

Results on Coherent Elastic Neutrino-Nucleus Scattering from the NEON Experiment

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 On behalf of the NEON collaboration

NEUTRINO '26

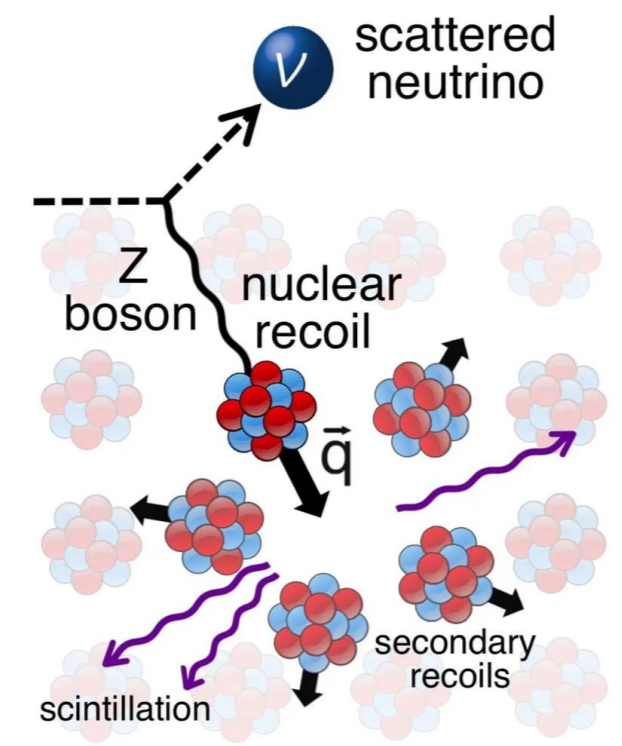
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UCI Department of Physics & Astronomy



1. Coherent Elastic Neutrino-Nucleus Scattering

$$\frac{d\sigma(E_\nu, T)}{dT} \approx \frac{G_F^2}{4\pi} [N - (1 - 4\sin^2(\theta_W))Z]^2 F^2(q^2) M \left(1 - \frac{MT}{2E_\nu^2}\right)$$



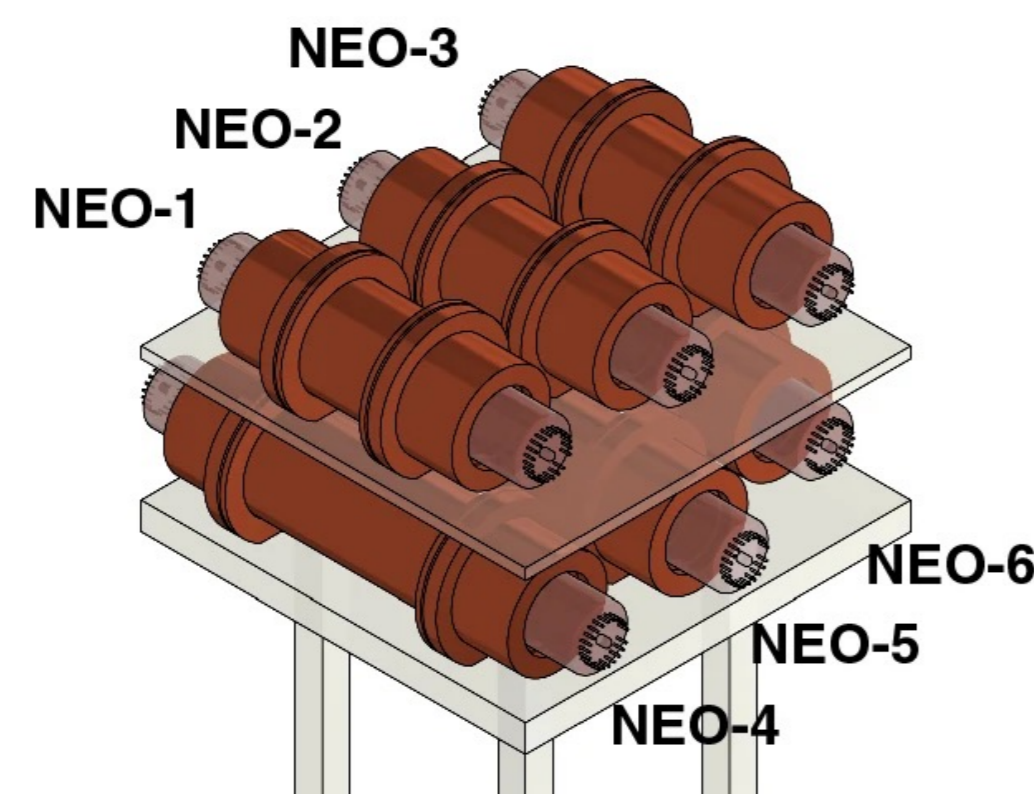
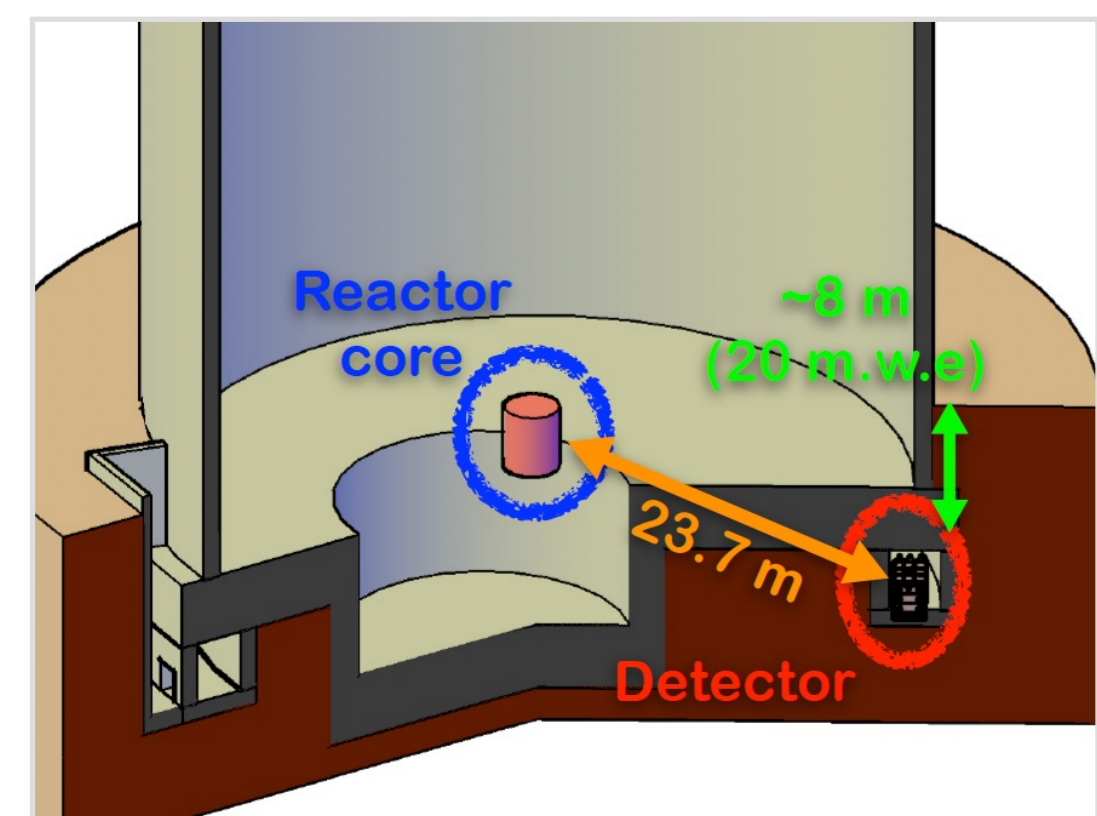
- Neutrino scatters off the nucleus as whole.
- Total cross-section is **proportional to target N^2**
- Physical potential on [**neutron floor / Light mediator / Non-standard interactions ...**]

