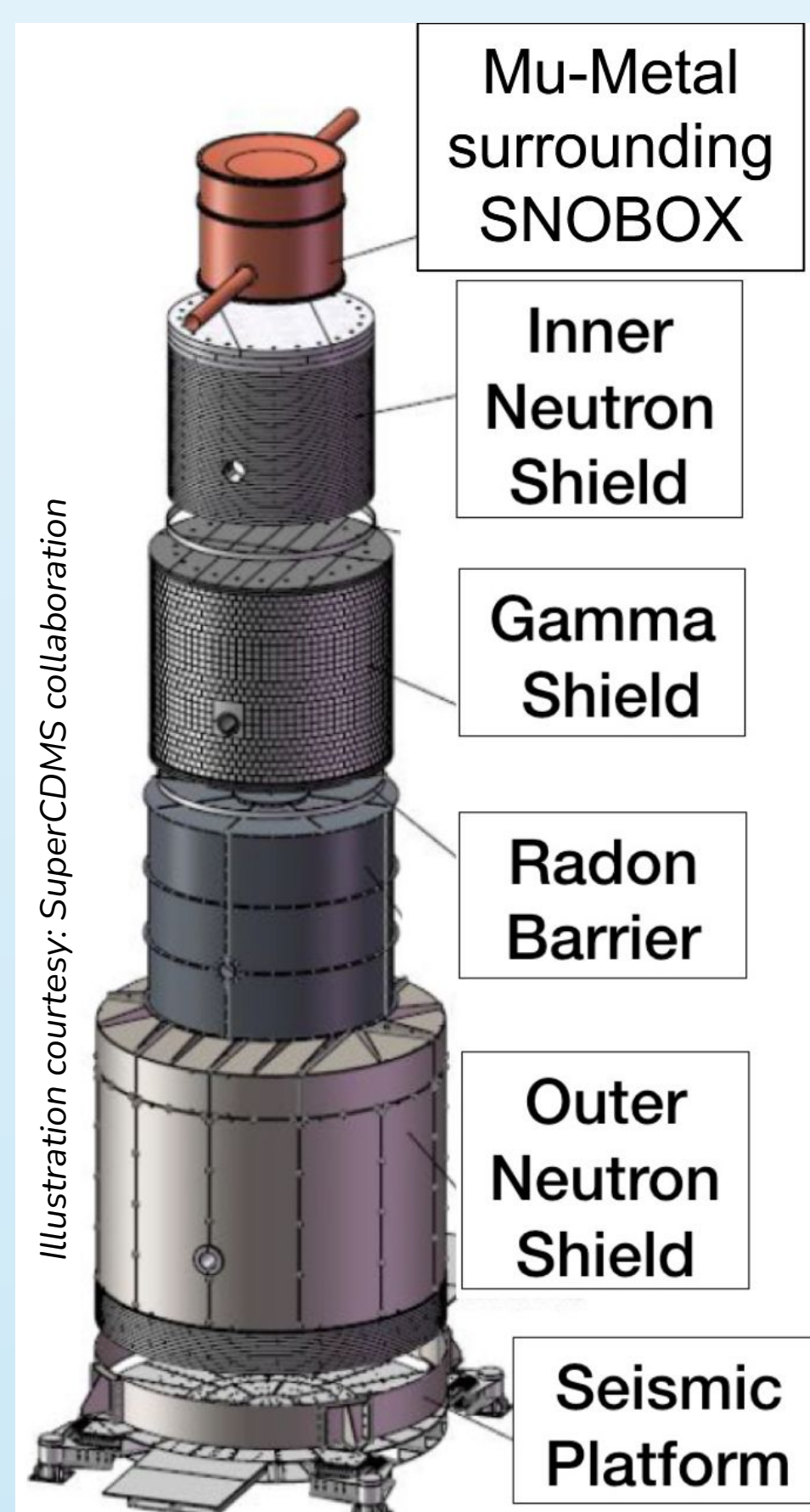


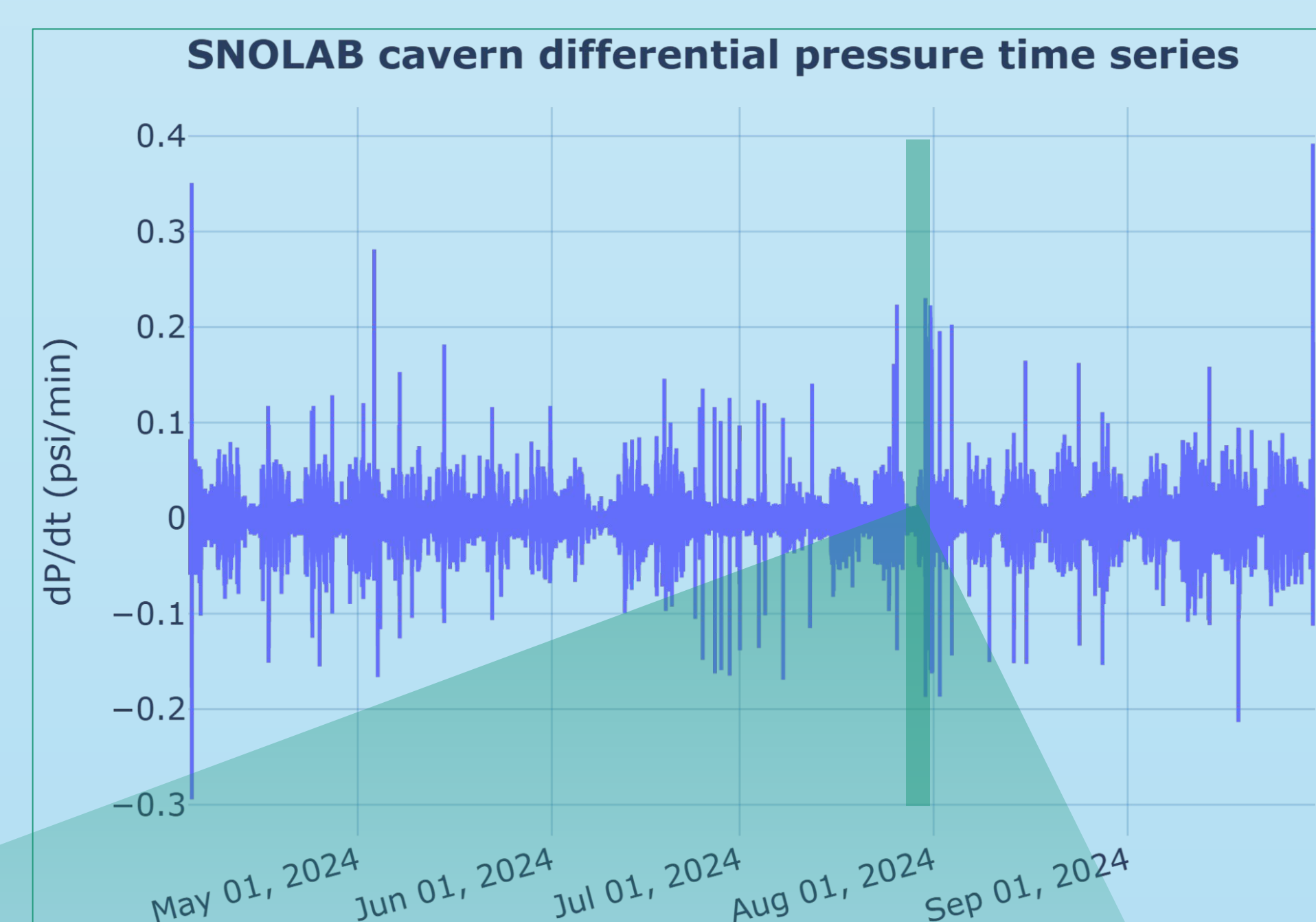
