AmBe Calibration in SNO+ Water Phase

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4th IDPASC Student Workshop
2018/06/28

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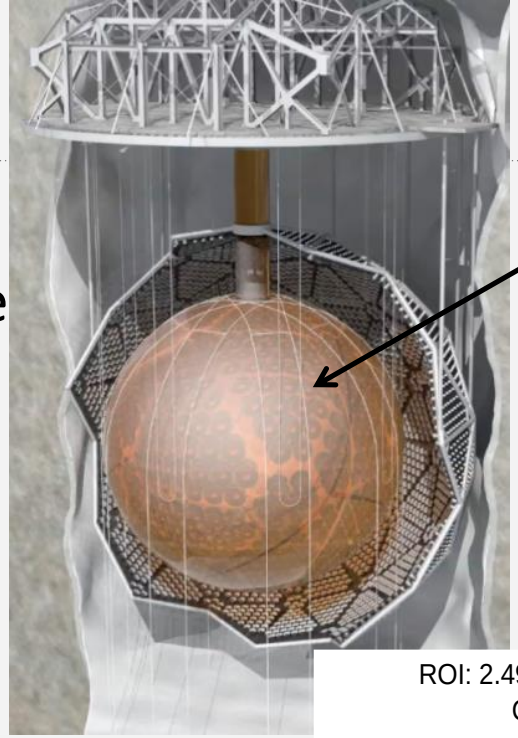
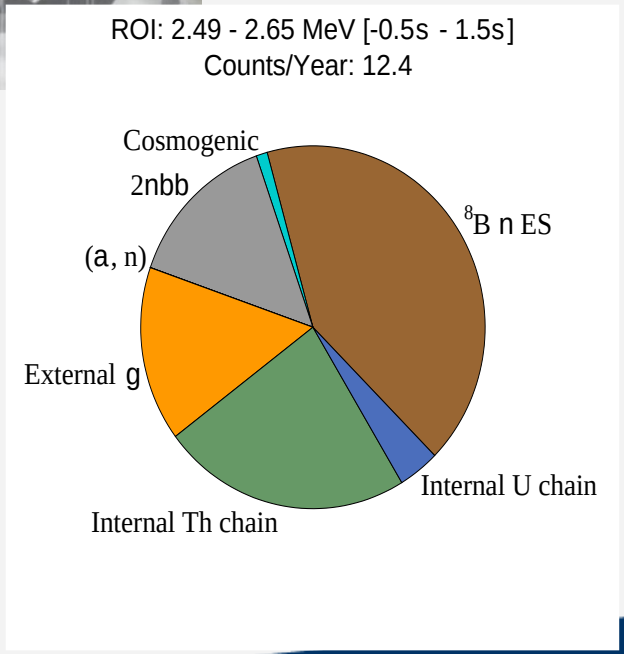
Overview

- SNO+ detector & its water phase
- SNO+ calibration program
- AmBe source calibration
- First look at AmBe Data
  - Neutron capture time constant
  - Neutron detection efficiency

