

SMALL STATION EME
(EME ON A BUDGET)

BY AL, K2UYH



INTRODUCTION

HISTORY

WHY EME?

TECH CHALLENGE

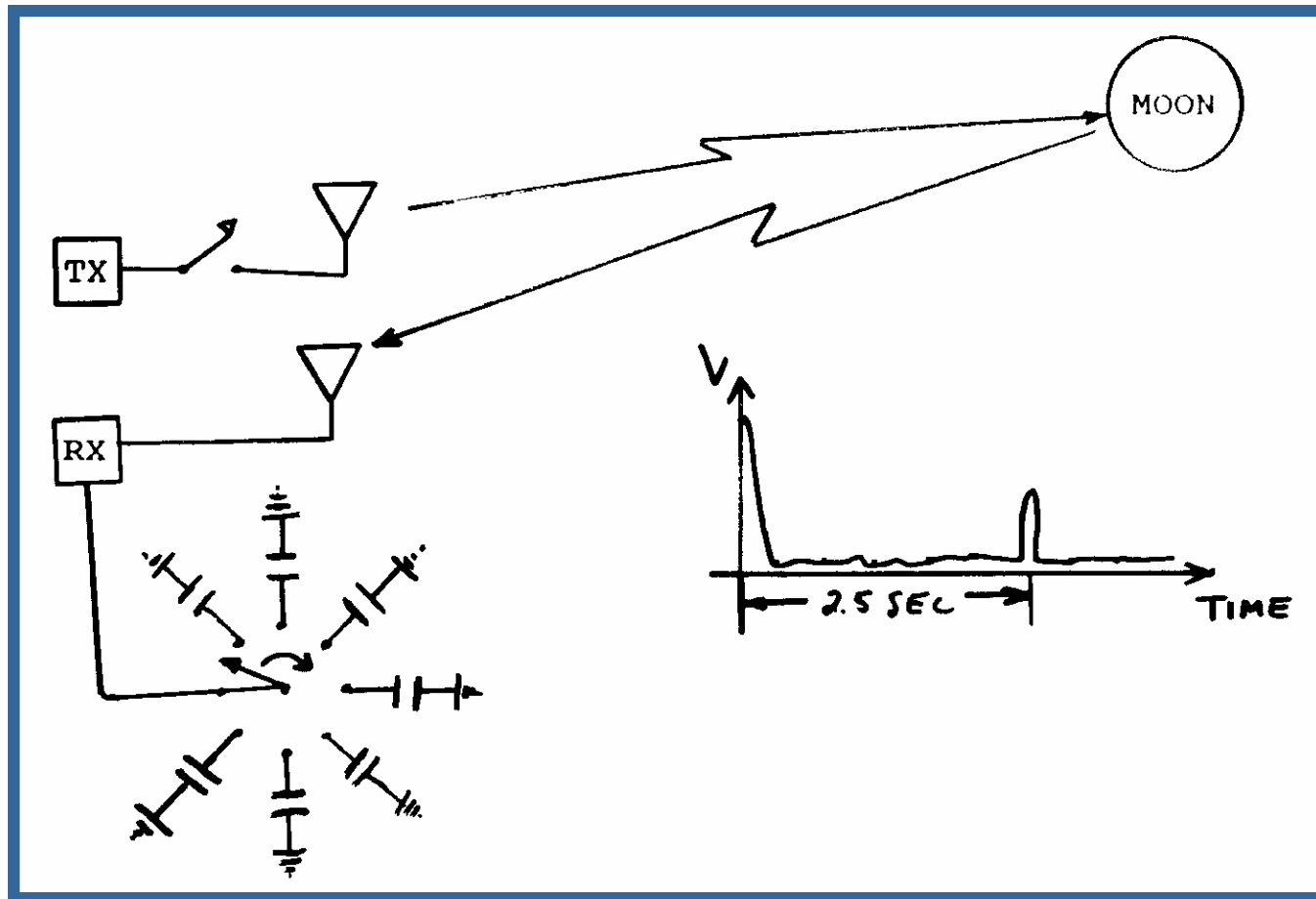
HOW DONE

WHAT YOU NEED

CONCLUSION

FIRST APPLIED IN RADAR

DIANA RADAR (115 MHz)
8 KW TO COLLINEAR ARRAY W4ERI IN CHARGE



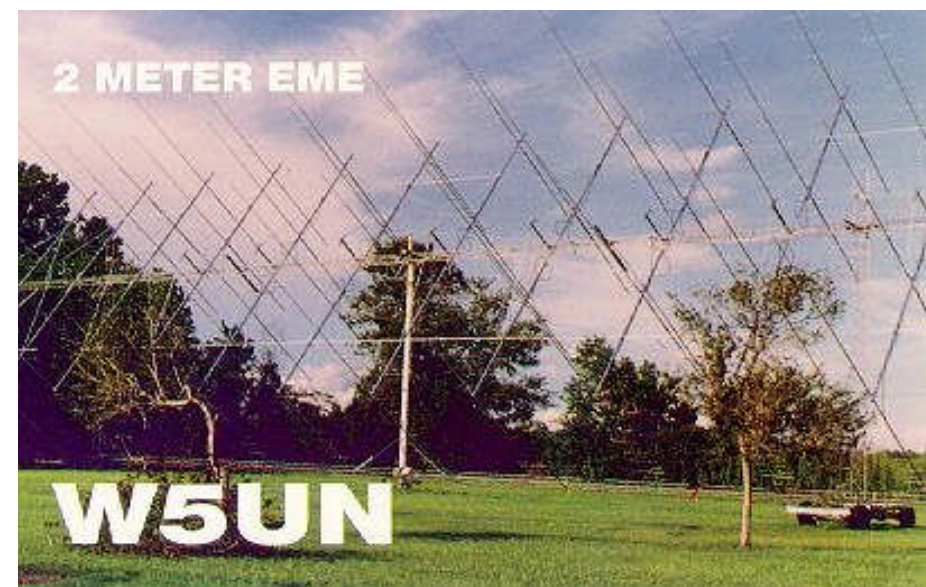
ANALYZED REPEATED TRANSMISSION OF A PULSE

