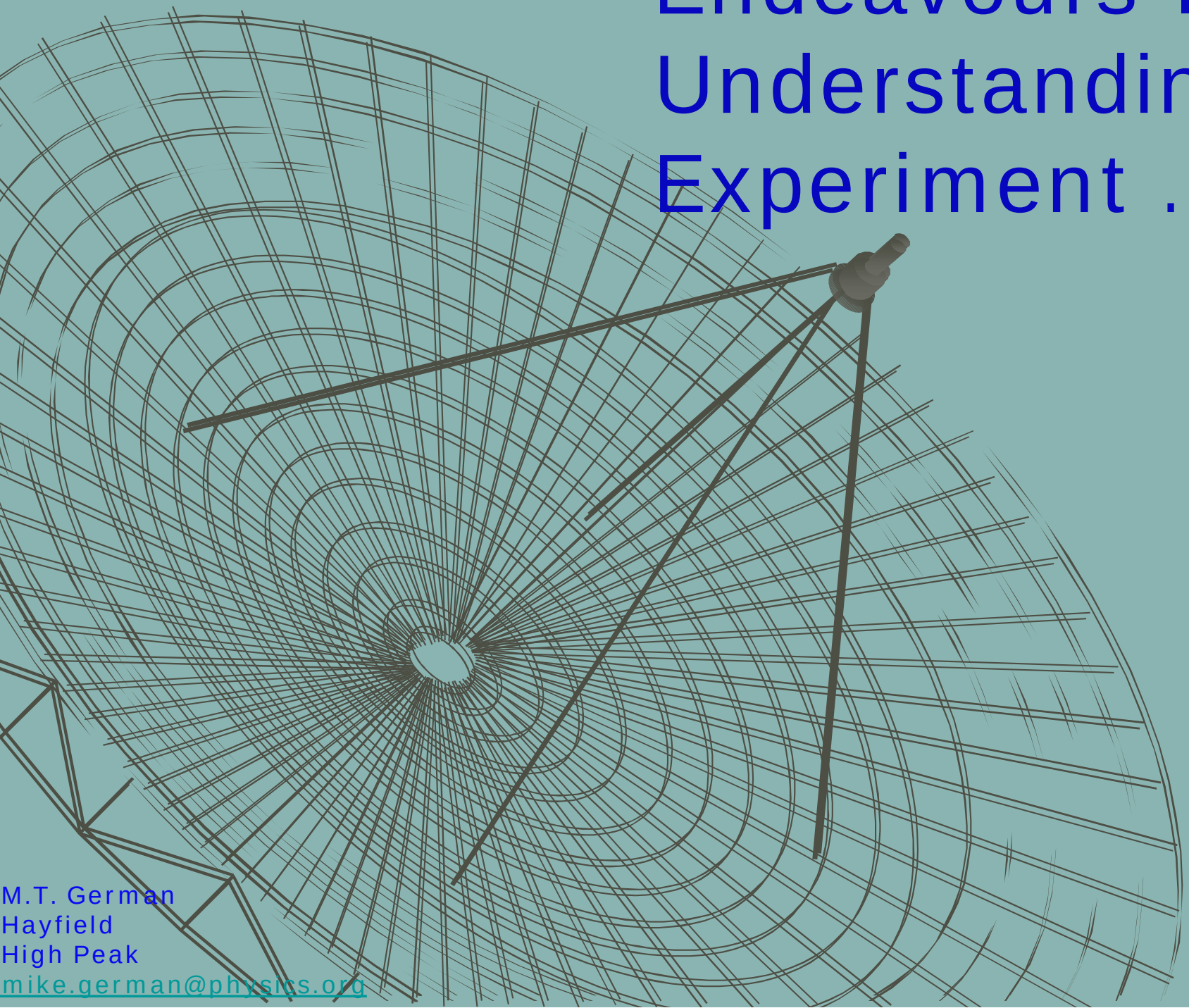
Endeavours In Understanding The Experiment .....



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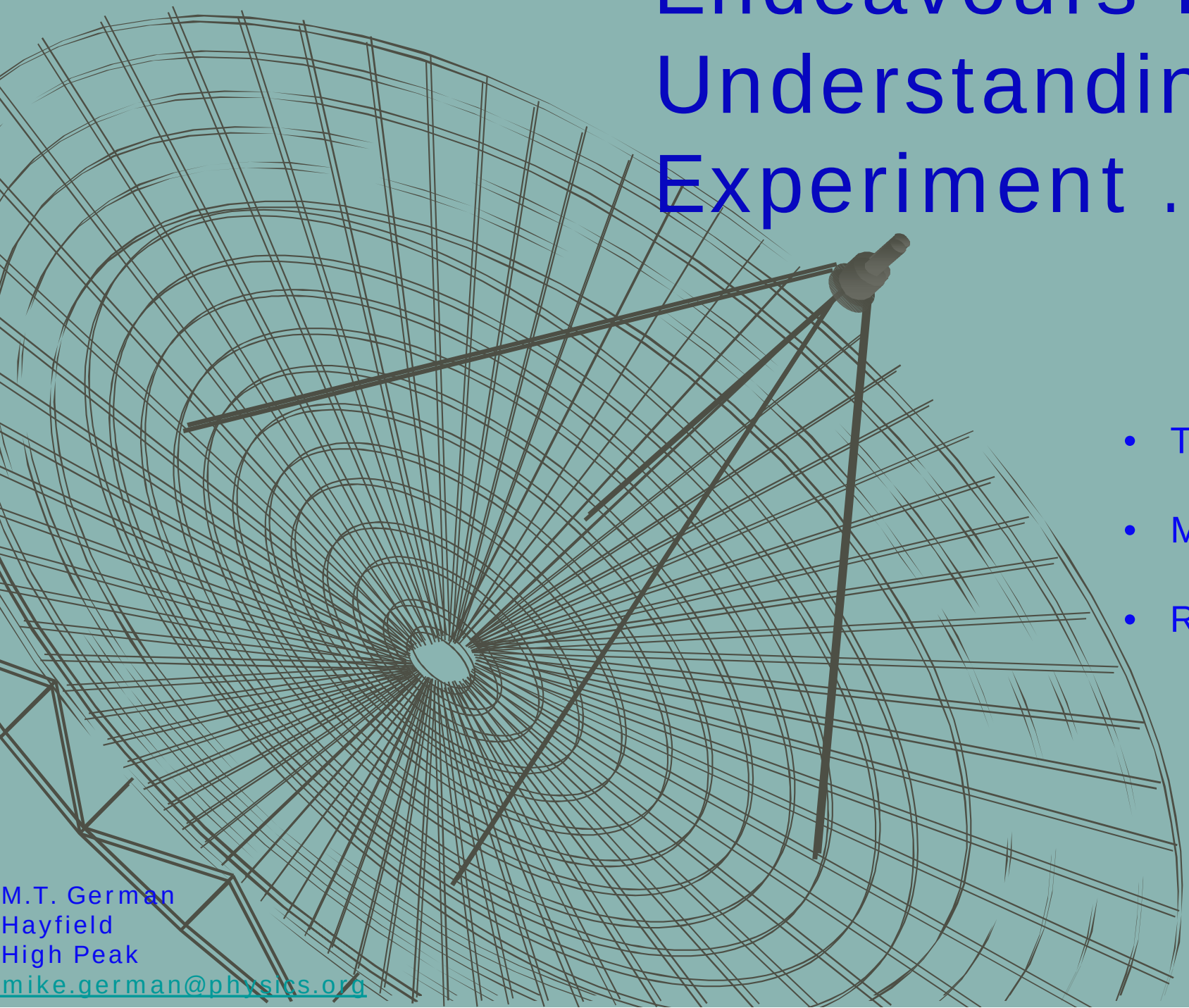
Endeavours In Understanding The Experiment .....



