Optimized Small-Station EME

X-pol at 432 MHz

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Motivation and Goals

- EME at W2PU (Princeton U ARC)
- Small antenna, modest cost
- Easy to build
- No “QRO++”
- ➔ “Practical EME for any QTH”
- Can work its twin by EME, any time

Which Band ? 144 MHz ??

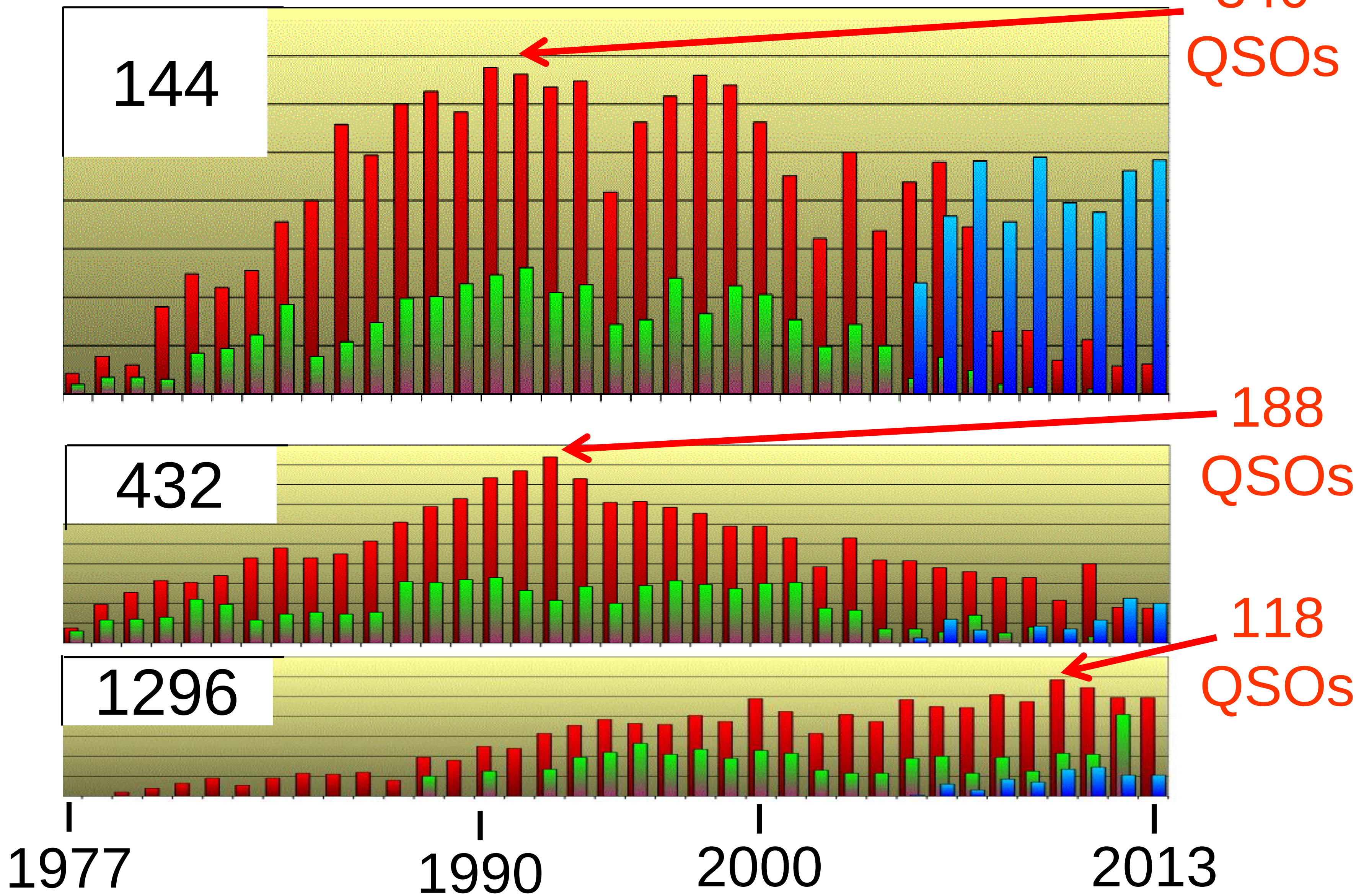
- Highest activity level
- Relatively simple equipment
- X-pol is very effective
- 4 yagis are enough
- Feedline losses are low

- High T_{sky}
- Antennas are BIG !

Which Band ? 1296 MHz ??

- Second highest activity level
- Very low T_{sky}
- Circular pol – very convenient !
- Dish antennas, d ≥ 2 m
- Problems for QTHs with tall trees

