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LLO X-End Excess Gas Load

Excess gas load based on pressure, RGA data and helium leak checking activities.

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A Brief History

- A noticeable difference in pump down times and ultimate pressure raised suspicion after the X-End vent/pump down Aug 28, 2014. (see plot next slide)

- Also following the successful repair of GV7 and comparing ultimate pressures of both X & Y end stations also heightened this sense of awareness and concern.

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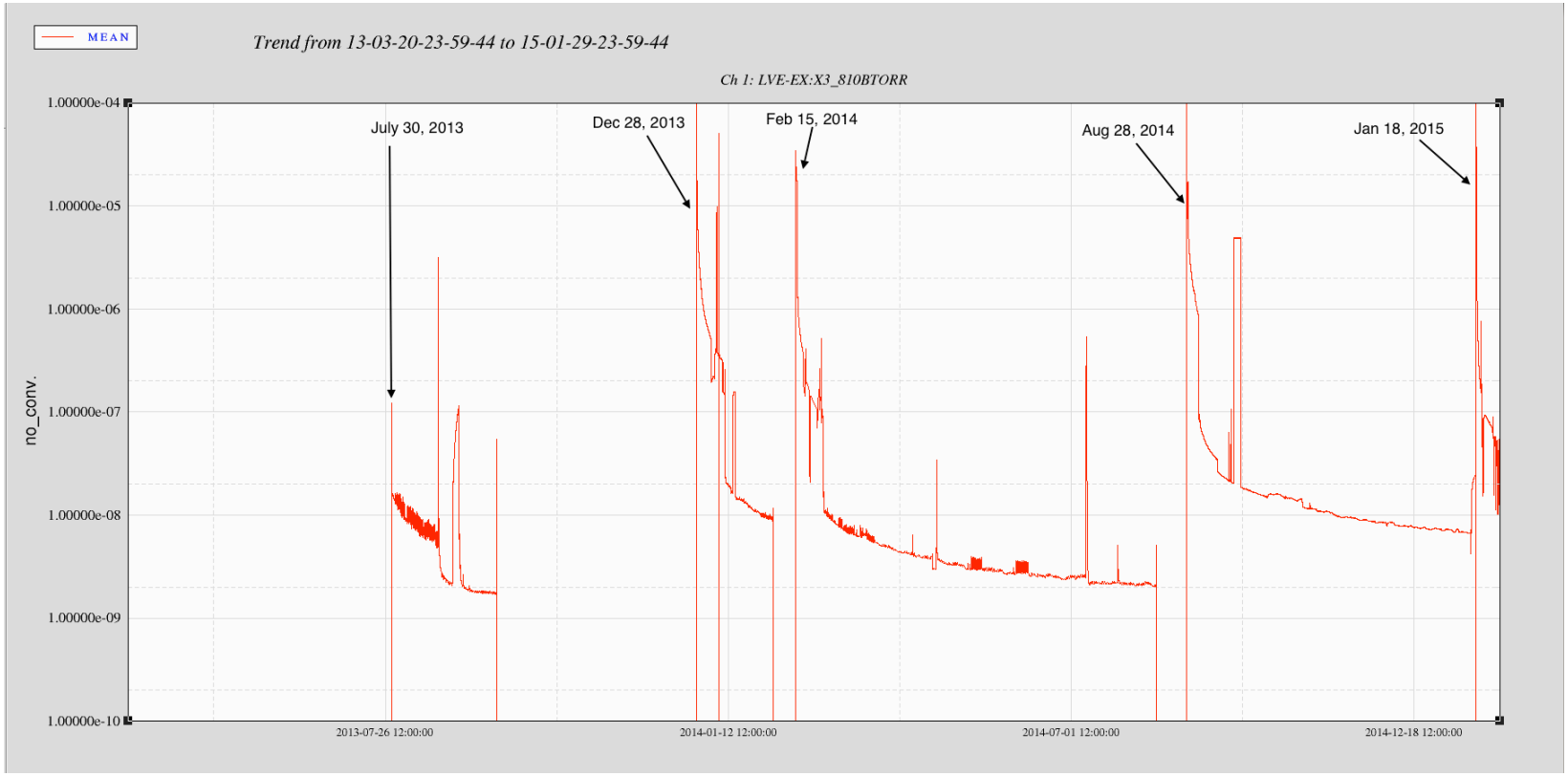
X-End Trend History for BSC4/PT810B



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X-End RGA and Leak Checking

Opportunity surfaced during the PSL maintenance period and simultaneously the vacuum recovery process post Test Mass Discharge attempts.

Jan 19th 2015

- Vacuum certification efforts began to commission the Balzers RGA located on the BSC4 chamber and extensive leak checking in the building with GV12 closed.

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Pumping & Leak Checking Configuration

- **All** pumping, leak checking and RGA data is performed from the BSC side of GV12

- **Pumping station configuration:** Seiko Turbo backed by the QDP80 roughing pump, no ion pump was introduced to the system during this time due to charge measurements taking place.

- **Leak Checking station configuration:** Seiko Turbo backed by the Inficon UL5000 leak detector. NOTE: This configuration is used only during the leak checking process or when monitoring the helium background after a direct hit of an outside air leak.

