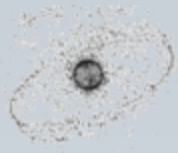# European Expert Centre for Space Safety Providing Services and Support for Space Surveillance and Traffic Management

T. Schildknecht,
P. Pessev, P. Patole, and J. Rodriguez

Astronomical Institute, University of Bern, Switzerland

T. Flohrer, B. Jilete, and E. Cordelli
ESA ESOC, Darmstadt, Germany

22nd International Workshop on Laser Ranging
7–311November, 2022, Yebes, Spain

Introduction

Expert Centre for Space Safety providing services and support for SST & STM

- Developed within ESA's Space Safety Program
- Hosted at the University of Bern, *AIUB*, Switzerland
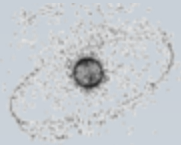
Observing:

- Passive optical
- Active optical (SLR)
- Active microwave (RADAR)

Addressing:

- ESA
- Sensor owner/operator
- SST/STM service providers
- …

Providing:

- Subject matter expertise
- Operational services
- Test services
- …

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Expert Centre Core Services
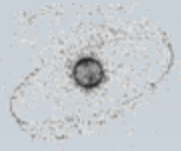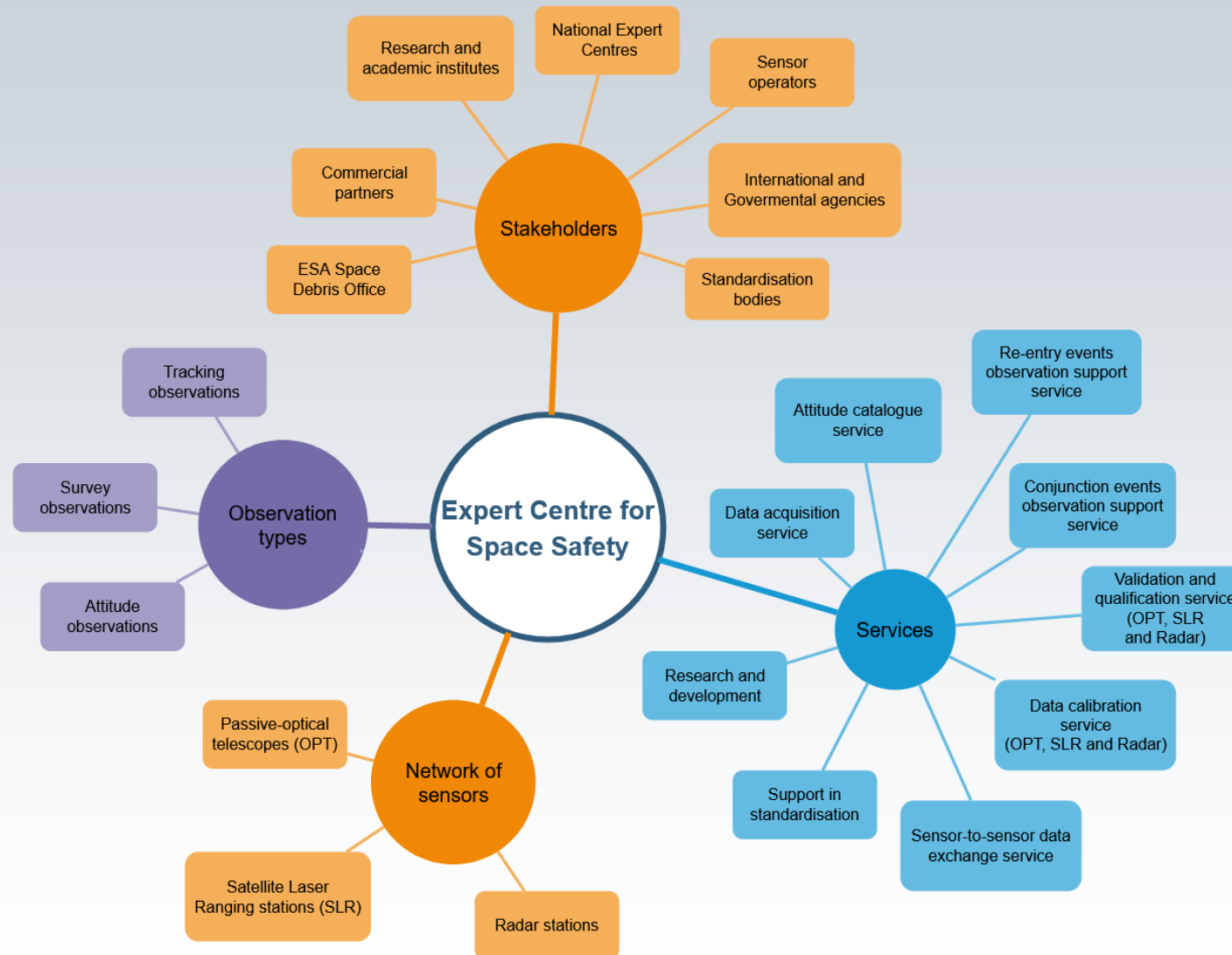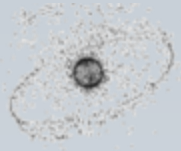
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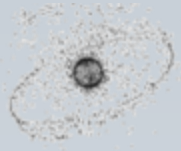Astronomical Institute University of Bern

