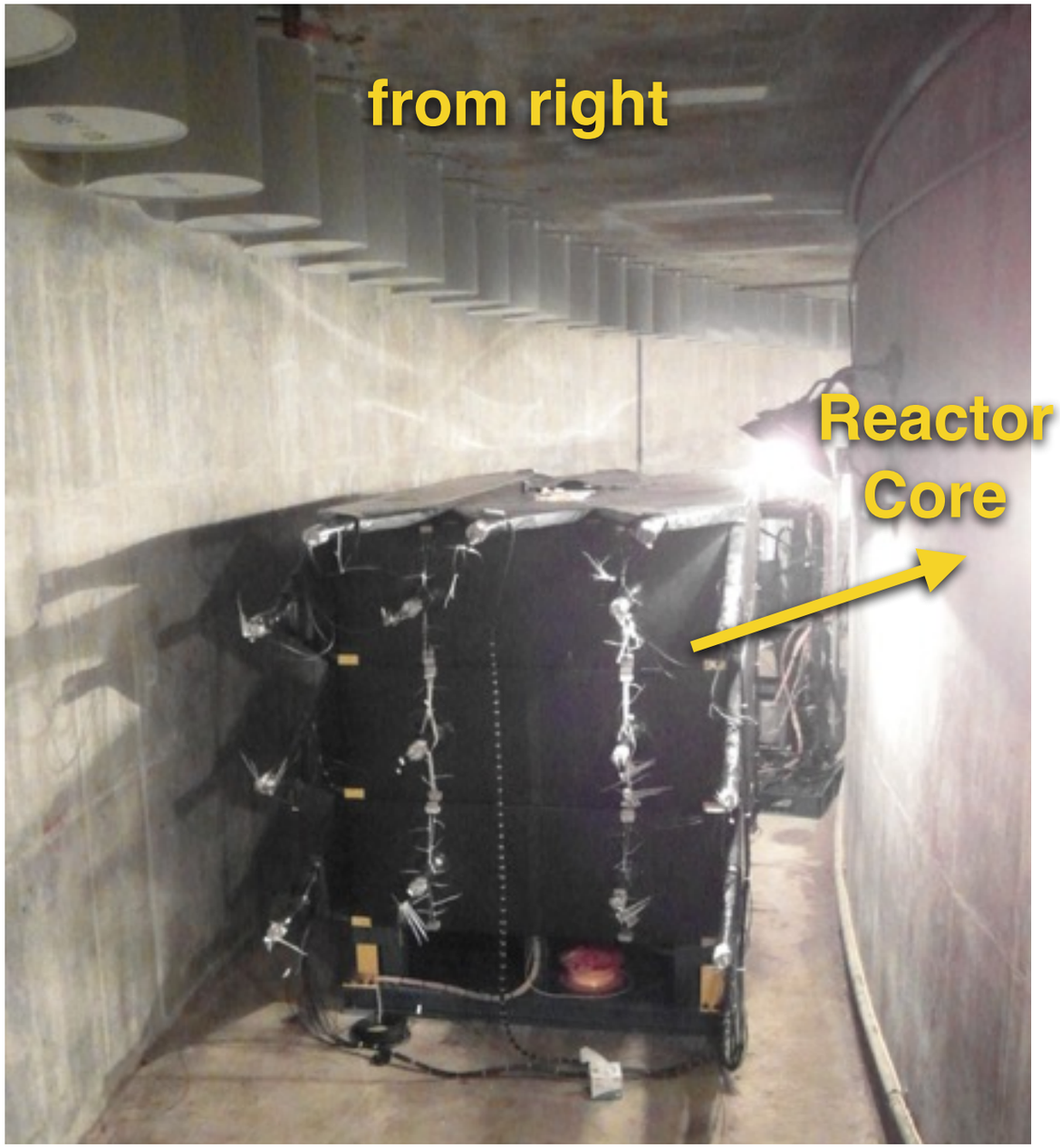


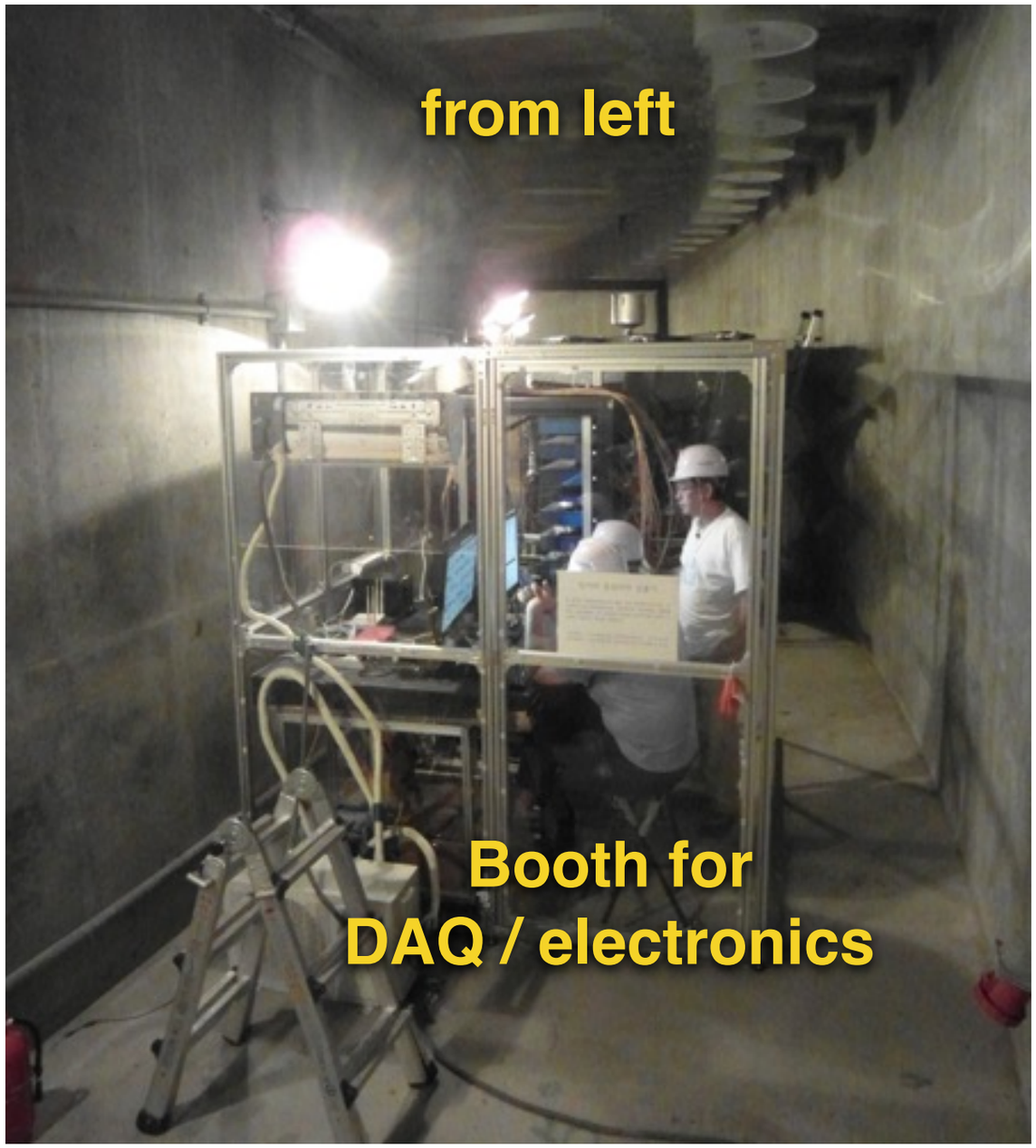


Installation in the Tendon Gallery

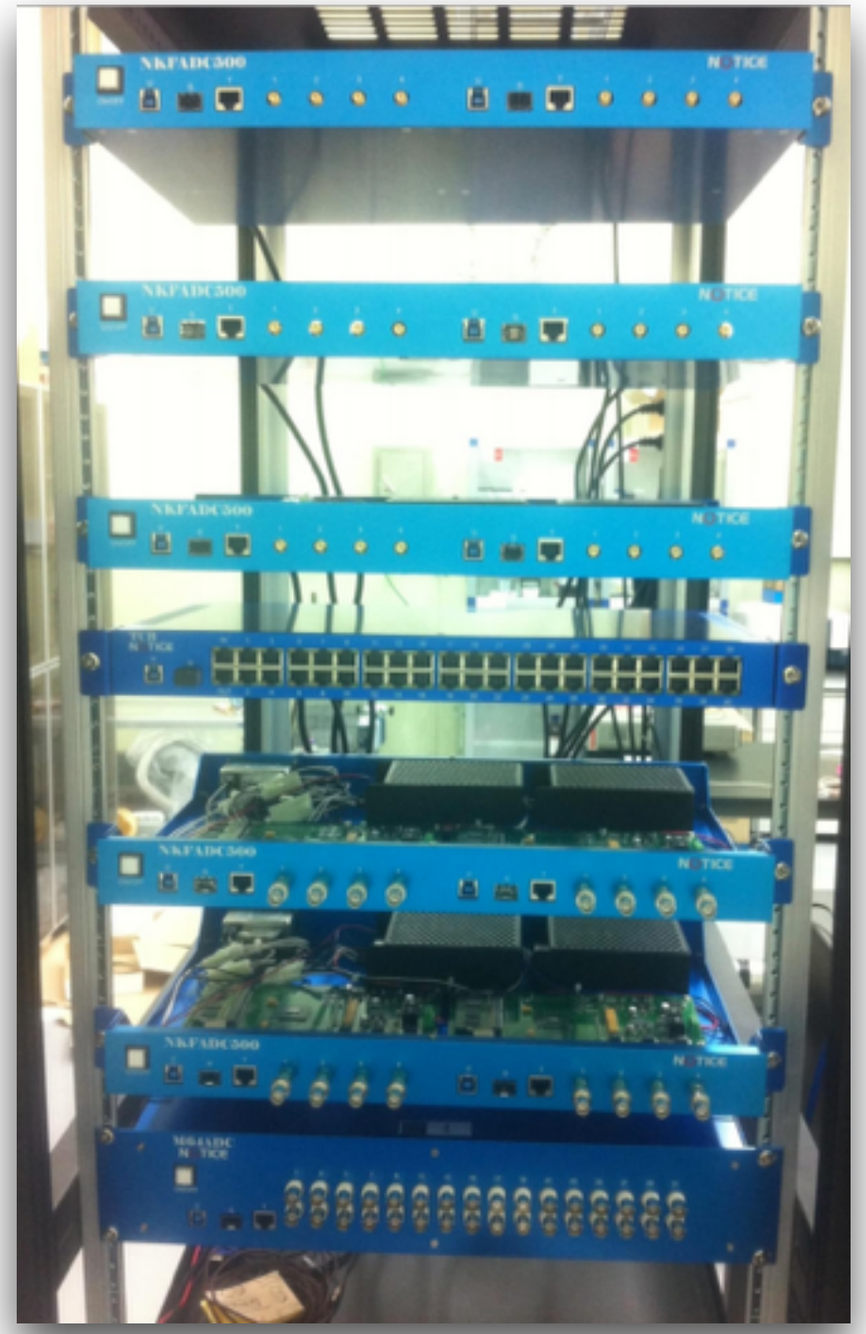


Installation in the Tendon Gallery



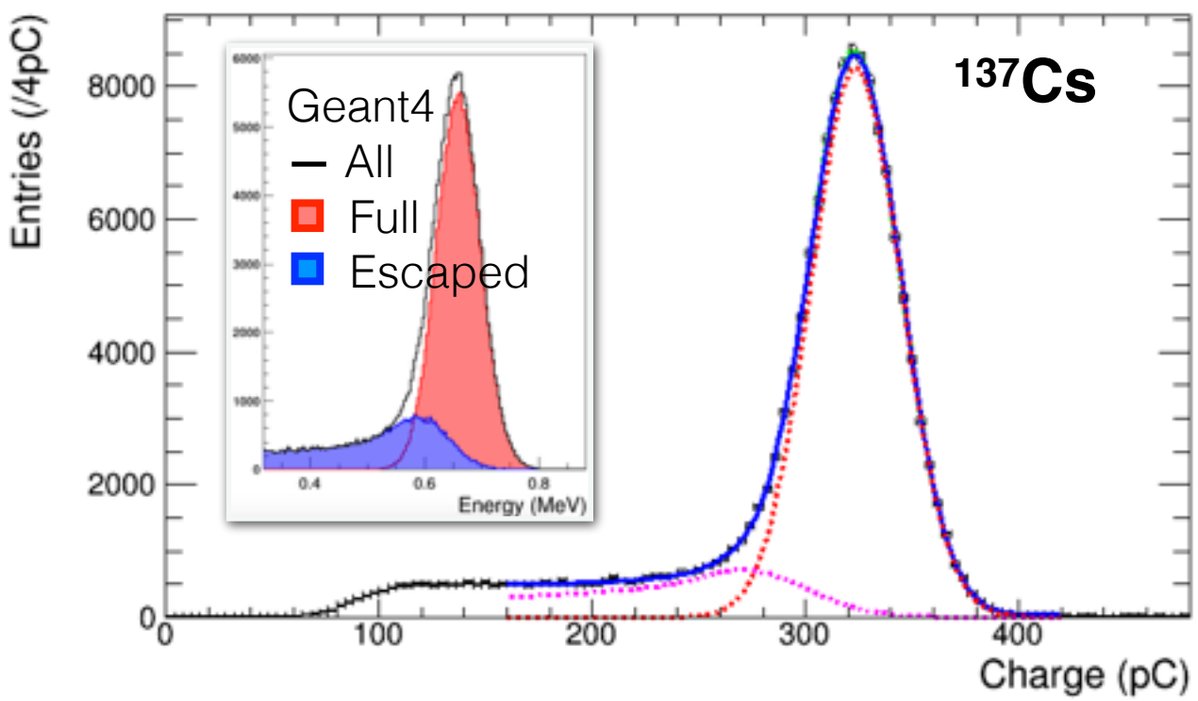


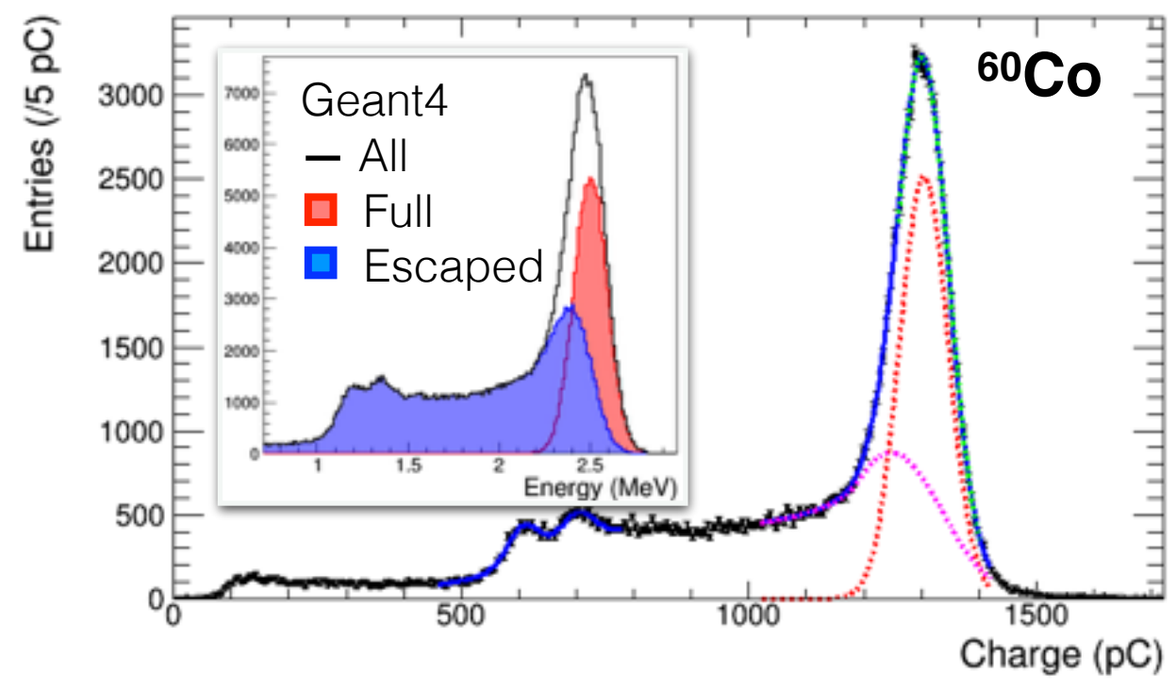
Data AcQuisition

