

# 4 Publications

- [1] P. Kubes, D. Klir, J. Kravarik, K. Rezac, J. Kortanek, V. Krauz, K. Mitrofanov, M. Paduch, M. Scholz, T. Pisarczyk, T. Chodukowski, Z. Kalinowska, L. Karpiński, E. Zielińska, Scenario of pinch evolution in a plasma focus discharge.  
*Plasma Physics and Controlled Fusion* (2013) **55**, :1-8
- [2] A. Czarnecka, M. Kubkowska, E. Składnik-Sadowska, E. Kowalska-Strzęciwilk, P. Parys, M. Sadowski, K. Malinowski, R. Kwiatkowski, M. Ladygina, Spectroscopic and corpuscular analysis of laser-produced carbon plasma.  
*Problems of Atomic Science and Technology* (2013) **83**, 1:258-260
- [3] M. Sadowski, K. Czaus, R. Kwiatkowski, K. Malinowski, E. Składnik-Sadowska, J. Żebrowski, M. Paduch, M. Scholz, I. Garkusha, V. Makhlay, Passive corpuscular diagnostics of charged particles emission from high-temperature plasma experiments.  
*Problems of Atomic Science and Technology* (2013) **83**, 1:252-257
- [4] E. Składnik-Sadowska, R. Kwiatkowski, K. Malinowski, M. Sadowski, J. Żebrowski, M. Kubkowska, M. Paduch, M. Scholz, V. Gribkov, I. Garkusha, M. Ladygina, A.K. Marchenko, Optical emission spectroscopy of free-propagating plasma streams and plasma produced during their interactions with solid targets.  
*Problems of Atomic Science and Technology* (2013) **83**, 1:279-283
- [5] L. Torrisi, S. Cavallaro, M. Cutroneo, L. Giuffrida, J. Krasa, D. Margarone, A. Velyhan, J. Kravarik, J. Ullschmied, J. Wołowski, A. Szydlowski, M. Rosiński, Deuterium–deuterium nuclear reaction induced by high intensity laser pulses.  
*Applied Surface Science* (2013) **272**, :42-45
- [6] L. Torrisi, M. Cutroneo, S. Cavallaro, L. Giuffrida, L. Ando, P. Cirrone, G. Bertuccio, D. Puglisi, L. Calcagno, C. Verona, A. Picciotto, J. Krasa, D. Margarone, A. Velyhan, L. Laska, E. Krousky, M. Pfeiffer, J. Skala, J. Ullschmied, J. Wołowski, J. Badziak, M. Rosiński, L. Ryć, A. Szydlowski, Proton driven acceleration by intense laser pulses irradiating thin hydrogenated targets.  
*Applied Surface Science* (2013) **272**, :2-5
- [7] L. Láská, J. Krása, J. Badziak, K. Jungwirth, E. Krouský, D. Margarone, P. Parys, M. Pfeifer, K. Rohlena, M. Rosiński, L. Ryć, J. Skála, L. Torrisi, J. Ullschmied, A. Velyhan, J. Wołowski, Studies of intense-laser plasma instabilities.  
*Applied Surface Science* (2013) **272**, :94-98
- [8] M. Rosiński, P. Gąsior, E. Fazio, L. Ando, L. Giuffrida, L. Torrisi, P. Parys, A.M. Mezzasalma, J. Wołowski, Laser generated Ge ions accelerated by additional electrostatic field for implantation technology.  
*Applied Surface Science* (2013) **272**, 109-113
- [9] J. Domański, J. Badziak, S. Jabłoński, Effect of laser light polarization on generation of relativistic ion beams driven by an ultraintense laser.  
*Journal of Applied Physics* (2013) **113**, 17:173302(1-6)
- [10] J. Rządkiwicz, W. Dominik, M. Scholz, M. Chernyshova, T. Czarski, H. Czyrkowski, R. Dabrowski, K. Jakubowska, L. Karpinski, G. Kasproicz, K. Kierzkowski, K. Pozniak, Z. Salapa, W. Zabolotny, P. Blanchard, S. Tyrrell, K.-D. Zastrow, Design of T-GEM detectors for X-ray diagnostics on JET.  
*Nuclear Instruments and Methods in Physics Research A* (2013) **A 720**, 36-38
- [11] R. Zagórski, I. Ivanova-Stanik, R. Stankiewicz, Simulations with the COREDIV code of DEMO discharges.  
*Nuclear Fusion* (2013) **53**, 1-6

