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Effective Jammer Detection and Classification using GNSS Receivers on a Highway Overhead Structure

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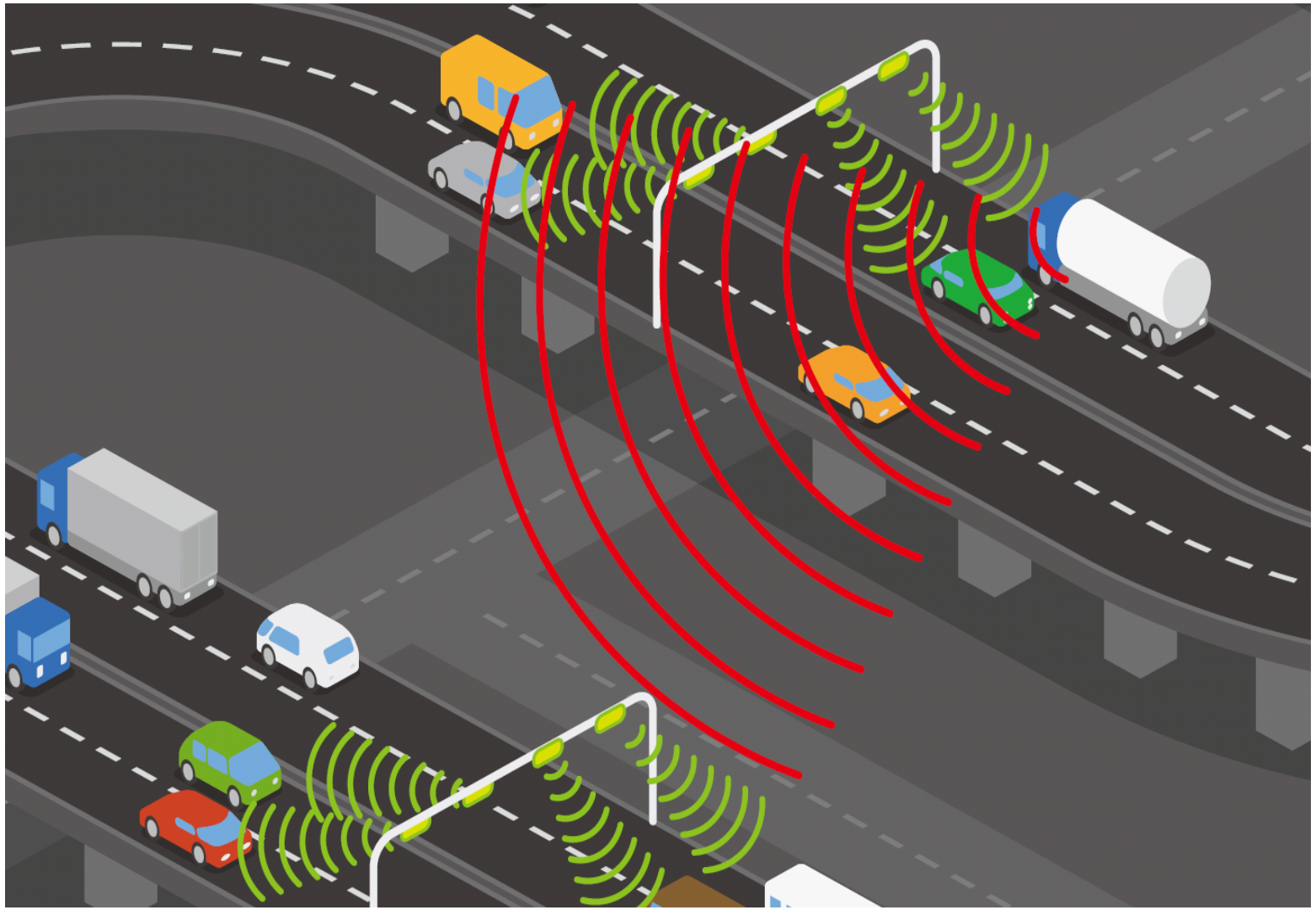
ION GNSS+ 2018

Jammer Alert!



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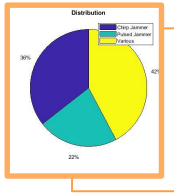
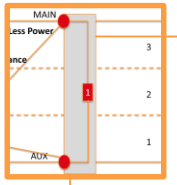
Setup



Detection and Classification



Direction&Lane Determination

Setup

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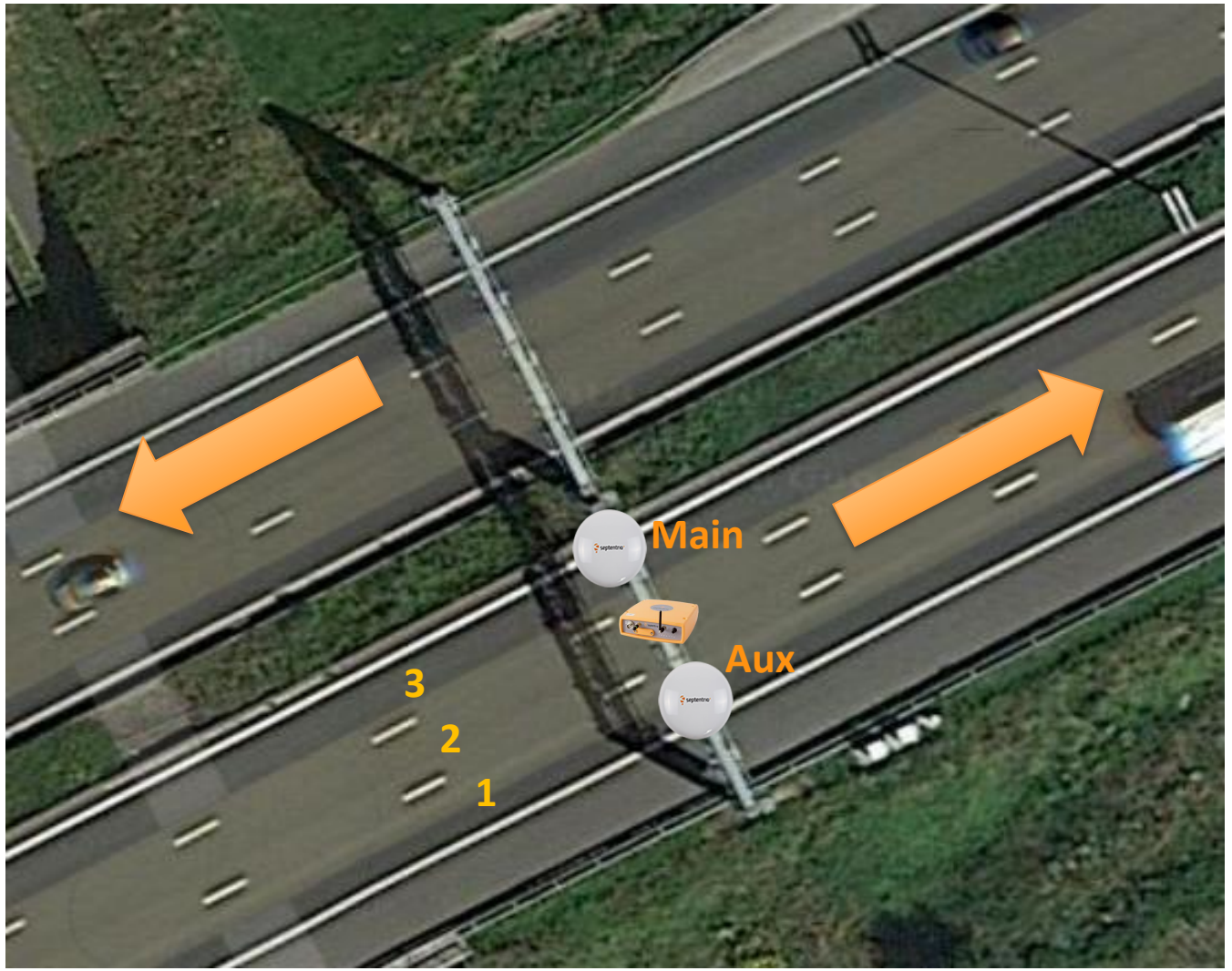
Antenna Location on Gantry



