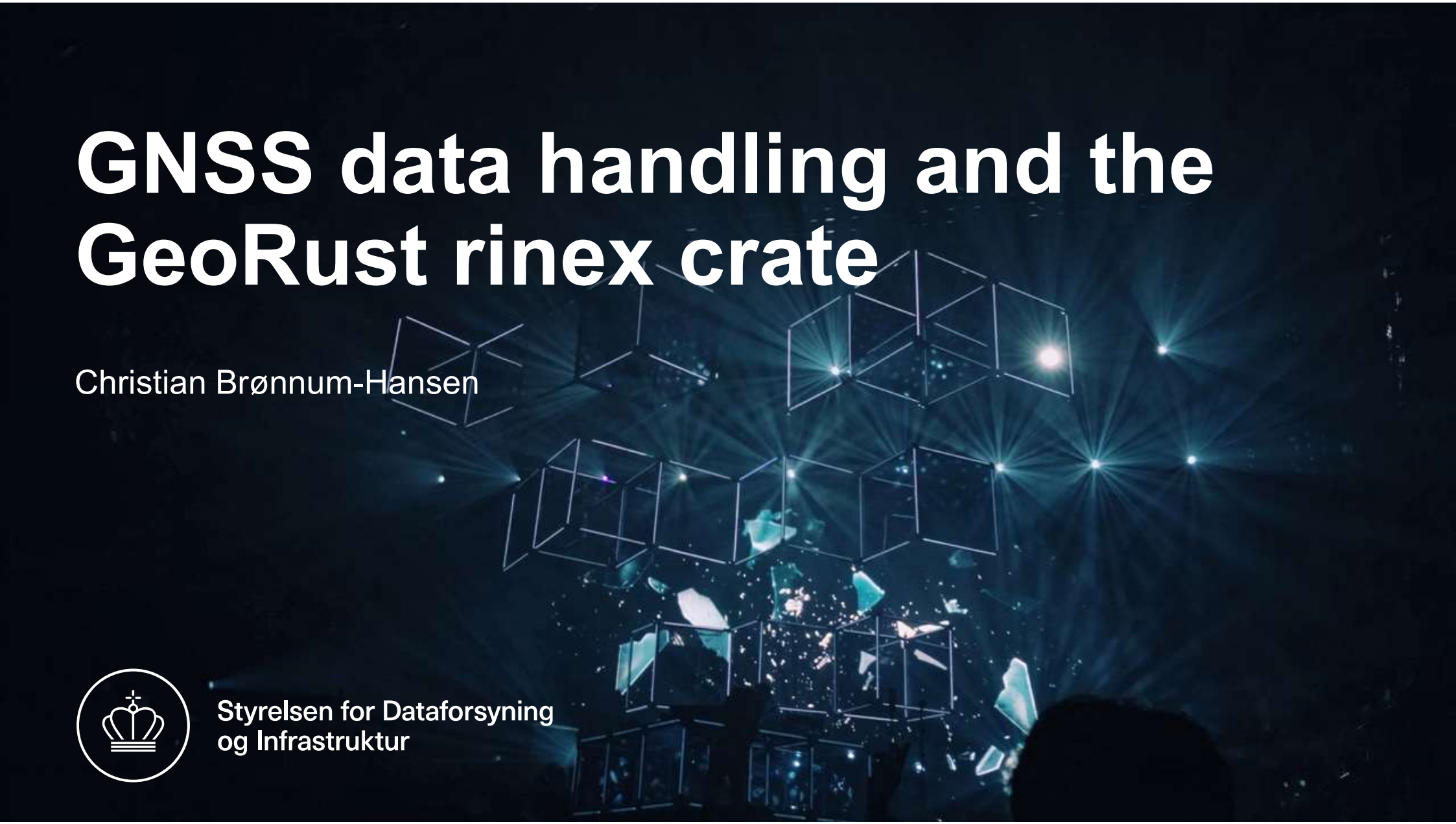
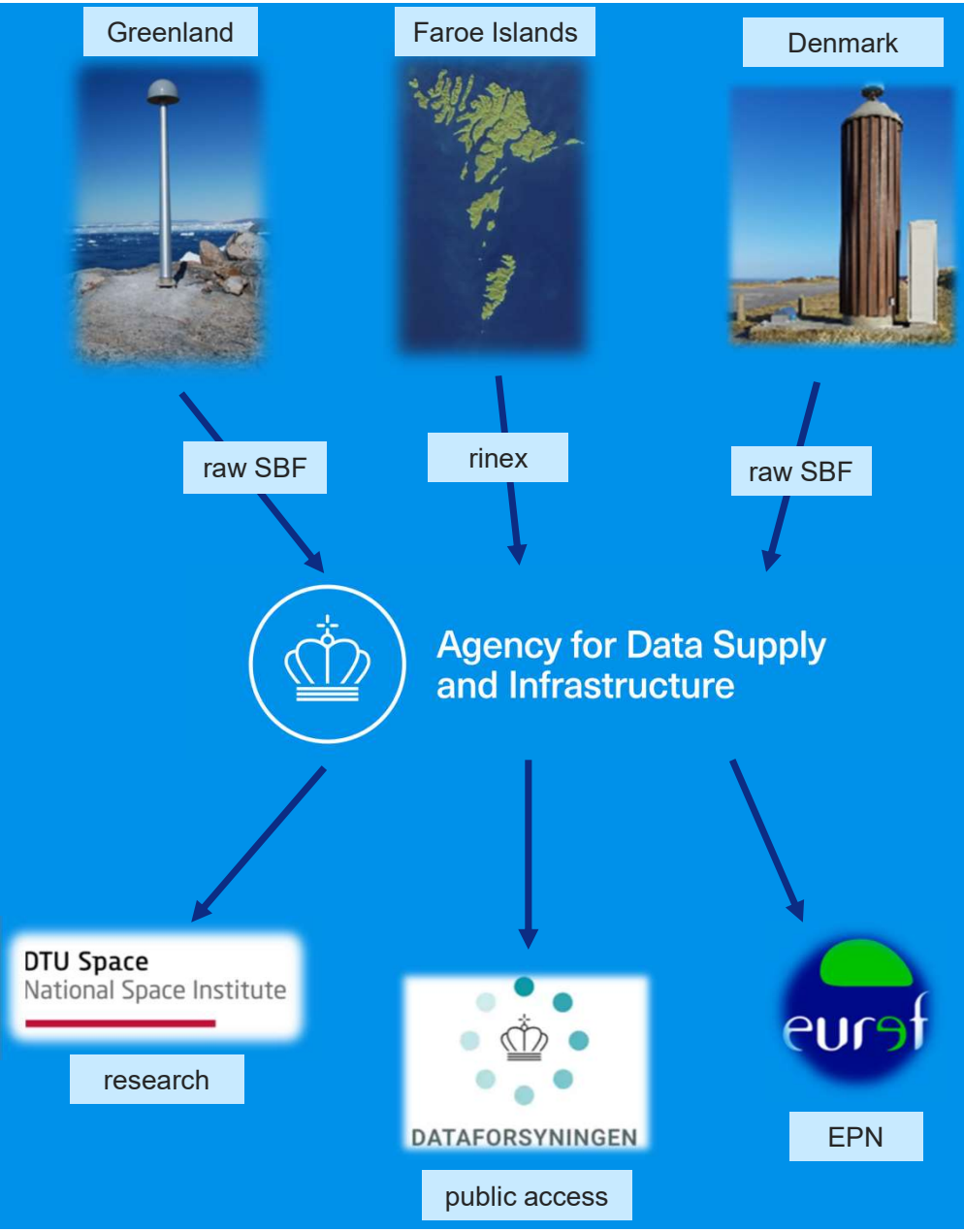
GNSS data handling and the GeoRust rinex crate

