Update on PSD and pumping properties measurements at SOLEIL

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On behalf of Vacuum Group, PSD and Transmission Bench Task Force

17th April 2024, IFAST Task 10.5 – 3rd Meeting, Paris (France)

Contents

- Vacuum measurements of first samples
- First 3 gauges vacuum chamber for PSD tests
- Preliminary results of a first 3 gauges type VC
- Other NEG related activities for SOLEIL II upgrade project

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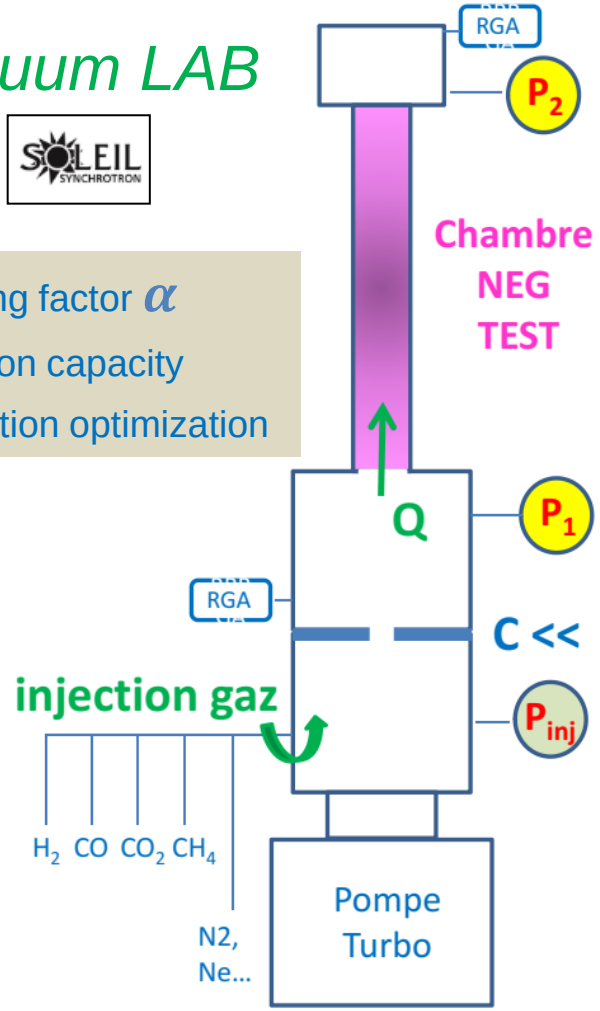
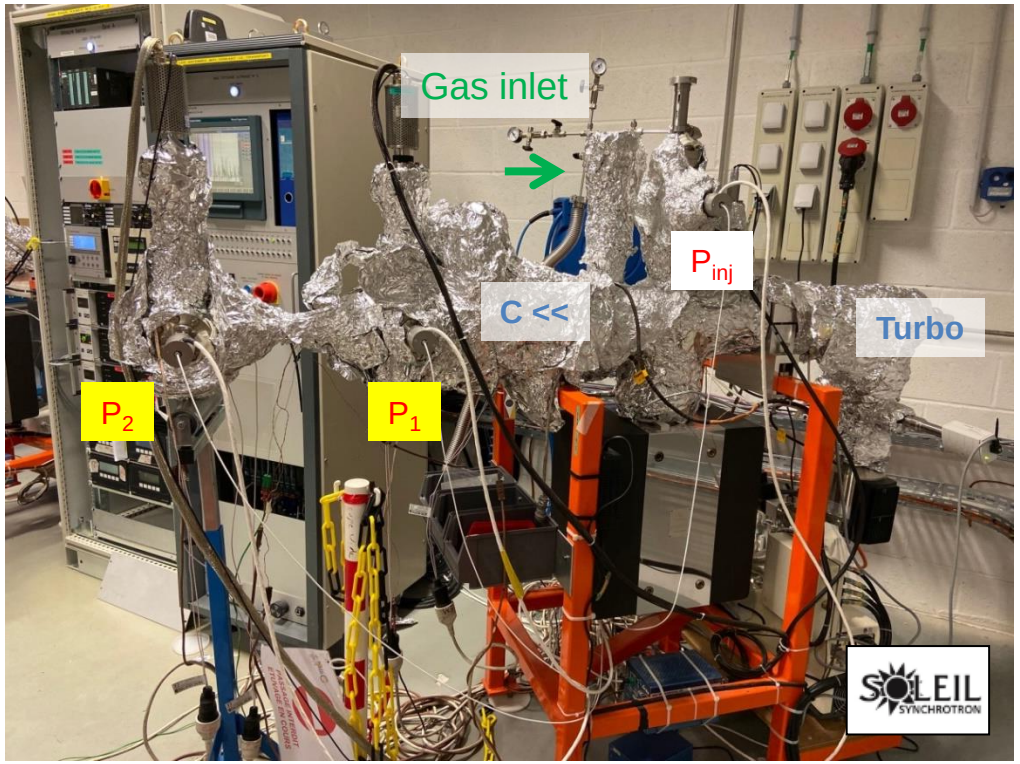
NEG coating characterization by transmission method

@ Vacuum LAB

- Sticking factor α
- Sorption capacity
- Activation optimization



2 Transmission Method Test Benches for NEG coating characterization

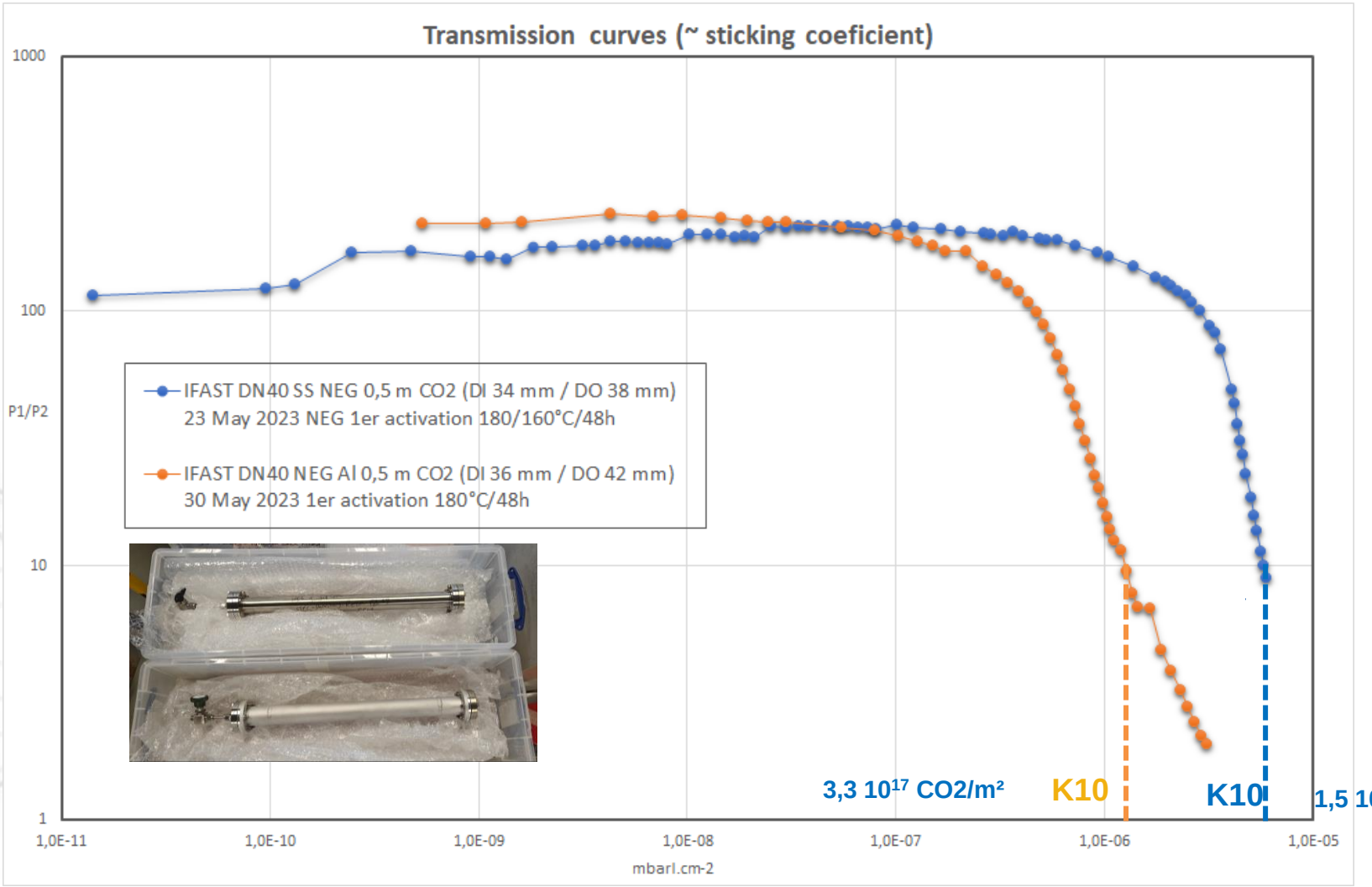


Transmission Method

P. Costa Pinto, P. Chiggiato, A. Sapountzis, T. Sinkovits, M. Taborelli,
CERN
80th IUVSTA Workshop, NSRRC, Hsinchu, Taiwan (2016)

P_1/P_2 is calibrated with **MOLFLOW+** to find α

Two first samples from UKRI measured at SOLEIL by transmission method



Second set of 2 samples from UKRI (dual layers) measured at SOLEIL

SOLIEL#01 - Deposition (25/01/24)

0.5 m x 34 mm Stainless Steel Tube

Bakeout – 150 °C

Pressure before deposition: 5.1×10^{-10}

Parameter	Unit	1st Layer	2nd Layer
Target		3 x 1 mm TiZrV twisted wire	
Power	W	Pulsed: 75	DC: 75
Current	A	0.2-0.22	0.46 – 0.47
Voltage	V	334-368	160 – 163
Solenoid Current	A	2	2
Solenoid Voltage	V	105-110	105-110
Pressure	mbar	1.0×10-2	4.9×10-1
Duration	HH:mm:ss	02:32:14	02:42:48

Total time: 05:15:02

Dual layer TiVZr coating

Gas injection (01/02/24)

Facility baked and tube activated following standard Daresbury procedure.

