The stealth dish

Mario Armando Natali, I0NAA

mario.natali@gmail.com

ARI Perugia

The stealth dish

AGENDA

- **Why a stealth dish.**
- **Mechanical design.**
- **Technical characteristics.**
- **Results obtained.**
- **Future plans.**

The stealth dish

Why a stealth dish...

- ✓ **Visibility** → **Low**
  - ➢ ***Limits as much as possible visibility when not in use***
- ✓ **Safety** → **High**
  - ➢ ***Makes access to the feeder easy and safe***
- ✓ **Maintainability** → **High**
  - ➢ ***Makes the set-up time short and repeatable***

The stealth dish

Why a stealth dish... : Challenges and advantages

CHALLANGES

- ✓ Accuracy and repeatibility of positioning.
- ✓ Complex mechanism.
- ✓ Much higher overall weight.
- ✓ Stability.

ADVANTAGES

- ✓ Very easy access to the feeder.
- ✓ «curiosity» minimization...
- ✓ No need to use stairs.
- ✓ Lower overall profile when in «resting» position that minimize lightening risk.
- ✓ .... Good sleep during thunderstorms ......

The stealth dish

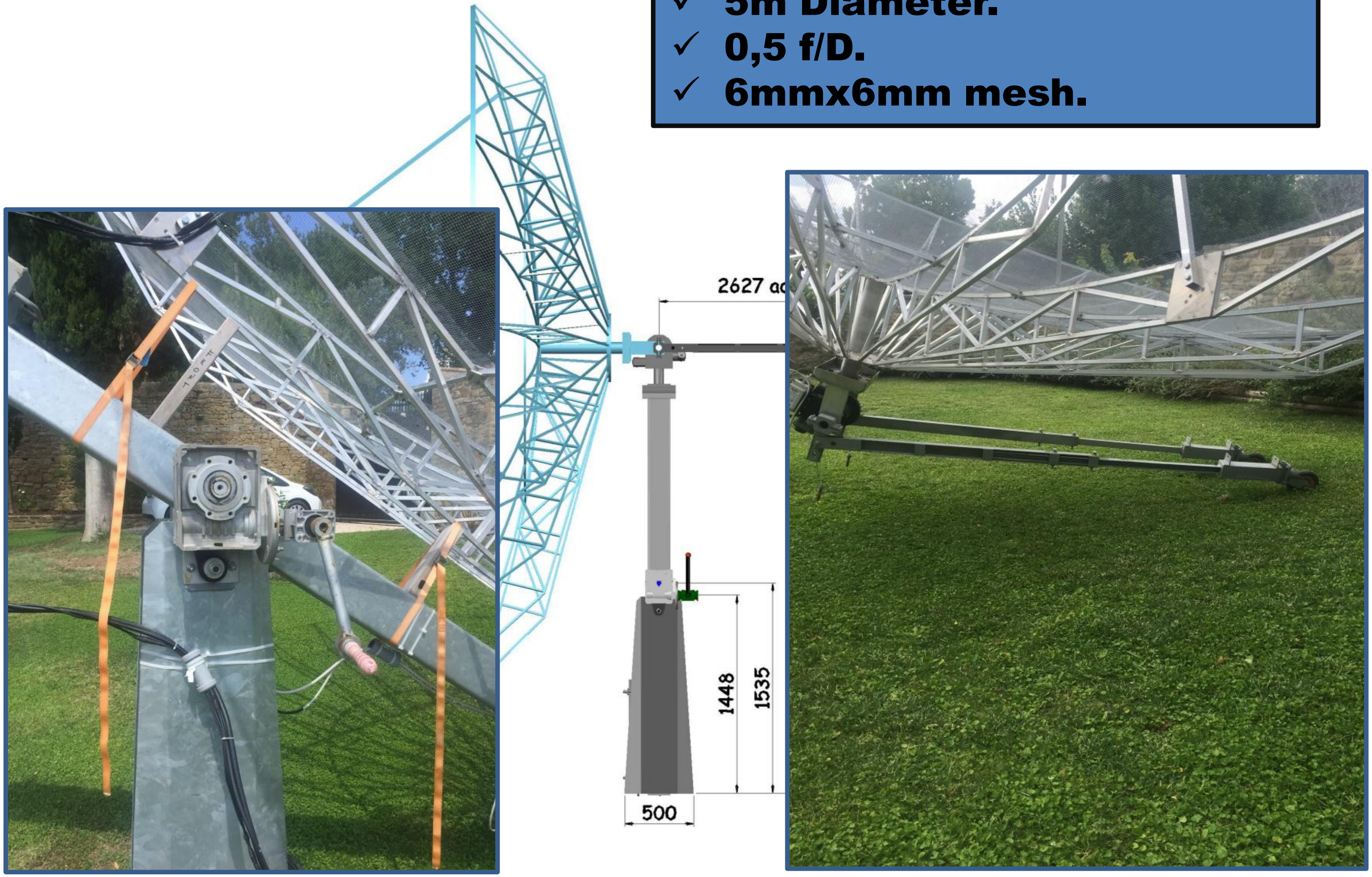
Why a stealth dish …. : a bit of history

