



Regional seminar for Europe and CIS on Spectrum Management and Broadcasting – Rome 29-30-31 May 2017

**FS and FSS Coordination Procedure for 3.6-3.8 frequency band
(Mauro Di Crescenzo)**

Measurement Campaign preamble

HUAWEI, MISE, FUB and Telespazio personnel made up a technical team for an interference measurement campaign, which was held on the autumn 2016 at the Fucino Space Centre with the objective to evaluate interference effects between an LTE emitting radio base station and a FSS and MSS Receiving Earth Station operating in the same 3.6-3.8 GHz frequency band, following ITU- R S.2368 guidelines.

These tests proposed could be considered as a starting point for a wider Telespazio program and should be completed for the works of the following WRC.

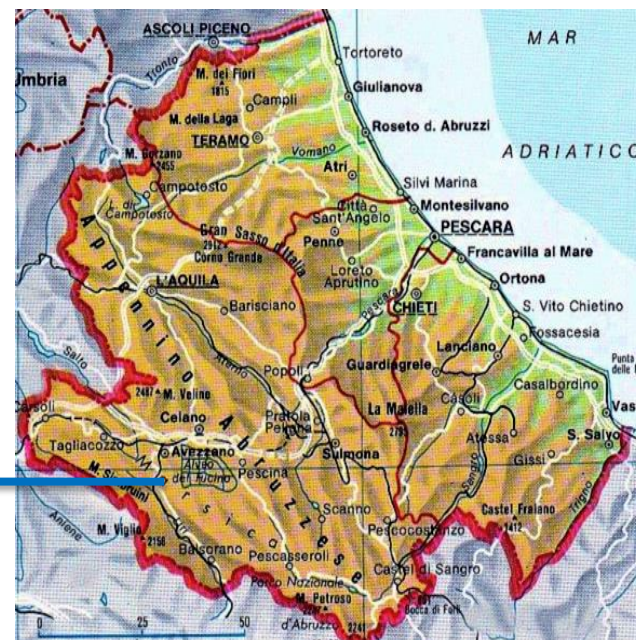
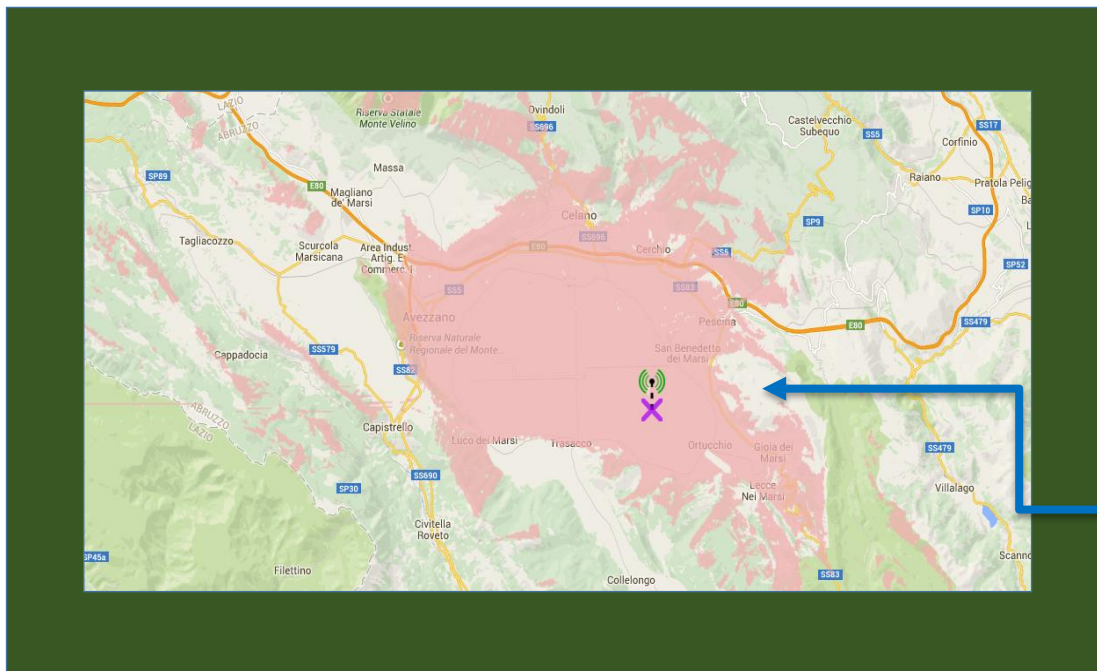
Measurement Campaign objectives

The objective of this basic measurement campaign was the evaluation of interference effects caused by LTE radio base station and the relevant end user terminals versus a satellite receiving earth station. International Regulating Agencies are evaluating the possibility to share 3600-3800 MHz frequency band between FS and FSS. Expected interference effects have been described as:

- In-band Interference (Frequency) – Direct interference. Interfering signals (both direct and reflected) act in the region of linearity of interfered system equipment (LNA, LNB, etc.)
- Out-of-band Interference (Power) – Satellite system are extremely sensible and are able to receive weak power signal compared with the terrestrial one. There is the possibility of a saturation effect on satellite system due to the sources emitting in the overall C band (3625 – 4200 MHz).

