The TerraSAR-X Mission

2nd STG/IPY SAR Coordination meeting

Oberpfaffenhofen, Sept 30, 2008

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Mission Manager

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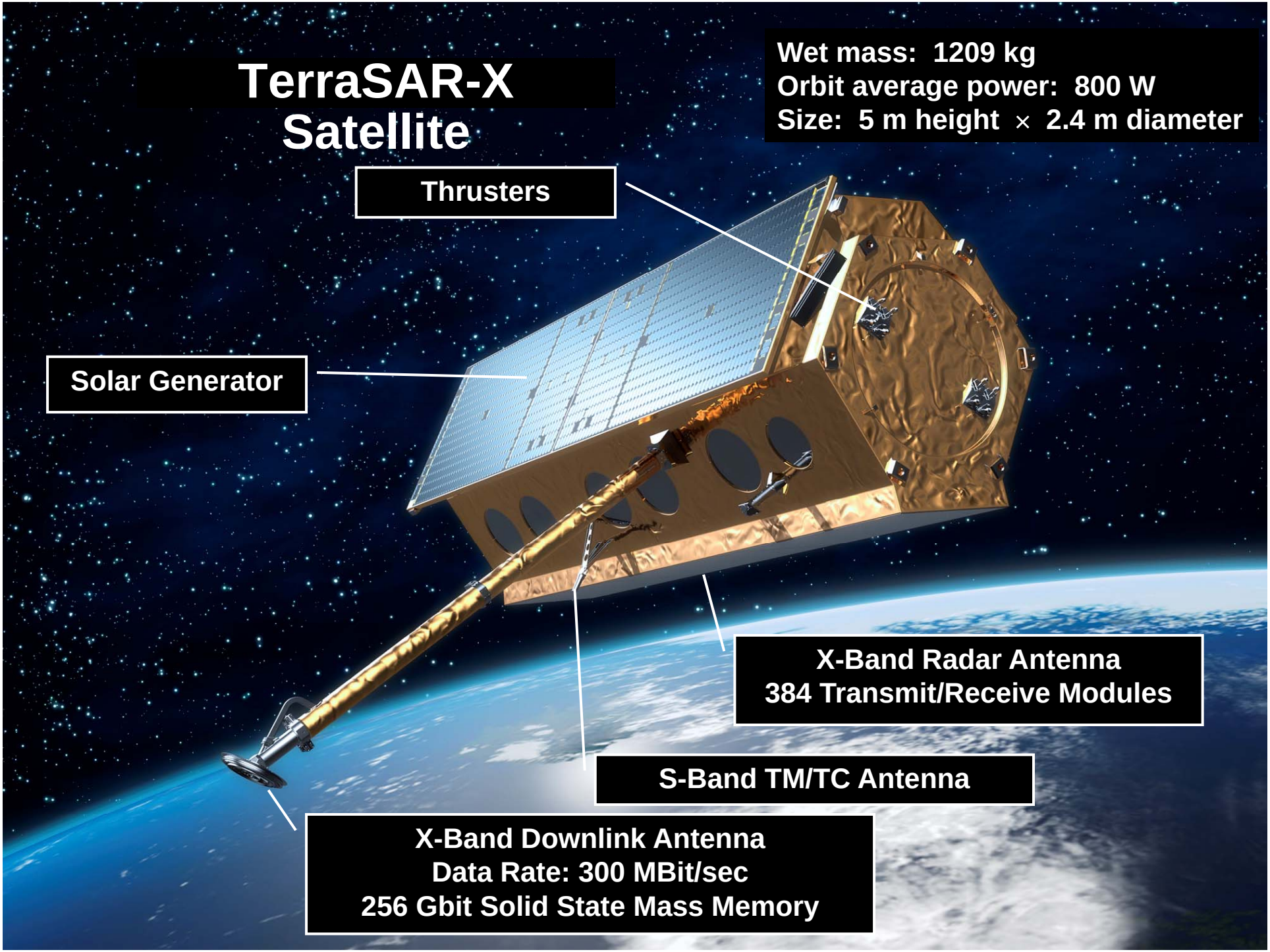
Science Coordinator