Tube activated to 180 °C

Sticking probability for CO ≈ 0.06

Sticking probability for CO2 ≈ 0.2

Sticking probability for H2 ≈ 0.01

Ratio=10 Capacity for CO ≈ 4×10^{18} CO/m²

SOLEIL Measure
$2{,}3\ 10^{17}$ CO/m²

SOLIEL#02 - Deposition (06/02/24)

0.5 m x 36 mm Aluminium Tube

Bakeout – 150 °C

Pressure before deposition: 3.7×10^{-10}

Parameter	Unit	1st Layer	2nd Layer
Target		3 x 1 mm TiZrV twisted wire	
Power	W	Pulsed: 75	DC: 75
Current	A	0.19-0.23	0.44 – 0.45
Voltage	V	325-390	167 – 170
Solenoid Current	A	2	2
Solenoid Voltage	V	100-105	105-110
Pressure	mbar	1.10×10-2	5.2×10-1
Duration	HH:mm:ss	02:32:03	02:29:01

Total time: 05:01:04

Dual layer TiVZr coating

Gas injection (15/02/24)

Facility baked and tube activated following standard Daresbury procedure.

Tube activated to 180 °C

Sticking probability for CO ≈ 0.09

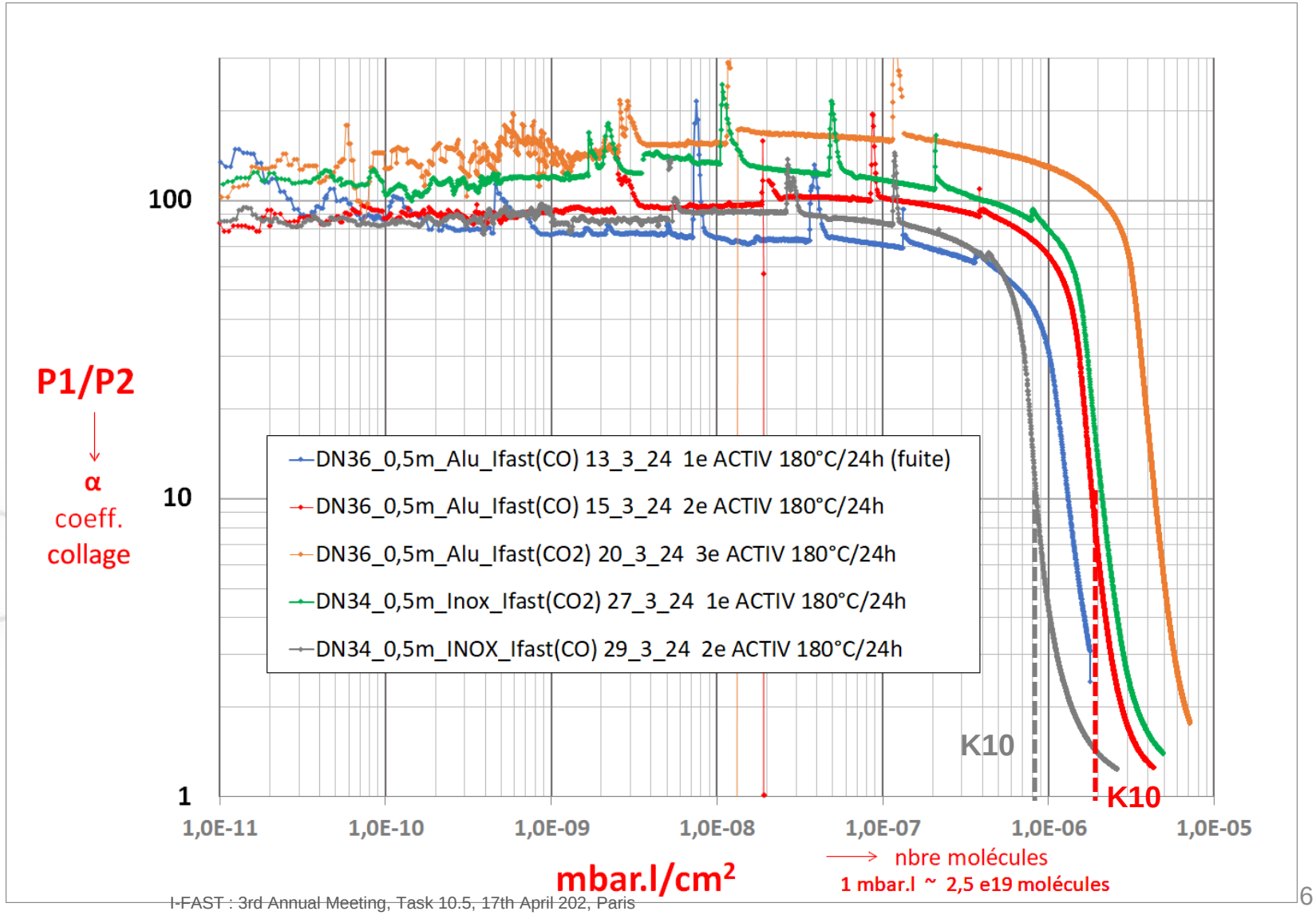
Sticking probability for CO2 ≈ 0.3

Sticking probability for H2 ≈ 0.01

Ratio=10 Capacity for CO ≈ 8.5×10^{18} CO/m²

SOLEIL Measure
$4{,}6\ 10^{17}$ CO/m²

Pressure ration measured by transmission method for both CO and CO_2 up to NEG saturation



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Reception and test of the first PSD sample so called 3-gage VC

IFAST Tube – **21207.1.01 #03**

Deposition (05/12/23)

Bakeout – 150 °C

Pressure before deposition: 6.1×10^{-10}

Parameter	Unit	Value
Target		3 x 1 mm TiZrV twisted wire
Power (Pulsed)	W	76 - 85
Current	A	0.47 – 0.51
Voltage	V	161 – 167
Solenoid Current	A	16 - 18
Solenoid Voltage	V	60
Pressure	mbar	2.5×10-2
Duration	HH:mm:ss	05:16:03

Dense TiVZr coating

Gas injection (08/01/24)

Facility baked and tube activated following standard Daresbury procedure.

Tube activated to 180 °C

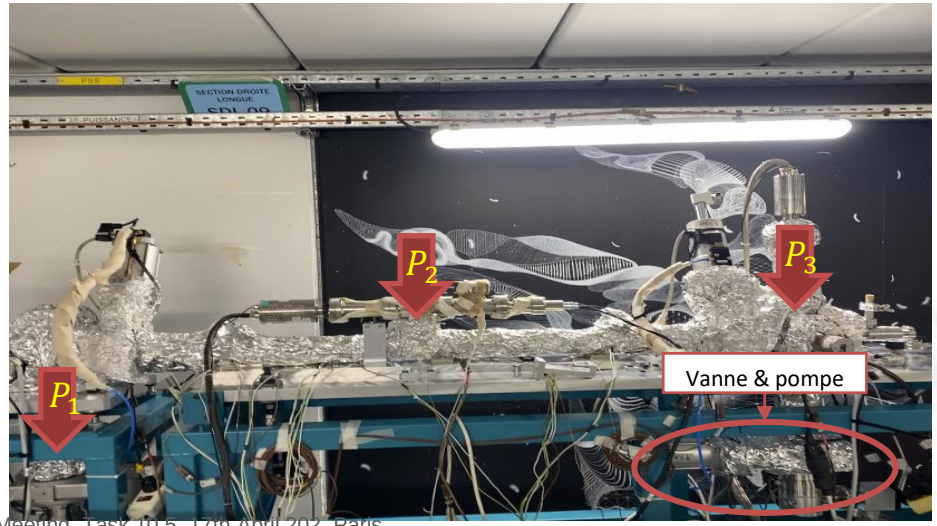
Sticking probability for CO ≈ 0.008

Sticking probability for H2 ≈ 0.001

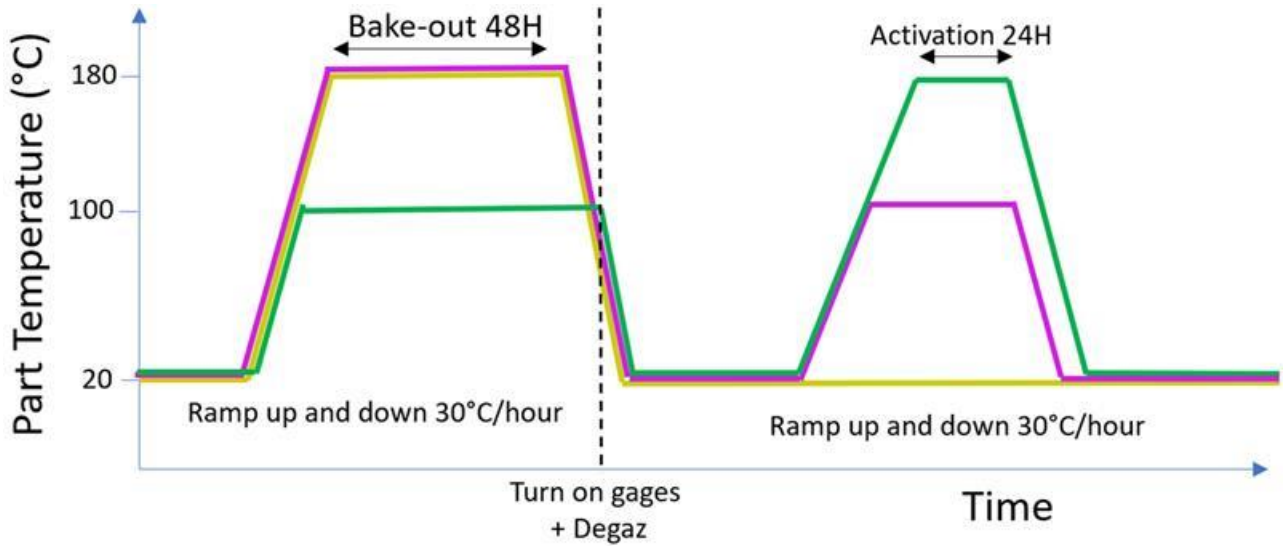
Ratio=10 Capacity for CO ≈ 2×10^{18} CO/m^2

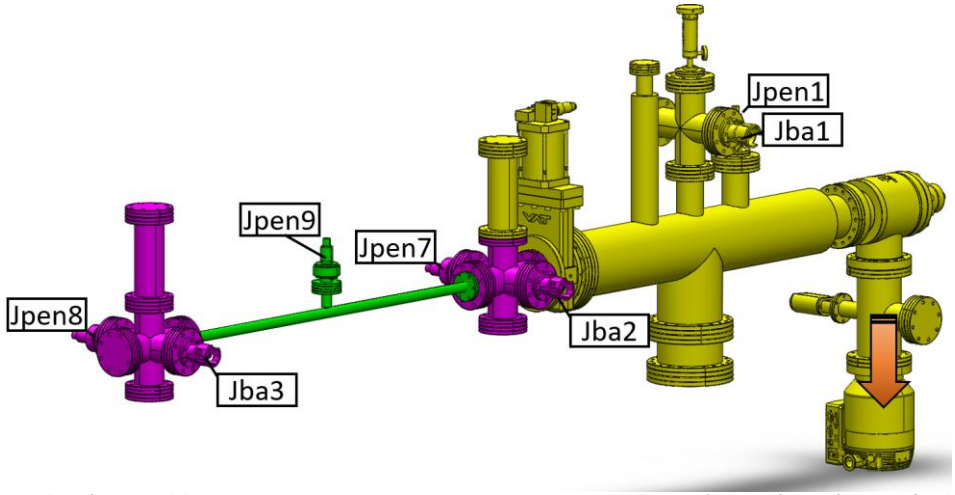
15/01/23 – Tube vented and filled with Nitrogen