Test Area definition

To analyze interfering effects the interfering source has been moved in the Fucino Space Centre visibility area (pink colored) and the relevant DeltaT/T have been detected for the satellite system under observation.



Test Area real view



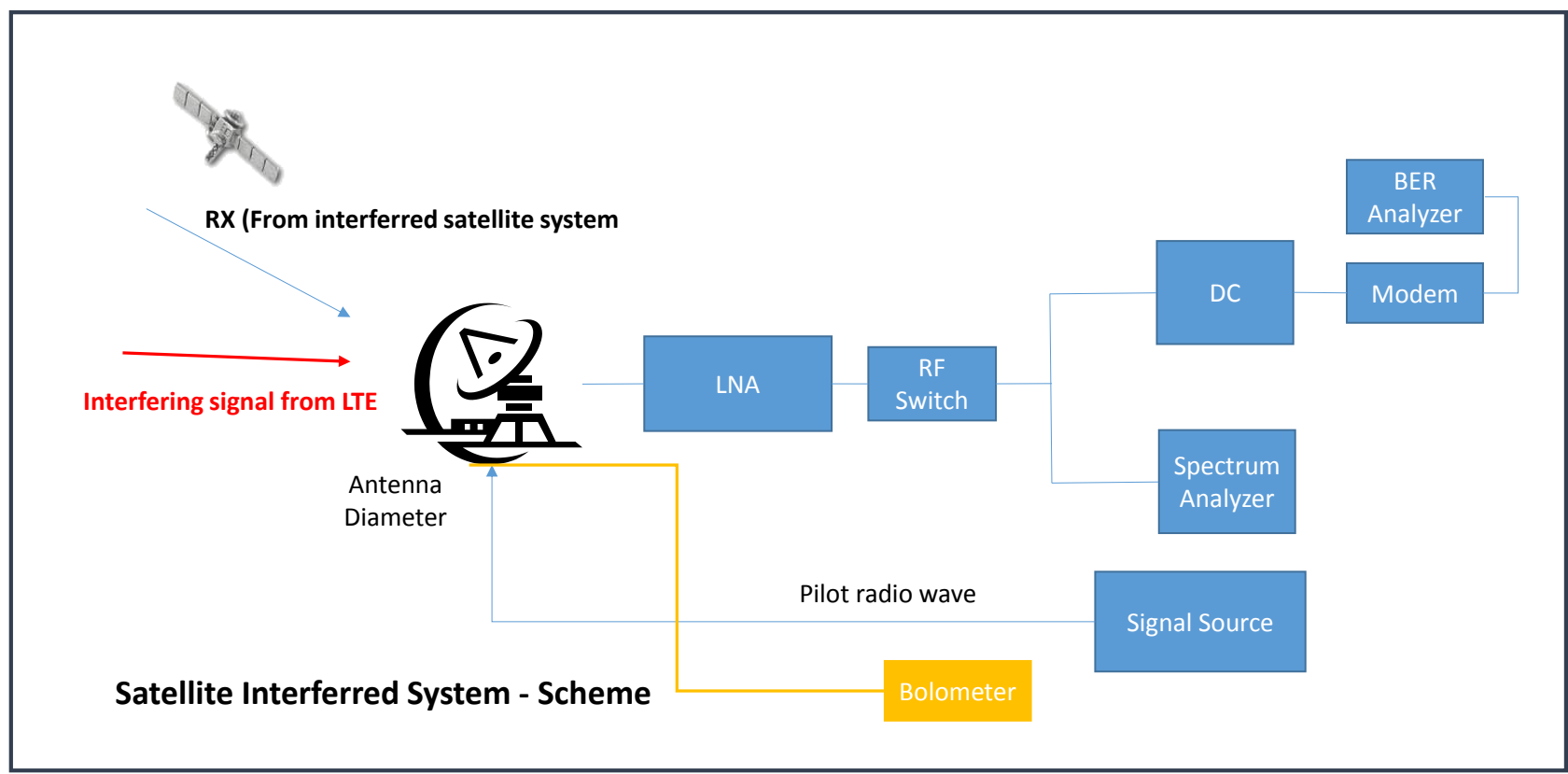
Space Centre in Fucino

Telespazio's "Piero Fanti" Space Centre in Fucino (L'Aquila) has been active since 1963 and today, with its 170 antennas and 370,000 square metres, it is recognized as the first and most important teleport in the world for civilian use.

