

PRad Hydrogen Gas-Flow Target

Chris Keith
JLab Target Group

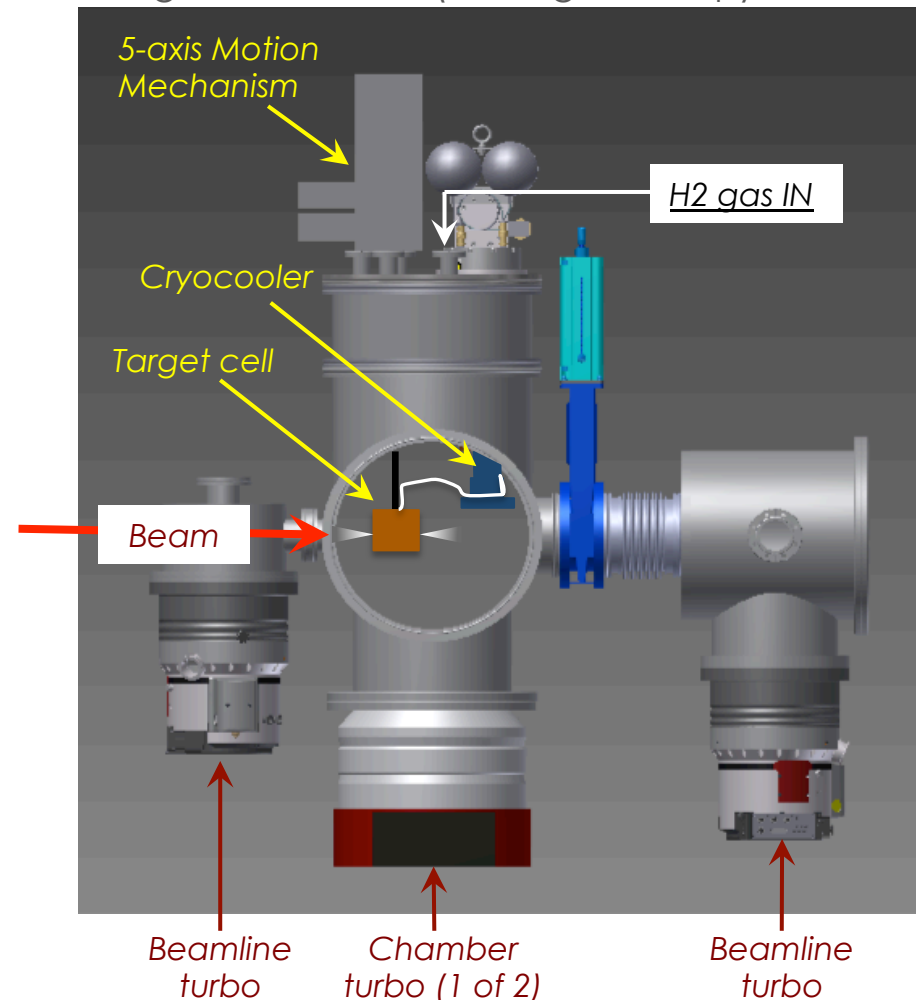
- Overview
- Installation
- Performance
- Future

PRad Target: Overview

- Hydrogen gas is cooled to $\sim 20\text{K}$ by a pulse tube cryocooler
- Gas enters a target cell with 2mm beam-entrance and exit orifices
- 5-axis motion mechanism allows precision alignment on beam line
- Large turbo pumps (3200 l/s) maintain target chamber vacuum $\sim 2 \times 10^{-3}$ torr
- Additional turbos (1500 l/s) maintain beamline vacuum $\sim 10^{-4}$ torr

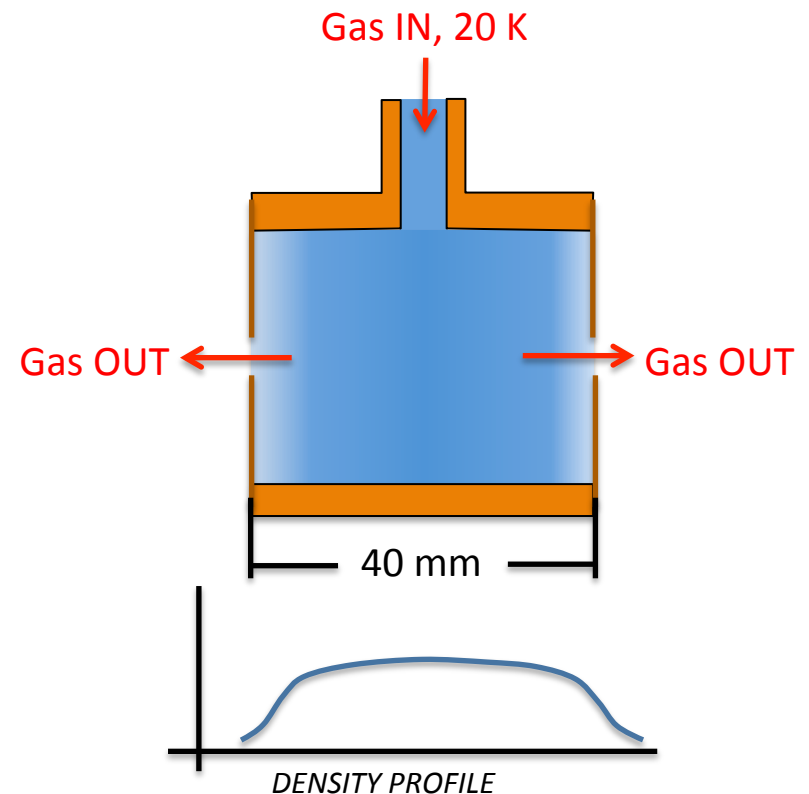
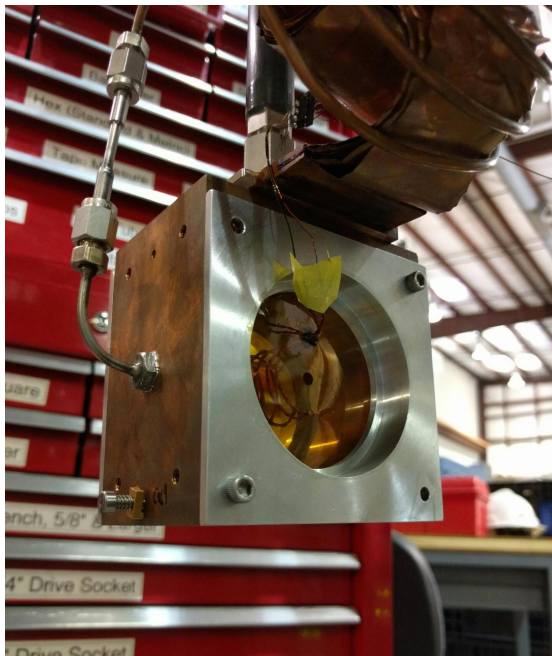
Goal: $1 \cdot 10^{18}$ H/cm²

