NRL Low-Frequency Antenna Development

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NRL Low Frequency Antenna Development

Our *goal* has been to research and develop wide-bandwidth low-frequency antennas to operate from 10 MHz (~ionospheric cut-off) to approximately 120 MHz for use with LOFAR.

Our *approach* has been to model, prototype, and test antenna designs by observing actual astronomical sources (e.g. Galactic drift scans, solar bursts, and other strong sources)

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Antenna System Components

- Active Baluns – Early NRL efforts focused on using high input impedance amplifiers coupled directly to folded dipole antennas. It was our intent to mitigate the widely varying impedances associated with such antennas at lower frequencies.
- Antenna Elements – Early NRL efforts focused on folded-dipole antennas.

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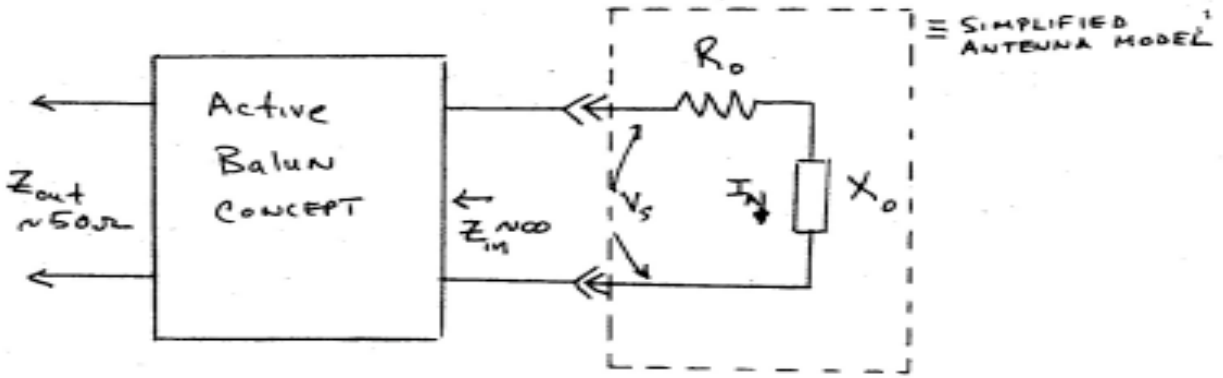

$R_o \equiv$ Radiation Resistance of Antenna
(Noiseless, signal developed across R_o)

$X_o \equiv$ Reactive Impedance of Antenna
(strong function of frequency)

