

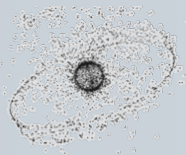


ESA Space Safety Expert Centre Sensor Validation and Qualification Service

T. Schildknecht

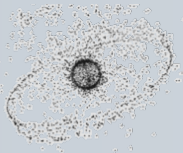
*Astronomical Institute, University of Bern,
Switzerland*

*42nd IADC Annual Meeting,
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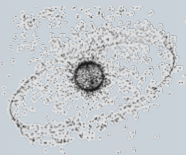
Introduction

- **ExpCen**: Expert Centre for Space Safety providing services and support for SST and STM
 - Developed within ESA's Space Safety Programme
 - Hosted at the University of Bern AIUB, Switzerland
- **Covering** variety of sensor/observation types
 - passive optical
 - active optical (SLR)
 - radar
- **Providing**
 - subject matter expertise
 - operational services
 - test services
- **Customers**
 - ESA
 - sensor owner/operator
 - SST/STM service providers

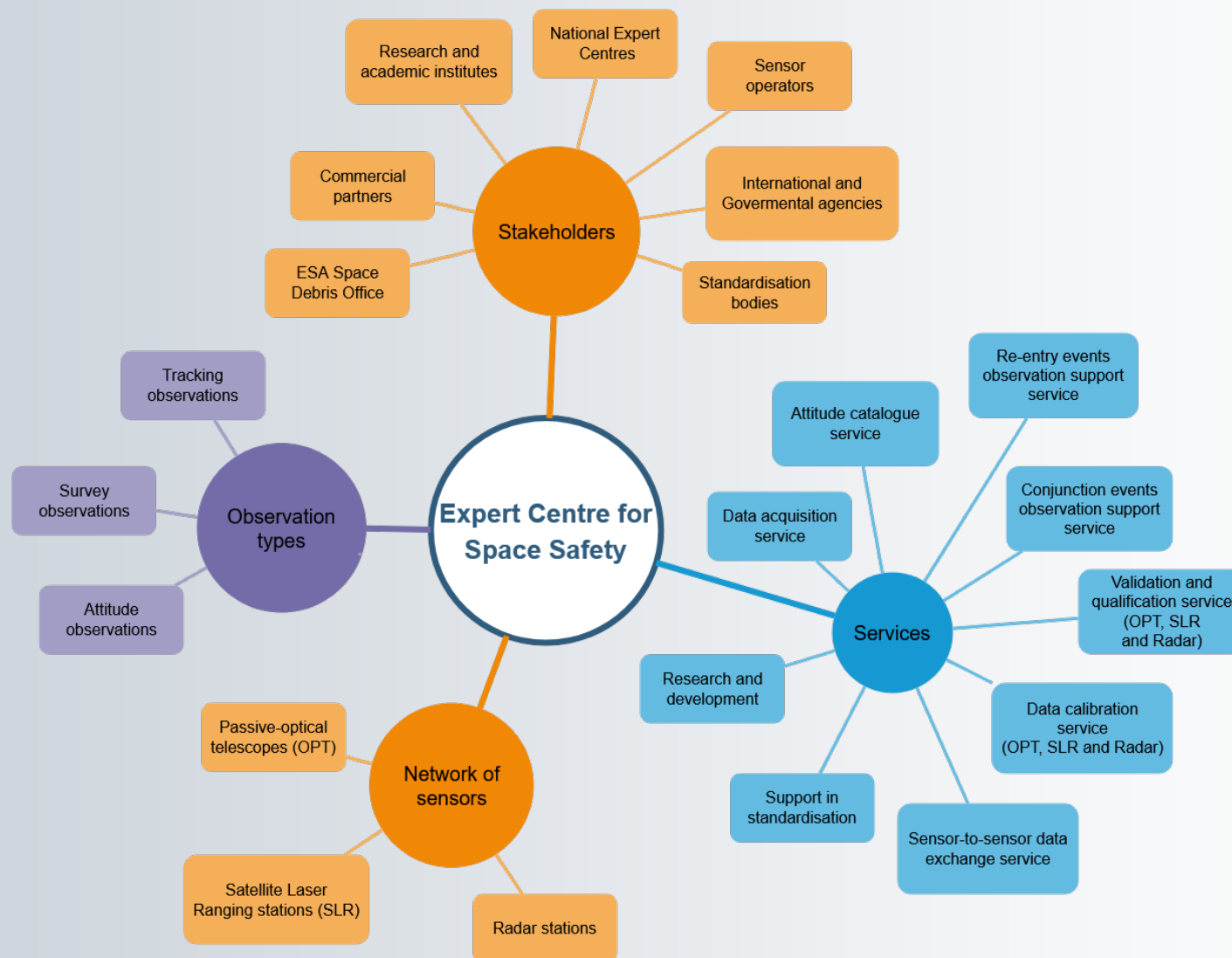


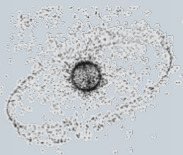
Space Safety Expert Centre Core Services





