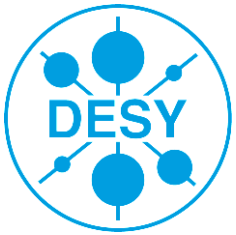


Preliminary results on contamination in SRF cavities mass production

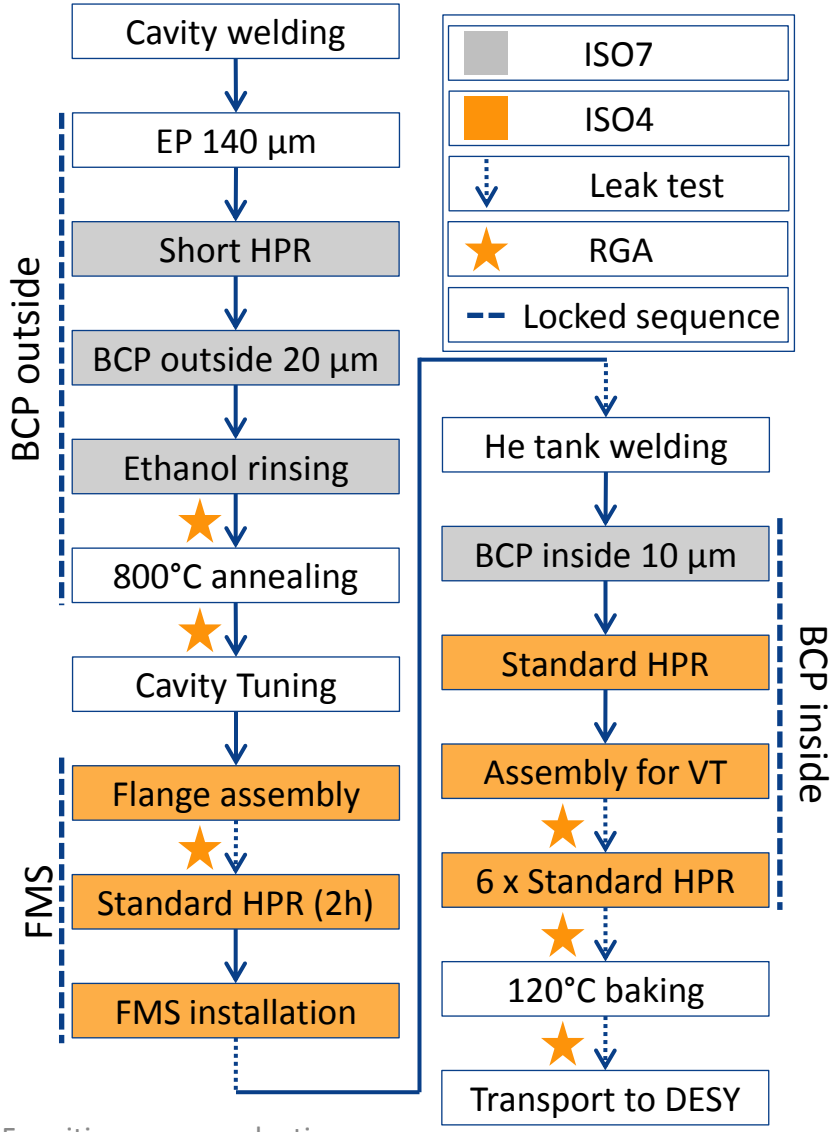
Speaker:
Dario Rizzetto

TTC meeting
DESY
24 - 27th March 2014

BCP Flash cycle

Possible contamination sources:

- Electropolishing
  - Sulphur
- Equipment
  - Hydrocarbons from assemblies' components
  - Hydrocarbons from UP water pumps
  - Additives from plastics/detergents
- Vacuum systems
  - Pre-assembled components (e.g. valves)
  - Defective components' cleaning process
- Others?



DEHP

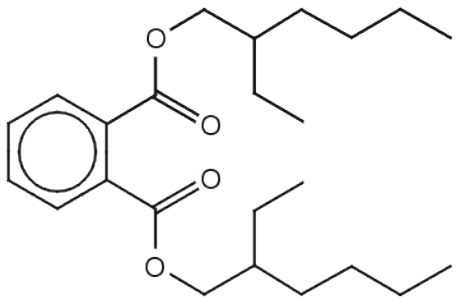
Viscous residues found in ethanol rinsing filters

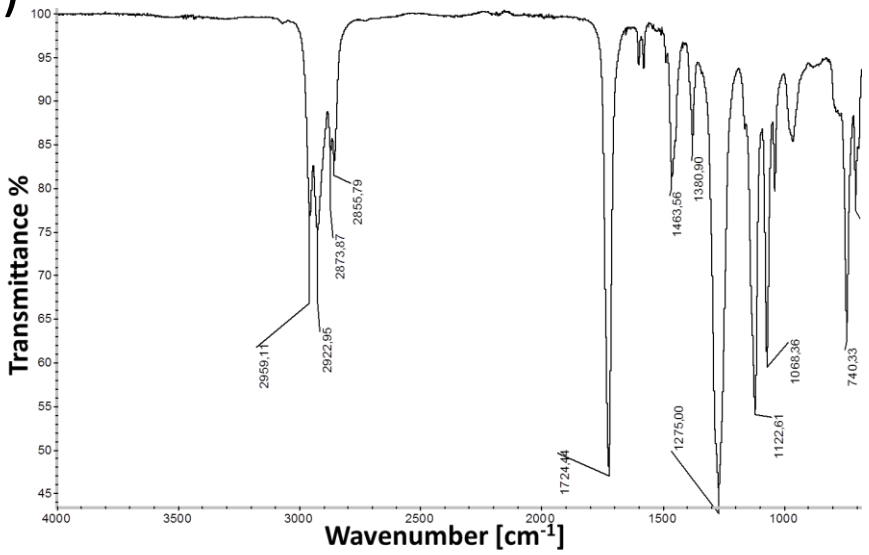
FT-IR analysis determines DEHP (diethylhexyl phthalate)

- Ethanol-soluble PVC plasticizer
- Present in ethanol rinsing PVC piping
- RGA gives no evidence (m/z<100)

Corrective action:

- Use of PVC free piping



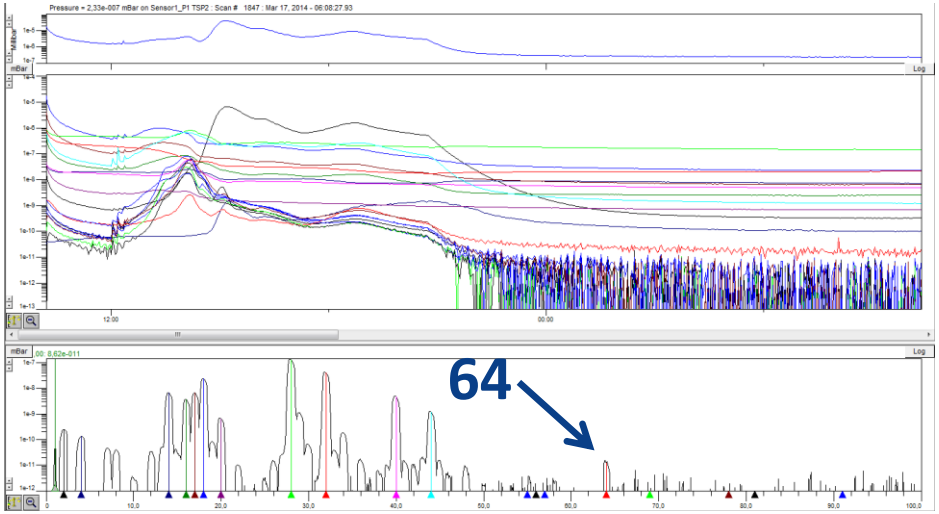


Sulphur contamination

Sulphur in ethanol

Sulphur in new ethanol rinsing pipe

Ethanol got coloured yellow well before foreseen change period



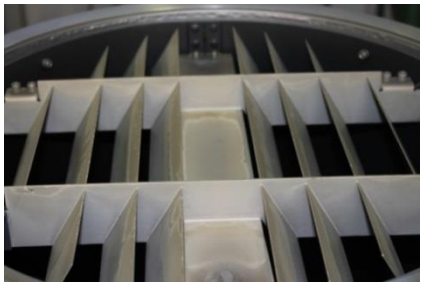
Corrective actions:

