CALIBRATION OF THE STEREO ANTENNAS AT LOW FREQUENCIES

To measure Electric Fields

To measure density fluctuations

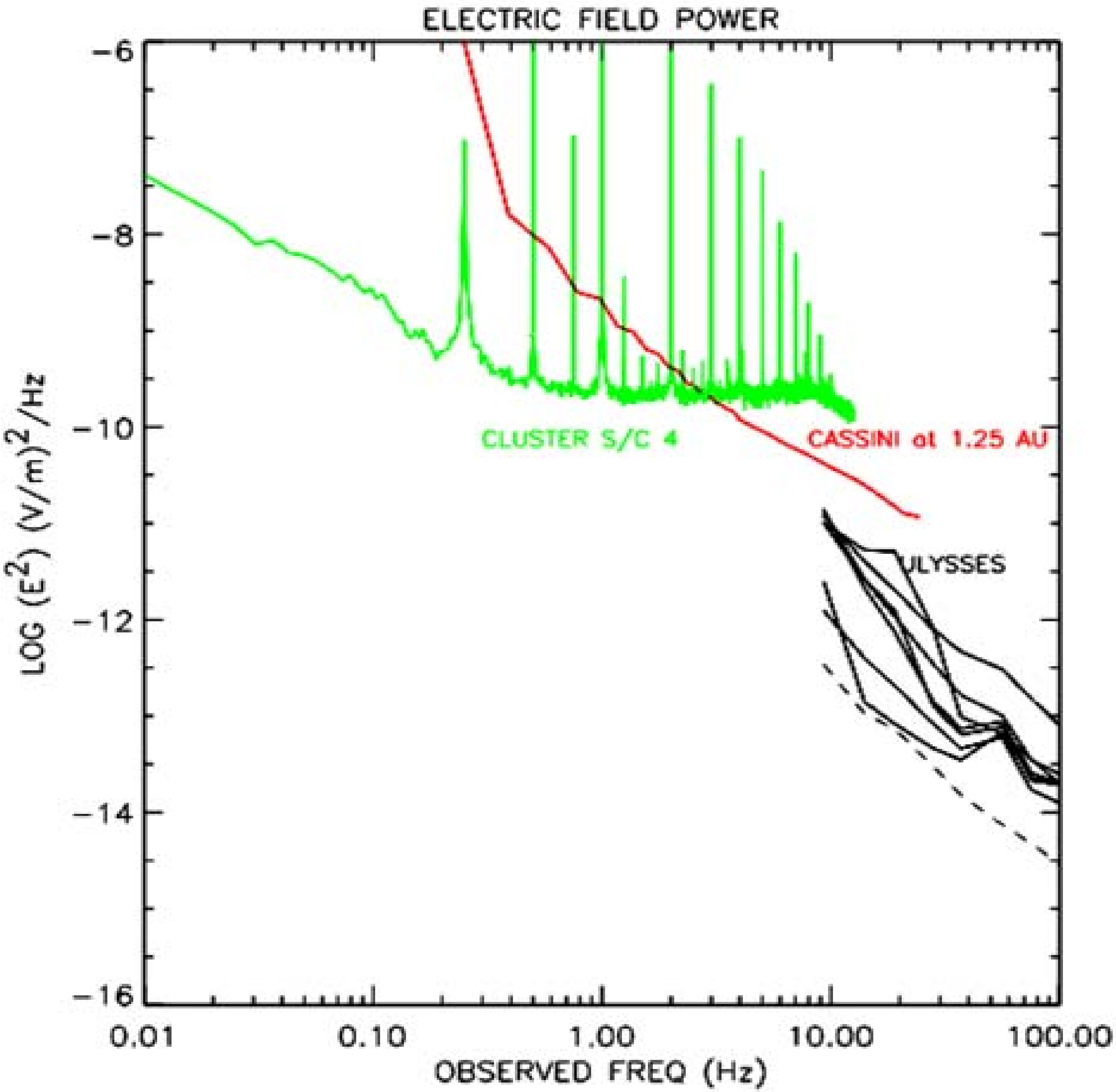
especially in the ion cyclotron frequency range

Electric Fields

Recently electric fields in the ion cyclotron frequency range have been measured consistently, using the EFW expeiment on Cluster (Kellogg et al in press ApJ, arxiv-physics 0602179) It turns out that the electric force on thermal ions of the solar wind is several times larger than that due to magnetic fluctuations in the ion cyclotron frequency range.

Electric fields therefore are more important than magnetic fluctuations in heating and diffusion in the solar wind. They are the “collisions” which make MHD work and are a factor in the state of the solar wind.

