W5HN

North Texas NTMS Microwave Society

NTMS Beacon Antennas and Beacon Update

KA5BOU, WA5TKU, WW2R

January 2009

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Slotted Waveguide Antenna

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- Section of waveguide for desired frequency with slots spaced at electrical half-wavelengths on both sides
- Omnidirectional pattern in azimuth
- Tight horizontal pattern in elevation
- Vertical slots provides horizontal polarization

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Typical Antenna Patterns

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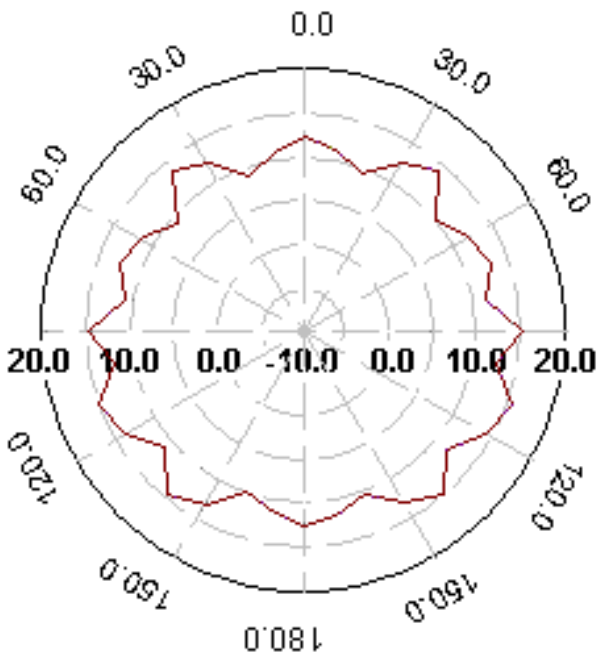
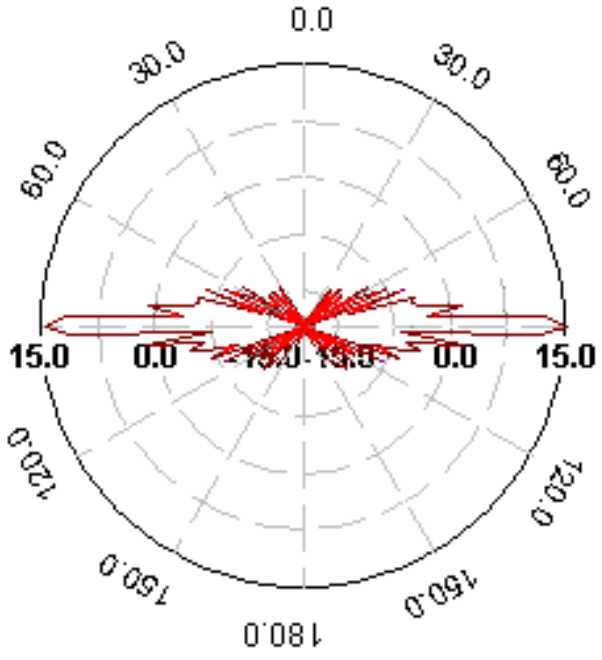


Azimuth Pattern Gain Display (dBi)



Elevation Pattern Gain Display (dBi)

How's it Work?

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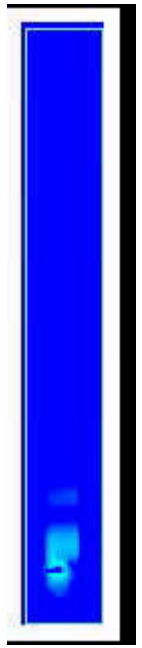
- Each slot is effectively a dipole antenna
- Array of slots phase together to provide gain and form desired pattern
- Movie shows array of 8-slots along a single broad face
- Lot's of detail provided in W1GHZ's online Antenna Handbook



NTMS Beacon Project

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- Construct updated beacons for 2304, 3456, 5760, and 10 GHz
- Single Box for ease of installation
- Segregated beacon assemblies for ease of maintenance
- New slotted waveguide antennas for better performance

