



# Modern 2 meter EME and weak signal operation

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# Agenda

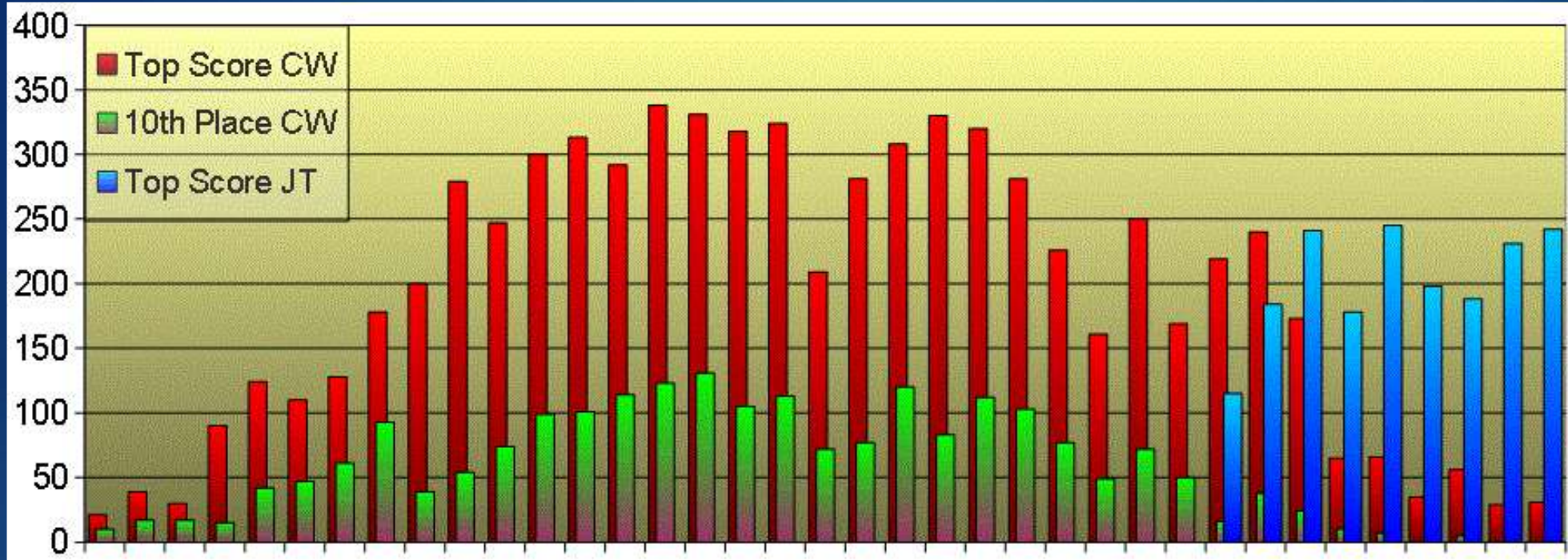
- ▶ Not your average appliance operator on EME
  - ▶ Why and who is on EME, VHF/UHF weak signal
  - ▶ K1JT station pictures – EME Contest station
- ▶ Technical details of noise and signal processing
  - ▶ Applicable to HF as well (WSPR)
  - ▶ Path loss, KTB/noise, Averaging and estimation
- ▶ How do you get started
  - ▶ NJ2R's EME first stations
  - ▶ Screen shots, and links – How to
  - ▶ Pictures of EME stations