AMATEURS WERE AMONG 1ST TO EXPERIMENT WITH EME COMMUNICATIONS

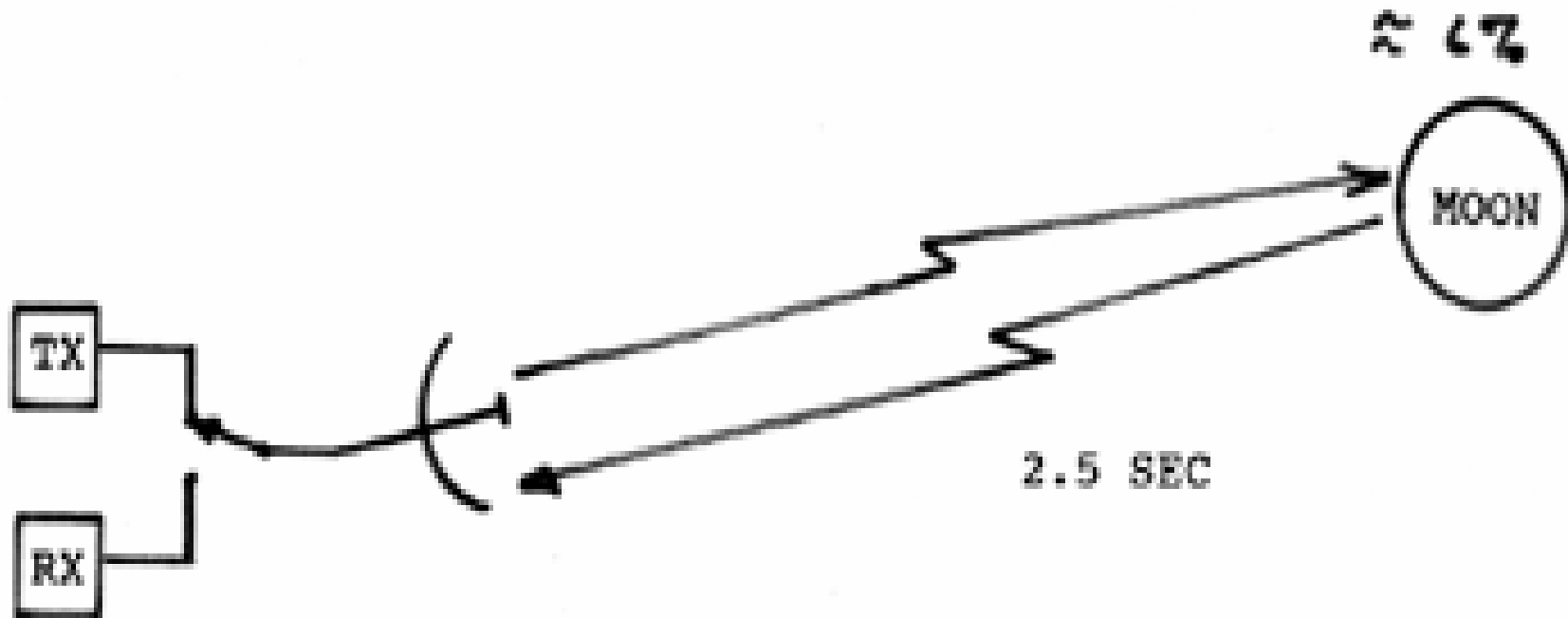
- ECHOES REPORTED ON 144 MHz IN 1953
- AMATEUR 2-WAY COMMUNICATION IN 1960
- ALL CONTINENTS WORKED IN 1976
- 10 GHz EME IN 1989
- 47 GHz EME IN 2002

WHY WORK MOONBOUNCE?

- IT IS EXCITING!
- MOST FUN IN HAM RADIO IS MAKING RARE, UNUSUAL, OR DIFFICULT CONTACTS.
- EME ALLOWS YOU TO WORK WORLDWIDE DX ON ANY BAND - 6 M UP.
- WAY TO INCREASE YOUR GRID SQUARE, STATE & DXCC COUNT.



EME CHALLENGE



$$P_L = 10 \text{ LOG } (D_M^2 W L \sigma / 16 \pi^2 R^4)$$
$$= 261 \text{ dB (AT 432 MHz)}$$

TECHNICAL CHALLENGE

ANTENNA - LARGEST SIZE DESIRED?

TRANSMITTER - HIGHEST POWER WANTED?

RECEIVER - LOWEST NF ESSENTIAL?

- YES – IF YOU WANT TO BE A ***BIG GUN!***

- SSB (VOICE) COMMON TODAY

- USING JT65 AND EVEN CW CAN GET BY WITH ***MUCH LESS.***

BIGGER IS BETTER!



HB9Q 15 M DISH



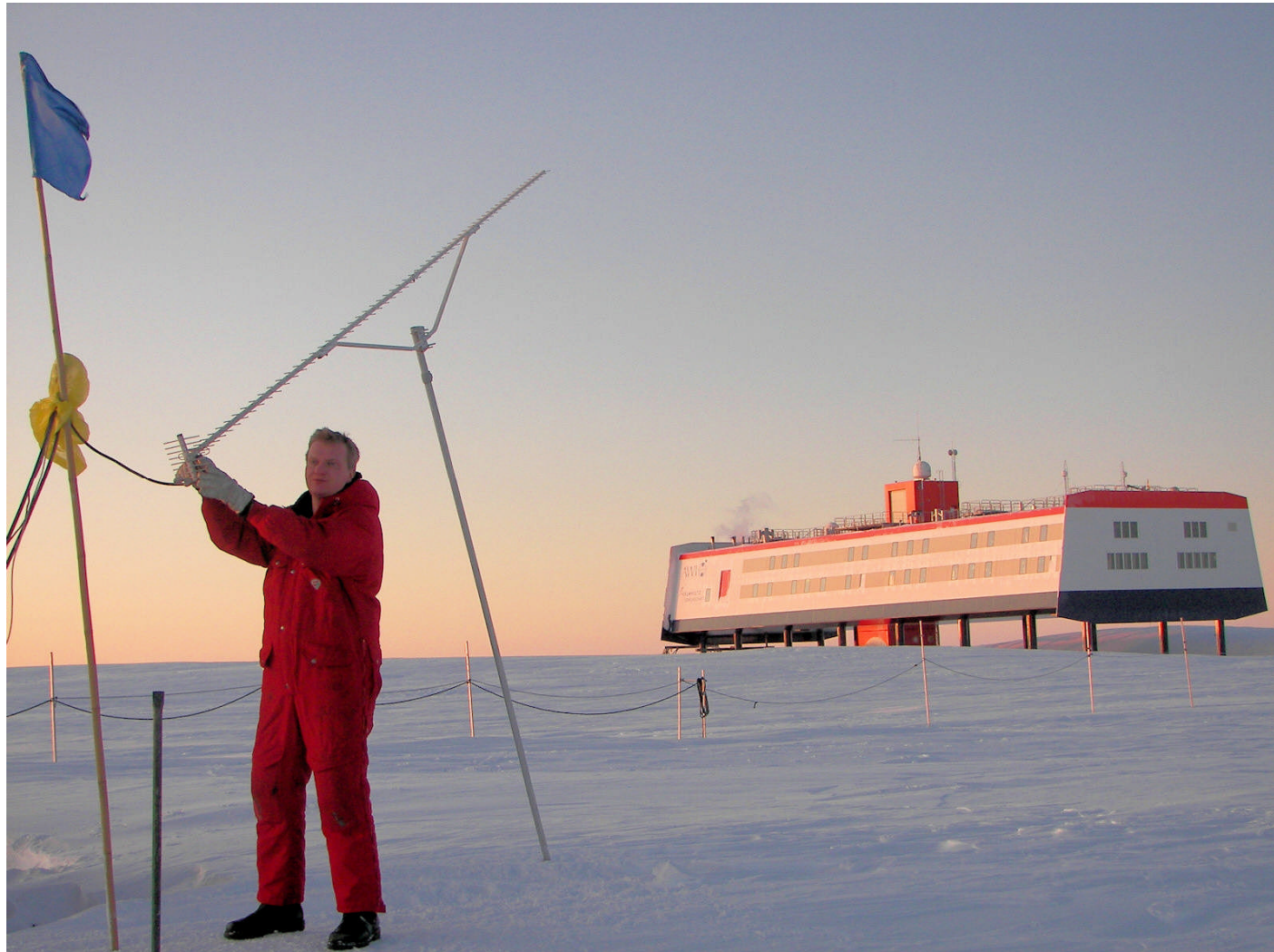
AD6IW JAMESBURG 30 M DISH

EME BY SMALL STATION



- MY 1ST DIGITAL CONTACT WAS ON 23 CM WITH OH3MCK.
- OH3MCK WAS USING 2 X 22 dBi YAGIES (LINEAR POL.) AND 40 W.

DP1POL – Felix & 67 EL YAGI WINTER AT SOUTH POLE!





