

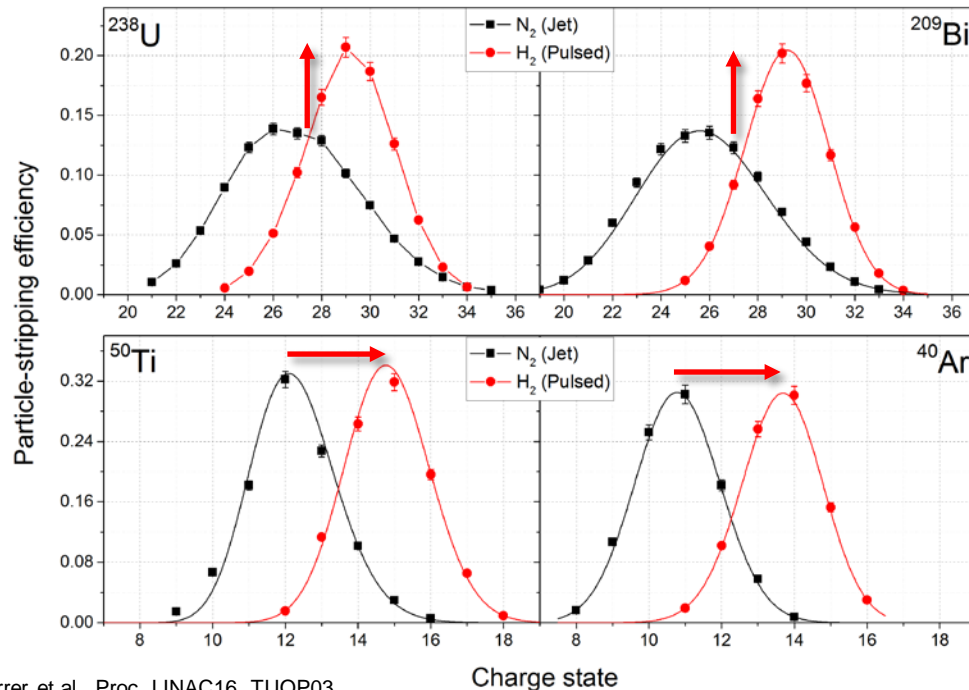
UNILAC Pulsed Gasstripper

P. Gerhard/PSU
on behalf of the gasstripper team

- Introduction
- Progress since 2022
- Oil issues
- Machine development beam time 2023
- Preparation for and experiences from beam time operation 2024
- Summary & outlook

Why do we want to use H₂ instead of N₂?

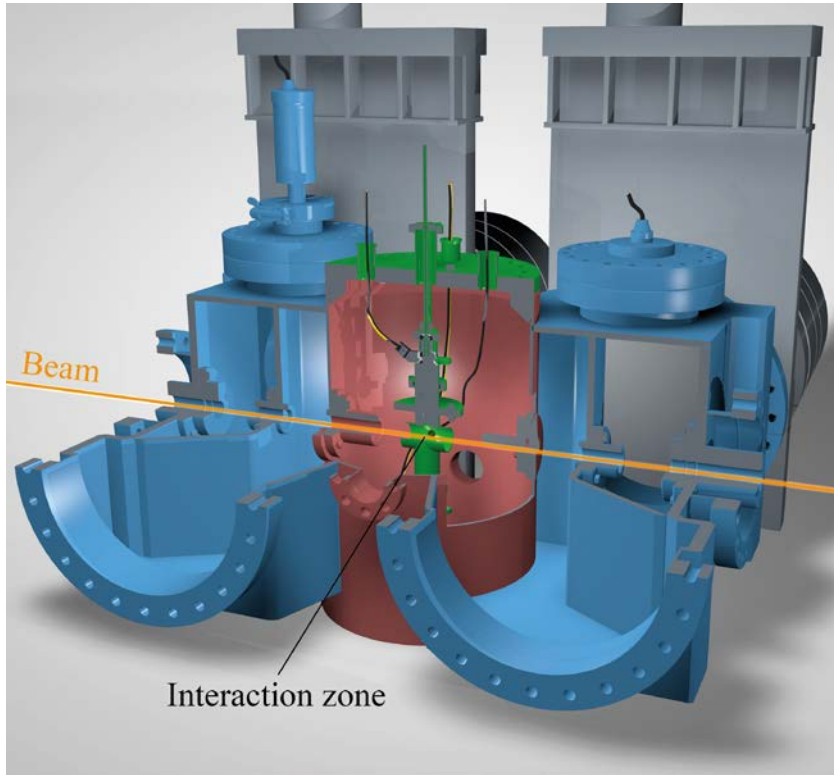
Measured charge state distributions with highest $\langle q \rangle$



