Working Out the 23 cm EME Band

N5BF 2014-2017

Microwave Update October 26-29, 2017

Santa Clara, California

http://cbduncan.duncanheights.com/HamRadio/HamRadio.html

Outline

- The N5BF 23 cm EME Station
- The Moon – humanity's beacon from antiquity
- Working the 23 cm EME Band in 2016-2017

The N5BF 23 cm EME Station

Why 1296? (1960)

1. It is the first ham band where Faraday polarization shift becomes negligible.
2. Lowest ham band in which galactic and solar noise are at a minimum.
3. Highest ham band on which receive noise figure of less than 1 dB are possible.
4. Highest ham band where tubes capable of a kW input are available.
5. The only ham band where we were definitely assured that a competent and reliable group would be duplicating our efforts on the other end."

- "Project Moon Bounce *As Seen from Rhododendron Swamp*" by F. S. Harris, W1FZJ at http://www.ok2kkw.com/eme1960/eme1960eng.htm

1296 at N5BF (2014-)

- Quiet sky and environment, particularly important in the Big City.
  - 2010 ARRL Handbook Section 30.9 and Figure 30.64, Section 5.8 and Table 5.2.
  - Observational and anecdotal evidence that the 144 and 432 MHz bands are not very quiet in the Los Angeles basin and that it is even worse on 50 MHz and down.
  - I am not a "drive out in the desert for the weekend" type of operator despite higher activity levels on the lower bands.
- Enough amateur activity to be worthwhile by my standards.
  - Experienced 23 cm EME operator Doug Millar K6JEY estimated about 85 active stations worldwide (in 2015). That was good enough.
  - Some evidence that 432 MHz activity worldwide is decreasing while 1296 MHz is increasing.
- Faraday rotation negligible
  - And unimportant due to current convention of using circular polarization.
- 1296 technology today is within reach of a hobby budget, good performance, better than 1960.
- Station capable of detecting self echoes.
- Exploration of the 23 cm EME space as visible from my house.
  - Ready to operate during brief or cramped availabilities.
- Decades of daydreaming about an advanced station in the back of the 1971 edition of ARRL's "How to Become A Radio Amateur" that I mistakenly thought was 1296 MHz. (I'm a romantic.)
- 1296 is where amateur radio EME started. (ditto, romantic, and amateur historian)
- *"Top Band" of microwaves*

Red ties to 1960
Green is important to me

GOTA

- Millar's Rule:

"Get your station on the air *then* improve it." - K6JEY

People tend to get stalled behind infinite complexity, unobtainium, and perfectionism

- Duncan's Rule:
  - Not about scrounging or minimizing $$ (within reason)
  - *Is* about fitting a real project into time available − N5BF

Single Yagis Don’t Work on 23 cm

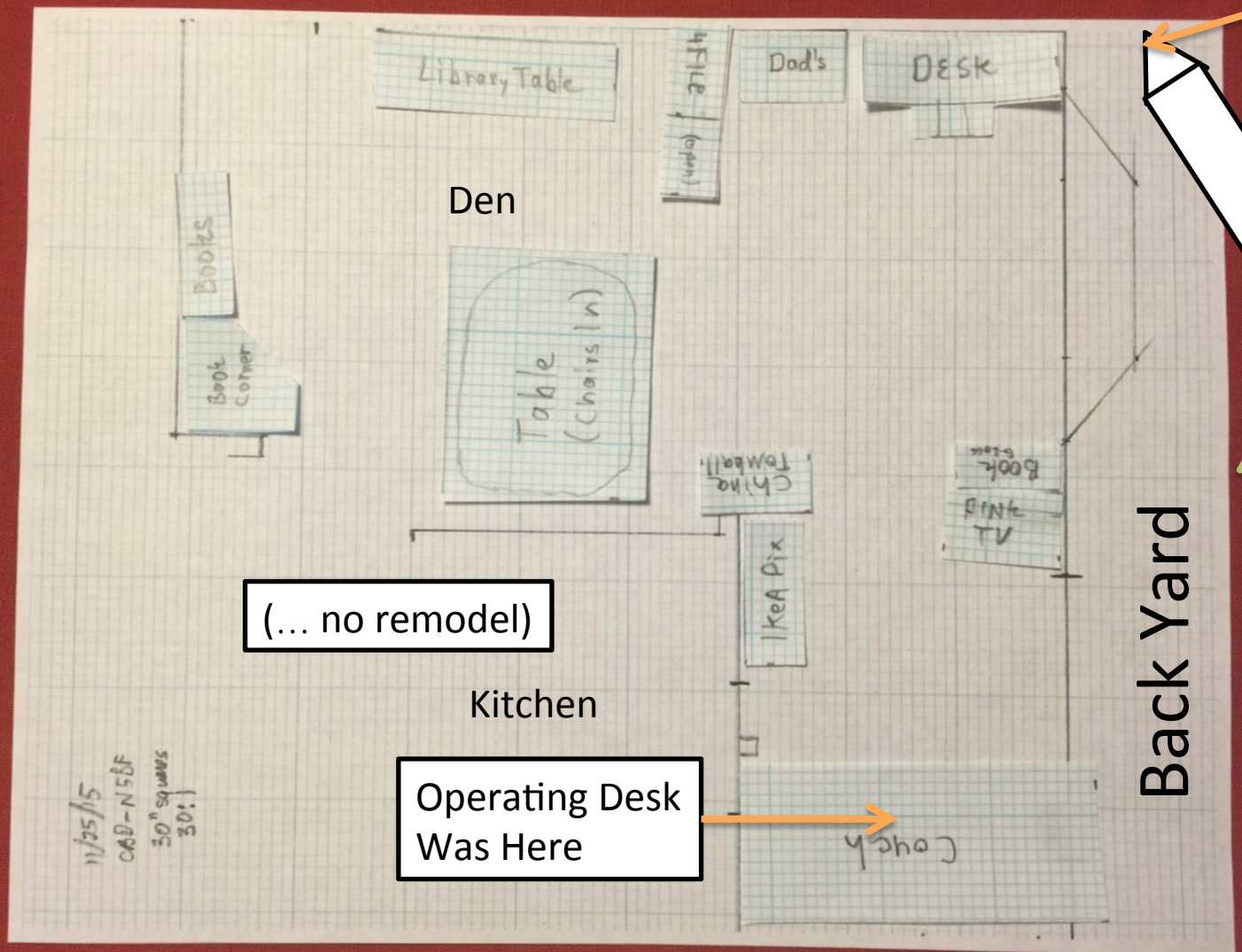
2014

1296 EME. N5BF 2017 SBMS / MUD

400 W de W6PQL

23cm35 tilted up - 2M12 shown for scale

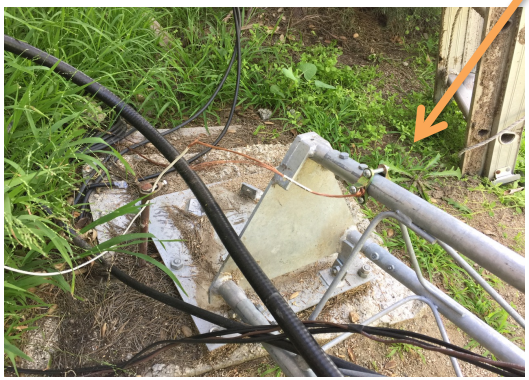
Shack Move Plan



“Construction” Began 1/1/16

Rohn HB25AG Adjustable House Bracket, 0-15”

Rohn BPH25G Hinged Base Plate



3” hole in wall ready for Heliax, etc.

Stop and Think

- 432 after all?
  - No, on prior research
  - Comparison was a wash
- 8x 23cm49 really?
  - At least 500 pieces
  - Linear
  - Single band
  - No
  - K2RIW's 12-foot stressed parabola was looking really good about now
    - 1974 ARRL Antenna Book
  - Switched to RF Ham Design parabola
    - With 48 hours to go
  - But M^2 was very helpful

(PA1T)

(You can't find pictures of big 23 cm EME yagi arrays for good reasons.)

RFHamDesign 3 m. 0.45 f/d

Four (heavy) boxes of parts

One rib assembled

Construction

12 ribs and 5 rings assembled

Feed Installed

Mesh attachment

Assembly performed on tower, on AlfaSpid

RX Testing

Good preamp behind marginal relay

Measuring System Noise Figure with Sabin Noise Source

TX Testing

300 Watts at Feed

First Sun Noise
Construction Configuration
Note Feed Shadow

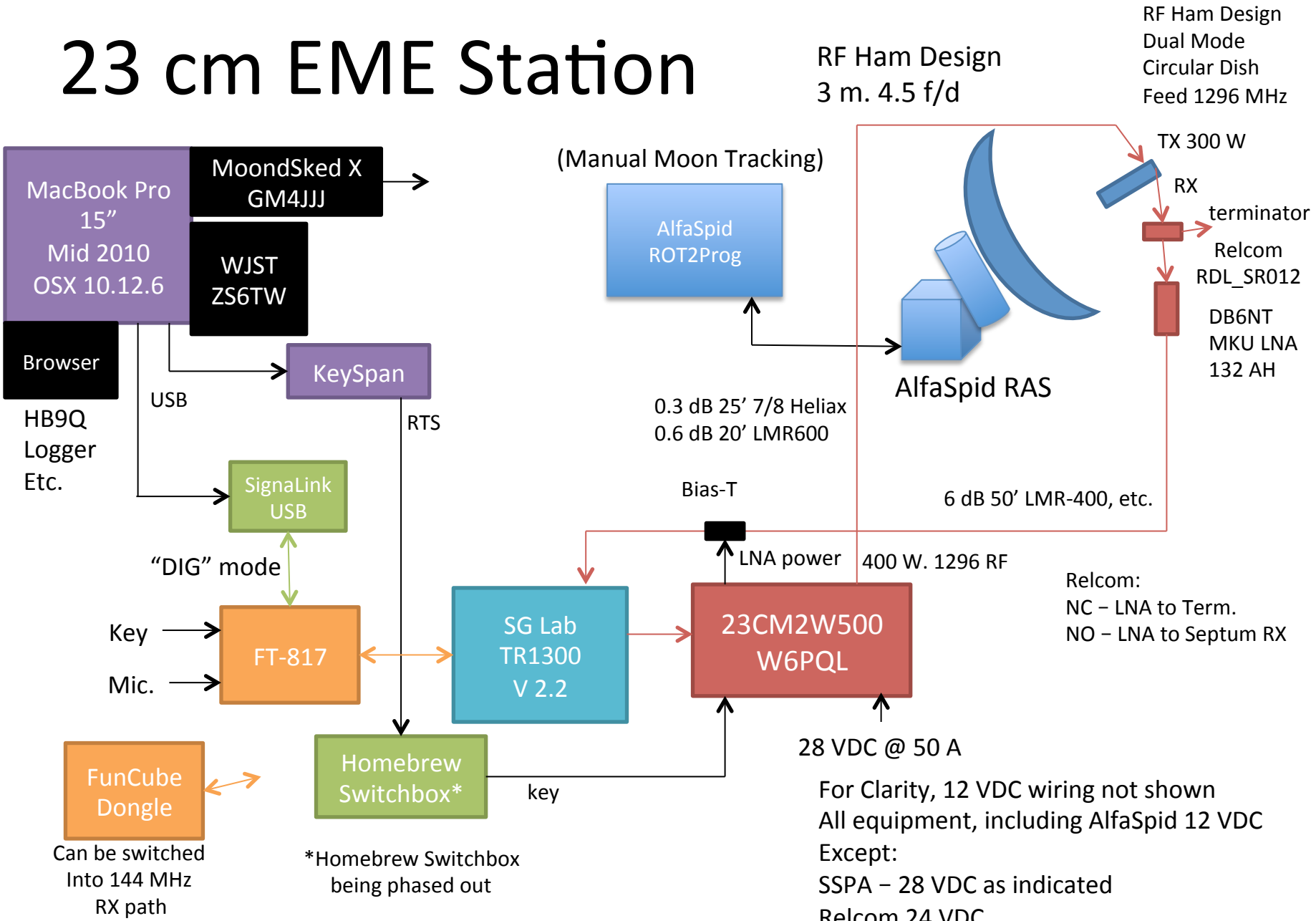
Tower in Maintenance Position

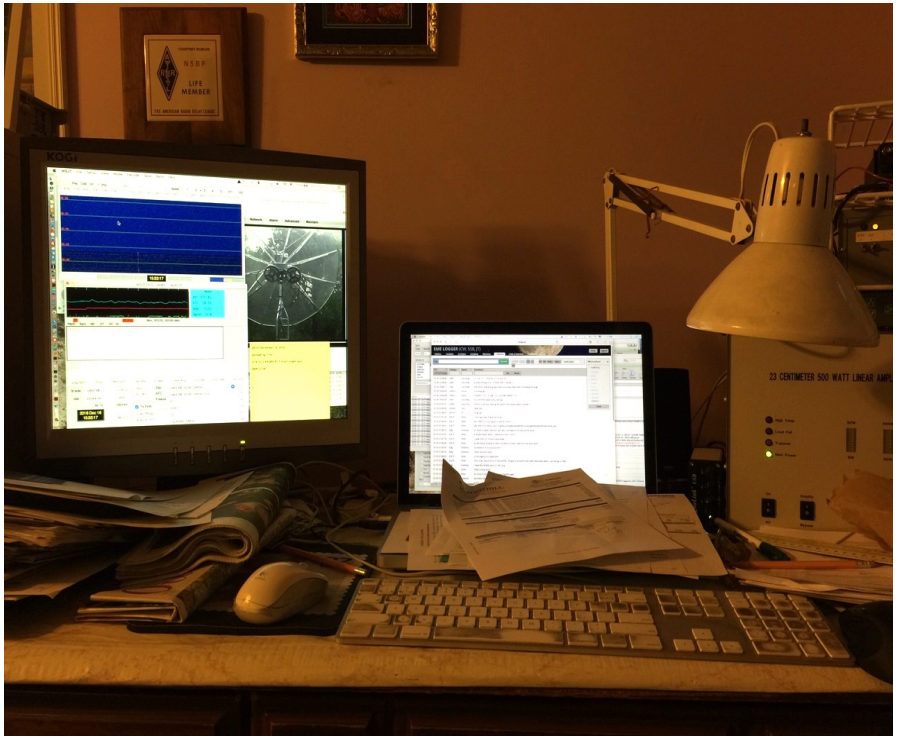
Tower in Operating Position

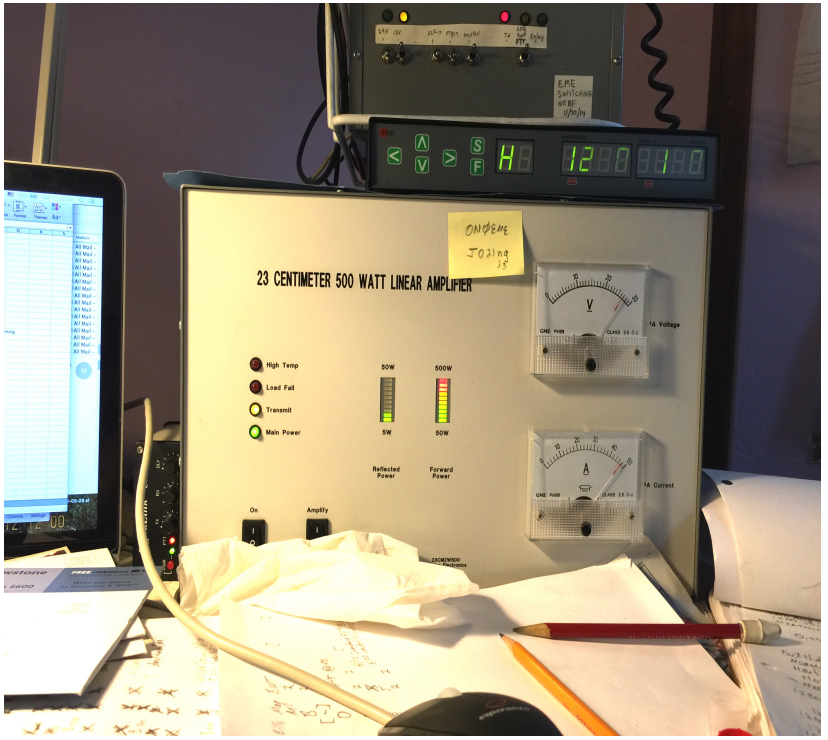
Dish in “Feed Maintenance Position”
070/-20
(photo from roof ridge)

The day I fixed the connector on the heliax
(after many successful tests of the W6PQL amplifier
“Load Fail” feature)

23 cm EME Station

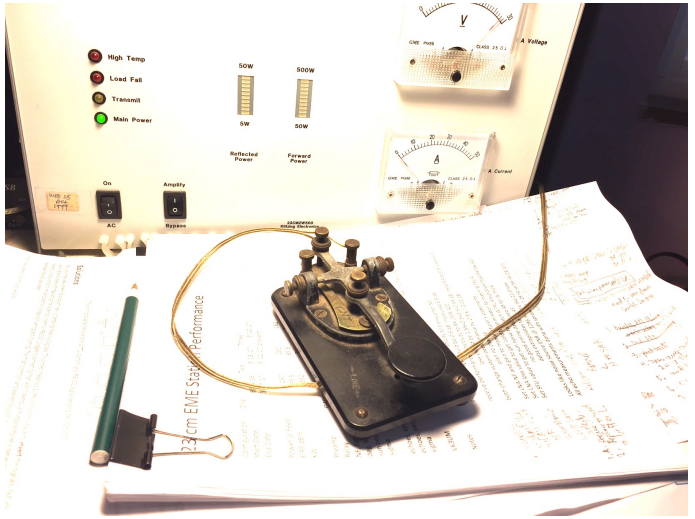






The View

(This is the only straight key I've been able to tolerate since 1972.