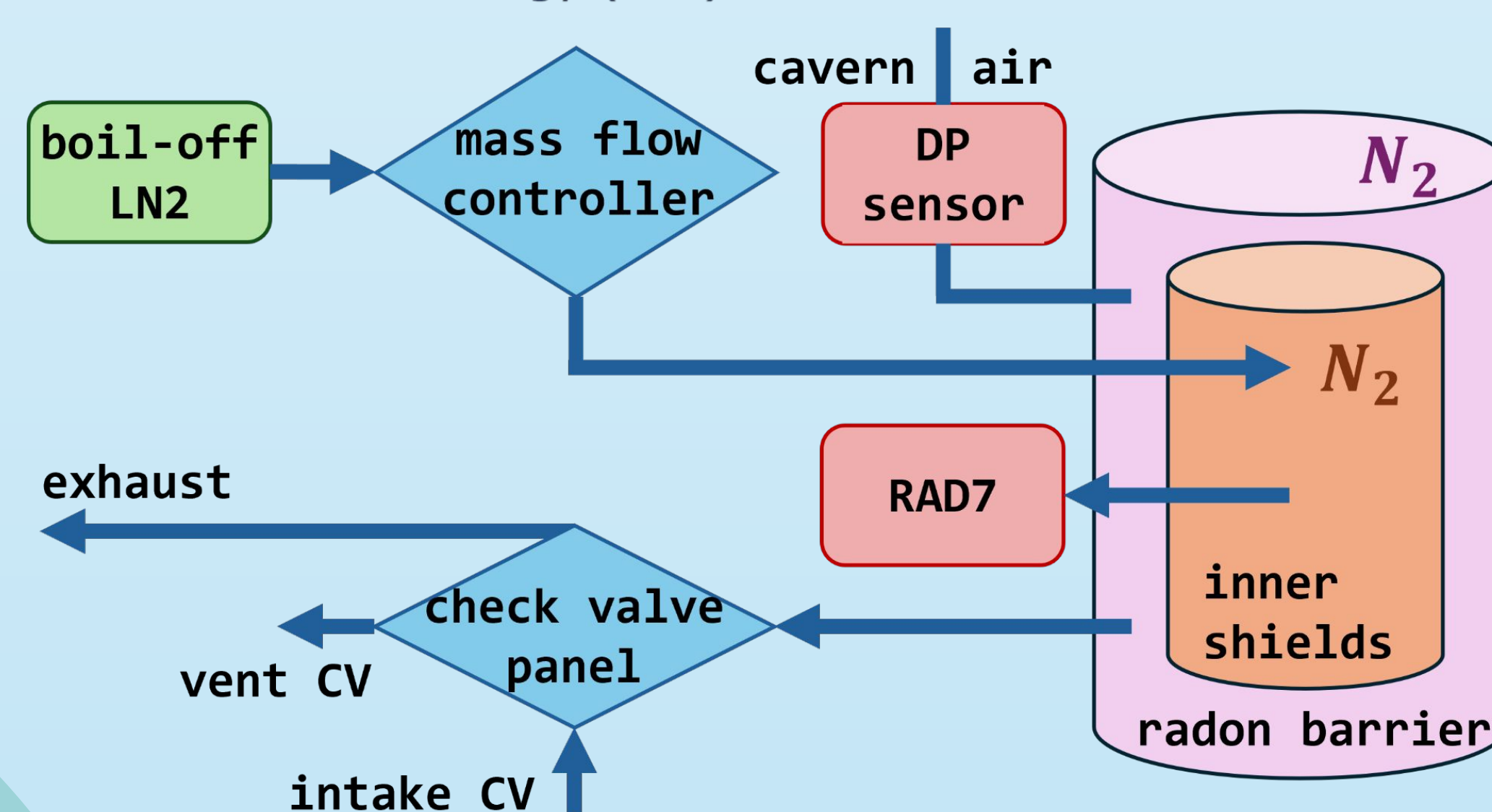