Present state of E measurements



Density Fluctuations

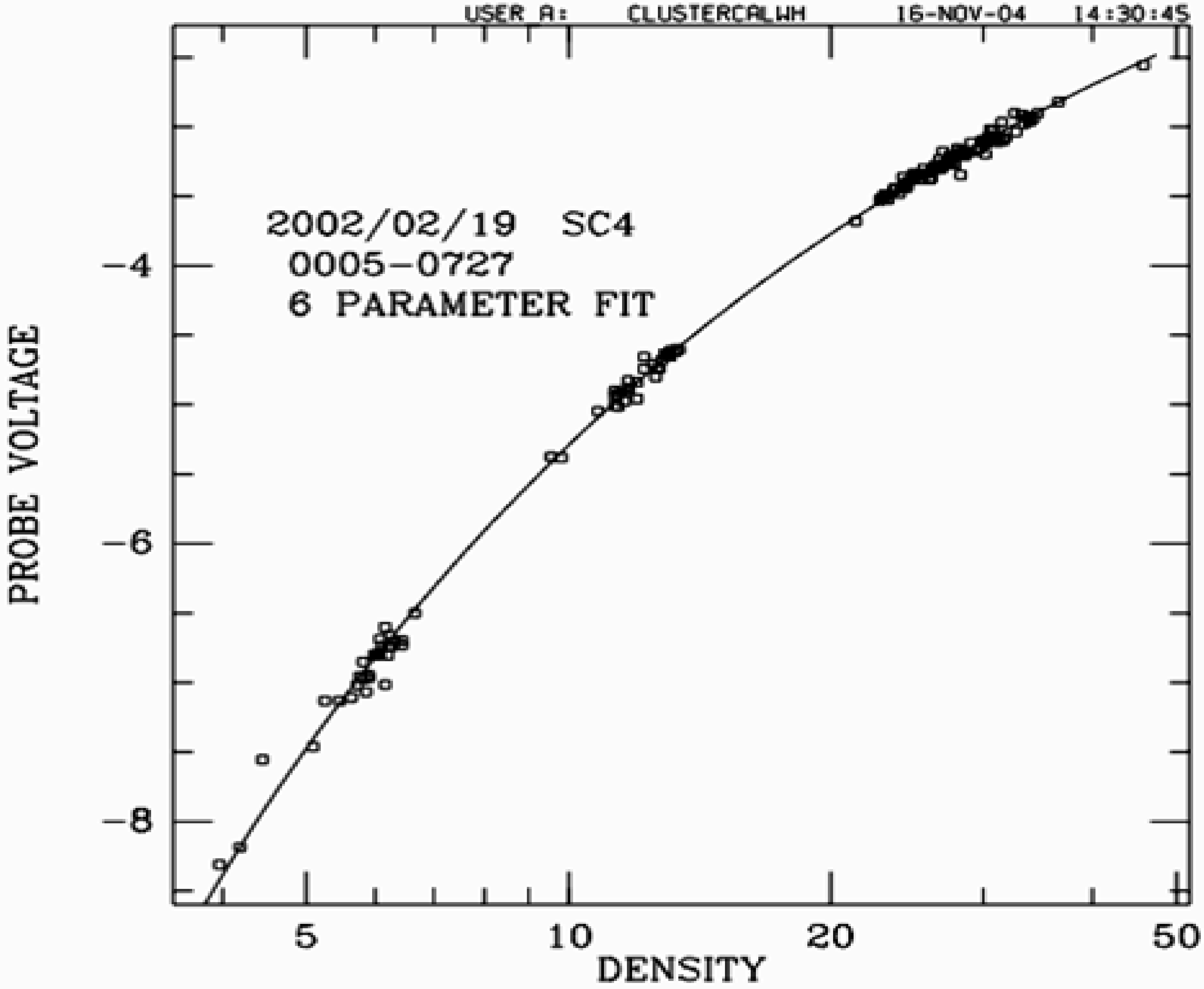
It has been suggested that the Langmuir wave to electromagnetic conversion takes place on density ramps, where a Langmuir wave reaches a point where its frequency is the plasma frequency, and it is reflected, with mode conversion for a narrow range of incident angles.

With rapid density measurements at low frequencies and Langmuir wave observations with the TDS and radio receivers, we intend to investigate this idea.

