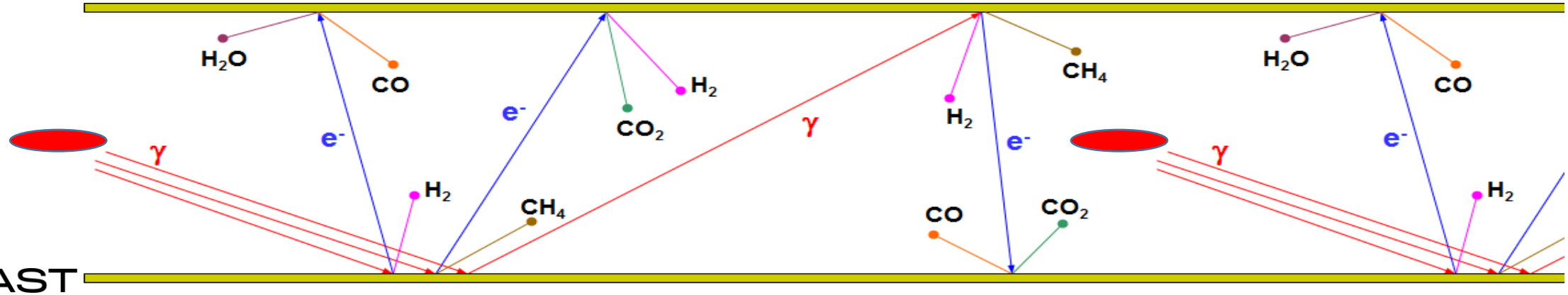
3rd I.FAST Annual Meeting on 16-19 April 2024

Oleg B. Malyshev (UKRI)
Task 10.5 leader

Vacuum in particle accelerators

- **Photon stimulated desorption (PSD)** is one of the most important sources of gas ***in the presence of synchrotron radiation (SR)***.
- **Non-Evaporable Getter (NEG)** coating is a good solution to meet vacuum specification:
  - Low installation and operation cost
  - Can applied to vacuum conductance limited (i.e. narrow) chambers

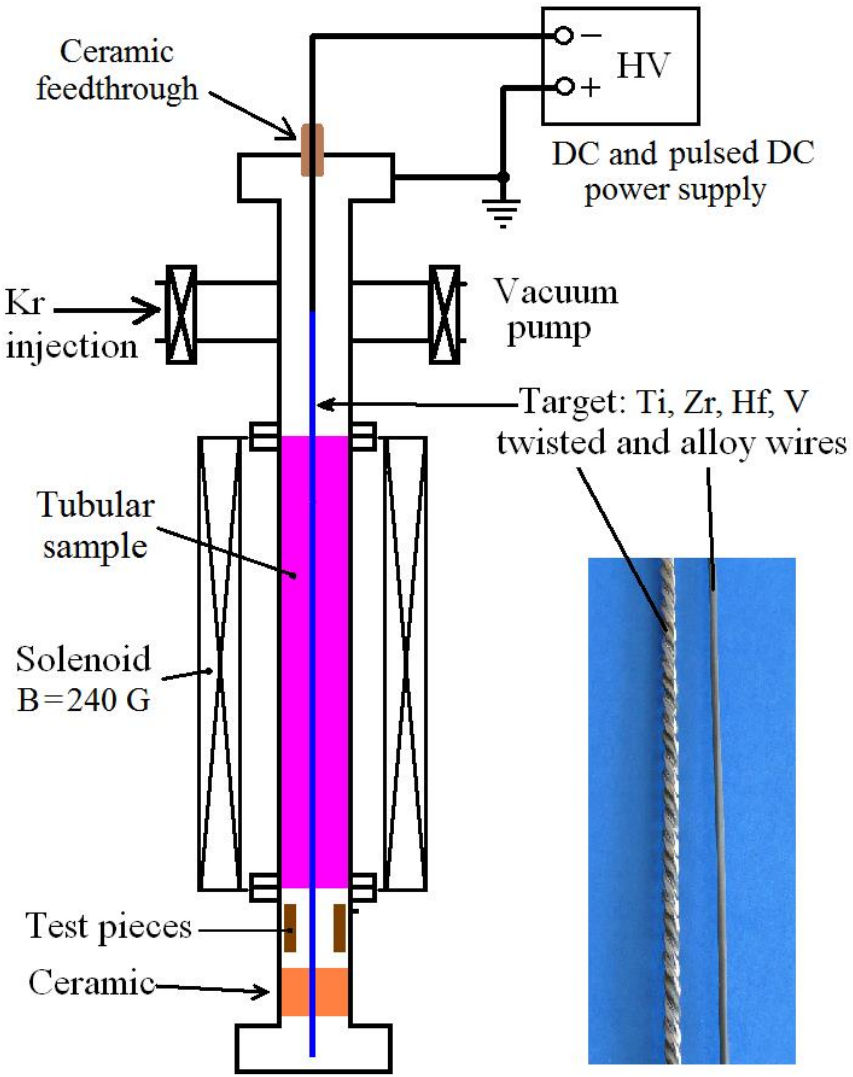
- **What information is needed:**
  - **Experimentally measured PSD yields, η, and sticking probabilities, α,** for H_2, CH_4, CO, CO_2 (*for modelling future machines*)
  - **Practical knowledge and experience** on what happens in case of various operation issues.
- Thus, one needs the data for **NEG coated prototypes under conditions similar to future light sources**



Task 10.5 objectives

- Building facilities for photon stimulated desorption (PSD) yield measurement on beamlines at DLS and Soleil
  - MS47 - done
- Obtaining and analysing the photon stimulated gas desorption (PSD) experimental data from Non-Evaporable Getter (NEG) coated prototypes under conditions similar to future light sources
  - ✓ Samples produced
  - ✓ Surface preparation at DESY
  - ✓ Coating with NEG film at UKRI,
  - ➢ PSD test at DESY and Solei - ongoing
  - ➢ Pumping property testing of NEG coated samples in all partners labs - ongoing

