GBES Antenna Efficiency Measurements

Glen Langston

Draft – 94 April 28

Overview

This document describes a set of measurements and calculations of the OVLBI GBES antenna gain. The antenna efficiency was measured by observations of radio sources of known brightness and small angular size. The antenna efficiency has not changed significantly since 1991. The addition of the FSS and ellipsoid appear detract little from the total antenna efficiency.

Introduction

Bright radio sources Cassiopeia A was observed continuously for 20 hours on 94 April 25. Radio source Cygnus A was observed for 4 hours on 94 April 26. A plot of the azimuth and elevation of these sources during the observations is shown in figure 1. Short observations of Tau A, Vir A, Ori A, 3C84 and 3C273 were made on 94 April 27. These observations were made with the ellipsoidal mirror and frequency selective surface (FSS) in place. The subreflector focus voltage was 1.32 V and the subreflector rotation voltage was 4.95 V. These observations were made with the Right Circularly Polarized channel of the Ku band feed over the band 14.1 to 14.6 GHz.

These measurements were made without the radome, but with a thin sheet of clear plastic taped over the FSS and ellipsoid. The plastic is nearly completely transparent at 2cm. One of the inner panels of the antenna was removed to allow access to the optics. There are 24 inner panels on the antenna and 48 outer panels. Removing one inner panel is believed to reduce the antenna efficiency by less than 1 %.

In memo GBES memo 14, by L. D'Addario, the antenna temperature is calculated for these radio sources for 100 % antenna efficiency. The predicted values are listed in table 1, with measurements of the antenna efficiency in 1991. The 1991 observations were made with a prime focus beam switching receiver operating at a center frequency of 14.9 GHz. In the bottom section of table 1, the 94 April 23-27 measurements are listed.

Figure 2. shows the intensity of Cas A and Cygnus A as a function of antenna elevation. The peak intensity of Cas A drops by 30 % as the antenna elevation changes from 90 to 20 degrees. Figure 3. shows the measured source size of Cas A as a function of antenna elevation. Notice the increase in measured size with decreasing elevation. At 90 degrees elevation, the measured size is 7.5 arc minutes and at 20 degrees elevation, the measured size is 7.75 arc minutes. The source peak intensity is decreased by a factor of $(7.5/7.75)^2 \sim 0.93$, a 7 % decrease due to the increased beam size.

Source Name	Flux Density at 14.9 GHz (Jy)	Angular Size (arcmin)	Resolution Factor Assumed	Antenna T Ideal (K)	Antenna T Measured (K)	Aperture Efficiency
Cas A	317.3	3	0.800	16.99	5.25±.05	0.39±.01
Cyg A	93.3	1×2	0.950	5.00	1.70±.10	0.36±.02
Tau A	464.7	3×5	0.706	24.90	7.71±.10	0.44±.01
Vir A	27.5	<1	1.000	1.47	0.57±.02	0.39±.01
3C84	Variable	<1	1.000		0.66±.10	
3C273	Variable	<1	1.000		0.66±.10	
Cas A					5.20±.10	0.38±.02
Cyg A					1.68±.05	0.35±.01
Tau A					7.08±.05	0.40±.01
Vir A					0.58±.05	
3C84					0.53±.05	
3C273					0.78±.02	
Ori A					0.44±.02	

Table 1: Measurements of the antenna efficiency in 1991 (top) and 1994 April 25 (bottom).

