



Nucifer Experiment at Osiris

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Nucifer Collaboration



Irfu



In2p3



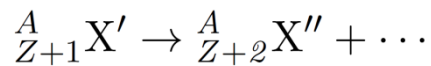
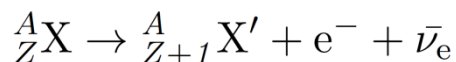
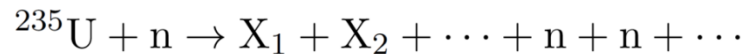
Reactor Monitoring



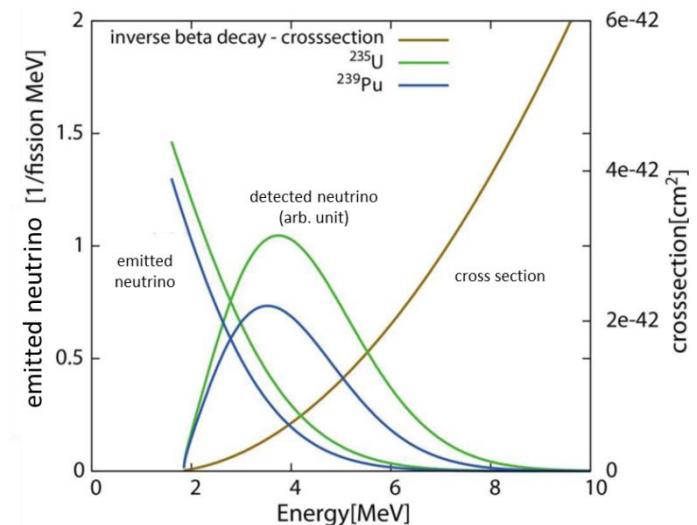
Reactor monitoring using antineutrino detectors

- Neutrinos cannot be shielded -> can be detected outside a reactor building
- There's no alternative source of antineutrino -> cannot hide reactor operation
- > Suitable for IAEA's inspection!

Reactor Neutrino

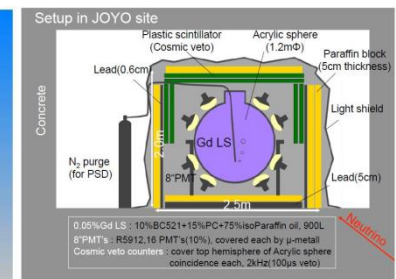
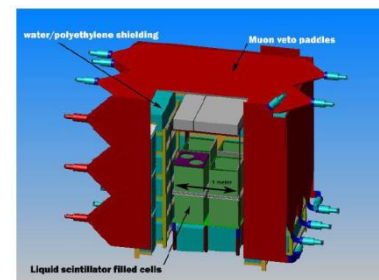


- 6 antineutrinos
- 200MeV
emitted per fission

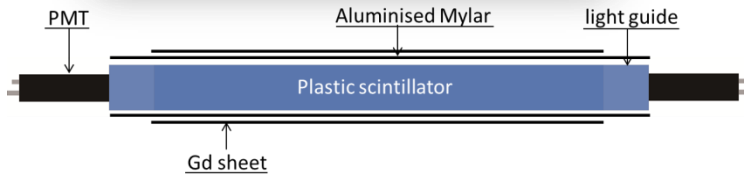
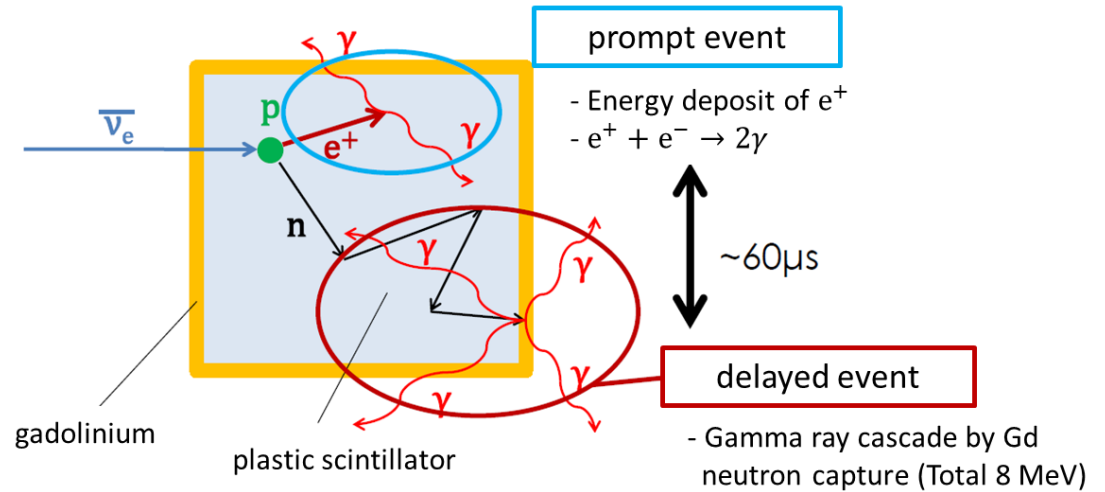