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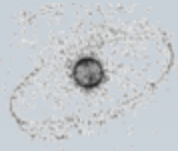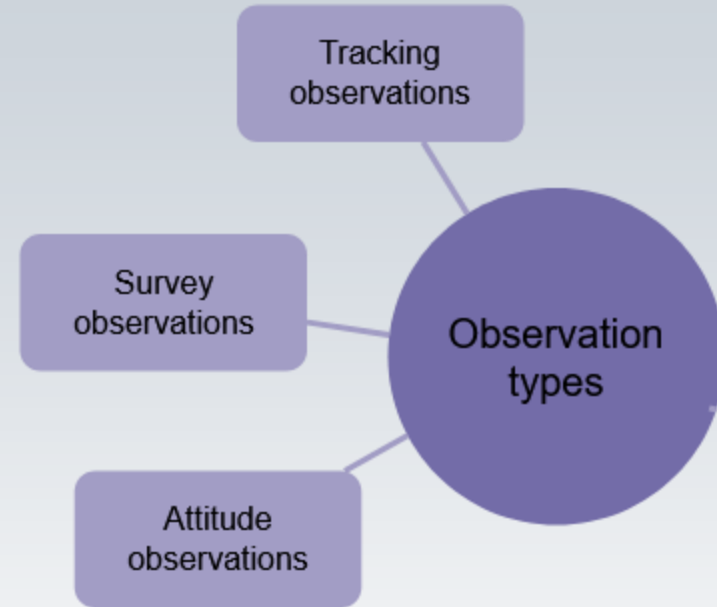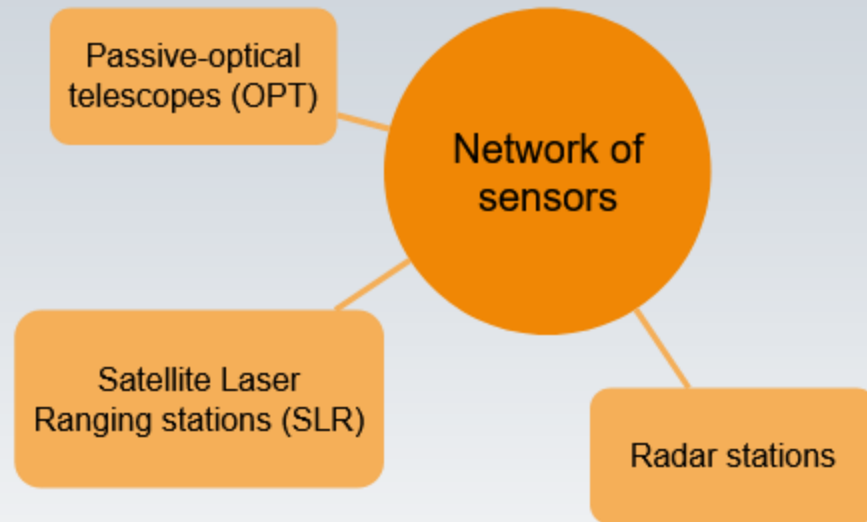
- **Service Level Agreements**
  - Unit prices
  - License model
  - KPIs