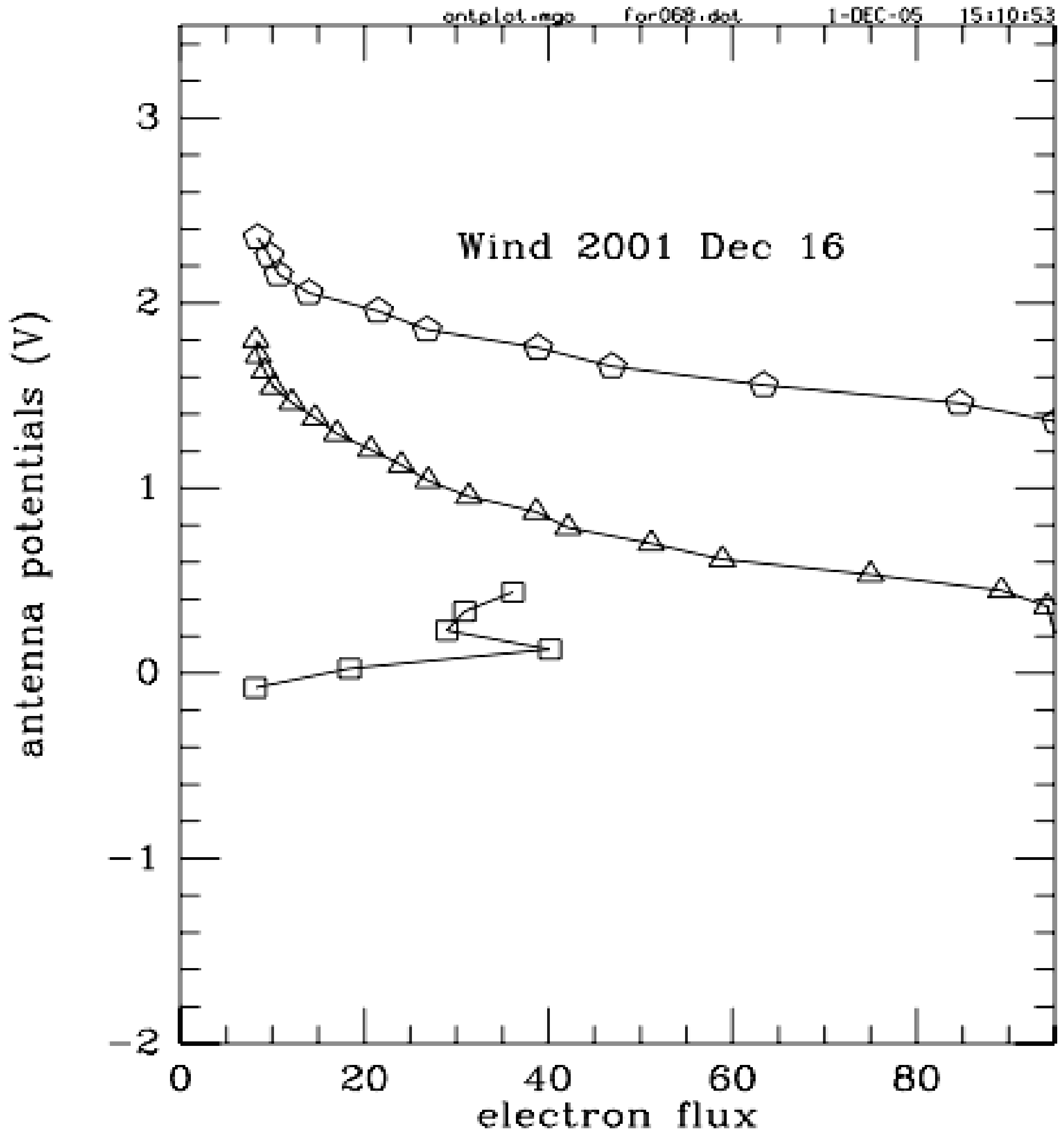
CLUSTER CALIBRATION FOR DENSITY

- In previous experiments which have used antenna potential to measure plasma density, the calibration function has been a six parameter function, three amplitudes and three photoelectron “temperatures”. (Pedersen Ann.Geo. 13, 118, 1995, Kellogg and Horbury, Ann. Geo.23,3765, 2005).

- $n_e(V) = A_1 \exp(-V/T_1) + A_2 \exp(-V/T_2) + A_3 \exp(-V/T_3)$


USER A: CLUSTERCALWH 16-NOV-04 14:30:45
2002/02/19 SC4
0005-0727
6 PARAMETER FIT
PROBE VOLTAGE
-4
-6
-8
5
10
20
50
DENSITY

WIND antenna-spacecraft potential

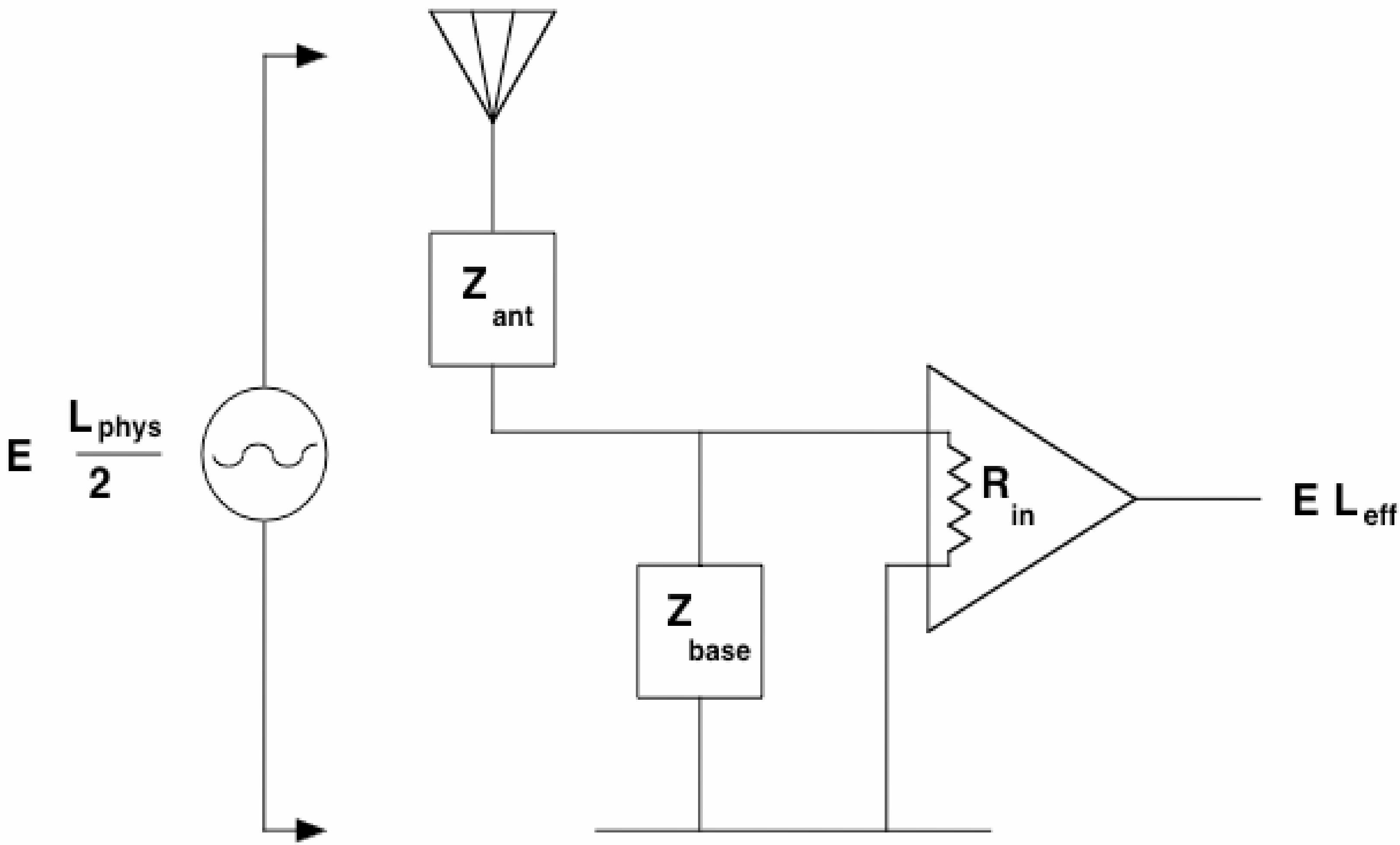


Effective Length

The instrument measures a voltage, but we want to determine electric fields. The ratio is a length, the effective length:

$$E = V/L_{eff}$$

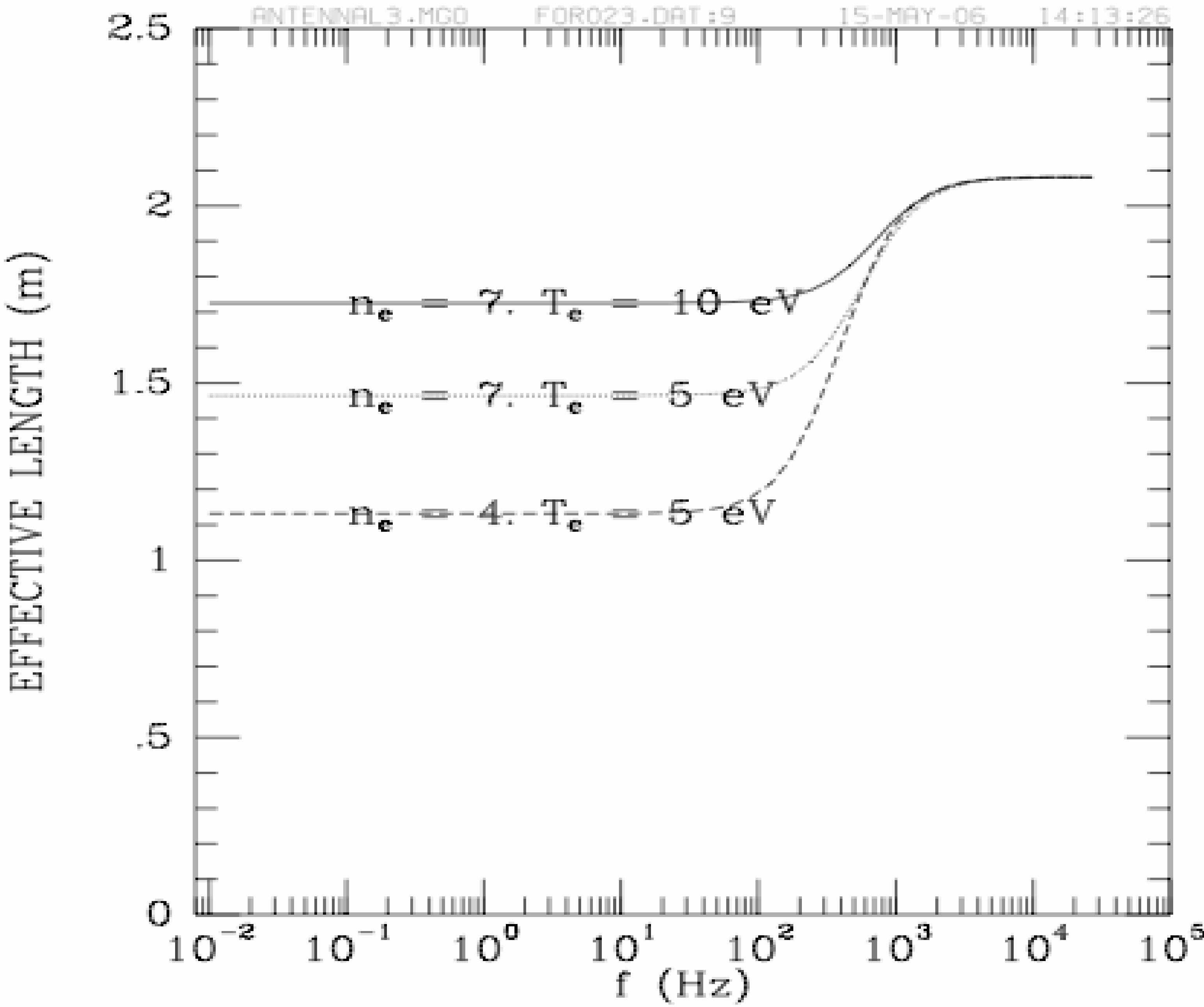
EQUIVALENT CIRCUIT



Strictly speaking, the effective length is a vector, giving a potential difference:

$$\Delta V = \mathbf{E} \cdot \mathbf{l}_{\mathbf{eff}}$$

The direction is to be determined by rheology, but the length is to be determined by comparison with **V x B** from IMPACT and PLASTIC.



ANTENNAL3.MGO FOR023.DAT:9 15-MAY-06 14:13:26
2.5
2
1.5
1
.5
0
EFFECTIVE LENGTH (m)
n_e = 7. T_e = 10 eV
n_e = 7. T_e = 5 eV
n_e = 4. T_e = 5 eV
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
f (Hz)

