Space Debris Study Group Meeting

October 14, 2016; 08:00-08:30 Hours

- Number of Stations tracking Space Debris (Laser + Light Curves) increased significantly:
  - Graz; Wettzell; Borowiec; San Fernando; Shanghai, + other Chinese stations; Stromlo; Stuttgart; ????

- Planned (or in preparation) SD operation:
  - Metsahovi; Yebes; San Fernando; Western Australia; KASI / Korea;

- Multi-Static / Bi-Color Debris Ranging to uncooperative targets;

- Stare & Chase to uncooperative targets successfully tested,

- Significant output / results: Science; POD; attitude motion; pre-reentry data etc.

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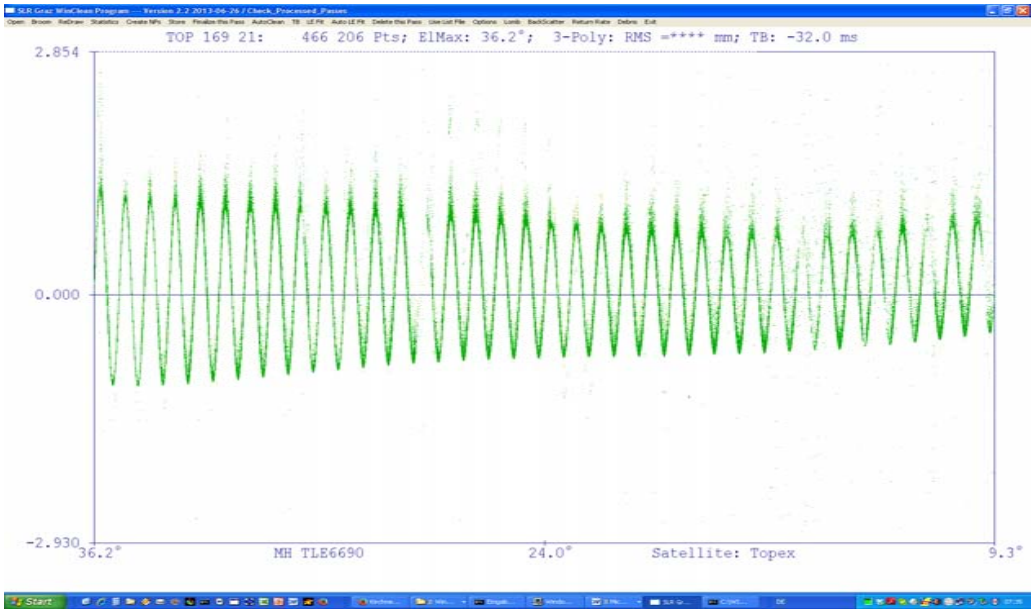
- TOPEX Campaign delivered excellent results
  - Several ILRS stations participated; data stored at SDSG Debris server Graz
  - Graz calculated very accurate CPF predictions (< 1 ms TB)
  - Analyis of Topex spin parameters: 11 s period; accelerating;
  - Solar Radiation pressure identified as pushing force (Daniel)
  - Topex solar panels final orientation determined via that (Daniel)



