Welcome

to all participants of the ExtreMe Matter Institute EMMI Workshop on 'High Energy Density Plasma Diagnostics at FAIR' !

This is the 5th international workshop in the framework of the series of EMMI workshops on 'Plasma Physics with Intense Heavy Ion and Laser Beams' which have been organized since 2008 jointly by the GSI Plasma Physics Division and closely collaborating institutes and held alternatively in Moscow and Darmstadt.

With respect to the scientific potential of the Facility for Antiproton and Ion Research, FAIR, and regarding the future experimental activities in the field of High Energy Density Physics using high energy, high intensity heavy ion beams, the emphasis of the workshop this time will be on novel laser based diagnostic methods and tools for High Energy Density Plasma experiments.

We appreciate the interest of the international plasma physics community in the excellent opportunities to be opened by FAIR and hope that this workshop will help to establish new national and international collaborations aimed on the design of novel laser based HED-diagnostics.

One of the important philosophy of the ExtreMe Matter Institute is the promotion of young scientists, who just started their scientific carrier. We were very glad to provide grants for 25 young physicists attending this workshop.

We thank you for your scientific contribution to our workshop program and wish you exciting discussions and a pleasant stay in Darmstadt.

For the Program and Organizing Committee

Olga Rosmej

Scientific case

The workshop focuses on the development of novel diagnostic methods and tools for investigations of High Energy Density Matter (HEDM).

At the Facility for Antiproton and Ion Research (FAIR), the HEDM-states will be created by intense heavy ion beams, which are capable to heat large-volume targets of any element uniformly and quasi-isochorically [1]. After this, an isentropic expansion in 1D planar geometry will give an opportunity for investigations of the Equation-of-State in unexplored regions of the phase transitions, transport and radiation properties of HEDM.

In other experiments relevant to planetary science, a multi-shock compression of e.g. cryogenic Hydrogen, inserted in a thick high Z tamper, heated by the rotating Uranium beam, will be investigated. In order to observe different phases of the shock dynamics using imaging techniques, pulsed high energy radiation and particle sources and appropriate diagnostic methods are required. In this context imaging applications of laser generated beams of protons, electrons, neutrons and gamma-rays will be discussed.

A macroscopic size ($1mm^3$) of heavy ion heated samples of high Z elements defines the requirements on the laser produced sources of photons and particles used for diagnostics:

- Radiation sources with photon energies above 1 MeV

- Electron beams with energies above 20 MeV

- Proton beams with energies above 50 - 100 MeV

- Highly brilliant pulsed neutron beam sources

Novel techniques used for improvements of the laser contrast, increase of the laser intensity far above the relativistic limit of 10^{18} W/cm^2, shortening of the laser pulse lead to generation of quasi mono-energetic, directed and coherent beams of particles and photons. All these improve the quality of imaging techniques dramatically. During the workshop novel methods of proton and electron acceleration as well as MeV-photon and neutron generation by the interaction of relativistic laser pulses with matter and their application as HEDM diagnostic tools will be discussed.

Unique opportunities will also be given by the high-energy storage ring HESR, where high quality beams of highly charged ions will be available at velocities up to $\gamma = 6$. Ideas for X-ray sources and high-field interaction scenarios in this storage ring are also welcomed.

[1] HEDgeHOB technical proposal, 2005, link:
http://hedgehob.physik.tu-darmstadt.de

Agenda

1. Proton generation by interaction of relativistic laser pulses with matter.
2. Electron acceleration in relativistic laser-plasma interactions.
3. A bright neutron source driven by short pulse lasers and applications.
4. Advanced hard X-ray and gamma-ray sources and applications.
5. Nuclear physics applications for the investigation of laser matter interactions.
6. Development of short pulse, high energy flux detectors for analysis of MeV photons and particle beams with sub-ns time resolution. Hard X-ray optics.

Program and organizing committee

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Book of Abstracts:

Talks

Name: **Florian Abicht**

Institute: **Max-Born-Institut Berlin GERMANY**

Title: **Coaction of strong electrical fields in laser irradiated thin foils and its relation to field dynamics at the plasma-vacuum interface**

Abstract:

The effective action of strong electrical fields on a beam of protons passing through a laser irradiated thin foil has been investigated. The energy distribution function of protons propagating along the surface normal changes in a pronounced way, exhibiting a gap in the spectrum accompanied by up to two local maxima. The temporal behavior is set into context with expectations derived from the evolution of strong electrical fields at the plasma-vacuum interface, usually being considered responsible for fast ion acceleration during the initial stage of laser driven plasma expansion. Our investigation reveals complex field effects in thin foils when irradiated with intense and ultra-short pulses with a very high temporal contrast. The experiments were performed with a laser accelerated proton beam, the probe, traversing a plasma slab created by ultra-short (80fs), high-intensity (~ 1 x 10^{19} W/cm^2) laser irradiation of a 30 nm to 800 nm thick foil. Laser pulses with different temporal contrast and pulse duration have been used, both for the probe and for the plasma slab creation (the pump). An analytical model is discussed to approach an understanding of the observation.

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Name: **Vincent Bagnoud**

Institute: **GSI Darmstadt 64291 Darmstadt GERMANY**

Title: **Status of the Helmholtz Beamline at FAIR and PHELIX-laser**

Abstract:

The Helmholtz Beamline at FAIR is part of the Helmholtz roadmap of infrastructure. This project aims at installing a laser at the FAIR facility as one of the main diagnostic tools for High Energy Density Physics experiments in the APPA cave, the common experimental area for Plasma Physics, Atomic Physics and Material research. To match the parameters accessible at FAIR, the laser will be a high-energy kilojoule short-pulse laser and it will build on the technology and expertise existing at GSI, HZDR and HI Jena.
In this talk, I will summarize as well the current status of the PHELIX laser facility and improvement directions that are being dictated by the experimental program at FAIR. I will also show a preliminary layout that enables a very flexible and multi-purpose facility for FAIR.

Name: **Sergey Bochkarev**

Institute: **P.N. Lebedev Physics Institute Moscow**

Title: **Electron acceleration in the the regime of stochastic heating withing a ps-duration laser pulse**

Abstract:

Production of high-energy electron beams with wide spectra driven by a ps-duration powerful laser pulse is of practical interest for many applications including so-called table-top astrophysics, radiation testing of spacecraft microelectronics (e.g. in view of single event effects). In this paper, we investigate stochastic electron acceleration by long laser pulse in underdense plasma in non-resonant conditions, where longitudinal size of the laser pulse is much longer than the plasma wave length. The PIC simulation demonstrates that a long relativistically strong laser pulse (~ 1 ps) propagating in underdense plasma generates thermal-like spectrum of electrons with maximum energy of ~ 0.5-1 GeV and effective temperature of several hundred MeV due to developing of the forward Raman scattering. To understand this generation we used test particle approach to study electron dynamics in several plasma waves with different phases within a laser pulse. Calculation of Laypunov exponent demonstrates stochastic behavior of electrons similar to that observed in PIC simulations. We also have developed analytical relativistic theory of electron distribution function which takes into account electron scattering by stochastic plasma waves behind laser pulse front (electron diffusion in the momentum space). PIC simulations demonstrate formation of the high-energy electron spectrum behind the laser pulse front due to the heating by the Raman plasma waves. This theory explains stochastic electron heating observed in PIC simulation of the ps-range relativistically strong laser pulse interaction with underdense plasma.

This study was supported by the Russian Foundation for Basic Research and the Ministry of Education and Science of the Russian Federation (project #8690).

Name: **Simon Busold**

Institute: **TU Darmstadt Darmstadt GERMANY**

Title: **results of the first experiments with the completed LIGHT beamline at GSI**

Abstract:

Laser-based ion acceleration as a source of high intensity MeV-range ion bunches became subject of extensive research during the last 15 years. The created ions (most often protons) are discussed as potential candidate for various applications in science, technology and medicin. However, their usage requires special ways of beam shaping first, as the particles are emitted in a wide energy spectrum and with a large divergence angle from the laser matter interaction point. Therefore, a test stand for collimation, energy selection and monochromation of laser accelerated protons has been build at GSI, using a pulsed high field solenoid and a radiofrequency cavity to produce intense proton bunches with low energy spread from a TNSA source. This beamline represents a central part of the LIGHT collaboration. Details of the beamline and first experimental results will be shown. .

Name: **David Denis-Petit**

Institute: **CENBG Gradignan FRANCE**

Title: **Nucleus-electronic cloud coupling in plasma: the case of 84Rb.**

Abstract:

The development of high-intensity lasers is opening up new opportunities for nuclear-physics studies. Lasers are promising tools to study nuclear properties in extreme plasma conditions, which cannot be reached with conventional particle accelerators. In a plasma, the interaction between a nucleus and its electronic cloud can be influenced by its environment and unusual excitation processes such as nuclear excitation by electronic capture (NEEC) and nuclear excitation by electronic transition (NEET) should be observed. Indeed, NEEC (unobserved) and NEET (observed in ^{197}Au [1], ^{189}Os [2,3] and ^{193}Ir [4] in accelerator based experiments) are exotic processes relevant to astrophysics, which can be dominant in particular plasma conditions of temperature and density [5], and therefore it is highly desirable to study them. These two processes involve a coupling between the nucleus and the electronic cloud. In the case of the NEET, a bound-bound atomic transition leads to a nuclear excitation if the two transitions are resonant and have the same multipolarity. The NEEC process is equivalent to the NEET process with the difference that the atomic transition is bound-free. We have undertaken a joint experimental and theoretical program to investigate the 84mRb excitation rate in laser produced plasma.

The long-lived isomeric state of the ^{84}Rb (energy of 463.6 keV, T1/2=20.26min) can be excited towards a higher lying short-lived state. According to the literature, the nuclear transition energy involved in this excitation is 3.05 (20) keV. It is possible to find atomic transitions, which match this nuclear transition for charge states between 27+ and 32+ allowing the NEET process to take place [6]. Searching for the NEET process in plasma requires an accelerator to produce the ^{84}Rb isomeric state and a high-energy- high-intensity

laser to create the plasma with the required charge states. This kind of facility exists at GSI (Darmstadt, Germany) where the PHELIX high-energy laser is combined with the UNILAC ion accelerator.

