

Russian Missions to the Moon, Venus, and Mars in the 1960s

Vladimir Krasnopolsky

- Russia was the world leader in space technology at the end of 1950s and beginning of 1960s
- First space flight: orbiter Sputnik, Oct. 1957
- First man in space: Yuriy Gagarin, Apr. 1961
- Missions to the Moon, Venus, and Mars were a significant part of the space program in Russia

End of 1950s and beginning of 1960s was a good period in Russia

- Stalin ceased, Berya executed
- The Party Congress condemned Stalin's terror
- Downgrading of Ministries of Internal Affairs and State Security
- The Korean war ended
- Reduction of Soviet Army by 1.8 million people (twice the current Russian army)
- More production for people needs at the expense of military production
- TV became accessible to many people



Sergey P. Korolyov
(1907-1966)

chief designer

head of Russian
space program



Mstislav V. Keldysh
(1911-1978)

President of USSR
Academy of Sciences

Head of science in
space program

16 spacecraft were sent to the Moon in 1959-1970. Basic technological achievements are

- First flyby (Luna 1, 1959)
- First hard landing (Luna 2, 1959)
- First soft landing (Luna 9, 1966)
- First orbiter of the Moon (Luna 10, 1966)
- First automatic sample return (Luna 16, 1970)

Scientific results on the Moon's environment

- No magnetic field
- No radiation belts
- Discovery of mascones
- IR and UV spectroscopy of the rocks
- Images of the Moon at wide range of scales
- X-ray and gamma-ray spectroscopy of the rocks

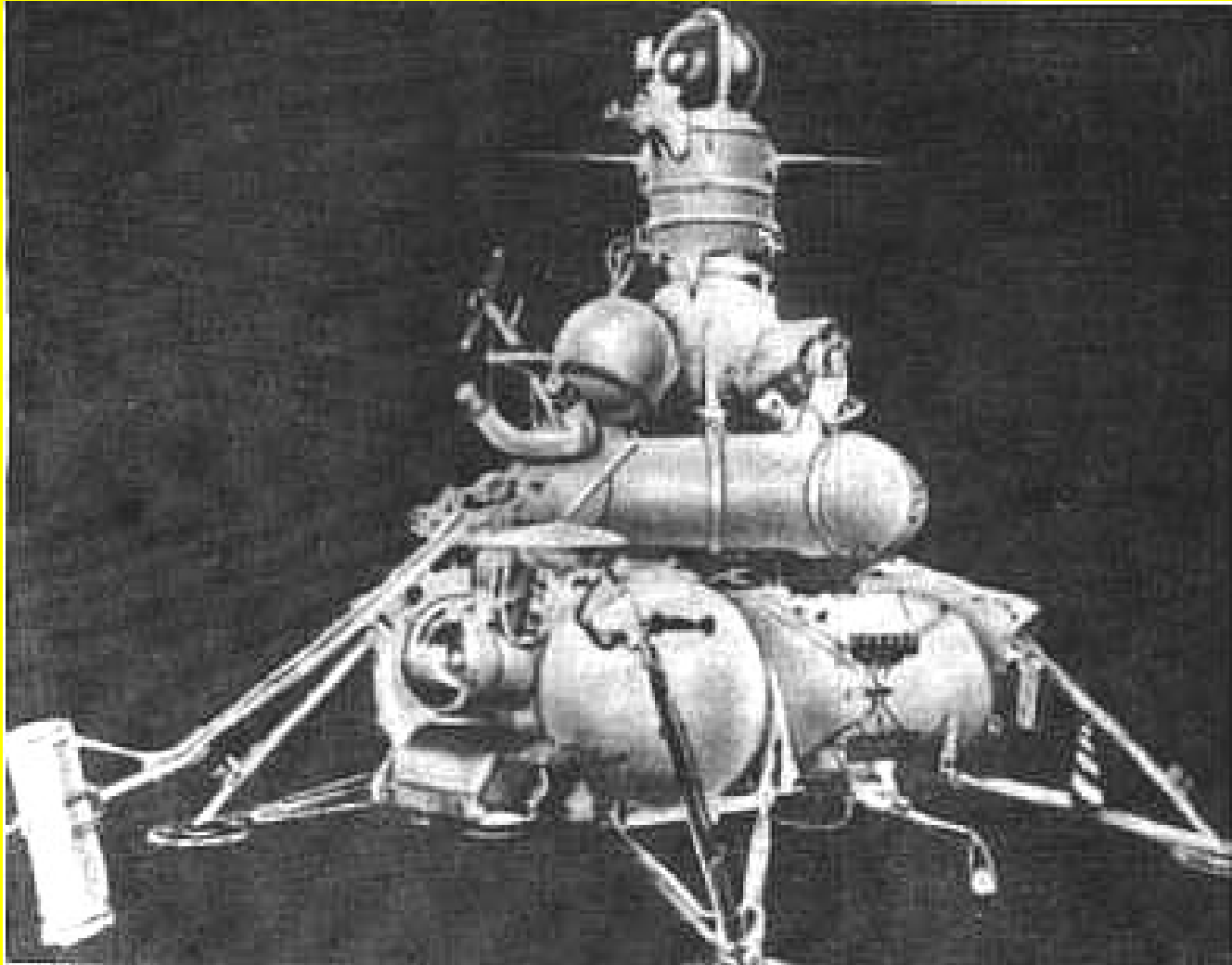
Science results on the interplanetary space