- Heavy ions (U, Bi):
 - more narrow distribution
 - **increased stripping efficiency**
 - **higher beam intensity**

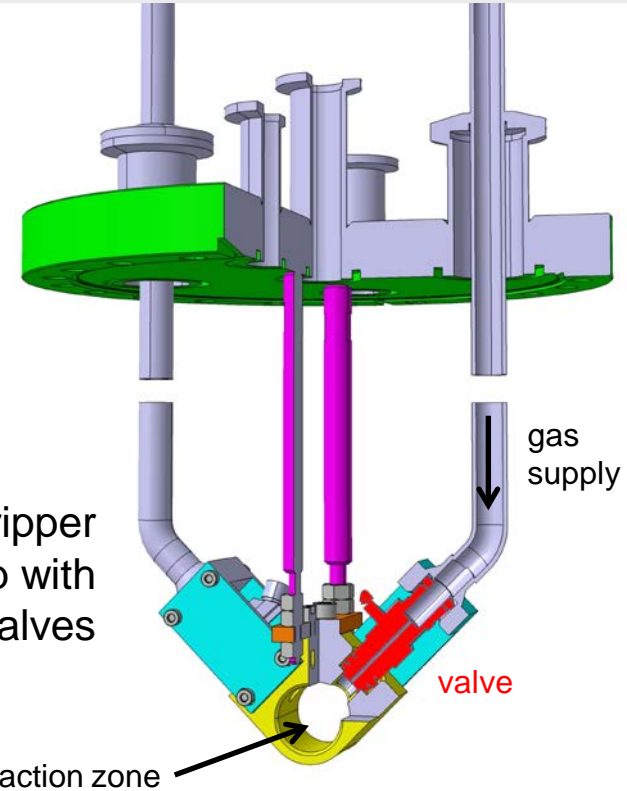
- All ions:
 - higher average charge state
 - less rf power
 - higher energy in SIS18

Gas Stripper Chamber and Pulsed Valves Setup



Liquid and gaseous media valves

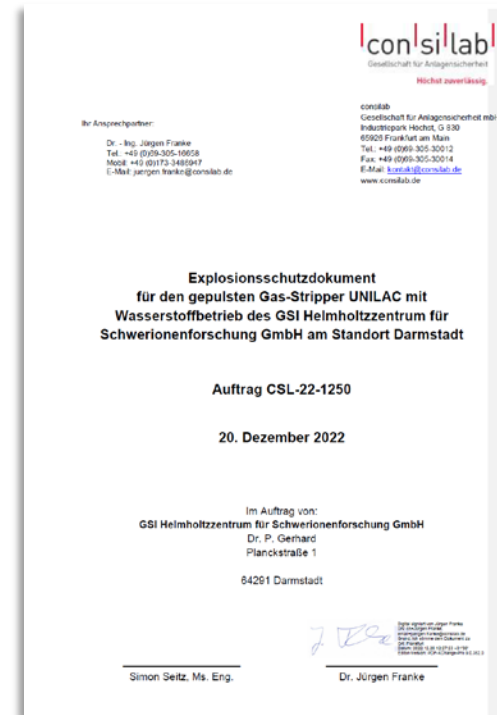
Pulsed stripper setup with two gas valves



