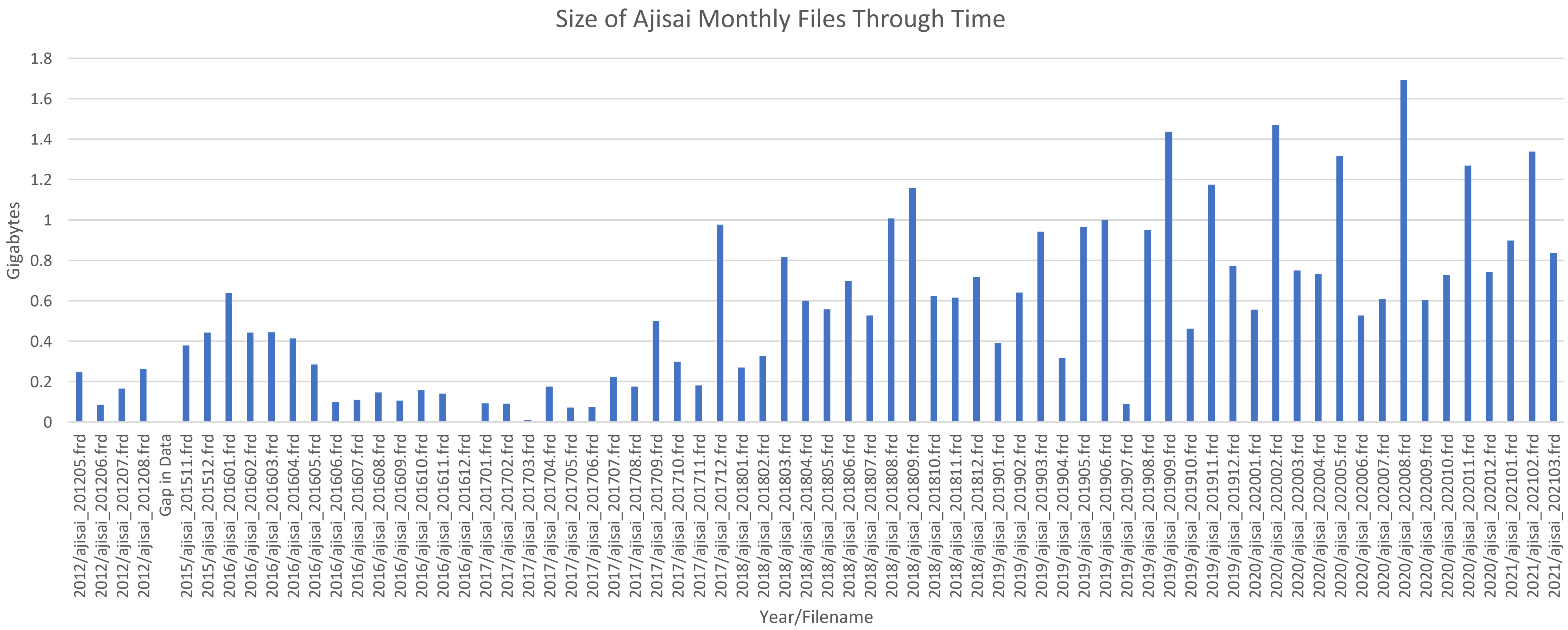
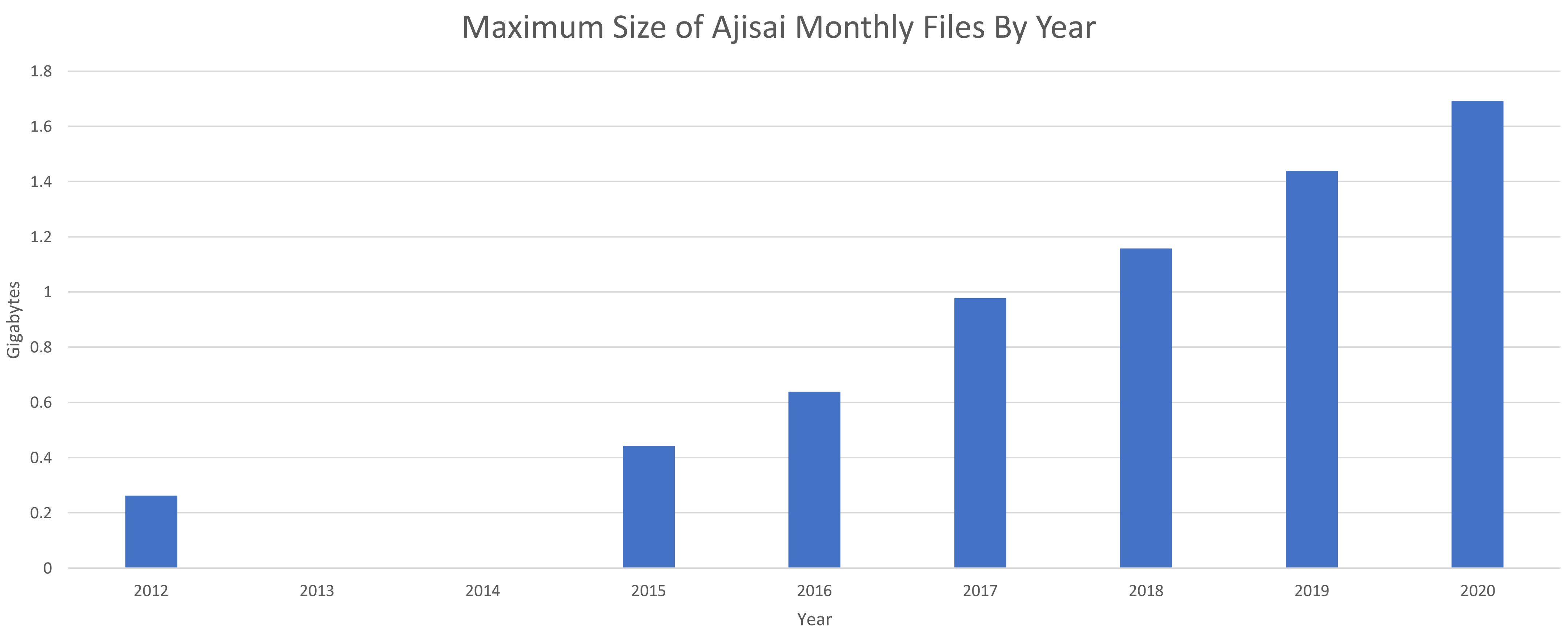
FRD Filesize Growth at the DCs

Created by: Justine Woo

Sample Rate of Growth by Year and Month



Largest Monthly File by Year for Ajisai



Additional Item:

- Items that will accelerate file size in the future
  - Release of new stations with kHz lasers
  - Last years values would have been higher if not for shutdowns
- How FRD files are currently stored:
  - Daily files supplied by OCs
  - Monthly files created at the CDDIS
- It may be a good preliminary step to evaluate how these files are used by the community and to determine new ways for these files to be archived

GASTON – ILRS support for the Galileo based project

ILRS Networks and Engineering Standing Committee

April 2021

C. Courde for the GRSM/7845 team

Methodology chosen

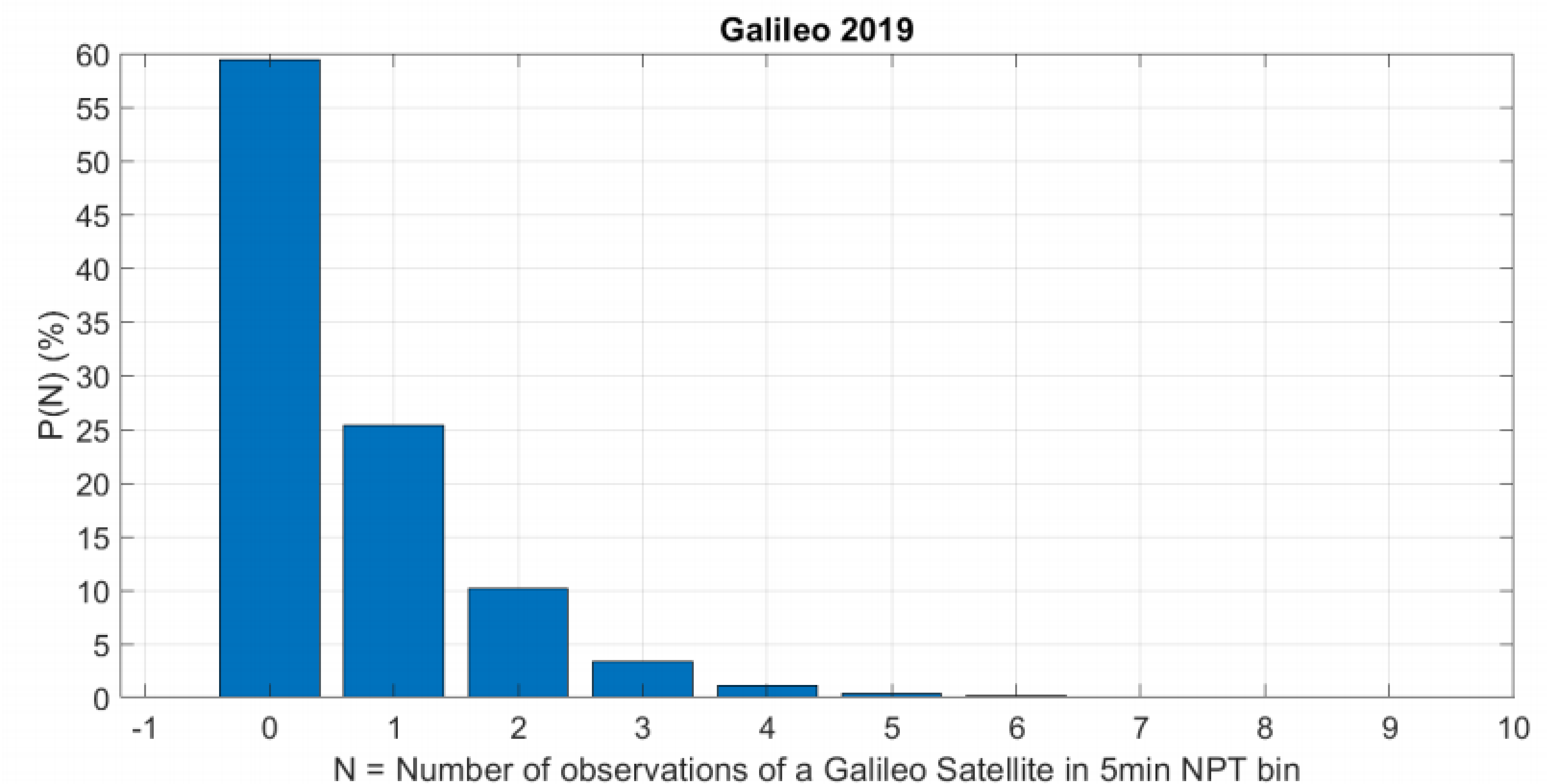
The **ideal methodology** to search for such transients using the Galileo constellation would be to always **have at least one ILRS station firing on a Galileo satellite**, during a three months campaign.

