



The stealth dish

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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*



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Why a stealth dish... : Challenges and advantages

CHALLENGES

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

ADVANTAGES

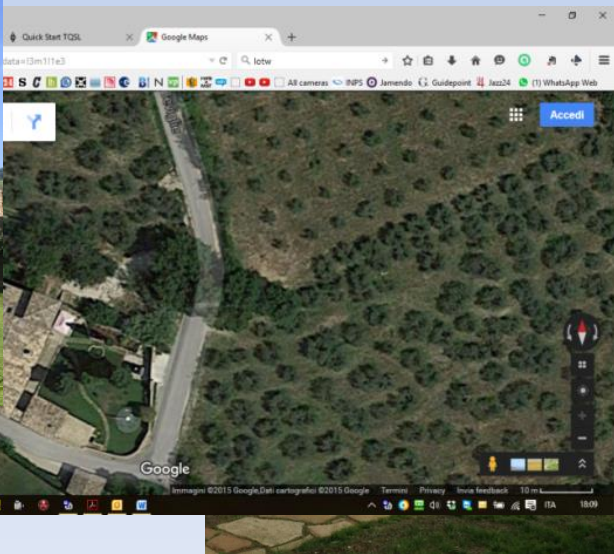
- ✓ **Very easy access to the feeder.**
- ✓ **«curiosity» minimization...**
- ✓ **No need to use stairs.**
- ✓ **Lower overall profile when in «resting» position that minimize lightening risk.**
- ✓ **.... Good sleep during thunderstorms**



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Why a stealth dish : a bit of history

..... From Braunau am Inn to Assisi

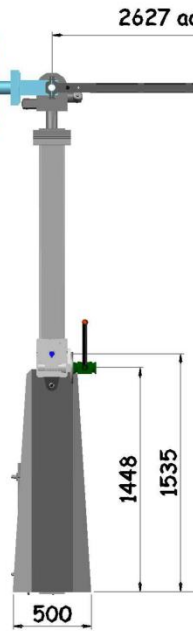
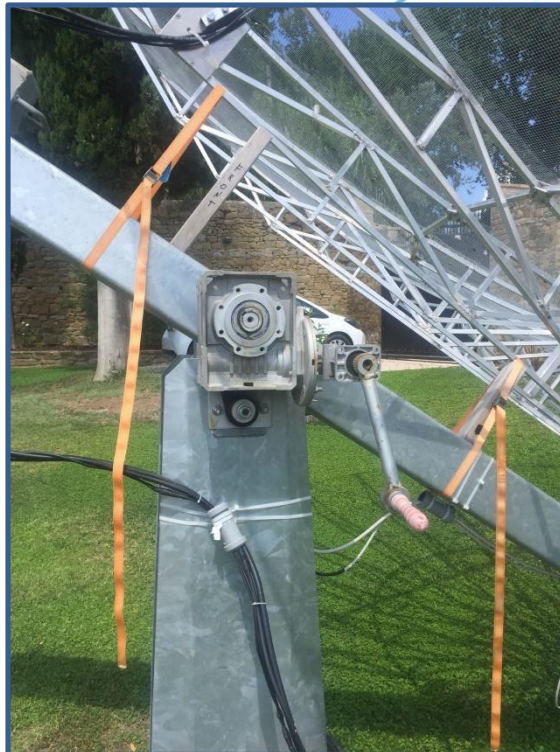




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Mechanical design : tower design