- **V & Q**
  - Tracking
  - Surveys
  - Characterization

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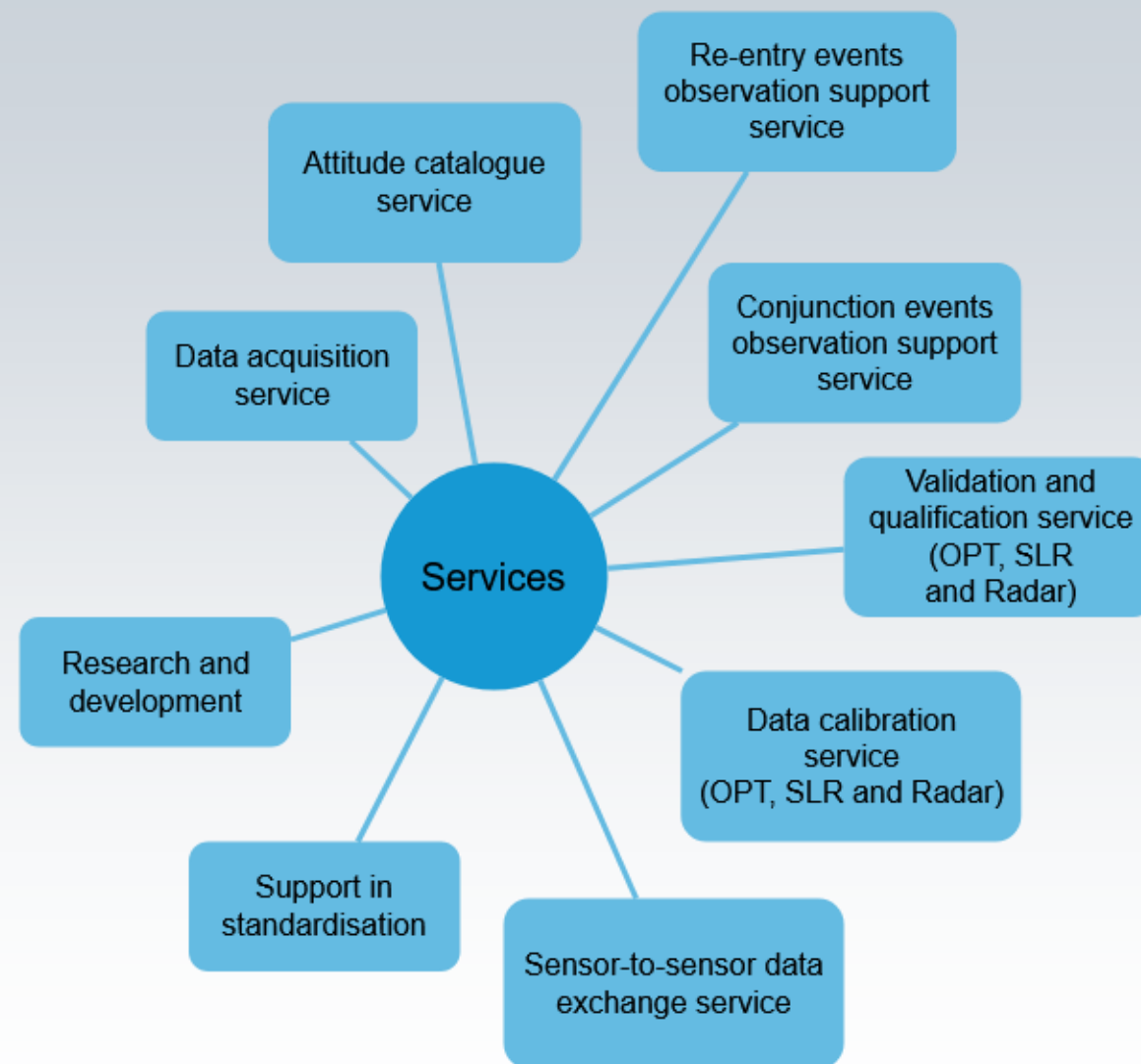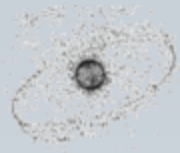
AIUB
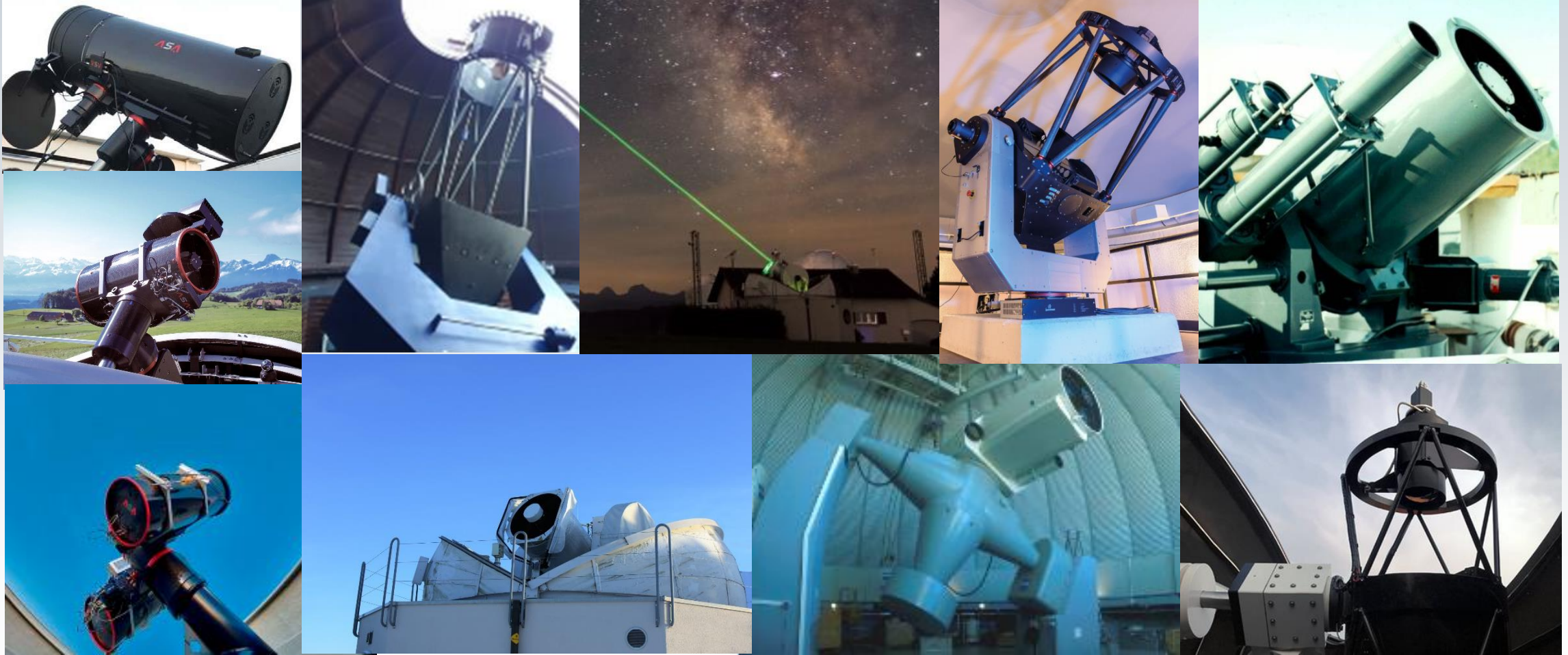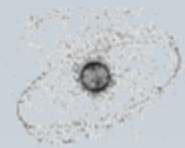
Single interface for user/customer

