



The SNO+ Experiment

Multi-purpose liquid scintillator detector

- Located 2070 m underground at SNOLAB
- 6-m radius acrylic vessel
- Light detected with 9362 PMTs
- 7000 m³ ultrapure water shielding
- Multi-phase strategy depending on medium
- Extensive physics programme in all phases

Water Phase



905 tonnes of ultrapure water

Partial Fill Phase



365 tonnes LAB + 0.6 g/L PPO

Scintillator Phase



792 tonnes LAB + 2.2 g/L PPO

Tellurium Phase



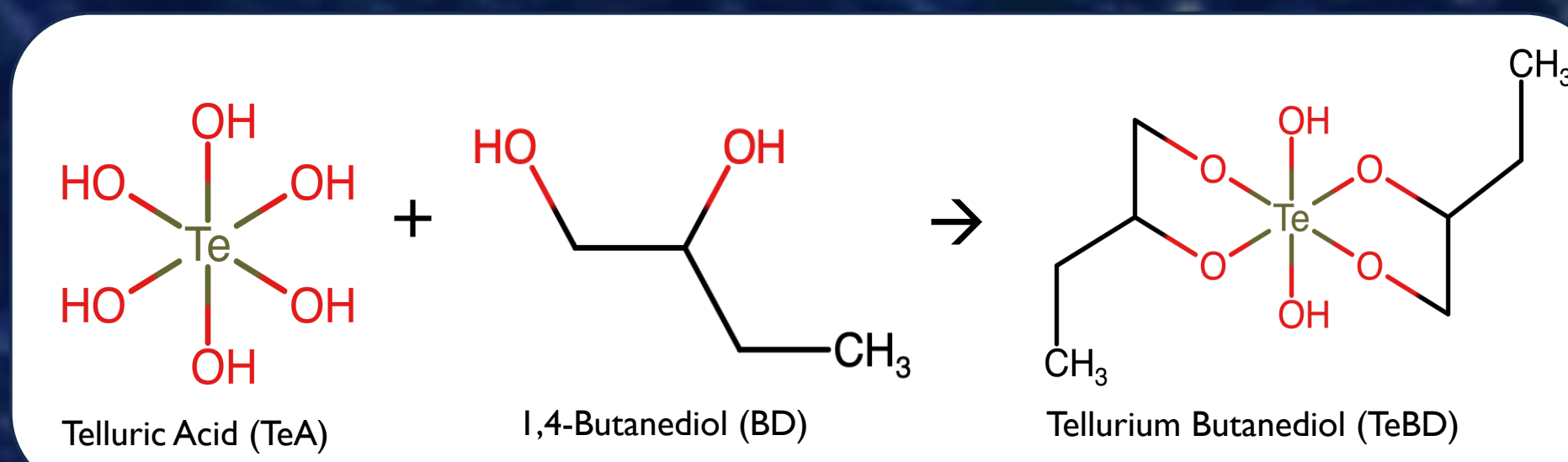
792 tonnes LAB + 2.2 g/L PPO + BHT + bis-MSB + DDA + 3.9 tonnes ^{nat}Te

$0\nu\beta\beta$ Programme

Primary SNO+ Objective: Searching for $0\nu\beta\beta$ of ¹³⁰Te

- Q-Value = 2.53 MeV
- Natural abundance of 34.1%

- Novel technique developed to load Te in LAB
- Initial deployment of 3.9 tonnes ^{nat}Te (2025)
- **1.3 tonnes of ¹³⁰Te**
- Scaling to ~12 tonnes ^{nat}Te planned (2028)
- Further scaling up to ~24 tonnes ^{nat}Te possible

