Date: April 10, 2024

To: Jeter Hall
Director of Research

Review of the SNO+ Experiment

Under the advice of the Experimental Advisory Committee, I request you initiate a review of the SNO+ project to determine the technical and scientific status in the context of the global search for neutrinoless double-beta decay.

Situation Leading to the Review

- SNO+ has been a project since the inception of SNOLAB. This project is technically complex with many phases of both R&D and experimental deployment. As such, SNOLAB periodically commissions reviews of current technological and project management.
- The previous Director's Review, in January 2021, recommended "*If the 130Te phase of the experiment is not shown to be technically possible on a timescale of approximately a year, the SNO+ Collaboration should consider focusing resources on a solar neutrino science program. SNOLAB should consider prioritizing [the solar neutrino] program if it becomes the highest-priority of the Collaboration.*"
- SNOLAB and SNO+ seek a world-leading measurement of neutrino mass through this search for neutrinoless double-beta decay. The strategy SNOLAB pursued was to focus on pure scintillator science, request that the collaboration create a higher-impact experiment, and support the operational development of the tellurium diol and telluric acid plants underground to create better estimates of the cost, labor, and time associated with that higher-impact experiment.

SNOLAB has several large projects in the design and construction phases that will overlap with the implementation of SNO+. As a result, SNOLAB may be forced to prioritize between the SNO+ project and its commitments to other projects. I am also aware that the implications of schedule delays due to technical issues and the COVID-19 pandemic has had an impact on the timelines and goals for the global scientific field.

The Fall 2023 EAC recommended:

> *We believe that it is the right time for the committee to receive an EOI from SNO+ for a high-Te-loading phase experiment and recommend that the collaboration prepare one for the next EAC meeting. Although SNO+ has experienced many delays over the years, a timely high-percentage Te*

experiment is still very competitive, and a strong EOI would unlock the Gateway process for the collaboration to seek funding, on a schedule that could allow SNO+ to make a world-leading measurement.

The EOI should:

Propose a clear target for the percentage of Te loading, driven by physics objectives.

- *Include all that is available in terms of modeling of TeLS yellowing.*
- *In addition, understand the expected scintillator lifetime for higher loading.*

SNOLAB and the SNO+ Collaboration has worked diligently to demonstrate the tellurium purification infrastructure underground and should complete a test batch through the telluric acid plant before this review.

Charge for the Review

The SNO+ experiment uses a kiloton-scale liquid scintillator detector to measure neutrino fluxes and properties using various physics channels including inverse-beta decay and electron scattering. The project proponents have built infrastructure for creating a proprietary scintillator that is loaded with percent-levels, by weight, of tellurium metal in solution. A test batch through one of the two critical tellurium chemical plants will be complete by the time of this review. Further tests and/or optimization may be necessary depending on the outcome of the test batch.

SNO+ is currently approved for liquid scintillator operation and R&D on the tellurium plants, but the tellurium project has been closed out. Both SNOLAB and SNO+ are working to see if a new tellurium project with more ambitious scientific goals, hereafter called the 'high loading' project, is possible given the state of the field and current constraints. The SNO+ collaboration has provided an Expression of Interest, the first step in the project lifecycle, and our Experimental Advisory Committee would like expert advice on the scope of the EOI.

Please review the scope, schedule, and budget for the higher loading project.

- What is the scientific goal for the high-loading project?
  - Is this a relevant and appropriate goal within the global scientific context?
- Are the high-loading project technical goals appropriate to achieving the scientific goal?
  - Are the backgrounds goals well understood, appropriate, and achievable?
  - Is the tellurium-loaded scintillator stability understood at a sufficient level to accomplish the scientific goal?

SNO+ is applying for funds for this higher-loading project. SNOLAB will hold a review of the project management and planning. SNO+ will provide the status of the project schedule, costs, personnel, and risk. Please give a preliminary review of the project management.

- Is the cost and schedule estimate credible at this stage?
- Is the required project documentation on track for a Gateway-1A review this Fall?
- Are there any concerns about preparedness for the Gateway-1A review?

Please review the progress of the test batch of the tellurium systems in the context of this higher-loading project.

- Do the outputs of the tellurium plants test batch meet the technical goals of the higher-loading project, or are additional commissioning tests on track to meet the technical goals?
    - Are additional tests needed to prove the plant performance meet the technical goals?
- Does the schedule and budget for the higher-loading project incorporate the knowledge of the plant learned from the test batch?
    - Does the schedule and budget incorporate any additional tests needed to prove the plant performance?

Outputs of the review:

Feedback should be provided to the Executive Director, SNOLAB, in the form of a short, written report addressing the questions detailed within this charge.

Sincerely,

Jodi A. Cooley

Jodi Cooley
Executive Director