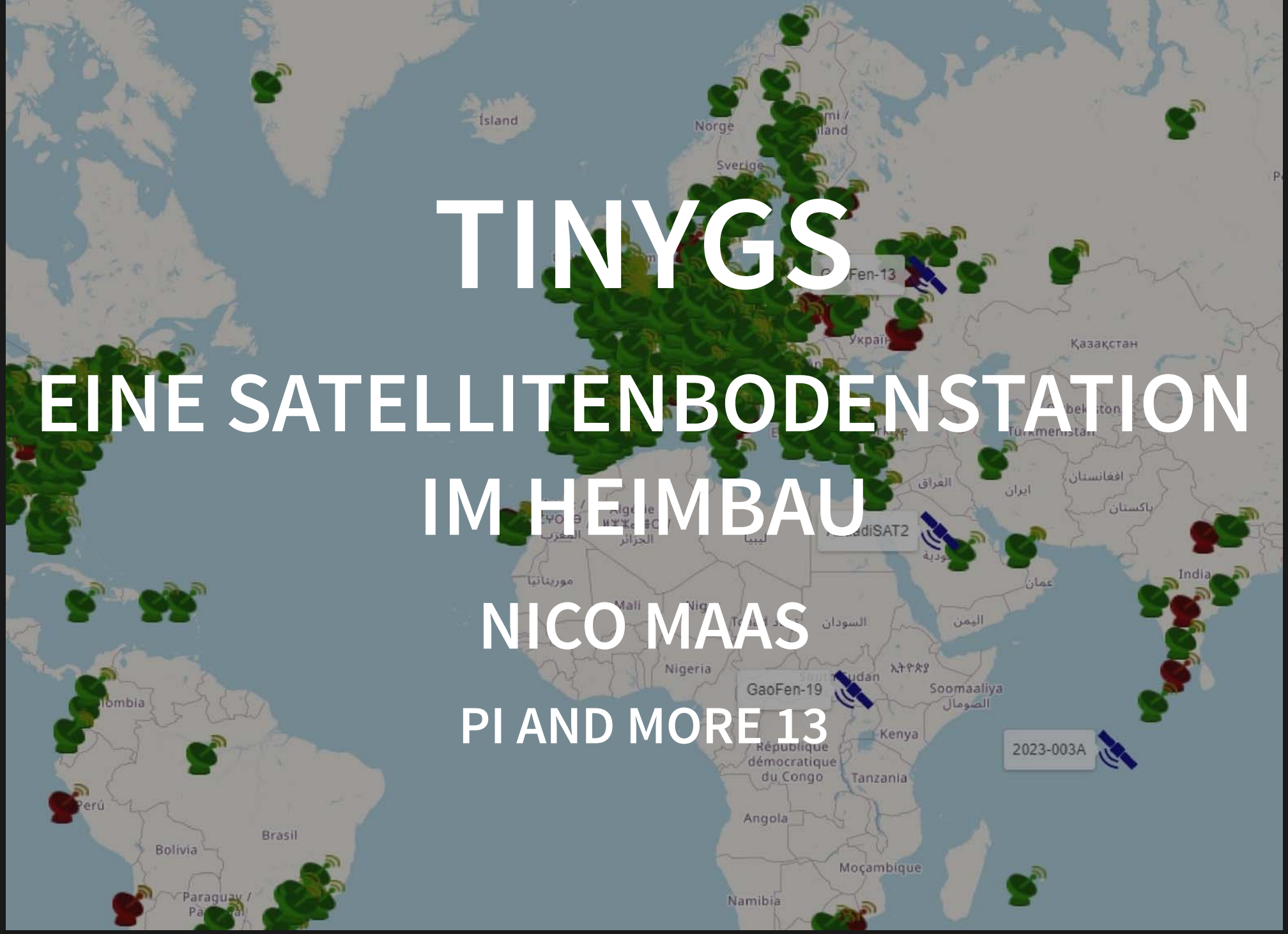


TINYGS

EINE SATELLITENBODENSTATION IM HEIMBAU

NICO MAAS

PI AND MORE 13

WER BIN ICH?

- Nico Maas
- Master of Science
- IT Systemelektroniker
- mail@nico-maas.de
- www.nico-maas.de
- Twitter: @nmaas87
- Mastodon: @nmaas87@chaos.social

AGENDA

- Einführung
  - TinyGS
  - LoRa (Exkurs)
- Eine eigene Groundstation bauen
- Ende

EINFÜHRUNG

TINYGS

https://www.tinygs.com/

Home
Stations
Satellites
Packets

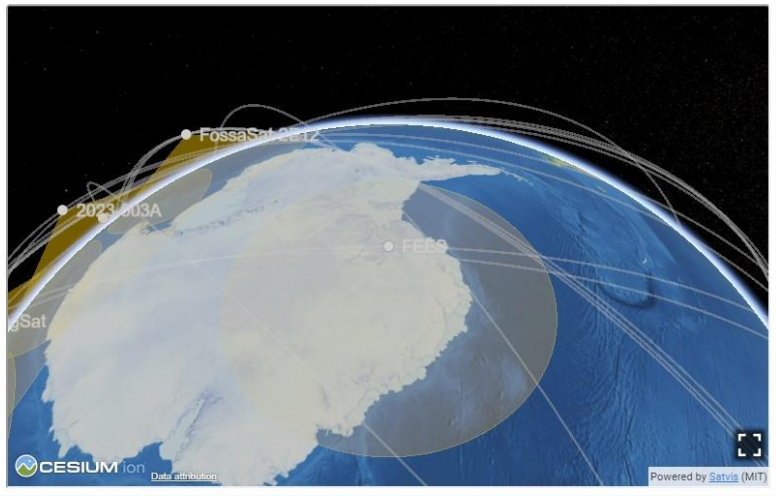
FEES

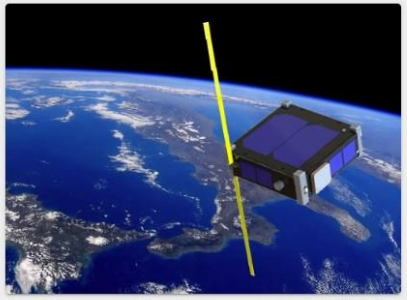
FEES (**Flexible Experimental Embedded Satellite**) is a self funded, collaborative project by the Italian GP Advanced Projects aimed at developing a low cost platform for In Orbit Testing and Validation of Electronics components.

The whole satellite, including the electronics boards, is entirely design and manufactured within the project. The flight will be also the validation of this platform and components. The 0.3 kg satellite is built to a 0.3UCubeSat (10 cm × 10 cm × 3 cm) form factor.

FEES Mission had three main goals. First of all, we aimed to obtain an in-orbit qualification of both an attitude determination architecture and a commercial GPS receiver. FEES also validated the exploitation of IRIDIUM global network to receive data, testing and supporting on-board traditional radio transmissions, which allowed us to manage the mission without a direct link to ground station and receiving early notifications. Finally, we meant to test a low cost UHF receivers with advanced modulation protocols.

