Institute of Radiation Physics

Radiation Source ELBE

Status report of ELBE and GaN

BETH kickoff meeting, Siegen

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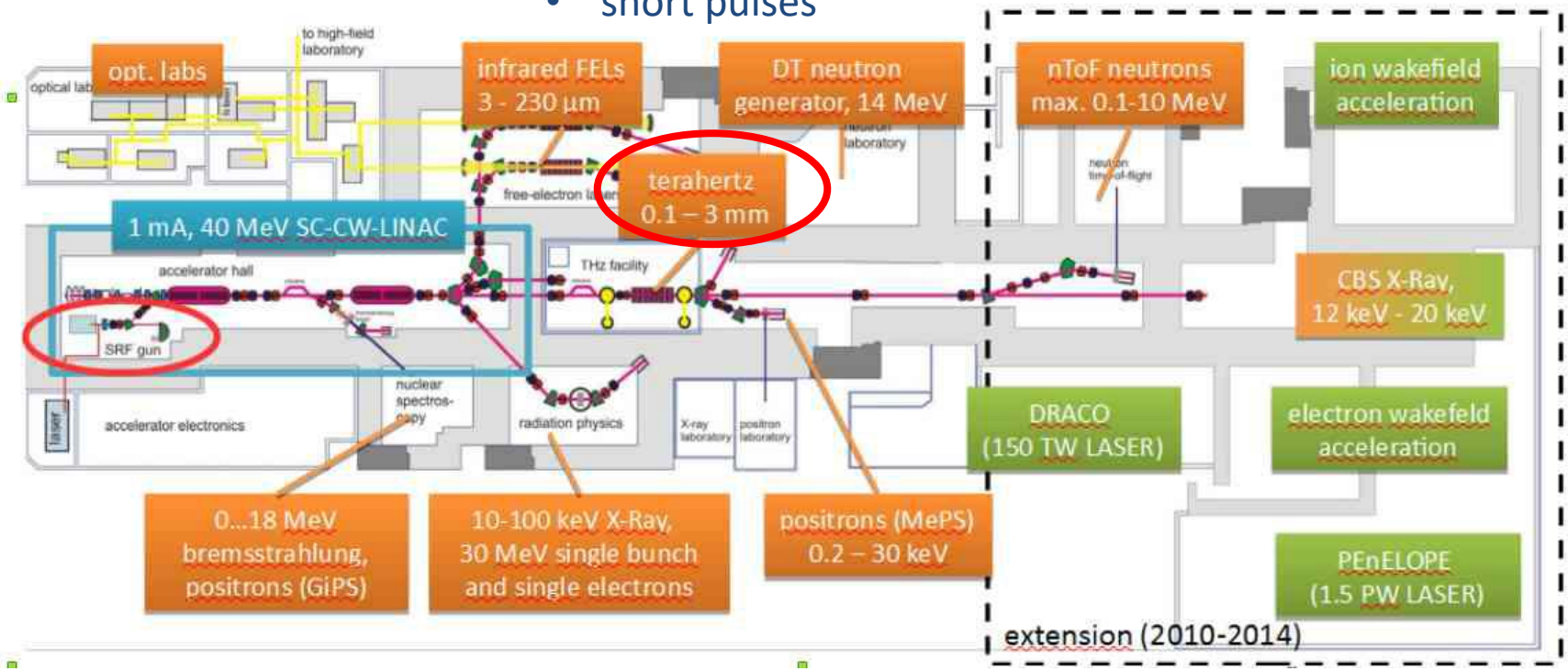
Performance of the SRF Gun

Advantages of SRF Gun II:

- continuous wave operation (CW)
- higher bunch charge
- lower transverse emittance
- short pulses

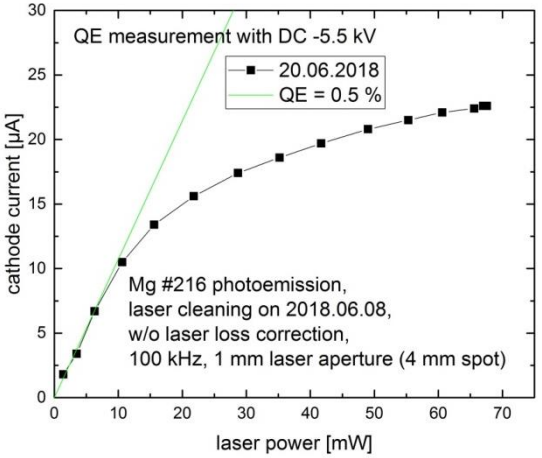


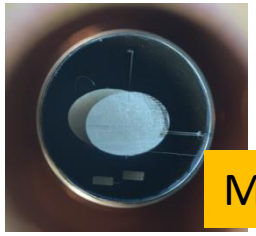
- working hours for THz radiation production at ELBE, all TELBE shifts in 2019 (101 shifts a 12 h)