- [12] O. Renner, M. Šmíd, T. Burian, L. Juha, J. Krása, E. Krouský, I. Matulková, J. Skála, A. Velyhan, R. Liska, J. Velechovský, T. Pisarczyk, T. Chodukowski, O. Larroche, J. Ullschmied, Environmental conditions in near-wall plasmas generated by impact of energetic particle fluxes. *High Energy Density Physics* (2013) **9**, 568-572
- [13] M. Kubkowska, P. Gąsior, E. Kowalska-Strzęciwilk, E. Fortuna-Zaleśna, J. Grzonka, L. Ciupinski, Investigation of the irradiation effects on laser-removal and surface morphology of mixed material sample. *Journal of Nuclear Materials* (2013) **438**, S750-S753
- [14] G. Telesca, R. Zagórski, S. Brezinsek, M. Brix, J. Flanagan, I. Ivanova-Stanik, M. Lehnen, M. Stamp, G. Van Ost, Simulation with the COREDIV code of JET discharges with the ITER-like wall. *Journal of Nuclear Materials* (2013) **438**, S567-S571
- [15] I.N. Demchenko, M. Chernyshova, X. He, R. Minikayev, Y. Sryanyy, A. Derkachova, G. Derkachov, W.C. Stolte, H. Liang, Experimental observation of quantum confinement in the conduction band of PbS quantum dots. *X-Ray Spectrometry* (2013) **42**, 4:197-200
- [16] V.I. Bobkov, G. Arnoux, S. Brezinsek, J.W. Coenen, L. Colas, M. Clever, A. Czarnecka, F. Braun, R. Dux, A. Huber, P. Jacquet, C. Klepper, E. Lerche, C. Maggi, F. Marcotte, M. Maslov, G. Matthews, M.L. Mayoral, K. McCormick, A. Meigs, D. Milanese, I. Monakhov, R. Neu, J.-M. Noterdaeme, Th. Pütterich, F. Rimini, G. Van Rooj, G. Sergienko, D. Van Eester, ICRF specific plasma wall interactions in JET with the ITER-like wall. *Journal of Nuclear Materials* (2013) **438**, S160-S165
- [17] C.C. Klepper, P. Jacquet, V. Bobkov, L. Colas, T.M. Biewer, D. Borodin, A. Czarnecka, C. Giroud, E. Lerche, V. Martin, M.-L. Mayoral, F. Rimini, G. Sergienko, D. Van Eester, RF sheath-enhanced beryllium sources at JET's ICRH antennas. *Journal of Nuclear Materials* (2013) **438**, S594-S598
- [18] A. Kasperczuk, T. Pisarczyk, T. Chodukowski, Z. Kalinowska, S. Gus'kov, N. Demchenko, J. Ullschmied, E. Krousky, M. Pfeifer, J. Skala, D. Klir, J. Kravarik, P. Kubes, J. Cikhardt, K. Rezac, P. Pisarczyk, Plastic plasma interaction with plasmas with growing atomic number. *Central European Journal of Physics* (2013) **11**, 5:575-579
- [19] V. Philipps, A. Malaquias, A. Hakola, J. Karhunen, G. Maddaluno, S. Almaviva, L. Caneve, Colao, E. Fortuna, P. Gąsior, M. Kubkowska, A. Czarnecka, M. Laan, A. Lisovski, P. Paris, H.J. van der Meiden, P. Petersson, M. Rubel, A. Huber, M. Zlobinski, B. Schweer, N. Gierse, Q. Xiao, G. Sergienko, Development of Laser Based Techniques for In Situ Characterization of the First Wall in ITER and Future Fusion Devices. *Nuclear Fusion* (2013) **53**, :093002
- [20] J. Badziak, P. Parys, M. Rosiński, E. Krousky, J. Ullschmied, L. Torrissi, Improved generation of ion fluxes by a long laser pulse using laser-induced cavity pressure acceleration. *Applied Physics Letters* (2013) **103**, :124104
- [21] P. Kubes, M. Paduch, D. Klir, J. Kravarik, K. Rezac, J. Cikhardt, J. Kortanek, E. Kowalska-Strzęciwilk, E. Zielińska, M. Scholz, L. Karpinski, Correlation of x-ray emission with interferometry and neutron diagnostics at tungsten anode face and deuterium filling in plasma-focus discharge. *Plasma Physics and Controlled Fusion* (2013) **55**, :115005
- [22] M. Paduch, E. Zielińska, P. Kubes, D. Klir, J. Kravarik, K. Rezac, J. Cikhardt, J. Kortanek, M. Scholz, L. Karpinski, Influence of the external magnetic field on pinch evolution and neutron production in plasma-focus discharge. *Plasma Physics and Controlled Fusion* (2013) **55**, :115013
- [23] J. Krása, D. Margarone, D. Klir, A. Velyhan, A. Picciotto, E. Krouský, K. Jungwirth, J. Skála, M. Pfeifer, J. Ullschmied, J. Kravárik, K. Rezác, P. Kubeš, P. Parys, L. Ryć, Generation of Secondary Particles from Subnanosecond Laser Irradiation of Targets at Intensities of  $10^{16}$  W cm<sup>-2</sup>. *IEEE Transactions on Plasma Science* (2013) **41**, 10:2819-2824
- [24] H.-S. Bosch, R.C. Wolf, T. Andreeva, J. Baldzuhn, D. Birus, T. Bluhm, T. Bräuer, H. Braune, V. Bykov, A. Cardella, F. Durodié, M. Endler, V. Erckmann, G. Gantenbein, D. Hartmann, D. Hathiramani,