Design: Josh Pierce (ex Target Group)



PRad Target: Overview

- Target cell is $\text{\O}63 \times 40$ mm long copper, attached to cryocooler via thermal strap
- Cell windows are $7.5 \mu\text{m}$ kapton with 2 mm beam orifices
- Cell has thermometry and pressure tap to estimate gas density
- Two solid target foils: $1.0 \mu\text{m}$ carbon
 $1.0 \mu\text{m}$ aluminum



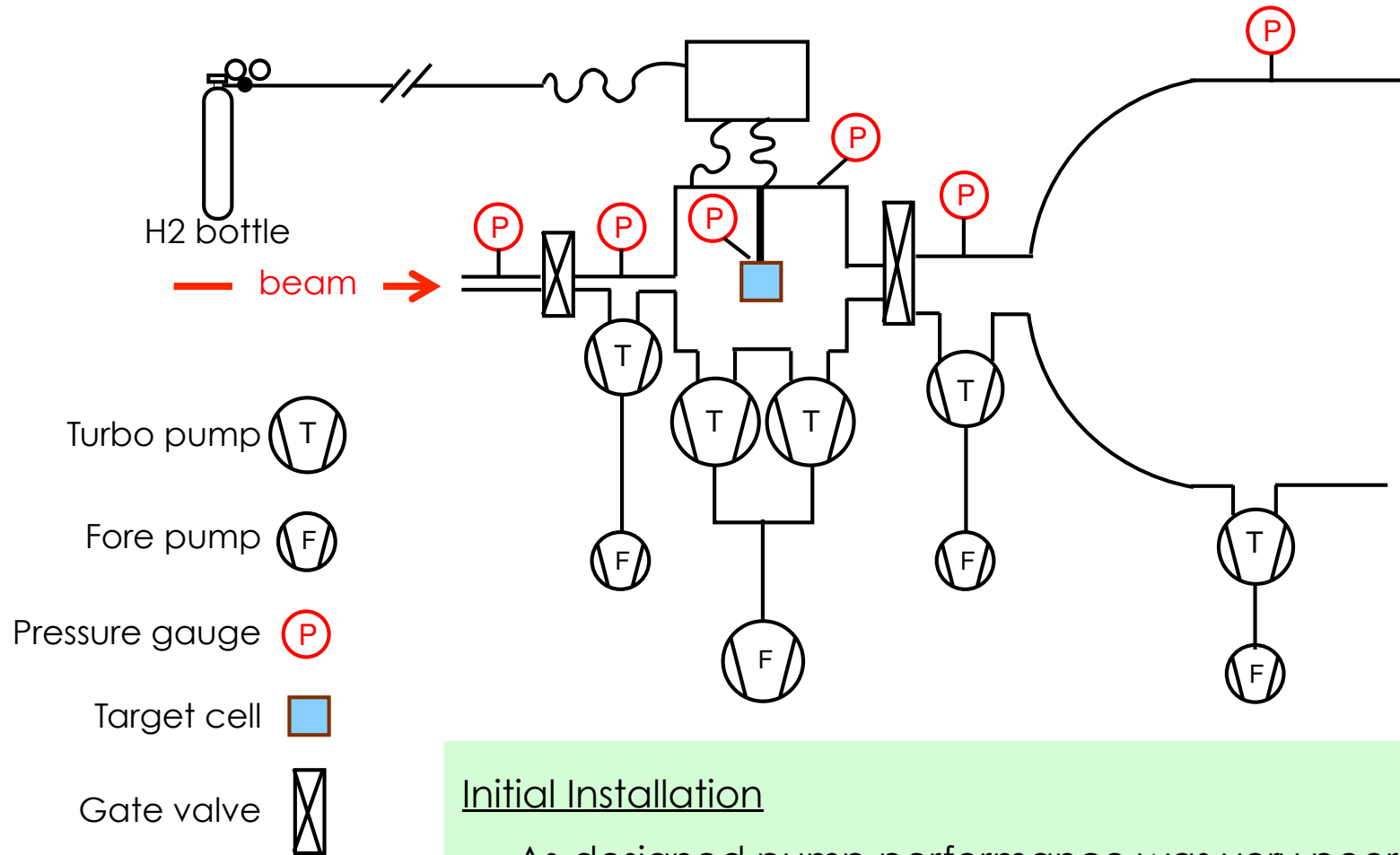
PRad Target: Installation

A windowless hydrogen target for Proton Charge Radius measurements in Hall B

- Installation began in January (~1 week)
- Continued in March (~1 week)
- Finished in May (~2 weeks)



