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6 Contribution to conferences and workshops

E-MRS 2012, France, Strassbourg, 13 – 18 May 2012

- **M. Rosiński,** et al., *Electrostatic field assisted laser implantation of Ge ions onto SiO2 substrates with the use of industrial Nd:YAG lasers in the set-up of acceleration and deflection by a cylindrical electrode (poster)*

20th International Conference on Plasma Surface Interactions, Germany, Aachen, 20 – 25 May 2012

- **M. Kubkowska**, et al., *Investigation of Effects of the Irradiation Parameters on Laser-Removal and Surface Morphology of Mixed Material Deposits and Substratem (poster)*
- **R. Zagórski,** et al., *Simulation with the COREDIV Code of Impurity Seeded Discharges of JET with ILW; Challenges of Power Exhaust in a Demonstration Fusion Power Plant; Comparative study of a conventional and snowflake divertor for the tokamak FAST (poster)*

25th Symposium on Plasma Physics and Technology, Prague, Czech Republic, 18-21 June 2012

- **S. Jednoróg,** *Shut down dose for large fusion devices (oral)*
- **J. Kurzyna,** et al., *Optimization of IPPLM krypron Hall effect thruster (poster)*

10th Direct Drive and Ignition Workshop, Prague, Czech Republic, 27 – 31 May 2012

- **J. Badziak,** et al., *Efficient acceleration of ion beams and macroparticles for fast ignition in the LICPA accelerator (oral)*

39th EPS Conference on Plasma Physics and 16th International Congress on Plasma Physics, Stockholm, Sweden, 2 - 6 July 2012

- **J. Badziak,** et al., *Highly efficient laser-induced cavity pressure acceleration of dense plasma (oral)*
- **A. Czarnecka**, et al., *Impurity behavior during ICRH and NBI operation with ITER-like wall at JET (poster)*
- **A. Kasperczuk,** et al., *Methods of backward and forward formation of metallic plasma jets at PALS (poster)*
- **M. Kubkowska,** et al., *1-D plasma X-ray radiation code as a first step for developing the fusion diagnostics (poster)*
- **T. Pisarczyk,** et al., *Interaction of the copper plasma jet with different media (poster)*
- **J. Wołowski,** et al., *Optimisation of laser ion source with acceleration and deflection system for implantation of Ge ions into SiO_2 substrate (poster)*

39th IEEE International Conference on Plasma Science, Great Britain, Edinborough, 8 – 12 July 2012

- **T. Chodukowski,** et al., *Correlation of electron density distributions and neutron emission during characteristic phases of plasma column evolution in PF-1000 device (poster)*
- **J. Domański,** et al., *Generation of relativistic ion beam driven by an ultraintense laser (poster)*
- **Z. Kalinowska** et al., *Investigation of efficiency of laser radiation energy transport into a planar massive target made of Al (poster)*
- **P. Rączka,** et al., Highly efficient acceleration of dense plasma in the LICPA accelerator *(oral)*
- **P. Rączka,** et al., Efficient generation of high-energy ion bunches via laser-induced cavity radiation pressure acceleration *(poster)*

ECLIM 2012 32nd European Conference on Laser Interaction with Matter (ECLIM 2012), Warsaw, Poland, 10 – 14 September 2012

- **J. Badziak**, et al., *Laser-induced cavity pressure acceleration of dense plasma and ion beams (invited lecture)*
- **S. Borodziuk**, et al., *Fast and dense macroparticles accelerated by iodine laser radiation of PALS (poster)*
- **J. Domański**, et al., *Acceleration of and C ions to GeV energies at the interactions of an ultra-intense laser pulse with a CH target (poster)*
- **T. Chodukowski,** et al., *Three-frame interferometric/shadowgraphic system for plasma research at PALS laboratory (oral)*
- **Z. Kalinowska**, et al., *PALS investigation of mechanisms of laser radiation absorption (poster)*
- **L. Ryć**, et al., *Multi-peak structure of fast-ion TOF spectra generated from plasmas at laser intensity higher than* 10^{15} *W/cm*^{2} *(poster)*
- **J. Wołowski,** et al., *Laser ion source with acceleration and deflection system for laser implantation technology (poster)*