EtOH period of usage halved

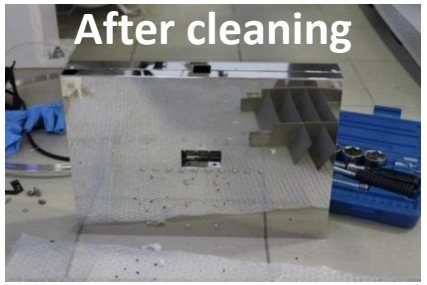
(change every 15 CAVs instead of 30)

Sulphur in 800°C oven's cryopump

1st stage



2nd stage



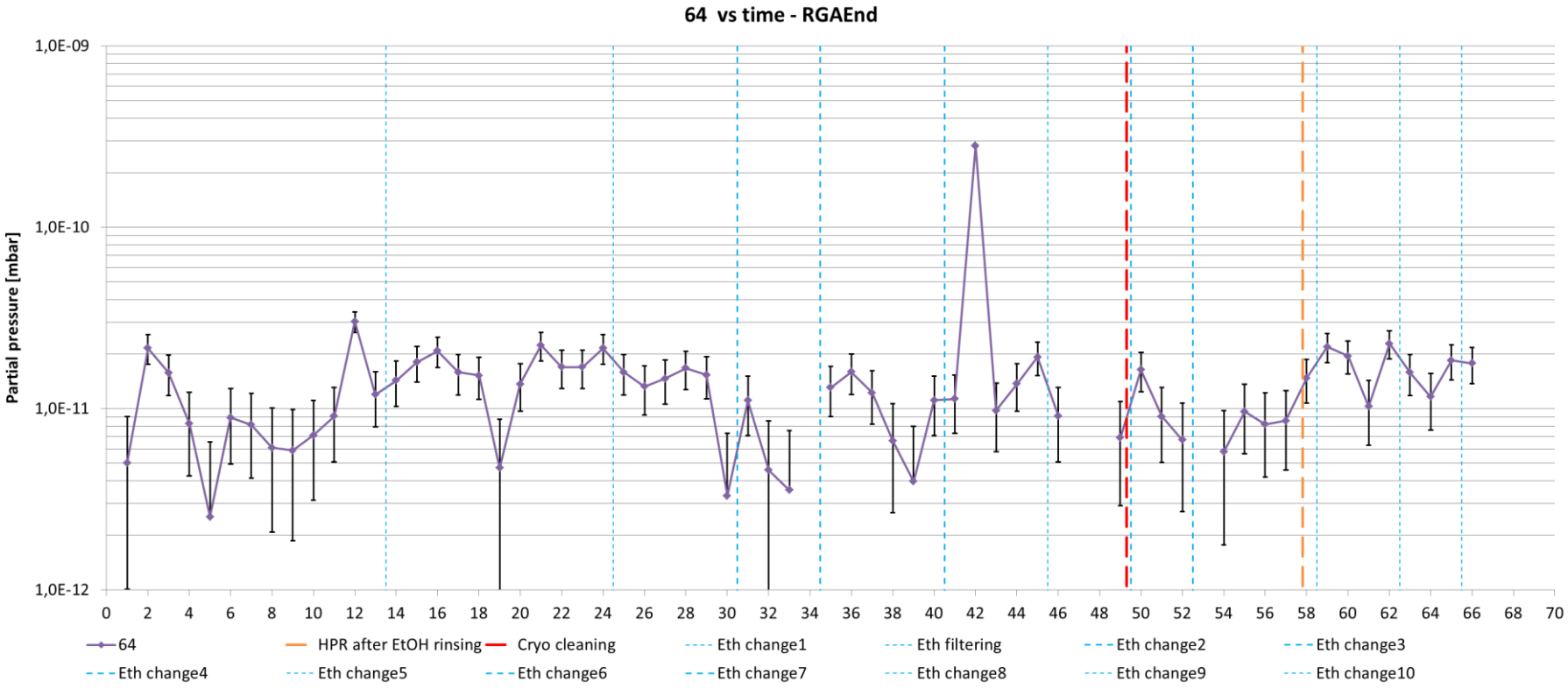
Corrective actions:

More 1100°C oven cleaning cycles

HPR after EtOH rinsing and after 800°C

After 800°C treatment

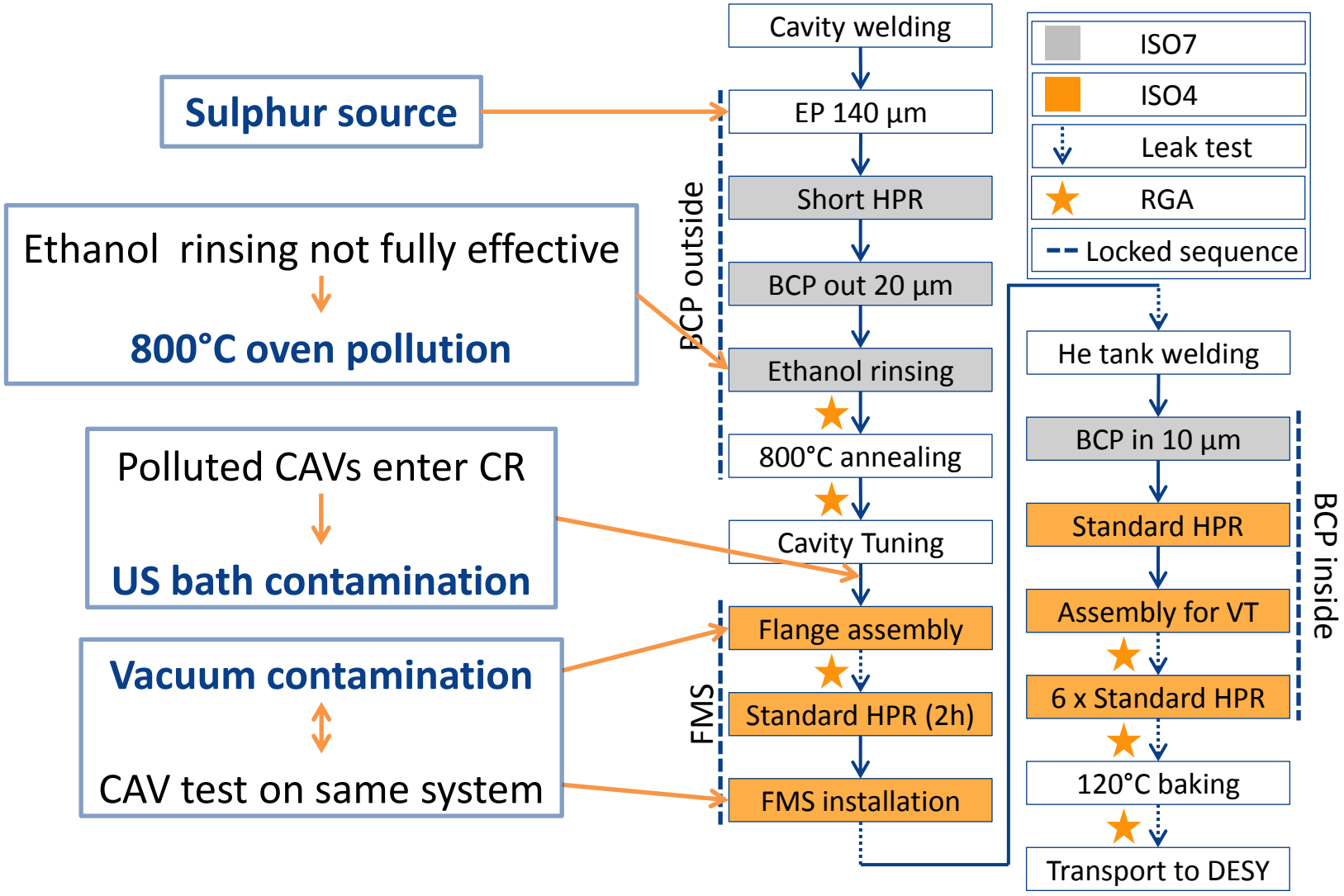
800°C oven - Tracking of sulphur as mass 64 (S_2, SO_2) with RGA