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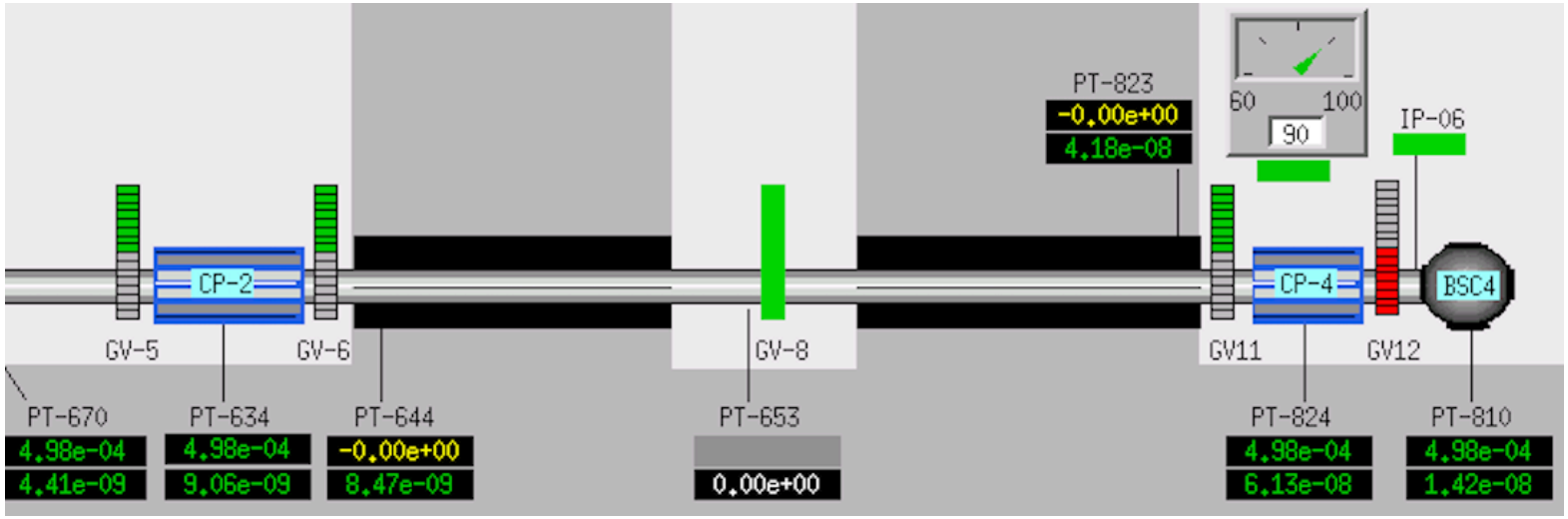
Map of Instrumentation

Discharge Gauges and Locations	
PT-810B	BSC4
PT-824B	Cryo trap # 4
PT-823B	In VEAX on Beam Tube
PT-653B	X-Mid Station
PT-644B	In LVEA on Beam Tube
PT-634B	Cryo trap #2
PT-670B	LVEA between GV-2&5



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Initial Leak Checking Results

Jan 19, 2015

- Start of extensive leak checking with GV12 closed. Leak checking activities covered the entire BSC and associated spool piece including GV12 annulus mini CF and sniffed around bonnet. NOTE: GV12 dust cover was not part of this leak checking process.

Jan 21, 2015

- A small permeation leak (~1e-9 torr l/s) was detected on a view port ETM-X-Video2 (VP6). View Port Assembly # LIGO-D1100999-v4
- Fault report entered 1/21/15 2587
- No other detectable leaks were found during this time period.

