



# SNOLAB Programme and Future Perspectives

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SNOLAB

# Our current Strategic Goals



- **Enable and spearhead world-class underground science**

To ensure SNOLAB supports, maintains and executes a world-class research programme, and plays its own significant role in the shaping and delivery of the science.

- **Develop and maintain world-class facilities and infrastructure**

To ensure SNOLAB remains at the forefront of infrastructure provision for underground science.

- **Educate, inspire and innovate**

To develop broad economic impact to Canada and our surrounding region by educating and inspiring through both public and professional outreach, developing highly qualified personnel and delivering innovative solutions through the use of small and medium scale enterprises.

- **Develop delivery systems of internationally recognised standard**

To develop SNOLAB internal quality management and delivery processes, and the connections to the experiments, through internationally recognised practices and processes to ensure efficient and effective management of resources and exemplary safety standards.

# Much progress on experiments



- SNO+: Uses existing SNO detector.
  - Heavy water replaced by scintillator loaded with  $^{130}\text{Te}$ . Modest resolution compensated by high statistical accuracy. ( $^{130}\text{Te} \rightarrow ^{130}\text{Xe} + e^- + e^-$ )
  - LAB process plant construction completes in September, transitions to commissioning. Cavity fill underway, Te plant in development.
- DEAP-3600: Single phase Liquid Argon using PSD
  - target construction complete, commissioning underway, expect argon fill this summer. All ancillary systems complete.
- MiniCLEAN: Single Phase Liquid Argon using PSD
  - target construction complete, expect argon fill this summer. Ancillary systems almost complete.
- SuperCDMS-SNOLAB: Dark matter Si / Ge crystals with ionisation / phonon readout
  - successful award through US G2 (and CFI).
- PICO: Rapid expansion bubble chambers. Insensitive to MIPS at operating temperature, threshold devices; alpha discrimination proven;
  - PICO-60: New science results imminent, background limited. New run underway to assess background source.
  - PICO-2: New science results posted, background limited (dust). New run underway.

