5th iFAST Task 10.5 Meeting

DESY Update

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Deutsches Elektronen-Synchrotron DESY

Machine Vacuum Systems (MVS)

SOLEIL, September 23-24, 2024

HELMHOLTZ

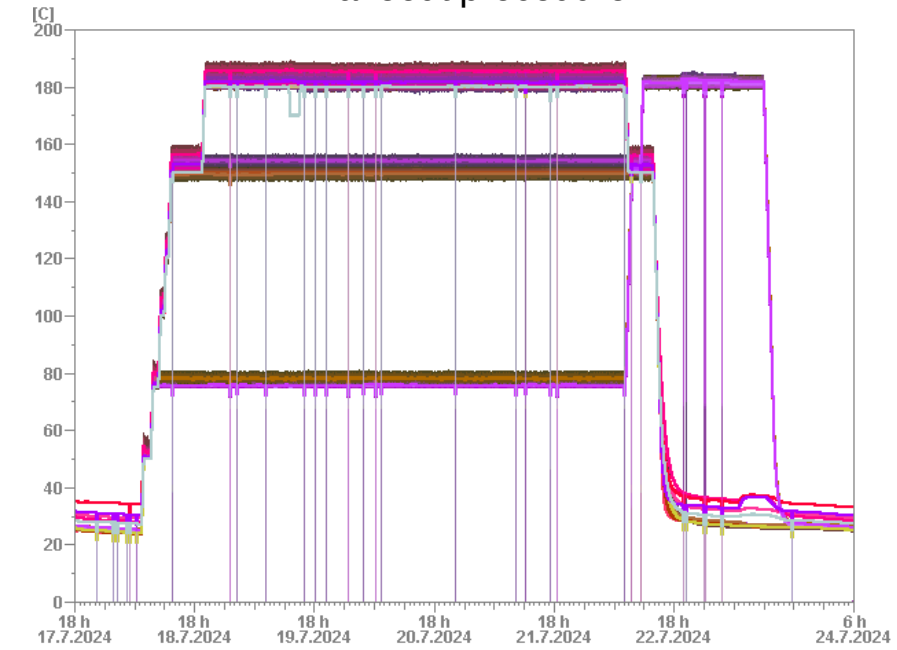
DESY.

