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TanDEM-X

ILRS Support for TerraSAR-X and TanDEM-X - Status and Future Prospects

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TerraSAR-X and TanDEM-X Missions

TerraSAR-X was launched on 15 June 2007 into a circular dawn-dusk , 11-day repeat orbit at 514 km altitude (sun-synchronous)

Primary instrument is a Synthetic Aperture Radar (SAR)

GFZ and UTCSR contributed the TOR payload (GPS + LRR) for

- Precise orbit determination, resulting in enhanced SAR data quality
- Collection of ionospheric and neutral-atmospheric radio occultation data for deriving vertical profiles of humidity and temperature - shall be used for improved SAR error correction

TanDEM-X will follow in fall 2009 for a close formation flight (target: 3 years!) with the nearly identical TerraSAR-X

- Use of both SAR instruments for bistatic measurements to derive DEMs
⇒ the baseline between both S/C is needed with mm accuracy!

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TanDEM-X shall fly in close formation (~300 ... 600 m distance) with TSX to obtain simultaneous X-band radar takes for Digital Elevation Models (DEM)

TOR Instrument Package (2F-GPS + LRR) is identical on both satellites

LRR is of CHAMP / GRACE type (small array with 4 CCRs)

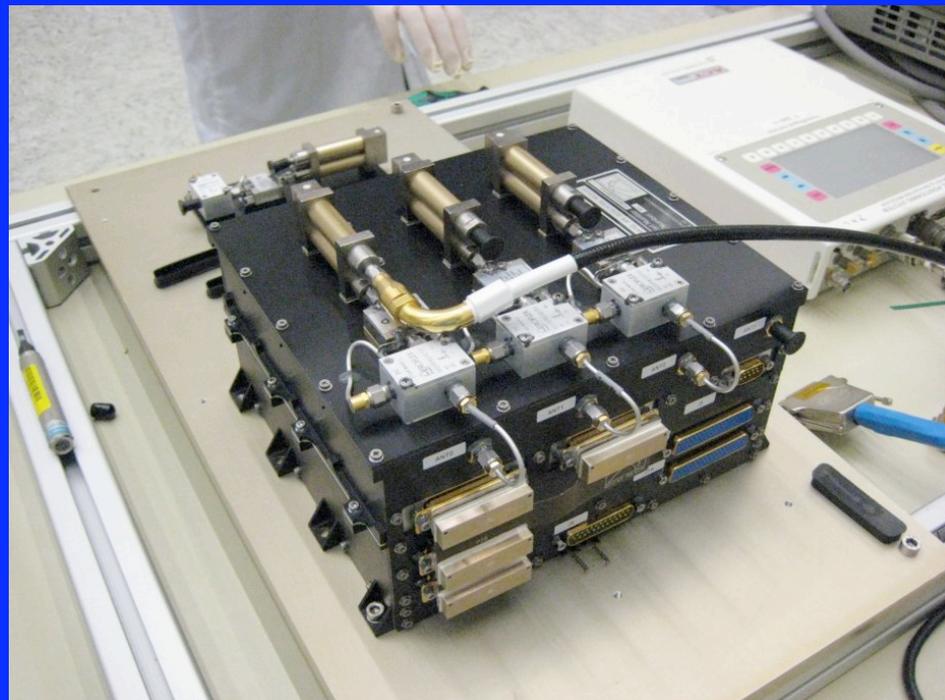
ILRS tracking support granted May 2008



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TanDEM-X Spacecraft Integration Status 10/2007

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Dual-frequency GPS receiver IGOR™

Derived from JPL's BlackJack GPS receivers for Jason-1/-2, CHAMP, GRACE, SAC-C ...

Design especially „hardened“ against intense X-Band radar frequencies

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TanDEM-X Spacecraft Integration Status 09/2008

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Product	Satellite	Latency	Accuracy
Rapid Science Orbits (RSO)	CHAMP	1 d	5 cm
	GRACE	1 d	5 cm
	GPS	1 d	8 cm
Ultra-Rapid Science Orbits (USO)	CHAMP	2 h	8 cm
	GRACE-A	2 h	7 cm
	GPS	2 h	10 cm
Near Real- Time Science Orbits (NRT)	CHAMP	15 – 40 min	5 – 20 cm
	GRACE-A	15 – 40 min	5 – 20 cm
	GPS	30 min	20 cm



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Requirements for GFZ Orbit Products / TSX and TDX

Product	Satellite	Latency	Accuracy
Precise Science Orbits (PSO)	TSX	28 d	3 cm
	TDX	28 d	3 cm
Rapid Science Orbits (PSO)	TSX	1 d	5 cm
	TDX	1 d	5 cm
Near Real-Time Science Orbits (NRT)	TSX	30 min	7 cm
	TDX	30 min	7 cm

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ILRS Tracking Statistics for TerraSAR-X (06 Oct 2008)

