

2019-06-06

SNOLAB Update

Present and future opportunities

Nigel Smith
Executive Director



Strategy and Leadership

Executive Director recruitment

- Process is still underway
- Expected completion time clearly pushed back from initial tenure
- Incumbent extended to end of calendar year to provide some headroom (NExit delayed?)
 - Also helps with CFI MSI proposal reviews





Our Vision

To be an internationally recognized laboratory and partner of choice for deep underground science, delivering world-class research, scientific discovery and benefit to Canada, and her global partners, by enabling national and international access to our unique capabilities, facilities and expertise.

The SNOLAB mandate has developed over time



Initial SNO experiment:

Site operations only
Project delivery within universities

Experiment Site

Initial SNOLAB construct:

Develop multi-use facility
Project delivery within universities

Infrastructure

Facility

'National' Laboratory

Long range objective:

Full role in research ecosystem
Role in science delivery
Major engagement in project delivery
Oversight with all stakeholders
Develop international networks

Current status:

Providing substantial support to project delivery
Held accountable for science delivery
Developing project oversight

What do we do for our community?



Project management support
 Expt. operational support
 International connections
 Research Scientists
 Construction support
 Future scanning

Maintain the environment for support
 Develop new capabilities that the community needs

Inspire new generation of scientists
 Diversity, equity, inclusivity
 Public and stakeholder return

Risk "legatee"
 Support project lifecycle
 EH&S and project reviews

Science Updates

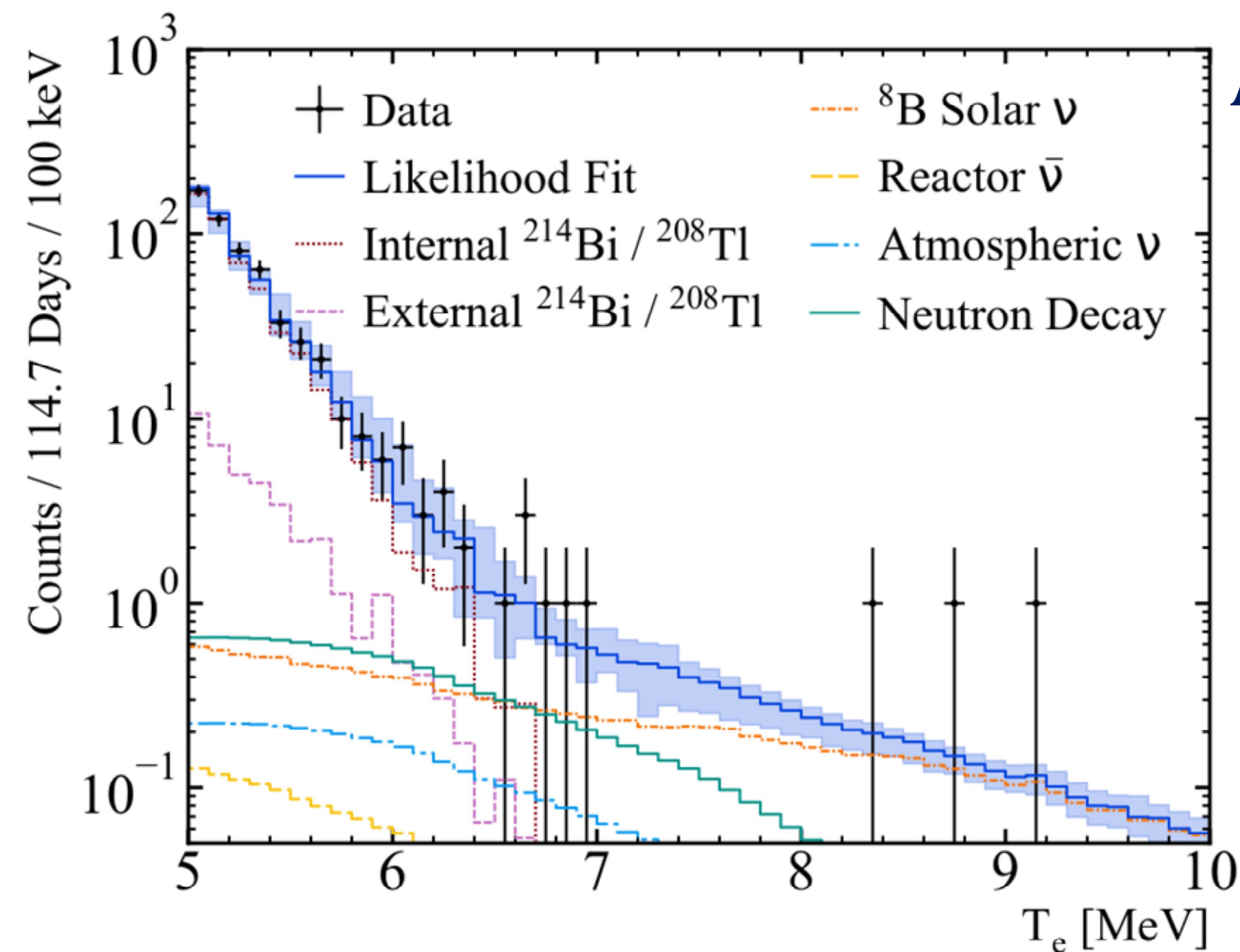
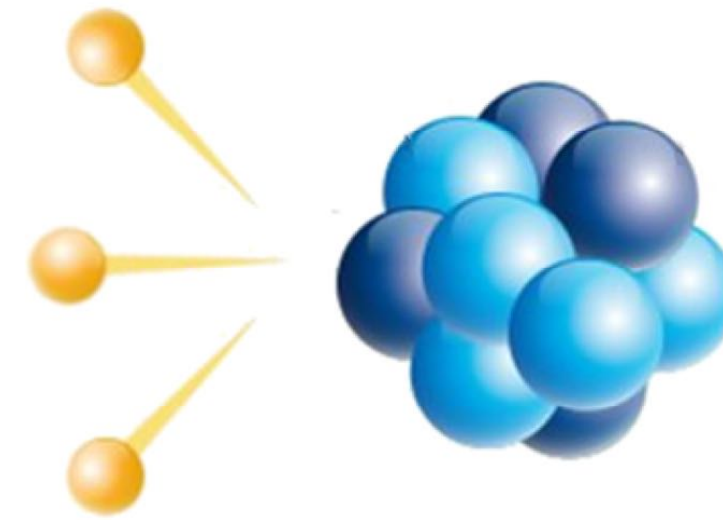
Recent progress on experiments

- SNO+: Uses existing SNO detector. Heavy water replaced by scintillator loaded with ^{130}Te .
 $(^{130}\text{Te} \rightarrow ^{130}\text{Xe} + e^- + e^-)$
 - Recent papers from water phase: invisible nucleon decay and ^8B solar neutrinos
 - LAB process plant in final commissioning
 - TeA plant constructed and in commissioning, TBD plant construction well advanced
- DEAP-3600: Single phase Liquid Argon using PSD
 - Detector collecting dark matter data continuously from Nov 2016. New publications submitted on data from year-long run
 - DarkSide/DEAP/MC forged Global Argon DM group to develop next generation of detectors. DS-20k first objective, then (SNOLAB) 300t detector. Connected to CERN Neutrino Platform.
- MiniCLEAN: Single Phase Liquid Argon using PSD
 - Gas phase data collected, project in decommissioning (PICO-500 to go in tank)

Water phase physics: Nucleon decay

Best limits so far for invisible mode:

- neutron decay lifetime: 5.8×10^{29} y
 - ◆ Phys. Rev. Lett. **96**, 101802 (KamLAND)
- proton decays lifetime 2.1×10^{29} y
 - ◆ Phys. Rev. Lett. **92**, 102004 (SNO)



Analysis of 235 days (May 4, 2017 - Dec 25, 2017)

- detector was live for 95% of the time
 - with 16.9% on calibration or maintenance
- Data quality checks to reduce instrumental backgrounds
- Cuts on energy, position, direction, isotropy to reduce backgrounds
- Final data set:
 - 114.7 days with expected 17.65 events in ROI

