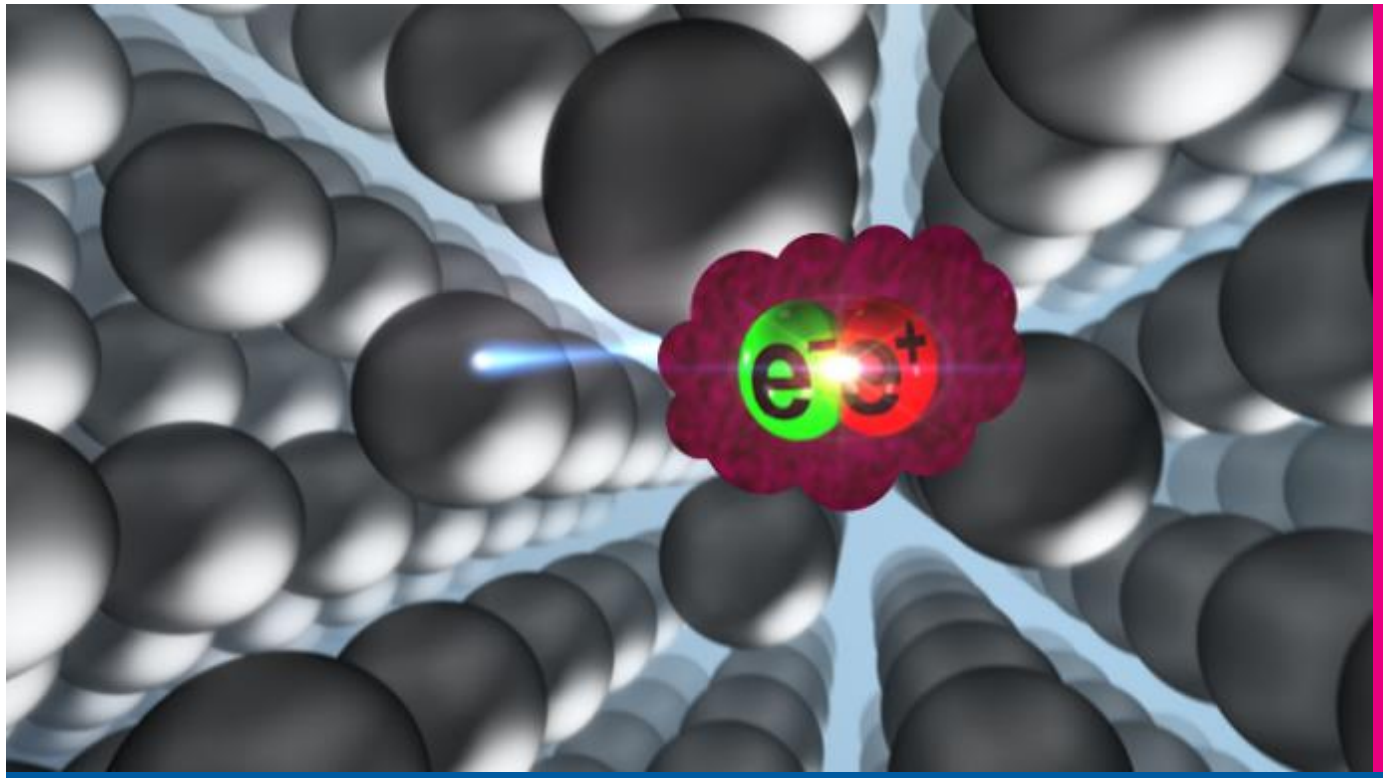
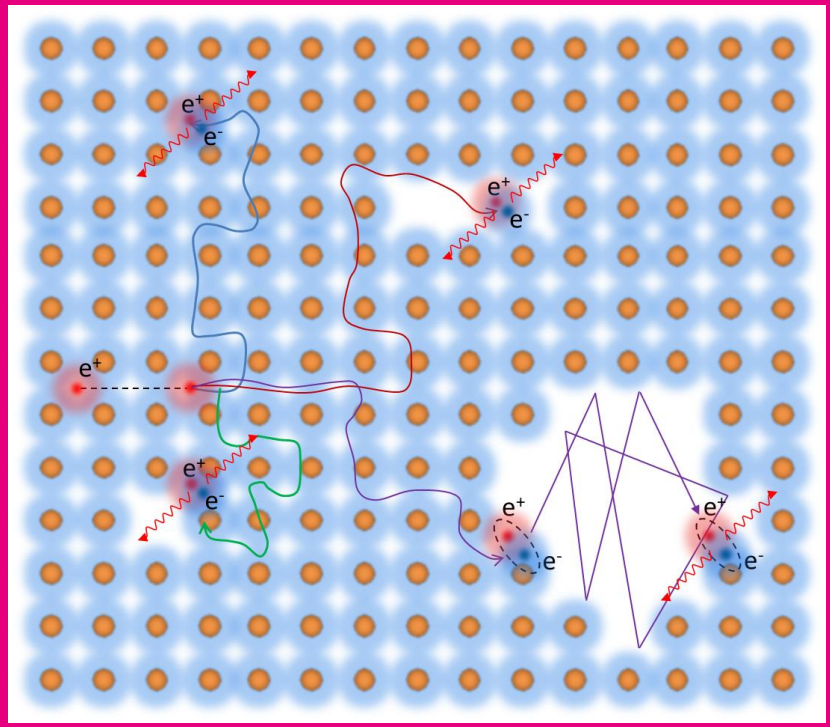
HELMHOLTZ ZENTRUM
DRESDEN ROSSENDORF