Where do we start from ?
Statistics from ILRS for 2019

5 min time bin over the year 2019
60% of the time: No Observation of a Galileo satellite
25% of the time, 1 satellite is observed

We need to reduce the time without an observation of Galileo satellite

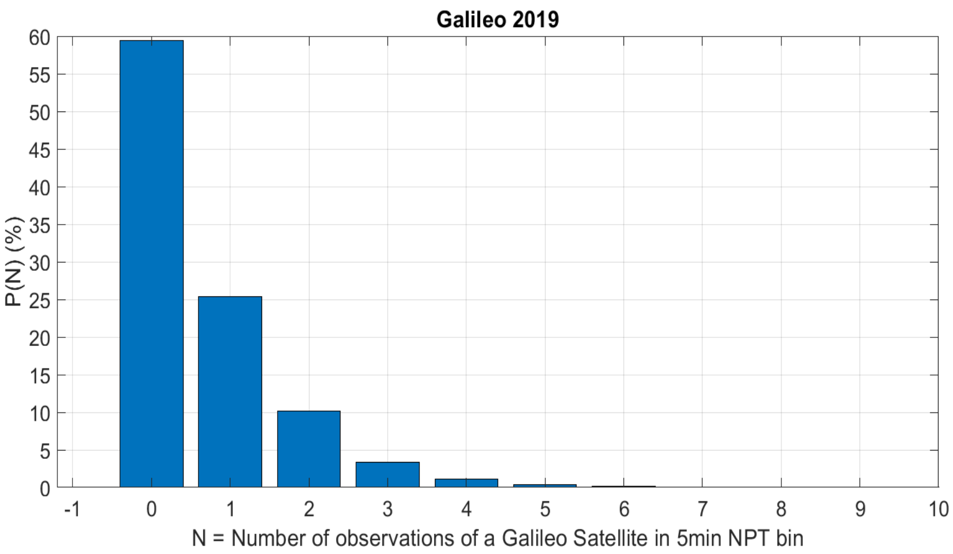
Challenge => try coordination of observations between SLR station

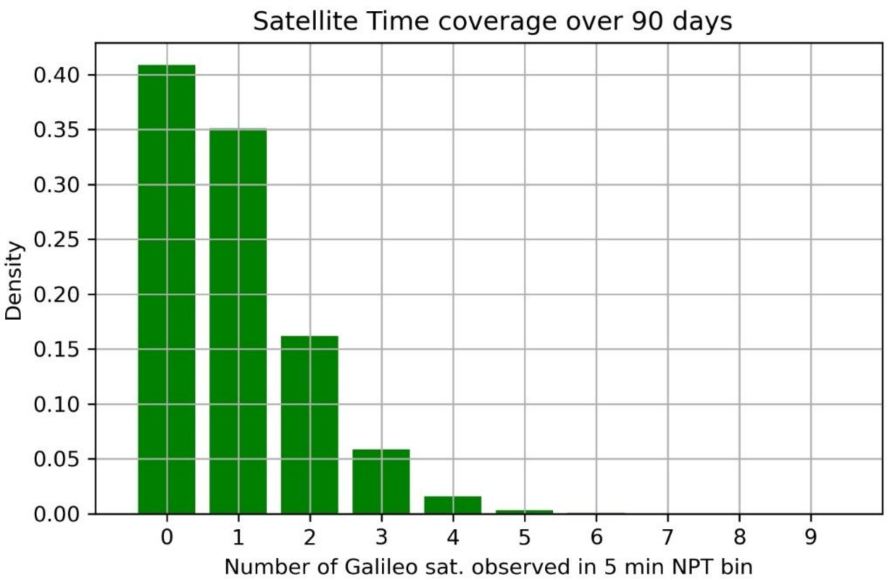


GASTON SLR campaign: A look over the 3 months

- Main goal achieved :

on average we have reached a time coverage by laser ranging ~ 59 %

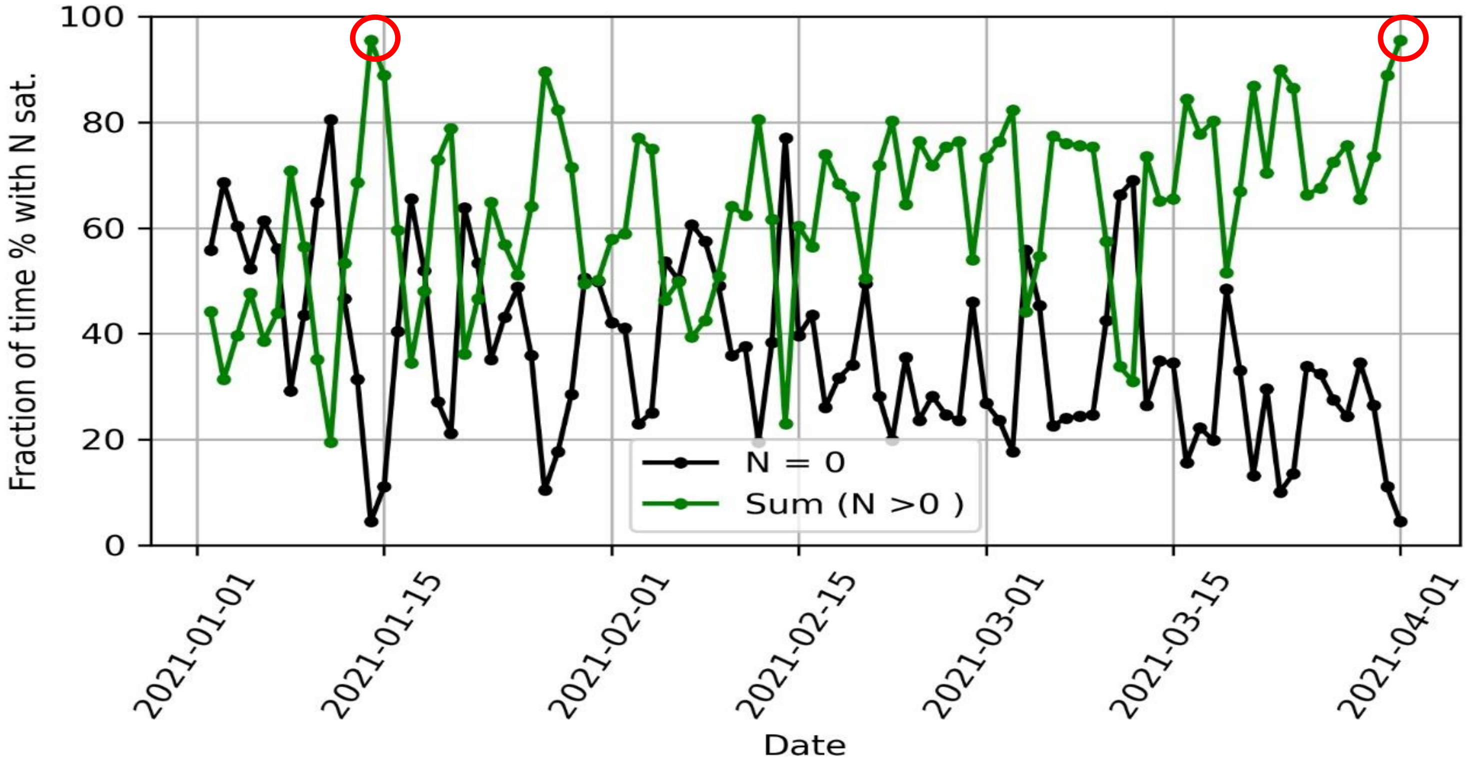




GASTON SLR campaign:
A look on time coverage over each day

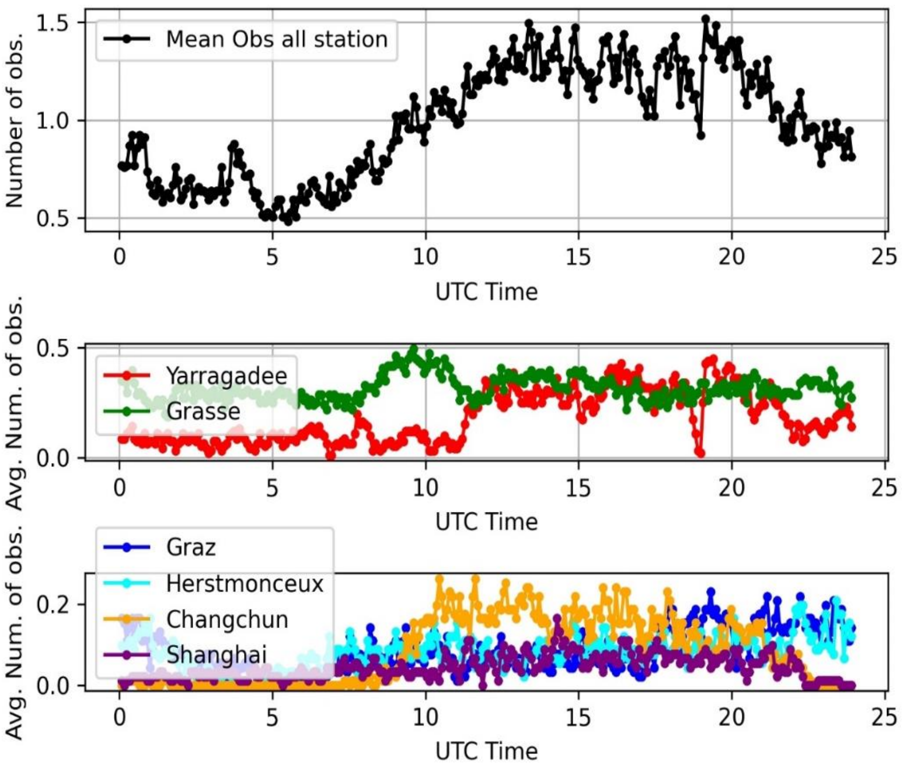
- A daily analysis shows we can **reach a time coverage > 90%**

  14 days on the 90 => time coverage > 80%
- It is getting better with time:
  - Weather ?
  - ILRS network inertia ?



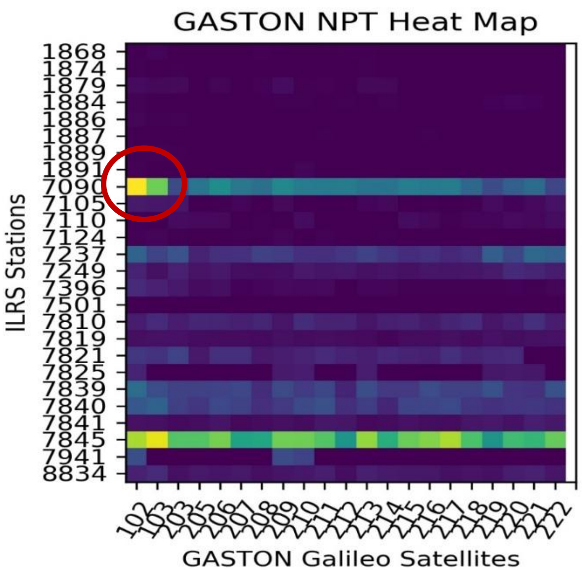
GASTON SLR campaign:
A look on daily observation

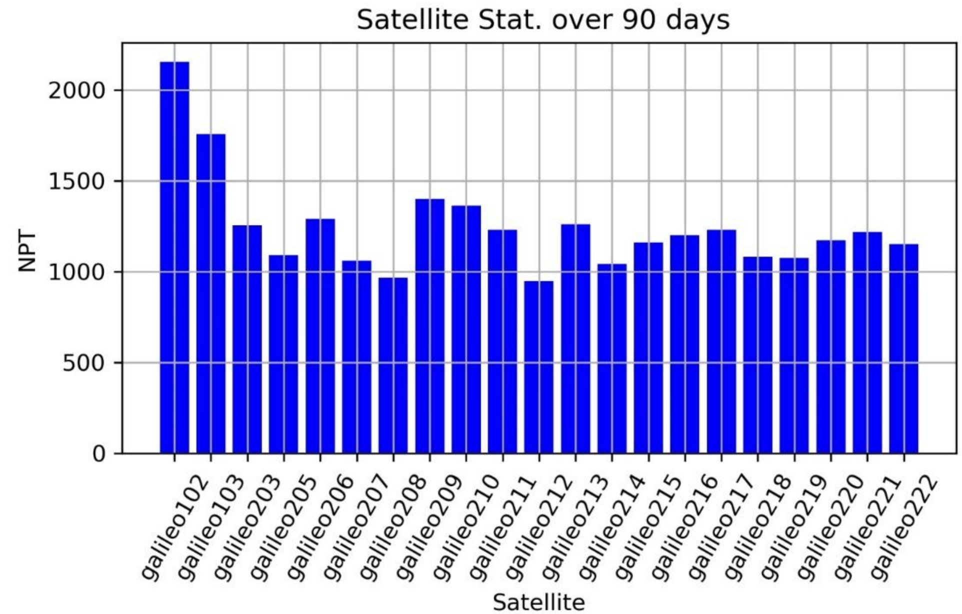
- The average observation over 24 hours for all the stations shows two states: the average number of observation is below 1 between 23h to 9h UTC and then is above 1 the next 12 hours.



