

Two-color and multistatic space debris laser tracking

20th Int. Workshop on Laser Ranging

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1 German Aerospace Center, Institute of Technical Physics, Stuttgart

2 Technical University Munich, Forschungseinrichtung Satellitengeodäsie, München

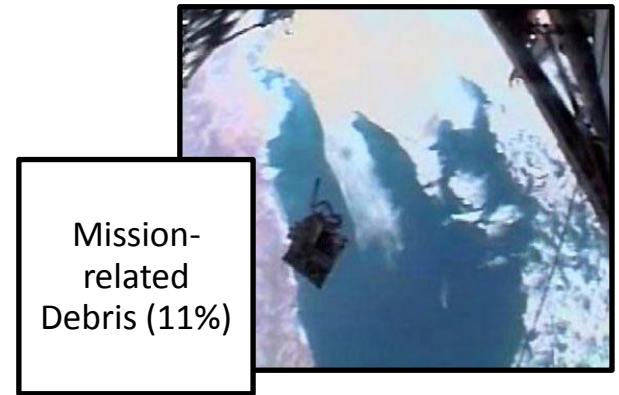
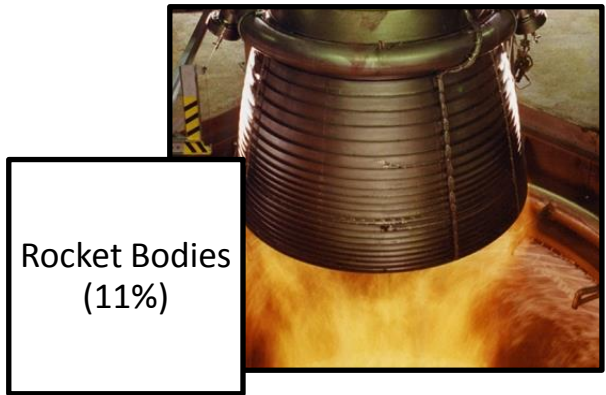
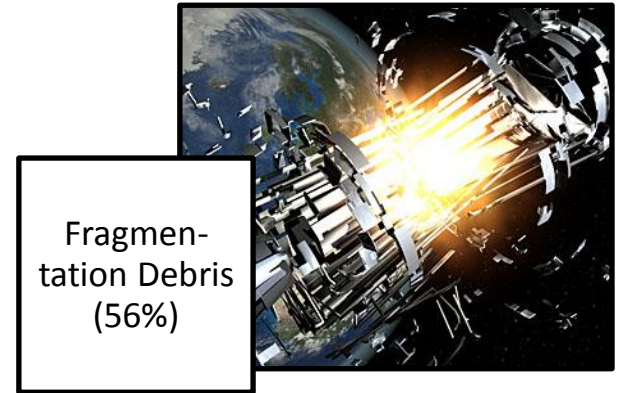
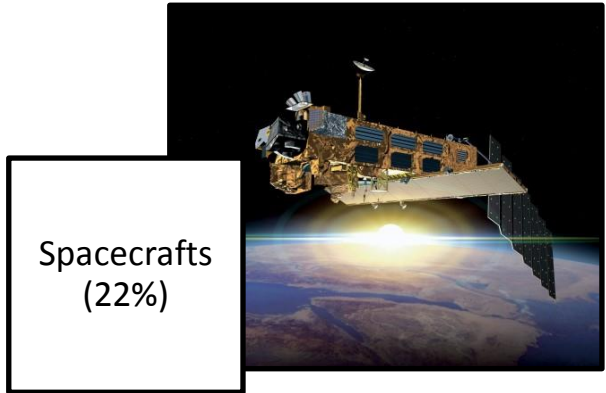
3 Austrian Academy of Sciences, Space Research Institute, Graz

4 Bundesamt für Kartographie und Geodäsie, Wettzell

Knowledge for Tomorrow

Space Debris Sources

- 17729 objects cataloged by U.S. Space Surveillance Network (5th July 2016)
- ca. 8% operational satellites
- Threat for manned space flight and active satellites



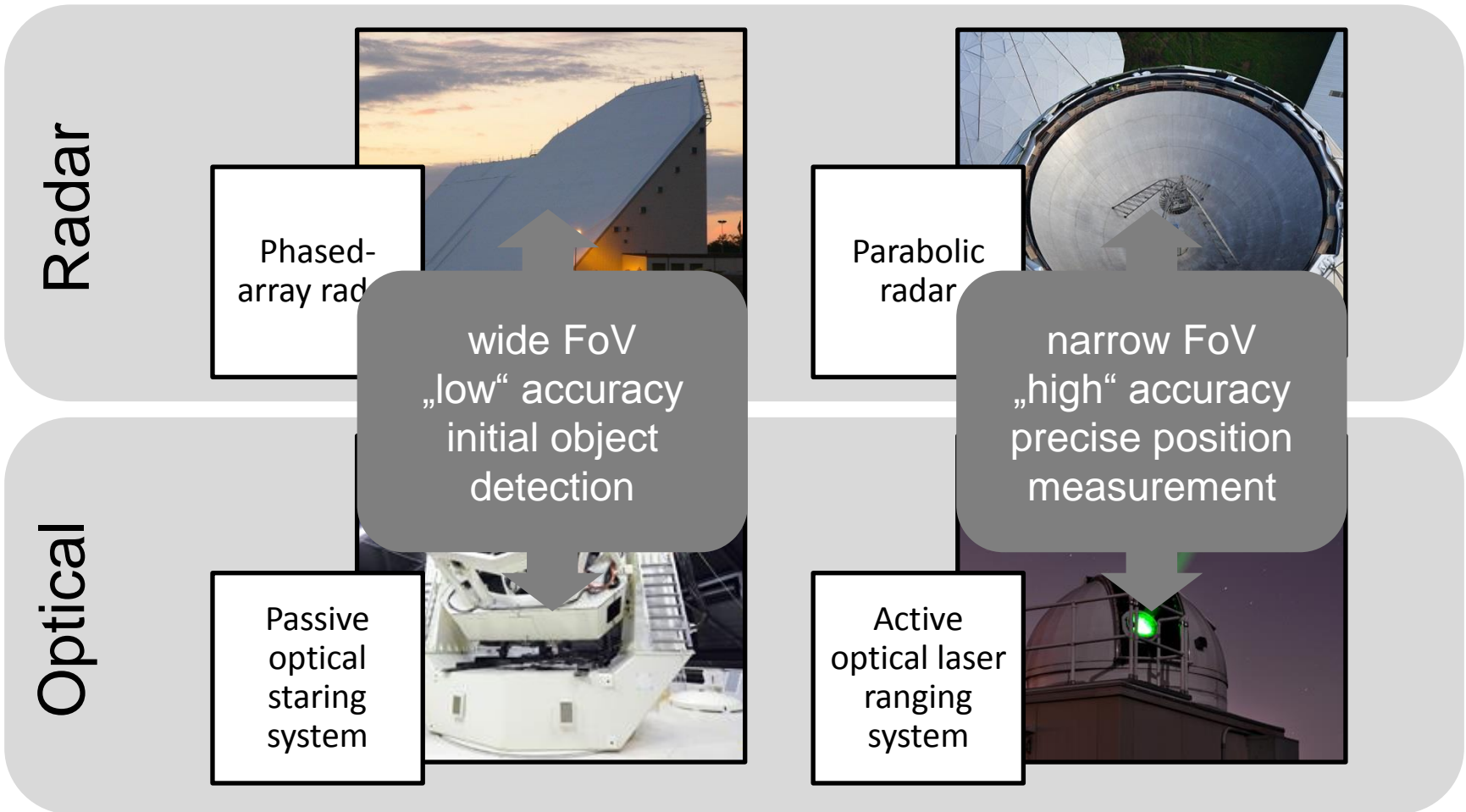
Orbital Debris Quarterly News Vol. 20, Issues 1&2, April 2016; <http://orbitaldebris.jsc.nasa.gov/>

