Association Euratom-IPPLM Council Meeting
Kraków, 15.03.2013

Euratom Inertial Fusion Energy Keep-in-Touch activity Information on developments in 2012

J. Badziak, T. Pisarczyk, J. Wołowski

S. Borodziuk, T. Chodukowski, S. Jabłoński, Z. Kalinowska,
A. Kasperczuk, P. Parys, P. Rączka, M. Rosiński, L. Ryć

Institute of Plasma Physics and Laser Microfusion, Warsaw

Presented by Piotr Rączka

IPPLM
EURATOM

Work Programme 2012 for the Contract of Association
Association Euratom-IPPLM

Topic 7

Coordination, in the context of a keep-in-touch activity, of the Member State's civil research activities on Inertial Fusion Energy

7.1. Scientific Developments:

To analyze the prospects of emerging options of IFE on the basis of results of experiments and numerical modeling.

7.4. Maintain a watching brief on inertial confinement civil research activities.

Inform the wider fusion community of developments in IFE.

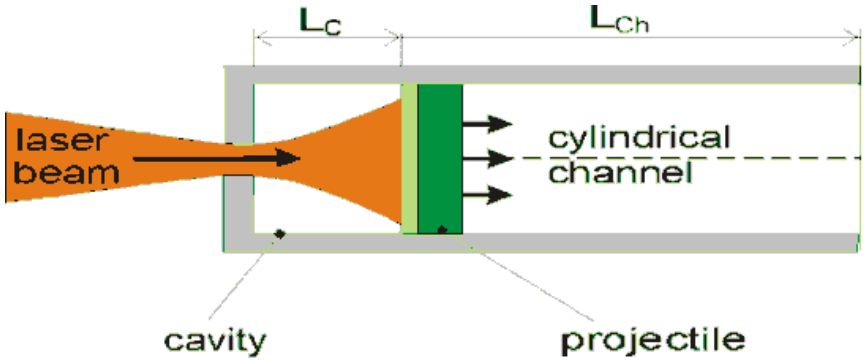
7.1. (a) Experiments at PALS in Prague on Laser-Induced Cavity Pressure Acceleration (LICPA)

In the LICPA scheme, a projectile placed in a cavity is irradiated by the laser beam and accelerated either by the pressure of the thermal laser-produced plasma generated in the cavity or by the pressure of photons captured in the cavity.

LICPA in the hydrodynamic regime (for impact FI):

$I_L \sim 10^{10} \div 10^{17}$ W/cm^2; $\rightarrow$ $v_p < 5 \times 10^8$ cm/s

The cylindrical LICPA accelerator working in the hydrodynamic regime, tested in the PALS experiment.



7.1. (a) Experiments at PALS in Prague on Laser-Induced Cavity Pressure Acceleration (LICPA)