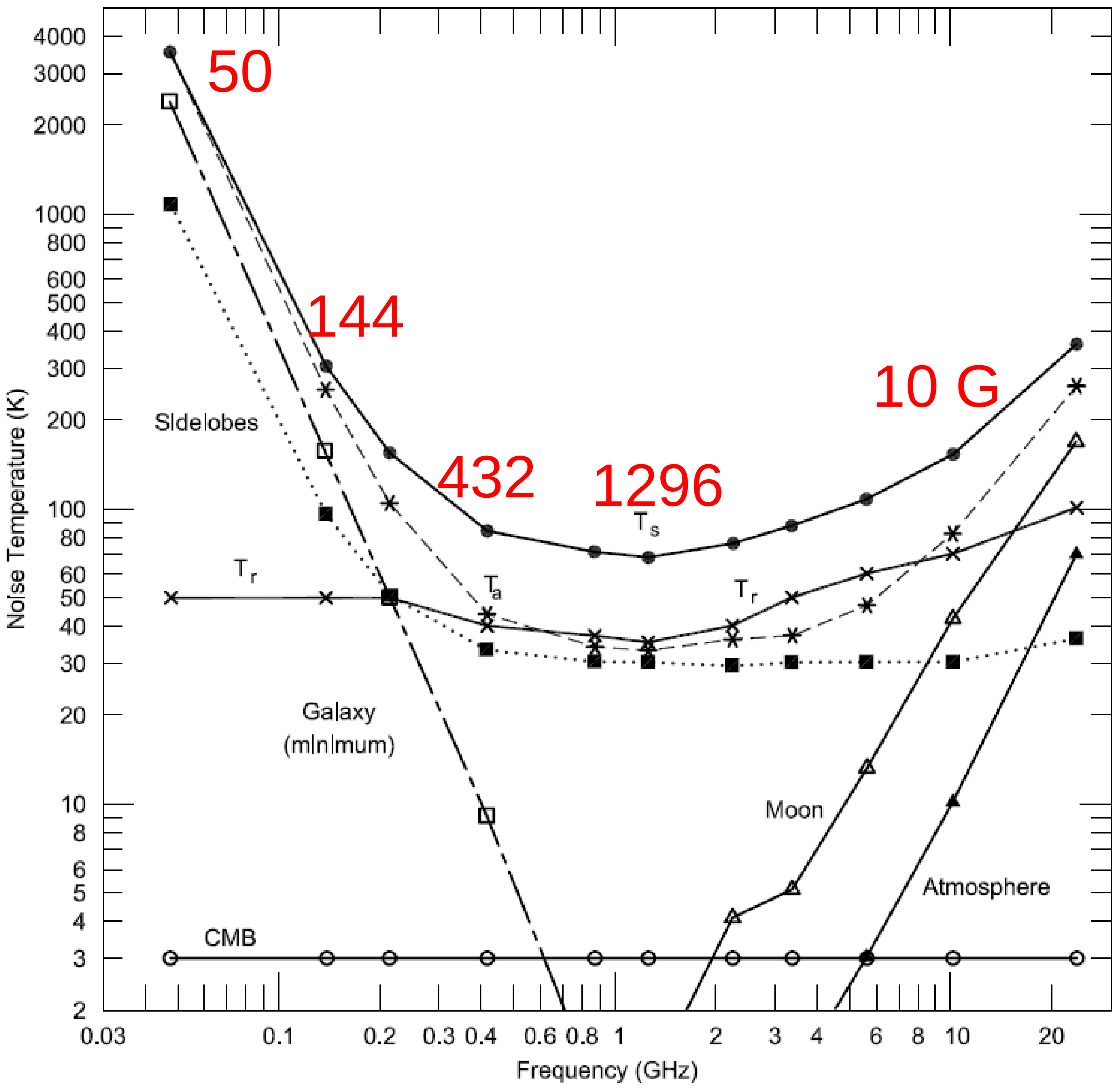
Activity trends



ARRL EME Contest

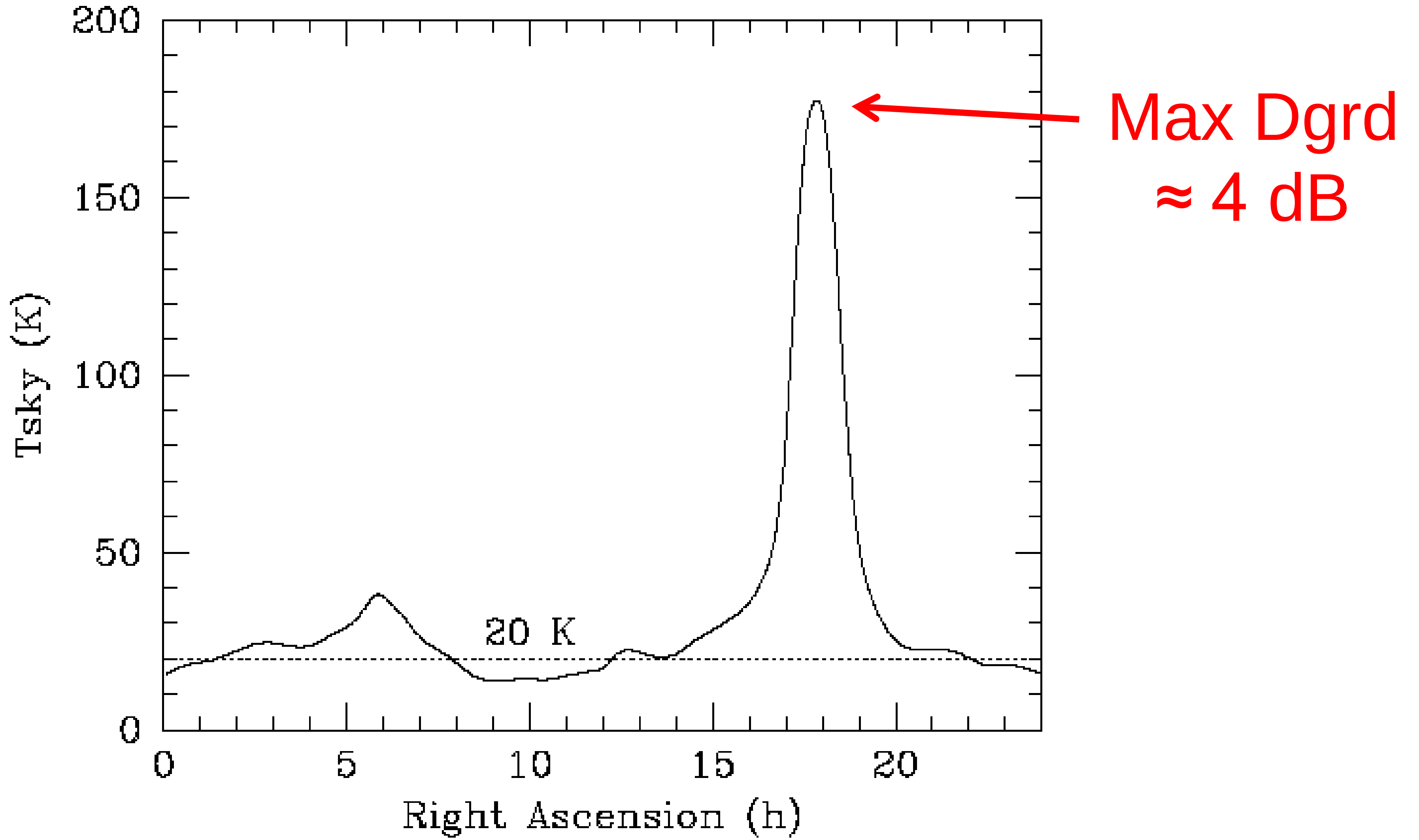
(de CT1DMK)

Achievable T_{sys} vs Frequency



T_{sky} on the Ecliptic, 432 MHz

(Beamwidth = 15°)



So: We Chose 432 MHz

- Equipment similar to 2m
- Plenty of off-the-shelf equipment
- Low T_{sky}
- Antennas ***much*** smaller than 2 m
- DXpedition- and neighbor-friendly
- X-pol highly desirable (but difficult?)
- The most under-utilized EME band !
- So… Where is everybody ?

Antenna Gain to work our "Twin"

$$SNR = P_t + G_t + G_r - L - P_n$$

$L = 261.5$ dB

$P_n = 10\log(kTB) = -174.6$ dBW

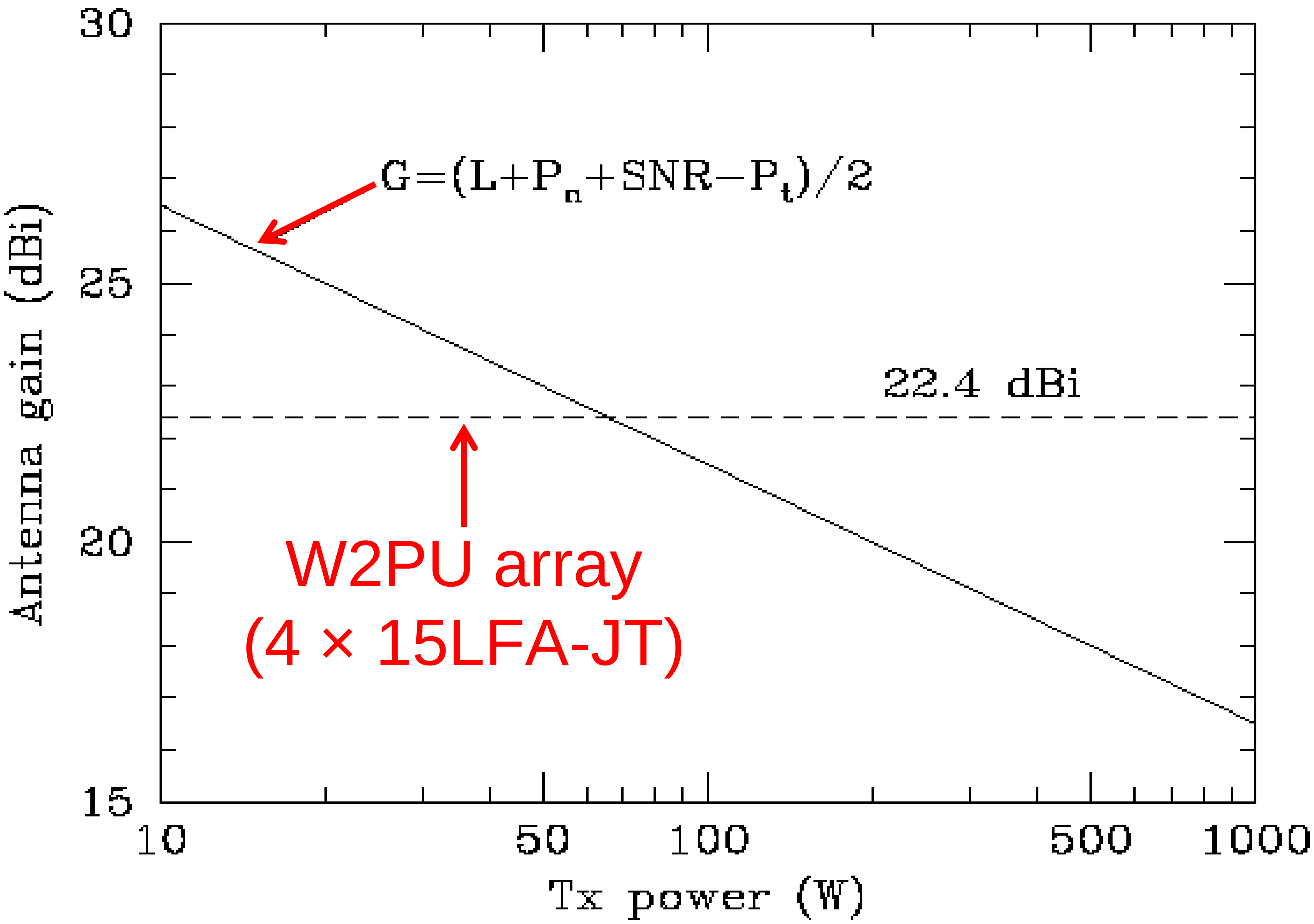
$(T = 100\text{ K}, B = 2500\text{ Hz})$

