Session 1D: ILRS Network Procedures
b: impact of supporting other applications

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Outline

- Recently, the expertise/capability at many of the ILRS' geodetic observatories has become recognised by agencies and organisations outside the traditional geodetic communities;
- e.g., there are growing concerns and realisations at governmental level that their space assets need monitoring and protecting against potential collisions
  - and that those agencies also have an obligation to the public to be able to forecast re-entry events

SST

- This ‘Space Situational Awareness’ has led *for instance* to the EU deciding to offer significant funding to EU countries that wish to support the development of a joined-up approach to multi-technique observation and analysis,
  - under the name of Satellite Surveillance and Tracking (SST)
- Project is currently entering its second period of approximately 18months duration:

Example SGF Herstmonceux

- SGF is engaged in EU-SST activities as a tracking station:
- Using the SLR system both in ranging and in passive-astrometric mode (for LEO), along with a further astrometric sensor mainly for GEO.
- Part of a UK consortium, itself part of an EU five-nation consortium.

Stations’ experiences

- In this Session we want to hear from stations that are involved in SST or in other such initiatives:
- how do you manage time between these activities and the 'ILRS mission' activities;
- are you building new dedicated systems to cope with demand;
- are the new initiatives helping with potential funding issues

Herstmonceux (HERL) <-> Chilbolton (CASTR) link

Orbit determination

- A laser range analysis capability was instigated at the start of the technological development of the SLR (1980s)
- Several university groups collaborated with and benefited from the SGF work
- Continuous development of the code
- Now a competitive package at the core of the SGF ILRS Analysis Centre work
  - SATellite ANalysis package SATAN

The ‘SATAN’ package

- Numerical integration of satellite equations of motion (‘orbit’)
  - Gauss-Jackson 8th order integrator
- Parameter estimation by weighted least-squares (‘rgodyn’)
- Recent use in an investigation that corrects the scale of the ITRF derived from global geodetic laser observations*
- Code modified to use RADAR data from CASTR
- Code modified to use Az, Alt data from HERL
- Pressing requirement to determine orbits using directional, laser and RADAR observations
- Valuable QC for all data types is operational

