40th International Workshop on High Energy Density Physics with Intense Ion and Laser Beams

Report of Contributions

https://indico.gsi.de/e/Hirschegg2020

Contribution ID: **0** Type: **Talk**

Meson-catalyzed fusion in ultradense plasmas

Wednesday, 29 January 2020 09:50 (25 minutes)

Negative muons in the MeV energy range are shown fully stopped in WDM and FIS/ICF plasmas on a psec time scale by including slowing down on partially degenerate electrons as well as on classical hydrogen isotope ions.
Atomic and molecular recombination on exotic and lowest available bound states are demonstrated.
The very existence of in situ exoatoms can then be probed through X-ray line Stark broadening.
The negligibility of meson sticking on alpha particules resulting from the DT-reaction is quantitatively asserted.
Meson catalysis of the fusion reactions is thus seen possible in short-lived plasma targets with rates orders of magnitude above usual cold deuterium ones.
The dipole exoatom orientation clearly favors the WDM option.

Primary author: Prof. DEUTSCH, claude (LPGP U-Paris-Saclay)

Co-author: Prof. DIDELEZ, jean-pierre (IPN U-Paris-Saclay)

Presenter: Prof. DEUTSCH, claude (LPGP U-Paris-Saclay)

Session Classification: Fusion Studies I

Contribution ID: **1** Type: **Talk**

Density jump as a function of magnetic field for collisionless shocks in pair plasmas: The perpendicular case

Tuesday, 28 January 2020 18:15 (25 minutes)

We extend the analysis presented last year to the perpendicular case.

Primary author: Dr BRET, Antoine (Universidad Castilla La Mancha)

Presenter: Dr BRET, Antoine (Universidad Castilla La Mancha)

Session Classification: Dynamics in Plasmas

Contribution ID: **2** Type: **Talk**

Stability boundaries for the Rayliegh-Taylor instability in elastic-plastic solid slabs

Tuesday, 28 January 2020 17:25 (25 minutes)

The linear theory of the incompressible Rayleigh-Taylor instability in elastic-plastic solid slabs is developed on the basis of the simplest constitutive model consisting in a linear elastic (Hookean) initial stage followed by a rigid-plastic phase. The slab is under the action of a constant acceleration and it overlays a very thick ideal fluid. The boundaries of stability and plastic flow are obtained by assuming that the instability is dominated by the average growth of the perturbation amplitude and neglecting the effects of the higher oscillation frequencies during the stable elastic phase. The theory yields complete analytical expressions for such boundaries for arbitrary Atwood numbers and thickness of the solid slabs.

Primary author: Prof. PIRIZ, Antonio Roberto (University of Castilla-La Mancha)

Co-authors: Dr TAHIR, Naeem Ahmad (GSI, Darmstadt); Ms PIRIZ, Sofía Ayelen (Universidad de Castilla-La Mancha)

Presenter: Prof. PIRIZ, Antonio Roberto (University of Castilla-La Mancha)

Session Classification: Dynamics in Plasmas

Contribution ID: **3** Type: **Talk**

Increased R&D preparing for first magnetized targets on NIF in 2020

Wednesday, 29 January 2020 09:25 (25 minutes)

A large design and development project has begun at the Lawrence Livermore National Laboratory with 30 scientists and engineers, towards a goal to field magnetically-assisted ignition targets on the National Ignition Facility using applied B fields up to 30 T for indirectly-driven cryogenic-layered DT capsules soon after 2020. First experiments will be conducted with warm gas-filled capsules planned for fall 2020, to be followed by cryo-DT ice layered capsules when ready after 2020. The 2020 experiments may also include a few polar directly-driven warm gas capsule implosions magnetized with the same NIF pulsed power system. Applied B-field diffusion through a high Z metal hohlraum requires a higher resistance material than gold, and we are investigating promising Au-Ta alloys.

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Co-author: Dr MOODY, John (LLNL-NIF)

Presenter: Dr LOGAN, B. Grant (Consultant to LLNL-NIF)

Session Classification: Fusion Studies I

Contribution ID: **5** Type: **Talk**

Geometrical effects on hydrodynamic instabilities in high energy density matters

Tuesday, 28 January 2020 17:00 (25 minutes)

we derived the dispersion relation for the RTI problem at cylindrical fluid/fluid, solid/solid and fluid/solid interfaces by the decomposition method and also its planar counterpart, which is still easily expanded to study the behaviors of the interfaces by the impulsively accelerated model. Searching for the mathematical details of the dispersion relation, we developed a methodology to study the evolution of the growth rates in terms of the Atwood number (At), the viscosity ratio(m), the elastic ratio (T) and the elastic/viscous ratio (S), and the controlling parameter Br and deduced a mathematical representation to understand the behaviors of the growth rates . Our approaches yield the same growth rates of RTI at cylindrical interfaces for fluid/
fluid interface in comparison with the numerical simulation results. In the solid case, this method produces reasonable explanations for the cutoff azimuthal mode number in
agreement with the experimental observations. Last, we expanded this theory to study
the evolutions of the linear growth rate at solid/fluid interface. This theory is expected to provide an instructive way to investigate the intrinsic properties of the behaviors of the solid target and its transitions into more complicated plasma states on Z-pinch and the future experiments LAPLAS at GSI. Finally, by using the impulsively accelerated mode, the RMI at different cases of interfaces are discussed, in particular for the low mode perturbations, which behaves totally different than that in the planar geometry. Also this method may prove to be helpful to study the Bell-Plesset effect and the transition from elasticity to plasticity in cylindrical geometry.

Primary author: Mr SUN, Yuanbo (Beijing institute of Technology)

Co-author: Prof. WANG, Cheng (Beijing Institute of Technology)

Presenter: Mr SUN, Yuanbo (Beijing institute of Technology)

Session Classification: Dynamics in Plasmas

Contribution ID: **6** Type: **not specified**

Towards Laser Acceleration of Spin-Polarized Helium-3 Ions

Tuesday, 28 January 2020 09:00 (25 minutes)

A well known means of increasing the cross section of fusion reactions and potential output energy gain is to use polarized particles [1]. For polarized fusion to occur, polarized and accelerated fuel is required. We have studied experimentally and theoretically the feasibility of laser-driven polarized ion acceleration using the PHELIX facility at GSI Darmstadt [2]. In our preparatory studies we used unpolarized ^3He and ^4He gas-jet targets with densities of $10^{19} cm^{-3}$ irradiated by high-intensity laser pulses with, I_L up to $10^{19} W cm^{-2}$. These experiments showed that acceleration of He^{2+} and He^{1+} ions is possible with high-energy cut-offs of 4.65 MeV and 3.27 MeV, respectively, but with strong dependence on the target density, laser pulse duration and laser energy. The accelerated ions were observed mainly at 90 degrees with respect to the propagation direction of the laser pulse. These results were analyzed with the help of 2D PIC simulations [2], which also indicated that forward, TNSA-like ion acceleration from the trailing edge of the gas jet is to be expected as well as the Coulomb-explosion driven 90-deg acceleration from the channel walls, consistent with previous works [3].

A second experimental run with a polarized target is scheduled at PHELIX for November 2020. For the preparation of a pre-polarized
^3He target, an external homogeneous magnetic holding field has been designed, optimized, and constructed to hold the gas target for a sufficiently long time inside the PHELIX target chamber. For the measurement of the $^3He^{2+}$ ion polarization, a polarimeter based on the $D(^3He, p)^4He$ fusion reaction has been built within the HGF/ATHENA project. It will be commissioned during a COSY test beam time in February 2020. Based on our previous ion acceleration measurements and simulations we will discuss how to optimize conditions for the upcoming spin-polarization measurements with multi-MeV ^3He ions.

References

[1] Engels R W, et al 2016 Springer Proceedings in Physics (Cham: Springer International Publishing). [2] Engin, Ilhan, et al. 2019 Plasma Physics and Controlled Fusion 61 115012. [3] Wei M S et al 2004 Phys. Rev. Lett. 93 155003,Willingale L et al 2006 Phys. Rev. Lett. 96 245002, Lifschitz A, et al 2014 New J. Phys. 16 033031.

Primary author: CHITGAR, Zahra (Jülich Supercomputing Centre, Forschungszentrum Jülich)

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Presenter: CHITGAR, Zahra (Jülich Supercomputing Centre, Forschungszentrum Jülich)

Session Classification: High-Intensity Lasers and Applications in HED Science I

Contribution ID: **7** Type: **not specified**

Generation of relativistic electronsand gammas in interaction of relativistic laser pulses with plasma of near critical density.

Tuesday, 28 January 2020 09:25 (25 minutes)

Experiments on the direct laser acceleration of electrons in long scale plasma of near critical density were carried out at the PHELIX laser facility at GSI, Darmstadt. Low density polymer foam layers of 300-450 um thickness and combination of foams with um up to mm-thin plane metallic foils were used as targets. Analysis of the electron energy distribution by application of the foam layers showed a 10-fold increase of the electron "temperature" from Thot =1-1.5 MeV, measured for the case of the interaction of 1019 W/cm2 laser pulse with a planar foil, up to 12 MeV for the case when the relativistic laser pulsed propagated through pre-ionized by a ns-pulse foam layer. Increase of the electron "temperature" was accompanied by a strong increase of the amount of relativistic electrons and well defined directionality of the electron beam. Using a combination of the foam layers with high Z convertors at the 1019 W/cm2 laser intensity, we measured up to 100-fold increase of the yield of the gamma-driven nuclear reactions Au (gamma, 3n) Au with a x-ray energy threshold beyond 23 MeV compared to the laser shots directly on to convertor foil at 1021 W/cm2 intensity.

Primary author: ROSMEJ, Olga (GSI, Darmstadt)

Presenter: ROSMEJ, Olga (GSI, Darmstadt)

Session Classification: High-Intensity Lasers and Applications in HED Science I

Contribution ID: **8** Type: **not specified**

About thermal and non-thermal ignition of nuclear fusion reactions

Wednesday, 29 January 2020 10:40 (25 minutes)

The fact that nuclear reactions are about ten million times more energetic than chemical reactions as e.g. the burning of carbon, requires the same difference of thermal equilibrium pressures with similar elevated fusion temperatures: not hundred oC but hundred million degrees. This was changed by the advent of the laser offering the addition of a non-thermal pressure as a nonlinear phenomenon, initially discovered by Thomson-Kelvin as ponderomotion in electrostatics and generalized by Maxwell's stress tensor for plasmas. This was visible from measurements after 1963 at sufficiently high laser intensities, theoretically predicted and experimentally confirmed as ultrahigh plasma acceleration by Sauebrey using CPA picosecond laser pulses of extremely high power. The measurements reached now parameters for non-thermal conditions of nuclear fusion even for the environmentally clean, but in contrast to thermal-classically very low energy-gain reaction of hydrogen and the boron-11 isotope. The increase was measured [1] showing many orders of magnitudes higher energy gains with CPA pulses for a radically new design of generators (Fig. 16 of [1], and [2][3]) for electricity.
[1] H. Hora, G. Korn, L. Giuffrida, D. Margarone, A. Picciotto, J.Krasa, K. Jungwirth, J. Ullschmied, P. Lalousis, S. Eliezer, G.H. Miley, S. Moustaizis and G. Mourou, Fusion energy using avalanche increased boron reactions for block ignition by ultrahigh power picosecond laser pulses. Laser and Particle Beams. 33, No. 4 (2015) 607
[2] Hora, H., Eliezer, S. Kirchhoff G.J., Nissim, N, Wang, J.X., Lalousis, P., Xu, Y.X., Miley, G.H., Martinez-Val, J..M, McKenzie, W., Kirchhoff, J., Road Map to clean energy using laser beam ignition of boron-fusion. Laser and Part. Beams, 35 (2017) 730-740
[3] US-Patent 10,410,752

Primary author: Prof. HORA, Heinrich (University of New South Wales Sydney/Australia)

Presenter: Prof. HORA, Heinrich (University of New South Wales Sydney/Australia)

Session Classification: Fusion Studies II

Contribution ID: **9** Type: **Talk**

Laser Inverse Compton Scattering on Relativistic Electrons in a Tokamak*

Wednesday, 29 January 2020 09:00 (25 minutes)

During a disruption in a tokamak plasma, current carrying electrons can be accelerated to multi-MeV energies, which can cause severe damage to wall components. Conventional ways to study these relativistic electrons include observation of synchrotron and bremsstrahlung radiation. But these measurements are line integrated, and it is difficult to unfold the original runaway electron source distribution. However, just as Thomson scattering is used to measure the thermal electron distribution properties, one can use Inverse Compton Scattering (1) to measure the relativistic electron distribution properties, pointwise in space, and with excellent time resolution. Progress in the design and component testing this new (never before attempted on a fusion experiment) diagnostic using Laser Inverse Compton Scattering to measure runaway electrons in the range of 3-30 MeV in the DIII-D tokamak during triggered disruptions is reported (2). An 80 picosecond, 2-5 Joule, rep-rated (100 Hz) Nd:Yag laser is being developed at Voss Scientific. A LANL gated soft x-ray imager (developed for NIF) has been tested on the synchrotron Advanced Photon Source at Argonne. A synthetic diagnostic model has been developed in Matlab. Finally, a suitable tangential port has been identified on the DIII-D tokamak, and a diagnostic design package is being prepared.

