SNOLAB Update: Science and Perspectives

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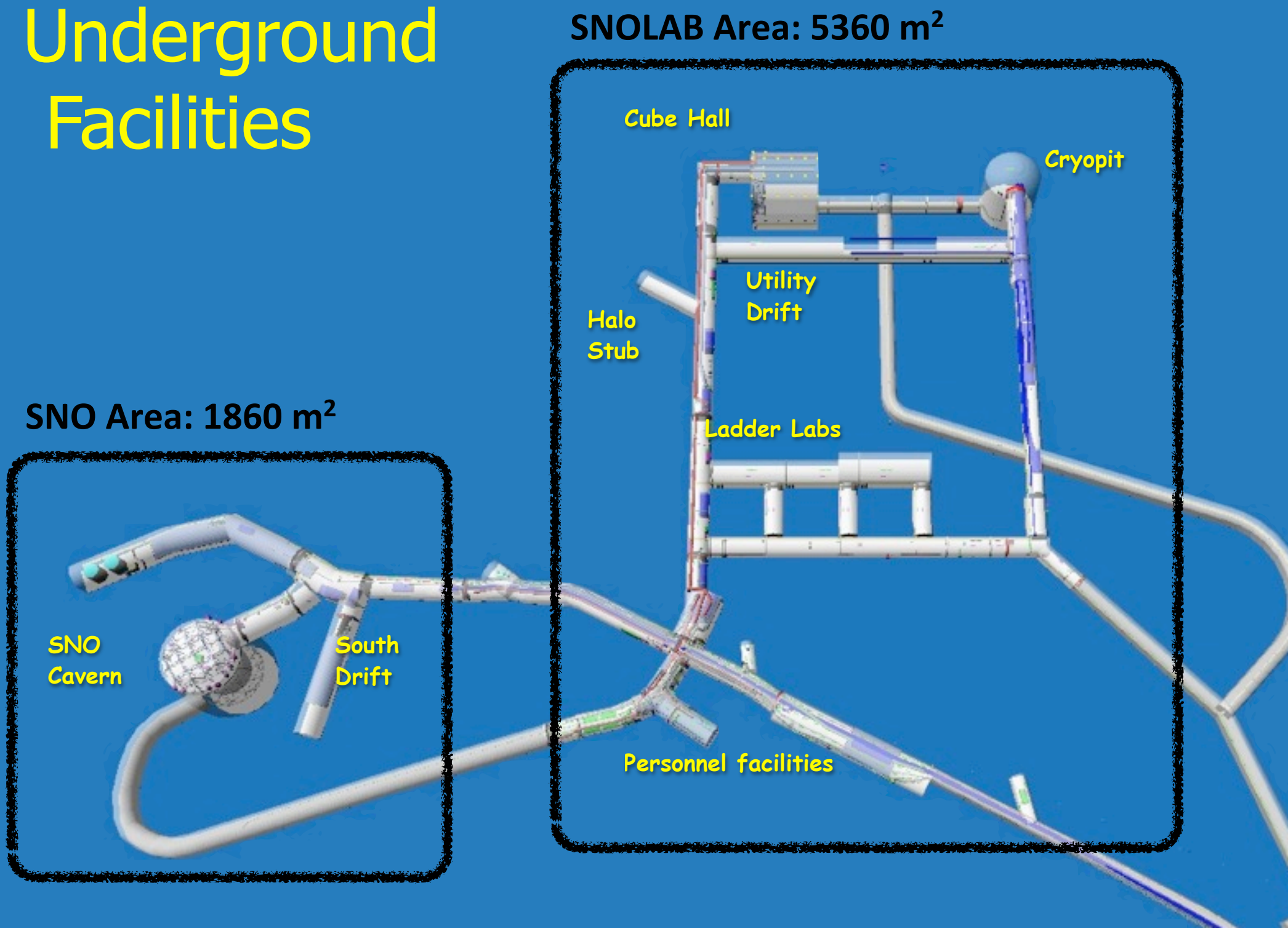
SNOLAB

SNOLAB Facility

- Operated in the Creighton nickel mine, near Sudbury, Ontario, hosted by Vale.
- Underground campus at 6800' level, 0.27μ/m^2/day
- Entire lab at class-2000, or better, to mitigate against background contamination of experiments.
- Focus on kilo-tonne dark matter, double beta decay, solar & SN neutrino experiments requiring depth and cleanliness.
  - Also provide space for prototyping of future experiments.
- Surface Facility (3100 m^2)
  - Operational from 2005 - Provides offices, conference room, dry, warehousing, IT servers, clean-room labs, detector construction labs, chemical + assay lab
  - 440m^2 class-1000 clean room for experiment setup and tests
- Underground Construction (5360 m^2)
  - Two additional (to SNO+ cavity) large cavities (Cube Hall, Cryopit) and support drifts
  - Additional linear drifts for smaller scale experiments
  - Materials handling and cleaning areas; tram transportation
  - Personnel areas: refuge/galley, change areas/showers, offices, meeting room

Underground Facilities



The SNOLAB Science Programme

Experiment	Solar ν	0νββ	Dark Matter	S/Nova ν	Geo ν	Other	Space allocated	Status
CEMI						Mining Data Centre	Surface Facility	In Construction
COUPP-4			√				"J"-Drift	Completed
COUPP-60			√				Ladder Labs	Operational
DAMIC			√				"J"-Drift	Operational
DEAP-1			√				"J"-Drift	Completed
DEAP-3600			√				Cube Hall	In Construction
DEAP-50T/CLEAN			√				Cube Hall	Letter of Intent
Ge-1T		√					Cryopit	Letter of Intent
nEXO		√					Cryopit	Request
HALO				√			Halo Stub	Operational
MiniCLEAN			√				Cube Hall	In Construction
PICASSO-III			√				Ladders Labs	Completed
PICO-2			√				"J"-Drift	Operational
PICO-500			√				Ladder Labs	Letter of Intent
PUPS						Seismicity	Various	Completed
SNO+	√	√		√	√		SNO Cavern	In Construction
SuperCDMS			√				Ladder Labs	Commitment
U-Toronto						Deep Subsurface Life	External Drifts	Completed

SNOLAB Annual Update

- Experimental programme
  - SNO+: process plant in construction, vessels complete, piping underway. Water systems refurbished, cavity fill to PSUP, Te plant in design.
  - DEAP-3600: AV construction complete, PMT installation complete, OV infrastructure in place, process systems constructed. ODA hazard mitigation in construction
  - MiniCLEAN: IV complete, DAQ complete, gas run exercised. OV construction underway. Process systems in construction.
  - PICASSO-III: science run complete
  - COUPP-4: science run complete
  - COUPP-60: constructed, commissioned, operational. Hazard mitigation complete. Science run underway.
  - PICO-2: constructed, commissioned, operational. Science run underway.
  - HALO: backup systems installed, calibrations underway. Live to SN.
  - MODCC: successful award from NOHFC for mining data centre
  - Bio: visit by deep subsurface life group from UoT
  - DAMIC: Initial science run complete, upgrade underway.
  - nEXO: engineering support to evaluate deployment at SNOLAB, following 'Future Projects Review' meeting summer, 2013.