PRad Target: Installation



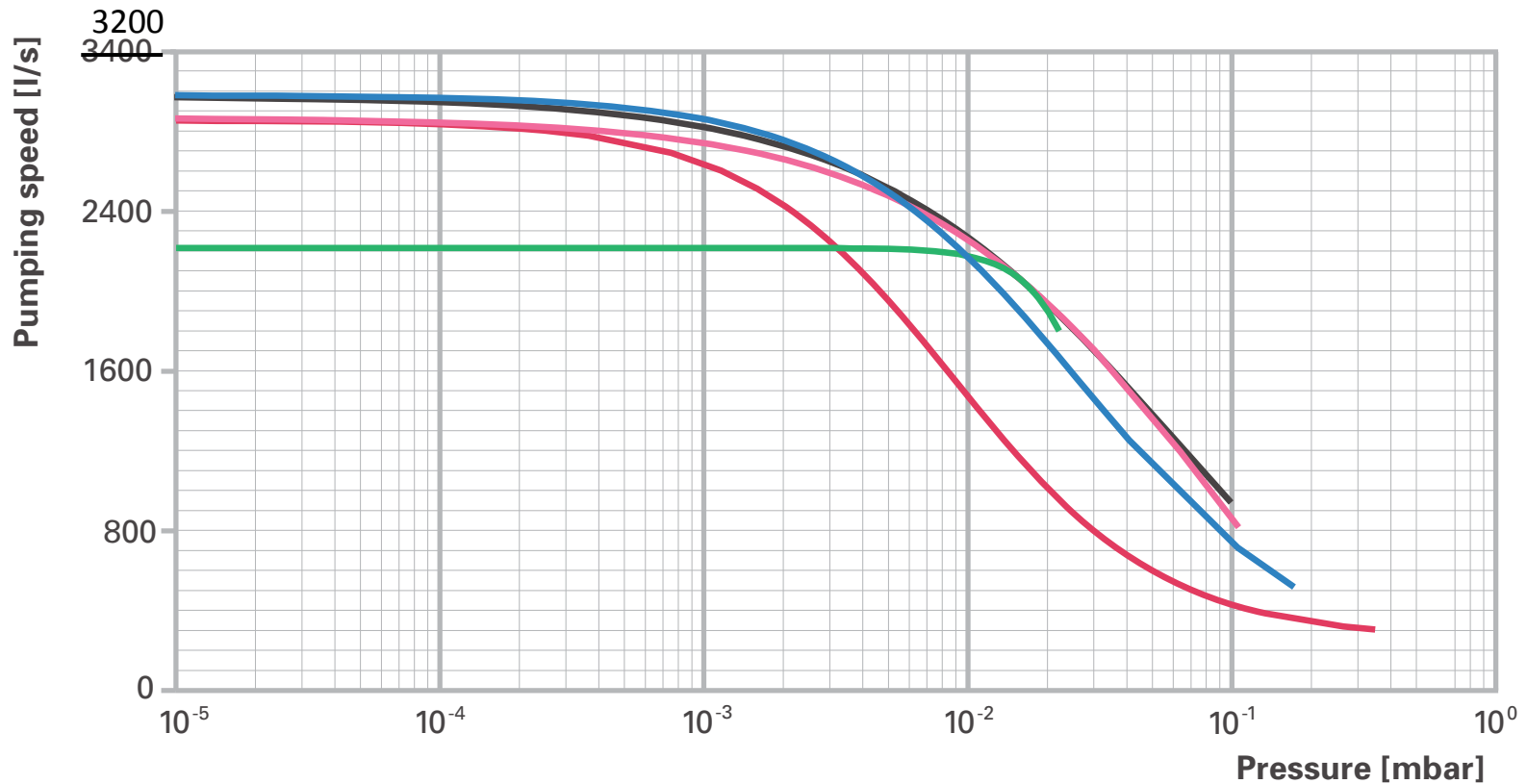
Initial Installation

- As-designed pump performance was very poor
- Chamber pressure 10x higher than expected

