Overview of the SNOLAB Facility and Current Programme Evolution

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Programme Development & Science
SNOLAB

Future Projects Workshop
24-25 Aug 2015

SNOLAB Vision

Vision Statement from SNOLAB's Strategic Plan:

"To be the location and partner of choice for deep underground science, delivering world-class science and benefit to Canada, and her international partners, by providing and promoting national and international access to the unique facilities and expertise at SNOLAB."

SNOLAB 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.

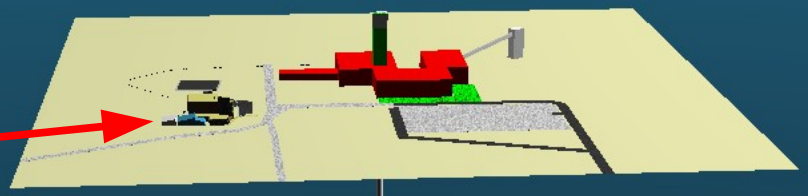
"Develop and maintain world-class facilities and infrastructure"

SNOLAB Facility

SNOLAB Facility Goals

- A deep underground facility to minimize cosmic ray interactions.
- A monolithic clean room to prevent radiological contamination and to create ease of access to experiments and laboratory infrastructure.
- Infrastructure provided by the facility to lessen the need for the experiments to provide cleaning staff, material handlers, maintenance technicians, electricians etc.
- Expertise in Design and Project Coordination specific to the unique SNOLAB environment.
- On site administration support for safety, logistics, procurement, training.

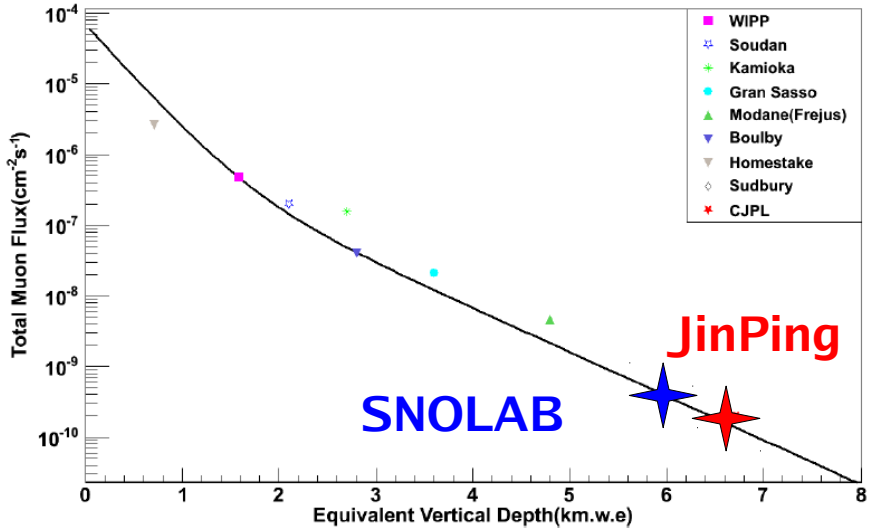
Surface Facility



2km overburden (6000mwe)

Underground Laboratory

Muon Flux = 0.27/m^2/day

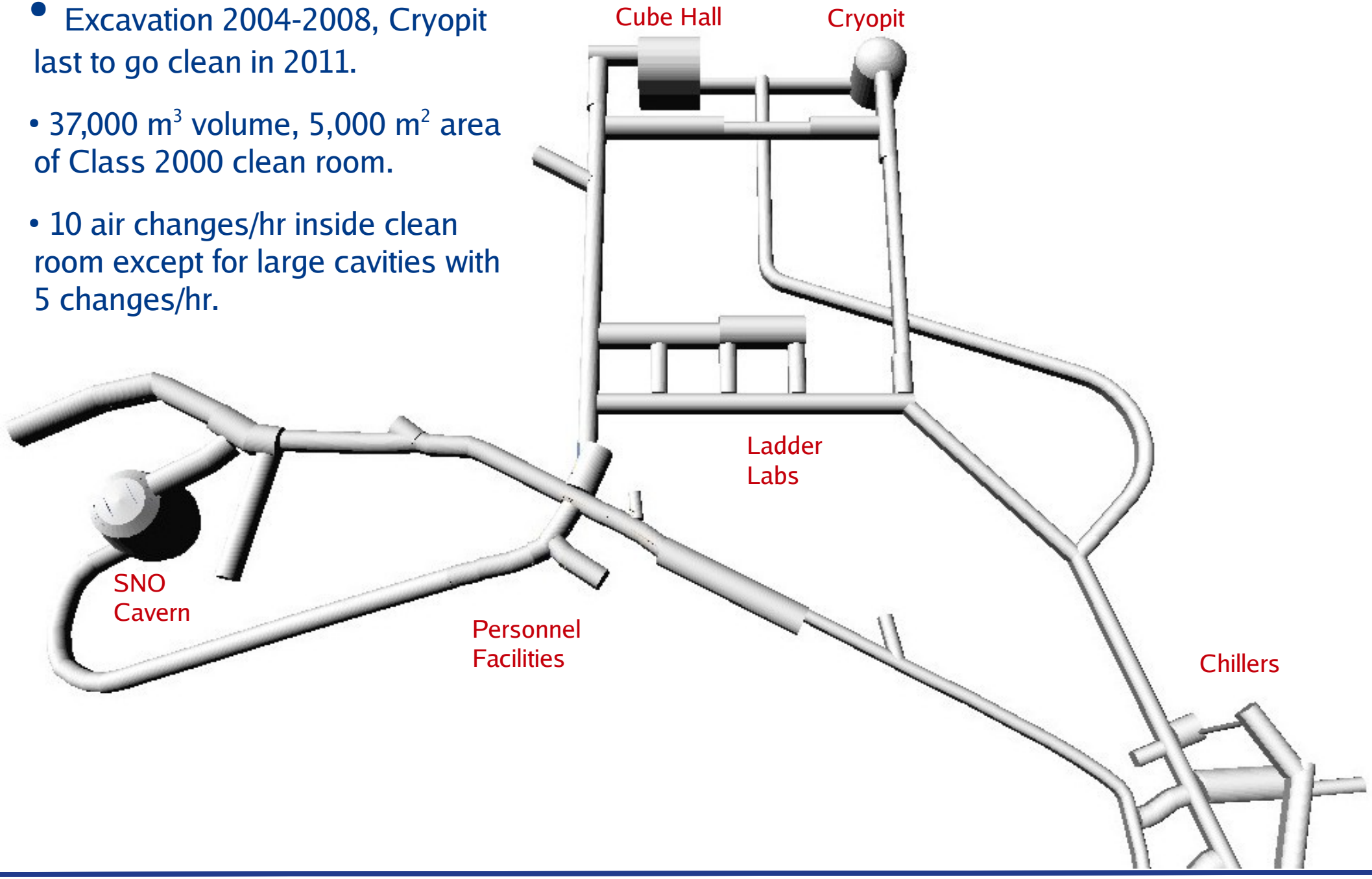


Wu et al arXiv:1305.0899

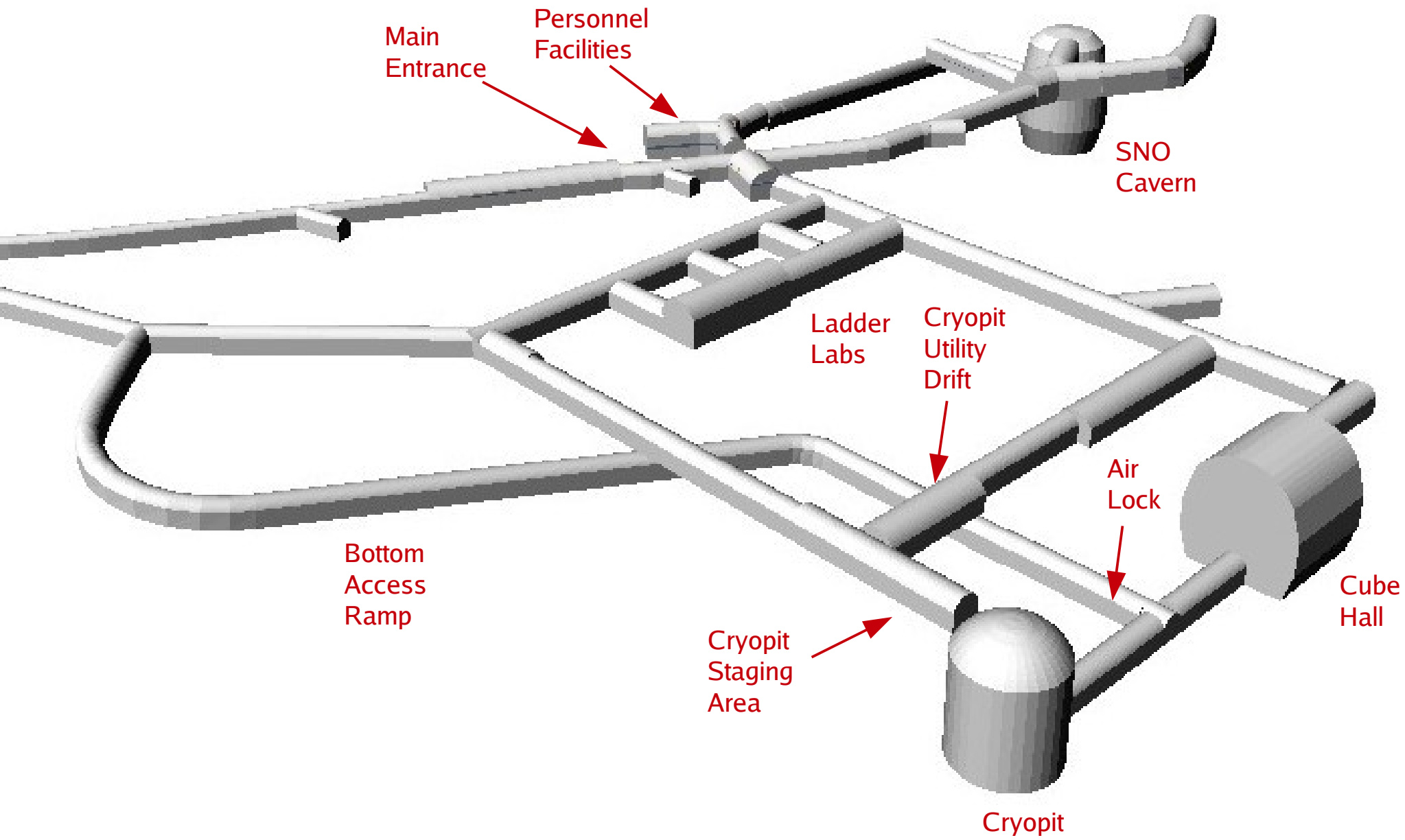

Route 144

The Laboratory

- Excavation 2004-2008, Cryopit last to go clean in 2011.
- 37,000 m^3 volume, 5,000 m^2 area of Class 2000 clean room.
- 10 air changes/hr inside clean room except for large cavities with 5 changes/hr.

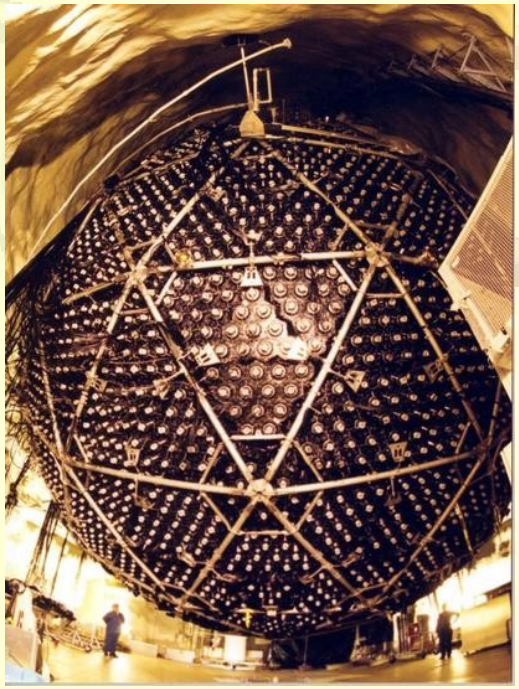


The Laboratory



SNO Cavern

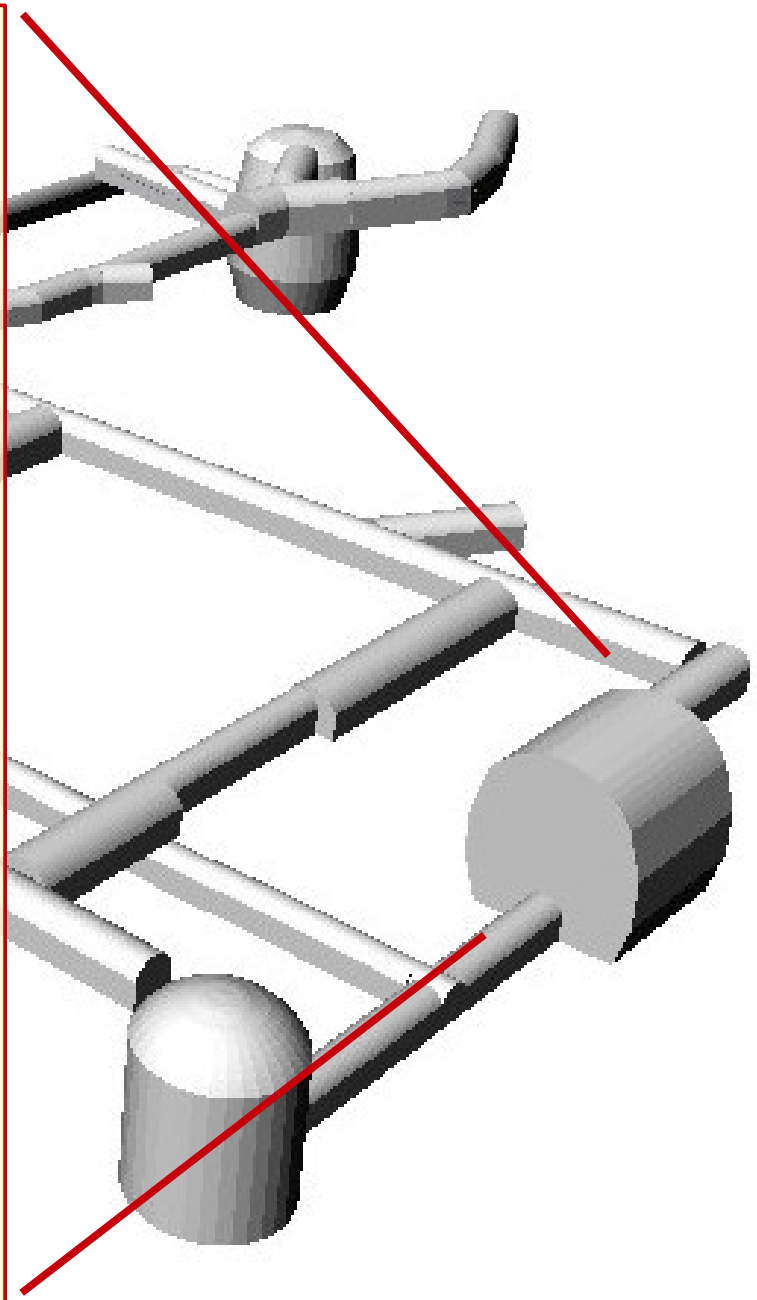
Shape	Barrel
Dim	22 m (dia) x 30 m (h)
Area	250 m^2
Volume	9,400 m^3