**QSO'D DF3RU, DJ9YW, ES5PC, ES6RQ, G4CBW,
G4CCH, K2UYH, LZ1DX, OE9ERC, OK1DFC,
OK1KIR, PA3CSG, RD3DA & W5LUA.**

RA0ACM's SINGLE 49 EL YAGI & 75 W FROM APT WINDOW



**OY3JE – COPIED K2UYH WITH A
PREAMP IN HIS SHACK**

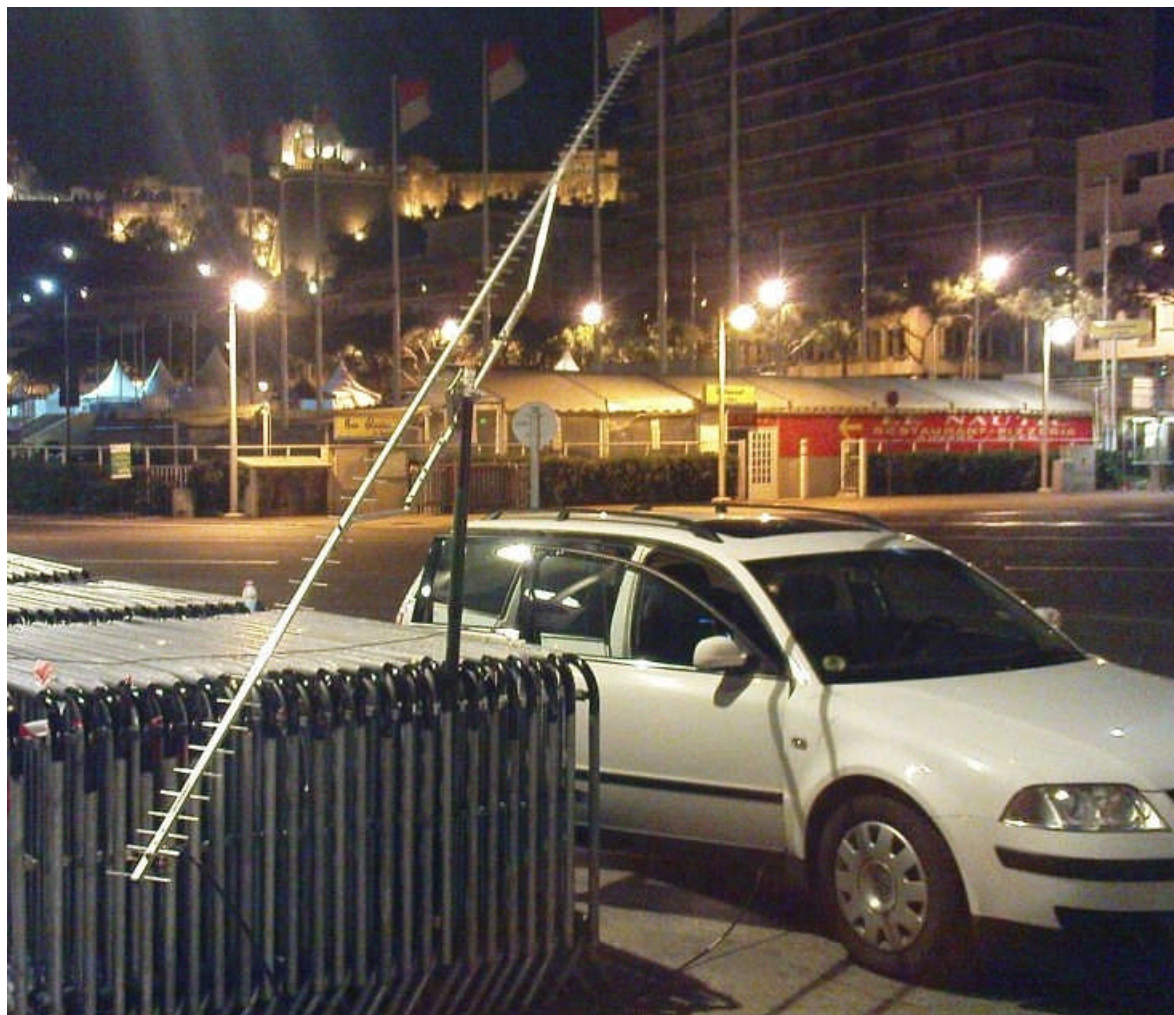


PORTABLE EME – DL30CH STYLE



- BODO USES IC-706, TRANSVERTER WITH 80 W AND A 59 EL YAGI (5 M LONG & 18.7 dBd) FROM HIS CAR.
- BESIDES DL, HE HAS OPERATED FROM 3A, HB0, EA8...

**3A/DL30CH ON 23 CM FROM MONACO
ON OF MOST SUCCESSFUL EME DXPEDITION OP
USES SINGLE YAGI, NO PREAMP & 80 W!**



**T7/HB9EHJ
San Marino**

5N0EME 70 CM YAGI POINTED TO MOON



**BODO (DL3OCH) WAS
ACTIVE FROM NIGERIA
ON 432**

**RUNNING A 6 M YAGI
WITH 100 W PA AND NO
PREAMP INTO IC706**

**HB9Q (21DB/26DB),
DL7APV (20DB/27DB),
PA3CSG (24DB/27DB),
K2UYH + MORE ON
JT65B AND
DL9KR ON CW!**

OK1TEH RUNS QRP EME ON 70 & 23 CM



**432: 400 W & 5.7
M YAGI**

**QSO'd K2UYH,
G4CCH,
HB9HAL,
OE9ERC, HB9Q,
F2TU & PI9CAM
on CW.**

**1296: 1 M DISH
& 100 W**

**QSO'd K2UYH +
OTHERS**

VP9/K2UYH IN BERMUDA



**IF FLYING NEED
PORTABLE ANTENNA
THAT FITS IN A
SMALL PACKAGE!**

DIGITAL BASICS

- **CHALLENGE TO DEVISE THE MOST EFFECTIVE SYSTEM.**
- **JT65 BY JOE TAYLOR, K1JT MOST POPULAR**
- **EACH TRANSMISSION IS 60 SECONDS LONG AND CONSISTS OF MESSAGE AND SYNC INFORMATION.**
- **THE SYNC IS INTERSPERSED WITH THE MESSAGE AND SENT ABOUT HALF THE TIME.**
- **USES ERROR CORRECTING CODE – 6 BITS/ SYMBOLE (64 TONE FSK) + SYNC = 65!**

OK1DFC'S JT65C SIGNAL

ZDENEK RUNS A SINGLE YAGI ON HORIZ

TIME SYNC →
 FREQ -- →
 TIME AMP - →

**HE'S
 WORKED
 2 YAGI
 STN**

WSJT 4 by K1JT

File Setup Mode Save Band Help

MOON (DX)
 Az: 262.51
 El: 7.40
 MOON
 Az: 165.27
 El: 49.96
 RA: 00:43
 Dec: 1.15
 LHA: -9.01
 SD: 15.39
 Freq: 432
 Tsky: 18
 Doppler: -443
 dB: -1.56
 Dgrd: -1.85