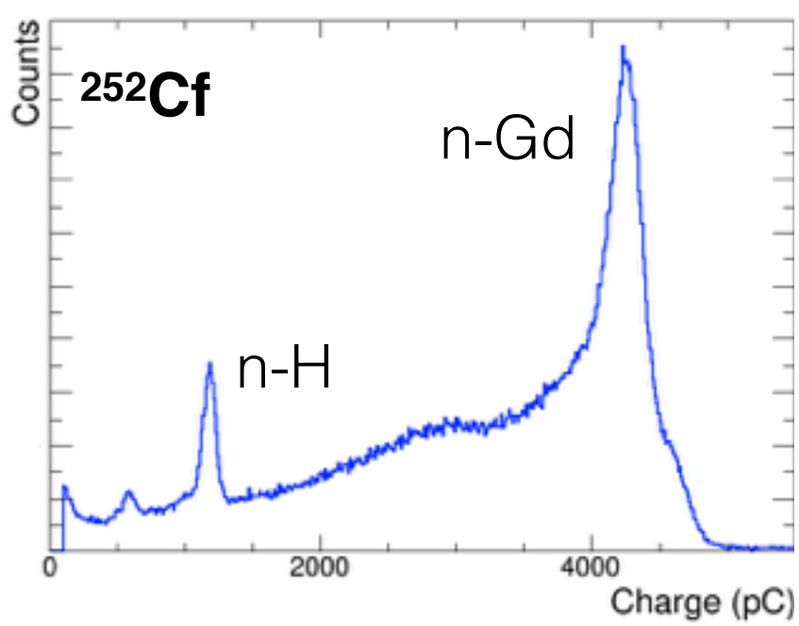


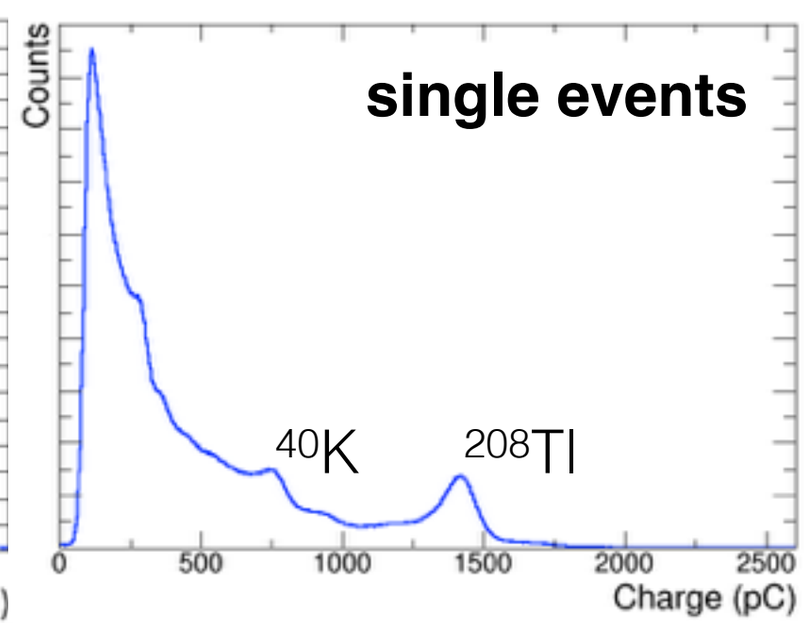
- 38 channels for the main detector:
  — 500 MHz FADCs for waveform analysis (PSD)
  — Multiplicity x height trigger
  — Regular pedestal monitor
- 30 channels for the muon veto detector:
  — 64 MHz FADC
  — Charge sum trigger