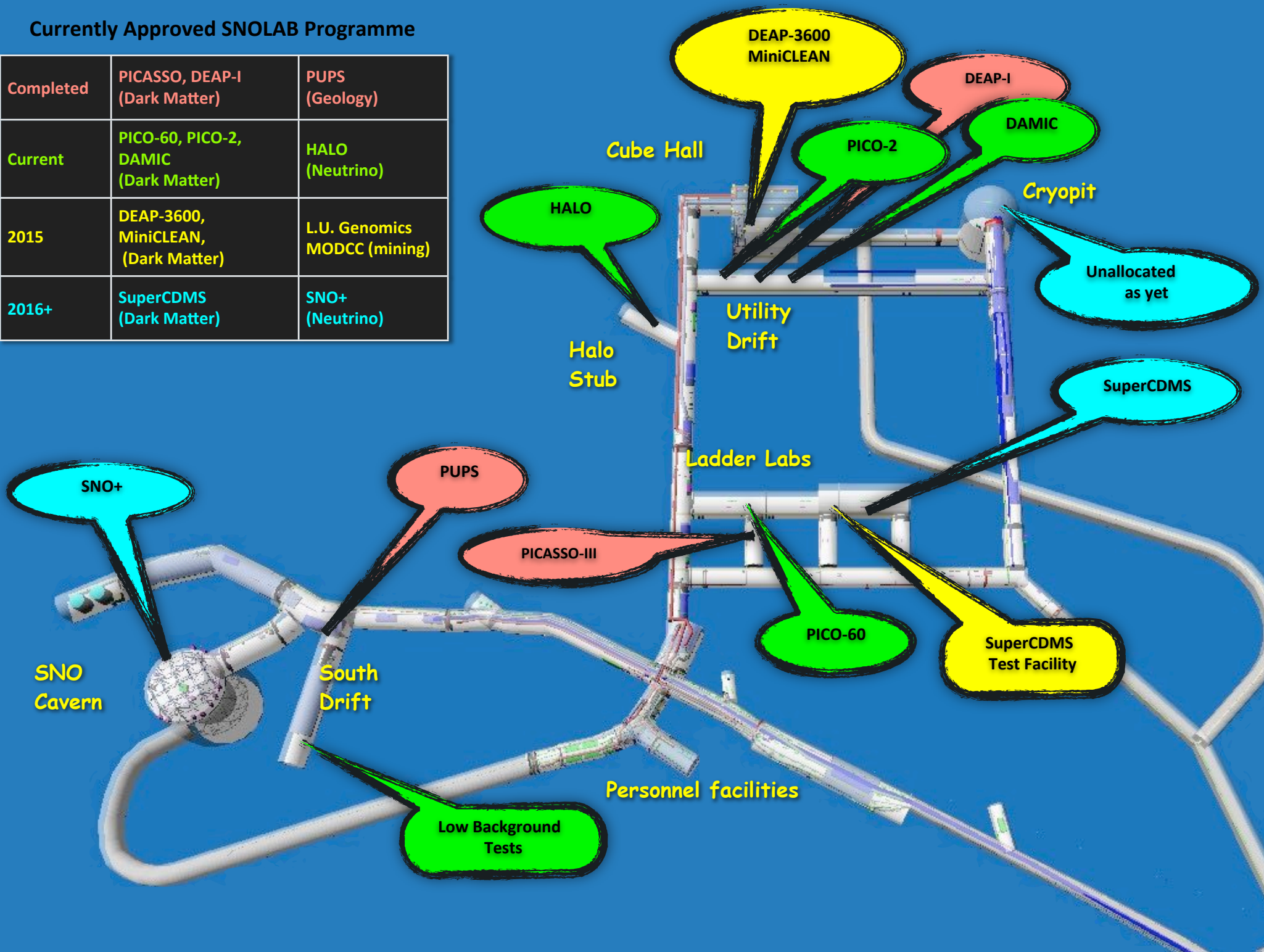
# Much progress on experiments



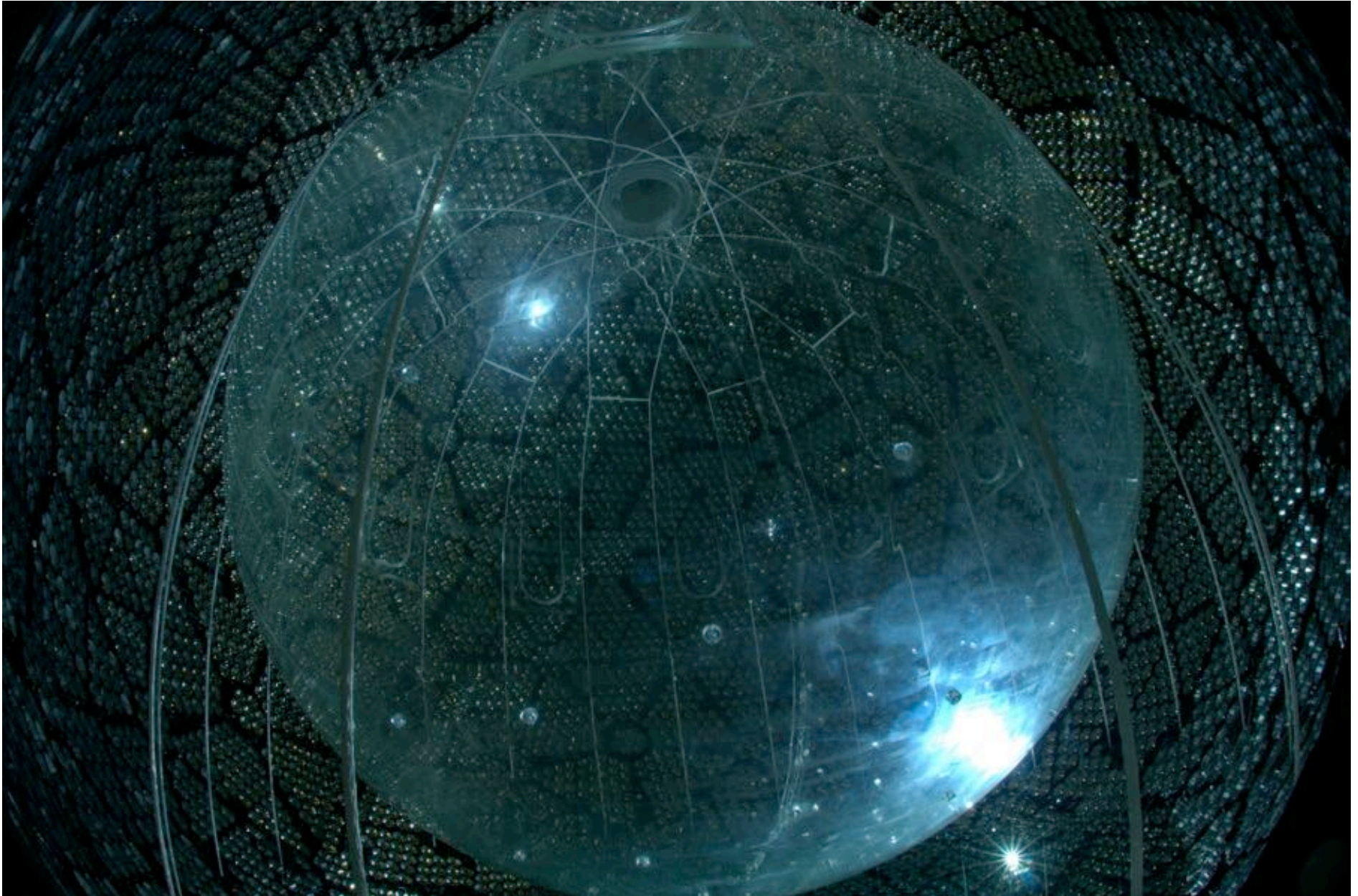
- HALO Supernova neutrino detector
  - SNEWS connection under test. Live to SN.
- MODCC Mining mining data
  - construction completes July 2015
- Genomics:
  - Low radiation environment impact on mutations, NSERC funded project in development with NOSM;
  - Fruit fly metabolism tests complete with Laurentian
- DAMIC CCD based dark matter detector
  - Initial science run complete, first 100g prototypes installed, upgrade underway.
- nEXO Double beta detector
  - engineering support to evaluate deployment at SNOLAB.
- NEWS DM detector: new project support and evaluation underway
- DMTPC DM directional detector: new project evaluation underway