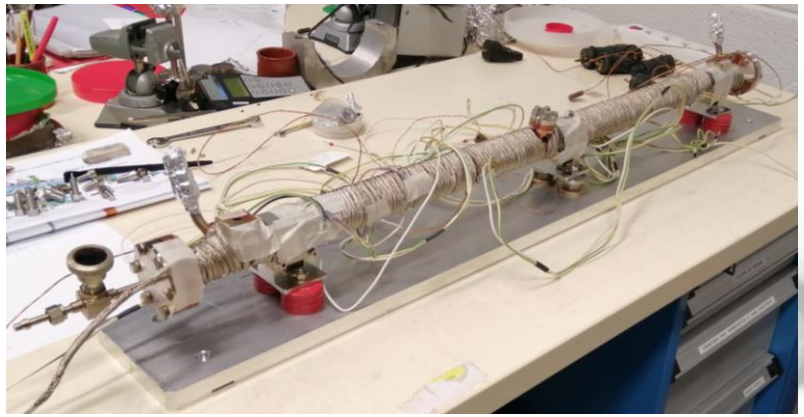
Presently getting ready for installation on PSD bench in SOLEIL's tunnel (April 2024) and 3-gages measurements…



Standardized NEG activation procedure for tests in progress…

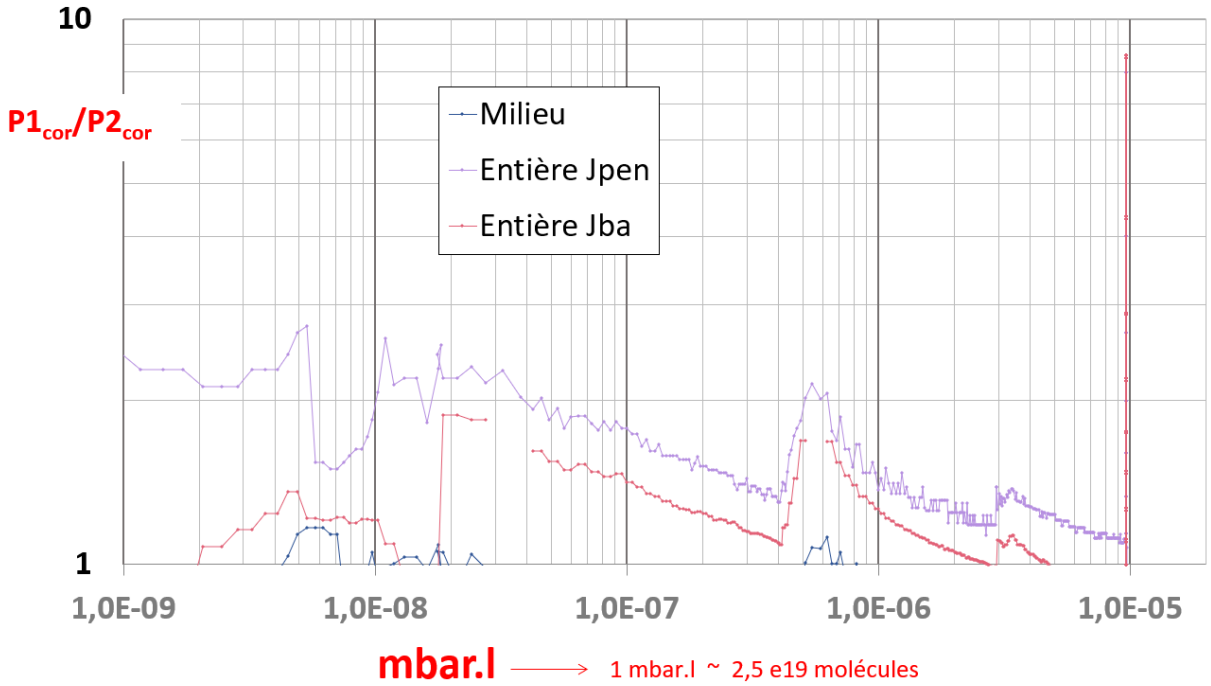


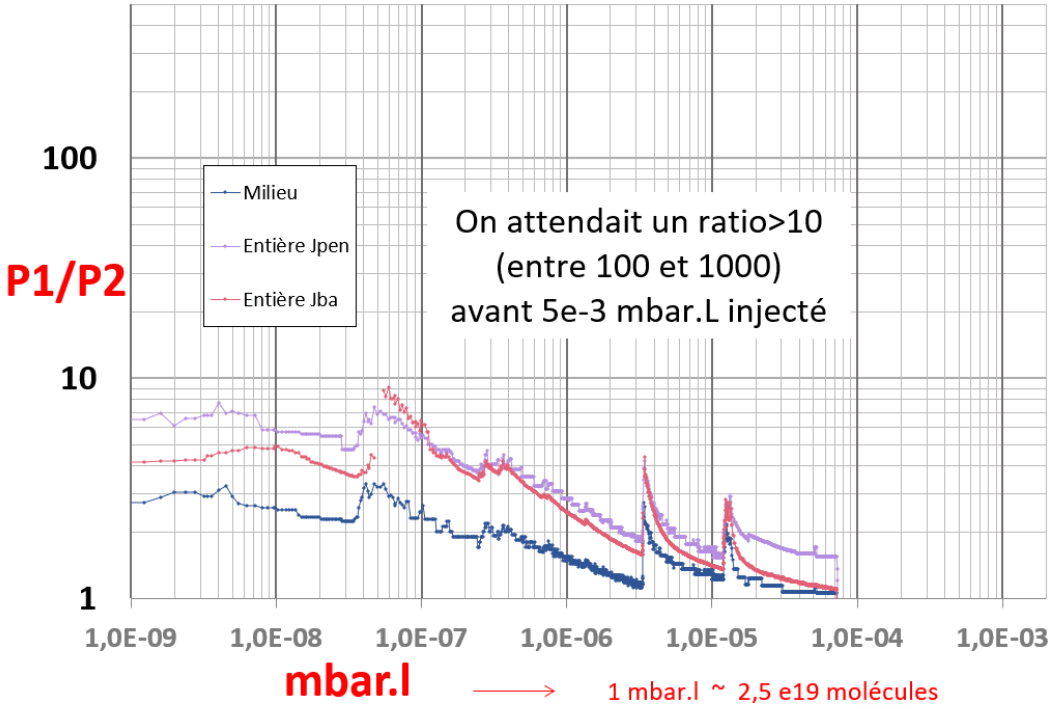




Pumping capacity measurements

Activation at 180 °C for 24 hours and CO injection



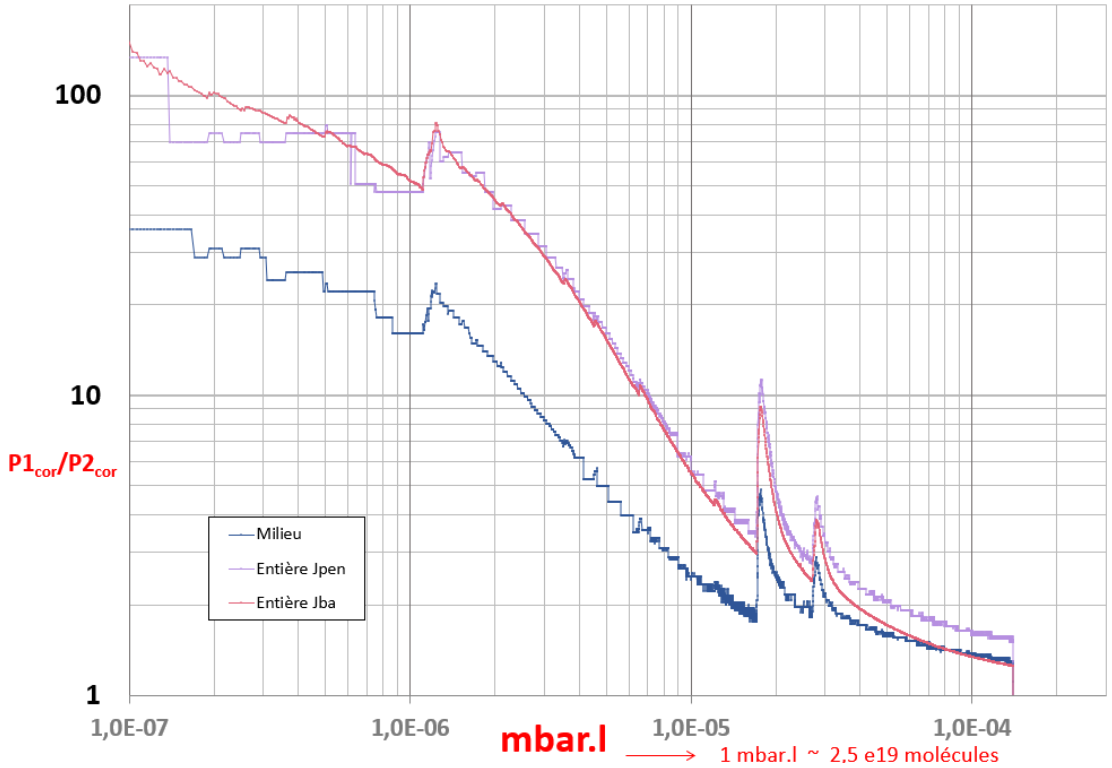


1st activation : issue with JPen 9 swichted on after activation

2nd activation : gauges switched on before activation

Pumping capacity measurements

Activation at 230 °C for 24 hours and CO injection



3rd activation : higher ratio but still a low capacity < 7x10e-6 mbar.l for a ratio of 10