The Elements

- Transmitter
- Meteor
- Receiving Station

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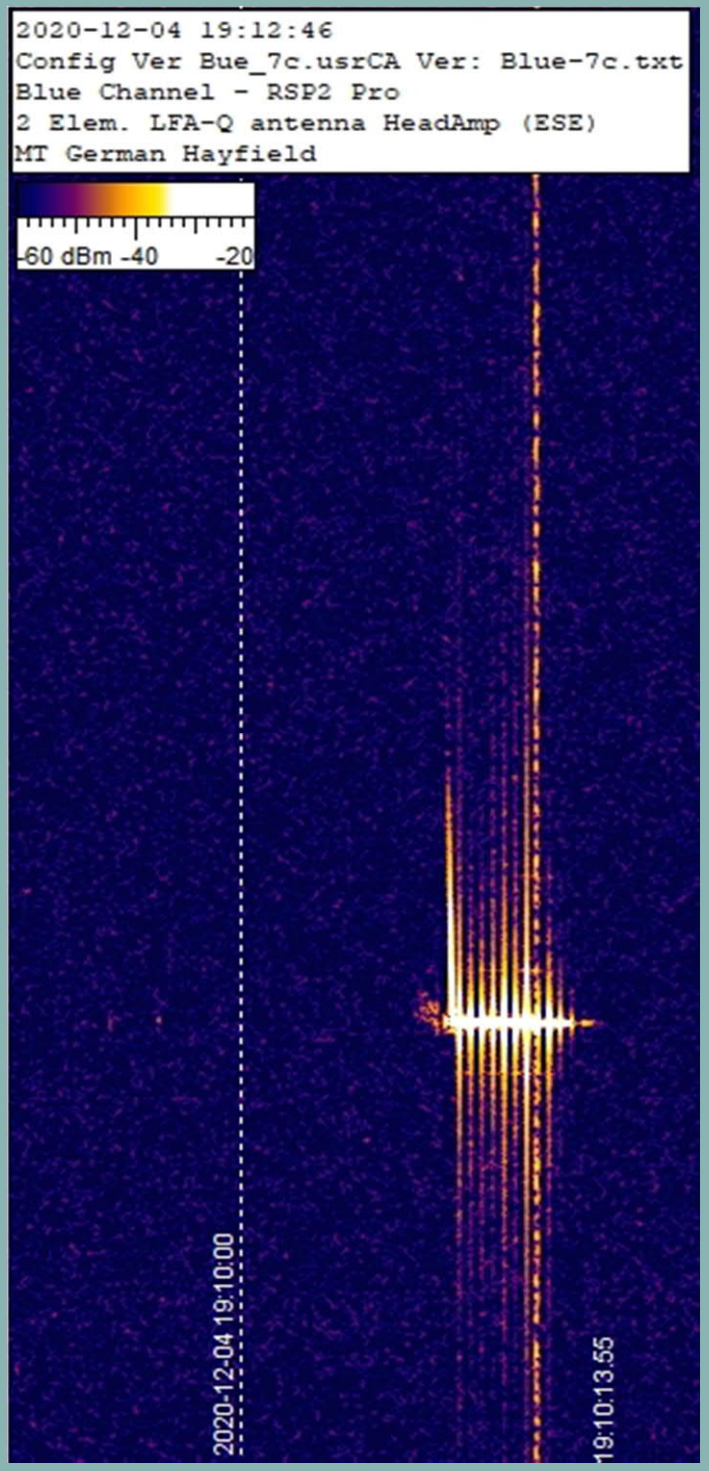
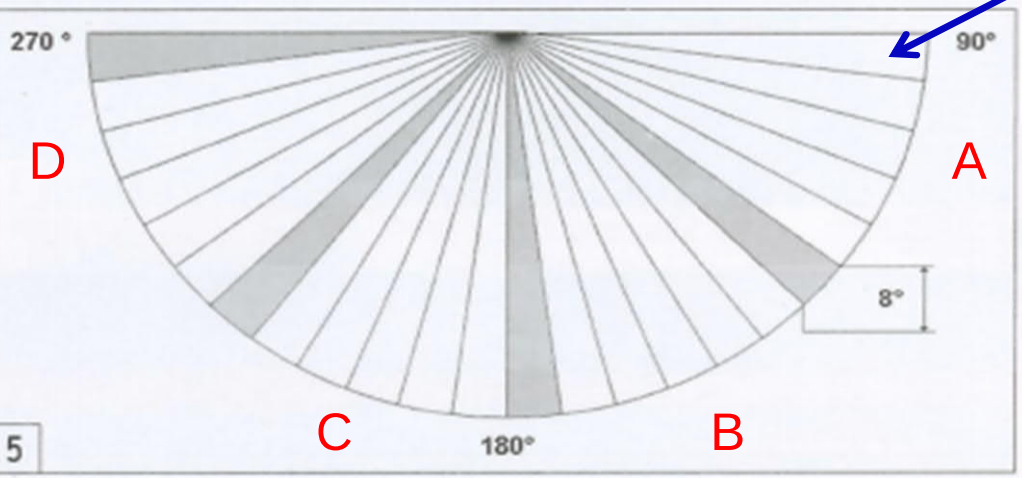


A familiar type of meteor signature …

… But what caused it?