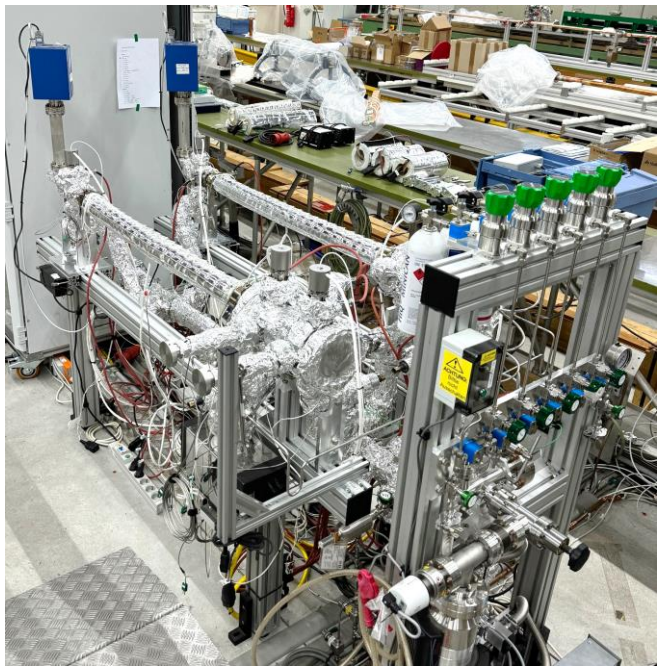
NEG Ageing Tests

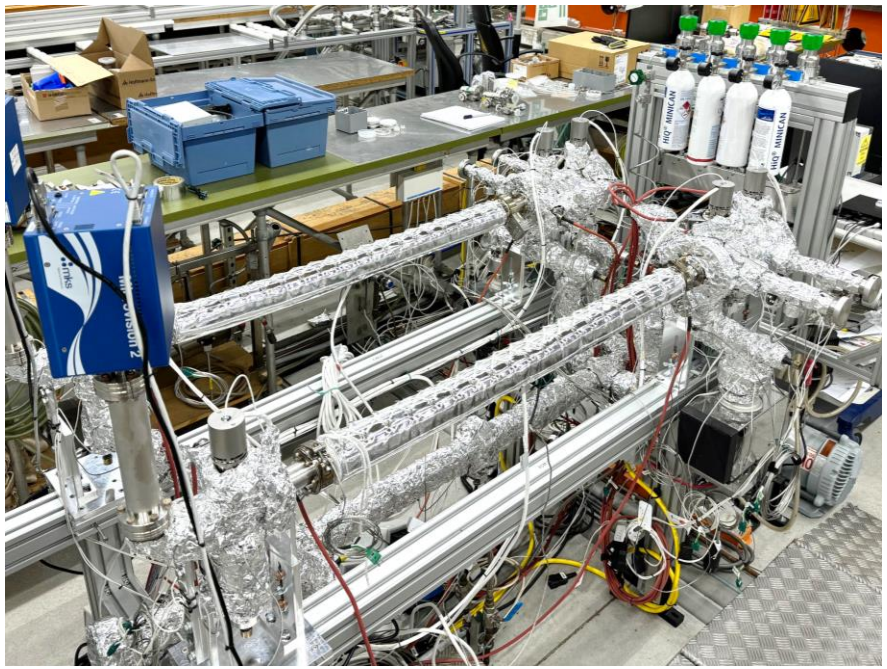
General Description

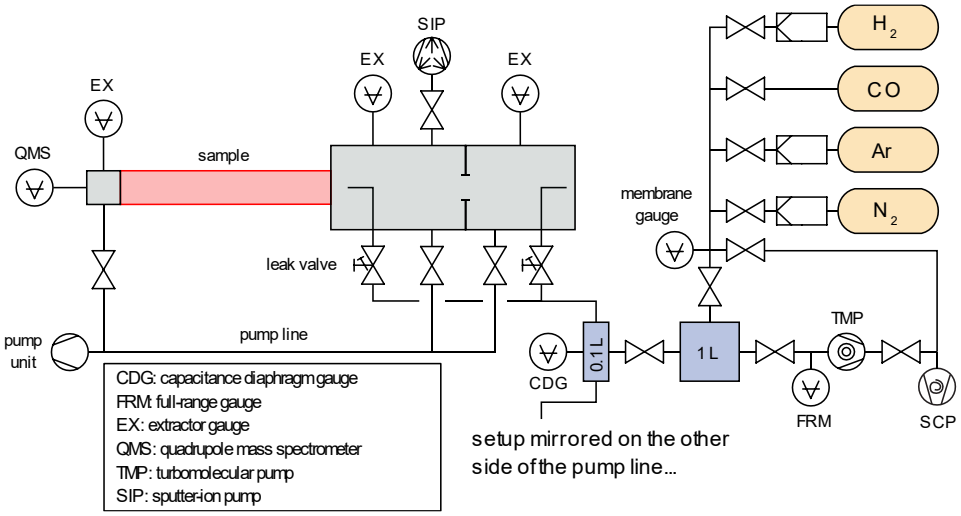
- Four standard samples coated with Zr and TiZrV (1 m long, 20 mm ID)
- Repeat activation/saturation cycles at fixed activation temperatures
  - Start with 180 °C and increase to 200 °C once pumping degrades consistently
  - Initial bakeout similar to STFC procedure; sample heated including flanges
  - Unheated pipes between sample and domes introduce tmeperature gradient

Bakeout procedure









sketch of the test setup

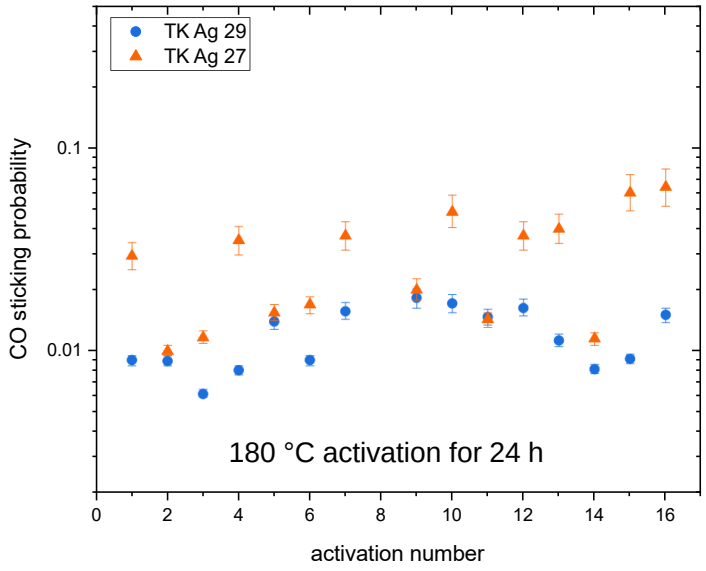
NEG Ageing Tests

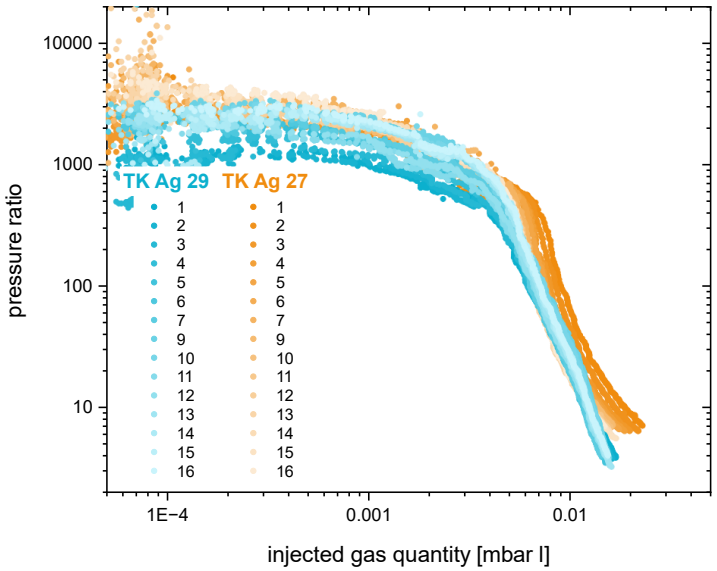
Results from Transmission Measurements

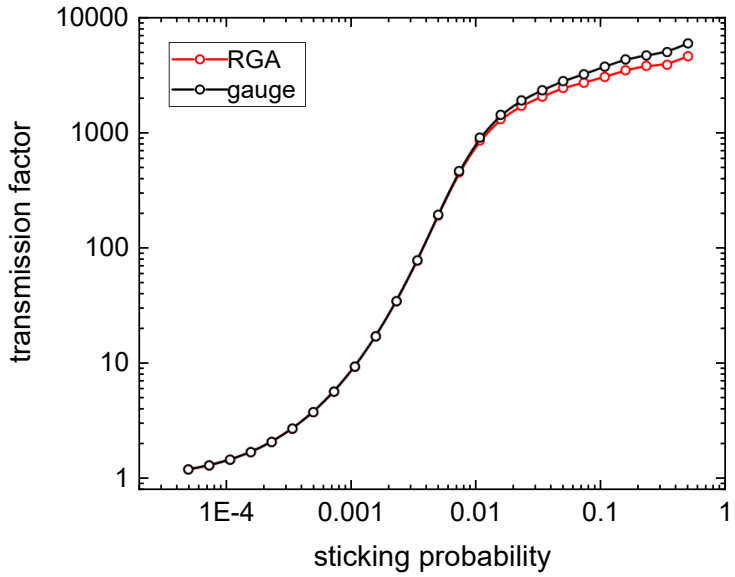
- Tests with **Zr** finished: *no consistent effect of ageing observed*
  - Slight reduction of capacity for dense samples