Solve for G, set $SNR = -24$ dB:

$$G = (G_t + G_r)/2 = (L + P_n + SNR - P_t)/2$$

$$= 31.5 - P_t/2$$ dBi

Antenna Gain to work our "Twin"



First: Build and test two yagis (Summer 2013)

2 × 15LFA-JT X-pol Yagis


2 × 15LFA-JT
19.4 dBi

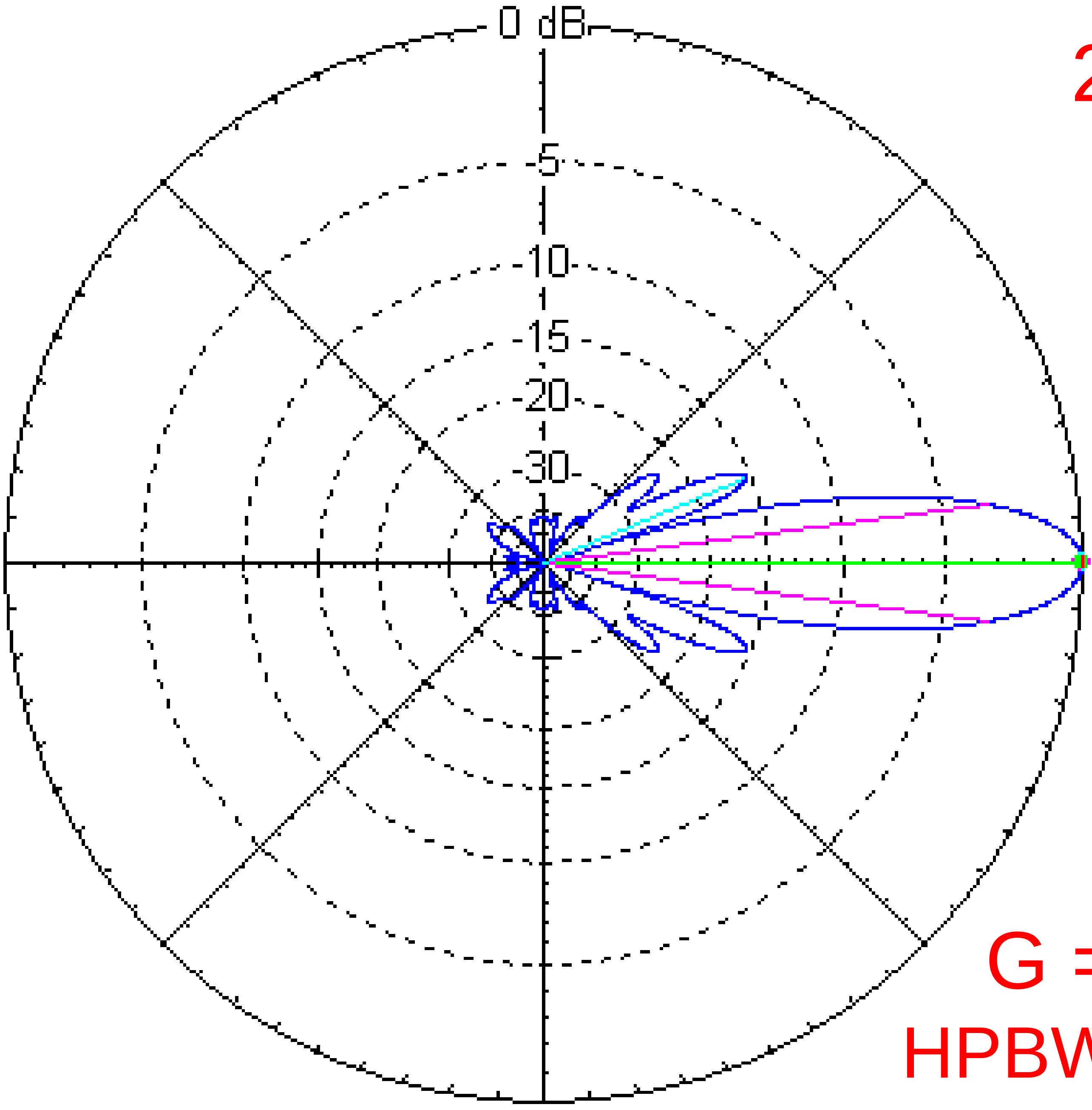
Yagi Design (G0KSC)

- Careful mechanical design
- Rear mounted
- Hollow fiberglass boom, 25×25 mm, 3.5 m
- Driven loops: 10 mm brass tubing
- Parasitic elements: ¼ inch aluminum rod
- Guys: 1/8 inch Dacron rope
- $Z = 50\ \Omega$
- Return loss > 25 dB, 427 to 437 MHz

Array Design

- Stacking distance 1.2 × 1.2 m
- Feedline exit through rear of boom
- RG-142 from loops to splitters
- Power splitters: 1.5 λ
- Overall size and weight: less than an HF tri-bander !


2



2 × 15LFA-JT

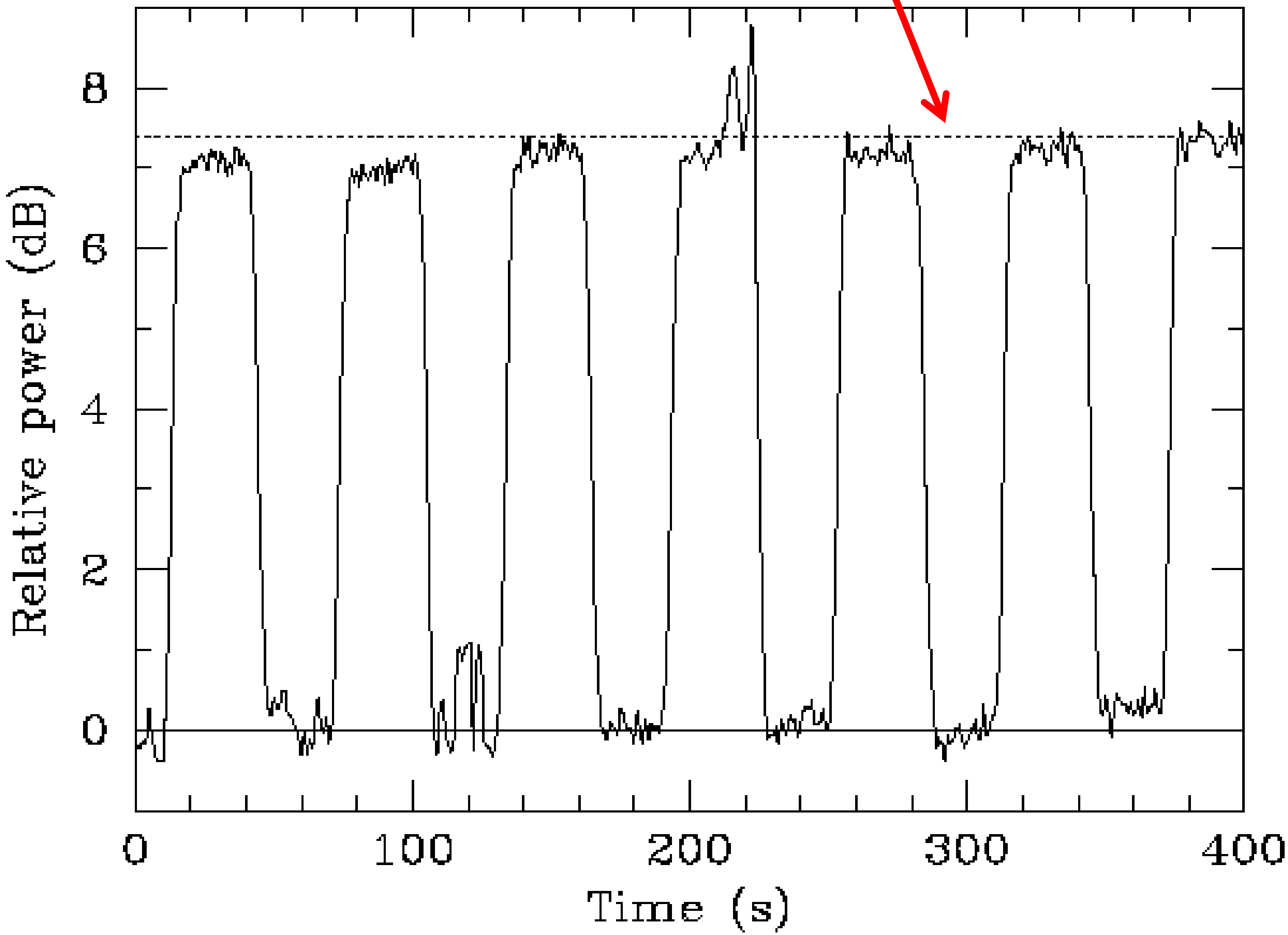
Calculated pattern (G0KSC)