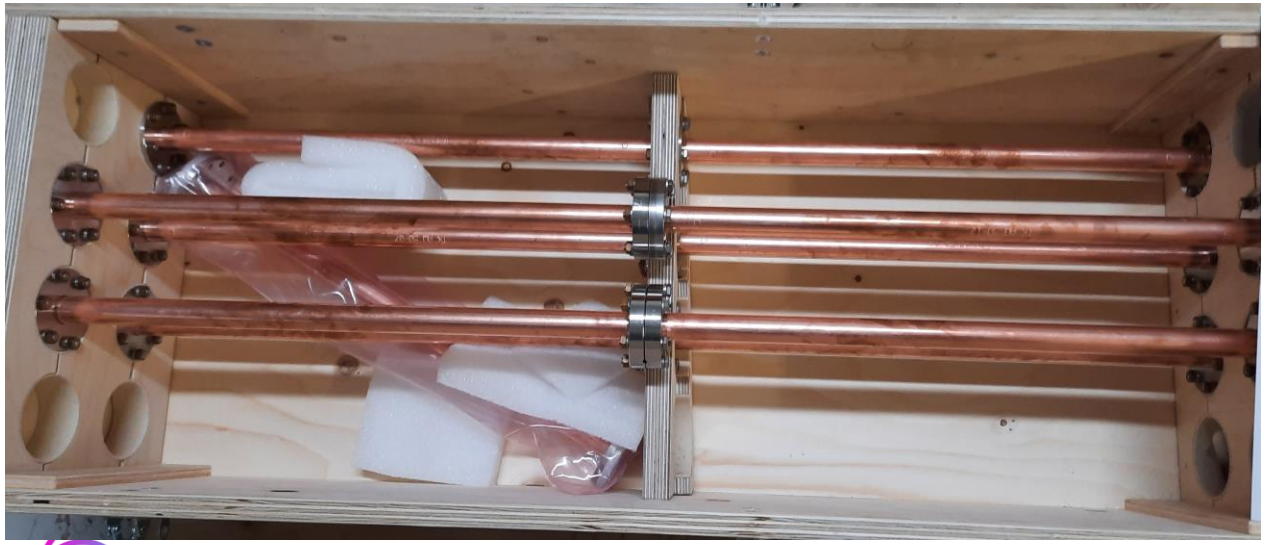
NEG deposition facilities at UKRI (Daresbury Laboratory)



- Two facilites is used for a routine coating of tubes with
  - a length of 0.5 - 1 m
  - Inner diameter 5-100 mm
  - CF16-CF150 flanges
- Problems solved over last year:
  - TiZrV alloy targets
    - No manufacturers
    - Brittle target cannot be stretched to aligh inside the tube
    - ✓ Returning to twisted wired
    - ✓ Or pure Zr target
  - No deposition at the end of 1-m sample:
    - ✓ New deposition system for 1-m samples with Moving magnet built and in operation from Jan 2024

Samples for pumping properties evaluation

- Agreed project *standard sample* for pumping properties evaluation is
  - made of OFHC or OFS copper samples
  - ID = 20 mm
  - L = 500 mm
  - equipped with two CF40 flanges
- 11 samples have been provided by DESY in 2022.

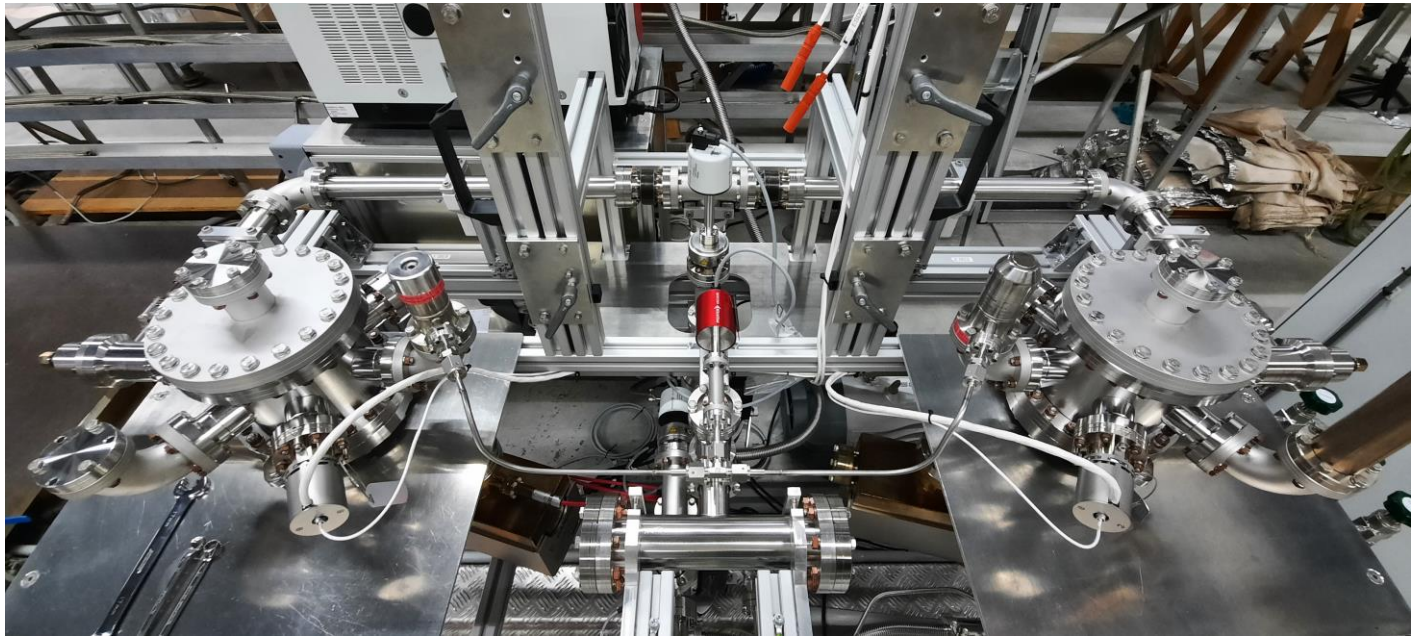


- Initial issue of cleaning/etching procedures
  - An inner surfaces of the samples have some black coverage - silver oxide.
  - Higher thermal outgassing than a reference sample cleaned at UKRU

  ✓The DESY cleaning procedure has been changed to address this issue (cleaning with BPS-172).
- 8 ***identical samples*** coated at UKRI:
  - 4 x Columnar TiZrV
  - 4 x Columnar Zr
  - To be tested in following months in 4 labs for comparing (cross-verifying) the results obtained on different facilities