Orbital Debris Quarterly News Vol. 20, Issues 3, July 2016; <http://orbitaldebris.jsc.nasa.gov/>

UCS Satellite Database, data from September 2016 <http://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database>



LEO Space Debris Tracking



<https://www.ll.mit.edu/about/images/SST-tt.jpg>

http://cddis.gsfc.nasa.gov/images/Ranging-2013-08-mod_500w.jpg

<http://www.fhr.fraunhofer.de/de/das-institut/technische-ausstattung/weltraumbeobachtungsradar-tira/eine-neue-huelle-fuer-das-weltraumbeobachtungsradar-tira.html>

<https://mostlymissiledefense.com/2012/04/12/the-fos-85-radar-april-12-2012/>



Radar

Phased-array radar



Parabolic radar



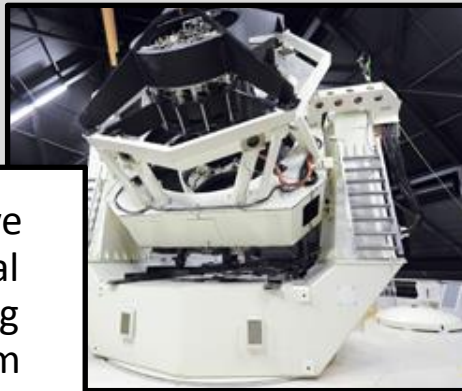
+ wavelength \ll object size \Rightarrow no Rayleigh behavior for small objects

+ narrower beam (better λ/D) \Rightarrow higher angular accuracy

+ signal strength independent accuracy \Rightarrow high accuracy for small objects

Optical

Passive optical staring system



Active optical laser ranging system



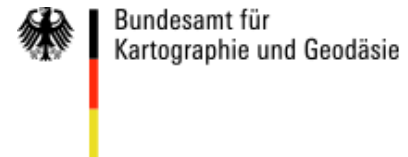
ESA GSTP Project „Accurate orbit determination of space debris with laser tracking/tasking“

- Tasks:

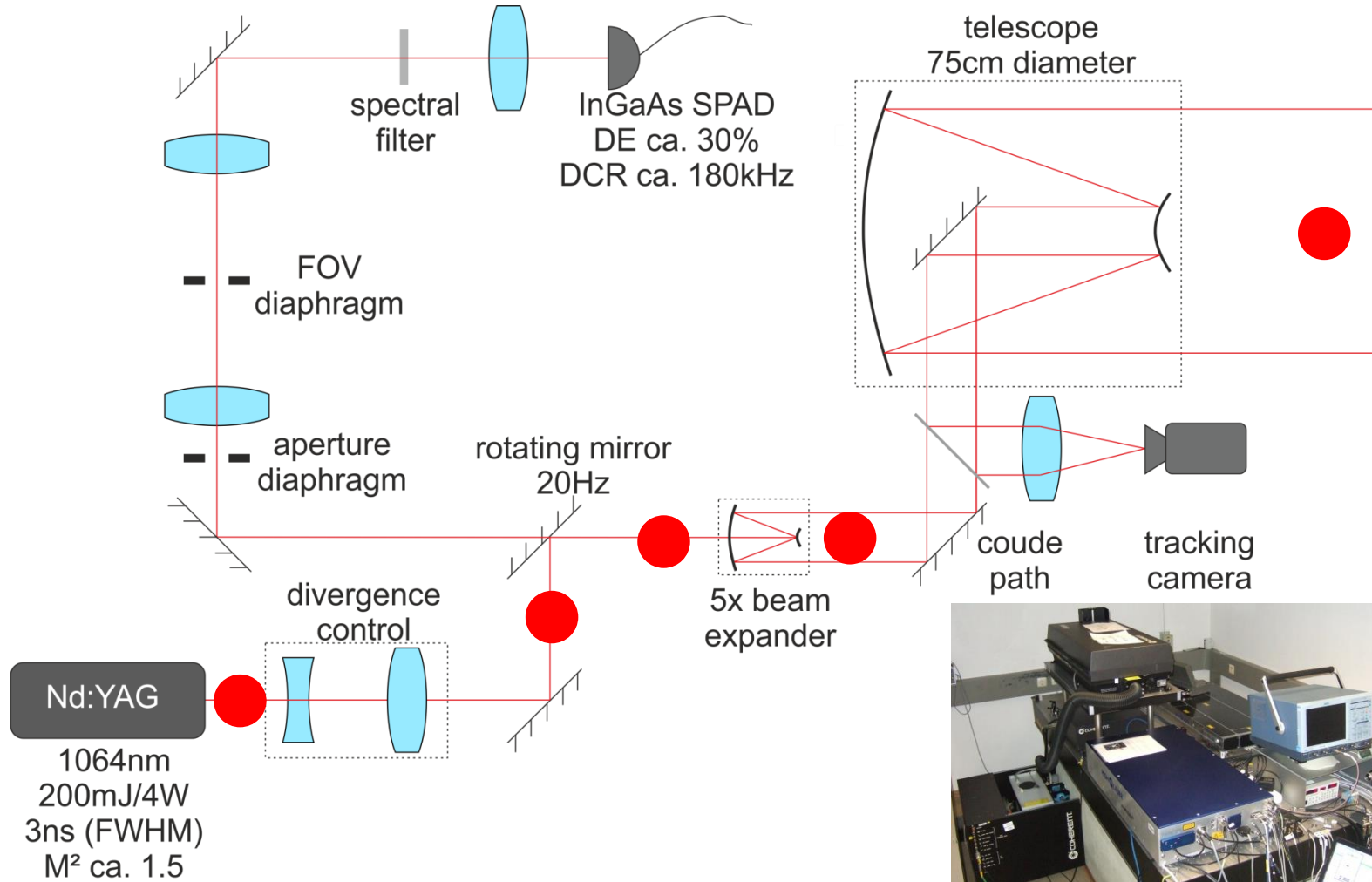
- Upgrade SLR station Wettzell to a debris laser ranging (DLR) station
- Perform standard two-way ranging to space debris
- Perform bi- and multistatic measurement campaigns
- Evaluate achievable orbit quality of the different configurations