39.7 Time (s) OK1DFC_040321_170600

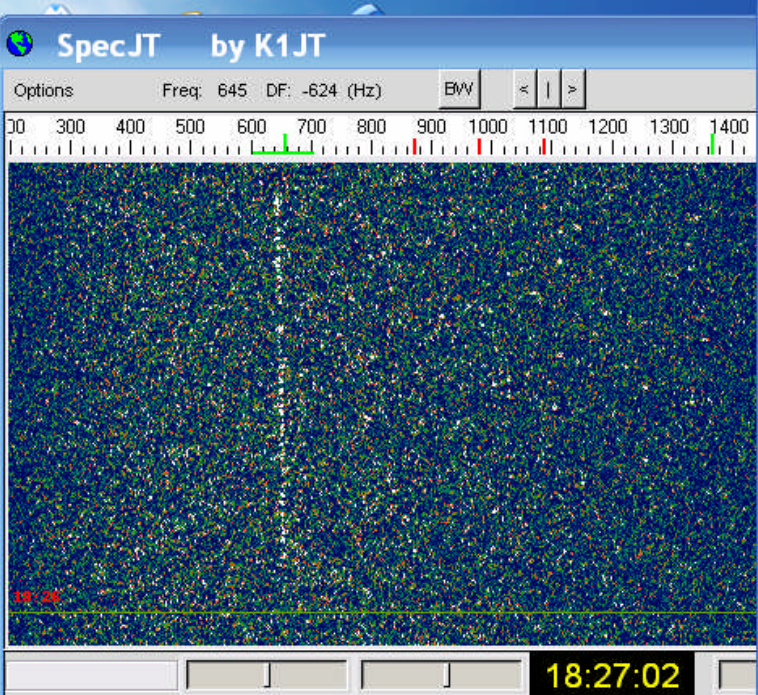
| File ID | Sync | dB | DT | DF | W | |
|---------|------|-----|-----|-----|---|-------------------------|
| 170000 | 3 | -27 | 2.4 | 262 | 6 | * |
| 170000 | 3 | -27 | 2.4 | 262 | 6 | * |
| 170200 | 4 | -23 | 2.6 | 256 | 7 | # K2UYH OK1DFC JN79 000 |
| 170400 | 3 | -22 | 2.5 | 248 | 6 | # K2UYH OK1DFC JN79 000 |
| 170600 | 10 | -25 | 0.0 | 240 | 8 | RRR ? |

170600 1 3/5 K2UYH OK1DFC JN79

Monitor Play Stop Save Last Decode Erase Clear Avg Include Exclude JT65 C TX First

To radio: OK1DFC Grid (6-digit): JO60tp Sync 1 Zap Freeze Custom
 4090 mi 6582 km
 Az: 48
 Gen Std Msgs Auto is ON Big Spectrum Dsec 0
 2004 Mar 21 17:07:43
 OK1DFC K2UYH FN20
 OK1DFC K2UYH FN20 000
 RO
 RRR
 73
 CW CW CW CW CW
 TX1 TX2 TX3 TX4 TX5 TX6 TX Stop

Transmitting message 3 RX noise: 0 dB Dsec=0 Sync > 1 Clip=0 Tol=400



ck.exe

| | | |
|----------|---------|------------|
| | AZ | E1 |
| Moon: | 157.44 | 35.26 |
| Moon/DX: | 97.35 | 8.43 |
| Sun: | 219.15 | 55.28 |
| Source: | 351.24 | -49.40 |
| | | |
| | Doppler | df/dt |
| DX: | 282 | -11.80 |
| self: | 282 | -11.80 |
| | | |
| | RA | DEC |
| Moon: | 12:51 | -11.67 |
| Source: | 00:00 | 0.00 |
| | | |
| Freq: | 1296 | Tsky: 3 |
| MNR: | 0.0 | Dgrd: -1.0 |
| DPol: | -32 | SD: 15.99 |

WSJT 6 by K1JT

File Setup View Mode Decode Save Band Help

Moon
 Az: 157.44
 E1: 35.26
 Dop: 282
 Dgrd: -1.0

26.8 1.0000 1.0000 Time (s) Mon_090823_182600

| FileID | Sync | dB | DT | DF | W | | | |
|--------|------|-------|------|------|------|-------------------|---|----|
| 182100 | 0 | -33 | 6.6 | -116 | 3 | | | |
| 182200 | 0 | -33 | 6.3 | 116 | 12 | | | |
| 182300 | 0 | -33 | 2.1 | 175 | 28 | | | |
| 182400 | 1 | -22 | 2.6 | -579 | 12 * | CQ DP1POL IB59 | 1 | 10 |
| 182500 | 0 | -33 | -1.7 | -560 | 47 | | | |
| 182600 | 4 | -21 | 2.5 | -619 | 11 * | CQ DP1POL IB59 | 1 | 10 |
| | | | | | | | | |
| 182600 | 1 | 10/63 | | | | K2UYH DP1POL IB59 | 1 | 10 |
| 182600 | 2 | 2/25 | | | | CQ W7UPF DM42 | 1 | 10 |

Log QSO Stop Monitor Save Decode Erase Clear Avg Include Exclude TxStop

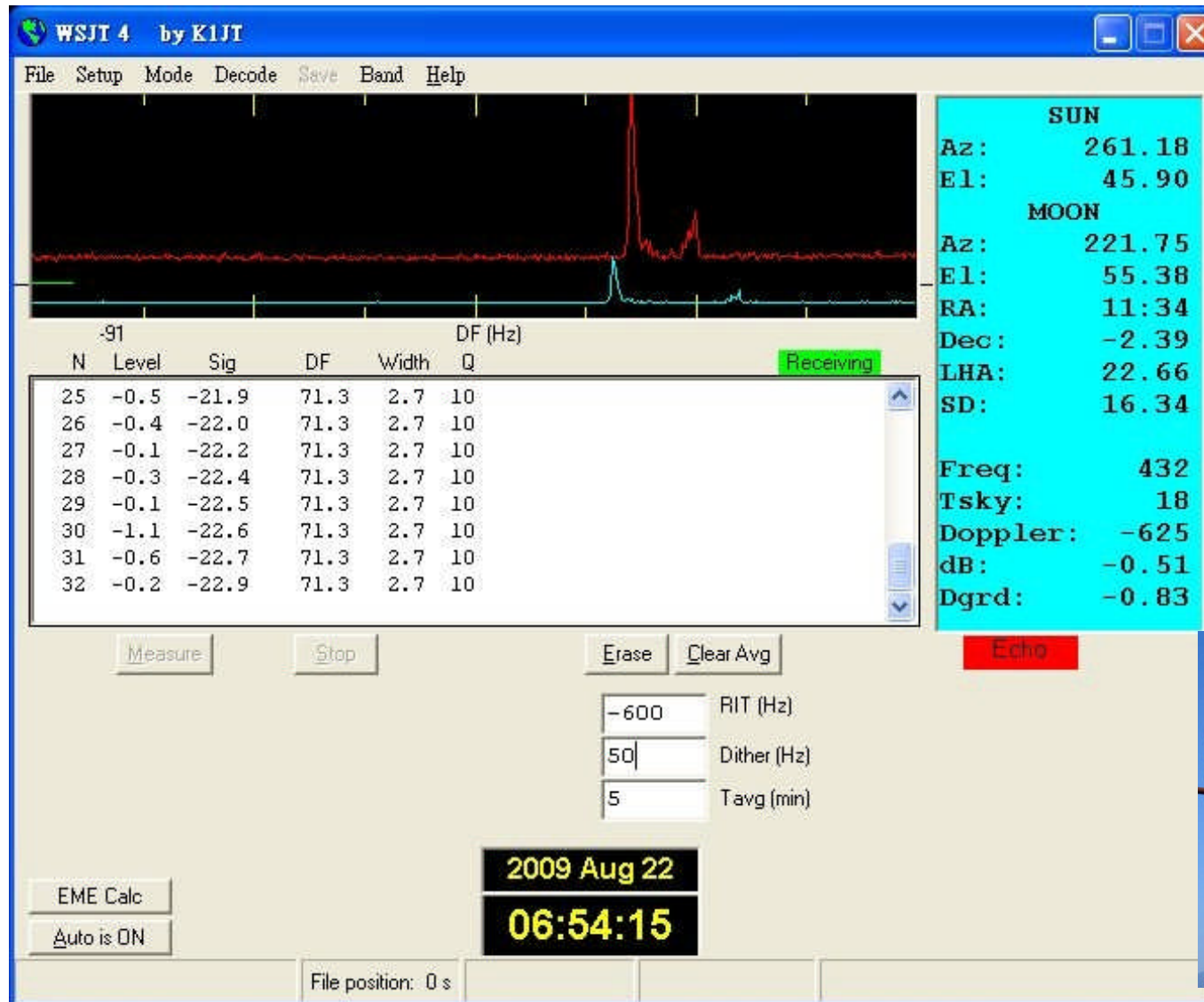
To radio: WD1V Lookup Grid: Add

Sync 1 Zap Tx First WD1V K2UYH FN20 Tx1
 Clip 0 NB 26 Rpt WD1V K2UYH FN20 OOO Tx2
 Tol 50 Freeze Sh Msg RO Tx3
 Defaults AFC TxDF = 0 RRR Tx4
 Dsec 0.0 Shift 0.0 GenStdMsgs 73 Tx5
 Auto is OFF CQ K2UYH FN20 Tx6

1.0000 1.0068 JT65C Freeze DF:-614 Rx noise: 0 dB TR Period: 60 s Receiving



ECHO MODE – WANT TO TRY EVEN IF DON'T USE EME



**BX1AD
2 YAGIS
100 W
70 CM
EME**



- LET'S YOU EVALUATE EME SYSTEM CAPABILITY.
- NOT GOOD FOR COMMUNICATIONS.