Observation History

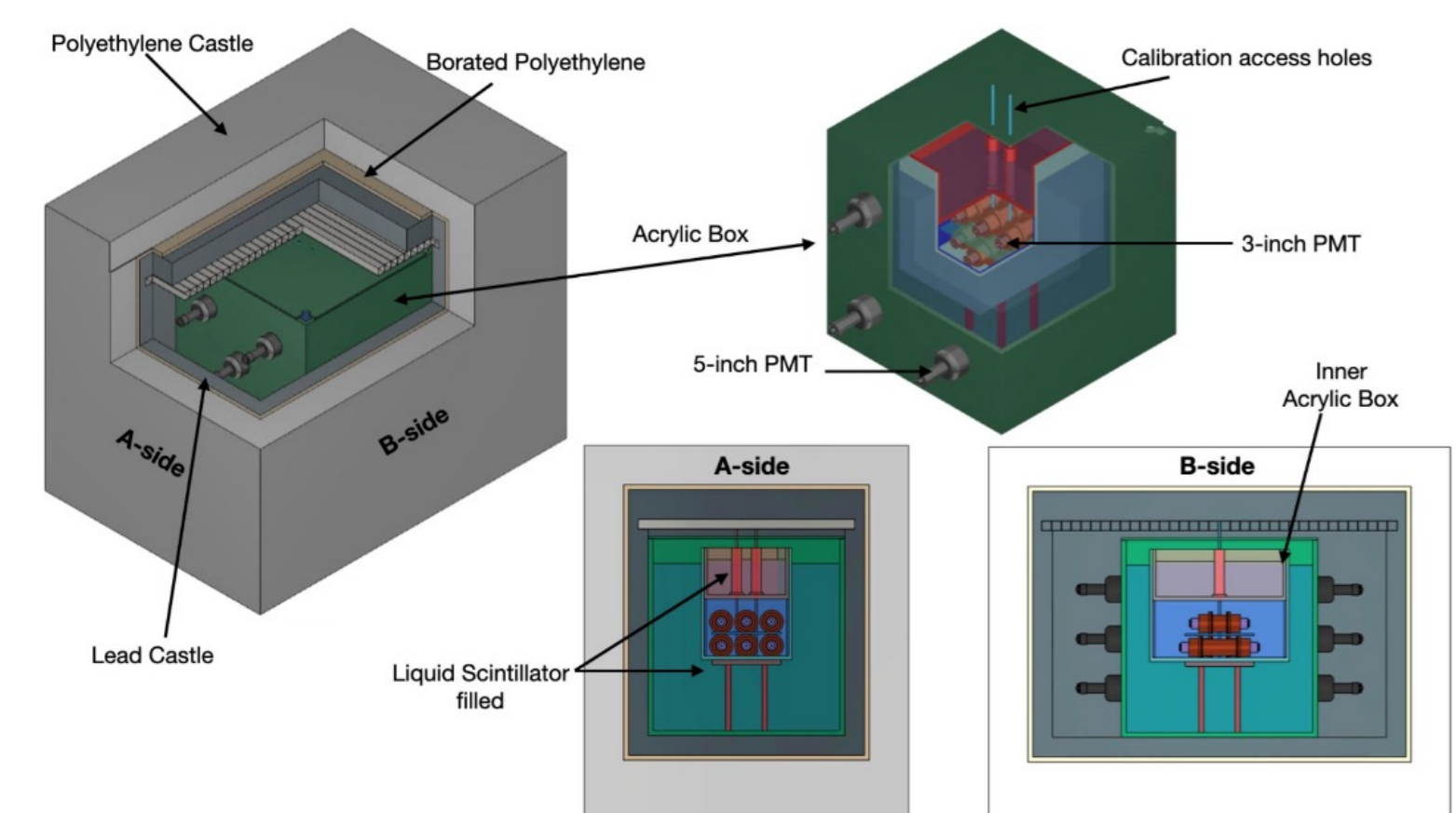
- COHERENT (Sapallation Neutron Source) : CsI[Na] (2017) & LAr target (2021)
- XENONnT (Solar ^8B neutrino) : (LXe) target at 2.78σ (2024)
- CONUS+ (reactor neutrino) : (HPGe) target at 3.7σ (2025)

