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Development of a physical mock-up of an electron spectrometer for studying fine aurora structures

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Scientific goals of the experiment



The main goal of the experiment is studying bright discrete arcs and rays of aurora. These fine structures are formed by interaction of electron beams with energies 1-10 KeV with the upper atmosphere.

The scale of these structures may be < 1 km, so measurements with high temporal and spatial resolution are required: with the speed of satellite of 7.9 km/s measurements with > 10 Hz frequency are need.



Goals of the instrument and its expected characteristics

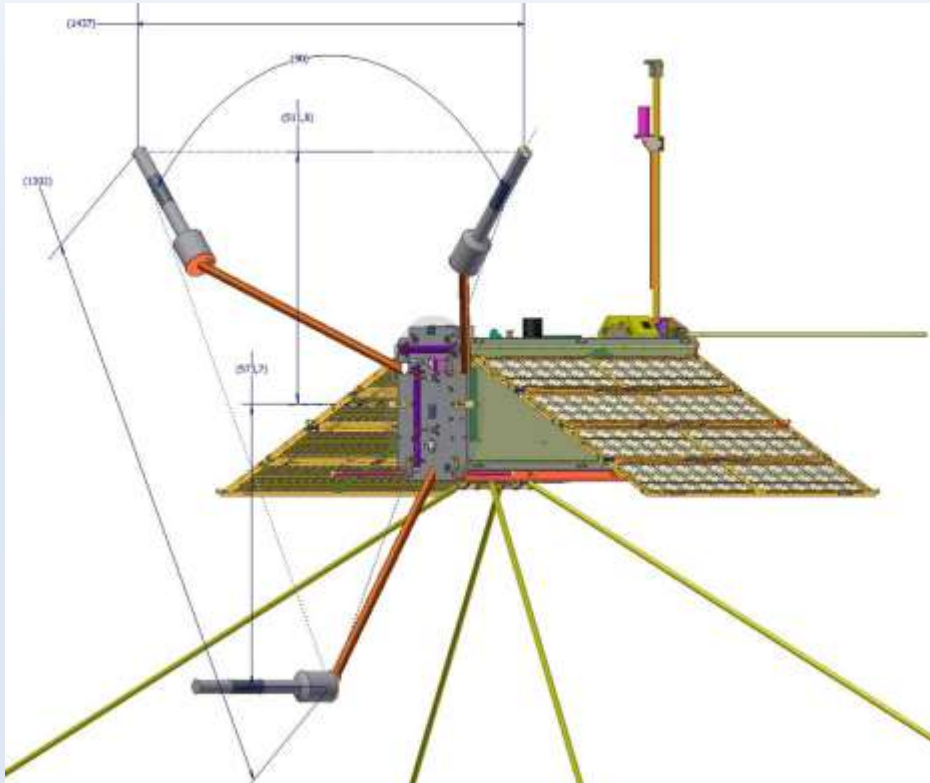
Expected characteristics of the instrument

Parameter	Value
Energy interval	1 KeV – 10 KeV
Energy resolution	10%
Angle of view	$\approx 5^\circ \times 5^\circ$
Mass	$\leq 2,5$ kg
Energy consumption	≤ 3 Вт
Informativity	10 Kbit/s (average) 30 Kbit/s (peak)

Instrument must conduct measurements:

Simultaneous electron energy spectra within the range of 1-10 KeV with no less than 10 Hz frequency

