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Planetary Radio Interferometry and Doppler Experiment (PRIDE) for studying the thermosphere of Venus

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Planetary Radio Interferometry and Doppler Experiment (PRIDE) is a generic experimental setup of on-board and Earth-based radio devices and facilities, which serves as an enhancement of the science return of planetary missions. The main goal of this technique is to provide precise estimates of the spacecraft state vectors, by performing precise Doppler tracking of the spacecraft carrier signal, at one or more Earth-based radio telescopes, and VLBI-style correlation of these signals in phase referencing mode [1].

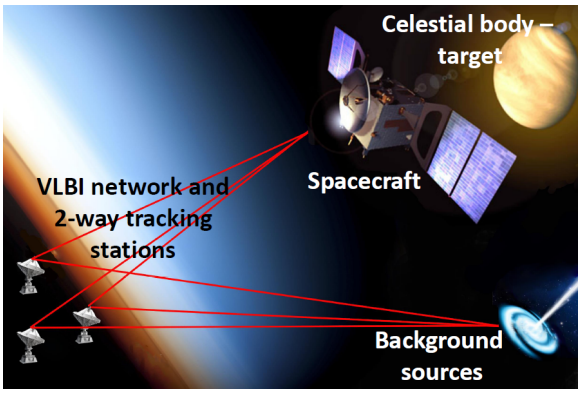

Figure 1: Generic PRIDE configuration.

By allowing an accurate examination of the changes in phase and amplitude of the radio signal propagating from the spacecraft to the multiple stations on Earth, the PRIDE technique can be used for several fields of research, among them: atmospheric and ionospheric structure of planets and their satellites, planetary gravity fields, planets' shapes, masses and ephemerides, solar plasma and different aspects of the theory of general relativity.

The PRIDE-team is participating in the so-called Venus Express Atmospheric Drag Experiment (VExADE) campaigns by tracking ESA's Venus Express with multiple radio telescopes on Earth. During each campaign, VEX's orbit pericenter is lowered into an altitude range of approximately 165 to 175 km in order to probe Venus upper atmosphere above its north pole. The first VExADE campaigns were carried out between 2009-2010 using Doppler tracking data acquired by the VEX radio science experiment (VeRa), which provided the first in situ measurements of the density of Venus' polar thermosphere at solar minimum conditions [2]. The last campaign was conducted in December 2012, in which the PRIDE-team participated by tracking VEX with several radio telescopes from the European VLBI Network (EVN) during pericenter passage. A Doppler frequency drop of $\sim$ 40 mHz was detected as VEX reached the lowest altitudes at around 170 km. The tracking data for each pericenter pass is fitted for precise orbit determination, from which drag acceleration estimates and the corresponding atmospheric mass density estimates are derived. The results of this campaign will give the opportunity to trace the density of the polar thermosphere along the increasing phase of the solar cycle, and to provide a wider data set of density estimates which will eventually contribute to the construction of a new empirical model of Venus' polar thermosphere.

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