G = 19.4 dBi

HPBW (Az) = 14.6°

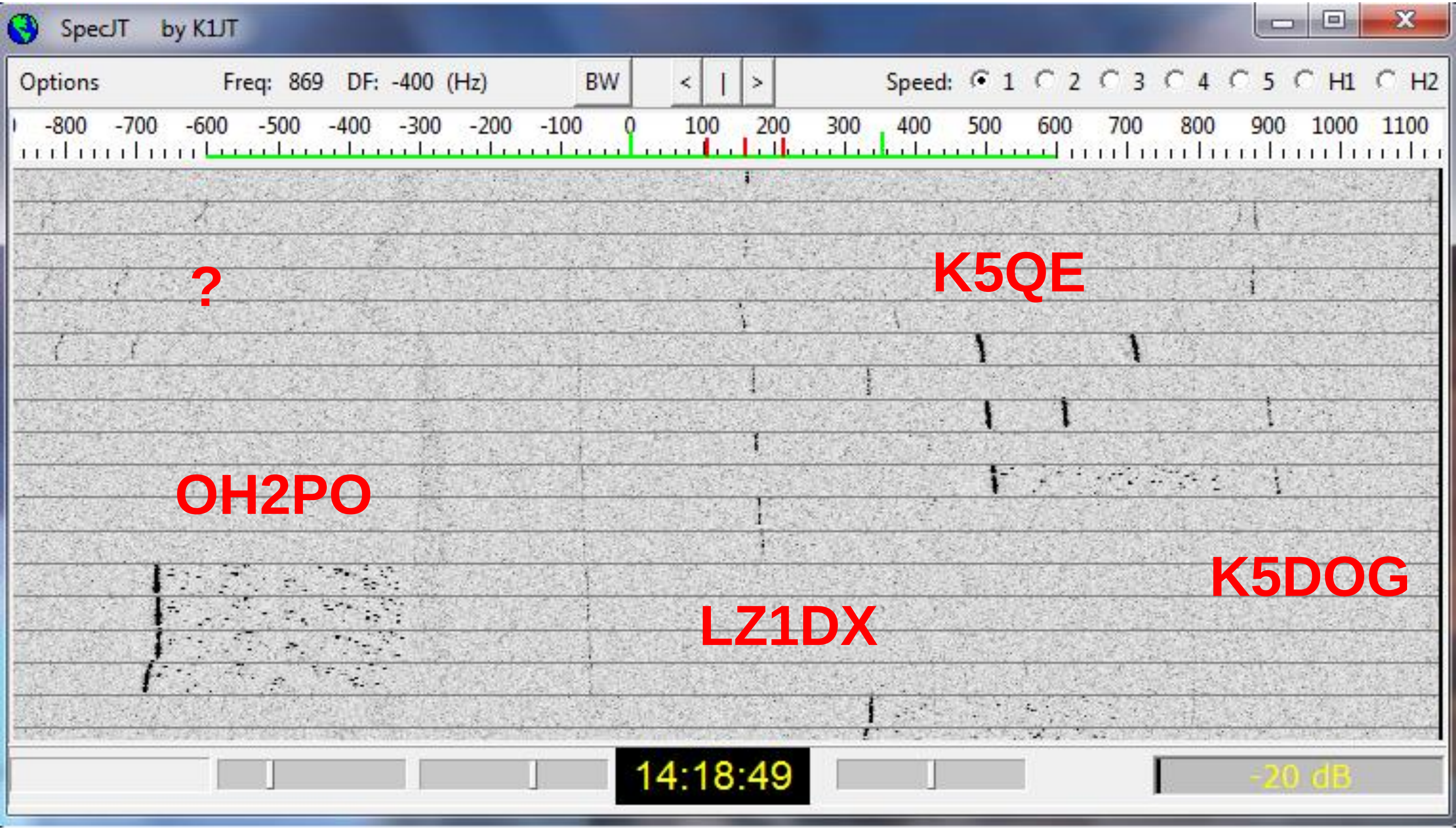
Measured Sun Noise: 2 × 15LFA-JT

(Predicted Y_{sun} = 7.4 dB)



EME signals at W2PU

November 2013 – 2 × 15LFA-JT




Present Setup
4 × 15LFA-JT
G = 22.4 dBi

Detailed Contributions to T_r

Component	Gain (dB)	NF (dB)	Contribution (K)
4 ft RG-142	-0.32		22.2
Power splitter	-0.05		3.6
3 ft LDF 4-50A	-0.04		2.9
T/R relay	-0.05		3.7
LNA 1	23.0	0.4	30.8
75 ft LMR-240	-3.74		2.3
LNA 2	20.0	0.5	0.5
IQ+		9	0.4
Total (K)			**66.4**

Every detail counts!

T_r

T_a

Tsys Worksheet	Gain	Noise Figure	Noise Contribution	
	(dB)	(dB)	(K)	% Total
4 ft RG-142	-0.32		22.2	18.7%
Power splitter	-0.05		3.6	3.1%
3 ft LDF 4-50A	-0.04		2.9	2.5%
T/R relay	-0.05		3.7	3.1%
LNA1 (DB6NT)	23.00	0.40	30.8	26.0%
10 ft LMR400	-0.27		0.1	0.1%
100 ft LMR240	-5.20		3.9	3.3%
10 ft RG58	-1.00		1.5	1.2%
LNA2 (ARR)	20.00	0.50	0.9	0.7%
LinkRF IQ+		9.00	0.5	0.4%
Tr at antenna feedpoint		**0.94**	**70.0**	59.2%
Antenna and feed losses	0.06		4.0	3.4%
Sky noise (main beam, on ecliptic)			20.0	16.9%
Side and rear lobes			25.0	21.1%
Total antenna noise, Ta			48.4	40.8%
System noise temperature, Ts			**118.4**	100.0%
Frequency (MHz)	432			
Lossless antenna gain (dBi)	22.40			
Solar Flux at 432 MHz (SFU)	44.0			
Tx power at antenna (W)	100			
EME path loss (dB)	261.6			
G/Ta (dB/K)	5.5			
G/Ts (dB/K)	**1.6**			
Y Sun (dB)	**9.9**			
EME S/N in B=2500 Hz (dB)	**-23.0**			
EME S/N in B=50 Hz (dB)	**-6.0**			