- P. Heimann, B. Heinemann, C. Hennig, M. Hirsch, D. Holtum, J. Jagielski, J. Jelonnek, W. Kasperek, T. Klinger, R. König, P. Kornejew, H. Kroiss, J.G. Krom, G. Kühner, H. Laqua, H.P. Laqua, C. Lechte, M. Lewerentz, J. Maier, P. McNeely, A. Messiaen, G. Michel, J. Ongena, A. Peacock, T.S. Pedersen, R. Riedl, H. Riemann, P. Rong, N. Rust, J. Schacht, F. Schauer, R. Schroeder, B. Schweer, A. Spring, A. Stäbler, M. Thumm, Y. Turkin, L. Wegener, A. Werner, D. Zhang, M. Zilker, T. Akijama, R. Alzbutas, E. Ascasibar, M. Balden, M. Banduch, Ch. Baylard, W. Behr, C. Beidler, A. Benndorf, T. Bergmann, C. Biedermann, B. Bieg, W. Biel, M. Borchardt, G. Borowitz, V. Borsuk, S. Bozhenkov, R. Brake, H. Brand, T. Brown, B. Brucker, R. Burhenn, K.-P. Buscher, C. Caldwell-Nichols, A. Cappa, A. Cardella, A. Carls, P. Carvalho, Ł. Ciupiński, M. Cole, J. Collienne, A. Czarnecka, G. Czymek, G. Dammertz, C.P. Dhard, V.I. Davydenko, A. Dinklage, M. Drevlak, S. Drotziger, A. Dudek, P. Dumortier, G. Dundulis, P.v. Eeten, K. Egorov, T. Estrada, H. Fauge, J. Fellinger, Y. Feng, H. Fernandes, W.H. Fietz, W. Figacz, F. Fischer, J. Fontdecaba, A. Freund, T. Funaba, H. Fünfgelder, A. Gałkowski, D. Gates, L. Giannone, J.M. García Regaña, J. Geiger, S. Geißler, H. Greuner, M. Grahl, S. Groß, A. Grosman, H. Grote, O. Grulke, M. Haas, L. Haiduk, H.-J. Hartfuß, J.H. Harris, D. Haus, B. Hein, P. Heitzenroeder, P. Helander, R. Heller, C. Hidalgo, D. Hildebrandt, H. Höhnle, A. Holtz, E. Holzhauser, R. Holzthüm, A. Huber, H. Hunger, F. Hurd, M. Ihrke, S. Illy, A. Ivanov, S. Jabłoński, N. Jaksic, M. Jakubowski, R. Jaspers, H. Jensen, H. Jenzsch, J. Kaczmarczyk, T. Kaliatk, J. Kallmeyer, U. Kamionka, R. Karaleviciu, S. Kern, M. Keunecke, R. Kleiber, J. Knauer, R. Koch, G. Kocsis, A. Könies, M. Köppen, R. Koslowski, J. Koshurin, A. Krämer-Flecken, R. Krampitz, Y. Kravtsov, M. Krychowiak, G. Krzesinski, I. Ksiazek, M. Kubkowska, A. Kus, S. Langish, R. Laube, M. Laux, S. Lazerson, M. Lennartz, C. Li, R. Lietzow, A. Lohs, A. Lorenz, F. Louche, L. Lubyako, A. Lumsdaine, A. Lysoivan, H. Maaßberg, P. Marek, C. Martens, N. Marushchenko, M. Mayer, B. Mendelevitch, Ph. Mertens, D. Mikkelsen, A. Mishchenko, B. Missa, T. Mizuuchi, H. Modrow, T. Mönnich, T. Morizaki, S. Murakami, F. Musielok, M. Nage, D. Naujoks, H. Neilson, O. Neubauer, U. Neuner, R. Nocentini, J.-M. Noterdaeme, C. Nührenberg, S. Obermayer, G. Offermanns, H. Oosterbeek, M. Otte, A. Panin, M. Pap, S. Paquay, E. Pasch, X. Peng, S. Petrov, D. Pilopp, H. Pirsch, B. Plaum, F. Pompon, M. Povilaitis, J. Preinhaelter, O. Prinz, F. Purps, T. Rajna, S. Récssei, A. Reiman, D. Reiter, J. Remmel, S. Renard, V. Rhode, J. Riemann, S. Rimkevicius, K. Riße, A. Rodatos, I. Rodin, M. Romé, H.-J. Roscher, K. Rummel, Th. Rummel, A. Runov, L. Ryć, J. Sachtleben, A. Samartsev, M. Sanchez, F. Sano, A. Scarabosio, M. Schmid, H. Schmitz, O. Schmitz, M. Schneider, W. Schneider, L. Scheibl, M. Scholz, G. Schröder, M. Schröder, J. Schruff, H. Schumacher, I.V. Shikhovtsev, M. Shoji, G. Siegl, J. Skodzik, M. Smirnow, E. Speth, D.A. Spong, R. Stadler, Z. Sulek, V. Szabó, T. Szabolics, T. Szetefi, Z. Szökefalvi-Nagy, A. Tereshchenko, H. Thomsen, M. Thumm, D. Timmermann, H. Tittes, K. Toi, M. Tournianski, U.v. Toussaint, J. Tretter, S. Tulipán, P. Turba, R. Uhlemann, J. Urban, E. Urbonavicius, P. Urlings, S. Valet, D. Van Eester, M. Van Schoor, M. Vervier, H. Viebke, R. Vilbrandt, M. Vrancken, T. Wauters, M. Weissgerber, E. Weiß, A. Weller, J. Wendorf, U. Wenzel, T. Windisch, E. Winkler, M. Winkler, J. Wołowski, J. Wolters, G. Wrochna, P. Xanthopoulos, H. Yamada, M. Yokoyama, D. Zacharias, J. Zajac, G. Zangl, M. Zarnstorff, H. Zeplien, S. Zoletnik, M. Zuin, Technical challenges in the construction of the steady-state stellarator Wendelstein 7-X. *Nuclear Fusion* (2013) **53**, :126001
- [25] D. Kalupin, I. Ivanova-Stanik, I. Voitsekhovitch, J. Ferreira, D. Coster, L.L. Alves, Th. Anie, J.F. Artaud, V. Basiuk, João, P.S. Bizarro, R. Coelho, A. Czarnecka, Ph. Huynh, A. Figueiredo, J. Garcia, L. Garzotti, F. Imbeaux, F. Köch, M.F. Nave, G. Pereverzev, O. Sauter, B.D. Scott, R. Stankiewicz, P. Strand, Numerical analysis of JET discharges with the European Transport Simulator. *Nuclear Fusion* (2013) **53**, :123007
- [26] T. Pütterich, R. Dux, R. Neu, M. Bernert, M. N. A. Beurskens, V. Bobkov, S. Brezinsek, C. Challis, J. W. Coenen, I. Coffey, A. Czarnecka, C. Giroud, P. Jacquet, E. Joffrin, A. Kallenbach, M. Lehnen, E. Lerche, E. de la Luna, S. Marsen, G. Matthews, M-L. Mayoral, R. M. McDermott, A. Meigs, J. Mlynar, M. Sertoli, G. van Rooij, Observations on the W-transport in the core plasma of JET and ASDEX Upgrade. *Plasma Physics and Controlled Fusion* (2013) **55**, :124036

