discosat.dk

IT-UNIVERSITETET I KØBENHAVN

Discosat Ground Station Workshop

14.03.2022
1000 – 1600

IT University of Copenhagen

Julian Priest
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https://discosat.github.io/groundstation-workshop

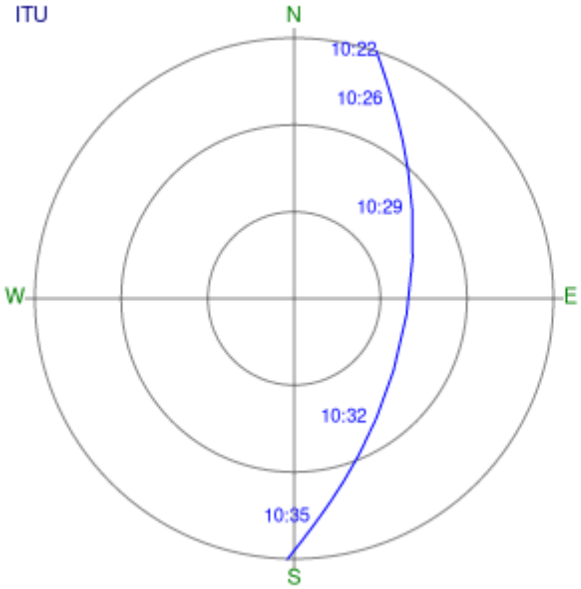
Housekeeping

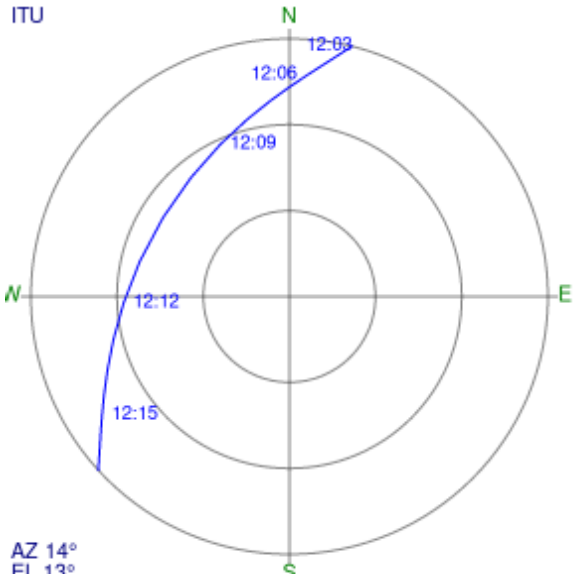
https://discosat.github.io/groundstation-workshop/

Network – ITU guest or eduroam
Coffee – analog - NW
Catering – canteen - SE
WC – Atrium
Julian, Sebastian, Paul, Emil, Jonas, Thomas, Robert, Jon
Emergency exits
Parking

Program

0930 coffee
1000 introduction
1022 noaa18 aos
1030 session 1
1200 lunch
1203 noaa 18 aos
1230 session 2
1400 coffee
1430 project space
1545 remarks
1600 close





Topics

Satellite Pointer – Paul
Rotator – Julian
Antenna – Emil and Jonas
Observation – Sebastian & Eric
Link budget - ?

Project space

Eric – Aarhus groundstation
Flat Sat – Jon
ML for images – Jacob, Linnea, Robert
++

Workshop Knowledge Base

Github

homepage, repo and wiki

https://discosat.github.io/groundstation-workshop/

https://github.com/discosat/groundstation-workshop

https://github.com/discosat/groundstation-workshop/wiki

Nextcloud

https://cloud.phys.au.dk/nextcloud/

Github invitations sent out – please join – make a github account.

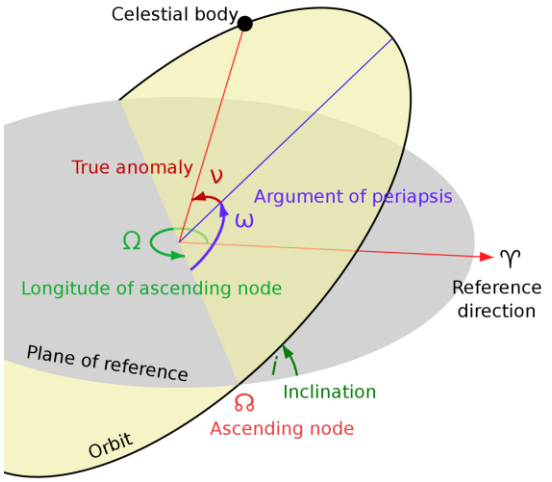
Add to the wiki!