….. From Braunau am Inn to Assisi

The stealth dish

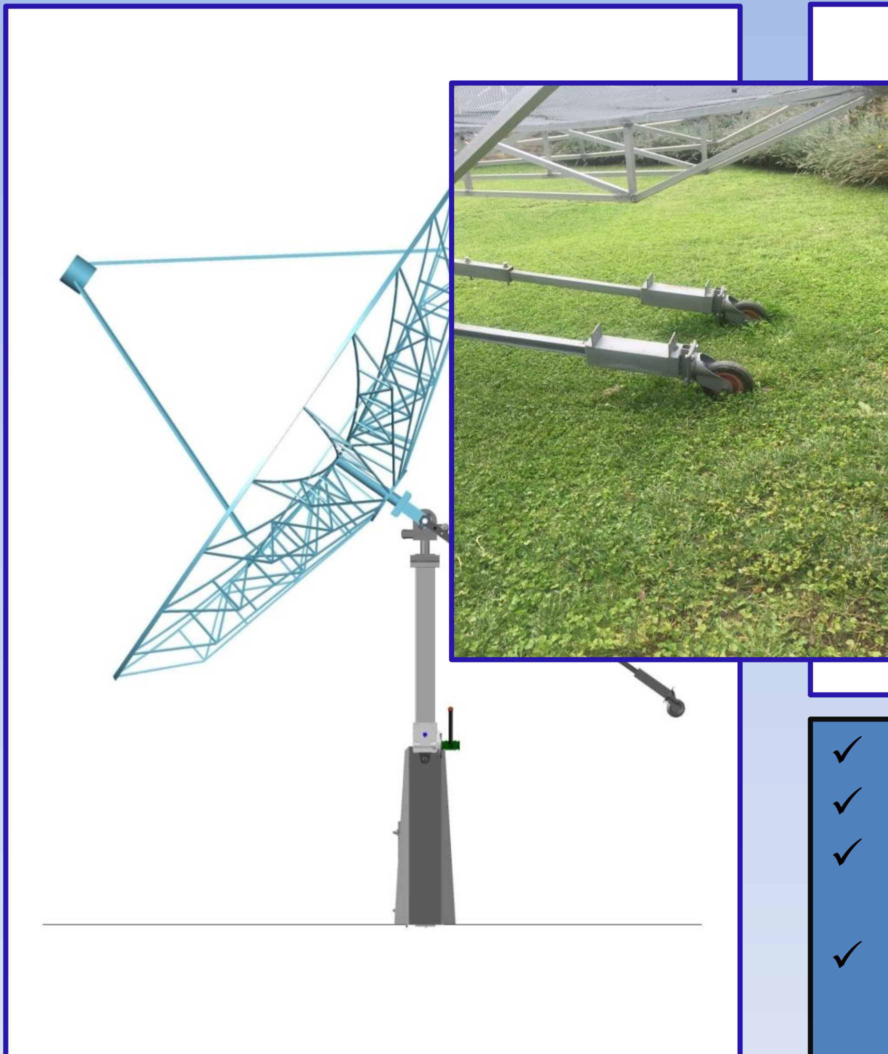
Mechanical design : tower design

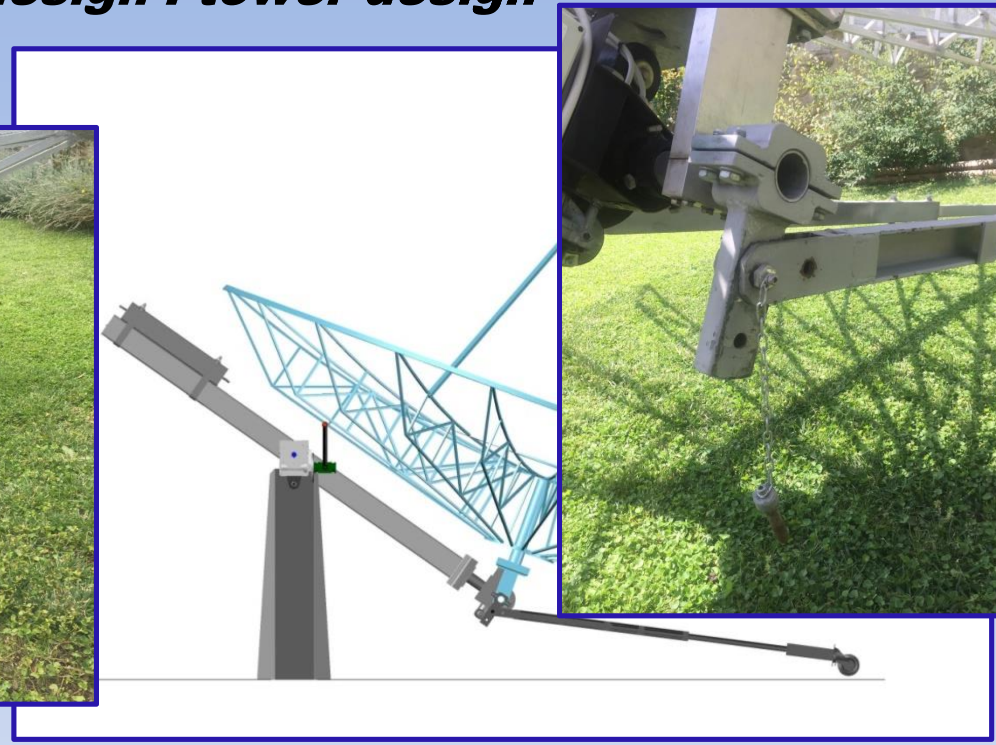
- ✓ **5m Diameter.**
- ✓ **0,5 f/D.**
- ✓ **6mmx6mm mesh.**