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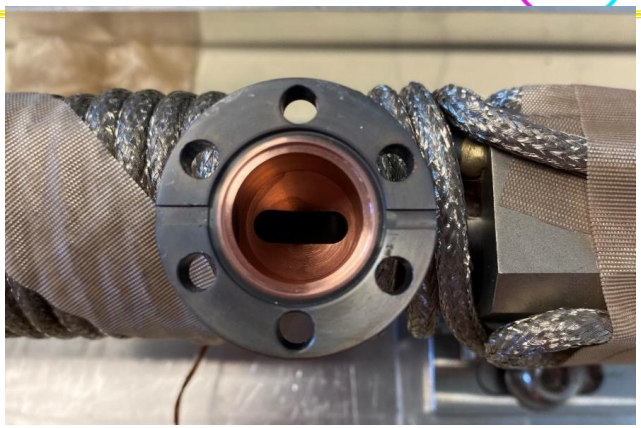
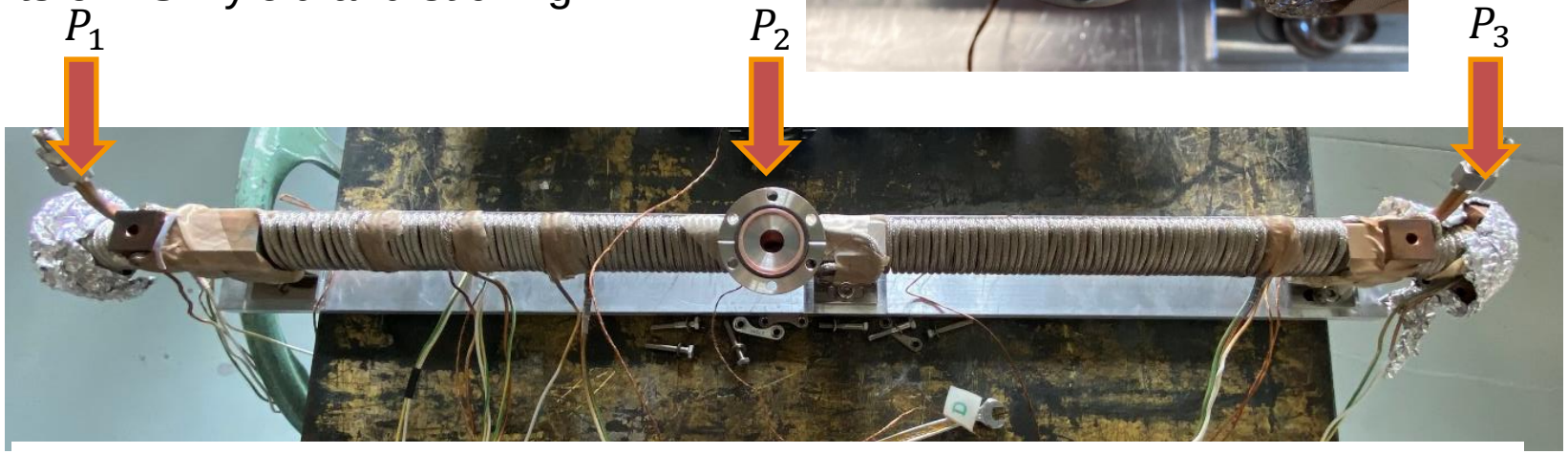
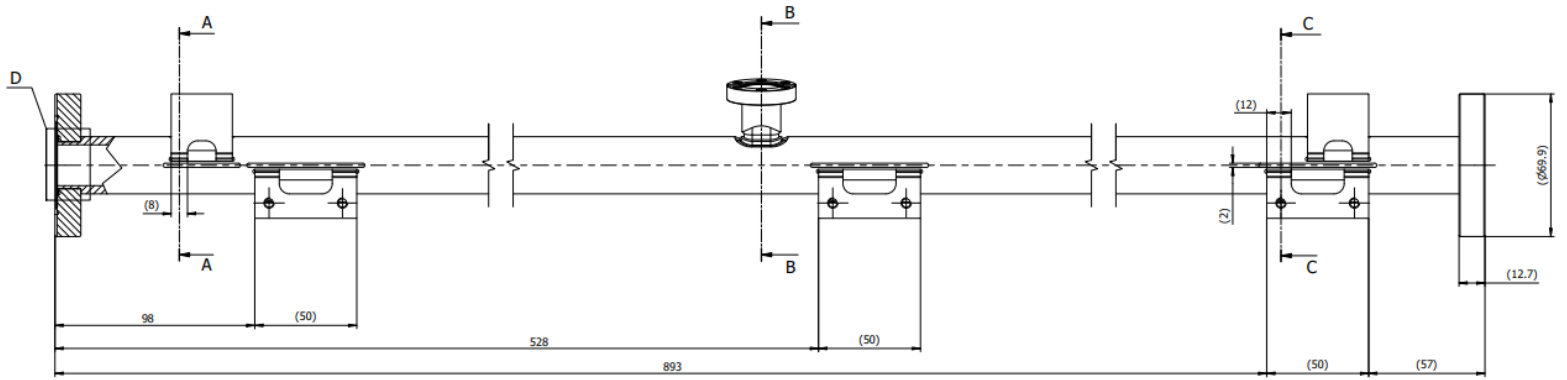
Test of the 3 Gauges Method experimental setup

During the training period of tour student Jonathan Gaudio, we had the opportunity to get a 3 gauge type vacuum chamber which allow us to check if our experimental setup was correct.

Its allowed also to get preliminary results of PSD yield and sticking factor

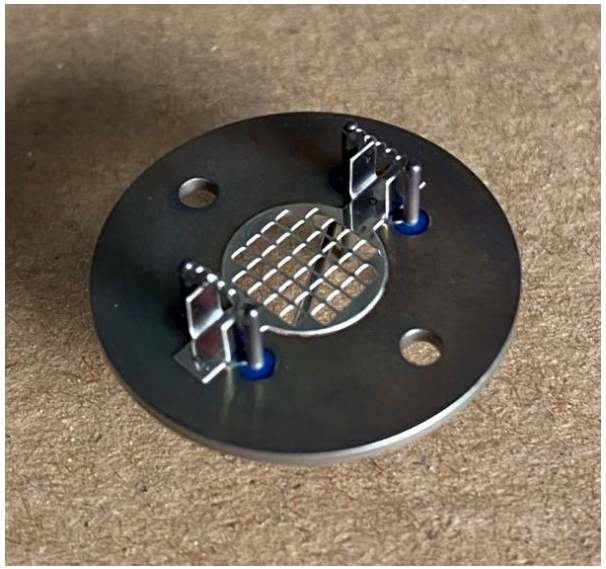




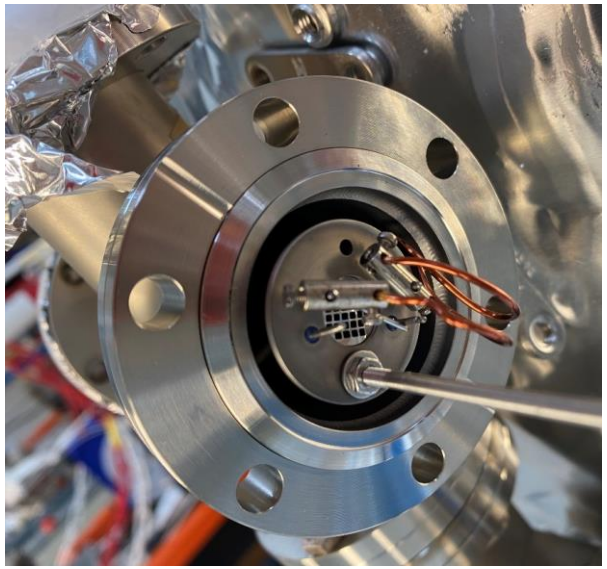


Electron gun

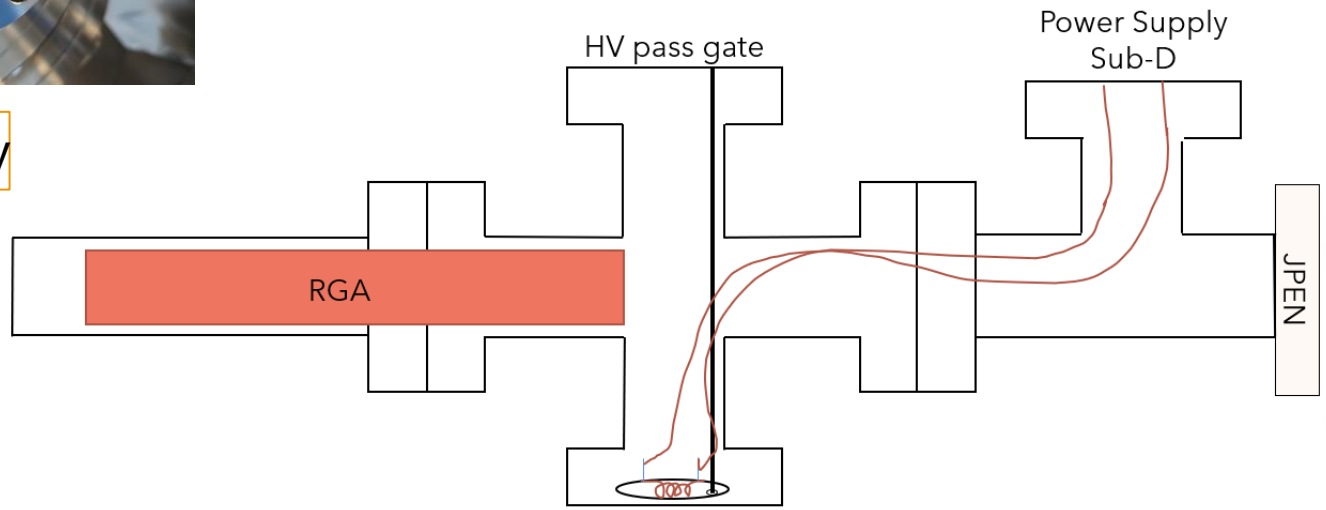
Assembly objective
- Reduce parasite photo-desorption
- Home made electron gun
- 2 powers supplies