Cube Hall

Shape	Rectangular
Dim	18 m (l) x 15 m (w) x 20 m (h)
Area	276 m^2
Volume	5,600 m^3

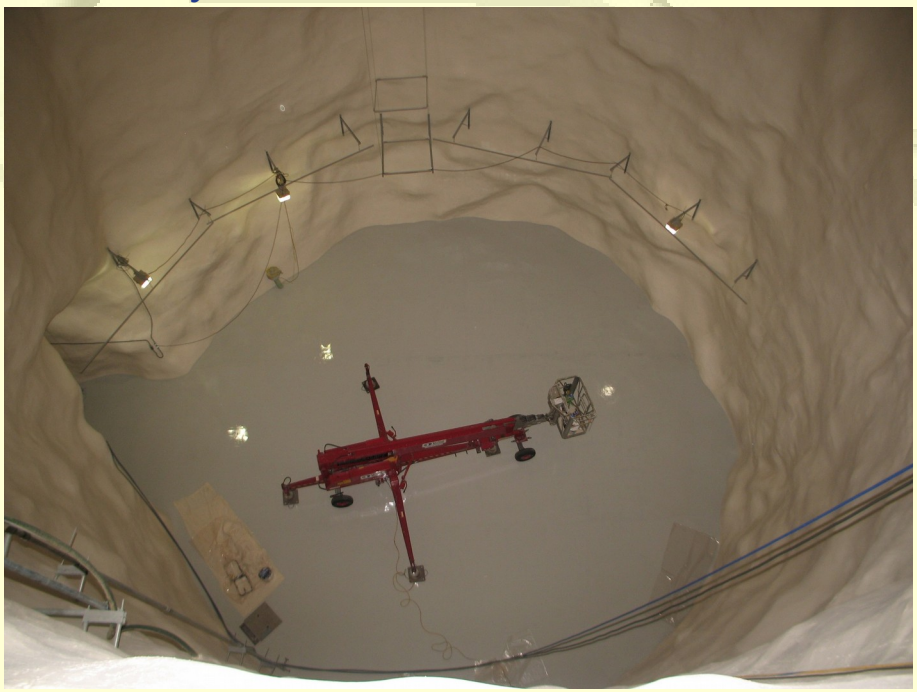
- 60% size of SNO Cavern
- Top access with stairwell to floor.
- 10 T monorail for material hoisting.

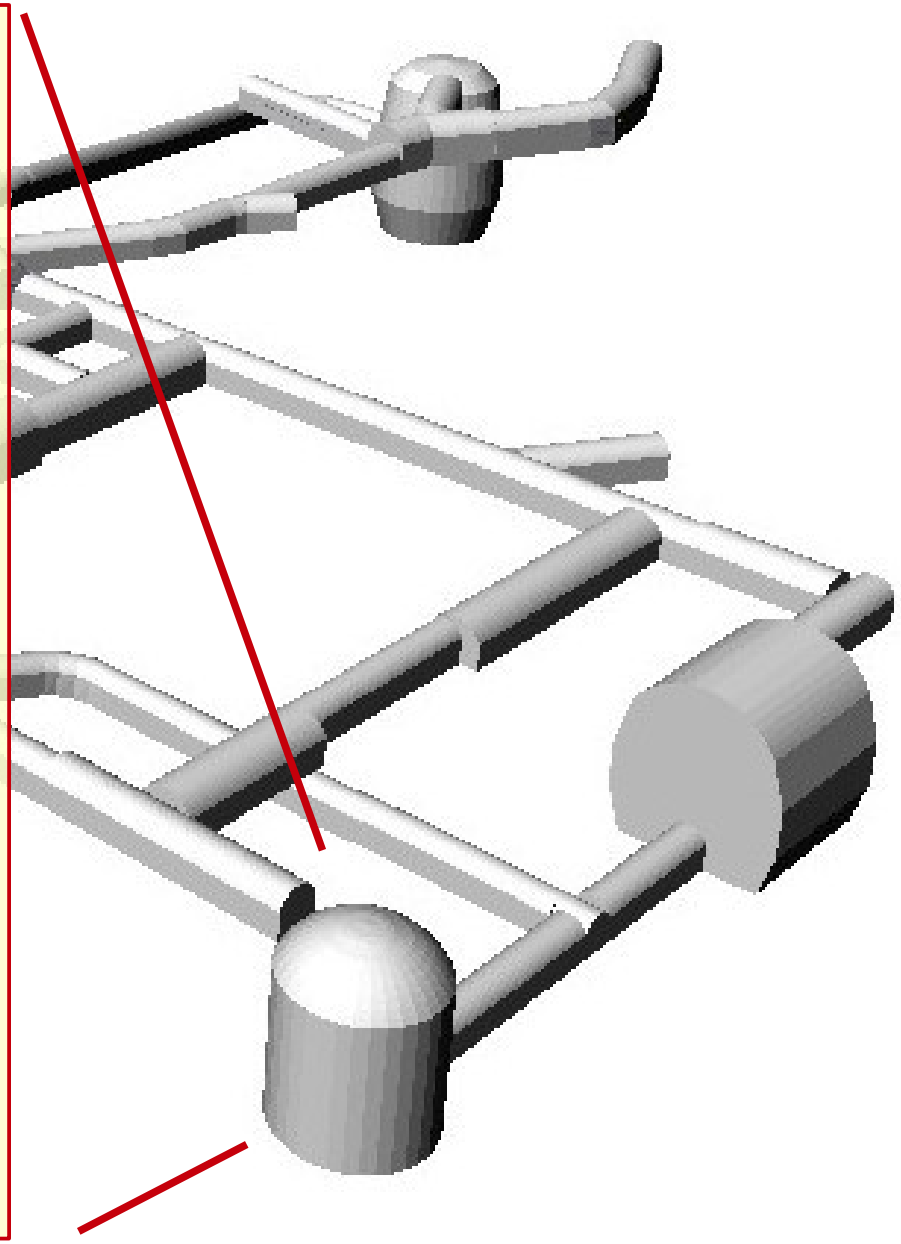


Cryopit

- 40% size of SNO Cavern
- Cavity designed to be flooded.
- Provisions for pressure bulkheads to isolate from the rest of laboratory

Shape	Cylinder
Dim	15 m (dia) x 20 m (h)
Area	181 m^2
Volume	3,900 m^3



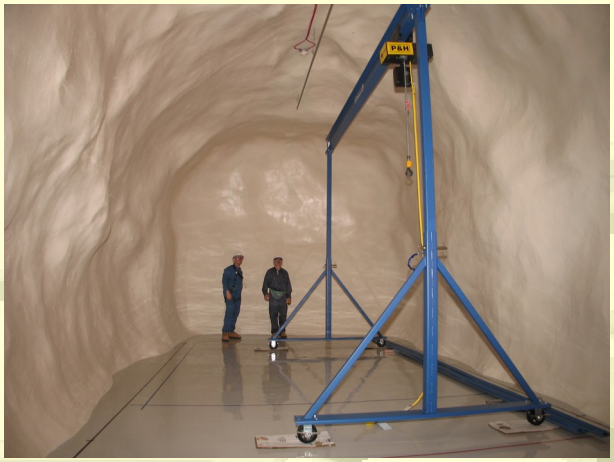


Ladder Labs

Shape	Connected Drifts
Dim	4-7.5 m (w) x 5-8 m (h)
Area	895 m^2
Volume	4,300 m^3

J-Drift, HALO Drift

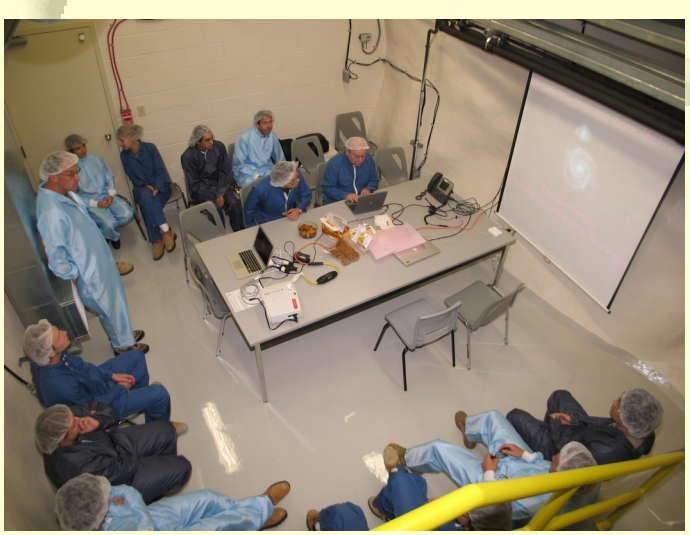
HALO Drift

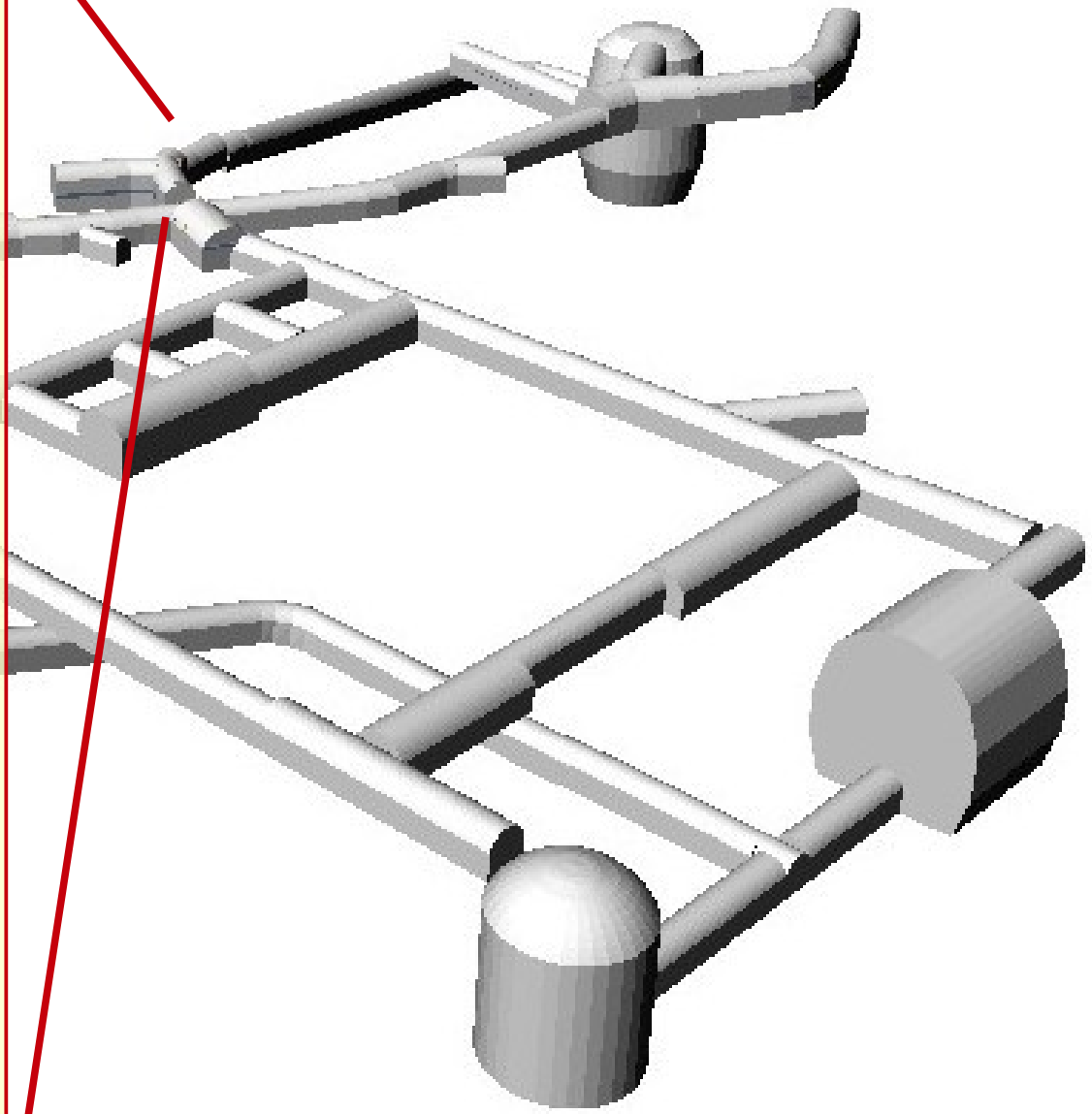


J-Drift	
Shape	Drift
Dim	35 m (l) x 6 m (w) x 5 m (h)
Area	209 m^2
Volume	925 m^3

