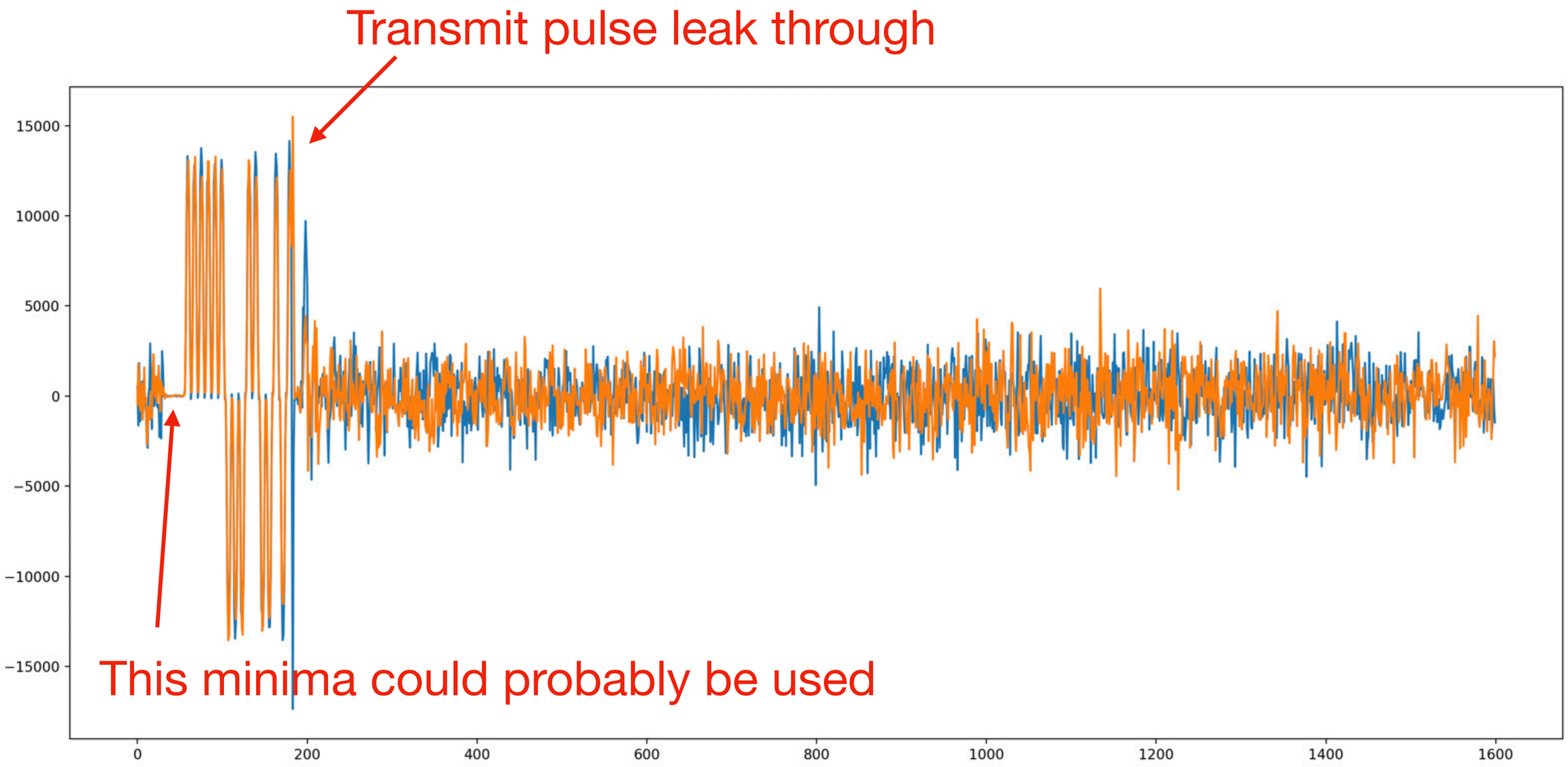
PANSY Mode Detection

Juha Vierine, Koji Nishimura

Mode detection need

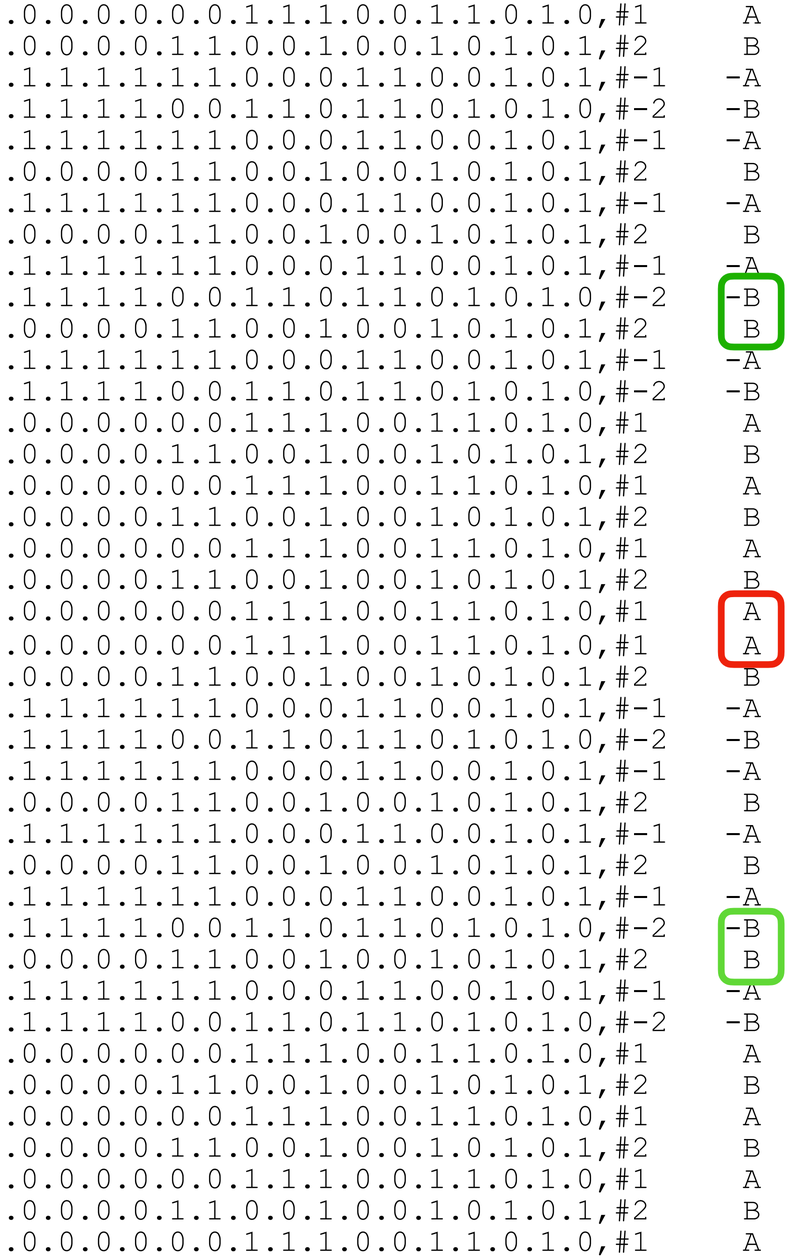
- Pansy Meteor Extension (PAMEX) is locked to GPS reference, while PANSY is locked to its own free running internal reference
- Based on the testing at Shigaraki, the PANSY clock is within about 1 ppm of the GPS reference
- This means that within a few pulses, the phase doesn’t change significantly at 47 MHz
- The interpulse period will also not significantly deviate over a tenth of a second or so with a 1 MHz sample rate
- We need to use the transmit sample to detetermine what beam pointing is currently used, and which part of the sequence we are currently in.