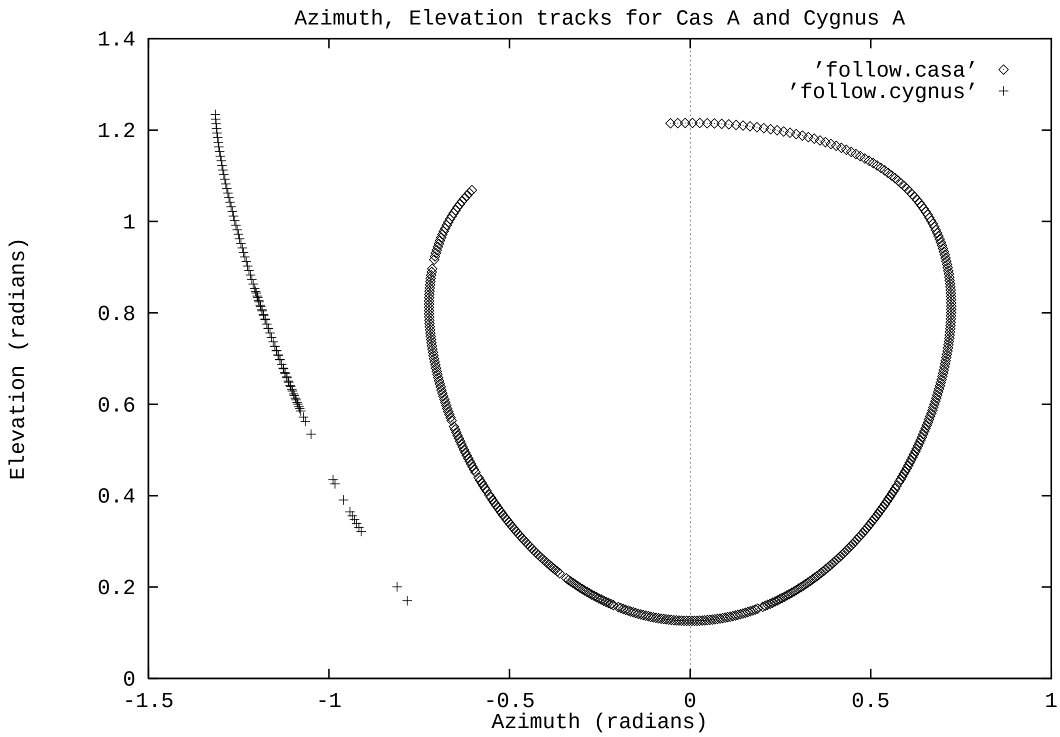

Figure 1: Plot of the Azimuth and Elevation (radians) locations of the radio sources when gain measurements were taken.