- Participants:

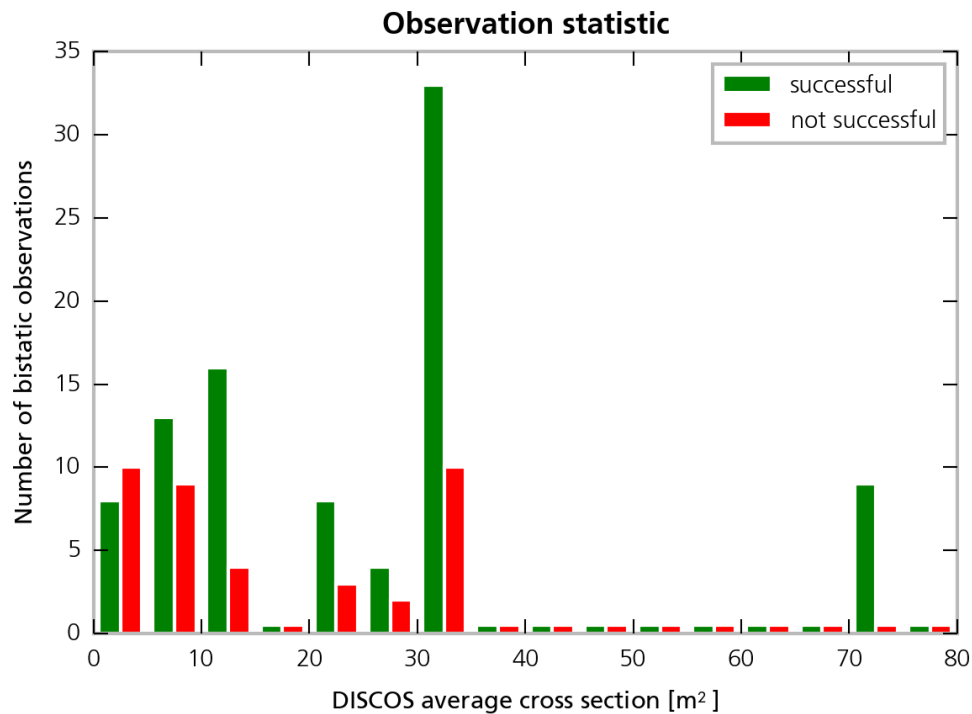
- German Aerospace Center Stuttgart (DLR)
- Technical University Munich (TUM)
- Space Research Institute Graz (IWF)