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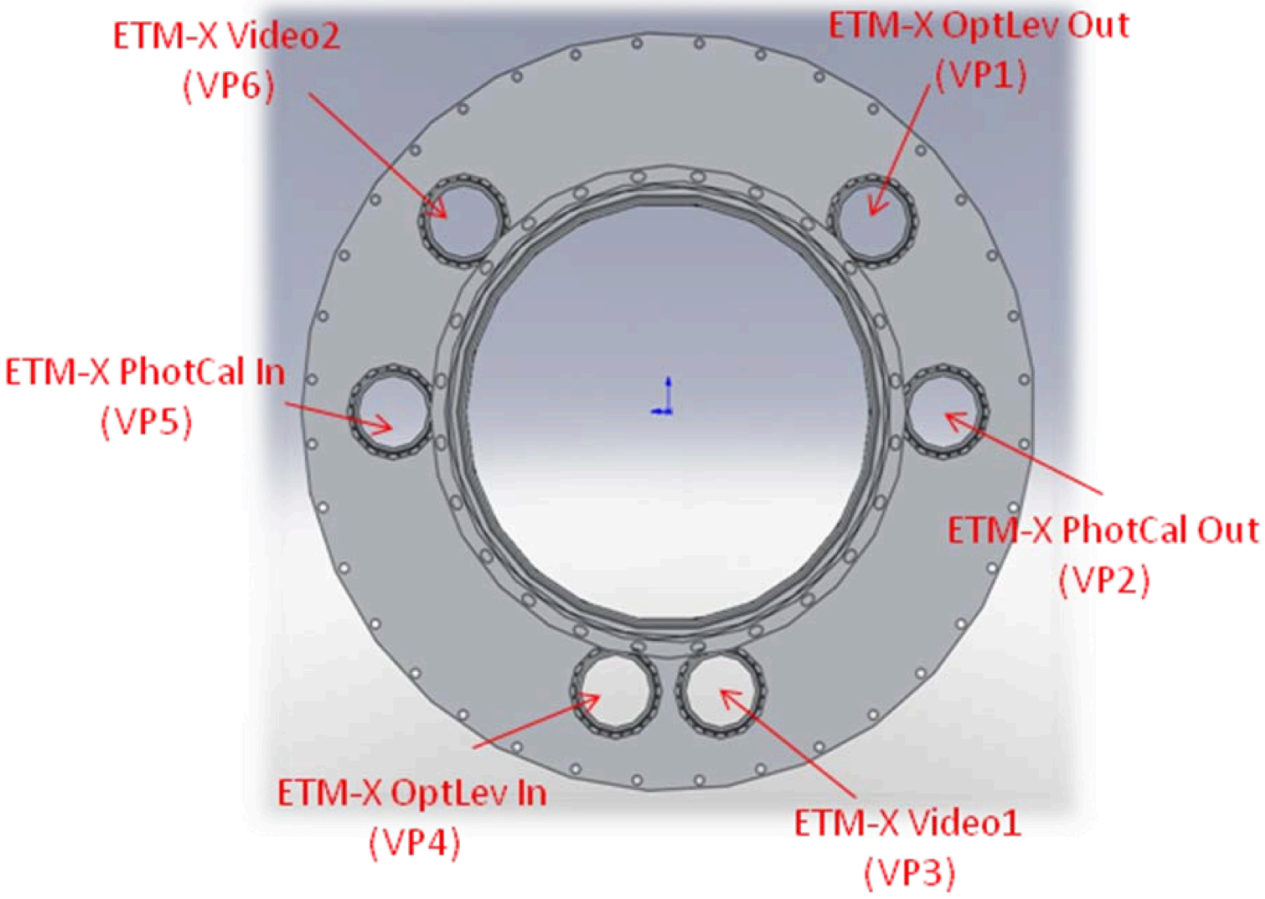
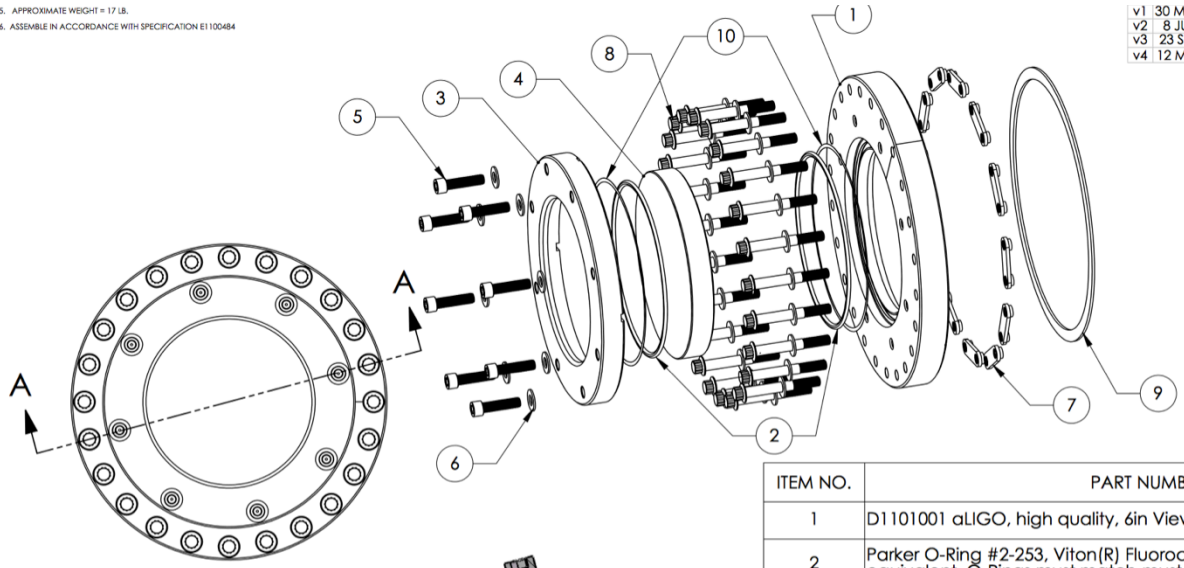
View Port Flange Location

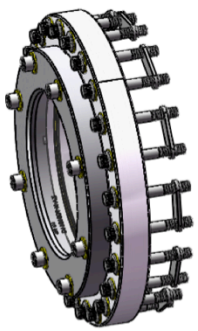


View Port- LIGO-D1100999

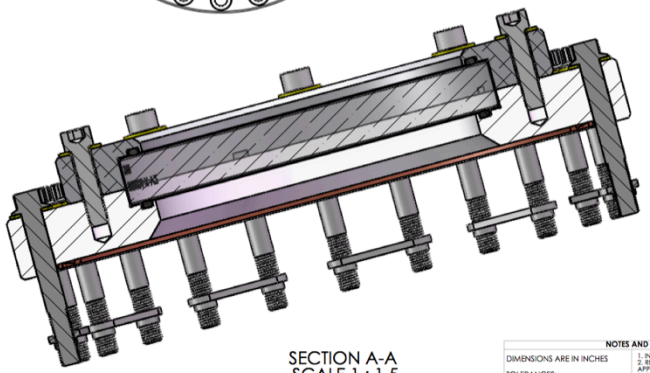
5. APPROXIMATE WEIGHT = 17 LB.
6. ASSEMBLE IN ACCORDANCE WITH SPECIFICATION E1100484

v1	30 MAY 2011	E1100478-x0	E1100479
v2	8 JUL 2011	E1100478-v1	E1100479
v3	23 SEP 2011	E1100478-v4	-
v4	12 MAR 2012	E1100478-v4	





ITEM NO.	PART NUMBER	QTY.
1	D1101001 aLIGO, high quality, 6in Viewport Flange	1
2	Parker O-Ring #2-253, Viton(R) Fluorocarbon (KFM), 75 Shore A or equivalent. O-Rings must match-must be from the same lot/batch.	2
3	D1101002 aLIGO, high quality, 6in Viewport Clamp	1
4	D1101006-1 aLIGO, high quality, non-wedged, 6in Viewport, Optic AR1064/532	1
5	5/16-24 UNF x 1.25", Silver Plated, UC Components #C-3120-NA or equivalent	8
6	5/16" FLAT WASHERS, NAS 1149-C0563R (OR EQUIV.)	8
7	Nut Plate, 10" Conflat, Nor-Cal NP-800 or equivalent	12
8	5/16-24 UNF x 2.5", Silver Plated, 12 PT Flange Bolt, and Washers MDC Kit #190067 (qty 25) or equivalent, discard nut.	24
9	Copper Gasket, 10" Conflat, MDC #191019 or equivalent	1
10	D1003207 aLIGO, high quality, 6in Viewport, Viewport Spacer	2



SECTION A-A
SCALE 1 : 1.5

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)
DIMENSIONS ARE IN INCHES
TOLERANCES: .XX ± .03
1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES, .005-.015. FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS.
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY
PART NAME: High Quality, Non-Wedged, 6in Viewport Assy_AR1064/532
SYSTEM: AOS SUB-SYSTEM: SIC
DESIGNER: Dennis Coyne 30 May 2011 SIZE DWG. NO. REV.