RGA after TT: 64 pp slightly increasing at ultimate pressure (1e-7 mbar range)

Oven is accumulating sulphur

Sulphur in production cycle



Sulphur decontamination

Sampling campaign:

1. Analysis of sulphur samples from cryopump screens
2. Sampling of ethanol after every cavity in ethanol rinsing

   Quantitative determination of sulphur amount per cavity.

   In progress. 30 samples collected.
3. Niobium and Silicon samples to be put in some cycle steps under analysis with TOF SIMS

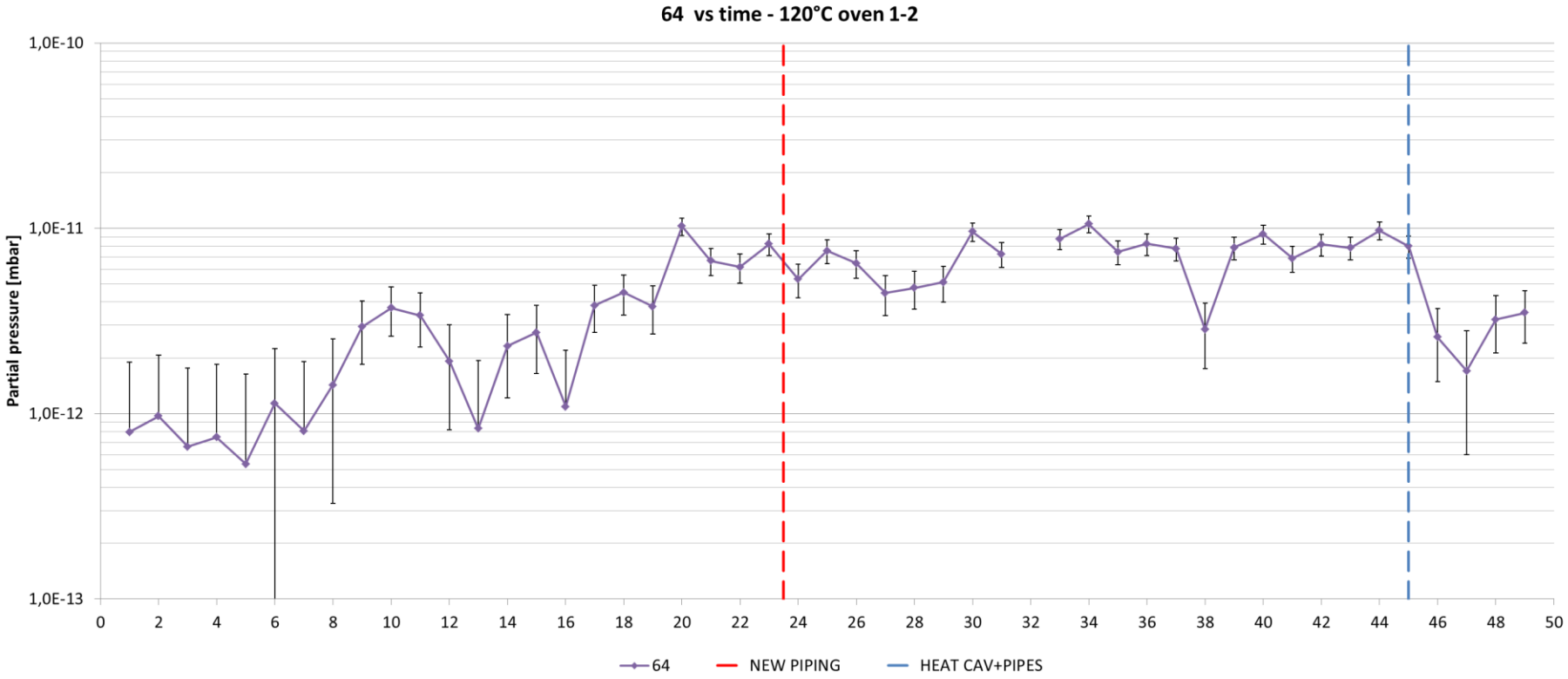
   Tracking of sulphur contamination throughout the production cycle.

   On going at the moment.

120°C oven

120°C oven - Tracking of sulphur as mass 64 (S_2, SO_2) with RGA

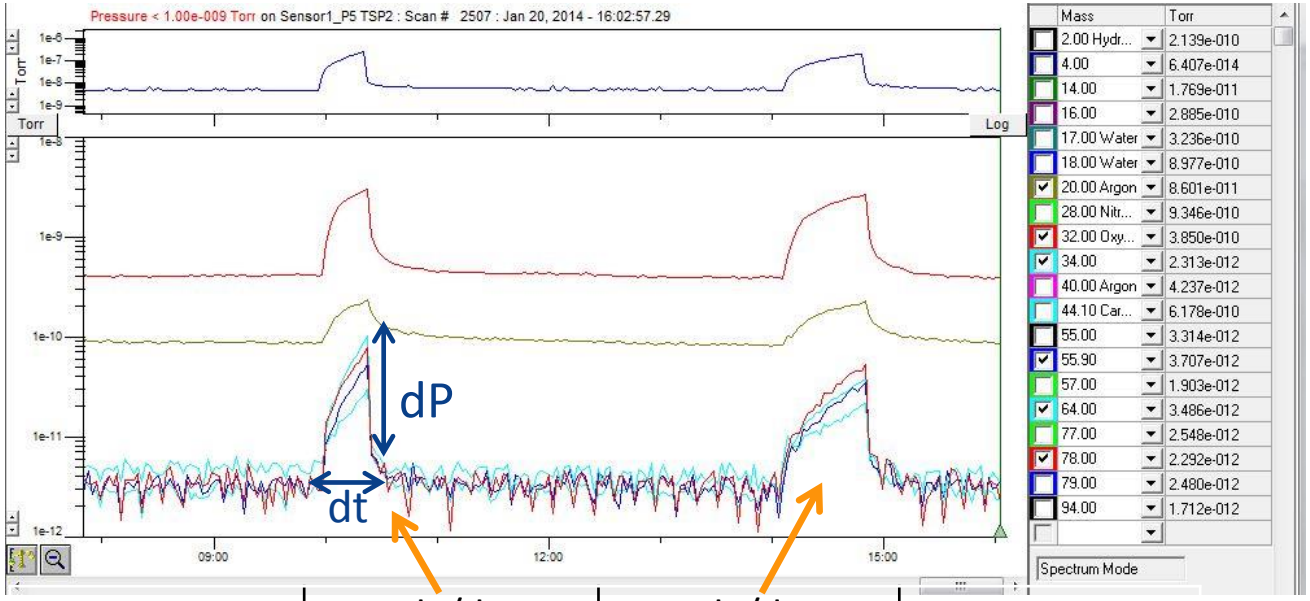
Total pressure at some 1e-9 mbar. Sulphur & hydrocarbons pps at some 1e-12 mbar.