Positron annihilation spectroscopy (PAS) - NOVALIS

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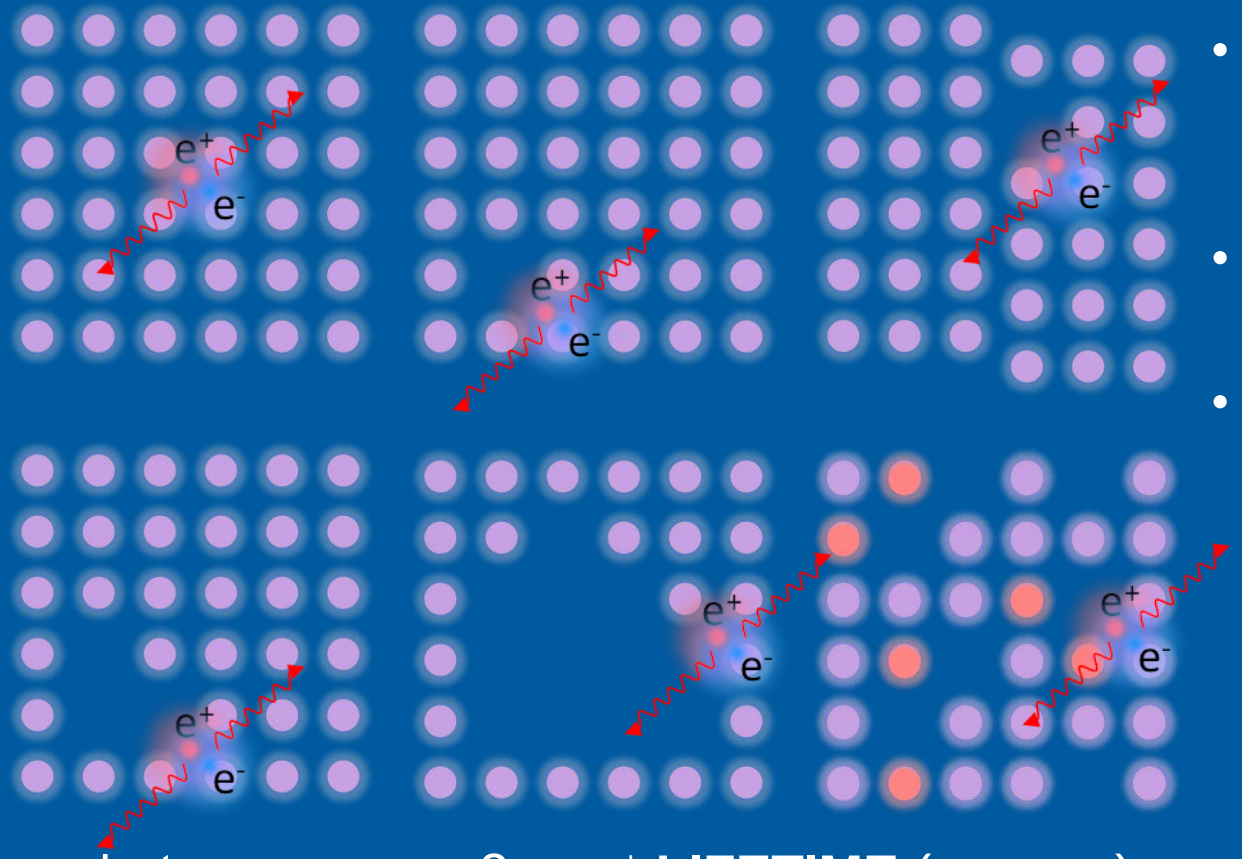
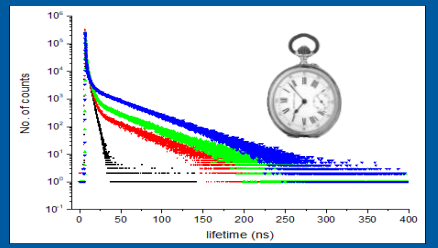
DRESDEN concept