The stealth dish

Mechanical design : tower design

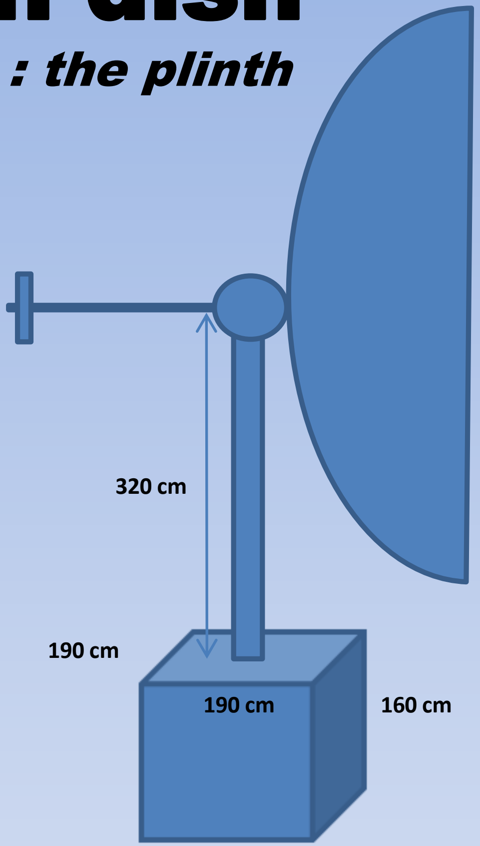




- ✓ **Total weight about 1,000Kg.**
- ✓ **Counterweights ….. with wheels.**
- ✓ **Tilting system built with standard gearbox.**
- ✓ **15 minutes from operations start to first echo.**

The stealth dish

Mechanical design : the plinth

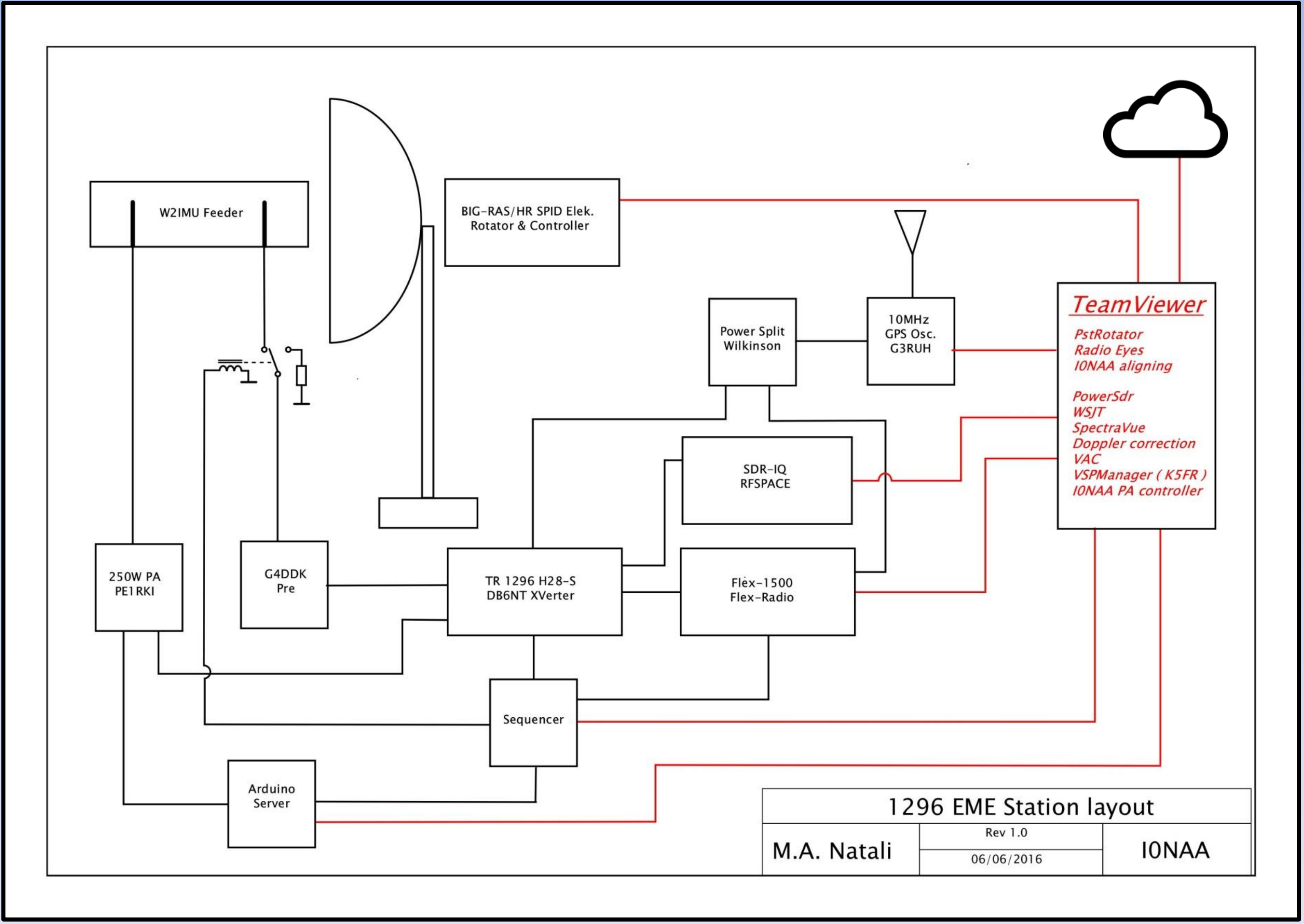


- ✓ **Stabilizing moment = 14,650 Kg.**
- ✓ **Tilting moment =6,900 Kg.**
  (wind @ 100Km/h)
- ✓ **η (stabilization moment) = 2.11.**