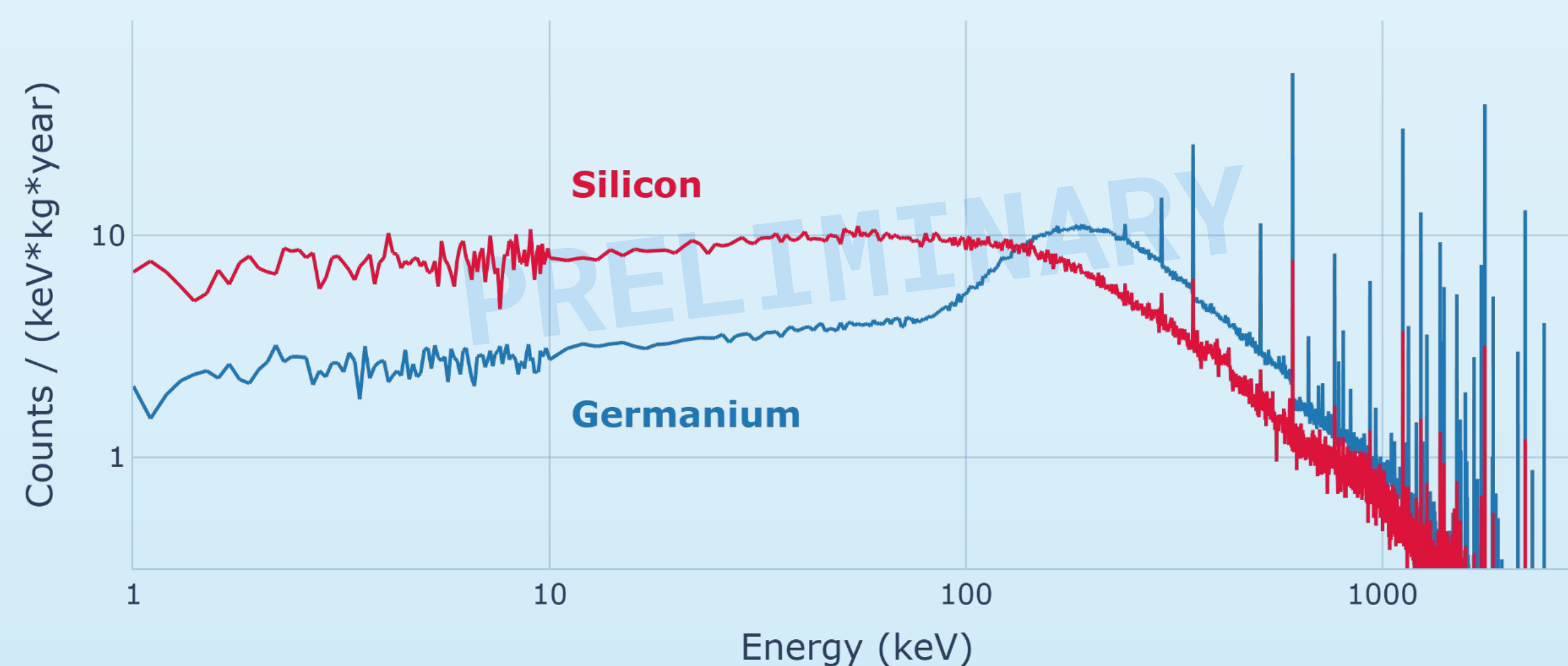
N. Cail, S. Sharma Poudel, R. Glayzer, R. W. Schnee | South Dakota Mines
for the @SuperCDMS collaboration

