SNO+ Tellurium Loading for Neutrinoless Double Beta Decay

Introduction

SNO+ is a new experiment that incorporates the existing SNO detector. By replacing the heavy water used in the SNO detector with a tellurium-loaded liquid scintillator, the experiment will focus on the search for neutrinoless double beta decay. In order to enable this search, novel metal-loading and purification techniques capable of achieving the required levels of radiopurity and optical quality have been developed.

Design and Location

SNO+ is located in the SNOLAB underground Facility in Sudbury, ON. This is equivalent to 6000 m.w.e. of shielding from cosmic rays.

SNO+ Scintillator Cocktail

- 780 T Linear Alkylbenzene (LAB)
- +2 g/L PPO (Primary Flavor)
- +15 mg/L bisMB (WS)
- Tellurium Butanediol (TeDiol) 0.5% Te in LAB
- DDA (stabilizing amine) 0.4% in LAB

Purification and Production Techniques

- LAB Target Levels: U: 10^-12 g/g Th: 10^-13 g/g
- The Telluric Acid Plant
- The TeDiol Production Plant

Telluric Acid target requirement: 232Th ~ 10^-14 g/g and 238U ~ 10^-15 g/g
Reduction factor of ~10^7 w.r.t. raw Te

Cosmogenic daughters of Tellurium: (196Co, 118Sn, 124Sn, 40Zr, 68Y, 124Sb)
Reduction factor of ~10^10

Butanediol target requirements: 238Th 3.5x10^-15 g/g, 232U 3.5x10^-14 g/g
Reduction factor of ~10^-4 w.r.t. raw BD

DDA amine target requirements: 238Th 2x10^-14 g/g, 232U 5x10^-15 g/g
Reduction factor of ~10^-6 w.r.t. raw DDA

SNO+ will be a kilo-tonne scale liquid scintillator-based experiment located at SNOLAB in Sudbury, Canada. The main advantages of this technology for the (0ββ) physics are:
- High Te target mass at fractional loading (1.3 tonnes of 128Te @ 0.5%Te by mass)
- Self-shielding and active discrimination (due to a large detector volume)
- Low internal backgrounds (effective purification techniques)

Double Beta Decay Physics

UV Absorption + Scattering

- Light Yield
- Particle Discrimination
- Timing Profiles

Main Advantages

- High light levels at 0.5% loading
- Minimal optical absorption
- Low radioactivity levels
- Distillable reagents
- Easily scalable

Loading Technique Mature and Well-tested

- Acrylic compatible & Stable
- Complex stable and tested under a variety of conditions
- Compatible with acrylic and materials of the experiment
- Robust synthesis technique developed
- LAB plant commissioning – first LAB fill imminent
- Telluric Acid plant entering commissioning phase
- TeDiol plant construction underway

Status and schedule

Lab Target Levels: U: 10^-12 g/g Th: 10^-13 g/g