To prepare the NEET experiment, nuclear and atomic physics experiments were conducted. We have made experiments at ELSA (CEA/DAM, Bruyères-le-Châtel) and at TANDEM/ALTO (Orsay) accelerators to measure the nuclear transition energy with high accuracy. Indeed, the accuracy of this transition energy in the tables was insufficient (200 eV) in comparison with the accuracy of the atomic data (few eV) [7]. We have also measured the X-ray spectra emitted by a Rb plasma at PHELIX. These spectra will be compared with theoretical ones to determine plasma conditions (charge states, temperature...) reached during the experiment. If these conditions are favorable for the observation of the NEET effect, the final NEET experiment will be conducted. The results of these preparation experiments will be presented.

References:

[1] S. Kishimoto et al., Observation of Nuclear Excitation by Electron Transition in 197Au with Synchrotron X Rays and an Avalanche Photodiode, Phys. Rev. Lett. 85, 1831 (2000)

[2] I. Ahmad et al., Nuclear excitation by electronic transition in 189Os, Phys. Rev. C 61, 051304 (2000)

[3] K. Aoki et al., Probability of nuclear excitation by electron transition in Os atoms, Phys. Rev. C 64, 044609 (2001)

[4] S. Kishimoto et al.,Evidence for nuclear excitation by electron transition on 193Ir and its probability, Nucl. Phys. A 748, 3 (2005)

[5] F.Gobet et al., Nuclear physics studies using high energy lasers, Nucl. Instrum. Methods Phys. Res. A 653, 80 (2011)

[6] G. Gosselin. Private communication.

[7] F.G. Kondev, Nuclear Data Sheets 110, 2815 (2009).

Name: **Oliver Deppert**

Institute: **Institut für Kernphysik-AG Laser& Plasmaphysik Darmstadt GERMANY**

Title: **Laser-accelerated ions in the break-out-after regime - Simulations, Applications and Diagnostics**

Abstract:

Laser driven ion acceleration offers a promising tool to either directly diagnose high energy density matter (HEDM) with high temporal and spatial resolution or indirectly by the generation of secondary neutron radiation which can be used as complementary diagnostic.

Beyond the quite established Target Normal Sheath acceleration (TNSA) scheme as ion driver a new and promising scheme called Break-Out-Afterburner (BOA) is discussed in literature. Based on this, increased conversion efficiencies, the efficient acceleration of heavier ions as well as the acceleration of protons far beyond 200MeV are possible.

In the context of our talk we will introduce the theoretical background and physics of the BOA mechanism. All theoretical discussions are accompanied by highly resolved particle-in-cell (PIC) simulations in order to communicate a basic picture behind BOA.

We will present different simulated BOA scenarios with the scope on possible applications as diagnostic for HEDM and proposed experiments at the future FAIR facility. Therefore, we will present Geant4 MonteCarlo (MC) calculations on the energy loss of charged particle and neutron spectra in HEDM and will demonstrate the spatial and temporal resolution of BOA driven ions and neutrons as diagnostic.

Moreover, we present first experimental results of the generation of secondary neutrons by the BOA mechanism and will compare and interpret the results with PIC and MC simulations.

In order to use BOA as diagnostic for HEDM, one needs optimised diagnostics to fully characterise the spatial and spectral distribution of the primary ion beam.

In this context we present an optimised radiochromic imaging spectroscopy method (RIS) which was extensively improved over the last years to minimise the uncertainties of the film calibration by including multi-colour analysis, quenching effects of the RCF films and a full error estimation of the de-convolved proton spectra.

On the other hand, a new designed and optimised ion-wide-angle-spectrometer (iWASP) will be presented which is able to measure angular resolved ion spectra up to 200MeV with high energy resolution and therefore offers detailed spectral and conversion efficiency measurements.

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Name: **Claude Deutsch**

Institute **LPGP UParis-Sud Orsay FRANCE**

Title: **Pion Stopping and Meso-Molecules Formation in Ultra-Dense Plasmas of FIS Concern**

Abstract:

In order to implement a scenario for negative pion-catalysis of DT-thermonuclear reactions in a hot and precompressed ICF/FIS target plasma,we pay a detailed attention to the nonrelativistice stopping of negative pions arising from electrodisintegration of target D+ and T+ ions through ultra-relativistic e-beams[1,2].Pi multiple scattering on plasma particles seems pretty negligible.Final thermalization of the negative pion leads to exo-atoms formations rapidly followed by Pi-DT hydrogeniclike molecular ions.The huge and surrounding Holtzmark electric field quenches the higher bound atomic Pi-D or Pi-T states around n~6.This then allows through numerous ion-ion collisions the exo-energetic production of exo-molecular ions which could initiate a fruitful catalytic cycle in a hot and very dense plasma.The Holtzmark E-field is also likely to successfully overcome the pion-nucleon strong attraction on the lowest levels of the exo-atoms and exo-molecules.

We also intend to show how the formation of these bound states could be diagnosed through appropriate Stark line-broadening mechanisms.

[1] C.Deutsch and J.P.Didelez, LPB 29, 39 (2011)

[2] C.Deutsch and P.Fromy, J Plasma Phys 2013 (in press)

Name: **Laura Di Lucchio**

Institute **Forschungszentrum Juelich GmbH**
52428 Juelich GERMANY

Title: **Interaction of few-cycle laser pulses with nano droplets**

Abstract:

We have studied the angular distribution of electron nanobunches produced in nanometer-size droplets by shooting them with a few-cycle laser pulse of relativistic laser intensity. We have found different results with respect to the already known Mie theory predictions in the high intensity regime using realistic solid droplets.

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Name: **Ilhan Engin**

Institute **Forschungszentrum Jülich, IKP 52425 Jülich GERMANY**

Title: **Hydrogen cluster-gas mixtures as novel target concept for laser-acceleration experiments**

Abstract:

The physics of laser driven particle sources has undergone dramatic developments in recent years. With increasing laser powers it is possible to accelerate particles out of different target types like, e.g., thin foils or gas jets. A novel target concept is a hydrogen cluster-gas mixture. A corresponding source for frozen hydrogen clusters - with up to 10^6 hydrogen molecules per cluster - has been prepared at Münster University. It is now being installed at the 300 TW 10 Hz Düsseldorf ARCturus laser facility. The laser-accelerated protons will be used for the production of MeV and thermal neutrons. Furthermore, the polarization degree of the protons will be investigated. .

Name: **John Farmer**

Institute: **Uni Düsseldorf Düsseldorf GERMANY**

Title: **Simulations of Raman amplification in Plasma**

Abstract:

Raman amplification in plasma is a potential technique for the realisation of the next generation of high intensity laser systems. Coupling between the pump and probe is achieved through the excitation of a plasma wave, removing limitation of the damage threshold present for conventional gain media. Such high intensity pulses have applications across physics and engineering applications, from opening new opportunities to probe the limits of the Standard Model, to increasing the energy attainable from existing techniques such as wakefield acceleration of electrons and ion acceleration from solid targets. We here present a new simulation model for Raman amplification in plasma, which will allow analysis of experimental results, and identification of the most promising parameter ranges for future experimental campaigns.

Name: **Sydney Gales**

Institute: **ELI-NP /IFIN-HH Magurele-Bucarest ROMANIA**

Title: **Nuclear Science and Applications with next generation of High Power Lasers and Brilliant Low Energy Gamma Beams at ELI-NP.**

Abstract:

The development of high power lasers and the combination of such novel devices with accelerator technology has enlarged the science reach of many research fields, in particular High energy, Nuclear and Astrophysics as well as societal applications in Material Science, Nuclear Energy and Medicine.

The European Strategic Forum for Research Infrastructures (ESFRI) has selected a proposal based on these new premises called “ELI” for Extreme Light Infrastructure. ELI will be built as a network of three complementary pillars at the frontier of laser technologies. The ELI-NP pillar (NP for Nuclear Physics) is under construction near Bucharest (Romania) and will develop a scientific program using two 10 PW class lasers and a Back Compton Scattering High Brilliance and Intense Low Energy Gamma Beam , a marriage of Laser and Accelerator technology at the frontier of knowledge. In the present paper, the technical description of the facility, the present status of the project as well as the science, applications and future perspectives will be discussed.

Name: **Alexander Green**

Institute: **Queen's University Belfast Belfast UNITED KINGDOM**

Title: **Observation of beamed neutrons employing high power laser driven ions in a beam-fusion scenario.**

Abstract:

Over the past decade, significant attention has been paid to laser driven neutron sources in light of rapid developments in laser technology, and, due to further advantages in terms of cost reduction and compactness, reduction of radioactive pollution and ability of radiation confinement by close-coupled experiments. In this context, a short burst of beamed neutron flux with narrow energy bandwidth would bring substantial advantage for its wide range of applications in scientific, technological and security sectors.

Among the possible laser energised nuclear phenomena, the most promising route to create a neutron source is employing laser accelerated ions in either fusion or spallation reactions. Employing the Vulcan Petawatt laser of Rutherford Appleton Laboratory, STFC, UK, several potential schemes for producing an appealing neutron source were explored. One of the striking results obtained in the experiment was the direct observation of beamed flux of MeV neutrons, which inherently features sub-ns burst duration. The neutron beam was produced from beam-fusion reaction by impinging laser driven deuterium ions, accelerated via the Target normal sheath acceleration and hole boring mechanisms, on a secondary deuterated plastic catcher. The neutron beam parameters, such as flux, spectrum, angular distribution and beam profile, were diagnosed simultaneously by several complementary diagnostics. The data shows significant anisotropy in neutron flux and energy spectrum, which is in good agreement with beam-fusion Kinematic calculations and Monte-Carlo simulations.

Name: **Marc Günther**

Institute: **GSI Darmstadt GERMANY**

Title: **Gamma optics in terms of optimization and characterization of novel coherent, high brilliant gamma ray sources and development of future imaging diagnostics**

Abstract:

X-ray optics play an important role in many applications such as material science and solid state physics performed at conventional synchrotron radiation facilities. These applications use both, the soft X-ray (several eV) and the hard X-ray (several keV) region. In many new applications, such as nuclear physics, medical science, and high energy density science, γ ray energies up to several MeV are needed. For these new applications high brilliant γ beams are of important interest. In high energy density science experiments, such as performed at FAIR, the target will be macroscopic composed of high Z material. To investigate spatial and time resolved high energy and density states within the target, powerful diagnostics are needed. A conventional technique is back lighting using X-ray photons in terms of absorption radiography. But the resolution will be decreased because intensity decreasing of X-ray photons, traveling through the target. For γ photons the absorption is lower. The consequence is that the transmitted intensity is increased, but the resolution is still decreased. In the γ energy range of several MeV refractive processes are several orders of magnitude higher than absorption processes. In that case the development of a time resolved γ ray phase contrast imaging method would be very promising to investigate density distributions inside the target.