German Remote Sensing Data Center

Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft


TerraSAR-X
Satellite
Wet mass: 1209 kg
Orbit average power: 800 W
Size: 5 m height × 2.4 m diameter
Thrusters
Solar Generator
X-Band Radar Antenna
384 Transmit/Receive Modules
S-Band TM/TC Antenna
X-Band Downlink Antenna
Data Rate: 300 MBit/sec
256 Gbit Solid State Mass Memory

"TerraSAR-X, a National Science Mission with Commercial Potential"

Public Private Partnership

DLR
- Project & Mission Mgmt.
- G/S Development & Ops
- Science Coordination
- System Engineering Support

EADS Astrium
- Platform Development
- Instrument Development
- Launch on Dnepr-1

Infoterra
- Service Infrastructure
- Information Products
- Commercial Exploitation

- Satellite tasking will be shared equally 50/50 (scientific/commercial)
- DLR is the owner of the TerraSAR-X satellite and all data
- Nominal mission duration is 5 years
- If commercially successful → TerraSAR-X2 (to be financed by industry)

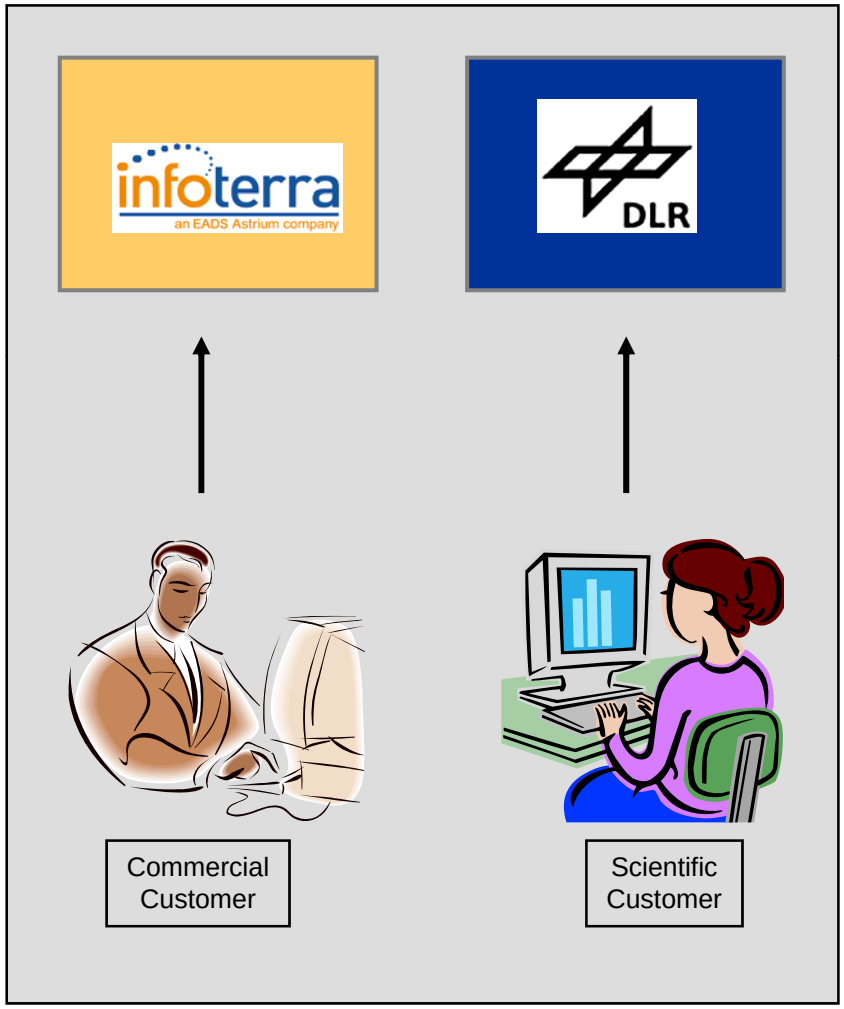
Data Availability

Scientific Data:

- DLR is in charge of coordinating the scientific use of the TerraSAR-X data
- Data will be generally provided via an evaluation process
  - Announcement of Opportunity
  - Permanent submission interface (COFUR: cost of fulfilling the user request)
- License agreement is required
- **http://www.dlr.de/tsx/main/science_en.htm**

Commercial data:

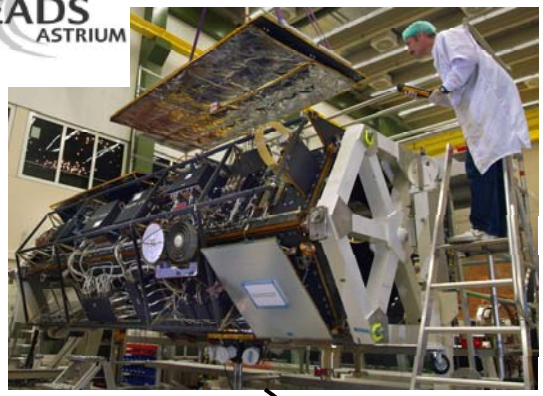
- Commercial Customers will receive data via Infoterra GmbH
- Market price will be determined by Infoterra GmbH
- **http://www.terrasar.de**

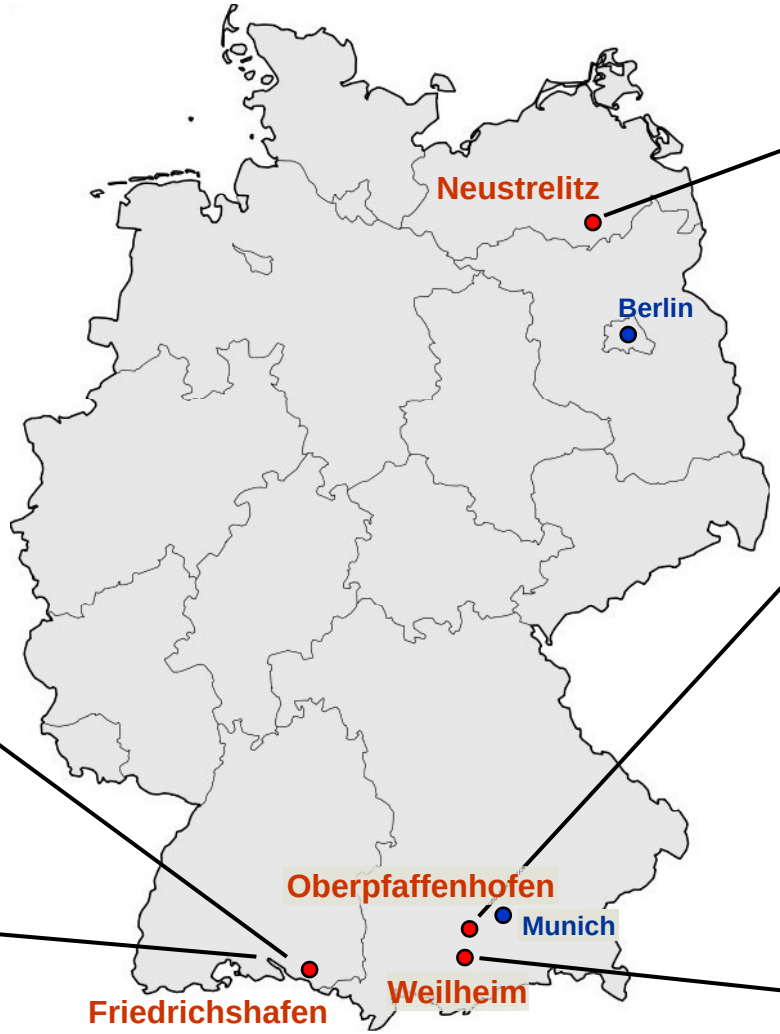


TerraSAR-X Locations in Germany

Spacecraft Development

EADS ASTRIUM





X-Band Payload Data Reception

DLR

Research Center & Mission Control

DLR

S-Band Telemetry & Telecommand

DLR

infoterra an astrium company

Commercial Exploitation

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

TERRA SAR X

TerraSAR-X Mission Profile

Downlink of stored radar data @ 300 Mbit/sec

S-Band Telemetry & Telecommand

Radar Data Take

Ground Segment

DLR-Oberpfaffenhofen:
Mission Operations/Planning, Flight Dynamics
Radar Operations, Calibration

DLR-Oberpfaffenhofen
DLR-Neustrelitz:
Data Reception,
SAR-Processing,
Archiving,
Data Distribution

