



Antenna radiation pattern measurement using a drone



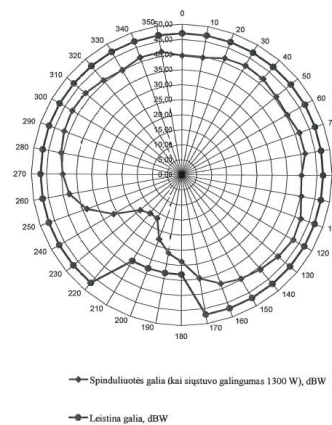
20-23 April 2021, FM22 #55

Why measure using drone ?

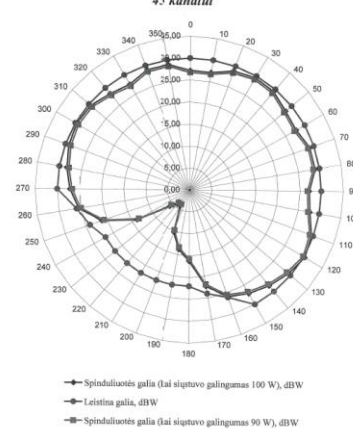
One antenna for 3 DVB-T channels
Different theoretical diagrams



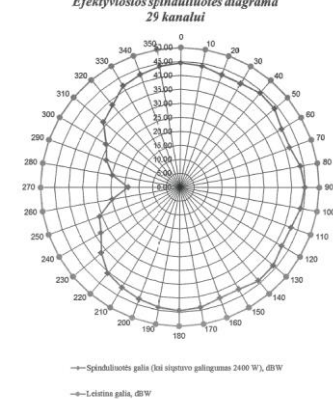
*Efektivosios spinduliuotės diagrama
60 kanalui*



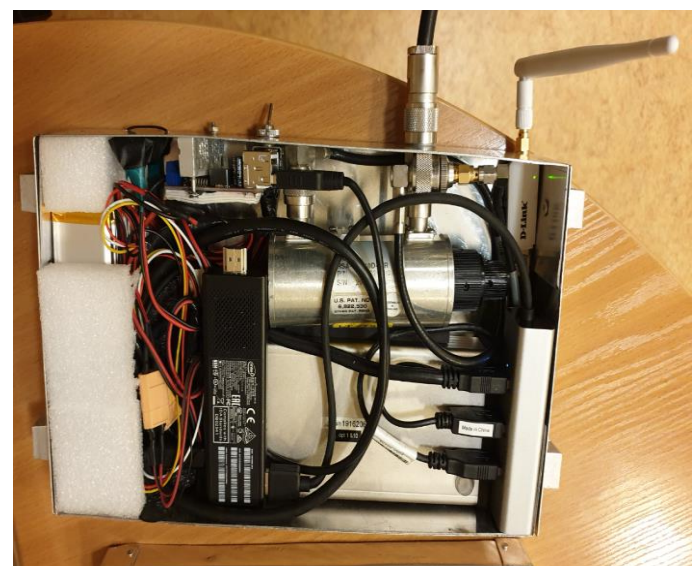
*Efektivosios spinduliuotės diagrama
45 kanalui*



*Efektivosios spinduliuotės diagrama
29 kanalui*



Experiments with different setups



Drone

Hexacopter and flight service provided by
Space Science and Technology Institute:

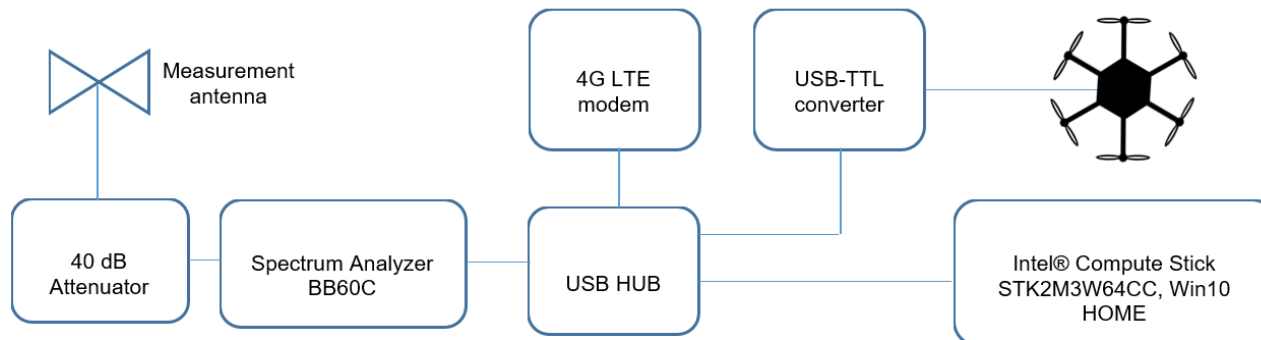
- Payload 2 kg, flight time 20 min
- Pixhawk autopilot controller
- GPS/Compass Ublox M8N
- Telemetry modules 866 MHz
- Additional manual 2,4 GHz control
- Laptop with Mission Planner software



