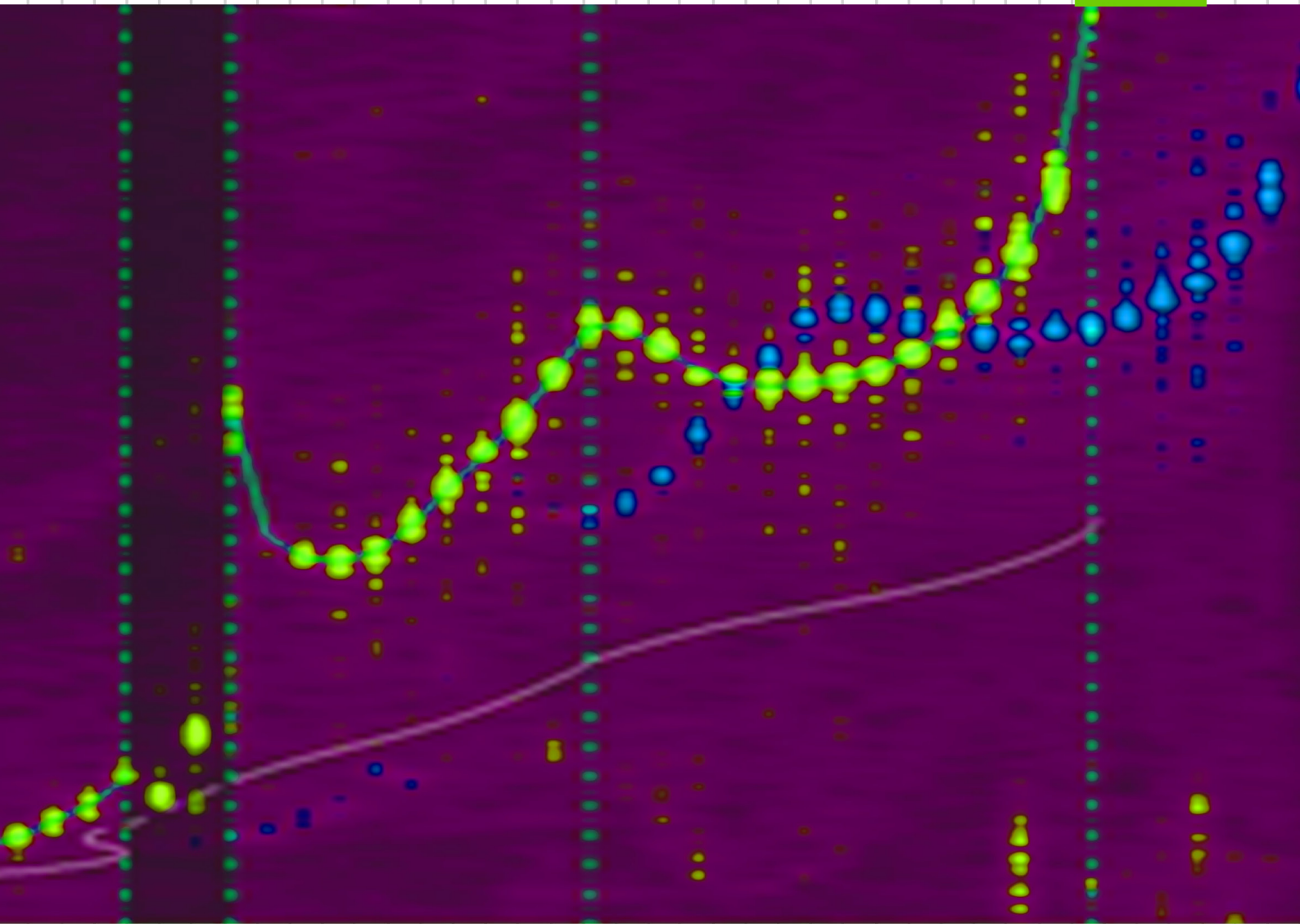


 **Norderelbe GmbH**

IONORDE4



IONNO

ADVANCED DIGITAL IONOSPHERE SOUNDER

Ionorde 4 is an advanced high frequency radar which monitors Earth's ionosphere by transmitting vertical pulses and precisely measuring the reflected signals parameters. It utilizes high technology hardware in conjunction with accurate and fast data processing techniques in order to remote sense of ionosphere. This low-cost and efficient scientific instrument extracts real time ionospheric condition and parameters from received signals by doing robust and precise measurements and calculations. Its compact and low weight Tx/Rx structures and easy to use software make it efficient and distinctive. Furthermore, unlike similar systems, it gives researchers a wide variety of options to select transmitted pulse waveform parameters such as amplitude, bandwidth, modulation, duty cycle and etc.