SNO+ experiment

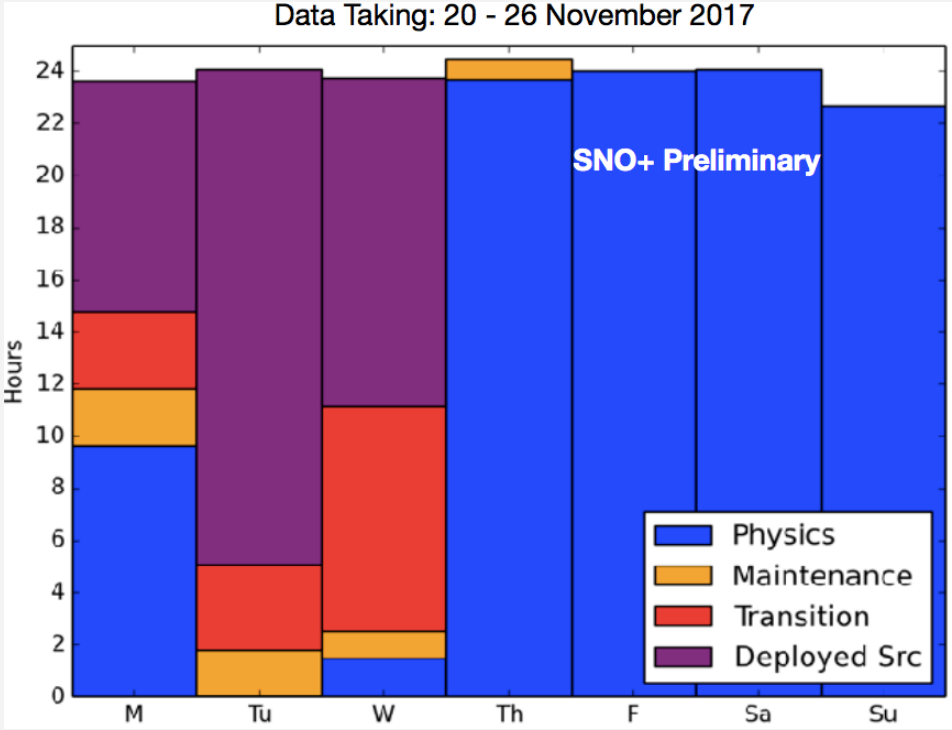


- Staged approach, with ultimate goal searching for 0νββ with ^{130}Te.
- Need
  - Large volume
    - ~0.5% loading corresponds to 1 ton target mass
  - Low background
    - Calibration important to understand background
    - Water phase provides first sights