Sample	Target	Mode*	Morph.	Set Par.	t (h)	p (mbar)
TK Ag 24	TiZrV	DC	Columnar	55 W	5	4.8e-1
TK Ag 25	TiZrV	Pulsed DC	Dense	70 W	5	7.2e-2
TK Ag 27	Zr	Pulsed DC	Dense	70 W	5	7.2e-2
TK Ag 29	Zr	DC	Columnar	55 W	6	4.8e-1

* Using the Advanced Energy Pinnacle Plus power supply







NEG Ageing Tests

Results from Transmission Measurements

- Tests with **TiZrV** ongoing: *ageing indicated*
  - Improved pumping of dense TiZrV compared to pure Zr

Sample	Target	Mode*	Morph.	Set Par.	t (h)	p (mbar)
TK Ag 24	TiZrV	DC	Columnar	55 W	5	4.8e-1
TK Ag 25	TiZrV	Pulsed DC	Dense	70 W	5	7.2e-2
TK Ag 27	Zr	Pulsed DC	Dense	70 W	5	7.2e-2
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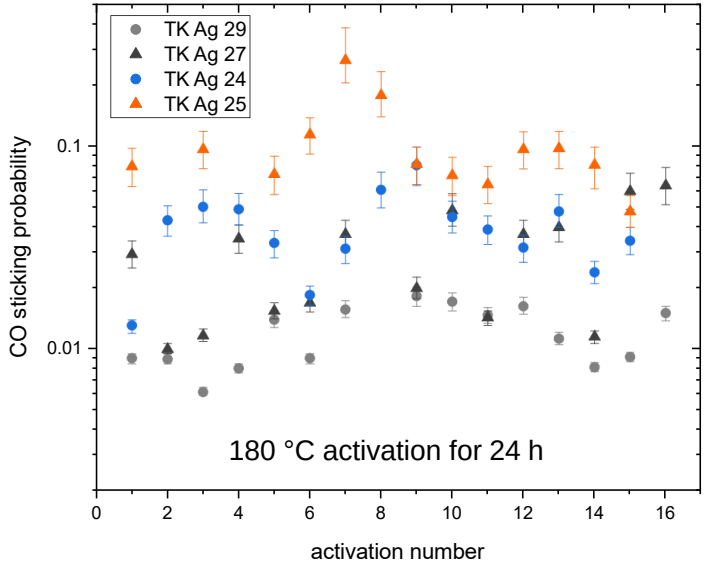
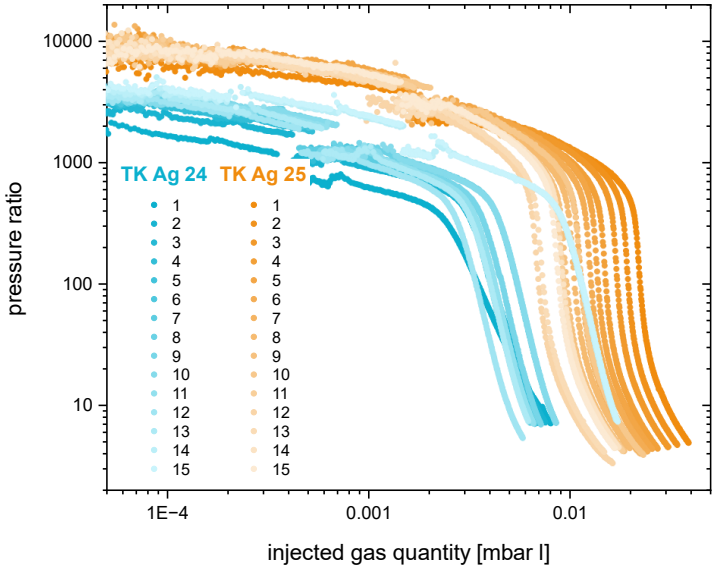
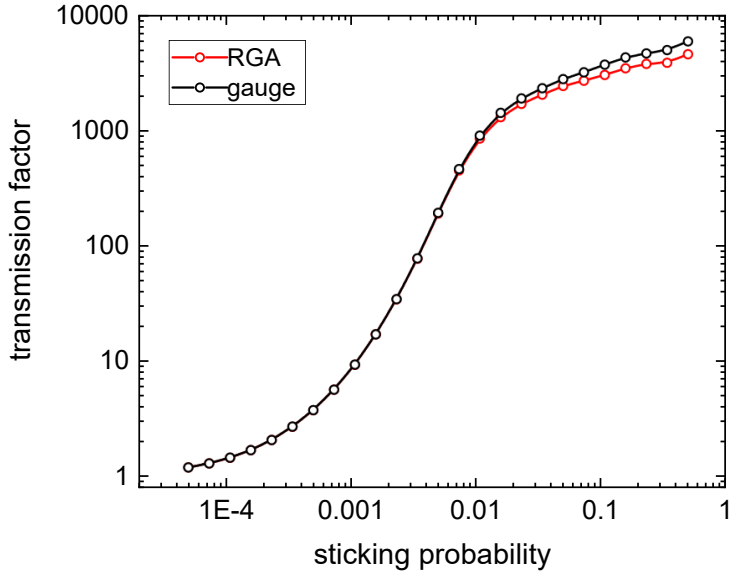
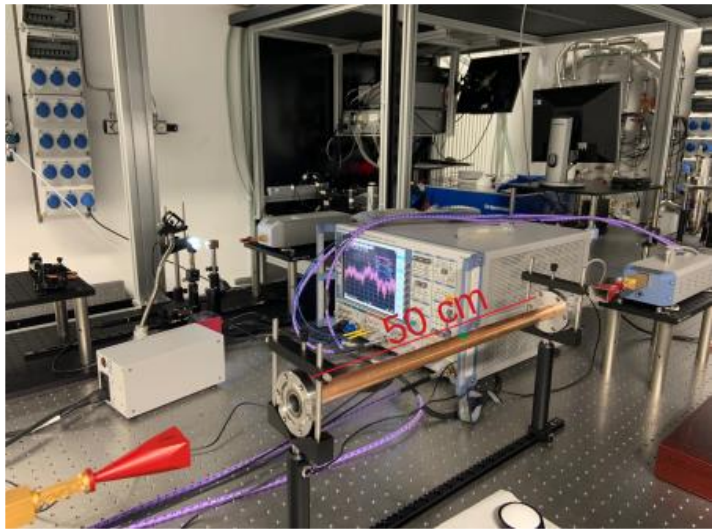