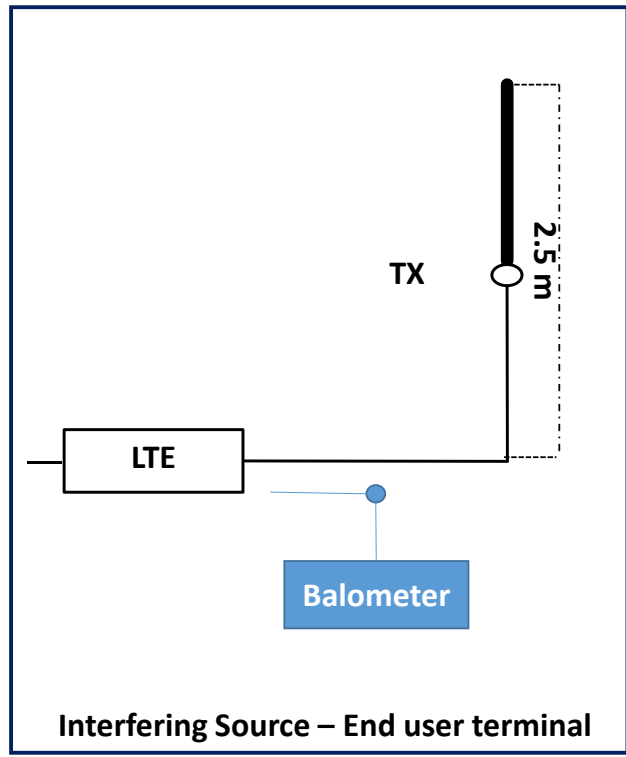
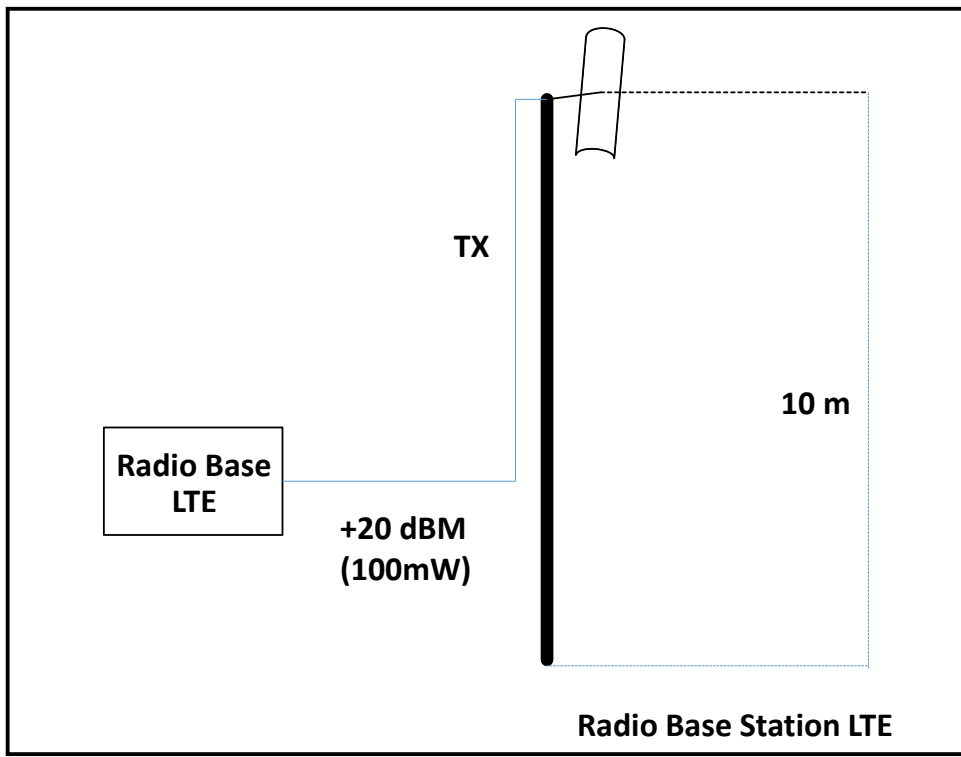
The Fucino Space Centre carries out in-orbit satellite control, space mission management and telecommunications, television and multimedia services. Operational logistics and field services are active in support to the services provided. It employs 250 workers including engineers, specialist technicians and operational staff.