Instrument will be probably installed on “Trabant” microsatellite

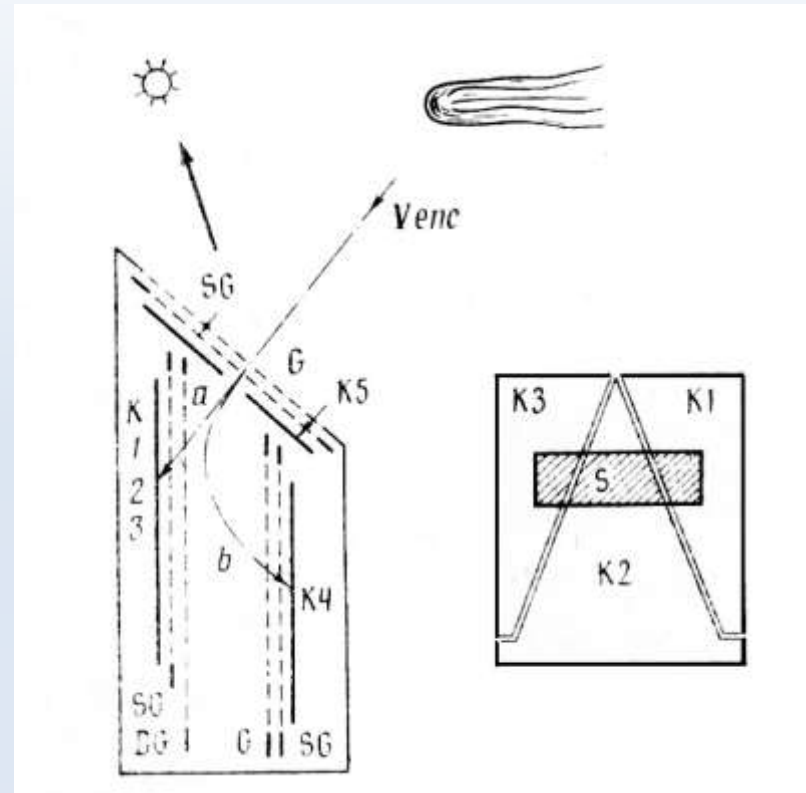
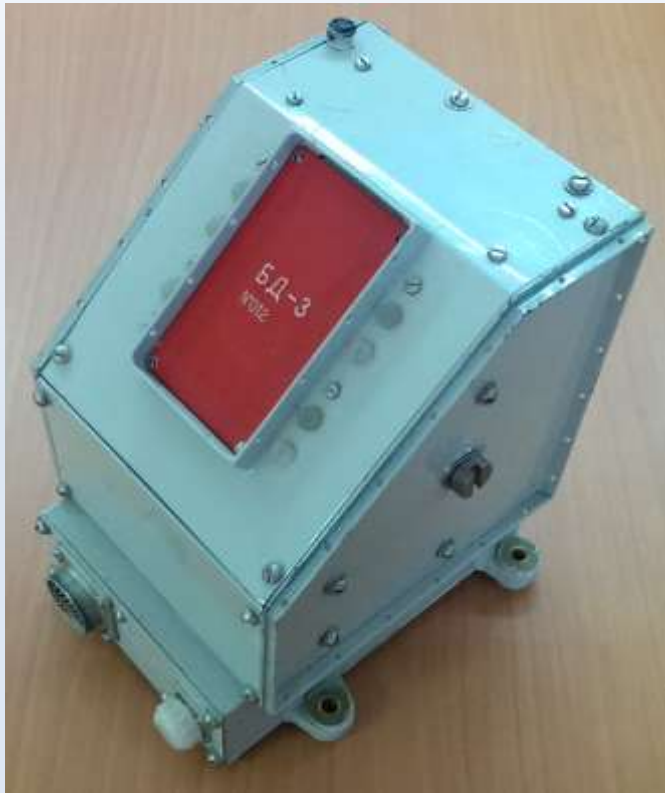


Main elements of constructive and maintenance systems of
«Trabant» microsatellite

Scientific goals of “Trabant” experiment:

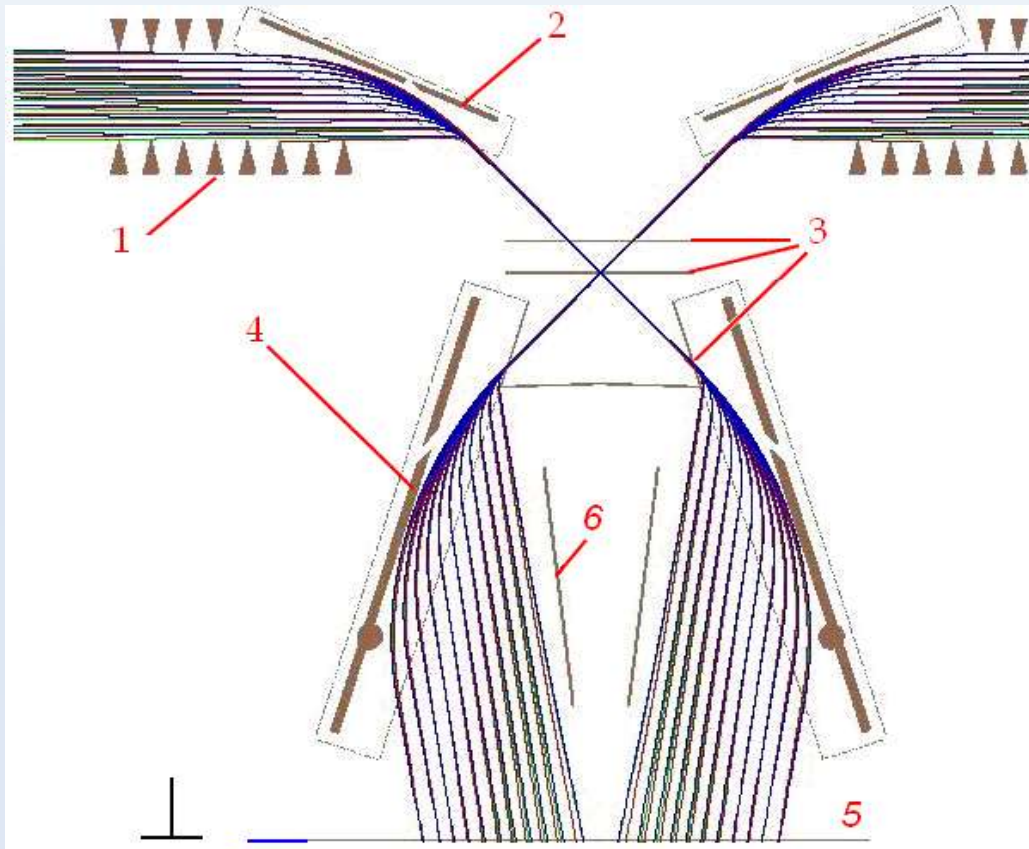
1. Conduction of long-term continuous measurements of complex spectra:
 - 1.1 electromagnetic ELF-ULF-VLF-HF natural and anthropogenic radiation
 - 1.2 Density fluctuations of thermal plasma in ELF-ULF-VLF ranges;
2. Development of forecasting methods of the ionosphere and the Earth's upper atmosphere on the basis of long-term monitoring.

Persecutors: BD-3 instrument for Vega spacecraft



Flat electrostatic mirror is used for separation of particles with different energies. The mirror is inclined to 45° to the initial particles' velocity direction.

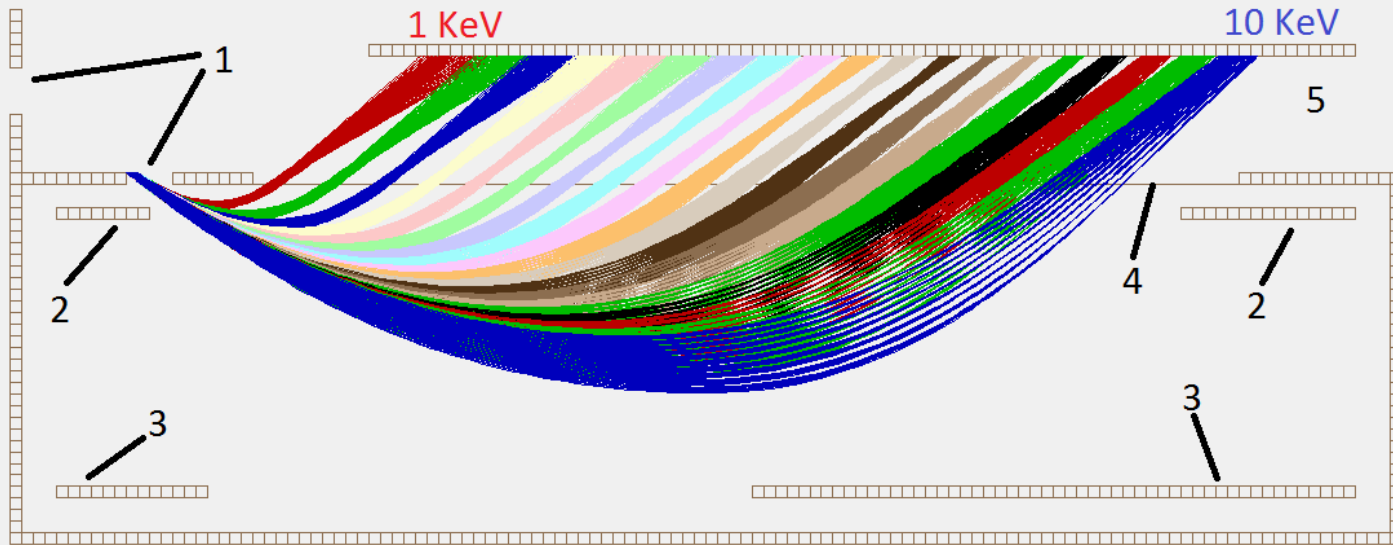
Persecutors: CAMERA-E instrument for RESONANCE project