Facility for pumping properties evaluation at DESY

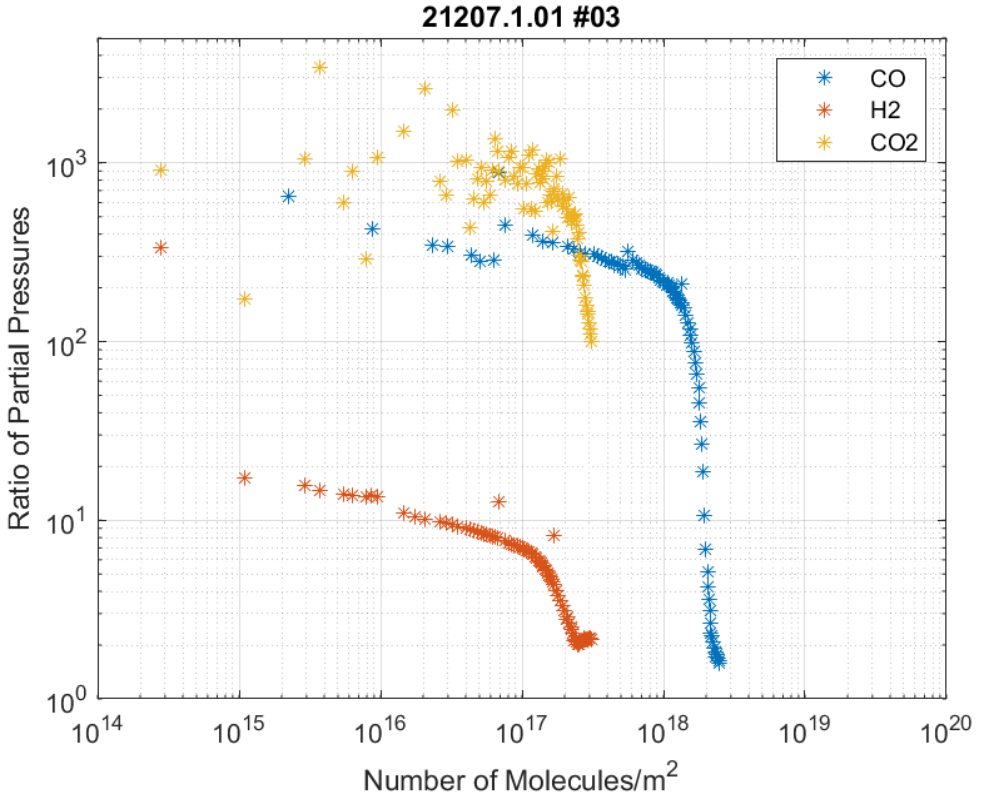
- **Pumping test setup is in operation**
- RGA or extractor gauge-based pressure ratio measurements
- Another mirroring system is lacking RGAs
- ESD setup (one of the two mirroring chambers) is ready for commissioning and pumping tests

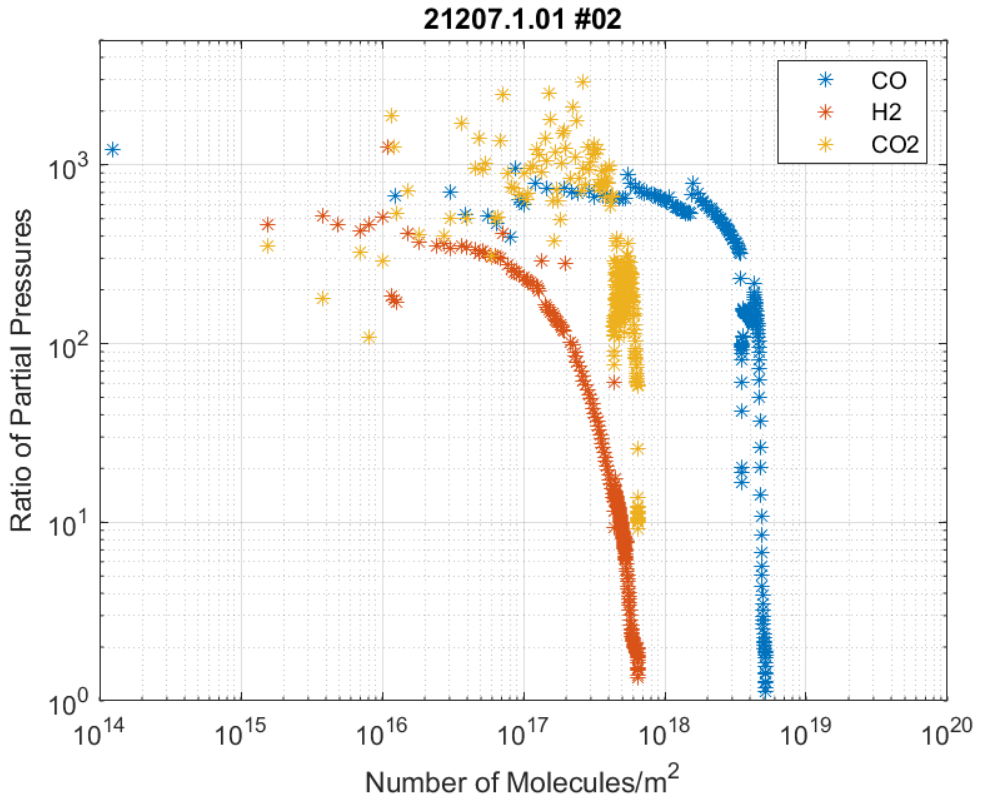


Courtesy of R. Sirvinskaite (DESY)

3-port Vessel for PSD tests at DLS and Soleil:

- Deposited with TiZrV dense NEG at UKRI
- Pre-analysed after 180°C activation at UKRI





Tube	α_{CO}	α_{H2}	α_{CO2}	CO Capacity (CO/m2)	Sent To:
#03	0.008	0.001	0.02	2×10^{18}	SOLIEL
#01	0.009	0.001	0.02	4.8×10^{18}	DLS

