

# Initial Results from Three Spectrum Survey Campaigns

Chriss Hammerschmidt  
Heather Ottke



# Three Survey Sites



Table Mountain



Denver Metro



San Diego

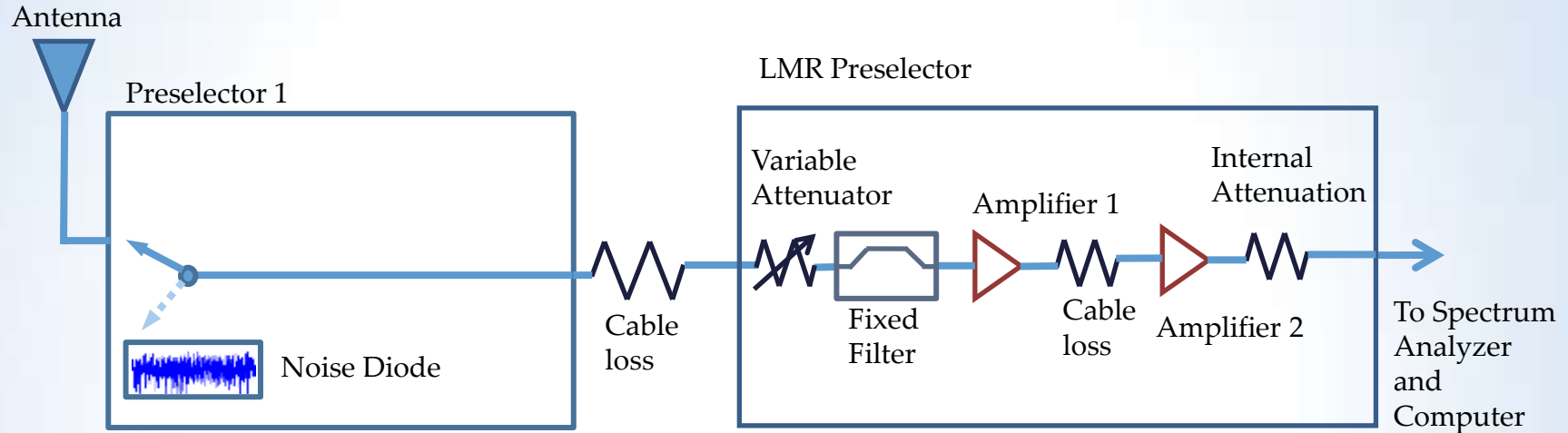
# Outline

- Motivation
- Equipment
- Algorithms
- Results
- Applications
- Conclusion

# Motivation

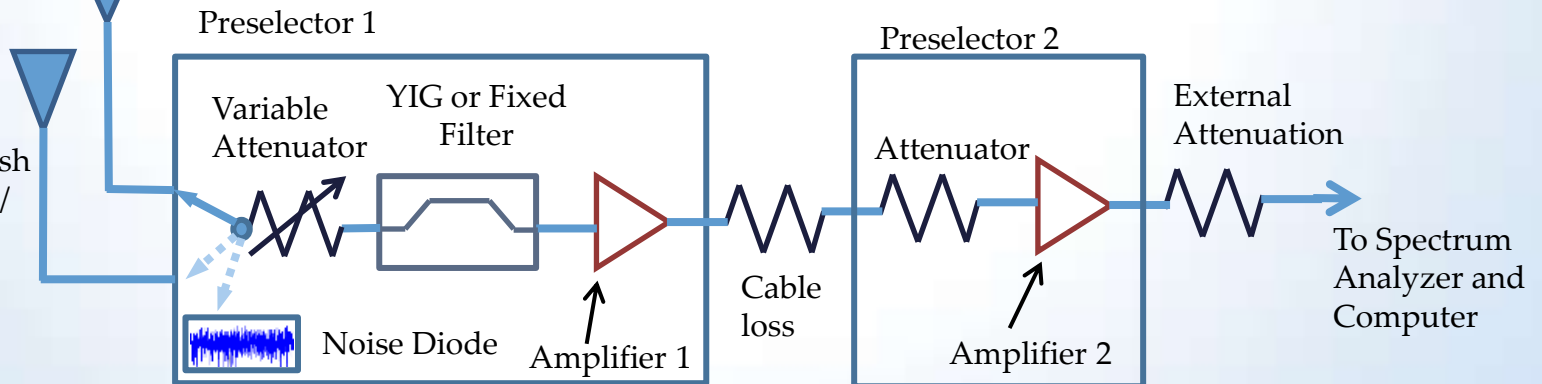
- Presidential Memorandum to find 500 MHz spectrum for wireless broadband
- FCC and GMF Databases show assignments
- Spectrum Surveys show activity levels

# Equipment and Setup

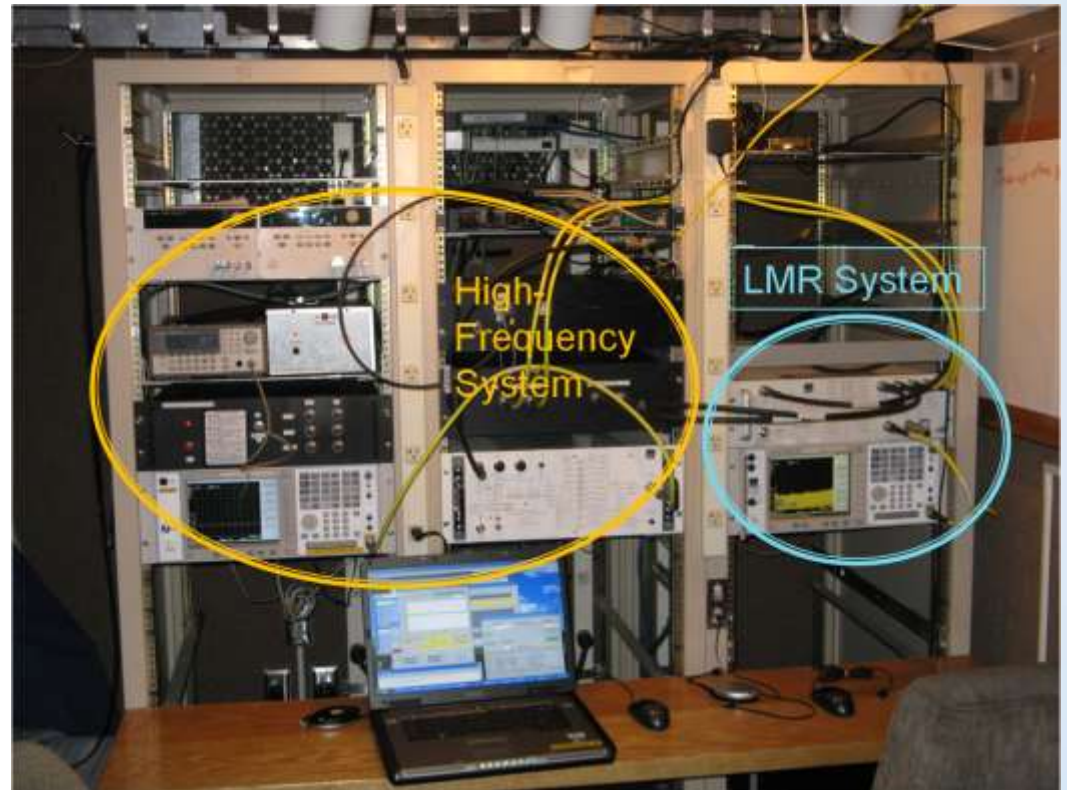


Discone Antenna  
Frequency < 1 GHz

Omni Antenna / Dish  
Frequency > 1 GHz /  
Point-2-Point



# Equipment and Setup

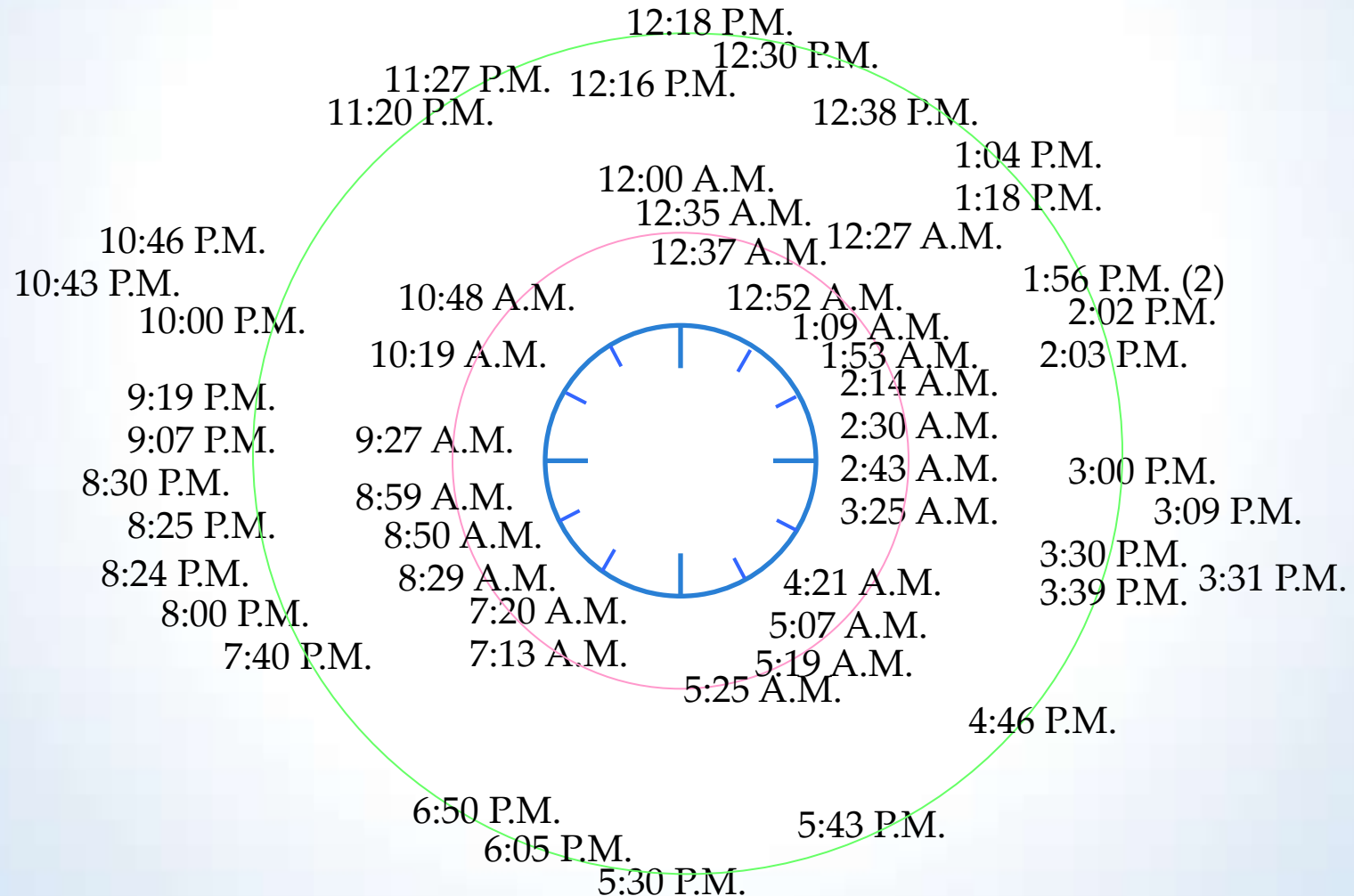


# Algorithms

- Swept-Spectrum Algorithm
  - Used for most of the measured bands
- Stepped-Spectrum Algorithm
  - Dynamic Range adjustment on a frequency-by-frequency basis
  - Measurement band stepping from frequency to frequency
  - Sweep Time is set to rotation or sweep rate of radar.
- FFT Algorithm
  - Measurements using time-domain mode of spectrum analyzer
  - Capture time ~ 200 ms
  - Median of 5 traces saved to file to minimize impulsive noise
- Azimuthal-Scanning Algorithm
  - High-gain antenna used to scan space in azimuth.
  - Data is captured point-2-point microwave bands .

# Clock Plots

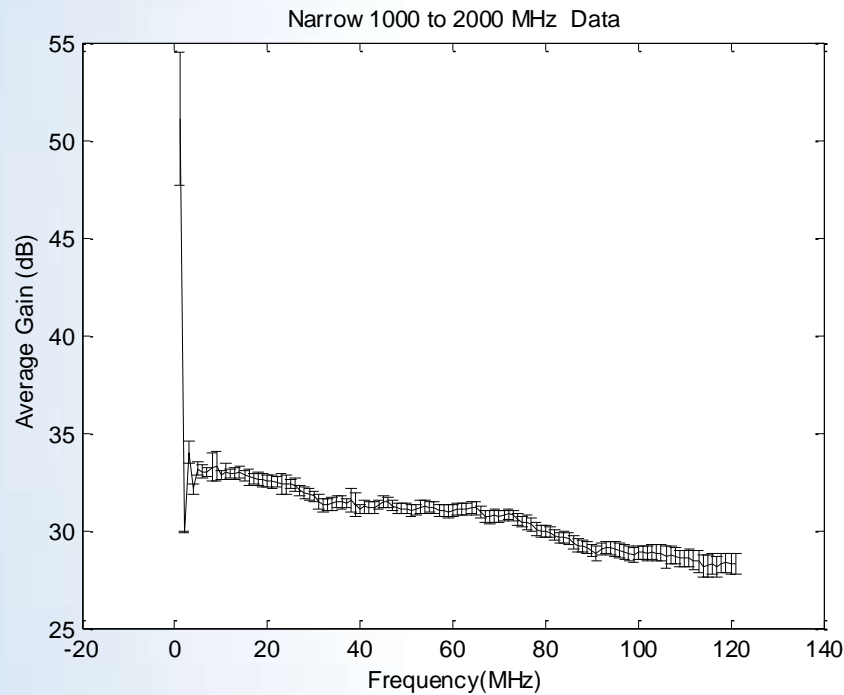
## Cellular, LMR, and Misc (763 - 1000 MHz)



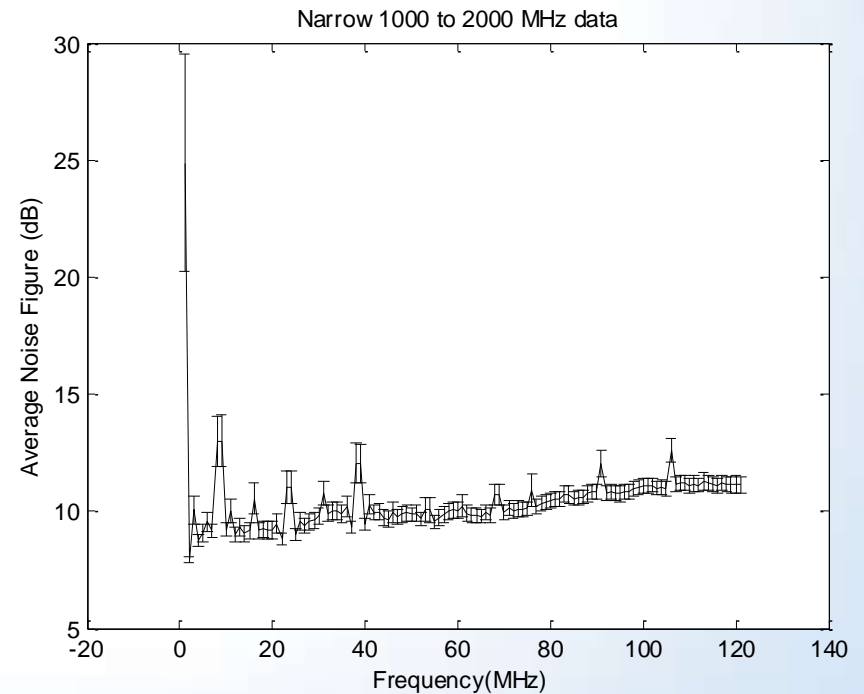


# Results

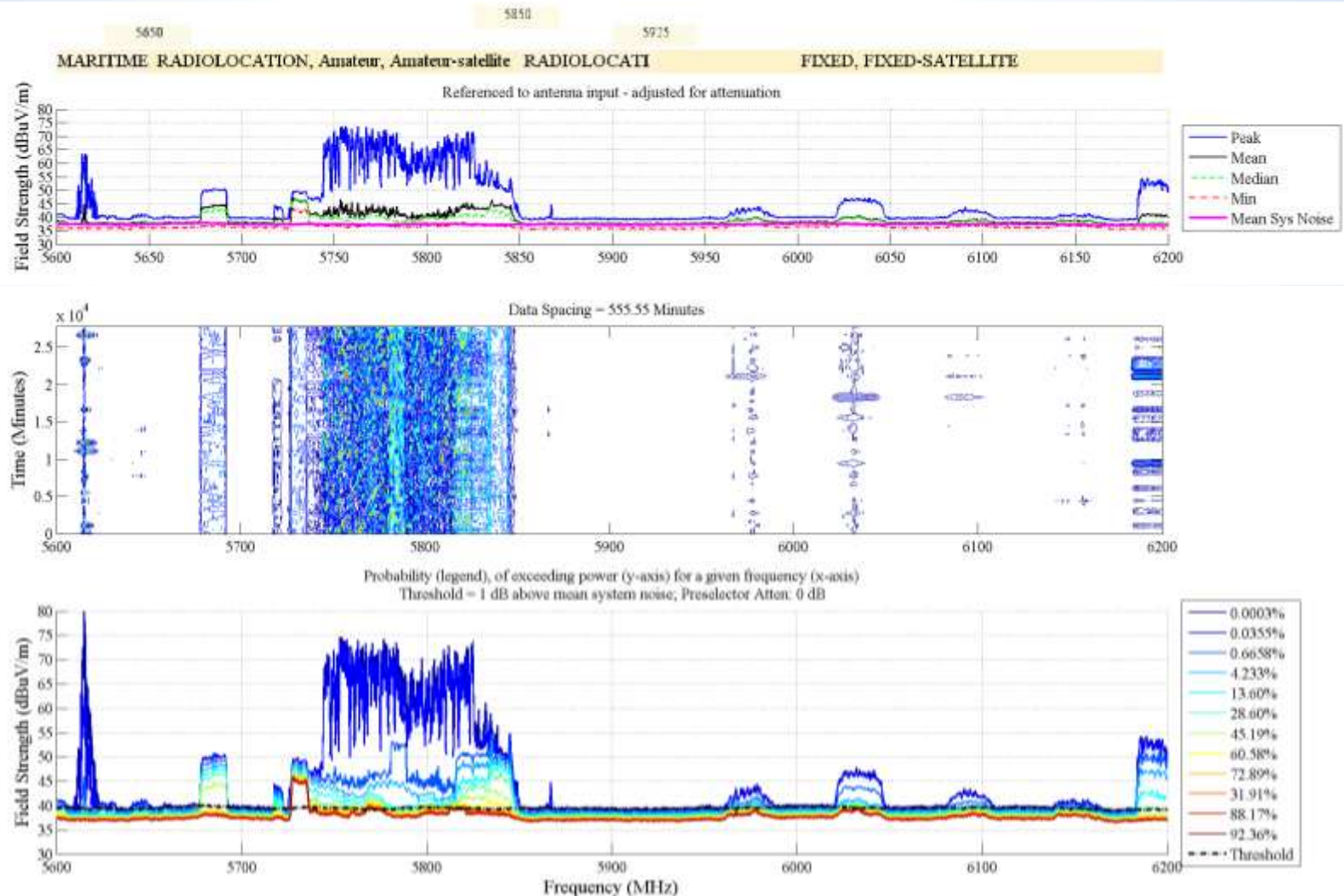
## Calibration Statistics



Narrowband  
1000 to 2000 MHz



# Results



# Percent Probability Distributions

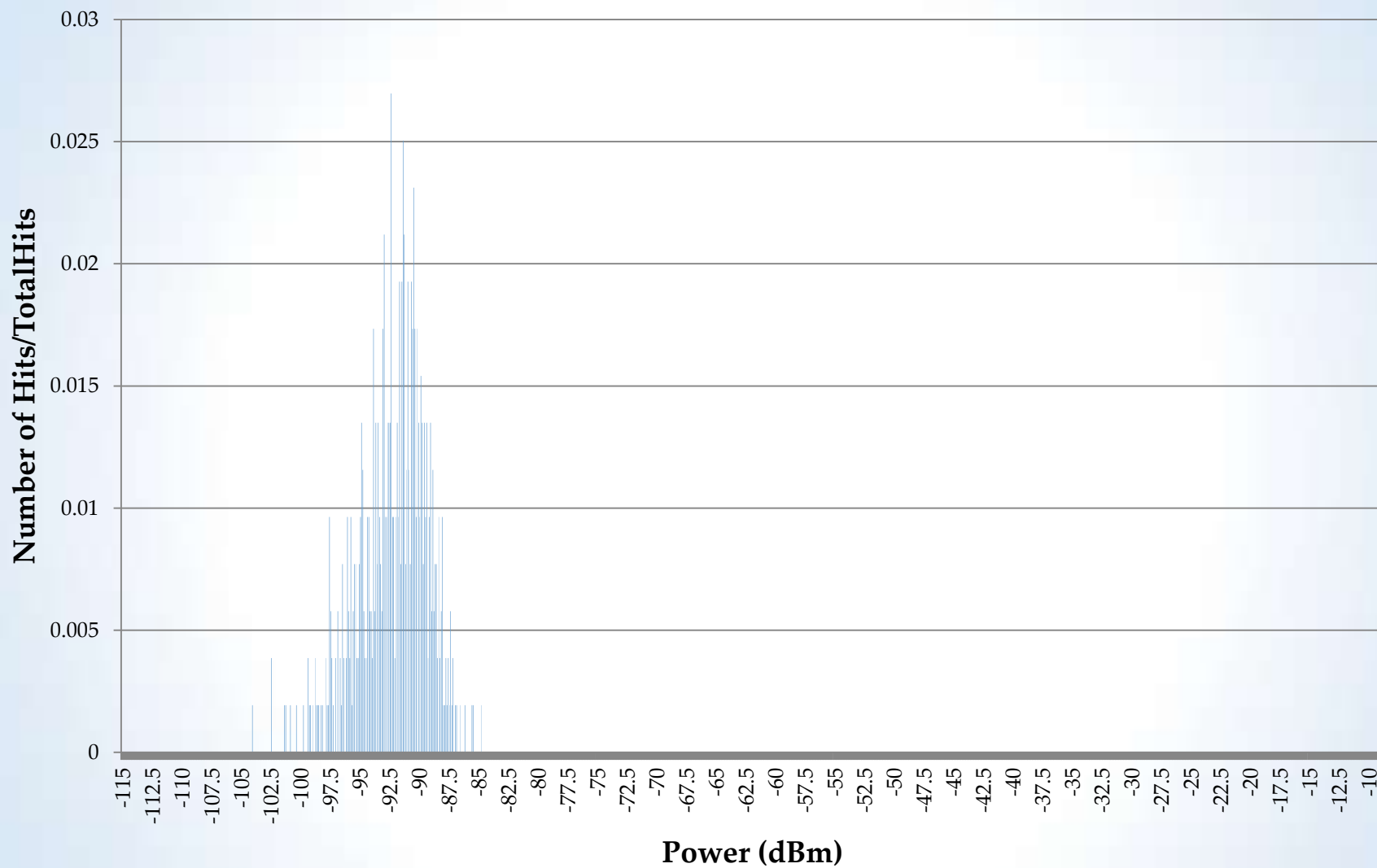
Frequency (MHz) - - - >

Power  
(dBm)