Example Raw Voltage



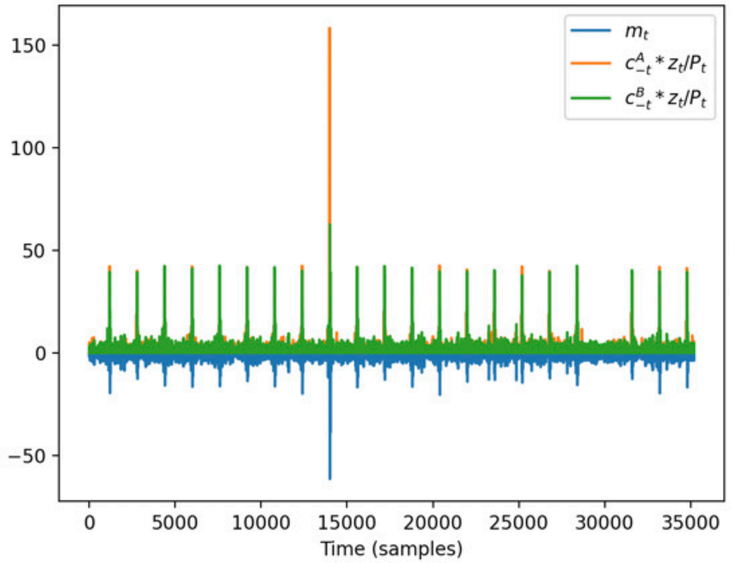
Strategy

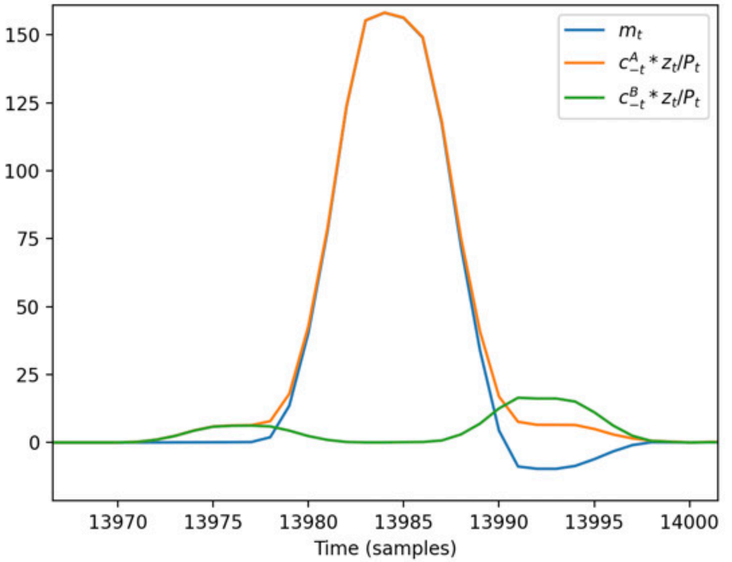
- The code sequence for the mesosphere mode only has a repeated A-code when starting a new sequence.
- The sequecy -BB would also work, but let’s try AA first



Strategy

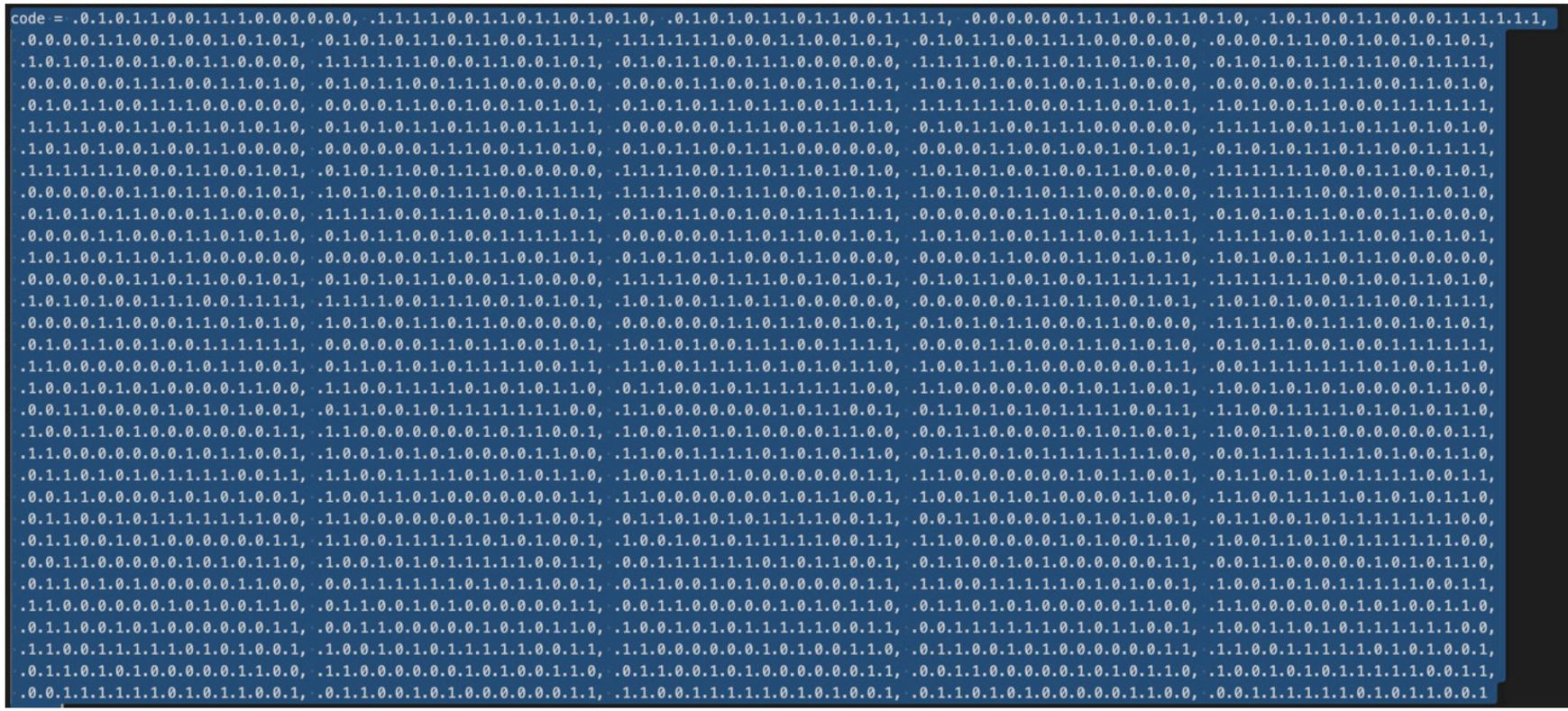
- The cross-correlation $c_{-t}^{A} * c_{t}^{A}$ is maximized when $c_{-t}^{B} * c_{t}^{A}$ is minimized. Here c_{t}^{A} is 16-bit complementary code A and c_{t}^{B} is code B
- Normalize with power within pulse length $P_t = r_{-t} * |z_t|^2 + \epsilon$ with r_t a rectangular window of length of transmit pulse
- Metric: $m_t = (c_{-t}^{A} * z_t - c_{-t}^{B} * z_t)/P_t$
- Avoid $P_t = 0$ with small number ϵ