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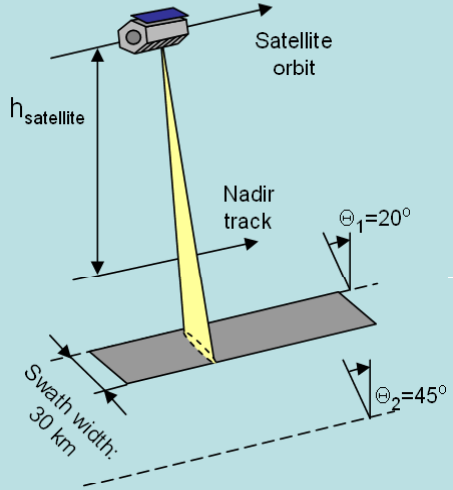
Commercial Exploitation

Science Coordination

TerraSAR-X Satellite Key Features

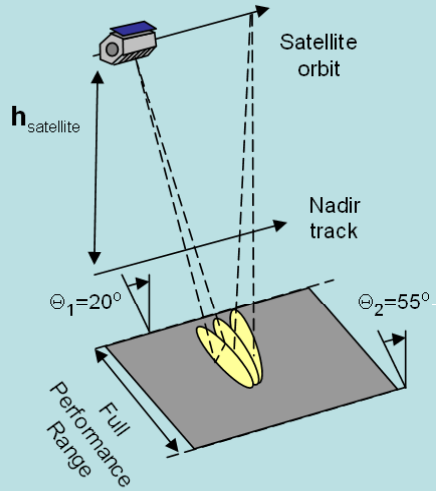
- High resolution in SpotLight mode
- Possibility of large area coverage by utilizing ScanSAR mode
- Multi-polarization capability
- Left Looking Mode (roll maneuver of S/C)
- Dual Receive Antenna (DRA) Mode (ATI, MTI, Quad. Pol.)
- 300 MHz transmit bandwidth (1 m range resolution)
- Reference orbit with ±250 m orbit tube (repeated acquisitions, interferometry, etc.)
- Total Zero Doppler Steering
- Secure operation by encryption of commands and data downlink
- Prepared for TanDEM-X operation (synchronization)

TerraSAR-X Nominal Imaging Modes



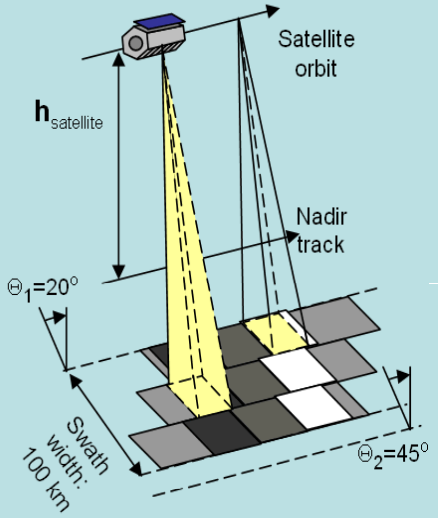
StripMap Mode

Resolution: 3 m × 3 m
Scene Size: 30 km × 50 km
[Range × Azimuth]



SpotLight Mode

Resolution: 1 m × 1,5... 3,5 m
Scene Size: 10 km × 5...10 km
[Range × Azimuth]

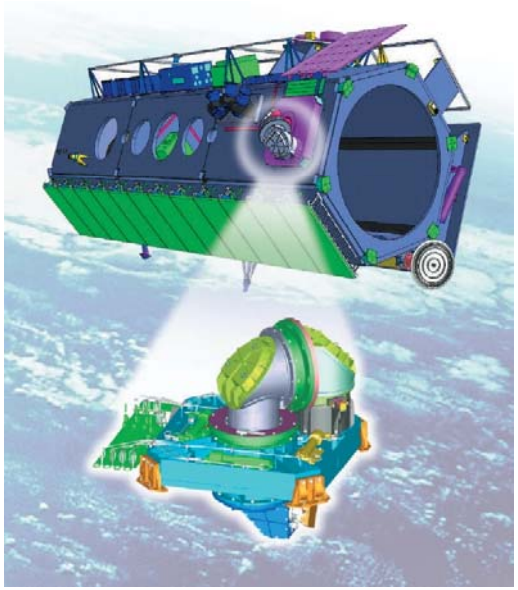


ScanSAR Mode

Resolution: 16 m × 16 m
Scene Size: 100 km × 150 km
[Range × Azimuth]

Secondary Payloads

- **LCT: Laser Communication Terminal**
  - DLR / TESAT
  - Technology-Demonstrator for Intersatellite Communication
  - Tests with NFIRE Satellite:
    → 5,5 Gbit/s transfer rate achieved!