PRad Target: Installation

Pfeiffer 3200 Pumping Curves

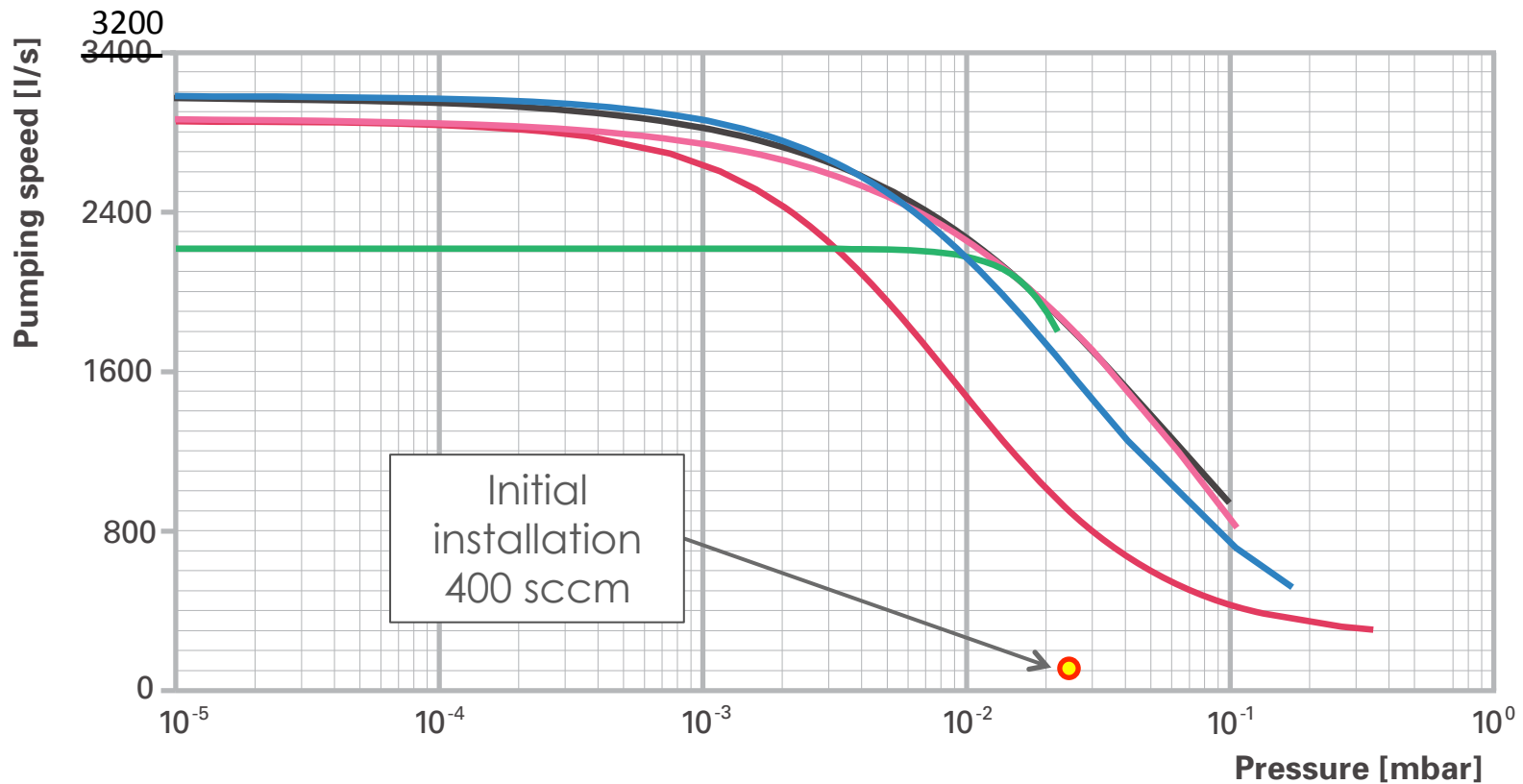
- Nitrogen
- Helium
- Argon
- Hydrogen
- CF₄



PRad Target: Installation

Pfeiffer 3200 Pumping Curves

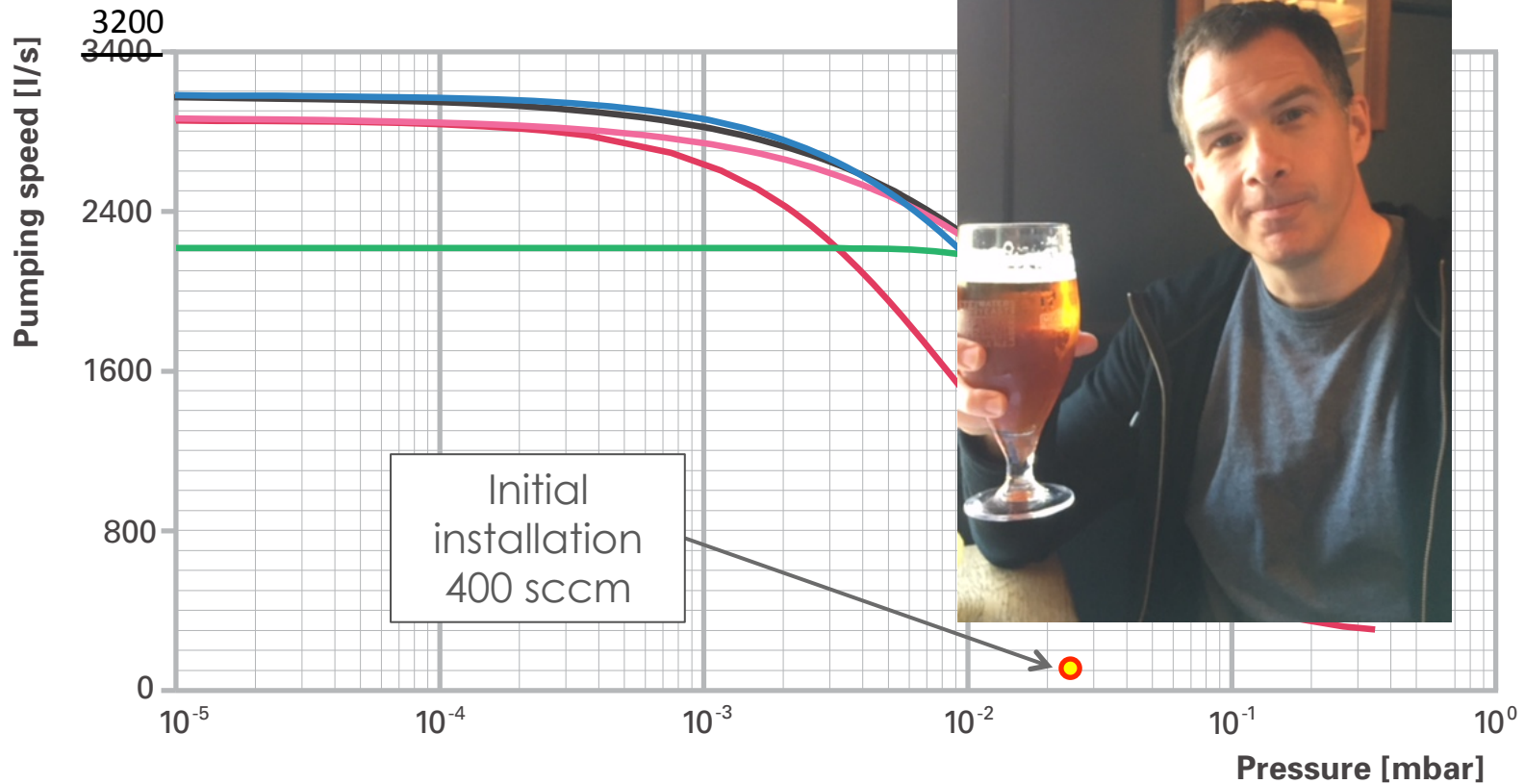
- Nitrogen
- Helium
- Argon
- Hydrogen
- CF₄