99 aLIGO, high quality, non-wedged, 6in Viewport Assy, PART PDM REV= X-015, DRAWING PDM REV= X-013

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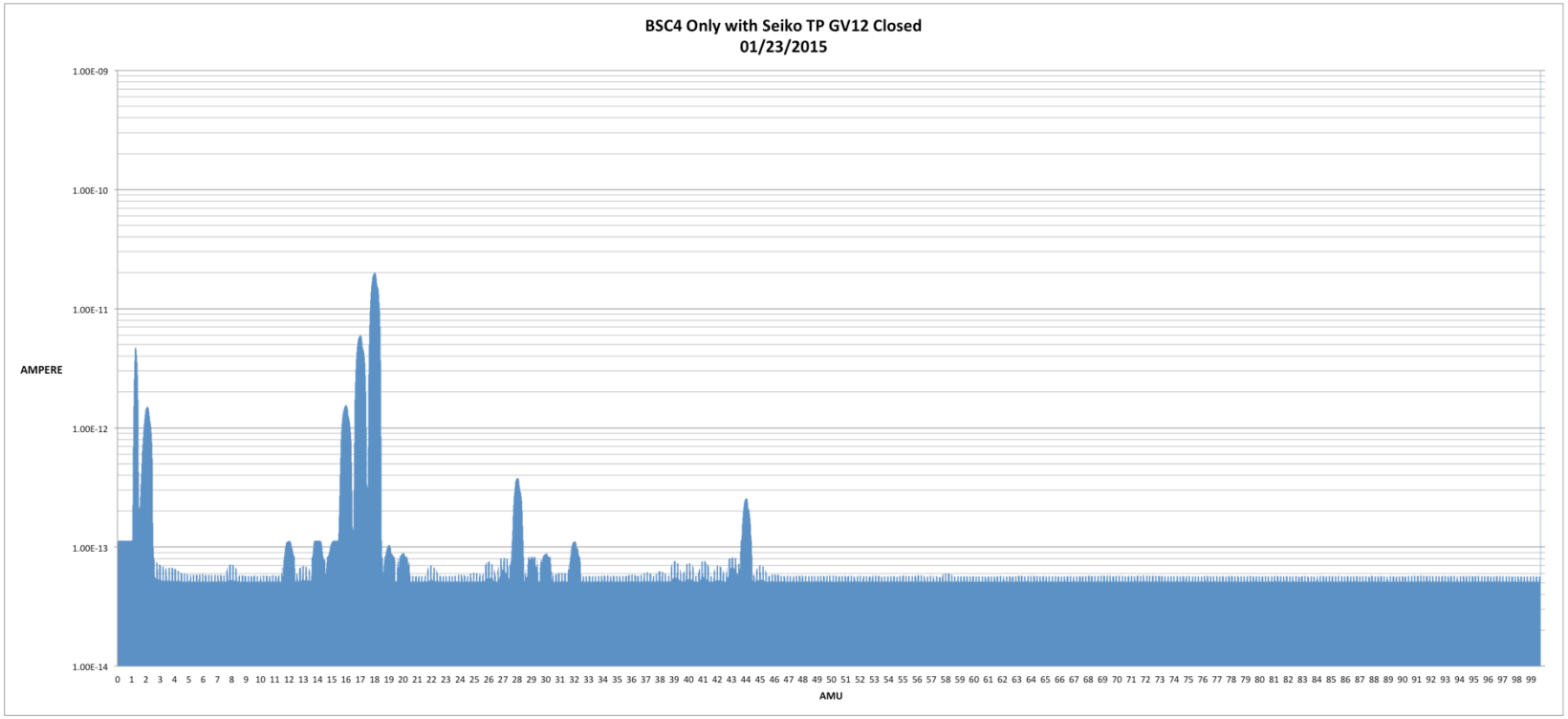
RGA DATA With GV12 Closed

- Jan 23, 2015 RGA scans saved
- RGA scan with GV12 closed (next slide)
- Water is the highest peak.
- No signs of an outside air leak.

RGA DATA With GV12 Closed Jan 23, 2015



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RGA Data With GV12 Open

Jan 26, 2015

- GV12 was opened, rendering the BSC4 chamber common with the Cryo Trap and X-Arm (GV11 Open).
- RGA scan displays a “text book” outside air leak signature (next slide)
- Peeks at AMU 14, 28, 32, and 40 indicate an air leak.