2. NEON experiment

*Rich ν flux : $\sim 8.09 \times 10^{12}/\text{cm}^2/\text{sec}$ at ~ 24 m

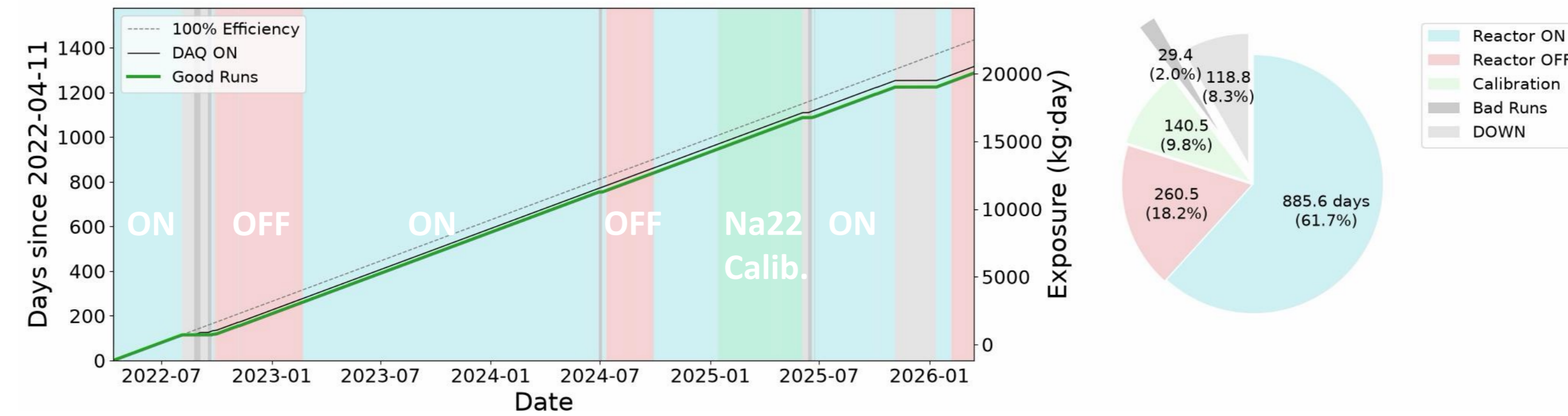


- **Reactor neutrino experiment**, aims to find the CEvNS to **Na target of NaI(Tl) crystals**
- Installed at tendon-gallery of Hanbit nuclear power plant in Korea
- 6 NaI(Tl) targets, with high light yield (~ 25 p.e / keV) *p.e = photoelectrons



- **Passive shields**
 - 20/30 cm thick Polyethylene [PE]
 - 2.5 cm thick Borated PE
 - 10/15 cm thick lead shield
- **Active shield**
 - 800 L Liquid scintillators in Acrylic box
 - 10 of 5 inch PMTs
 - Passive trigger for background tagging.