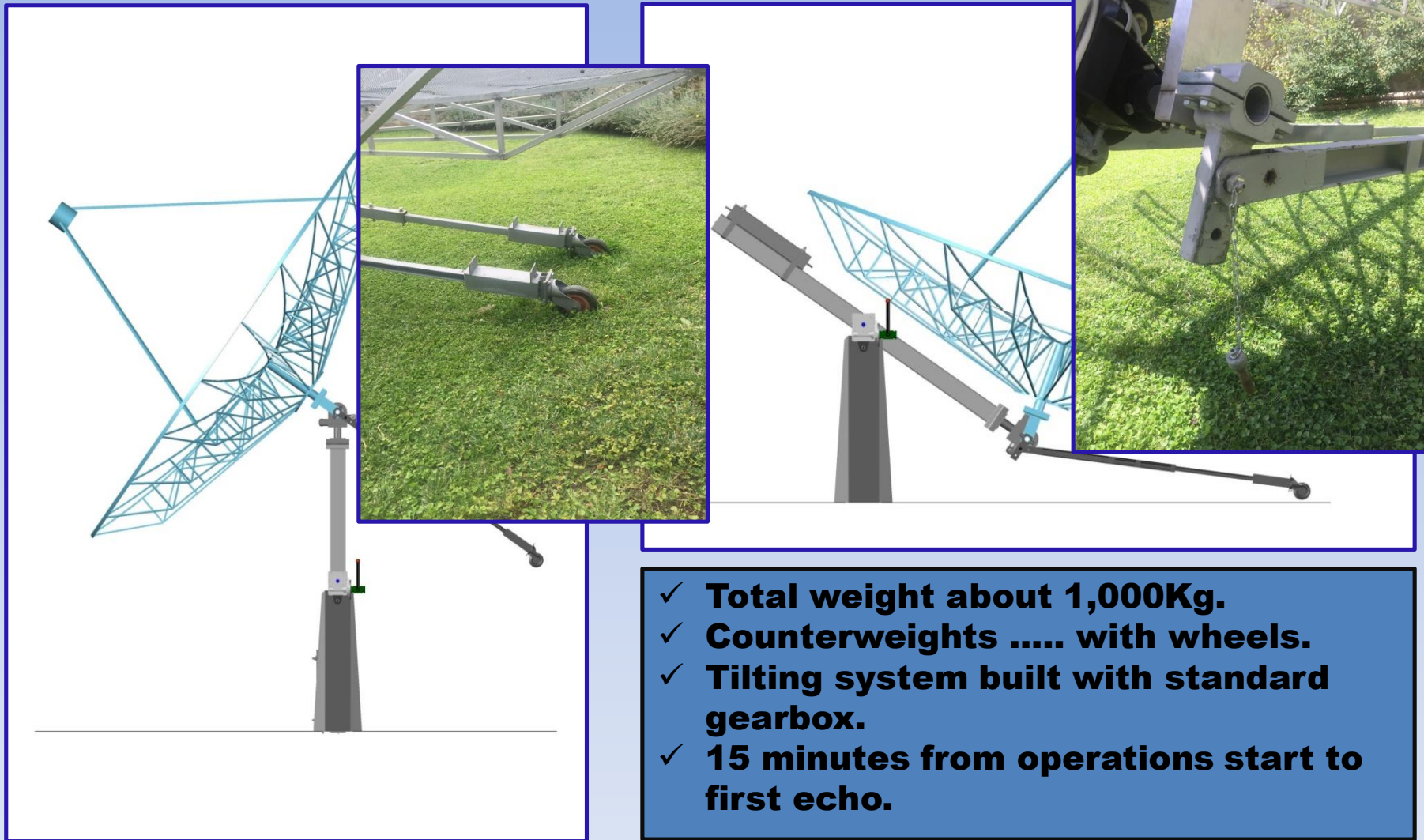
- ✓ **5m Diameter.**
- ✓ **0,5 f/D.**
- ✓ **6mmx6mm mesh.**





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Mechanical design : tower design