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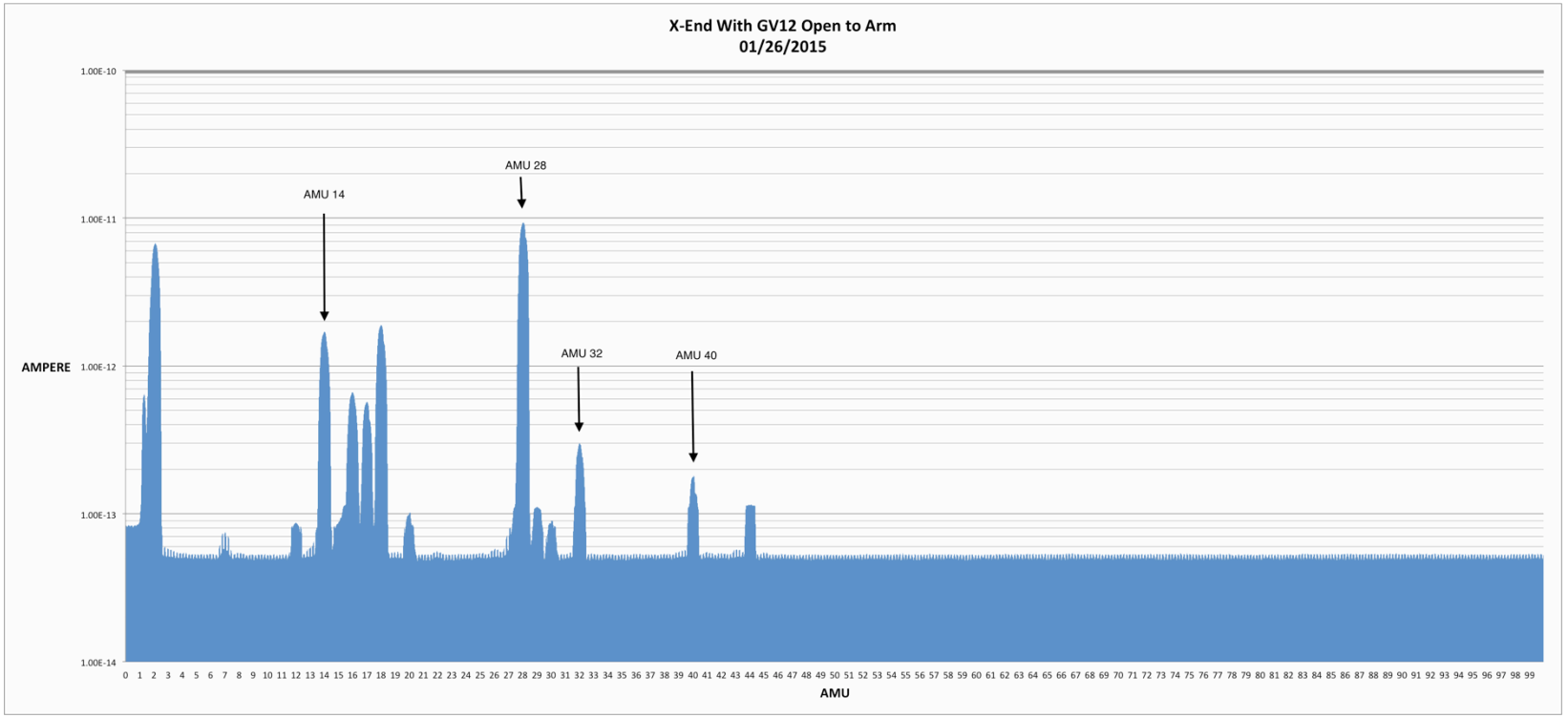
RGA Data With GV12 Open



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RGA Data and Leak Checking

Jan 26, 2015

- RGA scans indicated an air signature on the east side of GV12.

- Begin a complete leak check of all components accessible in the VEA performed to validate if the air signature was coming from the beam tube or something inside the VEA.

