PTPC2019

Contribution ID: **32** Type: **not specified**

Novel opportunities for physical chemistry: the Low Density Matter beamline at the FERMI Free Electron Laser

Wednesday 9 January 2019 11:00 (25 minutes)

Free-Electron-Lasers (FELs) in the EUV and XUV photon energy range have greatly expanded the feasibility range of experiments at the crossroad between tabletop lasers and synchrotrons, and promise the ultimate achievement of "molecular movies"capturing in particular the early steps of photochemical processes. The FERMI facility in Trieste (Italy) is unique in the FELs landscape because it has been designed as a seeded source, resulting in superior performances in terms of control and reproducibility of its light pulses. Of particular interest for spectroscopic applications are its broad tunability, wavelength purity (approaching the Fourier-transform limit, with sub-linewidth stability), short pulse duration and timing jitter. Transverse and temporal coherence are those expected from a true laser, and have been exploited in a series of pioneering experiments.

The Low Density Matter (LDM) beamline at FERMI has been serving the atomic, molecular and cluster science community since its opening at the end of 2012. Through the use of interchangeable supersonic jet sources, it offers the possibility of studying atoms and molecules (including aligned ones), as well as more exotic systems such as superfluid helium droplets or metallic nanoparticles. Ion and electron spectroscopies (time-of-flight; velocity map imaging) and coherent diffraction imaging are available in one of the few different standard configurations of the endstation. Users'equipment can be accommodated as well, and several experiments have also been performed in non-standard configurations. A synchronized infrared laser (with second- and third-harmonic generation capability) is available for optical+FEL, and a split-and-delay line for FEL-FEL, pump-probe experiments. The LDM beamline has worked in close synergy with the Machine Physics team to help characterize FERMI, and develop new modes of operation.

In this talk I will present the results of a few case studies performed at the LDM beamline as Users'experiments or as internal research and development, and some future perspectives for the physical chemistry community.

The results presented originate from the joint effort of many international laboratories and a large number of researchers, whose work is gratefully acknowledged.

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Session Classification: New opportunitites