MILLIMETER-WAVE MEMO #003

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HAYSTACK OBSERVATORY

WESTFORD, MASSACHUSETTS 01886

29 January 1993

Telephone: 508-692-4764
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To: Millimeter-wave VLBI Group

From: Alan E.E. Rogers AEER
Shep Doeleman SD

Subject: Broadband circular polarizer for 86-100 GHz

While the current polarizer design has low loss it lacks bandwidth. AT 86 GHz, the slope of the differential phase shift is 2 deg/GHz so that the axial ratio for circular polarization will depart from unity by 1 dB at ± 3.3 GHz.

A broadband design has been devised by William Fitzgerald (private conversation) using a combination of metal and dielectric plates. An alternate broadband design is proposed in which two sets of metal plates are used at right angles. One set of plates produces a phase shift around 200 degrees and the other around 110 degrees. The phase slopes of each set of plates is almost the same and thus the differential phase is a constant 90 degrees to within ± 3 degrees from 86 to 100 GHz. The design has been fully simulated using numerical solutions (see Memo dated 20 January 1993) of Maxell's equations for the propagating and evanescent modes for both components of linear polarization and includes the effects of finite plate thickness. Table 1 gives the design parameters. Figures 1, 2, and 3 show the calculated performance based on the assumption that the field solutions can be superposed. The loss in Figure 2 includes reflections from E-field components both normal and perpendicular to both sets of plates. However, it does not include ohmic losses and scattering effects (discussed in a previous memo) which are present for a finite number of plates across the beam. The model is invalid above 103 GHz where the A plate separation equals a wavelength. There is also a slight resonance when the A Plate spacing equals a wavelength at 95.6 GHz. (This resonance could be moved up in frequency by using thinner plates - although thinner plates are mechanically less stable unless held in tension.) We would like to build a unit and test it. If it performs as well as the model calculations suggest, it would give us a single polarizer for the 86-100 GHz band. Also, it might have applications in high power radar systems for which the use of dielectrics could pose thermal problems.

Plate Thickness	0.25
A Plate Separation	2.89
A Plate Spacing	3.14
A Plate Depth	10.00
B Plate Separation	2.07
B Plate Spacing	2.32
B Plate Depth	2.02