Report on the Absence of Ignition Sources in the Pulsed Valves



Draft Explosion Safety Document



New Explosion Safe Roots Pump Station

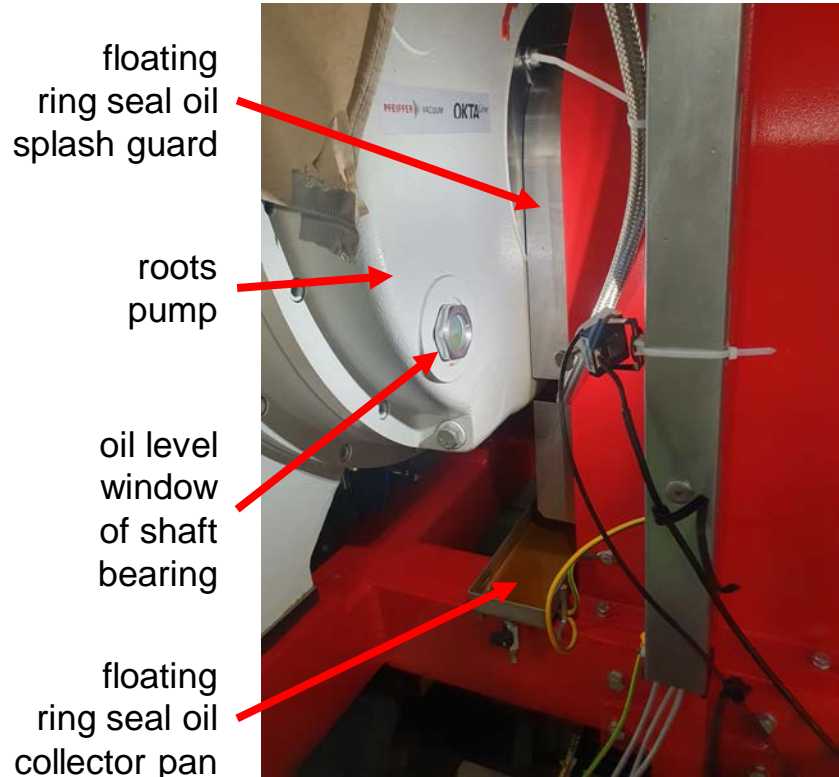
Delivery 2.5.23



Old Roots Pump Station Moved and Reinstalled



Oil Issues: Consumption and Oil in the Wrong Places



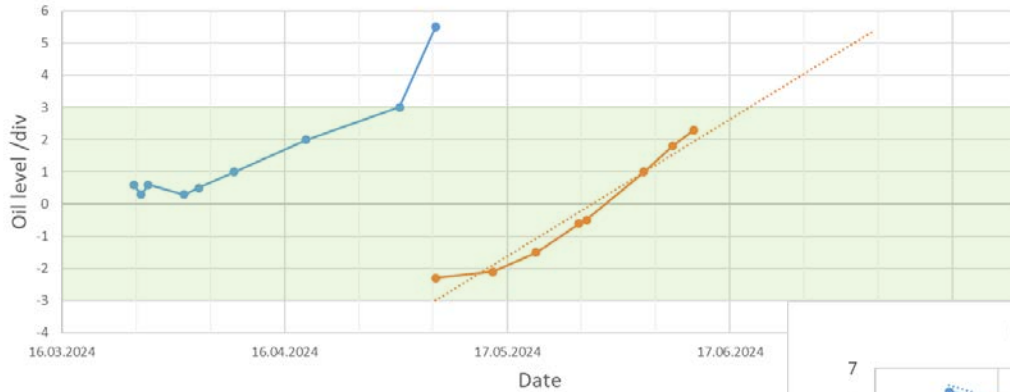
floating ring seal oil reservoir



pump bearing oil reservoir

Oil Issues: The Rise and Fall of Oil Levels

Oil level in transmission gear and bearing Okta 8000 @gasstripper

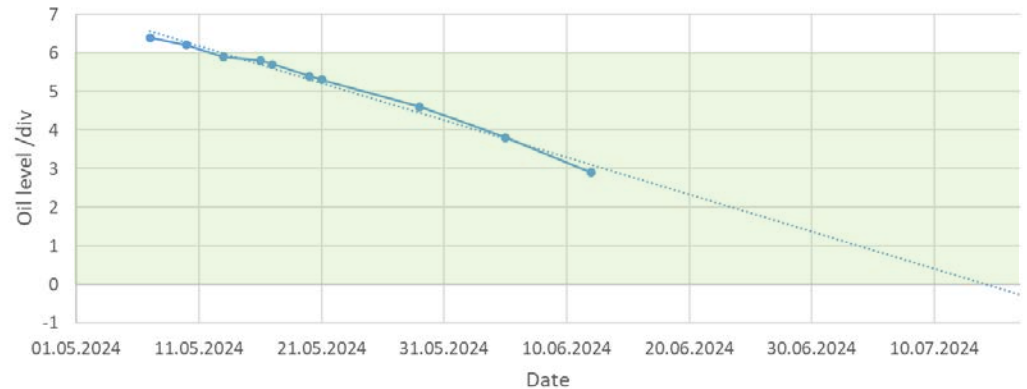


Green area = operational range

Level rise due to oil from the floating ring seal entering the transmission gear and bearing chamber