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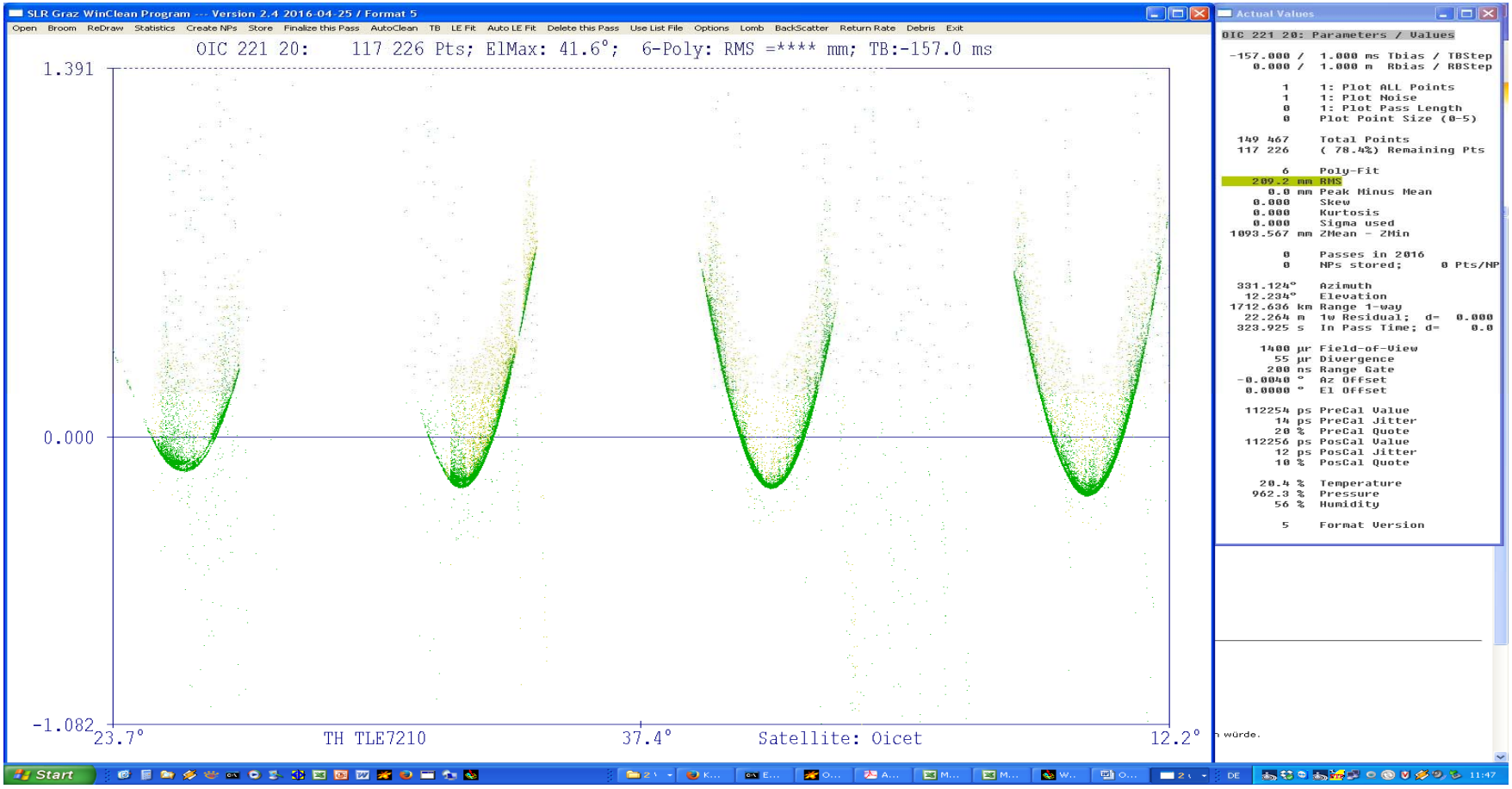
- OICETS, ADEOS-2 Campaigns started