- **TOR: Tracking, Occultation and Ranging Instrument Package**
  - Contribution of University of Texas and German Research Centre for Geosciences (GFZ)
  - Two-frequency GPS Receiver and Laser Reflector
  - High-precise Orbit determination for TerraSAR-X

Commissioning Phase (1)

- **Orbit and attitude verification via laser ranging**
- **Radar instrument characterization/verification**
  - instrument temperature characterization
  - check of instrument configurations
  - antenna pointing calibration, etc.
- **Overall SAR system performance characterization**
  - analysis of raw data and point targets
- **Calibration of the radar data**
  - geometric calibration
  - antenna pointing calibration
  - antenna model verification
  - relative radiometric calibration
  - absolute radiometric calibration
  - internal instrument calibration

Commissioning Phase (2)

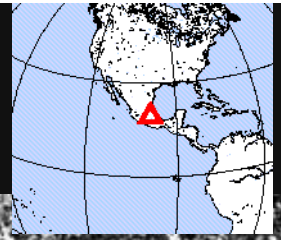
- **Check-out of DLR receiving station and processing system**
- **SAR product verification and release of the basic products**
  - Verification of format, annotation and content
  - Updated basic product specification
    Improvements w.r.t. initial version as for example
    - *absolute* radiometric accuracy: 1.1 dB → 0.6 dB
    - *relative* radiometric accuracy 0.68 dB → 0.31 dB
    - spotlight mode (azimuth) resolution 2.2 m → 1.7 m
    - pixel localization accuracy 2.0 m → 0.3 m in range
      2.0 m → 0.53 m in azimuth
    - side lobe ratio improved by ca. 4 dB*

      *(at the cost of a reduction of the slant range resolution of 9 % from 1.1 m to 1.2 m)

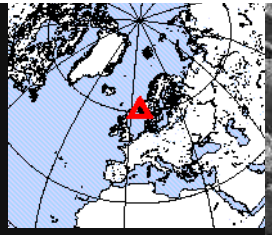
Commissioning Phase (3)