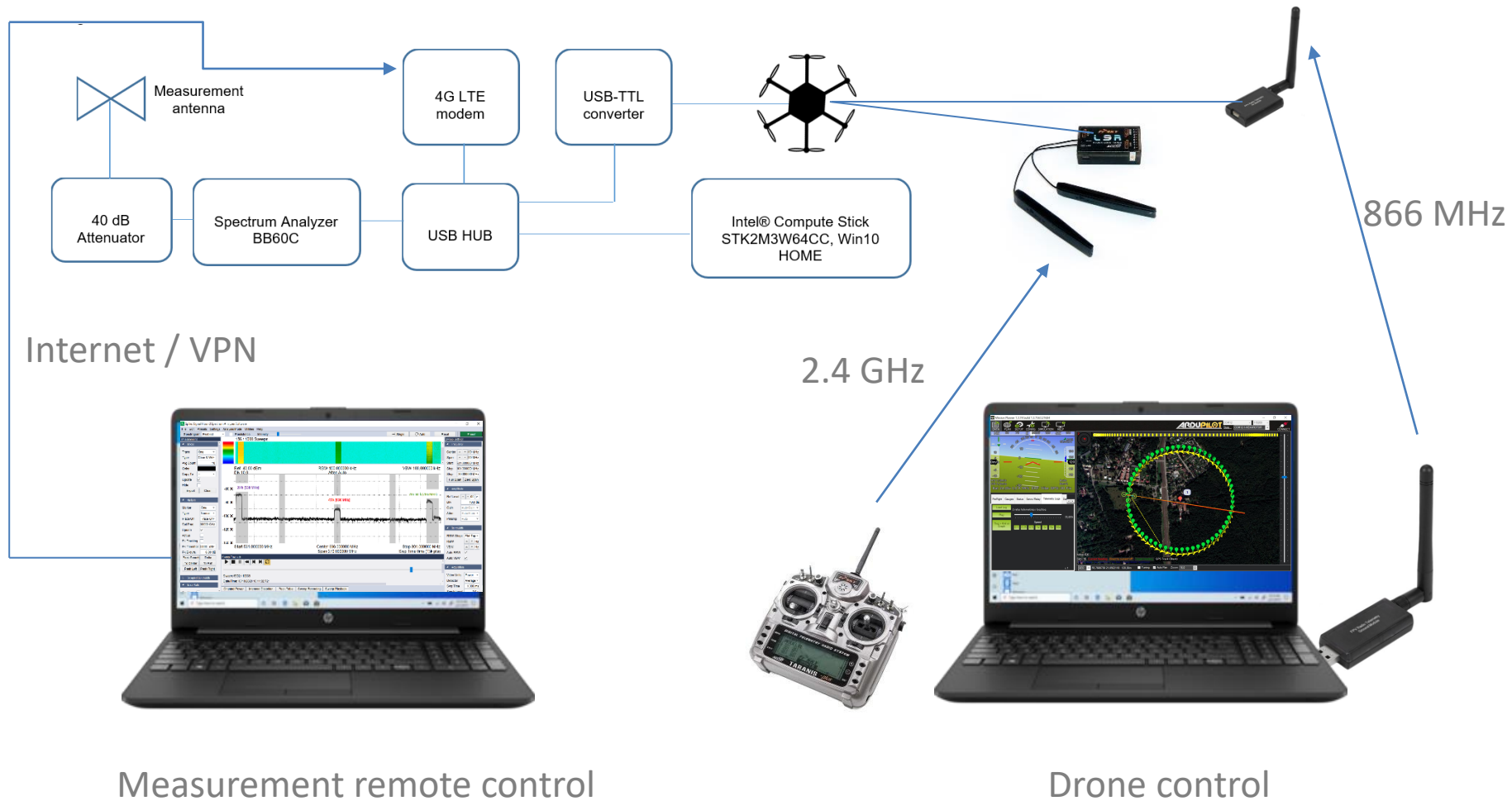
Measurement system

Assembled by RRT :

