

GLONASS Observation of Artificial Plasma Irregularities During EISCAT HF Experiment

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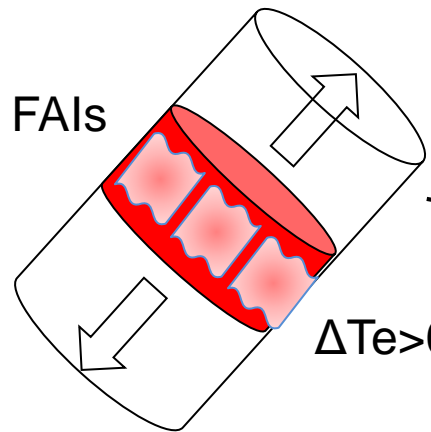
March 5, 2021
12th EISCAT 3D user meeting



Knowledge for Tomorrow



Experiment overview



Interaction region

km

300

200

MZ direction

GLONASS

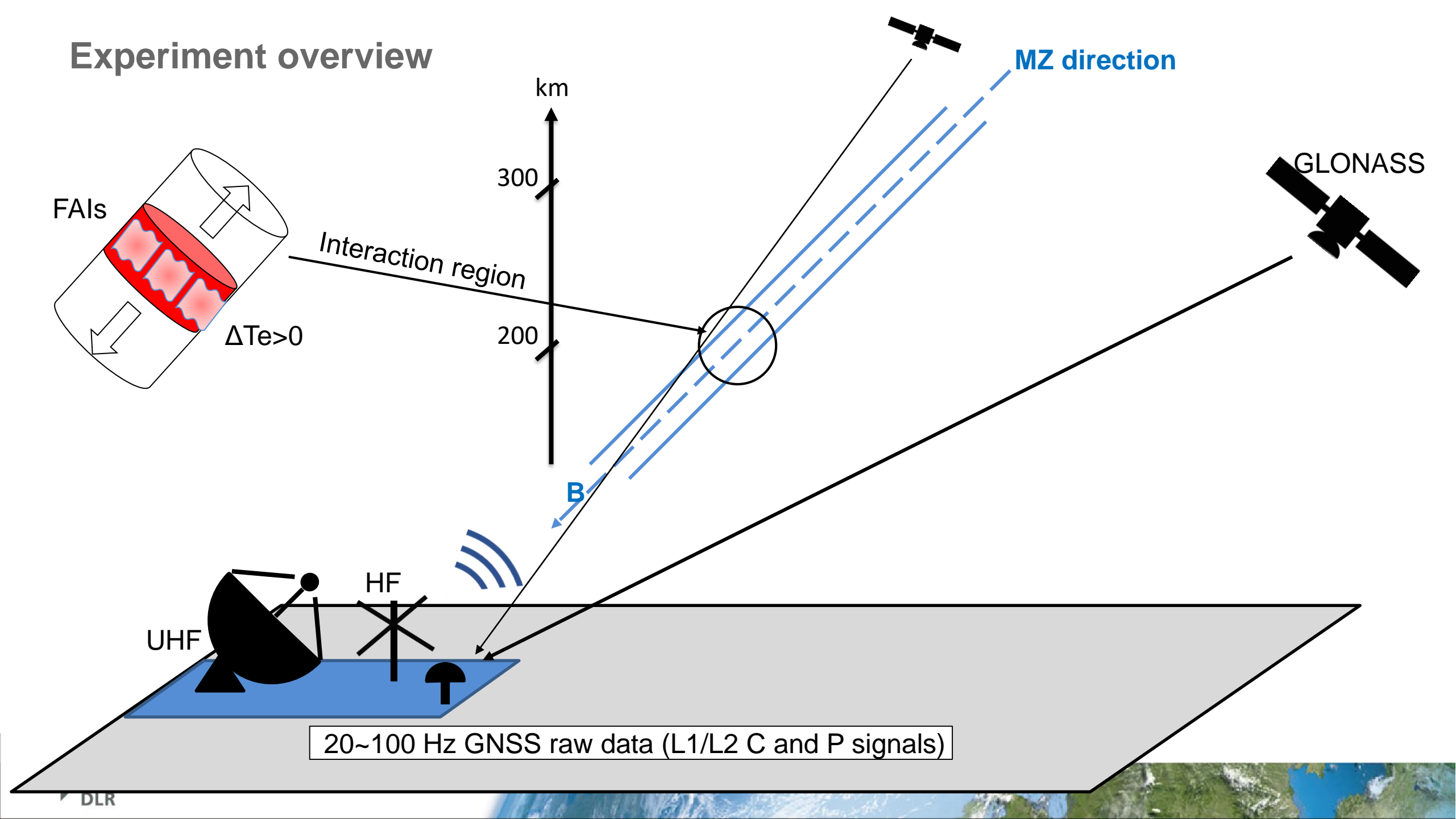
B

UHF

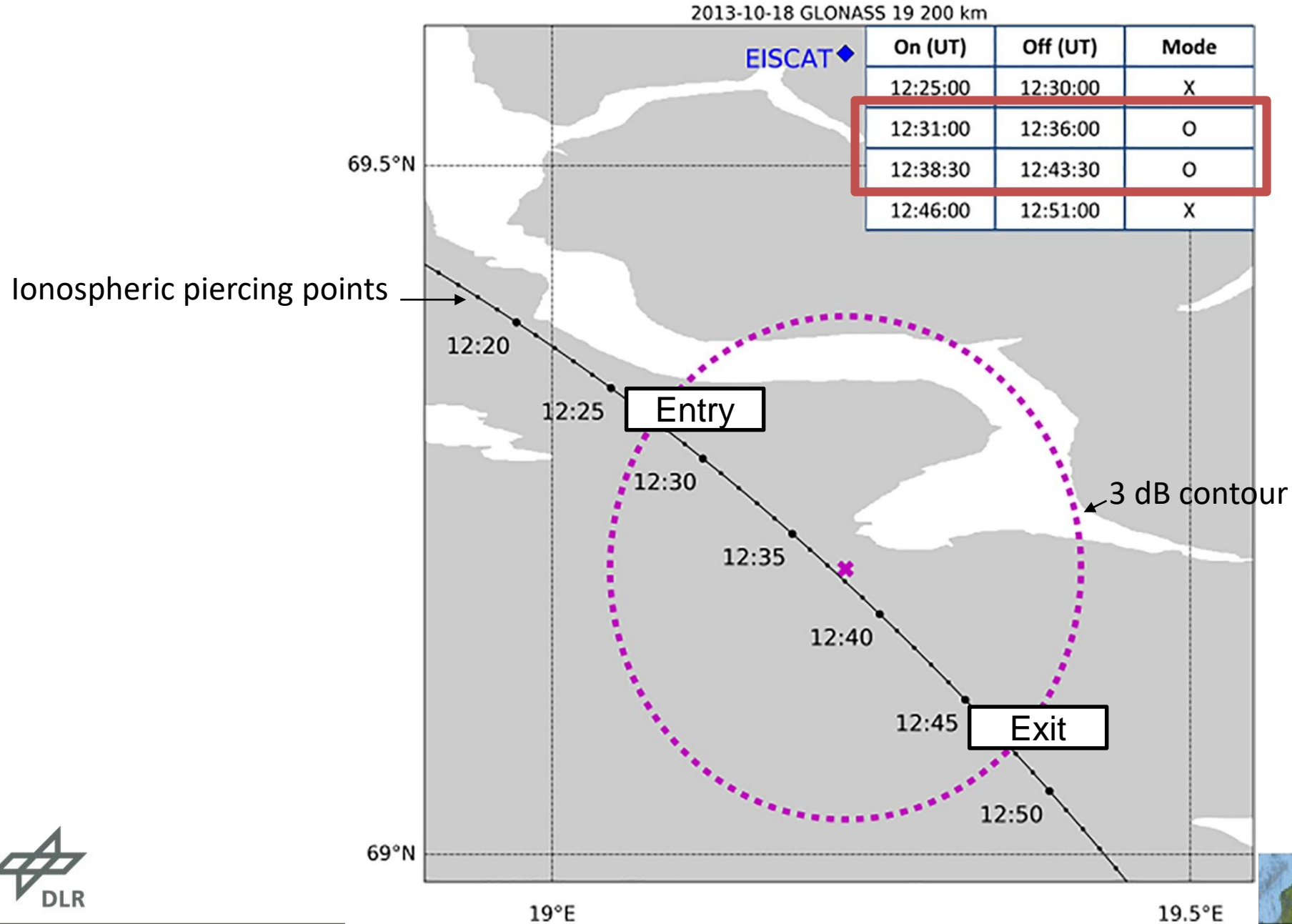
HF

20~100 Hz GNSS raw data (L1/L2 C and P signals)