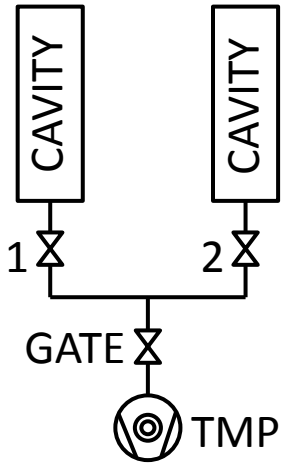


Contamination grows and arrive to equilibrium with new pipes.

Improvement heating both cavities and vacuum piping.

Test on 120°C oven



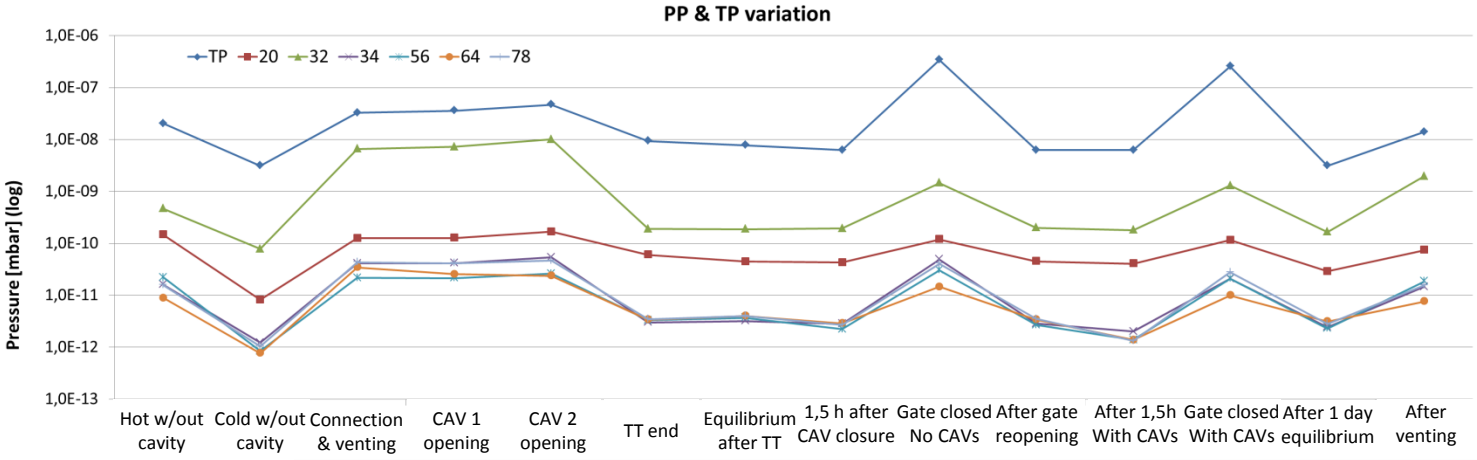


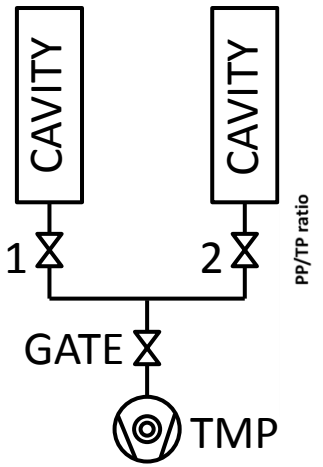
	dP/dt (No CAVs)	dP/dt (With CAVs)	Variation (%)
TP	1.34E-08	6.27E-09	-36.2
PP(20)	3.07E-12	1.87E-12	**-24.3**
PP(32)	5.05E-11	2.78E-11	**-28.9**
PP(34)	1.85E-12	4.71E-13	**-59.4**
PP(56)	1.13E-12	4.89E-13	-39.7
PP(64)	4.7E-13	2.15E-13	-37.2
PP(78)	1.52E-12	6.62E-13	-39.2

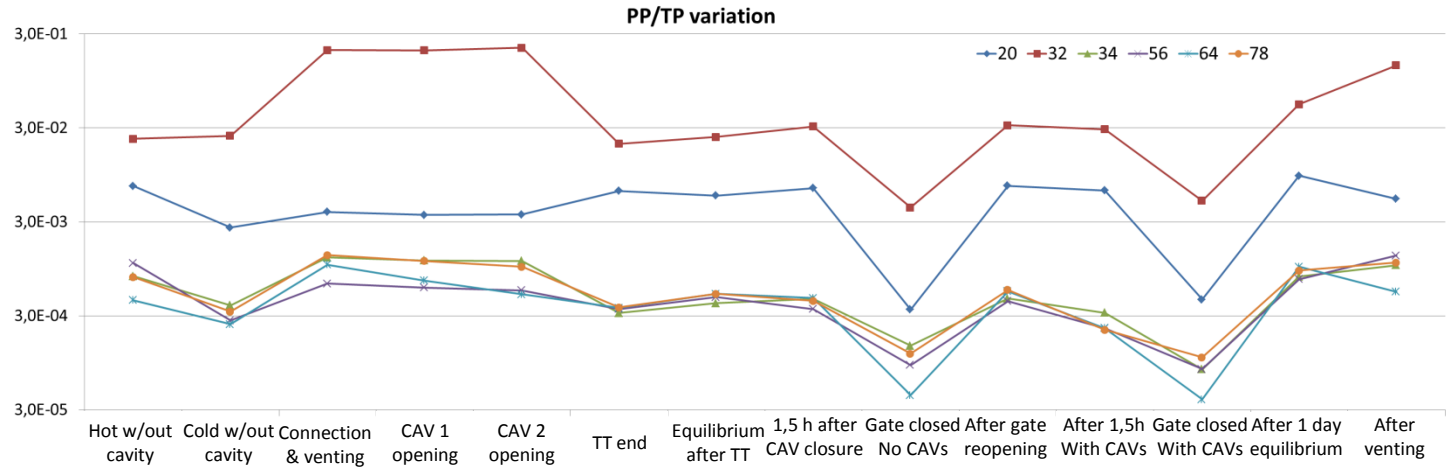
Pressure rise rate decreases with cavities connected.