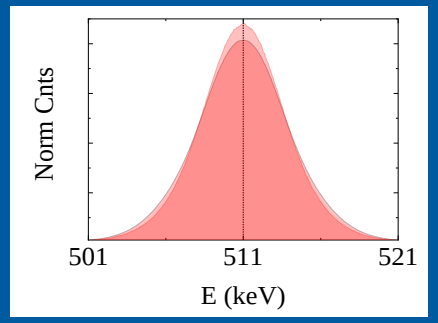
- positrons (e^+) annihilate with electrons (e^-) → gamma (511 keV) radiation
- where?

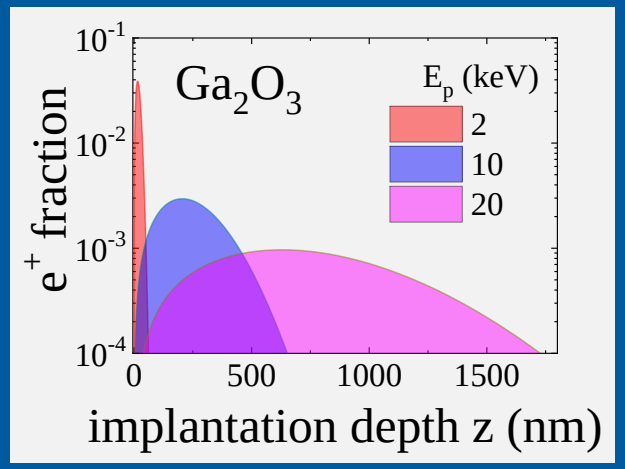


- what we measure? → e^+ **LIFETIME** (**ps – ns**)
- local chemistry → **decoration of defects**

- Defect SIZE and TYPE:
  single vacancy → dislocations → vacancy agglomeration → pores (<100 nm)
- Defect DENSITY:
  → **~10^{-7} – 10^{-3} atom^{-1}** (~10^{16} – 10^{20} cm^{-3})
- Implantation of positrons → depth profiling
  → **~20 nm to several µm**