Table 1. Broadband Polarizer Dimensions in *mm*

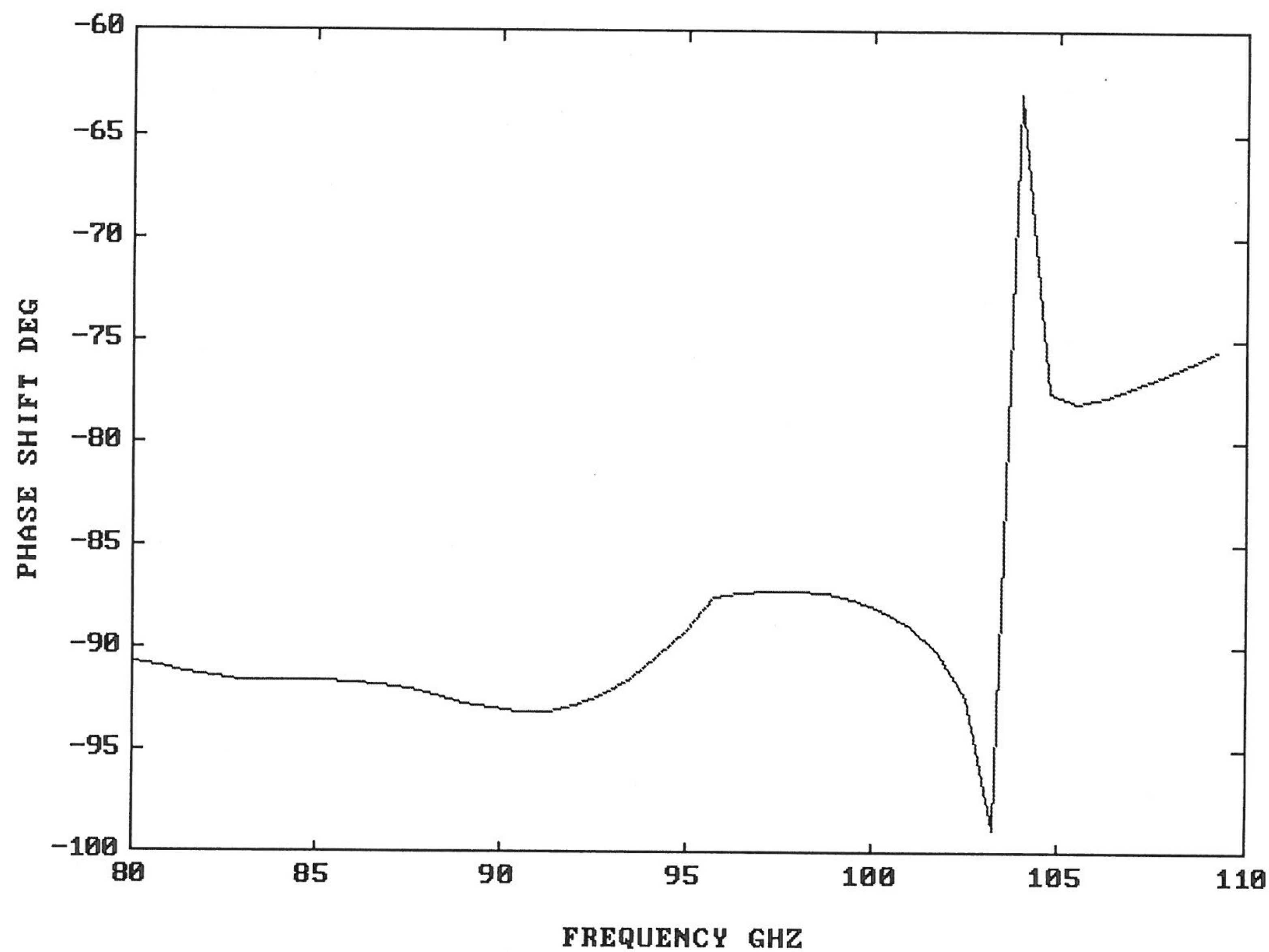

-60
-65
-70
-75
-80
-85
-90
-95
-100
PHASE SHIFT DEG
80
85
90
95
100
105
110
FREQUENCY GHZ

FIGURE 1.

