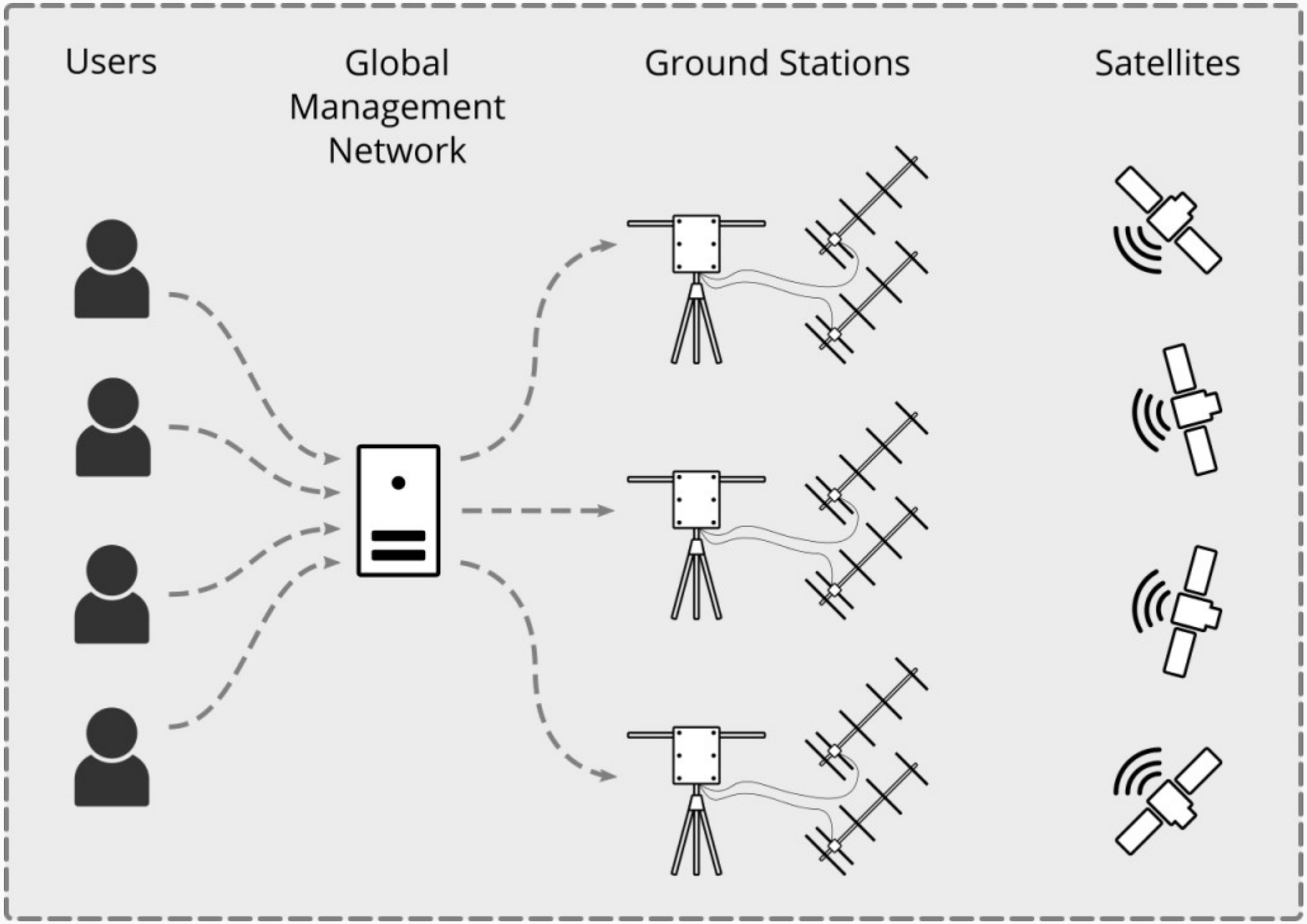
SatNOGS

Un réseau open source de station sol pour les satellites en orbites basses.

Par Julien NICOLAS 07/03/2020

Satellites défilants

- Durée de LOS assez courte
- Donc station sol inactive très souvent
- Nécessite des stations sol tout autour du monde
- Un réseau de partage et une communauté ont donc du sens


Users
Global Management Network
Ground Stations
Satellites


North Atlantic Ocean
Ponta Delgada
Ireland
Éire
United Kingdom
North Sea
Norge
Danmark
Latvija
Lietuva
Беларусь
Polska
Berlin
Deutschland
Paris
France
Bay of Biscay
España
Portugal
Italia
Roma
Hrvatska
Magyarország
România
Moldova
Україна
Київ
Москва
Србија
Shqipëria
Istanbul
Türkiye
Black Sea
Caspian Sea
Azerbaycan
Türkmenistan
O'zbekiston
Қазақстан
Kıbrıs
Mediterranean Sea
Casablanca
الدار البيضاء
المغرب
تونس
الجزائر
ليبيا
مصر
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Cabo Verde
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Dakar
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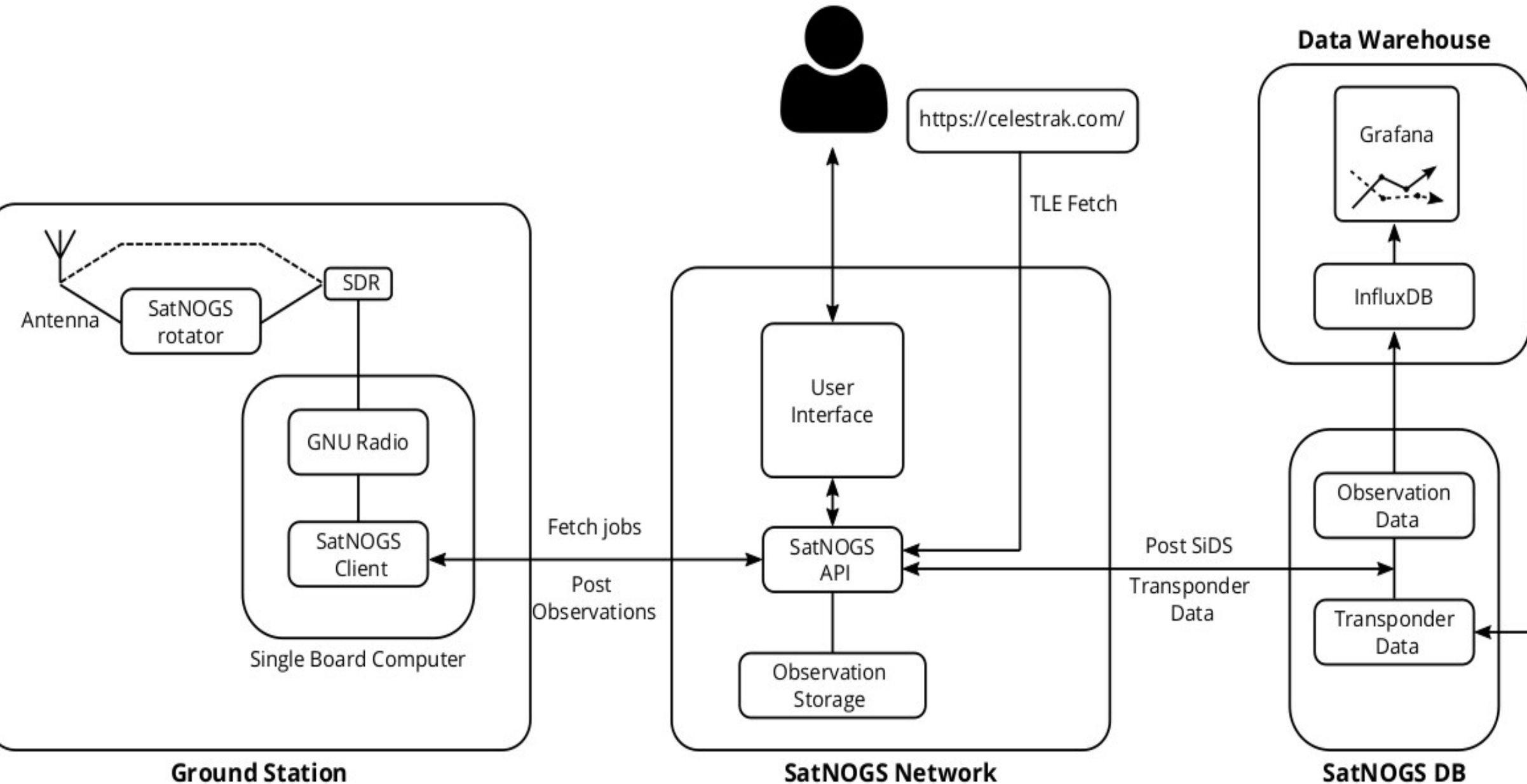
Liberia
Côte d'Ivoire
Bénin
Togo
Kano
Nigeria
South Sudan
Ethiopia
Eritrea
Djibouti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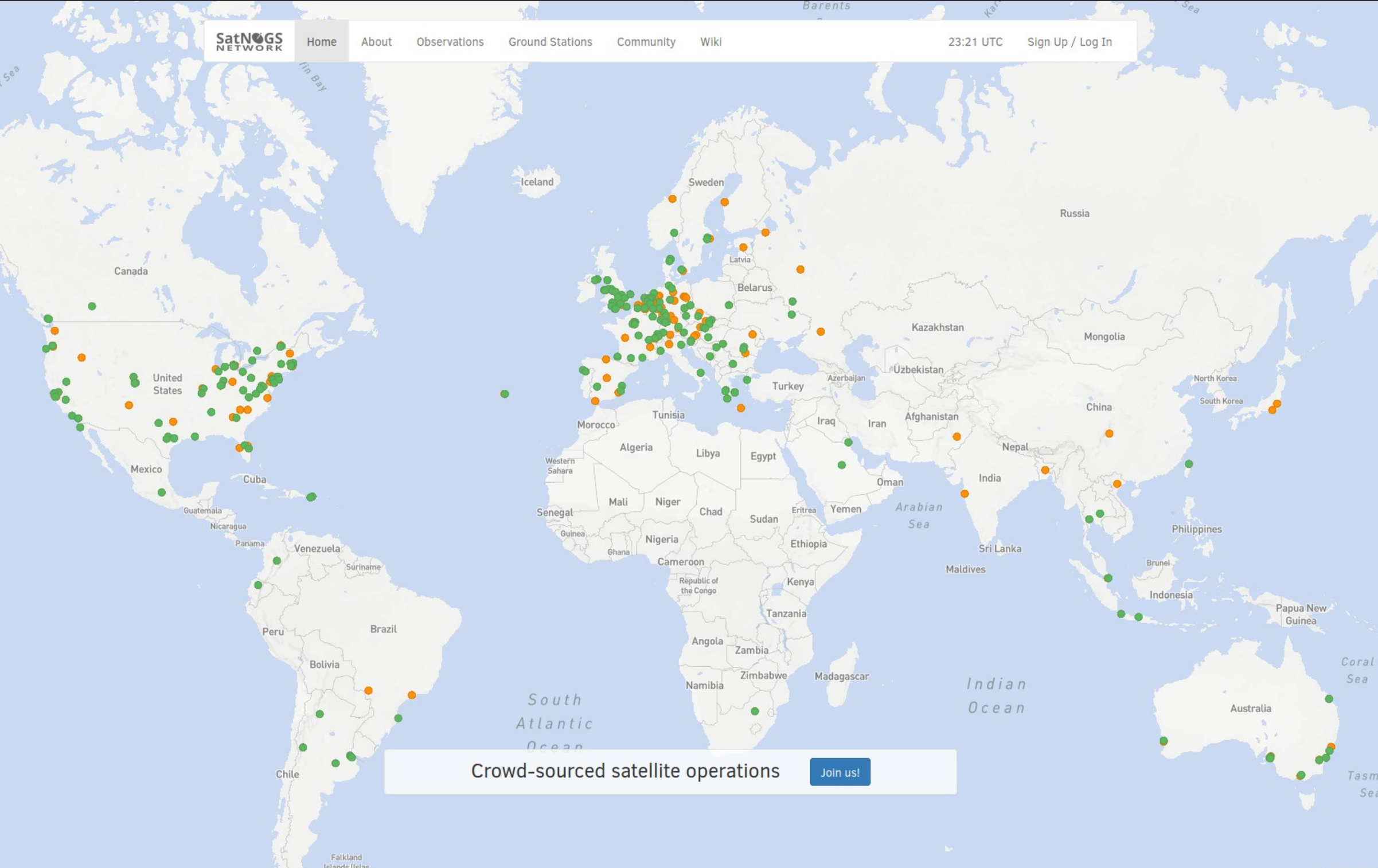
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Turkey
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Tunisia
Morocco
Iraq
Iran
Afghanistan
Algeria
Libya
Egypt
Nepal
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Mexico
Cuba
Oman
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Mali
Niger
Chad
Sudan
Eritrea
Yemen
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Guinea
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Ethiopia
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Ghana
Cameroon
Sri Lanka
Maldives
Suriname
Republic of the Congo
Kenya
Brunei
Indonesia
Tanzania
Papua New Guinea
Peru
Brazil
Angola
Zambia
Bolivia
Zimbabwe
Madagascar
Namibia
South Atlantic Ocean
Indian Ocean
Coral Sea
Australia
Chile
Falkland Islands (Islas