# Background

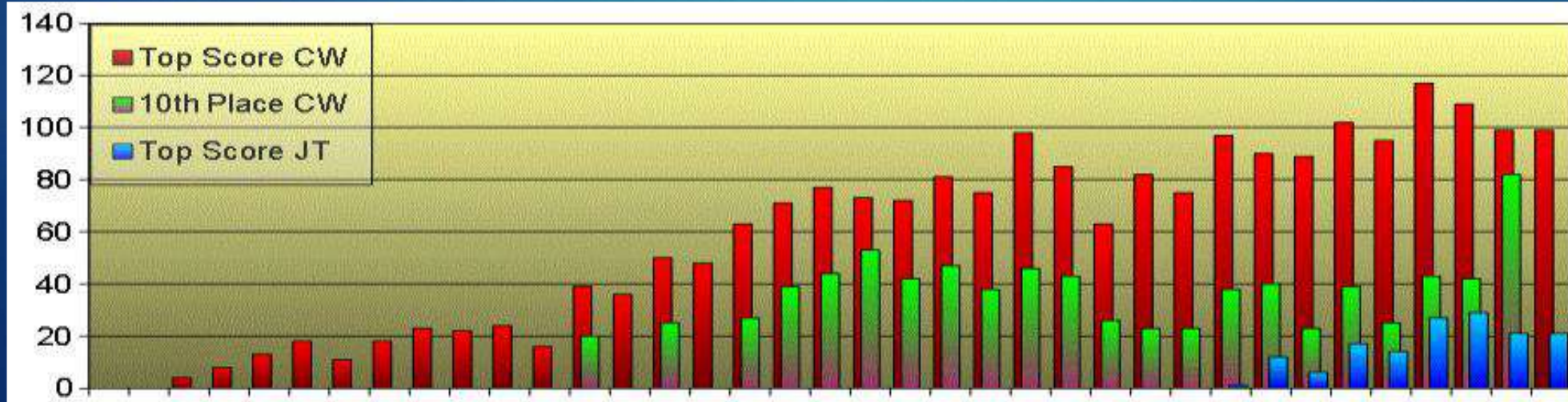
- ▶ Mid Atlantic VHF Conference <http://www.packratvhf.com/>
  - ▶ Inexpensive and close – October 2-4, 2015
- ▶ My elmers – Worldwide Winners 2014 EME contest:
  - ▶ Dr Al Katz – [K2UYH@tcnj.edu](mailto:K2UYH@tcnj.edu)
  - ▶ Dr Joe Taylor – [K1JT@Princeton.edu](mailto:K1JT@Princeton.edu)
  - ▶ Roger Shultz – [NJ2R@Verizon.net](mailto:NJ2R@Verizon.net)
- ▶ Two contest weekends – November and December full moon
- ▶ EME is 12 hours/day x 365 days/yr passive reflector
- ▶ Worldwide/DXCC independent of solar cycle
- ▶ RF skills are invaluable when every db counts



