How to realize a Canada-led large scale subatomic physics experiment at SNOLAB?

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SNOLAB Project Management Conference

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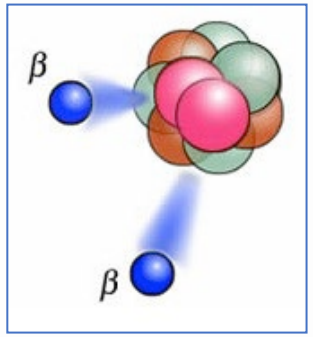
nEXO co-spokesperson

The nEXO Search for 0νββ decay

0νββ
@CRYOPIT

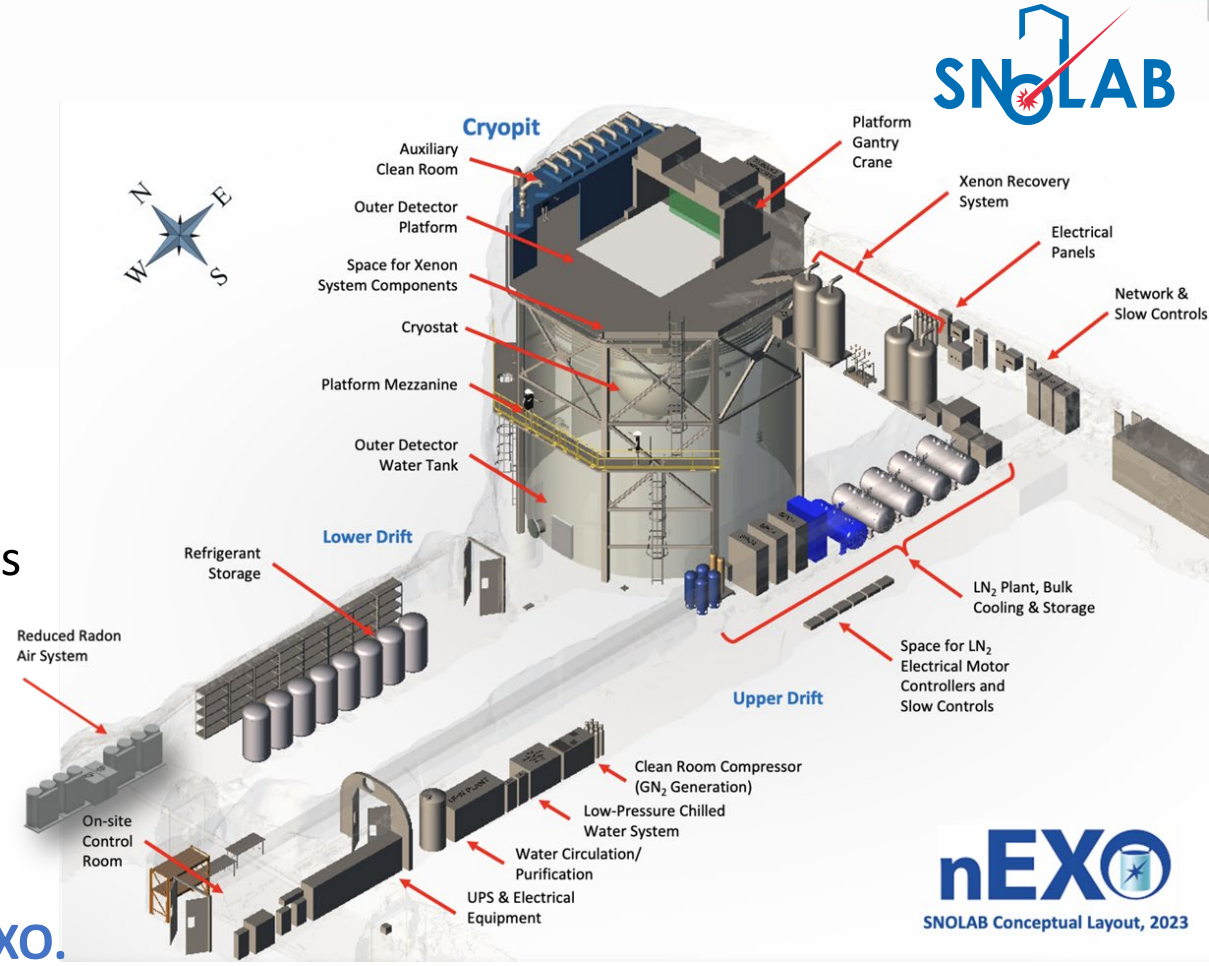


0νββ only possible if neutrinos are special particles, so-called Majorana particles.