Satellite system: Interfered Source

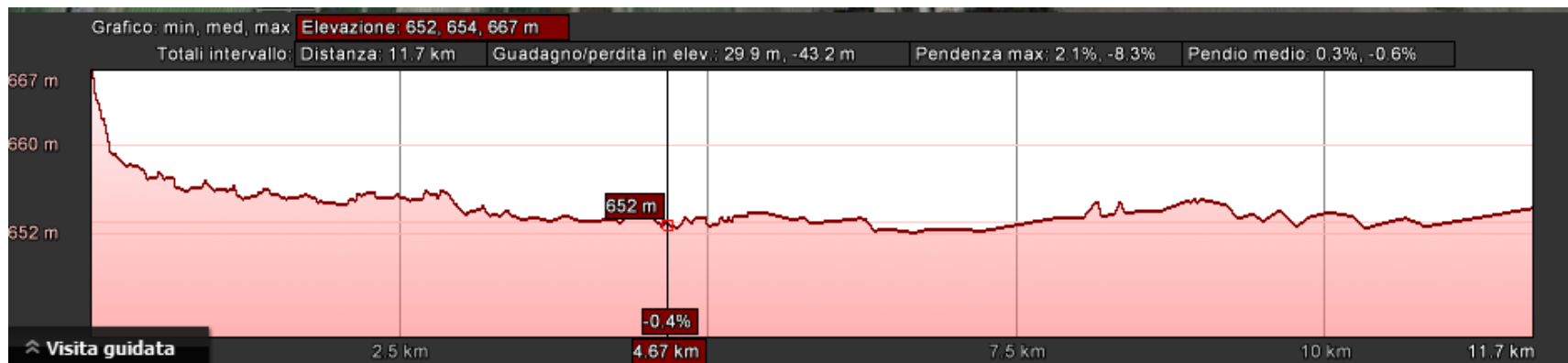


Radio Base Station: Interfering Source

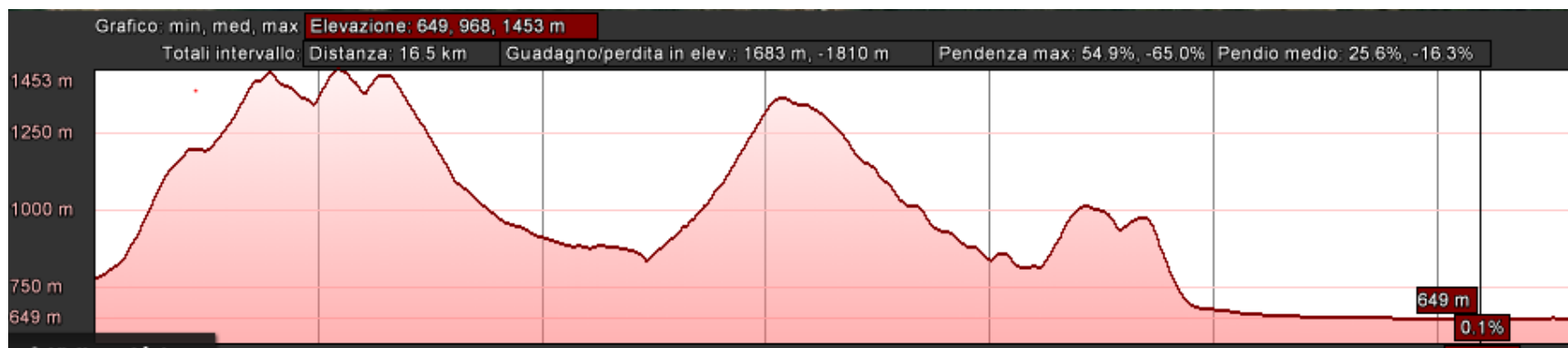


Mathematical model and data collection: Altitude Profiles

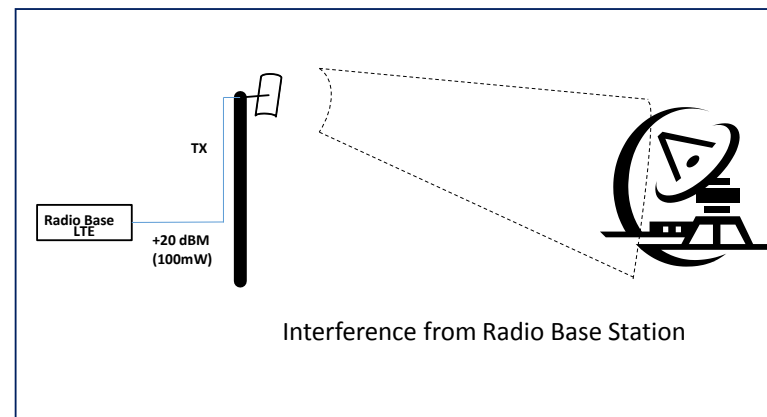
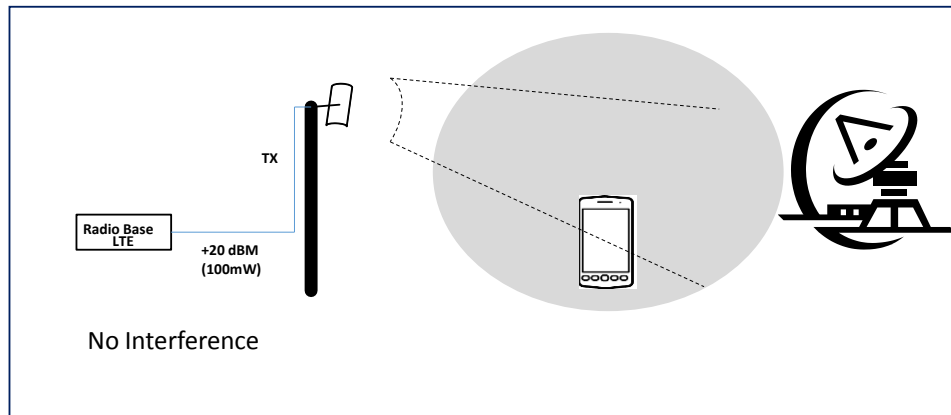
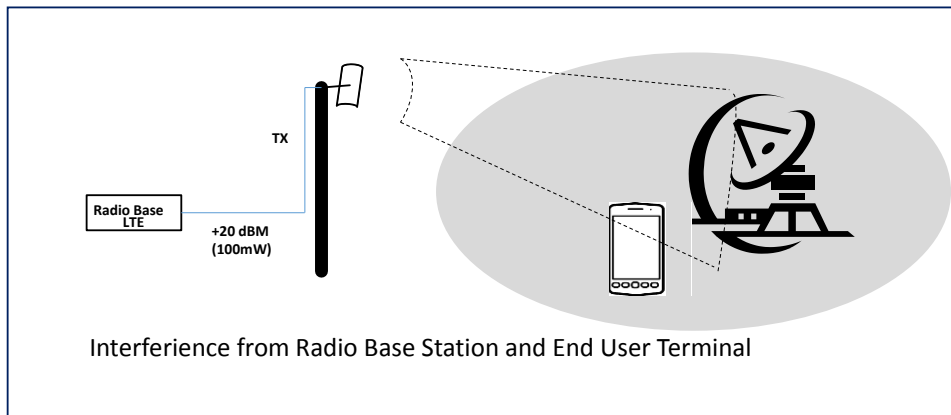
Lucano dei Marzi – Fucino Space Centre: altitude profile



