Ballistic and navigation support for “Spektr-R” spacecraft

A mathematical model of motion of a spacecraft with mounted space radio telescope has been developed.

The Radioastron project implicates radio astronomical observations using Very Long Baseline Interferometry (VLBI) technique. The 10-m space radio telescope, a payload of “Spektr-R” spacecraft, is an element of a ground-space interferometer, which distances from ground based radio telescopes as far as the apogee height of the spacecraft orbit. Such observations require an accurate knowledge of the baseline parameters and therefore of the spacecraft orbit. A mathematical model of motion of such spacecraft Is developed In Keldysh Institute of Applied Mathematics of RAS. Besides the motion of the spacecraft’s center of mass the model describes relation between operation of spacecraft stabilization and attitude control systems and the dynamics about the center of mass. The model underlies the implementation of precise determination and long term prediction of orbital parameters of the spacecraft. It helped to develop an algorithms of joint processing of different types of observations including radio ranges, Doppler data, laser ranges, optical angles and telemetry data about reaction wheels’ rotation, spacecraft attitude and stabilization thrusters’ operation. The algorithms are used successfully for navigational tagging of radio observations conducted within the Radioastron project. High accuracy of orbit determination and navigational tagging is confirmed by correlation statistics of ground-space interferometer observations gathered by ASC of Lebedev Physical

Institute (Fig. 1). Parameters of the correctional maneuver in 2016 have been calculated. The maneuver is to prevent upcoming unfavorable spacecraft shadowing (longer than 5 hours) in January 2017. Developed methods and algorithms will find useful applications in domains of precise orbit determination and long term orbital prediction of prospect space mission “Spectrum-RG” designed to conduct scientific experiments in astrodynamics in the vicinity of the Sun-Earth collinear libration point L2.

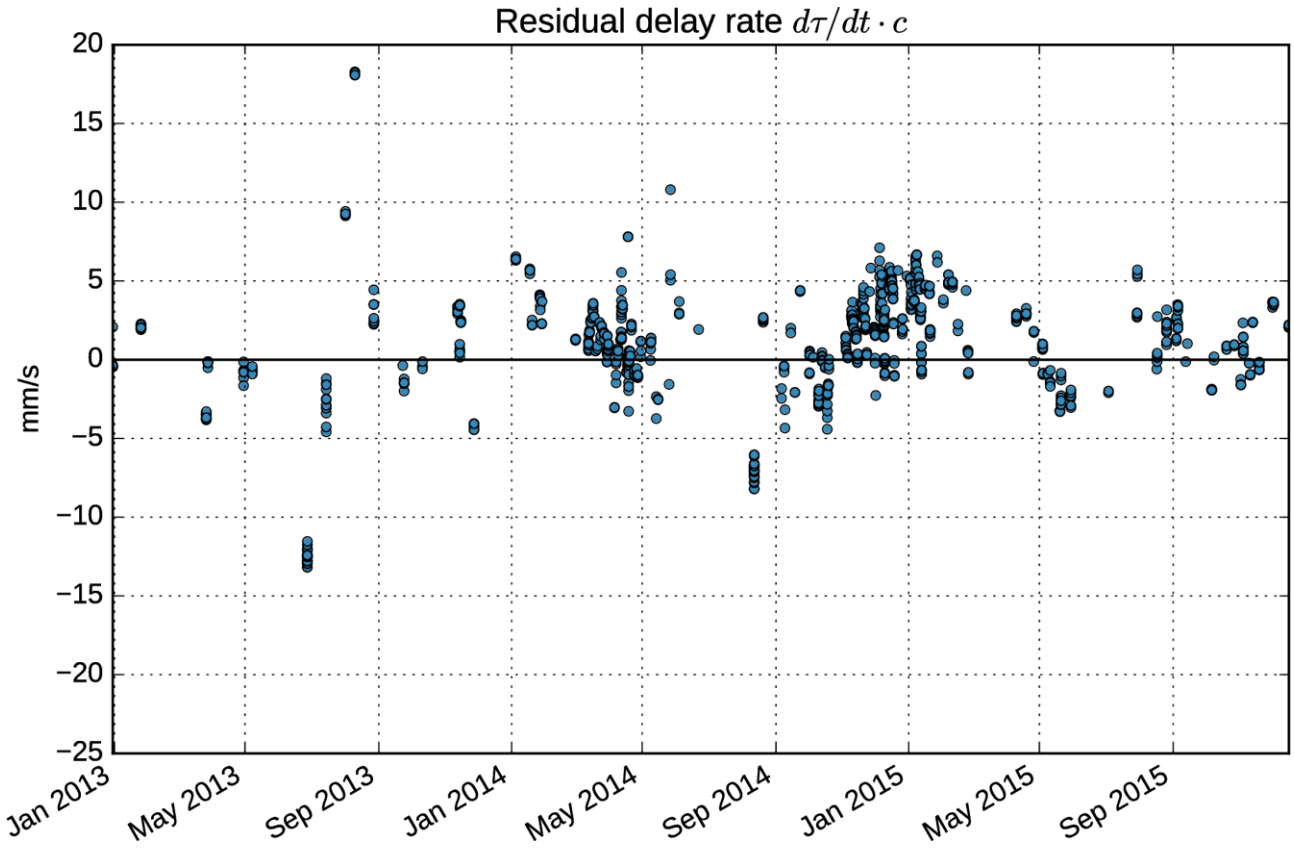

Fig. 1. Residual delay rate (*dτ/dt·c)* characterizing accuracy of spacecraft velocity determination in the direction of observed radio source. Requirements specification allows errors not greater than 2 cm/s.

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