Video

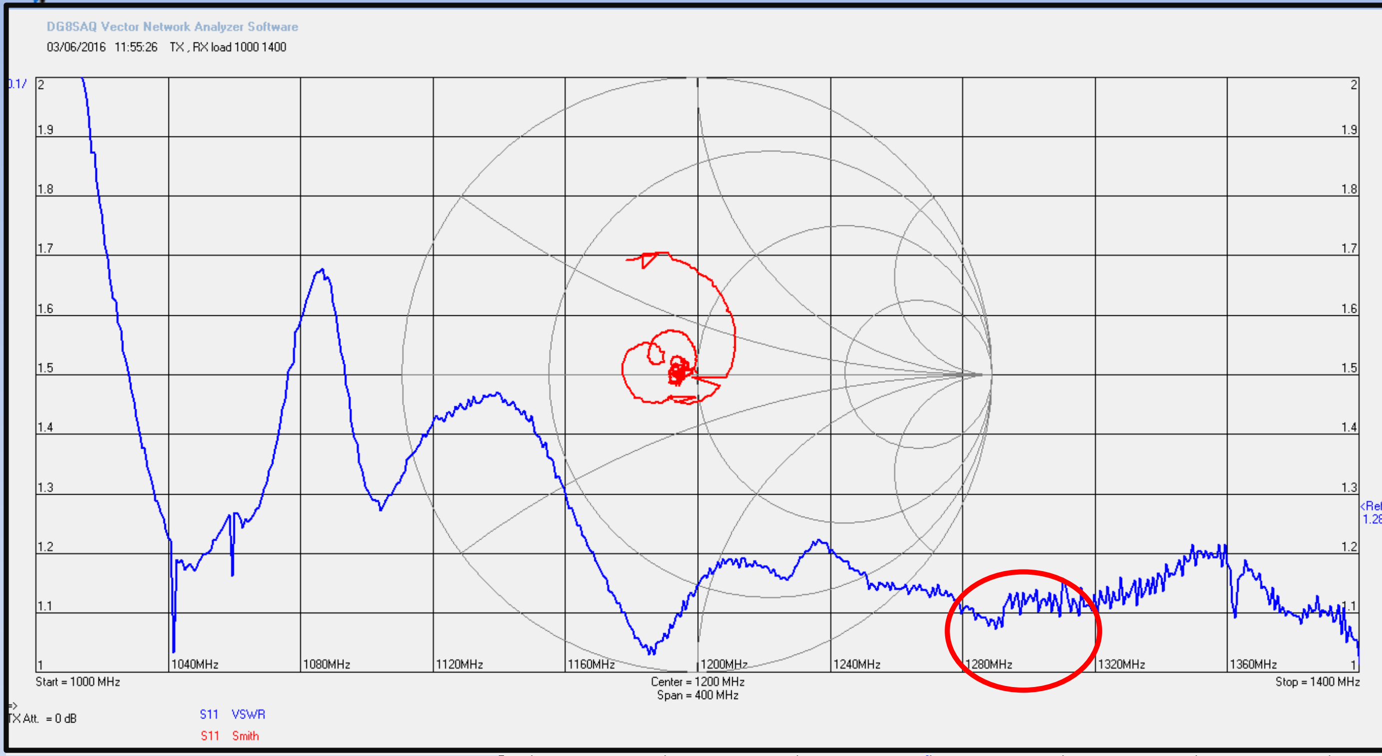
The stealth dish

Technical characteristics : the station

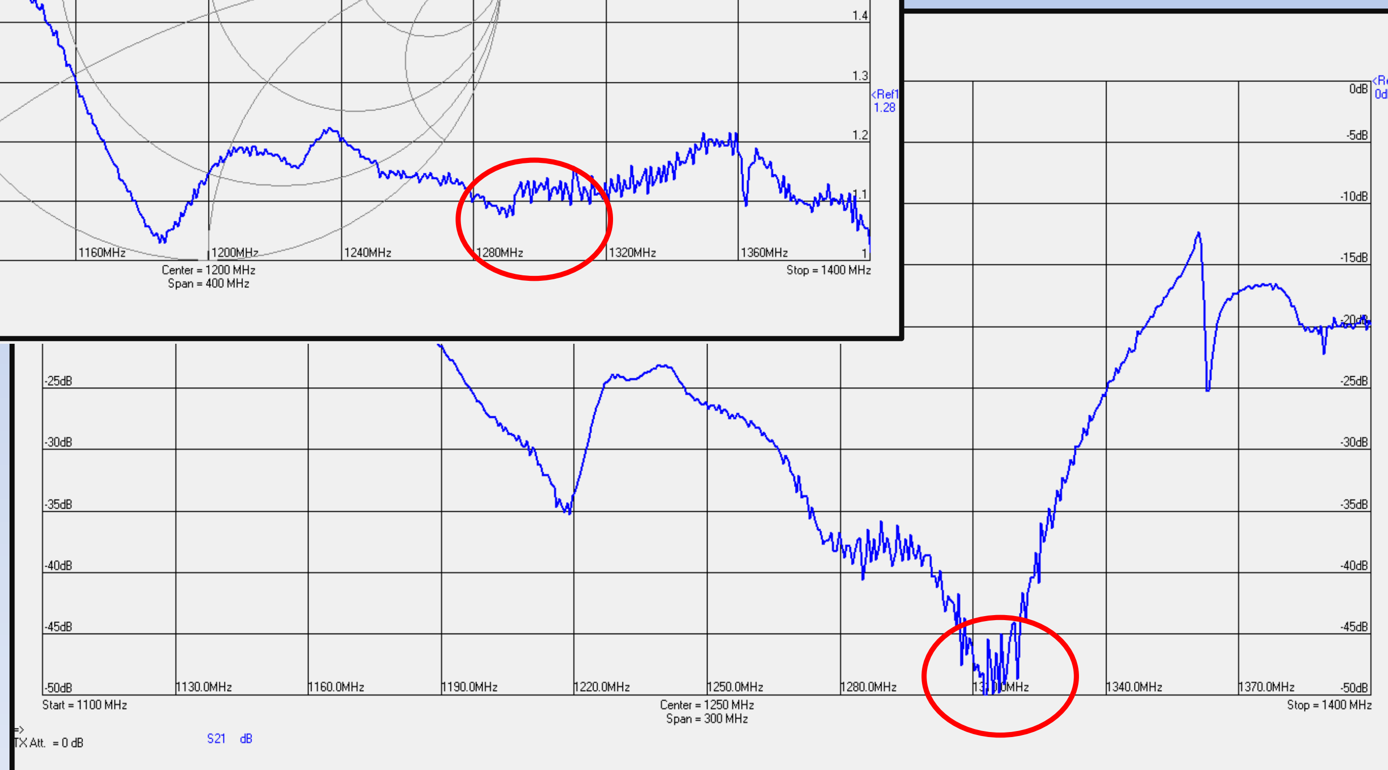


The stealth dish

Technical characteristics : the feeder



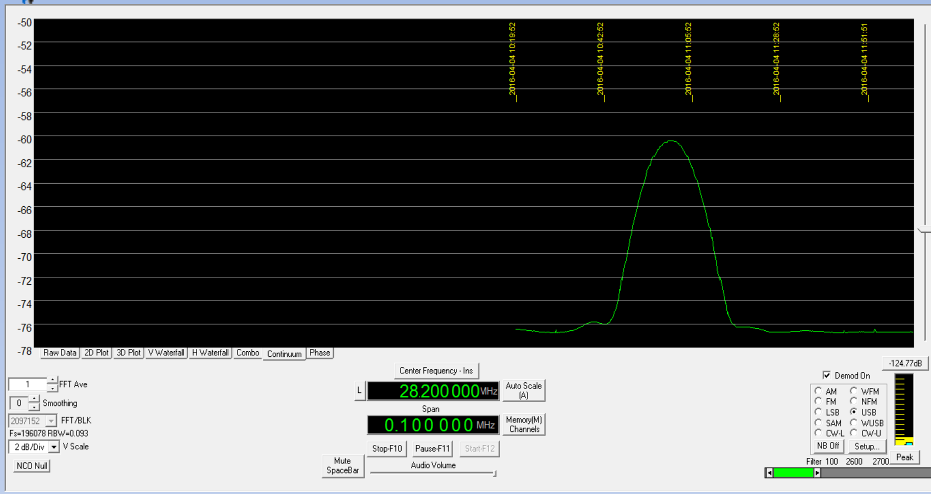
Very good S11 response over large bandwidth.

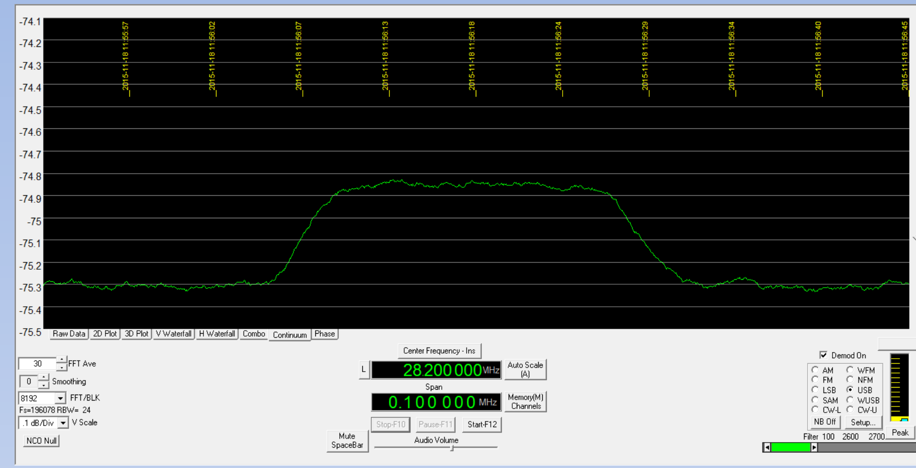


Pretty good crosstalk response at the target frequency.

The stealth dish

Technical characteristics : the results





UTC	Callsign	Name	Comment
09-15/Change			
03-15 17:25:20	RA3DGP	Victor	CQ 060 1 st
03-15 17:25:10	I0NAA	Mario	Good Keith, we did it !
03-15 17:24:46	I0NAA	Mario	171400 0 -26 3.3 -420 6 * I0NAA G4FUF JO01 ? 0 1
03-15 17:15:47	i1ndp	nando	171400 4 -20 3.0 226 9 * xxxxx G4FUF
03-15 17:15:46	I0NAA	Mario	Keith keep going see u
03-15 17:11:34	G4FUF	Keith	Mario, ok

- **Very consistent measurements of Cygnus-A @ 0,58dB Vs. 0,63dB Reference (92,1%).**
- **Very good measurement of sun noise @ around 96% Vs. Reference.**
- **Some problem on sidelobes to be fixed.**
