ELF Measurements in Hugo, Colorado Past and Present

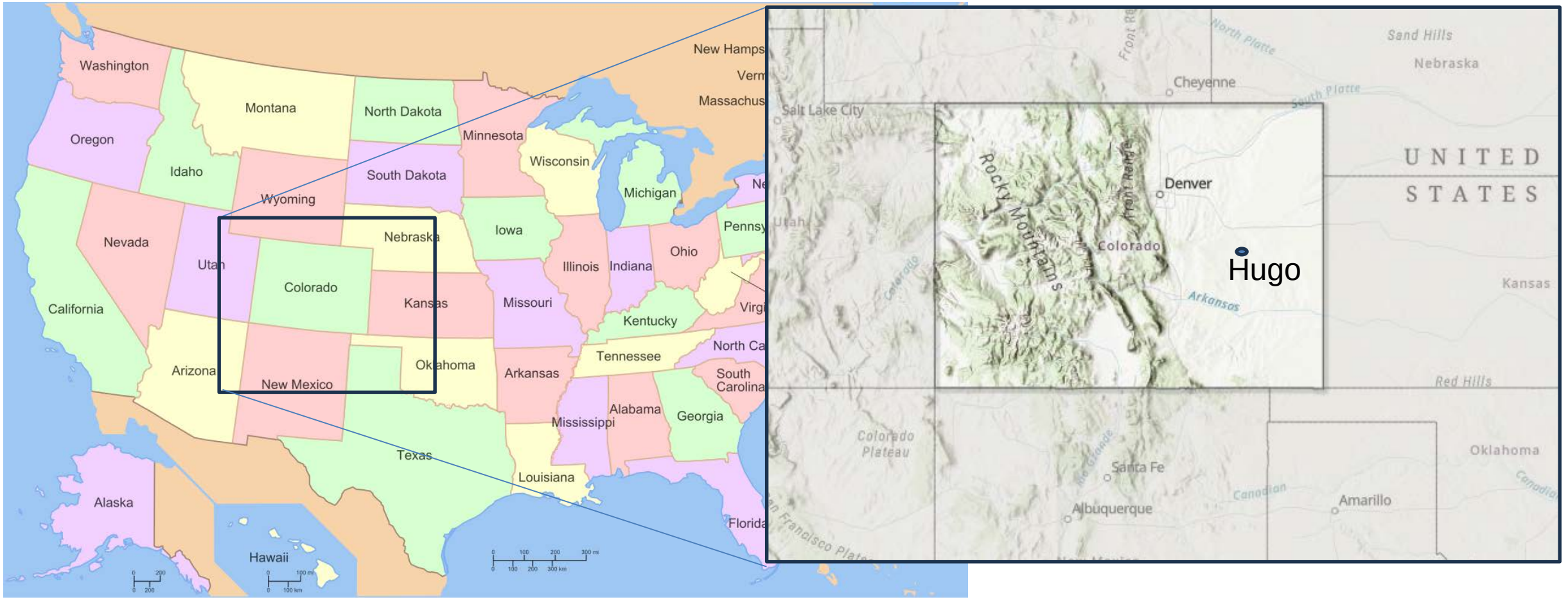
ELF Special Seminar May 27, 2026

University of Colorado Denver

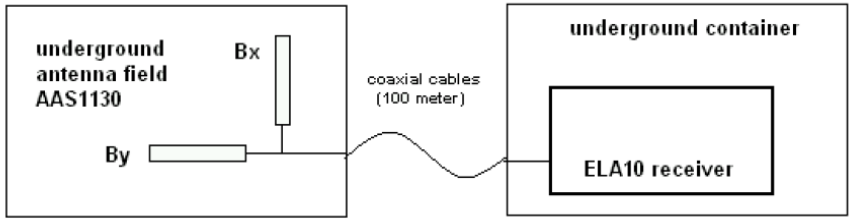
Outline

- Installation of the ELA10 Station in 2015
- Photo Narrative of the Installation of ELA12 in 2026
- Comparison of ELF vs VLF Recordings of Lightning Impulses
- Preliminary Analysis of Hugo vs. Hylaty data

Hugo, Colorado

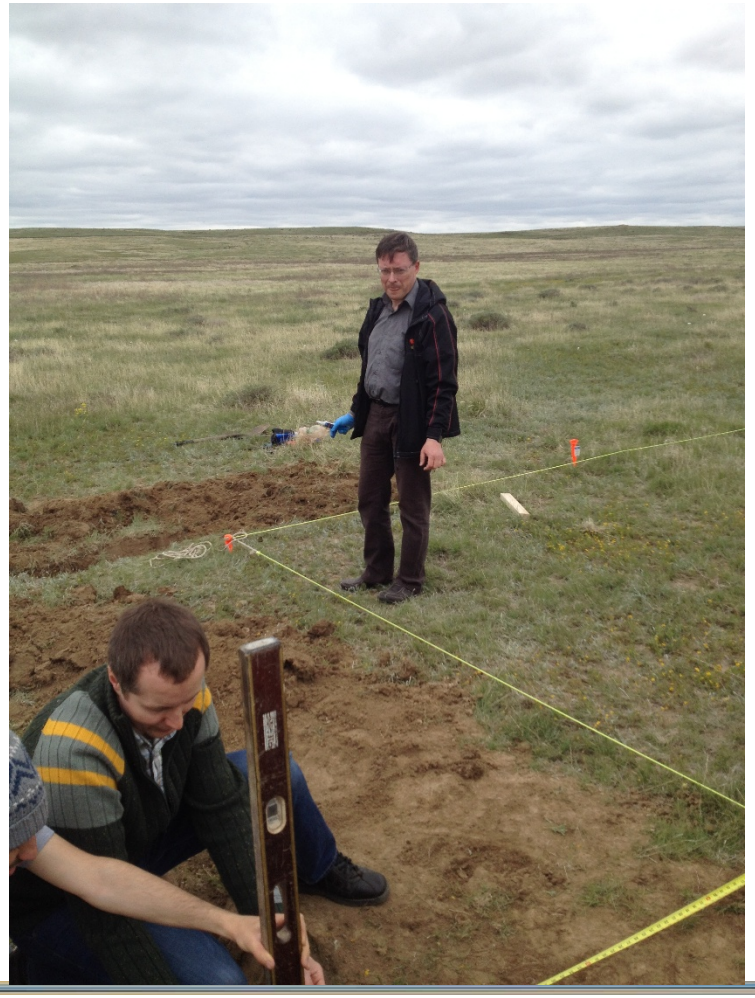


First Installation - May 2015



[*Kulak et al.*, 2014]

Antenna Placement



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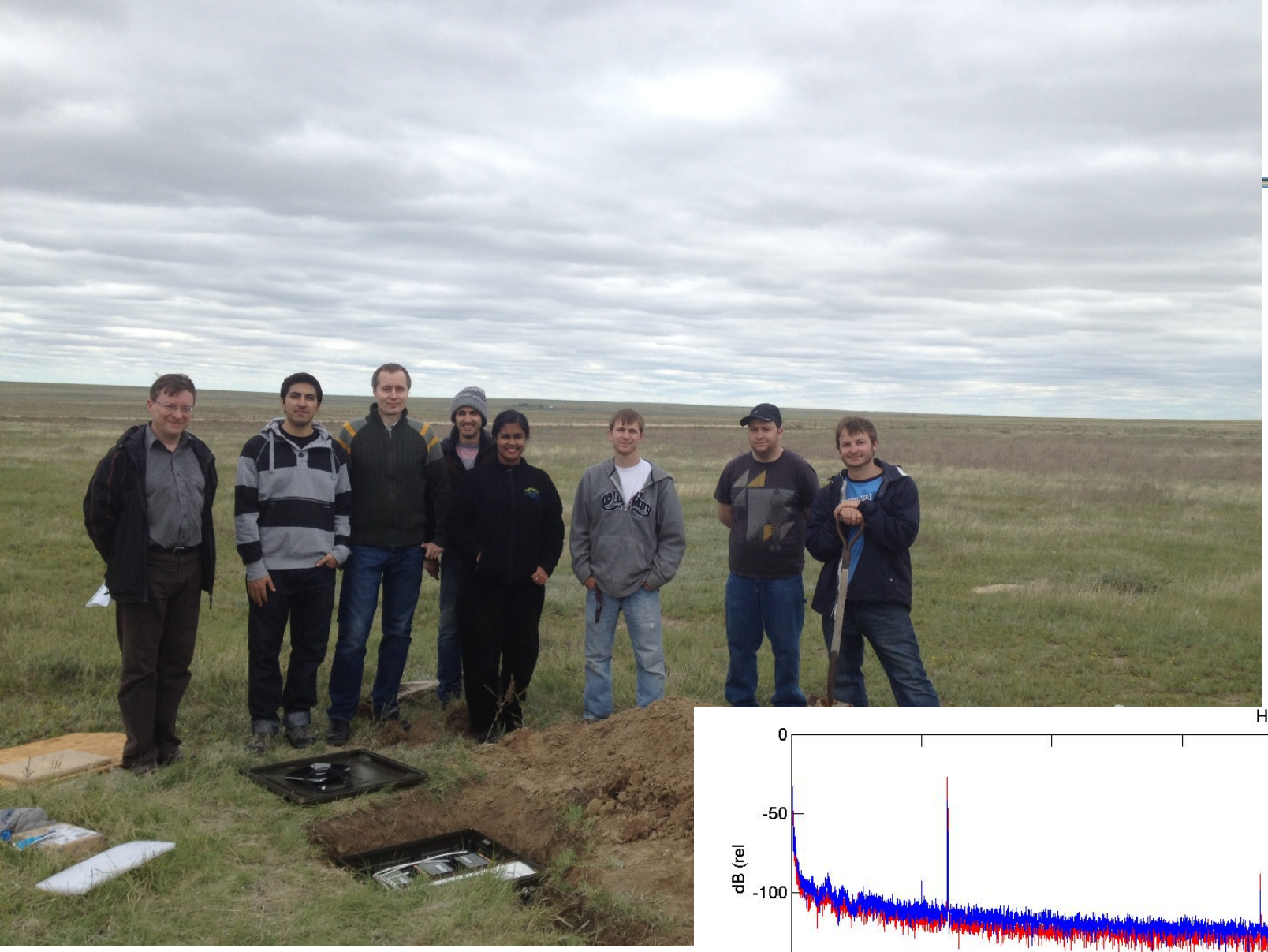

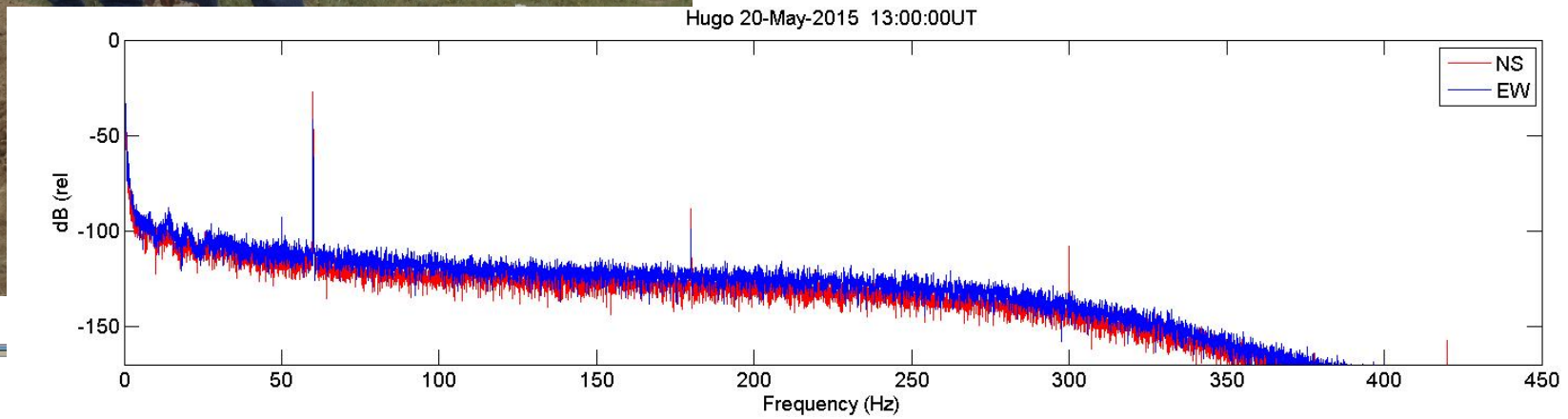

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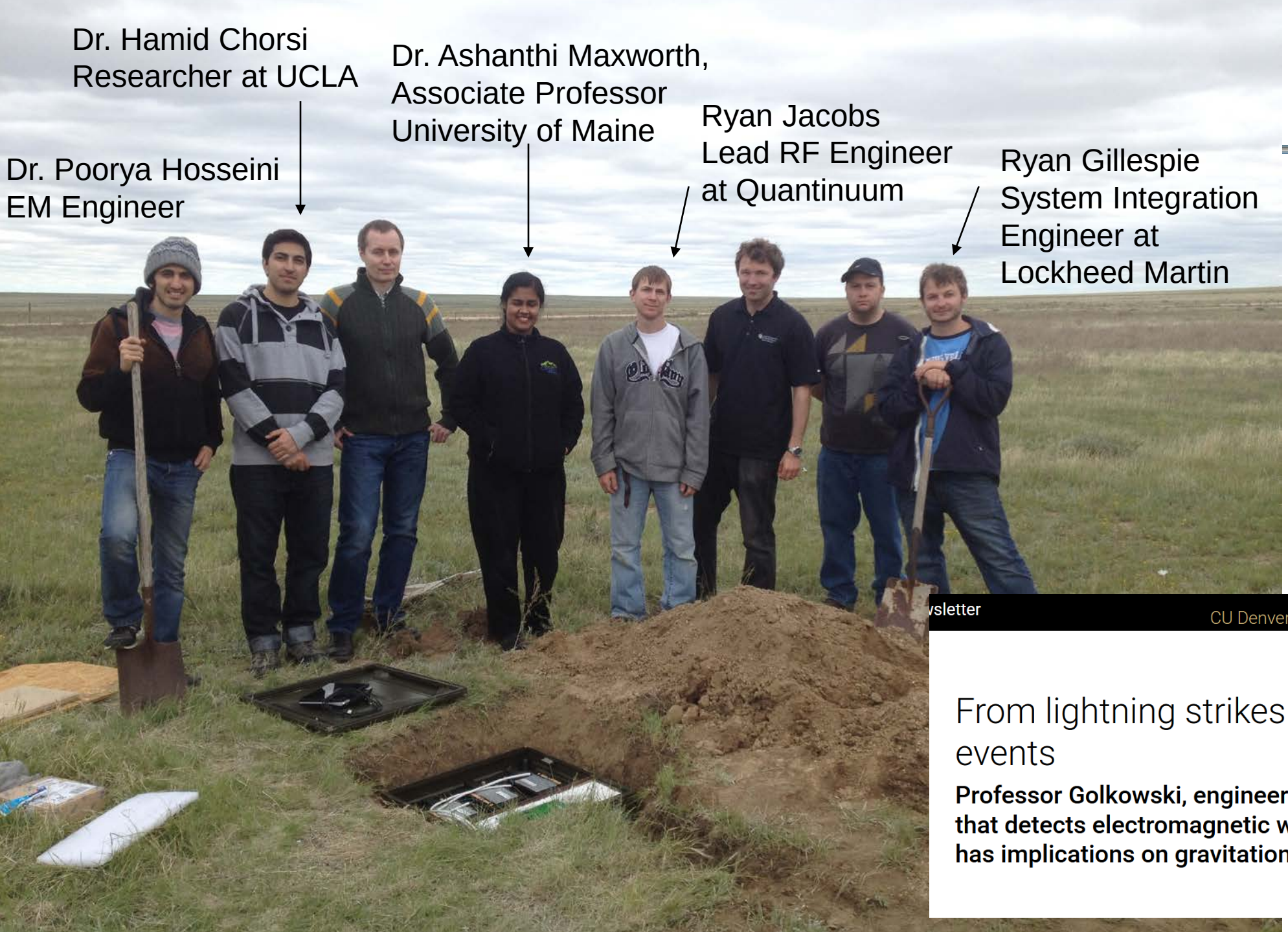


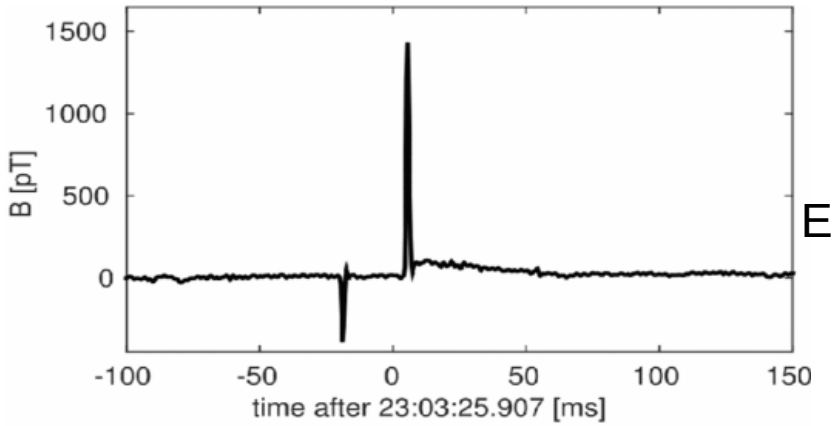
What does ELF Receiver Installation Prepare One For?

vsletter CU Denver **News**

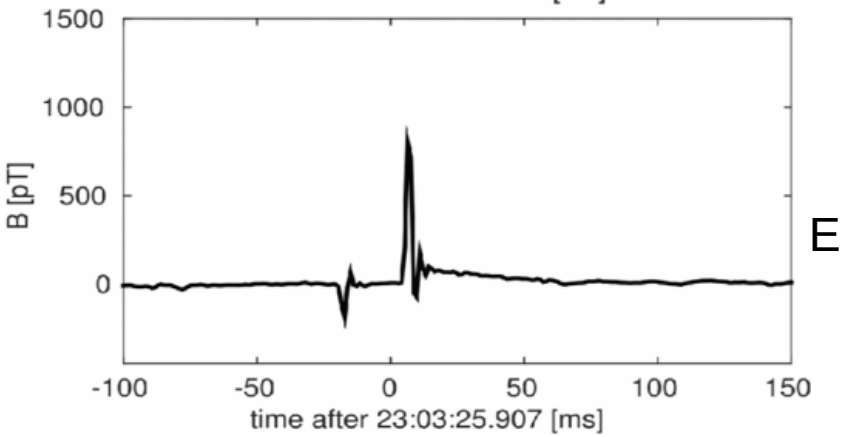
From lightning strikes to cosmic-scale events

Professor Golkowski, engineering students install receiver that detects electromagnetic waves from lightning strikes; has implications on gravitational wave research

ELA10 vs ELA12



ELA12: Bandwidth 900 Hz



ELA10: Bandwidth 300 Hz

Mlynarczyk et al.,2018

HUGO ELF Station Upgrade Process on March 13th 2026

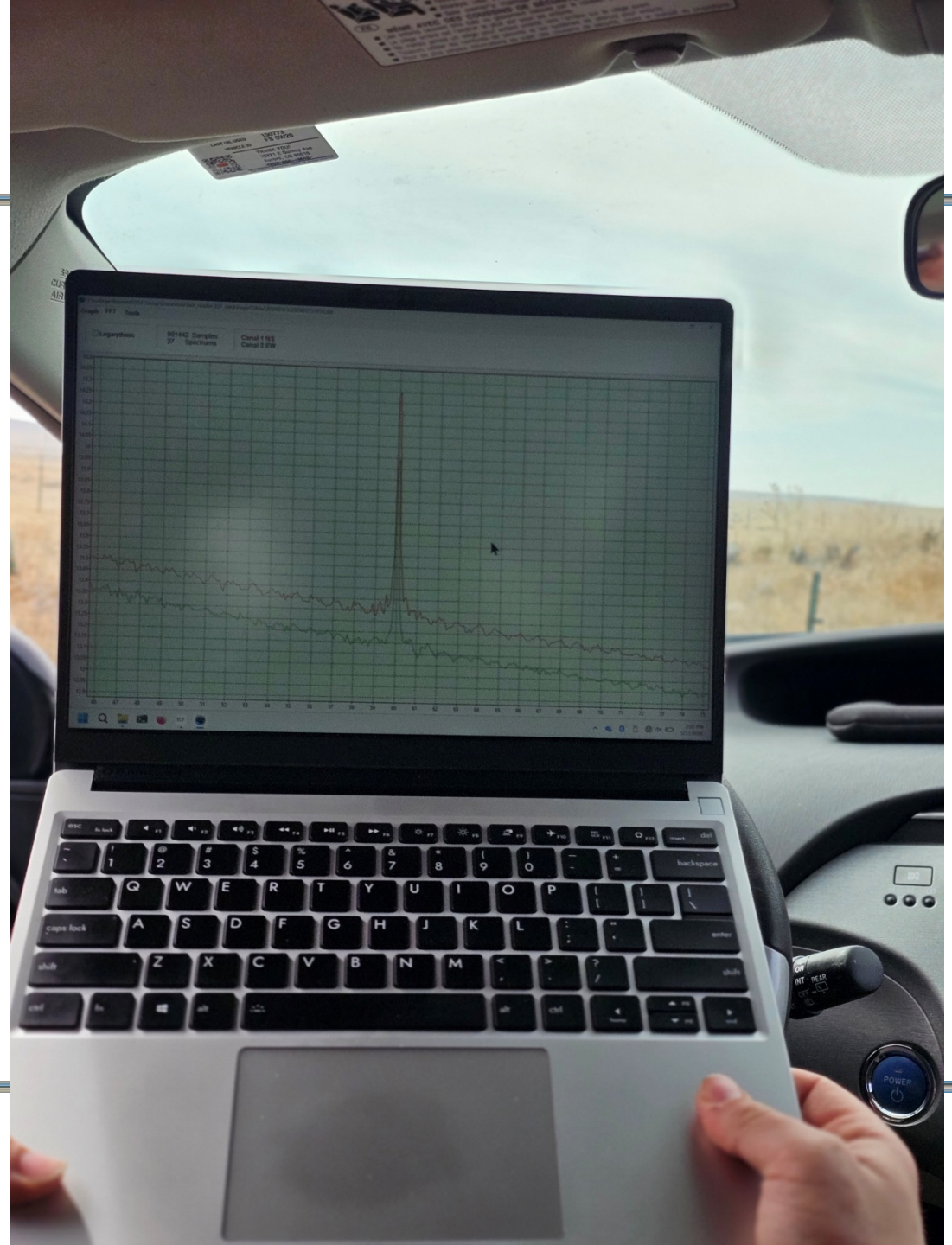

NIKE



GRAND
Canyon


BLOCK PARTY


Milwaukee



University of Colorado Denver

a ‚well-done job' smile of satisfaction on the team's faces sums up the completion of the task ☺

The pictures used in this presentation were taken by: Raahima, Kshama, Alex, Kalyan and Rafał. ©

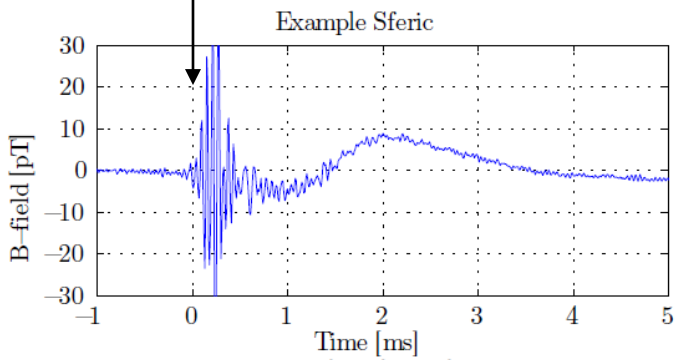
Comparisons of ELF and VLF Recordings of Lightning Impulses

URSI NRSM 2026, Boulder Colorado

Alex Sandersfeld, Mark Golkowski, and Malek Abusnina
University of Colorado Denver

Propagation Velocity of ELF Transients

VLF propagation (multimode): $v_g \approx 0.993$ c



ELF propagation (TEM mode): $v_g\,(f, h, \sigma) < c$

$$t_{ELF} = t_{VLF} + t_s$$

Very Simple Formula [*Wait*, 1960]

distance

current waveform

$$t_s = 0.09\left(\frac{\rho}{2h}\sqrt{\frac{\varepsilon_0}{\sigma}} + \sqrt{\delta}\right)^2$$

reflection height

Conductivity at reflection height

Propagation time strongly affected by ionospheric profile parameters.

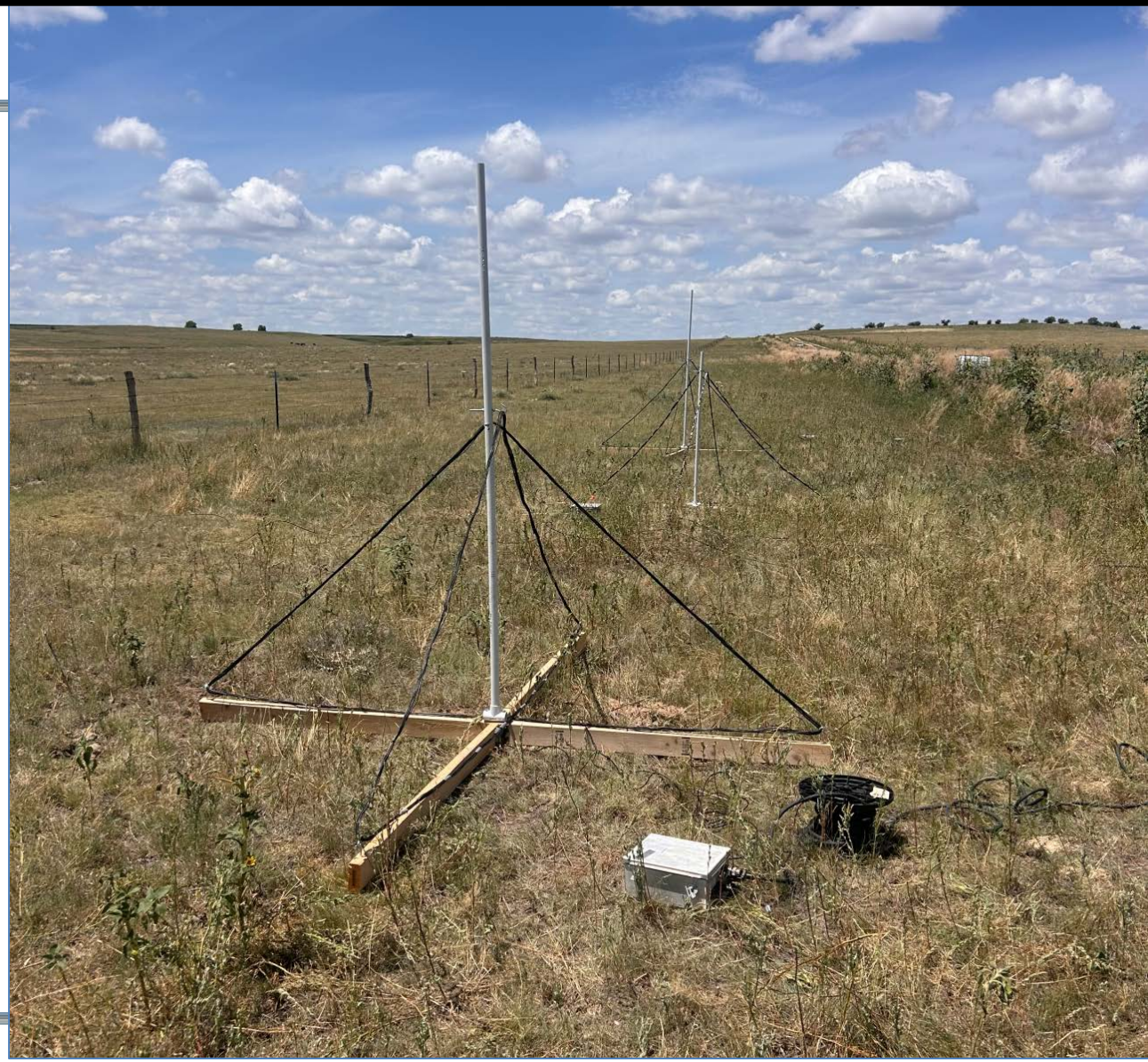
Recording Conditions: East Colorado

Site & Instruments

Combined VLF and ELF Measurements were taken near Hugo, Colorado, on 24 July 2025, between 1700 to 1900 UTC.

The instruments deployed included a Stanford University-designed VLF AWESOME system [2], a GeorgiaTech-designed VLF system, a SongMeter bioacoustic recorder adapted for VLF measurements [3], and an existing permanently installed ELF receiving site.

All equipment was owned/operated by faculty & students from the University of Colorado Denver.



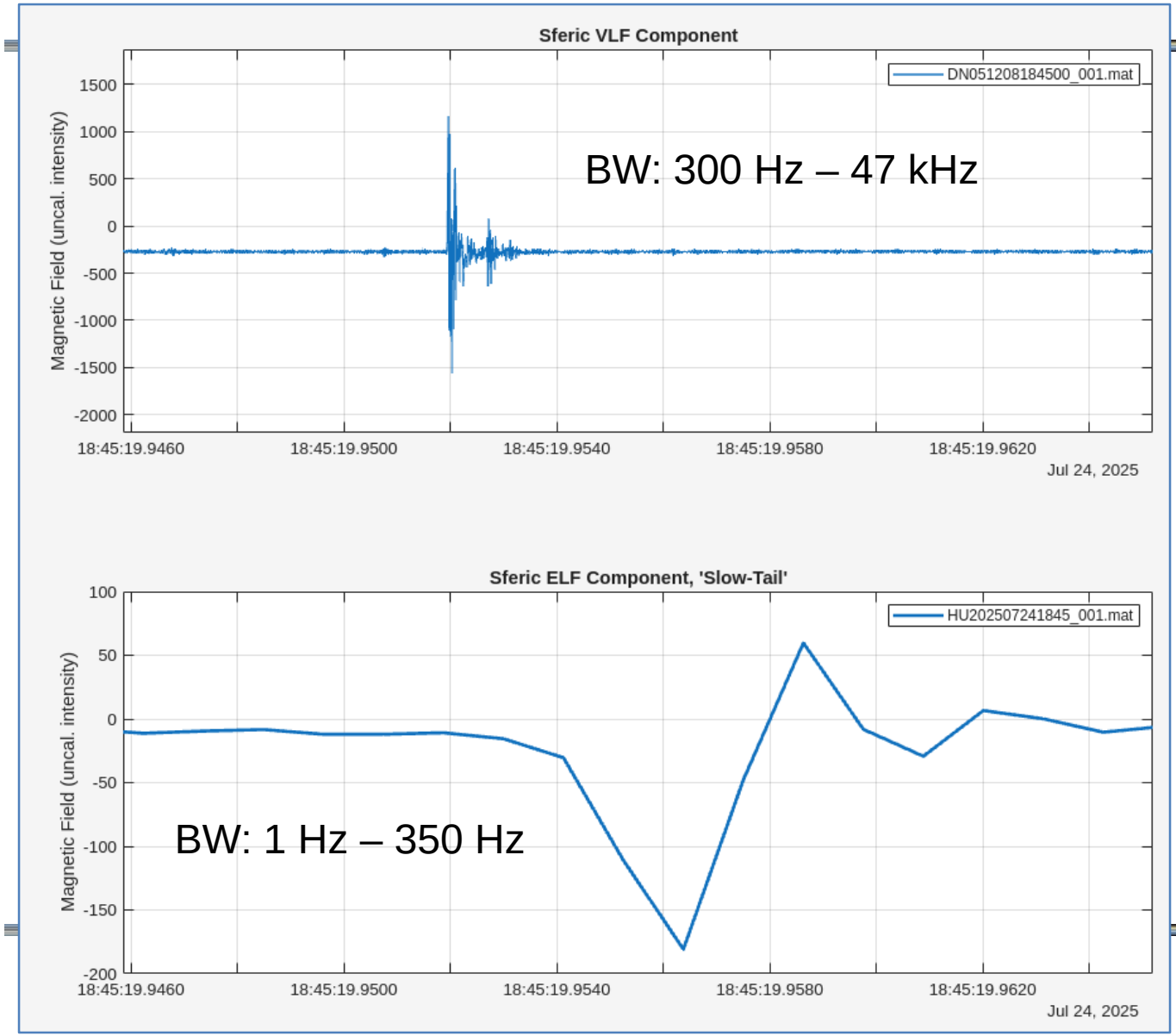
Context

ELF & VLF Sferic Components

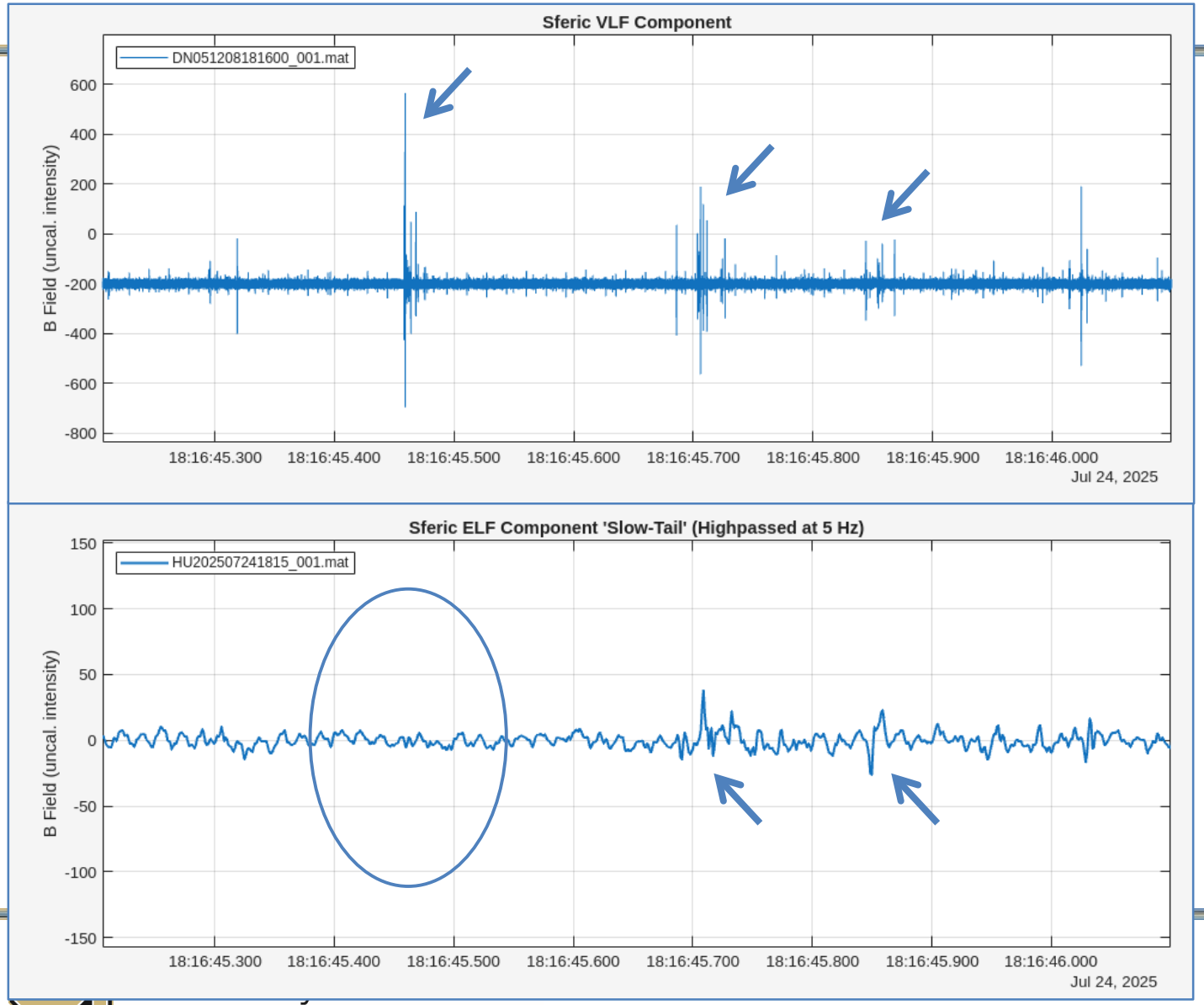
The ELF and VLF sferic components have significant differences in their propagation characteristics through the earth-ionosphere wave guide.