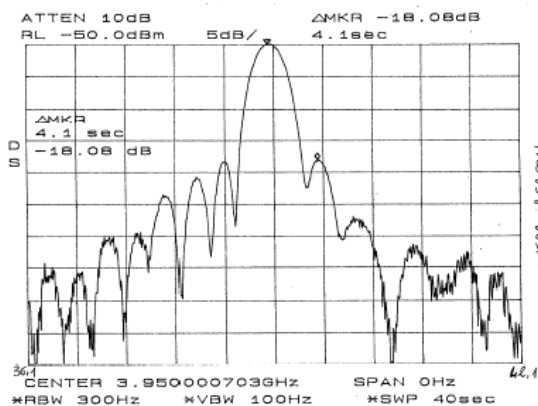
Anversa degli Abruzzi – Fucino Space Centre: altitude profile



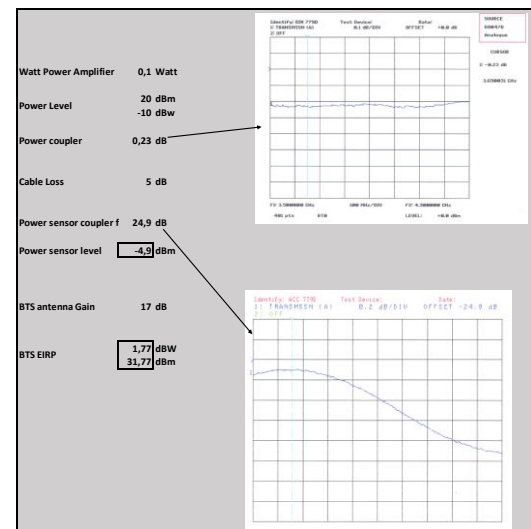
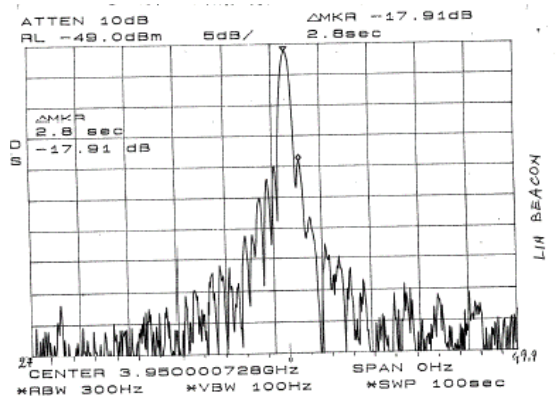
Mathematical model and data collection: Interference