*Supported by the US DOE Fusion Energy Sciences Advanced Diagnostic Program.

(1) G. A. Wurden, J. A. Oertel, T. E. Evans, Rev Sci. Instr. 85(11), 11E111, (2014)

(2) G. Wurden, T. Archuleta, J. Coleman, J. Oertel, Z. Wang, T. Weber, T. Evans, S. Woodruff, P. Sieck, E. Hollmann, D. Offermann, APS-DPP 2019, poster, Ft. Lauderdale, Florida.

Primary author: WURDEN, Glen Anthony (Los Alamos National Labs(LANL-PP))

Presenter: WURDEN, Glen Anthony (Los Alamos National Labs(LANL-PP))

Session Classification: Fusion Studies I

Contribution ID: **10** Type: **not specified**

Effects of non-paraxial off-axis focussing in high-energy laser systems on the reliability of phase retrieval algorithms

Wednesday, 29 January 2020 17:05 (5 minutes)

Modern high-intensity laser systems use off-axis-parabolic mirrors with short focal lengths to achieve highest on-target intensities. These mirrors offer the advantage of achromatic focusing while achieving small focal spots due to very small f-numbers. Adaptive optics (AO) is also commonly used to mitigate wavefront aberrations and therefore reduce deformations of the focal spot. A typical AO setup is built from a deformable mirror and a successive wavefront sensor to run in a closed loop. When used right before the final focusing optic, leakage light from a turning mirror is transported through an imaging system that both images the surface of the deformable mirror onto the wavefront sensor and reduces the beam diameter to a suitable size. This imaging-system, however, itself introduces aberrations to the beam, which therefore influence the quality of the achieved focal spot.
A widely used approach to compensate for this effect is to measure the intensity distribution in several planes of the focal region and run a phase retrieval (PR) algorithm to estimate the wavefront accountable for the deformations present in the focal spot. The commonly used algorithm for this application is the Gerchberg-Saxton algorithm which is most often implemented using complex Fourier transformations to switch between near and far field. However, this invokes that paraxial assumptions can be made, which is not the case for focusing with a high numerical aperture (NA).
In this talk, we present a numeric study of the effects of non-paraxial focusing on the intensity distribution of the focal spot compared with regular paraxial focusing. Also, the effect of off-axis focusing is discussed. The results are used to re-consider the reliability of PR results of the Gerchberg-Saxton algorithm when working with high-NA systems. A NA threshold where the regular algorithms still can be used is determined and a modification of the PR algorithm for higher NA is proposed.

Primary author: OHLAND, Jonas Benjamin (GSI, Darmstadt)

Presenter: OHLAND, Jonas Benjamin (GSI, Darmstadt)

Session Classification: Poster Session

Contribution ID: **11** Type: **not specified**

Non-equilibrium effects on the yield of D3He and DT reaction

Wednesday, 29 January 2020 17:00 (5 minutes)

We present an investigation of non-equilibrium effects on the reaction histories of D3He and DT near the shock front using Monte Carlo simulations. Distributions of temperature and density near the shock front are fitted based on our previous work (Front.Phys.11(6).115206), with the parameters given in the recent paper (PhysRevLett.122.035001). Considering the thermal non-equilibrium properties across the shock front, the averaged reactivities are calculated using the bimodal distribution rather than the Maxwell one under thermal equilibrium condition. The results show that the increase of the yields mainly comes from the enhanced ion temperatures, while both the decrease of temperatures and the consumptions of fuels could cause the drop of the yields.

Primary author: Mr YAN, Zixiang (Peking University)

Co-author: Prof. KANG, Wei (Peking University)

Presenter: Mr YAN, Zixiang (Peking University)

Session Classification: Poster Session

Contribution ID: **12** Type: **Talk**

Recent advances in research of underwater electrical explosion of wires and shock waves generation

Tuesday, 28 January 2020 17:50 (25 minutes)

Experimental and numerical data regarding recent results on underwater electrical explosion of wires and shock waves generation will be presented which include ultra-fast Al wire combustion, development of thermal instabilities during wire explosion and symmetry of converging shock waves.

Primary author: Prof. KRASIK, Yakov (Physics Department, Technion)

Co-authors: Mr ROSOSHEK, Alexander (Technion); Mr MALER, Daniel (Technion); Dr YANUKA, David (Imperial colege); Dr EFIMOV, Sergey (Technion); Dr BLAND, Simon (Imperial Colege)

Presenter: Prof. KRASIK, Yakov (Physics Department, Technion)

Session Classification: Dynamics in Plasmas

Contribution ID: **13** Type: **not specified**

Wake-field formation by high power microwave interaction with plasma

Wednesday, 29 January 2020 17:10 (5 minutes)

Experimental and modeling results regarding formation of wake-field and frequency shift during propagation of 0.6 ns duration, 500 MW power, 9.6 GHz microwave pulse in preliminary formed plasma will be reported

Primary author: Prof. KRASIK, Yakov (Physics Department, Technion)

Co-authors: Mr YANG, Cao (Technion); Dr LEOPOLD, John (Technion); Dr BIOKH, Yuri (technion)

Presenter: Prof. KRASIK, Yakov (Physics Department, Technion)

Session Classification: Poster Session

Contribution ID: **14** Type: **not specified**

PIC Simulation of laser irradiated Micro-Plasma with varying density

Friday, 31 January 2020 11:25 (25 minutes)

We report on a 3D simiulation study of relativistic short laser pulses (10< a0 <120, 20-150 fs FWHM) interacting with isolated targets of micrometer size.
Topic of the study is the emission of fast protons from targets representing hydrogen gas clusters or plastic spheres. Different densities from undercritical so solid conditions, show distinct acceleration mechanisms. We consider the difference between mono-species and two-species plasmas as well as linear and circular polarisation.

Primary author: Ms PAUW, Viktoria (LMU)

Presenter: Ms PAUW, Viktoria (LMU)

Session Classification: Special Session on PIC Simulations II

Contribution ID: **15** Type: **not specified**

Picosecond-contrast degradation in CPA laser systems

Tuesday, 28 January 2020 09:50 (25 minutes)

The importance of a high laser contrast in laser-plasma experiments is widely known. While the temporal contrast in the nanosecond time scale is well understood and optimized, short pulse laser systems around the world still suffer from a slow rising slope of the peak and hence a worse contrast in the regime of picoseconds prior the peak intensity.
We identified noise in a CPA stretcher to be the origin of this short timescale contrast degradation.
We present simulations on the influence of different kinds of noise – e.g. dust or surface deformation – onto the spectral phase and therefore the temporal pulse shape.
The simulation results are compared to measured pulse profile and recommendations for future stretcher designs are concluded.

Primary author: Mr SCHANZ, Victor (GSI, Darmstadt)

Co-authors: Prof. ROTH, Markus (TU Darmstadt); Dr BAGNOUD, Vincent (GSI, Darmstadt)

Presenter: Mr SCHANZ, Victor (GSI, Darmstadt)

Session Classification: High-Intensity Lasers and Applications in HED Science I

Contribution ID: **16** Type: **not specified**

Experimental facilities for High-Energy Density and Warm Dense Matter Experiments at FAIR

Monday, 27 January 2020 11:50 (30 minutes)

At the site of the Gesellschaft fuer Schwerionenforschung (GSI) in Darmstadt, the Facility for Antiproton and Ion Research (FAIR) is currently under construction. FAIR will offer unique high-intensity heavy ion beams and high-intensity proton beams for experiments covering many fields of research, including the study of high-energy density samples and the study of warm dense matter.

The research in this field is coordinated by the High Energy Density Science at FAIR (HED@FAIR) collaboration, which will focus on four main fields of study:

1) The study of the properties of materials driven to extreme conditions of pressure and temperature;
2) The study of shocked matter and of equations-of-state;
3)The study of basic properties of strongly-coupled plasma and warm dense matter; and
4)Nuclear photonics, including the excitation of nuclear processes in plasmas and laser-driven particle acceleration and neutron production.

The SIS-100 heavy ion synchrotron at FAIR will provide heavy ion beams with up to $5 \cdot 10^{11}$ U^{28+} ions with 2 AGeV in a 50 ns bunch for plasma physics experiments where they will be used either to isochorically heat macroscopic samples to eV temperatures or to indirectly compress them to megabar pressures. In addition, SIS-100 will also high-energy protons (up to 10 GeV with up to $2.5 \cdot 10^{13}$ protons per bunch) which will be used for a proton microscope.

Before the start of FAIR, experiments will use the upgraded UNILAC and SIS-18 accelerators at GSI ("Phase 0"). In my presentation I will give an overview of the experimental facilities that will be available for HED experiments at FAIR as well as at GSI in Phase 0, the current status and the timeline for the construction and commissioning of the experimental setup.

Primary author: NEFF, Stephan (FAIR, Darmstadt)

Presenter: NEFF, Stephan (FAIR, Darmstadt)

Session Classification: HED and HED Facilities II

Contribution ID: **17** Type: **not specified**

Parametric instabilities, electron injection and acceleration from relativistic laser interaction with solid targets

Thursday, 30 January 2020 10:30 (25 minutes)

Efficient direct electron acceleration in the plasma channel with injection through the breaking of plasma waves generated by parametric instabilities was demonstrated experimentally and reproduced in the 2D3V PIC simulations. The electron bunch was produced using the specific plasma profile containing arbitrary sharp, ~0.5λ, gradient at the vicinity of 0.1−0.5 critical density and a long tail of a tenuous preplasma. Such a preplasma profile was formed by an additional nanosecond laser pulse with intensity of 5×10^12 W cm−2. In the case of optimal preplasma parameters femtosecond laser pulse with an intensity of 5×10^18 W cm−2 and an energy of 50 mJ generates a collimated electron bunch having divergence of 50 mrad, exponential spectrum with the slope of ~2 MeV and charge of tens of pC. The charge was confirmed measuring neutron yield from Be(g, n) photonuclear reaction with threshold of 1.7 MeV. By the contrast, a ring-like electron beam with divergency of 300 mrad and significantly lower charge is generated if the prepulse intensity drops to 5×1011 W cm−2. The 2D PIC simulations confirmed beamed electron's acceleration in the plasma channel (so-called direct laser acceleration). This channel is formed in a long tail of teneous preplasma by the laser pulse specularly reflected from the arbitrary sharp gradient. The ring-like electron beam was attributed to the longer gradient case enlarging divergence of the reflected laser beam, preventing channel's formation and electron acceleration by the so-called vacuum laser acceleration, or VLA. We also showed that injected electrons appeared from the wave breaking of plasma waves of hybrid SRS-TPD instability for the both gradients. Electrons received an initial momentum from this breaking to be effectively injected into the plasma channel.

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Presenter: Prof. SAVEL'EV, Andrei (Lomonosov Moscow State University)

Session Classification: Applications of Plasmas

Contribution ID: **18** Type: **not specified**

Exascaling strategies for the EPOCH Community PIC Code

Friday, 31 January 2020 08:30 (30 minutes)

Since its public release in 2015, the EPOCH particle-in-cell community code has accumulated a large base of over 1100 registered users, becoming an indispensable workhorse tool for many groups worldwide whose research specialisation ranges from high-power laser-plasma interactions and QED-plasmas, to kinetic instabilities in tokamaks, space physics and particle accelerator design. EPOCH solves the Maxwell equations for the electromagnetic field with fully relativistic charge dynamics, providing a choice of several numerical implementations of the field solver and particle integration schemes respectively. EPOCH runs on computers ranging from standard laptops for one- and two-dimensional simulations, to national Tier-1 supercomputers with up to 10,000's of cores for more substantial three-dimensional problems.

Despite its wide acceptance and usability, the code still exhibits performance deficits in the parallel implementation of its communication scheme, including load balancing and data I/O. The PICeX project in the framework of the PRACE 6IP plans to carry out optimisation refactoring of EPOCH's core algorithmic kernels, considering parallelism, vectorization, and I/O libraries while maintaining the integrity of code's physics packages. One priority is to enable the code for contemporary Tier-0 PRACE supercomputers as well as to explore more innovative schemes for future Exascale machine architectures. In this talk we will outline these strategies in the light of recent hardware developments at the Juelich Supercomputer Centre and within EuroHPC.

