Symposium Plasma Induced Accelerators (SYPA)

jointly organised by
the Working Group on Accelerator physics (AKBP) and
the Hadronic and Nuclear Physics Division (HK)

Kurt Aulenbacher
Institut für Kernphysik
Universität Mainz
Becherweg 45
55099 Mainz
aulenbac@kph.uni-mainz.de

Silvia Masciocchi
GSI mbH
Planckstr. 1
64291 Darmstadt
s.masciocchi@gsi.de

Research on plasma-driven accelerators is developing dynamically. Beam energy and quality are being improved by new concepts such as the combination of plasma wakefield and laser-wakefield acceleration (hybrid LPWFA). First applications are in reach like for ultra-high dose rates in medical applications.

Overview of Invited Talks and Sessions

(Lecture hall Audimax)

Invited Talks

SYPA 1.1	Wed	11:00–11:30	Audimax	**Laser-driven ion acceleration -20 years of research: applications and prospect-** — •Markus Roth
SYPA 1.2	Wed	11:30–12:00	Audimax	**Laser-plasma ion accelerators for radio-biological research** — •Karl Zeil
SYPA 1.3	Wed	12:00–12:30	Audimax	**Hybrid plasma accelerators towards higher-quality electron beams** — •S. Karsch, M. Foerster, A. Döpp, M. Gilljohann, J. Götzfried, K. v. Grafenstein, F. Haberstroh, J. Wenz, S. Corde, O. Kononenko, B. Hidding, T. Heinemann, T. Kurz, J. Couperus-Cabadag, U. Schramm, A. Debus, A. Martinez de la Ossa

Sessions

SYPA 1.1–1.3	Wed	11:00–12:30	Audimax	**Plasma Induced Accelerators**

SYPA 1: Plasma Induced Accelerators

Time: Wednesday 11:00–12:30 Location: Audimax

Invited Talk SYPA 1.1 Wed 11:00 Audimax

Laser-driven ion acceleration -20 years of research: applications and prospect- — •Markus Roth — Technische Universität Darmstadt, Institut für Kernphysik, Darmstadt, Germany — Focused Energy GmbH, Im Tiefen See 45, Darmstadt, Germany

With the advent of ultra-intense laser beams at the beginning of this century we entered a new regime for ion acceleration. Intensities exceeding 1018 W/cm2 allowed for new acceleration schemes, based on relativistic plasma physics, resulting in intense, directed ion beams of excellent quality. The particle energies of the ion beams currently exceed the range of 100 MeV. Over the last 20 years, research has focused on understanding the underlying physics and optimizing the process. Moreover, new mechanisms have been discovered, sometimes using large-scale computer simulations and tested in the laboratory.

I will present the development of laser-driven ion acceleration over the years and the current state-of-the-art.

Based on the research, applications have been identified to make use of the unique parameters of laser-driven ion beams. They range from medical applications to novel diagnostics capabilities to the production of intense bursts of neutrons for non-destructive testing and to using laser ion beams as an ignitor in fusion energy.

Recently the neutron production and fusion research has gain significant interest, not only from the academia but also from private industry and investors. I will show some of the recent developments and upcoming prospects for non-destructive testing and fusion energy.

Invited Talk SYPA 1.2 Wed 11:30 Audimax

Laser-plasma ion accelerators for radio-biological research — •Karl Zeil — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany

Particle accelerators have always been fundamental engines of discovery and drivers of innovations in industry, basic research, and life sciences. Exploiting the strong electromagnetic fields that can be supported by a plasma, high-power laser-driven compact plasma accelerators can generate short, high-intensity pulses of high energy electrons and ions with special beam properties. By that they may expand the portfolio of conventional machines in many application areas.

For laser-driven ion accelerators, the full application in ultra-high dose rate radiotherapy (RT) research marks one of the most important research objectives and is perfectly timed with the emerging interest on ultra-high dose rate RT. Laser proton accelerators are ideal instruments to investigate ultra-high dose rate effects, yet their ability to provide radiobiological in-vivo data comparable in quality to a clinical reference standard has called for demonstration for a long time.

The talk will introduce the concept of laser-driven ion accelerators and challenges of this technology. For the example of the high power laser source DRACO operated at HZDR, key developments for the production of reliable polychromatic proton beams with maximum energies of around 60 MeV are presented. Most recently, these achievements enabled the first successful small animal pilot study on radiation-induced tumor growth delay in mice using a laser-driven proton source and a clinical reference.

Invited Talk SYPA 1.3 Wed 12:00 Audimax

Hybrid plasma accelerators towards higher-quality electron beams — •S. Karsch[1,2], M. Foerster[1], A. Döpp[1,2], M. Gilljohann[1,3], J. Götzfried[1,2], K. v. Grafenstein[1], F. Haberstroh[1], J. Wenz[1], S. Corde[3], O. Kononenko[3], B. Hidding[3], T. Heinemann[4,6], T. Kurz[5], J. Couperus-Cabadag[5], U. Schramm[5], A. Debus[5], and A. Martinez de la Ossa[6] — [1]Ludwig-Maximilians-Universität München — [2]Max-Planck-Institut für Quantenoptik — [3]Laboratoire d'Optique Appliquee — [4]University of Strathclyde — [5]Helmholtz-Zentrum Dresden-Rossendorf — [6]Deutsches Elektronen-Synchrotron

Laser wakefield acceleration (LWFA) and plasma wakefield acceleration (PWFA), are commonly treated as separate branches of high-gradient plasma- based acceleration. In combination they open a new path for generating ultralow-emittance electron beams from readily available laser sources. While LWFA can generate ultrahigh-current, highly relativistic electron bunches, their emittance is compromised by the strong plasma heating in the oscillating laser fields. By using LWFA-generated electron bunches to drive a wakefield in a secondary plasma, and employing cold injection schemes to provide a suitable witness bunch, we generate ultralow-emittance beams in a small laser lab in a scheme we call Hybrid LPWFA. I will present our experimental findings for the cases of externally and intenally injected witness bunches. They demonstate that LPWFA can yield more stable and higher quality beams than pure LWFA , which makes this approach very interesting for light source applications and as ultracold injectors.