Mathematical model and data collection: Sources

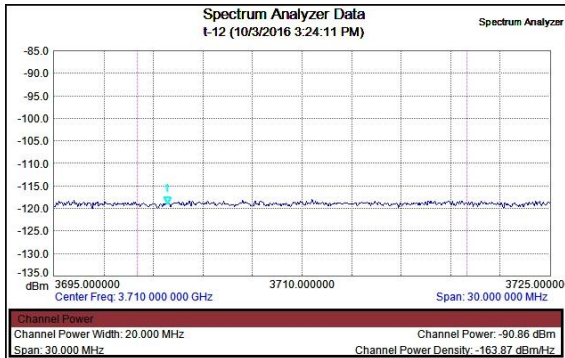


Satellite receiving antenna radiation pattern



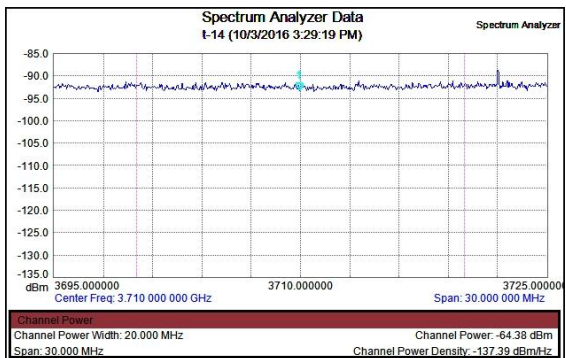
Base Transceiver Station (BTS) EIRP (0.1 W is the minimum BTS Power, being the lowest value available in the configuration range).

Test Configuration - Noise System Tuning



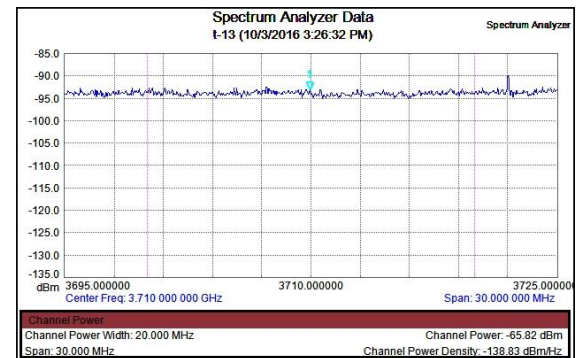
Measurement Parameters			
Trace A data Trace Average	10	Stop Frequency	3 725 000 000 GHz
Trace Mode	Average	Frequency Span	30 000 000 MHz
Preamp	ON	Reference Level	-85.000 dBm
Min Sweep Time	0.001 S	Scale	5.0 dB/div
Reference Level Offset	0 dB	Serial Number	1446150
Input Attenuation	0.0 dB	Base Ver.	V5.70
RBW	30.0 kHz	App Ver.	V6.95
VBW	3.0 kHz	Model	MS2720T
Detection	RMS	Options	9,25,31,732,880,881,883
Center Frequency	3 710 000 000 GHz	Date	10/3/2016 3 24:11 PM
Start Frequency	3 695 000 000 GHz	Device Name	CNCER Roma

Equipment Noise



Measurement Parameters			
Trace Mode	Max Hold	Stop Frequency	3 725 000 000 GHz
Preamp	ON	Frequency Span	30 000 000 MHz
Min Sweep Time	0.001 S	Reference Level	-85.000 dBm
Reference Level Offset	0 dB	Scale	5.0 dB/div
Input Attenuation	0.0 dB	Serial Number	1446150
RBW	30.0 kHz	Base Ver.	V5.70
VBW	3.0 kHz	App Ver.	V6.95
Detection	RMS	Model	MS2720T
Center Frequency	3 710 000 000 GHz	Options	9,25,31,732,880,881,883
Start Frequency	3 695 000 000 GHz	Date	10/3/2016 3 29:19 PM
		Device Name	CNCER Roma

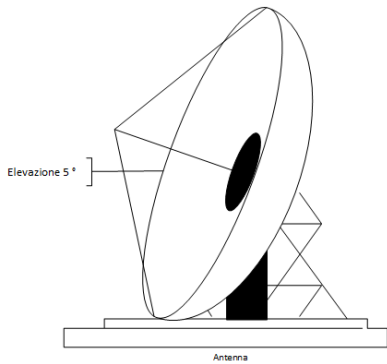
System Noise Level - Antenna 5° elevation



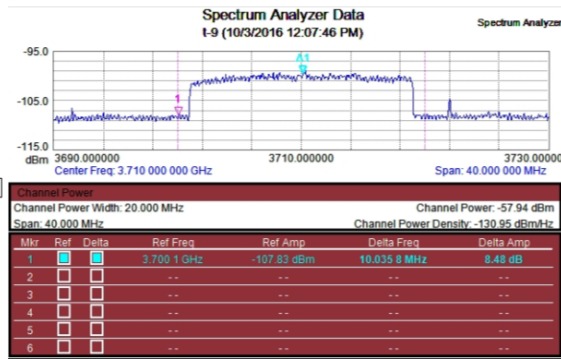
Measurement Parameters			
Trace Mode	Max Hold	Stop Frequency	3 725 000 000 GHz
Preamp	ON	Frequency Span	30 000 000 MHz
Min Sweep Time	0.001 S	Reference Level	-85.000 dBm
Reference Level Offset	0 dB	Scale	5.0 dB/div
Input Attenuation	0.0 dB	Serial Number	1446150
RBW	30.0 kHz	Base Ver.	V5.70
VBW	3.0 kHz	App Ver.	V6.95
Detection	RMS	Model	MS2720T
Center Frequency	3 710 000 000 GHz	Options	9,25,31,732,880,881,883
Start Frequency	3 695 000 000 GHz	Date	10/3/2016 3 26:32 PM
		Device Name	CNCER Roma