International Conference and School on Plasma Physics and Controlled Fusion, Alushta (Crimea), Ukraine, 17 – 22 September 2012

- **A. Czarnecka**, et al., *Spectroscopic and corpuscular analysis of laser-produced carbon plasma (poster)*

Frontiers in Intense Laser-Matter Interaction Theory, Germany, Garching, 18 – 22 September 2012

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Conference Proceedings in the Web of Science

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7 Research projects granted from the 7th FP and other international programmes

Research project carried out within programme of EURATOM-IPPLM Association

1. **Tokamak modelling. Support to the advancement of the ITER Physics Basis**
2. **Activities in support to DEMO design**
3. **Plasma-Wall Interaction**
   - Spectroscopic and ion diagnostics for laser-induced removal of fuel and co-deposits from PFCs in tokamaks
   - Emerging technologies: Qualification of the LIBS operation on ITER relevant calibrated Samples
   - High power ICRF with high Z Wall
4. **Plasma diagnostics**
   - Contribution to the W7-X project: Spectrometry of soft X-ray emission from W7-X stellarator with the use of PHA and MFS diagnostics
   - Development and application of neutron diagnostics based on activation method for magnetic confinement devices
   - Design, construct and test a neutron monitor based on a GEM detector capable of simultaneously determining the 2.5 and 14 MeV neutron fluxes separately
   - Construction of a prototype of GEM gas detector, filled with Neon, for detection of 14 MeV neutrons by means of neon activation in the drift region: priority support
   - Gas Electron Multiplier Detector for X-ray Crystal Spectrometry - GXS: JET notification and JET order
   - Assembly of the T-GEM imaging detector and perform home laboratory tests
5. **Coordination, in the context of a keep-in-touch activity, of the Member State's civil research activities on Inertial Fusion Energy**
   - Analysis of emerging options of IFE on the basis of results of experiments and numerical modelling – continuation.

Research projects supporting studies on plasma propulsion

- Grant Agreement No. 283279 (FP7-LμPPT): „Innovative Liquid Micro Pulsed Plasma Thruster for Nanosatellites".
- Grant Agreement SNECMA No.2009-016-E: „Simulation of electrons in Hall effect thrusters".
- Grant Agreement SNECMA No.2012-046-G:"Quasineutral PIC electron guiding center modelling in the presence of slow cross-field electron transport in a Hall thruster".
- Grant Agreement No.218859 (FP7-HiPER): „HiPER-High Power Electric Propulsion:a Roadmap for the future".
- SNECMA order 111800057710: "Numerical Study of a High Power Hall Thruster with Ar and Kr propellant".

Other projects supported by EU

- Project HiPER - European High Power Laser Energy Research Facility. (Grant Agreement no.211737).
- Project SILMI - Super-Intense Laser-Matter Interactions, Research Networking Programme (RNP) of European Science Foundation (ESF), Physical & Engineering Sciences Unit (PESC).
- Laserlab-Europe PALS001655 project: "The effect of preformed plasma on a laser-driven shock produced in a planar target at the conditions relevant to shock ignition".
- Laserlab-Europe PALS001676 project: "Mutual interactions of laser-produced plasmas with different atomic numbers in axially symmetric geometry".

The IAEA Coordinated Research Projects

- IAEA CRP: "Integrated Approach to Dense Magnetized Plasma Application in Nuclear Fusion Technology", 2007-2012, IAEA-IPPLM Contract No 14526, project title: "Development of PF-6 device for the goals of the mainstream fusion research and additional spin-off applications (medicine, biology, material science, etc.)".
- IAEA CRP: "Investigation of materials under High Repetition and Fusion-Relevant Pulses, 2012-2015, IAEA-IPPLM Contract No 16954, project title: "Application of the PF-6 device for the goals of the radiation material science in the frame of mainstream fusion researches and for additional spin-off applications (unveiling of hidden objects, radiation medicine and biology, etc.)".
- IAEA CRP: "Investigation of materials under High Repetition and Fusion-Relevant Pulses, 2011-2015, IAEA-IPPLM Contract No 16956, project title: "Experimental investigations of damage characteristics produced by hot plasma and fast ion beams generated by the 1-MJ dense plasma focus facility PF-1000 at irradiation of materials perspective for the main-stream fusion research".

