Queen's Engineering Team Projects

Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

CANADA FIRST RESEARCH EXCELLENCE FUND

NSERC CRSNG

A. Mir, J. Kingma, J. Corbett, K. Dering, M. Dean, N. Moss, R. Gagnon

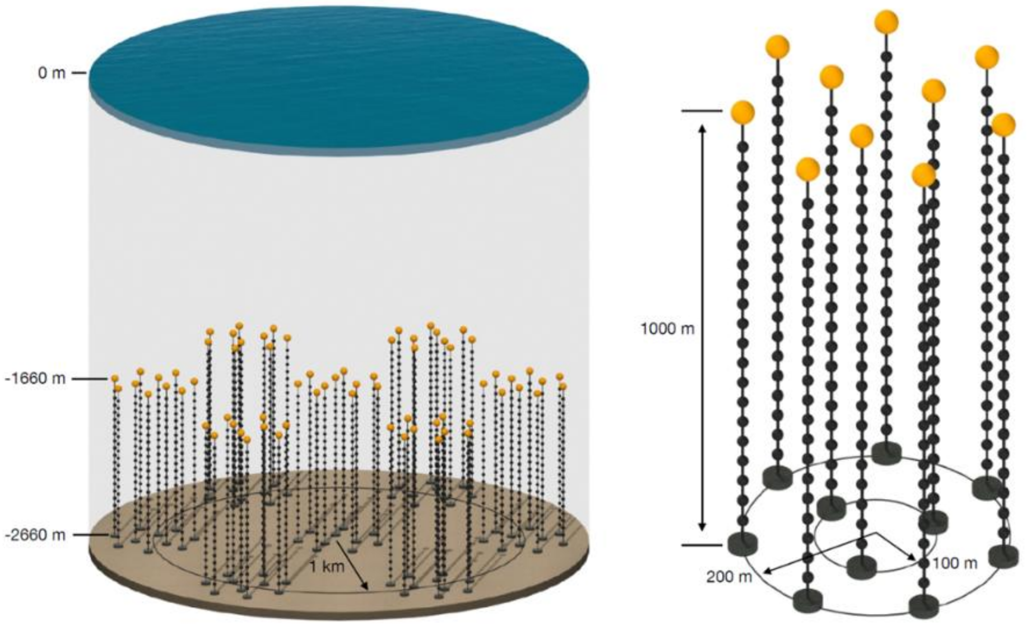
P-ONE PMT Testing

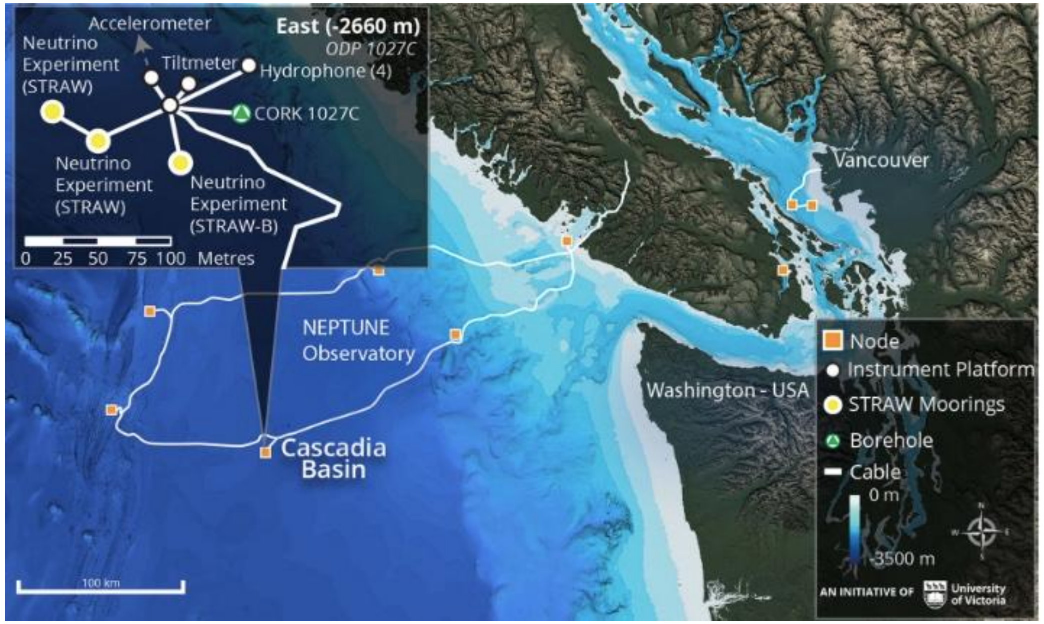
Pacific Ocean Neutrino Telescope (P-ONE)

Under*water* observatory, (like IceCube) to detect high energy neutrino events, off coast of Vancouver Island w/ existing Ocean networks infrastructure

20 light detectors (Precision optical modules, P-OMs) per “string”, 10 strings make a cluster, 7 clusters make P-ONE…
20*10*7 = 1400 light detectors to calibrate, verify performance!!

*See **Jessie, Jakub & Bryan’s** talk tomorrow for more about this*

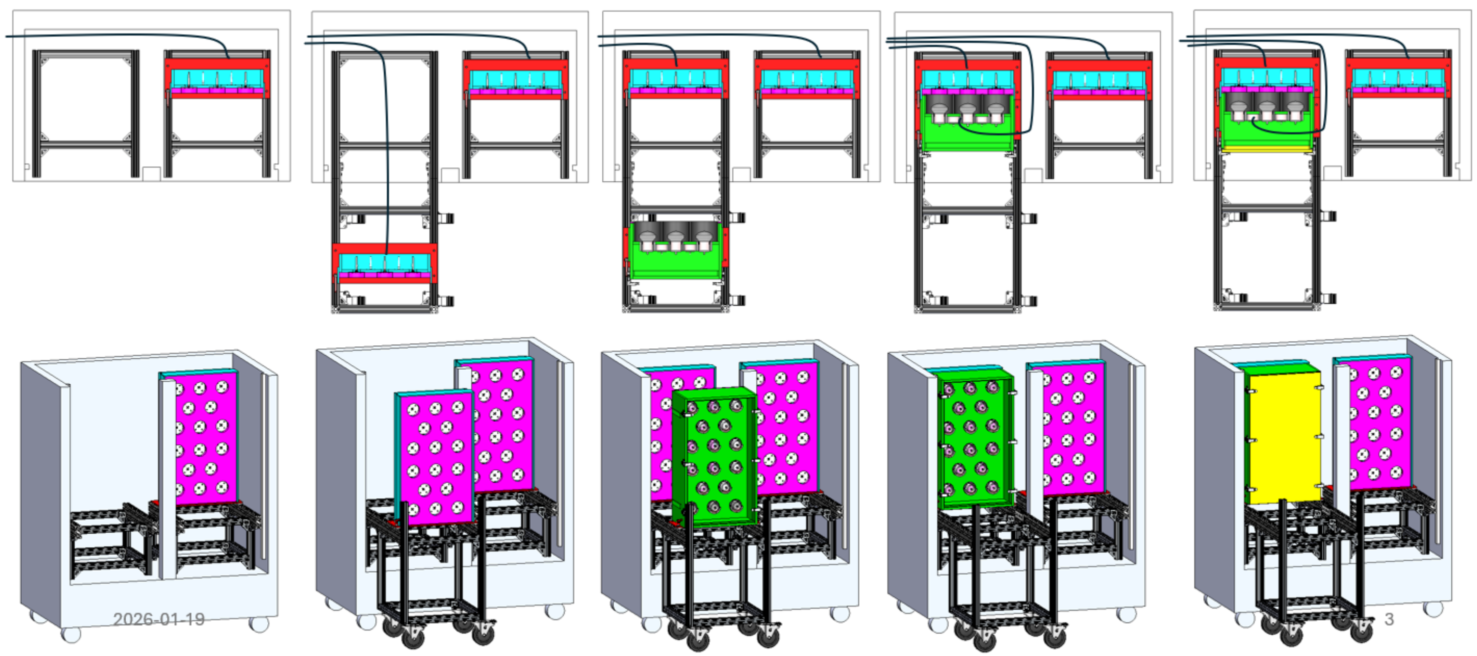




P-ONE PMT Testing

Ease of installation/removal for quicker turnaround (calibrate in batches of 2*16 → that's still 44 batches to complete all 1400 PMTs)

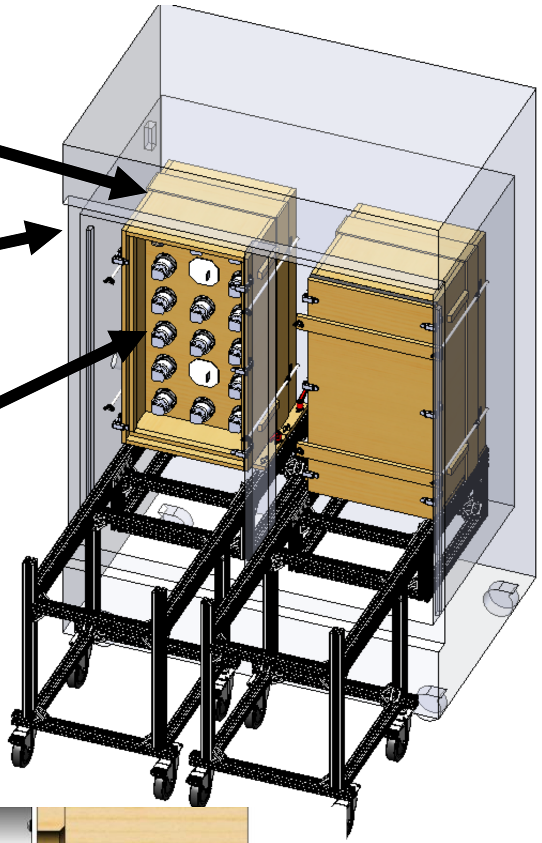
1. Insert fibre tray (right)
2. Connect fibres (right)
3. Connect fibres (left)
4. Insert fibre tray (left)
5. Prep PMT tray (left)
6. Insert PMT tray (left)
7. Connect PMT electrical (left)
8. Install PMT tray lid (left)
9. Repeat with right PMT tray

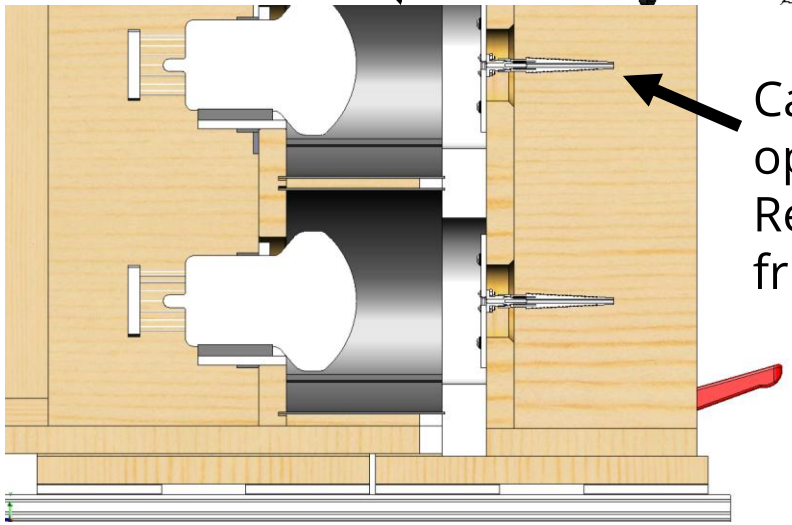


"Dark boxes"

Refrigerator (to cool to 5C)

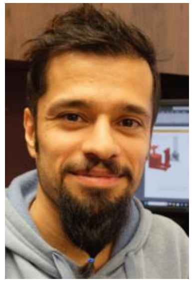
Within box, 16 spaces for PMTs to mount (isolated from neighbours)





Calibration optical fiber. Remains in fridge

P-ONE PMT Testing Construction

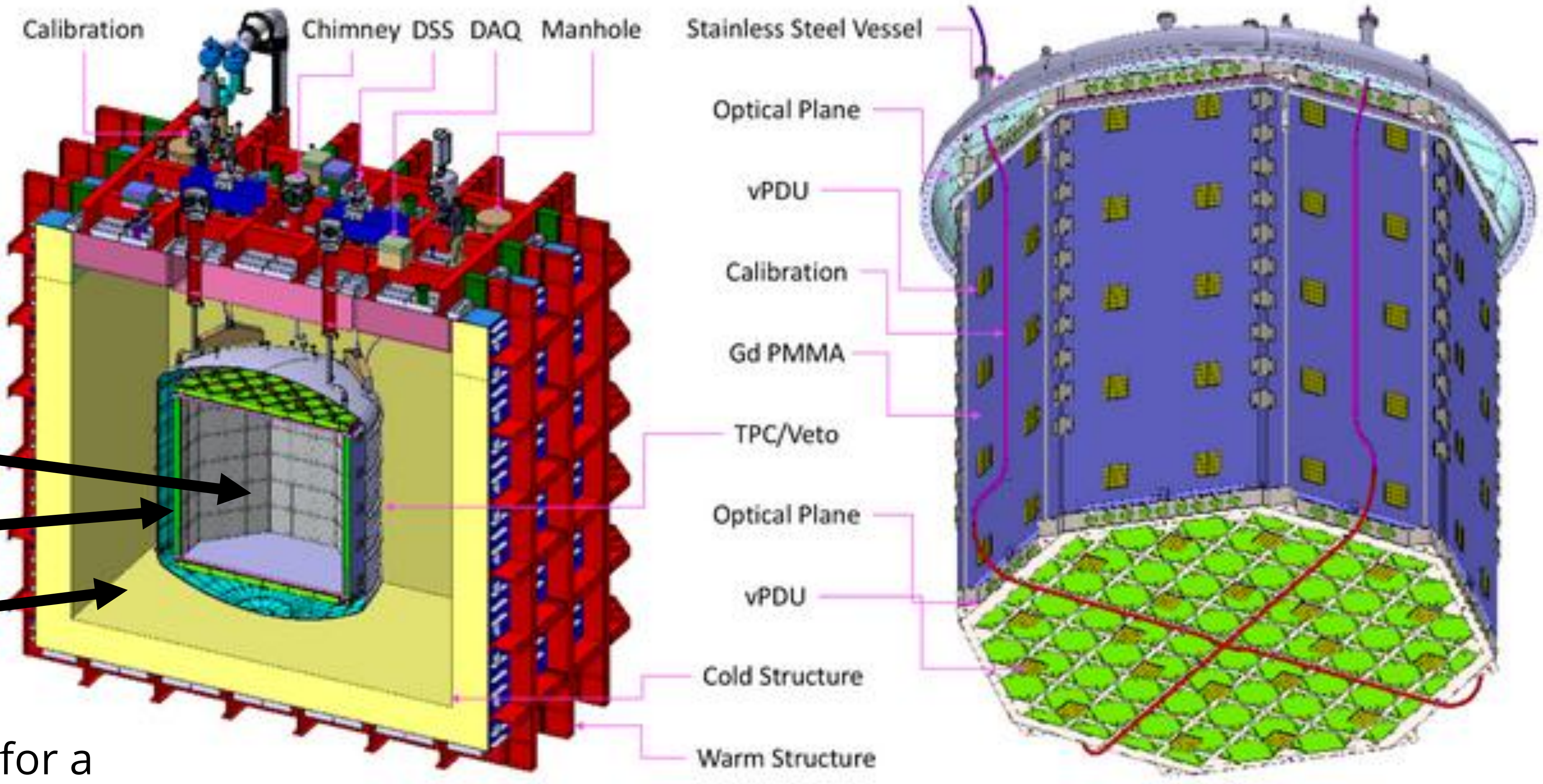

DarkSide-20k

Liquid Argon (LAr) Time Projection Chamber (TPC). Particle interactions cause scintillation light & ionization in detector