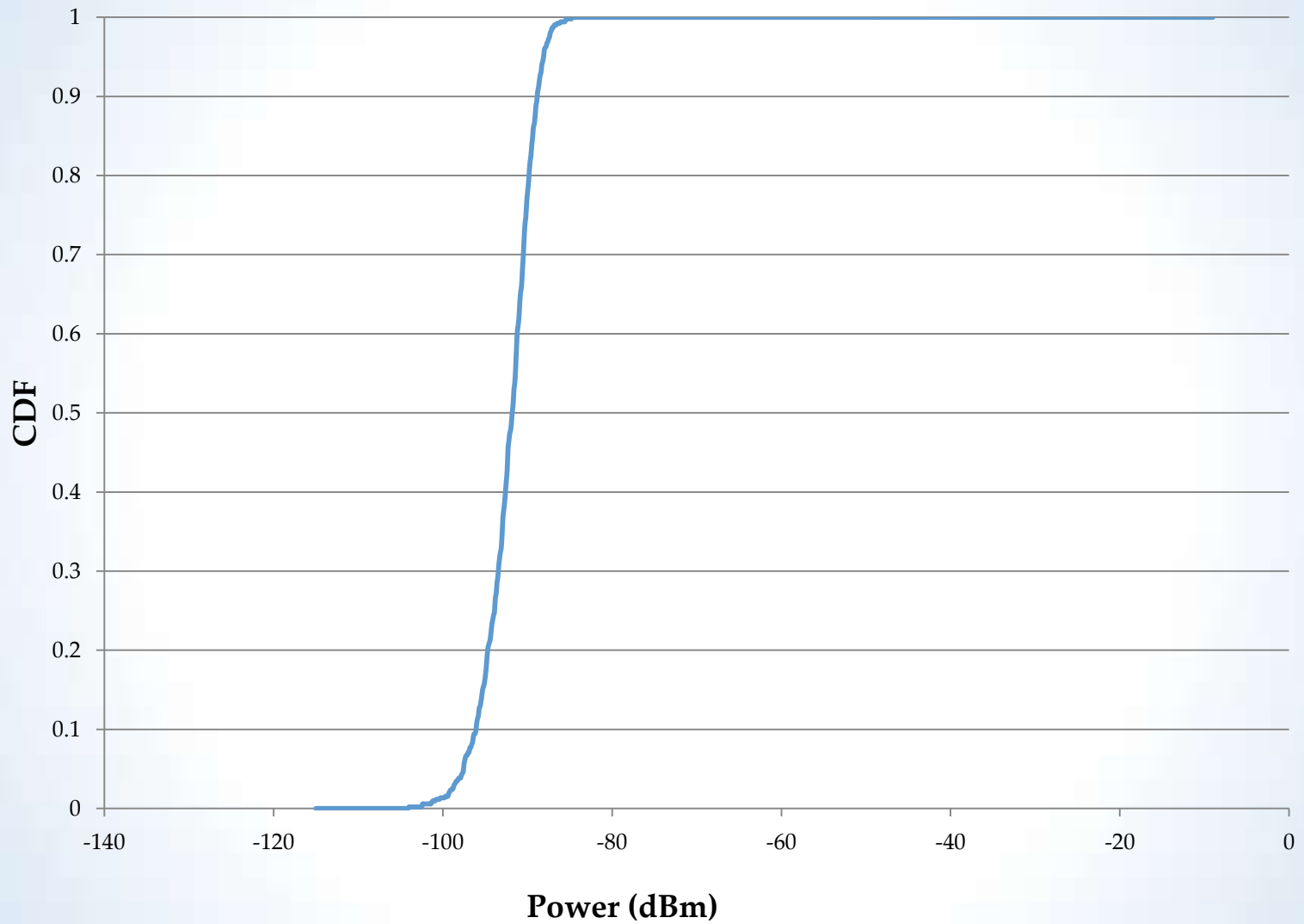
	116.0063	116.0125	116.0188	116.0250	116.0313
-91.4	10	8	12	6	6
-91.3	13	9	6	12	6
-91.2	11	9	8	4	9
-91.1	4	7	10	5	5
-91.0	6	10	12	8	11
-90.9	10	5	9	4	3

# PDF (116.00 MHz)



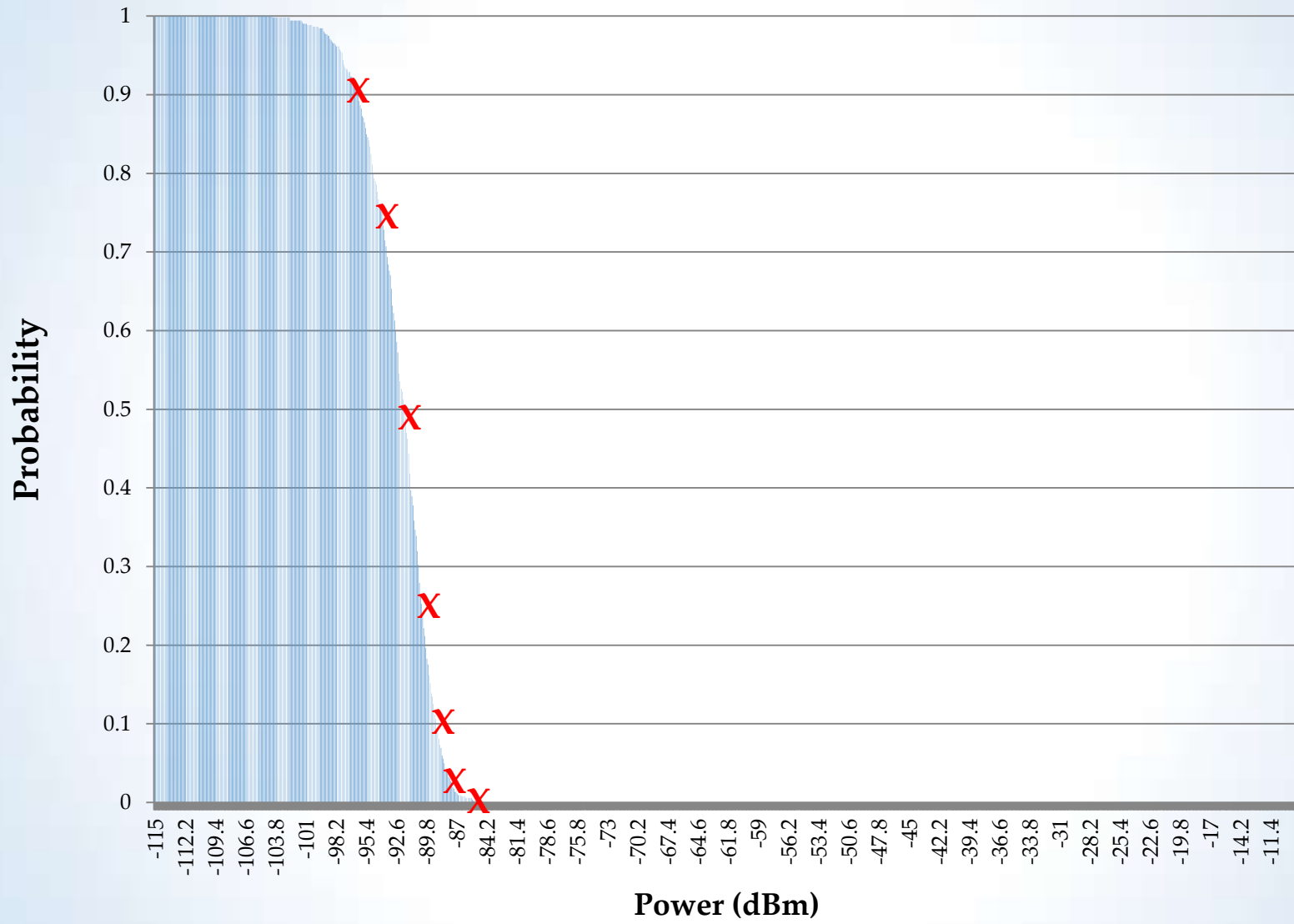
$$P(a \leq X \leq b)$$

## CDF - 116.00 MHz



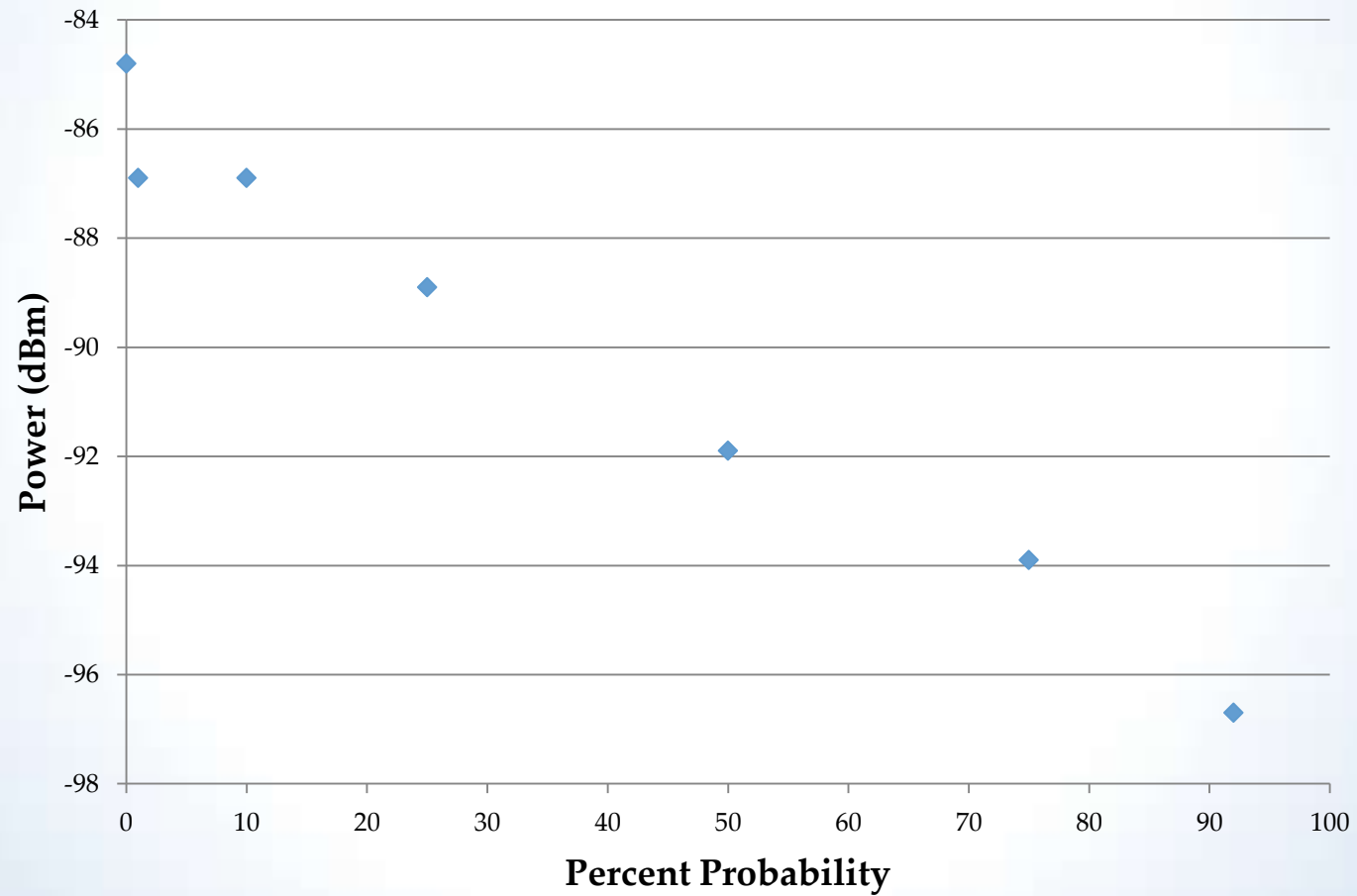
$$P(X \leq \text{Power})$$

# CCDF (116.00 MHz)

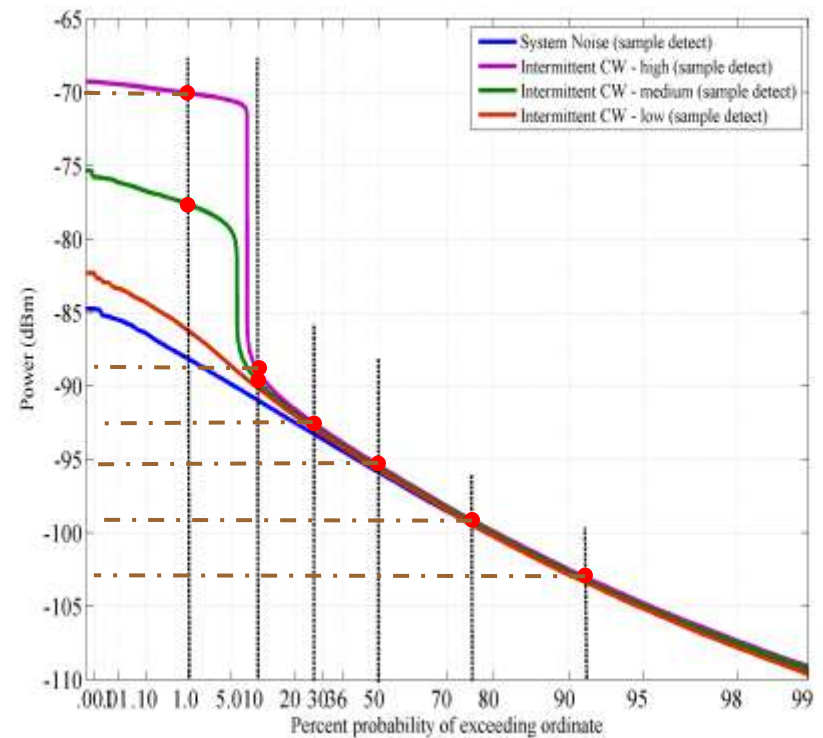
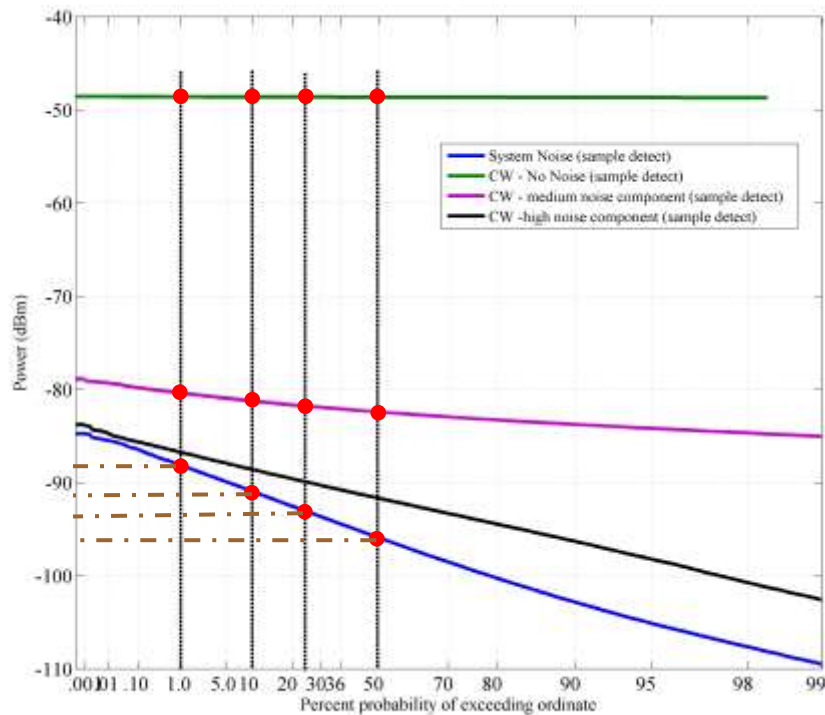