# Currently Approved SNOLAB Programme

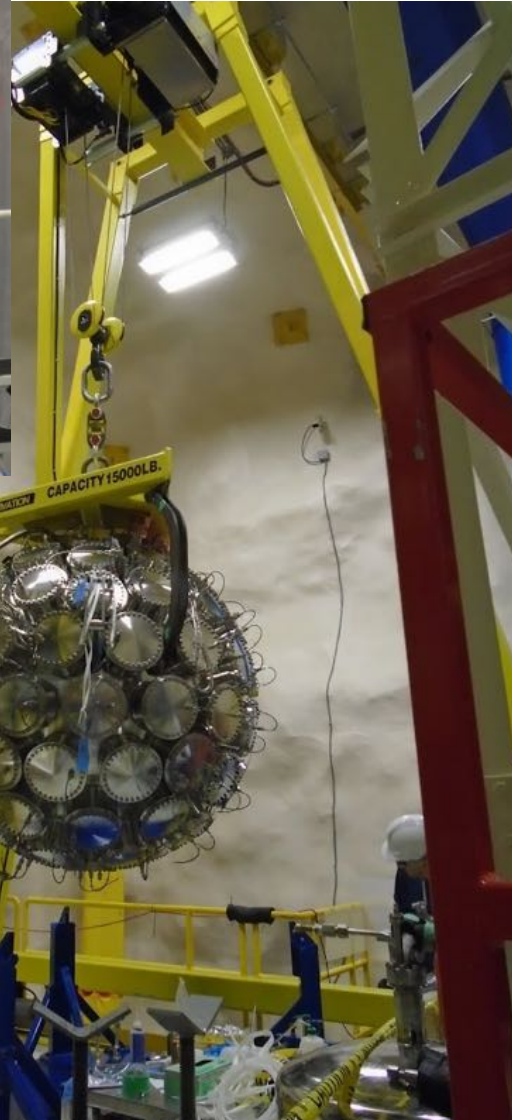
Completed	PICASSO, DEAP-I (Dark Matter)	PUPS (Geology)
Current	PICO-60, PICO-2, DAMIC (Dark Matter)	HALO (Neutrino)
2015	DEAP-3600, MiniCLEAN, (Dark Matter)	L.U. Genomics MODCC (mining)
2016+	SuperCDMS (Dark Matter)	SNO+ (Neutrino)