20t

50t

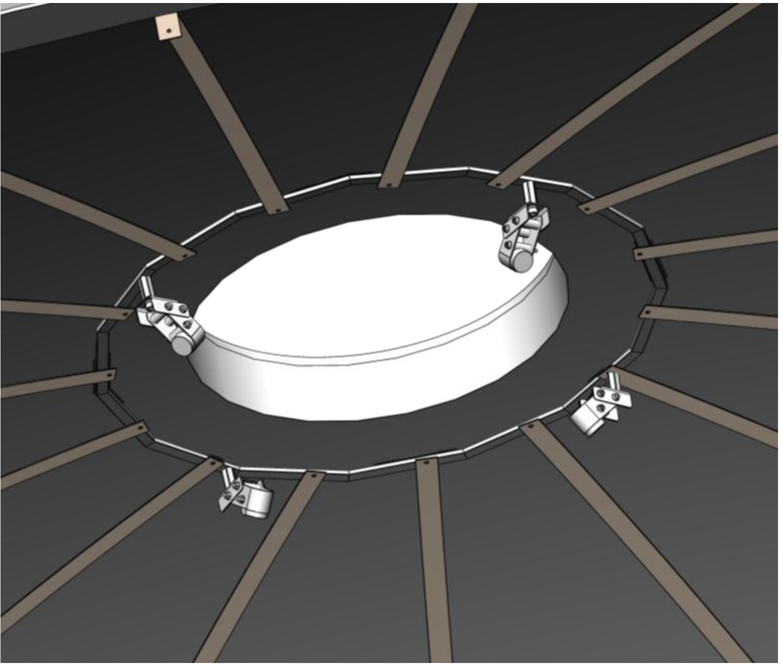
600t



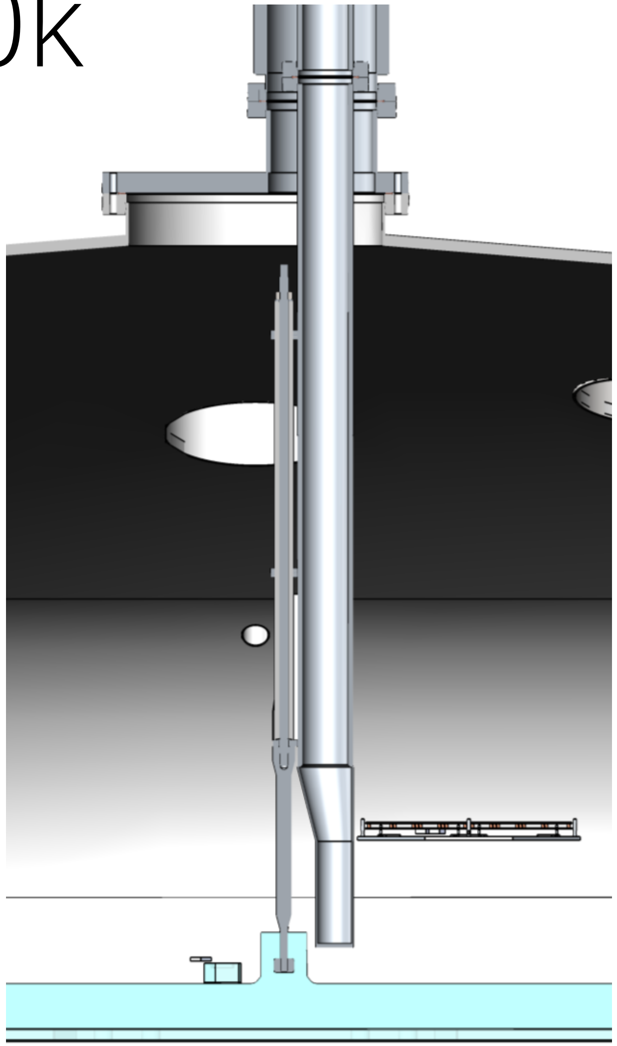
*See **Peter's** talk 2 hours ago for a related experiment (DEAP-3600)*

https://www.lngs.infn.it/en/darkside

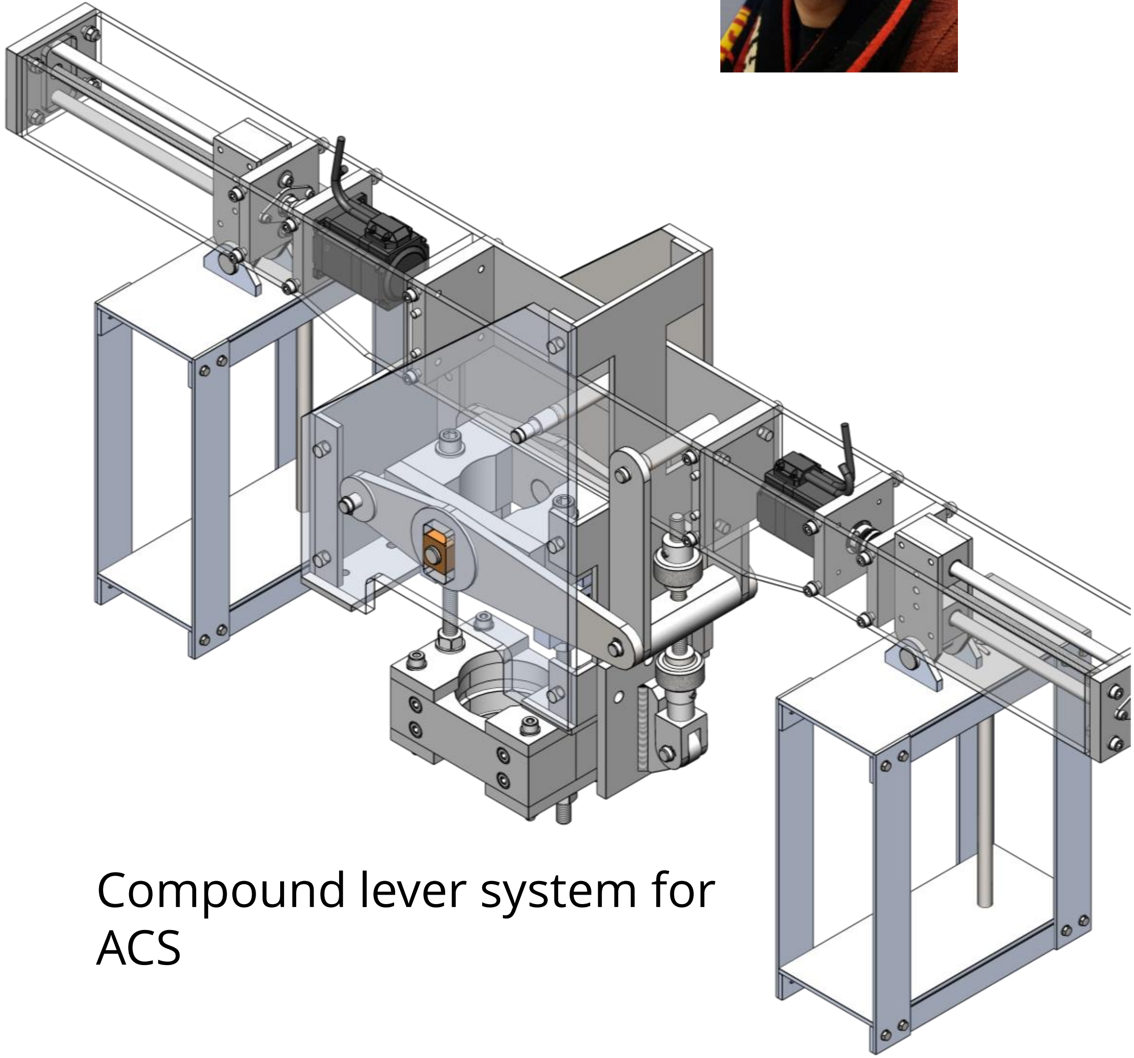
DarkSide-20k



Optical diffuser mounting inside stainless-steel vessel.

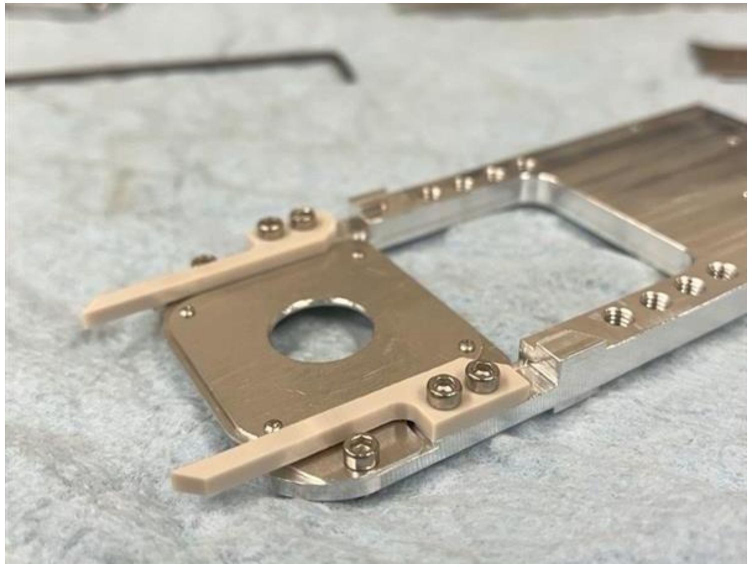


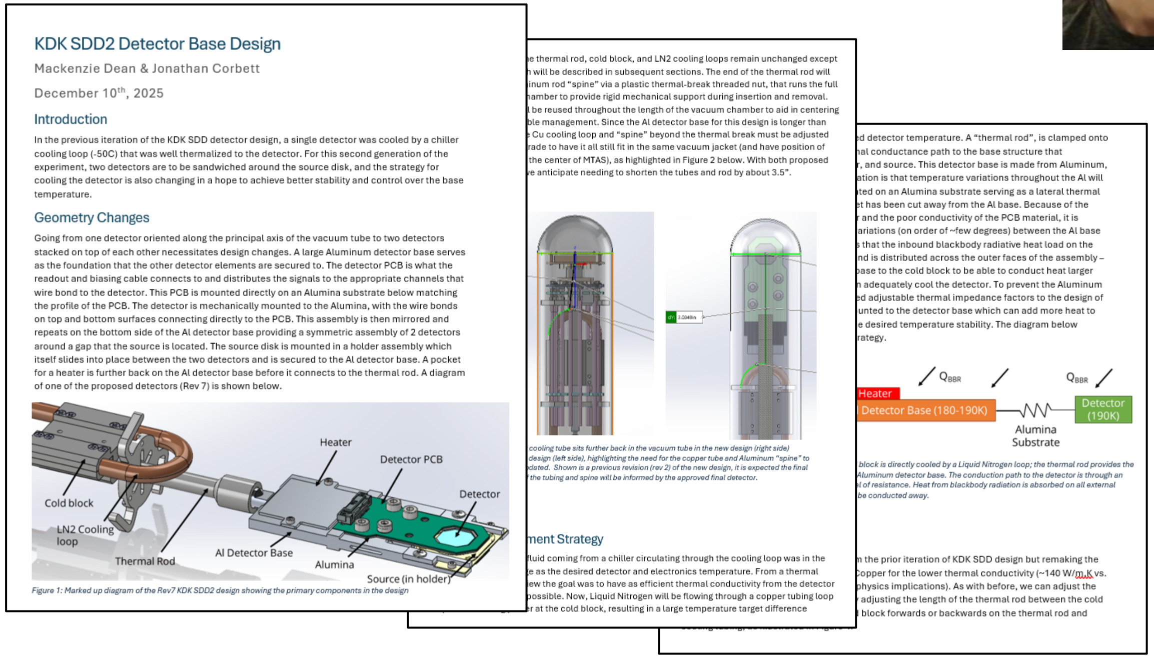
Actuator-anode interface for Anode Control System (ACS)



Compound lever system for ACS

KDK SDD2





KDK SDD2 Detector Base Design

Mackenzie Dean & Jonathan Corbett

December 10th, 2025

Introduction

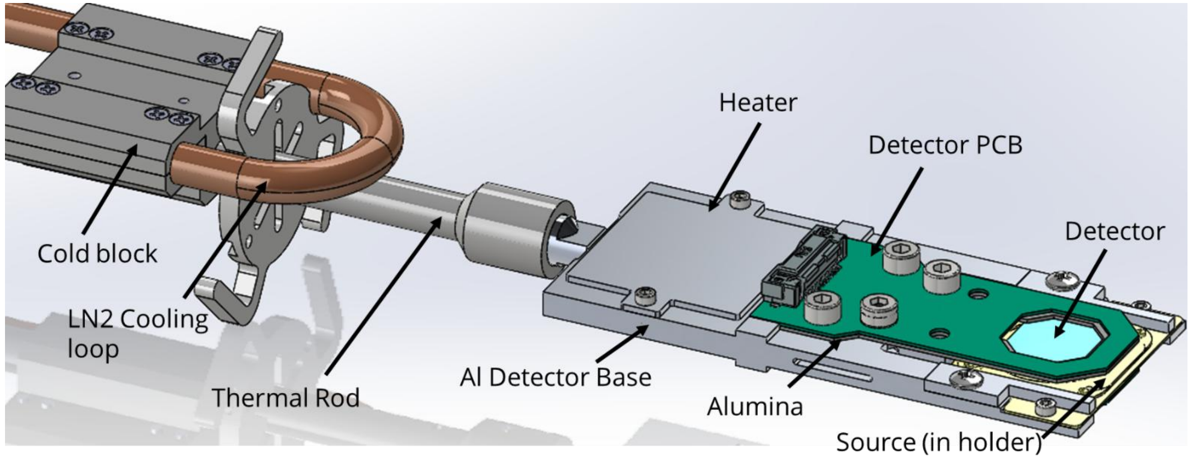
In the previous iteration of the KDK SDD detector design, a single detector was cooled by a chiller cooling loop (-50C) that was well thermalized to the detector. For this second generation of the experiment, two detectors are to be sandwiched around the source disk, and the strategy for cooling the detector is also changing in a hope to achieve better stability and control over the base temperature.

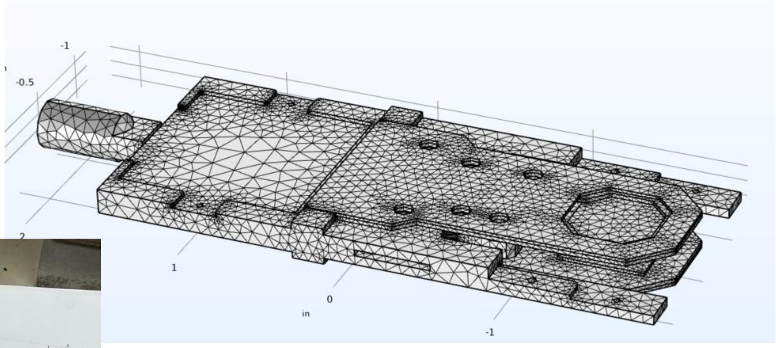
Geometry Changes

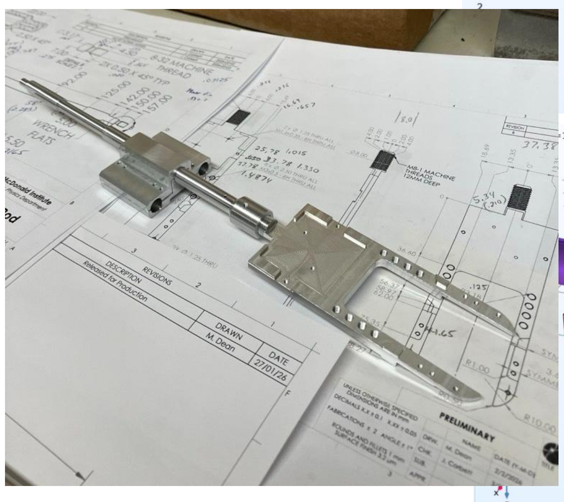
Going from one detector oriented along the principal axis of the vacuum tube to two detectors stacked on top of each other necessitates design changes. A large Aluminum detector base serves as the foundation that the other detector elements are secured to. The detector PCB is what the readout and biasing cable connects to and distributes the signals to the appropriate channels that wire bond to the detector. This PCB is mounted directly on an Alumina substrate below matching the profile of the PCB. The detector is mechanically mounted to the Alumina, with the wire bonds on top and bottom surfaces connecting directly to the PCB. This assembly is then mirrored and repeats on the bottom side of the Al detector base providing a symmetric assembly of 2 detectors around a gap that the source is located. The source disk is mounted in a holder assembly which itself slides into place between the two detectors and is secured to the Al detector base. A pocket for a heater is further back on the Al detector base before it connects to the thermal rod. A diagram of one of the proposed detectors (Rev 7) is shown below.

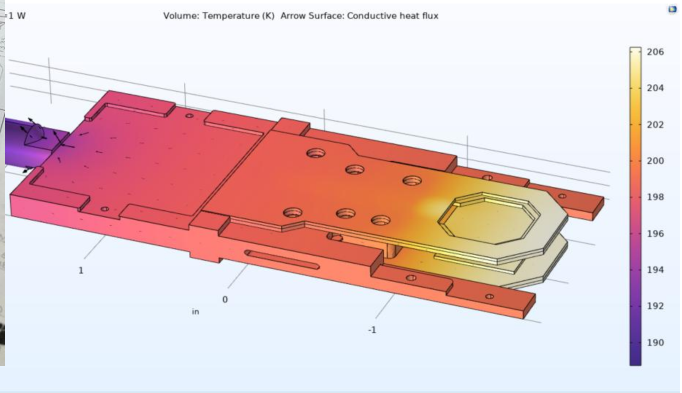
Figure 1: Marked up diagram of the Rev7 KDK SDD2 design showing the primary components in the design

Mechanical design, thermal verification, & fabrication for 2nd gen Silicon Drift Diode (SDD) experiment looking for rare nuclear decay modes



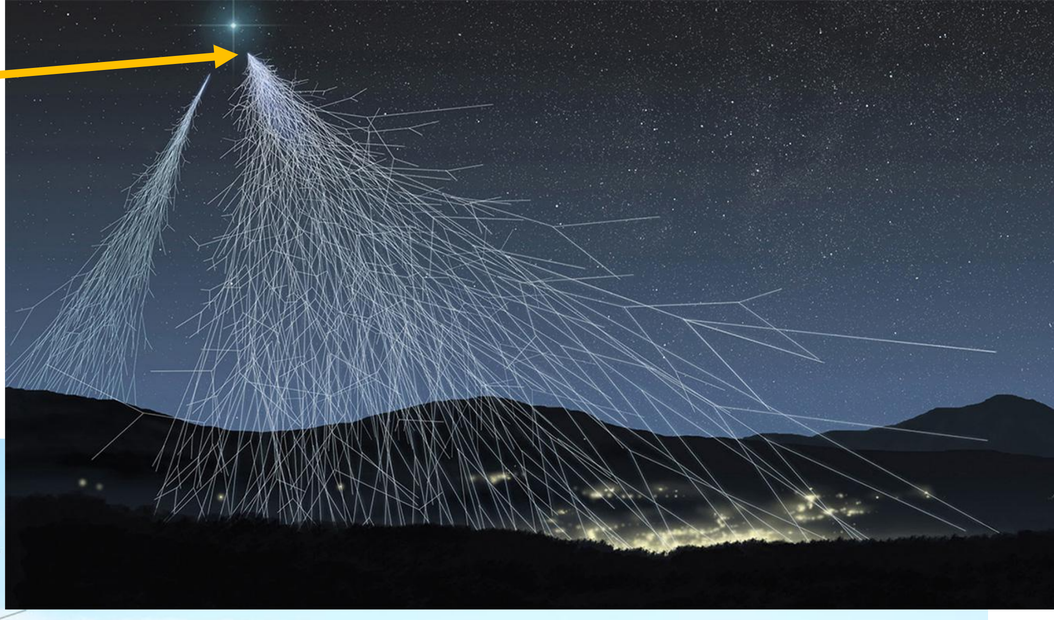






HELIX

The particle that made the shower (that we go to SNOLAB to shield ourselves from)



High Energy Light Isotope eXperiment (HELIX)