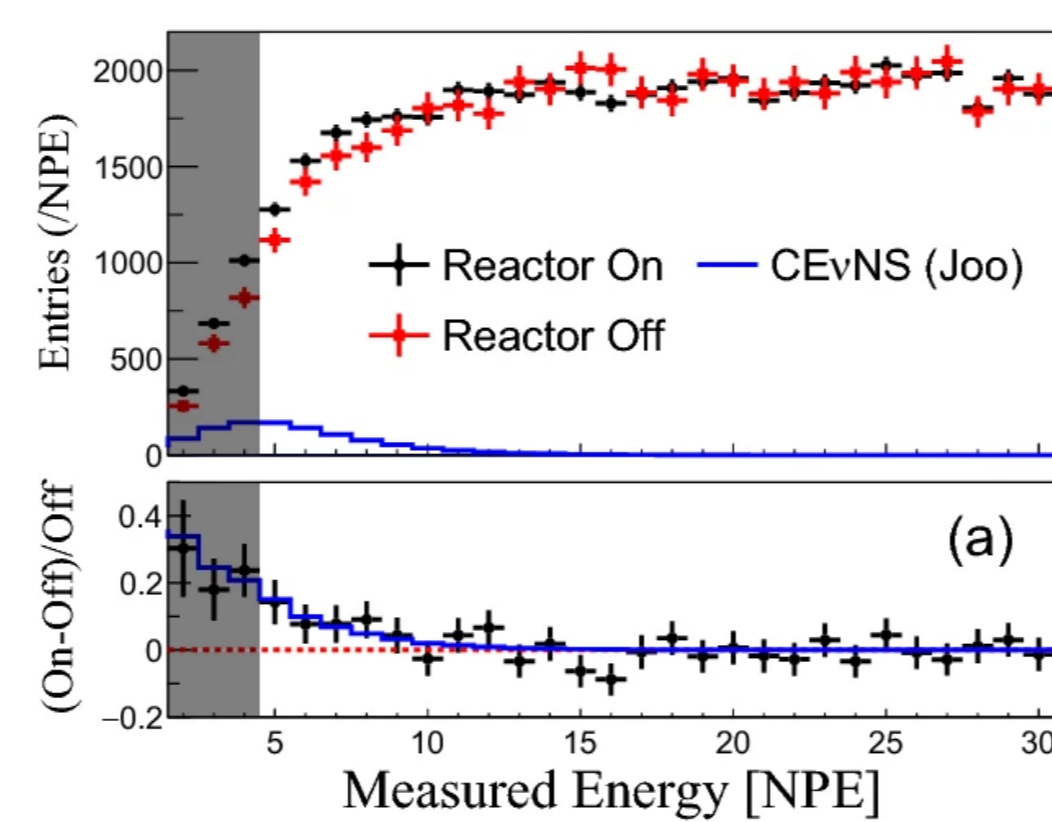
3. NEON exposure



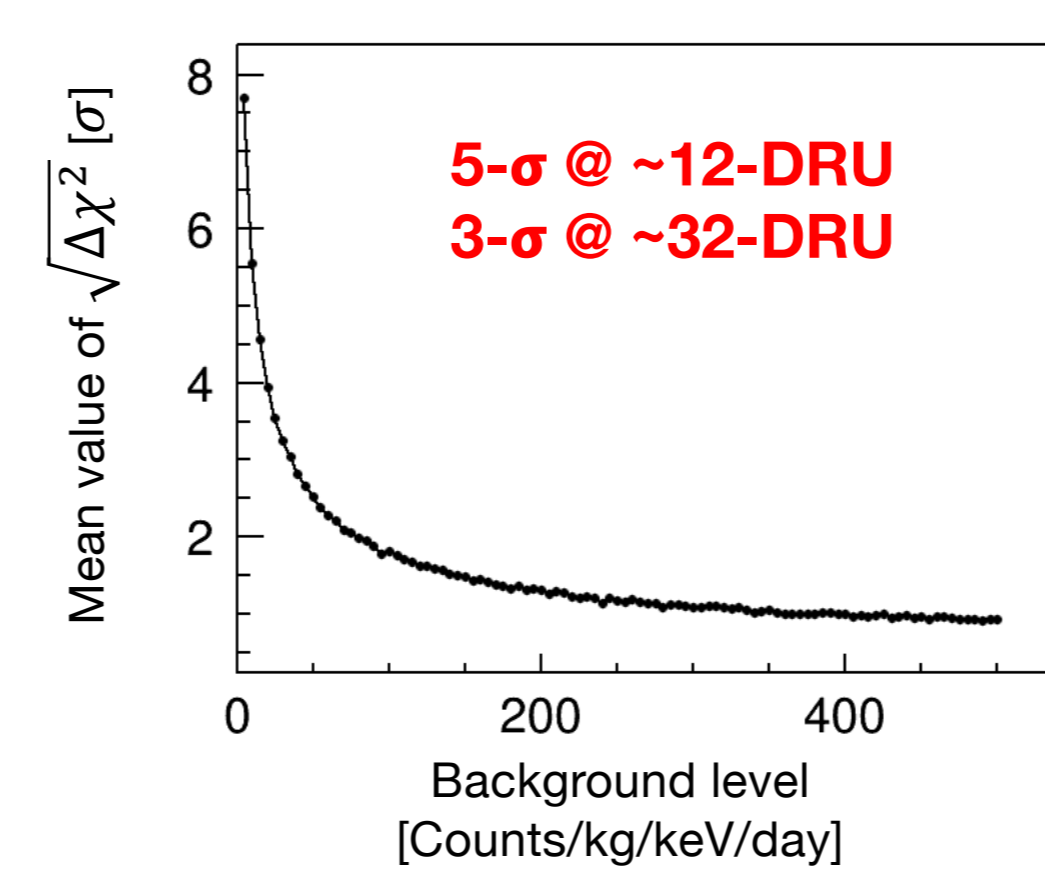
- Running from April 2022.
- ~ 19139.87 kg-day exposure & ON/OFF data : 886/260 days
- Data taking will be stopped in Fall 2026. (~ 3000 kg-day expected)