GASTON SLR campaign:

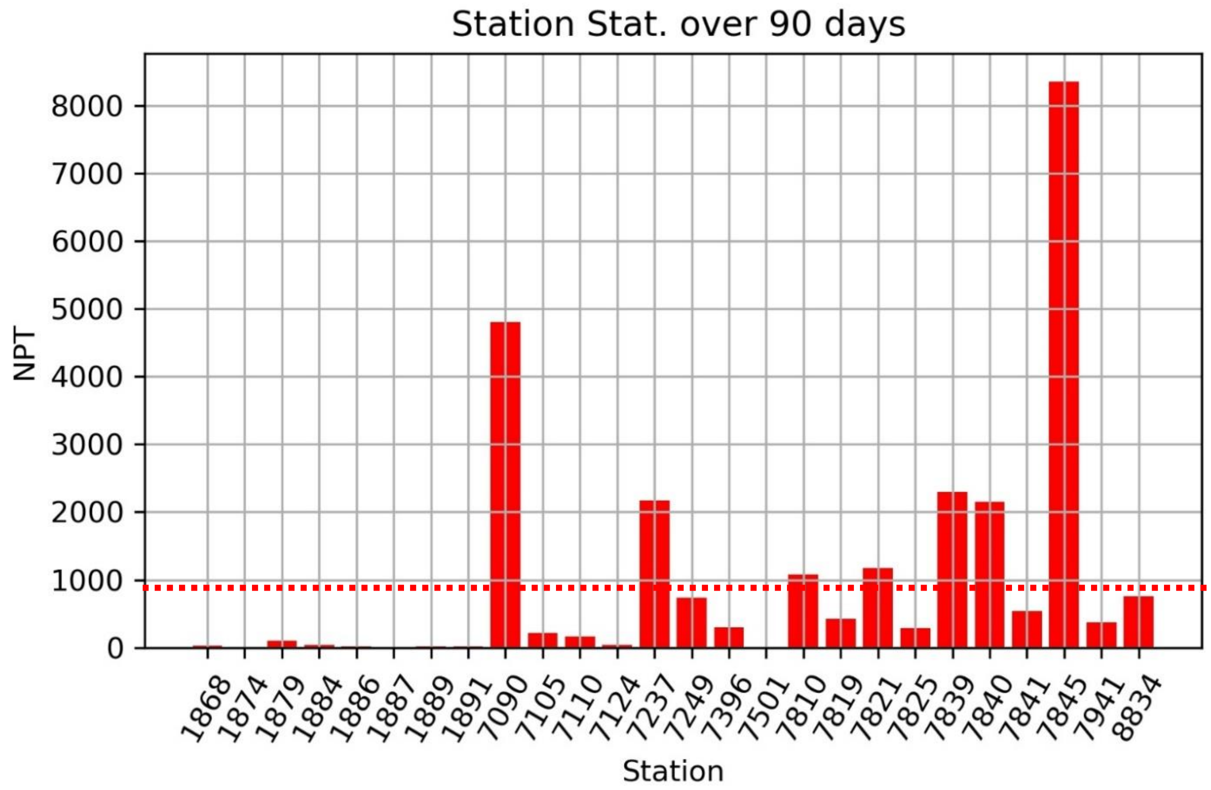
A total of 26116 normal points and 2176 hours of observations done by the ILRS network on the 90 days(=2160 hours) of the campaign





- The observations have been done quite homogenously over the different Galileo satellites with around 1000 normal points on each Galileo satellites, apart for Galileo 102 on which more than 2000 normal points have been obtained.

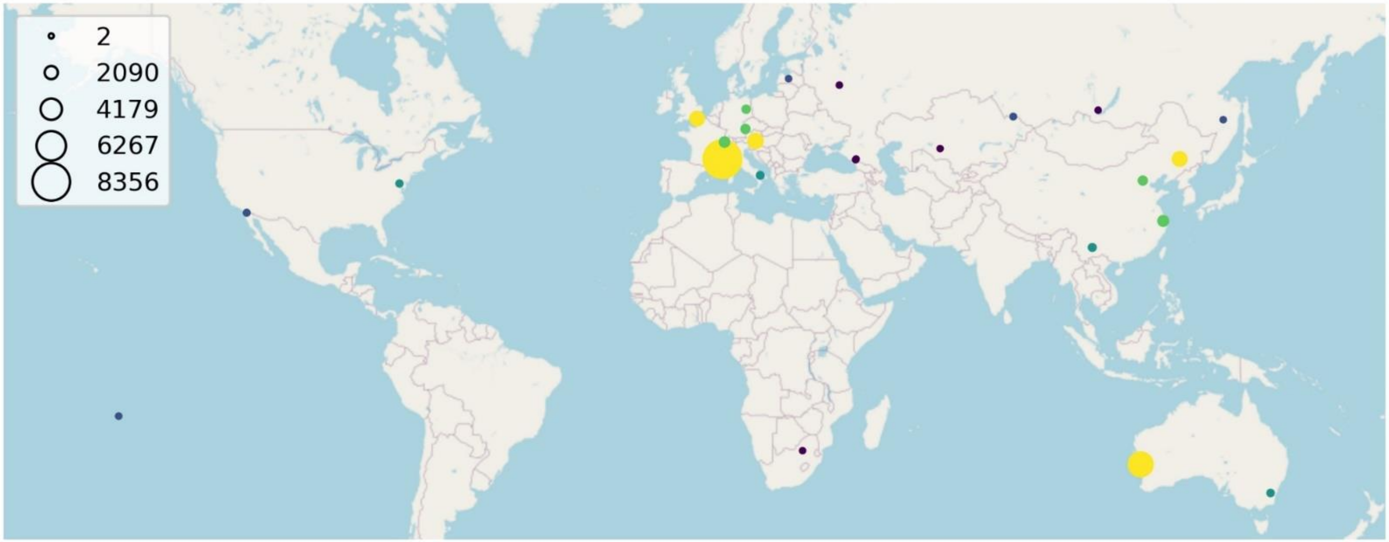
GASTON SLR campaign



- Contribution of ~15 stations
- 7 stations > 1000 Npts

GASTON SLR campaign:
A look on the geographical distribution of the observations

GASTON - ILRS Network effort (NPT)



- Europe, Asia and Oceania share the majority of the observations

And the Winner is ?

Dark Matter will be send to Yaragadee for their outstanding contribution

station_id	code	site	...	active	\	geometry	NPT
1868	KOML	Komsomolsk-na-Amure, Russia	...	yes		POINT (136.74383 50.69461)	27
1874	MDVS	Mendeleevo 2, Russia	...	yes		POINT (37.22490 56.02770)	11
1879	ALTL	Altay, Russia	...	yes		POINT (82.30000 51.20000)	105
1884	RIGL	Riga, Latvia	...	yes		POINT (24.05907 56.94855)	42
1886	ARKL	Arkhyz, Russia	...	yes		POINT (41.43330 43.65000)	16
1887	BAIL	Baikonur, Kazakhstan	...	yes		POINT (63.34220 45.70470)	8
1889	ZELL	Zelenchukskya, Russia	...	yes		POINT (41.56540 43.78870)	12
1891	IRKL	Irkutsk, Russia	...	yes		POINT (104.31640 52.21910)	22
7090	YARL	Yarragadee, Australia	...	yes		POINT (115.34670 -29.04640)	4805
7105	GODL	Greenbelt, Maryland	...	yes		POINT (-76.82770 39.02060)	220
7110	MONL	Monument Peak, California	...	yes		POINT (-116.42270 32.89170)	168
7124	THTL	Tahiti, French Polynesia	...	yes		POINT (-149.60630 -17.57680)	42
7237	CHAL	Changchun, China	...	yes		POINT (125.44330 43.79050)	2173
7249	BEIL	Beijing, China	...	yes		POINT (115.89200 39.60690)	732
7396	JFNL	Wuhan, China	...	yes		POINT (114.490195 30.5156853)	298
7501	HARL	Hartebeesthoek, South Africa	...	yes		POINT (27.68610 -25.88970)	2
7810	ZIML	Zimmerwald, Switzerland	...	yes		POINT (7.46520 46.87720)	1074
7819	KUN2	Kunming, China	...	yes		POINT (102.79770 25.02980)	426
7821	SHA2	Shanghai, China	...	yes		POINT (121.18660 31.09610)	1176
7825	STL3	Mt Stromlo, Australia	...	yes		POINT (149.00990 -35.31610)	286
7839	GRZL	Graz, Austria	...	yes		POINT (15.49420 47.06780)	2301
7840	HERL	Herstmonceux, United Kingdom	...	yes		POINT (0.33610 50.86740)	2153
7841	POT3	Potsdam, Germany	...	yes		POINT (13.06490 52.38000)	535
7845	GRSM	Grasse, France (LLR)	...	yes		POINT (6.92160 43.75460)	8356
7941	MATM	Matera, Italy (MLRO)	...	yes		POINT (16.70460 40.64860)	369
8834	WETL	Wettzell, Germany (WLRS)	...	yes		POINT (12.87800 49.14440)	757

Acknowledgment

- Thanks to ESA and ILRS for theirs supports regarding this 3 months SLR campaign

- Thanks to all the ILRS station for theirs contributions

State Scientific Center
of the Russian
Federation
VNIIFTRI

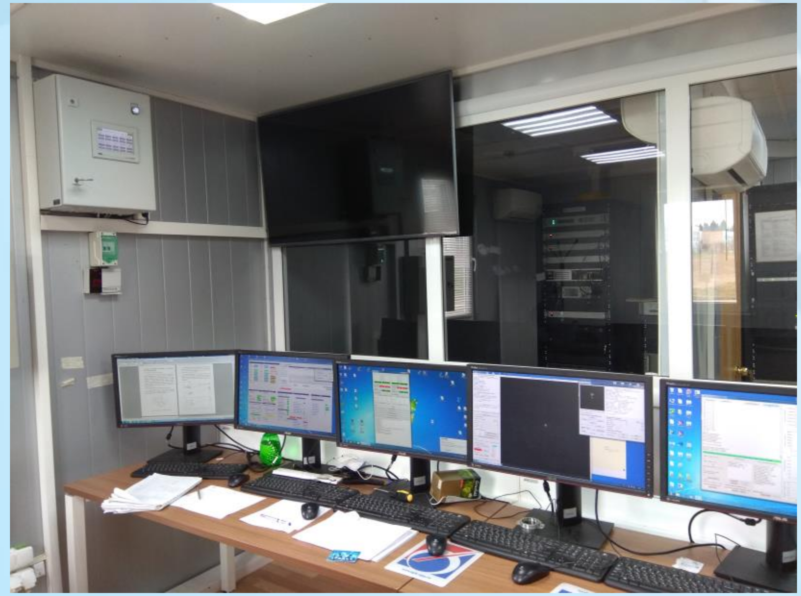
National Research Institute for
Physical-Technical and Radio Engineering Measurements

