EXPERIMENTAL STAND TO STUDY EXPLORATION OF THE AFTERGLOW OF THE PULSED ELECTRON CYCLOTRON RESONANCE SOURCE UNDER THE INJECTION OF NEUTRAL FLUXES

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Abstract

An experimental stand to study the free expansion of a laser ablation plasma under the injection of neutral fluxes is described. The Q-switched YAG:Nd^{+3} laser is focused onto the surface of a Zn target. The plasma pulse duration is 10 μs, the ionization degree in the flux is about 5%, the velocity of neutrals is in the range of 10^6 cm/s. The control and measurement system is based on the CAMAC standard, an IBM PC computer and a digital oscilloscope. The control solution has been created with the LabVIEW graphical language and "WaveStar" Software for Tektronix oscilloscope.

1 THE EXPERIMENTAL STAND

An experimental test facility[1] to investigate injection of the laser ablation plasma into the open magnetic bottle traps simulating the ECRIS magnetic field configuration has been developed at PPL JINR. The schematic of the experiment is shown on Fig. 1.
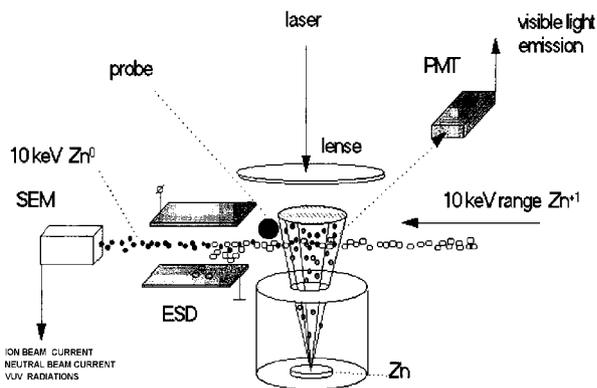

Figure 1: The experimental setup scheme.

The laser beam of YAG:Nd^{+3} Q-switched laser was focused by a lens onto a 0.5 mm spot on the Zn target mounted in a vacuum chamber to produce the laser ablation plasma. The plasma fluxes are collimated by a drift tube and then crossed at 5.5 cm from the target by a laser produced ion Zn^+ beam (5-25 keV, 0.4 mA, 20 •s). A small fraction of ions is neutralized due to resonant charge-exchange processes in $Zn^+ + Zn^0$ collisions, leaves

the plasma, and enters into a time-of-flight mass spectrometer. These neutrals are fast enough to be efficiently detected by a secondary emission multiplier (SEM). An electrostatic deflector (ESD) was mounted to remove the charged particles from the flux before the SEM. The charged components of the plasma were investigated using a stainless steel 0.2 mm diameter cylindrical probe placed close to the drift tube. A digital oscilloscope was used to record the SEM and probe outputs. A fast photomultiplier tube (PMT) was used to detect visible radiation emitted by the plasma and Zn^+ beam.

A delay between the ion beam and the laser ablation plasma production was adjusted to have sufficient time intersection of the fluxes.

2 THE CONTROL ELECTRONICS

2.1 *The control electronics of the experimental stand.*

The concrete experimental setup was constructed from standard CAMAC modules (amplifiers, ADC, TDC, counters …) and a program for multiparameter analysis "VEDA". Gamma-spectrometer, X-ray spectrometer and other measurement schemes can be realized in this setup. To set different time intervals between the two laser shots, a new electronic module based on a Phillips 80552
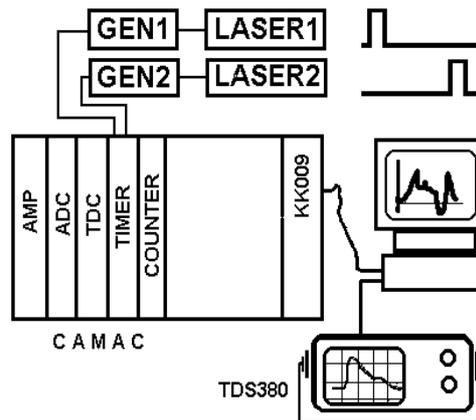

Figure 2: The electronics scheme.

microcontroller was created. The control program for this module is loaded by a serial interface RS232 from a

personal computer and may be easily modified for a specific experiment.

The second task of this module is to produce time intervals for X-ray spectra accumulations. We try to find some phenomena in the plasma by analyzing the growth of the spectra at fixed time intervals from 2-5 ms.

2.2 Software for digital oscilloscope TDS380.

Digital oscilloscope TDS380[3] is used for signal registrations. "WaveStar" software from Tektronics is very attractive to handle the scope manually, but it is impossible to start a new cycle of measurement automatically. One oscillogram is generated for each shot of the lasers. At the next measurement step a new time interval will be set and a new oscillogram will be produced. Cycles repeat until the end of interesting diapason.

The TDS380 communicates with the personal computer by sending commands and queries by GPIB or RS232. Commands [4] modify oscilloscope settings or tell the oscilloscope to perform specific actions; queries cause the oscilloscope to return data and information about its status.

We needed faster development, so we used LabView (National Instruments) with its graphical programming, integrated libraries and flexibility for easy modification.

3 CONCLUSIONS

With a Tektronix TDS380 digital real-time oscilloscope as a very attractive tool for displaying and measuring waveforms, a multichannel analyzer in CAMAC and a powerful graphical development language (LabView) we were able to create high performance solutions for our test stand to study the free expansion of laser ablation plasmas.

REFERENCES

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