Make a howto for one activity.

Groundstation

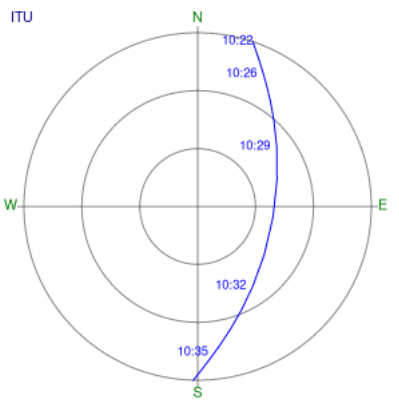
System Elements	Workshop topics
satellite	satellite pointer
radio transceiver	
antenna	
(link budget)	link budget
rotator	rotator
antenna	antenna mounting
amplification	
radio transceiver	observation
recording	
demodulation	demodulation
message	

Satellite location



Where is the satellite?

Orbital Elements
Orbital_elements
Satellite Catalog
Celestrak satellite catalog
Two Line Elements TLE
NOAA 18
1 28654U 05018A 22072.16780969 .00000133 00000-0 96006-4 0 9990
2 28654 98.9587 142.6478 0013494 241.0722 118.9097 14.12697903866472
Identifier, Inclination, Right ascension of the ascending node, eccentricity, argument of perigee, Mean anomaly, mean motion, drag coefficient
Orbital ephemerides
https://rhodesmill.org/skyfield/
Azimuth and Elevation
Az: compass heading (NESW)
El: angle from horizon (distance from center)



Satellite location

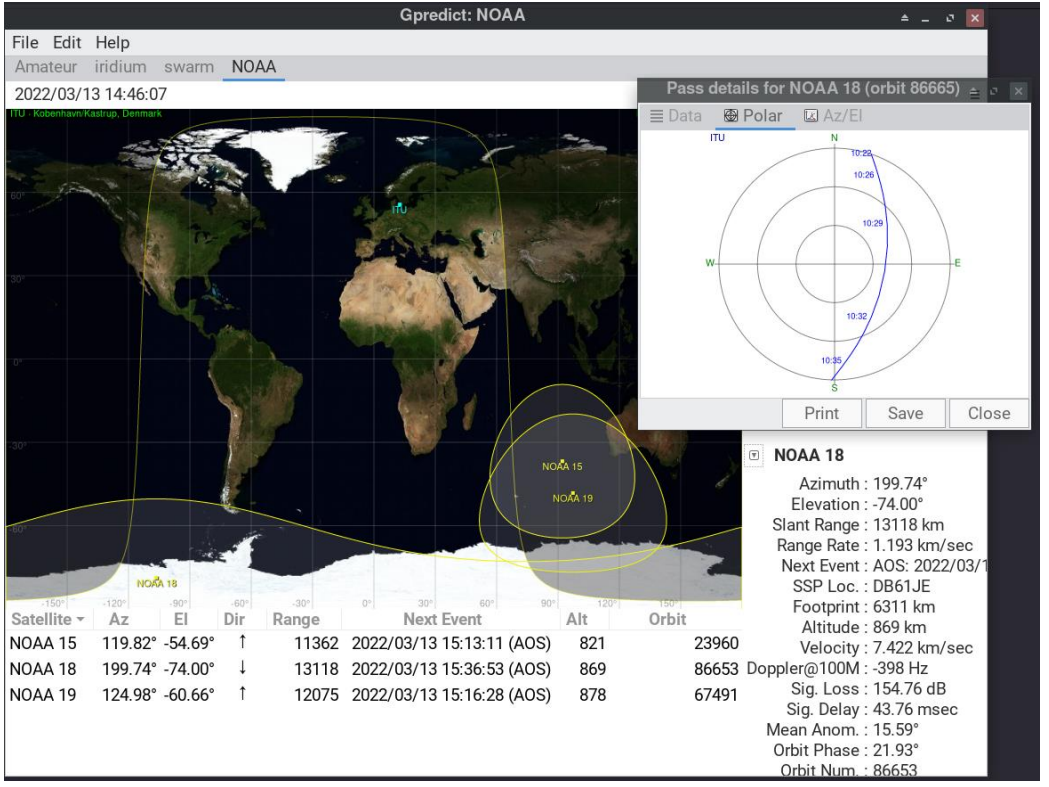
Azimuth and Elevation
Generated by gpredict