Configuration	One	Two	Three	Four	Five
Start Date	8/16/16	3/18/17	5/12/17		
End Date	3/17/17	present	7/21/17		
				Septum choke	VE4MA feed
Power @ Feed	280	280	280		
EIRP dBm	85.5	85.5	85.5		
KW	352	352	352		
Preamp	G4DDK	DB6NT	G4DDK #2		
Relay	CX-520D	Relcom	Relcom		
NF, sys., dB	2.19	1.50	1.41		
deg. K	190	120	111.3		
sun noise, dB	7.96	8.06	8.55		
sigma	0.50	0.10	0.06		
echoes, apogee	-24.5	-22.0	-22.8		
echoes, perigee	-20.1	-18.9	-17.3		
sigma	1.9	2.1	2.2		
VK3UM	done	done	done		

Formal Configuration Comparisons

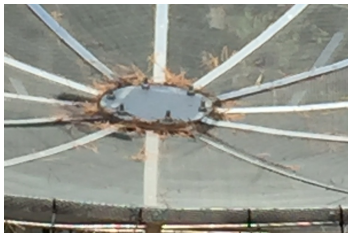
Next thing to try is reducing RX spillover with choke.

Already have empirical tree RX data.

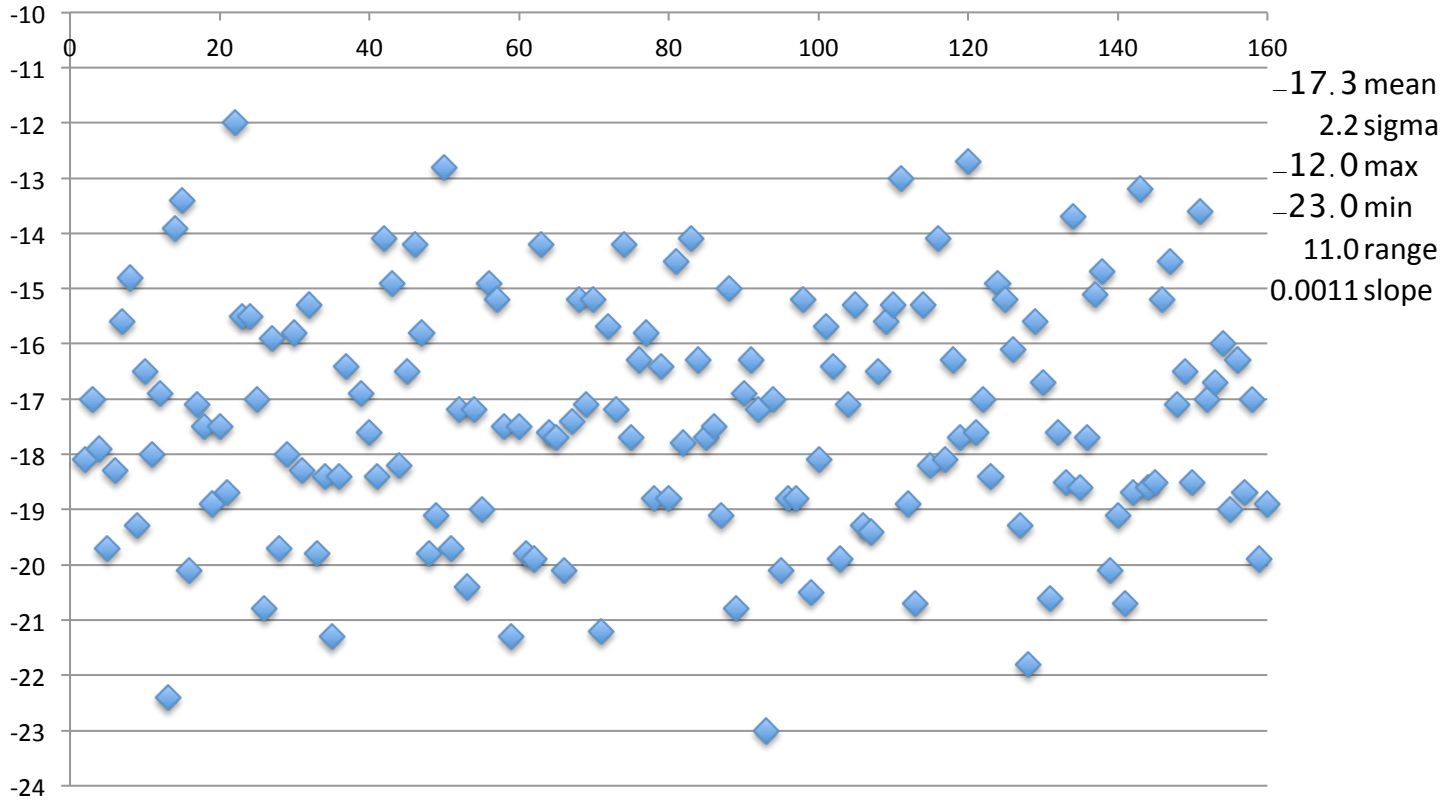
6/24/17 Perigee Echoes Recheck
Configuration Three
Note: Moon 10 degrees from sun

160 pts.

before



after



Worried about pointing yesterday, where lagging a degree or two in each direction seemed to help a lot, realigned on sun shadow and sun noise in “measure mode”.

Change was minus on degree elevation and minus three degrees azimuth from old indicated to new indicated.

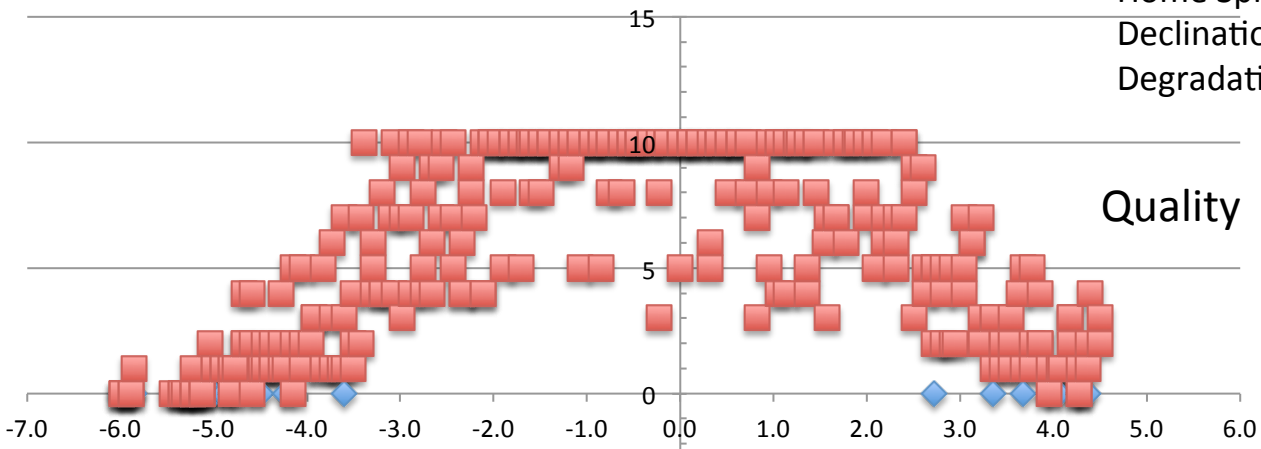
Re-did yesterday’s echo test but not as long and got better statistics by about two dB.

6/9/17 Apogee Moonrise, Bottom Declination, Azimuth 125 (118-132)

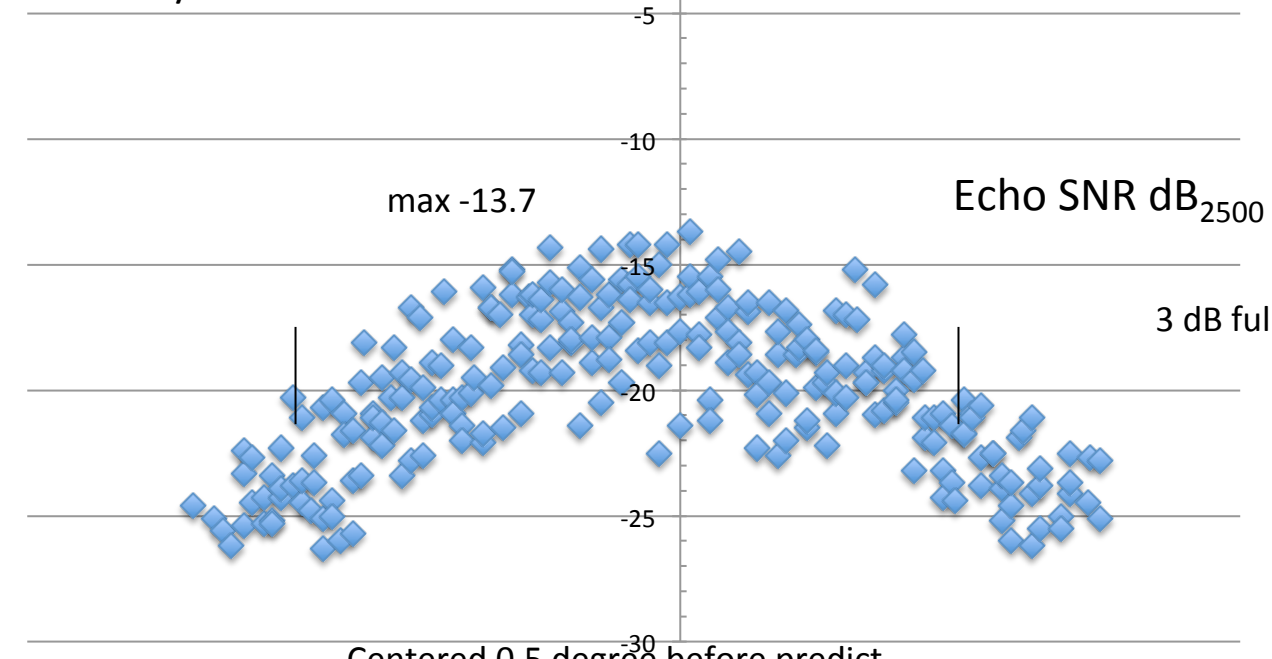
Picture is 03:51, 125/015, just above Rob's Oak and entering my pine limbs. 802 pts.
(Taken from north ledge, source of big top limb.)

5/21/17 14:43Z Beam Cut Echoes

Home Spreading 22 Hz
Declination -2 deg.
Degradation 0.8 dB



Degrees from 148/049



3 dB full beamwidth 7 deg.

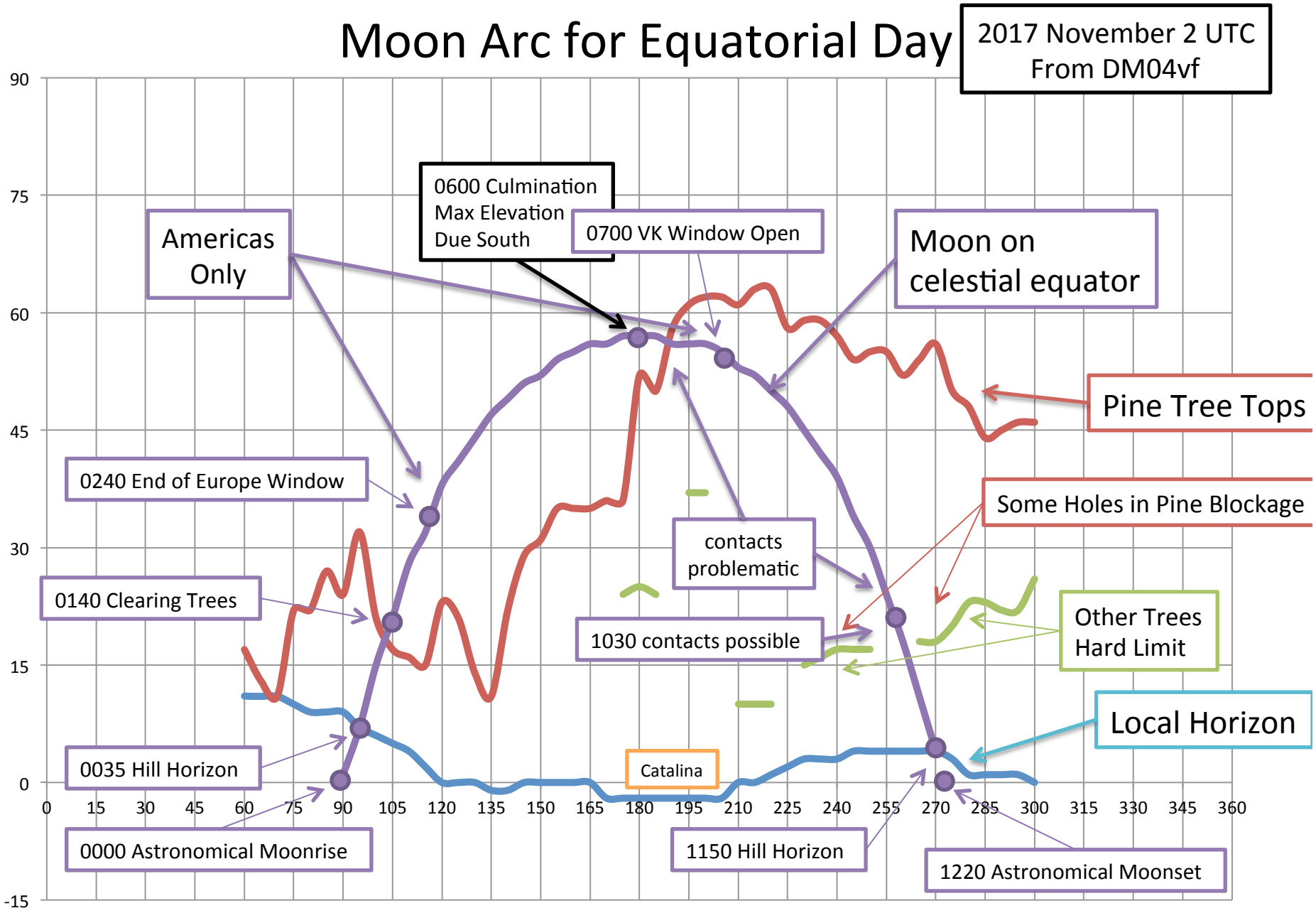
(measured at 6 dB echo,
3 dB up, 3 dB down)

Centered 0.5 degree before predict
Indicates trailing half degree is best pointing