- M=20 & 32 rates decrease less than total pressure
- M=34 shows the biggest rate reduction

Test on 120°C oven







Pollution seems to reside in piping

CAVs are cleaner than piping and act as getters

Other issues in RGA & Vacuum

Contaminants are at low level but spread all over the systems

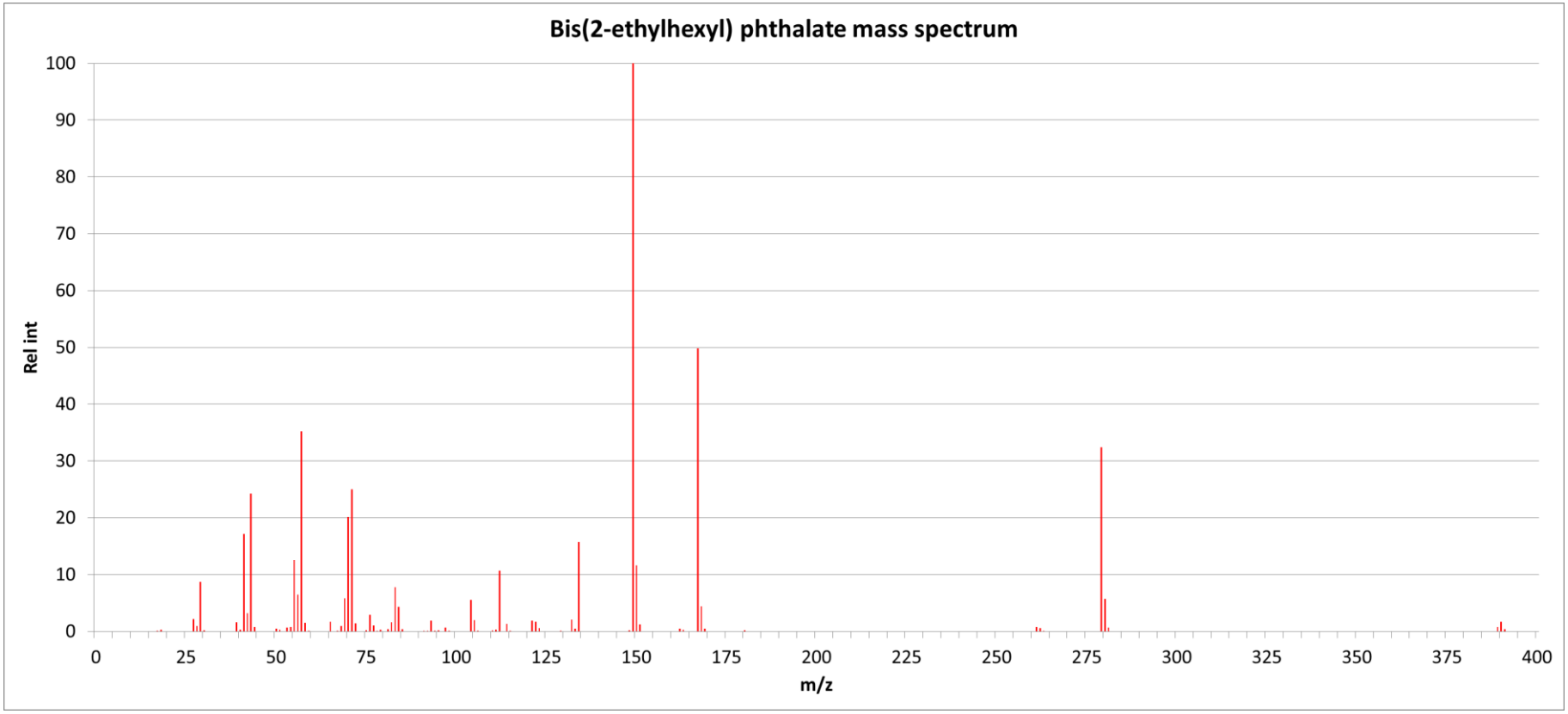
We are working on how they move and on their removal

Still open issues:

- Unusual 28/32 ratio in all RGAs
- Mass 32: which are the contributions?
- 78: is it an aromatic compound? Why is it growing? From where does it comes?
- 91: is it an aromatic compound?
- Noticeable background noise at ultimate pressure after 120°C (some 1e-12 mbar at 1e-9 mbar TP)
- Background noise increased recently. Spectrometer's source or detector degradation due to pollutants?