RGA Filament plate

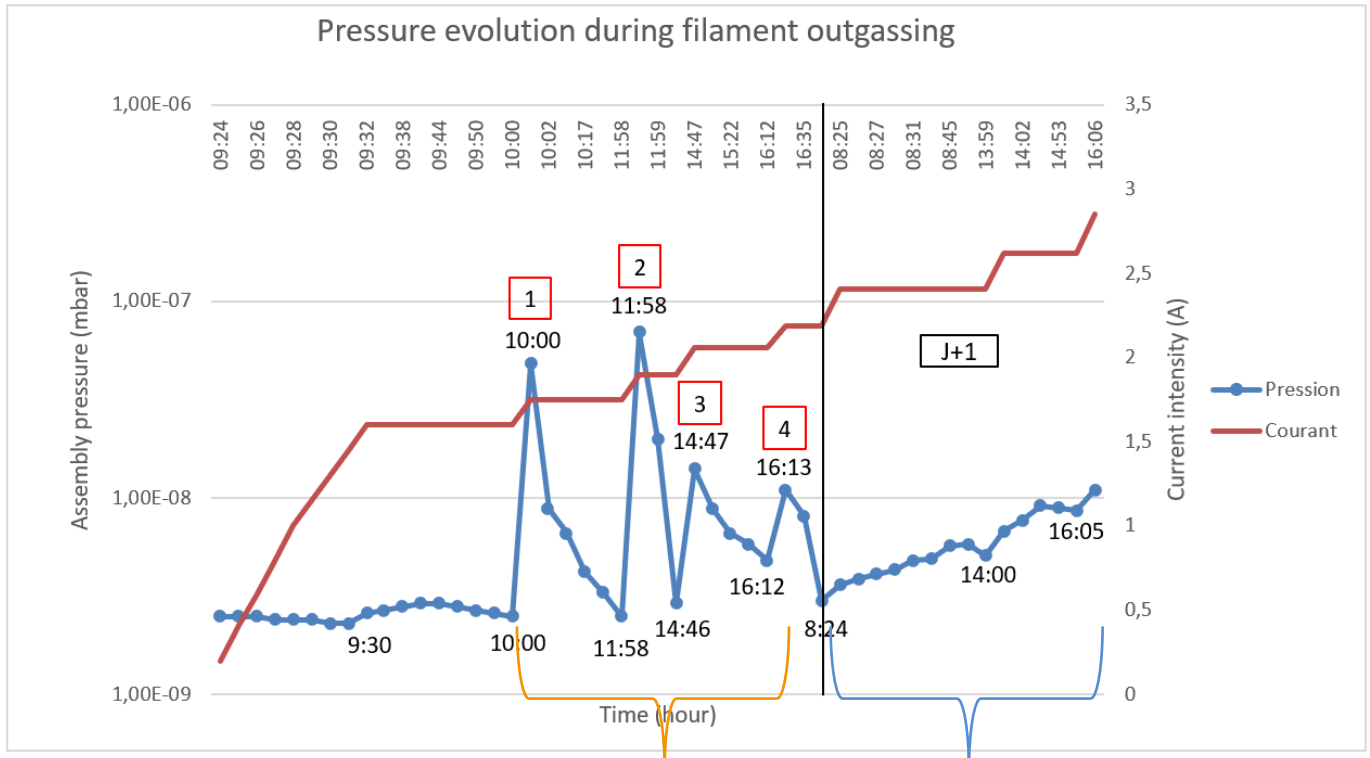


Assembly



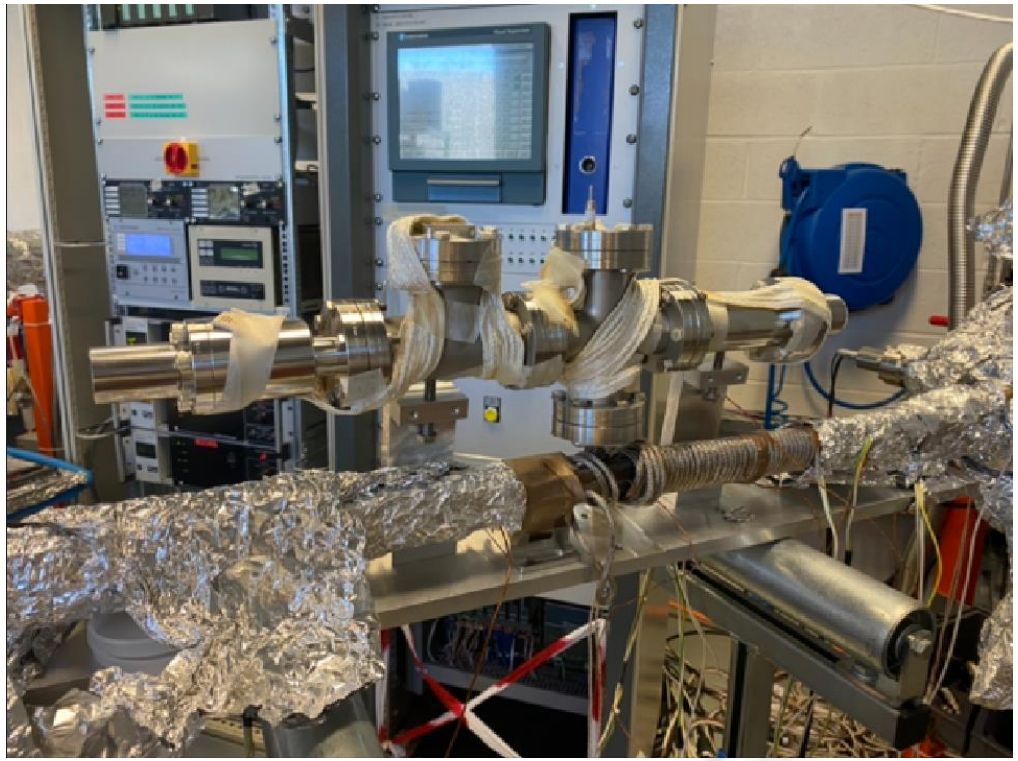
Solidwork modeling

Conditionning on transmission test bench

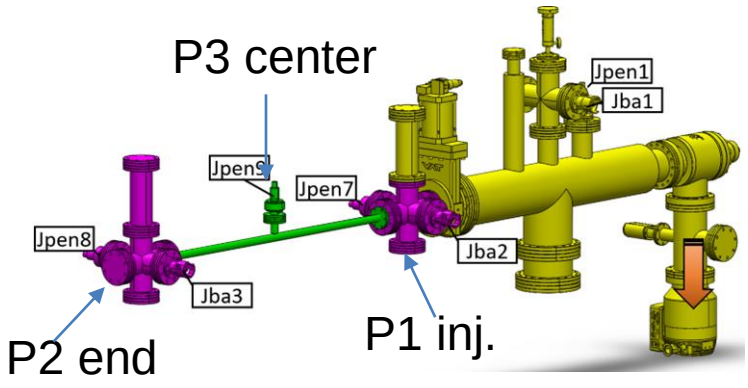


Pressure increase due to current increase, **conditionning**

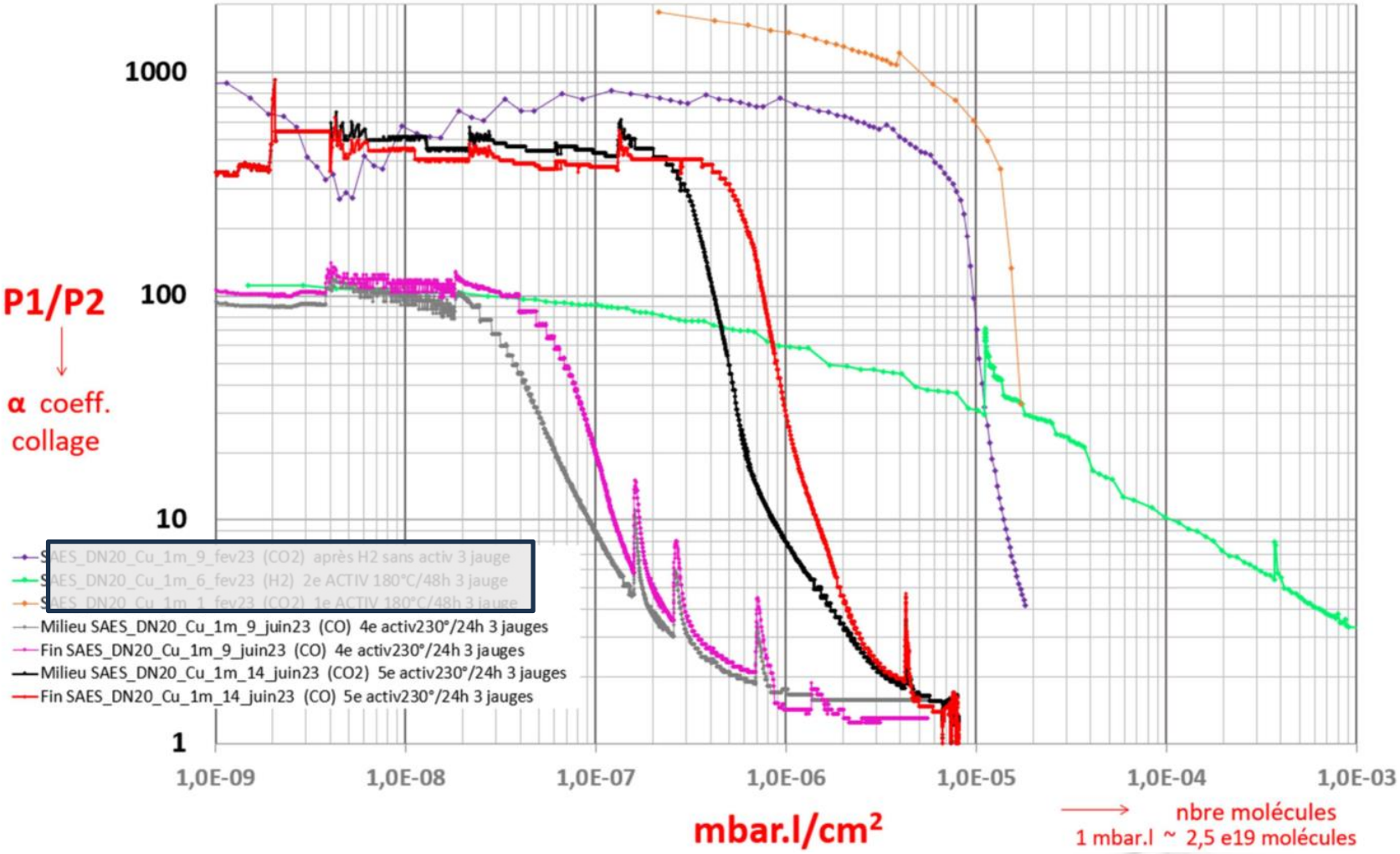
Pressure increase due to filament temperature