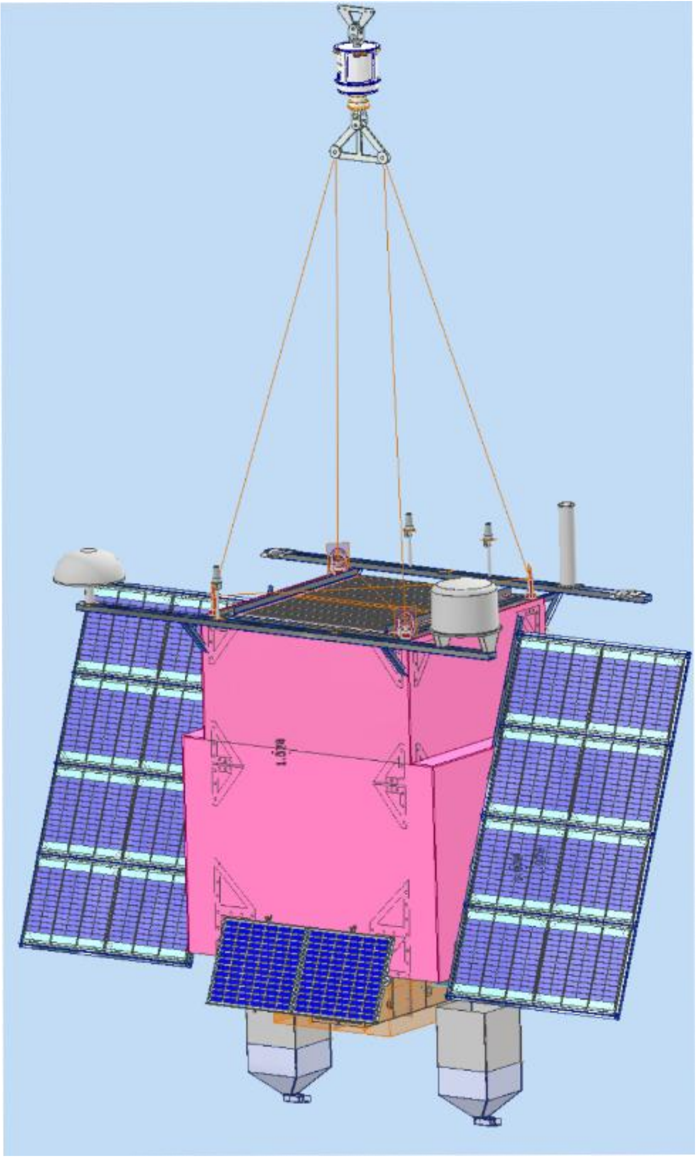
40km up, “cosmic rays” hitting upper atmosphere
What’s the composition of cosmic rays?
- 90% Protons
- 9% Helium/alphas
- 1% **everything else**

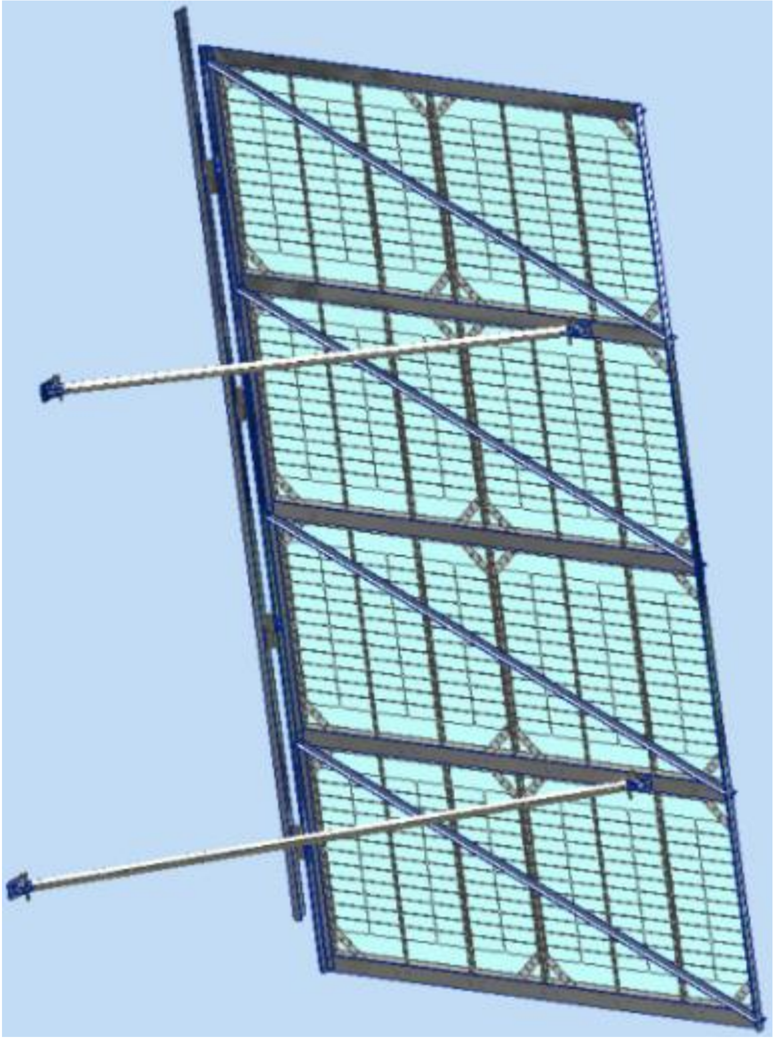
This experiment is measuring the composition of “everything else”

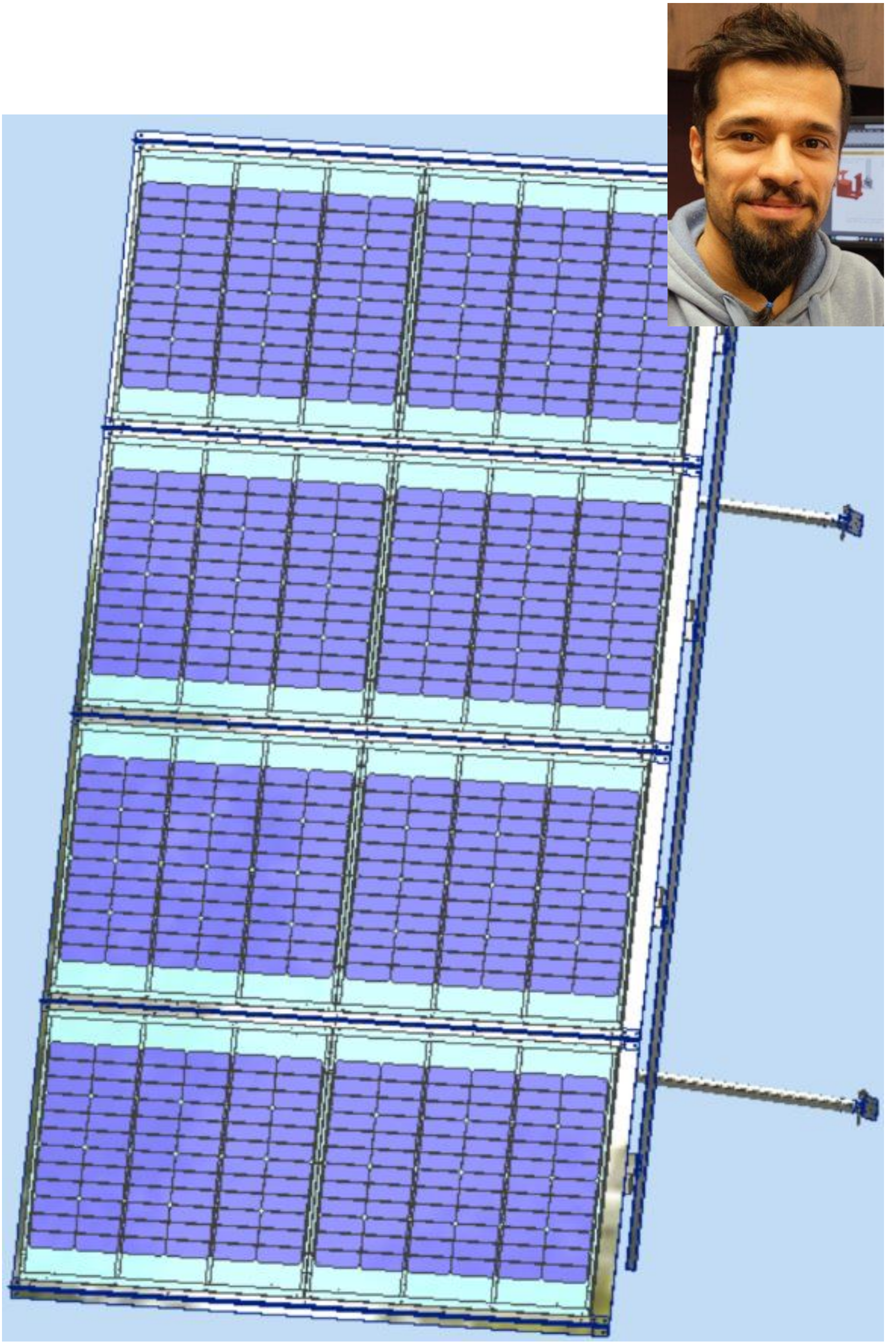
*See **Conor’s** talk tomorrow for more about this*

https://www.queensu.ca/physics/lemma/first-flight-helix
https://news.uchicago.edu/explainer/what-are-cosmic-rays

HELIX







HELIX - Requirements

Procedures and Guidelines (PG)

DIRECTIVE NO.	820-PG-8700.0.1A	**APPROVED BY Signature:**	*Original Signed By*
EFFECTIVE DATE:	November 5, 2024	**NAME:**	Andrew Hamilton
EXPIRATION DATE:	November 5, 2029	**TITLE:**	Chief, Balloon Program Office

COMPLIANCE IS MANDATORY

Responsible Office: Code 820/ Balloon Program Office (BPO)

Title: Gondola Structural Design Requirements

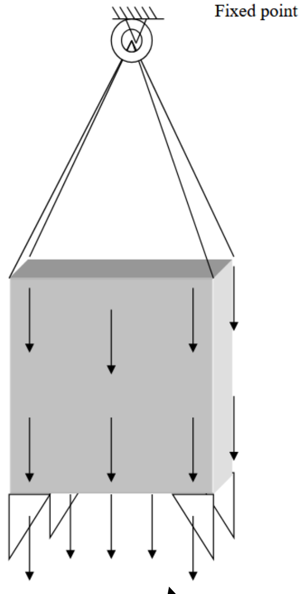


Figure 2: Load Case #1 – Gondola Vertical Loading

Parachute "shock" – 8g

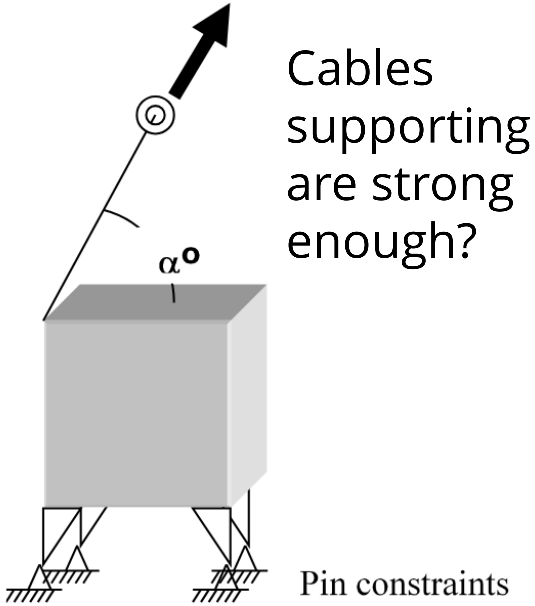


Figure 3: Load Case #2 – Gondola Single Cable Loading

Cables supporting are strong enough?

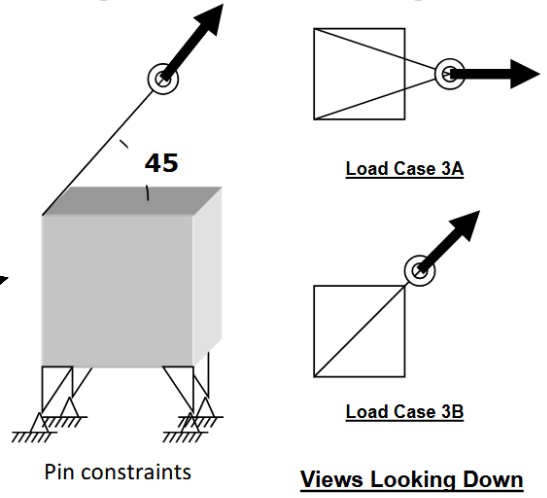


Figure 4: Load Case #3 – Off-Vertical Gondola Loading

Parachute failure – only 1 or 2 cables supporting – tilt!

Gondola rotated, falling sideways

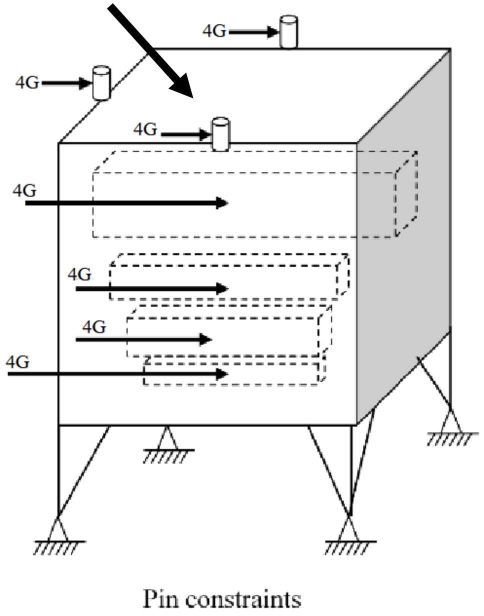


Figure 5: Load Case #4 – Gondola Lateral Loading

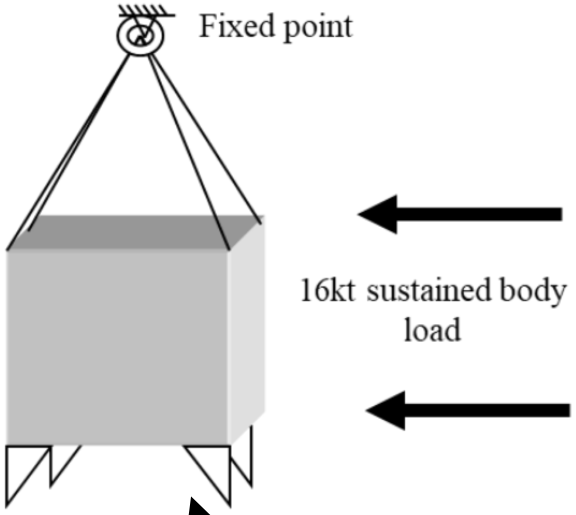


Figure 6: Load Case #6 – Sustained Wind Loading

Upper atmosphere is windy!

SNO+ Platform needed

Make platform to attach to this shell structure (safely)

To be able to remove some equipment in the way (PMT panels)

So that they can look at this

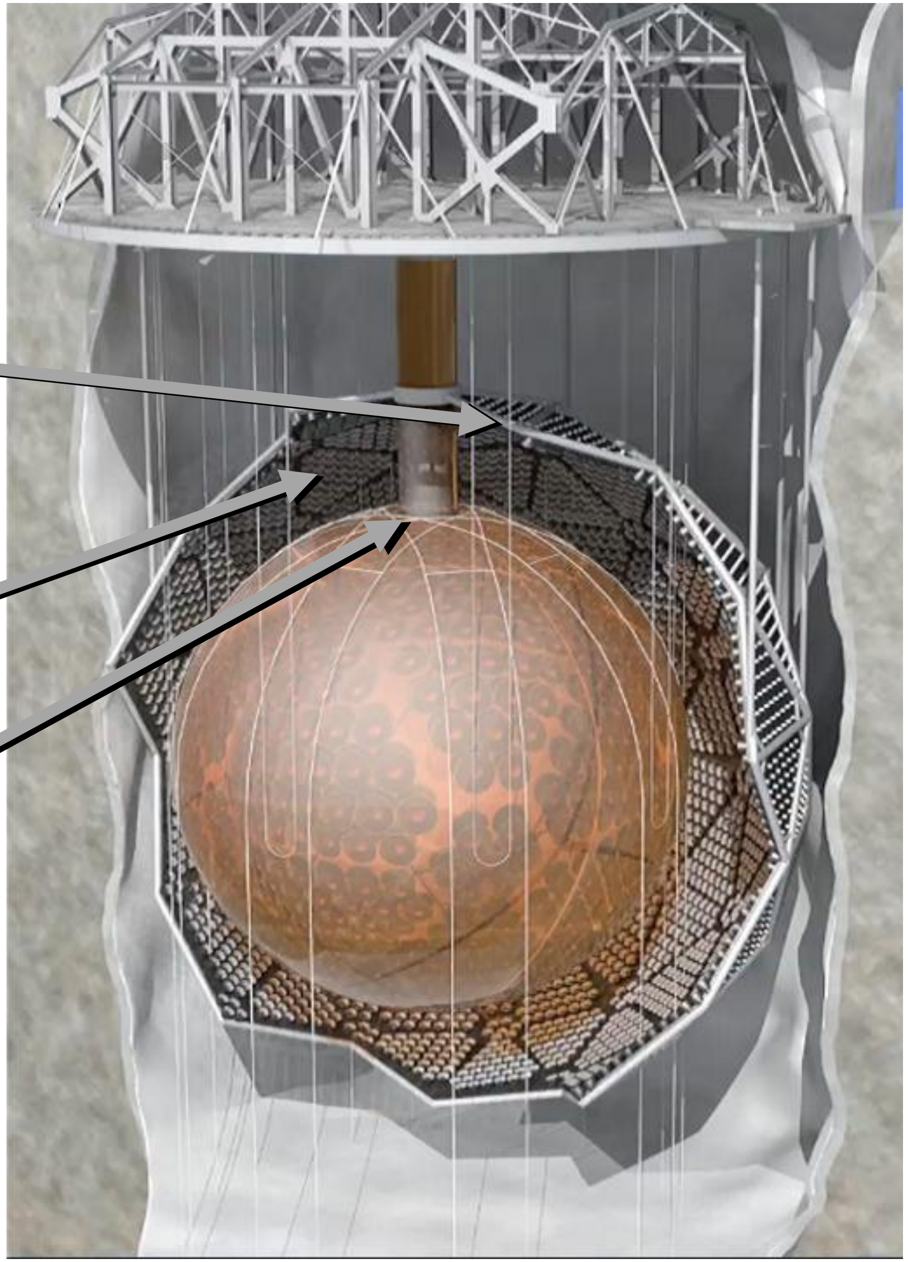
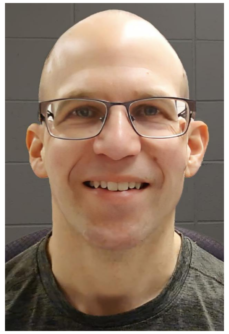
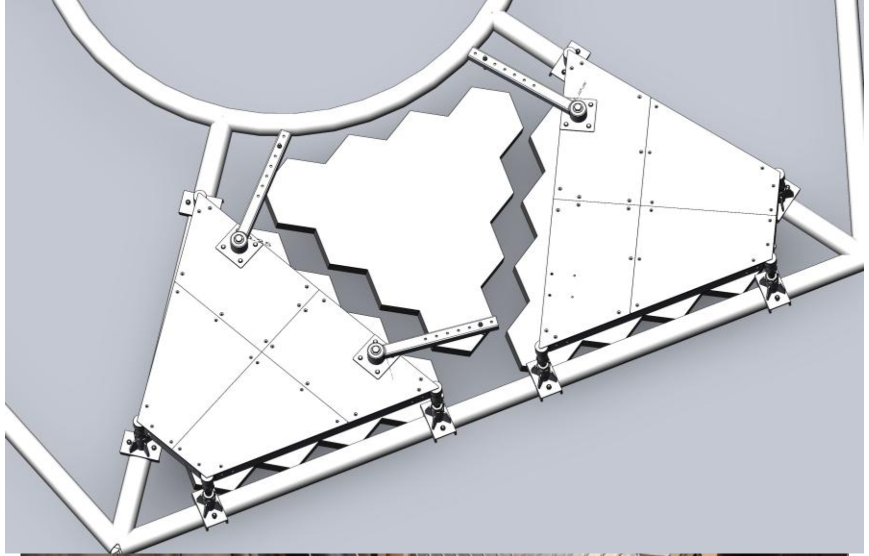