Thanks for your attention

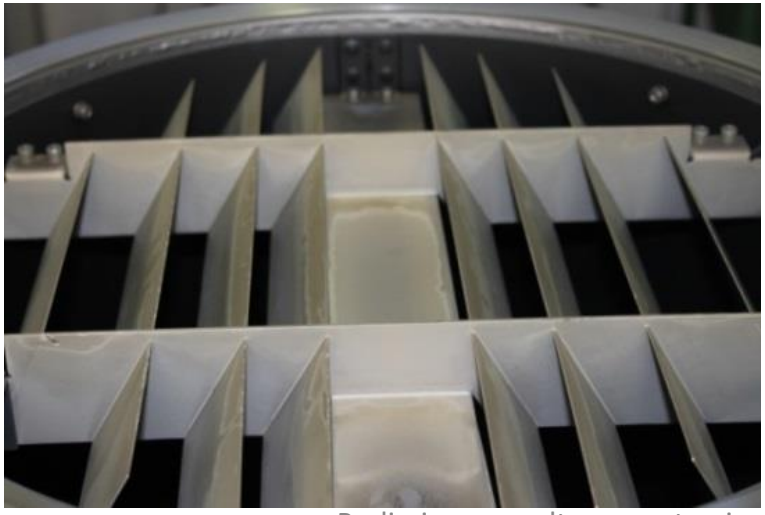
DEHP Mass spectrum

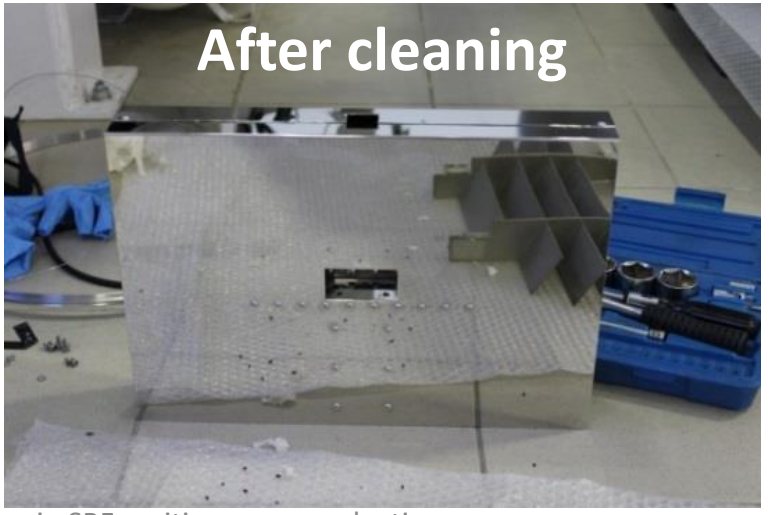


Sulphur contamination

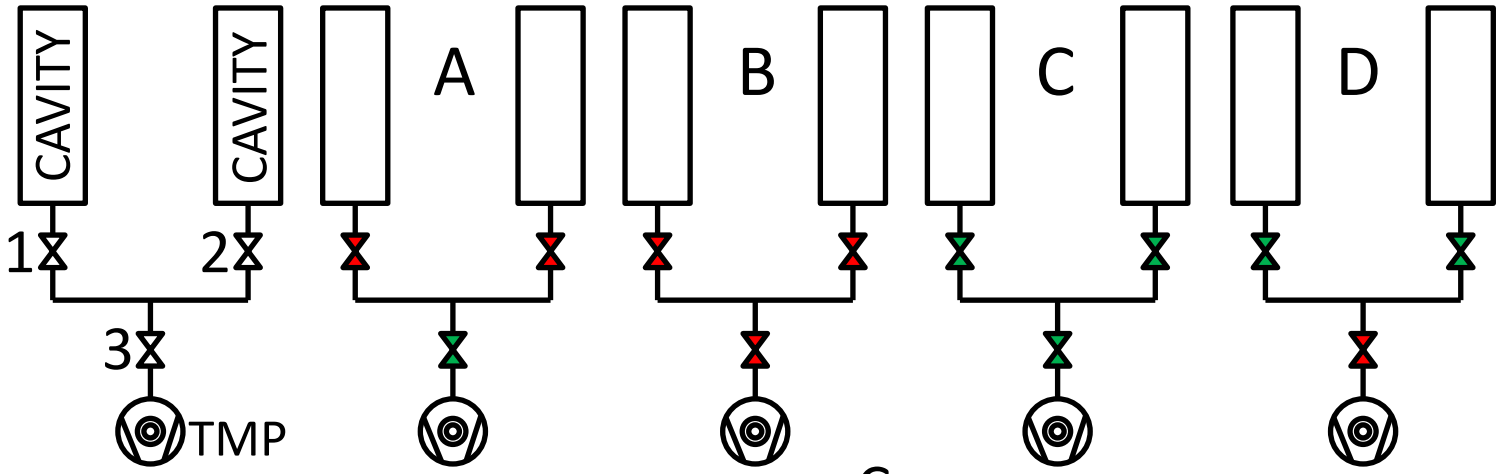
1st stage

2nd stage





Contaminants behaviour



- A

Mass 64 almost constant excluding CAVs.

- B

Mass 64 is less volatile than other compounds of comparable mass.

Pollution from gate valve.

- C

With CAVs connected pollutants levels are lowered, especially mass 64.

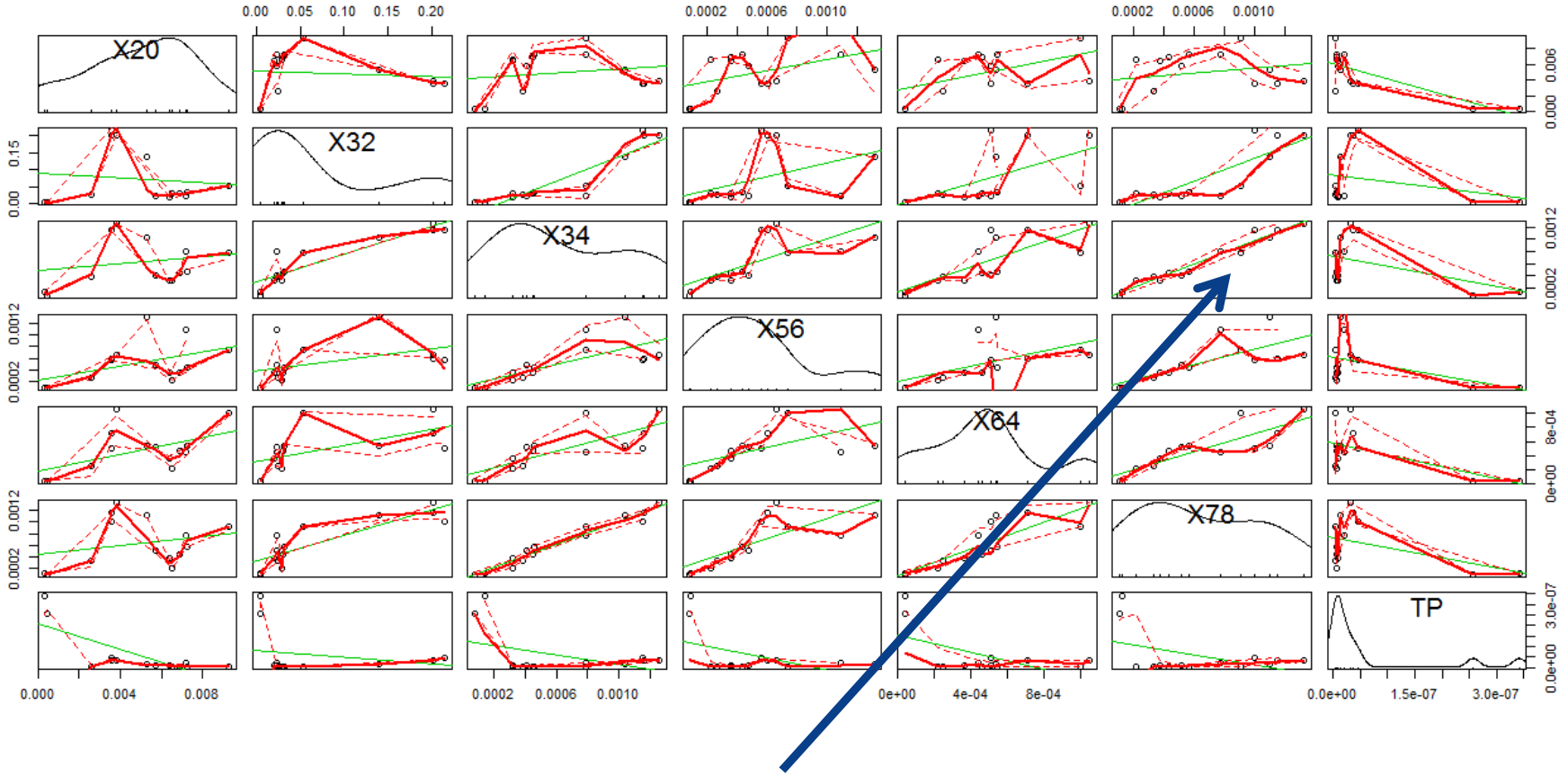
- D

Lower pressure rise rate respect to B.
Contaminants rose ≈40% less than in B.

