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The potential of the EuPRAXIA photon beams for CoViD-19 research

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The advent of Free Electron Lasers (FELs) opened up the way for an unprecedented, wide class of experiments exploiting the peculiar features of these radiation sources. Key elements of FEL beams are the high peak brilliance, the short pulse duration, which is of the order of tens of femtoseconds, and the high degree of coherence of the radiation.
EuPRAXIA is the first European project that develops a dedicated particle accelerator research infrastructure based on novel plasma acceleration concepts and laser technology. It focuses on the development of electron accelerators and underlying technologies, their user communities, and the exploitation of existing accelerator infrastructures in Europe.
Within this framework, the Laboratori Nazionali di Frascati (LNF) will be equipped with a unique combination of a high brightness GeV-range electron beam generated in a state-of-the-art X-band RF linac, a 0.5 PW-class laser system and the first 5th generation light source driven by a plasma accelerator. These features will enable at LNF new promising synergies between fundamental physics oriented research and applied physics experiments with high social impact applications. Among these, there are research lines which will exploit the photon beams generated by the EuPRAXIA facility to perform experiments and contribute to the development of techniques aimed at understanding the mechanisms of CoViD-19 infection and at evaluating its consequences.
The facility will indeed produce two beams in the X-ray region. It will exploit plasma acceleration to produce ultra-bright photon pulses with durations of few femtoseconds in the soft X-ray regime, down to a wavelength between 2 and 4 nm, in the so called "water window". Since the plasma source also accelerates and wiggles electrons, it will give rise to a brilliant keV X-ray emission referred to as betatron source.
These two photon beams produced by EuPRAXIA can be exploited to perform a variety of experiments on condensed and biological matter. Among these, in this presentation we highlight three classes of experiments that are relevant for CoViD-19 related studies:

1- Coherent imaging experiments that exploit the soft X-ray FEL pulses to determine the 3D shape of viral particles in native conditions (e.g. in a fully hydrated environment) and/or in complex with cells, cells nuclei and cells membranes.
2- Hard X-ray absorption and serial crystallography test experiments aimed at exploring the potential application of betatron radiation to obtain information on metal binding and atomic resolution electron density maps of viral proteins.
3- Hard X-ray phase-contrast imaging that exploit betatron radiation to perform high-resolution microtomographic imaging on samples of tissues affected by CoViD-19.

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