$$P(X > \text{Power})$$

## Power Probability Distribution (116.00 MHz)

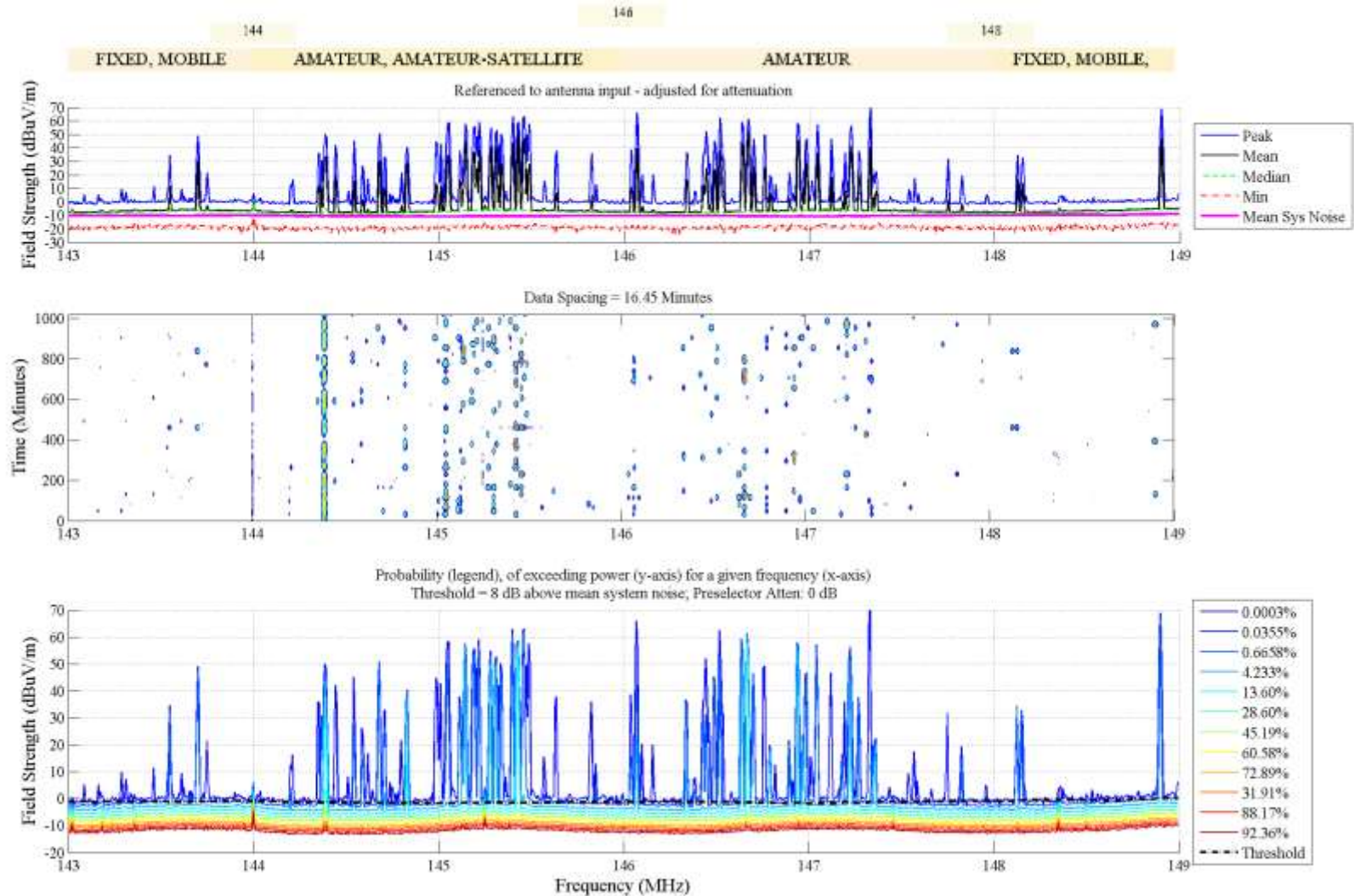


# Signal classification

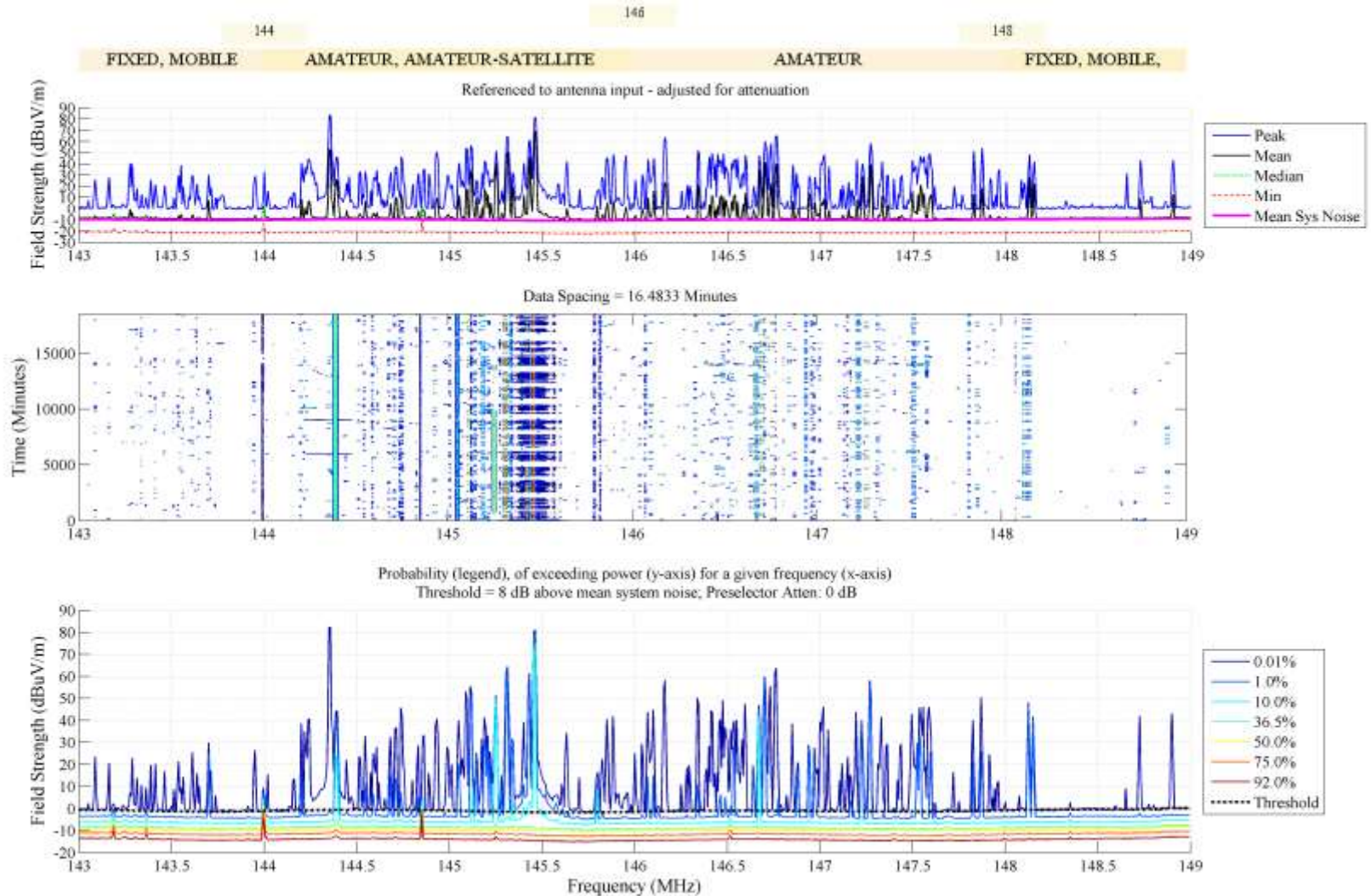




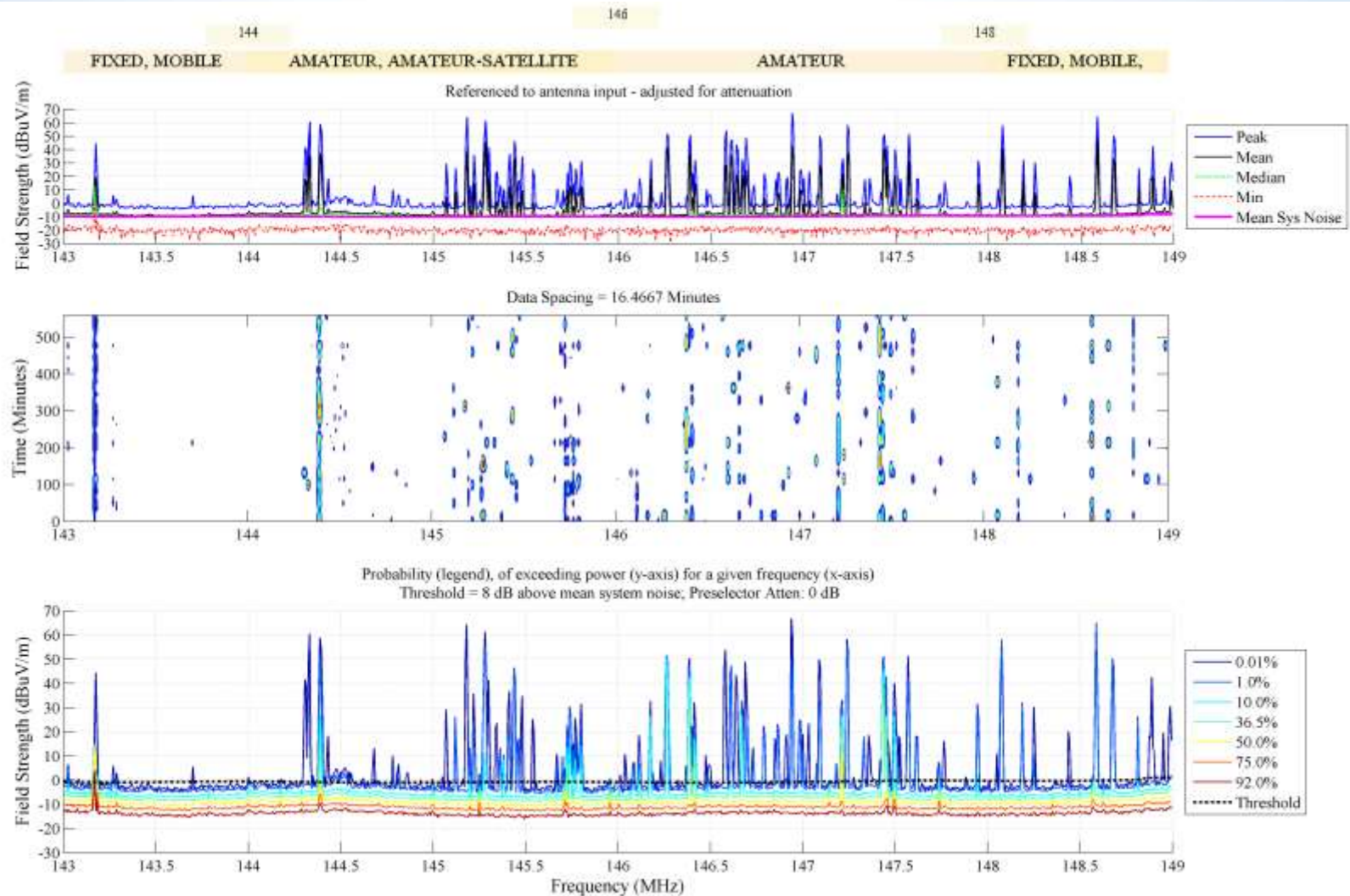
# Results (143 – 149 MHz)



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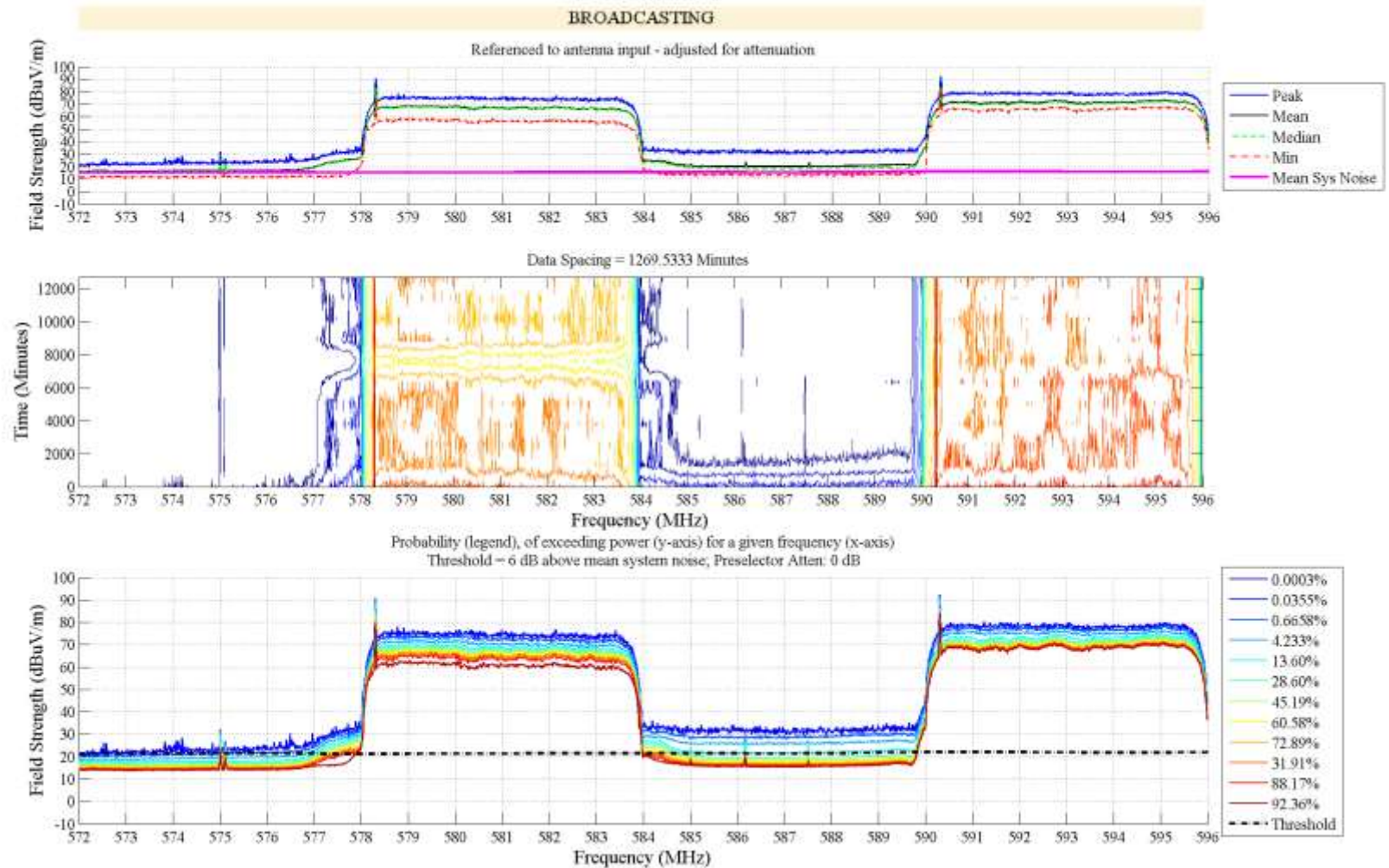


# Results (143 – 149 MHz)

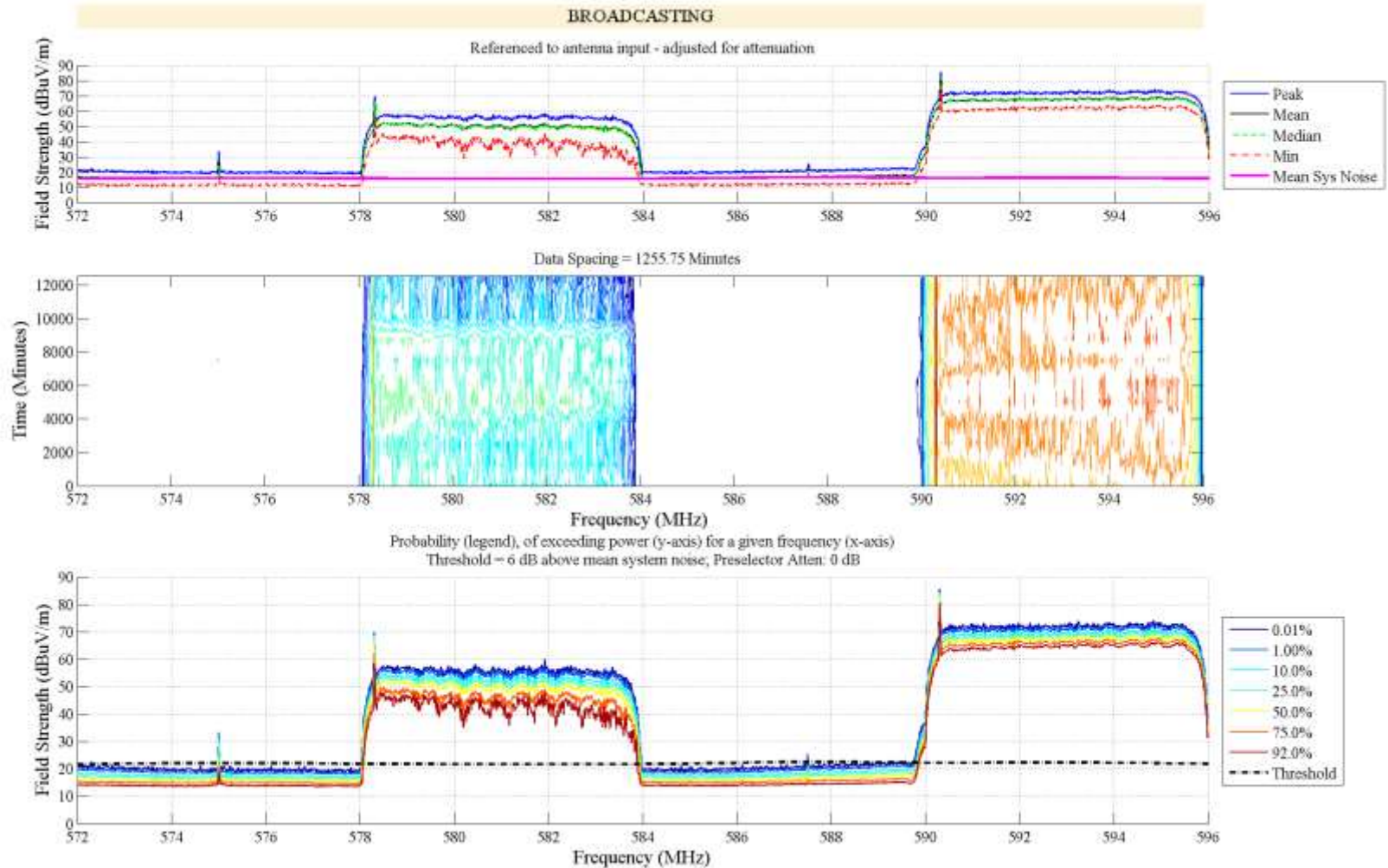




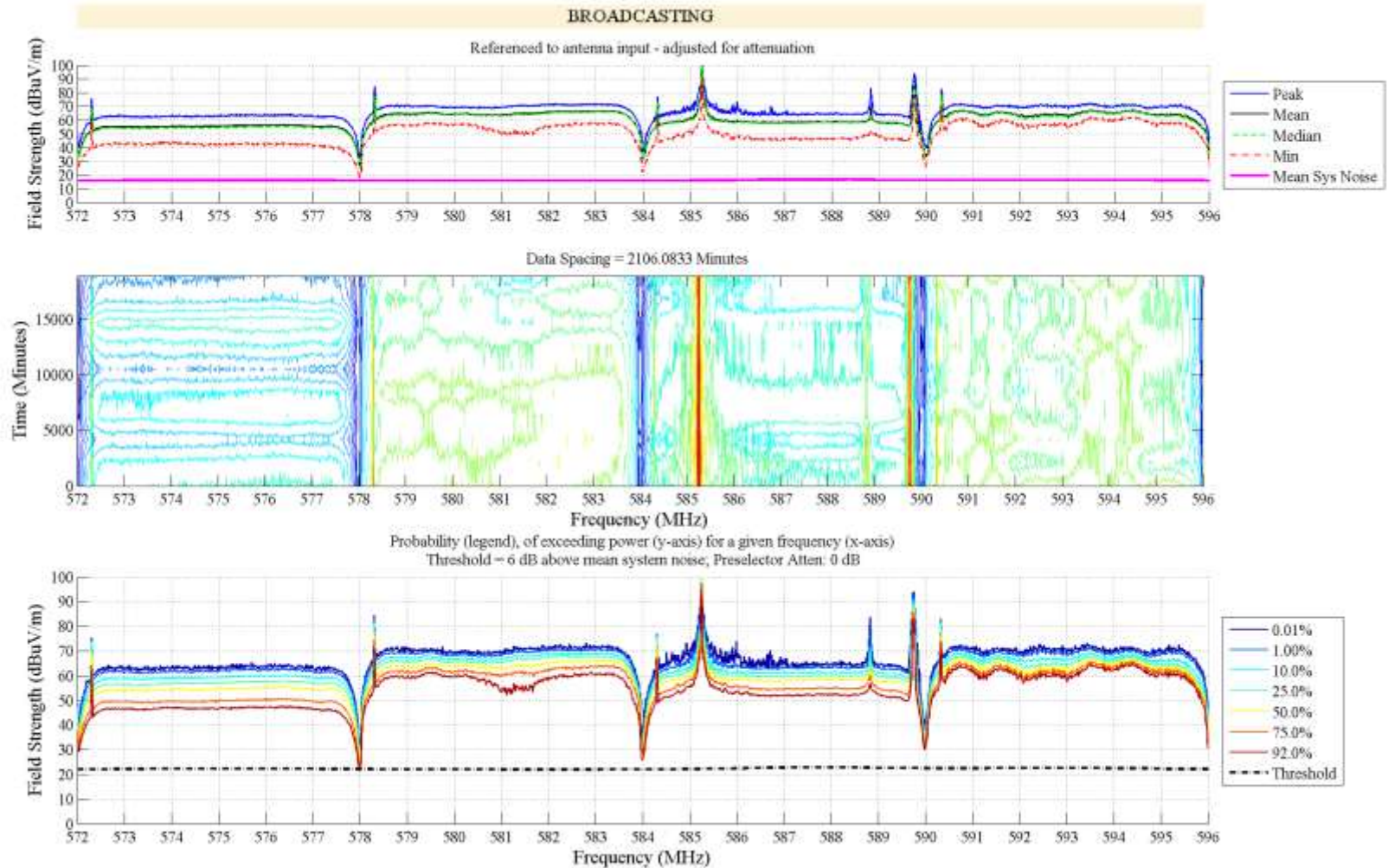
# Results (572 – 596 MHz)



