

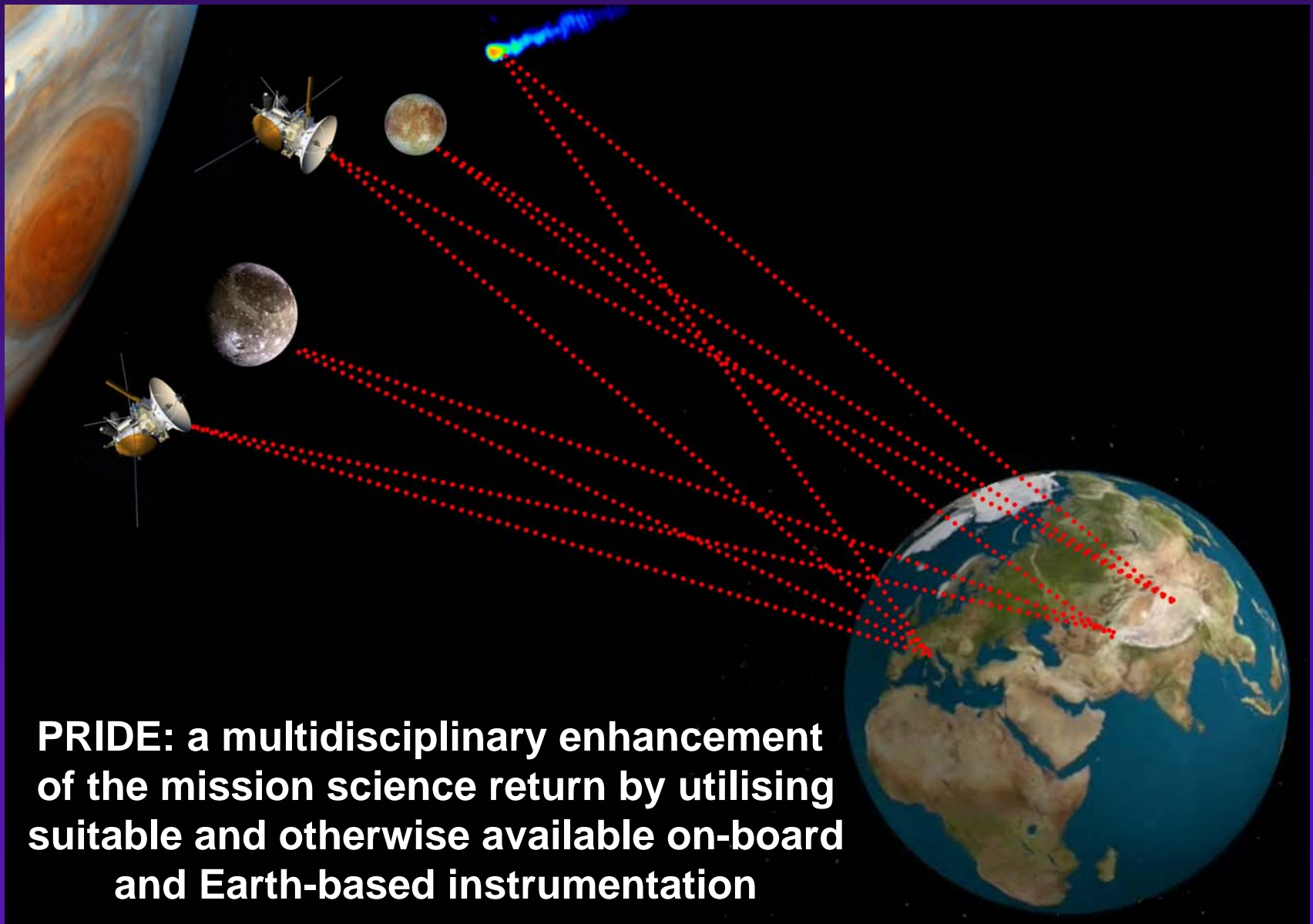
Status of the Planetary Radio Interferometry and Doppler Experiment (PRIDE) for the Europa Jupiter Ssystem Mission

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Generic PRIDE configuration – just to remind



PRIDE: a multidisciplinary enhancement of the mission science return by utilising suitable and otherwise available on-board and Earth-based instrumentation

