# HK 45: Beschleuniger II

Time: Wednesday 16:30–19:00 Location: A-1

**Group Report** HK 45.1 Wed 16:30 A-1

**Are laser-induced beams spin polarized?** — Markus Büscher[1], Ilhan Engin[2,1], Paul Gibbon[3], Mohammad Aziz Hessan[2,1], Anupam Karmakar[3], Andreas Lehrach[1], •Natascha Raab[1], Monika Toncian[4], Toma Toncian[4], and Oswald Willi[4] — [1]Institut für Kernphysik (IKP) and Jülich Center for hadron Physics (JCHP), Forschungszentrum Jülich — [2]RWTH Aachen — [3]Jülich Supercomputing Center (JSC), Forschungszentrum Jülich — [4]Institut für Laser-Plasma Physik (ILPP), Heinrich Heine Universität Düsseldorf

The physics of laser-plasma interactions has undergone dramatic developments in recent years, both experimentally and in the theoretical understanding of high-brightness light and particle sources. However, it is a yet untouched issue whether the laser-generated particle beams are or can be spin-polarized and, thus, whether laser-based polarized sources are conceivable.

A first measurement of the degree of polarization of laser-accelerated protons have recently been carried out at the Düsseldorf Arcturus Laser Facility where proton beams of typically 3 MeV were produced in foil targets. The results have been analysed with the help of particle-in-cell simulations to follow the generation of static magnetic field gradients ($\sim$ 100s of Megagauss per micron) in thin foil targets.

As a next step, measurements with unpolarized $H_2$ (for proton acceleration) and $^3$He gas (for $^3$He ions) are planned and, finally, prepolarized $^3$He will be used.

HK 45.2 Wed 17:00 A-1

**Electron acceleration mechanisms in cone targets - scaling up the energy of laser accelerated ions** — •Thomas Kluge[1], Gaillard Sandrine[1], Flippo Kirk[2], Brady Gall[3], Tom Lockard[4], Matthias Geissel[5], D. Offermann[2], M. Schollmeier[3], Stefan D. Kraft[1], Josephine Metzkes[1], Karl Zeil[1], Ulrich Schramm[1], Yasuhiko Sentoku[4], Wolfgang Enghardt[6], Roland Sauerbrey[1], Michael Bussmann[1], and Tomas E. Cowan[1] — [1]Forschungszentrum Dresden-Rossendorf (FZD), 01328 Dresden, Germany — [2]Los Alamos National Laboratory, Los Alamos, NM 87545, USA — [3]University of Missouri, Columbia, MO 65201, USA — [4]University of Nevada, Reno, NV 89503, USA — [5]Sandia National Laboratories, Albuquerque, NM 87123, USA — [6]OncoRay, TU Dresden, 01307 Dresden, Germany

In 2009, at the LANL Trident laser facility a new world record in laser accelerated proton energy has been set, exceeding 65 MeV, using hallow conical targets. We performed 2D collissional PIC simulations and identify two novel electron acceleration mechanisms that have not been considered before to enhance ion acceleration: the direct acceleration of electrons comoving with the driving laser along the the cone-wall inner surface (DASE) and the acceleration of electrons in surface plasma waves (PWA). We find that they are responsible for a significant increase in both electron number and energy in the case of a grazing laser incidence onto the inner cone wall surface compared to regular flat foils. We study the scaling of the electron and ion energies for various target and laser parameters.

HK 45.3 Wed 17:15 A-1

**Enhanced laser ion acceleration from mass-limited foils** — •Thomas Kluge[1], Wolfgang Enghardt[2], Stephan D. Kraft[1], Karl Zeil[1], Thomas E. Cowan[1], and Michael Bussmann[1] — [1]Forschungszentrum Dresden-Rossendorf (FZD), 01328 Dresden, Germany — [2]OncoRay, Technische Universität Dresden, D-01307 Dresden, Germany

We have performed an analysis of ultra-intense laser interaction with solid mass-limited targets (MLT) via electrodynamic 2D3V particle-in-cell simulations. The interaction with long (300 fs) high intensity ($10^{20} W/\mathrm{cm}^2$) laser pulses with targets of diameter down to 1 micron is described in detail with respect to electron dynamics and proton and ion acceleration. Depending on the foil diameter, different effects consecutively arise. Electrons laterally recirculate within the target, smoothening the target rear accelerating sheath and increasing the hot electron density and temperature. We developed an analytical model which enables us to predict the electron energy distribution of an MLT. Our results suggest that the most significant ion energy enhancement should be expected for MLT with diameter below the laser focal spot size. The spread of energetic protons is decreased for medium sized foils while it is greatly increased for foils of size near the focal spot size.