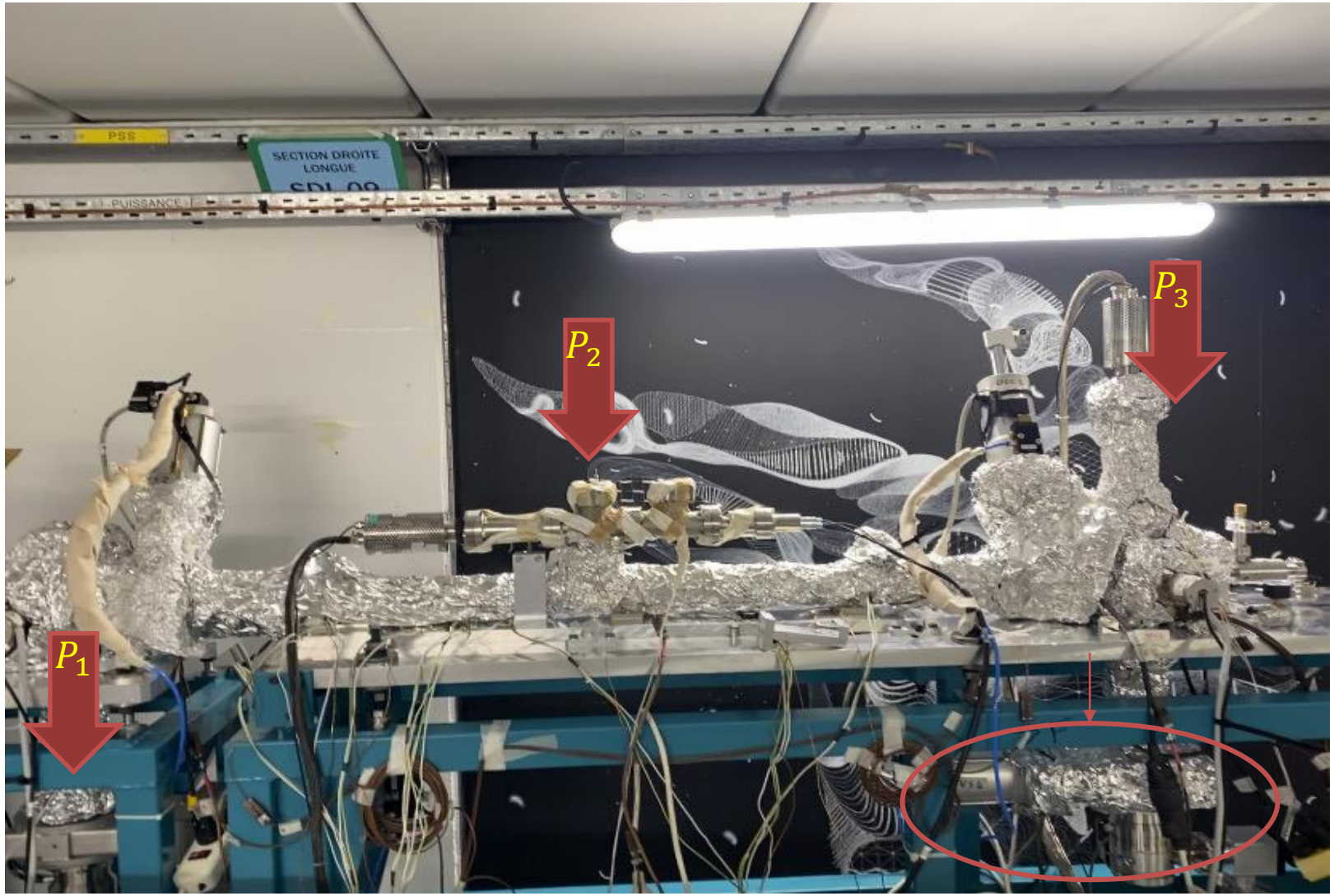
Capacity measurement of a 3 gauges NEG coated VC



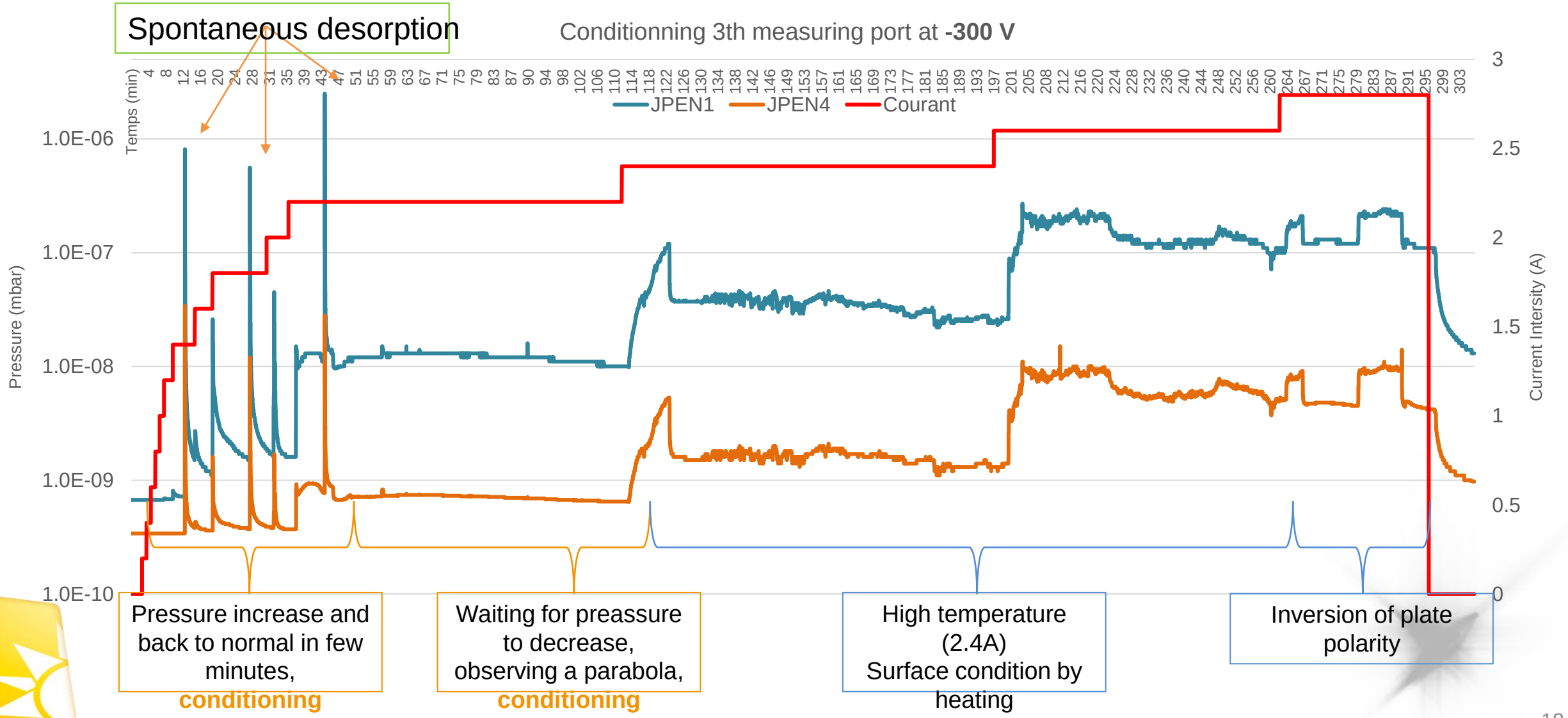
P1/P2 ↓ α coeff. collage



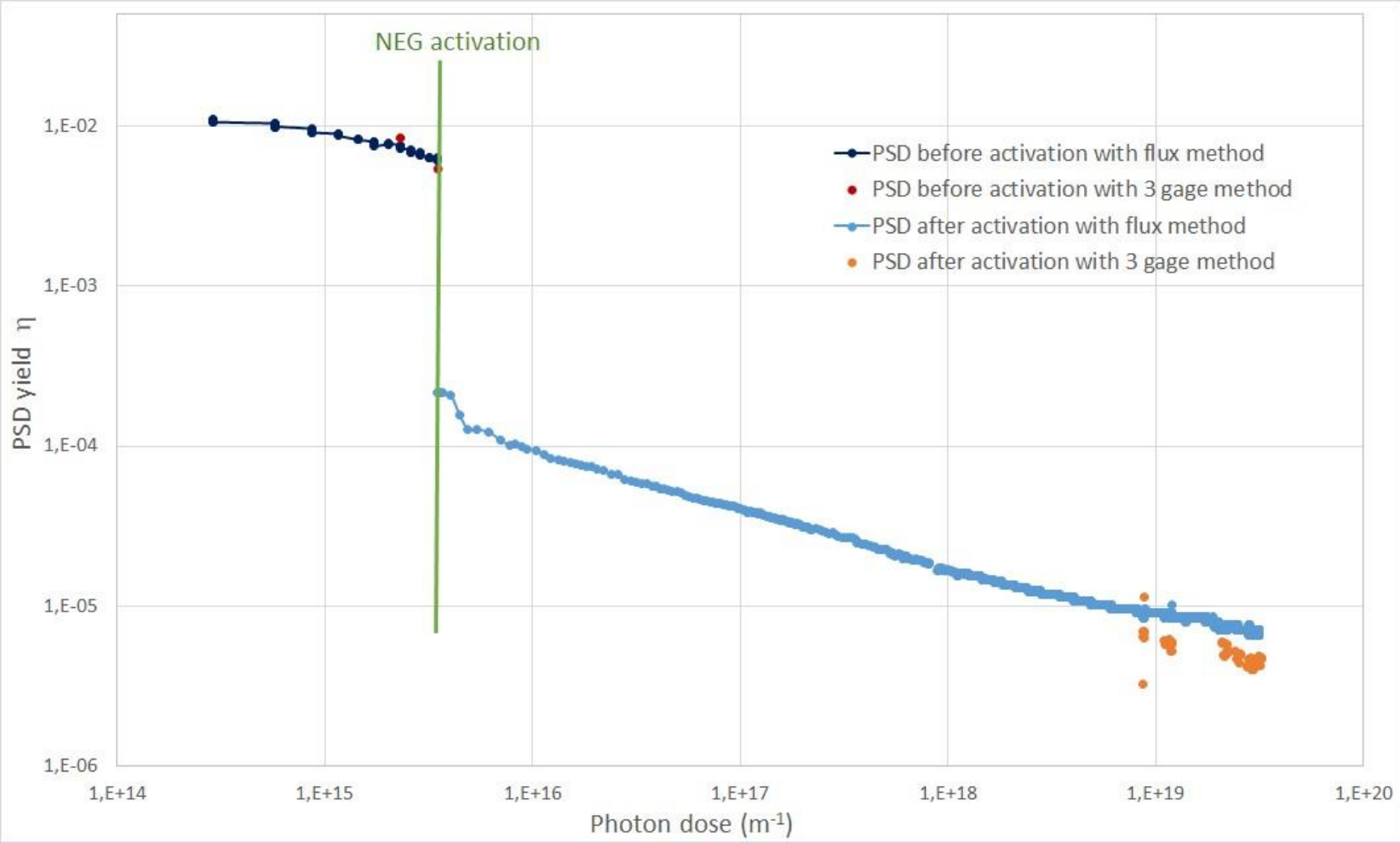
3 gauges VC installed on the PSD Beamline



Conditionning on PSD experimental setup



First results : comparison of flux method and 3 gauges method



Résultats

PSD yield :

Méthode des flux prioritaire

PSD decreasing from 6×10^{-3} to 1.210^{-4} molecules/photon after NEG activation

Flux method and 3 gauges method give coherent results

Sticking factor :

α = 2.3×10^{-3} for H2

Standard deviation = 3.3×10^{-4}

Coherent with value published in the literature (ex : Oleg Malyshev)