PRIDE-EJSM summary

- **PRIDE-EJSM – a multidisciplinary enhancement of science return**
- **Minimum requirements to on-board instrumentation, but...**
 - *PRIDE: a highly heterogeneous system; TRL of the system is a complex function of TRL of its components*
 - *But most to be developed for other purposes/experiments*
- **Lots of “piggy-back” use of the existing instrumentation:**
 - *On-board radio systems (service and science)*
 - *USO*
- **Lots of synergies with other EJSM technology developments**
- **PRIDE-EJSM for Penetrator(s) – special (most challenging) case**
 - *VLBI part of PRIDE for Penetrators at UHF band is impractical*
- **Backup DtE of (all) EJSM S/C through low-gain antenna possible:**
 - *6–60 bps at UHF, 20–200 bps at S-band, and 10–100 bps at X-band with SKA*
 - *0.5 -2 bps from penetrator at X-band with a “standard” 64-m Earth-based antenna*

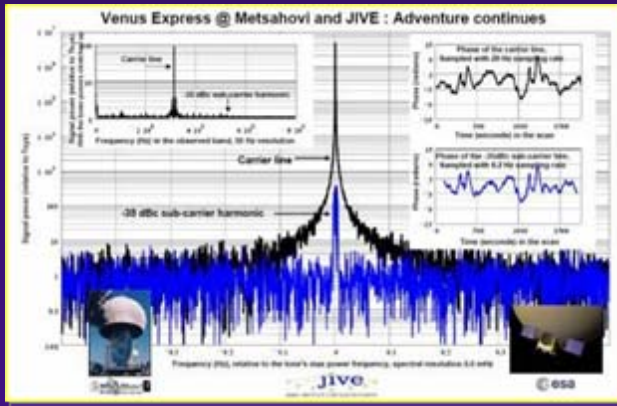
PRIDE-EJSM versus Huygens VLBI tracking

Mission	Distance	Transmitter power/gain	Band	Time resolution	Delay noise	Positional accuracy (lateral)
	[AU]		[GHz]	[s]	[ps]	[m]
Huygens VLBI	8	3 W / 3 dBi	2.0 (S)	500	15	1000
PRIDE EJSM	5	10 w / 6 dBi	2.3 (S)	100	5	120
			8.4 (X)	10	3	70
			32 (Ka)	10	1	23

- Conservative estimate, today's technology
- Minimal special requirements for the on-board instrumentation
- In-beam "Orbiter-Probe" calibration can improve SNR further

VEX Doppler tracking demo

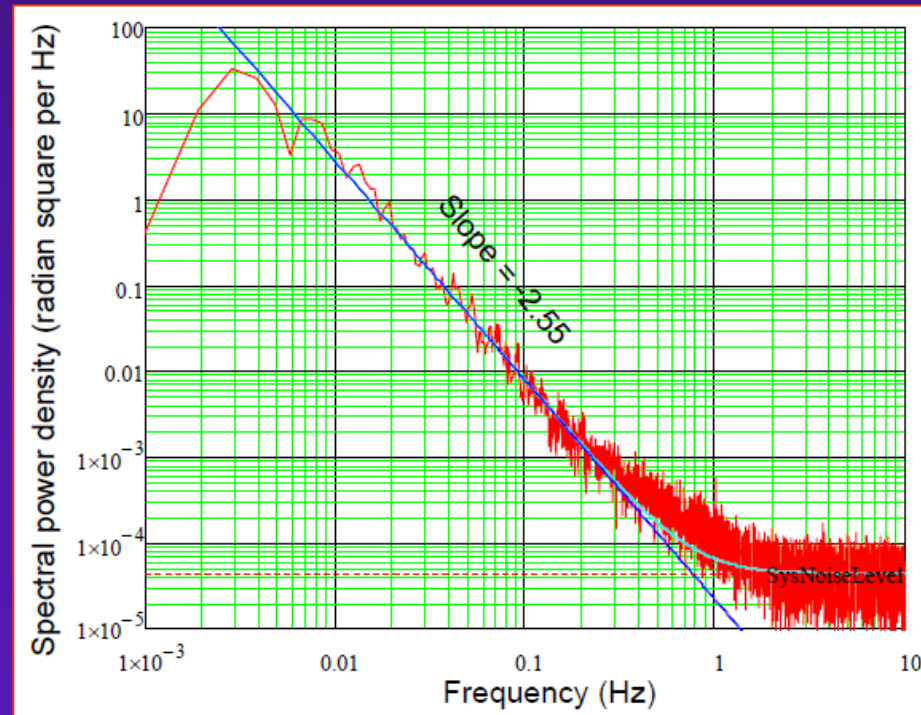
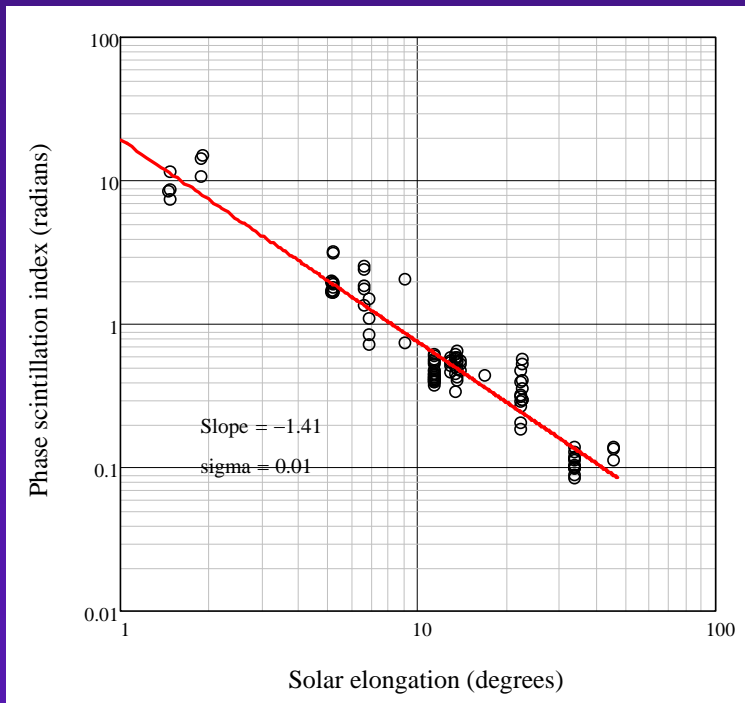
- ESA's Venus Express carrier spectrum,
- Metsahovi observation,
- New S/W spectrometer
- 0.6 mHz spectral resolution