Christian Brønnum-Hansen

Styrelsen for Dataforsyning
og Infrastruktur





Flow of GNSS data

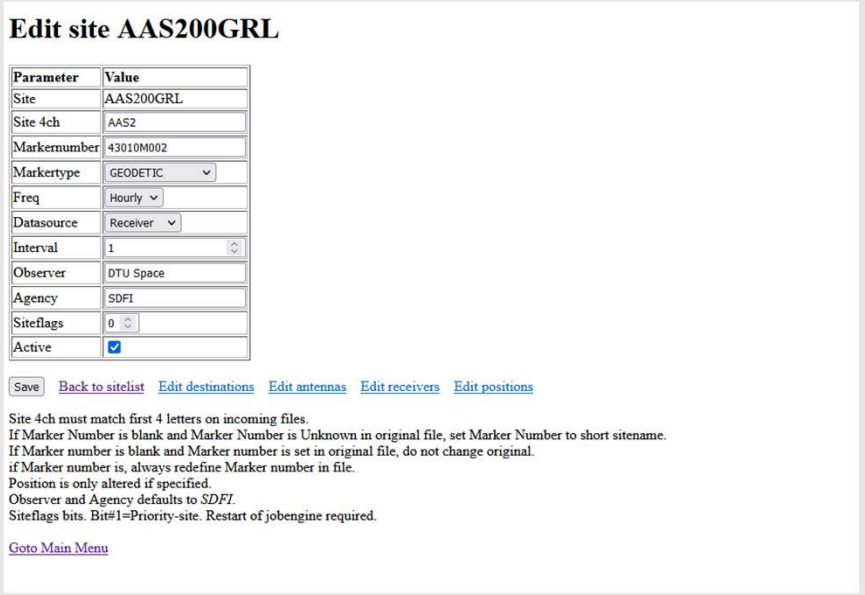
- different data formats arrive at SDFI from Greenland, Faroe Islands, and Denmark as well as commercial providers
- for Greenland the observation interval relies on the available data connection
- processed at our servers and distributed to
  - DTU
  - dataforsyningen.dk
  - EPN (EUREF Permanent GNSS Network)
- EPN guidelines for reference stations largely sets the standard for outgoing data

Agency for Data Supply and Infrastructure

GORM

GNSS Operations, Register and Monitoring system

- old (read: thoroughly tested)
- developed in PERL
- relies on closed-source software



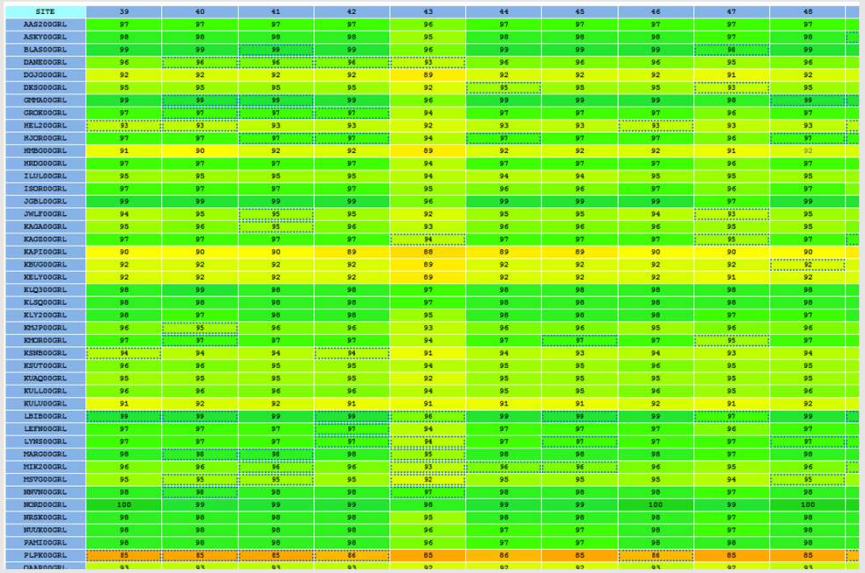
Edit site AAS200GRL

Parameter	Value
Site	AAS200GRL
Site 4ch	AAS2
Markernumber	43010M002
Markertype	GEODETIC
Freq	Hourly
Datasource	Receiver
Interval	1
Observer	DTU Space
Agency	SDFI
Siteflags	0
Active	☑

Save Back to sitelist Edit destinations Edit antennas Edit receivers Edit positions

Site 4ch must match first 4 letters on incoming files.
If Marker Number is blank and Marker Number is Unknown in original file, set Marker Number to short sitename.
If Marker number is blank and Marker number is set in original file, do not change original.
if Marker number is, always redefine Marker number in file.
Position is only altered if specified.
Observer and Agency defaults to *SDFI*.
Siteflags bits. Bit#1=Priority-site. Restart of jobengine required.