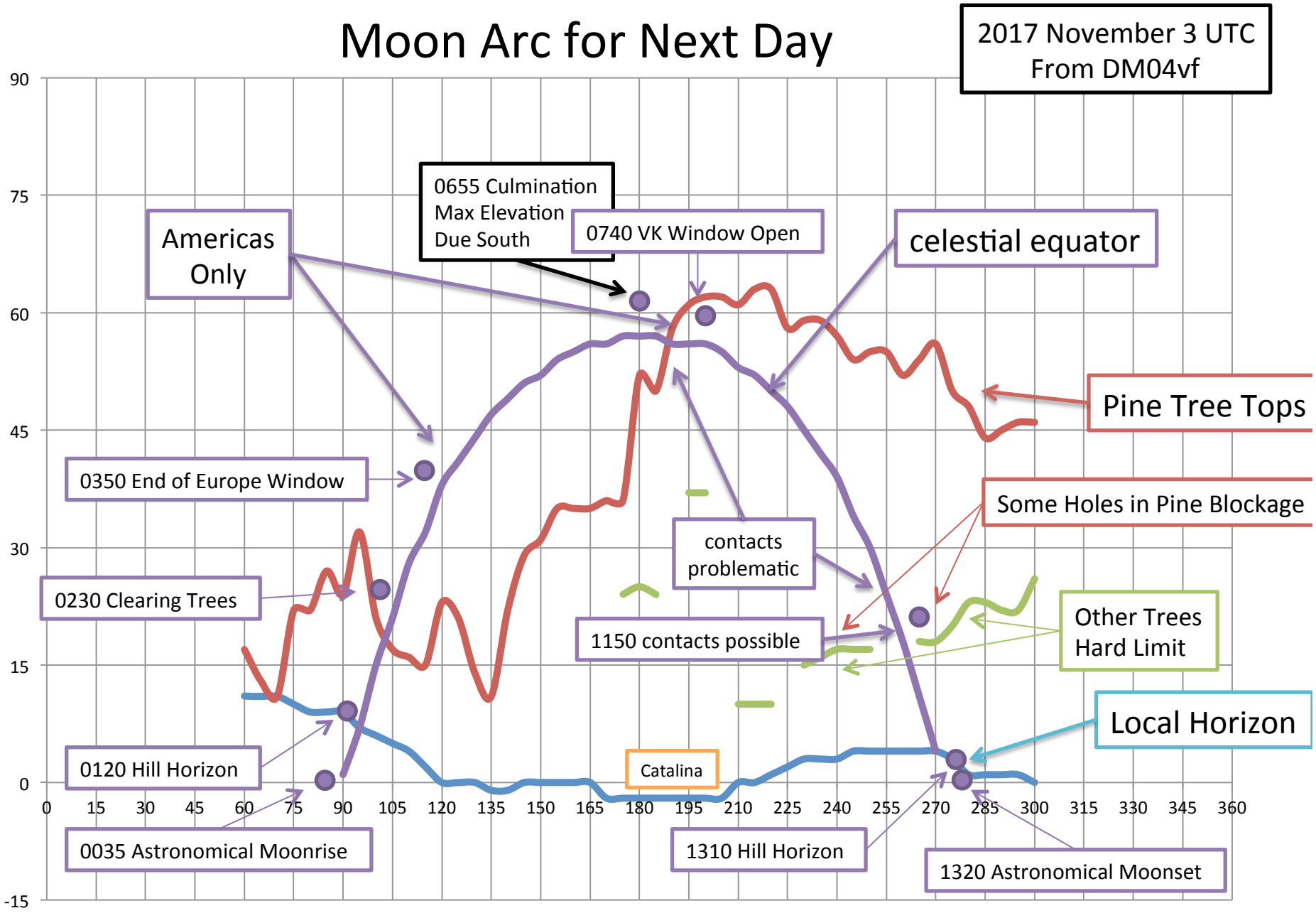
The Moon

Humanity's Beacon from Antiquity

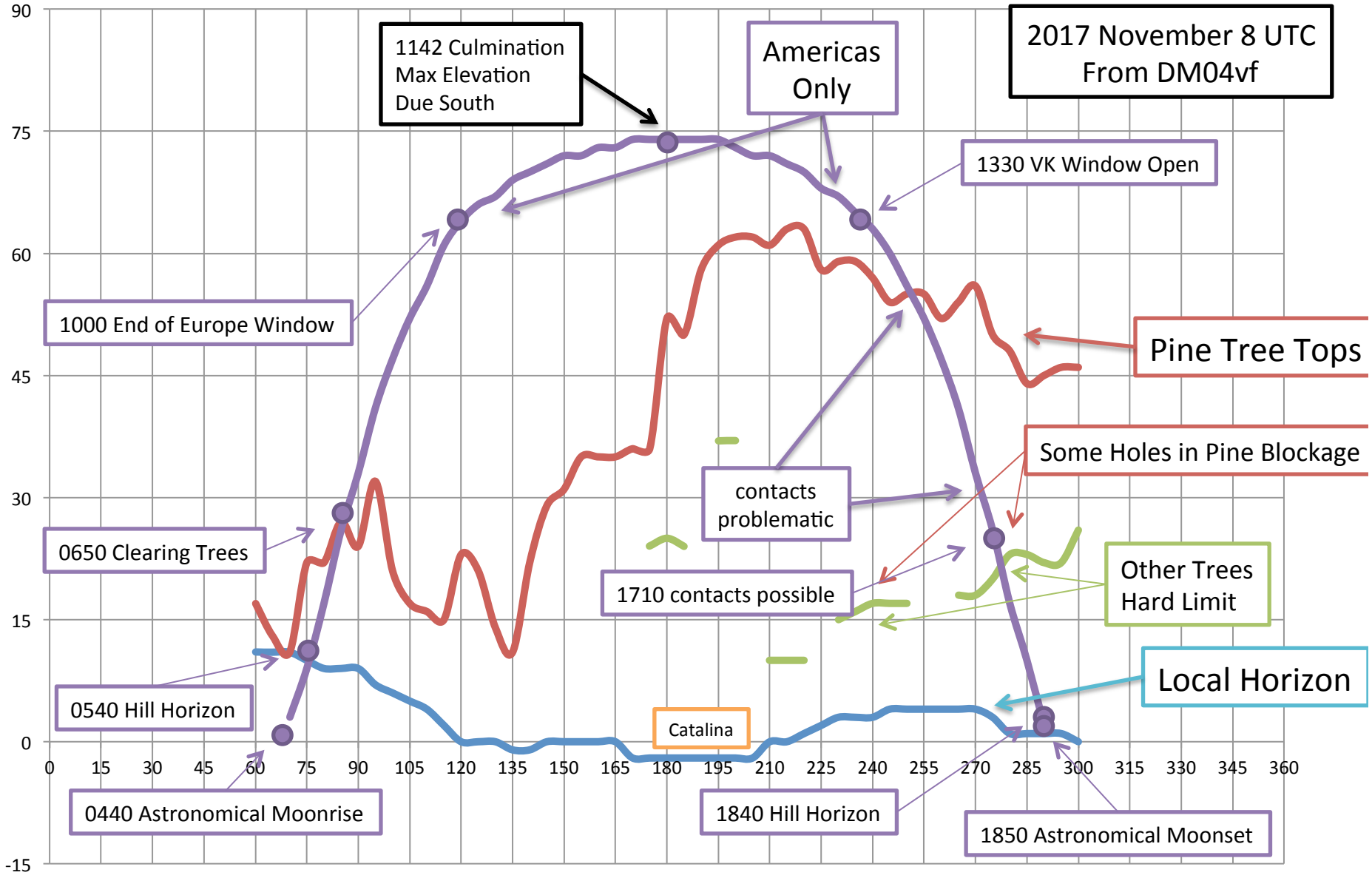
Moon Arc for Equatorial Day



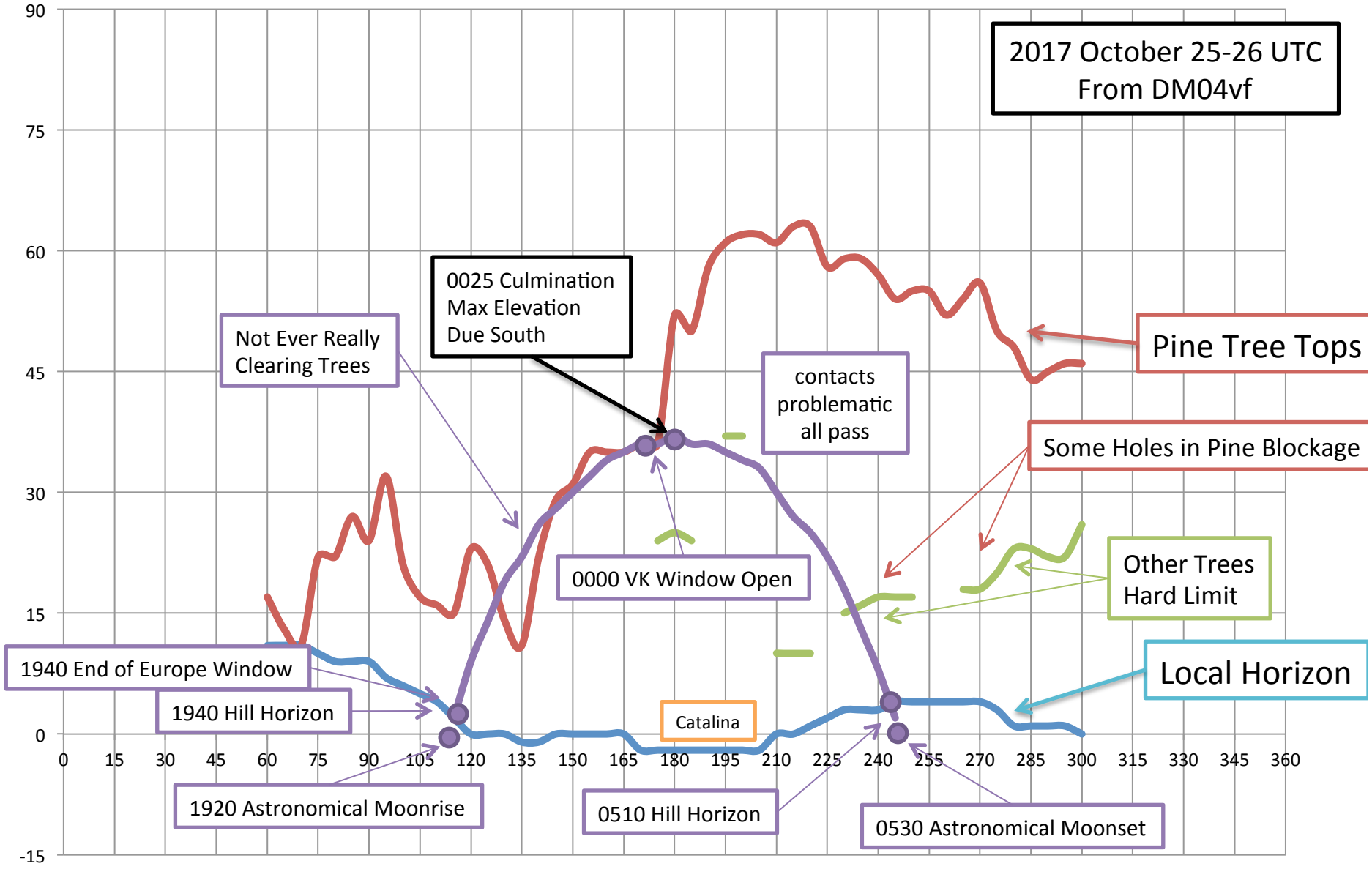
Moon Arc for Next Day



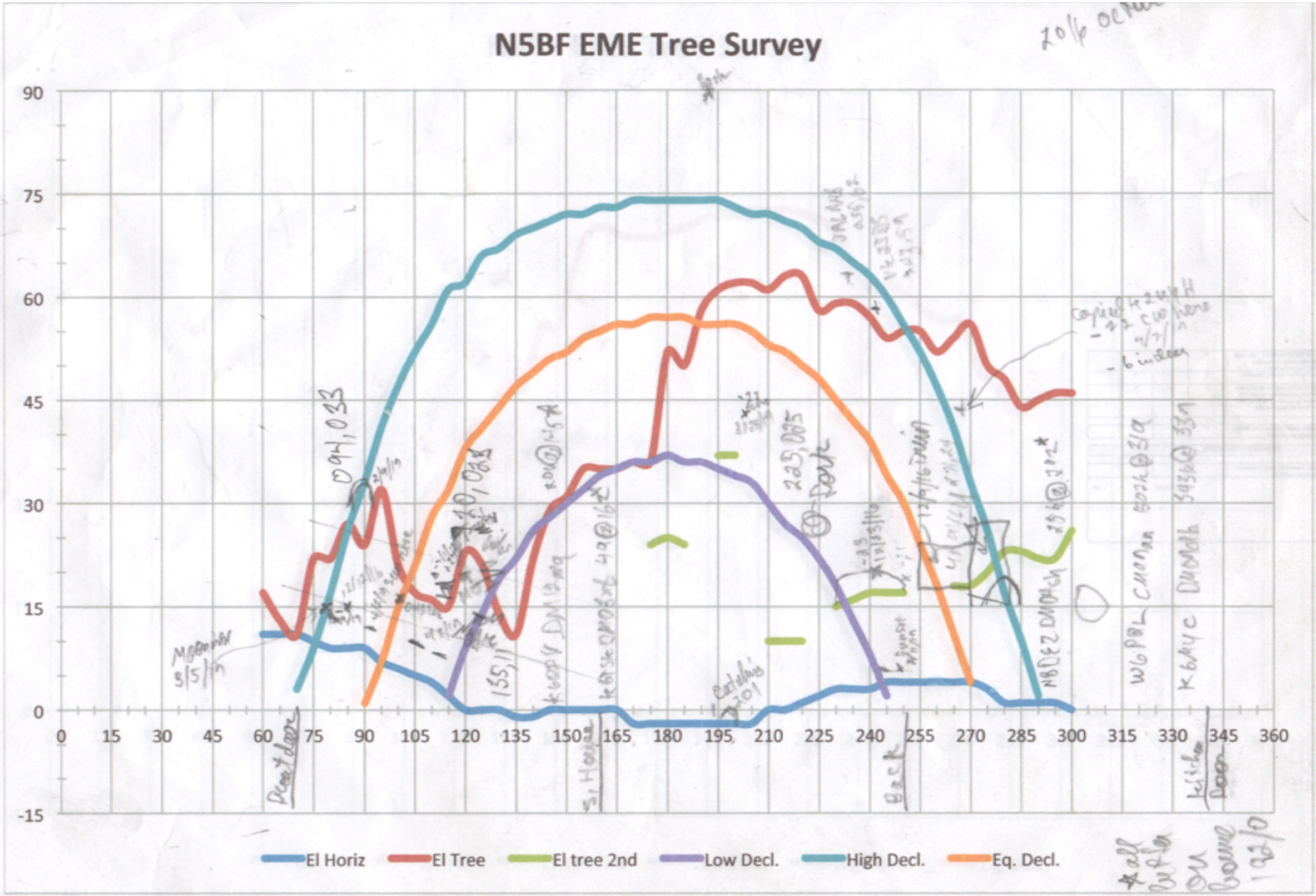
Moon Arc for High Declination Day



Moon Arc for Low Declination Day



Working Victor UA9YLU Through a Slot in Pines / Oaks
DM04 to MO92


N5BF EME Tree Survey
90
75
60
45
30
15
0
-15
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360
El Horiz
El Tree
El tree 2nd
Low Decl.
High Decl.
Eq. Decl.

Day to Day and Month to Month

- Everything happens about the same local time everywhere in the world each day
  - But the time zones are different

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- Everything happens about 50 minutes later each day
  - Moon proceeds east one diameter per hour (0.5^{o})

Day to Day and Month to Month

- Everything happens about the same local time everywhere in the world each day
  - But the time zones are different
- Everything happens about 50 minutes later each day
  - Moon proceeds east one diameter per hour (0.5^{o})
- Everything happens 2 hours earlier each month
  - Sun proceeds east one degree per day

The Good Declination Times

Winter	All night with the full moon
Spring	Afternoon through evening with the first quarter moon
Summer	All day with the new moon (on the sun…)
Fall	Midnight to morning with the last quarter moon

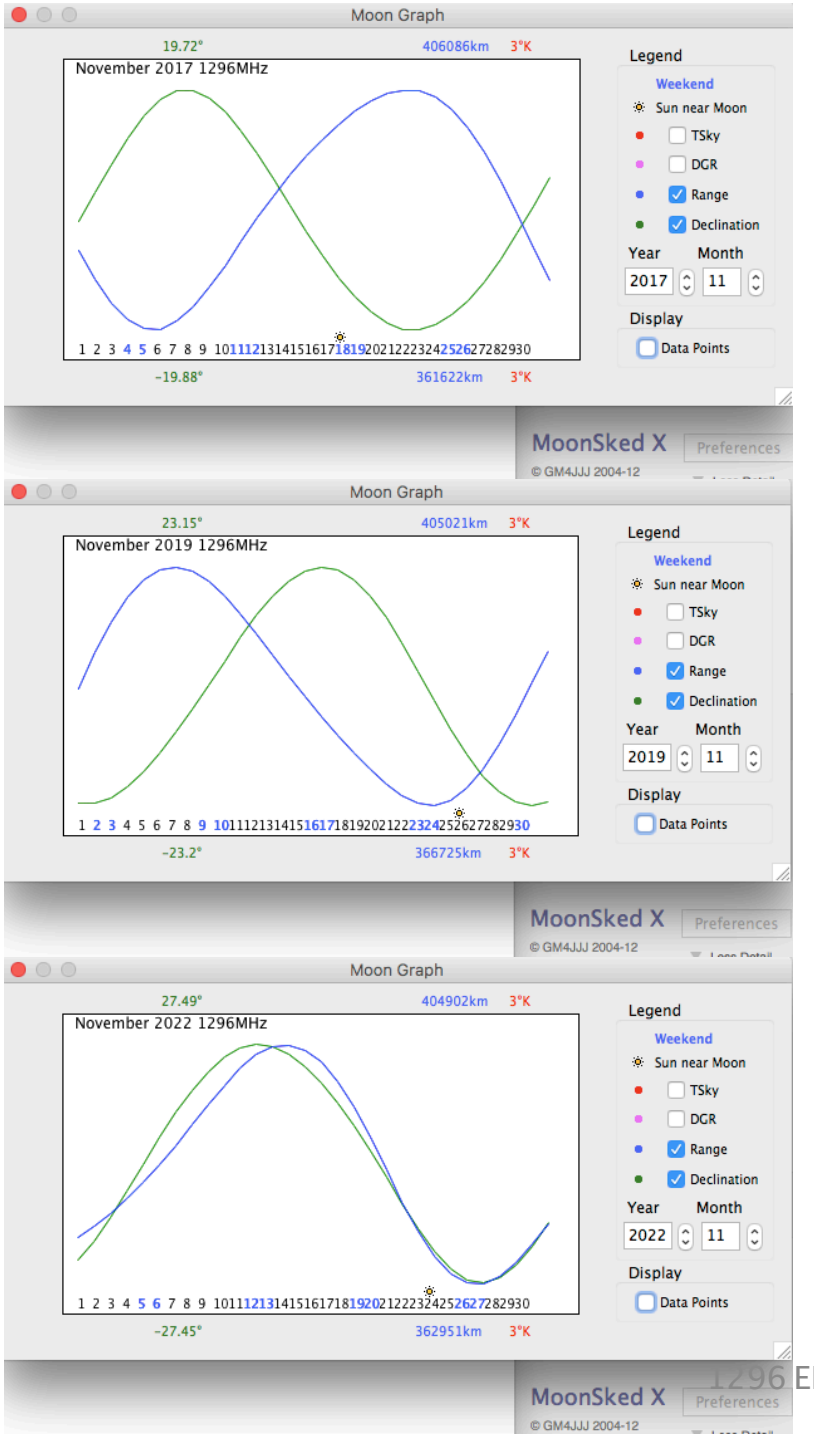
This is true south or north but most of the stations are in the north so northern seasons and conditions are favored in planning and on the air.