- One trigger board controls synchronization
- Data size : ~100 Gbytes / day
- Continuous unattended data taking

Energy Calibration Sources



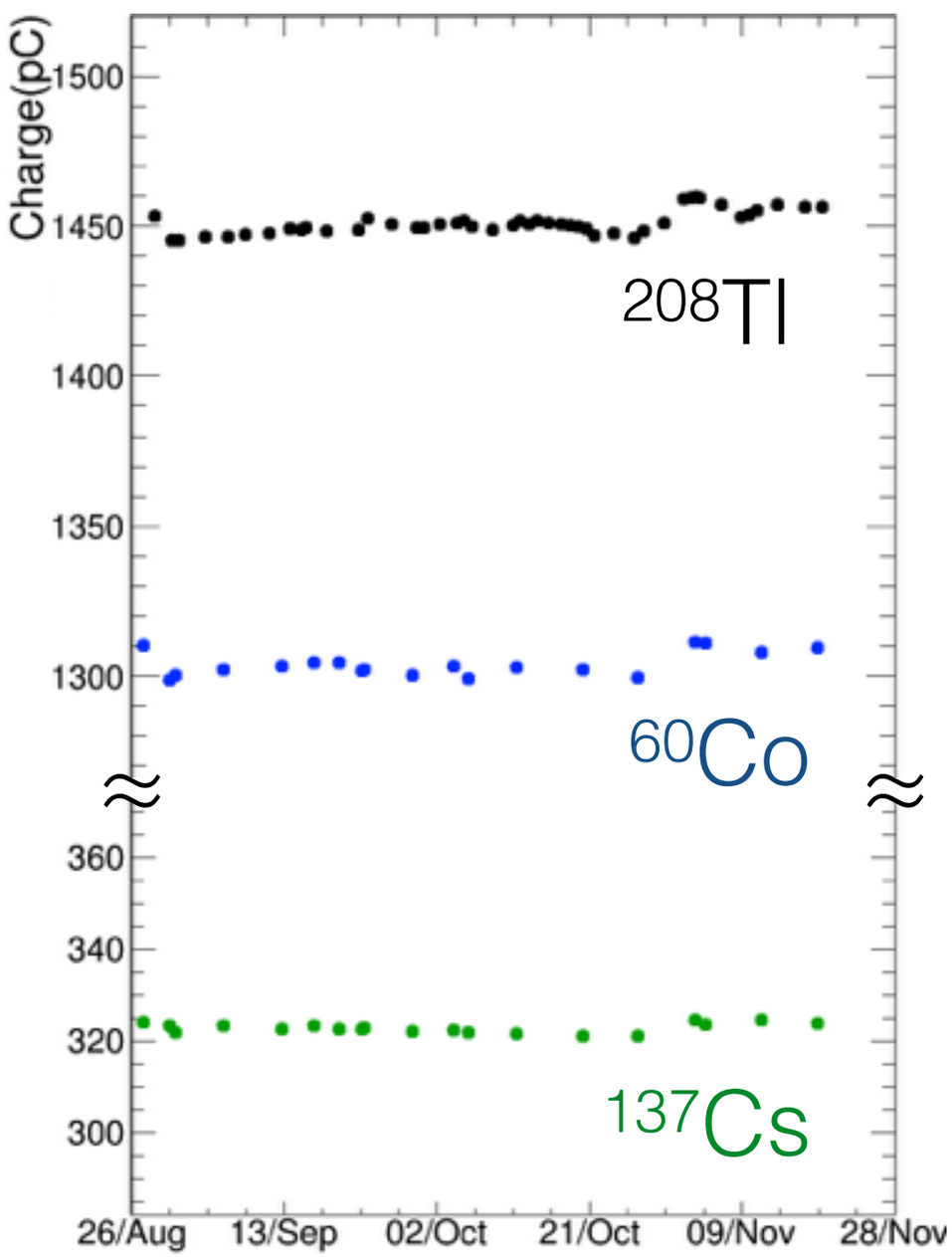


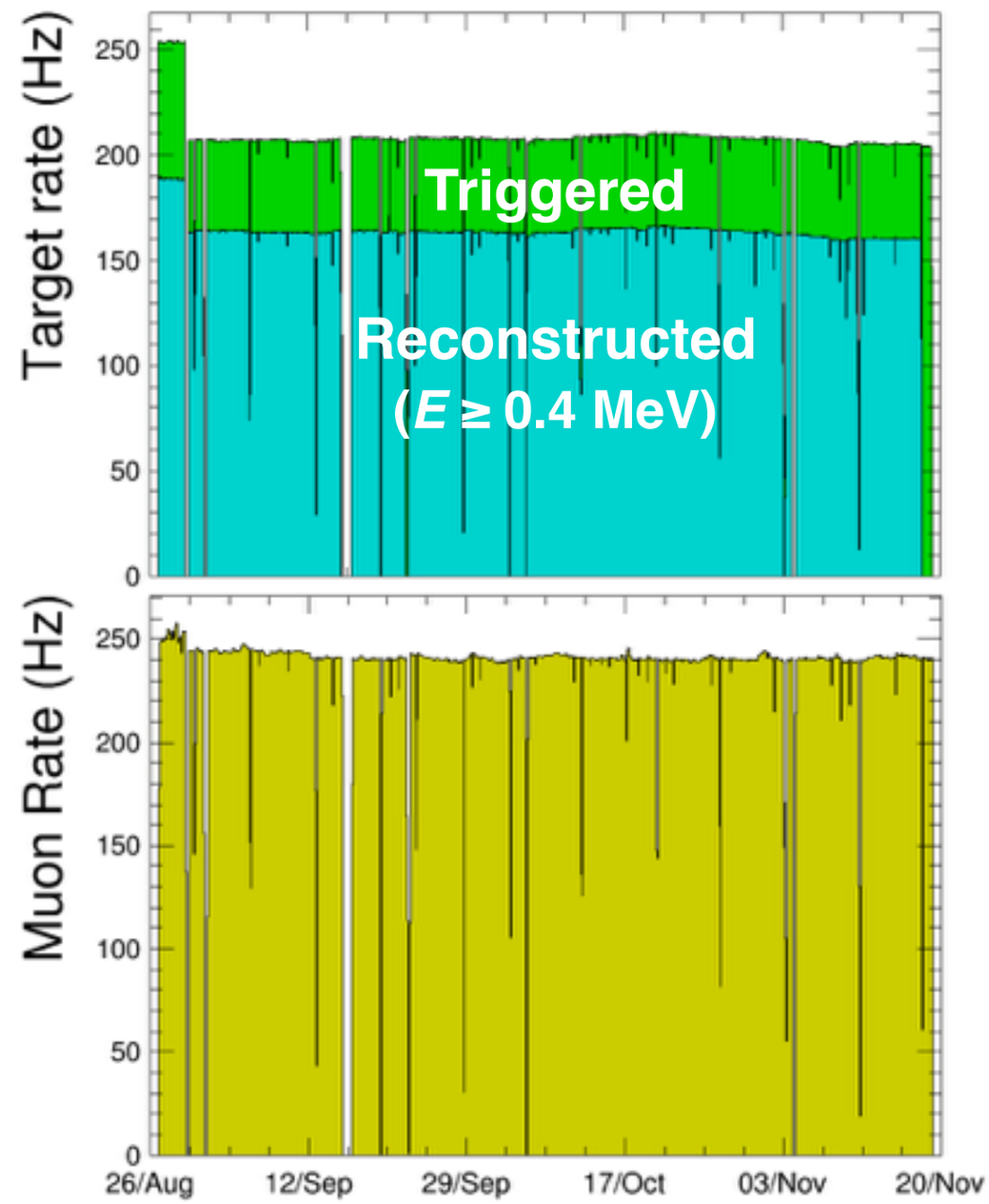




- Not easy to calibrate true full peak due to escaping γ.
- $\sigma/E \sim 5\%$ at 1 MeV.