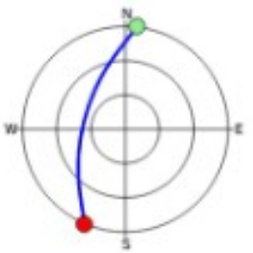
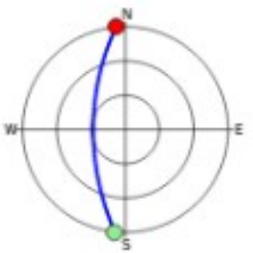
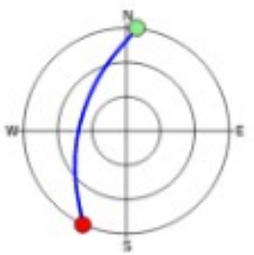
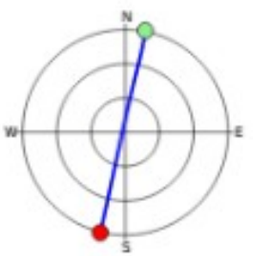
Pass predictions

Success Rate

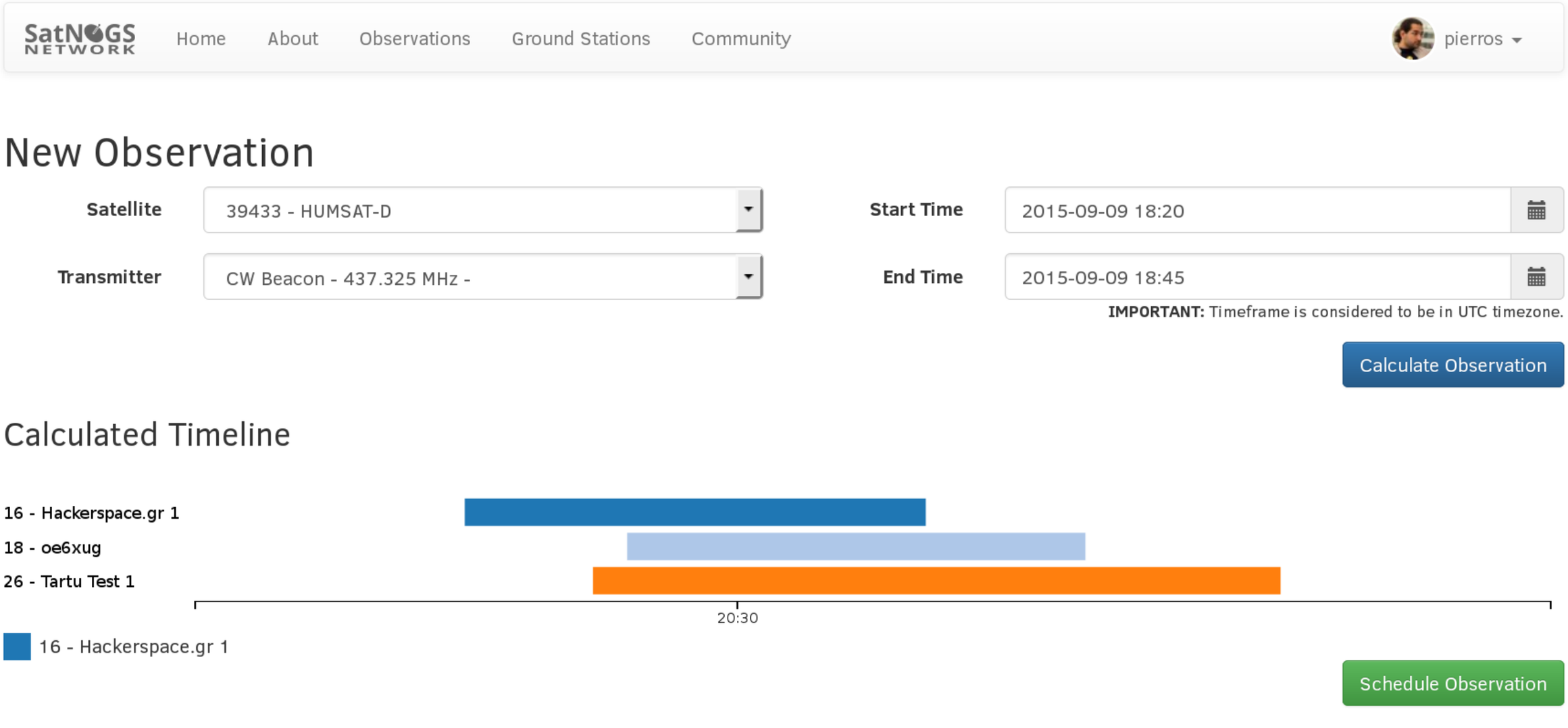
Max Elevation

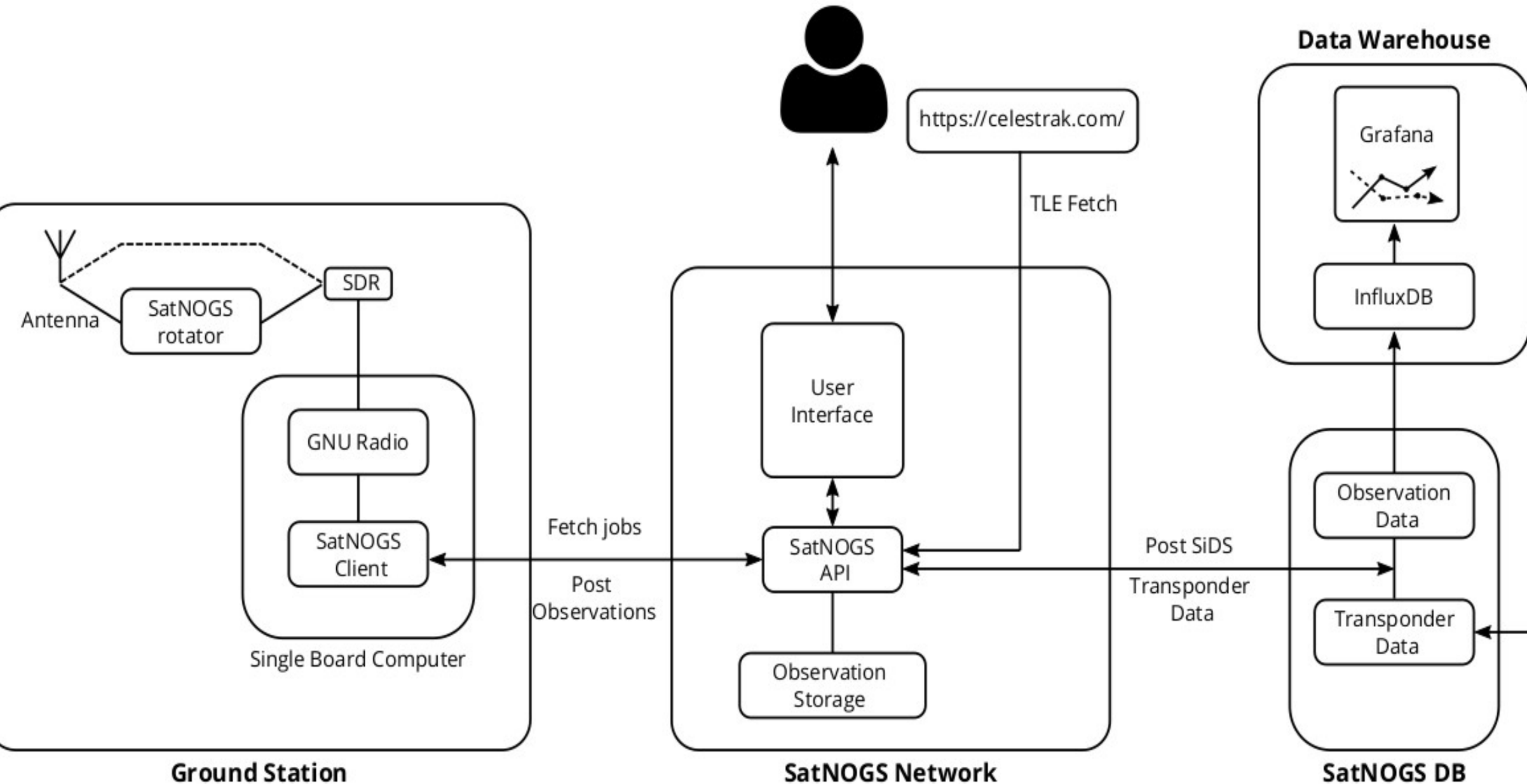
Overlap

Include unsupported satellites

Name	AOS	LOS	↑ ↔ ↓	Polar plot	
42775-AALTO-1	15:46 2018-10-30	15:57 2018-10-30	↑6° ↔53° ↓203°		schedule 40%overlap
965-TRANSIT 5B-5	16:11 2018-10-30	16:30 2018-10-30	↑186° ↔62° ↓355°		schedule 29%overlap
43137-FOX-1D	16:13 2018-10-30	16:25 2018-10-30	↑6° ↔49° ↓205°		schedule
43155-Xiaoxiang-2	16:32 2018-10-30	16:44 2018-10-30	↑11° ↔87° ↓194°		schedule 43%overlap