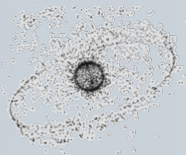
Space Safety Expert Centre Architecture



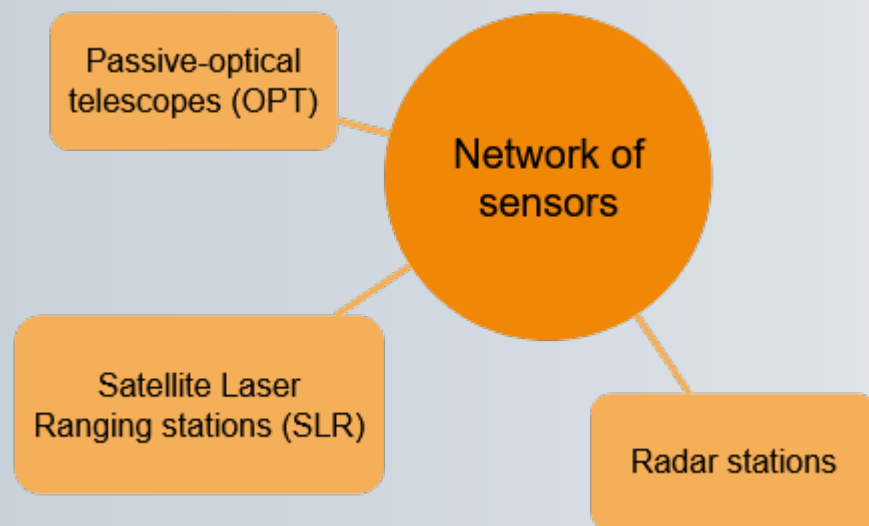


Space Safety Expert Centre Stakeholders/Users



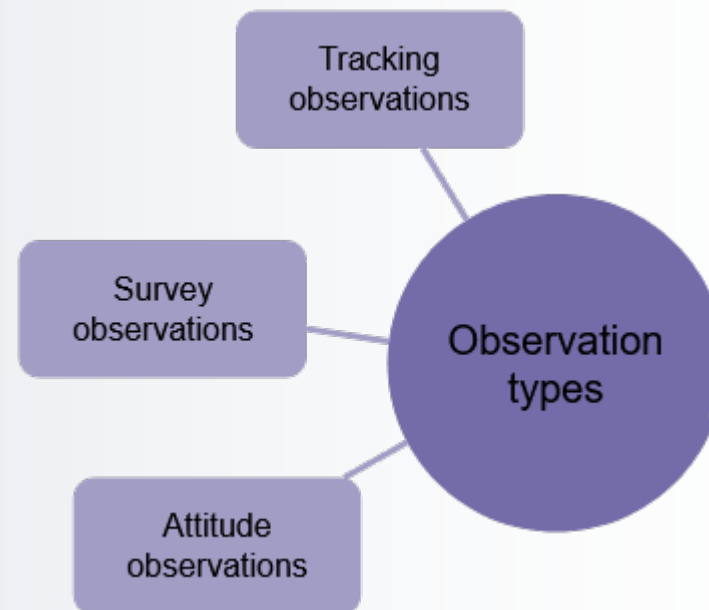


Expert Centre Network & Observation Types



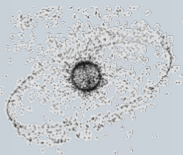
- **Service Level Agreements**

- Unit prices
- License model
- KPIs



- **V & Q**

- Tracking
- Surveys
- Characterization



Sensor Validation and Qualification Service

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

Observation Types

- optical tracking
- optical surveys
- optical light curves
- SLR ranging

Validation

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

Orbital regimes

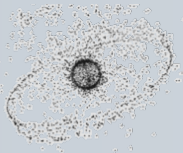
- LEO
- MEO
- GEO/HEO

Qualification

- Observation campaign (few nights)
- Assessment according to Key Performance Indices (KPIs)