The Sidereal Month is 27.3 days
The Anomalistic Month is 27.5 days
The Syndonic Month is 29.5 days

All the charts go with the Sidereal Month because it goes with the stars or "inertial space."
We think in terms of the Syndonic or "Solar" Month since we are locked to the solar day.
The perigee-apogee goes with the Anomalistic Month…

Beat Notes of the Month(s)

Month	Period, Days	Period, Secs.	Frequency, Hz		Sidereal Beat Note	period, secs.	period, years
Sidereal	27.32166204	2360591.6	4.23623E-07	stars			
Syndonic	29.53058796	2551442.8	3.91935E-07	sun	3.16875E-08	31558169.09	1.000018034
Anomalistic	27.55455	2380713.12	4.20042E-07	perigee	3.58041E-09	279297557.7	8.850405534
Draconic	27.21222	2351135.808	4.25326E-07	node	-1.70372E-09	-586949399.8	-18.59930412
Tropical	27.32158	2360584.512	4.23624E-07	equinoxes	-1.27199E-12	-7.8617E+11	-24912.23745
Others	For reference				Saros is a hybrid of Draconic and Syndonic		
Day		86400	1.15741E-05	(G-22)			
Year		31558152.96	3.16875E-08	(C-30)			
sunspot cycle		694279365.1	1.44034E-09	(G-35)			
https://en.wikipedia.org/wiki/Month			1.296E+09	(Eb+25)			



The anomalistic month does this

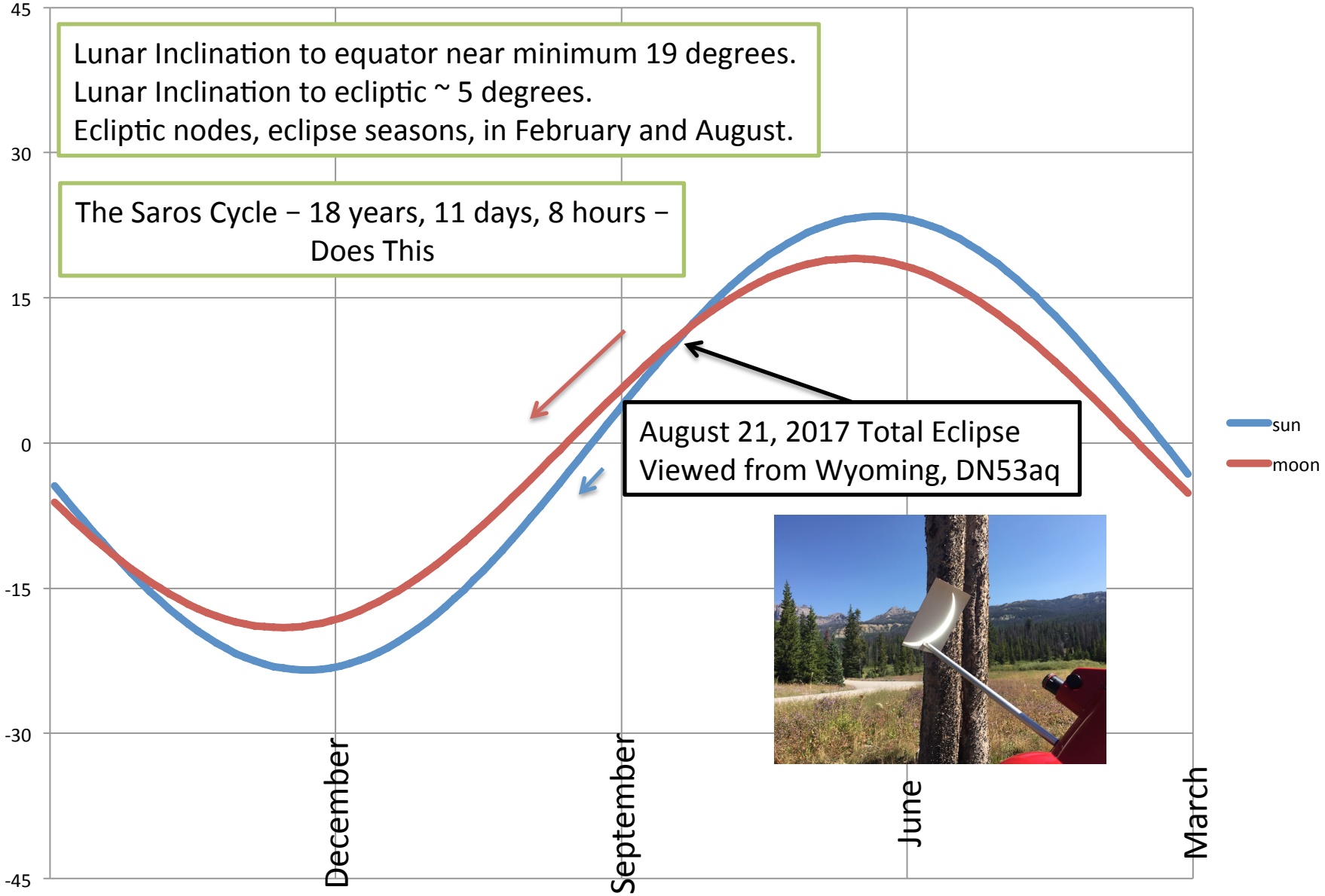
Perigee and High Declination Aligned
November 2017 - good

Perigee and High Declination in quadrature
November 2019 - OK

Apogee and High Declination Aligned
November 2022 – Sad (for the north)

Apogee / Perigee ~ 406/356 k-km
40*log(406/356 ~ 2.3 dB “degradation”
(“radar”)

Sun and Moon Declinations 2017

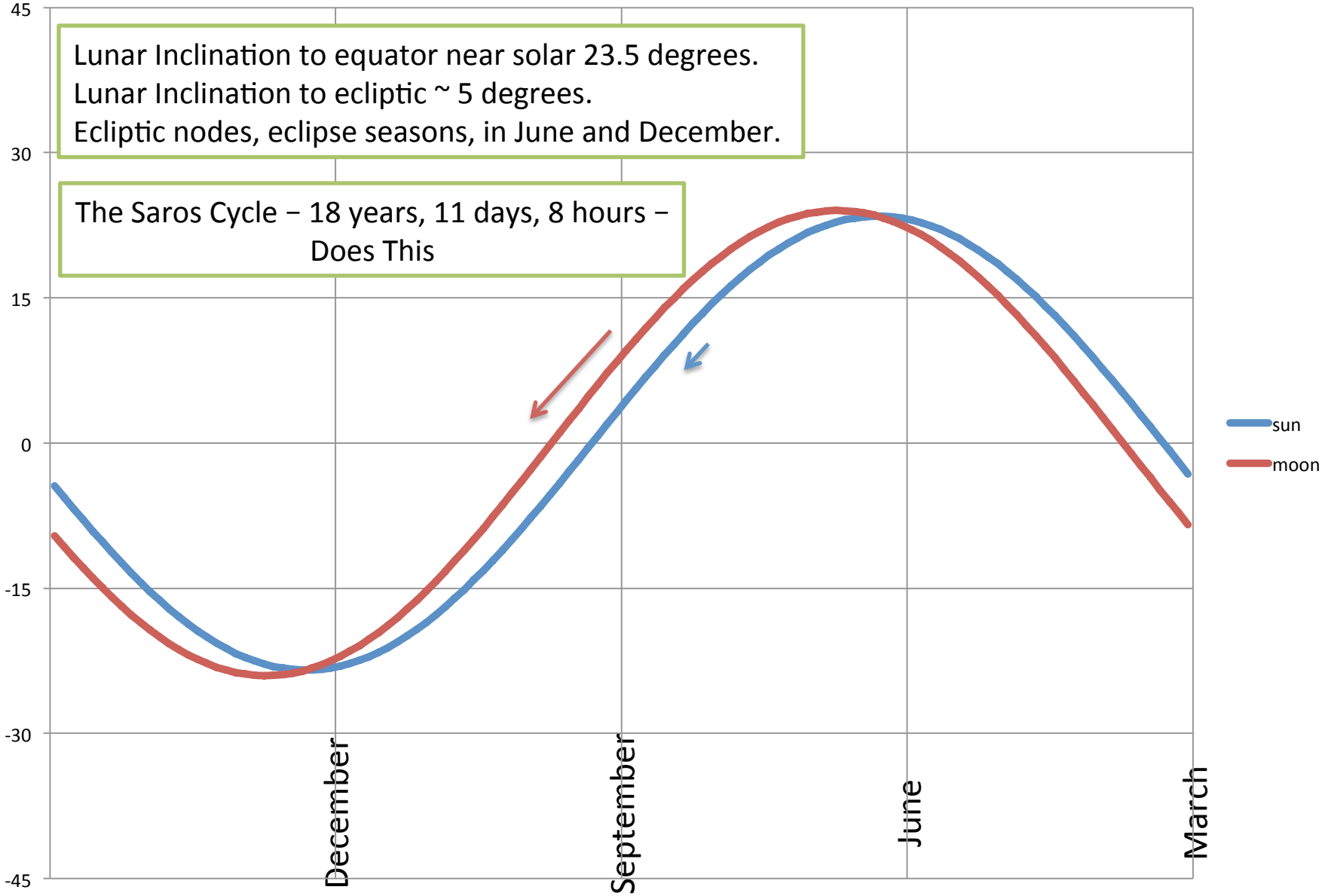


Lunar Inclination to equator near minimum 19 degrees.
Lunar Inclination to ecliptic ~ 5 degrees.
Ecliptic nodes, eclipse seasons, in February and August.

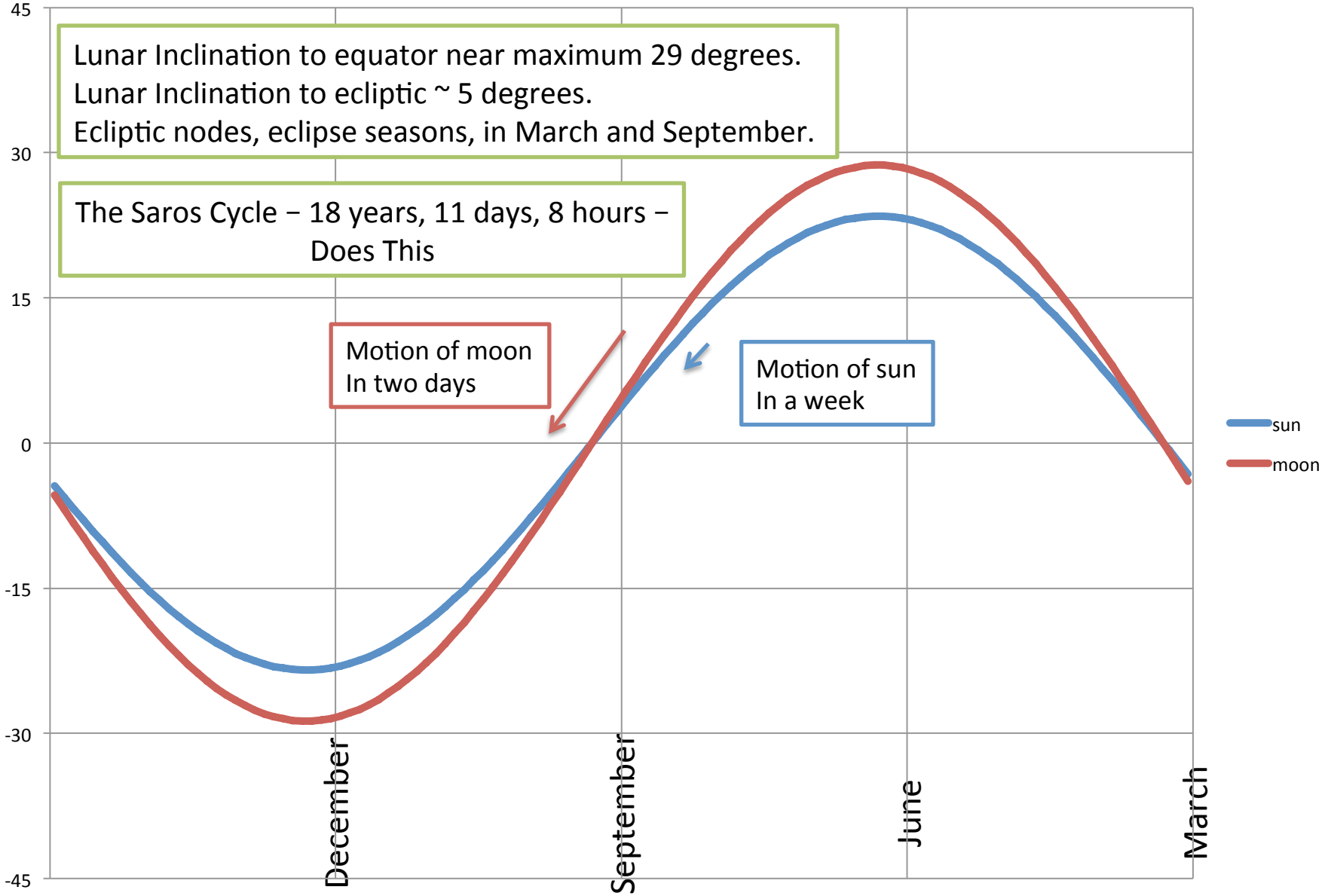
The Saros Cycle – 18 years, 11 days, 8 hours – Does This

August 21, 2017 Total Eclipse
Viewed from Wyoming, DN53aq

Sun and Moon Declinations 2020



Sun and Moon Declinations 2024



Working the 23 cm EME Band

In 2016-2017

First Contact

- Katz' Rule
  - "TRANSMIT!" - K2UYH
  - On one's first contact, don't just calculate and tune around looking, transmit so *they can find you!*
    - (Observation after my first QSO indicates that lots of newcomers do this)
    - Through patience, I was unwittingly W1PV's first 23 cm EME QSO − he had experience but not on 1296

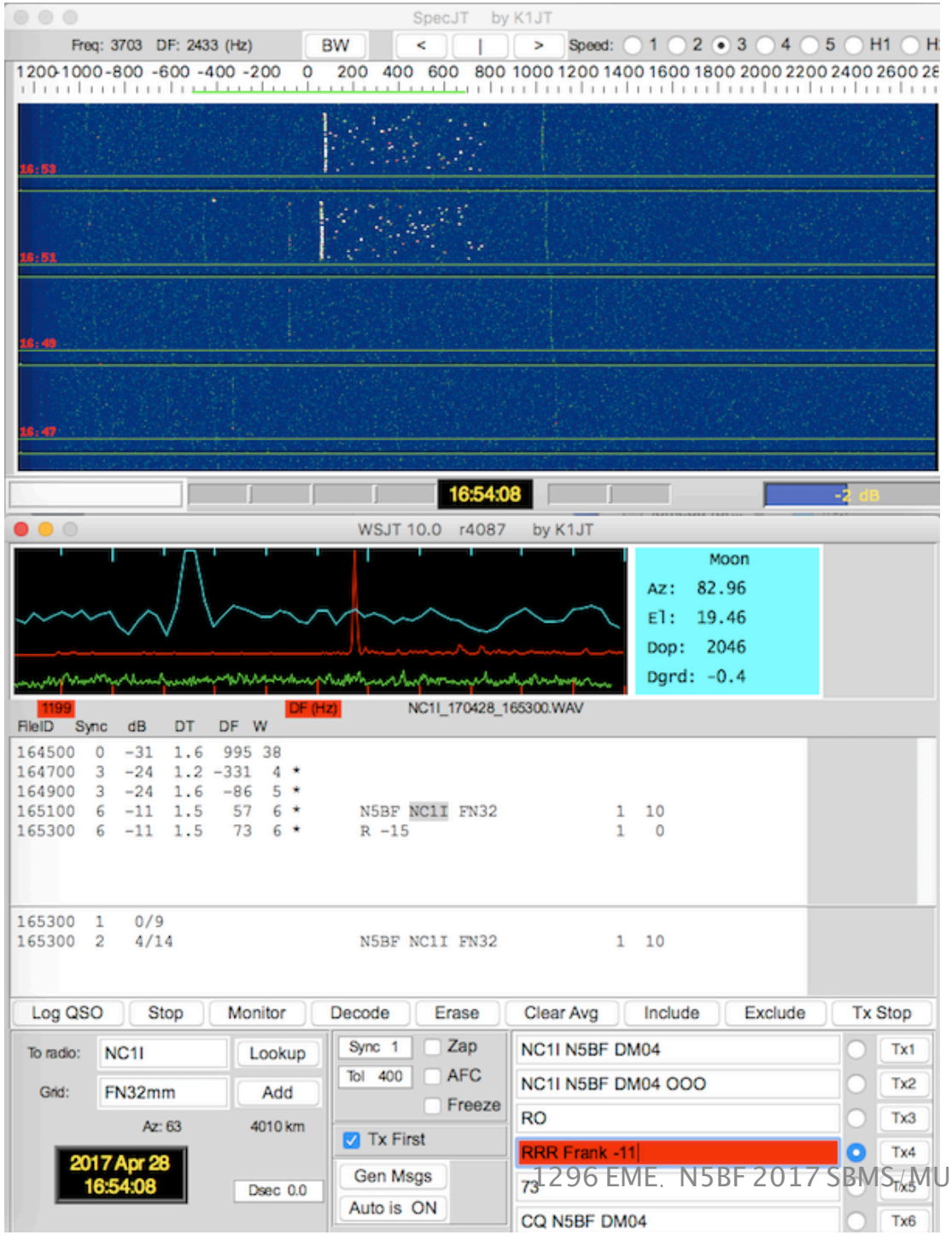
First Contacts

- K2UYH (#1) Al (plus CW)*
- HB9Q (#2) Dan
- DK3WG (#3) Jurg
- G4CCH (#4) Howard
- KNOWS (#5) (schedule proposed by Carl)
- VA6EME (#6) Randy
- I1NDP (#7) Nando
- IZ5TEP (#8) Fil
- K5DOG (#9) Esteban (was Stevedog)
- Then 1st ARRL weekend 2016