Background and Goals

- SuperCDMS:** Rare event search for sub-GeV dark matter underground at SNOLAB, using germanium and silicon crystal detectors
- Radon Purge Goal 1:** Mitigate *prompt interstitial radon* in radon barrier surrounding detectors to $<1 \text{ Bq/m}^3$ with overpressure of pure N_2 gas
- Goal 2:** Protect barrier from SNOLAB air filtration system pressure swings, with dynamic N_2 flow
- Prompt interstitial radon:** Gammas from decays of ^{222}Rn daughters ^{214}Pb , ^{214}Bi
- SNOLAB cavern has radon concentration $\sim 130 \text{ Bq/m}^3$
- Unmitigated:** $\sim 5\times$ increase in total background
- Mitigated:** $\leq 5\%$ of total background
- Radon barrier:** Aluminum chamber surrounds gamma shield; system purges a 4 m^3 volume of air



Expected background from 1 Bq/m^3 of shield ^{222}Rn for SuperCDMS
Goal % of total rate from interstitial ^{222}Rn : $\leq 1.4\%$ (Si), $\leq 2.6\%$ (Ge)



Design

Original design

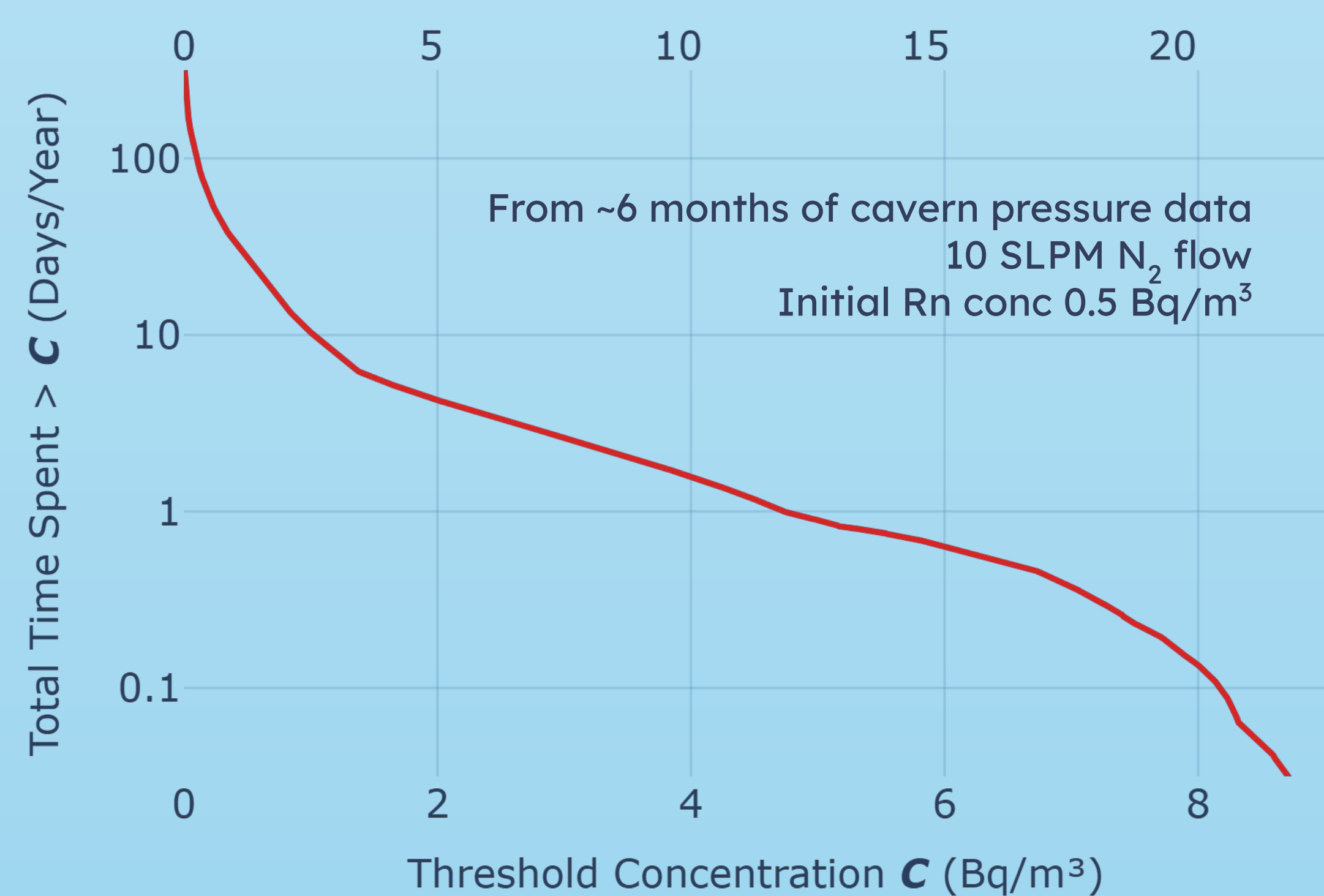
- Dynamic N_2 flow rate: MFC & DPS in control loop
- Maintain $+10^{-3}$ psid in barrier
- Leak-tight barrier: $\sim 1 \text{ LPM}$ at target dP, determined by exhaust line impedance
- Check valves (CVs) open at ± 0.1 psi, minimize stress on potential leaks
- RAD7 samples passively from exhaust
 - Exhaust & CV release overpressure
 - MFC and CV mitigate underpressure
 - Intake CV opens $<10\times/\text{year}$, with MFC capacity $\sim 0.3 \text{ psi/min}$