* Appleby, Rodriguez, Altamimi, JoG, 2016

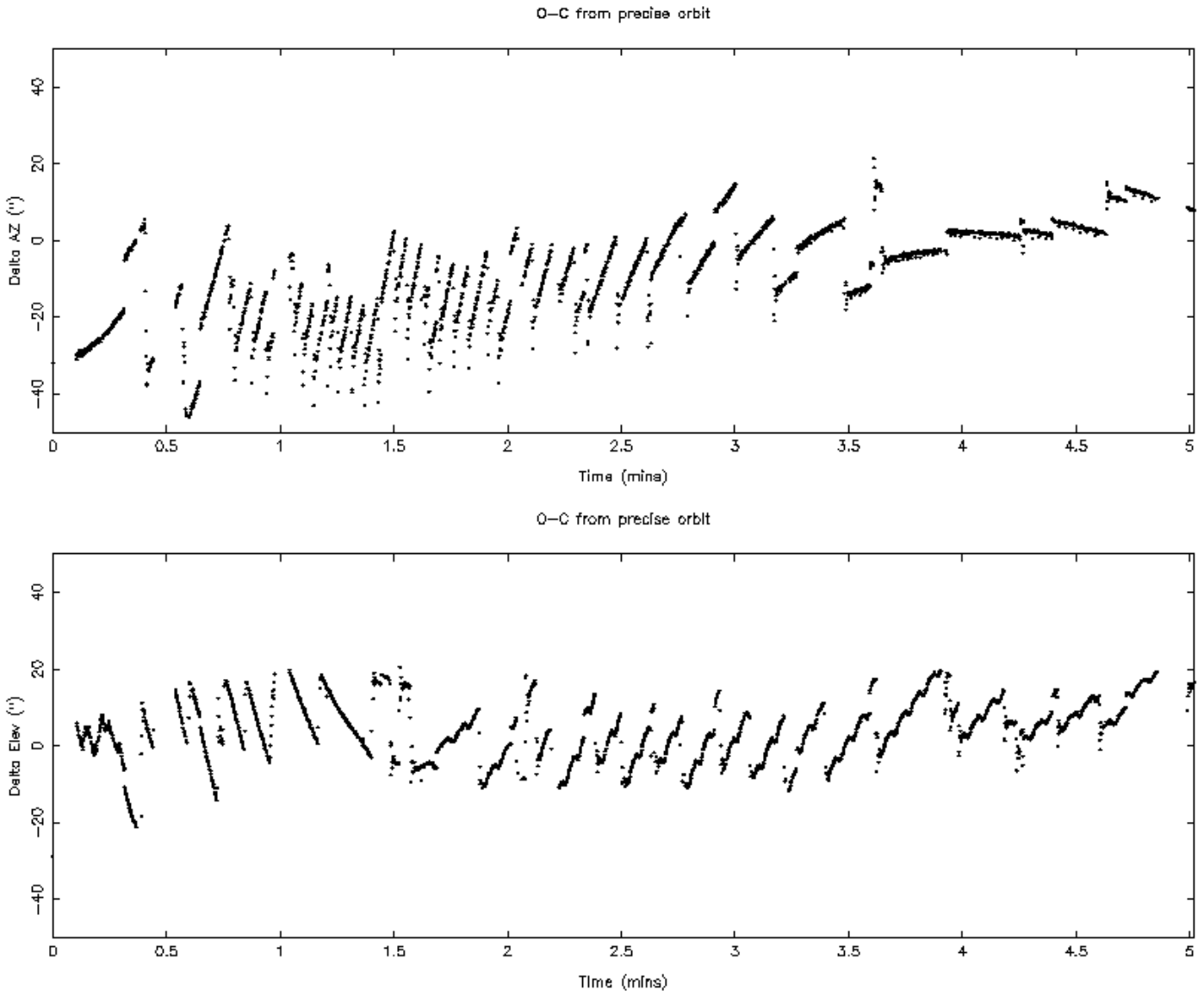
Use of observations of ENVISAT

- The now-defunct altimeter satellite Envisat is an ideal target for the HERL-CASTR cuing experiments
- Large RCS, optically bright, laser-tracked by the ILRS as a contribution to debris research
  - Possibility to derive precise laser-orbit (~2m) as ‘truth’
- Several passes secured by HERL in astrometry mode (Az, Alt) and by CASTR
- Some passes utilised visual tracking from HERL to cue CASTR
  - as discussed in previous talks

Precise orbit

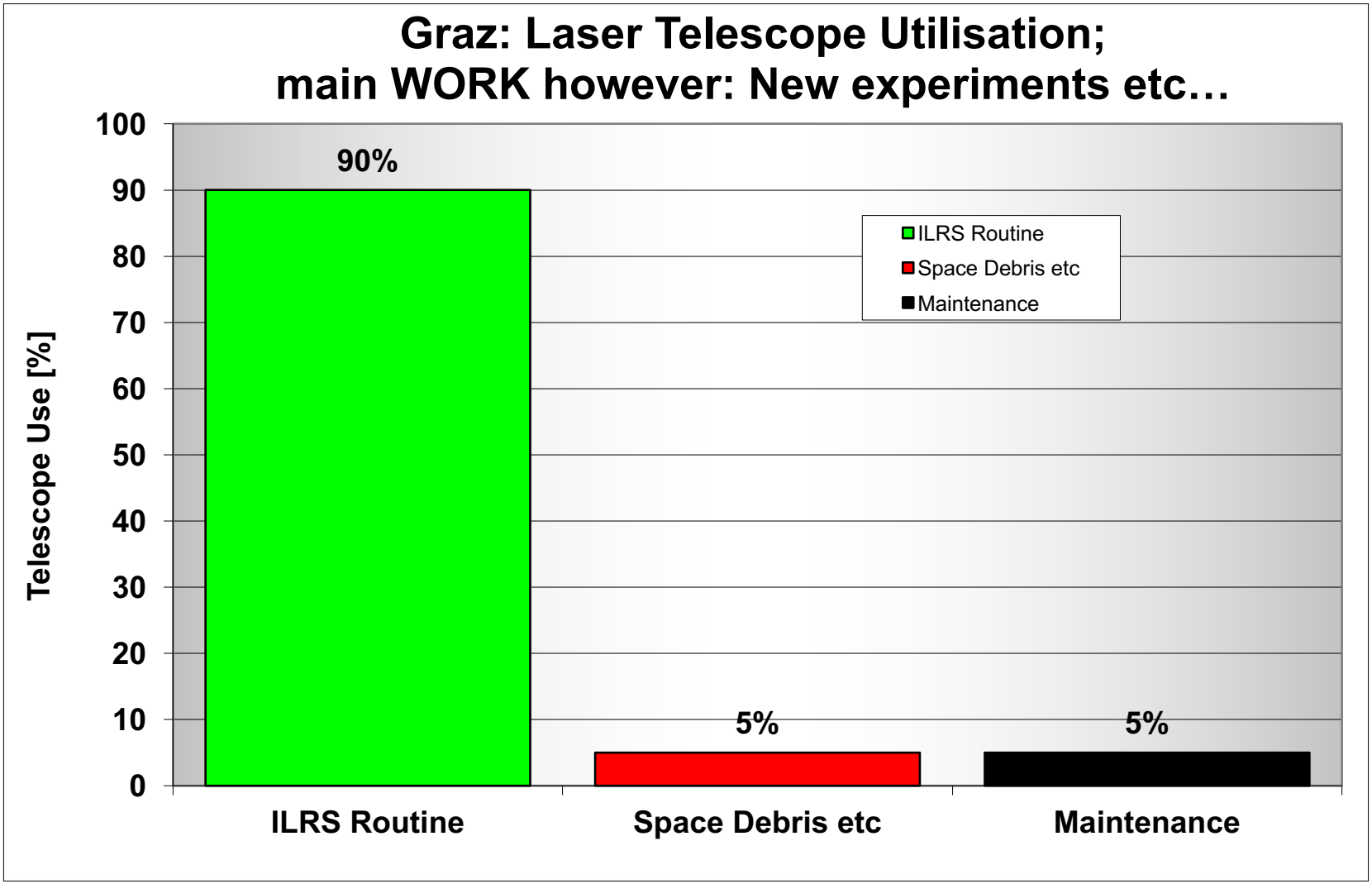
- ILRS laser range ‘normal points’:
- used to form a precise ephemeris by iteration of initial state vector, empirical along-track acceleration and solar radiation coefficient
- Typical 3-day arc post-fit RMS 2m
- Ephemeris in J2000 inertial frame, 1-min steps
- Can then be interpolated to instants of astrometric and RADAR observations
- Full topocentric ‘Computed’ position or range calculated, in the frame of the data, using known station coordinates;
- Light-time corrections, etc., applied