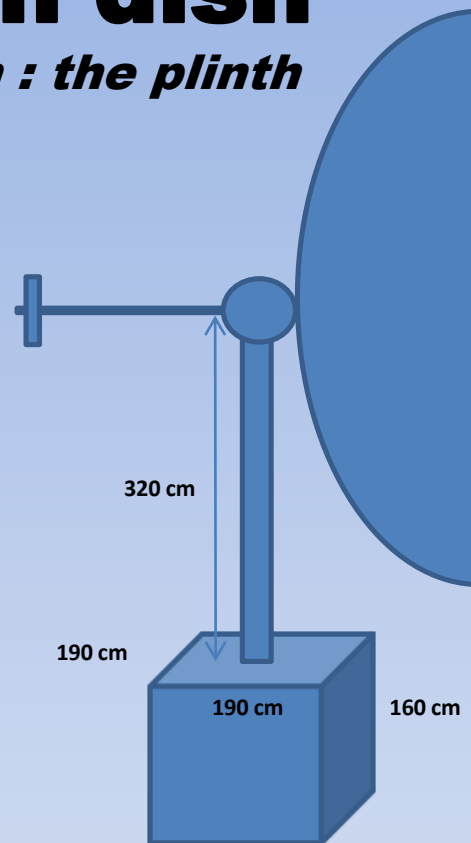


- ✓ **Total weight about 1,000Kg.**
- ✓ **Counterweights with wheels.**
- ✓ **Tilting system built with standard gearbox.**
- ✓ **15 minutes from operations start to first echo.**



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Mechanical design : the plinth



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



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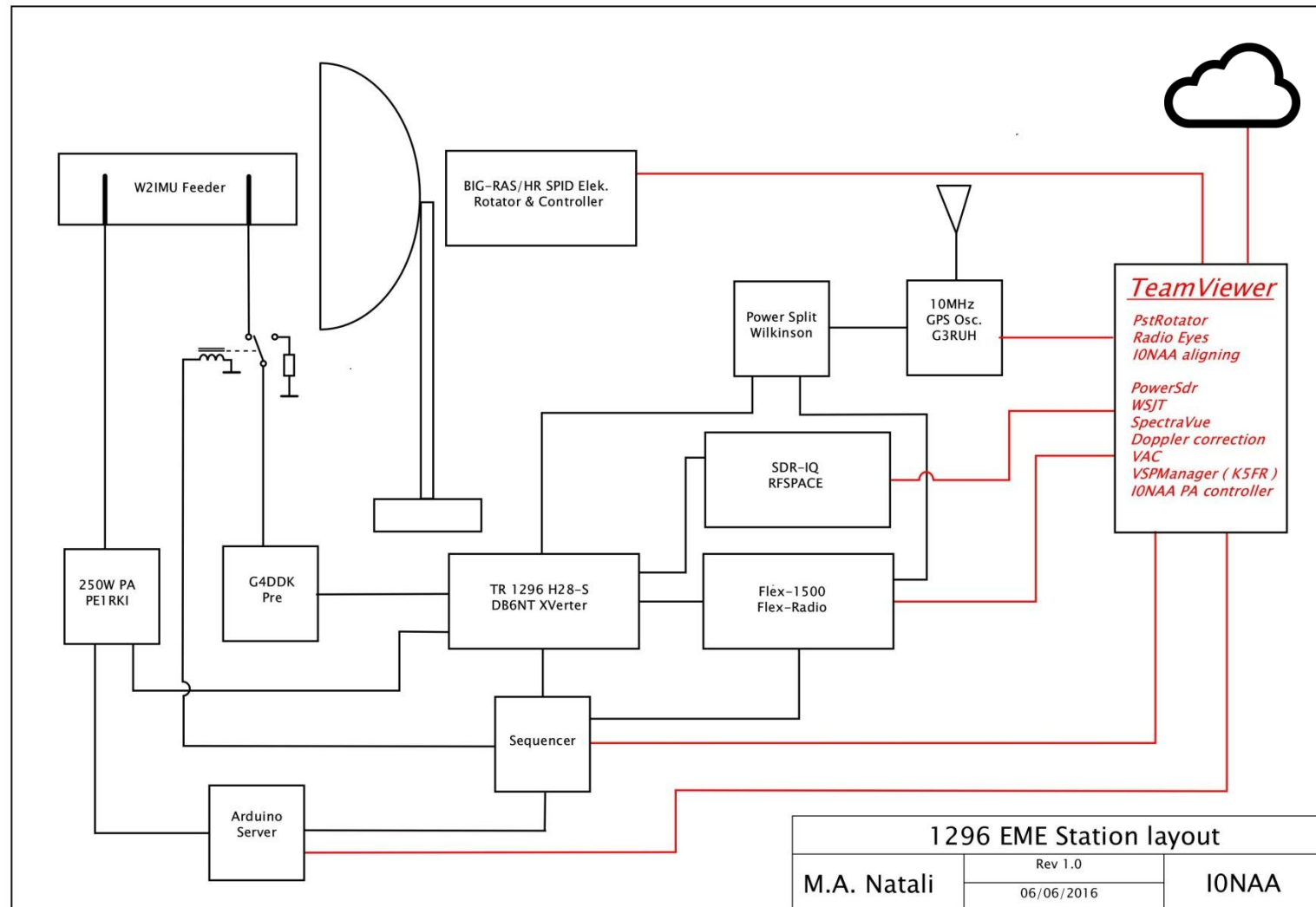
Mechanical design