- Request
- Product delivery
- …

High–level user requests

- OD & OI for tasked object
- Customized surveys
- Attitude estimation
- Astrometry/photometry
- …

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Service Example: Sensor V & Q

AIM:
Certify that a sensor can *reliably* provide data respecting defined *quality* criteria

1. ## Validation

   - **Establish the communication interfaces I/O**
   - **Sensor is able to provide tracking data of the tasked objects**
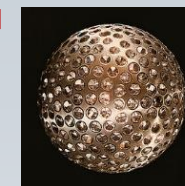   - **Validate formats**

2. ## Qualification

   - **3 full observation nights (passive optical)/radar session**
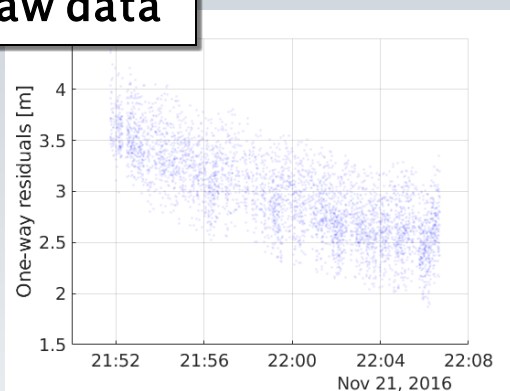   - **12 calibration objects and 4 program objects (calibration objects: e.g. ILRS objects with fiducial orbits)**

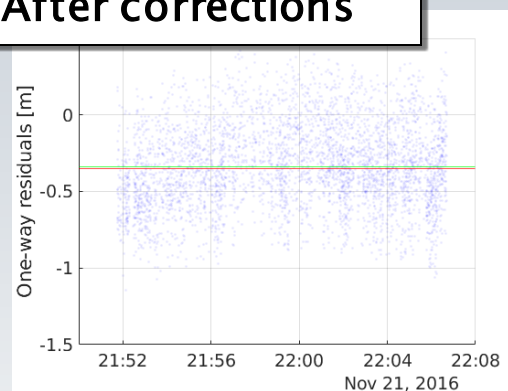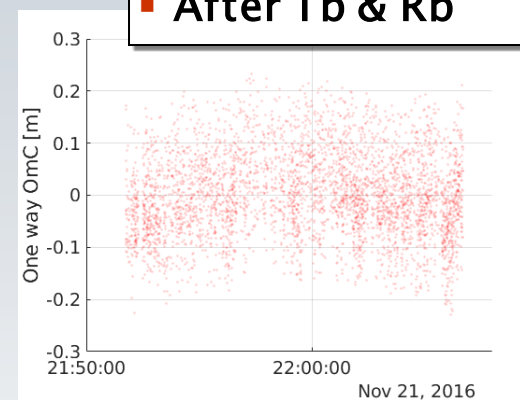Astronomical Institute University of Bern

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Data Validation Example
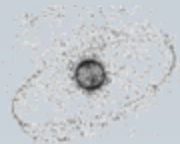
- **Raw data**

- **After corrections**

- **After Tb & Rb**

- **Measurement Quality**
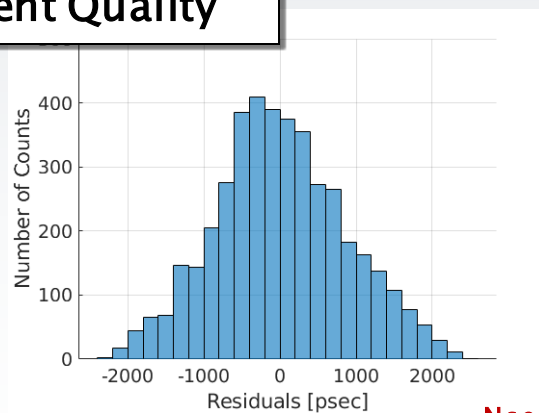
- **Signal characterization**

N sec − > pulse width

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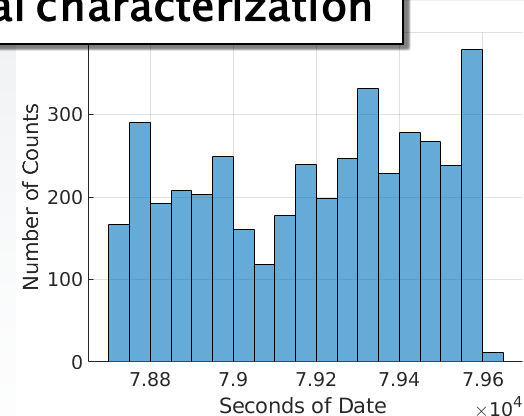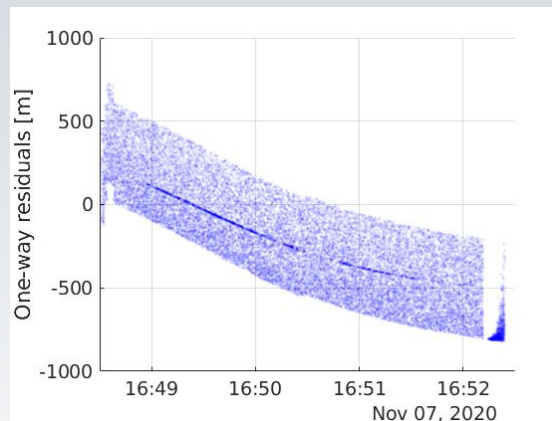
Data Qualification Example
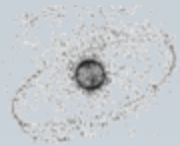
Rocket body
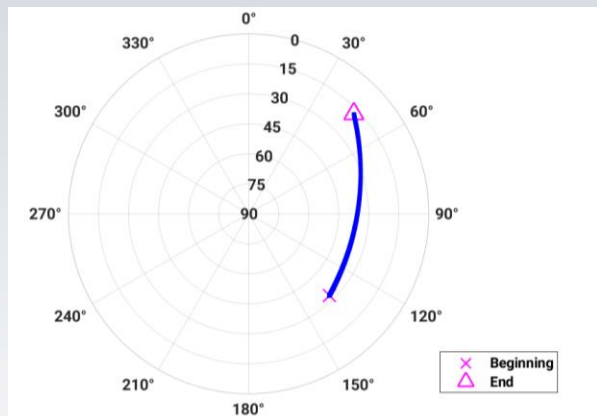
- Relative geometry

