STINGER GHAFFARIAN TECHNOLOGIES

Transient Molecular Transfer during Vacuum Testing

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Transient Deposition?

- A common question in contamination budgeting involves the loss of collected volatiles during ambient I&T activity under vacuum and the resultant cross-contamination from outgassing.
  - How much of the material collected under ambient conditions evaporates under vacuum?
  - Why do pristine surfaces sometimes show increased molecular contamination after vacuum bakeout?
  - How much of the collected molecular contamination is transient (i.e. migratory) and how much is permanent?
- Measuring the transient deposition may be accomplished using a thermally passive QCM

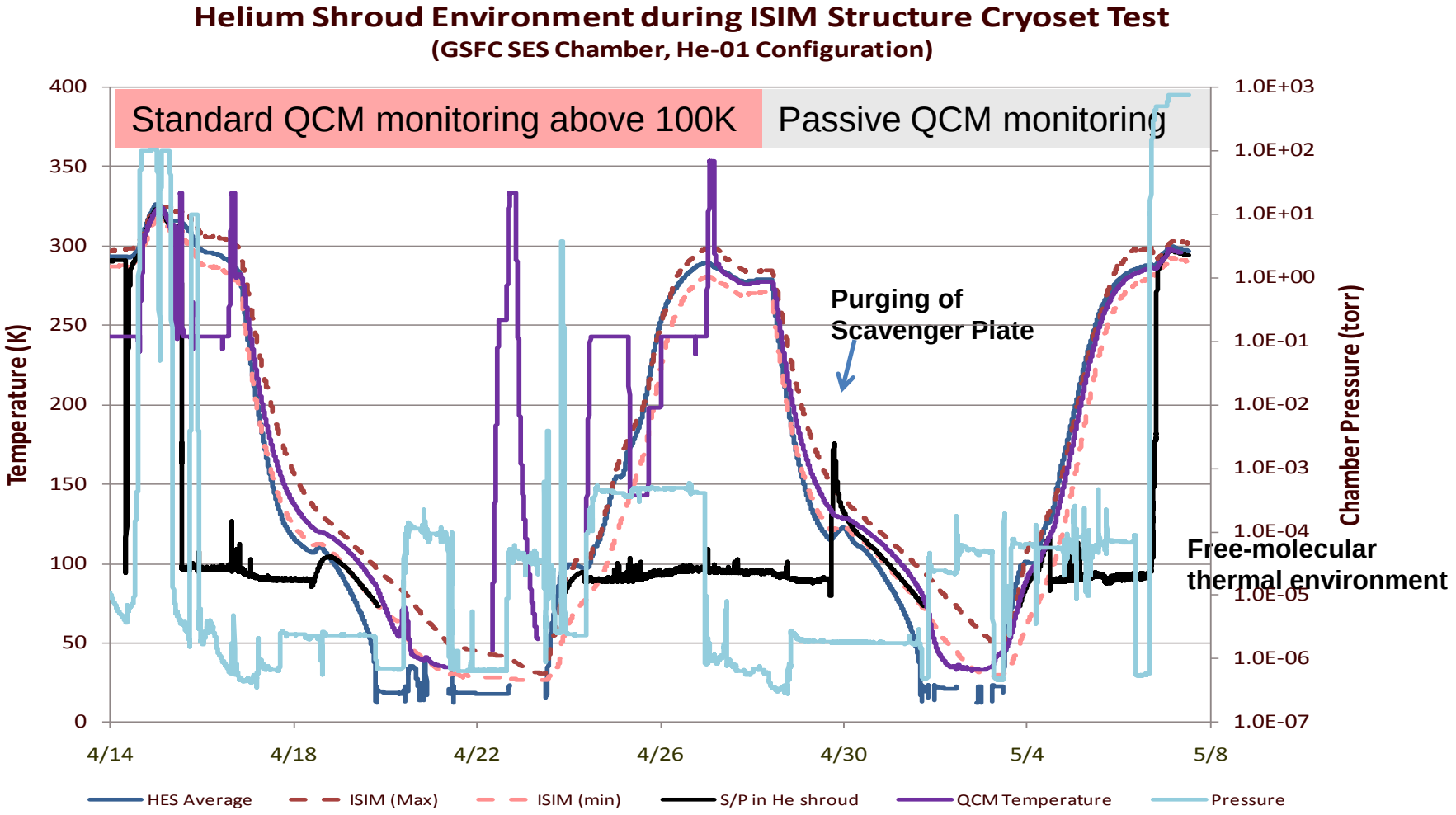
Passive QCM Monitoring

- Allow QCM to drift passively with general environmental temperature (no active thermal control)
- Monitor frequency and temperature
- Calibrate frequency for full temperature range (QCM Research provides calibration curve from 395K to 95K)
- Conversion from frequency to deposition thickness based on unit density and sensitivity of QCM Research 15 MHz QCM ($1.96x10^{-9}g/cm^2$-Hz)

$$\frac{1.96x10^{-9}\,g}{cm^2 - Hz} \bullet \frac{cm^3}{1.0g} \bullet \frac{10^8\,\text{Å}}{cm}$$

$$\therefore 1.0Hz \cong 0.2\text{Å}$$

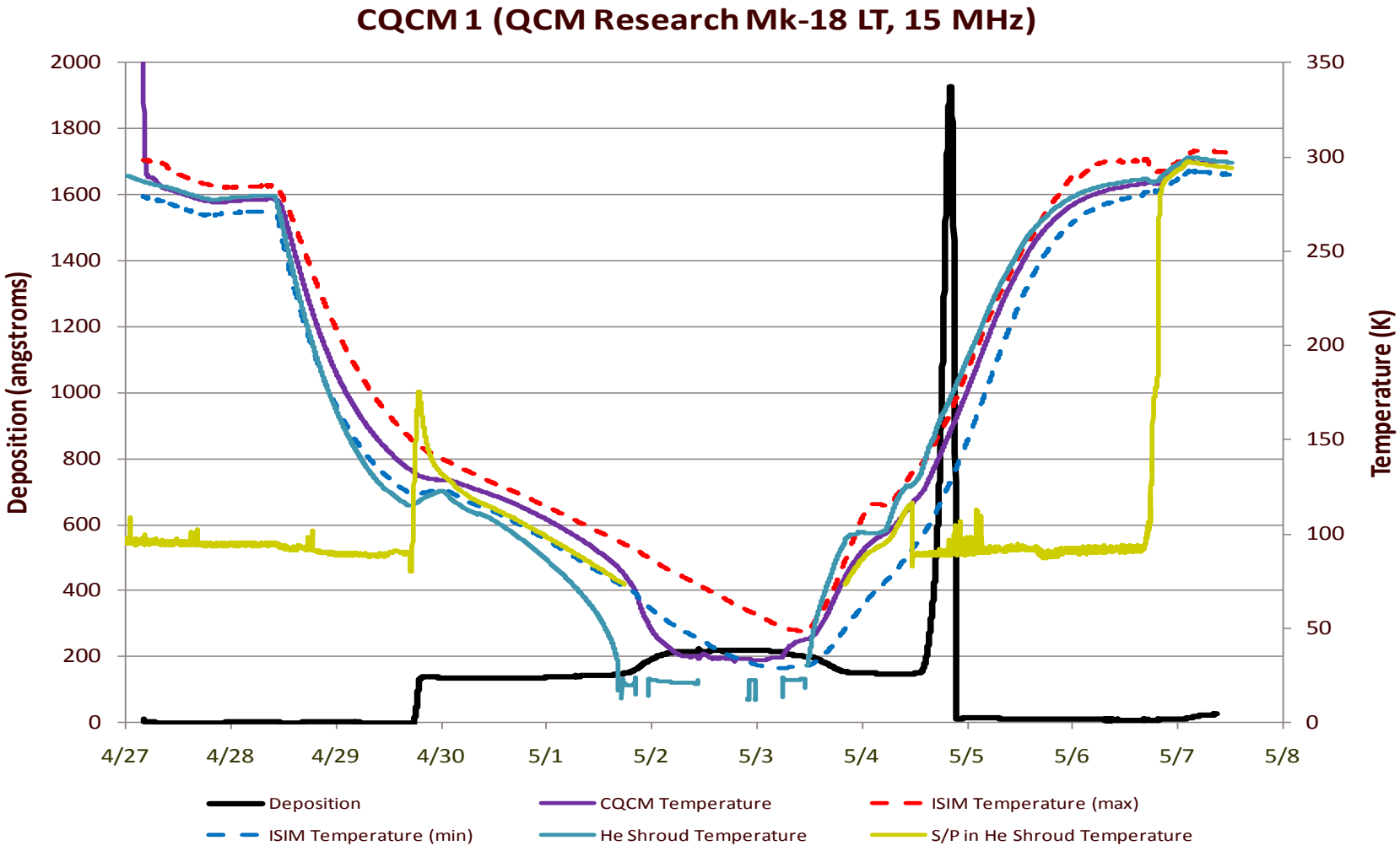
Overview of the Cryocycle Test Environment