Prediction Software
Gpredict http://gpredict.oz9aec.net/
n2yo https://www.n2yo.com

Rotator Server
rotctl and rotctld
https://hamlib.github.io/

Rotator controller
MD-01
K3ng rotator

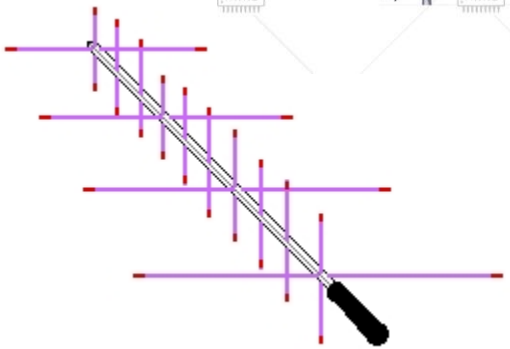
Azimuth and Elevation rotator
RF Hamdesign SPX and BIG RAS



Antennas

Different antennas for different frequencies

2.4 Ghz	12.5 cm	λ = v / f (v=c in vacuo.)	
434 Mhz	70cm		
144 Mhz	2m,	137 Mhz	2.18m

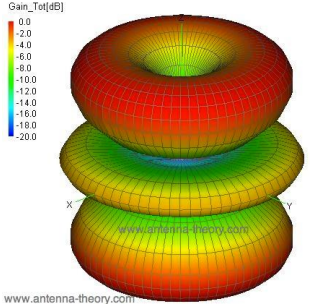


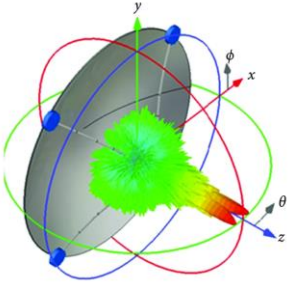
Antenna components

Radiator or dish feed + passive elements or reflectors

Radiation patterns

www.antenna-theory.com





Polarization

Horizontal, vertical, circular

Antenna types

Yagi, X-quad, helical, v-dipole, parabolic dish

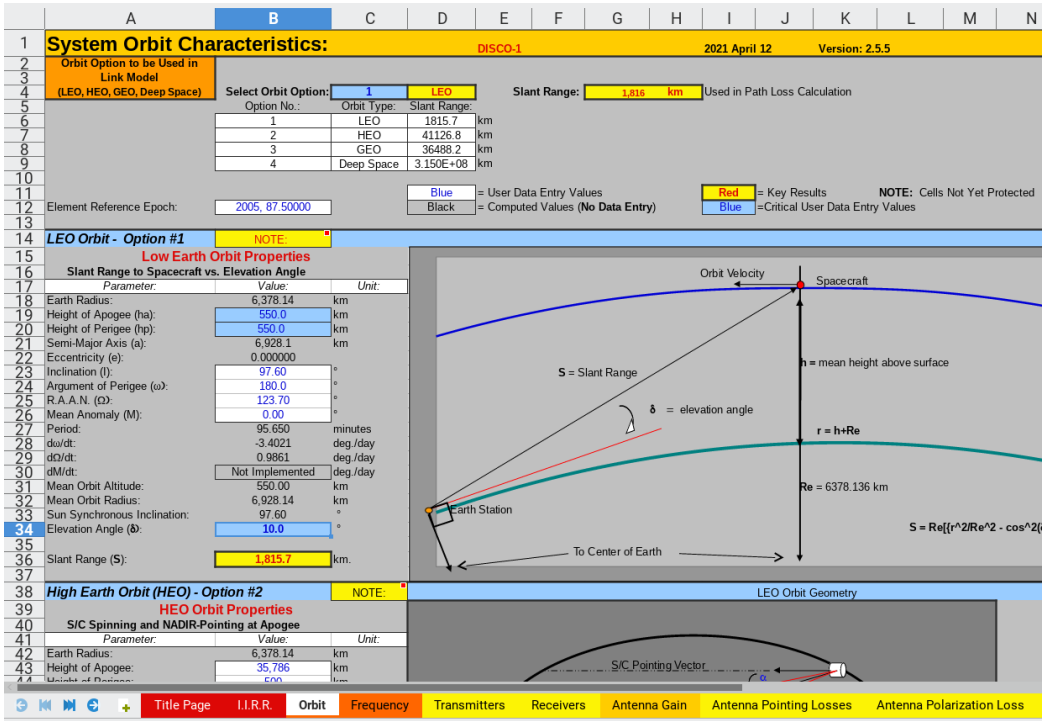
Mounting

Link Budget

Will the system allow communication with the satellite?

Orbital distances
Free space loss
Transmit power
Receive power
Antenna Gain
Pointing loss
Polarization loss