Stable Detector Response

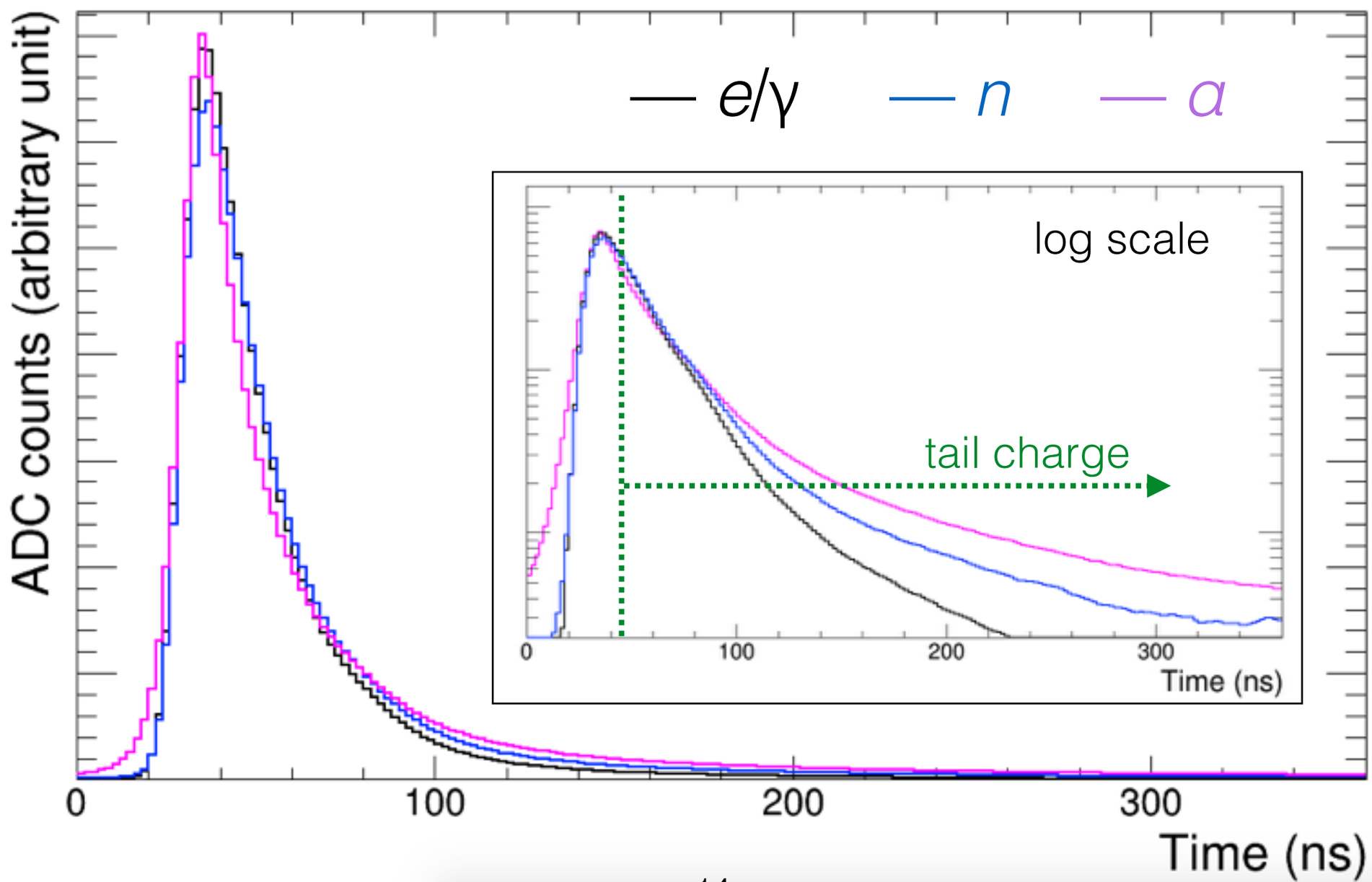




Change ≲ 1%

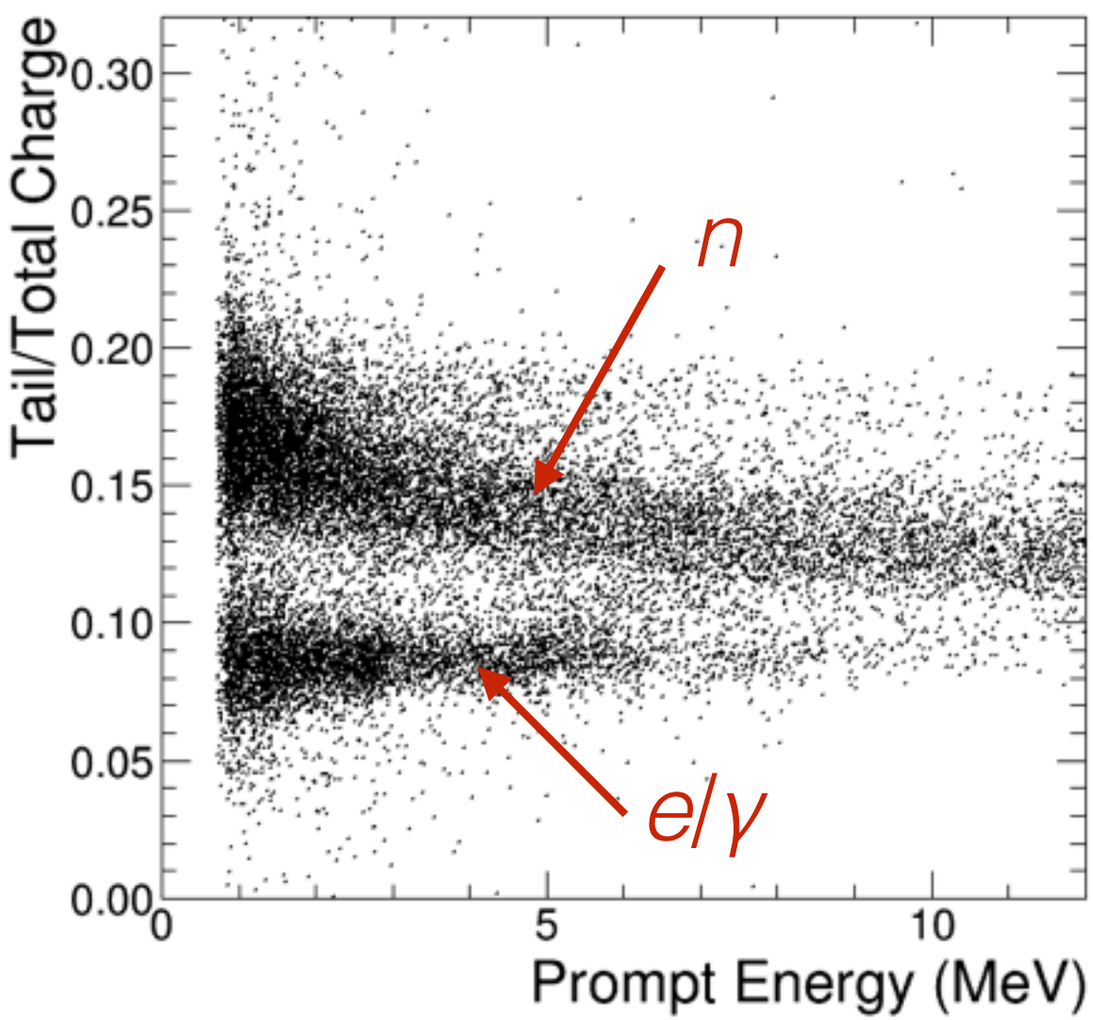
Pulse Shape Discrimination

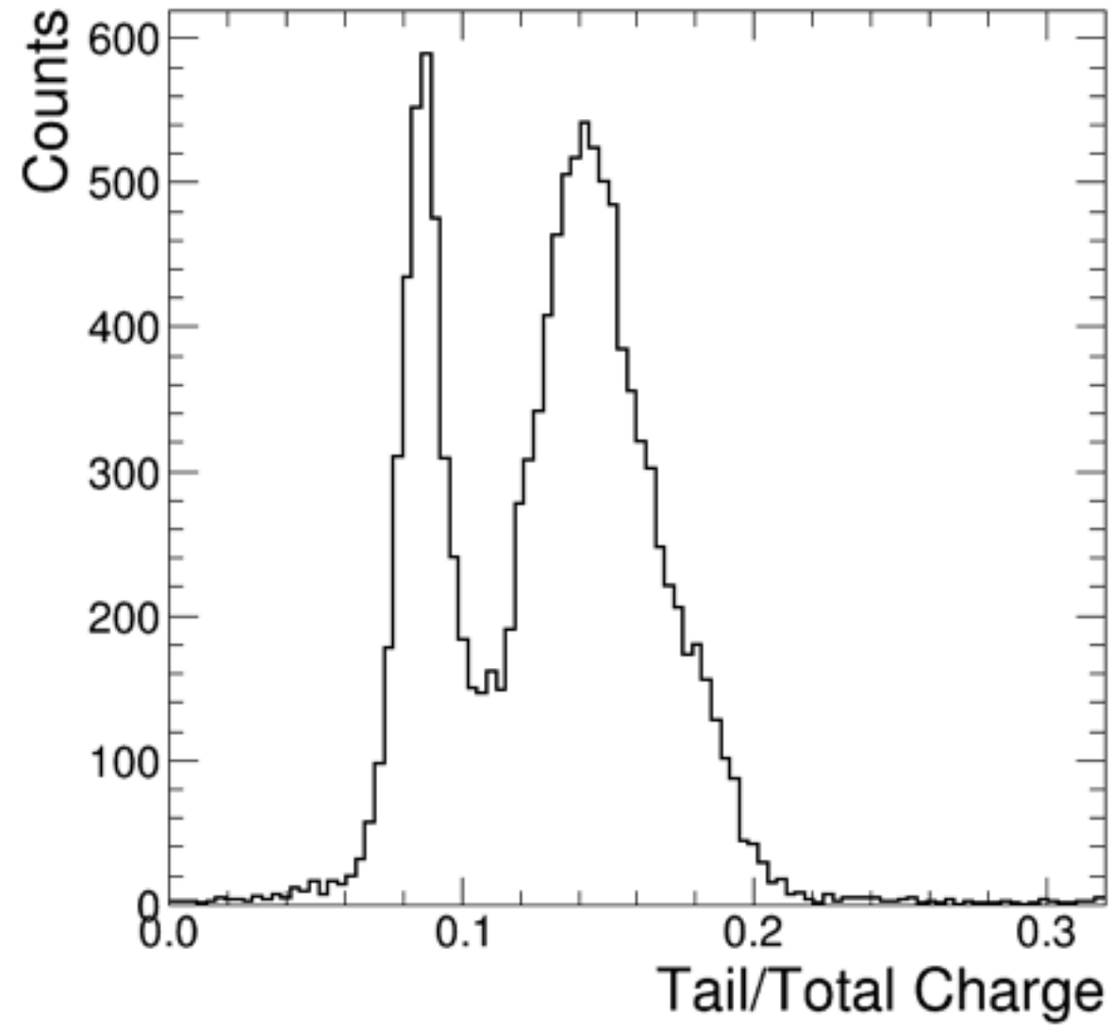