Pollution seems to reside in piping

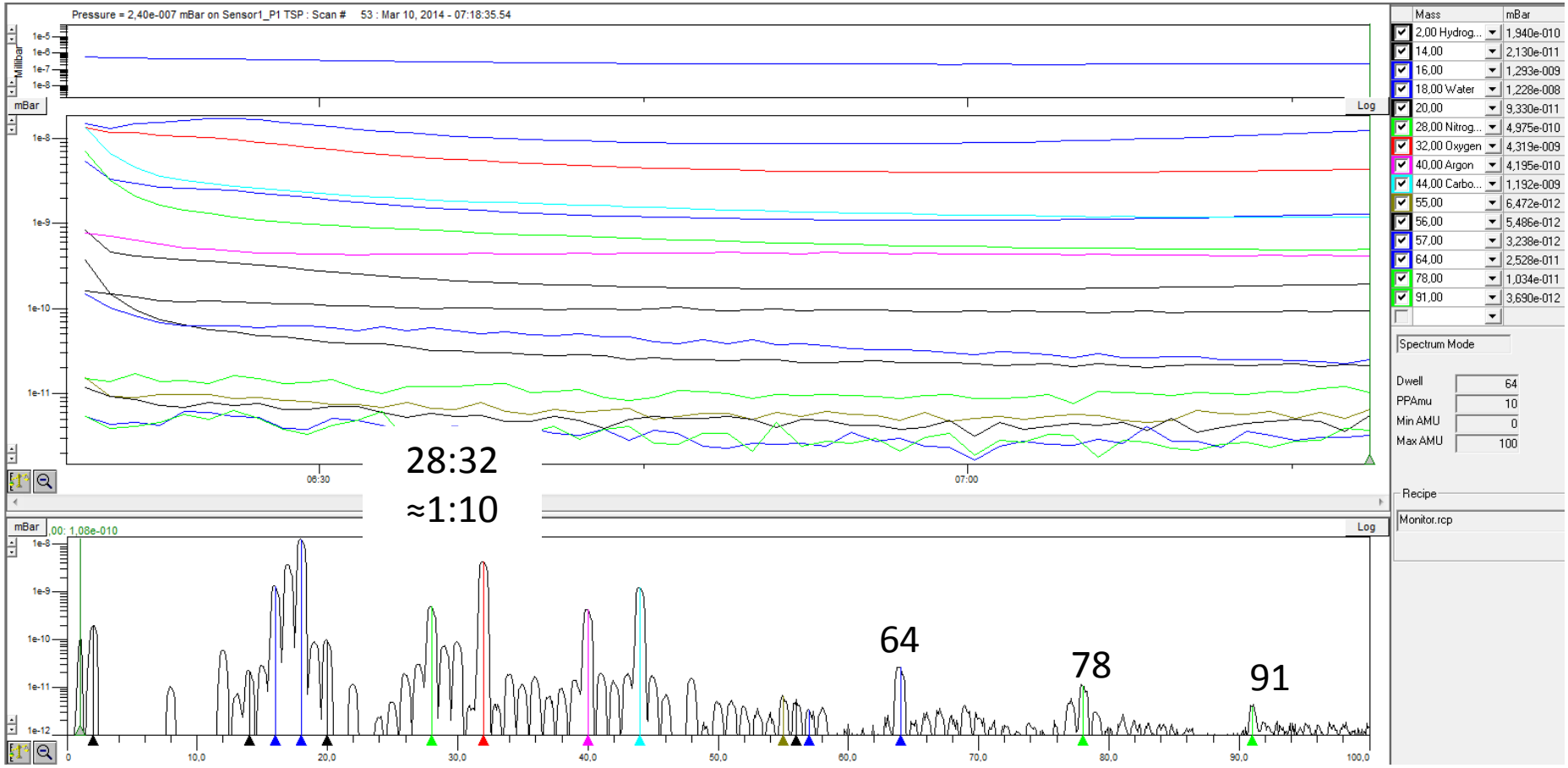
CAVs are cleaner than piping and act as getters

Scatterplot of PP vs PP dependence



M=34 and M=78 seems to be strongly correlated

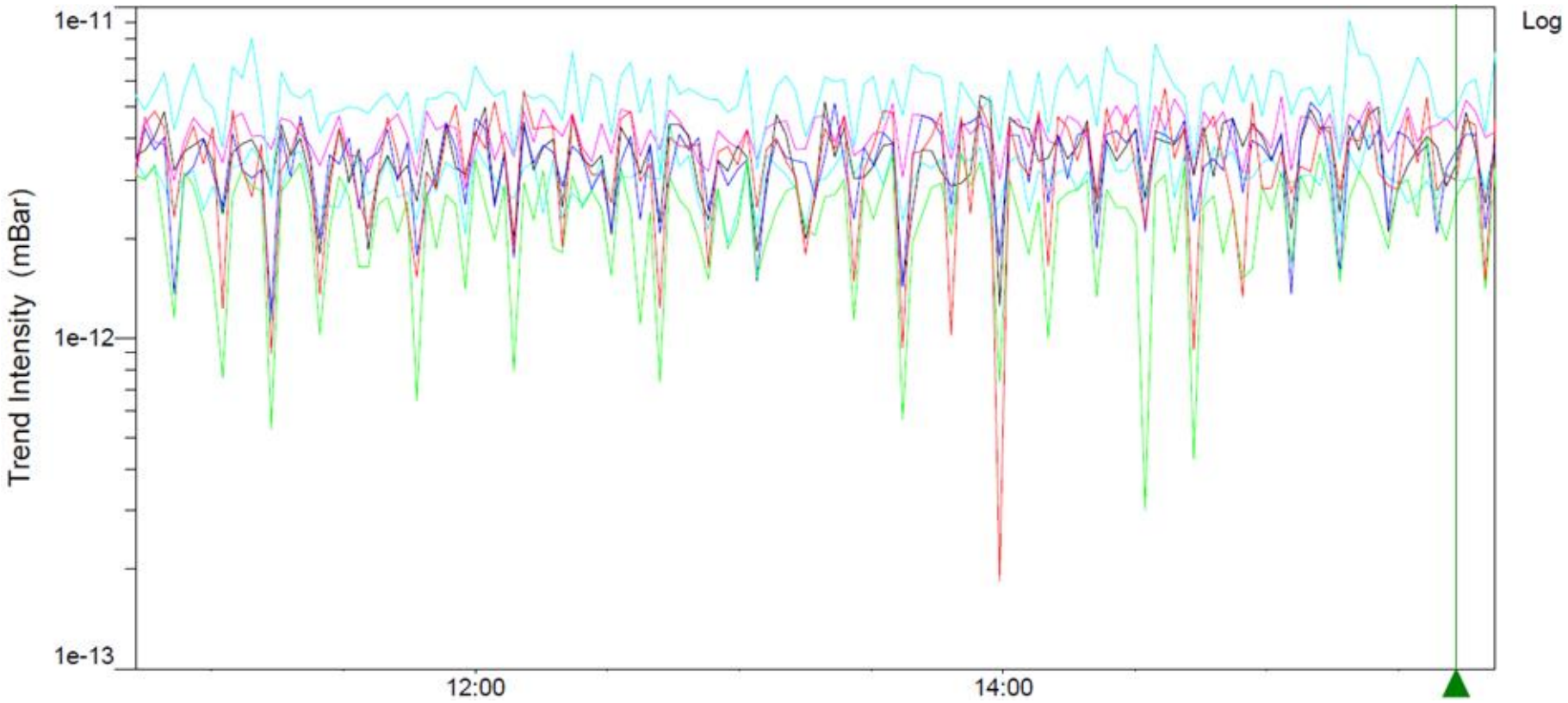
RGA issues


Pressure = 2,40e-007 mBar on Sensor1_P1 TSP : Scan # 53 : Mar 10, 2014 - 07:18:35.54
MilliBar
mBar
Log
06:30
07:00
28:32
≈1:10
mBar
00: 1,08e-010
Log
64
78
91
Mass
mBar
2,00 Hydrog... 1,940e-010
14,00 2,130e-011
16,00 1,293e-009
18,00 Water 1,228e-008
20,00 9,330e-011
28,00 Nitrog... 4,975e-010
32,00 Oxygen 4,319e-009
40,00 Argon 4,195e-010
44,00 Carbo... 1,192e-009
55,00 6,472e-012
56,00 5,486e-012
57,00 3,238e-012
64,00 2,528e-011
78,00 1,034e-011
91,00 3,690e-012
Spectrum Mode
Dwell 64
PPAmu 10
Min AMU 0
Max AMU 100
Recipe
Monitor.rcp

Noise

Background signal of RGA at 1e-9 mbar total pressure range.