- Spectrum analyzer BB60C, weight 500 g
- Stick PC STK2M3W64CC with Spike spectrum analyzer software
- Homemade biconical dipole, weight 40 g
- LTE modem for remote control

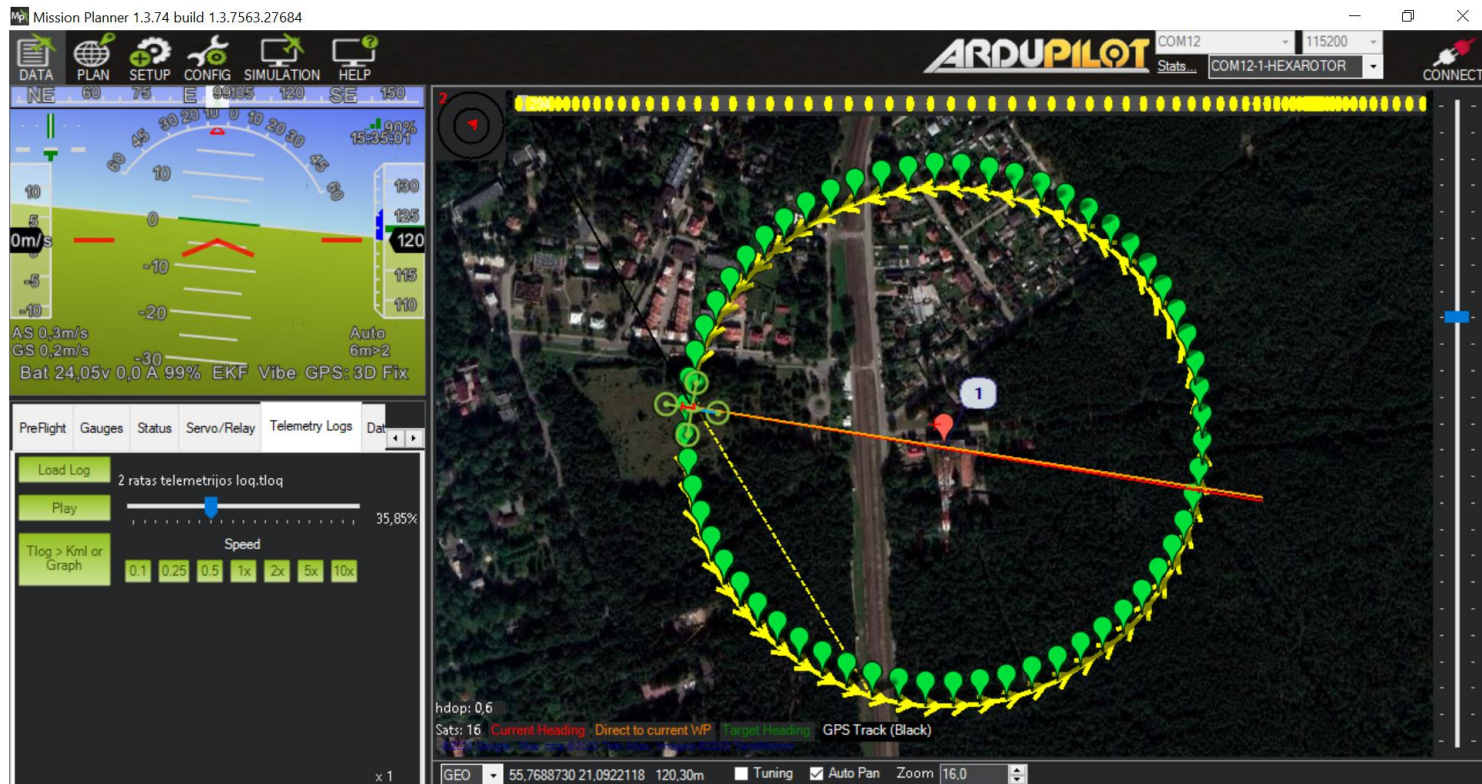


General setup



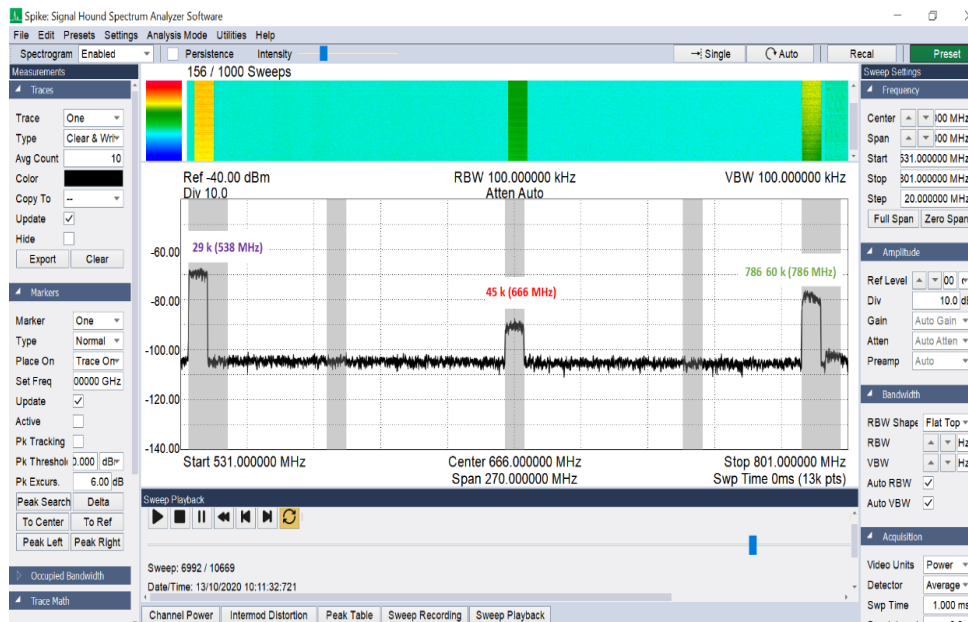
Software used

- Mission Planner for drone control and flight telemetry data logging



Software used

- Spike Spectrum Analyzer – controlling spectrum analyzer, channel power logging



Channel	Power	Version	1	
Main	Channel	Center	Freq	666000000
Main	Channel	Bandwidth	8000000	
Channel	1	Offset	72000000	
Channel	1	Bandwidth	8000000	
Channel	2	Offset	120000000	
Channel	2	Bandwidth	8000000	
Channel	3	Offset	128000000	
Channel	3	Bandwidth	8000000	

Date	Time	Main_Channel	Channel1_Lower	Channel1_Upper
13-10-2020	09:59:52:104	-51,06112601	-50,58144043	-51,59962703
13-10-2020	09:59:52:120	-50,83111132	-50,37667563	-51,66727571
13-10-2020	09:59:52:151	-51,16258078	-50,5486946	-51,72021815
13-10-2020	09:59:52:182	-50,79394129	-50,28912661	-51,24062422
13-10-2020	09:59:52:214	-51,06927838	-50,42987179	-51,77491259
13-10-2020	09:59:52:261	-51,0005482	-50,45473714	-51,30800305
13-10-2020	09:59:52:276	-50,9357795	-50,22156479	-51,37349363