The VLF component arrives first, generally exhibiting 3 to 10 rapid oscillations over 0.2 to 2 ms.

The ELF component arrives during or after the VLF component depending on distance and ionospheric conditions along the propagation path from source to receiver, and generally consists of 2 to 5 half-oscillations over 8 to 12 ms.



Context

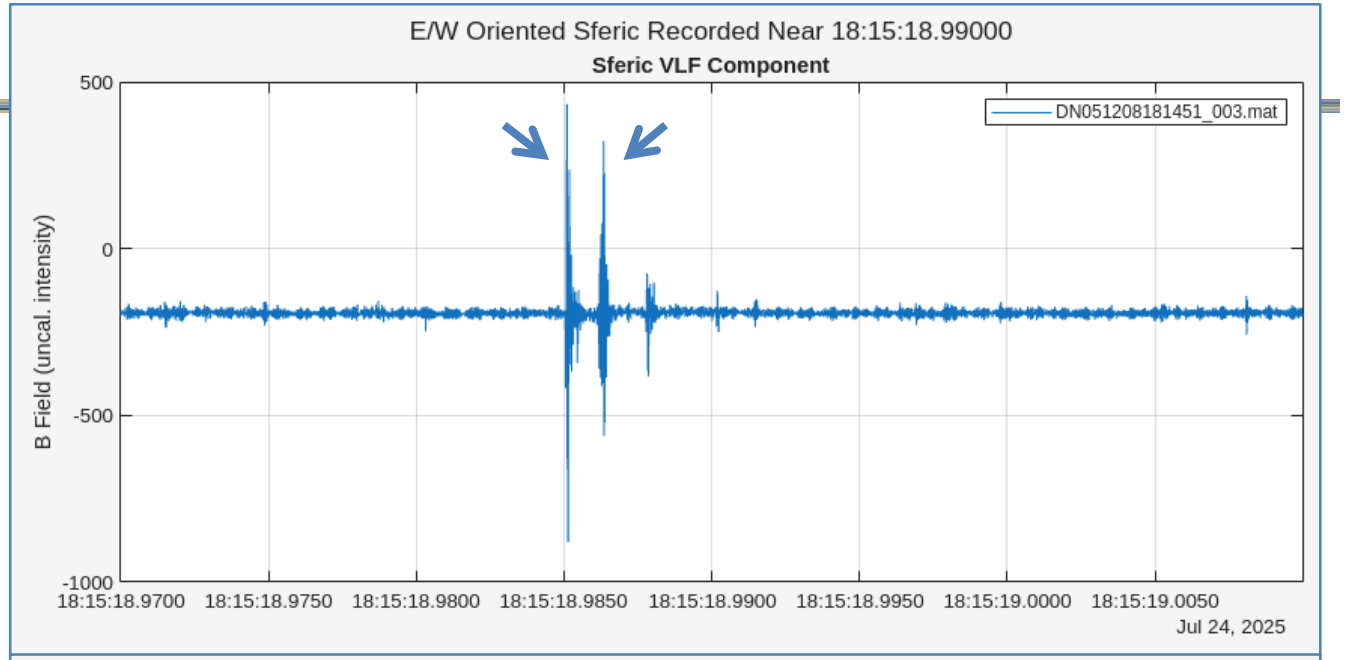


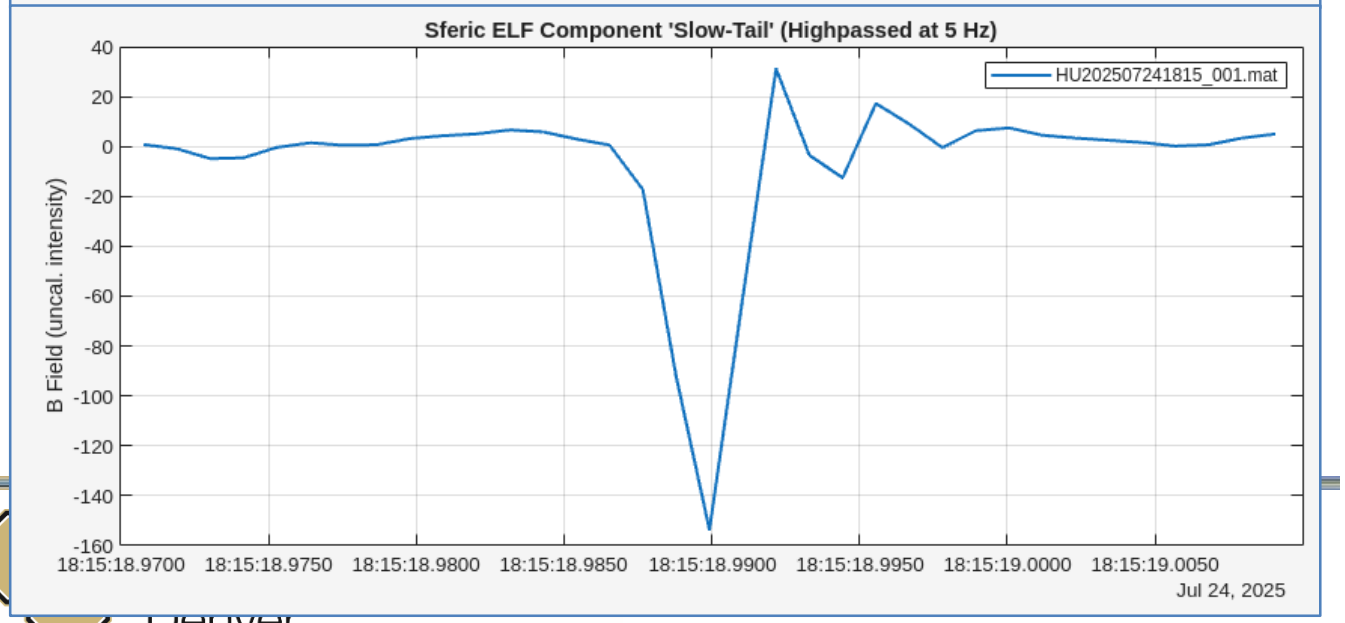
ELF Component Presence

ELF components in sferics are not always observed as their presence and intensity depends the lightning event characteristics and on the ionospheric propagation conditions along the path from source to receiver as mentioned.

In particular, as ELF components propagate by a quasi-transverse magnetic mode, the altitude of the lowest layer of the ionosphere and the presence of a day-night transition along the propagation path can prevent ELF propagation [1].

Context



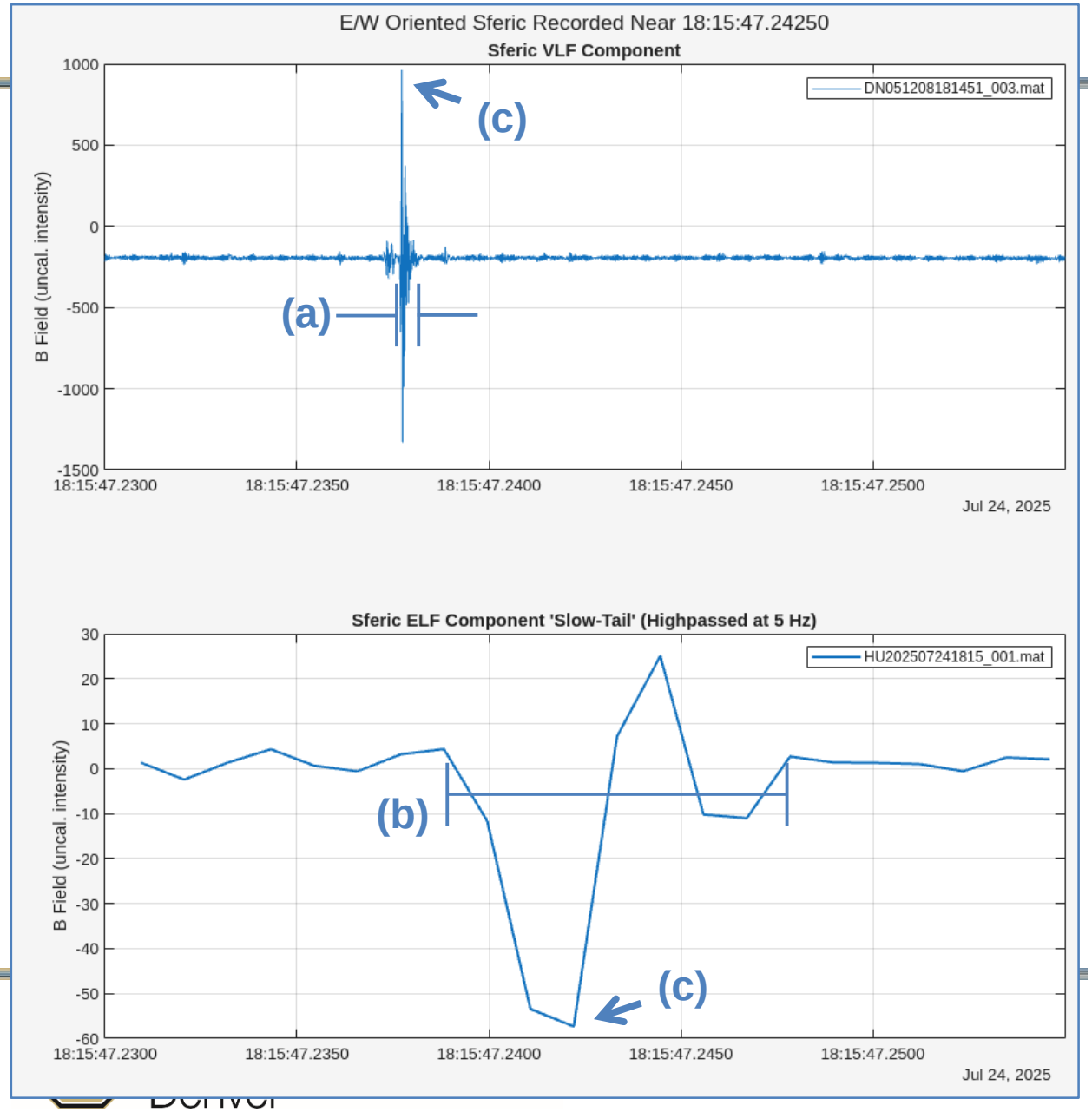


VLF/ELF Overlap

Single ELF components can also be coincident with multiple observed VLF impulses of similar intensity, indicating multiple lightning discharges happening in quick succession. In these cases it's difficult to ascertain accurate statistics for the set of events.

Occurrences such as these are discarded the analysis to follow if the spacing of the VLF impulses are sparse, distinct, and greater than 1 ms. If the time from the beginning of the VLF impulse chain to it's end takes less than 1 ms, or the chain is highly dense, the results were included.

VLF/ELF Data Comparison Overview



For the following analysis, start and stop times are recorded for the VLF and ELF components of each sferic 'event' inspected (a, b). All times given are UTC. Sferics not containing both VLF and ELF components were not included in this analysis.

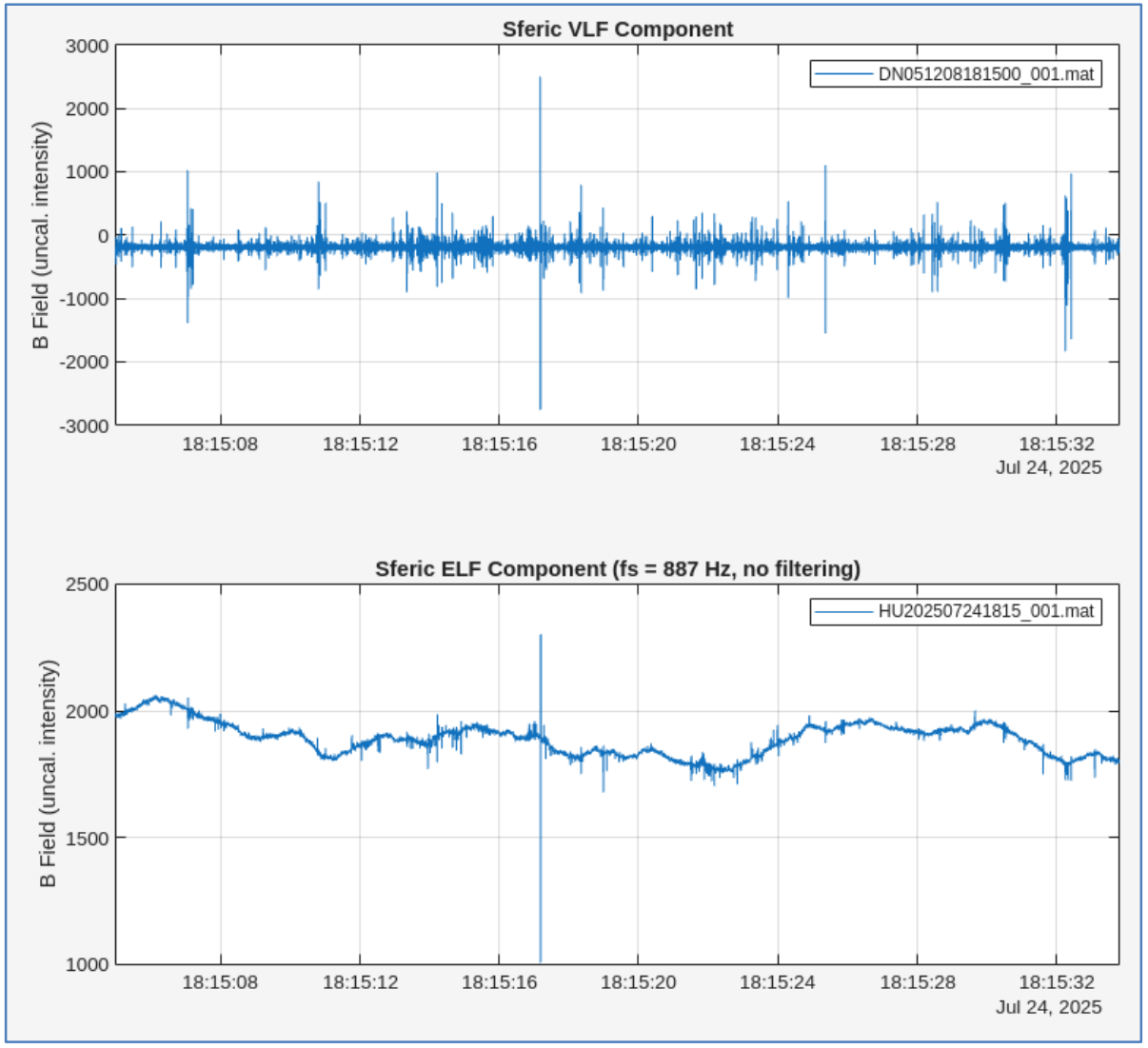
Durations and lag times are calculated. Peak intensities of the magnetic field measured by the instruments are also recorded (c), but as the data is raw digital output and not calibrated to a known physical quantity, this information is not analyzed here.

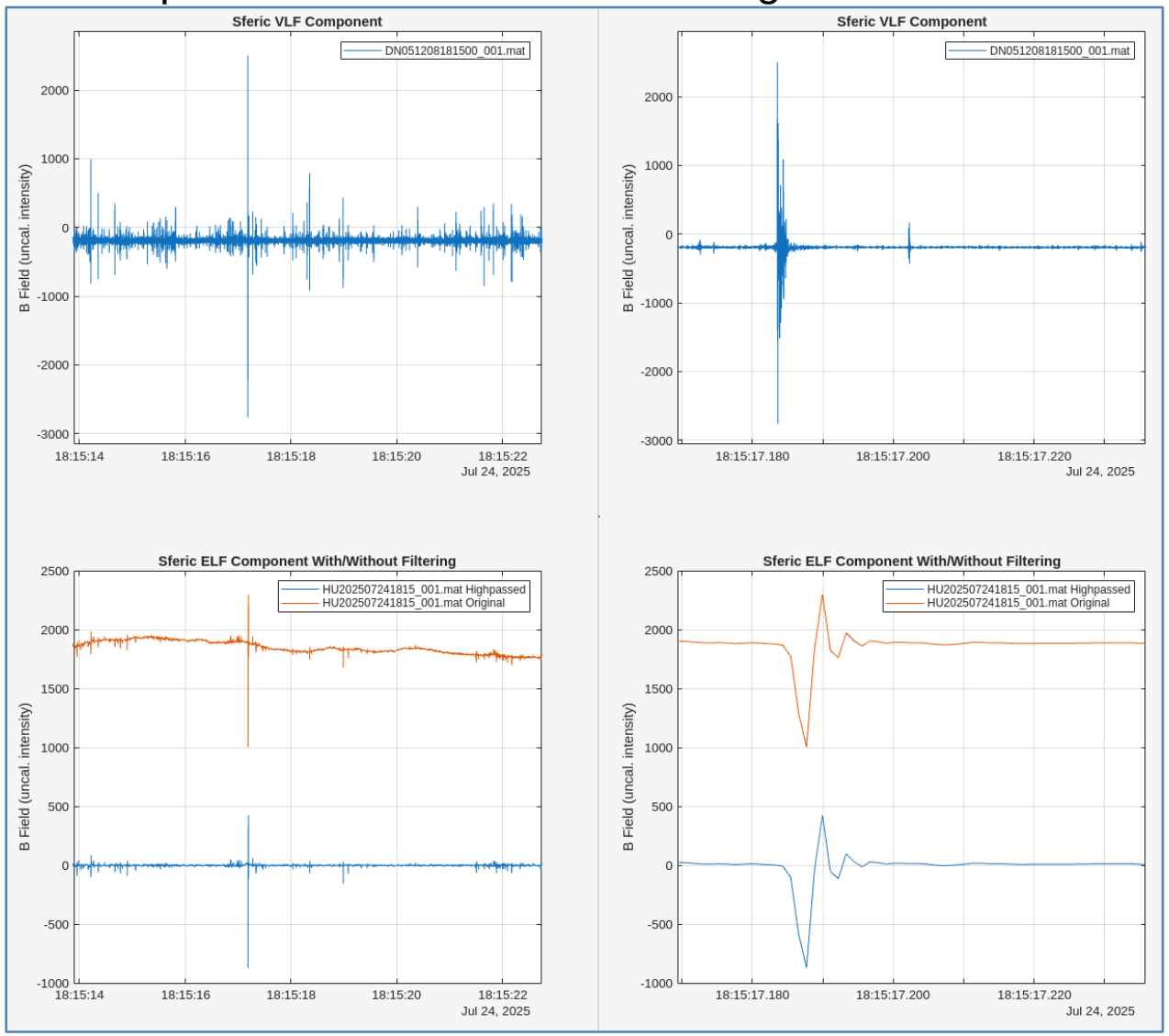
95 sferic events were recorded manually over the course of the field recordings. Instruments used here were the AWESOME VLF receiver and the existing ELF receiver installation. For both instruments data from their East/West oriented antenna was used.

Filtering in Results

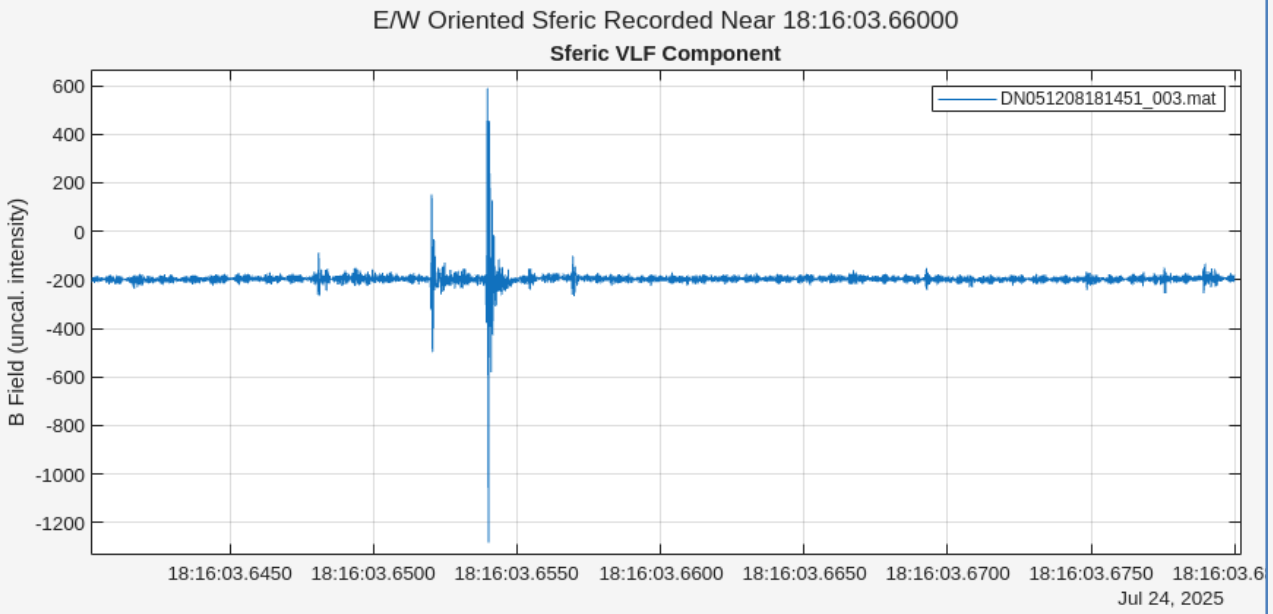
As ELF measurements exhibit slow and gradual variation in intensity over long intervals below 5 Hz, all following results shown are high-pass filtered at 5 Hz.

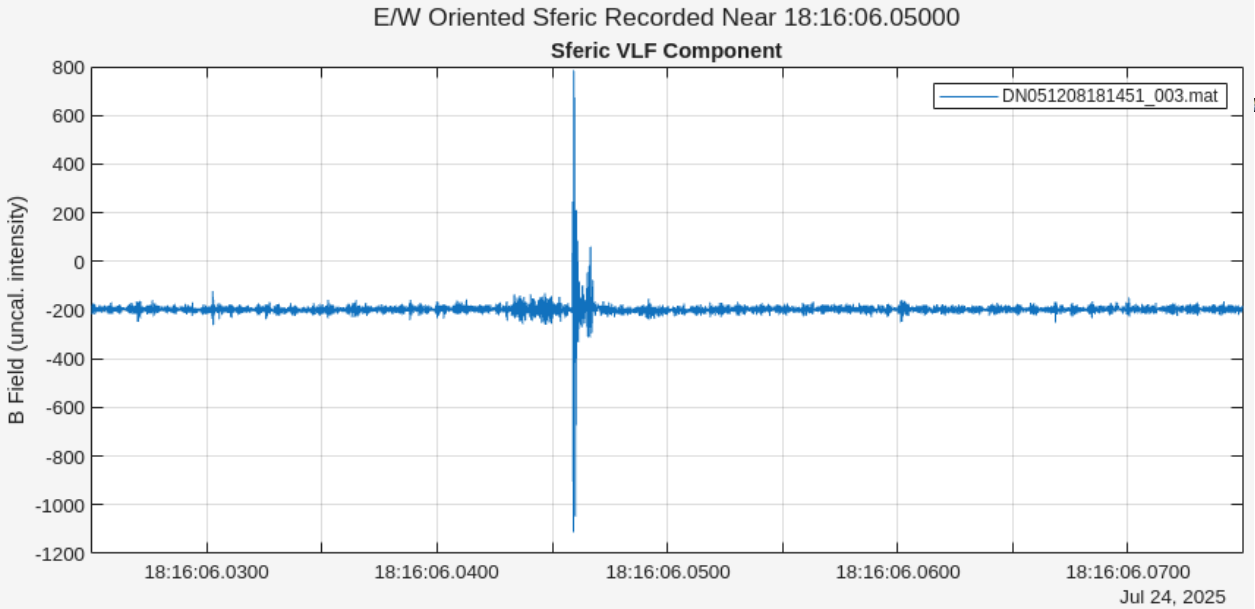
Figure on bottom left are those gradual variations, on right are comparisons of unfiltered/filtered signal measurements.