SNOLAB Annual Update

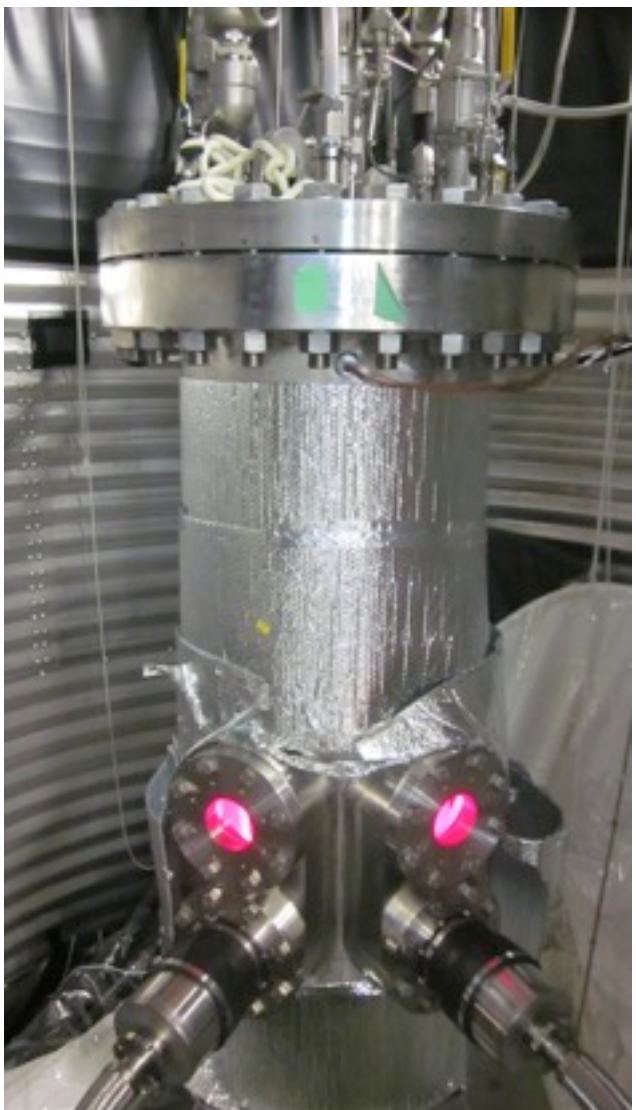
- SNOLAB Infrastructure:
  - SNOLAB underground lab is a single, contiguous clean room
  - Facility projects mainly deferred to focus on experimental support
    - e.g. low background capabilities
  - MODCC project providing funds to refurbish surface facility
  - Capital infrastructure needed for back-up power, surface pre-deployment and logistics
- SNOLAB Processes:
  - Overhaul of SNOLAB operational policies/procedures continues, with objective to achieve ISO/OHSAS accreditation during 2014/5
  - All hazard and risk identification and management processes in place
    - task, job, experiment, area, facility
  - Business processes evolving
  - User management processes evolving
  - Experiment lifecycle management evolving

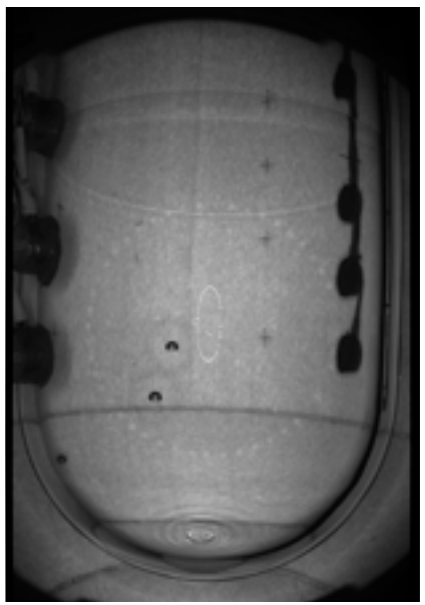
Additional Development - Experiments

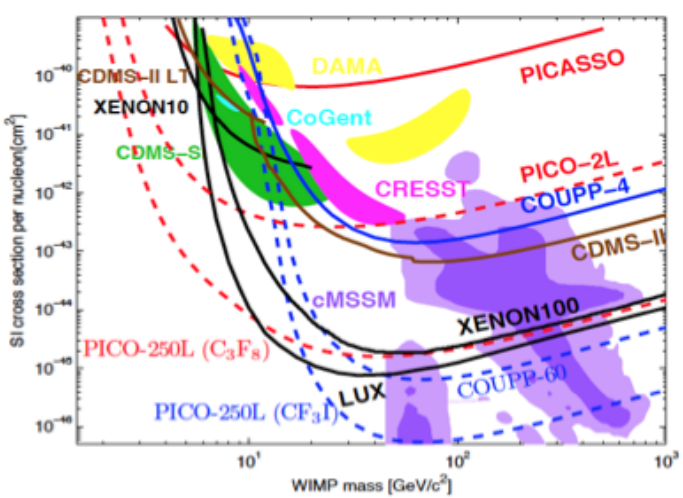
- Existing Space will become available as projects complete
  - “J” drift anticipated for R&D/rapid deployment at all times
  - Ladder labs: SuperCDMS area committed; PICO for next few years
  - Cube Hall: argon programme for next five++ years
  - SNO+ cavity: occupation over next decade
  - Cryopit: process underway to select project:
- Planned projects for Cryopit
  - No commitment yet made, several projects presented to 2011 Cryopit review and 2013 Future Projects Planning Workshop
  - DEAP-CLEAN, EXO, GeoDM, COUPP, PICASSO, (PICO), 1TGe
  - Process continues in tandem with EAC and external agencies