Previous experiments

- ROVNO experiment (Ukraine, 1984)
- SONGS experiment (California, 2006)
- KASKA Prototype experiment (Japan, 2007)



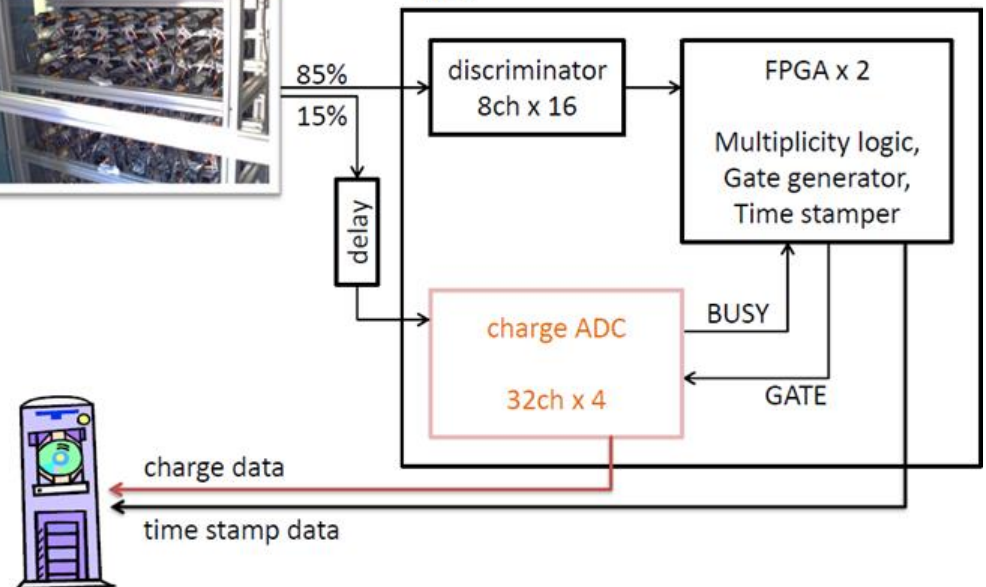