- **«Theoretical» result achieved comparing reception of the same signal with Nando I1NDP !!!**

The stealth dish

Software tools : EZmoon

INPUT PARAMETERS								
Frequency	Mhz	1,296	Line loss before LNA	dB	0.10	Moon distance	Km	390,000
TX antenna gain	dBi	33.00	LNA noise figure	dB	0.23	Moon diameter	Km	3,470
RX antenna gain	dBi	33.00	LNA gain	dB	38.00	Moon reflectivity	%	7
TX Power	Watt	250.00	Line loss after LNA	dB	0.50	Sky temperature (TSky)	K	100
TX line loss	dB	0.10	RX noise figure	dB	4.00			
			Bandwidth	Hz	3,000			

OUTPUT PARAMETERS								
EIRP	Watt	487,461	Line loss before LNA	G	0.98	Receiving system noise factor	f	1.08
EIRP	dBw	56.88	Line noise factor before LNA	f	1.02	Receiving system noise figure	dB	0.33
RADAR Equation	dB	47.04	LNA gain	G	6310	Noise temperature of receiving system	K	22.98
Path loss	dB	**271.13**	LNA noise factor	f	1.05	Overall noise temperature (including TSky)	K	122.98
			Line loss after LNA	G	0.89	Overall noise power (including TSky)	dBw	-172.93
			Line noise factor after LNA	f	1.12			
			RX noise factor	f	2.51			
EXPECTED SNR (best)	**dB**	**-8.32**						