Science Highlight #1

- Operation of PICO/COUPP dark matter detectors

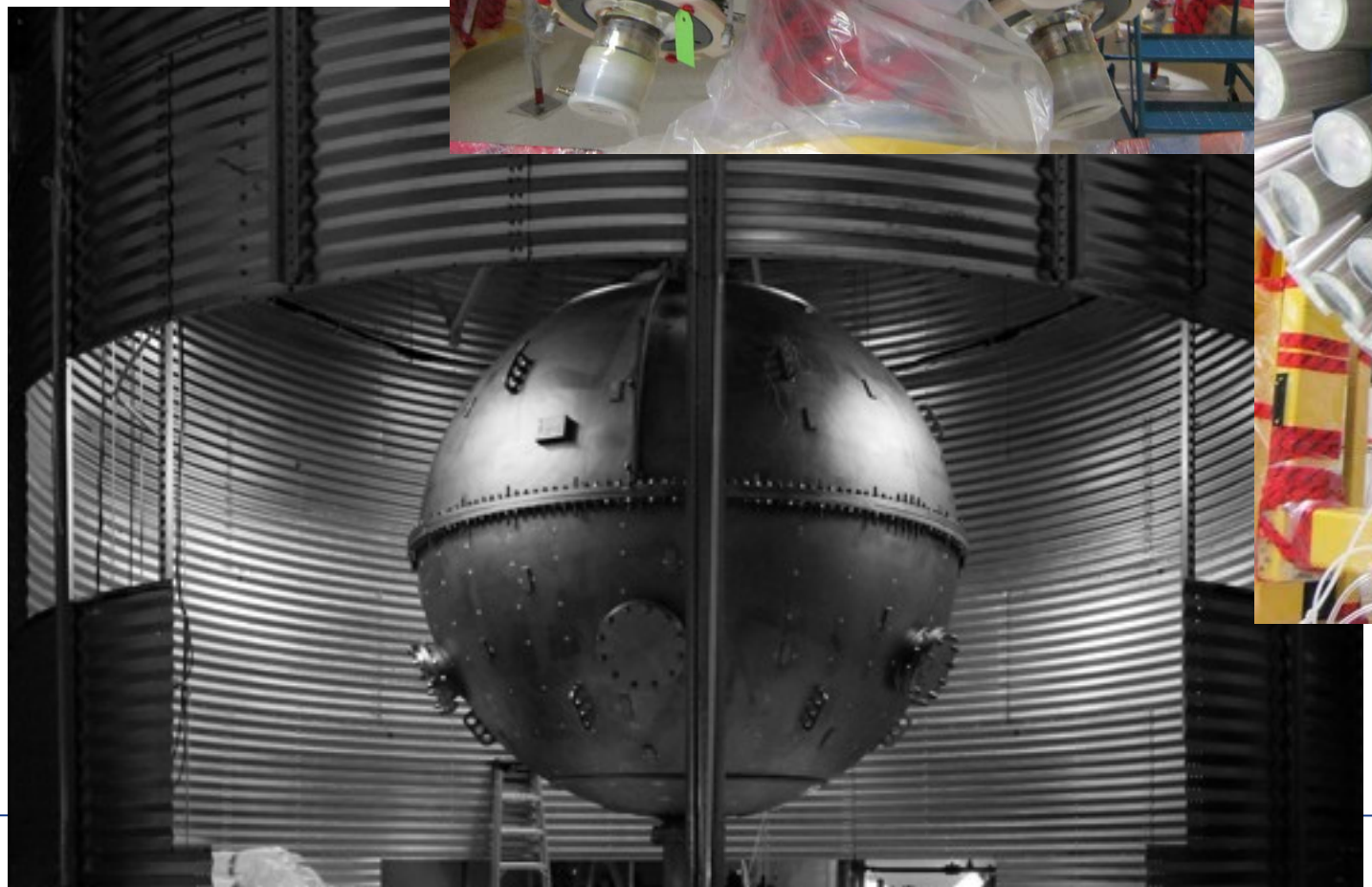




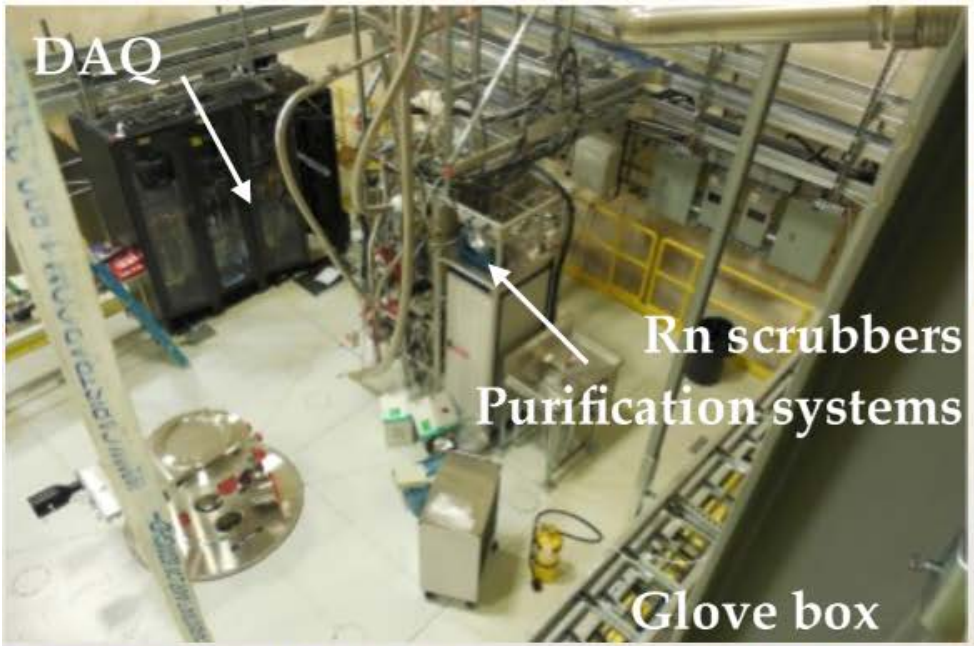


Science Highlight #2

- Construction of DEAP dark matter detector

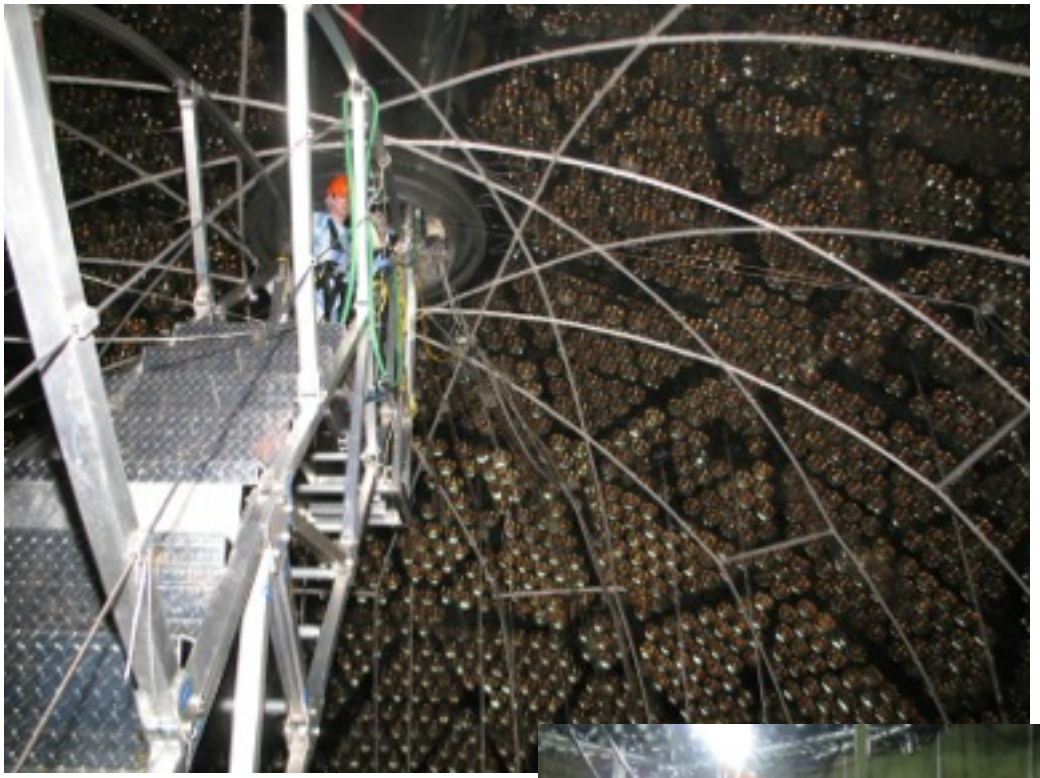


Science Highlight #2



Science Highlight #3

- SNO+ Refurbishment and process plant