ExpCen Qualification Certificate

- observation type(s)
- orbital regime(s)
- sensor specific quality figures



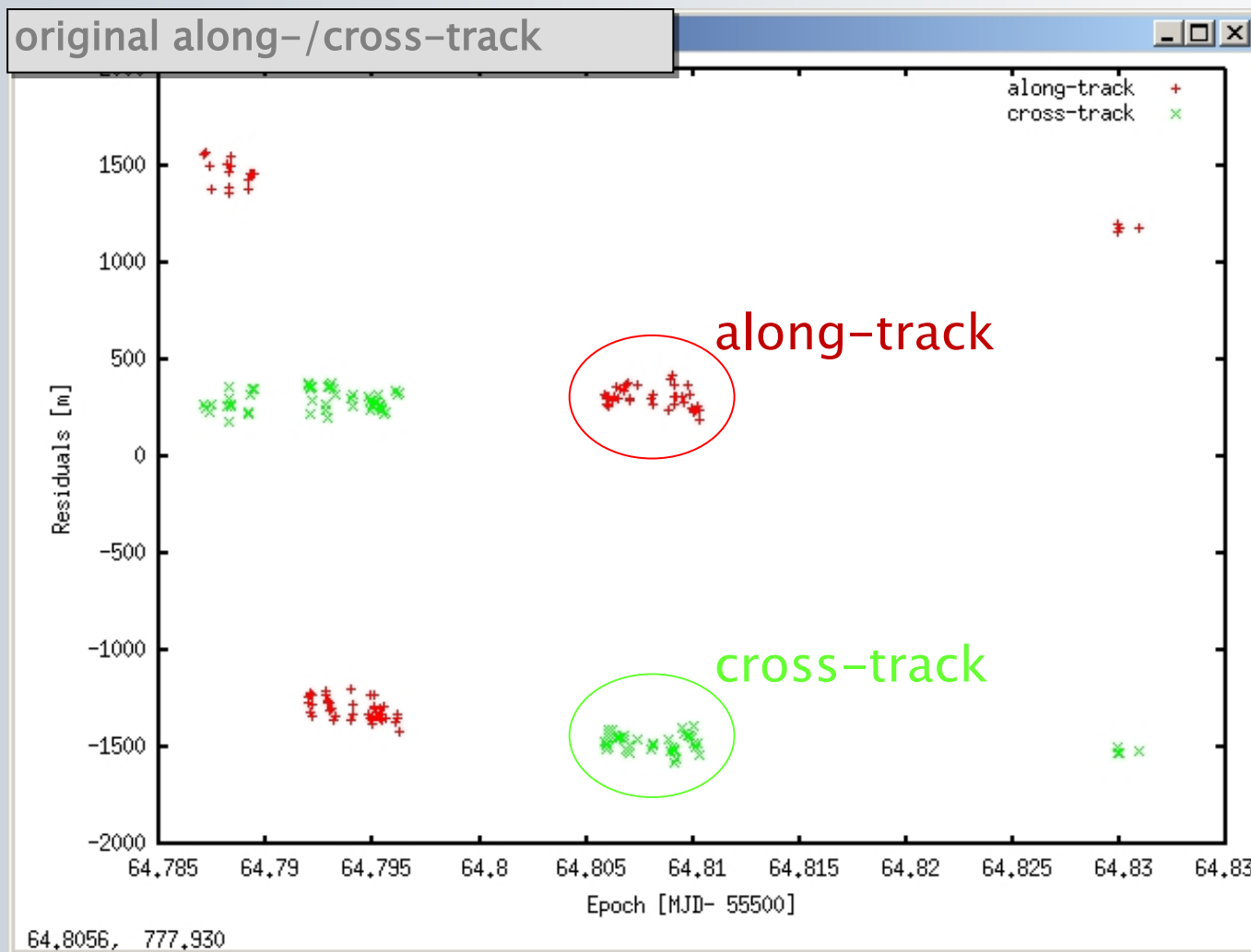
Example KPI for Sensor Qualification

- KPI for tracking observations of passive optical sensors

Efficiency	percentage of objects successfully tracked and processed with respect to tasked objects
Epoch offset	epoch offset w.r.t. UTC as derived from processing the calibration objects (GNSS s/c)
Epoch offset stability	stability of the epoch offset within one night and from night to night
Astrometric accuracy (after time bias correction)	astrometric accuracy as derived from processing the calibration objects (GNSS s/c)
Miss-correlation	observations which do not belong to the tasked object

Data Validation Examples

Residuals [m]