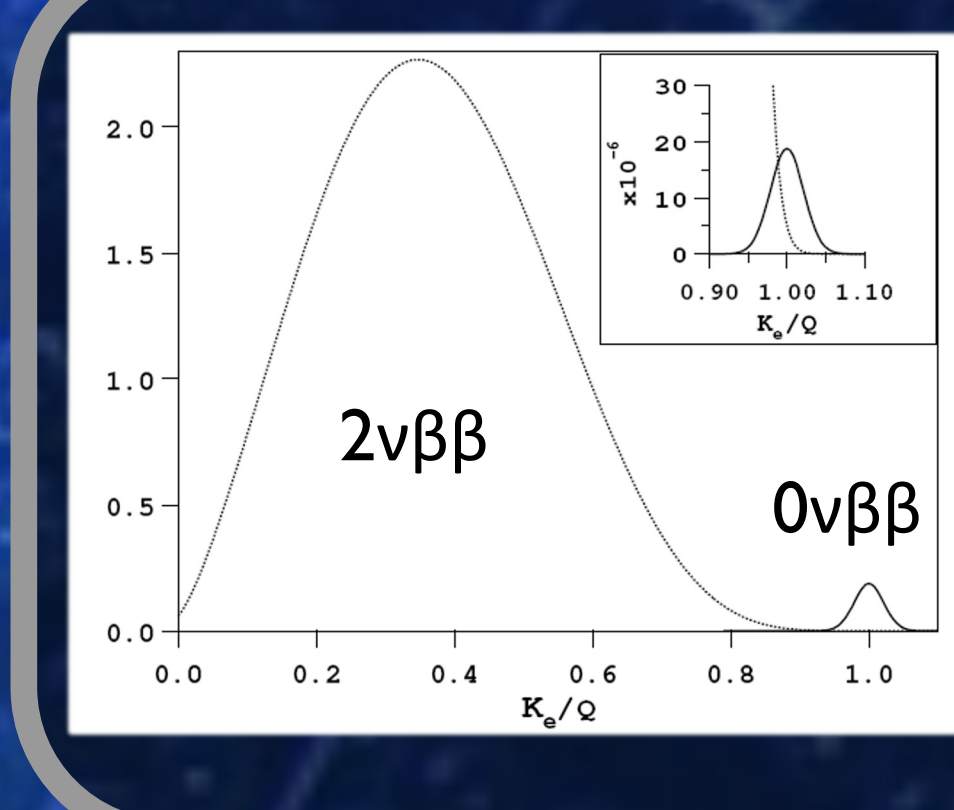


- Maximizing $0\nu\beta\beta$ half-life sensitivity requires:
 - Large isotope **mass**
 - Accurate knowledge of **backgrounds**
 - Calibrated model of **detector response**

See posters by P. Huang and R. Hunt-Stokes

The background model for the $0\nu\beta\beta$ ROI

$$\text{ROI} = [-0.5, 1.5]\sigma = [2.42, 2.56] \text{ MeV, FV with radius of 3.3 m}$$



Two Neutrino Double Beta Decay

- Standard Model process from ¹³⁰Te
- Mitigated through energy resolution
- Intrinsic for $0\nu\beta\beta$

Cosmogenics

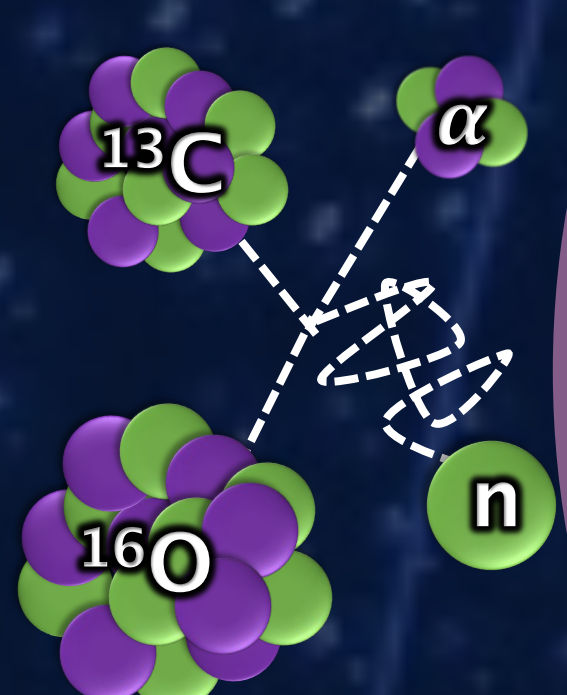
- Created from muon spallation on Te nuclei: ¹¹⁰Ag, ⁶⁰Co, ²²Na, ⁴⁴Sc, ⁸⁸Y, ¹³⁰I, ¹³⁰mI
- Mitigated through 6+ years of "cooling off" and purification, multi-site discrimination

Expected cumulative ROI counts: (after purification) **0.11 counts/year**

See posters by K. Dixon and J. Simms

(α ,n) Interactions

- Alpha captures on ¹³C in LAB
- Mitigated with delayed coincidence tagging



Expected ROI counts: **0.02 counts/year**

External γ

- ²³⁸U and ²³²Th in detector materials
- Mitigated by fiducialisation
- Measured during water phase to be 50% smaller than target

Expected ROI counts: **1.21 counts/year**

Solar Neutrinos

- Major expected background for $0\nu\beta\beta$
- Mitigated through energy resolution
- Flux measured by SNO+