Mg Photocathode

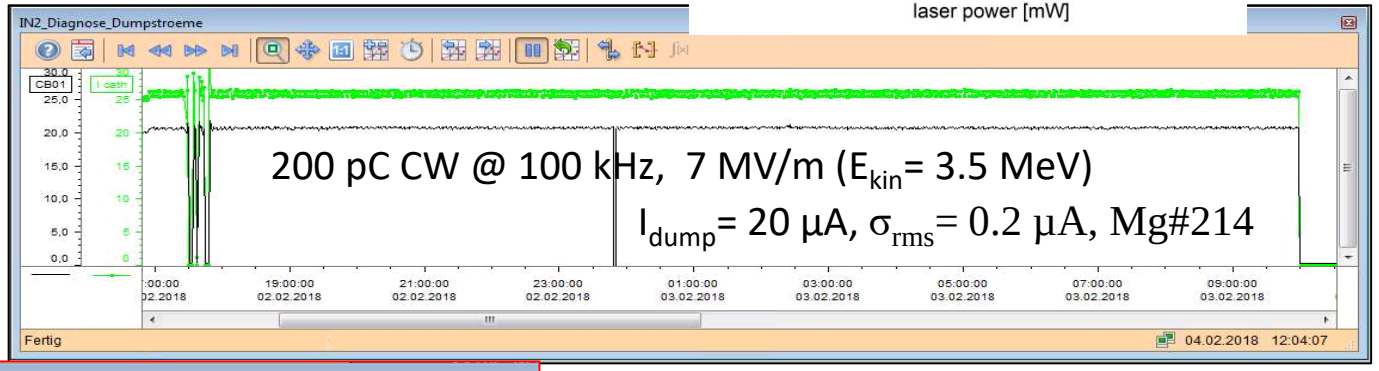
Mg cathodes work routinely in ELBE SRF gun at HZDR

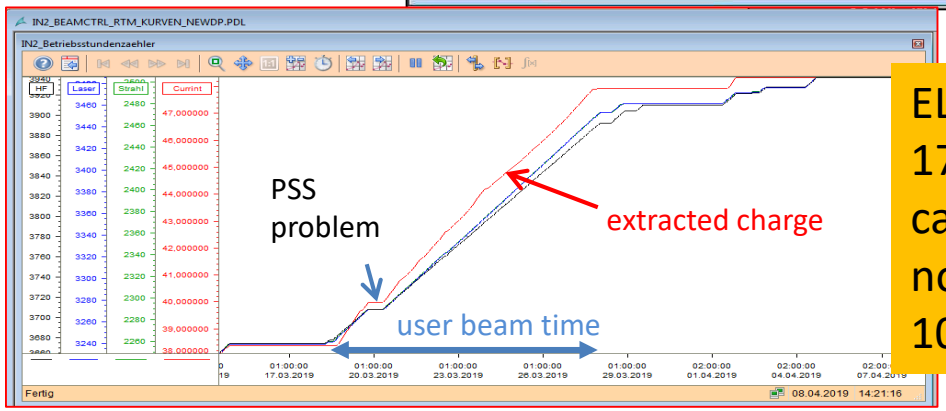
- bulk Mg plugs, polished and chem. cleaned
- UV laser cleaning (drive laser)
- best QE 0.3 % … 0.5 %
- low risk of cavity contamination
- extremely long life time in 10^{-9} mbar vacuum
- cleaning can be several times repeated