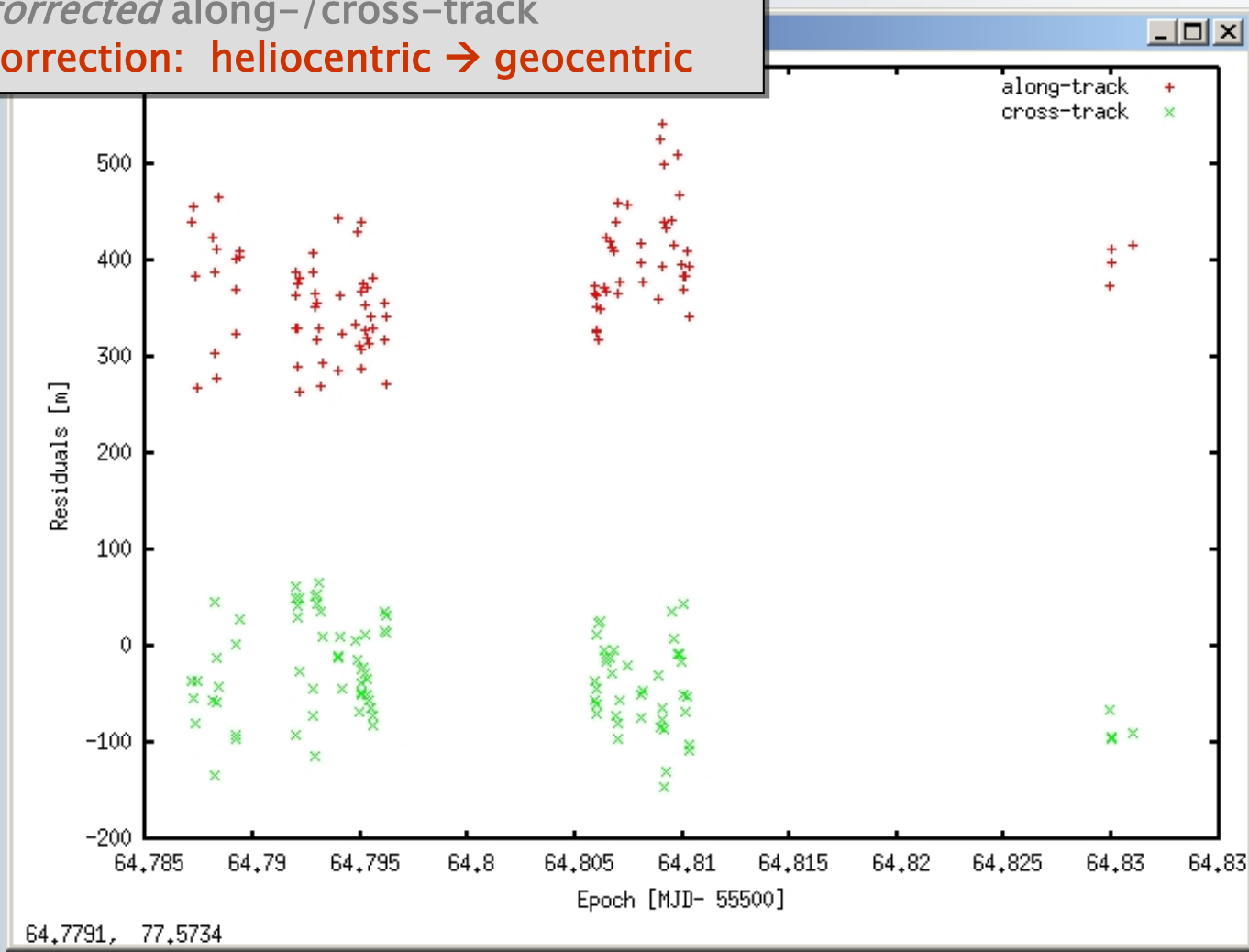


Epoch [mjd]

- along-track errors may indicate epoch biases
- along-track errors are not the same for the individual observation series
→ not simply an epoch bias

Data Validation Examples

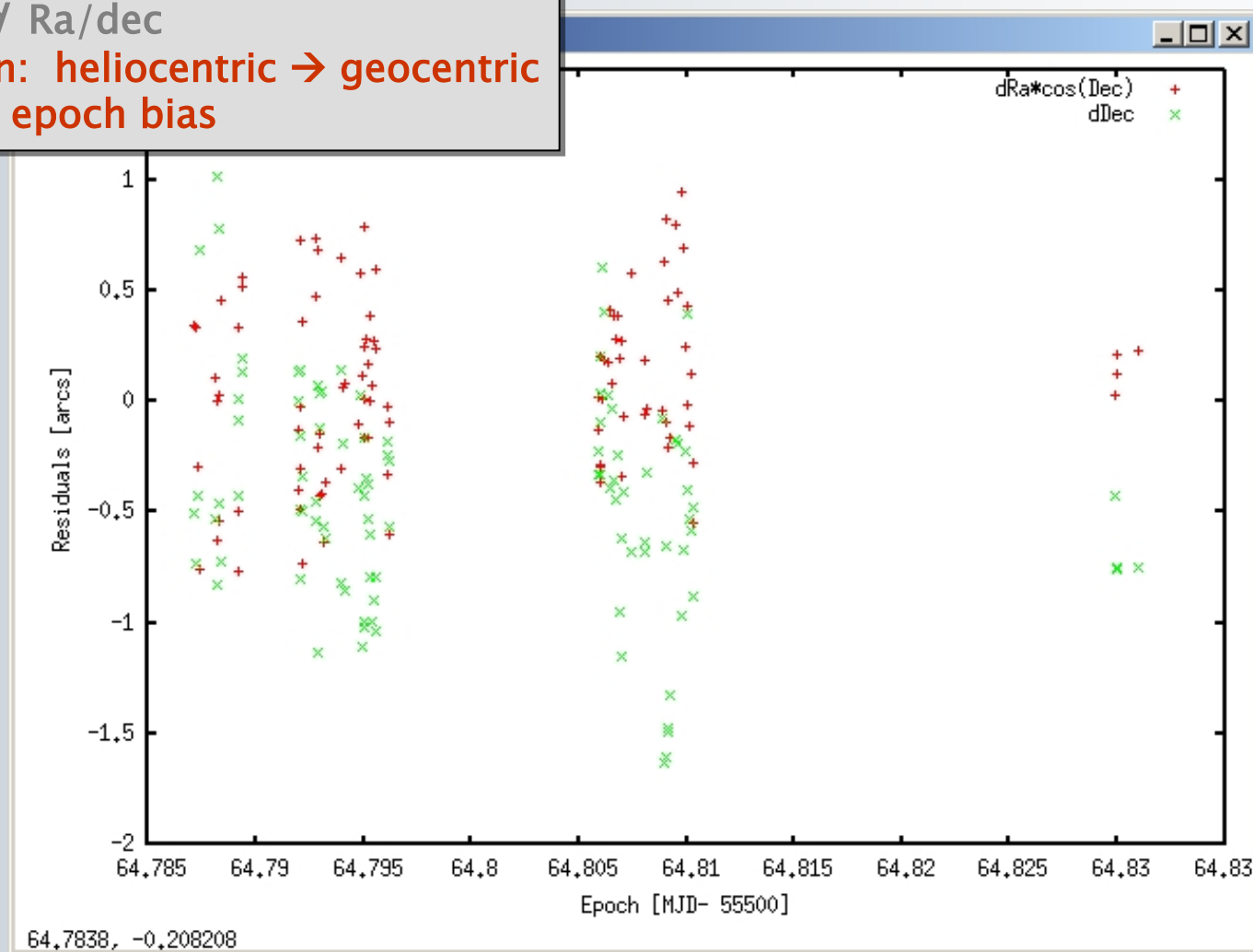
corrected along-/cross-track
correction: heliocentric → geocentric



- systematic offsets in along-/cross-track of up to ~400m
- common along-track bias for the individual observation series
→ epoch bias