QC of Herstmonceux HERL astrometry – Envisat 2017 Apr 11



Deductions on HERL astrometry

- There are systematic trends in both the Azimuth and Elevation O-C values;
- the trends in the Azimuth values reflect the frequent offsets, primarily along-track, applied by the observer to account for the poor predictions (TLEs)
- Those in Elevation primarily result from a small encoder periodic signal that has yet to be modeled
- The observations have a scatter of ~20”, with little systematic offset from an overall zero mean


Graz: Laser Telescope Utilisation;
main WORK however: New experiments etc…
Telescope Use [%]
100
90
80
70
60
50
40
30
20
10
0
90%
5%
5%
ILRS Routine
Space Debris etc
Maintenance
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Space Debris etc
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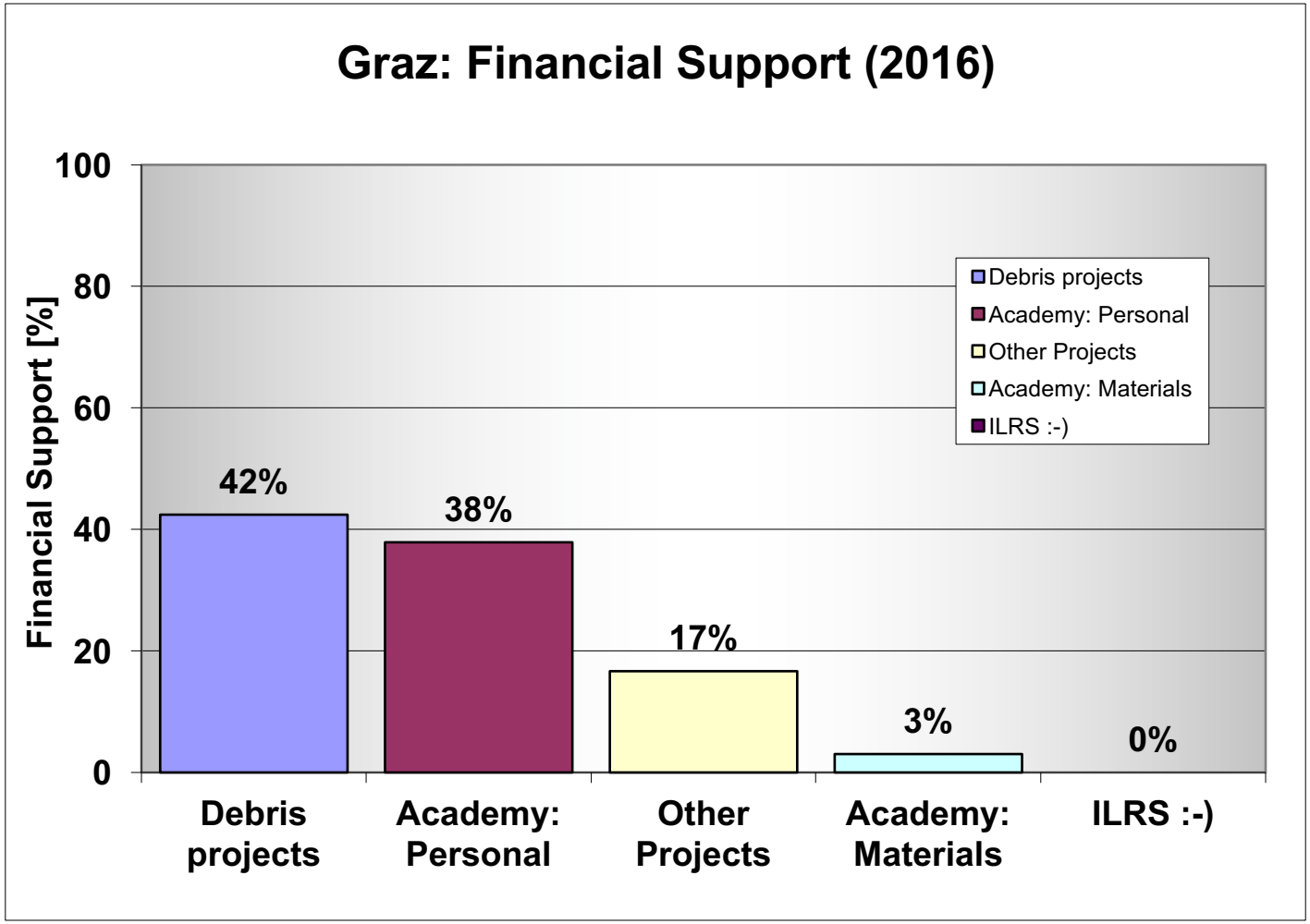
Graz: Financial Support (2016)
Financial Support [%]
100
80
60
40
20
0
42%
38%
17%
3%
0%
Debris projects
Academy: Personal
Other Projects
Academy: Materials
ILRS :-)
Debris projects
Academy: Personal
Other Projects
Academy: Materials
ILRS :-)