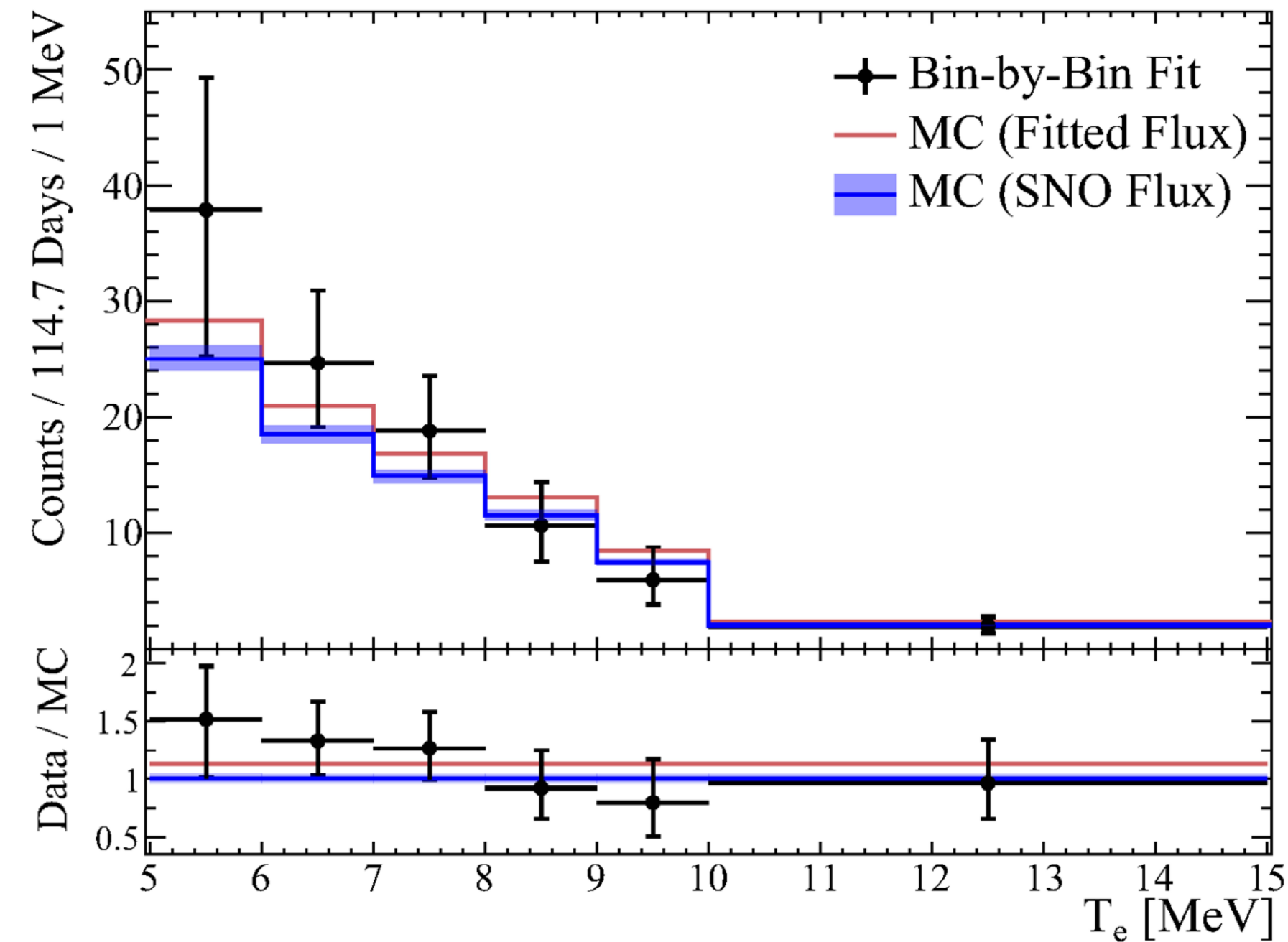
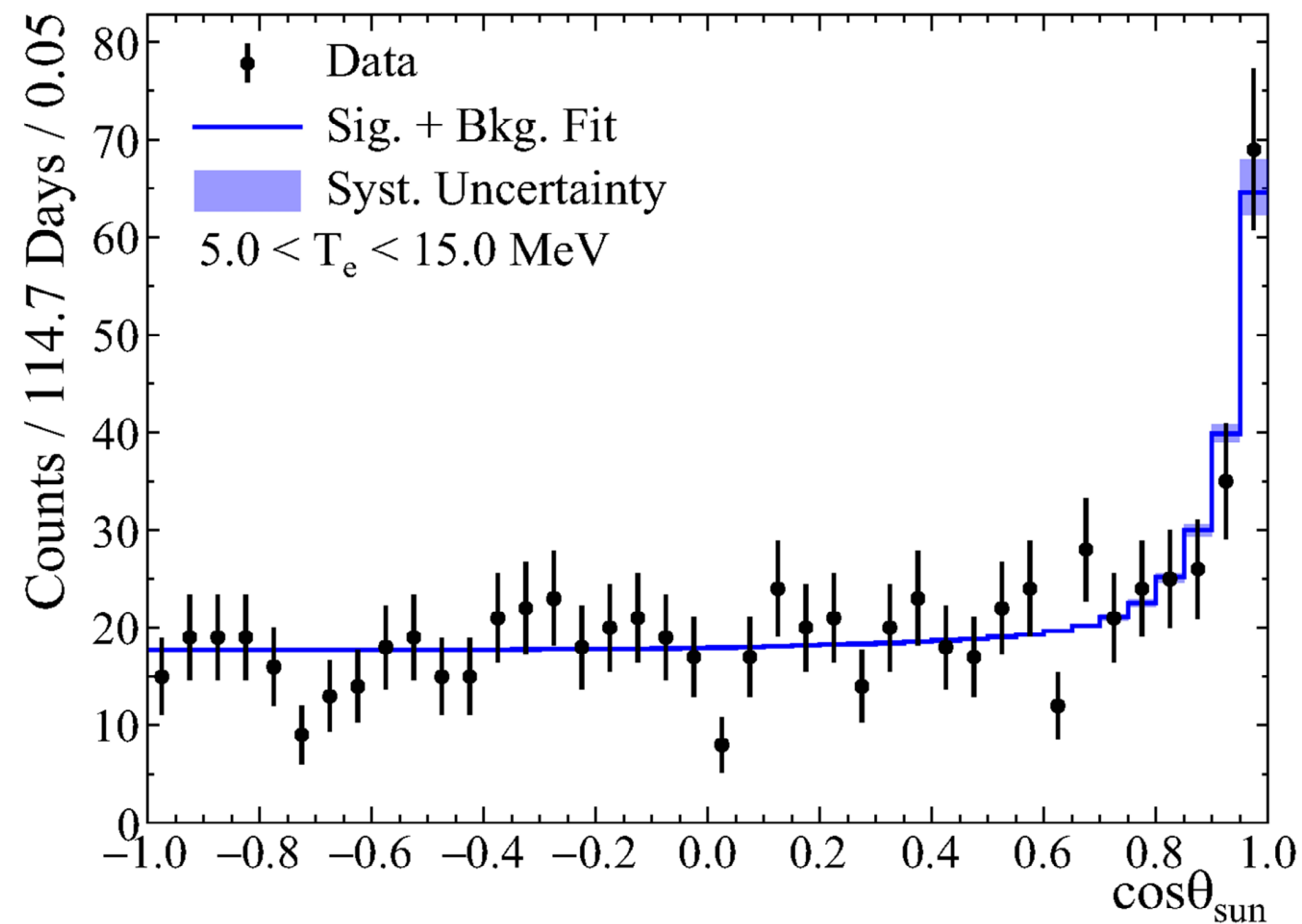
➤ SNO+ sets world-leading limit on invisible modes of proton decay:

3.6×10^{29} years

Phys. Rev. D **99**, 032008

Water phase physics: ^8B solar neutrinos

- Analysis of data May- December 2017
 - Quality checks -> lifetime of 114.7 days



➤ SNO+ measures ^8B solar neutrons flux:

$$\Phi_{^8\text{B}} = 5.95^{+0.75}_{-0.71} (\text{stat})^{+0.28}_{-0.30} (\text{syst}) \times 10^6 \text{ cm}^{-2} \text{ s}^{-1}$$

Phys. Rev. D **99**, 012012

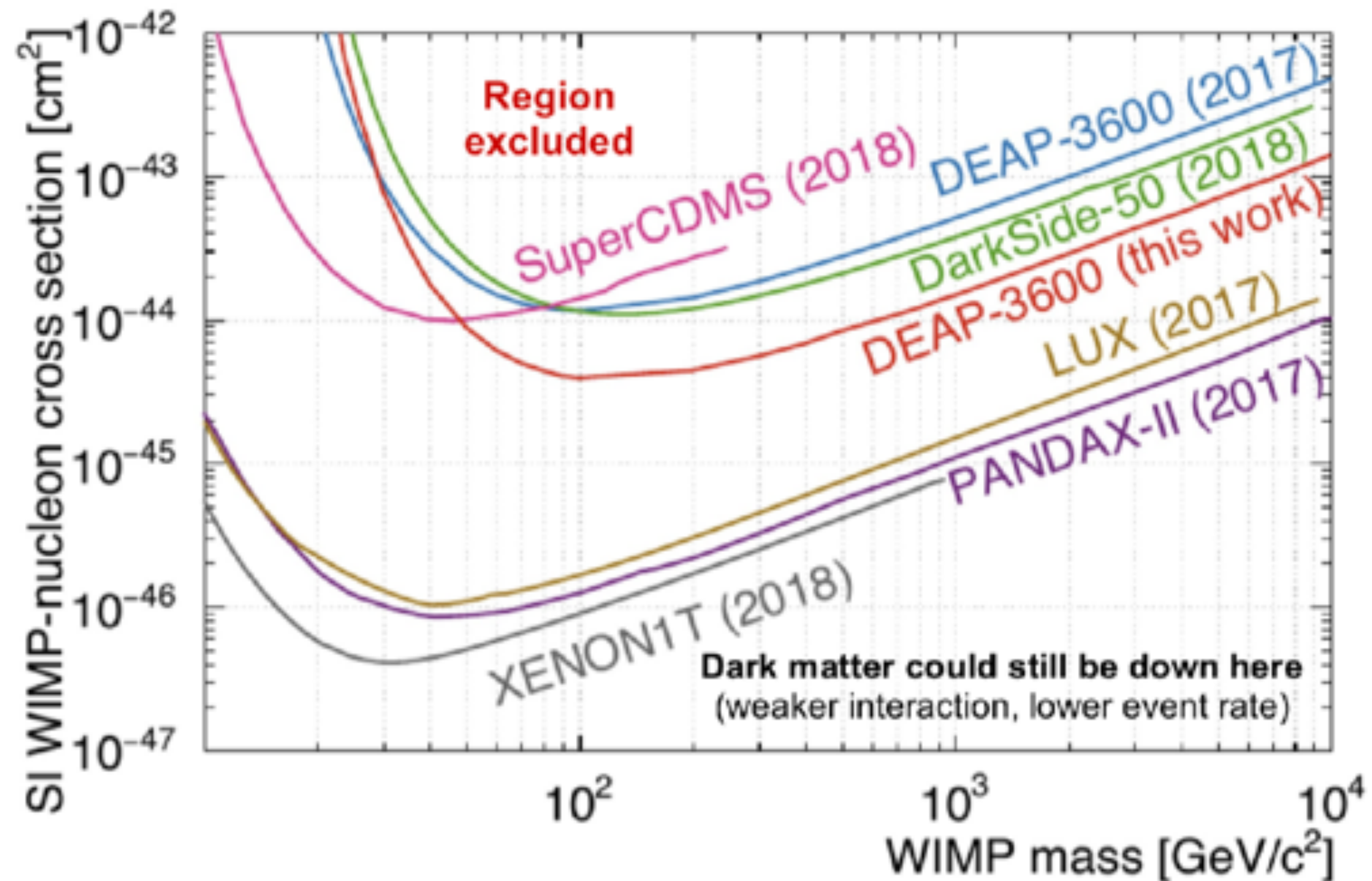
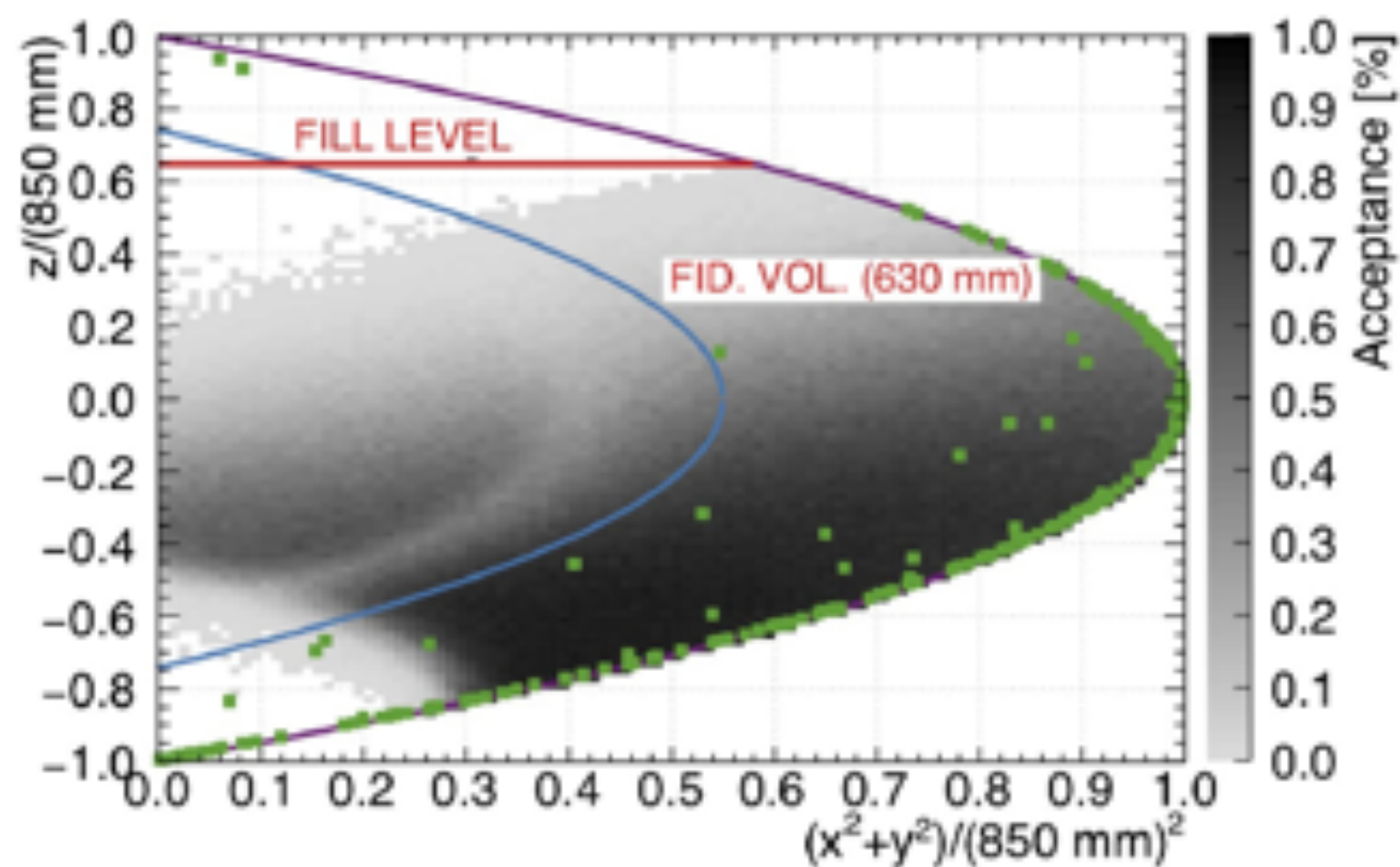
- Consistent with SNO results

