

WP S P E

FZJ CAPABILITIES AND PLANS FOR 2022

2022-03-02 | T. Dittmar on behalf of the FZJ team



Content

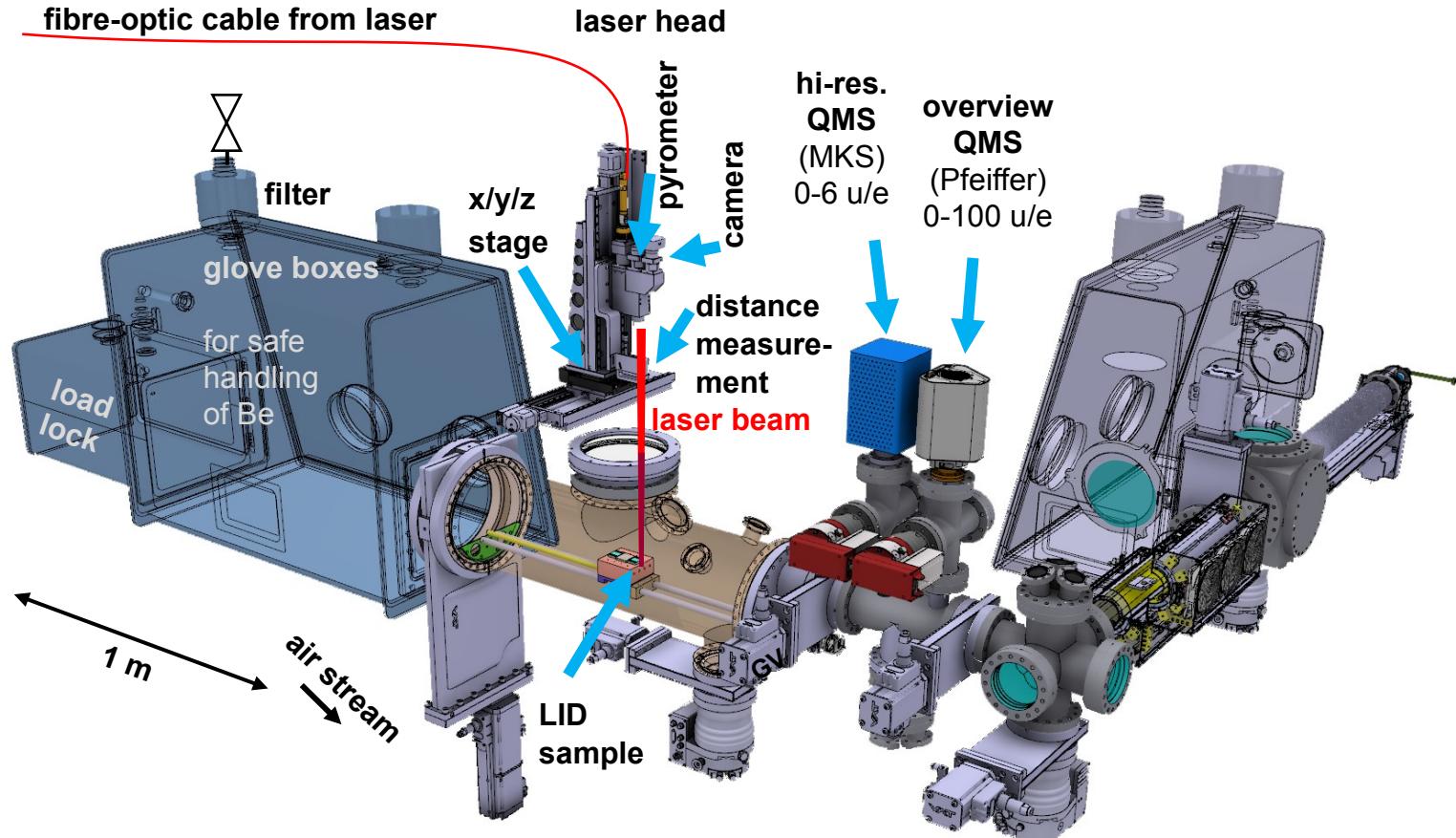
1. Capabilities

- ♦ LID-QMS & TDS
- ♦ LIBS