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Antenna Placement

Receiver and Data Recording

AsteRx-U dual-antenna receiver

- **Simultaneous GNSS measurements on Main and Aux antennas**
- **Simultaneous logging of batches of A/D samples on Main and Aux**
- **Interference Detection turned off!**

Recording over a 5-day period

- **25GB of GNSS and A/D samples**

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Detection & Classification

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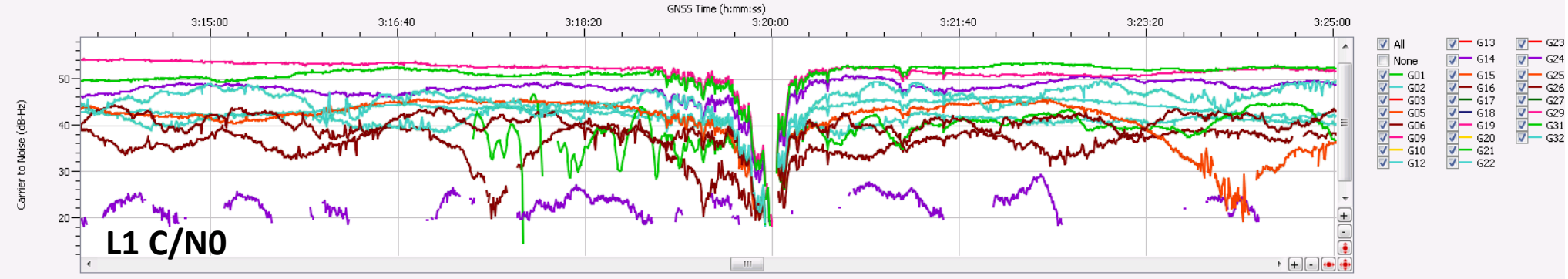
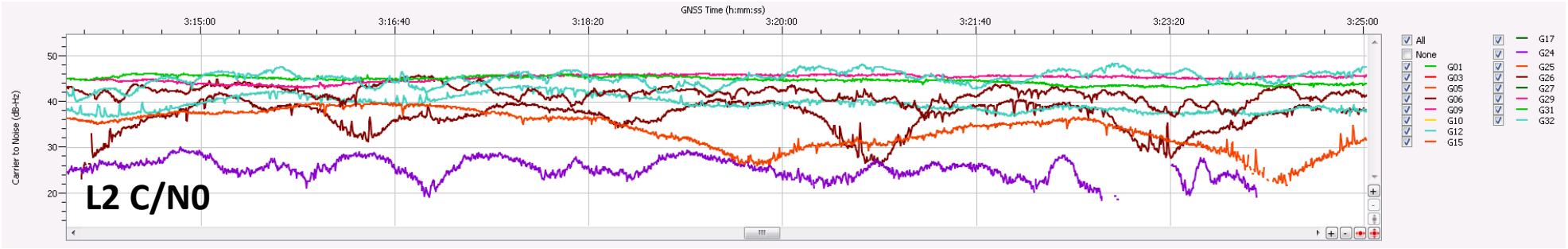
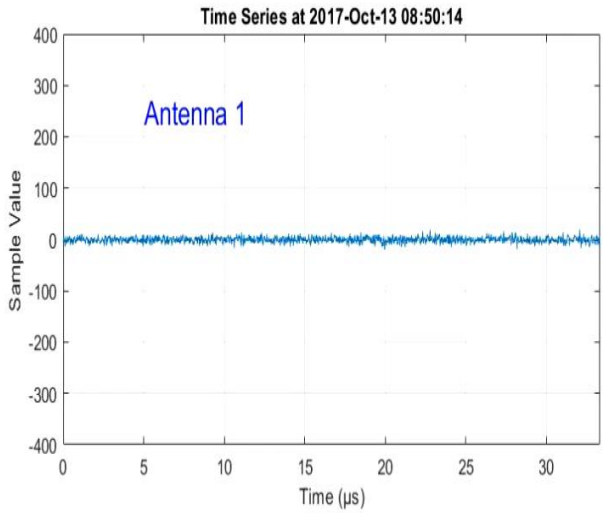
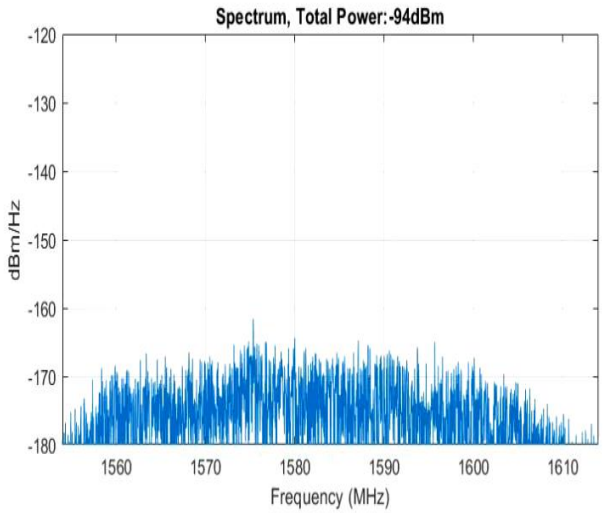
Example of Event