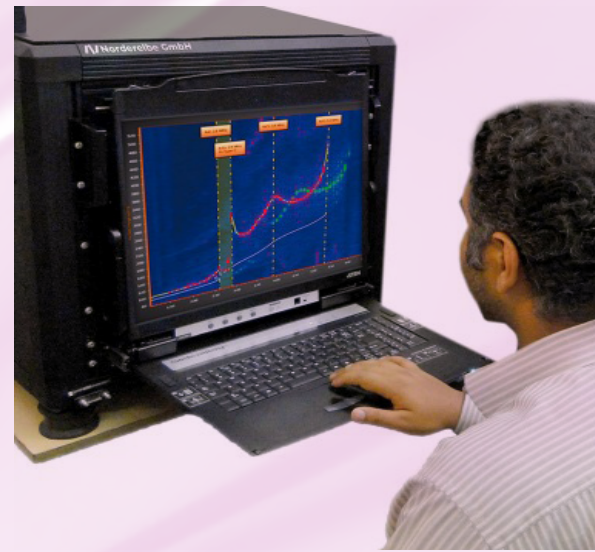
.....Applications

- ❖ Accurate measurement of ionosphere reflected signal parameters: Amplitude, phase, delay, wave polarization, Doppler frequency and angle of arrival.
- ❖ Real-time monitoring of ionospheric plasma characteristics
- ❖ Collecting a compact database of ionospheric parameters to develop or improve the reliability of prediction models
- ❖ Continuously observing and studying ionospheric structure and dynamics
- ❖ Travelling Ionospheric Disturbances (TID) detection and characterization



.....Main Features

- ❖ A complete but compact pulsed radar with selectable transmitted pulse waveform parameters
- ❖ High height and Doppler resolution measurements capability
- ❖ Improved received signal to noise ratio by coherent integration of coded pulses and using efficient antennas
- ❖ User-friendly graphical user interface capable of control and supervision of the system



.....Hardware Specifications

- ❖ Dual transmit-receive polarization (Linear or RHP/LHP)
- ❖ Antenna arrester and spark gap discharge devices used as lightning protections
- ❖ Operator-selectable transmitting power 10~200 Watts
- ❖ High precision self-calibration setup
- ❖ High quality tunable band-selection filters for Interference rejection
- ❖ Portable active crossed loop antenna for receiving and separating the reflected RHP/LHP signals
- ❖ 4-channel digital board with high-speed 16-bit A/D convertor
- ❖ Built-In Test Equipment (BITE)
- ❖ 9U Rack size