4. CEvNS detection strategy

CEvNS detection simulation with 5 PE threshold

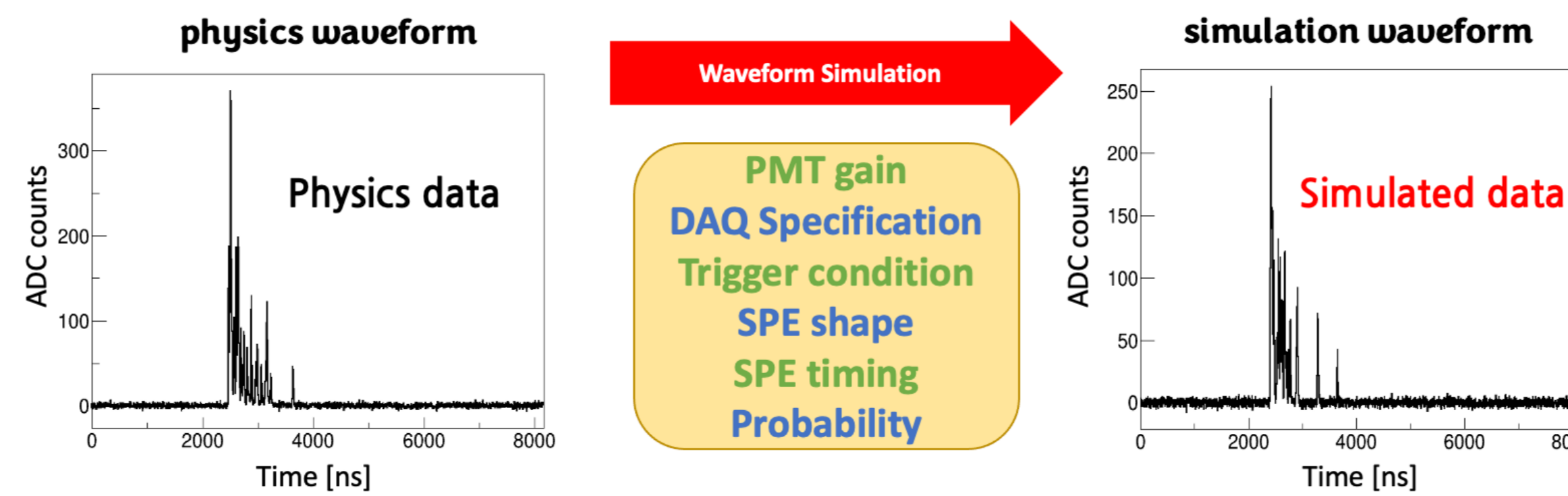


CEvNS Significance over background rate

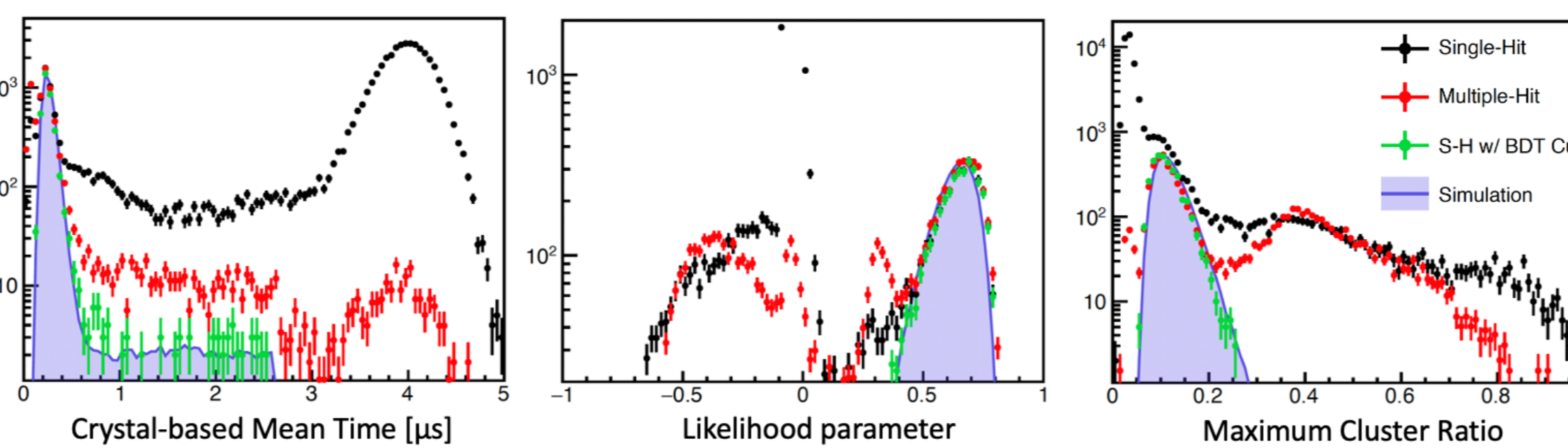


- CEvNS events can be derived by 'On - Off' data strategy.
- **Requirements for 3σ CEvNS observation in NEON,**
 - 5 photoelectrons (P.E.) , ~ 200 eV threshold
 - Stable background rate over time
 - Background level < 32 counts/kg/keV/day @ 5 PE level.