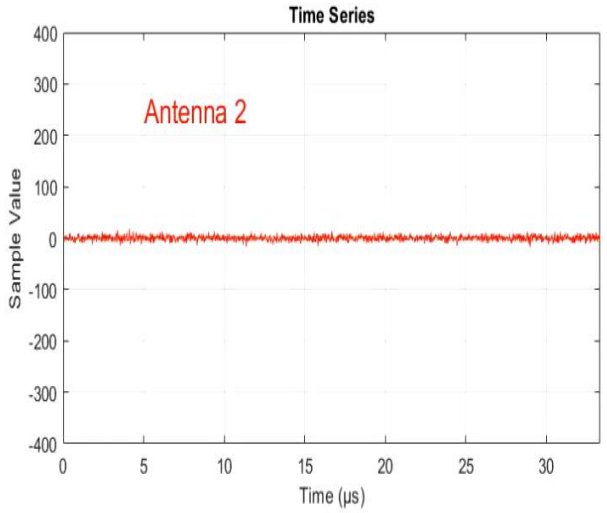


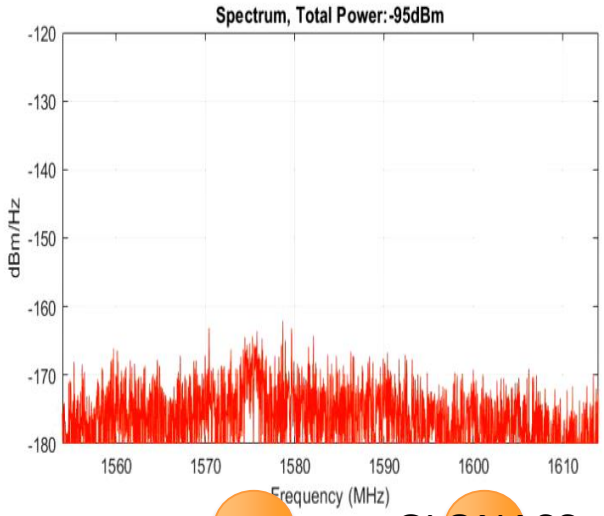


Example of Event



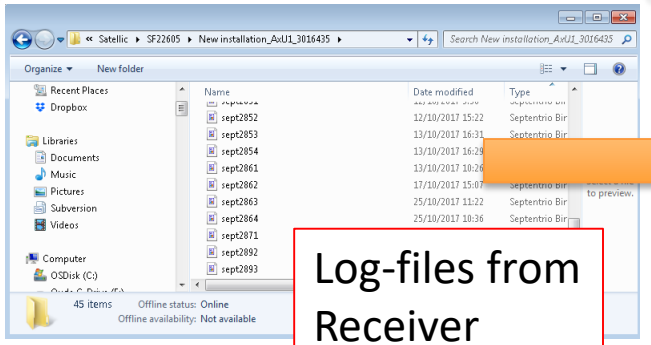






GPS GLONASS

Interference Detection & Classification



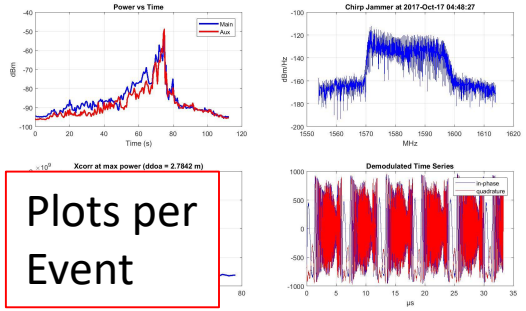
Log-files from Receiver

Interference Detection & Classification Tool

Developed in Matlab, compiled as a standalone application

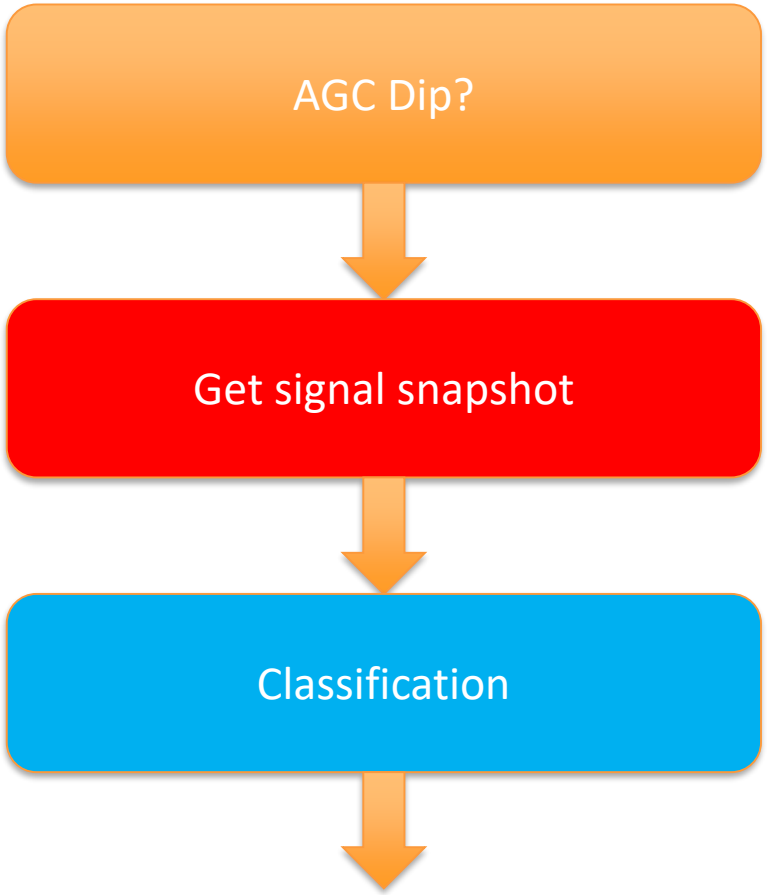
	A	B	C	D
1	DATE	TYPE	DURATIO	POWER
2	10/10/2017 11:53	Narrow Band Interference at 1580,3 MHz	1	-80,3575
3	10/10/2017 12:29	Pulsed Jammer	3	-75,6594
4	10/10/2017 13:54	Narrow Band Interference at 1583,8 MHz	1	-91,2539
5	11/10/2017 9	Hz	5	-70,8908
6	11/10/2017 10	Hz	1	-90,5378
7	11/10/2017 13	Hz	1	-77,1272
8	11/10/2017 14	Hz	1	-88,2579

Spreadsheet
One entry per event



Plots per Event

Detection & Classification Workflow



2000 I/Q A/D samples at local minimum AGC

Heuristic Time-Frequency Domain Processing

Fully Automated!

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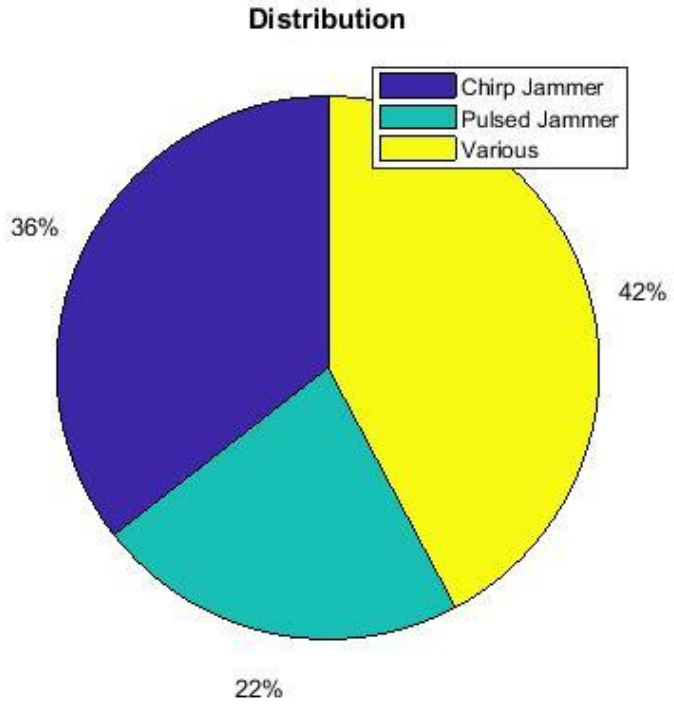
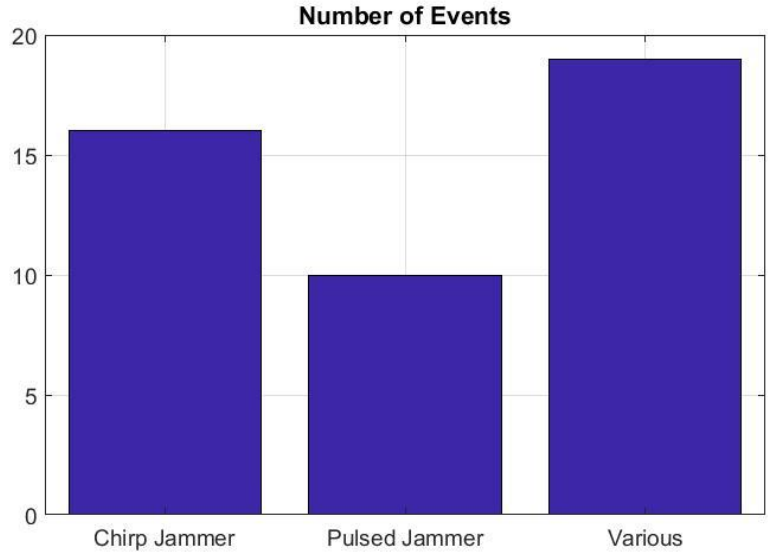
Event Statistics

