

Libre Space Foundation

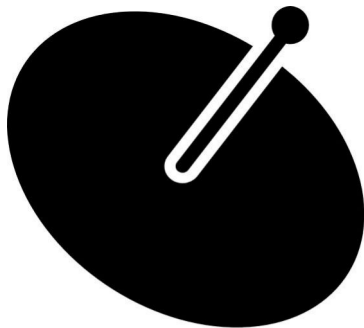


SLIDE 1

Libre Space Foundation



SLIDE A



SatNOGS

Open Source Ground Station Network

State of the Union

by Alfredos Damkalis

What is SatNOGS Project?

A global network of ground stations focused on automating ground segment operations



What is SatNOGS Project?

A global network of ground stations focused on automating ground segment operations

- Telemetry and TC&C capabilities
 - VHF, UHF, L-Band, S-Band
 - Telemetry and data visualization
- Observation Artifacts Collection
 - Data from satellites
 - Waterfall, audio and IQ data
- Orbit determination & TLE generation
- Satellite identification
- Record of frequency violations



What is SatNOGS Project?

An Open Source Stack:

- Software projects
- Hardware projects
- Services
- Data



What is SatNOGS Project?

An Open Source Stack:

- Software projects
- Hardware projects
- Services
- Data

Contributors:

- Universities
- Organizations
- Space Agencies
- Satellite Teams/Missions
- The Radio Amateur Community
- Scientists
- Engineers
- Researchers
- Space Enthusiasts
- Individuals



What is SatNOGS Project?

Ground Station:

- Client
- gr-satnogs and flowgraphs
- Rotator, Antennas and other hardware

Web and other Services:

- Network
- DB
- Decoders
- Dashboards

Operations:

- Observations Scheduling
- Satellites Identification
- Orbits determination
- TLE sets generation



Ground Station - SatNOGS Client

Ground Station Software

- Communicates with Network
- Performs Observations



Ground Station - SatNOGS Client

The last year:

- Codebase refactoring, bug fixes and maintenance
- Improving Artifacts support (waterfall artifact in beta phase)
- Configuration of Artifacts uploading

Future:

- Continue refactoring
- Improve Artifacts support
- Support data artifacts streaming
- Support transmission under SatNOGS COMMS project



Ground Station - gr-satnogs & flowgraphs

Radio Software

- Responsible for processing, demodulating and/or decoding received signals
- gr-satnogs: Out-Of-Tree GNU Radio Module
- flowgraphs: GNU Radio flowgraphs for processing different satellite transmissions



Ground Station - gr-satnogs & flowgraphs

Modes supported by satnogs-flowgraphs:

- FM
- CW
- APT
- DUV
- APRS
- IEEE 802.15.4
- BPSK
- FSK
- MSK
- AFSK
- SSTV
- ARGOS BPSK



Ground Station - gr-satnogs & flowgraphs

The last year:

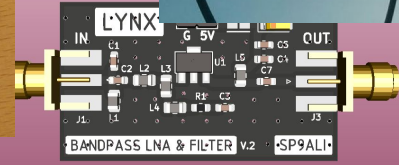
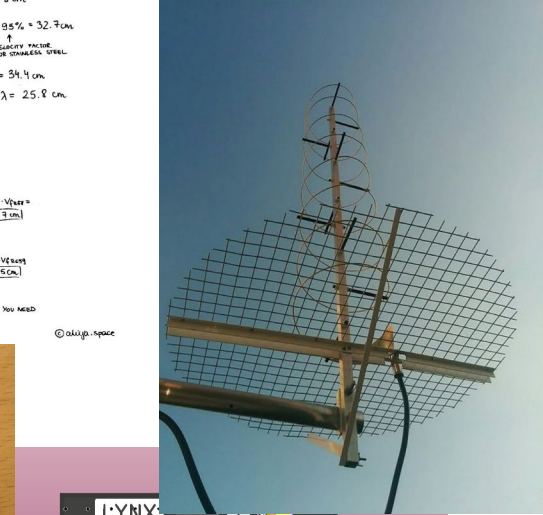
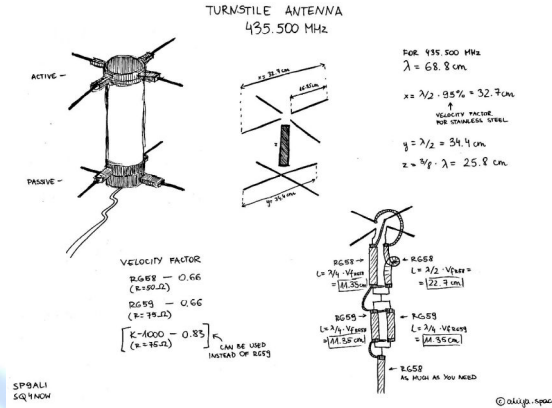
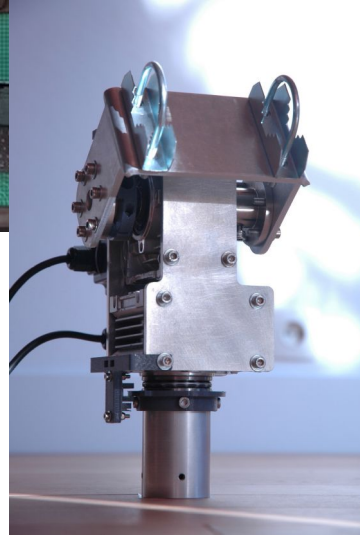
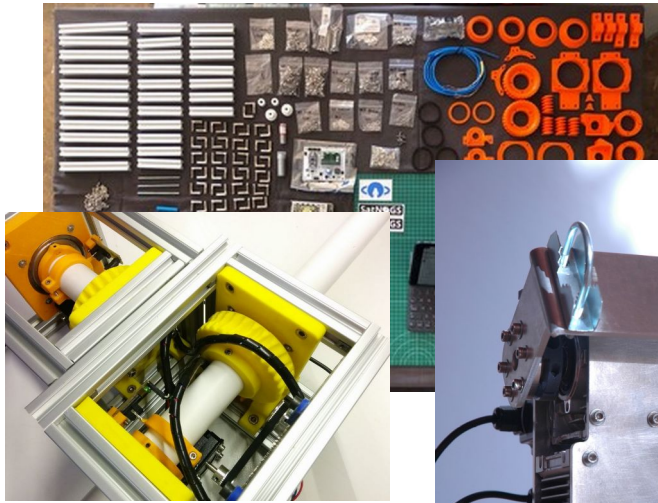
- Performance improvement and maintenance work
- Adding new encoders and decoders
- SigMF for metadata generation (machine learning and other applications)
- UDP I/Q sink for analysis and demodulation with third party tools

Future:

- Improve and add more flowgraphs
- On-the-fly flowgraph generation
- Update to GNU radio 3.10
- Improve Artifacts Support
- Support transmission under SatNOGS COMMS project