- ♦ sample cutting

2. Samples at FZJ

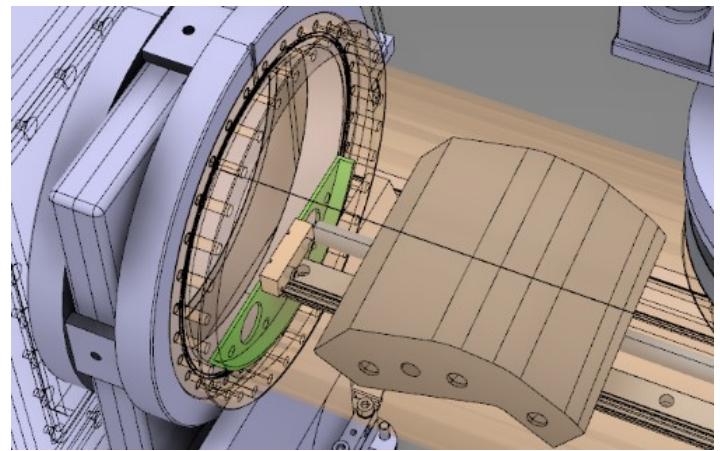
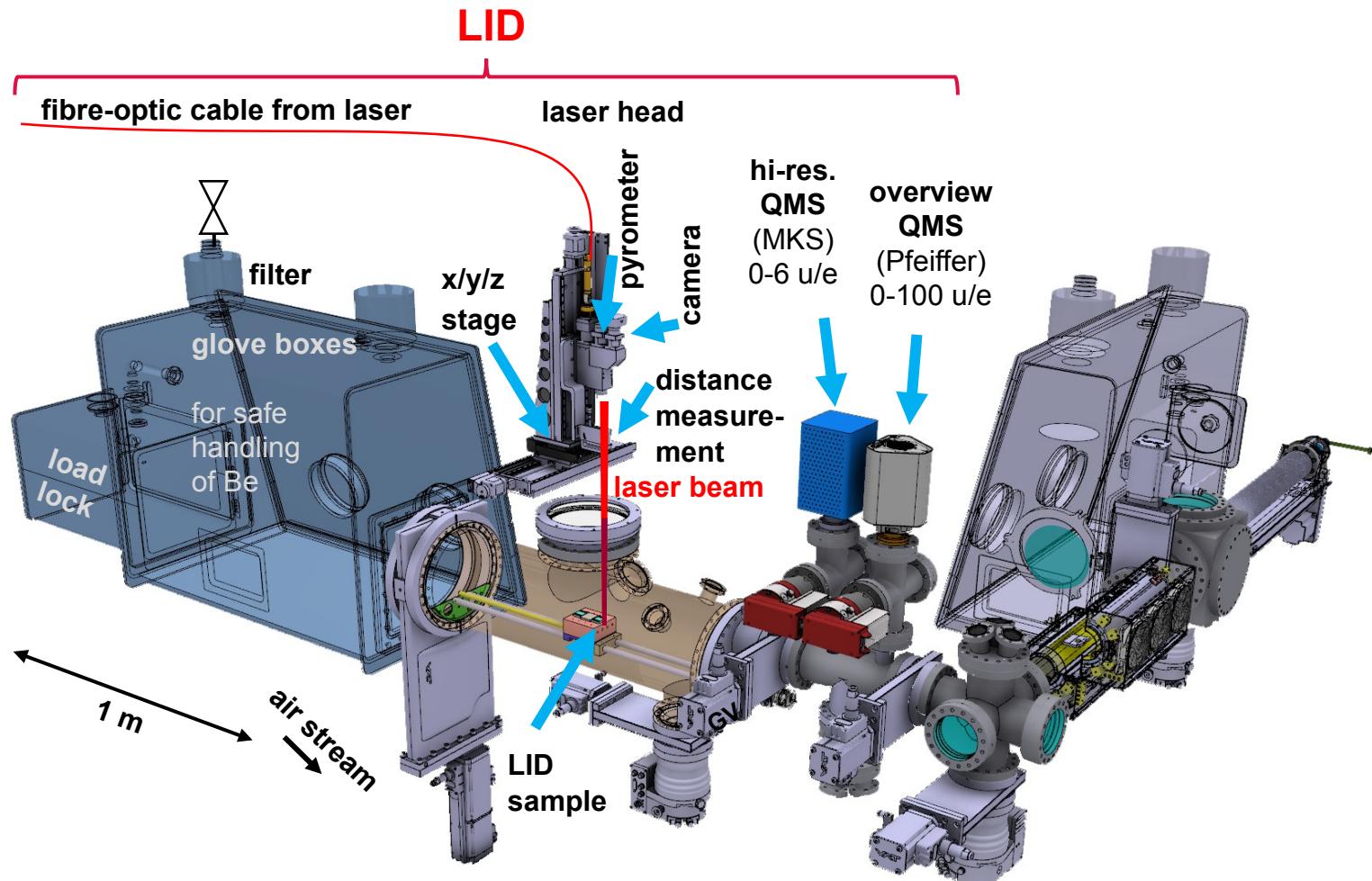
3. Plans

Analysis Device in Jülich: FREDIS (Fuel Retention Diagnostic Setup)