- **Status:** Supported
- **Launch Date:** Mar 22, 2021 6:07 AM





TLEs

```
FEES
1 48082U 21022AL  23098.71199112  .00032873  00000+0  14181-2 0  9991
2 48082  97.5049   0.7229 0011208 180.3496 179.7734 15.22411078111272
```

Last telemetry

500mW 3722mV 212.75mA
188.74mV 303.81mA
1.11604846

	Mode	Received by	
FEES Apr 9, 2023 3:01 PM (13 minutes ago)	LoRa@437.2	2 stations	500mW 3722mV 212.75mA 188.74mV 303.81mA 1.11604846
FEES Apr 9, 2023 2:59 PM (15 minutes ago)	LoRa@437.2	5 stations	500mW 3726mV 213.65mA 202.05mV 303.91mA 1.11604728

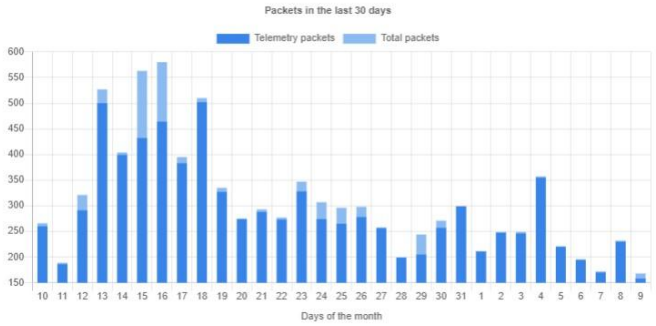
BACK

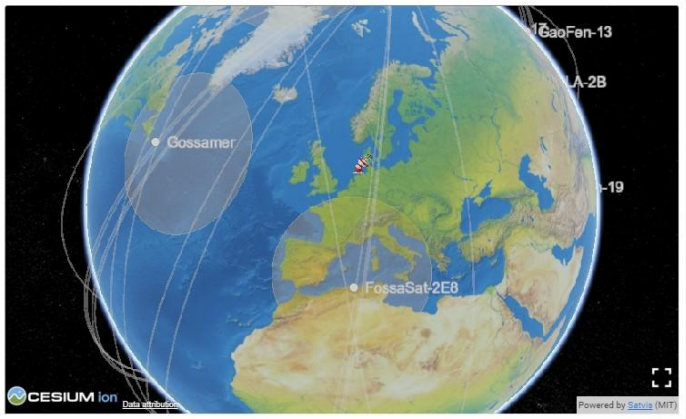
DJ2DS Console

Status	Listening	Version	Creation date
Online	FossaSat-2E8	2303291	2 years ago
Last seen	**Last Packet**	**Position (Lat, Lang)**	**QTH Locator**
a few seconds ago	a few seconds ago	53.546, 7.58	JO33sn
Elevation	**Auto tuning**	**Test mode**	**Confirmed packets**
9.00 m	ON	OFF	56146
Telemetry packets	**Type of antenna**	**Band**	**Record distance**
47924	5/8λ Collinear	400 - 465 MHz	13236.5 Km

Description

Antenna: X-5000 Preamplifier: SSB DBA 270 Receive: LILYGO® TTGO LoRa 433MHZ OLED 0.96 Inch





	Mode	Power	Distance	Elevation	RSSI	SNR	Predicted Doppler	Frequency Error	CRC Error	Received by
FossaSat-2E8 Apr 9, 2023 3:22 PM (a few seconds ago)	LoRa@401.7	158mW	1254Km	17.68°	-94.75 dBm	-2.75 dB	-9024.40Hz	5643.96Hz		138 Stations
Unknown										

FEES

Received on: April 9, 2023 2:59 PM
LoRa 437.2 Mhz SF: 9 CR: 5 BW: 125 kHz
Sat in Umbra Eclipse Depth: 26.07°
Theoretical coverage 4940 km

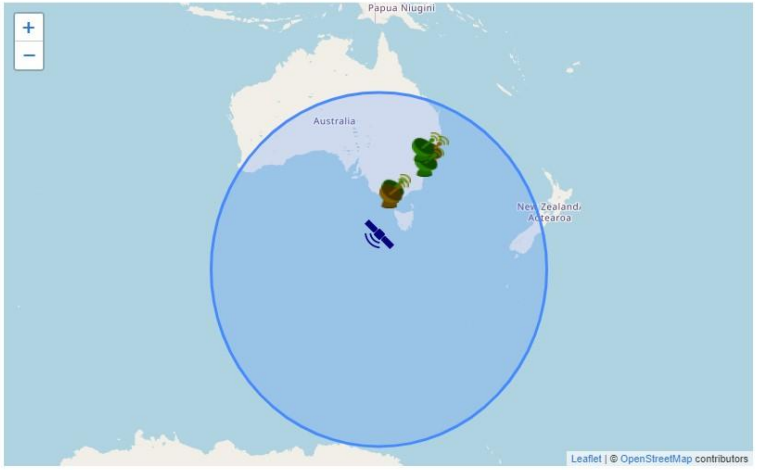
500mW 3726mV 213.65mA
202.05mV 303.91mA
1.11604728

Hexadecimal view

Download

```
     0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F 0123456789ABCDEF
0000 00 FE E5 2F B0 F8 12 B1 00 7C 00 00 00 01 00 00 .../.....|......
0010 00 00 F8 07 CB 0B CA 08 7A 00 7D 00 15 00 77 00 ........z.}...w.
0020 79 00 02 01 6F 01 A3 00 B3 00 A9 00 BF 87 59    y...o.........Y
```


```
{
  header: {
    msgTypeId0: [
      0: 0
    ],
      msgTypeId1: 254,
      msgTypeId2: 229
  },
  payload: {
    frameId: 45103,
    timestamp: 11604728,
    automaticFwCheckerCounter: 124,
    commandedFwCheckerCounter: 1,
    unknown4: 0,
    vanalog: 2040,
    vacd2v5: 3019,
    vbat: 2250,
    vsol: 122,
    pxCellV: 125,
    mxCellV: 21,
    pyCellV: 119,
    pzCellV: 121,
    iload: 258,
    icharger: 367,
    pxCellI: 163,
    mxCellI: 179,
    pyCellI: 169,
```

Station Name	Distance	Elevation	Time	RSSI	SNR	Predicted Doppler	Frequency Error	CRC Error
GosfordHill_1	1580 Km	12.18°	14:59:55.399	-129.75 dBm	-11.75 dB	-9197.33 Hz	2678.063 Hz	

FEES

Received on: April 9, 2023 2:59 PM
LoRa 437.2 Mhz SF: 9 CR: 5 BW: 125 kHz
Sat in Umbra 🌘 Eclipse Depth: 26.07°
Theoretical coverage 4940 km

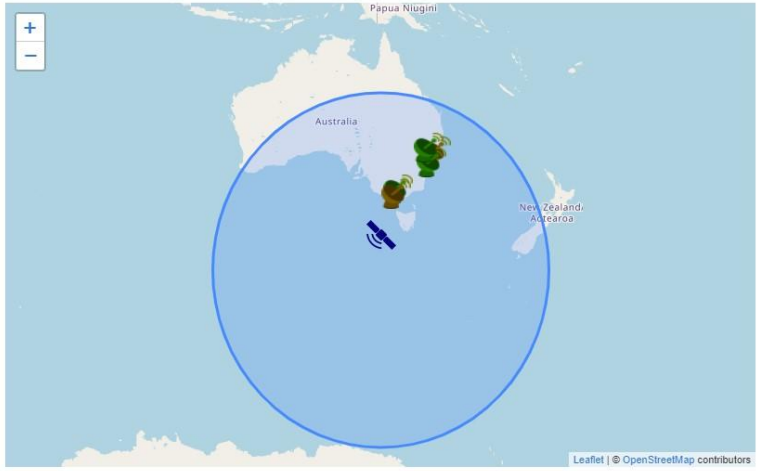
📻 500mW 🔋 3726mV ⛽ 213.65mA
🌞 202.05mV 🔦 303.91mA
📦 1.11604728