45 heavy interferences found (~9 per day)





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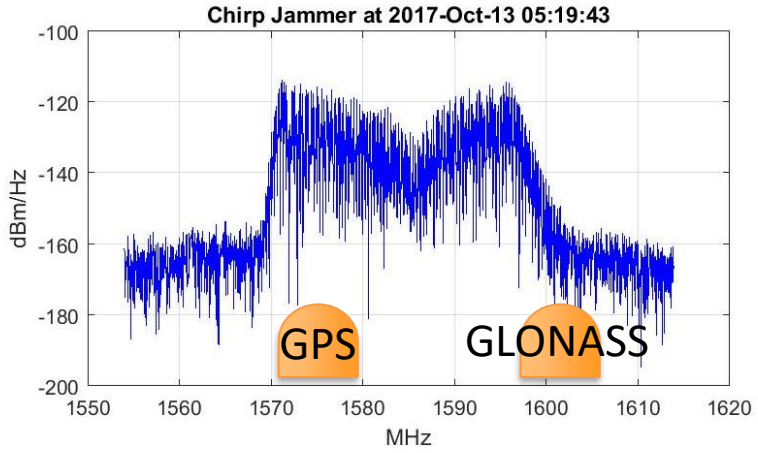
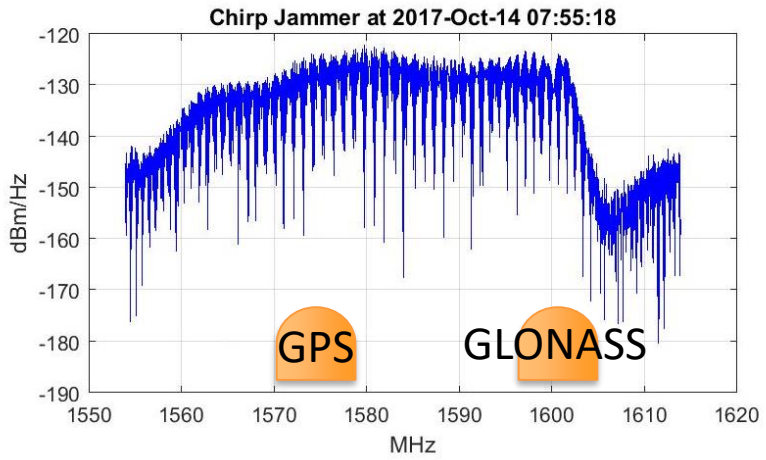
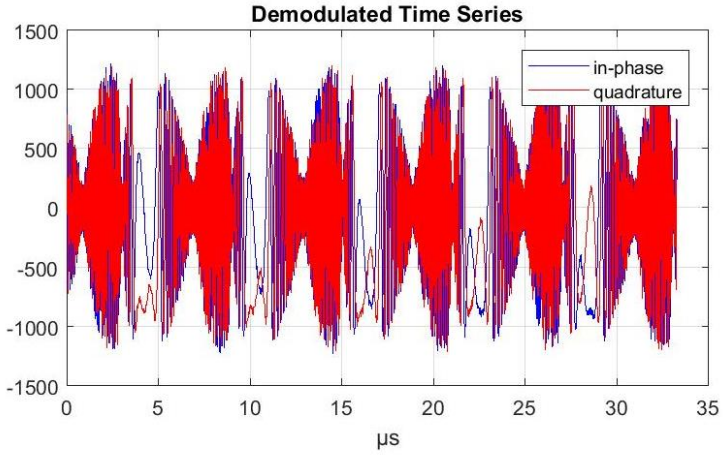
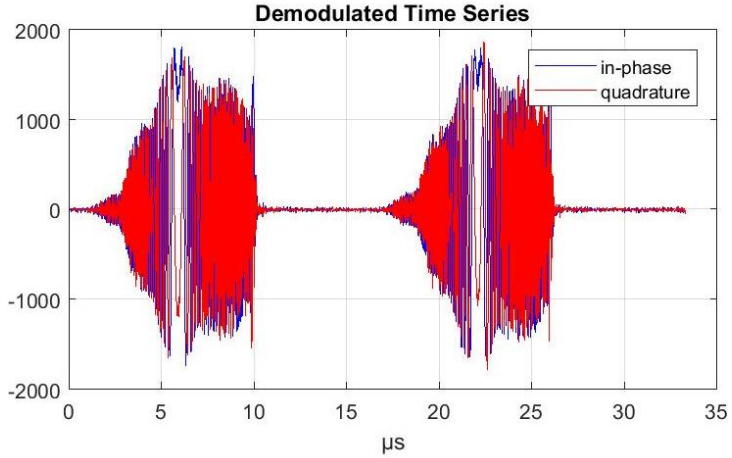
Example 1: Chirp Jammers