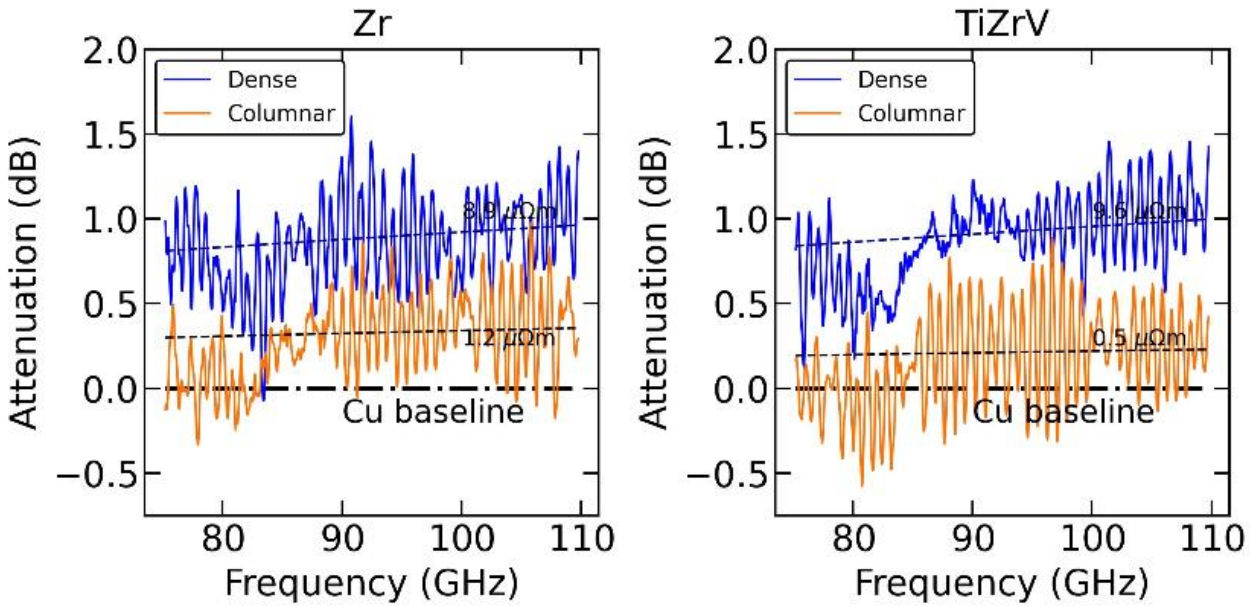


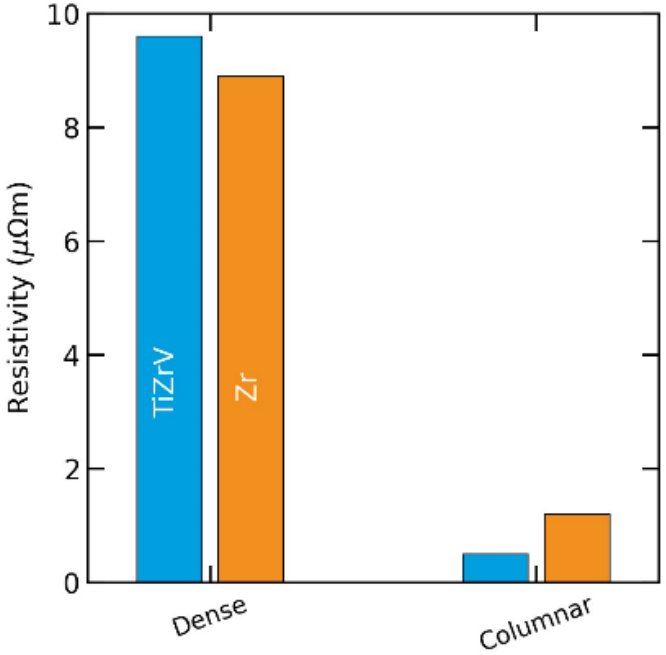
Resistivity Measurements

Summary of the Results for 5 µm OFS-Cu Samples



- ❖ 1 µm NEG films indistinguishable from bulk Cu → 5 µm used for testing!
  - For 1 µm films the resistivity has little impact on the impedance's real part in a frequency range relevant to 40 ps beam (but different with imaginary part!)
  - General guideline is <2 µΩm (possible frequency shifts for short bunch operation)
- ❖ Dense films show much higher resistivity at DESY in contrast to other facilities!
- Dense TiZrV sample could be showing higher resistivity due to a surface defect