Bottom line:

T_{sys}=118 K

Y_{sun}=9.9 dB

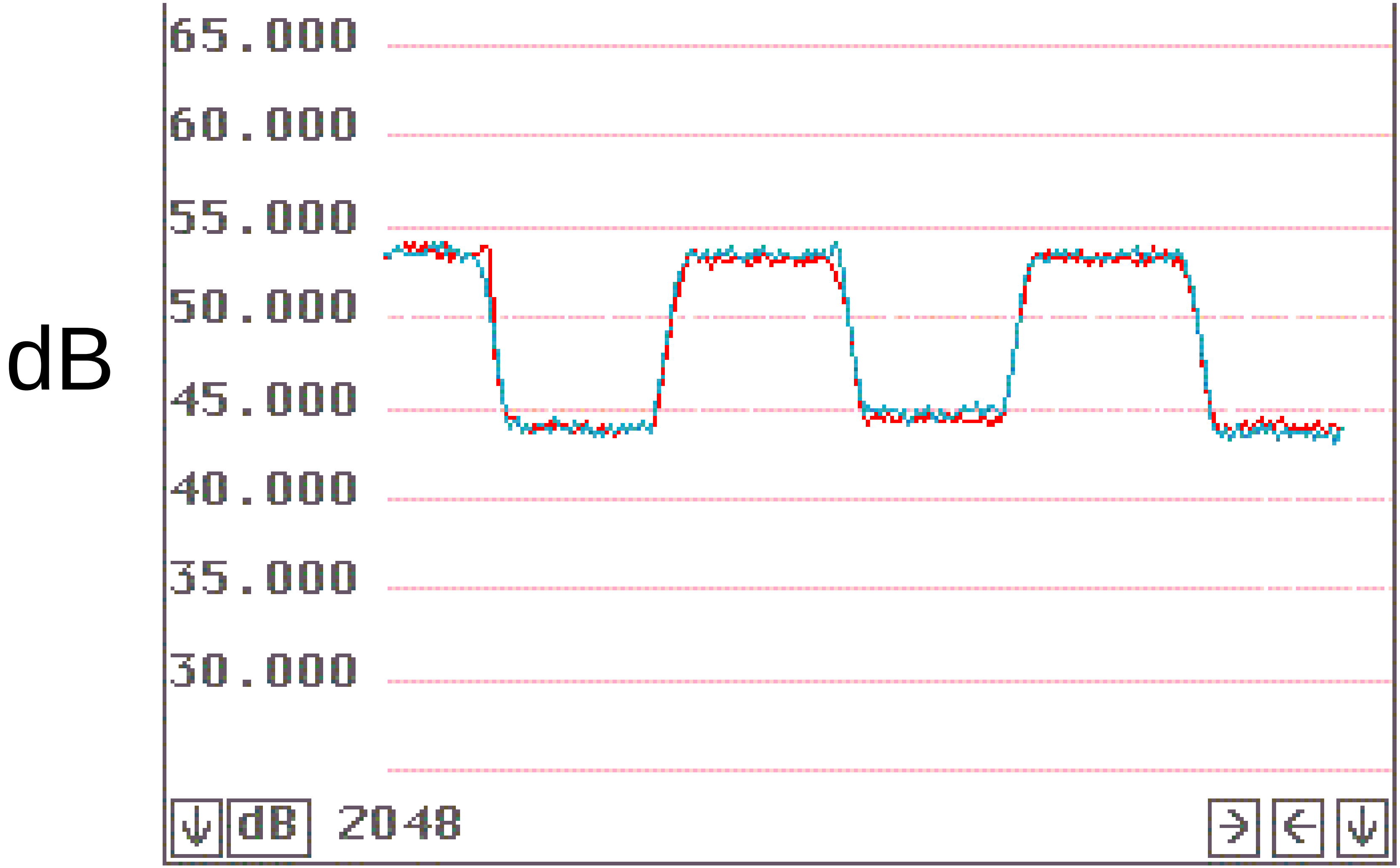
P = 100 W

S/N=−23 dB

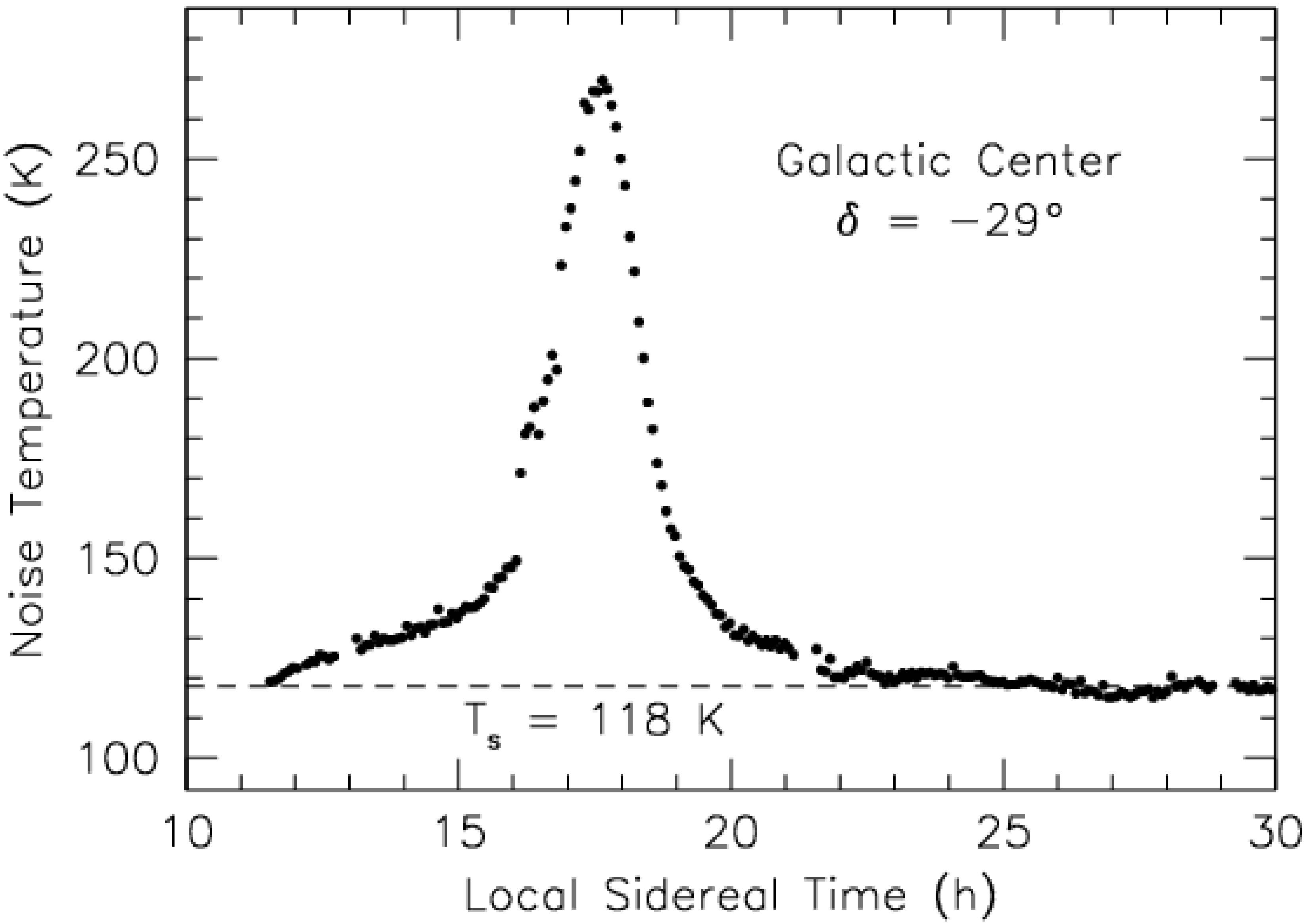
Spreadsheet available online

Sun Noise using Linrad S-meter

