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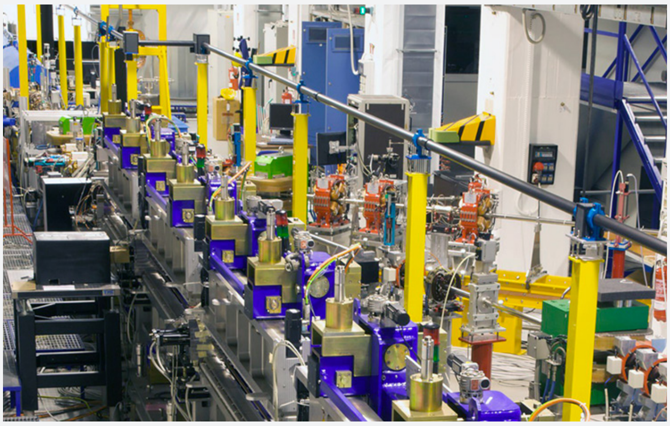

SPARC LAB, RESEARCH IS INTERDISCIPLINARY AT THE FRASCATI NATIONAL LABORATORIES

An innovative research infrastructure, based on the combination of high brightness electron beams with high intensity ultra-short laser pulses, is active since 2013 and is now available to the international scientific community working in the field of particle accelerators and their applications.

SPARC LAB (Source for Plasma Accelerators and Radiation Compton with Lasers and Beams): this is the name of the interdisciplinary laboratory of the INFN Frascati National Laboratories. The SPARC LAB enables the detailed study of the most modern plasma acceleration techniques and the development of leading-edge interdisciplinary research, in a spectrum that ranges from materials science to biology, cultural heritage and medicine: a first step towards the possible future applications of EUPRAXIA (European Plasma Research Accelerator with eXcellence In Applications).

The idea of this unique infrastructure originated in 2013 at the INFN Frascati Laboratories from the fruitful combination of pre-existing projects, with the aim of providing unparalleled performance at world level. Stemming from the integration of a latest-generation photo-injector (SPARC), capable of producing electron beams with energy of up to 170 MeV with high peak current (higher than one kiloampere) and low emittance (less than 2 millimetres per milliradiant), and of a high power (more than 200 terawatt) laser (FLAME) able to generate ultra-short pulses (less than 30 femtoseconds), SPARC LAB has already led to the implementation of innovative radiation sources and the experimentation of new laser particle acceleration techniques.

In particular, a Free-electron Laser (FEL) was realized. The FEL produces coherent radiation with frequency tunability, from 500 to 40 nm. In addition, new operational regimes were observed; for example, the two-colours FEL. A high energy (higher than 10 mJ), narrowband (lower than 30%) THZ source was also made: this led to the publication of a paper about topological insulators on Nature Communications.

There's also another major result: the electrons were accelerated up to 350 MeV in a 2 mm long plasma jet

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excited by the high power laser FLAME. And other experiments on the manipulation of the electron beam with the plasma were run, in order to develop compact focussing elements.
Recently, electrons and photons beam were synchronized with great precision (less than 50 femtoseconds). This is a required condition for the operation of a X Thomson source (around 50 keV) and for future researches on high gradient (higher than 1GV/m), compact accelerators based on external injection of high quality electron beams in a plasma wave excited by a laser or by another electron beam. A new plasma acceleration experiment is currently under development. In the next 5 years, the SPARC_LAB laboratory will allow LNF to establish a solid background on the physics of high-gradient accelerators and to train a young generation of scientists able to face all the challenges raised by the EUPRAXIA project. ■