Mg #214

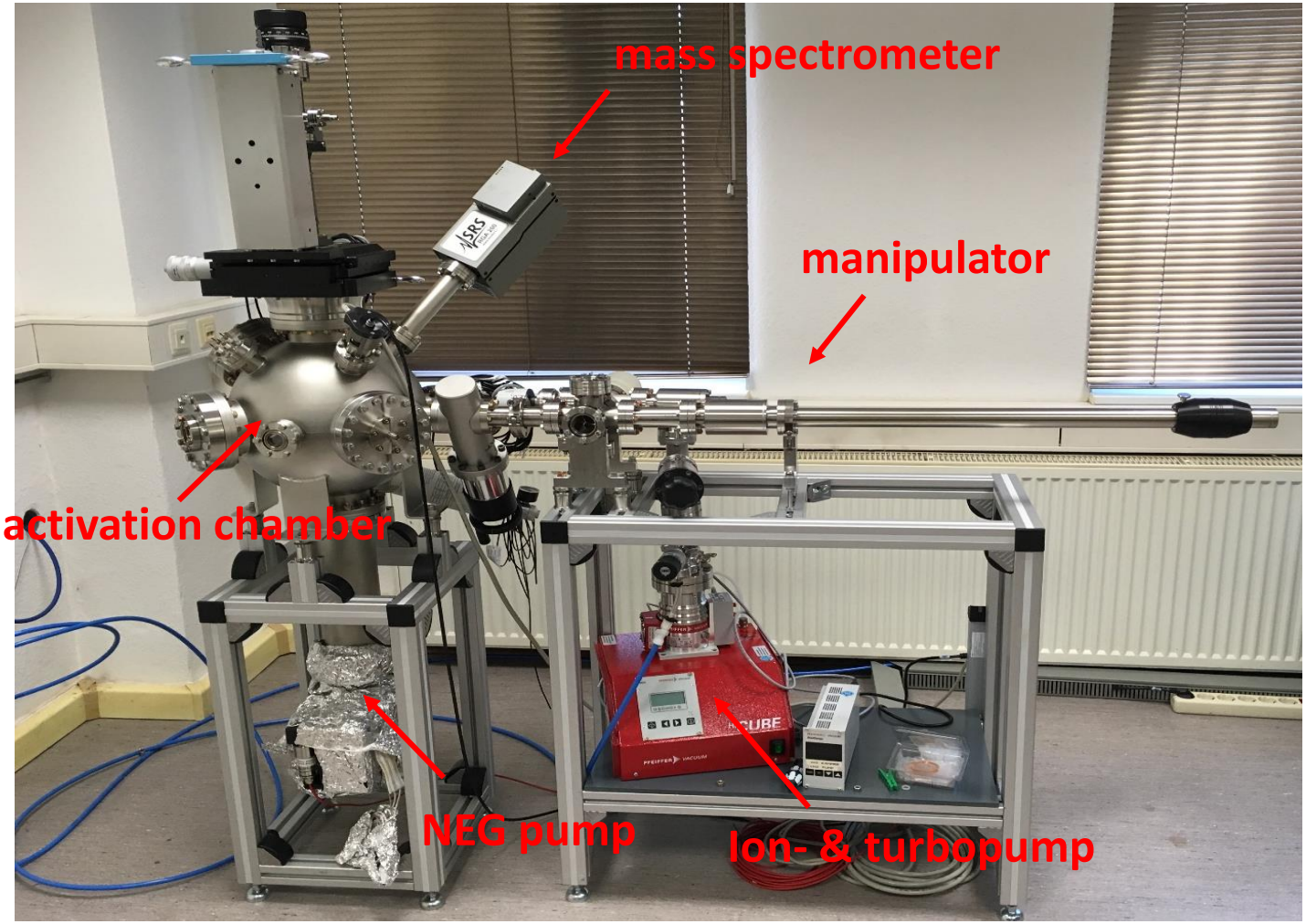




ELBE run spring 2019
17 x 12 h shifts for external users
ca. 200 h beam time in CW
no break due to gun problems
10 C charge extracted