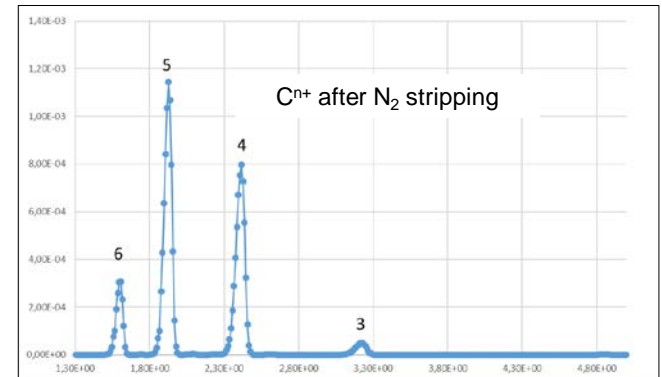
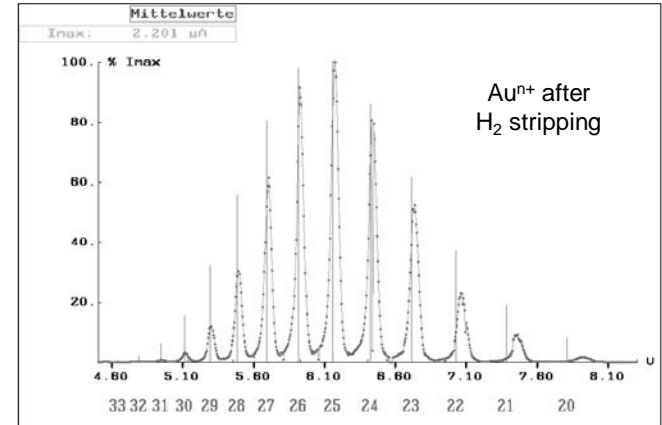
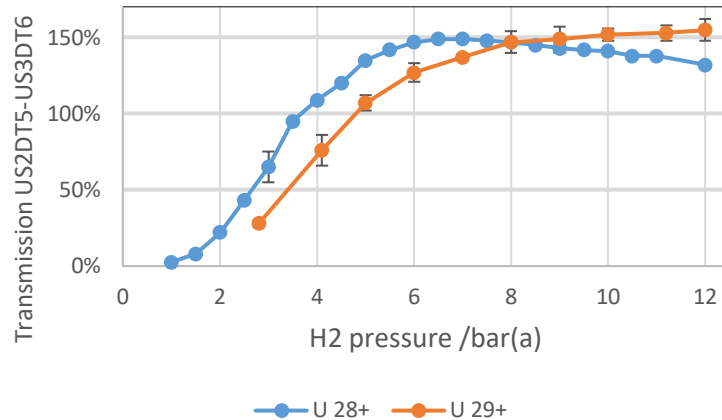
Time between intervention **1-2 months**

Oil consumption of floating ring seal Okta 8000 @gasstripper



Time between refills **2-3 months**

- $U^{28+} \rightarrow H_2$ stripper operation for SIS18 Booster Mode and other experiments
- Pulsed stripper operation with N_2 for other experiments
- Collect more data on stripping of $[CH_3 \Rightarrow C, Ar, Fe, Au, U]$ by $[N_2, H_2]$
- Gather essential operating parameters for **light, inter-mediate and heavy ions** for specification of gas station