Current implementation

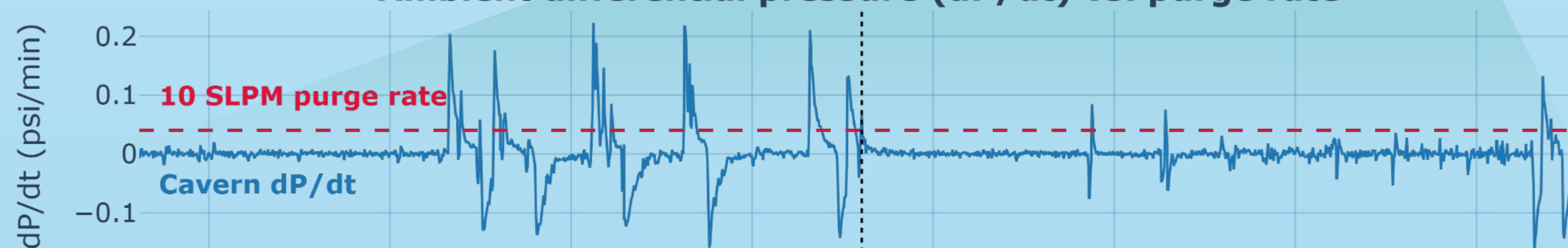
- Barrier found to require $\sim 70 \text{ SLPM}$ N_2 to maintain $+10^{-3}$ psid, ~ 1 dewar/1.6 days
- Time constraints necessitated modification of the original design
- Constant flow rate (10, 20 SLPM)
- RAD7 pumps air from close to detector cryostat
- Pressure equilibration via barrier leaks
- CVs unlikely to open
- dP sensor always $<10^{-4}$ psid

Projected time exceeding threshold concentration

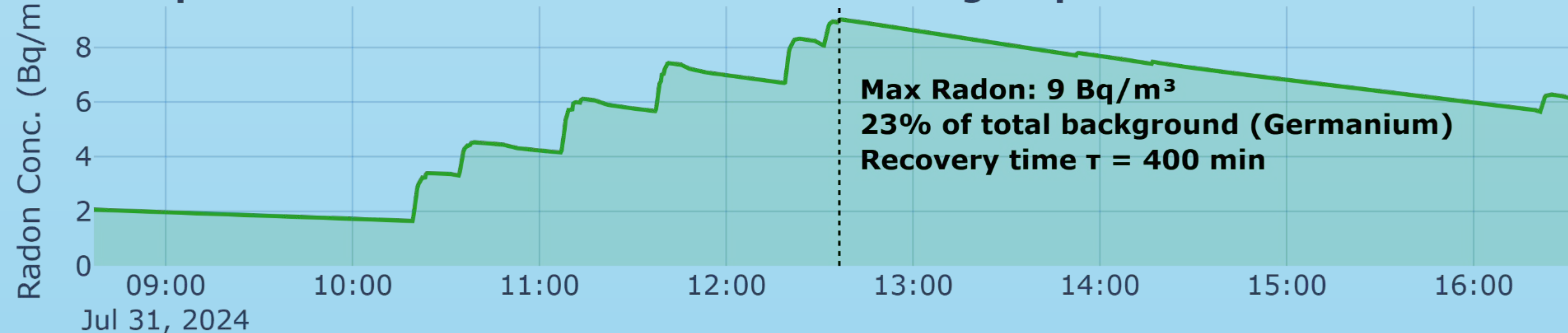
% of total background (Germanium)