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Presenter: GIBBON, Paul (Forschungszentrum Juelich GmbH)

Session Classification: Special Session on PIC Simulations I

Contribution ID: **19** Type: **not specified**

Towards the QED limits

Friday, 31 January 2020 09:00 (25 minutes)

we consider a few options to access the ultimate QED limit of matter in the strong electro-magnetic field, when \xi \alpha^2/3 > 1, where \alpha=1/137 is the fine-structure constant and \xi is the non-linear quantum parameter.
This regime of fully non-perturbative QED has long been assumed to be not accessible experimentally. Yet, the progress in laser technology and particle accelerators may bring this regime within experimental reach.

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Presenter: Prof. PUKHOV, Alexander (Uni Dusseldorf)

Session Classification: Special Session on PIC Simulations I

Contribution ID: **20** Type: **not specified**

Reflectivity and spectral shift from plasma mirrors generated by KrF laser

Thursday, 30 January 2020 09:20 (25 minutes)

It was recently shown 1 that plasma mirror can be an applicable pulse cleaning method even for UV lasers, as up to 70~\% efficiency can be obtained for intensities of 10^{15}~W/cm^2. High acceleration of KrF laser produced plasmas was also observed 2. Even recent results show that absorption and reflection of intense ultrashort laser pulses from laser plasmas depend strongly on the temporal contrast of the laser beam [3]. In our lab a new non-linear Fourier-filter method [4] was demonstrated for the contrast improvement of short-pulse KrF lasers and this was applied the first time here for high-intensity laser plasma experiments. It was found that increasing the intensity of the 248~nm, 600~fs laser pulse from 10^{15}~W/cm^2 to 10^{18}~W/cm^2 the plasma reflectivity not only saturates but decreases below 20~\% for different target materials and different polarizations. The spectral shift of the reflected beam depends strongly on the contrast of the beam. Using the improved contrast of $5 \cdot 10^{11}$ with the Fourier filtering spectral blue shift up to 0.6~nm was observed, corresponding to the plasma acceleration of $4 \cdot 10^{18}$~ms^{-2}. This is approximately four times higher than the previous result 2 and it does not depend strongly on the incoming beam polarization. Thus the acceleration is probably caused by the ponderomotive force.

\vspace{10mm}

\noindent\textbf{References}
\vspace{5mm}

\noindent1 B. Gilicze et al.; Rev. Sci. Instrum. \textbf{87}, 083101 (2016)

\noindent2 R. Sauerbrey; Physics of Plasmas \textbf{3}, 4712 (1996)

\noindent[3] P.K. Singh et. al.; Scientific Reports \textbf{5}, 17870 (2015)

\noindent[4] B. Gilicze et. al.; Optics Express \textbf{27}, 17377 (2019)

Primary author: Mr KOVACS, Zsolt (Wigner Research Centre for Physics and University of Szeged)

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Presenter: Prof. FÖLDES, Istvan (Wigner Research Centre for Physics)

Session Classification: High-Intensity Lasers and Applications in HED Science III

Contribution ID: **21** Type: **not specified**

The GSI and FAIR laser cooling activities

Wednesday, 29 January 2020 17:15 (5 minutes)

Stored and cooled relativistic heavy-ion beams have a small relative momentum spread (Δp/p) and a small emittance (ϵ) and are therefore ideally suited for high-precision experiments, such as laser and X-ray spectroscopy. At storage rings, cooling is typically achieved by means of electron and/or stochastic cooling, which yield cooling times of several seconds and Δp/p $\sim 10^{-5}$.
Laser cooling can, however, cool ion beams even faster and reach Δp/p $\sim 10^{-7}$. Furthermore, laser cooling becomes more effective at higher energies than electron cooling, and is – unlike stochastic cooling – not limited to low ion beam intensities. The future Facility for Antiproton and Ion Research (FAIR) will offer heavy-ion beams (as well as antiproton beams) with highest energies and intensities. The heavy-ion synchrotron SIS100 is (at) the heart of FAIR and stores, accelerates, and delivers the beams – initially provided by the GSI accelerators – to the FAIR experiments (i.e. the APPA, CBM, NUSTAR and PANDA collaborations).
At the SIS100, laser cooling of bunched heavy-ion beams is our preferred method and is currently being prepared for [1,2]. Cooling is achieved by balancing the force from anti-collinear laser light exerted on the ions by the counter-acting force from the rf-bucket.
Calculations show that laser cooling at the SIS100 can be almost as effective as has been demonstrated at the ESR [3]. Furthermore, it should assist in making the SIS100 ion bunches – achieved by means of bunch compression (< 50 ns) – even shorter, thus offering world-wide unique possibilities. Because of the huge magnetic rigidity (100 Tm) of the SIS100, very large gamma factors (up to 13) and correspondingly large Doppler-shifts can be achieved, which should enable laser cooling (and laser spectroscopy) of a broad range of ion species. We will present the general concept of bunched beam laser cooling and provide an overview of the laser cooling pilot facility at the SIS100.

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Session Classification: Poster Session

Contribution ID: **22** Type: **not specified**

Development of Poly- and Monochromatic X-Ray Imaging Techniques for Phase-0 and FAIR

Monday, 27 January 2020 17:50 (25 minutes)

Intense uranium ion beams that will be available after commissioning of the new synchrotron SIS100 in Darmstadt will be used for volumetric heating of any type of material and generation of extreme states of matter with Mbar pressures and some eV of temperature. Investigation of their EOS is one of the main goals of the plasma physics program at FAIR. Diagnostic of such extreme states of matter demands development of new diagnostic methods and instruments, which are capable to operate in an environment with a high level of radiation damage. The precise knowledge of the energy density distribution of the U-beam on the target is a very important input parameter for numerical simulations of the hydrodynamic response of the target on deposited energy. Simulations are crucial during the planning of experiments and for the interpretation of obtained experimental data. To investigate the energy density distribution, we propose to use the target and heavy ion beam X-ray fluorescence for imaging of the target expansion and mapping of the heavy ion beam distribution in the interaction region with a high spatial resolution of at least 100 µm. First pilot experiments on measurements and characterisation of the heavy ion and target fluorescence using pinholes, X-ray CdTe-diodes and dispersive systems have been carried out in 2016 and 2019 at the UNILAC Z6 experimental area in collaboration with the Plasma Physics Group of GSI, Darmstadt, the Institute for Optics and Quantumelectronics of the Friedrich-Schiller_University, Jena and the Institute for Theoretical and Experimental Physics, Moscow. The obtained results can be scaled to high heavy ion energies available at SIS18 and SIS100.

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Presenter: Mr ZÄHTER, Sero (GSI-Darmstadt)

Session Classification: Activities of HED@FAIR

Contribution ID: **23** Type: **not specified**

Development of a new ultra-high contrast module at PHELIX

Wednesday, 29 January 2020 17:20 (5 minutes)

Since the implementation of the ultrafast optical parametric amplifier [1,2] (uOPA) as first amplifier within the frontend of the PHELIX laser system, which enables operation at extremely low ASElevels, the high-contrast operation mode has become the most favorable one for users at the PHELIX system.

Nonetheless, aside from the ASE-contrast, there is still lots of space for improvement concerning the laser-contrast in general. Especially the appearance of pre-pulses, spreaded over a timescale of few nanoseconds around the main-pulse [3], is still a challenging issue.

To overcome this problem, an ultra-high contrast module is being developed in the context of the ATHENA-project, which will act as the first amplifier at the PHELIX- and also at the PENELOPE-frontend.
Using this novel module will allow the removement of pre-pulse-generating amplifiers and even further enhance the ASE-contrast by2-3 orders of magnitude.

On this poster, we will present the the design, goals and current status of the module-development.

1 Dorrer, C., et al. "High-contrast optical-parametric amplifier as a front end of high-power laser systems." Optics letters 32.15 (2007): 2143-2145.

2 Wagner, F., et al. "Temporal contrast control at the PHELIX petawatt laser facility by means of tunable subpicosecond optical parametric amplification." Applied Physics B 116.2 (2014): 429-435.

[3] V. A. Schanz, C. Brabetz, D. J. Posor, M. Roth, V. Bagnoud, High dynamic range, large temporal domain laser pulse measurement, Appl. Phys. B 125.61 (2019)

Primary author: ZOBUS, Yannik

Co-authors: Dr BRABETZ, Christian (GSI, Darmstadt); Dr BAGNOUD, Vincent (GSI, Darmstadt)

Presenter: ZOBUS, Yannik

Session Classification: Poster Session

Contribution ID: **24** Type: **Talk**

Advanced Heavy Ion Accelerators for HED Research

Monday, 27 January 2020 09:40 (30 minutes)

This presentation outlines ongoing activities on development of heavy ion accelerator facilities, providing high-brightness beams capable of generating intense beams extreme state of matter. Manifested facilities goals is pushing the "intensity" and the "precision frontiers" to the extremes when accelerating full range of ion beam species from p+ to U to highest beam intensities and luminosities.
Consideration is focused on the recent achievements in high power linear accelerator injection chains, rapid cycling superconducting magnets of large synchrotron rings, ultra-high dynamic vacuum technologies, efficient accumulation and cooling of intense heavy ion beams.
Generation of "precision beams", sophisticated beam manipulation methods-stochastic and electron cooling of ion beams, also applicable to the secondary radioactive beams of exotic nuclei is under discussion.
Construction of new generation of heavy ion accelerator facilities is progressing well and forefront accelerator technologies are under development in JINR for low energy as well as for relativistic heavy ion nuclear physics.

Primary author: Prof. SHARKOV, Boris (JINR Dubna)

Presenter: Prof. SHARKOV, Boris (JINR Dubna)

Session Classification: HED and HED Facilities I

Contribution ID: **25** Type: **not specified**

Ion beam plasma interaction with respect to High Energy Density Science and relevance to energy from nuclear fusion -Proton Boron Fusion revisited-

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High intensity particle accelerators like FAIR at GSI Darmstadt and the proposed HIAF facility in China are a new tools to induce High Energy Density states in matter. We will give an account of High Energy Density Physics with aspects of inertial fusion energy and due to recent developments we will address Proton-11Boron fusion.

Primary author: Prof. HOFFMANN, Dieter H.H. (TU-Darmstadt)

Presenter: Prof. HOFFMANN, Dieter H.H. (TU-Darmstadt)

Contribution ID: **26** Type: **not specified**

On perspectives of HED@FAIR experimental study of dual unexplored phenomenon - anomalous thermodynamics regions nearby entropic phase transitions

Monday, 27 January 2020 18:15 (25 minutes)

There are three basic points for discussions on perspectives of HED@FAIR experimental study of unexplored phenomena: (*1*) – how to arrange HIB energy deposition; (*2*) – how to arrange diagnostics; (*3*) – what fundamental physical phenomenon should be explored to justify our using such huge facilities like FAIR, LHC, NICA *etc* for thermophysical investigations. In my talk I plan to continue my previous discussions on point (*3*). I.e. – very plausible but still hypothetical objects – *anomalous thermodynamics regions* (ATR) accompanying *entropic phase transitions* (*S*-PT). Remarkable feature of ATR - negative isochoric pressure/temperature derivative $(\partial P/\partial T)V$ leads to non-standard sequence of expansion and compression of isochorically heated sample within HIHEX scenario. Another feature of ATR – anomalous negative isentropic pressure/temperature derivative $(\partial T/\partial P)S$ leads to non-standard behavior of temperature on isentropic compression within LAPLAS scheme, i.e. T-decreasing instead of naively expected T-increasing, and anomalous T-increasing instead of expected T-decreasing along isentropic expansion in second stage of HIHEX. In my discussions I base on example of hot dense nitrogen as the material with (*S*-PT + ATR) anomalies, which were predicted by dynamic experiments and by the First-Principle numerical simulation.

This work is supported by the Presidium RAS Scientific Program "Novel approaches to investigations of matter under high energy density conditions"

Primary author: Prof. IOSILEVSKIY, Igor (Joint Institute for igh Temperature)

Presenter: Prof. IOSILEVSKIY, Igor (Joint Institute for igh Temperature)

Session Classification: Activities of HED@FAIR

Contribution ID: **27** Type: **not specified**

Setup and investigation of a plasma window with optimized apertures for intense particle beam transmission to high pressure targets

Thursday, 30 January 2020 11:45 (25 minutes)

A plasma window (PW) provides a membrane free particle beam transmission while separating low pressure areas such as accelerator vacuums from high pressurized environments. It offers advantages over conventional low pressure interfaces such as higher operation times and shorter length scales. At IAP Frankfurt, a PW was successfully developed and investigated in terms of its pressure separation performance, its electrical characteristics and plasma parameters. The talk will outline the current state and further design considerations for future applications on intense particle beams at FAIR.