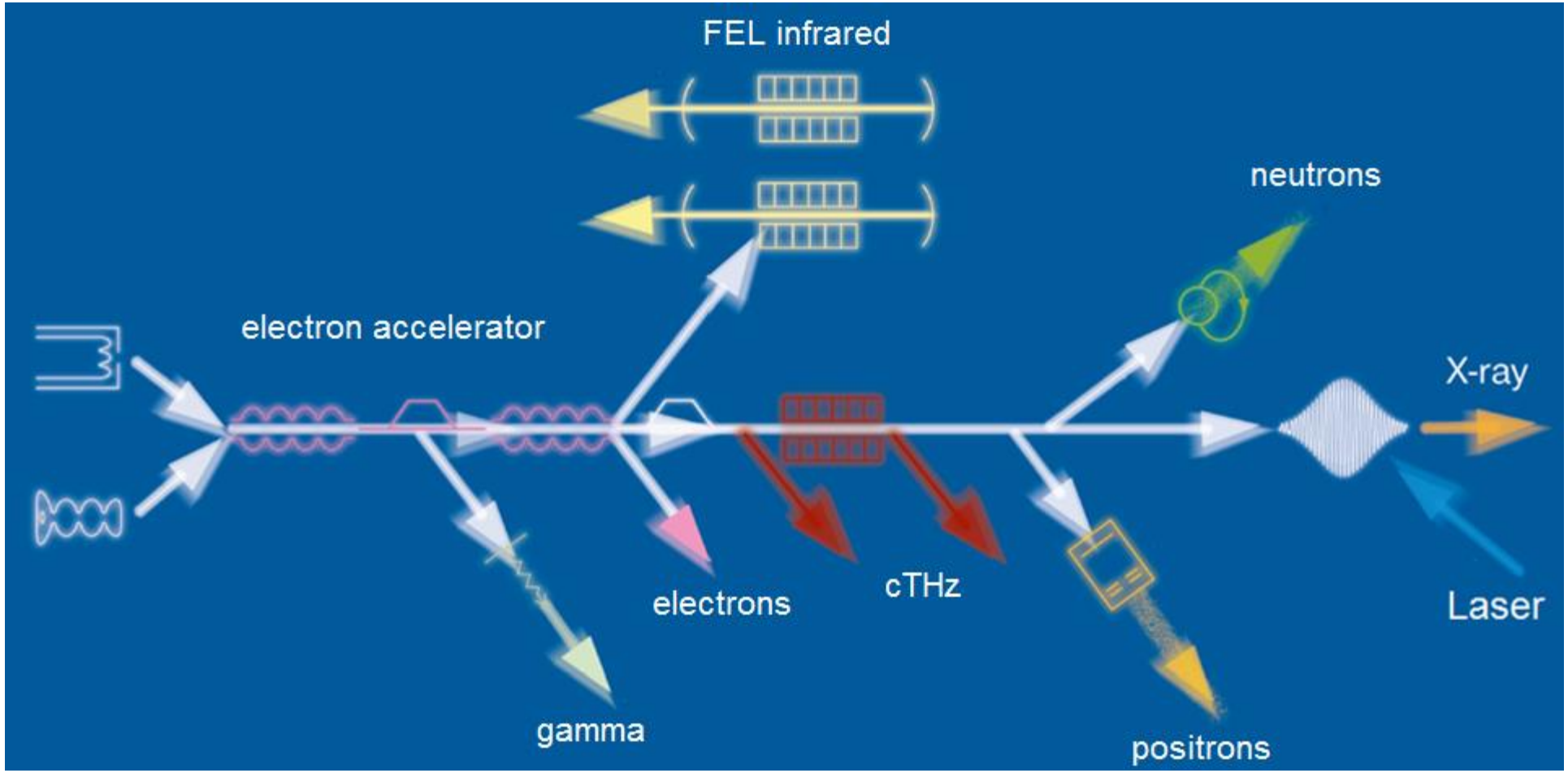






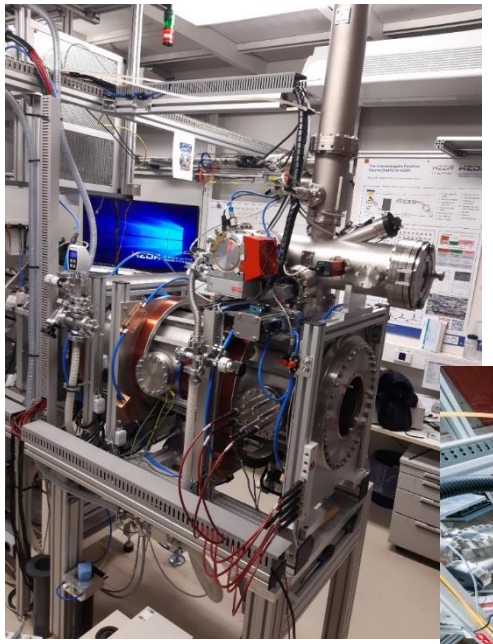
ELBE Center for High-Power radiation Sources

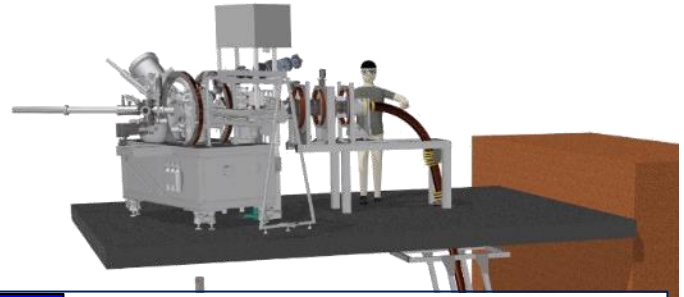
(Electron Linear accelerator with high Brilliance and low Emittance)