…. We need to understand the experiment…

ce projet, il apparaît que de vantes les plus connus :



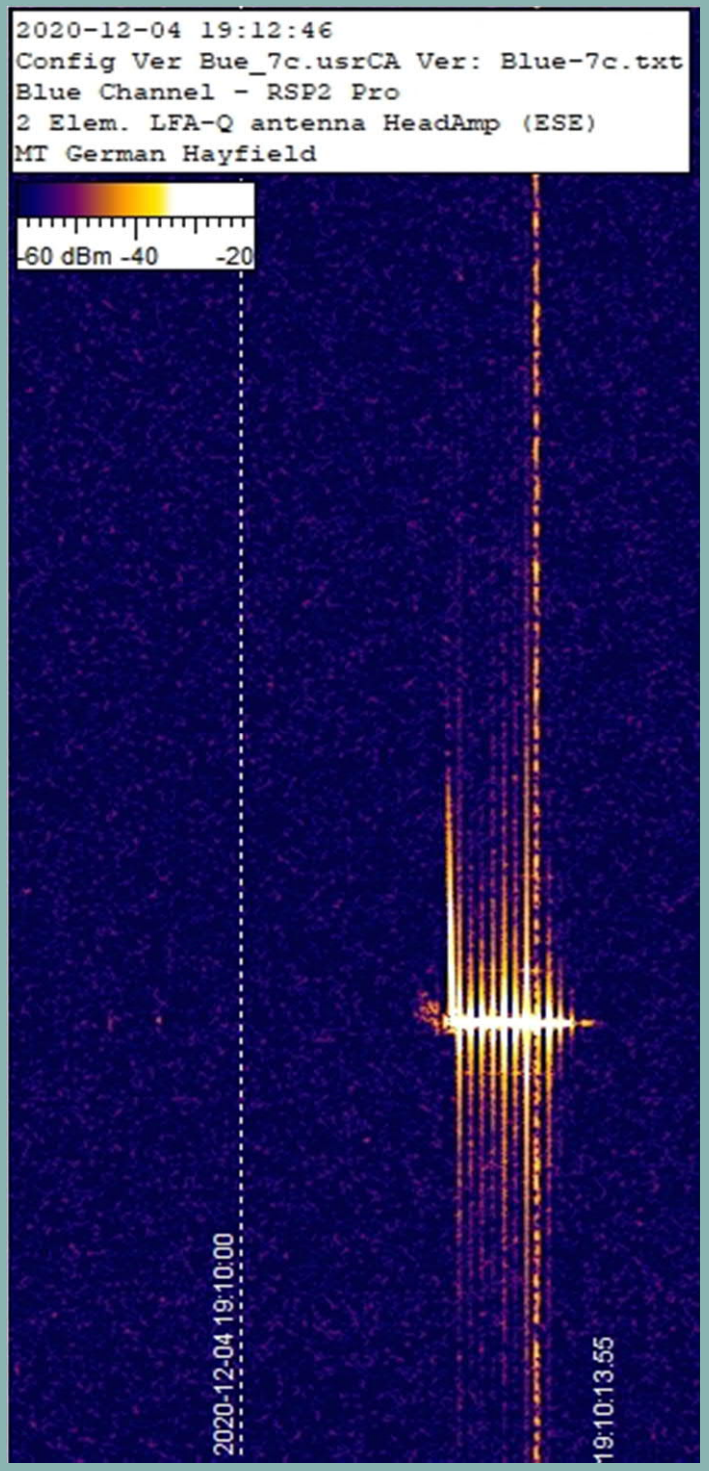
nombreux choix technolo- - Spectrum Lab de DL4YHF :

References at end [1]

Four TX Antenna Array Panels
Four Sectors each covering 45° to South A to D
Six Sub-sectors 7.5° eg A0 to A5

Beam Switch Sequence - sub-sectors synched
All 0th sectors turn on together for 800ms
i.e. A0,B0,C0,D0 then all next sub-sectors 1, and so on until back to 0. There is a phase change when the beam switches

Beam Sequence is accurately Time Synchronised. All 0th sub-sectors start with first second of hour



Does this help explain the signature?