*All JT65C except as noted

JT QSOs

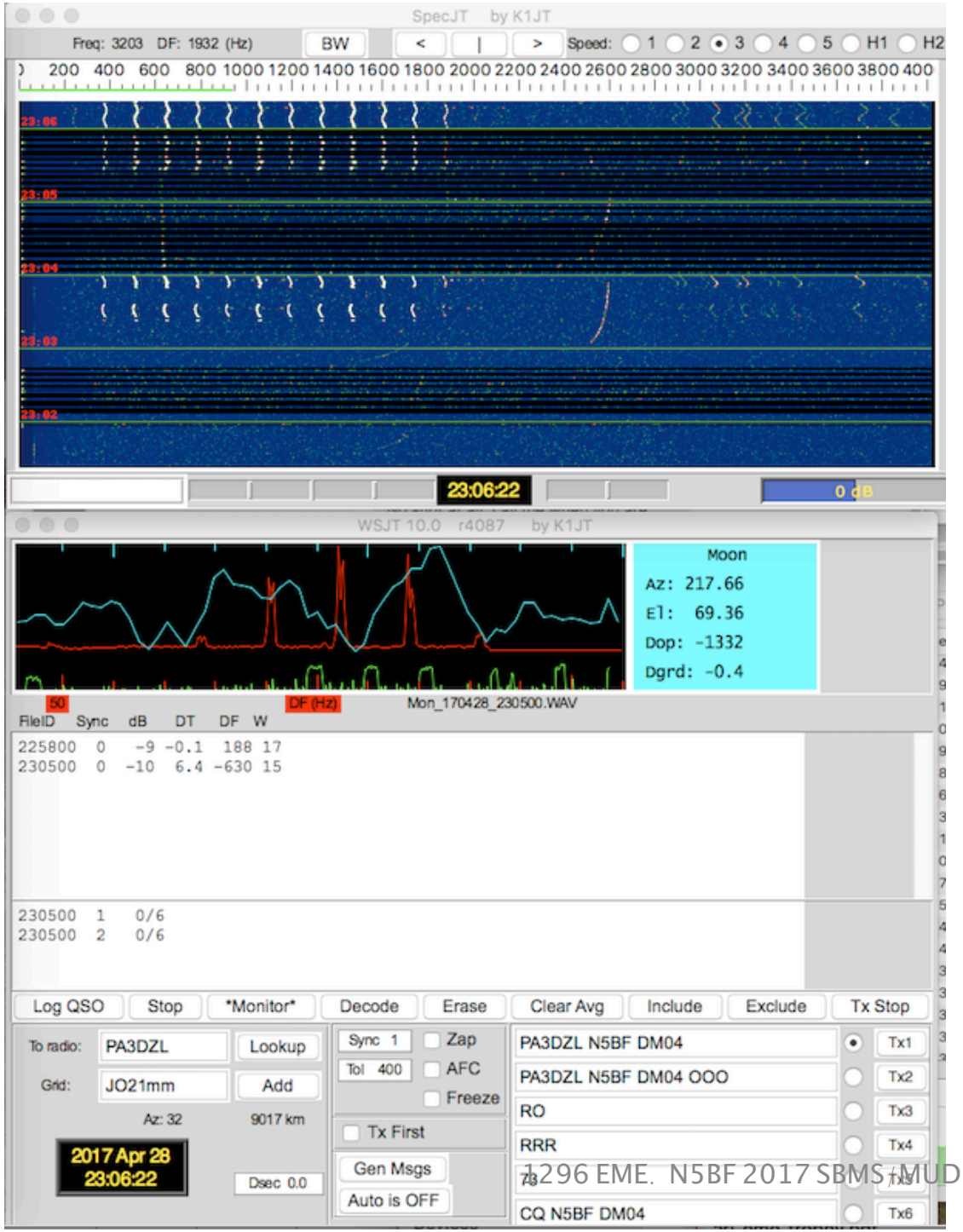
- Follow the template, click the buttons:
  - CQ N5BF DM04
  - N5BF K6JEY DM03
  - K6JEY N5BF DM04 OOO
  - RO
  - RRR
  - 73
  - 73
- One minute each, 6 minutes total
- $SNR_{2500\ Hz}$ is standard, always reported, < 0 dB



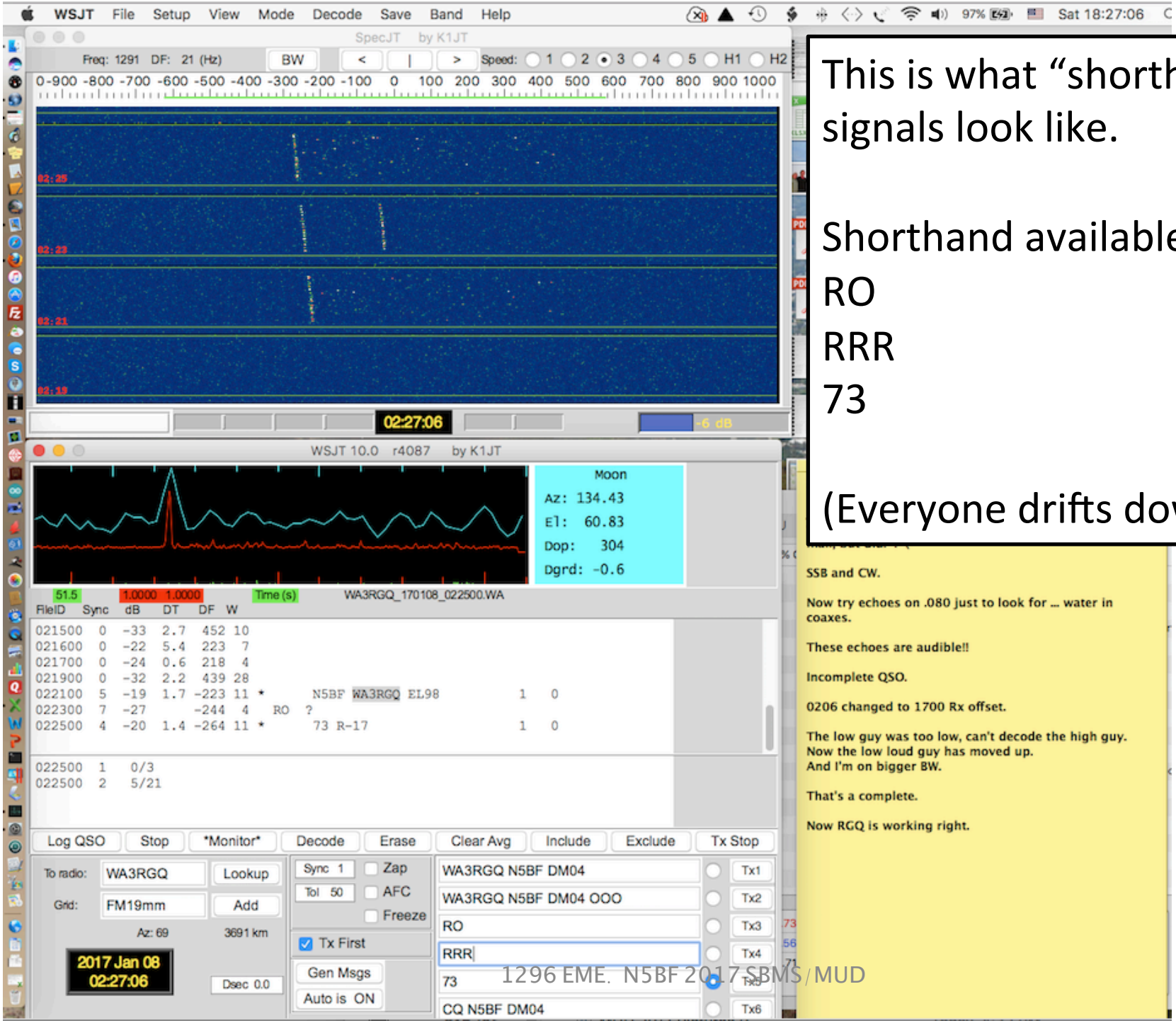
This is what a typical loud (-11) station (NC1I) looks like.

This is CW quality and audible.

Base tone (0) is 1270.5 Hz audio.



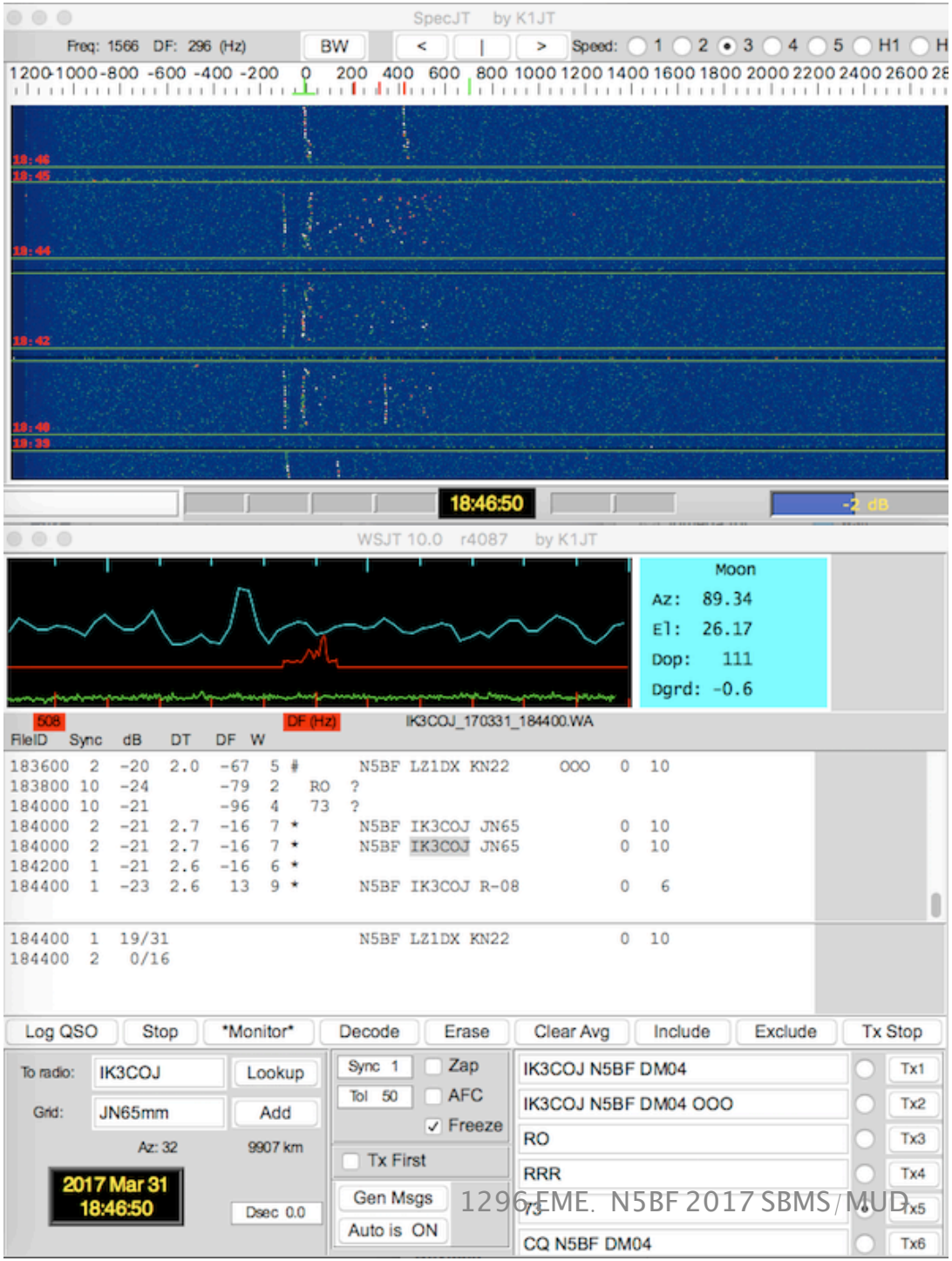
This is what a nearby repeater looks like.



This is what “shorthand” signals look like.

Shorthand available for:
RO
RRR
73

(Everyone drifts down.)



An example of JT picking out one signal in the presence of overlapping QRM

EW1AA

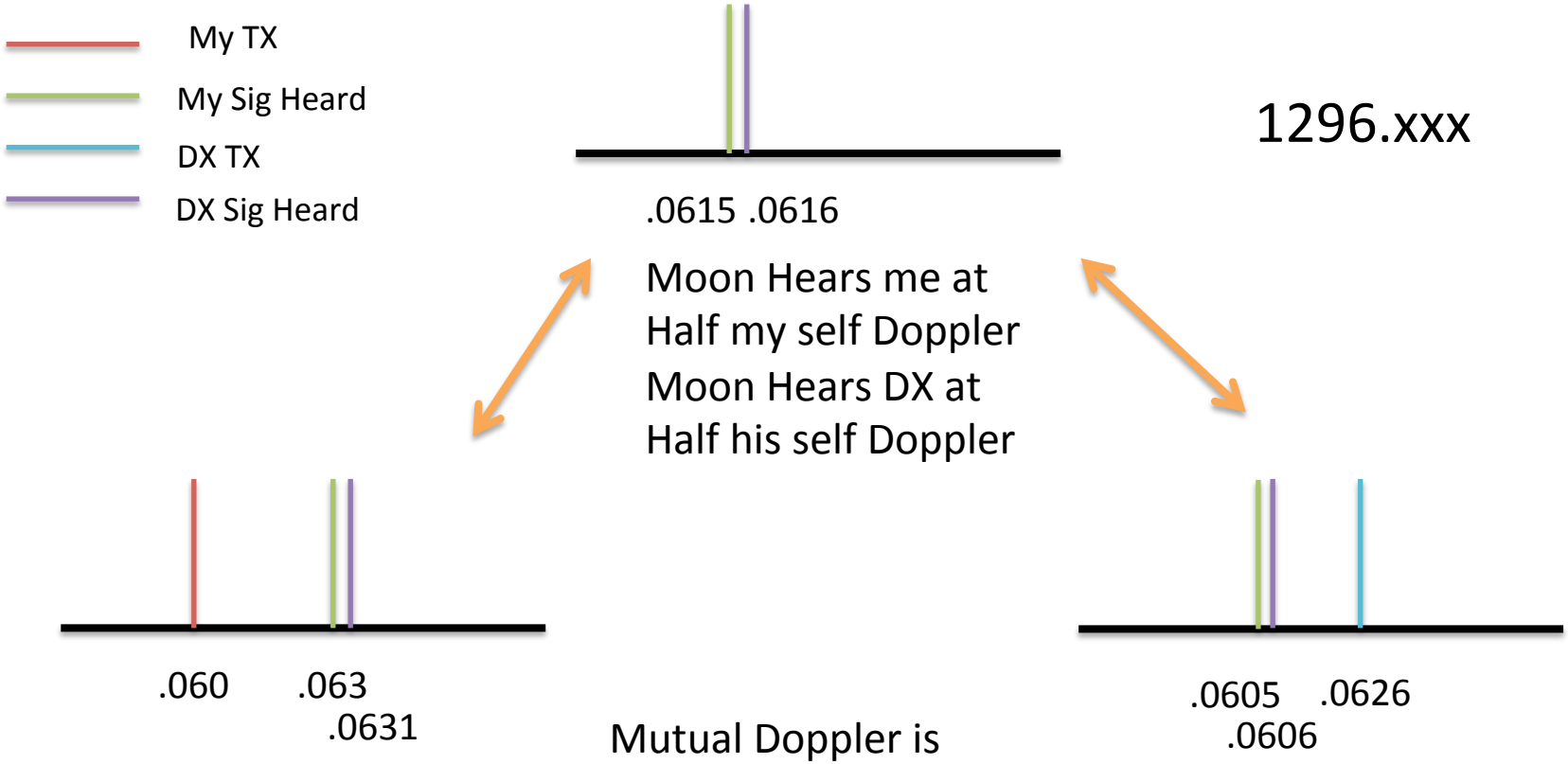
EW1AA's new 1.2 m dish with 1296 septum feed

This is the smallest station I've worked on JT65C. 100 W.