- [27] P. Koester, L. Antonelli, S. Atzeni, J. Badziak, F. Baffigi, D. Batani, C.A. Cecchetti, T. Chodukowski, F. Consoli, G. Cristoforetti, R. De Angelis, G. Folpini, L.A. Gizzi, Z. Kalinowska, E. Krousky, M. Kucharik, L. Labate, T. Levato, R. Liska, G. Malka, Y. Maheut, A. Marocchino, P. Nicolai, T. O'Dell, P. Parys, T. Pisarczyk, P. Rączka, O. Renner, Y. J. Rhee, X. Ribeyre, M. Richetta, M. Rosiński, L. Ryć, J. Skala, A. Schiavi, G. Schurtz, M. Smid, C. Spindloe, J. Ullschmied, J. Wołowski, A. Zaraś, Recent results from experimental studies on laser–plasma coupling in a shock ignition relevant regime. *Plasma Physics and Controlled Fusion* (2013) **55**, :124045
- [28] K. T. Pozniak, A. Byszuk, M. Chernyshova, R. Cieszewski, T. Czarski, W. Dominik, K. Jakubowska, G. Kasprowicz, J. Rządkiwicz, M. Scholz, W. Zabolotny, FPGA based charge fast histogramming for GEM detector. *Proc. of SPIE* (2013) **8903**
- [29] W. M. Zabolotny, A. Byszuk, M. Chernyshova, R. Cieszewski, T. Czarski, W. Dominik, K. Jakubowska, G. Kasprowicz, K. Pozniak, J. Rządkiwicz, M. Scholz, Embedded controller for GEM detector readout system. *Proc. of SPIE* (2013) **8903**
- [30] P. Gąsior, M. Rosiński, Review on developments in LIS (laser ion source) at the IPPLM and its possible applications in photonics. *Proc. of SPIE* (2013) **8903**
- [31] P. Gąsior, Can ICAN can CERN into a can?: review study. *Proc. of SPIE* (2013) **8903**
- [32] K. Szewczak, S. Jednoróg, P. Krajewski, Individual dose monitoring of the nuclear medicine departments staff controlled by Central Laboratory for Radiological Protection. *Nuclear Medicine Review* (2013) **16**
- [33] D. Klir, V.A. Kokshenev, P. Kubes, A.Yu. Labetsky, M. Paduch, K. Rezac, A.V. Shishlov, Search for Drive Parameter of Neutron Optimized Z-Pinches and Dense Plasma Foci. *IEEE Transactions on Plasma Science* (2013) **41**
- [34] V. Pericoli Ridolfini, R. Zagórski, G. Artaserse, G. Calabrò, F. Crisanti, G. Maddaluno, G. Ramogida, B. Viola, Preliminary 2D code simulation of the quasi-snowflake divertor configuration in the FAST tokamak. *Fusion Engineering and design* (2013) **88**

# 5 Contribution to conferences and workshops

## **International Seminar on Actual Problems of Plasma Physics, Kharkov, Ukraine, 16-17.01.2013**

- **M. Sadowski**, et al., *Passive Corpuscular Diagnostics of Charged Particles Emission from High-Temperature Plasma Experiments* (invited)

## **SPIE Optics and Electronics 2013 and Laser Energy Workshop, Czech Rep., Prague, 14-19.04.2013**

- **J. Wołowski**, et al., *Results of recent experimental works performed by the IPPLM team within HiPER project* (poster)
- **T. Pisarczyk**, et al., *Investigation of efficiency of laser radiation energy transport into the shock wave with the use of a planar target* (oral)
- **J. Badziak**, et al., *Efficient laser-driven generation of ultra-intense ion beams for fast ignition in the LICPA accelerator* (oral)

## **11<sup>th</sup> Direct Drive and Fast Ignition Workshop, Italy, Rome, 05-09.05.2013**

- **P. Rączka**, et al., *Cavity-enhanced laser-driven acceleration of intense ion beams for ion fast ignition* (oral)

## **7<sup>th</sup> IAEA Techn. Meeting on Steady State Operation of Magn. Fusion devices, France, Aix en Provence, 13-17.05.2013**

- **I. Ivanova-Stanik**, et al., *COREDIV modelling of WEST plasma scenarios* (poster)

## **XXXII<sup>th</sup> IEEE-SPIE Joint Symposium Wilga 2013, 26.05-02.06.2013, Poland, Wilga**

- **K. Jakubowska**, et al., *FPGA based charge fast histogramming for GEM detector* (oral)
- **K. Jakubowska**, et al., *Embedded controller for GEM detector readout system* (oral)

## **20<sup>th</sup> Topical Conference on radio Frequency Power in Plasmas 2013, Italy, Sorento, 24-29.06.2013**

- **A. Czarnecka**, et al., *Spectroscopic investigation of heavy impurity behaviour during ICRH with the JET ITER-like wall* (poster)

## **Towards Technical Design Reports (TDR) of experiments with intense laser beams at ELI-NP, Romania, Bucharest, 26-29.06.2013**

- **P. Rączka**, *Advanced target designs optimizing laser driven ion beam parameters for photonuclear and high field experiments* (oral)

## **3<sup>rd</sup> Conference on Micro-Pattern Gaseous Detectors, Spain, Zaragoza, 30.06-07.07.2013**

- **M. Chernyshova**, et al., *Development of GEM gas detectors for X-ray crystal spectrometry* (poster)
- **T. Czarski**, et al., *Development of GEM gas detectors for X-ray crystal spectrometry* (poster)

**40<sup>th</sup> European Physical Society Conference on Plasma Physics and EPS Satellite Conference on Plasma Diagnostics 2013, Finland, Espoo, 30.06 – 07.07.2013**

- **T. Czarski**, et al., *Fundamental data processing for GEM detector measurement system applied for X-ray diagnostics of fusion plasmas* (poster)
- **K. Jakubowska**, et al., *Soft-X-ray measurements in WEST using GEM detectors* (poster)
- **T. Pisarczyk**, et al., *Investigation of energy transfer from PALS iodine laser beam to shock wave generated in solid target relevant to shock ignition* (poster)
- **P. Rączka**, et al., *The influence of performed plasma on a laser-driven shock produced in a planar target at the conditions relevant to Shock Ignition* (poster)
- **I. Ivanova-Stanik**, et al., *Modelling of JET hybrid scenarios with the European Transport Solver* (poster)

**54<sup>th</sup> Course “Atoms and Plasmas in Super-Intense Laser fields”, Italy, Erice, 20-31.07.2013**

- **J. Domański**, et al., *Effects of light polarization and target composition on parameters of ion beams produced at the interactions of an ultra-intense laser pulse with two-species targets* (poster)