Hexadecimal view

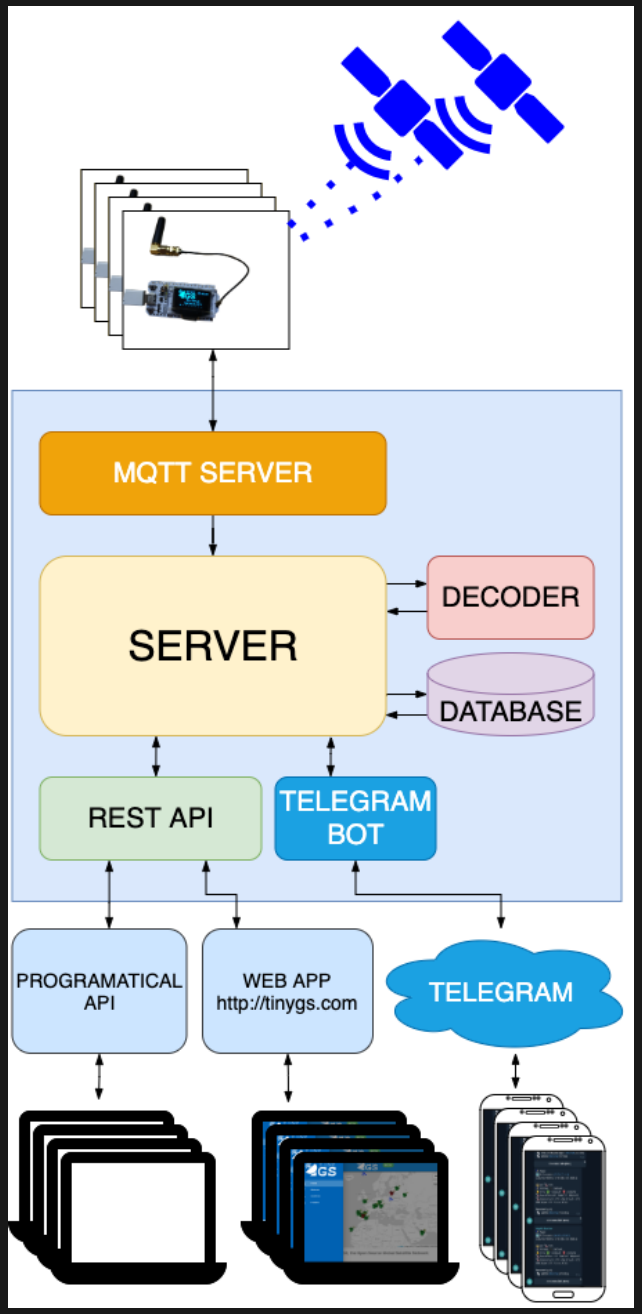
Download

```
     0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F 0123456789ABCDEF
0000 00 FE E5 2F B0 F8 12 B1 00 7C 00 00 00 01 00 00 .../.....|......
0010 00 00 F8 07 CB 0B CA 08 7A 00 7D 00 15 00 77 00 ........z.}...w.
0020 79 00 02 01 6F 01 A3 00 B3 00 A9 00 BF 87 59    y...o.........Y
```


```
    pyCellI: 169,
    unknown13: 191,
    unknown14: 22919,
    vSol: 0.20205366015236834,
    tinygsTxPower: 500,
    tinygsSolarVoltage: 202.05366015236834,
    iPxCell: 0.134978469691951,
    vPyCell: 0.09854256376283538,
    vMxCell: 0.01738986419344154,
    vPxCell: 0.10351109638953296,
    iCharger: 0.3039085789996688,
    tinygsChargeCurrent: 303.9085789996688,
    iLoad: 0.21364690294799601,
    coefficient: 0.0008280887711162637,
    tinygsLoadCurrent: 213.646902947996,
    iPyCell: 0.13994700231864857,
    vBat: 3.7263994700231864,
    tinygsTimestamp: 11604728,
    vPzCell: 0.10019874130506791,
    iMxCell: 0.14822789002981118,
    tinygsBatVoltage: 3726.3994700231865
  },
  type: "Beacon",
  telemetry: true
}
```

Station Name	Distance	Elevation	Time	RSSI	SNR	Predicted Doppler	Frequency Error	CRC Error
GosfordHill_1	1580 Km	12.18°	14:59:55.399	-129.75 dBm	-11.75 dB	-9197.33 Hz	2678.063 Hz	


MQTT SERVER
SERVER
DECODER
DATABASE
REST API
TELEGRAM BOT
PROGRAMATICAL API
WEB APP http://tinygs.com
TELEGRAM

EINFÜHRUNG

LORA (EXKURS)

LORA

- proprietärer, energiesparender Funkstandard der Firma Semtech (USA)
- Verwendet u.a. das ISM (433,05 - 434,79 MHz) und SRD (863 - 870 MHz) Band in Europa
- Ermöglicht Datenraten von 0,3 - 50 kbit/s bei hoher Reichweite (Stadt ca. 2 km, Land ca. 40 km) und niedrigem Energiebedarf
- Aktuelle Verbreitung ca. 178 Millionen Geräte weltweit (März 2021)

LORAWAN

- Offener Standard der LoRa implementiert zur Entwicklung von LPWAN-IoT (Low Power Wide Area Networks)
- z.T. kostenfrei durch die Community betriebene Netzwerke für Sensoren aller Art (quasi Freifunk für Sensoren…)
- Verwenden AES 256 Bit Verschlüsselung
- Down- & Uplink möglich
- The Things Network (zentralisiert)
- Chirp Stack (selfhosted)

We are a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.

Start building Learn more

91.9K	65.3M	153	1.3K	188.8K	21.2K	1.4M	16.5K	812
Forum posts	Messages today	Countries	Certified developers	Members	Gateways	YouTube views	YouTube subscribers	GitHub sta