- IAEA CRP: “Integrated Approach to Dense Magnetized Plasma Application in Nuclear Fusion Technology”, 2007-2012, IAEA-IPPLM Contract No 14525, project title: “Modernization of the PF-1000 facility for the goals of the mainstream fusion research”.
- IAEA CRP: “Conceptual development of a Steady-State Compact Neutron Source”, 2012-2016, IAEA-IPPLM Contract No 17165, project title: “Conceptual development of a compact neutron source based on plasma-focus”.

8 Research projects granted from the Ministry of Science and Higher Education

Research project carried out within programme of EURATOM-IPPLM Association

1. Project of the National Centre for Research and Development (NCBiR) No SP/J/2/143234/11: "Research and development of the technology for controlled thermonuclear fusion" in the framework of the strategic research project called "Technologies supporting the development of safe nuclear energy". Tasks carried out in 2012:

- NCBiR: Phase 1.1 Investigation of intense plasma streams interaction with solid targets at the PF-1000 device
- NCBiR: Phase 1.2 The construction of a theoretical model describing interaction of pulsed plasma beams with targets, simulation of initial experiments.
- NCBiR: Phase 2.3 Development of plasma imaging technique in the range of X-ray radiation for monitoring impurities released from the walls of thermonuclear reactor.
- NCBiR: Phase 3.1 The design, construction and run of the modified system of generator power for plasma generation and acceleration.

2. Regional Operational Program of the Mazovian province: "Development and modernization of laboratories of high-power lasers".

3. Grant "Harmonia" of National Centre of Science: "Studies of nonlinear laser-plasma interactions and shock wave generation in plasma for the shock ignition of thermonuclear target within inertial confinement fusion (ICF) programme"

4. PhD grant: "Studies of plasma in PF-1000 device with the use of multiframe interferometry".

9 Domestic commercial contracts

- PZL Mielec (contract): Resistance tests of fuel tanks' covers against a lightning strike .
- AN-KOM (contract): „Resistance investigation of connectors in the lightning conductor during a lightning strike".

10 International conferences and workshops organized by IPPLM

11th Kudowa Summer School „Towards fusion energy” Kudowa Zdrój, Poland, 11-15.06.2012

The Institute of Plasma Physics and Laser Microfusion (IPPLM, Warsaw, Poland), the Association EURATOM-IPPLM, and the International Centre for Dense Magnetised Plasmas (ICDMP) organized the 11th Kudowa Summer School "Towards Fusion Energy", which was held in Kudowa Zdrój, Poland, on June 11-15, 2012.

The school was designed for young scientists from different countries, and it concerned mainly various aspects of a fusion energy, plasma experiments, and technology. The participants presented short (10-15 min.) talks about their research activities.

The topics:

- Magnetic Confinement Fusion
- Inertial Confinement Fusion
- Fusion Technology
- Plasma Diagnostic Techniques

The School was led by Dr. Jef Ongena (Royal Military Academy, Brussels)

In summary, 21 invited talks about plasma physics and fusion lectures were given by experienced invited speakers. About 80 scientists and 8 representatives of the commercial enterprises participated in the 11th Kudowa Summer School.

Most of the papers (invited and contributed) presented at the 11th Kudowa Summer School were published in “Nukleonika” journal after a peer review procedure.

11 PhD Theses

Tomasz Chodukowski	Study of plasma parameters and dynamics in PF-1000 device during forming and disruption phases of plasma column by means of multiframe laser interferometry National Centre for Nuclear Research, Świerk/Otwock
Agata Czarnecka	Studies of plasma impurities in fusion device tokamak JET with teh use of the new VUV spectroscopic technique National Centre for Nuclear Research, Świerk/Otwock
Paweł Gąsior	Studies of properties of codeposit and dust in tokamak devices with the use of laser techniques and special diagnostic methods National Centre for Nuclear Research, Świerk/Otwock
Katarzyna Jakubowska	Application of diagnostic methods based on optical emission spectroscopy for studies of hot plasma in tokamak and Plasma-Focus devices National Centre for Nuclear Research, Świerk/Otwock
Marcin Rosiński	Studies of generation of laser-produced ions and their application for modification of semiconducting materials National Centre for Nuclear Research, Świerk/Otwock