**PLASMA-2013 Research and Applications of Plasmas, Poland, Warsaw, 02-06.09.2013**

- **M. Kubkowska**, et al., *Investigation of interactions of intense plasma streams with tungsten and CFC targets in the PF-1000 facility* (oral)
- **P. Gąsior**, et al., *Study of correlation of deuterium contents in a-C:D dust induced by laser irradiation from co-deposited surface with the grain size and velocity* (oral)
- **P. Gąsior**, et al., *Comparison of high and low-power density regimes of operation of laser-based methods for fuel removal and cleaning of plasma facing components* (poster)
- **S. Jabłoński**, et al., *Two-dimensional relativistic particle-in-cell code for simulation of laser-driven ion acceleration in various acceleration schemes* (poster)
- **Z. Kalinowska**, et al., *The interferometric studies of the pre-plasma influence on the laser energy transfer to the shock wave with the use two-layers planar targets* (poster)
- **K. Jakubowska**, et al., *A spectroscopic study of laser ablation plasma from Mo target* (poster)
- **J. Domański**, et al., *Acceleration of ions to GeV energies at the interactions of an ultra-intense laser pulse with two-species target* (poster)
- **L. Ryć**, et al., *Measurement of ion emission from plasmas obtained with a 600-fs, 60-mJ KrF laser* (poster)
- **E. Kowalska-Strzęciwilk**, et al., *Principal Component Analysis of soft X-ray signals generated by the PF 1000 facility in experiments with solid targets* (poster)
- **A. Czarnecka**, et al., *Analysis of soft X-ray signals generated by the PF 1000 facility in experiments with solid targets* (poster)
- **J. Kurzyna**, et al., *Plasma inside a small hall thruster for satellites* (poster)
- **T. Chodukowski**, et al., *Interactions of plastic plasma with different atomic number plasmas* (poster)

**Intern. Workshop on Dense Magnetized Plasmas (ICDMP-2013), Warsaw, Poland, 6-7.09.2013**

- **M. Sadowski**, et al., *Overview of Experimental Studies at DPF-1000 Performed by the NCBJ Team in 2013* (invited)

**Inertial Fusion Sciences and Applications 2013, Japan, Nara, 06-15.09.2013**

- **T. Chodukowski**, et al., *Interactions of plastic plasma with different atomic number plasmas*(poster)
- **M. Rosiński**, et al., *The effect of laser wavelength on a laser-driven shock produced in a planar target at the conditions relevant to Shock Ignition* (poster)

**International Conference on Fusion Reactor Diagnostics, Italy, Varenna, 8-14.09.2013**

- **B. Bieńkowska** et al., *Neutron counter based on beryllium activation* (poster)

**International Symposium on Fusion Nuclear Technology, Spain, Barcelona, 15-20.09.2013**

- **M. Kubkowska**, et al., *Study of laser-removal and structural changes of W:Al:C layer with deuterium content*
- **E. Kowalska-Strzęciwilk**, et al., *Microstructural studies and surface analysis of laser irradiated in-situ Co-TiC composites* (poster)

**The seventh Euro-Mediterranean Symposium on Laser Induced Breakdown Spectroscopy, Italy, Bari, 15-20.09.2013**

- **P. Gašior**, et al., *Application of LIBS detection of food contamination with heavy metal elements (Pb, W, Ni)* (poster)

**Plasma Edge Theory in Fusion Devices, Polska, Kraków, 22-26.09.2013**

- **R. Zagórski**, et al., *Integrated modelling of N seeding discharges for JET and ITER-like wall for H-mode and hybrid scenario* (oral)
- **I. Ivanova-Stanik**, et al., *Integrated core-SOL simulations of ITER H-mode scenario: effect of pedestal density on fusion performance and divertor loads* (poster)
- **G. Pełka**, et al., *TECXY code simulation of the snowflake divertor configuration in DEMO reactor* (poster)
- **W. Stępniewski**, et al., *Limit on reduction of the power load to the target plates for DEMO reactor* (poster)

**Plasma Physics by laser and Applications 2013, Włochy, Lecce, 02-06.10.2013**

- **J. Badziak**, et al., *The LICPA accelerator of dense plasma and ion beams* (invited)

**33<sup>rd</sup> International Electric Propulsion Conference, USA, Washington, 5-12.10.2013**

- **J. Miedzik**, et al., *Wall-induced cross-field electron transport with oblique magnetic field lines* (oral)
- **D. Daniłko**, et al., *Quasineutral PIC electric guiding center modelling in the presence of slow cross-field electron transport in a Hall thruster* (oral)
- **S. Barral**, et al., *Active control and excitation of breathing oscillations in a Hall thruster with a fast digital signal processor* (oral)
- **J. Kurzyna**, et al., *Development status of an open capillary pulsed plasma thruster with non-volatile liquid propellant* (oral)

**8<sup>th</sup> Workshop on Fusion Data Processing, Validation and Analysis, Belgium, Ghent, 4-6.11.2013**

- **A. Czarnecka**, et al., *W-Control in JET and AUG* (oral)

**International Conference on Plasma Science and Applications, Singapore, 01-08.12.2013**

- **V. Gribkov**, *Fields of researches and applications domains for compact and large DPF devices (radiation materials science, dynamic quality control, radiation biology, etc.): current assets, problems and essentials* (oral)

**Second IAEA DEMO Programme Workshop, Austria, Vienna, 16-20.12.2013**

- **I. Ivanova-Stanik, R. Zagórski**, *COREDIV modelling of the DEMO tokamak scenario*

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

## Research project carried out within the programme of EURATOM-IPPLM Association

### Theory and modelling of tokamaks

- Support to the advancement of the ITER Physics Basis (OPPM)
- Activities in support to DEMO design
- Development of concept improvements and advances in fundamental understanding fusion plasmas.

### Plasma-wall interaction

- Support to the advancement of the ITER Physics Basis
- Activities in support to DEMO design. PWI- Plasma Wall Interaction.