DEAP Results

Second fill: **First year dataset**
 November 2016 – October 2017

3279 kg LAr
 231 live-days passing data quality

arXiv:1902.04048, submitted to PRD
 arXiv:1905.05811, submitted to PRD

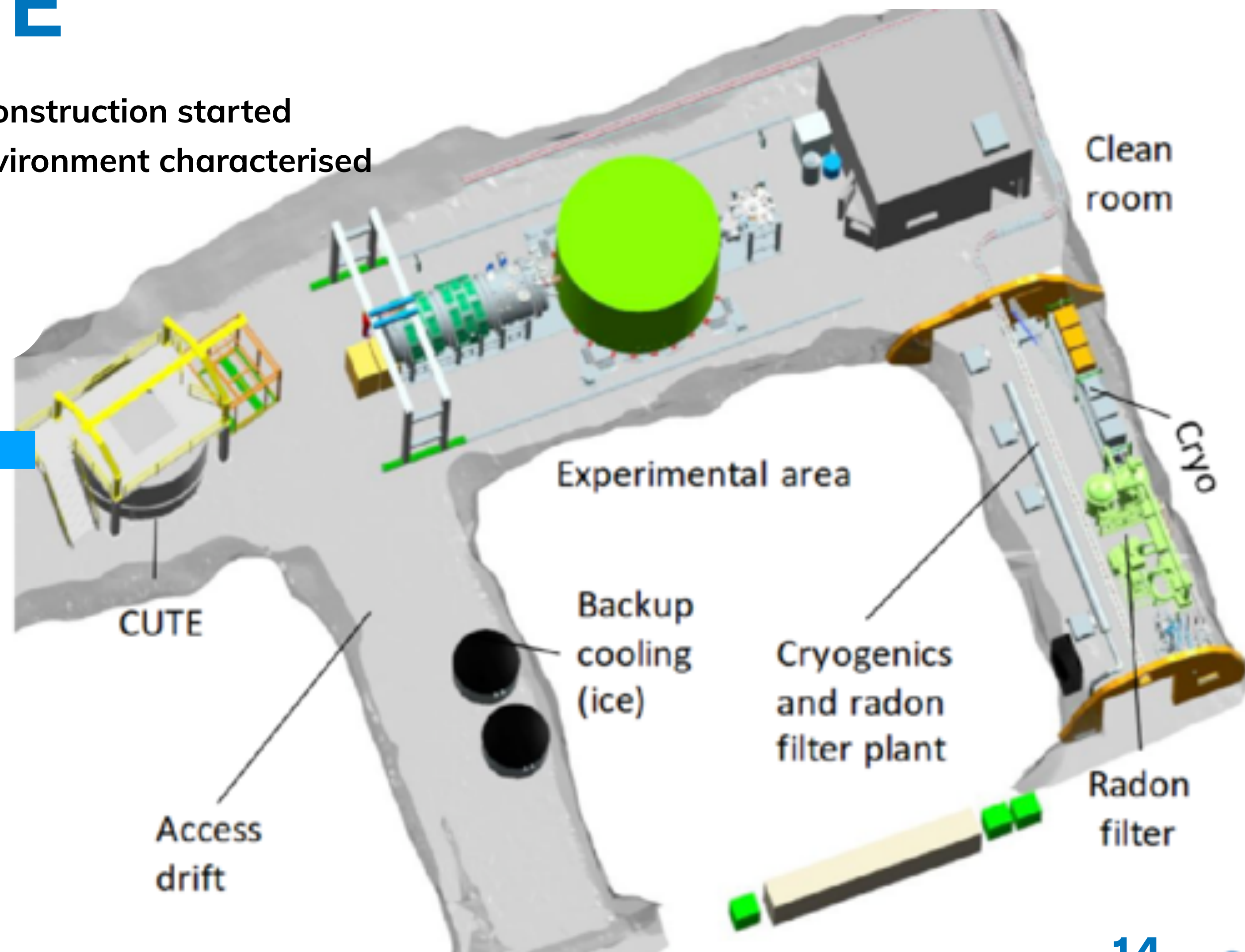


Progress on experiments

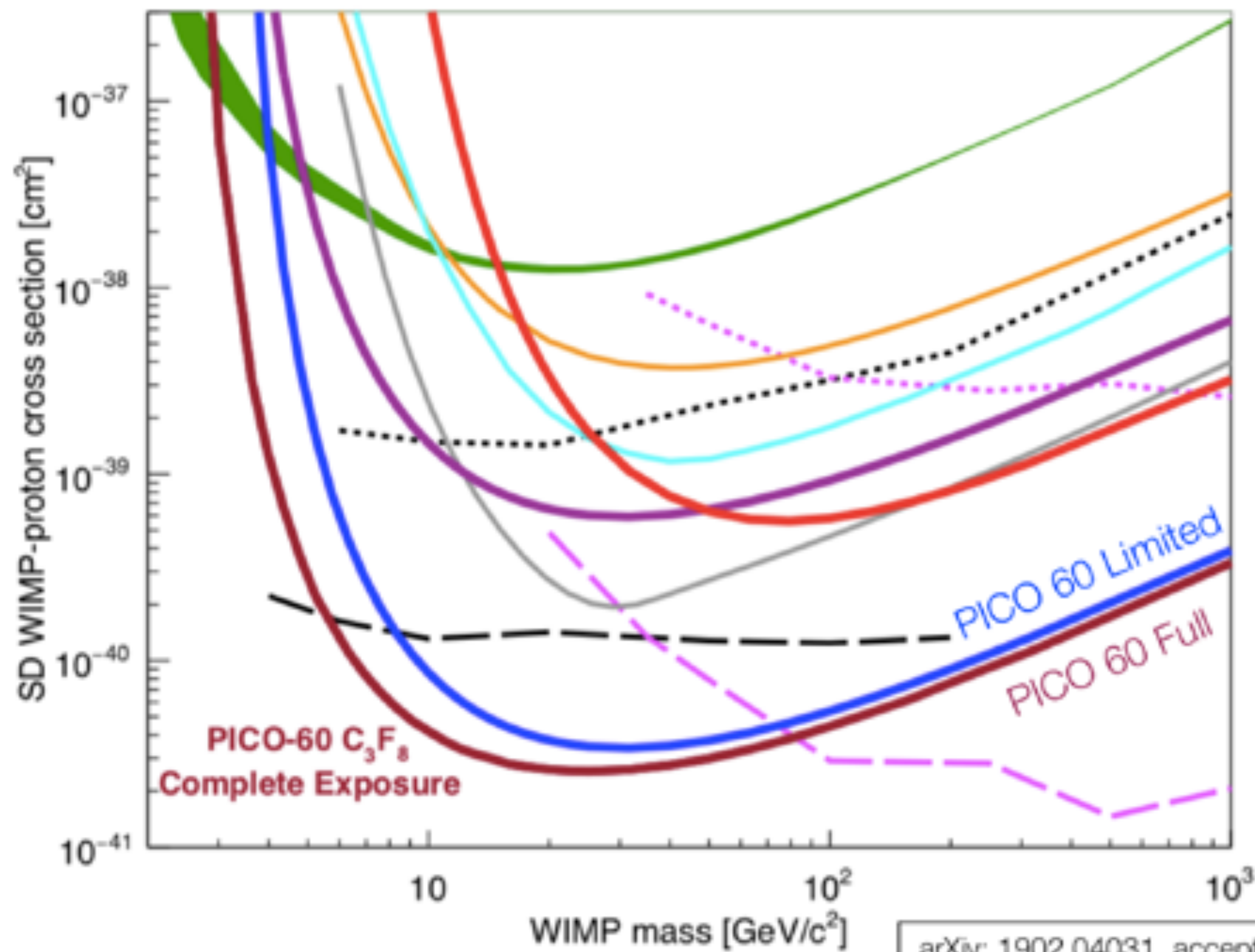
- SuperCDMS-SNOLAB: Dark matter Si / Ge crystals with ionisation / phonon readout
 - CUTE test facility constructed, 'fridge in deployment
 - SuperCDMS-SNOLAB infrastructure under construction
 - Expect early science from CUTE 2019/20; first payload runs for SuperCDMS 2021
- PICO: Rapid expansion bubble chambers. Insensitive to MIPS at operating temperature, threshold devices; alpha discrimination proven;
 - PICO-60: New results submitted (full exposure),
 - PICO-40 under construction (right-side up chamber)
 - PICO-500 in development
- DAMIC - HALO - REPAIR - FLAME: all taking data
- NEWS-DM - SENSEI - SBC - Xe still: all in development or construction