Programmer une observation

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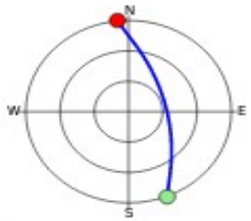
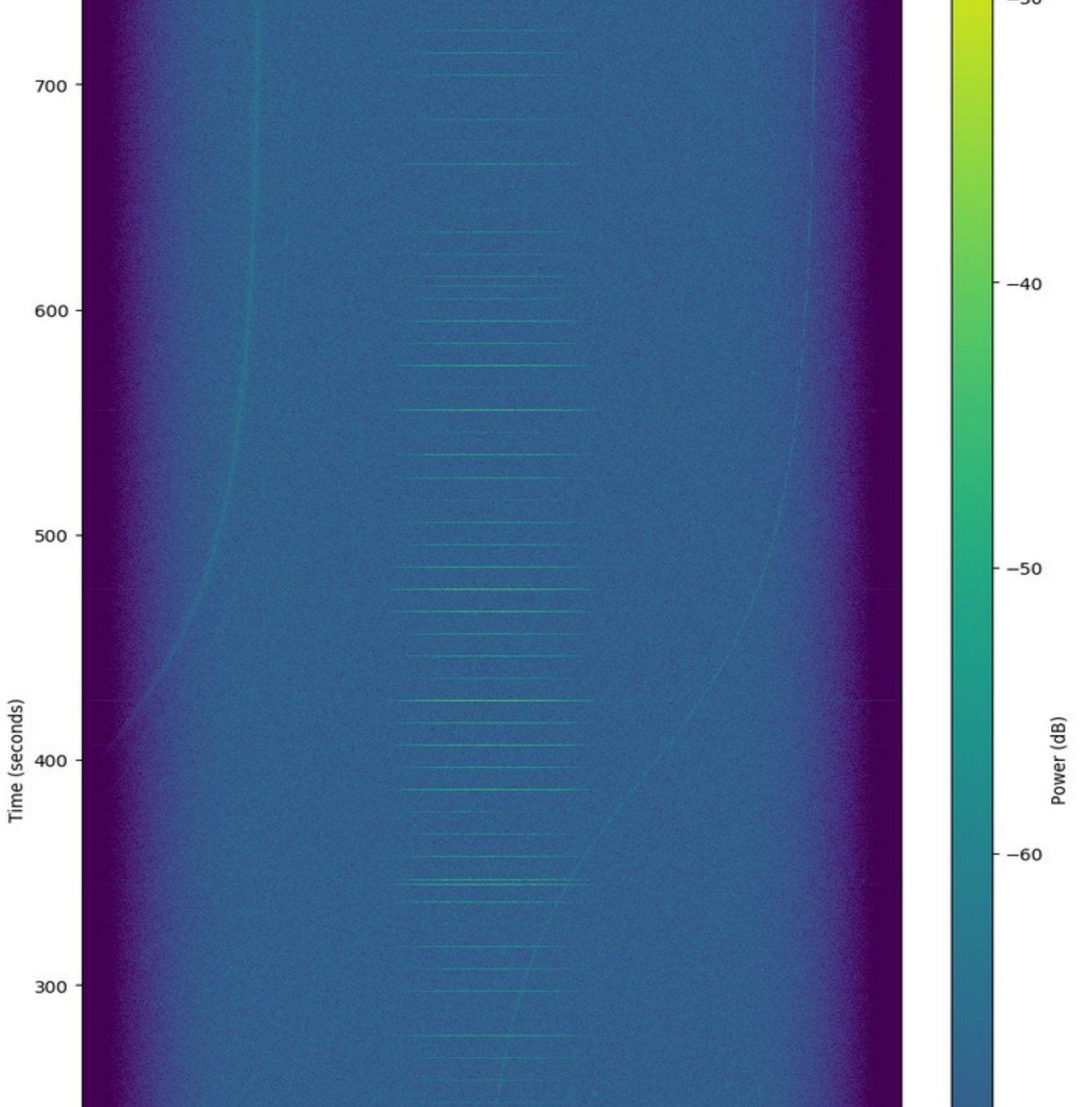
La station sol

- Image carte uSD pour raspberry
  - Client en python qui exécute les observations
  - Interface web propre à la station
  - Démodulation avec Gnuradio

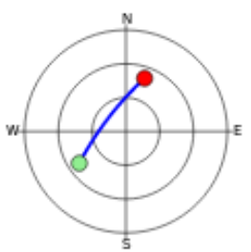
Satellite	40012 - UNISAT-6
Station	50 - N5CNB-UHF
Observer	n5fxh
Status	Good
Transmitter	9k6 FSK TLM
Frequency	437.421 MHz
Encoding	FSK9k6
Timeframe	2019-04-12 14:32:23 2019-04-12 14:45:47
Rise	158.0°
Max	57.0°
Set	354.0°
Client Version	0.8
Metadata	▶ { 4 items }
Polar Plot	
Downloads	Audio Waterfall



