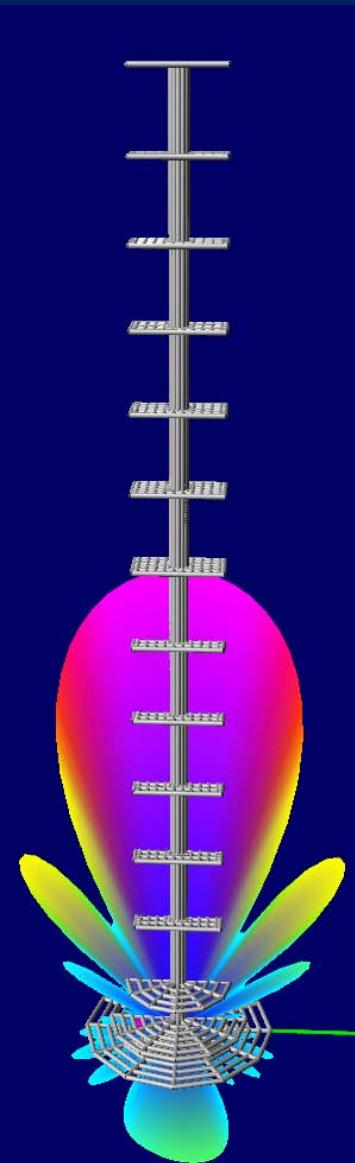


# *21cm Wavelength Circular\_Patch\_Feed Disk Director Yagi Antenna*

*An  
Efficient Low\_Noise  
Portable Economical  
21cm Neutral Hydrogen  
Radio Telescope  
Antenna*

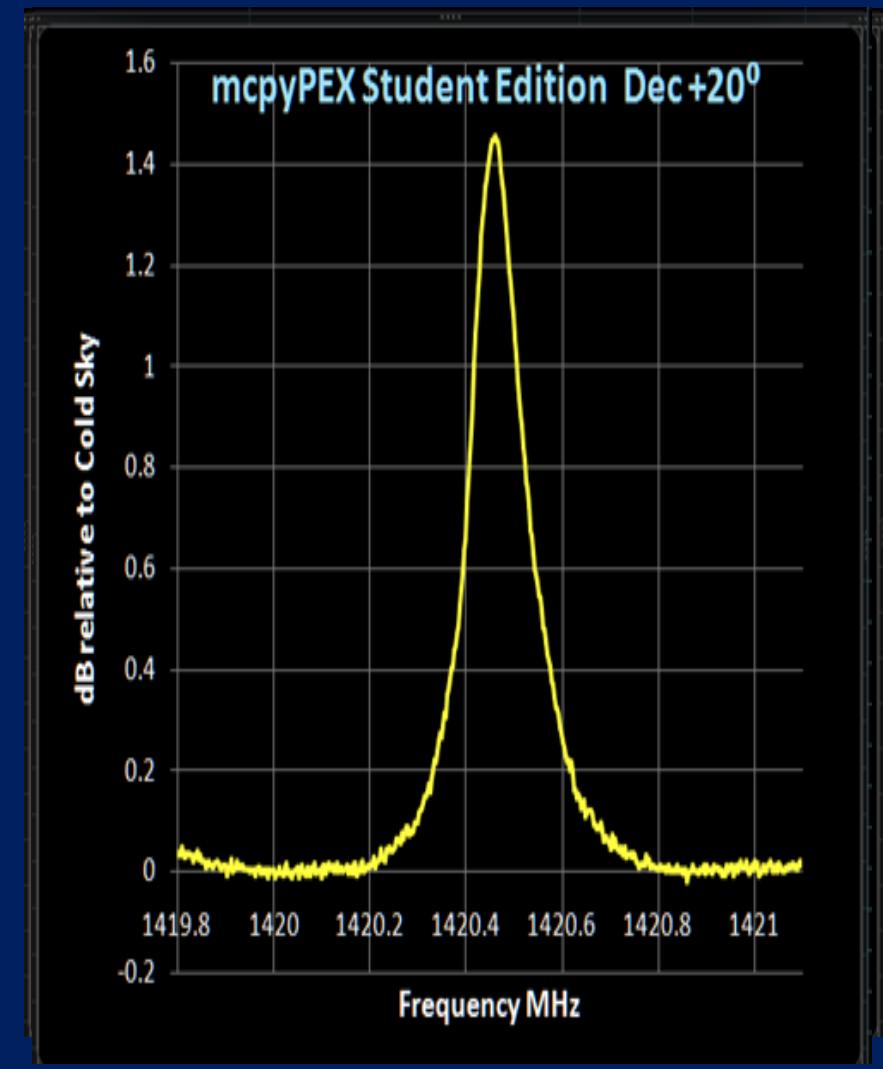
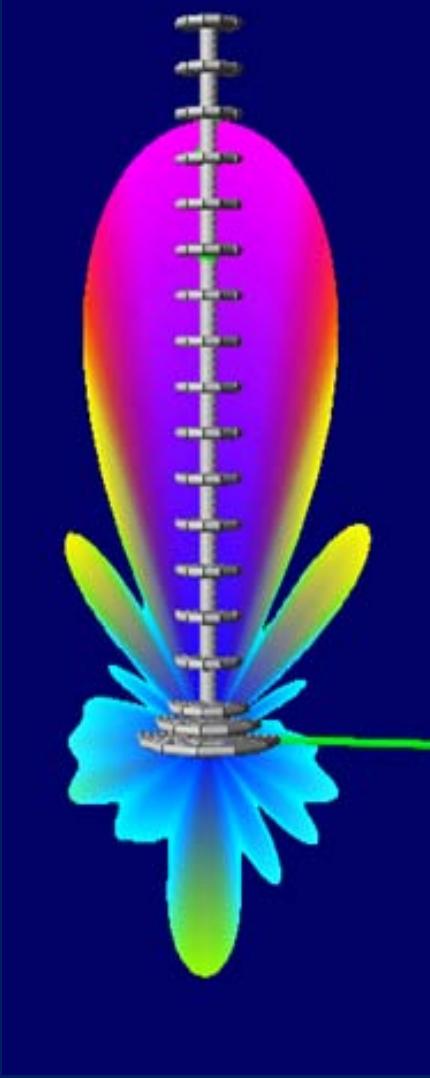
## ***STUDENT EDITION***

*If built carefully to correct dimensions  
This antenna will have similar  
performance to the original  
&  
It is light enough to be mounted on a  
low cost photo tripod*