### Plasma diagnostics

- Development of neutron, gamma ray and soft X-ray diagnostics for tokamaks.

### Contribution to the Wendelstein 7-X

- Development of the soft X-ray spectrometry systems and neutron activation technique.

### JET activities

- Participation to the JET experimental campaigns in 2013
- JET related projects.

### Keep-in-touch activity 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.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:Roadmap for the future”.

- SNECMA order 111800057710: "Numerical Study of a High Power Hall Thruster with Ar and Kr propellant".
- Project KLIMIT: „Krypton Large Impulse Thruster” sponsored by ESA (Programme PECS)

### **Other projects supported by EU**

- Project COST Action MP 1208: „Developing the Physics and the Scientific community for Inertial Confinement Fusion at the time of NIF ignition”.
- Project POLONIUM - LAS-PLAS: "Studies of laser-matter interaction and laser fusion"; within Polish-French collaboration (Agreement IPPLM - CELIA Univ. Bordeaux-1).
- Project of LaserLab-Europe Consortium - PALS001914: "Laserlab-Europe Research project: Femtosecond polaro-interferometric investigation of initial stages of the shock ignition relevant plasmas generated by laser irradiation of planar targets”.

### **The IAEA Coordinated Research Projects**

- 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: "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”.

## 7 Research projects granted from the Polish funding institutions

- 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 2013:
  - 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.
- Regional Operational Program of the Mazovian province No RPMA.01.01.00-14-002/10: "Development and modernization of laboratories of high-power lasers" (finished on 30.06.2013).
- Grant of National Centre of Science (NCN) "Harmonia" No DEC-2012/4/M/ST2/00452 : "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".
- Grant of National Centre of Science (NCN) No 871-1/N-SILMI-RNP/2010/0 entitled "Studies of macroscopic effects of intense laser pulse interaction with matter and preparation of different applications achieved result of these studies". This project is related to the Project SILMI - Super-Intense Laser-Matter Interactions realized in IPPLM within the Research Networking Programme (RNP) of European Science Foundation (ESF).



## 8 International conferences and workshops organized by IPPLM

### **PLASMA-2013 - the International Conferences on Research and Applications of Plasmas (<http://plasma2013.ipplm.pl/>)**

The biannual International Conferences on Research and Applications of Plasmas (PLASMA) have been organized every two years since 1993. The scope of the PLASMA conference series, which idea was originally to facilitate the exchange of knowledge and to spread the collaboration between the scientists and engineers from the Eastern European Countries, covers most of issues of broadly understood plasma physics and technology. This conference is designed for interested plasma researchers, engineers, and students from all the countries.

In 2013, the conference was organized in Warsaw by the Institute of Plasma Physics and Laser Microfusion (IPPLM – <http://www.ipplm.pl>), and the Polish Physical Society (PPS) on September 2-6 at the Central Agriculture Library located in the heart of Warsaw.

The Conference programme included both invited and contributed papers related to the following topics:

- Elementary processes and general plasma physics
- Plasmas in tokamaks and stellarators and magnetically confinement fusion
- Plasmas generated by laser beams and inertial confinement fusion
- Plasmas produced by Z-pinch and Plasma-Focus discharges
- Low density plasmas produced by discharges
- Space plasmas and laboratory astrophysics
- Plasma diagnostic methods and applications of plasmas.

Prof. Marek Sadowski (IPPLM, Warsaw) was the chairman of the International Scientific Committee. The Local Organizing Committee (appointed in IPPLM) was managed by Prof. Jerzy Wolowski.

The papers presented at the conference were published on CD, conference web page and in the peer-reviewed international journal "Physica Scripta".

At the conference participated about 130 researchers from more than 20 countries. The 21 invited talks were given by the outstanding scientists.

### **14<sup>th</sup> International Workshop on Plasma Edge Theory in Fusion Devices 23-25 September, 2013 Cracow, Poland (<http://pet14.ipplm.pl/>)**

The 14<sup>th</sup> International Workshop on Plasma Edge Theory in Fusion Devices was organized by Institute of Plasma Physics and Laser Microfusion (IPPLM – <http://www.ipplm.pl>), EURATOM Association and the Polish Physical Society. Like all the preceding workshops, the subject of that year's workshop was plasma theory of the edge region in magnetic confinement fusion devices. Current status of the theory for the boundary layer of fusion plasmas was presented. The emphasis was laid on the development of

theory and of appropriate numerical methods, with a secondary interest in self-consistent modeling of experimental data (including also empirical elements).

The workshop consisted of invited lectures, oral presentations and poster contributions. Contributed papers were mainly presented as posters. It was recommended that orally presented papers were also accompanied by a poster.

The following topics were intended to be covered by invited and contributed lectures:

- **Basic edge plasma theory**
- **Models of special phenomena and edge control**
- **Integrated edge plasma modeling.**

Prof. J.A. Heikkinen (VTT, Espoo, Finland) was the chairman of the International Scientific Committee. The Local Organizing Committee (appointed in IPPLM) was managed by Prof. Roman Zagórski.

The invited and accepted contributed papers were included in the proceedings of the workshop and published in the journal "Contributions to Plasma Physics" after usual refereeing process.

The number of attendees of the workshop from about 12 countries was about 59.