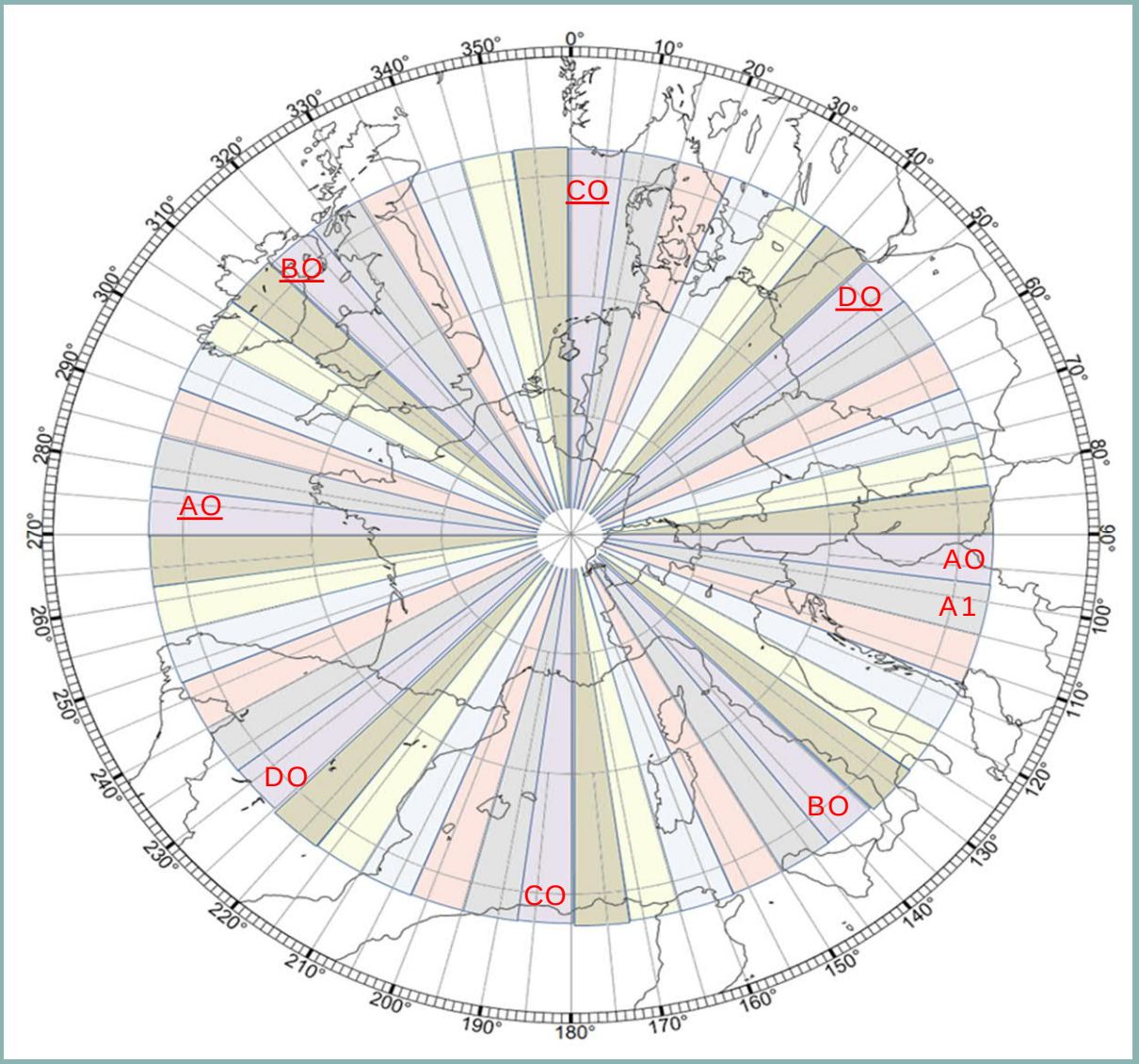
- The first part of the trace is the Doppler frequency shift of the Head Echo and not a GRAVES artefact
- GRAVES introduces a phase change when beams are switched to next sub-sectors
- FFTs (such as in Spectrograms) sees phase changes as discontinuities and generate these spikes
- The 11 spikes coincide with a beam-switch at intervals of exactly 800ms

Can we analyse this further ?

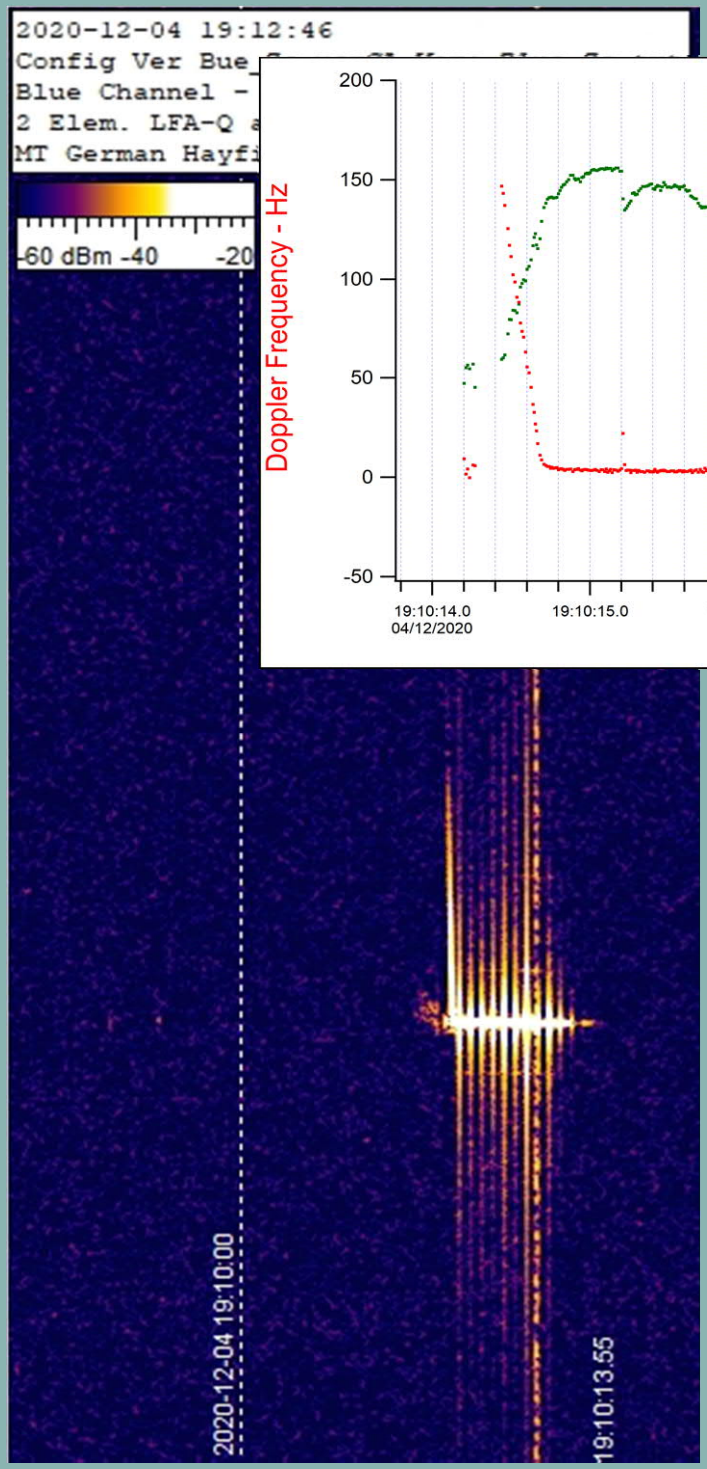
- Overlay sub-sectors on an azimuthal plot centred on GRAVES