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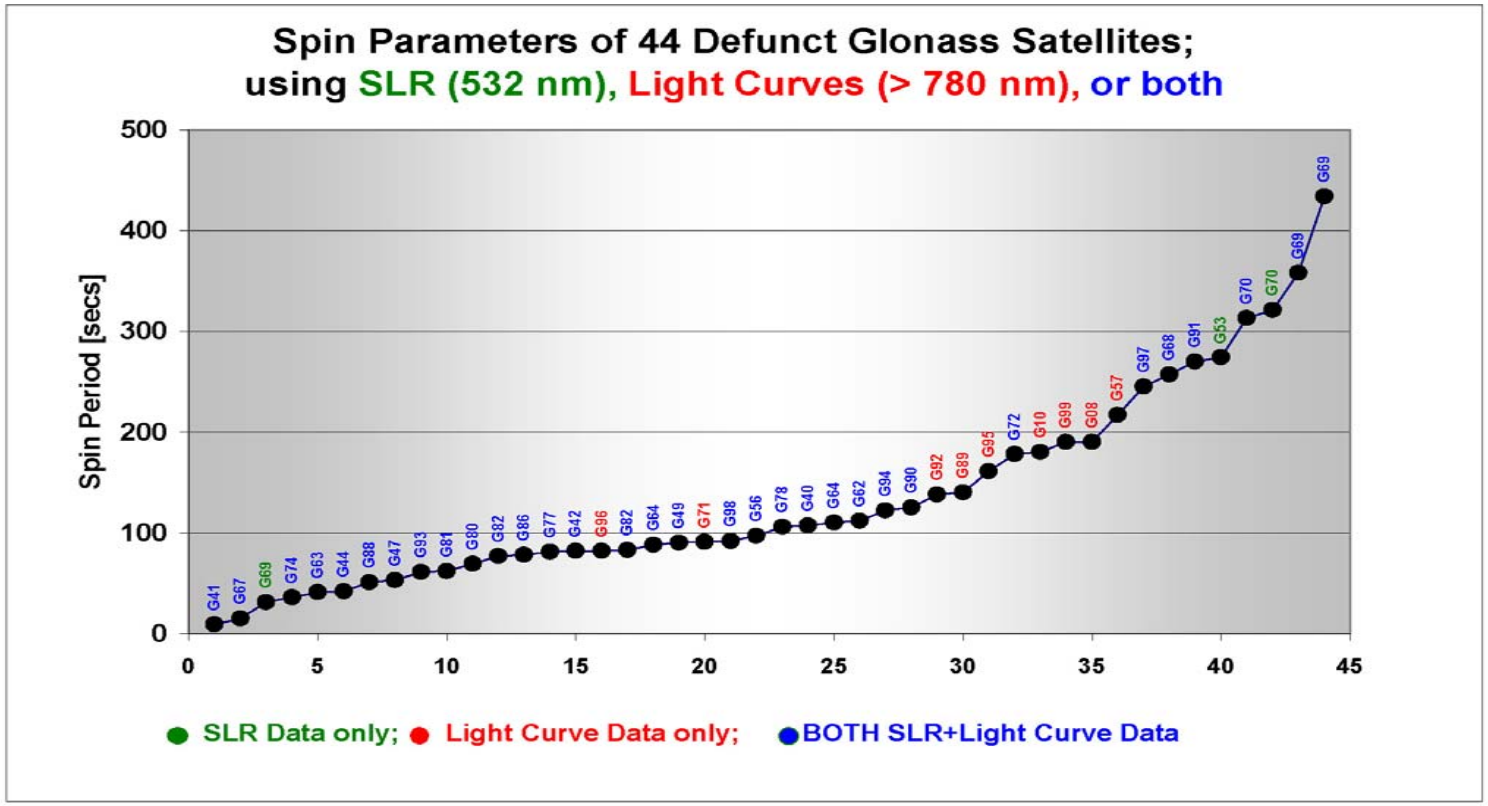
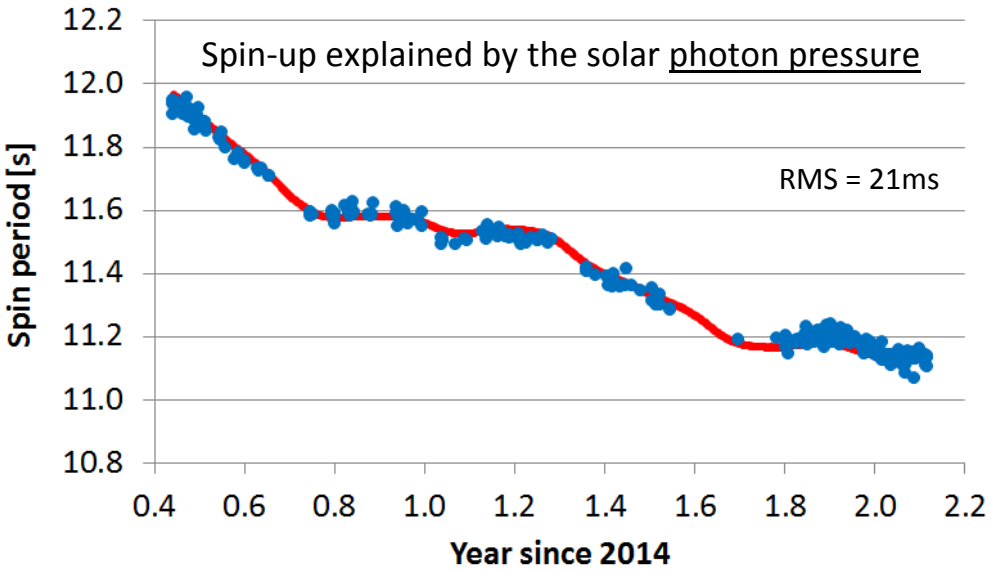
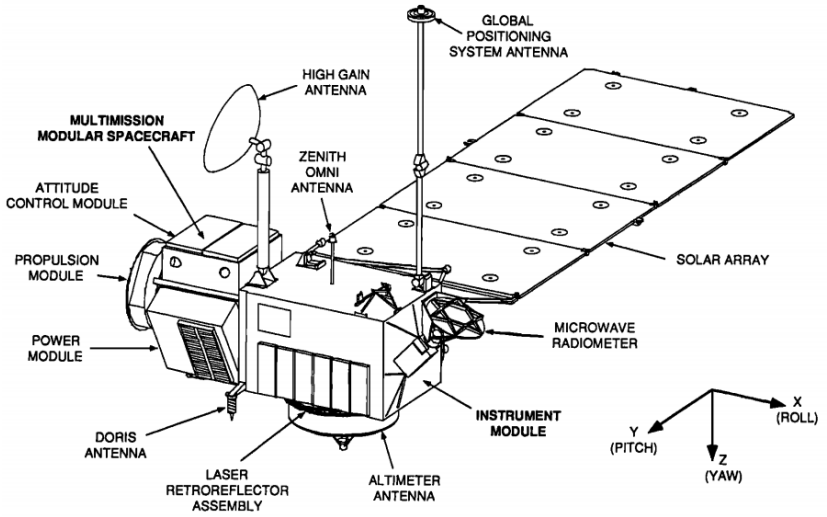
- Attitude Motion Determination Projects: ongoing