For $Z_{IN} \sim \infty$, $I_A \sim 0$

$\therefore V_{X_o} \sim \emptyset$ and $V_s \sim V_{R_o}$

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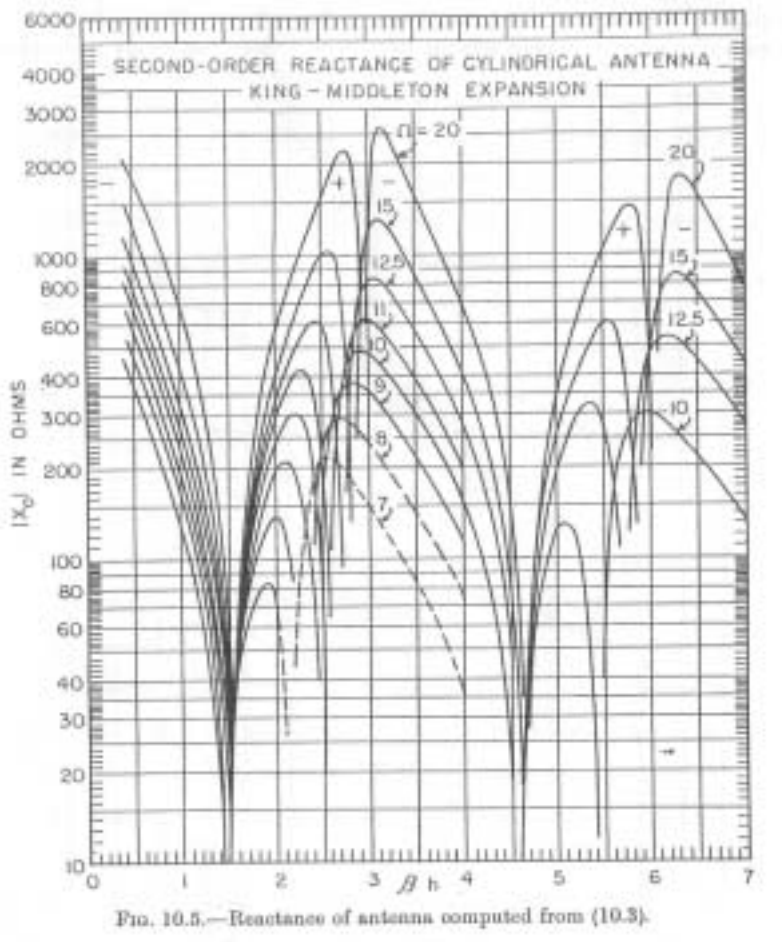
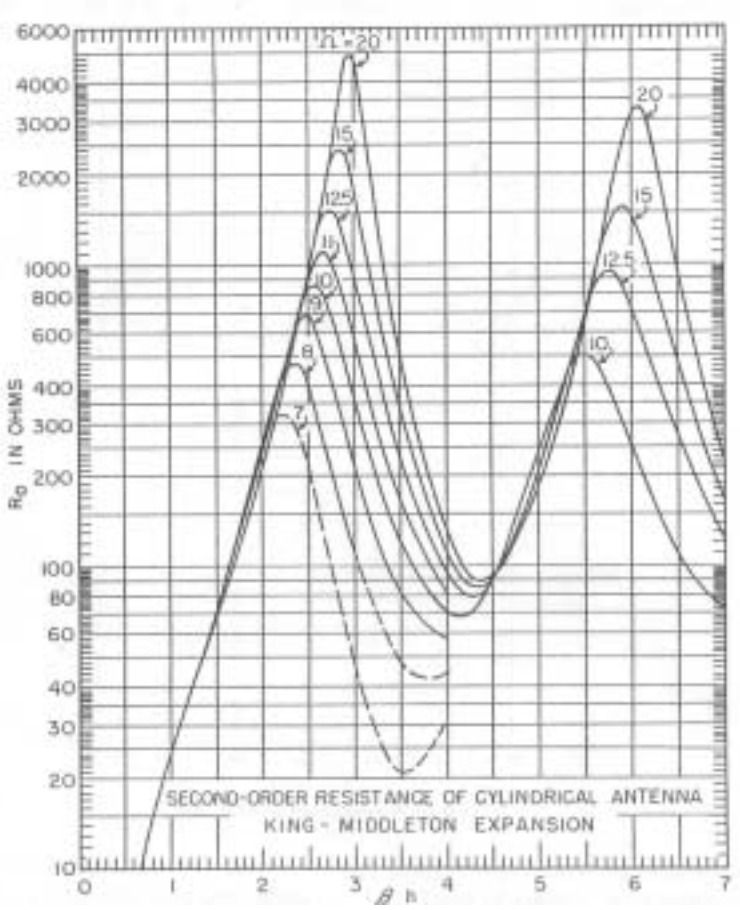


Fig. 10.5.—Reactance of antenna computed from (10.3).

Antenna Reactance vs. Frequency



Antenna Resistance vs. Frequency

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Active-dipole tests based on folded dipole