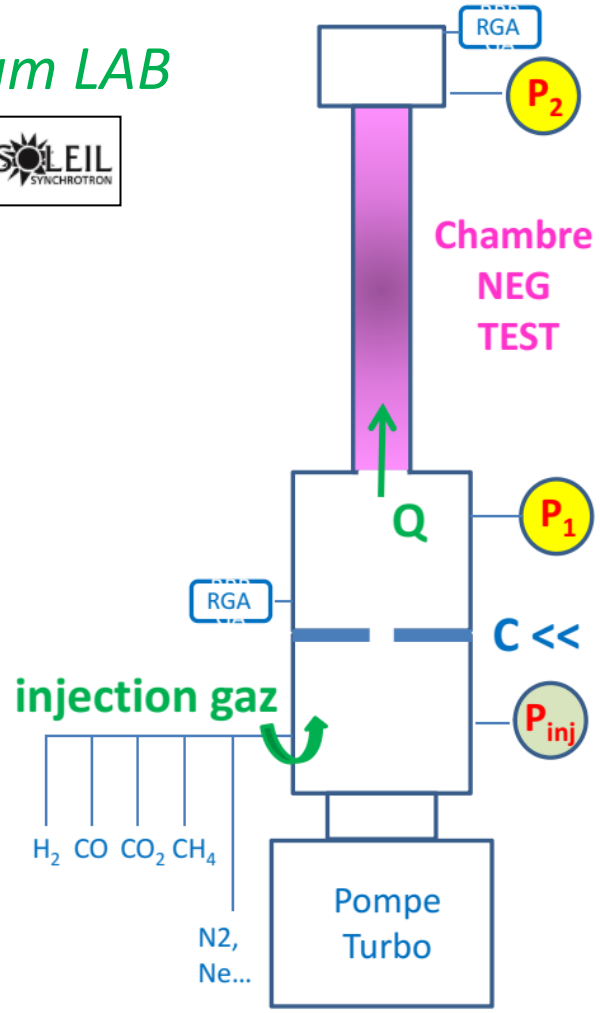
Facilities for pumping properties evaluation at Soleil

@ Vacuum LAB

- Sticking factor α
- Sorption capacity
- Activation optimization

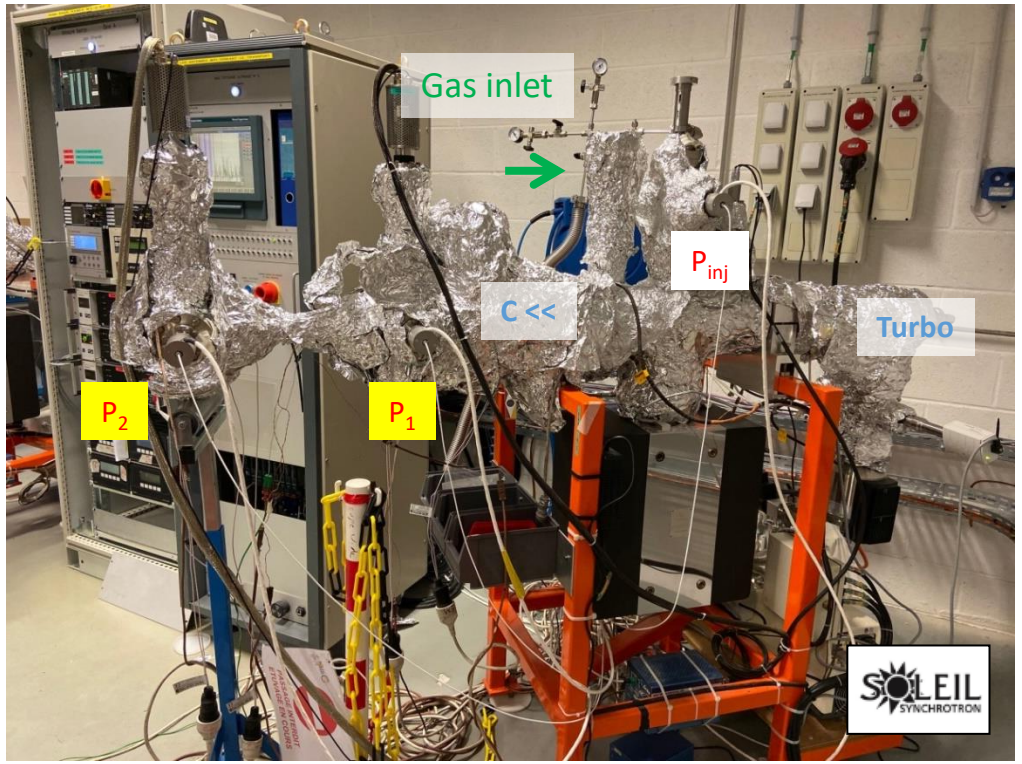
Transmission Method

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



Courtesy of C. Herbeaux (Soleil)