Development of a scaffold for cleaning internal surface of the acrylic vessel

First LAB plant vessel being installed into utility drift (prior to completion of steelwork)

Cavity now being filled with UPW....

Science Highlight #3

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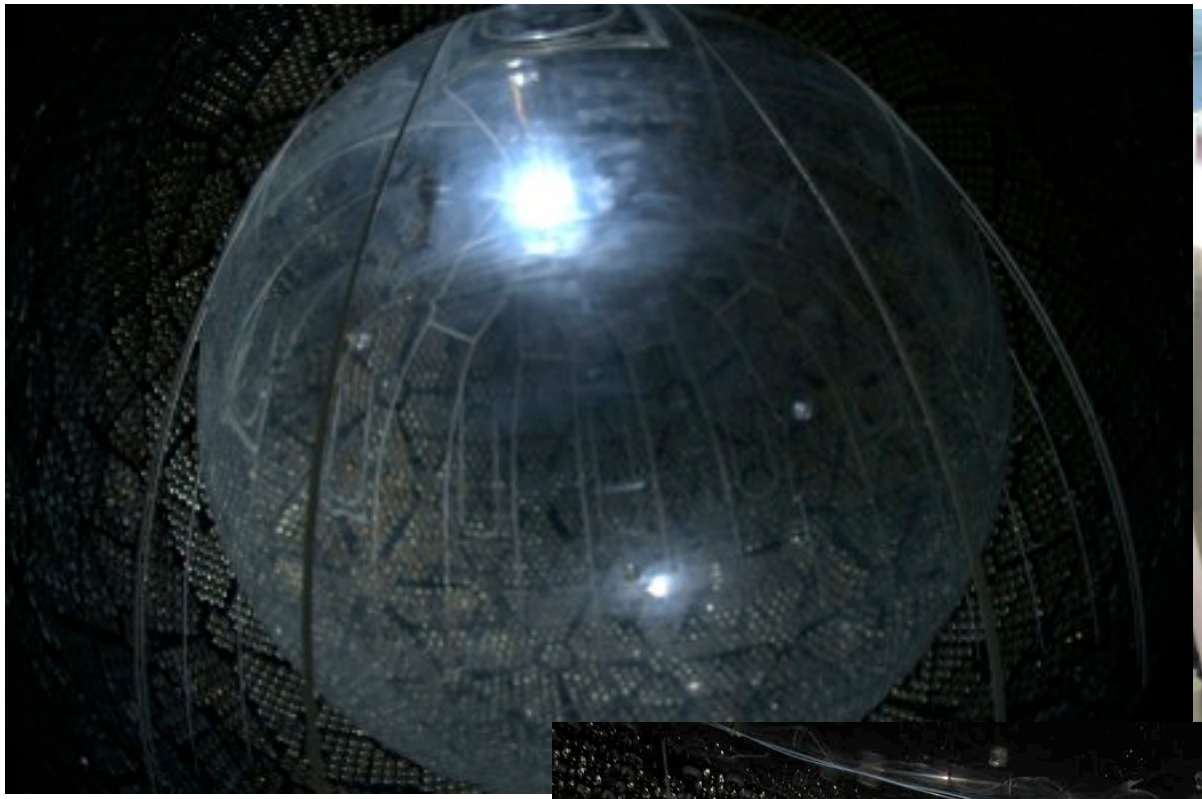