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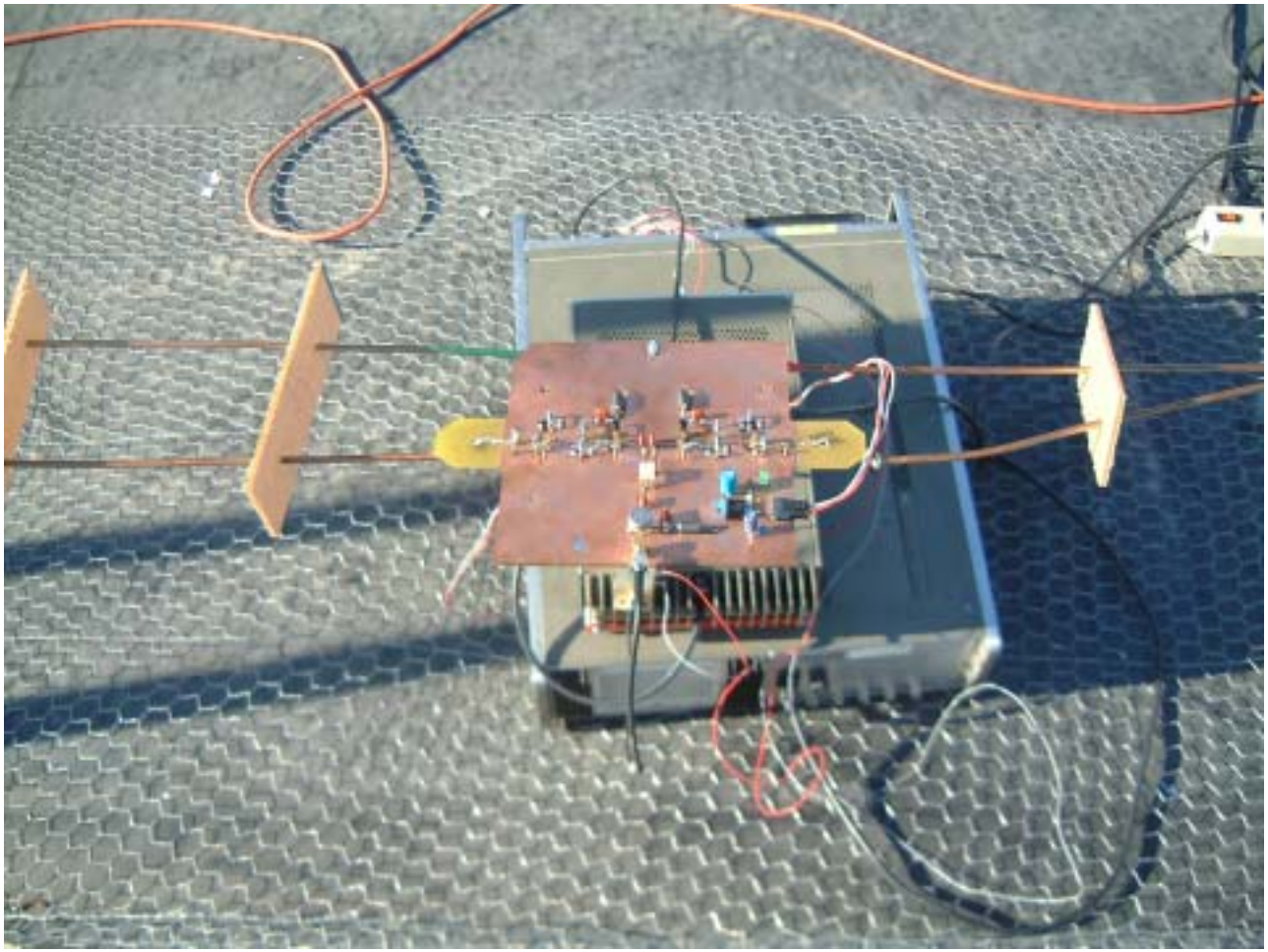

Early active-balun design coupled to folded-dipole

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Active-balun prototype utilizing commercial wide-bandwidth Operational Amplifier

Newer designs focus on mainstream components such as CATV amplifiers

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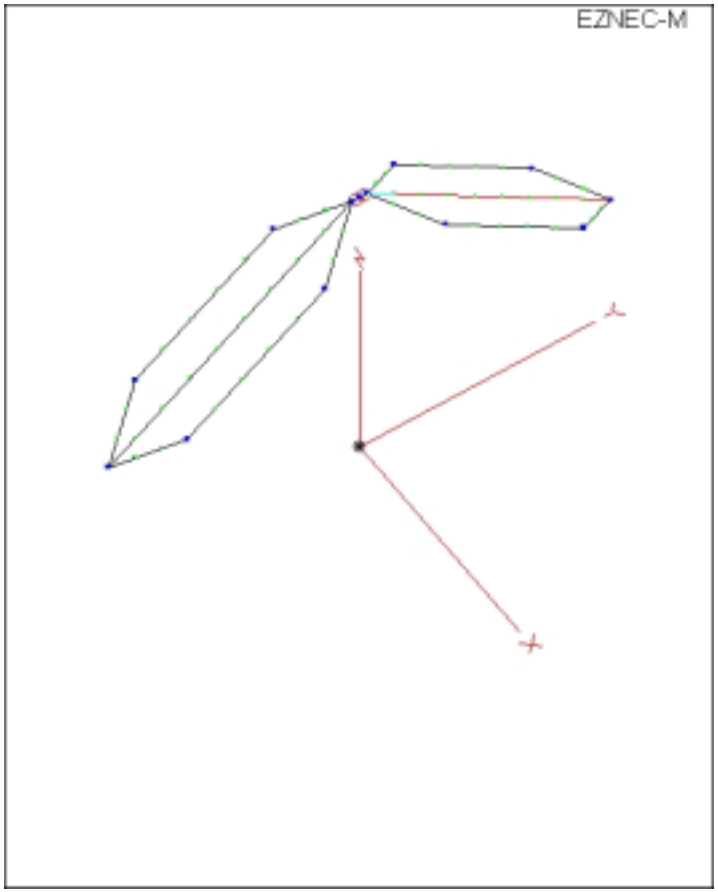