2 Transmission Method Test Benches for NEG coating characterization

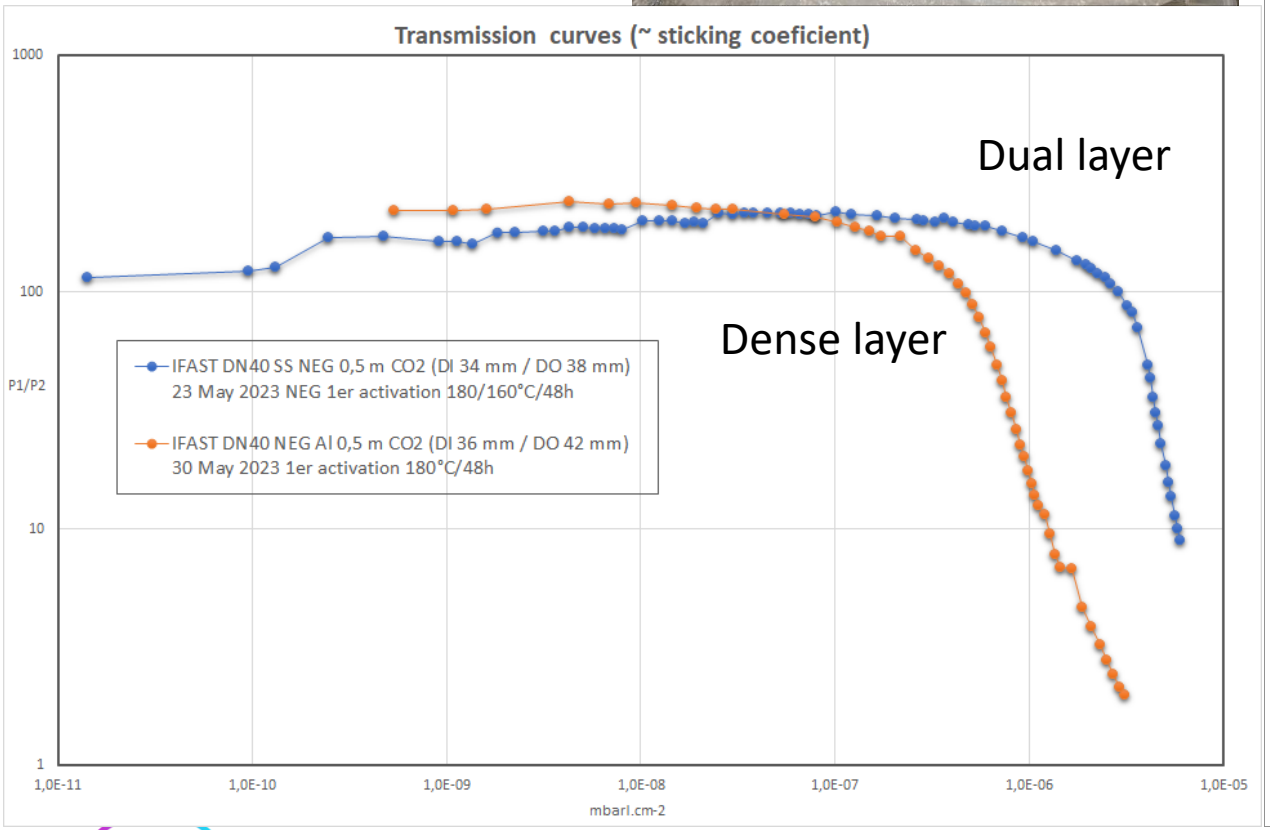


P_1/P_2 is calibrated with **MOLFLOW+** to find α

Facility is in operation:

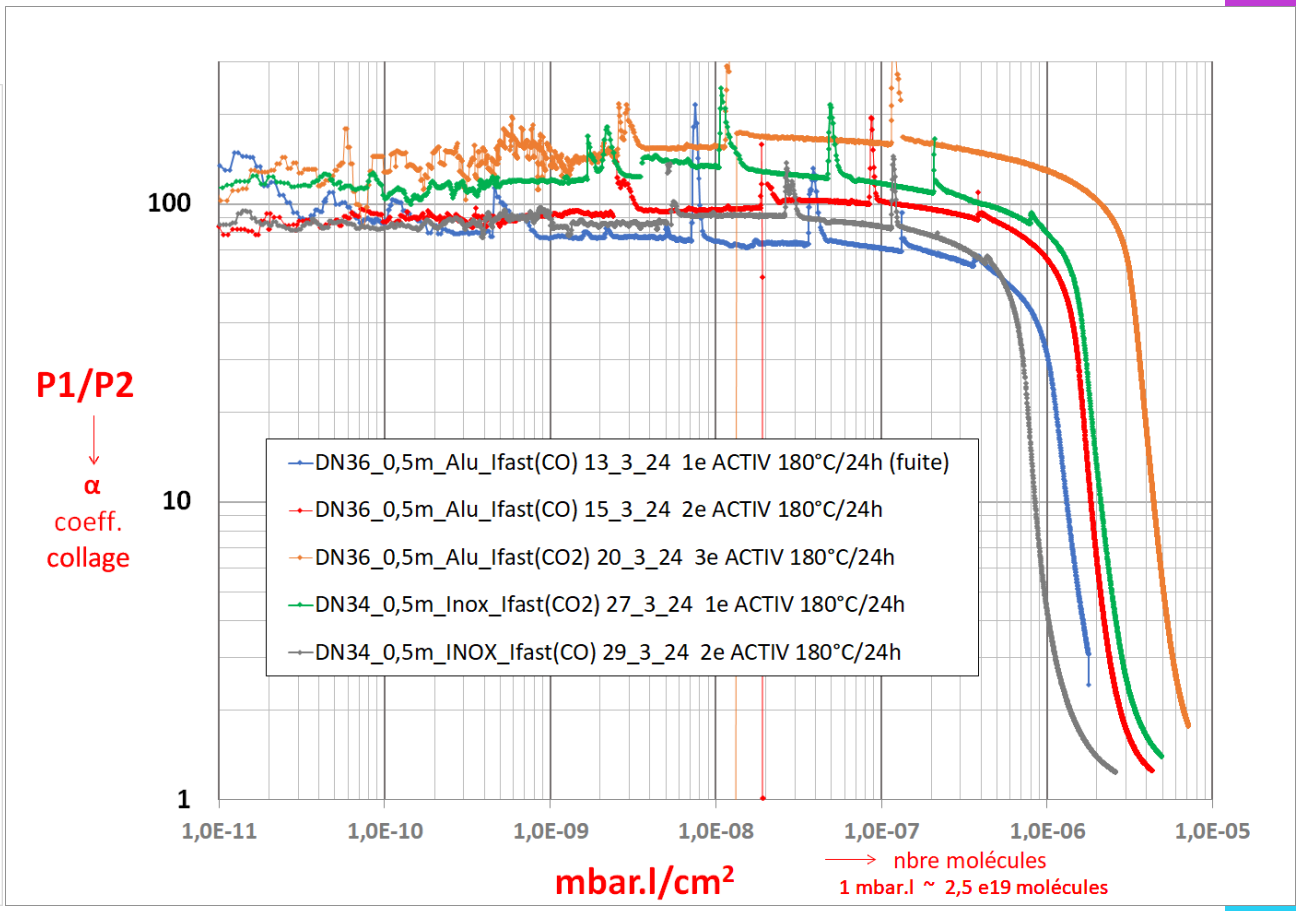
- 4 samples (ID=36-40 mm and L=50 cm) has been coated at UKRI and tested at Soleil
- 2 samples (ID=20 mm and L=50 cm) will be sent soon

Two first samples from UKRI measured at SOLEIL by transmission method



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

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



Courtesy of C. Herbeaux (Soleil)