OTHER REQUIREMENTS

- MUST KNOW TIME TO ~ 1 SECOND. S
*** SOFTWARE IS AVAILABLE TO
AUTOMATICALLY TO UPDATE YOUR
CLOCK VIA THE INTERNET
<<http://www.thinkman.com/dimension4/>>.

- MUST BE ABLE
TO TRACK THE MOON
* HAS BUILT IN TRACKING.

| | | |
|----------|---------|------------|
| | AZ | E1 |
| Moon: | 157.44 | 35.26 |
| Moon/DX: | 97.35 | 8.43 |
| Sun: | 219.15 | 55.28 |
| Source: | 351.24 | -49.40 |
| | Doppler | df/dt |
| DX: | 282 | -11.80 |
| Self: | 282 | -11.80 |
| | RA | DEC |
| Moon: | 12:51 | -11.67 |
| Source: | 00:00 | 0.00 |
| Freq: | 1296 | Tsky: 3 |
| MNR: | 0.0 | Dgrd: -1.0 |
| DPol: | -32 | SD: 15.99 |

FASCINATING PROPAGATION

- **DISTANCE TO MOON VARIES (2 dB)**
- **SKY NOISE CHANGES WITH MOON LOCATION**
- **DOPPLER SHIFT MOVES FREQUENCY**
- **FARADAY ROTATES POLARIZATION**
- **MOON LIBRATION EFFECTS SIGNAL QUALITY**

CONCLUSION

- EME IS CHALLENGING.
- BUT ALL YOU NEED IS A YAGI, ~50 W, A COMPUTER AND JT65!
- IT IS PRETTY EASY WITH A BIG STATION, BUT THERE IS STILL A LOT TO IT: ACCURATE FREQ AND TIME, MOON TRACKING, DOPPLAR, POLARIZATION (ON 432).
- WITH A WEAK STATION, ALL THE ABOVE PLUS MUST UNDERSTANDING HOW TO USE JT65
- ACTIVITY ~ .070
- NL <<http://www.nitehawk.com/rasmit/em70cm.html>>

**OFFSET DISHES
SOME IDEAS
FOR SMALL & LARGER DISHES**

OFFSET DISH ADVANTAGE:

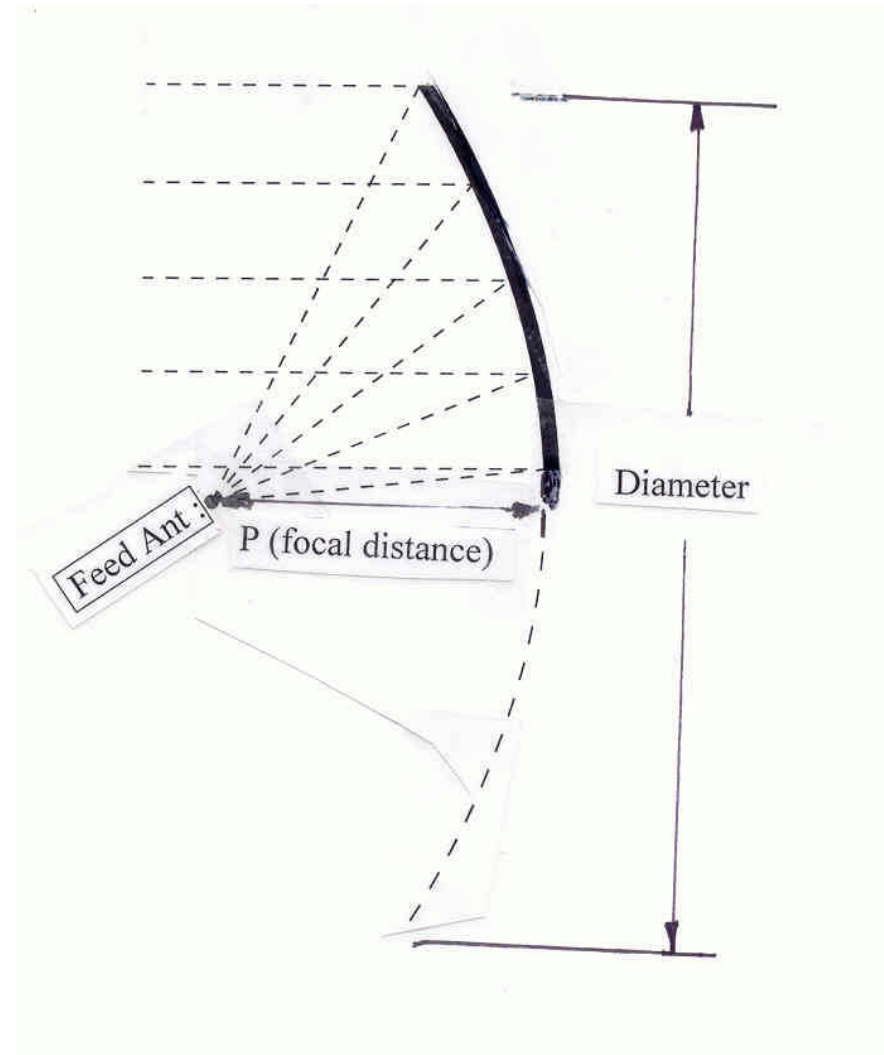
**SMALL DISH'S EFFICIENCY REDUCED
BY APERTURE BLOCKAGE**

- AN **OFFSET DISH** SOLVES THIS
PROBLEM

BUT ALSO USEFUL FOR LARGER DISHES

OFFSET DISH USES PART OF SURFACE

- USES $\sim \frac{1}{4}$ DISH SURFACE
- FEED POINT DOES NOT CHANGE
- MOVES FEED HORN OUT OF MAIN BEAM
- FEED POINTS TO SURFACE
- NEEDS DEEPER DISH *EQUIVALENT F/D OR HIGHER GAIN FEED*