Spin of defunct TOPEX

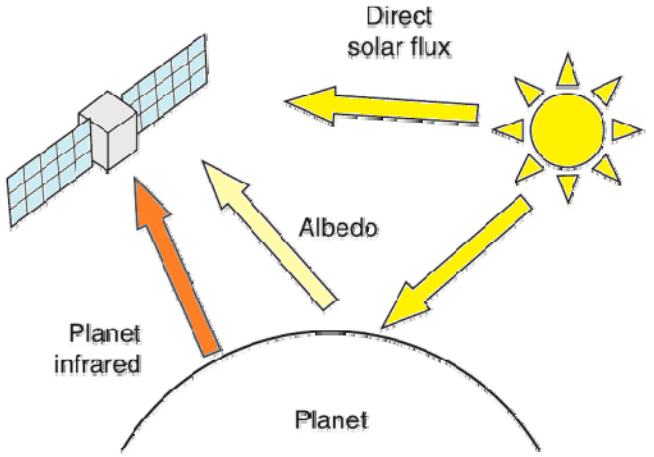




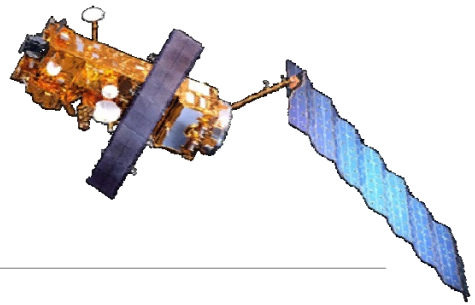
Solar photon pressure force

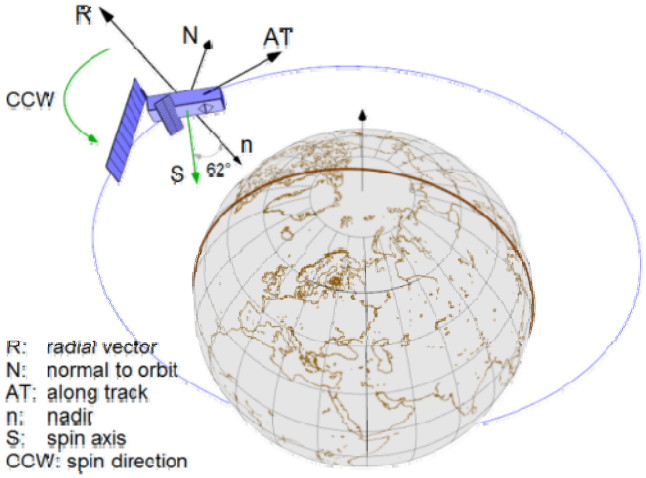
$$\overline{F} = \frac{I}{c}\sum_{i=0}^{n} A_i(\overline{u}\cdot\overline{n}_i)\left[2K_i^s(\overline{u}\cdot\overline{n}_i)\overline{n}_i + K_i^d\left(\overline{u}-\frac{2}{3}\overline{n}_i\right) + K_i^a\overline{u}\right]$$

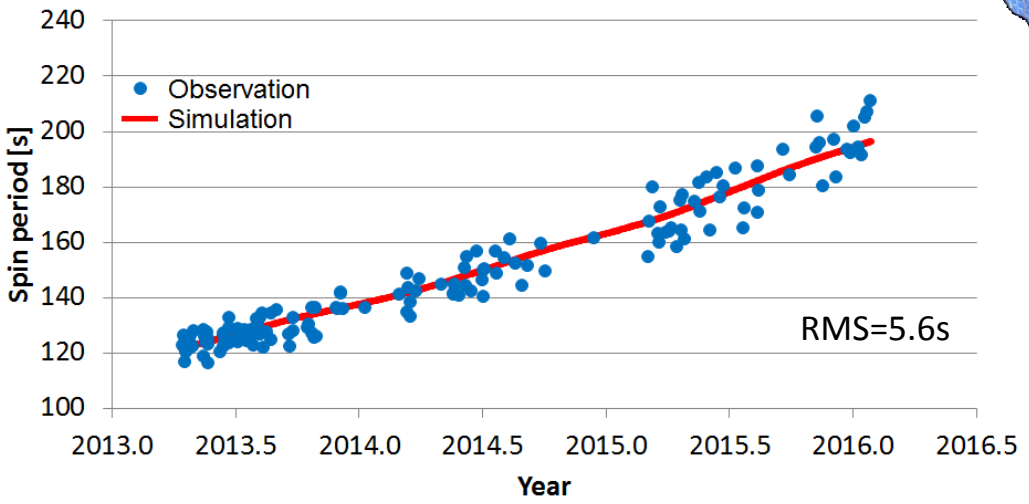
I: power of radiation flux
A_i: exposed surface area
$\overline{u}, \overline{n}_i$: direction of the incident flux and normal vector to the surface
K_i^s, K_i^d, K_i^a: coefficients of specular, diffused and absorbed portion of the received power