Upgrade Wettzell SLR Station to DLR Station



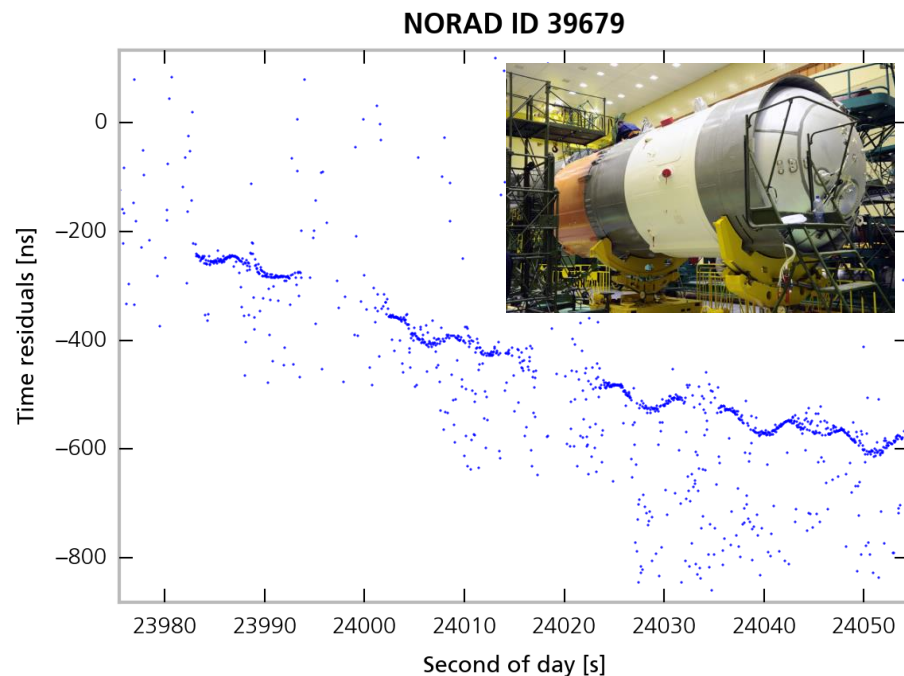
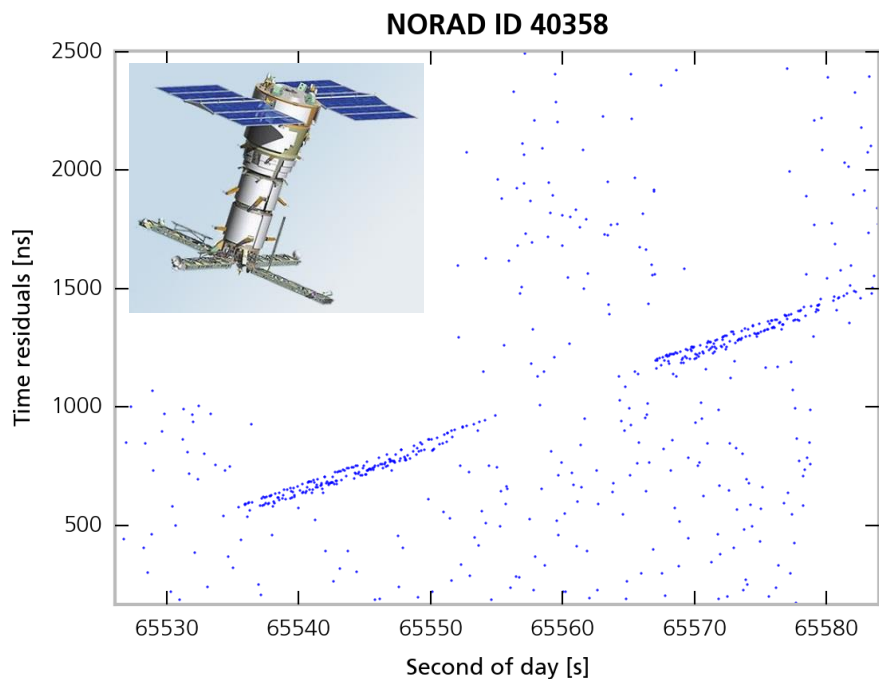
Single Station Ranging (Wettzell)



Objects tracked	169
Successful	107 (60%)
Smallest Object	1.2m ² @1200km (from DISCOS)



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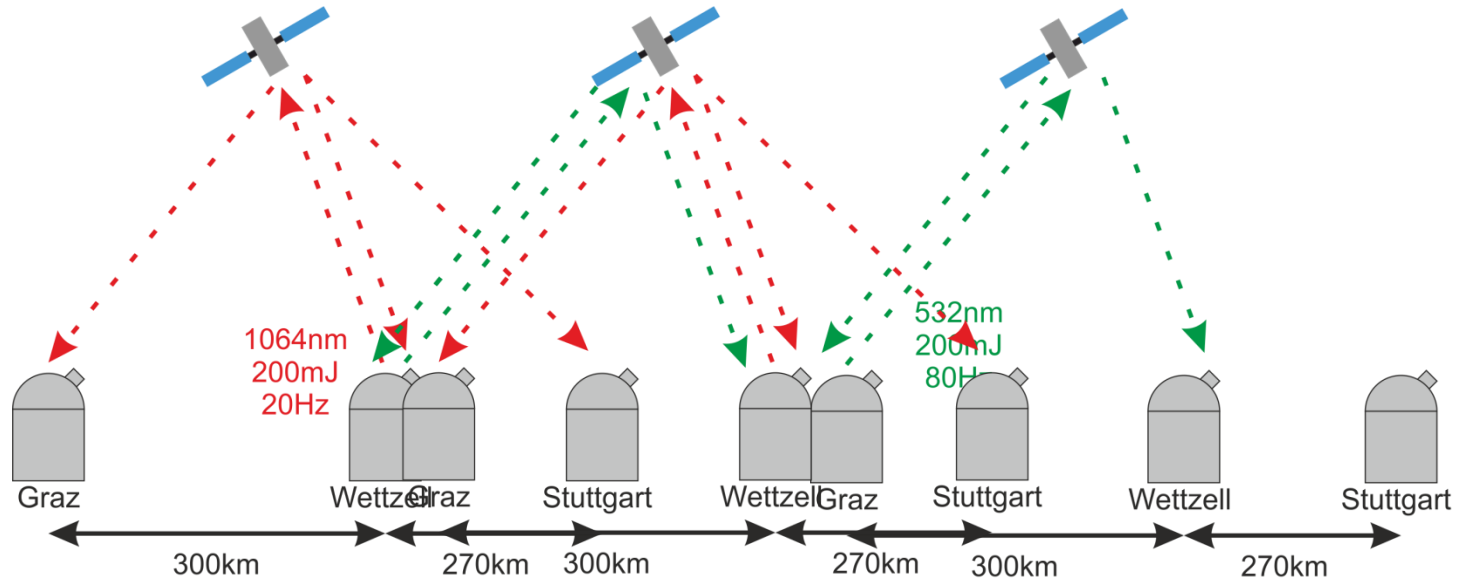


Laser ranging provides additional object information

http://space.skyrocket.de/doc_sdat/lotos.htm
<http://spaceflight101.com/re-entry/re-entry-sl-4-rb-41437/>