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Presenter: MICHEL, Andre (IAP, Goethe University Frankfurt)

Session Classification: Applications of Plasmas

Contribution ID: **28** Type: **not specified**

New findings on laser electron acceleration and enhanced multi MeV high intense γ-ray generation at moderate laser intensities

Wednesday, 29 January 2020 17:40 (5 minutes)

We report on new findings in laser electron acceleration and high intense bremsstrahlung generation in the multi MeV energy range at moderate laser intensities. The new findings demonstrate the feasibility in terms of applications in the research field of nuclear photonics.

In recent laser matter interaction experiments at PHELIX facility (GSI, Darmstadt) using special foam targets, irradiated at moderate laser intensities of only 10^{19} W/cm^2, we have observed reproducible an enhancement in the production of particles and high intense bremsstrahlung photons concerning number and energy. Electrons with >10 times increasing of the averaged kinetic energy (temperature) and protons with an enhanced Intensity are observed compared to the observations in the same experimental campaign using foil targets irradiated with higher laser intensities of more than 10^{21} W/cm^2. Furthermore, using polymer foam targets combined with different thick metal foils we investigated nuclear reactions in several Isotopes of different elements induced by protons as well as bremsstrahlung photons. For example, multi gamma induced photon-neutron disintegration reactions in gold and tantalum within an energy range of 8 MeV up to more than 30 MeV were observed with a 100 times higher reaction yield and a smaller angular spread at 10^{19} W/cm^2 compared to experiments with conventional targets at intensities of 10^{21} W/cm^2.

The new findings shown the capable feasibility in the realization of laser assisted nuclear physics experiments concerning the investigation of proton and photon induced fission reactions as well as time resolved experiments and nuclear structure physics up to nuclear astrophysics experiments. Therefore, the presented results are promising for applications in the research field of nuclear photonics using high-power pulsed laser systems in the TW range at moderate laser intensities.

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Presenter: Dr GÜNTHER, Marc (GSI, Darmstadt)

Session Classification: Poster Session

Contribution ID: **29** Type: **not specified**

Hematite phase diagram under laser shock compression

Wednesday, 29 January 2020 17:45 (5 minutes)

Iron–oxygen (Fe-O) binary systems are of the utmost importance for planetary evolution. However, their phase diagrams and physical properties at extreme pressure and temperatures are poorly known. As an example, recent static compression experiments have demonstrated the existence of new iron oxide stoichiometries at high pressure and temperature such as FeO2 1, Fe4O5 [3], Fe5O6 [4]. These discoveries, with the wide variety of iron oxides phases existing at high pressure [5], highlight the complexity of iron-oxygen phase diagram in extreme condition. In this context, measurements of physical properties, phase transition processes and phase diagrams of Fe-O systems with laser shock compression techniques offer unique opportunities to extend the actual pressure and temperature ranges of such studies. Here, I will present main results from a laser shock experiment at the ID24 ESRF beamline using time-resoved X-ray absorption measurement on Fe2O3 samples. In addition, I will show a preliminary analysis of a very recent experiment performed at LULI 2000 to measure equation of state along the Fe2O3 Hugoniot and above 500GPa. I will also describe the experimental setups, as well as the target designs and fabrications used for both experiments.

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (ERC PLANETDIVE grant agreement No 670787).

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1 Q. Hu and al., "FeO2 and FeOOH under deep lower-mantle conditions and Earth's oxygen–hydrogen cycles" Nature, 534, 241 – 244, (2016).

2 E. Boulard et al., "Ferrous iron under oxygen-rich conditions in the deep mantle" Geophysical Research Letter, 46, 1348 – 1356, (2019).

[3] B. Lavina et al., "Discovery of the recoverable high-pressure iron oxide Fe4O5" Proceedings of the National Academy of Sciences of the United States of America, 108(42), 17281–5, (2011).

[4] B. Lavina et al., "Unraveling the complexity of iron oxides at high pressure and temperature: Synthesis of Fe5O6" Science Advances, 1, e1400260, (2015).

[5] E. Bykova et al., "Structural complexity of simple Fe2O3 at high pressures and temperatures" Nature communication, 7, 10661, (2016).

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Session Classification: Poster Session

Contribution ID: **30** Type: **not specified**

Journey from Heavy Ion Fusion to High Energy Density Physics over the Past 40 Years

Monday, 27 January 2020 10:10 (30 minutes)

In 1979 a heavy ion beam driven inertial confinement fusion (ICF) reactor study, named HIBALL was organized by the GSI, in which 50 scientists from different institutions participated. This study included the driver design, the target design and the reactor chamber design. A small group of scientists worked to propose a viable ICF target for the HIBALL reactor system. Suitable target parameters were determined and the target performance was analyzed in detail (Tahir, Long & Mayer-ter-Vehn). This basically was the beginning of the plasma physics at GSI. It was concluded that the very high beam intensities (10^{14} ions / bunch) and short bunch lengths (10 ns) needed for the target implosion, were not possible to achieve with the available technology. Moreover, it was realized that this parameter range could not be accessed even with the technology available in the foreseeable future. For example, today we expect that in 2025, the SIS100 will deliver $5x10^{11}$ uranium ions in a 70 - 100 ns long bunch. However, theoretical work done over the past years has shown that that with such beam parameters, large samples of High Energy Density (HED) matter can generated over a wide range of parameters. Two experiments, namely, HIHEX (Heavy Ion Heating and Expansion) and LAPLAS (Laboratory Planetary Physics), have been proposed for the HED physics research program at FAIR. The former experiment will allow studies of thermo-physical properties of HED matter, whereas, the latter will enable to generate the planetary core conditions in the laboratory. In fact these two experiments can also be used to study the equation-of-state of the deuterium-tritium fuel of an ICF target during the irradiation by the pre-pulse. This talk presents an overview of this work.

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Presenter: Dr TAHIR, Naeem Ahmad (GSI, Darmstadt)

Session Classification: HED and HED Facilities I

Contribution ID: **31** Type: **Talk**

Non-adiabatic effects and exciton-like states during insulator-to-metal transition in warm dense hydrogen

Tuesday, 28 January 2020 18:40 (25 minutes)

Transition of molecular hydrogen to atomic ionized state with increase of temperature and pressure poses still unresolved problems for experimental methods and theory. Here we analyze the dynamics of this transition and show its nonequilibrium non-adiabatic character overlooked in both interpreting experimental data and in theoretical models. The non-adiabatic mechanism explains the strong isotopic effect [Zaghoo, Husband, and Silvera, Phys. Rev. B 98, 104102 (2018)] and the large latent heat [Houtput, Tempere, and Silvera, Phys. Rev. B 100, 134106 (2019)] reported recently. We demonstrate the possibility of formation of intermediate exciton-like molecular states at heating of molecular hydrogen that can explain puzzling experimental data on reflectivity and conductivity during the insulator-to-metal transition.

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Presenter: Dr STEGAILOV, Vladimir (JIHT RAS)

Session Classification: Dynamics in Plasmas

Contribution ID: **32** Type: **not specified**

Optically tunable proton acceleration in femtosecond ultraintense laser-foil interaction

Thursday, 30 January 2020 10:55 (25 minutes)

The rapid development, especially in the intensity and temporal contrast of ultraintense short-pulse lasers and the achievable technology of the nanometer materials have enabled new regimes of relativistic laser-plasma-interaction research and applications, such as laser-driven ion acceleration based on novel mechanisms, warm dense matter generation. A critical aspect of these is the initial spatial density distribution of the plasma for the ultrathin foil modulated by the laser prepulse, which significantly affects or dominates the laser energy absorption, hot electron generation, transport and then ion acceleration mechanisms or whatnot. For ion beam generated from the new-parameters regime of the laser-foil interaction, its spatial quality (uniformity and collimation) is particularly important for these applications and closely related to the plasma density state.

In this paper, we propose a hybrid acceleration scheme of relativistically induced transparence and sheath acceleration for controlling the properties of proton beam by using a femtosecond prepulse in high-contrast laser-foil interaction. Two groups of collimated protons with uniform spatial distribution are observed along the target normal direction and the laser propagation direction from vacuum-gapped double-foil target, respectively. Meanwhile, it is found that the flux density of proton beam emitted along the laser axis is enhanced via increasing the intensity of the femtosecond prepulse. Hydrodynamic simulations and 2D particle-in-cell simulations indicated that the plasma shutter foil becomes relativistically transparent during the interaction due to the optically tunable preplasma density state. As a result, the distribution of hot electrons at the target rear side is mainly deflected to the laser axis. The implications for ion acceleration driven by multi-petawatt laser facilities under this hybrid acceleration scheme are also investigated.

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Presenter: Dr WEI, Wenqing (Xi'an Jiaotong University)

Session Classification: Applications of Plasmas

Contribution ID: **33** Type: **not specified**

Study of gamma-rays produced by intense laser interactions with low density foams using nuclear diagnostic

Wednesday, 29 January 2020 17:25 (5 minutes)

In the recent experiment carried out in September 2019 in PHELIX laser facility in Darmstadt, Germany, the interaction of relativistic laser pulse with different targets namely low density CHO foams, high-Z foils and high Z-radiators was investigated.

Using different diagnostic tools especially electron-spectrometers in different angles, TLD-spectrometers and nuclear samples, it was possible to determine electron spectra, measure dosis and evaluate the gamma spectra by means of photonuclear reactions.

Photonuclear were observed and quantified in Cr, In, Ta and Au samples. These Samples were placed in different angles relative to target and the reactions yields were determined by HPGe gamma spectrometry. The results show activation products as 194Au a (g, 3n) reaction using CHO foam in combination of gold as radiator, requiring gamma rays exceeding 23 MeV in energy. In addition this method was also used to determine reaction yields caused by thermal and fast neutrons.

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Presenter: Ms TAVANA, Parysatis (Goethe University)

Session Classification: Poster Session

Contribution ID: **34** Type: **Talk**

PRIOR-II - Proton Radiography for FAIR

Monday, 27 January 2020 17:25 (25 minutes)

High energy proton radiography is a diagnostics technique suitable for many applications in the field of high energy physics, materials science and in the medical sector. The use of an imaging lens combined with a custom beam line configuration upstream of the experiment produces high quality images with the unique possibility of adjusting the image contrast according to the needs of the respective experiment.

A radiographic device — PRIOR-II — has been developed at the GSI Helmholtzzentrum für Schwerionenforschung GmbH Germany, specifically designed for fully exploiting the capabilities of the present SIS-18 synchrotron. The design of the setup is based on the experience acquired during the commissioning of the PRIOR-I prototype using permanent magnet quadrupoles {1,2}. PRIOR-II is expected to achieve a spatial resolution performance in the order of 10 microns with 4 GeV protons. Furthermore, it is possible to capture dynamic processes using the 0.3 Hz fast extraction mode of the synchrotron.

The setup is foreseen for transfer to the future FAIR facility, where the spatial resolution performance is expected to increase due to a slightly higher proton energy of 5 GeV. In addition, the temporal resolution capabilities will be enhanced due to the 0.1 Hz fast extraction mode from the SIS-100 synchrotron.

The magnets and power supplies are currently being manufactured, the FAT and installation is scheduled for January of 2020. In mid 2020 a beam time is scheduled which will include the static commissioning of the new setup as well as dynamic experiments with a newly developed pulsed power setup. Several further experiments regarding biomedical imaging for heavy ion tumor therapy as well as the propagation of shock waves in matter driven by high explosives are currently being prepared.

{1} D. Varentsov et al., "*Comissioning of the PRIOR proton microscope*", Rev. Sci. Instrum. **87**, 023303 1– 8 (2016).

{2} M. Schanz et al., „*High Energy Proton Induced Radiation Damage of Rare Earth Permanent Magnet Quadrupoles*", Rev. Sci. Instrum. **88**, 125103 (2017).

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Presenter: Mr SCHANZ, Martin (GSI, Darmstadt)

Session Classification: Activities of HED@FAIR

Contribution ID: **35** Type: **not specified**

Estimation of preplasma properties via time-resolved spectroscopy of back-reflected light

Tuesday, 28 January 2020 10:35 (25 minutes)

Nowadays research on laser-driven proton acceleration is focusing on the interaction of relativistic-intensity laser pulses with sub-micrometer targets, aiming for advanced acceleration mechanisms. Despite very positive estimates delivered by numerical simulations, a significant discrepancy is found in the experimental realization so far, which requires further investigations. The predicted mechanisms rely on well-defined plasma conditions at the time of the maximum laser intensity. These conditions, especially the preplasma scale length are extremely hard to measure and remain mostly not known, which prevents a detailed study and an efficient use of these acceleration mechanisms.