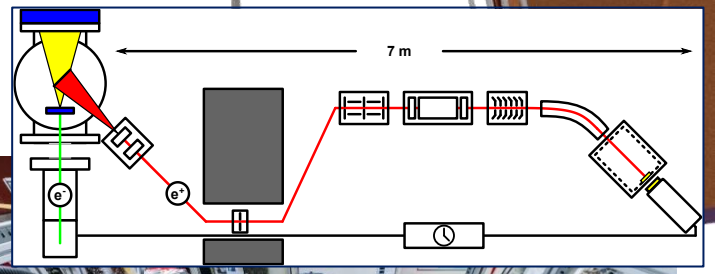


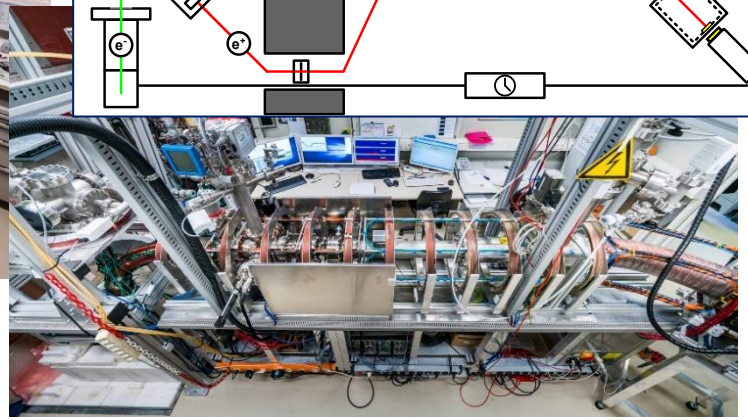
Positron User Facilities

MePS / AIDA-II







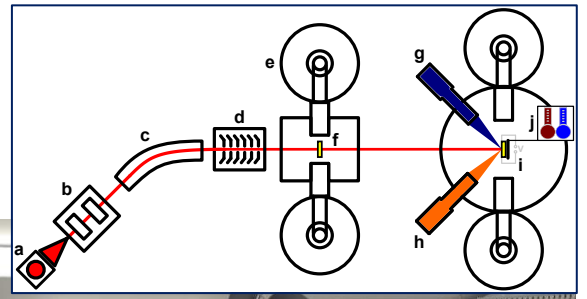


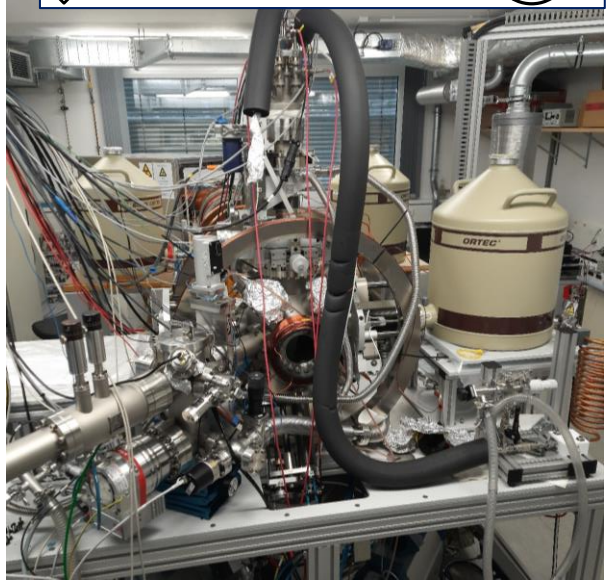
A. Wagner, et al., AIP Conf. Proc. 1970, 040003 (2018)