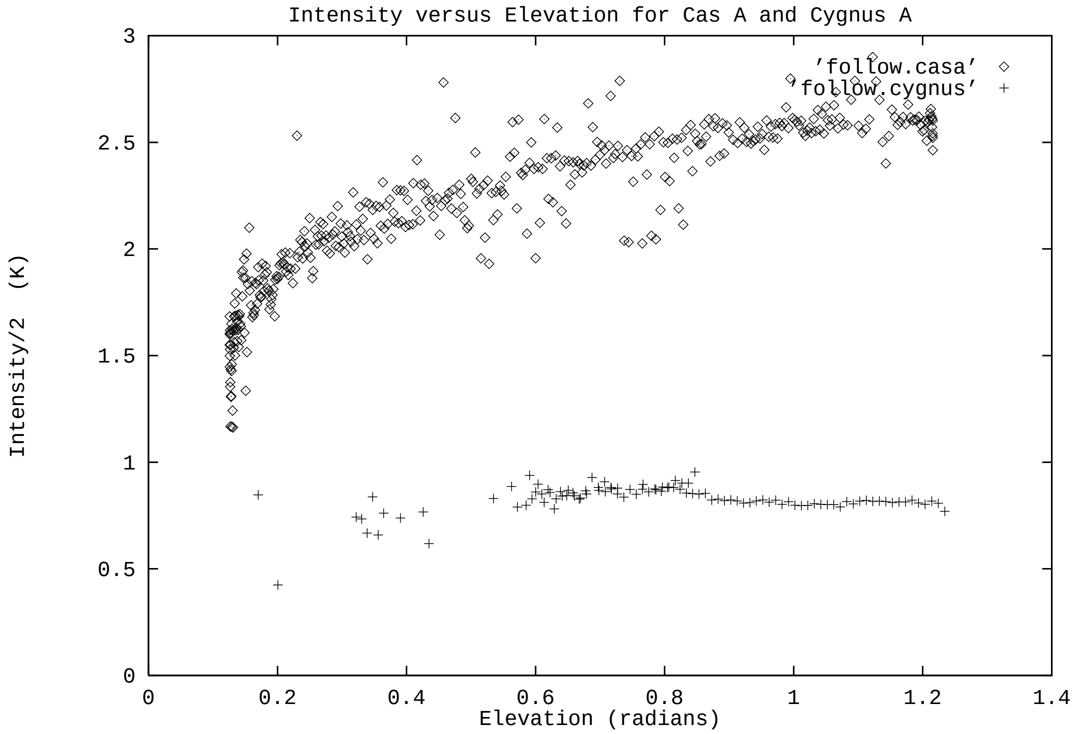

Figure 2: Plot of the half antenna temperature for the radio source as a function of source elevation when the gain measurements were taken.

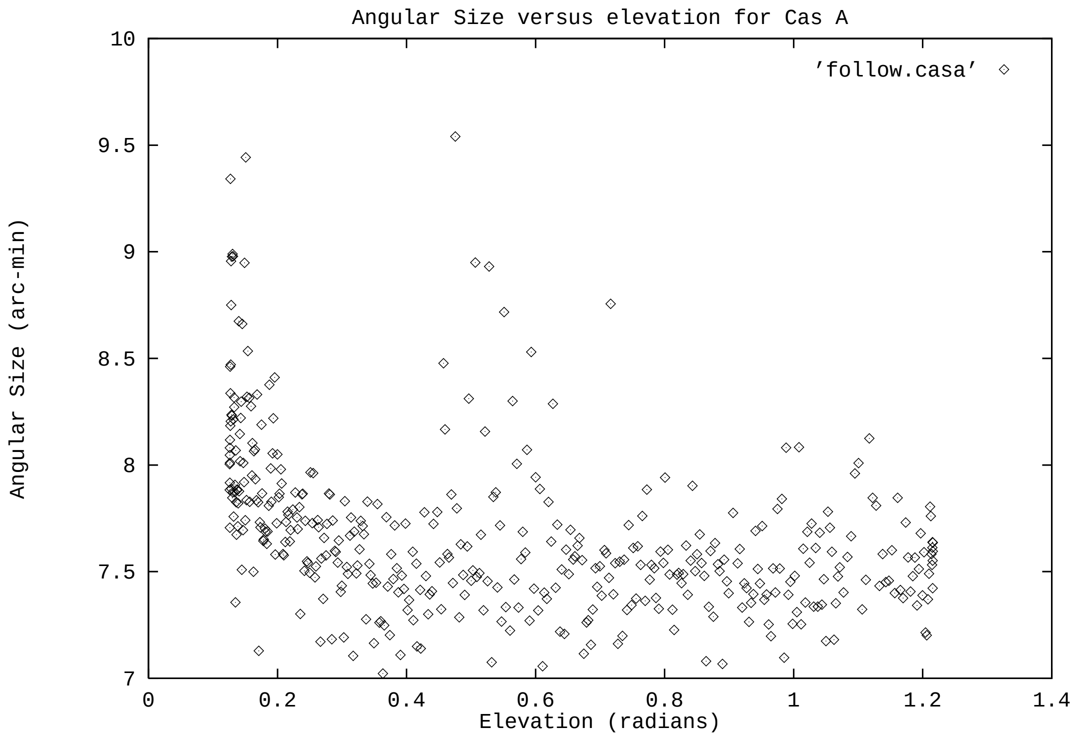

Figure 3: Plot of the Angular size of the fit to the Cas A as a function of the antenna elevation when the gain measurements were taken.