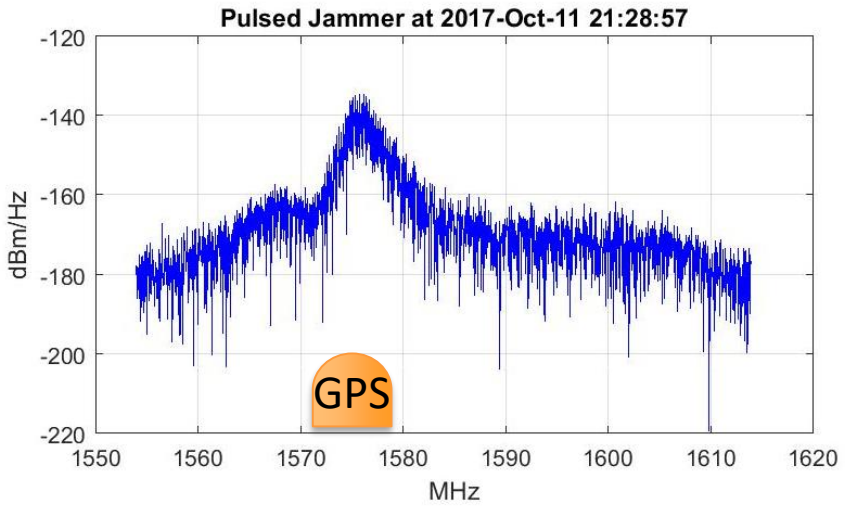


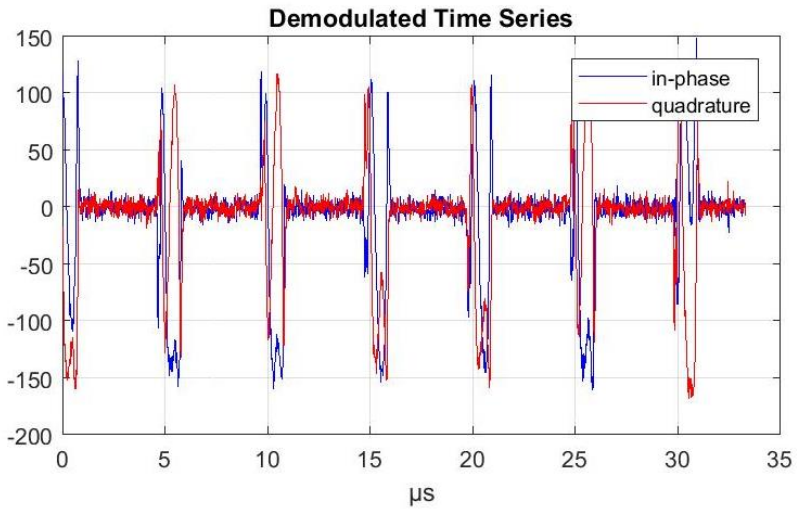






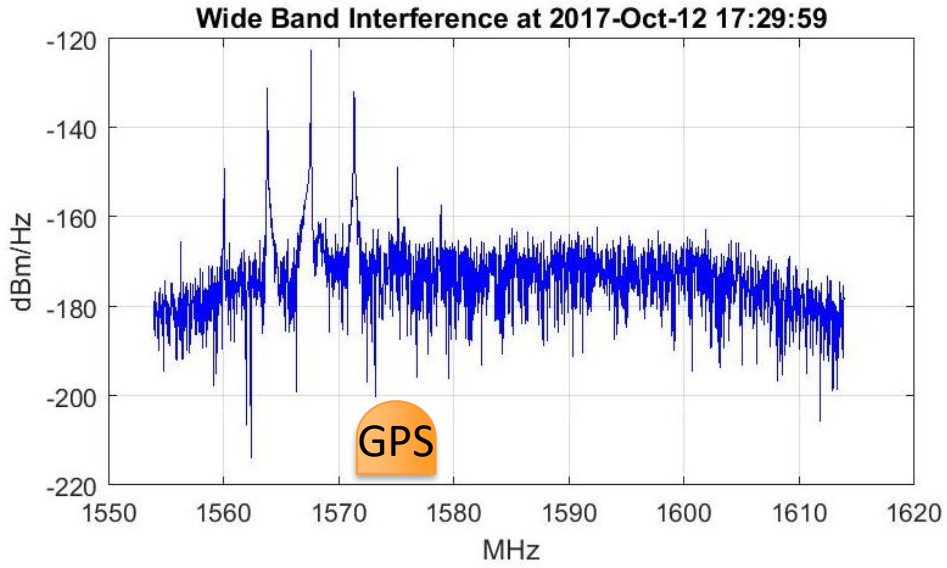
Example 2: Pulsed Jammers

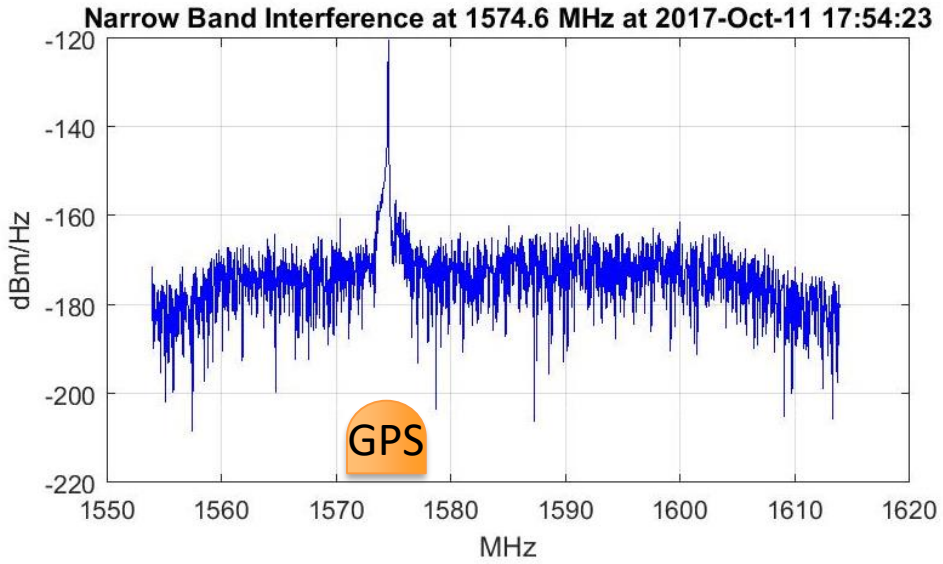




Example 3: Various

Unintentional?





CW at GPS L1, intentional?

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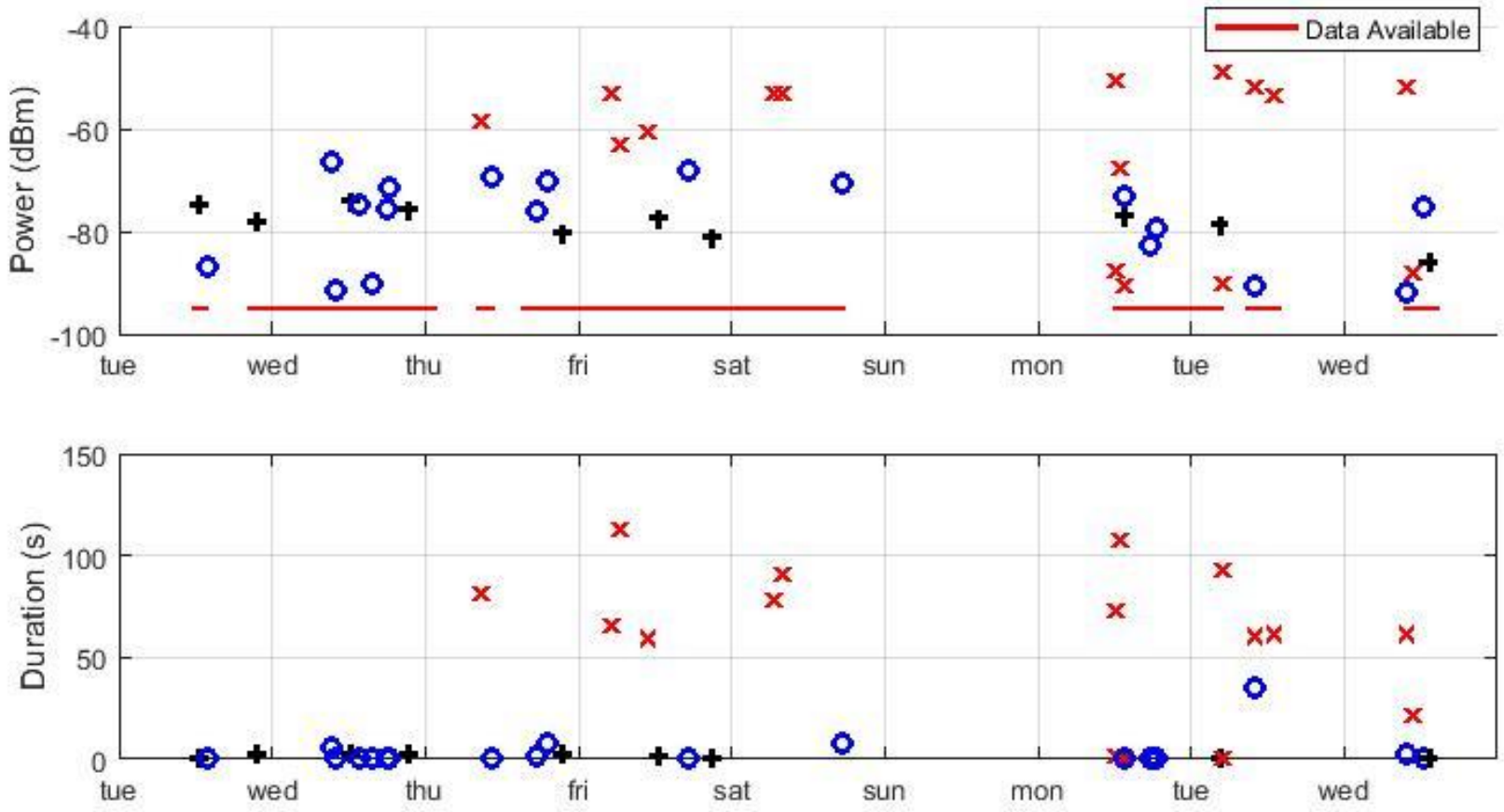
Event Power & Duration