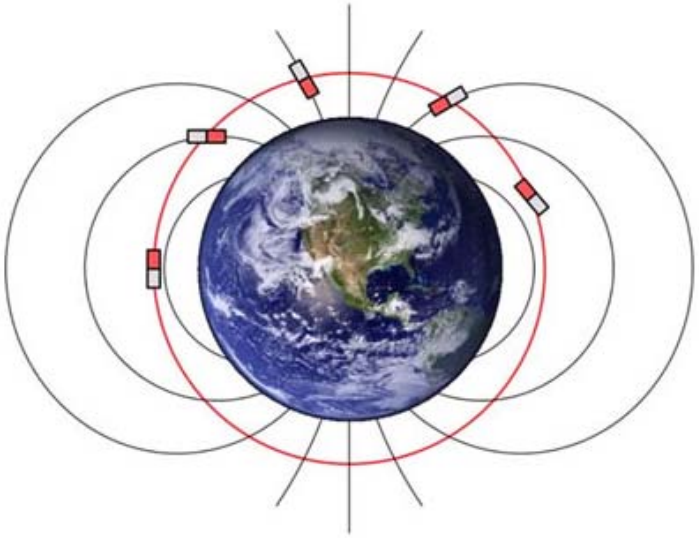
Spin of defunct Envisat







The spin period increases by 72 ms/day (doubles every 4 years)



M: magnetic torque
m: magnetic moment
B: magnetic field
K: interaction const.
ω: sat. spin vector

$$\overline{M} = \overline{m} \times \overline{B}$$

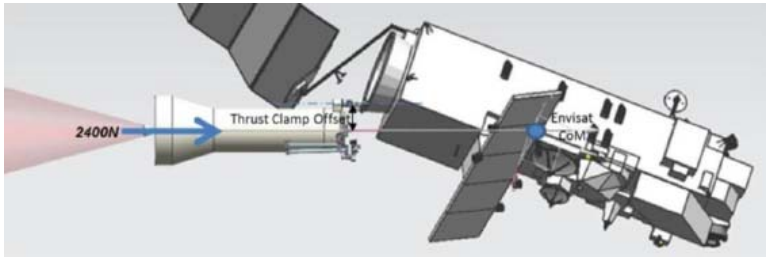
$$\overline{m} = K(\overline{\omega} \times \overline{B})$$

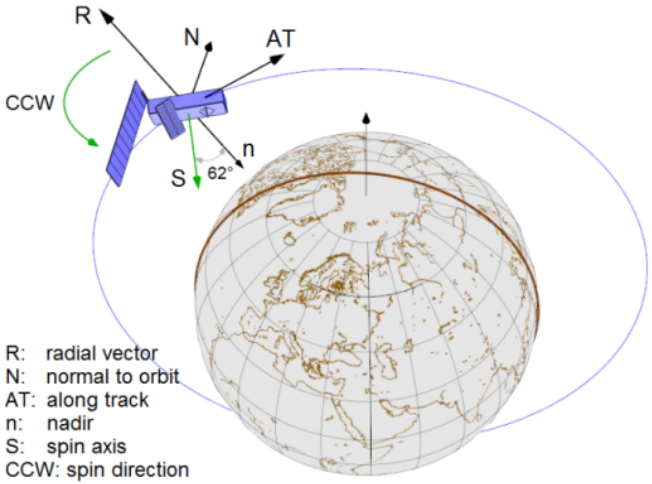
Attitude and spin period of space debris Envisat measured by Satellite Laser Ranging. IEEE TGRS, doi:10.1109/TGRS.2014.2316138 (Dec 2014)