Observation #526273

Timeframes are in UTC

Discuss

Satellite	40968 - BISONSAT
Station	488 - W7KKE
Observer	W7KKE Ken Swaggart
Status	Good
Transmitter	Telemetry
Frequency	437.375 MHz
Encoding	FSK9k6
Timeframe	2019-03-11 05:33:01 2019-03-11 05:36:54
Rise	236.0°
Max	70.0°
Set	19.0°
Client Version	0.9
Metadata	▶ { 5 items }
Polar Plot	
Downloads	Audio Waterfall

Waterfall | Audio | Data 5

ASCII HEX

data_obs/526273/data_526273_2019-03-11T05-33-22

```
AE 90 64 B0 A0 9A 60 9C 6E A6 96 86 40 E1 03 F0 50 00 00 00 00 01 00 42 45 41 57 48 32
58 50 4D 11 02 11 05 48 47 48 A0 32 CB 8D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 A6 FF F3 99 F2 FF F3 FF F3 02 F0 FF F3 FF F3 B5 F2 FF F3 FF F3 02 F0 FF F3
A2 F2 FF F3 44 F1 9E F0 FF F3 48 F3 43 F1 9F F0 0E F3 18 F3 FF F3 3F F3 E8 F2 FF F3 C4
FE BC FF C4 FE 60 F2 F4 FD 3B FF D5 FF 00 00 00 00 00 00 03 05 01 06 01 08 02 00 00 00
01 F0
```

data_obs/526273/data_526273_2019-03-11T05-34-23

```
AE 90 64 B0 A0 9A 60 9C 6E A6 96 86 40 E1 03 F0 50 00 00 00 00 01 00 42 45 41 57 48 32
58 50 4D 11 02 11 05 49 49 05 AC 4A CB 8D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 A6 FF F3 AB F2 FF F3 FF F3 02 F0 FF F3 FF F3 C0 F2 FF F3 FF F3 03 F0 FF F3
B3 F2 FF F3 44 F1 9F F0 FF F3 48 F3 45 F1 A0 F0 0E F3 17 F3 FF F3 3F F3 FA F2 FF F3 C8
FE E0 FF B0 FD B0 F1 0C FD D0 00 10 00 00 00 00 00 00 00 03 05 01 06 01 08 02 00 00 00
01 F0
```

data_obs/526273/data_526273_2019-03-11T05-35-25

```
AE 90 64 B0 A0 9A 60 9C 6E A6 96 86 40 E1 03 F0 50 00 00 00 00 01 00 42 45 41 57 48 32
58 50 4D 11 02 11 05 50 50 61 B8 62 CB 8D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 A6 FF F3 BE F2 FF F3 FF F3 02 F0 FF F3 FF F3 C9 F2 FF F3 FF F3 02 F0 FF F3
C3 F2 FF F3 45 F1 9F F0 FF F3 48 F3 44 F1 A1 F0 0E F3 18 F3 FF F3 3F F3 0B F3 FF F3 A0
FF 9C FF 4C FE 00 F1 8A FD 42 FF E7 FF 00 00 00 00 00 00 03 05 01 06 01 08 02 00 00 00
01 F0
```

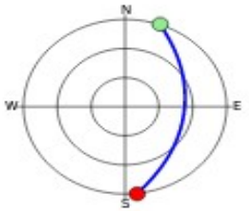
data_obs/526273/data_526273_2019-03-11T05-35-54

```
AE 90 64 B0 A0 9A 60 9C 6E A6 96 86 40 E1 03 F0 00
```

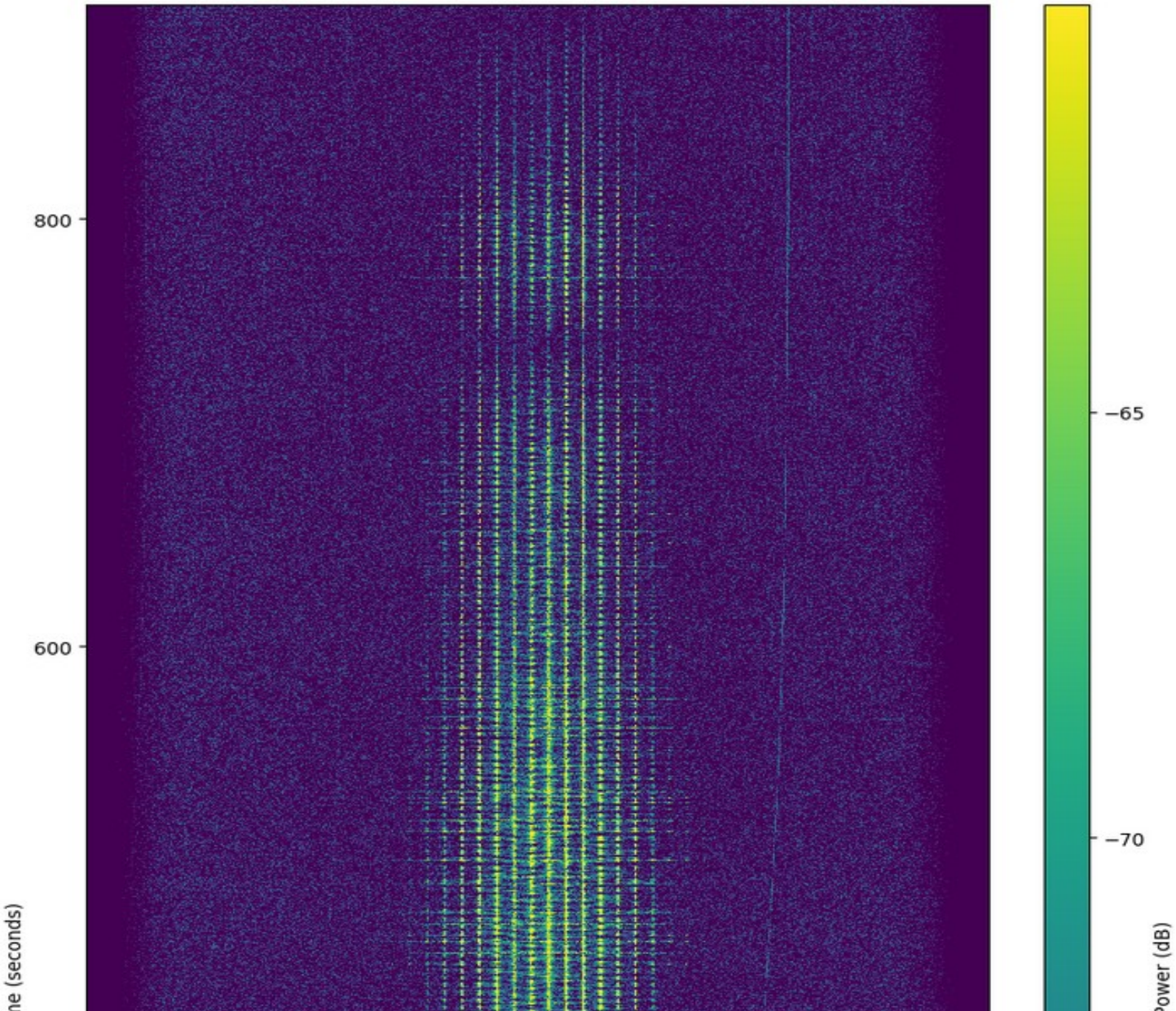
Observation #588503

Timeframes are in UTC

Discuss

Satellite	25338 - NOAA 15
Station	91 - M0EYT / 2E0NOG
Observer	uhf-satcom
Status	Good
Transmitter	APT Downlink
Frequency	137.620 MHz
Encoding	APT
Timeframe	2019-04-12 06:47:58 2019-04-12 07:03:01
Rise	20.0°
Max	37.0°
Set	173.0°
Client Version	0.9
Metadata	▶ { 5 items }
Polar Plot	
Downloads	Audio Waterfall