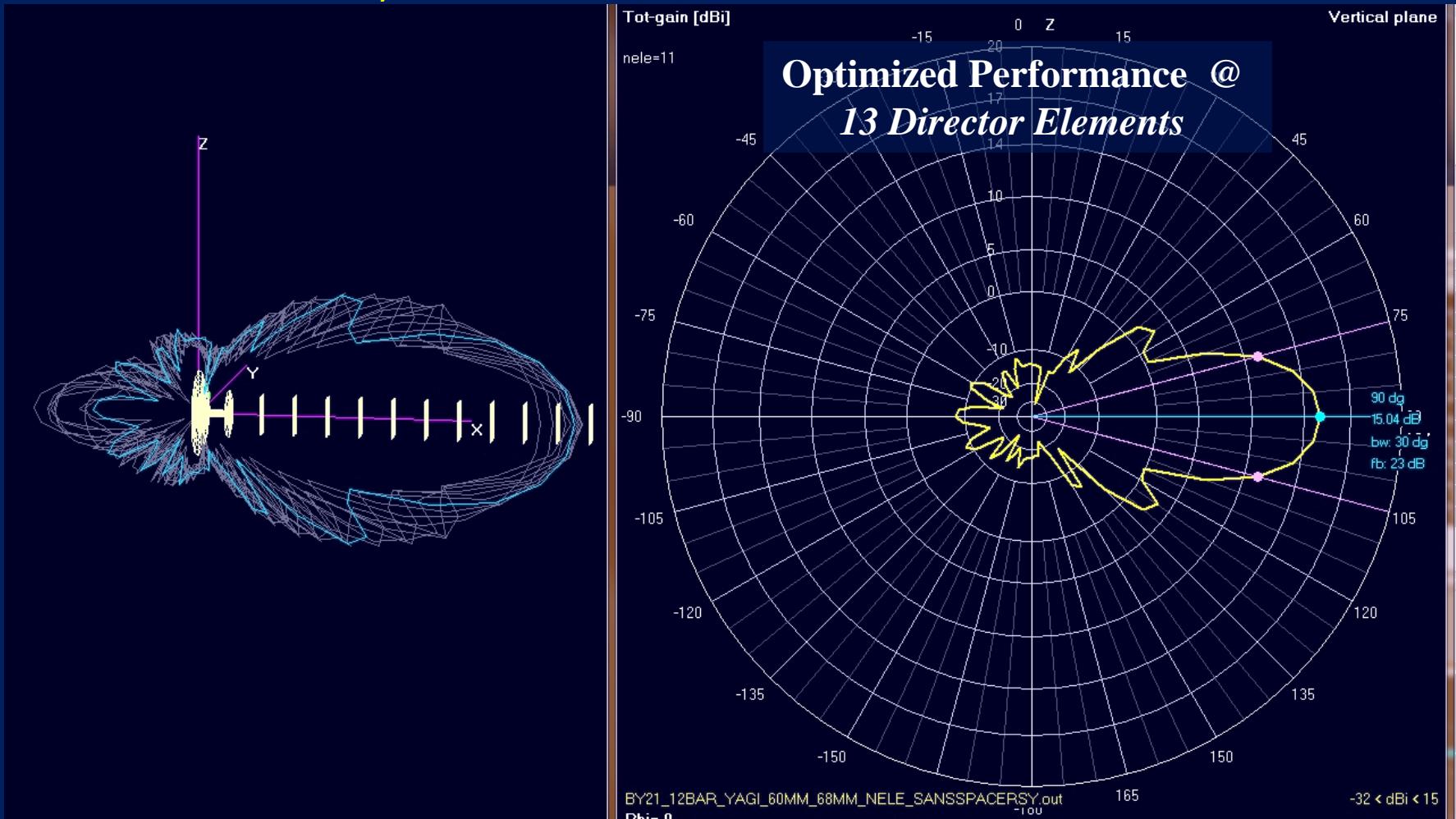
*alex pettit jr September 24*

## Performance Characteristics

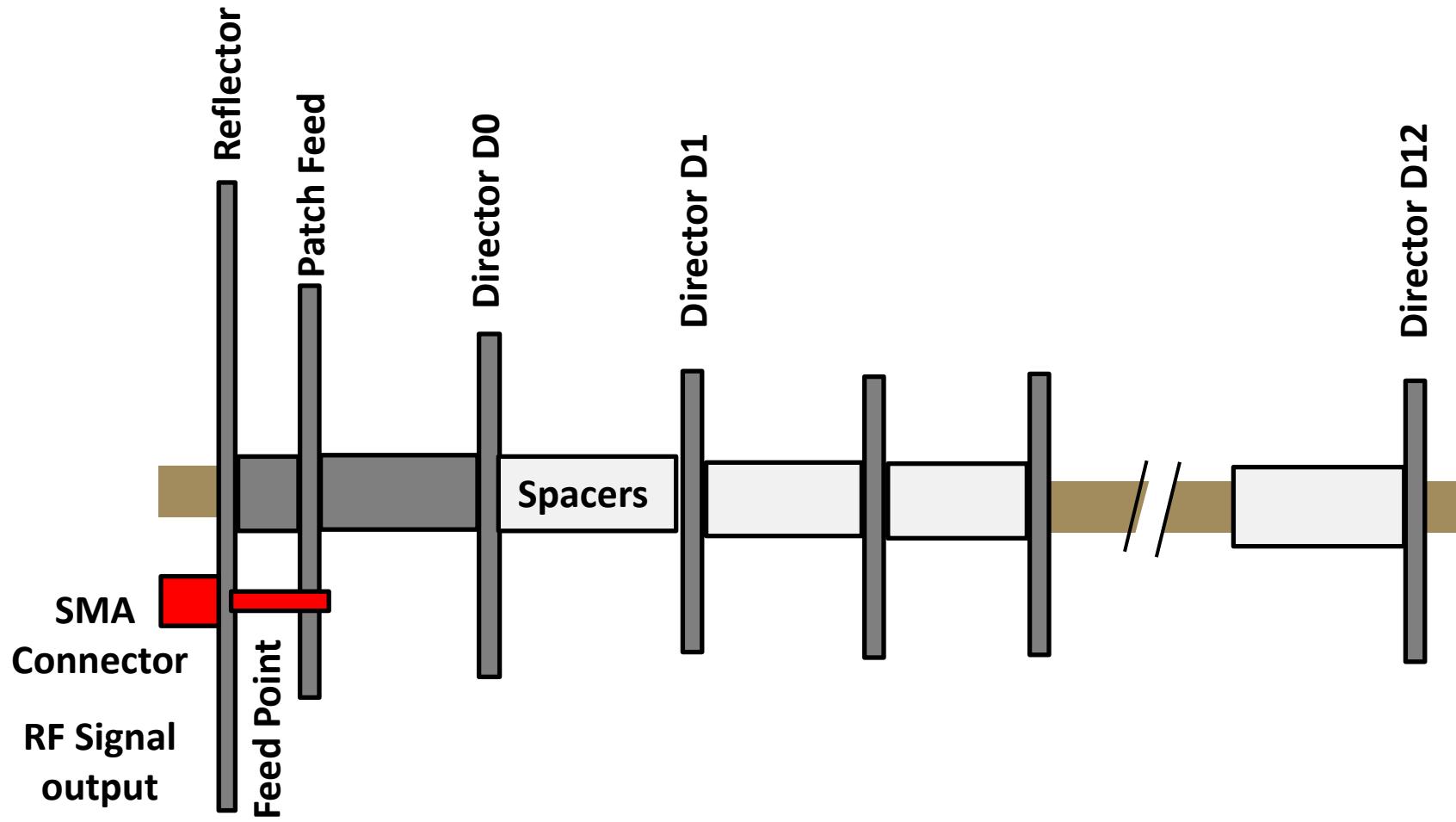


# Performance Characteristics

## Analysis : Number of Director Elements



# *Yagi Antenna Element Names*



# Antenna Components Using 0.020" & 0.030" Aluminum Sheet

## REMOVE BLUE FILM

1 set = 2 sheets 0.030"  
for Reflector and Patch Feed

- 2 Pack 6061 T651 Aluminum Sheet Metal 6 x 6 x 1/32 (0.0315") Inch Flat Plain Aluminum Plate Covered with Protective Film, Heat Treatable Rectangle Aluminum Metal Plate for Crafting, DIY, 0.8mm Thick

Brand: Lswteiz

4.7 ★★★★★ 231 ratings | Search this page

\$7<sup>99</sup> (\$4.00 / Item)



2 sets = 4 sheets 0.020"  
for 13 Directors

- 2 Pieces 6061 T651 Aluminum Sheet Metal 6x 6x0.02(24Gauge) Inch Rectangle Metal Plate, 0.5mm Aluminum Sheet, Plate for Crafting, Industry

Brand: iteshuai

4.7 ★★★★★ 112 ratings | Search this page

Amazon's Choice

in Aluminum Sheets & Plates by iteshuai

200+ bought in past month

\$5<sup>99</sup> (\$3.00 / Item)



Roll over image to zoom in

## SharkBite

1/2-in x 5-ft White PEX-B Pipe



\$3.<sup>28</sup>



K & S Precision Metals  
83035 Round Aluminum  
Tube, 1/2" OD x 0.035"  
Wall Thickness x 12"  
Length, 0.5 in OD, 1 pc,  
Made in USA

Visit the K&S Store

4.5 ★★★★★ 239 ratings

\$6<sup>99</sup>

prime Two-Day

# Antenna Components

## misc Purchase at Local Hardware Store

3/8"-16 tpi Stainless Steel Nuts 2 ea



Hillman 2532 3/8-16-Inch  
Stainless Steel Hex Nut,  
10-Pack  
Visit the Hillman Store  
4.7 ★★★★☆ 39 ratings  
\$5.99  
✓prime Same-Day  
FREE Returns ✓  
Material: Stainless Steel  
Fastener: Hex  
Type: Thread  
Thread: 3/8"-16

#6-32 x 1/4" screw & nut



#2-56 x 1/4" screws & nuts  
( 2.5mm x 6mm if you can find them )



*Oak or Poplar*



\$3.28

Dowel Rods Wood Sticks  
Wooden Dowel Rods - 3/8  
x 36 Inch Unfinished

1ft Copper Wire  
( old lamp cord )  
#18 ga



Speaker Wire (By-the-foot)

\$.53

# Electronic Components



NooElec SAWbird+ H1 - Premium Saw Filter & Cascaded Ultra-Low Noise Amplifier (LNA) Module for Hydrogen Line (21cm) Applications. 1420MHz Center Frequency. Designed for Software Defined Radio (SDR)

[Visit the NooElec Store](#)

4.4 ★★★★★ 62 ratings | [Search this page](#)

\$44<sup>95</sup> (\$89.90 /100 g)



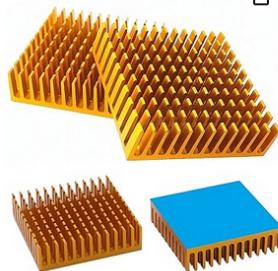
NooElec NESDR Smart XTR SDR - Premium RTL-SDR w/Extended Tuning Range, Aluminum Enclosure, 0.5PPM TCXO, SMA Input. RTL2832U & E4000-Based Software Defined Radio

[Visit the NooElec Store](#)

4.3 ★★★★★ 189 ratings | [Search this page](#)

\$43<sup>95</sup>

prime Two-Day  
FREE Returns



WWZMDIB 4Pcs 40mm Heatsink Back Side Thermal Conductive Tape 40mm x 40mm x 11mm Heat Sink

[Visit the WWZMDIB Store](#)

4.7 ★★★★★ 11 ratings | [Search this page](#)

\$5<sup>99</sup> (\$1.50 / Item)

prime

FREE Returns

Did you know? There's no annual fee for Prime Visa. [Get a \\$100 Amazon Gift Card instantly upon approval.](#) [Learn more](#)

Brand

WWZMDIB



SMA Male to SMA Male Coaxial Cable 50 ohm KMR240 Coax Cable Ultra Low Loss Antenna Extension Cable with SMA Connector for 3G/4G/5G/LTE Network Equipment, GPS, RF Radio to Antenna (25FT)

[Visit the MOOKEERF Store](#)

4.5 ★★★★★ 77 ratings | [Search this page](#)

\$23<sup>99</sup> (\$0.96 / Foot)

prime One-Day



USB 3.0 Extension Cable 1 ft, Yeung Qee High Speed USB 3.0 A Male to A Female Extension Cord for Data Transfer USB Flash Drive, Keyboard, Mouse, Playstation, Xbox, Card Reader, Printer etc (1ft/0.3M)

Brand: Yeung Qee

4.5 ★★★★★ 113 ratings | [Search this page](#)

\$5<sup>79</sup>



DHT Electronics RF coaxial connector adapter SMA male coaxial Termination Loads 1W DC- 3.0GHz 50 ohm Pack of 2

Brand: DHT Electronics

4.4 ★★★★★ 215 ratings | [Search this page](#)

Amazon's Choice

50+ bought in past month

\$5<sup>50</sup> (\$2.75 / Count)

prime

FREE Returns  
30-day refund/replacement

Specific personal



onelinkmore SMA Panel Mount Connector SMA Male 2-Hole Panel Chassis Mount Flange Solder Post Plug Connector Mounting Panel Post Straight Insulator PCB Coaxial Converter Pack of 5

[Visit the onelinkmore Store](#)

5.0 ★★★★★ 3 ratings | [Search this page](#)

\$6<sup>98</sup> (\$1.40 / Count)

## Hand Tools

### cutting PEX tube to length

#### SharkBite 1/4-in to 1-in Pex Cutter

Item #2590607 | Model #U701

[Shop SharkBite](#)

[Shop the Collection](#)



\$9.55



### cutting Aluminum (PEX) tube to length



Olson Saw 35-241 Fine  
Kerf Saw 35-550 42 tpi  
with Aluminum Thin Slot  
Miter Box, Slot Size .014-  
Inch, Slot Angles 45, 60,  
90, Cutting Depth 7/8-  
Inch, Pack of 1

Brand: ZONA  
4.3 ★★★★☆ 1,806 ratings  
200+ bought in past month

-10% \$21<sup>62</sup>



### cutting aluminum sheet into disks



Sponsored ⓘ

10" Left Cut Aviation Snip - Left  
Cut Offset Stainless Steel Cutting  
Shears with Forged Blade &  
Power Comfort Grips Aviation...