12 Seminars and lectures

Seminars at IPPLM

7.02.2012 – Marek Scholz (IPPLM): The development of GEM-type detectors for X-ray diagnostics on JET

6.03.2012 - IPPLM reporting seminar for 2011

22.05.2012 – Agata Czarnecka (IPPLM): Studies of plasma impurities in fusion device tokamak JET with the use of the new VUV spectroscopic technique

24.05.2012 – Tomasz Chodukowski (IPPLM): Study of plasma parameters and dynamics in PF-1000 device during forming and disruption phases of plasma column by means of multiframe laser interferometry

18.06.2012 - Aleksander Polański (National Centre for Nuclear Research): Nuclear transmutations and sub-critical reactors

19.06.2012 – Marcin Rosiński (IPPLM): Studies of generation of laser-produced ions and their application for modification of semiconducting materials

19.06.2012 – Paweł Gąsior (IPPLM): Studies of properties of codeposit and dust in tokamak devices with the use of laser techniques and special diagnostic methods

25.09.2012 – Jacek Kurzyna (IPPLM): Plasma thrusters at IPPLM – current projects and perspectives

30.10.2012 – Tomasz Czarski (IPPLM): Measuring system of the GEM detector for JET KX1 diagnostics

13.11.2012 – Jarosław Domański (IPPLM): Laser acceleration of ions with the use of ultra-intense laser pulse – numerical simulations

11.12.2012 – Aleksandr Borisov Blagoev (Faculty of Physics, University of Sofia, Bulgaria): Investigations with the 4 kJ PF device in the University of Sofia

18.12.2012 – Sławomir Jednoróg (IPPLM): Radiation hazard near big fusion devices after experiments with D-D (based on the PF-1000 experiment).

Seminars of the Plasma Physics Section of the Polish Physical Society

17.01.2012 – Marek Scholz (IPPLM): Experimental studies of the current sheet in PF-1000 plasma discharges

21.02.2012 – Serge Barral (IPPLM): Hall thrustertheory and numericalmodeling

16.10.2012 – Paweł Gąsior (IPPLM): Studies of properties of codeposit and dust in tokamak devices with the use of laser techniques and special diagnostic methods

18.12.2012 – Sławomir Jednoróg (IPPLM): Radiation hazard near big fusion devices after experiments with D-D (based on the PF-1000 experiment).

13 Public Information

- ***The Eleventh International Workshop and Fusion Summer School in Kudowa-Zdrój***

The 11th Kudowa Summer School "Towards Fusion Energy" was held this year in Kudowa Zdrój, Poland, in June 11-15, 2012, on the initiative of the Institute of Plasma Physics and Laser Microfusion (IPPLM), the Association EURATOM-IPPLM and International Centre for Dense Magnetised Plasmas (ICDMP). It is a scientific event that takes place annually in Kudowa Zdrój and aims at young scientists (PhD and Master students) from different countries, and provides courses on various aspects of a fusion energy, plasma experiments and technology. Participating students were encouraged this year to present short (10-15 min.) presentations about their research activities and provide 2-4 pages contribution based on given presentation. There was a competition for the best presentation at the end of the school.

The topics of the lectures were as follows:

• Magnetic Confinement Fusion (MCF),

• Inertial Confinement Fusion (ICF),

• Fusion Technology,

• Plasma Diagnostic Techniques

18 distinguished lecturers presented lectures during the school. Among others, the group included: J. Ongena (Director of the School), D. Batani, P. Kubes, G. Maddaluno, L. Torrisi, U. Woźnicka. The topics ranged from warm dense matter and high energy density physics to exciting times ahead in Fusion research. Around 35 persons (mainly Doctors and PhD students) from Ukraine, Italy, Czech Republic, Bulgaria, Russian Federation, Germany, Estonia and Poland met in Kudowa in 2012.

The Information and Promotion Panel of the Mazovia Province Regional Operational Project: „*Extension and modernization of the high power laser laboratory in IPPLM*" was organized on 13-15 of June 2012 in the framework of the Kudowa Summer School in Kudowa Zdrój. The project aims at the modernization of High Power Laser Laboratory in IPPLM and providing the research workplace of the new 10 TW laser with a state-of-the-art measurement equipment for laser-plasma interaction research.