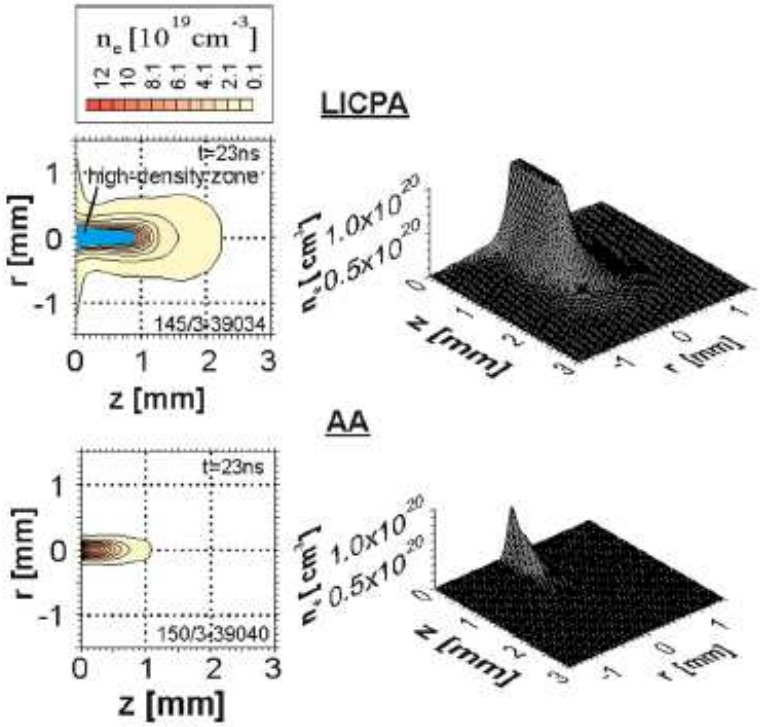
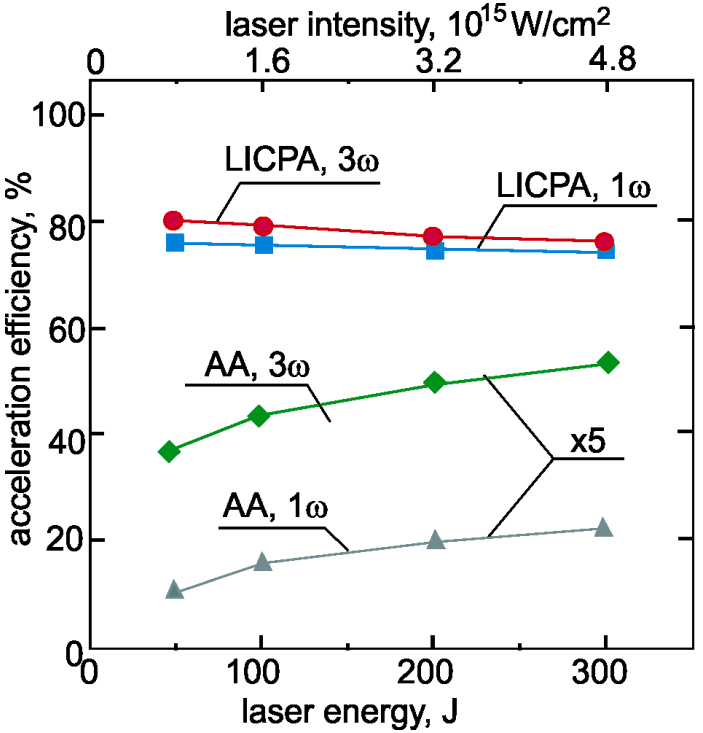
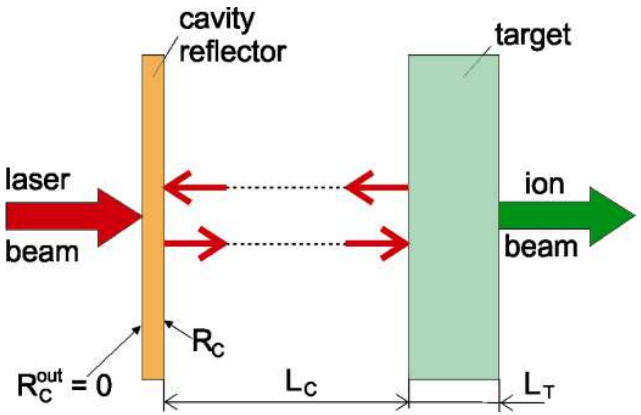


FIG. 6. The electron isodensitograms and the space profiles of electron distributions for the plasma flowing out of the channel in the LICPA and AA cylindrical schemes recorded 23 ns after the target irradiation. CD_2 target of $l_t = 25\ \mu m$, $L_{Ch} = 2$ mm, $d_c = 0.3$ mm, $L_c = 0.2$ mm, $d_h = 0.15$ mm. 3ω laser beam of $E_L = 177$ J for LICPA and 180 J for AA. Note that the plasma driven by LICPA is faster and carriers much more electrons and ions than that driven by AA.



J. Badziak, S. Jabłoński, T. Pisarczyk, P. Rączka, E. Krousky, R. Liska, M. Kucharik, T. Chodukowski, Z. Kalinowska, P. Parys, M. Rosiński,1 S. Borodziuk, and J. Ullschmied, Phys. Plasmas **19**, 053105 (2012)