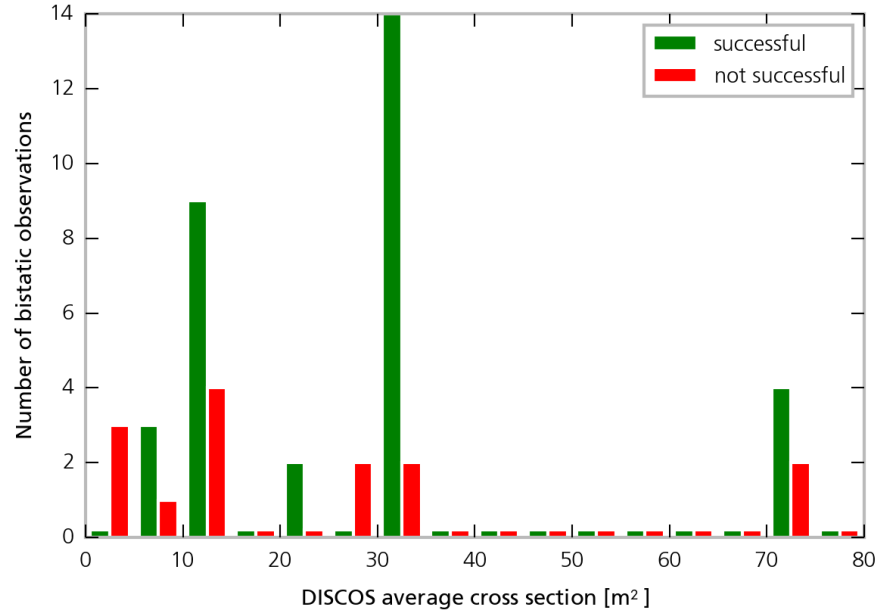


Multistatic Ranging Configuration

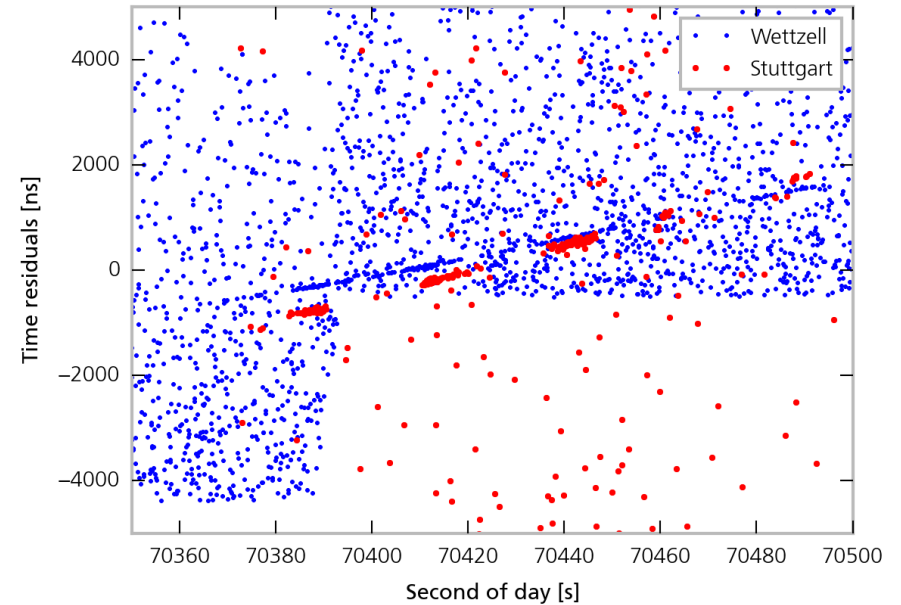


Bistatic Results 1064nm

Observation statistic



NORAD ID 31793



	Stuttgart	Graz
Objects tracked	84	32
Successful Wettzell (single station)	51 (60%)	23 (72%)
Successful bistatic	36 (70%)	13 (56%)



Further Steps

- Analyze tristatic measurements.
- First multi-color ranging conducted. Performing further measurements.

	1064	532	Already tested?
Graz	R	T/R	yes
Wettzell	T/R	R	no
Wettzell	T/R	T/R	first test

- Calculate and evaluate orbits from ranging data.
 - more information in talk of C.Bamann



Space Debris Sources

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Spacecrafts
(22%)



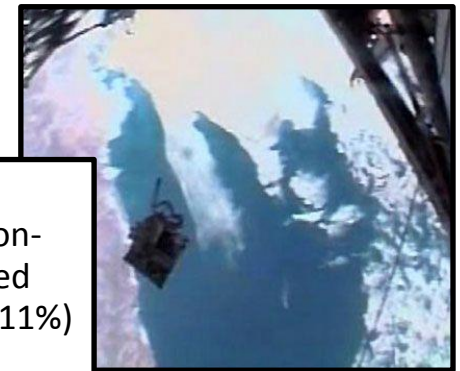
Fragmen-
tation Debris
(56%)



Rocket Bodies
(11%)



Mission-
related
Debris (11%)