# SNO+ Rope Net in place



# MiniCLEAN Construction



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# DEAP-3600

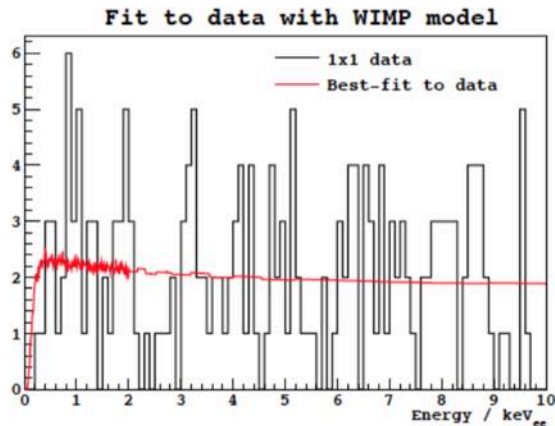




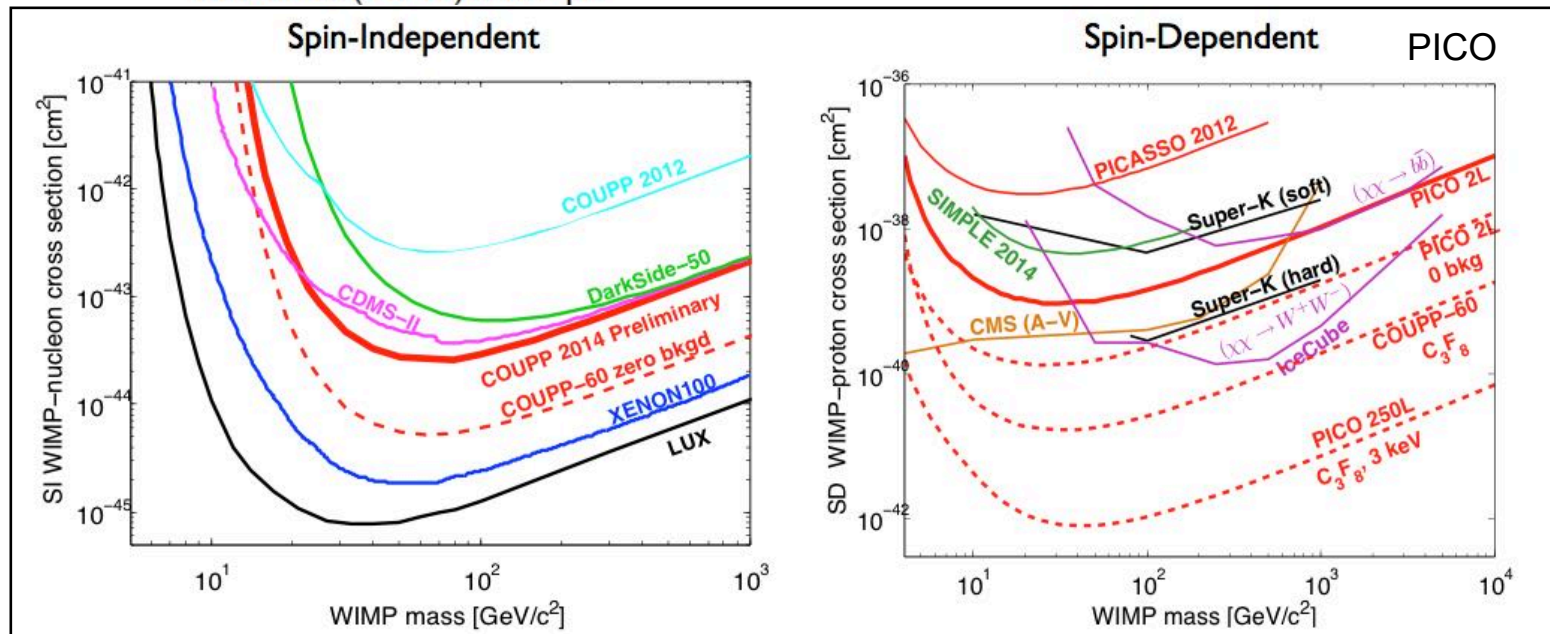
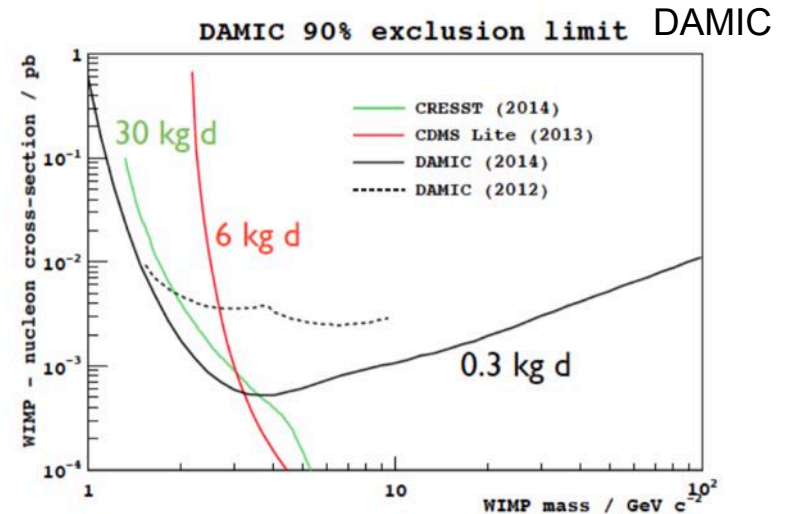
# Results from DAMIC & PICO



- Results since last CAP
- Preliminary (on Arxiv)
  - 1503.00008
- Covering complementary physics spaces