- Chirp Jammer
- Pulsed Jammer
- Various

Direction & Lane Sensing

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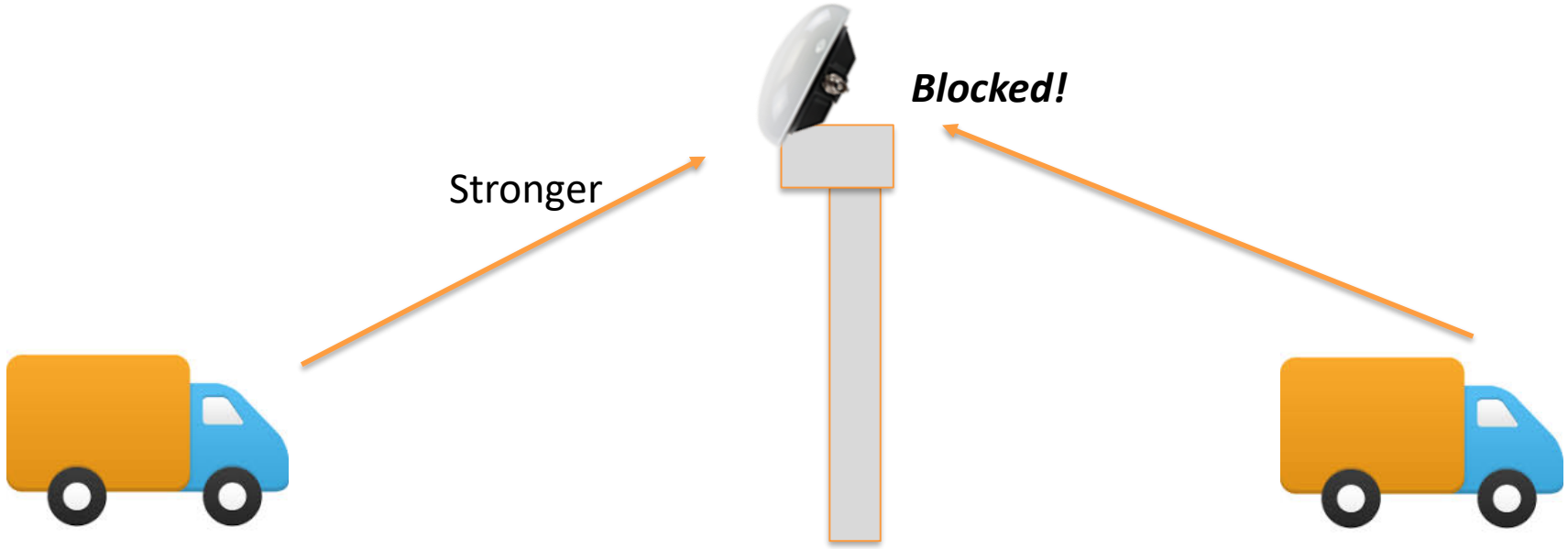
Direction Sensing

Skewness of power vs time



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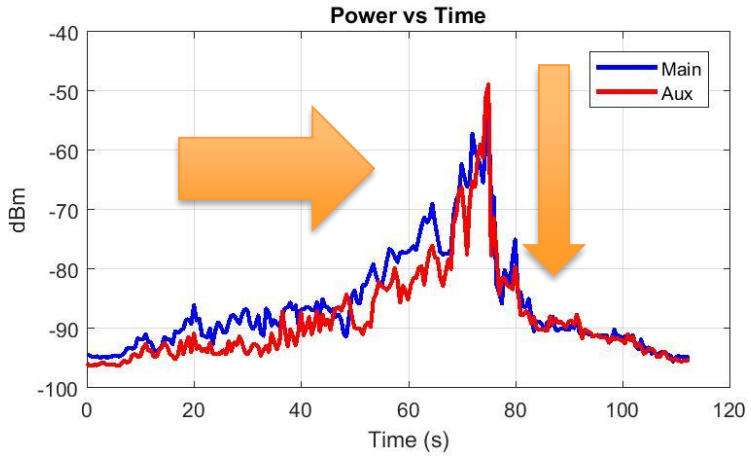
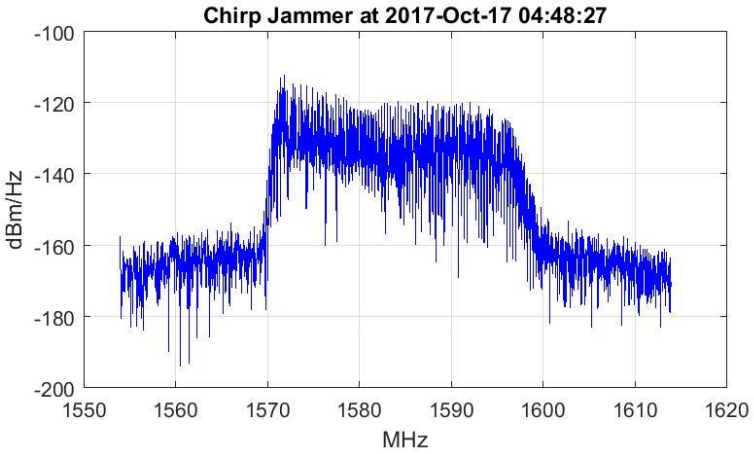
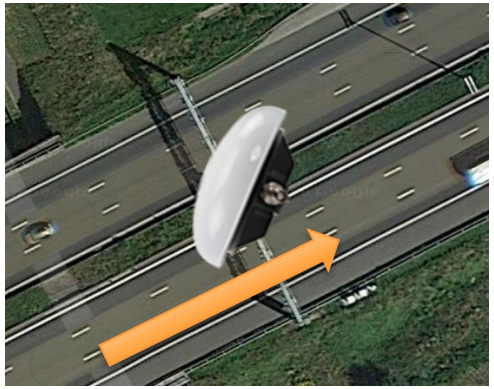
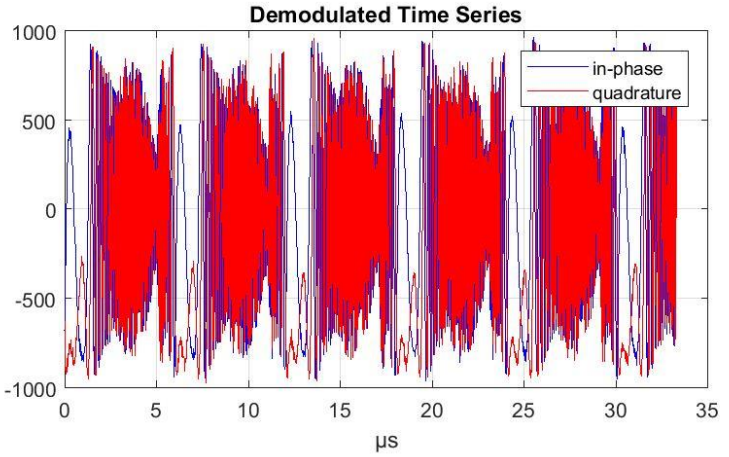
Eastbound Jammer