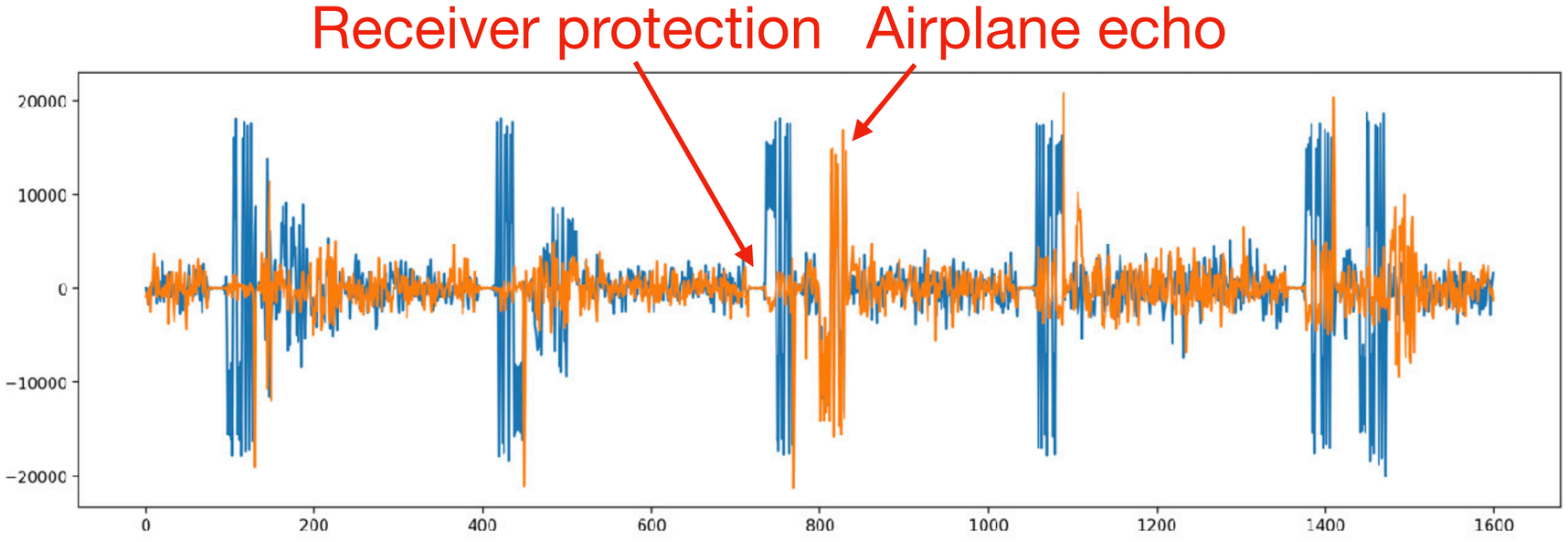


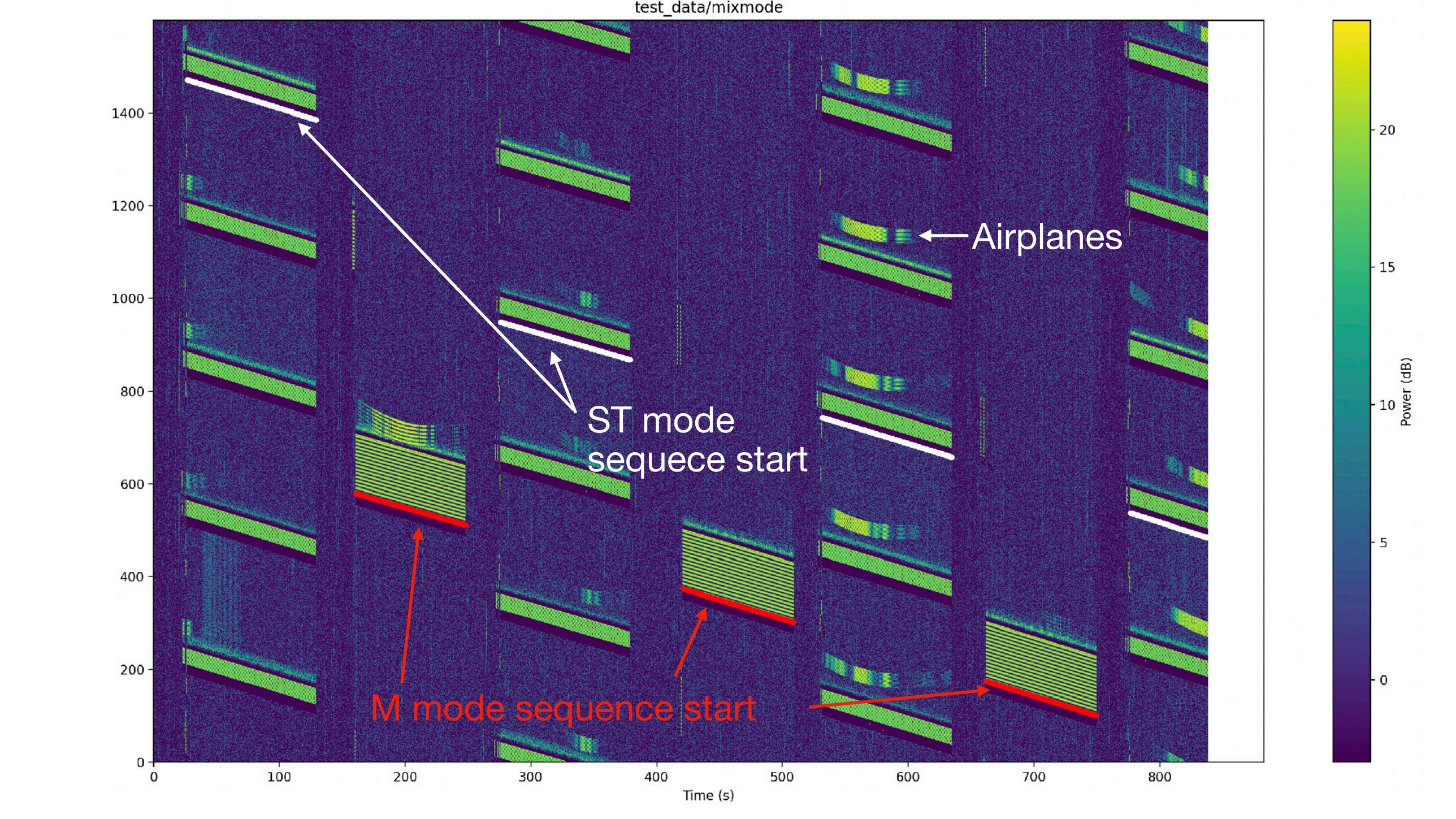


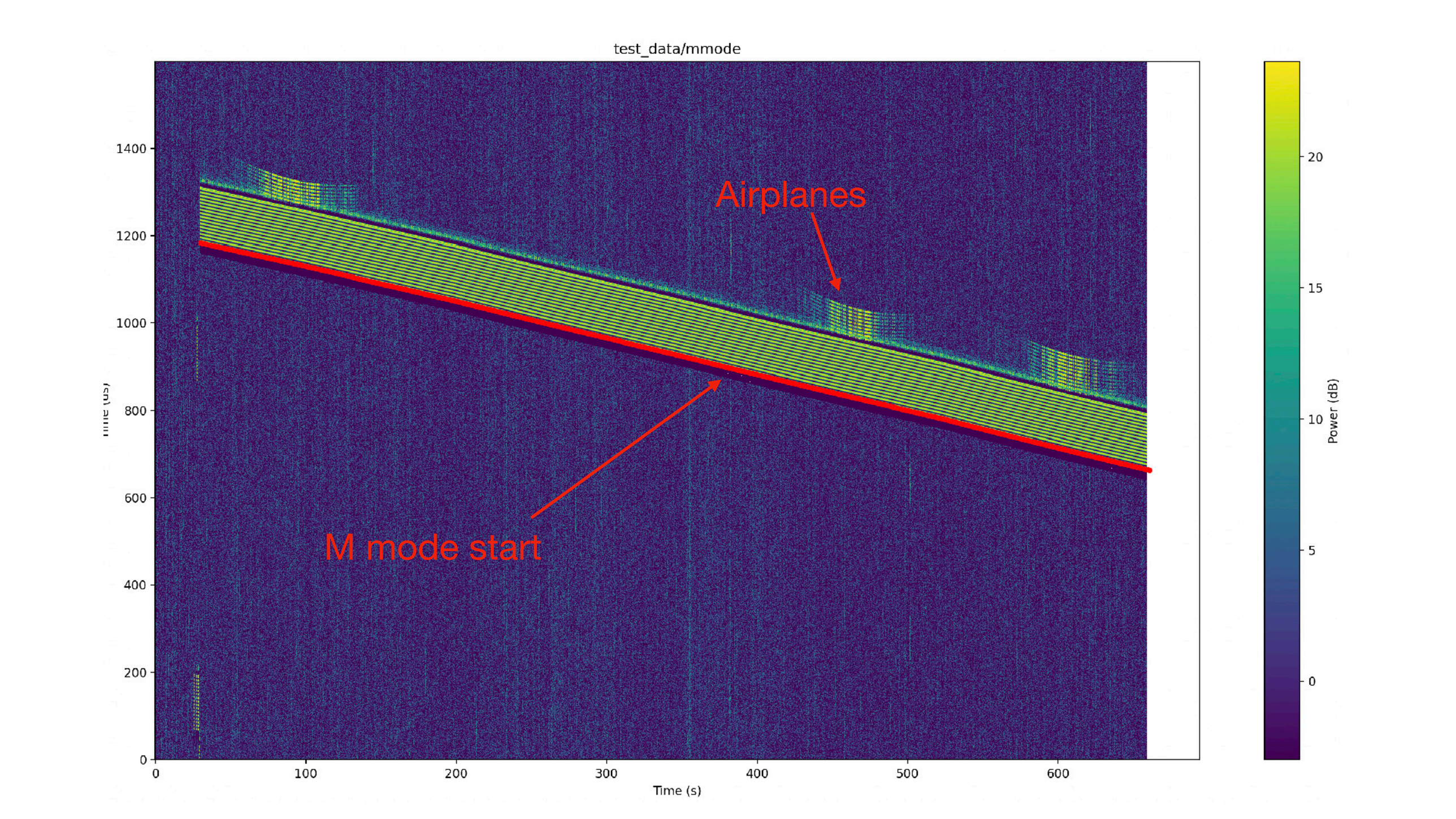
Strategy

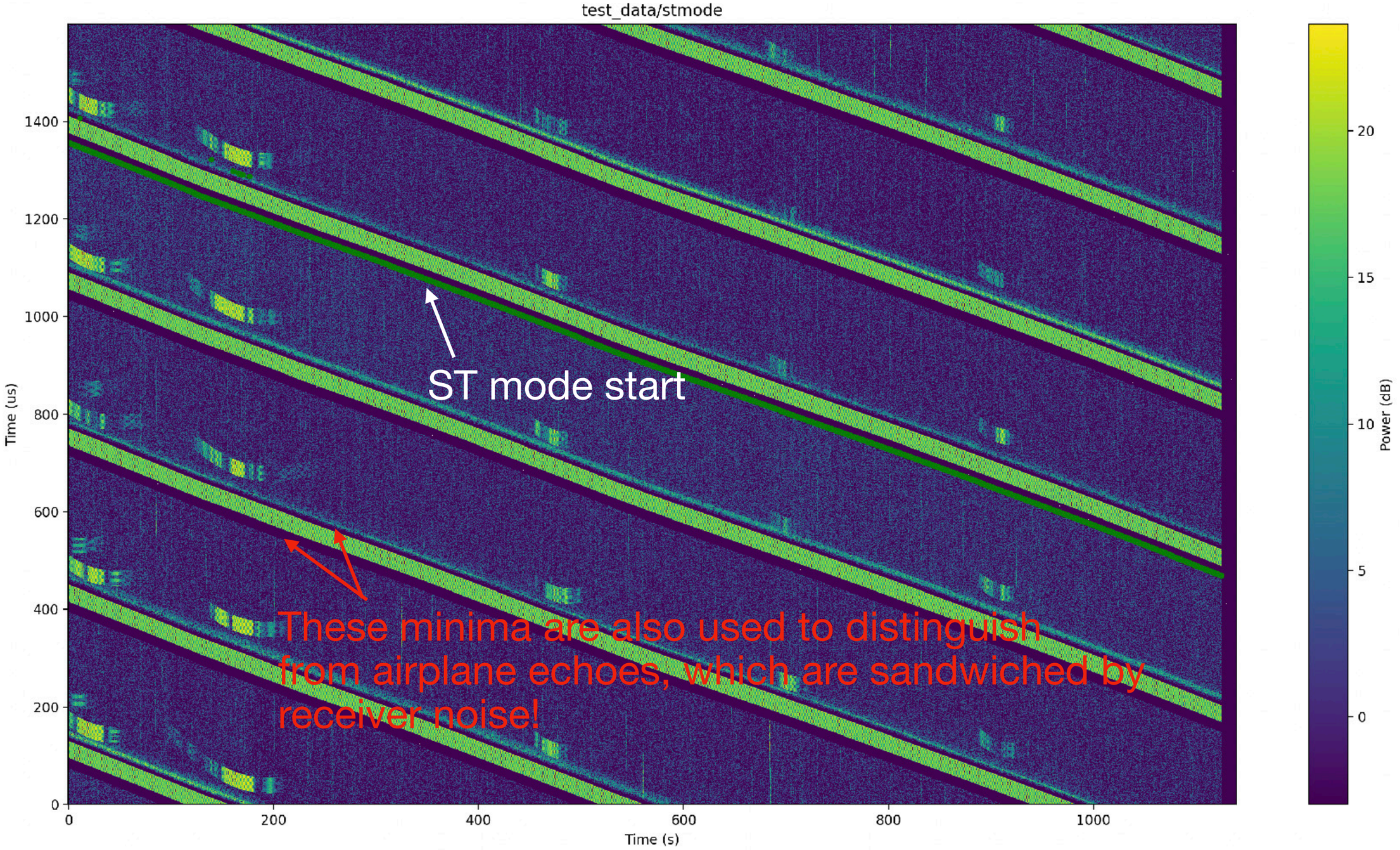
- For the ST mode, we can detect based on the first 10 pulses only occurring once in the beginning of the 160 pulse sequence
- We also need to find the receiver protect minima before the transmit pulse to make sure that we don't accidentally detect strong airplane echoes as transmit pulses






test_data/mixmode
Airplanes
ST mode
sequece start
M mode sequence start
Time (s)
Power (dB)
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
0
5
10
15
20


test_data/mmode
Airplanes
M mode start
Time (s)
Power (dB)
0
100
200
300
400
500
600
0
200
400
600
800
1000
1200
1400
0
5
10
15
20


test_data/stmode
ST mode start
These minima are also used to distinguish from airplane echoes, which are sandwiched by receiver noise!
Time (us)
Time (s)
Power (dB)
0
200
400
600
800
1000
1200
1400
0
5
10
15
20

TODO

- Test against various signal levels and airplane echo amplitudes
- Airplanes will be more challenging for the ST mode, because they are near zero Doppler shift and can be stronger than the transmit sample