Furthermore, to characterize new γ sources and to match the beam depending on the application it is necessary to use diffractive and

refractive γ ray optics. For γ energies it seems impossible to use refractive optics.

In recent experiment at ILL in Grenoble for the first time the index of refraction at γ ray energies was measured. The index of refraction is given by $n(E)=1+\delta(E)+i\beta(E)$, where δ is the real part of the dispersion correction of n, describes the deflection of the beam by scattering processes. Up to now the estimation was that the index of refraction is determined by Rayleigh scattering or Thomson scattering. The consequence was that the real part δ of the refraction index is scaled with the photon energy like $1/E^2$. A sign change of δ in the energy range of about 1 MeV was observed. After sign change δ scales with the γ energy like 1/E. So the refraction effect at γ energies is much stronger as before assumed.

This consolidated findings lead to a new era in science and applications. Using a combination of refractive and diffractive optics, efficient monochromators for γ beams are being developed. Thus, it has to optimize the total system: the γ beam facility, the γ beam optics and γ detectors. This is interesting for many applications.

Further experiments for the investigation of the refractive index and the development of new γ ray optics, are planned in the near future.

Name: **Ingo Hofmann**

Institute: **GSI-HI-Jena Darmstadt GERMANY**

Title: **Laser accelerated protons - a candidate for WDM imaging @ FAIR**

Abstract:

The increasing prospects that laser accelerated protons can reach the energy rang of 50…100 MeV in the very near future are motivating studies to use them as complementary fast (ns-time scale) imaging diagnostics tool for future plasma physics experiments within FAIR. Along this line the LIGHT-project at GSI - with typically 10-20 MeV protons - is an important step to explore the interplay of laser acceleration, focusing, transport, energy selection and re-focusing in space and time. Advancing to higher energies requires, however, reconsideration of the optimum focusing and transport concepts. We show that among the “conventional” focusing options both, a pulsed solenoid and a quadrupole doublet/triplet remain possible options; with rising energies – above typically 5-10 MeV – we find, however, that the quadrupolar option is increasingly advantageous. Beyond these standard accelerator technologies for focusing we suggest that novel, advanced focusing methods warrant future experimental studies as alternatives. In recent years laser driven micro-lenses have been shown in various laboratories to yield Mega-Gauss magnetic fields on ns time scales. While these experiments have been pursued mostly for focusing of electrons in the context of fast ignition inertial fusion, they promise advantages also for laser proton focusing. We review the status of these experiments and discuss the perspectives of applying them to laser proton imaging for future FAIR high energy density experiments.

Name: **Astrid Holler**

Institute: **Forschungszentrum Jülich 52428 Jülich**

Title: **Polarized ion beams generated by means of laser-induced relativistic plasmas**

Abstract:

The physics of laser-plasma interactions have undergone dramatic improvements in recent years. By directing a multi-TW, ultra-short laser pulse onto a thin foil or a gas, it is nowadays possible to produce multi-MeV proton, ion and electron beams. It is a yet untouched issue whether the laser-generated beams are or can be spin-polarized and, thus, whether laser-based polarized sources are conceivable. One may either think of a selection of certain spin states through the huge magnetic field gradients that are inherently generated in the laser-generated plasmas, or of pre-polarized target particles which maintain their polarization during the rapid acceleration procedure. We have developed a method to measure the degree of polarization of protons that have been accelerated at the 200 TW laser facility Arcturus at Düsseldorf University. For establishing the method first measurements have been carried out with foil targets where typical proton energies of up to 10 MeV are achieved and, according to 1- D Monte-Carlo simulations, no significant polarization effects are to be expected. This method is also useful for the detection of the polarization of arbitrary ions. As a next step, preliminary measurements with 4He gas were carried out to optimize the ion generation from a gas target. It was possible to generate ions up to 5 MeV in this way. To use pre-polarized 3He, is the next planed step on the way to a polarized 3He-ion source.
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Name: **Liangliang Ji**

Institute: **Institut für Theoretische Physik I, University of Düsseldorf Düsseldorf 40225 GERMANY**

Title: **Energy conversion channel and gamma-photon emission in the near-QED regime of laser-plasma interaction**

Abstract:

Electrons in laser-plasma interactions could radiate high-energy photons. When the laser intensity is higher than 10^{23}W/cm^2, the radiation reaction (RR) force on electrons becomes important. A considerable portion of laser energy goes to emitted photons. Using the three-dimensional particle-in-cell simulation VLPL, which includes a QED model describing RR force and electron-positron pair creation, the energy conversion channel is investigated. When the laser amplitude rises, the energy amount obtained by electrons drops while the one for photons continuously increases. Photons dominate the energy channel and gain up to 20%-40% of laser energies at 10^{24}W/cm^2-5.10^{24}W/cm^2. A high-density carbon target and a low-density hydrogen target regimes are verified for circularly-polarized (CP) and linearly-polarized (LP) lasers. The angular distributions of energetic photons are analyzed. A CP laser generates a hollow-like structure in the distribution, which shows a peaked divergence angle ~30 degree. A LP laser, however, generates a saddle-like one, which peaks at the propagating axis with a FWHM of ~25 degree. As it comes to the low-density regime, distributions for both laser polarizations are greatly centralized. Photons are emitted at a much smaller divergence angle (10-20 degree), forming more collimated gamma-ray beams.

Name: **Anupam Karmakar**

Institute: **Leibniz Supercomputing Centre Garching bei München GERMANY**

Title: **From megaGauss to gigaGauss - high magnetic field generation by laser pulses at relativistic intensities.**

Abstract:

Authors: Anupam Karmakar, Amrutha Gopal, Laura Di Luccio and Paul Gibbon. .

We will report our recent studies on the magnetic field generation of the order of several hundred megaGauss to almost a gigaGauss using short and long pulse lasers at relativistic intensities. The polarization changes of the self-generated harmonics were recorded to estimate the magnetic field strengths. A parameter scan was performed by varying the input laser intensity as well as the contrast ratio. External optical probing diagnostics were performed using the second harmonic of the incident laser. Additionally, the optical transition radiation from the rear of the target was also recorded. Detailed numerical analysis using PIC simulations verifying these experimental results will be presented.

1. Gopal, Karmakar, Gibbon, et al., Plasma Phys. Control. Fusion 55, 035002 (2013).
2. Gopal, Karmakar, Di Luccio, Gibbon, et al., in press, (2013).

Name: **Konstantin Khishchenko**

Institute: **Joint Institute for High Temperatures RAS Moscow RUSSIA**

Title: **Hydrodynamic simulation of thermonuclear burn wave processes in DT fuel under intense laser irradiation**

Abstract:

A one-dimensional problem on synchronous bilateral action of two identical laser pulses on opposite surfaces of a layer of DT fuel with different initial density is simulated numerically. The solution of the problem includes two thermonuclear burn waves propagating to collide with each other at the symmetry plane. A wide-range equation of state for the fuel, electron and ion heat conduction, self-radiation of plasma and plasma heating by alpha-particles are taken into account in the present hydrodynamic simulations. .

Name: **Artem Korzhimanov**

Institute: **Institute of Applied Physics RAS Moscow RUSSIA**

Title: **Petawatt-class laser accelerated high energy mid-Z ions for nuclear physics**

Abstract:

A. Korzhimanov[1,2], E. Efimenko[1], S. Golubev[1], A. Kim[1]

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In this talk we will present a method of generation and acceleration of high-energy highly charged ion beams by petawatt laser irradiating structured solid targets which was proposed recently as a tool for nuclear physics [1, 2]. The method is based on the interaction of circularly polarized laser pulses with nanothick flat targets.

We show that the petawatt lasers are able to produce highly charged ions on the femtosecond scale. Namely, a 10 fs pulse with the intensity of 10^{22} W/cm^2 ionizes iron atoms up to Fe24+ and gold ions – up to Au68+. Furthermore, due to a big gap in the ionization potentials of corresponding atoms an extremely narrow charge distribution is being formed.

The acceleration in the considering method is based on the scheme proposed in [3]. It utilizes targets consisted of two species of different energy-to-mass ratio. Like in the widely discussed RPA scheme the laser pressure acting on electrons in the targets produce an electrostatic field which in turn accelerate lighter fraction of ions. Heavier ions in this case play a role of relatively slow moving substrate. The method is effective if the heavy ions substrate is made of high-Z atoms like gold and light ions are low-Z or mid-Z like iron or

calcium. So this scheme can be used for production of mid-Z ion bunches.

By means of the PIC simulations we showed that highly charged ions produced by field ionization can be accelerated up to tens of MeV/u with energy spread less than 2%. We believe that the accelerated beams has parameters which make them an attractive tool for high energy density experiments. Despite the ions energy and beam emittance are much lower than obtained at conventional accelerators other beam characteristics such as peak power are much higher. For instance, in the optimal regime the total number of accelerated ions is about 100 particles and the beam duration is about 5 fs so the produced ion current is of the order of 1 MA. The total energy deposited in ions is about 0.5 J and the ion beam power is about 80 TW, which is almost two orders higher than designed under FAIR [4].

[1] A. V. Korzhimanov, E. S. Efimenko, S. V. Golubev, A. V. Kim, Phys. Rev. Lett., 109, 245008 (2012).

[2] A. V. Korzhimanov, E. S. Efimenko, S. V. Golubev, A. V. Kim, Quantum Electron., 43, 217 (2013).

[3] A. V. Korzhimanov et al., JETP Lett., 86, 577 (2007); A. A. Gonoskov et al., Phys. Rev. Lett., 102, 184401 (2009).

[4] N. A. Tahir et al., Phys. Rev. Lett., 95, 035001 (2005).