- 1 – collimator
- 2 – electrostatic mirror
- 3 – system of diaphragms
- 4 – electrostatic analyzer
- 5 – detector plate
- 6 – correcting electrode



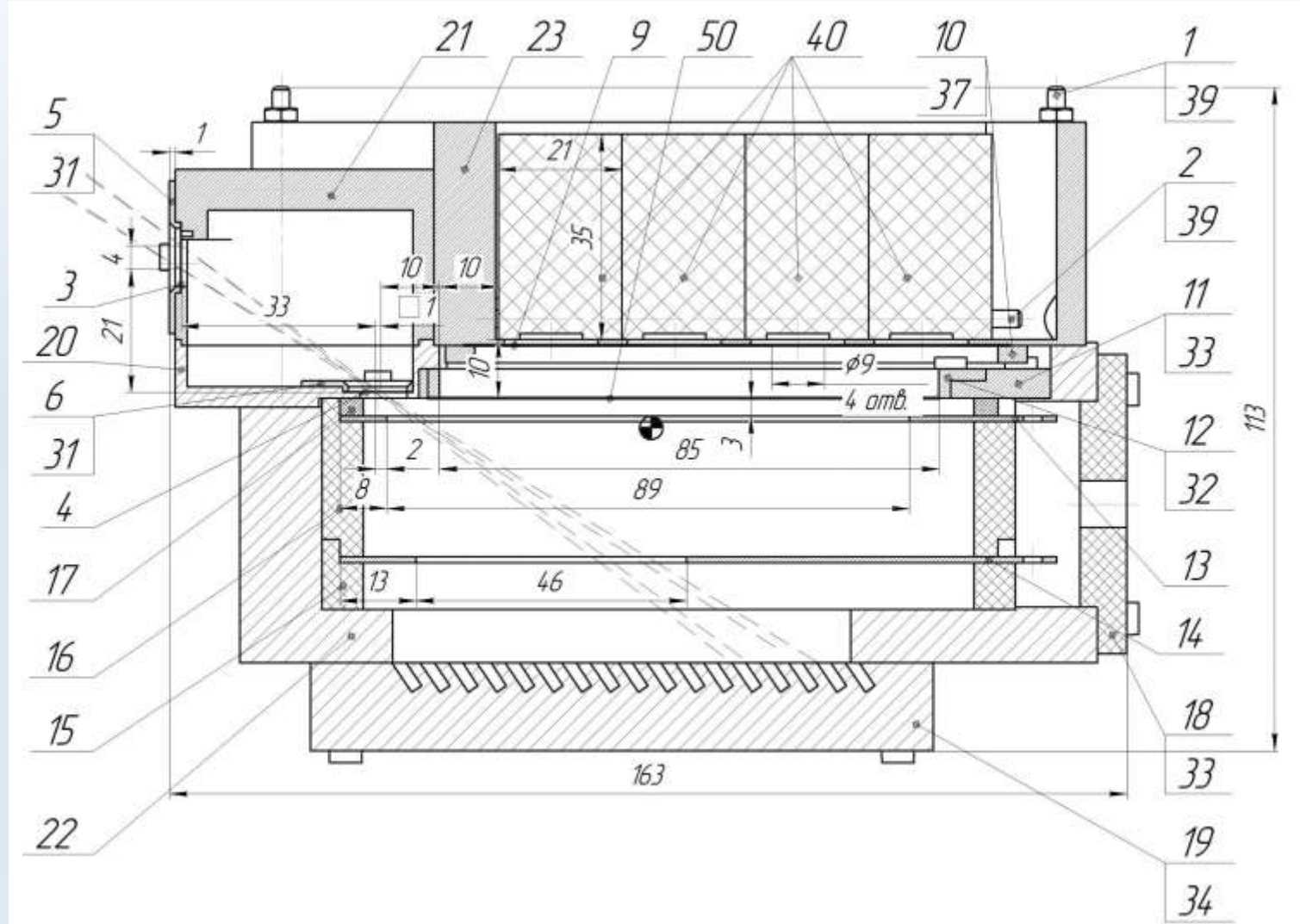
Model of electron optics unit of the instrument