Ambient differential pressure (dP/dt) vs. purge rate



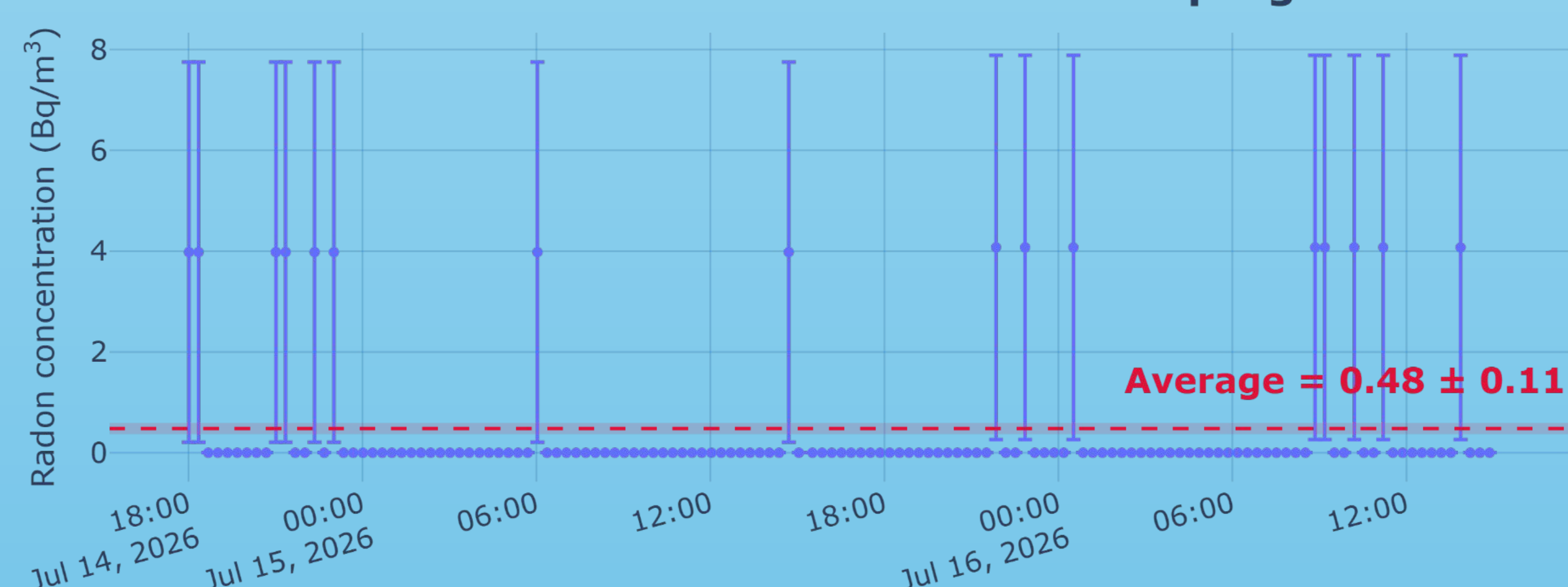
Expected internal Rn concentration from largest pressure-driven incursion