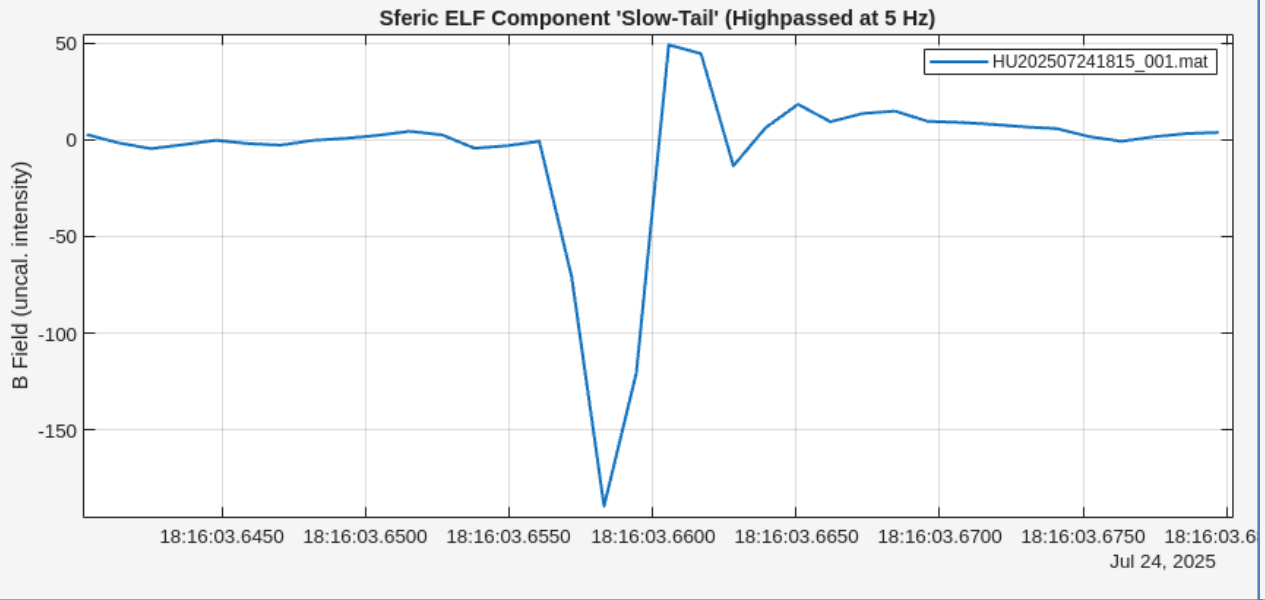


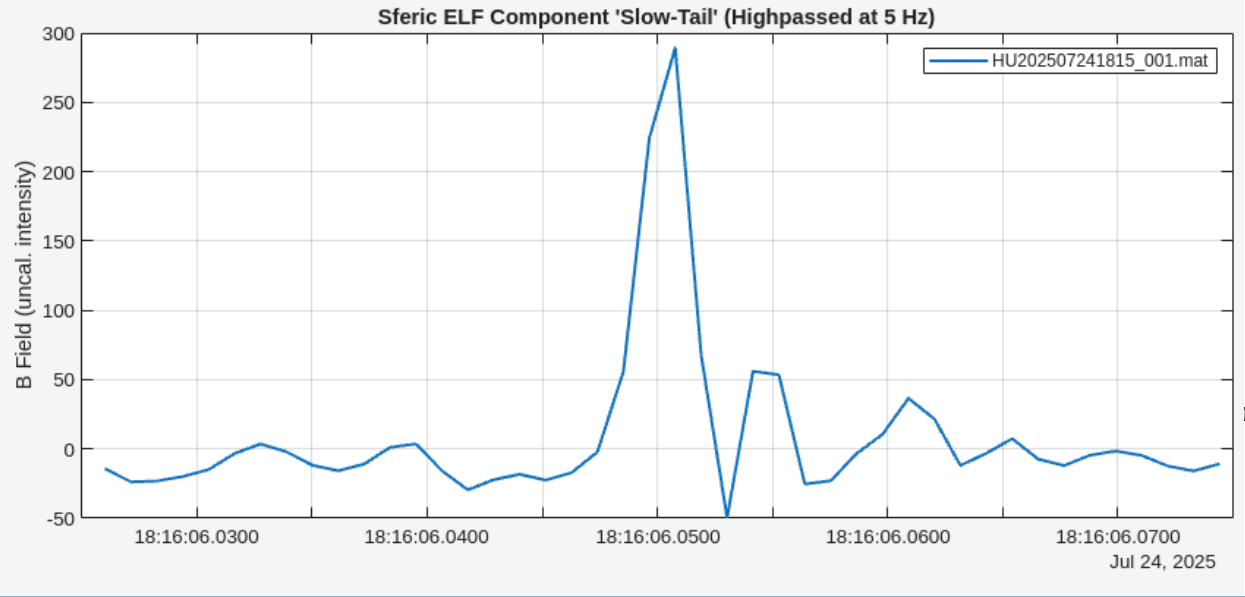


Selected VLF/ELF Sferic Examples

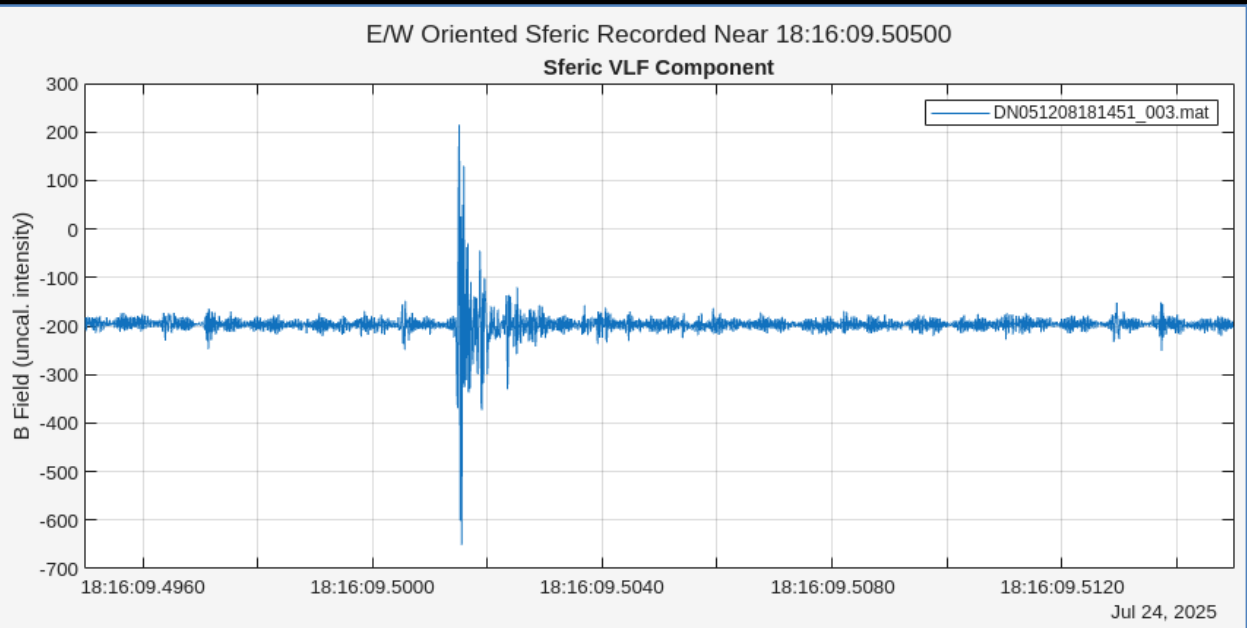


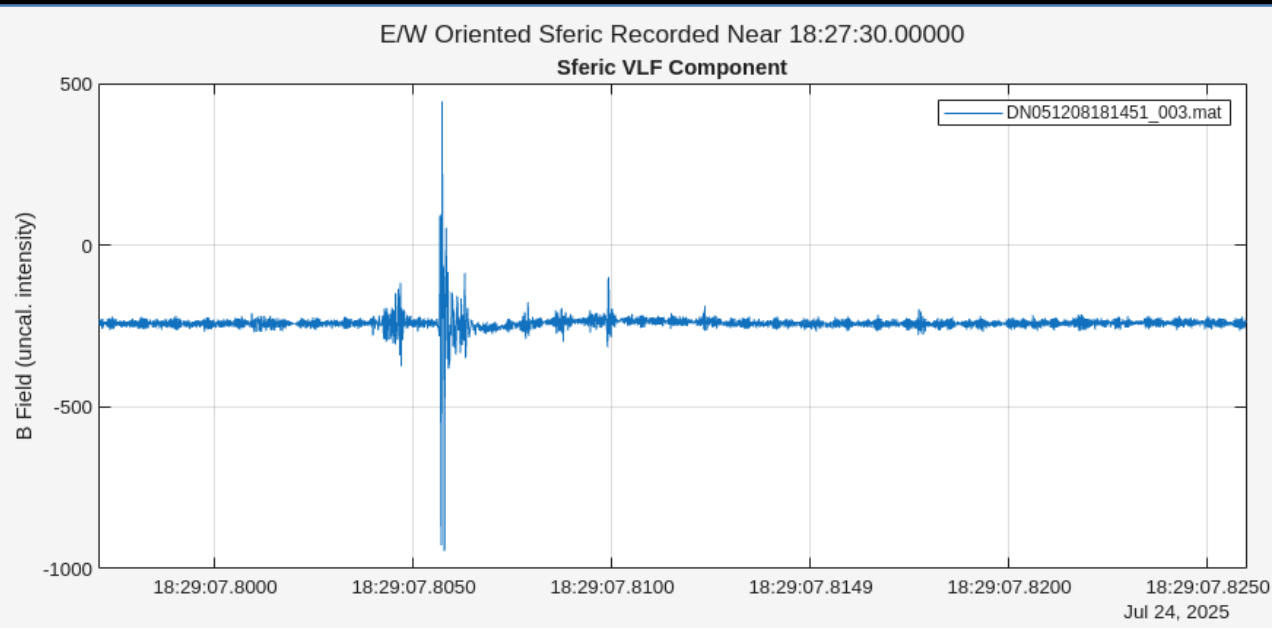


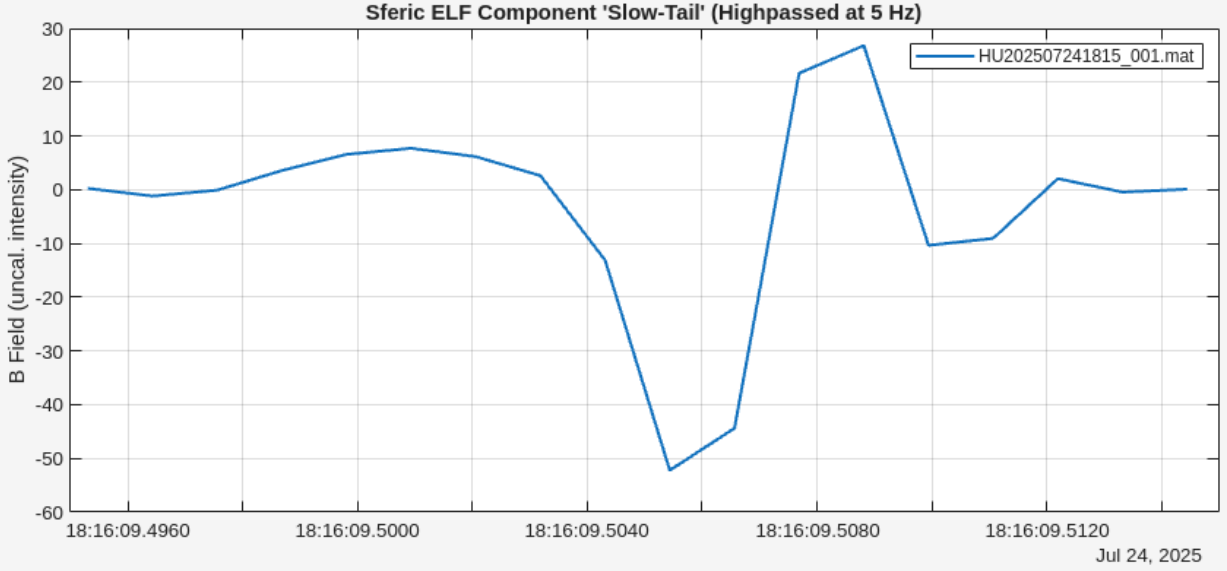


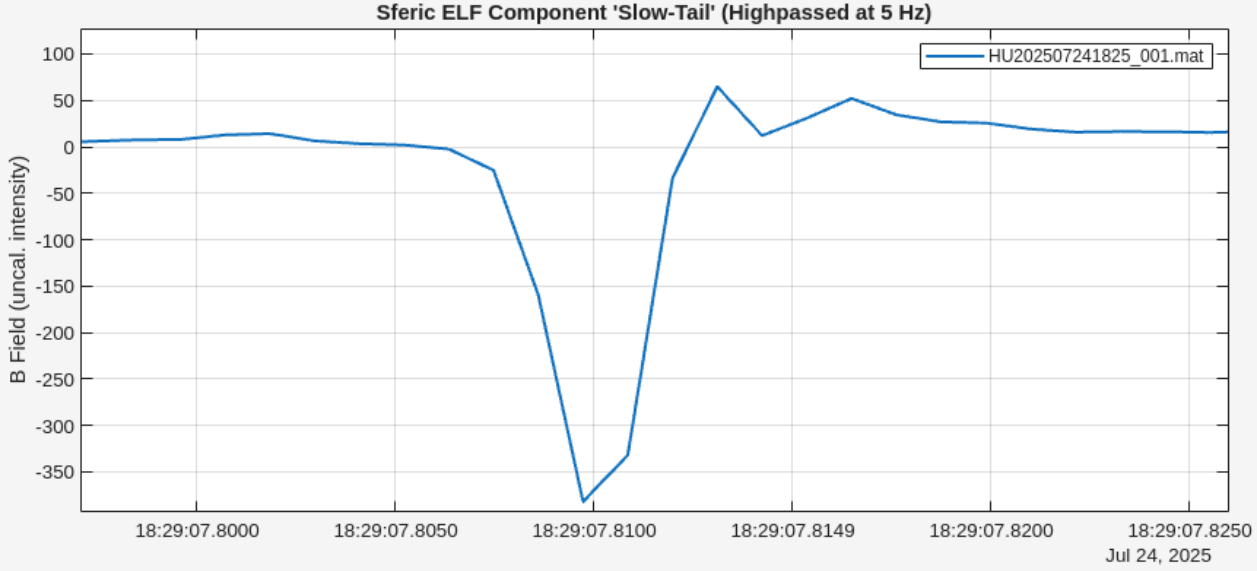


Selected VLF/ELF Sferic Examples



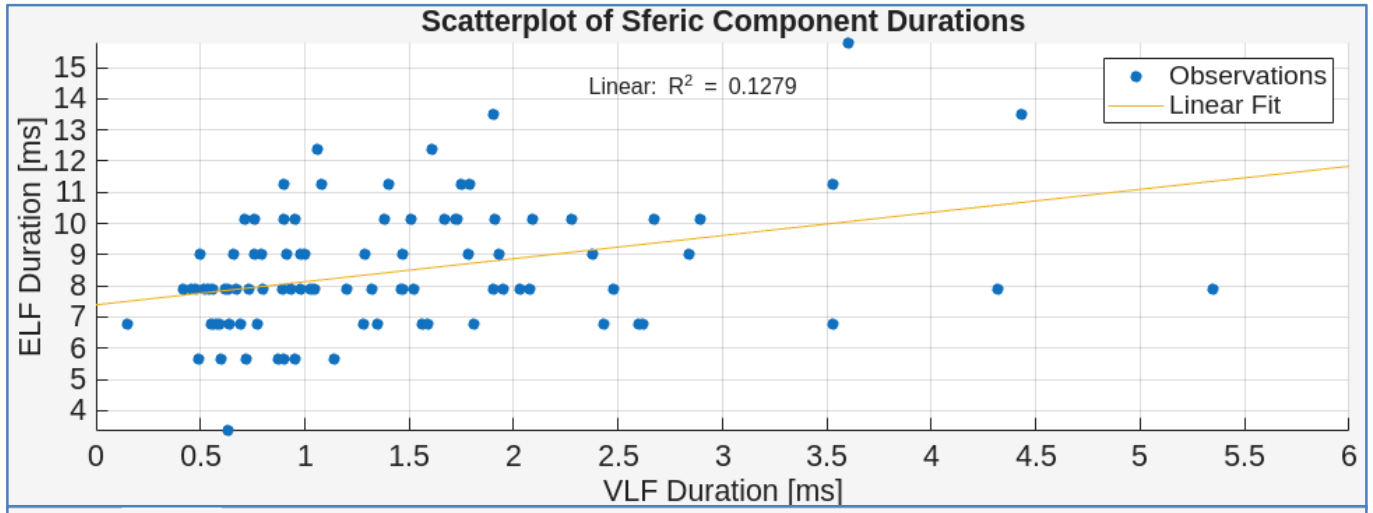


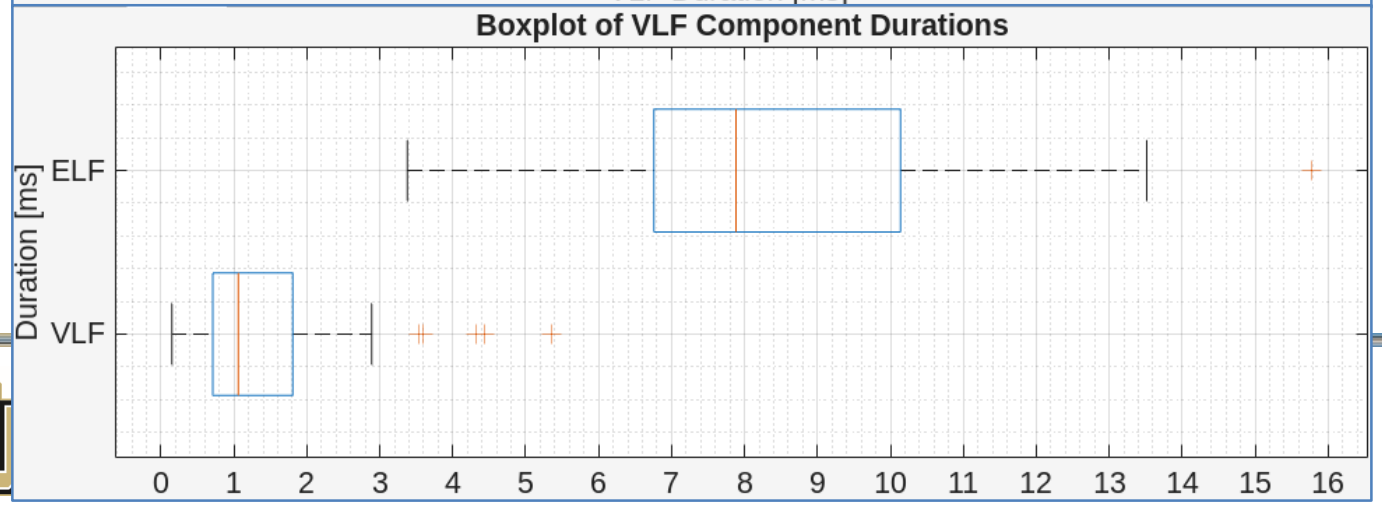


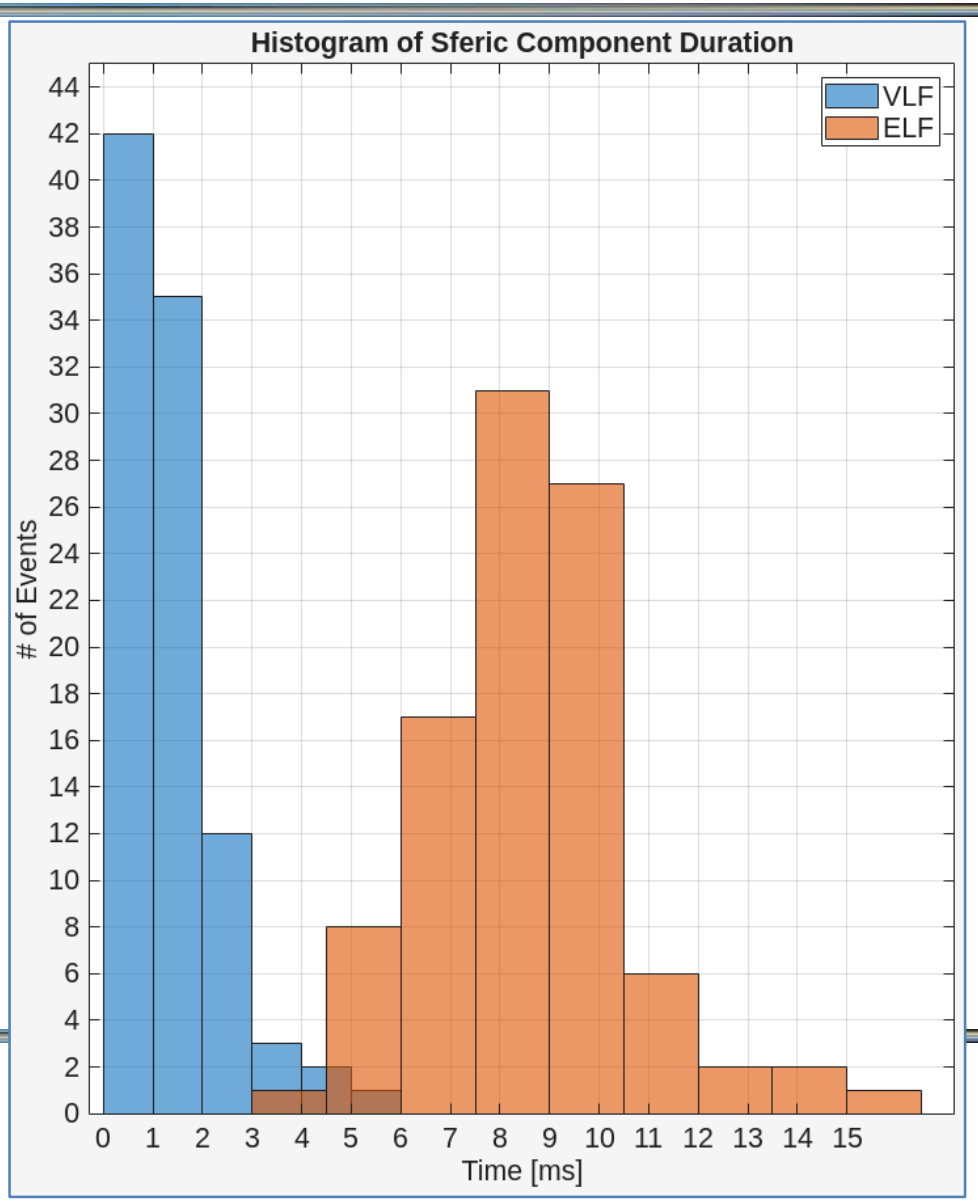


Recorded VLF/ELF Statistics - Component Duration

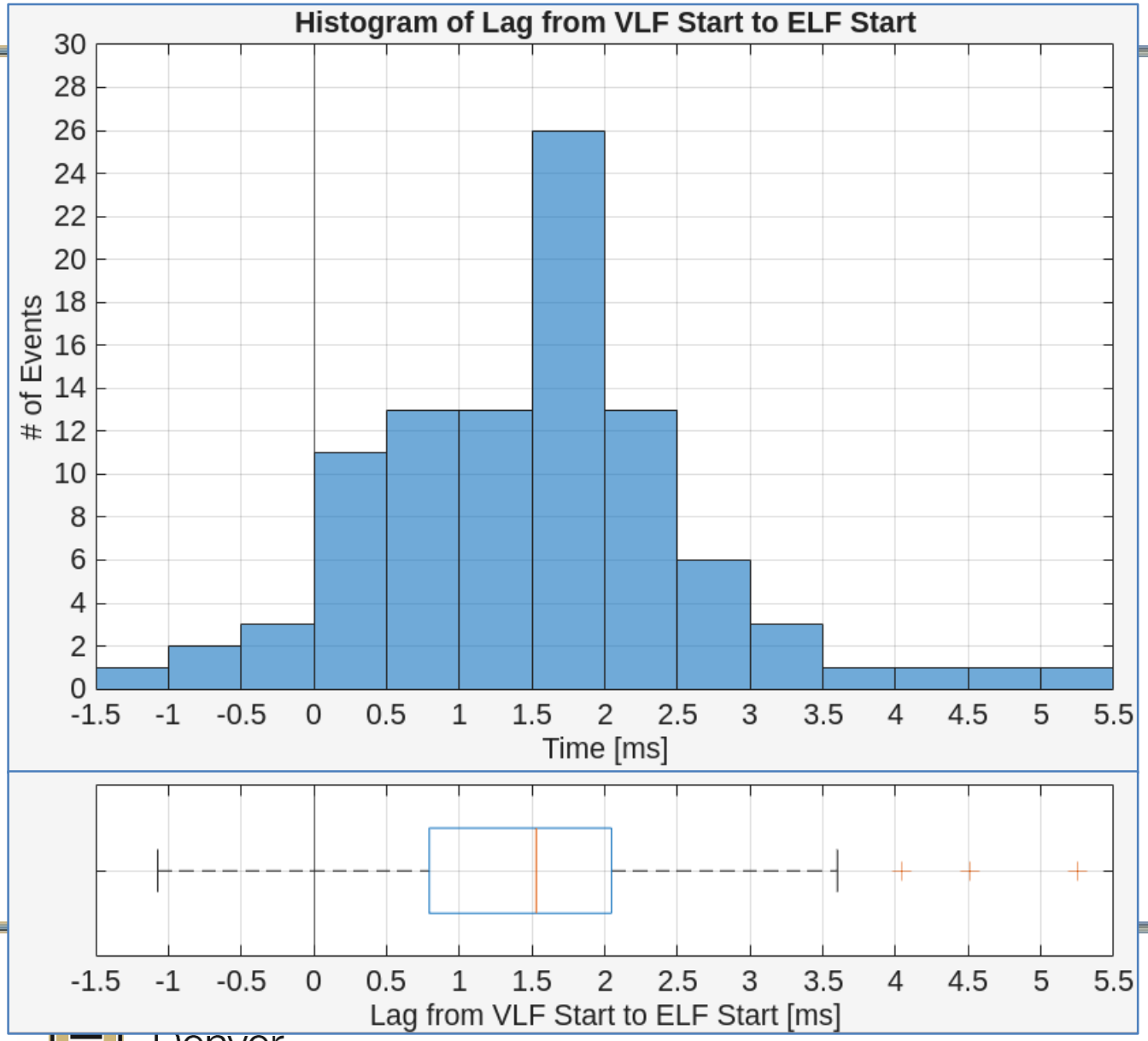
This is the length of the individual components for each sferic.
50% of VLF sferic components persisted between 0.8 & 1.9 ms, and having a median duration of 1.1 ms.
50% of ELF components persisted between 6.8 & 10.1 ms with a median of 7.88 ms.





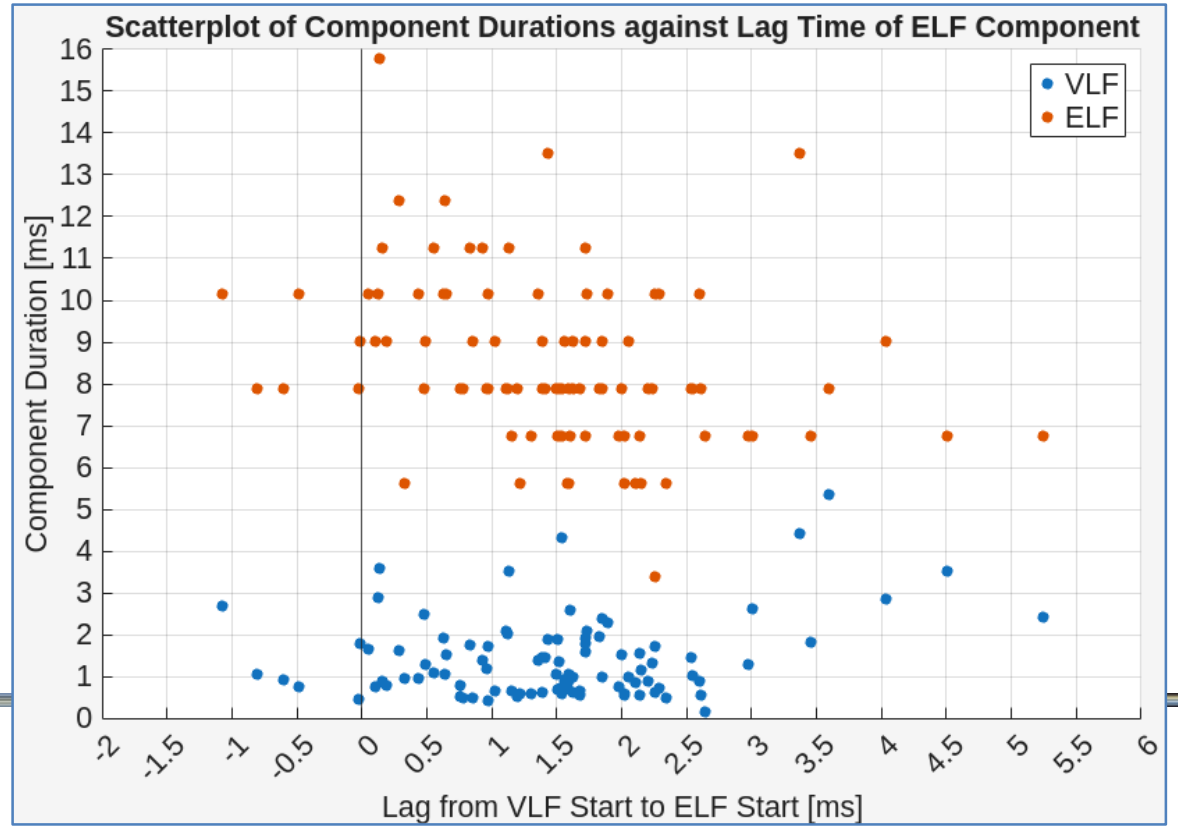


Recorded VLF/ELF Statistics - VLF to ELF Delay



This is the measured delay from the beginning of the sferic in the VLF band to the beginning of the ELF slow-tail.

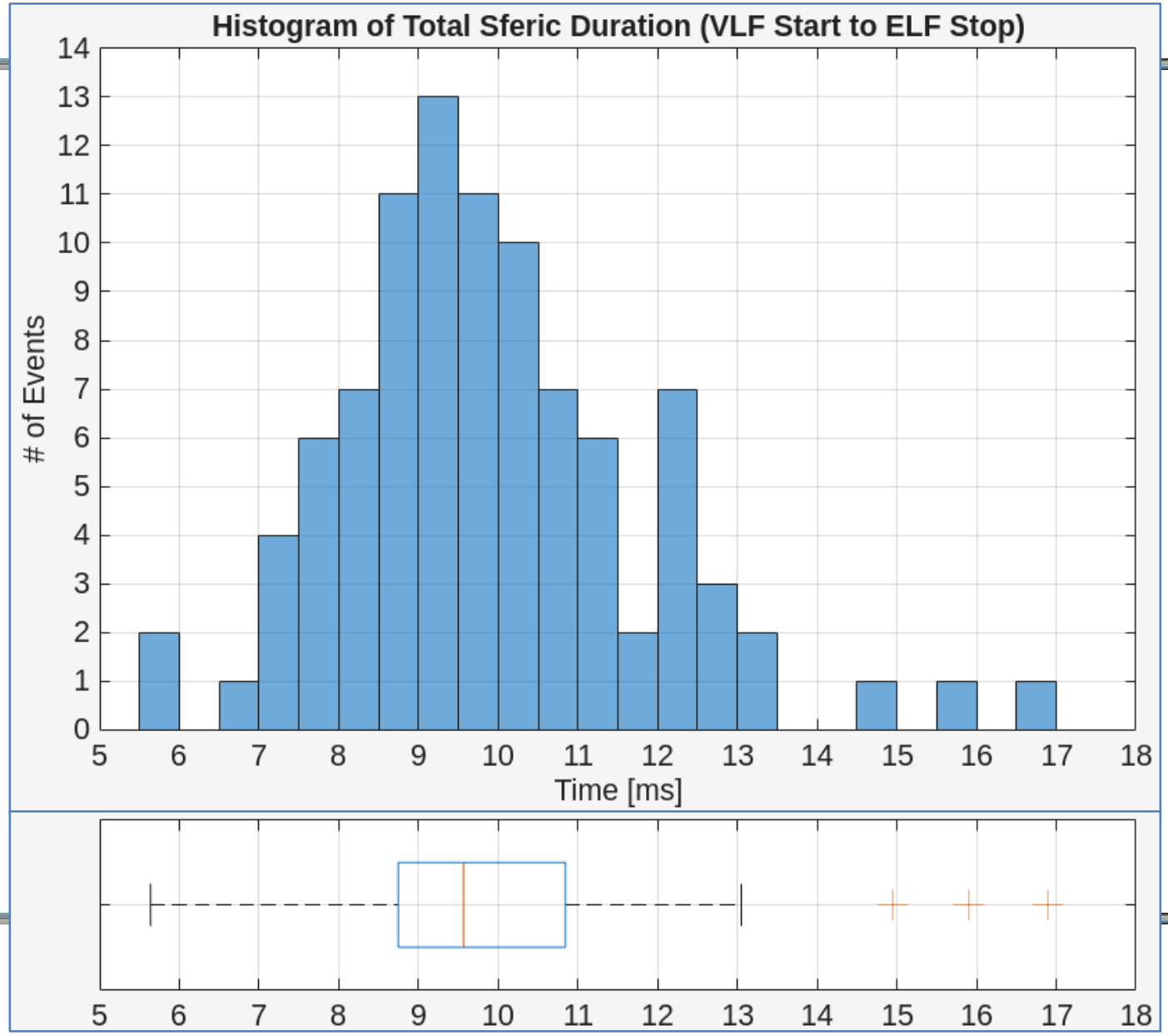
50% of all ELF components appeared between 0.84 to 2.05 ms from the appearance of the VLF component.
Some few data points (~6%) indicated ELF components appearing before the VLF component, these are likely to be a result of errors in data point gathering.



Recorded VLF/ELF Statistics - Total Sferic Duration

This is the total length of the sferic from it's first impulse seen in VLF to the end of the ELF slow-tail.

50% of the recorded sferic events lasted in total between 8.74 & 10.84 ms, with a median of 9.56 ms.

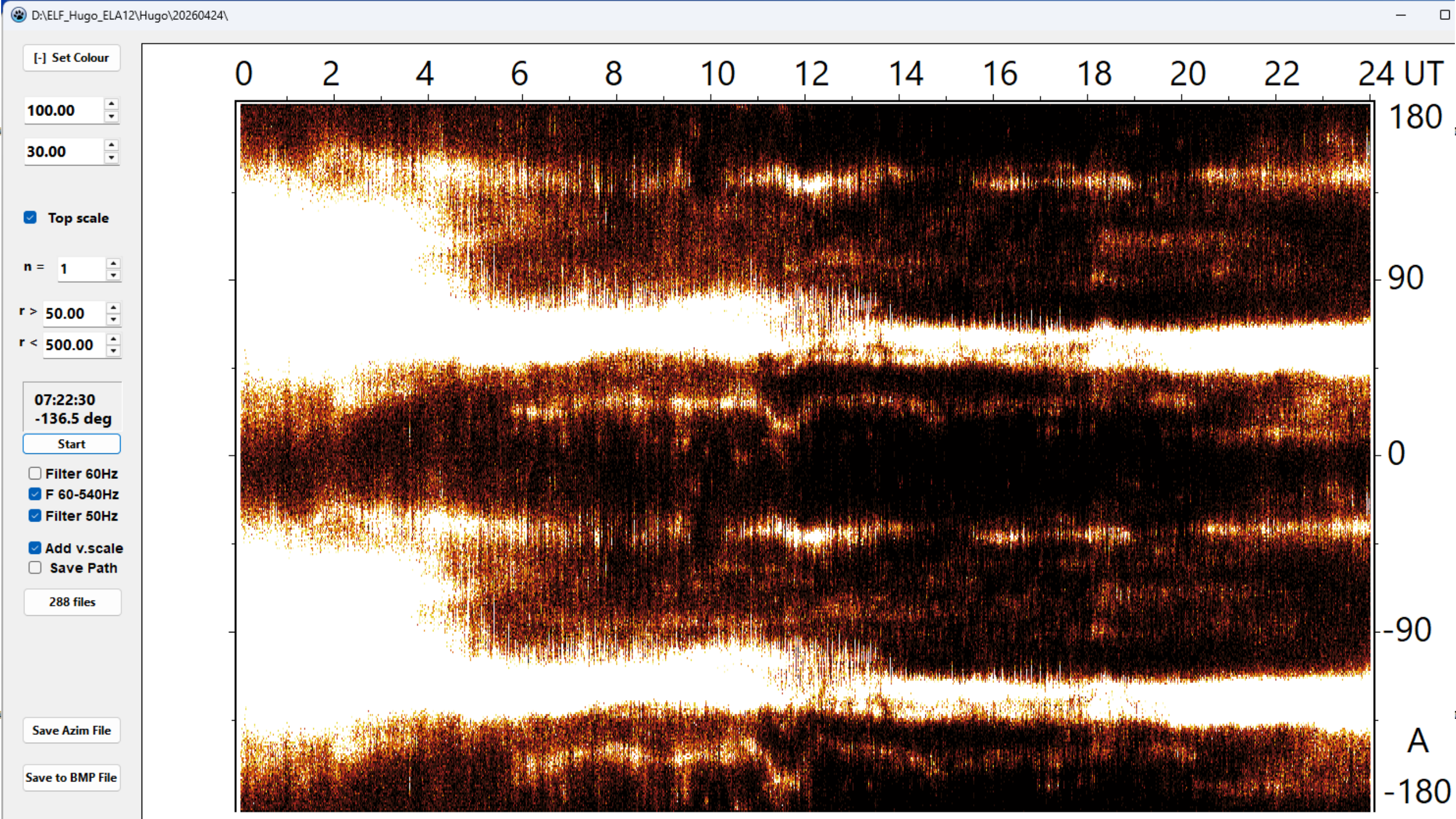


Hugo

April 24, 2026

4 azimuth slides with decreasing amplitude+

last slide for high amplitude impulses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Top scale
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r < 500.00
07:22:30
-136.5 deg
Start
Filter 60Hz
F 60-540Hz
Filter 50Hz
Add v.scale
Save Path
288 files
Save Azim File
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180
90
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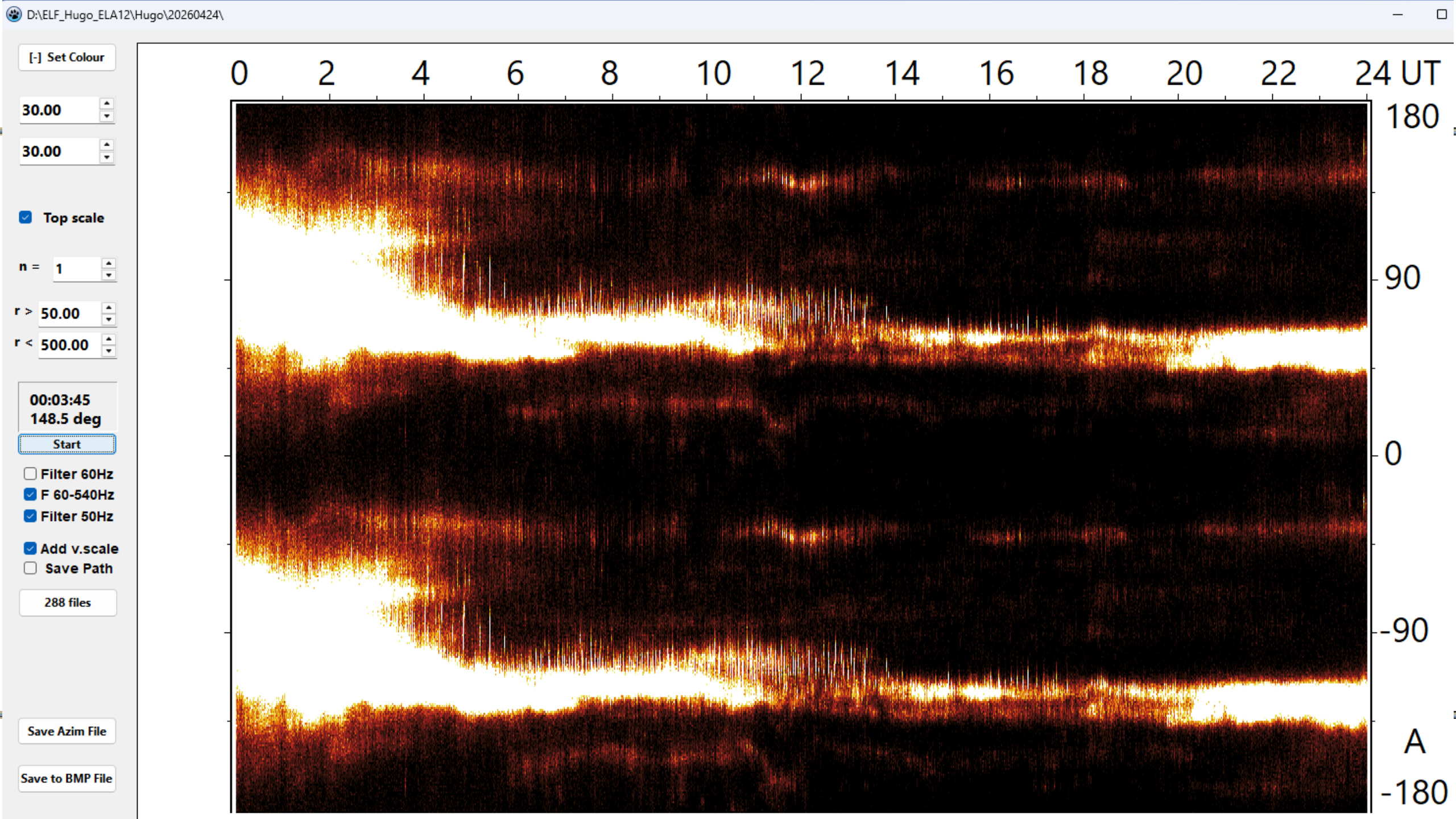
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Filter 50Hz
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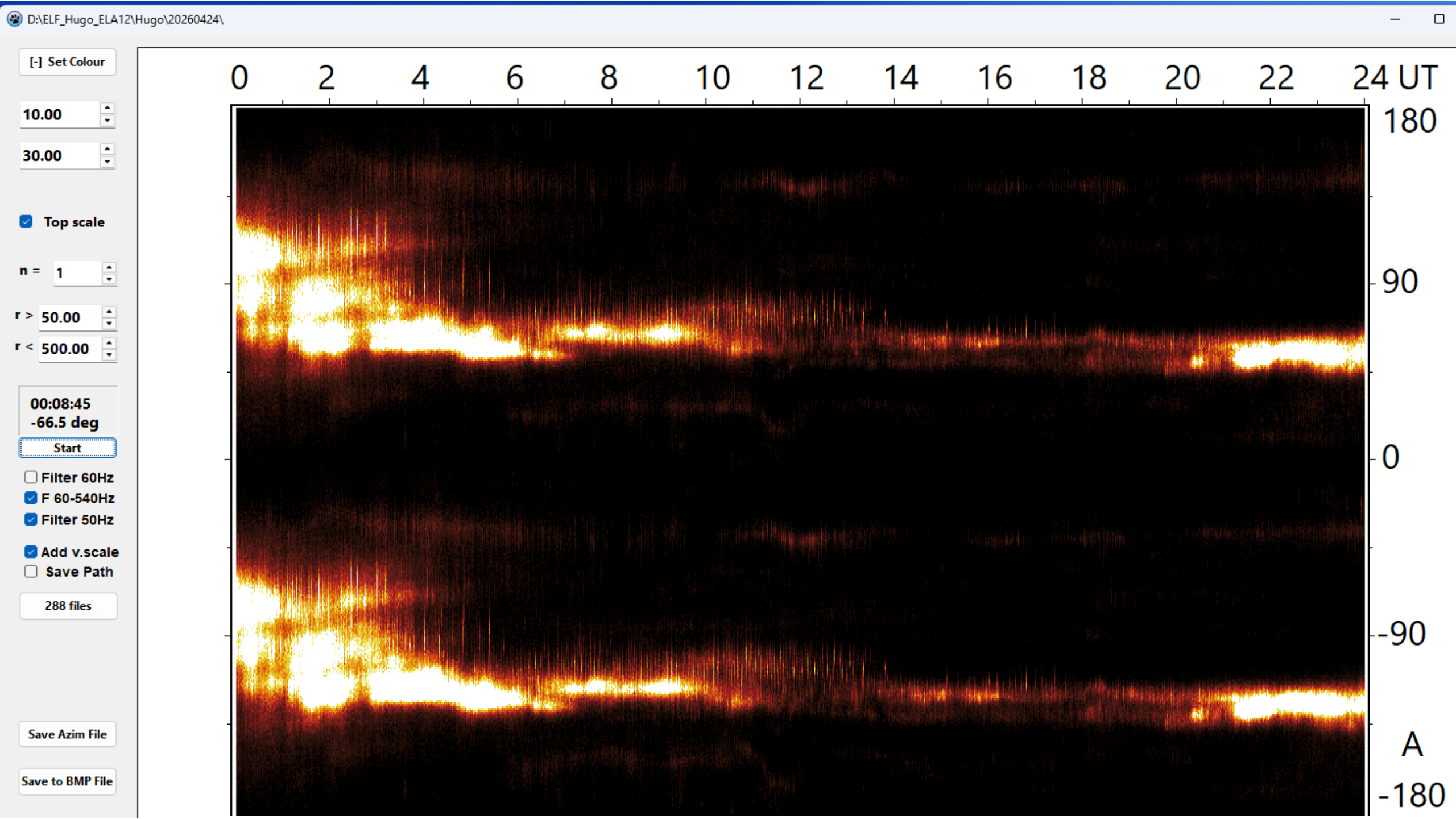
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Filter 50Hz
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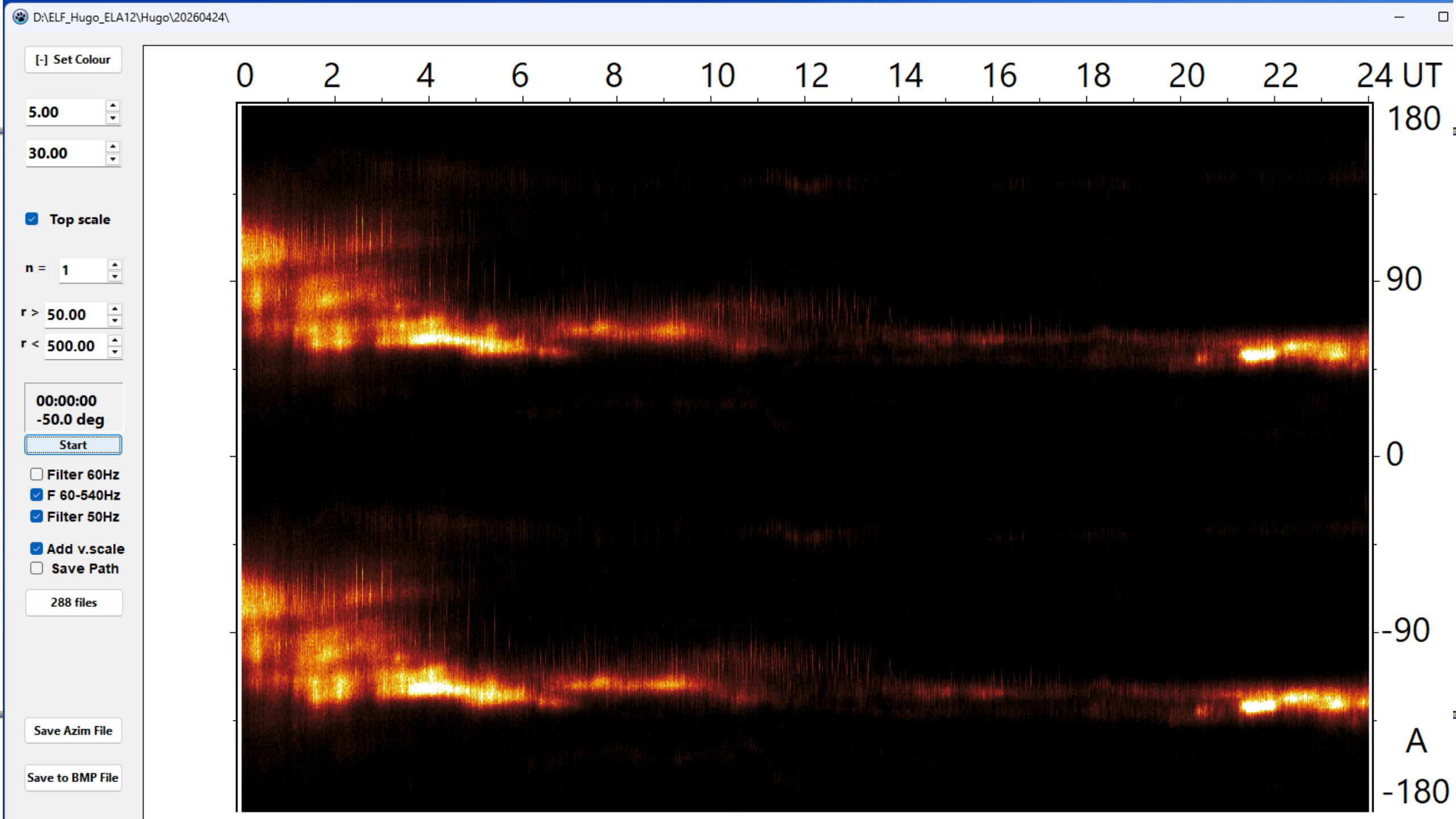
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F 60-540Hz
Filter 50Hz
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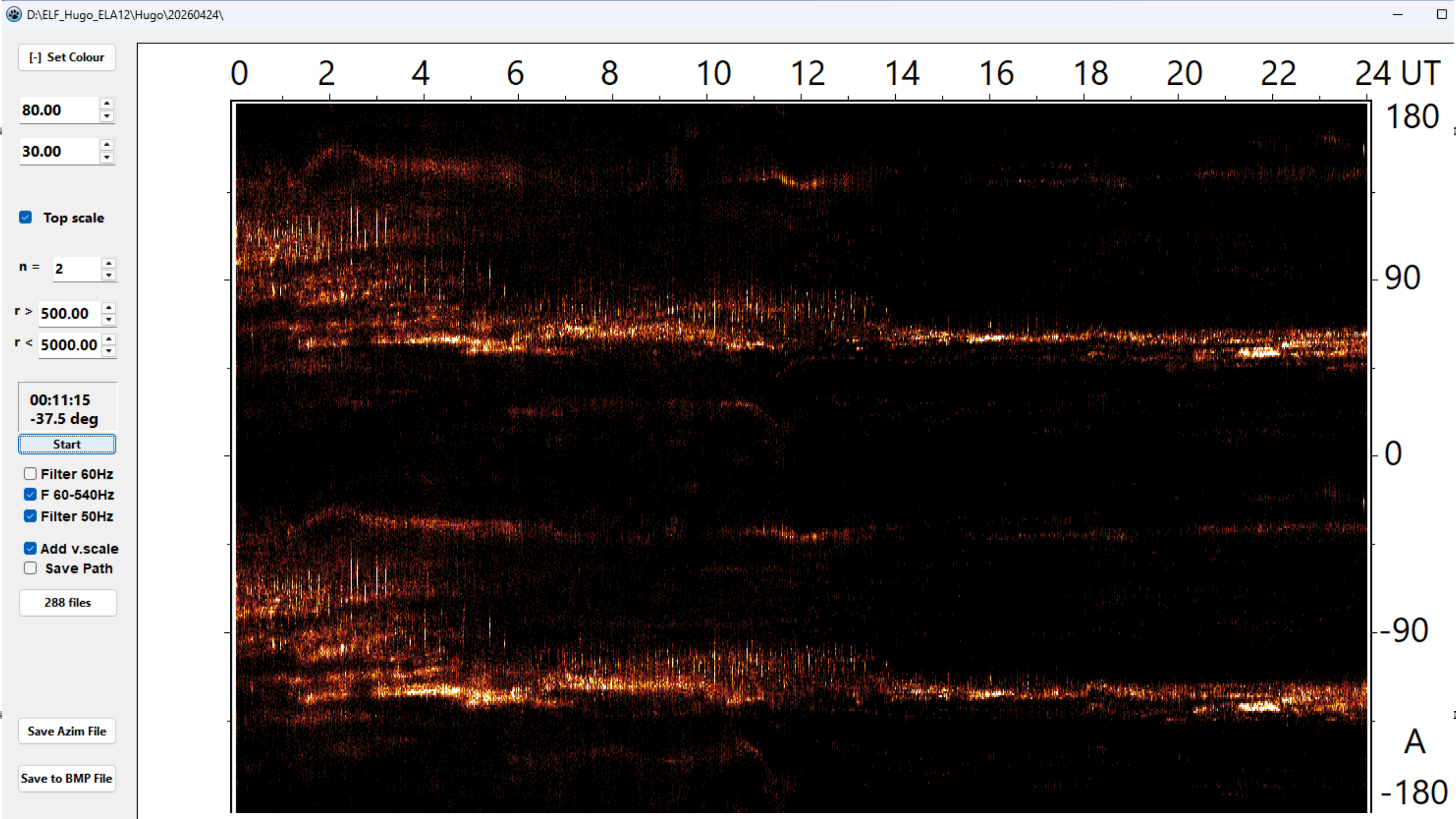
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Filter 60Hz
F 60-540Hz
Filter 50Hz
Add v.scale
Save Path
288 files
Save Azim File
Save to BMP File
0 2 4 6 8 10 12 14 16 18 20 22 24 UT
180
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-90
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-180