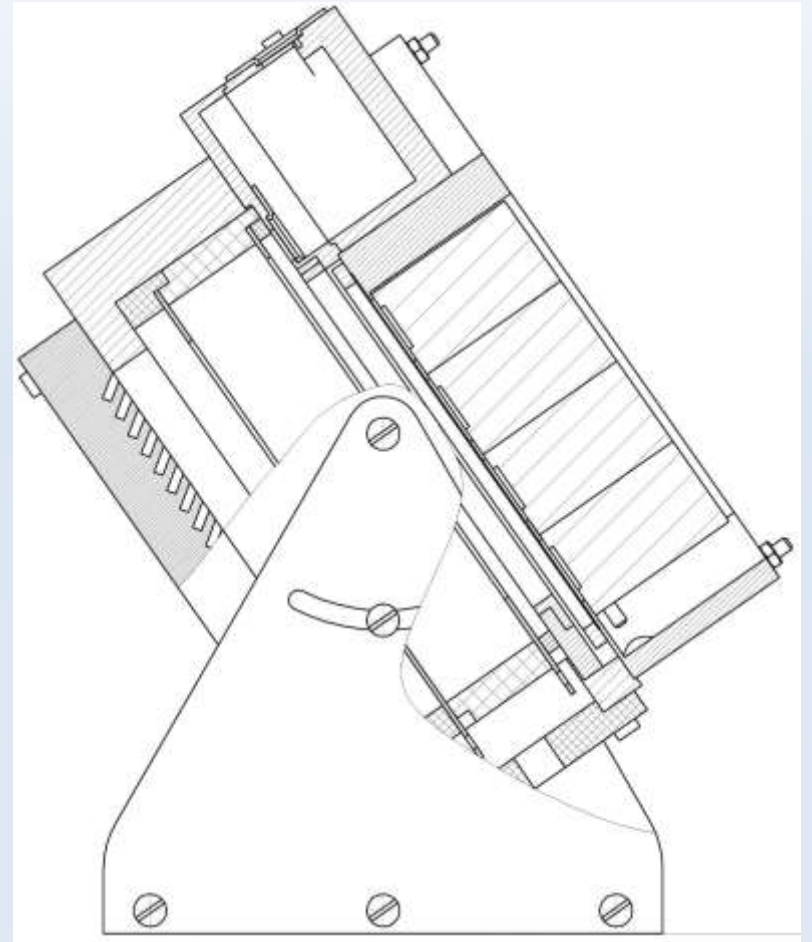
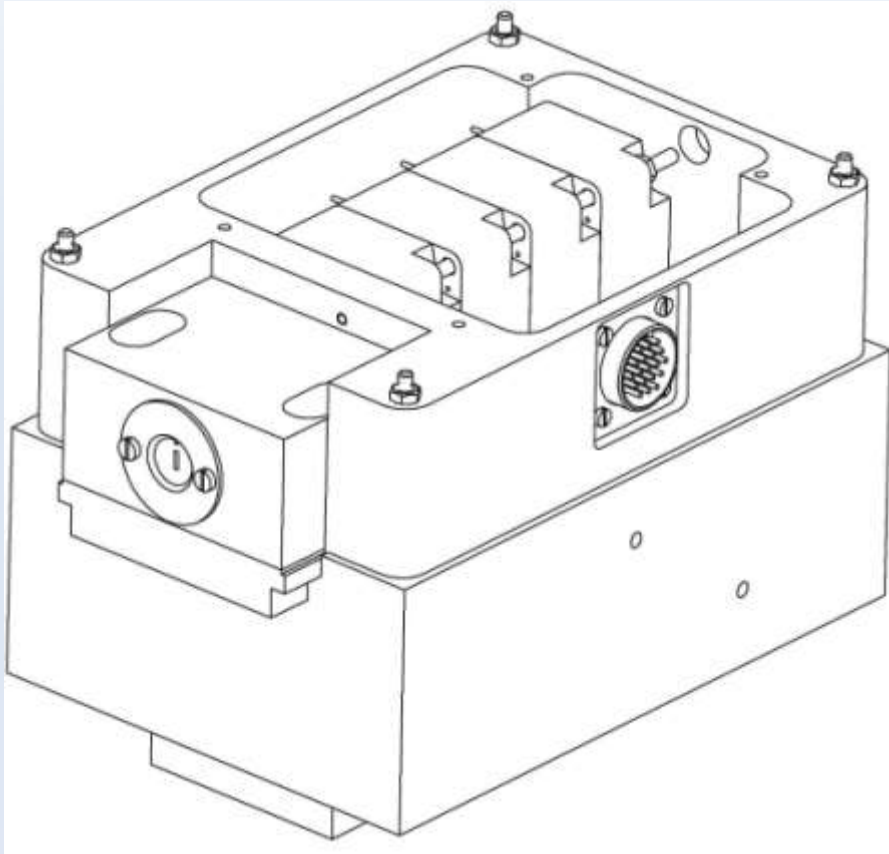
- 1 – collimator with 2 entrance diaphragms
- 2 – electrode 1 (~-500 Volts)
- 3 – electrode 2 (~-7500 Volts)
- 4 – grid with zero potential
- 5 – detector plate