The 23 cm Problems

- Doppler
- Trees
  - Absorb TX, 4-5 dB typical based on reception reports
    - With other variables so this is not well determined
  - Noise and Absorb RX, 8 dB measured on K2UYH CW CQ, DUBUS
    - Worked in the clear at 0205, 251/051, -12
    - Struggled to pick out CQ in the trees later at 0400, 265/040, -20
    - Suspect 4-5 dB absorption and the rest increased noise floor
    - Thin pines
  - Oaks are seen to be infinite absorbers
- Libration can be > 30 Hz
  - Eats up elements and characters at 20 WPM
  - Causes missed, mangled, or misread tones on JT
- Doppler – *echoes can fall outside of SSB passband*

Doppler Convention, self echo

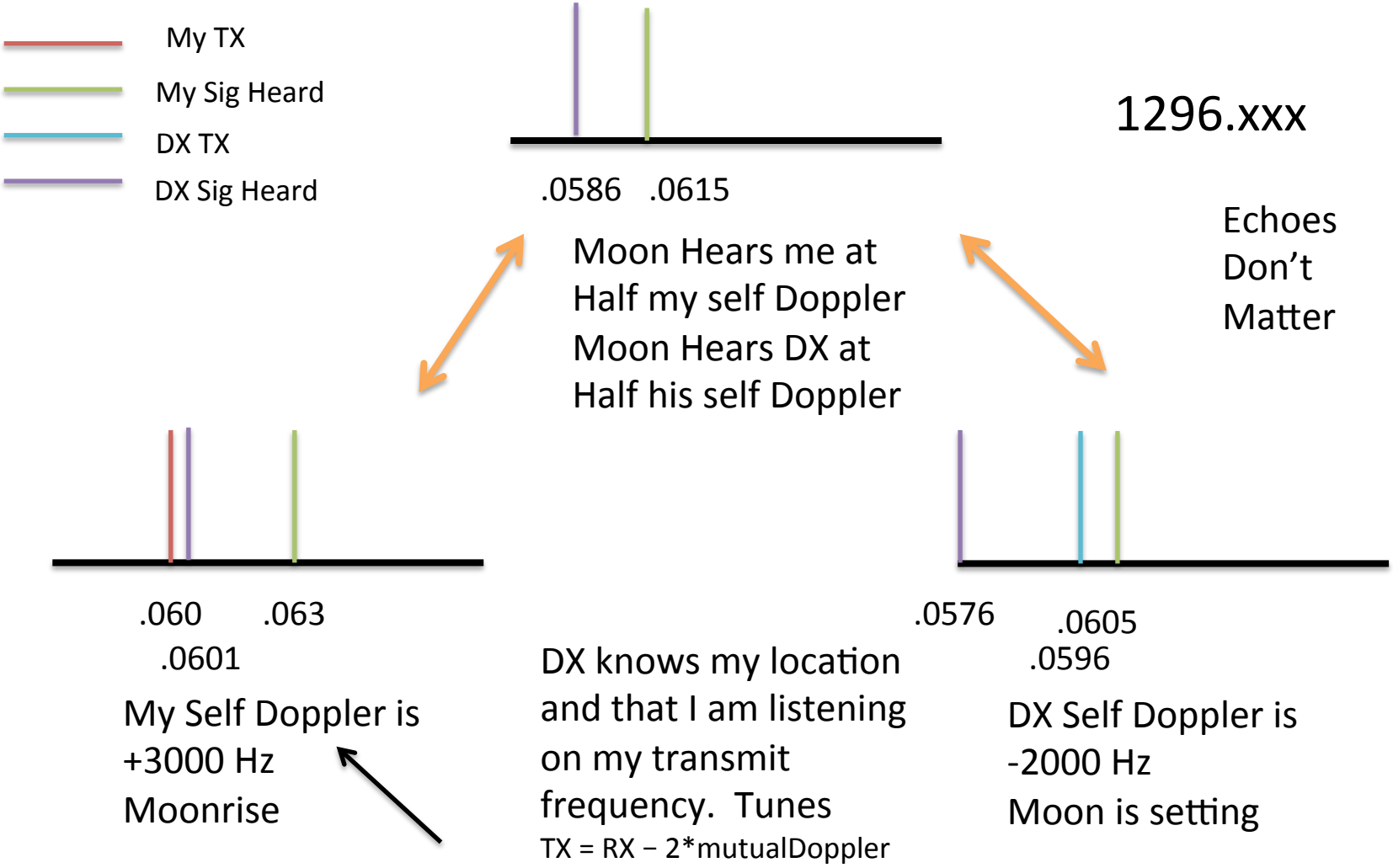


My Self Doppler is
+3000 Hz
Moonrise

Mutual Doppler is
+500 Hz.
No one needs to know
other's location or
mutual Doppler for
this to work.

DX Self Doppler is
-2000 Hz
Moon is setting

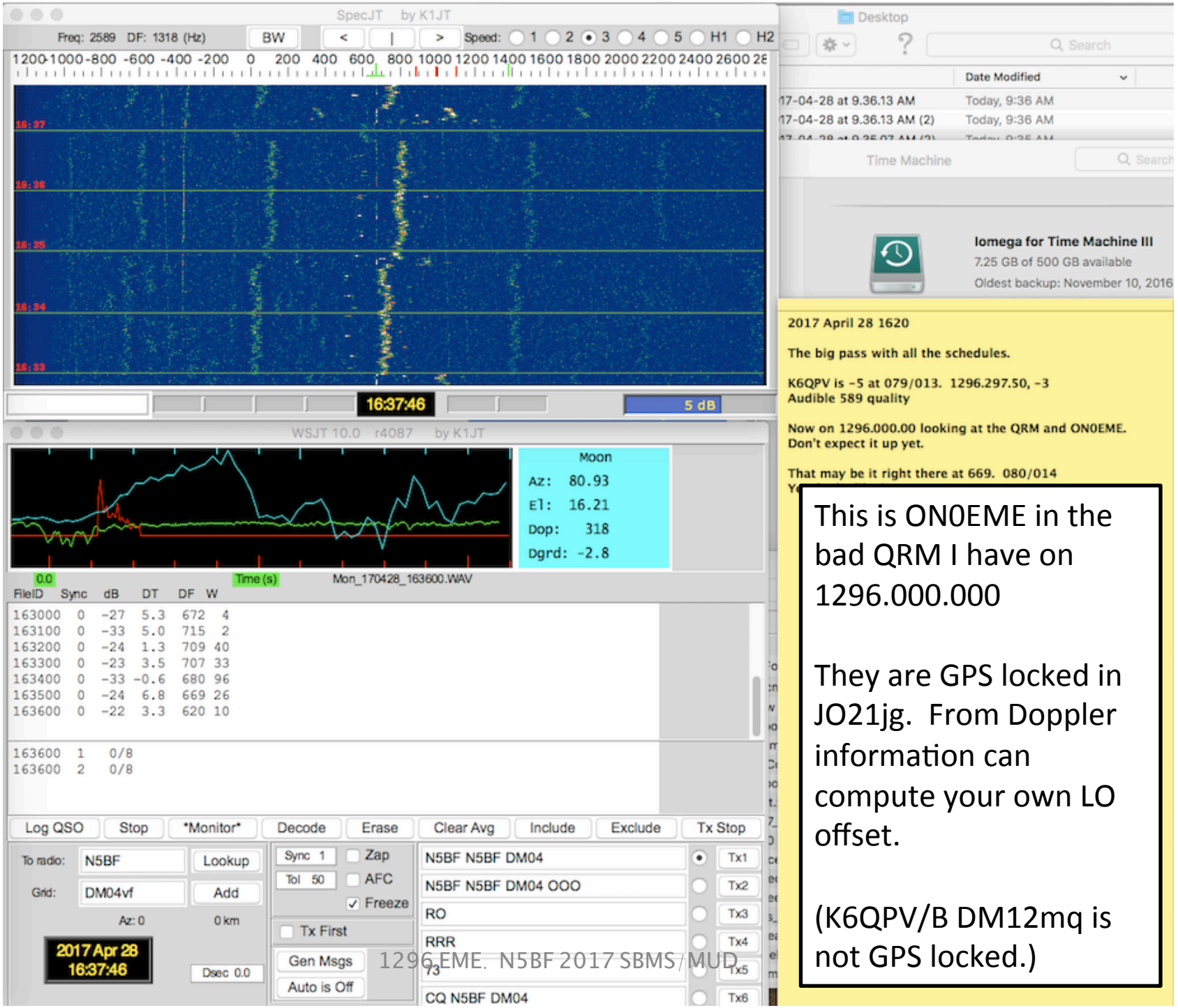
Doppler Convention, simplex

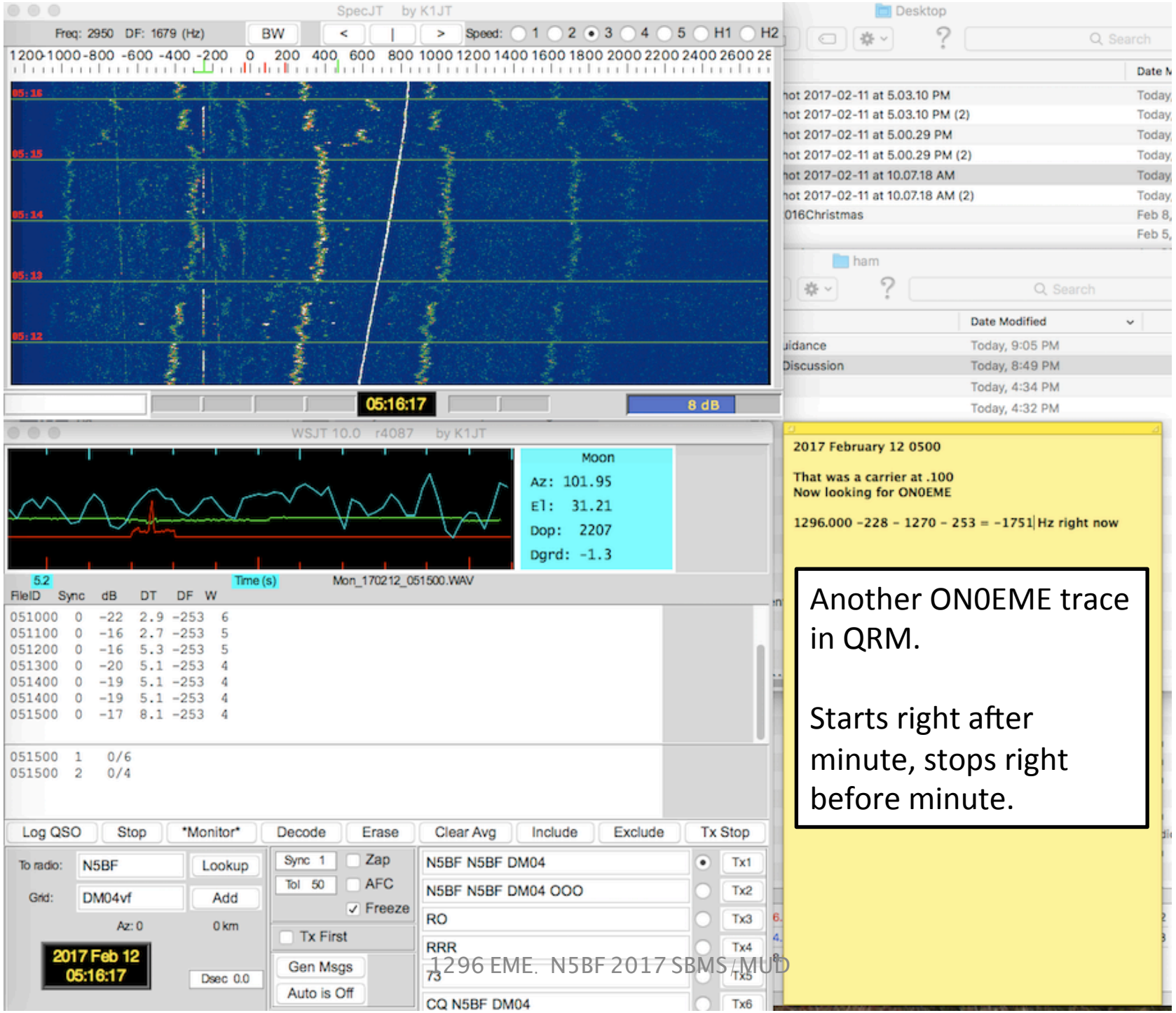


(plus 100 Hz so you can see it on my dial)

Looking East Calls 2nd Period

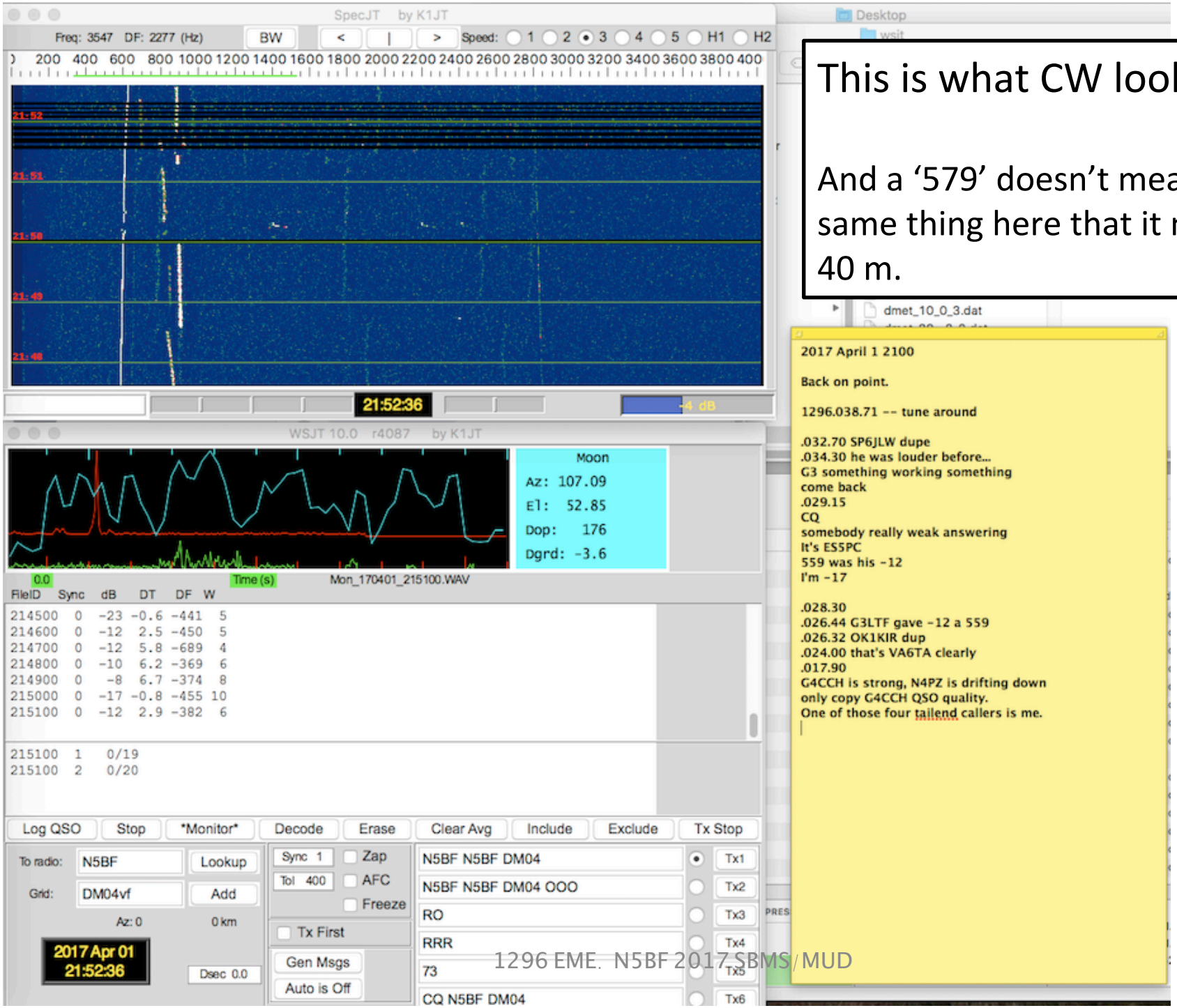
- I didn't know this until after I'd written and turned in this paper!
  - 1st period even minutes
  - 2nd period odd minutes
  - CW conventions are different: 2 minute, 2.5 minute, and are not much employed today
- How do you know your frequency if you don't have reference?
  - (See Millar's Rule" just get on the air then work on stuff like this)
  - Meanwhile, use beacons