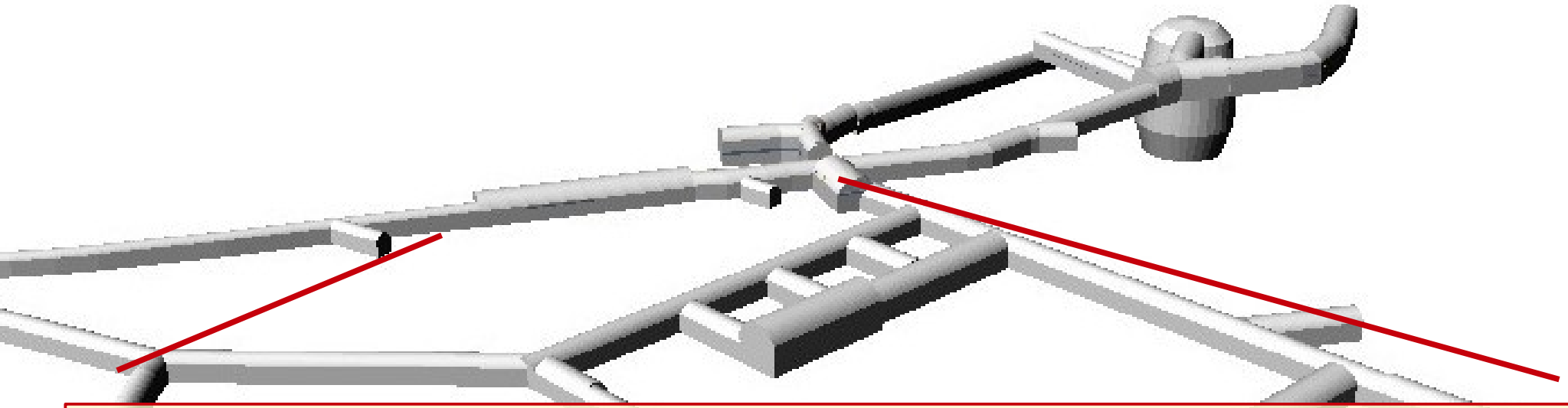
Personnel Facilities

Refuge Station has 120 person capacity





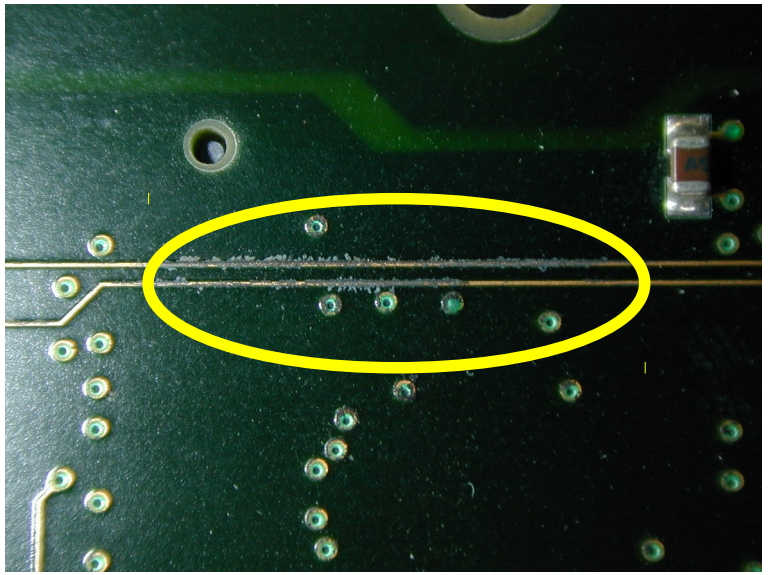
Lab Entrance



Transport, Material Handling, Cleaning

Environment

- Air Pressure: ~1.25 x sea level and can fluctuate by 5% . Need to design vacuum vessels accordingly.
- Radon levels in air: ~150Bq/m^3
- Small quantities of H_2S in air. Filters in the air handlers reduce it but some remains causing corrosion (for example on the copper on circuit boards).
- Seismicity: Mining induced seismic activity. Design basis event is "1 in a 100 yrs" 4.3 M_N on the Nuttli Scale (~3.4 M_R Richter). Designing seismically rated equipment can be challenging.



Services

- Electricity
- Cooling
- Ultrapure water
- Compressed Air
- Liquid Nitrogen
- Network
- Ventilation

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- 13.8kV feed to the mine level, 600V, 3 phase distribution inside lab.
- Just completed an upgrade of electrical distribution from 2MW to 3MW capacity. Improved isolation from Vale systems.

Services

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- Cooling
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- Compressed Air
- Liquid Nitrogen
- Network
- Ventilation

- 1 MW cooling capacity using chilled water at 8C.
- The CW loop is at 250 psi so secondary cooling loops may be necessary for some equipment.

Services

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- Cooling
- Ultrapure water
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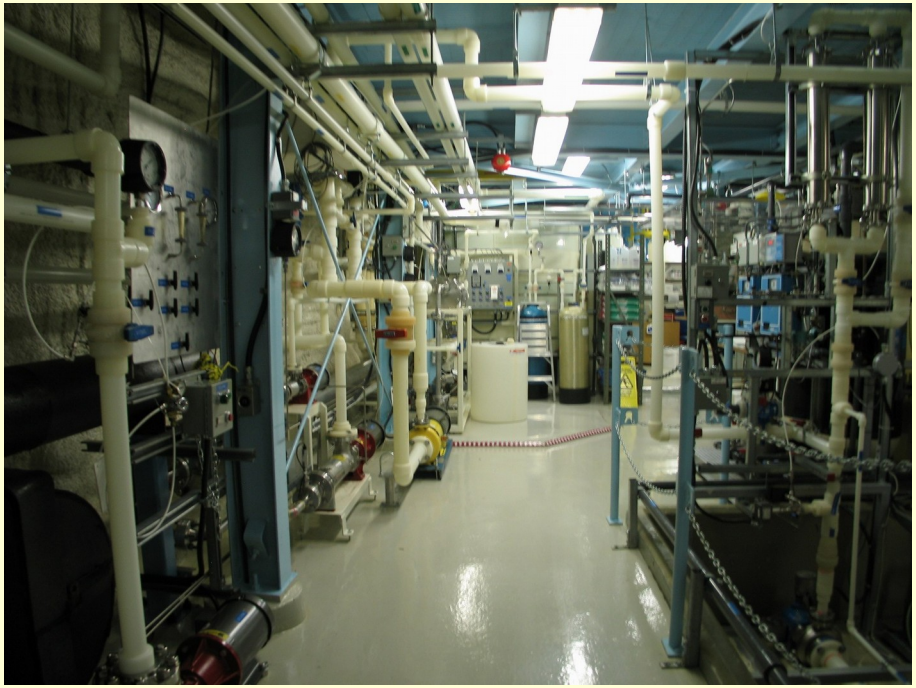
- 140 L/min capacity from the original SNO UPW plant.
- While the plant can produce high purity water, polishing should be done locally.



Services

- Electricity
- Cooling
- Ultrapure water
- Compressed Air
- Liquid Nitrogen
- Network
- Ventilation

- Limited supply (of order 100 cfm) of compressed air from surface. Has 40 times less radon than mine air.
- Can be used on a limited basis to create lower radon environments for experiments.

Services

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- Cooling
- Ultrapure water
- Compressed Air
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- Commercially produced low radon LN_2 supplied by 230L dewars shipped from surface.
- Used for cooling and cover gas.

Services

- Electricity
- Cooling
- Ultrapure water
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- Liquid Nitrogen
- Network
- Ventilation

- Fibre optic link from underground to surface recently upgraded to 2x10Gb/s.
- 1 Gb/s surface to off site. Can be expanded at the cost of additional user fees.
- GPS syncronized time standard available underground.

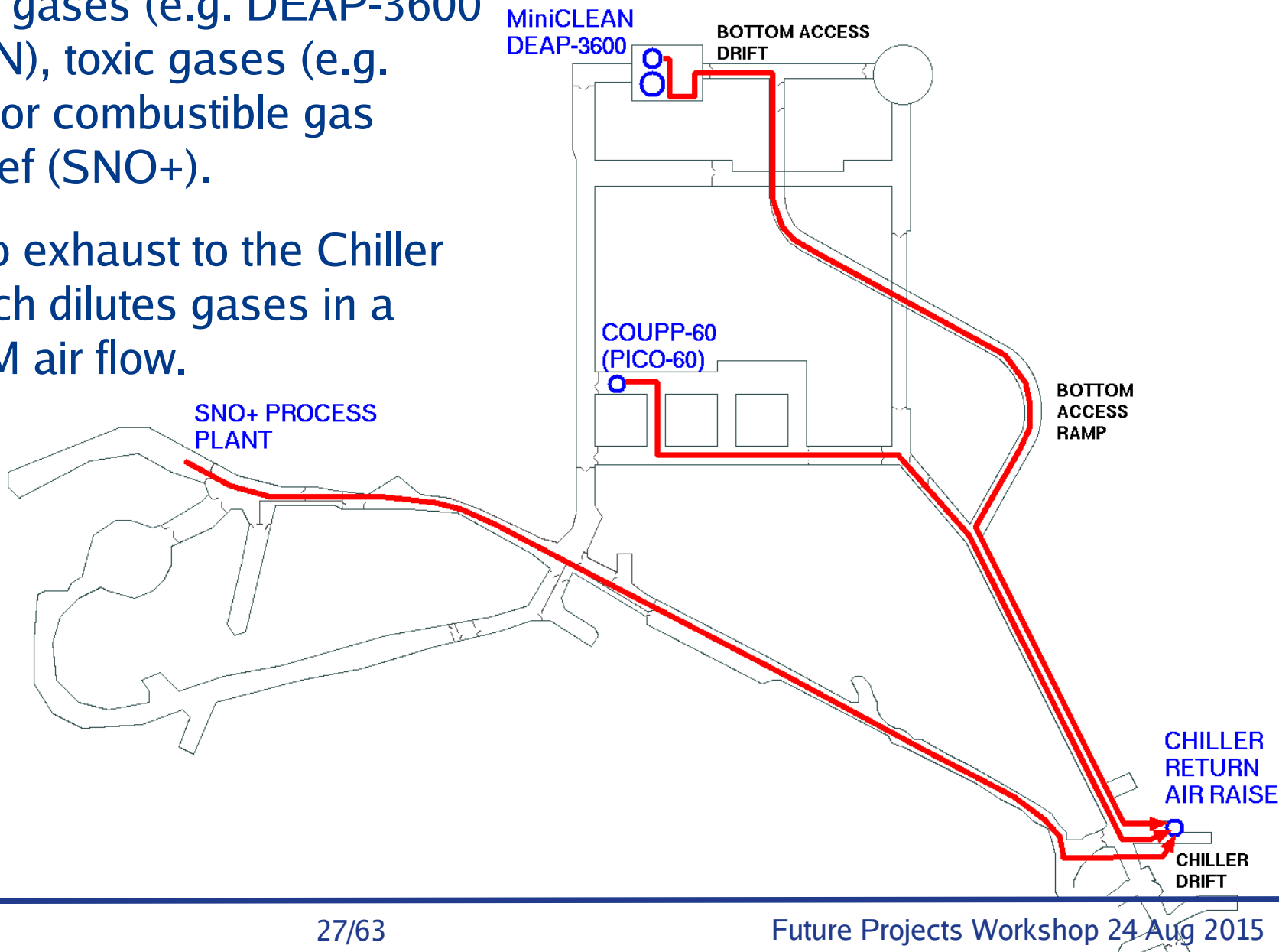
Services

- Electricity
- Cooling
- Ultrapure water
- Compressed Air
- Liquid Nitrogen
- Network
- Ventilation

- 13 air handlers with HEPA filters clean and cool the air.
- Lab is pressurized with 7000 cfm fresh air (makes up ~5% of the recirculated air).
- Limited amount of fresh air available so exhausting a space is a challenge.

Exhaust Venting

- Some experiments may require emergency venting of spaces to remove inert gases (e.g. DEAP-3600 & MiniCLEAN), toxic gases (e.g. COUPP-60) or combustible gas pressure relief (SNO+).
- Strategy is to exhaust to the Chiller air raise which dilutes gases in a 100,000 CFM air flow.



UG Infrastructure

- Existing
  - Low Background Counting
  - 'Clean' Machine shop
- Future
  - Low Background Counting Lab
  - Outfitting airlocks and bringing TAD drift clean

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- See talk by R.Ford.
- Presently operating two Ge detectors ug. one coaxial, one well.
- A second coaxial detector is being installed. Plans to host a detector from Bern within the EXO collaboration.

UG Infrastructure

- Existing
  - Low Background Counting
  - 'Clean' Machine shop
- Future
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  - Outfitting airlocks and bringing TAD drift clean

- Mill, Lathe, drill press, saws, ...
- Gives ability to make adjustments to equipment underground.
- Can do sensitive work such as machining cosmogenically activated materials.

UG Infrastructure

- Existing
  - Low Background Counting
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- Future
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  - Outfitting airlocks and bringing TAD drift clean

- Retrofit the old refuge station as a low background counting lab.

UG Infrastructure

- Existing
  - Low Background Counting
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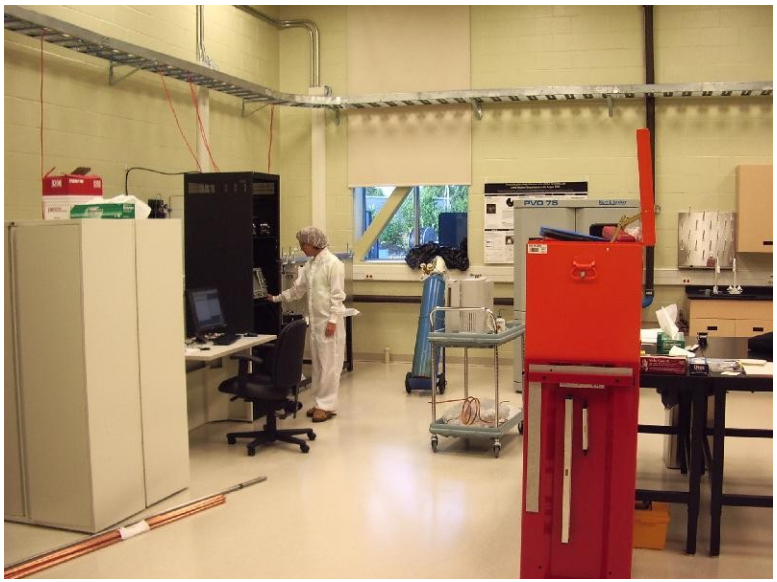
- Future
  - Low Background Counting Lab
  - Outfitting airlocks and bringing TAD drift clean

- Expansion of the clean room boundary outside the Ladder Labs.
- Completion of the BAR airlock.