Parameter	Value
Particles' sort	electrons
Energy	1-10 KeV; step 500 eV
Initial velocity direction	112°-115° to vertical direction (uniform)

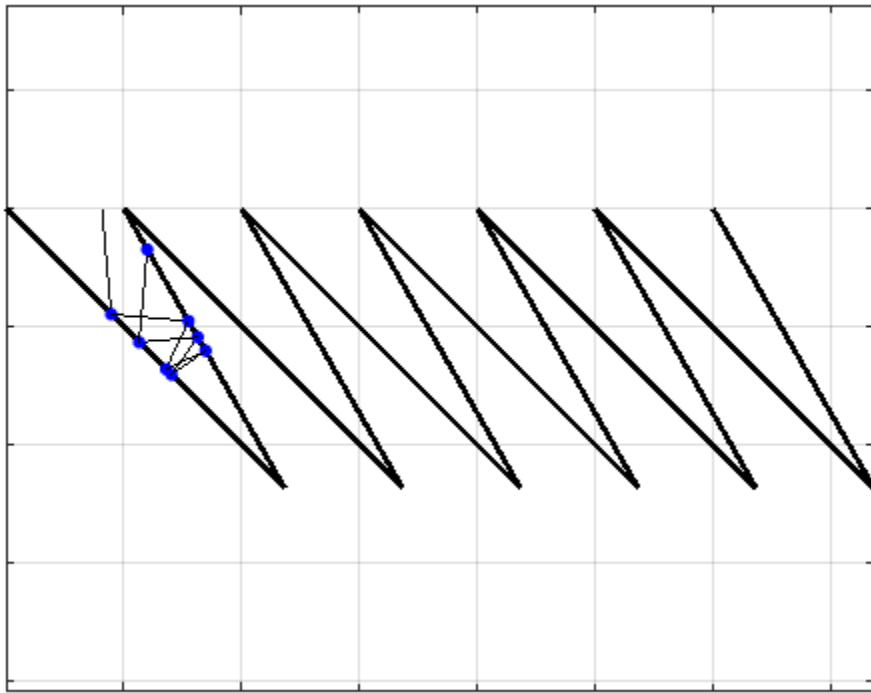
Technical drawings



Overall view and installation in vacuum chamber



Light trap development



Mirror-reflection modelling

- The task is to choose parameters of structure to absorb **UV photons** and **sputtered ions**
- Initial angles of photons' velocities are 112° - 180° to vertical direction
- There must be at least **3 reflections** before particle escapes from the structure

Summary

- We are developing a **relatively small** instrument for electron spectra registration
- Energy range is **1-10 KeV**
- Sensivity allows registration of energy spectra with **10 Hz** frequency with electron flux **$\sim 10^6 \text{ cm}^{-2}\text{s}^{-1}$**
- A computer model of an electron optics unit of the instrument was made and proved energy resolution **$\Delta E/E \sim 10\%$**
- A mock-up of the instrument is nearly developed and its manufacturing is begun

Thank you for your attention!



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