5. Waveform simulation



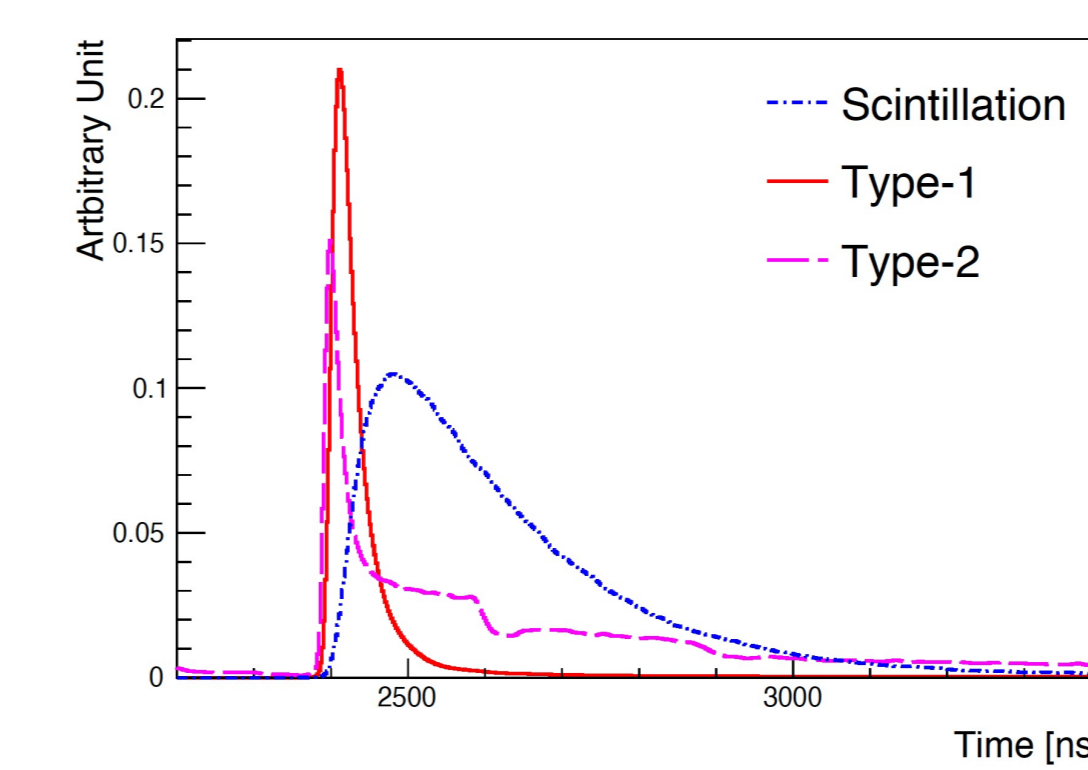
Distributions of pulse shape discrimination parameters [y-axis : Number of events]