Surface Facilities

- Site Surface: 4,700 ft^2 CLASS 1000 Clean Room Laboratories, IT Infrastructure (high speed off site), office, meeting rms, control rms, material handling, machine shop.
- Laurentian Water Facility: Intended for spike work not appropriate for site.



Third Floor Outfitting

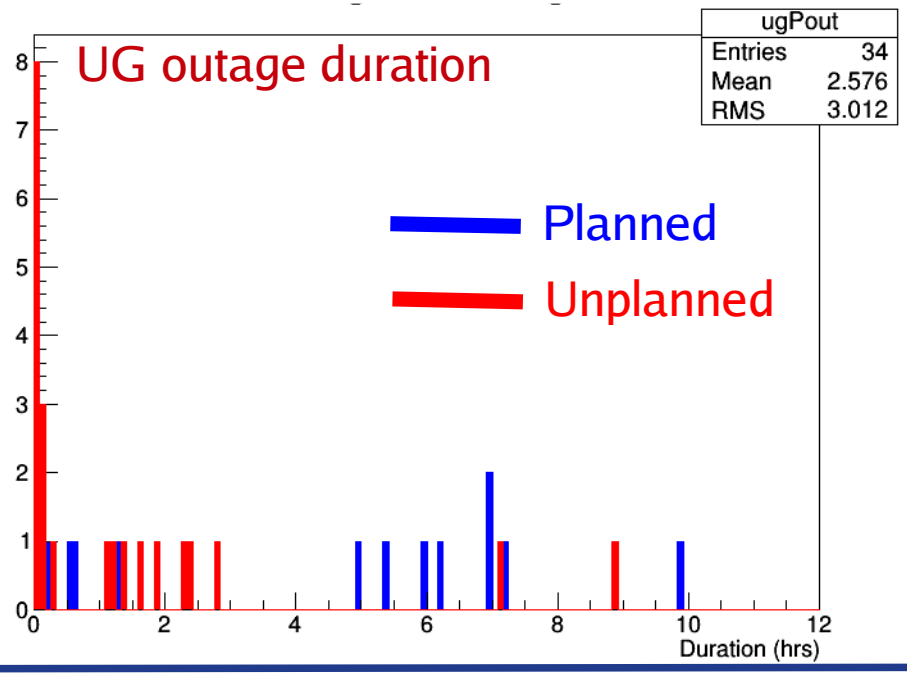
- Outfitting of the third floor as part of the hosting of CEMI (Centre for Excellence in Mining Innovation) and MODCC (Mining Observatory Data Control Centre).
- Added meeting, desk and office space.
- Upgraded HVAC in IT server room for increased capacity and redundancy.

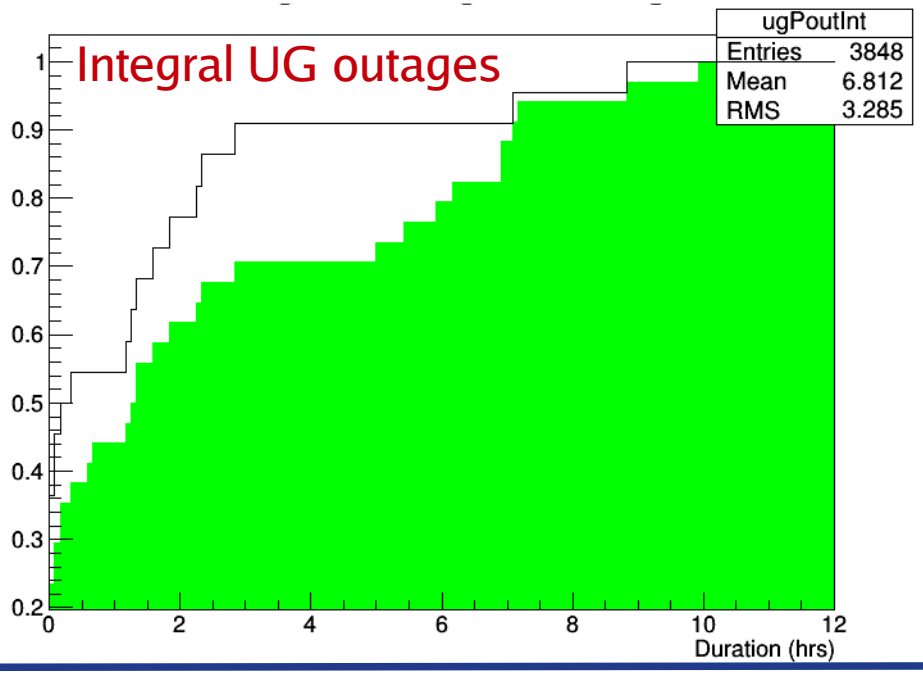
Emergency Generator

- Have been tracking power outages at SNOLAB over several years.
- Planned outages include annual electrical shutdown (8-12 hrs), repairs, modification of Vale and SNOLAB systems. Unplanned includes weather, UG failures, regional power failures.
- This frequency/duration is problematic for many experiments.

Time	Events	Rate (yr^{-1})
< 10 min	11	3.9
> 10 min	23	8.2
> 30 min	21	7.1
> 1 hr	19	6.8
> 2 hr	13	4.6
> 4 hr	10	3.6
> 8 hr	2	0.7
Total	34	12.1

Dec 2011 – Sep 2014



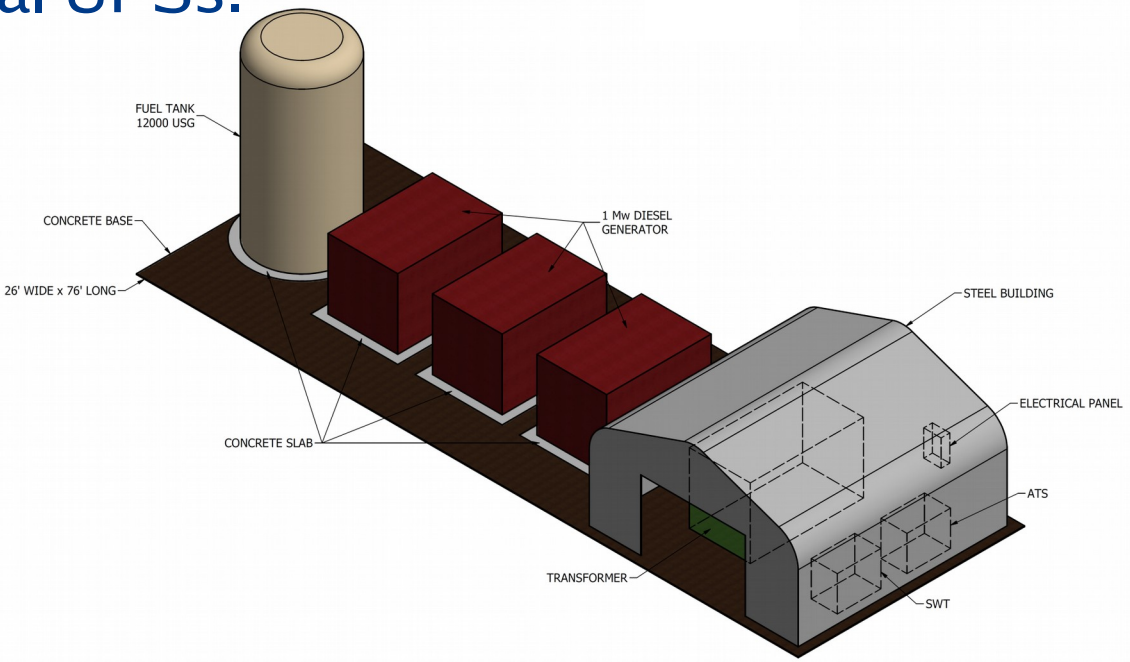


Emergency Generator

- Had originally considered a small (150 kW) underground generator but this had issues including:
  - Unable to operate SNOLAB chillers
  - Need for parallel emergency power distribution
  - Hazards of large fuel storage underground
- Decided on a surface generator that would be able to power the entire SNOLAB electrical system. Advantages include:
  - Able to operate all experiment loads
  - Chiller and cooling is maintained
  - Easy access to service and refuel
- Approved and funded by CFI (Canada Foundation for Innovation).

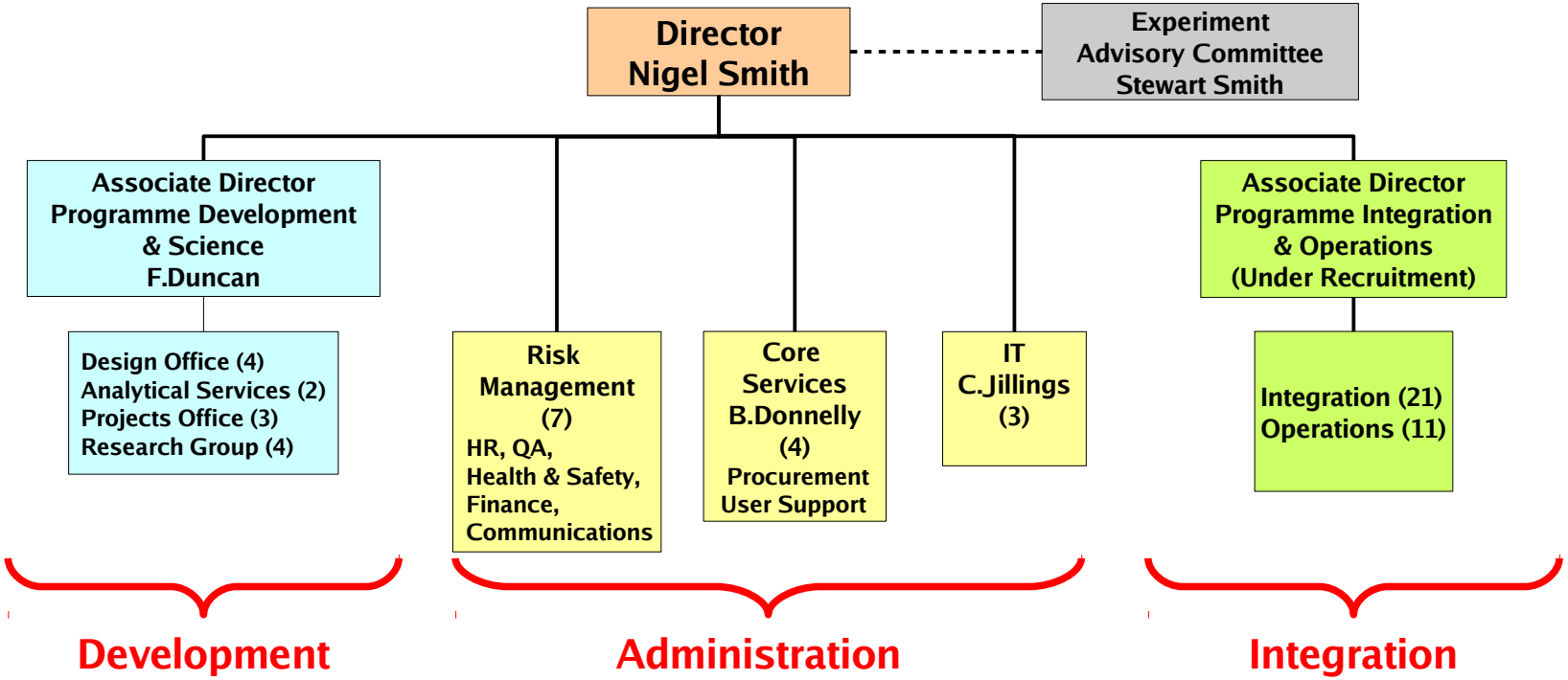
Emergency Generator

- System will consist of three 1MW generators.
- Cost is $5M. Only possible by an 'in kind' contribution utilizing the new Vale #18 circuit. Cost of installing our own dedicated feeder would be an additional ~$5m.
- System is not uninterruptable. I.e. in the event of a power outage to site, there will be an interruption while the generators start up and similarly when normal power is restored. Experiments that can't tolerate this will need local UPSs.
- Final design and authorization from Vale in progress.
- Intent to install in 2016 and go operational in 2017.