★★★★★ 10

\$9<sup>99</sup>

a petit jr Aug24

# Hand Tools

marking disk diameter  
cutting lines on aluminum sheets



2pcs Compass for Geometry, Professional Drawing  
Compass,Metal Compass, Circle Compass Drawing  
Tool for Geometry, Math, Drafting, Drawing,  
Measuring, School & Office Supplies by CUALORK

Brand: Cualork

4.5 ★★★★☆ ✓ 253 ratings | [Search this page](#)

200+ bought in past month

\$5<sup>68</sup>

cutting 0.02"sheet into 4 pcs  
for Directors ( will not cut 0.03" )



Aviation Tin Snips 8 Inch Heavy  
Duty Metal Cutter, Straight  
Shears with Stainless Steel  
Blade & Comfort Grips,  
Multifunction Cutting of  
Branches, Cable Wires, Thin  
Iron, Cardboard etc..

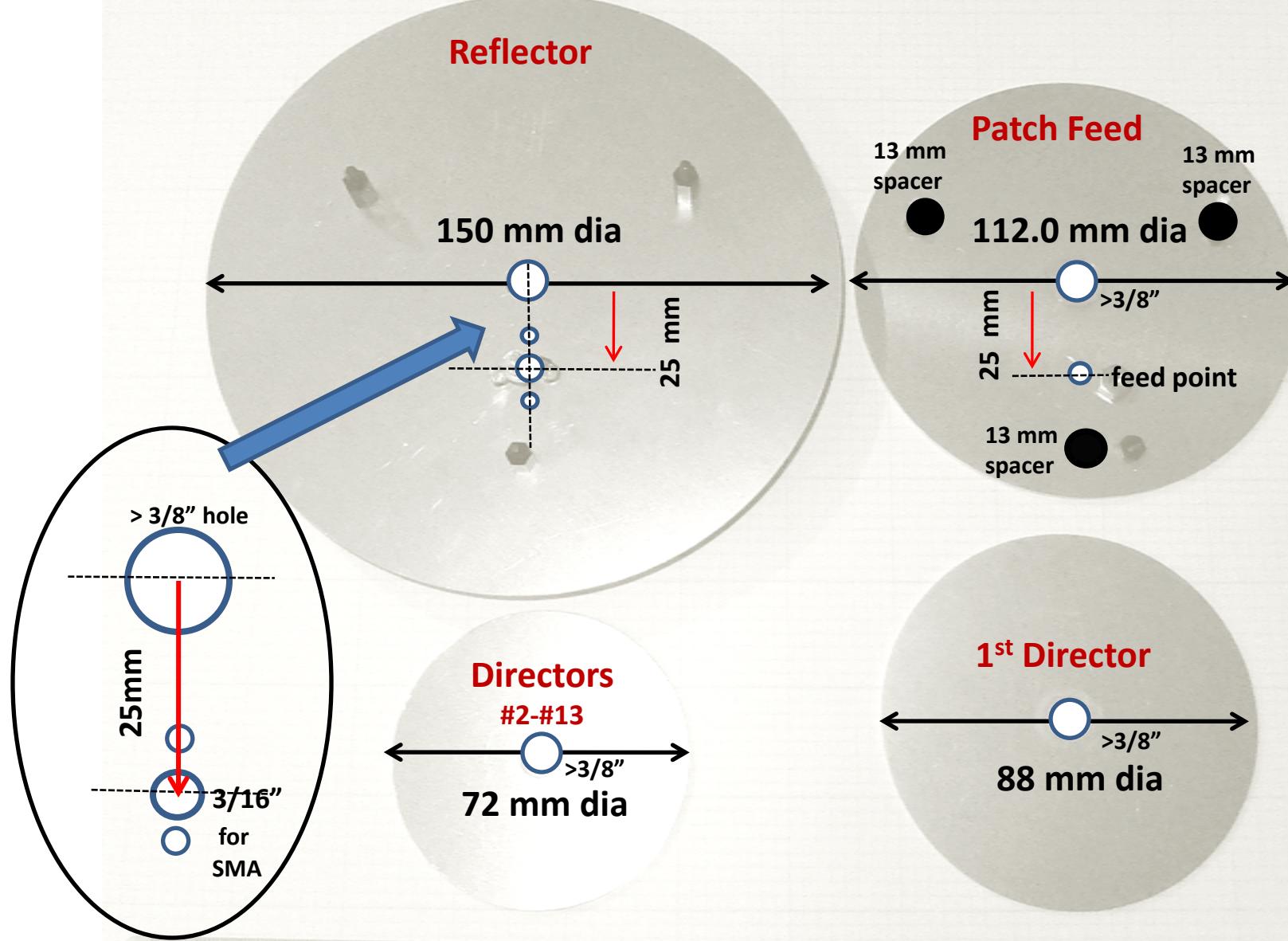
[Visit the TOOLMAK Store](#)

4.5 ★★★★☆ ✓ 258 ratings

600+ bought in past month

-17% \$9<sup>99</sup>

# Cir Patch Feed Plate Yagi Component Dimensions



# Fabrication Details

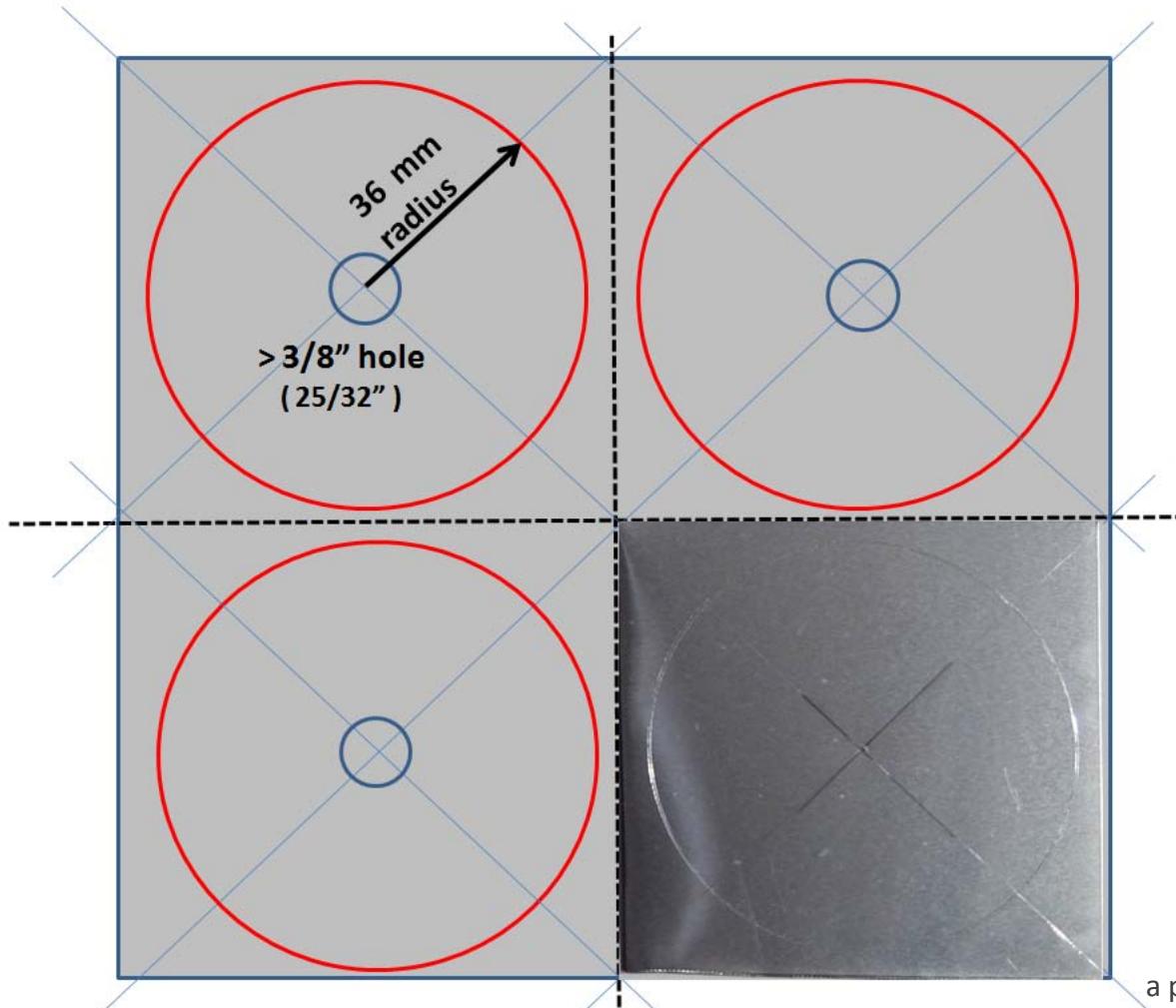
## 72 mm diameter Director Layout

*it may be easier to drill all 4 dowel rod holes before cutting sheet into small pieces*

*indent centers w/ punch or sharp nail*

*Start with a 1/16" drill bit and work progressively in 3 or 4 steps to 3/8"+ ( 25/64")*

*( OR cut out all circles , stack, clamp properly, and drill all 72mm disks at one time*



# *Fabrication Details*

**Remove excess outer aluminum in stages to make final cut easier  
the small amount remaining will curl away and not cause the disk to distort**



**Because of the amount of aluminum that must be cut away and the 0.030"  
thickness of the 112.5mm Patch Feed disk, It is the Most Difficult  
Trim away excess in small steps..  
The less material that is removed at each step , the easier each is to cut.**



**Left Cut Aviation Shears  
( for a right handed person )**

# *Fabrication Details*

## **Cutting Spacers to Length**

use a C-clamped wood block as both a length guide  
and to hold the miter block to a table



## **Spacer Sleeve Dimensions**



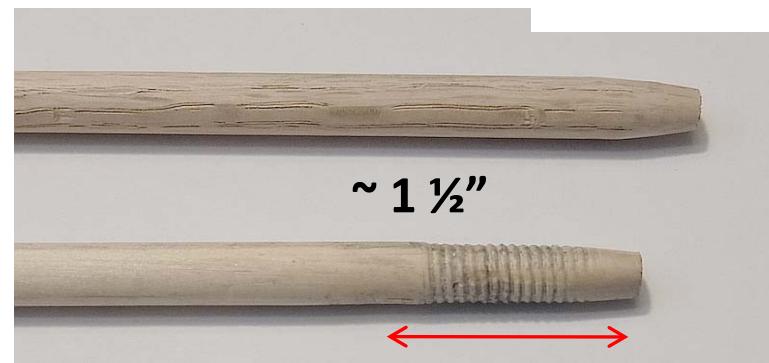
13mm 50mm 40mm 60mm

13mm spacers of plastic or wood



# *Fabrication Details*

**Threading Wood Dowel Rod**  
**Taper the dowel ends & Start the nut by hand**  
**( rub candle wax on dowel to make threading easier )**