Name: **Thomas Kuehl**

Institute: **GSI Darmstadt GERMANY**

Title: **X-ray laser for FAIR**

Abstract:

Current X-ray laser (XRL) research activities at PHELIX / GSI are dedicated to establish a reliable, fully characterized nickel-like plasma - XRL source for performing spectroscopy experiments on highly charged heavy-ions stored in the Experimental Storage Ring (ESR) of the GSI accelerator structure and later on at the HESR High-Energy Storage Ring at FAIR. These sources will allow the direct excitation of 1S - 2P1/2 transitions of a large number of Lithium like ions at the ESR. At the HESR, due to the larger Doppler-shift at relativistic velocities of ($\gamma = 6$) [1], even the excitation of the 2S1/2 - 2P3/2 transition will be possible for several cases[. In both storage rings also radioactive isotopes will be available for precision studies.

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Name: **Jiri Limpouch**

Institute: **Czech Technical University in Prague Praha CZECH REPUBLIC**

Title: **Laser-induced ion acceleration - towards higher ion energies**

Abstract:

Ion acceleration at intensities of 10^{20} W/cm^2 is studied via numerical simulations. Enhancement of ion acceleration via TNSA mechanism due to microstructures at the target surface is demonstrated. Transition from TNSA to RPA acceleration mechanism for linear polarization is analyzed. Theory and simulation results are compared with experiments.

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Name: **Igor Lomonosov**

Institute: **Institute of Problems of Plasma Chemistry, Chernogolovka, Russia**

Title: **Laser-driven shock waves and equation of state of matter**

Abstract:

We discuss in the talk the modern problem of equation of state at extreme conditions. It includes challenges of experimental methods of producing high pressure, high temperature with complementary diagnostic tools as well as the progress in modern theories. The importance of laser-driven shock waves in exploration material properties at extreme conditions is discussed.

Name: **Wenjun Ma**

Institute: **Department of Physics, Ludwig-Maximilians University (LMU) Garching GERMANY**

Title: **Novel particle and radiation sources enabled by nanotechnology and nanomaterials**

Abstract:

The development of nanotechnology and nanomaterials provide novel targets like ultrathin freestanding foils and low-density aerogel for high-power lasers. Recent results of our group reveals that efficient ion acceleration , relativistic electron mirror and coherent extreme ultraviolet radiation (XUV) can be achieved by employing these novel targets. Multiple physical processes including radiation pressure acceleration (RPA), coherent Thomson backscattering and self-focussing in near critical density plasma happens during the interaction of high power laser with these targets. Here we present the recent experimental results of our group to show the emerging chances for laser-driven particle and radiation sources.

Name: **Jingyi Mao**

Institute: **TU Kaiserslautern Kaiserslautern GERMANY**

Title: **Femtosecond laser-driven X-ray sources and target surface electron acceleration**

Abstract:

My presentation is about femtosecond laser-driven x-ray sources and highly collimated target surface electron generation.

Study of intense X-ray generation, optimization and its imaging application with interaction of noble cluster (such as Ar, Kr, Xe) irradiated by intense femtosecond laser. (a) We obtain laser-driven X-ray source with high brightness which is comparable to the peak brightness of the third generation synchrotron radiation sources. In detail, the X-ray photon flux reaches as high as 10^{11} photons/J and conversion efficiency is as high as 10^{-4}, from which we achieved sharp X-ray imaging towards insect wings by single laser shot. (b) This X-ray source is proved to be intense, monochromatic and fs time scale, which may make possible single shot laser-driven X-ray ultrafast application.

Development of appropriate X-ray instrumental diagnostics in the pursuit of femtosecond laser-driven X-ray sources for imaging application, with a design that preserves resolving power while maintaining high sensitivity. (a) Study of hard X-ray spectroscopy of characteristic K and K emissions of Mo target by using a transmission curved crystal spectrometer and off-Rowland Circle imaging technique. (b) We find that resolving powers $E/\Delta E$ of around 300 for Mo Kalpha at 17.37 keV were obtained with an end-to-end spectrometer efficiency of about 10^{-5}. (c) This sensitivity is sufficient for registering X-ray lines with high signal to background from targets following irradiation by a single laser pulse, demonstrating the utility of this method in the study of the development of medium-intensity laser driven X-ray sources.

Study of MeV electron beam guiding and acceleration along the target surface from the interaction of bulk target irradiated by femtosecond laser at relativistic intensity. We obtain highly-collimated quasi-monoenergetic MeV electron beam with high charge and small divergence angle, which is important for being applied as a stable injector in accelerators and in synchrotron betatron radiation and FEL generation.

Name: **Paul Neumayer**

Institute: **ExtreMe Matter Institute EMMI Darmstadt GERMANY**

Title: **High-energy density matter experiments with the PHELIX laser**

Abstract:

Study of matter at high energy densities (HED), relevant to planetary science, is one of the scientific pillars of the FAIR scientific program in the area of plasma physics. Using GSI's PHELIX laser many diagnostic techniques foreseen to be fielded at the FAIR plasma physics end-station can already be tested and developed towards the requirements specific to experiments on heavy ion driven plasmas. We will highlight recent experimental activities at PHELIX and other high-energy laser facilities both in the production and x-ray diagnostic characterization of HED matter which allow us to extrapolate their performance to possible applications within the FAIR plasma physics program.

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Name: **Alexander Pukhov**

Institute: **Uni Duesseldorf GERMANY**

Title: **Particle acceleration by ultra-intense laser pulses including QED effects**

Abstract:

Laser-driven ion acceleration attracts more and more attention nowadays because of its potential to realize table-top size ion accelerators, which would greatly reduce the expense and occupying area compared to conventional accelerators. In most proposals, intense/ultra-intense laser pulses are employed to stimulate strong electrostatic fields with amplitude several magnitudes higher than that of conventional methods. These fields move at high velocities thus ions can be continually accelerated to large energy in a short distance. In Target Normal Sheath Acceleration (TNSA) [1], the sheath field, formed at the target back by laser heated super-thermal electrons, moves at several to tens of the ion acoustic speed. Ions co-move with the field and are accelerated to tens of MeV, while energy above hundred MeV is quite a challenge because of the weak scaling law versus laser intensity. In Light Pressure Acceleration (LPA) [2] electrons in the thin plasma foil are pushed inward by the laser pressure and build up an intense charge separation field, by which protons are accelerated. As the foil is driven as a whole, protons move along with the electrostatic field and are successively accelerated to energies that theoretically may reach GeV. Nevertheless, even in simulations it is difficult to overcome the ten GeV barrier for protons with LPA, since the accelerating gradient drops quickly due to the relativistic Doppler Effect. As soon as the protons become relativistic, their energy grows very slowly with time.

We discuss here a new acceleration scheme that combines shock wave acceleration (SWA) and light pressure acceleration (LPA). When a thin foil driven by light pressure of an ultra-intense laser pulse propagates in underdense background plasma, it serves as a shock-like piston, trapping and reflecting background protons to ultra-

high energies. Unlike in SWA, the piston velocity is not limited by the Mach number and can be highly relativistic. Background protons can be trapped and reflected forward by the enormous “dragging field” potential behind the piston which is not employed in LPA. Our one- and two-dimensional particle-in-cell simulations and analytical model both show that proton energies of sever-al tens to hundreds of GeV can be obtained, while the achievable energy in simple LPA is below 10 GeV.

As known in LPA, the laser-driven foil is accompanied by an intense charge separation field. When it propagates through the low density plasma, background protons can be continuously trapped in certain conditions. The foil plays the role of a relativistic piston. In the frame of the relativistic piston, background protons clash towards the electrostatic field at the foil velocity, then are slowed down by the field in and behind the foil and finally reflected.

We make 1D and 2D PIC simulations of the mechanism. Because the ion acceleration requires high laser amplitudes, a_0>100, QED effects – like the radiation damping reaction – have been included in the code.

Acknowledgements: The work has been supported by DFG and Russian Ministry for Science and Higher Education. L. Ji acknowledges Alexander-von-Humboldt fellowship at the Heinrich-Heine-University of Dusseldorf.

1. A. Pukhov, Phys. Rev. Lett. 86, 3562 (2001) ; S. C. Wilks et al., Phys. Plasmas 8, 542 (2001).

2. T. Esirkepov et al, Phys. Rev. Lett. 89, 175003 (2002).

A. Macchi et al, Phys. Rev. Lett. 94, 165003 (2005).

Name: **Sergey Romashevskiy**

Institute: **JIHT RAS Moscow RUSSIA**

Title: **Registration technique of ^{57}Fe isotope nucleus emission generated by femto-second laser pulses**

Abstract:

The experimental verification of nuclear transition excitation in femtosecond laser plasma encounters with serious difficulties such as low efficiency of excitation mechanisms and challenge in separation of nuclear state decay product from intrinsic high-power plasma emission.

The novel technique of isomeric state excitation of the ^{57}Fe isotope at the energy of 14.4 keV and its radiation detection is presented in [1]. The main idea of the given technique is using of two space-divided targets. The laser plasma created under the action of high power femtosecond laser pulses on the first Me-target is the source of electrons with the energy of more than the second target isomeric level energy (more 14.4 keV for ^{57}Fe) and x-ray emission in the energy range of 14.4 keV. Then these electrons and x-ray emission are directed to the second target containing ^{57}Fe isotope, where the first isomeric level excitation with energy of 14.4 keV takes place. Radiation detection of ^{57}Fe nuclei is realized with a time delay that is slightly less than the life time (98 ns) of the ^{57}Fe isotope excited state.

Due to such experimental conditions the reliability of interpretation of the findings as a nuclear radiation is greater as compared with the previous studies. However, the development of a method that enables to decrease dramatically a noise level of laser plasma is still required for efficient implementation of the given approach**. In the present work** the time ranges of possible conversion electron detection were experimentally found and confirmed. The conversion electron spectra due to ^{57}Fe isotope decay is found to be measured in the range from 20 to 100 ns.

1. G.V. Golovin, A.B. Savel'ev-Trofimov, D.S. Uryupina, R.V. Volkov, "Internal electron conversion of the isomeric ^{57}Fe nucleus state with an energy of 14.4 keV excited by the radiation of the plasma of a high-power femtosecond laser pulse", Quantum Electron, 2011, 41 (3), 222–226.