- Discovery of the solar wind and study of its properties
- First studies of the outer radiation belt
- In situ studies of interplanetary dust particles (micrometeorites)
- Cosmic rays in the interplanetary space

Moon sample return (Luna 16, 1970)

- Launch to Earth's orbit
- Flight to the Moon with one mid-course correction
- Entered a Moon's circular orbit $h = 110$ km
- Two orbital adjustments to get $h_{\min} = 15$ km
- Soft landing
- Drilling and collection of a soil sample (35 cm, 105 g)
- Launch of the upper stage to Earth
- Parachute landing near the expected point

Landing module of Luna 16 (mass 1,880 kg). Total mass was 5,600 kg



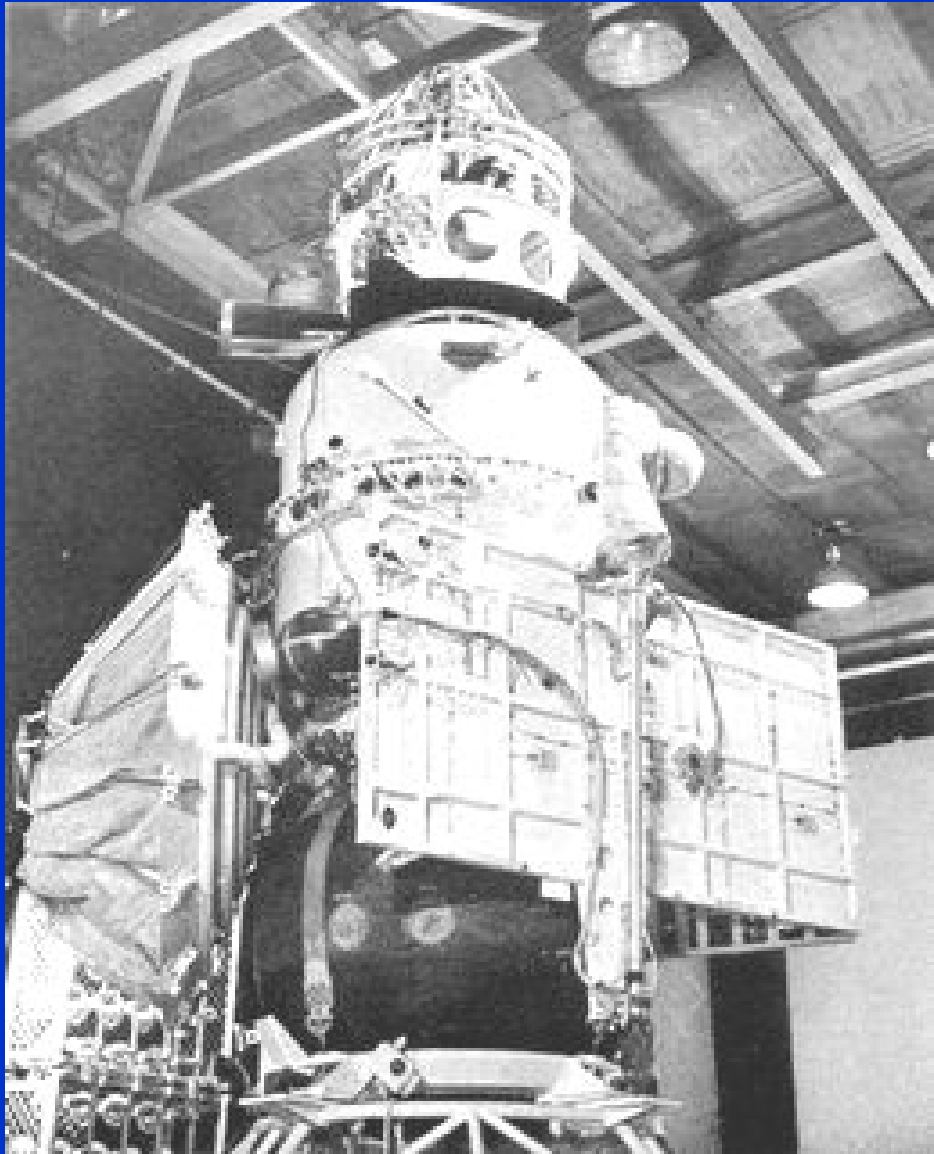
Missions to Venus and Mars in 1960s

- Badly affected by insufficient reliability of the 4th rocket stage (which drove a spacecraft from orbit around Earth) and some spacecraft subsystems
- Venera (Feb. 1961), first interplanetary probe; lost on the way to Venus
- 2MV (launch in 1962): landing to Venus and flyby of Mars. Mars 1 was lost halfway to Mars.
- 3MV (launch in 1964-1965): landing to Venus and flybys of Venus and Mars. Veneras 2 and 3 were lost before their flyby and hard landing, respectively
- Spacecraft to Mars was not ready in time and was sent to the Moon as Zond 3 (1965)



Four-stage Soyuz
rocket to launch
spacecraft of 1000 kg
to Moon and planets
in the 1960s

Missions to Moon and planets were transferred to Babakin Space Center in 1965



Venera 4 (1967)
was the first soft
entry probe; direct
measurements at
55 to 23 km (18 bar)

Veneras 5 and 6
(1969): down to 17
km (28 bar)



Venera 7 (1970):
first soft landing
on another planet.

On-orbit mass
1180 kg, mass of
lander 500 kg

Mars 1969: new
large spacecraft and new powerful
rocket. Crashed at the launch

Scientific return from the early Venera missions

- Direct measurements of atmospheric pressure, density, and temperature from 55 km down to the surface
- Chemical composition: $\text{CO}_2 > 90\%$, $\text{N}_2 < 7\%$
- Hydrogen corona, upper limit to atomic oxygen
- No magnetic moment ($< 3 \times 10^{-4}$ of the Earth's)
- Plasma bow shock at 19,000 km and solar wind interaction with the induced magnetosphere
- Solar wind, cosmic ray, interplanetary dust measurements at the cruise phases