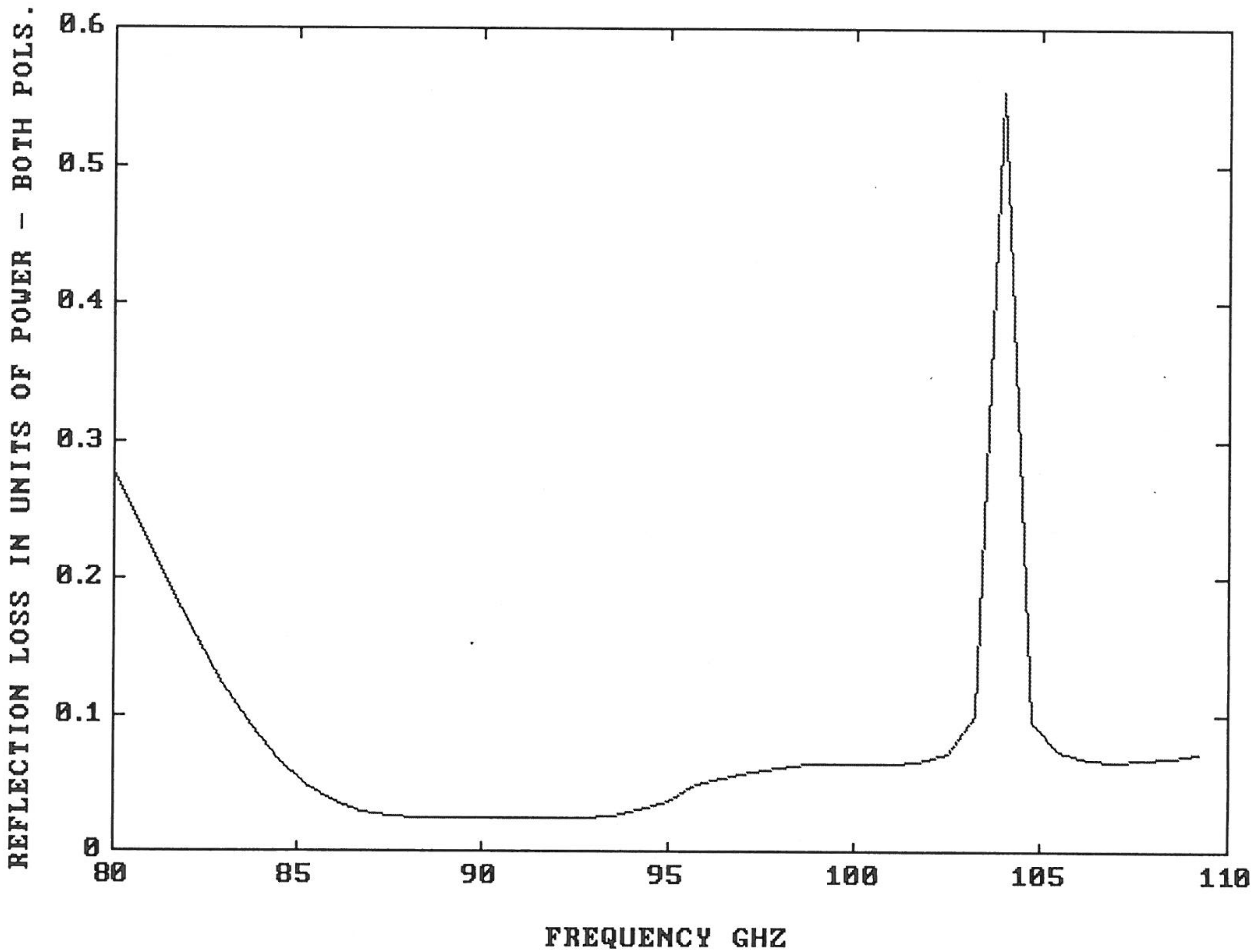
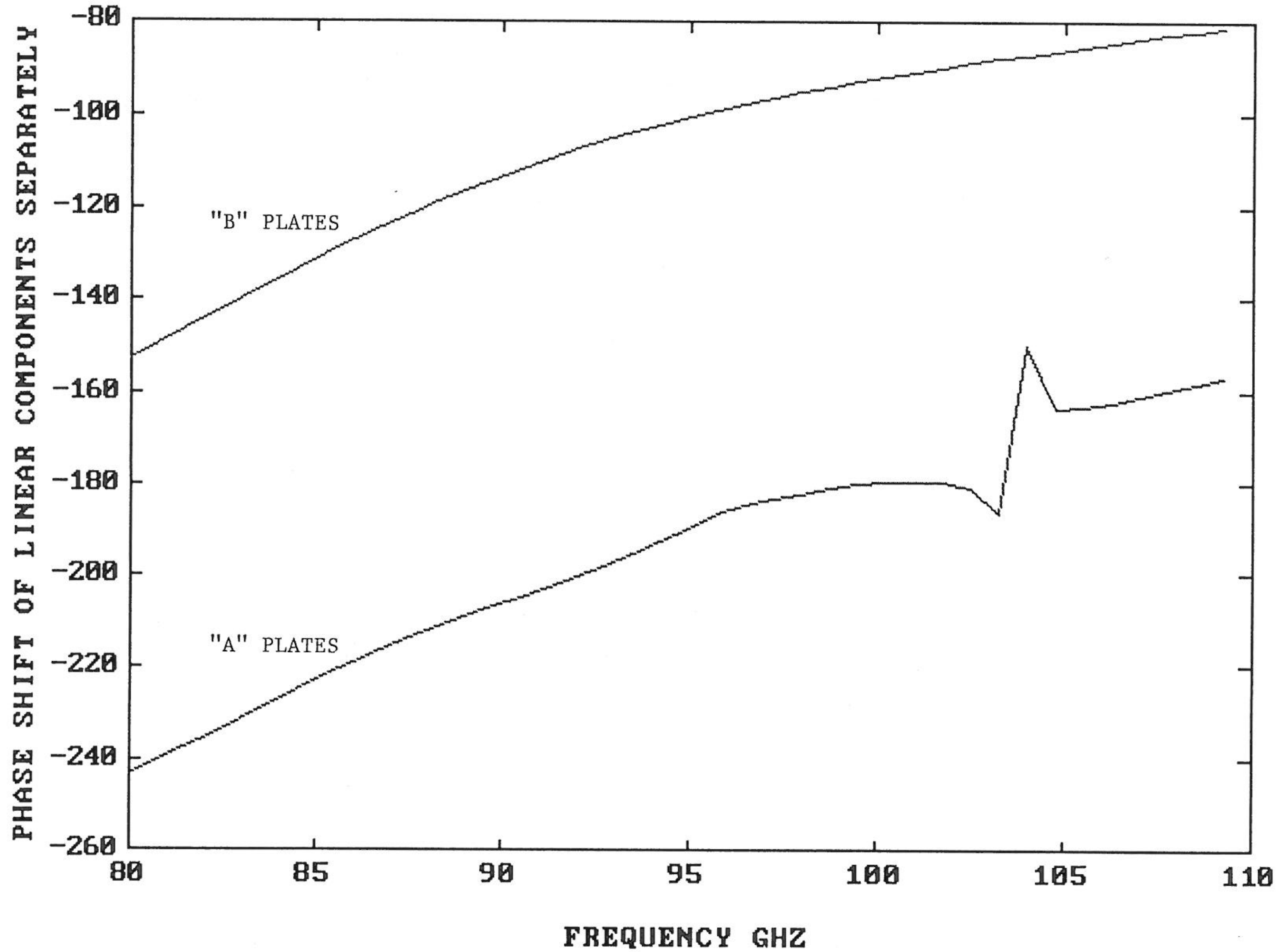

REFLECTION LOSS IN UNITS OF POWER - BOTH POLS.
0.6
0.5
0.4
0.3
0.2
0.1
0
80
85
90
95
100
105
110
FREQUENCY GHZ

FIGURE 2.



-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
80
85
90
95
100
105
110
"B" PLATES
"A" PLATES
PHASE SHIFT OF LINEAR COMPONENTS SEPARATELY
FREQUENCY GHZ

FIGURE 3.

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