Name: **Hartmut Ruhl**

Institute: **Computational Physics Munich GERMANY**

Title: **Circular Attosecond Pulses from Nano Foils**

Abstract:

Nano foils irradiated by short, intense, circular laser pulses can emit circular attosecond radiation. An idealized 1D analytical model will be presented. It will be compared with numerical simulations. Complexities to be encountered in 3D will be discussed.
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Name: **Andrey Savel'ev**

Institute: **Lomonosov Moscow State University Moscow RUSSIA**

Title: **Impact of a pre- pulse onto relativistic laser plasma interaction: electron, proton and heavy ion acceleration and surfac structuring**

Abstract:

Wide variety of electron acceleration mechanisms were proposed to impact to electron acceleration from dense plasma under relativistic femtosecond laser-plasma interaction - jxB and ponderomotive acceleration, resonant and stochastic heating, parametric instabilities, and even wakefield acceleration could play a dominant role. Besides of the laser pulse intensity, its duration and temporal structure (pre-pulses, leading edge sharpness, ASE level and duration) determine pre-plasma scale and length, that in its turn give rise to the different acceleration mechanisms.

We used Ti:Sapphire laser system, which generates femtosecond pulses (40fs, 100mJ, 10Hz) of relativistic intensity (up to 10^{19} W/cm^2). Numerical simulatons were done using fully relativistic 3D PIC code Mandor and well as the Boltzman-Vlasov- Poisson model.

We consider peculiarities of electron, proton and heavy ion acceleration depending on the target properties (solid and liquid metal targets), pre- pulse characteristics, etc. We reveal certain specific regimes at which properties of accelerated electrons and ion bunches can be efficiently controlled by the pre-pulse.

N**ame:** **Graeme Scott**

Institute: **Central Laser Facility STFC / University of Strathclyde Chilton UNITED KINGDOM**

Title: **Plasma mirror lifetime characterisation and its applications to laser plasma interactions**

Abstract:

Over the past decade it has become increasingly apparent that for laser plasma interactions the laser contrast is as important an intrinsic parameter of a laser system as its wavelength, pulse duration or energy. The plasma mirror is one tool that allows contrast control by reducing the ASE by some experimentally measurable value.

Here we present experimental results obtained on the PHELIX laser where the effective plasma mirror lifetime was measured when a temporally controlled prepulse was used to activate the plasma mirror, before a higher intensity pulse was used to probe the plasma mirror optical quality via measurements of its far field.

The applications of this technique will be discussed in the context of recently developed double pulsing techniques that enhance the conversion efficiency of laser energy into protons in laser driven ion acceleration

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Name: **Boris Sharkov**

Institute: **FAIR Darmstadt GERMANY**

Title: **FAIR and prospects of High Energy Density Physics**

Abstract:

FAIR will be one of the largest research projects and most sophisticated accelerator centers worldwide.

The FAIR GmbH will coordinate the construction of the accelerator and experiment facilities. The participating countries will contribute their technical and scientific expertise to the project, in addition to their financial and in–kind input.

The FAIR accelerator center to be built in Darmstadt is one of the largest projects for basic research in physics worldwide. Up to 3,000 scientists from more than 40 countries are already working on the planning of the experiment and accelerator facilities. FAIR will generate antiproton and ion beams of a previously unparalleled intensity and quality. When completed, FAIR will comprise eight ring accelerators of up to 1,100 meters in circumference, two linear accelerators and around 3.5 kilometers of beam pipes. The existing GSI accelerators will serve as preaccelerators for the new facility. FAIR will make it possible to conduct a wider range of experiments than ever before, enabling scientists from all over the world to gain new insights into the structure of matter and the evolution of the universe since the Big Bang. Researchers working at FAIR will also have the opportunity to investigate antimatter, dark matter and hot stellar matter. FAIR will be able to generate ion beams, which occur naturally in cosmic radiation. This will enable scientists to study the effects of ion beams on materials and tissue samples for space exploration.

Name: **Christian Spielmann**

Institute: **Institut für Optik und Quantenelektronik, Friedrich Schiller Universität Jena**

Title: **X-ray sources for experiments at the HESR**

Abstract:

In the current FAIR planning, the High-Energy Storage Ring (HESR) will be available for storing ionic species accelerated by the SIS. This opens the way for a far reaching expansion of present laser experiments using stored heavy-ion beams. As a novel and unique possibility for research in ultra-high field science the HESR will provide brilliant intense stored ion pulses at relativistic velocities. For the interaction with light pulses ranging from the IR to the x-ray region, the interaction frame will see a Doppler shift of the light frequency by more than one order of magnitude paving the way to new spectroscopic applications. In this contribution we report on the development of novel laser driven x-ray sources which are well suited for the envisaged experiments. The most developed source is the plasma x-ray laser. Upcoming new approaches are Thomson laser scattering from medium energy electron beams, high harmonics generation, and betatron emission in laser driven plasmas. Exploiting the unique combination of a large Doppler shift and the excellent beam properties, novel spectroscopy approaches for studies not only in the ionic states, but also in nuclear excitations and pair-creation processes are accessible.

Name: **Anna Tauschwitz**

Institute: **ITP Frankfurt am Main GERMANY**

Title: **Experimental investigation of two-phase metastable states at FAIR: need for laser-driven diagnostics.**

Abstract:

The area between the binodal, the boundary to the two-phase liquid-vapor region of the phase diagram, and the spinodal, which delimits the region of absolute thermodynamic instability, corresponds to metastable states, where the equation of state is double-valued. In hydrodynamic calculations either the metastable branch or the fully equilibrium equation of state can be used. We propose an experimental scheme which allows studying dynamics of matter passing through the liquid-vapor metastable states using intense ion beams at FAIR. The presented hydrodynamic simulations make use of a new theoretical treatment based on the local criterion of explosive boiling, derived by applying the theory of homogeneous bubble nucleation in superheated liquids. The new theoretical results reveal significant effects in the target response due to the transition from the metastable to the equilibrium state and specify the requirements for laser-based diagnostics with high temporal and spatial resolution. .

Name: **Vitaliy Trofimov**

Institute: **Prokhorov General Physics Institute of the Russian Academy of Sciences (GPI RAS) Moscow RUSSIA**

Title: **Formation of Compressed High-Energy Electron Bunches by Interfering Laser Pulses with Tilted Fronts and Their Application for Generation of Gamma-Rays**

Abstract:

A scheme of generating bunches of electrons is based on their acceleration in optical traps that formed in the fields of intense ultrashort laser pulses with tilted amplitude fronts. Simulations show that the traps move with the velocities close to the speed of light, collect and compress electrons. The size of thus formed electron bunches is far below the laser wavelength and electron energy reaches several hundred GeV at the laser intensities which are currently attainable. If an additional laser pulse that propagates in the direction opposite to that of the bunch motion interacts with electrons an inverse Compton scattering occurs with most of the electron energy being transferred to the resulting gamma-quanta.

References:

1. A.L. Galkin, V.V. Korobkin, M.Yu. Romanovskiy, V.A. Trofimov, and O .B. Shiryaev, Acceleration of electrons to high energies in a standing wave generated by counterpropagating intense laser pulses with tilted amplitude fronts Phys. Plasmas 19, 073102 (2012).

2. V.V. Korobkin, M.Yu. Romanovskiy, V.A. Trofimov, et al, Concept of generation of extremely compressed high-energy electron bunches in several interfering intense laser pulses with tilted amplitude fronts Laser and Particle Beams 31, 23-28 (2013).

3. A.L. Galkin, V.V. Korobkin, M.Yu. Romanovsky, O.B. Shiryaev and V.A. Trofimov, Emission of ultrashot electromagnetic pulses from electron bunches formed and accelerated by laser beams with tilted amplitude fronts Contrib. Plasma phys. 53, 109-115 (2013).

Name: **Dmitry Varentsov**

Institute: **GSI Helmholtzzentrum für Schwerionen-forschung Darmstdat, Germany**

Title: **High Energy Density Experiments with Intense Heavy Ion and Proton Beams at FAIR**

Abstract:

Knowledge of basic physical properties of matter under extreme conditions of high energy density, and in particular, of the so-called warm dense matter (WDM), such as equation-of-state, static and dynamic electrical conductivity and opacity is of fundamental importance for various branches of basic and applied physics. Intense beams of energetic heavy ions provide a unique capability for the high energy density (HED) physics research compared to traditional drivers. Using intense ion beams, one can heat macroscopic volumes of matter fairly uniformly and generate this way high-density and high-entropy states. This new approach permits to explore fascinating areas of the phase diagram that are difficult to access by other means.

In this paper we discuss various physics and technical issues of the high-energy-density (HED) physics research that is to be carried out at FAIR. In particular, a special attention is given to the emerging diagnostic technique - high energy proton microscopy (HEPM) which provides unique capabilities in penetrating radiography including the combination of high spatial resolution and field-of-view, dynamic range of density for measurements, in addition to the key attribute of reconstructing the density variations to less than 1% inside volumes and in situ environments. The PRIOR (Proton Microscope for FAIR) facility which is currently being constructed at GSI will use a 4.5 GeV proton beam from the SIS-18 synchrotron and allow for a significant step forward in spatial resolution (>10 µm) to advance high-energy-density physics and heterogeneous materials research. We discuss the status of the PRIOR project and proposed HEPM experiments in different fields from non-ideal plasma physics to particle radiosurgery.

Name: **Laura Vassura**

Institute: **LULI, École Polytechnique, CNRS, CEA, UPMC, 91128 Palaiseau, France; Sapienza Università di Roma, Roma, Italy**

Title: **Narrow band neutron sources produced by ultra intense laser**

Abstract:

Several experiments aimed to the generation of energetic neutrons at laser facilities have led to preliminary promising results regarding laser-driven neutron generation. The general approach for generating laser-driven neutron sources relies on using ultra-intense lasers to generate picosecond, collimated neutrons from a dual target configuration, where ions, accelerated from a laser-irradiated target, impinge on a catcher foil.

We tested in the Elfie facility for the first time the possibility to obtain this kind of neutrons source and also to achieve an energy selection of this source. The energy selection has been obtained using a laser-triggered micro lens that allows selecting and focusing ions within a narrow energy band. In fact the ions generated from the first target pass through to a micro-cylinder of aluminum focused with a picosecond laser. Thanks to a transient electric field inside the micro-cylinder they are focused and selected in energy. So the ions beam that impinges on the catcher is almost monoenergetic and can generate a neutron sources with a narrow energy spectrum.