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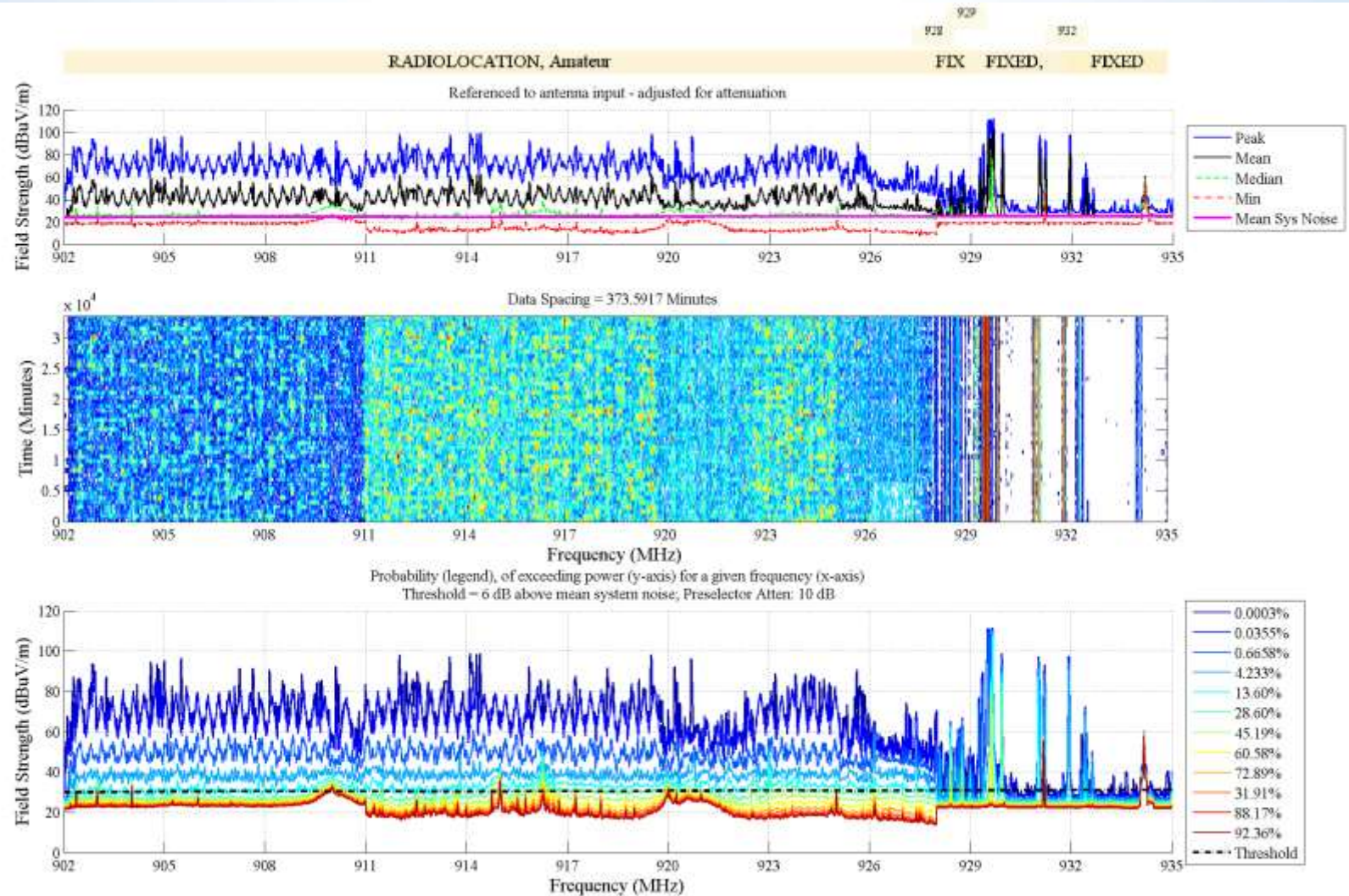


# Results (572 – 596 MHz)

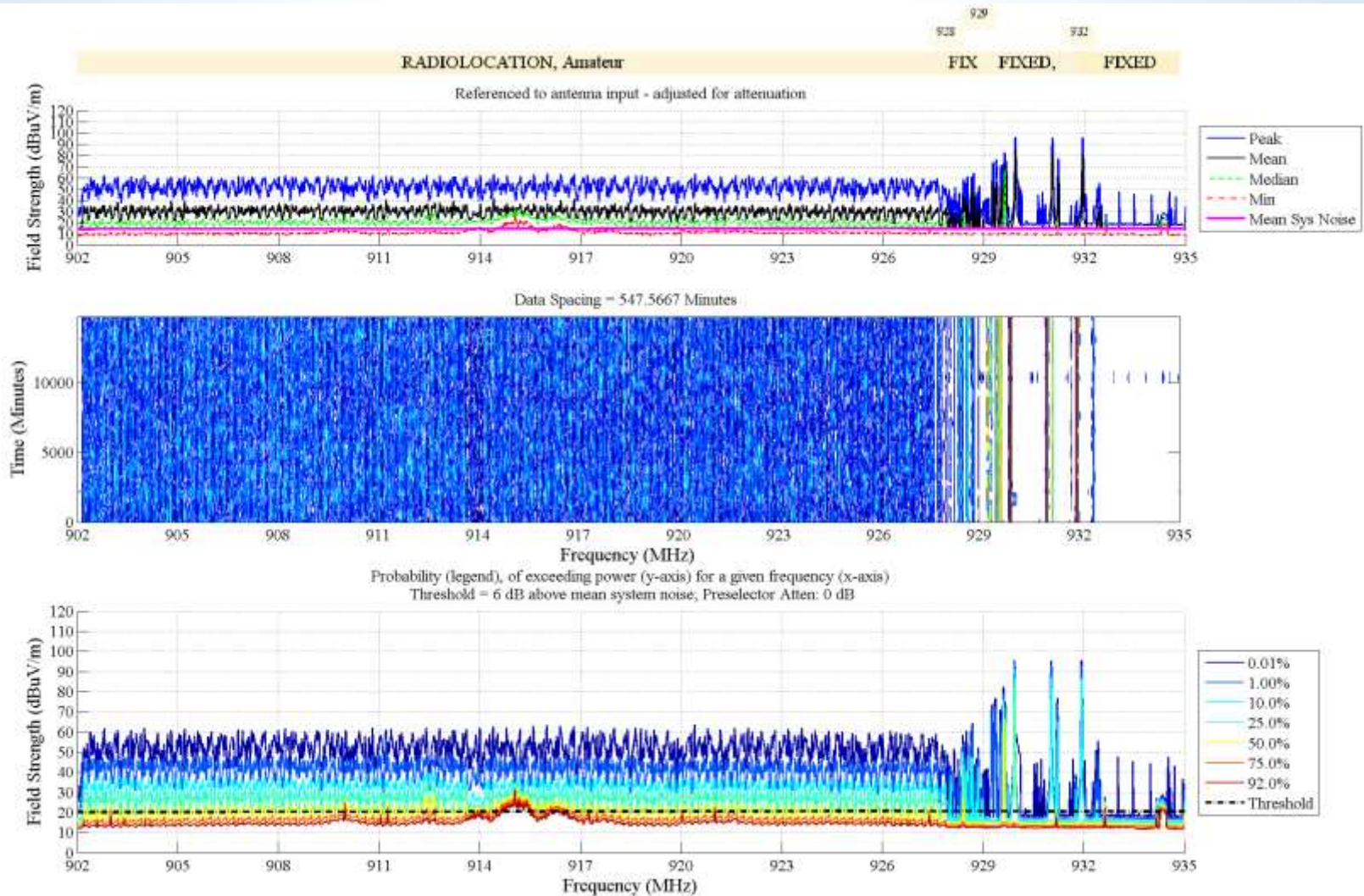




# Results (902 – 928 MHz)

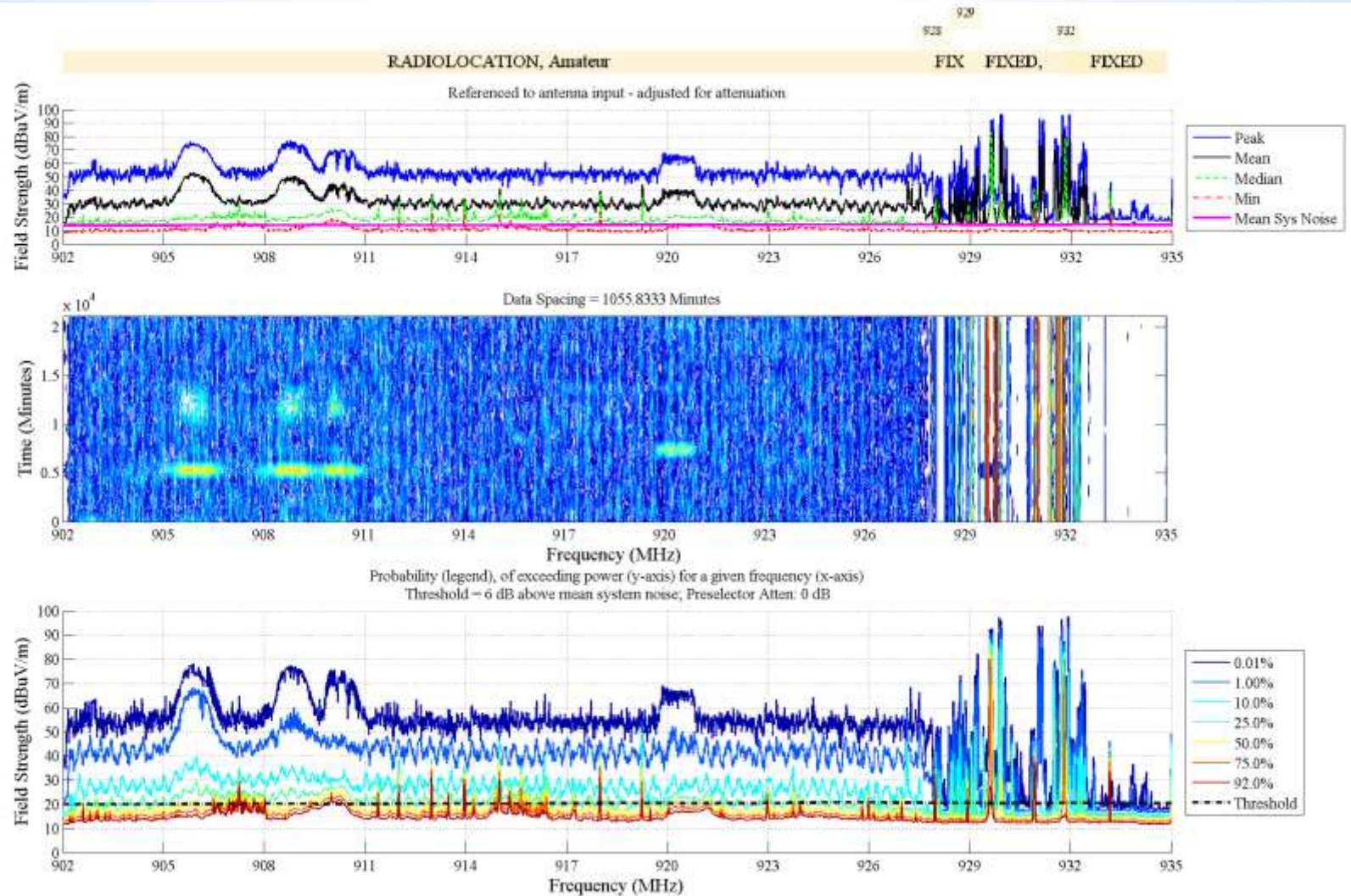


# Results (902 – 928 MHz)

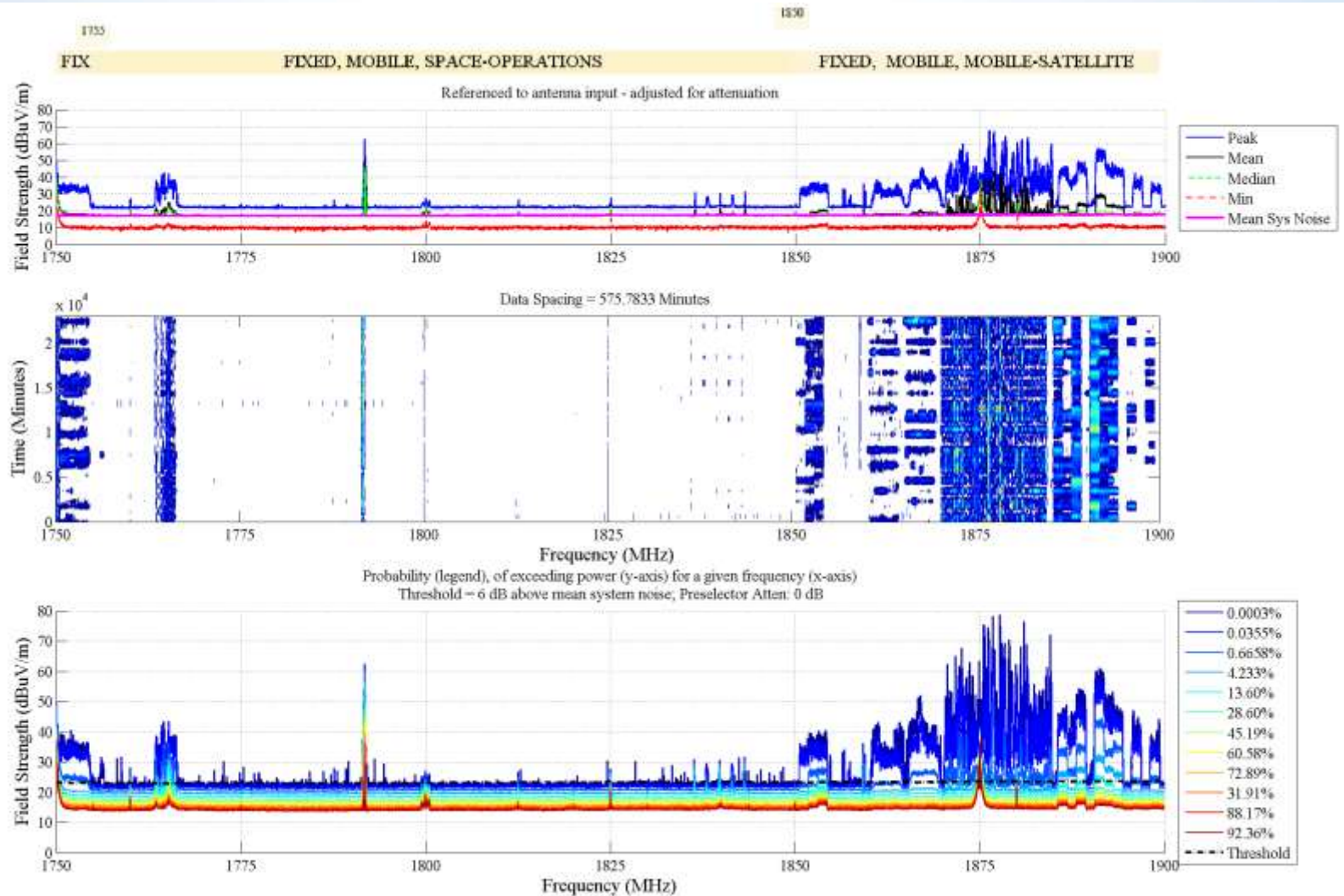




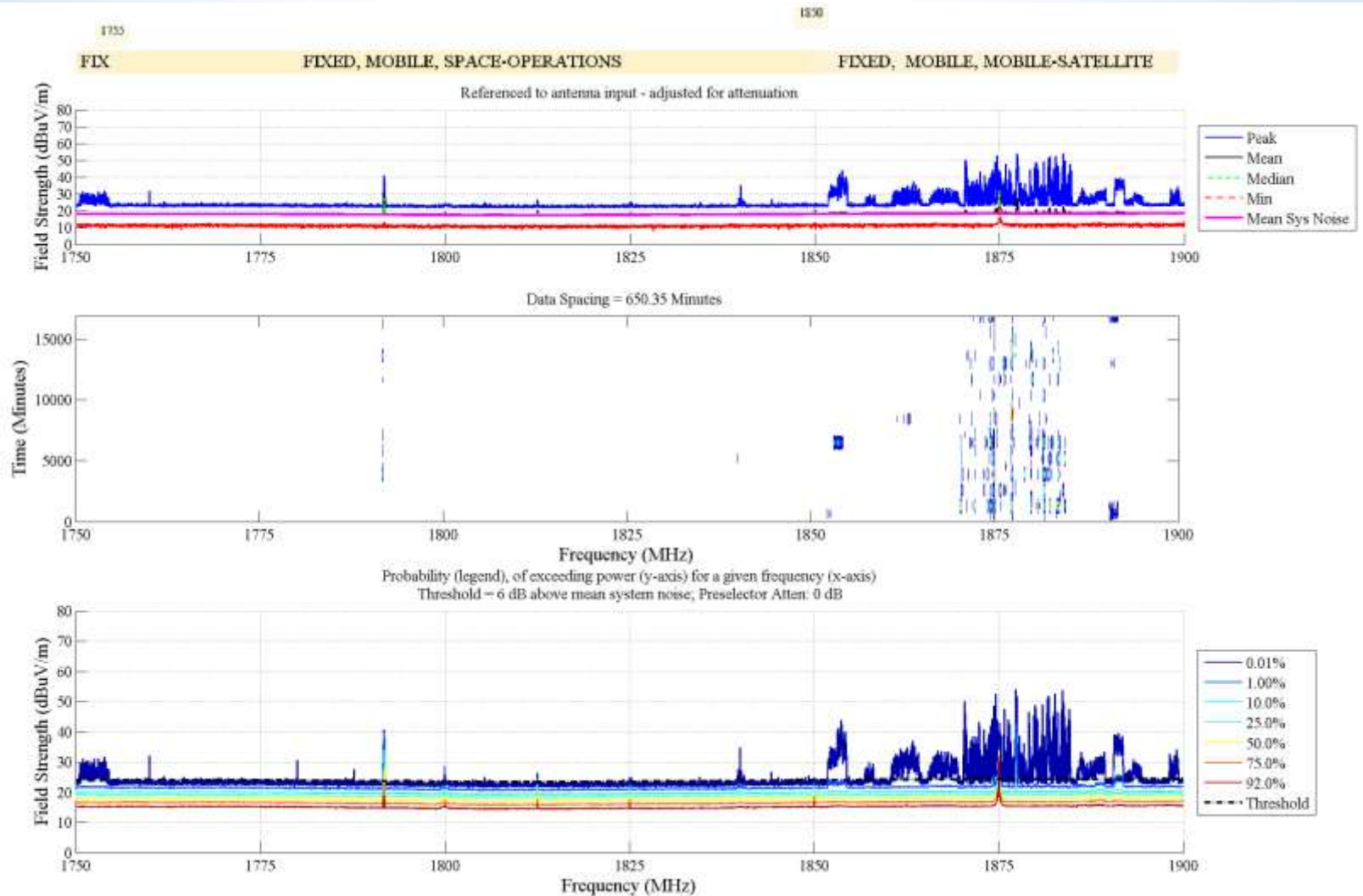
# Results (902 – 928 MHz)