Image credit: https://snoplus.phy.queensu.ca/about.html

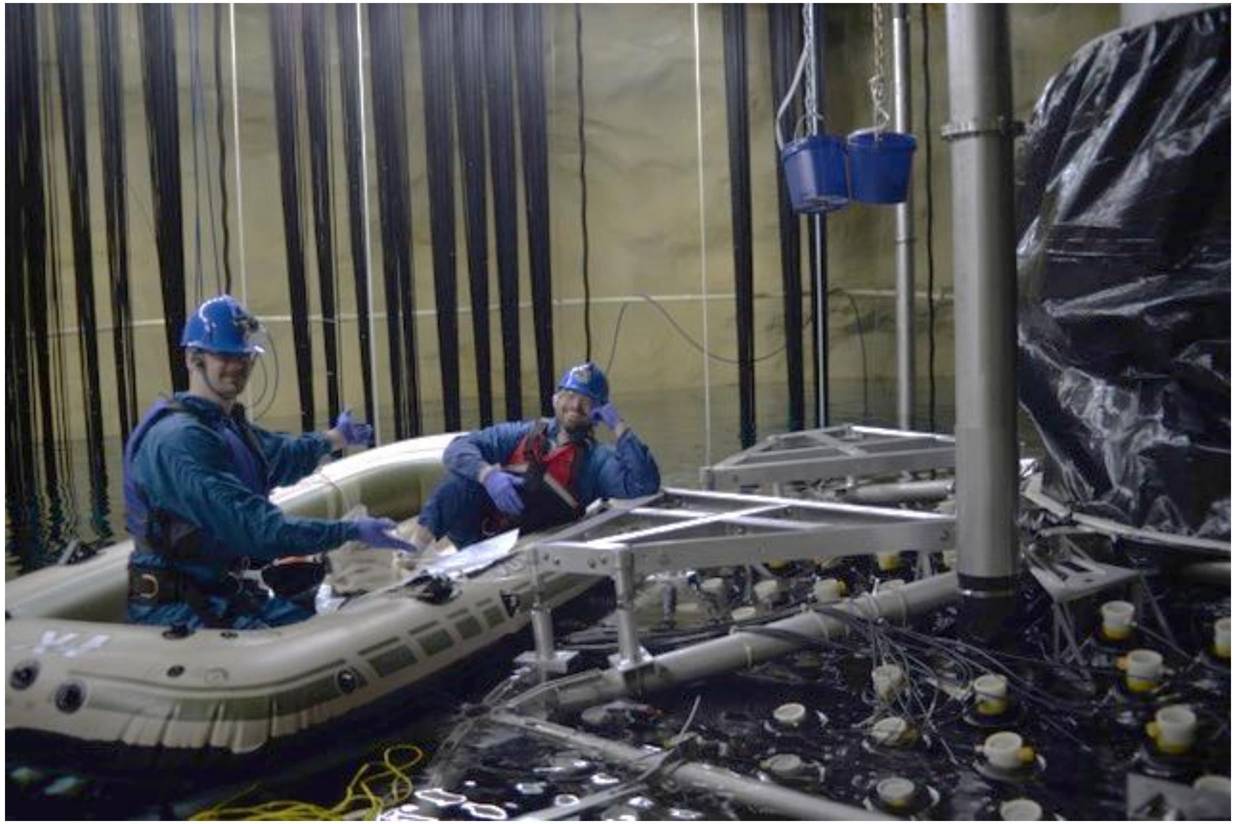
SNO+ Solution



- Nic responded to the high urgency call. Great job, Nic!
- Reviewed old design & fabrication drawings/documents
- Designed platform segments
- Design reviewed & approved by SNOLAB's structural Engineer (Civil P.Eng)
- Built @ Queen's, critical (structural) welding done by certified shop in Kingston



SNO+ Platform Deployed

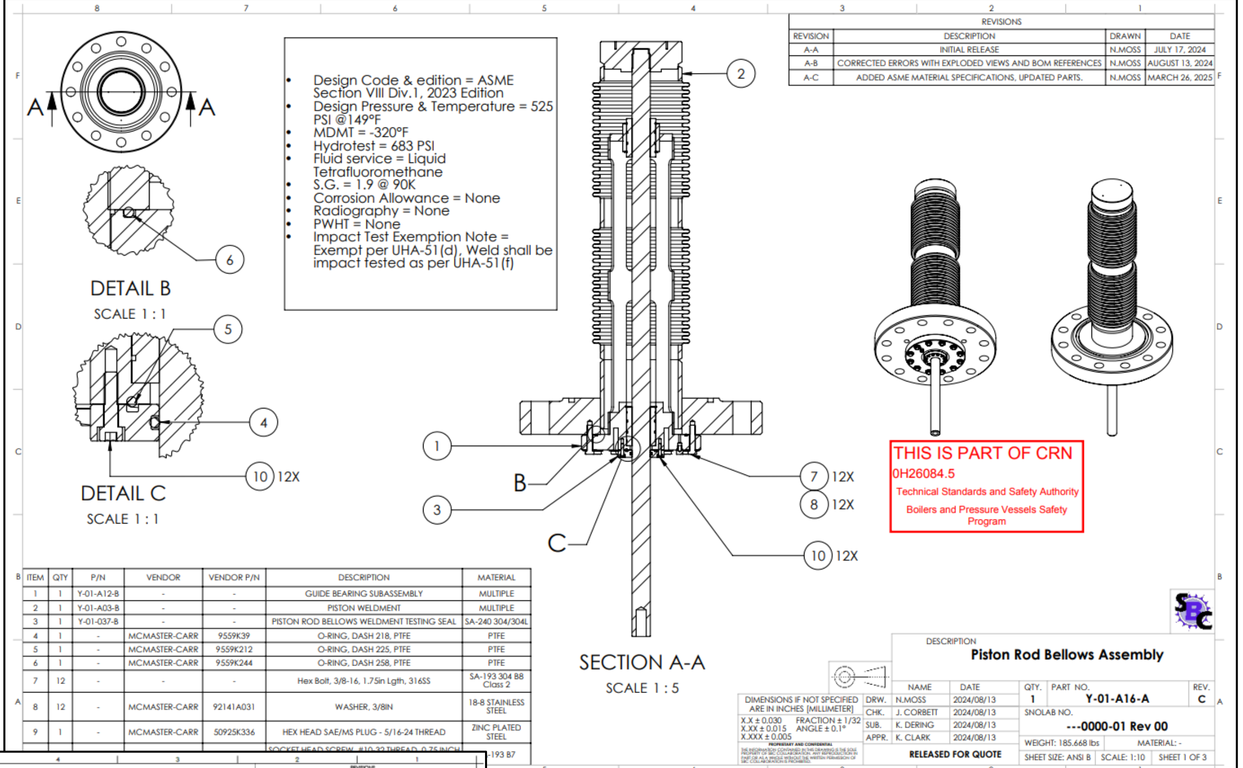


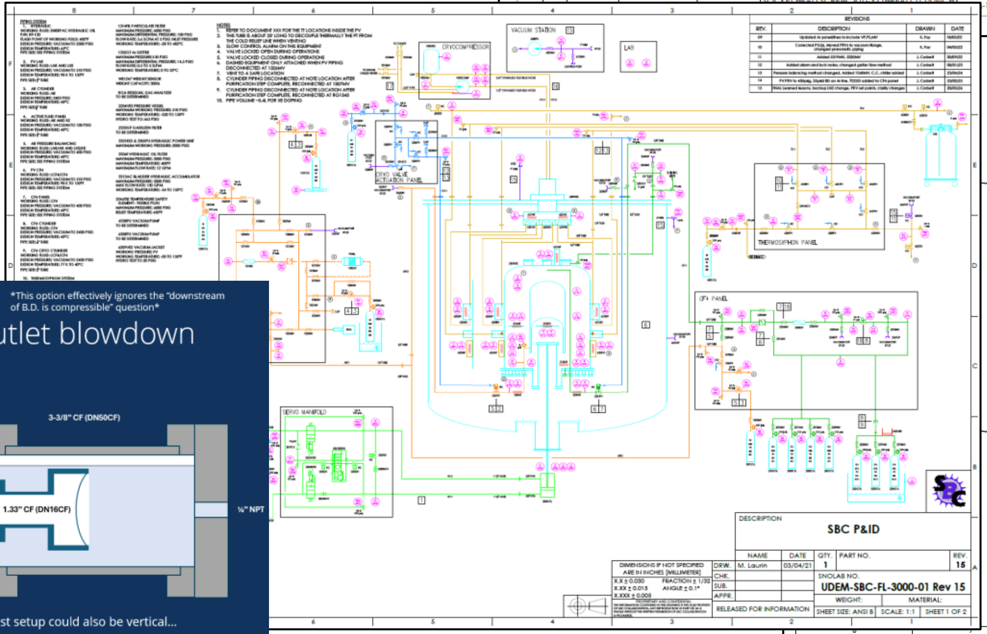
SBC

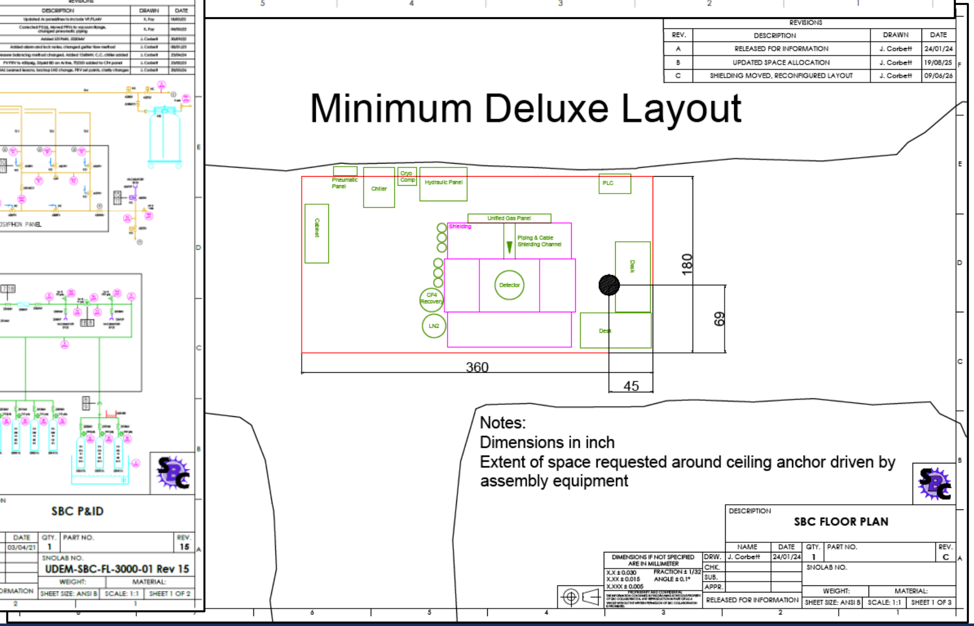


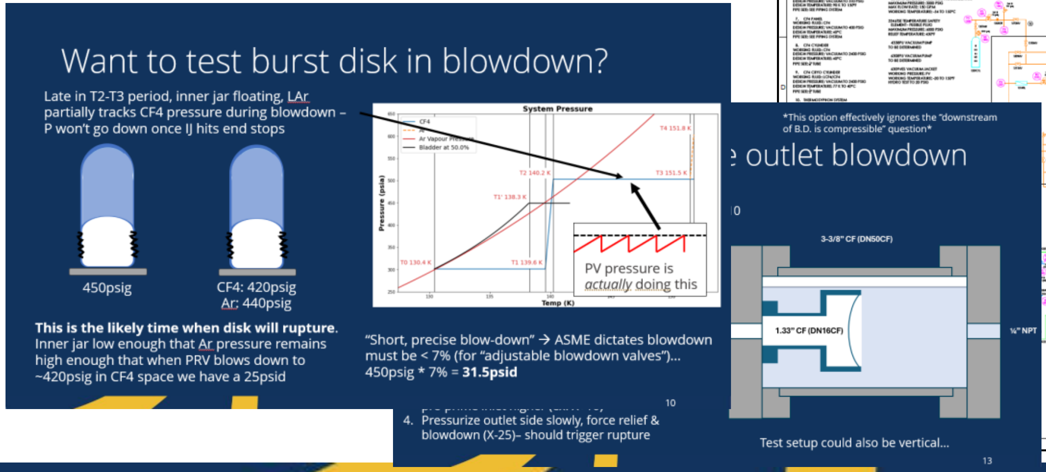
- PV Construction & TSSA Registration managing
- Maintaining engineering drawings
- Supporting documentation, engineering studies

*See **Carter, Ezri, & Alex's** talks this afternoon*



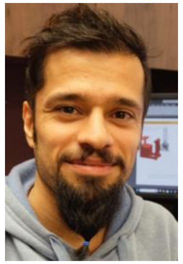








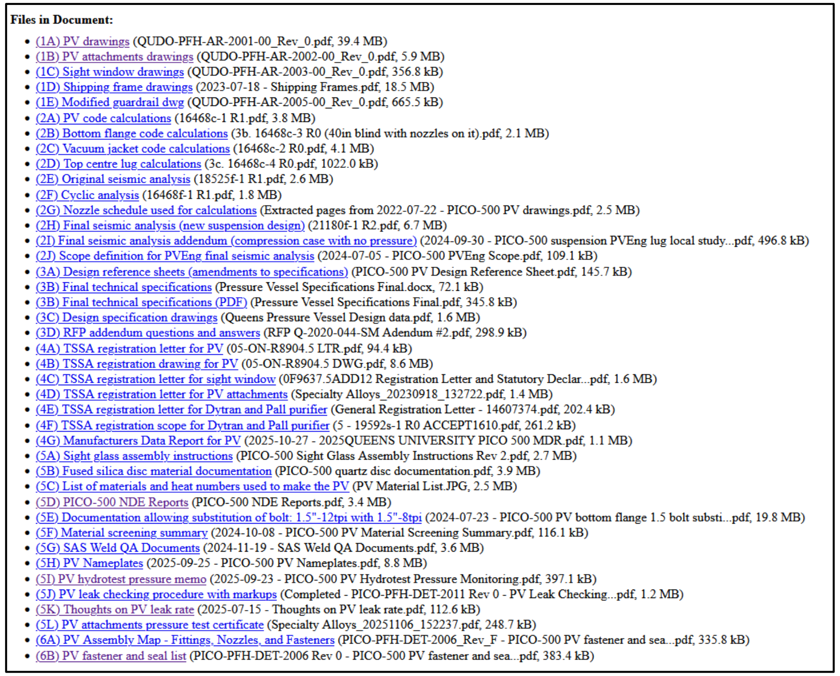




PICO-500

- PV contract, design, registration
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters*
- R.R.s & C.C.s*
- … and more

*See **William's** talk this afternoon*



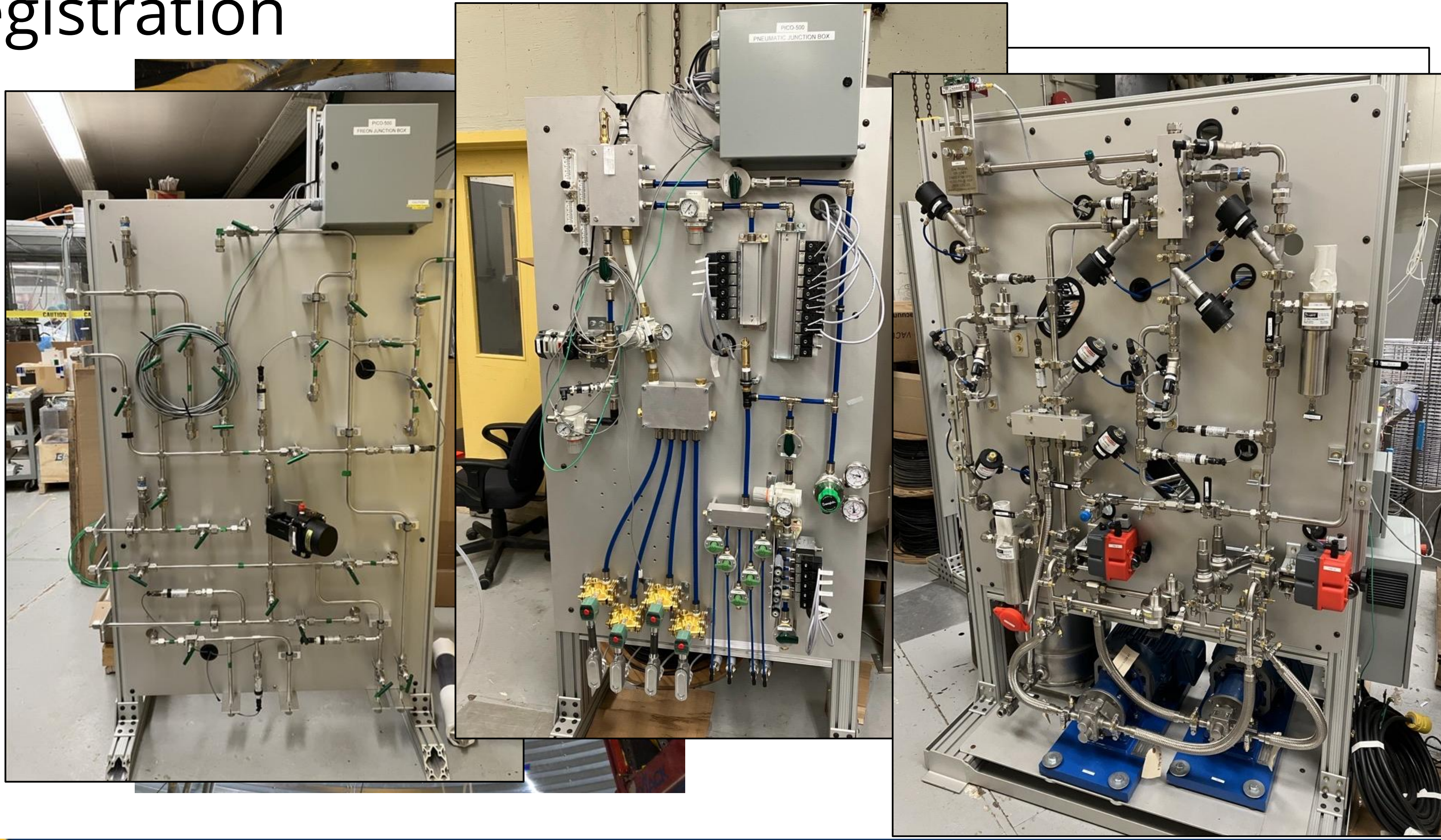
Files in Document:

- (1A) PV drawings (QUDO-PFH-AR-2001-00_Rev_0.pdf, 39.4 MB)
- (1B) PV attachments drawings (QUDO-PFH-AR-2002-00_Rev_0.pdf, 5.9 MB)
- (1C) Sight window drawings (QUDO-PFH-AR-2003-00_Rev_0.pdf, 356.8 kB)
- (1D) Shipping frame drawings (2023-07-18 - Shipping Frames.pdf, 18.5 MB)
- (1E) Modified guardrail dwg (QUDO-PFH-AR-2005-00_Rev_0.pdf, 665.5 kB)
- (2A) PV code calculations (16468c-1 R1.pdf, 3.8 MB)
- (2B) Bottom flange code calculations (3b. 16468c-3 R0 (40in blind with nozzles on it).pdf, 2.1 MB)
- (2C) Vacuum jacket code calculations (16468c-2 R0.pdf, 4.1 MB)
- (2D) Top centre lug calculations (3c. 16468c-4 R0.pdf, 1022.0 kB)
- (2E) Original seismic analysis (18525f-1 R1.pdf, 2.6 MB)
- (2F) Cyclic analysis (16468f-1 R1.pdf, 1.8 MB)
- (2G) Nozzle schedule used for calculations (Extracted pages from 2022-07-22 - PICO-500 PV drawings.pdf, 2.5 MB)
- (2H) Final seismic analysis (new suspension design) (21180f-1 R2.pdf, 6.7 MB)
- (2I) Final seismic analysis addendum (compression case with no pressure) (2024-09-30 - PICO-500 suspension PVEng lug local study...pdf, 496.8 kB)
- (2J) Scope definition for PVEng final seismic analysis (2024-07-05 - PICO-500 PVEng Scope.pdf, 109.1 kB)
- (3A) Design reference sheets (amendments to specifications) (PICO-500 PV Design Reference Sheet.pdf, 145.7 kB)
- (3B) Final technical specifications (Pressure Vessel Specifications Final.docx, 72.1 kB)
- (3B) Final technical specifications (PDF) (Pressure Vessel Specifications Final.pdf, 345.8 kB)
- (3C) Design specification drawings (Queens Pressure Vessel Design data.pdf, 1.6 MB)
- (3D) RFP addendum questions and answers (RFP Q-2020-044-SM Adendum #2.pdf, 298.9 kB)
- (4A) TSSA registration letter for PV (05-ON-R8904.5 LTR.pdf, 94.4 kB)
- (4B) TSSA registration drawing for PV (05-ON-R8904.5 DWG.pdf, 8.6 MB)
- (4C) TSSA registration letter for sight window (0F9637.5ADD12 Registration Letter and Statutory Declar...pdf, 1.6 MB)
- (4D) TSSA registration letter for PV attachments (Specialty Alloys_20230918_132722.pdf, 1.4 MB)
- (4E) TSSA registration letter for Dytran and Pall purifier (General Registration Letter - 14607374.pdf, 202.4 kB)
- (4F) TSSA registration scope for Dytran and Pall purifier (5 - 19592s-1 R0 ACCEPT1610.pdf, 261.2 kB)
- (4G) Manufacturers Data Report for PV (2025-10-27 - 2025QUEENS UNIVERSITY PICO 500 MDR.pdf, 1.1 MB)
- (5A) Sight glass assembly instructions (PICO-500 Sight Glass Assembly Instructions Rev 2.pdf, 2.7 MB)
- (5B) Fused silica disc material documentation (PICO-500 quartz disc documentation.pdf, 3.9 MB)
- (5C) List of materials and heat numbers used to make the PV (PV Material List.JPG, 2.5 MB)
- (5D) PICO-500 NDE Reports (PICO-500 NDE Reports.pdf, 3.4 MB)
- (5E) Documentation allowing substitution of bolt: 1.5"-12tpi with 1.5"-8tpi (2024-07-23 - PICO-500 PV bottom flange 1.5 bolt substi...pdf, 19.8 MB)
- (5F) Material screening summary (2024-10-08 - PICO-500 PV Material Screening Summary.pdf, 116.1 kB)
- (5G) SAS Weld QA Documents (2024-11-19 - SAS Weld QA Documents.pdf, 3.6 MB)
- (5H) PV Nameplates (2025-09-25 - PICO-500 PV Nameplates.pdf, 8.8 MB)
- (5I) PV hydrotest pressure memo (2025-09-23 - PICO-500 PV Hydrotest Pressure Monitoring.pdf, 397.1 kB)
- (5J) PV leak checking procedure with markups (Completed - PICO-PFH-DET-2011 Rev 0 - PV Leak Checking...pdf, 1.2 MB)
- (5K) Thoughts on PV leak rate (2025-07-15 - Thoughts on PV leak rate.pdf, 112.6 kB)
- (5L) PV attachments pressure test certificate (Specialty Alloys_20251106_152237.pdf, 248.7 kB)
- (6A) PV Assembly Map - Fittings, Nozzles, and Fasteners (PICO-PFH-DET-2006_Rev_F - PICO-500 PV fastener and sea...pdf, 335.8 kB)
- (6B) PV fastener and seal list (PICO-PFH-DET-2006 Rev 0 - PICO-500 PV fastener and sea...pdf, 383.4 kB)

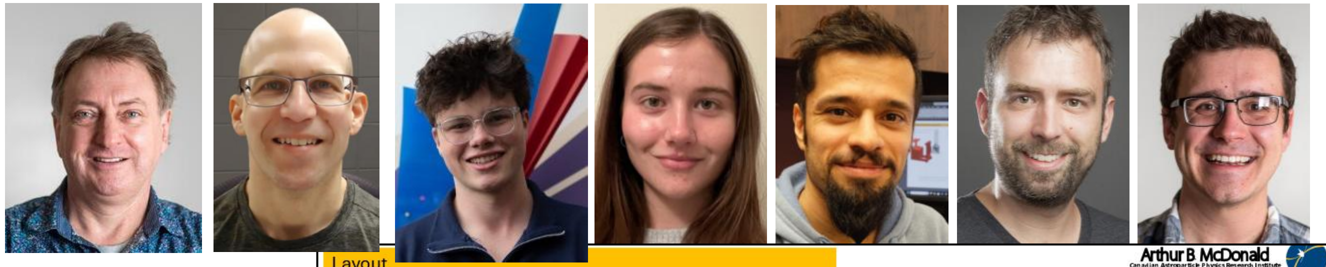
PICO-500

- PV contract, design, registration
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters*
- R.R.s & C.C.s*
- … and more

*See **William's** talk this afternoon*

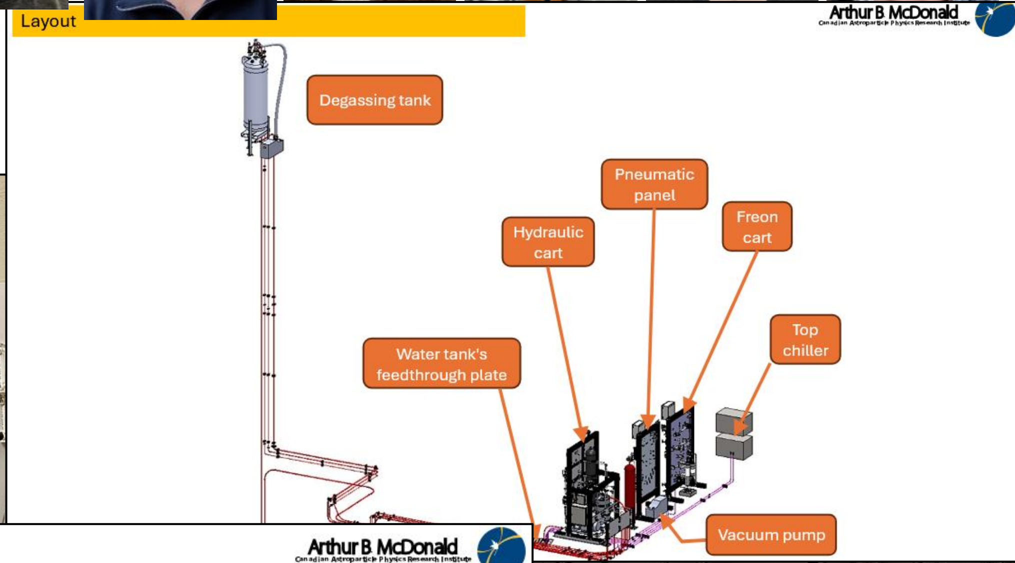


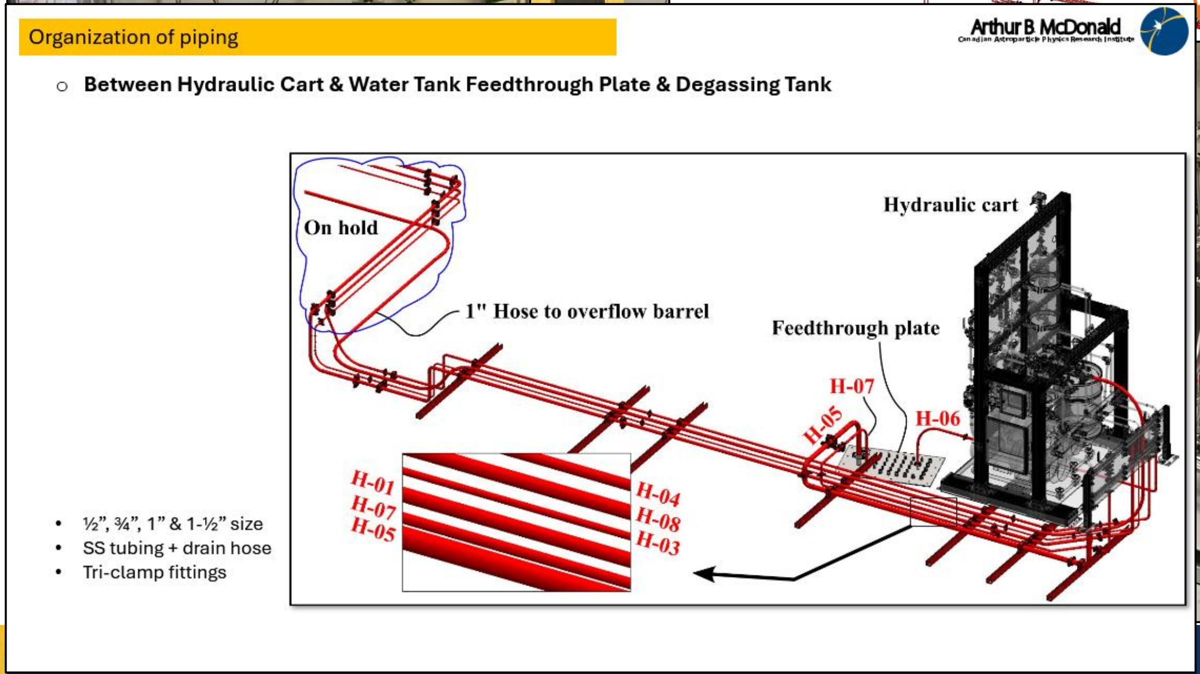
PICO-500



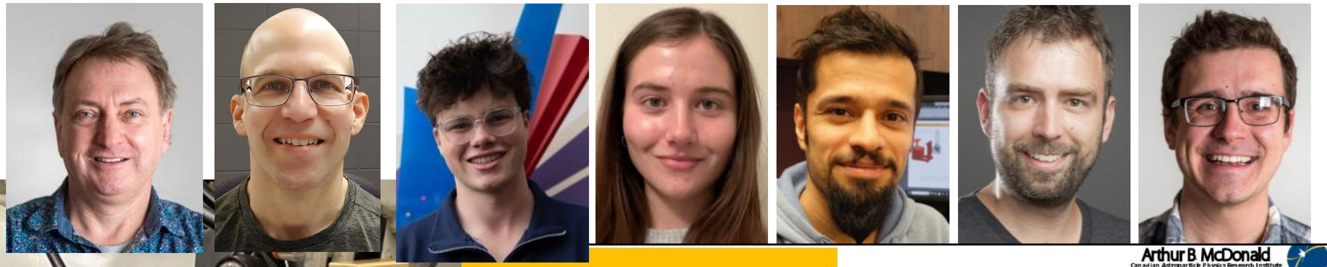
- PV contract, design, registration
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters*
- R.R.s & C.C.s*
- … and more

*See **William's** talk this afternoon*



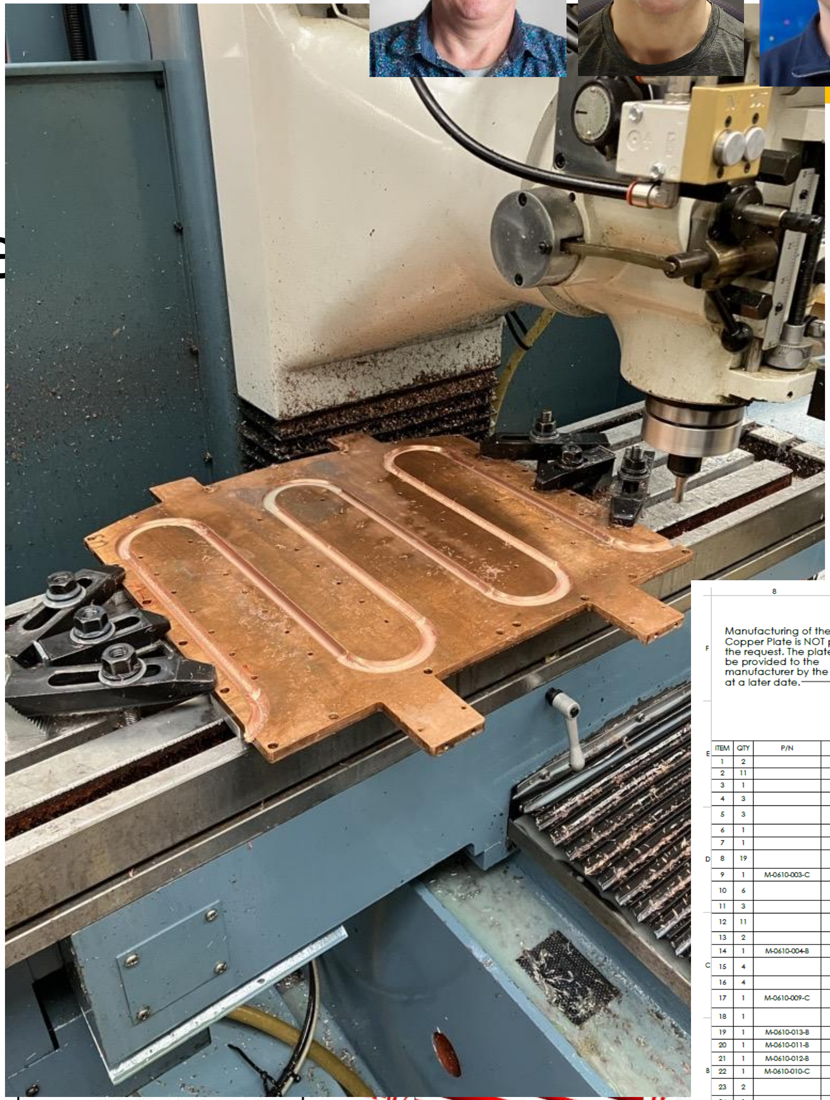


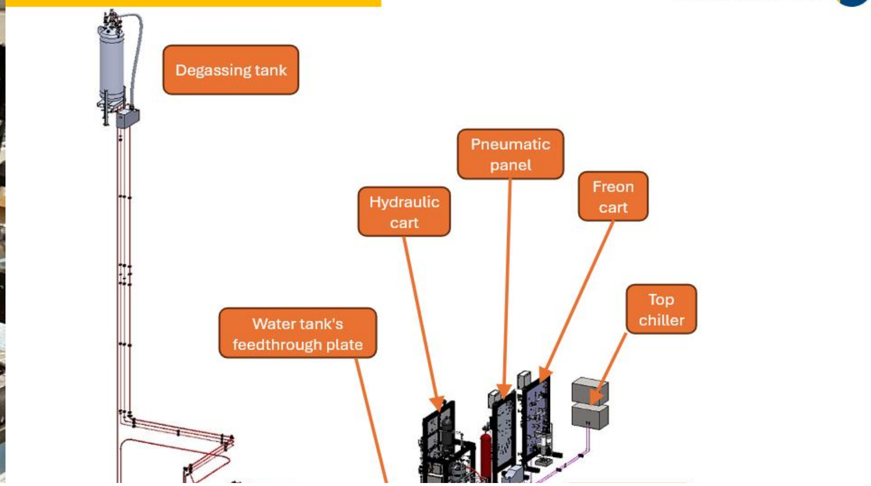
PICO-500

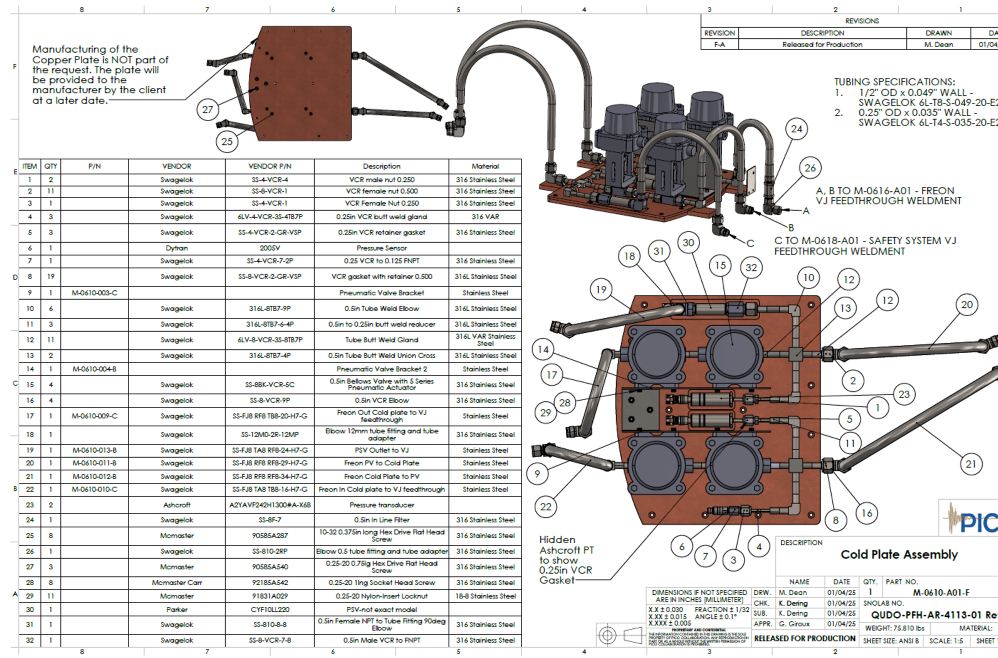


- PV contract, design, re
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters*
- R.R.s & C.C.s*
- … and more