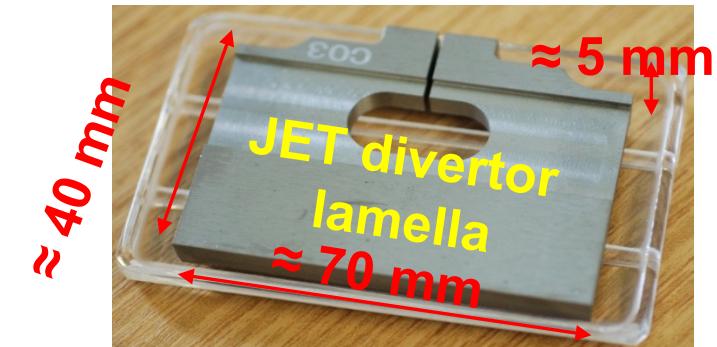
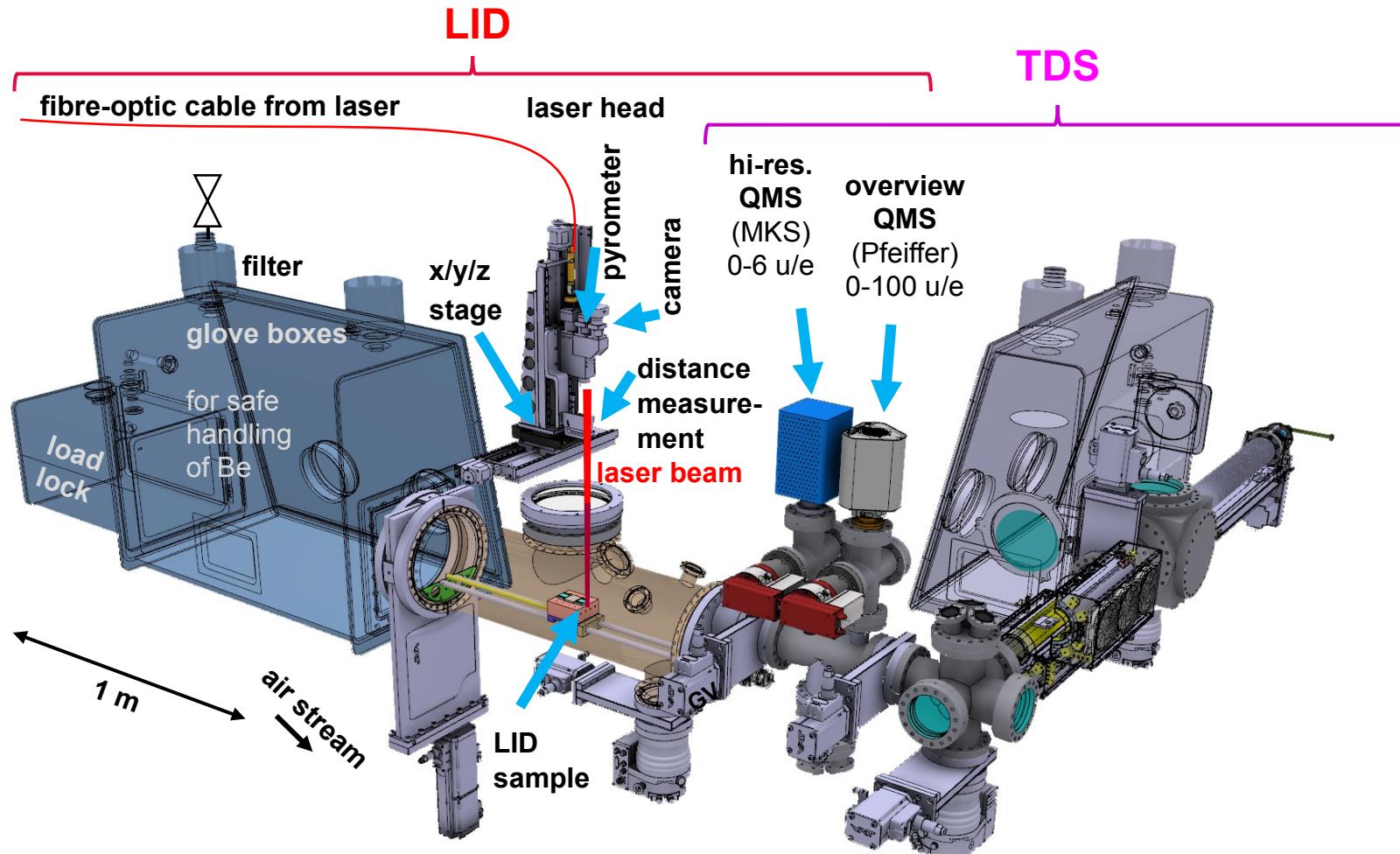
Ref: M. Zlobinski et al.,
Fus. Eng. Des. (2019) in press,
doi:10.1016/j.fusengdes.2019.02.035

Analysis Device in Jülich: FREDIS (Fuel Retention Diagnostic Setup)



Full JET divertor tile

Analysis Device in Jülich: FREDIS (Fuel Retention Diagnostic Setup)