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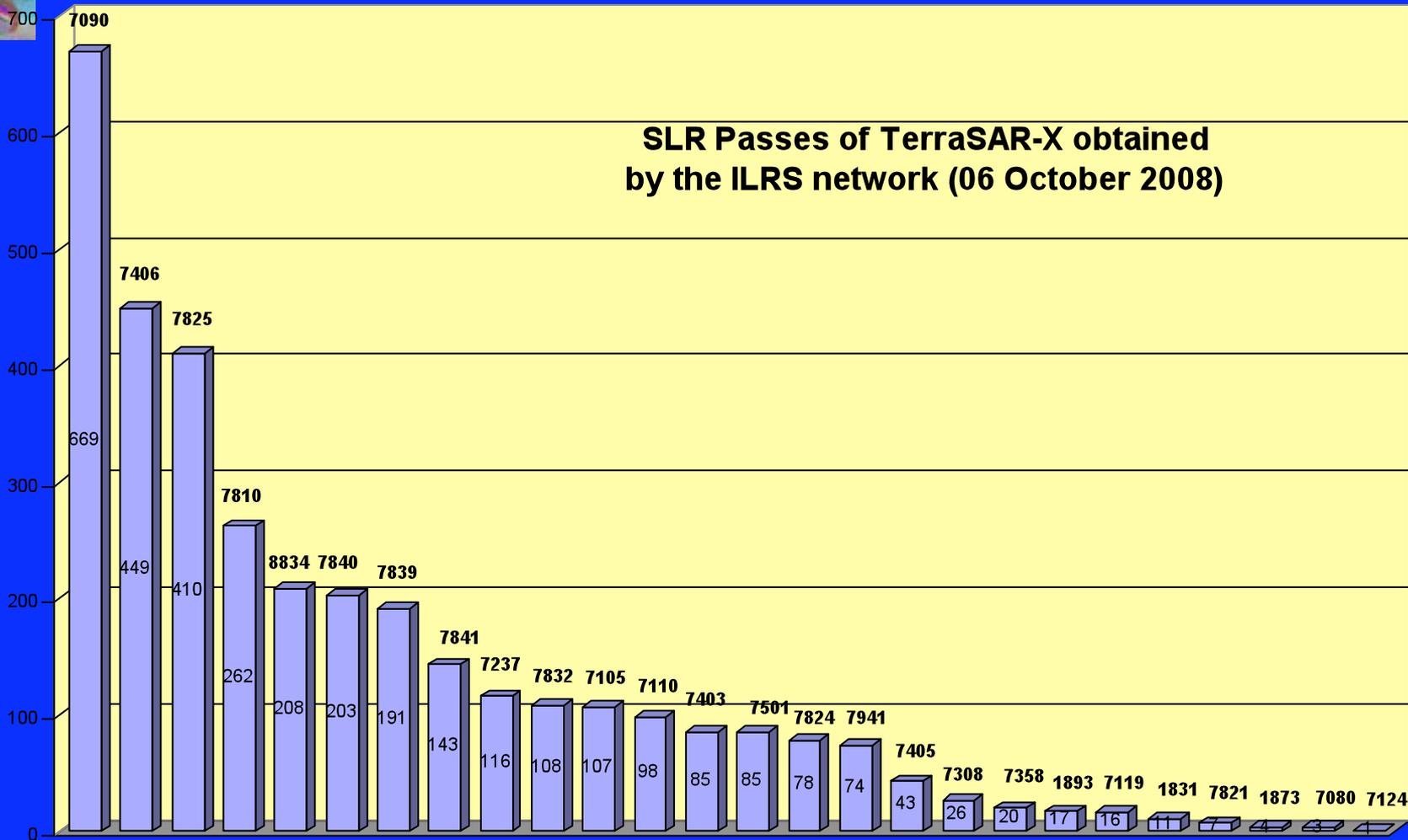
<i>Station</i>	<i>PAD ID</i>	<i>Passes</i>	<i>NPs</i>	<i>NPs / Pass</i>
<i>Yarraqadee</i>	7090	669	27539	41
<i>San Juan</i>	7406	449	17053	38
<i>Mt. Stromlo</i>	7825	410	9174	22
<i>Zimmerwald</i>	7810	262	8274	32
<i>Wetzell</i>	8834	208	2872	14
<i>Herstmonceux</i>	7840	203	4673	23
<i>Graz</i>	7839	191	6807	36
<i>Potsdam</i>	7841	143	5243	37
<i>Changchun</i>	7237	116	2025	17
<i>Riyadh</i>	7832	108	1856	17
<i>Greenbelt</i>	7105	107	4533	42
<i>Monument Peak</i>	7110	98	2836	29
<i>Arequipa</i>	7403	85	1812	21
<i>Hartebeesthoek</i>	7501	85	1780	21
<i>San Fernando</i>	7824	78	1960	25
<i>Matera</i>	7941	74	1082	15
<i>Concepcion</i>	7405	43	505	12
<i>Total</i>		3329	100024	30

- Stations with >30 passes included in Table
- High average number of NPs per pass (excellent for orbit comparison with GPS!)

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ILRS Tracking Statistics for TerraSAR-X (06 Oct 2008)





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TerraSAR-X Orbit Assessment with SLR

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- **10-day assessment:** comparison of independently generated 10-day orbit solutions by GFZ and DLR (using different SLR analysis tools) yields RMS range biases for the IGOR-based orbits between 2.5 and 3.1 cm.

SLR stations used: Changchun, Graz, Herstmonceux, Hartebeesthoek, Matera, Monument Peak, Mount Stromlo, Potsdam, Wettzell, Yarragadee and Zimmerwald

- **5-months-assessment:** comparison with IGOR-based precise orbits yields an average orbit agreement of 2-3 cm and a mean station bias below 1 cm (< 0.5 cm for a subset of 6 stations).

SLR stations used: Graz, Herstmonceux, Hartebeesthoek, Monument Peak, Mount Stromlo, Potsdam, Yarragadee and Zimmerwald

(based on contributions by GFZ and DLR)

- The ILRS support for TerraSAR-X is excellent; the large number of tracked passes allows for a precise assessment of the GPS-derived orbit quality.
- The average orbit agreement is within few centimeters with a mean station bias below 1 cm for a selected sub-network. This is an exciting result for a large, actively attitude-controlled spacecraft!
- The upcoming tandem flight of TerraSAR-X and TanDEM-X poses a new challenge for laser tracking. SLR will be a viable means of external validation of the inter-satellite baseline which is required with millimeter accuracy for deriving world-wide DEMs with meter precision.

The Project expresses special thanks to all contributing ILRS stations for their excellent support!