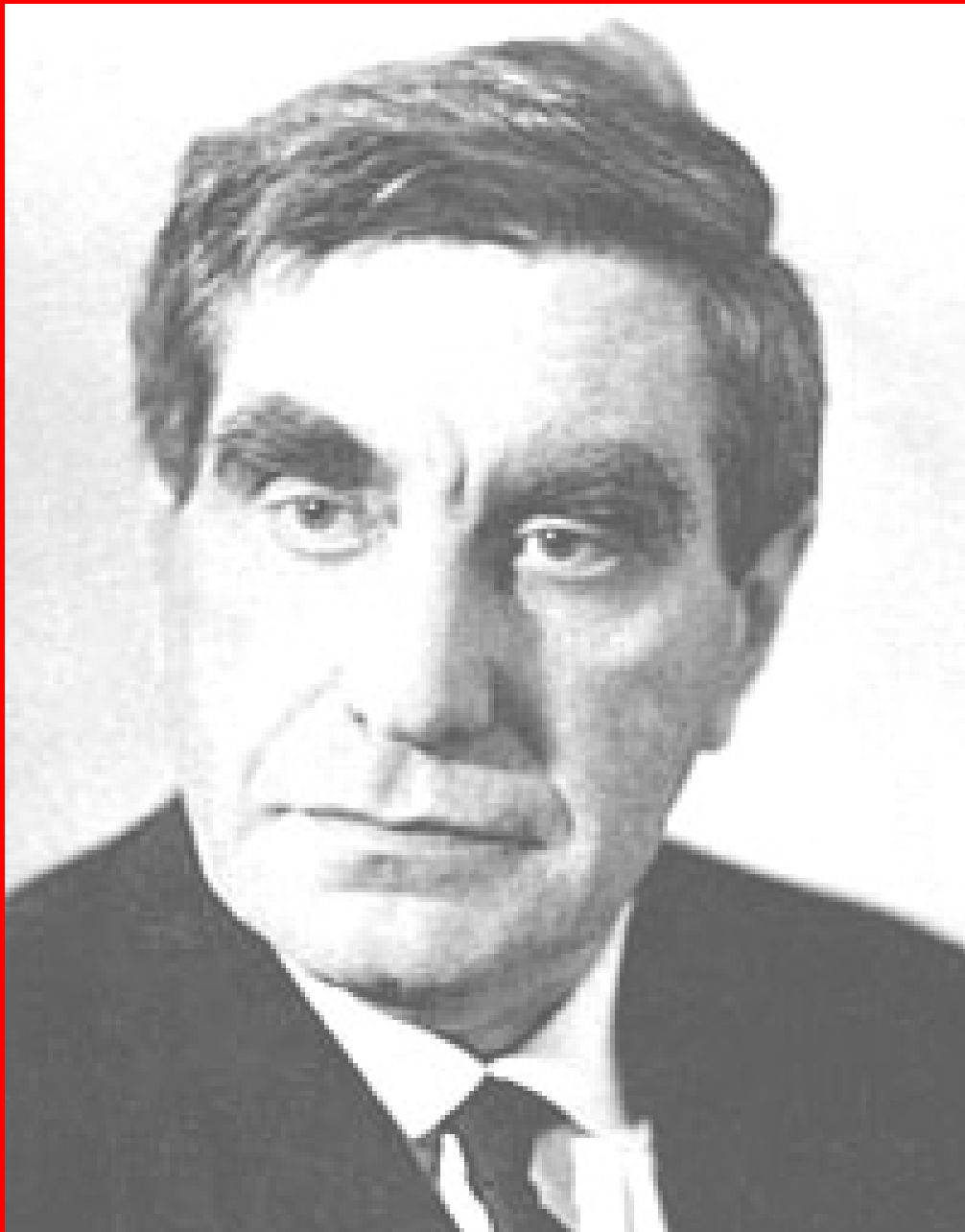
Mars Sample Return

(similar to NASA-ESA mission in the next decade)

- Planned launch in 1975
- Total spacecraft mass 20 tons
- New powerful rocket N1
- After drilling and sample collection, it should be delivered into a Mars orbit and wait for the favorable return launch during 10 months
- The program was not completed because of some conceptual drawbacks of the N1 rocket

My work in the 1960s

- I graduated at Moscow State University and joined a team of Aleksander Lebedinsky (1913-1967) in 1961
- Technically responsible for:
 - surface phase state and gamma-ray detector at the Venus lander of 2MV (1962)
 - photometer at the Venera 3 lander (1965)
 - electronics of the IR radiometer at Luna 13 (1966)
 - UV spectrometers at Venera 2 (1965), Zond 3 (1965), Cosmos 65 (1965) and Cosmos 121 (1966)
- Principal investigator of:
 - UV spectrometer at Mars 69
 - dayglow photometer at Cosmos 224 (1968)



Aleksandr
Lebedinsky

(1913-1967)