Ground Station - Rotator, Antennas and other hardware



Ground Station - Rotator, Antennas and other hardware

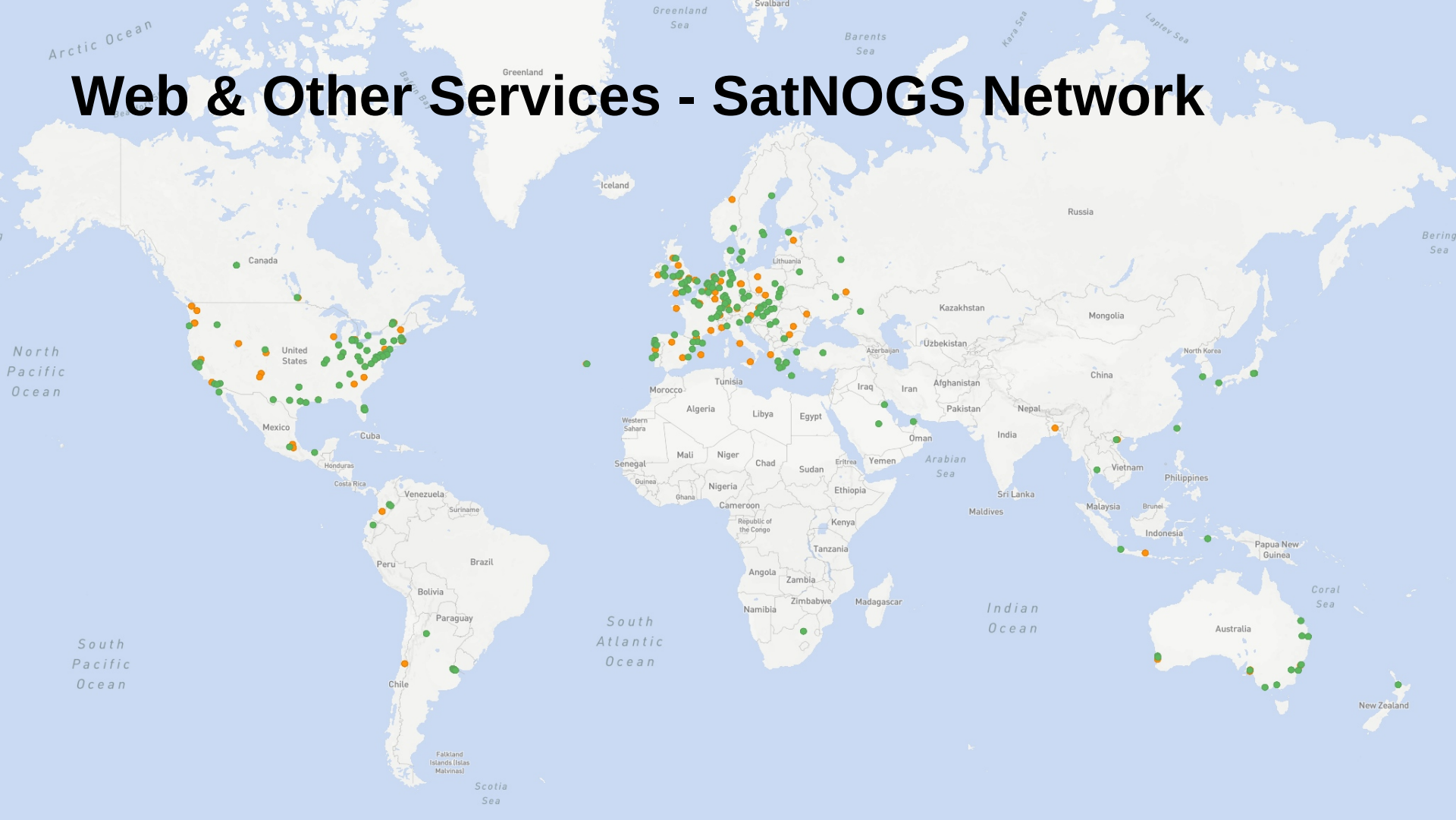
The last year:

- No significant updates on SatNOGS Rotator and antenna designs
- Development, documentation and testing by contributors on
 - RF components, like filters, amplifiers, diplexers etc
 - Rotators
 - Antennas

Future:

- Experiments with new concepts for ground stations setups (SatNOGS tiny)
- More development, documentation and testing on ground station components

Web & Other Services - SatNOGS Network



Web & Other Services - SatNOGS Network

Network Web Service

- Stations management
- Scheduling satellite observations
- Store, display and rate artifacts



Web & Other Services - SatNOGS Network

The last year:

- Performance improvements, bug fixes and maintenance
- UI improvements
- Changes for supporting Artifacts
- Support S3 storage
- Performed ~1.9 million observations!!!