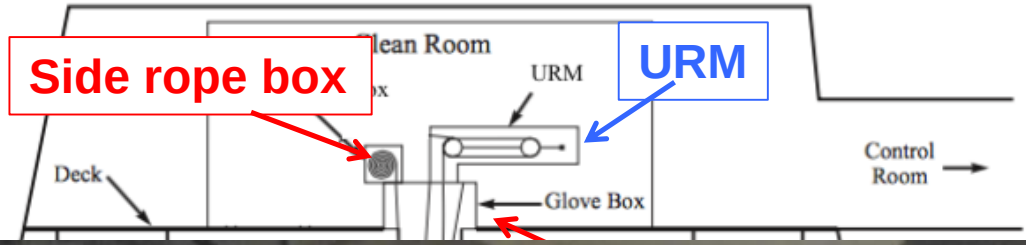


SNO+ water phase

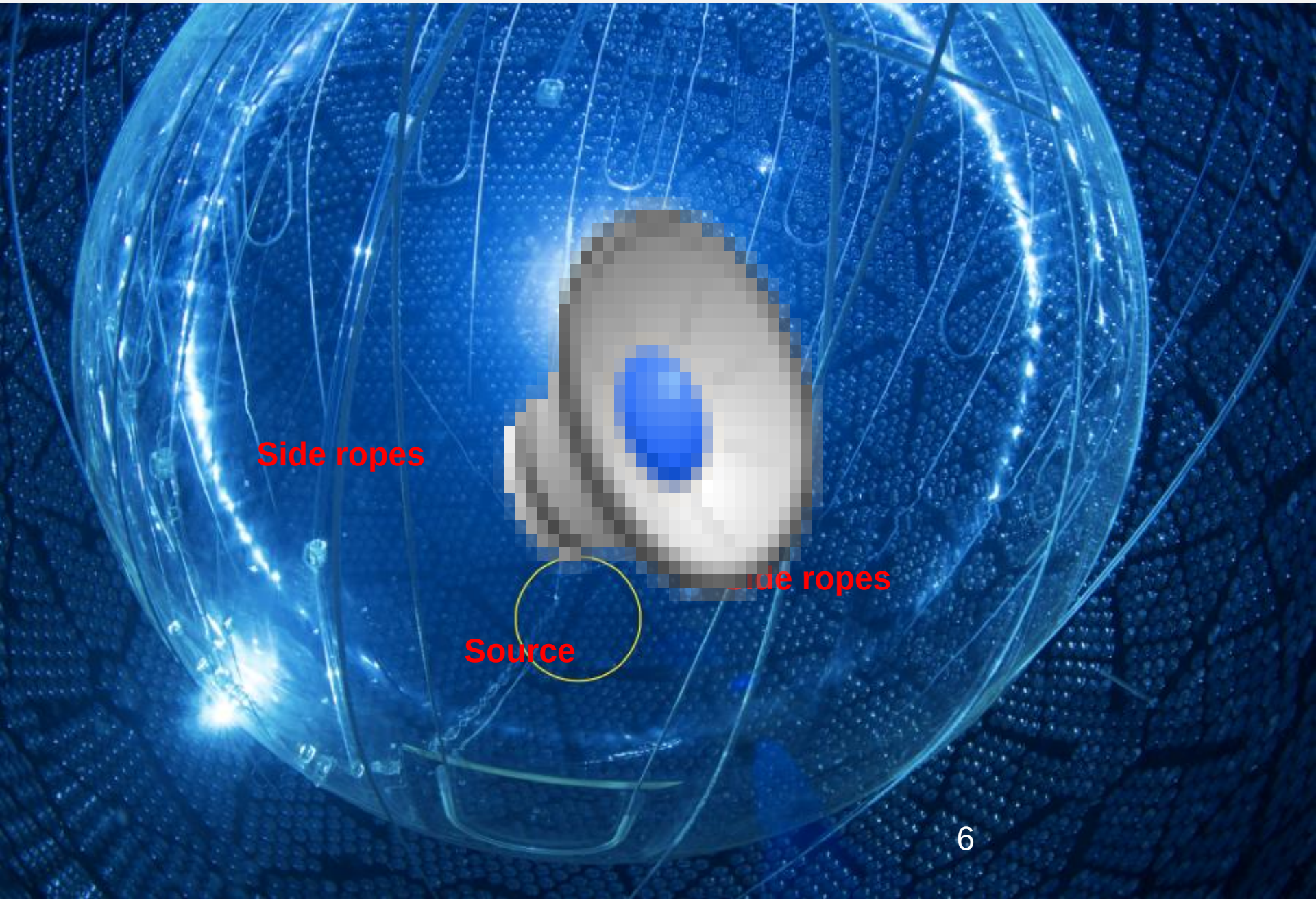
- Started May 4th, 2017.
- Continuously taking physics data for more than a year.
- Interesting physics topics like nucleon decay and antineutrinos are being explored.



SNO+ calibration system



Source deployment



AmBe physics

$$\alpha + {}^{9}Be \longrightarrow {}^{12}C + n(\sim 40\%),$$

$$\alpha + {}^{9}Be \longrightarrow {}^{12}C^{*} + n(\sim 60\%),$$

$${}^{12}C^{*} \longrightarrow {}^{12}C + \gamma(4.4MeV).$$

- Prompt signal: 4.4 MeV gammas
- Delayed signal: neutron captured on protons: 2.2 MeV gammas
  - Good Cherenkov light yield allows us seeing this low energy
  - Coincidence tagging provides an efficiency way to extract the signal

AmBe motivation

$$\alpha + {}^{9}Be \longrightarrow {}^{12}C + n(\sim 40\%),$$

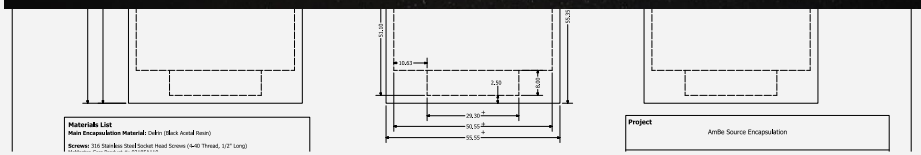
$$\alpha + {}^{9}Be \longrightarrow {}^{12}C^{*} + n(\sim 60\%),$$

$${}^{12}C^{*} \longrightarrow {}^{12}C + \gamma(4.4MeV).$$

- Source signal mimics antineutrino signals
  - Ultra low background allows us to observe neutrons with normal trigger settings (first to do so in the world)
- Provide two additional energy calibration points
  - Check energy scale
  - Most background for 0νββ at similar energies