*See **William's** talk this afternoon*



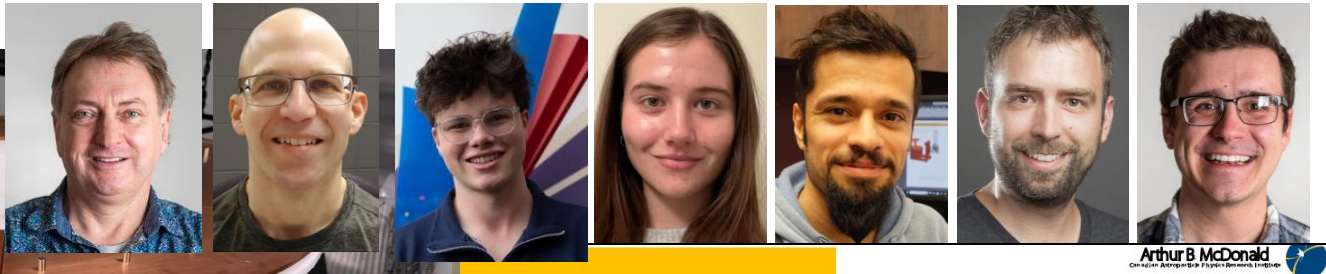


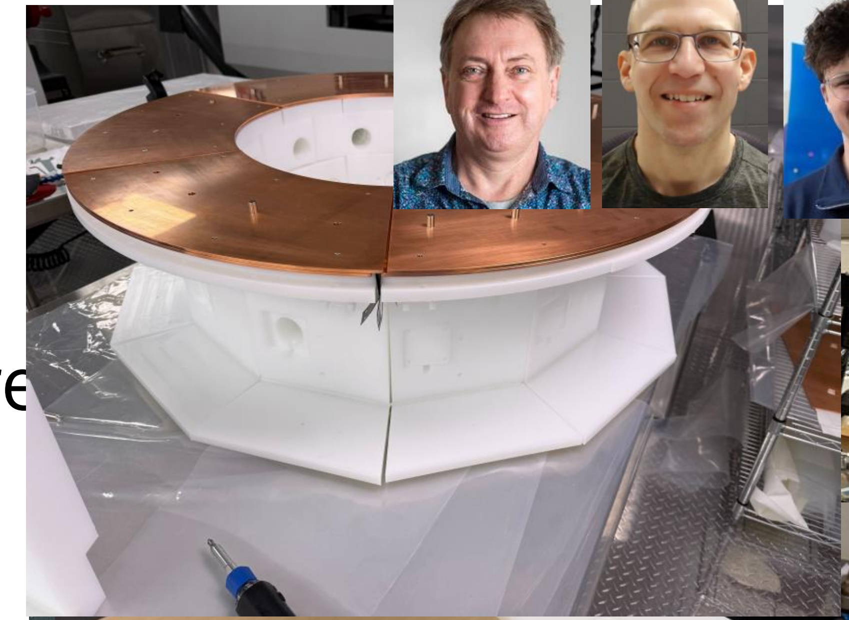


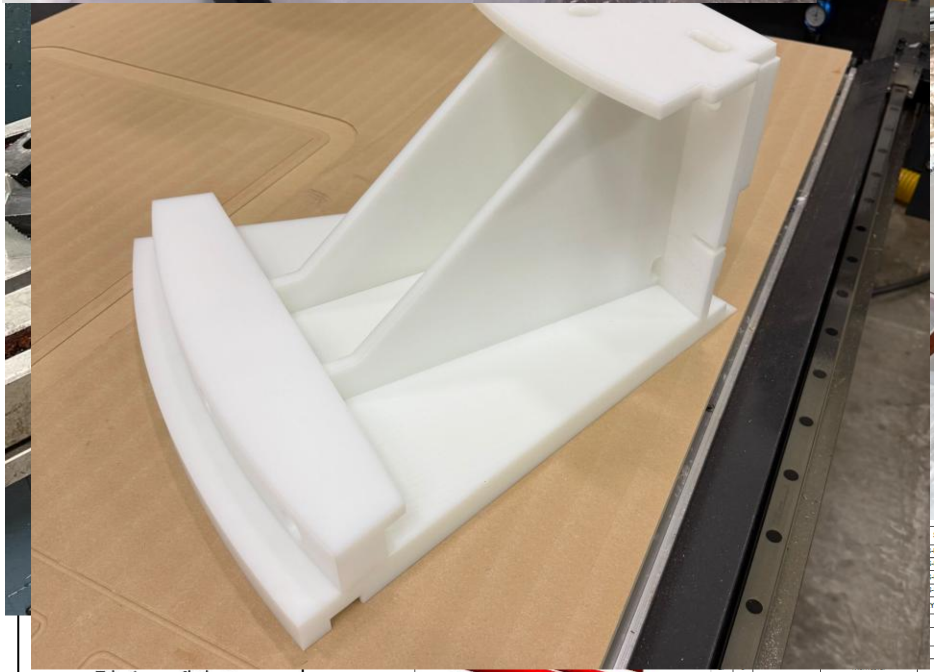
PICO-500

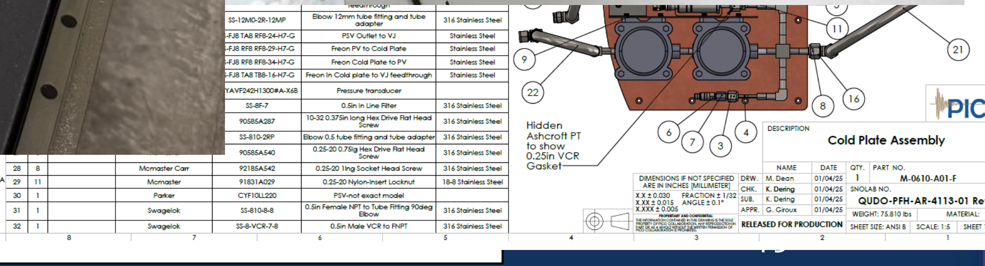
- PV contract, design, re
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters*
- R.R.s & C.C.s*
- … and more

*See **William's** talk this afternoon*





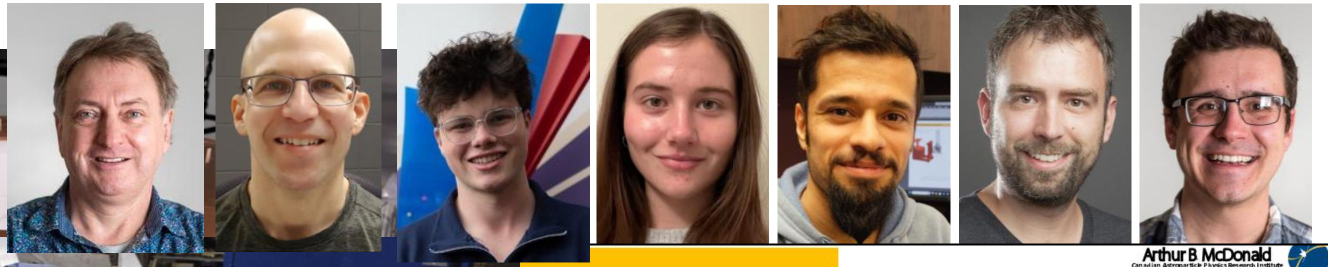
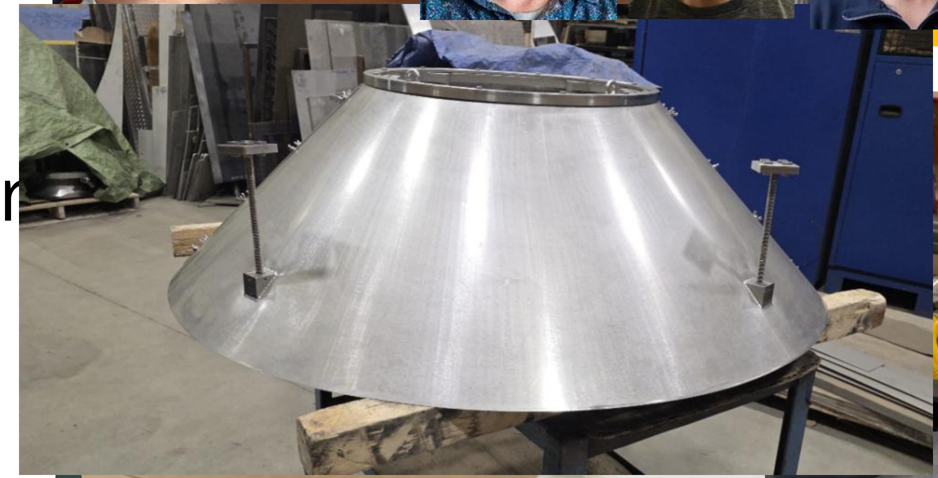




PICO-500

- PV contract, design, r
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters
- R.R.s & C.C.s*
- … and more

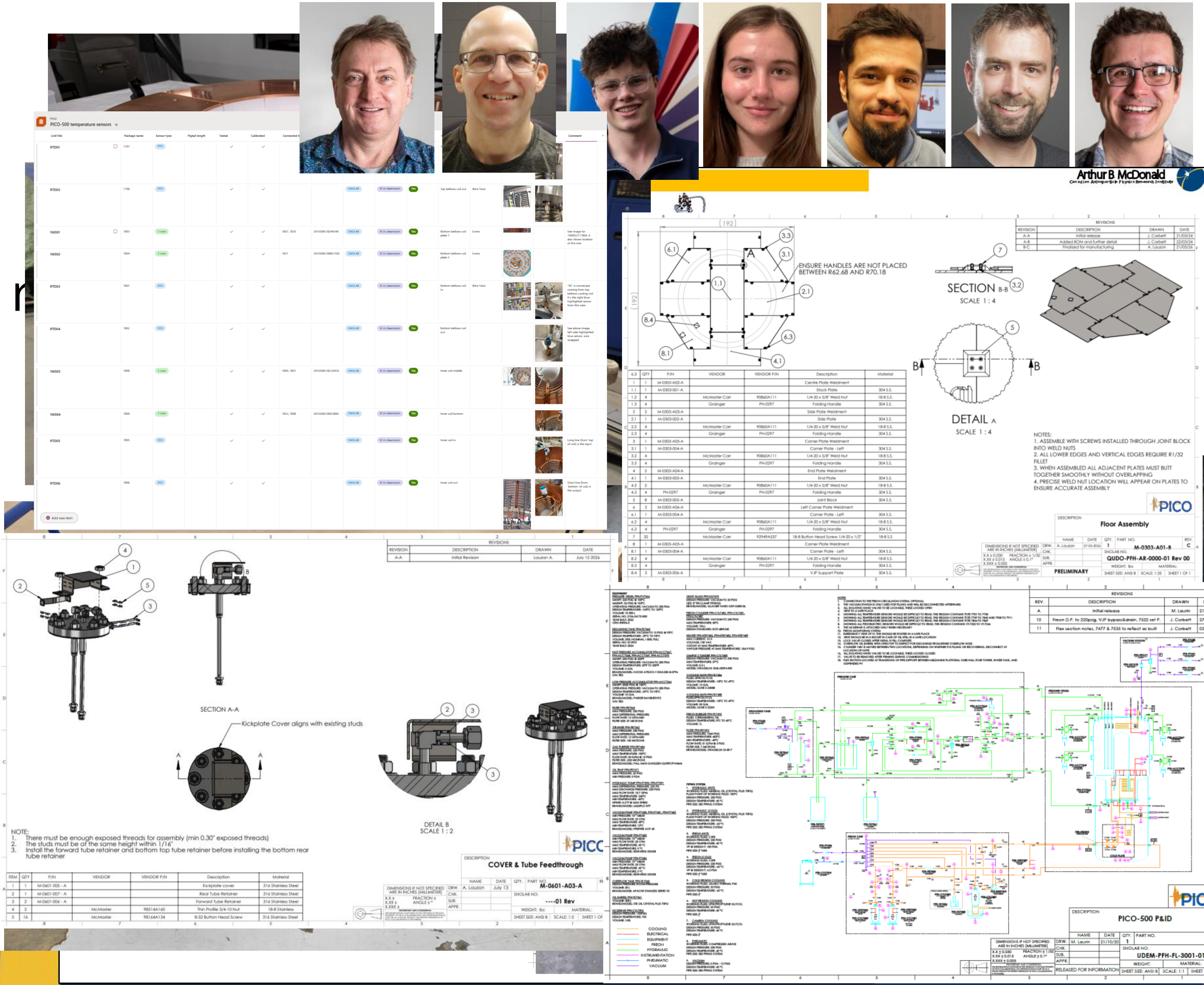
*See **William's** talk this afternoon*


PICO-500

- PV contract, design, r
- Fluid carts
- Field Piping
- Cold plate
- Insulation & heaters
- R.R.s & C.C.s*
- … and more

*See **William's** talk this afternoon*



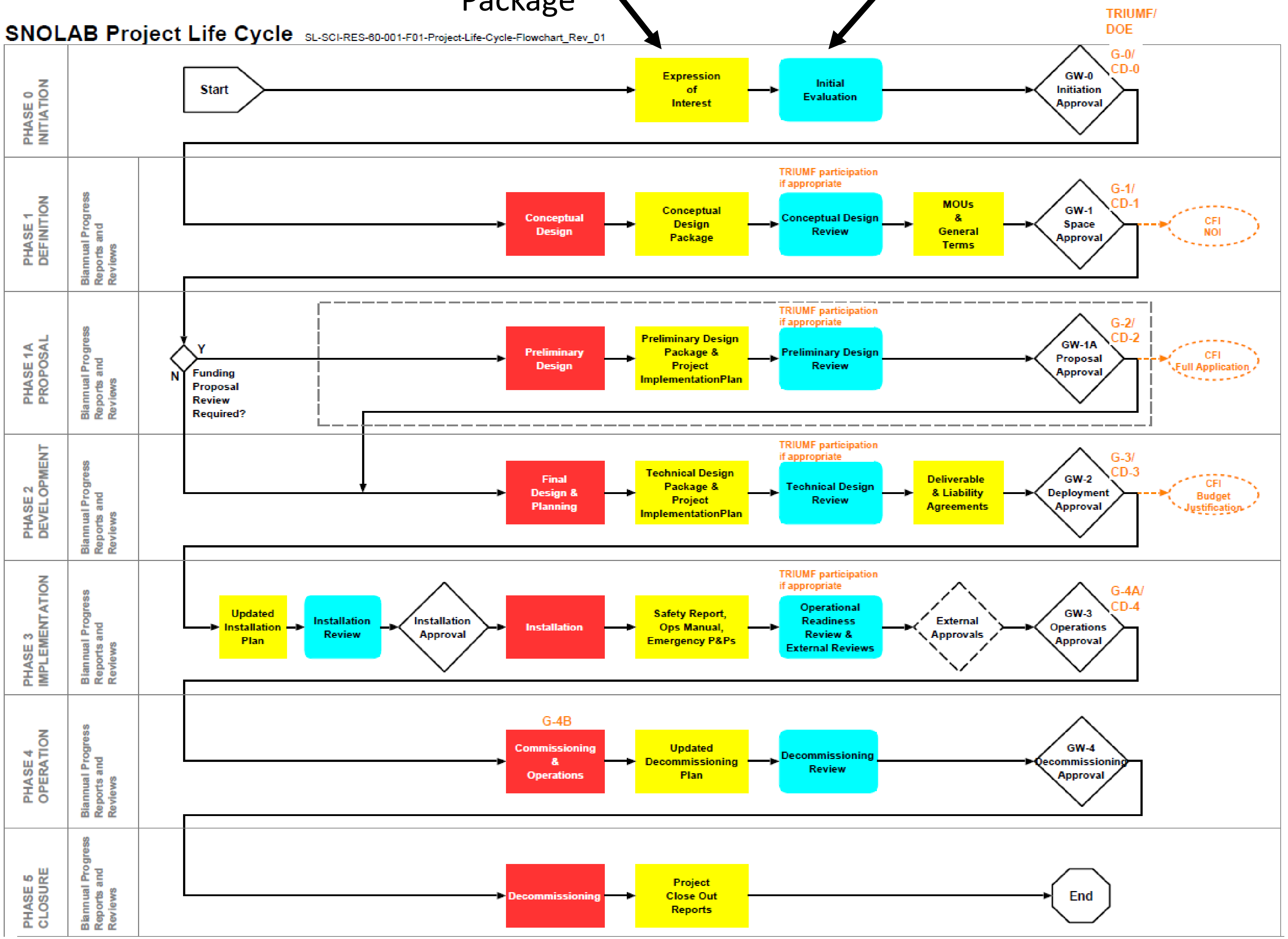
SNOLAB Project Life Cycle

I've seen/participated in this process, but for multi-year design processes!