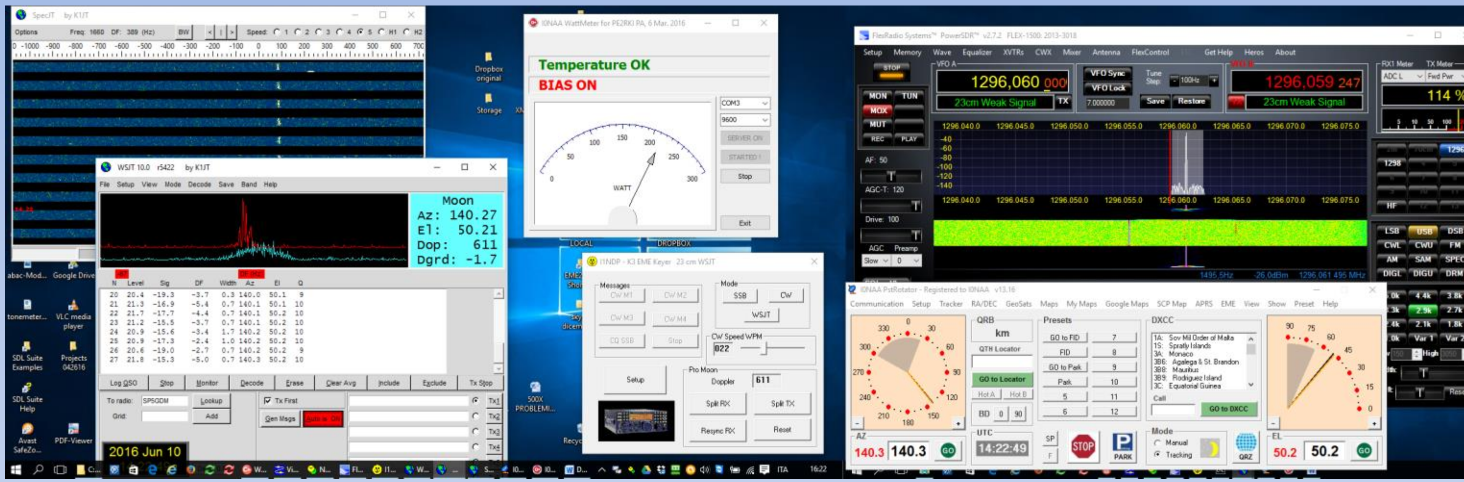
FORMULA	
EIRP	=TX Power*(POWER(10;((TX antenna gain-TX line loss)))
EIRP	=10*LOG10(EIRP)
RADAR Equation	=10*LOG10(4*Moon distance^2/Moon diameter^2)
Path loss	=(32.45+20*LOG10(Frequency)+20*LOG10(Moon distance*2)+RADAR Equation-10*LOG10(Moon reflectivity/100))
Line loss before LNA	=POWER(10;(-Line loss before LNA/10))
Line noise factor before LNA	=POWER(10;(Line loss before LNA/10))
LNA gain	=POWER(10;(LNA gain))
LNA noise factor	=POWER(10;(LNA noise figure/10))
Line loss after LNA	=POWER(10;(-Line loss after LNA/10))
Line noise factor after LNA	=POWER(10;(Line loss after LNA/10))
RX noise factor	=POWER(10;(RX noise figure/10))
Receiving system noise factor	=G12+((G14-1)/G11)+((G16-1)/(G13*G11))+((G17-1)/((G15*G13*G11)))
Receiving system noise figure	=Line noise factor before LNA+((LNA noise factor-1)/(Line loss before LNA)+((Line noise factor after LNA-1)/(LNA gain*Line loss b ((RX noise factor-1)/((Line loss after LNA*LNA gain*Line loss before LNA)))
Noise temperature of receiving system	=(10^(Receiving system noise figure/10)-1)*290
Overall noise temperature (including TSky)	=Noise temperature of receiving system+Sky temperature (TSky)
Overall noise power (including TSky)	=10*LOG10(Bandwidth *1.39E-23*Overall noise temperature (including TSky))
EXPECTED SNR	=EIRP-Path loss-Overall noise power (including TSky)+RX antenna gain

EZMoon i0naa Rev 1.0.0 June 2016

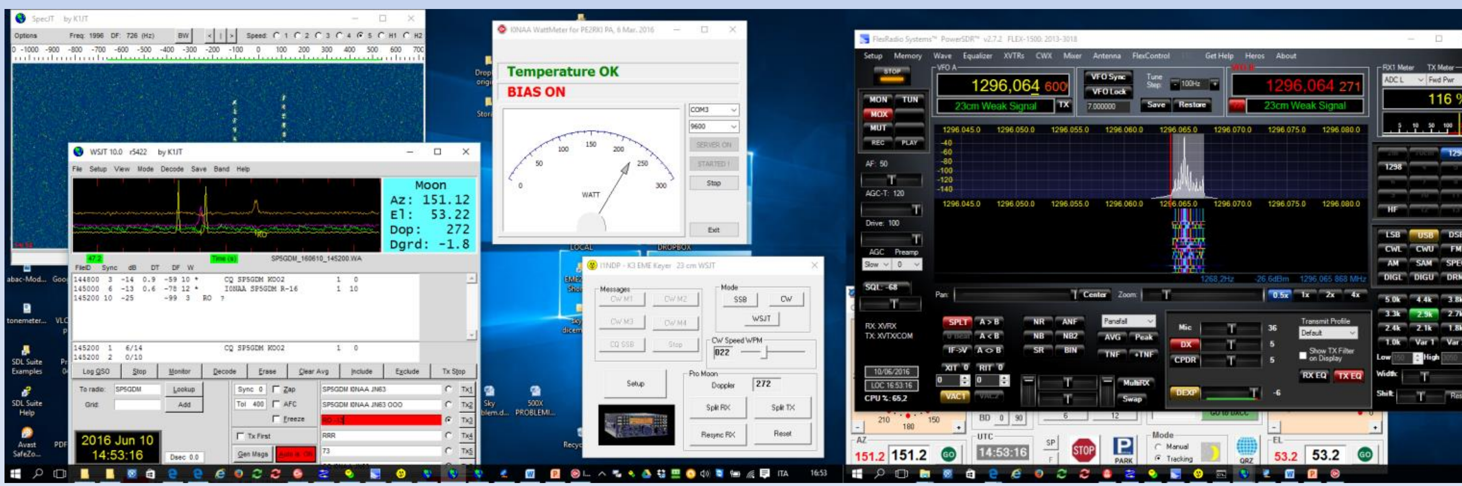
Very basic worksheet to evaluate the EME path with formulas in evidence to allow good understanding and easy customization.
Go to download section of ARI PG http://www.aripg.it/