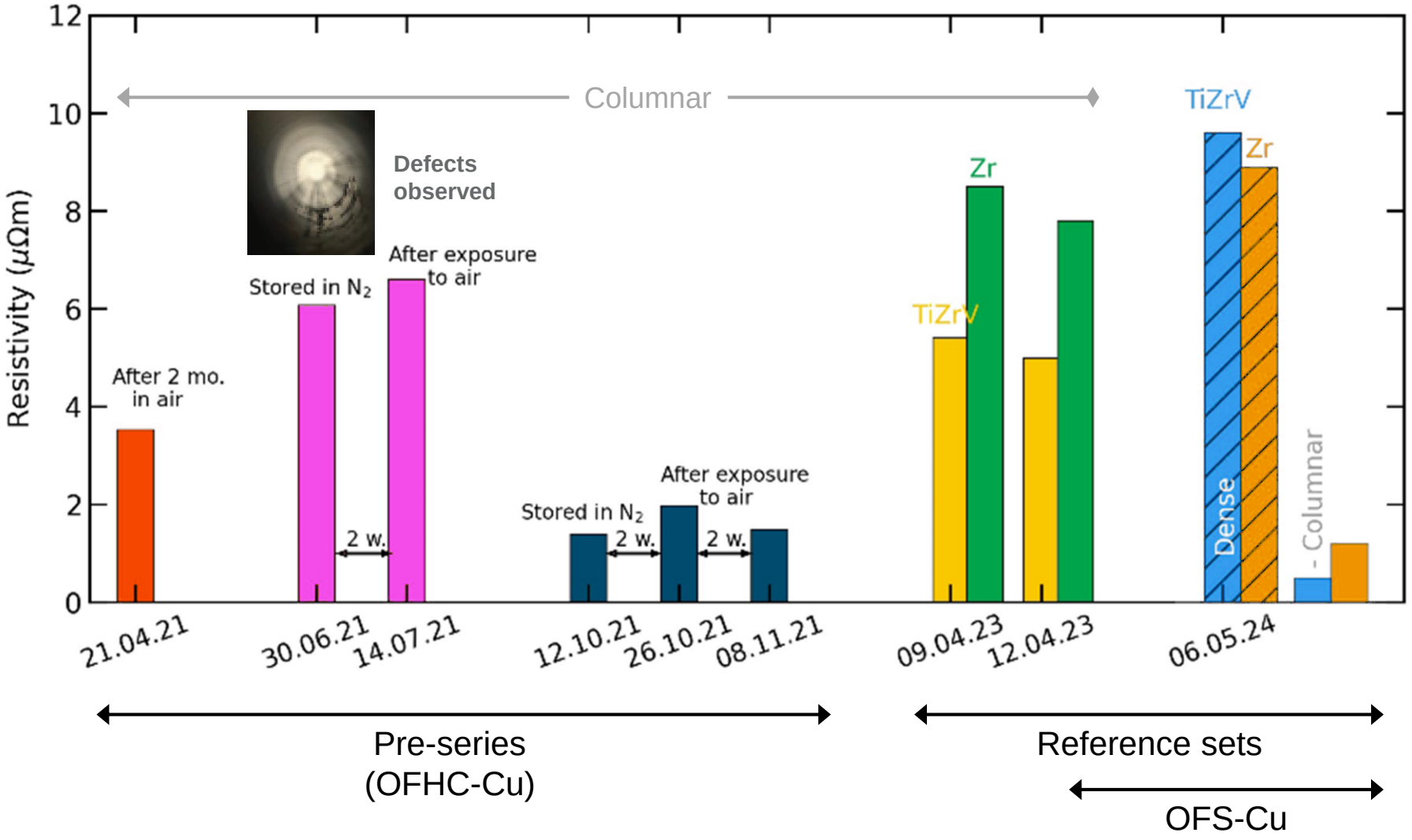




Resistivity Measurements

Comparison with Results Obtained for OFHC-Cu Samples

- Air exposure does not seem to influence the electrical properties (neither NEG nor bulk Cu)
- Surface treatment before deposition affects the NEG resistivity (see reduction for **etched samples**)
- Surface defects increase the resistivity (see relative increase for **dense TiZrV samples**)
- <2 µΩm seems generally achievable, but we have yet to understand the variations better and improve statistics!



Conclusions...

... and future plans

- Continue to perform resistivity test on more samples to assure
- Resonable pumping observed also for dense Zr samples

Thank you!