- Raw data

- After Tb & Rb

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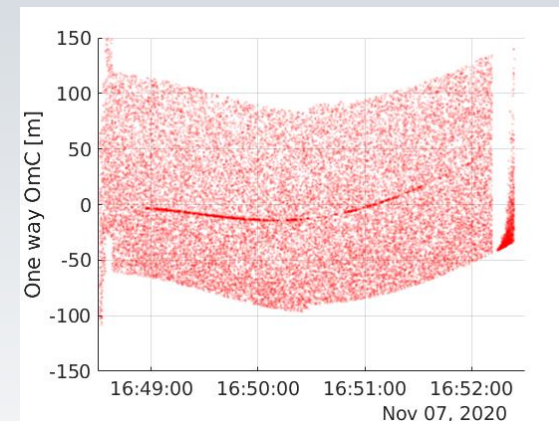
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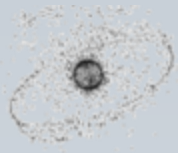
Example KPI for Sensor Qualification

- **Examples of KPI for SLR sensors**

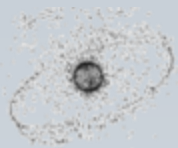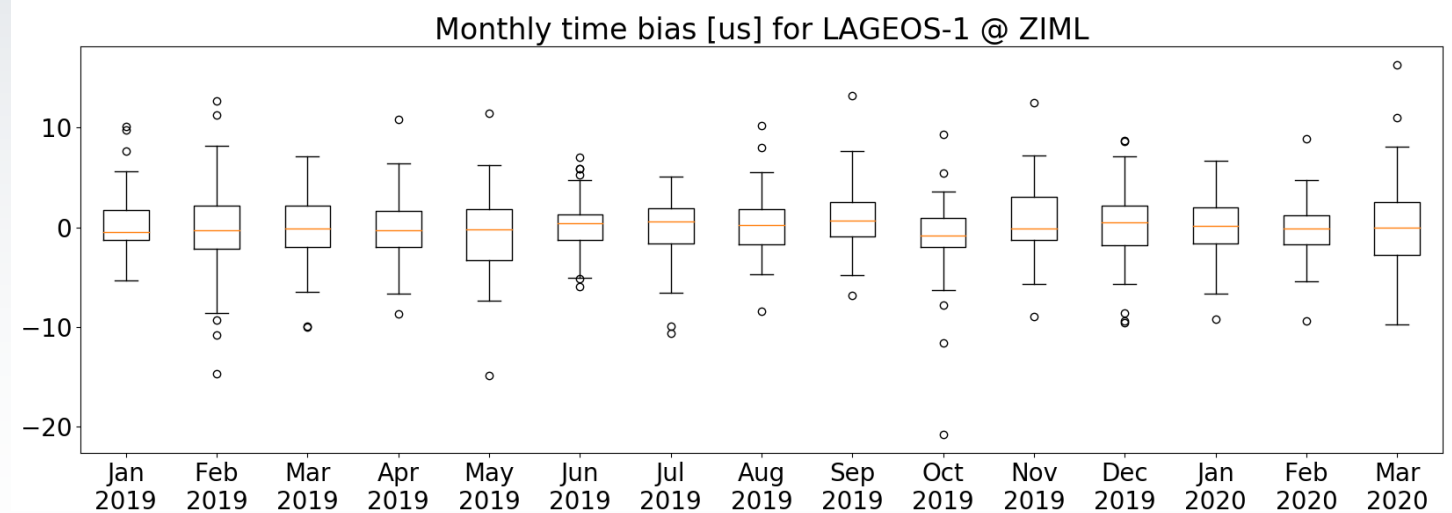|	
Efficiency (%)	Objects successfully tracked and processed / Total # tasked objects
Time Bias (usec)	Estimated from single passes using observations to fiducial ILRS targets (next talk)
Range Bias (mm)	Estimated together with the Time Bias (next talk)
Number of Normal Points & RMS	Total number of normal points after detection, detrending and screening procedures
SNR per Normal Point	Ratio between returns classified as signal compared to the ones classified by noise / NP/ target

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Example KPI for SLR Sensor Qualification