BASE AND ANTENNA RESISTANCE ON WIND

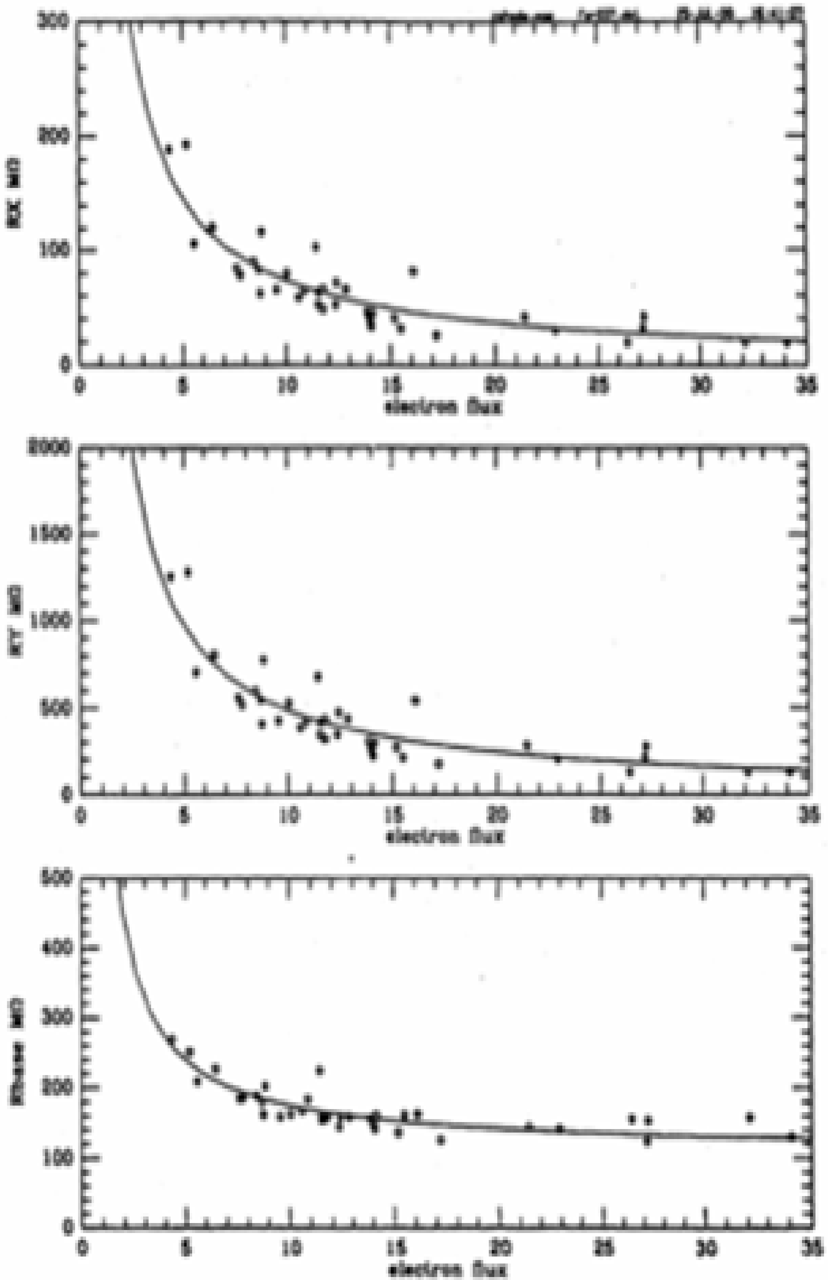