# 9

## PhD Theses

**Rafał Prokopowicz** Neutron diagnostics in nuclear and thermonuclear reactors using activation  
PAS Institute of Nuclear Physics, Cracow



# 10 Seminars and lectures

## Seminars at IPPLM

29.01.2013 – dr Grzegorz Pełka (IPPLM): Evaporation of a material from a surface of tungsten plate with a plasma stream generated in PF-1000U device

12.02.2013 – dr Sławomir Jednoróg (IPPLM): Radiation around us

24.04.2013 – dr Stefan Borodziuk (IPPLM): Laser-induced hydrodynamic acceleration of dense matter and its potential application for „impact fast ignition”

28.05.2013 – mgr Jan Miedzik (IPPLM): One-dimensional modeling of plasma in Hall thrusters – near-wall electron transport

27.06.2013 – mgr inż. Irena Ivanova-Stanik (IPPLM): Self-consistent modelling of plasma in JET tokamak with the use of COREDIV code

25.09.2013 – dr Jacek Kurzyna (IPPLM): Plasma satellite thrusters at IPPLM – current projects and perspectives

01.10.2013 – mgr Dariusz Daniłko (IPPLM): Plasma modelling with the use of Particle In Cell (PIC) and guiding center approximation for electrons assuming their slow drift

26.11.2013 - mgr Agnieszka Szelecka (IPPLM): The principle of correspondence in case of chaotic systems

17.12.2013 – dr Maryna Chernyshova (IPPLM): The project of GEM detector construction for KX1 diagnostics in JET tokamak

## Seminars of the Plasma Physics Section of the Polish Physical Society

19.02.2013 – prof. Jan Badziak (IPPLM): Laser thermonuclear fusion: current status, challenges and perspectives

21.05.2013 – dr Stefan Borodziuk (IPPLM): Laser acceleration of micro-projectiles / plasma streams – history and current status

18.06.2013 – dr Paweł Gąsior (IPPLM): New possibilities of laser plasma and charged particles acceleration studies in view of the project concerning construction of 240-TW fiber laser of 10 kHz repetition rate



# 11 Public Information

- ***International Conference PLASMA-2013 Research and Applications of Plasmas, 2-6.09.2013***

The international conference PLASMA-2013 was organized by the Local Organizing Committee created at IPPLM. The Polish Physical Society was the co-organizer of this venture. More than 140 participants from various countries declared the participation in PLASMA-2013. The International Scientific Committee invited more than 20 recognized specialists from Poland and abroad to give an oral presentation. The Ministry of Science and Higher Education supported the organization of the conference with a special subsidy. Several Polish and foreign private companies sponsored the conference presenting their scientific equipment.

The PLASMA conferences have been organized since 1993 mainly in Poland. In 2007 the conference took place in Germany and in 2010 – in France. The main goal of the next PLASMA conferences is to create a scientific forum for detailed discussion and evaluation of progress in research of plasma physics and plasma technology as well as thermonuclear fusion. The majority of presented works is performed in the framework of the international cooperation, most frequently covered by the European programmes. The conference has been considered an important international scientific event of exceptional importance for scientific communities in Eastern and Western Europe. It facilitates the meetings of young scientists with experienced researchers from renowned centres in Poland and abroad.

The total number of participants (including 11 IPPLM scientists) amounted to 131 persons from 24 countries. The invited lectures were presented by 18 distinguished researchers and oral presentations (2 of them by IPPLM scientists - P. Gašior and M. Kubkowska) were delivered by 24 participants. Moreover, 90 posters (10 from IPPLM) were put on display and discussed. The conference participants took part in a trip to Wilanów Palace, which was built for the Polish king Jan III Sobieski in the last quarter of the 17th century, and enjoyed it immensely.

- ***14<sup>th</sup> International Workshop on Plasma edge Theory in Fusion Devices, 23-25.09.2013***

The 14th International Workshop on Plasma Edge Theory in Fusion Devices was organized by IPPLM, EURATOM Association and Polskie Towarzystwo Fizyczne (Polish Physical Society). Like all the preceding workshops, the subject of that year's workshop was plasma theory of the edge region in magnetic confinement fusion devices (invited and contributed presentations included basic edge plasma theory, models of special phenomena and edge control, and integrated edge plasma modelling). Current status of the theory for the boundary layer of fusion plasmas was presented. The emphasis was laid on the development of theory and of appropriate numerical methods, with a secondary interest in self-consistent modeling of experimental data (including also empirical elements).

The workshop consisted of invited lectures, oral presentations and poster contributions. Contributed papers were mainly presented as posters.

The participants accounted for 59 persons from 12 countries.

- ***Participating in the XVII Science Festival in Warsaw, 20-29 September, 2013***

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 physicians 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, six classes from junior and high schools (150 persons in total) participated in the festival lessons on weekdays and around 70 persons of various age joined IPPLM during weekends.

- ***Visits of students***

The students from the Department of Physics of Warsaw University (April) and the students from the Department of Physics of the Warsaw University of Techno (December) visited IPPLM to attend a lecture of P. Gašior dealing with thermonuclear energy. Participants had a chance to see the PF-1000 device, 10TW laser laboratory as well as PlanS.

Around 50 persons (two classes) from LXIII High School named after L. Kossuth visited IPPLM in March. M. Paduch conducted a lecture on thermonuclear fusion and tokamaks, W. Stępniewski described the functioning of PF-1000 device, and scientists proposed a tour of the PlanS laboratory.

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

Opening of the Hall thruster laboratory called PlanS to examine plasma propulsion techniques for satellites and space probes (newsletter) – January 2013

Participation of Prof. J. Wołowski in the scientific and technical conference “Science and technology in the context of challenges in the construction of the nuclear plant” and presenting the topic called “Laser fusion as a future energy source” – February 2013

Participation of Prof. J. Wołowski and Dr. M. Paduch at the meeting in the National Information Processing Institute devoted to the possibilities of selling of the research results of the scientific institutes as a result of cooperation of science and economy given their problems and challenges – April 2013

Meeting with the participation of IPPLM researchers at Warsaw University devoted to the perspectives of thermonuclear fusion research – May 2013

Article in Bemowo News – “Physics right around the corner” describing activities taking place at IPPLM, its equipment and staff – June 2013

LaserLab newsletter: Laserlab Forum” No 15 – publication of the history of Prof. T Pisarczyk’s access to PALS – June 2013

Membership of Prof. Jan Badziak in the Programme Committee of the EPS Plasma Physics Conference 2013, Finland, Helsinki - June/July 2013

Article in PrzeglądTechniczny (Technical Review): “An engineer designs the future” – information about the participation of IPPLM researchers in the Second Convention of the Polish Engineers – July 2013