Receiving and testing the first PSD sample (dense TiZrV) at Soleil

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

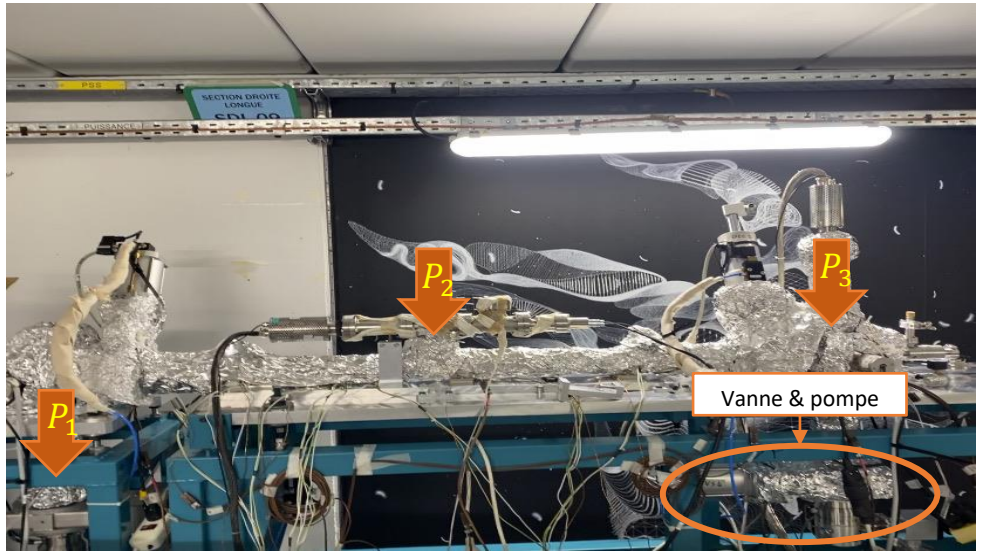
Sticking probability for H2 ≈ 0.001

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

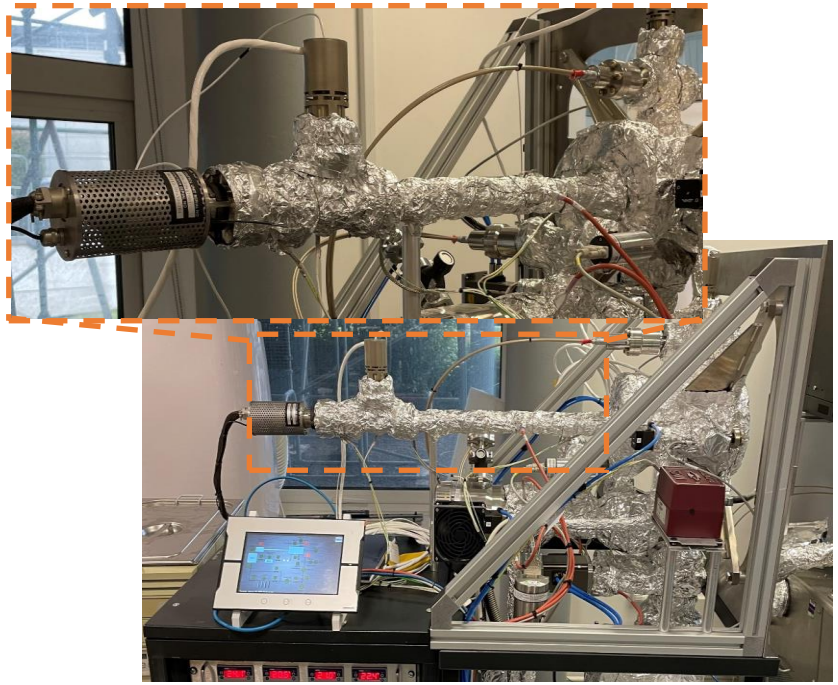
15/01/23 – Tube vented and filled with Nitrogen

Courtesy of C. Herbeaux (Soleil)

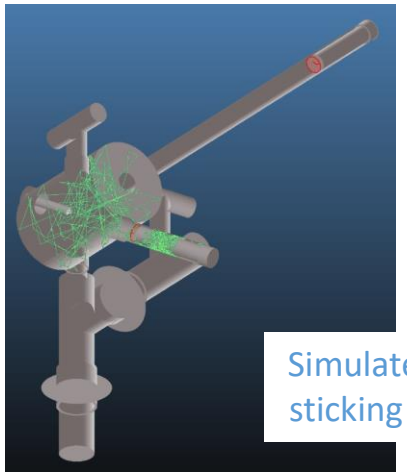
Presently getting ready for installation on PSD bench in SOLEIL's tunnel (April 2024)