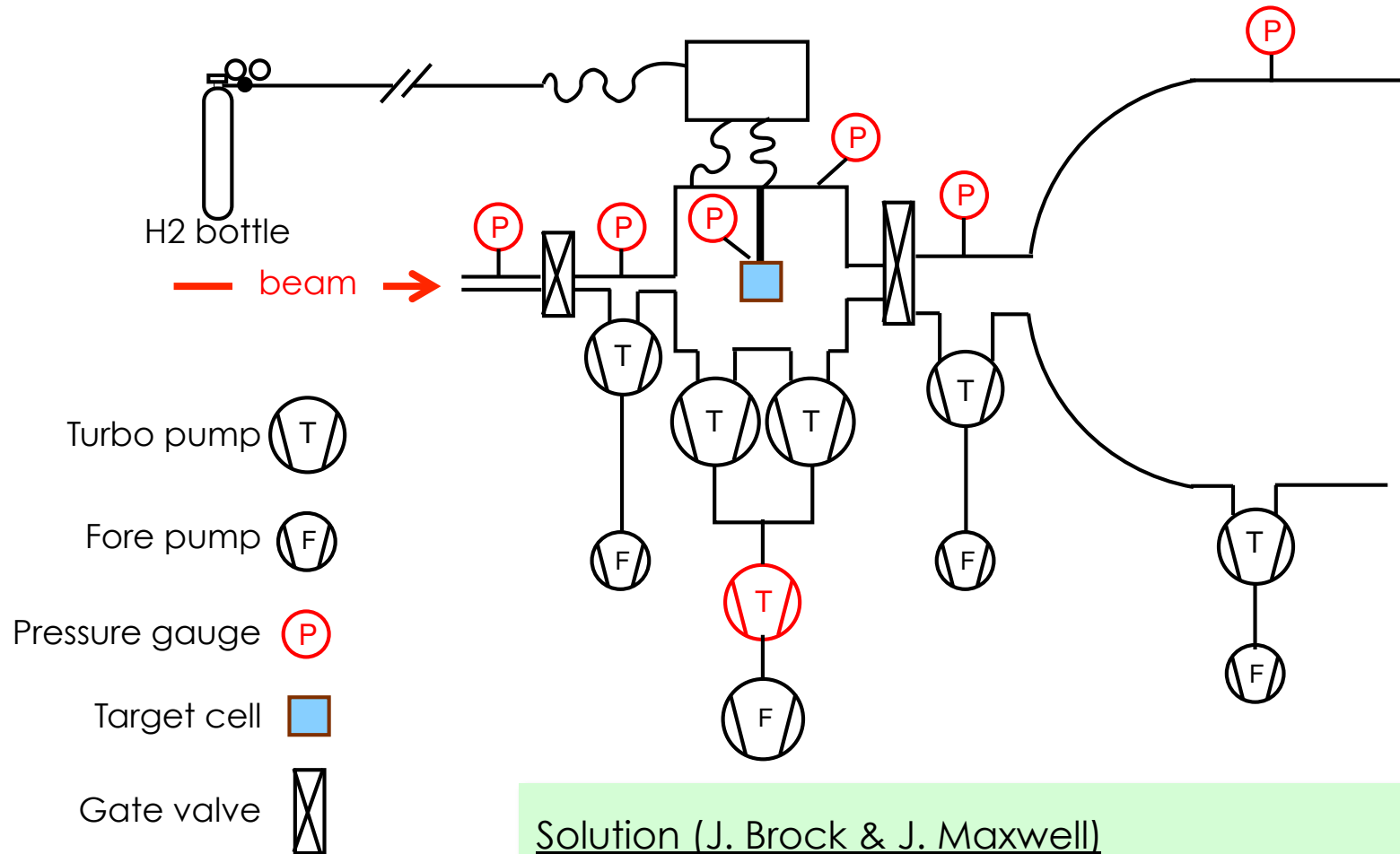
PRad Target: Installation

Pfeiffer 3200 Pumping Curves

- Nitrogen
- Helium
- Argon
- Hydrogen
- CF₄



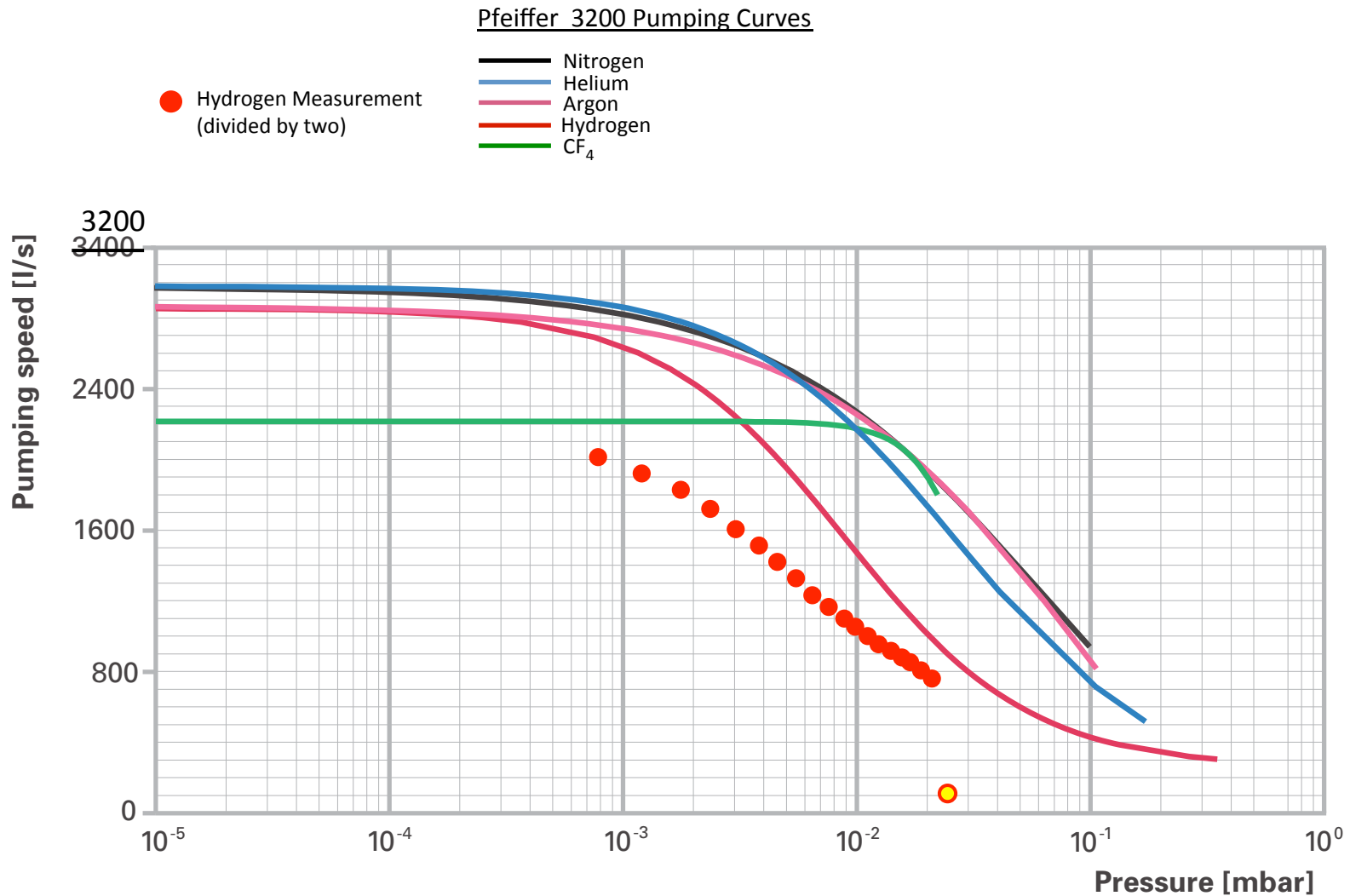