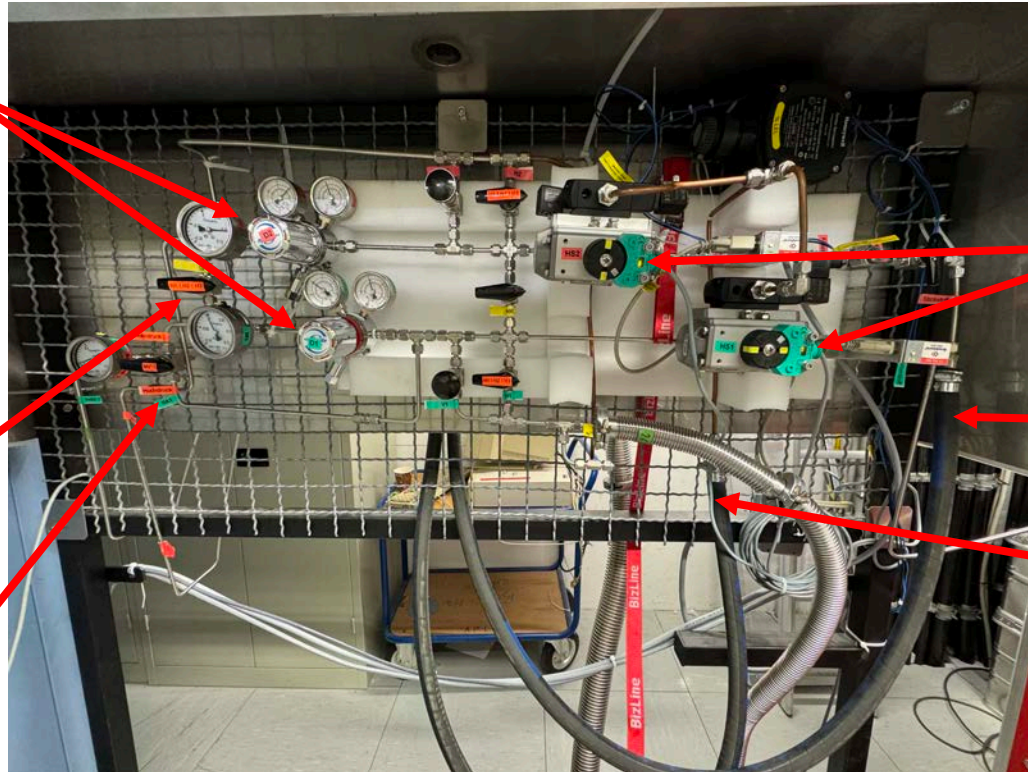


Preparation for beam time operation 2024

new low pressure regulators

split purge line

flexible use of 2 injection valves, bypass line



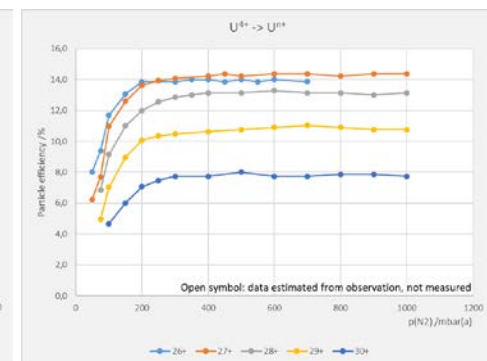
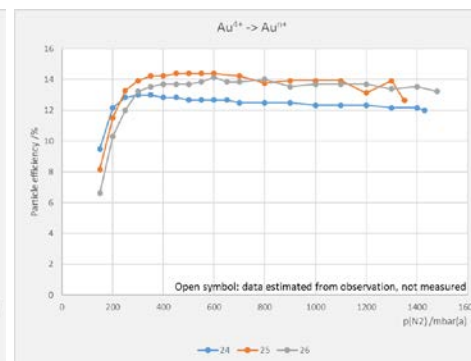