Hylaty

April 24, 2026

azimuth slides

Are there solar flates after 8 and 18 ?

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[-] Set Colour

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30.00

Top scale

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Start

Filter 50Hz

F 50-450Hz

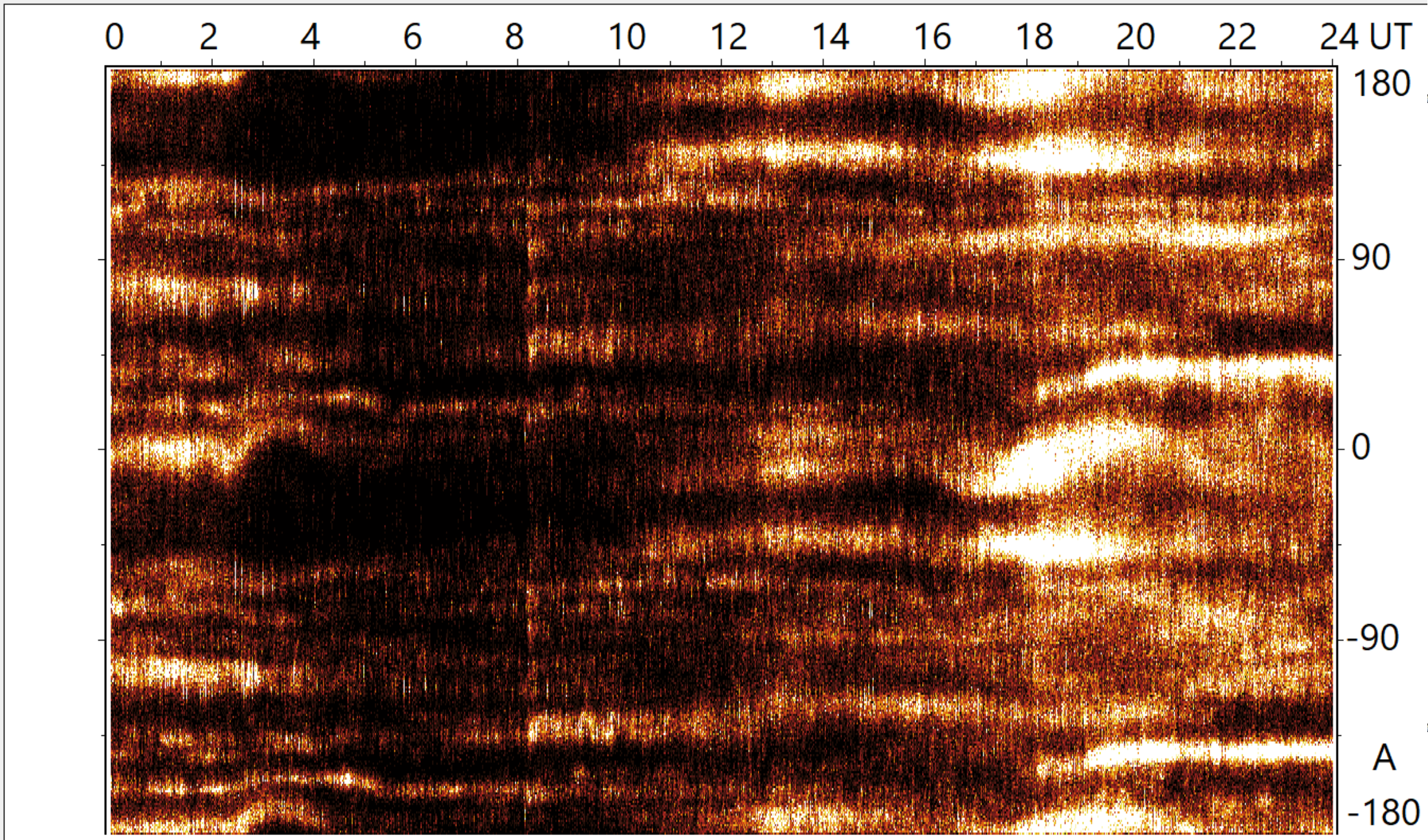
Add v.scale

Save Path

288 files

Save Azim File

Save to BMP File



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[-] Set Colour

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Top scale

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F 50-450Hz

Add v.scale

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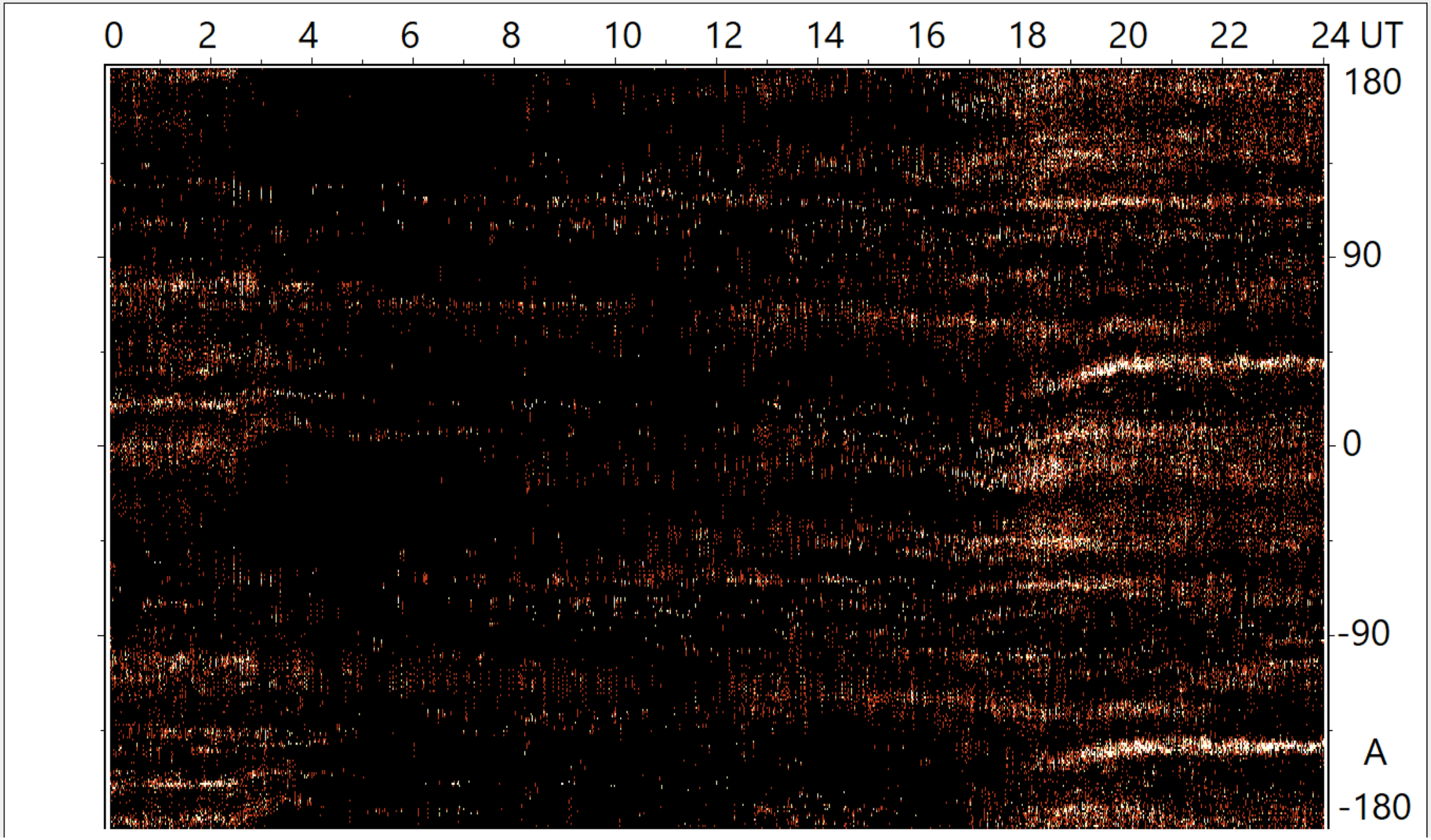

Hugo

April 25, 2026

5 azimuth slides with decreasing amplitude+

2 last slides for high amplitude impulses

D:\ELF_Hugo_ELA12\Hugo\20260425\

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30.00

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Add v.scale

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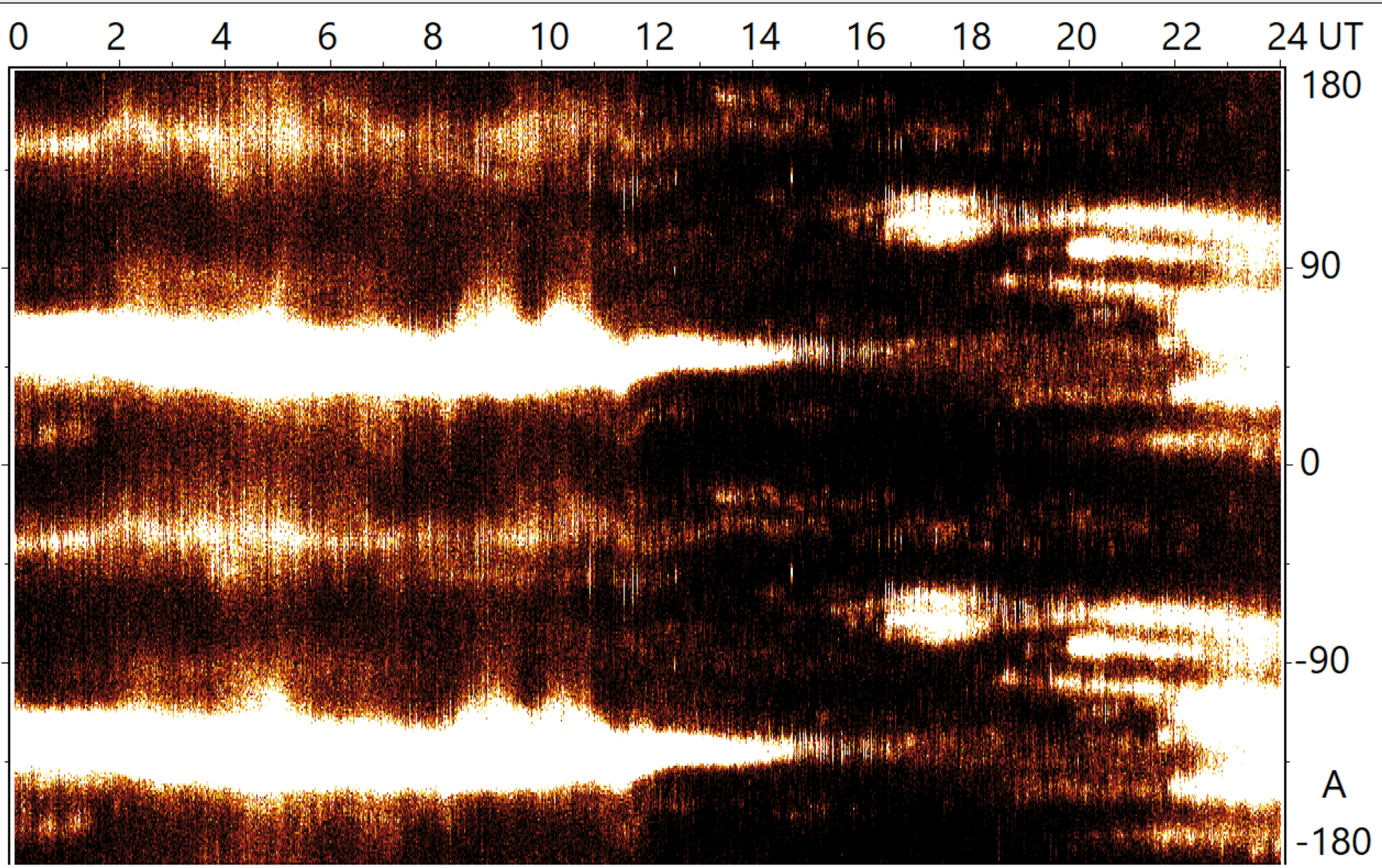

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30.00

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Filter 60Hz

F 60-540Hz

Filter 50Hz

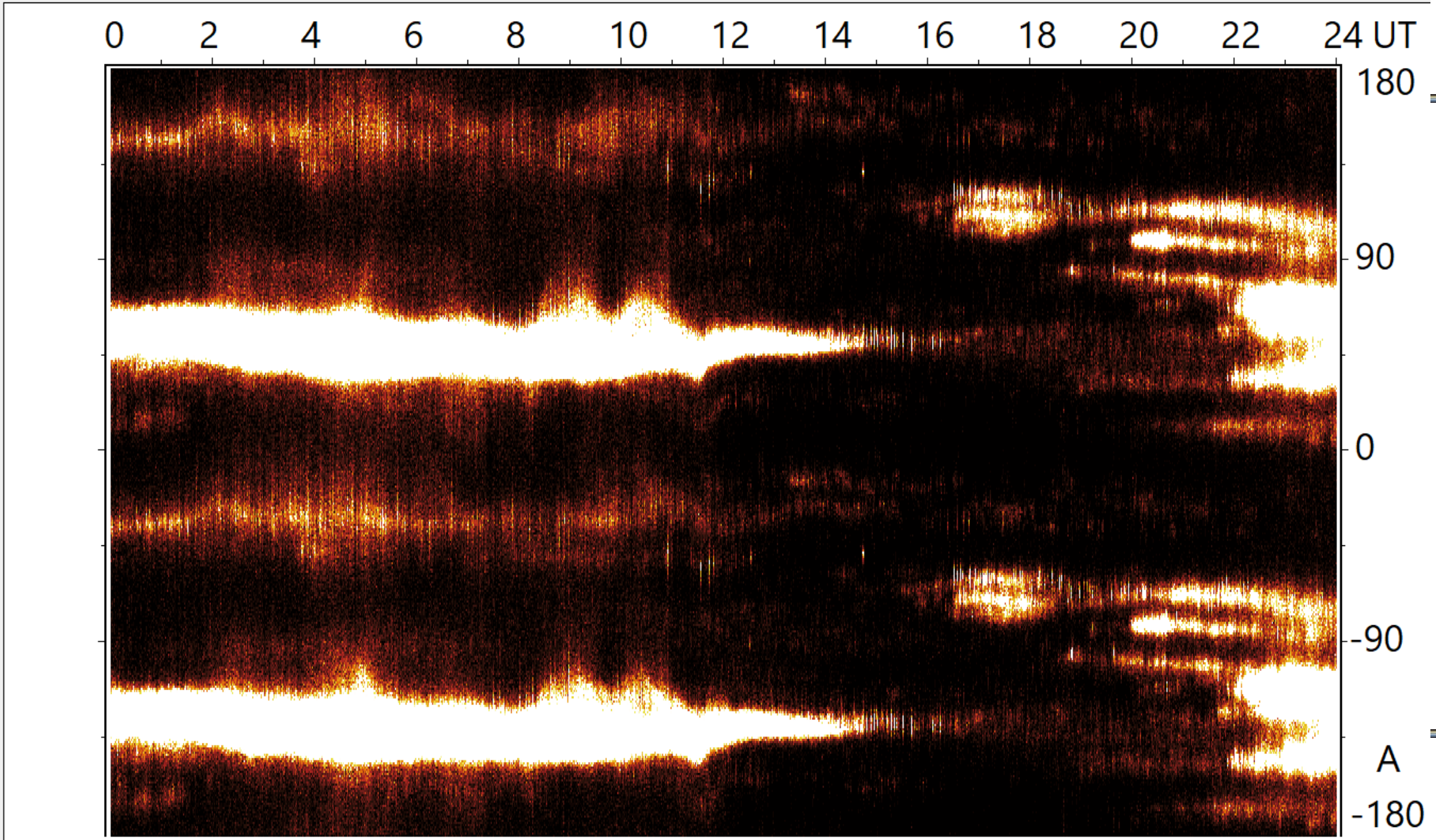
Add v.scale

Save Path

288 files

Save Azim File

Save to BMP File



D:\ELF_Hugo_ELA12\Hugo\20260425\

[-] Set Colour

30.00

30.00

Top scale

n = 1

r > 50.00

r < 500.00

00:43:45
32.5 deg

Start

Filter 60Hz

F 60-540Hz

Filter 50Hz

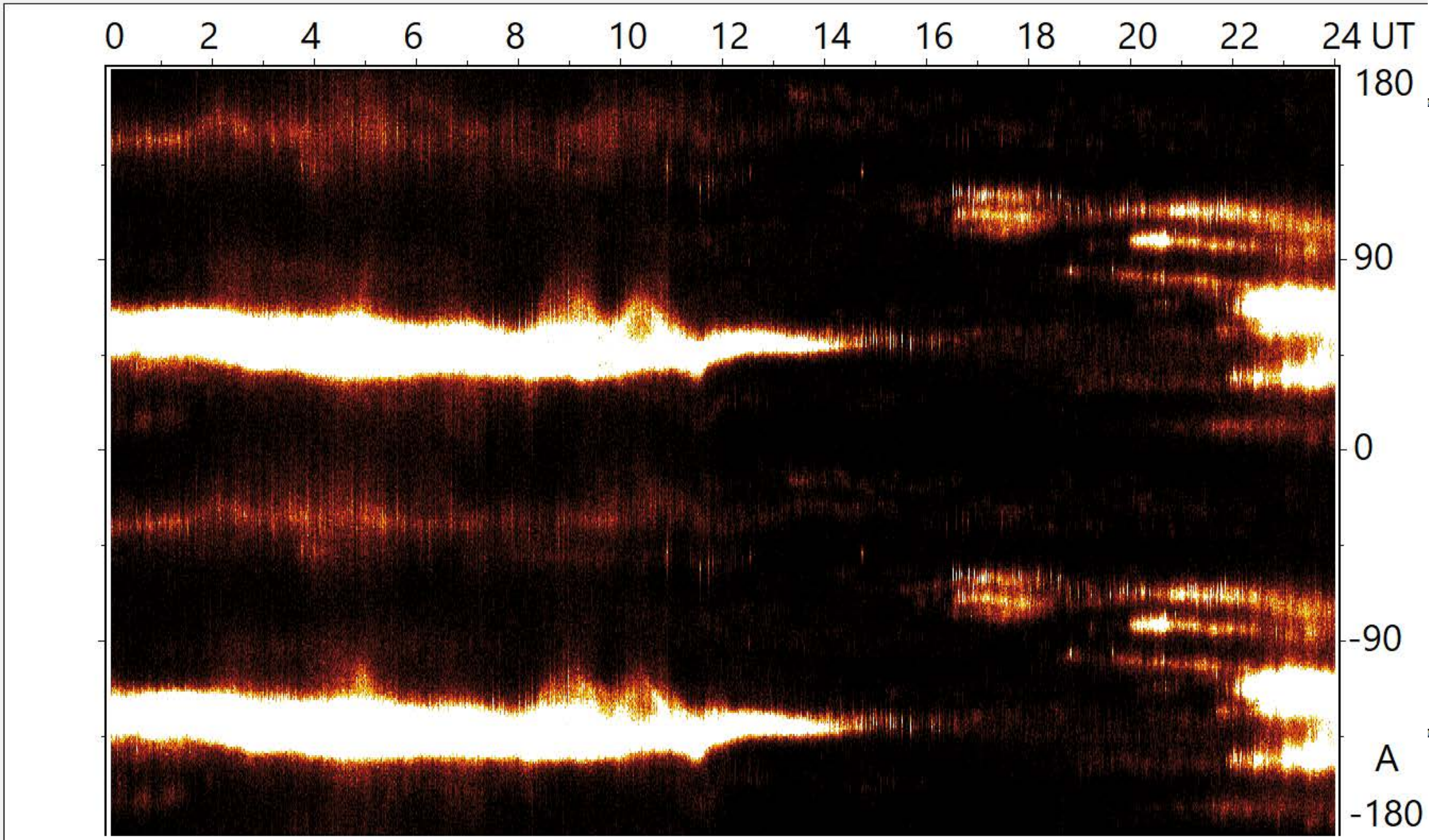
Add v.scale

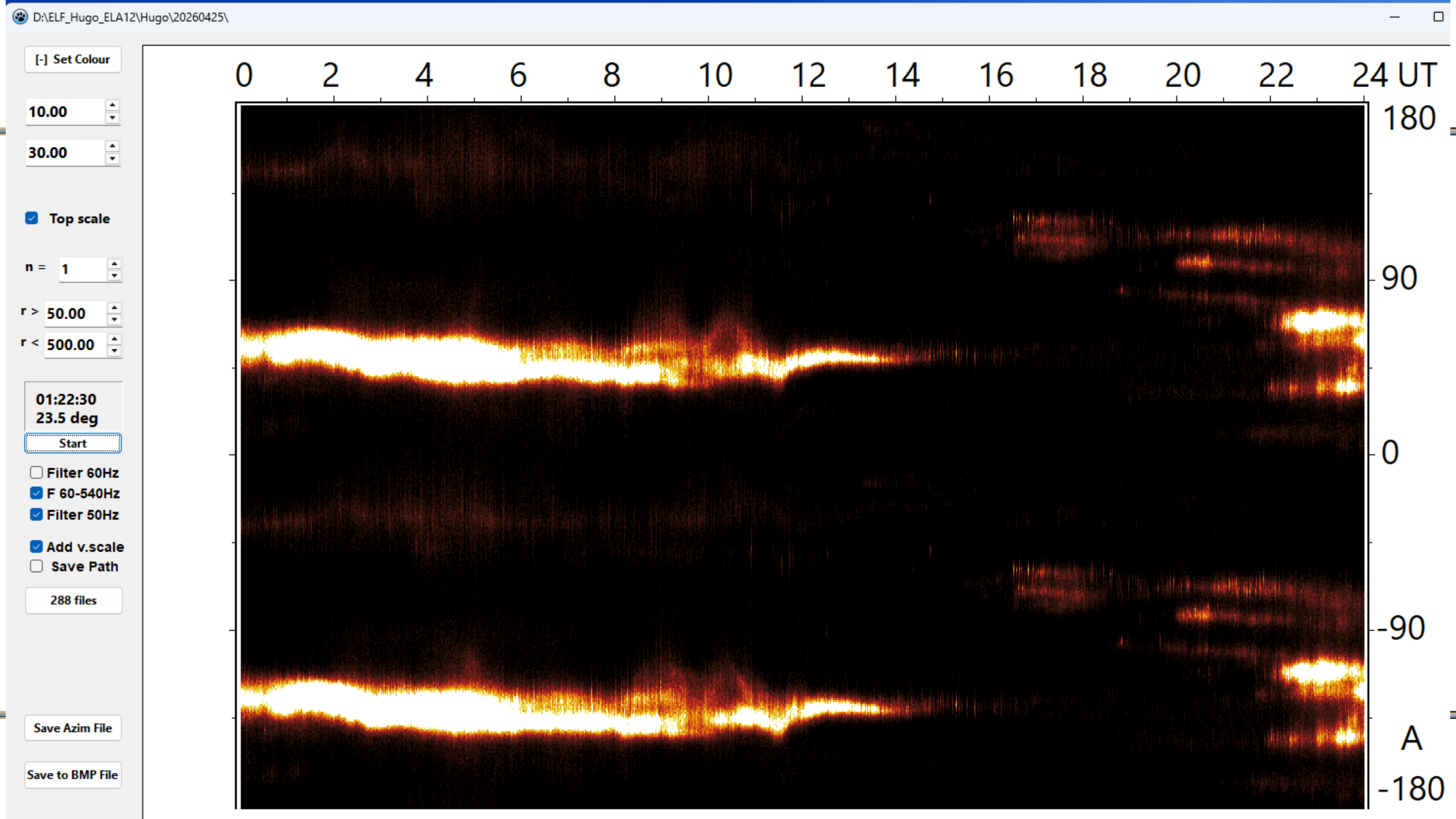
Save Path

288 files

Save Azim File

Save to BMP File




D:\ELF_Hugo_ELA12\Hugo\20260425\
[-] Set Colour
10.00
30.00
Top scale
n = 1
r > 50.00
r < 500.00
01:22:30
23.5 deg
Start
Filter 60Hz
F 60-540Hz
Filter 50Hz
Add v.scale
Save Path
288 files
Save Azim File
Save to BMP File
0 2 4 6 8 10 12 14 16 18 20 22 24 UT
180
90
0
-90
A
-180