# Fabrication Details

## Use Wood Block for Base

### Glue / Screw Wood Block

for **Tripod Mount** capability :

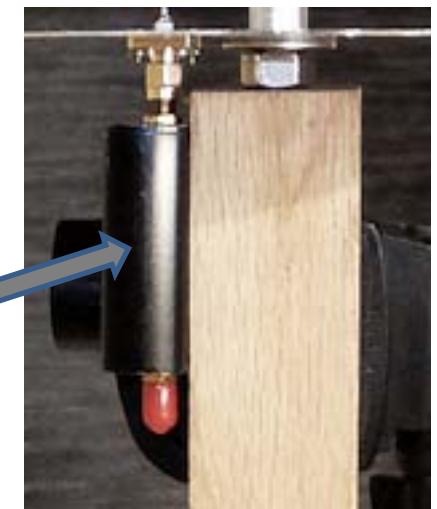
Drill 7/16" hole and make a thread pattern  
with a 1/4"x 20tpi screw to match **Tripod Shoe**



### Wood Block Dimensions

$\frac{3}{4}'' \times 1\frac{1}{4}'' \times 3''$  (not critical ... *Except*, the Optimal Orientation of the Antenna's Beam Pattern is such that the Feed Point is East <> West.  
Meaning : The Width of the block needs to accommodate the SMA connector & LNA amp unit )

3/8" hole for Dowel (drill from each end)



# Fabrication Details

## Aluminum Spacers

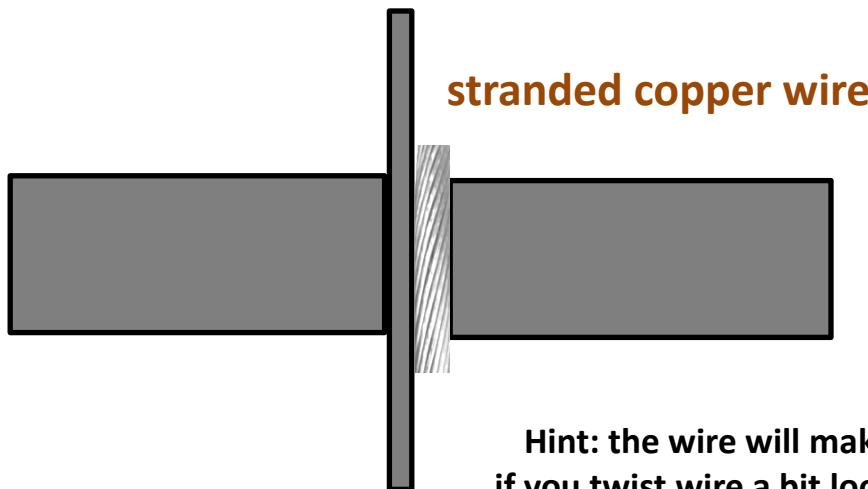
It is important that good physical and electrical contact exist between each Disk and Spacer

As it is all but Impossible to saw perfectly smooth right angles on each Spacer end,  
There needs to be a method to compensate.

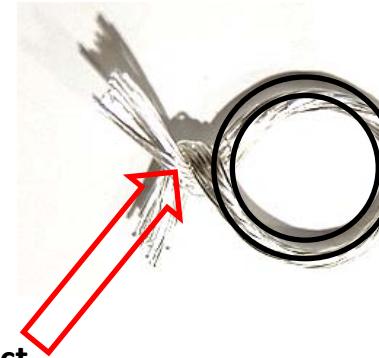
Solution :

Add a loop of **stranded copper wire** to maintain Good Electrical Continuity between each element  
>> When Compressed It will fill in small gaps <<

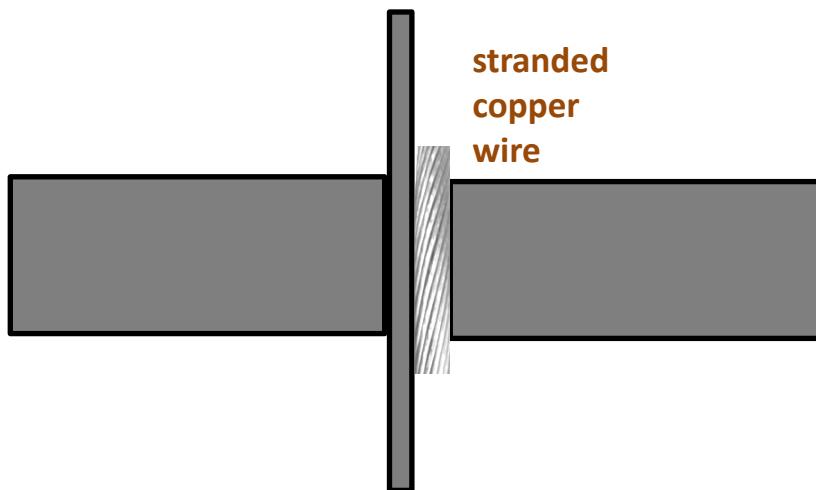
Tinned copper wire will not oxidize as easily as **bare copper**



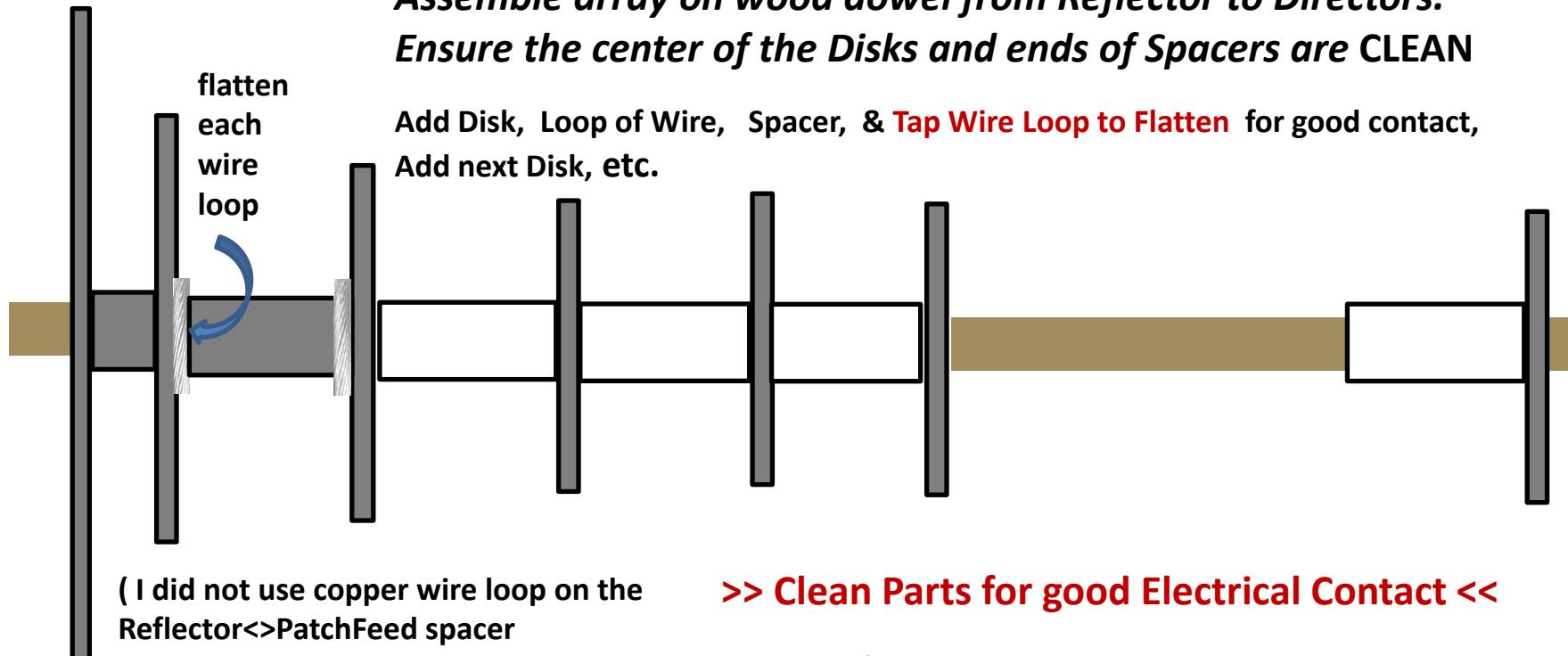
Hint: the wire will make better contact if you twist wire a bit loosely so the thicker overlap is *not* under the Spacer



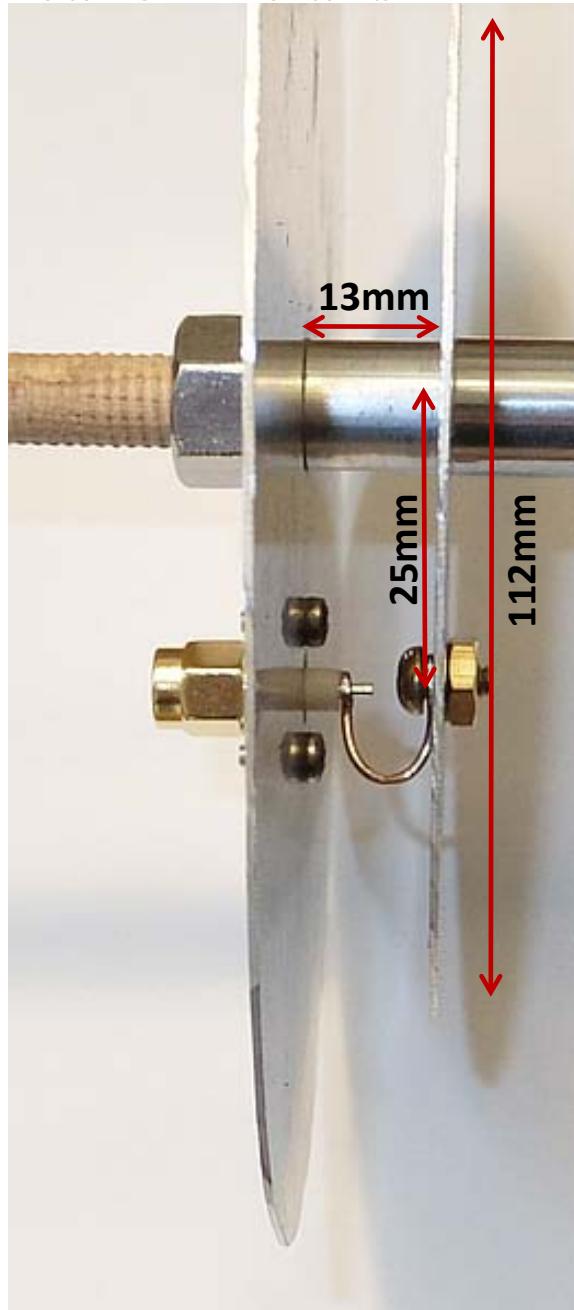
# Fabrication Details



*Assemble array on wood dowel from Reflector to Directors.  
Ensure the center of the Disks and ends of Spacers are CLEAN*