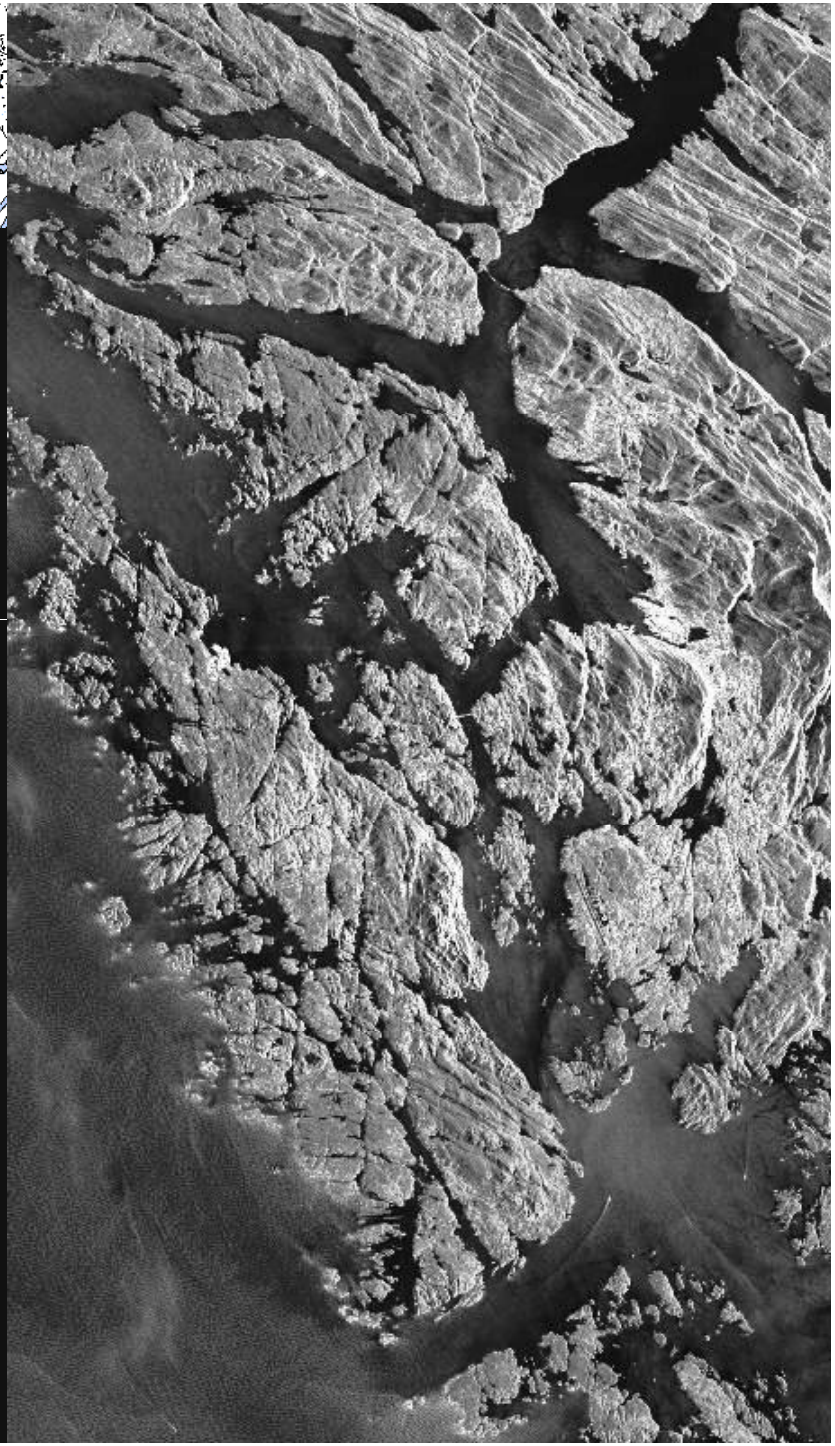
- **Check out of Direct Access Stations operated by Infoterra GmbH**
- **Load tests including the Commercial Service Segment (Infoterra GmbH)**
  - Simulation of a realistic load for ordering, processing and delivery work flow
- **Interferometric processing**
  - Verification of complex data product format
  - Consistency checks for Doppler, timing, velocity “B” parameter, etc.
  - Assessment of relative geolocation accuracy
  - Assessment of relative orbit accuracy
  - Verification of phase preserving processing