4 × 15LFA-JT: Predicted Y_{sun} = 9.9 dB

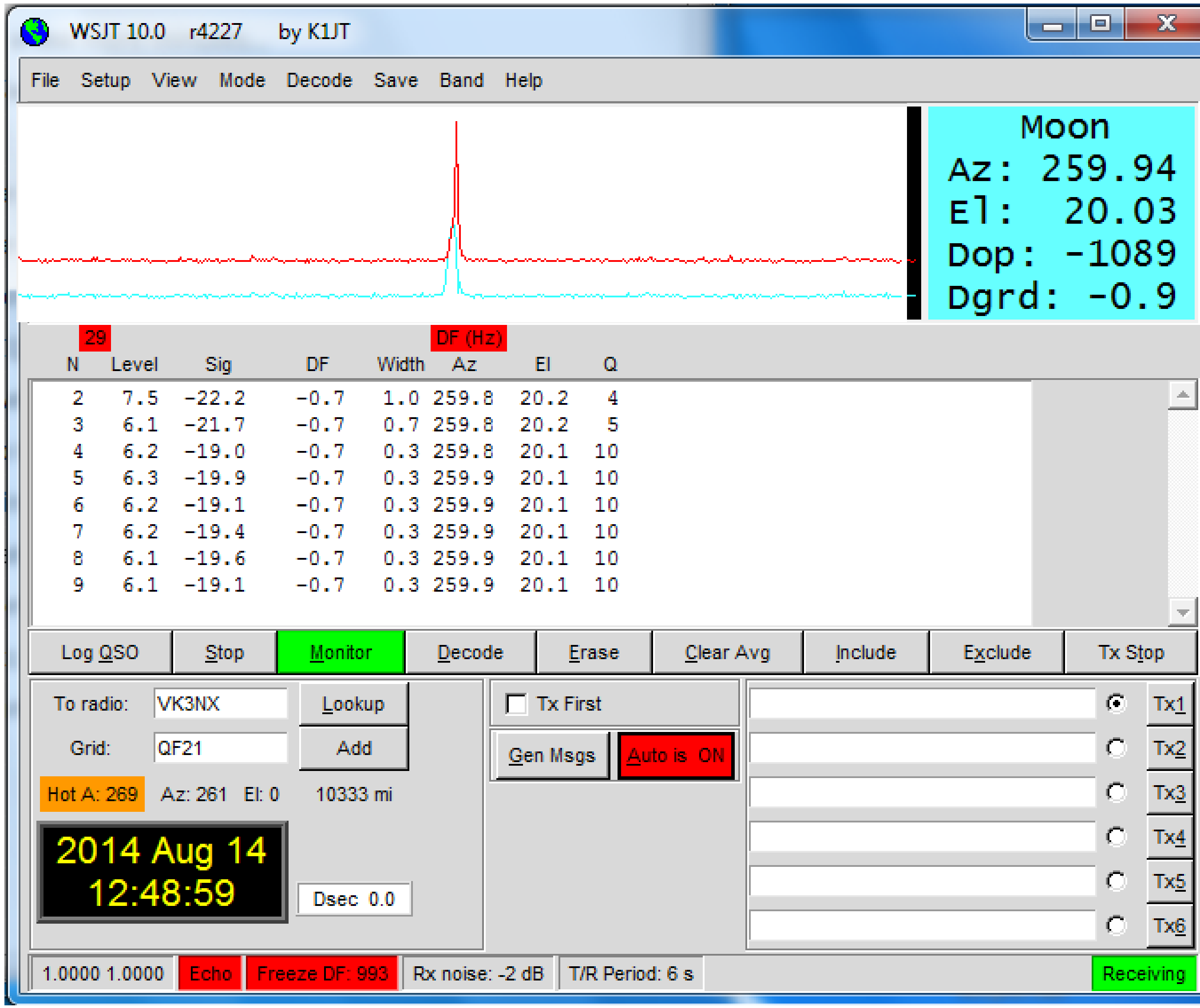


Drift curve of galactic center

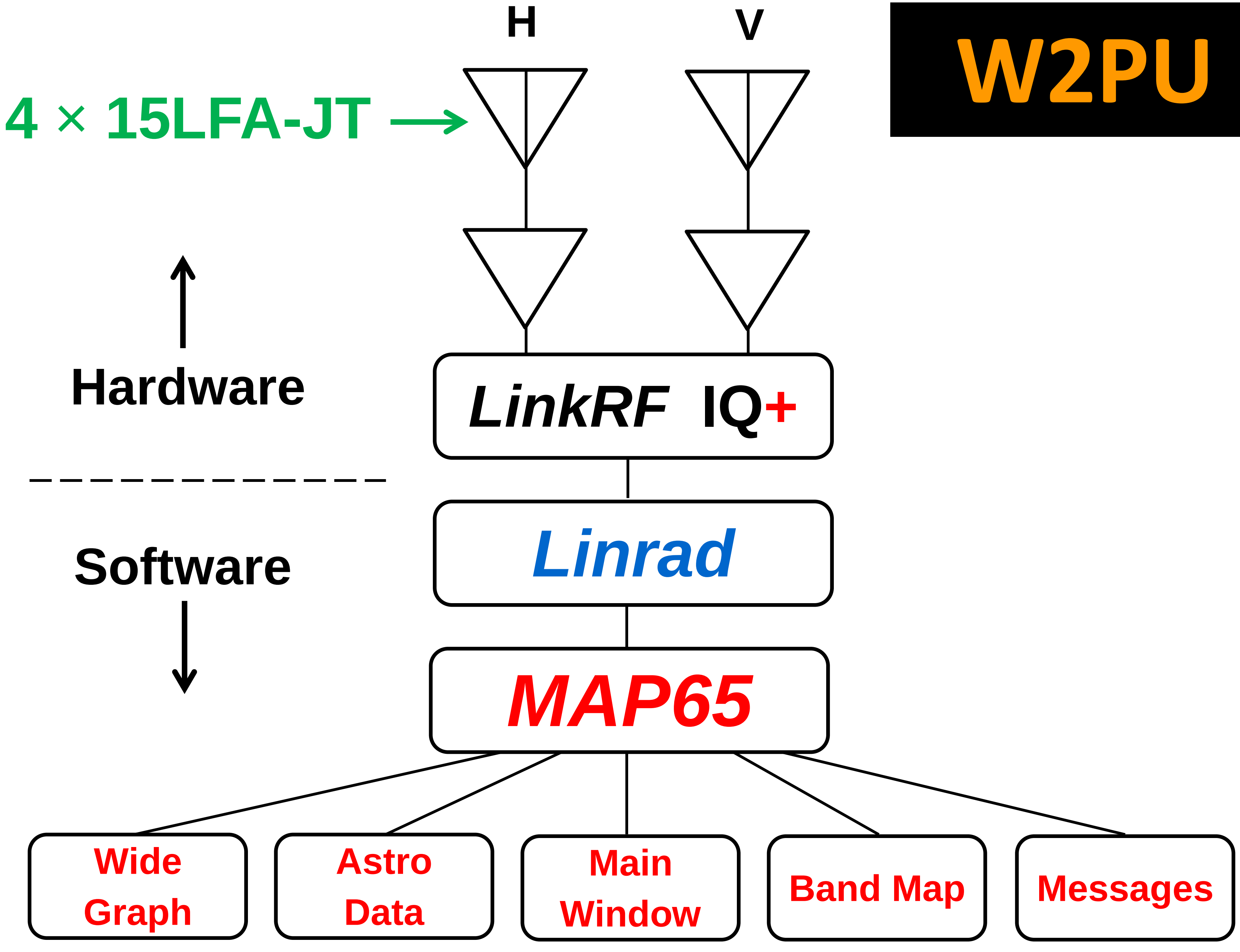


W2PU Echo-mode “selfie”