Goal: observation of neutrinoless double beta decay (0νββ)

→ Observation would violate lepton number in weak decays
→ **Observation would help explain the origin of Matter!**

- Search for 0νββ in nEXO:
  - **nEXO is an international flagship 0νββ experiment.**
  - **Projected sensitivity of nEXO beyond 10^{28} years.**
  - **SNOLAB in Sudbury is the preferred location for nEXO.**



nEXO in a Nutshell

- International collaboration of >200 scientists, 39 institutions in 10 countries on 4 continents (70% US, 22% Canada, 8% other)
- Project led by US Department of Energy (DOE) following Order 413.3B
- Canadian Infrastructure Contributions largely anticipated through CFI Innovation Fund (IF) and Major Science Initiatives (MSI) Programs, and to some degree from NSERC, and McDonald Institute
- Cost estimate by country (DOE point estimate, July 2024):

	USA		Canada	Other international		
DOE Project	National Laboratories Research Contribution	US Universities Contributions	Canadian Contribution (CAD)	Chinese Contribution	French Contribution	Grand Total
$384,630,698	$39,498,272	$11,852,924	$81,739,152	$3,924,947	$1,156,591	$522,802,585

Status of nEXO

- DOE's decision from December 2024 put on hold a timely realization of the experiment:

> Dear Mike [M. Heffner, nEXO Project Director],
>
> … The decision is to move forward with LEGEND-1000 in the near term. …
>
> While CUPID and nEXO are viewed as demonstrating high potential for scientific impact, under constrained budgets it is unlikely that U.S. funding will allow these projects to advance significantly in the near term. R&D activities will continue, supported through the DOE NP fundamental symmetries research program, with the level dependent upon appropriations. **DOE NP remains committed to working with the international community to realize an international campaign with multiple isotopes and more than one large ton-scale experiment, with the potential for future investment in these experiments. …**
>
> Paul Mantica (he/him/his)
>
> Director, Facilities and Project Management Division, Office of Nuclear Physics (NP), US Department of Energy (DOE), Office of Science (SC)

- In response to DOE's decision, CFI put IF 2020 and 2023 awards on hold in early 2025.

An opportunity for Canada

- nEXO concept has been developed by an international collaboration for more than one decade, with its design ready to start construction.
- nEXO has been one of the three contenders in an international 0νββ program.
- Canada is well positioned to take over the lead of the nEXO project:
  - Leverage more than 10 years of R&D efforts in Canada and the US.
  - SNOLAB as site is the ideal and preferred location.
  - Strong community interest.
- **Question: How can we realize an experiment of this magnitude?**