Software used

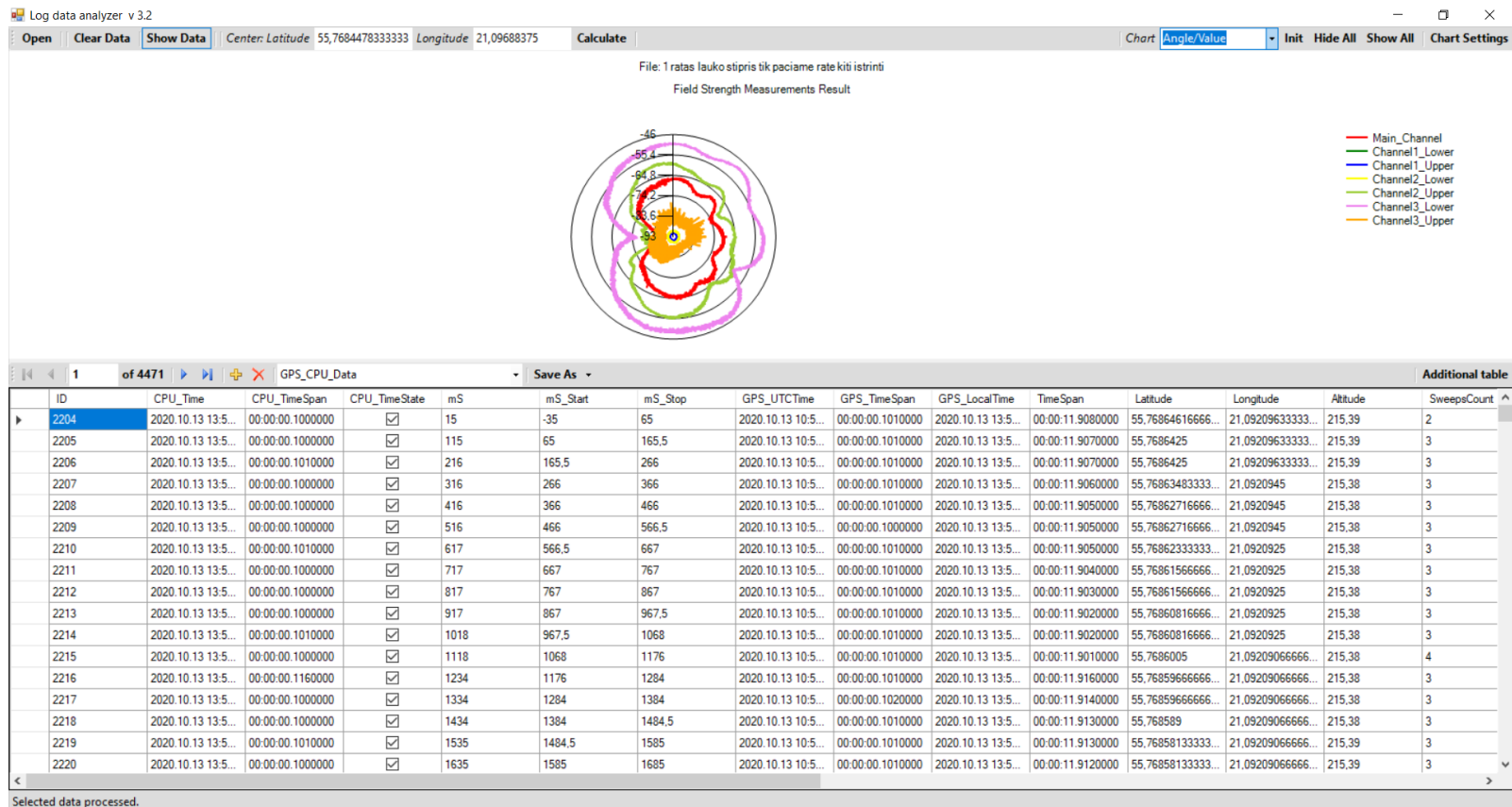
- Tera Term – GNSS data logging



```
[2020-10-13 09:59:52.057] $GPGGA,065939.946,5545.96565,N,02105.90332,E,1,06,02.0,0016.47,M,0.0,M,,*52
[2020-10-13 09:59:52.073] $GPRMC,065939.946,A,5545.96565,N,02105.90332,E,0.24,333.13,131020,,*0B
[2020-10-13 09:59:52.151] $GPGGA,065940.046,5545.96565,N,02105.90332,E,1,06,02.0,0016.44,M,0.0,M,,*56
[2020-10-13 09:59:52.167] $GPRMC,065940.046,A,5545.96565,N,02105.90332,E,0.23,333.61,131020,,*0E
[2020-10-13 09:59:52.261] $GPGGA,065940.146,5545.96565,N,02105.90332,E,1,06,02.0,0016.42,M,0.0,M,,*51