PANDA



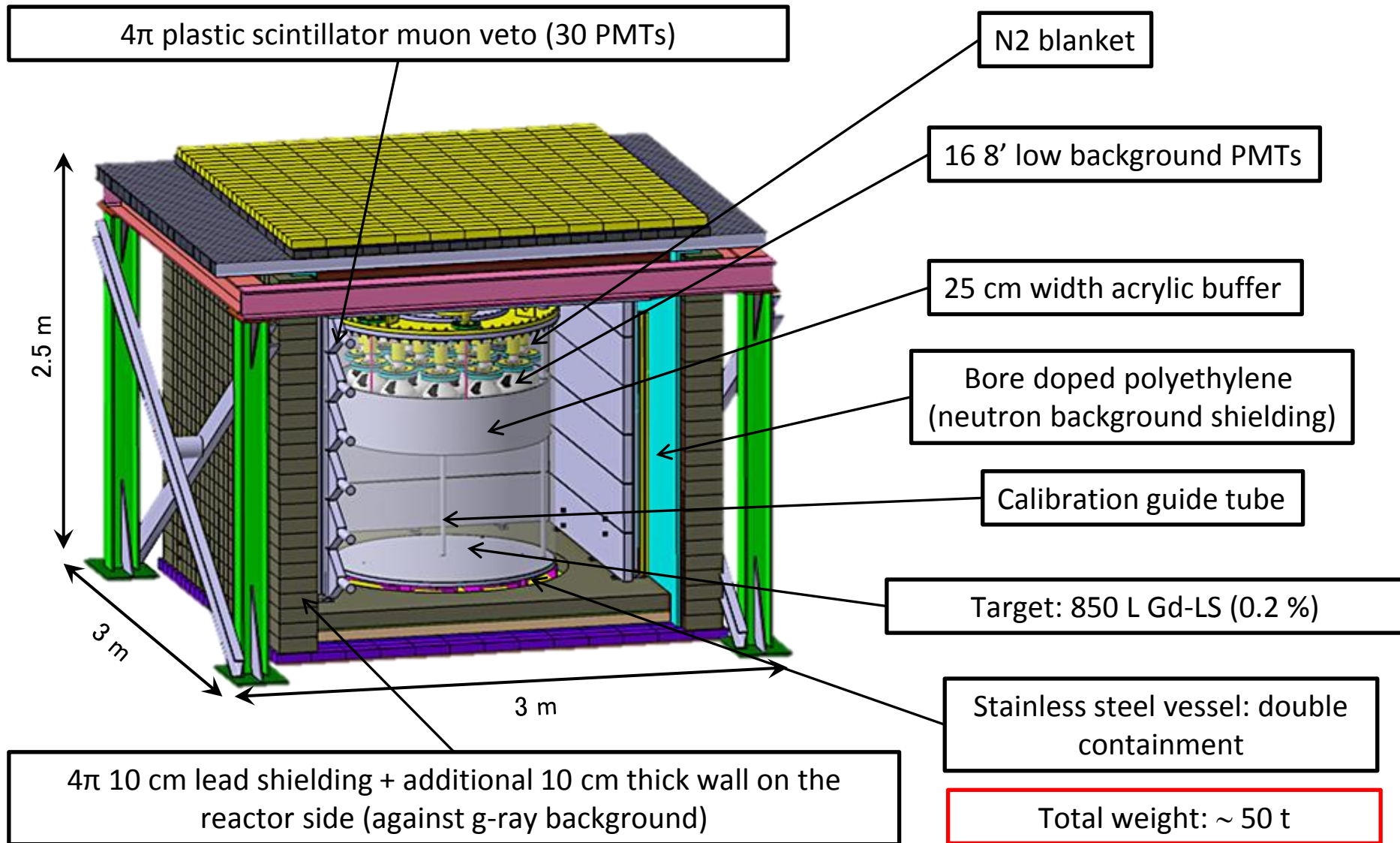
PMT x 128, asymmetric divider



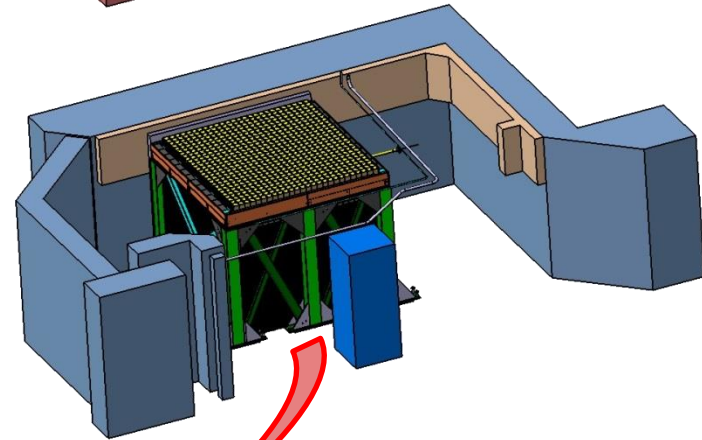
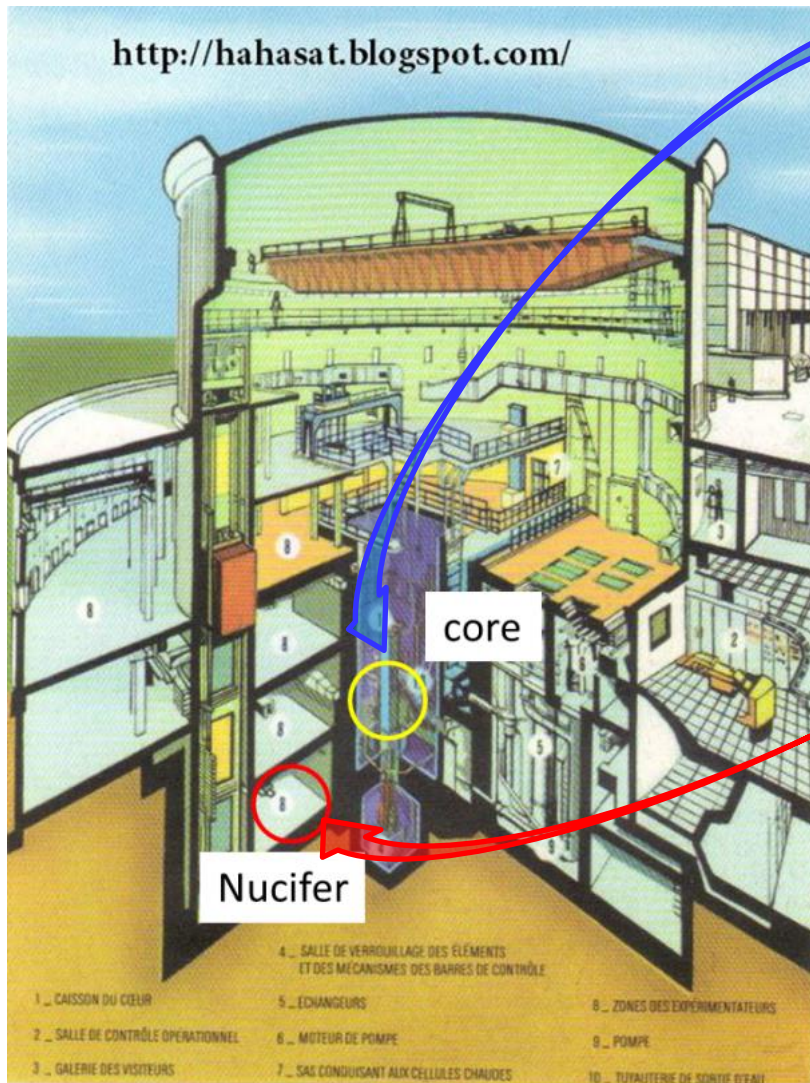
VME



