# Detector Stability in NEOS-phase2

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NEUTRINO 2020

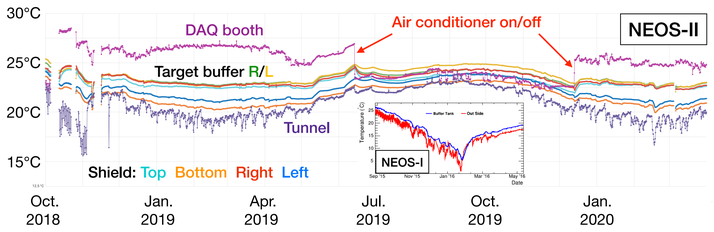
CENTER FOR UNDERGROUND PHYSICS

**NEOS Introduction (Click)**

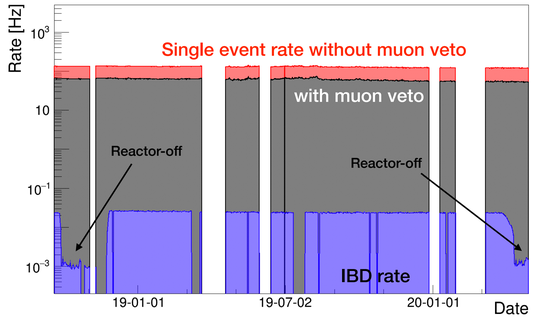
## Detector Stability

### Stability Check

- Temperature
  - An air conditioner was installed to stabilize temperature.
  - Temperatures of target buffers moves within ~2°C (~20°C in NEOS-I).

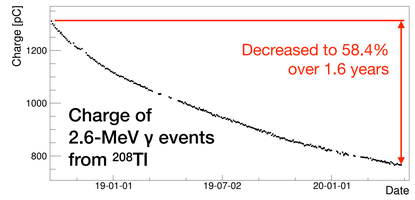


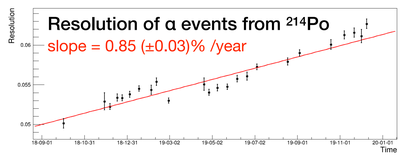

- Single & IBD event rate




### Issue for Decreasing Light Output

- It has been found that the light yield of LS is decreasing.
  - Precipitation is observed in stored LS.
- The exact cause is unknown, but the issue only occurs when mixing LAB-based LS and DIN-based LS (UG-F) together.
- From the viewpoint of energy calibration, the decreasing light output can be corrected, but the change of energy resolution can affect the analysis.

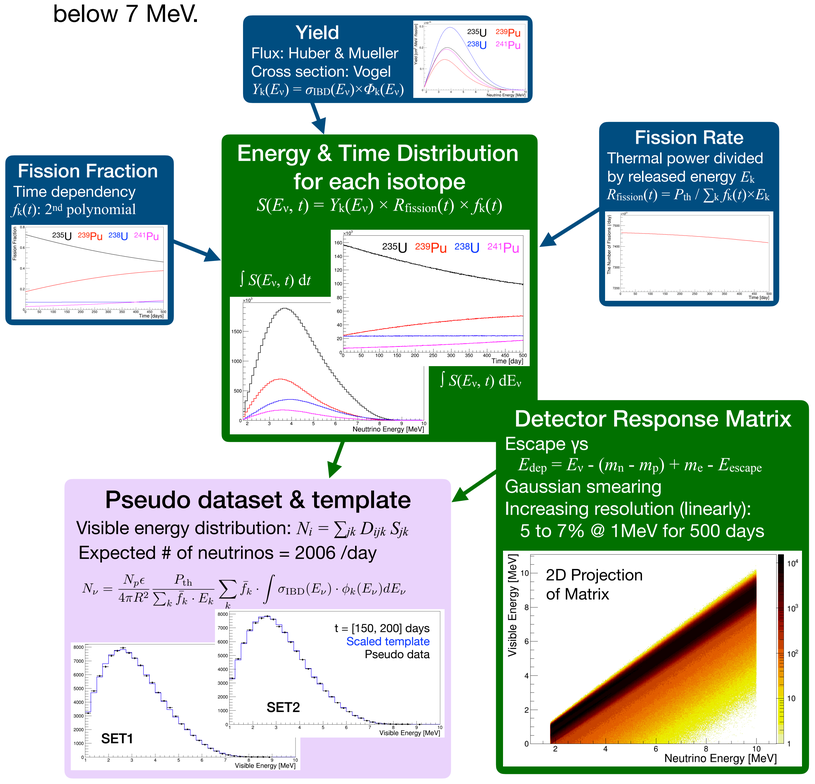



## Effect on Analysis

### Pseudo Templates of Reactor Neutrinos

- Converting neutrino energy to visible energy via detector response matrix
- Detector response matrix including variation of resolution in time
- SET1 & SET2: w/ & w/o resolution change in time
  - There are almost no difference b/w SET1 and SET2 reference spectra below 7 MeV.