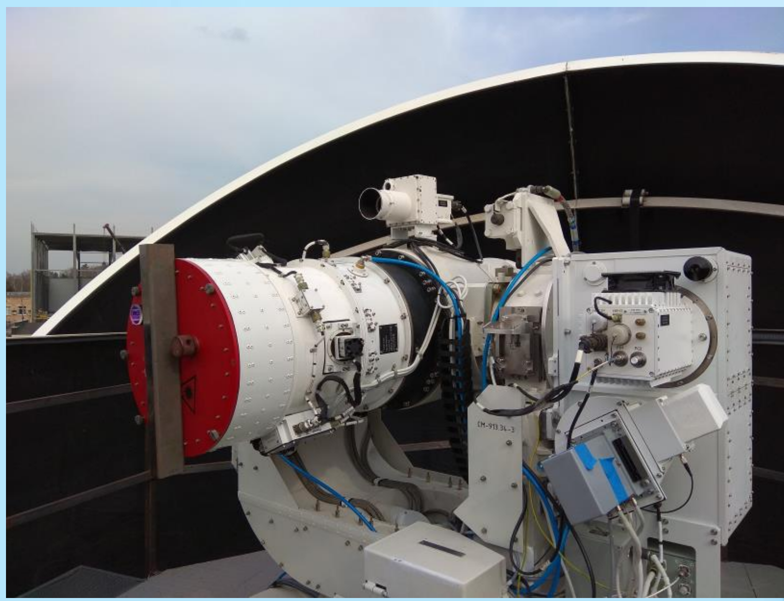
Mendeleevo 1874

I. Ignatenko, V. Ivanov, A. Drozdov

ILRS Networks and Engineering Standing Committee 2021

New generation laser station «Tochka»



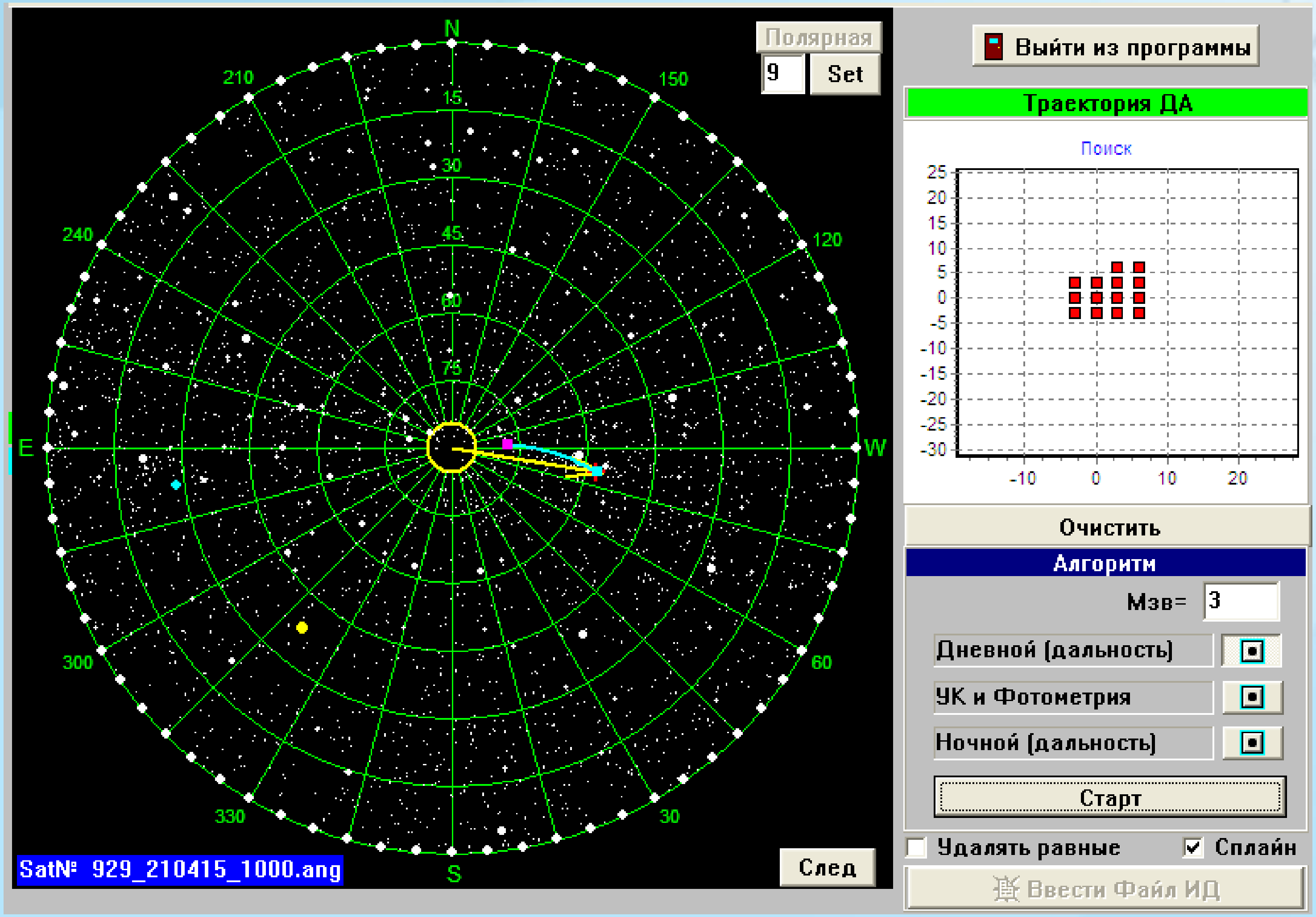


SLR station «Mendeleevo-1874»

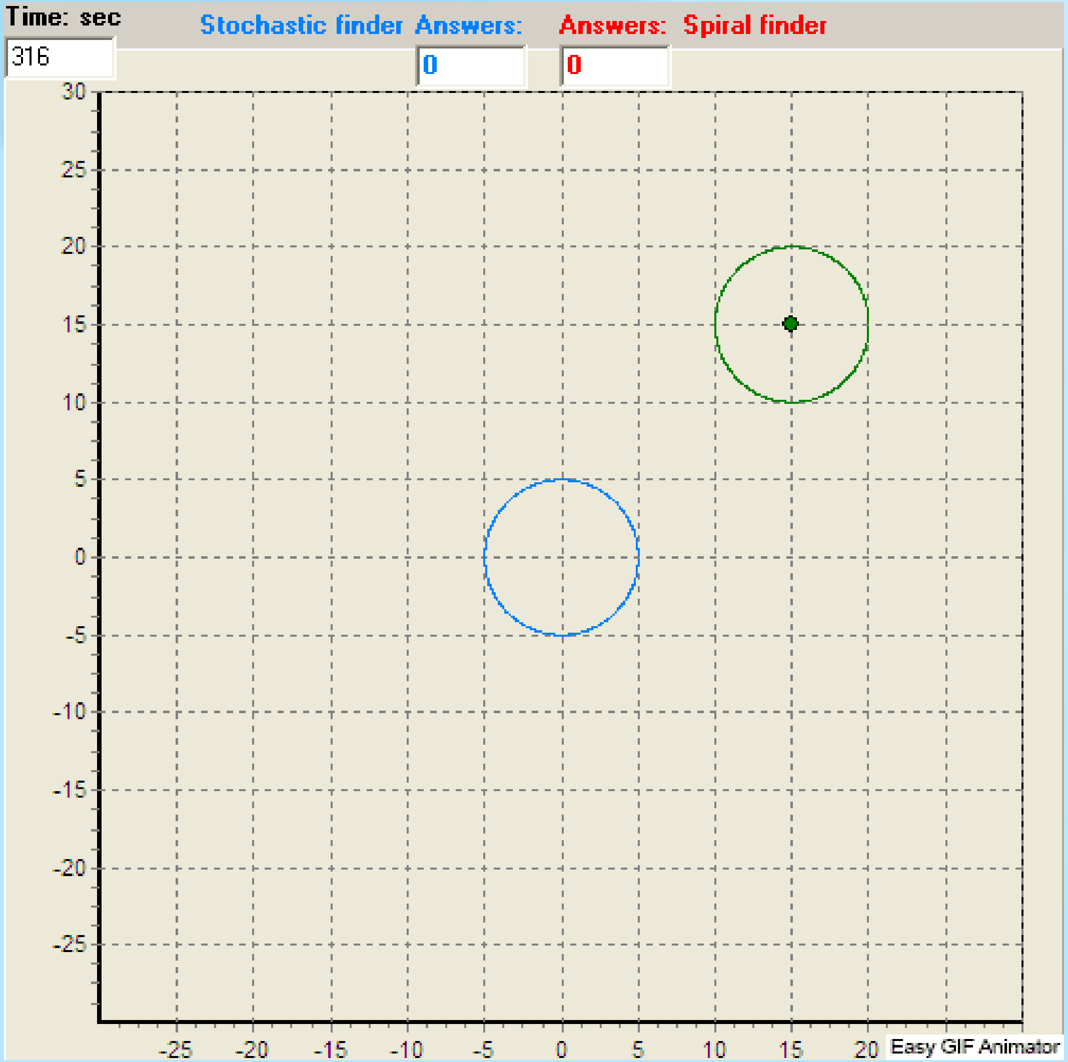
- Aperture 25 cm
- Laser repetition rate 300 Hz

VNIIFTRI

Guidance program with «spiral» algorithm



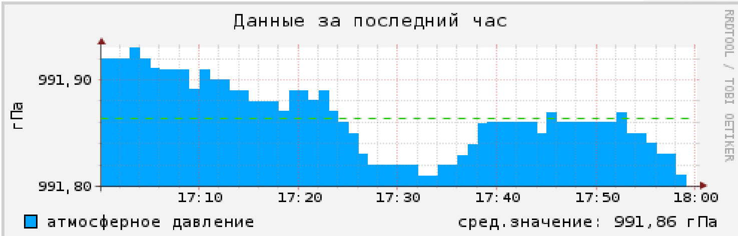
Modeling search algorithms

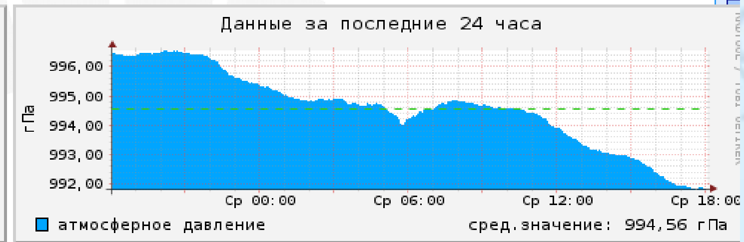


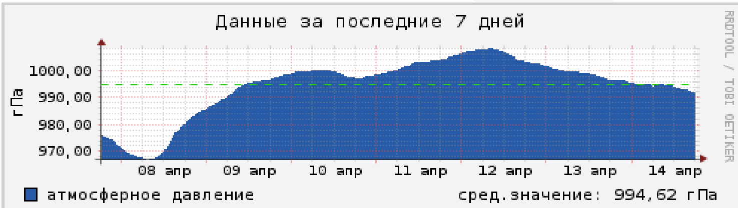
- Red — old search «Spiral» algorithm
- Blue — new Stochastic search algorithm
- Green — sattelite model

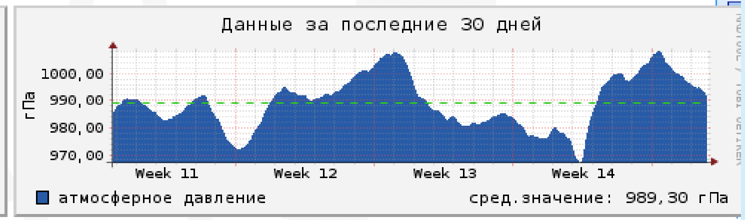
Verification of Atmospheric Pressure

14.04.2021 18:00:01 - 991.80 гПа









Измерения атмосферного давления производятся барометром **БРС-1М-1** заводской номер **0905144**, расположенный в корпусе 28 этаж -1 каб.011. Высота над уровнем моря ~**210 м**.