Nucifer



Osiris



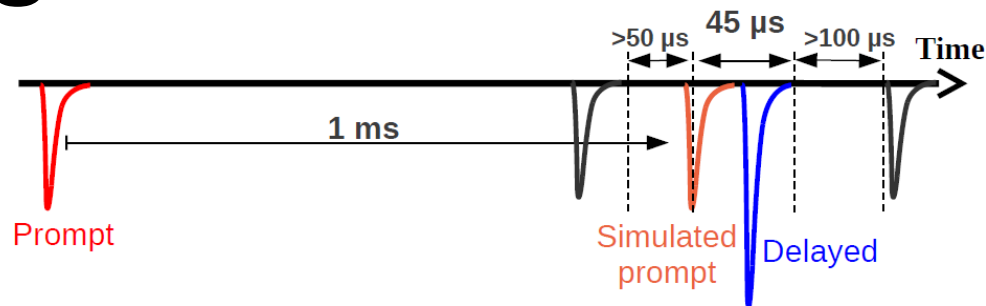
- Located at CEA Saclay (FR)
- Experimental nuclear reactor
- $70 \text{ MW}_{\text{th}}$, enriched ^{235}U fuel (20%)
- Operating cycle: 3 weeks ON + 10 days OFF
- Distance between core and detector: 7 m
- 11 m underground, 10 m.w.e. overburden

Backgrounds

Accidental background

- Natural radioactivity (gamma)
- Thermal neutrons

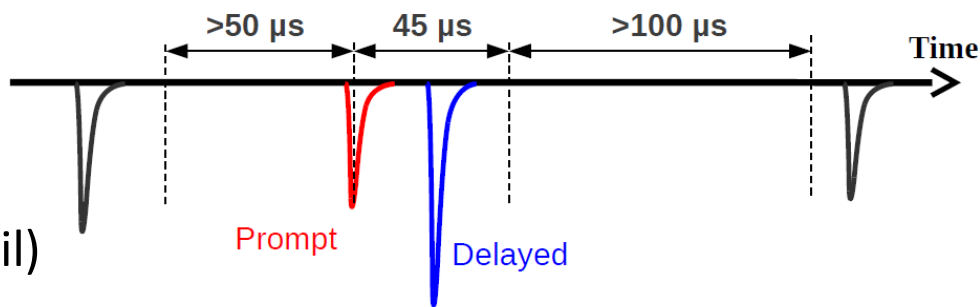
-> Can be estimated using shifted time window



Correlated background

- Fast neutrons
(prompt-like event : proton recoil)
- Double neutron capture (caused by muon spallation)
- Long-lived cosmic ray activation product (^9Li , ^8He)

-> Can be estimated using reactor off data



$$N_{\bar{\nu}_e} = N_{\text{corr}}^{\text{ON}} - N_{\text{acc}}^{\text{ON}} - N_{\text{corr}}^{\text{OFF}}$$

Selection Cuts

Energy Cut

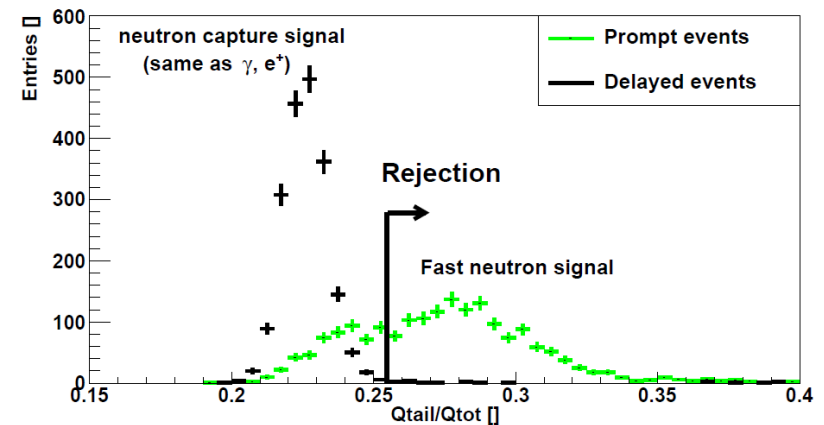
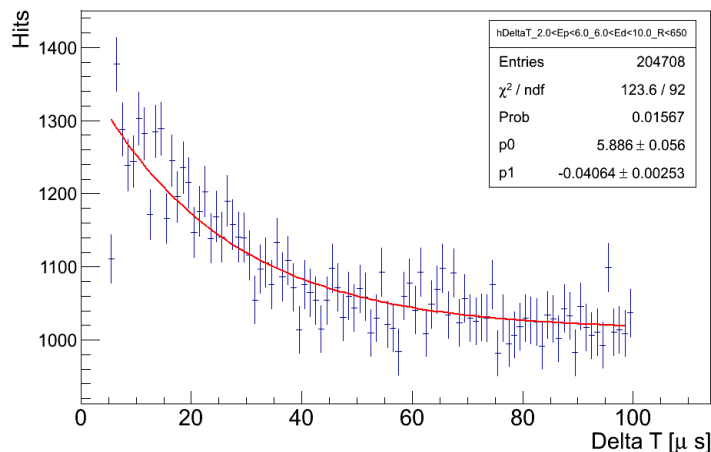
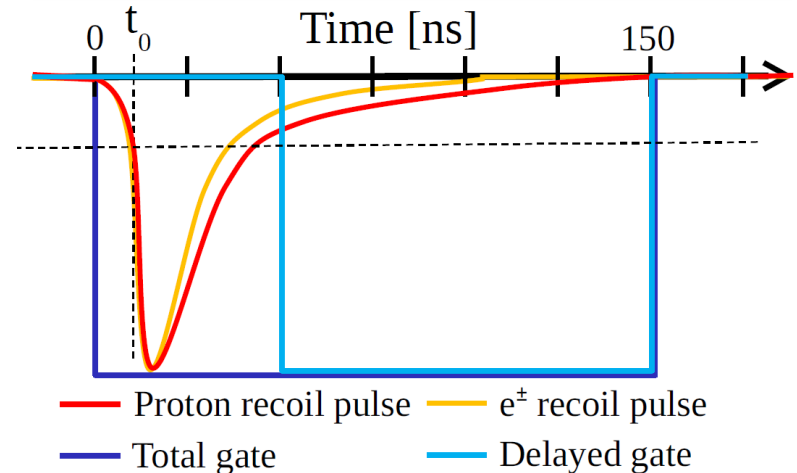
Prompt Q_{tot}	2 – 6 MeV
Delayed Q_{tot}	6 – 10 MeV