# Activity Trends – ARRL EME Contest de CT1DMK



144



1296

1977

1990

2000

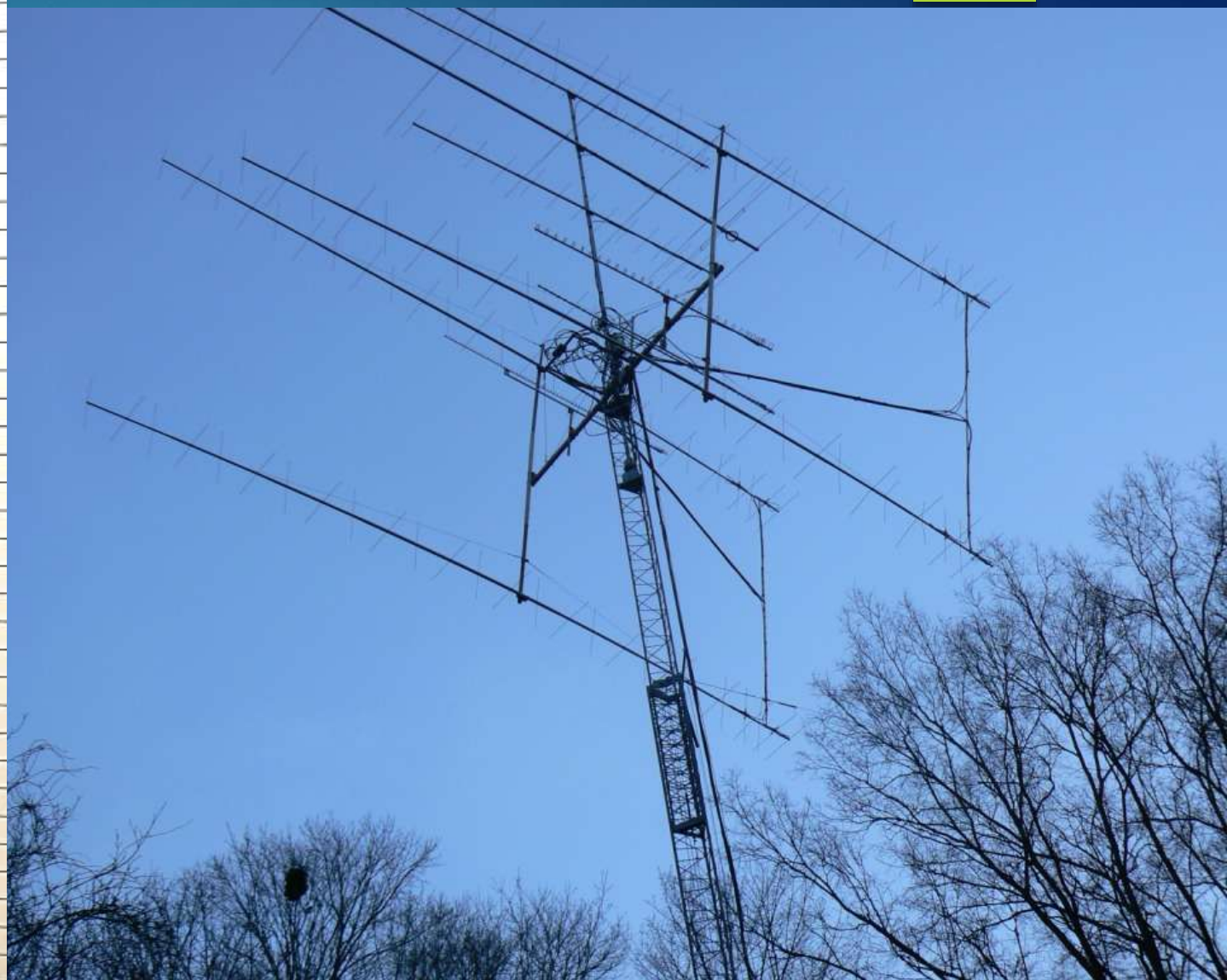
2013



Call Used K1JTARRL Section or Country SNJ

Freq	Mode	Date/Time UTC	Station Worked	Complete Exchange		List New Multipliers	Points
				Sent	Received		
(144) 1	JT6S	8 Nov 2014 0002	556P	RO	0	SS-1	100
2		0012	DLIVPL	RO	0	DL-2	↓
3		0020	SV6KRW	RO	0	SV-3	
4		0026	OKIDIX	RO	0	OK-4	
5		0031	DKSLA	RO	0		
6		0040	RN4AT	RO	0	RM-5	
7		0052	LZIVPV	RO	0	LZ-6	
8		0100	PA3ECU	RO	0	PA-7	
9		0104	YL2AJ	RO	0	LY-8	
10		0110	UT5ZN/P	RO	0	UT-9	
11		0118	I2SV/A	RO	0	I-10	
12		0124	CX2SC	RO	0	CX-11	
13		0127	H6IW	RO	0	HA-12	
14		0132	SP5OAT	RO	0	SP-13	
15		0144	RXIAS	RO	0		
16		0150	UN9L	RO	0	UN-14	
17		0156	4X1DG	RO	0	4X-15	
18		0212	I3LDP	RO	0		
19		0226	NØKE	RO	0	Co-16	
20		0234	LU7FA	RO	0	LU-17	
21		0240	K2OP	RO	0	Ma-18	
22		0248	W6YX	RO	0	Ca-19	
23		0252	AA7A	RO	0	Az-20	
24		0258	AD4TJ	RO	0	Va-21	
25		0304	W5ZN	RO	0	Ar-22	
26		0320	DH3YAK	RO	RO		
27		0326	RK3FG	0	RO		
28		0328	AAVSC	0	RO	SC-23	
29		0332	PA3HDG	0	RO		
30		0336	SM4GGC	0	RO	SM-24	
31		0338	WFOJ WLC	0	RO	<del>KS-25</del>	
32		0348	WFOJ	0	RO	KS-25	
33		0356	UA3PTW	0	RO		
34		0358	OH2BC	0	RO	OH-26	
35		0402	WY2QA	0	RO		
36		0406	LZ1DPK ARYT	0	RO	MN-27	
37		0418	K6EME	0	RO		
38		0426	HAGNQ	RO	0		
39		0436	K87Q	RO	0	MT-28	