Данные за последний час, поминутно (гПа)

14.04.2021 18:00:00	991.80
14.04.2021 17:59:00	991.81
14.04.2021 17:58:00	991.83
14.04.2021 17:57:00	991.83
14.04.2021 17:56:00	991.84
14.04.2021 17:55:00	991.85
14.04.2021 17:54:00	991.85
14.04.2021 17:53:00	991.87
14.04.2021 17:52:00	991.86
14.04.2021 17:51:00	991.86
14.04.2021 17:50:00	991.86

Данные за последние 24 часа, среднее значение за 10 минут (гПа)

14.04.2021 18:00:00	991.84
14.04.2021 17:50:00	991.86
14.04.2021 17:40:00	991.83
14.04.2021 17:30:00	991.85
14.04.2021 17:20:00	991.89
14.04.2021 17:10:00	991.91
14.04.2021 17:00:00	991.94
14.04.2021 16:50:00	991.98
14.04.2021 16:40:00	992.05
14.04.2021 16:30:00	992.11
14.04.2021 16:20:00	992.22

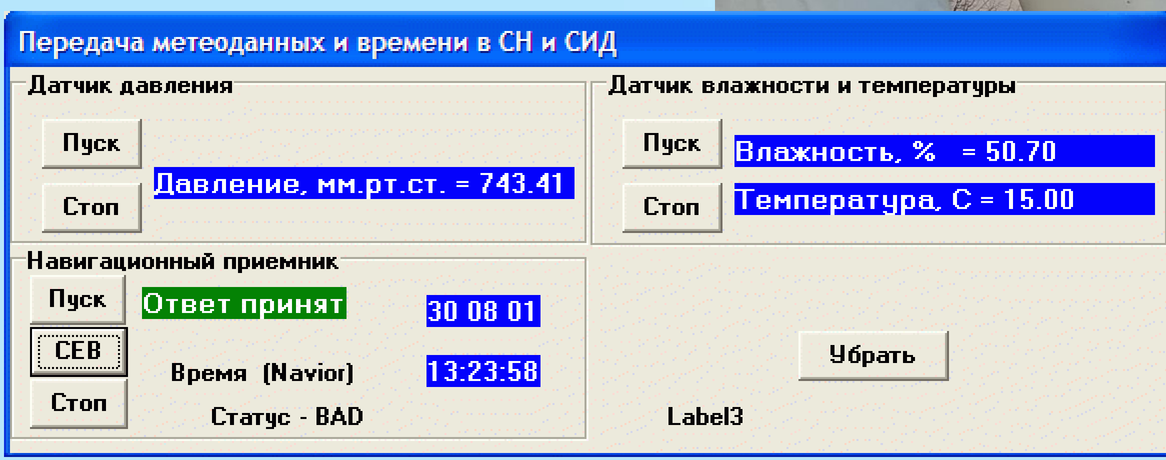
Sensors Calibration in VNIIFTRY

Stationary calibration facility for atmospheric pressure measuring instruments

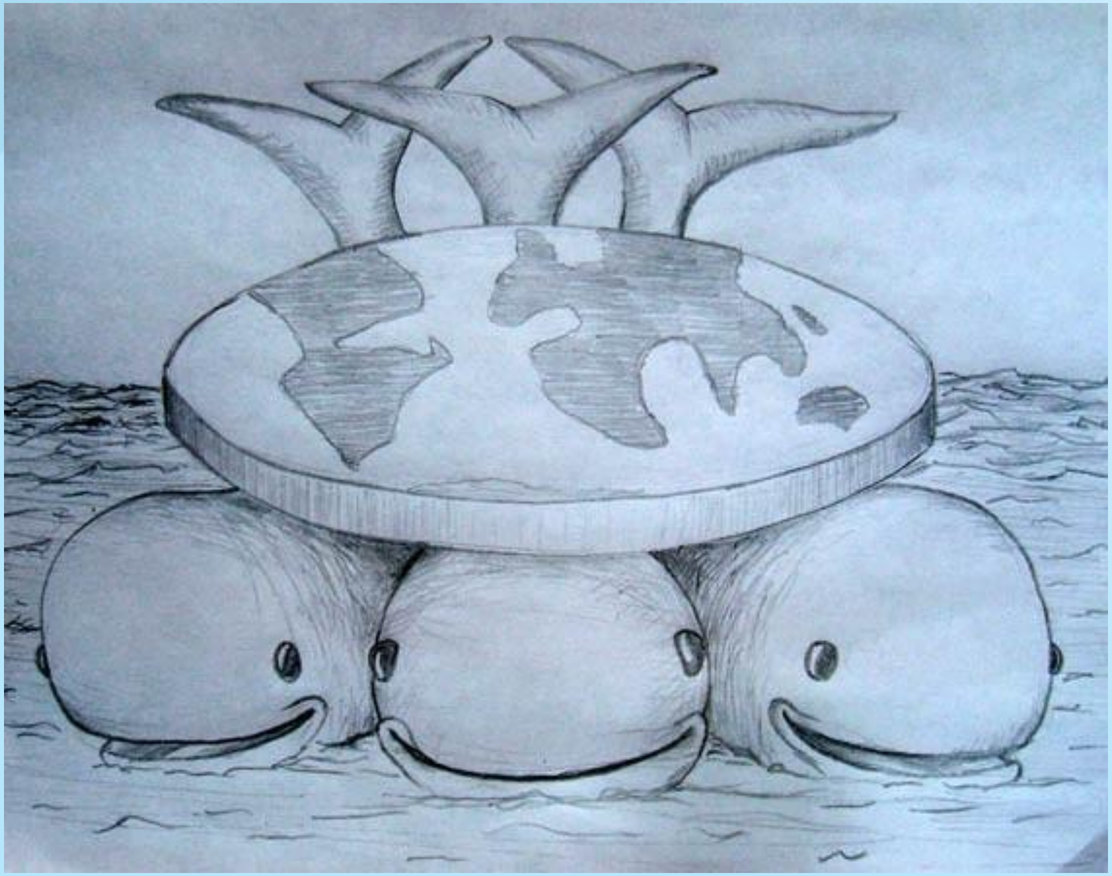
Stationary calibration complex for air humidity sensors

Stationary calibration complex for air temerature sensors

Control of Meteorological Parameters In action



VNIIFTRI



Thanks!! ☺

Special gratitude to our colleagues, who participated in the discussion of the issues involved.

VNIIFTRI

Accurate Time Transfer

by laser link

SLR is the only (optical) 2-way technique in space geodesy

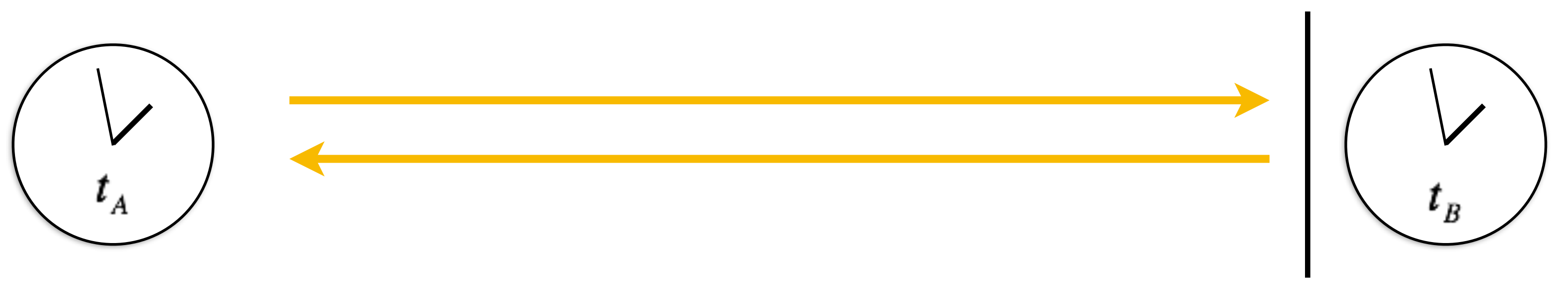
consequence: It is ideal to compare (synchronize) clocks in different inertial systems

applications in fundamental physics (GR)

in a nutshell: coherent clocks in space geodesy: higher resolution, less errors

Einstein Synchronization

2 clocks are operated in two different inertial systems.
How can we synchronize them?



We send a light pulse at t_A from clock A to clock B, which is detected and reflected at clock B. It returns back to clock A at t'_A. The time of arrival at clock B in the timescale of clock A can be computed as:

$$t_B = t_A + \frac{t'_A - t_A}{2}$$

Good clocks on Satellites make clock comparisons globally available

For non-common view time transfer we need: **satellite + clock**

For common view clock comparisons we only need: **0-delay reflector**

OPEN ACCESS
IOP Publishing | Bureau International des poids et Mesures Metrologia