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Leak Checking Continued

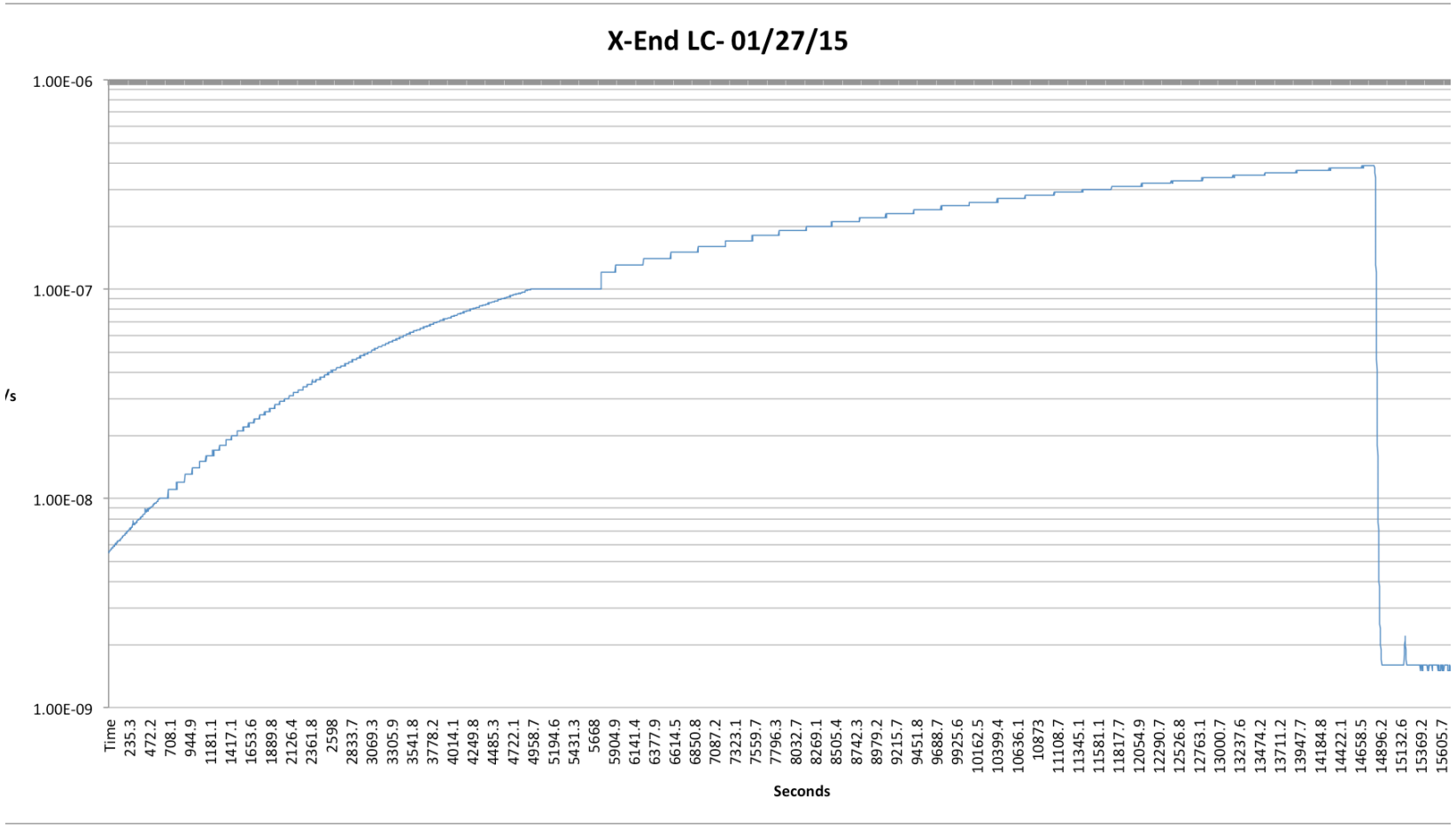
Jan 26, 2015

- Ruled out all suspect flanges, welds, all metal valves (pump out ports), gate valve on CP-4, and feed-through locations.

Jan 27, 2015

- A delayed (~ 5-10 min) response but positive, on the leak detector after spraying helium in the dust cover of GV11 and in the process of spraying GV12 dust cover.

INFICON UL5000 Leak Detector Data



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Post Leak Checking

Jan 28, 2015 **Morning Activities**

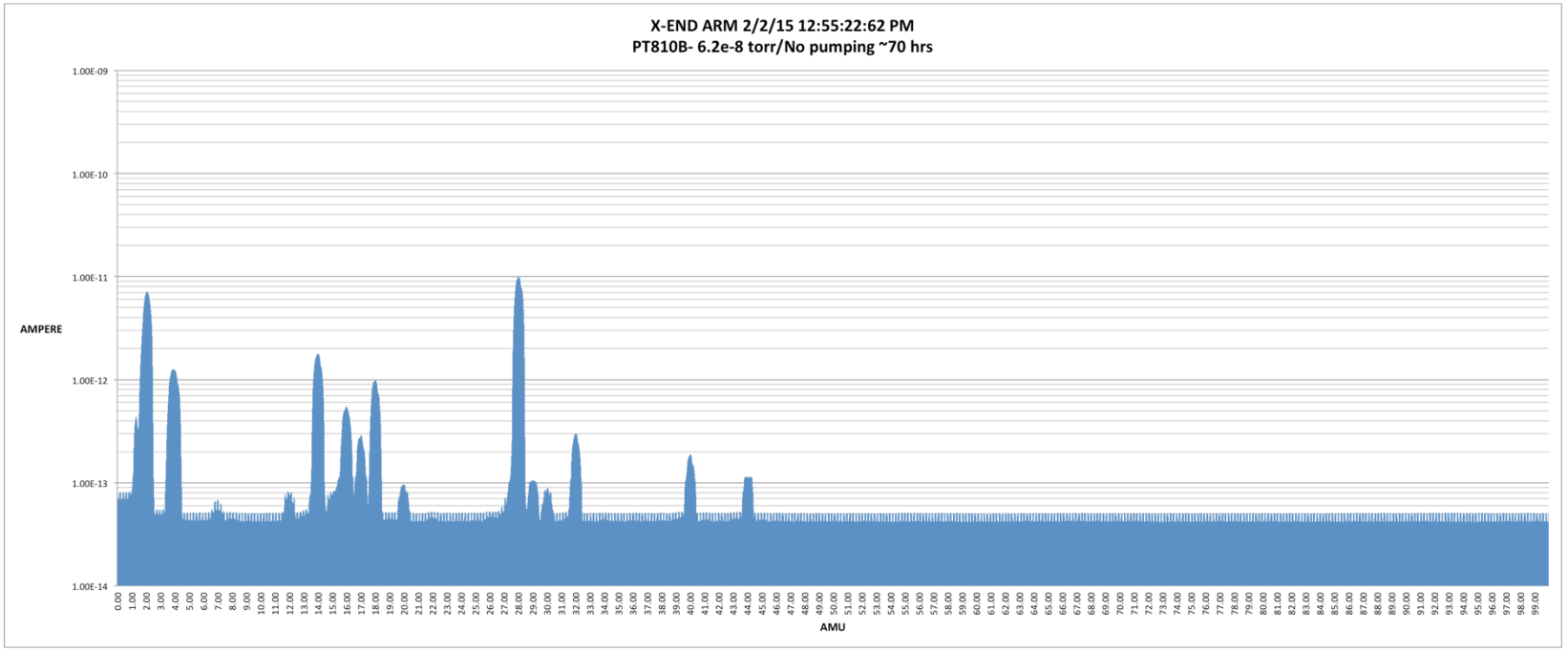
- Use the Seiko TP to pump down and recover the pressure (no ion pump).
- Introducing the leak detector and isolating the QDP80 to sample the helium back ground in the morning.
- Leak rate 2e-6 torr l/s
- Repeat this method daily through Friday Jan 30, 2015. Each days results were very close and repeatable.