SuperCDMS/CUTE

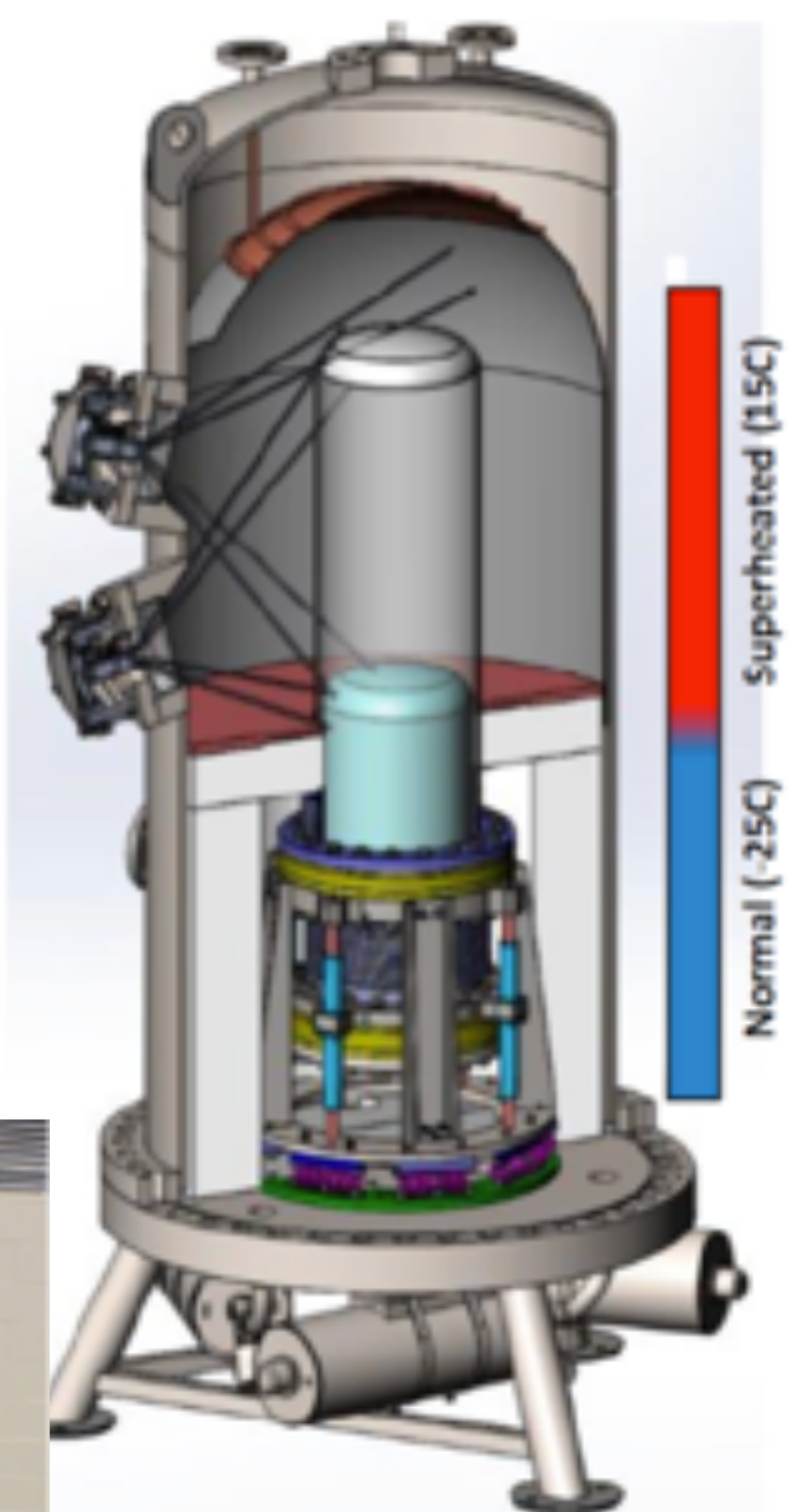
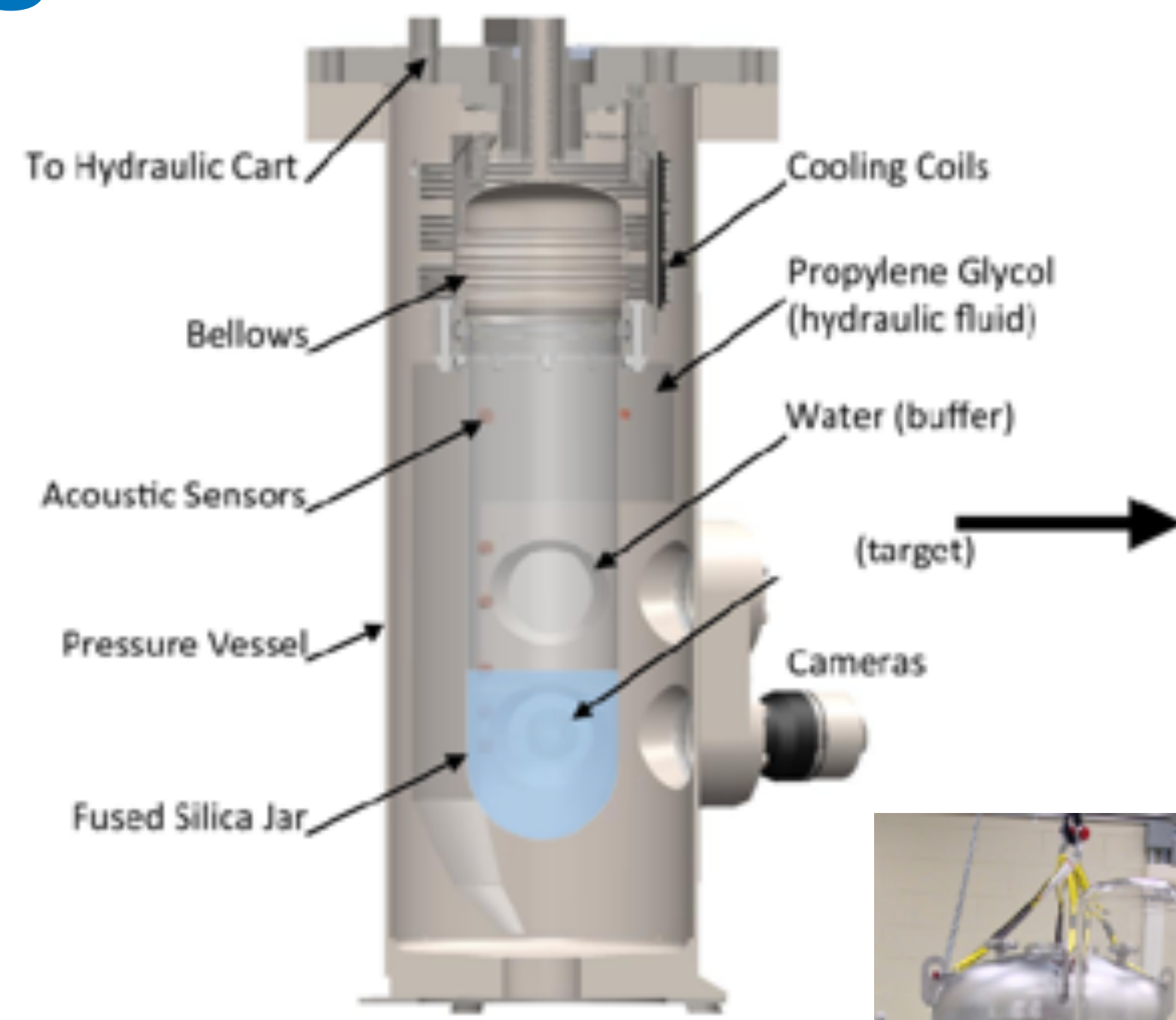
Infrastructure construction started
Radiological environment characterised