- **Surface Reflector**

- **f/d f/d**

- **0.90 0.46**

- **0.85 0.44**

- **0.80 0.43**

- **0.75 0.41**

- **0.70 0.40**

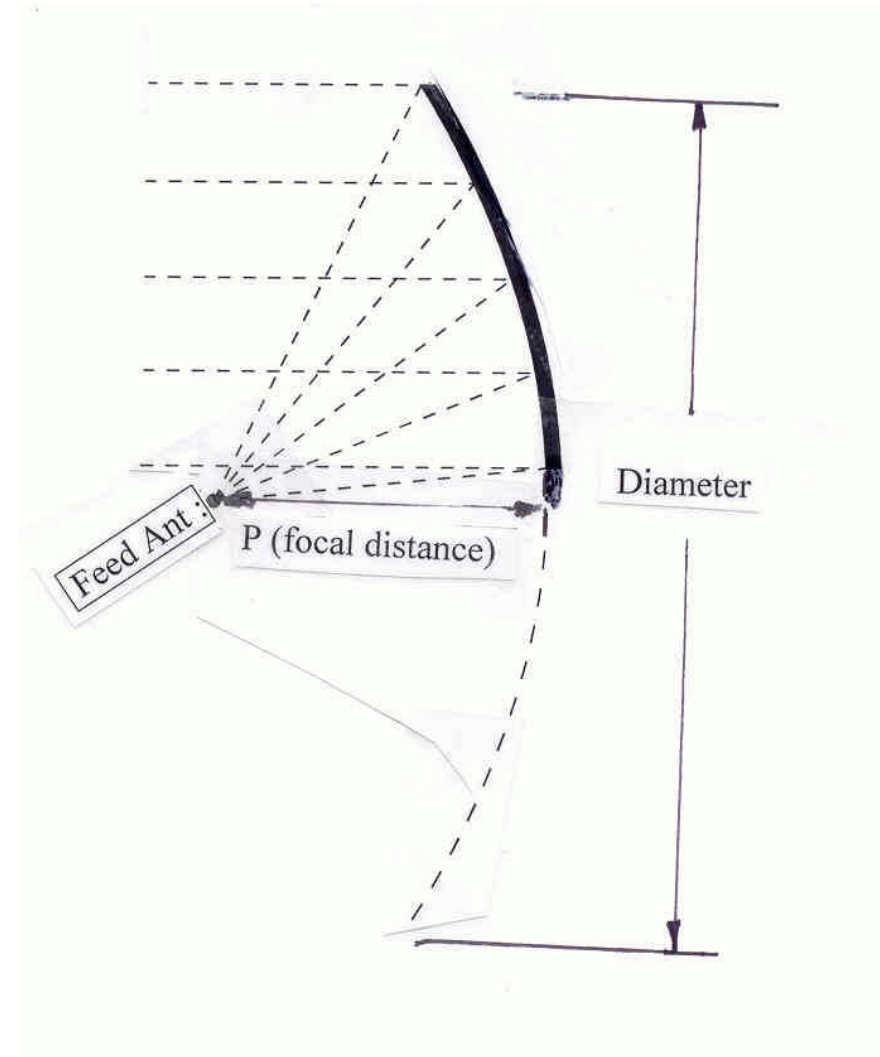
- **0.60 0.36**

- **0.55 0.34**

- **0.50 0.32**

- **0.45 0.30**

- **0.40 0.28**

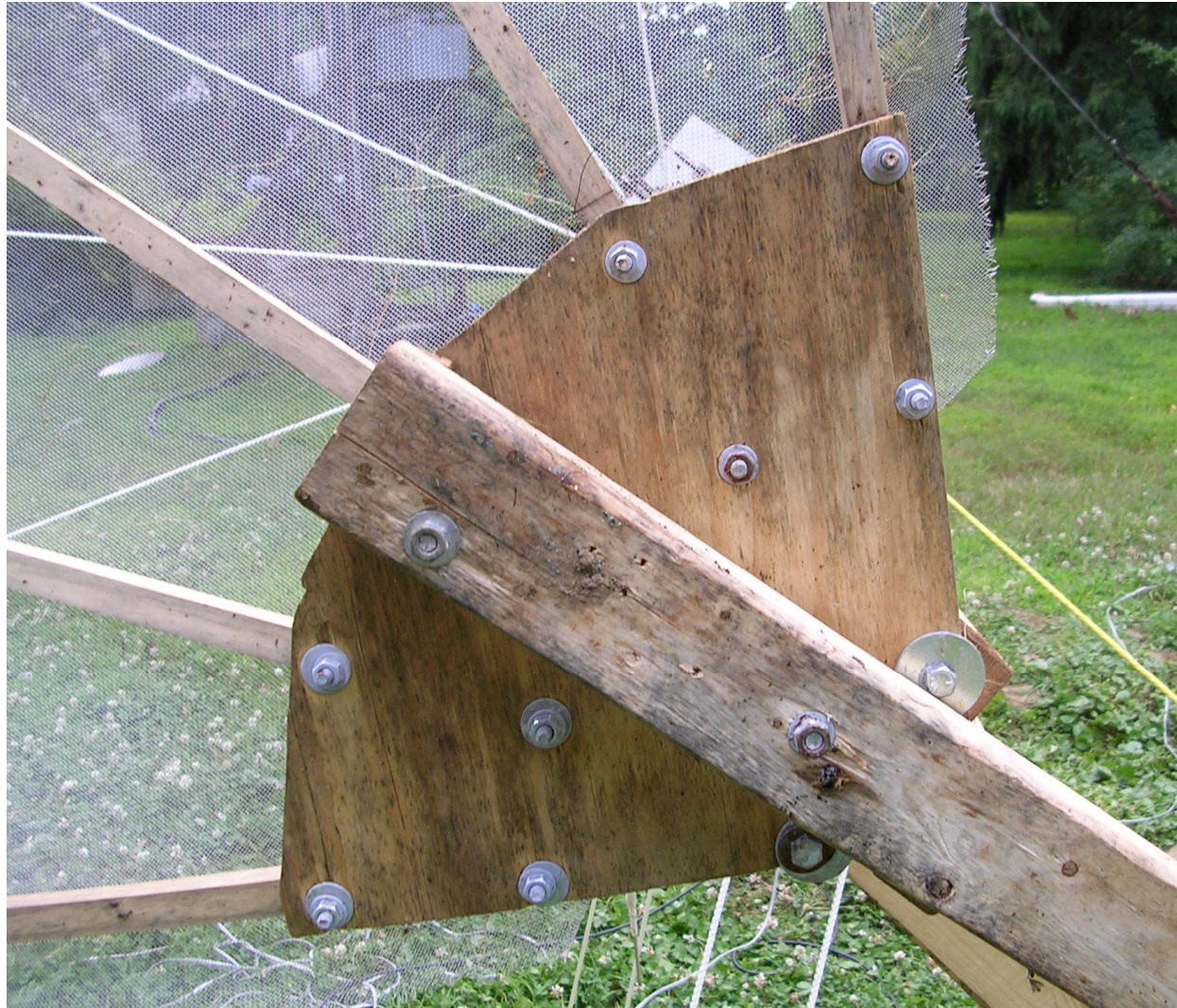


OFFSET DISH CONSTRUCTION



- **7.5' OFFSET DISH**
- **5 LENGTHS OF
7' x 1/2" x 3/4" WOOD
MOLDING STOCK**
- **f/d ~ 0.3**
- **FEED HORN BW
~ 90°**
- **POLAR MOUNT**