Metrologia **58** (2021) 025009 (9pp) https://doi.org/10.1088/1681-7575/abde9e

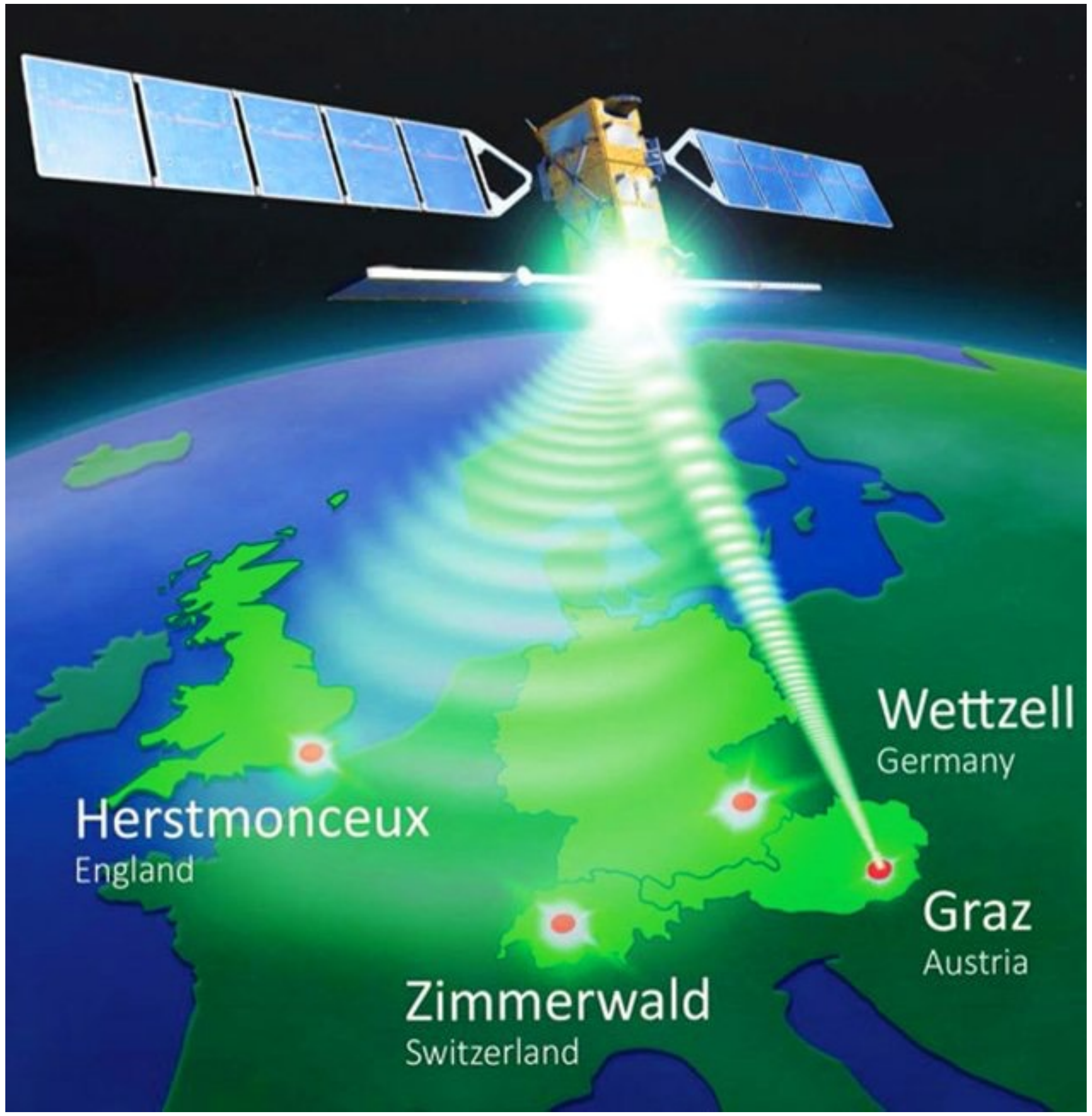
Accurate ground-to-ground laser time transfer by diffuse reflections from tumbling space debris objects

T Liu[1], J J Eckl[2], M Steindorfer[3], P Wang[3] and K U Schreiber[1,*]

[1] Technical University of Munich, Research Unit Satellite Geodesy, Geodetic Observatory Wettzell, 93444 Bad Kötzting, Germany
[2] Bundesamt für Kartographie und Geodäsie, Geodetic Observatory Wettzell, 93444 Bad Kötzting, Germany
[3] Space Research Institute, Austrian Academy of Sciences, Lustbühelstraße 46, A-8042 Graz, Austria

E-mail: ulrich.schreiber@tum.de

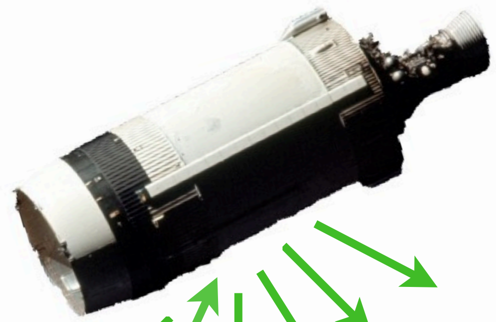
... we remember the Space Debris campaign 2015



- one station transmits
- several stations detect

- space target acts as 0-delay reflector

Now we adapt the same concept for time transfer

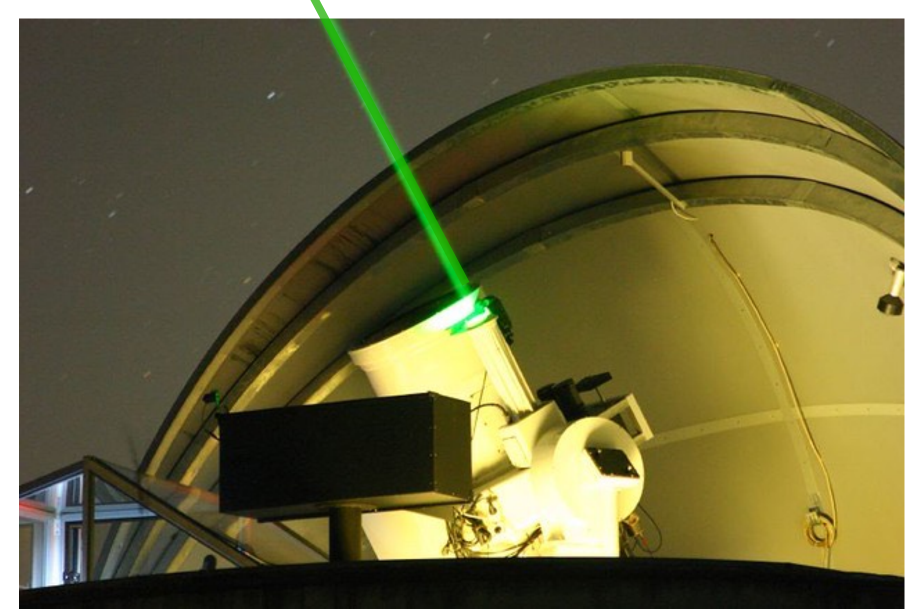


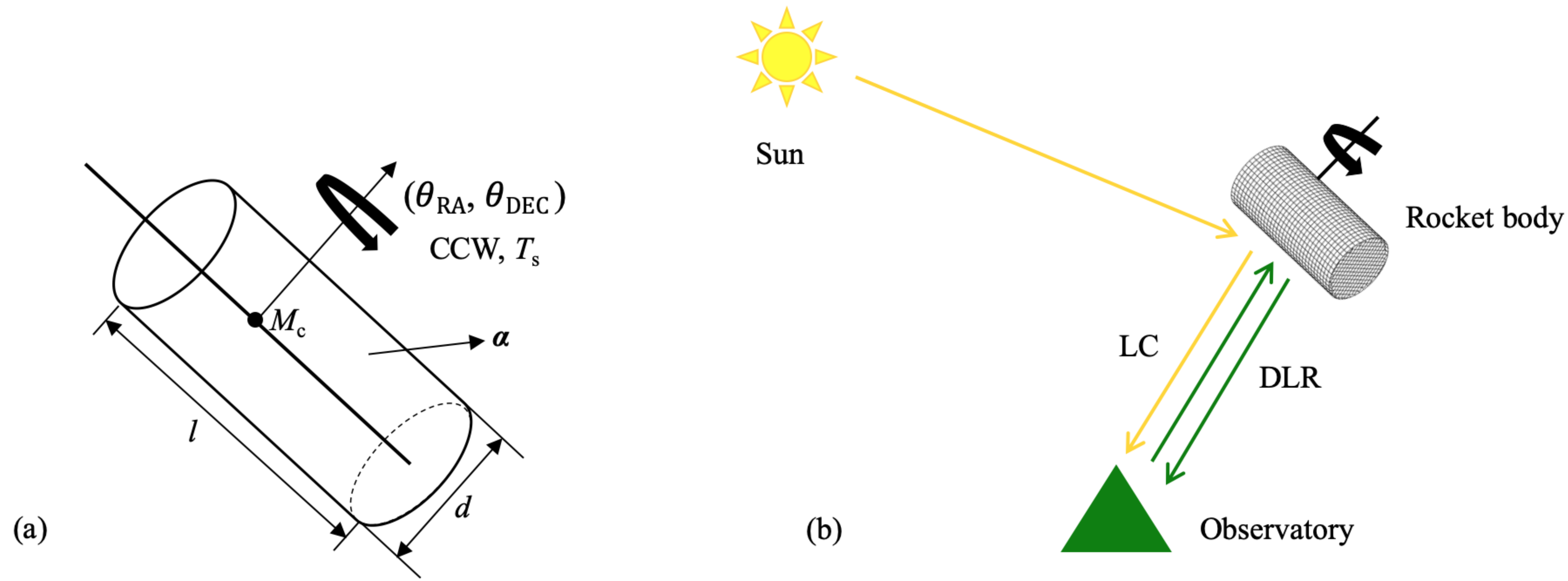
basic concept

- one station transmits
- it detects its own signal
- the other station detects the returns too

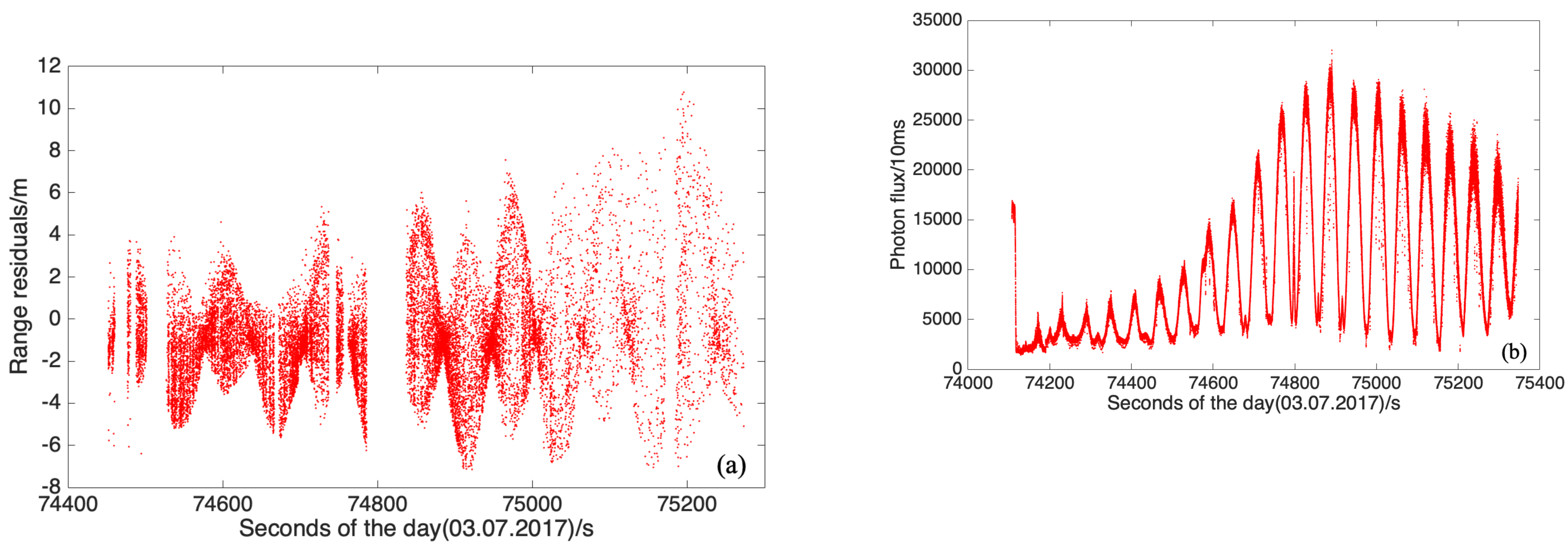
highly dynamic situation

- satellite motion along the orbit
- target tumbling motion
- reflection model for target