PICO developments

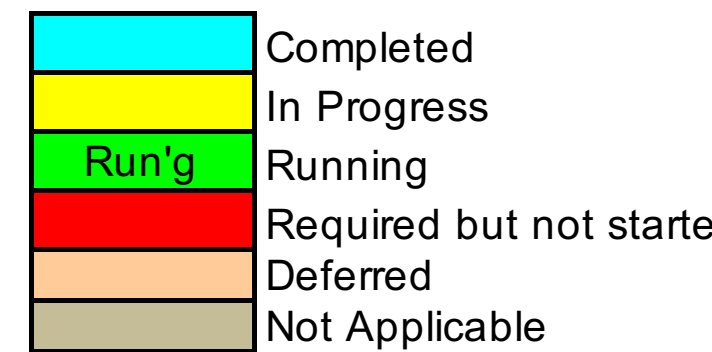


arXiv: 1902.04031, accepted to PRD



SNOLAB Projects and Lifecycle

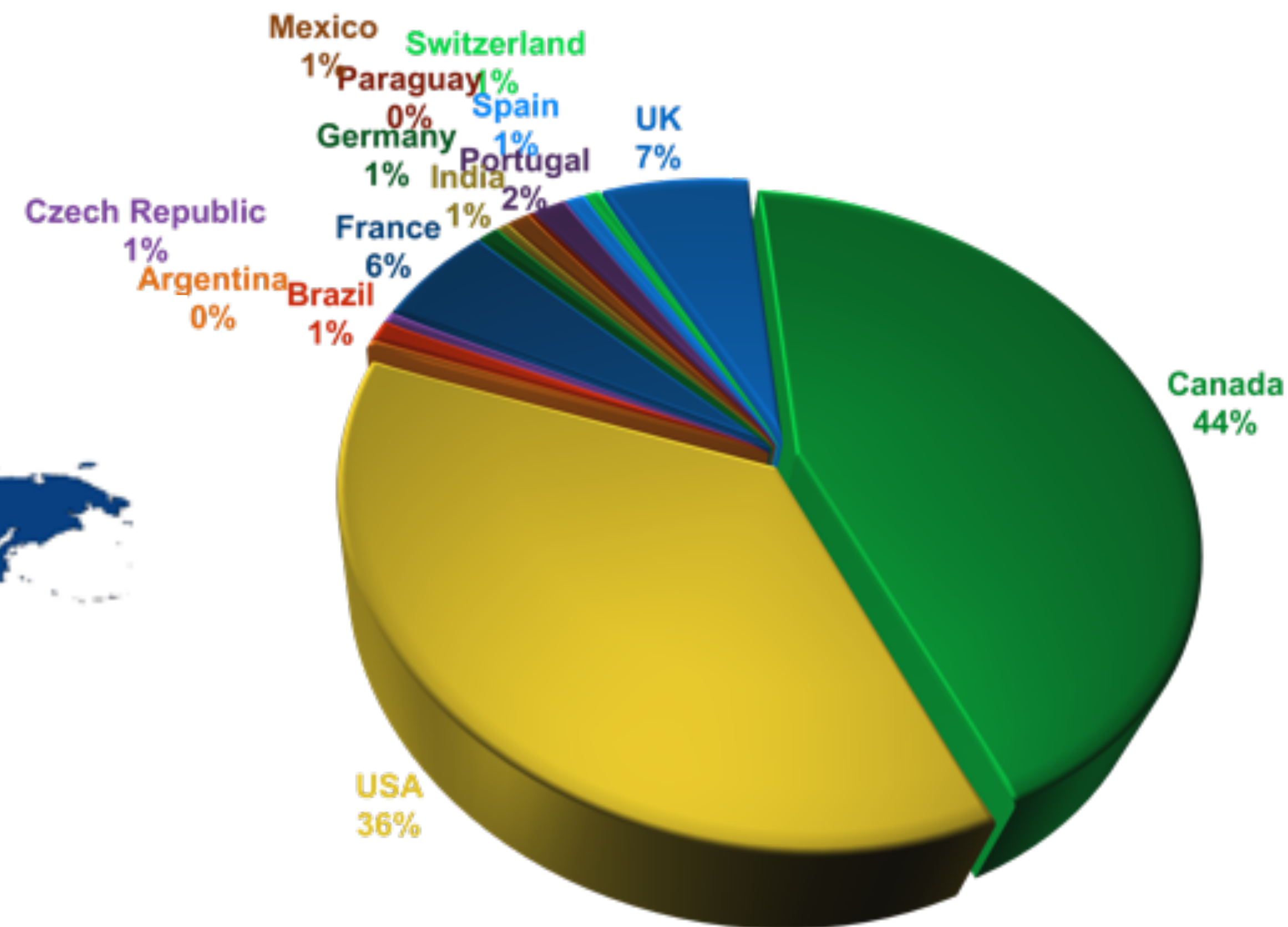
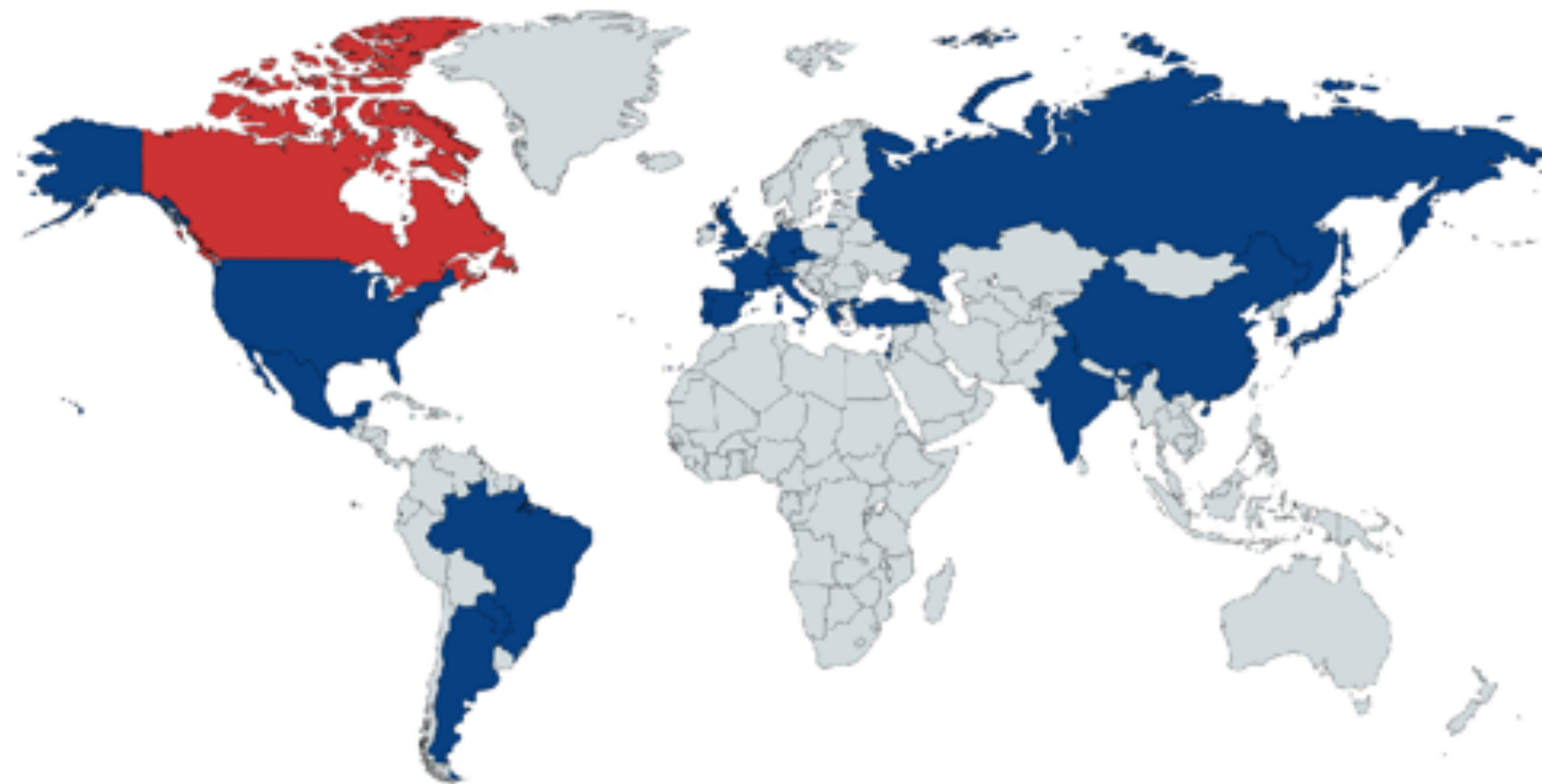
Proj #	Project	GW Status	Initiation	GW-0	Definition	GW-1	Proposal	GW-1A	Development	GW-2	Implementation	GW-3	Operation	GW-4	Closure	End
025	PUPS	5														
19	COUPP-4	5														
012	PICASSO	5														
018	DEAP-1	5														
007	HALO	3											Running			
030	DAMIC	3											Running			
019	PICO-60	5														
033	PICO-2L	5														
041	REPAIR	3											Running			
042	Flys in a Mine	3											Running			
020	DEAP-3600	3											Running			
023	MiniCLEAN	3														
013	SNO+	3											WaterRun			
013-A	SNO+ TeA	2														
013-B	SNO+ TeDiol	2														
001	SuperCDMS-SNOLAB	1														
038	NEWS-G	1														
040	DMTPC	0														
044	CUTE	2														
045	PICO-500	0														
046	DUST	0														
037	Ge-1T?	x														
032	nEXO	0														
019A	PICO 40	2														
47	Sensei	0														
48	NEWS-DM	0														
49	SBC	0														