System Noise Level - Antenna 60° elevation

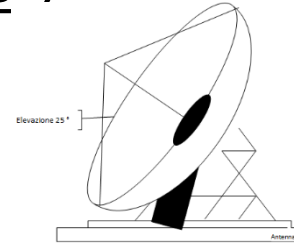
Test 1 - Direct interference with different satellite receiving antenna elevation angle (5°, 25° and 50°)



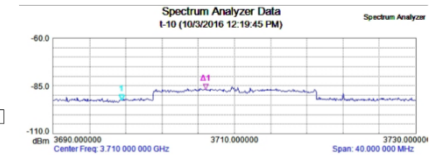
I/N=7,7dB



Measurement Parameters			
Trace Mode	Max Hold	Stop Frequency	3.730 000 000 GHz
Preamp	ON	Frequency Span	40.000 000 MHz
Min Sweep Time	0.001 S	Reference Level	-95.000 dBm
Reference Level Offset	0 dB	Scale	2.0 dB/div
Input Attenuation	10.0 dB	Serial Number	1446150
RBW	1.0 kHz	Base Ver.	V5.70
VBW	1.0 MHz	App Ver.	V6.95
Detection	RMS	Model	MS2720T
Center Frequency	3.710 000 000 GHz	RMS Options	9.25, 31.732, 880, 881, 883
Start Frequency	3.690 000 000 GHz	Date	10/3/2016 12:07:46 PM
		Device Name	CNCER Roma

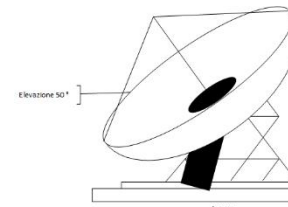


I/N=4,5dB

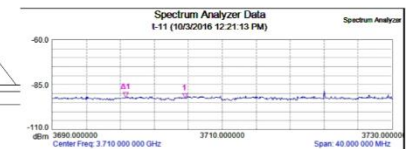


Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	3.697 5 GHz	-92.41 dBm	8.313 0 MHz	5.80 dB
2	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
3	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
4	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
5	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
6	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--

Measurement Parameters			
Trace Mode	Max Hold	Stop Frequency	3.730 000 000 GHz
Preamp	ON	Frequency Span	40.000 000 MHz
Min Sweep Time	0.001 S	Reference Level	-60.000 dBm
Reference Level Offset	0 dB	Scale	5.0 dB/div
Input Attenuation	10.0 dB	Serial Number	1446150
RBW	30.0 kHz	Base Ver.	V5.70
VBW	3.0 kHz	App Ver.	V6.95
Detection	RMS	Model	MS2720T
Center Frequency	3.710 000 000 GHz	RMS Options	9.25, 31.732, 880, 881, 883
Start Frequency	3.690 000 000 GHz	Date	10/3/2016 12:19:45 PM
		Device Name	CNCER Roma



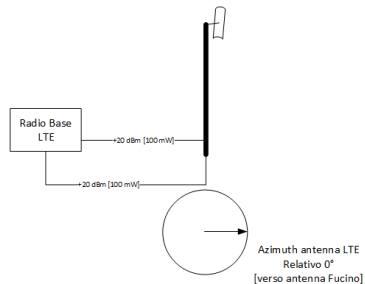
I/N=-8,2dB



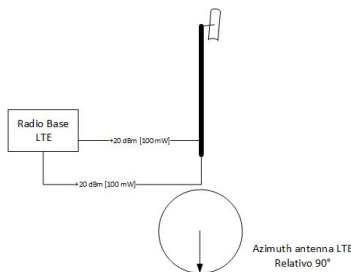
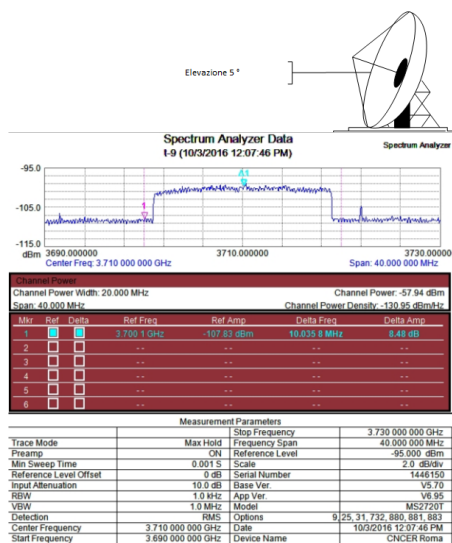
Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	3.705 5 GHz	-85.54 dBm	4.881 8 MHz	0.35 dB
2	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
3	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
4	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
5	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--
6	<input type="checkbox"/>	<input type="checkbox"/>	--	--	--	--