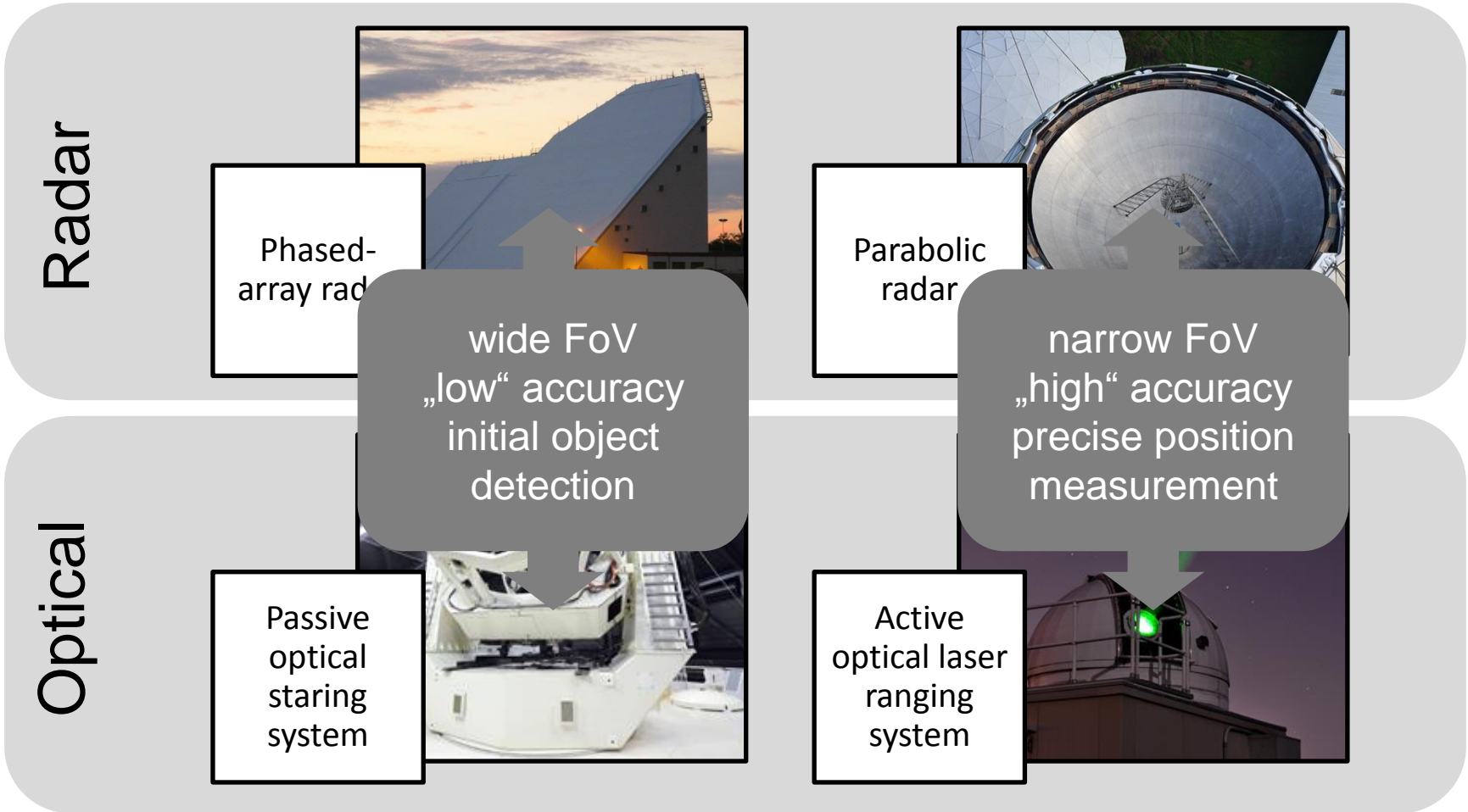
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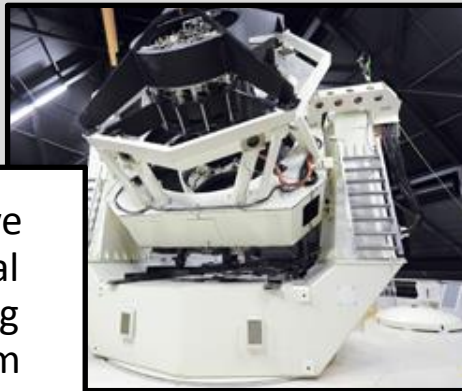
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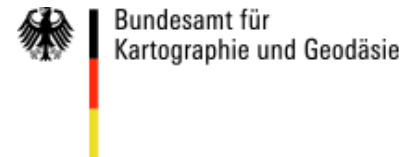
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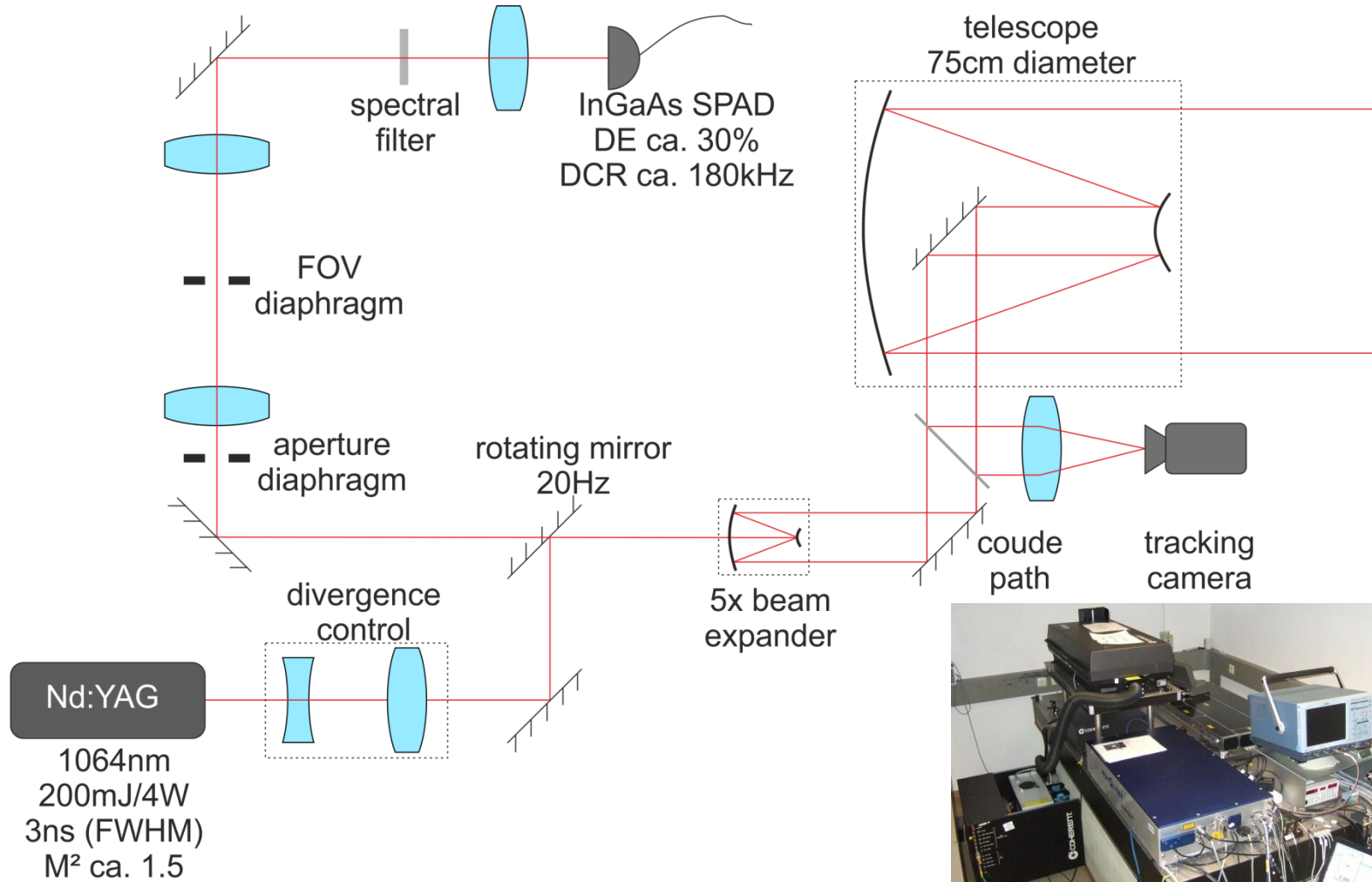
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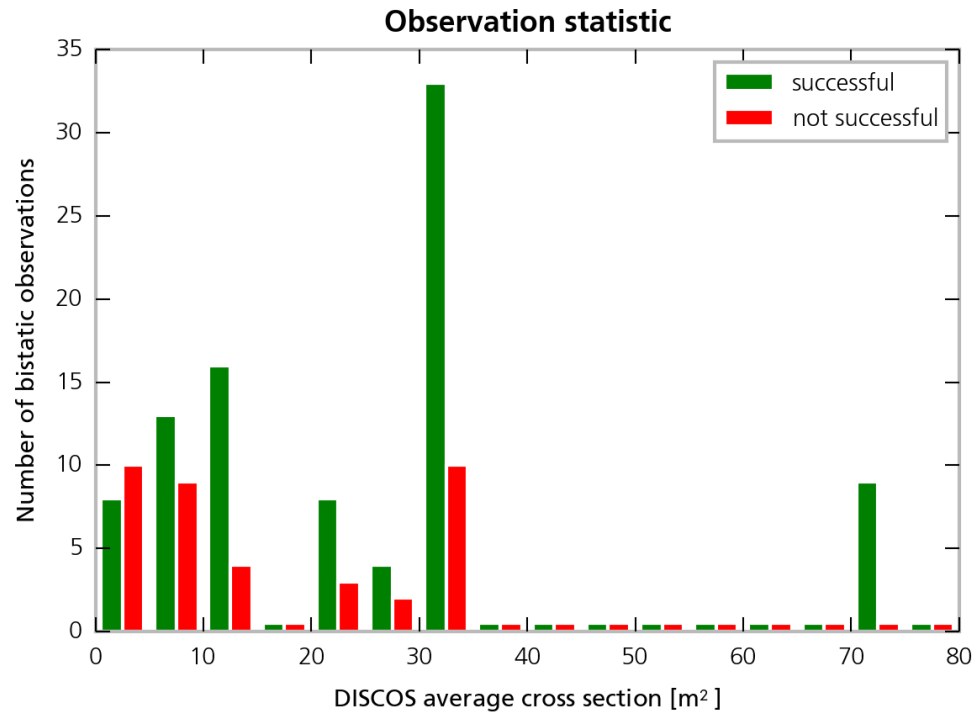