GaN Photocathode Research

Build-up and commissioning of GaN chamber

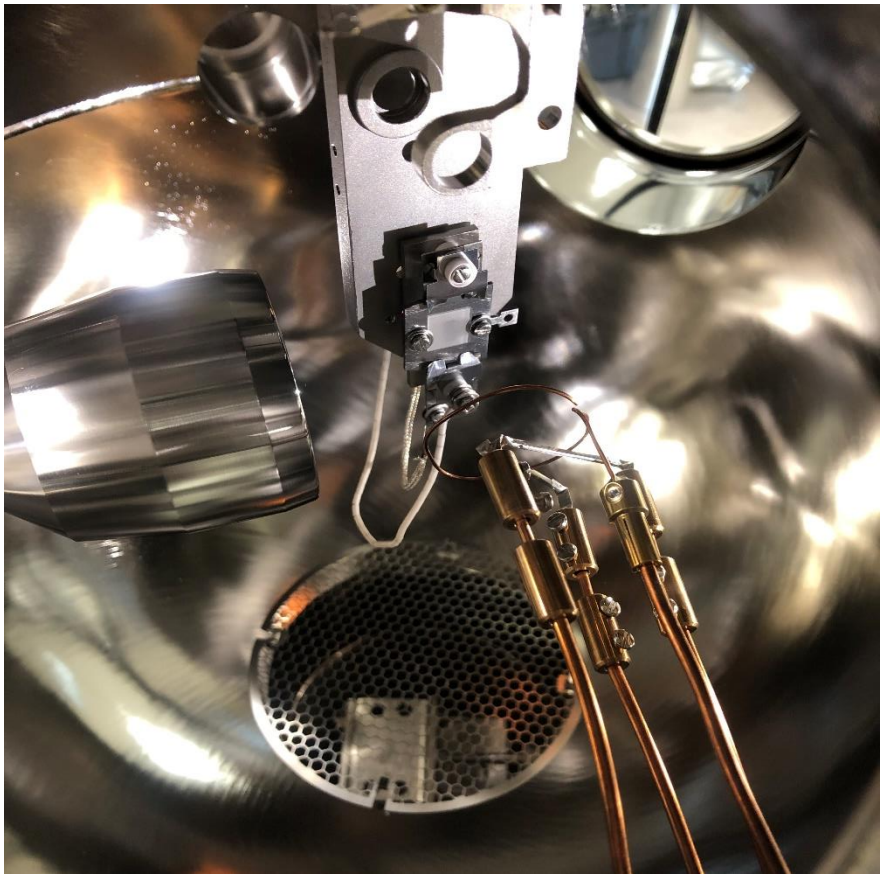


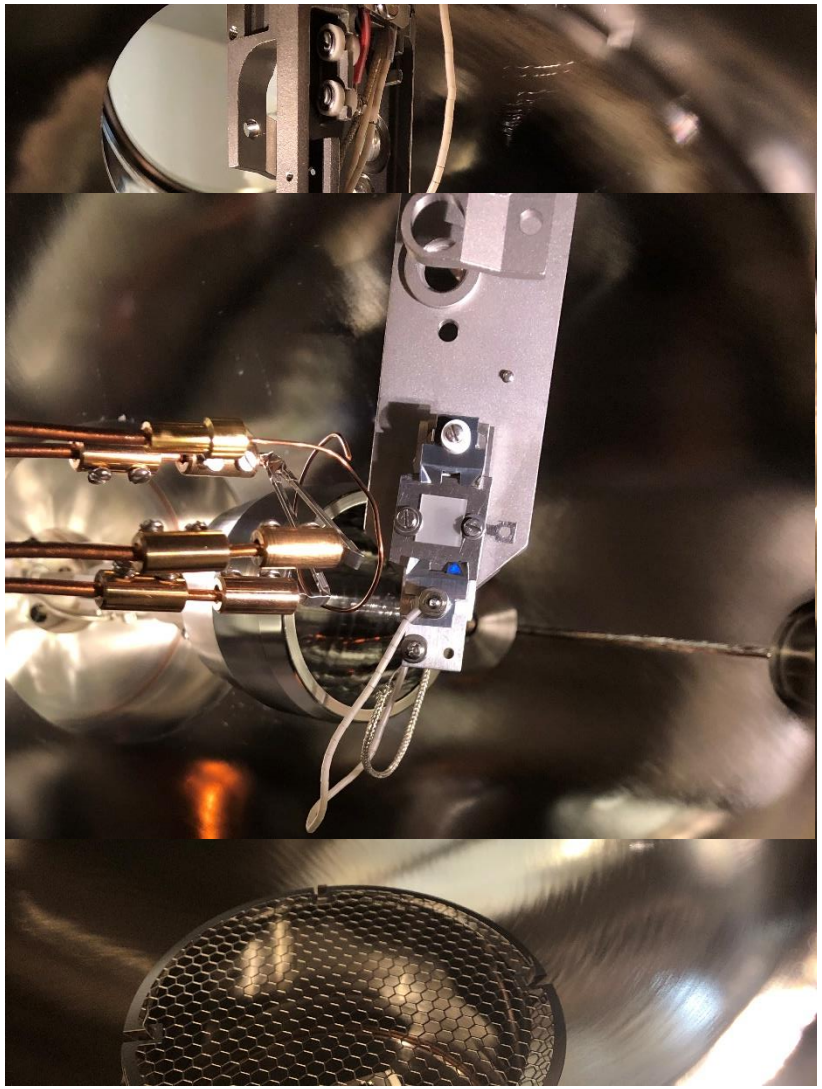