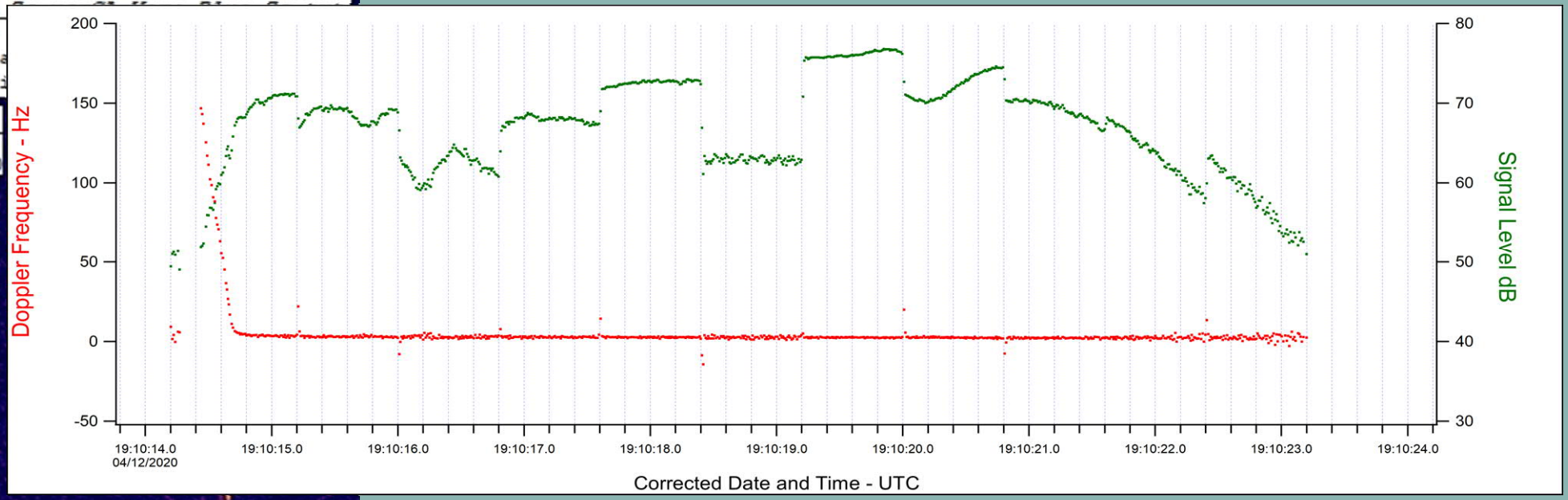
- Southern Sectors
  - sub-sector relate to bearing from GRAVES
  - Sequence time is linked to sub-sector and hence bearing

- Northern Sectors
  - Known scatter from ISS
  - Antenna rear/side lobes
  - Cannot assume match
  - Unlikely to be contained in sub-sector



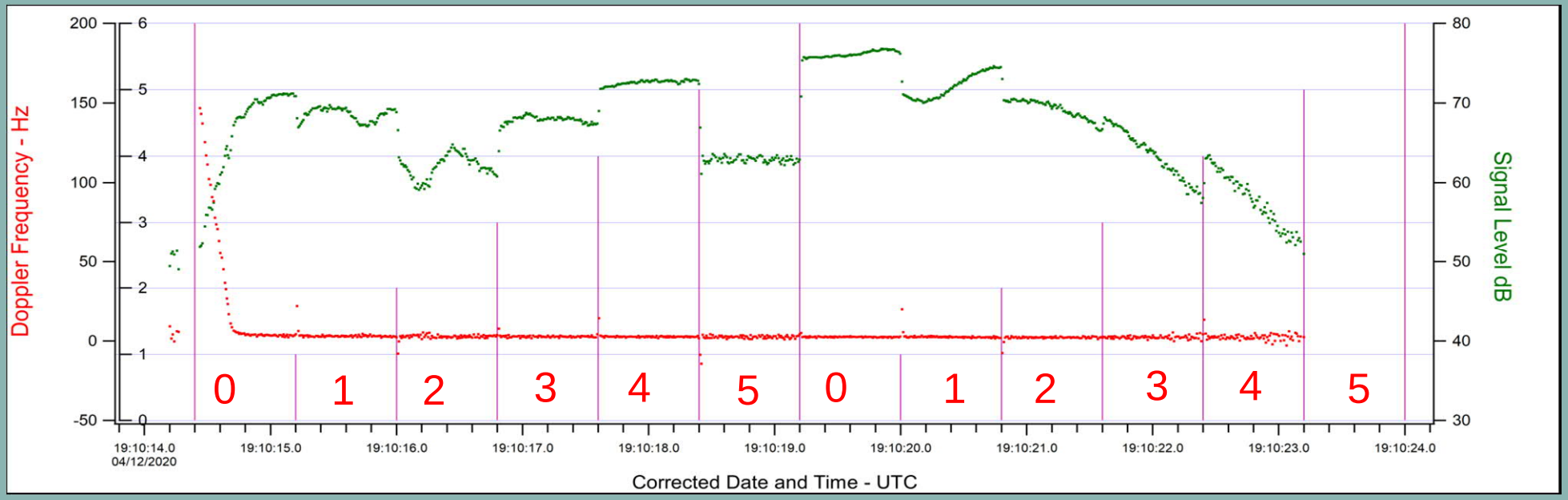
- To investigate sub-sector and sequence time relationship in the Northern Sectors we need to compare known positional data with radio accurate and precise timing measurements