SPOKES ATTACHED TO QUARTER ROUND PLYWOOD CENTER



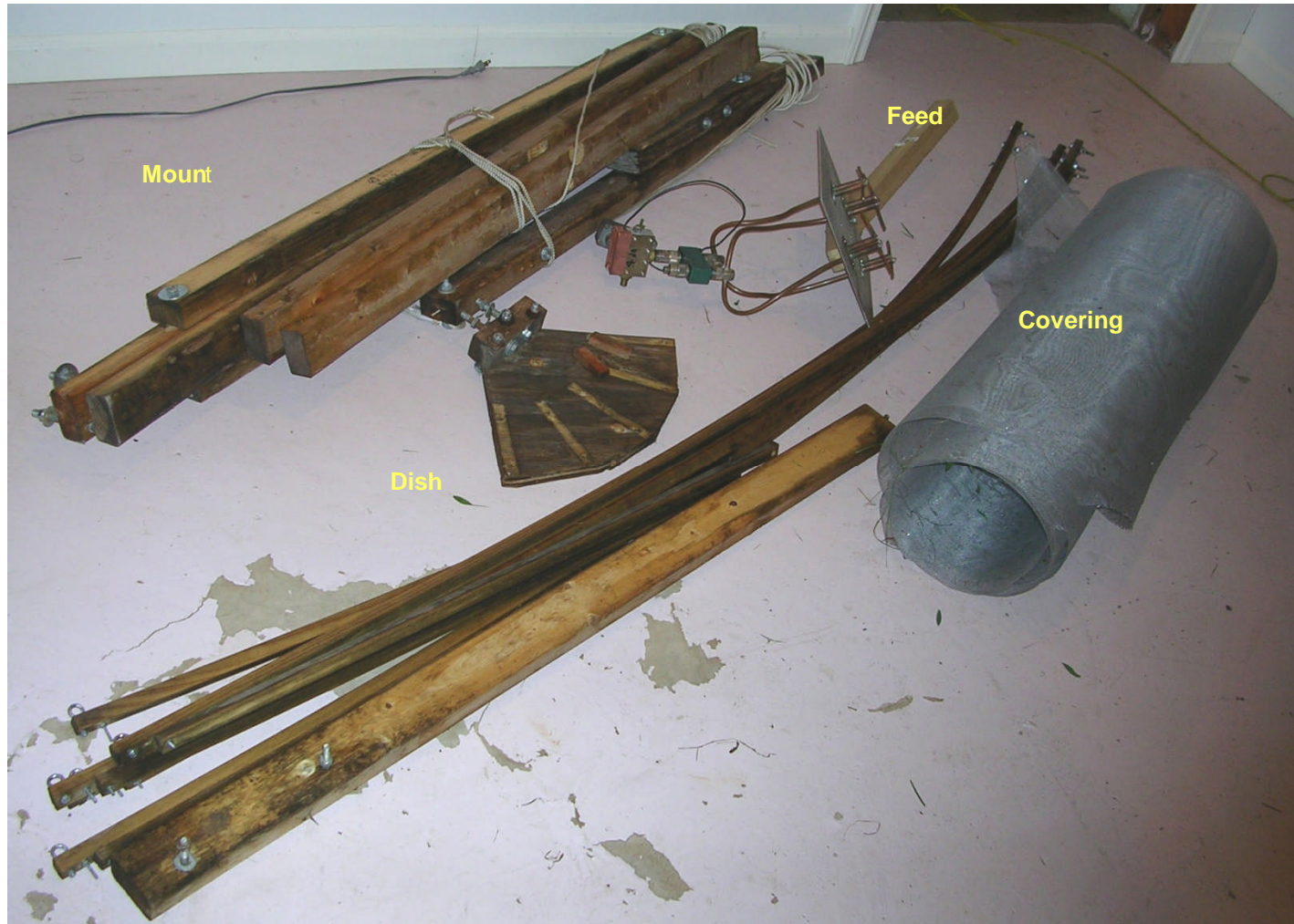
OUTSIDE RIM FORMED FROM 3.5' LENGTH MODELING STRIPS



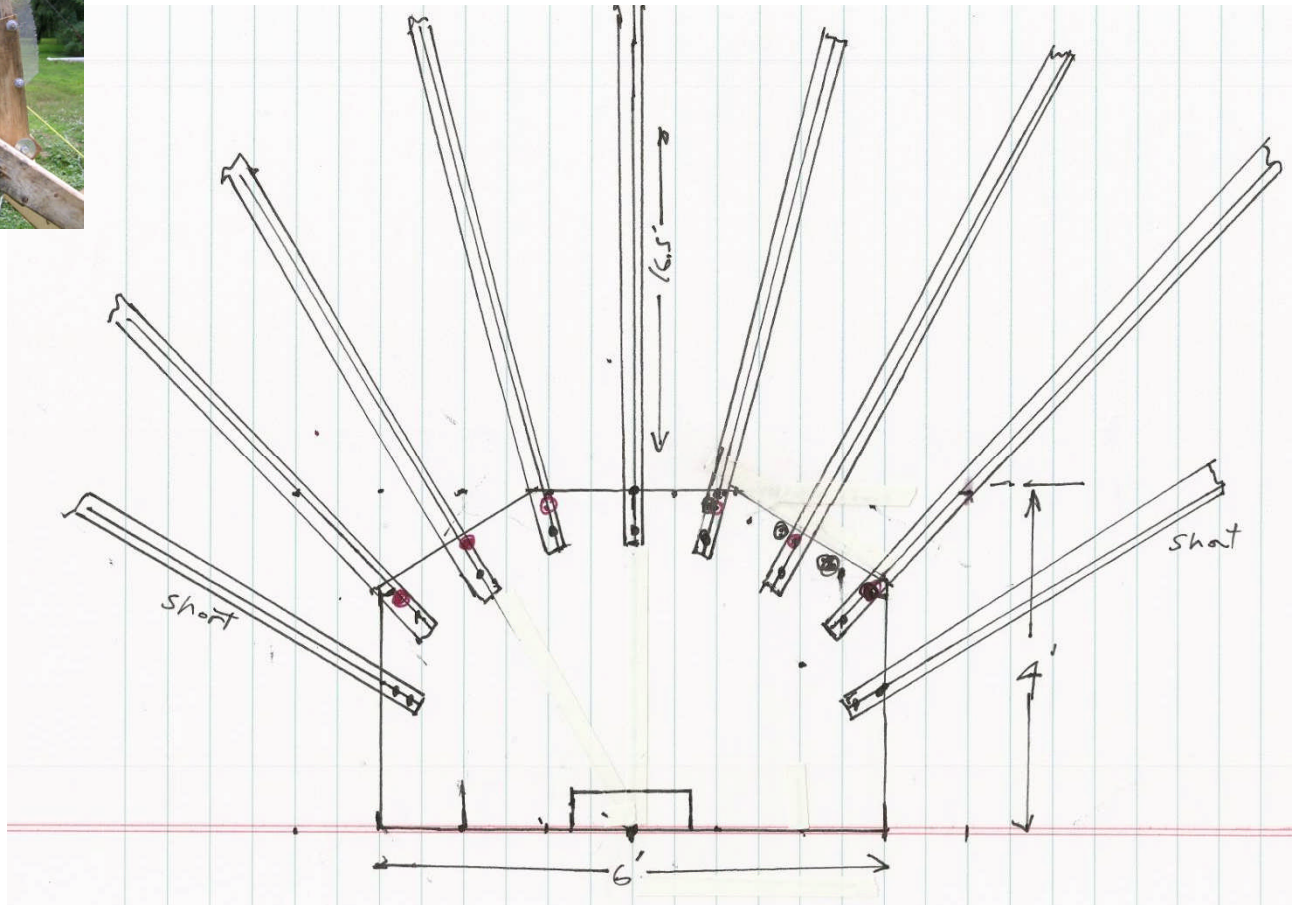
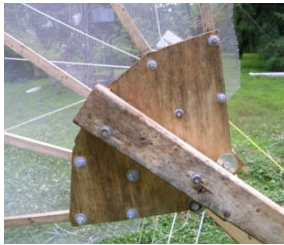
COVERED BY ALUMINUM SCREENING TIED TO THE SPOKES USING WIRE