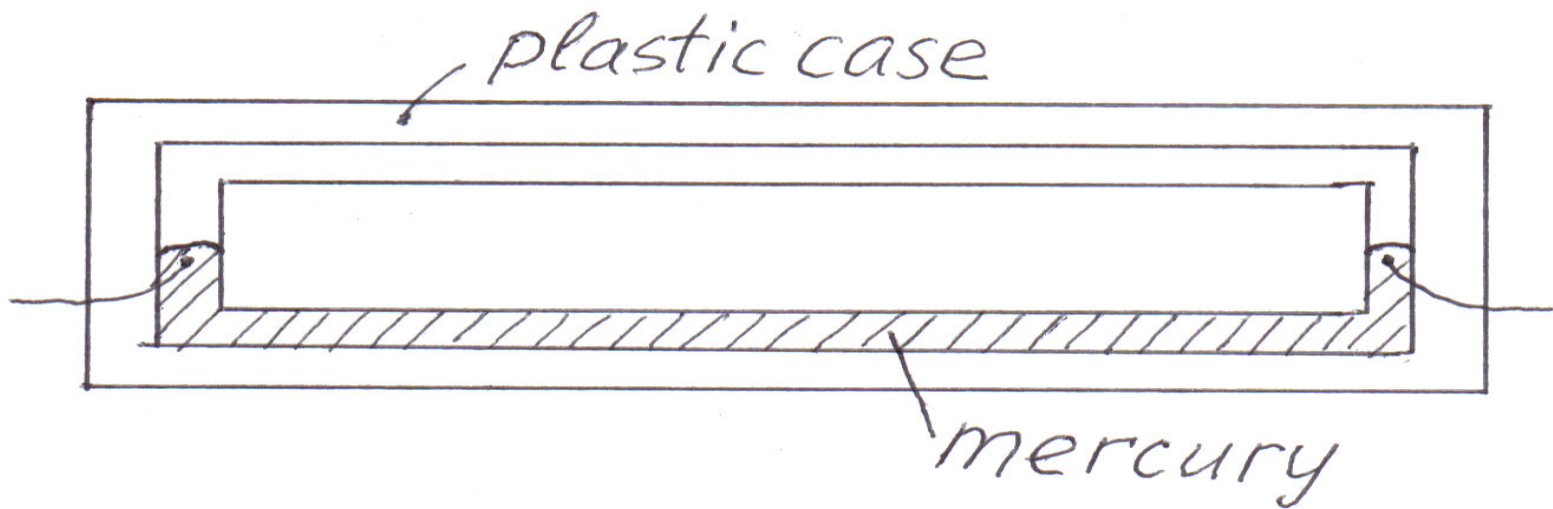
Surface phase state and gamma-ray detector (2MV, 1962)

- Venus was considered as Earth's sister with a possible ocean
- Microwave observations at the end of 1950s indicated high temperature and pressure in the lower atmosphere of Venus
- However, it was suggested that the observed signal might be caused by some ionospheric phenomena
- Lebedinsky told me in June 1961 that Keldysh had approved his idea of a simple device to distinguish between liquid and solid surfaces for 2MV (launch in August 1962). He asked me to be responsible for that instrument

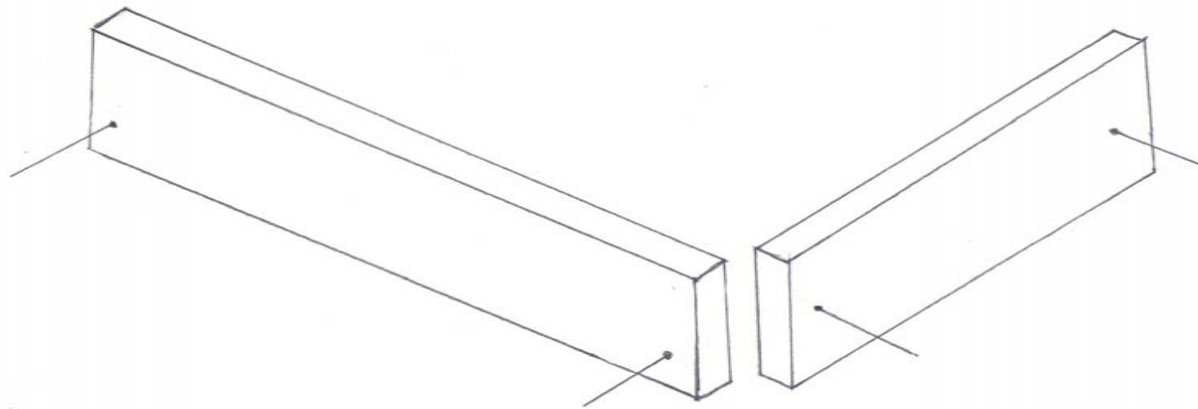
Mercury level

$\alpha > 3^\circ \rightarrow$ solid surface
(mean $\alpha \approx 15^\circ$)