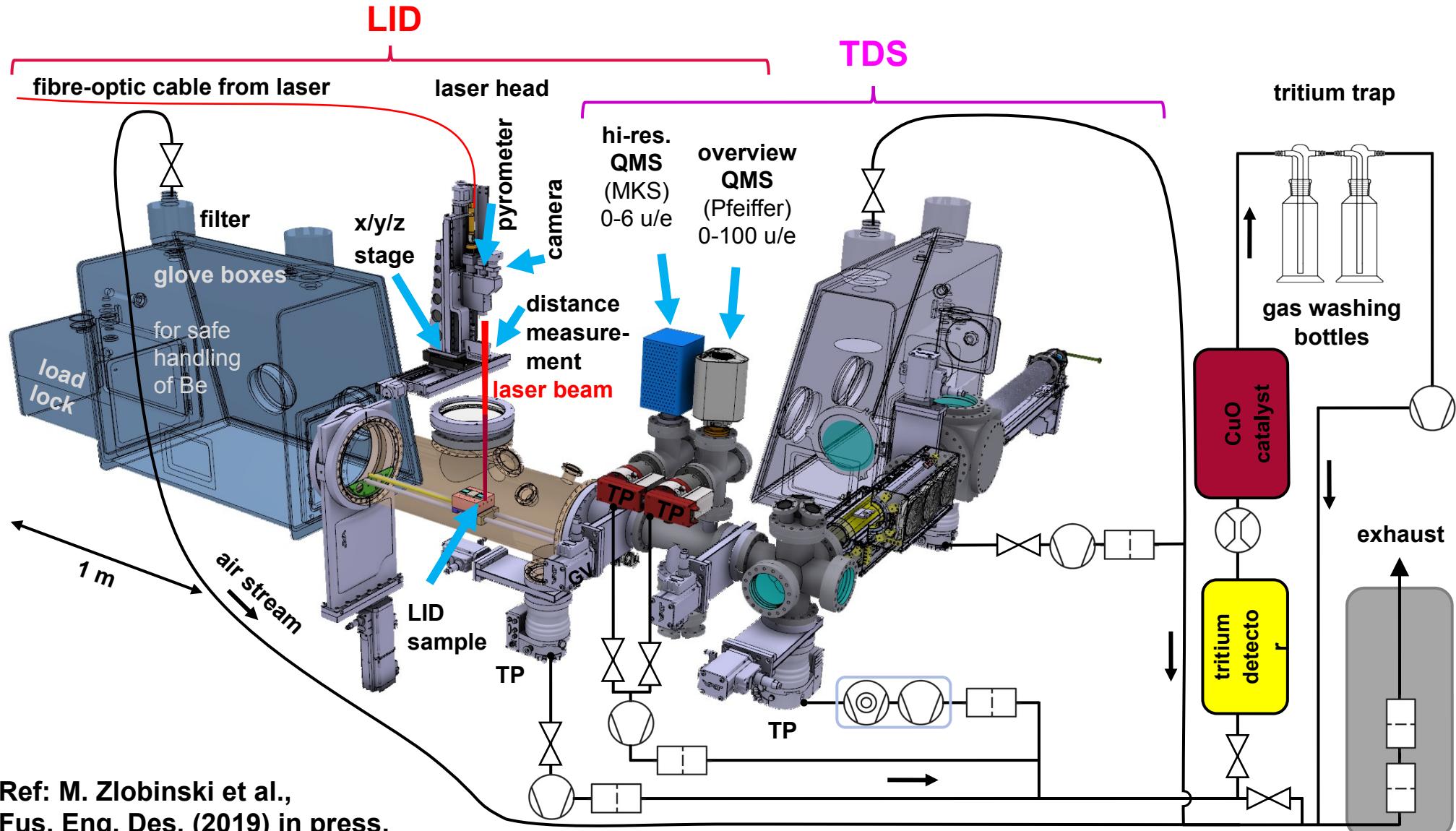


quartz
sample table
for TDS

TDS tube
inner \varnothing 52 mm

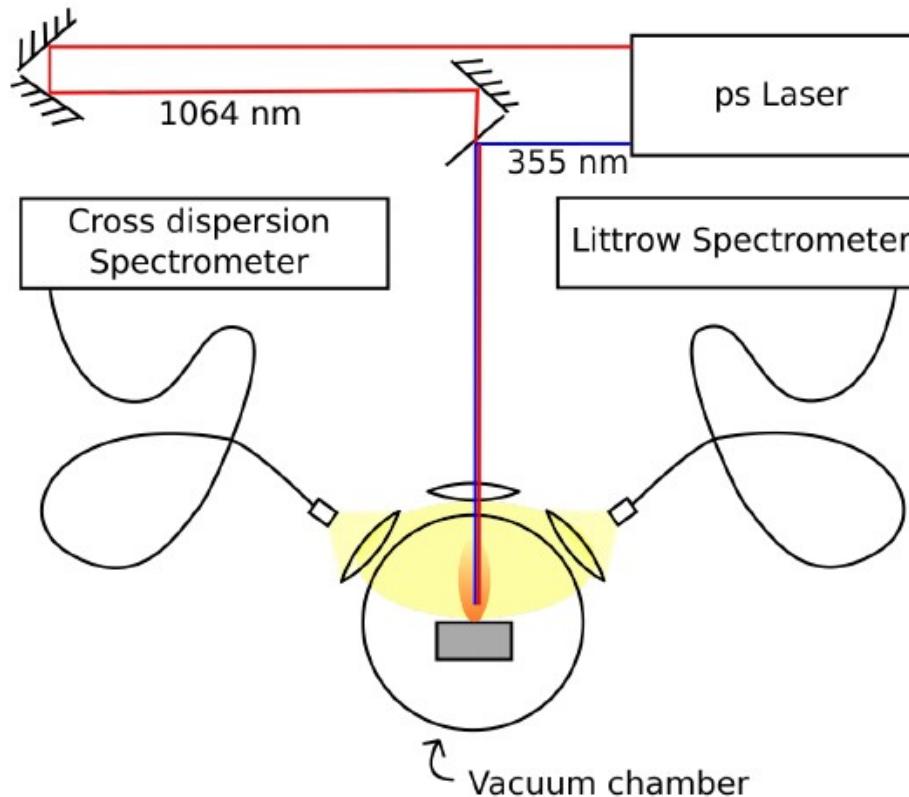
Analysis Device in Jülich: FREDIS (Fuel Retention Diagnostic Setup)

HML T licence limit
 2.5×10^{10} Bq (for gaseous T)
 2.5×10^{13} Bq (for bound T in material)



- located in radiation controlled area
- Tritium compatible
- Beryllium compatible