Figure 1 Ionorde4 Transmit antenna

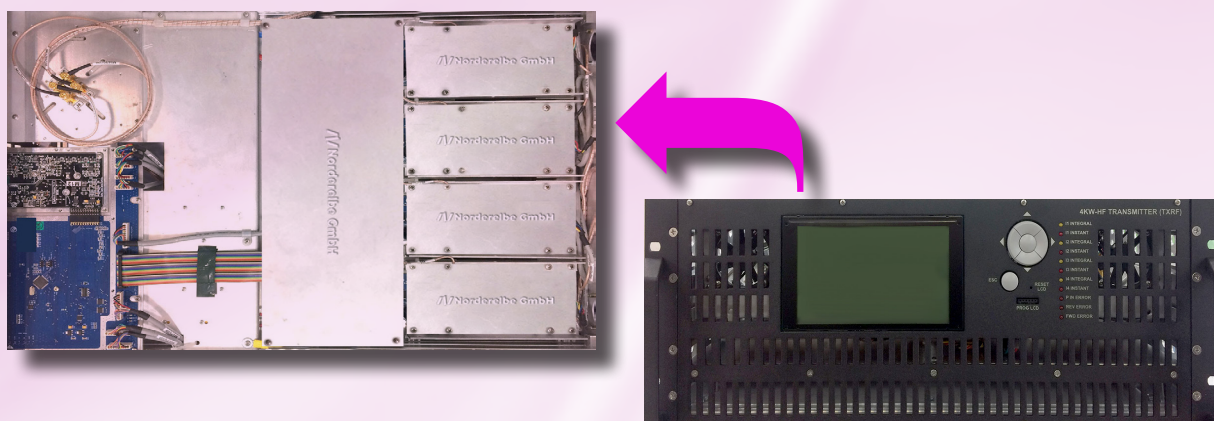


Figure 2 Ionorde4 Transmitter: a) Front view, b) Back view, c) Top view

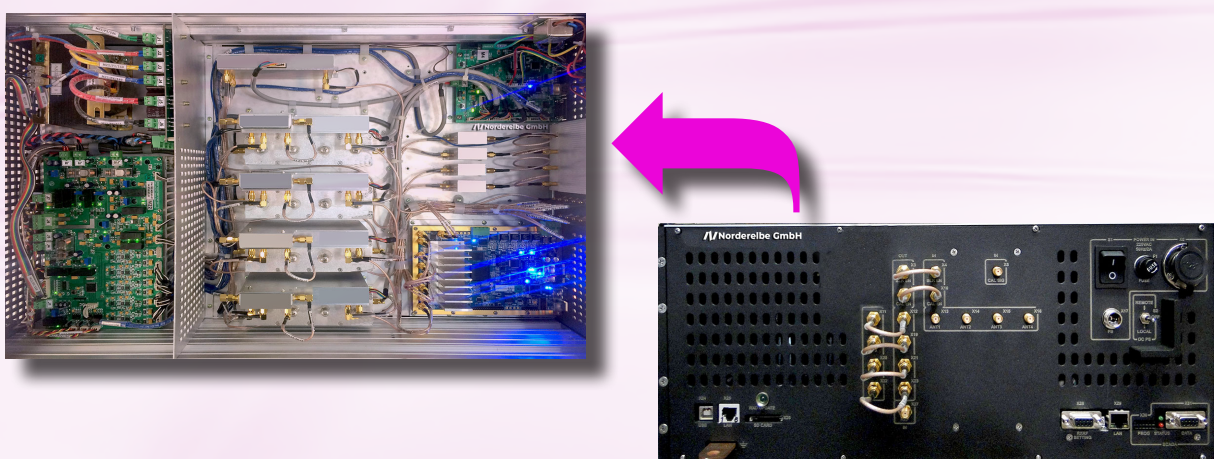
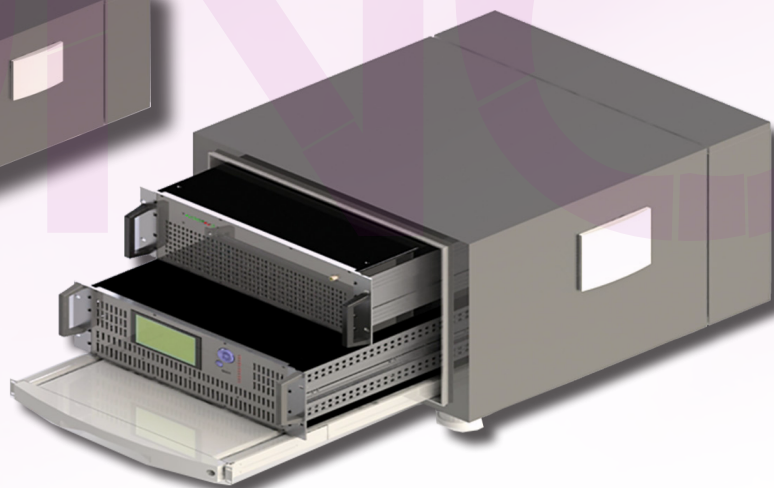
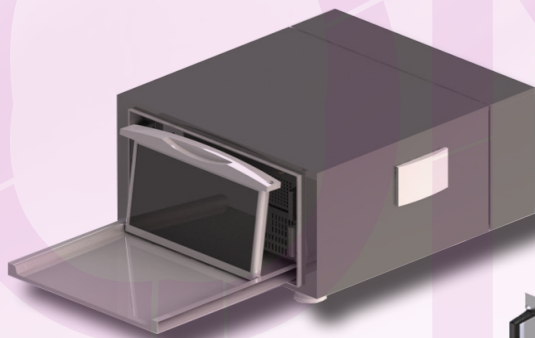
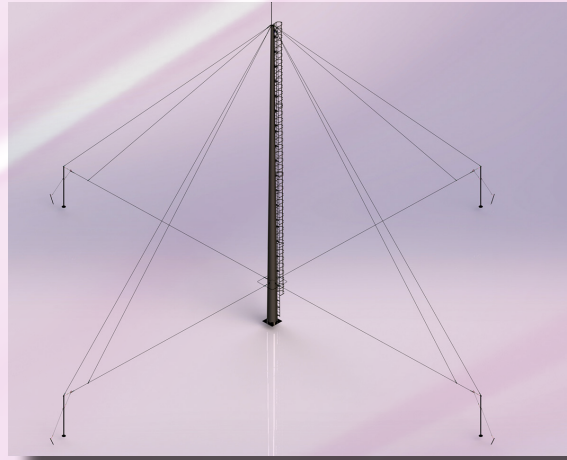