Powered by
Raspberry Pi
RAK
PoE HAT
RAK739

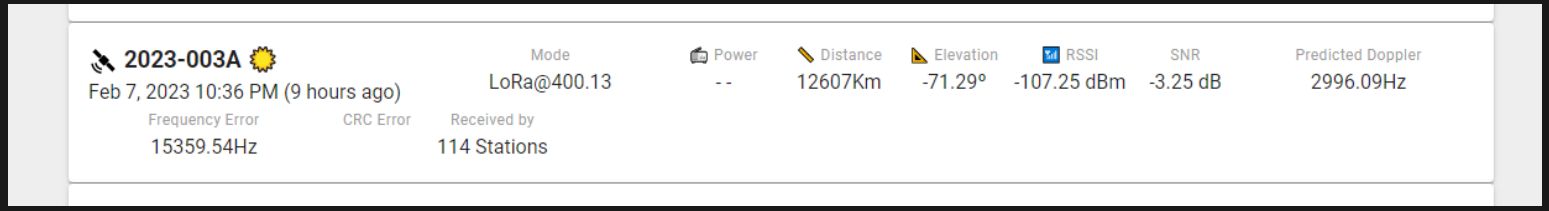

2
WisGate OS


RAK
RAK11300
FCC ID:2AF6B-RAK11300
Made in China
LoRa

Entfernungen

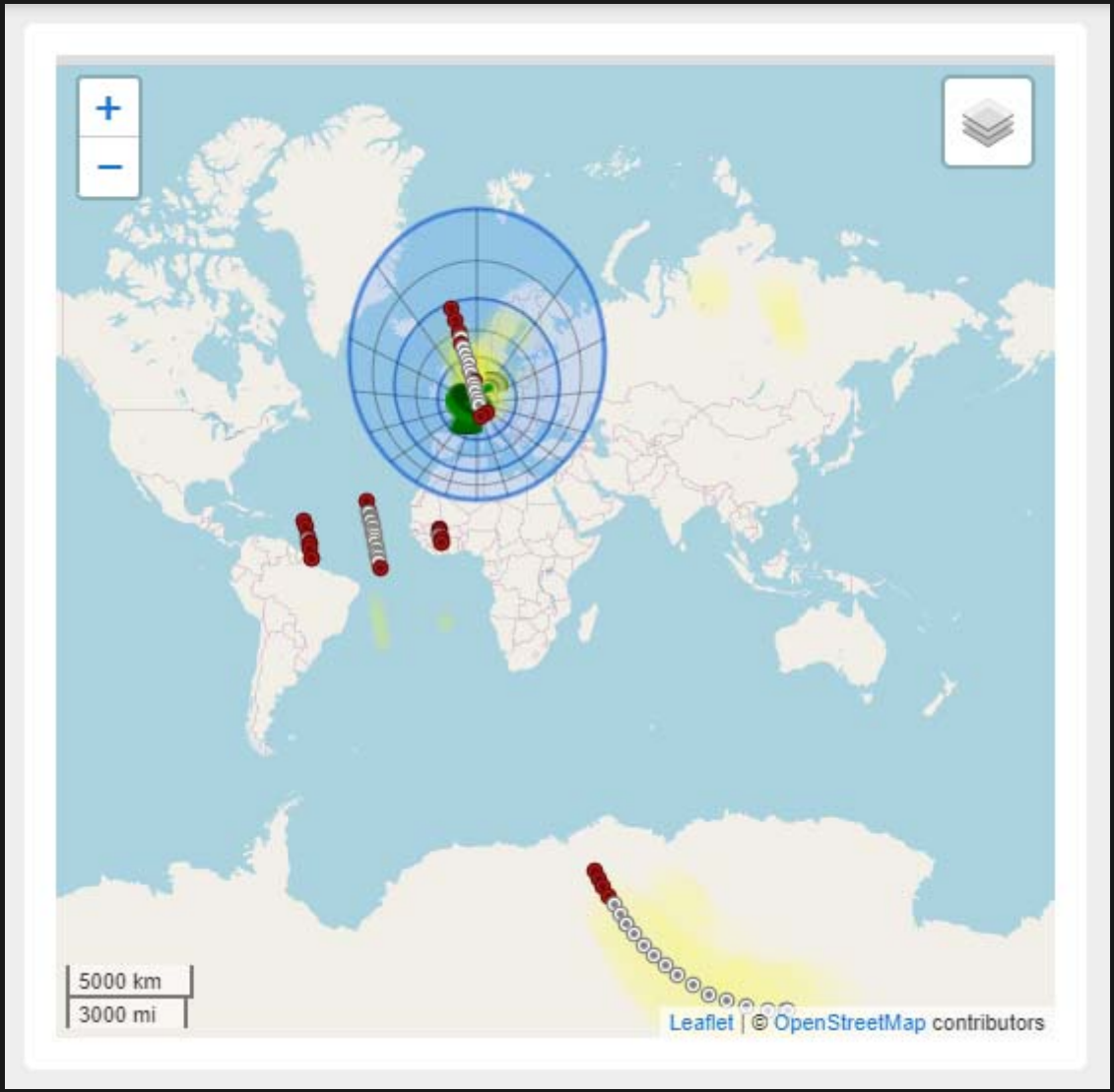
- Stadt ca. 2 km
- Land ca. 40 km

Bei geringen Sendeleistungen… Wie sieht das bei “freiem Feld” von einem Satellit in ca. 400 km Orbit und 3 Watt Sendeleistung aus?



12607 km…

Bei -3.25 dB SNR



(114 Zeugen)

EINE EIGENE GROUNDSTATION BAUEN?

https://github.com/G4lile0/tinyGS/wiki

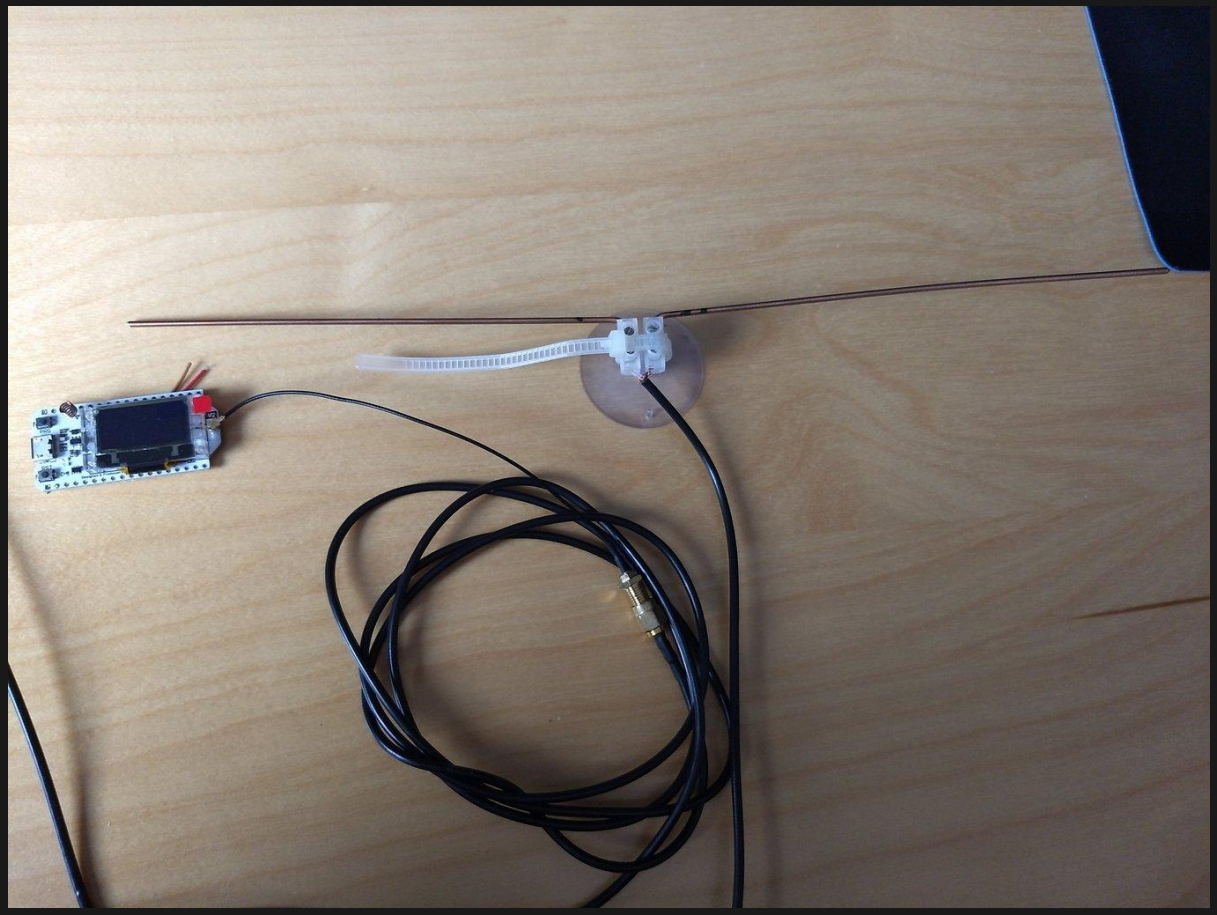
HARDWARE

- Kompatibles LoRa / ESP32 Modul + Netzteil
  - z.B. Heltec WiFi LoRa 32 V2 @ 433 MHz
- U.FL / SMA Female Adapter (“Pigtail”)
- 433 MHz Antenne
  - kaufen
  - Selbstbau
- WLAN
- Handy (+Telegram)

LAMBDA/4 ANTENNE IM SELBSTBAU

- SMA Male Koaxial Kabel, abisoliert
- 2x Lüsterklemmen
- 2x Schweißdraht (ca. 17 cm Elemente)
- ein Element an Ground anschließen
- das andere an Signal anschließen