Dual pulse LIBS setup



1. Pulse: 355 nm, 35 ps, ~30 mJ
2. Pulse: 1064 nm, 35 ps, ~30 mJ
second Pulse arrives on sample 50 ns after first Pulse

Littrow spectrometer
466-480 nm, 150-300 ns

„Normal“ lab area:
• max 1 GBq T
• moderately Be compatible

Sample cutting & metallurgy

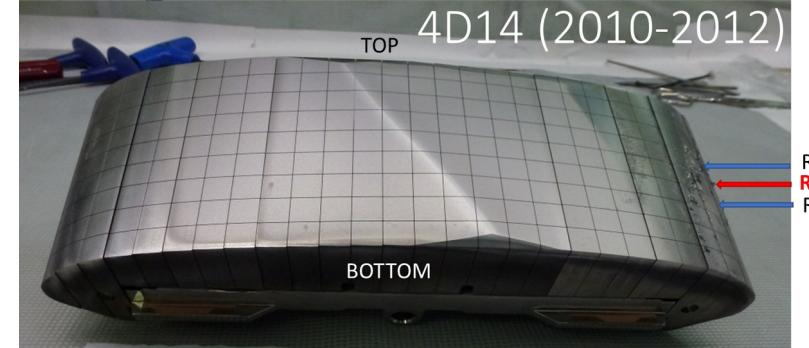
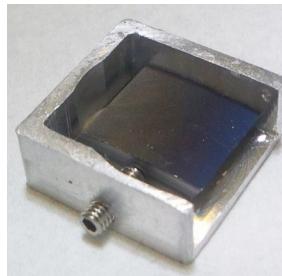
- dry or wet cutting
- epoxy embedding & polishing
- Be compatible
- limited T amounts
- „warm“ SEM



Available JET samples at FZJ for fuel retention analysis by TDS and LID-QMS

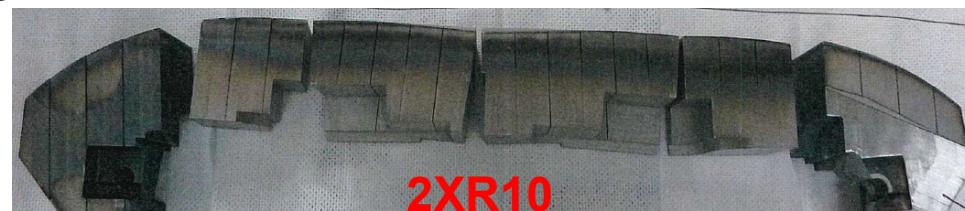
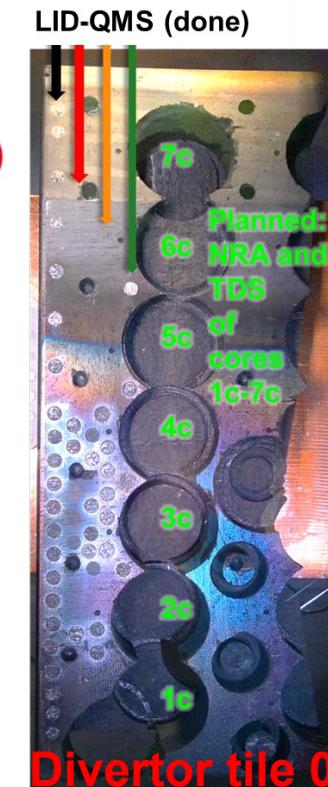
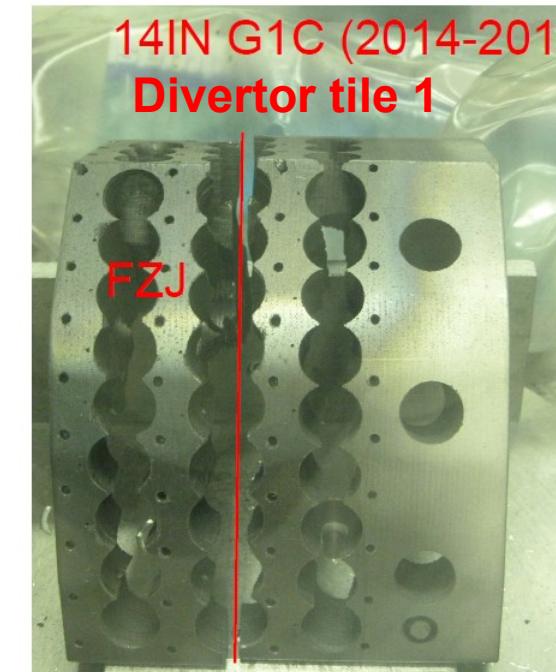
TDS:

- small Be block samples from 2XR10IWGL, 2B2C dump plate, 4D14WPL (9 from ILW-1, 7 from ILW-2)
- 9 small Be block samples from 2XR11 and 4D15 (exposed 2011-2016)
- Poloidal fraction of HFGC14LH (= divertor tile 0 from ILW3): cores 1c-7c: for comparison of D retention with LID-QMS and NRA possible external cooperation: Image Plate (IP) analysis of laser spots
- 4 W divertor lamellas (A14, B14 from ILW2; B12, B13 from ILW3)



LID-QMS (Laser-Induced Desorption):

- Poloidal fraction of 14ING1C (divertor tile 1 from ILW3): perform poloidal laser scan for D profile
- Cut blocks of Be limiter 2XR10 from ILW3 for poloidal D profile
- some small further samples



Plans

- Fuel retention studies with LID-QMS & TDS
 - on samples to be agreed upon here
- Baking experiments
 - LID-QMS for pre- and post fuel content estimate
 - Baking in TDS part
- LIBS & metallurgy on W-divertor lamella
- T imaging plate measurements on LID-QMS samples

Draco dormiens nunquam titillandus

(Motto of the *Hogwarts School of Witchcraft and Wizardry* and also pretty good live advice)