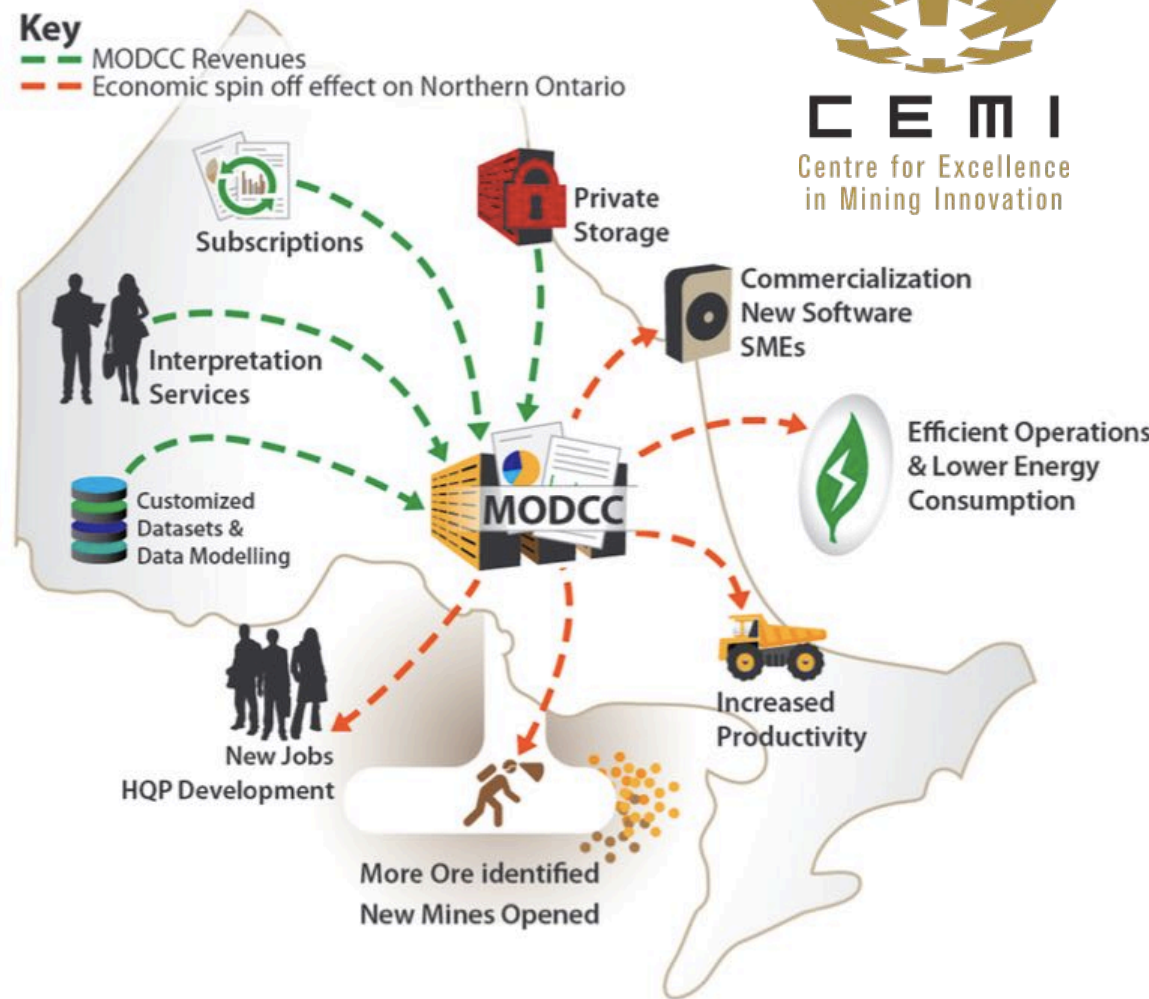


Best fit mass:  $26 \pm 46 \text{ GeV}/c^2$   
 Best fit xs:  $(7 \pm 16) \times 10^{-4} \text{ pb}$



# Developing local interests

- Seismic studies of rocks essential for our design process
- Additional information imparted to geosciences, mining, rock characterisation
- Unique problems for mining groups as ore bodies go deeper
- MODCC - mining data observatory using pp culture
- PUPS - study of surface vs deep seismic events, comparison of s/p propagation
- SNO cavity - excavation details and rock mass characterisation



