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The EuPRAXIA FEL project: ultra-bright light pulses for imaging and spectroscopy

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EuPRAXIA is a leading European project aimed at the development of a dedicated, ground-breaking, ultra-compact accelerator research infrastructure based on novel plasma acceleration concepts. The INFN Laboratori Nazionali di Frascati will be equipped with an X-band LINAC followed by a plasma wakefield acceleration stage driving the first fifth-generation free electron laser (FEL) source driven by a plasma-based accelerator, the EuPRAXIA@SPARC_LAB facility [1]. The FEL will be characterized by a small footprint and will deliver ultra-bright photon pulses for experiments in the water window (3-5 nm) to the user community [2]. In addition, the possibility of building a second photon beamline with seeded FEL pulses in the range between 50 and 180 nm [3] and of exploiting the X-ray betatron radiation emitted by the electrons accelerated in plasma [4] are being explored.
We present an overview of the foreseen applications of these photon sources, which include imaging and spectroscopic studies on a variety of biological and inorganic materials, giving information on their structure and dynamical behavior.

Figure 1. Layout of the EuPRAXIA@SPARC_LAB facility.

[1] M. Ferrario et al.. EuPRAXIA@ SPARC_LAB Design study towards a compact FEL facility at LNF. Nuclear Instruments and Methods in Physics Research Section A, 2018, 909, 134-138.
[2] A. Balerna et al. EuPRAXIA@ SPARC_LAB for radiation based techniques. Condensed Matter, 2019, 4: 30.
[3] F. Villa et al.. ARIA—A VUV Beamline for EuPRAXIA@ SPARC_LAB. Condensed Matter, 2022, 7, 11.
[4] F. Stellato et al. Plasma-Generated X-ray Pulses: Betatron Radiation Opportunities at EuPRAXIA@ SPARC_LAB. Condensed Matter, 2022. 7, 23.

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