The stealth dish

Technical characteristics : the results



Echo with 220W.

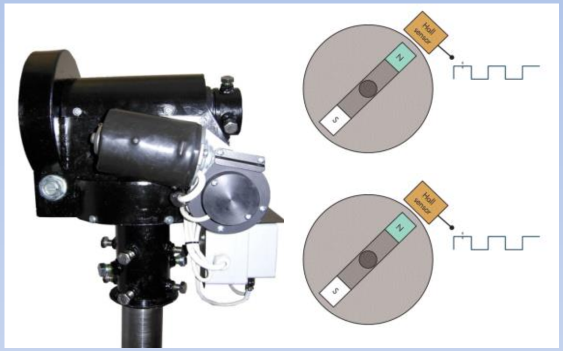


JT65C QSO with SP5GDM.

The stealth dish

Future plans : automatic alignment

- ✓ **The main problem with the stealth dish is the repeatability of the alignment.**



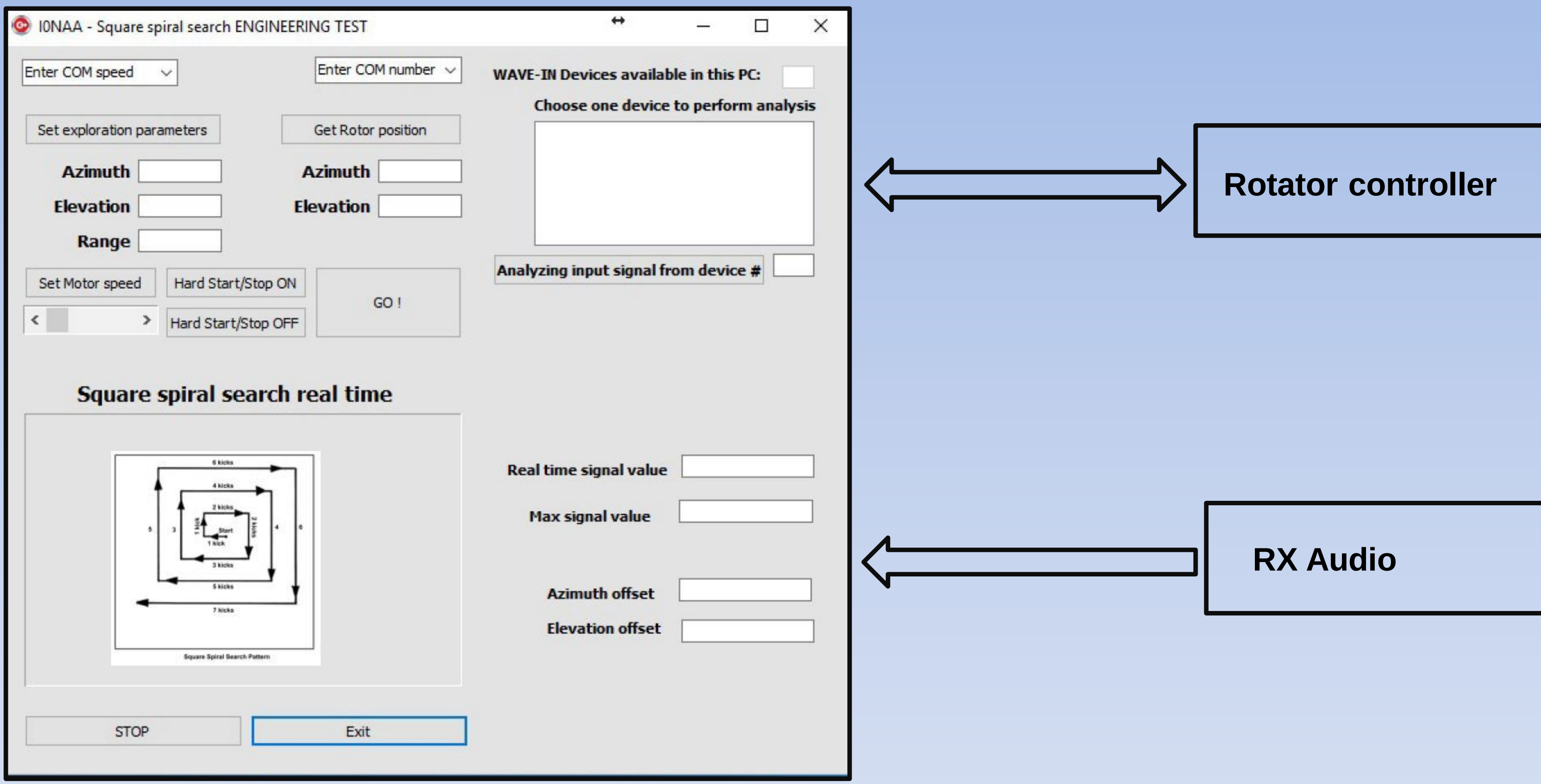
The very narrow HPBW (about 3 Deg.) requires strict control of orientation and the incremental encoders (Hall sensors) of SPID BIG-RAS/HR , together with the tower tilting mechanism, impose a re-alignment at the beginning of each session.