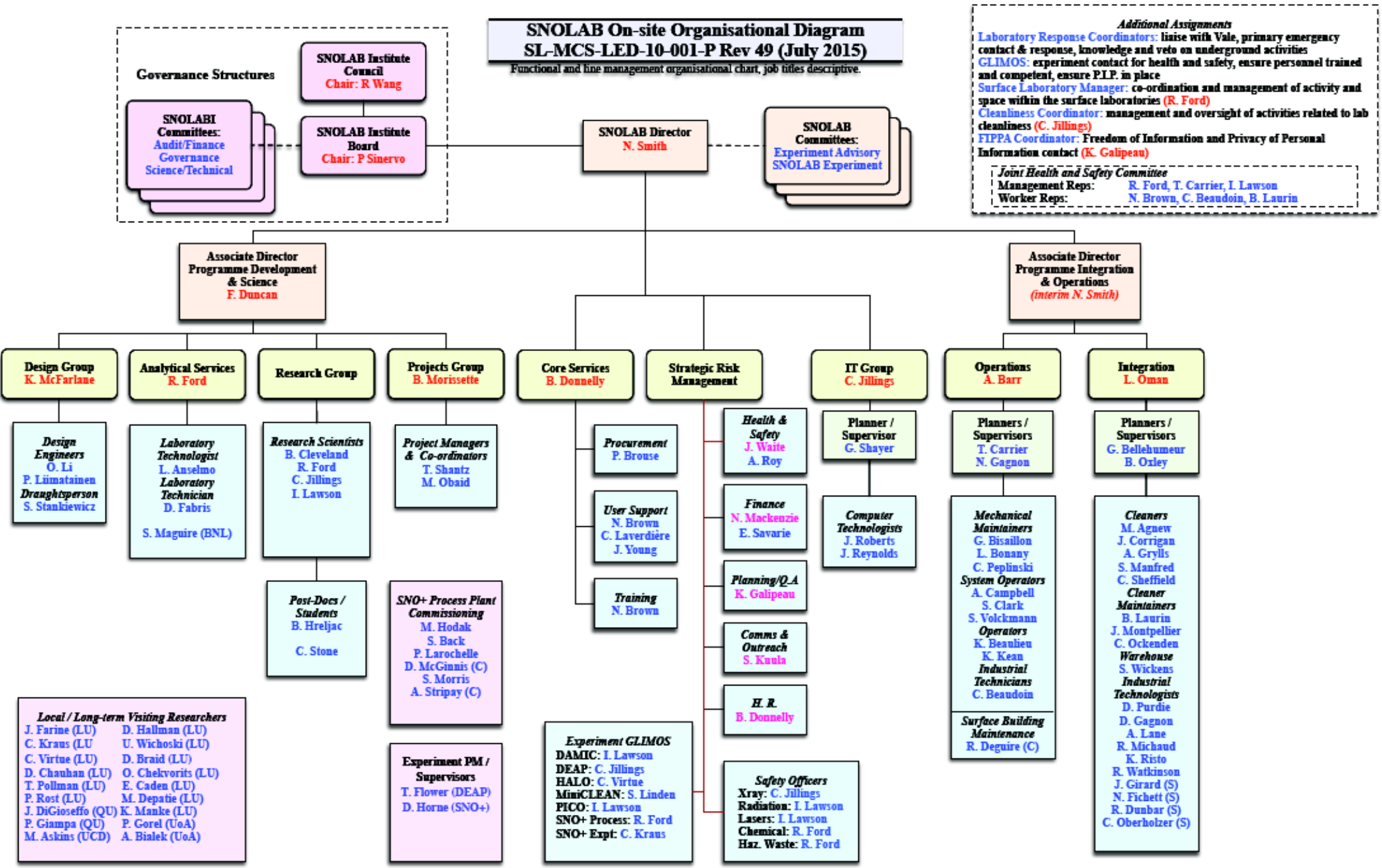


Operations

- Presently have ~65 staff comprised of scientists, engineers, technicians and administrators. This will be expanded to ~75 over the next two years.
- Have recently restructured the SNOLAB organization with two divisions directed specifically towards the science programme:
  - **Programme Development & Science** advances experiments to the point where they are ready to deploy at SNOLAB.
  - **Programme Integration & Operations** sees the installation of experiments and their incorporation into the operation of SNOLAB.

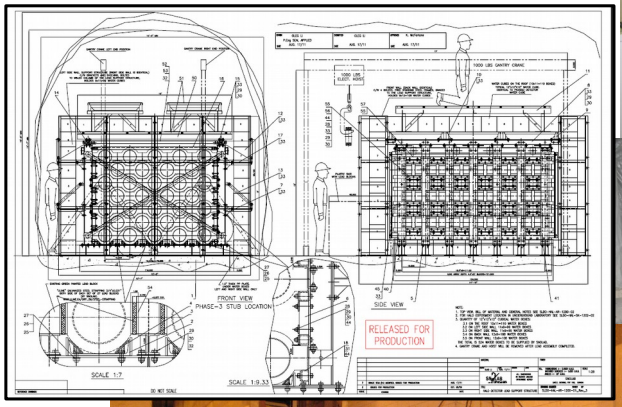


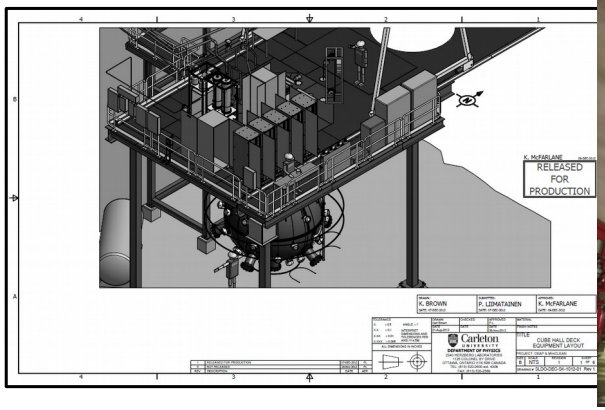
Operations

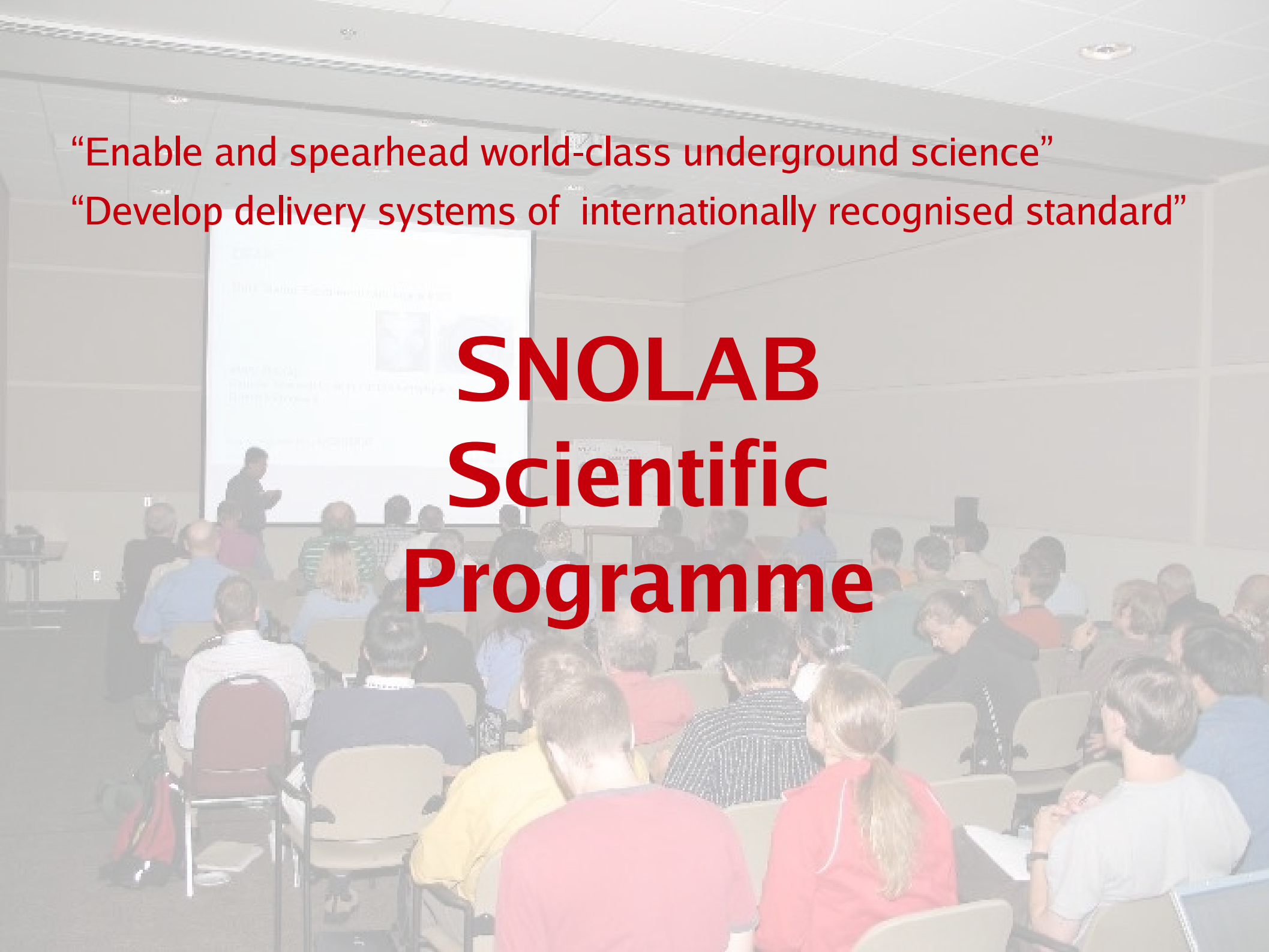

SNOLAB On-site Organisational Diagram
SL-MCS-LED-10-001-P Rev 49 (July 2015)
Functional and line management organisational chart, job titles descriptive.
Governance Structures
SNOLAB Institute Council
Chair: R Wang
SNOLABI Committees:
Audit/Finance
Governance
Science/Technical
SNOLAB Institute Board
Chair: P Sinervo
SNOLAB Director
N. Smith
SNOLAB Committees:
Experiment Advisory
SNOLAB Experiment
Additional Assignments
Laboratory Response Coordinators: liaise with Vale, primary emergency contact & response, knowledge and veto on underground activities
GLIMOS: experiment contact for health and safety, ensure personnel trained and competent, ensure P.I.P. in place
Surface Laboratory Manager: co-ordination and management of activity and space within the surface laboratories (R. Ford)
Cleanliness Coordinator: management and oversight of activities related to lab cleanliness (C. Jillings)
FIPPA Coordinator: Freedom of Information and Privacy of Personal Information contact (K. Galipeau)
Joint Health and Safety Committee
Management Reps: R. Ford, T. Carrier, I. Lawson
Worker Reps: N. Brown, C. Beaudoin, B. Laurin
Associate Director Programme Development & Science
F. Duncan
Associate Director Programme Integration & Operations
(interim N. Smith)
Design Group
K. McFarlane
Analytical Services
R. Ford
Research Group
Projects Group
B. Morissette
Core Services
B. Donnelly
Strategic Risk Management
IT Group
C. Jillings
Operations
A. Barr
Integration
L. Oman
Design Engineers
O. Li
P. Liimatainen
Draughtsperson
S. Stankiewicz
Laboratory Technologist
L. Anselmo
Laboratory Technician
D. Fabris
S. Maguire (BNL)
Research Scientists
B. Cleveland
R. Ford
C. Jillings
I. Lawson
Post-Docs / Students
B. Hreljac
C. Stone
Project Managers & Co-ordinators
T. Shantz
M. Obaid
SNO+ Process Plant Commissioning
M. Hodak
S. Back
P. Larochelle
D. McGinnis (C)
S. Morris
A. Stripay (C)
Experiment PM / Supervisors
T. Flower (DEAP)
D. Horne (SNO+)
Procurement
P. Brouse
User Support
N. Brown
C. Laverdière
J. Young
Training
N. Brown
Health & Safety
J. Waite
A. Roy
Finance
N. Mackenzie
E. Savarie
Planning/Q.A
K. Galipeau
Comms & Outreach
S. Kuula
H. R.
B. Donnelly
Planner / Supervisor
G. Shayer
Computer Technologists
J. Roberts
J. Reynolds
Planners / Supervisors
T. Carrier
N. Gagnon
Mechanical Maintainers
G. Bisaillon
L. Bonany
C. Peplinski
System Operators
A. Campbell
S. Clark
S. Volckmann
Operators
K. Beaulieu
K. Kean
Industrial Technicians
C. Beaudoin
Surface Building Maintenance
R. Deguire (C)
Planners / Supervisors
G. Bellehumeur
B. Oxley
Cleaners
M. Agnew
J. Corrigan
A. Grylls
S. Manfred
C. Sheffield
Cleaner Maintainers
B. Laurin
J. Montpellier
C. Ockenden
Warehouse
S. Wickens
Industrial Technologists
D. Purdie
D. Gagnon
A. Lane
R. Michaud
K. Risto
R. Watkinson
J. Girard (S)
N. Fichett (S)
R. Dunbar (S)
C. Oberholzer (S)
Local / Long-term Visiting Researchers
J. Farine (LU)
C. Kraus (LU
C. Virtue (LU)
D. Chauhan (LU)
T. Pollman (LU)
P. Rost (LU)
J. DiGioseffo (QU)
P. Giampa (QU)
M. Askins (UCD)
D. Hallman (LU)
U. Wichoski (LU)
D. Braid (LU)
O. Chekvorits (LU)
E. Caden (LU)
M. Depatie (LU)
K. Manke (LU)
P. Gorel (UoA)
A. Bialek (UoA)
Experiment GLIMOS
DAMIC: I. Lawson
DEAP: C. Jillings
HALO: C. Virtue
MiniCLEAN: S. Linden
PICO: I. Lawson
SNO+ Process: R. Ford
SNO+ Expt: C. Kraus
Safety Officers
Xray: C. Jillings
Radiation: I. Lawson
Lasers: I. Lawson
Chemical: R. Ford
Haz. Waste: R. Ford

Experiment Support

- Logistics & Material Handling
- Cleaning
- Installation
- Analytical Services
- IT
- Procurement
- Training
- Design
- Project Coordination







"Enable and spearhead world-class underground science"

"Develop delivery systems of internationally recognised standard"

SNOLAB Scientific Programme

Science Programme

- The intent is to have an ongoing rotation of experiments in all phases of planning, design, construction and operation. As experiments complete, space will be made available for new opportunities.
- Primary focus has been on astro-particle physics
  - Dark Matter
  - Neutrinos ($0\nu\beta\beta$, solar, geo, supernovae)
- Have extended the science program with projects in
  - Seismic studies
  - Mining Data Centre
  - Genomics

