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EUPRAXIA: PLASMA ACCELERATION AMONG NEXT EUROPEAN RESEARCH CHALLENGES

EuPRAXIA is a future multidisciplinary experimental research infrastructure based on the use of plasma acceleration - an innovative particle acceleration technique - and intended for basic research and applications in physics and other scientific sectors. It is one of the two international projects, with the Einstein telescope, which the INFN, and Italy, with the MUR Ministry of Universities and Research, has successfully nominated for the 2021 Roadmap of the ESFRI European Strategy Forum on Research Infrastructure, the European strategic forum that identifies the future major research infrastructures in which to invest at the European level.

One of the main challenges for future accelerators is to achieve increasingly higher energies in order to explore new realms of matter. As stated in the Conceptual Design Report, funded with €3 million under the Horizon 2020 program and *published* at the end of 2019, the EuPRAXIA project consists in the creation of a new generation of accelerators, capable of achieving higher energies than those reached by current accelerators, but with reduced costs and size.

The EuPRAXIA acceleration technique entails using an ionised gas excited by laser or particle beams as a means of accelerating the electrons injected into it. This new technique promises to revolutionise the field of accelerator machines, not only by boosting their performance in terms of energy, but also by making them more powerful, compact (at least 10 times shorter) and hence cheaper. One of the factors that most limits the application of plasma accelerators is the energy spread that the beam accumulates during acceleration in the plasma module. An experiment conducted by researchers of the SPARC_LAB group at the INFN Frascati National Laboratories demonstrated, for the first time, that it's possible to solve this problem and thus accelerate a beam of high-quality electrons. The result, *published on Nature Physics in January,* was obtained using an innovative technique and it paves the way for future developments in particle accelerators based on plasma technology.

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Obtaining more performative and smaller accelerators would have an important impact not only in the field of basic research in high-energy physics, but also in other areas: it would allow, among other things, the construction of compact sources of X-ray laser radiation (free-electron lasers), useful, for example, in diagnostic imaging, in various industrial sectors and in applied research, including the possibility of investigating the structures of bacteria and viruses, and thus providing valuable information for the development of therapies and vaccines. The aim of EuPRAXIA is thus to demonstrate the functionality of a plasma accelerator and, at the same time, to make a free-electron laser available to users from international universities and research centres. The compact size of these machines will also enable them to be installed in small research centres, such as those in universities, hospitals or industries.
The commitment made by the MUR to host this new infrastructure at the INFN Frascati National Laboratories, as established by the international community that supports its realisation, and to start its construction is supported by the formal expressions of commitment at the Government level of four other EU countries (United Kingdom, Portugal, Czech Republic and Hungary). The construction of the infrastructure, scheduled for 2028, will involve hundreds of young scientists and engineers with experiences across plasma physics, accelerators, lasers and the most advanced electronic and computer technologies.■

* EuPRAXIA was proposed by a consortium of over 40 institutes from ten European countries (Italy, France, Germany, Portugal, Poland, United Kingdom, Czech Republic, Sweden, Switzerland, Hungary), as well as 10 other observatory institutions from China, Israel, Russia and the United States, and a number of industrial partners. Italy is taking part with INFN, the Italian National Research Council, the Universities of Roma Sapienza and Tor Vergata, ENEA and Elettra Sincrotrone Trieste.