# Results (1750 – 1900 MHz)

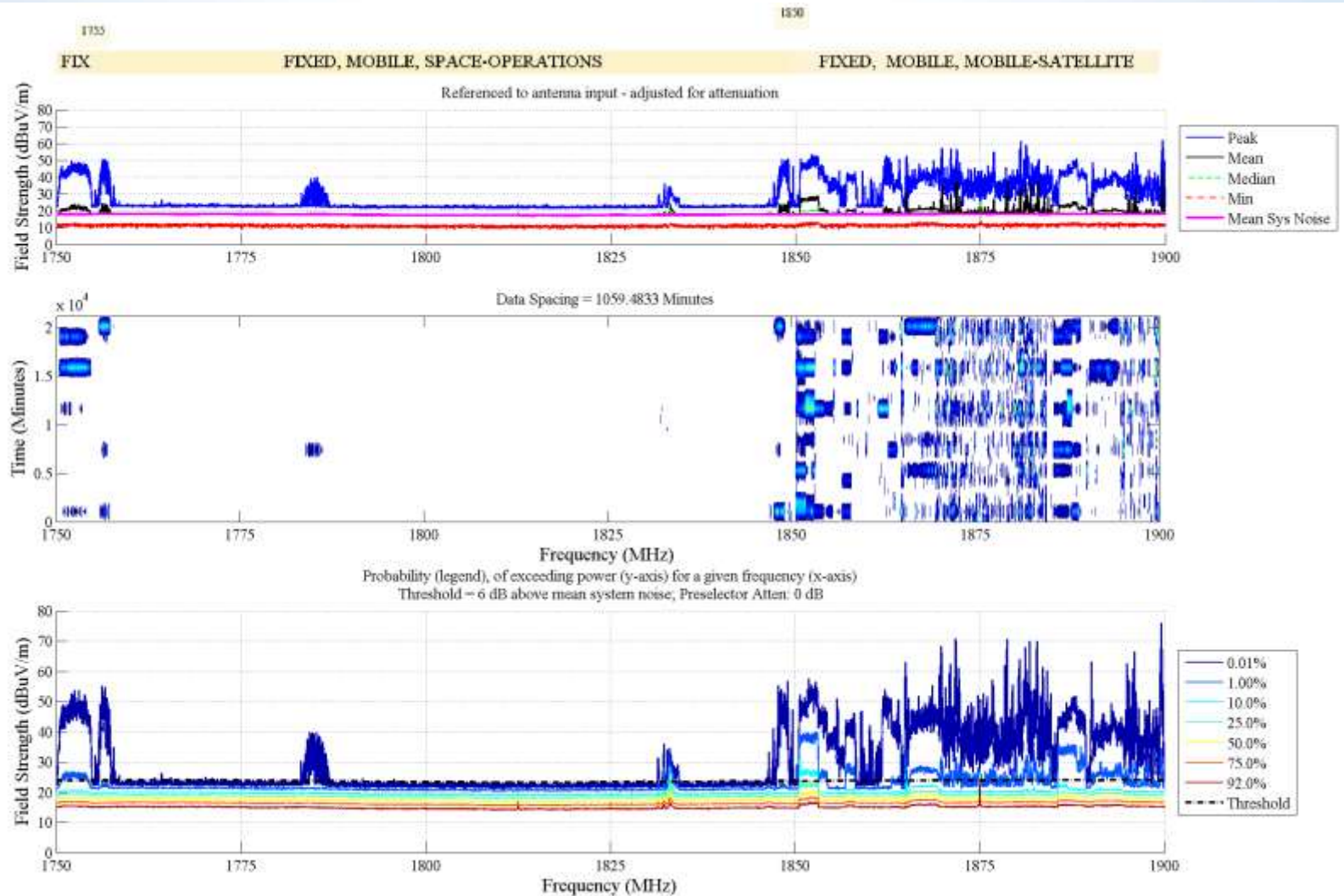


# Results (1750 – 1900 MHz)

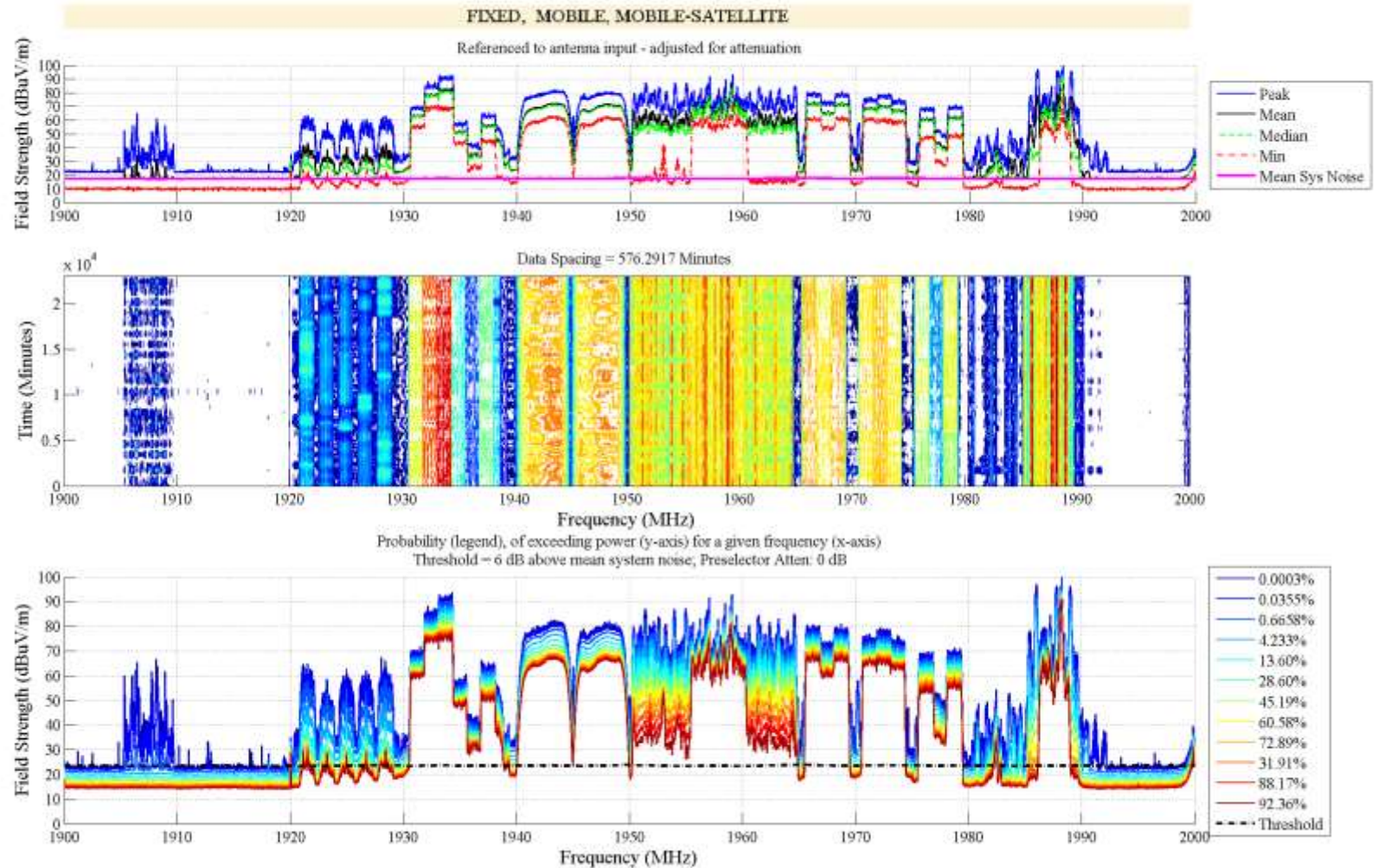




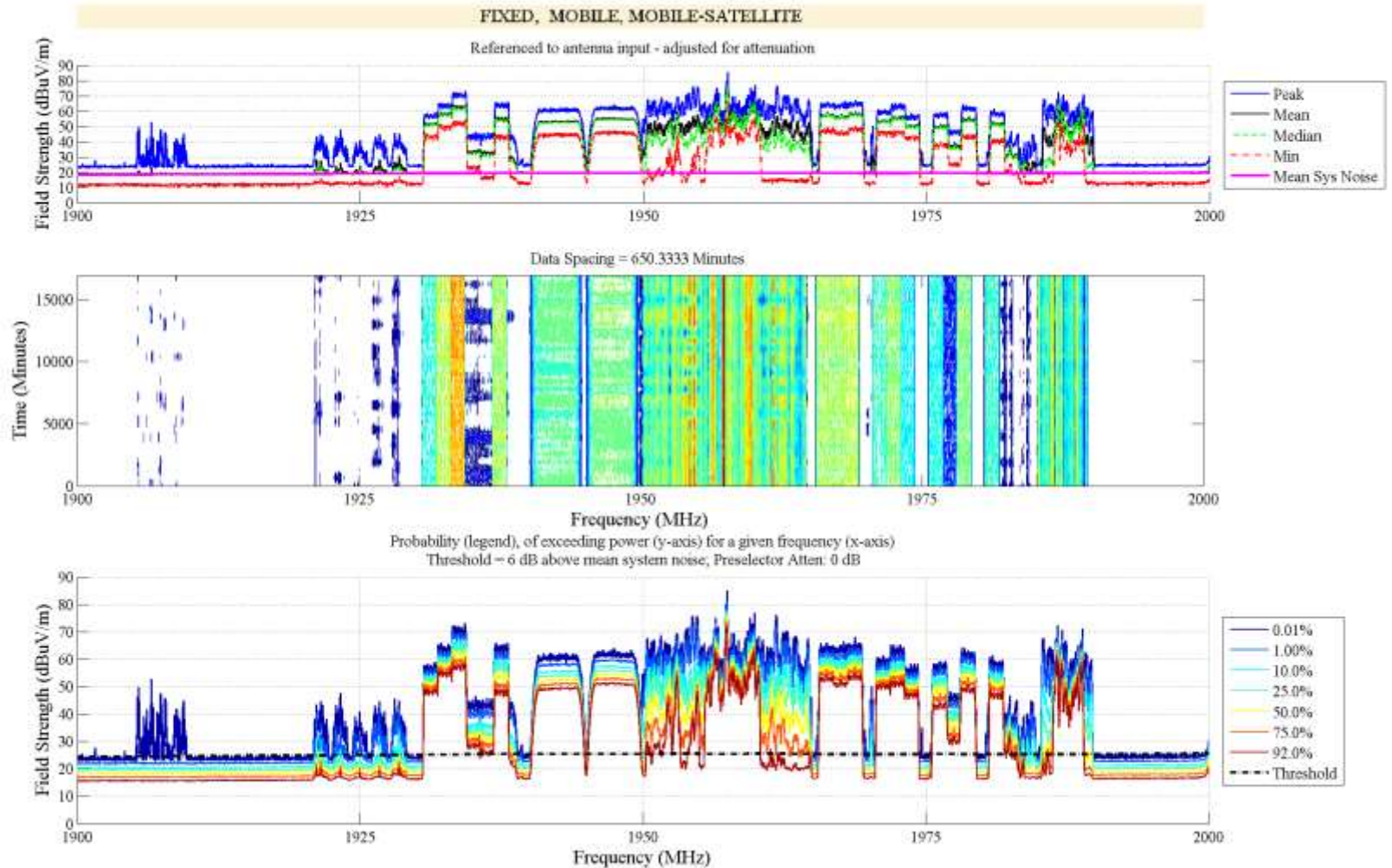
# Results (1750 – 1900 MHz)