# Fabrication Details



## Patch Feed Construction Details

### >> Most Critical Dimensions <<

**112 mm Diameter of the patch feed**

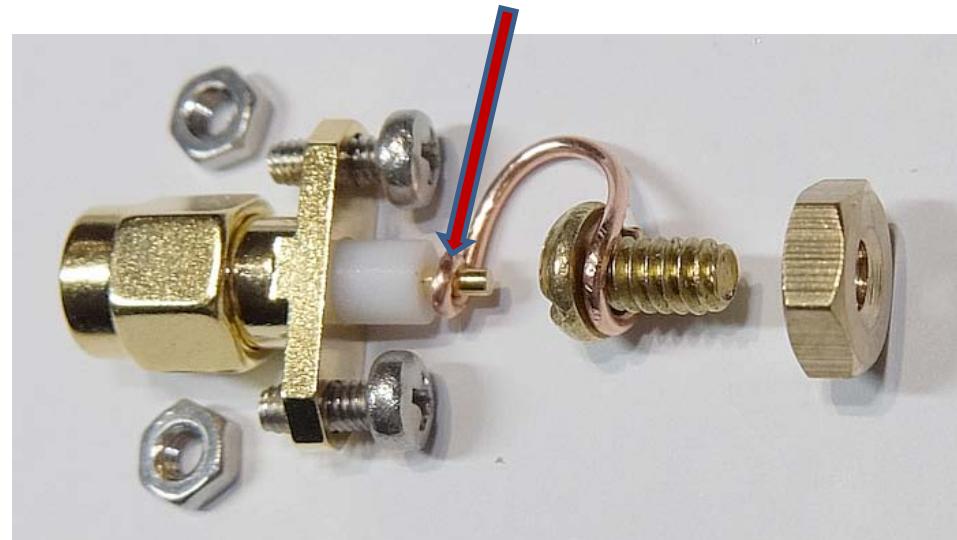
**13 mm spacer Thickness reflector<>patch feed**

**25 mm Radius of the Feed Point**

( plastic spacers not installed in photo )

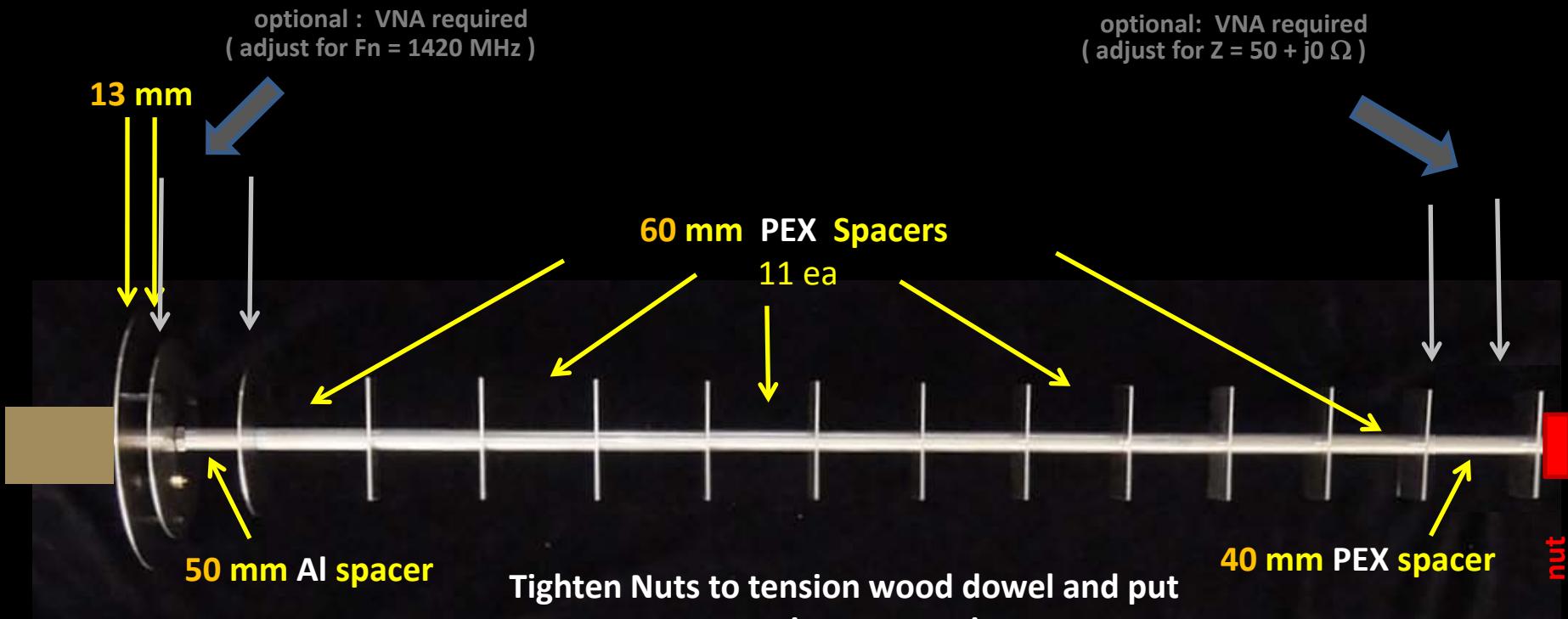
( copper wire loop on the SMA center conductor pin  
**Should Be Soldered**

after SMA connector is installed on Reflector Disk )



**>> Clean Parts for good Electrical Contact <<**

# Cir Patch Feed Disk Yagi Dimensions for Student Edition



Reflector 150 mm dia

Patch Feed 112 mm dia

Director# 01 88 mm dia

Director# 02 72 mm dia

Director #13 72 mm dia

**Cir Patch Feed Disk  
Yagi  
Student Edition**

**Mounting Options**

# Interface Ideas

## low cost lightweight Tripod



Roll over image to zoom in

JOILCAN Tripod for Camera, Camera Tripod 67" Heavy Duty Tripod, Phone Tripod for Video Recording Photo Vlog, Aluminum Camera Tripods with Holder & Travel Bag for Camera DSLR

[iPhone Projector Laser](#)

Visit the JOILCAN Store

4.5 ★★★★★ 1,580 ratings

| [Search this page](#)

300+ bought in past month

**-24% \$27<sup>99</sup>**



a petit jr Aug24

LNA ( low noise amplifier ) Installation :  
optimal orientation is for the feed point to be East-West

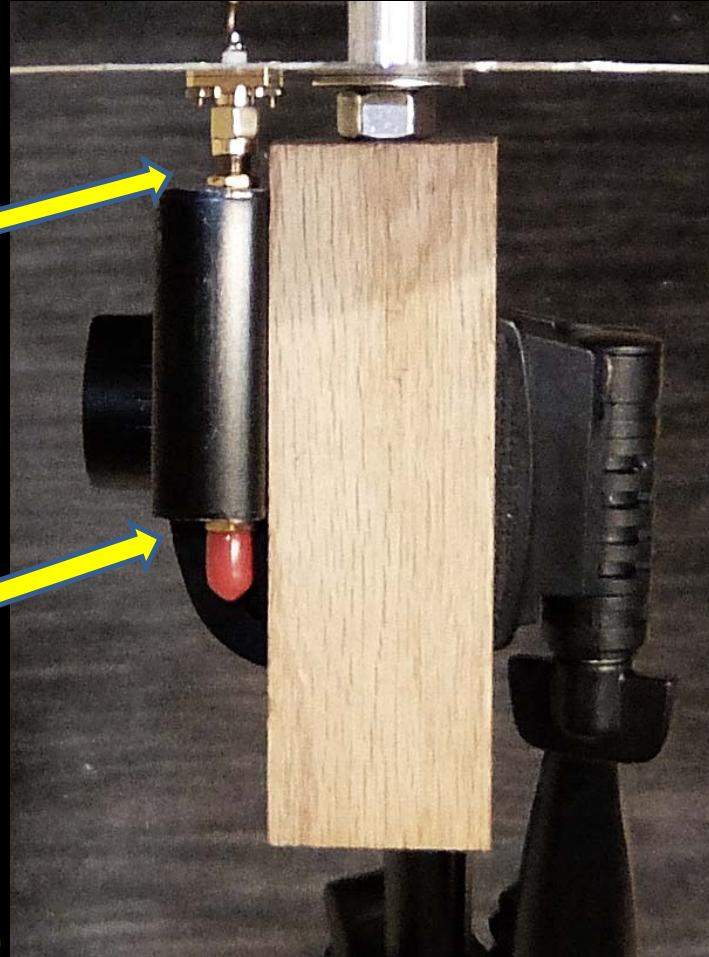
**LNA : INPUT**

signal  
from  
antenna

**LNA : OUTPUT**

amplified signal  
to  
coaxial cable

( other end of  
cable connects to  
SDR  
software defined radio )