Name: **Laszlo Veisz**

Institute: **Max-Planck-Institut für Quantenoptik, Garching**

Title: **Generation and applications of relativisitic quasi-single-cycle laser pulses**.

Abstract:

A novel relativistic light source with quasi-single-cycle pulse duration is described. It delivers pulses with sub-5-fs pulse duration and 18 TW peak power and it is focusable to ultra-relativistic intensities of about 10^{20} W/cm^2. This unparalleled source is ideally suited for the generation of intense isolated attosecond XUV pulses via high harmonic generation in gases or overdense plasmas as well as relativistic attosecond electron bunches from laser-plasma interaction. The first experiments are going on. These XUV and electron beams open up various fields of applications, among others nonlinear XUV science or electron diffraction in the attosecond domain.

Name: **Mikhail Veysman**

Institute: **JIHT RAS Moscow RUSSIA**

Title: **Laser wakefield electrons acceleration in capillary waveguides under non-symmetric laser coupling conditions**

Abstract:

The effect of asymmetrical focusing of laser radiation in gas-filled capillary waveguide on the structure of wakefields generated in the capillary and on the effectiveness of electron bunch acceleration is studied.

The conditions on the maximum adoptable asymmetry when the generated wakefields are regular enough for effective acceleration of electron bunches to high energies and with low emittance and energy spread are found.

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Name: **Lucy Wilson**

Institute: **Central Laser Facility, STFC Didcot UNITED KINGDOM**

Title: **Laser generated gamma ray source optimisation for imaging applications**

Abstract:

High power lasers have long been used for the generation of secondary sources. This talk will present work carried out using a 50J laser source with pulse lengths of 1ps to generate a source of gamma rays in the MeV region via laser interaction with a variety of solid targets. A study of the properties of the gamma ray source in relation to target thickness, Z and laser intensity has been undertaken in order to determine the optimal conditions for imaging.

Name: **Matt Zepf**

Institute: **Queen's University Belfast UK, HJ Jena, Germany**

Title: **Picosecond response of materials to ultrafast ion bursts.**

Abstract:

One of the unique features of laser driven ion beams is the ultrafast pulse duration. We used the ps duration proton beam from the Taranis laser facility at Queen's University Belfast to produce beams with endpoint energies of 15 MeV. These were used to irradiate transparent samples. The transient opacity of the materials was recorded showing relaxation timescales on the order of 10s of ps. These experiments open the path to investigate a host of ion induced phenomena with temporal resolution for the first time.

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Posters

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Name: **Marius Blecher, P1**

Institute: **Uni Düsseldorf, 40223 Düsseldorf, GERMANY**

Title: **Generation of high energy few-cycle laser pulses for particle acceleration using the ionization self-compression effect**

Abstract:

Particle acceleration from targets irradiated by high-intensity laser pulses is a promising technique with a number of applications in scientific, technological and medical areas. State of the art CPA Laser systems are able to provide pulses in the multi-hundred TW regime with durations down to about 25 fs. But there is a broad interest to enable these systems to enter the single-cycle regime. This would be beneficial for a broad range of relativistic laser plasma experiments such as electron acceleration or optical diagnostics relying on short probe pulse duration. At the university of Düsseldorf we aim to provide a robust and comparably cheap setup to achieve sub -10 fs pulses with energies from ten to several hundred mJ using the ionization-induced self-compression effect in gas filled capillaries. Threrefore experiments as well as simulations have been done to investigate the self compression mechanism, its foundations and prospects.

Name: **Lidia Borisenko, P2**

Institute: **P.N. Lebedev Physical Institute RAS, Moscow, RUSSIA**

Title: **About target structure in laser plasma experiments.**

Abstract:

In early high-power irradiation experiments on low-density targets the structure was reported to have slight if any influence on the major results. Further the distinct unpredicted effects appeared to be connected with initial solid structure, especially when the diagnostic means achieved higher resolution and accuracy.

Polymer aerogels, unlike many other low-density materials (foam, dust, nano-snow) have a net-like structure, consisting of macromolecular fibers and globules. That means they are highly regular as regards their spatial structure, so high repeatability was demonstrated in interaction experiments with polymer aerogel targets. However we yet have definite molecular structure in the polymer before irradiation.

Should we take into account or neglect a molecular structure for plasma effects? Below we consider the initial phase of soft x-rays to rapture molecular bonds, then atomic structure to estimate if those could be visualized in plasma. .

Name: **Christian Brabetz, P3**

Institute: **Goethe-Universität Frankfurt am Main, Frankfurt, GERMANY**

Title: **Laser beam control and further developments at PHELIX**

Abstract:

We present the latest improvements done to the PHELIX laser facility regarding beam control and quality. Robust mechanisms addressing low order aberrations were installed throughout the system to relieve the requirements on the deformable mirror and ultimately give better control on the wavefront during a full power shot and alignment. In parallel, the wavefront diagnostics were reworked, resulting in higher resolution and dynamic range. As a result of this effort, the beam control reaches a better precision. This enables users of the PHELIX laser facility to benefit from better focus profiles for their experiments.

For further developments to the upcoming Helmholtz beam line (FAIR), a high repetition pre amplifier including an active wavefront control module is currently under development. With this new double pass system it is possible to maintain good beam properties while increasing the repetition rate to 2-3 shots/minute.

Name: **Stephanie Brauckmann, P4**

Institute: **ILPP, Uni Düsseldorf, 40223 Düsseldorf, GERMANY**

Title: **Optical probing of plasma dynamics generated by high intensity laser pulses on ultrathin foils**

Abstract:

The investigation of acceleration processes of charged particles by employing high intensity laser pulses undergoes large scientific interest in the light of attractive applications. Extensive experimental and theoretical studies concentrate on both, for identifying new efficient acceleration regimes and optimizing the electron and ion beam properties (brilliance, energy spectrum, duration, divergence). The acceleration process of ions depends on physical parameters of the interaction like laser pulse duration, intensity, contrast and polarization, target thickness and geometry [1]. The investigations of plasma expansion of the targets irradiated by high intensity laser can offer relevant information in order to characterize the ion acceleration regime (TNSA, RPA-HB or RPA-LS) [2, 3].
Here we report on recent experimental investigations on the topic of ion acceleration by sub-picosecond, high-intensity laser pulses of 10^{20} W/cm^2 interacting with ultra-thin foil targets. In particular, we are presenting the temporal evolution of plasma expansion and the formation of plasma jets on the rear side detected by optical interferometry and shadowgraphy. The generation of a collimated plasma expansion with steep density gradients strongly depends on the target thickness, the duration of the laser pulse. The interaction regime of the presented experiment is one where both, TNSA and RPA are coexisting, indicated by the appearance of narrow band spectral features of the accelerated ions. The investigation concentrates on early plasma expansion, over time intervals of 0 - 150ps after the laser pulse irradiation. Targets of different thicknesses (10-100 nm) and different materials have been employed in the experiment. The experimental outcomes are compared to 2D hydrodynamic simulations which deliver longitudinal and transversal phase velocities, the density and the temperature distribution after certain time steps.

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[2] S.C. Wilks et al, Physics of Plasmas, 8, 542 (2001); P. Mora, Physical Review Letters, 90, 185002 (2003)
[3] S. Kar, Phys. Rev. Lett, 100, 225004 (2008)

Book of Abstracts
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EMMI Workshop

Name: **Pierre Forestier-Colleoni, P5**

Institute: **CELIA, Talence, FRANCE**

Title: **Magnetic fields measurement developing at the interaction surface of a target iradiated by a high intensity laser**

Abstract:

Autor: Pierre Forestier-Colleoni, Dimitri Batani, Frédéric Burgy, Fanny Froustey, Fabien Dorchies, Claude Fourment, Lorenzo Giuffrida, Sébastien Hulin, Emmanuel d'Humières, Laurent Merzeau, Stephane Petit, Adama Samaké, Christopher Spindloe and João Jorge Santos

The experimental investigation of the intense laser-solid interaction, with particular attention to the fast electron beam (FEB) generation mechanisms, is of paramount interest for the development of applications based on FEB-energy transport into target depth, such as the fast ignition of inertial confined targets, the laser-acceleration of ion beams or the isochoric creation of warm dense matter states. In particular, the characterization of the structure of the magnetic fields developing at the interaction surface would allow to understand FEB source parameters, such as its energy, radial and angle distributions. This magnetic field can be the consequence of the Weibel instability created by the interaction between the FEB inside the target and the cold electrons of the target. The goal here is to characterize experimentally the spatial and temporal evolution of this magnetic field by a laser pump w, probe 2w method. The experiment was carried out at the ECLIPSE laser facility at CELIA, Univ. Bordeaux, delivering up to 200mJ, 34 fs, intensity contrast 10^{-7} laser pulses at 800nm. The target is a SiO_2 plate with a surface roughness under lambda/2, with a 100nm Al-deposited layer. The pump beam has a 45° incidence angle into the target Al-surface, with p-polarization, focused to 12µm FWHM focal spot and reaching up to 10^{18} W/cm^2 intensity. The probe beam (with 2.5% of the laser source energy) has a normal incidence into the target. The probe light is

reflected at a depth bigger than the pump beam (nc_probe=4 nc_pump). During its propagation inside the magnetized plasma created by the pump beam, its polarization change (due to the Cotton-Mouton and Faraday rotation effects), which is measured by a polarimeter. Our polarimeter splits the reflected probe laser beam into 4 beams corresponding to the 4 Stokes parameters (using a Wollaston prism for two parameters and a lambda/4 waveplate and a polarizer for the other two parameters). The Stokes components are independently detected at the image plane of the target surface with a magnification of 10, using two identical 12bits CCD cameras (two components per camera), providing 6 µm-resolution images of the target surface, according to the transverselly-2D-resolved light polarization. The time-evolution, with respect to the pump-target interaction is given by multiple laser shots, using a motorized delay line for the probe beam (providing a time resolution of 0.2ps). Preliminary results at 1ps after the pump beam interaction with the target, indicate the presence of magnetic-field structures of 30 kG average amplitude distributed over a ~140 µm diameter region around the pump interaction spot center. These structures reach a maximum magnetic field amplitude of ~80MG.