Data Validation Examples

corrected Ra/dec
correction: heliocentric → geocentric
+ 100ms epoch bias



~ 0.5" rms

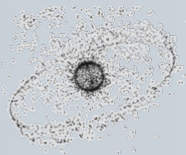
Sensors Qualified

Month-year	Day of the month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Feb-23																++															
Mar-23																					+									++	
Apr-23																		++									*	++			
May-23	++																						++	+							
Jun-23																															
Jul-23				++									+		*		++								X	X	X			++	++
Aug-23							++	*	*		*			++						++	++	+				++					
Sep-23					*	++	*																								
Oct-23							+	+	+		+	*	X	+	+											++					
Nov-23						++	X	X	+	+	X			+						+	++				+					+	
Dec-23						+	+					++	++	++	++	++	++		++												
Jan-24																															
Feb-24																++															
Mar-24				++	++								*	++																	
Apr-24			++	++	++	*				++	++	++	++																		

- 13 sensors on 4 continents qualified over past 15 months (75 coordinated observation nights)
- established and new sensors operators

Legend:

X : planned campaign failed due to weather related reasons
 * : planned campaign failed due to technical reasons
 + : campaign only partially successful
 ++ : campaign successful
 Different sensors indicated by different colors

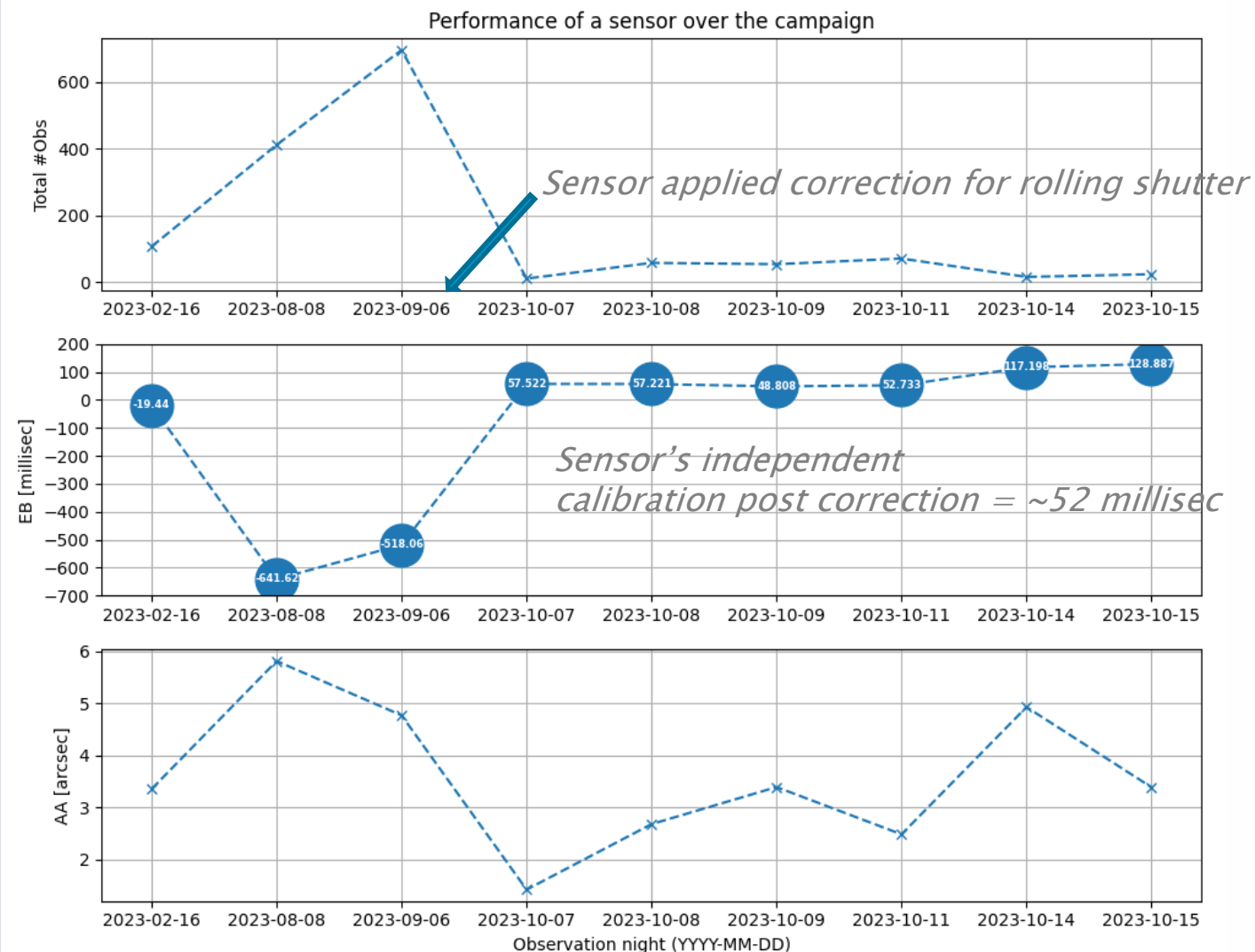


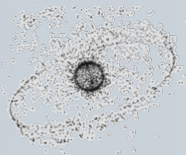
Example of Sensor Performance

outliers

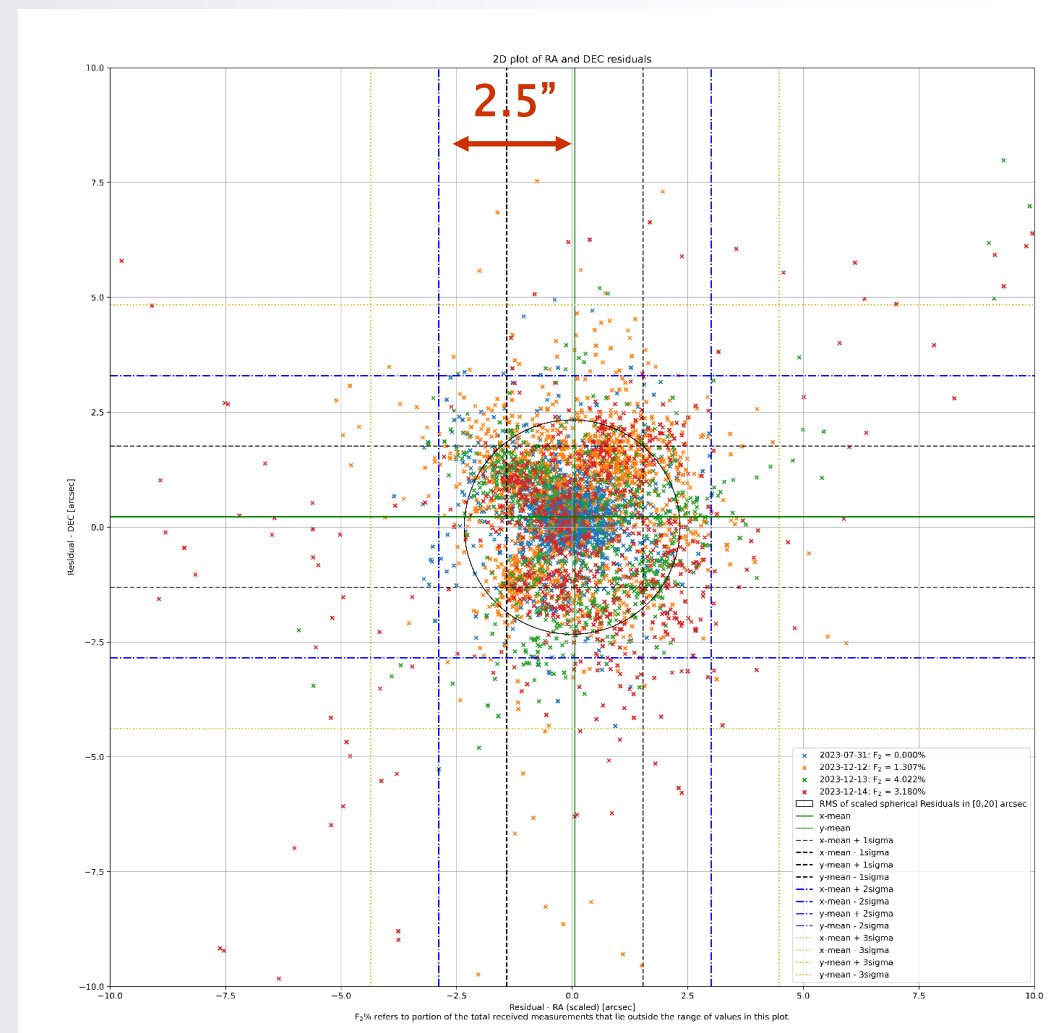
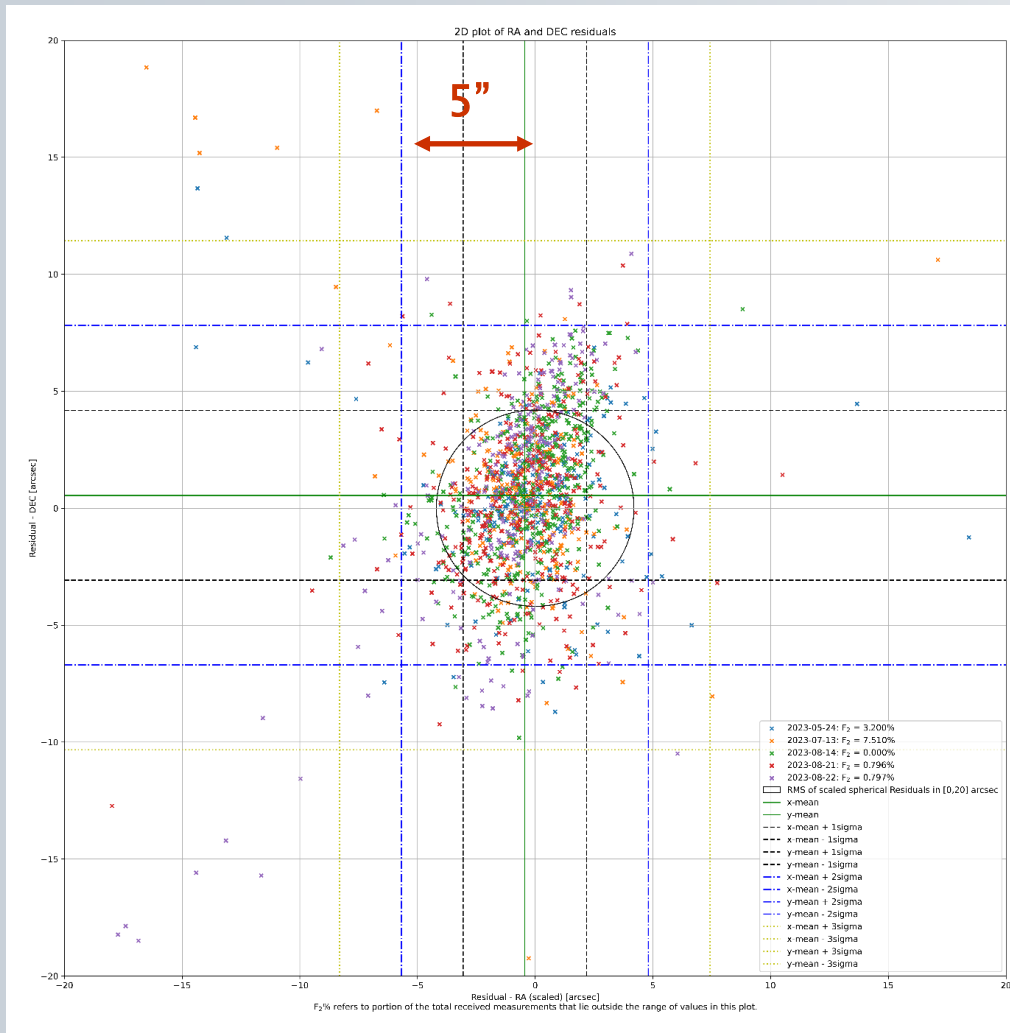
epoch bias