SpecJT by K1JT
Freq: 2589 DF: 1318 (Hz)
BW
Speed: 1 2 3 4 5 H1 H2
16:37:46
5 dB
WSJT 10.0 r4087 by K1JT
Moon
Az: 80.93
El: 16.21
Dop: 318
Dgrd: -2.8
Time (s)
Mon_170428_163600.WAV
FileID Sync dB DT DF W
163000 0 -27 5.3 672 4
163100 0 -33 5.0 715 2
163200 0 -24 1.3 709 40
163300 0 -23 3.5 707 33
163400 0 -33 -0.6 680 96
163500 0 -24 6.8 669 26
163600 0 -22 3.3 620 10
163600 1 0/8
163600 2 0/8
Log QSO
Stop
Monitor
Decode
Erase
Clear Avg
Include
Exclude
Tx Stop
To radio: N5BF
Lookup
Grid: DM04vf
Add
Az: 0
0 km
2017 Apr 28
16:37:46
Dsec 0.0
Sync 1
Zap
Tol 50
AFC
Freeze
Tx First
Gen Msgs
Auto is Off
N5BF N5BF DM04
N5BF N5BF DM04 OOO
RO
RRR
73
CQ N5BF DM04
Tx1
Tx2
Tx3
Tx4
Tx5
Tx6
Desktop
Search
Date Modified
17-04-28 at 9.36.13 AM
Today, 9:36 AM
17-04-28 at 9.36.13 AM (2)
Today, 9:36 AM
Time Machine
Iomega for Time Machine III
7.25 GB of 500 GB available
Oldest backup: November 10, 2016
2017 April 28 1620
The big pass with all the schedules.
K6QPV is -5 at 079/013. 1296.297.50, -3
Audible 589 quality
Now on 1296.000.00 looking at the QRM and ON0EME.
Don't expect it up yet.
That may be it right there at 669. 080/014
This is ON0EME in the bad QRM I have on 1296.000.000
They are GPS locked in JO21jg. From Doppler information can compute your own LO offset.
(K6QPV/B DM12mq is not GPS locked.)
1296 EME. N5BF 2017 SBMS/MUD


SpecJT by K1JT
Freq: 2950 DF: 1679 (Hz)
BW
Speed: 1 2 3 4 5 H1 H2
05:16
05:15
05:14
05:13
05:12
05:16:17
8 dB
Desktop
Search
Date Modified
Today, 9:05 PM
Today, 8:49 PM
Today, 4:34 PM
Today, 4:32 PM
ham
WSJT 10.0 r4087 by K1JT
Moon
Az: 101.95
El: 31.21
Dop: 2207
Dgrd: -1.3
Time (s)
Mon_170212_051500.WAV
FileID Sync dB DT DF W
051000 0 -22 2.9 -253 6
051100 0 -16 2.7 -253 5
051200 0 -16 5.3 -253 5
051300 0 -20 5.1 -253 4
051400 0 -19 5.1 -253 4
051400 0 -19 5.1 -253 4
051500 0 -17 8.1 -253 4
051500 1 0/6
051500 2 0/4
Log QSO
Stop
Monitor
Decode
Erase
Clear Avg
Include
Exclude
Tx Stop
To radio: N5BF
Lookup
Grid: DM04vf
Add
Az: 0
0 km
2017 Feb 12
05:16:17
Dsec 0.0
Sync 1
Zap
Tol 50
AFC
Freeze
Tx First
Gen Msgs
Auto is Off
N5BF N5BF DM04
N5BF N5BF DM04 OOO
RO
RRR
73
CQ N5BF DM04
Tx1
Tx2
Tx3
Tx4
Tx5
Tx6
2017 February 12 0500
That was a carrier at .100
Now looking for ON0EME
1296.000 -228 - 1270 - 253 = -1751 Hz right now
Another ON0EME trace in QRM.
Starts right after minute, stops right before minute.

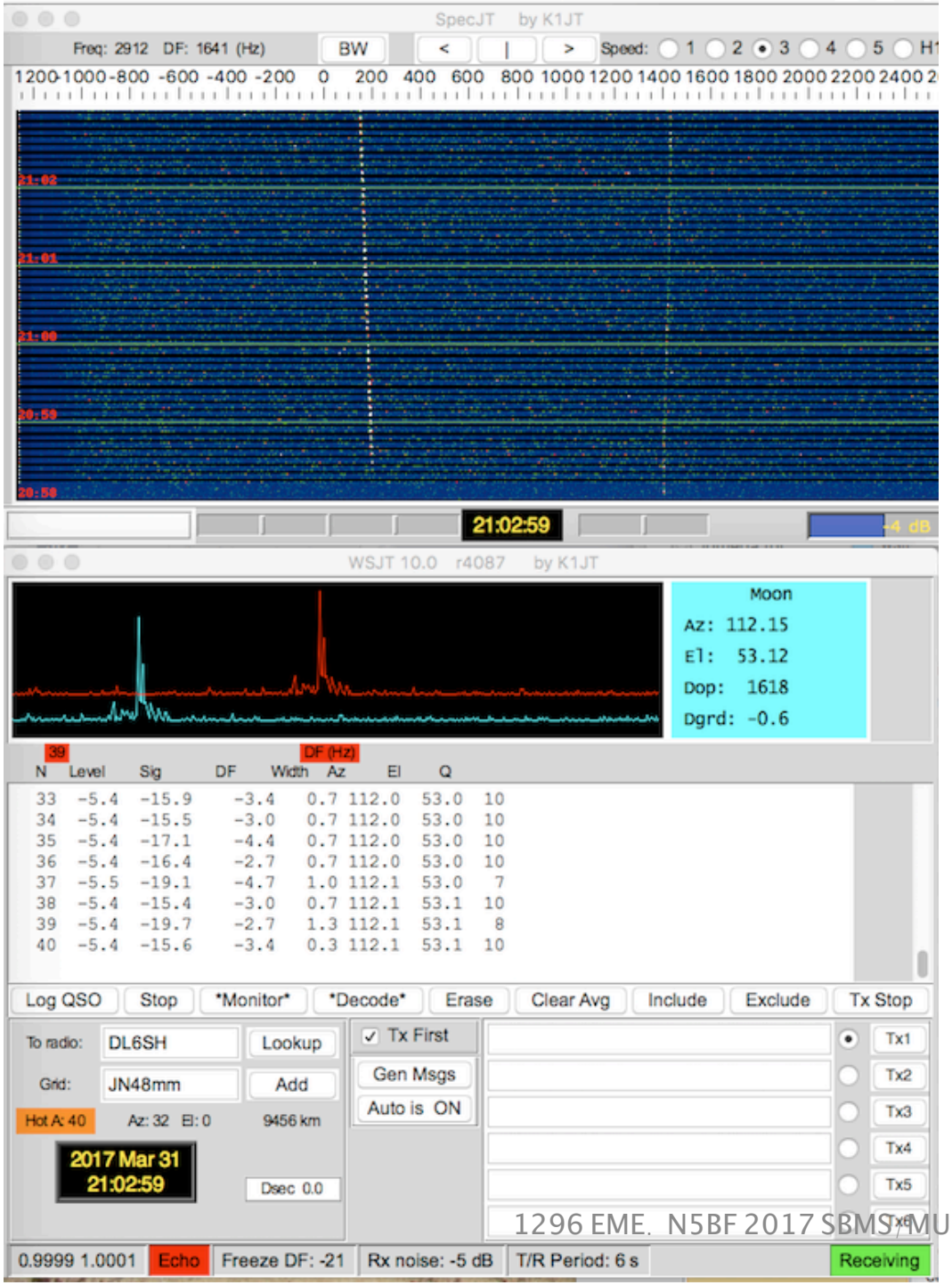
ON0EME

Autonomous CW transmitter on 1.296000000 GHz
Whenever moon is > 10^{o} in JO21jg (Belgium)
3.7 m. 400 W.



This is what CW looks like.

And a '579' doesn't mean the same thing here that it means on 40 m.



Echoes

(digital, but CW looks about the same if you have a steady fist)

CW QSOs (and SSB)

$SNR_{2500\ Hz}$	RST	Remark
-20	-	Typically not workable
-18	539	Half hour of repeating everything
-16	559	Nominal with similar station
-14	569	Easy QSO
-12	579	First try, even in trees (SM4IVE: 10 m. 100 W.)
-04	53	SSB (PI9CAM 25 m. 150 W.)

Libration:

Eats up elements and characters at 20 WPM

Mitigation is lots and lots of QSM

You hear pieces, write them down, piece them together

Coordination Warning:

Easy JT stations may be below the CW threshold (~10 dB difference)

JT works down to -28 or even -30 with Deep Search and/or averaging enabled

SSB QSOs

- Same as CW
- A “small” station like mine does not resolve the moon so it gets all the libration from all of the moon
- Female voice helps (like everywhere)
  - PI9CAM operator was Joanna DJ5YL

A QSO Is

- From long long tradition
  - Both callsigns heard on both sides
  - Something else heard on each side
  - Rogers heard by both sides
  - 73 optional

Assistance / Coordination

- CALL3.TXT − tells algorithm what to try first
  - It's like knowing the answer, which we often do
  - But not always…
- The HB9Q logger http://www.hb9q.ch/hb9q/
- The reflector
  - http://www.nlsa.com/nets/moon-net-help.html
- The "432 and Above EME Newsletter" K2UYH
- E-mail schedule, info from https://qrz.com/
  - But what works better is just to find people when they are actually on the air
- 14.345 Sunday 1500Z seems to be QRT
- Assistance and coordination is controversial and ubiquitous
  - *For GOTA, use all the assistance you need*
  - For contest or award credit, check the rules
  - ARRL allows and encourages coordination now − DUBUS prohibits (even pre-coordinated contacts are penalized)

Assistance / Coordination

- The very first amateur radio EME QSO:
  - W1BU W6HB
  - Three hours in the middle of the night 7/17/60
  - Telephone (long distance) the whole time
  - T/R involved "box wrenches"– and landline coordination
  - Other mitigations
    - Yelling at people to
      - Stop stomping around and upsetting the LO
      - Stop making noise so he could hear in headphones
      - Etc.
- *For GOTA, use all the assistance you need*
- The "Credit QSO" was 7/21/60 @ 0600 PDT (presumably unassisted)
  - Report was 8 dB in 100 Hz, pointing in fog (would be -6 in JT today)
  - 2 dB system temperature, 170K
- "Project Moon Bounce *As Seen from Rhododendron Swamp*" by F. S. Harris, W1FZJ at http://www.ok2kkw.com/eme1960/eme1960eng.htm

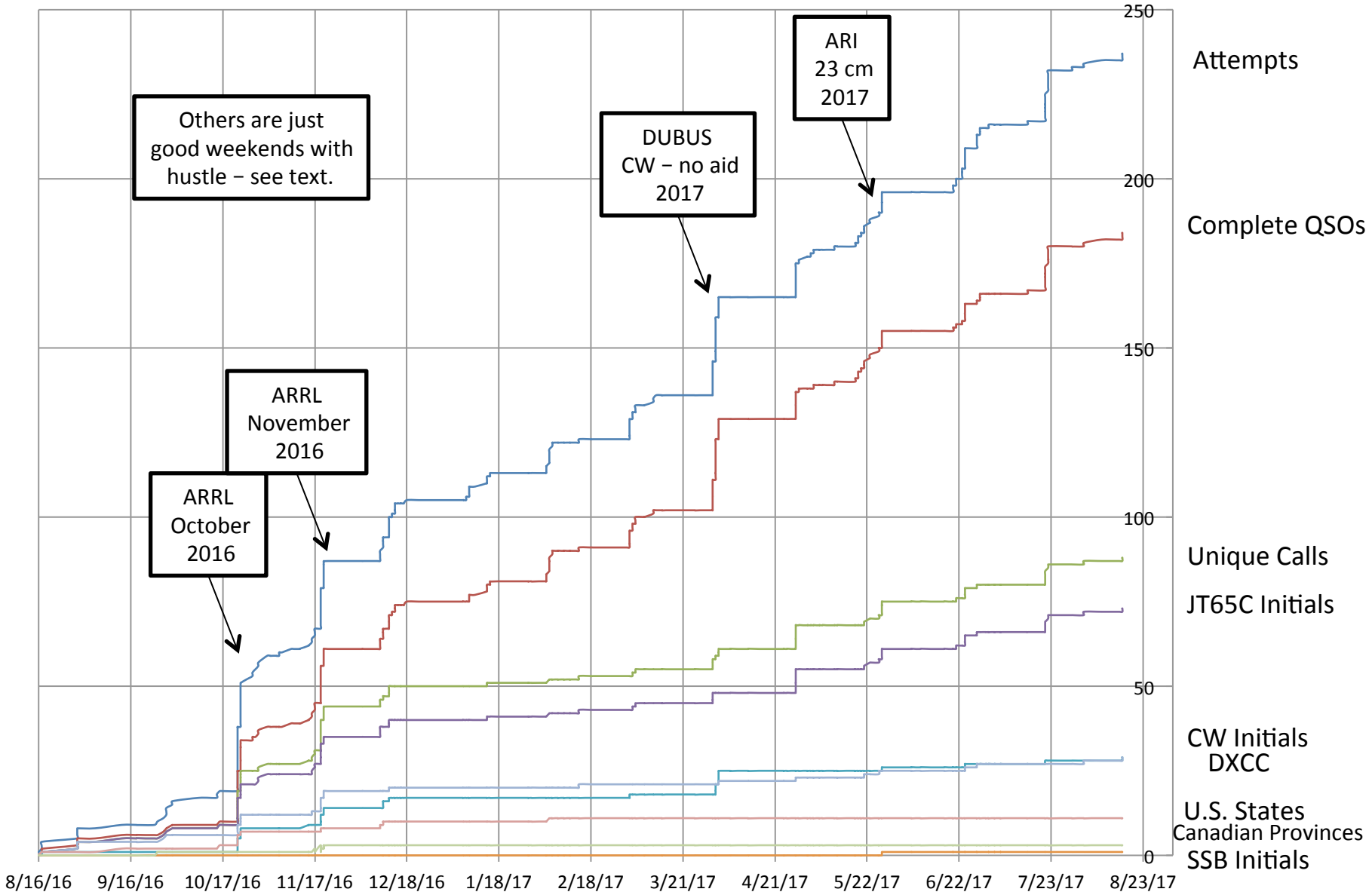
Interesting "Excuses"

- Receive Only
- No Elevation
- Pointing in your direction not calibrated well enough
- Can't see as far west as DM due to building to the west (EU)
- Rare DX vacationing at Disneyland this month
- I'm at the "Weinheim Convention" this weekend
- Don't have (whatever) set up yet (digital, CW, etc.)
- I'm on 6 cm this weekend
- Elevation rotator just blew a fuse
  - Did work some months later
- Whenever I turn my 23 cm dish controller all the lights flash
- My dish is on the west side of the tower (Australia), I can only work Europe
- Work (!)

But…

- Ops like PA3DZL will accommodate
  - Had agreed to schedule via e-mail
  - Was at a restaurant with family
  - Was in touch by e-mail and logger
  - Let me know he was on the way
  - Arrived home with 3 degrees of moon left
  - Made the QSO!
- There are many stories like this

N5BF 23 cm EME QSO attempts, completes, initials, etc.



N5BF 23 cm EME Statistics
August 16, 2016 - August 16,2017

QSOs Attempted	**237**	
QSOs Completed	184	78% completions
Unique Initial Callsigns	88	(some callsigns on both JT65C and CW)
JT65C Initials	73	83% (KN0WS completed in JT65C2)
CW Initials	29	33%
SSB Initials	1	PI9CAM / DJ5YL op.: 25 m. 100 W.
DXCC Entities	29	14 confirmed
U.S. States	11	4 confirmed
Canadian Provinces	3	2 confirmed
Most Completions	12	VA6EME DO44, Randy (nice auto-Doppler)
Calls to east, Eu, Asia, Afr	58	65%
Calls in Americas	25	28% includes VE4MA in both MB and AZ
Calls to the west, Au, Ja, As	6	7% includes UA9YLU MO92

Three Contests

2016 ARRL, Oct/Nov

Operating Time	44:50	Two weekends, October and November '16
Attempts	52	Online coordination is encouraged
QSOs	36	12 CW, 24 JT65C. Dups logged, not counted
Multipliers	26	States, provinces, other DXCC countries
Score	93,600	
Rate	0.80	Yes, 1.25 hr. / QSO
New Initials Overall	29	

2017 DUBUS, Apr

Operating Time	11:01	48 hour weekend
Attempts	19	Not counting "didn't get enough to call"
QSOs	18	CW only, no coordination during event
Multipliers	15	Unique prefixes, e.g. G3, G4, K5, W5…
Score	27,000	
Rate	1.6	37 minutes / QSO
New Initials Overall	3	

2017 ARI Spring, May

Operating Time	3:30	48 hour weekend
Attempts	6	
QSOs	5	3 JT65C (3), 1 CW (20), 1 SSB! (20)
Multipliers	4	2x Italian Stations Worked
Score	196	Category A, 3 m. parabola, x1 mult. @ 1296
Rate	1.4	
New Initials Overall	4	Worked PI9CAM on CW and SSB!