Figure 3 Ionorde4 Receiver : a) Back view, b) Top view

Parameter	Value	Description
Frequency	1 - 20 MHz	Tunable
Frequency Steps	20 to 400kHz	Operator-selectable
Bandwidth	5 to 100 kHz	Operator-selectable
Output Power	10 to 200 Watt Peak Pulse Power	Operator-selectable
Tx Output / Rx Input Impedance	50 Ohm	
Tx Antenna	1 or 2 Delta Antenna	Optional
Receiver Sensitivity	-117 dBm	
Receiver input dynamic Range	80 dB	
Rx Antenna	4 Active Crossed loop Antenna	Optional

.....System Layout



.....Processing Specifications

- ❖ More than 35 dB SNR gain achieved by coherent integration and pulse compression techniques
- ❖ Interference Rejection up to 35 dB using RFIM
- ❖ Take advantage of image enhancement methods for ionogram interpretation
- ❖ Efficient and easy to use display
- ❖ Real-time electron density extraction from ionogram
- ❖ Doppler processing and ionospheric dynamic characterization
- ❖ Compatible with SAO software and standard ARIST5 package for ionogram analysis and scaling

Parameter	Value	Description
Height Range	60 - 1500 km	
Range Resolution	1.5 km	
Pulse Waveform	LFM/NLFM/Phase Coded	Operator-selectable
Pulse Repetition Interval	1 to 10 ms	Operator-selectable
Duty Cycle	4 to 25 percent	Operator-selectable
Number of Pulses per Frequency	10 to 1000	Operator-selectable
Doppler Resolution	0.1 Hz	Dependent on Pulse Parameters
Ionogram Scan Time	10 sec to 4 mins	Dependent on Pulse Parameters



Figure 4 Ionorde4 Software

Measured File Address

Raw Data Address:

☒ Automatic ☐ Manual ☐ Offline

From Cycle: To:

Run Options

☒ Online Show ☐ Offline Show

☐ Fast Read

Optional Parameters

View Options

Options

☐ Ordinary Mode

☐ Extraordinary Mode

☐ Extraordinary and Ordinary

☒ Leading Edge

☒ Scaled Parameters

☒ Electron Density

Plot Limits

Freq Start(MHz):

Freq Stop(MHz):

Height Start(Km):

Height Stop(Km):