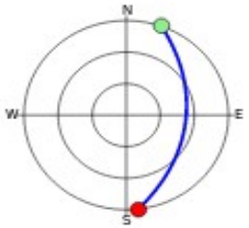
Waterfall | Audio | Data 1



Observation #588503

Timeframes are in UTC

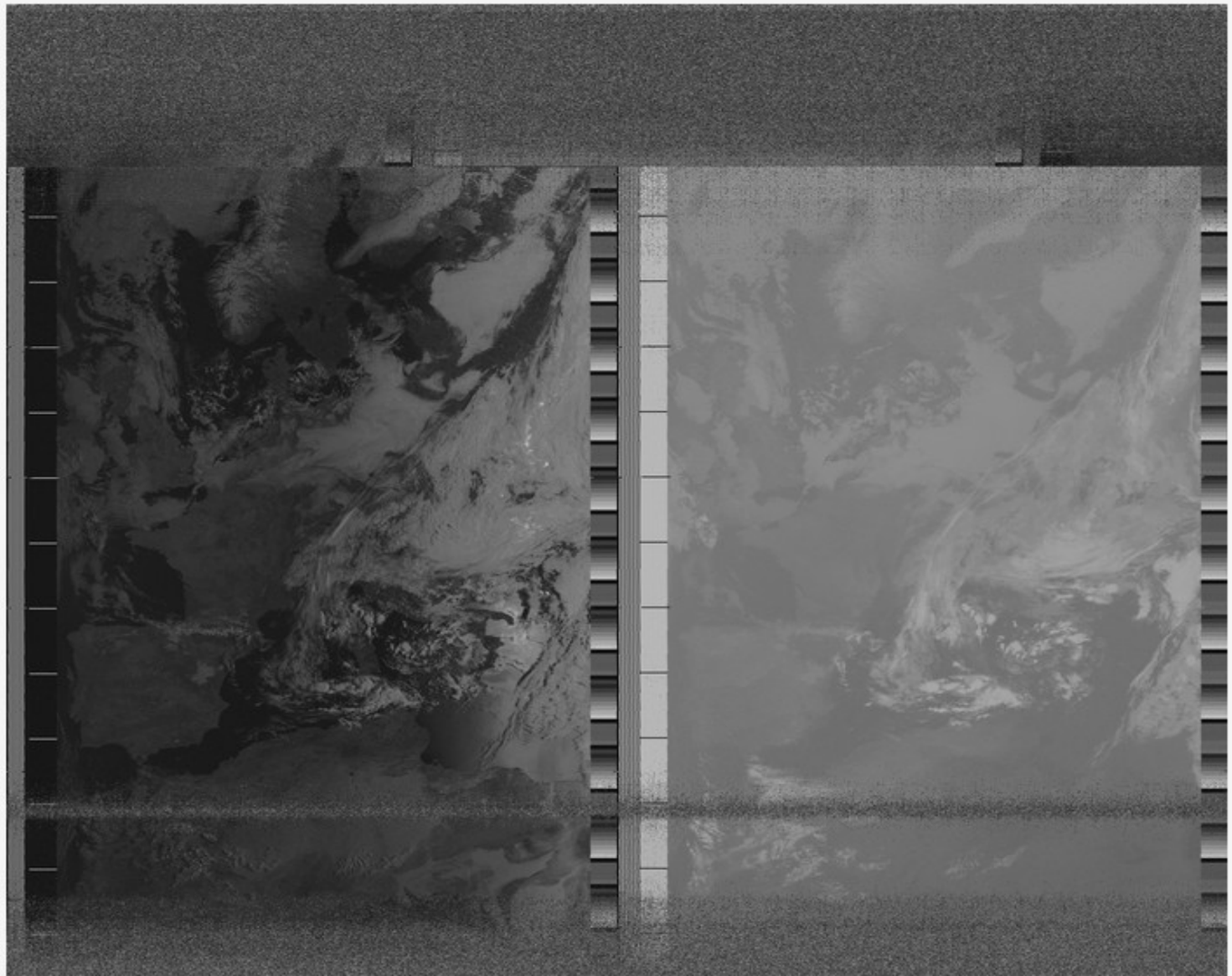
Discuss

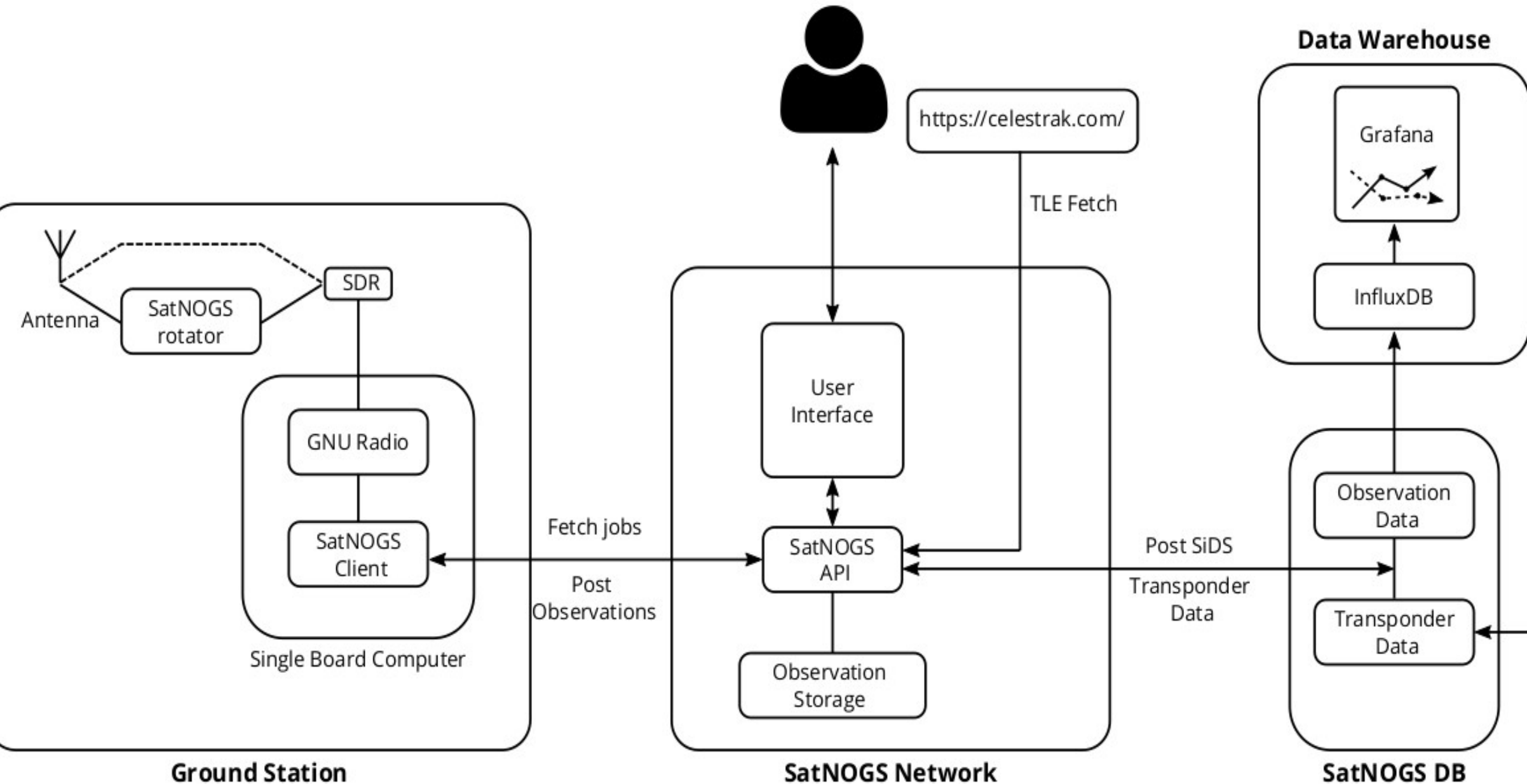
Satellite	25338 - NOAA 15
Station	91 - MOEYT / 2E0NOG
Observer	uhf-satcom
Status	Good
Transmitter	APT Downlink
Frequency	137.620 MHz
Encoding	APT
Timeframe	2019-04-12 06:47:58 2019-04-12 07:03:01
Rise	20.0°
Max	37.0°
Set	173.0°
Client Version	0.9
Metadata	▶ { 5 items }
Polar Plot	
Downloads	Audio Waterfall

Waterfall | Audio | Data 1

ASCII HEX

data_obs/588503/data_588503_2019-04-12T06-47-58.png

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Telemetry / BUGSAT-1

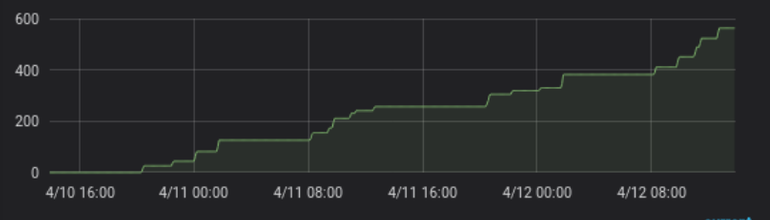
Last 2 days UTC

suid 40014

Messages

Time	message
2019-04-12 12:47:28	EMAIL :tita@satellogic.com Upt: 16:30:00 Bat:12.14v Temp:33.1C Gyr:1.46d/s
2019-04-12 12:44:45	EMAIL :tita@satellogic.com Upt: 16:27:15 Bat:12.09v Temp:32.9C Gyr:1.48d/s
2019-04-12 12:44:43	EMAIL :tita@satellogic.com Upt: 16:27:15 Bat:12.09v Temp:32.9C Gyr:1.48d/s