[2020-10-13 09:59:52.261] $GPRMC,065940.146,A,5545.96565,N,02105.90332,E,0.23,333.67,131020,,*09
[2020-10-13 09:59:52.354] $GPGGA,065940.246,5545.96565,N,02105.90321,E,1,06,02.0,0016.39,M,0.0,M,,*5C
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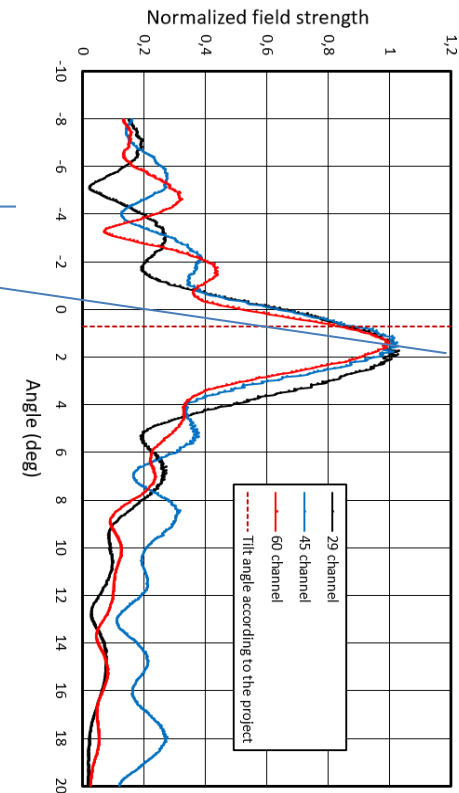
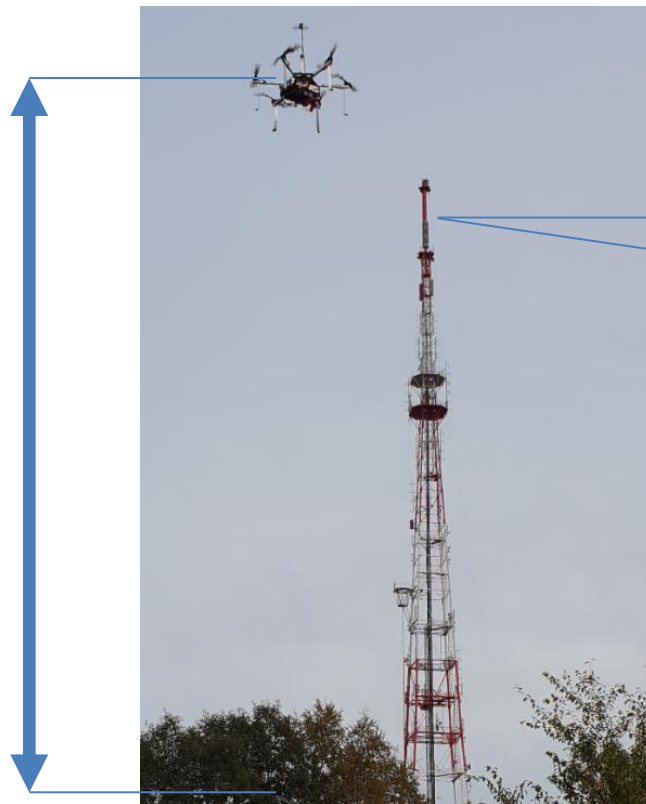
Software used

- Lod data analyzer – merge channel power and GNSS log files, draw polar diagram (created by RRT)



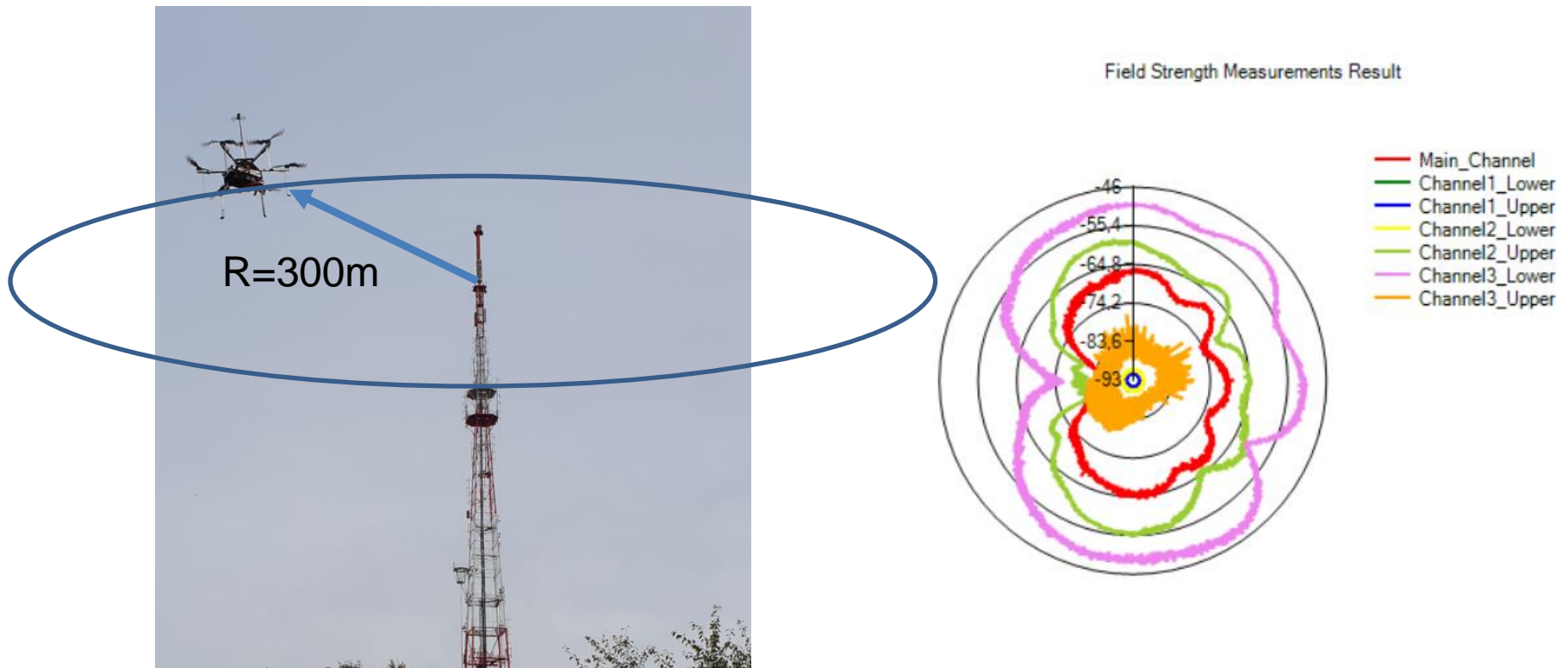
Measurement steps

1. Measure vertical diagram - drone took off strictly vertically above transmitting antenna and descended vertically.



Measurement steps