Approaches to fund large scale infrastructure

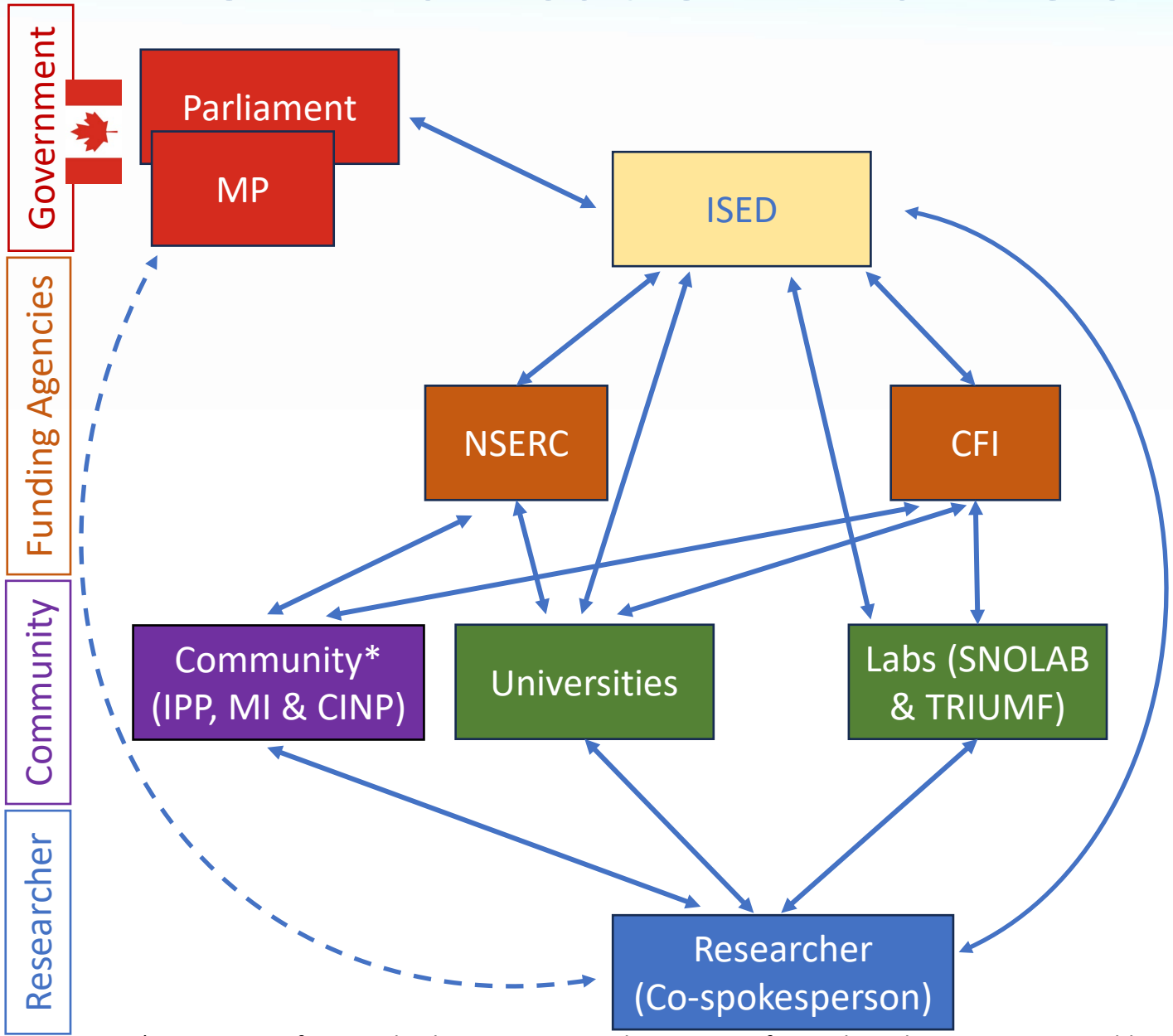
- US Department of Energy: Mission driven approach
  - DOE defines “Mission Need” based on community input and prioritization
  - DOE mandates National Laboratories to develop and deliver infrastructure
  - **Project largely supported through DOE**
  - **Continuous oversight from DOE throughout project life cycle**
- Canada: Bottom-up approach
  - Community priorities are identified in long range plan, prioritization not always clear
  - No streamlined approach to fund large scale experiments:
    - Infrastructure provided through CFI Innovation Fund (IF) which is limited in size through university envelopes (and CFI IF overall funding level)
    - Lab infrastructure supported through CFI Major Science Initiatives (MSI) Fund
    - HQP supported largely through NSERC and McDonald Institute (MI)
- **Challenge: Mismatch between international funding agencies in terms of securing commitments, schedule, and oversight.**

Challenges of the bottom-up approach

- No entity or institution in Canada with a mandate to realize large scale experiments or investments, including oversight.
- No clear path to fund large scale infrastructure.
- Challenging to attract an international flagship experiment to Canada without significant Canadian financial backing.
- Host country expected to contribute ~20% - 40% to large scale experiments, larger contribution expected from leading country.

- **Question: How to get the project going under Canadian leadership?**

Communication Channels in Canada



- No established process to realize projects of this size.
- Lobbying for support with:
  - SNOLAB & TRIUMF
  - Universities, IPP, CINP, and MI
- In communication with ISED.
- Challenges:
  - No direct communication of researchers with CFI or NSERC
  - Funding agencies are granting agencies but not mandated to deliver a research project
- **Future: Develop communication between researcher and Parliament.**

*IPP: Institute for Particle Physis, CINP: Canadian Institute for Nuclear Physics, MI: McDonald Institute