BEISPIEL FÜR FERTIGE GROUND STATION

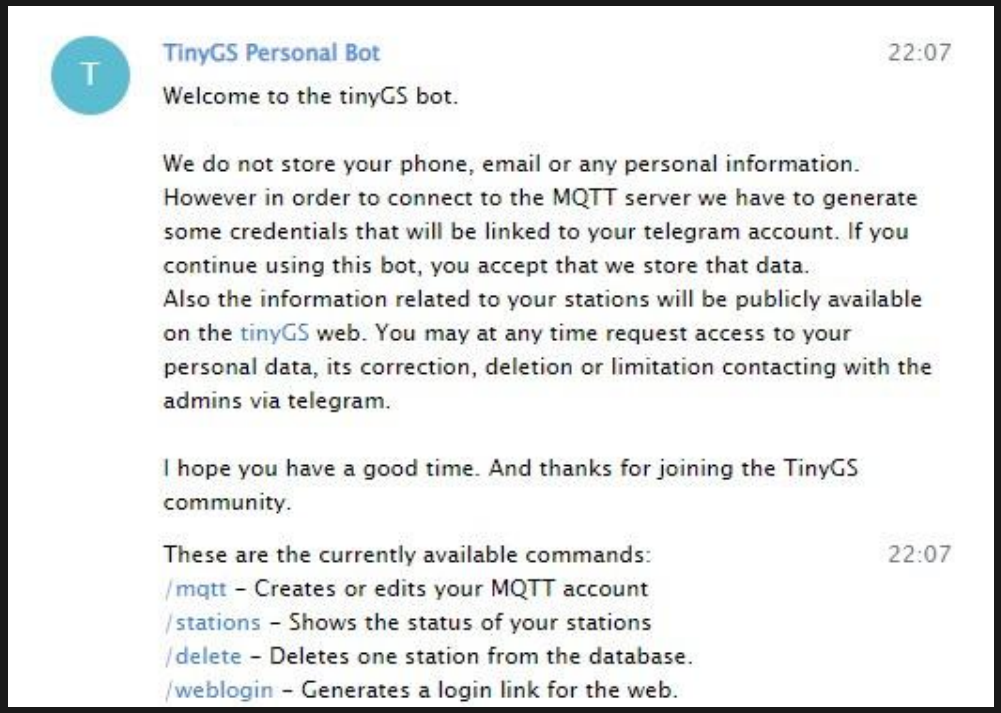


WICHTIG

- Bitte niemals ein Radio/Sender-/Empfänger ohne Antenne betreiben!
- Senden außerhalb bestimmter Bänder und Leistungen sind nur mit entsprechender Lizenz erlaubt!

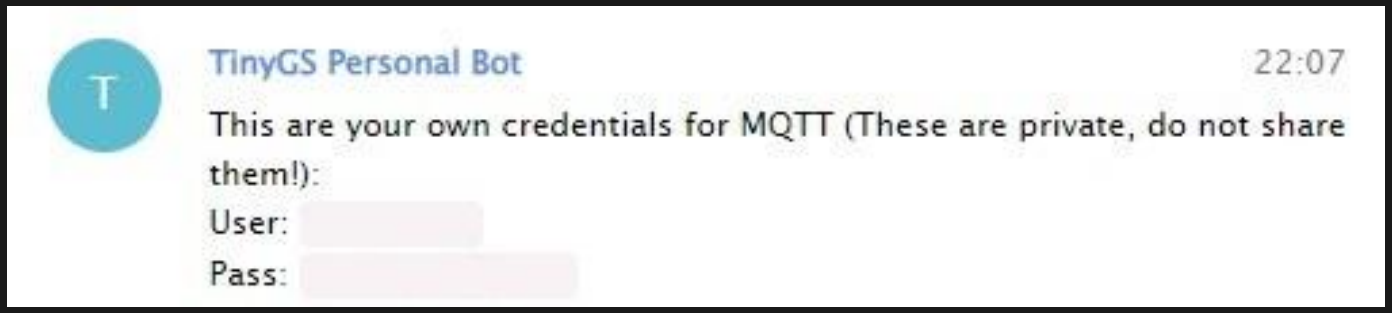
GROUND STATION ANMELDEN 1/2

Telegram Gruppe beitreten,
https://t.me/joinchat/DmYSElZahiJGwHX6jCzB3Q
TinyGS Personal Bot mit /start anschreiben:



GROUND STATION ANMELDEN 2/2

TinyGS Personal Bot mit /mqtt anschreiben:



Die erhaltenden Logindaten aufschreiben für später

SOFTWARE

- https://github.com/G4lile0/tinyGS/releases
- Uploader für Win/Lin/Mac herunterladen und damit das Modul flashen
- Modul startet neu, auf Handy das WLAN “My TinyGS” suchen und damit verbinden
- Browser öffnen und zu http://192.168.4.1 navigieren


Connect to AP:
->My TinyGS
to configure your Station
IP: 192.168.4.1
PRG
RST
25
BAT


22:48
0,0KB/s
192.168.4.1/config
TINY
GS
System configuration
GroundStation Name (will be seen on the map)
4m1g0
Password for this dashboard (user is **admin**)
WiFi SSID
WiFi password
Latitude (will be public)
Longitude (will be public)

KONFIGURATION 1/4

- GROUNDSTATION NAME
- PASSWORD Dashboard
  - lokales TinyGS Passwort
- WiFi SSID and WiFi PASSWORD
  - Login lokales WLAN
- TIME ZONE
- LATITUDE / LONGITUDE
  - Koordinaten GS
- MQTT_USER / MQTT_PASS
  - vom Telegram Bot erhalten

KONFIGURATION 2/4

- BOARD TYPE
  - wichtig, gemäß eigenem einstellen
- OLED Bright
  - kann auf 0 gesetzt werden um Display auszuschalten
- Enable TX
  - wenn keine Funkamateur Lizenz immer aus(!)

KONFIGURATION 3/4

- Automatic tunning
  - immer an, stellt sich selbst auf den nächsten Satelliten ein
- Telemetry to third party
  - kann ausgeschaltet werden um keine Daten an third-parties weiterzugeben
- Automatic Firmware Update
  - kann ausgeschaltet werden wenn man bedenken hat

KONFIGURATION 4/4

- Apply
  - Speichert die Optionen, dann im Hauptmenü Restart Station wählen
- Station startet neu, verbindet sich mit dem WLAN und bezieht sich per DHCP eine Addresse (zeigt diese im OLED an falls nicht ausgeschaltet)
- Station kann jederzeit über diese IP und Admin Password im lokalen LAN konfiguriert, überwacht und neugestartet werden

Groundstation Status

Name	
Version	2105260
MQTT Server	CONNECTED
WiFi	CONNECTED
Radio	READY
Test Mode	DISABLED

Modem Configuration

Listening to	FossaSat-2E12
Modulation	LoRa
Frequency	401.70
Spreading Factor	11
Coding Rate	8
Bandwidth	125.00

Last Packet Received

Received at	15:38:50
Signal RSSI	-123.50
Signal SNR	-9.50
Frequency error	5714.21

CRC ERROR!