Expected ROI counts: **4.61 counts/year**

See poster by D. Cookman

- ²³⁸U Chain: Contributions from ²¹⁴Bi, ²¹⁰Tl
- Measured in LAB: $(5.3 \pm 0.3) \times 10^{-17}$ g/g

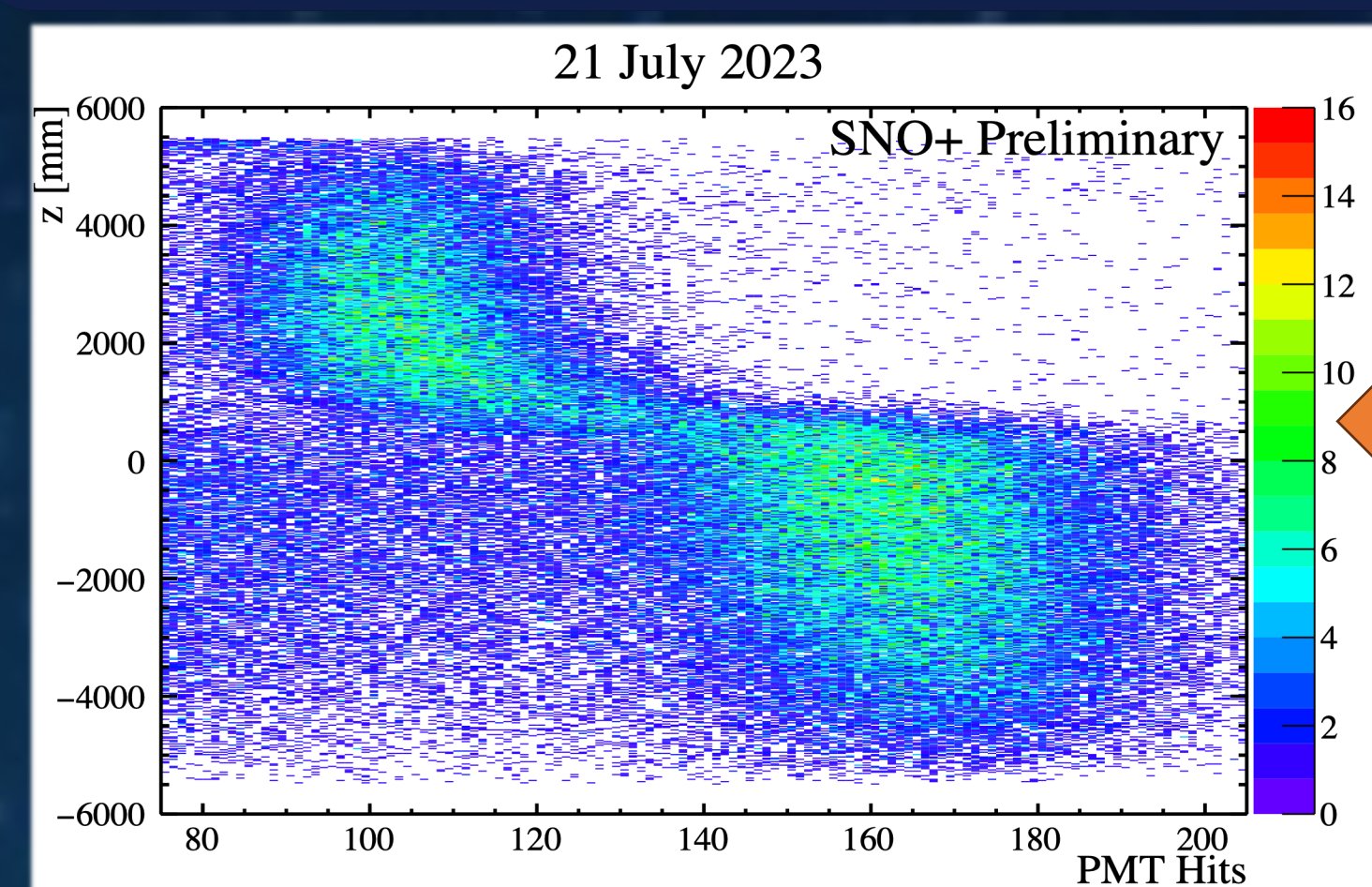
- ²³²Th Chain: Contributions from ²¹²Bi, ²⁰⁸Tl
- Measured in LAB: $(5.7 \pm 0.3) \times 10^{-17}$ g/g

- U/Th from Te addition will be mitigated through purification

Expected ROI counts: **0.40 + 1.92 counts/year**

See poster by R. Hunt-Stokes

To the Tellurium Phase...