Name: **Pierre Forestier-Colleoni, P6**

Institute: **CELIA, Talence, FRANCE**

Title: **Reflectivity measurement of spherical crystals used as K_alpha-fluorescence imagers**

Abstract:

Autors: Pierre Forestier-Colleoni, Luca Antonelli, Dimitri Batani, Fabien Dorchies, Anatoly Faenov, Luca Fedeli, Giulia Folpini, Claude Fourment, Lorenzo Giuffrida, Sébastien Hulin, Sergey Pikuz, João Jorge Santos and Luca Volpe

Spherical Crystal Imaging (SCI) of atomic K-shell fluorescence is a commonly used diagnostic to study the propagation of laser-accelerated fast electrons in dense matter. The fast electrons remove inner electrons in the atoms, which then emit a x-ray photon of energy given by the gap between the L- and K-shells, called K_alpha emission. Spherically bent crystals allow to selecting and making images of the K_alpha source in the laser-irradiated target imbedded K-shell fluorescence tracer onto a detector (in our case a CCD camera). This allows to measure the K_alpha source size, therefore the electron beam size at the tracer position, which is very useful to understand, by using the tracer at different target depths, the radial spread against depth of the electron beam. The measurement of the absolute reflectivity of K_alpha crystals used as imagers is also essential in order to be able to evaluate the total number of emitted K_alpha photons, and then the number of fast electrons crossing the K-shell fluorescence tracers. From the measurements at different tracer positions, one can deduce the electron beams range, and possibly the total number of fast electrons generated by the intense laser interaction at the target surface.

We performed a calibration experiment at the Eclipse laser facility at CELIA, where we measured the reflectivity of three crystals of quartz 21-31 used to reflect the K_alpha from Copper (Cu). Cu targets,

10µm in thickness, were irradiated at intensity of 10^{18} W/cm^2. Emitted photons were recorded using a X-ray CCD which was either placed in the image plan of the crystal, or directly exposed to the X-ray flux (in a single photon counting mode). For all shots a second X-ray CCD (also in single photon counting mode) was used as a reference. The comparison between signals recorded on the first CCD with and without the crystals allow to measure their reflectivity. The detailed geometry and spectral shape of the K_alpha emission, as well as the crystals spectral resolution and of the CCD spectral quantum efficiency were taken into account. The reflectivity measured for the different tested crystals are of the order of 6.10^{-4}.

Name: **Milan Holec, P7**

Institute: **ELI beamlines, Institute of Physics, Academy of Sciences of Czech Republic, Czech Technical University in Prague, Chrudim, CZECH REPUBLIC**

Title: **Hydrodynamic simulations at PALS kJ laser beam**

Abstract:

We aim to provide a theoretical background for laser-matter experiments at Prague Asterix Laser System. In particular, a nanosecond kJ Iodine laser beam is of main interest. We develop our own hydrodynamic codes PALE (2.5D) and RHYDRO (1D) to simulate the interaction of the beam with a solid target. Both codes have been used to describe spatial and temporal evolution of generated plasma, taking into account a pre-pulse pedestal.

In order to describe the laser produced plasma, we adopt a radiation-hydrodynamics continuum model enclosed by SESAME equation of state. Results of simulations of CH_2, Al, and Cu targets irradiated with intensities up to 10^{16} W/cm^2 are presented. .

Name: **Konstantin Ivanov, P8**

Institute: **Physics Faculty and International Laser Center of M.V. Lomonosov MSU, Moscow, RUSSIA**

Title: **Preplasma effect on the hot electron generation at the action of sub-relativistic laser pulse onto the surface of solid targets**

Abstract:

We present our recent results on diagnostics of the plasma, created by a sub-relativistic femtosecond laser pulse onto the surface of solid targets (metals and dielectric) with varied initial plasma density scalelength. We have shown that the preplasma plays a significant role in hot electron acceleration process. In our experiments we used a laser pulse delivered by the Ti:Sa laser system (pulse duration - 40 fs, energy on target - up to 50 mJ, wavelength - 800 nm, repetition rate - 10 Hz, peak intensity - up to $5x10^{18}$ W/cm^2). The preplasma was formed by introducing a prepulse with varied duration, energy and delay (by decreasing the contrast of the laser pulse or by using an additional Nd:YAG laser). The appearance of high energetic hot electron component with the temperature up to a few hundreds of keV is observed for the case of a long scale warm preplasma. The effect may be connected with the self-focusing of laser pulse in the preplasma and with the growth of parametric instabilities near 1/4 critical density (two-plasmon decay and Raman scattering) leading to the generation of hot particles. We have also observed the appreciable amplification of the hot electron temperature when the duration of the laser pulse was increased from 40 to a few hundreds of femtoseconds with constant fluence for metal targets with a large preplasma. The effect is not observed at the sharp plasma boundary and for the high ablation threshold material (SiO_2), when the preplasma cloud is much smaller by comparing to metal targets. The experimental results are supported by PIC simulations of laser-plasma interaction and optical shadowgraphy of preplasma.
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Name: **Annika Kleinschmidt, P9**

Institute: **TU Darmstadt, Darmstadt, GERMANY**

Title: **Spatial characterization of a laser driven neutron source**

Abstract:

The subject of laser-ion-acceleration has been of constant interest for the last 10 to 15 years, because of its various potential applications. For example, ion beams could be used as a diagnostic in material science as well as fusion research or medical applications. Using these acceleration mechanisms as a small and cheap alternative to conventional accelerators is one of the key aspects in this field of research. The acceleration of neutrons by conversion of laser induced ions is of particular interest. We would like to introduce possible applications and methods to produce and detect these neutrons.

One of the acceleration mechanisms is the Break Out Afterburner (BOA), where high energy short pulse lasers with intensities up to 10^{21}W/cm^2 are needed. These lasers are focused on a thin target foil, where hot electrons are produced. These travel through the target to the rear side, where a sheath is formed. Due to relativistic effects, the target becomes transparent to the laser. Thus, the entire target volume is heated and the ions will be accelerated to energies up to 80 MeV. If these ions hit a thick converter target (for instance copper or beryllium), they generate neutrons in the converter material through several processes. These neutrons can also be used for various applications. For example, the interaction of neutrons with a material is complementary to that of x-rays. This provides an additional diagnostic in materials research. Furthermore, laser accelerated neutron sources could be a compact and flexible alternative to conventional accelerators. Therefor the investigation of these neutron sources is of fundamental importance. The neutron spectra and the angular distribution are basic properties that contain information for a better understanding and specification.

Within the framework of this poster we introduce the experiments and results of two campaigns, where a directed neutron beam was produced by conversion of laser-accelerated deuterons.

Name: **Dmitry Knyazev, P10**

Institute: **Joint Instittute for High Temperatures RAS, Moscow, RUSSIA**

Title: **Ab initio calculation of transport and optical properties of dense metal plasma created by intense laser radiation**

Abstract:

The knowledge of transport and optical properties of dense metal plasma is important during the simulation of different experiments in high energy density physics: the interaction of intense laser radiation with matter (including femtosecond laser radiation), the interaction of heavy ion beams with matter, exploding wire experiments. The investigation of transport and optical properties in the necessary region of phase diagram with experiment and simple theoretical models faces considerable difficulties. Therefore ab initio methods are used widely nowadays to obtain the necessary data on the properties of metals.

The calculation in this work is based on the quantum molecular dynamics (QMD) simulation, density functional theory and the Kubo-Greenwood formula. During the QMD simulation at the given temperature the ionic trajectories are calculated. Independent ionic configurations are selected from the equilibrium section of the QMD simulation. Then for each of the selected ionic configurations the precise resolution of the band structure is performed. The electronic energy levels and wave functions are obtained. The dynamic Onsager coefficients are calculated using wave functions and energy levels via the Kubo-Greenwood formula. Static Onsager coefficients are calculated by extrapolating the dynamic ones to the zero frequency. Transport properties (static electrical and thermal conductivities) are expressed via the static Onsager coefficients. Dynamic electrical conductivity is one of the dynamic Onsager coefficients. If the dynamic electrical conductivity is known, the other optical properties may be calculated (complex dynamic electrical

conductivity, complex dielectric function, complex refraction coefficient, reflectivity and absorption coefficient). The method of calculation was described in detail in our paper [1].

In this work the transport and optical properties were calculated for liquid aluminum and silver at their normal densities and temperatures from 3000 K up to 20000 K. The results for aluminum and silver differ significantly. The curves of the dynamic electrical conductivity possess Drude-like shapes in the whole range of frequencies under consideration. The curves for silver consist of two main segments. At low frequencies the curves have Drude-like shapes. At high frequencies the dynamic electrical conductivity is almost constant as the function of frequency. Static electrical conductivity decreases with the temperature growth both for aluminum and silver. For aluminum the thermal conductivity increases with the temperature growth. The thermal conductivity for silver undergoes nonmonotonic changes as the temperature increases. The value of the Lorenz number for aluminum is close to the ideal value in the whole range of temperatures under consideration. The values of the Lorenz number for silver differ significantly from the ideal value.

The work is to be continued. The model of the optical properties is to be built based on the results of the ab initio calculation. The results on the dielectric function are to be approximated by the sum of the Drude term and the set of the Lorenzian poles. Such form of approximation provides the stability of the computational scheme, used for the numerical solving of the Maxwell equations. The model of the optical properties will find use during the simulation of femtosecond laser heating of metal. The usage of the model during the simulation of the experiments at the PHELIX laser in GSI is among the fruitful applications of this work.

1. Knyazev D.V., Levashov P.R. Comp. Mater. Sci. 2013. Accepted Manuscript. .

Name: **Anton Koshelev, P11**

Institute: **Joint Institute for High Temperatures RAS, Moscow, RUSSIA**

Title: **On the structure of accelerating wakefields generated by laser pulses and charged particle bunches**

Abstract:

The structure of plasma waves excited by intense laser pulses or beams of charged particles is investigated on the base of cold hydrodynamic model. The laser wakefield is analyzed in homogeneous plasma and also in wide and narrow (compared with the plasma wavelength) plasma channels. Analytical solutions in the linear approximation are supplemented by numerical simulations of the nonlinear wakefields generated by intense laser pulses and charged particle beams. In view of the planned AWAKE experiment at CERN, acceleration of externally injected electrons in proton driven plasma wake-field is modelled using elaborated numerical code.
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Name: **Thomas Kuehl, P12**

Institute: **GSI, Darmstadt, GERMANY**

Title: **High Power lasers at the HESR**

Abstract:

In the current FAIR planning, the High-Energy Storage Ring (HESR) will be available for storing ionic species accelerated by the SIS.This opens the way for a far reaching expansion of present laser experiments using stored heavy-ion beams. The large SPARC community, mainly centering on Atomic Physics and bound state QED has gathered a strong physics case for experiments with these stored, cooled particles.

