Multifunctional Ion Beam Installation “HELIS” as a new instrument for advanced LENR research

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Abstract. The ion beam installation HELIS (P.N. Lebedev Physics Institute, Moscow, Russia) represents an ion accelerator of light elements with atomic number in the range Z=1-54 with ion energies ranging from 0.5 to 50 keV operating at deuteron current densities up to 2 A/cm^2 and intended to perform a wide spectrum of physical experiments related to LENR.

1. Introduction

The ion beam installation HELIS (P.N. Lebedev Physics Institute, Moscow, Russia) represents an ion accelerator of light elements with atomic number in the range Z=1-54 with ion energies ranging from 0.5 to 50 keV operating at deuteron current densities up to 2 A/cm^2 and intended to perform a wide spectrum of physical experiments: study of interaction of ion beam with various materials; preparing of thin-films of various materials (including films of high-temperature superconductors) by ion beam sputtering method; study of elementary and collective processes in ion-beam plasma, formed at interaction of intensive ion beam with gas medium; study of collisions of light nuclei with low energies.

- We propose to extend HELIS ability to wide spectrum of future physical experiments related to LENR: study of collisions of light nuclei with solid target at very low energies; study of DD-reaction enhancement down to Ed = 1 keV and multi-body (3D) reactions in metal targets; study of elementary and collective processes in ion-beam plasma, formed at interaction of intensive ion beam with gas and/or solid targets; preparation of thin-film coatings of various materials (including oxide films) by ion beam sputtering method; possibility of direct calorimetric measurements of excess heat *in-situ* during ion bombardment of metal targets; He-4 measurements during D-bombardment with quadrupole mass-spectrometer; direct X-ray measurements during metal target ion bombardment; four probe resistivity measurements of D-loading in Pd targets

2. Experimental

HELIS (Fig.1) is an accelerator of ions of various gases(Z=1-:-54, E $\leq$ 50 keV, I $\leq$ 50 mA) and consist of ion source (actually the accelerator) with an ion source gas system, LV and HV system; ion beam focusing system; vacuum system; ion beam diagnostic equipment for measurement of a current and energy of an ion beam.

The basic ion source HELIS is duoplasmatron (see Fig.2). It can produce the ion beam with characteristics presented in Tabl.1.

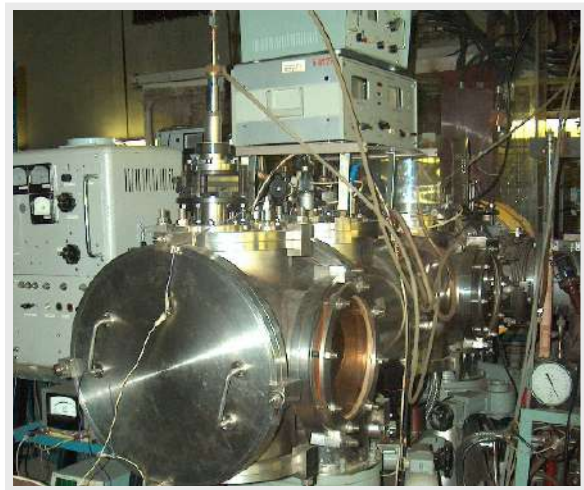

Fig.1 - General view of HELIS installation.

Table 1.

Total hydrogen beam current (at 50 keV)	≤50 mA
Energy range	1 -:- 50 keV
Energy spread	10 -:-100 eV
Reduced emittance	$2{\cdot}10^{-5}$ -:- $5{\cdot}10^{-5}$ cm·rad

HELIS have two additional sources of ions:1) high-frequency source with a current up to 1 mA and energy of ions ≤30 keV (emittance at 30 keV ~1.5·10-3 cm·rad); 2) high-frequency source with a current up to 8 mA and energy of ions 0,25-:-0,5 keV. For beam focusing the electromagnetic lens which provides focal length f=11 cm at I=780A is used.

Fig.2. presents proposal of HELIS total experiment set up. Ion accelerator and detector holder need to fill up by different detecting systems. They include flow calorimeter, Q-mass-spectrometer, fast and slow neutron detectors (NE-213 and He-3), charged particle detectors (CR-39 track and dE/E SSB detectors), gamma and X-ray detectors (Ge and CdTe). Sample holder need to be add by four probe resistivity measurements of D-loading in targets and thermistor for target temperature control.

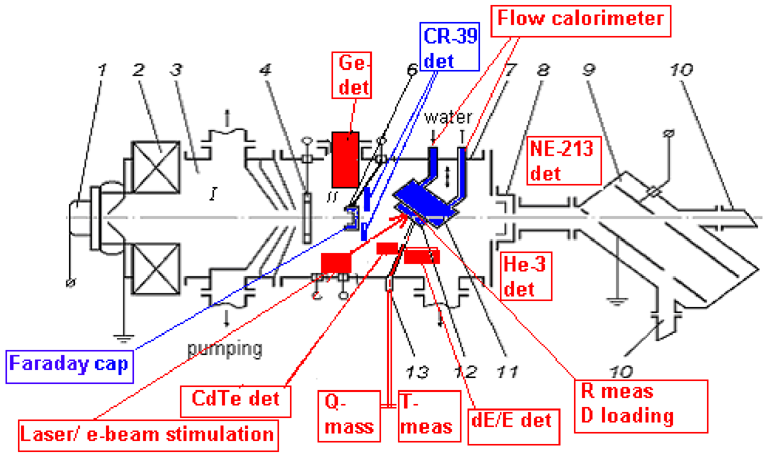

Fig. 2 - HELIS total experiment set up: 1 – ion source (duoplasmatron); 2 – electromagnetic lens; 3 – three-stage chamber of differential pumping; 4 – meter of a current of a transient-time type; 5 – auxiliary ion source; 6 - Faraday cap; 7 – chamber of targets; 8 – the device for calorimetric definition of a current of an ion beam; 9 – electrostatic analyzer; 10 – receivers of parsed fragments; 11 – water (or liquid gas)-cooled holder of the target; 12 - target; 13 – feeder of gas in an vacuum chamber. Detector blocks: ■ Blocks already existing. ■ Blocks needed to be add.

Fig. 3 - Target holders with water cooling.

3. Conclusion

The HELIS facility can be used for study of dd- and dT-reactions yields from various targets at low energy of deuterons and can be equipped by various nuclear detectors, including dE/E Surface Silicon Barrier detector pair, CR-39 plastic track, neutron and X-ray detectors. In general, the HELIS facility with additional installations mentioned above, will allow us to carry out full LENR experiment upon a deuterium implantation into metal targets, involving simultaneous measurements of excess heat, D-loading and He-4 emission, along with accompanying nuclear radiations.

Part II

About the nuclear origin