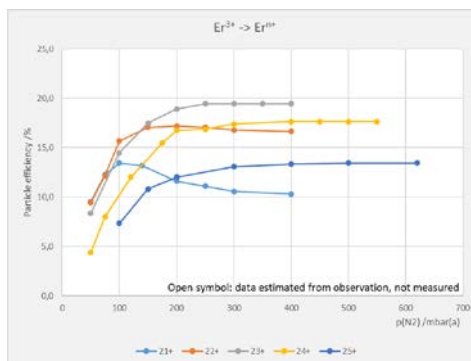
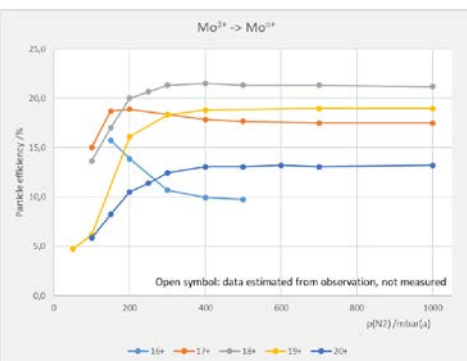
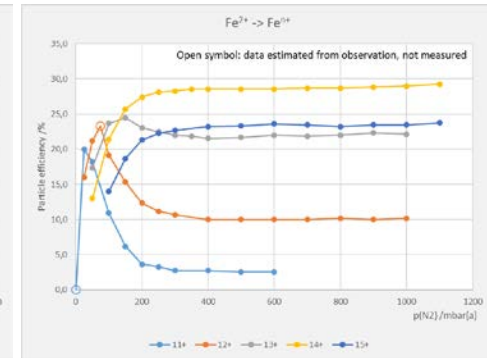
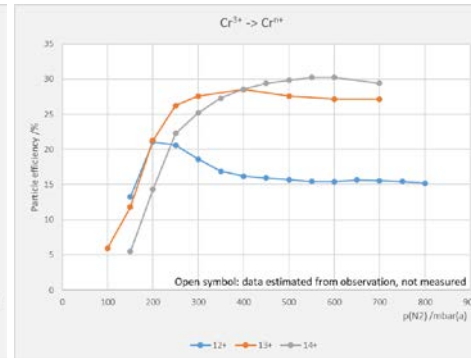
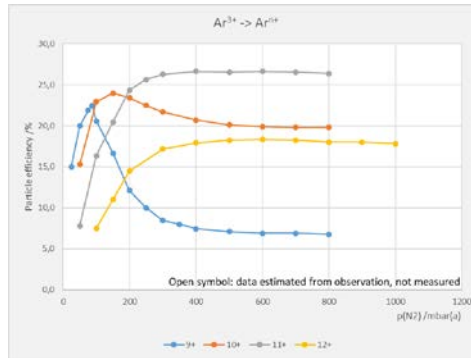
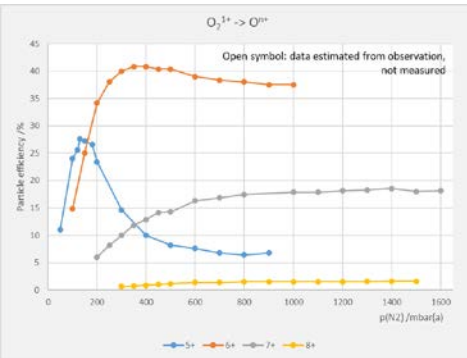
interlock signals to vacuum controls