Accumulated Waveforms



PSD

Reactor OFF IBD Candidates

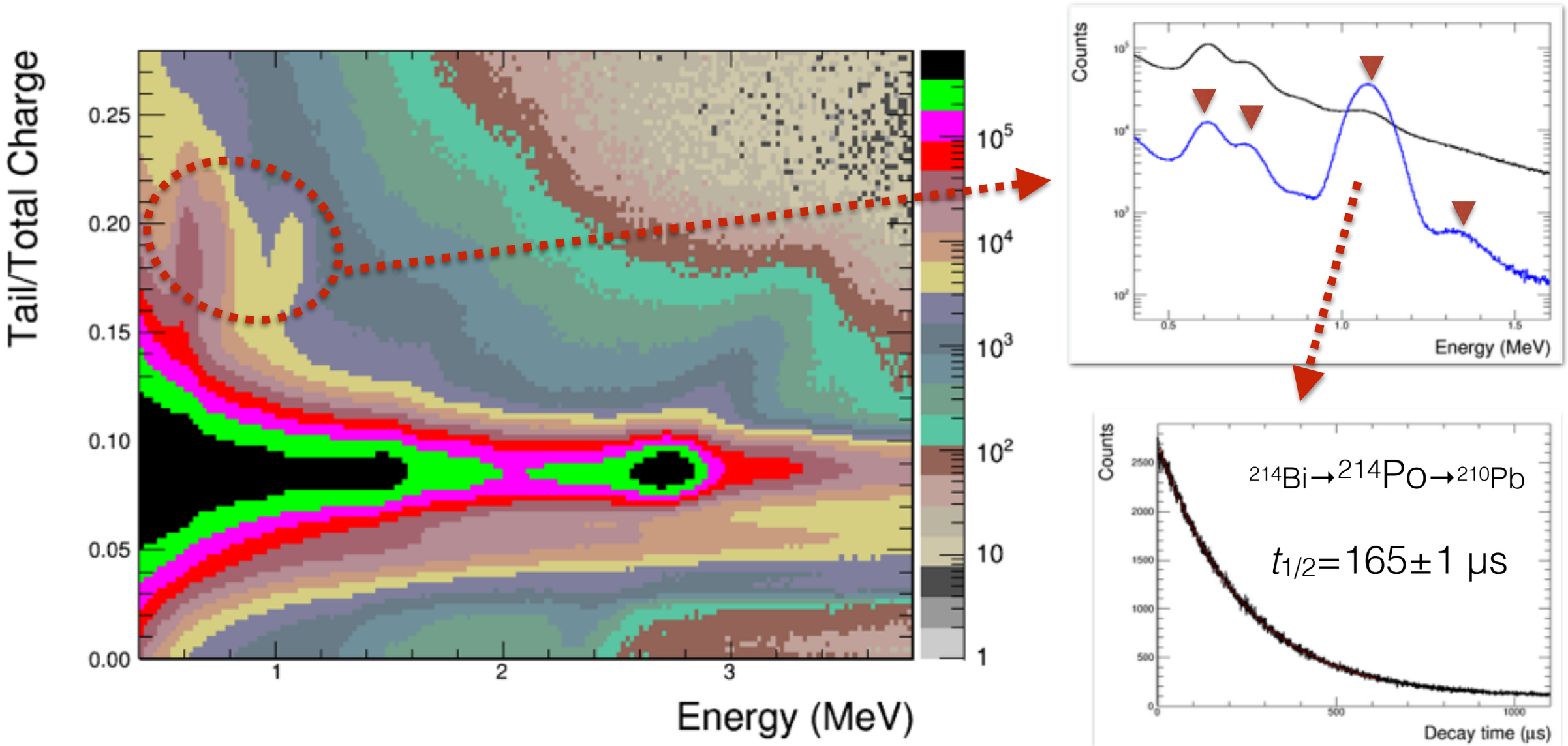




70% background reduction
with 99.5% γ-like event selection