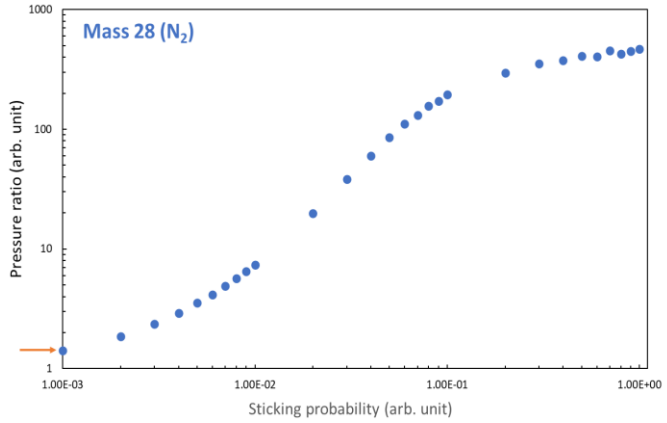
Diamond Light Source - NEG & PSD update



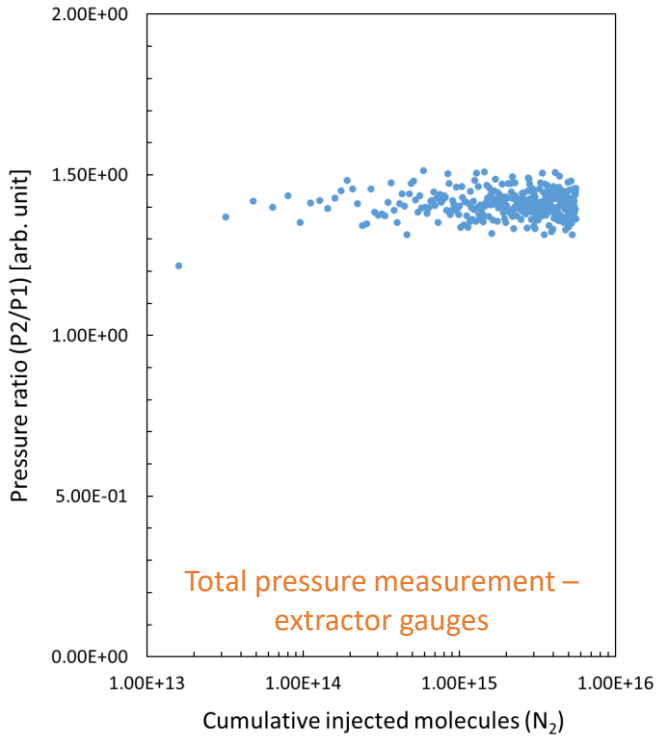
- Coating rig operational with ternary (TiZrV) twisted wire
- Pumping speed measurement rig in use and operating



Simulated pressure ratio-sticking probability curve



Pressure ratio plot for injected N_2 in non-coated vessel



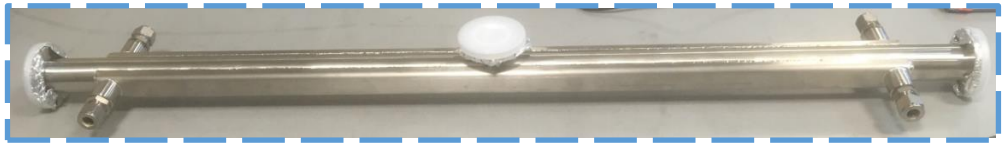
Courtesy of C. Burrows (DSL)

- **Next steps**: pumping speed measurements on PSD vessel removed from test beamline (coated at UKRI)
- Sticking factors used in PSD data analysis