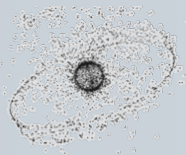
astrometric accuracy



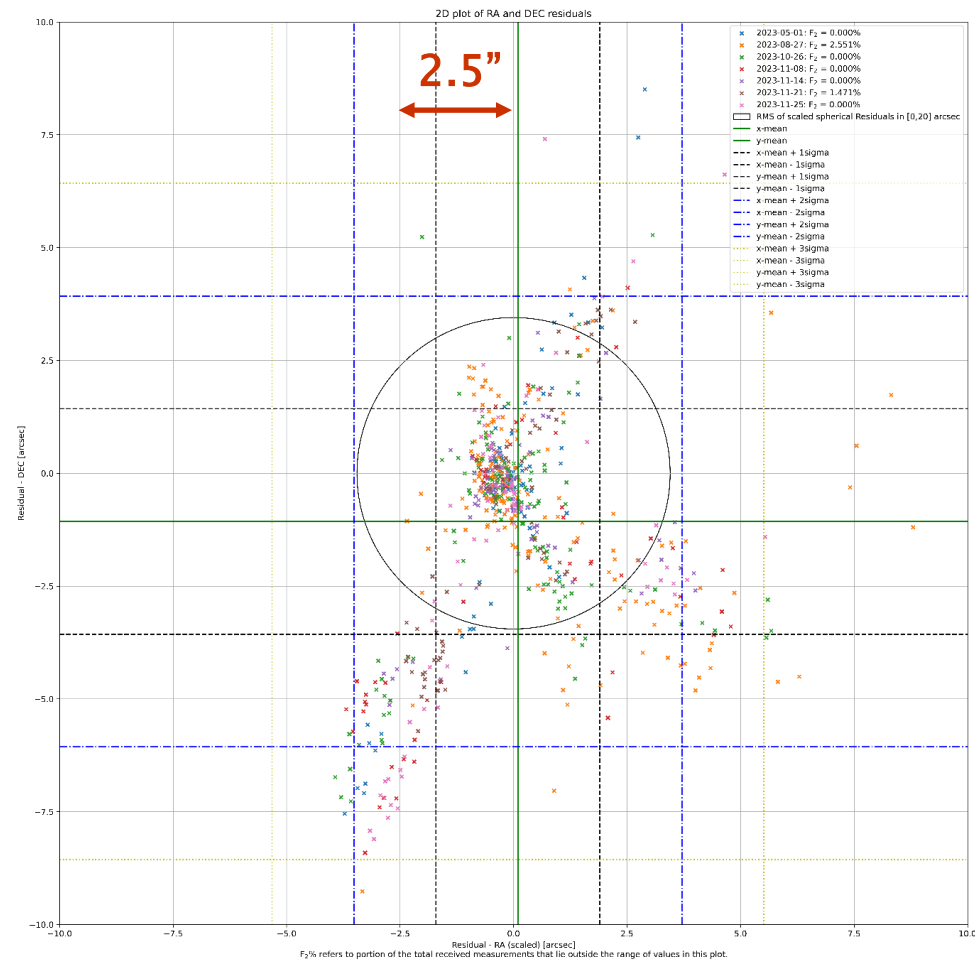
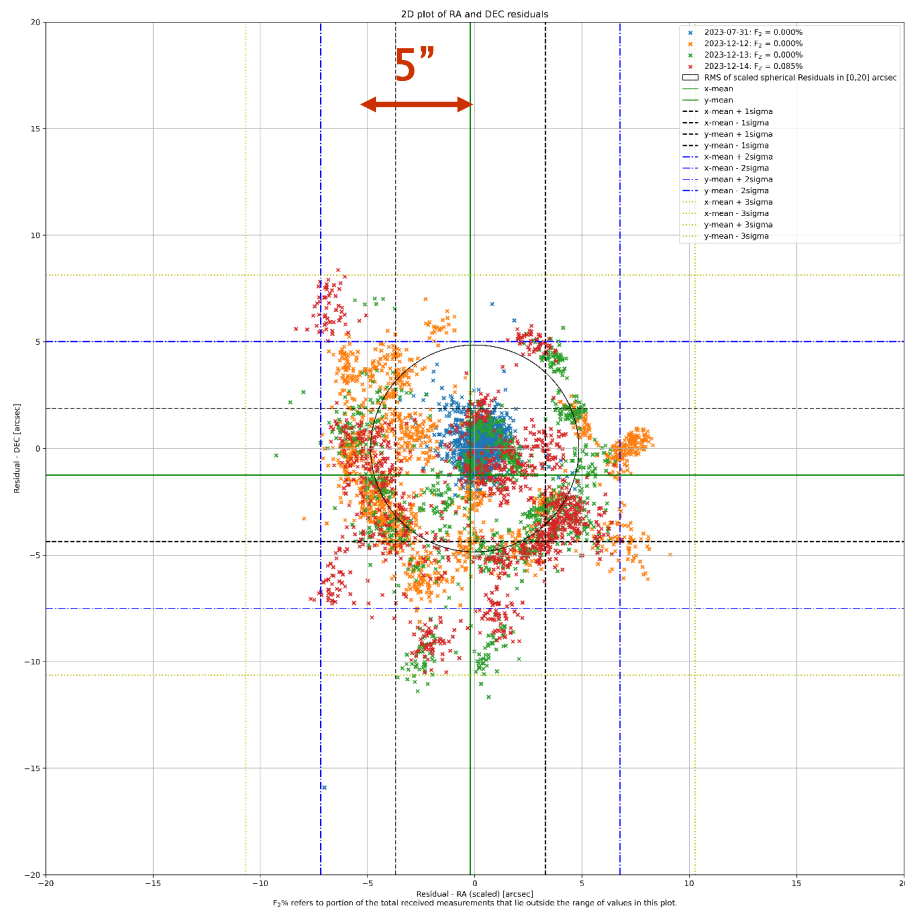