Requires good organization, project management, detail focus and methodical follow up

Documentation Package

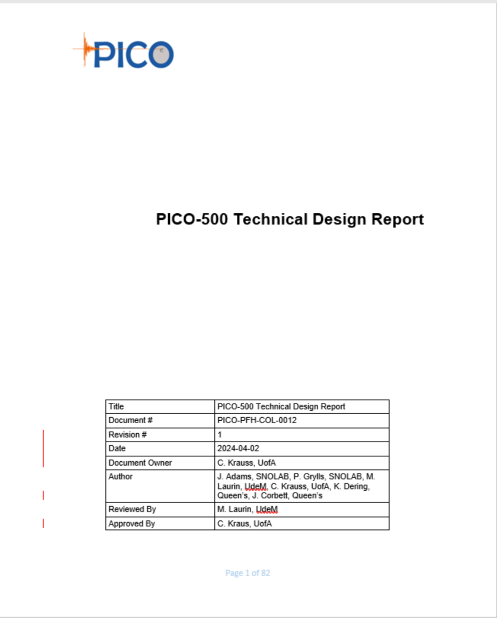
Presentation



Slide from ENPH 459 Practical Cryogenic Engineering

Queen's-IPDC GW Involvement

CDR → PDR → TDR → IRR → ORR → DR



PICO

PICO-500 Technical Design Report

Title	PICO-500 Technical Design Report
Document #	PICO-PFH-COL-0012
Revision #	1
Date	2024-04-02
Document Owner	C. Krauss, UofA
Author	J. Adams, SNOLAB, P. Grylls, SNOLAB, M. Laurin, UdeM, C. Krauss, UofA, K. Dering, Queen's, J. Corbett, Queen's
Reviewed By	M. Laurin, UdeM
Approved By	C. Kraus, UofA

Page 1 of 82

File Number	Name	Folder	Last Upda	Responsible	Done	Uploaded
PICO-PFH-COL-0012	PICO-500 TDR	Top Level	TDR	Jonathan	Yes	Yes
PICO-PFH-DET-0013	Initial installation plan	Technical Documents	TDR	Jonathan	Yes	Yes
	PV 2D drawing package	Technical Drawings	TDR	SAS/Paul	Yes	Yes
	IV quartz 2D drawing package	Technical Drawings	PDR		Yes	Yes
	IV 2D drawing package	Technical Drawings	TDR	Mitch	Yes	Yes
PICO-PFH-DET-8000	Background simulation	Technical Documents	PDR		Yes	Yes
PICO-PFH-DET-2001	Pressure vessel overpressure protection	Technical Documents	TDR	Koby	Yes	Yes
PICO-PFH-DET-2000	PICO-500 pressure vessel specification	Technical Documents	PDR	Koby	Yes	Yes
	PV documentation (PVEng code calcs, drawings, QA)	Technical Drawings	PDR	Koby	Yes	Yes
PICO-PFH-DET-1005	Seal and clamping design	Technical Documents	PDR	Koby	Yes	Yes
PICO-PFH-DET-1004	Jar and seal design	Technical Documents	PDR	Koby	Yes	Yes
UDEM-PFH-FL-3001	PICO-500 P&ID	Technical Drawings	TDR	Jonathan	Yes	Yes
PICO-PFH-DET-0011	PICO-500 Master equipment list	Equipment & Utilities	TDR	Mathieu	Yes	Yes
PICO-PFH-DET-4001	PICO-500 Thermal simulation report	Technical Documents	PDR	Carsten	Yes	Yes
PICO-PFH-DET-6600	PICO-500 Control and acquisition system	Technical Documents	PDR	Mathieu	Yes	Yes
UDEM-PFH-SK-0010	PICO-500 floor plan	Technical Drawings	TDR	Mathieu	Yes	Yes
	Cube hall deck study report (Makami)	Technical Documents	PDR		Yes	Yes
	2020-08-24 - PICO 500 Tank Seismic Memo	Technical Documents	PDR		Yes	Yes
PICO-PFH-DET-0100	PICO-500 utility requirements	Equipment & Utilities	PDR	Mathieu	Yes	Yes
PICO-PFH-DET-1006	IV seismic	Technical Documents	PDR		Yes	Yes
PLC-SNOLAB-P2046-PICO-500-FHA-0	PICO-500 Fire hazard assessment	Technical Documents	PDR		Yes	Yes
PLC-QueenU-P2350-PICO-500-FHA-0	PICO-500 Fire hazard assessment review	Technical Documents	TDR		Yes	Yes
PICO-PFH-DET-0015	PICO-500 Commissioning fire assessment	Technical Documents	TDR	Koby	Yes	Yes
	HAZOP report	Risk and Hazard	PDR		Yes	Yes
	SNOLAB PICO-500 Project Budget	Project Management	TDR	Paul	Yes	Yes
	PICO-500 Schedule	Project Management	TDR	Paul	Yes	Yes
	Hazard table	Risk and Hazard	PDR		Yes	Yes
PICO-GEN-COL-9005	EDI	EDI & Code of Conduct	TDR	Jeremy	Yes	Yes
PICO-PFH-DET-0010	PICO-500 HAZOP	Risk and Hazard	PDR		Yes	Yes
PICO-PFH-DET-0700	PICO-500 ODH analysis	Risk and Hazard	PDR		Yes	Yes
PICO-PFH-DET-0701	PICO-500 ODH calculation	Risk and Hazard	PDR		Yes	Yes
SLDO-PFH-AR-0402	PICO-500 PV Placement Overview	Technical Drawings	PDR	Paul	Yes	Yes
SLDO-PFH-FL-0600	PICO-500 Shield Tank Circulation and Purification Flowsheet	Technical Drawings	PDR	Paul	Yes	Yes
SLDO-PFH-E-0100	PICO-500 Utilities Electrical Installation Package	Technical Drawings	PDR	Paul	Yes	Yes
SLDO-UGL-E-4105	SNOLAB Single Line Diagram Ladders Labs 413-MCC-04	Technical Drawings	PDR	Paul	Yes	Yes
SLDO-UGL-FL-1200	Forced Draining P&ID	Technical Drawings	PDR	Paul	Yes	Yes
SLDO-UPW-FL-0106	New Lab Area UPW Distribution Flowsheet	Technical Drawings	TDR	Paul	Yes	Yes
SLDO-UGL-FL-2009	Compressed Air System Flowsheet for New Lab Area	Technical Drawings	PDR	Paul	Yes	Yes
PICO-PFH-COL-0002	Project charter	Project Management	TDR	Paul		
PICO-GEN-COL-0002	QA Management Plan	Project Management	TDR			
PICO-GEN-COL-9000	Code of conduct	EDI & Code of Conduct	PDR		Yes	Yes
PICO-PFH-DET-0017	PICO-500 Run plan	Project Management	PDR	No Change	Yes	Yes
PICO-PFH-DET-0014	PICO-500 decommissinoing plan	Project Management	PDR	No Change	Yes	Yes
PICO-PFH-DET-5000	PICO-500 Fluid Systems	Technical Documents	TDR	Mathieu	Yes	Yes
PICO-PFH-DET-4000	PICO-500 Heaters	Technical Documents	TDR	Michael	Yes	Yes
PICO-PFH-DET-6601	Alarms & Interlocks	Technical Documents	TDR	Mathieu	Yes	Yes
	Itaska 2023 Seismicity Data	Technical Documents	TDR		Yes	Yes
PICO-PFH-COL-9000	PICO-500 WBS	Project Management	TDR	Paul	Yes	Yes
PICO-PFH-DET-2004	Welding Cleanliness Procedure	Project Management	TDR	Mel	Yes	Yes
PICO-PFH-DET-2005	PV Logistics Plan	Project Management	TDR	Mel	Yes	Yes
PICO-PFH-COL-0005	PICO-500 Risk Management Plan	Risk and Hazard	TDR	Paul	Yes	Yes
PICO-PFH-COL-0006	PICO-500 Hazard Management Plan	Risk and Hazard	TDR	Paul	Yes	Yes
PICO-PFH-COL-0008	PICO-500 Project Hazard Register	Risk and Hazard	TDR	Paul	Yes	Yes
PICO-PFH-COL-0016	PICO-500 Risk Register	Risk and Hazard	TDR	Paul	Yes	Yes

From Aug 2025-Present our team helped prepare documentation for/presented at…

3x of these

1x of these

Example of a document submittal list (PICO-500 TDR)

… and >150 2D drawings

PICO-500 Fluid systems

Title	PICO-500 Fluid systems
Document #	PICO-PFH-DET-5000
Revision #	0
Date	2024-03-11
Document Owner	Guillaume Giroux, Queen's
Author	Guillaume Giroux, Queen's, Mathieu UdeM, Jonathan Corbett, Queen's, Adams, Queen's, Mackenzie Dean, Queen's, Madelyn Bratuz, Queen's
Reviewed By	Koby Dering, Queen's
Approved By	Guillaume Giroux, Queen's

1

2 Hydraulic system

The hydraulic control system is an essential part of the PICO-500 detector. This system is responsible for controlling the pressure of the pressure vessel, and thus the freon pressure. It is also used for detector filling and draining. It consists of a hydraulic cart, a degassing tank, 4 fast pressure accumulators (FPA), and one low pressure accumulator (LPA). Since this system uses STE Crystal Plus 70FG mineral oil under 250 psig and 150 °F, it complies with TSSA exception O. Reg. 220/01 2.(2)(e) regarding the use of "Liquid no more hazardous than water", meaning the system, with some equipment exceptions described below, doesn't require TSSA registration. PICO-40L previously retained PVEng for a professional opinion of the applicability of this exemption for mineral oil, and PVEng agreed that the piping system conveying mineral oil is exempt. The accumulators (low pressure accumulator and fast pressure accumulators) will have a CRN.

During operation the general sequence of steps requires priming the freon in the PV in its superheated state, at a low pressure (nominally around 25 psia) with a 2-stage expansion; a gross expansion directly to the degassing tank followed by a slower careful expansion into the LPA. When an event occurs, there is a rapid compression of the PV from the FPAs followed by pumping which resets the FPAs and brings the PV back up to its fully compressed state. The cycle then repeats to prepare the detector for another event. This sequence is summarized in Figure 1 below where the degassing tank is referred to as the storage tank.

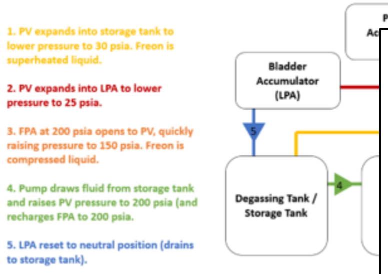


Figure 1 Compression cycle sequence summary.

2.1 Hydraulic cart

The hydraulic cart contains elements that control the movement vessel during all stages of the project lifecycle. Elements on bladder accumulator, filters, and sensors. The hydraulic cart wi and brought to SNOLAB as one assembled package, just needin to become integrated to the experiment. Several types of valv

pneumatically actuated valves (Ex. CV-7304) and motorized valves (Ex. CV-7306). The pneu valves are actuated by inputs from the pneumatic panel while the motorized valves are cont by the pressure PLC. The pneumatic angle seat valves are used for switching operational paths within the cart and external hydraulic systems (degassing tank and PV). The moto valves, also controlled by the pressure PLC, are used for switching between pumps (CV-733 7335) or regulating flow rates (CV-7306). Based on flow rate calculations, CV-7306 was ch with a Cv > 5 to ensure that the valve can be closed partially to have an expansion time tha be adjusted to approximately 10 seconds. Additionally, there are lockable, manually ope valves for isolation of the cart and infrequent actions. At various stages in the commissi process, operation and decommissioning process, different flow paths will be used for va functions. These processes are described in section 7: Detector operation. The design of the passed a thorough internal review which evaluated equipment selection, flow calculations, la and integrity of the physical design which took place over a series of meetings following methodology laid out in PICO-GEN-COL-9006.

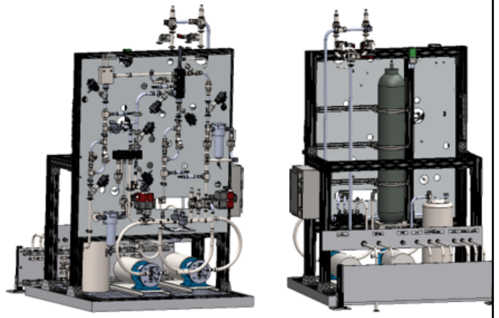


Figure 2 Hydraulic cart preliminary CAD model. Front and back views.

2.1.1 Pump Assembly

The hydraulic cart contains two magnetic drive gear pumps to fill/empty, cycle, and grad increase pressure of the system when needed. Although two pumps are available, only one p will be used at a time. The pumps are connected in parallel using two 3-way motorized va with which a switching relay circuit will forbid both pumps from running at the same time pump failure happens, the system can easily (and remotely) be switched over to the second p by actuating motorized valves without significantly delaying operational time. The relay c has been designed to prevent improper operation of the valves and pumps, like wrong valve

8

7 Detector operation

Final flow path drawings for each of the operations will be produced and reviewed at the time of the Operations Readiness Review, but the following gives an overview of the anticipated detector operations.

22

7.1 Detector fill

The order of the subsequent steps are listed in the rough sequencing order, however some steps can happen in parallel, and may be subject to change after a more thorough review is done at the time of the Operations Readiness Review.

7.1.1 Vacuum

The filling process begins at the hydraulic cart. All lines will be vacuum pumped to prepare the detector for filling. For the degassing tank, hydraulic cart and PV this is pumped through CV-7634 at the degassing tank, through V-7630 on the PV directly, and for the freon system through V-7636. To vacuum prime the system, all valves on the hydraulic and freon carts and valves on the PV are open *except* the ones listed below. Note that this implies all pneumatic normally closed valves must be actuated to be open. The 3-way valves in the systems (V-7315, V-7334, V7335) will be cycled between their different states to ensure that vacuum is adequately pulled in all volumes. Vacuum pumps are then run until the pressure is on the order of 10^{-2} mbar. Pumps are shut off and all remaining valves closed.

Hydraulic System closed valves: V-7300, V-7301, V-7307, V-7312, V-7313, V-7317, V-7333, V-7336, V-7337, V-7338, V-7345, V-7635

Freon System closed valves: V-7452, V-7453, V-7457, V-7463, V-7464, V-7465, V-7466, V-7471, V-7472, V-7473, V-7477, V-7637

7.1.2 Degas tank fill and initial oil filtration

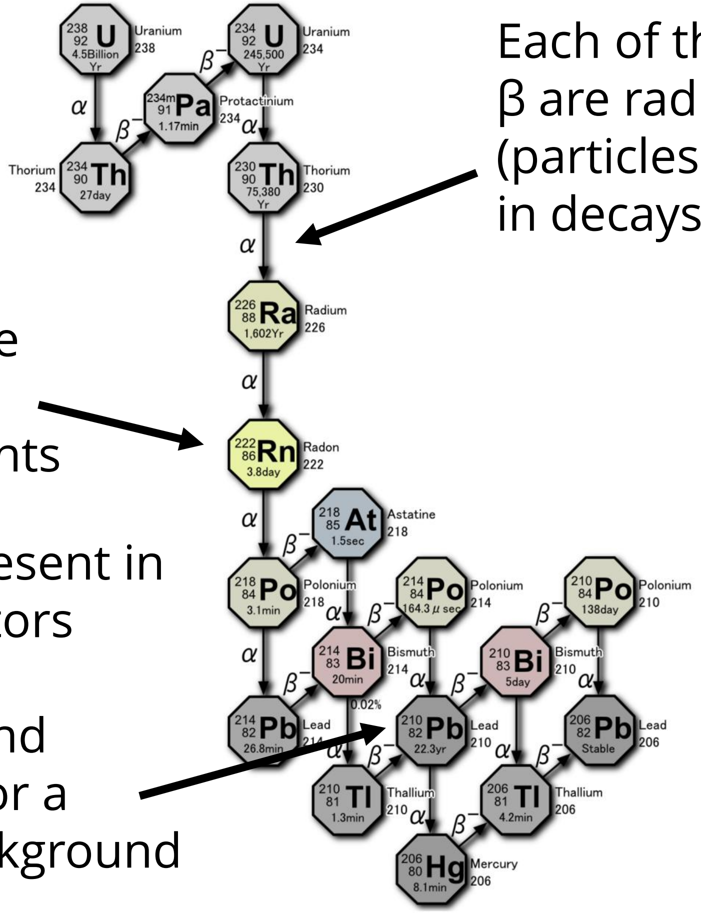
The degassing tank is filled from an oil barrel using the pump, strainer, and filter on the hydraulic cart. The strainer filters the oil of particulates greater than 149 microns before it enters the pump. After the pump, oil is filtered a second time to 25-micron purity before travelling to the degas tank. The capacity of one oil barrel should completely fit inside the degas tank which has a capacity of approximately 250 L. This is done while continuously degassing with the vacuum pump on the degassing tank. The transfer will end before the oil level in the barrel reaches the intake tube to prevent accidental suction of lab air into the hydraulic cart.

Level transducer LT-7219 monitors the oil level in the degas tank and PT-7601 monitors the pressure. Additionally, level threshold sensors LS-7249 (top) and LS-7250 (bottom) will trigger alarms indicating if the oil level becomes too high or too low. The vacuum pump will continue to degas the oil until the pressure reaches the oil vapour pressure.