During the interaction of the laser and plasma, a part of the laser pulse is reflected back at the critical plasma density, carrying important information about the interaction process itself. The spectrum is modulated due to effects such as relativistic self-phase-modulation and is additionally Doppler-shifted by the moving critical density occurring during hole boring or plasma expansion. The interplay between these effects is intimately related to the plasma density gradient in the vicinity of the reflection point as well as the plasma temperature. A shallow plasma gradient will favor hole boring, leading to a red Doppler-shift for instance, whereas a steep plasma gradient will impose a strong electron-pressure, counteracting the laser pressure.

To study these effects and corresponding time scales, a diagnostic for back-reflected light based on frequency resolved optical gating (FROG) has been commissioned at the PHELIX facility where intensities above 1020 W/cm² and pulses with ultra-low temporal pedestal are available. We have conducted measurements for different plasma conditions: at first with the standard temporal profile of the laser pulse, then with a double plasma mirror setup that dramatically steepens the pulse.

As a support to the experimental data, we have performed 2D simulations using the particle-in-cell code EPOCH, with parameters as close as possible to the experiment, including a pre-expanded target. We varied the scale length and temperature of the plasma and monitored its effect on the time dependent spectrum of the back-reflected pulse. With decreasing scale-length around or below 1 µm, a transition from a red shifted spectrum to a blue shifted one at even higher gradients is visible, as observed experimentally.

We believe that this method can deliver some estimates on the preplasma expansion on a sub-micrometer scale, a spatial range which can be hardy covered by other experimental methods like shadowgraphy or interferometry (though more complex Frequency Domain Interferometry can access similar ranges). This result is of particular interest for the understanding of experiments aiming at laser-driven ion acceleration, which mostly rely on unexpended foils to maximize the acceleration process.

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Presenter: HORNUNG, Johannes (GSI, Darmstadt)

Session Classification: High-Intensity Lasers and Applications in HED Science II

Contribution ID: **37** Type: **not specified**

The Open-Source Particle-In-Cell Code SMILEI

Friday, 31 January 2020 09:25 (25 minutes)

Started in 2013, the electromagnetic PIC code SMILEI has achieved significant progress, both on the physics and performance aspects. To match its open-source and community-driven approach, it is now well documented and has a user-friendly design. New physics modules include collisions, ionization, radiation reaction, multiphoton Breit-Wheeler pair creation, an envelope model for laser-plasma ponderomotive interaction, and cylindrical geometry with azimuthal Fourier decomposition. High scalability and performance are ensured with a hybrid shared/distributed-memory parallel computation, a space-filling-curve dynamic load-balancing technique, and a novel, efficient adaptive vectorization method. Particle merging and splitting processes bring additional control on the performance. These aspects will be reviewed. Large-scale simulations relevant to laser-plasma interaction, particle acceleration or astrophysics, and performed by the SMILEI community will also be presented.

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Presenter: Dr GRECH, Mickael (LULI, CNRS)

Session Classification: Special Session on PIC Simulations I

Contribution ID: **38** Type: **not specified**

Equation of state for vanadium at high energy densities

Thursday, 30 January 2020 17:55 (25 minutes)

A new semiempirical equation of state for vanadium is proposed with taking into account melting and evaporation effects. Calculations of thermodynamic characteristics and the phase boundaries of solid, liquid and vapor over a wide range of densities and temperatures are carried out. Comparison of calculated results with available experimental data and theoretical predictions at high energy densities is presented. Obtained multiphase equation of state for vanadium can be used effectively in numerical modeling of processes under conditions of intense pulsed influences on the metal. The work is supported by the Russian Science Foundation (grant No. 19-19-00713).

Primary author: Dr KHISHCHENKO, Konstantin (Joint Institute for High Temperatures RAS)

Presenter: Dr KHISHCHENKO, Konstantin (Joint Institute for High Temperatures RAS)

Session Classification: Modelling HED Physics

Contribution ID: **39** Type: **not specified**

The problem of radiation reaction in intense laser fields

Thursday, 30 January 2020 17:00 (30 minutes)

It is well-known that interacting fields pose fundamental problems. A prototypical example is radiation reaction. The well-known LAD equation in the context are of little use since they are ill-defined. Up to now it is not fully clear how to derive consistent equations of motion for interacting fields. We propose to give up the notion that electrons are point-like or in other words are represented by simple worldlines in spacetime. Instead, we assume that electrons are fundamental 2D objects in the latter. The equations we derive from this assumption show no unphysical properties as do the LAD equations. We can also hint at why the LAD equations seem to fail. In the wake of our derivation the concept of emergent inertia occurs. Inertia, as it seems, is a direct consequence of interaction. Our new equations can be solved numerically in a much more efficient way than the Landau-Lifshitz equations. Hence, they might serve as a replacement for appropriate equations of motion in the context of high field laser-matter interaction in the future.

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Session Classification: Modelling HED Physics

Contribution ID: **40** Type: **not specified**

Ab initio methods for modelling and simulation of warm dense hydrogen: how to get beyond Born-Oppenheimer approximation?

Wednesday, 29 January 2020 17:50 (5 minutes)

Insulator-to-metal transition (IMT) in fluid warm dense hydrogen (WDH) is one of the unresolved problems of the last decades. There are a large number of experiments aimed at determining this transition, but they have a large number of disagreements among themselves.

Today, the theoretical description of experiments has come down to the use of *ab initio* methods. One of the most used is the Born-Oppenheimer dynamic with finite-temperature density functional theory (FT DFT). This method assumes that at each step the system has a certain average (fractional) distribution of electrons over states. Accordingly, it is important to understand that for this method to work, it is necessary that the electron transition times between these states are significantly less than the molecular dynamics step. To verify this assumption, it is necessary to move away from DFT and use methods in which the dynamics of electrons is considered explicitly.

The aim of this work is to study the IMT problem by non-adiabatic *ab initio* methods that would allow us to consider the non-equilibrium nature of this IMT that has not been considered previously in its theoretical assessments.

Primary authors: Mr FEDOROV, Ilya (Moscow Institute of Physics and Technology); Mr OREKHOV, Nikita (Moscow Institute of Physics and Technology); Dr STEGAILOV, Vladimir (JIHT RAS)

Presenter: Mr FEDOROV, Ilya (Moscow Institute of Physics and Technology)

Session Classification: Poster Session

Contribution ID: **41** Type: **not specified**

Development and plasma physical investigation of a plasma window for the generation of high pressure differences

Thursday, 30 January 2020 11:20 (25 minutes)

A plasma window (PW) is a device for separating two areas of different pressures while letting particle beams pass with little to no loss.
It has been introduced by A. Hershcovitch.
In the course of this talk, the properties of a PW with apertures of 3.3 and 5.0mm will be presented which was investigated during my PhD thesis.

As working gas, a 98%Ar-2%H_2 mixture has been used due to the intense Stark broadening of the H_β-line and the well-described Ar characteristics, enabling an accurate electron density and temperature analysis.
At the low pressure side around some mbar, high-pressure values reached up to 750mbar while operating with volume flows between 1slm and 4slm (standard liter per minute) and discharge currents ranging from 45A to 60A.
The achieved ratios between high and low pressure with an active discharge range from 40 to 150.
This is an improvement of a factor up to 12 over the performance of an ordinary differential pumping stage of the same geometry.

Primary author: BOHLENDER, Bernhard F. (Goethe University Frankfurt, Institute for Applied Physics)

Co-authors: MICHEL, Andre (IAP, Goethe University Frankfurt); JACOBY, Joachim

Presenter: BOHLENDER, Bernhard F. (Goethe University Frankfurt, Institute for Applied Physics)

Session Classification: Applications of Plasmas

Contribution ID: **42** Type: **not specified**

The formation of shock waves during explosive processes at the cathode

Wednesday, 29 January 2020 17:30 (5 minutes)

The relevance of studying high-voltage nanosecond pulsed gas discharges is due to their wide practical applications such as plasma-stimulated combustion, plasma aerodynamics, plasma medicine, surface treatment. At the same time, the rich variety of physical also determines the complexity of interpretation of observed phenomena. From a practical point of view, the study of spark discharges is considerably interested because they arise very often in high-voltage technology, including as a negative factor in the form of breakdown which leads to short circuits and to an erosive effect on electrodes and insulators. It is known that acting as a piston an expanding spark channel forms a cylindrical shock wave. In all cases, these waves propagate in weakly ionized plasma.
This work is devoted to the results of studies of the formation and propagation of shock waves from an expanding cathode spot and a spark channel and it researches the features of waves formation in magnetic fields. An explosive model of the cathode spot's development [2, 3] involves the release of large energy at the emission center and then subsequent heating and explosion of the micro-tip. It was shown that an energy of 60 kJ/g is released in the cathode spot during a short time 10 ns. In this case, the cathode spot plasma is characterized by the intense lines of ions of the cathode material and with continuous radiation in a wide range of wavelengths (260-360 nm). The maximum spectrum intensity is reached after 20-30 ns.
The plasma expansion of cathode spot occurs at a speed which is much higher than the speed of sound and then electrons temperature significantly increases in wave's front. The ionization at shock wave front is transferred with its velocity at the first 40-50 ns, in the future the size of ionized region changes slightly.
Moreover, it was demonstrated that the rate of cathode spot expansion in air with comparable energy deposition is much lower than the rate of cathode spot expansion in argon. It indicates that the attenuation of the shock wave transporting the ionization front in air occurs faster than in argon. This can be explained by the fact that in air the wave energy is additionally spent on the dissociation of air molecules. The dependence of the cathode spot's radius on time is obtained, which is in satisfactory agreement with the experimental values at the initial stage of cathode spot's expansion.
This work was supported by a grant from the Russian Foundation for Basic Research (project No. 19-08-00611a)

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Presenter: Prof. MAIOROV, Sergey (Prokhorov General Physics Institute of the Russian Academy of Sciences)

Session Classification: Poster Session

Contribution ID: **43** Type: **not specified**

Strong Laser-Driven Magnetostatic Fields for Magnetized High Energy-Density Physics

Tuesday, 28 January 2020 11:00 (25 minutes)

We present experimental studies and optimization prospects of a robust open-geometry platform for generation of ultra-strong magneto-static fields.
The all-optical principle is based on a ns-laser pulse of several hundred Joule at 10**17 W/cm2 driving a target-discharge. The laser is tightly focused into a Capacitor Coil Target 1 comprising two parallel plates connected by a coil-shaped wire. The subsequently rising return current of up to hundreds of kA is guided by the target geometry and induces a strong magnetic field up to the order of kT.
We will review the main results and physical understanding in driving such strong discharge currents and B-fields, obtained over the last 5 years in experiments carried out at the LULI2000, Gekko-XII, Vulcan and PALS laser facilities. At LULI2000 2 and Gekko-XII [3] laser facilities, nanosecond-scale B-field pulses, above 500 T at the center of 500 μm-diameter coils were spatially and temporally characterized by ultra-high frequency B-dot probing and by proton deflectometry.
Modelling of the mechanisms yielding the looping discharge current [4] motivated more recent experimental efforts on a better understanding of the laser interaction processes giving rise to the discharge current. We show first results concerning the dependence of the generated B-field's strength to the laser-target parameters, employing complex interferometry measurements of the plasma density and self-generated B-field profiles in the laser driven diode plasma [5].
The distance of coil and laser interaction region is on the scale of mm. This proximity renders not only accurate measurements of the field strength difficult [6], it also means a possible threat to applications counting on employing the ultra-strong magnetic fields to secondary targets. Notably, future projects will focus on novel high energy-density physics (HEDP) investigations, e.g. i) exploring magnetized laser-plasma interactions at relativistic intensities in view of triggering phenomena relevant to astrophysics; ii) combining the magnetized liner fusion (MagLIF) approach to inertial confinement fusion (ICF) with a laser-driven seed B-field, so as to rise the magnetization level; iii) developing novel magnetized atomic physics simulation tools for improved characterization of complex plasma states in HED experiments. We present novel experimental results obtained at LULI2000 in September 2019 that show high performance of a modified target design with an improved shielding of the coil region.
We successfully applied B-fields of hundreds of Tesla to magnetize solid-density [7] or laser-compressed targets [8], and therein radially confine and guide relativistic electron beams (REB) over distances of the order of 100 μm.

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Presenter: Mr EHRET, Michael (TU Darmstadt)

Session Classification: High-Intensity Lasers and Applications in HED Science II

Contribution ID: **44** Type: **not specified**

Physical processes in condensed and hollow optical fibers under laser action

Wednesday, 29 January 2020 17:35 (5 minutes)

Silica is perspective material for component of powerful laser setups and new optical fibers. Damage of the light conductivity in the silica optical fiber transporting intense laser radiation leads to the absorption of energy and the appearance of a bright laser plasma with solid density. The plasma begins to move towards the radiation source, irreversibly damaging the light guide. Depending on driving laser energy, different damage propagation velocities are possible [1-4]. New scientific challenge is creation extremal states inside hollow optical fibers under laser action [5].

