# Development and modernization of the High Power Laser Laboratory at IPPLM

Experimental chamber No 1 connected with the laser-pulse optical compressor of laser pulse.

**The Institute of Plasma Physics and Laser Microfusion (IPPLM) was founded on the 1st of January 1976. The research carried out at IPPLM mainly includes studies of plasma physics and thermonuclear fusion to provide safe energy for the humankind and the environment in the future. The structure of IPPLM includes two research divisions: Division of Laser-Produced Plasma (DLPP), and Division of Plasma in Magnetic Field (DPMF). Main areas of interest of the DLPP are as follows: laser-produced plasma physics and applications, inertial fusion energy (IFE), laser-matter interaction physics at ultrahigh laser intensities and hydrodynamic processes accompanying the laser-matter interaction.**

The IFE is a scheme whereby lasers are used to compress spherically a small capsule of hydrogen isotopes (D and T) to the extent that the nuclei D and T fuse together in the centre of dense and hot plasma to form helium, releasing significant energy in the form of neutrons. The laser driven fusion research has predicted the need for extremely large-scale systems to achieve ignition and thus energy gain. The laser National Ignition Facility (NIF) in USA will come into full operation during next 2-3 years.

The alternative concepts for igniting thermonuclear fuel – "fast ignition" and "shock ignition", are explored as new methods to reach high gain of ICF targets. The spherical pre-compressed DT fuel can be induced by an intense burst of high-energy electrons or protons generated by a multi-petawatt laser, or by a strong, spherically convergent shock driven by the high intensity spike at the end of the laser pulse. Factor-10 reductions in scale are calculated to result from this innovation.

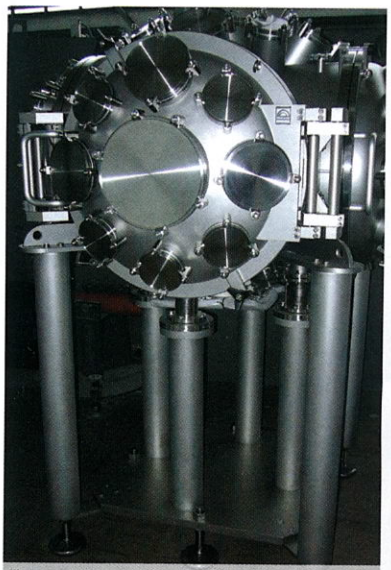
In the IPPLM studies on laser-matter interaction and inertial fusion energy (IFE) are carried out as a part of HiPER project, projects supported by LASERLAB-Europe Consortium and other projects. In 2011, Mazovia Regional Board decided to earmark European Union funds to support the project "Develop and Modernise High Power Laser Laboratory in the Institute of Plasma Physics and Laser Microfusion. The financial support will allow the institute to participate more intensively in the innovative fusion research programme.

## Project's Aim

The aim of the project is to create real infrastructural facilities that are vital to carry out highly specialized research with the help of high power lasers, especially investment in scientific equipment and modernization of the premises. Describing more precisely, investment in scientific equipment means either purchasing some parts of equipment or producing new ones.

Thanks to the project, the institute will be capable of intensifying its fusion related research within international projects and also broadening its activities in the domain of high-intensity laser-matter interactions, inertial fusion energy, science at extreme conditions, materials technologies, medical science (e.g. hadron diagnostics and therapy).

Thanks to the Ministry of Science and Higher Education financial support and some money from HiPER, it was possible to purchase in 2011 a very modern, high power laser (with parameters: power - 10TW,



New experimental chamber (No 2) to be also used for experiments with the use of 10TW laser system.

impulse time duration - 40 fs, maximum intensity - 1019 W/cm$^2$).

Within the Mazovia project the following equipment has been purchased or built:

- fast X-ray camera
- X-ray spectrometers (for soft and hard X-ray radiation)
- precise multi-frame interferometer
- two Thomson parabola ion mass spectrometers
- apparatus for detecting and data processing
- system for the precise arrangement of the laser irradiated samples
- vacuum system (pumps, valves, connecting elements, control systems).

Adaptation and modernization of laboratory premises were performed also within this project.