As a novel and unique possibility for research in ultra-high field science the HESR will provide brilliant intense stored ion pulses at relativistic velocities of ($\gamma = 6$). For the interac-tion with laser pulses, the interaction frame will see a Doppler shift of the laser frequency by more than one order of magnitude. In addition, the relativistic Doppler effect will shorten a counter-propagating laser pulse, in total boosting the power density by more than 2 orders of magnitude. Changes in the ionic charge can be detected on a single particle level. Interaction with lasers and x-ray laser sources will be possible in the straight sections, or just before the 180° arcs. Novel laser sources given by e.g. the PHELIX laser, and laser driven x-ray sources can be used in this context. Additional developments for increasing the accessible parameter range are in progress.

Exploiting the large Doppler shift and the excellent beam quality, novel spectroscopy approaches for studies not only in the ionic states, but also in nuclear excitations and pair-creation processes are accessible.

Name: **Kun Li, P13**

Institute: **GSI, Darmstadt, GERMANY**

Title: **In-line hard x-ray imager and spectrometer**

Abstract:

In-line hard x-ray (20~1000 keV) imager and spectrometer are designed. Instead of using image plate, screens (DRZ, LANEX) and scintillator (LYSO, BGO) are used to convert x-ray photons to visible photons.For the imager, the spatial resolution is measured to be around 100 um on screens, with field of view of ~30 x 30 mm^2. For the spectrometer, the plasma temperatures are measured to be 50 keV, 100keV, and 200 keV, respectively.

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Name: **Michaela Martinkova, P14**

Institute: **ELI - Institute of Physics, v.v.i., Prague, CZECH REPUBLIC**

Title: **Analysis of Plasma Jets from PALS Laboratory**

Abstract:

Laboratory plasma jets attract their attention for example because of its relation to astrophysical phenomena and several concepts of fast ignition scenarios. In this contribution the analysis of the laboratory plasma jets created at Prague Asterix Laser System (PALS) will be provided and some of their parameters estimated using simplified analytical approach based on crater volume and spatial-temporal density distribution will be given. Jets are at PALS created because of the special laser beam profile which has an intensity decrease on axis resulting in annular shape of the beam profile. This provides the PALS laboratory a possibility to create jets from solid bulk targets just by use of one single laser beam compared to other means, like multiple beams or shaped targets used in other laboratories.

Intensities and focal spot radius of the laser pulse used during the experiments at PALS varied from ~ 7.1×10^{13} W/cm^2 to ~ 2.3×10^{14} W/cm^2, and was set to 300 mm on the target surface respectively. Third harmonic of the iodine laser used during the experiment was 438 nm with pulse duration ~ 300 ps. The analysis will include jets created during the interaction of laser pulse with solid planar metal targets made of aluminium, copper, and tungsten at different laser pulse energies varied from ~ 60 to ~ 200 J. Densities of created jets were found to be of the order of 10^{-4} g/cm^3 and their velocities estimated from free electron density reconstructions varied from about 360 to 730 km/s. Average free electron densities taken at 4 ns after the shot, reached by the frequency tripled (438 nm) three frame interferometer, were around 2.2×10^{19} cm^{-3} for Al, ~ 2.4×10^{19} cm^{-3} for Cu, and ~ 1.6×10^{19} cm^{-3} for Ta. On some of the reconstructions it was seen the diamonds like structure corresponding to the supersonic

propagation of the jet. Such structures appear when the established shock waves create areas of local density increase and decrease. The corresponding Knudsen number of selected Cu jets was about 0.006 and for Ta jets it was about 0.015.

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Name: **Claudia-Veronika Meister, P15**

Institute: **Institut für Kernphysik, 64289 Darmstadt, GERMANY**

Title: **1) Material destruction analysis related to future Super-FRS experiments at FAIR,**

2) The influence of boundary conditions on the excitation of instabilities in magnetohydro-dynamic systems

Abstract:

1) In the Super-FRS target and in the beam catchers at GSI stress waves are generated by intense, fast-extracted ion beams which deposit a high amount of energy within a very short time into the target material. This may cause material damage. In this connection, measurements and simulations of thermal parameters and eddy-currents resistivity are planned or already under performance as monitoring techniques. Here methods are discussed and briefly outlined, which are being used to calculate the physical characteristics. First results concerning material-dependent thermal conductivities are presented.

2) The magnetohydrodynamic energy principle is further developed for laboratory fusion and astrophysical plasmas. It is shown, that some well-known types of instabilities as sausage, kink, interchange and ballooning ones may be caused by the plasma boundaries only. That means, they would not occur in the same plasma if there were no or other boundaries of the system. Special applications to fusion and planetary plasmas are discussed.

Name: **Alex Ortner, P16**

Institute: **TU Darmstadt, Darmstadt, GERMANY**

Title: **Heavy ions energy loss experiments in dense plasma using hohlraum targets**

Abstract:

We report on heavy ion energy loss experiments in dense carbon plasma heated by hohlraum generated X-rays. The energy deposition of ions in plasmas is a key question in ICF simulations, for the evaluation of heavy ions as drivers or ion driven fast ignition concepts. The GSI Helmholtzzentrum für Schwerionenforschung offers the unique possibility to create a dense plasma with the hight energy laser PHELIX and to probe it with a heavy ion beam from the UNILAC accelerator. A special double hohlraum configuration has been designed to generate a homogeneous carbon plasma with an electron density of 10^{22} cm^{-3}, an temperature of 15 eV and an ionization degree of 4. In our last experiments in 2012 with a Ca^{17+} ion beam with 4 MeV/u we observed an increase oft the stopping power of up to 80%. These results are compared with new theoretical models and simulations. .

Name: **Katrin Philipp, P17**

Institute: **TU Darmstadt, Darmstadt, GERMANY**

Title: **Characterisation of a novel ion wide angle spectrometer**

Abstract:

Laser driven ion acceleration provides a useful tool to a large number of applications, e.g. the diagnosis of high energy density matter, cancer therapy, novel types of neutron sources and the design of a new generation of compact particle accelerators.

Recently a new and promising acceleration mechanism, the so-called Break-Out-Afterburner (BOA) has been experimentally investigated, as an alternative to the quite established and well understood Target Normal Sheath Acceleration (TNSA). This novel mechanism offers increased conversion efficiencies, efficient acceleration of heavier ions as well as the acceleration of protons well beyond 200MeV.

In order to characterise this high energetic photons and higher order ions new diagnostics have to be build. In the scope of this poster a newly designed and optimised ion Wide Angle Spectrometer (iWASP) is presented, which is able to measure angular resolved ion spectra up to 200MeV with sufficient energy resolution.

The main principle behind the iWASP is magnetic field deflection of charged particles. Spatial resolved measurement of deflected ions provides angular resolved information about ion kinetic energies. To achieve high spectral resolution the magnetic field strength has to be maximised. Halbach cylinders are a possible solution to address this need, since

they provide strong magnetic fields through an intelligent alignment of segments with rotational changing remanence.

The design of a Halbach cylinder for this purpose leads to magnetic strengths up to 1.4T and therefore to a spectral resolution of 200MeV protons well below 20%. The so designed iWASP is capable of measuring angular resolved high energetic proton and heavier ion spectra and thus offers detailed spectral and conversion efficiency measurements.

Name: **Leonid Pugachev, P18**

Institute: **Joint Institute for High Temperatures RAS, Moscow, RUSSIA**

Title: **3D PIC modeling of surface fast electrons generation during the interaction of high intensity femtosecond laser radiation with inhomogeneous preplasma at the target surface**

Abstract:

The work is aimed to study surface fast electrons generation from targets with preplasma under the irradiation by high intensity femtosecond laser pulses. In our 3D simulations, the preplasma density distribution formed under the influence of the laser system prepulse is set as an input parameter.

In the case of laser pulse propagation along the target surface in the underdense preplasma with transverse inhomogeneity scale length long enough in comparison with the laser focal spot, 3D PIC simulations, in agreement with the previous 1D simulations and experiment , show the formation of accelerated electron bunches at nonrelativistic intensities in the presence of density inhomogeneities at the boundary along the laser pulse propagation.

For relativistic intensities and oblique laser incidence on the target with overcritical plasma density and preplasma with sharp, scale length of 1 mkm, exponential decaying density profile across the laser pulse propagation, the parameters of accelerated electrons obtained in our 3D simulations are in qualitative agreement with 2D PIC results.

Electron energy spectra and angular distributions of electron bunches are presented. The fields and electron currents structure is analyzed to discuss possible mechanisms of surface fast electrons generation. The conditions for the surface acceleration process and electron energy scalings with input parameters of laser pulses and preplasma are considered.

This simulation results are important to refine parameters of the experiment planned at PHELIX, GSI.

Name: **Darya Sedyakina, P19**

Institute: **Joint Institute for High Temperatures RAS, Moscow, RUSSIA**

Title: **On the phonon excitations of rich borides: phenomenological modelling and neutron in-elastic scattering experiments**

Abstract:

The work is aimed to study lattice dynamics in YbB_{12} and SmB_6. In our phenome-nological modeling interatomic forces are defined by the dynamical matrix and boron clusters are replaced by pseudo atoms with the mass of the corresponding cluster. Dispersion curves and density of states obtained are in agreement with the data on neutron inelastic scattering experiments.

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Name: **Ge Xu, P20**

Institute: **IAP, University of Frankfurt am Main, Frankfurt am Main, GERMANY**

Title: **Energy loss and charge states of a Calcium beam after interaction with a hydrogen plasma produced by a theta-discharge**

Abstract:

An ion-plasma interaction experiment has been carried out at the Z6 experimental area, GSI. The energy loss and charge state distribution of the ion beam after plasma and cold gas have been measured, respectively. The energy loss in plasma and cold gas are obtained from a phase difference at a stopping detector. The charge states distinctly increase after the plasma which shows that the theta pinch device has a potential to be used as a plasma stripper.