Time Cut

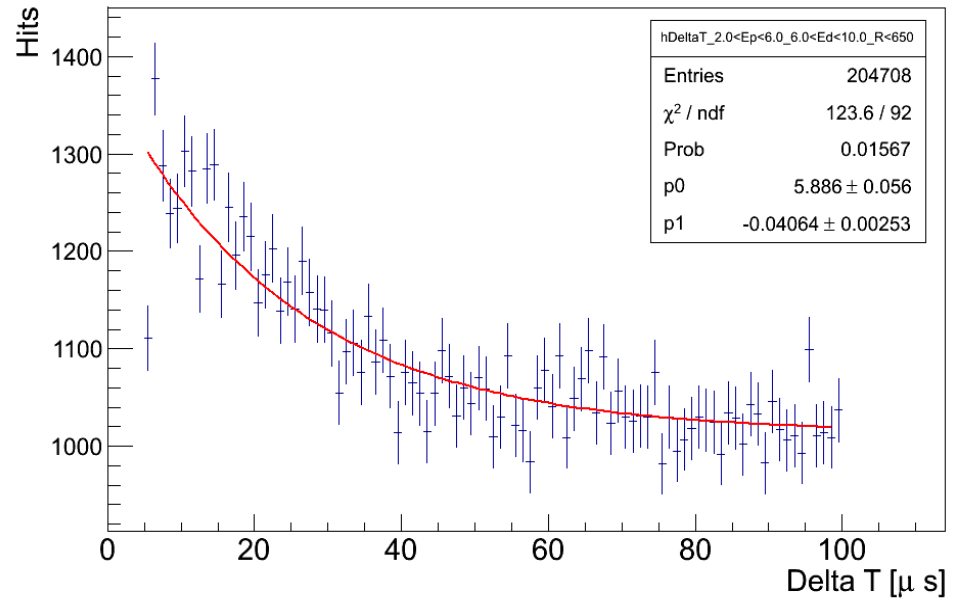
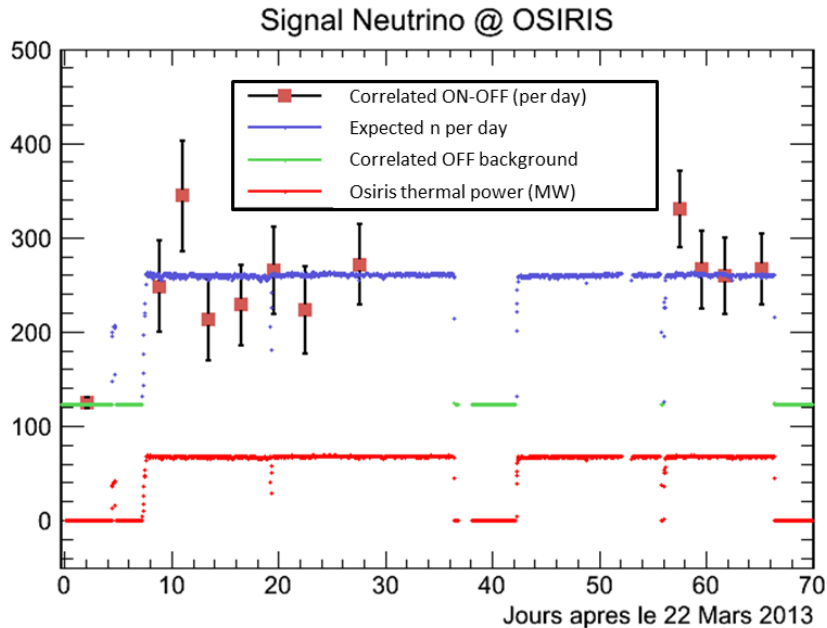
Delta T	5 – 45 μs
Clean Before Window	> 50 μs
Clean After Window	> 100 μs

