ENVISAT
Spin and Attitude Determination Using SLR

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History:

- ENVISAT is dead since April 2012; Graz re-started SLR using TLE (October 2012)
- DLR started producing CPF predictions in May 2013: e.g. envisat_cpf_131028_8011.dlr
- Graz started producing CPF predictions in Sept. 2013: e.g. envisat_cpf_131028_8011.aas
- 19 SLR stations successfully tracked ENVISAT in 2013 - THANK YOU!

- This SLR data allows us now to determine
  - Accurate orbits
  - Spin duration
  - Spin axis

For other methods, like RADAR and PASSIVE OPTICAL SYSTEMS, it is difficult (and more expensive) to determine attitude, spin etc. of such targets …
ISAR (Inverse Synthetic Aperture Radar) image – using the TIRA Radar system near Bonn - with superimposed wireframe model of the solar panel (white) and plotted direction of the sun (yellow).

Optical images also have been acquired by a space based telescope (French Pléiades system) for a short period of time, from a distance of approximately 100 km; but this requires special conditions (sun-lit, short distance etc.)

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ENVISAT: Tracked with HQ Laser; retros ‘visible’

- A typical GRAZ ENV pass: July 2013
- Tracked with 2 kHz laser / 400 µJ
- Retros ‘visible’ from Graz Station
- > 700 000 good returns
- Large oscillations (± 2 m) due to spin
- Slight pre-tracks due to laser leakage

And this is what we get via SLR: Only distances, BUT:
- Measured from 19 ILRS Stations;
- During day and night;
- No special conditions required
ENVISAT: Same pass, with 30-degree poly fit

- Same GRAZ ENV pass: July 2013
- > 700 k good returns from RETROS
- 30 degree poly fit necessary
- Small oscillations (± several mm)
- Due to 8 retro-reflectors
- Used to derive spin period
Small oscillations (± several mm) due to retros: Used to derive inertial spin period.
Inertial spin period (black circles) and apparent spin period (gray points) of Envisat during 2013: 134.74 s ± 0.91 s (September 25, 2013), slowing down with 0.0367 s / day.
R: radial vector
N: normal to orbit
AT: along track
n: nadir
ENVISAT Orientation & Spin AFTER May 2013

- **R:** radial vector
- **N:** normal to orbit
- **AT:** along track
- **n:** nadir
- **S:** spin axis
- **CCW:** spin direction
Just for Completeness: ENVISAT tracked with DLR Laser #2: 200 mJ, 80 Hz, 3 ns

NO retros visible – only diffuse reflections from body / solar panel / antennas etc.
Conclusion of ENVISAT tracking

- Accurate spin duration and spin axis orientation can be derived from SLR data
- Retros of ENVISAT are only visible from any SLR Station:
  - During daylight passes: If the pass is EAST of your station
  - During night passes: If the pass is WEST of your station
- The other passes can be tracked only with (strong) debris laser

ENVISAT image: French Pleiades Space based telescope, 100 km distance, 15 April 2013

Thank you