Frame count



	current
Frames	563

Mode

4

Last frame

12:47:59

Last Frame Rcvd By

CGBSAT-UHF-JO32eu

Reset Count

1910

Fm

LU7AA

Low Voltage Count

4

To

CQ

Uptime

16 hours, 30 minutes, 30 seconds

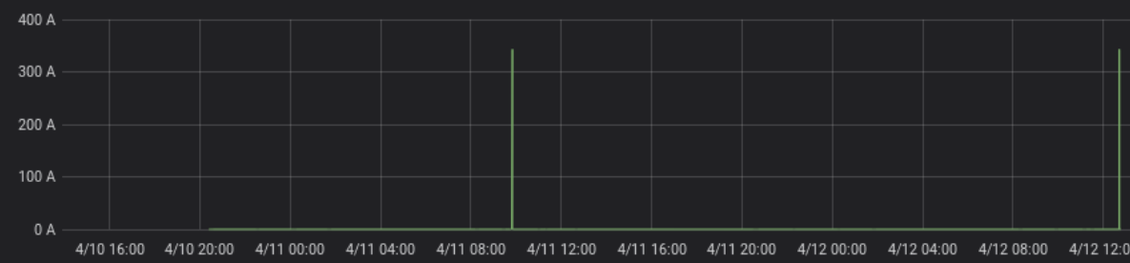
Timestamp

1555073275

Battery Voltage

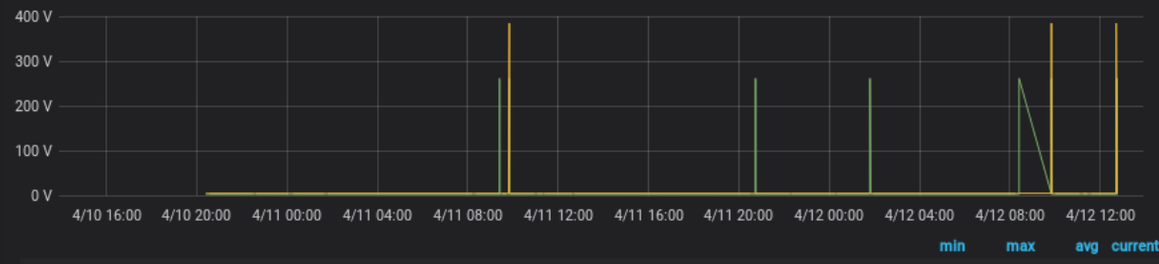
	min	max	avg	current
Voltage	10.941 V	12.468 V	11.755 V	12.136 V

Battery Current



	min	max	avg
Current	0 A	343 A	3 A

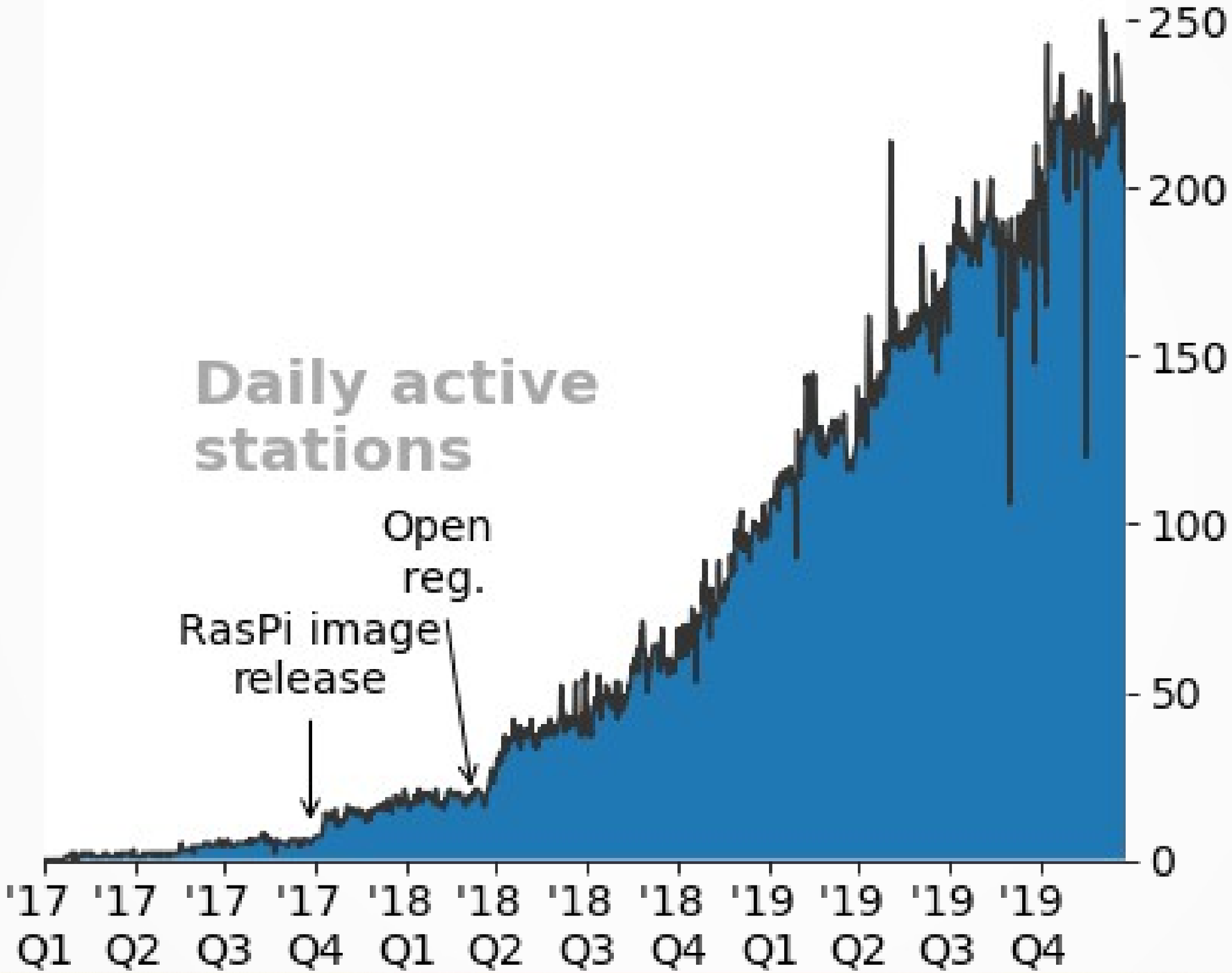
PCM Voltage

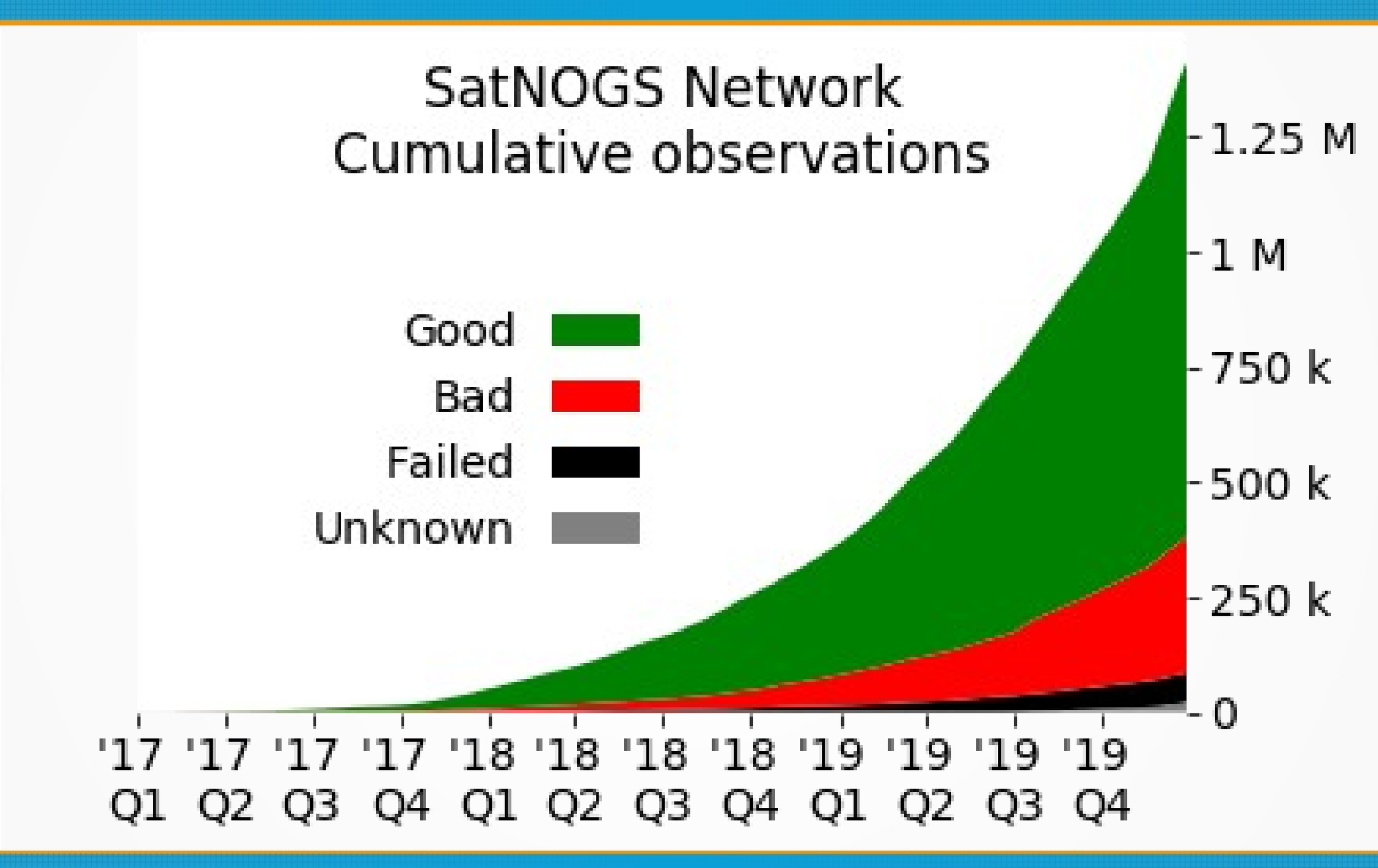


	min	max	avg	current
Voltage 3V3	3 V	261 V	13 V	3 V
Voltage 5V	5 V	384 V	10 V	5 V

PCM Current

	min	max	avg
Voltage 3V3	0 A	343 A	8 A
Voltage 5V	0 A	343 A	6 A


Daily active stations
Open reg.
RasPi image release
250
200
150
100
50
0
'17 Q1
'17 Q2
'17 Q3
'17 Q4
'18 Q1
'18 Q2
'18 Q3
'18 Q4
'19 Q1
'19 Q2
'19 Q3
'19 Q4