SNO LAB



CEMI  
Centre for Excellence  
in Mining Innovation

# Our programme is expanding

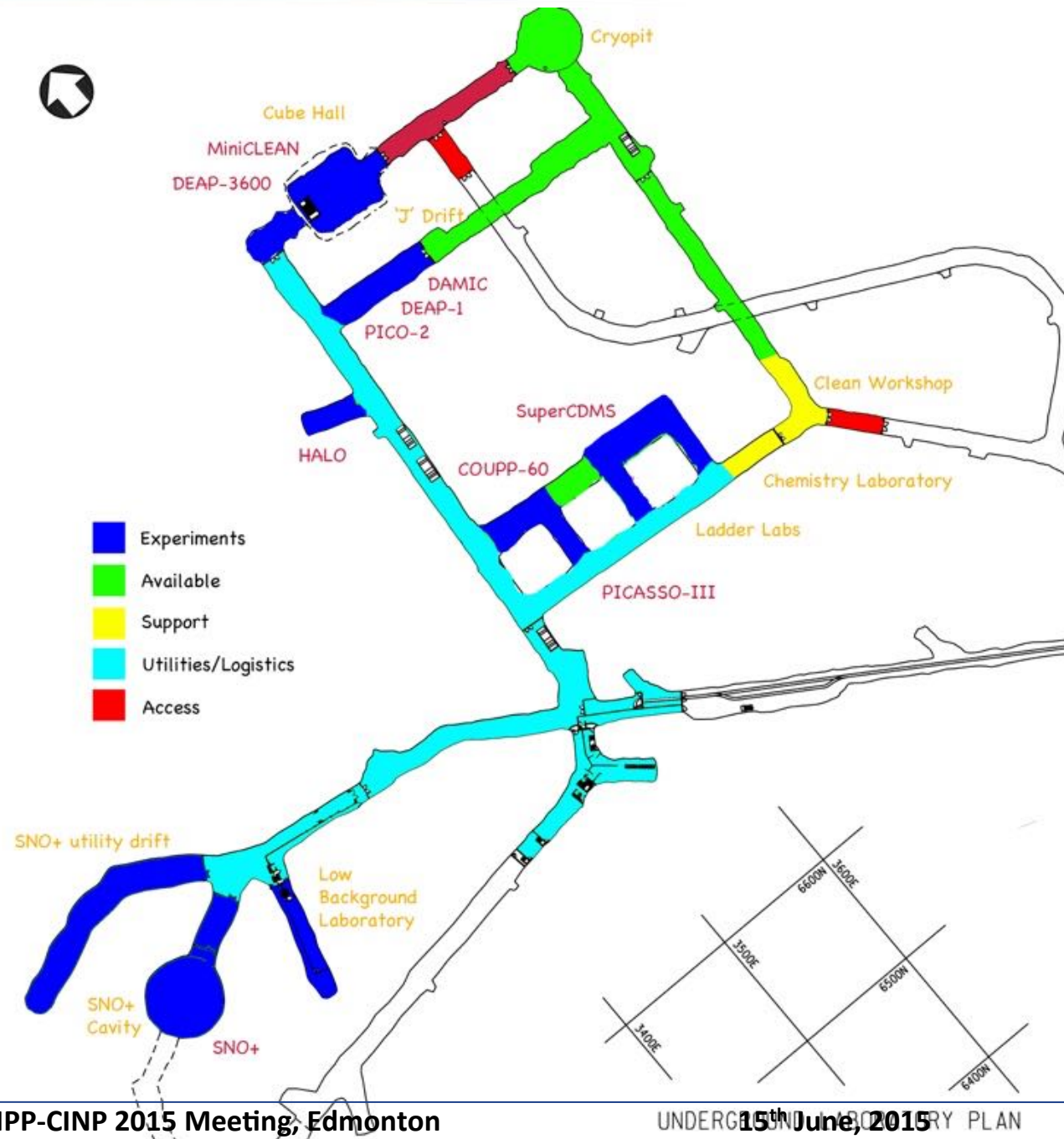


Experiment	Neutrino	Dark Matter	Other	Space allocated	Status
CEMI			Mining Data Centre	Surface Facility	In Construction
COUPP-4		√		"J"-Drift	Completed
DAMIC		√		"J"-Drift	Operational
DEAP-1		√		"J"-Drift	Completed
DEAP-3600		√		Cube Hall	In Construction
DEAP-50T/CLEAN		√		Cube Hall	Letter of Intent
DMTPC		√		Ladder Labs	Letter of Intent
Ge-1T	√			Cryopit	Letter of Intent
nEXO	√			Cryopit	Concept Phase
HALO	√			Halo Stub	Operational
MiniCLEAN		√		Cube Hall	In Construction
NEWS		√		Cryopit?	Letter of Intent
PICASSO-III		√		Ladders Labs	Completed
PICO-2L		√		"J"-Drift	Operational
PICO-60		√		Ladder Labs	Operational
PICO-250		√		Ladder Labs	Letter of Intent
PINGU			Test facility	Ladder Labs	Letter of Intent
PUPS			Seismicity	Various	Completed
SNO+	√			SNO Cavern	In Construction
SuperCDMS		√		Ladder Labs	In Preparation
U-Laurentian			Genomics	External Drifts	Operational

# Space is still available



- Cryopit
  - Unallocated (process underway)
  - Potential short term site for NEWS
- Bio/Chemlab under discussion with genomics teams from NOSM
- Low background lab reprioritised due to experiment focus, now higher focus



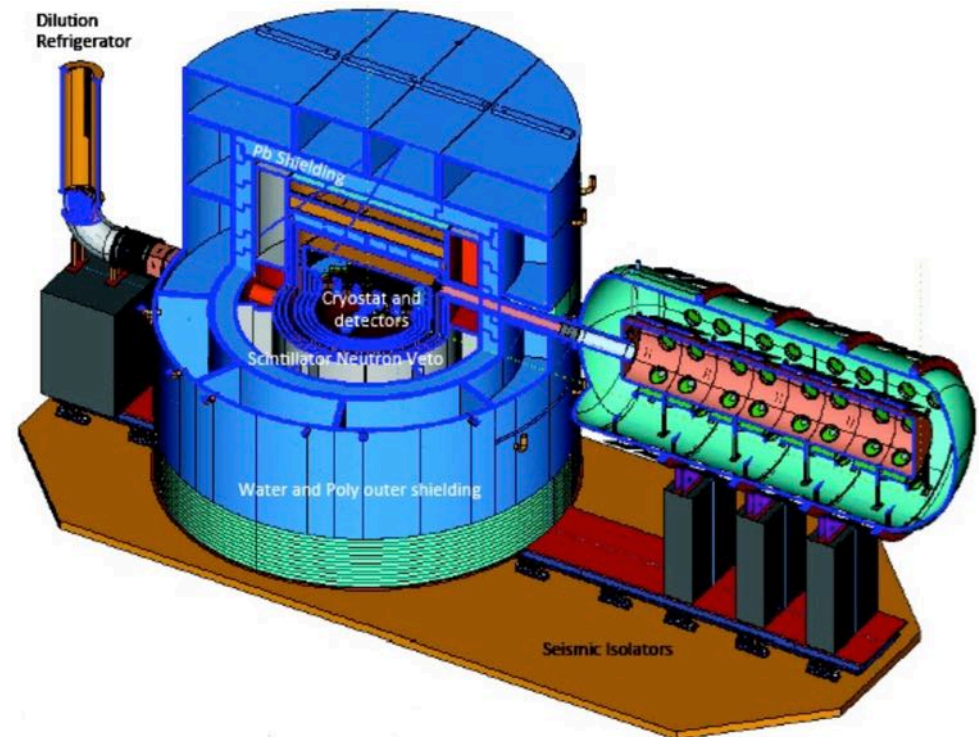
# Developing as location of choice



- US G2 Down-select funded SuperCDMS-SNOLAB with emphasis on low energy WIMPS. Cryostat and system to accommodate full 400 kg capacity but only ~50 kg will be initially deployed.
  - Potential future international developments (Gilles Gerbier focus)
- SNOLAB in discussion with SuperCDMS to coordinate between funding agencies, laboratory and experiment.



Ladder labs @2011/12



# Validates strategic vision



- *“The DOE Office of High Energy Physics and the NSF Physics Division have jointly selected a portfolio of projects for the “second generation” of direct detection dark matter experiments. We are pleased to announce that the joint DOE/NSF second-generation program will include the LZ and SuperCDMS-SNOLAB experiments with their collective sensitivity to both low and high mass WIMPS, and ADMX-Gen2 to search for axions. It will also include a program of R&D to test and develop technologies for future experiments, consistent with the recent P5 recommendations. The agencies will work with the proponents to develop project plans that can achieve their compelling science goals as expeditiously as possible.”*
- First major investment in SNOLAB by DOE/NSF rather than through secondary partner (FermiLab, LANL, PNNL, etc.)
- Realisation of vision as ‘location of choice’