Beacon Package Block Diagram

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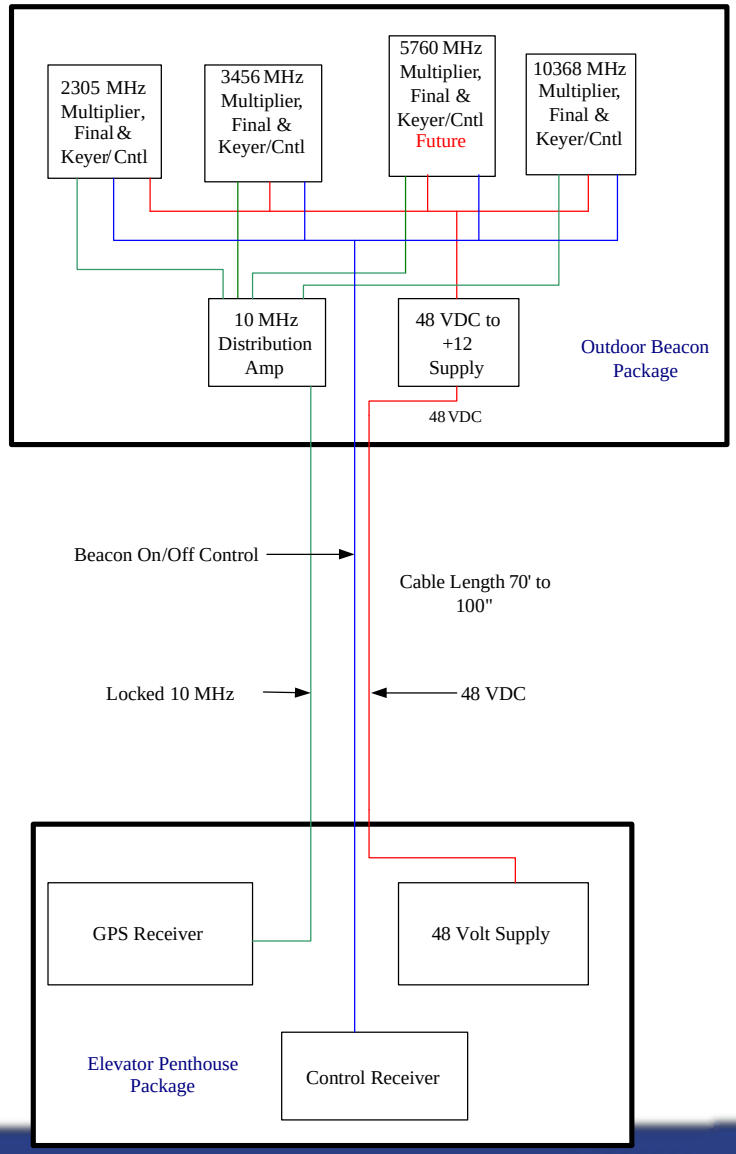
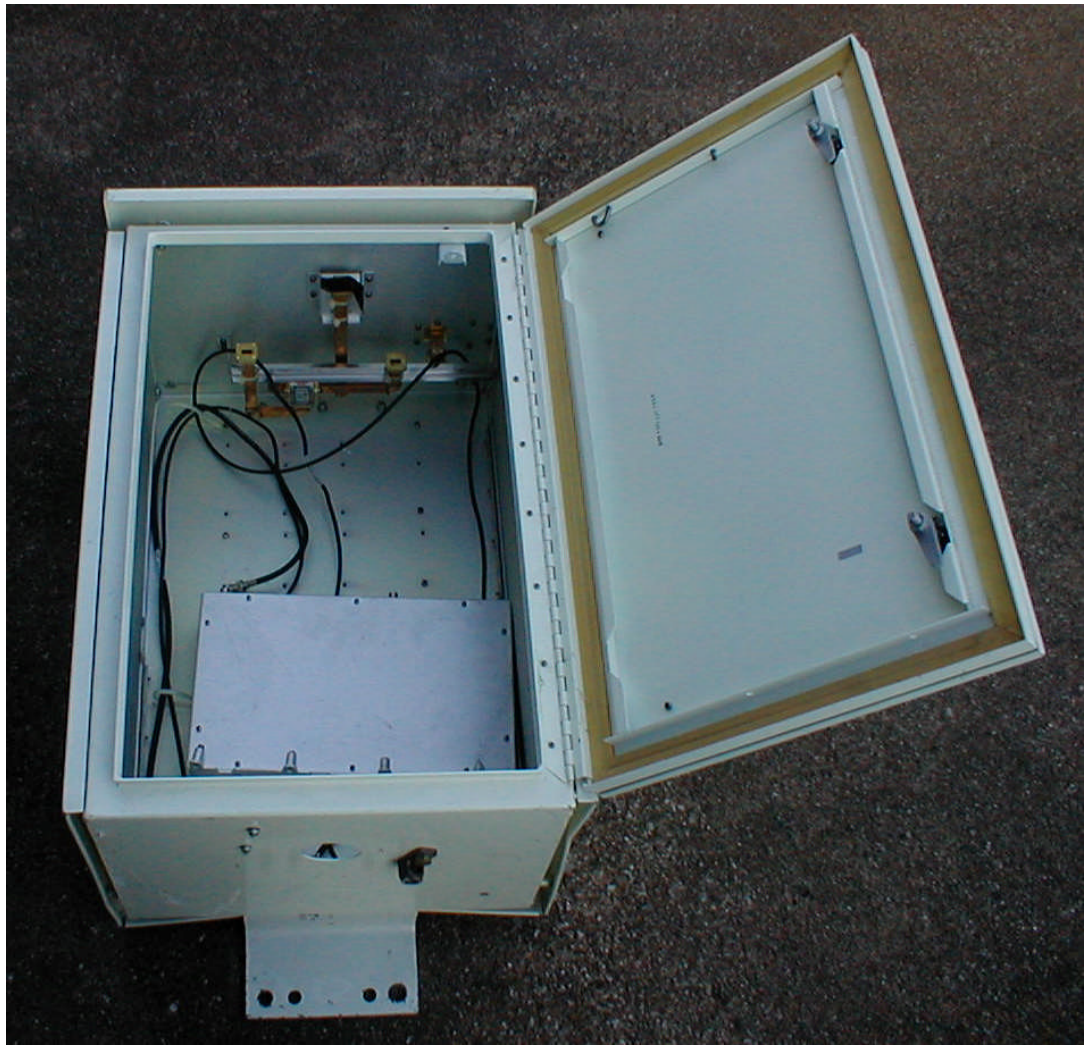