User-base by Country

>850 users, ~100 staff

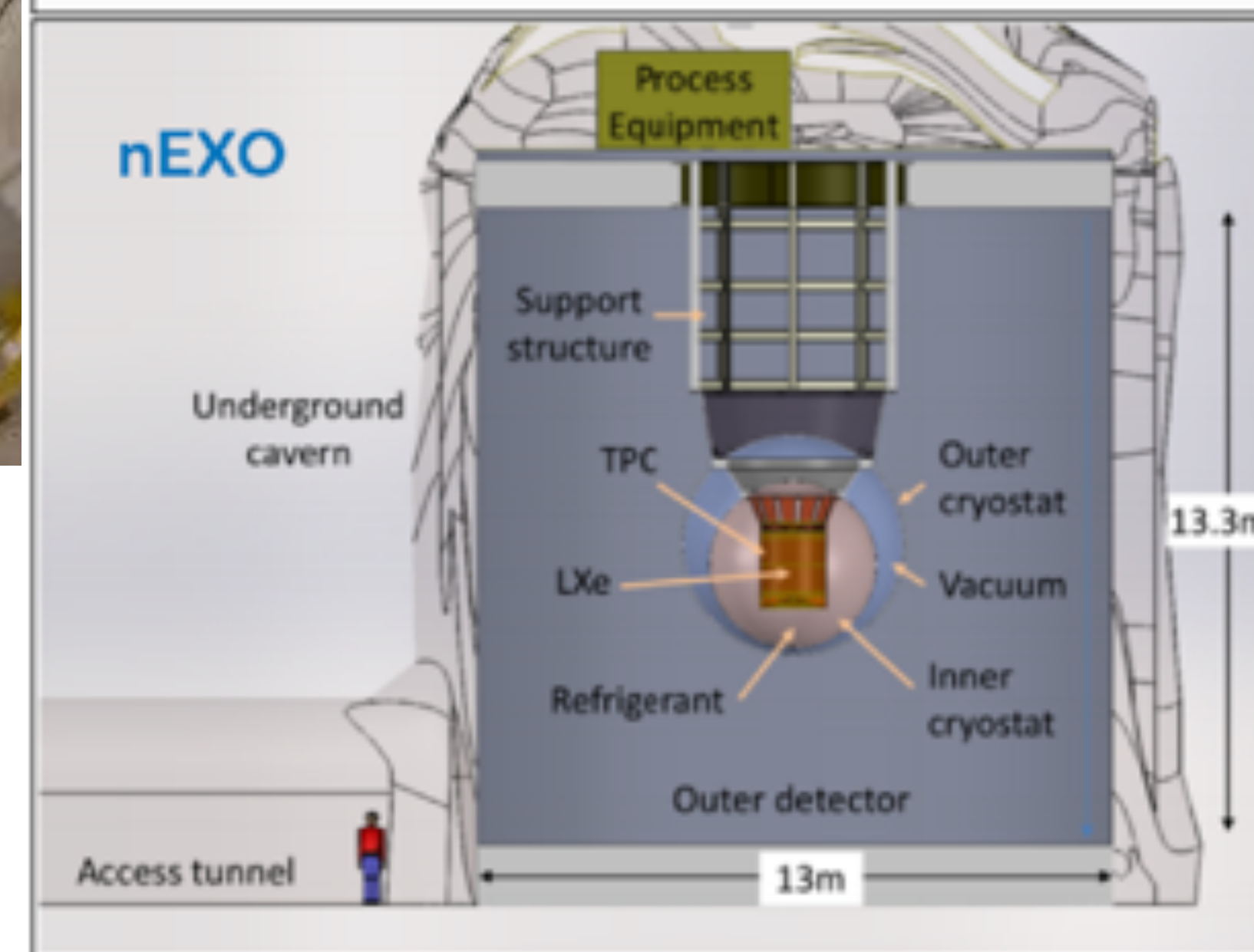
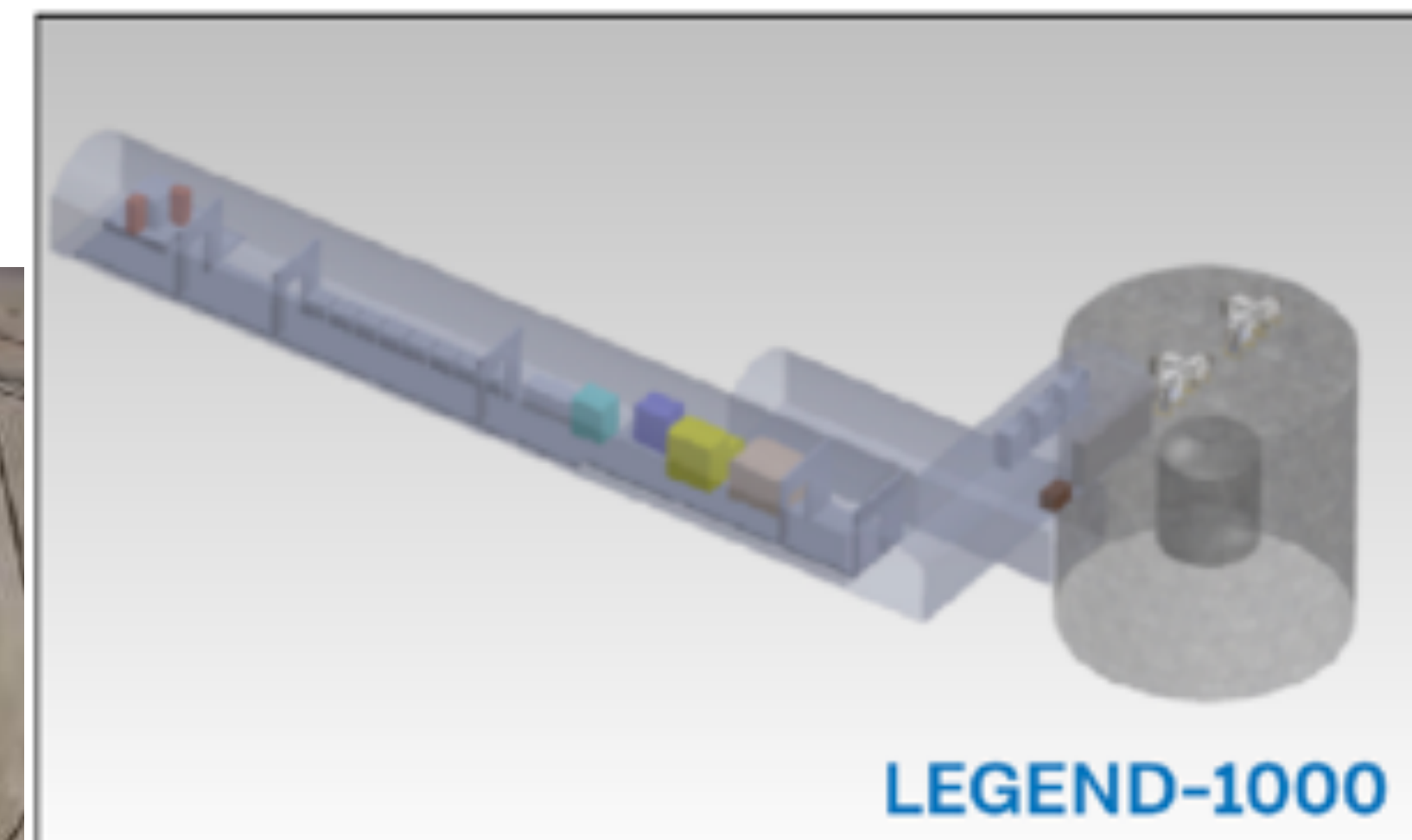
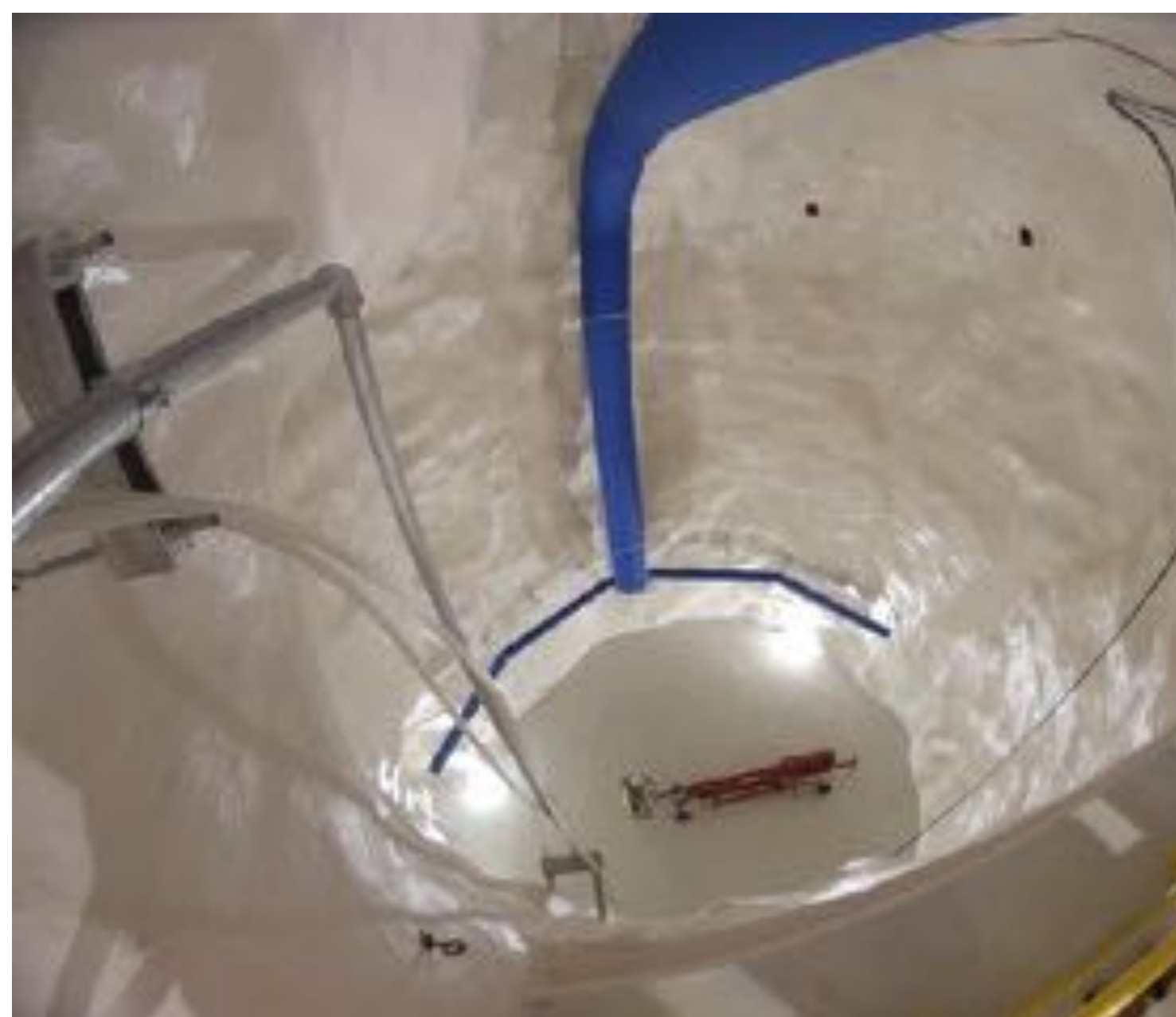
128 Institutes from 22 countries