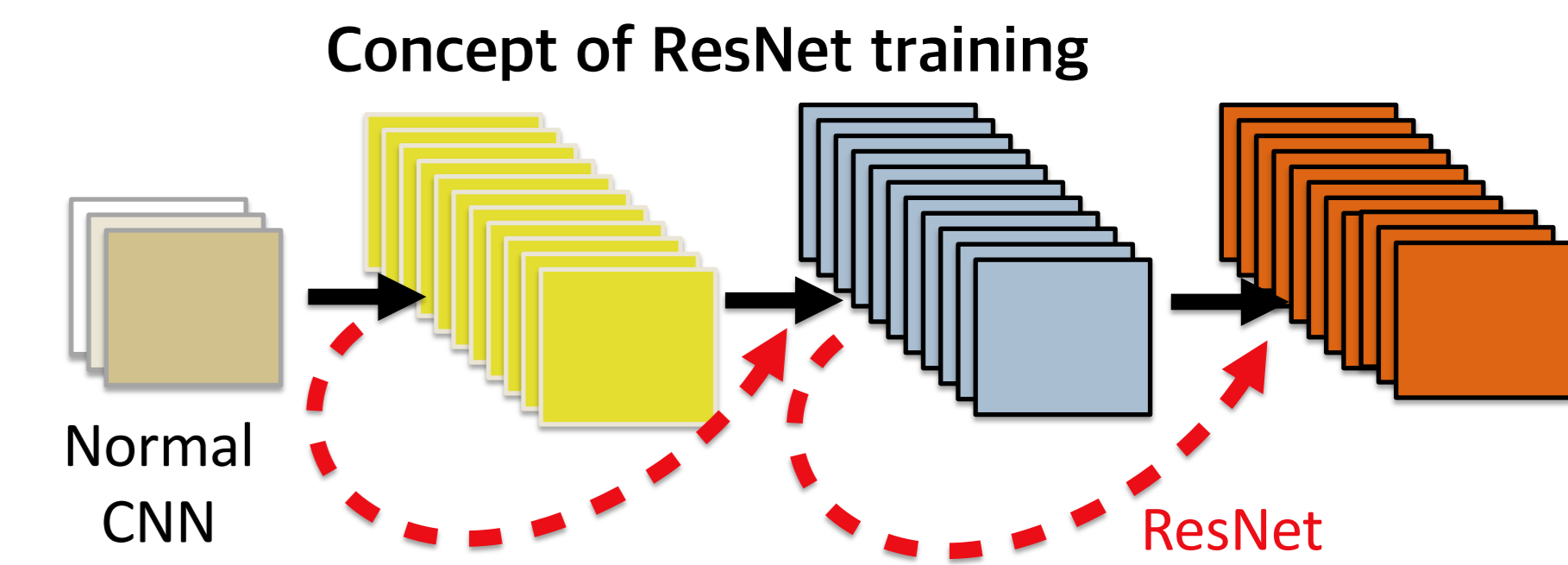
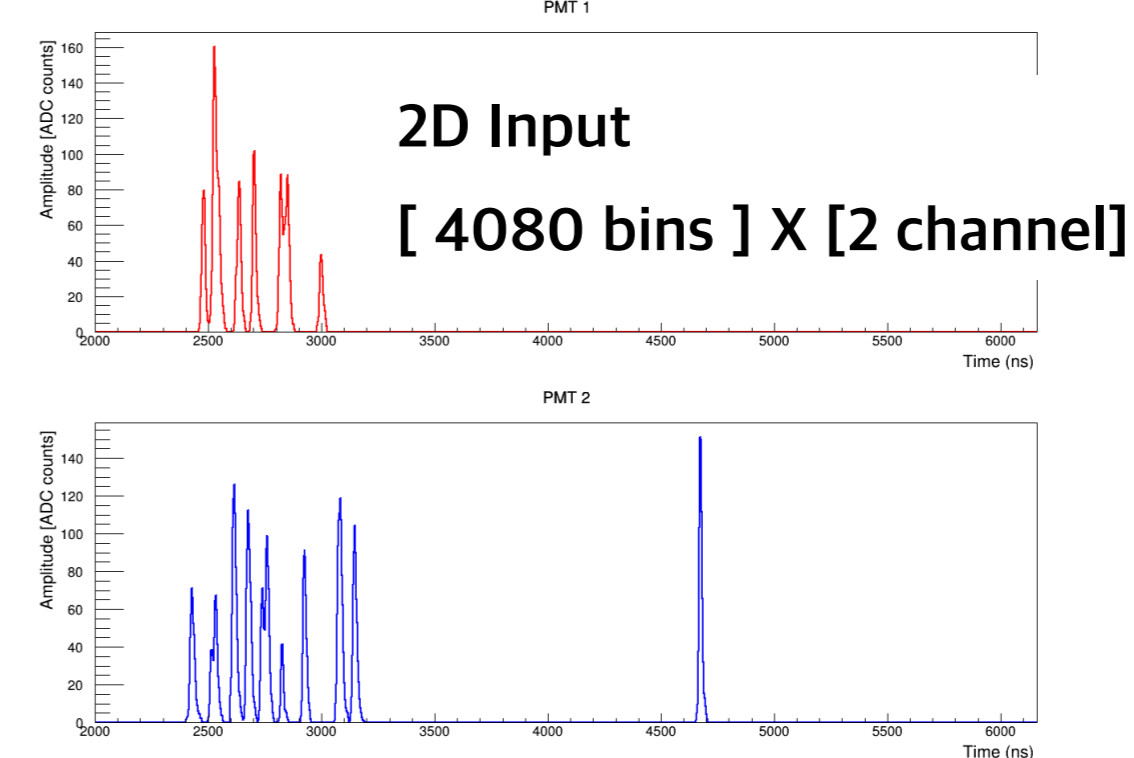
- Waveform simulation w/ precisely modeled single photon pulse / charge / time distribution.
- Validated with PSD parameters showing consistent distribution w/ real scintillation.

6. Deep-Learning for noise selection

Accumulated waveform of each event type

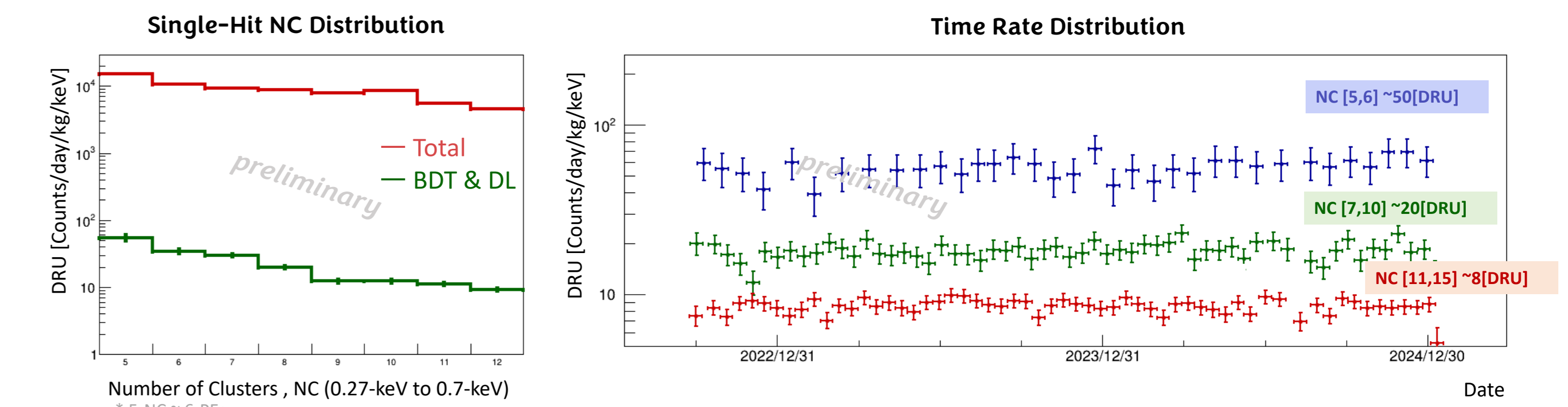


- **Type 1 (PMT-induced noise)**
 - Short pulses (< 50 ns), fast decaying distribution \rightarrow easy to be separated.
- **Type 2 (Phosphorous events)**
 - Slowly decaying distribution \rightarrow hard to be separated from scintillation.