Communication Channels in Canada

0νββ
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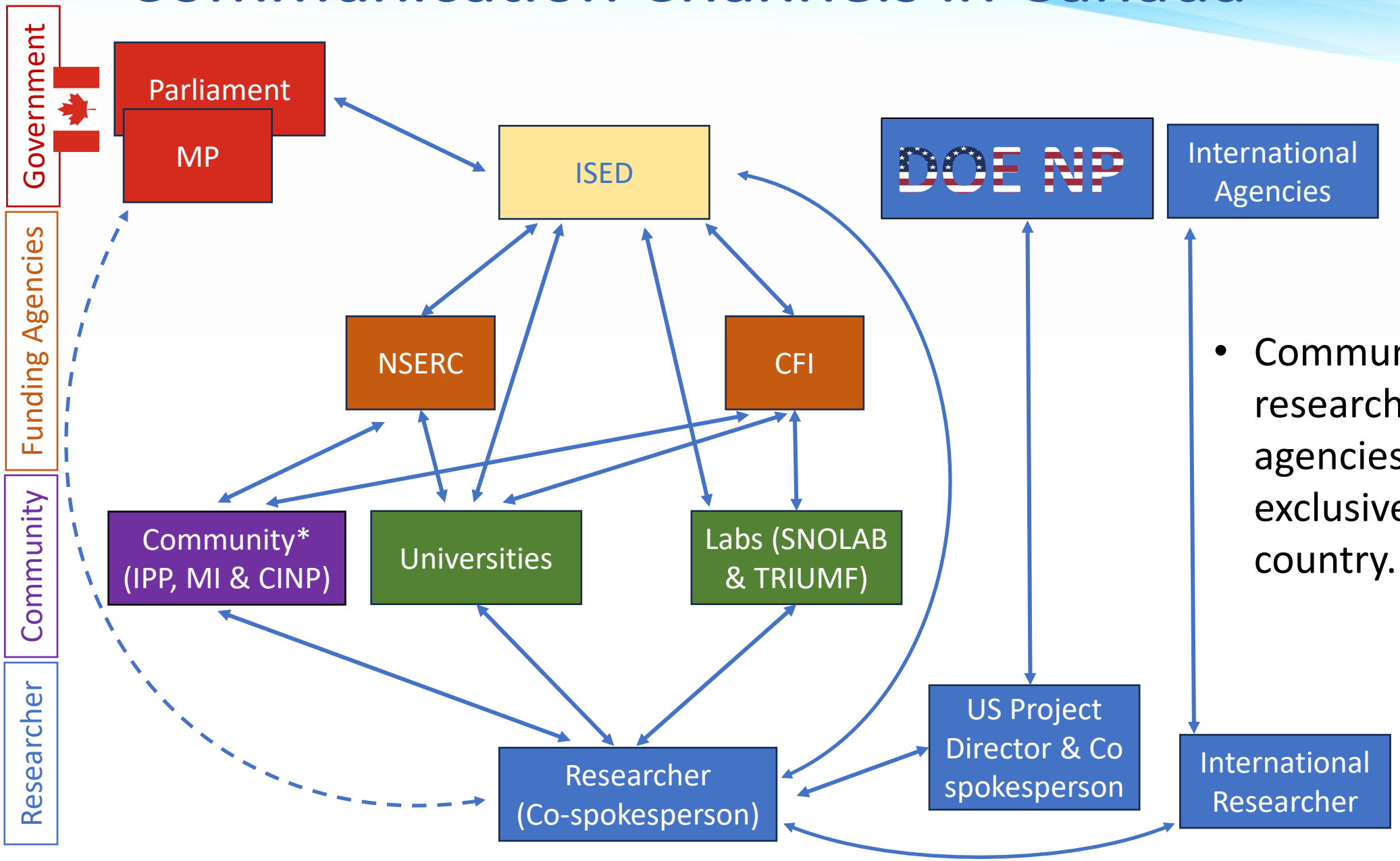

- Communication between researcher and funding agencies limited almost exclusively within each country.