HK 45.4 Wed 17:30 A-1

**Long optical undulators with Traveling-Wave Thomson Scattering** — •Alexander Debus, Klaus Steiniger, Mathias Siebold, Axel Jochmann, Arie Irman, Michael Bussmann, Ulrich Schramm, Thomas Cowan, and Roland Sauerbrey — Forschungzentrum Dresden-Rossendorf, Institute for Radiation Physics, 01328 Dresden, Germany

We present a novel concept for optical undulators that avoids the restrictions by the Rayleigh limit of the laser, which allows to define interaction length and diameter independent of each other. With an ultrashort, high-power laser pulse in an oblique angle scattering geometry using tilted pulse fronts, electrons and laser remain overlapped while both beams travel over distances much longer than the Rayleigh length. This allows to realize side-scattering in laser-electron beam interactions, without compromises with regard to luminosity or overlap. This is of particular interest for linac-driven Thomson sources, where this Traveling-wave Thomson scattering (TWTS) setup could increase per pulse photon yields 2-3 orders of magnitudes beyond current head-on (180°) scattering designs. Also, the smallest achievable scattered bandwidth is controlled by the width of a cylindrically focused laser beam and thus is independent of the ultrashort laser bandwidth. Due to the flexibility in side-scattering angle, photon energies become tunable over a large spectral range without requiring a change in electron energy.

HK 45.5 Wed 17:45 A-1

**Transporting laser-accelerated protons by a pulsed solenoid to a $CH^-$ DTL** — •Ali Almomani[1], Martin Droba[1], Ulrich Ratzinger[1], and Ingo Hofmann[2] — [1]Institute for Applied Physics, Goethe Universirty Frankfurt, Max-von-Laue str.1, 60438 Frankfurt am Main, Germany — [2]GSI/Helmholtz Institute Jena, Planckstr.1, 64291 Darmstadt, Germany

This study demonstrates the transporting and focusing of laser-accelerated protons at energies of ten to several tens of MeV, by a pulsed magnetic solenoid with a field gradient up to 18 T. The unique features of the protons distribution like extremely small emittances and high yield of the order of $10^{13}$ protons per shot, make them attractive for study. With respect to transit energies further acceleration by matching into rf linac seems adequate. The bunch injection into a proposed $CH^-$ structure is under investigation at IAP Frankfurt. Options and simulation tools are presented.

HK 45.6 Wed 18:00 A-1

**ELENA - 100 keV Antiprotonen am CERN / AD** — •Walter Oelert — Forschungszentrum Jülich, IKP, 52425 Jülich

Am Antiproton Decelerator (AD) am CERN werden Antiwasserstoff-Experimente betrieben, wobei die derzeitigen Aktivitäten dahin gehen, diese exotischen Atome mit so geringer Energie zu erzeugen, dass sie in einer magnetischen Falle eingefangen werden können. Erste erfolgreiche Versuche wurden Kürzlich veröffentlicht. Die gewünschte grosse Zahl und hohe Dichte von Antiprotonen kann derzeit vom AD durch ein einzelnes Teilchenpaket nicht geliefert werden.

Die Effizienz, die Produktivität sowie die Verfügbarkeit für weitere Experimente dieser einmaligen Anlage am CERN würde gewaltig ansteigen, wenn der Antiprotonenstrahl mit derzeit 5 MeV Energie durch einen zusätzlichen Entschleuniger auf etwa 100 keV abgebremst würde. Ein solcher Ring "ELENA" wie er bereits 1982 für den LEAR angedacht wurde [1], soll nun nach neuem Design und in drastisch überarbeiteter Form [2] gebaut werden. ELENA wird die Anzahl einfangbarer Antiprotonen um etwa zwei Grössenordnungen erhöhen und aufgrund elektrostatischer Strahlführung bis zu vier Experimente parallel versorgen können.

Eigenschaften und Betriebsmoden werden vorgestellt.