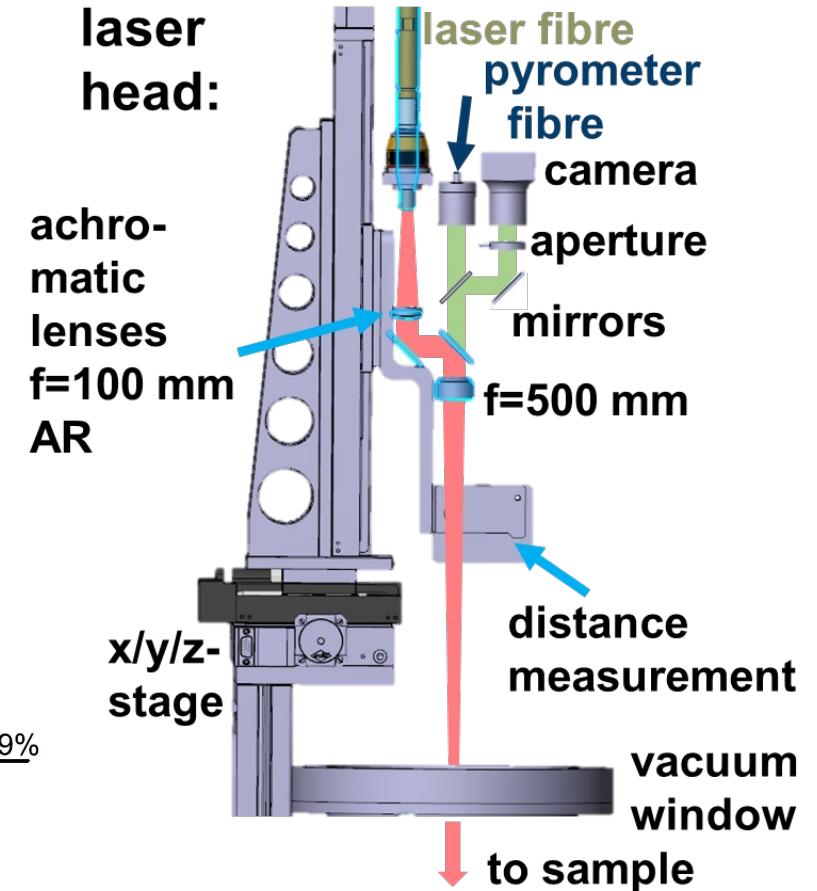
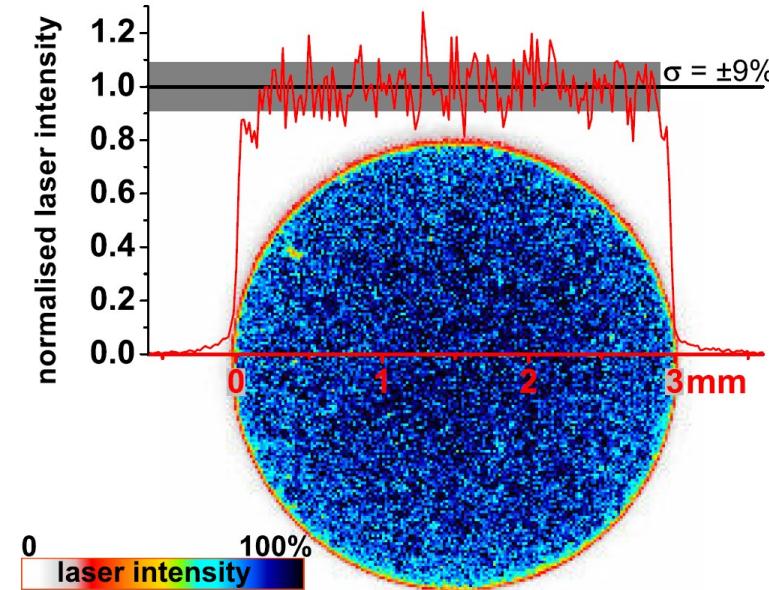
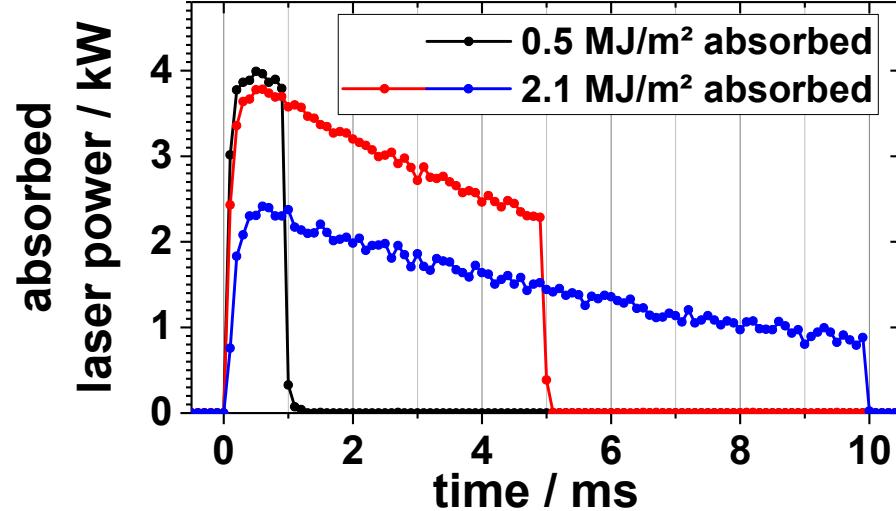


„one waking“, Jackie Morris, 2008

Thanks
for your
attention

LID parameters at FREDIS

- pulsed Nd:YAG laser (1064 nm) with 0.1-20 ms pulse duration
- up to 40 kW peak power (2.5 ms)
- up to 100 J/pulse (above 2.5 ms pulse duration)
- up to 1000 Hz, but max. 500 W average power