Beacon Box



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New Antennas for NTMS Beacons

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- To support the new beacons, new antennas were constructed for each of the four bands
  - 2304 – 2” x 4” aluminum tube
  - 3456 – WR-229 waveguide
  - 5760 – WR-187 waveguide
  - 10368 – WR-75 waveguide
- Target of 10-12 dB gain for each band

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2304 Antenna Specs

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Waveguide Slot Antenna Calculator

updated 5/30/2002 ***W1GHZ 2000***

Parameter	Metric		Inches		Metric		Inches	
ENTER INPUT PARAMETERS HERE:								
Frequency	2.3043	GHz	**2.304**	GHz				
Waveguide large dim	95.377	mm	**3.755**	inch				
Waveguide small dim	44.78	mm	**1.763**	inch				
Number of slots	12		**12**	**total on two sides**				
Estimated Performance	**Gain =**		**9.1**	dB	**Beamwidth=**		**12.4**	deg
READ FINAL SLOT DIMENSIONS HERE:								
	old from KB7TRZ				*improved from Elliott*			
Offset from centerline	8.66	mm	0.341	inch	**9.57**	**mm**	**0.377**	**inch**
Length	65.09	mm	2.563	inch	**63.28**	**mm**	**2.492**	**inch**
Width	8.91	mm	0.351	inch	**6.62**	**mm**	**0.261**	**inch**
Slot spacing center to cen	89.06	mm	3.506	inch	**89.06**	**mm**	**3.506**	**inch**
End space = 1/4 wave	44.53	mm	1.753	inch	**44.53**	**mm**	**1.753**	**inch**
End space = 3/4 wave	133.60	mm	5.260	inch	**133.60**	**mm**	**5.260**	**inch**
End space is from shorted end to center of last slot								
Wavelength - free space	130.19	mm	5.126	inch				
Wavelength - cutoff	190.75	mm	7.510	inch				
Guide wavelength	178.13	mm	7.013	inch				

2304 Antenna Layout

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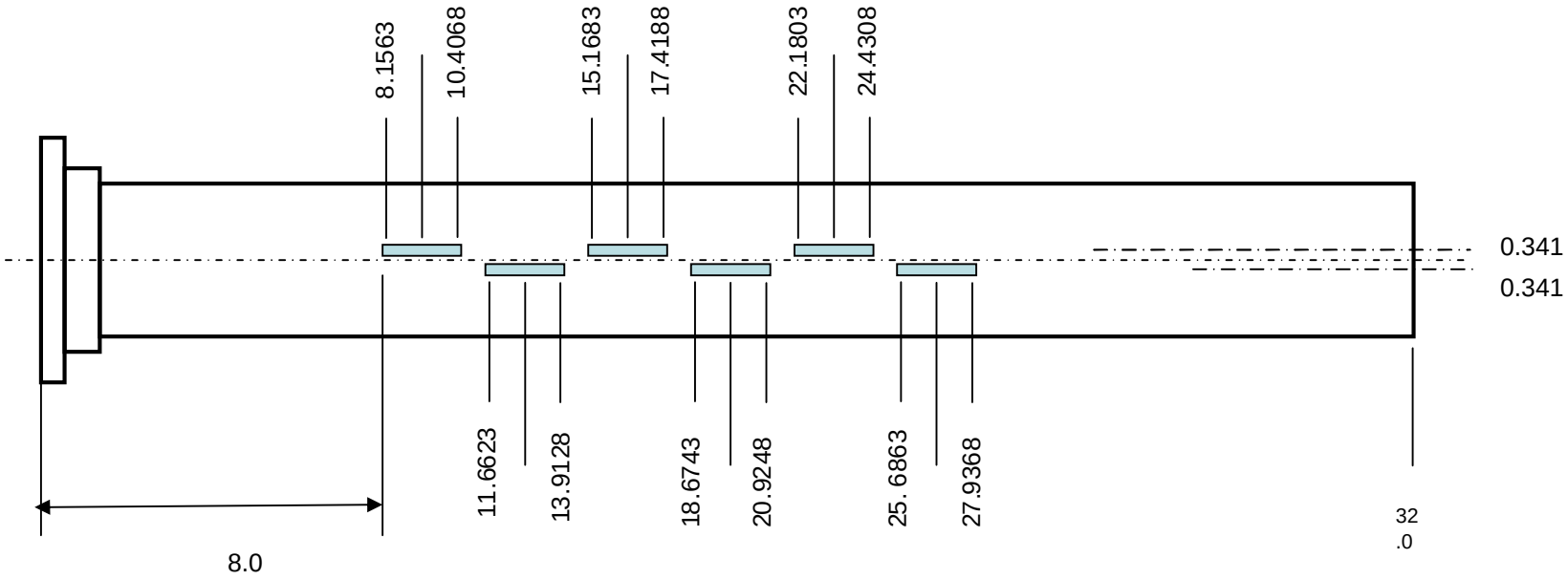