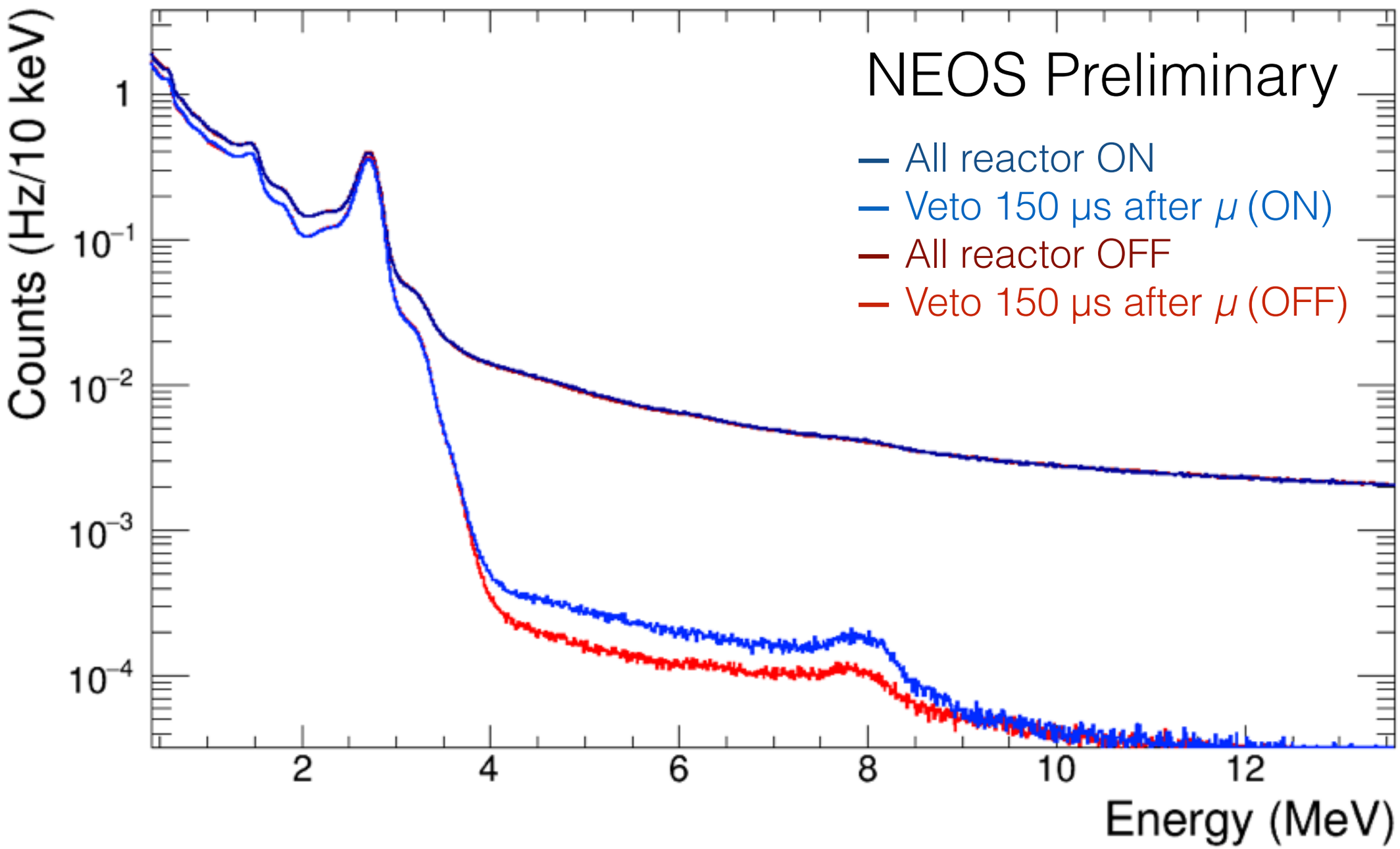
PSD

Alpha background

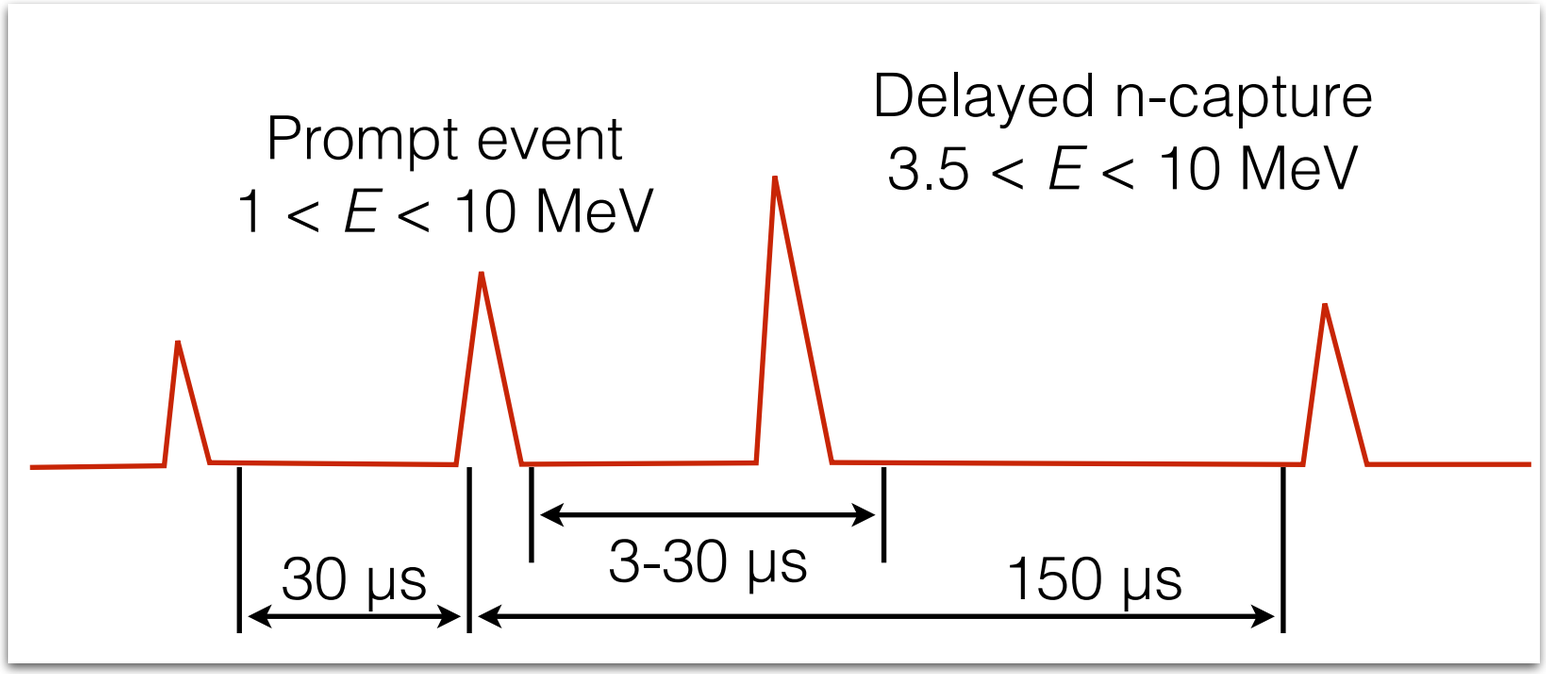


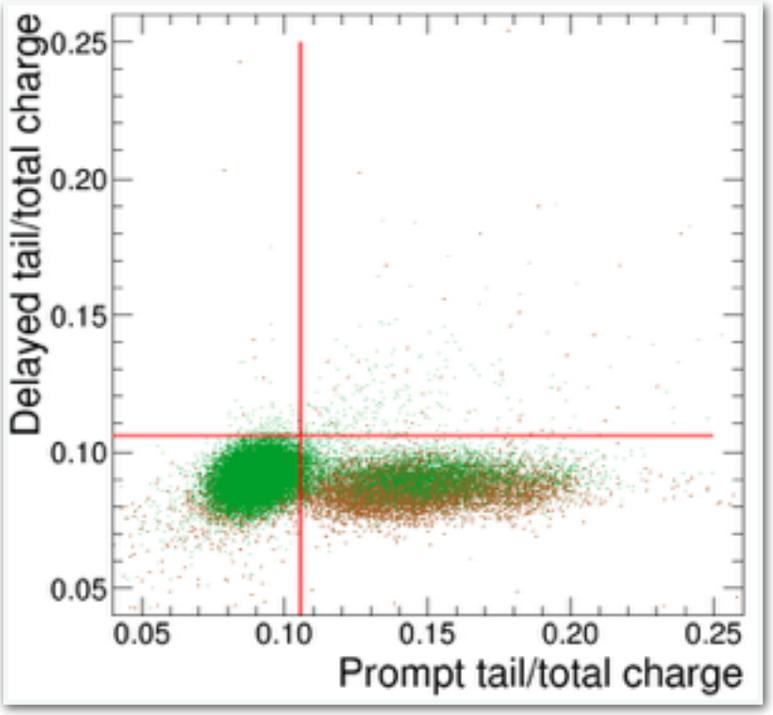
As point sources, utilized to understand detector responses