Spotlight Image: Teotihuacán
January 20, 2008



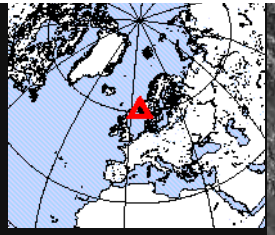
StripMap:
Bergen, Norway
March 13, 2008

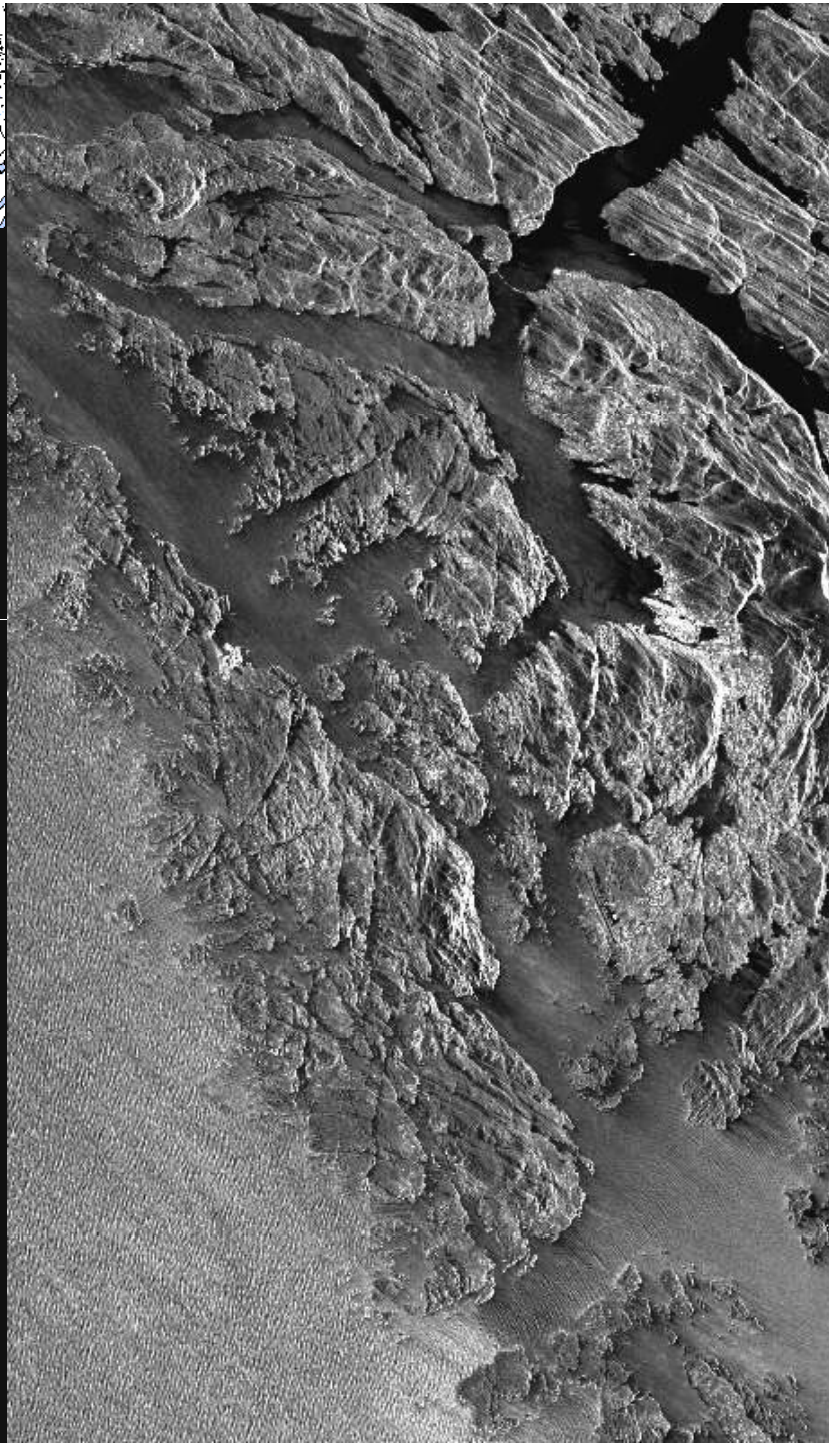




by German Remote Sensing Data Center TU3.203.1, S. Lehner

StripMap: Bergen, Norway March 13, 2008





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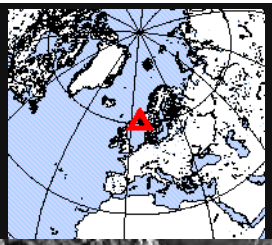