SatNOGS Network
Cumulative observations
Good
Bad
Failed
Unknown
1.25 M
1 M
750 k
500 k
250 k
0
'17 Q1
'17 Q2
'17 Q3
'17 Q4
'18 Q1
'18 Q2
'18 Q3
'18 Q4
'19 Q1
'19 Q2
'19 Q3
'19 Q4

SatNOGS Network - Popular satellites
Total observations
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
TRANSIT 5B-5
OSCAR 7
UOSAT 2
NOAA 9
LUSAT
ITAMSAT
RADIO ROSTO
JAS-2
NOAA 15
TECHSAT 1B
ISS
ORSTED
PCSAT
SAUDISAT 1C
CUTE-1
CUBESAT XI-IV
MOZHAYETS 4
INMARSAT 4-F1
HAMSAT
NOAA 18
CUBESAT XI 5
METOP-A
CARTOSAT-2
FALCONSAT 3
CAPE1
CARTOSAT-2A
CUTE-1.7+APD II
COMPASS-1
AAUSAT-II
DELFI-C3
SEEDS II
YUBILEINY
FENGYUN 3A
PRISM
STARS
KKS-1
NOAA 19
SWISSCUBE
BEESAT
ITUPSAT 1
XIWANG-1

Un exemple de station sol

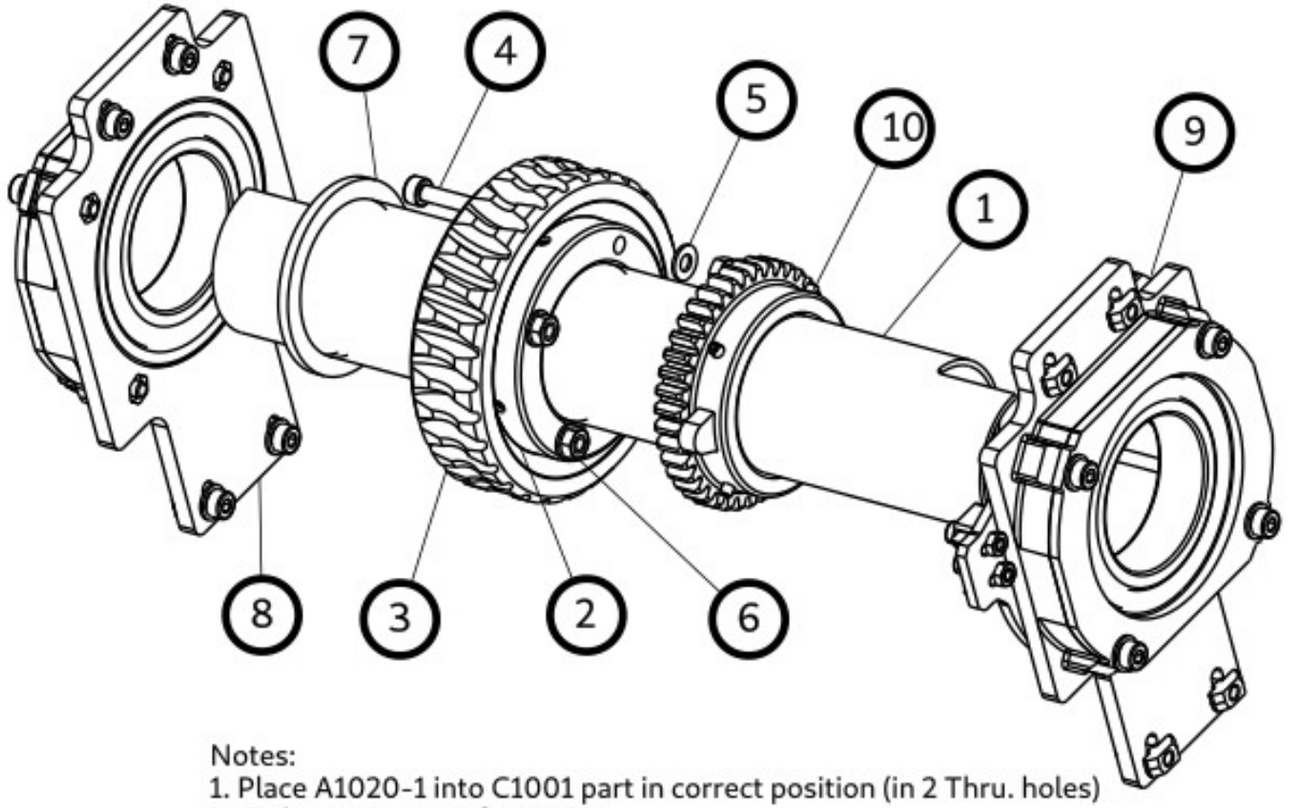
Station sol basique

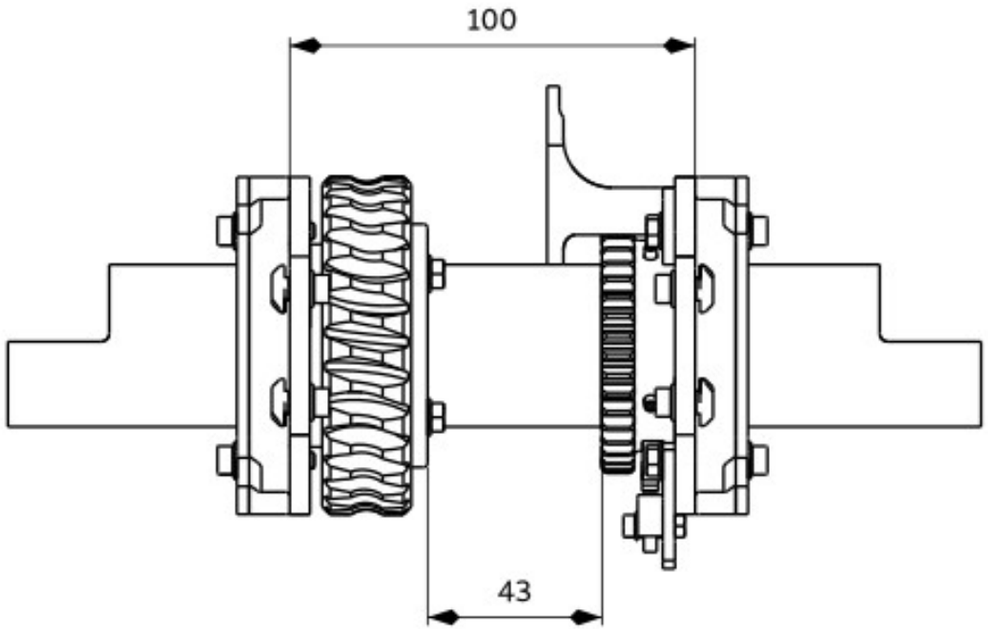
- Raspberry pi : 30 euros
- Clef rtl-sdr : 6 euros
- Antenne : fil de cuivre + tube pvc

Station sol avec antennes directionnelles

- Raspberry
- Rtl-sdr ou mieux : USRP, hackrf, airspy, lime-sdr ...
- Antennes directionnelles : hélix/yagi/parabole
  - tube de cuivre/alu et support
- Motorisation des antennes
  - Imprimante 3D + rail alu + moteurs et contrôleur chinois
- Amplificateur à faible bruit
- Filtres
  - Amusant à fabriquer

part #	source file	quantity
1	C1001-1_symmetric_tube	1
2	A1020-1_shaft_collar	1
3	C1020-1_shaft_gear	1
4	H1100-1_screw_M4L25_din912	4
5	H1110-1_washer_M4_din125	4
6	H1080-1_nut_M4_din934	4
7	C1022-3	1
8	A1031-1_bearing_side	1
9	A1032-1_bearing_side	1
10	A1033-1_encoder_gear	1





Notes:
1. Place A1020-1 into C1001 part in correct position (in 2 Thru. holes)
2. Tight set screws of A1020-1
3. Place C1020-1 into above sub-assembly, align the holes for part screws #4
4. Tight the screws with #5 and #6
5. Place the A1033-1 (#10) in correct position (as shown: 43) and tight the set-screws
6. Place C1022-3, #7
7. Put bearing sides (#8, #9) the dimension between is 100 (as shown)
8. Bearing inner ring tolerances: +0.003 -0.013 (K6), Normal ISO tolerance class
9. Aluminum tube 6063 OD tolerances: +0.0 -0.3 (h12)
10. Fit Type: 40 K6/h12, Transition fit
11. Same process for A1030-3, by using differnent aluminum tube, C1001-3

