# 5 DEPARTMENT OF PLASMA PHYSICS AND TECHNOLOGY

Head of Department: Prof. Marek J. Sadowski
phone: (22) 718-05-36
e-mail: msadowski@ipj.gov.pl

## Overview

In 2005 research activities in Department P-V were concentrated on the continuation of previous studies in the field of plasma physics and CNF, but new investigations were also undertaken, particularly in the field of plasma technology. The main tasks were as follows:

1. Studies of physical phenomena in pulsed discharges producing dense magnetized plasma;
2. Development of methods and tools for high-temperature plasma diagnostics;
3. Research in the field of plasma technologies.

As to the first task, particular attention was paid to studies of X-ray pulses and pulsed electron beams, by means of different diagnostic techniques. Measurements of the polarization of the selected X-ray spectral lines and their correlation with pulsed e-beams were performed in the MAJA-PF facility. Taking into account microscopic irreproducibility of so-called “hot-spots”, particular efforts were devoted to the correlation of the X-ray emission from a single hot-spot with corresponding non-thermal electron pulses. Some observations of X-rays were performed also at the PF-1000 facility at IPPLM in Warsaw. Other studies concerned the correlation of fast-neutron pulses with X-rays and other corpuscular emissions. Results of experimental studies carried out in the IPJ-IPPLM collaboration were analyzed and summarized. New measurements, carried out in the MAJA-PF facility, determined the temporal correlation of X-rays pulses, fusion-neutrons, fast electron beams and high-energy ion beams. Other efforts concerned studies of fast (ripple-born) electrons in tokamaks. An analysis of the capability of special Cerenkov-type detectors (based on diamond-crystal radiators) was performed, and measuring heads for the CASTOR and TORE-SUPRA facilities have been designed.

Concerning the development of plasma diagnostic techniques, characteristics of PM-355 nuclear track detectors were analyzed and the calibrated detectors (with appropriate absorption filters) were used for measurements of fast (> 3 MeV) protons that originated from D-D fusion reactions in PF-360 and PF-1000 facilities. Using several pinhole cameras equipped with such track detectors, it was possible to investigate the angular distribution of fusion protons and to determine the location of fusion-reaction regions. To measure fusion protons within the TEXTOR facility (in the collaboration with ERM-Brussels and FZ-Juelich) a special ion-pinhole camera was designed and constructed. It was used during the preliminary tests within the TEXTOR machine, but detailed measurements have been postponed until February 2006.

Optical spectroscopy methods were also developed, and in particular we performed time-resolved studies of the dynamics and parameters of plasma streams during their free propagation and interaction with different targets within the PF-1000 facility. It was shown that the VR spectrum changes considerably during the PF discharges investigated. In addition, a miniature Thomson-type spectrometer was designed and constructed for measurements of ion mass- and energy-spectra.

As to technological studies, many efforts were devoted to the improvement of the deposition of thin Nb-layers upon internal surfaces of RF cavities designed for particle accelerators. Experimental studies concerned the stabilization and reduction of the arc-discharge current at ultra-high vacuum (UHV) conditions. The influence of the residual gases was studied, and a prototype of the cylindrical magnetic filter for the linear-cathode system was built and tested. In collaboration with Tor Vergata University, different types of magnetic filters for the planar-cathode system were constructed and tested. Research activity also concerned the development of thin Pb-film deposition technology, designed for the formation of a Pb-cathode within an RF electron gun. We also continued research on the dynamics of plasma discharges in IPD-type accelerators. Other studies of plasma-ion techniques for material engineering were performed in collaboration with the P-IX Department (see chapter IX of this report).

The most important achievements of our Department in 2005 were as follows: 1. New data about dynamics and parameters of pulsed plasma streams were collected by means of optical spectroscopy during their free propagation and interaction with different targets; 2. Detailed images of sources emitting fusion-produced protons were obtained in different PF systems; 3. The technology of the deposition of superconducting layers by means of UHV arc-discharges was improved, test coating of an RF cavity was performed and three different magnetic-filters (for the elimination of micro-droplets) were tested.