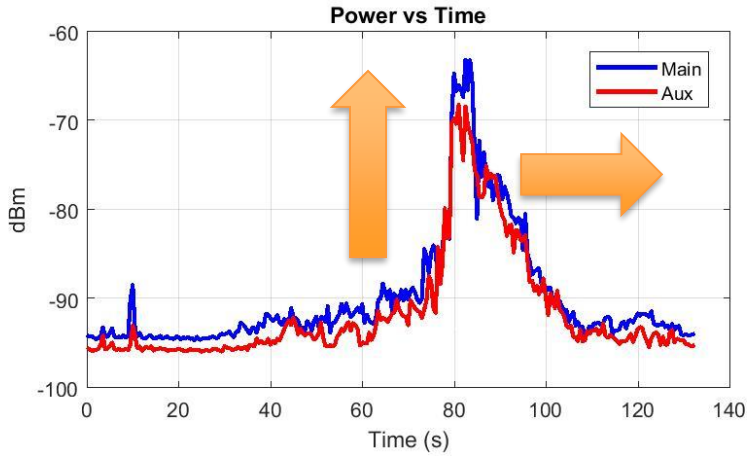


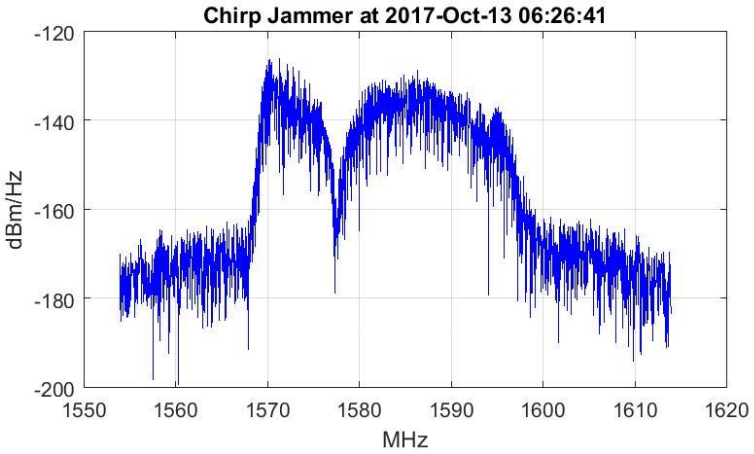


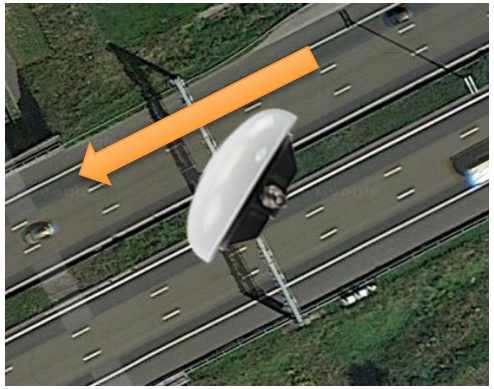


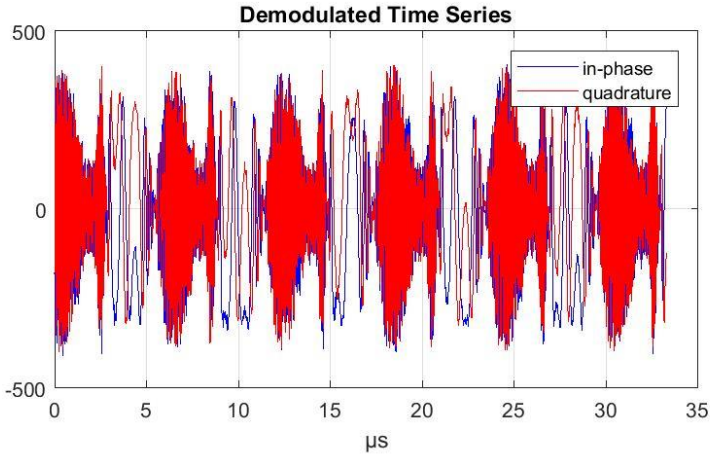


Westbound Jammer

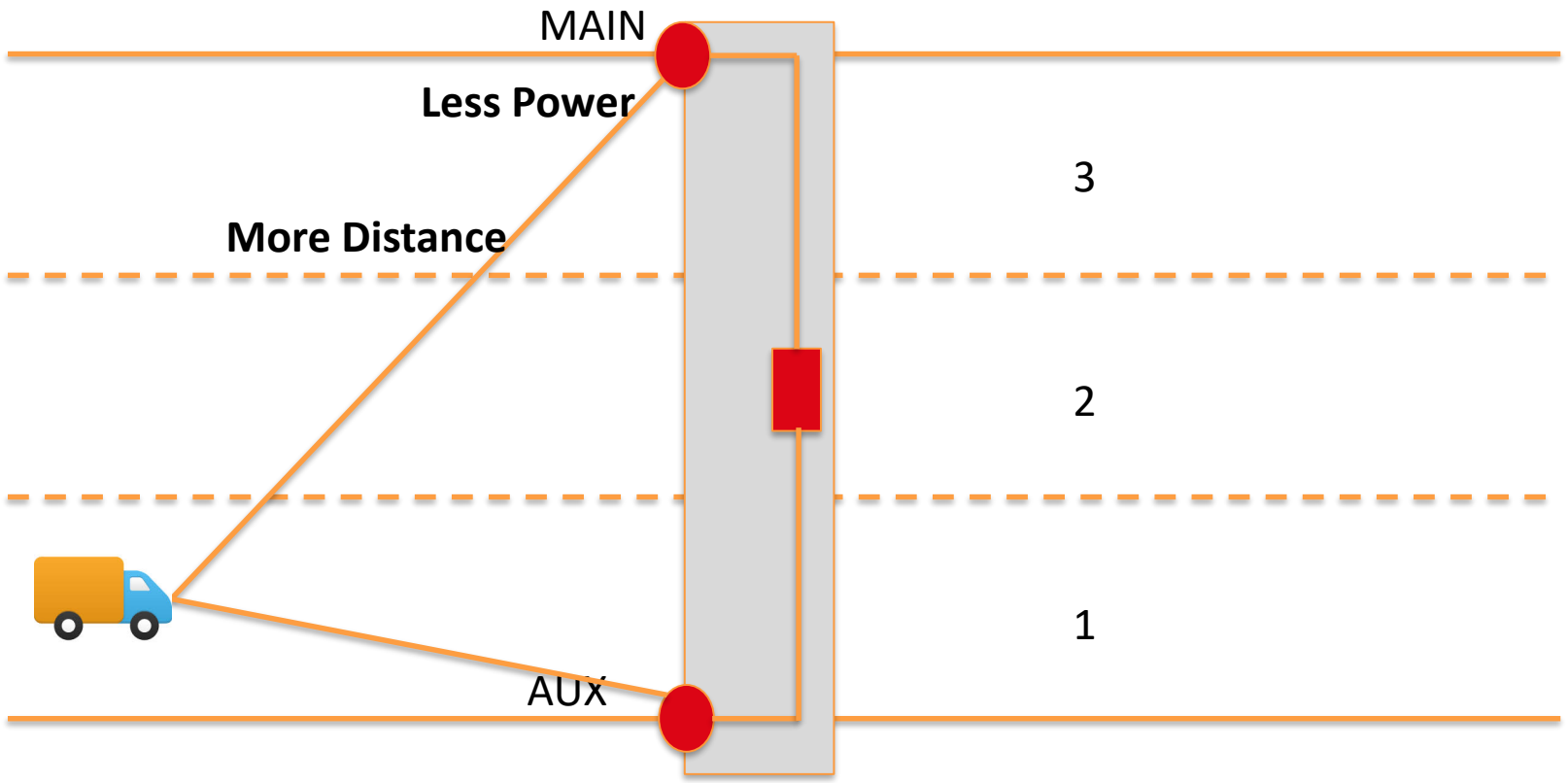








Lane Sensing



Main-Aux dtoa obtained from cross correlating the main and aux A/D samples

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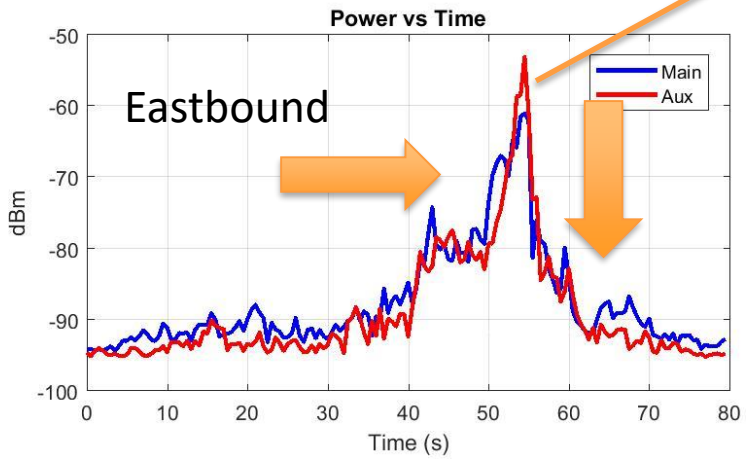
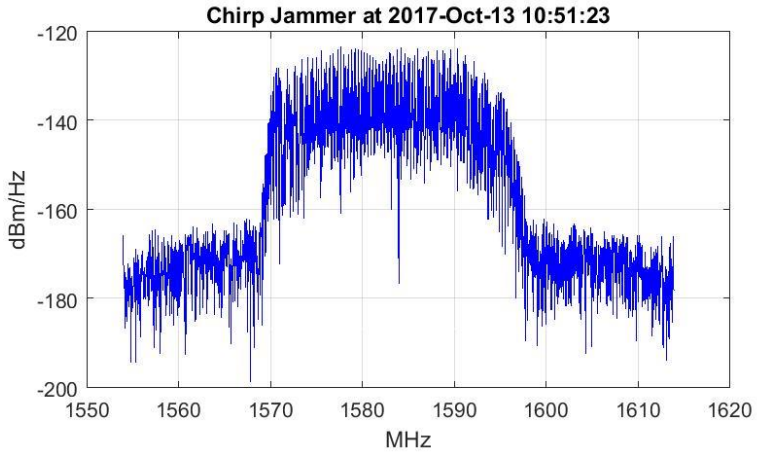