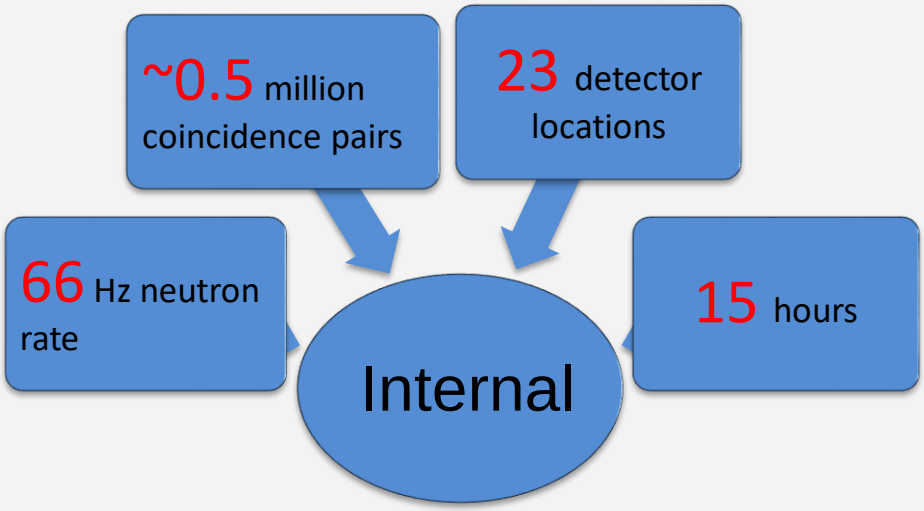
AmBe source preparation

- Use SNO AmBe source
- A new encapsulation needed for cleanliness of the detector