7.1. (b) PIC simulation of LICPA in the photon pressure regime

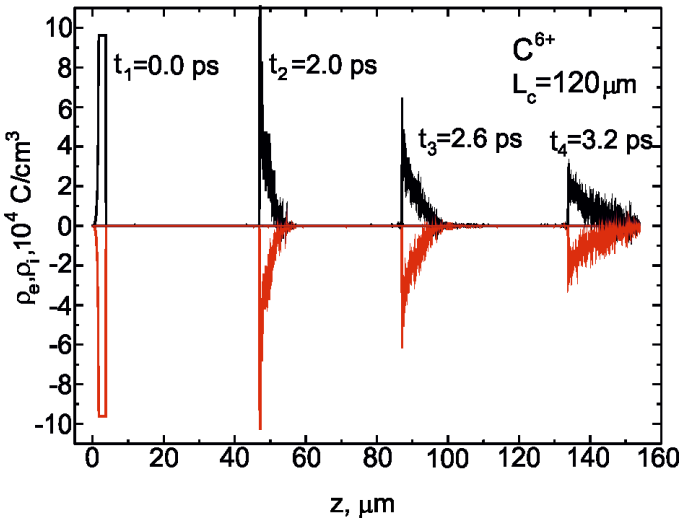


A fully relativistic electromagnetic 1D Particle-In-Cell (PIC) simulation of the ion bunch acceleration.

The effects of plasma parametrs and light polarization on the ion bunch parameters and the laser-ions energy conversion efficiency had been studied .

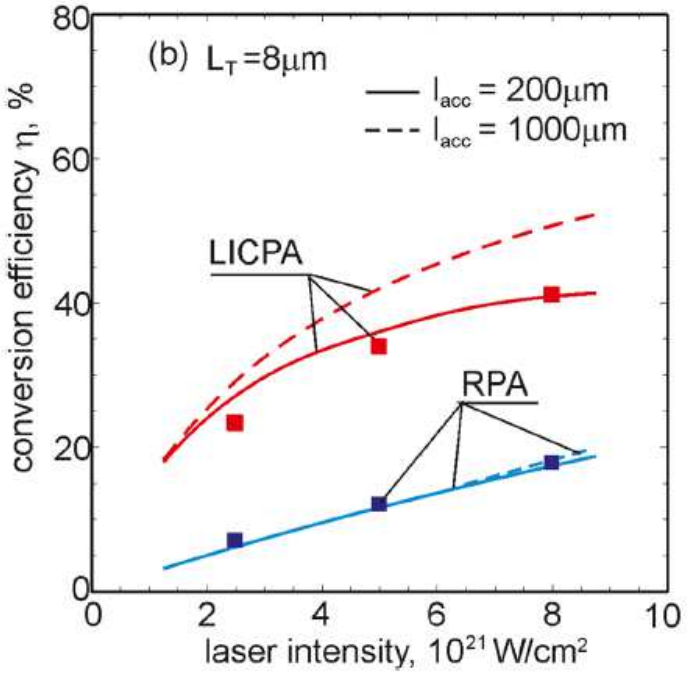
LICPA in the photon pressure regime (for ion FI):

$I_L > 10^{20}$ W/cm^2; → $v_p > 10^9$ cm/s.



The acceleration efficiency in the LICPA scheme is much higher than in the conventional scheme.

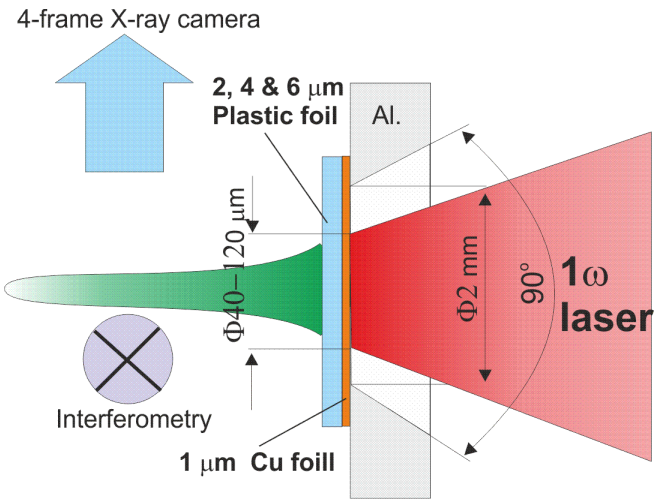
Snapshots of the carbon ion and electron charge density distributions.