PRad Target: Installation



Solution (J. Brock & J. Maxwell)

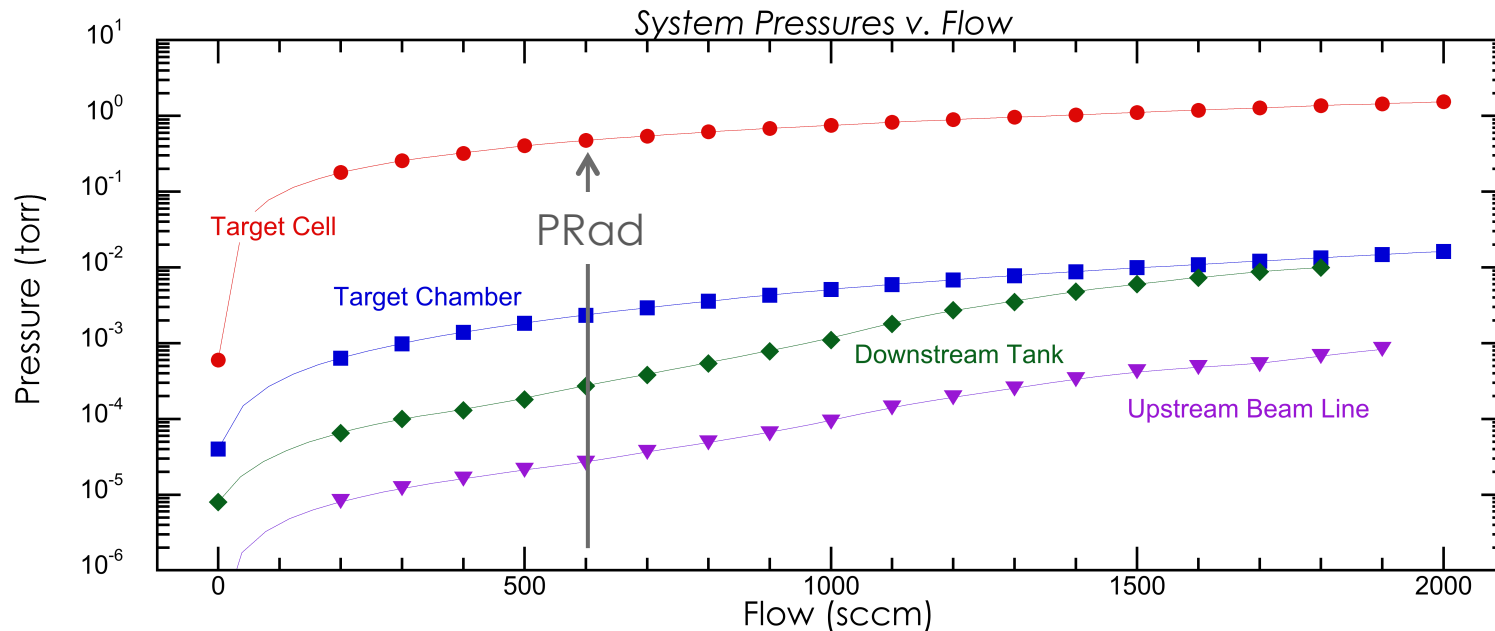
- Add additional turbo pump behind Pfeiffer 3200s
- Chamber pressure 10x lower!