PSD Cut

$Q_{\text{tail}}/Q_{\text{tot}}$	0.18 – 0.26
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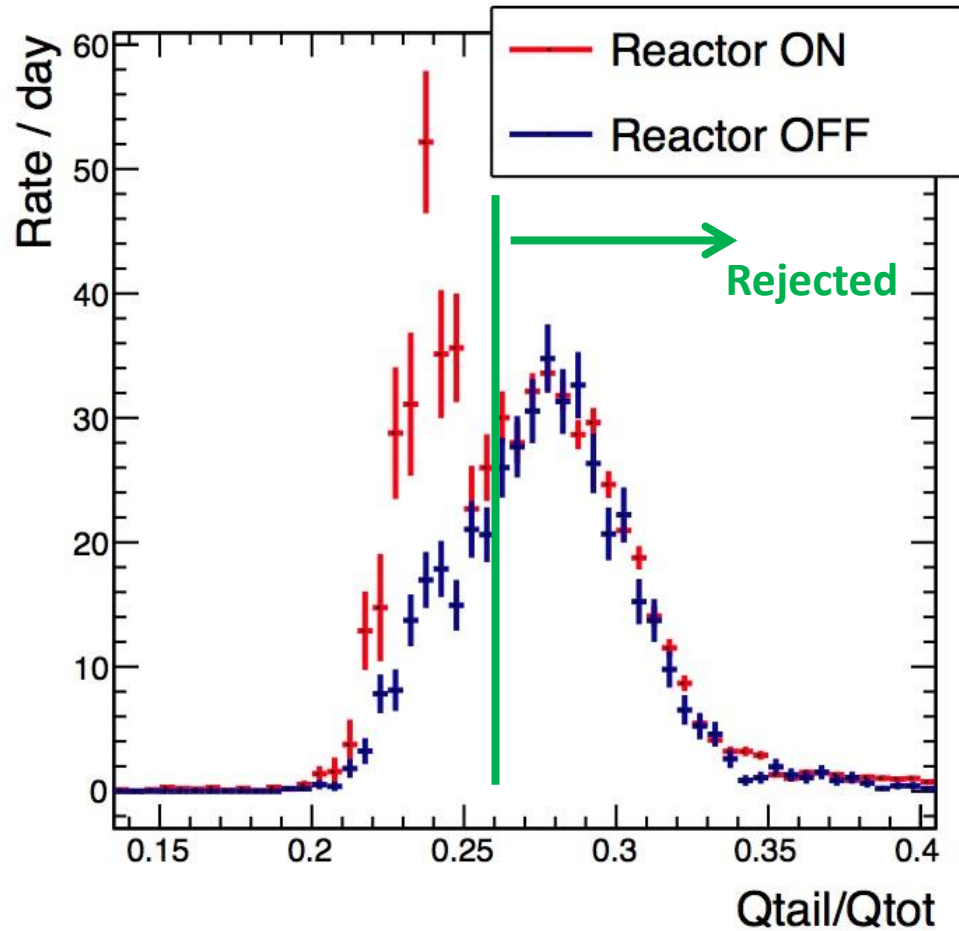
Preliminary Results