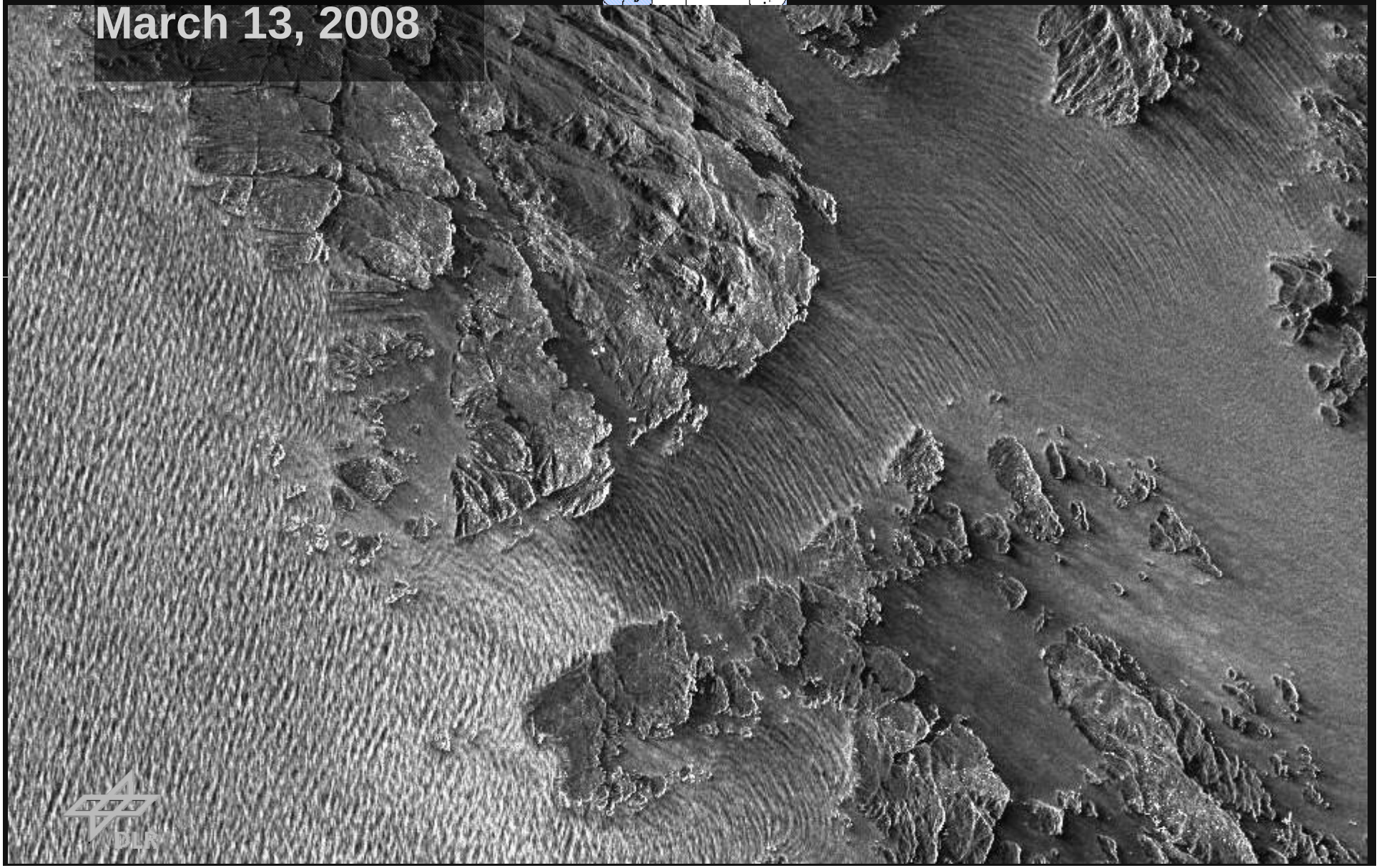

Status Scientific Use

- **234 proposals accepted**

- **One user account is opened for each proposal**
  - Prerequisite for connection: User license, list of users and confirmation of funding
  - 159 active accounts released for ordering
  - ca. 107 PIs have been ordering products and data takes

- **AO for experimental products will be released in October 2008**

- ***3rd TerraSAR-X Science Team Meeting***
  November 25-26, 2008 at DLR Oberpfaffenhofen, Germany

Status Summary

- Spacecraft and ground segment are fully operational
- Image products (Spotlight, Stripmap, ScanSAR) are calibrated and released
- Product quality within initial specification or better!
- SAR instrument proved to be very stable
- Demonstration of Repeat Pass Interferometry, Along Track Interferometry, persistent scatterer evaluation, TOPSAR, total zero Doppler steering
- Demonstration of quadpol mode
- The use of TerraSAR-X data was demonstrated for geo-scientific applications, oceanography and disaster monitoring during commissioning phase

Way Forward

- **Dual Receive Antenna (DRA) mode:**
  - Calibration, Checkout and tests for GMTI and Quadpol-mode
  - Product release probably end of 2008
- **Operational implementation of TOPSAR mode (2009 tbc)**
- **Preparation of TanDEM-X mission**
- ***3rd TerraSAR-X Science Team Meeting*,**
  November 25-26, 2008 at DLR Oberpfaffenhofen, Germany