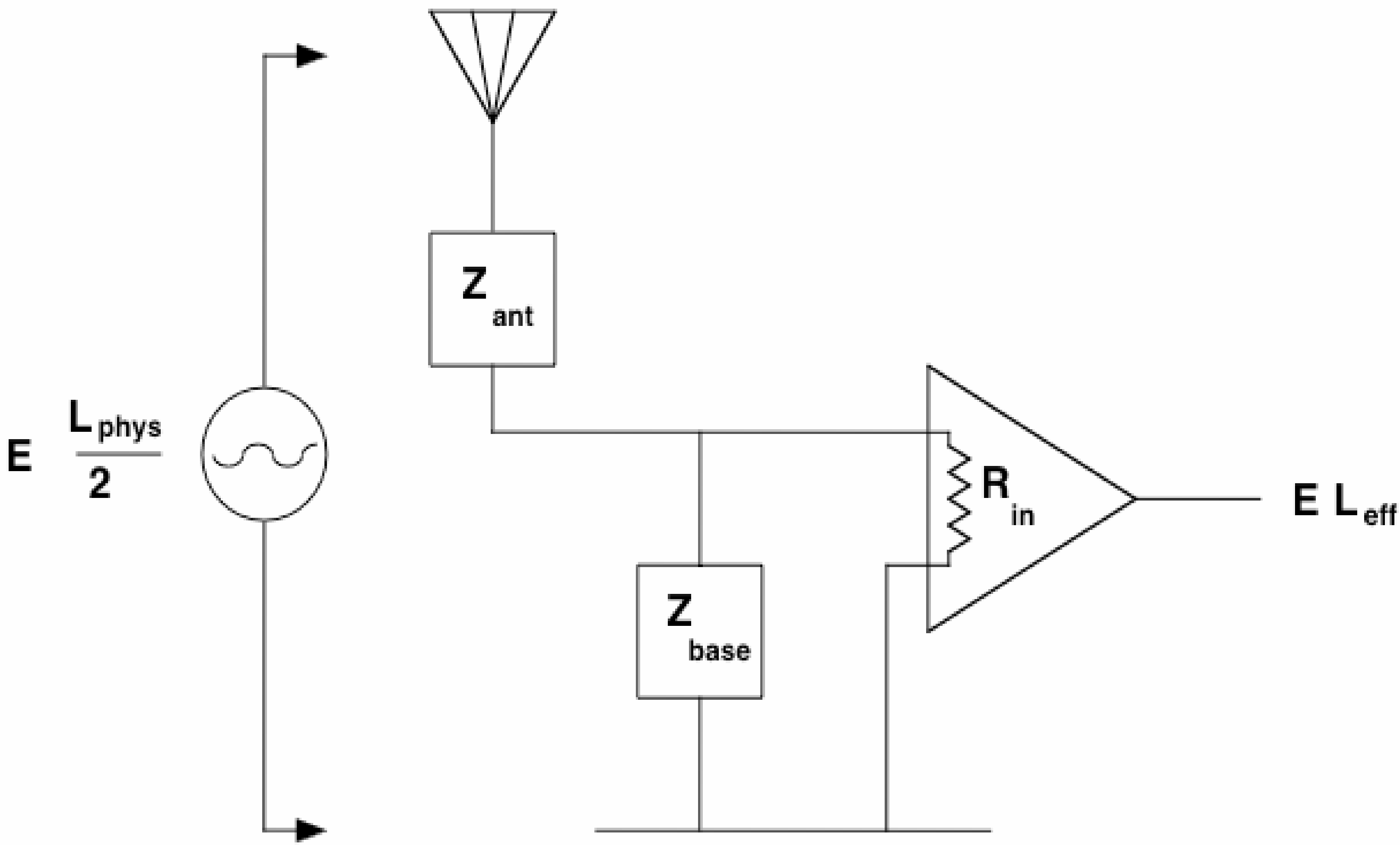
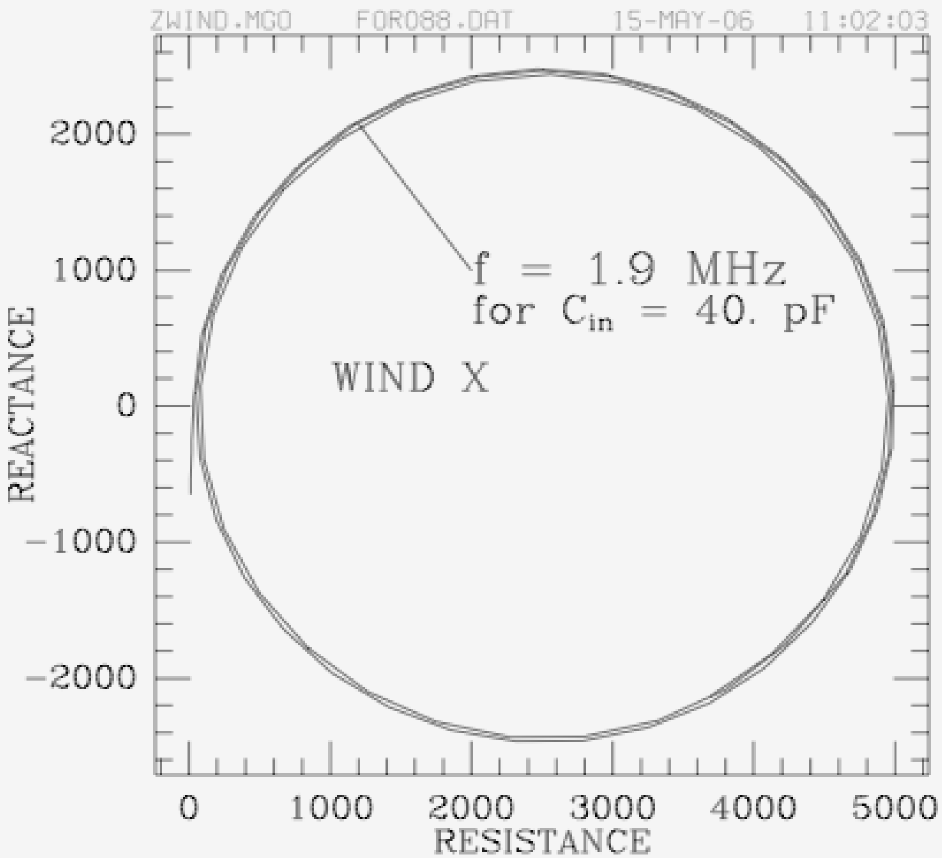