Deposited from TiZrV alloy target at UKRI

Diamond Light Source - NEG & PSD update

Deposited from TiZrV alloy target at UKRI

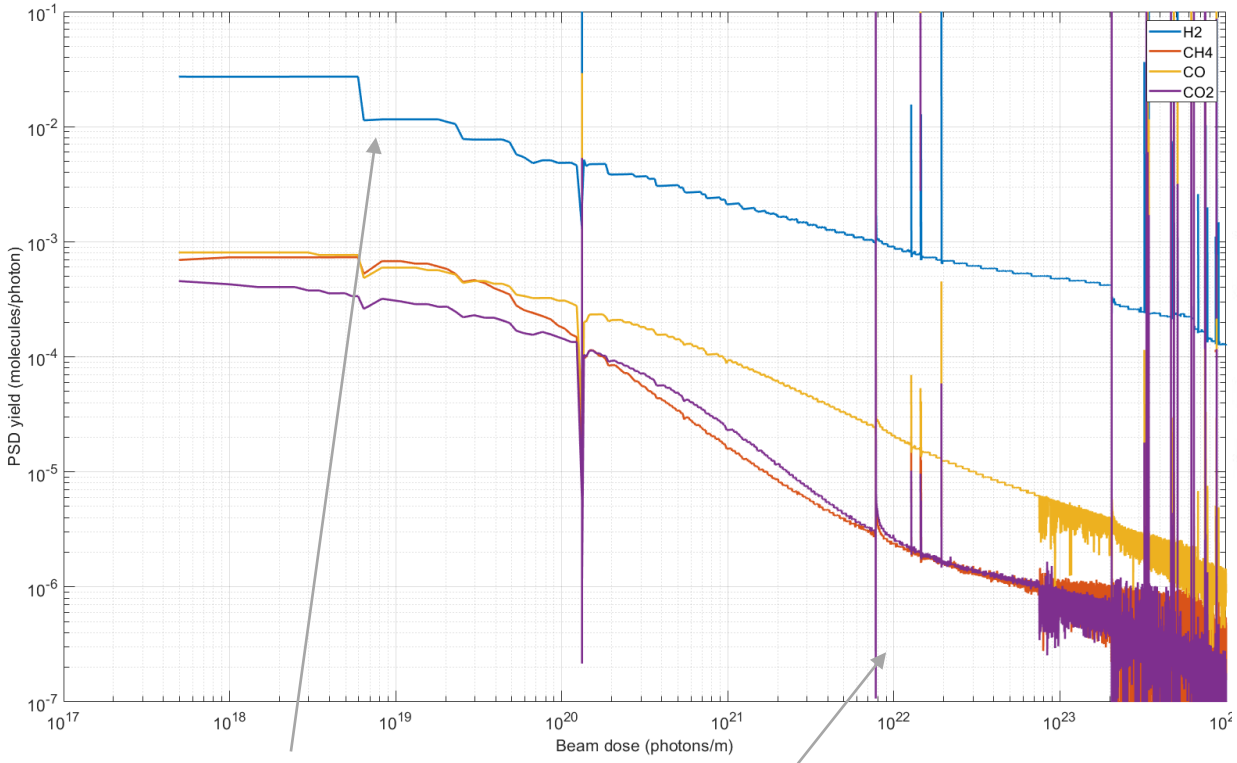


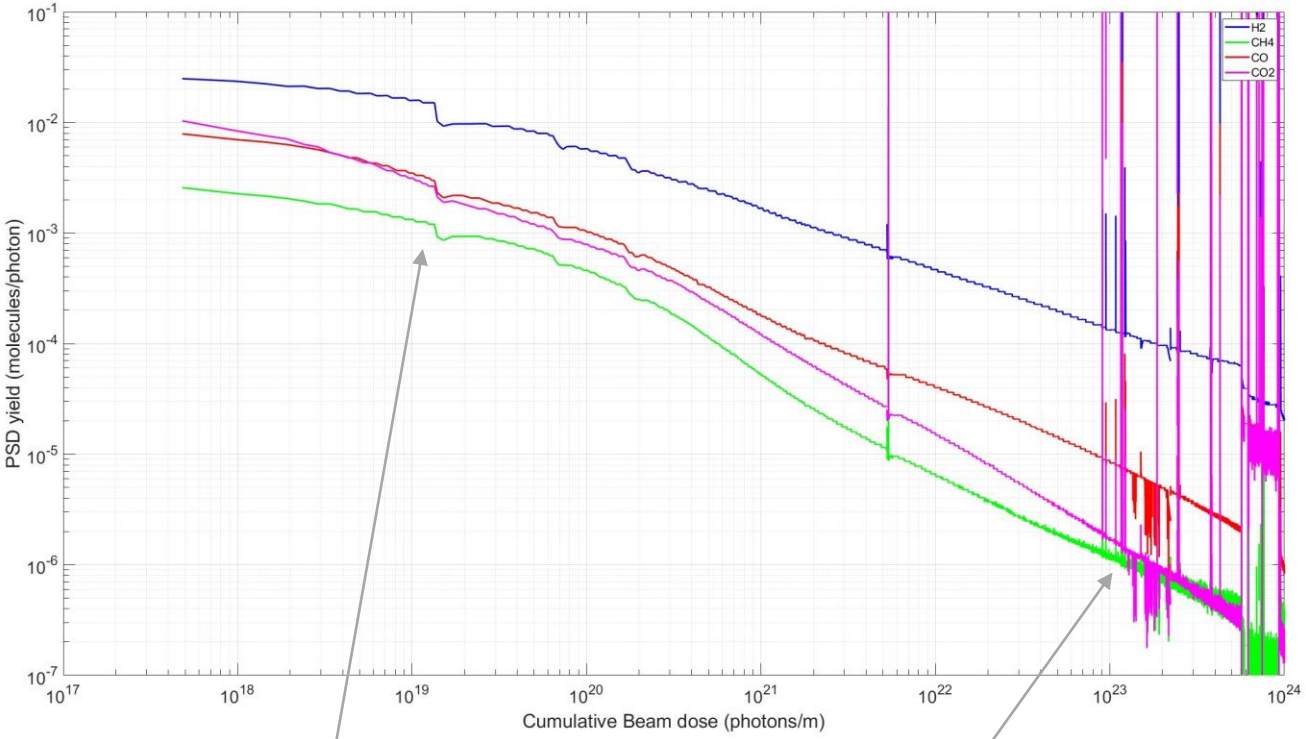
Photon-stimulated desorption data collected from:

a) uncoated stainless-steel vessel - shown below left

b) TiZrV coated stainless-steel vessel - shown below right

Vessels are ∅34.9 mm and 1000 mm long





Preliminary non-coated PSD data

- Deviations from beam current changes or transient events (e.g. valve moves)
- Step changes due to partial background correction – analysis to be refined

Preliminary NEG-coated PSD data

- Large excursion in CO/CO_2 PSD yield likely due to sticking probability variation – offline lab measurements to confirm values
- Deviations again due to beam current changes or transient vacuum events

Diamond Light Source - NEG & PSD update

Current status:

March 2024 – installed new ⌀20mm Cu-vessel (I.FAST-type), coated at UKRI with TiZrV NEG layer (from twisted-wire target)

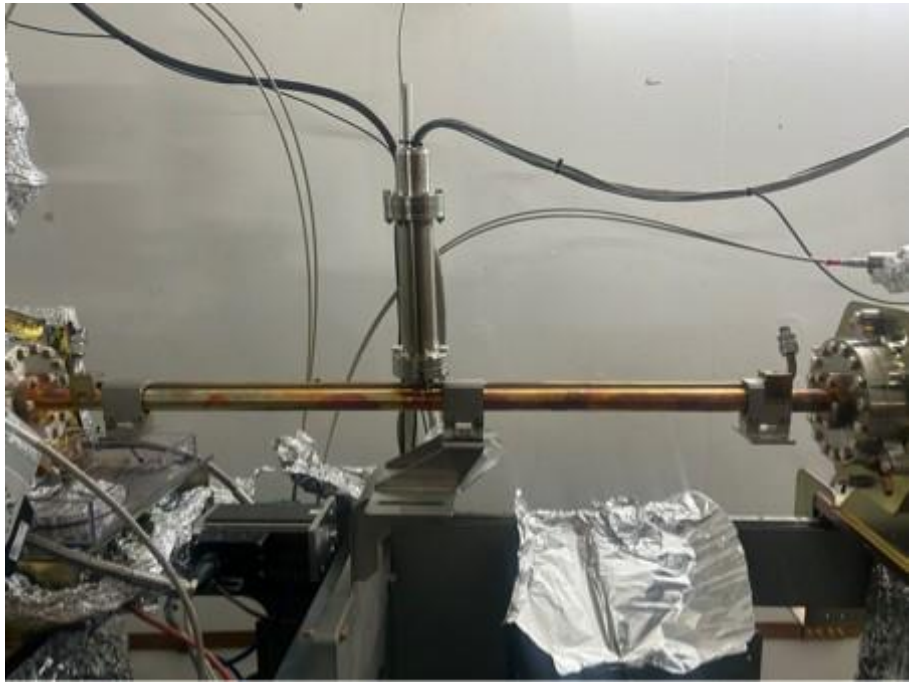
Next steps:

#1

- End-station and vessel bake but **no activation** of NEG layer
- Short PSD yield measurement

#2

- **Activation** of NEG coating
- In-situ pumping speed measurements
- Extended PSD yield measurements
- Analysing the data
- Writing Delivery report D10.4



Summary

- Task 10.5 team works in full capacity according its plan
- All necessary capabilities exist at least with two partners
  - Deposition facilities are operational at UKRI and DESY, in conditioning at DSL, can be used at Soleil
  - Pumping property evaluation facilities are operational at UKRI, DESY and Soleil, in conditioning at DSL.
- Samples:
  - 8 samples for pumping property measurements deposited:
    - 4 samples coated with TiZrV columnar film
    - 4 samples coated with Zr columnar film
    - For testing and cross-verification in 4 labs
- SR beamlines
  - IFAST Task 10.5 samples are (or will be) installed in both PSD facilities
    - at DLS from March 2024
    - at Soleil from end of April 2024
- Delivery 10.4 report delayed due to technical difficulties to M44 (instead of M36)

Acknowledgment (Task 10.5 team)

DLS

- Matthew Cox
- Chris Burrows
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iFAST

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