ISIM Cryocycle Test

- Perform bakeout, two (2) cryocycles, and outgassing measurement of the ISIM Structure
- First cycle:
  - Initial outgassing estimate and bakeout
  - Measure outgassing deposition on 243K QCM
  - Bakeoff QCM and allow to thermally drift while test environment below 100K
  - Perform QCM bakeoff to 350K while environment at 30K to calibrate frequency/temperature effects
  - Monitor outgassing deposition on 243K QCM during warmup, confirm outgassing measurement
- Second cycle:
  - Bakeoff QCM to 350K while environment at 290K
  - Allow QCM to thermally drift during cycle, until environment returns to 290K

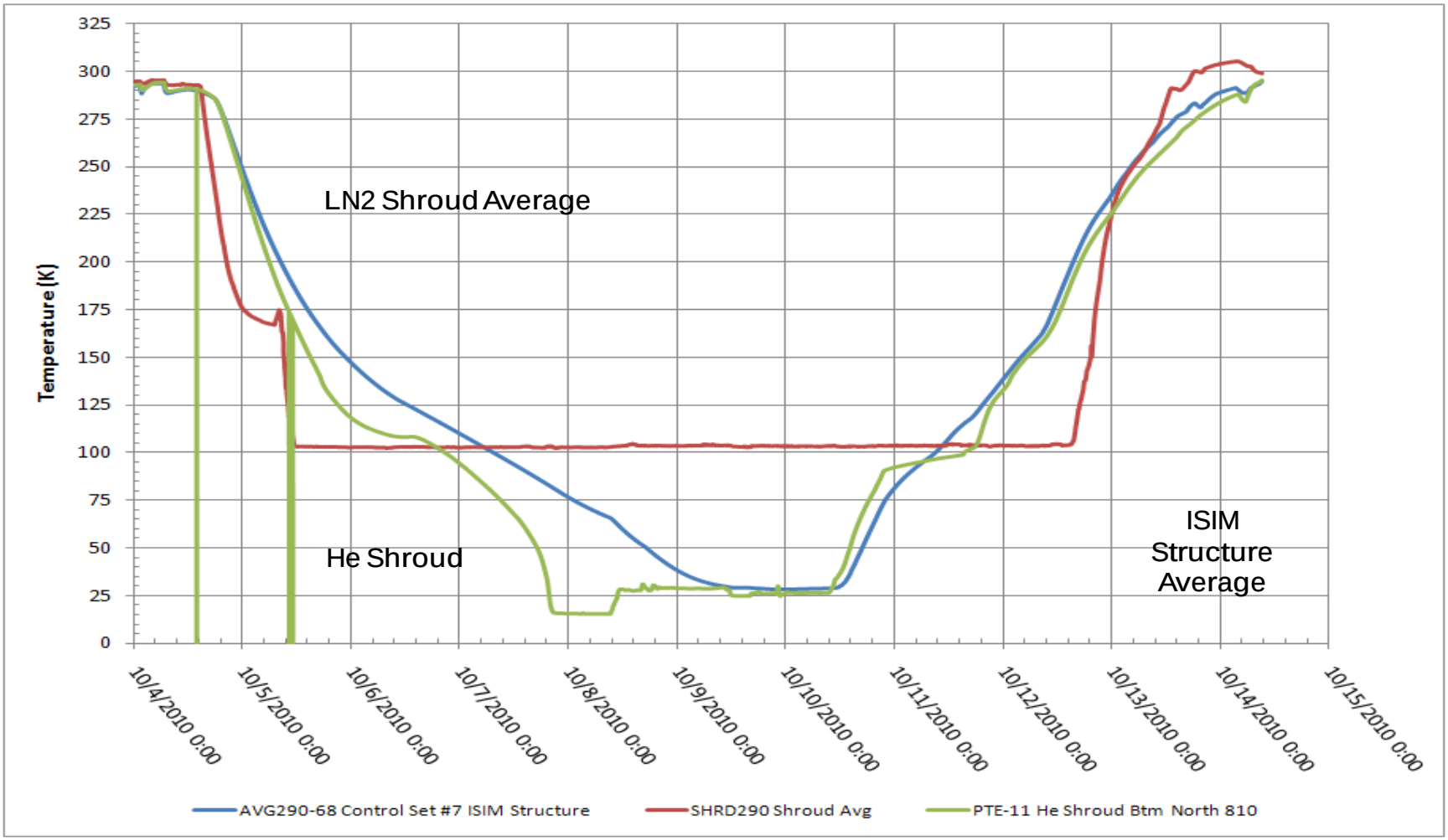
ISIM Cryocycle (#2) Test



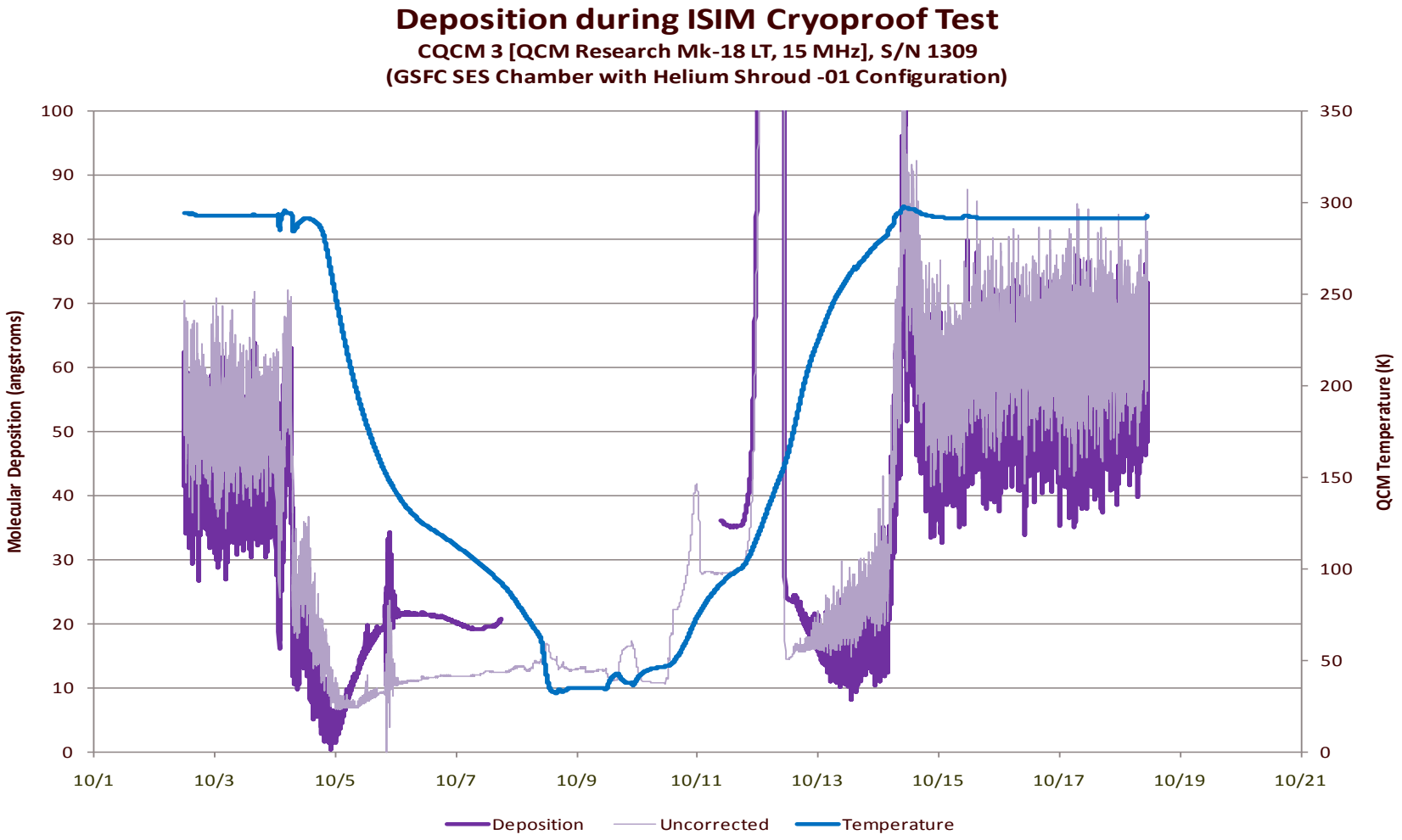
ISIM Cryoproof Test

- Perform single cryocycle of the ISIM Structure
- Monitor deposition with thermally passive QCM:
  - Two (2) days of ambient (cleanroom) conditions