Video



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Technical characteristics : the station

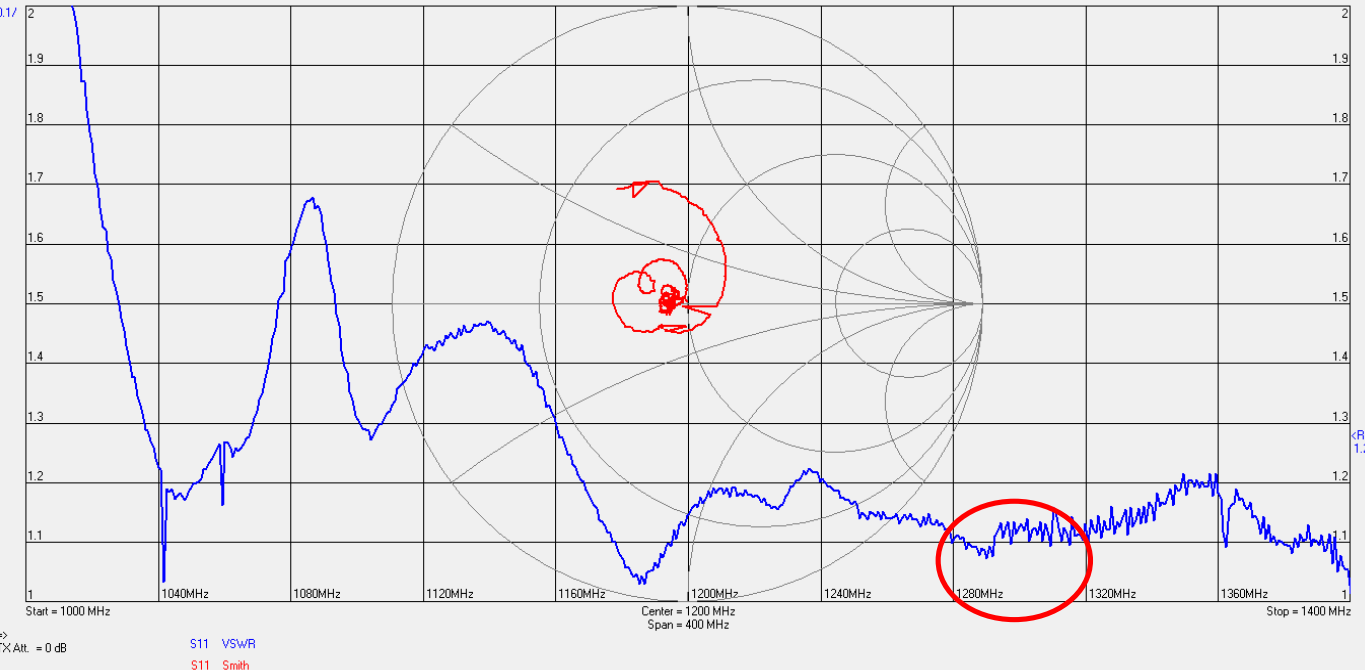




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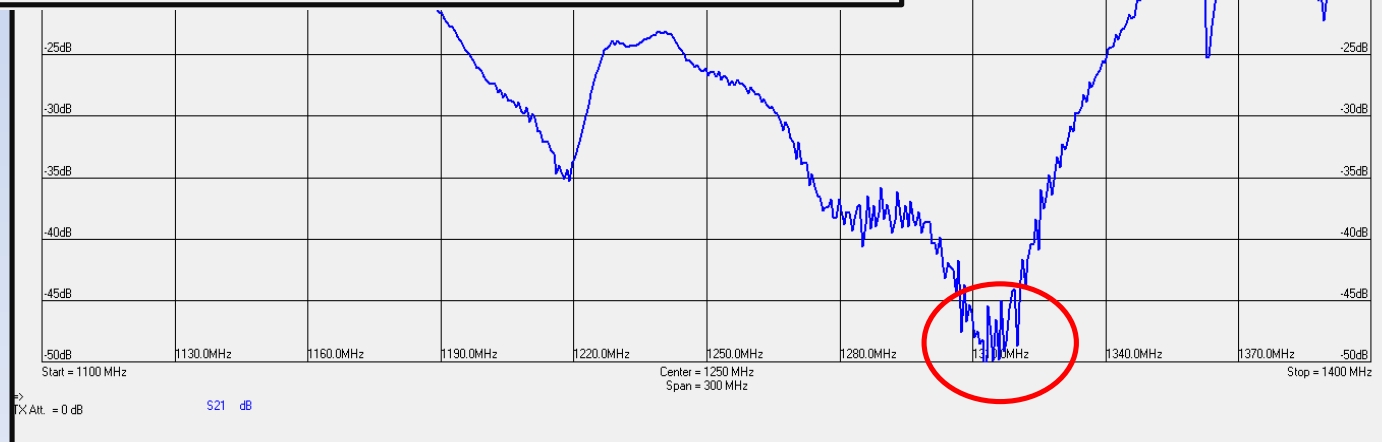
Technical characteristics : the feeder

DG85AQ Vector Network Analyzer Software
03/06/2016 11:55:26 TX, RX load 1000 1400



Very good S11 response over large bandwidth.