Future:

- Improve API and API client
- Complete Artifacts support
- Improve scheduling automation
- Improve Artifact and observation rating system
- Support transmission under SatNOGS COMMs project

Web & Other Services - SatNOGS Network

Current Data	Last Year
~255 Online Stations	~245
~123 Testing Stations	~134
~5200 Observations/day	~5000
~28000 Demodulated Frames/Day	~25000



Web & Other Services - SatNOGS DB

DB Web Service

- Crowd-sourced satellite mission database
- Repository for Artifacts

The screenshot displays the SatNOGS DB web interface. The page is titled "Welcome to SatNOGS DB" and features a navigation sidebar on the left with options like Home, About, All Satellites, All Transmitters, and Statistics. The main content area is divided into three columns: "New Satellites", "Latest Data", and "Recent Contributors".

New Satellites:

- FITSat-1 News**
 - # ZPLU-7926-5127-3528-0122
 - No Data
- New Satellite**
 - # YKXP-8112-7199-1648-8213
 - # 206
 - # 2021-12-06 20:07:16
 - # SP7THR-UHF
- SanoSat-1**
 - # RZWR-6172-2789-3807-5423
 - # 3
 - No Data
- FLOCK 2K 1S**
 - # COVZ-0712-1074-2081-8850
 - # 0
 - No Data
- Ladybird 1 OBJECT**
 - # BGLZ-4681-1869-5650-0861
 - # 0
 - No Data

Latest Data:

- SARAL**
 - # CVR-7644-2588-4230-2659
 - # 1
 - # 53778
 - # 2021-12-09 10:09:15
 - # notch
- TIGRISAT**
 - # XCT1-8747-8578-2256-0301
 - # 2
 - # 1815426
 - # 2021-12-09 10:09:01
 - # JASBLZ
- Es'hail 2**
 - # 00-106
 - # LBQ-6987-6865-3928-8294
 - # 23
 - # 3102010
 - # 2021-12-09 10:13:08
 - # UVOLL
- AUSTECHSAT2**
 - # MBH-7029-8546-1995-2723
 - # 3
 - # 223702
 - # 2021-12-09 10:12:27
 - # EAETC
- UVSQ-SAT LATMOS1**
 - # VFGS-7446-6140-1963-2095
 - # 3
 - # 5838954
 - # 2021-12-09 10:06:06
 - # EU14EM
- LEDSAT**
 - # JLZT-0277-4784-7719-1707
 - # 1
 - # 369229
 - # 2021-12-09 10:09:50
 - # EU14EM

Recent Contributors:

- Data - Last 24h
- # WYKKE - 19964 Frames
- # LYOL - 18619 Frames
- # FAETC - 12018 Frames
- # Pucketeiro UHF - 8943 Frames
- # ST14EM - 5028 Frames
- # MAUJyepi - 4182 Frames
- # notch - 2531 Frames
- # F4ROV - 1975 Frames
- # KB6LTV - 1824 Frames
- # SP7THR-UHF - 1704 Frames
- # NSZKX-UHF-HELICAL - 1577 Frames
- # FAKUJ-CS-UPEC - 1474 Frames
- # Newell-UHF2 - 1386 Frames
- # PEGSAT1 - 1035 Frames
- # EARWA-OPH-NA - 1031 Frames
- # DRYASC - 921 Frames
- # SAZONG-Gms-UHF/VHF - 843 Frames
- # M7RED - 840 Frames
- # SICABET - 804 Frames
- # UKXSL - 802 Frames
- # ko1net - 801 Frames
- # ZDANF - 720 Frames
- # PEGSAT - 583 Frames
- # W6MRS1 / BHF - 501 Frames

Thank you to our contributors! Please visit wiki.satnogs.org to learn how to contribute data.