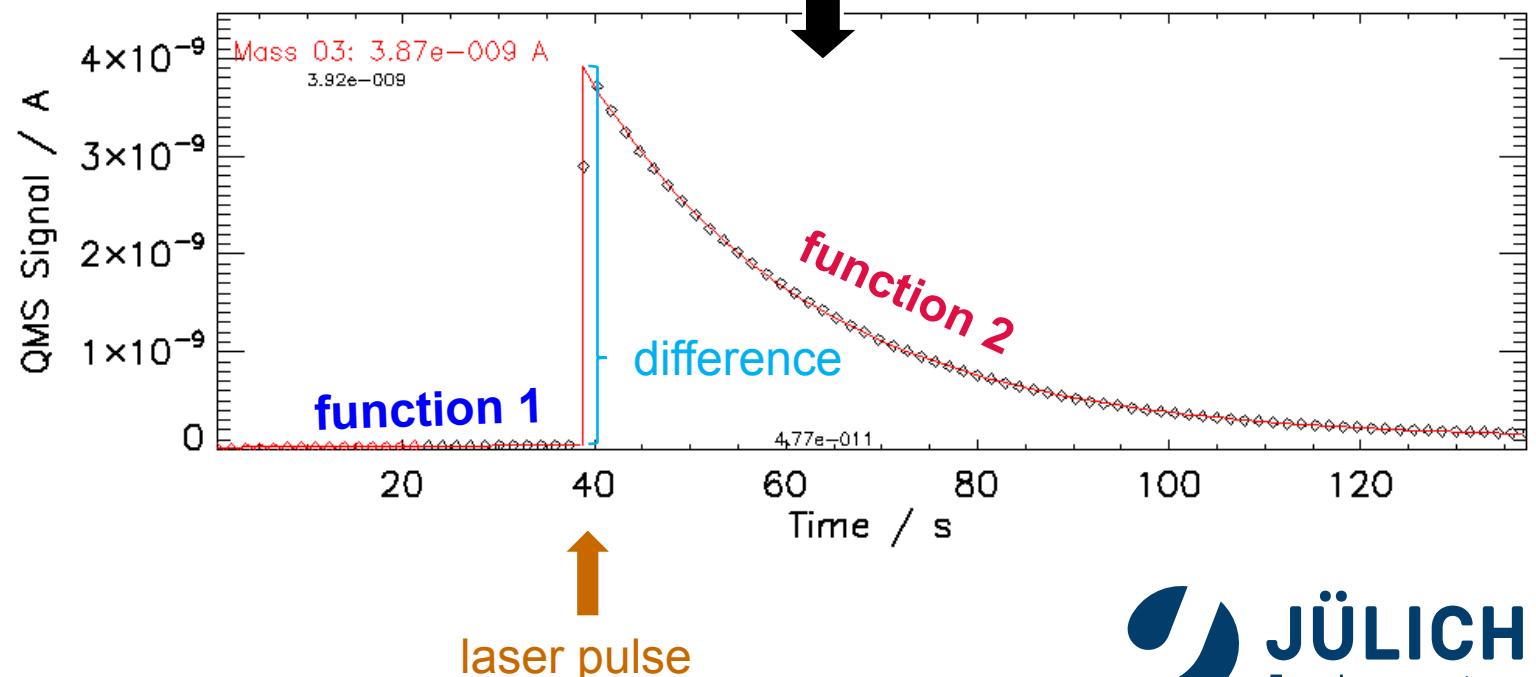
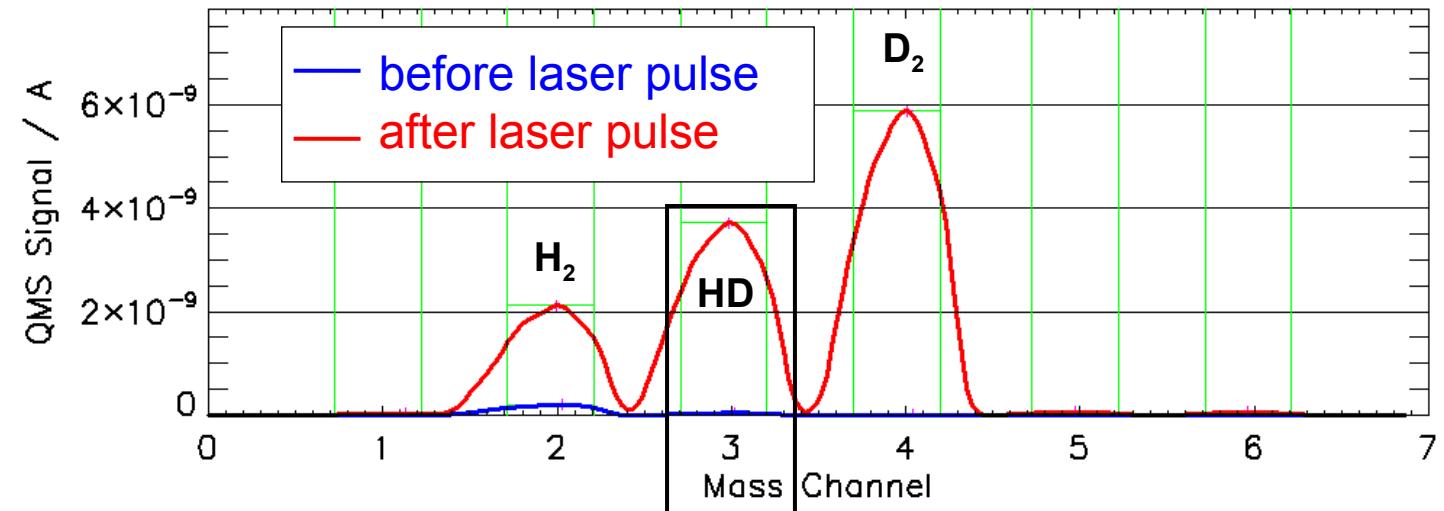
LID Measurement and Evaluation Procedure