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3456 Antenna Specs

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Waveguide Slot Antenna Calculator

updated 5/30/2002

W1GHZ 2000

Parameter	Metric		Inches		Metric		Inches	
ENTER INPUT PARAMETERS HERE:								
Frequency	3.4563	GHz	**3.456**	GHz				
Waveguide large dim	58.166	mm	**2.29**	inch				
Waveguide small dim	29.21	mm	**1.15**	inch				
Number of slots	16		**16**	**total on two sides**				
Estimated Performance	**Gain =**		**10.8**	dB	**Beamwidth=**		**8.4**	deg
READ FINAL SLOT DIMENSIONS HERE:								
	old from KB7TRZ				*improved from Elliott*			
Offset from centerline	3.69	mm	0.145	inch	**4.10**	**mm**	**0.161**	**inch**
Length	43.40	mm	1.709	inch	**42.11**	**mm**	**1.658**	**inch**
Width	6.52	mm	0.257	inch	**4.04**	**mm**	**0.159**	**inch**
Slot spacing center to cer	65.18	mm	2.566	inch	**65.18**	**mm**	**2.566**	**inch**
End space = 1/4 wave	32.59	mm	1.283	inch	**32.59**	**mm**	**1.283**	**inch**
End space = 3/4 wave	97.77	mm	3.849	inch	**97.77**	**mm**	**3.849**	**inch**
End space is from shorted end to center of last slot								
Wavelength - free space	86.80	mm	3.417	inch				
Wavelength - cutoff	116.33	mm	4.580	inch				
Guide wavelength	130.36	mm	5.132	inch				

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5760 Antenna Specs

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Waveguide Slot Antenna Calculator

updated 5/30/2002

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Parameter	Metric	Inches		Metric	Inches
ENTER INPUT PARAMETERS HERE:					
Frequency	5.760325 GHz	**5.760** GHz			
Waveguide large dim	47.5488 mm	**1.872** inch			
Waveguide small dim	22.1488 mm	**0.872** inch			
Number of slots	20	**20** **total on two sides**			
Estimated Performance	**Gain =**	**10.8** dB		**Beamwidth=**	**8.5** deg
READ FINAL SLOT DIMENSIONS HERE:					
	old from KB7TRZ			*improved from Elliott*	
Offset from centerline	5.77 mm	0.227 inch		**6.34 mm**	**0.250 inch**
Length	26.04 mm	1.025 inch		**25.23 mm**	**0.993 inch**
Width	3.11 mm	0.123 inch		**3.30 mm**	**0.130 inch**
Slot spacing center to cen	31.12 mm	1.225 inch		**31.12 mm**	**1.225 inch**
End space = 1/4 wave	15.56 mm	0.613 inch		**15.56 mm**	**0.613 inch**
End space = 3/4 wave	46.68 mm	1.838 inch		**46.68 mm**	**1.838 inch**
End space is from shorted end to center of last slot					
Wavelength - free space	52.08 mm	2.050 inch			
Wavelength - cutoff	95.10 mm	3.744 inch			
Guide wavelength	62.24 mm	2.451 inch			