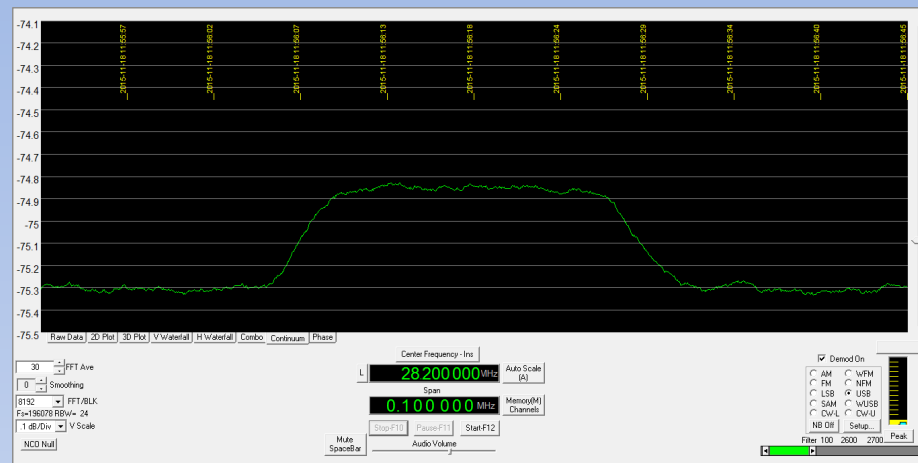
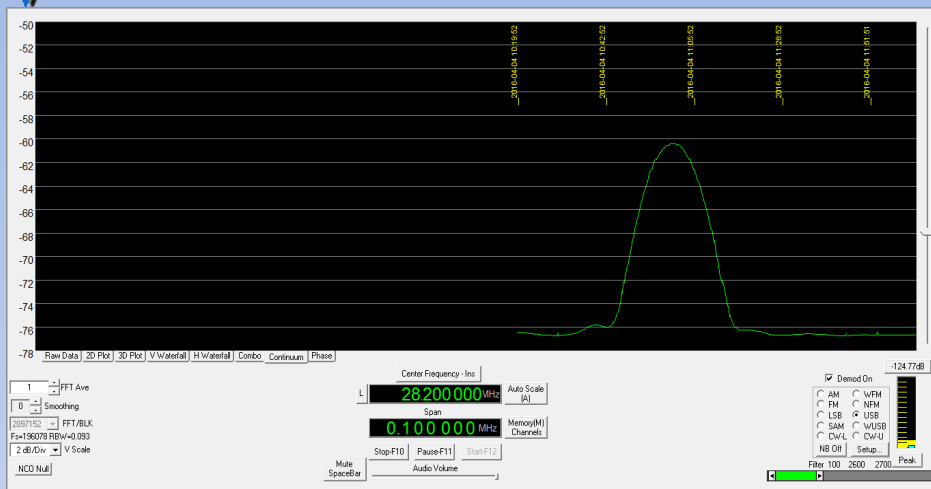
Pretty good crosstalk response at the target frequency.





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Technical characteristics : the results



EME LOGGER (CW, SSB, JT)

50MHz 144MHz 222MHz 432MHz 902MHz 1296MHz 2300-5760MHz 10000MHz and up

Say: Submit

« first » prev 1 2 ... 50 51 next » last » goto page: Go

UTC	Callsign	Name	Comment
09-15/Change			Set Reset
03-15 17:25:20	RA3DGP	Victor	CQ 060 1 st
03-15 17:25:10	IONAA	Mario	Good Keith, we did it !