D:\ELF_Hugo_ELA12\Hugo\20260425\

[-] Set Colour

5.00

30.00

Top scale

n = 1

r > 50.00

r < 500.00

00:02:30
77.5 deg

Start

Filter 60Hz

F 60-540Hz

Filter 50Hz

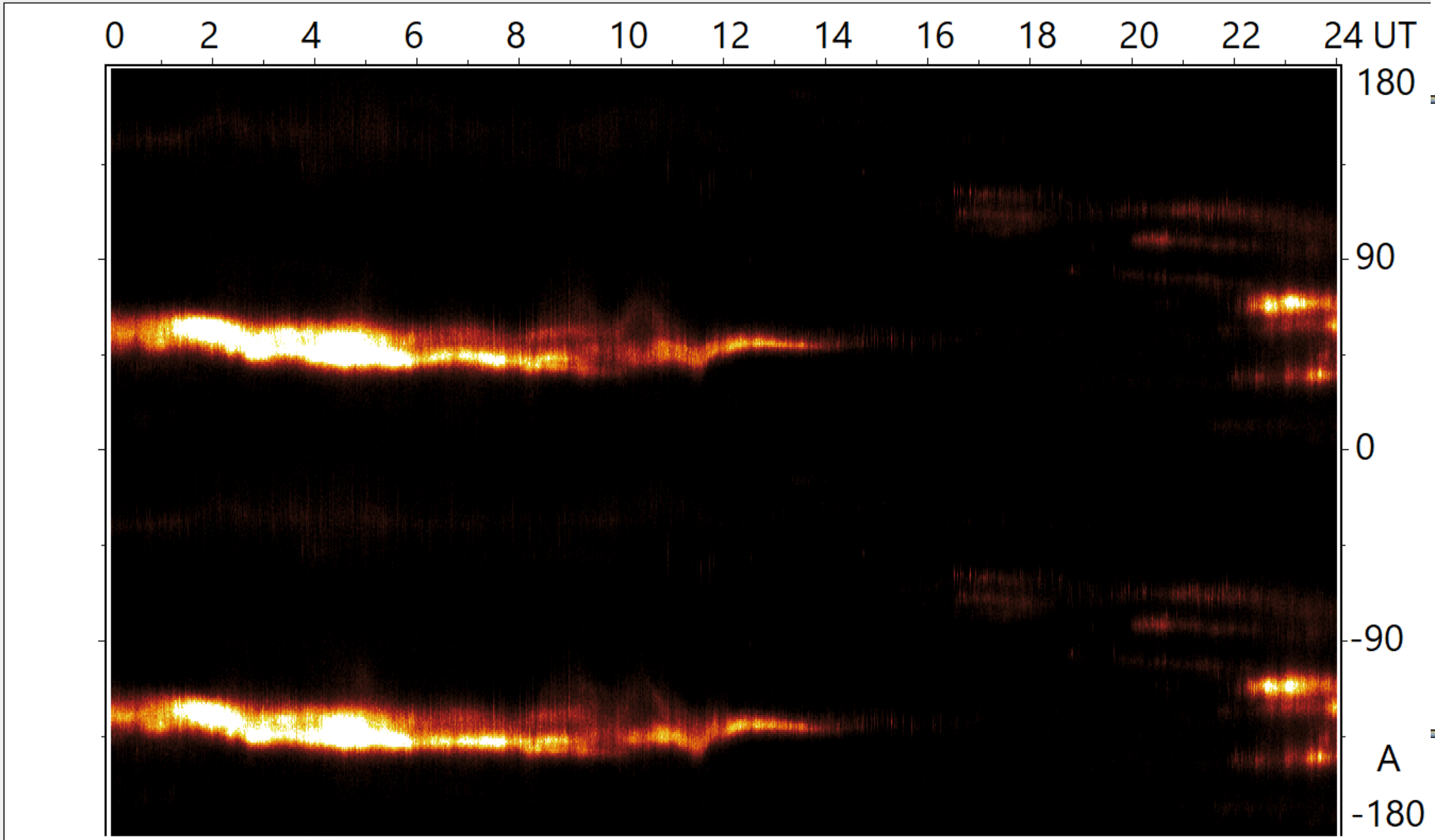
Add v.scale

Save Path

288 files

Save Azim File

Save to BMP File



D:\ELF_Hugo_ELA12\Hugo\20260425\

[-] Set Colour

80.00

30.00

Top scale

n = 2

r > 500.00

r < 5000.00

03:25:00
-34.5 deg

Start

Filter 60Hz

F 60-540Hz

Filter 50Hz

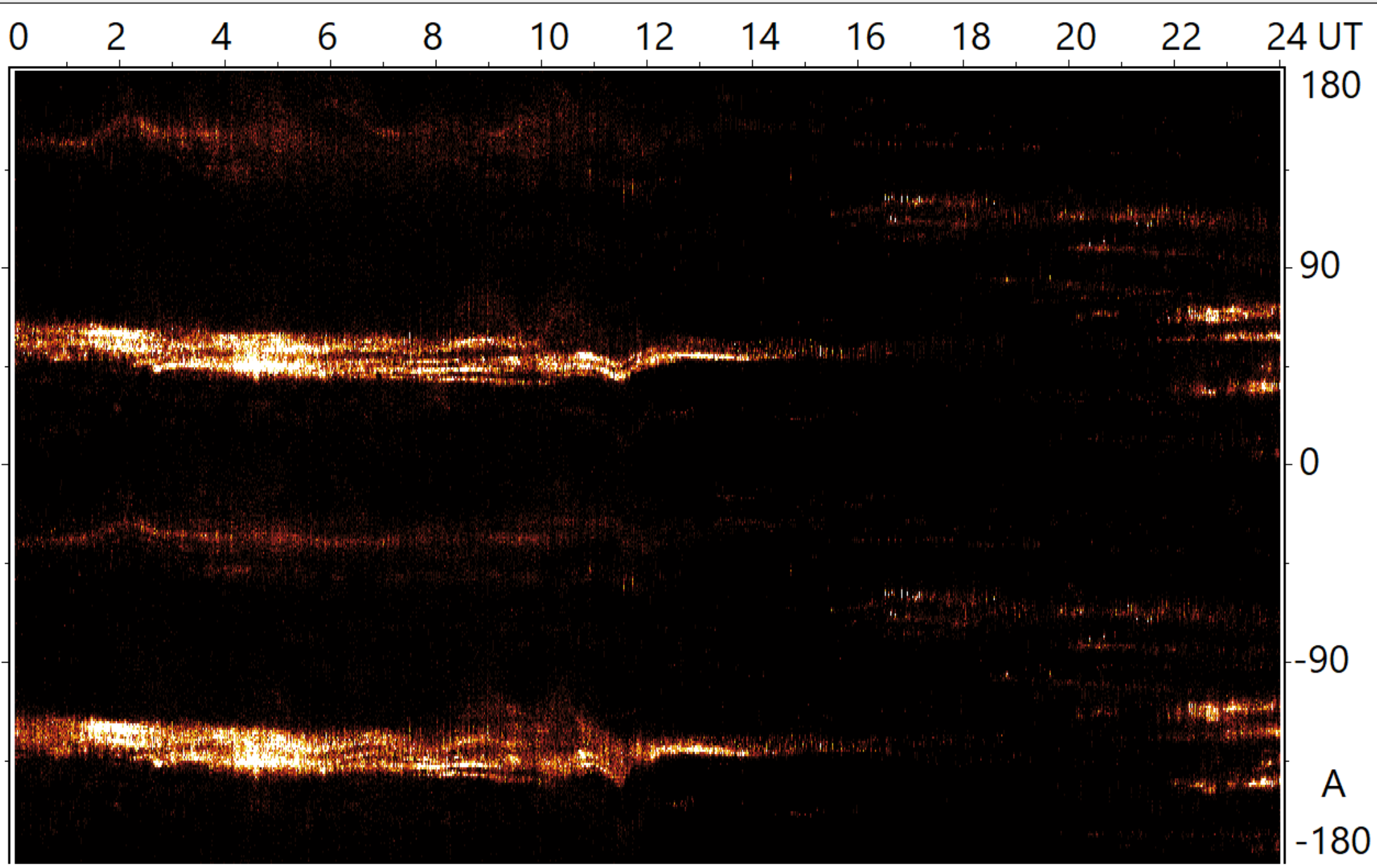
Add v.scale

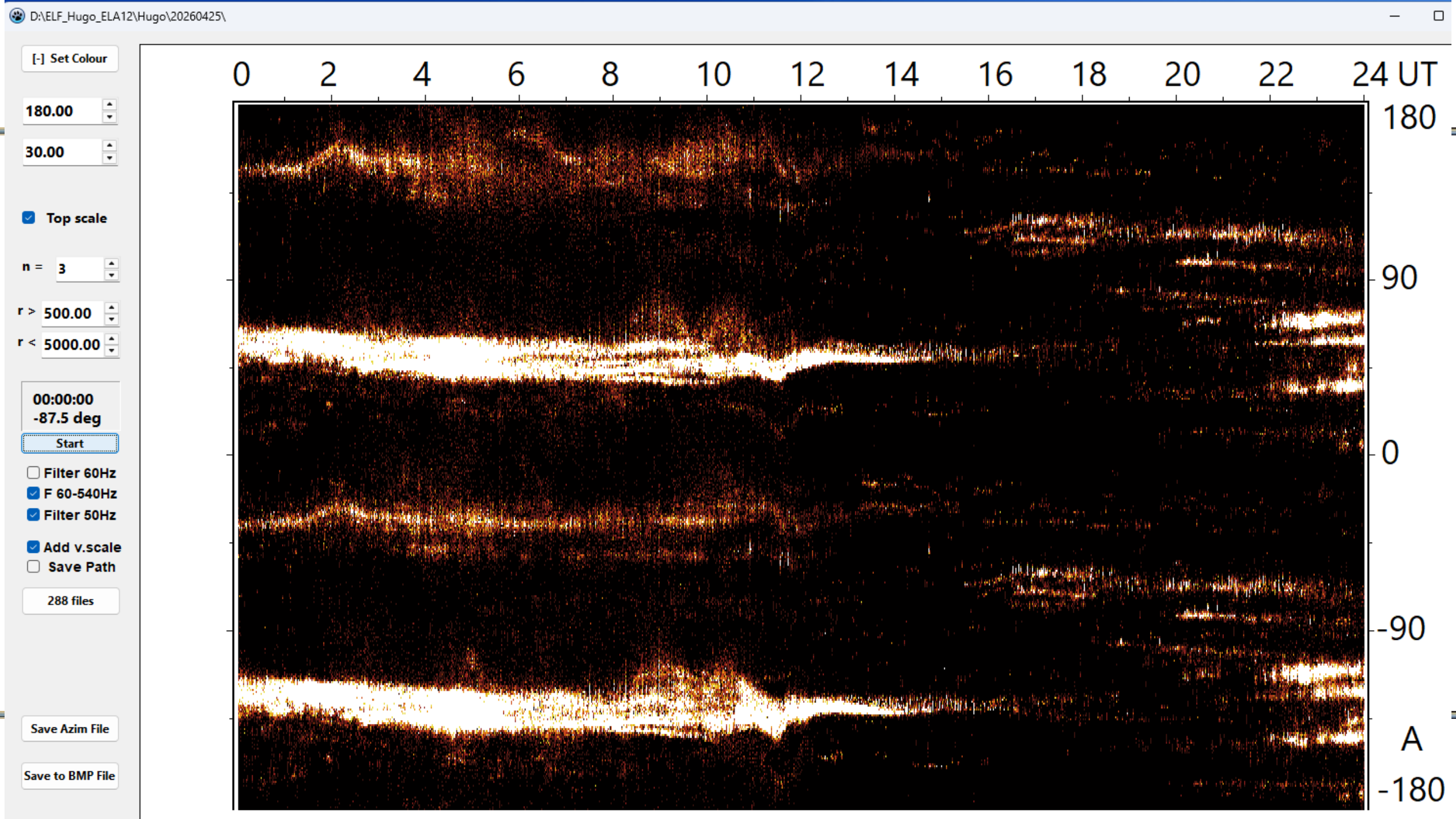
Save Path

288 files

Save Azim File

Save to BMP File

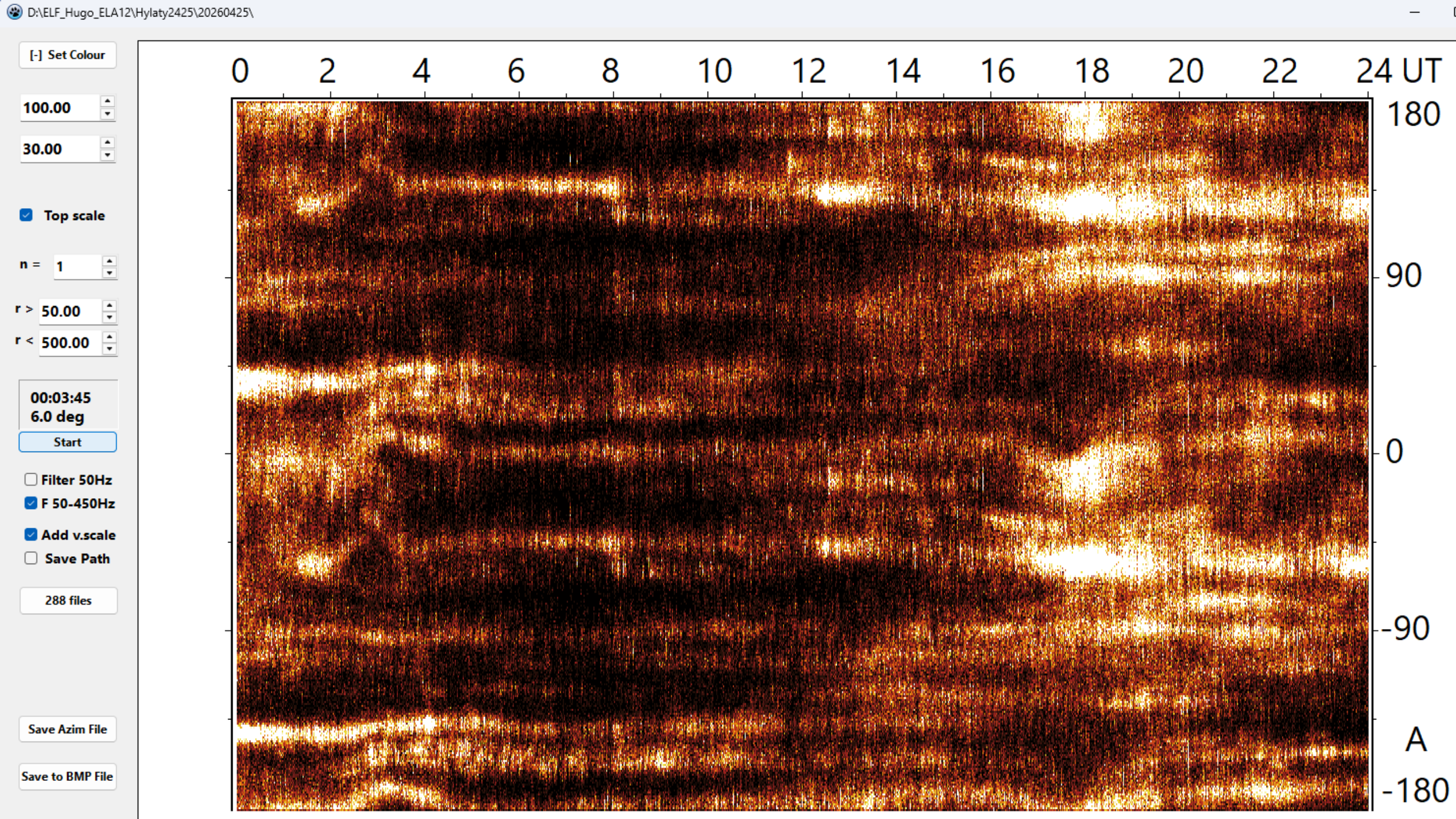


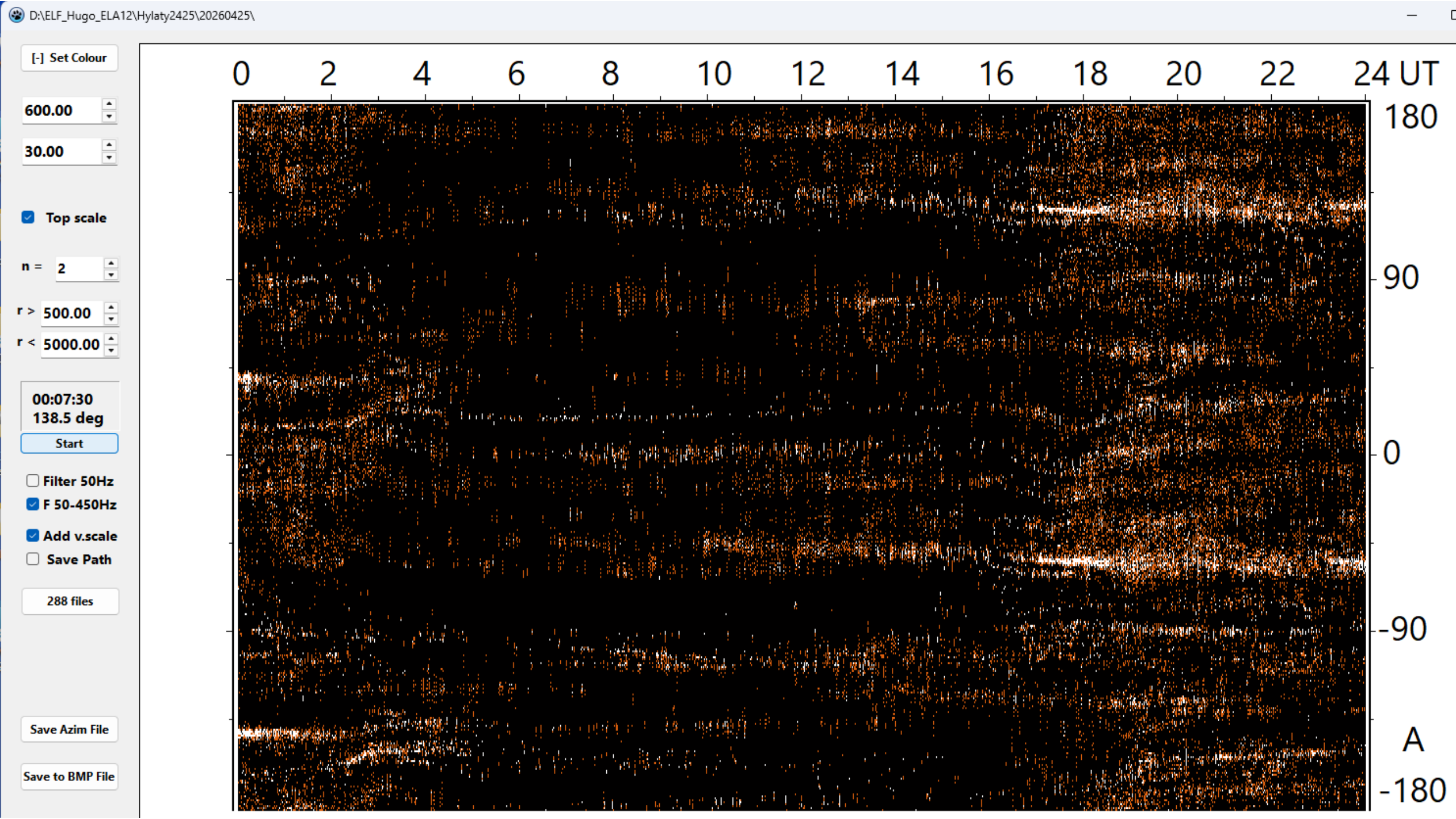

D:\ELF_Hugo_ELA12\Hugo\20260425\
[-] Set Colour
180.00
30.00
Top scale
n = 3
r > 500.00
r < 5000.00
00:00:00
-87.5 deg
Start
Filter 60Hz
F 60-540Hz
Filter 50Hz
Add v.scale
Save Path
288 files
Save Azim File
Save to BMP File
0 2 4 6 8 10 12 14 16 18 20 22 24 UT
180
90
0
-90
A
-180

Hylaty

April 25, 2026

azimuth slides, medium and high amplitude

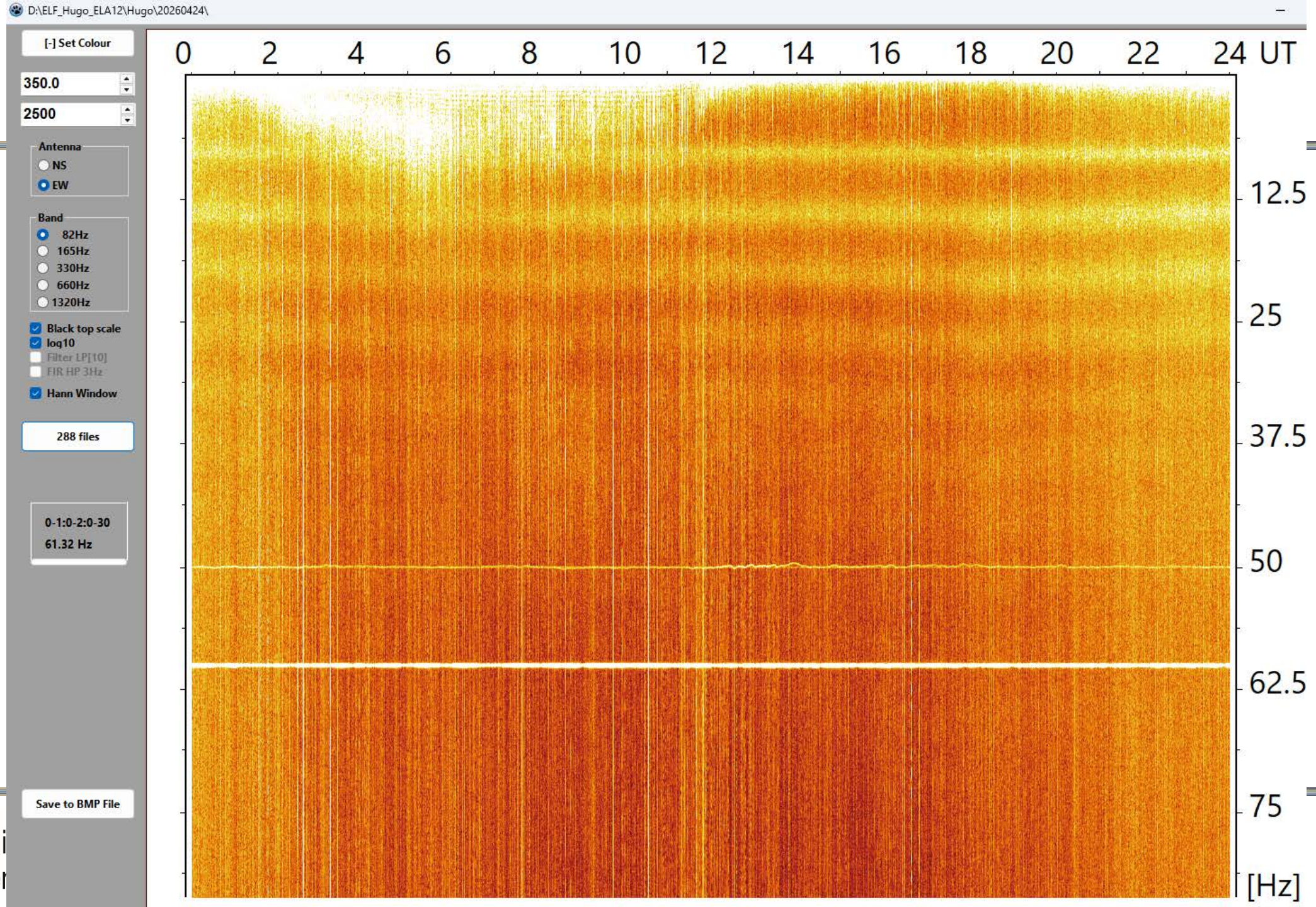

D:\ELF_Hugo_ELA12\Hylaty2425\20260425\
[-] Set Colour
100.00
30.00
Top scale
n = 1
r > 50.00
r < 500.00
00:03:45
6.0 deg
Start
Filter 50Hz
F 50-450Hz
Add v.scale
Save Path
288 files
Save Azim File
Save to BMP File
0 2 4 6 8 10 12 14 16 18 20 22 24 UT
180
90
0
-90
A
-180

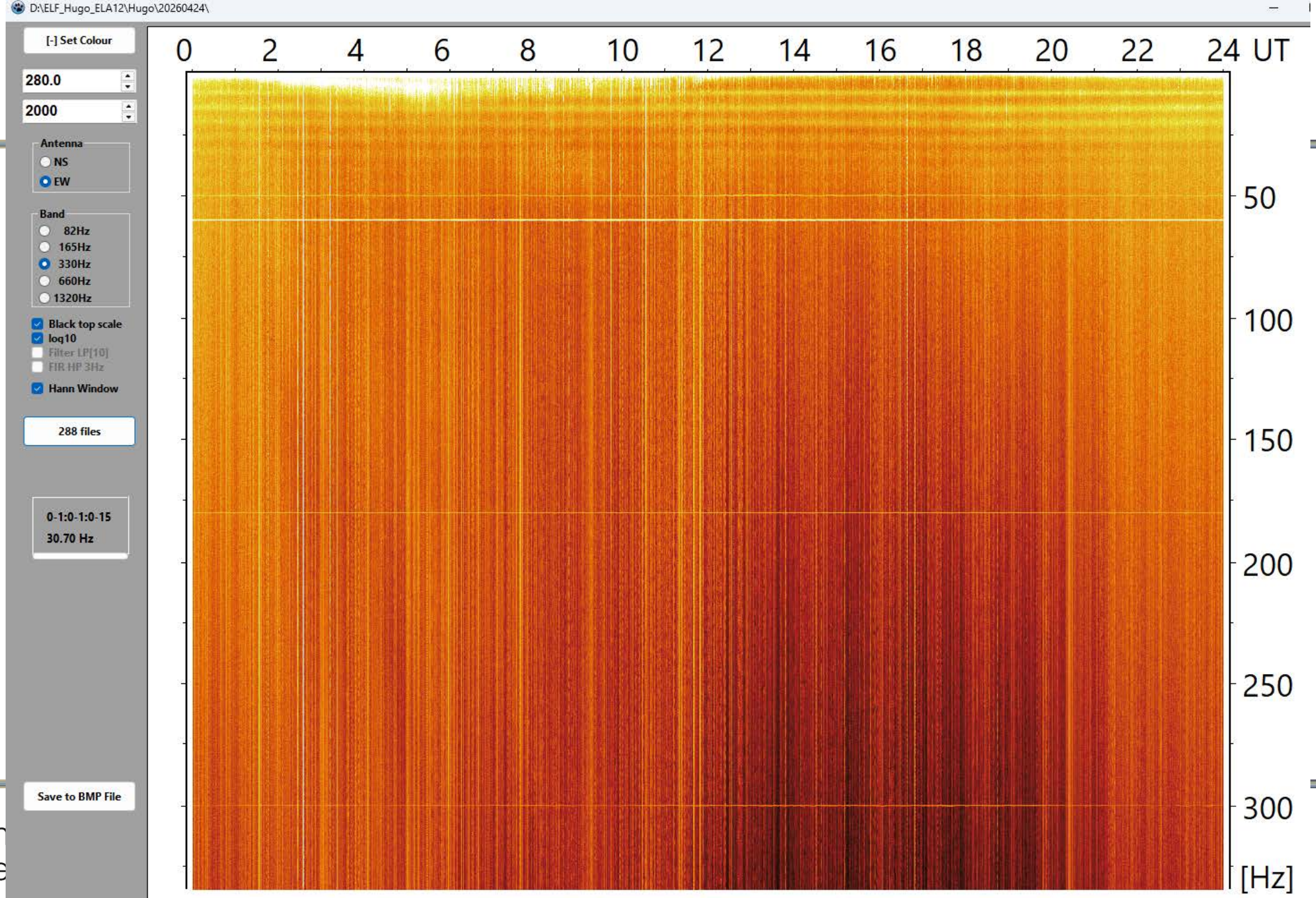

D:\ELF_Hugo_ELA12\Hylaty2425\20260425\
[-] Set Colour
600.00
30.00
Top scale
n = 2
r > 500.00
r < 5000.00
00:07:30
138.5 deg
Start
Filter 50Hz
F 50-450Hz
Add v.scale
Save Path
288 files
Save Azim File
Save to BMP File
0 2 4 6 8 10 12 14 16 18 20 22 24 UT
180
90
0
-90
A
-180

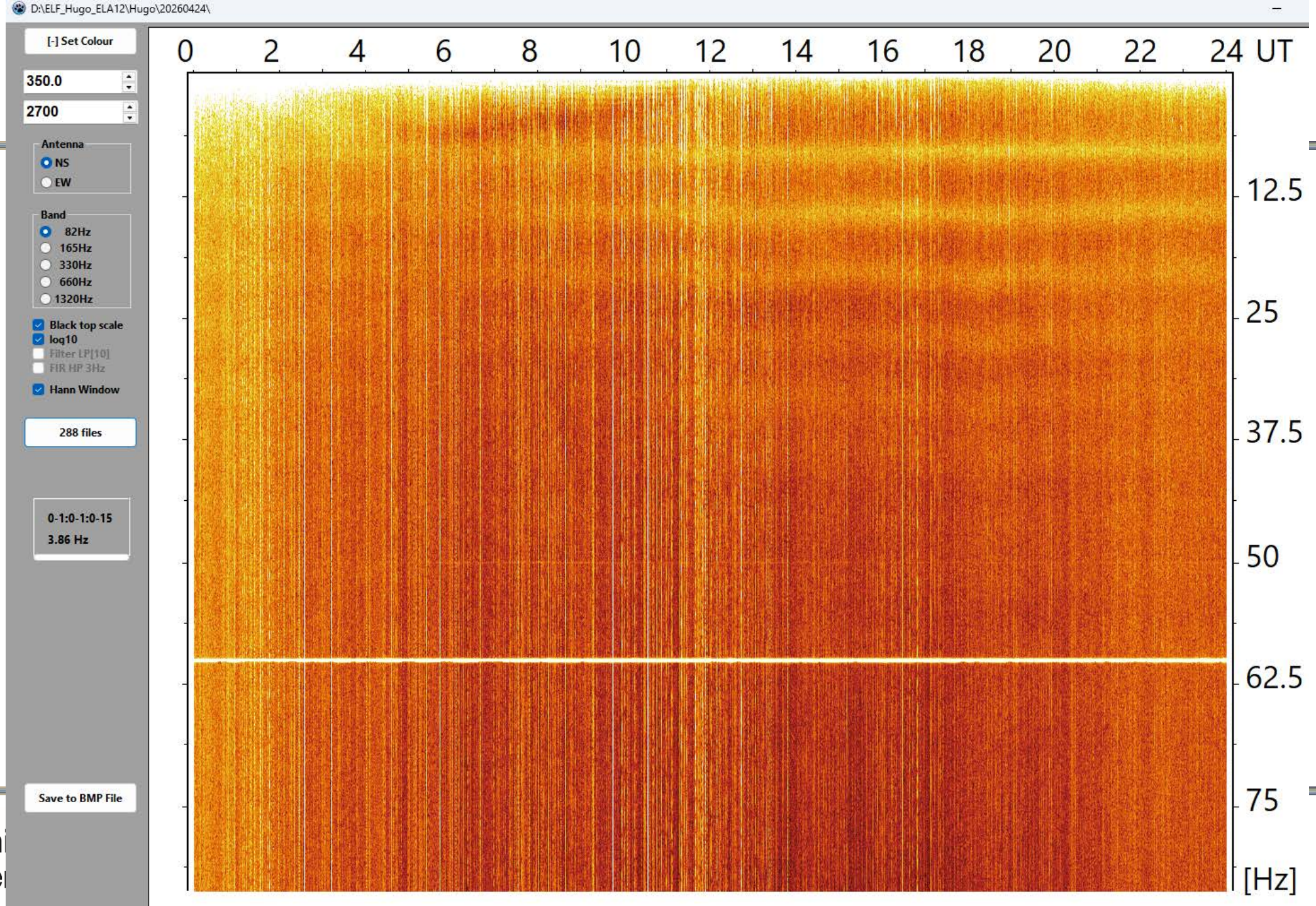
Hugo

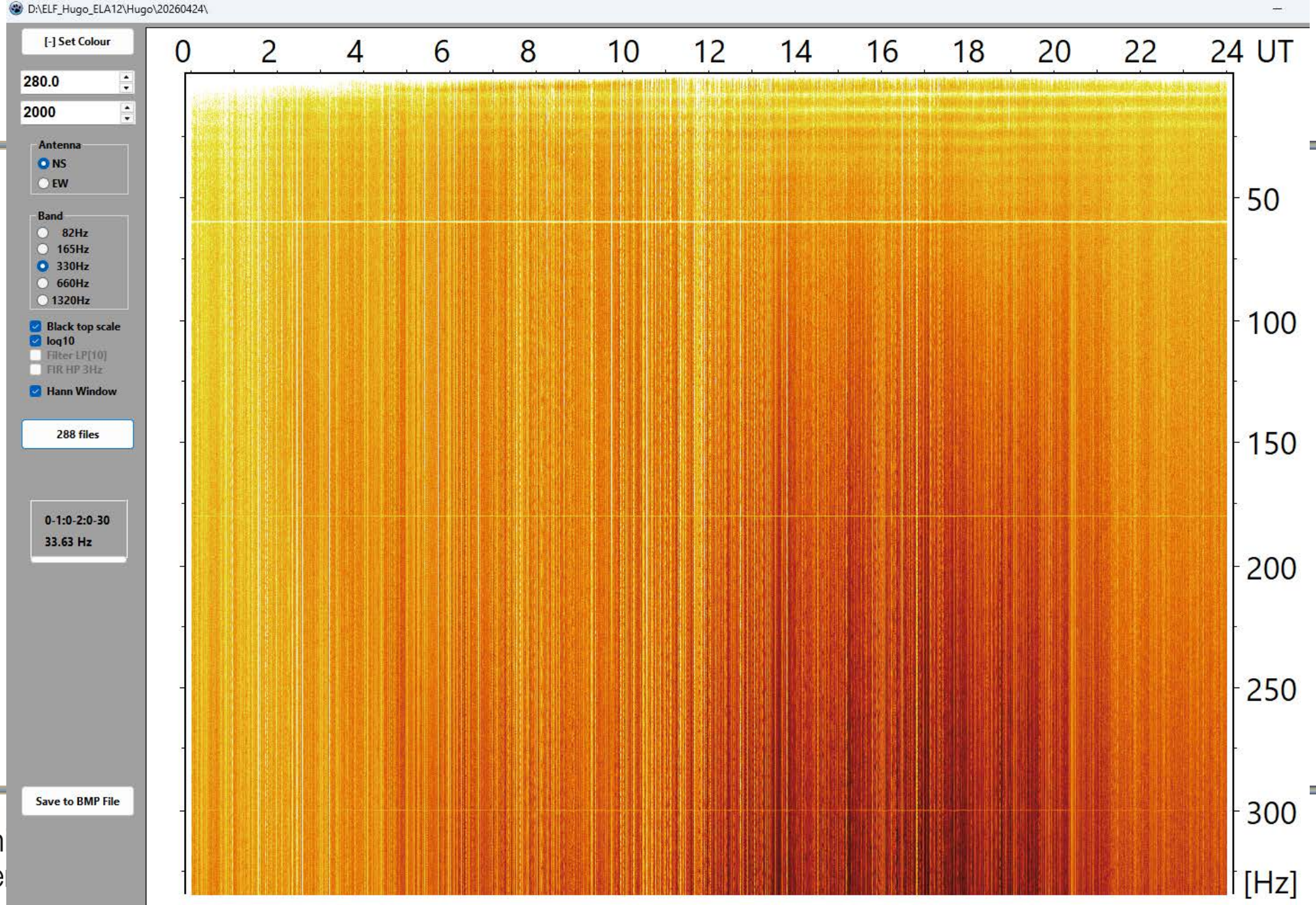
dynamic spectra

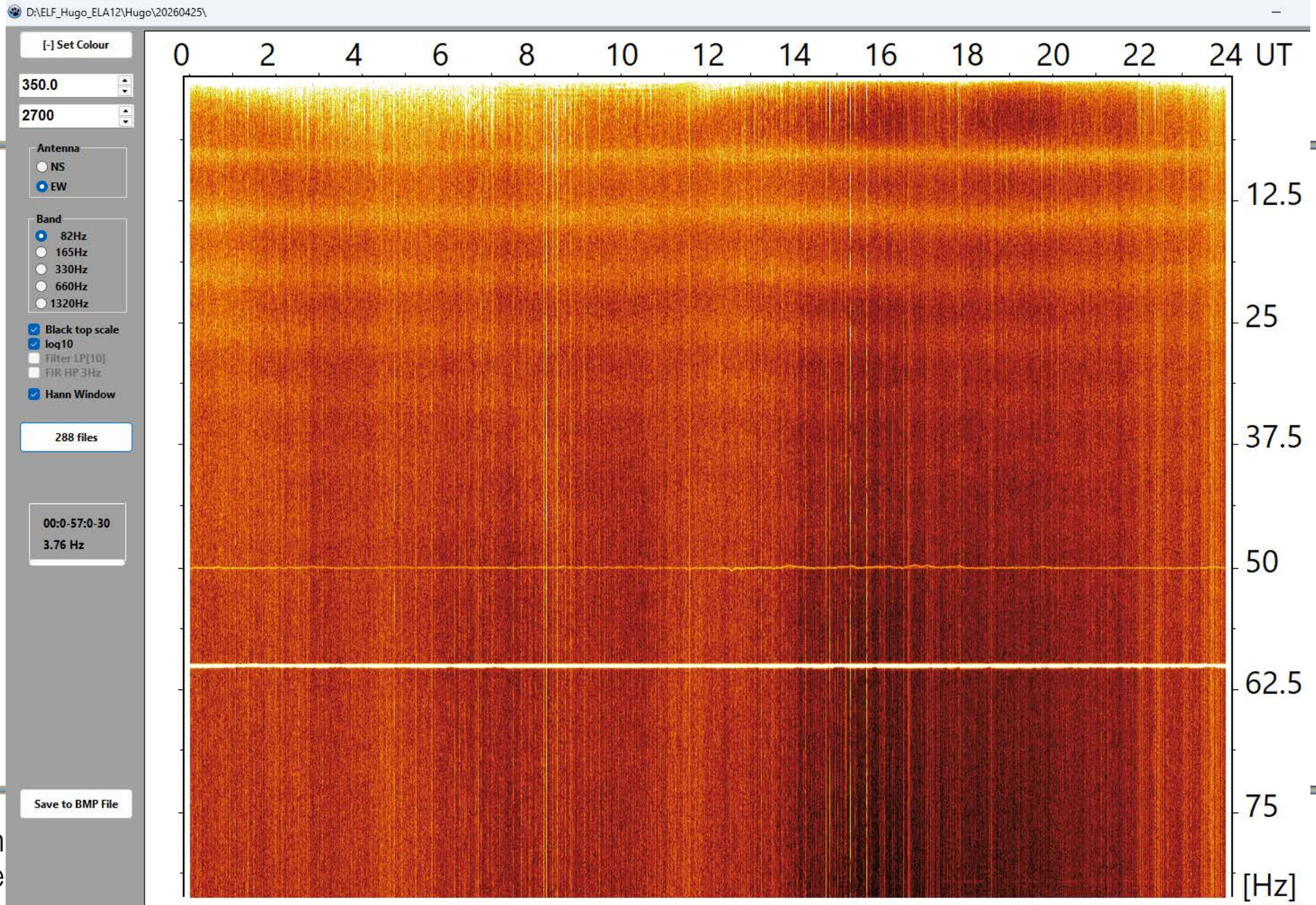
24 and 25 Apr.