# Results (1900 – 2000 MHz)

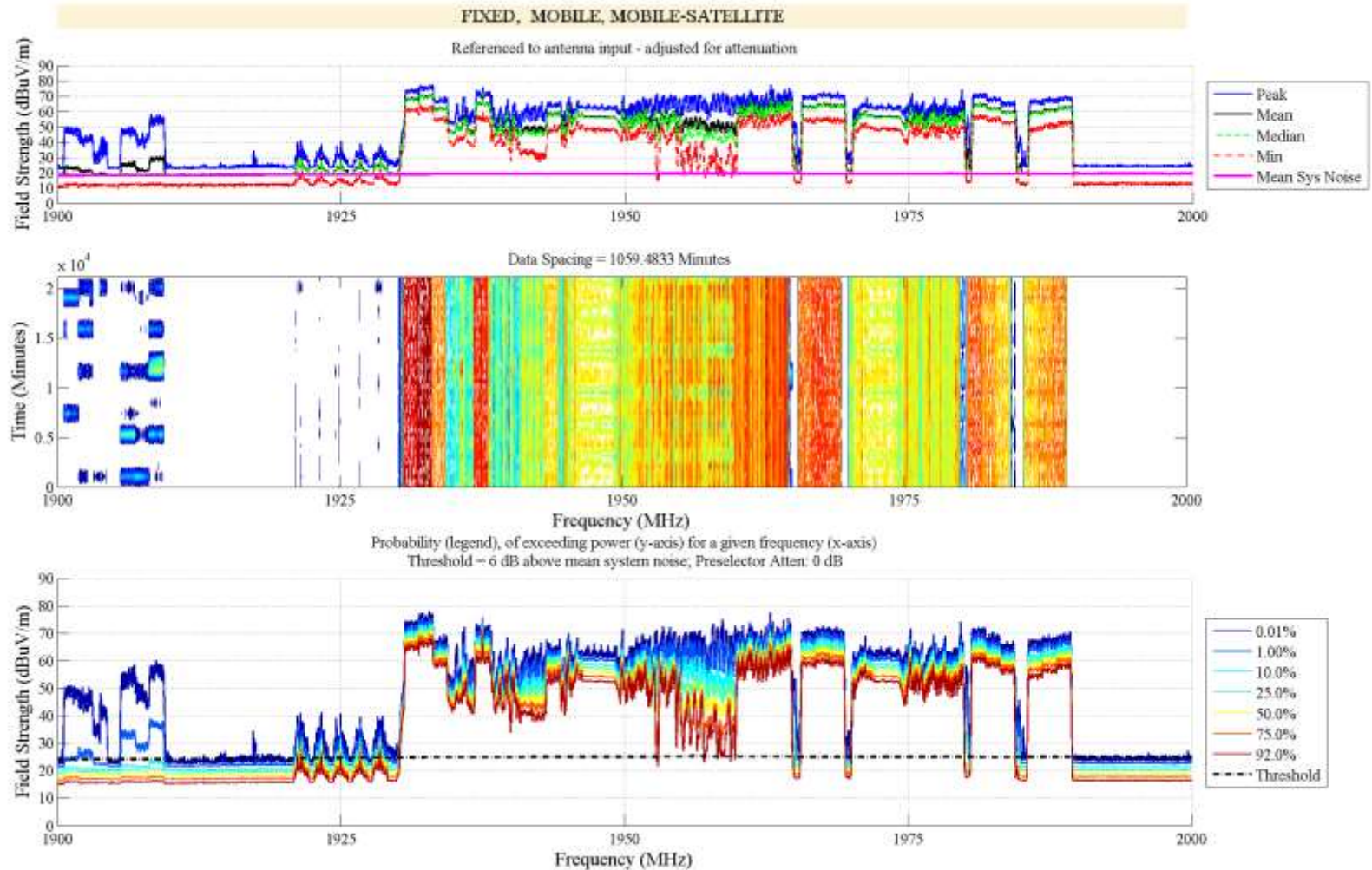


# Results (1900 – 2000 MHz)

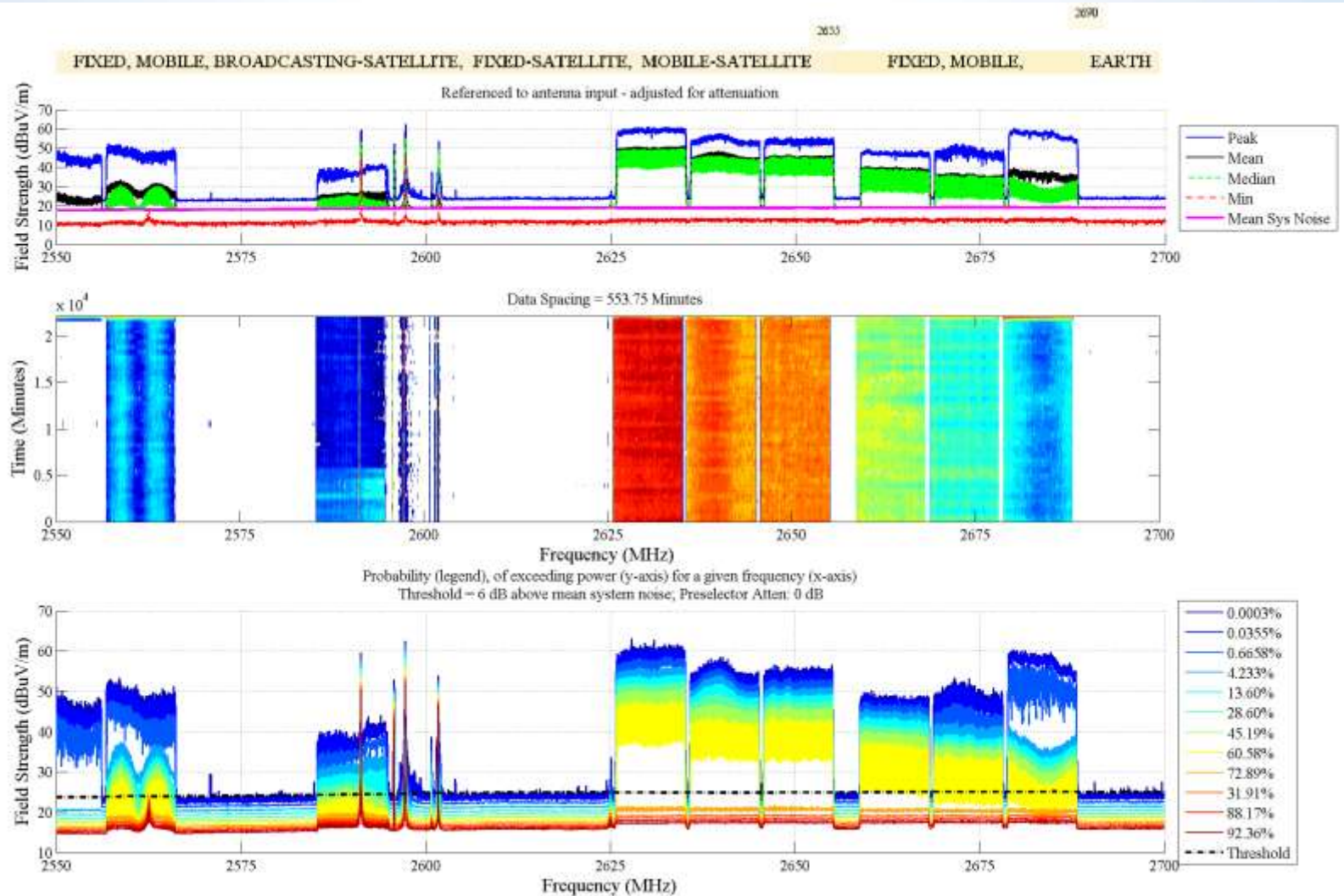




# Results (1900 – 2000 MHz)

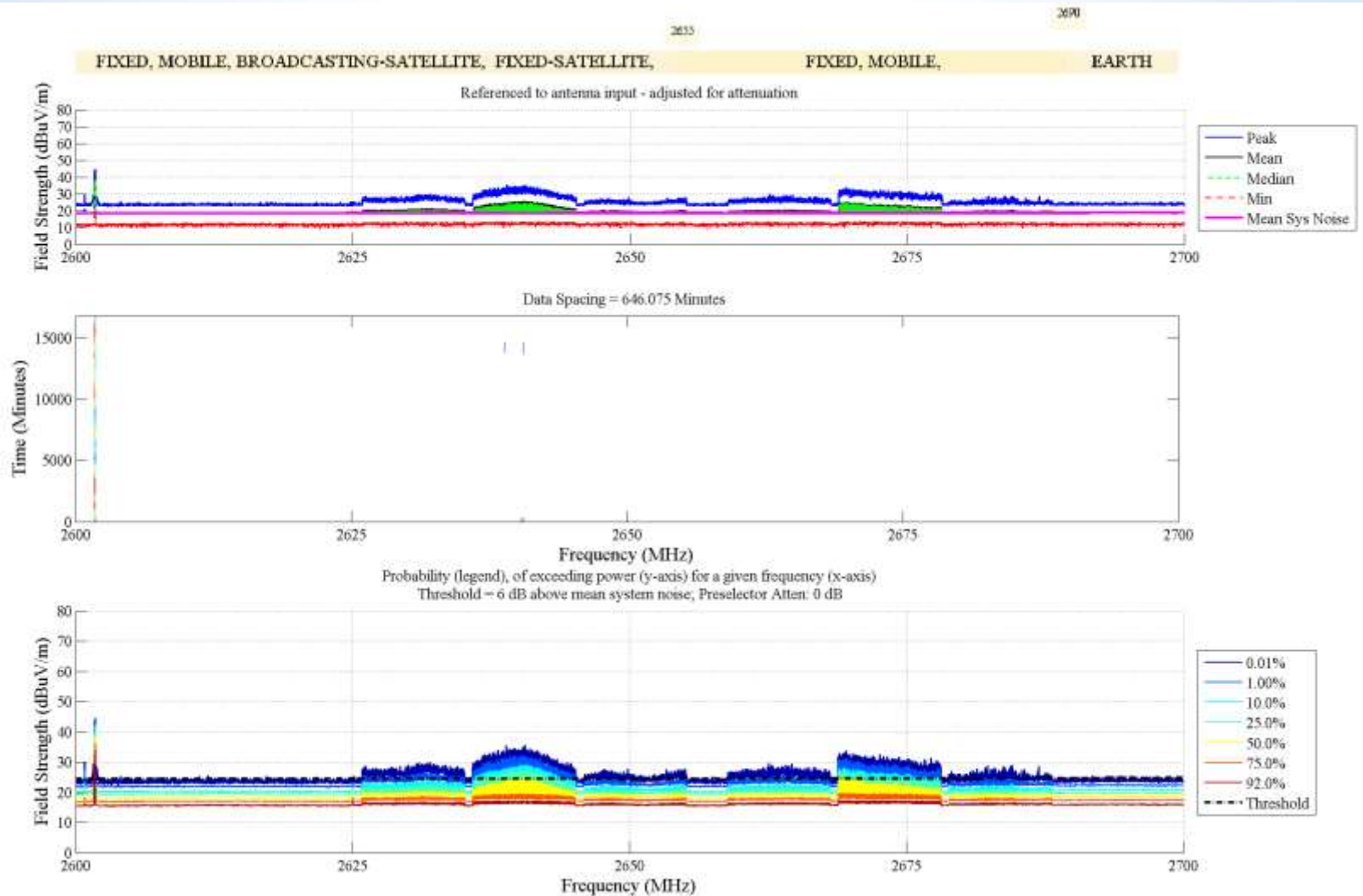


# Results (2550 – 2700 MHz)

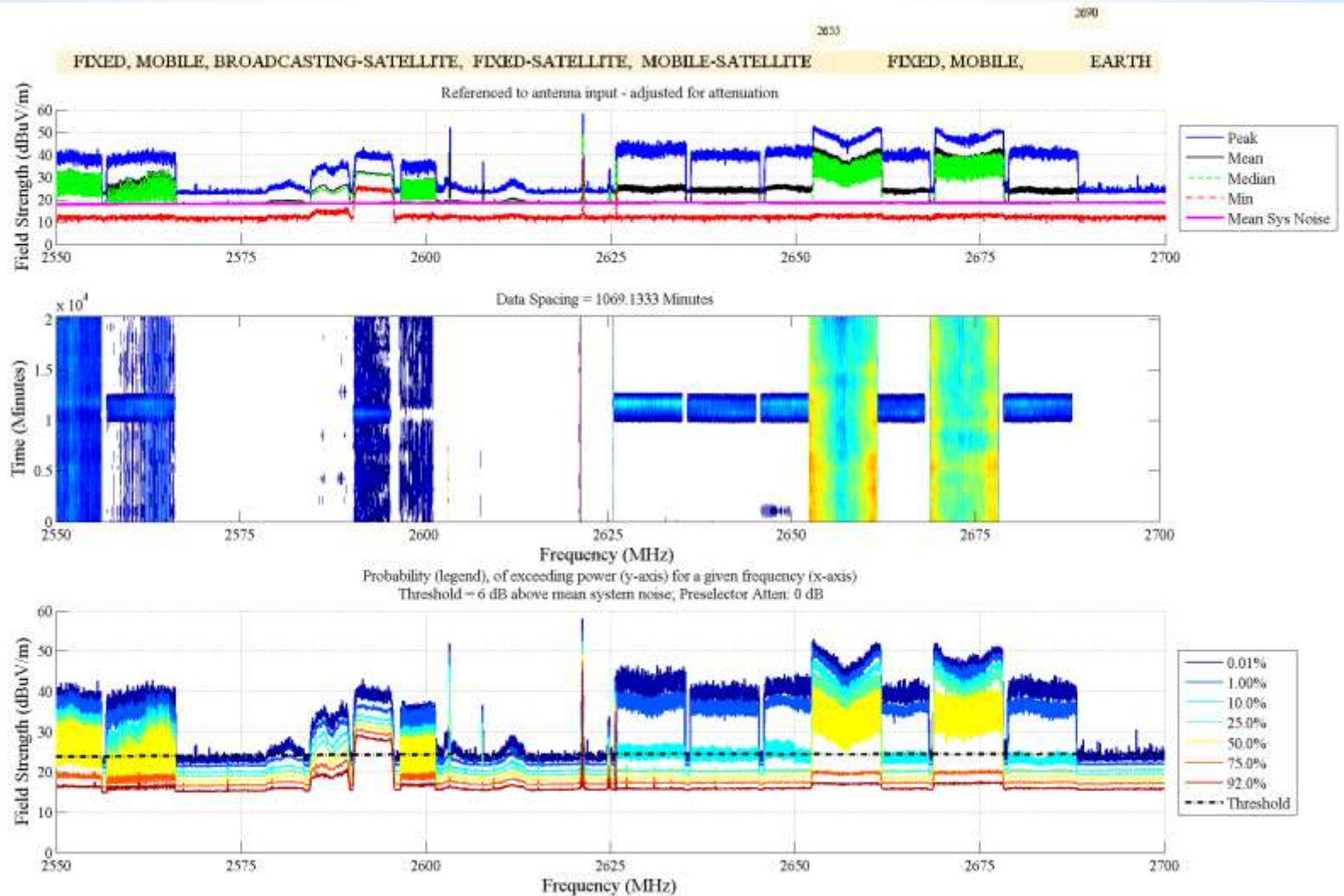




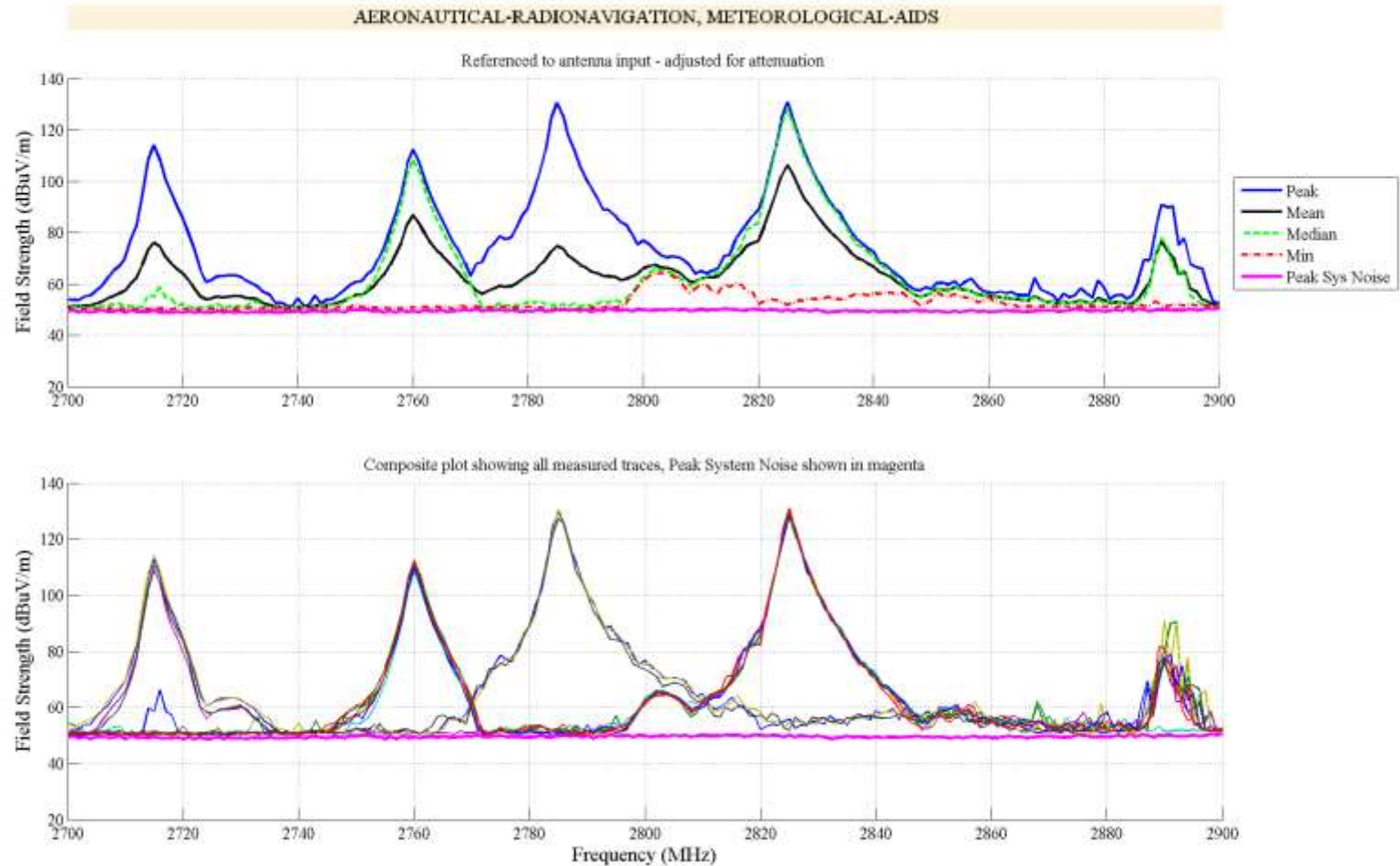
# Results (2550 – 2700 MHz)



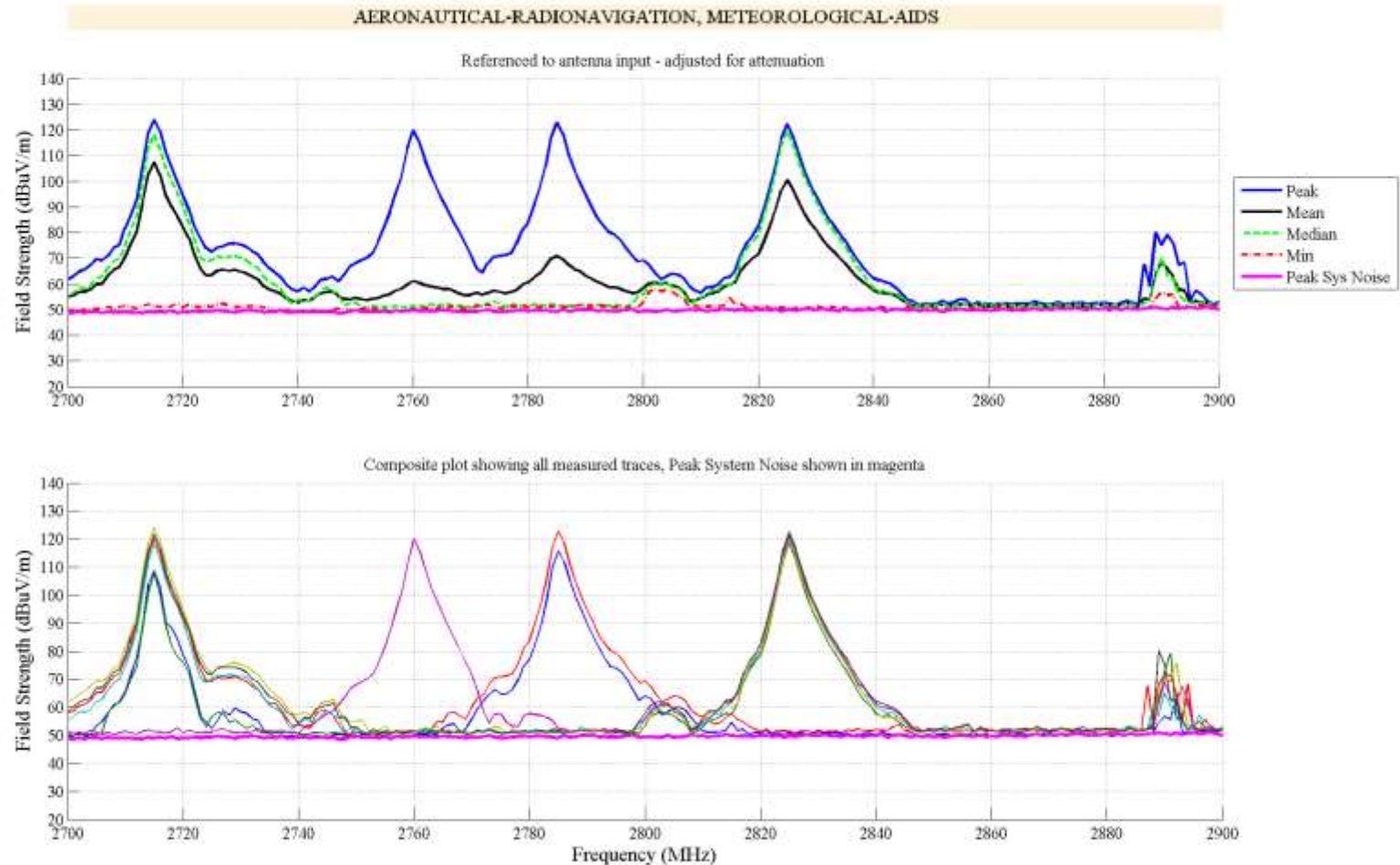
# Results (2550 – 2700 MHz)