# The log/antennas





# K1JT Station - 2014

Linrad

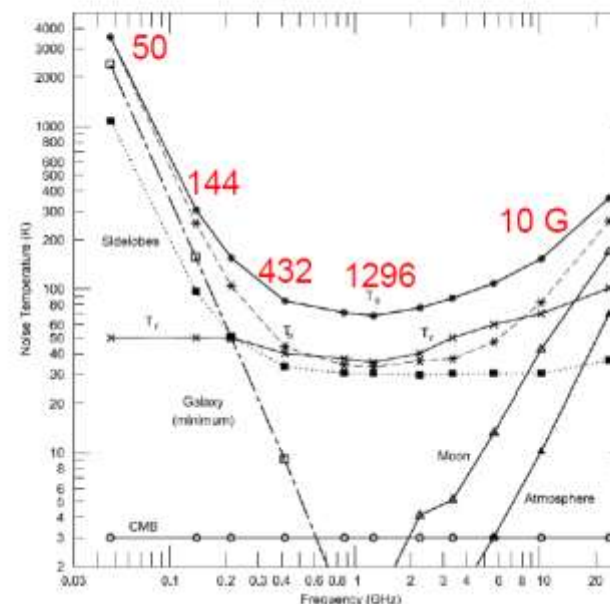


# EME specifics

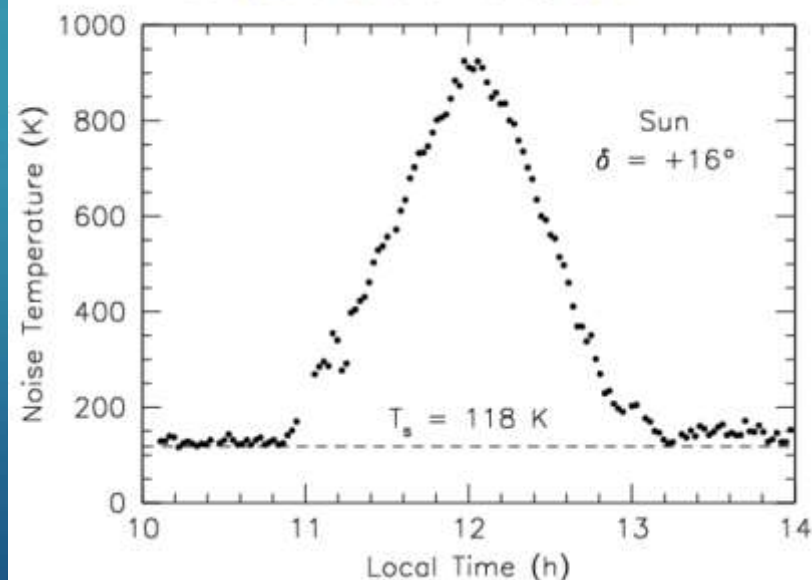
- ▶ Doppler shift
- ▶ Faraday rotation
- ▶ Polarization
- ▶ Sequencing
- ▶ Schedules, activity night
- ▶ Q&A



## Achievable $T_{\text{sys}}$ vs Frequency



## Drift curve of Sun





(Δf)

# Technical Details: Noise and signals

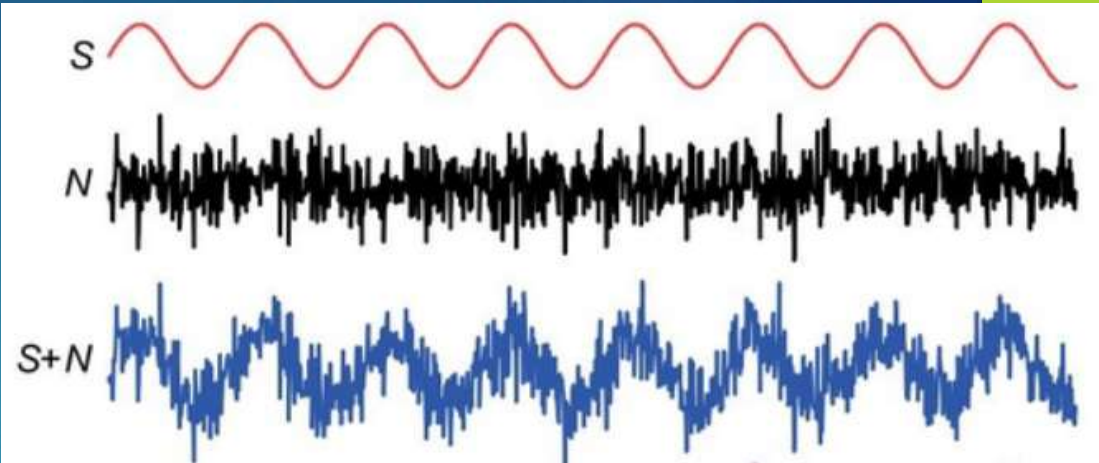
Thermal Noise floor (KTB)

$$P_{\text{dBm}} = -174 + 10 \log_{10}(\Delta f)$$

Delta F is compared to 1 Hz

(Δf) Bandwidth	Thermal noise power
1 Hz	-174 dBm
10 Hz	-164 dBm
100 Hz	-154 dBm
1 kHz	-144 dBm
10 kHz	-134 dBm

Plus other noise sources!