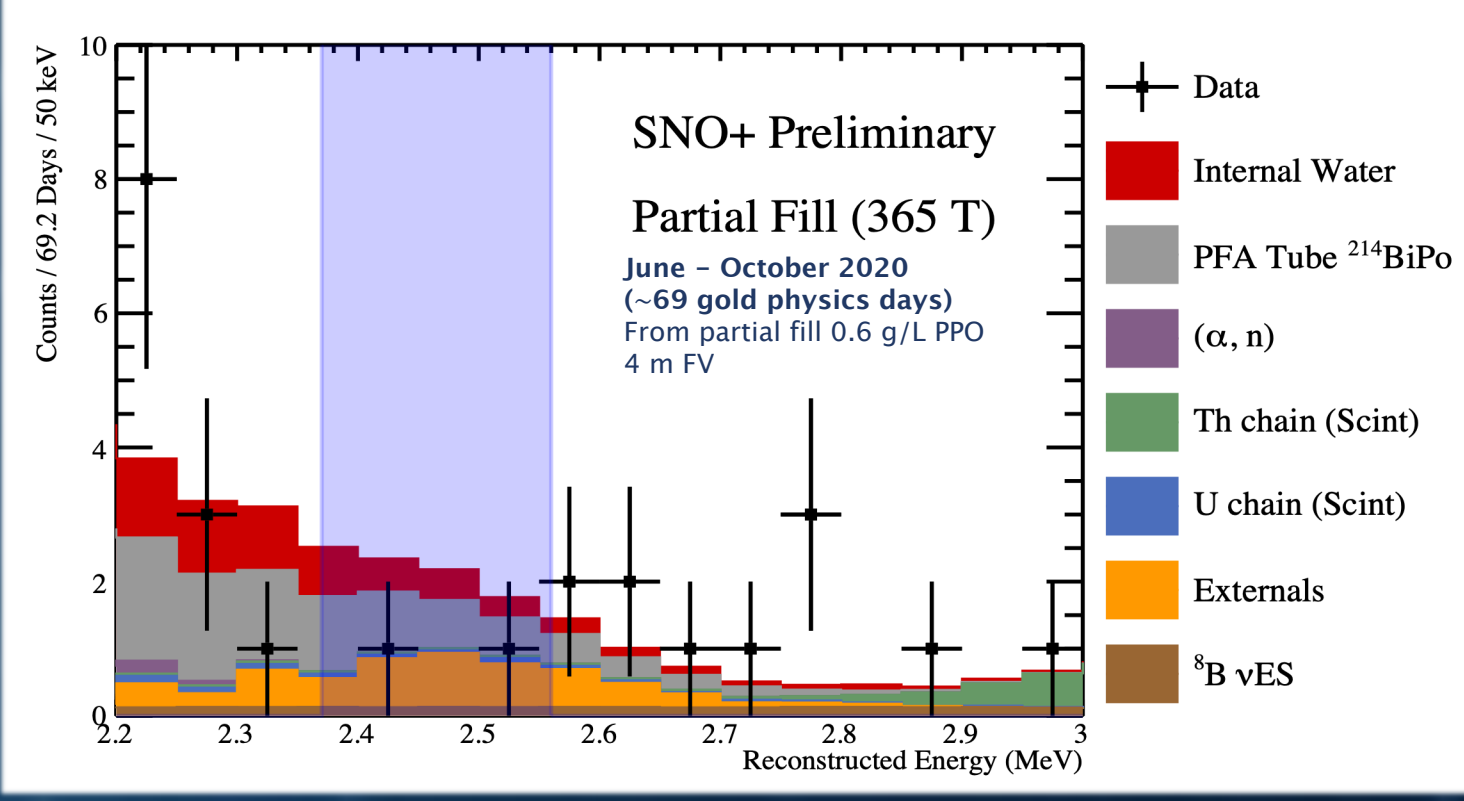


- bis-MSB addition underway
- Tracking ²¹⁰Po peak
- 1st batch: ~0.5 kg bis-MSB added to bottom of AV
- 1.5x improvement in light output

- More reagents will be added to further improve light yield and stability

- All Te loading systems tested or in late stages of commissioning

- On-going "target-out" analysis to quantify backgrounds before addition of Te



...and Beyond!

Initial Projected Sensitivity

$$S_{1/2}^{0\nu} = 2 \times 10^{26} \text{ years}$$

after 3 year live time (90% C.L.) in optimised FV and energy ROI

- Final sensitivity dependent on purity achieved during tellurium loading
- Further loading of up to 24 tonnes ^{nat}Te (3% by mass) possible and planned
- Potential to cover the whole inverted ordering band
- Excellent optical properties and long-term stability demonstrated

