Laboratory testing of neutral particle converter device 
"Aries-L"

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Abstract. This paper presents the testing results of the neutral particles converter device 
"Aries-L" for the "Luna-Resurs" project of the Space Research Institute (RAS).

1. Introduction
Currently, within the "Luna-Resurs" project of the Space Research Institute (RAS) the "Aries-L" device is under construction [1], designed to study solar wind interaction with the surface of the Moon and for determination of its structure by means of secondary-ion mass spectrometry and spectrometry of secondary neutral atoms. The analysis of neutral atoms with electrostatic analyzers is only possible when these atoms are converted into charge fractions. Currently in space research solid-state converters are most widely used due to the ease of operation, small size and weight, as well as small distortion of the initial beam parameters [2,3]. This paper presents the testing results of the neutral particles converter device "Aries-L".

2. Description of the experiment
The experiment was conducted on the "Big monochromator of MEPhI". Neutral particles gathering occurs by the surface recharge on a golden target of positive hydrogen ions. The ion beam extracted from the source (1) is focused by the electrostatic lenses (2) and is separated according to the relation of mass to charge in the electromagnet (3) (figure 1). By varying the current in the electromagnet a necessary mass component can be isolated from the beam and directed through the aperture to the target (4) arranged in the interaction chamber. The ion current to the target is measured using a Keithley 6485 picoammeter (9). Then the reflected ions and neutral particles "light up" the input window of the converter (6) passing through the grid (5). For isolation of the ion component a positive potential up to 4000+ W could have been applied with the BNV-31 power supply. Reflected and ionized particles from the converter are focused on the input of electron multiplier-6m (7), and the number of pulses is registered with the Tektronix TDS 2004B oscillograph (8).

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Firstly, a neutral beam was directed perpendicularly to the converter input window (i.e. with sliding pitch angle to the target $\alpha_0=8^\circ \leftrightarrow \beta=0$).

![Experimental setup diagram](image)

**Figure 1.** Experimental setup. 1 - ion source; 2 – electrostatic lenses; 3 – separating electromagnet; 4 – target(Au); 5 – reflecting grid; 6 – converter; 7 – electron multiplier; 8 – oscillograph; 9 – picoammeter; 10, 11, 12, 13 – power supply; 14 - comparator.

3. Testing results
The input window of the converter was irradiated with a flux of hydrogen H atoms reflected from the target in the energy range from 200 to 1000 eV. Each value of the initial beam energy varied potentials parameters on the inner and outer plates of the converter, and thus a number of pulses has been registered on the Tektronix TDS 2004B oscillograph. Gathered results (figure 2) show that all dependencies possess a dome shape for almost all values of the initial ion beam energy. The graphs also show that the most effective operating potentials are 300 V on the inner ($U_1$) and 500 V on the outer ($U_2$) plates (except for the dependency with initial accelerating voltage of 200 eV). Also from the graphs we see that for the ratio $U_{inner} = \frac{1}{2} U_{outer}$ the number of pulses is higher than for the ratio $U_{inner} = \frac{1}{3} U_{outer}$.
Figure 2. Working potentials variation on the converter electrodes. Pulse counting speed rates related to the voltage on the converter plates. $I_v$ – number of pulses from the converter; $I_0$ – current of primary ion beam; $U_1$ – potential of inner plate; $U_2$ – potential of outer plate; $E$ – energy of incident particle.

Figure 3. Correlation of neutral hydrogen atoms entering the input window of the converter to the registered counting speed of the electron multiplier.

Table 1 shows the values of the ion current to the target and the reflected neutrals flux estimate at the input of the converter depending on the accelerating voltage. A comparison of the flux of neutral particles coming into the input window of the converter with a registered counting speed of the electron multiplier is shown in Figure 3. As we can see, this dependence is linear and at the first
approximation we find that at a rate of 1010 particles per second coming into the input of the converter we receive approximately 77000 pulses per second at the output of electron multiplier.

To check the efficiency of the converter on the particles of different masses, the input window of the converter has been irradiated by the atoms of hydrogen, helium and argon at the range of energies from 200eV to 2500eV.

| U₀ (keV) | I₀⁺ (nA) | I_reflected₀ ×10¹⁰ (part/sec) |
|---------|----------|-----------------------------|
| 1000    | 1500     | 1.76                        |
| 700     | 500      | 0.87                        |
| 500     | 400      | 0.31                        |
| 300     | 150      | 0.05                        |
| 200     | 90       | 0.04                        |

The measurements of current to a target and pulses counting speed have been conducted at the most efficient operating potentials (300 V on the inner and 500 V on the outer plates), at perpendicular flow of the neutrals into the converter and at the most efficient angle of incidence of 16 degrees to the normal to the plane of the input window of the converter. Hydrogen atoms were obtained in two ways: by neutralization of H⁺ ions and neutralization and dissociation over the surface of excimer H³⁺ ions. It should be noted that the energy in the scattered beam of H atoms (in this case) will be 3 times lower. Since the use of different ions changes the intensity of the primary beam on the target, the pulse counting measurements are normalized to the initial current (figure 4). As can be seen, with increasing masses of the incident particles electron multiplier signal intensity (normalized to the initial current) decreases due to the decrease in the overall output of reflected particles entering the converter.

**Figure 4.** Converter efficiency testing on the particles of different masses.

**References**

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