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Planetary Radio Interferometry and Doppler Experiment (PRIDE) for the JUICE mission

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The Planetary Radio Interferometry and Doppler Experiment (PRIDE) is a multi-disciplinary enhancement of the scientific suite of the Jupiter Icy Moons Explorer (JUICE). PRIDE will exploit the technique of Very Long Baseline Interferometry (VLBI) observations of spacecraft and natural celestial radio sources by a network of Earth-based radio telescopes (Fig. 1, see [1,2]). The main "measured deliverables" of PRIDE are lateral coordinates of spacecraft in the celestial reference frame. In addition to the lateral coordinates, a by-product of PRIDE is the measurement of the line-of-sight velocity of spacecraft. It is worth to notice the synergistic nature of PRIDE measurements to other key experiments of the JUICE mission, in particular addressing the quest of Icy Moons interior and Jovian system ephemerides. In addition of providing consistency checks of a number of experiments, PRIDE is highly synergistic to a number of other JUICE experiments, in particular radio science and laser ranging ones.

Tracking of the spacecraft in the gravity field of Jupiter and its satellites will allow us to not only provide valuable inputs into the determination of the spacecraft trajectory, but also to improve the ephemerides of Jupiter and the Galilean Satellites. VLBI tracking of the spacecraft, in combination with routine observations of background radio sources of the celestial reference frame, will also allow us to firmly tie the Jupiter system into the celestial reference frame. This would represent a major contribution to the Solar System celestial mechanics and the definition of the Solar System reference system.

Furthermore, PRIDE will contribute to various aspects of Ganymede's, Callisto's and Europa's science. VLBI positioning and radio occultation data may represent an important and independent reference for the GALA laser altimeter data. The trajectory data during the multiple satellite flybys will help to further constrain the low order gravity field parameters.

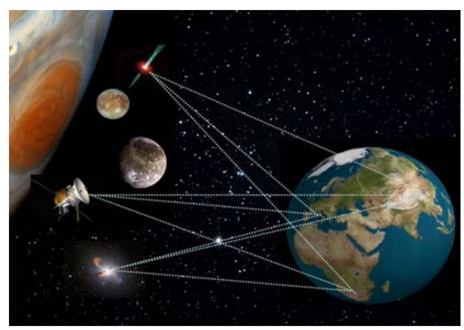

Fig. 1. A generic configuration of PRIDE-JUICE

In addition to the science topics, PRIDE can provide support to the mission operations by engaging, as necessary, an extended network of Earth-based radio telescopes. A separate and potentially beneficial application of PRIDE is its ability to provide limited Direct-to-Earth delivery of data from JUICE spacecraft.

PRIDE offers a high degree of synergy with JUICE's on-board instrumentation and does not include components requiring mission-critical technology developments. The on-board instrumentation required by PRIDE (transmitters, ultra-stable oscillators, antennas) will be developed and used by other JUICE experiments and mission service module systems. PRIDE observations of the spacecraft can be carried out simultaneously to radio science observations to provide consistency checks and complementary lateral position of the spacecraft. Furthermore, PRIDE measurements can also run while the spacecraft is communicating with Earth. PRIDE will not require additional load on the mass budget and is expected to require minimal experiment specific power budget of the JUICE mission.

It is important to underline that PRIDE-JUICE does not require any specific on-board instrumentation beyond those devices which will be available on board the mission spacecraft independently of PRIDE.

The Earth-based segment of PRIDE includes a network of radio telescopes and specialised data processing centre. These components of PRIDE constitute a backbone of the European and global VLBI networks. Their current state is already consistent with the PRIDE requirements. The work in progress at JIVE, other organisations of the PRIDE-JUICE consortium as well as members of the European VLBI Network (EVN) will extend the broad-band capability of the European radio telescopes and data processing facility (correlator) from its current 1 Gbs per station to 4 Gbs and higher data rates. This will further advance the capability of PRIDE by enabling high-accuracy observations with weaker celestial background reference radio sources. The timeframe of this EVN development is well within the timeline of the JUICE implementation.

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