Goto Main Menu



Goals for data handling: scalability and maintainability

- Python for maintainability

  - concurrency (asyncio)

- containerized for easy deployment (Docker)

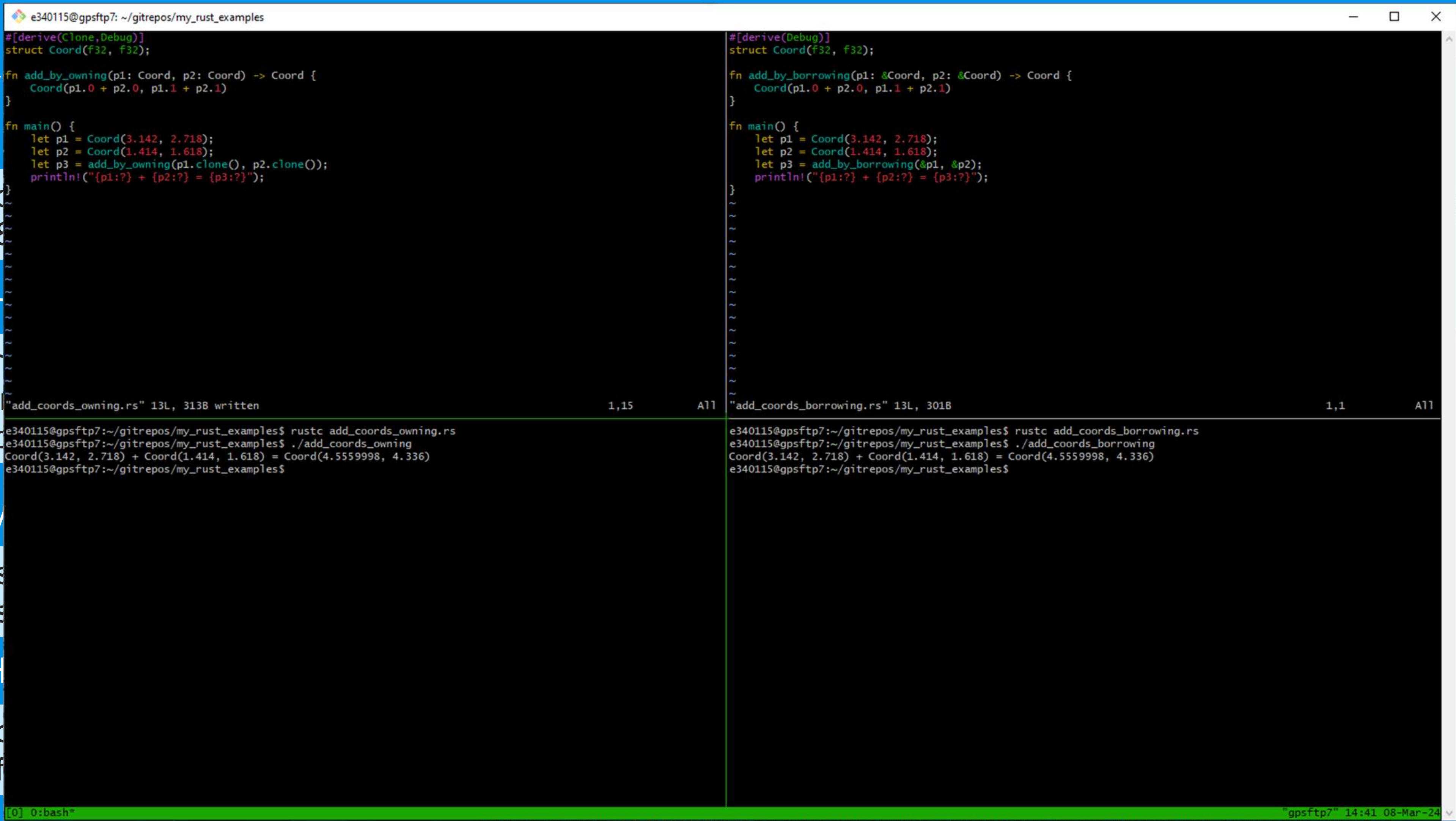
- central database (postgreSQL)

- open-source
  - version control with git
  - external dependencies

Software dependencies for data processing

Processing step	Current software	Open?	OSS alternatives (non-exhaustive list)
SBF to rinex (ver. 3)	sbf2rin [1]	✖	? (some projects)
decimate	gfzrnx [2]	✖	BNC [4], **GeoRust rinex** [5]
gap analysis	GORM		**GeoRust rinex**
file splicing	gfzrnx	✖	BNC, **GeoRust rinex**
quality check	g-nut/anubis [3]	✖	BNC, **GeoRust rinex**