2. Measure horizontal diagram - drone took off to the height of maximum field strength, then flew around antenna maintaining constant height

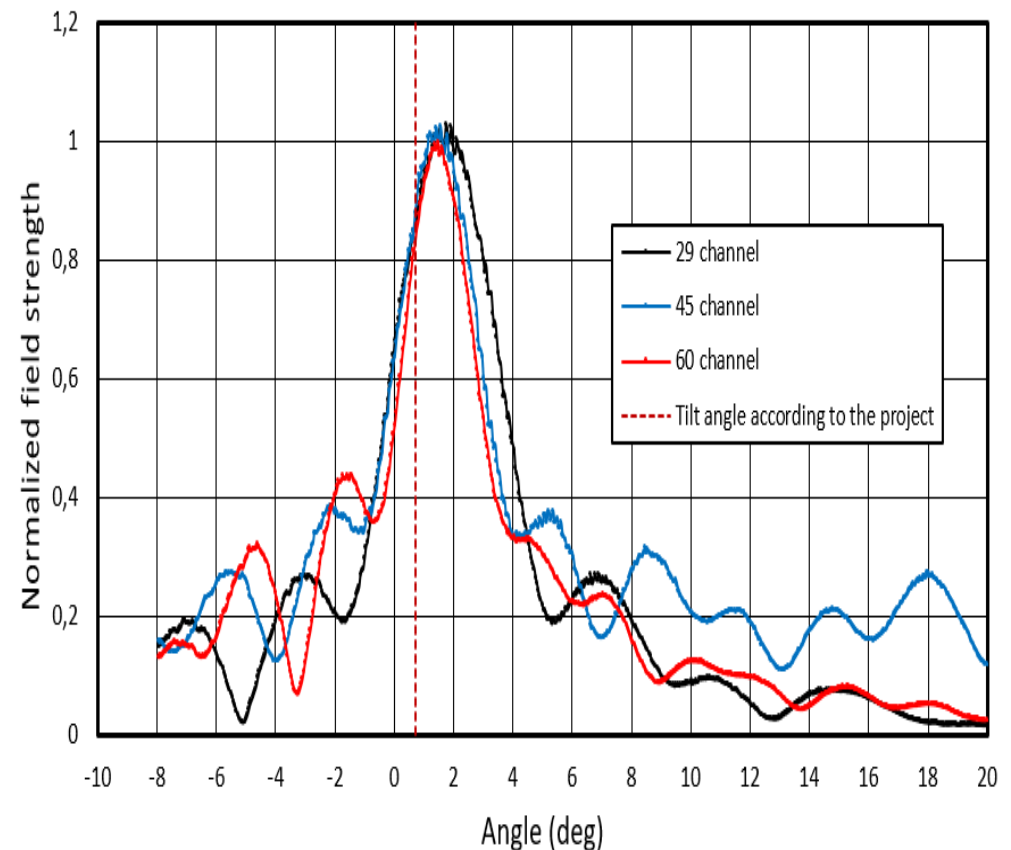


Measurement results

Vertical diagram:

- beam tilt differs significantly from the design (project);
- the width of the main lobe is in good agreement with the project value:

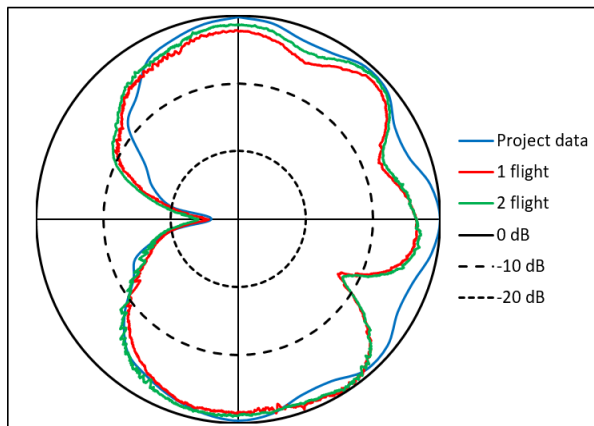
Channel number	Project data	Measured data
29	4.52°	4.33°
45	3.29°	3.62°
60	2.84°	3.07°



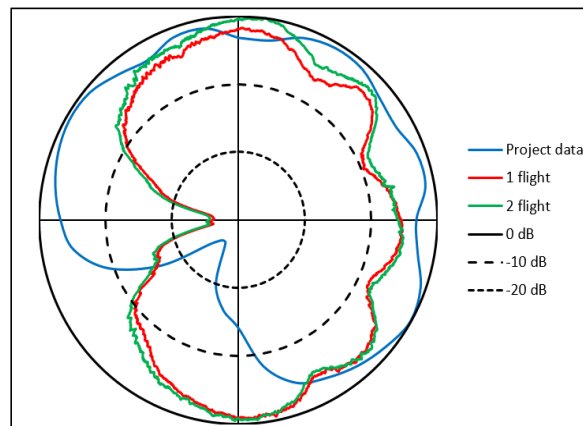
Measurement results

Horizontal diagrams:

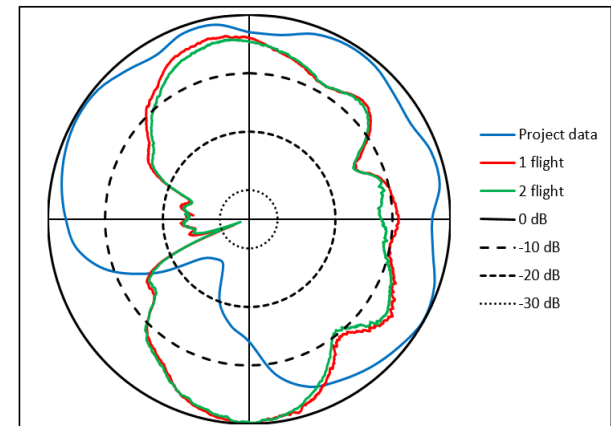
- For channel 29 is close to project data
- For channels 45 and 60 are rotated by about 60 degrees
- Measurements we repeated, results of two flights overlap within 2 dB



Channel 29



Channel 45



Channel 60

Issues to consider

- Measurement accuracy – more repeated measurements needed, accuracy of GNSS, need of RTK;
- Flight time extension – helicopter with petrol engine ?
- EMC issues – compass failure; LTE modem – drone controller interference;
- Remote link to measurement computer on drone (Wi-Fi, LTE);
- New EU regulations, possibility to use certified drone ?



Questions ?

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