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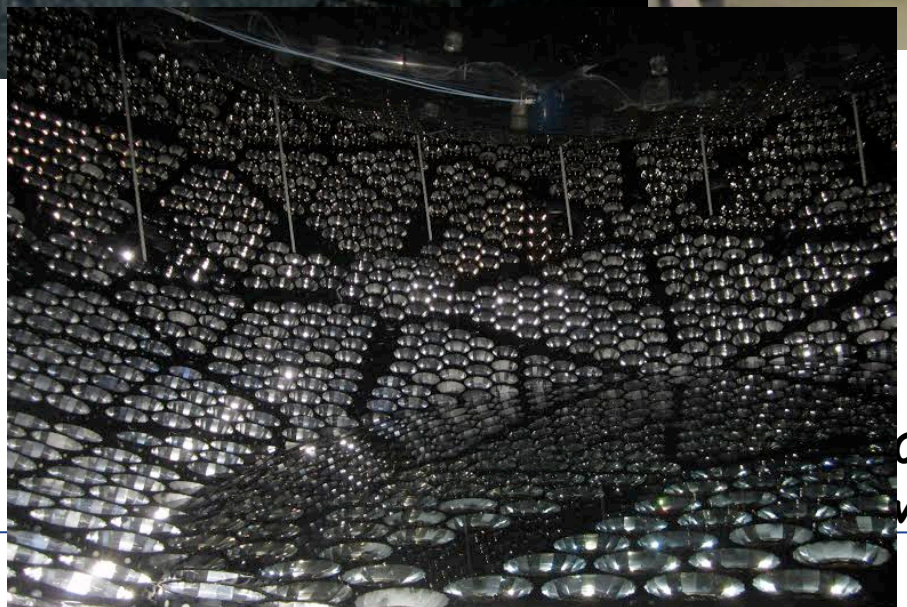
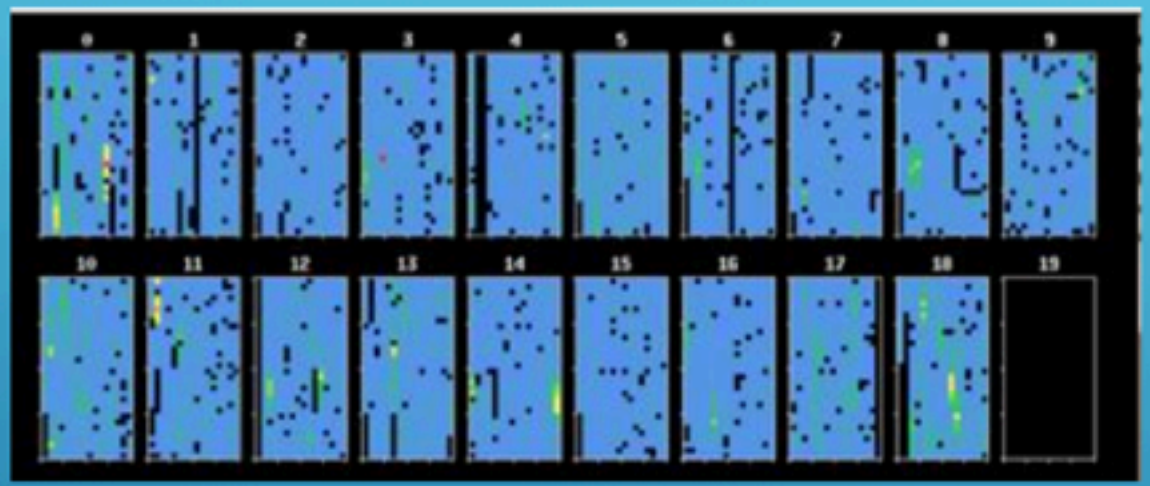


Cavity now being filled with UPW....

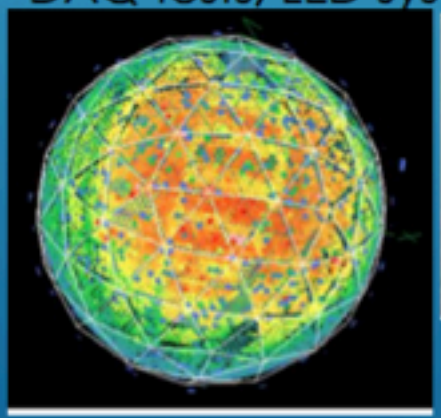
Science Highlight #3

DETECTOR

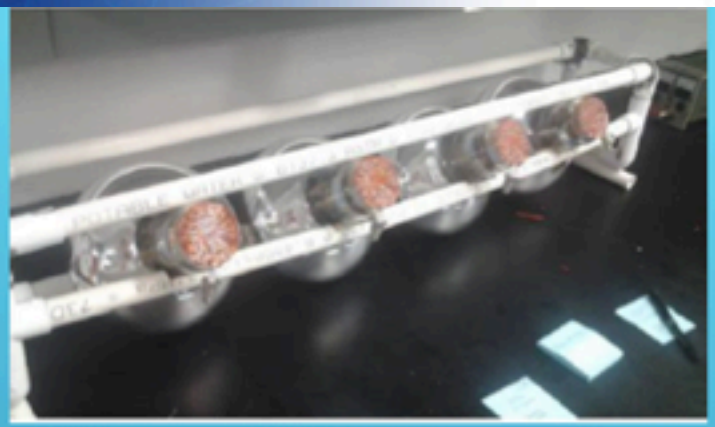
Upgrade electronics, bring everything online



DAQ tests, LED system tests, air-filled running

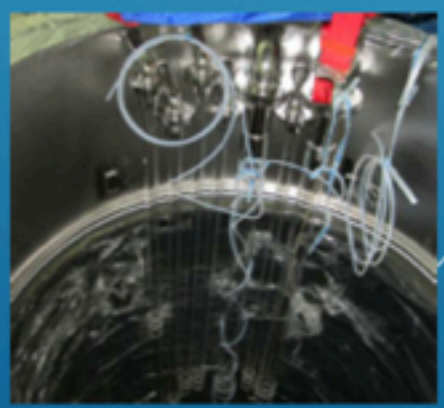


Getting ready for running with water - 2013



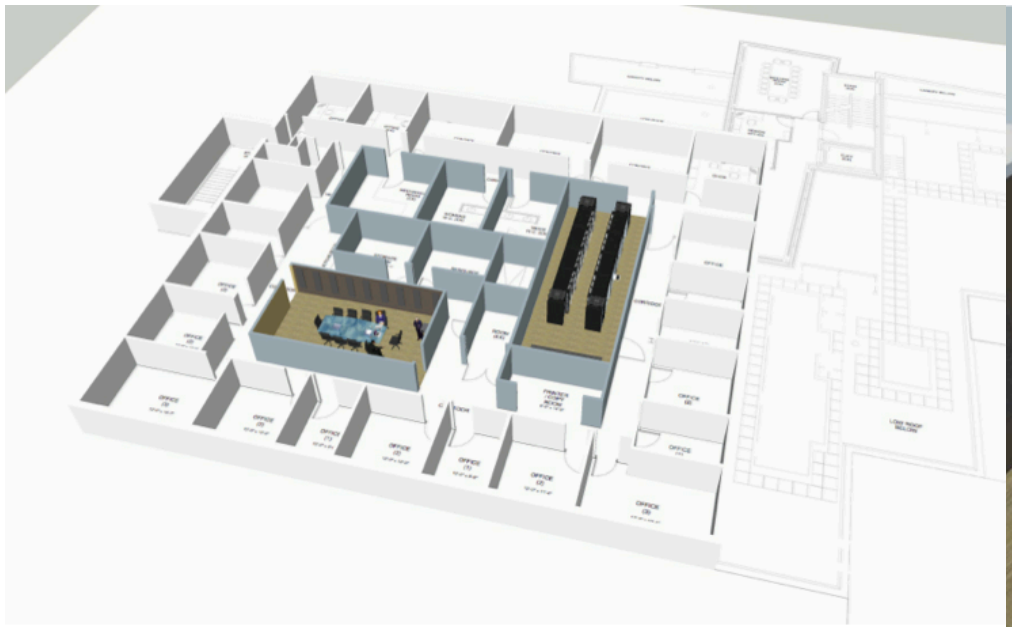
Repair PMTs ~300 so far

Install
UI and acrylic pipes
May 2013



Science Highlight #4

- Broadening of science programme to look at connections to local innovation groups (CEMI/CMIC)
- “Mining Observatory Data Control Centre”
- $750k award from NOHFC to develop infrastructure at SNOLAB
  - anticipate construction end 2014