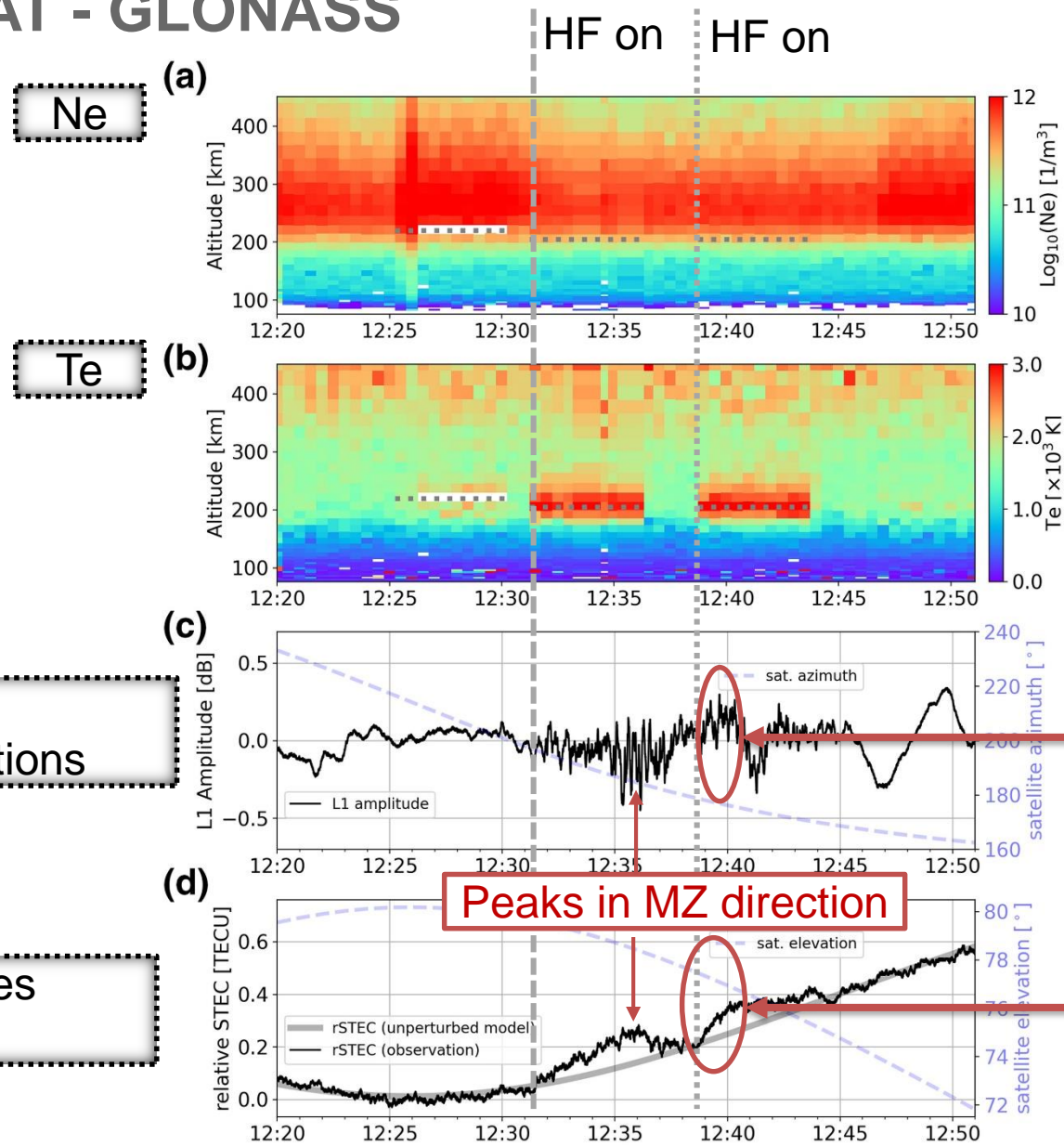
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Satellite geometry



