## Proposal for DALI - Dresden Advanced Light Infrastructure

The Dresden Advanced Light Infrastructure (DALI) is being designed as a successor to the ELBE facility, which has been operated since 2004. DALI will be the ultimate THz source, spanning the entire range from 0.1 to 30 THz (wavelength 3 mm to 10  $\mu$ m) with extremely intense and flexible – with regard to repetition rate, bandwidth, polarization, pulse form, and pulse delays – radiation pulses. This will be complemented by a coherent VUV source between 5 and 25 eV photon energy (wavelength 250 – 50 nm), therefore enabling new research directions beyond condensed matter physics. These include, e.g., discovering mechanisms and exploring the dynamics of chemical reactions, which in turn would open the possibility of controlling chemical reaction pathways, in gas phase, in solution or at surfaces, or resolving complex dynamics of biomolecular processes initiated by strong-field pulses. Strong-field phenomena in condensed matter will of course remain an important research area, e.g. for coherently controlling collective phenomena and new quantum phases.

A preliminary conceptual design report (preCDR) has been completed in 2020 with input from many potential user groups. Presently HZDR staff is working on the full CDR, which will be followed by a detailed technical design report. Subsequent inclusion in the German National Roadmap for Research Infrastructures would then guarantee the funding for this 200 M€ investment.

The basic layout of the new DALI facility is shown in Figure 1. Two superconducting CW RF accelerators generate electron beams of 300 MeV and 50 MeV, respectively. VUV and THz radiation is generated in appropriate undulators and guided into the user laboratories. The radiation will be available to users in individual experimental stations. In addition to the photon sources, a high-intensity positron source for materials research and an ultrafast electron diffraction (UED) facility are also envisioned.



Fig. 1: Envisioned layout of DALI (conception and drawing: Pavel Evtushenko). The labels for the user labs are only examples.

## **DALI – short characteristics**

The Dresden Advanced Light Infrastructure (DALI) is designed as an integrated, acceleratorbased THz and VUV source that covers the frequency range from 0.1 THz to 30 THz with coherent, semi-narrowband (~10% spectral bandwidth) few-cycle radiation pulses and the VUV spectral range from 50 nm to 250 nm with intense, quasi-transform-limited subpicosecond pulses. Driven by a superconducting 50 MeV electron linear accelerator (LINAC), the THz source will provide radiation with high pulse energy (100  $\mu$ J – 1 mJ) and high repetition rate (100 kHz up to 1 MHz), an unprecedented combination of both parameters being a factor of at least 100 larger compared to what is available to date. The VUV FEL source will be based on a 300 MeV superconducting accelerator, implemented as a 150 MeV recirculation LINAC, and provide up to 30  $\mu$ J pulse energy at 0.1 – 5 MHz repetition rate. With a sub-100 fs synchronization, this combined, worldwide unique THz/VUV facility will open a wealth of new avenues for investigations of nonlinear and high-field-driven phenomena.