# Much progress on facility systems

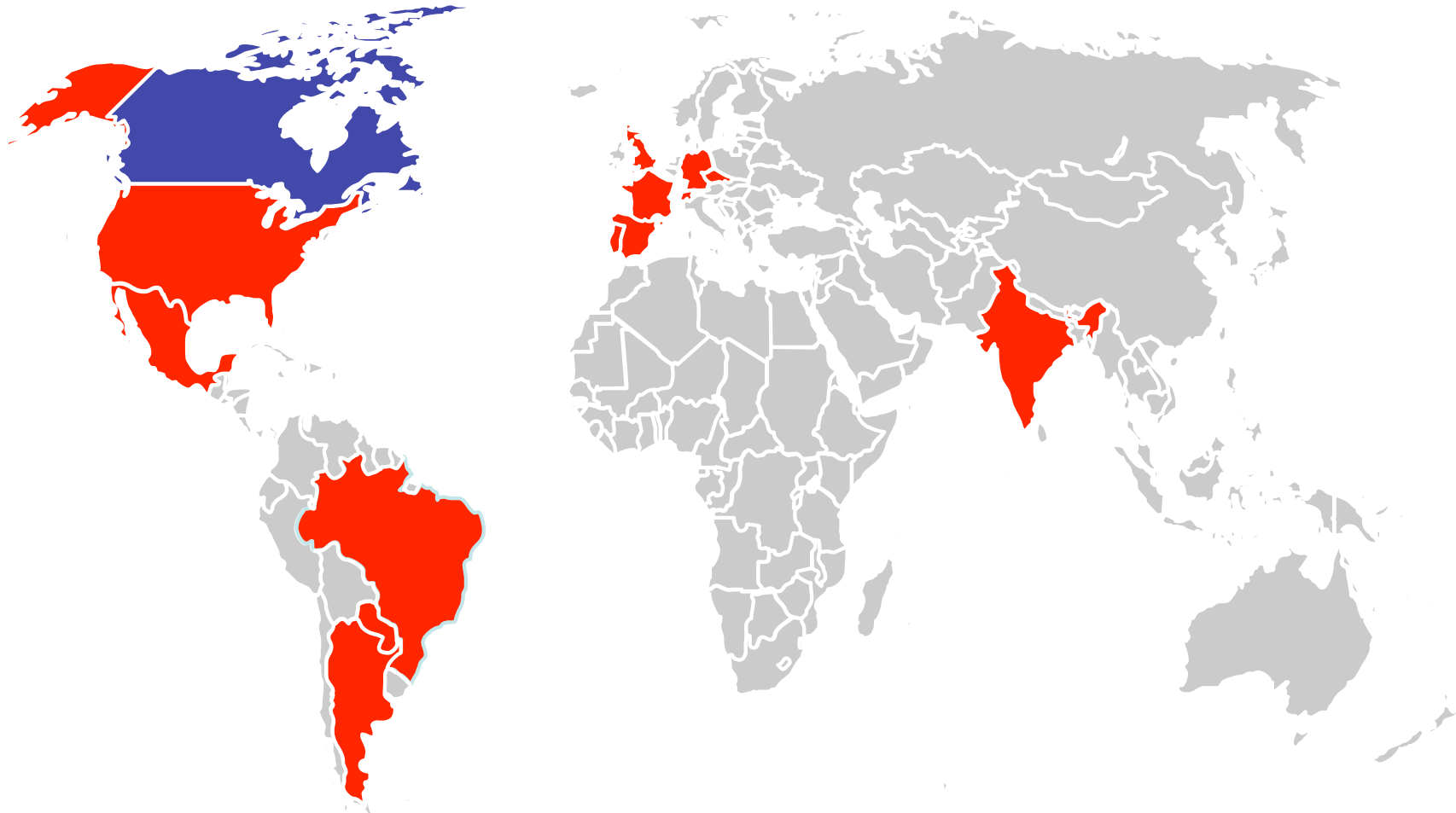


- SNOLAB Infrastructure:
  - Low background capabilities increased in priority due to community needs and review feedback
    - Richard Ford collating community requirements
  - MODCC project providing funds to refurbish surface facility
  - Capital infrastructure secured for surface generator plant emergency power, in final discussion with Vale
- SNOLAB Processes:
  - Overhaul of SNOLAB operational policies/procedures continues, with objective to achieve ISO/OHSAS accreditation
  - User management processes evolving
  - Experiment lifecycle management evolving to include gateways, with required reviews at each stage to ensure clear understanding of resource requirements

# Our community is expanding



- 149 faculty researchers from 70 institutions over 14 countries
  - ~25% of faculty are Canadian
- >500 faculty, highly qualified personnel and technical support
- ~11,000 underground person-shifts per year (~50/dayshift)





- Summer school for particle physics
- Jointly run by TRIUMF, SNOLAB and Perimeter Institute
- Rotates between organisations
  - 2014 at SNOLAB
- 35 Students
- 7 Countries
- 2 Weeks



# Increasing HQP training



- Two methodologies to assess
  - Shows the number of people trained to work underground at SNOLAB (done through NorCAT and local site specific)
  - Grey boxes illustrate HQP in our community from collaboration author data