Contact

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Appendix

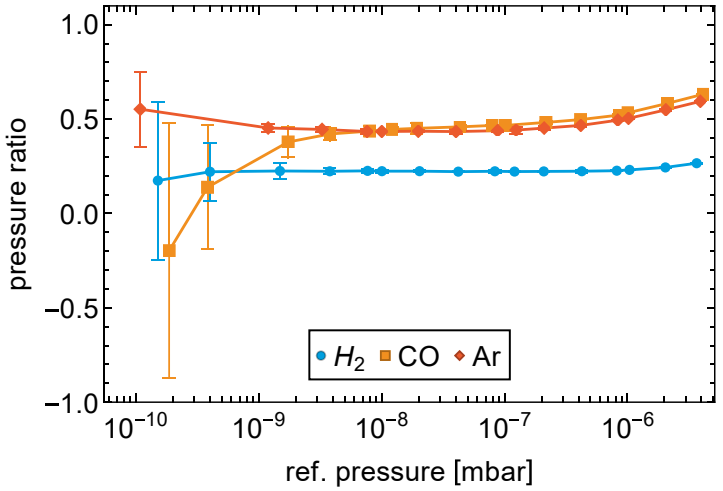
Pumping Speed Measurement Setup

Gauge Calibration

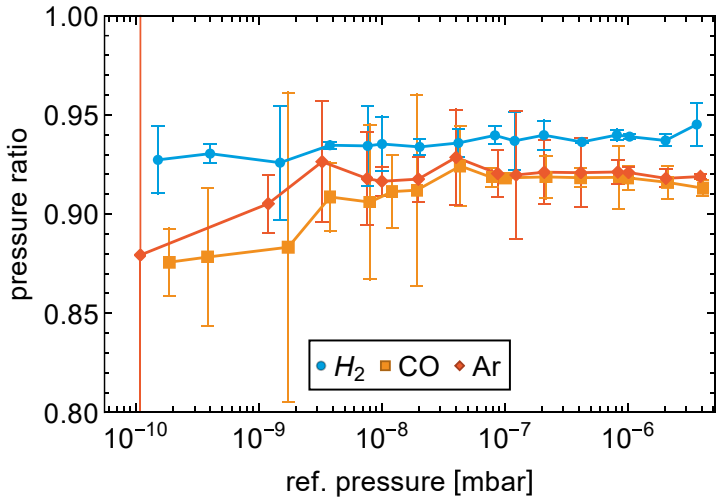
Error bars for RGA not reliable

- The gauge/RGA “calibration” is regularly repeated
  - MKS Microvision 2 only linear in Faraday mode (we only use highest amplification until ~10^{-8} mbar)
  - We use single correction factors + error for Faraday and SEM mode (longterm stability is not given anyway)
  - Extractor gauges are stable within few percent between calibrations