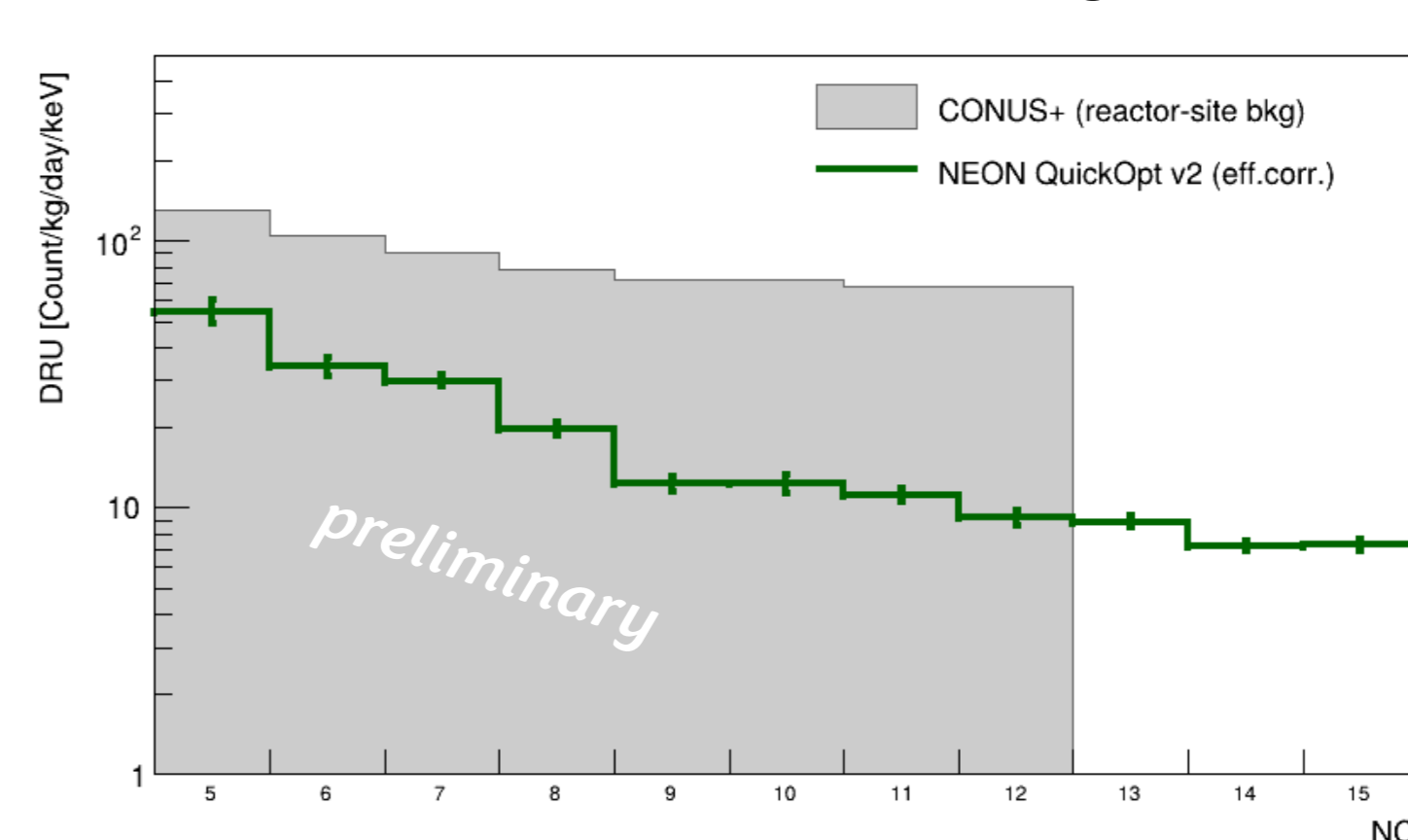
- Waveform classification : long & complicated event structure \rightarrow requires 'deep network'
- **ResNet : avoid gradient-vanishing, using 'residual connection'**
- **ResNet enables deep convolutional layers** of CNN training.
- Training sample : WF simulation (Signal) & Data (Noise)

7. After selection & Future plan



- DL score based selection has been applied, and **checked stable event rate over time.**
- **~ 50 DRU at 5-NC level** has been achieved, and fine-tuning for lower rate is ongoing

NEON vs CONUS+ background



- Our background level is **comparable to or better than that of CONUS+ above NC-5.**
- We will model the background using Reactor-Off data and apply a likelihood fit to the On-period data to extract the CEvNS signal.

The results are expected to be announced soon!

Should you have any questions, please feel free to contact below
 E-mail : bckoh0719@gmail.com