Signal Power after gain/loss:

Componet	dB/dBm	Comments
TX	60	dBm for KW
Ant	23	4 x yagis
Loss	-262	EME path loss
Ant	23	4 x yagis
RX	-156	dBm into pre-amp

CS/G ratio and sun noise for system test



5

- 





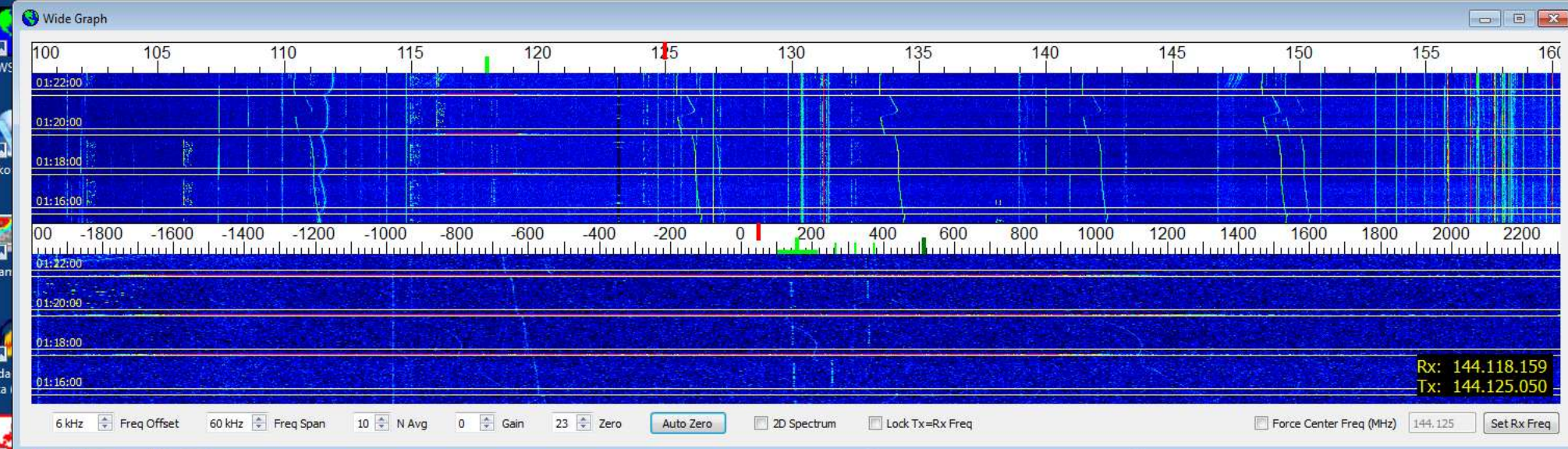
World Map - Moon Footprint

File Edit Window Help

Astronomi...

2014 Dec 07  
UTC: 01:22:29  
Az: 95.0  
El: 34.5  
MyDop: 226  
DxAz: 228.5  
DxEI: 49.3  
DxDop: 25

Desktop icons: Mozilla Thunderbird, Inno Setup Compiler, DX4Win, SeaMonkey, Emacs, ScopeFIR