Programme Administration

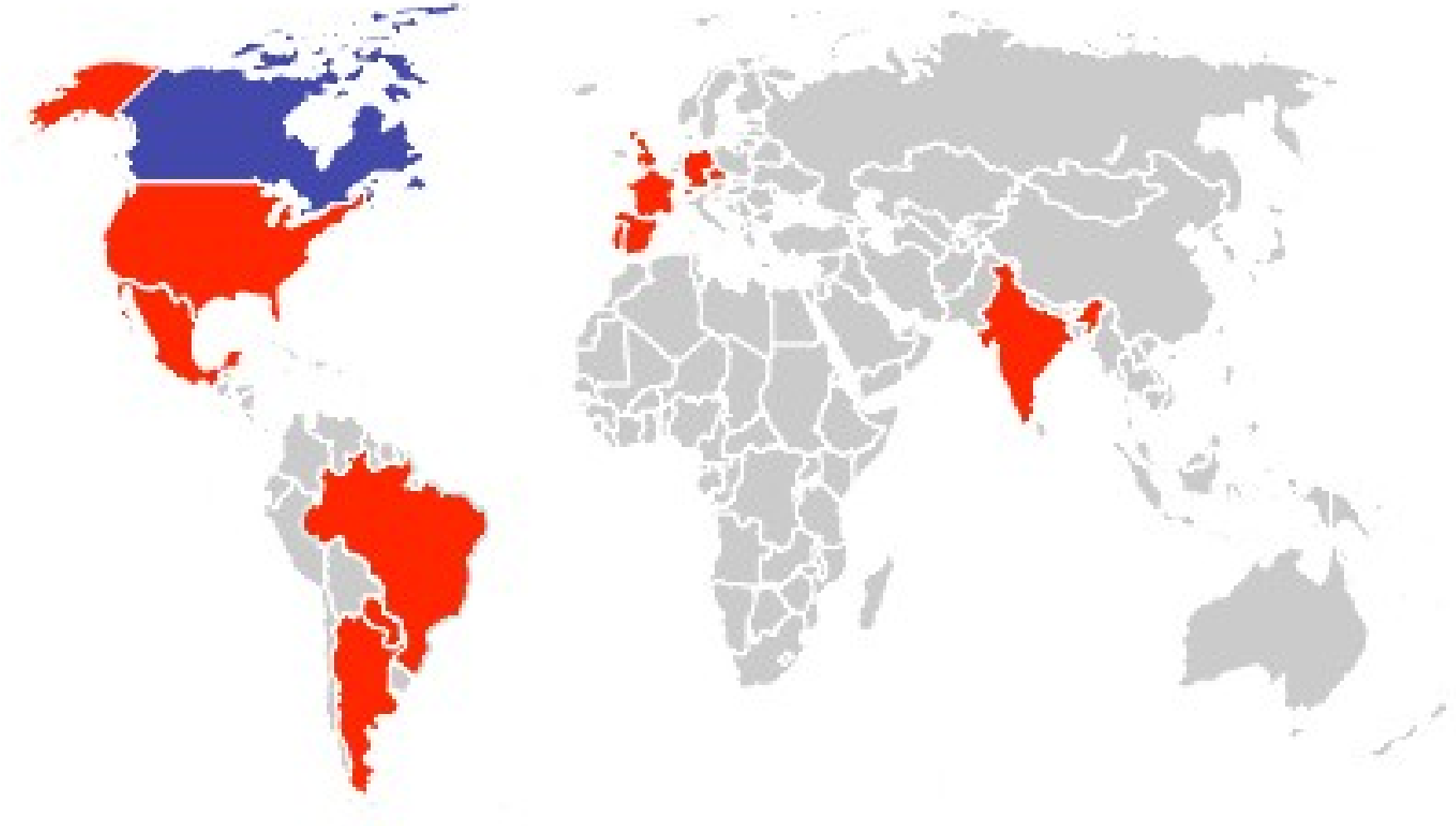
- Experiments will be administered through a formal Life Cycle (see next talk).
- To ensure scientific excellence, the science program is steered by an Experiment Advisory Committee (EAC) reporting to the SNOLAB Director. Chaired by Stewart Smith with international membership.
- To ensure quality delivery, SNOLAB is in the process of obtaining ISO 9001 (Quality) and OHSAS 18001 (Health and Safety) accreditation.
- **SNOLAB Experiment Forum (SEF):** Forum of representatives from each active experiment and the facility. To ensure that we are meeting the collective needs of the experiment programme and to get feedback on the effectiveness of our processes. One instance identified by the SEF was the need to prioritize the Low Background Counting Lab.

Current Science Program

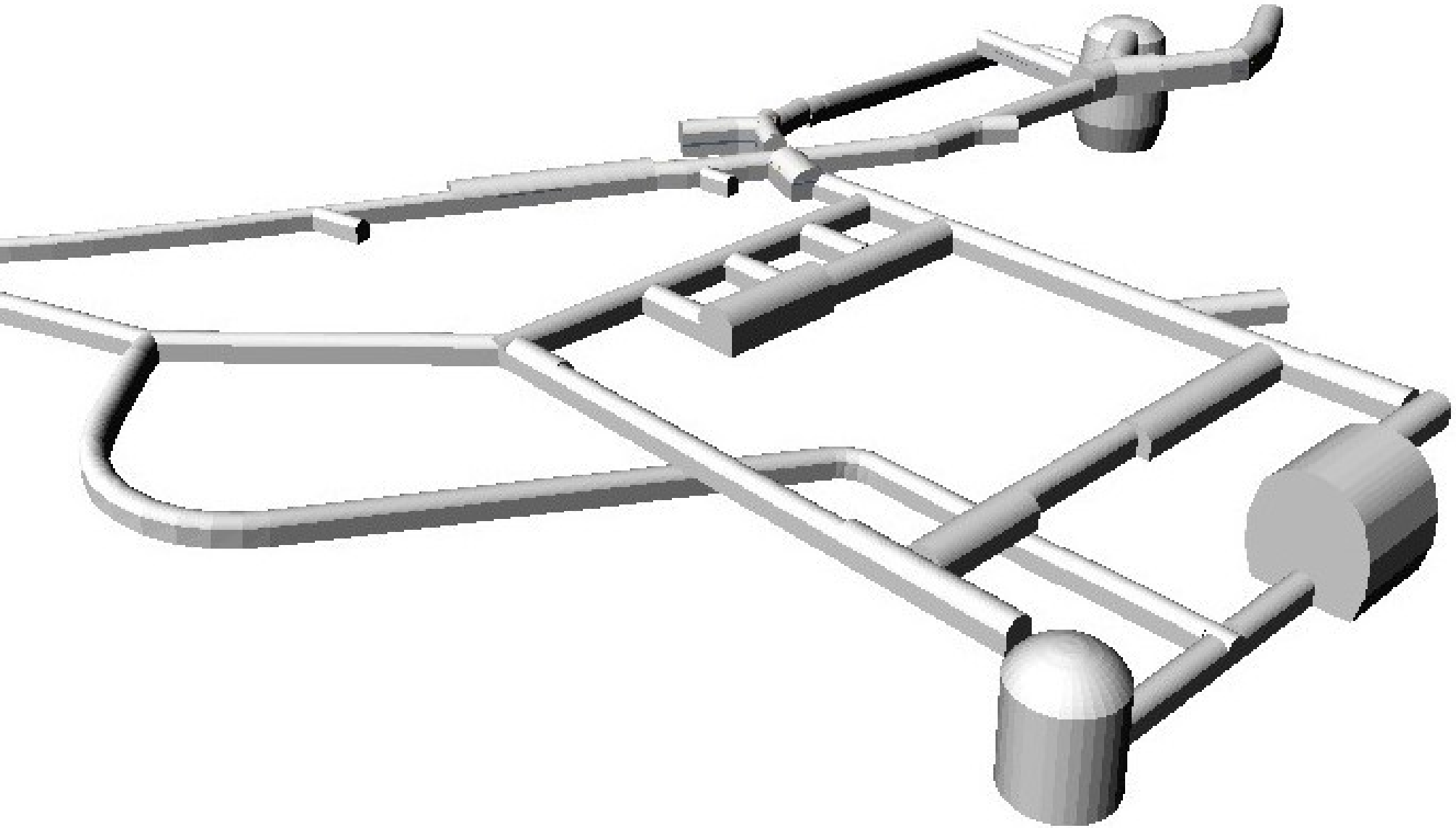
Experiment	Neutrino	Dark Matter	Other	Space Allocated	Satus
CEMI			Mining Data Centre	Surface Facility	**In Construction**
COUPP-4		X		J-Drift	Completed
DAMIC		X		J-Drift	**Operational**
DEAP-1		X		J-Drift	Completed
DEAP-3600		X		Cube Hall	**In Construction**
DEAP- 50T/CLEAN		X		Cube Hall	Expression of Interest
DMTPC		X		Ladder Labs	Expression of Interest
Ge-1T	X			Cryopit	Expression of Interest
nEXO	X			Cryopit	Feasibility Phase
HALO	X			HALO Stub	**Operational**
MiniCLEAN		X		Cube Hall	**In Construction**
NEWS		X		Cryopit?	Expression of Interest
PICASSO-III		X		Ladder Labs	Completed
PICO-2L		X		J-Drift	**Operational**
PICO-60		X		Ladder Labs	**Operational**
PICO-250		X		Ladder Labs	Expression of Interest
PINGU			Test Facility	Ladder Labs	Expression of Interest
PUPS			Seismicity	Various	Completed
SNO+	X			SNO Cavern	**In Construction**
SuperCDMS		X		Ladder Labs	**In Preparation**
U-Laurentian			Genomics	External Drifts	**Operational**

The SNOLAB Community

- 149 faculty researchers from 70 institutions over 14 countries
- > 500 faculty, highly qualified personnel and technical support.
- ~11,000 underground person-shifts per year (~60/shift/day).