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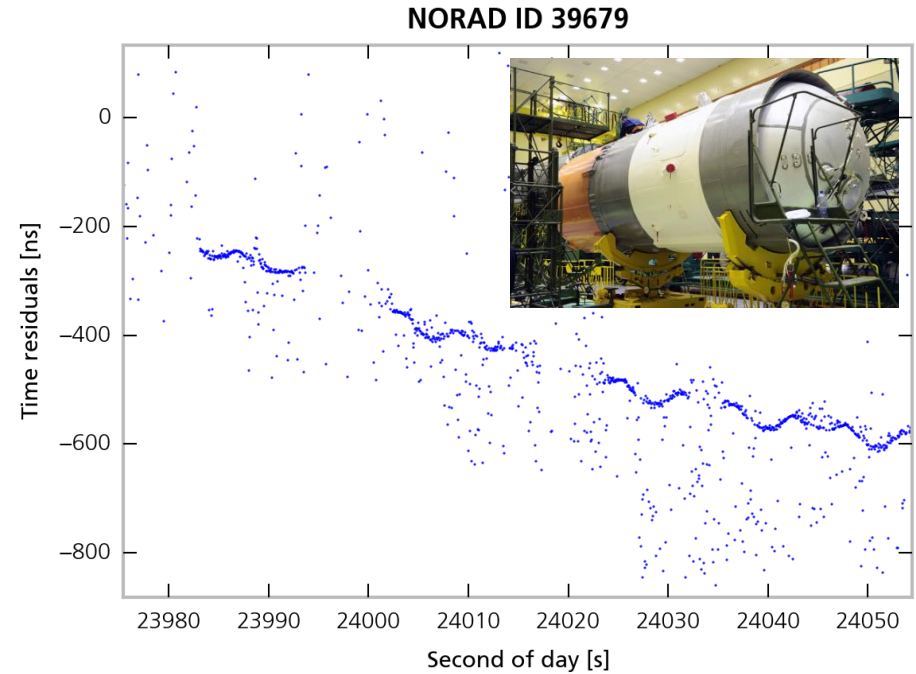
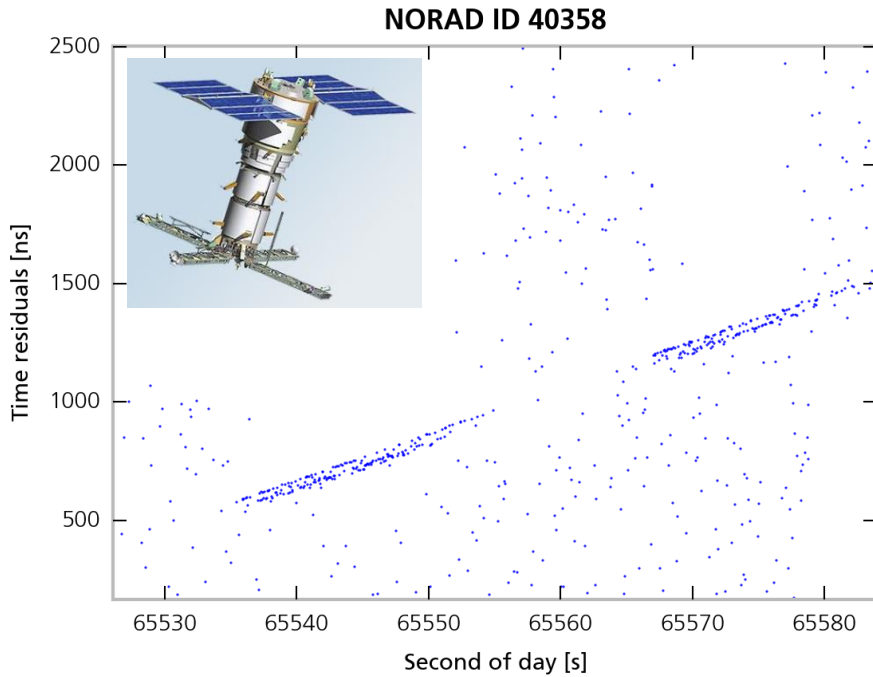
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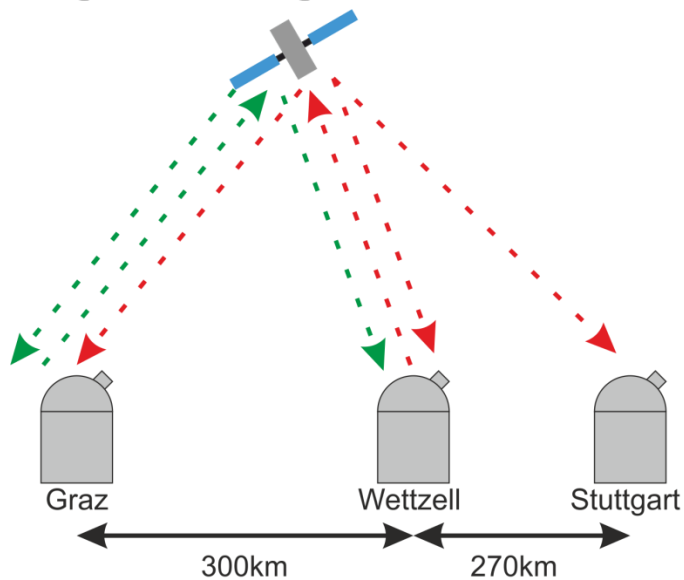
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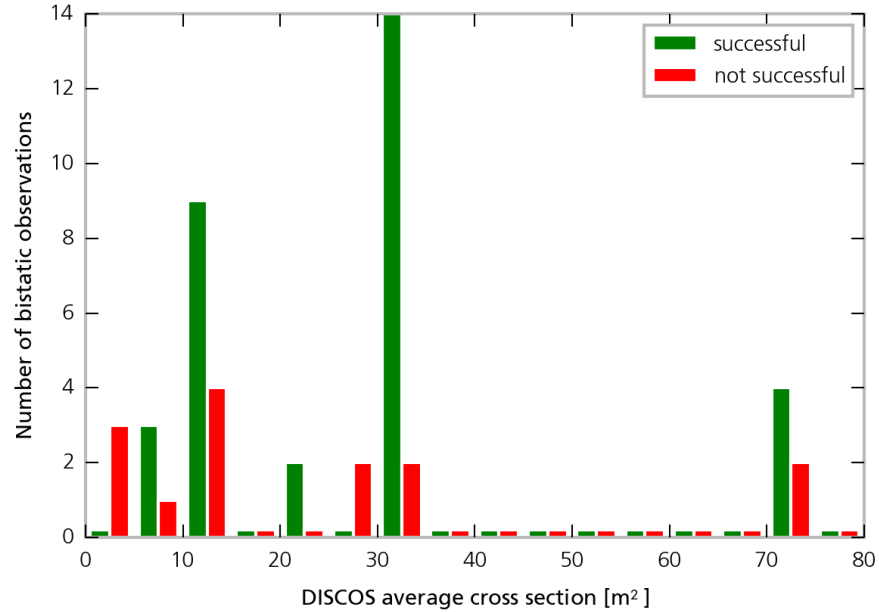