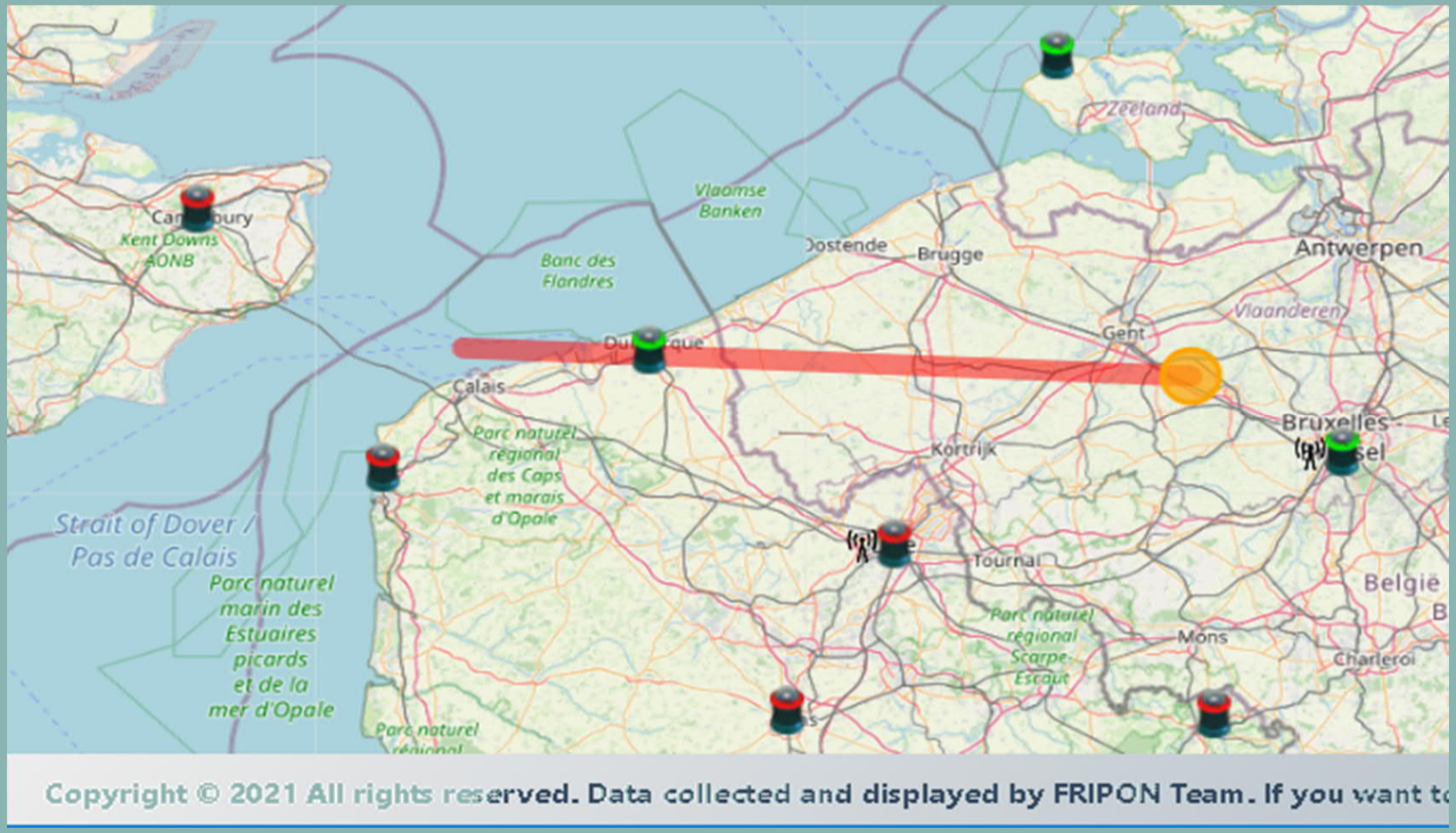
- Timing Data from Meteor Logger*
  - Data sampled every 10 ms
  - Output Frequency and Signal Level v Time
- Red data points - Doppler frequency shift Hz
  - Head Echo then specular scatter trail
  - Spikes reduced to small blips
- Green data points - signal levels in arbitrary dB
  - Changes in amplitude associated with beam switching
- Event 8.76 seconds long or 818 data points

* Software from Wolfgang Kaufmann
Reference [2]