7% Station by K1JT

144.132.000

Band: 1.8 3.5 5.3 7 10 14 18 21 24 28  
50 144 222 432 903 1.2 2.3 3.4 5.7 10.3

HF Ant: ☒ Vert 160/80 ☐ Doublet ☐ Mosley ☐ RoverLog

Pointing: ☐ Manual ☒ Moon ☐ Sun ☐ RoverLog ☐ W3CCX/B ☐ Service ☐ Stow

Offset: 3.0

95 38

MAP65 v2.5, r4729 by K1JT

File Setup View Mode Decode Save Help

Freq	DF	Pol	UTC	DT	dB	KV	DS	TxPol
118			005900					
118			010000					
118			010200					
125	220	20	010200	0.1	-16	OK1UGA W1PV FN20	1	0 20 H
118			010400					
118			010600					
118	159	131	010800	2.0	-23	K1JT OK2DE JO70	1	0 113 V
118	159	131	010800	2.0	-23	K1JT OK2DE JO70	1	92 113 V
118	159	135	011000	3.1	-22	RO	0	0 0
118	153	135	011200	3.2	-18	73	0	0 0
118	150	113	011400	1.9	-21	K1JT OK1NI JO70	1	0 97 V
118	144	90	011600	3.1	-21	RO	0	0 0
118	141	90	011800	3.2	-22	73	0	0 0
118	136	90	012000	6.0	-23	73	0	0 0

Log QSO Stop Monitor Decode Erase Auto + ON Stop Tx

DX Call Grid OK1NI

☐ Tx first Set Tx Freq ☒ NB 50 Tol CQ K1JT FN20

2014 Dec 07 01:22:29

Receiving F2 QSO Freq: 118 QSO DF: 159 Rx noise: 25.6 25.8 0.3 % JT65B Avq: 5

Band Map

102	S96P	124	E14DQ
106	R01AA	125	PA3HDG
111	SV6KRW	131	OK2PM9
111	YL2AJ	132	PA0C
115	S06EME	138	UA3PTW
116	R01AA	143	UA3MBJ
118	OK1NI		

Messages

Freq DF Pol UTC dB ☒ CQ\* Only ☐ CQ Only



# NJ2R's Initial EME Station



ARR pre-amp, Bypass relay

9 element F9FT portable antenna



# Roger's EME Results – Past 5 Years

## ▶ Why EME?

## ▶ Results

- ▶ 246 “Initials” An initial is a contact with a new station. 56 are within the US
- ▶ 58 DXCC countries
- ▶ All continents
- ▶ 34 EME states
- ▶ 195 Grid Squares
- ▶ The majority of stations are in Europe

## ▶ Station

- ▶ Kenwood TS-2000X and IQ+ SDR
- ▶ Signalink USB, W2DRZ sequencer
- ▶ 2 2MXP20 cross pole antennas
- ▶ Dual ARR 25 db gain preamps followed by DCI bandpass filters
- ▶ Lots of relays for switching
- ▶ Home brew 8877 amp from the ARRL Handbook in 1976 to 1990