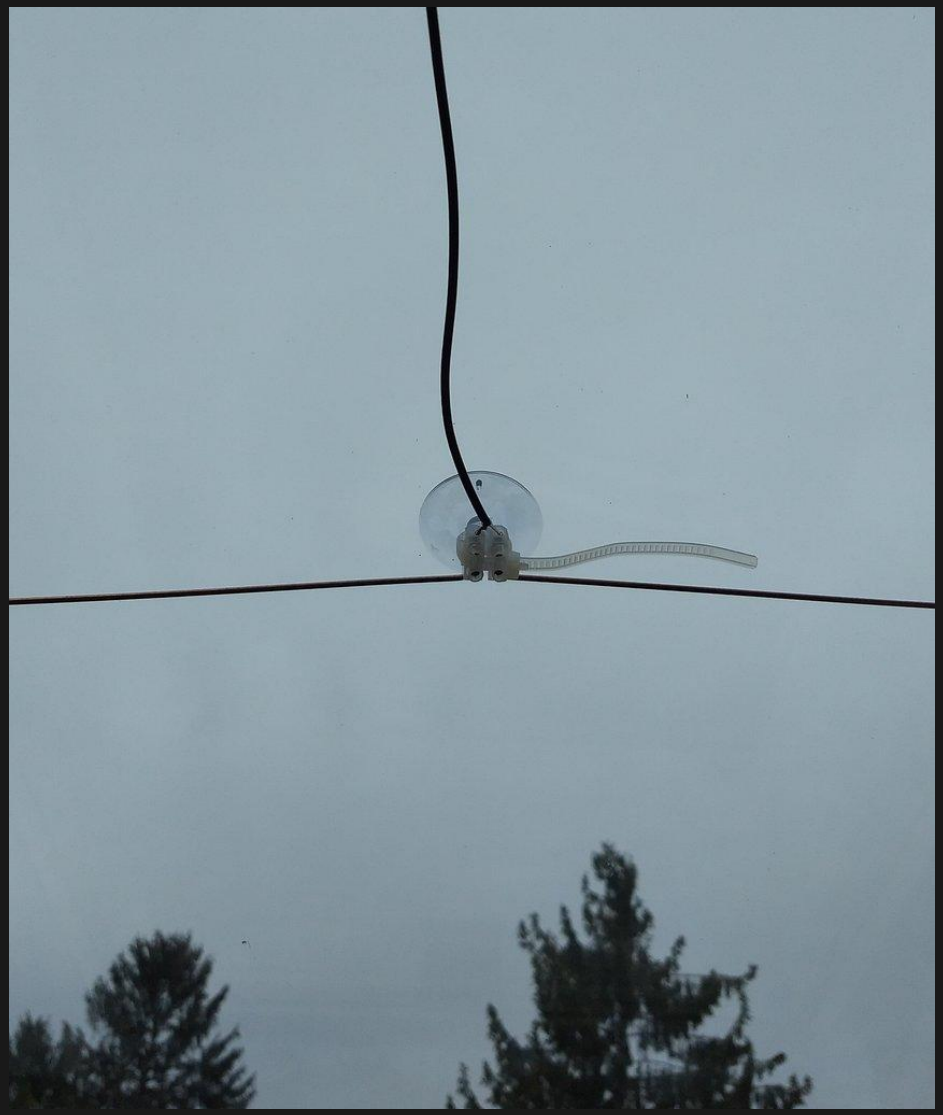
```
00:00:01 b - reboot the board
00:00:01 p - send test packet to nearby stations (to check transmission)
00:00:01 ----------------------------------
14:51:22 Attempting MQTT connection...
14:51:22 If this is taking more than expected, connect to the config panel on the ip:              to review the MQTT connection credentials.
14:51:27 Attempting MQTT connection...
14:51:27 If this is taking more than expected, connect to the config panel on the ip:              to review the MQTT connection credentials.
14:51:28 Connected to MQTT!
14:52:28 [SX12x8] Starting to listen to FossaSat-2E8
15:08:28 [SX12x8] Starting to listen to GaoFen-17
15:25:28 [SX12x8] Starting to listen to FossaSat-2E12
15:35:42 [SX12x8] RSSI:          -136.000000 dBm
[SX12x8] SNR:           -21.000000 dB
[SX12x8] Frequency error:        -3488.088135 Hz
15:35:42 [SX12x8] CRC error! Data cannot be retrieved
15:38:50 [SX12x8] RSSI:          -123.500000 dBm
[SX12x8] SNR:           -9.500000 dB
[SX12x8] Frequency error:        5714.214844 Hz
15:38:50 [SX12x8] CRC error! Data cannot be retrieved
15:43:05 [SX12x8] Starting to listen to 2023-003A
15:43:28 [SX12x8] Starting to listen to FossaSat-2E12
```

Enter command

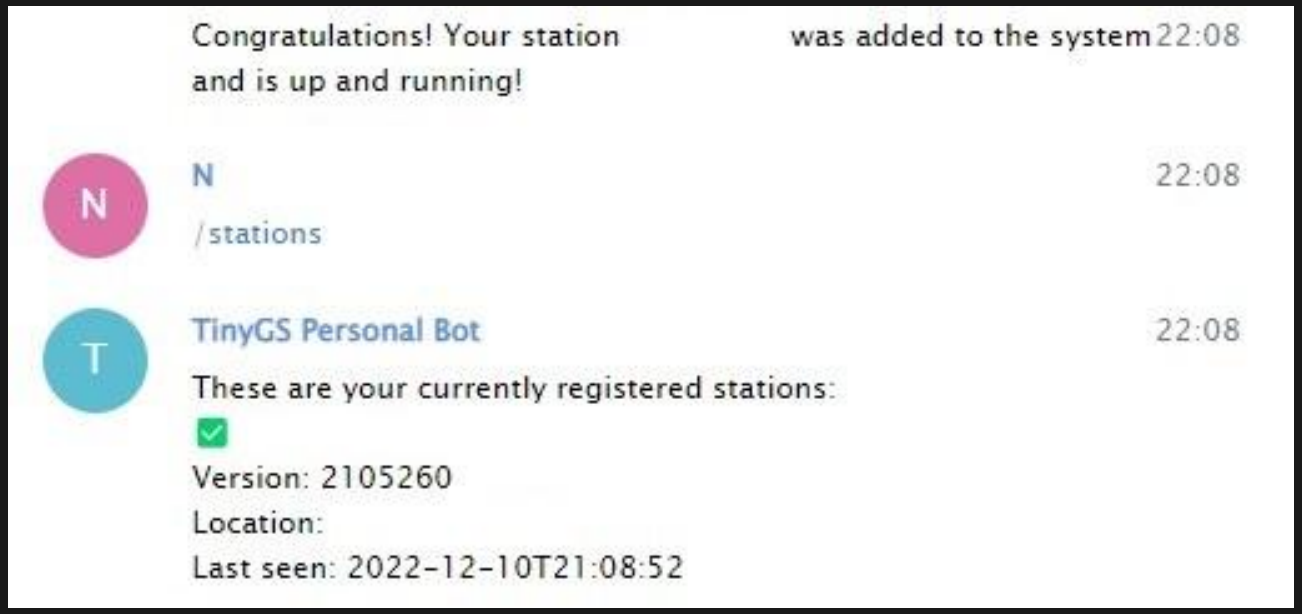
Go Back

AUFSTELLEN & ANSCHLIESSEN

- ideal: Dachfenster mit freiem Blick zum Himmel
- allgemein Indoor vorzuziehen für den Testbetrieb
  - Blitzschutz/Stromdurchführung nicht benötigt
  - (bei großen Antenne) Windlastprobleme egal
  - Erlaubnis vom Vermieter nicht benötigt
  - …