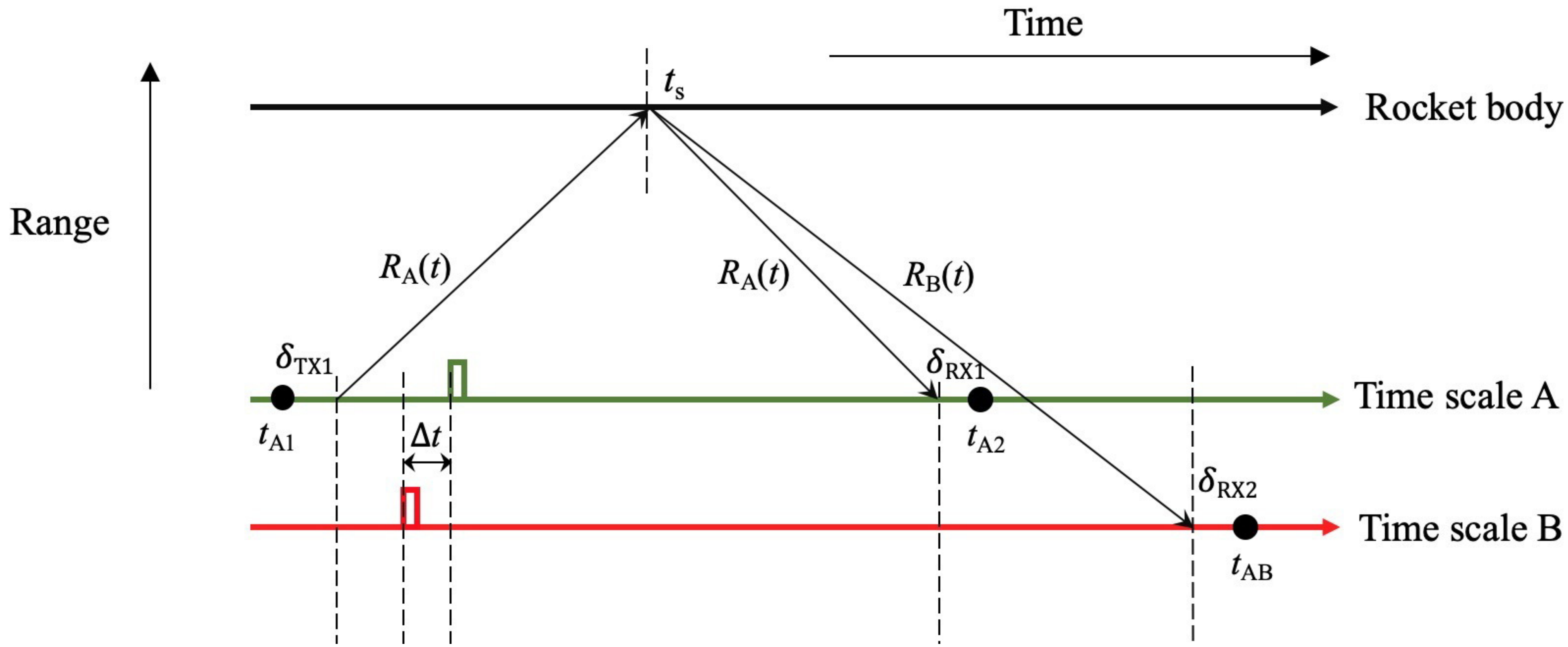




(θRA, θDEC)
CCW, Ts
Mc
α
l
d
(a)
Sun
Rocket body
LC
DLR
Observatory
(b)



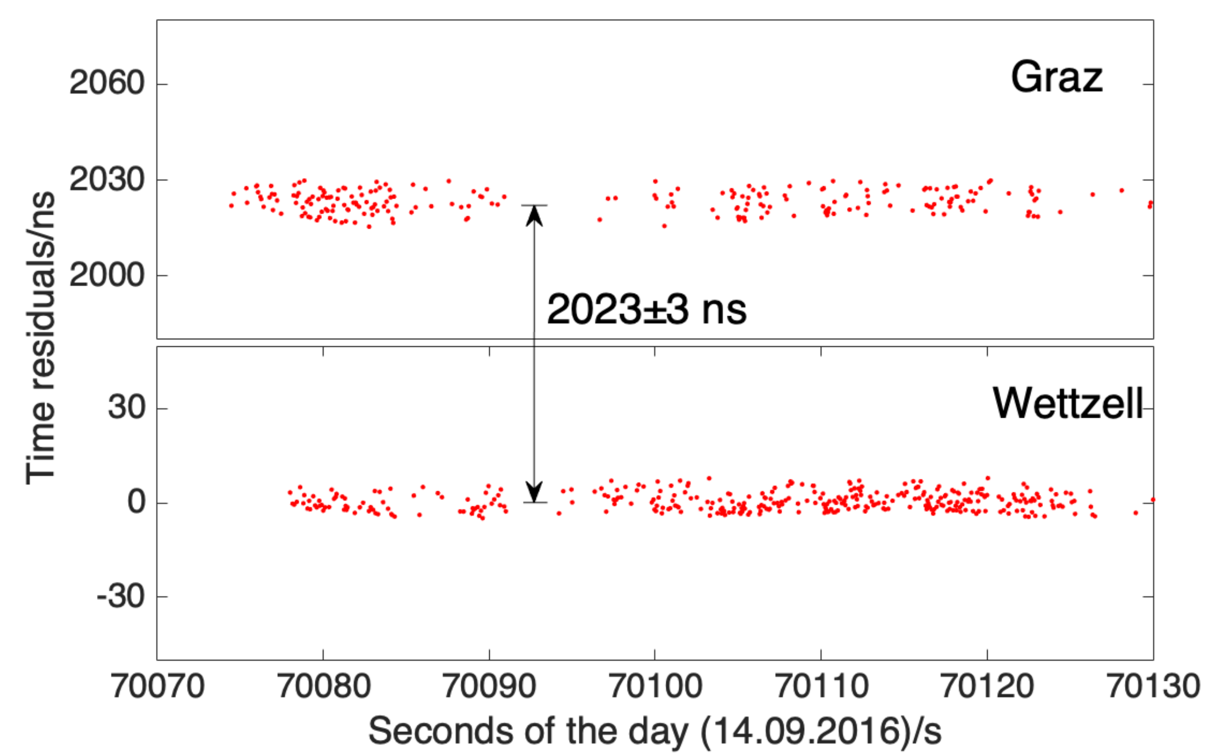
Range residuals/m
Seconds of the day(03.07.2017)/s
(a)
Photon flux/10ms
Seconds of the day(03.07.2017)/s
(b)



- Although only one pass was published, we had about 8 useful ones with some consistency.
- At the time the start epoch was not recorded with sufficient resolution in Graz
- There was no good clock in Graz

There are plans to redo these things:

- We have a Cs clock waiting for Graz
- We want to use better targets
- We want to go bi-directional
- There are similar plans with Grasse



$\Delta t \approx 0.5$ ns per pass appears possible

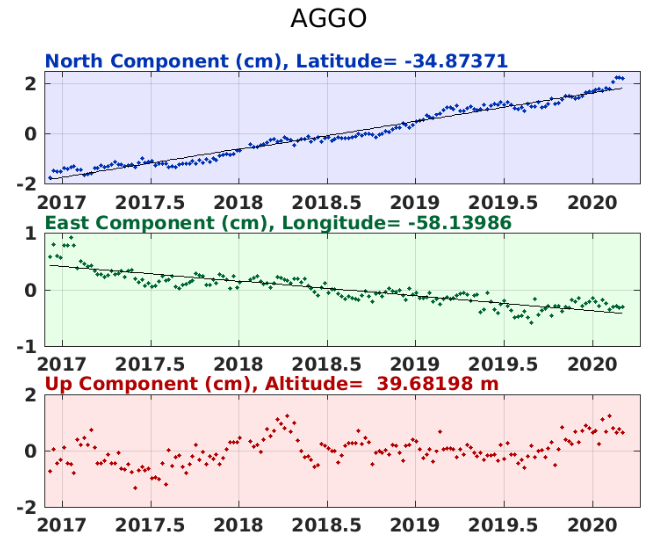
AGGO SLR

Michael Häfner, BKG
Florencia Toledo, CONICET

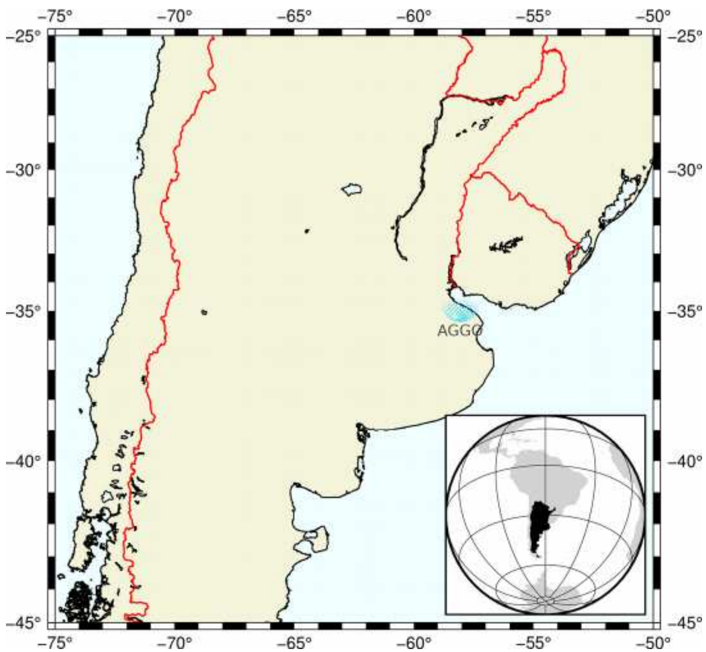
ILRS NESC, 15.04.2021

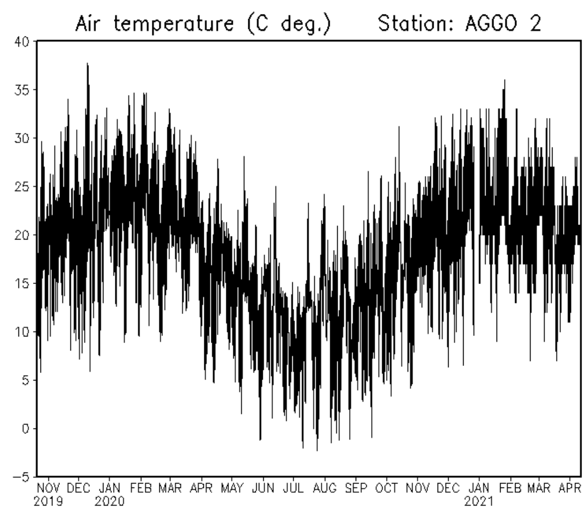
Location

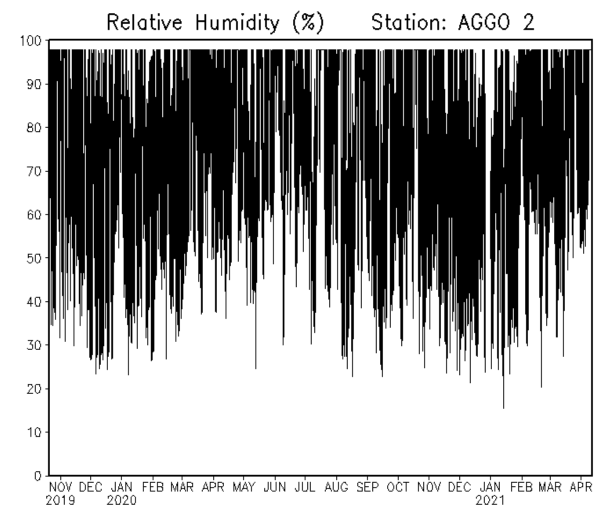
- Close to La Plata, Buenos Aires and La Plata River
- Stable site: continous drift 1.15 cm/y NNW direction
- Low altitude, warm and humid clima