# What do you need?

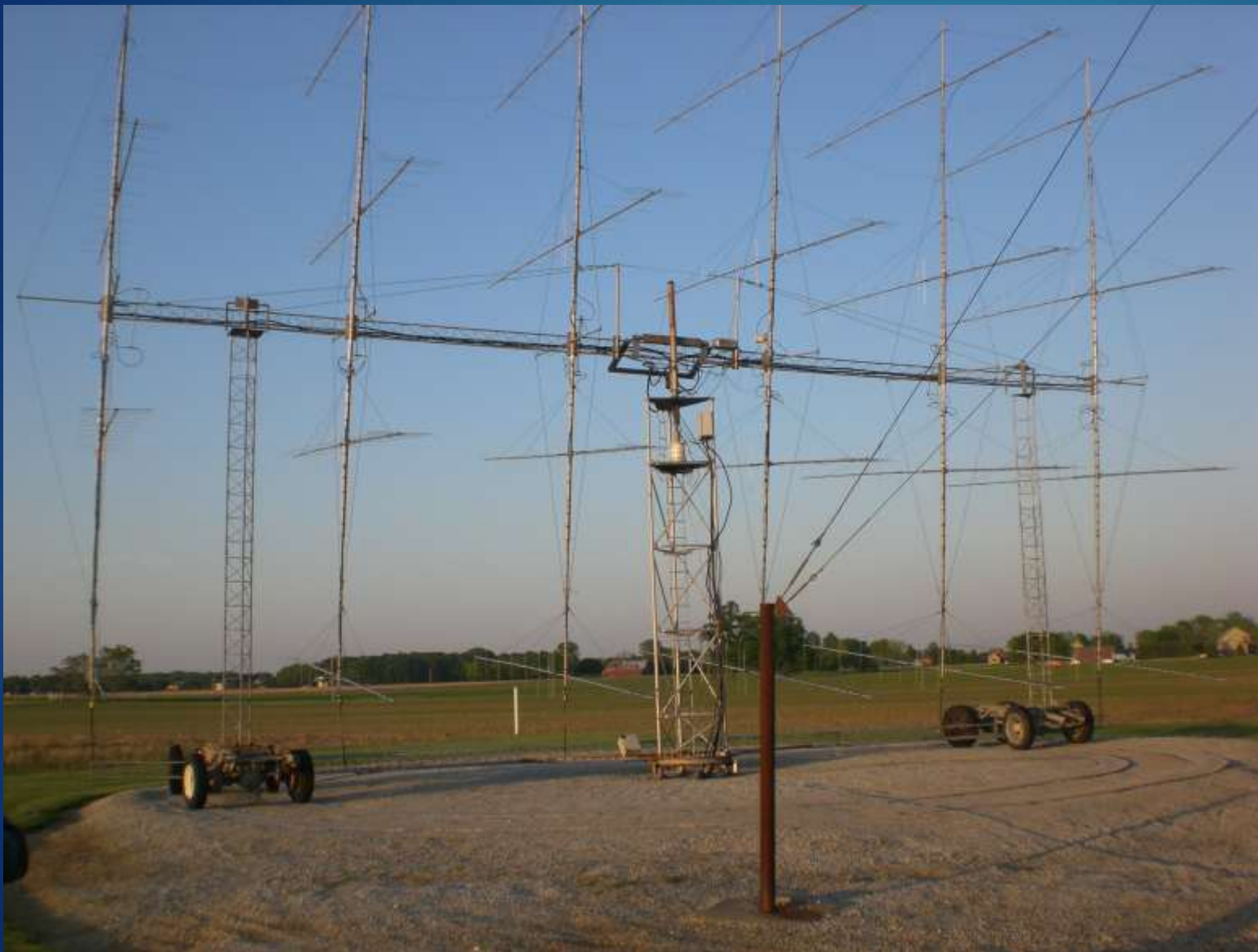
- ▶ Antennas are the best investment!
- ▶ 2 meter all mode radio to drive amplifier
- ▶ Amplifier, the more power the better
- ▶ Sound card interface to computer
- ▶ WSJT software from K1JT and Time sync software for PC
- ▶ Sequencer to switch everything in the proper order
- ▶ Pre-amp at the antenna will be needed
- ▶ A few relays T/R, polarity, pre-amp protection
- ▶ Azimuth rotor, elevation rotor is also very helpful
- ▶ Attention to detail Where is the moon? Activity?
- ▶ Visual antenna alignment with moon to start
- ▶ Patience with single polarization antennas

# Links to software, amps, presentations

- ▶ WSJT, WSJT-X, MAP65, WSPR, SimJT, Open Source
  - ▶ <http://physics.princeton.edu/pulsar/k1jt/>
  - ▶ References: <http://physics.princeton.edu/pulsar/k1jt/refs.html>
  - ▶ N0UK logger for scheds <http://www.chris.org/cgi-bin/jt65emeA>
  - ▶ Moon tracking <http://www.f1ehn.org/>
  - ▶ Live CQ144 <http://www.livecq.eu/>
  - ▶ <http://members.shaw.ca/ve7sl/eme.html> for a good user example with a single yagi
- ▶ <http://wsprnet.org/drupal/wsprnet/map>
- ▶ Solid State VHF Amplifiers (+ eBay)
  - ▶ [http://www.w6pql.com/1\\_kw\\_2m\\_ldmos\\_amplifier.htm](http://www.w6pql.com/1_kw_2m_ldmos_amplifier.htm)
  - ▶ <http://www.beko-elektronik.de/index.php?do=03,01,01,02,05&lang=en>
- ▶ VHF conference proceedings CD available
  - ▶ Starting out on EME-23cm K2UYH.ppt
  - ▶ W2PU Princeton Univ 432 EME station
  - ▶ K3RWR reducing noise sources
- ▶ EME newsletter: <http://www.nitehawk.com/rasmit/em70cm.html>