Article in Rzeczpospolita: “The power of the Sun will be released on Earth” – information about IPPLM as a participant of the ITER project aiming at the construction of the thermonuclear reactor in Cadarache (France) – July 2013

Annual Meeting of the International Scientific Committee of an International Centre for Dense Magnetised Plasmas held to discuss the accomplished goals within the activities at PF-1000 and laboratories in frame of ICDMP and define the scope of works for the future – September 2013

Article in Quality News: “Development and modernization of the High Power Laser laboratory at IPPLM” – September 2013

Article in Fusion in Europe No 2/2013: “A fruitful collaboration between neighbours” – devoted to the contribution of IPPLM into the construction of W7-Xstallarator in Greifswald (Germany) through two systems of X-ray diagnostics – September 2013

Membership of Prof. Jerzy Wołowski in the Scientific Committee of the Plasma Physics by Laser and Applications 2013 Lecce - October 2013

Article in Gazeta Echo and KronikaMiastaStołecznegoWarszawy: „Only at Bemowo – Art and science together” – depicting Teatr GO and its collaboration with IPPLM to promote art. And science among young people

Presentation in Multimedia “WojewództwoMazowieckie – SercePolski” (issued by Negatyw Sp. z o.o. ): article „Sylwester Kaliski Institute of Plasma Physics and Laser Microfusion – Mazoviancenter of research for the future” (in print)

Newsletter regarding the operation of launching the prototype of the first Polish plasma thruster – December 2013

- ***Collaboration with Teatr GO located on the premises of IPPLM***

Metaphysical workshops called The Fifth State of Matter as well as The Theatre of Science were organized by Teatr GO in 2013 with growing popularity. 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 utilized 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.



# Index

---

## B

Badziak, J. · 11, 12, 104, 110, 111, 113, 114, 116, 117, 155, 157, 167, 171  
Barral, S. · 12, 144, 147, 148, 149, 157  
Bieńkowska, B. · 12, 47, 50, 65, 71, 79, 135, 157  
Borodziuk, S. · 12, 104, 107, 116, 117, 167

---

## C

Chernyshova, M. · 12, 51, 56, 59, 63, 71, 99, 155, 167  
Chodukowski, T. · 12, 104, 117, 124, 156, 157  
Czarnecka, A. · 12, 23, 74, 76, 84, 94, 99, 100, 103, 124, 155, 156, 157  
Czarski, T. · 12, 51, 56, 63, 71, 79, 155

---

## D

Daniłko, D. · 12, 144, 148, 149, 157, 167  
Domański, J. · 12, 156  
Dominik, W. · 11

---

## F

Figacz, W. · 9, 76, 84

---

## G

Gałkowski, A. · 4, 9, 11, 12  
Gąsior, P. · 11, 12, 74, 81, 84, 88, 93, 124, 156, 157, 167, 169, 170  
Gribkov, V. · 12, 130, 158

---

## I

Ivanova-Stanik, I. · 9, 12, 19, 23, 28, 29, 35, 40, 135, 155, 156, 157, 158, 167

---

## J

Jabłoński, S. · 9, 12, 63, 74, 76, 108, 110, 111, 113, 114, 116, 151, 153, 156  
Jakubowska, K. · 11, 12, 51, 56, 99, 135, 155, 156  
Jednoróg, S. · 12, 65, 77, 79, 167

---

## K

Kaczmarczyk, J. · 9, 12, 74, 76  
Kalinowska, Z. · 12, 104, 107, 117, 124, 156  
Kasperczuk, A. · 9, 12, 104, 107, 117

Kowalska-Strzęciwilk, E. · 12, 79, 81, 84, 124, 126, 135, 156, 157  
Kubkowska, M. · 11, 12, 74, 76, 81, 99, 124, 126, 130, 135, 156, 157, 169  
Kurzyrna, J. · 11, 12, 144, 147, 156, 157, 167

---

## L

Lewandowska, M. · 11

---

## M

Miedzik, J. · 12, 144, 147, 148, 149, 157, 167  
Miklaszewski, R. · 7, 12, 84, 126, 135

---

## N

Nadrowski, P. · 11

---

## P

Paduch, M. · 7, 11, 12, 124, 126, 130, 135, 139, 140, 144, 170  
Parys, P. · 12, 120, 123  
Pełka, G. · 12, 15, 18, 157, 167  
Peradzyński, Z. · 12  
Pisarczyk, T. · 9, 11, 12, 104, 107, 116, 117, 124, 155, 156, 171  
Pluta, J. · 11  
Pokorska, A. · 4  
Pokorska, J. · 124  
Prokopowicz, R. · 8, 12, 47, 50, 65, 71, 79, 165

---

## R

Rachubiński, H. · 144  
Rączka, P. · 11, 12, 111, 113, 155, 156  
Rosiński, M. · 11, 12, 81, 120, 123, 157  
Rubel, M. · 11  
Ryć, L. · 9, 12, 74, 76, 84, 123, 156  
Rzadkiewicz, J. · 12, 51, 56, 59, 99

---

## S

Sadowski, M. · 11, 12, 135, 155, 156  
Sieczkowska, E. · 11  
Stankiewicz, R. · 12, 19, 23, 29, 40, 47  
Stępniewski, W. · 12, 15, 40, 157, 170  
Szelecka, A. · 12, 144, 167  
Szydłowski, A. · 12, 79

---

**W**

Wołowski, J. · 4, 11, 12, 76, 123, 155, 170, 171

Woźnicka U. · 11

Wrochna, G. · 11

---

**Z**

Zagórski, R. · 11, 12, 15, 18, 19, 23, 28, 34, 35, 39, 40, 47,  
99, 157, 158

Zaraś-Szydłowska, A. · 12, 120

Zielińska, E. · 12, 124, 130, 135, 139, 140, 144

Ziółkowski, A. · 56

Publisher: Institute of Plasma Physics and Laser Microfusion  
Publication financed by  
the Ministry of Science and Higher Education