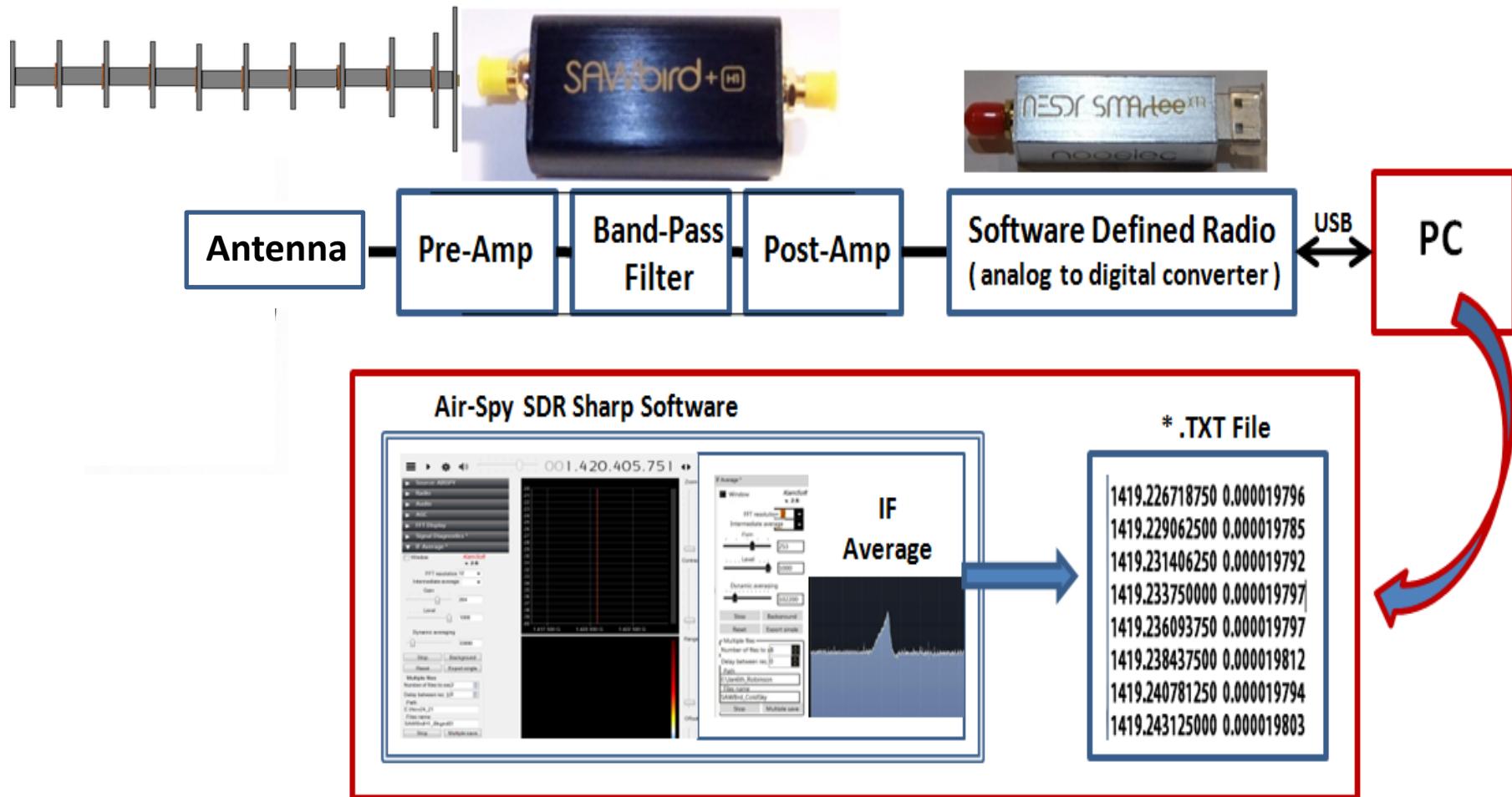
**\*\* Improving Weather Resistance \*\***