# Results (2700 – 2900 MHz)

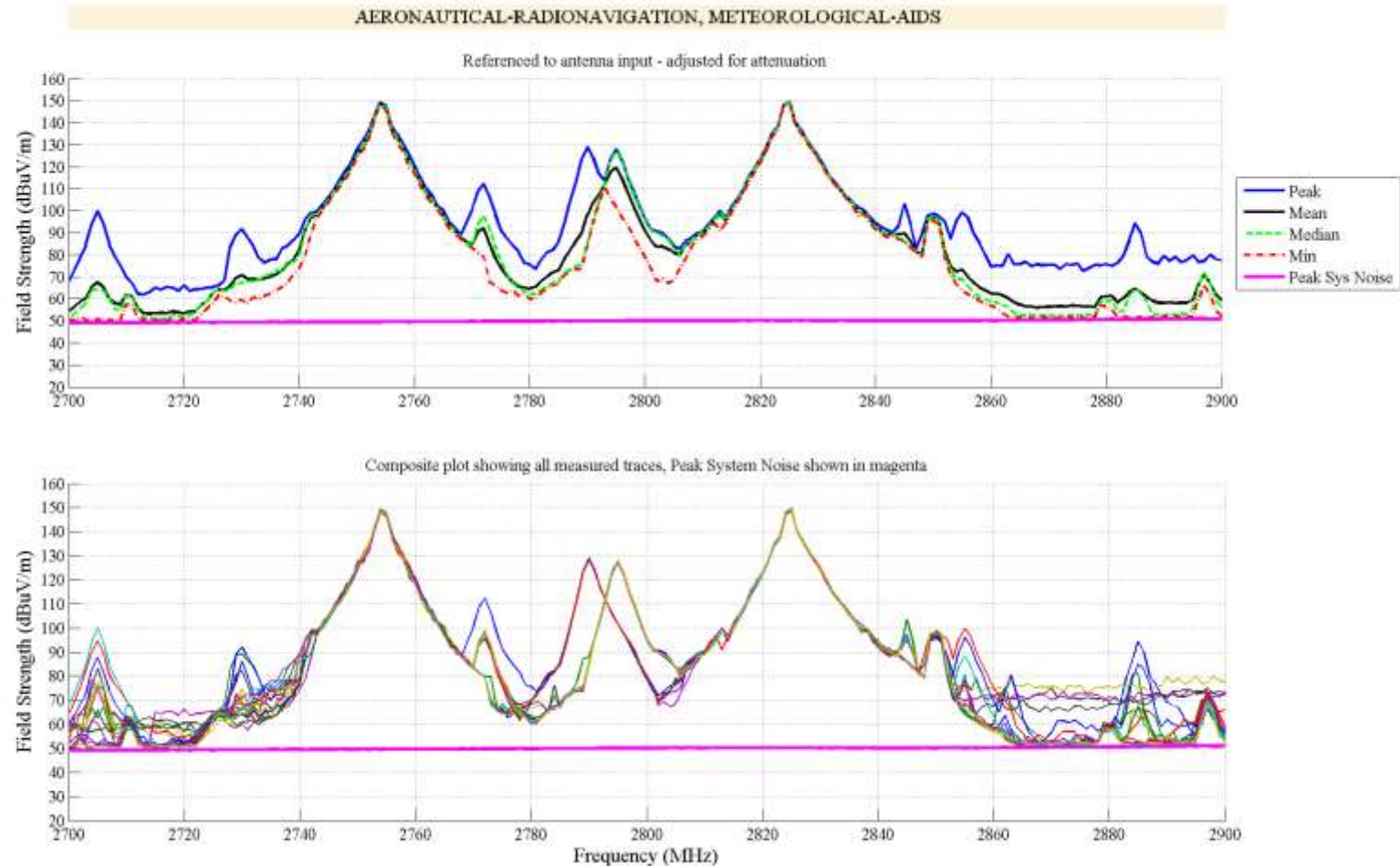


# Results (2700 – 2900 MHz)

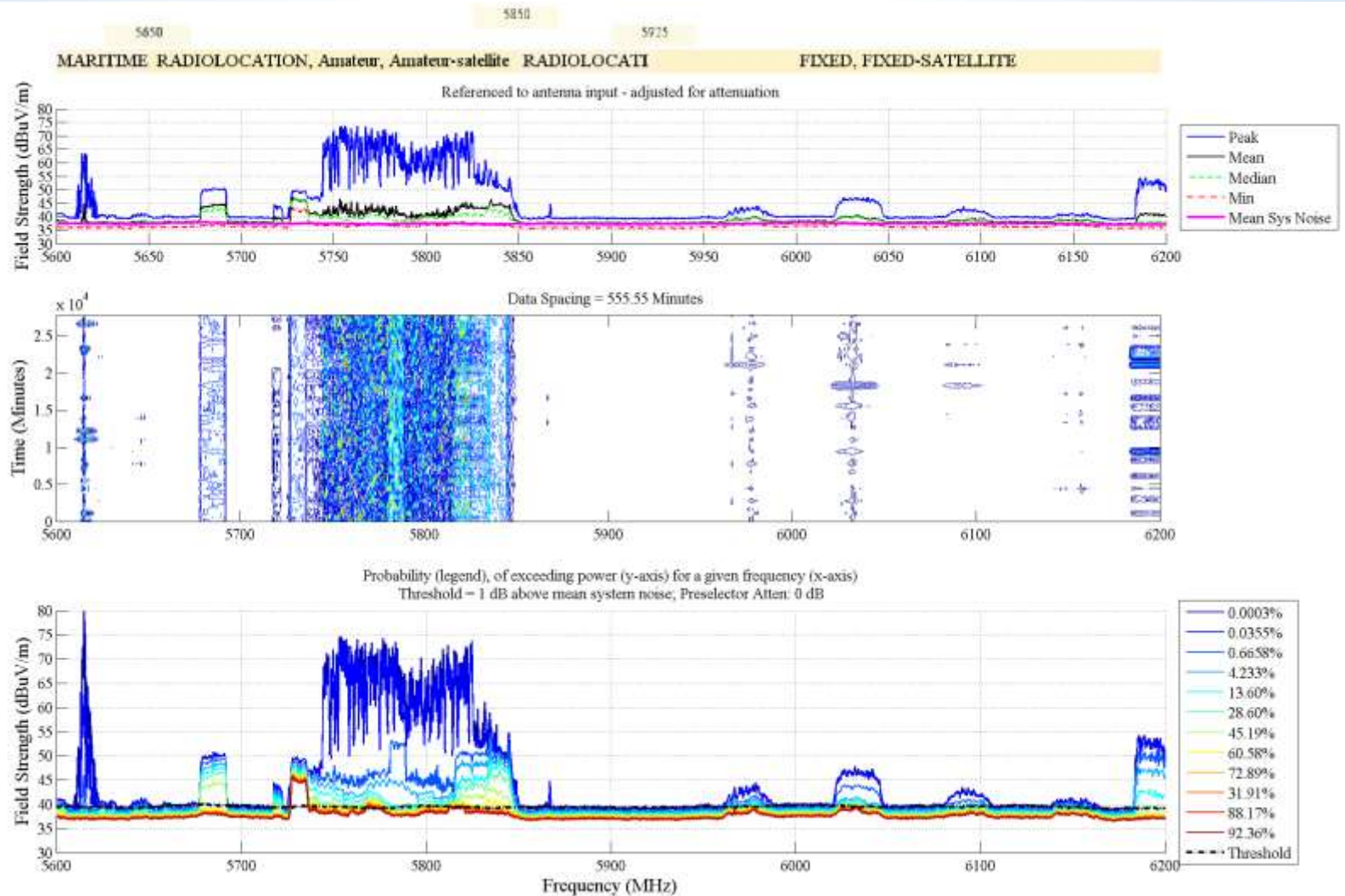




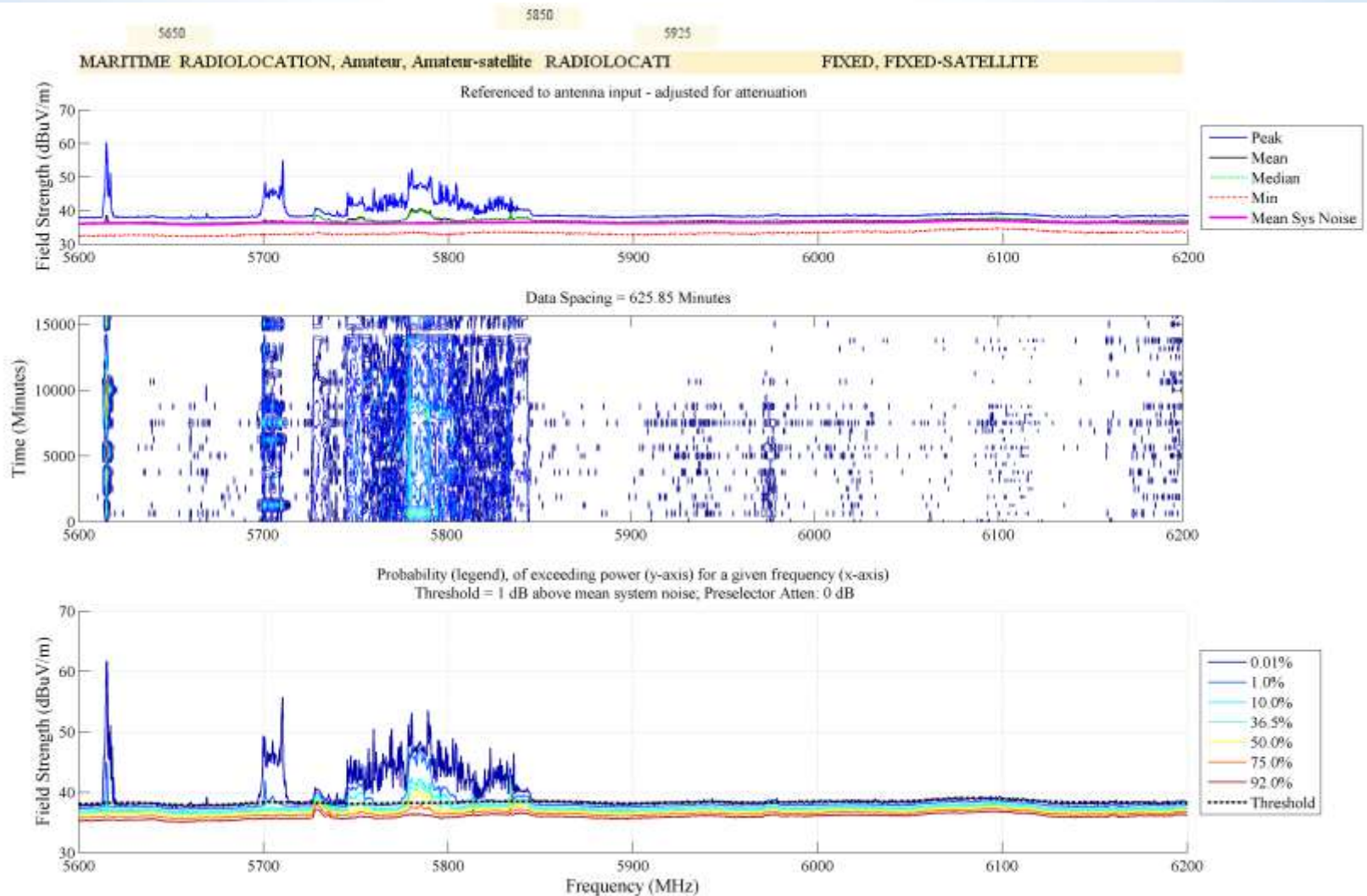
# Results (2700 – 2900 MHz)



# Results (5600 – 6200 MHz)

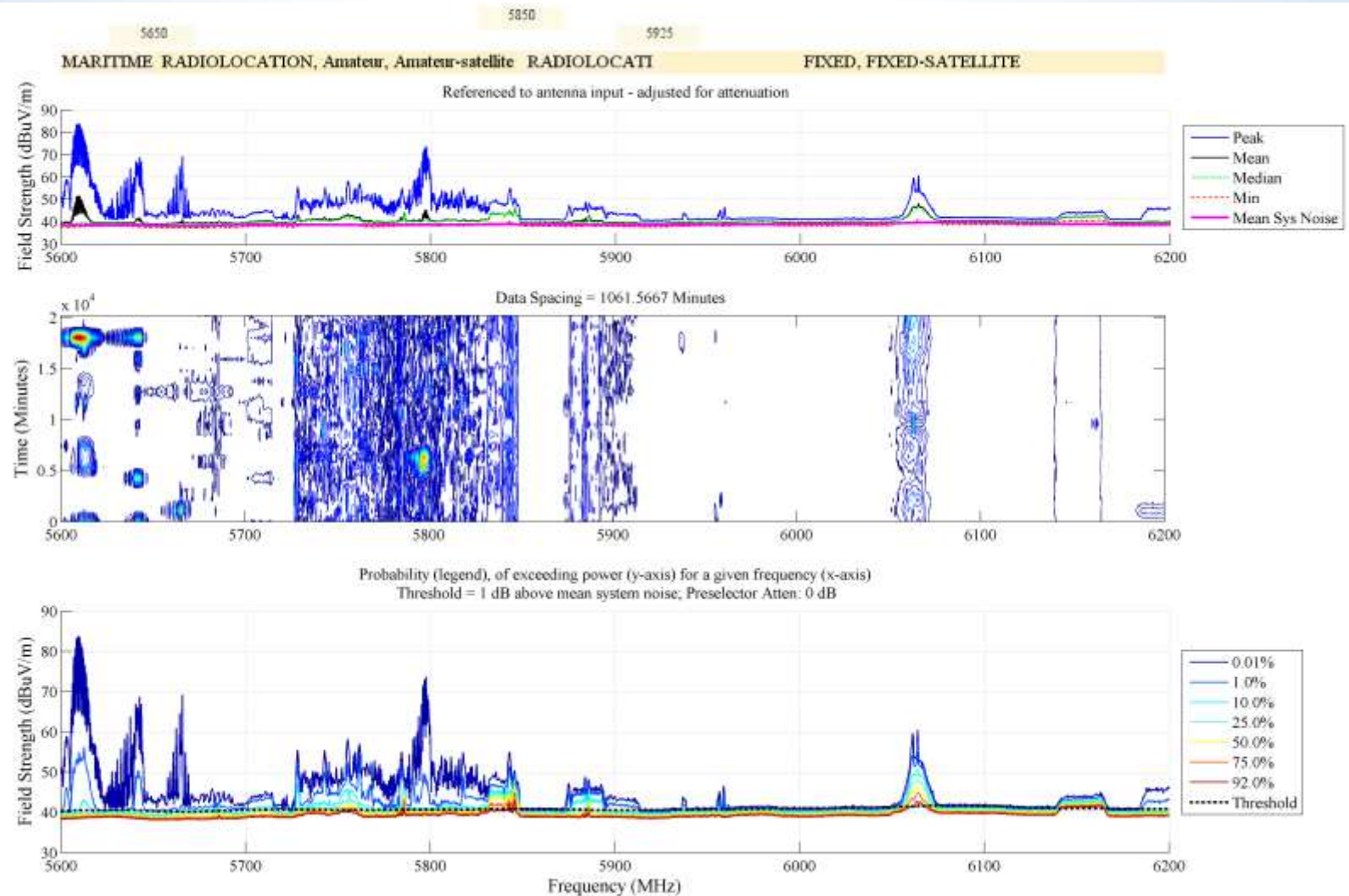


# Results (5600 – 6200 MHz)



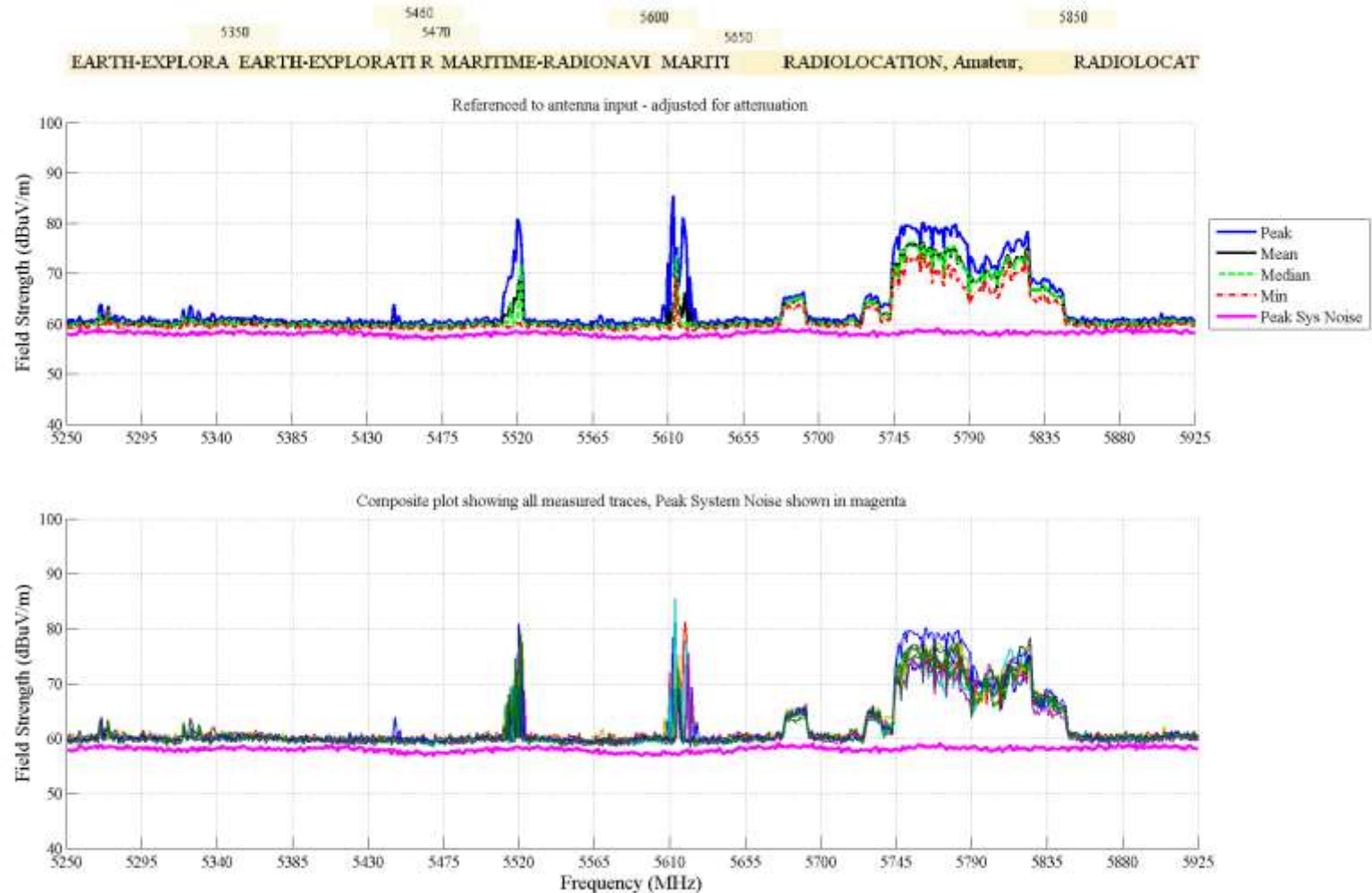


# Results (5600 – 6200 MHz)

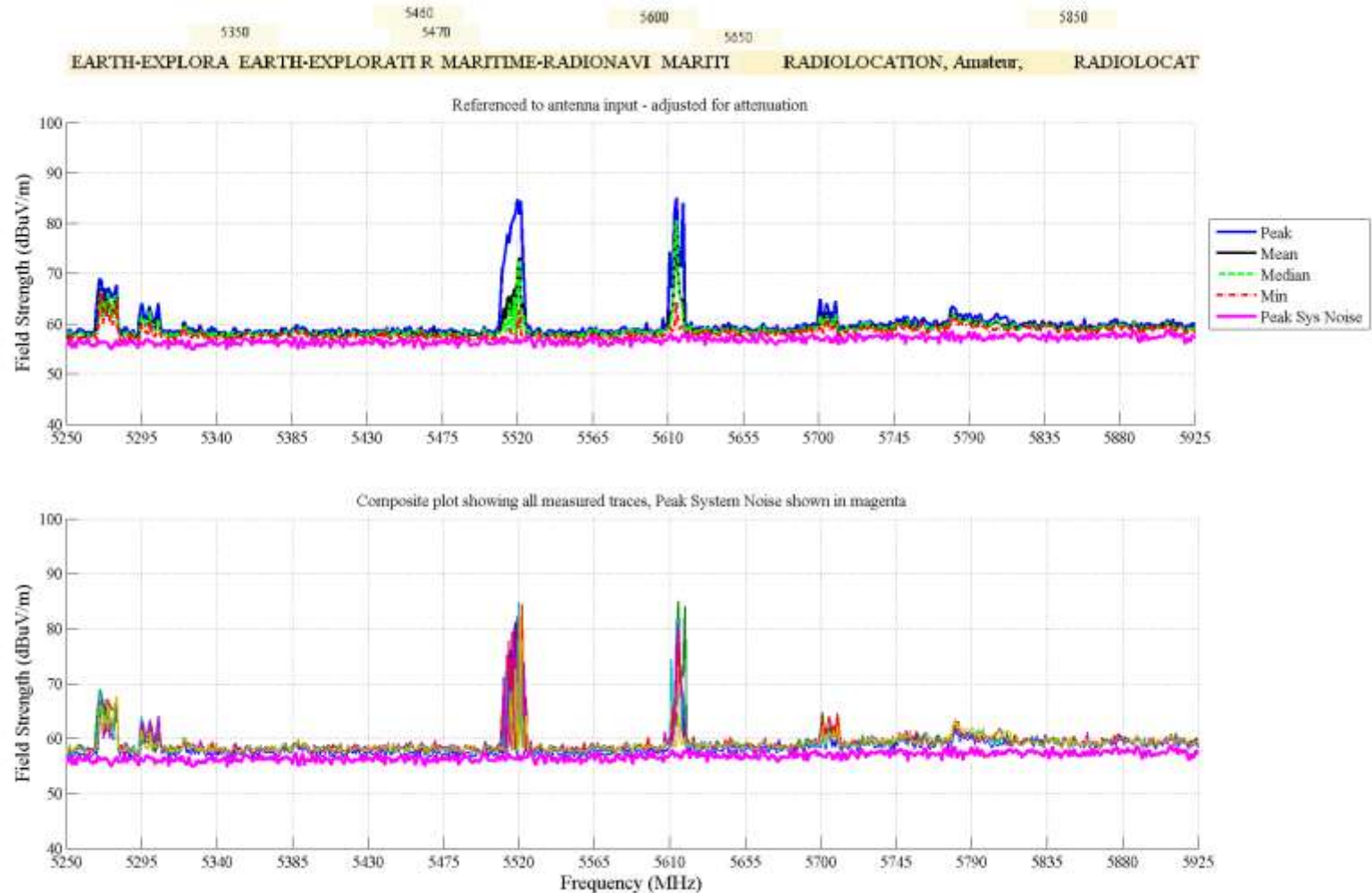




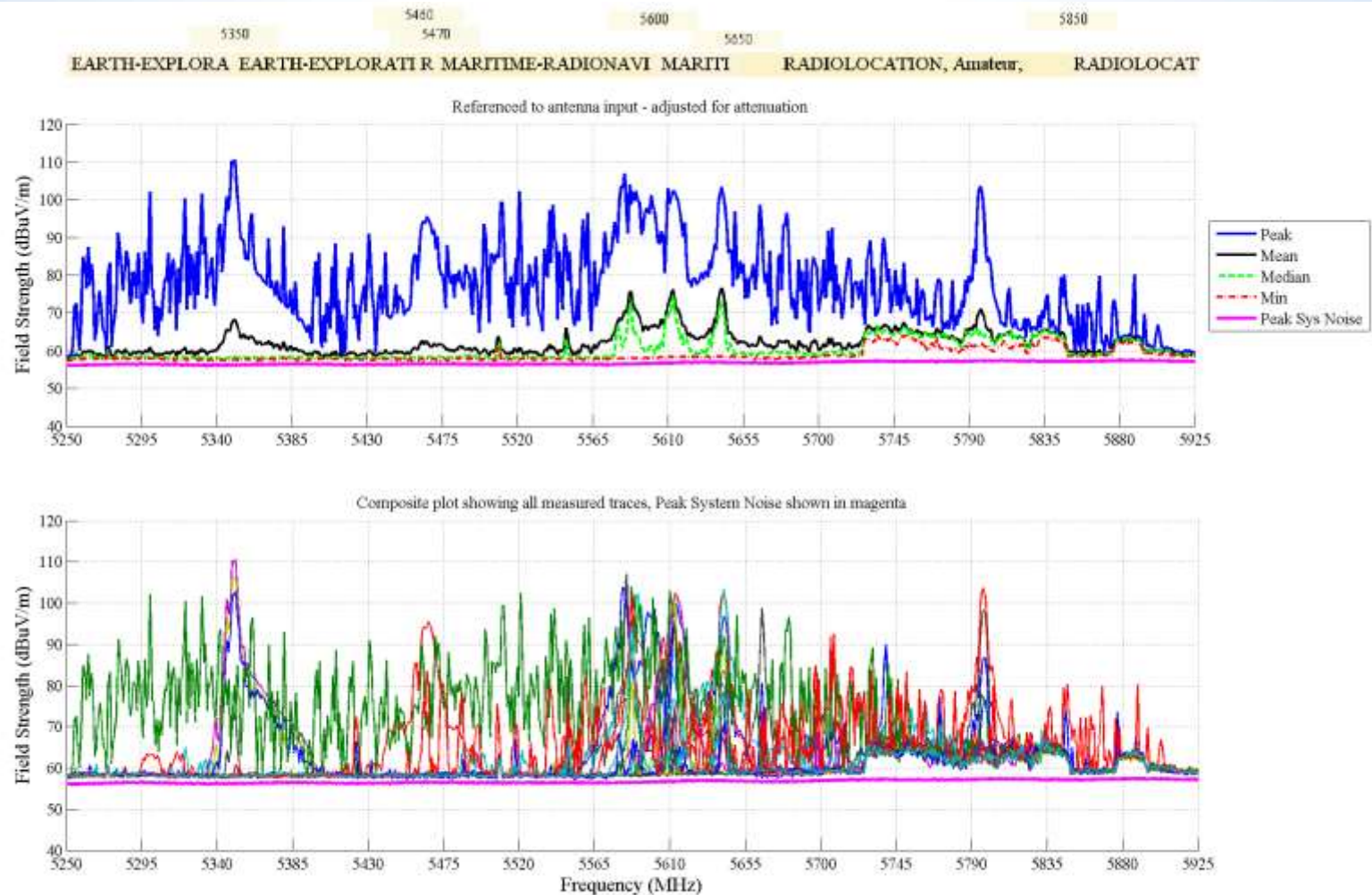
# Results (5250 – 5925 MHz)