-19 dB →

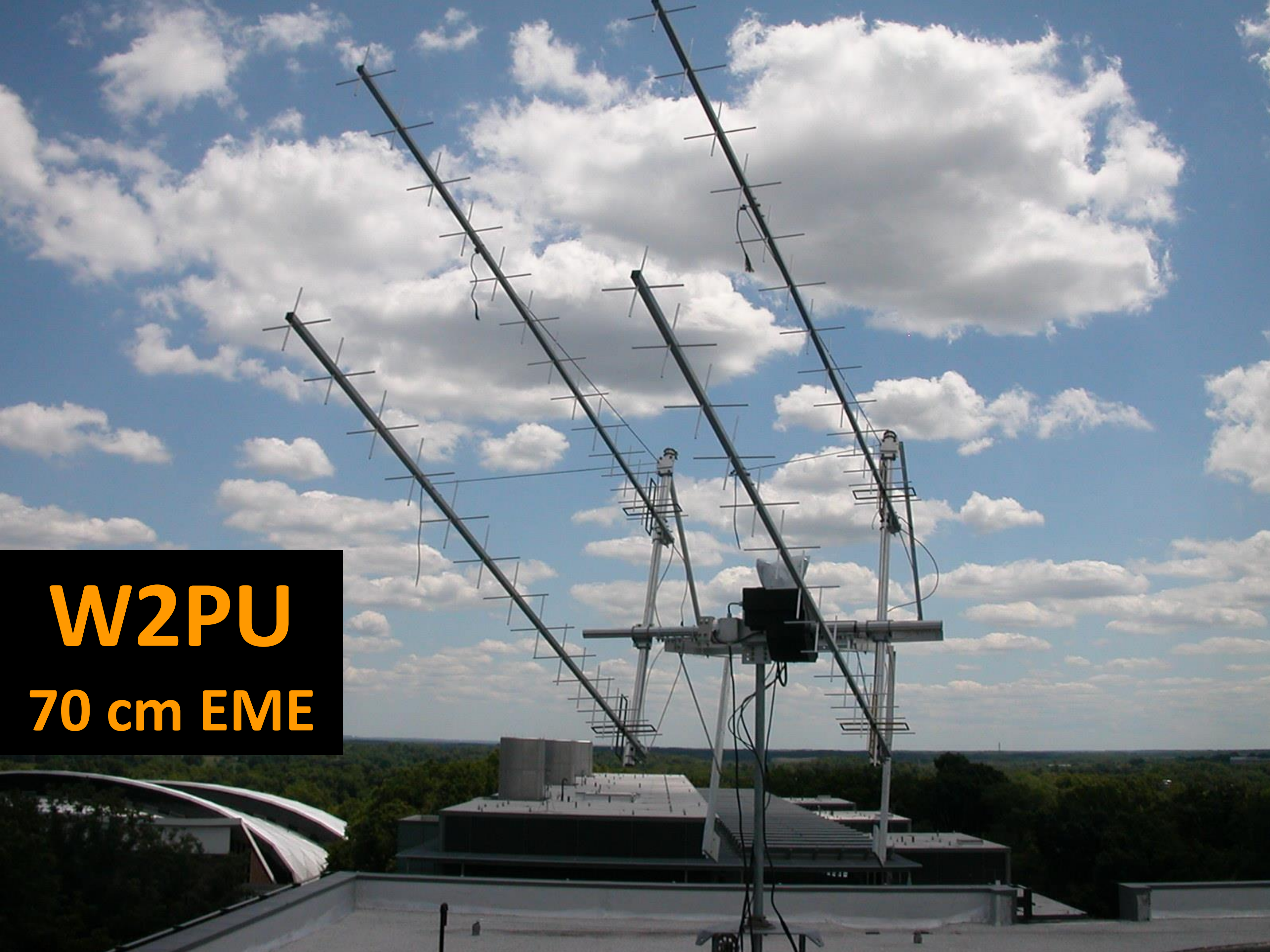


W2PU

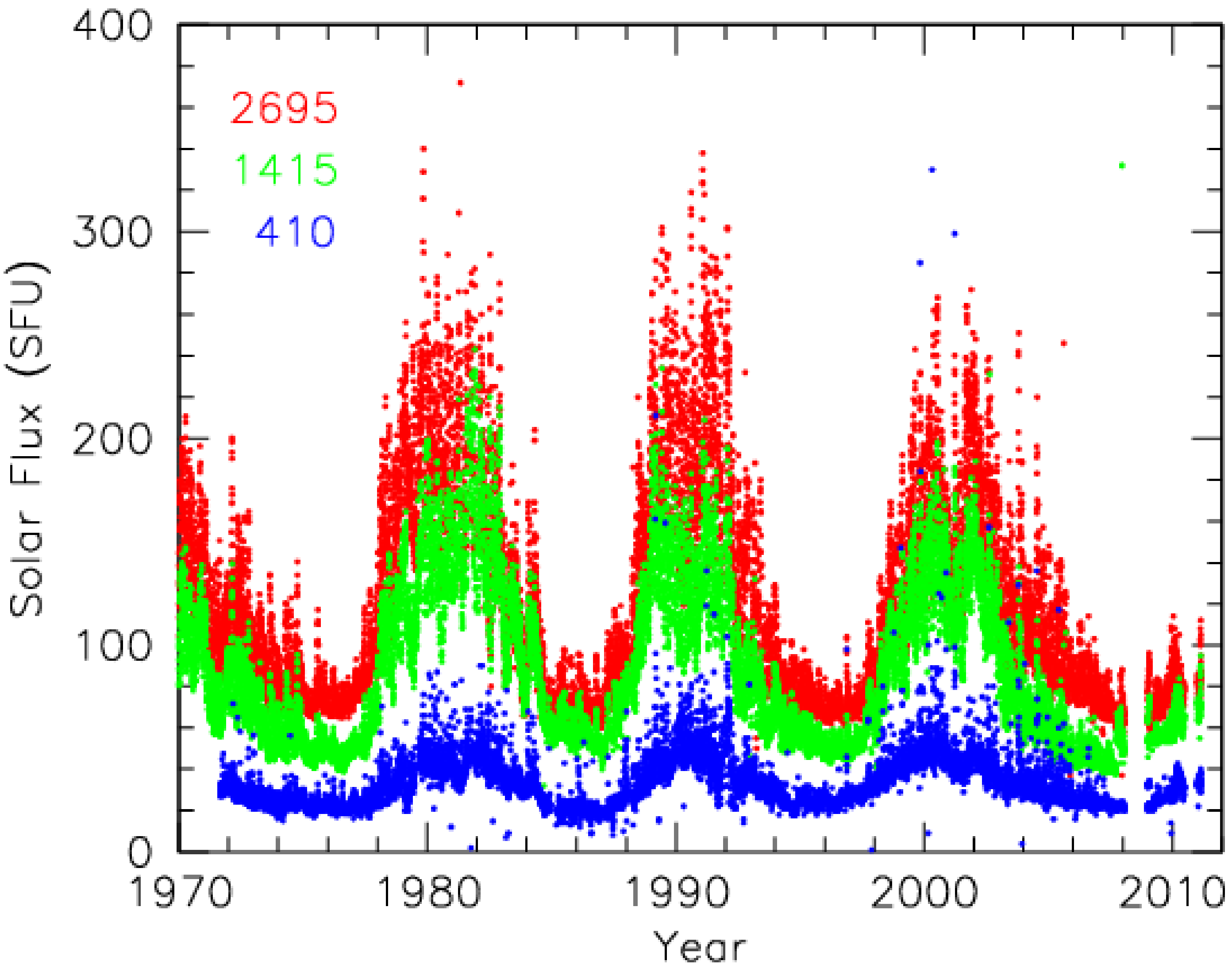

H
V
4 × 15LFA-JT
Hardware
Software
LinkRF IQ+
Linrad
MAP65
Wide Graph
Astro Data
Main Window
Band Map
Messages