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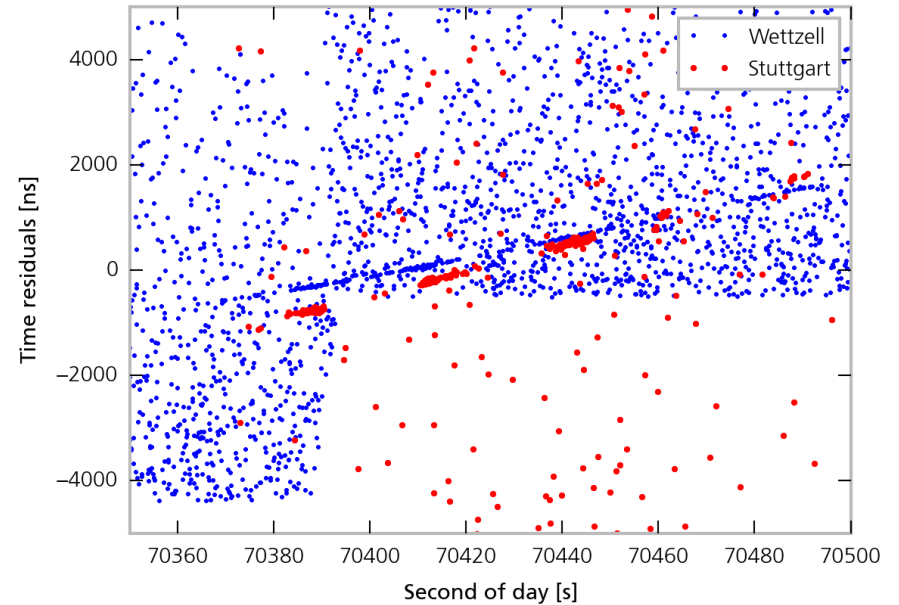


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