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10368 Antenna Specs

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Waveguide Slot Antenna Calculator

updated 5/30/2002 ***W1GHZ 2000***

Parameter	Metric	Inches	Metric	Inches
ENTER INPUT PARAMETERS HERE:				
Frequency	10.368 GHz	**10.368** GHz		
Waveguide large dim	19.05 mm	**0.75** inch		
Waveguide small dim	9.525 mm	**0.375** inch		
Number of slots	24	**24 total on two sides**		
Estimated Performance	**Gain =**	**12.7** dB	**Beamwidth=**	**5.5** deg
READ FINAL SLOT DIMENSIONS HERE:				
	old from KB7TRZ		*improved from Elliott*	
Offset from centerline	0.94 mm	0.037 inch	**1.04 mm**	**0.041 inch**
Length	14.47 mm	0.570 inch	**14.01 mm**	**0.552 inch**
Width	2.22 mm	0.088 inch	**1.32 mm**	**0.052 inch**
Slot spacing center to cer	22.24 mm	0.875 inch	**22.24 mm**	**0.875 inch**
End space = 1/4 wave	11.12 mm	0.438 inch	**11.12 mm**	**0.438 inch**
End space = 3/4 wave	33.36 mm	1.313 inch	**33.36 mm**	**1.313 inch**
End space is from shorted end to center of last slot				
Wavelength - free space	28.93 mm	1.139 inch		
Wavelength - cutoff	38.10 mm	1.500 inch		
Guide wavelength	44.47 mm	1.751 inch		

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Antenna Construction

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- Slots cut with End-mill of diameter close to slot width
- Lots of room left on both ends of antenna
  - Room for clamping at bottom
  - Room for u-shaped short at top
- Transitions either built into same WG (2304), or out of scraps (3456, 10368)

3456 thru 10 GHz Antennae

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2304 Antenna

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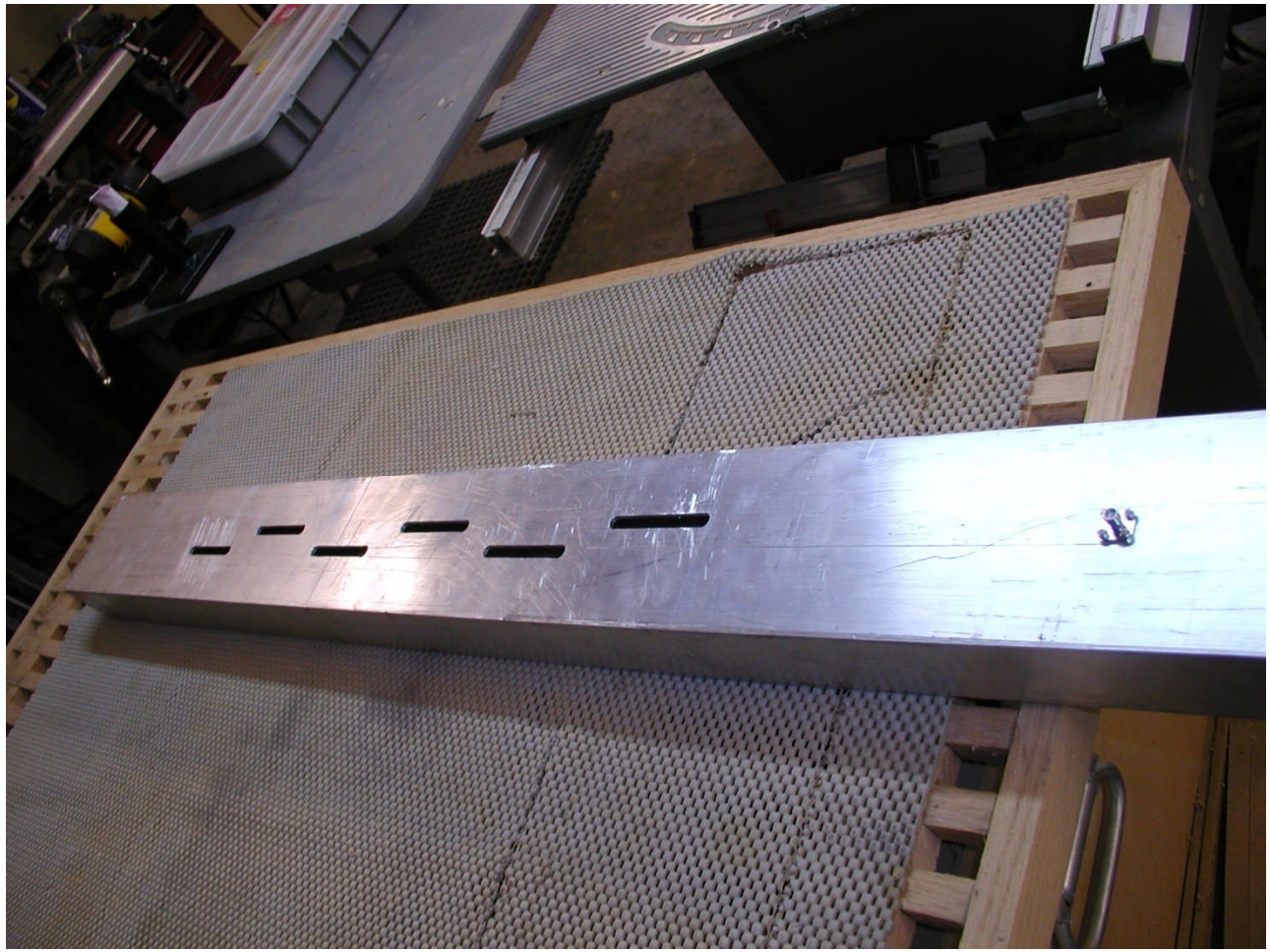