	Number of Canadians							Number of non-Canadians						
	2011	2012/ 2013	2013/ 2014	2014	2014/ 2015	2015/ 2016	2016/ 2017	2011	2012/ 2013	2013/ 2014	2014	2014/ 2015	2015/ 2016	2016/ 2017
Undergraduates	-	36	31	50	51	40	40	-	5	5	14	8	5	5
Masters students	-	13	16	16	43	30	30	-	1	6	26	11	5	5
PhD students	27*	9	7	17	9	10	10	16*	13	26	59	24	25	25
Postdoc Fellow / Research Fellow	31	8	15	31	25	30	30	32	29	24	50	14	20	20
Technicians	58	53	74	63	98	100	100	20	2	1	41	2	5	5
Others (Contractor)	-	21	19	15	7	5	5	-	0	0	0	0	0	0
<b>TOTAL</b>	<b>89</b>	<b>140</b>	<b>162</b>	<b>192</b>	<b>233</b>	<b>215</b>	<b>215</b>	<b>52</b>	<b>50</b>	<b>62</b>	<b>190</b>	<b>59</b>	<b>60</b>	<b>60</b>

# Increasing facility access



- Underground visits by category (SNOLAB/Users/Visitors)
- 10 hour shifts (i.e 4/week): an average 52 people/day
- Steady increase from 2011/12, almost to double number of shifts
- All driven by increase in user (and visitor) shifts
- Supporting >twice the user visits in 2011/12
  - and commensurate increase in equipment and supplies logistics

	2011/12	2012/13	2013/14	2014/15
Staff	5000*	5369	5172	4868
Users	1400*	2384	4371	4531
Visitors	509	984	1001	1003
<b>TOTAL</b>	<b>6909*</b>	<b>8737</b>	<b>10544</b>	<b>10402</b>

# Funding secured to 2017



- SNOLAB is funded by CFI and Ontario Province awards 2012-2017
  - Total award over 2012/17 is CFI: \$29.4M; Ontario: \$19.8M
  - Vale in-kind support over same period is \$40.7M
- Additional funds were secured in the CFI mid-term MSI review for:
  - Additional user and project support staff (~\$1M/yr)
  - Surface back-up generator set (\$4.9M)
- Budget assumptions include current governance structure (e.g. additional staff costs may be incurred with potential incorporation) and current scope and remit of facility (focus on infrastructure support to experiments, current volume of facility operations)
- In-kind support from Vale underestimated, recent KPMG audit indicates ~25% higher support would be required to operate 'mine-side'
- Aiming to support CFI in developing mandate for next round of MSI operations funds from 2017
- Also, in dialogue on contingency options (facility, rather than experiments)

# Strategic Planning Process



- Next Strategic Plan will need to be in place 2017-2022
  - Aiming to complete by September 2016
- The SNOLAB Institute Board owns the Strategic Plan and oversees its development by the SNOLAB management
- Anticipated process (under alignment with other Canadian strategic processes)
  - Community engagement through Town Meetings (SNOLAB / TRIUMF?)
    - expected during Fall 2015 / Spring 2016
  - Steering committee to manage process (Community lead)
  - Feed into writing group (SNOLAB lead)
  - Draft Strategic plan iterated with community Spring/Summer 2016
  - Finalisation by Board Summer 2016
  - Release by September 2016
- In addition, Future Projects Meeting anticipated Summer 2015 in conjunction with the EAC, SEF and STRC meetings
  - <https://www.snolab.ca/science/meetings-and-workshops/workshops>

# International context



- Several expansions of deep underground facilities in construction or in planning
- Other facilities have space opening up as programmes complete
- SNOLAB competes on depth, cleanliness and services

Site	Depth (m)	Expansion Size (m <sup>3</sup> )	Status	Available	Space available within 2 years (m <sup>3</sup> )
Kamioka	1000	5.5 x10 <sup>3</sup>	Complete	2008	-
SNOLAB	2070	3 x10 <sup>4</sup>	Complete	2009	5 x10 <sup>3</sup>
LSC	850	8 x10 <sup>3</sup>	Complete	2010	2 x10 <sup>3</sup>
CJPL	2400	1.7 x10 <sup>3</sup>	Complete	2011	-
SURF	1480	>3 x10 <sup>4</sup>	Complete	2012	-
Gran Sasso (Hall B)	1400	2 x10 <sup>4</sup>	Complete	2015	2 x10 <sup>4</sup>
CJPL-II	2400	1 x10 <sup>5</sup>	In Construction	2015	1 x10 <sup>5</sup>
Boulby	1100	5 x10 <sup>3</sup>	In Construction	2016	5 x10 <sup>3</sup>
LSM	1400	4 x10 <sup>4</sup>	Planned	2016+	4 x10 <sup>4</sup>
LSC-CUNA	850	2 x10 <sup>3</sup>	Planned	2017	-
LBNF/SURF	1480	>10 <sup>5</sup>	Planned	2017	-
ANDES	1750	7.5 x10 <sup>4</sup>	Planned	<2024	-
Baksan	1550	4 x10 <sup>4</sup>	Planned	Under Discussion	-

# Programme and Future Perspectives



- SNOLAB funding secured to 2017 (CFI, Ontario, Vale)
  - Providing support to CFI for case for next MSI round
- New Strategic Planning process underway
- SNOLAB programme developing well:
  - New results from PICO and DAMIC in the last year
  - PICO, HALO, DAMIC Operational
  - DEAP-3600 and MiniCLEAN completed this summer
  - LAB plant for SNO+ complete this Fall
- International context evolving
  - SuperCDMS-SNOLAB selected as US G2 project
  - Global community looking towards co-operation, with additional space developing underground
  - SNOLAB continues to have the ambition to be the location of choice for the field