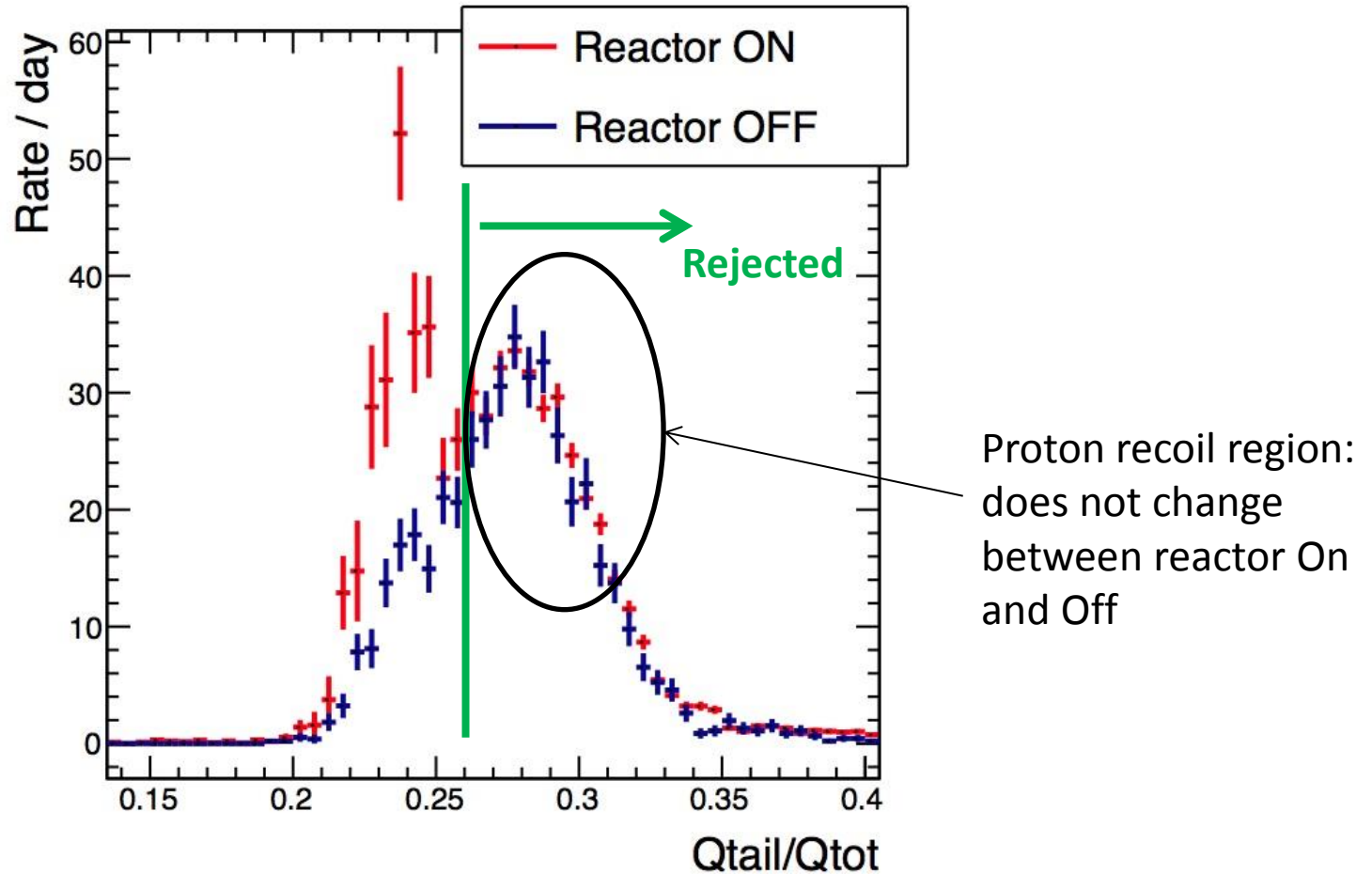
Reactor State	Accidental Rate [/day]	Correlated Rate [/day]
On	4372 ± 6	251 ± 17
Off	35.3 ± 0.3	123 ± 6
On - Off		128 ± 18

Good agreement with expected rate **132 events/day** (12% efficiency)