Manual Modification

☐ Filtering

☐ Leading Edge

☐ Scaled Parameters

Other Plot Options

☐ Animate ☐ Profiogram

☐ TID

☐ Consecutive Ionograms Plot

☐ Time Variation of Ionosphere Parameters

☐ SAO Analysis ☐ Inversion Results

Freq = MHz

Range = km

Ord = dB

Ext = dB

Messages

Successful Run

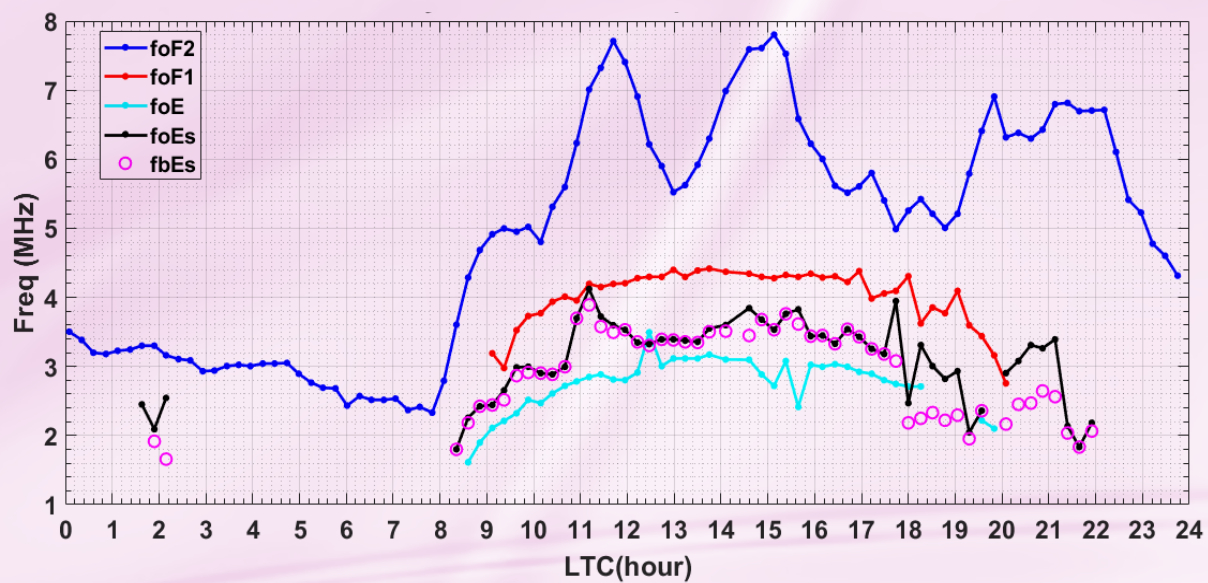


Figure 5 Time Variation of Ionosphere Parameters

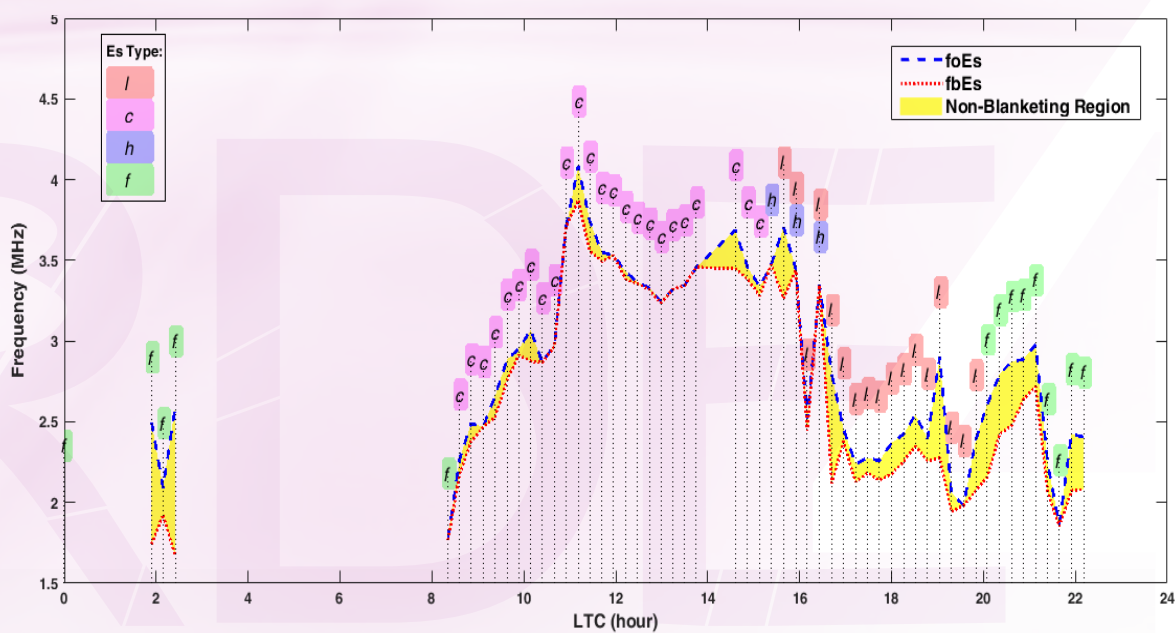


Figure 6 Hourly Variations of Es Layer Types and Critical Frequencies

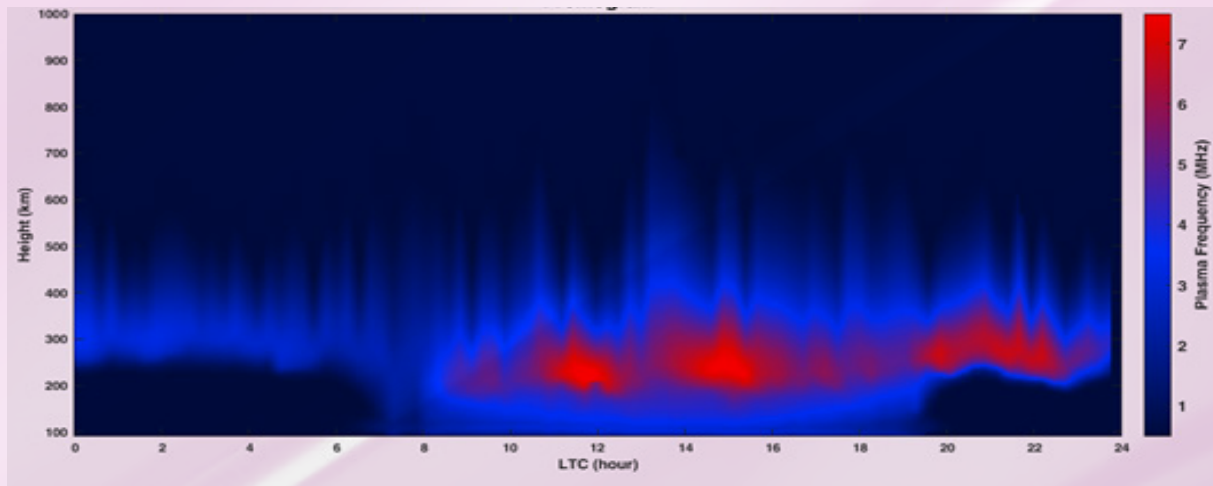