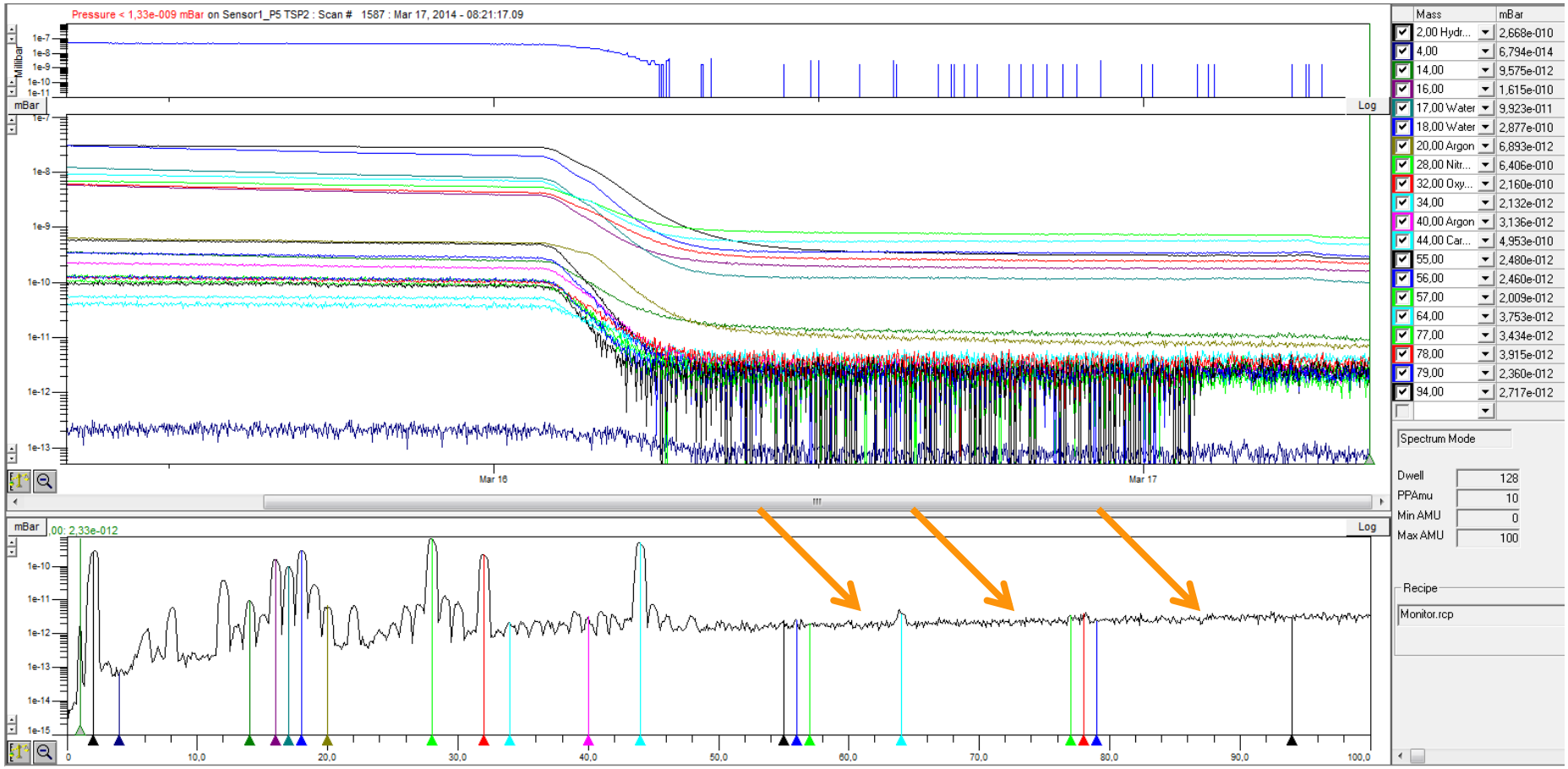
Δpp ≈ 5-7 e-12 mbar



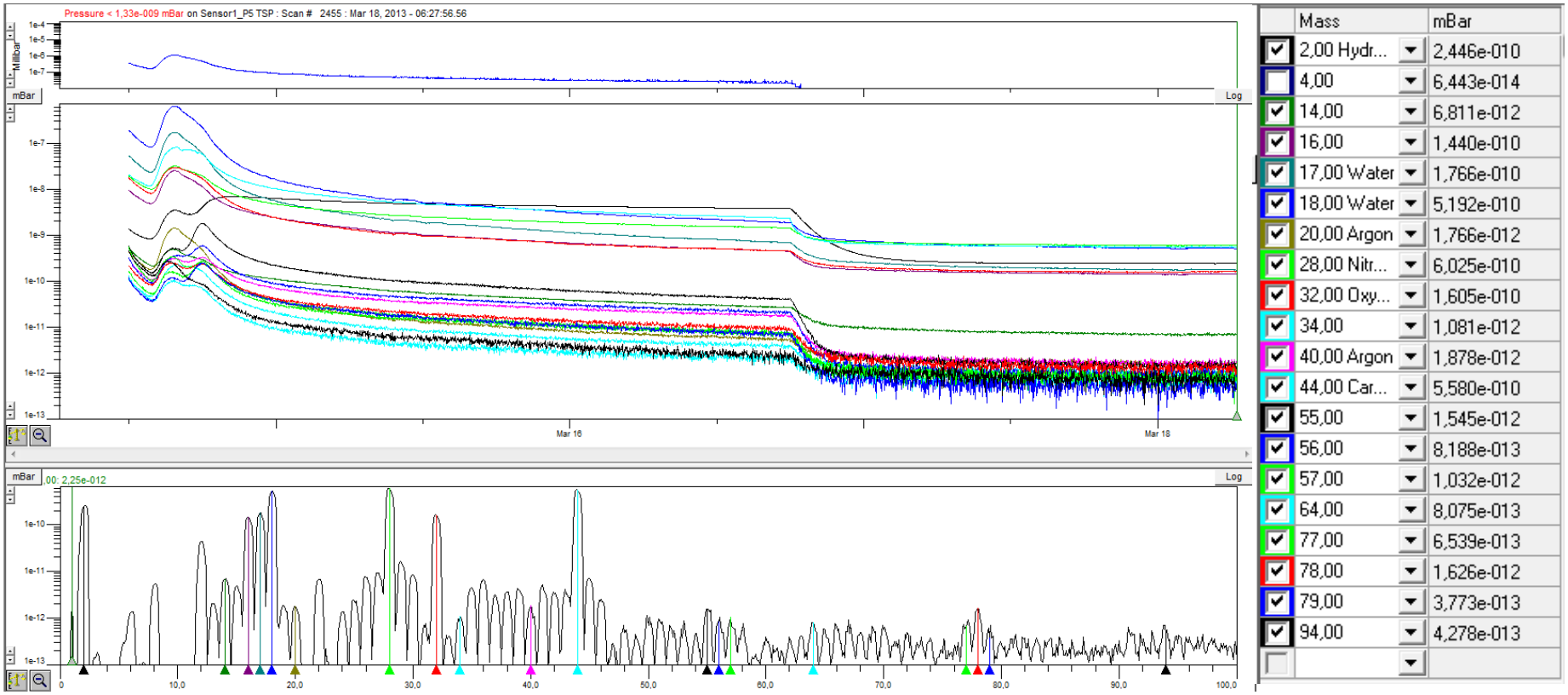
Background increase

Background signal of RGA at 120°C TT end (1e-9 mbar range).

For M > 50 background is high and increasing.



120°C final RGA



Mass	mBar
2,00 Hydr...	2,446e-010
4,00	6,443e-014
14,00	6,811e-012
16,00	1,440e-010
17,00 Water	1,766e-010
18,00 Water	5,192e-010
20,00 Argon	1,766e-012
28,00 Nitr...	6,025e-010
32,00 Oxy...	1,605e-010
34,00	1,081e-012
40,00 Argon	1,878e-012
44,00 Car...	5,580e-010
55,00	1,545e-012
56,00	8,188e-013
57,00	1,032e-012
64,00	8,075e-013
77,00	6,539e-013
78,00	1,626e-012
79,00	3,773e-013
94,00	4,278e-013