Lots of documentation

NEWS-G Radon Removal

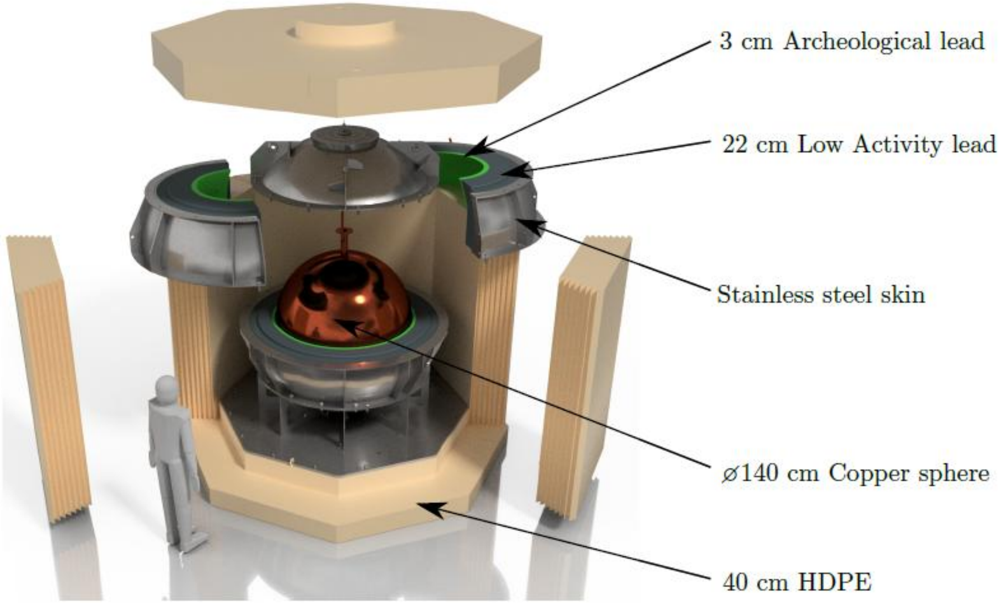
*UG Rn concentration is ~100 Bq/m^3 (decays/s/m^3)



Each of these α and β are radiation (particles) emitted in decays

All are solids, except this one (gas). Mobility into experiments

Radon (Rn) present in particle detectors cause a signal background and "plate" ^{210}Pb for a long-term background (bad)

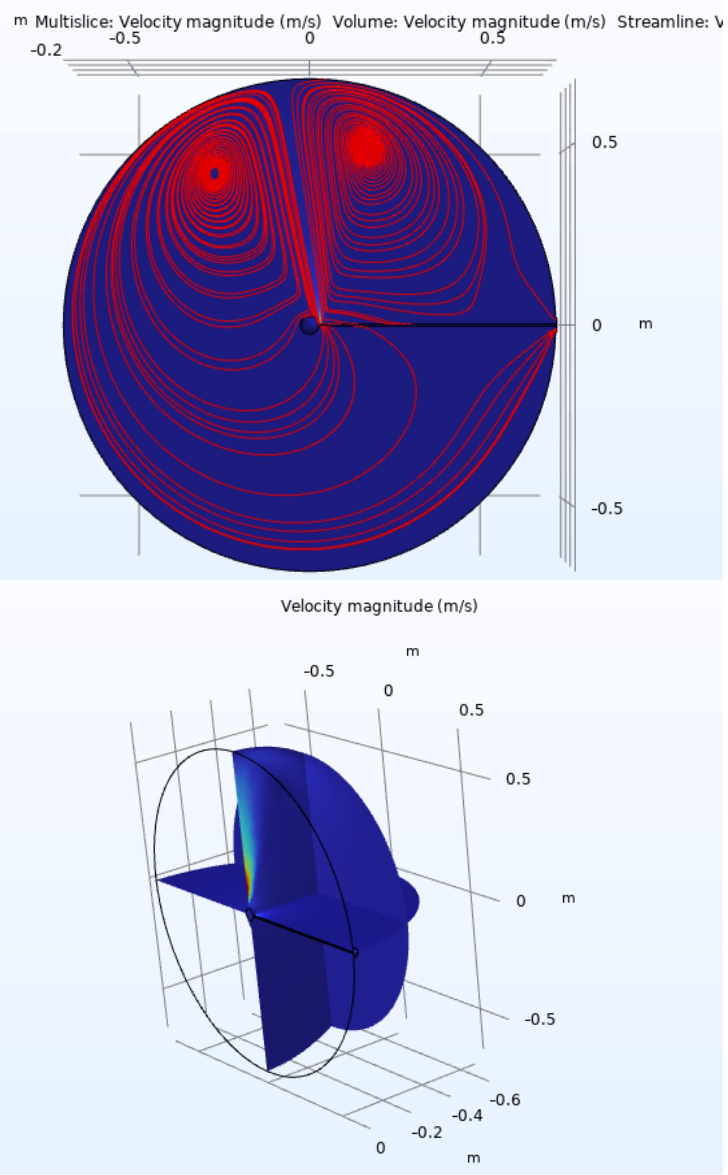


Experiments build shielding to protect detectors from *external* radiation. Many efforts (cleaning/etching surfaces) to reduce particle decays coming from within

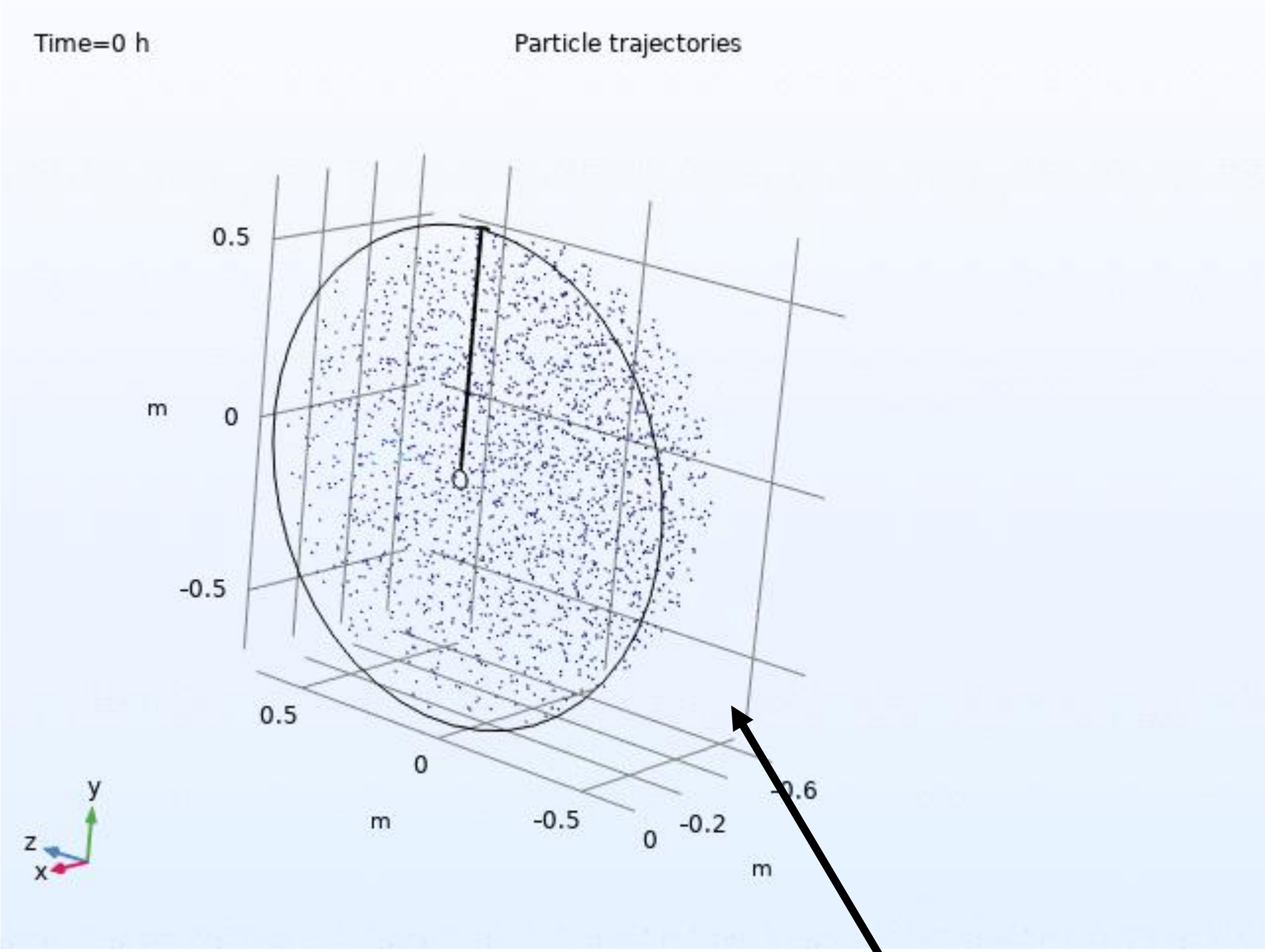
https://en.wikipedia.org/wiki/Radon-222#/media/File:Decay_chain(4n+2,_Uranium_series).PNG

https://www.snolab.ca/experiment/news-g/

NEWS-G Radon Removal



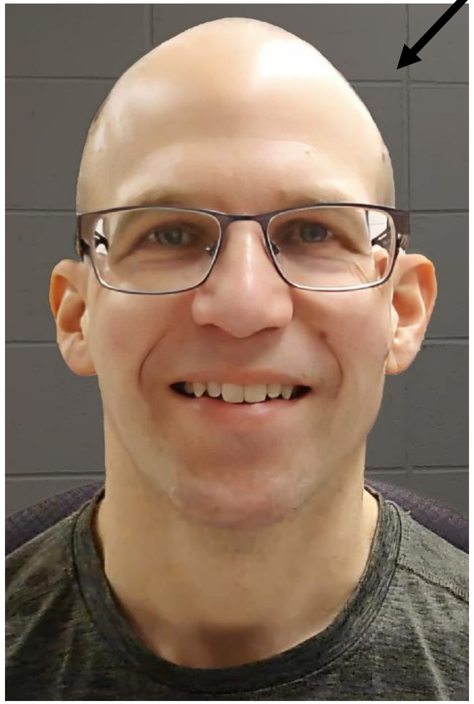
Current progress: Model existing experiment recirculation method, how effective is it at removing particles from inside?



Next steps: What modifications can we make to design to improve that

Fabrication & Assembly

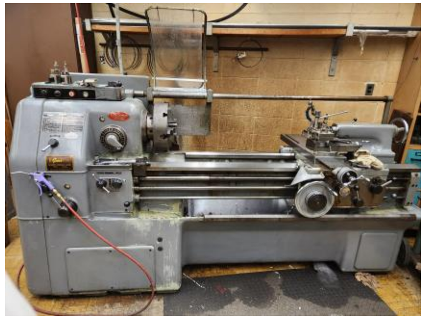
IPDC Members!



These guys would have appeared on pretty much *every* slide with fabrication. They are integral part of our ability to deliver. Thank you Jeff, Rob, Pat, and Chuck (retired)

Machine Shop

- Machining services available at Queen's shop supporting MI-AP projects
  - **Not currently charging for time**
  - Billing for materials and consumables
  - Prioritization based on current shop load, suitability, requested schedule – fold this into the management responsibilities for IPDC
- CNC mill/lathe, some welding, manual tools (mill, lathe, drill press, bandsaw, shear, press brake, press), 3D printer, water jet
- Reach out for details



Deckel DMU 50T CNC Mill

- 3 axis plus 2 milling machine
- 3 axis (XYZ) controlled by CNC and 2 axis of table can be manually rotated
- Capable of machining parts 19.5 inches x 15.75 inches and 17 inches in height
- Spindle RPM range of 10 to 9000 RPM
- Automatic tool changer holds 16 tools
- Well suited to producing multiple intricate parts

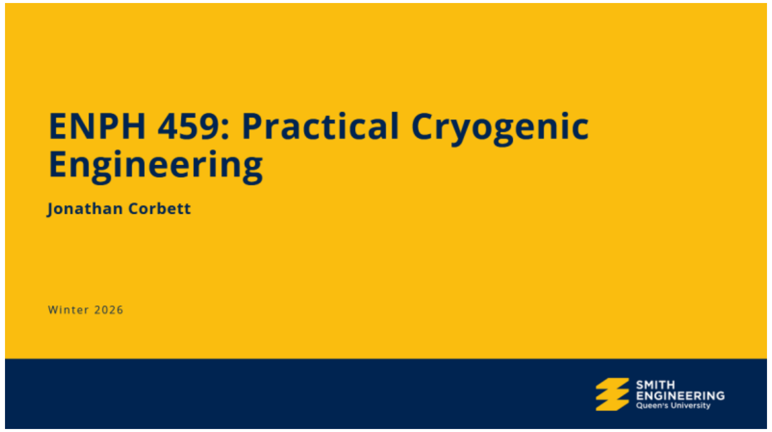
ProtoTrak RMX DPM RX5 CNC Mill

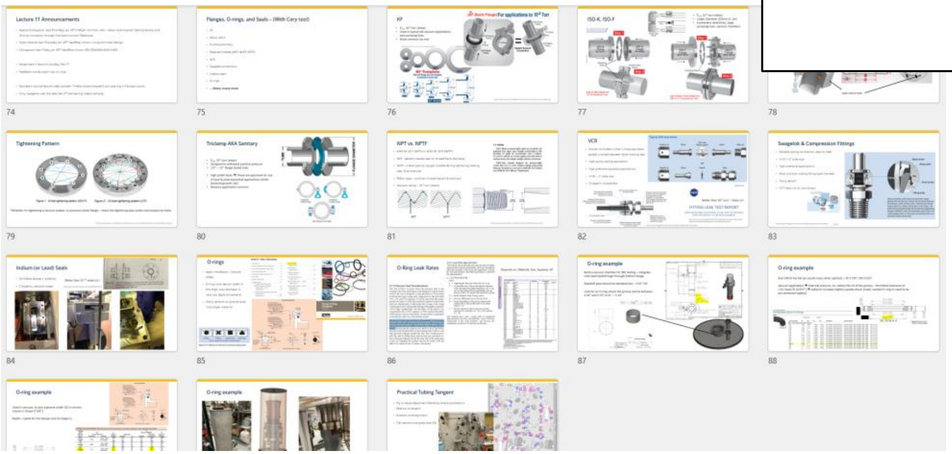
- 3 axis milling machine
- Combination of a conventional mill and a CNC
- Programmed by Mastercam or Trak software at the controller
- Capable of machining parts 40 inches x 20 inches and 20 inches in height
- Spindle RPM range of 40 to 5000 RPM
- Max of 400IPM in X and Y axis table movements. Z axis 250 IPM max

ProtoTrak RLX CNC Lathe

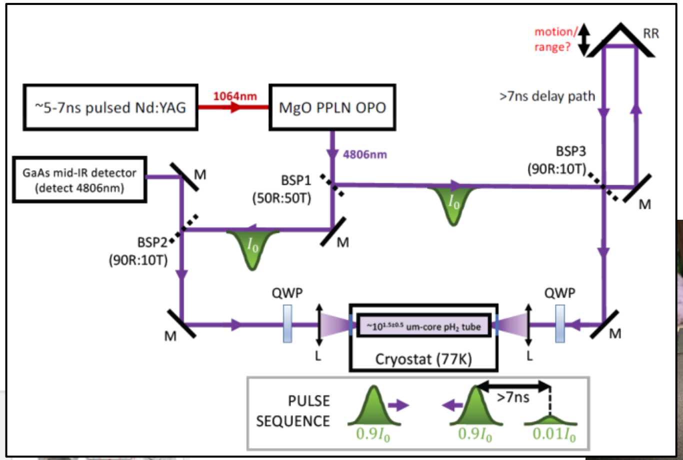
- Combination of a conventional lathe and a CNC
- Programmed by Mastercam or Trak software at the controller
- 18" diameter swing and 40" length. 9.0"diameter round parts at full working length
- Spindle through hole 2.36" diameter
- 10 hp motor with a max of 2500 RPM

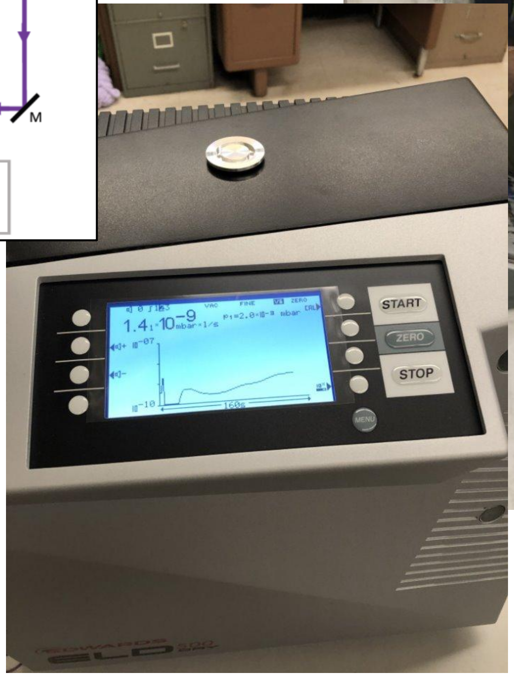
Teaching/Consulting student projects, mentoring, lab work, **L0**





*See **Avani's** talk 2 hours ago*





Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

Queen's University
SNOLAB
CIFAR CANADIAN INSTITUTE FOR ADVANCED RESEARCH
Carleton UNIVERSITY
INSTITUTE OF PARTICLE PHYSICS
Laurentian University Université Laurentienne
McGill
PI PERIMETER INSTITUTE
UBC THE UNIVERSITY OF BRITISH COLUMBIA
TRIUMF
UNIVERSITY OF ALBERTA
Université de Montréal
UNIVERSITY OF TORONTO
CANADA FIRST RESEARCH EXCELLENCE FUND
CITA ICAT Canadian Institute for Theoretical Astrophysics L'institut Canadien d'astrophysique théorique
UDS Université de Sherbrooke
SFU SIMON FRASER UNIVERSITY
UVIC UNIVERSITY OF VICTORIA CANADA
NSERC CRSNG

Thank you

Contact me at: jtc7@queensu.ca

This research was undertaken thanks in part to funding from the Canada First Research Excellence Fund and the Natural Sciences and Engineering Research Council of Canada through the Arthur B. McDonald Canadian Astroparticle Physics Research Institute.