PRad Target: Performance



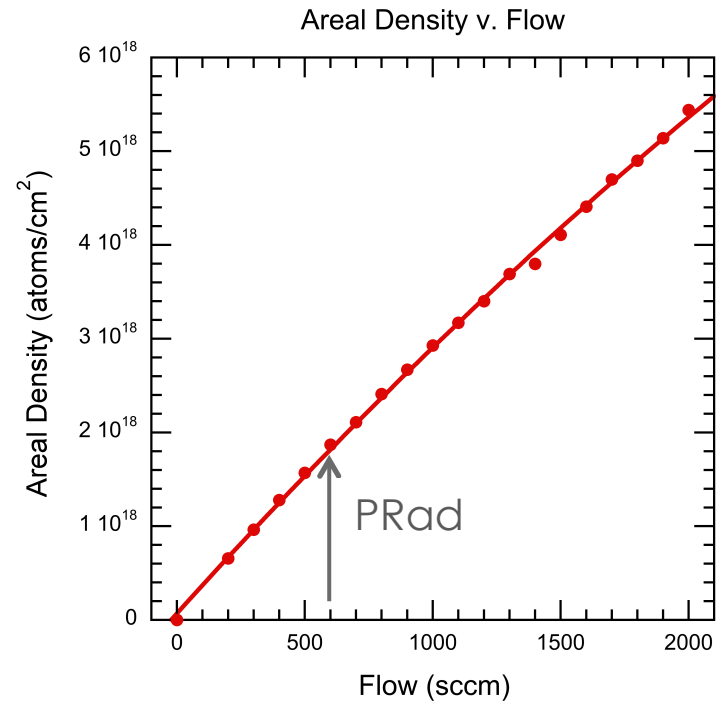
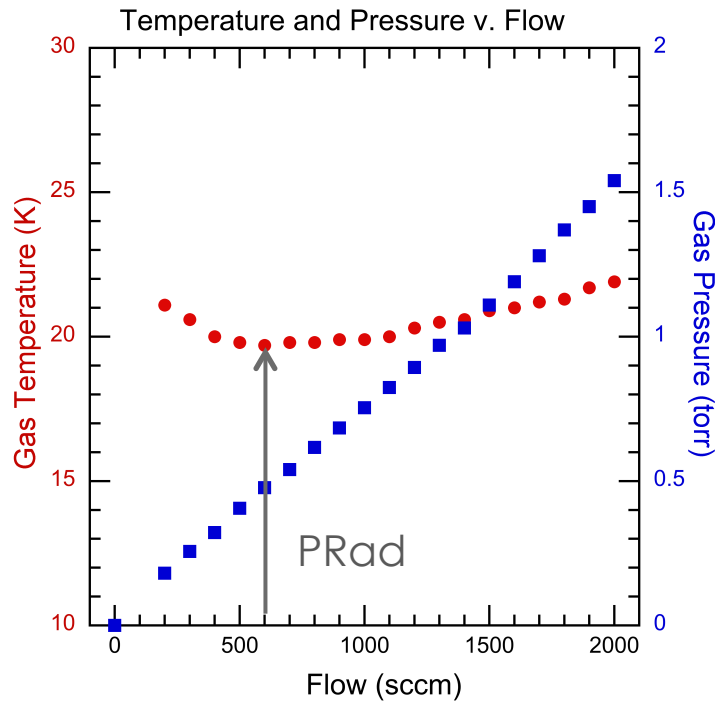
PRad Target: Performance

* Preliminary. Pressures not corrected for H₂ gas.



As flow increases, tank pressure converges to chamber pressure.
➔ Insufficient pumping speed for tank.