RGA Data Post Leak Checking LGV Dust Covers

Feb 2, 2015

- The vacuum system was left static over the weekend, no pumping from Seiko or Ion pump (~70 hrs.)
- RGA scan (next slide) demonstrates the helium in the system is substantial. RGA in faraday cup mode (No CEM) indicates two things now.
  - » Outside air leak
  - » Helium saturation overcomes the water peak

RGA Scan Baseline
~ 70 hrs. With No Pumping



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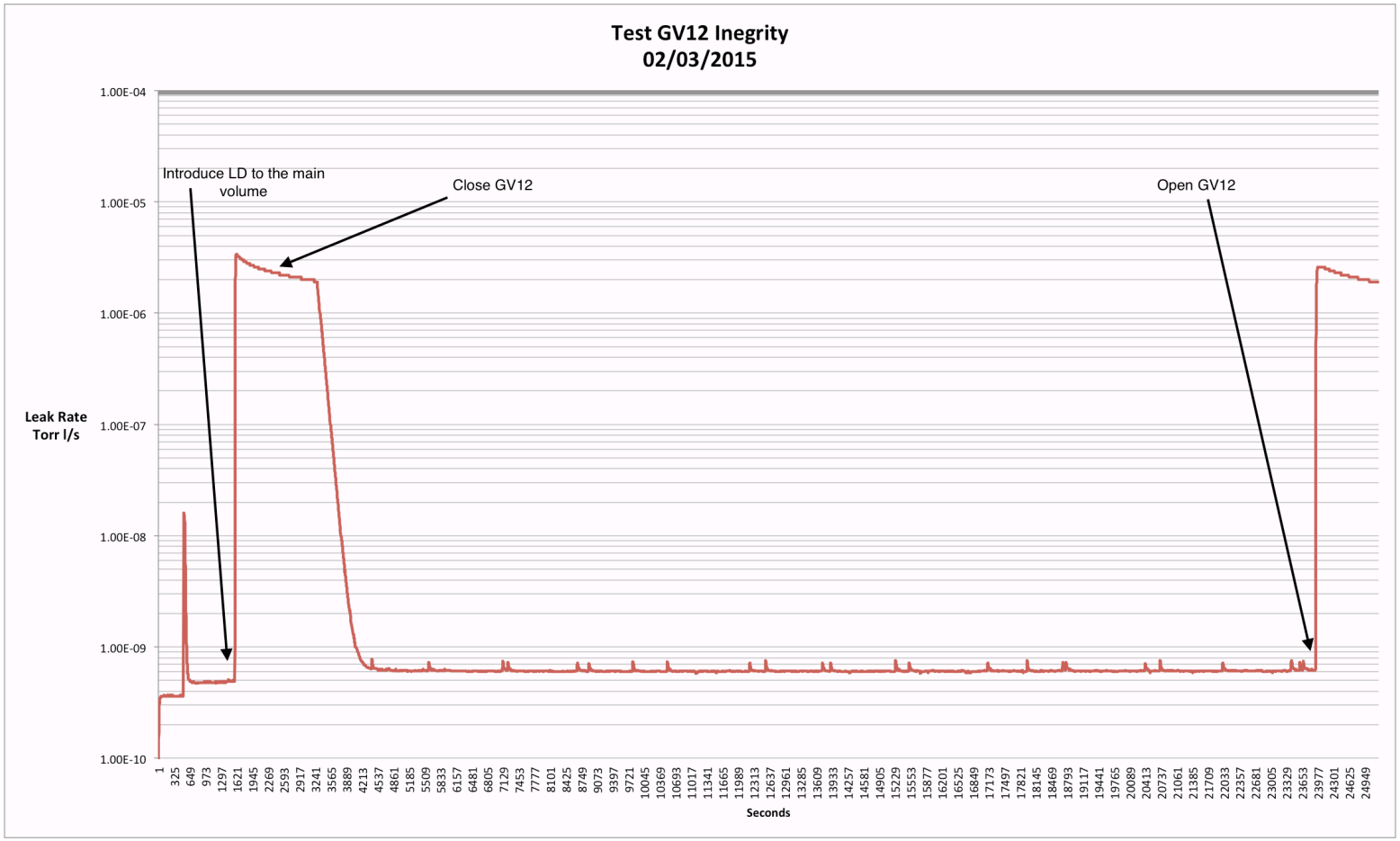
Test Integrity of GV12

Feb 3, 2015

- A test was initiated to determine if both LGV's were contributing to the source of helium.
- Test consisted of base line readings of pressures at the BSC and Cryo Trap, helium leak rate on the leak detector (common with the main volume) and RGA data monitoring.
- After all base line measurements were recorded GV12 was closed for ~ 6 hrs. and then re-opened.
- During this time period the data proved that GV12 was not a source of the outside air leak and present helium background.

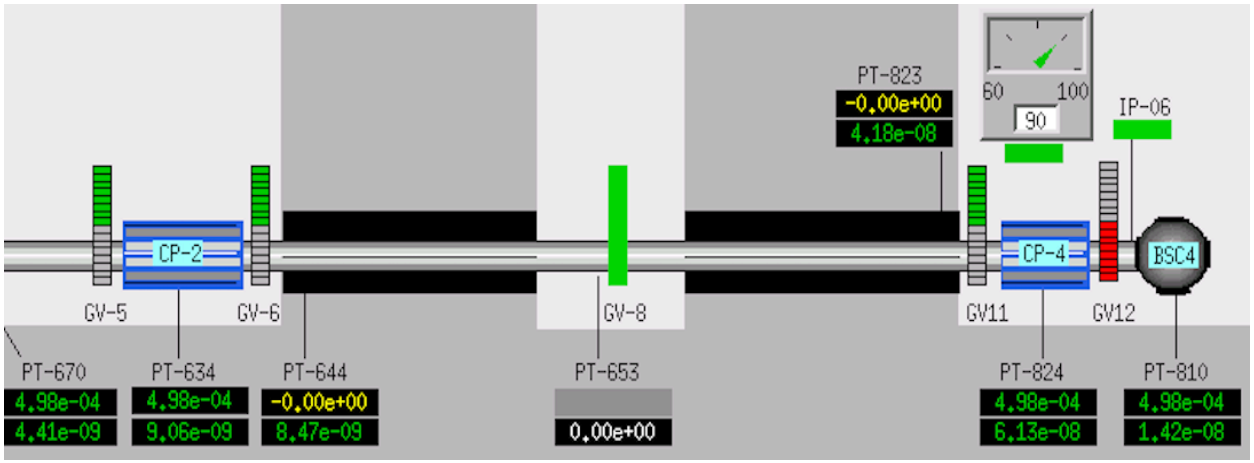
INFICON Leak Detector Data During GV12 Integrity Test