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Session Classification: Poster Session

Contribution ID: **45** Type: **not specified**

Electrons acceleration in intense laser-plasma interaction

Tuesday, 28 January 2020 11:25 (25 minutes)

Secondary sources of high energy particles and hard X-rays, produced in the interaction of relativistically intense laser pulses with matter, are widely used to create and diagnose extreme states of matter. The production of high-energy electrons, as well as the elaboration of compact sources of relativistic electrons and hard X-rays, requires the development of advanced acceleration methods. Among these methods, the actively developing approach is based on the use of wake fields generated in rarified plasma under the action of relativistically intense femtosecond laser pulses. In the case of a more dense plasmas, the effective transfer of the laser energy to hot electrons was demonstrated by the use of structured targets.
In view of current and future experiments, various methods of electrons acceleration in plasma are discussed. In particular, effective generation of high-energy electrons with an energy of tens of MeV in a plasma of near critical electron density was demonstrated. These collimated high energy electron beams reache effective temperatures that many times exceed those predicted by the ponderomotive Wilks scaling and carry charges of hundreds of nC.
Acceleration of electrons to high energies up to the TeV range with a large acceleration gradient, much higher than that available in conventional radio frequency accelerators, can be achieved in a multistage laser wakefield accelerator, operating in a moderately nonlinear mode. An analytical model of the electron beam emittance dynamics has been developed. Matching the beam with the focusing force at the point of injection prevents the growth of the emittance during acceleration.

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Presenter: Prof. ANDREEV, Nikolay (JIHT RAS)

Session Classification: High-Intensity Lasers and Applications in HED Science II

Contribution ID: **46** Type: **Talk**

Building a fast ignition fusion power plant

Wednesday, 29 January 2020 08:30 (30 minutes)

Marvel Fusion will start the first laser fusion company in Europe

Fusion energy is the ultimate energy source and a vital part of fighting climate change. So far the IFE community has focused on indirect-drive hot-spot ignition. Much progress has been made since the start of the NIC campaign in 2009. However, even though only short of about a factor of two in most parameters, ignition has not been achieved.
We report on a new enterprise to take on IFE and to aim for demonstration of ignition, burn and gain until 2030 using the direct-drive proton fast ignition approach.

This research endeavor foots on the expertise of NIF, LIFE and the HIPER project, but is powered by the speed of a private start-up company, that is entirely mission driven and will be based in Germany.

We will report on the concept and the team that has started to work on the goal for a base-load fusion power plant in Europe.

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Presenter: Prof. ROTH, Markus (TU Darmstadt)

Session Classification: Fusion Studies I

Contribution ID: **47** Type: **not specified**

Quantum statistical operator approach to optical properties of metallic and classical plasmas

Thursday, 30 January 2020 18:20 (25 minutes)

Hydrodynamic simulations of action of intense energy fluxes on metals requires knowledge of their kinetic coefficients in a wide range of temperatures and densities, and taking into account the recent progress in powerfull short-wavelength laser systems, also in a wide range of frequencies. The quantum-statistical operator method and linear response theory allow to express kinetic coefficients through correlation functions, and to calculate them for a wide range of frequencies (from infrared to X-ray range) and for a wide range of substance parameters.

Using this method, analytical expressions for the first-order correlation functions [1-3], taking into account in the case of metalic plasmas simultaneously electron-phonon interaction, Umklapp processes and interband transitions, were obtained for the first time. When describing the contribution of interband transitions, the forces of the oscillators were calculated from a quasi-classical model [4]. Using the constructed model, the dependences of the real part of dynamic conductivity on the frequency of laser radiation for both simple (aluminium) and noble (silver) metals was investigated for the case of disordered [1,5] ion subsystem, when individual electron-electron and electron-ion interactions are important, and the case of ion lattice, when electron-phonon interaction and Umklapp processes play a main role [1-3].

For simple metals, transitions from the discrete to the continuous spectrum occur at relatively high quant energies (higher than Fermi energies). This transitions are accompanied by a sharp increase in the real part of correlation functions and dynamic conductivity. For noble metals, the energy distance from the d-zone to the conduction zone is comparable to Fermi energy. In this case both thermal and optical excitation of the d-zone play a role at temperatures and quant energies of the order of Fermi energy.

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Primary author: Dr VEYSMAN, Mikhail (JIHT RAS)

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Presenter: Dr VEYSMAN, Mikhail (JIHT RAS)

Session Classification: Modelling HED Physics

Contribution ID: **48** Type: **not specified**

Online detection of radioactive fission isotopes following laser accelerated proton induced fission of 238U

Wednesday, 29 January 2020 11:55 (25 minutes)

To explain astrophysical phenomena, in particular those related to heavy nuclei synthesis and to verify theoretical models, we need laboratory nuclear reaction experiments under high en-ergy density conditions to get benchmark data.
In conventional linear accelerators the duration of proton pulses is of the timescale of many nanoseconds. If we use a high energy short-pulse laser, we can create similar proton pulses in a timescale of a few picoseconds and accordingly much higher intensity. Even in comparison to world leading proton accelerators like LANSCE in Los Alamos and FAIR at GSI in Darm-stadt, the intensity is one order of magnitude higher. Already today, this provides a larger particle intensity for the nuclear processes, although still lower than in astrophysical scenar-ios.
The experiment was performed at the Petawatt High-Energy Laser for Heavy Ion Experiments (PHELIX) at GSI. By using laser pulses of 0.7 ps duration with energies up to 200 J, proton pulses in excess of 1012 protons with energies up to 70 MeV were achieved. These pulses were used for proton induced fission of 238U.
In this experiment, an on-line detection method was applied. A key problem to be solved was the impact of the elector-magnetic pulse perturbation on the very sensitive nuclear detector.
A gas flow in a capillary tube provided rapid transport of the fission products over several meters to a germanium detector. Different gases were used to optimize capture and transport and to reduce radioactive background from the activated gas. The fission products were caught in a carbon filter in direct contact to the detector. Since all fission isotopes are pro-duced almost instantaneously, short-lived isotopes could be studied in detail, and avoiding the background from the longer lived nuclei. So it was possible after a few seconds to identify short-lived isotopes.
This demonstration represents a first step to illustrate the relevance of laser-accelerated par-ticles for applications in nuclear physics.

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Presenter: Mr BOLLER, Pascal (TU Darmsadt)

Session Classification: Fusion Studies II

Contribution ID: **49** Type: **not specified**

Laser-driven X-ray sources for investigating extreme states of matter generated by intense heavy ion beams

Monday, 27 January 2020 17:00 (25 minutes)

One of the unique features of the infrastructure and facilities at GSI is the possibility to carry out experiments combining the heavy-ion beam of the accelerator with the high-power laser PHELIX. With the new beamline guiding the long-pulse (nanosecond) beam of PHELIX to the HHT experimental cave, which is currently being installed at GSI, new diagnostic methods for the investigation of heavy-ion heated states of matter will become available in the near future. These include using laser-driven X-rays for diffraction, imaging or spectroscopy for investigating the behavior of matter under such conditions. After a brief report on the status of the beamline we will discuss our plans for first experiments using the new capabilities at HHT. We have also performed a preliminary study into characterizing the laser-driven X-ray source in order to experimentally confirm the feasibility of our plans, which we will also present here.

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Presenter: SLATTERY-MAJOR, Zsuzsanna (GSI, Darmstadt)

Session Classification: Activities of HED@FAIR

Contribution ID: **50** Type: **not specified**

Investigation of QED effects in thin foil targets

Friday, 31 January 2020 11:50 (25 minutes)

We have investigated the generation of dense electron-positron pairs and intense photonray bursts in the laser plasma interaction using quantum electrodynamics (QED) effects included in particle-in-cell (PIC) simulations. Linearly polarized laser pulses were used to irradiate a thin foil (1 μm) with an intensity of 4*1023 W/cm2. A scan of targets with varying Z (Al, Cu and Au) is investigated for the QED effects. Abundant electronpositron pair production is possible at laser intensity of 1023 W/cm2 at wavelength of 1 μm. We studied the various pair production processes in all the targets. The number of pairs created for Al and Cu targets is 1014 and 1013 respectively. But in case of Au, due to high electron density there is no pair production. We also calculated how the electron energy changes with respect to these targets, and also how pair production is changing with respect to varying target densities. The results indicate that target Z plays a very important role in the pair production process, which will be explained in this paper.

Primary author: Prof. RAMAKRISHNA, Bhuvanesh (IIT Hyderabad)

Presenter: Prof. RAMAKRISHNA, Bhuvanesh (IIT Hyderabad)

Session Classification: Special Session on PIC Simulations II

Contribution ID: **51** Type: **not specified**

Charged particle detector for Breit-Wheeler pair-production experiments

Wednesday, 29 January 2020 18:25 (5 minutes)

We present a device for positron detection in the framework of quantum-electrodynamics (QED) laser experiments. This instrument is a crucial element of a large project aiming at demonstrating for the first time the creation of electron-positron pairs via the so-called Breit-Wheeler (BW) process in the laboratory. This QED phenomenon occurs when the collision of two high-energy photons gives rise to the creation of an electron and a positron 1. The cross section of the BW process is in the order of 10-25 cm2, and the product of the photon energies must be above a threshold of 0.25 MeV2 in the optimal case of a head-on collision. In the proposed experimental scheme 2, the two necessarily intense gamma-ray sources are driven by ultra-high-intensity (UHI) laser pulses. Furthermore, the large gamma-ray flux being generated can also cause pair productions via other processes (Bethe-Heitler and multiphoton-collision) which are irrelevant in our study. In a nutshell, the small production of BW pairs, the typical electronic noise of UHI laser experiments and the "pollution" by other pair-production processes make the detection of BW pairs a highly challenging task.

To address the electronic noise issue, the instrument must be capable of segregating positrons from electrons. An appropriate design is the magnetic lens, it consists of an assembly of electromagnetic coils ordered so that the magnetic field lines form a quasi-circular loop. Iron cores can be placed within the coils for their magnetic susceptibility properties strengthening the field intensity. As a result, charged particles entering the device are deflected according to the polarity of their charge in- or outwards with respect to the optical axis, or line of sight. Moreover, magnetic lenses allow us for compensating the small pair production with large numerical apertures.

The next step towards detection consists in the conversion of particles into light signal for their monitoring on a camera device. We plan to address the parasitic pair production problem at this stage. We will realize a photon counting channel in a glass medium by utilizing the Cherenkov effect, whose assets are its short-lived nature and the linearity of its response. Then, the light signal is being conducted thanks to an optical fiber to a streak camera, performing a time-resolved detection. Overall, we will be able to know the energy of the detected positrons and when they were produced, which speaks whether they qualify or not for a BW origin. Furthermore, this method prevents from disruption due to electromagnetic pulses as the electronic parts can be set away from the laser interaction area.

We will present simple methods that help for dimensioning the instrument, from the physics laws that govern the magnetic lens optics to numerical tools that simulate its behavior. We have also performed measurements on a prototype, and we will discuss the results.

This project is supported by the French National Research Agency (Nr. ANR-17-CE30-0033 – Project Leader: Xavier Ribeyre).

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Presenter: Dr KHAGHANI, Dimitri (University of Bordeaux)

Session Classification: Poster Session

Contribution ID: **52** Type: **Poster**

Proton-11Boron Fusion Revisited

Wednesday, 29 January 2020 17:55 (5 minutes)

The easiest fusion reaction to achieve energy gain is $D+T \rightarrow \alpha+n$ However, this reaction has the disadvantages of releasing neutrons with energy approximately 14 MeV and tritium is an unstable isotope of hydrogen One of the most promising fusion reactions, which is p+□11, has been gaining considerable attention of researchers for its negligible radioactivity Unfortunately, the existing literature shows a discrepancy in measured cross section
At present, we studied this reaction by measuring the cross section of the reaction The experiment was conducted at the Shanghai Institute of Applied Physics, Chinese Academy of Sciences The cross section for the □11(p,α)αα reaction has been measured using proton beams of energies from 500 keV to 1 35 MeV The proton beams were provided by a 4 MV electrostatic accelerator and bombarded on a boron target of 400μ g/cm2 thickness The α particles are detected at 15□and 165□ in the lab frame.