**Overnight Dew Shield : use a plastic polyethylene container**

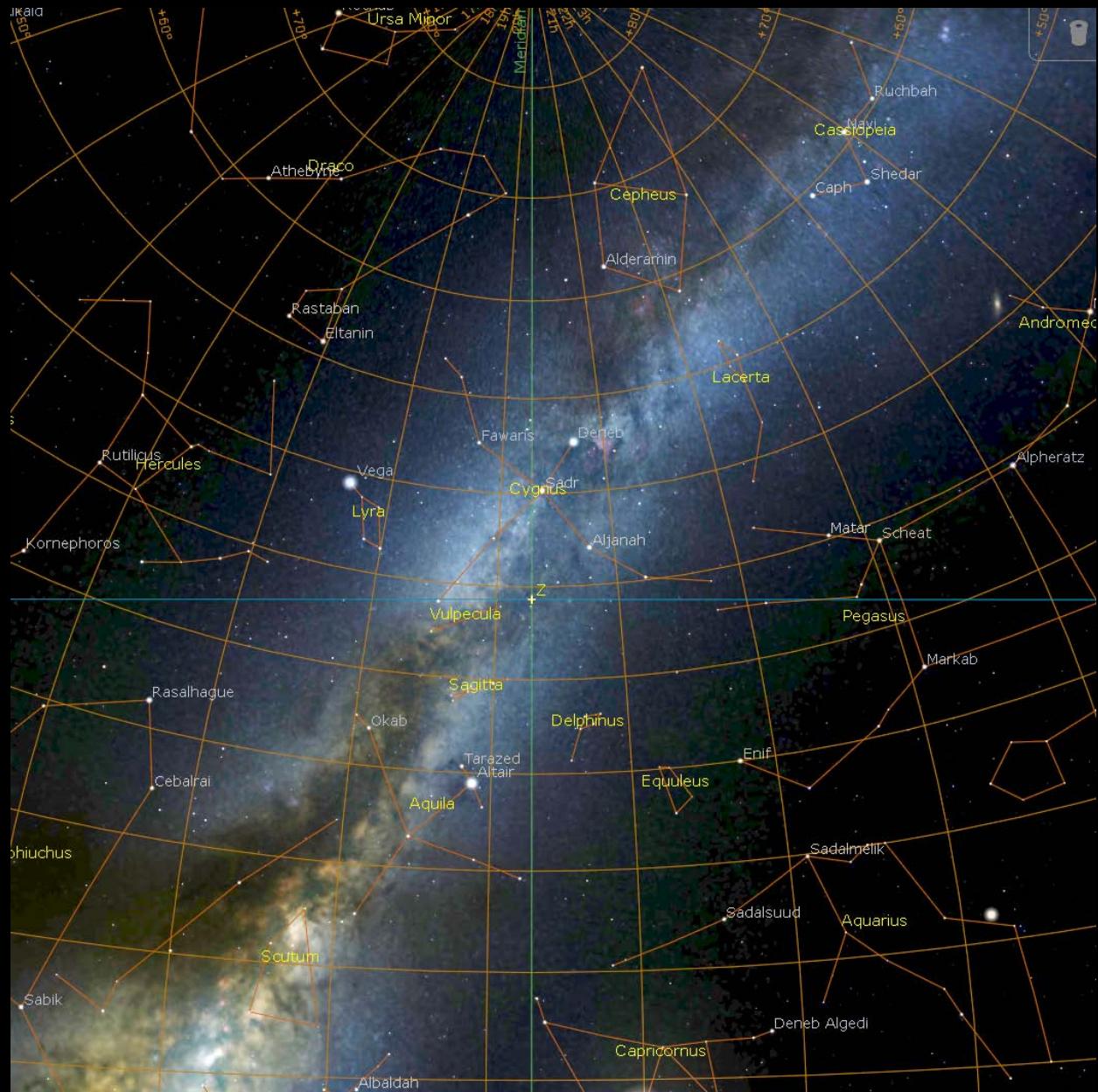


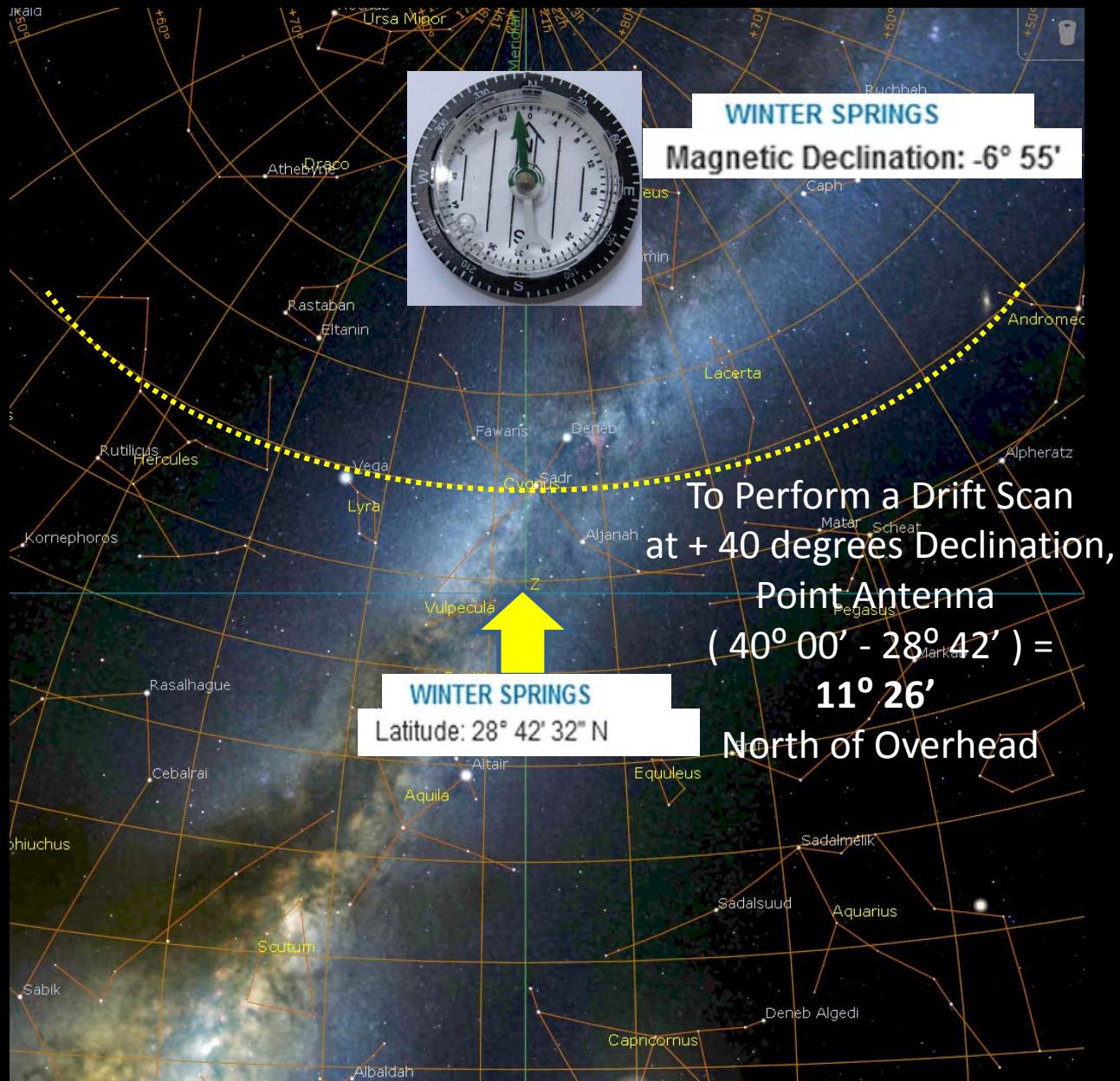
# System Hardware and Software

Hardware & Software System Block Diagram



# Stellarium Planetarium Software





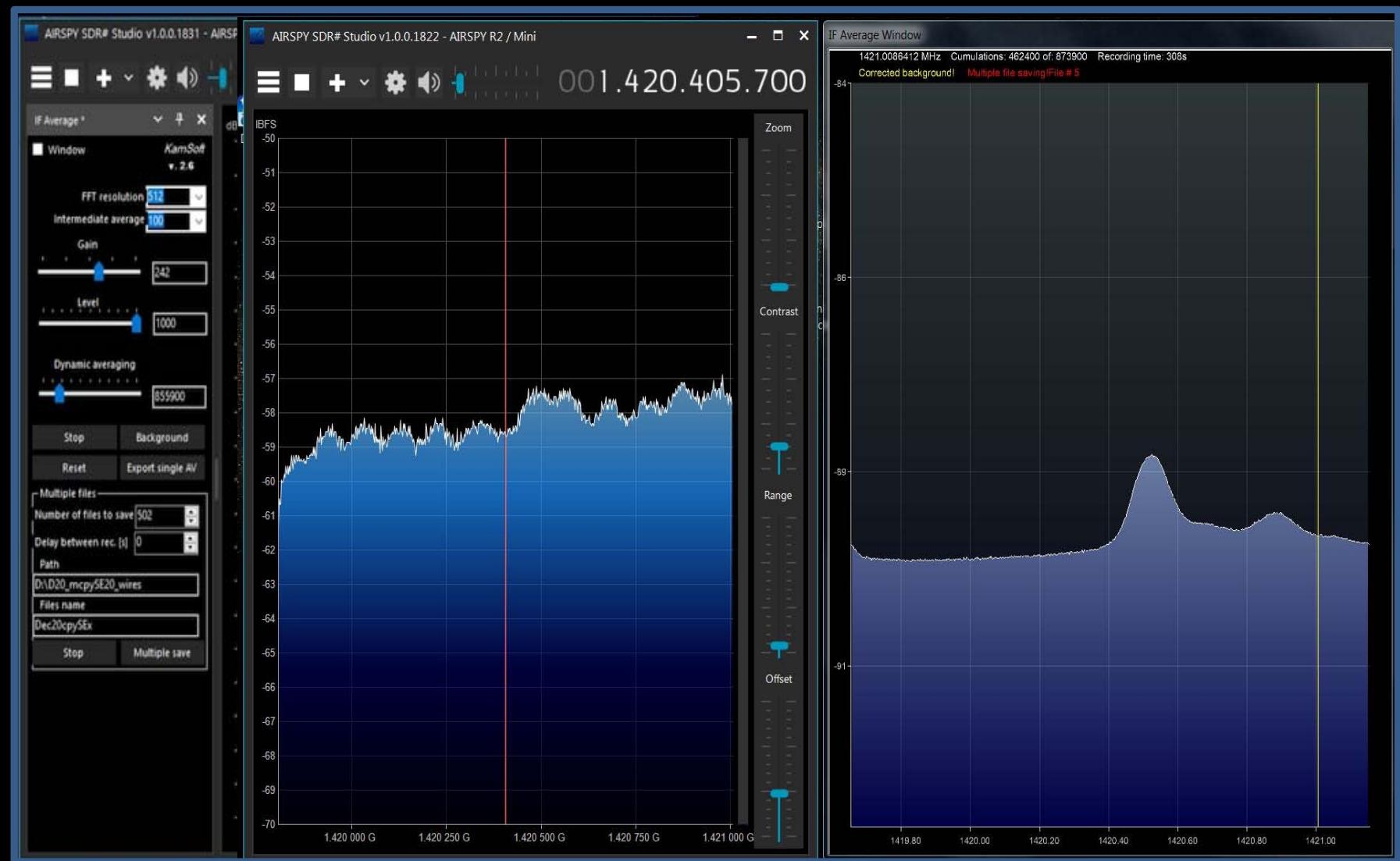


To Perform a Drift Scan  
at + 40 degrees Declination,  
Point Antenna  
 $(40^\circ 00' - 28^\circ 42') =$   
**11° 26' towards**  
North of Overhead

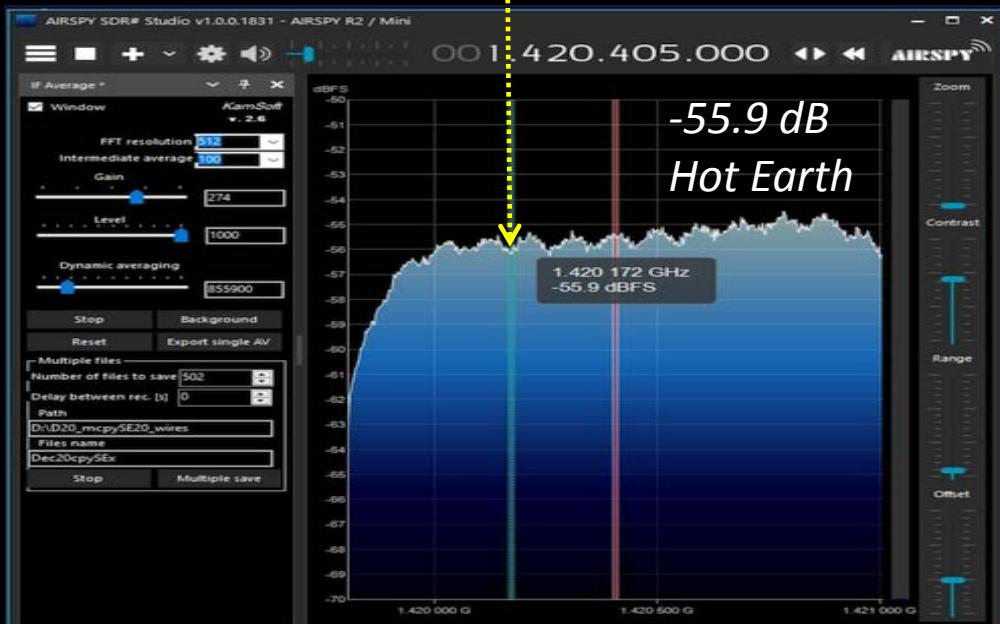
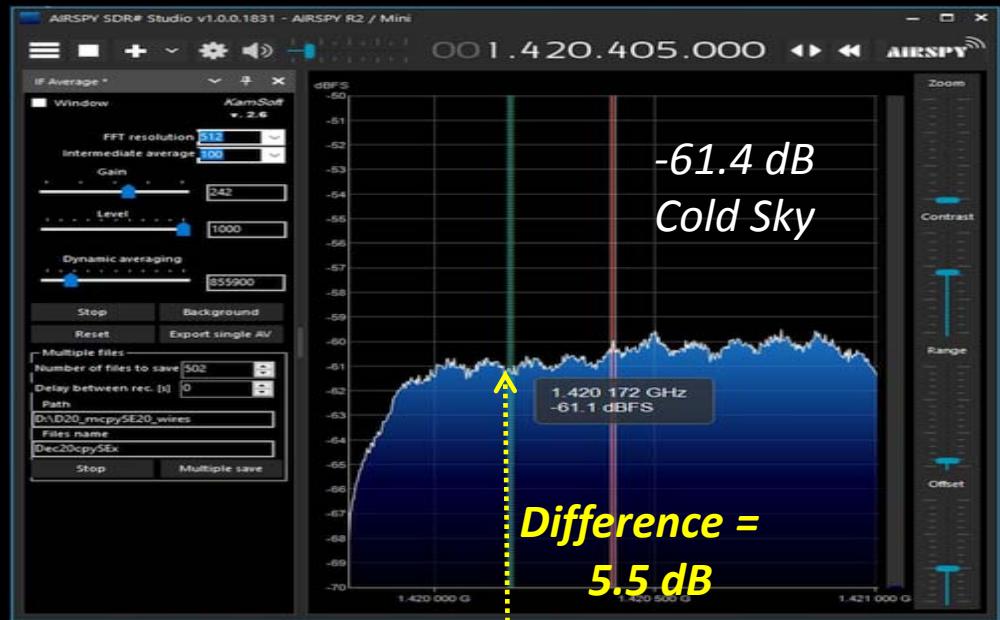


# Signal Acquisition Software

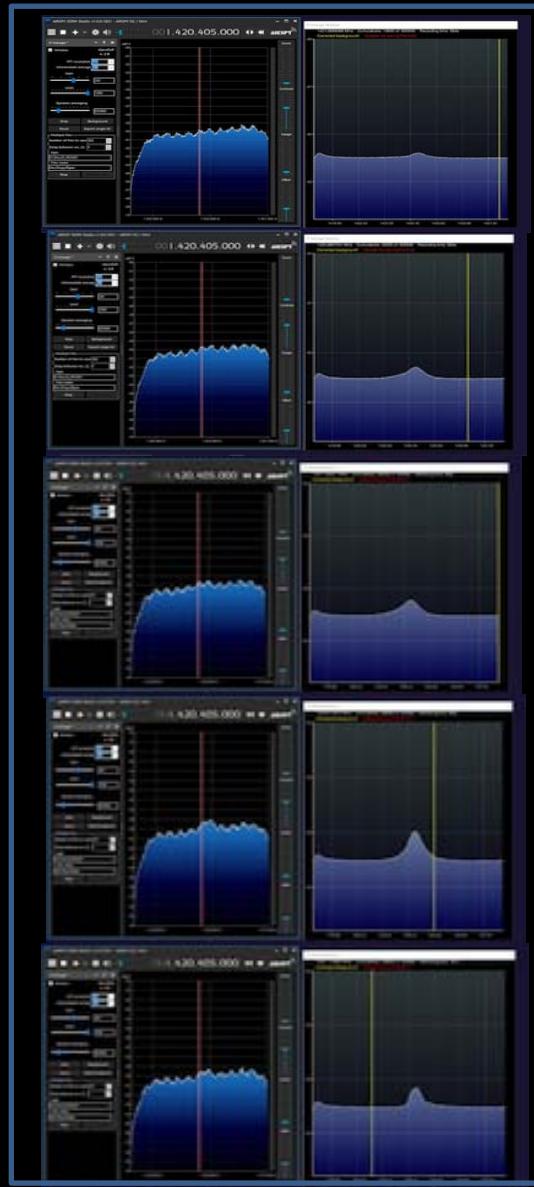
## AirSpy SDR# Studio & Kaminski IF\_Ave Plugin software