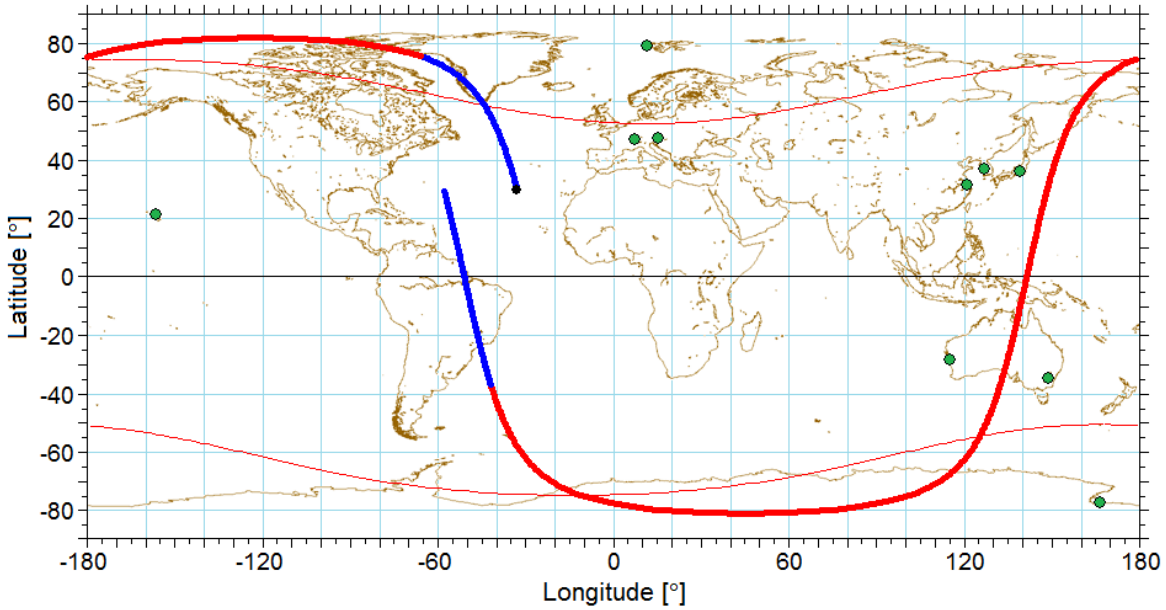
Envisat: laser de-spin simulation

The experience with the solar photon pressure modeling on Topex has been applied to investigate the possibility of using laser force to de-spin Envisat for the Active Debris Removal mission.

Robotic ADR mission possible with a stable object (e.Deorbit/ESA)