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Session Classification: Poster Session

Contribution ID: **53** Type: **not specified**

Ionization in high-density plasmas: an ab initio study for carbon at Gbar pressures

Thursday, 30 January 2020 18:45 (25 minutes)

We apply density functional theory molecular dynamics (DFT-MD) simulations to calculate the ionization degree of plasmas in the warm dense matter regime. Standard descriptions of the ionization potential depression (IPD) have been challenged recently by experiments approaching unprecedentedly high densities indicating that improved IPD models are required to describe warm dense matter. We propose a novel ab initio method to calculate the ionization degree directly from the dynamic electrical conductivity using the Thomas-Reiche-Kuhn
(TRK) sum rule. This
approach is demonstrated for carbon at a temperature of 100 eV and pressures in the Gbar range. We find substantial deviations from widely applied IPD models like Stewart-Pyatt and Ecker-Kröll implying that condensed matter and quantum effects like band structure and Pauli blocking need to be included explicitly in ionization models. Our results will help to precisely model matter under conditions occurring, e.g., during inertial confined fusion implosions or inside astrophysical objects such as brown dwarfs and low-mass stars.

Primary author: Prof. ROEPKE, Gerd (Universitaet Rostock, Institut fuer Physik)

Presenter: Prof. ROEPKE, Gerd (Universitaet Rostock, Institut fuer Physik)

Session Classification: Modelling HED Physics

Contribution ID: **54** Type: **not specified**

Modeling radiation spectra and polarization from particle-in-cell simulations

Friday, 31 January 2020 09:50 (25 minutes)

Computing radiated fields from particle-in-cell (PIC) simulations are limited by the grid resolution. In PIC codes, the spatial scales are either the plasma skin-depth or the laser wavelength. Hence, resolving the radiated fields on the PIC grid requires extremely large computational resources. As the PIC codes can compute the particle trajectories for the entire simulation duration, a practical and efficient method is to post-process the position and momenta of the particles over time to calculate the radiated fields at a fixed point of observation. We describe a recently developed radiation post-processing code CASPER that can compute the radiated fields and their polarization from a sample of particles extracted directly from PIC simulations on a detector similar to those employed in experiments. Furthermore, using CASPER, we describe radiation and polarization generated during the propagation of a relativistic electron-positron beam in a magnetized electron-ion plasma and compare it with astrophysical observations and laboratory astrophysics experiments.

Primary author: Dr SINHA, Ujjwal (Juelich Supercomputing Center, Juelich Forschungszentrum GmbH)

Co-authors: KUMAR, Naveen (Max-Planck-Institut für Kernphysik (MPIK)); Prof. GIBBON, Paul (Forschungszentrum Juelich GmbH)

Presenter: Dr SINHA, Ujjwal (Juelich Supercomputing Center, Juelich Forschungszentrum GmbH)

Session Classification: Special Session on PIC Simulations I

Contribution ID: **55** Type: **not specified**

Two-dimensional energy and carrier diffusion in silicon upon X-ray irradiation or swift heavy ion impact

Thursday, 30 January 2020 17:30 (25 minutes)

We present the dynamics of carrier density and carrier/atomic energy in silicon after its excitation by an X-ray laser or swift heavy ion in two-dimensional geometry. The dynamics is modeled using the so-called nTTM model, i.e., a system of three coupled partial differential equations: one for carrier ambipolar diffusion and two coupled diffusion equations for carriers and phonons. To solve this system, we utilize a finite-difference integration algorithm based on Alternating Direction Implicit method with additional predictor-corrector algorithm, which takes care of the nonlinearities. After a detailed description of the method, we show its first results and discuss possible applications. Extension to three dimensions is also discussed.

Primary author: Dr LIPP, Vladimir (CFEL, DESY)

Co-author: Prof. ZIAJA, Beata (DESY)

Presenter: Dr LIPP, Vladimir (CFEL, DESY)

Session Classification: Modelling HED Physics

Contribution ID: **56** Type: **not specified**

Direct-Drive Inertial confinement fusion studies for LMJ at CEA

Monday, 27 January 2020 11:00 (30 minutes)

We will begin the presentation by a description of the state of the LMJ completion (numbers of bundles installed or operational, diagnostics completed, etc.).
Then, we will present a review of our recent activities regarding direct-drive implosion and preparation of Inertial Confinement Fusion on the Laser MégaJoule Facility.
Various aspects will be addressed such as the sensitivity of the self-ignition threshold of direct-drive
ICF targets to numerous physical phenomena such as heat conduction at the hot spot edge or stopping
power modelling. A study on the characterization of fuel using secondary fusion products will be also
shown. Finally we will address the first direct-drive gas-filled capsule implosions done recently on LMJ that have produced the first neutrons on LMJ coming from D+D thermonuclear fusion. This will
be supplemented by pre-and post-shot 3D TROLL-code results.

Primary author: Mr CANAUD, BENOIT (Commissariat à l'Énergie Atomique)

Presenter: Mr CANAUD, BENOIT (Commissariat à l'Énergie Atomique)

Session Classification: HED and HED Facilities II

Contribution ID: **57** Type: **not specified**

Status and first results of ATLAS-3000 at CALA

Tuesday, 28 January 2020 08:30 (30 minutes)

The Center of Advanced Laser Applications (CALA), a new high-intensity laser infrastructure, is nearing completion of commissioning its main laser system ATLAS-3000. The target parameters of the laser are 60J pulse energy in 25 fs at 1 Hz repetition rate. Currently, the laser pulses is serving experiments in two of CALA's target area while its peak power is being ramped up in accordance with the power handling capability of the experiments, currently limited by e.g. the level of EMP suppression. This power is currently approximately 250 − 300 TW in the electron target chamber, and 150 TW in the ion acceleration chamber, and a fast increase is expected in 2020. First results indicate excellent beam quality, with a high-contrast Strehl ratio of >75%, a temporal ASE contrast of >1010 with no significant prepulses and stable laser acceleration performance. Quasi-monoenergetic electron beams with charges of >300 pC at the GeV level and > 1 nC at 350 MeV mark new record figures. We will present the latest commissioning results from both the electron and ion accelerator experiments and well as the latest laser performance figures.

Primary author: Prof. KARSCH, Stefan (Universität München)

Presenter: Prof. KARSCH, Stefan (Universität München)

Session Classification: High-Intensity Lasers and Applications in HED Science I

Contribution ID: **58** Type: **not specified**

Amplification of a surface electromagnetic wave by a running over plasma surface ultrarelativistic electron bunch as a new scheme for generation of Terahertz radiation

Wednesday, 29 January 2020 18:20 (5 minutes)

The amplification of a surface electromagnetic wave (SEW) by means of ultrarelativistic monoenergetic electron bunch running over the flat plasma surface in absence of a magnetic field is studied theoretically. It is shown that when the ratio of electron bunch number density to plasma electron number density multiplied by a powered to 5 relativity factor is much higher than 1, i.e □5 nb /np≫1 , the saturation field of the surface electromagnetic wave induced by trapping of bunch electrons approaches the surface electromagnetic wave front breakdown threshold in plasma:
eEx=eBy=0.16ω pmc e (2 γ5 nb /np)1/ 7 . The SEW saturation energy density in plasma can exceed the electron bunch energy density. Here, we discuss the possibility of generation of superpower Teraherz radiation and on a basis of such scheme.
The SEW on plasma surface and plasma-like media (gaseous plasma, dielectric and conducting media, etc.) attract special attention of researchers due to their unique properties. First of all, due to its high phase and group velocities close to light speed in vacuum at high media conductivity what makes them the most valuable in radiophysics 1. The SEW are widely applied in physical electronics due to its high phase velocity leading to its uncomplicated generation by relativistic electron bunches and output from plasma.
We consider the case of ultrarelativistic monoenergetic electron bunch which remains relativistic in the frame of reference of SEW generated by this bunch compared to the works [2-4], where the bunches were nonrelativistic. Such a problem of generation of three-dimensional electromagnetic wave (wakefields) in plasma with the help of ultrarelativistic electron and ion bunches through Cherenkov resonance radiation was solved in [5].
The estimated SEW transverse electric field is ∣Ex ∣=∣By ∣□109V /cm=1011 V/m, hence,
the energy density flux (Poyinting vector) ∣P∣=c /4 π(Ex
2)□6. 1015W /cm−2 .

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1984).
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Primary author: Dr SADYKOVA, Saltanat (Juelich Research Centre, Juelich Supercomputing Centre)

Presenter: Dr SADYKOVA, Saltanat (Juelich Research Centre, Juelich Supercomputing Centre)

Session Classification: Poster Session

Contribution ID: **59** Type: **not specified**

Status of SIS18 for the FAiR Phase 0 experimental program

Monday, 27 January 2020 09:10 (30 minutes)

SIS18 underwent a massive upgrade program to become the booster for SIS100, the main accelerator of the FAIR project. We will report on the status of the upgrade program. As part uf the upgrade SIS18, ESR, Cryring and HEBT were all retrofitted to run with a completely new control and timing system which is being developed for the FAIR project. We will report on the status and capabilities of SIS18 in scope of the coming beamtime.

Primary author: STADLMANN, Jens (GSI, Darmstadt)

Presenter: STADLMANN, Jens (GSI, Darmstadt)

Session Classification: HED and HED Facilities I

Contribution ID: **60** Type: **not specified**

Charged-particle guiding in magnetized cylindrical targets

Wednesday, 29 January 2020 11:30 (25 minutes)

The magnetized liner inertial fusion (MagLIF) scheme has been proposed for cylindrical implosions of magnetized fuels with lower implosion velocities and convergence ratios, resulting in an appealing scheme for inertial fusion 1. Recently, a laser-driven version of MagLIF has been explored at the Omega facility 2 to study the magnetized implosion physics of MagLIF targets scaled down by a factor of 10 in linear dimensions. The advantages of using the Omega laser system are the good illumination symmetry, the higher repetition rate and better diagnostic access. B-field amplifications through flux compression of about 550 have been measured so far in cylindrical and spherical implosions on Omega [3].
Here, we analyze the implosion of a magnetized cylindrical target similar to that used in Omega MagLIF by means of 2-D MHD simulations with the FLASH code [4]. The target is a plastic (CH) hollow cylinder of 2 mm long, 300μm outer radius and 30μm thick filled with a CH foam with the density as a parameter. It is driven by 40 laser beams with a total energy of 15.2 kJ in 1.5 ns. The Omega MagLIF illumination scheme was assumed 2. Simulations show amplification of the B-field up to 10 kT and higher and magnetic flux conservation around 70% for a foam density of 20 mg/cm3. As such a B-field is high enough to guide fast electrons and even protons, we have conducted 3D hybrid simulations of fast electron and proton transport and energy deposition in the imploded cylindrical target [5,6]. Specifically, we have analyzed if the intense B-fields achieved at target stagnation are able to guide highly diverging laser-driven fast electrons and even the less diverging TNSA protons. The first experimental evidence of fast electron beams guiding by external magnetostatic fields was described in [7]. Here, the B-fields are increased by roughly one order of magnitude due to magnetic flux conservation in cylindrical target implosions. Our study will be useful to determine the conditions of the high energy density matter generated by perfectly collimated electron and ion beams. It may be also relevant for hydrodynamics of magnetized cylindrical targets.
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Primary author: Prof. HONRUBIA, Javier (Polytechnic University of Madrid)

Presenter: Prof. HONRUBIA, Javier (Polytechnic University of Madrid)

Session Classification: Fusion Studies II

Contribution ID: **61** Type: **not specified**

Enhancement of laser-driven, cold X-ray sources through front side modification

Thursday, 30 January 2020 08:55 (25 minutes)

Analysis of dense plasmas, such as Warm Dense Matter (WDM), proves to be a challenging field. Due to near solid densities and relatively low temperatures (0.1-100 eV), active optical analysis or passive probing through emission spectroscopy is not possible. However, higher photon energies are able to penetrate the samples and can be used to study WDM through scattering and absorption experiments, such as X-ray Thomson scattering (XRTS) or X-ray Absorption Near Edge Structure (XANES)1. The development of bright X-ray sources is thus fundamental for the study of WDM states generated in the laboratory.
Experiments using microstructured targets have shown an enhanced energy conversion between laser and target 2. In particular, the number of heated electrons and subsequent X-ray emission was increased when compared with unstructured targets. Using a microstructured front surface with a secondary layer of copper on the backside of the target uses the enhanced electron distribution to generate X-ray emission from the cold secondary material. Satellite line emission from higher ionization states, as are common in front surface X-ray sources, are suppressed while the Kα-emission is increased when compared with indirectly driven backlighting sources.
The talk will present findings from experiments performed at the PHELIX laser facility using the two-layer targets at high intensities. Further possibilities through modifications of the secondary layer will be discussed. The analysis of the spectral data presented is supported with FLYCHK calculations to derive the electron temperature and density [3].