Measurement Parameters			
Trace Mode	Max Hold	Stop Frequency	3.730 000 000 GHz
Preamp	ON	Frequency Span	40.000 000 MHz
Min Sweep Time	0.001 S	Reference Level	-60.000 dBm
Reference Level Offset	0 dB	Scale	5.0 dB/div
Input Attenuation	10.0 dB	Serial Number	1446150
RBW	30.0 kHz	Base Ver.	V5.70
VBW	3.0 kHz	App Ver.	V6.95
Detection	RMS	Model	MS2720T
Center Frequency	3.710 000 000 GHz	RMS Options	9.25, 31.732, 880, 881, 883
Start Frequency	3.690 000 000 GHz	Date	10/3/2016 12:21:13 PM
		Device Name	CNCER Roma

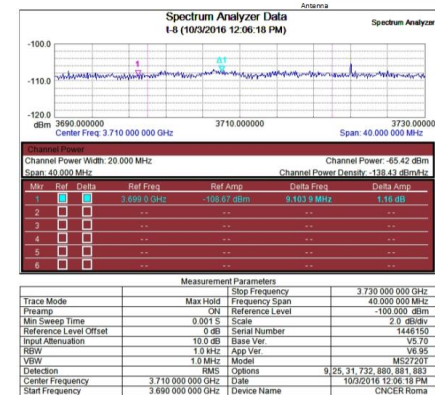
Test 2 - Reflected signals obtained rotating the LTE base radio antenna, at different satellite receiving antenna elevation angle.



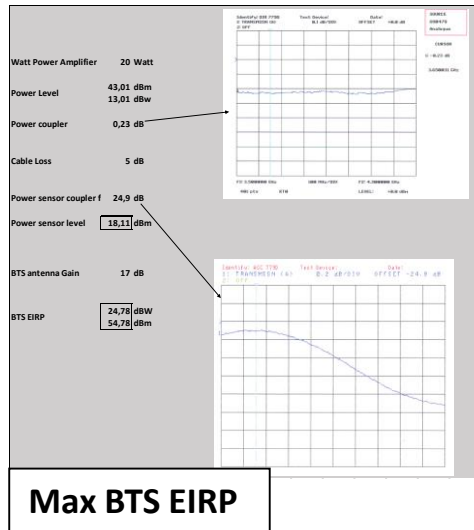
I/N=7,7dB



I/N=4,9dB



Test 3 - Moving the LTE radio base outside Fucino's direct visibility area. (Anversa degli Abruzzi)



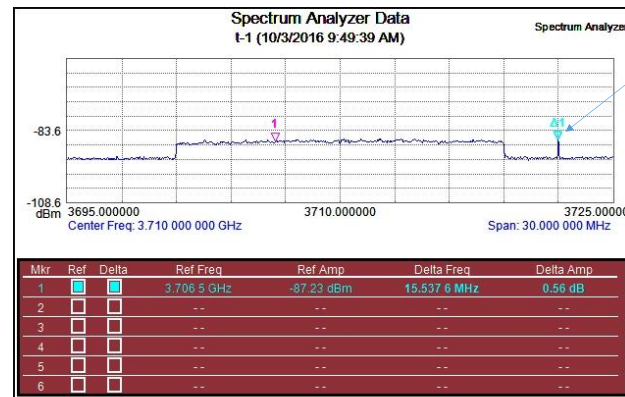
Using Max BTS EIRP from Anversa degli Abruzzi, the interfered antenna didn't receive any signal within measurable range.

Power Flux density determination

Max BTS EIRP

Using the Continuous Wave (CW) Pilot comparing method, it has been carried out the Power Flux density received at Fucino Earth Station with BTS transmitting Minimum EIRP.

Power Flux Density measurement



CW Level at LNA Input = -125,9 dBm

Measurement Parameters			
Trace Mode	Normal	Stop Frequency	3.725 000 000 GHz
Preamp	OFF	Frequency Span	30.000 000 MHz
Min Sweep Time	0.1 S	Reference Level	-58.600 dBm
Reference Level Offset	0 dB	Scale	5.0 dB/div
Input Attenuation	0.0 dB	Serial Number	1021120
RBW	30.0 kHz	Base Ver.	V3.38
VBW	300.0 Hz	App Ver.	V4.35
Detection	Peak	Model	MS2712E
Center Frequency	3.710 000 000 GHz	Date	10/3/2016 9:49:39 AM
Start Frequency	3.695 000 000 GHz	Device Name	

Considerations

The large amount of DeltaT/T measurements demonstrate that a FS always causes harmful interference on FSS in Fucino Space Centre visibility (this is confirmed by test 1 and 2 results). The only solution to avoid such interference seems to define an area not allowed to FS sized as the visibility area of the teleport itself (this is confirmed by test 3 results). Anyway a DeltaT /T value just represent an alarm which claim for more accurate investigations about the nature of interference and an ad hoc simulation model should improve the accuracy of the analysis minimizing the protection area size. The data collected represent a valid test for the validation of the mathematical model reliability.

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THANK YOU FOR YOUR ATTENTION