03-15 17:24:46	IONAA	Mario	171400 0 -26 3.3 -420 6 * IONAA 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	IONAA	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 !!!



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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 before LNA))+((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 iOnaa Rev 1.0.0 June 2016

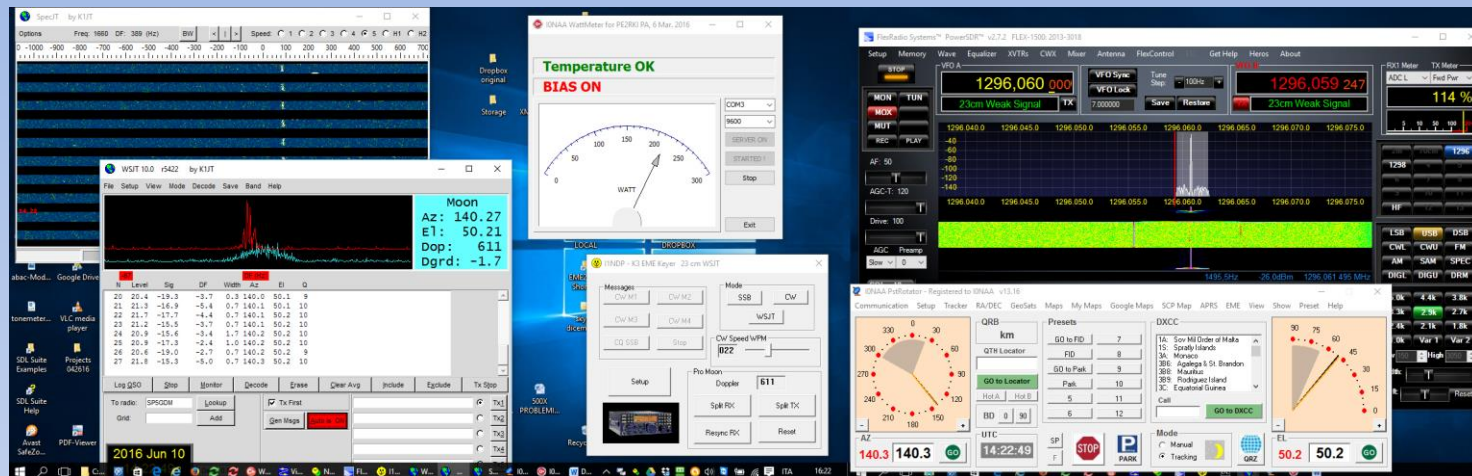
Very basic worksheet to evaluate the EME path with formulas in evidence to allow good understanding and easy customization.