Notes of INFICON Leak Detector During GV12 Integrity Test

Feb 3, 2015

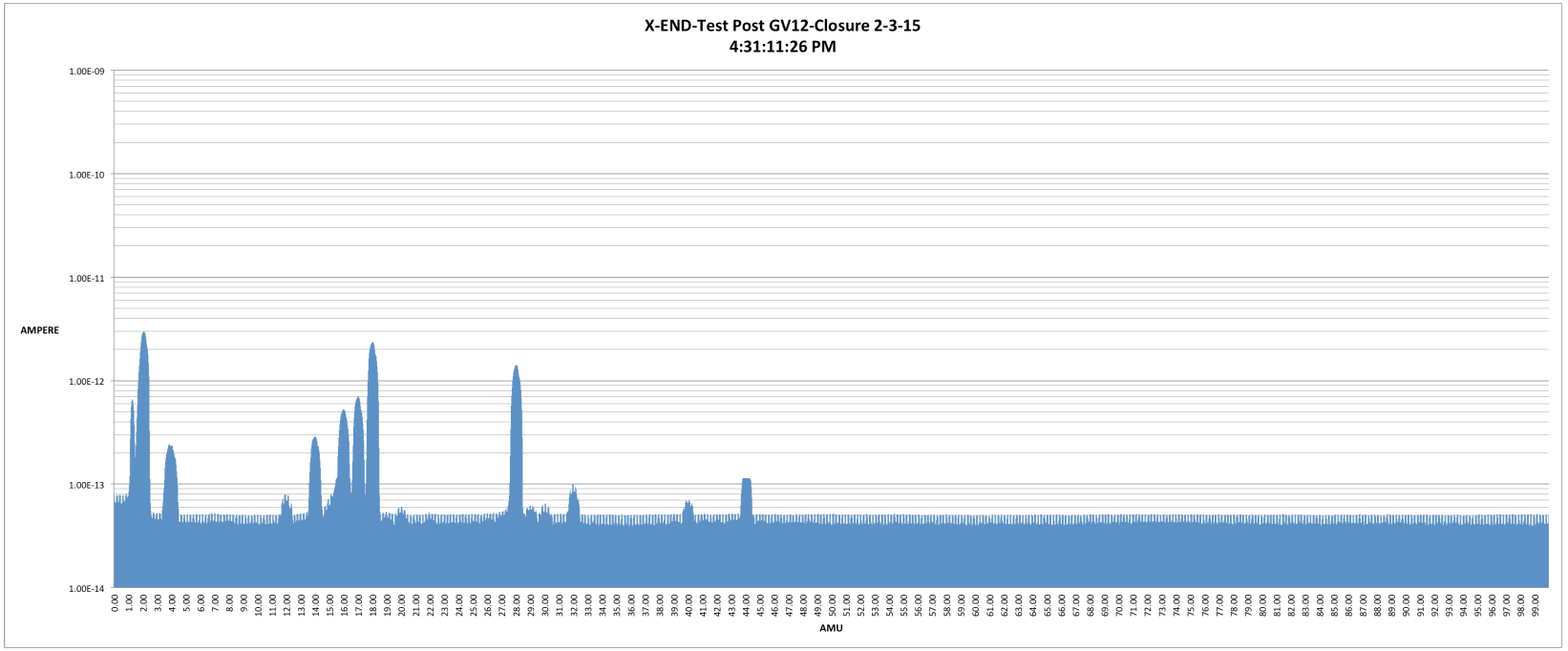
Time CST	Leak Rate on leak detector torr l/s	GV12 status	SeikoGV status
09:33	5.0e-10	Open	Closed
09:35	3.3e-6	Open	Open
10:05	1.4e-6	Closed	Open
10:15	2.1e-9	Closed	Open
10:25	6.4e-10	Closed	Open
15:42	6.1e-10	Closed	Open
15:55	2.6e-6	Open	Open
16:21	5.1e-10	Open	Closed



RGA Data with GV12 Closed for ~ 6 hrs.

- Helium peak (AMU 4) reduced significantly. Helium was reduced from ~ 1.1e-12 amps to 2.2e-13 amps in 6 hours.
- Air signature (AMU 14, 28, 32, 40) also reduced significantly.
- Water (AMU 18) is higher due to lack of cryo trap when GV12 is closed.
- See scan on the next slide

RGA Data with GV12 Closed for ~ 6 hrs.



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GV12 & GV11 Total Cycles

GV11	GV12
63	52

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Action Items
Up for discussion

1. Measure leak rate now and monitor over time
   - How
   - When
2. Monitor LN2 consumption on CP-4 and CP-3
   - How
   - Who
   - When
3. Install RGA at X-Mid
   - In Progress, RGA is working (currently in VPW)
4. Get helium Out
   - How
   - When
5. Leak check GV8 and other LGV's
   - When