Development of Laser-Driven High-Energy Particle and Radiation Sources

J. Schreiber[1,2]

(1) Ludwig-Maximilians-Univsersity Munich, (2) Max-Planck-Institute for Quantum Optics Garching, Germany

Energetic particles are the basis for a large variety of applications in science and technology. In classical accelerators such as synchrotrons or linear accelerators, relativistic electrons are routinely used for generating bright radiation pulses for scientific studies in physics, biology and medicine. Ions bare, along with their use in fundamental science, a considerable advantage for curing certain types of tumors by using their specific behavior when interacting with matter. This Bragg-peak behavior is sought in ion-beam-therapy centers that are currently established in hospitals around the world. The potential to accelerate particles with highly intense, ultrashort (femtosecond) laser pulses has been demonstrated experimentally in the past decade. This new technology is on the verge of becoming a viable experimental tool, with the prospect of realizing compact accelerators in the future.

The most intriguing feature of laser-driven sources is their short duration and their micrometer small source size (low longitudinal and transverse emittance), which is a direct consequence of the laser pulses at play. The talk will impart the most relevant underlying principles of laser acceleration and generation of radiation, supported by recent examples demonstrating the potential of laser-driven X-rays and ions. I will highlight technological challenges and opportunities that arise from the specific nature of laser-driven sources which motivate our efforts to build the Center for Advanced Laser Applications (CALA) at the research campus in Garching.