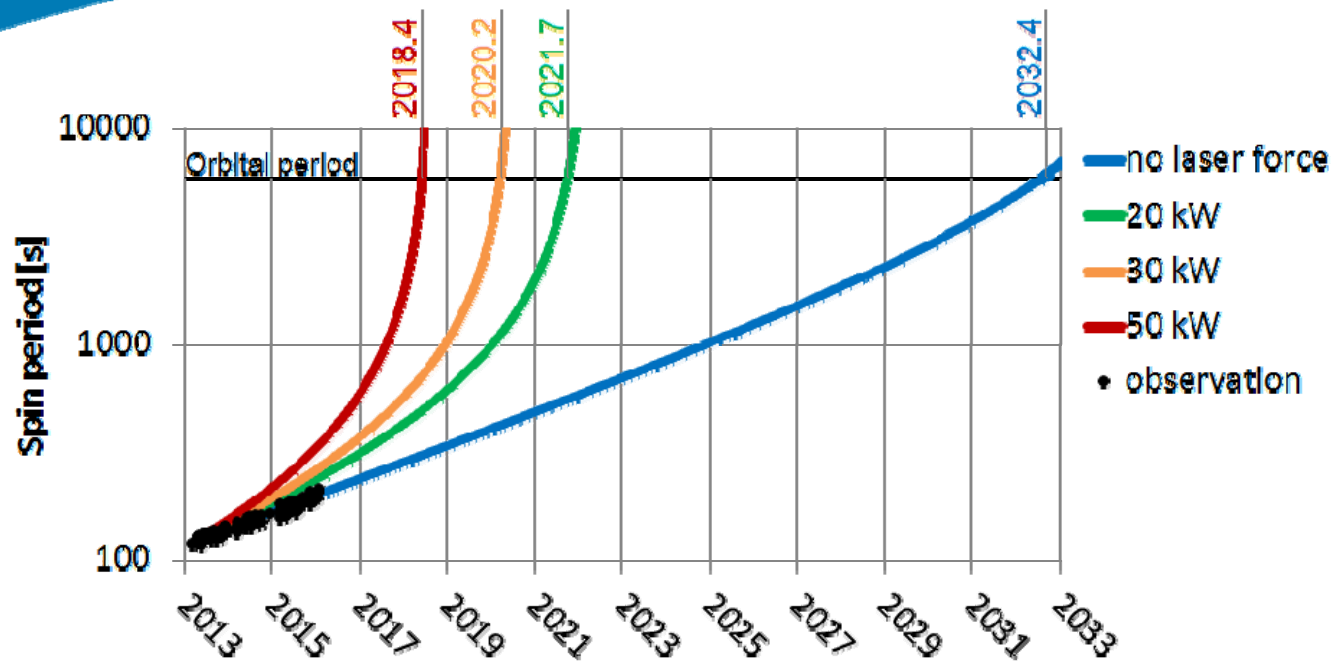


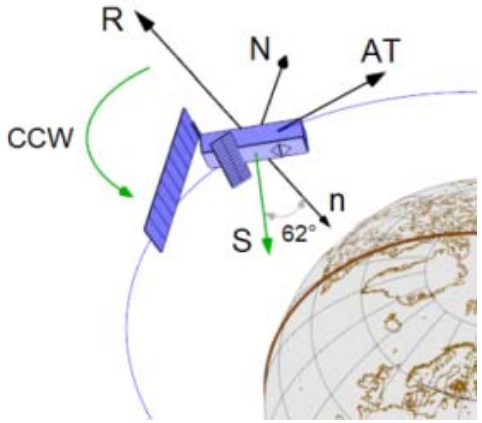
Hi-power laser systems:
1) Graz, AT
2) Haleakala, US
3) Mount Stromlo, AU
4) Sejong, KR
5) Shanghai, CN
6) Tokyo, JP
7) Yarragadee, AU
8) Zimmerwald, CH

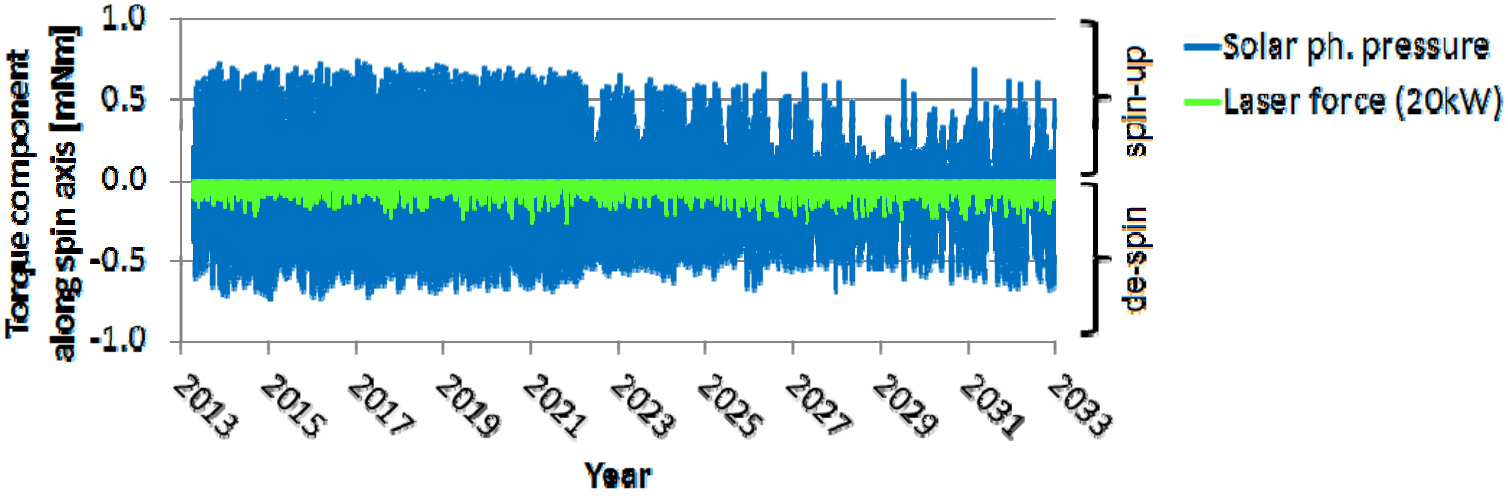
plus 2 polar systems:
9) Ny-Ålesund (Spitsbergen), NO
10) Antarctica (McMurdo, US)

Envisat: laser de-spin simulation

The laser photon pressure exerts torque on the space debris object, and can efficiently act against its spin.