- positron lifetime = defect size and density
- depth resolved measurements
- high intensity → prerequisite for kinematic experiments

SPONSOR / AIDA-I

W. Anwand, et al., Def & Diff. Forum 331 (2012) 25





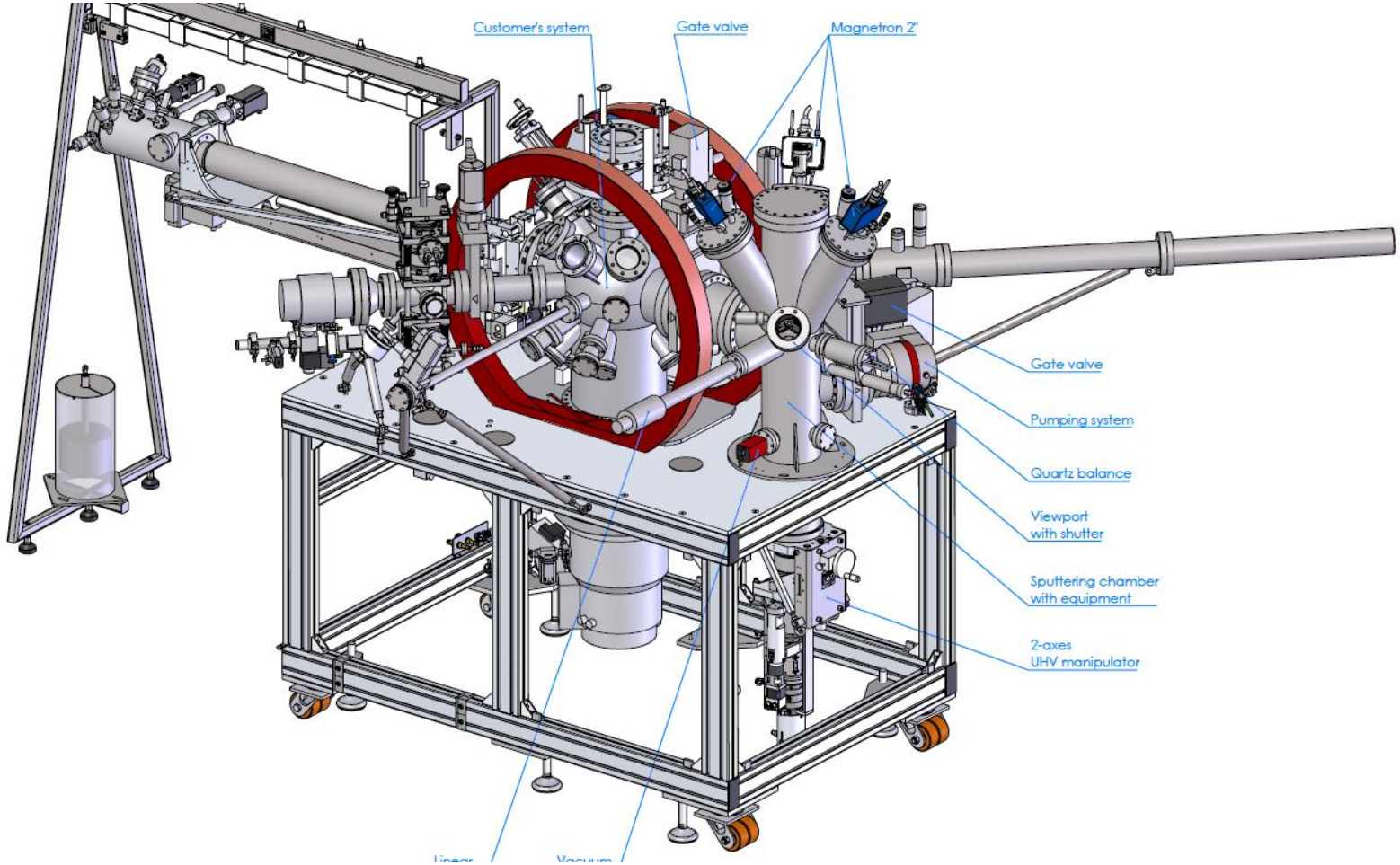
M.O. Liedke et al., J. Appl. Phys. 117 (2015) 163908

