Millimetron Space Observatory Mission Development

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Millimetron Space Observatory (MSO) is mission of Russian Space Agency devoted to astrophysical observations in the far infrared wavelength regime. It is built around a space telescope which is based on deployable 10 m diameter main reflector. The observatory is planned to be launched in the timeframe of 2029. The main working orbit of MSO will be a halo around the Sun-Earth Lagranian point L2. This orbit has an excellent thermal environment and this allows to actively cool main dish to cryogenic temperatures of below 10 K. Low antenna temperature allows Millimetron mission to achieve a very low background limited sensitivity for a direct detector based spectrometer type instruments. MSO will work in two major regimes: Space-Earth interferometer and single dish observatory modes. For the Space-Earth very large baseline interferometer (SE-VLBI), Millimetron will work together with Earth ground telescopes such as Event Hirisont Telescope (EHT) and other millimeter submillimeter facilities to achieve extremely high spatial resolution images of nearby objects. In order to improve a u-v coverage of Millimetron SE-VLBI, after operating at the L2 orbit, the satellite will be pushed on to highly elongated elliptical orbit with perigee and apogee of 10000 km and 300000 km respectively. Orbit period will be 10 days which, in combination with EHT ground based telescopes allows to build dynamic images of event horizon shadow of massive black holes in the center of our galaxy and other large galaxies such as M87.

The Millimetron antenna has central non-deployable mirror of 3 m diameter which consists of 24 panels and 24 deployable petals each of which has 3 surface panels. Panels of the telescope are made from carbon fiber reinforced composite material which is formed on top of the highly accurate and highly dimensionally stable Astrosital glass mould. This technique allows to achieve high panel accuracy of order of 4.7 micron RMS surface deviation from an ideal parabola, while keeping the specific mass of the antenna structure very small 8.5 kg/m^2.

The antenna and instrument compartment is protected from Solar infrared radiation by a 5 layer deployable screens which allow to minimize the parasitic thermal load on the antenna to the levels of below 100mW at 4 K. This makes it feasible to use space qualified closed cycled refrigerators to actively cool both the main dish and the instrument compartment.

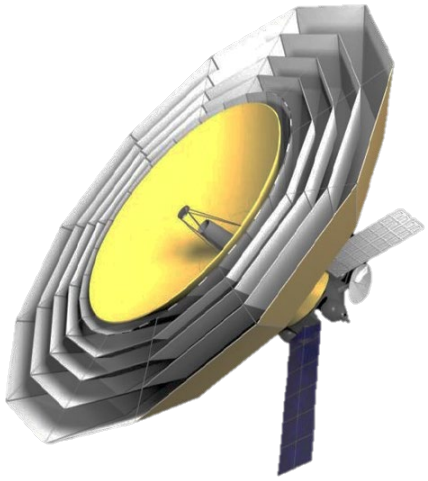

Fig. 1. Millimetron Space Observatory in deployed configuration .

Antenna panels are mounted on the support structure by using actuators. Laser based absolute metrology system will be used for the in-flight panel position measurements and alignment.

Millimetron instrumentation will include both heterodyne type to support VLBI mode and high resolution spectroscopy and both grating and Fourier transform type direct detector based spectrometers. Millimetron instruments will cover from 40 GHz up to 4.7 THz frequency range.

In this contribution we will report current status of Millimetron mission development and design solutions and achieved parameters for main subsystems such as antenna structure, antenna alignment system, instrument content, thermal system and optics. We also summarize key science cases as well as expected on-board instrumentation parameters and requirements.

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