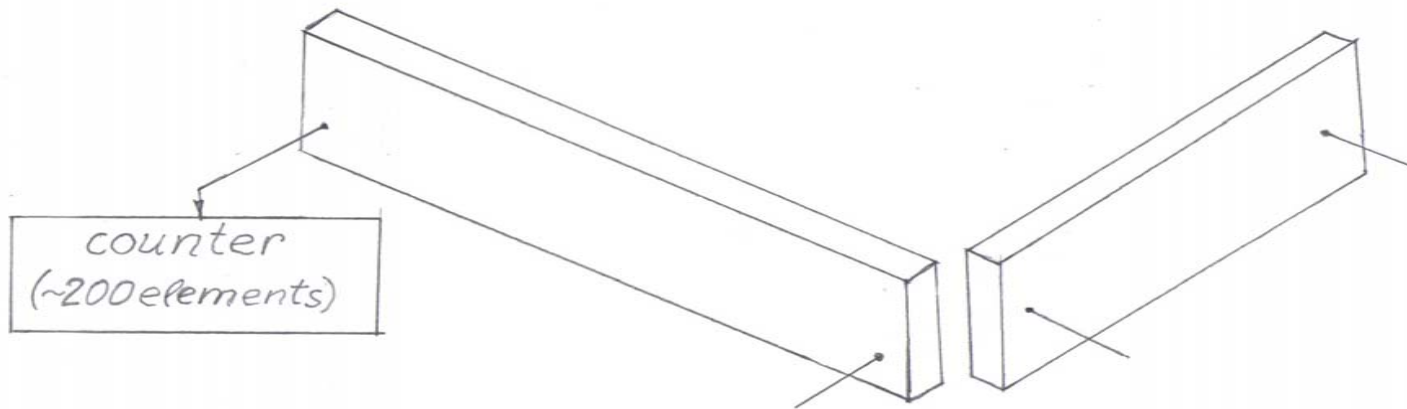
$\alpha < 3^\circ \rightarrow$ liquid surface