Results: EISCAT - GLONASS



FAI generation
L1 amplitude fluctuations

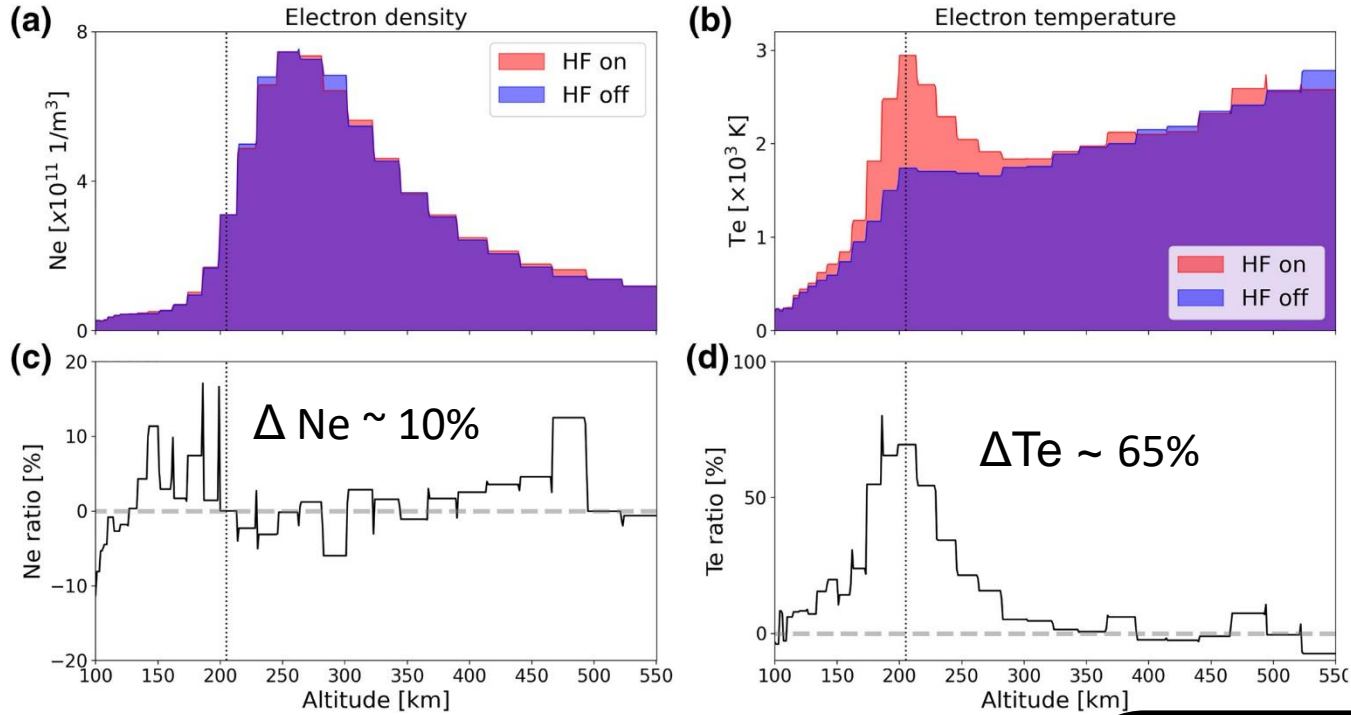
Growth time ~ 30 seconds

Density disturbances
TEC increase

Growth time ~ a few minutes

Sato, H., Rietveld, M. T., & Jakowski, N. (2021). GLONASS observation of artificial field-aligned plasma irregularities near magnetic zenith during EISCAT HF experiment. *Geophysical Research Letters*, 48, e2020GL091673.