- ***Participating in the XVI Science Festival in Warsaw, 22-30 September, 2012***

The idea of the Science Festival originated in September of 1996. Originally, 72 meetings were held within 2 days at 44 research institutes and organizations. In the subsequent years, the project has developed significantly. Over 100 research institutes propose festival activities. Some events during the Festival remain invariable from year to year: clubs and discussions, weekend meetings such as laboratory presentations for a limited number of participants (they are delivered in the form of presentation and can be accompanied by lecture) and festival lessons on weekdays mainly for primary or secondary school students.

Lectures on the IPPLM side referred to nuclear fusion as a solution for energy problems in the world, laser-plasma interaction as a source of fast particles, satellite plasma thrusters, Sun on Earth, laser

acceleration of particles and others. After lectures delivered by physicists with doctor degrees, participants had a chance to visit laser laboratories and PF-1000 device, as well as take part in hands-on experiments in relation to radiation.

In total, five junior and high schools (one class from each) participated in the festival lessons on weekdays and around 100 persons of various age joined IPPLM during weekends.

- ***Visits of students***

Around 30 persons form Maria Skłodowska-Curie University (Institute of Physics) visited IPPLM in March. Lectures included such topics as thermonuclear fusion in the context of the energy crisis, magnetic and inertial confinement, fusion technology and plasma thrusters. Participants had a chance to see the PF-100 device and laser laboratory.

Around 50 persons (two classes) from LXIII High School named after L. Kossuth visited IPPLM in April. M. Scholz conducted a lecture on thermonuclear fusion and tokamaks, W. Stępniewski described the functioning of PF-1000 device, S. Jednoróg focused on spectrometry, and young scientists proposed a tour of the laser laboratory.

- ***Press release, web page publications, distribution of materials, organising informative meetings, public lectures***

Article 'Modern technologies in Mazovia province' on www.mazovia.pl on the visit of Mr Adam Struzik, Marshal of the Mazovia province, in IPPLM who got to know the Institute's activity and scientific staff. March 2012

TV spot 'Age of Inventions' on TVP Info Channel on the future of nuclear and thermonuclear energy in Poland presenting PF-1000 device. September 2012

Video spot 'Foresight for thermonuclear energy' on www.dotacjenasukces.pl (of the National Center for Research and Development) on the project aimed at developing procedures for engaging Polish science and industry in works devoted to thermonuclear energy. October 2012

Article 'The Polish Hall thruster – krypton plasma thruster for space probes' in "Urządzenia dla Energetyki" journal on the efforts of Dr. J. Kurzyna and his team to implement noble gas krypton to be used in plasma thrusters as opposed to expensive xenon which is difficult to obtain. October 2012

The structure of IPPLM, its scope of activity and offer for potential partners for cooperation. Catalogue of technologies developed by Polish Research Institutes, Section: Physics and Astronomy, developed by the Ministry of Foreign Affairs. November 2012

Article of the Director of IPPLM Andrzej Gałkowski 'Thermonuclear energy' in Przegląd Techniczny (issue 25 and 26) on the methods of plasma heating, JET tokamak as well as ITER and DEMO reactors. December 2012

Video spot on the website of the Mazovian Unit of EU Programmes Implementation devoted among others to the modernization of the High Power Laser Laboratory and and IPPLM's efforts to bring under control in laboratoty conditions fusion occurring in the Sun's ihnterior.

- ***Collaboration with Teatr GO***

Workshops called The Art Of Science have been organised for two years by Teatr GO, and their popularity is still growing. In 2012, 500 participants attended the cycle of ten meetings. Children as well as junior and high school students, when taken aback by the new technology, want to understand the phenomena in nature. That is why they have visited IPPLM, talked to scientists, invented scenarios for their plays about atoms, played jokes with scientific themes. One of the main IPPLM facility, Plasma Focus 1000, was utilised to make science more familiar to different age groups to which the lecture/explanations were provided. Thanks to the workshops, participants have built their trust in science. Plans of joint efforts of Teatr Go and IPPLM for 2013 include among others workshops with the Budapest youth which will lead to the artistic performance.

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