Embarrassing goofs:

RA3AUB − Doppler wrong sign for west

K4EME − Didn't know how to accommodate Simplex

23 cm EME Log Spreadsheet (during DUBUS)

	N	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK
1		A#	Q#	IU#	IJ#	IC#	IS#	DXCC	State	Prov	Evnt	Evnt Mlt	QT	QR	Entity	Ult.	DC	SC	PC	Date Z	Time Z	Call	Mode	Tx	Rx	Grid Tx	Grid Rx	Name	Az	El	Freq	QSL	W	D		Coord.
2		239	78%	48%	83%	33%	1%	30	11	3		80%	16%	13%		12	14	4	2														7	11	45	QSLs pending
3		239	186	89	74	29	1	30	11	3	5	4	30	24																					
294																				4/3/17	0:00						27000	final score							End DUBUS EME 1.2
295																				4/2/17															
296		165	129								18	15			OE5	2				4/2/17	21:49	OE5JFL	CW	569	559			Hannes	95	41	1296.01700	pend				no
297		164	128			25					17	14			UA3	2				4/2/17	21:43	UA3PTW	CW	569	559			Dmitry	94	40	1296.01700	Done JT				no
298		163	127	61		24					16					1				4/2/17	21:33	OK1CS	CW	549	559			Emil	92	38	1296.01500	pend			1	no
299		162	126			23					15	13			NC1	6				4/2/17	21:25	NC1I	CW	549	539			Frank	91	36	1296.01500	Done				no
300		161	125								14					3				4/2/17	20:36	OK1DFC	CW	549	559			Zdenek	85	27	1296.01200	pend				no
301		160	124	60		22		22			13	12			Sweden, SM4	1				4/2/17	19:53	SM4IVE	CW	579	549			Lars	80	18	1296.02059	QRZ says send IRC				no
302																				4/2/17	19:45	ON0EME		-15					79	16						
303																				4/2/17	5:46	CQ			-19				279	20	1296.03220					
304																				4/2/17	0:20		ECHO		-16						1296.03060					
305		159	123								12	11			KL6	2				4/1/17	22:44	KL6M	CW	559	559			Mike	121	62	1296.02490	pend				no
306		158	122								11					2				4/1/17	22:36	VE6BGT	CW	559	559			Skip	118	61	1296.02490	pend				no
307		157	121								10	10			G4	7				4/1/17	22:05	G4CCH	CW	579	559			Howard	110	55	1296.02650	TX 06/07/17 in same envelope with 8/29/16 JT QSL				no
308		156	120								9	9			G3	2				4/1/17	21:38	G3LTF	CW	559	569			Peter	104	50	1296.02460	pend				no
309		155	119								8	8			ES5	3				4/1/17	21:28	ES5PC	CW	559	559			Viljo	102	48	1296.02725	pend				no
310		154	118								7	7			OK1	4				4/1/17	20:26	OK1KIR	CW	579	559			Tonda	92	36	1296.03865	pend				no
311		153	117			21					6	6			HB9	4				4/1/17	20:14	HB9Q	CW	589	559			Dan	91	33	1296.04240	Done				no
312		152	116			20					5	5			DL6	2				4/1/17	20:03	DL6SH	CW	559	559			Slawek	89	31	1296.04000	pend				no
313		151	115								4	4			OK2	3				4/1/17	19:29	OK2DL	CW	569	559			Marek	85	24	1296.02775	pend				no
314		150	114	59		19					3	3			SP6	1				4/1/17	19:18	SP6JLW	CW	569	559			Andy	84	22	1296.02610	pend			1	no
315																				4/1/17	19:00	ON0EME		-14					82	19	1296.00090					
316																				4/1/17	4:15	CQ	CW						273	25	1296.03120					
317		149																		4/1/17	2:12	unk.	CW						253	50	1296.31200					
318		148	113								2	2			K2	4				4/1/17	2:05	K2UYH	CW	569	559			Al	252	51	1296.03120	Done				no
319		147	112								1	1			VE6	3				4/1/17	1:57	VE6TA	CW	559	559			Grant	250	52	1296.03120	pend				no
320											0	0								4/1/17	0:00														DUBUS EME 1.2 WEEKE

23 cm EME "Looking For" Spreadsheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Date	Source	Call	can work?	Grid	Name	138		10	sked prec.	sked notes	station	89	227	39%		
2							unworked		attempted	0. Made			inits wkd.	hoped workable			
3	9/3/17	1:08	last check							1. Proposed							
4										2. Make							
5										3. Want							
6										4. Watch							
7										5. Blocked		Blocked means "no", "unknown", or somehow configured where it is impossible, like "no elevation"					
13							0	0									
14							0	0									
15	9/2/17	HB9Q	VE3NXK	yes	FN05gr	Bill	2	1	1	2		3 m. 100 W., first seen 12/7/16 in log, attempted 10/27/16					
16	8/27/17	HB9Q	DL1SUZ	yes	JO53un	Uwe	2	1		2		2 m. 100 W					
17	8/27/17	HB9Q	DG0FE	yes	JO62UN	Lothar	2	1		2		4.50 m. 100 W.					
18	8/27/17	HB9Q	ON5GS	yes	JO21sc	Dirk	2	1		2		6 m. 230 W.					
19	8/25/17	HB9Q	OH2DG	yes	KP30ck	Eino	2	1		2		8 m.					
20	8/24/17	HB9Q	II0IAAR/5	yes	JN53eu	Fil	2	1	1	2		3 m. 150 W, attempt 3/12/17 but unclear what was up, callsign, pointing, frequency....					
21	8/15/17	HB9Q	F1RJ	yes	JN18at	Jean	2	1		2		3 m. 200 W.					
22	8/13/17	HB9Q	WA3LBI	yes	FN20ji	Jim	2	1		2		2.4 m. 250 W.					
23	8/13/17	HB9Q	G4RGK	yes	IO91on	Dave	2	1		2		4.6 m. 200 W. In PA3DZL 2017 DUBUS report, reported me as "heard" in DUBUS 2017 in K2UY news					
24	2/13/17	DK3WG	RW0LDF	yes	PN74	Serge	2	1	1	2		attempt on 11/20/16 failed due to my cockpit error (+/- Doppler), decoded -27, 2.1 m. 200 W.					
25	8/26/17	HB9Q	VE4MO	edge	EN19kt	Kirk	1	1		2		4x45 100 W. -26 to NC1I. Looked and didn't find 8/26/17 but didn't look long because worked ZS6J(					
26	8/22/17	HB9Q	UA9FA	edge	LO87dx	Vlad	1	1		2		1.8 m. 100 W. 6/23/17 14:49:43 UA9FA 144000 1 -27 2.2 404 5 * CQ N5BF DM04 0 6 while looking					
27	7/3/17	HB9Q	ZL3RC	edge	RE66fl	Roger Corbett	1	1		2		4x60 350 W. Long attempt at his moonrise 7/2/17 0100-0200 (no elevation). No trace seen on eith					
28	8/27/17	HB9Q	G4DML	yes	JO02oj	Graham	2	1		3		2.3 m., 500 W. He was in the trees before I was out of them 6/28/17 (9 deg. Decl.) Propose or wat(					
29	8/27/17	HB9Q	OH3LWP	yes	KP21am	Arl	2	1		3		1.8 m. 350 W. at feed, worked VA6EME -22 7/16/17, 7/21/17 nearly completed, try again 7/22/17.					
30	8/20/17	HB9Q	OZ1LPR	yes	JO44uw	Peter	2	1		3		2.4 m. offset 350 W. but doesn't say 23 cm on it. Has 6 cm and 24 GHz					
31	8/20/17	HB9Q	W7MEM	yes	DN17nt	Mark	2	1		3		16' dish, > 50 W.					
32	8/20/17	HB9Q	GM4PMK	yes	IO66xj	Roger	2	1		3		3.2 m. 100W.					
33	8/20/17	log/contest	K4EME	yes	FM08	Cowles	2	1	1	3		looking for KN0WS, Nebraska 8/20/17, was mentioned but not on logger					
34	8/20/17	reflector	IK1FJI	yes	JN44ll	Valter	2	1		3		build 3.2 m. KW					
35	8/19/17	HB9Q	ON7FLY	yes	JO10lt	Ronald	2	1		3		3 m. 125 W.					
36	8/17/17	HB9Q	CT7AFN	yes	IM59pk	Carlos	2	1		3		2.7 m. 200 W., first seen 12/13/16					
37	8/16/17	HB9Q	I0NAA	yes	JN63gc	Mario	2	1		3		5 m. 150 W.					
38	8/16/17	HB9Q	W3HMS	yes	FN10mf	John	2	1		3		3 m. 500W.					
39	7/27/17	HB9Q	DK5AI	yes	JO51go	Wolf	2	1		3		1.75m. 250 W.					
40	7/27/17	HB9Q	PA0PLY	yes	JO22ih	Jan	2	1		3		3 m. 200 W. Back after seven years 7/16/17					
41	7/25/17	HB9Q	WA2FGK	yes	FN21de	Herb	2	1		3		3.65 m., 400 W., copied Herb working others 6/28/17, moved off to get F5EJZ and he disappeared fr					
42	7/25/17	HB9Q	UN6PD	yes	MN69jm	Nikolai	2	1		3		3 m. 300W. QSL RW6HS					
43	7/24/17	HB9Q	OK8WW	yes	JN79dv	Richard	2	1		3		3.5 m. 500 W. First day on EME was 7/22/17, worked 6 on CW. I couldn't copy him well enough. M					

"Looking For" doesn't work for everyone – e.g. SM4IVE in DUBUS or IK2MMB in the ARI – SS trick

Levels of Amateur Obsession

- 10. Quit job, family, etc., sit on the air and internet 24/7 (12/7 for EME) in order to jump immediately on all opportunities. Spend off time (the other 12/7) and resources to the limits to improve capabilities.
- 9. Sit on the internet 24/7, leave whatever (job, family, etc.) to rush to the station and respond to any opportunities seen there immediately. Work deals for capability improvement.
- 8. Stay online and on air at all times something else (job, family, etc.) doesn't interfere. Push special events as equal priority to job, family, etc.
- 7. Stay online and on the air when at home (or at the station) and without the priority pushing - (i.e., lower priority than job, family, etc.)
- 6. Check opportunities daily and work to coordinate with the rest of life.
- 5. Plan for maximized effect in limited, allocated time and resources at appropriate priority.
- 4. Has a station that he/she once set up in a season of obsession and turns it on once in a while when somebody makes a request.
- 3. Be a reasonable person and see what you can do in your "spare time."
- 2. Talk to somebody about it once in a while.
- 1. Daydream about it once in a while.
- 0. Not interested.

- 4/3/17

Seat of the Pants Link Budget

Value		dB	units
My EIRP	352 KW	+85.5	dBm
Fraction of Sky Occupied by Moon	5.1 ppm	-52.9	dB
My power on moon disk	1.8 W	+32.6	dBm
Percentage reflected (from various research)	7%	-11.5	dB
Isotropic sphere around moon @ earth distance	$2x10^{18}$ m^2	-182.7	dB (m^2)
Area of 3 meter dish	7.1 m^2	+8.5	dB (m^2)
Power Intercepted (neglect efficiency and losses)		-153.1	dBm
Dish efficiency of 70% applied twice		-3.0	dB
Boltzmann's Constant in 2500 Hz @ 110 Kelvin		-144.2	dBm
Expected echo SNR		-11.9	dB
VK3UM echo predict		-12.4	dB
Observed echo (best ever)		-9.9	dB
Observed echo (typical perigee)		-17.3	dB
Close enough for "seat of the pants"			

Who knew?

Workability Heuristic

$d^2_{dx} * p_{dx}$	mode	Heuristic QSO
>300	JT65C	EW1AA
>5000	CW	SM7FWZ
>50,000	SSB	PI9CAM

N5BF is 2700 on this metric, self spot is typically -16 to -20

ON0EME is 5500 on this metric, typically -14

G4FUF is 2x49 yagis * 400 W.
Approx. 1 m. dish equivalent (so, “400”)
Linear polarization, another 3 dB down

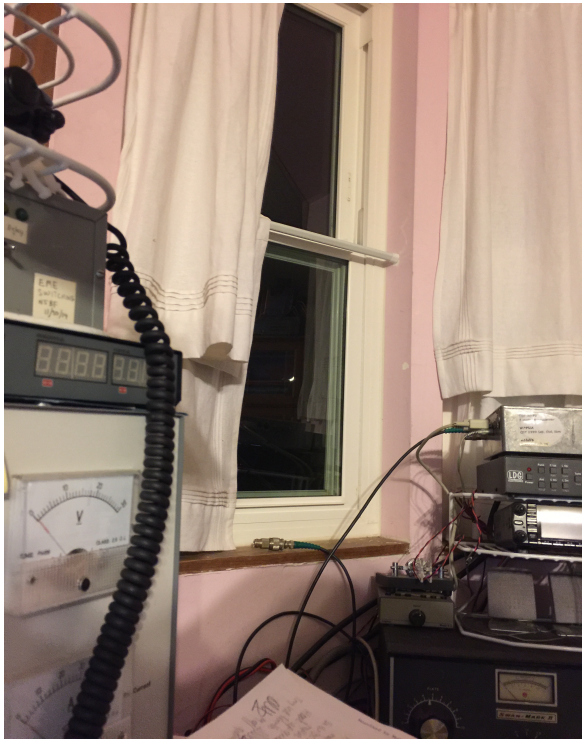
All attempts to date with 4x yagis have failed
… much less 8x yagis

Conclusion

- Everyone on 23 cm EME is a celebrity
  - Everyone wants to work everyone else
- Humanity is what it is and timekeeping is what it is because of the moon
  - EME is a great way to get back in touch
  - (Humanity may *exist* because of the moon)
    - (but that's another talk)

Working the Spring 2017 ARI

See you on the Moon!



Moonset out the window from the shack

Young moon after 8/21/17 eclipse

Backup

Further Reading

- Master's Thesis - 2015
  - Magnus Lindgren SM6XMA
  - "A 1296 MHz Earth-Moon-Earth Communications System – Theory and Practice"
    - Department of Earth and Space Sciences
    - Chalmers University of Technology
    - Gothenburg, Sweden
  - http://publications.lib.chalmers.se/records/fulltext/217884/217884.pdf
- Excellent and thorough discussion of the concepts, practicalities, and history of EME including in depth look at the theory behind link analysis and noise, construction projects, and basically getting it going

QSLs

- Treasurewood Productions
- TreasurewoodArts@gmail.com
- Katherine L. D. Wallin KG6HUI

The Barely Works Technology Four

1. 23 cm EME
2. 6 m meteor scatter
3. 3 cm contesting
4. Everything else

Todo List 9/1/17

- Integral 100 KHz SDR for improved noise measurements and operational band scanning.
- Shack PC for WJST, VK3UM, DSP-10 and other PC-only software. I have shown that this can be done on an Apple computer, but having to run Parallels (a PC emulator) to run important amateur radio software is always problematic and sometimes impossible.
- Good frequency reference. I have a Packrat GPS Receiver and SG Lab TR1300 V 2.3 (that takes the 10 MHz reference input) sitting here ready to build up. On the long to-do list … soon as I finish writing this paper.
- Cake Pan choke for existing septum feed. Sitting here – ditto … to-do list. This will be Configuration Four.
- VE4MA feed. Configuration Five. Ditto to-do.
- QRSS CW. It seems to me that operators would be able to read CW right off their waterfall displays for much less signal than could be copied by ear at regular CW speeds. Character elements would go for seconds so that the pattern in the scrolling spectrum would be clear. Transmissions would go for a minute or two, similar to digital modes. Could be automated. I've tried this a few times but think it will take working with a QSO partner over the air, and probably over the telephone, to get it going under 23 cm EME fading conditions. Anyone interested?
- DSP-10 PUA43 contacts. Some on the band have expressed interest. I need the frequency reference working and the DSP-10 hooked back up.
- Other bands? There is no current plan or equipment for other bands, but I did upgrade to the 10 GHz mesh on the RFHamDesign dish, just in case. In the present EME world, however, the possibility of "random" QSOs seems to top out at 23 cm.
- Boost the 23CM2W500 input 30 VDC, possibly gaining 1 dB of output power.
- Try the existing 2 meter and 70 cm tropo station (no elevation) to work the Big Guys on those bands. Just need to hook up a SignLink to that rig and make a schedule. ... to-do.
- Try the 10 GHz portable contest rig (1 m. 8 watt) on the big 3 cm guys. Need to add digital to that rig. … to-do.
-
- So, as always, I have an unreasonably long to-do list.

Notable Quote

- 17-10-25 00:47:14 k5dog **k5dog**
  - **Name** Steve
  - **Equipment** 3.6 meter Dish with 150 watts on 23 cm, 450 w on 70 cm
  - **Locator** EM00wh

- *"23 cm is really the bestest for EME. Plenty of activity, good challenge, and even CW activity."*