End Cap Construction

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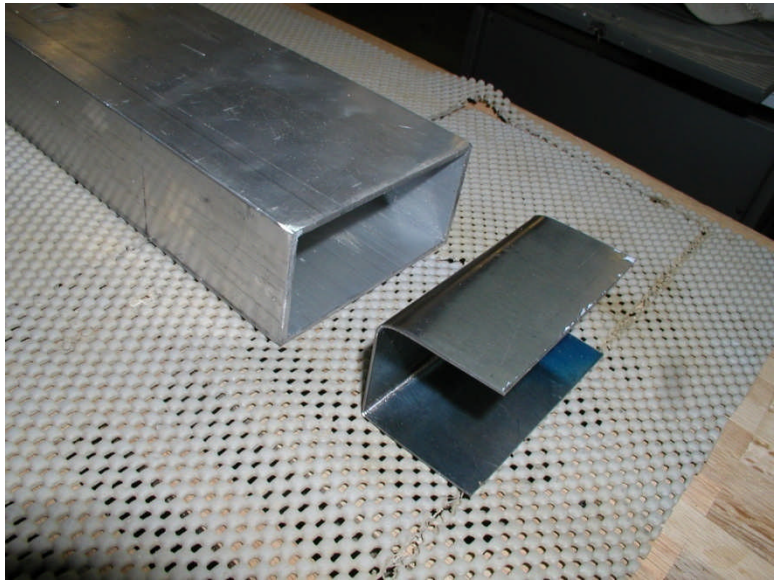

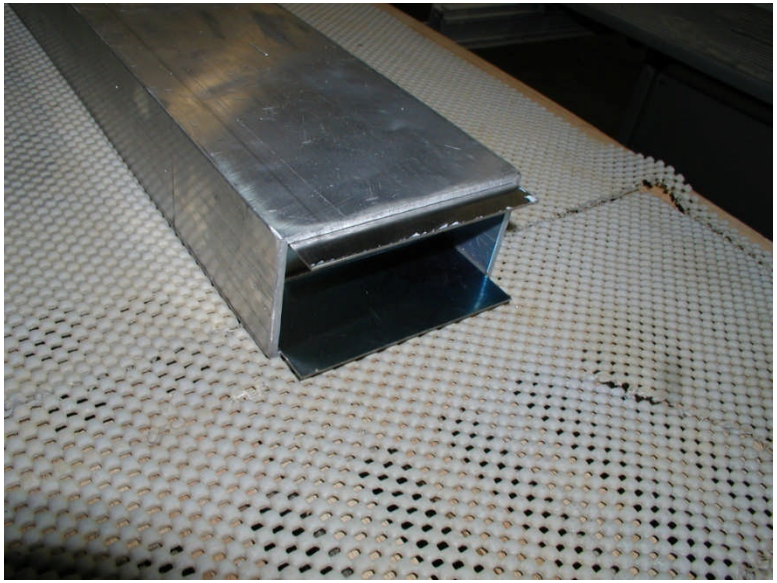

U-shaped end cap fabricated from same material as waveguide.
Friction-fit for tuning. Bolted/braised/soldered on permanently after tuning.

Antenna Mounting

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- Mounted through top of weather-proof enclosure
- “Clamps” made from angle-iron