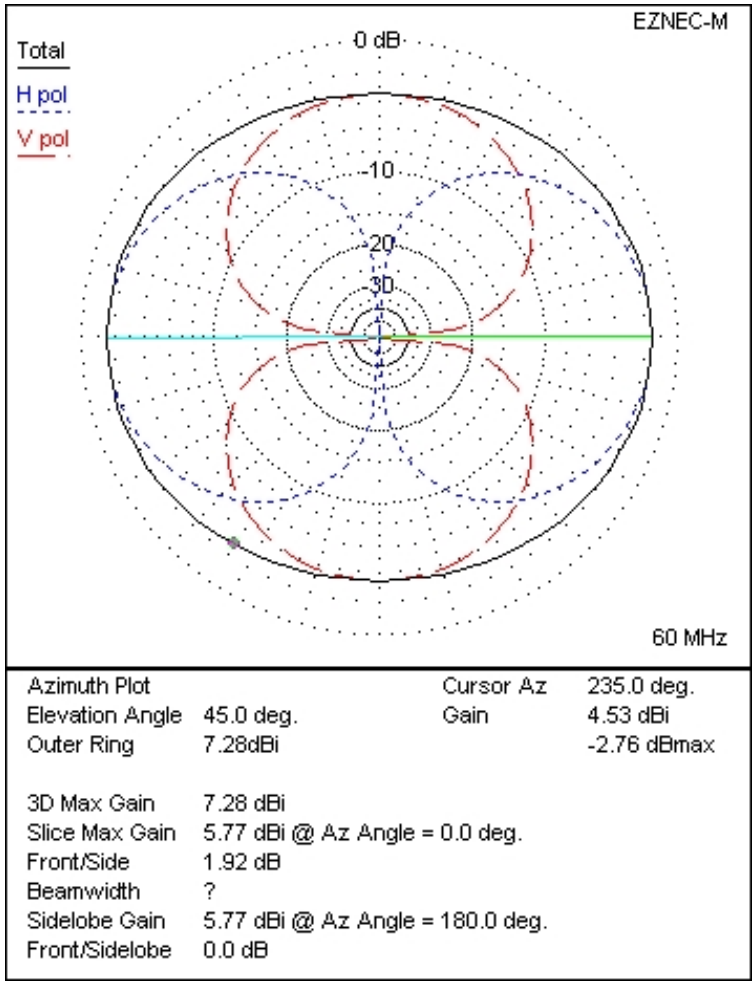

Azimuth Plot		Cursor Az	235.0 deg.
Elevation Angle	45.0 deg.	Gain	4.53 dBi
Outer Ring	7.28dBi		-2.76 dBmax
3D Max Gain	7.28 dBi		
Slice Max Gain	5.77 dBi @ Az Angle = 0.0 deg.		
Front/Side	1.92 dB		
Beamwidth	?		
Sidelobe Gain	5.77 dBi @ Az Angle = 180.0 deg.		
Front/Sidelobe	0.0 dB		