Figure 4. Measured resistance for EX (top panel) and EY (middle panel) and base resistance (bottom panel) as function of electron flux for the case when the antenna bases are both in the shadow of the spacecraft. Electron flux is in units of density (in cm^{-3}) times $\sqrt{k_B T_e}$ (in eV). The curves are explained in the text.

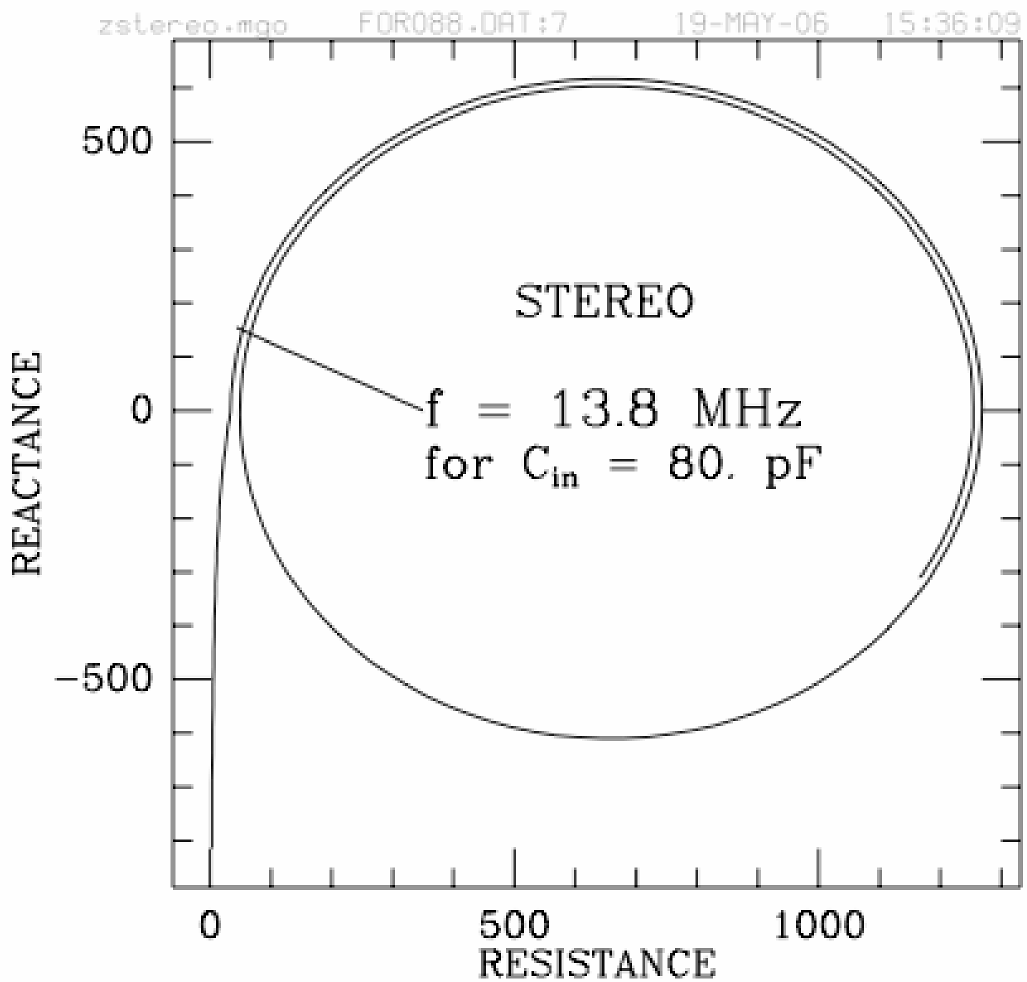
EQUIVALENT CIRCUIT



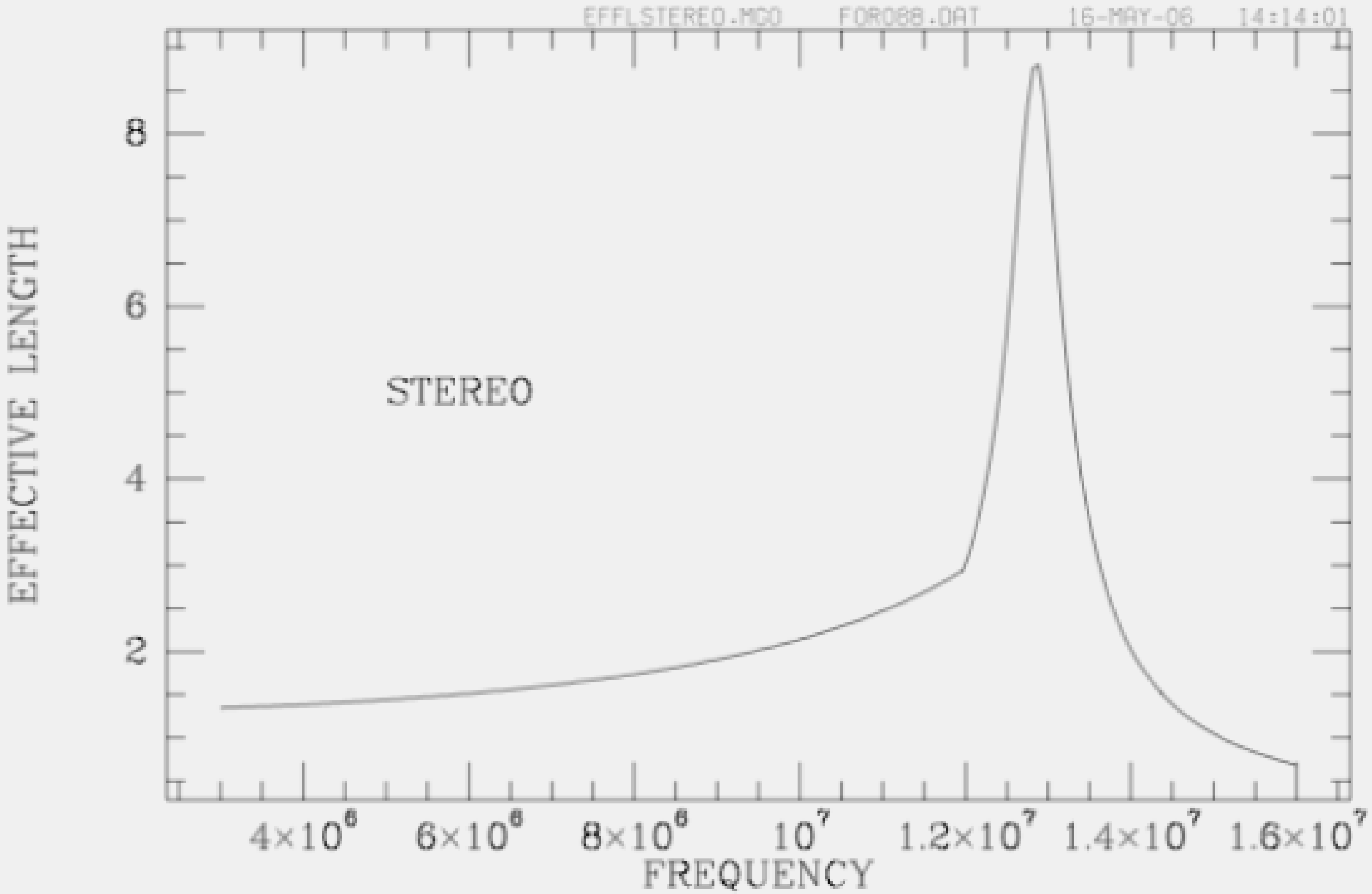