### Decomposition of Spectra

- The number of expected events in $i^{th}$ energy bin

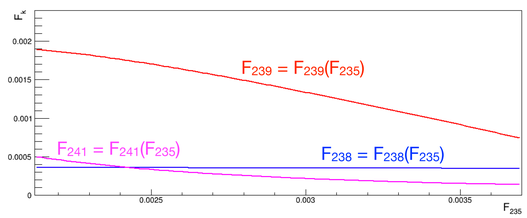
$$N_i(t) = \frac{N_p \epsilon}{4\pi R^2} P_{th} \cdot \sum_k \frac{f_k(t)}{\sum_l f_l(t) \cdot E_l} \cdot \int_i \sigma_{IBD}(E_\nu) \cdot \Phi_k(E_\nu)\, dE_\nu$$

$$= A \cdot \sum_k F_k(t) \cdot Y_{ik}$$

$$\text{where } A = \frac{N_p \epsilon}{4\pi R^2} P_{th},\ F_k(t) = \frac{f_k(t)}{\sum_l f_l(t) \cdot E_l}$$

$$Y_{ik} = \int_i \sigma_{IBD}(E_\nu) \cdot \Phi_k(E_\nu)\, dE_\nu$$

- Time $t$ can be replaced with $F_{235}$ through the relation b/w $F_{235}$ and other $F_k$.
- Parameterization of $F_k = F_k(F_{235})$ w/ a 4th polynomial.




- Pseudo data is fitted for each bin independently.
- Neutrino spectra from 235U and 239Pu can be decomposed by fitted parameter $p_{ik}$.

$$N_i(t) \rightarrow N_i(F_{235}) = \sum_k p_{ik} \cdot F_k(F_{235}) \quad \text{where } p_{ik} = A \cdot Y_{ik}$$

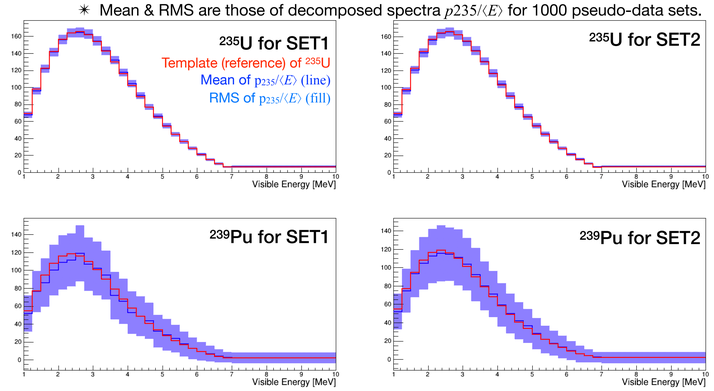
$$D_{ik} = \frac{N_p \epsilon}{4\pi R^2} P_{th} \frac{1}{\sum_k \bar{f}_k E_k} \int_i \sigma_{IBD}(E_\nu) \cdot \Phi(E_\nu)\, dE_\nu$$

$$= \frac{p_k}{\sum_k \bar{f}_k E_k}$$

## Result

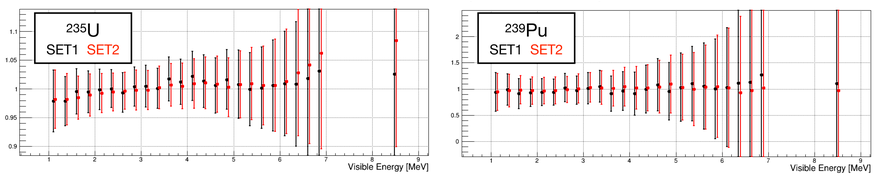
- 1000 pseudo sets are generated and decomposed.

✶ Mean & RMS are those of decomposed spectra $p235/\langle E\rangle$ for 1000 pseudo-data sets.




- In both of SETs, decomposed spectra have some bias less than ~2% and ~10% for 235U and 239Pu, respectively.
  - 5-MeV excess can be observed if neutrinos from 235U spectrum has that.
  - Poor result of 239Pu spectrum: constraint for 238U and 241Pu is under consideration to improve 239Pu.
- The effect on decomposition by variation of resolution is not observed to be a significant issue.
  - We cannot see any significant difference or issue due to the resolution change.

Ratio of Decomposed spectra to templates




✶ Error bars: RMS of decomposed spectra divided by template