Atmospheric loss
Modulation
Connector and cable loses

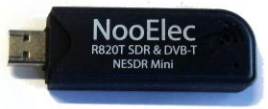
Used in frequency allocation



Radio

Software defined radio hardware

RTL-SDR, Hackrf, Funcube dongle pro, Ettus research



LNA

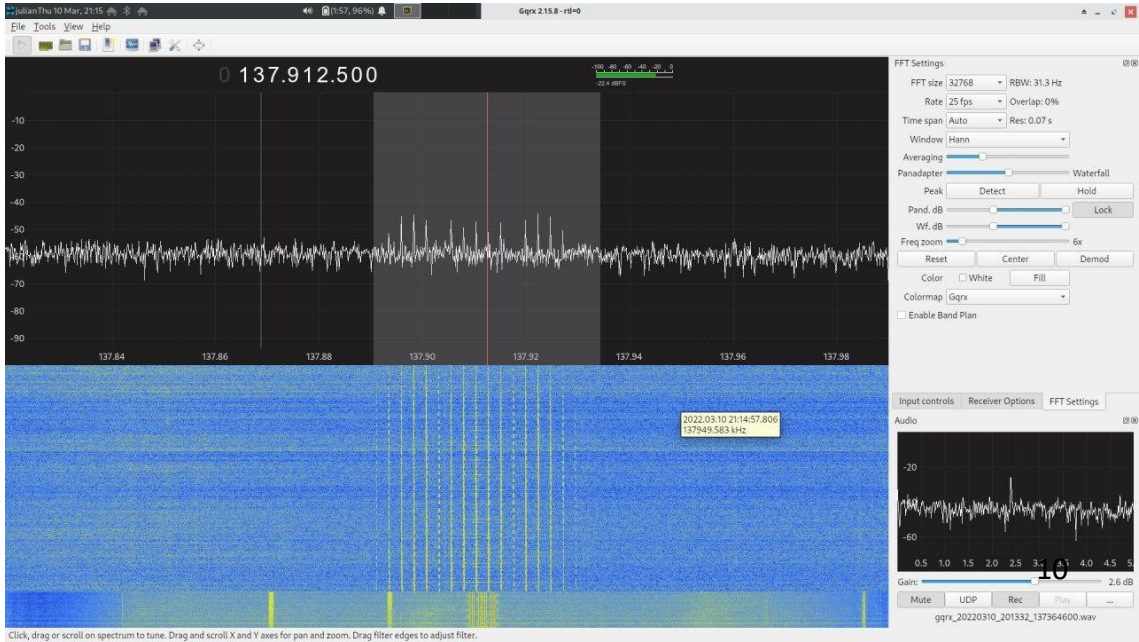
Amplification, wideband, narrow band, filtering

Software defined radio software

https://gqrx.dk/

Doppler

Use gpredict and hamlib rigctl, to compensate for doppler in gqrx.



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Demodulation

Observing NOAA satellites
Use circular polarized ie turnstile or v-dipole (53.4cm) antenna.
Gqrx rtl-sdr howto

NOAA-18 Weather satellite
location Frequencies
137.9125 Mhz

Demodulation of APT
Record wav output and downsample to 11025 khz using sox
sox input.wav output.wav rate 11025
Convert to image with wxtoimg or noaa-apt
wxtoimg output.wav output.png

Test Signal
Try fm test signal using raspberry pi fm transmitter
De-mdodulate NOAA-18 observations from Satnogs