Primary author: Mr SANDER, Steffen (IKP, TU Darmstadt)

Presenter: Mr SANDER, Steffen (IKP, TU Darmstadt)

Session Classification: High-Intensity Lasers and Applications in HED Science III

Contribution ID: **62** Type: **not specified**

Nanosecond laser driven x-ray backlighter for diagnostic applications at the HHT-cave

Wednesday, 29 January 2020 18:00 (5 minutes)

bla

Primary author: Dr NEUMAYER, Paul (GSI, Darmstadt)

Presenter: Dr NEUMAYER, Paul (GSI, Darmstadt)

Session Classification: Poster Session

Contribution ID: **63** Type: **not specified**

Taming the complexity of laser plasma accelerators

Friday, 31 January 2020 10:35 (25 minutes)

Laser plasma acceleration is transitioning from basic research to application and this transition is not finished.
At the one side of the spectrum, new experimental techniques and facilities enable a first look on the acceleration dynamics with atomic resolution.
On the other hand, simulations of the fundamental process are reaching predictive capabilities in both laser-driven elctron and ion acceleration.
Yet, this is still only true for a limited set of cases and a more general approach requires new approaches to transition to reliable and useable laser-driven particle beam sources.
We argue that besides progress in the fundamental understanding of the underlying plasma processes accompanying techniques that enhance our capabilities to better understand real world experiments are timely and needed to push laser plasma acceleration closer to application.

Primary author: Dr BUSSMANN, Michael (Helmholtz-Zentrum Dresden - Rossendorf)

Presenter: Dr BUSSMANN, Michael (Helmholtz-Zentrum Dresden - Rossendorf)

Session Classification: Special Session on PIC Simulations II

Contribution ID: **64** Type: **not specified**

Laser based Neutron Sources as a Tool for Material Analysis

Thursday, 30 January 2020 09:45 (25 minutes)

In recent years the demand for small sized neutron sources has immensely grown, which is caused by several factors. On one side, as technology advances, structures become more complex and an in-situ diagnostic is required that promises a sensitivity to small material variations while maintaining a high transmission range. On the other side the potential thread of undiscovered sensitive fissile material, explosives or contraband crossing borders is of great concern to our civilization.

Neutrons are able to solve both problems since they are capable of penetrating deep into samples since they do not interact electromagnetically and they are highly sensitive to variations in the isotopic number inside the probed object. This can not only be used to identify materials but also to trace them back to their origin since isotopic compositions vary strongly depending on geographic composition.

While conventional neutron sources are large in size, expensive and produce strong background radiation with large pulse widths, it is more desirable for this purpose to have additional sources, that are smaller, transportable with short pulse lengths and which require less shielding.

With laser based neutron sources this advantage can be achieved and with the current development of lasers, the amount of neutron per pulse is increasing drastically as well as the repetition rate of future laser systems . This will soon lead to a point where laser based neutron sources will become a serious competitor to existing sources as they provide capabilities and opportunities where the conventional sources have their limits.

The international center for nuclear photonics was recently founded by the LOEWE initiative for excellence at the institute of nuclear physics at the TU Darmstadt and aims for the development of a laser driven neutron source. In line with this efforts first experiments were conducted that proved the applicability of these sources for neutron resonance spectroscopy as well as for thermal neutron radiography.

Primary author: Mr ZIMMER, Marc (Technische Universität(TUDA))

Presenter: Mr ZIMMER, Marc (Technische Universität(TUDA))

Session Classification: High-Intensity Lasers and Applications in HED Science III

Contribution ID: **65** Type: **not specified**

Band Occupation and Optical properties of Warm Dense Gold

Thursday, 30 January 2020 08:30 (25 minutes)

Intense and short laser pulses can be used to create dense plasma or warm dense matter. States under these extreme conditions are very complex and new experimetal methods as well theoretical approches are required. After excitation with a laser pulse, electrons are driven out of thermodynamic equilibrium. They then relax on a few femtoseconds. However, there exits different types of nonequilibria which can relax on a different timescale. For gold excited with optical photons, two main bands are generally involved, namely the $5d$-valence band and the $6sp$-conduction band.
In this contribution, we focus on the case where a temperature has already been established within the electrons. Moreover, due to fast energy exchange between the bands, the electrons of both bands quickly reach a joint temperature. However, since particle exchange require much longer time, the occupation of the bands stays much longer in nonequilibrium. We model electrons dynamics in gold using a set of rate equations which trace the occupation numbers of the bands as well as the energy balance. These predictions are then used to calculate the optical properties, like the reflectivity and compared with time-resolved measurements.

Primary author: Mr NDIONE, Pascal Diougue (Student)

Presenter: Mr NDIONE, Pascal Diougue (Student)

Session Classification: High-Intensity Lasers and Applications in HED Science III

Contribution ID: **66** Type: **not specified**

A SPIDER for an improved laser-plasma back-reflection module at PHELIX

Wednesday, 29 January 2020 18:10 (5 minutes)

Bla

Primary author: Mr RÖDER, Simon (TU Darmstadt)

Presenter: Mr RÖDER, Simon (TU Darmstadt)

Session Classification: Poster Session

Contribution ID: **67** Type: **not specified**

Status of the FAIR facility

Monday, 27 January 2020 08:40 (30 minutes)

tba

Primary author: Dr GOLUBEV, Alexander (ITEP)

Presenter: Dr GOLUBEV, Alexander (ITEP)

Session Classification: HED and HED Facilities I

Contribution ID: **68** Type: **not specified**

Status of the HED@FAIR collaboration

Monday, 27 January 2020 11:30 (20 minutes)

tba

Primary author: Prof. SCHOENBERG, Kurt (EMMI GSI)

Presenter: Prof. SCHOENBERG, Kurt (EMMI GSI)

Session Classification: HED and HED Facilities II

Contribution ID: **69** Type: **not specified**

Pushing the frontiers of high-energy density science with X rays on LCLS and NIF

Tuesday, 28 January 2020 11:50 (25 minutes)

Overview

Primary author: Dr GLENZER, Siegfried (SLAC National Laboratory)

Presenter: Dr GLENZER, Siegfried (SLAC National Laboratory)

Session Classification: High-Intensity Lasers and Applications in HED Science II

Contribution ID: **71** Type: **not specified**

Measurement of the compressibility and temperature of shock compressed monocrystalline silicon up to 500 GPa

Wednesday, 29 January 2020 18:15 (5 minutes)

to follow

Primary author: Dr NIKOLAEV, Dmitry (senior researcher, Institut of problems of chemical physics, Chernogolovka, Russia)

Presenter: Dr NIKOLAEV, Dmitry (senior researcher, Institut of problems of chemical physics, Chernogolovka, Russia)

Session Classification: Poster Session

Contribution ID: **72** Type: **Talk**

HEDP at HIAF in China, the Status and Perspectives

Monday, 27 January 2020 18:40 (25 minutes)

to follow

Primary author: Prof. ZHAO, Yongtao (XJTU & IMP)

Presenter: Prof. ZHAO, Yongtao (XJTU & IMP)

Session Classification: Activities of HED@FAIR

Contribution ID: **73** Type: **not specified**

Charge Transfer Measurement of Laser-Accelerated Carbon Ions in Dense Ionized Matter

Wednesday, 29 January 2020 18:05 (5 minutes)

tf

Primary author: REN, Jieru (Xi'an Jiaotong Unversity)

Presenter: REN, Jieru (Xi'an Jiaotong Unversity)

Session Classification: Poster Session

Contribution ID: **75** Type: **Talk**

OSIRIS: A highly scalable kinetic plasma simulation platform

Friday, 31 January 2020 11:00 (25 minutes)

The OSIRIS 1 Electromagnetic particle-in-cell (EM-PIC) code is widely used in the numerical modeling of many kinetic plasma laboratory and astrophysical scenarios. Working at the most fundamental microscopic level and needing to resolve the smallest spatial and temporal scales, these are the most compute-intensive models in plasma physics, requiring efficient use of large scale HPC systems. Exascale computing opens the opportunity for ab initio full-scale modeling of many relevant HEDS scenarios, allowing the code to address an increasingly wider range of problems. In this presentation, I will discuss our efforts on deploying OSIRIS for doing computation in these advanced architectures, focusing on the latest trends and emerging technologies. I will present the recent developments in the framework, in terms of new algorithms and physics models introduced for dealing with the extreme scenarios and requirements HEDS kinetic modeling. I will conclude by presenting our recent full-scale simulations of the AWAKE experiment at CERN, focusing both on the results and on the computational challenges.

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Primary author: Prof. FONSECA, Ricardo (Instituto Superior Técnico)

Presenter: Prof. FONSECA, Ricardo (Instituto Superior Técnico)

Session Classification: Special Session on PIC Simulations II

Contribution ID: **76** Type: **Talk**

Progress in spherical hohlraum studies and experimental campaign on high energy laser facilities in China

Wednesday, 29 January 2020 11:05 (25 minutes)

We began to study the octahedral spherical hohlraums in 2013, and we have made both theoretical and experimental progresses in spherical hohlraum study since then. From our theoretical studies, we gave the configuration, concept and design of the octahedral spherical hohlraums, proposed a novel octahedral spherical hohlraum with cylindrical laser entrance holes (LEH) and LEH shields, compared the robustness of the octahedral spherical hohlraum with that of the cylindrical hohlraum and the rugby hohlraum, and gave a design island for determining the geometrical sizes of octahedral spherical hohlraum for ignition target design. Up till to now, we have a series experiments in the Spherical Hohlraum Campaign on SG laser facilities since 2014, such as, improvement of laser transport by using the cylindrical LEH, comparisons of LPI between sphere and cylinder, LPI of spherical hohlraum under high intensity laser, energetic of 6LEH Spherical hohlraum, and so on. As a result of our theoretical and experimental studies, the octahedral spherical hohlraum has advantages in a natural and robust high symmetry without supplementary technology, a high energy coupling efficiency, and a low LPI. In addition, we supposed to use the 4⊠ - 2⊠ lasers for future ignition facility with a configuration designed for the octahedral spherical hohlraum.

Primary author: Prof. LAN, Ke (Institute of Applied Physics and Computational Mathematics)

Presenter: Prof. LAN, Ke (Institute of Applied Physics and Computational Mathematics)

Session Classification: Fusion Studies II

Contribution ID: **77** Type: **not specified**

Phase transition-like anomalies in spatial distribution for strongly non-ideal ionic systems in traps

Wednesday, 29 January 2020 18:30 (5 minutes)

Phase transition-like (PT-like) discontinuities in equilibrium spatial charge distributions of ions in non-uniform Coulomb systems is a common phenomenon in wide number of problems for equilibrium thermo-electrostatic profiles. It was shown [1-4] that such discontinuities are peculiar micro-level manifestation of phase transitions and intrinsic macro-level non-ideality elects in local equation of state (EOS), which should be used for description of non-ideal ionic subsystem in frames of local-density (or "pseudo fluid") approximation. Special emphasis is made in present paper on the mentioned above non-ideality elects in non-uniform ionic subsystems, such as equilibrium charge profile in ionic traps with different external (retaining) potentials. Multiphase EOS for simplified ionic model - classical Charged Hard Spheres (CHS) on uniformly compressible electrostatic background was constructed. Several examples of discussed phase transition-like discontinuous ionic profiles were calculated for three variants of the traps.

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Primary author: Mr CHIGVINTSEV, A. Yu. (MIPT, Dolgoprudny, Russia; JIHT RAS, Moscow, Russia)

Co-author: Prof. IOSILEVSKIY, Igor (Joint Institute for High Temperature (Russian Academy of Science))

Presenter: Prof. IOSILEVSKIY, Igor (Joint Institute for High Temperature (Russian Academy of Science))

Session Classification: Poster Session

Contribution ID: **78** Type: **not specified**

Modelling of Laser Driven Neutron Sources

In order to meet the increasing demand for neutron sources, laser driven sources are a potential candidate for compact sized devices.
The setup for a laser driven neutron source can be split into two separate parts, first the laser acceleration of protons or deuterium from thin targets, second the ion to neutron conversion process.
Combining those parts into one model and predicting the output performance is difficult since both parts require different physics approaches.
The first part of this contribution focuses on the optimization of the acceleration mechanism utilizing particle-in-cell (PIC) simulations.
Parameter studies in simplified 1.5D geometries are used to extract optimized laser parameters. In the second part neutron converter studies and optimization via Monte Carlo simulations are presented. This includes a review of nuclear codes in the needed energy range for a correct estimation of neutron production.
Last, an effective combined model for the identification and optimization of all important parameters is presented. This is supposed to aid the design of a modular laser neutron source, to be added to existing laser systems.

Primary author: Mr SCHMITZ, Benedikt (TEMF, TU Darmstadt)

Presenter: Mr SCHMITZ, Benedikt (TEMF, TU Darmstadt)