Operational Challenge #1

- Major operational challenges still exist as we continue transition from a single project (SNO) to a facility based programme (SNOLAB)
- Still aiming for ISO/OHSAS accreditation: development of processes slowed to transfer resources onto projects
- Several aspects previously covered by University groups now being taken on formally into SNOLAB processes
- User management / training
  - Evolving practices based on dialogue with TRIUMF and CLS
  - More formal agreements with each user being introduced
  - Covers liability, workers compensation, medical insurance
  - Definition of line supervision and emergency contact
  - Definition of required training and competencies

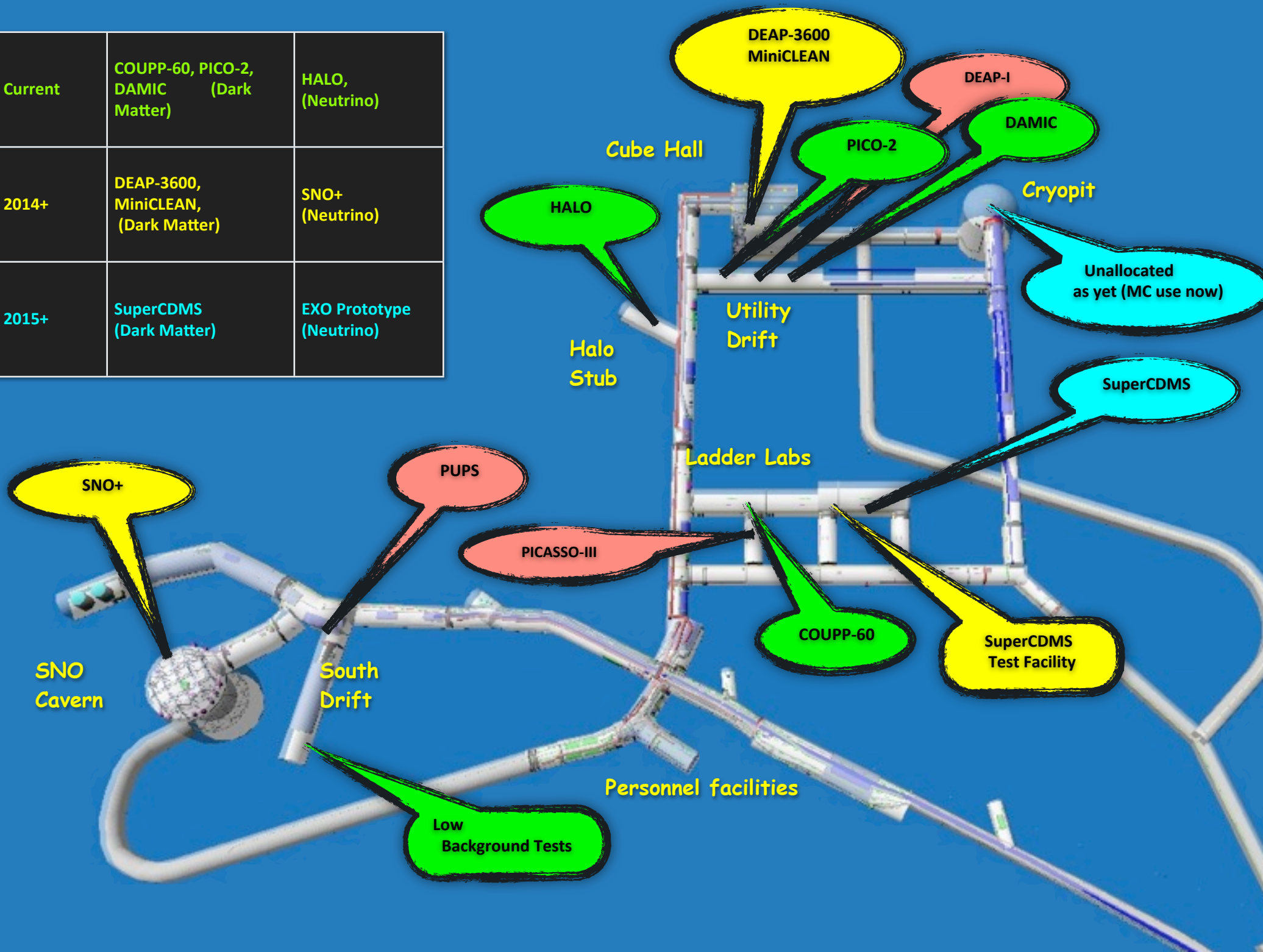
Operational Challenge #2

- Support of experiments
- SNOLAB programme currently consists of a handful of long-term, medium-cost ($10M currently) experiments that are designed and constructed over many years
- A major challenge for the current programme has been project management and engineering support, as projects move from bench-top to deployed scale
- SNOLAB has been providing support in project co-ordination, project management, integration engineering, health and safety requirements, local logistical requirements
- It has become clear that our initial estimations of those service requirements was under specified. Our response has been to focus on experiments and only essential facility projects
- Development of contingency planning needs to evolve, with expected additional requests for engineering and project support in CFI MSI mid-term review

Operational Challenge #3

- Science programme planning for third generation experiments
- As experiments move to $150M scale (e.g. next potential project in the Cryopit) additional project lifecycle requirements will be needed
  - Project lifecycle planning (Gateway process)
  - Full project implementation planning
  - Engagement between experiments, facility, funding agencies to ensure appropriate support is in place...
  - ... including appropriate oversight mechanisms that have authority over programme

Current	COUPP-60, PICO-2, DAMIC (Dark Matter)	HALO, (Neutrino)
2014+	DEAP-3600, MiniCLEAN, (Dark Matter)	SNO+ (Neutrino)
2015+	SuperCDMS (Dark Matter)	EXO Prototype (Neutrino)