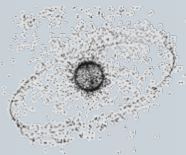
Examples of Astrometric Accuracy (RA/DEC)



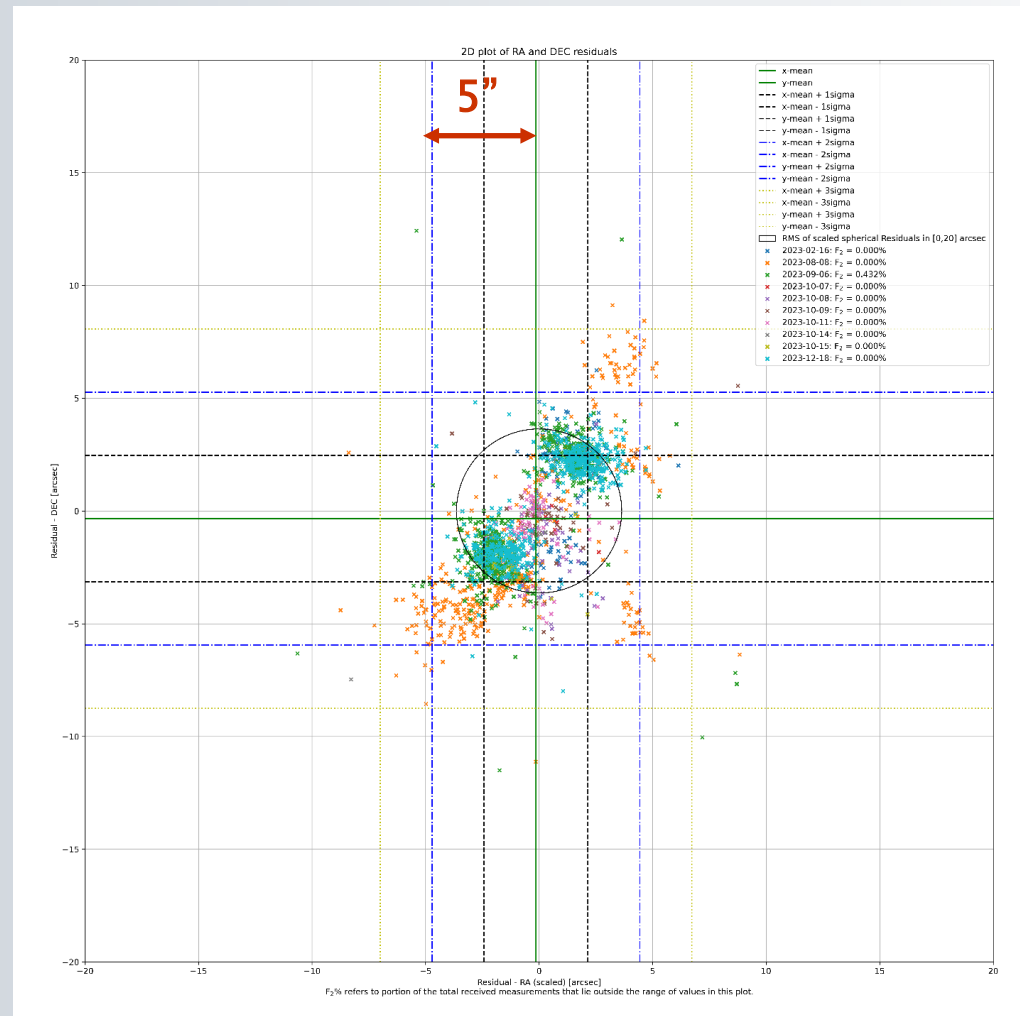


Examples of Astrometric Accuracy (RA/DEC)





Examples of Astrometric Accuracy (RA/DEC)





Summary

- ESA Space Safety Expert Centre provides services in support of sensor operators and service providers
- Passive optical sensors are validated and qualified for different orbital regimes and observation types:
 - tracking observations
 - survey observations
 - attitude characterization observations
- Service provided for free during pilot phase
→ **sensor operators encouraged to apply for Qualification**