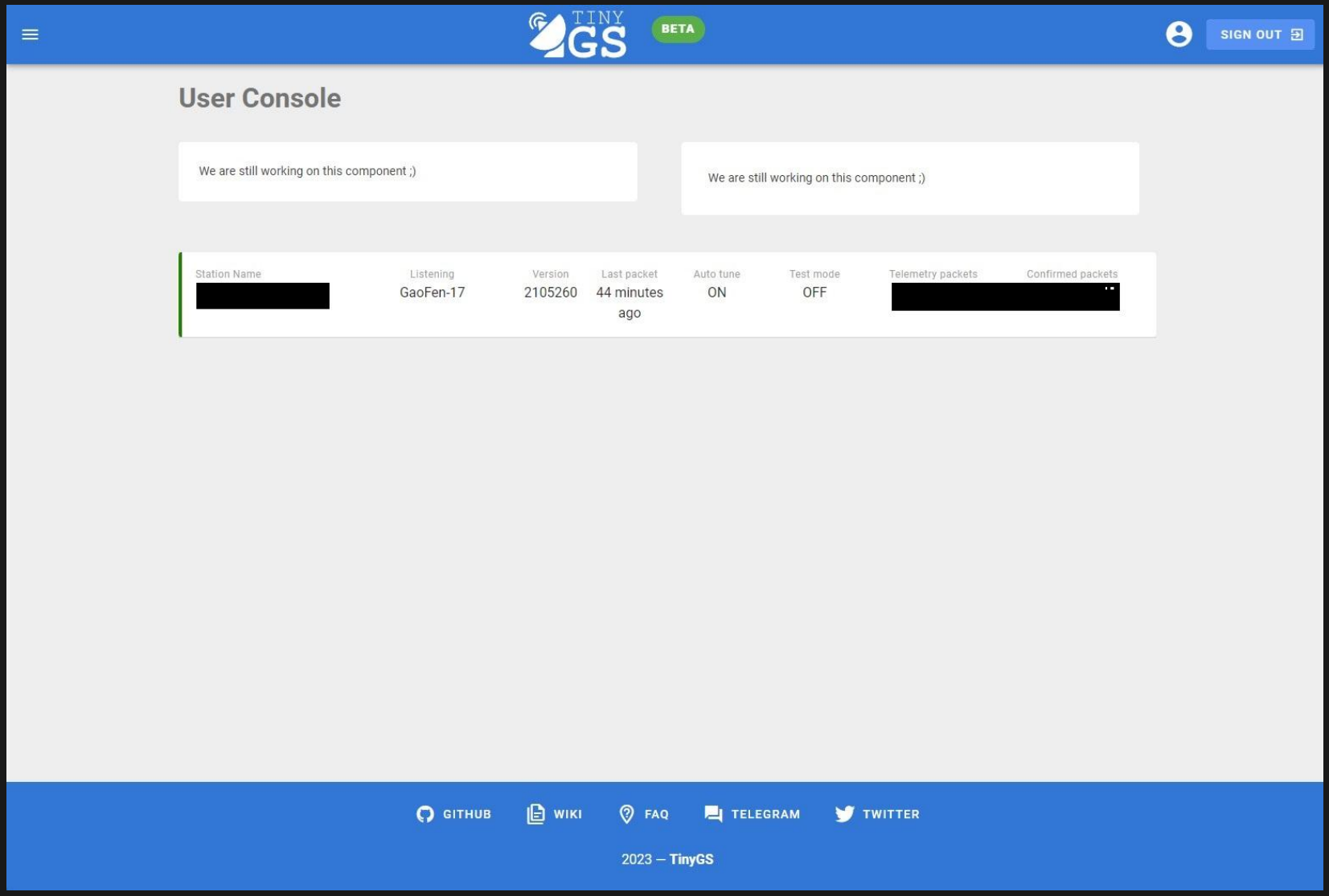
WAS SAGT DER TELEGRAM BOT?