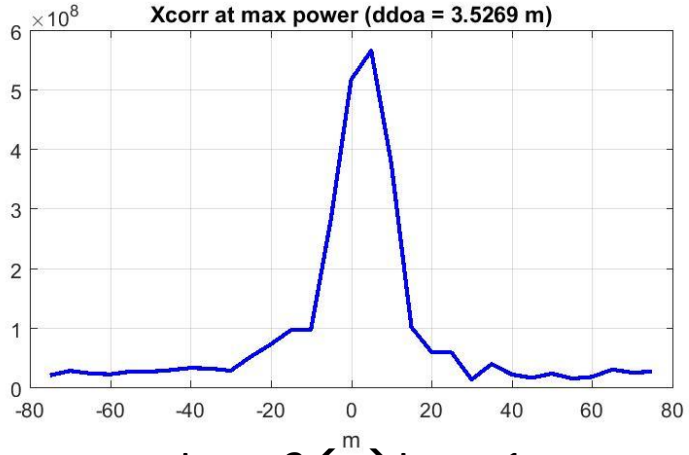
Lane Sensing

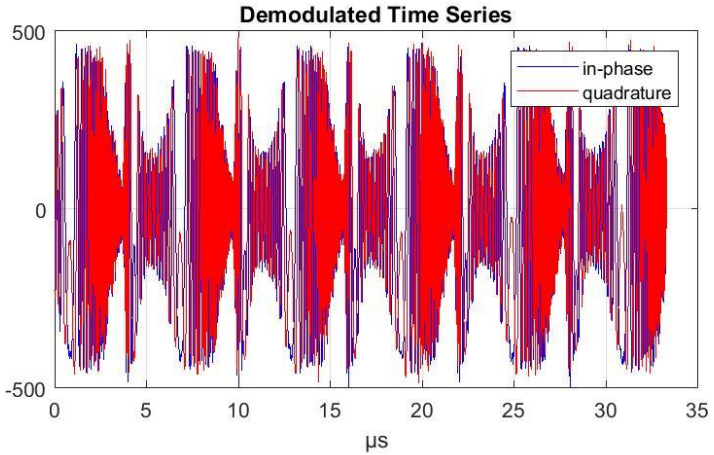
Aux power is highest
=> Lane 1







Lane 3←→Lane 1



Conclusions

Jammer detection&classification possible with GNSS receiver thanks to:

- Built-in A/D sample logging
- Detection and Classification tool

9 events per day. Chirp & pulsed jammers in 60% of the cases.

Direction and lane sensing possible with synchronous sampling of A/D on two antennas

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