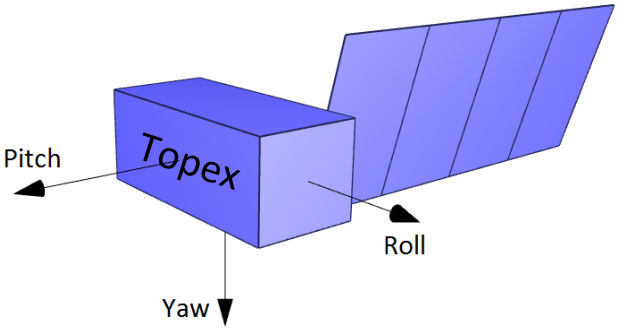


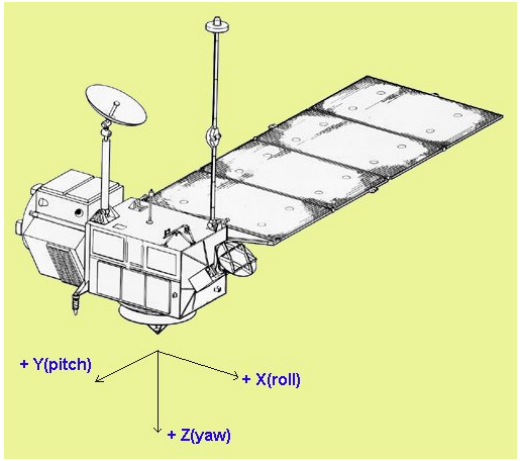


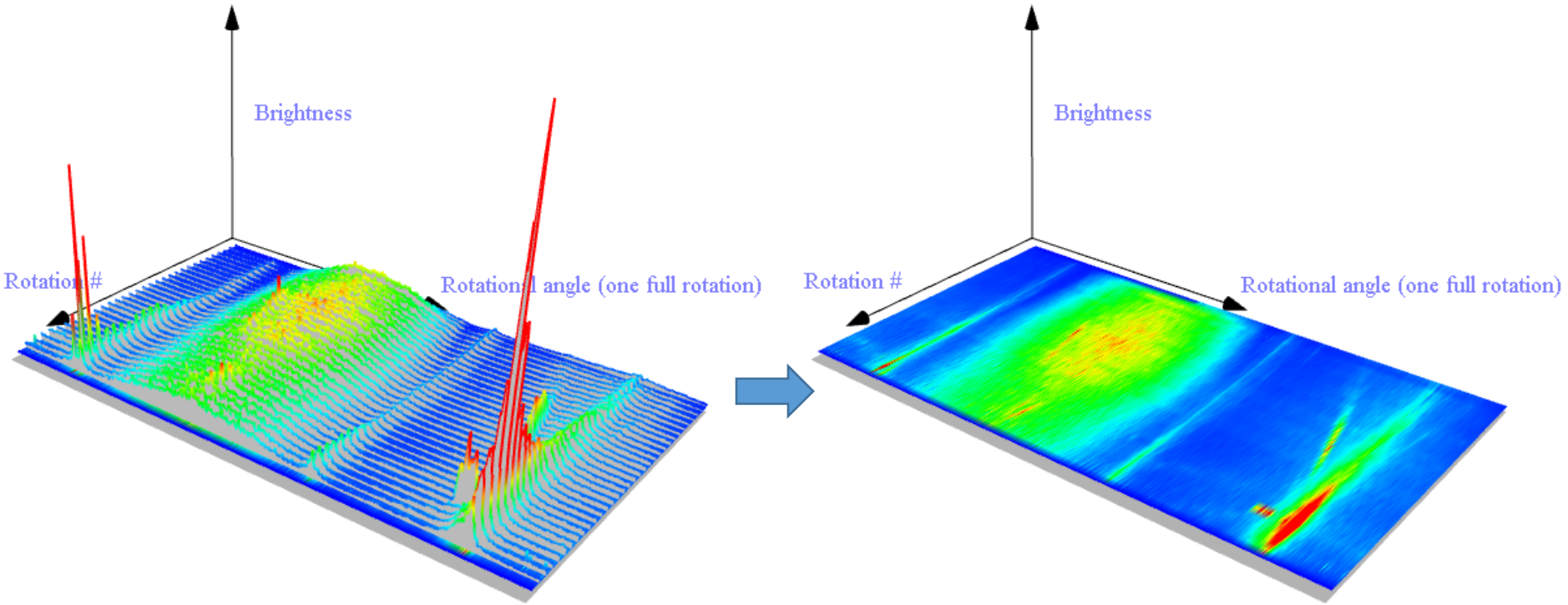


Adding new techniques: SP light curves (Graz)

Topex light curve, 3D representation
July 2015, sampling rate 100 Hz
spin period 11.3 s, 33 rotations (6:13)







Adding new techniques: SP light curves (Graz)

Topex light curve, 3D representation
March 2016, sampling rate 100 Hz
spin period 11.1 s, 57 rotations (10:33)