N₂ from supply line

control air from supply line

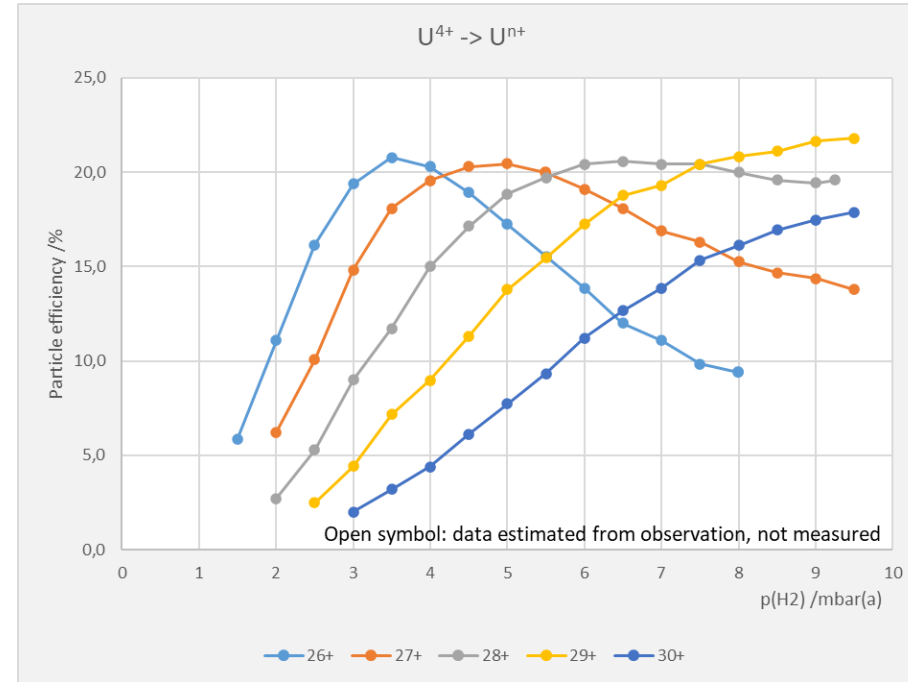
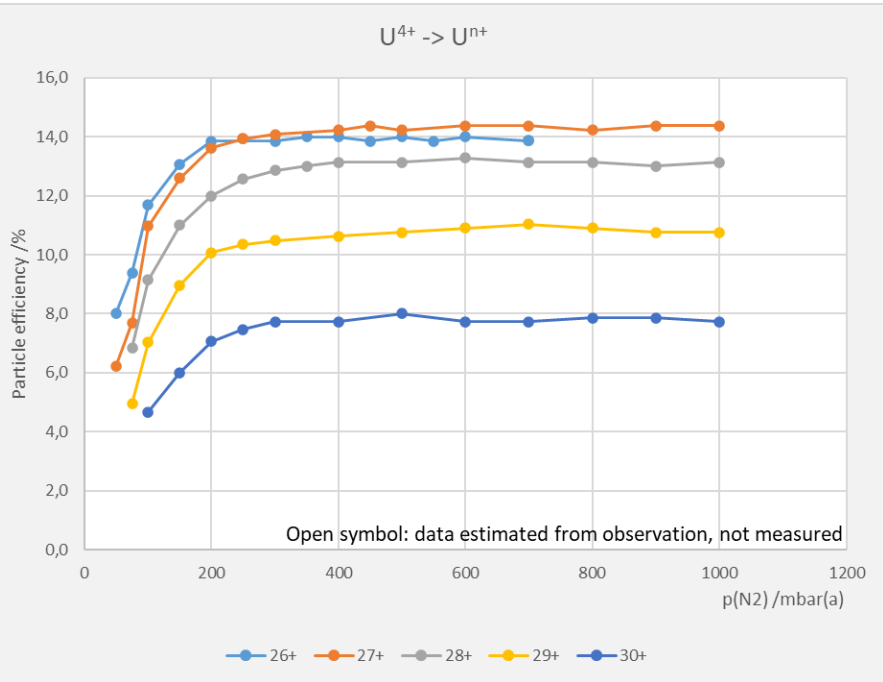
Stripping data collected during beam time