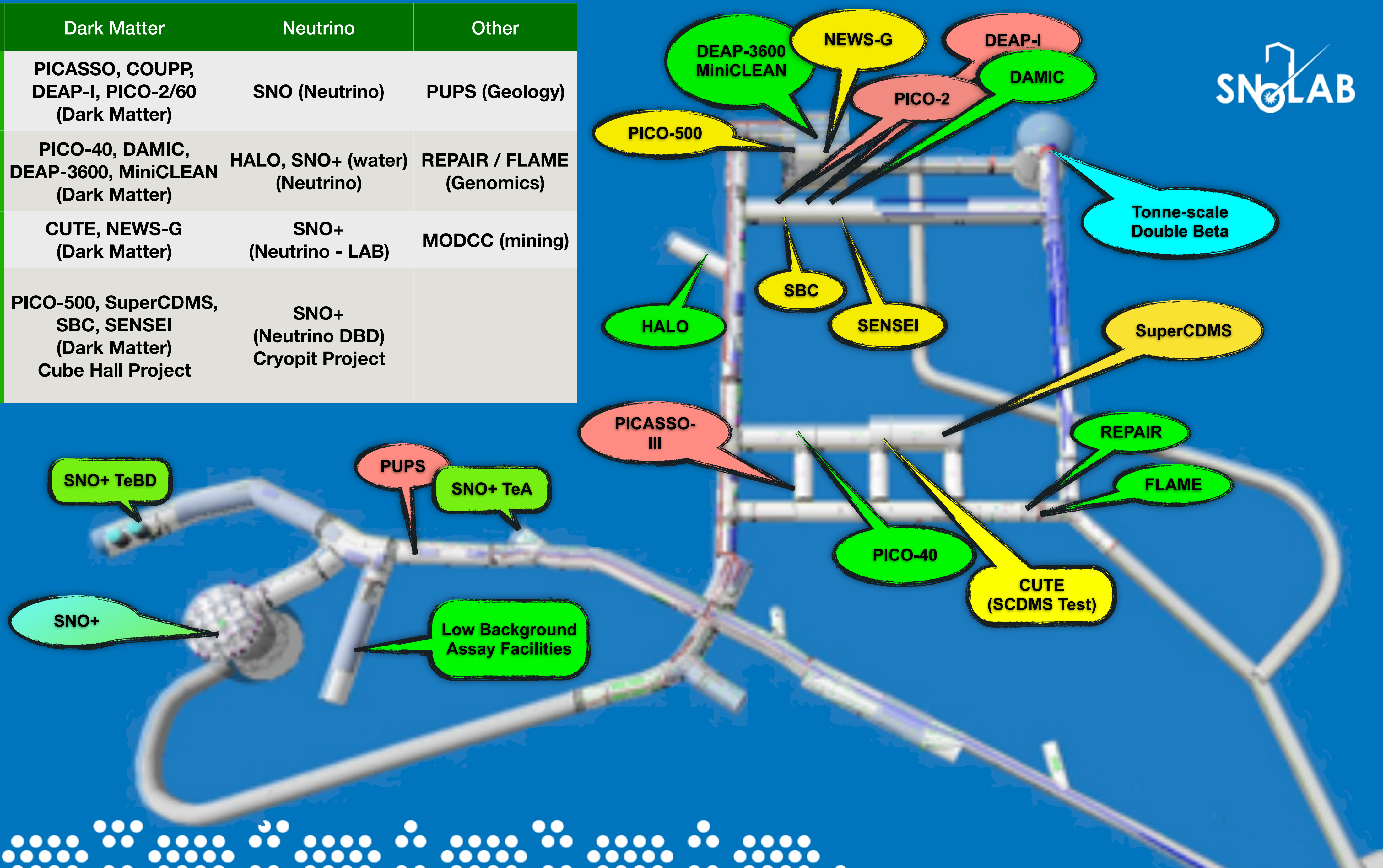
Future Programme

US DOE CD-0: Tonne-Scale $0\nu\beta\beta$

- DOE Nuclear Physics released CD-0 for tonne-scale double-beta decay programme end of December 2018
- Provides 'mission-need': i.e. it will happen
 - Caveats on funding, timescale, etc.
 - Likely projects are nEXO and LEGEND-1000 for major US investment
 - SNOLAB Cryopit targeted to this programme



	Dark Matter	Neutrino	Other
Completed	PICASSO, COUPP, DEAP-I, PICO-2/60 (Dark Matter)	SNO (Neutrino)	PUPS (Geology)
Current	PICO-40, DAMIC, DEAP-3600, MiniCLEAN (Dark Matter)	HALO, SNO+ (water) (Neutrino)	REPAIR / FLAME (Genomics)
2019 Start	CUTE, NEWS-G (Dark Matter)	SNO+ (Neutrino - LAB)	MODCC (mining)
2019+	PICO-500, SuperCDMS, SBC, SENSEI (Dark Matter) Cube Hall Project	SNO+ (Neutrino DBD) Cryopit Project	



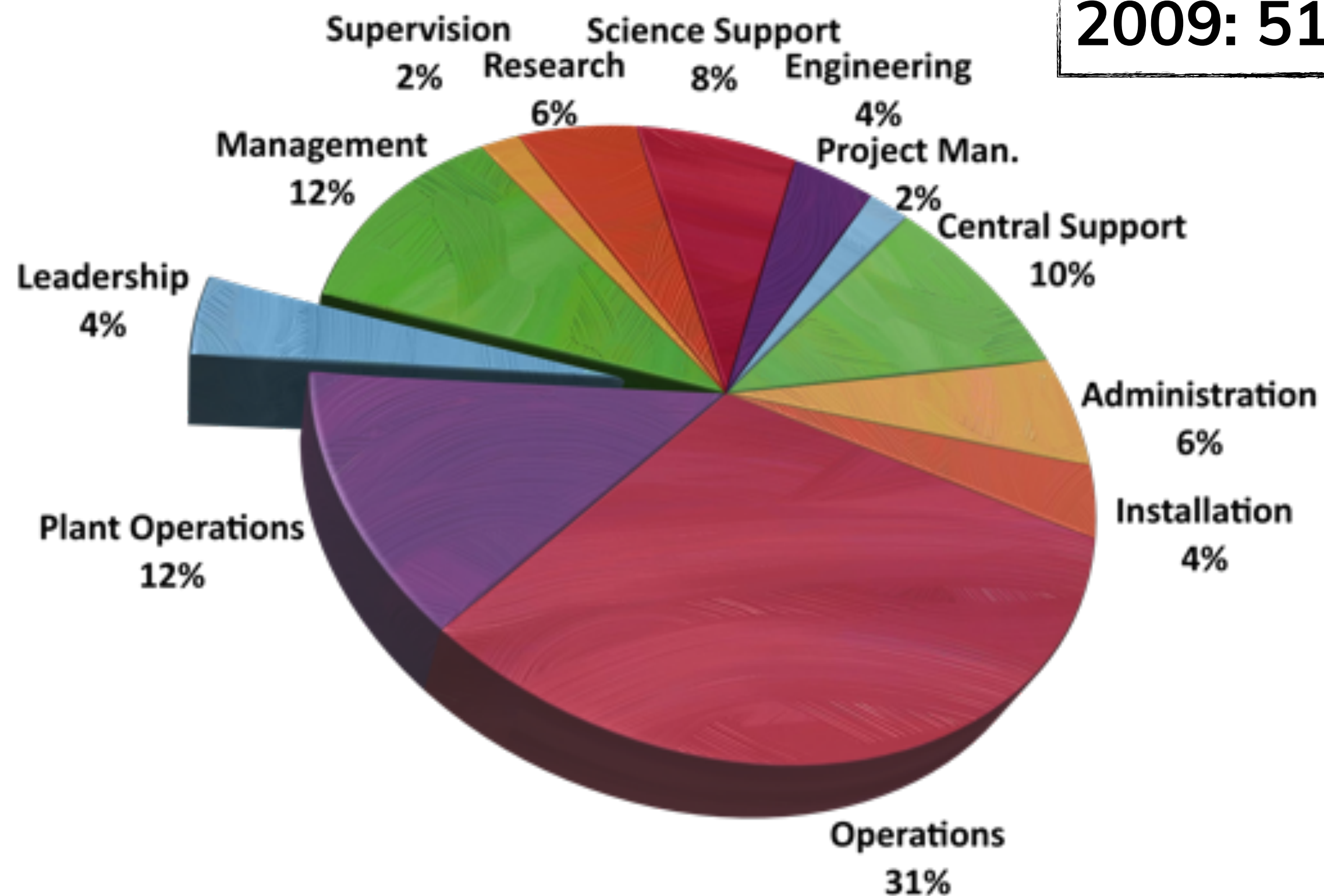
MSI Programme and staff evolution

- CFI Change in eligibility for MSI to 60:40 ratio as proposed in the Naylor review (big deal!)
- MSI programme now six years, submission in two weeks for April 2020 extension
- Expanded eligibility - students/trainees on eligible MSI O&M activities can be included from 2018/19
- R&D for 'improving services', strategic planning, incorporation
- Ineligible - direct research costs, real or leased property, science internships and exchanges, stipends
- Plant operations are currently deemed eligible, but science operations are not (cf NSERC support)