[1] https://www.septentrio.com/en/products/gps-gnss-receiver-software/rxtools
[2] https://gnss.gfz-potsdam.de/services/gfzrnx
[3] https://gnutsoftware.com/software/anubis/
[4] https://igs.bkg.bund.de/ntrip/bnc
[5] https://github.com/georust/rinex



W

- T
- M
- H

[1] https://survey.stackoverflow.co/2023/#section-admired-and-desired-programming-scripting-and-markup-languages
[2] https://google.github.io/comprehensive-rust/cargo/rust-ecosystem.html
[3] https://benchmarksgame-team.pages.debian.net/benchmarksgame/fastest/rust-gpp.html

The GeoRust ecosystem

Handling GIS data formats

GDAL	Bindings for the Geographic Data Abstraction Library (GDAL) for reading and writing raster and vector GIS files.	GitHub	crates.i
GeoJSON	Work with GeoJSON files.	GitHub	crates.i
GPX	Work with GPS files.	GitHub	crates.i
GeoTIFF	Work with GeoTIFF raster files.	GitHub	crates.i
KML	Work with KML files.	GitHub	crates.i
netCDF	Bindings for Network Common Data Form (netCDF) library. Can read and write HDF5 files.	GitHub	crates.i
OSM	Work with the OpenStreetMaps PBF files.	GitHub	crates.io
Shapefile	Work with shape (SHP) files.	GitHub	crates.io
TileJSON	Work with TileJSON files.	GitHub	crates.io
Transit	Work with GTFS files.	GitHub	crates.io
WKT	Work with Well-Known Text (WKT) files.	GitHub	crates.io
World-file	Work with World-files.	GitHub	crates.io
STAC	Work with SpatioTemporal Asset Catalogs (STAC)	GitHub	crates.io
PgSTAC	Read from and write to pgstac databases.	GitHub	crates.io
OGC API	OGC API building blocks	GitHub	crates.io
RINEX	Read, parse and generate RINEX files. Can read RINEX4 files.	GitHub	crates.io
SP3	Read, parse and generate SP3 files (high precision orbits).	GitHub	crates.io

[1] https://georust.org

GeoRust rinex[1] operations: decimation and splicing

- decimation with gfzrnx ~1s

```
e340115@gpsftp7:~/gitrepos/georust_rinex_examples$ time gfzrnx -finp files/SKG100DNK_R_20240510000_01H_01S_MO.rnx -fout ::RX3:: -
smp 30 -f -q -kv

real    0m0.866s
user    0m0.801s
sys     0m0.064s
```

- with BNC ~15s

```
e340115@gpsftp7:~/gitrepos/georust_rinex_examples$ time bnc --nw --conf /dev/null --key reqcAction Edit/Concatena
te --key reqcObsFile files/SKG100DNK_R_20240510000_01H_01S_MO.rnx --key reqcOutObsFile bnc_decimate.rnx --key req
cRnxVersion 3 --key reqcSampling 30

real    0m15.852s
user    0m13.690s
sys     0m0.077s
```

- with GeoRu

```
e340115@gpsftp7:~/gitrepos/georust_rinex_examples
01S_MO.rnx -P decim:30 --filegen

real    0m3.382s
user    0m2.906s
sys     0m0.445s
```

- GeoRust us
  memory tha

- splicing with gfzrnx ~23s

```
e340115@gpsftp7:~/gitrepos/georust_rinex_examples$ time gfzrnx -finp files/SKG100DNK_R_20240510000_01H_01S_
MO.rnx files/SKG100DNK_R_20240510100_01H_01S_MO.rnx -fout splice.rnx -f -q -kv -splice_direct

real    0m23.446s
user    0m23.101s
sys     0m0.336s
```