GaN Photocathode Research

Software program

GaN Photocathode Research

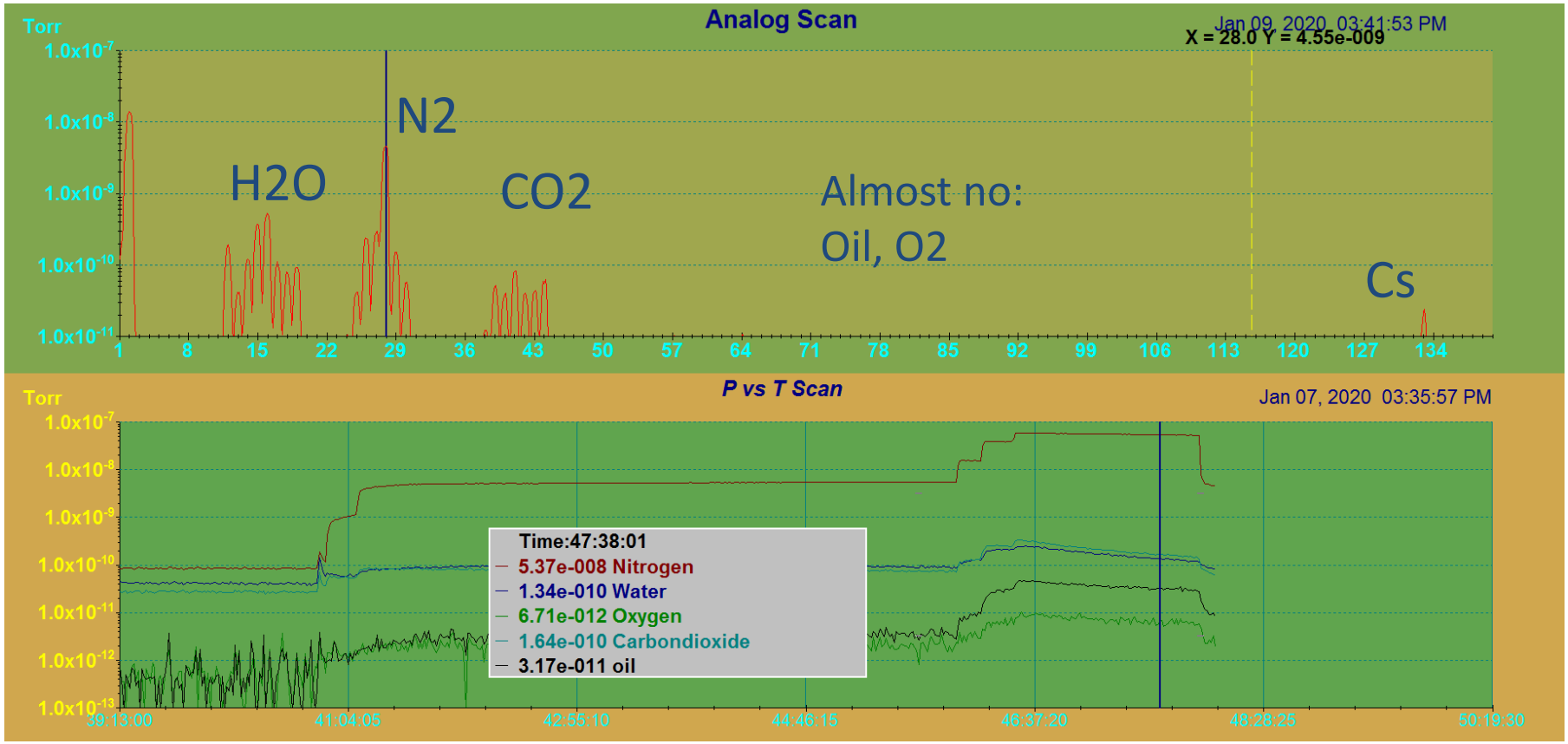
Build-up and commissioning of GaN chamber





