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Precise VLBI tracking of planetary probes revisited

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Abstract. VLBI technique has a long and successful record of precise tracking of deep space missions. Latest technological developments - higher data rates, lower noise characteristics of radio telescopes, advanced data processing equipment and algorithms - enable applications of VLBI tracking for extremely distant missions. In some cases, VLBI is the only method of providing navigation data sufficiently accurate for trajectory maneuvers and various in-situ experiments. We present the current status of VLBI tracking technique based on the assessment study of the Huygens Planetary Probe VLBI experiment. The aim of the experiment is to tie the position of the Probe to the framework of background extragalactic radio sources. We demonstrate the feasibility of direct detection and receipt of the S-band radio signal from the Huygens Probe during descent to the surface of Titan. We analyse the power budget of the Huygens-Earth radio link, the potential accuracy of the VLBI determination of the Probe's coordinates in the atmosphere of Titan, and some scientific applications of these measurements. Special attention is given to the calibration procedures and preparatory studies of the background field of celestial radio sources around the position of Titan during the Huygens atmosphere descent. We also discuss the prospects of the VLBI technique for tracking future planetary and deep space missions using the next generation of Earth-based radio telescopes, in particular the Square Kilometre Array (SKA).