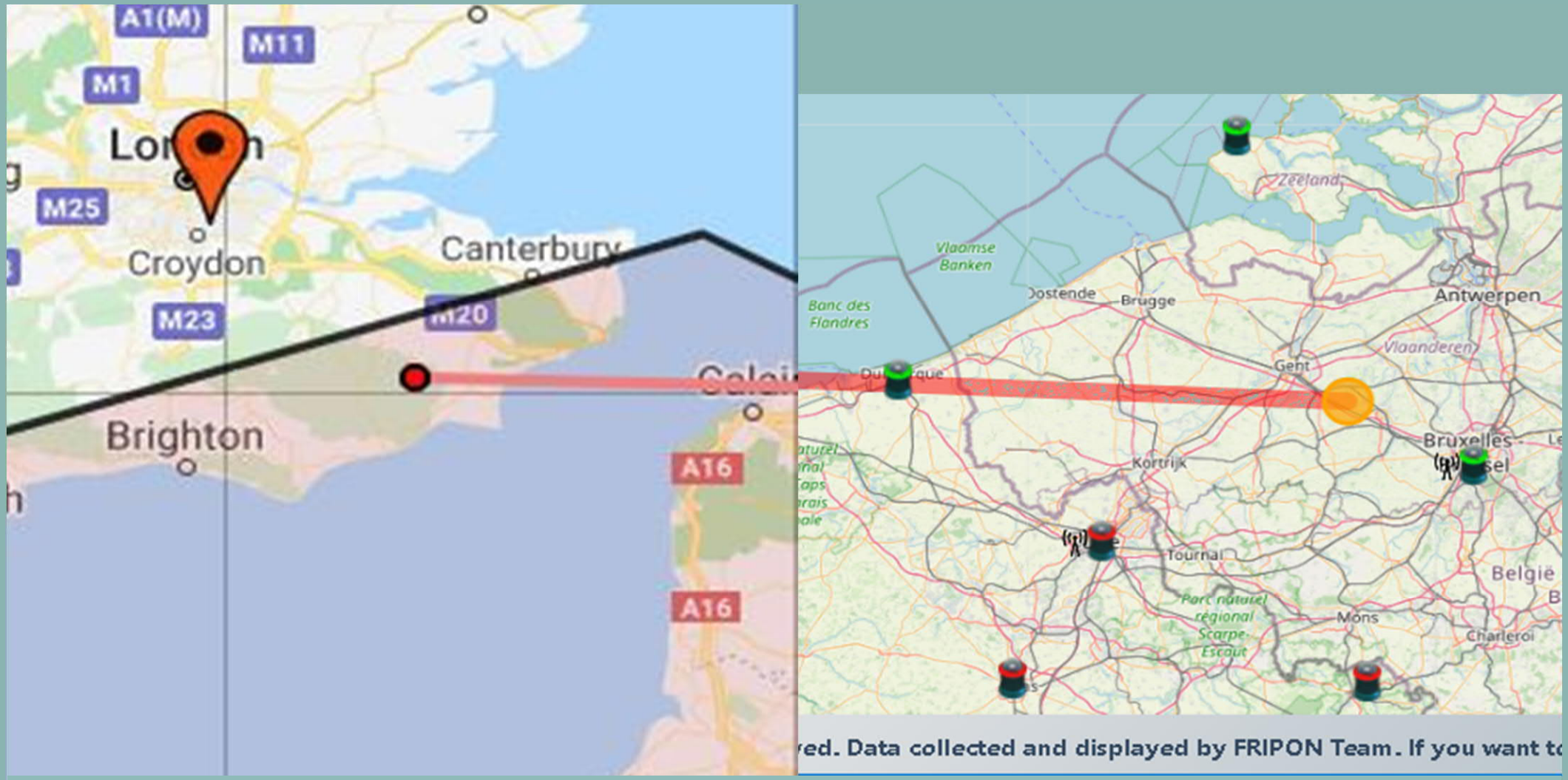


- By correcting the logged time to allow for latency (delays) in the PC software (SDR) the signal level can be aligned and brought into synch with GRAVES sequence time
- The adjustment here was about 250ms but alignment would also have be achieved at 250 + 800 ms, 250 + 1600ms ….
- The time correction provides better absolute time accuracy
- Signal Levels within the 800ms pulse do not represent the motion of the meteor crossing a sub-sector beam. The data points are the changing signal within the beam as a whole.
- Location data is required to link the time sequence and sub-sector position

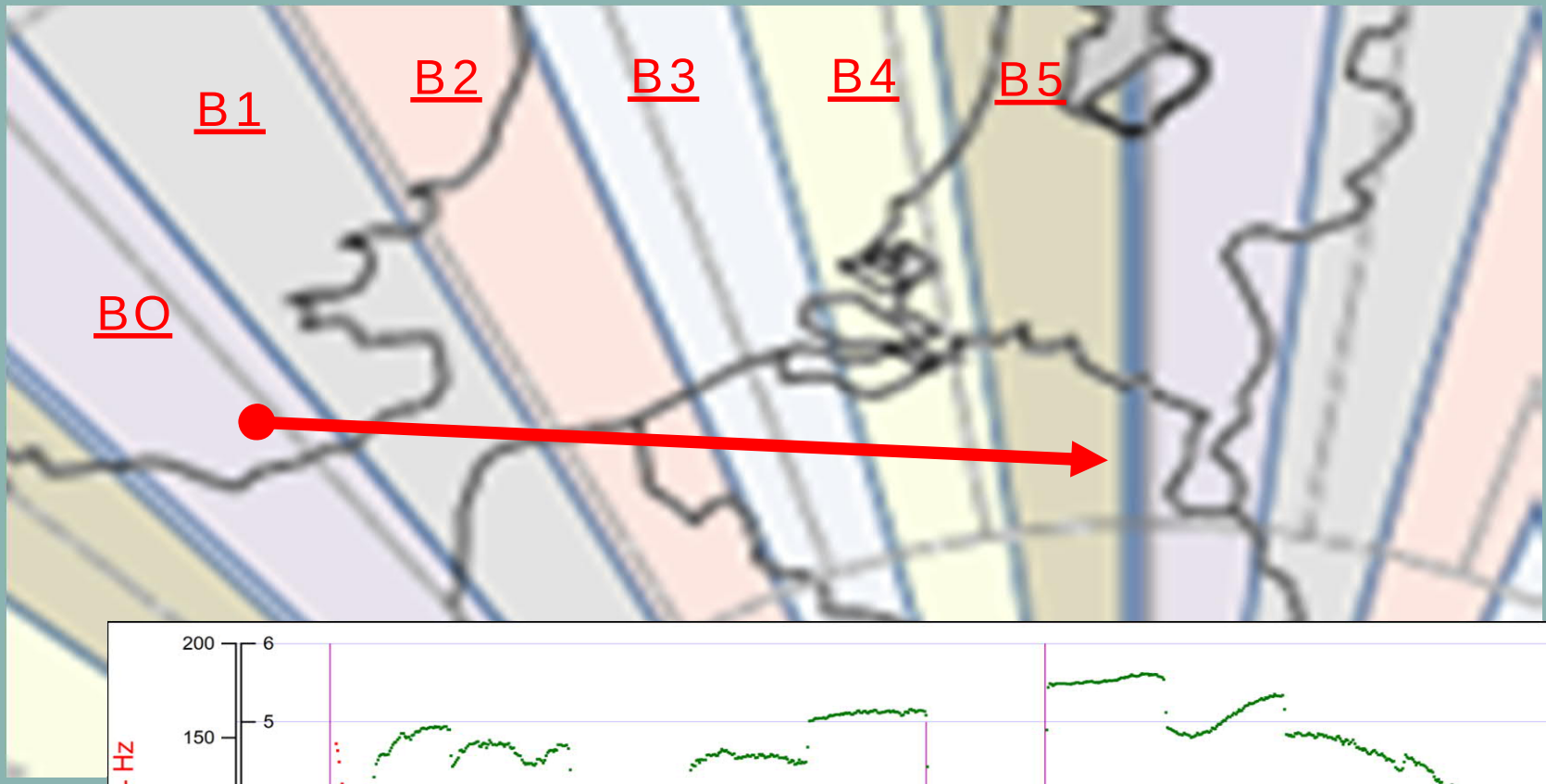
- On the IMO fireball database, I found a video event overlapping the radio start time and lasting a similar ~8.6s. Video event was from a NEMETODE camera.[3]
- John Berman found another NEMETODE record and generated a track. Speed ~19 km/s There were 4 or 5 other possible matches to the radio event [4]