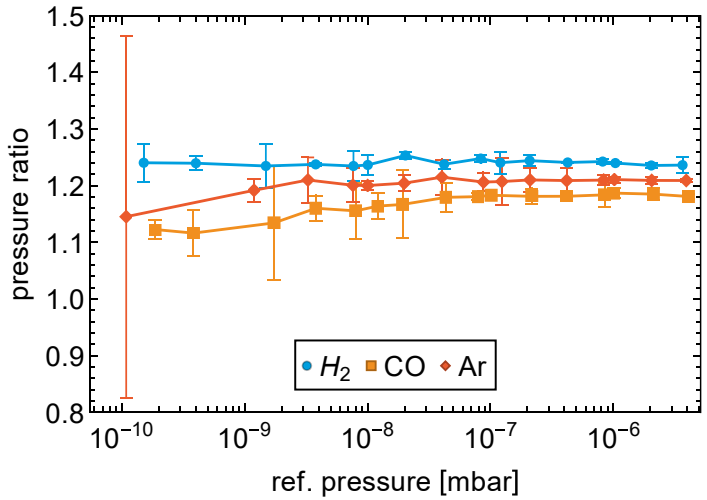
RGA/p1 – FAR



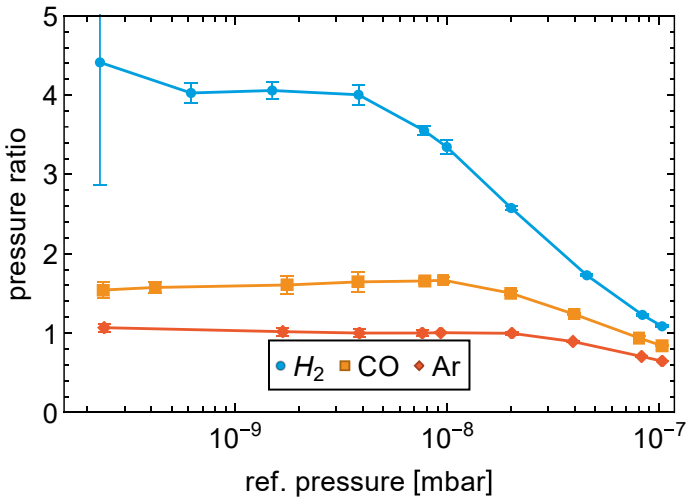
p2/p1 – FAR



p3/p1 – FAR



RGA/p1 – SEM

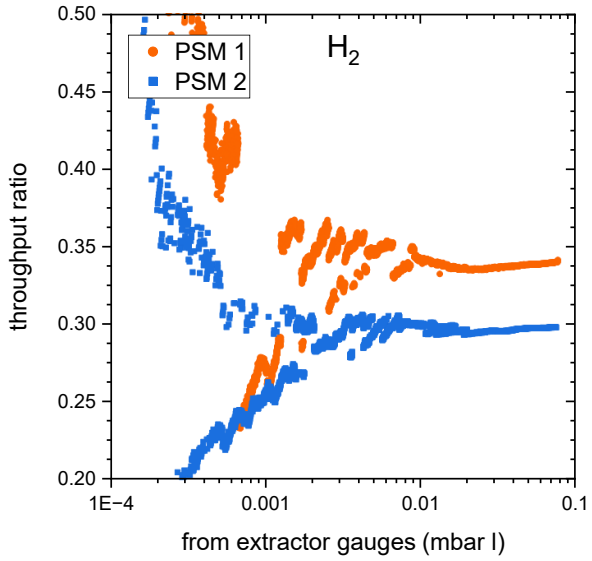


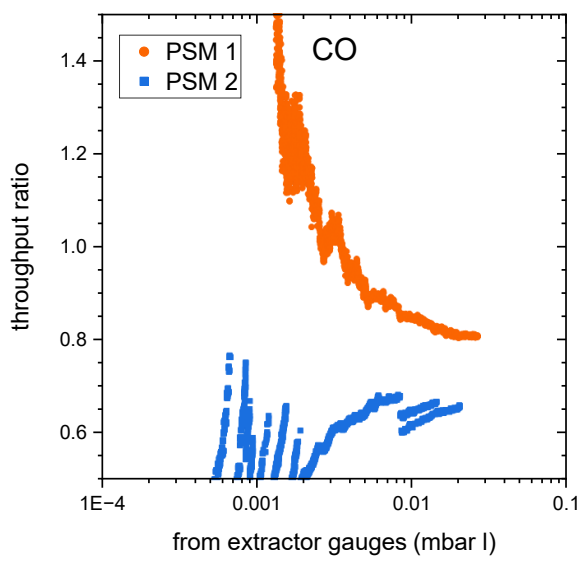
Pumping Speed Measurement Setup

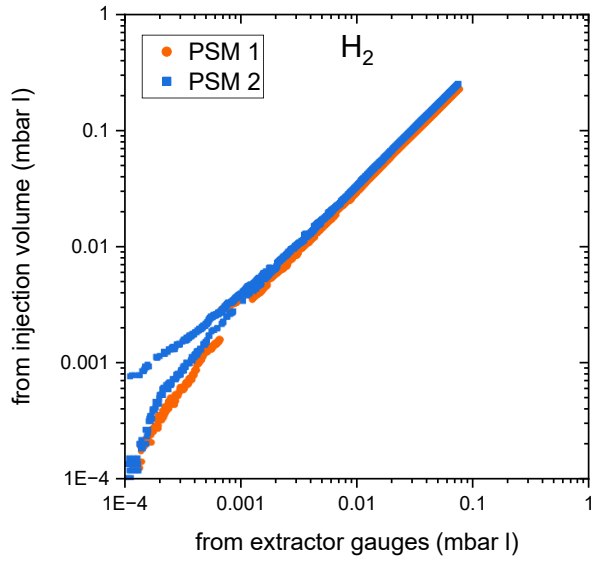
Throughput Comparison

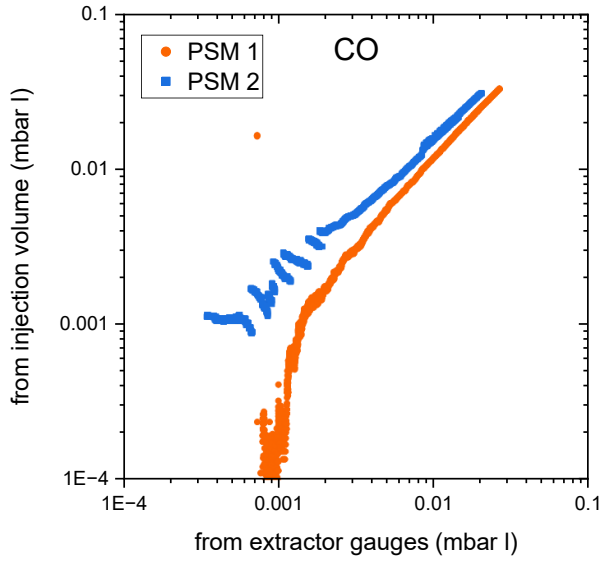
- The calculated throughput was compared
  a) Diaphragm gauge (CDG) on the gas supply system
  b) Extractor gauges on the dome
- The used diaphragm gauge is not able to reliably measure low gas injections
  - To be changed in near future by adjusting the CDG range (1 instead of 10 mbar) and model

flow	interval
$5x10^{-8}$	5 h
$1x10^{-7}$	2.5 h
$5x10^{-7}$	0.5 h
$1x10^{-6}$	0.5 h
$5x10^{-6}$	0.5 h
$1x10^{-5}$	10 min
	9:10