Web & Other Services - SatNOGS DB

The last year:

- Maintenance, performance improvements and bug fixes
- Adding (SatNOGS) Satellite Identifier
- Improvement of Artifacts Support
- Continuing integration of Metasat Schema by using JSON-LD format

Future:

- Complete Artifacts support
- Improve API and API client
- Improve station and data statistics
- Standardize and improve DB service in coordination with other projects that use it

Web & Other Services - SatNOGS DB

Current Data	Last Year
766 Satellites	467 Satellites
1344 Transmitters	985 Transmitters
More than 125 million frames by 1790 stations that use SatNOGS Network or third party software	~88.5 million frames by 1276 stations



Web & Other Services - SatNOGS Decoders

Decoders Service

- Describe encoding of transmission frames with kaitai.io structures
- Generate scripts that decode these transmission frames



Web & Other Services - SatNOGS Decoders

The last year:

- New Decoders
- More people and satellite teams involved, some before the satellite deployment
- Decoded ~66% of DB frames

Future:

- Create more decoders
- Continue involve people and satellite teams
- Improve the process design of decoders



Web & Other Services - SatNOGS Decoders

Supported Decoders

(last year entries with **BLUE**)

- AAUSAT4(**Updated**)
- ACRUX-1
- ALSAT-1N
- AMICALSAT
- AMSAT FOX DUV
- ARMADILLO
- AX.25 frame decoder
- BISONSAT
- BOBCAT-1(**Updated**)
- BUGSAT-1
- CAPE-1
- CAS-4A & CAS-4B
- CHOMPTT
- CUBEBEL-1
- **CUTE**
- **DELFI N3XT**
- **DhabiSat**
- **DIY-1**
- DUCHIFAT-3
- ELFIN-A & ELFIN-B
- ENTRYSAT
- EQUISAT
- ES'HAIL-2 (QO-100)
- **GRBAAlpha**
- IRAZU
- IRVINE
- ISS
- **KSU-Cubesat**
- **LEDSat**
- LIGHTSAIL-2
- **MIR-SAT1**
- **MiTEE-1**
- MEZNSAT
- MINXSS
- MYSAT-1
- **NETSAT**
- NEUTRON-1
- OPSSAT-1
- ORIGAMISAT-1
- PAINANI
- PHOENIX(ASU)
- POLYITAN-1
- PWSAT-2
- **RAMSAT**
- QARMAN
- QBEE
- QUBIK-1 & QUBIK-2
- QUETZAL-1
- **SALSAT**
- SIRIUSSAT-1 & SIRIUSSAT-2
- SKCUBE
- SPOC
- STRAND-1
- TBEX-A & TBEX-B
- UNISAT-6
- UWE-4
- VZLUSAT-2

Web & Other Services - SatNOGS Dashboards

Dashboard Web Service

- Display/Visualize decoded data from satellite transmissions in Grafana dashboards



Web & Other Services - SatNOGS Dashboards

The last year:

- New Dashboards created by the community and satellite teams, some before the satellite deployment
- Satellite teams used dashboards for mission analysis

Future:

- Create more dashboards
- Continue involve people and satellite teams
- Experiment with the Grafana alert system



Operations - Observations Scheduling

The last year:

- Improving auto-scheduler
- Scheduling
 - Several ARISS Contact and SSTV events
 - More than 15 satellite deployments
 - Public requests from Satellite Teams