- analysis of the annihilation spectrum = defect size, density, and **chemistry**
- depth resolved measurements
- **AIDA**: in-situ manipulation of defects: temperature, ions, MBE, high power light

Positron User Facilities

AIDA-II + sputtering chamber

- 3 Magnetrons: 2 x DC, 1 x RF; 400W
- 2 inch targets, 1-6 mm thick
- base pressure <10^{-9} mbar
- alloy-C-276 sample holder for operation with reactive gases
- temperature range -180°C to 800°C
- working gases: Ar, N_2, O_2 + mixtures
- HiPIMS power supply will be acquired this year



PhD project of Sebastian Klug

- Dipl.-Ing. from TU Dresden: “Development and investigation of epitaxial superconducting $REBa_2Cu_3O_{7-x}$-layers on textured templates” – supervisor Prof. Kornelius Nielsch
- expertise in XRD, SEM, and low temperature PPMS
- know how of PVD

- he will learn: positrons for defect analysis, magnetron sputtering (a short visit in Siegen to get familiar with sputtering systems and eventually prepare samples for the planned measurements at pELBE)
- we will start the PhD project from deposition of Nb3Sn, Nb, NbN, NbTiN with a final aim of SIS layers
- on Si/Nb, Cu (interdiffusion studies), Al2O3 (isolator; entry to SIS)
- Sebastian will coordinate PAS measurements related to NOVALIS and will conduct the data analysis (in the first stage, from the previously measured SIS systems from M. Vogel)

Collaboration with Hamburg and Siegen

2 proposals related to NOVALIS has been submitted (the evaluation results will be known after 13.05.2024):

- **“Magnetic flux-expulsion studies on and S-I-S / S-S Structures” by Marc Wenskat (POS24203546):**

S-I-S with 15nm AlN and 60nm NbTiN on **Nb** as-deposited and annealed

S-S with 60nm NbTiN on Nb as-deposited and annealed

S-I-S with 15nm AlN and 60nm NbTiN on **Si** as-deposited and annealed

I-S samples from the PSI beamtime

- **“The role of point defects in NbTiN thin film deposited by DC/HiPIMS magnetron sputtering” by Aleksandr Zubtsovskii (POS24203543)**

varied **deposition pressure** and **cathode power** of DC and HiPIMS deposited NbTiN films as well as hybrid DC/HiPIMS co-sputtering

HZDR in perspective of SESAM

! HZDR provides the access to the positron ELBE facility in order to study defect microstructure in the novel superconducting materials

! sample preparation by sputtering (including HiPIMS) and MBE possible

➢ direct collaboration with Hamburg and Siegen

➢ PhD position at one of the universities with a work package for HZDR connected to in-situ analysis of defects and material deposition using the sputtering chamber, e.g. Nb3Sn, MgB2 (HiPIMS necessary)