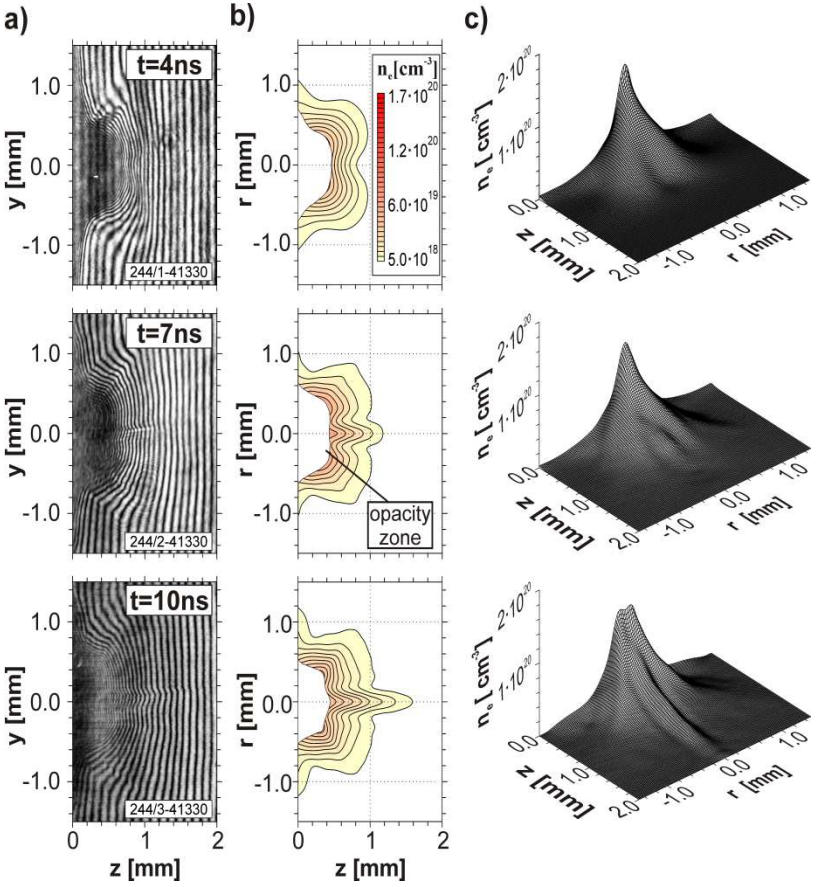
cavity depth 120 μm; R = 0.64

J. Badziak, S. Jabłoński, and P. Rączka, Appl. Phys. Lett. **101**, 084102 (2012)

7.1. (c) Optimization of laser-produced plasma jets



The Al plasma jet in the form of a narrow bright stream can be clearly distinguished from the plastic plasma background.



The electron density distributions were measured using a 3-frame interferometer and shape of plasma jet was imaged by sequences of x-ray plasma images for a plastic target with Al cylindrical insert.

A. Kasperczuk, T. Pisarczyk, T. Chodukowski, Z. Kalinowska, P. Parys, O. Renner, S. Yu. Gus'Kov, N. N. Demchenko,
B. J. Ullschmied, E. Krousky, M. Pfeifer and K. Rohlena: Physics of Plasmas **19**, 092106 (2012).

7.4. Inform the wider fusion community of developments in IFE.

(a) Overview of laser fusion: J. Badziak, ***Laser nuclear fusion: current status, challenges and prospect*****,** Bull. Pol. Acad. Sci. Tech. Sci. 60, 729 (2012)

(b) P. Rączka, ***Current issues in ion fast ignition*****,** lecture at the Kudowa Summer School ``Towards Fusion Energy", 11-15. 06.2012, Kudowa Zdrój, Poland

Publications

1. J.Badziak, S.Jabłoński, T.Pisarczyk, P.Rączka, E.Krousky, R.Liska, M.Kucharik, T.Chodukowski, Z.Kalinowska, P.Parys, M.Rosiński, S.Borodziuk, and J.Ullschmied, Highly efficient accelerator of dense matter using laser-induced cavity pressure acceleration. *Physics of Plasmas* 19, 1-8 (2012).

2. J.Badziak, S.Jabłoński, and P.Rączka, Highly efficient generation of ultraintense high-energy ion beams using laser-unduced cavity pressure acceleration. *Applied Physics Letters* 101, 084102 (2012).

3. A.Kasperczuk, T.Pisarczyk, T.Chodukowski, Z.Kalinowska, P.Parys, O.Renner, S.Yu.Gus'kov, N.N.Demchenko, J.Ullschmied, E.Krousky, M.Pfeifer, K.Rohlena, and J.Skala, Laser-produced aluminum plasma expansion inside a plastic plasma envelope. *Physics of Plasmas* 19, 092106 (2012).

4. J. Badziak, Laser nuclear fusion: current status, challenges and prospect, *Bull. Pol. Acad. Sci. Tech. Sci.* 60, 729 (2012).