BREAKS INTO A FEW SMALL & LIGHT WEIGHT PIECES

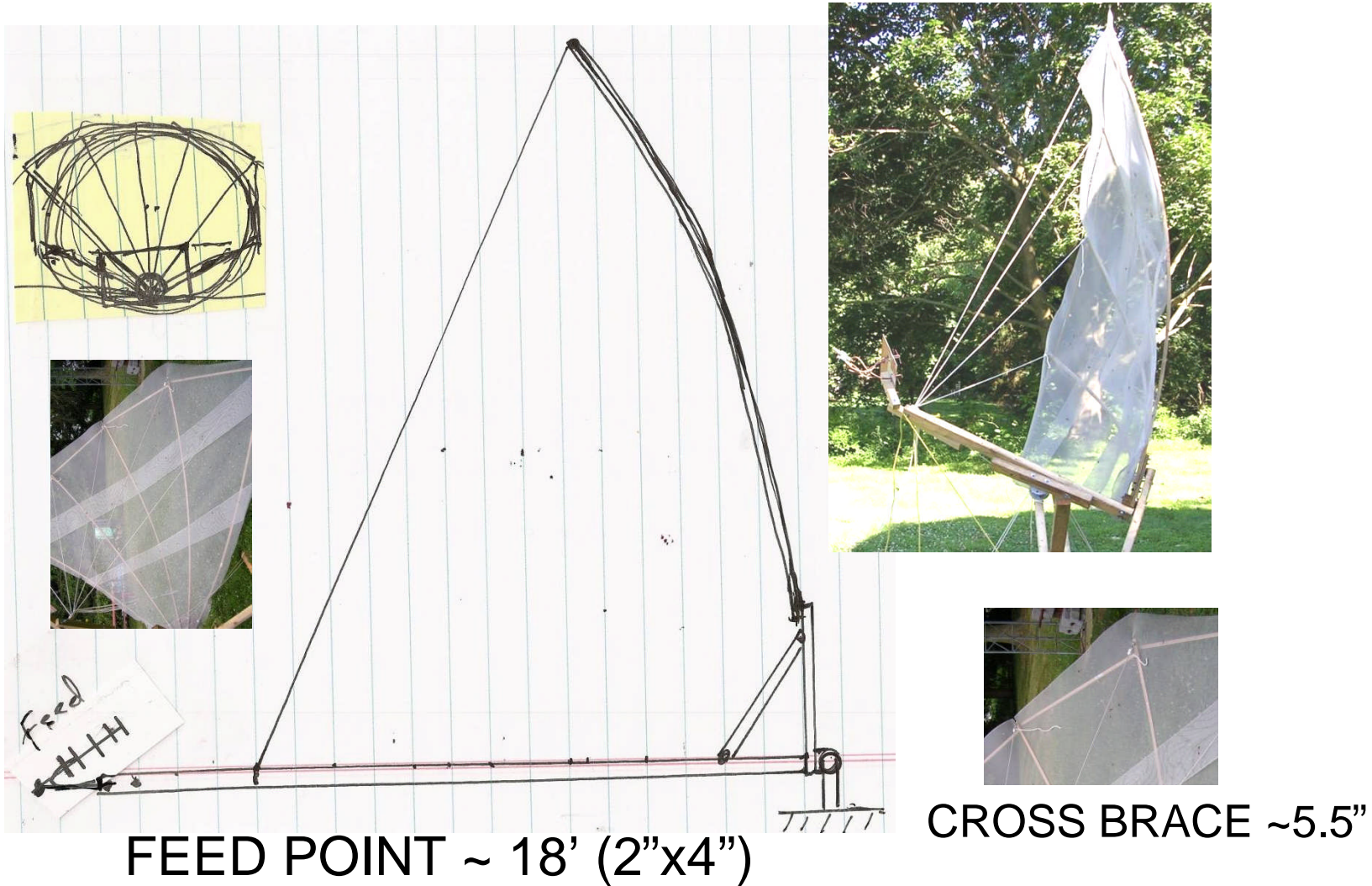


BIG OFF-SET STRESS DISH (20')
CENTER 6'x4', SPOKES (7 OR 9) 16.5'x1"x2"



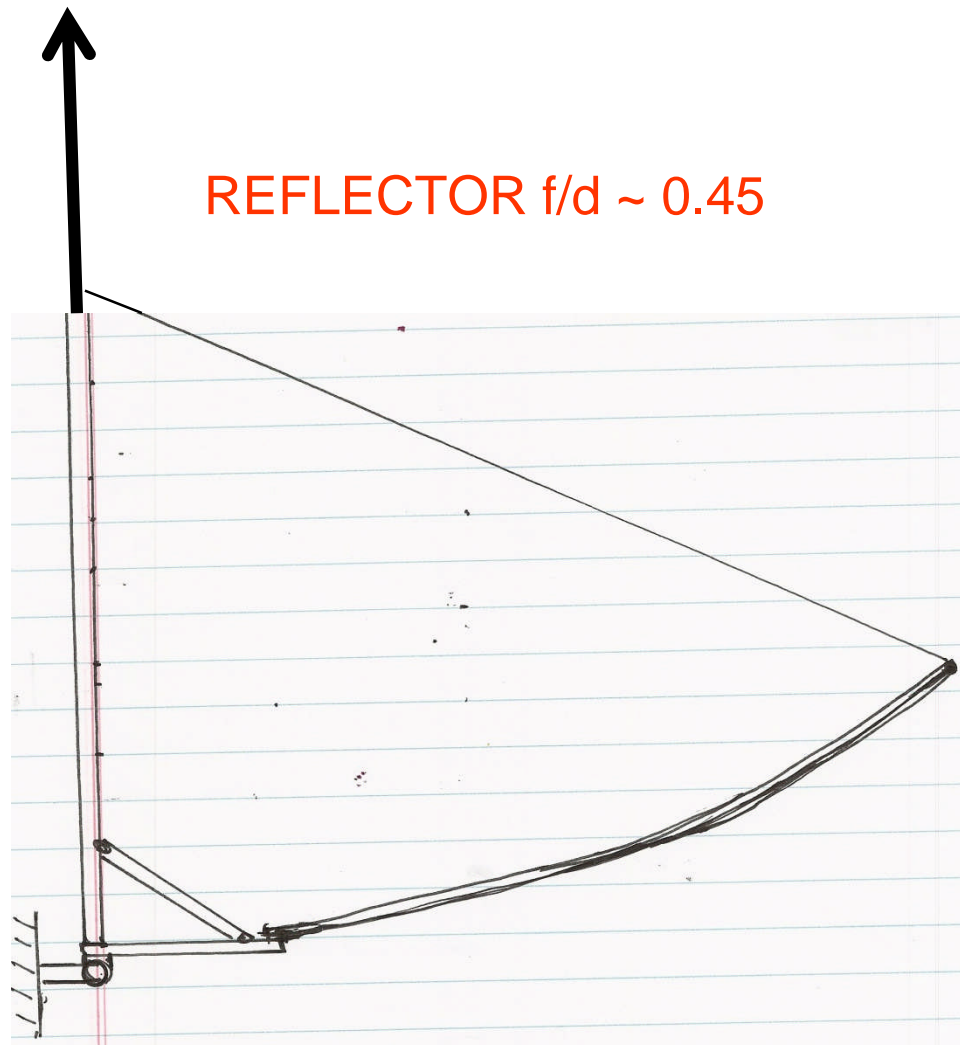
SIDE VIEW – OFFSET STRESS DISH

$f/d \sim 0.9$ – CAN USE YAGI TO FEED



SIDE VIEW – OFFSET STRESS DISH

WHEN NOT IN USE ROTATE SO FLAT ON GROUND



REFLECTOR $f/d \sim 0.45$

PARTS:

1 – 4'x6' (3/4" PLYWOOD) CENTER PLATE

7 (OR 9) - 16.5"x1"x2" REDWOOD SPOKES

6 (OR 8) – 5.5' x 3/4"x1/2" CROSS BRASES

1 – 18'x2"x4" FEED SUPPORT

~ 400 SQ FEET MESH OR WIRE COVERING

FEED MOUNTING HARDWARE

MOUNT HARDWARE



CONCLUSION

SMALL/LARGE STRESS DISHES:

- **INEXPENSIVE AND SIMPLE WAY OF OBTAINING ANTENNA FOR 70 OR 23 CM**
- **OFFSET MORE EFFICIENT > 8 dB OF SUN NOISE**
- **VERY SIMPLE MOUNT**
- **CAN MOUNT VERY CLOSE TO THE GROUND**
- **STORE WITH DISH FLAT ON GROUND**