# System Operational Verification Hot\_Earth vs Cold\_Sky

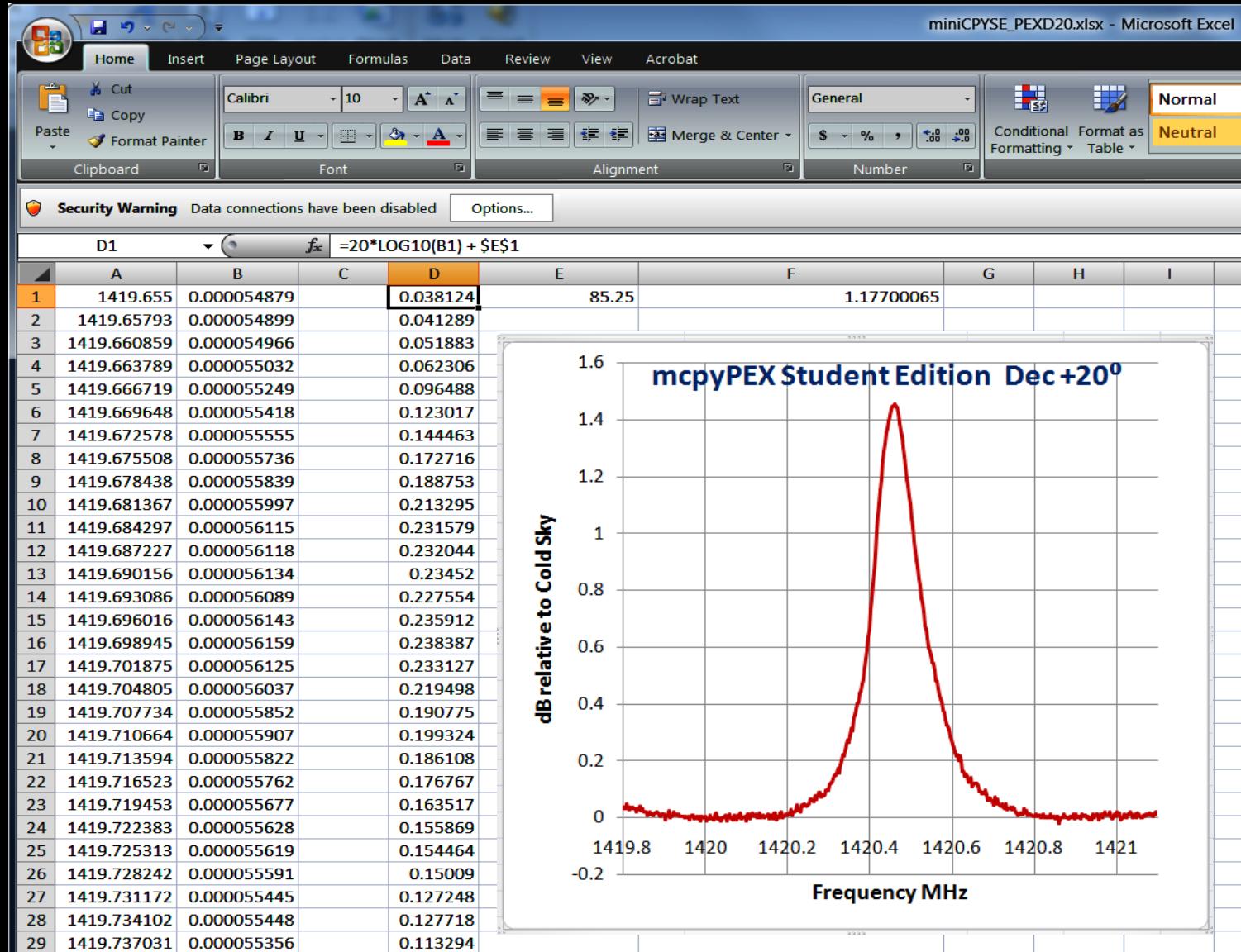


# Perform a Drift Scan and Save a Data File Set

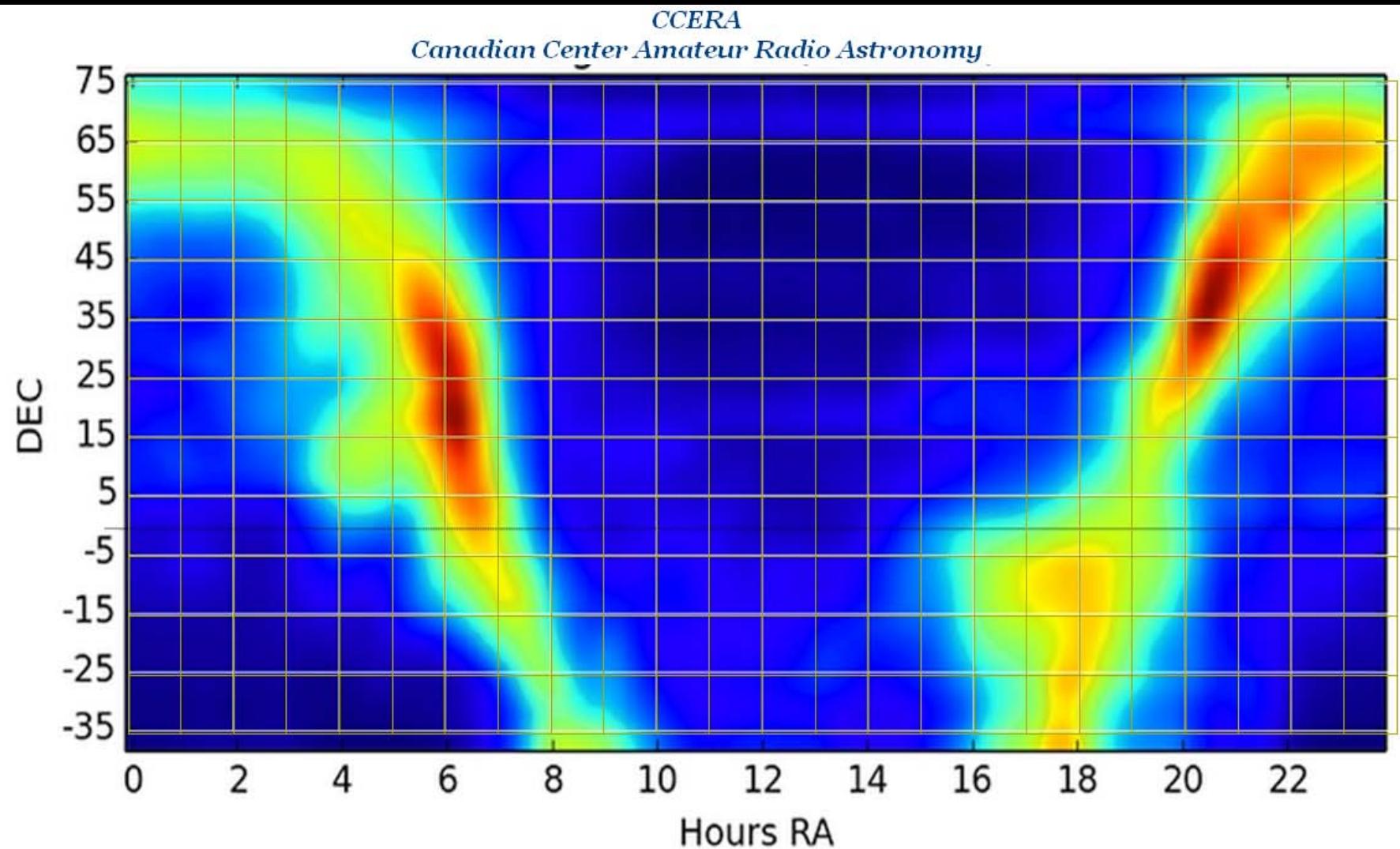


Dec40_cpy_SE01_0001.txt	8/18/2024 11:31 A...	Text Document	15 KB
Dec40_cpy_SE01_0002.txt	8/18/2024 11:36 A...	Text Document	15 KB
Dec40_cpy_SE01_0003.txt	8/18/2024 11:41 A...	Text Document	15 KB
Dec40_cpy_SE01_0004.txt	8/18/2024 11:46 A...	Text Document	15 KB
Dec40_cpy_SE01_0005.txt	8/18/2024 11:50 A...	Text Document	15 KB
Dec40_cpy_SE01_0006.txt	8/18/2024 11:55 A...	Text Document	15 KB
Dec40_cpy_SE01_0007.txt	8/18/2024 12:00 PM	Text Document	15 KB
Dec40_cpy_SE01_0008.txt	8/18/2024 12:05 PM	Text Document	15 KB
Dec40_cpy_SE01_0009.txt	8/18/2024 12:10 PM	Text Document	15 KB
Dec40_cpy_SE01_0010.txt	8/18/2024 12:15 PM	Text Document	15 KB
Dec40_cpy_SE01_0011.txt	8/18/2024 12:20 PM	Text Document	15 KB
Dec40_cpy_SE01_0012.txt	8/18/2024 12:24 PM	Text Document	15 KB
Dec40_cpy_SE01_0013.txt	8/18/2024 12:29 PM	Text Document	15 KB
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Dec40_cpy_SE01_0017.txt	8/18/2024 12:49 PM	Text Document	15 KB
Dec40_cpy_SE01_0018.txt	8/18/2024 12:54 PM	Text Document	15 KB
Dec40_cpy_SE01_0019.txt	8/18/2024 12:59 PM	Text Document	15 KB
Dec40_cpy_SE01_0020.txt	8/18/2024 1:03 PM	Text Document	15 KB
Dec40_cpy_SE01_0021.txt	8/18/2024 1:08 PM	Text Document	15 KB
Dec40_cpy_SE01_0022.txt	8/18/2024 1:13 PM	Text Document	15 KB
Dec40_cpy_SE01_0023.txt	8/18/2024 1:18 PM	Text Document	15 KB

# Plot Data via Excel ( Open\_Office\_Calc )



# Reference Chart MW neutral hydrogen distribution



## Software

AirSpy SDR# Studio and Kaminski IF\_Ave plug-in

<https://www.dropbox.com/scl/fi/2f67lyu6qgt2cp98rg9kp/SDR-2.ZIP?rlkey=y82yv6jzjyu7e92sap3x8ewm7&st=tcil7w3s&dl=0>

Stellarium planetarium software

<https://stellarium.org>

( Excel or Apache Open Office Calc )

<https://www.openoffice.org/product/calc.html>

# Software

( 2D Data Set Processing and 3D Graphics )