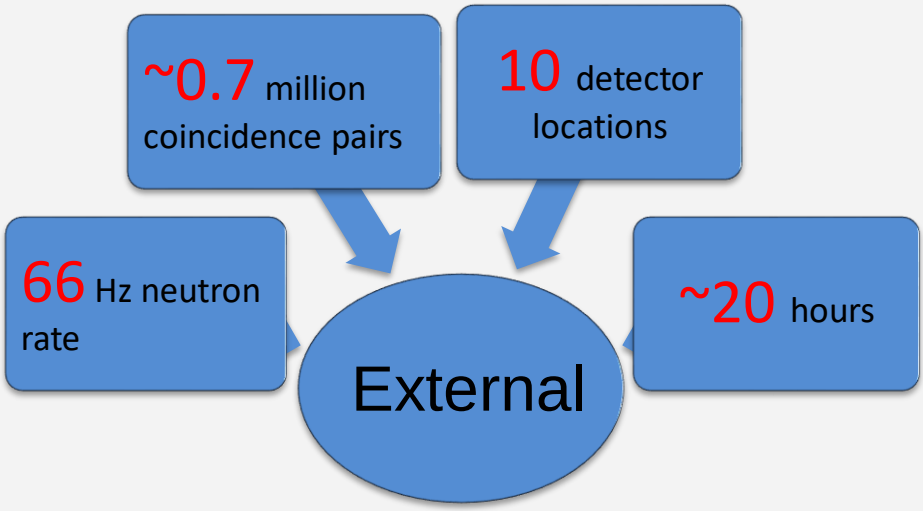
AmBe deployment

- January 2018 internal calibration

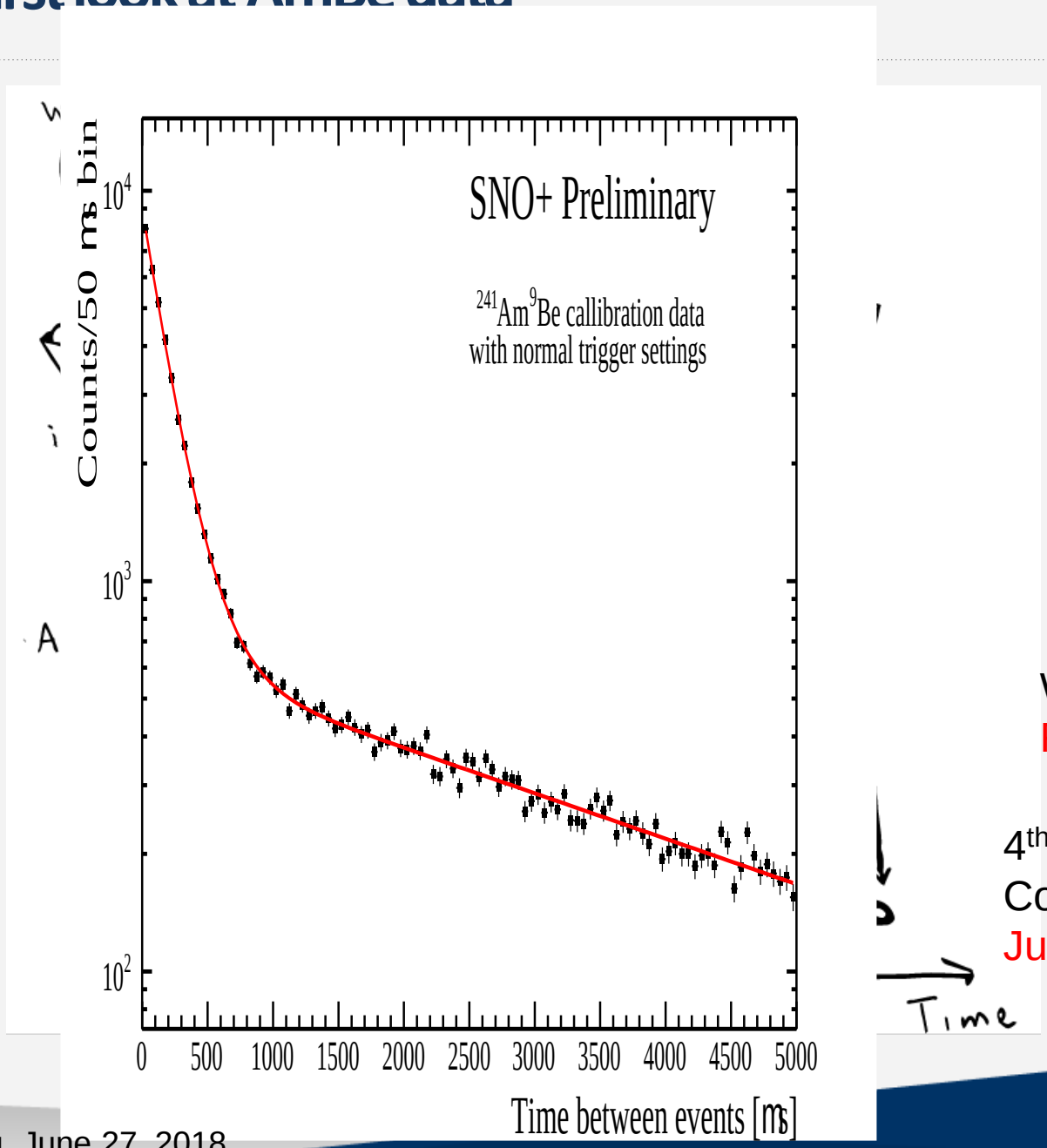


- June 2018 external calibration

3 days ago!