GaN Photocathode Research

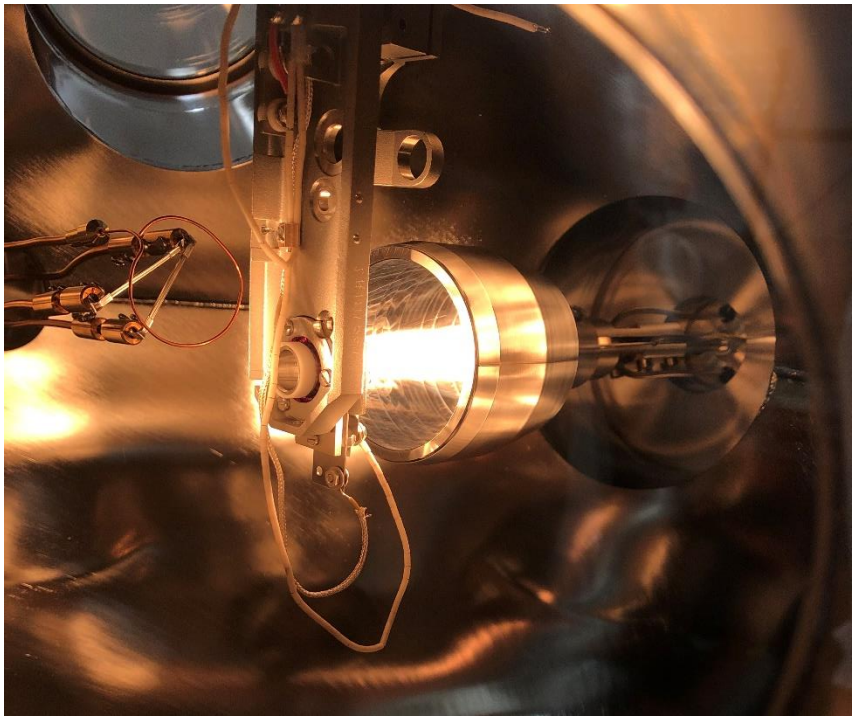
Outgassing of Cs-dispenser

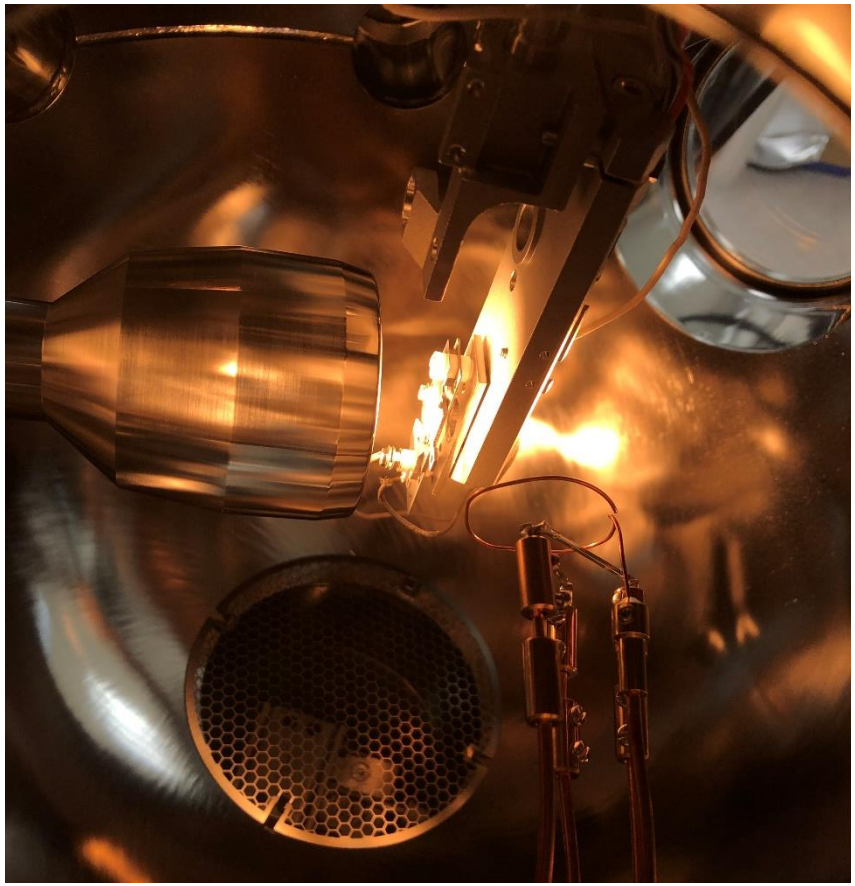


- Current to Cs: from 2 to 4.3 A
- 4 h at 2.7 A
- Kept at 1 A during outgassing/heating with halogen lamp

GaN Photocathode Research

Outgassing of halogen lamp & heating sample





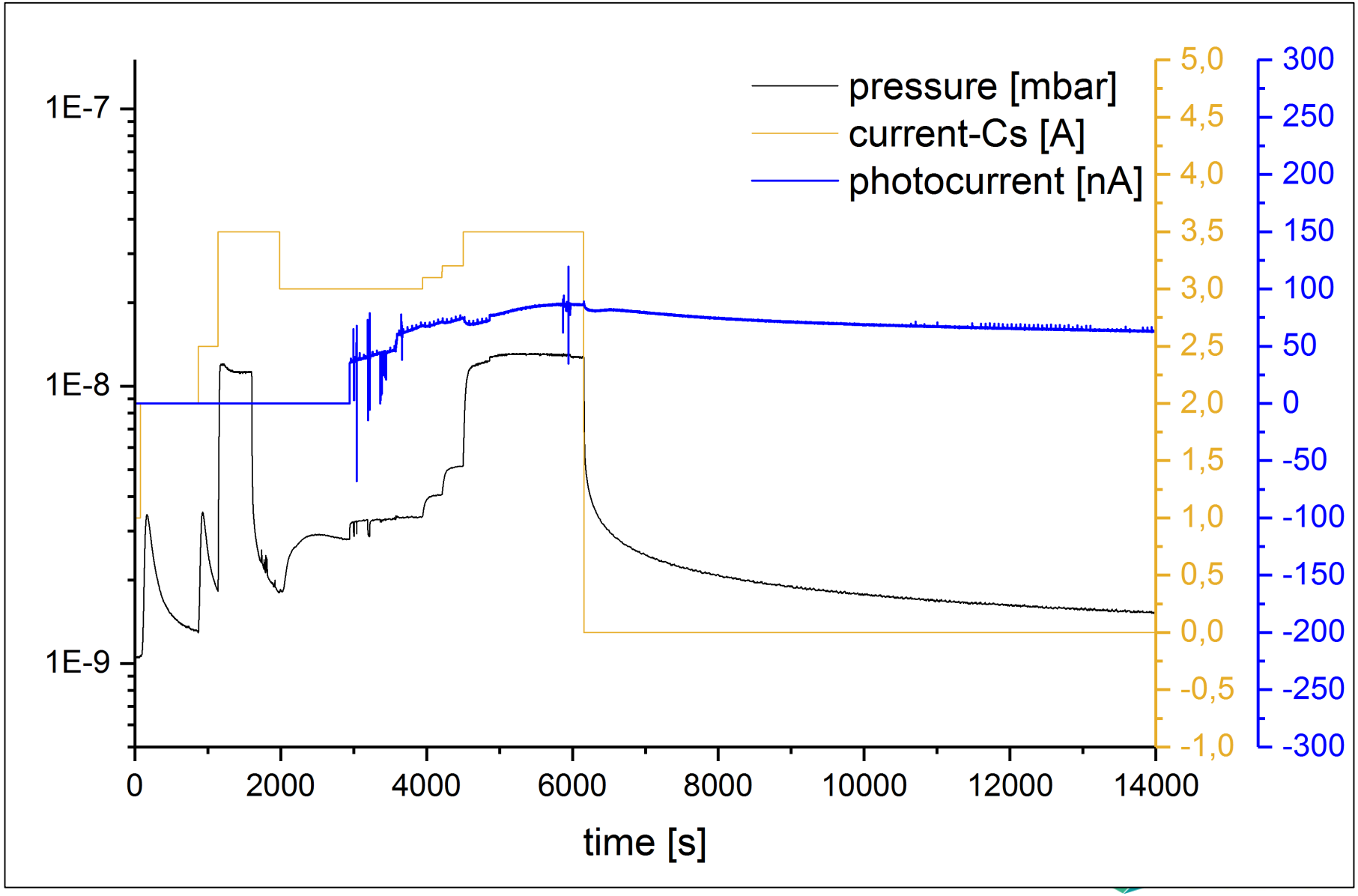
→ Reached T on sample: 610°C

→ Heating time: 15 min

→ Stopped because of too bad vacuum (~ 1E-6mbar)