Clamped in Place

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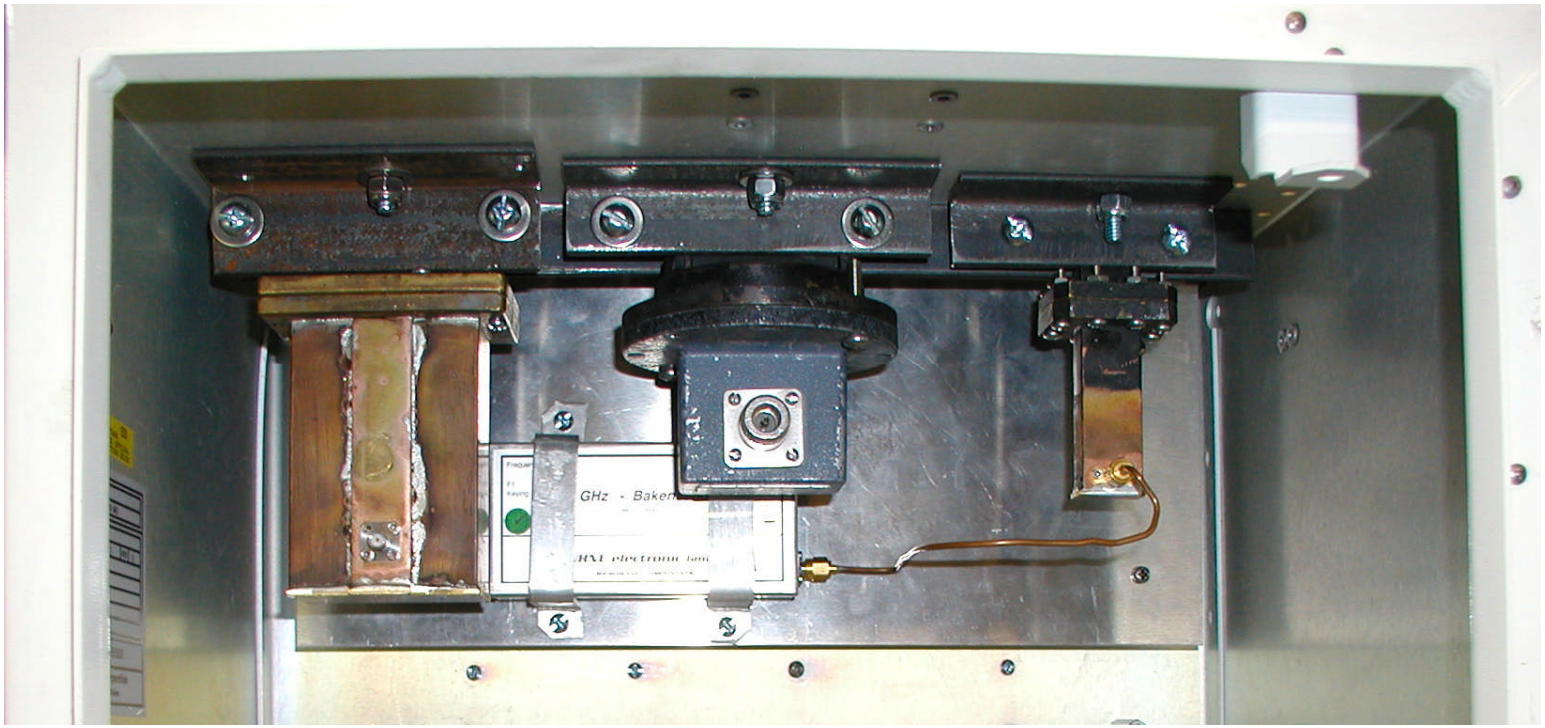

Radomes

- To protect the antennas from the weather and critters, “radomes” of PVC pipe were made
- Gain tested with/without radome in place
  - Some improvement noted with radome in place due to effect on antenna pattern

Radome Attachment

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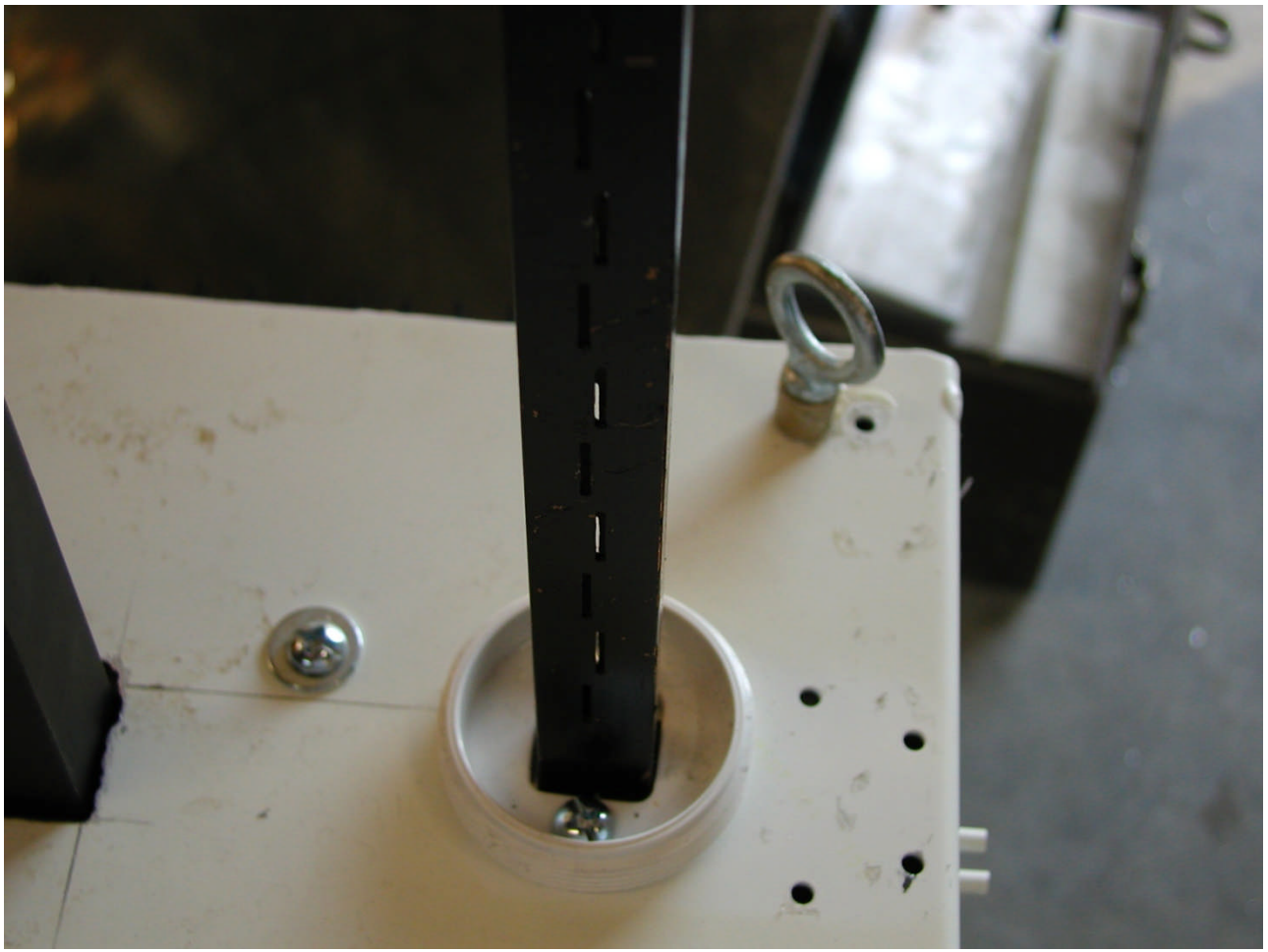