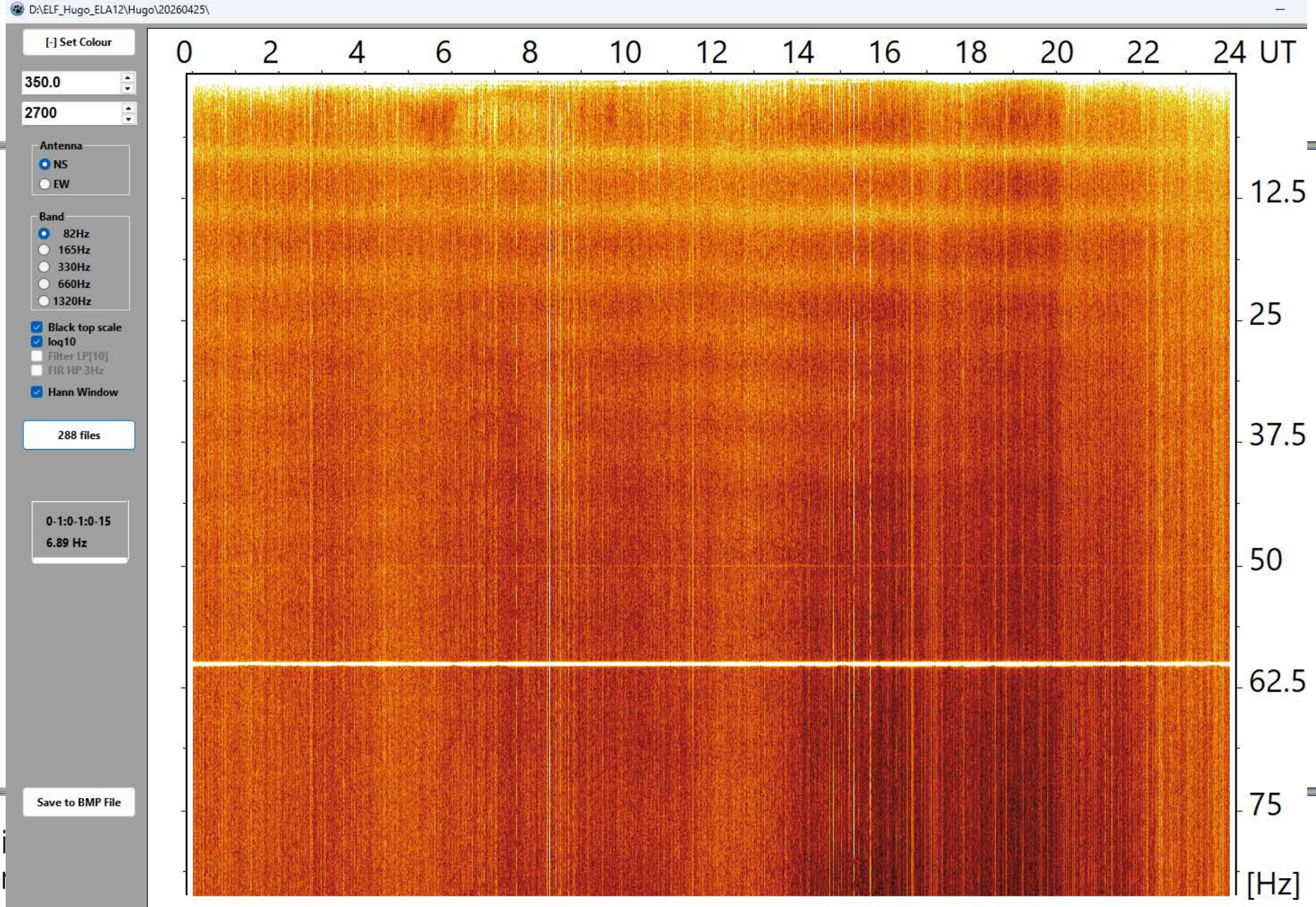

D:\ELF_Hugo_ELA12\Hugo\20260424\
[-] Set Colour
350.0
2500
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
0-1:0-2:0-30
61.32 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]


D:\ELF_Hugo_ELA12\Hugo\20260424\
[-] Set Colour
280.0
2000
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
0-1:0-1:0-15
30.70 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
50
100
150
200
250
300
[Hz]


D:\ELF_Hugo_ELA12\Hugo\20260424\
[-] Set Colour
350.0
2700
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
0-1:0-1:0-15
3.86 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]


D:\ELF_Hugo_ELA12\Hugo\20260424\
[-] Set Colour
280.0
2000
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP(10)
FIR HP 3Hz
Hann Window
288 files
0-1:0-2:0-30
33.63 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
50
100
150
200
250
300
[Hz]

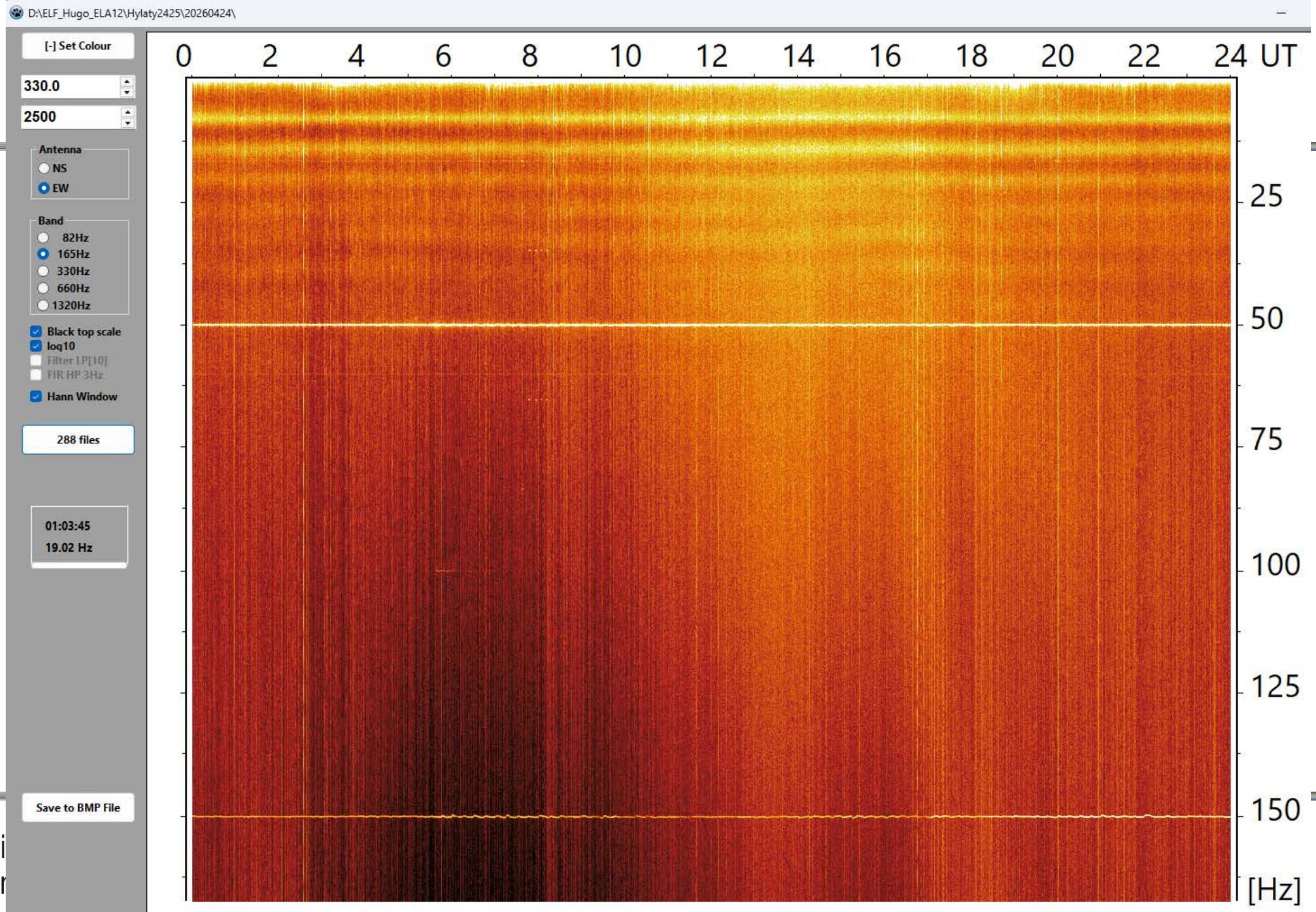

D:\ELF_Hugo_ELA12\Hugo\20260425\
[-] Set Colour
350.0
2700
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
00:0-57:0-30
3.76 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]

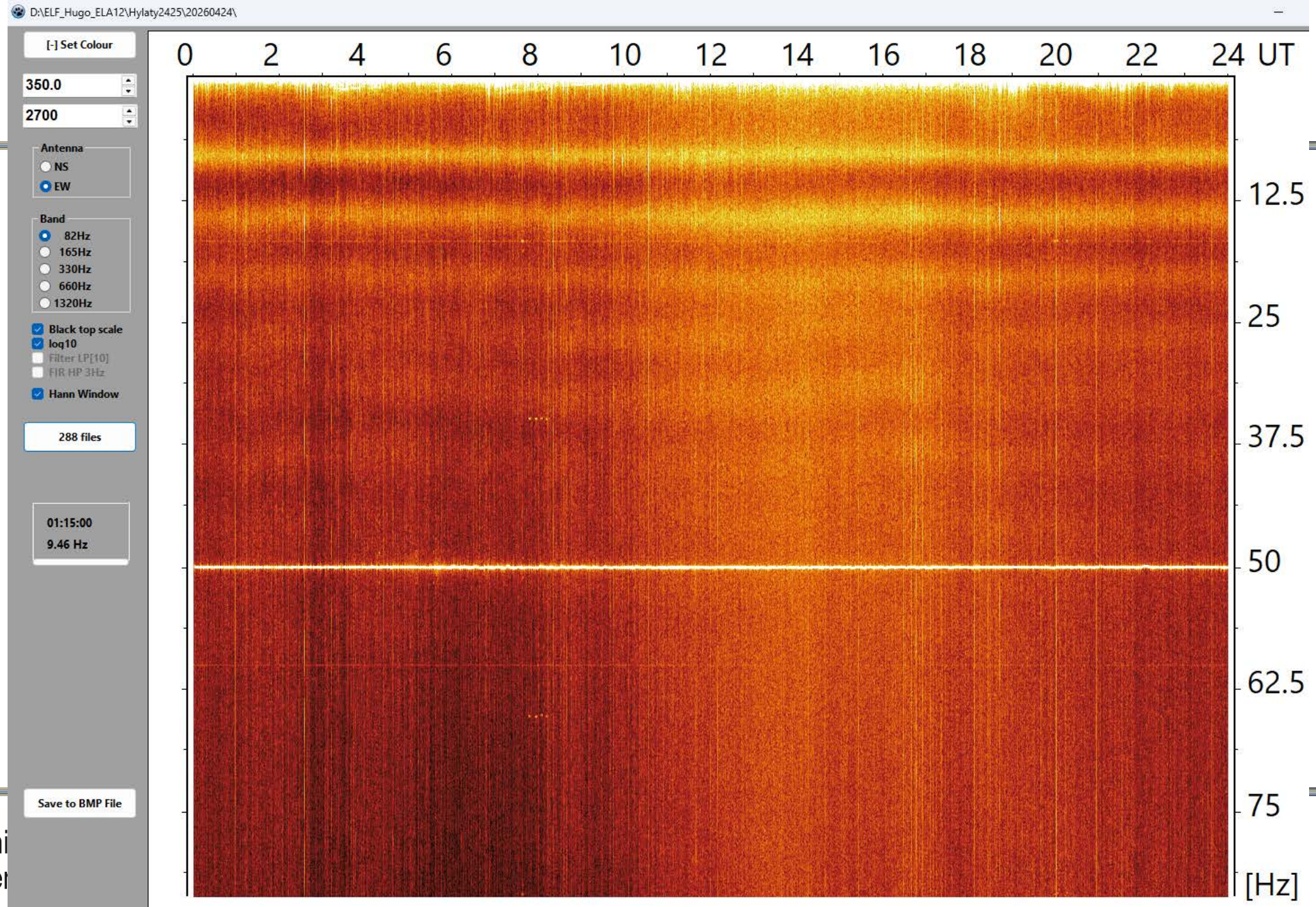

D:\ELF_Hugo_ELA12\Hugo\20260425\
[-] Set Colour
350.0
2700
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
0-1:0-1:0-15
6.89 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]

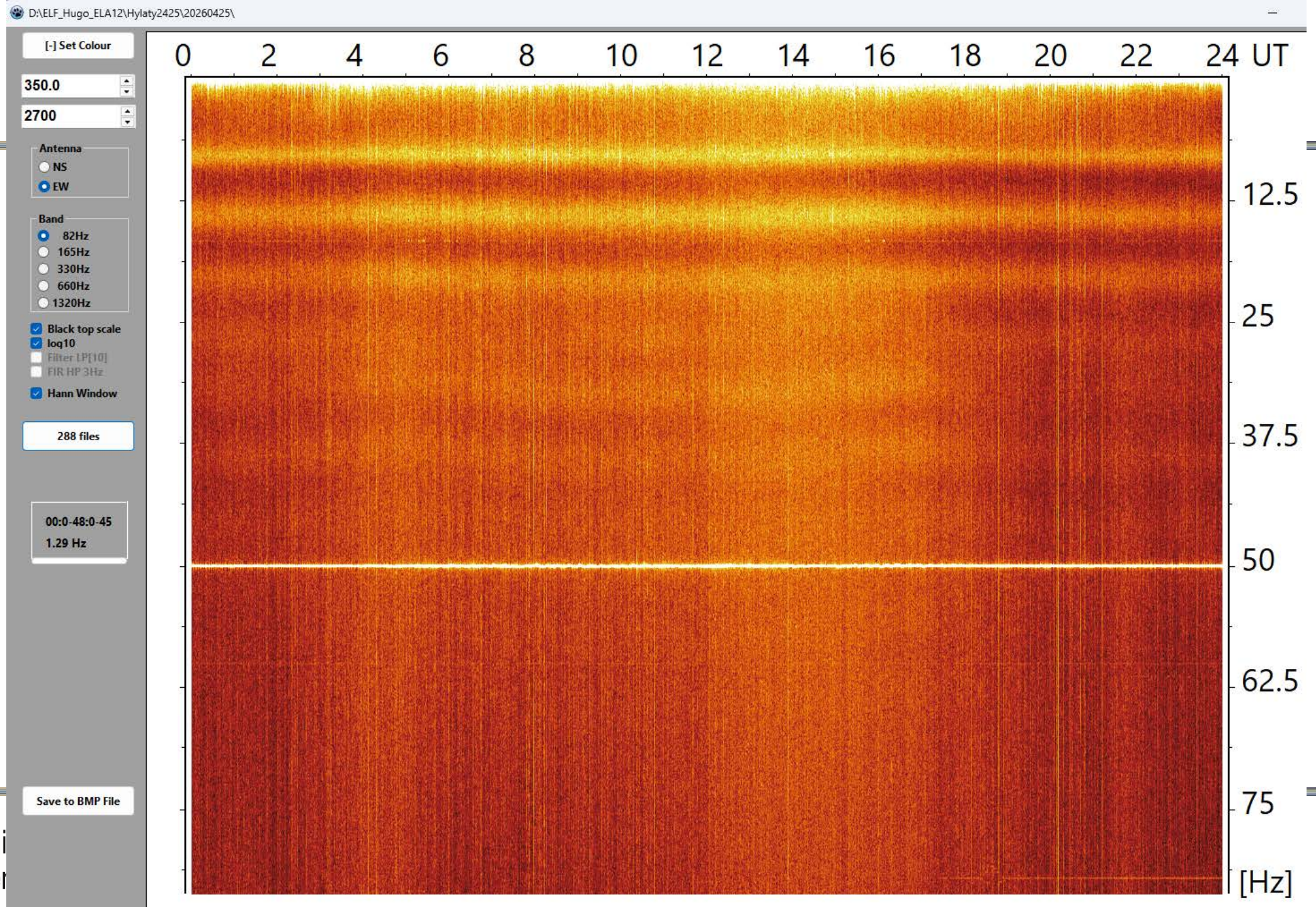
Hylaty

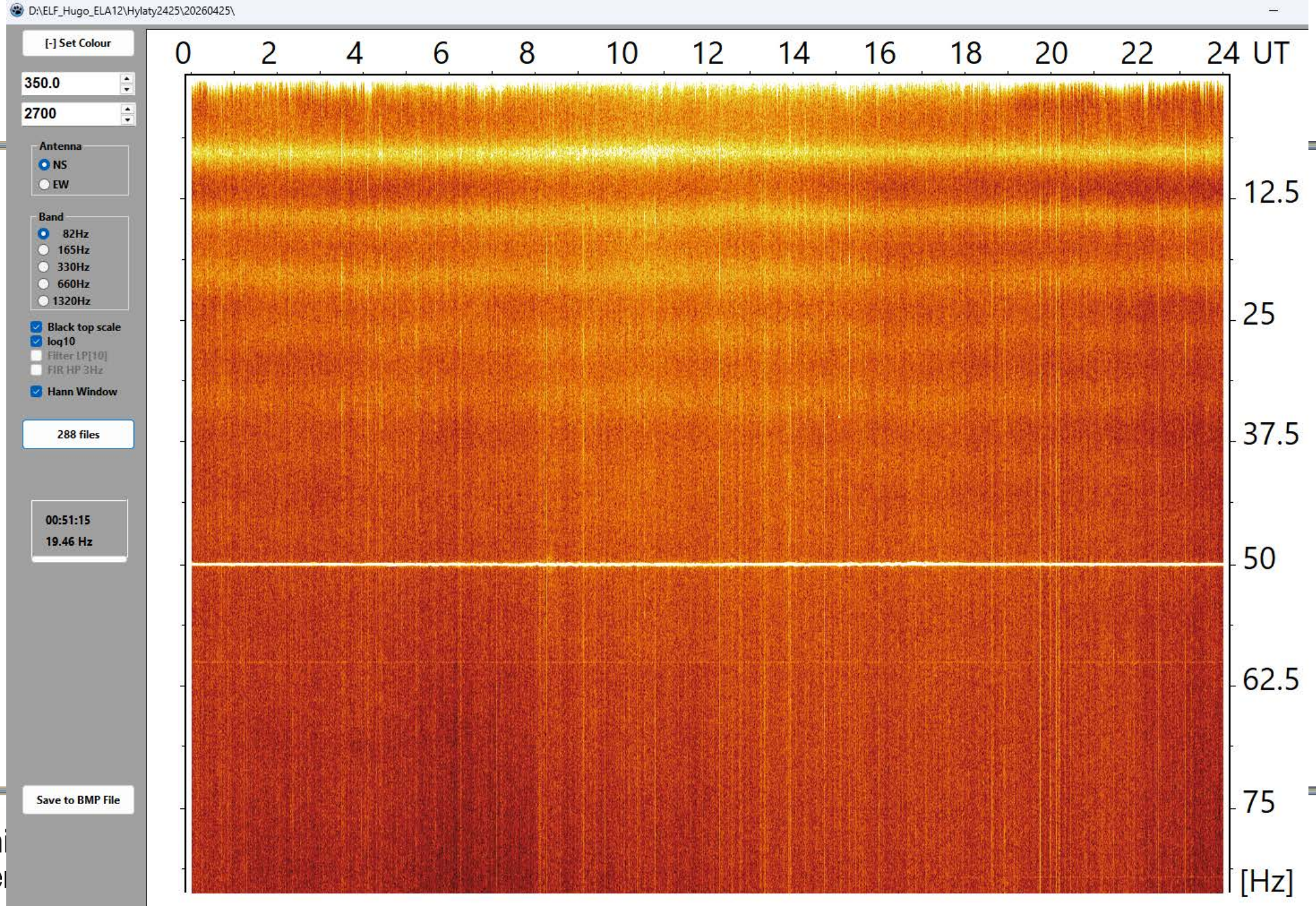
dynamic spectra

24 and 25 Apr.


D:\ELF_Hugo_ELA12\Hylaty2425\20260424\
[-] Set Colour
330.0
2500
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
01:03:45
19.02 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
25
50
75
100
125
150
[Hz]


D:\ELF_Hugo_ELA12\Hylaty2425\20260424\
[-] Set Colour
350.0
2700
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
01:15:00
9.46 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]

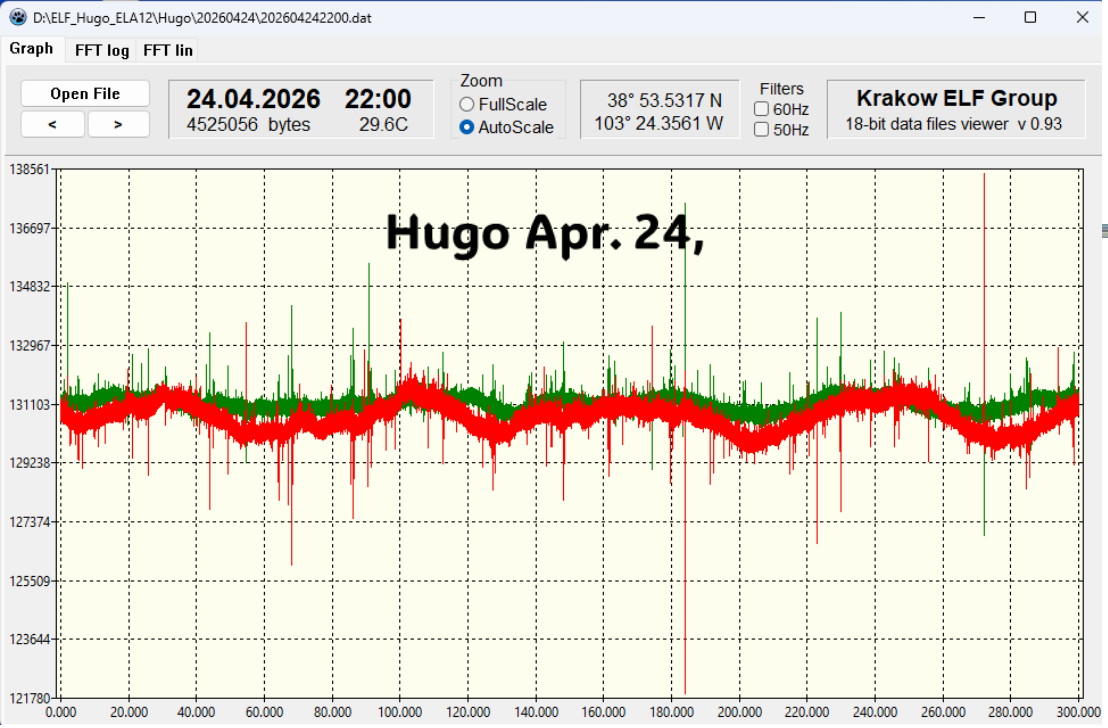

D:\ELF_Hugo_ELA12\Hylaty2425\20260425\
[-] Set Colour
350.0
2700
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
00:0-48:0-45
1.29 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]

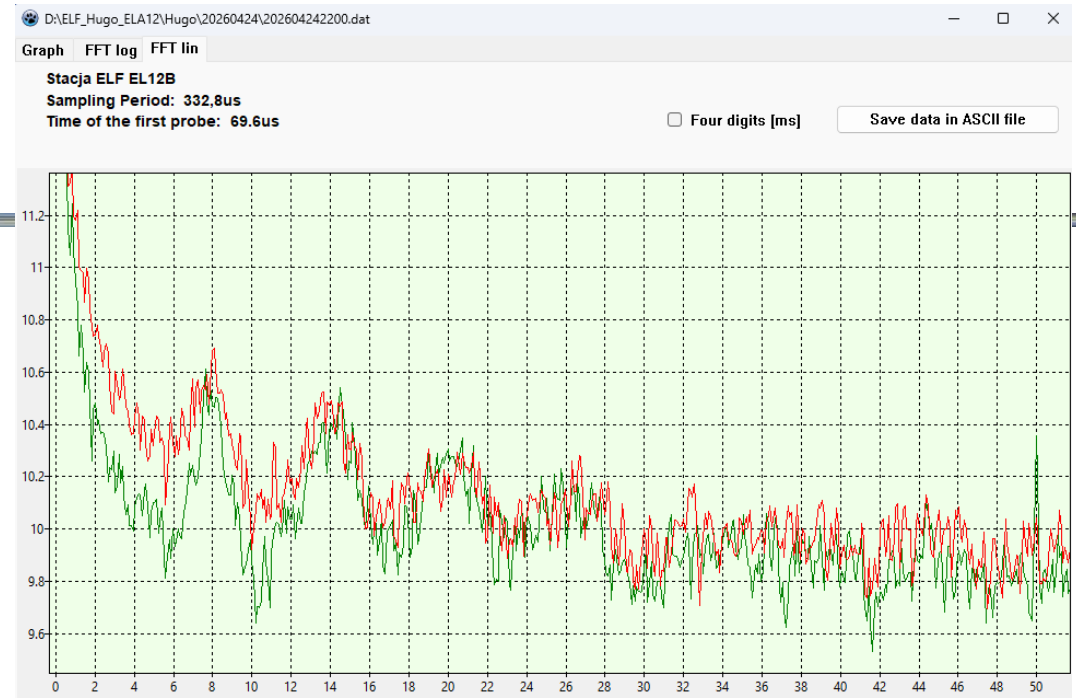

D:\ELF_Hugo_ELA12\Hylaty2425\20260425\
[-] Set Colour
350.0
2700
Antenna
NS
EW
Band
82Hz
165Hz
330Hz
660Hz
1320Hz
Black top scale
log10
Filter LP[10]
FIR HP 3Hz
Hann Window
288 files
00:51:15
19.46 Hz
Save to BMP File
0
2
4
6
8
10
12
14
16
18
20
22
24 UT
12.5
25
37.5
50
62.5
75
[Hz]

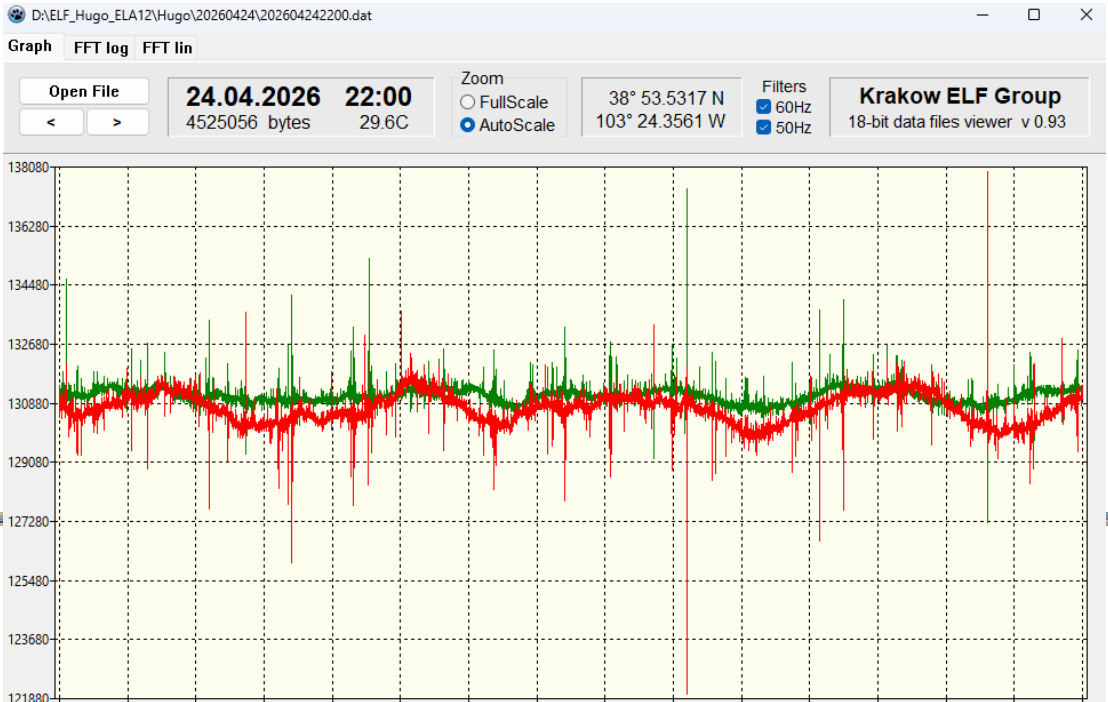
Hugo and Hylaty

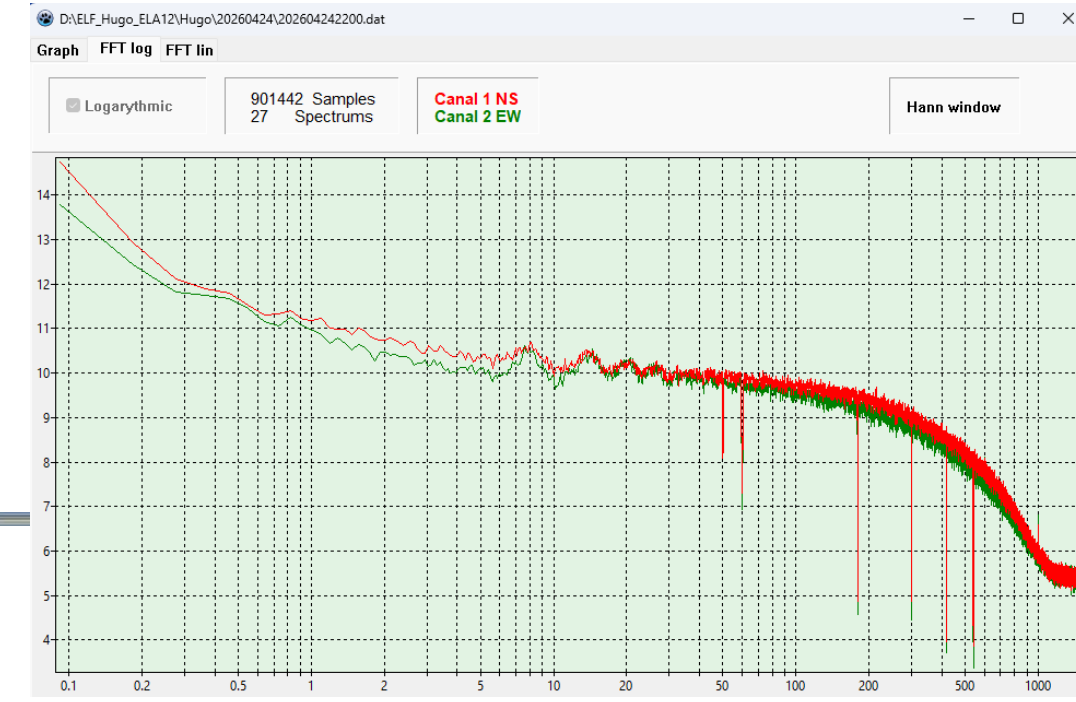
5 minute data and spectra

filtering 50 or 60 Hz

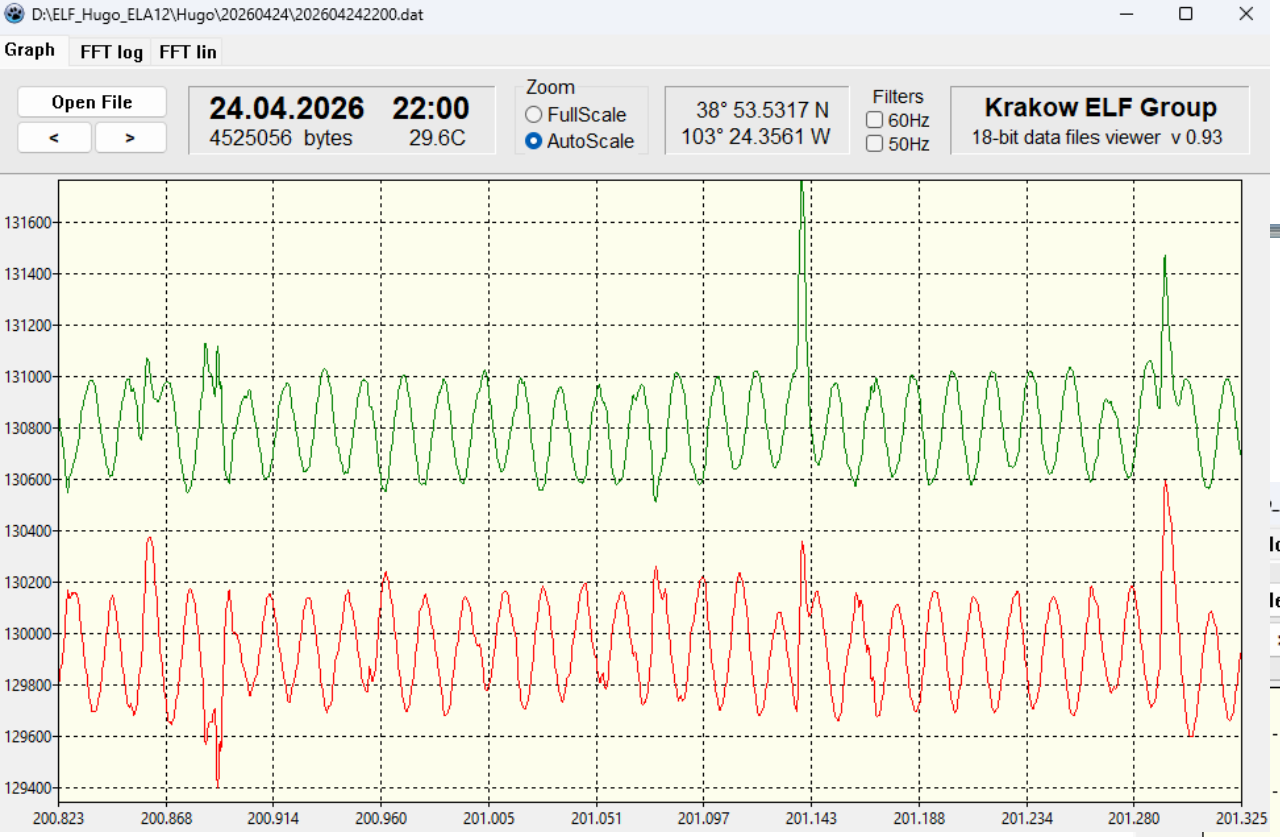

D:\ELF_Hugo_ELA12\Hugo\20260424\202604242200.dat
Graph
FFT log
FFT lin
Open File
<
>
24.04.2026 22:00
4525056 bytes 29.6C
Zoom
FullScale
AutoScale
38° 53.5317 N
103° 24.3561 W
Filters
60Hz
50Hz
Krakow ELF Group
18-bit data files viewer v 0.93
Hugo Apr. 24,
138561
136697
134832
132967
131103
129238
127374
125509
123644
121780
0.000
20.000
40.000
60.000
80.000
100.000
120.000
140.000
160.000
180.000
200.000
220.000
240.000
260.000
280.000
300.000

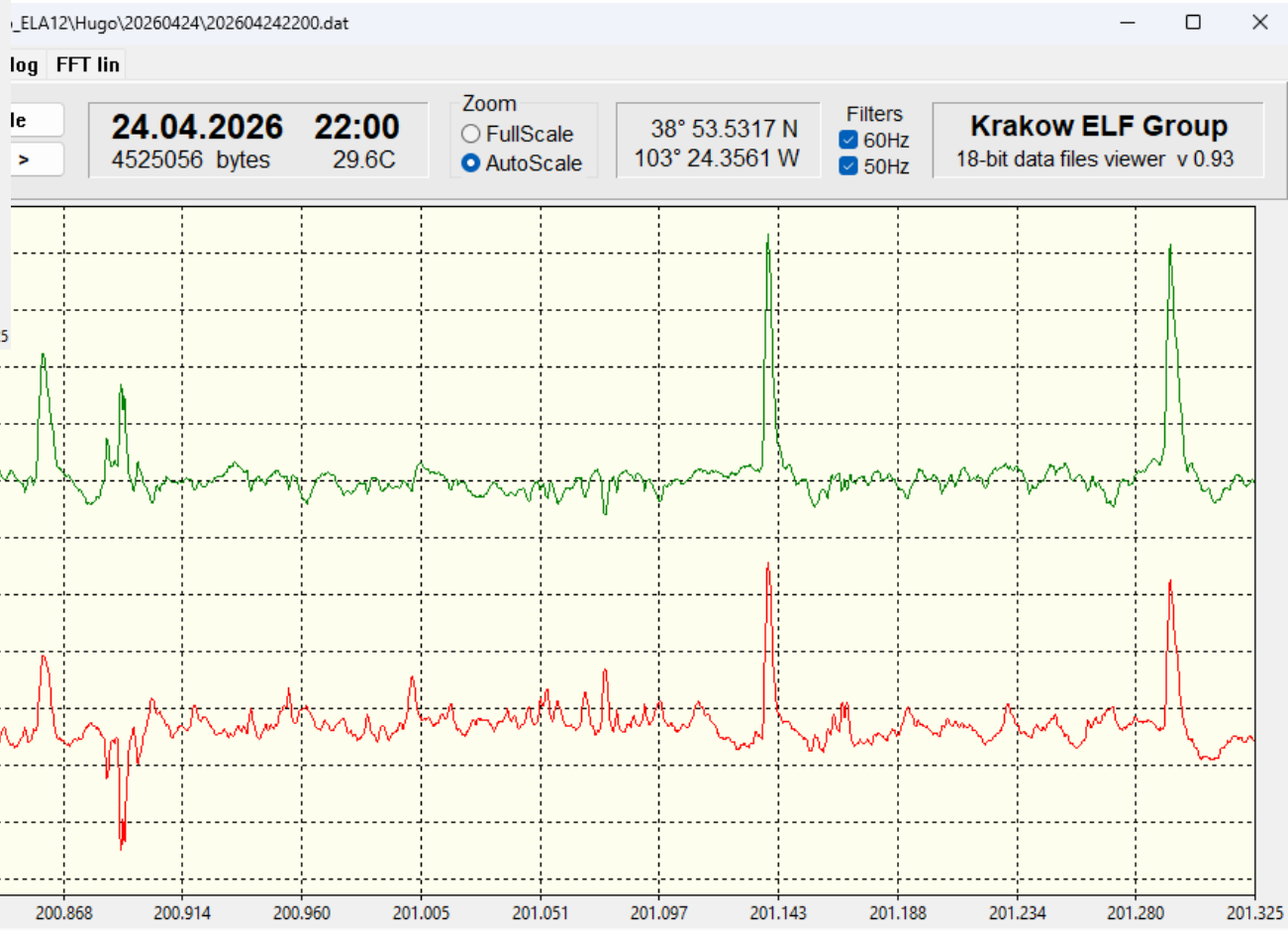

D:\ELF_Hugo_ELA12\Hugo\20260424\202604242200.dat
Graph
FFT log
FFT lin
Stacja ELF EL12B
Sampling Period: 332,8us
Time of the first probe: 69.6us
Four digits [ms]
Save data in ASCII file
11.2
11
10.8
10.6
10.4
10.2
10
9.8
9.6
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50