~100 20-min scans over 2008-2009

Power spectrum of phase scintillations of the VEX S/C carrier line, Noto, 2000.11.26.

Evaluation of phase stability



Backup PRIDE-DtE assessment

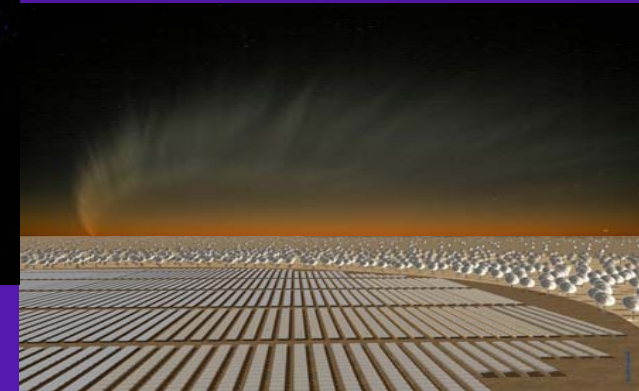
- Report on backup DtE assessment for a (generic) Jovian mission will be released in Feb 2010
- Emphasis on S- or X-band communication
 - *Suitable for safe-mode?*
 - *Ad-hoc use?*
- DtE at UHF (400 MHz) for penetrator(s)
- Square Kilometre Array (SKA) as a backup DtE facility

Arecibo – 220 m



Effelsberg – 100 m

SKA – 1 km



DtE data rate [bit per second] with SKA

UHF-band

P_{tr}, W	1.0	3.0	5.0	10.0
$R = 5.0 AU$	5.64	16.92	28.20	56.40
$R = 7.0 AU$	2.88	8.63	14.39	28.77
$R = 10 AU$	1.41	4.23	7.05	14.1

S-band

P_{tr}, W	1.0	3.0	5.0	10.0
$R = 5.0 AU$	19.74	59.21	98.69	197.38
$R = 7.0 AU$	10.07	30.21	50.35	100.70
$R = 10 AU$	4.93	14.80	24.67	49.345

X-band

P_{tr}, W	1.0	3.0	5.0	10.0
$R = 5.0 AU$	9.869	29.61	49.35	98.69
$R = 7.0 AU$	5.035	15.11	25.18	50.35
$R = 10 AU$	2.47	7.40	12.34	24.68

NB: Extremely conservative assumption on SKA parameters!

Instrumental requirements of PRIDE-EJSM

- **Earth-based segment:**

- *A global network of radio telescopes (and tracking stations)*
 - **X- and Ka-band antennas and receivers**
- *(Mission-adjusted) data processing centre*
- *Logistical network*

**EJSM-oriented work commenced
Jul 2009**

- **Onboard segment (all probes/spacecraft of EJSM):**

- *Multi-frequency transmitters and related instrumentation (antennas etc.)*
- *Stable Local Oscillator (LO) - USO*

**Need for working link with
the mission study teams**

- **Issues to address:**

- *Demo experiments are desirable (and in fact being planned)*
- *Multi-target multi-frequency mode can be verified using operational S/C*
- *PRIDE EJSM @ UHF with penetrators: very challenging case*