GaN Photocathode Research

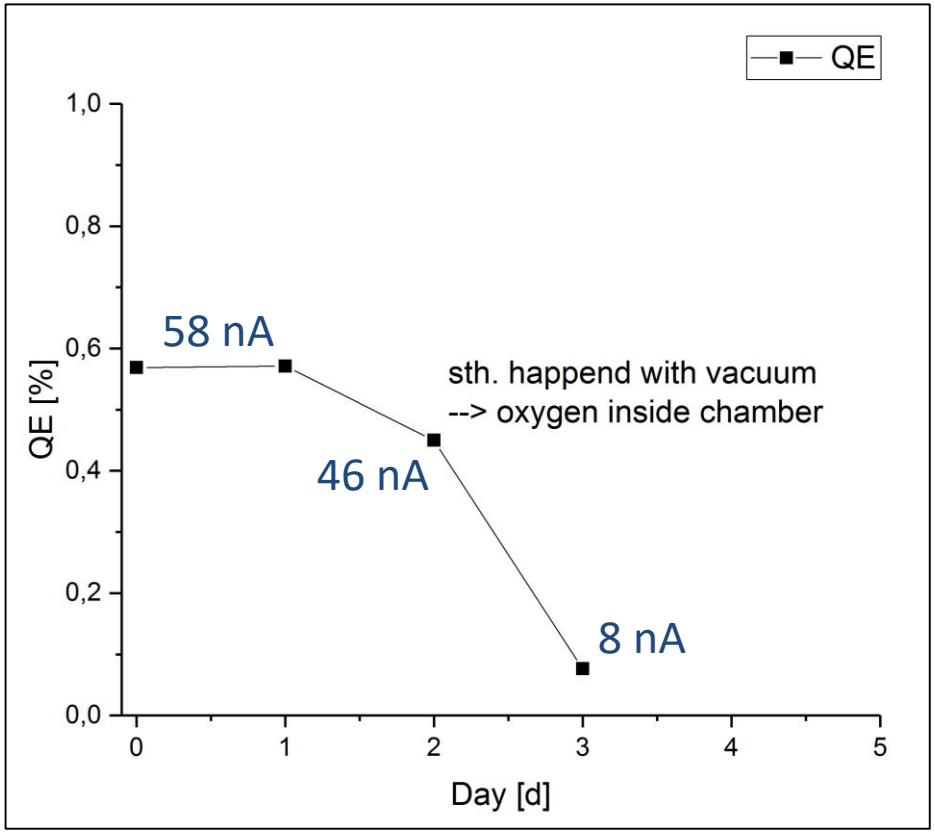
First activation- process



GaN Photocathode Research

First activation- QE

$$QE = \frac{N_{electrons}}{N_{photons}} = \frac{h \cdot c}{q_e} \cdot \frac{I}{\lambda \cdot P_{Light}(\lambda)}$$



- Planck-const. (h): 6.626E-34 J*s
- c: 2.9E9 m*s-1
- Elementary elect. charge (qe): 1.6E-19 C
- λ: 3.1E-7 m (310 nm)
- Power: 4E-5 W (40 µW)

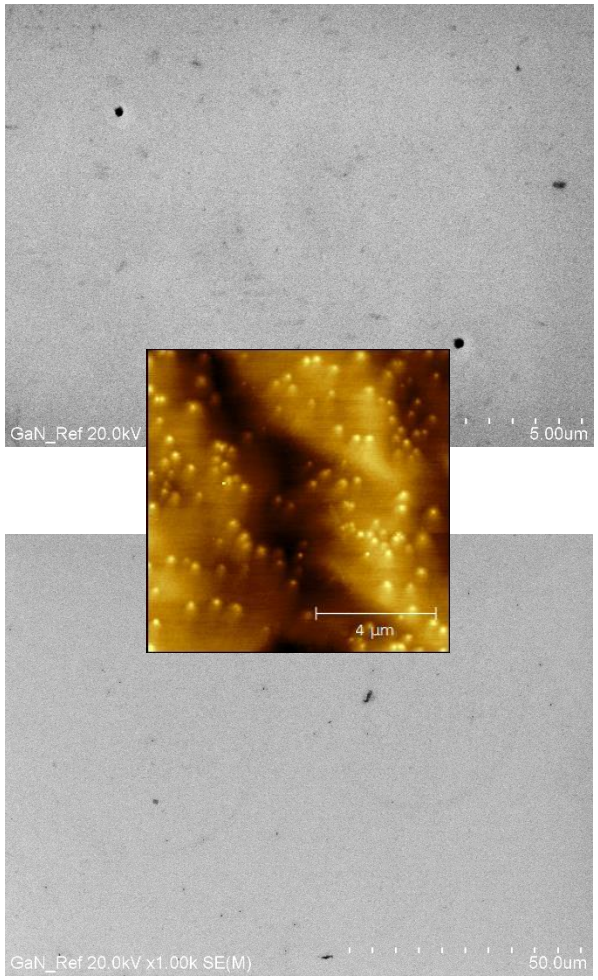
- reached ~0.58 %
  →no loss during the first hours
- On 2nd day after activation: oxygen in chamber
  → destroyed cathode