International Context

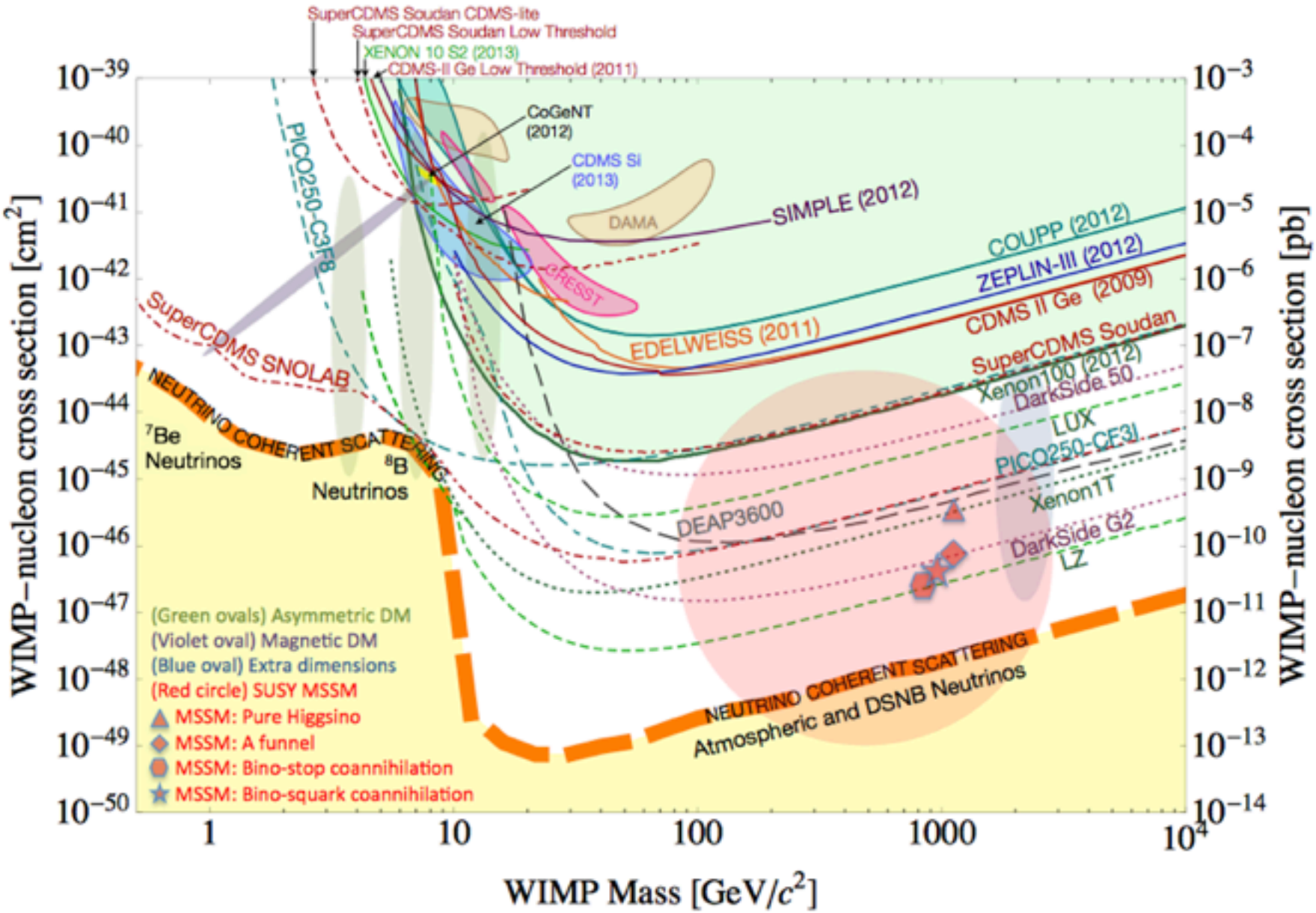
- SNOLAB is one of a handful of international deep underground facilities, and is the deepest & cleanest large-scale facility, providing unique advantage to its science programme and Canada

- Aim to be North American site of choice for our type of science
- SNOLAB interlinks to the Canadian Universities, Perimeter Institute and TRIUMF, providing complementary skills and capabilities.