ANTENNA IMPEDANCE,--WIND



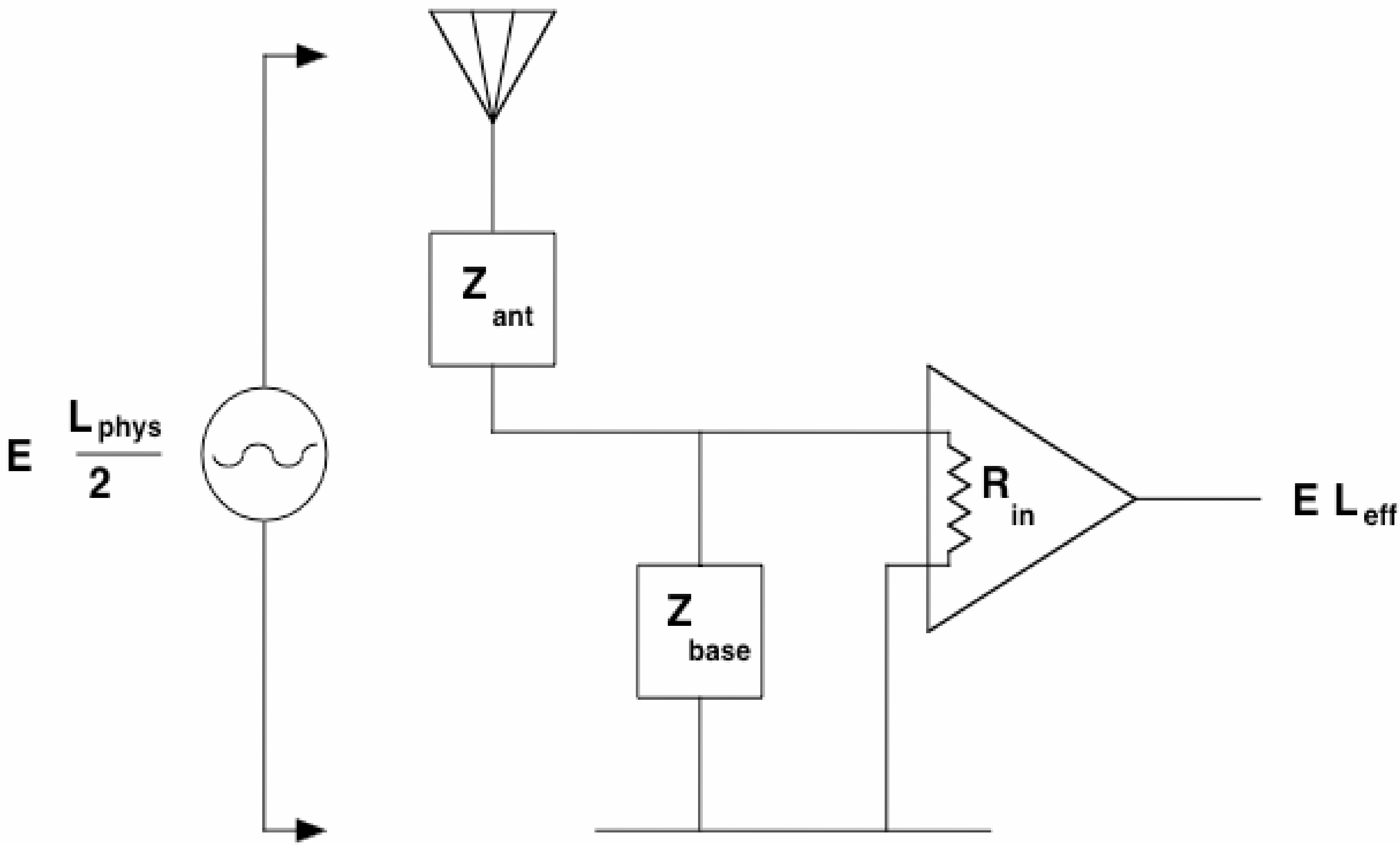
ANTENNA IMPEDANCE -- STEREO



Hi frequency effective length -- stereo

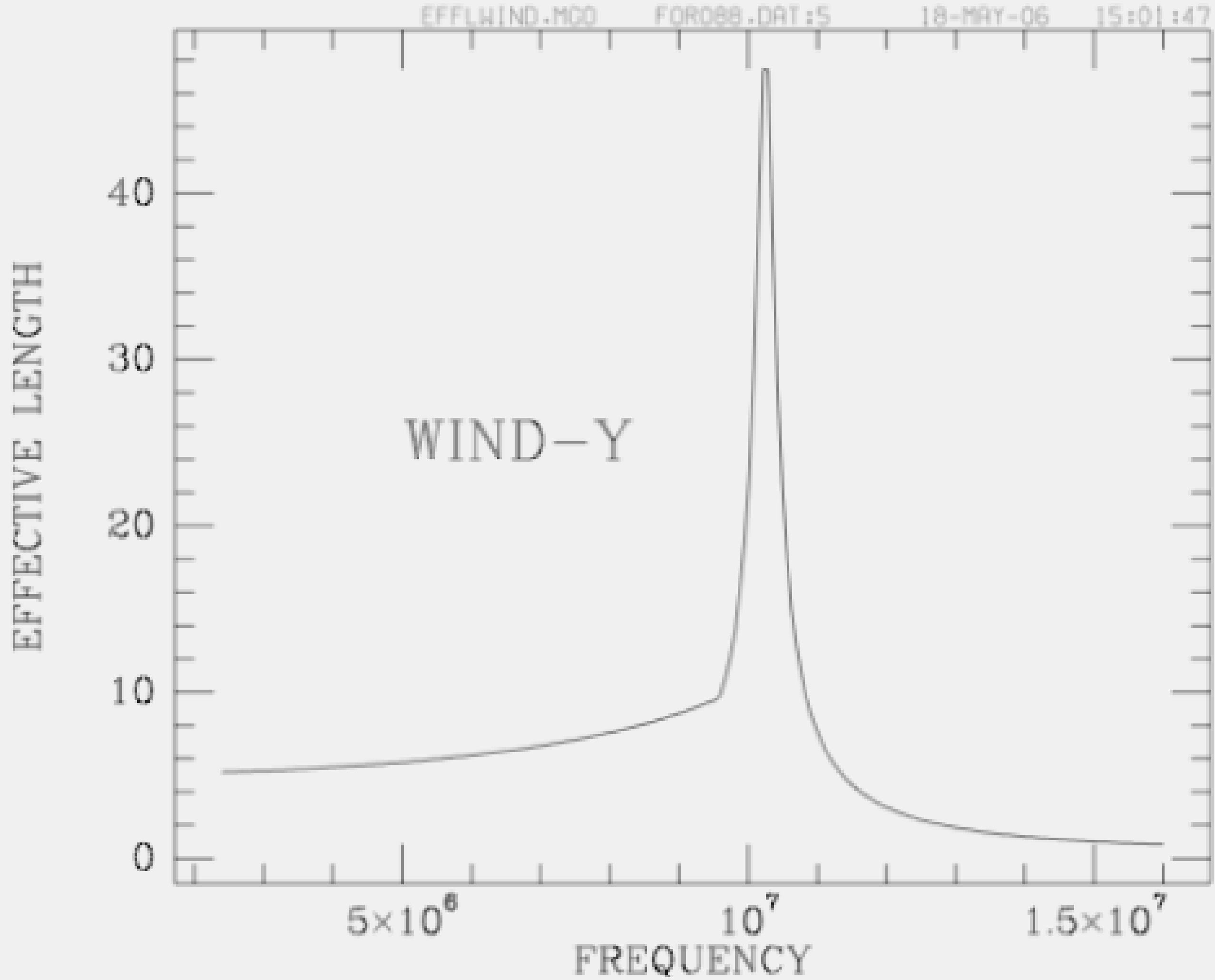


EQUIVALENT CIRCUIT



In the capacitive range:

$$V^2(f) = \frac{4kTR_{in}}{1 + \omega^2 R_{in}^2 C_{in}^2}$$


EFFLWIND.MGO FOR088.DAT:5 18-MAY-06 15:01:47
WIND-Y
EFFECTIVE LENGTH
0
10
20
30
40
5×10^6
10^7
1.5×10^7
FREQUENCY