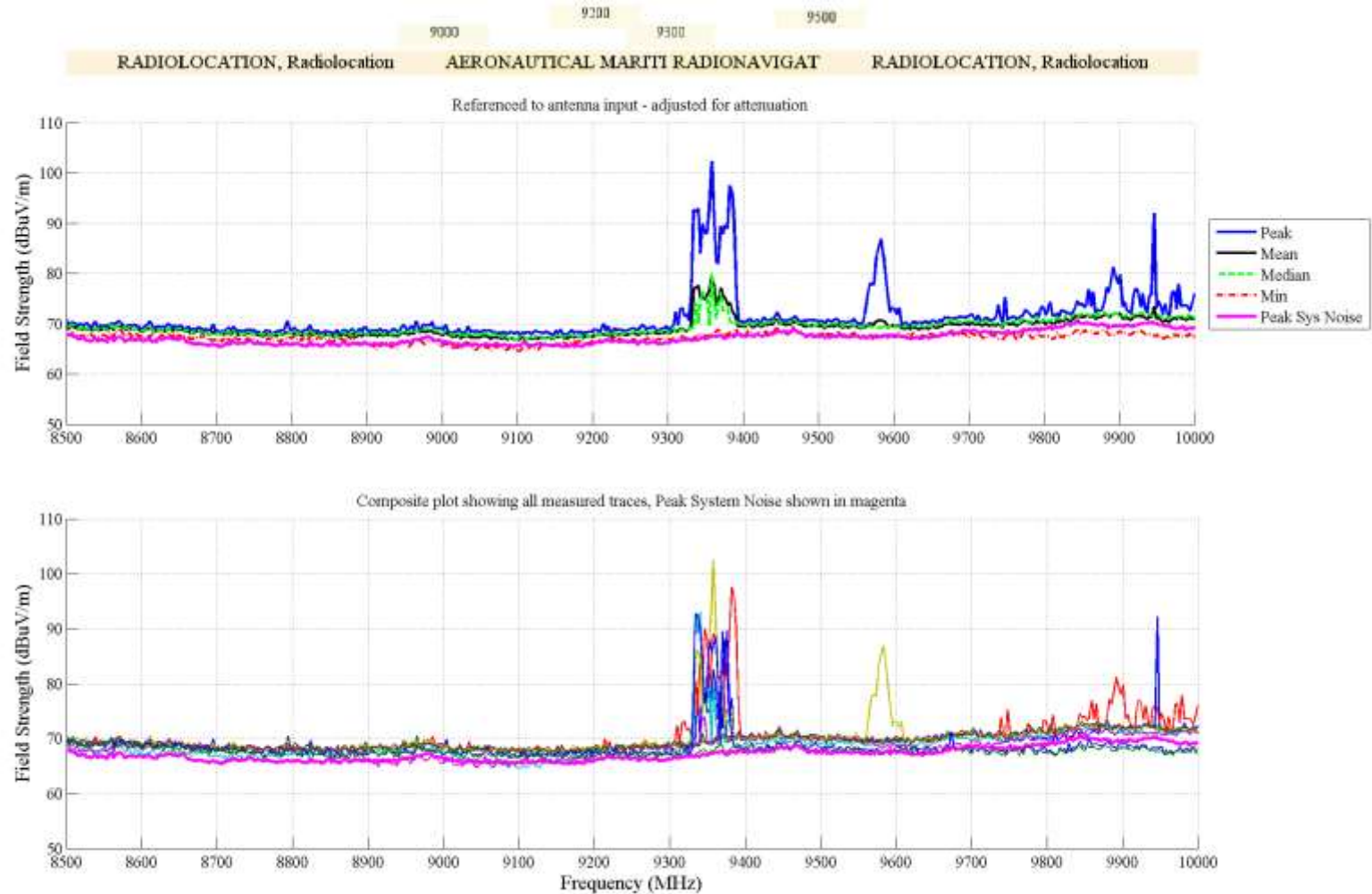
# Results (5250 – 5925 MHz)



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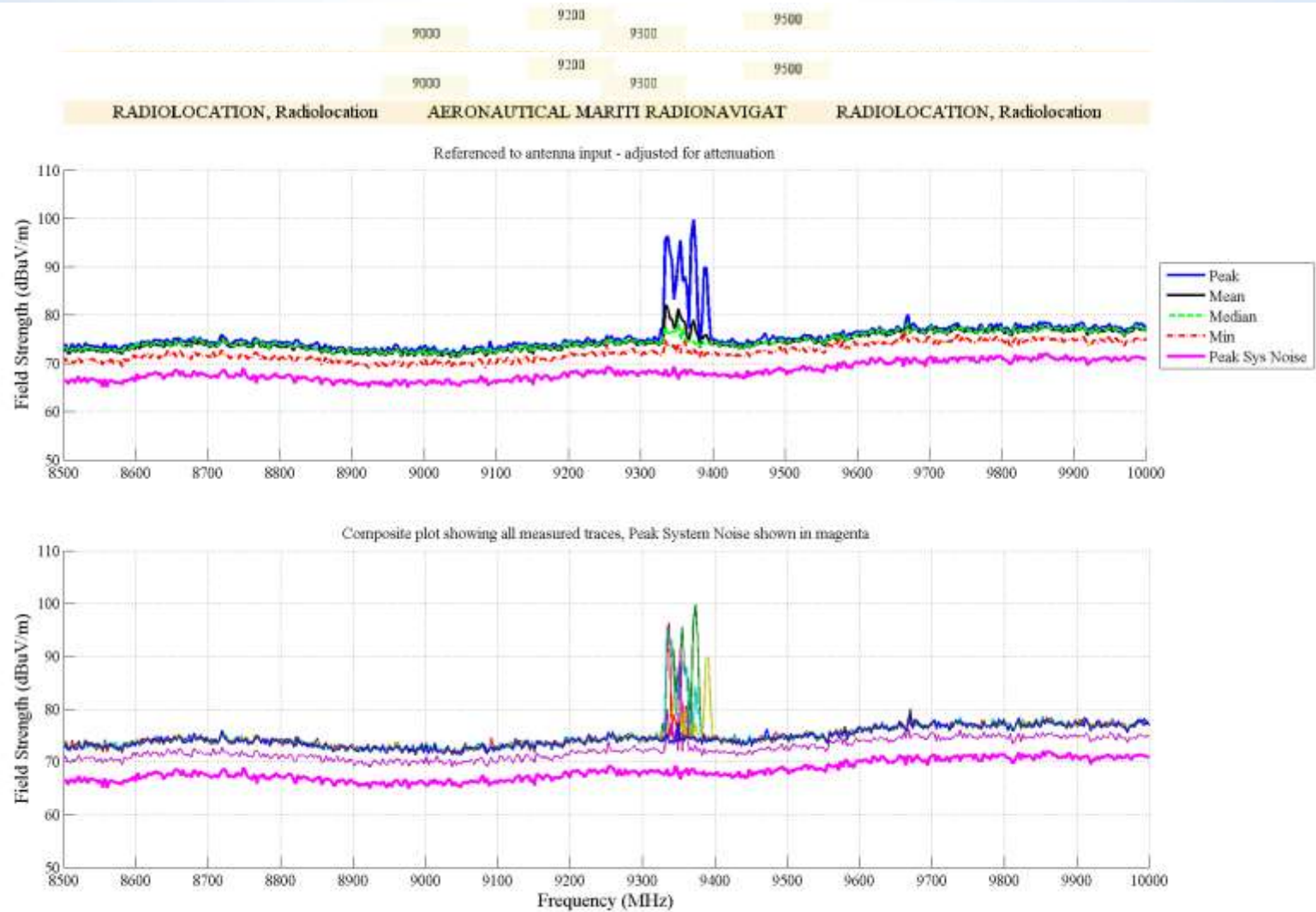


# Results (8500 – 10000 MHz)

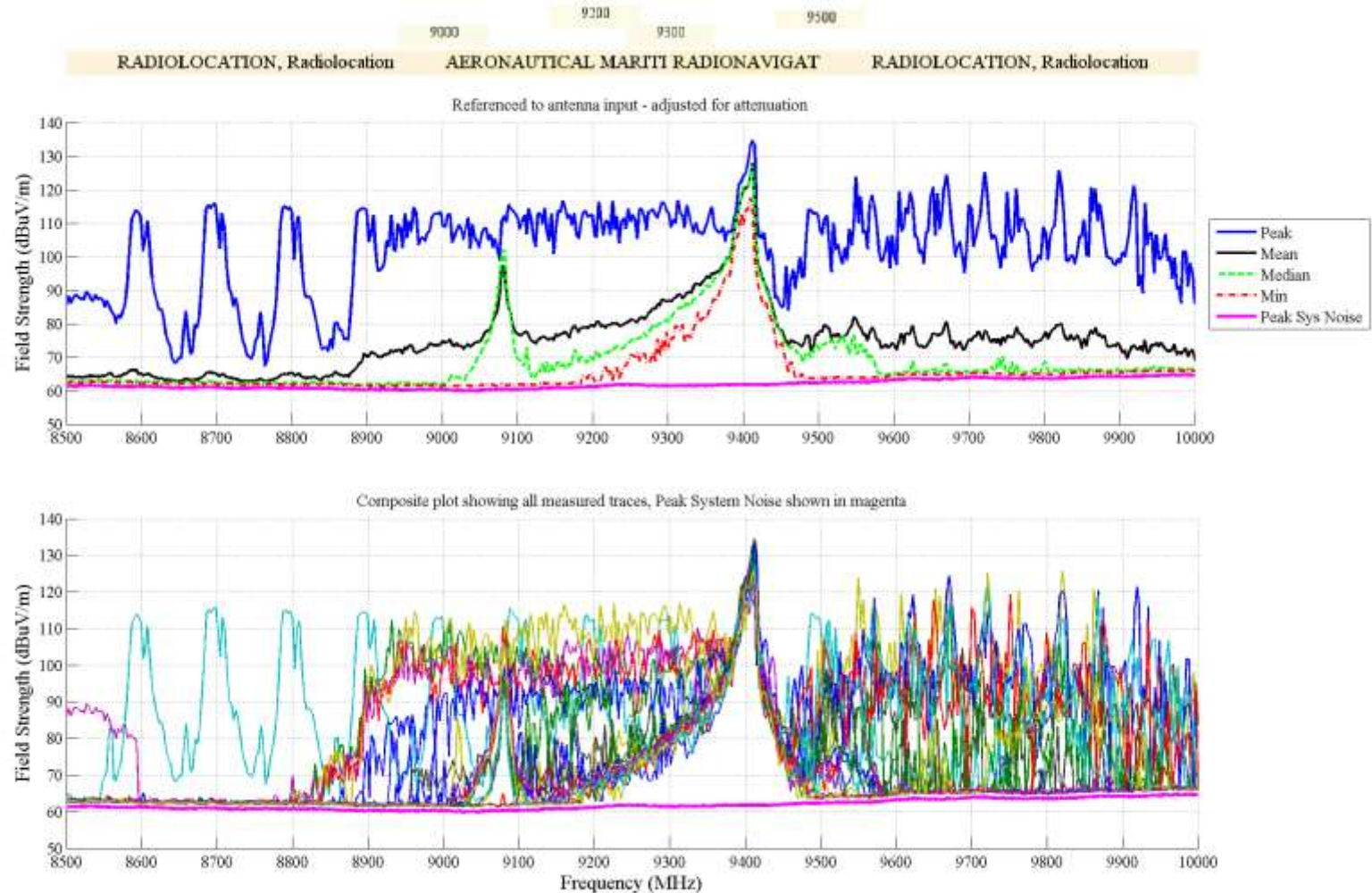




# Results (8500 – 10000 MHz)

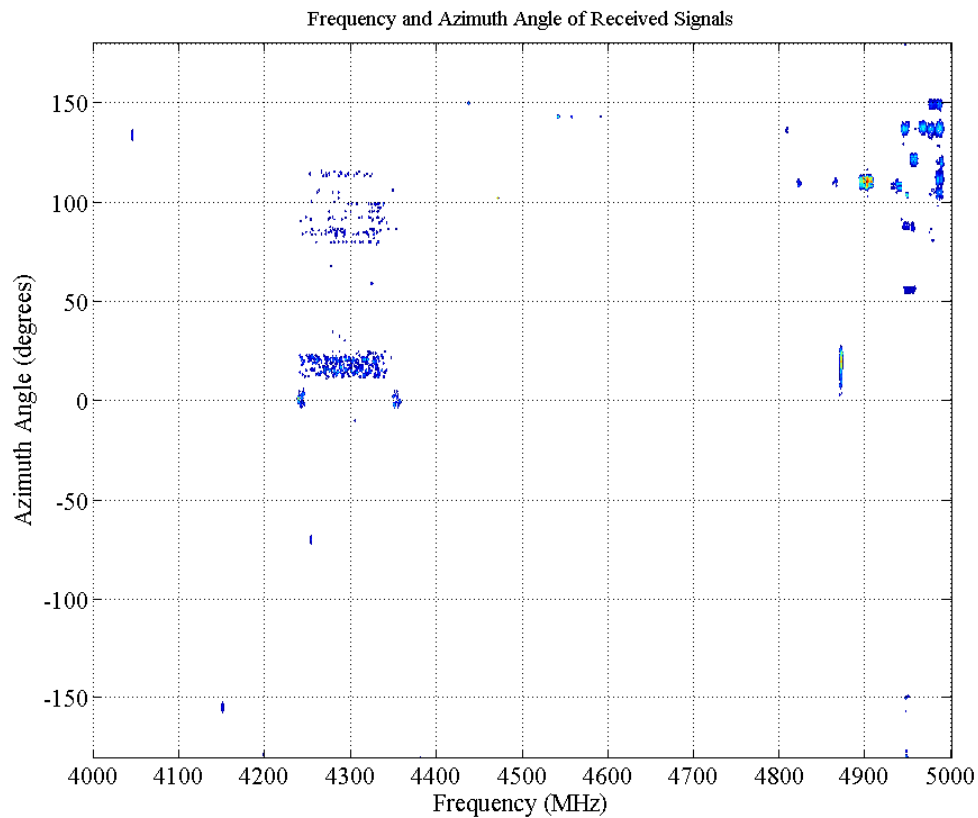


# Results (8500 – 10000 MHz)



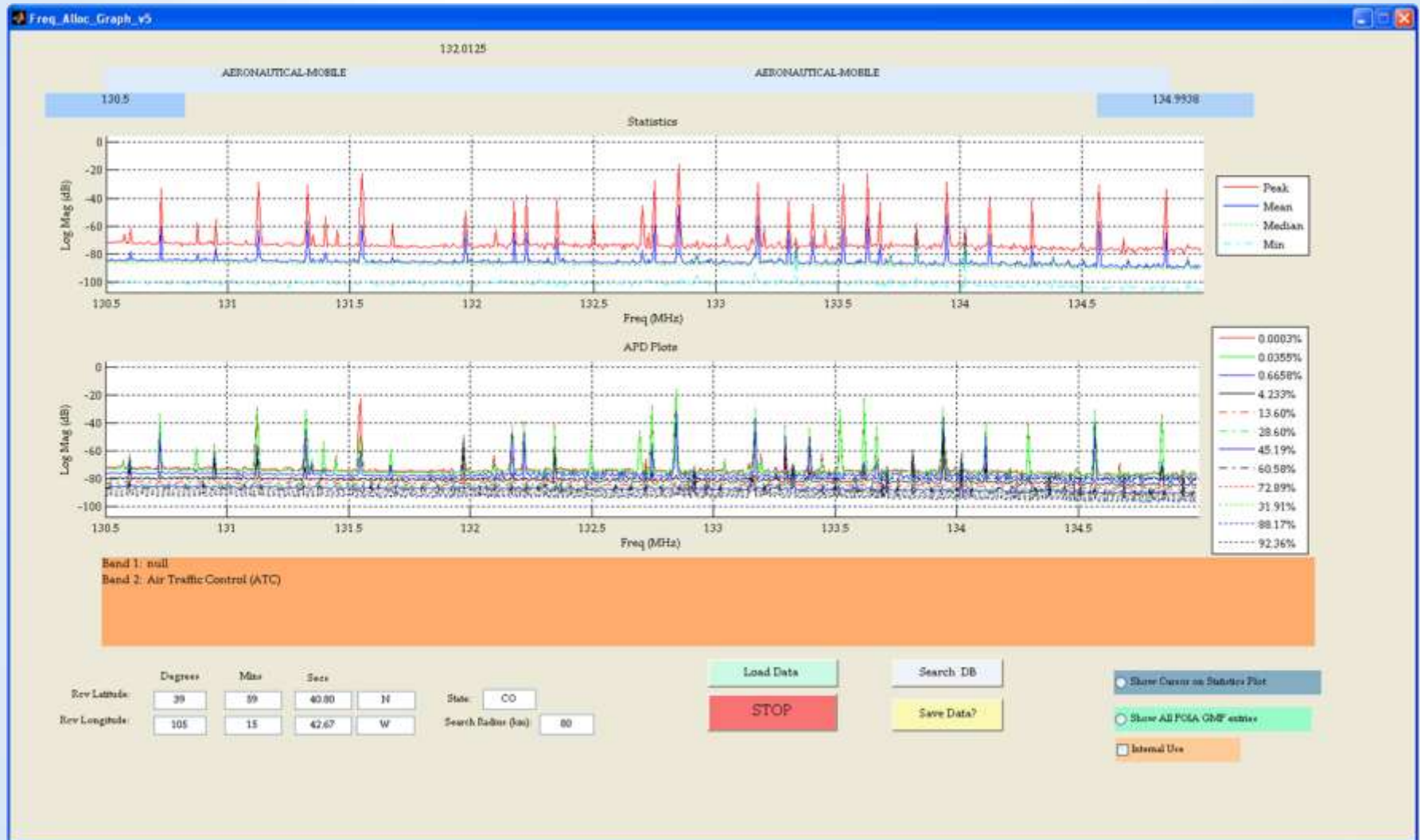
# Results

## Azimuthal Scanning





# Applications





	Entity	Assigned Freq (MHz)	Power (ERP)	LOCity	LOState	XmitType	Distance(km)	LicStatus	DB Table
1	AviSRI	130.5750	0	CO			58.7532 A		MarAvGnd
2	AviSRI	130.6000	0	CO	F		52.3094 A		MarAvGnd
3	AviSRI	130.7250	0	CO			52.4921 A		MarAvGnd
4	AviSRI	130.7250	0	CO	F		45.8728 A		MarAvGnd
5	AviSRI	130.7500	0	CO			46.2490 C		MarAvGnd
6	AviSRI	130.7500	0	CO			52.4921 C		MarAvGnd
7	AviSRI	130.7750	0	CO			52.4921 A		MarAvGnd
8	AviSRI	130.8000	0	CO	F		52.3094 A		MarAvGnd
9	AviSRI	130.8250	0	CO	F		52.9172 C		MarAvGnd
10	AviSRI	130.8500	0	CO	F		52.3094 A		MarAvGnd
11	AviSRI	130.9000	0	CO	F		52.9172 A		MarAvGnd
12	AviSRI	130.9500	0	CO	F		52.3094 A		MarAvGnd
13	AviSRI	130.9500	0	CO	F		52.9163 C		MarAvGnd
14	AviSRI	131	0	CO			52.4921 C		MarAvGnd
15	AviSRI	131.0500	0	CO	F		52.9163 C		MarAvGnd
16	AviSRI	131.0750	0	CO	F		52.3094 A		MarAvGnd
17	AviSRI	131.1000	0	CO			52.4921 E		MarAvGnd
18	AviSRI	131.1250	0	CO	F		52.4921 A		MarAvGnd
19	AviSRI	131.1250	0	CO	F		52.4921 A		MarAvGnd
20	AviSRI	131.1250	0	CO	F		52.5507 A		MarAvGnd
21	AviSRI	131.1500	0	CO			52.4921 A		MarAvGnd
22	AviSRI	131.2000	0	CO	F		52.9172 C		MarAvGnd
23	AviSRI	131.3250	0	CO			52.4921 A		MarAvGnd
24	AviSRI	131.3500	0	CO			52.4921 A		MarAvGnd
25	AviSRI	131.3750	0	CO			59.1395 A		MarAvGnd
26	AviSRI	131.4000	0	CO	F		52.9172 A		MarAvGnd
27	AviSRI	131.4500	0	CO			52.4921 A		MarAvGnd
28	AERRI	131.4750	0	CO			52.4921 C		MarAvGnd
29	AviSRI	131.5000	0	CO	F		52.9172 A		MarAvGnd
30	AviSRI	131.5500	0	CO	F		52.4921 A		MarAvGnd
31	AviSRI	131.5500	0	CO	F		52.4921 A		MarAvGnd
32	AviSRI	131.5500	0	CO	F		55.0819 C		MarAvGnd
33	AviSRI	131.5500	0	CO	F		58.8939 A		MarAvGnd
34	AviSRI	131.5500	0	CO	F		53.3157 A		MarAvGnd
35	AviSRI	131.5500	0	CO	F		52.5507 A		MarAvGnd
36	AviSRI	131.6250	0	CO			18.6142 A		MarAvGnd
37	AviSRI	131.7250	0	CO			15.5846 A		MarAvGnd
38	AviSRI	131.7750	0	CO			58.7532 C		MarAvGnd
39	AviSRI	131.8250	0	CO			52.4921 A		MarAvGnd
40	AviSRI	131.9000	0	CO			52.4921 A		MarAvGnd
41	AviSRI	131.9250	0	CO			52.4921 A		MarAvGnd
42	AviSRI	131.9500	0	CO	F		52.3094 A		MarAvGnd
43	AviSRI	131.9750	0	CO			52.4921 A		MarAvGnd
44	AviSRI	132	0	CO			52.4921 C		MarAvGnd
45	ColDoA	132.0750	0	CO	F		30.0984 A		MarAvGnd
46	ASM	133.8250	0	CO	F		18.1361 A		MarAvGnd
47	TowwoE	133.8250	0	CO	F		18.1361 A		MarAvGnd
48	COLSO	134.1750	0	CO	F		28.6476 A		MarAvGnd
49	ColDoA	134.3250	0	CO	F		48.1873 A		MarAvGnd

# Conclusions

- Algorithms and system are still being tested and refined.
- Report for Denver Metro Survey is written and awaiting review.
- Table Mountain report has been started.
- Possible survey in Chicago area being planned for September 2012.

# Detectability Plots