Performance

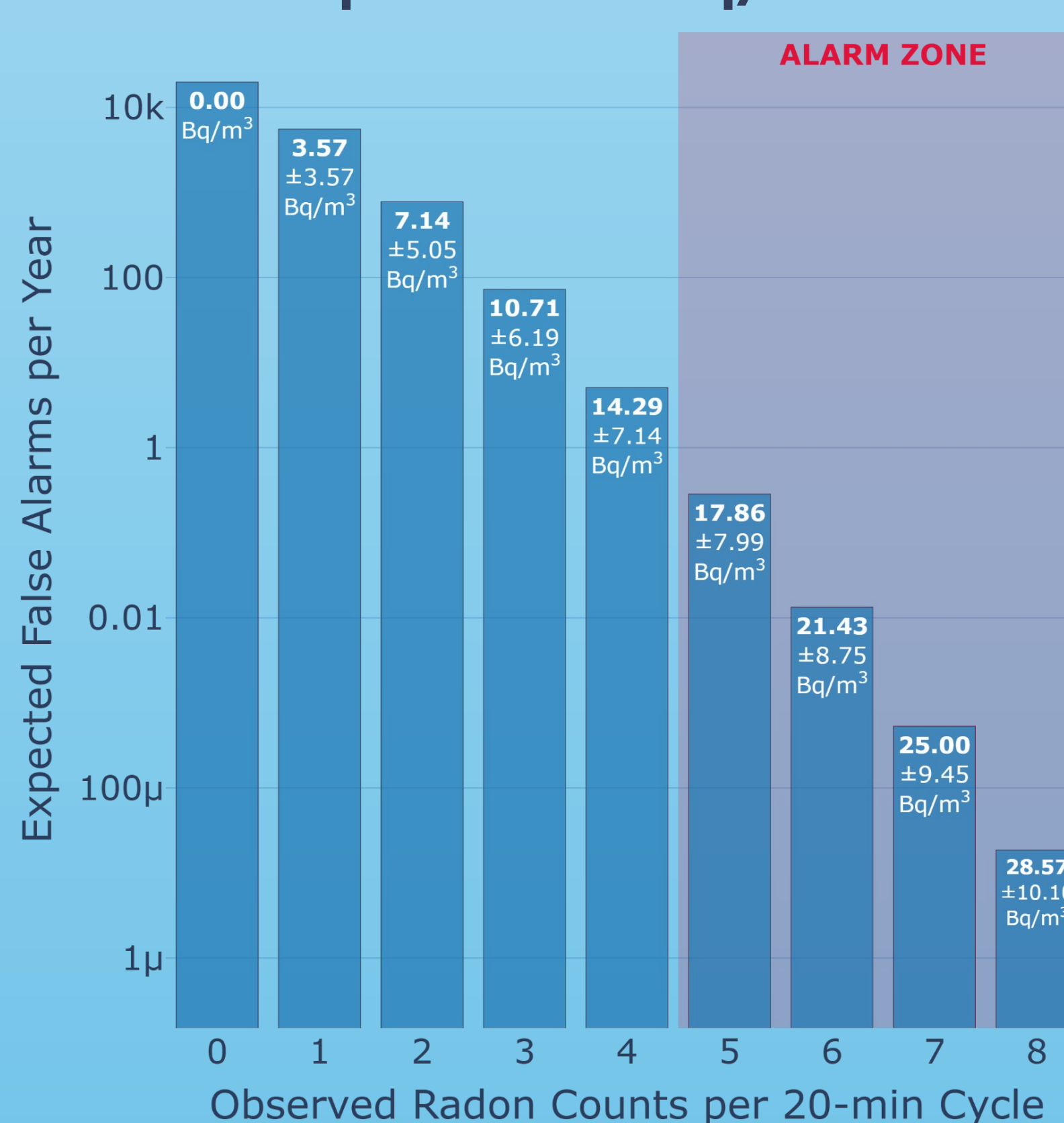
- First looks at data have shown meeting the goal $<1 \text{ Bq/m}^3$ despite system simplifications, purging at 10 and 20 SLPM
- $0.39 \pm 0.14 \text{ Bq/m}^3$ at 10 SLPM (1 day of data)
- RAD7 background $0.03 \pm 0.01 \text{ Bq/m}^3$

Radon concentration with 20 SLPM purge



Future Work

Radon concentration alarm for expectation 1 Bq/m^3



- Barrier leak sealing effort after first Science Run, particularly to remove reliance on RAD7 pump
- Simultaneous measurement near cryostat versus from exhaust
 - Measure level of mixing in barrier
 - Identify possible source terms
- Need to observe over longer time periods to understand pressure-driven incursion
- Optimize and integrate system alarms/flags for monitoring and data quality

Acknowledgements

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