Design and Simulation of Inverted-V Dipole Antenna

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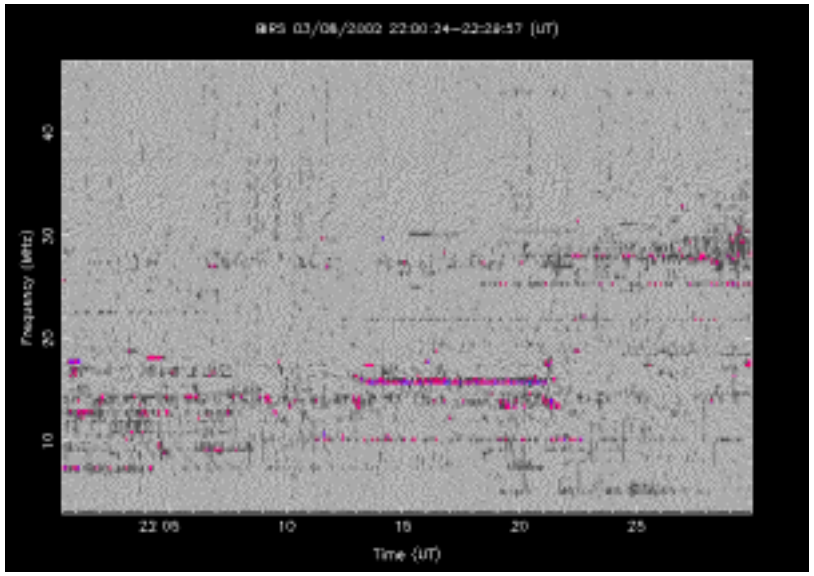
Log-Periodic at BIRS Site
(Bruny Island Radio Spectrometer)

William Erickson's BIRS system conducts solar burst observations in the 3 to 20 MHz range. In operation since 1995, BIRS utilizes digital avoidance and excision techniques to minimize terrestrial RFI. BIRS data is updated daily on its WWW site.



BIRS data from 3-8-2002

BIRS Web-Site: http://fourier.phys.utas.edu.au/birs/

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Ken Stewart

William Erickson

Groundbreaking for Recently Completed Field Tests at William Erickson's BIRS Site
(Bruny Island, Tasmania)

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Ground Screen

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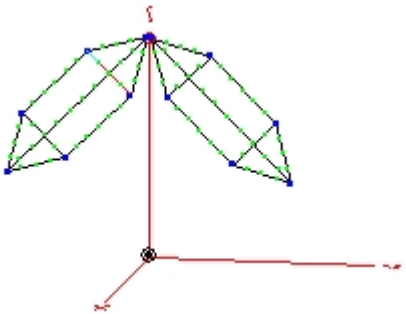