PRad Target: Performance

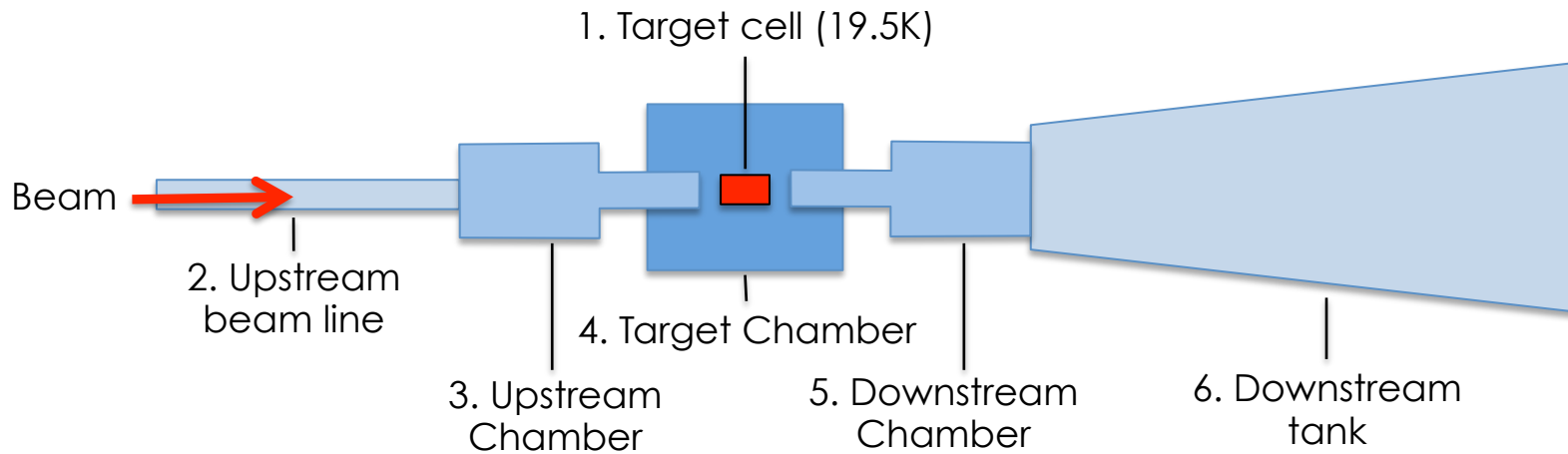


Pulse tube temperature regulated at ~15 K.
H₂ freezes inside fill line at lower temperature.

PRad Target: Performance

Estimate of target background gas

* Preliminary. Pressures not corrected for H2 gas.



Region	Length (cm)	Pressure (torr)	Thickness (cm ⁻²)	Percent of total
1	4	0.48	1.9 e18	99.5
2	300	1.0 e-5	2.0 e14	.01
3	71	2.6 e-5	1.2 e13	.006
4	14	2.3 e-3	2.1 e15	.11
5	71	1.4e-4	6.1 e14	.03
6	400	2.4-4	7.2 e15	.38

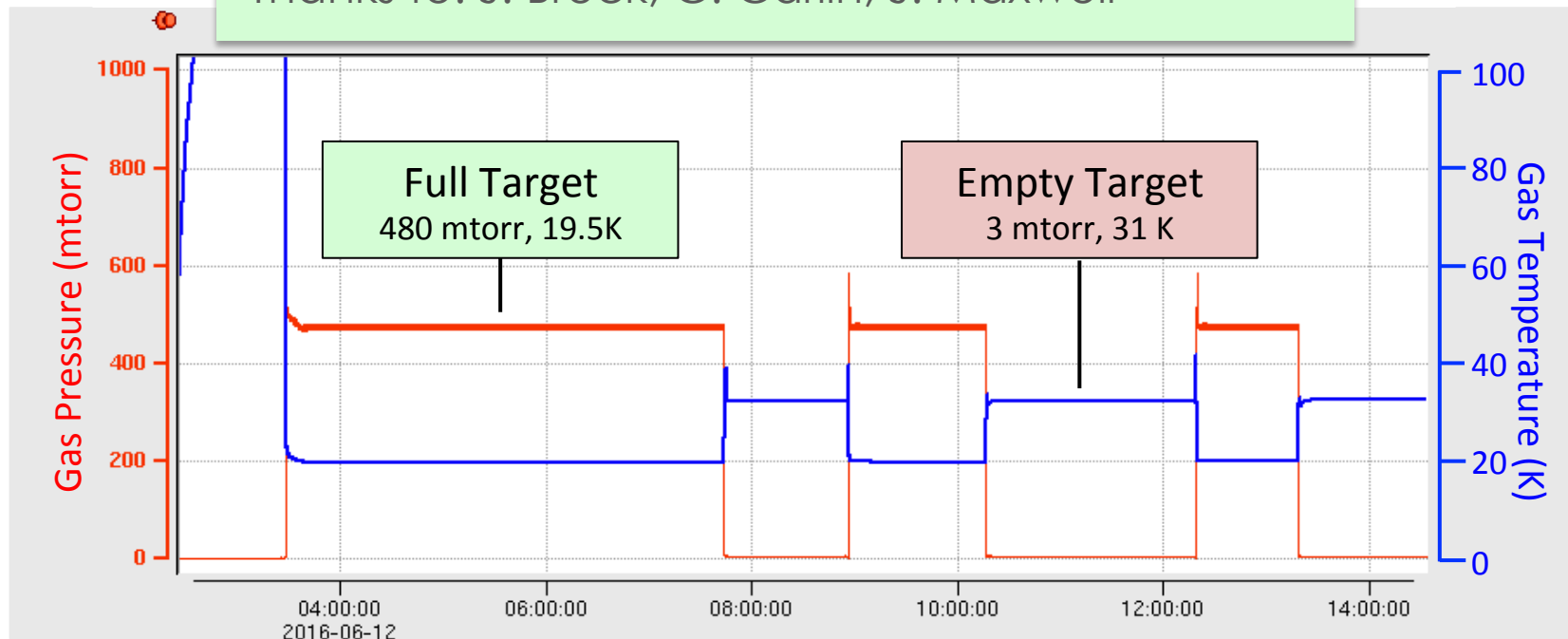
PRad Target: Summary

Operated smoothly w/ beam June 4 - 22

- Cell length, 4 cm
- Cell pressure, 500 mtorr
- Gas temperature, 19.5 K

→ $2 \cdot 10^{18}$ H/cm²

Thanks to: J. Brock, C. Carlin, J. Maxwell



PRad Target: Future plans

- Target will be removed from Hall B *sometime*
- Target will be maintained in current state and stored *someplace*
- Possible future use with other gas species (D_2 , 4He , ...) will be relatively straightforward.
- 3He not so straightforward (\$650k per day)
- Work will begin on a NIM article in the near future