Figure 7 Profilogram

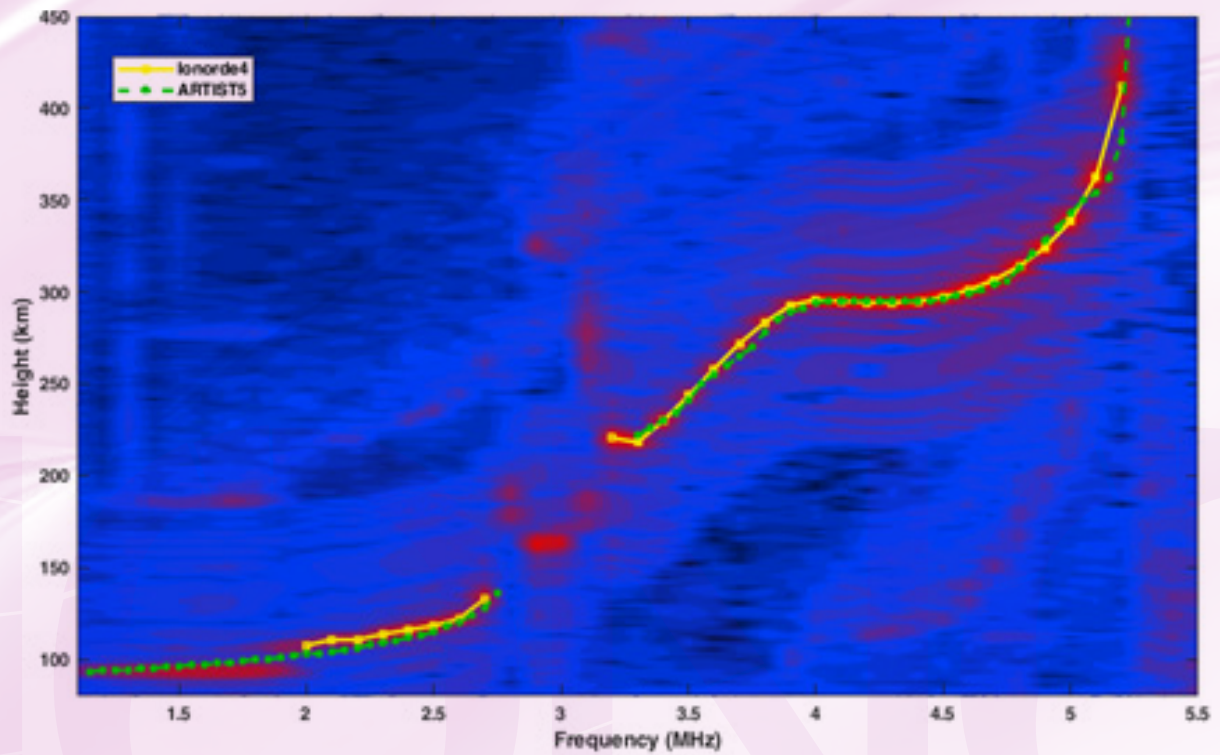


Figure 8 Ionogram Interpretation Comparison: Ionorde4 with ARTIST5

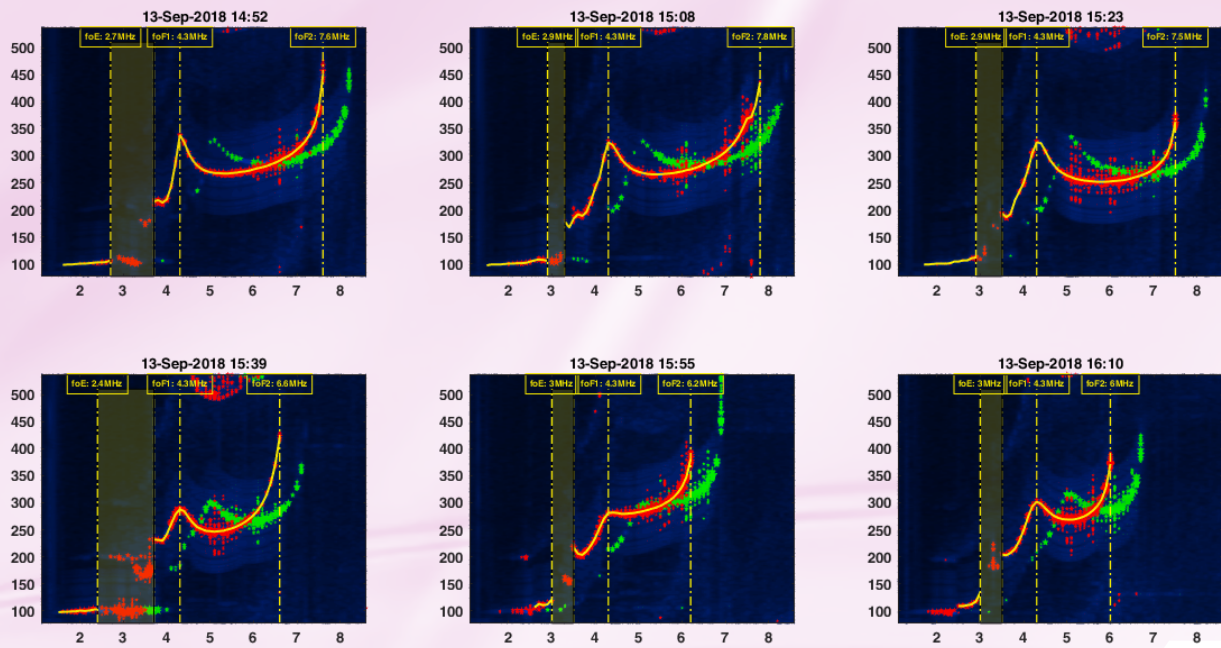


Figure 9 Consecutive Ionograms



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