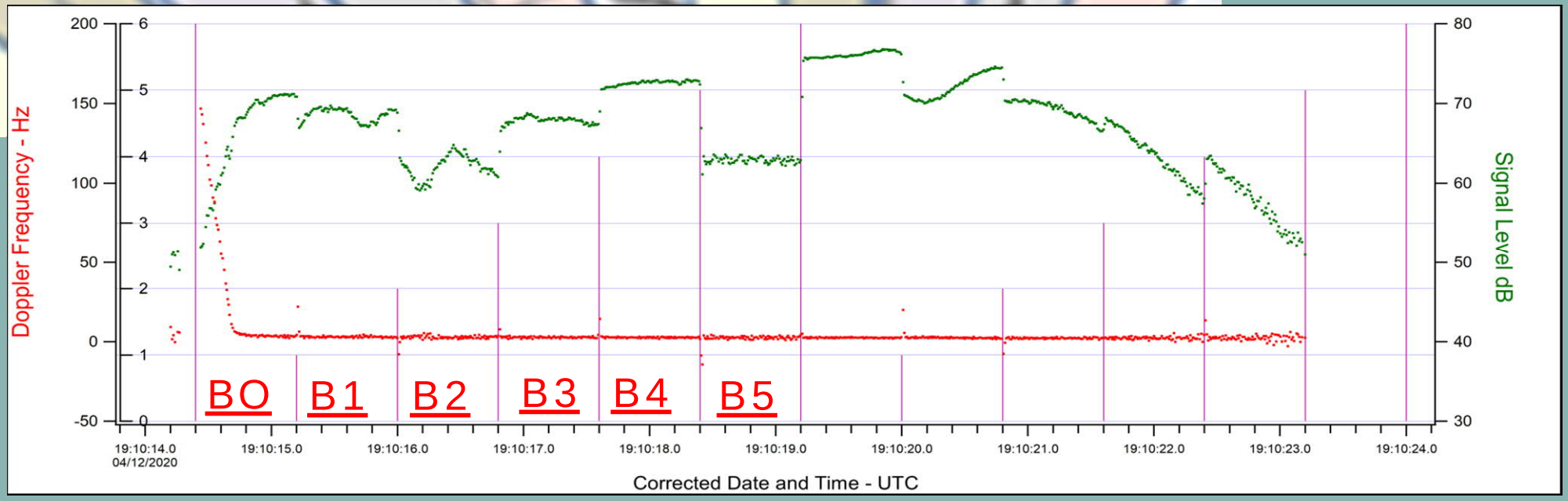


- Jean Louis informed us after RAG Zoom 1 that FRIPON database was now on-line and publically accessible
- There was coverage of this event by 3 cameras [5]
- The track passes by Calais and close to Ghent
- Speed (as far as I can tell) ~ 22 -> 18 km/s



- Combining the two maps there is a pretty good match
- It looks like the same event to me ☺


B1
B2
B3
B4
B5
BO


Doppler Frequency - Hz
Signal Level dB
Corrected Date and Time - UTC
200
150
100
50
0
-50
6
5
4
3
2
1
0
80
70
60
50
40
30
19:10:14.0
04/12/2020
19:10:15.0
19:10:16.0
19:10:17.0
19:10:18.0
19:10:19.0
19:10:20.0
19:10:21.0
19:10:22.0
19:10:23.0
19:10:24.0
BO
B1
B2
B3
B4
B5

Conclusion

- This Proof-of-Principle approach shows alignment of beam-switching with meteor data and provides route to improved time accuracy
    - I conclude the knowingly naïve translation of sub-sectors from South to North as a single formed beam was wrong and antennas undoubtedly have side lobes
    - There is ambiguity in the time correction from a meteor event which would be resolved with a more practical, exact method of Latency calibration
- First opportunity to compare video–radio event in this way
    - More questions than answers – but interesting!
    - Not possible here to reconcile radio and video “positions”
    - Need similar meteor event South of GRAVES
    - Tying video positional data to times of Head Echo would provide valuable data to test another of my endeavours!

Continuing Endeavours to Understand The Experiment

- Use accurate Meteor Logger data of ISS positions and timings to map Southern sub-sectors and investigate Northern sectors
- ISS position data gives bearing from receiver antenna. Investigate comparing signal levels with matched systems
    - Use Simultaneous differential signal levels of angularly separated radiation patterns to provide direction
- Develop latency calibration system based on MSF modulation of precision frequency oscillator at 143.05 MHz
- Obtain and use experimental Head Echo positional data to validate numerical simulation model, HEDA [6]
- Watch out for more radio-video matches
- ... and then (hopefully) begin to understand the detail of radio meteor signatures ...

References

[1] GRAVES

Source book
https://fas.org/spp/military/program/track/graves.pdf

Timing Information (N.B.some is out-of-date)
https://ea4eoz.blogspot.com/2015/05/determining-radiant-of-meteor-using.html
https://ea4eoz.blogspot.com/2016/04/determining-radiant-of-meteor-using.html

[2] Meteor Logger
http://www.ars-electromagnetica.de/robs/download.html

Kaufmann, W. “New radio meteor detecting and Logging Software”, WGN, The Journal of the IMO 48:1 (2020)

[3] IMO fireball Video Events
https://fireballs.imo.net/members/imo_view/report/216490

[4] Collaborative Database Video Event
https://radiometeordetection.org/visualmeteorsview/13663?showdetail=radio_meteors

[5] FRIPON Database Video Events
https://radiometeordetection.org/visualmeteorsview/13663?showdetail=radio_meteors

[6] Head Echo Doppler Assessment (HEDA) Model
German, M.T. “A Head Echo Doppler Model for Assessment of Meteoroid Forward Scatter Characteristics” WGN, The Journal of the IMO 48:1 (2020)

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26 March 2021
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