Monthly range bias [mm] for LAGEOS-1 @ ZIML

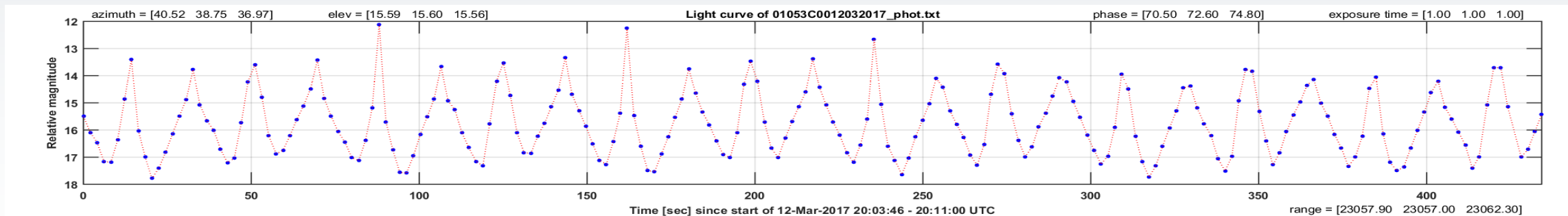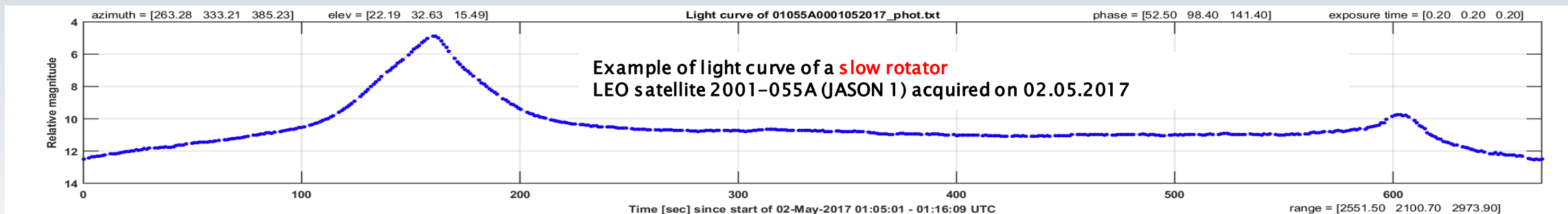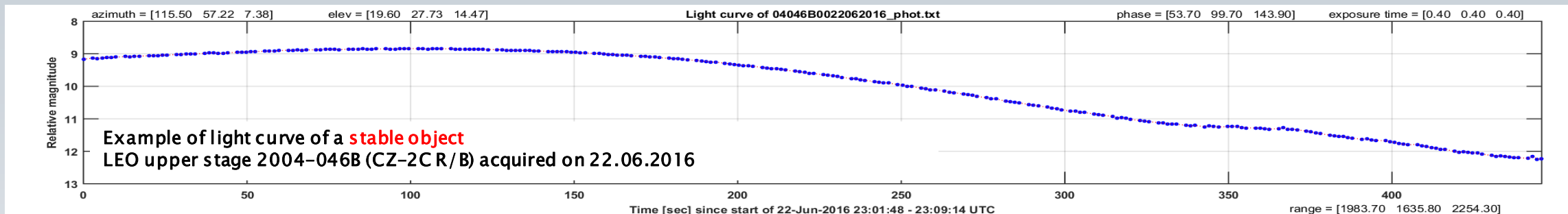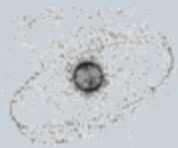Monthly time bias [us] for LAGEOS-1 @ ZIML
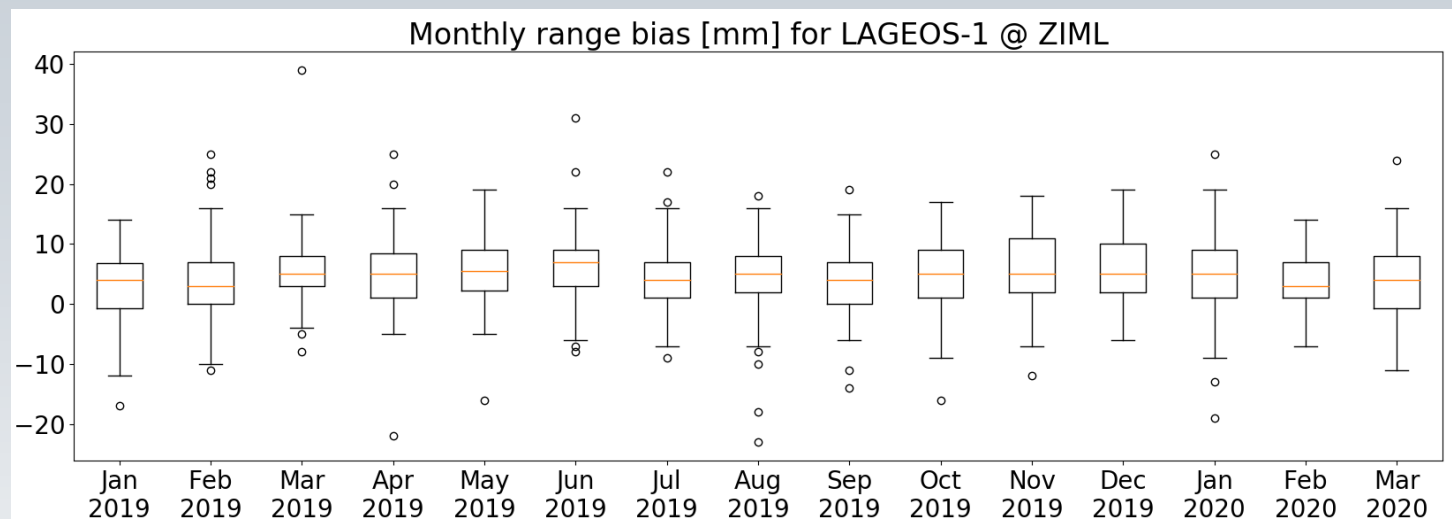
- ▪ **Single passes only**
- ▪ **Outliers due to few normal points or poor relative geometry/length of observed pass**
- ▪ **Analysis of KPIs over time**
- ▪ **Stability & magnitude of KPIs → reliability & quality**