Courtesy Romina Galván





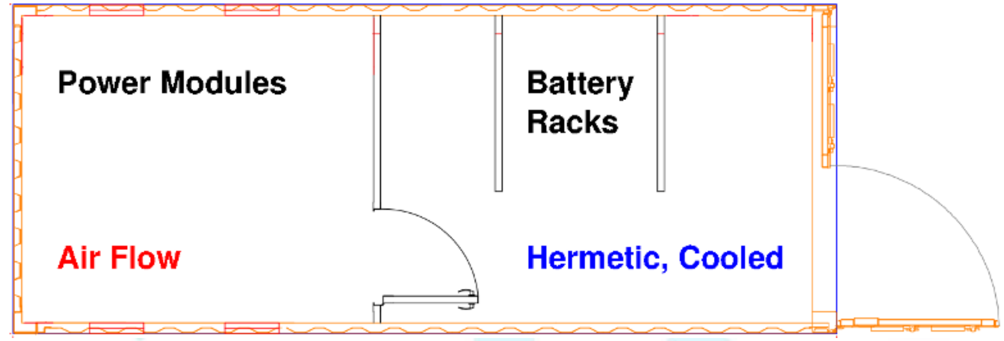


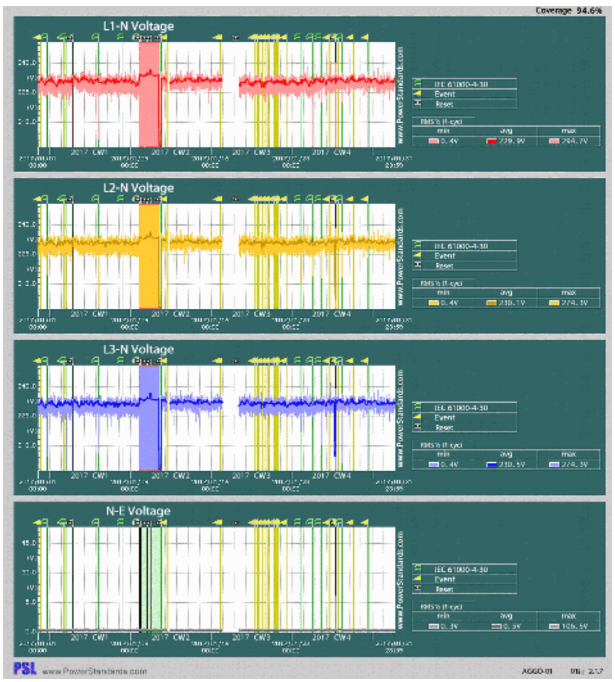
Courtesy Pablo Antico

Infrastructure

- Rural Area: Poor quality of Power Line
- Delays in supply chain
- Solution: Backup SLR system with UPS
- Lead battery hazard at T > 25 °C
- Future: Flywheel Solution?

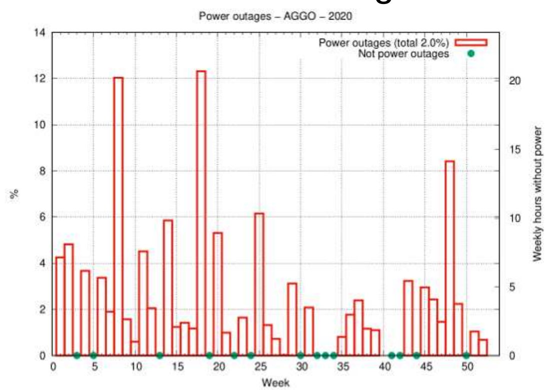
UPS Container





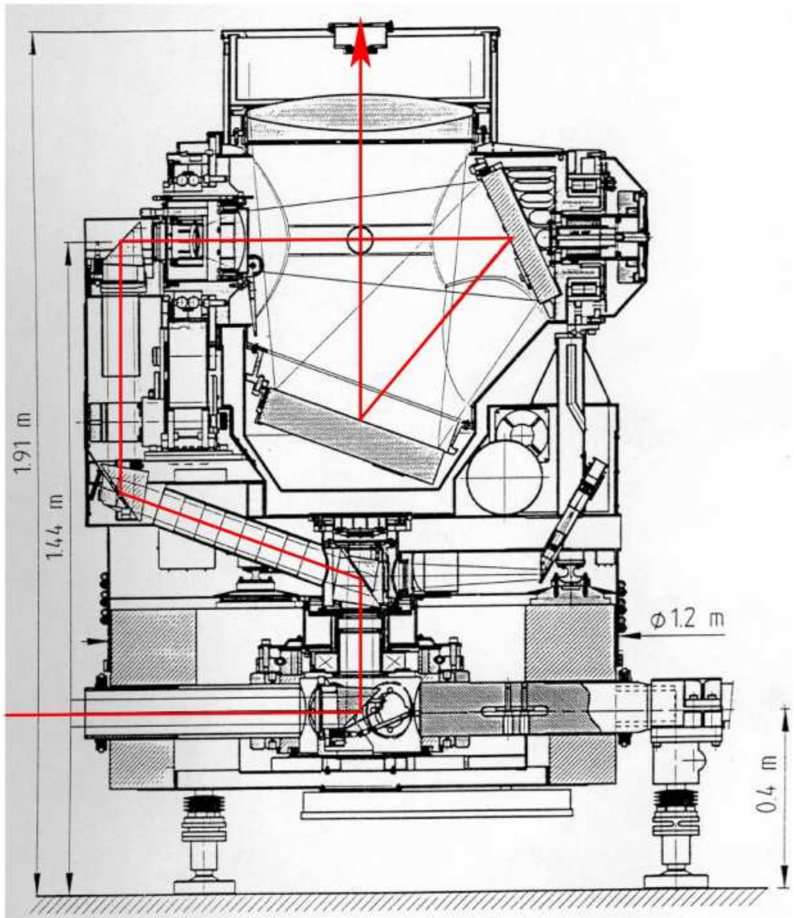
Power Line analysis:
~1000 events in 01/2017

Ø 2020: 2 outages/week
2 h/outage



Courtesy Federico Bareilles

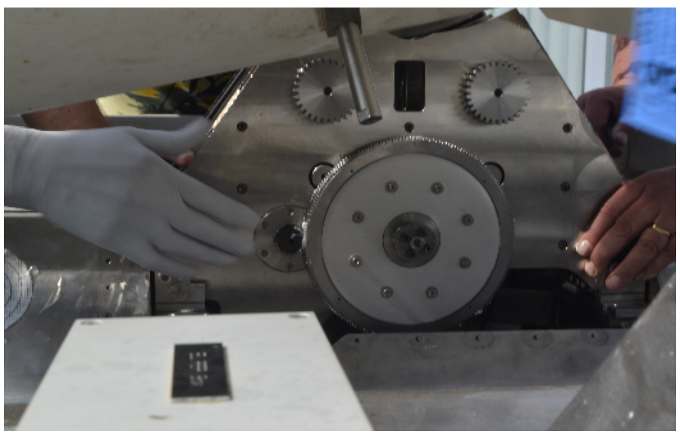
System setup

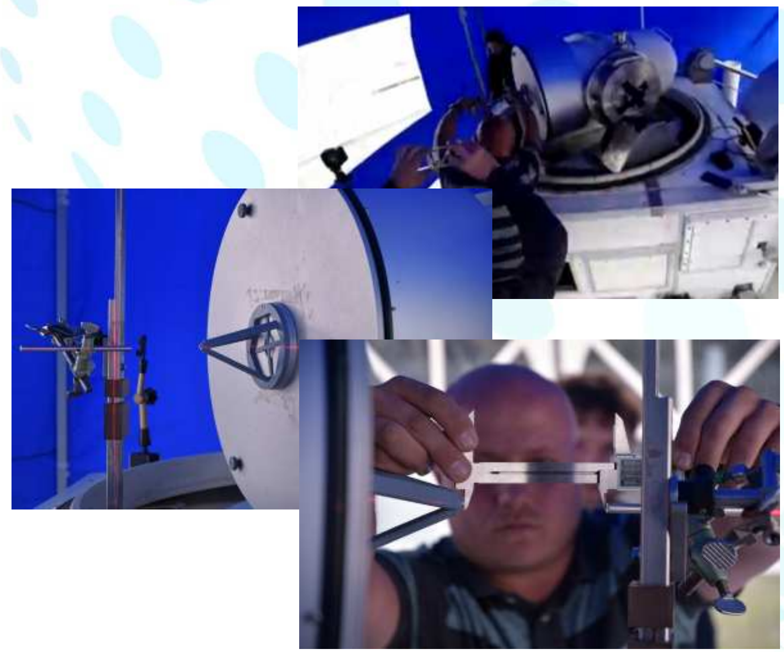


General	Monostatic system Az-El mount Transportable
Telescope	50 cm Galilean Refractor 10 m focal length
Laser	Ti:Sa 847nm & 423.5 nm 12 mJ @ 100 Hz 35 ps pulse length
Signal Chain	C-SPAD, PET

2019: Elevation Gearbox Overhaul

- No sophisticated tools needed
- Telescope tube remains sealed
- Simple alignment procedure



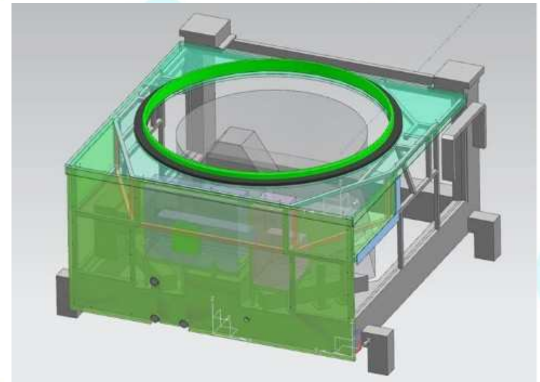


Since 2017: Overhaul Telescope Control Unit (TCU)

TCU Hardware reached end of lifetime; transportability no longer needed.

New TCU:

- Motor controls at telescope
- Overhaul cart and cabling
- Control system based on industry standard PLC
- Easy error detection and maintenance
- Acceptance Test 12/2018
- Hardware arrived 01/2020
- On-site Installation 02/2020 postponed
- Outlook: Continue with old TCU once UPS installed



Capacity Building

Build up a regional SLR community

- 12/2017: 2nd LA SLR-Workshop in Mendoza
- 09/2019: GGRF Workshop IGN/AGGO in Buenos Aires
- 11/2019: 3rd LA SLR-Workshop in Rio de Janeiro
- 04/2021: UNLP/AGGO Virtual School in La Plata
  >140 participants, 16 countries

michael.haefner@bkg.bund.de