    - Configuration completed and chamber door closed on Friday evening
    - Chamber evacuation started Monday morning
  - Allow QCM to thermally drift during cycle
  - Two (2) days of ambient (cleanroom) conditions
    - Chamber returned to ambient and contamination witness samples removed on Friday afternoon
    - Disassembly of chamber configuration began on Monday

Thermal Overview of Cryoproof Test



Deposition during Cryoproof



Passive CQCM Results

- The light line is the raw QCM frequency minus the minimum read value.
- The dark line is temperature corrected using the manufacturers 9th order polynomial calibration curve (valid from -180 to +120°C).
- Reported values in table are averaged over one hour, parenthetical values are from the last cycle of the Cryoset Test.

Condition	Net Deposition (Å)	Temperature (°C)	Shroud (°C)	Comments
Ambient	48±14	20.9		30-50% rH
Rough Out	17±7	15.6		Moisture loss
Begin Cooling	18±8 (1.2±0.05)	15.6 (4.3)	(6.1)	High vacuum
Non-Water	19±0.3 (1.5±0.4)	-115.0 (-114.0)	(-136.5)	
Max Water	919 (1927)			Peak width ~ 20 Hr (~13 Hr)
Post-H_2O Flash	24±0.3 (12±0.3)	-112.7 (-111.2)	(-93.8)	
Begin N_2 Backfill	19±6 (9±0.6)	11.7 (10.7)	(13.7)	High vacuum
500 torr N_2	58±17 (25±0.2)	21.7 (12.9)	(14.4)	Transfer from walls?
Ambient	72±14	18.6		Moisture regain
Ambient (3 days)	63±15	18.0		30-50% rH

Conclusions

- The passive “drifting” QCM provided a reasonable proxy to the hardware temperature.
- Initial deposition loss during evacuation was consistent with the removal of humidity.
- Maximum deposition was due to water transfer from the walls during warm-up, but readily evaporated.
- Net deposition during cycling appears minimal, with gain occurring during backfill.
- Future work will include starting the chamber backfill with a simulated instrument purge.