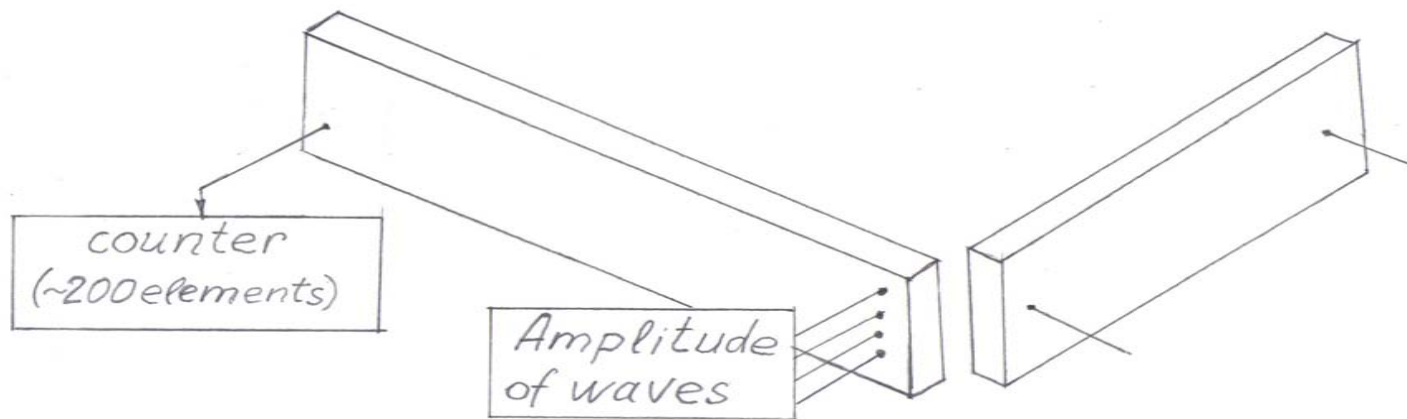
Evolution of the instrument



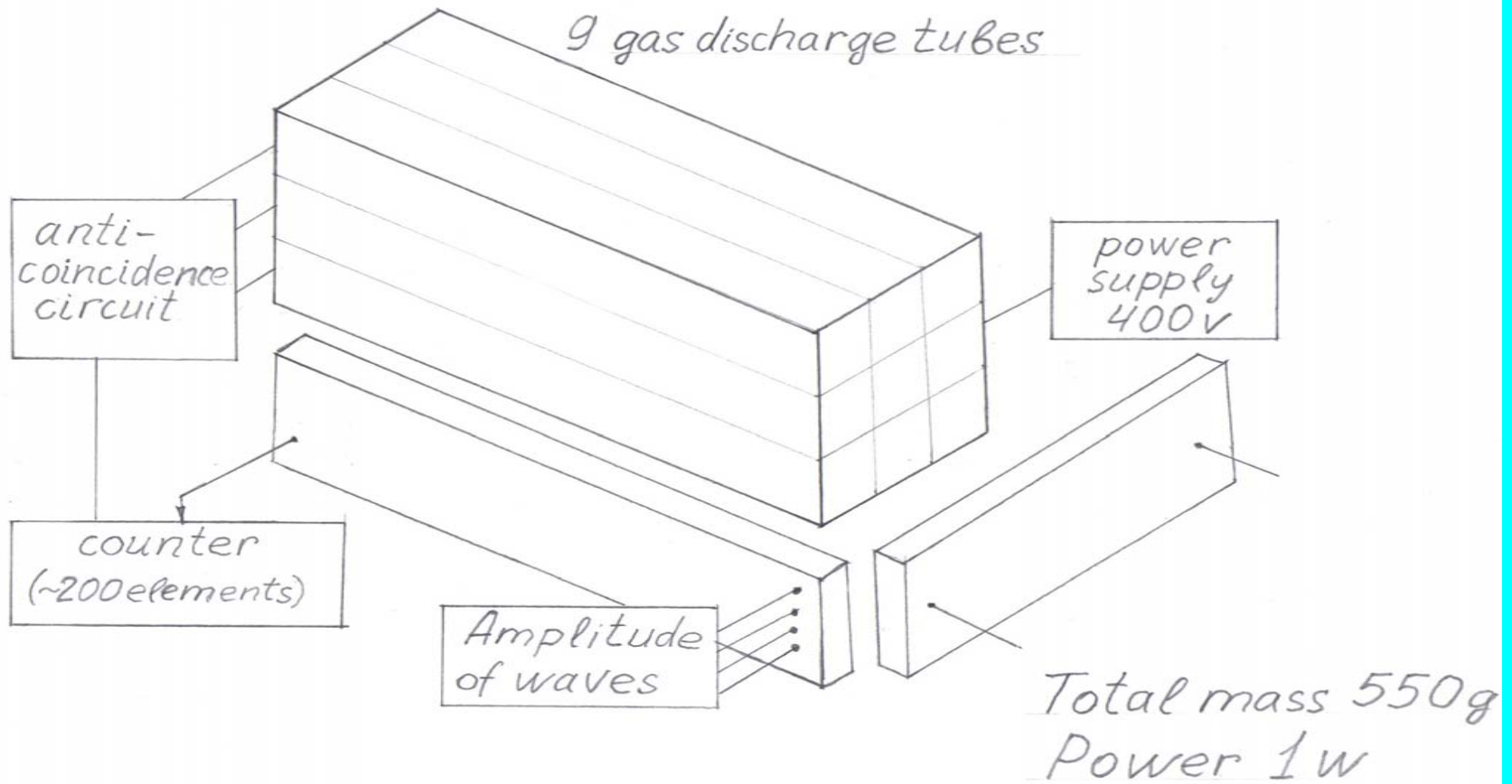
Evolution of the instrument



Evolution of the instrument



Evolution of the instrument



The 1960s were a period of great progress in space research

- Apollo 11 (1969): the first manned mission to land on the Moon, the greatest achievement in space
- Luna 16 (1970): sample return from the Moon, the most sophisticated robotic mission
- Voyager (1977-1989): mission to the outer planets, the highest scientific return in the solar system studies

Some poorly known facts (not related to space research)

- The car engine was invented by Nicolaus Otto, a German
- TV was invented by Vladimir Zvorykin, a Russian American
- Special relativity was created by Lorentz, Poincare, Einstein, and Minkowski