Meeting participants in front of GSI's PHELIX high power laser facility

Strategy meeting on high power laser technology for future accelerators

A first strategy meeting was held at GSI Darmstadt, April 8-10 on the laser technology needed to meet the challenge of future accelerators that use or rely on very high average power lasers. The event was opened by Hartmut Eickhoff, Technical Director of GSI and Wim Leemans from LBNL, chairman of the newly established *Joint Task Force on Future Applications of Laser Acceleration.* The *Joint Task Force* operates under the umbrella of ICFA and ICUIL and invited experts on high power laser technology as well as accelerator technology and their applications to this first meeting. The 47 participants came from China (1), France (4), Germany (18), Japan (4), Switzerland (2), the UK (4) and the US (14).

The main topics discussed at the workshop were the laser performance needed for accelerator technology to support the most challenging present and future accelerator needs, as well as questions of laser architecture, laser material and optical components. At the workshop, accelerator and light source representatives outlined the top level laser requirements for potential laser-based accelerator applications, i.e. colliders, light sources and medical applications.

The largest challenge for laser technology is a laser-plasma e-e collider up to the 10 TeV goal. The consensus in the world high energy physics community is that the next large collider after the LHC would be a TeV-scale lepton collider. Options currently under study include the ILC (0.5-1 TeV), CLIC (up to 3 TeV) and the muon collider (up to 4 TeV), all using RF technology. The very high gradients (~10 GeV/m) possible with laser acceleration, on the other hand, open up new avenues to reach even higher energy and more compact machines. This workshop investigated the beam and laser parameters of a 1-10 TeV, 10^{36} $cm^{-2}s^{-1}$ e+e- collider based on two different technologies – laser plasma acceleration (LPA) and direct laser acceleration (DLA). The main challenges to the

practical achievement of laser acceleration are: high average power (~100 MW), high repetition rate (kHz to MHz), high efficiency (~40-60%) at a cost that ideally would be an order of magnitude lower than using RF based technology. The workshop also studied the laser requirements for a 200 GeV $\gamma\gamma$ collider, proposed as the first stage of a full scale ILC or CLIC. The required laser systems for such a collider may be within reach of today's technology.

For light sources, lasers already play a significant role in existing facilities, and face new challenges with future light sources that aim at much higher repetition frequency. Ultrafast (femtosecond) lasers reaching 1-10 kW levels will be required for seeding and user driven experiments. The third area of application has been medical applications of laser acceleration of protons/ions and its potential to replace current technology used in tumor therapy. Such lasers are typically very high peak power (PW-class) and require special pulse shapes with very high temporal contrast. Again, multi-kW compact lasers will be needed.

Laser requirements for these applications are often many orders of magnitude beyond the capabilities of the lasers used in today's scientific demonstrations, i.e. MW's vs 10's of W's. Laser science representatives at the meeting discussed and outlined how, with appropriate R&D, emerging 100-kW-class industrial lasers, 10-MW-class laser fusion energy technologies and MW-class defense laser systems might be adapted to meet these challenging requirements.

Results of the workshop, including parameter tables on laser technology requirements and goals will be compiled in a workshop report and submitted to ICFA and ICUIL for their approval, prior to public release.