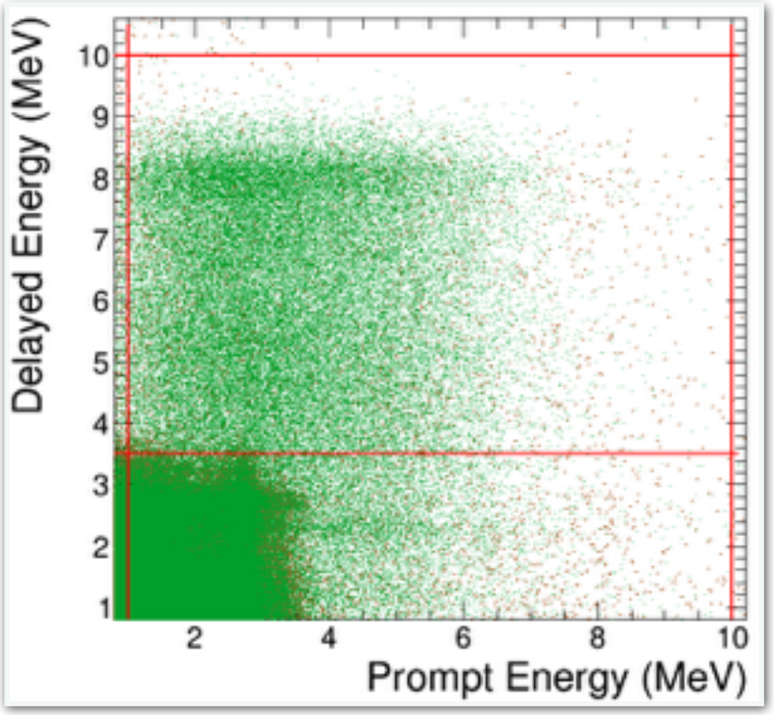
Single Events

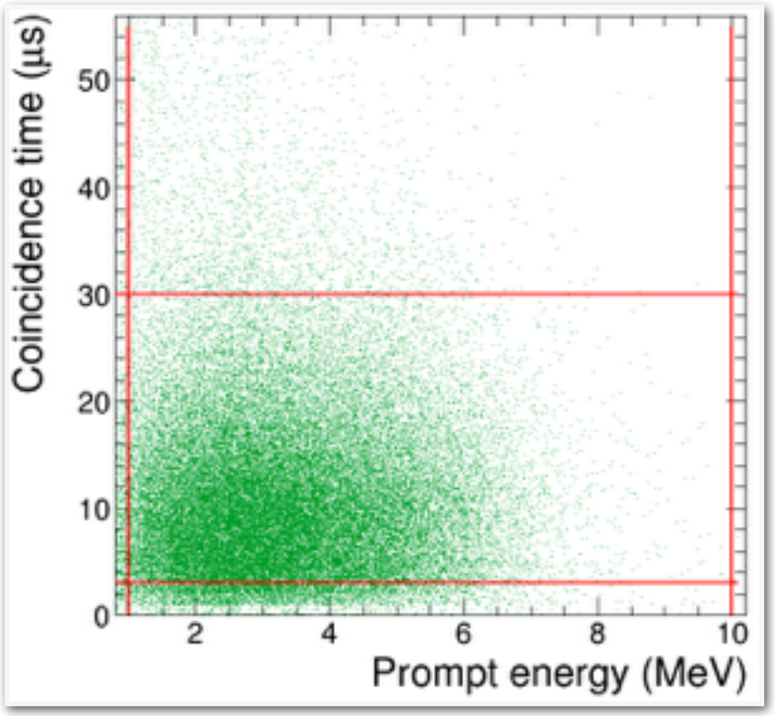


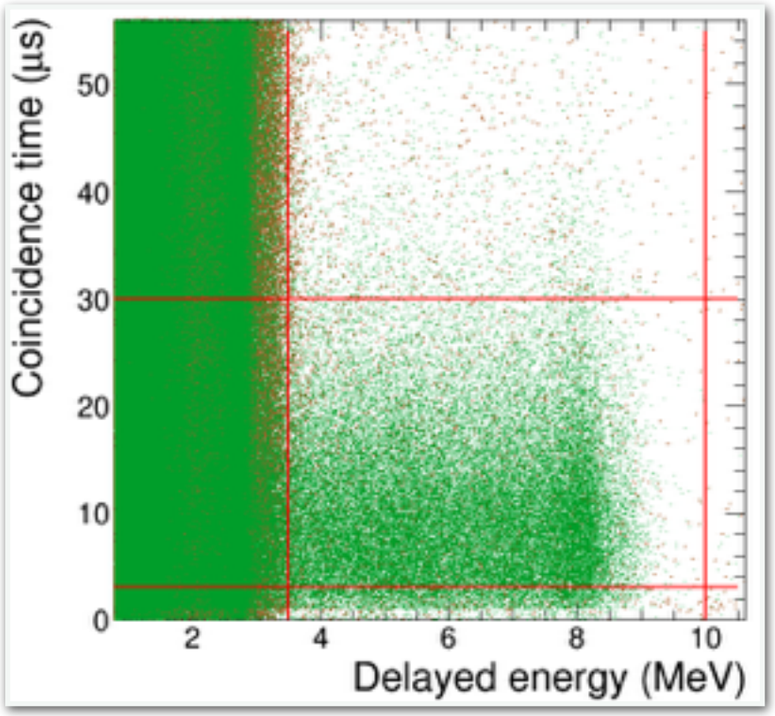
IBD Selection



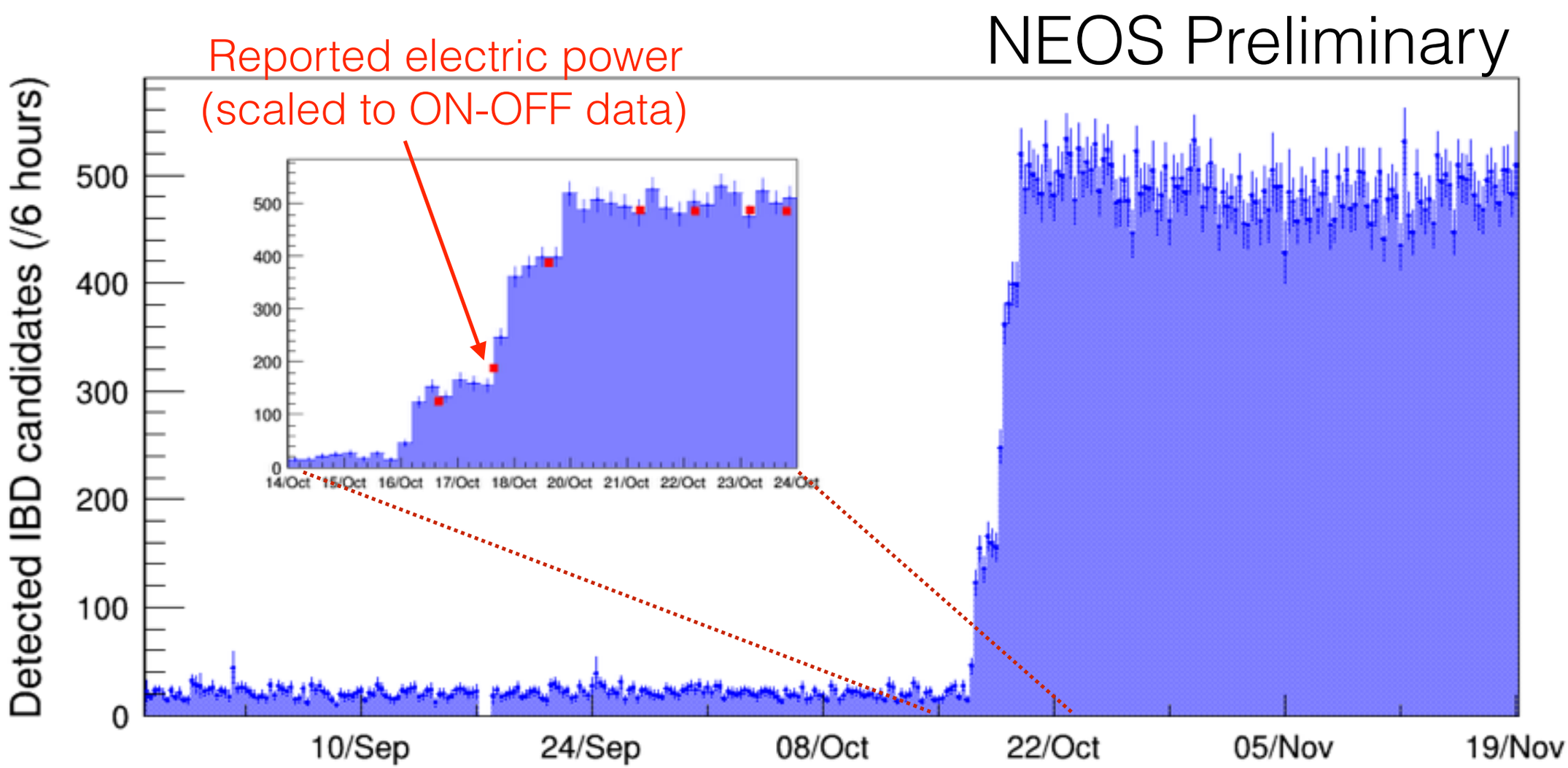








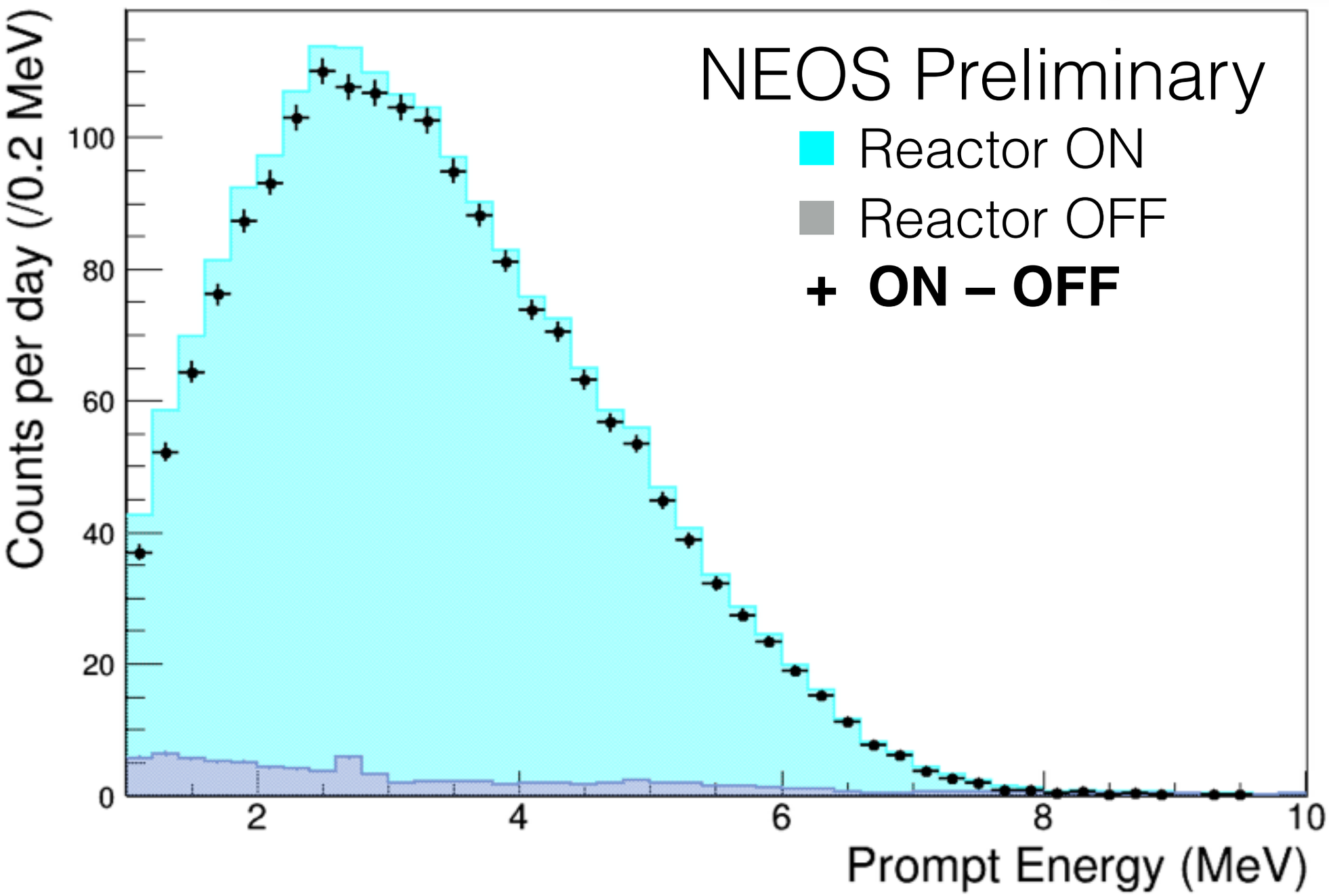
IBD Counting Rate



OFF: 84 ± 1; ON : 1946 ± 8 cpd

Signal / Background ~ 22

IBD Prompt Energy



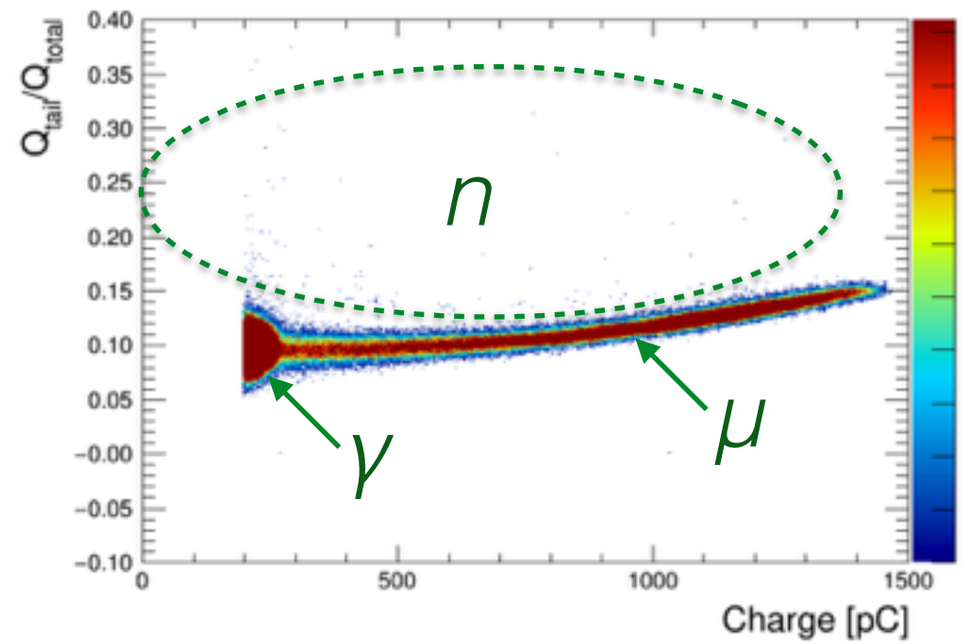
Summary and Plan

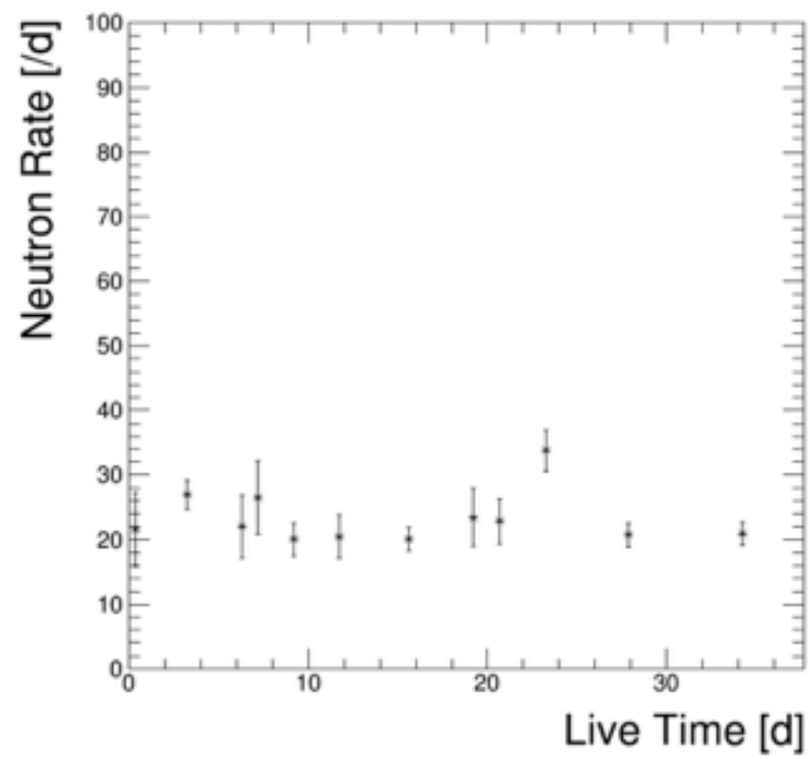
- Homogeneous detector of 1000 L of 0.54% Gd loaded LS with sufficient PSD power
- Close to 2000 IBD events per day. S/N~20.