D:\ELF_Hugo_ELA12\Hugo\20260424\202604242200.dat
Graph
FFT log
FFT lin
Open File
<
>
24.04.2026 22:00
4525056 bytes 29.6C
Zoom
FullScale
AutoScale
38° 53.5317 N
103° 24.3561 W
Filters
60Hz
50Hz
Krakow ELF Group
18-bit data files viewer v 0.93
138080
136280
134480
132680
130880
129080
127280
125480
123680
121880


D:\ELF_Hugo_ELA12\Hugo\20260424\202604242200.dat
Graph
FFT log
FFT lin
Logarythmic
901442 Samples
27 Spectrums
Canal 1 NS
Canal 2 EW
Hann window
14
13
12
11
10
9
8
7
6
5
4
0.1
0.2
0.5
1
2
5
10
20
50
100
200
500
1000

Hugo Apr. 24,





University of Colorado Denver

D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604242200.dat

Graph | FFT log | FFT lin

Open File | < | >

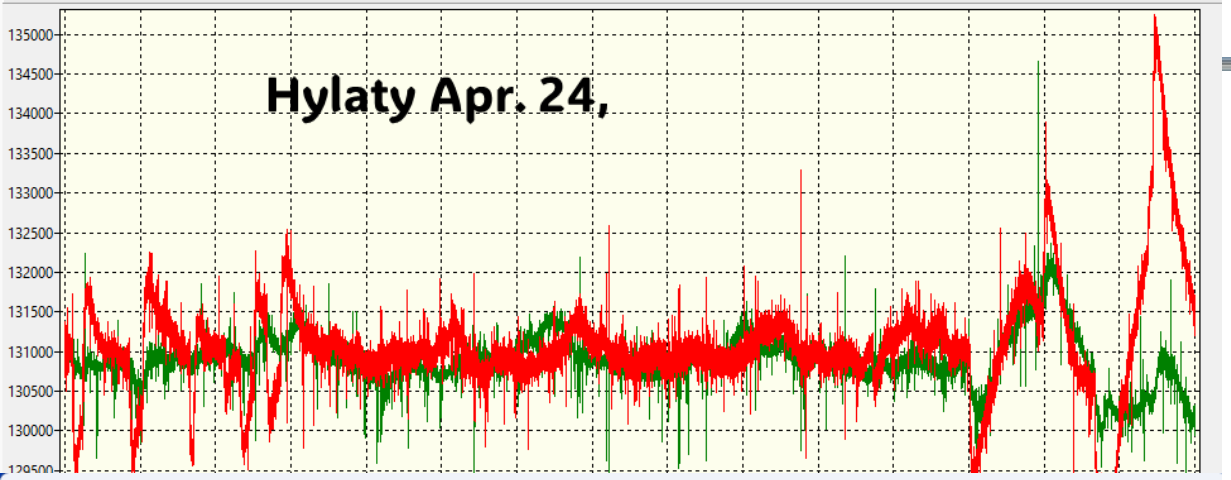
24.04.2026 22:00
4525056 bytes 09.3C

Zoom: FullScale / AutoScale

49° 11.6226 N
22° 33.2971 E

IIR 50Hz

Krakow ELF Group
18-bit data files viewer ver 0.93



D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604242200.dat

Graph | FFT log | FFT lin

Open File | < | >

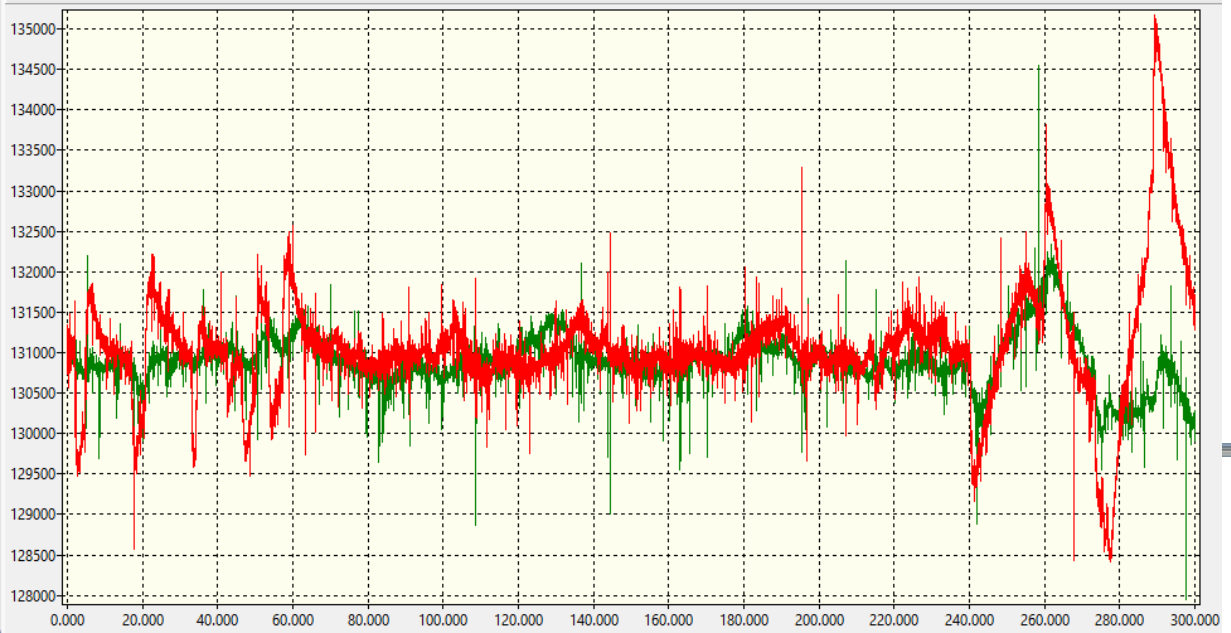
24.04.2026 22:00
4525056 bytes 09.3C

Zoom: FullScale / AutoScale

49° 11.6226 N
22° 33.2971 E

IIR 50Hz

Krakow ELF Group
18-bit data files viewer ver 0.93



D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604242200.dat

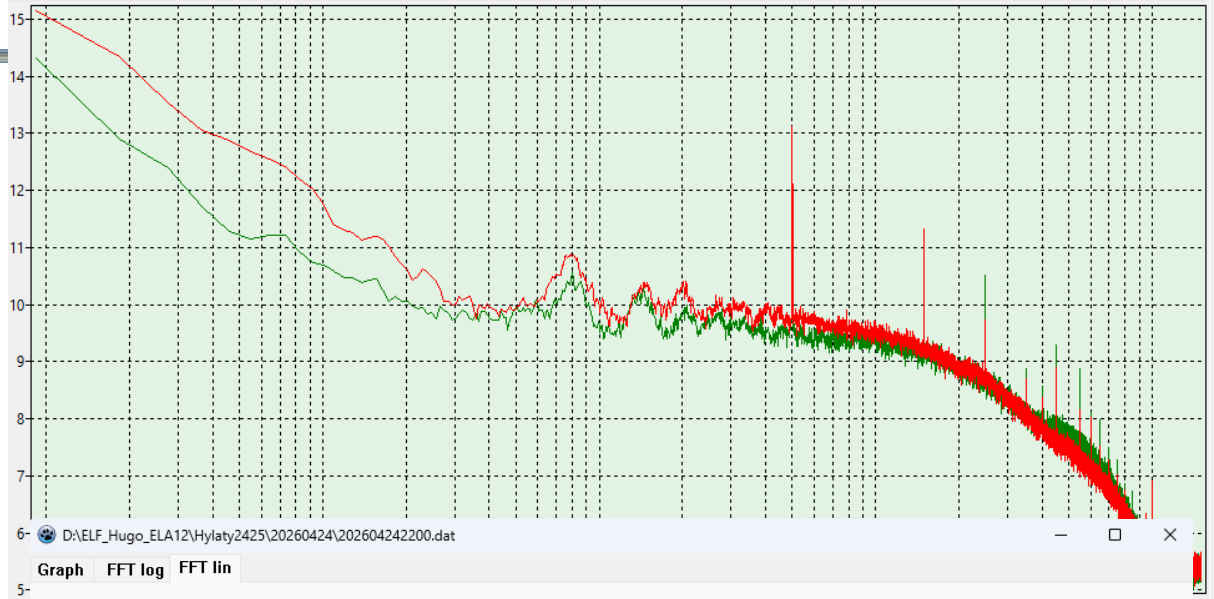
Graph | FFT log | FFT lin

Logarithmic

901442 Samples
27 Spectrums

Canal 1 NS
Canal 2 EW

Hann window



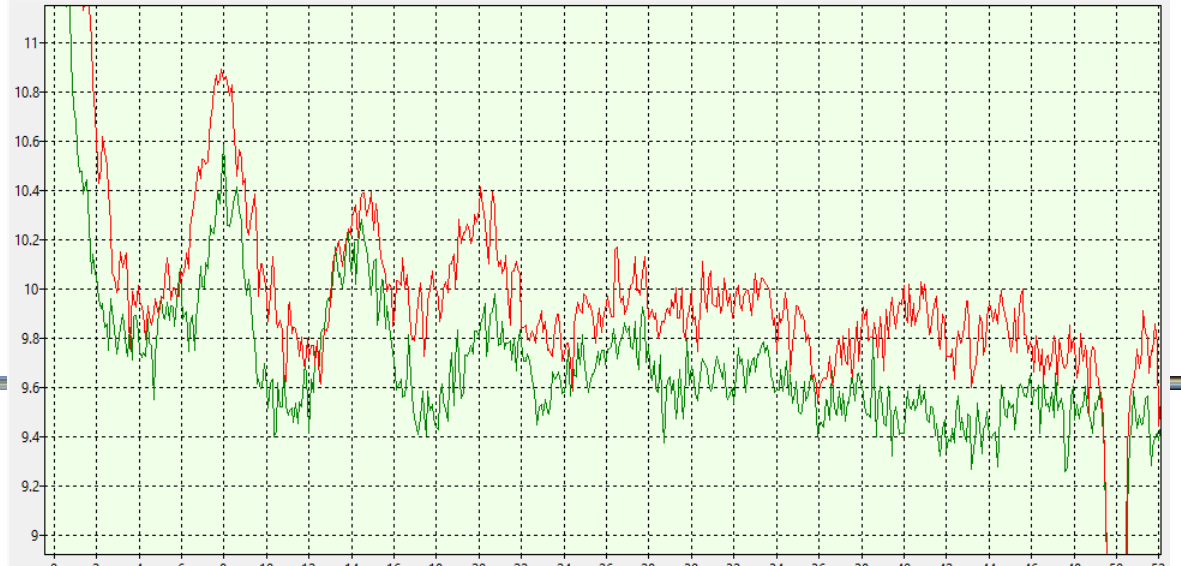
D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604242200.dat

Graph | FFT log | FFT lin

Stacja ELF EL12A
Sampling Period: 332.8us
Time of the first probe: 95.2us

Four digits [ms]

Save data in ASCII file



Hylaty Apr. 24,

D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604242200.dat

Graph | FFT log | FFT lin

Open File | < | >

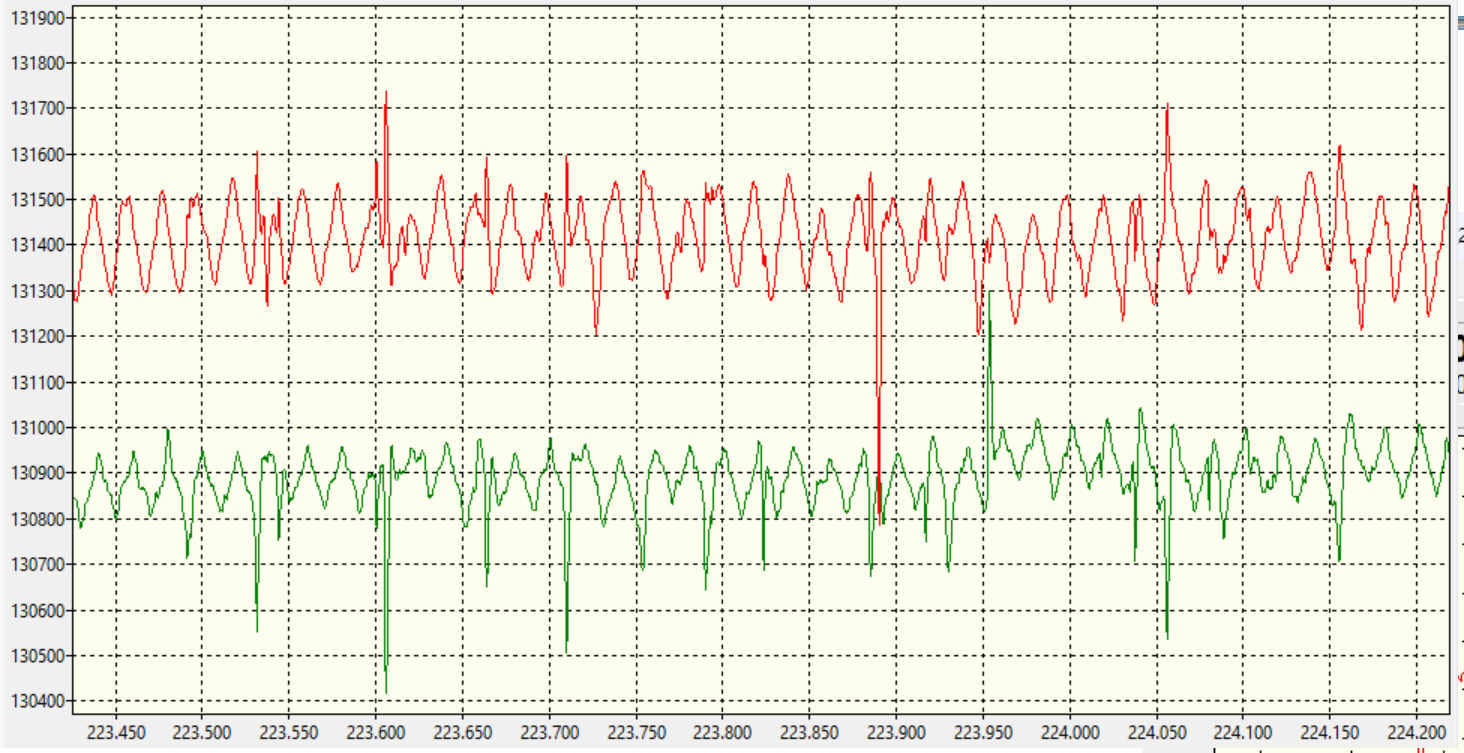
24.04.2026 22:00
4525056 bytes 09.3C

Zoom
FullScale
AutoScale

49° 11.6226 N
22° 33.2971 E

IIR
50Hz

Krakow ELF Group
18-bit data files viewer ver 0.93



20260424\202604242200.dat

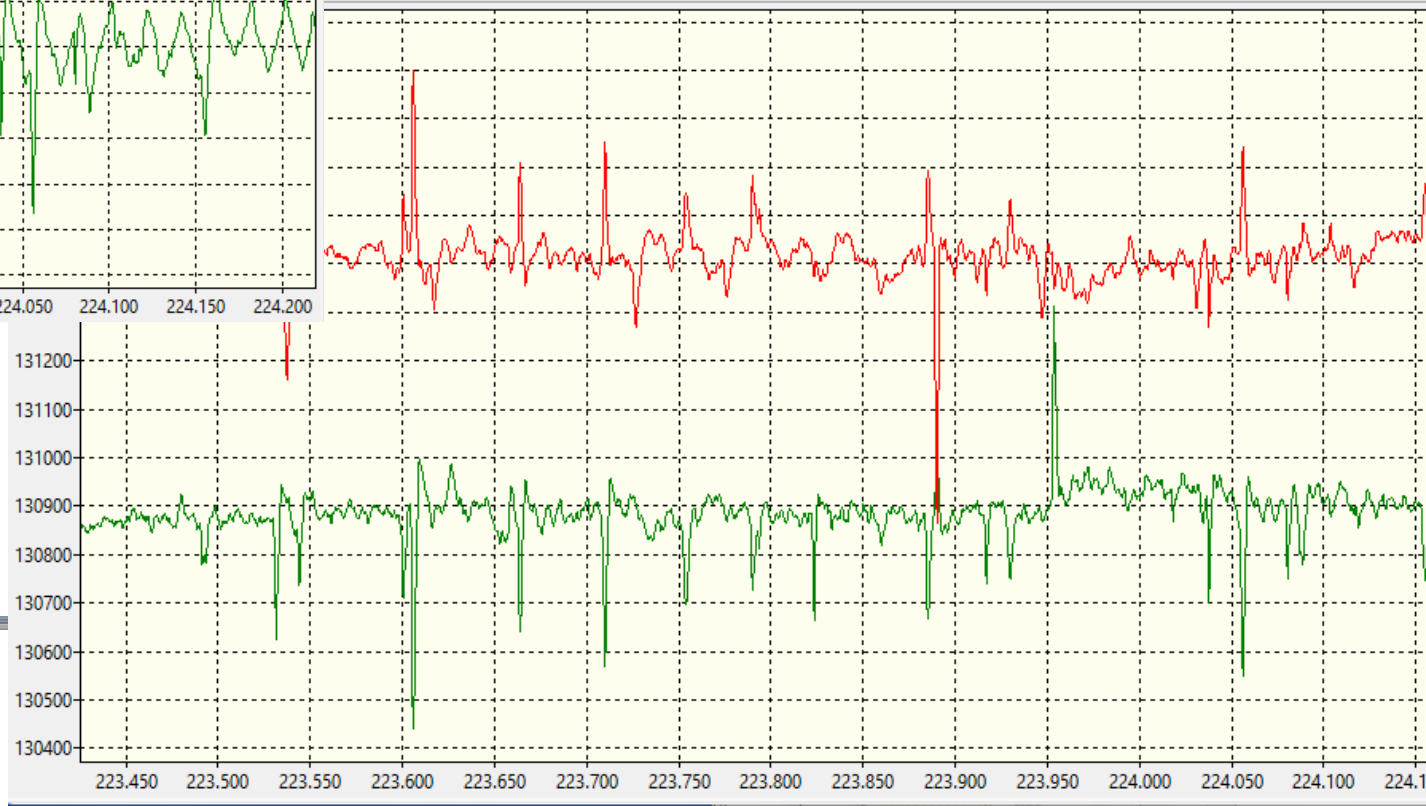
04.2026 22:00
056 bytes 09.3C

Zoom
FullScale
AutoScale

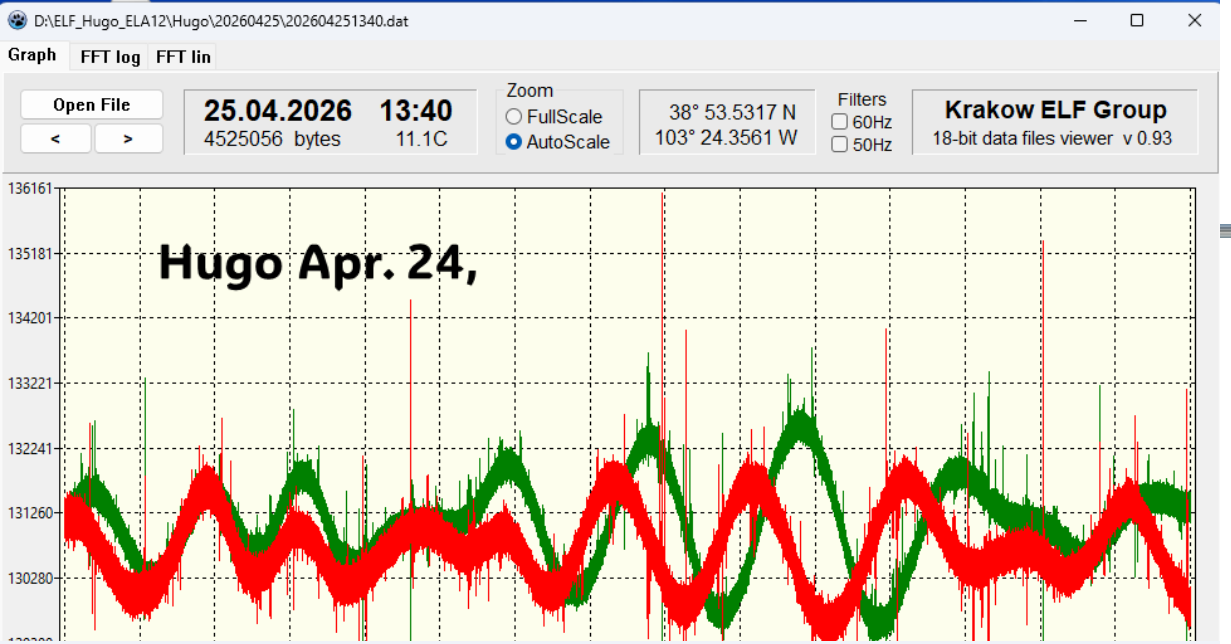
49° 11.6226 N
22° 33.2971 E

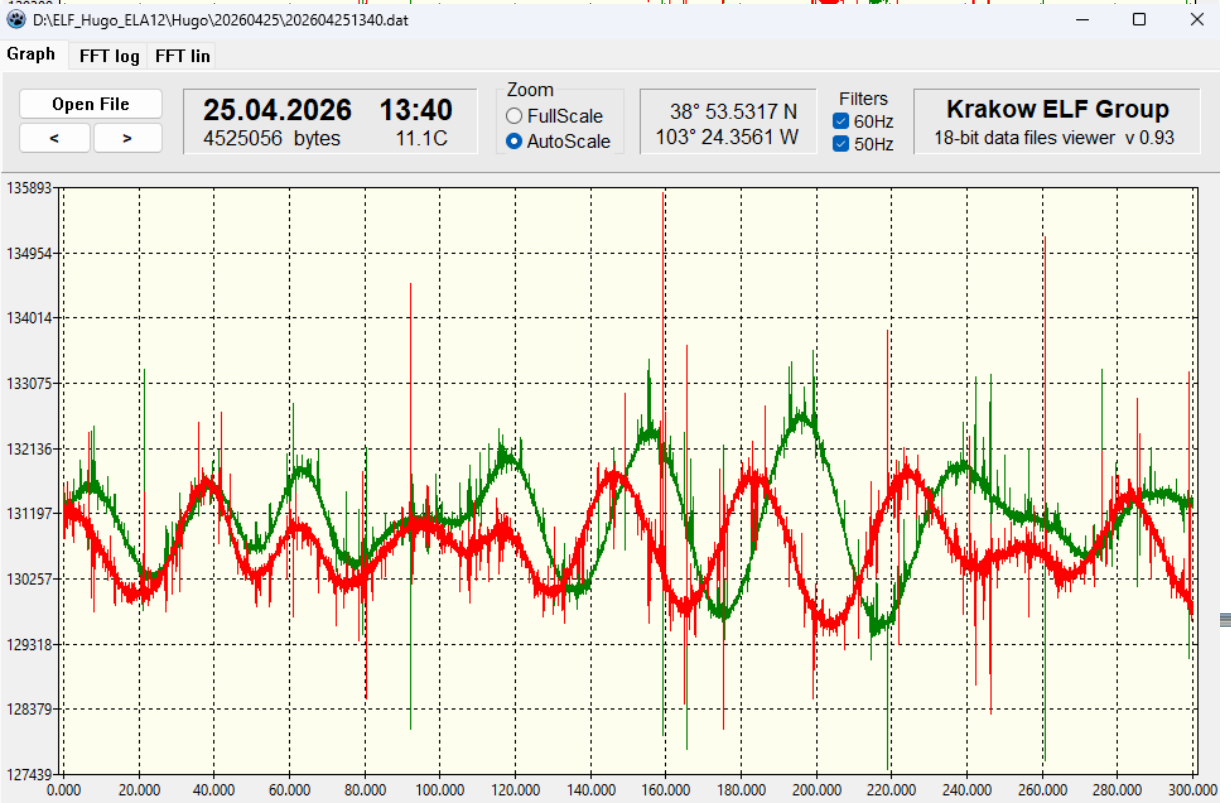
IIR
50Hz

Krakow ELF Gro
18-bit data files viewer ve



University of Colorado Denver


D:\ELF_Hugo_ELA12\Hugo\20260425\202604251340.dat
Graph
FFT log
FFT lin
Open File
<
>
25.04.2026 13:40
4525056 bytes 11.1C
Zoom
FullScale
AutoScale
38° 53.5317 N
103° 24.3561 W
Filters
60Hz
50Hz
Krakow ELF Group
18-bit data files viewer v 0.93
Hugo Apr. 24,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Graph
FFT log
FFT lin
Open File
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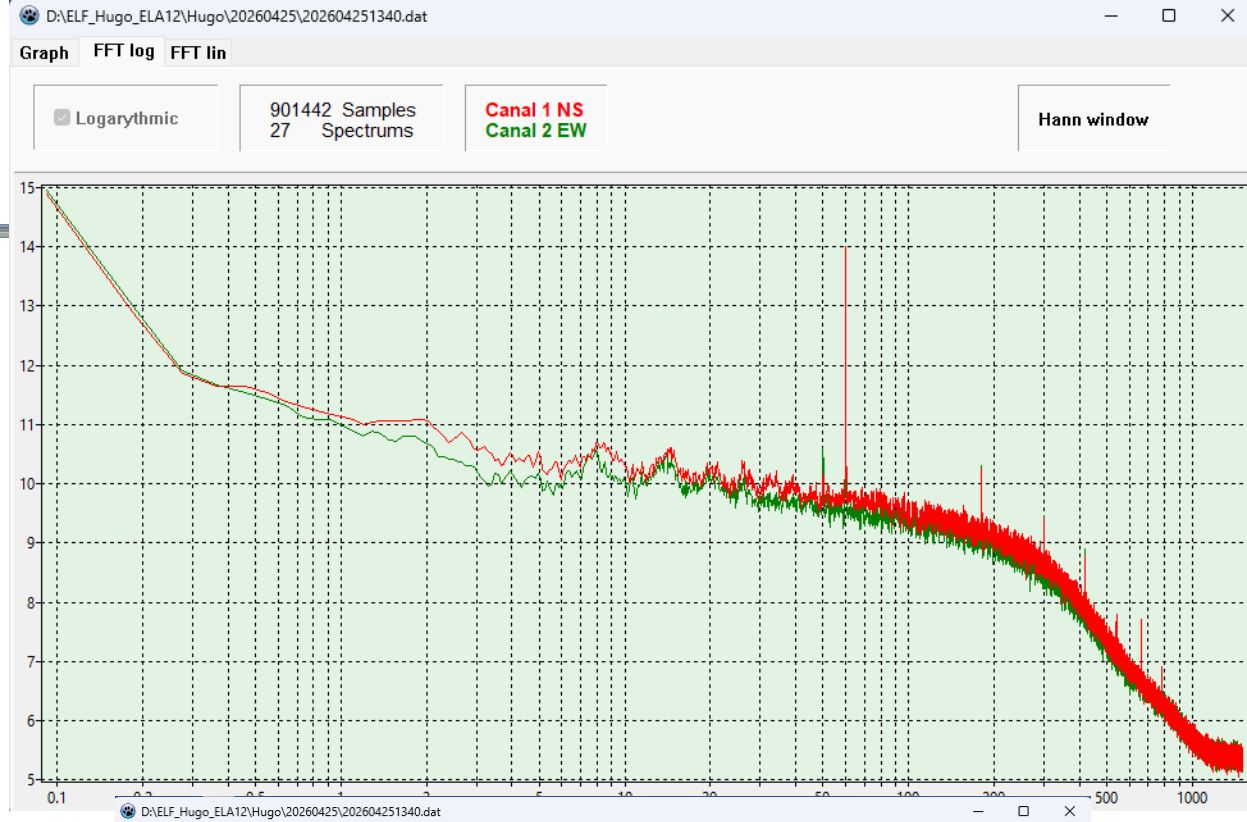
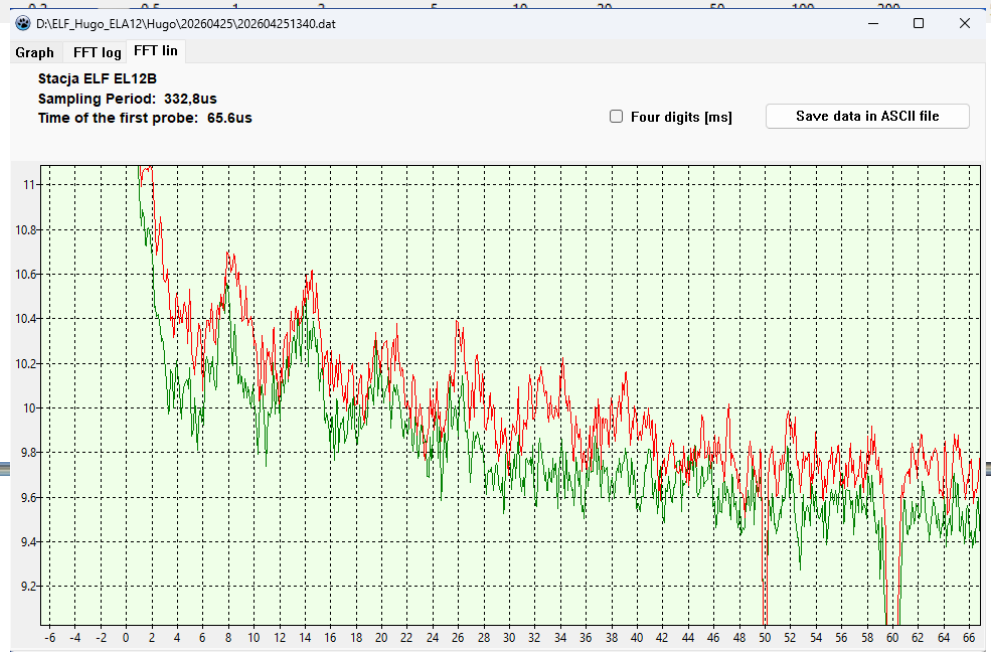
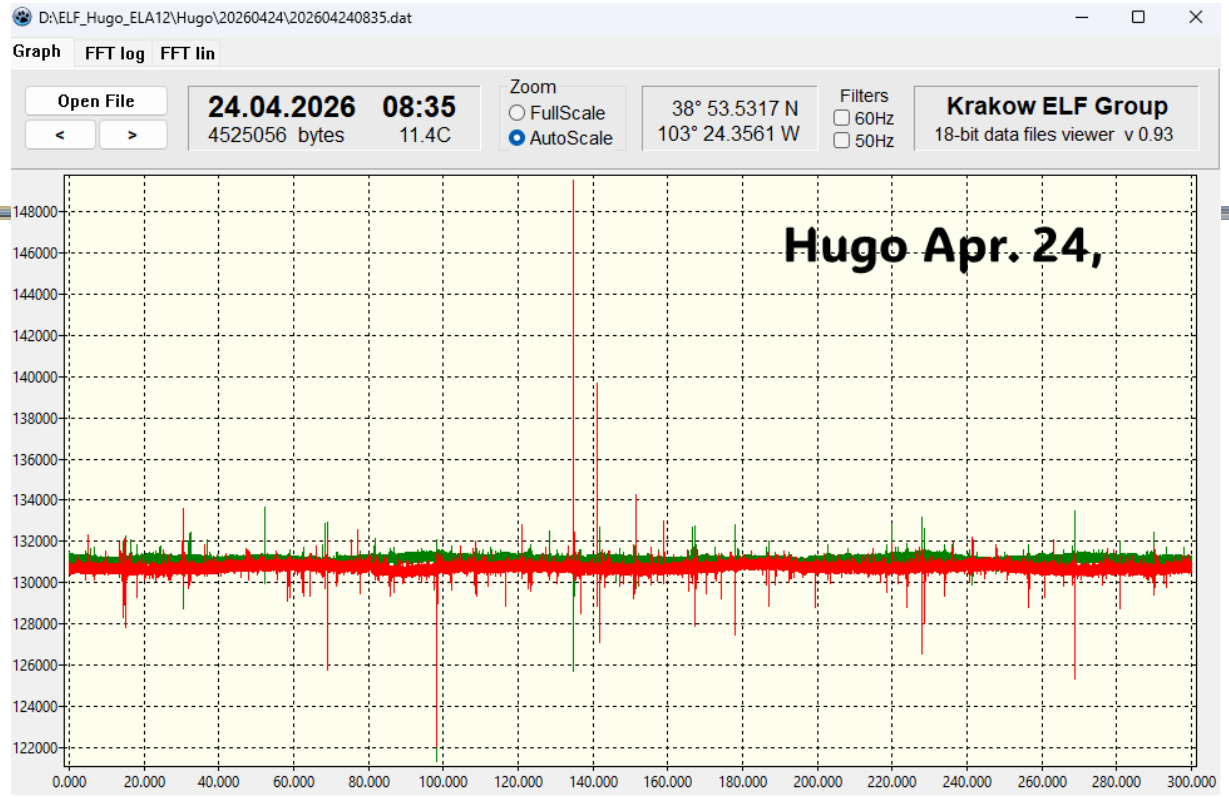
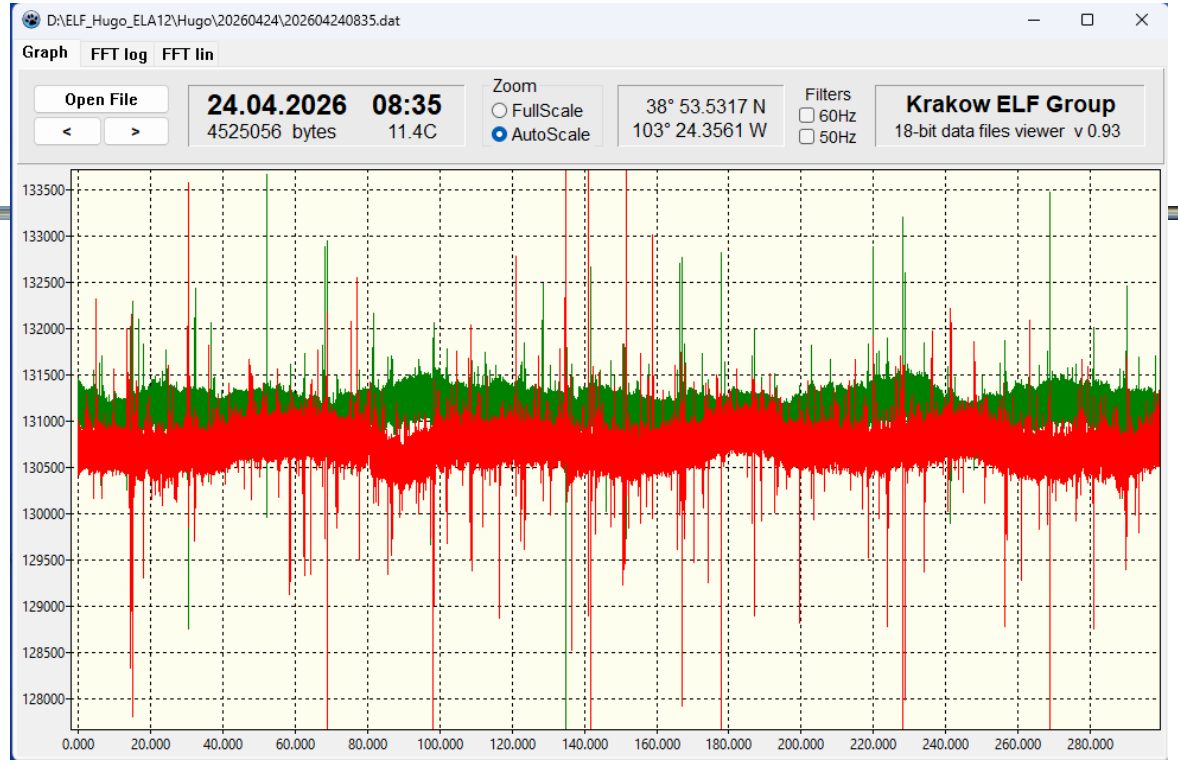
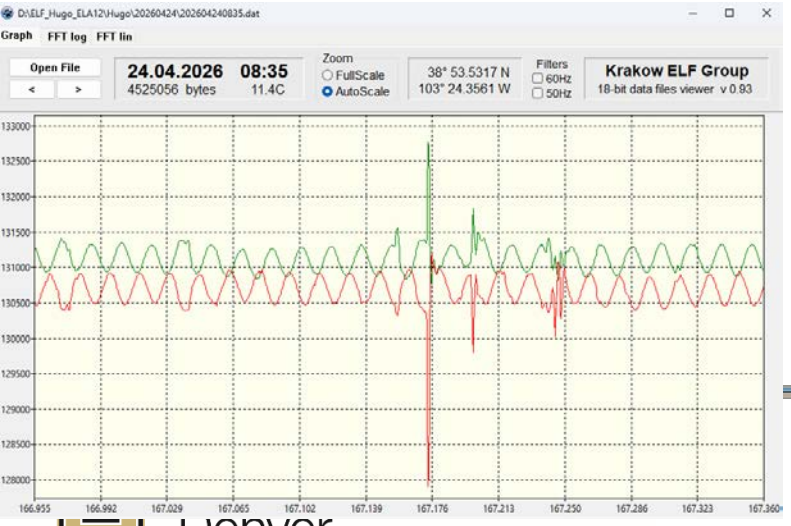
25.04.2026 13:40
4525056 bytes 11.1C
Zoom
FullScale
AutoScale
38° 53.5317 N
103° 24.3561 W
Filters
60Hz
50Hz
Krakow ELF Group
18-bit data files viewer v 0.93