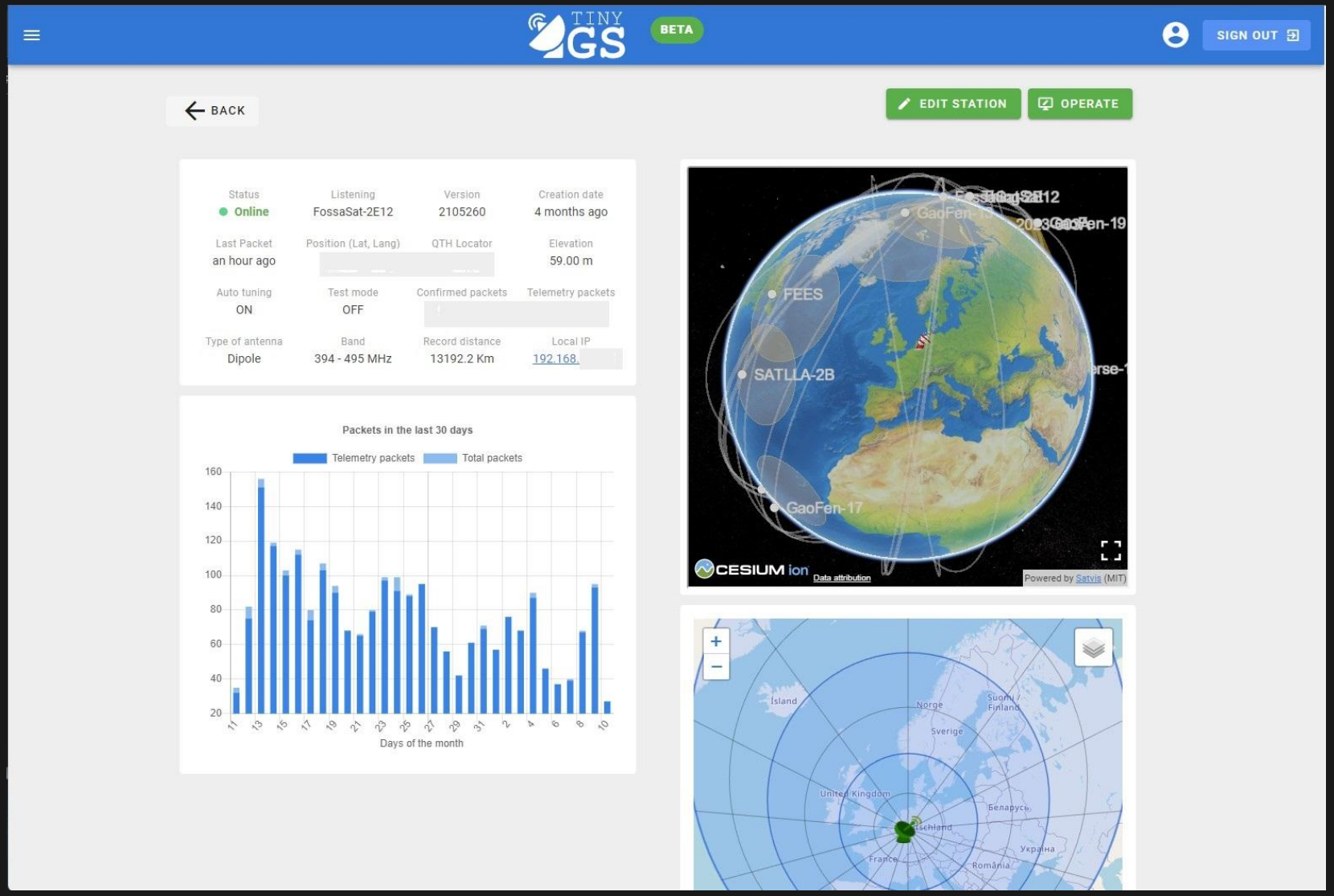
REMOTE LOGIN BESORGEN

mittels /weblogin

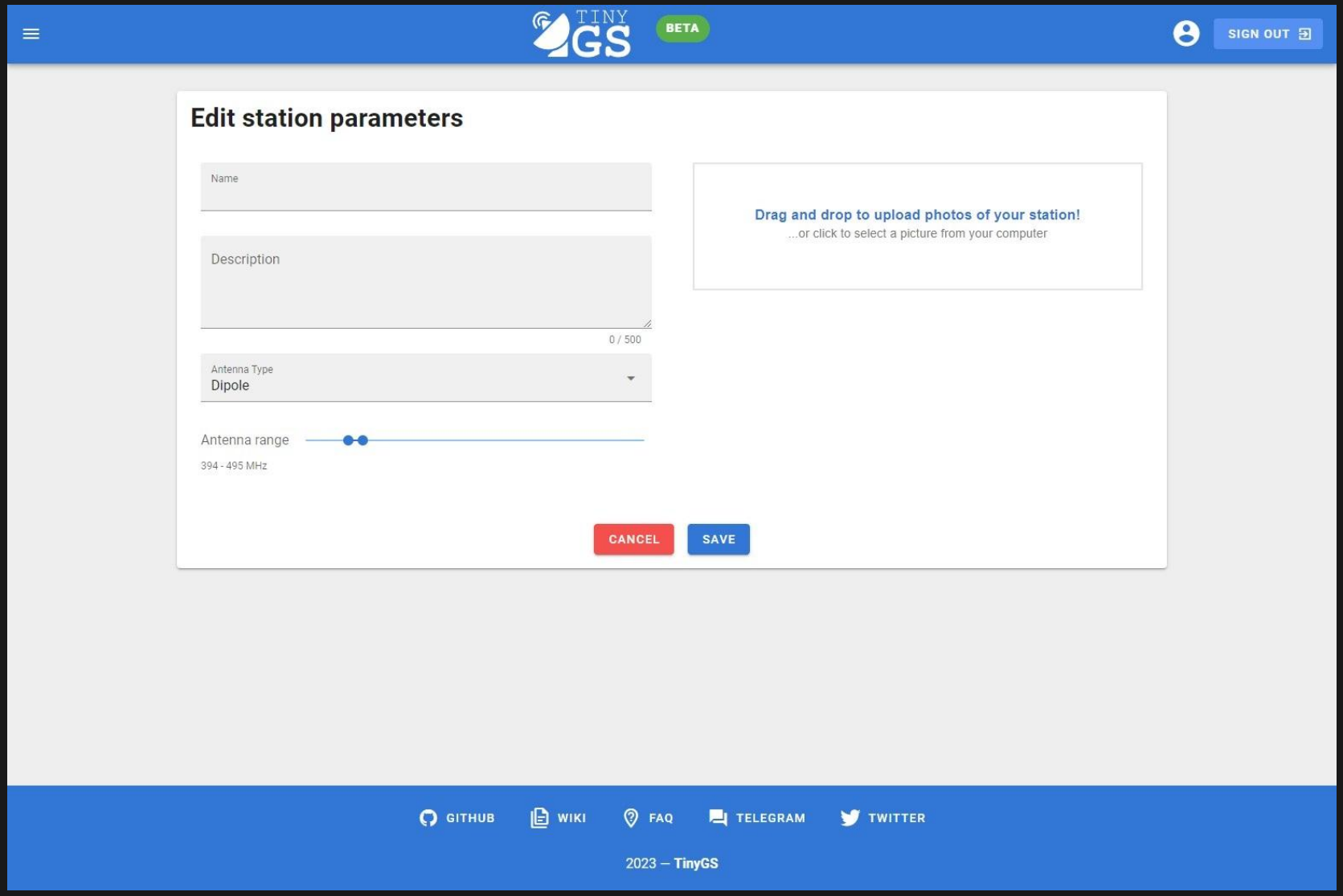
TINYGS LOGIN



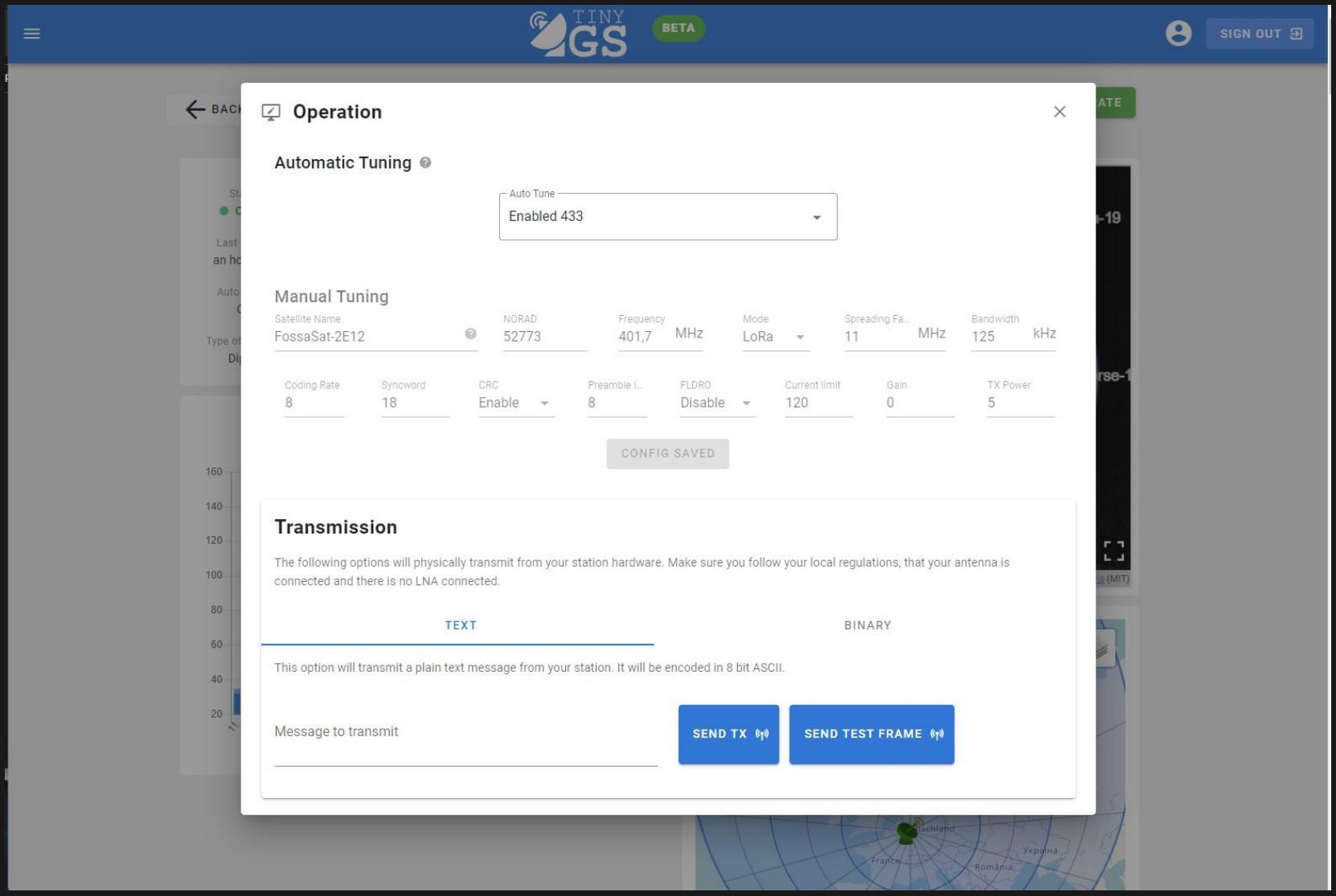
TINYGS CONSOLE



TINYGS CONSOLE STATION PARAMETERS



TINYGS CONSOLE OPERATION



FRAGEN?

Danke für Ihre Aufmerksamkeit -

und viel Spaß auf der Pi And More 13 :)!

www.nico-maas.de