  6 Months' data (~300,000 ν) will be statistically enough to verify the oscillation.
- Further study to reconstruct energy from raw charge information.
- Monte Carlo simulation under tuning to understand detector responses.

Thank you

Backup

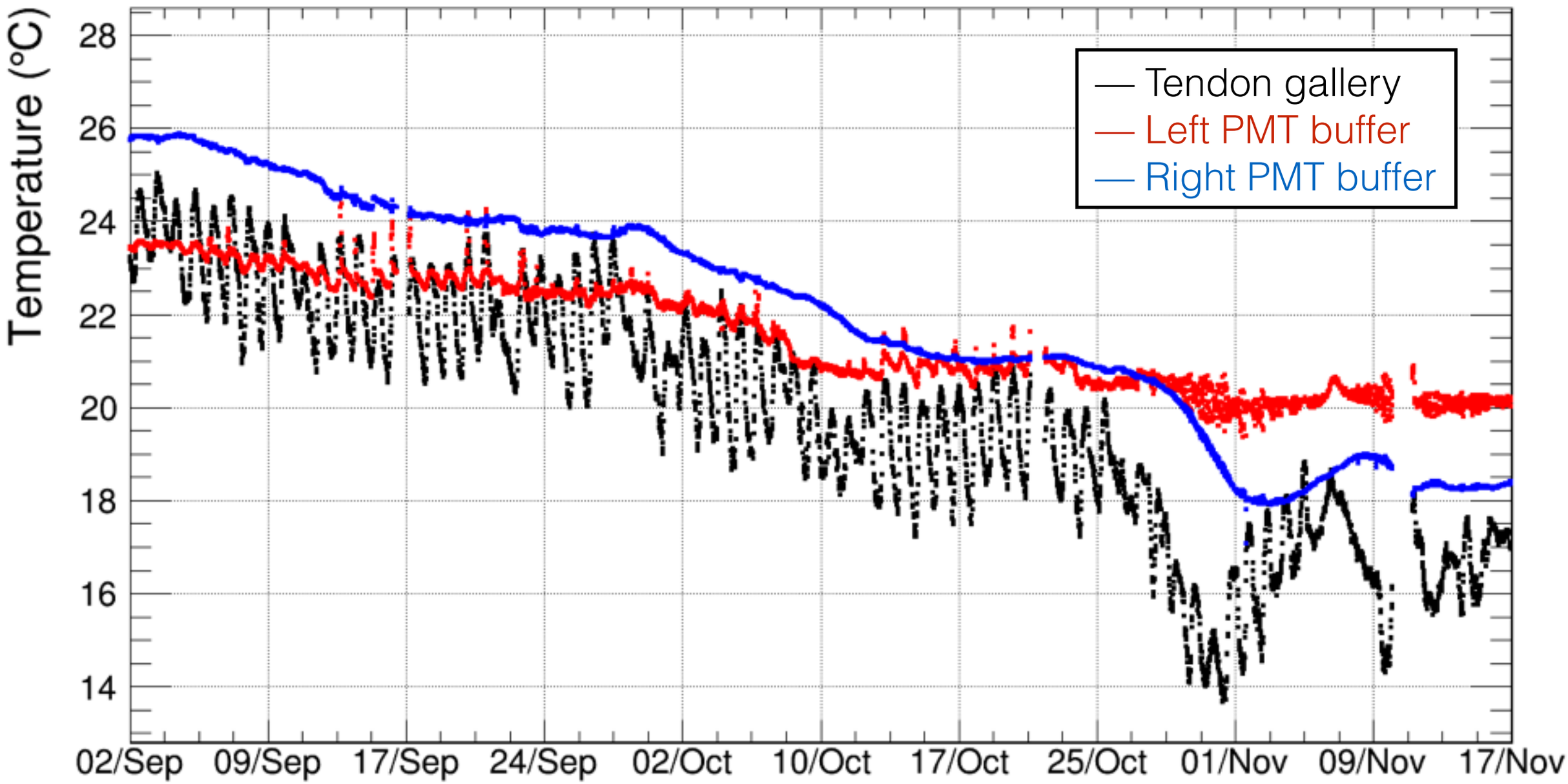
Independent Background Measurement in the Tendon Gallery





- Using 780 mL of UG-F LS,
  fast neutron rate has been observed for about 30 days around the ramping up period.
- No particular change was found between before / after ramping up.

Temperature



Reactor On / Off IBD Events