- with BNC ~45s

```
e340115@gpsftp7:~/gitrepos/georust_rinex_examples$ time bnc --nw --conf /dev/null --key reqcAction Edit/Concatenate --key reqcOb
sFile files/SKG100DNK_R_20240510000_01H_01S_MO.rnx files/SKG100DNK_R_20240510000_01H_01S_MO.rnx --key reqcOutObsFile bnc_splice.
rnx

real    0m45.447s
user    0m43.004s
sys     0m0.412s
```

switch to a stream-based approach desired

```
e340115@gpsftp7:~/gitrepos/georust_rinex_examples$ time ./a.out
Epochs 3600
decimated to 120

real    0m0.064s
user    0m0.047s
sys     0m0.016s
```

```
get/release/rinex-cli -f files/SKG100DN
01H_01S_MO.rnx
```

s more
memory than gfzrnx when merging 24 one-hour files

[1] GeoRust RINEX Team (2023), RINEX: analysis and processing (Apache-2/MIT), https://georust.org

GeoRust rinex operations: quality analysis

- aims for teqc-like quality check with support for new rinex fo
- excerpts from GeoRus

	first epoch	last epoch	hrs	dt	#expt	#have	%	mp1
SUM	10 4 30 00:00	10 4 30 23:59	24.00	30	41538	41293	99	0.39

RINEX Quality Check summary

Version	rinex-qc: v0.1.10
Context	

File	Name
Observations	ARGI00FRO_R_20240600000_01D_30S_MC
Broadcast Navigation	ARGI00FRO_R_20240600000_01D_MN.rnx
ANTEX	None
SP3	None

Epochs

Total#	2880
w/ observations	2880 (100%)
Complete Epochs with at least Phase + PR in dual frequency, with both SNR and elev above masks	G12 L2/L1 | 1009 (35%) G05 L2/L1 | 1051 (36%) G22 L2/L1 | 979 (33%) G06 L2/L1 | 1075 (37%) G13 L2/L1 | 790 (27%) G03 L2/L1 | 1029 (35%) G09 L5/L1 | 1024 (35%) G19 L2/L1 | 1040 (36%) G28 L5/L1 | 1063 (36%) G31 L2/L1 | 1043 (36%) G29 L2/L1 | 1045 (36%) G07 L2/L1 | 1091 (37%) G26 L5/L1 | 1040 (36%) G25 L2/L1 | 992 (34%)

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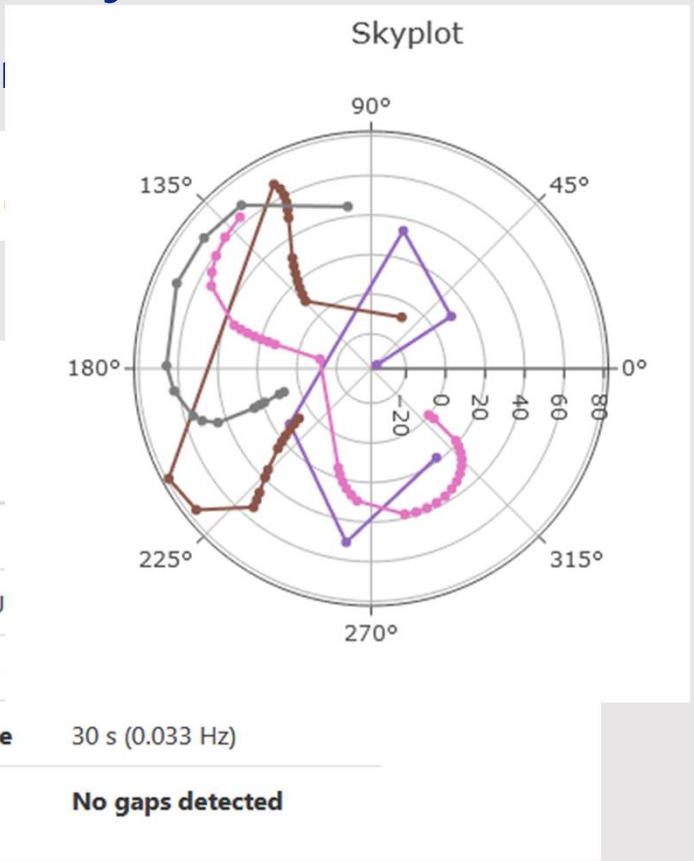
ng

-28T23:59:23 U

rate (Header)

ant Sample rate 30 s (0.033 Hz)

alysis **No gaps detected**



[1] https://www.unavco.org/software/data-processing/teqc/teqc.html

GeoRust rinex is (promising) work in progress

- promising with plenty functionality, but more work needed
- on-going development
- get involved?
  - coding
  - testing
  - feature requests