# Or the very best! 24 Yagis



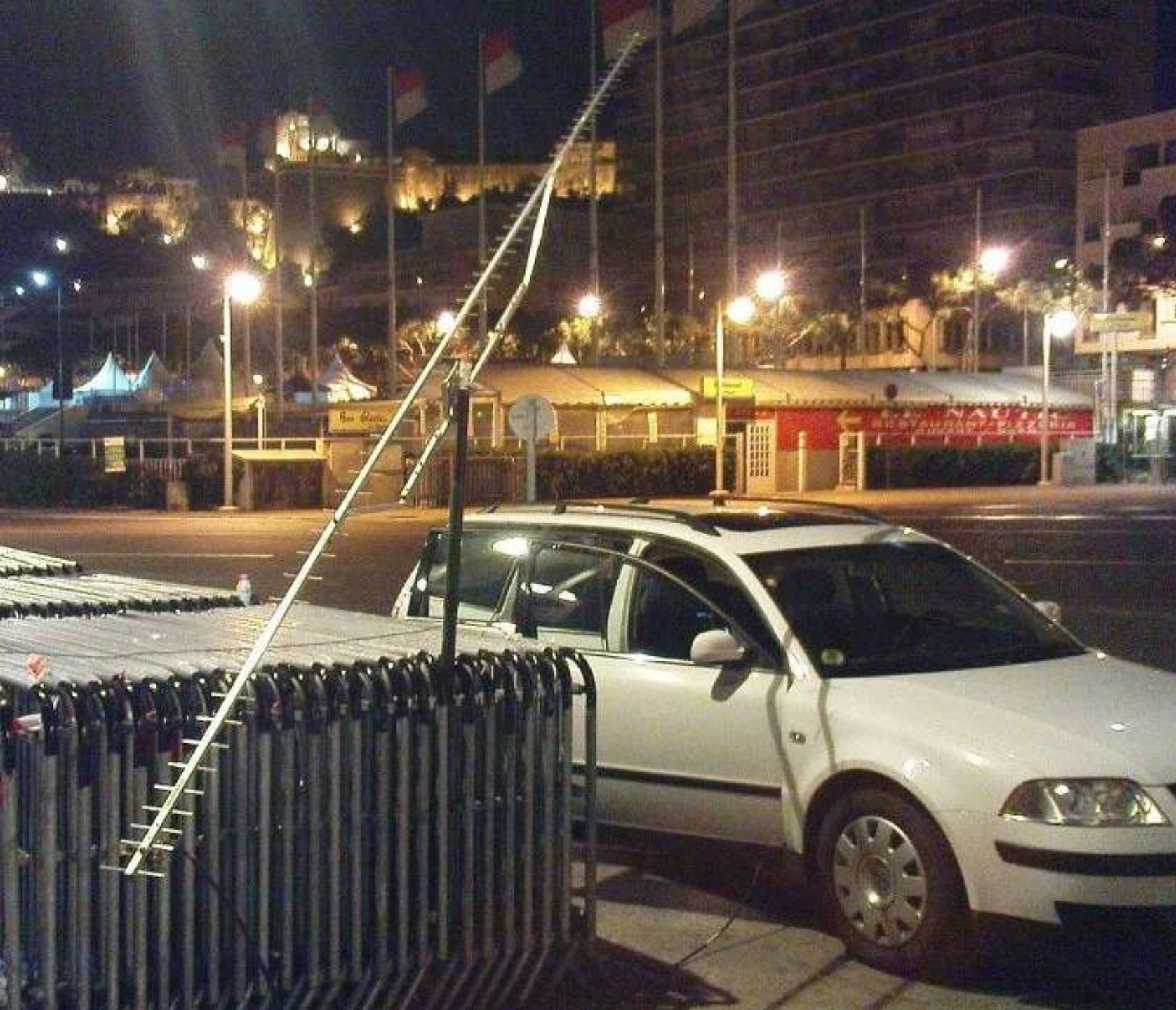
KB8RQ Gary  
Many hams first EME QSO



# KB5WIA just 2 X 7 Element yagi's







**MONACO 3A/DL3OCH**  
**ONE OF MOST SUCCESSFUL**  
**EME DXPEDITION OPS (1296)**  
**USES SINGLE 59 EL (5 m) YAGI,**  
**NO PREAMP & 80 W!**





**DP1POL – Felix  
67 EL 1296 YAGI  
WINTER AT  
SOUTH POLE!**

Present Setup  
4 × 15LFA-JT  
 $G = 22.4$  dBi  
Princeton Univ.  
W2PU

C:\Users\joe\Pictures\2014-07-25  
W2PU\_25July2014\W2PU\_25July2014 002.JPG