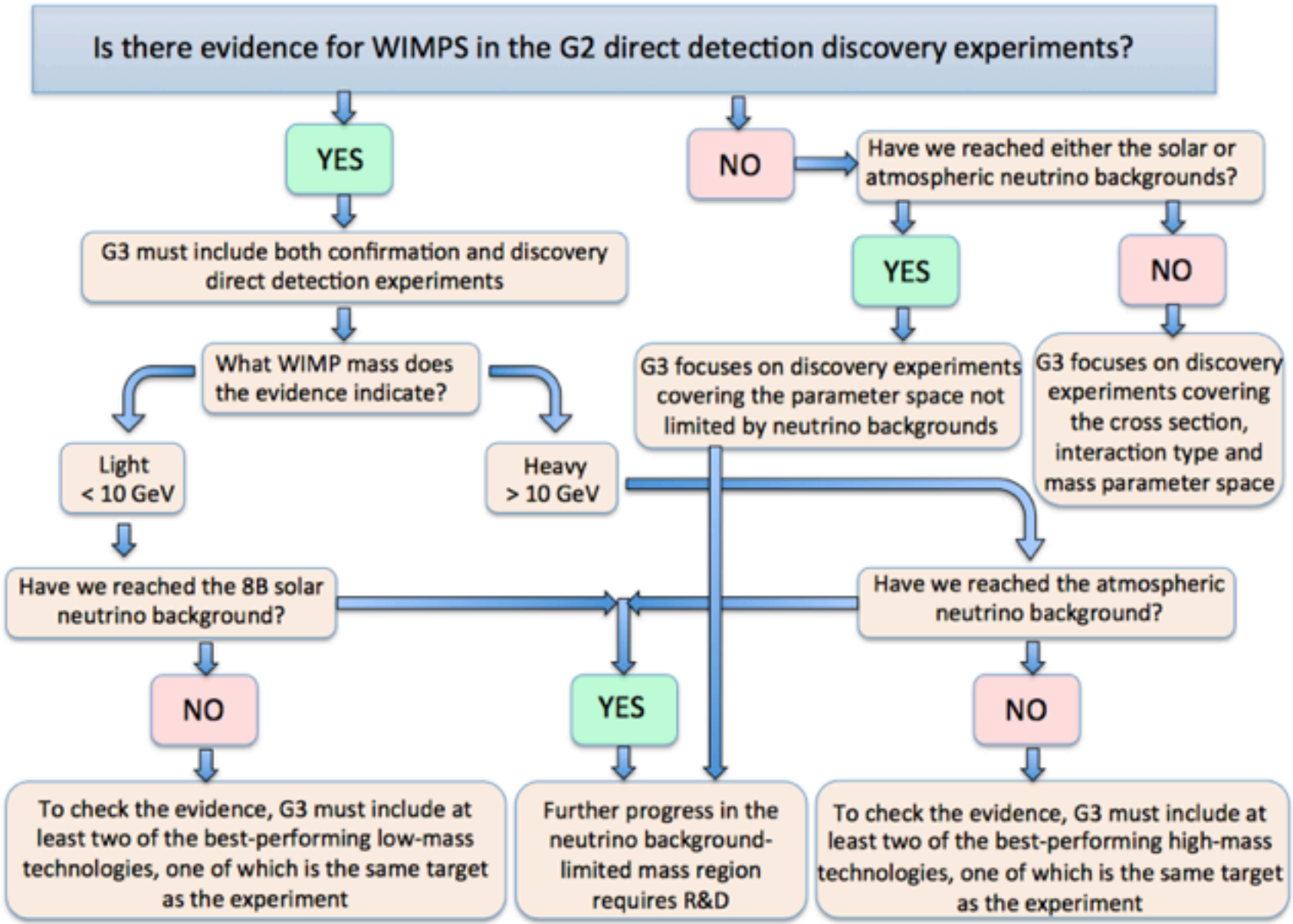
International Context

- New facilities available at CJPL (2.4km depth)
- Frejus expansion part-funded
- Space becoming available at Gran Sasso with removal of OPERA and ICARUS
- Boulby transitioned to environmental studies
- WIPP operations temporarily suspended
- Science programme reviews over last year:
  - US Snowmass process
    - Extensive review of overall US programmes
  - US DOE NP $0\nu\beta\beta$ NSAC
    - 2-3 years before decision possible
  - US DOE/NSF P5 process
    - "Substantial increase in dark matter studies"
    - Discussion of G3 projects
    - Internationalisation of LBNF
  - US DOE DM G2 down-select expected within weeks

Snowmass DM limit plot



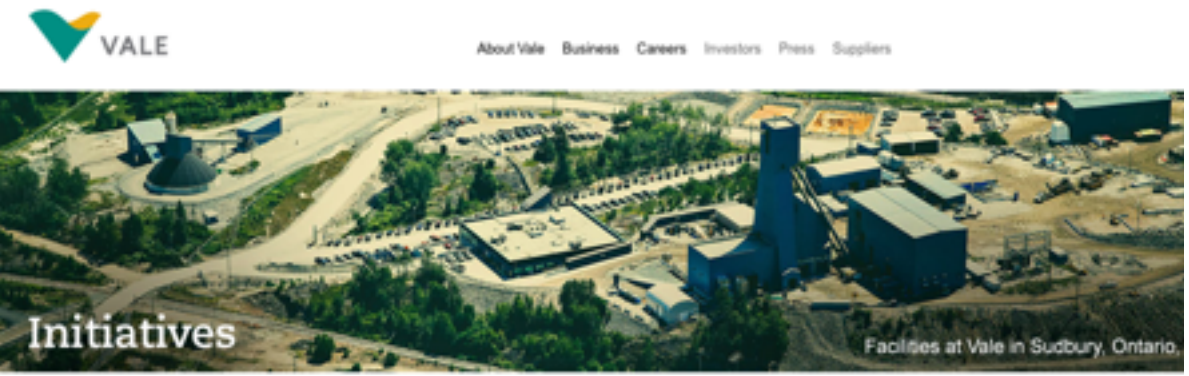
Snowmass decision mapping

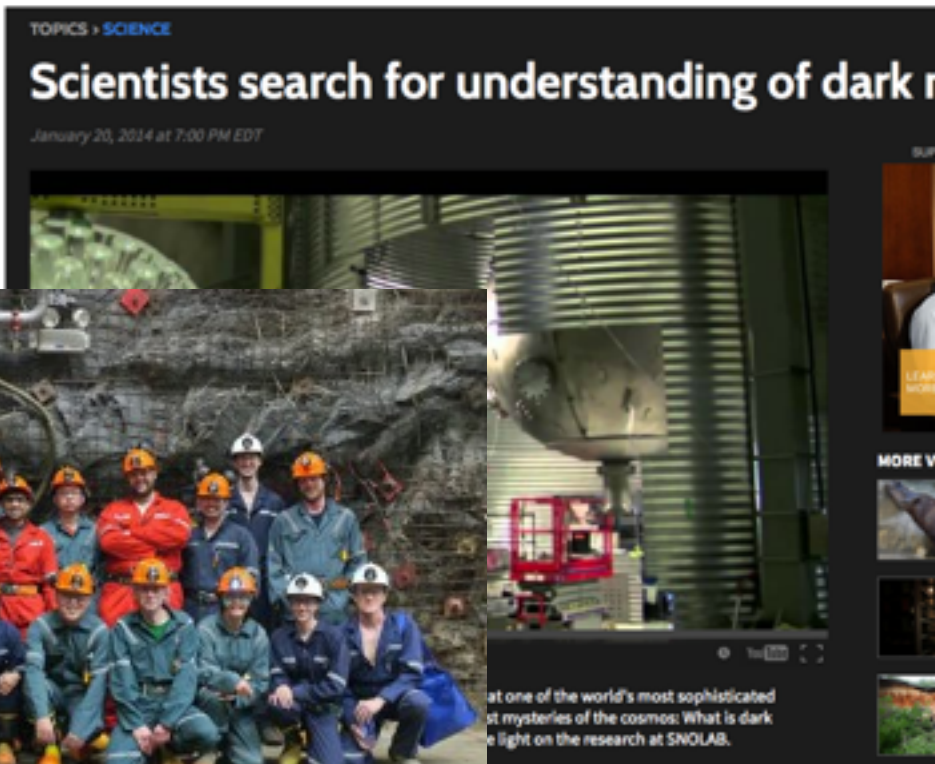


NSAC Timeline

- Justification of 2-3 year horizon for decision process
- GERDA/Majorana in discussion of a single future detector
- SNO+, nEXO with Canadian involvement

Outreach and education





Going deep underground in Canada in search of dark matter

IVAN SEMENIUK
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Outlook

- SNOLAB facility developments limited to focus on projects
  - Processes evolving in user and project management
- SNOLAB programme developing well:
  - Initial science programme operational and has already delivered world-leading science (PICASSO, COUPP-4)
  - PICASSO, COUPP-4, DAMIC completed science run
  - PICO-2 on-line since last CAP; COUPP-60 operational
  - DAMIC upgrade underway
  - Three large scale detectors continue construction
    - DEAP-3600, SNO+, MiniCLEAN
- International context evolving
  - Global community looking towards co-operation
  - Opportunity to develop major programmes at SNOLAB over the next 3-5 years