FAIs and density disturbances



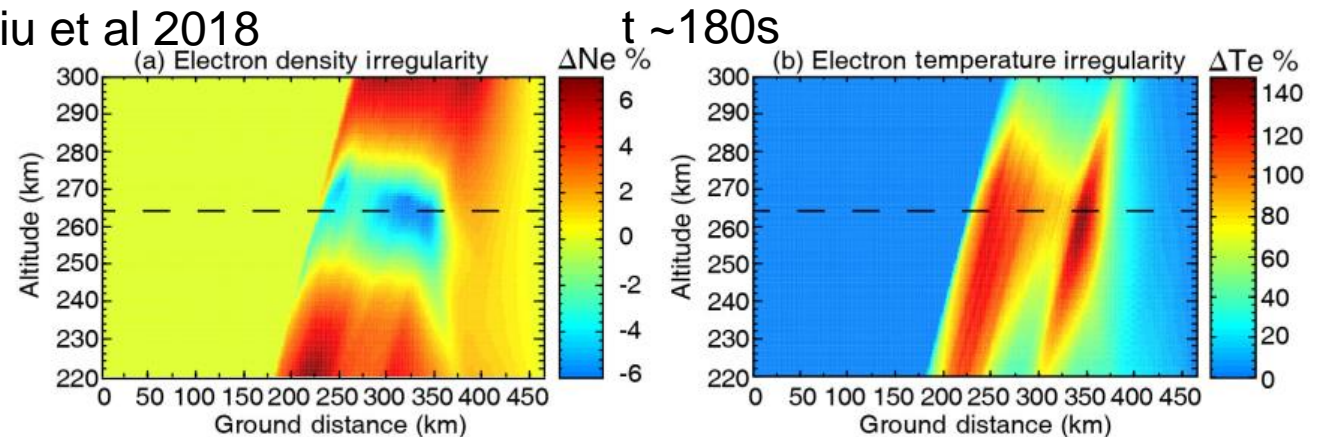
Summary

- FAI grows in 30 seconds.
- Fresnel dimension $\sim 290 \text{ m}$
- Large-scale electron density perturbation ($\sim 0.1 \text{ TECU}$) developed in a few minutes.
- Electrons are pushed up and below the interaction region
 \rightarrow thermal self forcing instability

$\Delta \text{STEC (GLONASS)} \sim 0.14 \text{ TECU}$

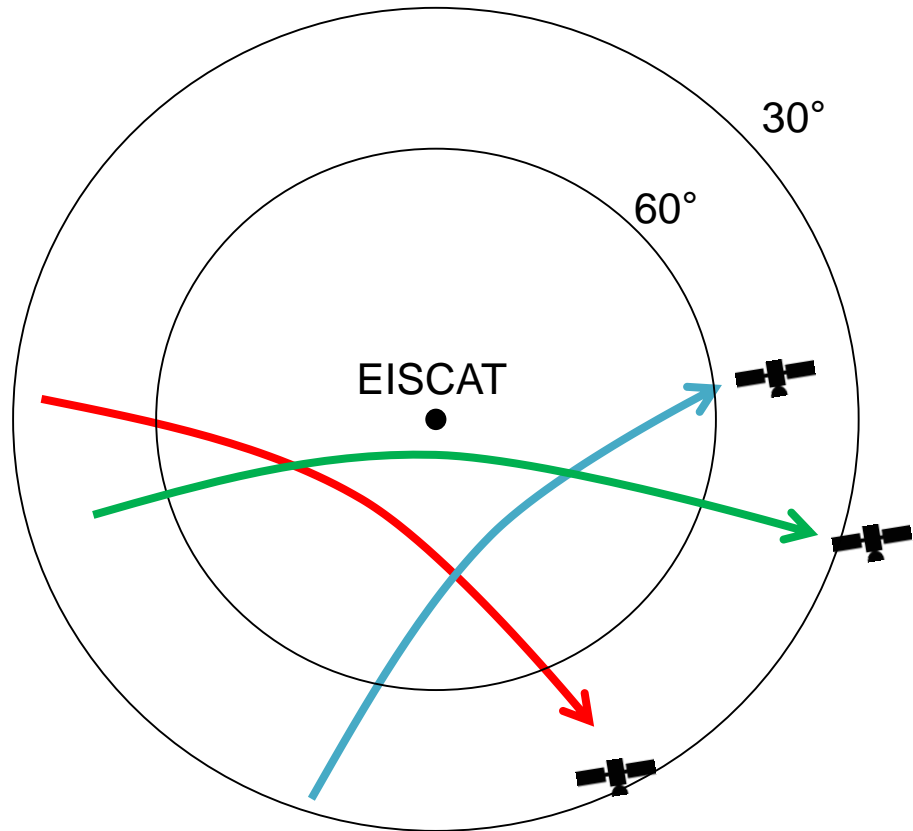
$\Delta \text{STEC (EISCAT)} \sim 0.16 \text{ TECU}$

Liu et al 2018



GLONASS data availability for EISCAT experiments

Typical GLONASS high elevation trajectories near EISCAT



Each of the trajectory types occurs several times a day

if (HF) experiment > a few hours
Field aligned GNSS measurements may be available
for
your new/archived experiments



Outlook

Apparent density enhancements in UHF ISR data (WAILEs)

An apparent increase in electron density observed above the HF reflection altitude

Medium- to large-scale HF-induced field aligned irregularities (**tens to hundreds of metres scale**) act to refract the radar signals (?)

(Rietveld and Senior, Ann. Geophys., 2020)

Field aligned experiments for EISCAT 3D

Field-aligned measurements with E3D may be possible when heater beam can be tilted eastwards with extra phased coaxial cables (11th E3D UM slides by M. Rietveld')