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



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Technical characteristics : the results



Echo with 220W.



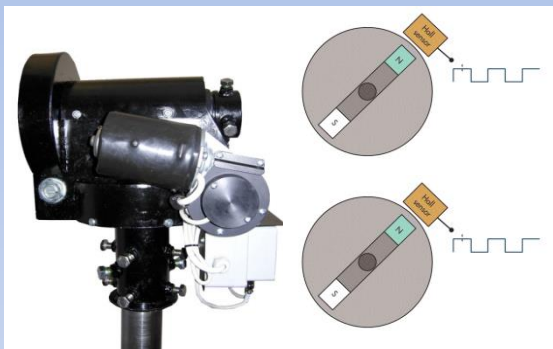
JT65C QSO with SP5GDM.



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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 😊**



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Future plans : automatic alignment

IONAA - Square spiral search ENGINEERING TEST

Enter COM speed Enter COM number

Set exploration parameters Get Rotor position

Azimuth Azimuth

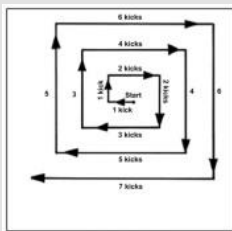
Elevation Elevation

Range

Set Motor speed Hard Start/Stop ON GO !

< > Hard Start/Stop OFF

Square spiral search real time



STOP Exit

WAVE-IN Devices available in this PC: ☐

Choose one device to perform analysis

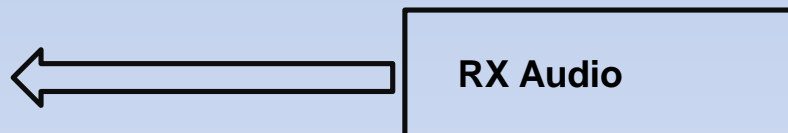
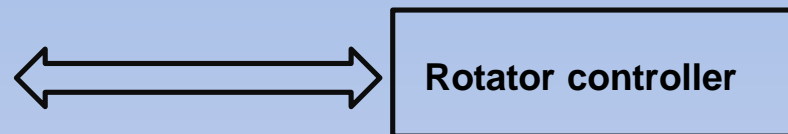
Analyzing input signal from device #

Real time signal value

Max signal value

Azimuth offset

Elevation offset



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.



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Future plans : the sky ...

- ✓ **The next challenge is the reception of pulsars**
- ✓ **Pulsars reception is an outstanding «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 «detectability» 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.**



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Future plans : Murmur

Murmur Rev. 1.6.4 080316 - IONAA mario.natali@gmail.com

TIME

☒ UTC
☐ Local

Location
Assisi-Beviglie

Latitude
43.0922

Longitude
12.5772

UTC Time
16/08/2016 09:03:38

SAVE current set as default

SET Observation location

CALCULATE

TRACK noise sources

Next 24h Pulsar

1 Month Pulsar

Return to main screen

Show main screen

Dish diameter 5 m
Dish efficiency 50 %
Sensitivity constant Ks 1
Frequency 1290 Mhz
Line loss before LNA 0.1 dB
LNA Noise figure 0.23 dB
LNA gain 38 dB
Line loss after LNA 0.5 dB
Receiver noise figure 4 dB
T sky 30 K
T spillover 10 K
T atmosphere 0 K
Integration time 3600 sec.
Integration bandwidth 5000 KHz