Centered in Radome

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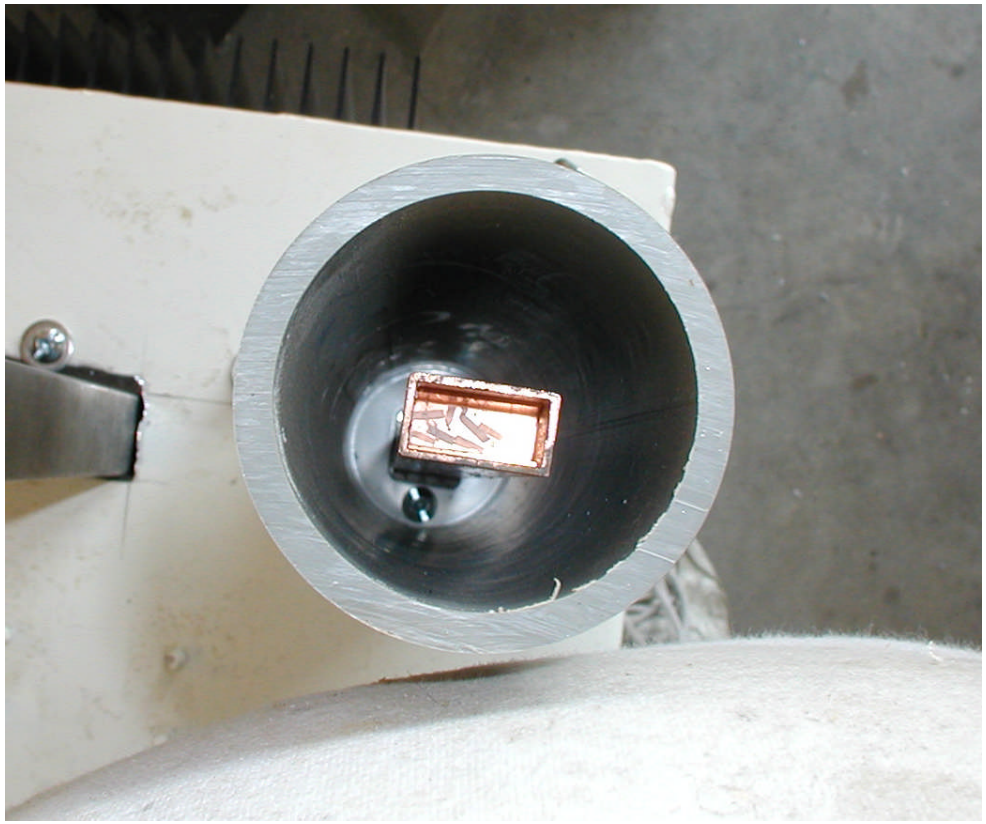

With Radomes in Place

Completed Antenna Installation

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Next Steps

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- Mount remaining beacons and supporting hardware on their plates
- Wire it up!
- Pull together work party for installation