CAD Model

1.2 and 3.4 meter Dipole Prototypes at Bruny Island

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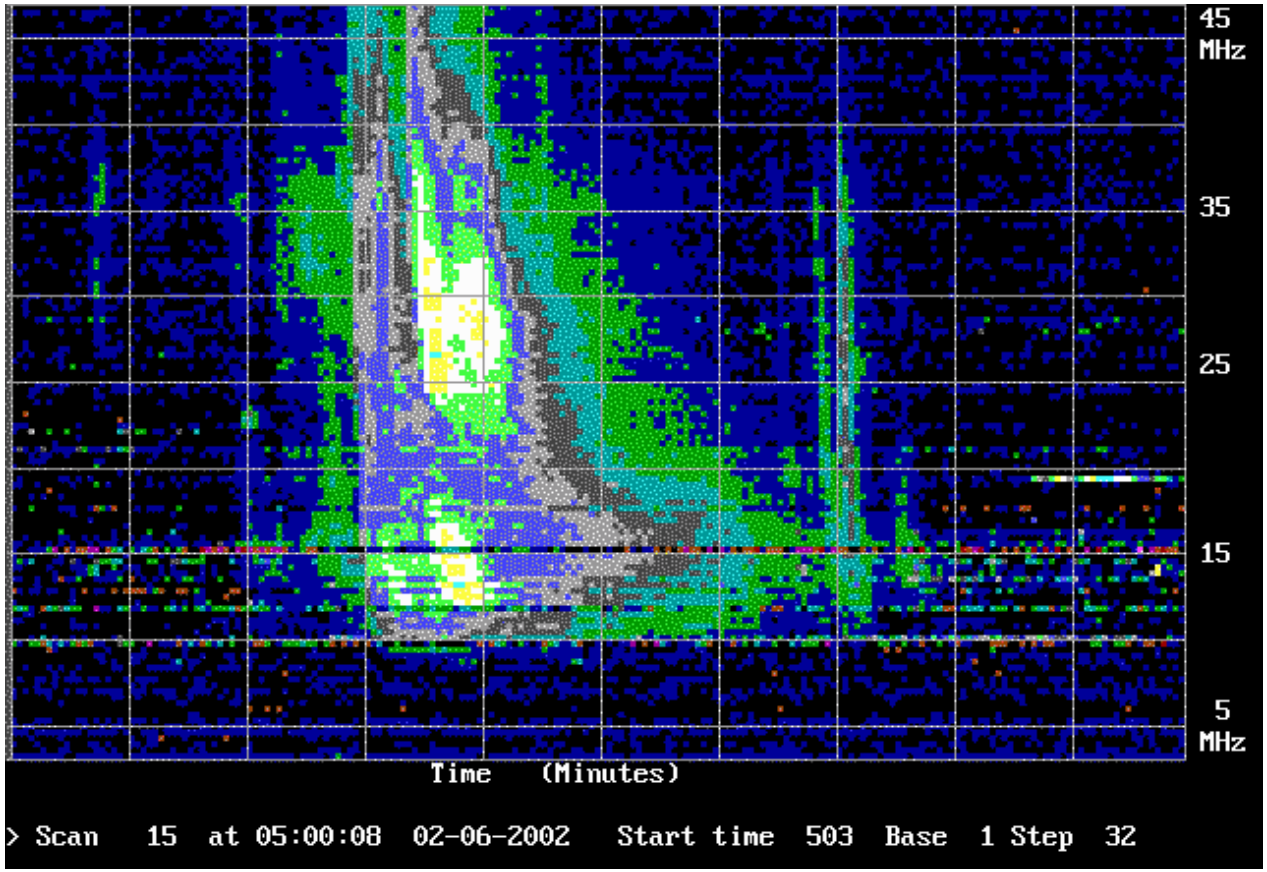

Type V Solar Burst Observed with Prototype LF Antenna

The prototype antenna was integrated into the BIRS system and astronomical observations (e.g. Galactic drift scans, solar burst observations) were conducted.