Summary

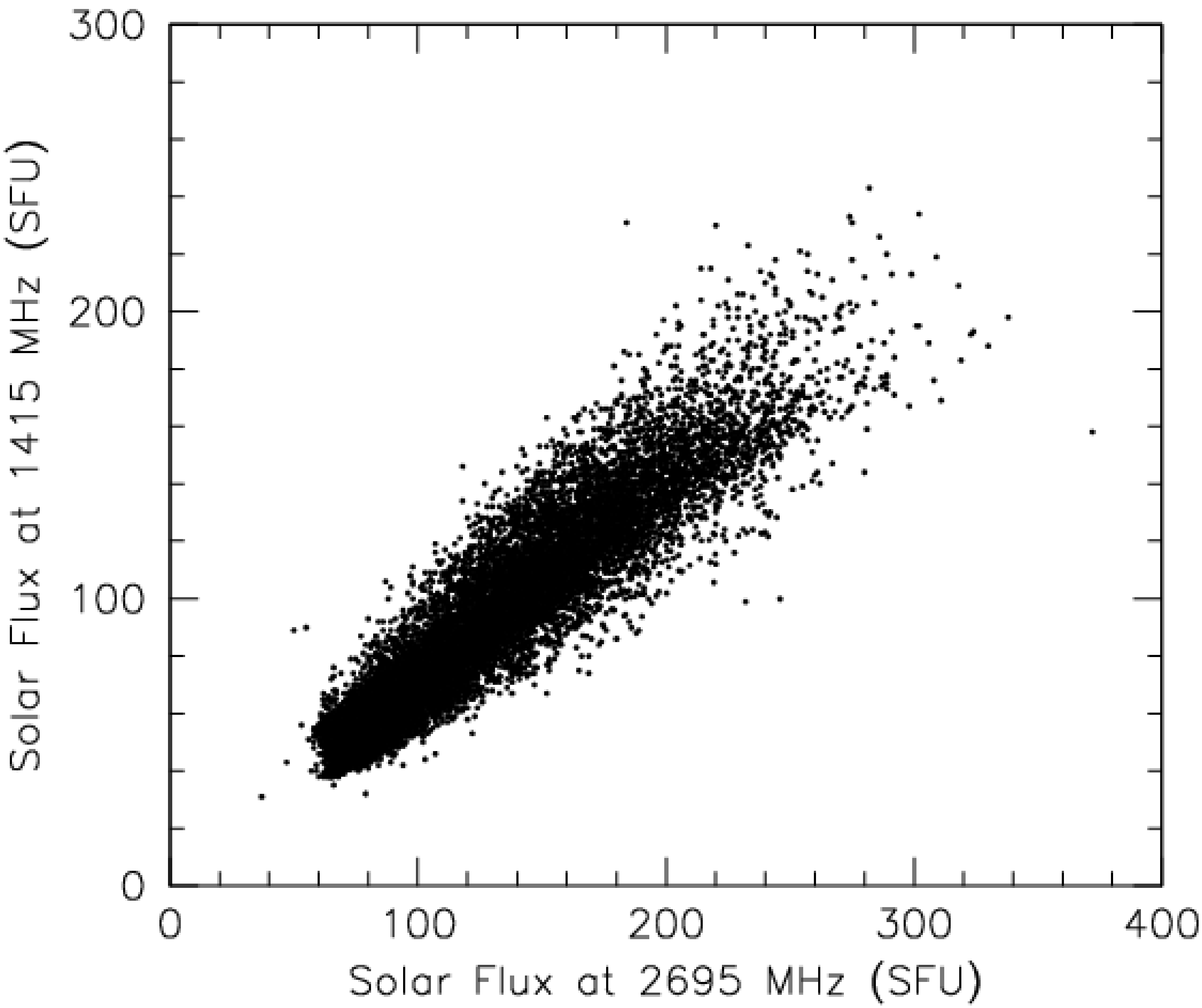
- Small, lightweight, rugged antenna
- Easy to point in Az, El
- Easy to build; moderate cost
- Many EME QSOs in past few weeks
- No “Faraday lockouts”
- Able to work its twin, nearly any time


W2PU
70 cm EME

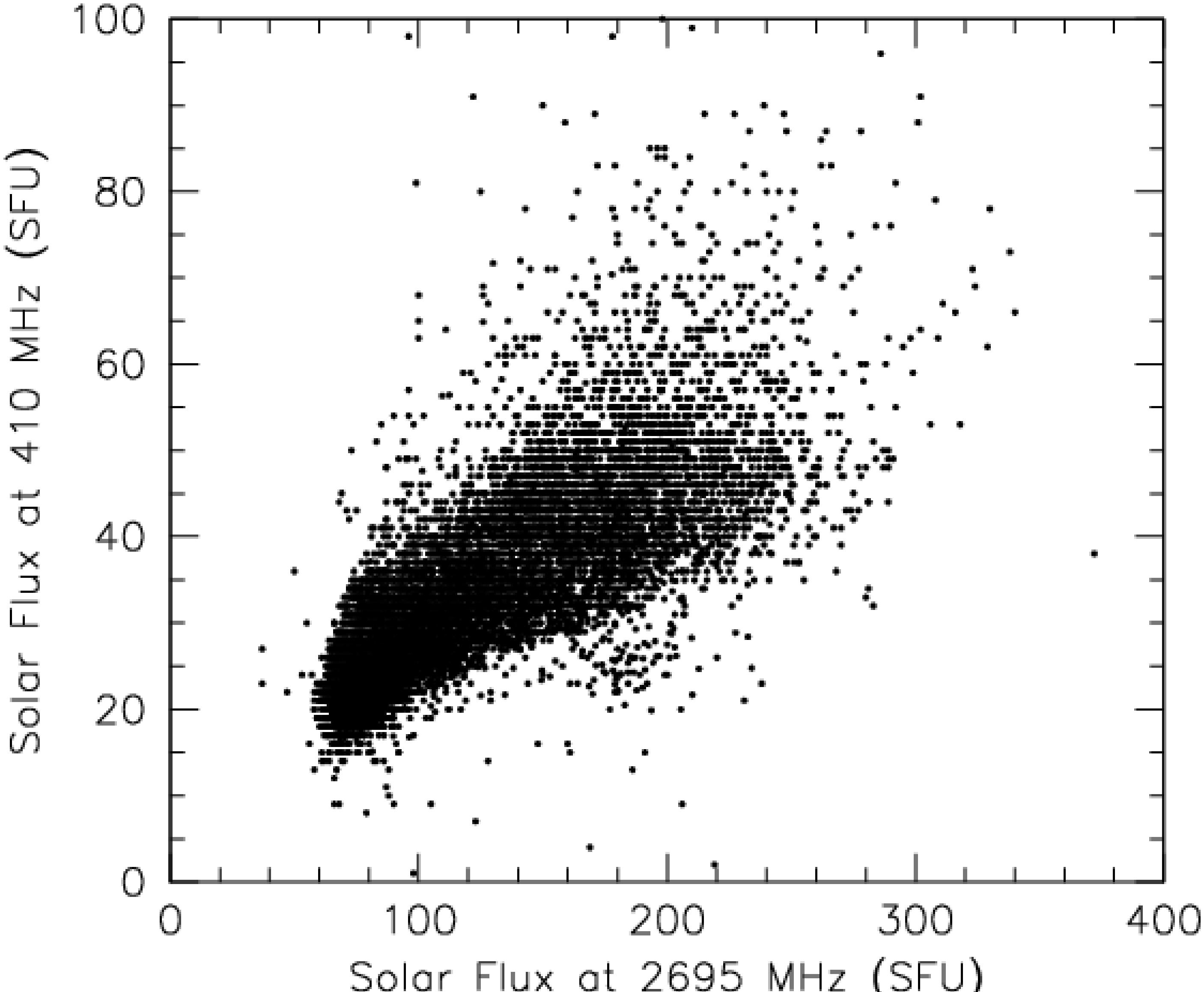
Beware use of 10.7 cm Solar Flux !



S_{1415} vs. S_{2695}



S_{410} vs. S_{2695}



Drift curve of Sun