A Coherent Imaging XUV-FEL users end-station for the EuPRAXIA@SPARC_LAB Free Electron Laser

A. Balerna [a], S. Bartocci [b], G. Batignani [c], A. Cianchi [a,d], E. Chiadroni [a], M. Coreno [a,f], A. Cricenti [f], S. Dabagov [a,g,h], A. Di Cicco [i], M. Faiferri [b], C. Ferrante [c,j], M. Ferrario [a], G: Fumero [c,k], L. Giannessi [l,m], R. Gunnella [i], J.J. Leani [n], S.Lupi [c,o], S. Macis [d,e], R. Manca [b], A. Marcelli [a,f], C. Masciovecchio [l], M. Minicucci [i], S. Morante [d,e], E. Perfetto [d,p], M. Petrarca [c,o], F. Pusceddu [b], J. Rezvani [a], J.I. Robledo [d,e], G.C. Rossi [d,e,q], H.J. Sanchez [n,r], T. Scopigno [c,j], G. Stefanucci [d,e], F. Stellato [d,e], A. Trapananti [i], F. Villa [a]

[a] INFN - Laboratori Nazionali di Frascati, Frascati, 00044, Italy
[b] Università degli studi di Sassari, Dipartimento di Architettura, Design e Urbanistica, Alghero, 07041, Italy
[c] Università degli studi di Roma "La Sapienza", Dipartimento di Fisica, Roma, 00185 Rome, Italy
[d] Università degli Studi di Roma Tor Vergata, Dipartimento di Fisica, Roma, 00133, Italy
[e] INFN Sezione di Roma Tor Vergata, Roma, 00133, Italy
[f] ISM-CNR, Roma, 00133, Italy
[g] NR Nuclear University MEPhI, Moscow, 115409, Russia
[h] RAS - P.N. Lebedev Physical Institute, Moscow, 119991, Russia
[i] Università degli studi di Camerino, Physics Division, Camerino, 62032, Italy
[j] Istituto Italiano di Tecnologia, Center for Life Nano Science @Sapienza, Rome, 00161, Italy
[k] Università degli studi di Roma "La Sapienza" Roma, Dipartimento SBAI, Rome, 00161, Italy
[l] Elettra-Sincrotrone Trieste, Area Science Park, Trieste, 34149, Italy
[m] ENEA C.R., Frascati, 00044, Italy
[n] National Scientific and Technical Research Council, Argentina
[o] INFN Sezione di Roma La Sapienza, Roma, 00185, Italy
[p] CNR-ISM, Division of Ultrafast Processes in Materials (FLASHit), Monterotondo Scalo, Italy
[q] Centro Fermi – Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi", Rome, 00184, Italy
[r] Faculty of Mathematics Astronomy Physics, National University of Córdoba, Argentina
e-mail: stellato@roma2.infn.it

Keywords: Free Electron Lasers, Coherent Imaging, Raman spectroscopy

A proposal for building a Free Electron Laser, EuPRAXIA@SPARC_LAB, at the Laboratori Nazionali di Frascati, is at present under consideration [1]. This FEL facility will exploit plasma acceleration to produce ultra-bright photon pulses with durations of few femtoseconds down to a wavelength between 2 and 4 nm, in the so called "water window". The project is now focused on machine development, but it will host a user end-station to allow performing photon experiments in different areas [2].

The advent of FELs opened up the way for an unprecedented, wide class of experiments exploiting the peculiar features of these radiation sources. Key elements are the high peak brilliance and the short pulse duration, which is of the order of tens of femtoseconds. FELs can therefore allow high time resolution measurements and may provide a high signal-to-noise ratio.

The main class of experiments that will be performed at the EuPRAXIA@SPARC_LAB FEL will include coherent diffraction imaging, soft X-ray absorption spectroscopy, Raman and photofragmentation measurements (Figure 1). These techniques will allow studying a variety of samples, both biological and inorganic, providing information about their structure and dynamical behavior. In this context, the possibility of inducing changes in samples via pump pulses leading to the stimulation of chemical reactions or the generation of coherent excitations would tremendously benefit from pulses in the soft X-ray region. High power synchronized optical lasers and a TeraHertz radiation source will indeed be made available for THz and pump-probe experiments. Moreover, a split-and-delay station will allow performing XUV-XUV pump-probe experiments (see Figure 2 for a schematic layout of the machine) .

In order to perform the widest possible class of experiments, from coherent imaging, to diffraction and spectroscopy, emission, absorption, a top class experimental end-station, including a dedicated section with beam diagnostics and focusing devices and a highly flexible experimental chamber will be built [3]. In this talk an overview of the user end-station including details about sample delivery, data collection, analysis and data storage will be given.

[1] M. Ferrario et al., Nucl. Instr. Met. Phys. A 909 (2018) 134-138.
[2] A. Balerna et al., Cond. Matt. 4 (2019) 30.
[3] F. Villa et al., Nucl. Instr. Met. Phys. A 909 (2018) 294-297.

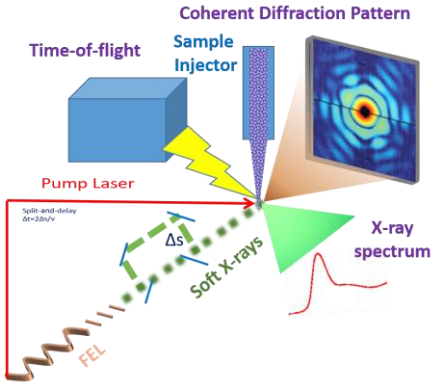

Figure 1. A simplified layout of the experiments that will be performed at the EuPRAXIA@SPARC_LAB FEL.

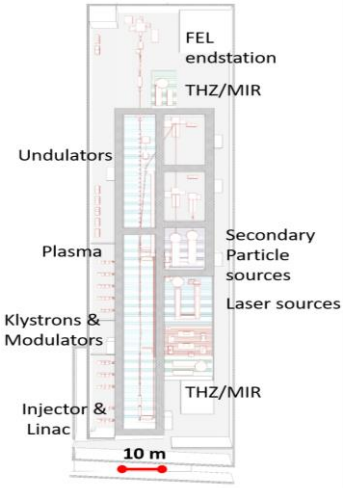

Figure 2. A layout of EuPRAXIA@SPARC_LAB. The building will be about 135 m long and 35 m wide and will host a THz and a FEL experimental end-station.