First look at AmBe data

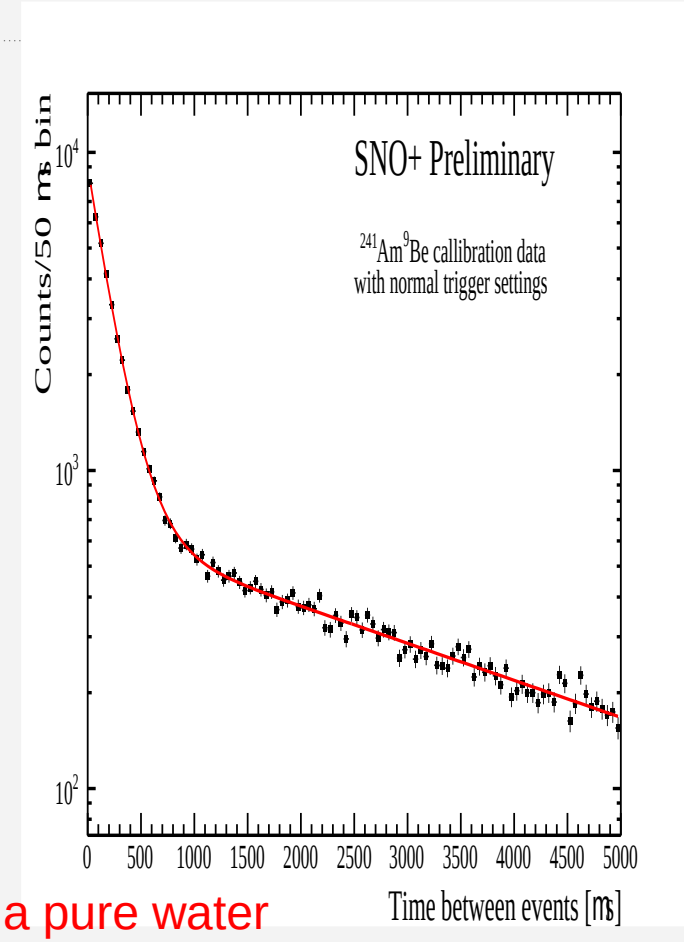


~~WNPPC, Monte Tremblant~~
~~Feb. 15~~, 2018

4th IDPASC student workshop
Coimbra
Jun. 28, 2018

First look at AmBe data

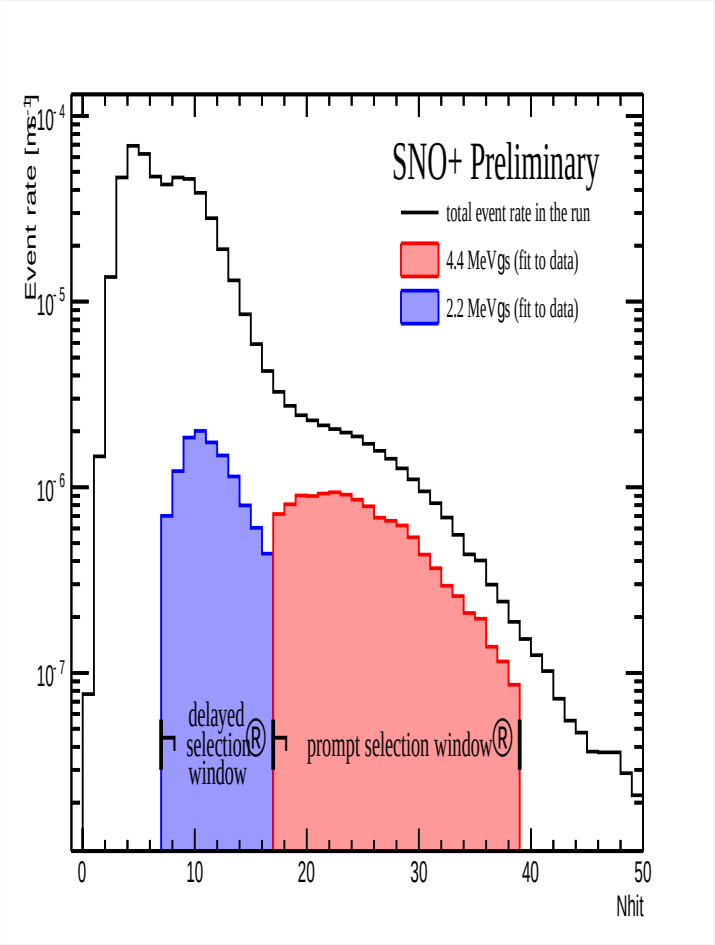
- With only 1 hour calibration with source at detector center
- Measured neutron capture time constant: 208.2 ± 2.1 μs
- Measured neutron detection efficiency: >46%



Highest recorded with a pure water Cherenkov detector!

First look at AmBe data

1 hour calibration with source at detector center



} 4.4 MeV Ɣs without following neutron

We are able to extract the signals under “huge” background

Thanks!