[1] H. Herr, Workshop Physics at LEAR with Low Energy Cooled Antiprotons, Erice 1982. [2] CERN-AB-2007-079 OP und eine Neufassung, die gerade erstellt wird

HK 45.7 Wed 18:15 A-1

**Toward Polarized Antiprotons** — •Christian Weidemann für die PAX-Kollaboration — Institut für Kernphysik, Forschungszentrum Jülich, Jülich, Germany

The spin-filtering experiments at COSY and AD (-CERN) within the framework of the **P**olarized **A**ntiproton E**X**periments (PAX) are proposed to measure the polarization build-up of an initially unpolarized stored antiproton beam by multiple passage through an internal polarized gas target. Spin-filtering will first be done with protons at COSY in order to commission the experimental setup for the AD and understand machine parameters.
After the installation and commissioning of the low $\beta$-section in 2009, which is required to guide the proton beam through a storage cell target, the PAX target chamber together with the so-called Breit-Rabi polarimeter and the atomic beam source have been installed. In a recent beamtime in 2010 studies on beam lifetime limitations like intra-beam scattering and the electron-cooling performance as well as machine acceptance measurements have been realized. In addition the experimental setup such as the newly developed openable storage cell was commissioned. It provides target densities of $5\times10^{13}$atoms/cm$^2$ without substantial beam losses at injection.
The talk reports on the results of the studies and the progress toward spin-filtering experiments in 2011.

HK 45.8 Wed 18:30 A-1

**PIConGPU - A scalable GPGPU implementation of the particle-in-cell algorithm** — •Michael Bussmann[1], Heiko Burau[1], Florian Berninger[1], Thomas Kluge[1], Alexander Debus[1], Ulrich Schramm[1], Thomas E. Cowan[1], Felix Schmitt[2], René Widera[2], Wolfgang Hönig[2], Guido Juckeland[2], Wolfgang Nagel[2], Patrick Kilian[3], Urs Ganse[3], Stefan Siegel[3], Felix Spanier[3], Benjamin Ragan-Kelley[4], and John Verboncoeur[4] — [1]HZDR, Dresden, Germany — [2]ZIH, Dresden, Germany — [3]University of Würzburg, Germany — [4]UC Berkeley, CA, USA

We present PIConGPU, an efficient and scalable implementation of the particle-in-cell algorithm for GPGPUs. We discuss the main building blocks of PIConGPU, the data access patterns used for both particle and field data and the communication model that allows to hide the large latency of network communication between GPGPU nodes on a cluster. PIConGPU provides a general framework which can be used to study both relativistic and nonrelativistic plasmas. We show first results on relativistic laser wakefield acceleration of electrons in underdense plasmas and on the progress of integrating new physics models. The fast response time of the code makes it possible to receive results in hours compared to weeks with particle-in-cell codes running on mid-size commodity clusters. With this increase in computational speed extensive parameter scans become possible even for large physical systems.

HK 45.9 Wed 18:45 A-1

**Experimente mit einem schnellen Choppersystem für intensive Ionenstrahlen** — •Hannes Dinter, Martin Droba, Marcel Lotz, Oliver Meusel, Ilja Müller, Daniel Noll, Ulrich Ratzinger, Kathrin Schulte, Christopher Wagner und Christoph Wiesner — Institut für Angewandte Physik, Universität Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt

Choppersysteme dienen dazu, geladenen Partikelstrahlen eine Zeitstruktur aufzuprägen. In den meisten Fällen werden elektrische Deflektoren dazu verwendet, um Strahlpulse definierter Länge bei entsprechenden Wiederholraten zu erzeugen. Bei hohen Strahlintensitäten muss die Feldverteilung des Choppersystems präzise auf die Strahldynamik abgestimmt sein, um Abbildungsfehler zu vermeiden. Die technische Herausforderung besteht darüber hinaus in einem robusten Design, um den zuverlässigen Einsatz des Choppers für strahlinduzierte Experimente zu gewährleisten. Für die geplante Frankfurter Neutronenquelle FRANZ wird am IAP ein E×B-Choppersystem entwickelt, das Strahlpulse mit einer Plateaulänge von 50 ns bei einer Wiederholrate von 250 kHz erzeugen soll. Mit den mit dem elektrischen Deflektor erreichten Spannungen von ±5,5 kV wurden Helium-Ionenstrahlen statisch ausgelenkt und die experimentellen Befunde den theoretischen Berechnungen des Deflektorsystems sowie numerischen Simulationen gegenübergestellt. Im Pulsbetrieb wurden Ionenstrahlen verschiedener Energien deflektiert und die resultierende Antwort mit einem Strahltransformator vermessen. Dadurch konnten der theoretische Ansatz und die numerischen Modelle für den Chopper validiert werden.