Notes:
12. Adjust end-stop to work properly for both directions
13. Install rotary encoder to C1043-1, encoder base, and adjust

DESIGNED BY: Azisi
DATE: 20/08/2018

A1030

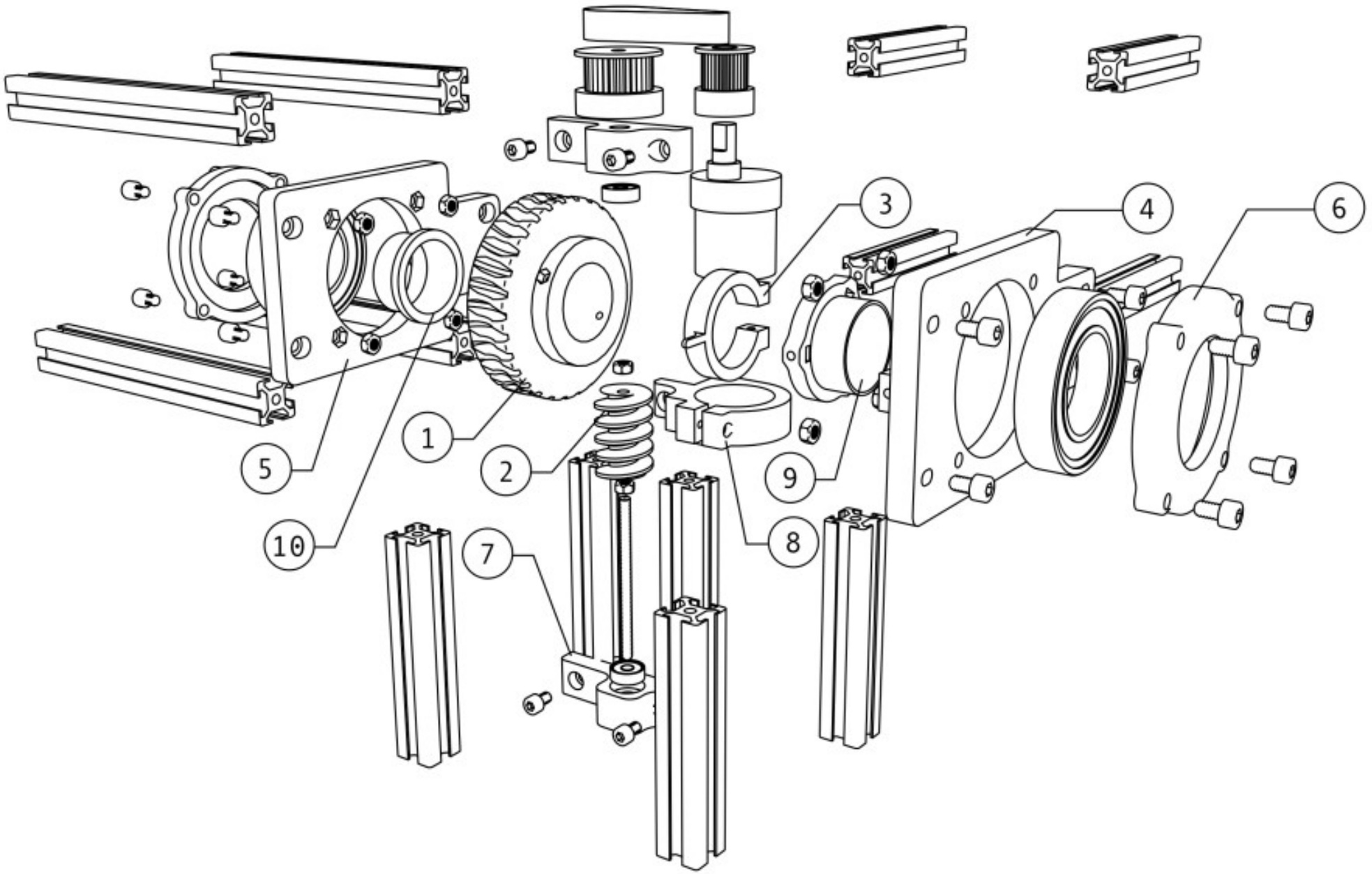
Rotator Axis, -1 and -3

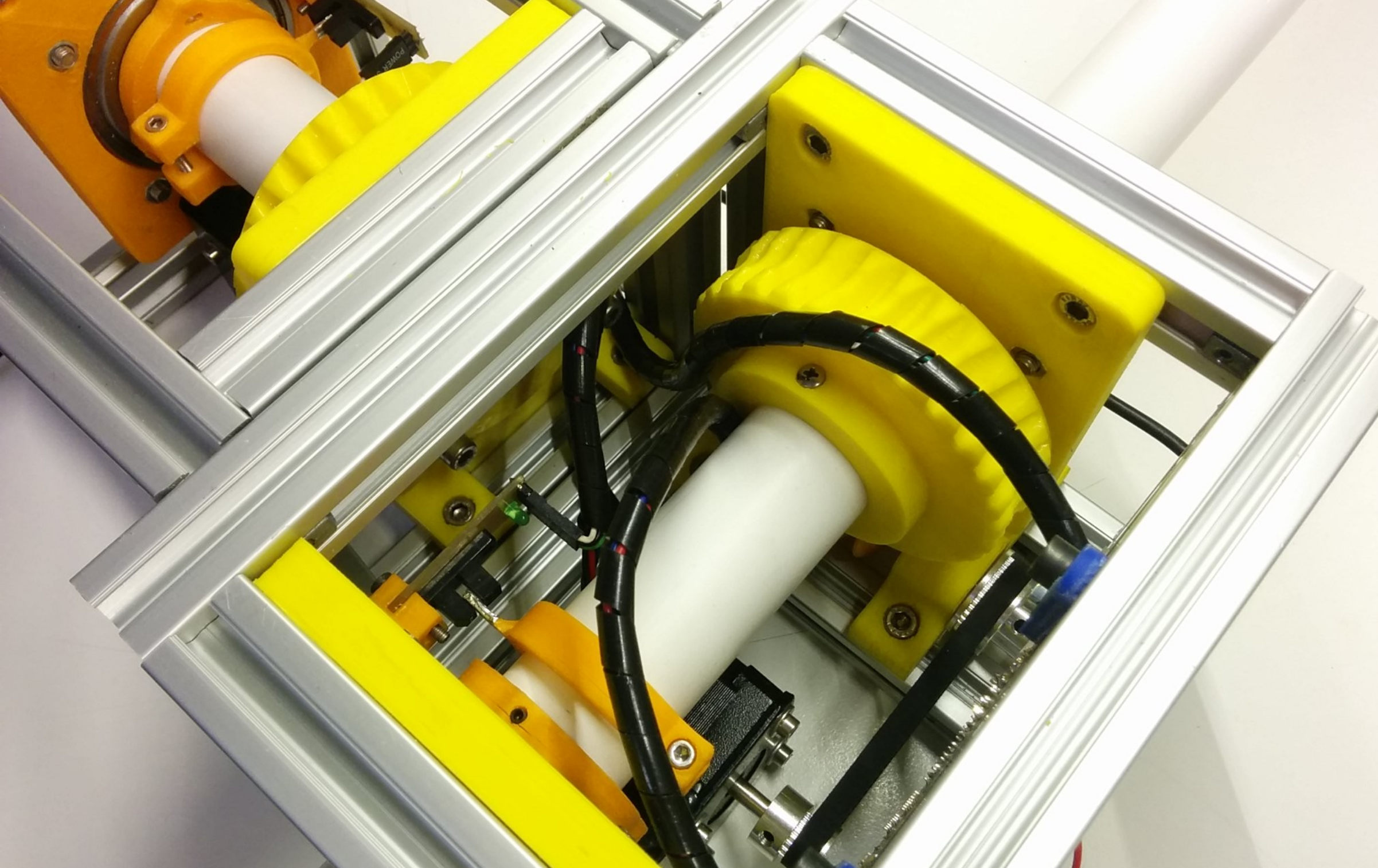
SIZE A4 | SCALE 1:2 | WEIGHT (kg) N/A

UNLESS OTHERWISE SPECIFIED
TOLERANCES
DIN ISO 2768- mk
ROUGHNESS
-

DIMENSIONS ARE IN MILLIMETERS
DO NOT SCALE
DEBURR AND BREAK SHARP EDGES ±0.2

SHEET 1/1 | REV A | MATERIAL -


1
2
3
4
5
6
7
8
9
10



Les dernières évolutions du projet

Les nouveautés

- gr-soapy/Gnuradio 3.8
- Métadonnée par observation et donnée décodée
- Waterfall avec structures modulaires et horodatage
- Système de démodulation modulaire
- Système de décodage modulaire
- Meilleur perf démodulation et CW
- Support du modem GomSpace AX100
- Démodulation SSTV

Questions ?

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