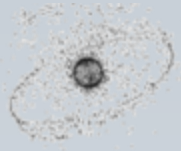Astronomical Institute University of Bern

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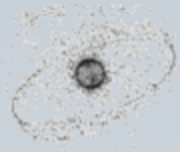
Attitude Information Service

- Maintenance of attitude information catalogue

- Planning, scheduling, acquisition, and processing of the basic observation (light curves, SLR, …)

- Automated attitude type characterization ("stabilized", "slow rotator", "fast rotator")
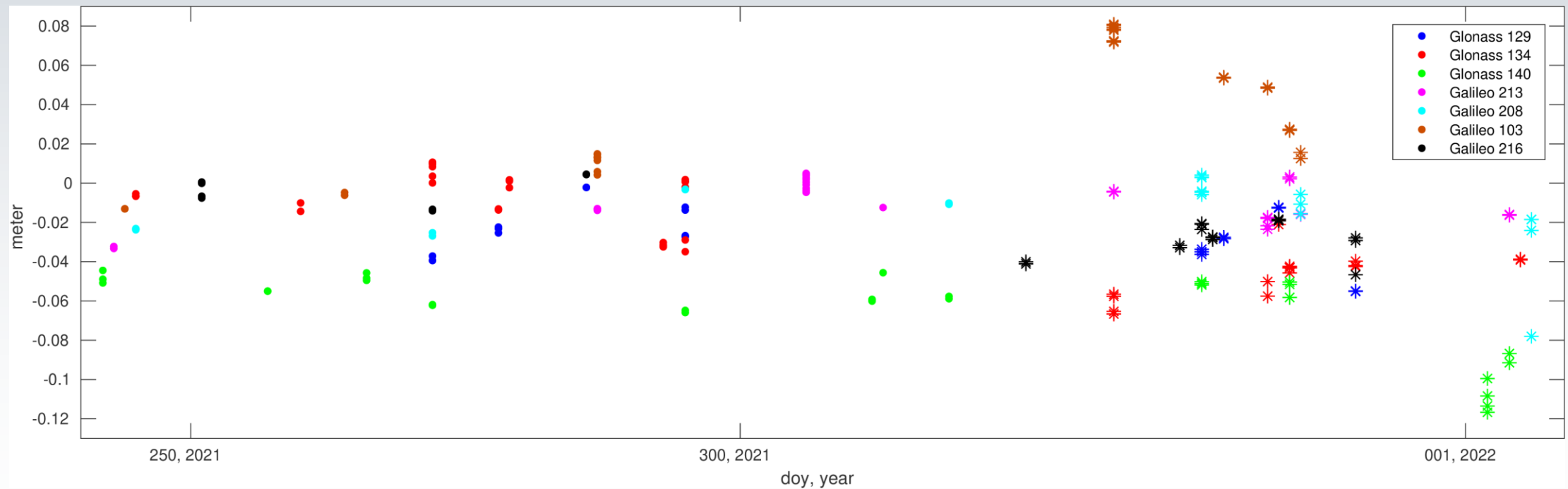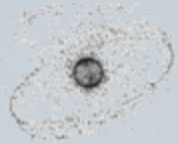
- Estimation of rotation/tumbling rates

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Type of Light Curves

Example of light curve of a **stable object**
LEO upper stage 2004-046B (CZ-2C R/B) acquired on 22.06.2016

Example of light curve of a **slow rotator**
LEO satellite 2001-055A (JASON 1) acquired on 02.05.2017

Example of light curve of a **rotator**
GLONASS satellite 2001-053C (COSMOS 2380) acquired on 12.03.2017

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Example

- **Validation of IZN–1 observations (Experts, Bernese s/w)**
(CODE MGEX satellite orbits, …)