Dish area 19.63 m²
Wave length 0.23 m
Effective ant. aperture 9.81 m²
Far field 215 m
Antenna gain 33.58 dBi
HPBW 3.26 deg
System noise temp. 62.98 K
System noise figure 0.85 dB
MDS 132.04 mJy

The analysis does not take into account the polarization of the signal as this parameter is strongly depending on the specific Pulsar. Please evaluate carefully case by case as this may deteriorate performance up to 3dB.

List of PULSARS potentially detectable based on ATNF Pulsar catalogue

B0833-45
B1641-45
B0329+54
J0437-4715

Right Ascension (J2000) 53.25 deg
Declination (J2000) 54.58 deg
Width of pulse at 50% of peak 6.6 msec.
Barycentric period 0.71452 sec.
Dispersion measure 26.76 cm⁻³ pc
Flow 400Mhz 1500.0 mJy
Flow 1,400Mhz 203.0 mJy
Max. integration bandwidth (without de-dispersion) 33 Mhz
Expected S/N 5.51
Azimuth 308.41 deg
Elevation 49.96 deg

Set Observer location

- ☐ Set observer location with sexagesimal notation (DMS)
- ☐ Set observer location with QRA locator
- ☐ Set observer location with decimal notation (D.DDD)

Latitude (DMS) 43 05 31.915 N 43.0922 Calculated QRA Locator JN63GC92
Longitude (DMS) 12 34 37.915 E 12.5772

Confirm

QRA Locator JN63GC92 Calculated Latitude (D.DDD) 43.0938
Calculated Longitude (D.DDD) 12.5792

Confirm

Latitude (D.DDD) 43.0922 Calculated Latitude (DMS) 43 05 31.9200
Longitude (D.DDD) 12.5772 Calculated Longitude (DMS) 12 34 37.9200

$$MDS = \frac{2k}{A_e} \frac{T_{sys} K_s}{\sqrt{\Delta\nu} \tau n}$$

k= Boltzmann's constant (=1.38 *10⁻³⁸ joule K⁻¹)
Ae = effective aperture of antenna, m²
Ks = Sensitivity constant (order of unity)
Δν = Predetection bandwidth
Tsys=Tsky+Tspill+Tatm+Ttotal
τ = Postdetection integration time, sec.
n = Number of records averaged, dimensionless

J.D. Kraus, Radio Astronomy, 2nd edition,
Cygnus-Quasar Books 1986, chapter 3, pp43-46

Expected system S/N ratio for the specific Pulsar

$$\frac{S}{N} = \frac{S_{mean} G^2 \tau_{int} \Delta f}{T_{sys}^2 \sqrt{\frac{W}{P-W}}}$$

$\frac{S}{N}$ = Signal to Noise ratio. The higher the better.
For amateur minimum of 4 is expected.

S_{min} = Pulsar flux density (mJy)
G = Antenna gain
τ_{int} = Integration time (sec.)
Δf = Integration bandwidth (Hz)
Tsys = System noise temperature (K)
W = Pulsar width of pulse (sec.)
P = Pulsar period of pulse (sec.)

D. Lorimer M. Kramer, Handbook of Pulsars Astr
Cambridge University Press, 2012, pp264, 265

	Azimuth Deg.	Elevation Deg.	Range Km	Doppler Hz (1290Mhz)	Degradation dB (1290Mhz)
Moon	353.61	-64.08	383136.7	365.89	-1.36
Sun	130.23	51.4			
Cygnus A	357.77	-6.14			
Taurus A	243.26	55.33			
Cassiopeia A	333.34	21.22			
B0329+54	308.92	48.11			

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



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Conclusions : the beauty of the antennas



oe5jfl



i0naa

.... who said that hamradio is not romantic