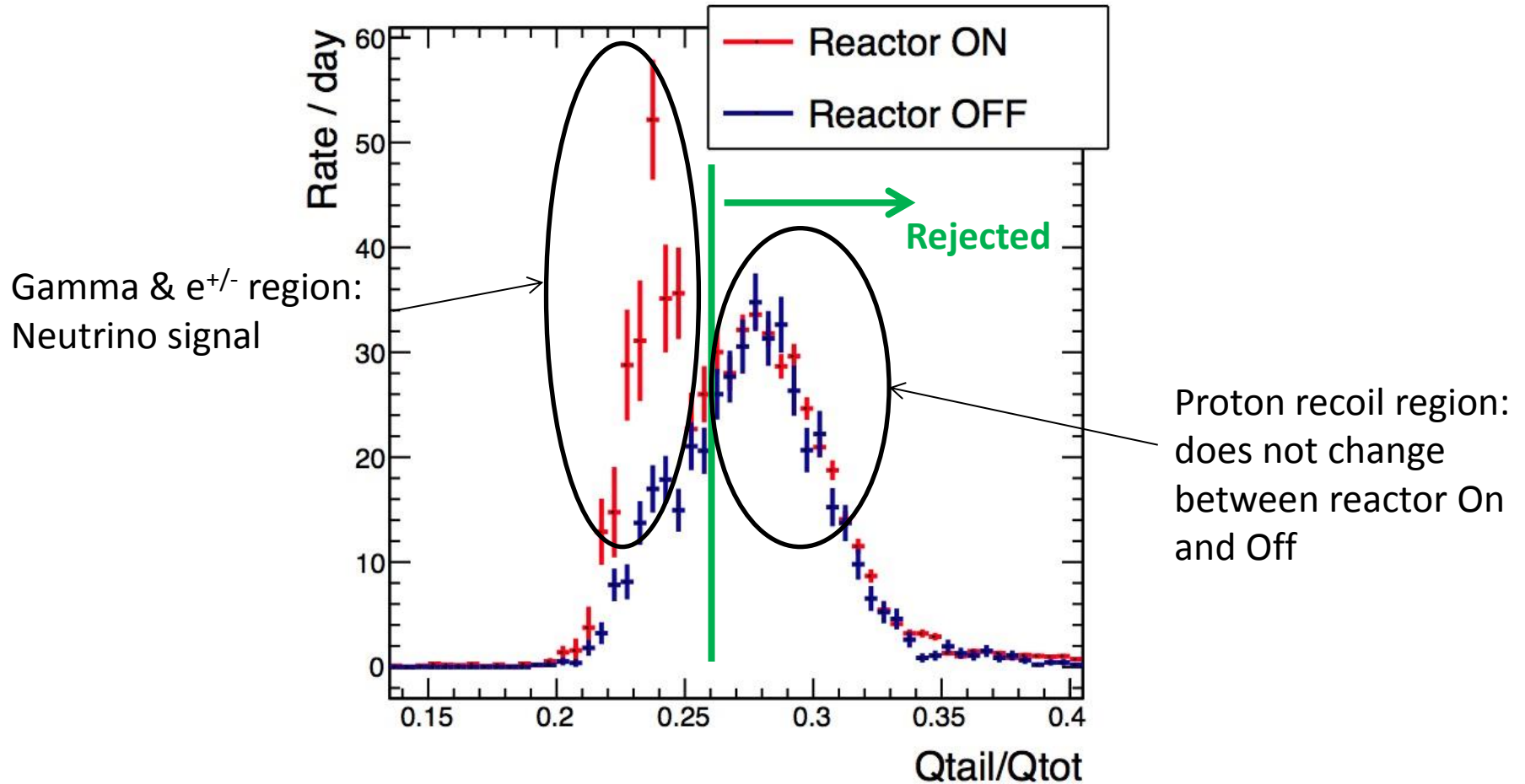
Preliminary Results



Preliminary Results



Preliminary Results



New Cuts

Energy Cut

	Old cut	New cut
Prompt Q_{tot}	2 – 6 MeV	2.0 – 7.1 MeV
Delayed Q_{tot}	6 – 10 MeV	4.2 – 9.6 MeV

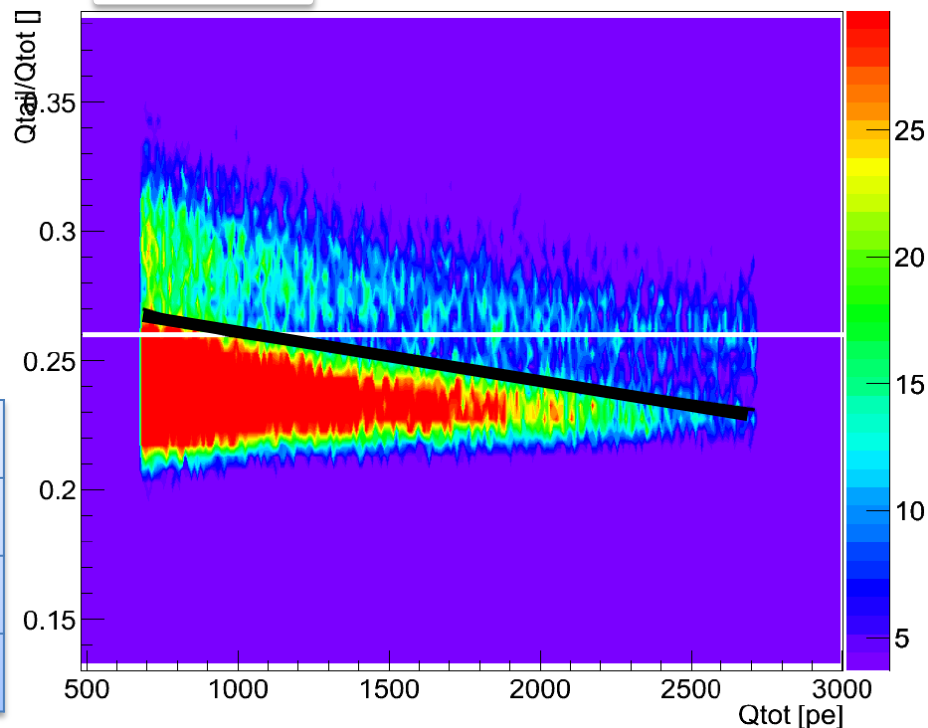
Time Cut

	Old cut	New cut
Delta T	5 – 45 μs	5 – 40 μs
Clean Before Window	> 50 μs	> 50 μs
Clean After Window	> 100 μs	> 100 μs

Expected rate: 272 events/day

(Old cut: 132 events/day)

PSD Cut



	Old cut	New cut
Low cut	QQ>0.18	QQ>0.18
High cut	QQ<0.26	QQ<0.282-1.77e-05×Qtot

Summary

- First neutrinos were detected by Nucifer in April-May 2013.
- Good agreement of measured neutrino signal with simulations.
- New selection cuts have been optimized.
- New data are being taken since November 2013.
- Study of detector systematics is now on-going.