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discrimination of laser returns
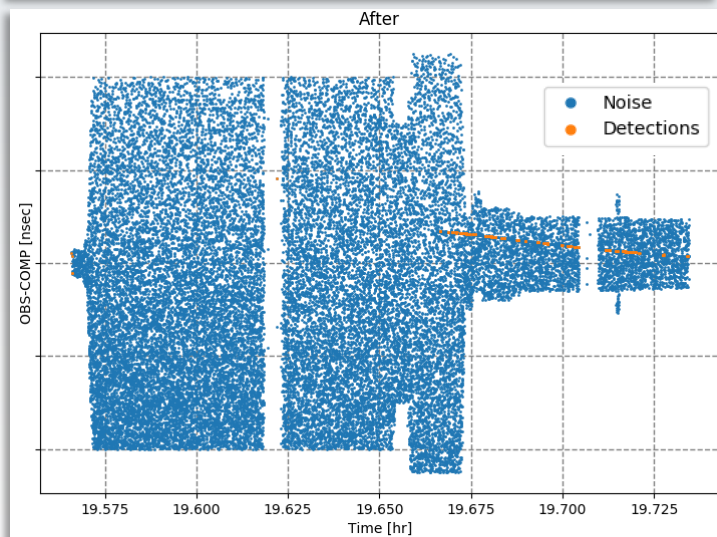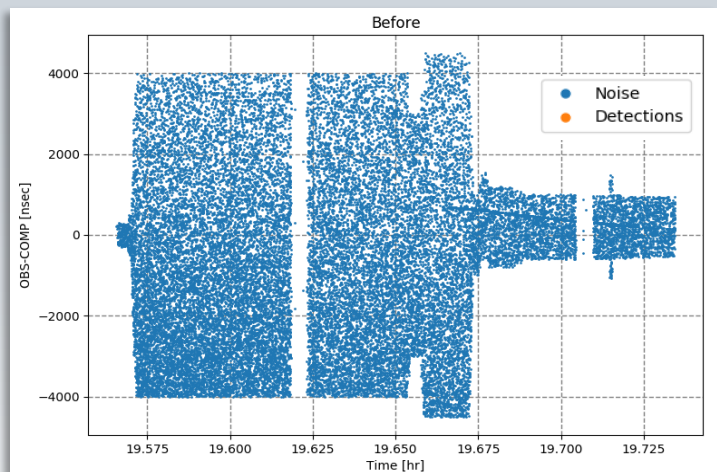
Data Fusion

ENVISAT

SLR range residuals

light curve

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Slide 17

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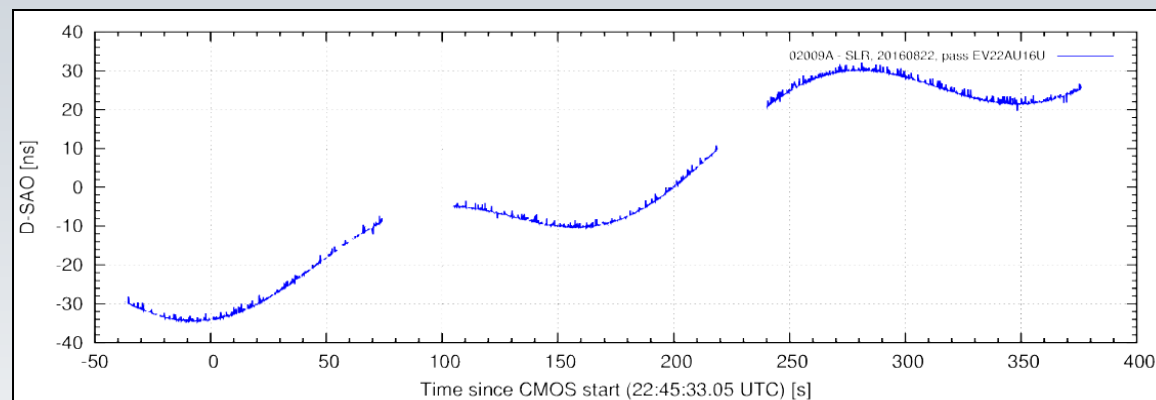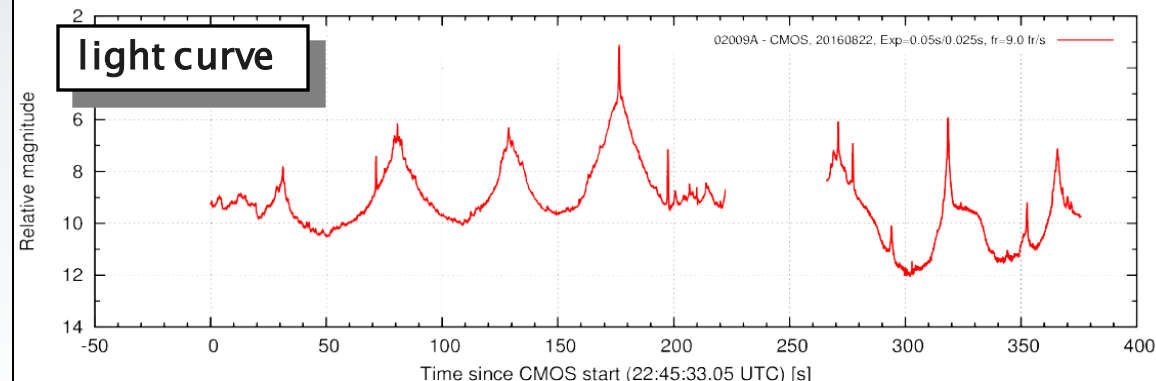
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Take Home

The ESA/AIUB ExpCen for Space Safety
provides a multitude of services in support of SST and STM:

- Sensors: passive optical, debris SLR, tracking radar

- Coordination of observation campaigns for customers

- Qualification of sensors

- Attitude information service

- Subject matter expertise

- …

Thank you for your time!