Measured stripping efficiencies of O₂, Ar, Cr, Fe, Mo, Er, Au, U on N₂



Stripping data collected during beam time

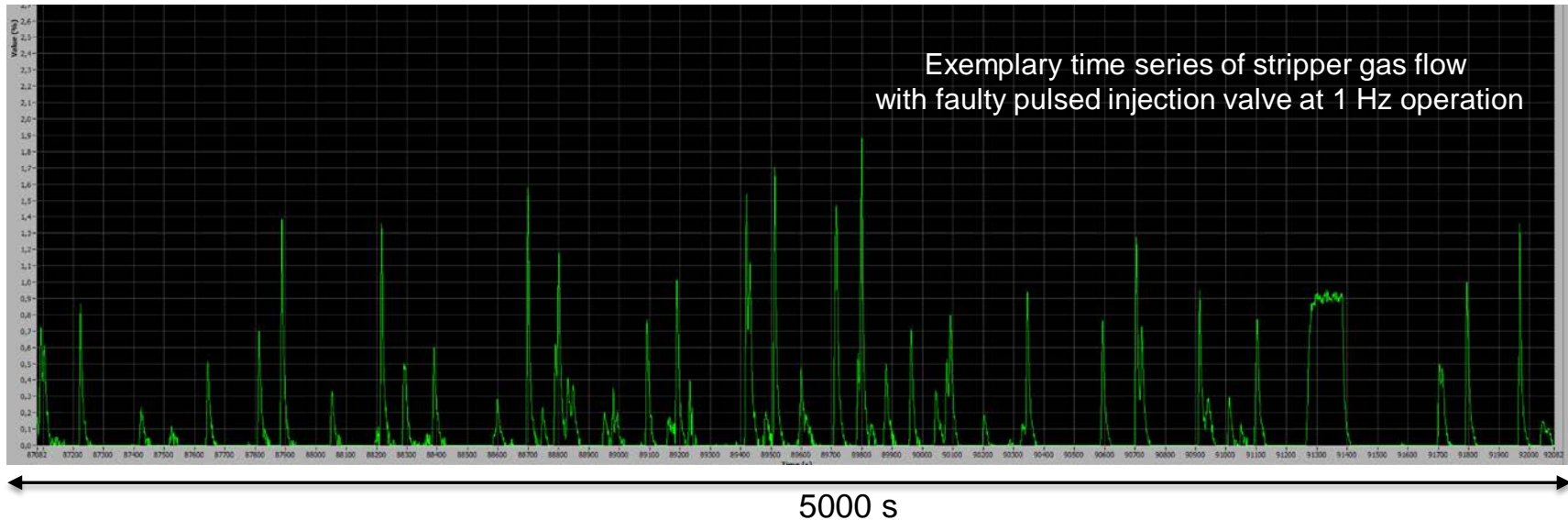
Measured stripping efficiencies of U on N₂ and H₂



- Nominal service life under intended use: 380.000.000 cycles, equivalent to 88 days of 50 Hz operation
- Pulsed gas stripper does not comply with intended use in several ways
 - different gases, very low gas pressure & flow, higher voltage & current, very high cycle rates over extended periods
- 3 valves broke premature during beam time 2024
 - serial 2-11-08-16 010154 **reached 20% of expected service life**
 - **history:** delivery 06.2017, used for 5 machine beam times, development, safety tests, SAT roots pump station a. o. since 2018 with N₂ and H₂
 - **usage:** approx. 76.000.000 cycles in total, of which 73.500.000 @50Hz in beam time 2024
 - serial 2-11-08-16 005603 **reached 20% of expected service life**
 - **history:** delivery 06.2017, used for 6 machine beam times, development, safety tests, SAT roots pump station a. o. since 2018 with N₂ and H₂
 - **usage:** usage approx. 77.000.000 cycles in total, of which 8.600.000 @50Hz and 62.600.00 @25Hz in beam time 2024
 - serial 2-30-10-17 005056 **reached 14% of expected service life**
 - **history:** delivery 05.2018, used since 7.5.24 with N₂, unused before 2024
 - **usage:** usage approx. 54.000.000 cycles in total, most of which @50Hz

Injection Valve Failure: Mitigation

- Added gas flow monitoring as diagnostics
- Look into opportunities to operate valves more gentle, closer to intended use, and for alternative ways of operation for high duty cycle beams



- Pulsed gas stripper project is progressing
 - Safety concept reviewed by expert companies, proceed with implementation based on this
 - Gas alarm system extension completed, commissioned 22.12.2023
 - ATEX Roots pump station in operation, remaining issues will be fixed together with manufacturer
 - Shutdown 2024: Replacement of 4 Turbopumps for differential pumping stages
 - Major remaining parts: Gas control, vacuum exhaust treatment, safety interlock
 - Many other small things to do ...
 - Commissioning of fully-fledged pulsed gas stripper planned for end of 2025
- Provision of 5 months of pulsed stripper operation during user beam time 2024 (unexpected, unplanned, on short notice) and machine beam time 2023
 - Lots of data and experience gained
- Issues
 - Premature failures of injection valves
 - Short maintenance intervals of roots pump due to oil issues
 - Automated stripper gas pressure control, procurement of gas control

Thank you
for your attention!

General System Overview