- ✓ **The re-alignment is done manually calculating an offset and it is quite easy to perform during the day with the sun … but becomes much more difficult without the sun !**

- ✓ **Absolute encoders are the obvious answer …. But this is too easy ….. ☺**

The stealth dish

Future plans : automatic alignment



Square Spiral Search Pattern program is in development and I plan to release it for SPID BIG-RAS/HR rotator in October. This program will use the latest firmware release from SPID that will allow better motor control to minimize start-stop oscillations.

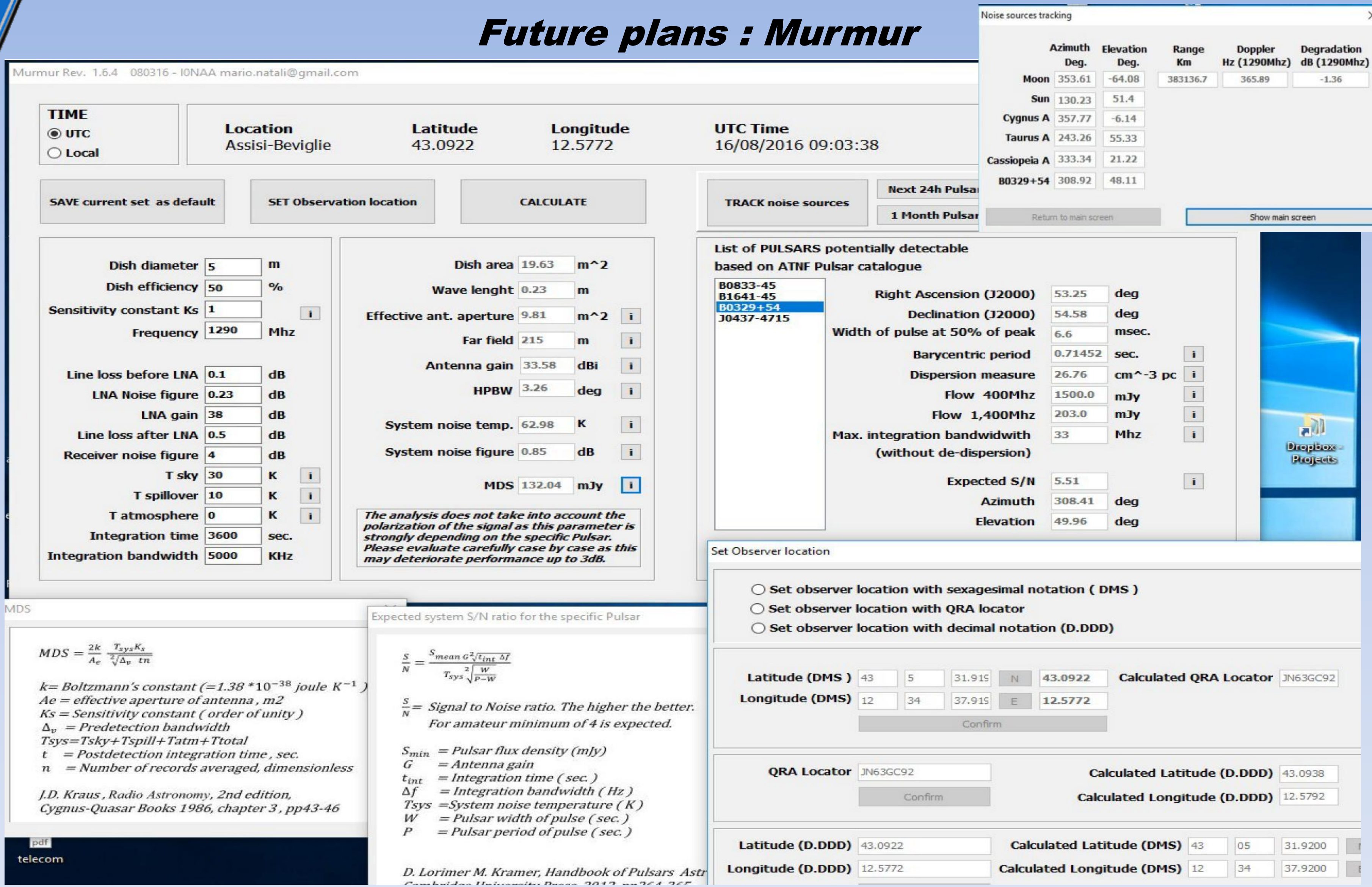
The stealth dish

Future plans : the sky ...

- ✓ **The next challenge is the reception of pulsars ....**
- ✓ **Pulsars reception is an outstandig «methodology» to fine tune an EME station and to understand digital signal processing.**
- ✓ **The start to this long journey was the development of a program that can predict the «detactability» of a pulsars comparing the MDS (Minimum Detectable Signal) of a station with pulsar flow data derived from ATNF pulsar catalogue.**
- ✓ **The MDS is calculated entering standard station parameters and integration bandwidth / time.**
- ✓ **The program is also able to track / predict the position of the most important radio sources.**

The stealth dish

Future plans : Murmur



Go to download section of ARI PG http://www.aripg.it/

The stealth dish

Conclusions : the beauty of the antennas

oe5jfl

i0naa

.... who said that hamradio is not romantic .....