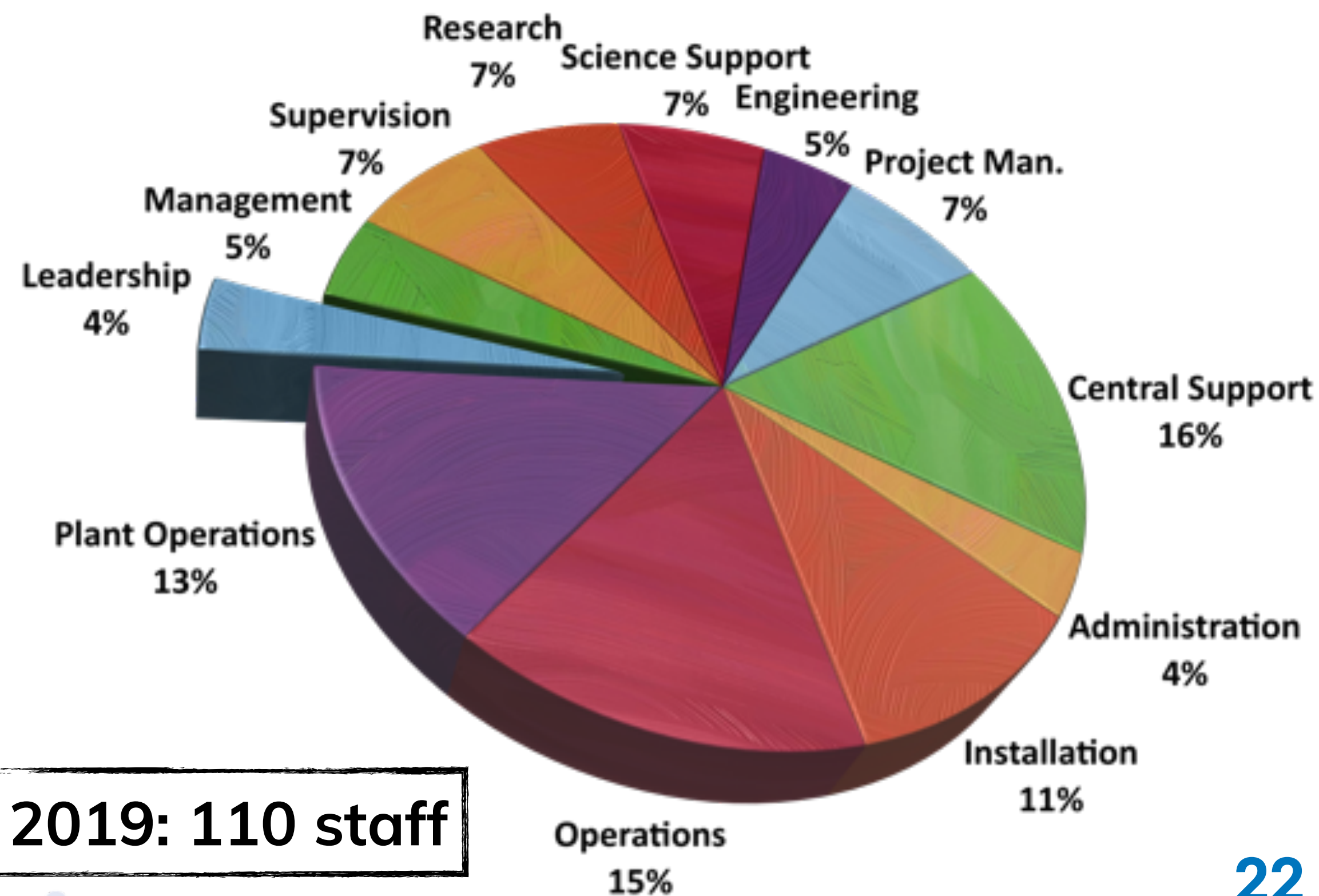
Competency / Group	Current Staff level	FY19/20 ramp	Target Staff level
Directorate	4	4	4
PA/Admin Support	4	4	4
Core Services	3	-	-
Strategic Risk	10	18	19
I.T.	3	4	4
Engineering Office	6	8.5	9
Scientific Support	7	8.5	9
Projects Office	5	12	14
Project Management	10	8	8
Scientific Research	9	10	11
Students	-	8	15
Programme Integration	25	27	27
Programme Operations	23	25	27
TOTAL	109	137	150

Staff category evolution

2009: 51 staff



2019: 110 staff



Planning for CFI IF round

- IF Round for 2020 confirmed, Jan submission
- We are aware of nEXO, DarkSide
- SNOLAB anticipated projects require substantial SNOLAB investment and potentially new spaces
- Working with projects to conclude “GW-1A” reviews (Cost evaluation for CFI)



To: Canadian SNOLAB Research Community

From: Richard Ford, Director Program Development, SNOLAB

SNOLAB Project Proposals to next CFI IF Competition

This note is to clarify the timeline and requirements for any potential SNOLAB based applications to the anticipated 2019 Canada Foundation for Innovation (CFI) Innovation Fund (IF) competition. Following the most recent federal budget allocation to CFI, we now anticipate an Innovation Fund competition launching in late 2018, with probable submission deadline being the summer of 2019.

Applications for CFI IF funds for SNOLAB based projects are required to undergo a top-level review by SNOLAB (the gateway GW-1A review) and then be supported by a letter from SNOLAB to CFI. Progression to this point in the project lifecycle process is required and will ensure a strengthened CFI application, including a reviewed conceptual design, agreement on scope and deliverables, a work breakdown structure, a preliminary resource-loaded schedule, and cost-estimated budget.

Future Project Development

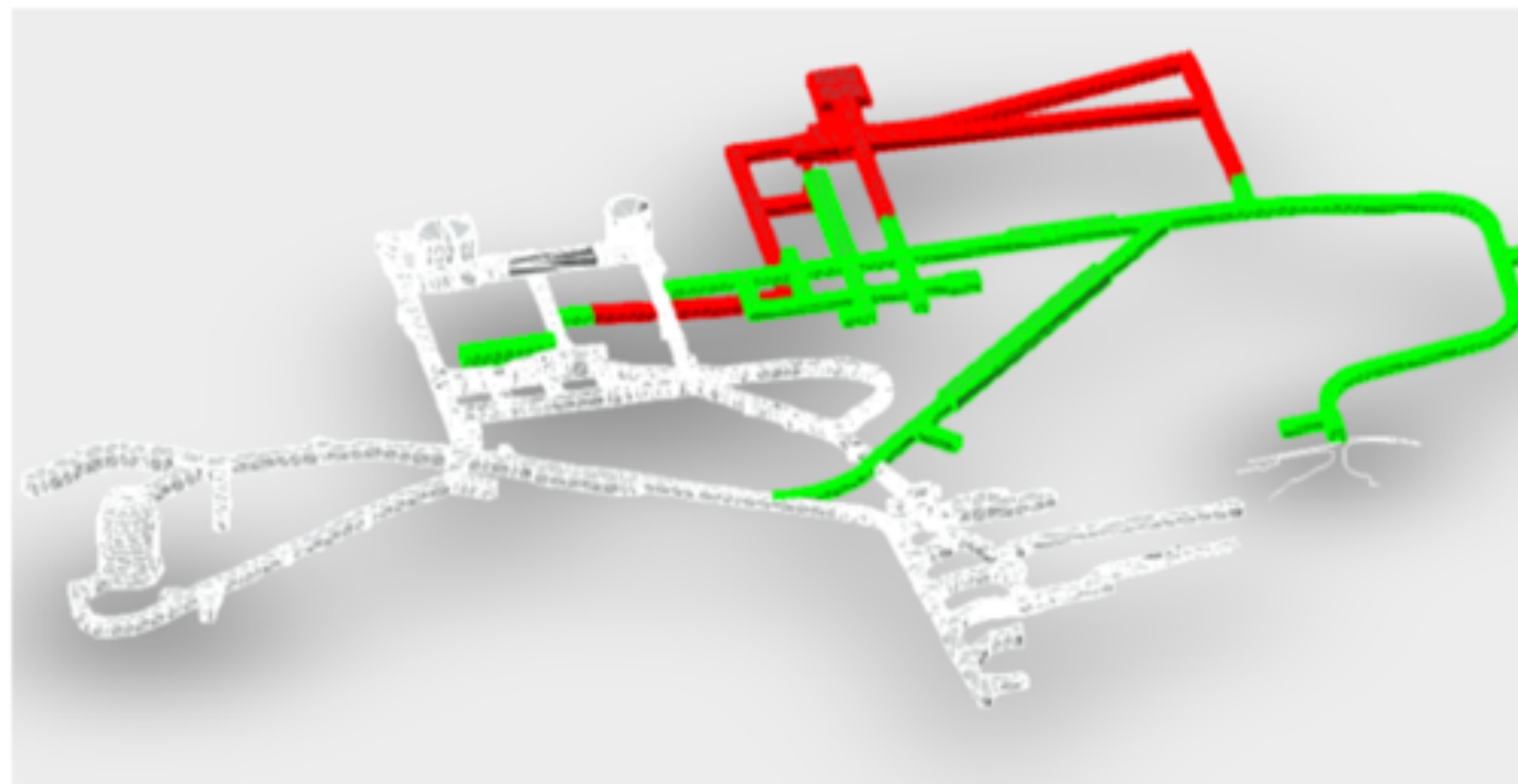
- Planning for future programme underway with community
- McDonald Institute leading ‘Snowmass’ type review to develop community plan
 - Need to dovetail with NSERC, EU, US, ...
- Community discussion identifies several potential infrastructure needs at SNOLAB
 - Liquid noble plant, storage, purification;
 - Additional drift space, surface facility refurb., independent power feed
 - Some are achievable...



Surface generator plant operational 2019

Potential future development

- Evaluation of expansion possibilities completed
- Included current (ambitious) plans as communicated by community
- Cost prohibitive O(\$100M) without appropriate funding programme
- Such development would require substantial ROI (eg LEGEND-1000 at cost \$400M) and substantial support from community
- Space will be fixed at SNOLAB for the foreseeable future
 - This may impact ability to host development projects (and clearly limits large-scale projects)





Questions?