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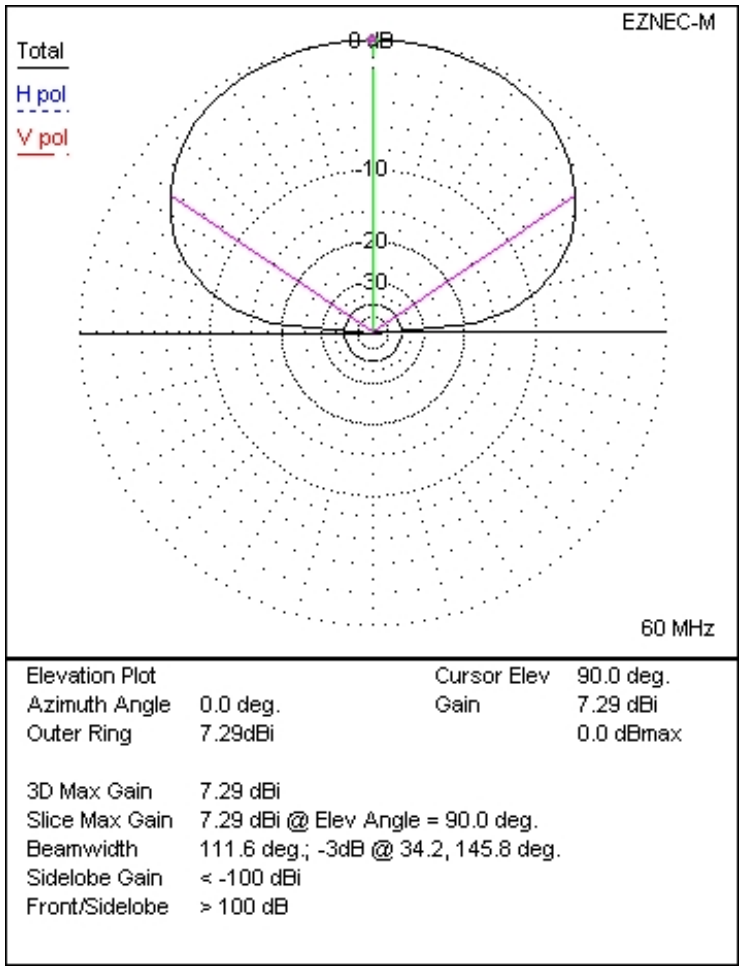
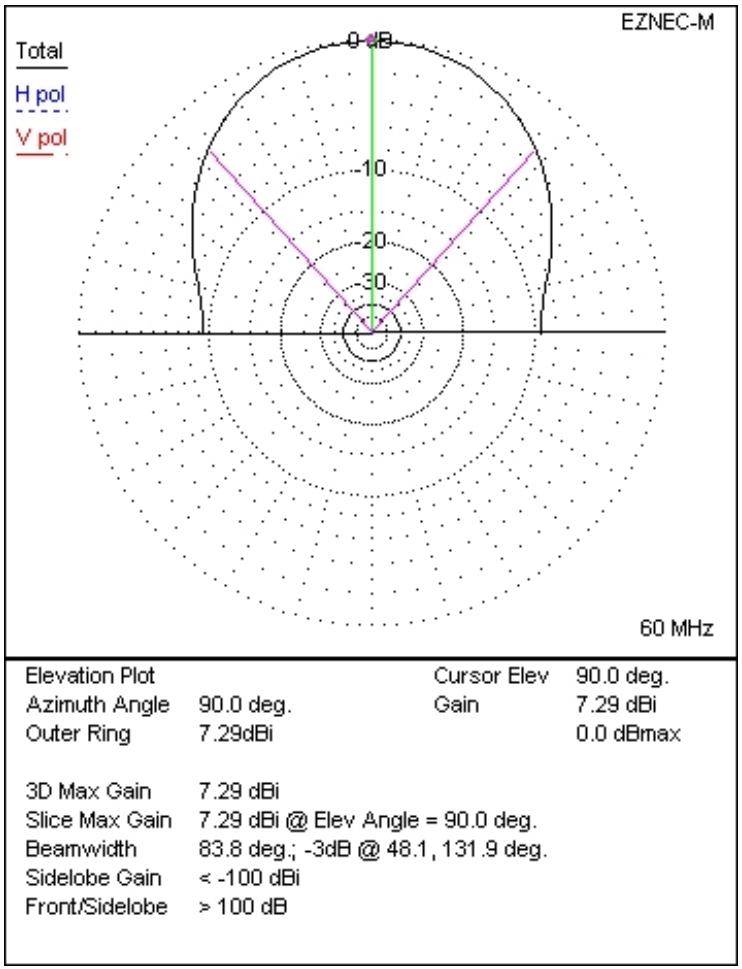


Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	0.0 deg.	Gain	7.29 dBi
Outer Ring	7.29dBi		0.0 dBmax
3D Max Gain	7.29 dBi		
Slice Max Gain	7.29 dBi @ Elev Angle = 90.0 deg.		
Beamwidth	111.6 deg.; -3dB @ 34.2, 145.8 deg.		
Sidelobe Gain	< -100 dBi		
Front/Sidelobe	> 100 dB		



Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	90.0 deg.	Gain	7.29 dBi
Outer Ring	7.29dBi		0.0 dBmax
3D Max Gain	7.29 dBi		
Slice Max Gain	7.29 dBi @ Elev Angle = 90.0 deg.		
Beamwidth	83.8 deg.; -3dB @ 48.1, 131.9 deg.		
Sidelobe Gain	< -100 dBi		
Front/Sidelobe	> 100 dB		

Expected Power Pattern Model Now Available For Other Design Simulations available to all LOFAR consortium members

NRL Low Frequency Antenna Development

- Goals and Milestones
  - Present until November, 2003:

    Form partnership with commercial antenna manufacturer to optimize design for mass production and manage risk.
  - Present until July, 2002:

    Develop two element interferometer test system to provide refined antenna performance data to LOFAR consortium.
  - Present until November, 2003:

    Develop prototype stations using cross-polarized LF antenna design.

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Genuine Tasmanian Devil

Popular Anthropomorphization