## Innovation of the Project and its influence on the region

The innovative project of modernization and development of the High Power Laser Laboratory at IPPLM presumes three assumptions:

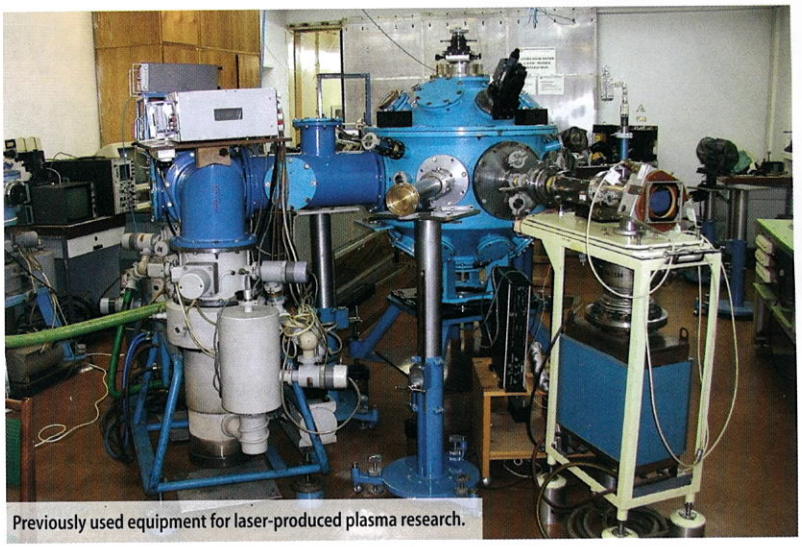
1) Improvement of the international position of the Laboratory in the research on plasma physics and on fusion energy.

2) Possibility of using high power lasers and capabilities gained by IPPLM personnel in fields other than fusion, cooperation with Polish research groups.

3) Intensification of collaboration with industry and private sector and beginning of commercial research together with other national R&D institutions.

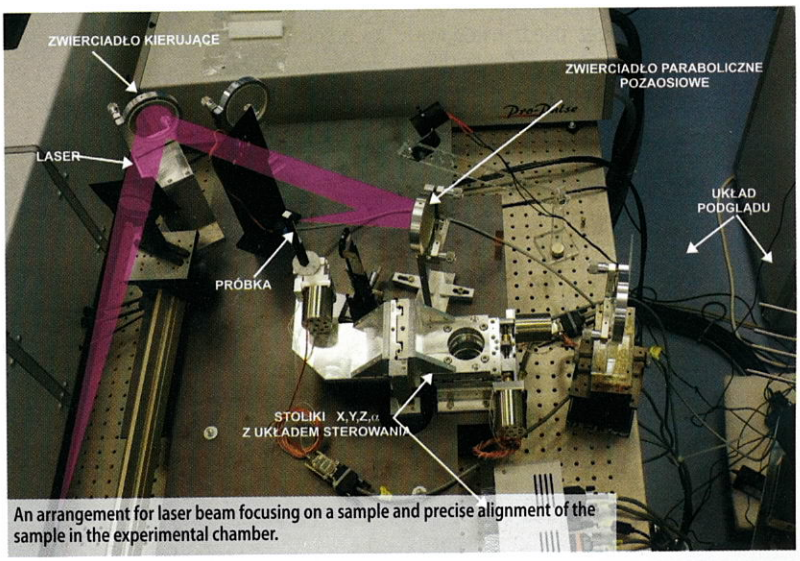
The equipment purchased and built thanks to the project is very modern. The diagnostic systems and other devices will be continuously improved during its operation time. They are highly probable to be produced later for commercial use, as they will be tested, as required, in their home laboratory. Together with the IPPLM engineers, some private corporations will take part in the process of constructing and testing the devices.

All the innovations within the project, devices and measuring methods will be entirely new in Poland and some of them new in Europe as well.



Previously used equipment for laser-produced plasma research.


Experimental stand for optimization of technological applications of laser-target interaction.




An arrangement for laser beam focusing on a sample and precise alignment of the sample in the experimental chamber.