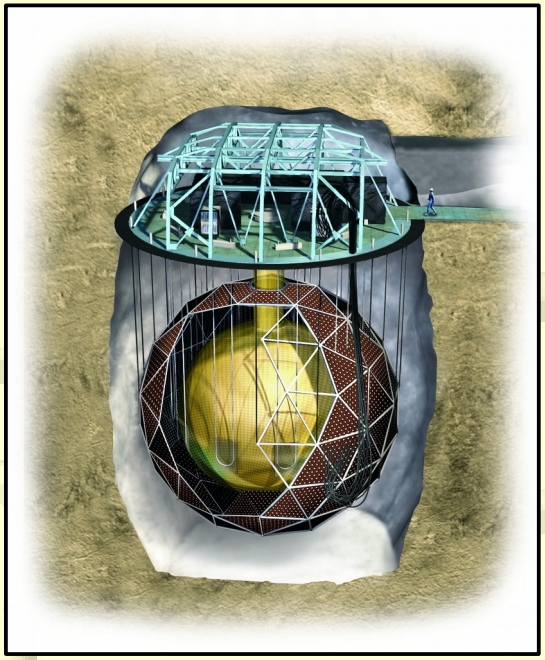


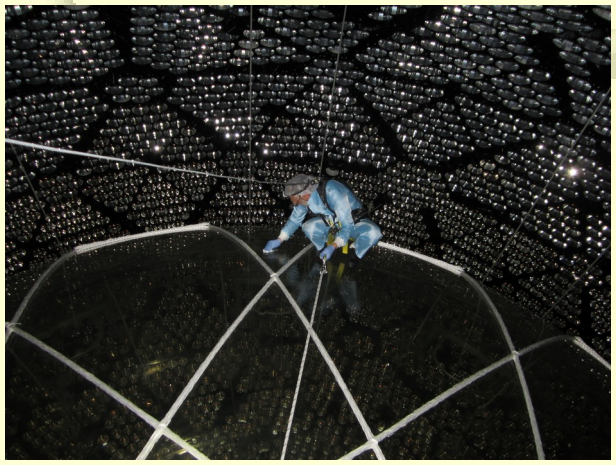
Current Experiments



Current Experiments

SNO+

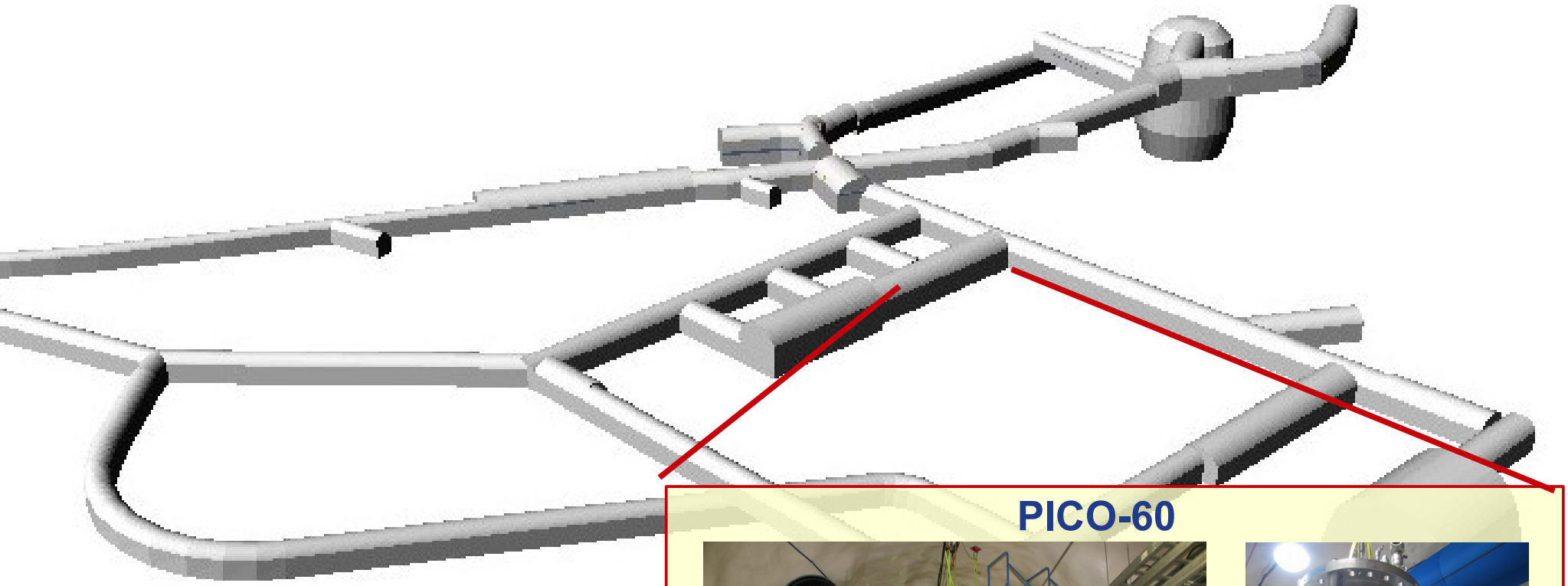




Current Experiments

DEAP-3600, MiniCLEAN

Current Experiments



PICO-60

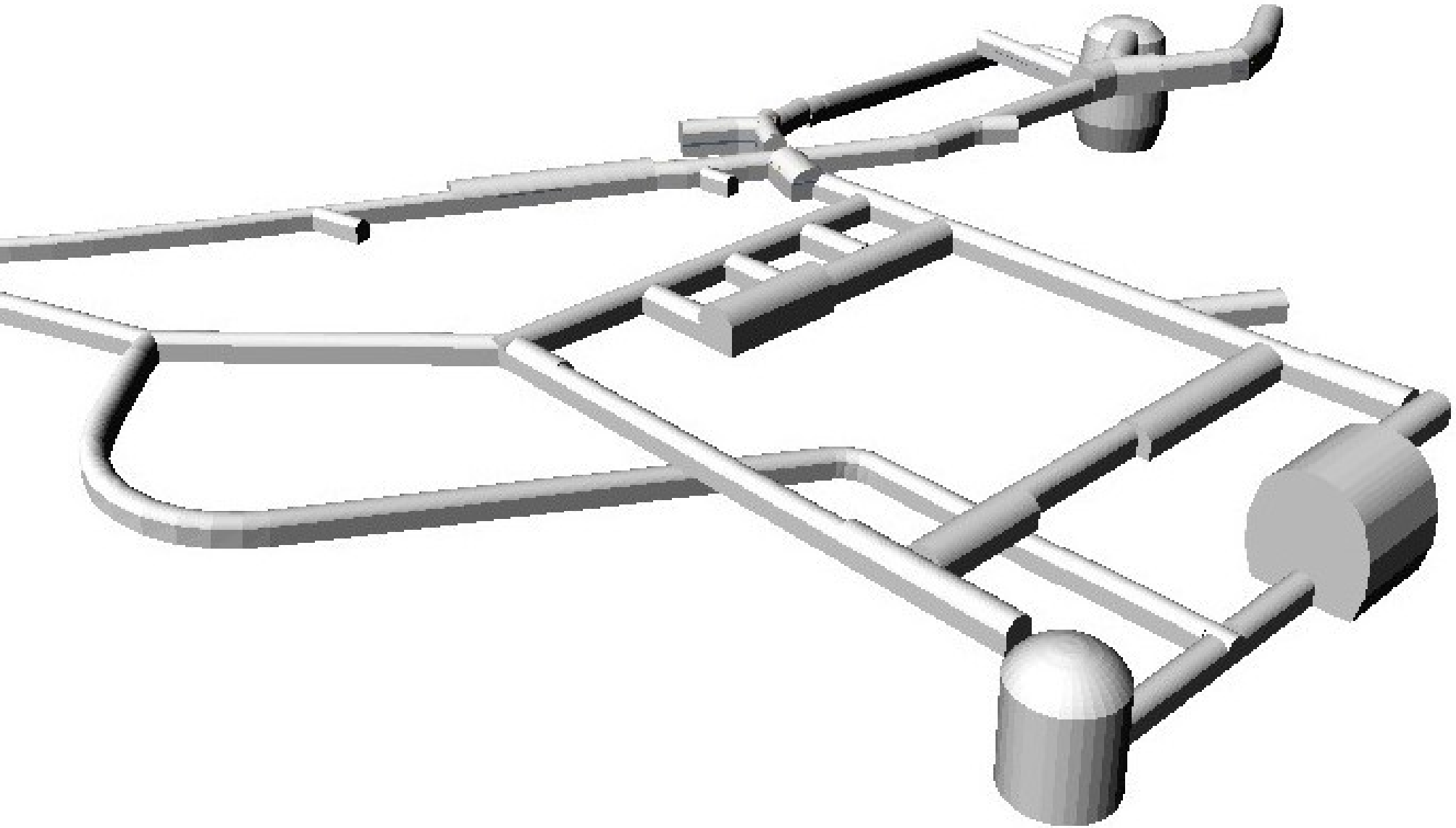
Current Experiments

HALO

PICO-2L

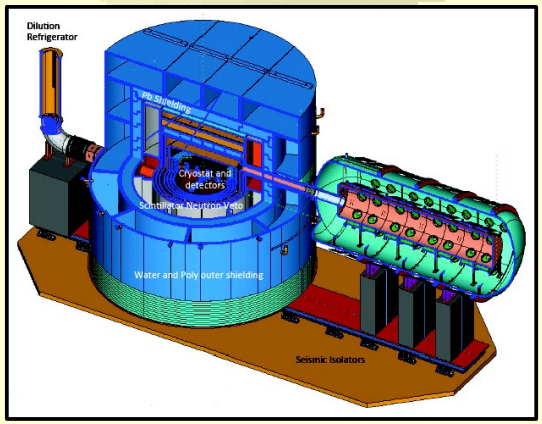
DAMIC

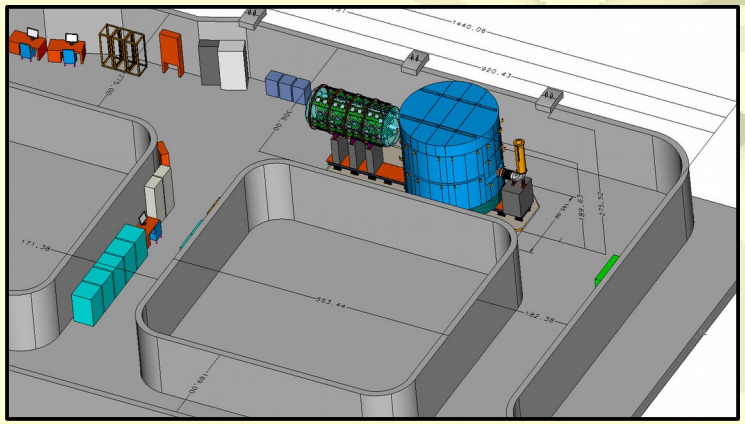
Near Future Experiments



Near Future Experiments

SuperCDMS

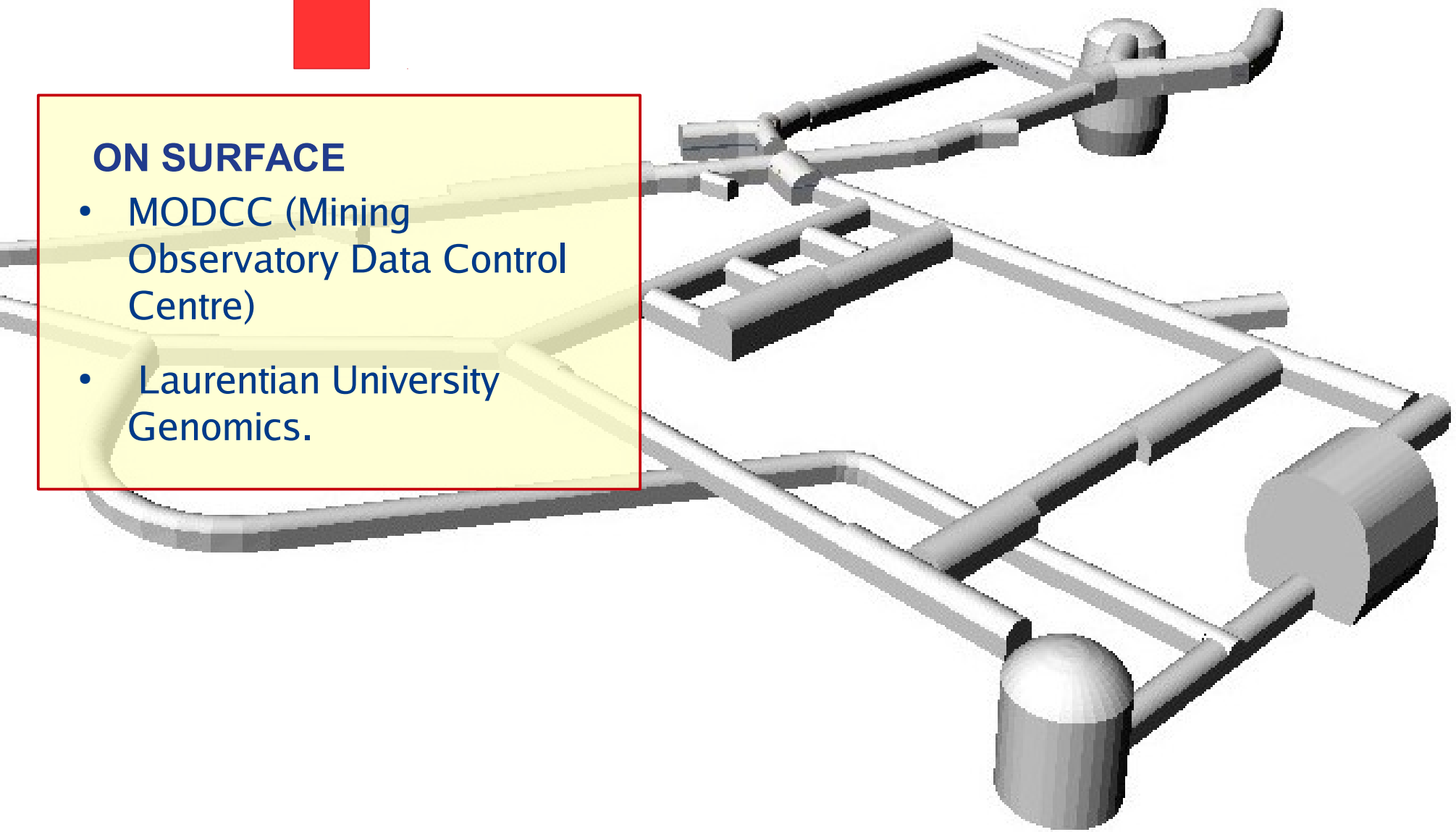




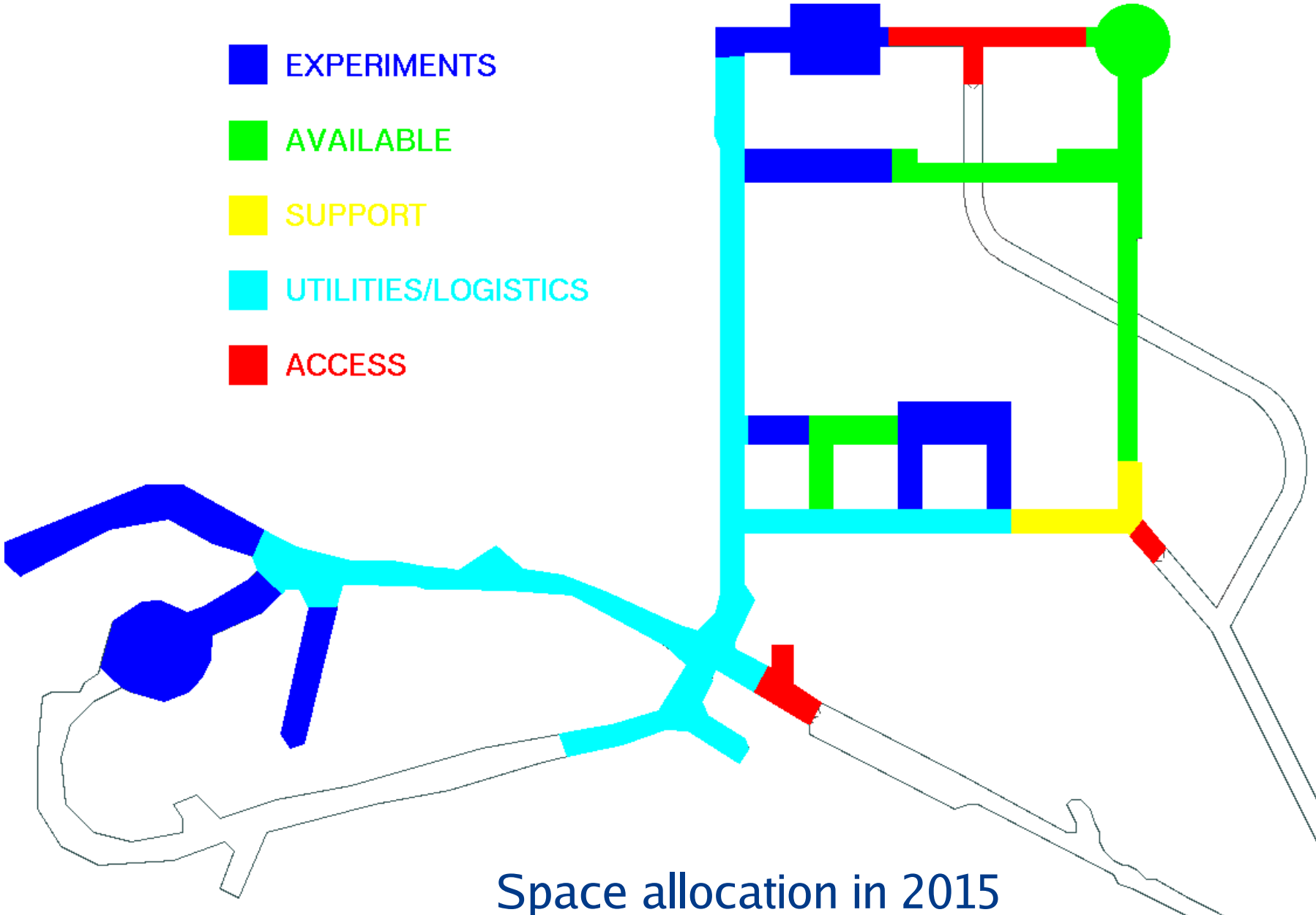
Near Future Experiments

ON SURFACE

- MODCC (Mining Observatory Data Control Centre)
- Laurentian University Genomics.