Gas	α	ΔP (Pa)	η, (molecules/photon)
	NEG coated vacuum chamber		
	After activation		
H_2	0.007	7×10^{-9}	1.5×10^{-5}
CH_4	0	2×10^{-9}	2×10^{-7}
$C_xH_y(28)$	0	$<5\times 10^{-10}$	$<3\times 10^{-8}$
CO (28)	0.5	$<3\times 10^{-10}$	$<1\times 10^{-5}$
CO_2	0.5	$<7\times 10^{-11}$	$<2\times 10^{-6}$

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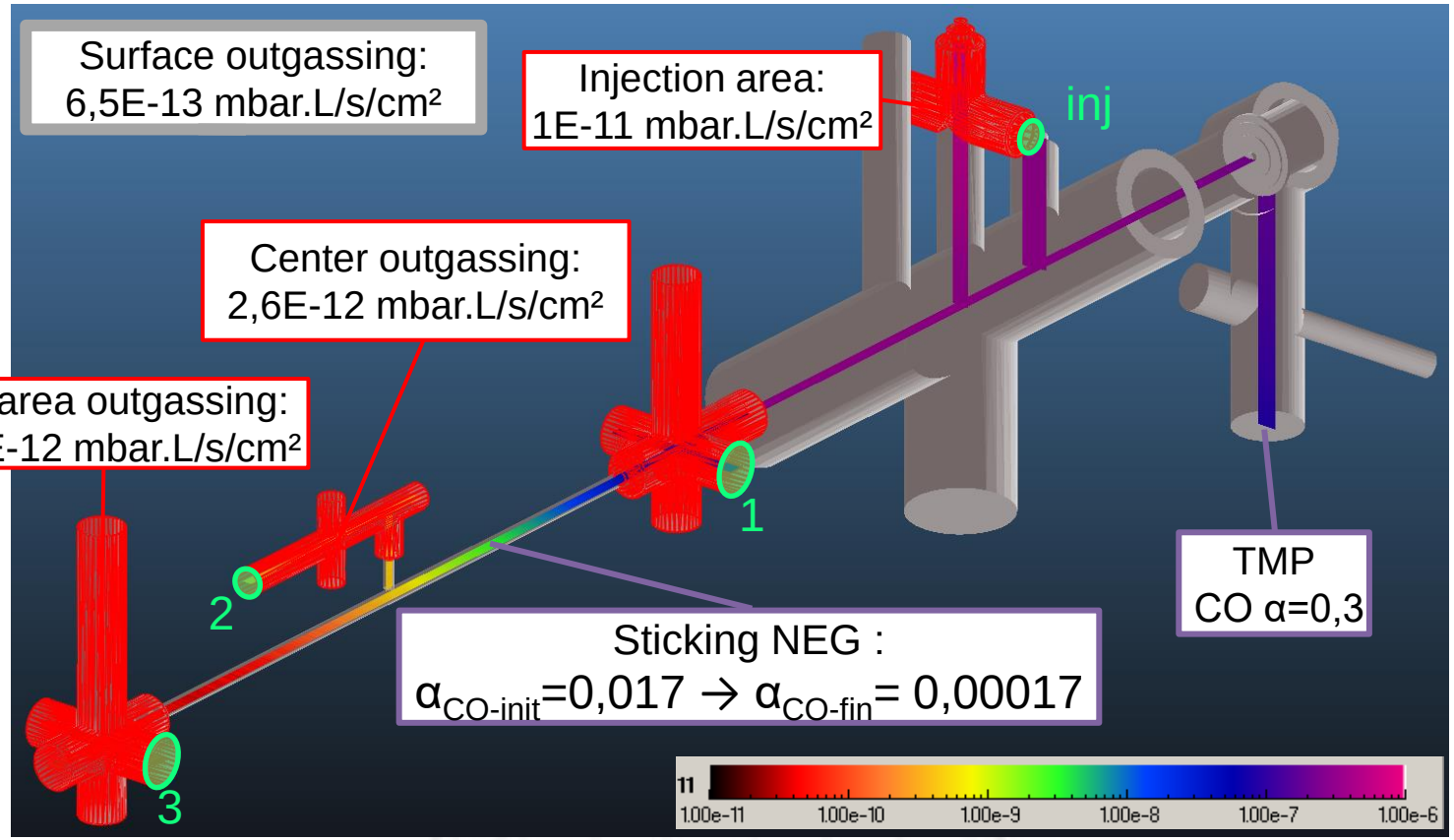
Use of VacuumCOST code

- Simulation of the pressure profiles in the future storage ring
- Evolution of the residual sticking factor for MOLFLOW+ simulation
- Evolution of the saturation rate as a function of time and photon dose
- Use of VacuumCOST code developed by P.L. HENRIKSEN
  - P.L. Henriksen, M. Ady, R. Kersevan,Vacuum chamber conditioning and saturation simulation tool (VacuumCOST): Enabling time-dependent simulations of pressure and NEG sticking in UHV chambers,

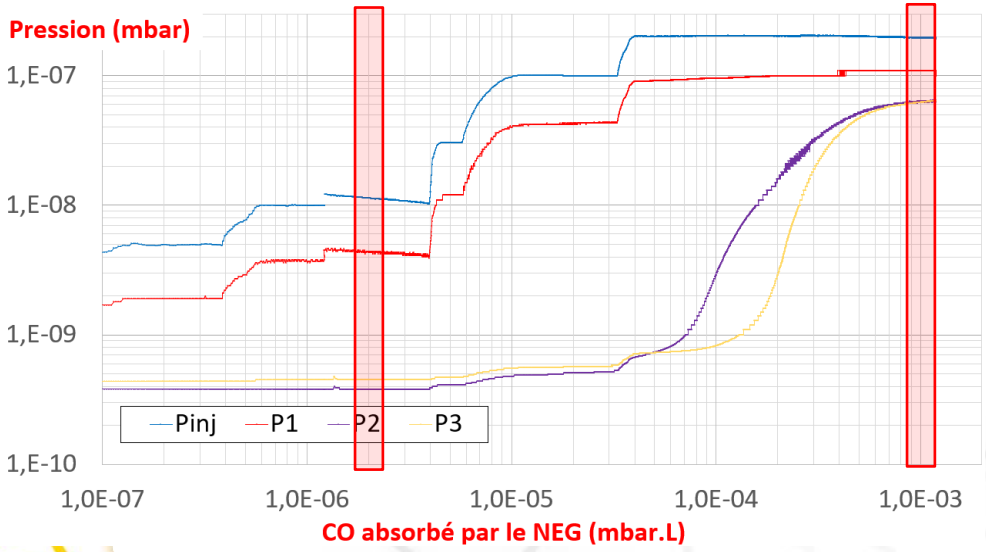
Initial and final boundary conditions for MOLFLOW simulation

Definition of characteristics of:

- Setup (quantity of injected gas, conductance, wall outgassing)
- NEG coated VC (sticking factor, capacity, …)



Study of the system at time t with MOLFLOW+



Courtesy by Thomas SOUSKE

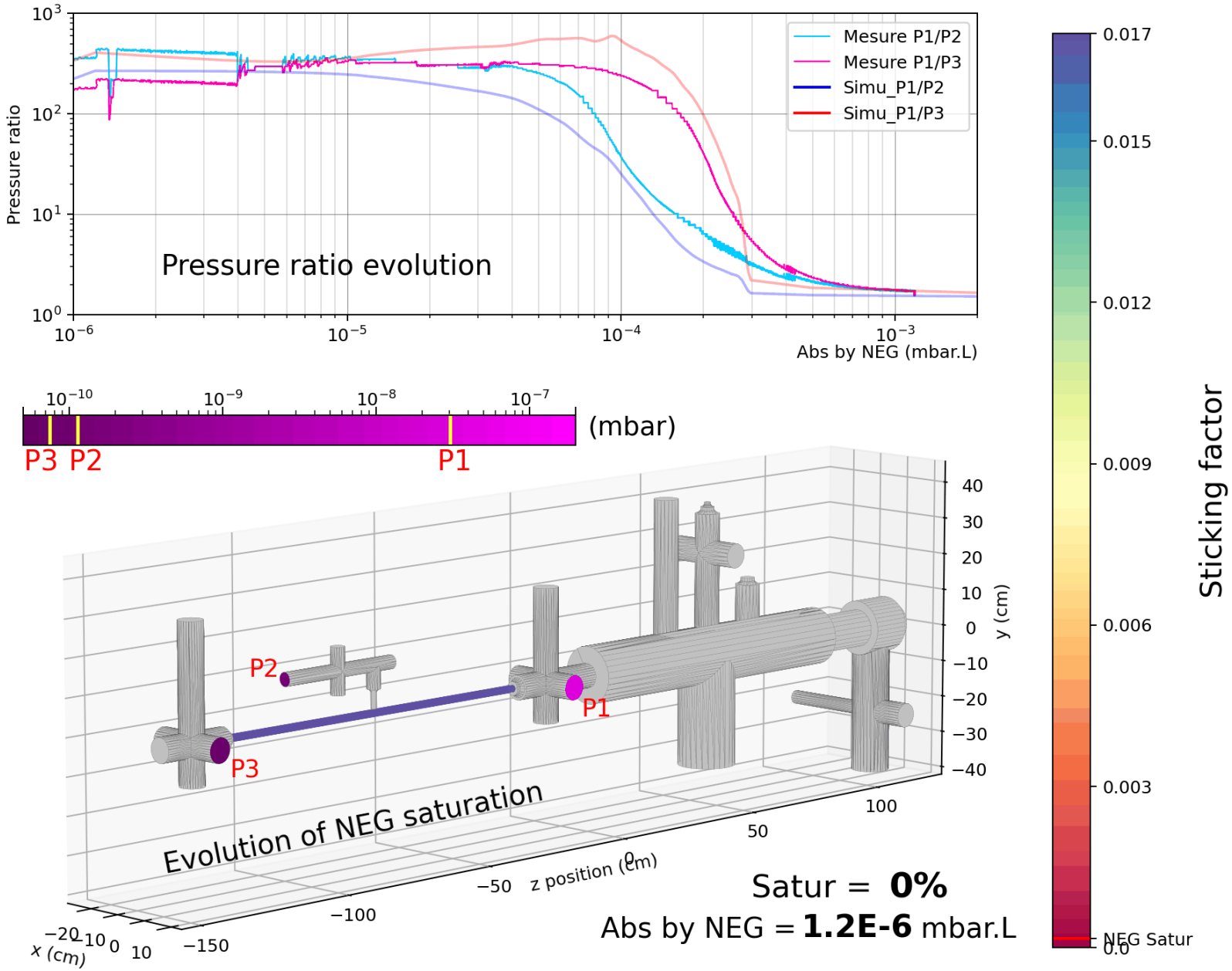
Résults :

Satisfying model

Discrepancy between measure and simulation is related to accuracy of the pressure measurement and the homogeneity of the NEG coating