LID measurement procedure:

- valve to pump is closed
⇒ background pressure is rising
- QMS scans starting
- 1 laser pulse fired
⇒ jump in desorbed mass channels
- QMS stopped
- valve opened

LID evaluation procedure:

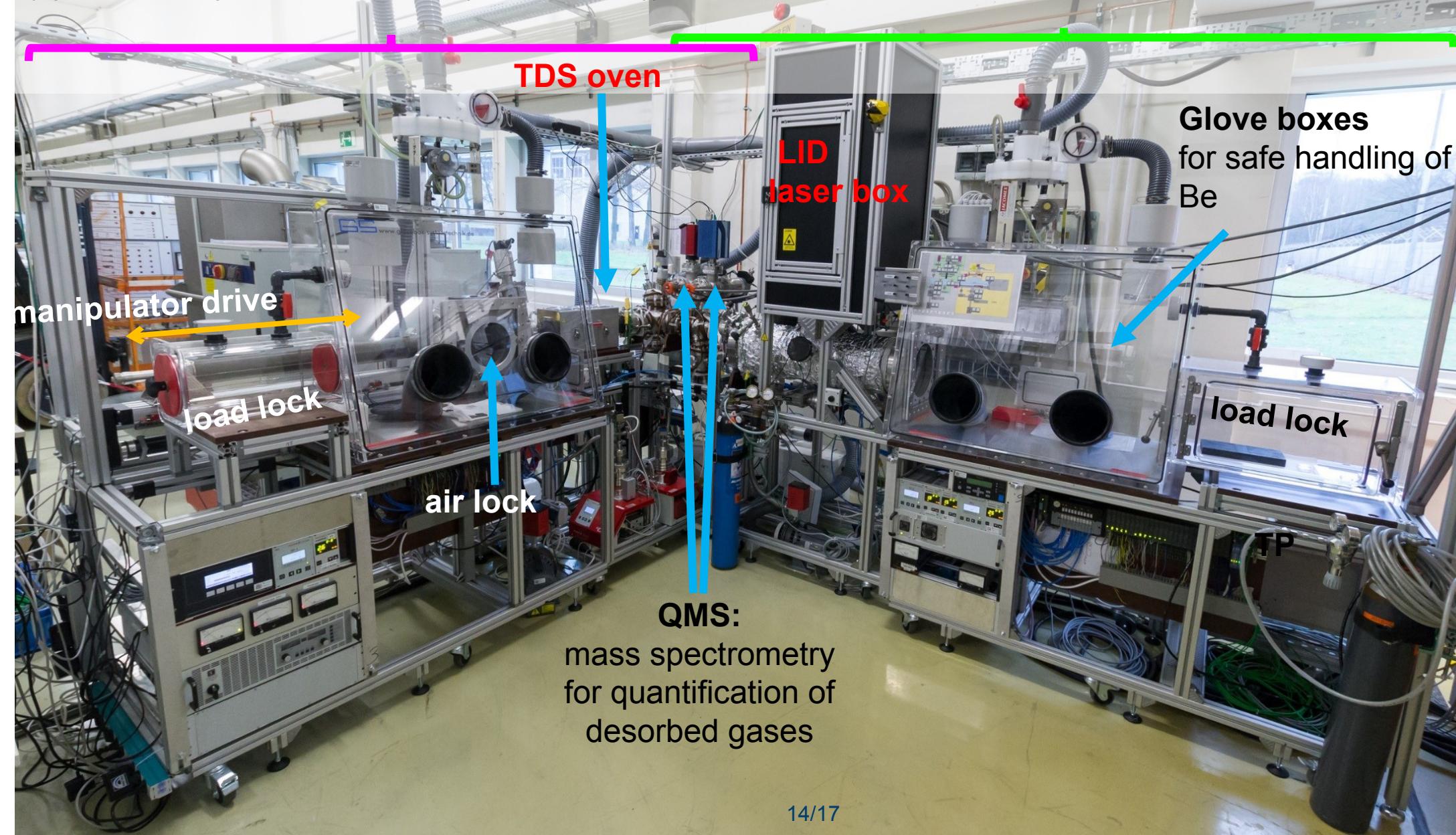
- fit of partial pressure evolution before laser pulse ⇒ **function 1**
- fit after laser pulse ⇒ **function 2**
- extrapolation of function 1 and 2 to **time of laser pulse**
⇒ **difference of both functions at that time is the desorption from sample**
- LID signal for D =
sum of mass 3 (HD) and 4 (D_2), ...



FREDIS IN HML

TDS: Heating of a sample by 6 IR lamps, PLC-controlled linear heating ramps (up to 1 K/s, up to 1273 K tested, (max. 1433 K))

LID: Heating of a small ($\varnothing 3$ mm) spot with a high energy laser pulse (up to 100 J, 0.1-20 ms duration, Nd:YAG @1064 nm)



Analysis Device in Jülich: FREDIS