Upcoming problems: Mainly due to ‚bureaucratic terrorists' ☺

⇒ Night shifts most likely will have to be reduced

⇒ Students cannot work anymore by contracts => employments
⇒ … we expect a reduction of night passes by 50%
⇒ … weekend shifts most probably will have to be cancelled ☹

The positive side:

⇒ Several additional projects (mainly concerning space debris):
⇒ Better financing (hardware)
⇒ Space debris laser will be mounted permanently on telescope
⇒ This allows much more flexibility (ILRS targets / space debris)

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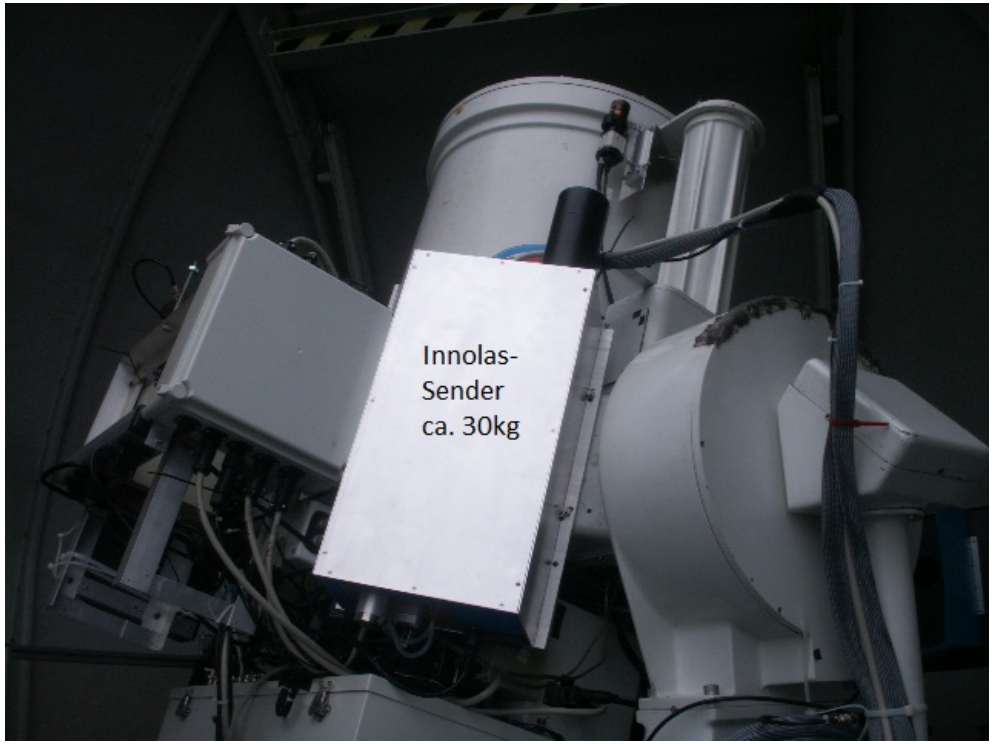

Space debris laser mounted on our telescope:
Operational: End of Oct 2017

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