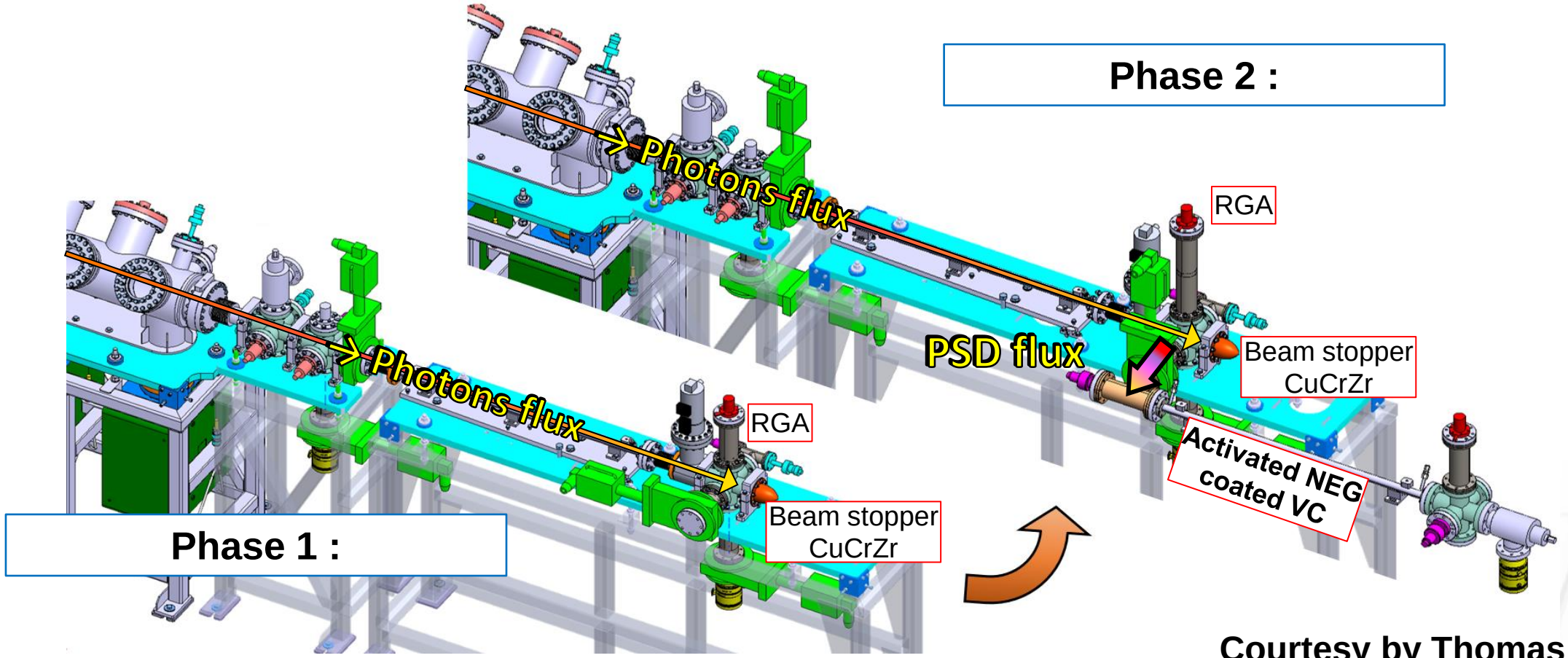
Few parameters:

- 200 Iterations on NEG saturation (step of 0,5%)
- 1E6 simulated molecules per iteration
- 48 h of simulation
- 1 simulated molecule for pour 3 000 000 000 real molecules
  That to say 1.2E-10 mbar.l (CO)
- 1% of injected/desorbed gas is pumped by the NEG surface



Courtesy by Thomas SOUSKE

Phase 1→2 Photo-désorption pour saturation NEG



Courtesy by Thomas SOUSKE

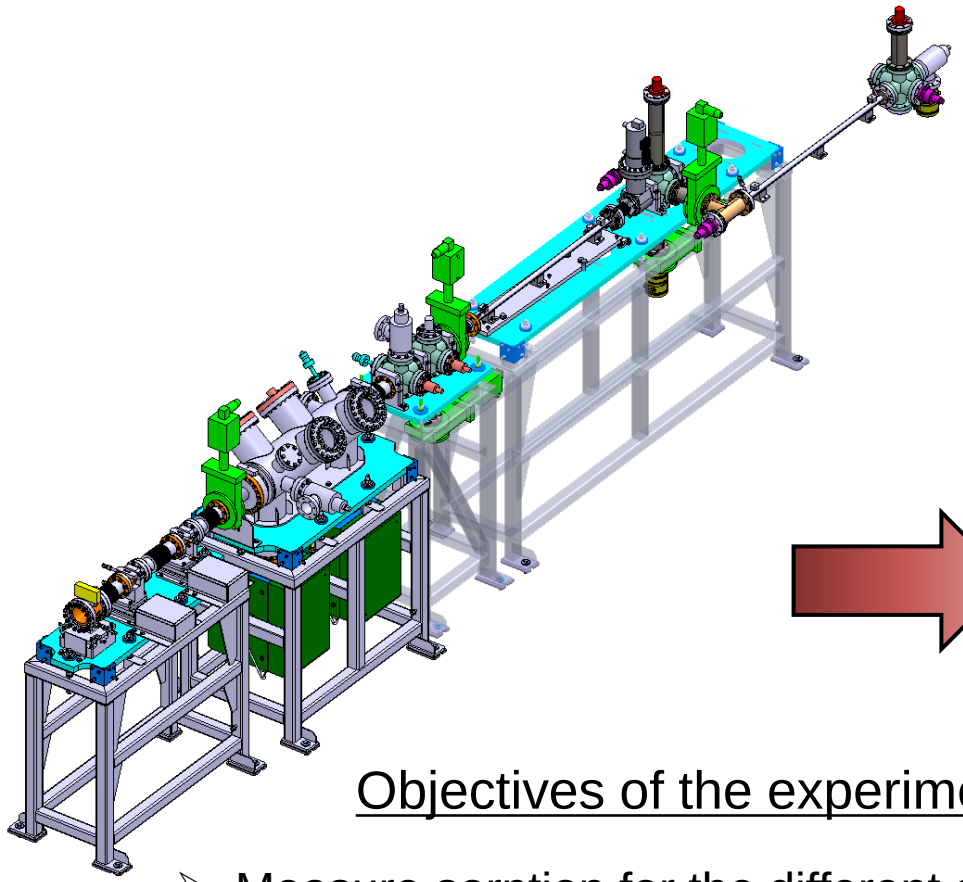
Phase 1 :

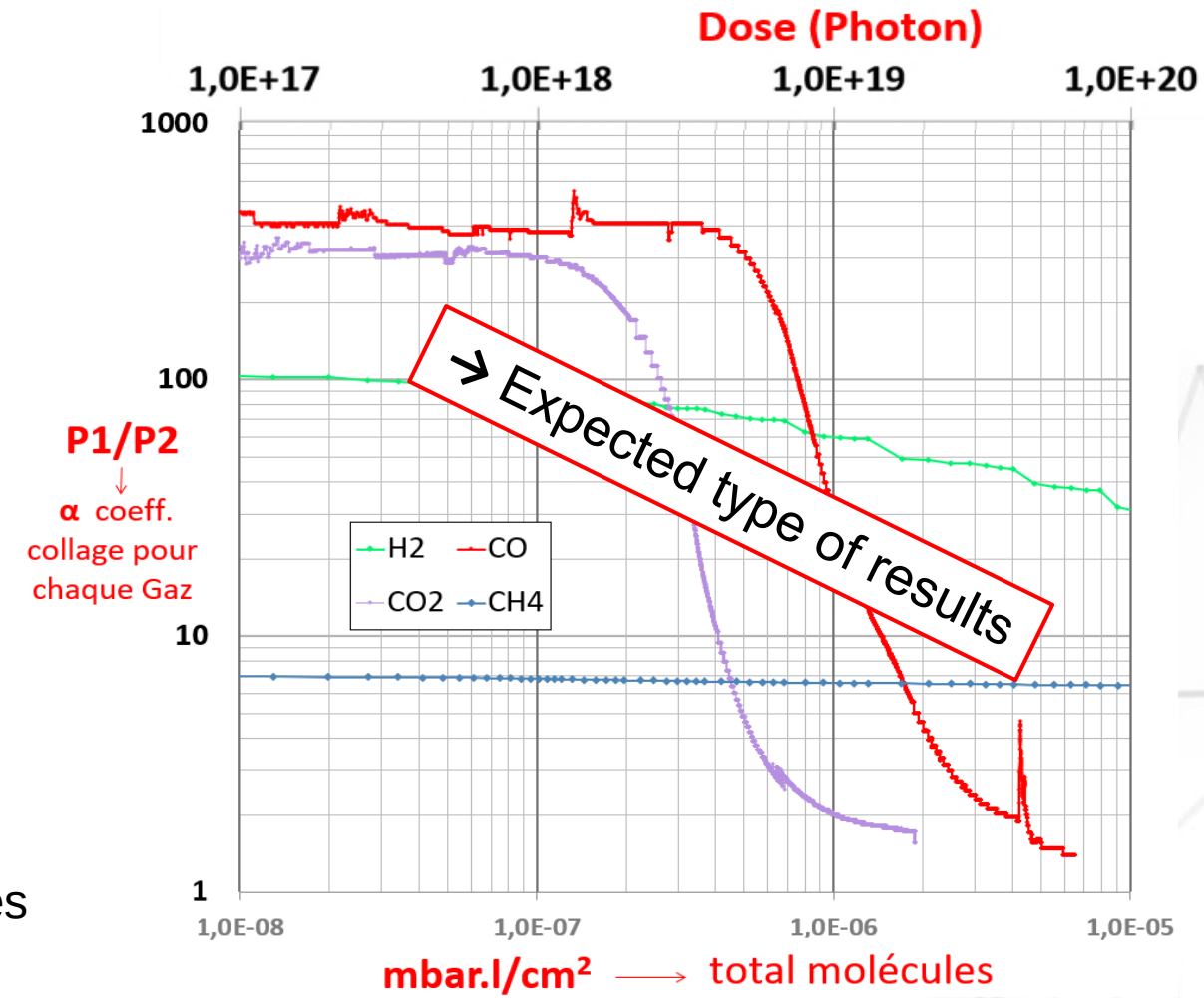
- All the PSD beamline is aligned on the photon beam axis
- All the photon beam hits the CuCrZr beam stopper
- Desorbed gas is pumped by the pumping chamber through the conductance

Phase 2 :

- The PSD gas is mainly pumped by the activated NEG coated VC

Characterization of NEG coating in real conditions





Objectives of the experiment:

- Measure sorption for the different gas species
- Validate the iterative model of simulation
- Define the parameters for the simulation of the pressure profil of the future storage ring of SOLEIL II

Courtesy by Thomas SOUSKE