GaN Photocathode Research

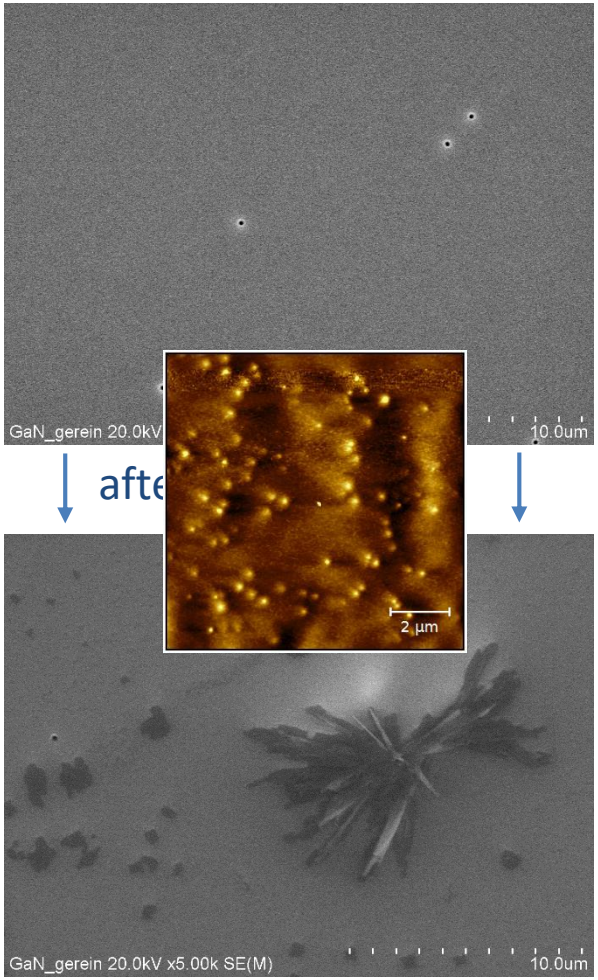
Cleaning of GaN on sapphire

SEM/EDX
AFM

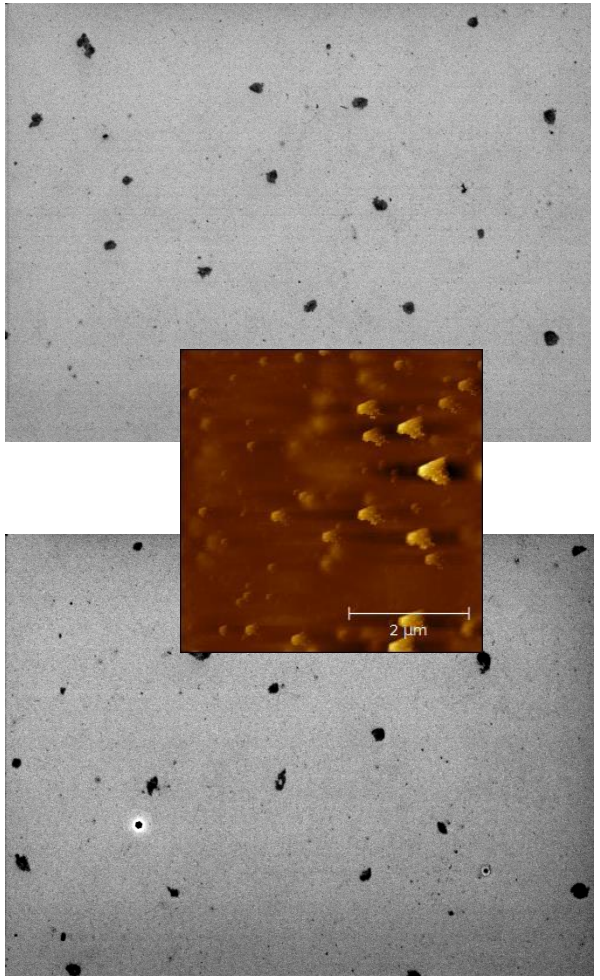
GaN: reference



GaN: piranha+ 0.5 HF



GaN: piranha/ water, after 4h on air



Crystal growth after cleaning ?!?!

→ Avoid air exposure+ use Glovebox & sealed bags

Conclusion

- Charaterization and comparison of commercial available GaN wafer
  → GaN on sapphire, Si, SiC (different substrates)
  → AFM, XPS, EDX, SEM, RBS
- Connection from activation chamber to XPS chamber → 1st quarter 2020
- Activation of GaN wafer with Cs and characterization of activated GaN
  → further activations and improvement
- Comparision to GaAs & selfmade GaN (Uni Siegen)
- If sucessfully: test in SRF Gun II as a photocathode for high brightness beam

Thank you for your attention!

Thanks to the ELBE team

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