Communication Channels in Canada

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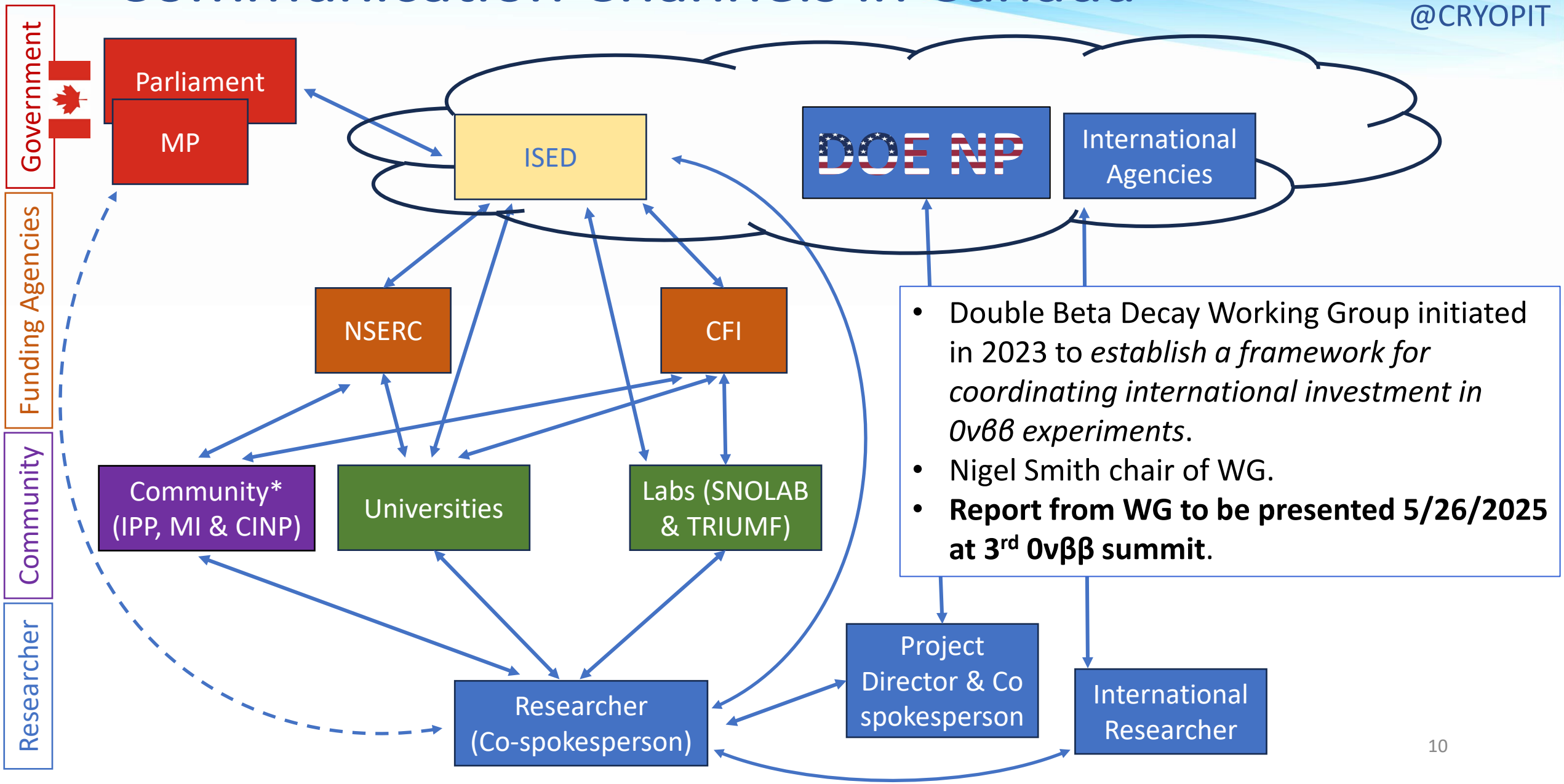

- Double Beta Decay Working Group initiated in 2023 to *establish a framework for coordinating international investment in 0νββ experiments*.
- Nigel Smith chair of WG.
- **Report from WG to be presented 5/26/2025 at 3rd 0νββ summit**.

Summary

- It is challenging to realize a large-scale international experiment in Canada due to missing processes to secure funding of required amount and on required timescale.
- We have developed communication channels with our universities, representatives of the community (CINP, IPP, MI), and ISED.
- We benefit from support from SNOLAB and TRIUMF
- Funding agencies are working on establishing a framework to coordinate international investments in the 0νββ program.
- Next step: develop communication channels with members of parliament and lobby for a Canada-led 0νββ experiment to be realized at SNOLAB.