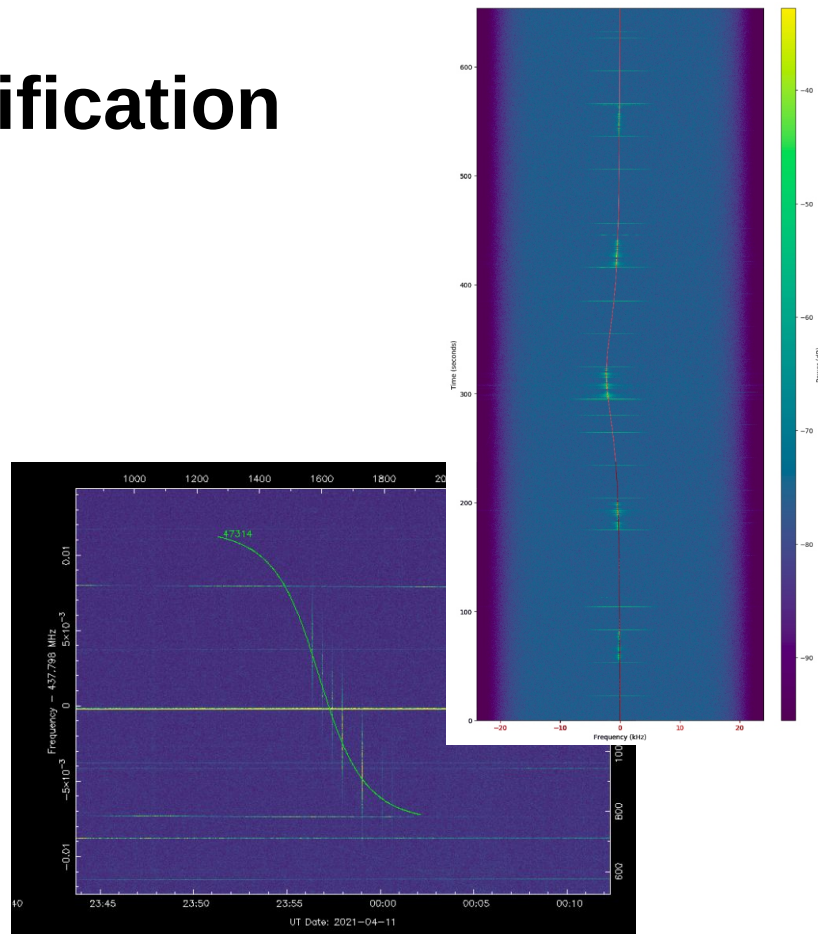
Future:

- Continue automate scheduling and make it smarter
- Add auto-scheduling in SatNOGS Network
- Continue support events and scheduling requests

Operations - Satellites Identification

Using STRF tools and Ikhnos

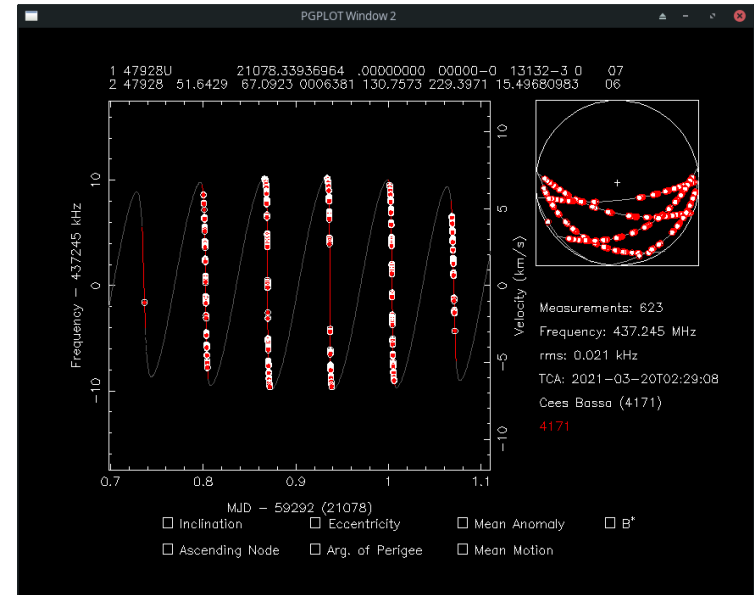
- Identified more than 150 satellites until today
- Building tools that use waterfall-data Artifact for analysis and identification



Operations - Orbit Determination & TLE Generation

Using STRF tools

- Generated more than 140 TLE sets the last year
- Currently generate TLE set first hours after launch and hours before re-entry
- Building tools that use waterfall-data Artifact for analysis, orbit determination and TLE sets generation



SatNOGS Community Contribution Highlights

- Feedback and Support through issues, community forum and chat
- Updates on SatNOGS Wiki
- Scheduling and rating observations
- Being amazing Station Owners!



THANK YOU!

SatNOGS COMMUNITY



SatNOGS – Join us!

Web Sites: <https://satnogs.org> & <https://libre.space>

Wiki: <https://wiki.satnogs.org>

Discussion Forum: <https://community.libre.space>

Repos: <https://gitlab.com/librespacefoundation/satnogs>

Contact me: fredy@libre.space

Thank you!