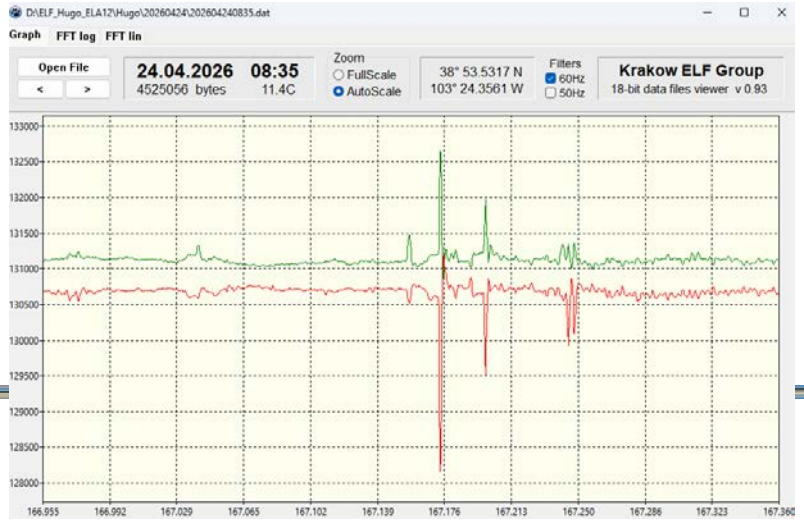

D:\ELF_Hugo_ELA12\Hugo\20260425\202604251340.dat
Graph
FFT log
FFT lin
Logarythmic
901442 Samples
27 Spectrums
Canal 1 NS
Canal 2 EW
Hann window


D:\ELF_Hugo_ELA12\Hugo\20260425\202604251340.dat
Graph
FFT log
FFT lin
Stacja ELF EL12B
Sampling Period: 332,8us
Time of the first probe: 65.6us
Four digits [ms]
Save data in ASCII file


D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat
Graph
FFT log
FFT lin
Open File
24.04.2026 08:35
4525056 bytes 11.4C
Zoom
FullScale
AutoScale
38° 53.5317 N
103° 24.3561 W
Filters
60Hz
50Hz
Krakow ELF Group
18-bit data files viewer v 0.93
Hugo Apr. 24,


D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat
Graph
FFT log
FFT lin
Open File
24.04.2026 08:35
4525056 bytes 11.4C
Zoom
FullScale
AutoScale
38° 53.5317 N
103° 24.3561 W
Filters
60Hz
50Hz
Krakow ELF Group
18-bit data files viewer v 0.93





Denver

D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat

Graph | FFT log | FFT lin

Open File | < | >

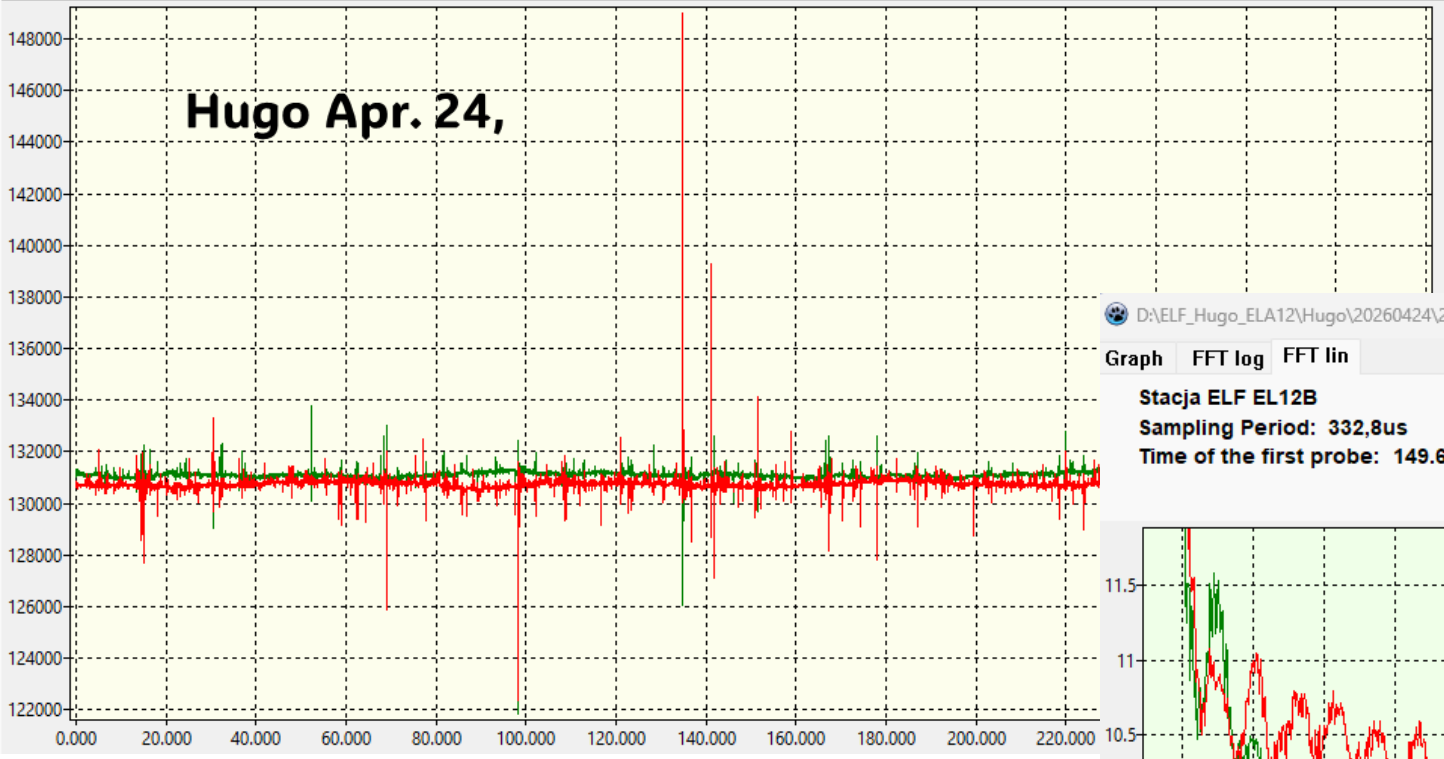
24.04.2026 08:35
4525056 bytes 11.4C

Zoom
FullScale
AutoScale

38° 53.5317 N
103° 24.3561 W

Filters
60Hz
50Hz

Krakow ELF Group
18-bit data files viewer v 0.93



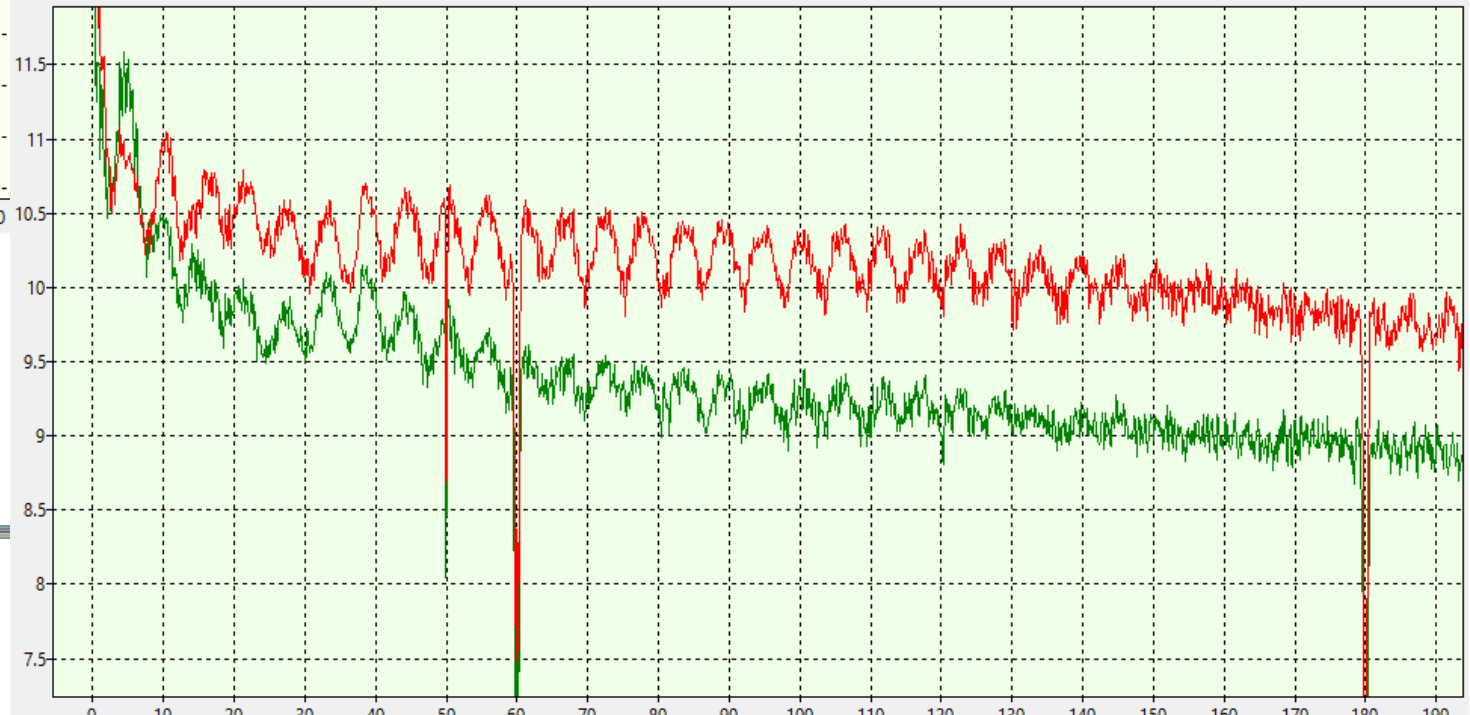
D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat

Graph | FFT log | FFT lin

Stacja ELF EL12B
Sampling Period: 332,8us
Time of the first probe: 149.6us

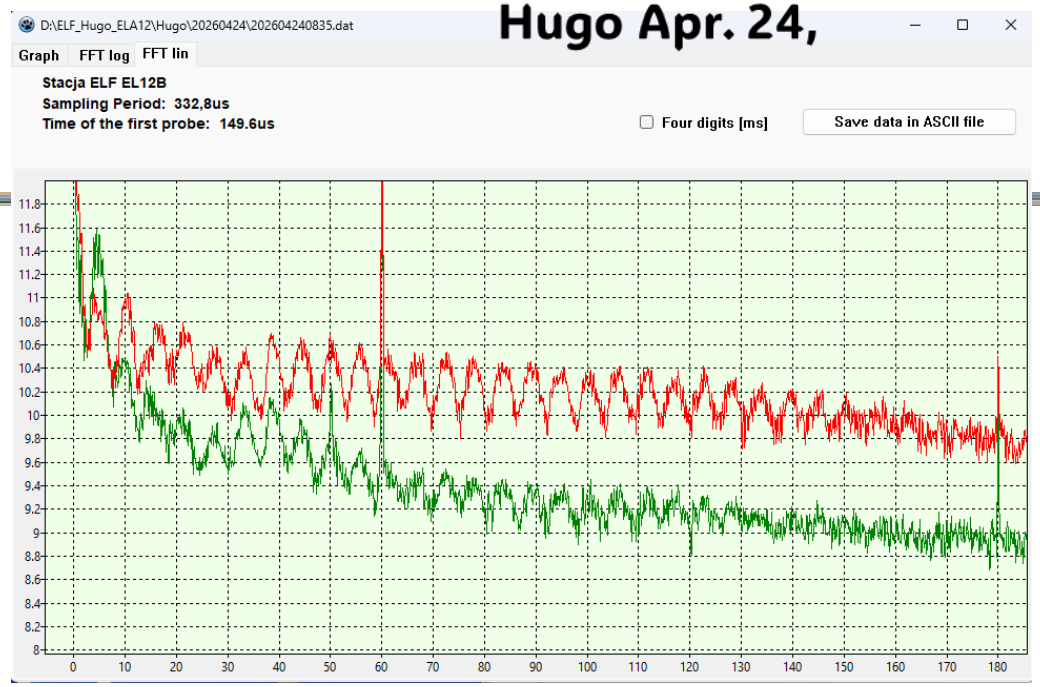
Four digits [ms]

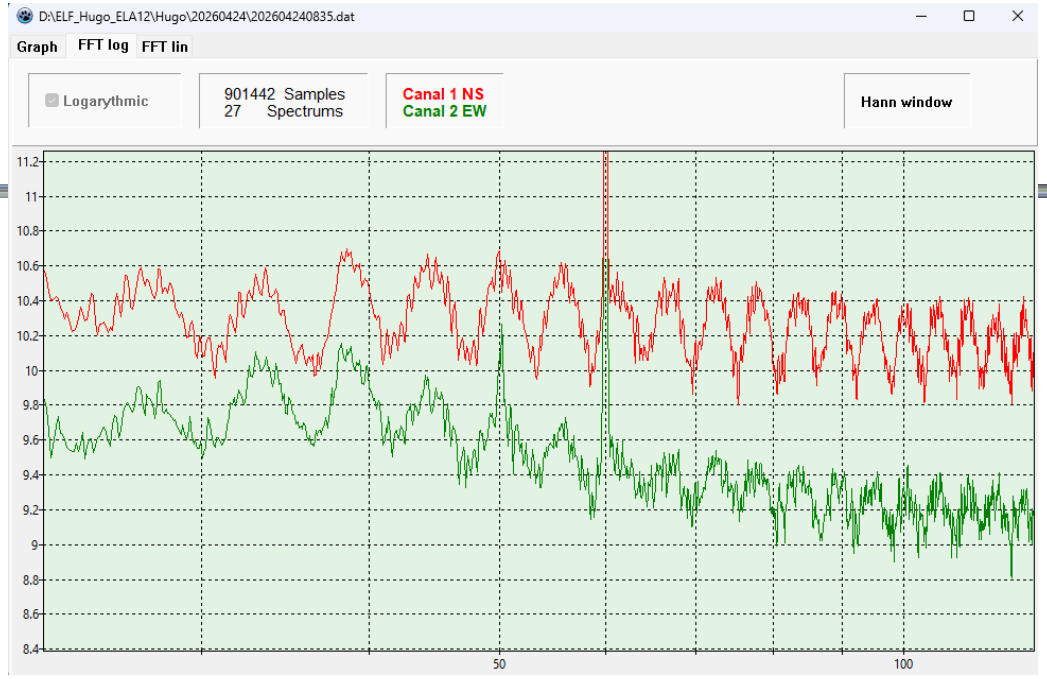
Save data in ASCII file

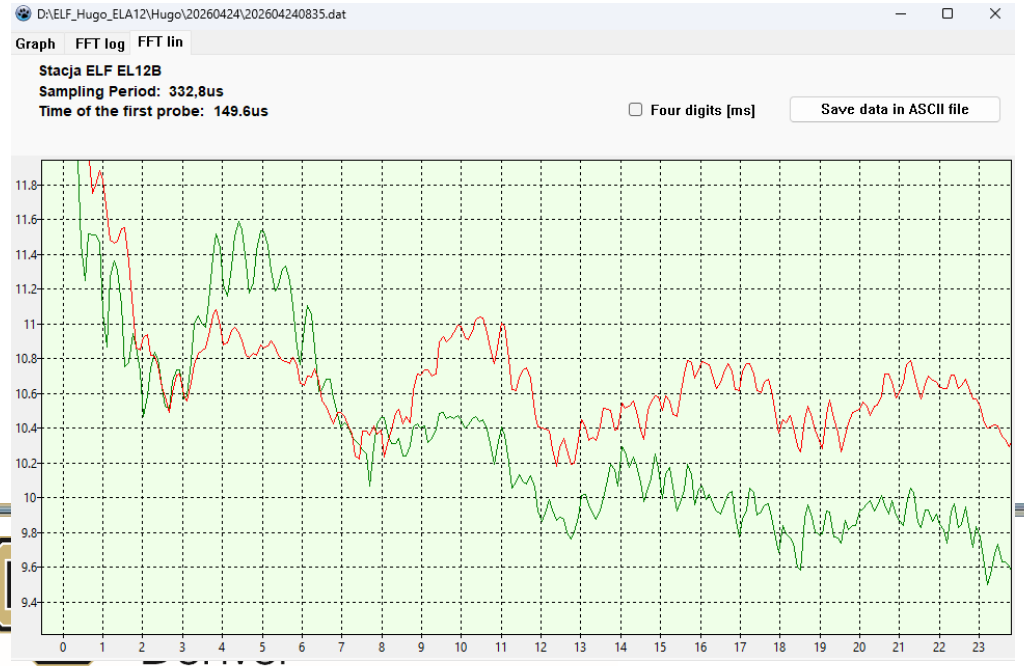


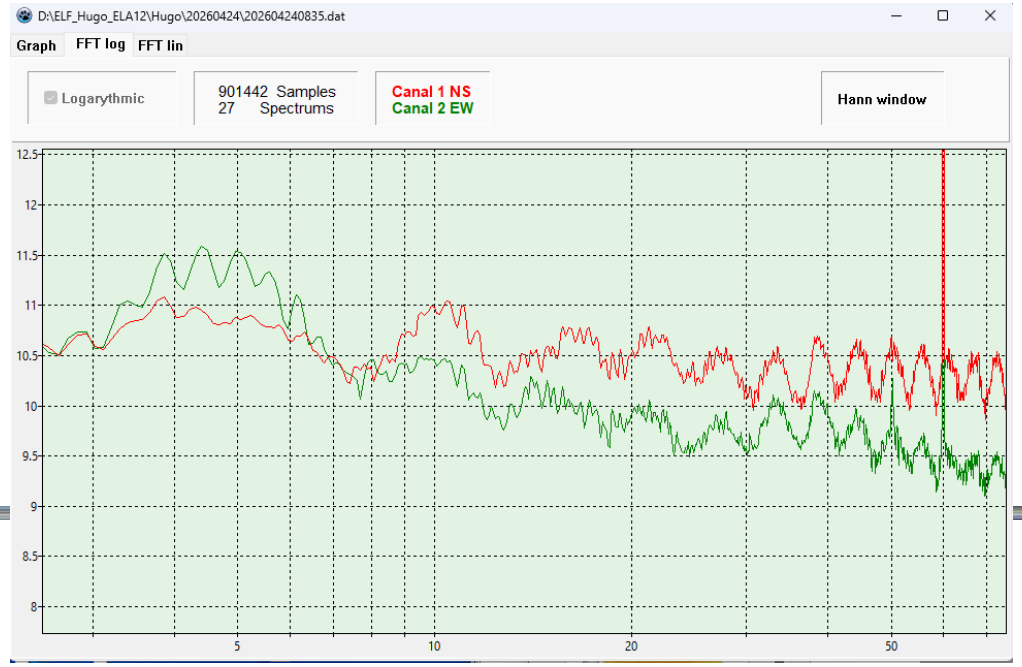
University of Colorado Denver

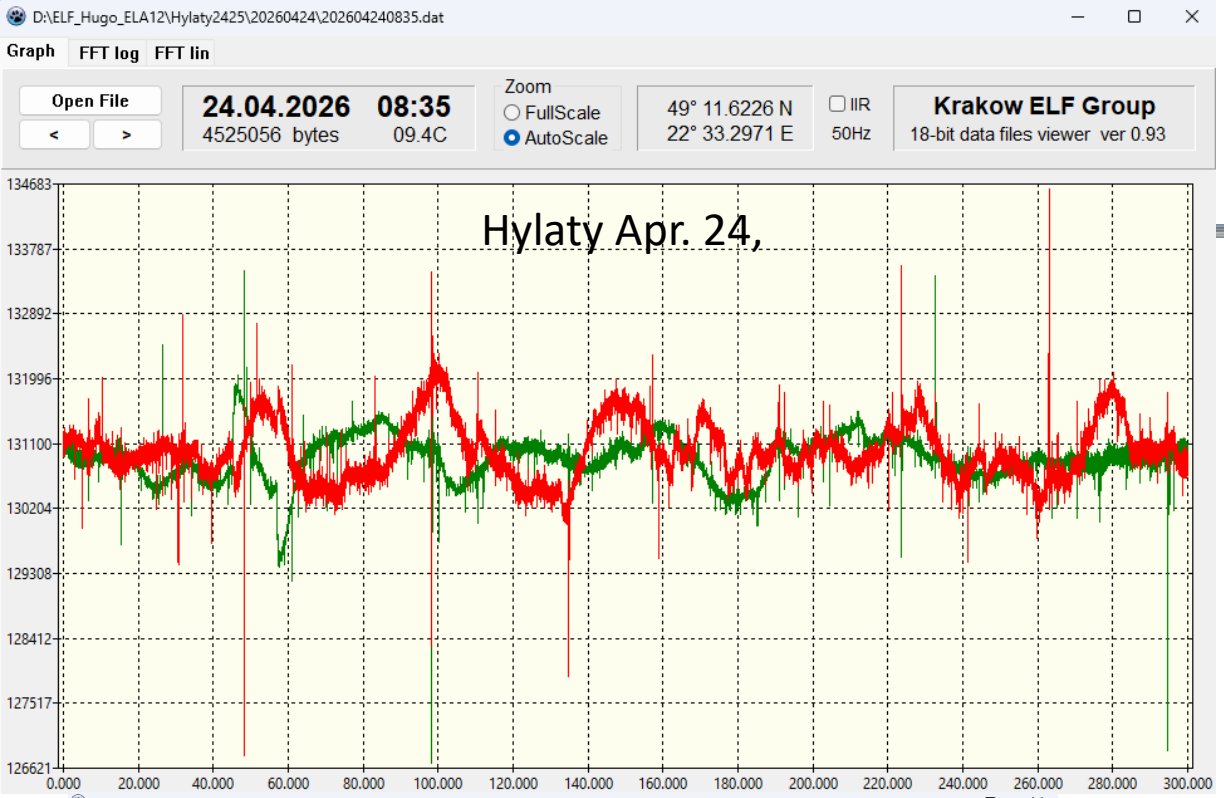
Hugo Apr. 24,


D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat
Graph
FFT log
FFT lin
Stacja ELF EL12B
Sampling Period: 332,8us
Time of the first probe: 149.6us
Four digits [ms]
Save data in ASCII file


D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat
Graph
FFT log
FFT lin
Logarythmic
901442 Samples
27 Spectrums
Canal 1 NS
Canal 2 EW
Hann window


D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat
Graph
FFT log
FFT lin
Stacja ELF EL12B
Sampling Period: 332,8us
Time of the first probe: 149.6us
Four digits [ms]
Save data in ASCII file


D:\ELF_Hugo_ELA12\Hugo\20260424\202604240835.dat
Graph
FFT log
FFT lin
Logarythmic
901442 Samples
27 Spectrums
Canal 1 NS
Canal 2 EW
Hann window


D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604240835.dat
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FFT lin
Open File
24.04.2026 08:35
4525056 bytes 09.4C
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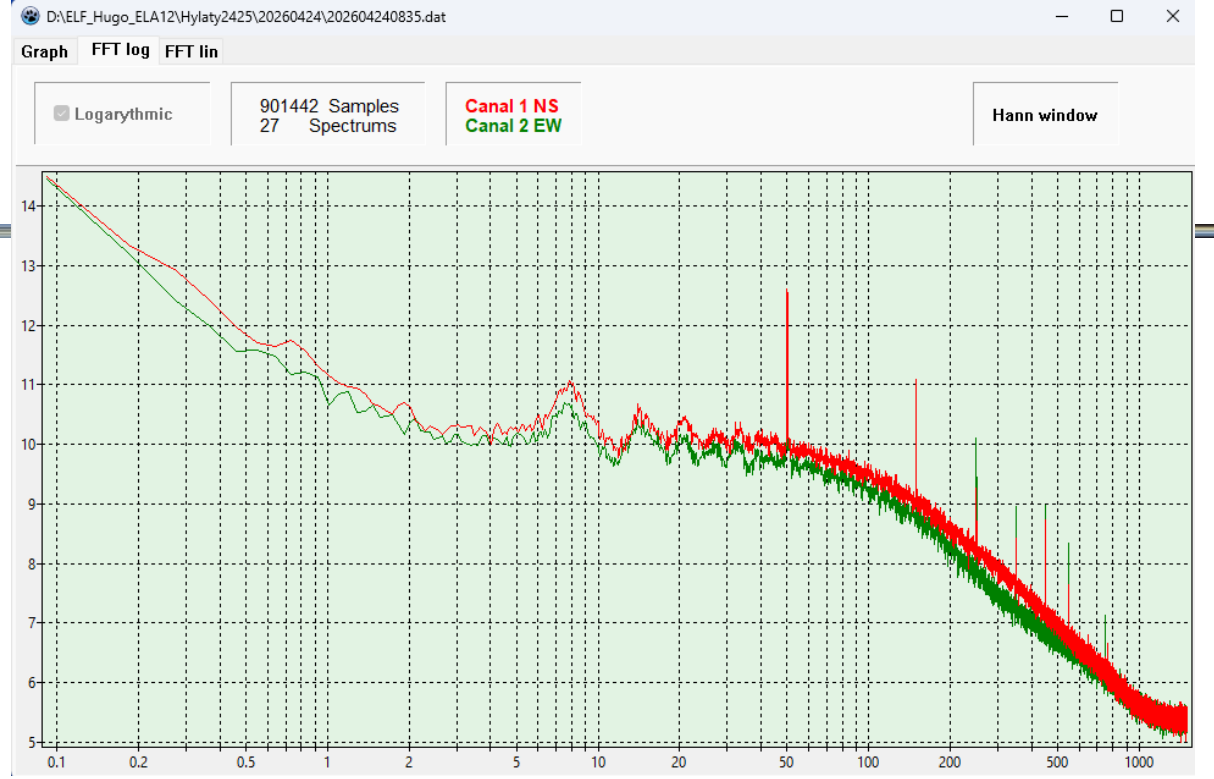
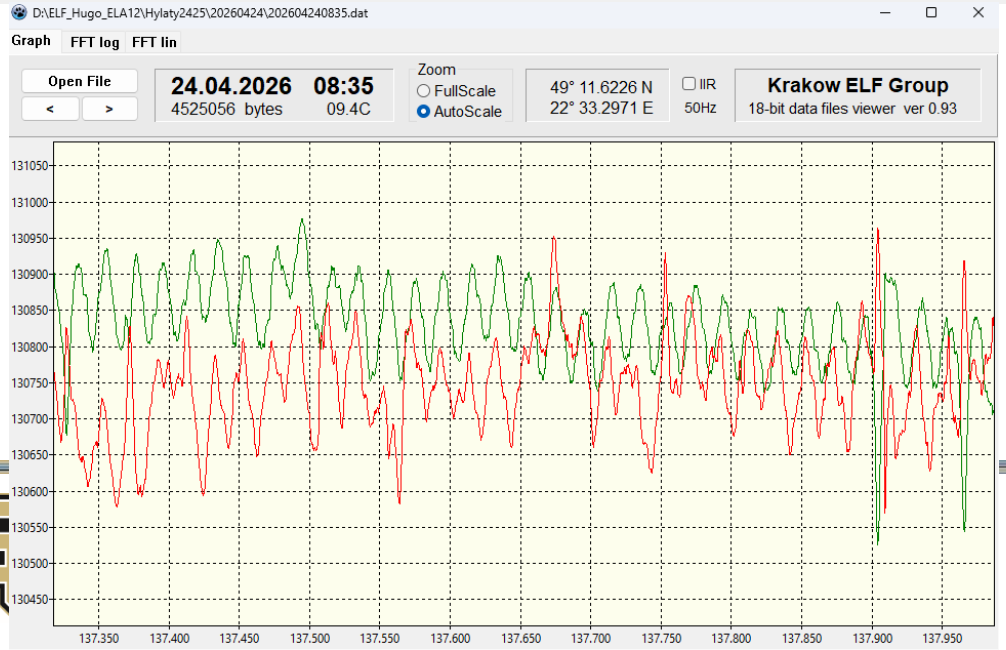
AutoScale
49° 11.6226 N
22° 33.2971 E
IIR
50Hz
Krakow ELF Group
18-bit data files viewer ver 0.93
Hylaty Apr. 24,


D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604240835.dat
Graph
FFT log
FFT lin
Logarythmic
901442 Samples
27 Spectrums
Canal 1 NS
Canal 2 EW
Hann window


D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604240835.dat
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Open File
24.04.2026 08:35
4525056 bytes 09.4C
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49° 11.6226 N
22° 33.2971 E
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50Hz
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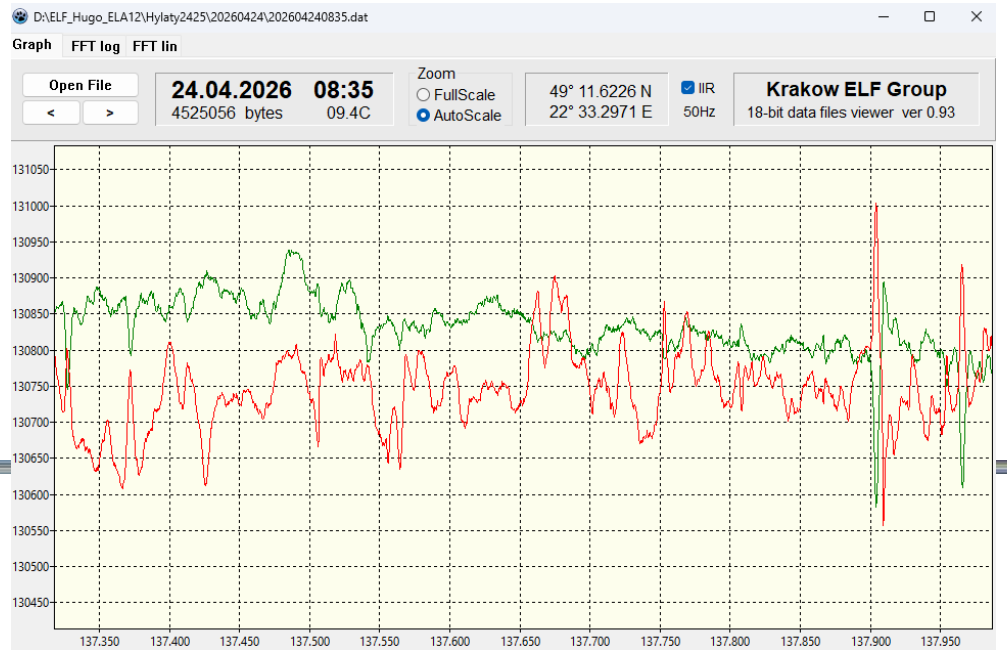
18-bit data files viewer ver 0.93


D:\ELF_Hugo_ELA12\Hylaty2425\20260424\202604240835.dat
Graph
FFT log
FFT lin
Open File
24.04.2026 08:35
4525056 bytes 09.4C
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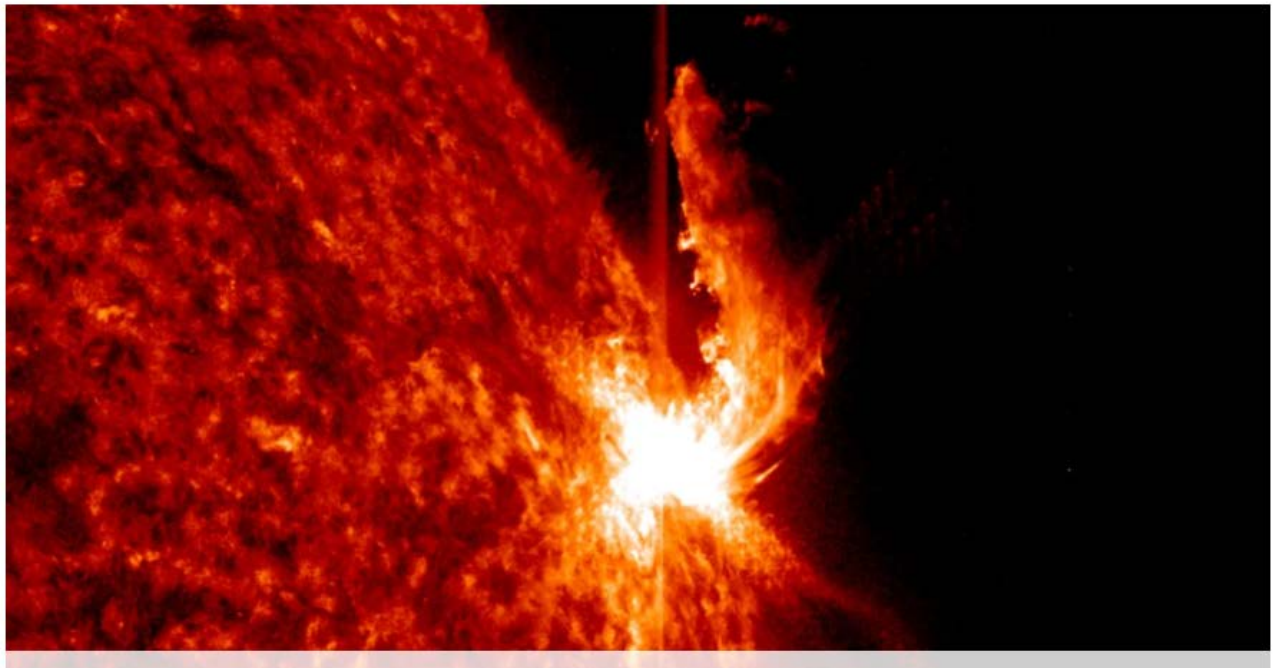
AutoScale
49° 11.6226 N
22° 33.2971 E
IIR
50Hz
Krakow ELF Group
18-bit data files viewer ver 0.93

X2.5

An **X2.5 solar flare** erupted from Active Region 4419 at 08:13 UTC on April 24, 2026, marking the second X-class event within hours after an earlier X2.4 flare at 01:07 UTC. The event started at 08:01 UTC and ended at 08:18 UTC. A large coronal mass ejection (CME) was produced.

An X2.5 solar flare erupted from Active Region 4419 at 08:13 UTC on April 24, 2026, marking the second X-class event within hours after an earlier X2.4 flare at 01:07 UTC. The event started at 08:01 UTC and ended at 08:18 UTC. A large coronal mass ejection (CME) was produced.



X-ray Solar Flares
6-hr max: **M6** 1815 UT Apr24
24-hr: **X2** 0814 UT Apr24