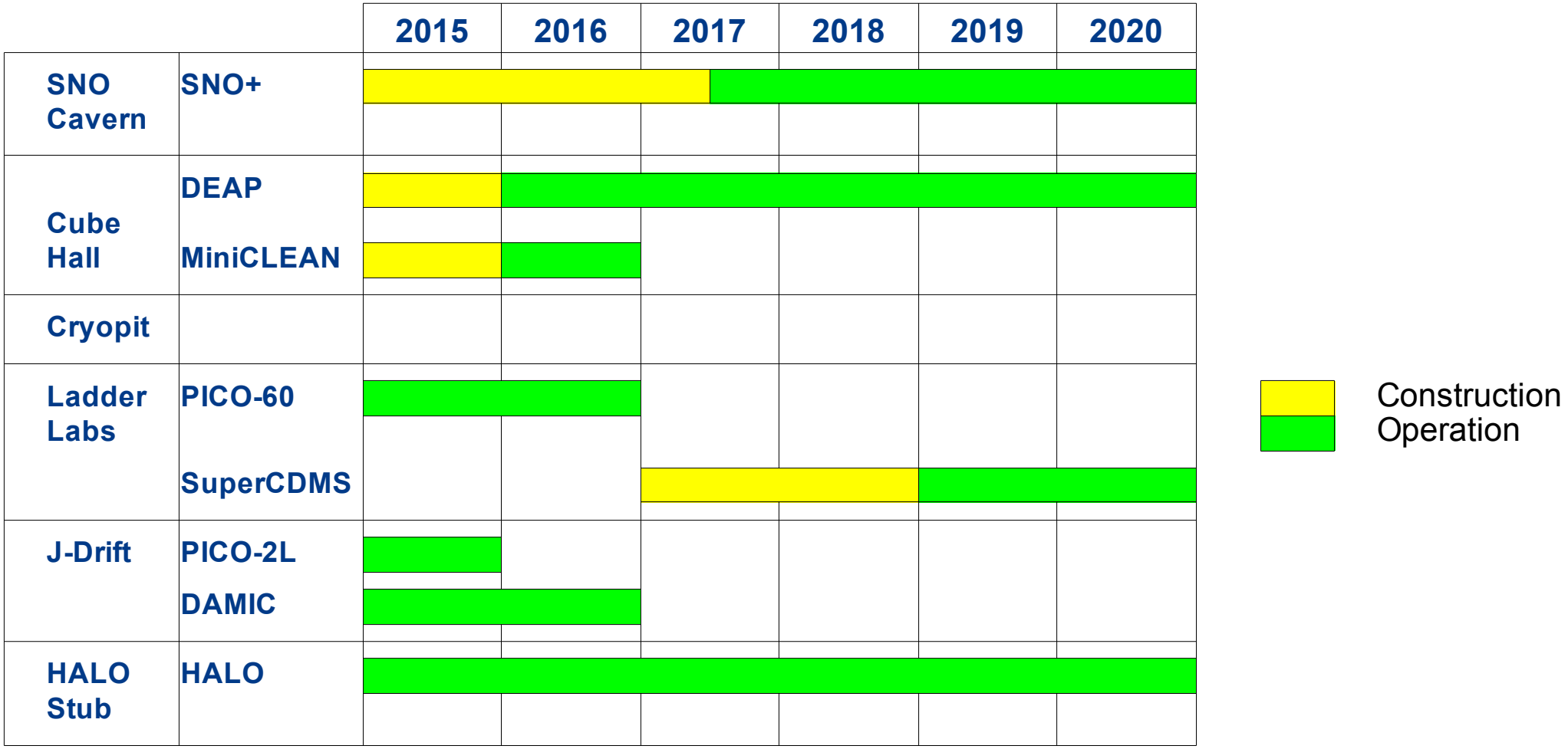


Space Allocation



Space allocation in 2015

Programme Timeline



- Cryopit presently unallocated.
- J-Drift will open up over next 2 years.
- Space in Ladder Labs with more in 2 years.

Allocating the Cryopit

- Within the SNOLAB Project Life Cycle space allocation occurs at GW-1, *Space Approval*, and requires completion of a Conceptual Design Review which will include:
  - Review of the technical fitness of the Project.
  - Review of the planned mitigation strategies for safety.
  - Assessment of the veracity of the Project's cost and viability of funding.
- 'Viability of Funding' might meant that while the Project does not yet have funding in place, it is expected with high probability. In that case space approval may be given conditionally upon receipt of funding within a reasonable time frame.

Allocating the Cryopit

- **The Chicken and the Egg:** Ideally SNOLAB would like a Project asking for a major commitment like the Cryopit to have funding in place before we allocate the space. Conversely we expect funding agencies would like to know that there is a home for a Project before allocating funds.
- SNOLAB wants to avoid locking up the Cryopit and later find out that the Project selected is not funded. So...
- SNOLAB will work with the community and the funding agencies with the intent of coordinating the allocation of the Cryopit with the funding of the Project.

Allocating the Cryopit

- **Meanwhile,** our current informal understanding of the time scales for next generation $0\nu\beta\beta$ and Dark Matter experiments is that the Cryopit will not be needed within the next five years.
- We are prepared to commit the Cryopit to a Project that fits within that window.

Strategic Planning

- This workshop is part of our horizon scanning process.
- Within the next few months, there will be a SNOLAB strategic planning Workshop as input to our 5 year funding cycle which we apply for next year.
- This will be integrated with the NSERC (Natural Sciences and Engineering Research Council of Canada) 5 year plan.

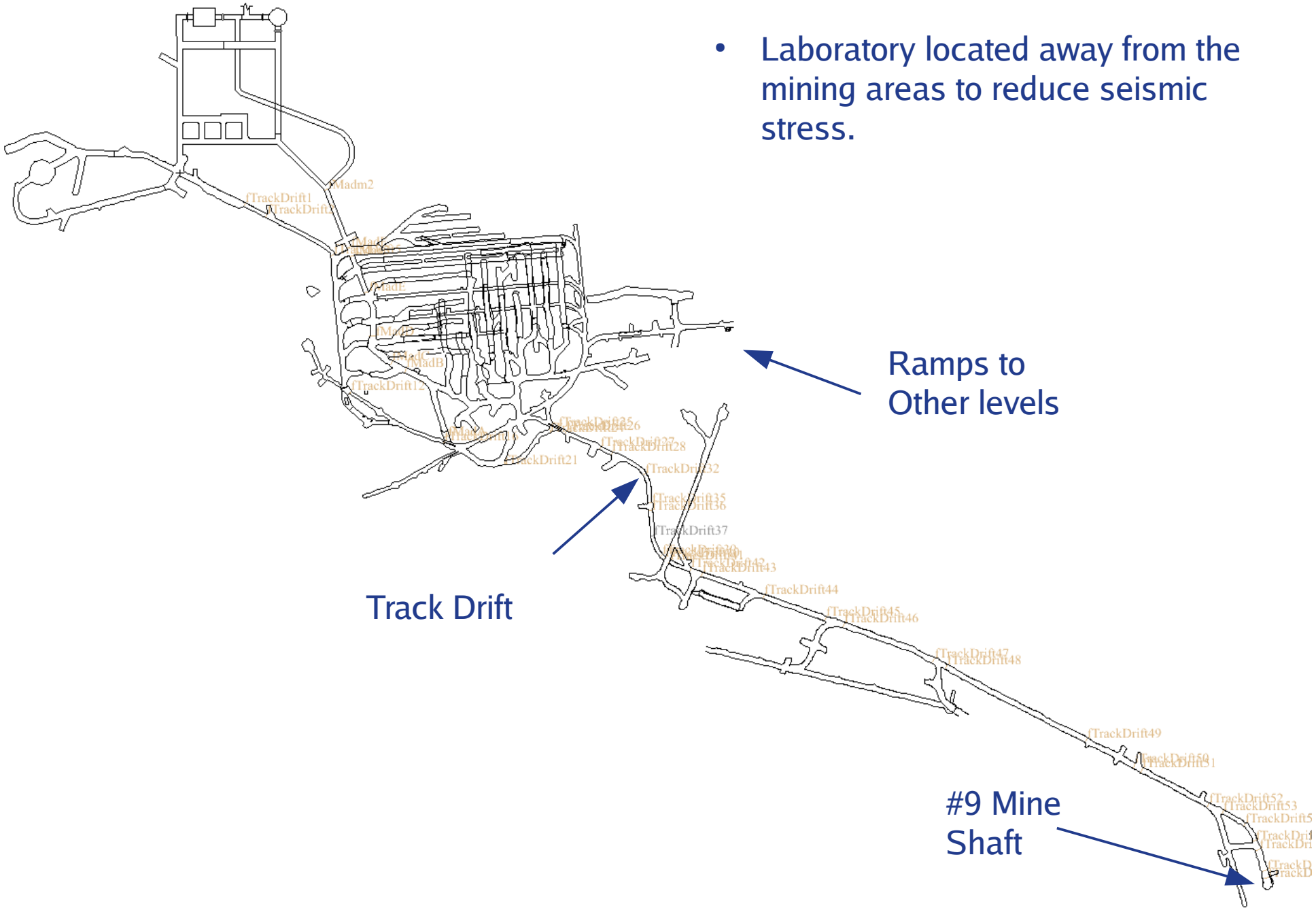
Summary

- **Facility**
  - Recent upgrades to electrical distribution and surface facilities.
  - Planning new surface backup generator, low background laboratory, expansion of the clean boundary.
  - Restructuring of the organization to focus on science delivery and planning additions to the operations team.
- **Scientific Programme**
  - 4 experiments operational, 3 major experiments in construction, 1 in the planning stage. Others moving towards space allocation.
  - Diversifying programme to other fields (mining data, biology).
  - Putting a more formal Gateway driven Project Life Cycle in place.
  - Strategic Planning for next 5 year grant cycle.

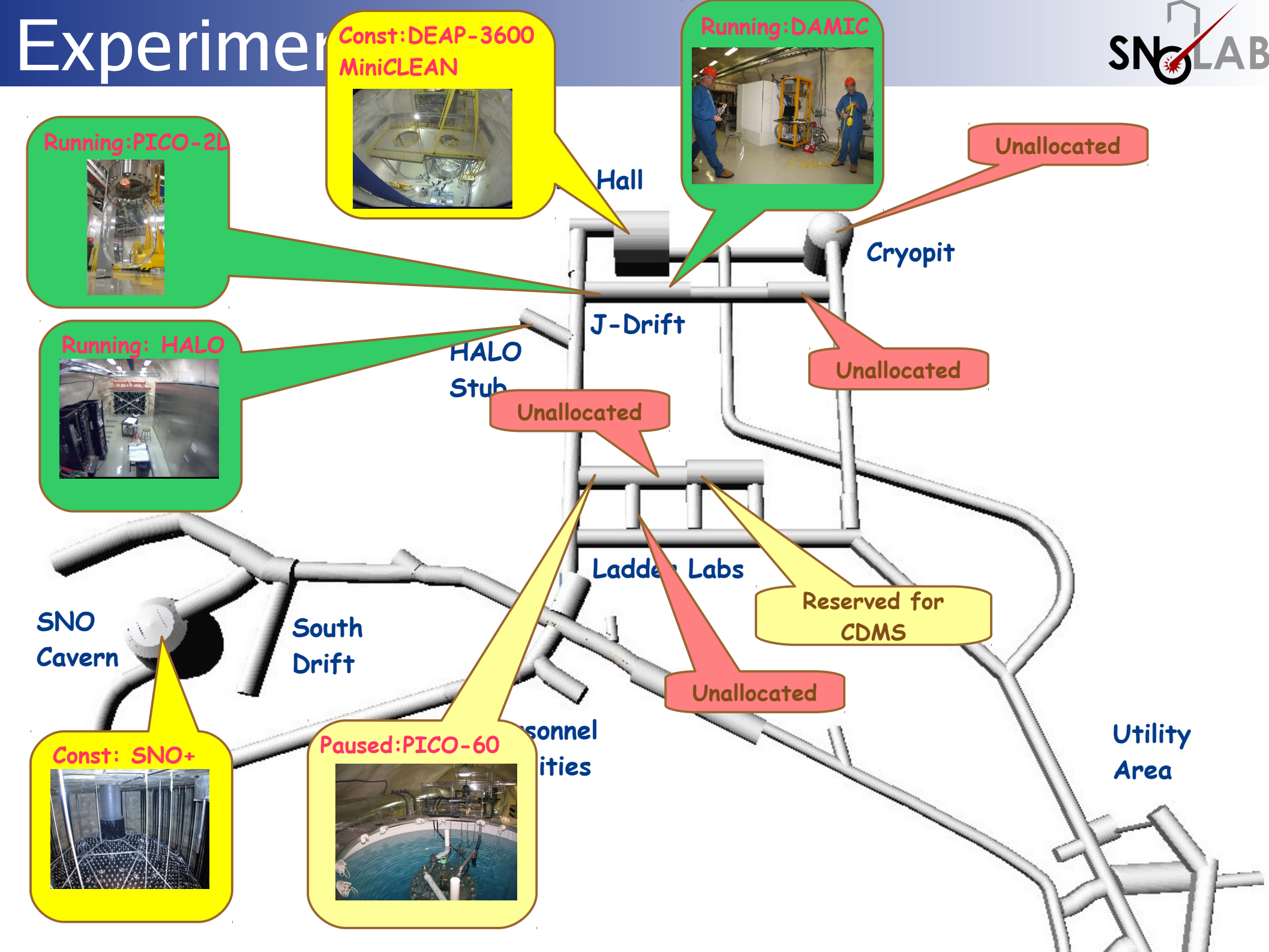
End

Creighton Mine 6800L

- Laboratory located away from the mining areas to reduce seismic stress.



Experimen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Hall
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Running: HALO
HALO
Stub
Unallocated
Unallocated
Ladde Labs
Reserved for
CDMS
SNO
Cavern
South
Drift
Unallocated
Const: SNO+
Paused:PICO-60
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