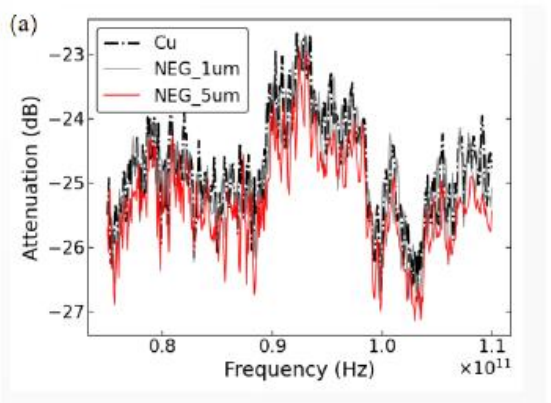


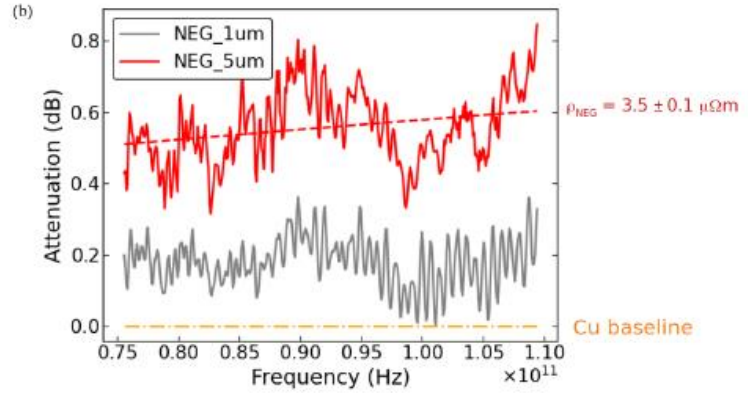


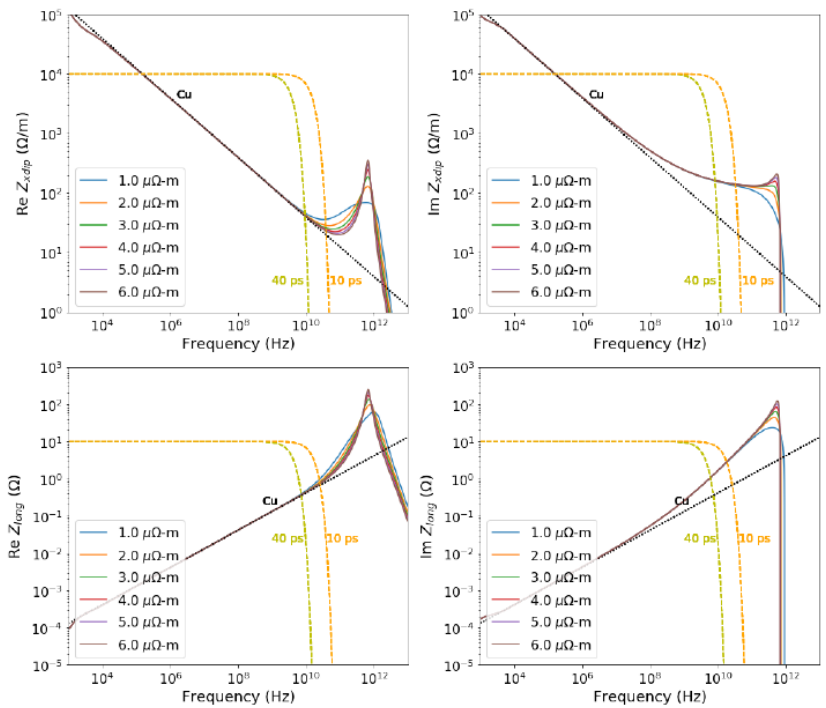
Resistivity Test Setup

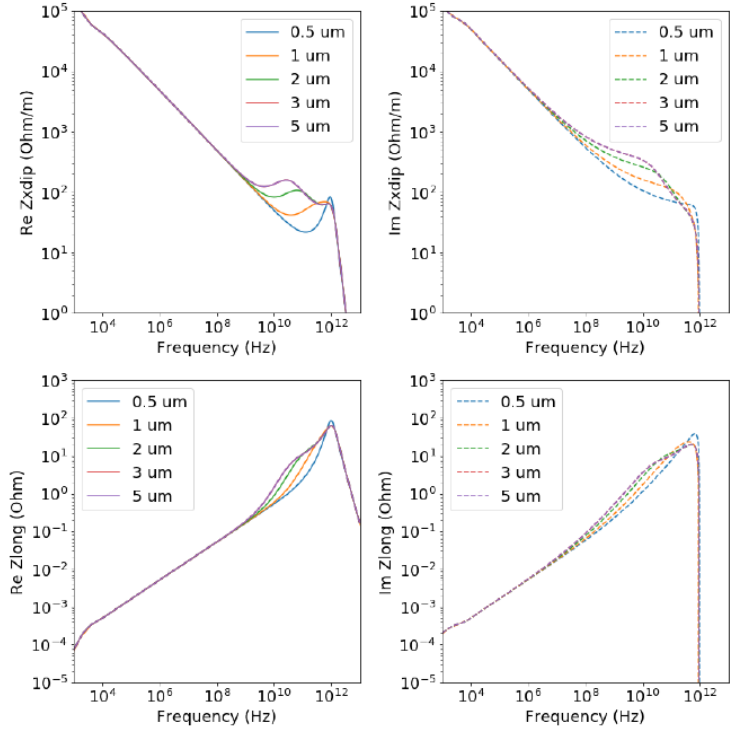
- Technical report written in 2022 by S. Antipov and R. Širvinskaitė

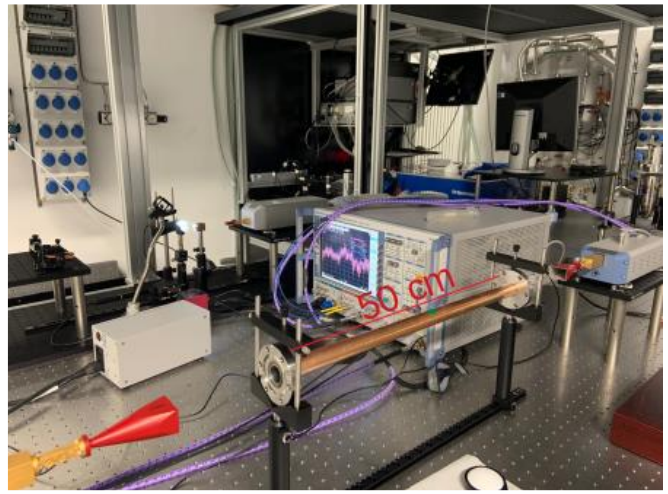
Example measurement (after averaging)











412 and Eq. (2.1) becomes

$$\alpha_{11}^{TE}(f) = \frac{R_s}{Z_0 r\sqrt{1-\left(\frac{f_c}{f}\right)^2}} \times \left[\left(\frac{f_c}{f}\right)^2 + \frac{1}{1.8412^2 - 1}\right] \text{Np/m}.$$

e sheet resistance is connected to the material resistivity ρ as

$$R_s = \sqrt{\pi f \rho \mu_0},$$