Please note, the NRAO Library's records included two versions of Engineering Memo 131, one dated June 15, 1979 in letter format to S. von Hoerner from L.J. King and the second dated July 17, 1979 formatted as a memorandum from L.J. King. There is no indication which is the genuine Memo 131 so both are included in this scan in chronological order.

Interoffice

National Radio Astronomy Observatory

Charlottesville, Virginia

6-15-1979

Engineering Memo #131

To: S. von Hoerner

From: L. J. King

Subject: Best-fit focus locations for 140-foot surface measurement

The focus coordinates of the best fitted paraboloids of the 140-foot surface measurements (data refer to Engr. Report #130, 5-11-79, by J. Findlay) are calculated.

Two sets of coordinates are obtained for each run. Case I is calculated based on $\omega(r)=1.0$ for all measured points, and Case II, $\omega(r)=r\,e^{-2.60r^2}$ (weight eq. suggested in Engr. Report #125, 9-8-78, by S. von Hoerner).

The best-fit parameters are: (Units in mm and minutes)

		Vertex			Axis	
	Focus	x	y	z	x	y
Case I Run #1	18272.30	18.99	-11.31	-0.48	-0.93	-1.61
Run #2	18271.85	1.60	-7.77	-0.61	-0.63	-0.25
Case II Run #1	18272.41	24.95	-10.63	-0.46	-0.87	-2.13
Run #2	18271.89	8.70	-6.58	-0.60	-0.52	-0.86

The resulting focus coordinates: (Units in cm)

		x	y	z
Case I	Run #1	2.76	-1.62	1827.18
	Run #2	0.29	-1.11	1827.12
Case II	Run #1	3.63	-1.52	1827.19
	Run #2	1.33	-0.93	1827.13
SvH Report #125		3.6	1.2 North	

The magnitudes of x- & y-coordinates of Case II, run #1 are in good agreement with that of the Report #125. Note that the positive-x is to the East and positive-y, to the South. Then, zenith is to the West of H_o, the offset feed is to the East which agrees with x-coor.

cc: J. Findlay
G. Peery

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

140 FT SURVEY OCT 17-22 RUN #1 (Case I)

ORIGINAL FOCAL LENGTH = 18272.0000 NO. POINTS IN ANALYSIS = 2388

INPUT DISTORTIONS OBTAINED ANALYTICALLY - OPTION 1

MINIMIZATION OF RMS WITH RESPECT TO RIGID BODY MOTION

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.235880

DEVIATION OF THE MEAN - 1/2 LAMBDAS = -0.00232
SUM-UNIT AREA*1/2 LAMBDA = -10.4070
SUM-UNIT AREAS = 2244.0000 1.0 for each pt

X COORDINATE OF VERTEX = 18.98940

Y COORDINATE OF VERTEX = -11.30638

Z COORDINATE OF VERTEX = -0.51548

ROTATION ABOUT X AXIS = -0.0002703

ROTATION ABOUT Y AXIS = -0.0004690

MINIMIZATION OF RMS WITH RESPECT TO FOCAL LENGTH CHANGE

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.235599

NEW FOCAL LENGTH = 18272.2991

DEVIATION OF THE MEAN - 1/2 LAMBDAS = -0.00000
SUM-UNIT AREA*1/2 LAMBDA = -0.0000
SUM-UNIT AREAS = 2244.0000

X COORDINATE OF VERTEX = 18.99005

Y COORDINATE OF VERTEX = -11.30643

Z COORDINATE OF VERTEX = -0.48275

ROTATION ABOUT X AXIS = -0.0002703

ROTATION ABOUT Y AXIS = -0.0004690

ALL LENGTH UNITS ARE CONSISTENT WITH INPUT

ROTATION UNITS ARE RADIANS

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

140 FT SURVEY OCT 17-22 RUN #2 (Case I)

ORIGINAL FOCAL LENGTH = 18272.0000 NO. POINTS IN ANALYSIS = 2388

INPUT DISTORTIONS OBTAINED ANALYTICALLY - OPTION 1

MINIMIZATION OF RMS WITH RESPECT TO RIGID BODY MOTION

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.291503

DEVIATION OF THE MEAN - 1/2 LAMBDAS = 0.00114
SUM-UNIT AREA*1/2 LAMBDA = 5.1085
SUM-UNIT AREAS = 2244.0000 1.0 for each pt

X COORDINATE OF VERTEX = 1.60518

Y COORDINATE OF VERTEX = -7.77438

Z COORDINATE OF VERTEX = -0.58945

ROTATION ABOUT X AXIS = -0.0001829

ROTATION ABOUT Y AXIS = -0.0000715

MINIMIZATION OF RMS WITH RESPECT TO FOCAL LENGTH CHANGE

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.291438

NEW FOCAL LENGTH = 18271.8532

DEVIATION OF THE MEAN - 1/2 LAMBDAS = -0.00000
SUM-UNIT AREA*1/2 LAMBDA = -0.0000
SUM-UNIT AREAS = 2244.0000

X COORDINATE OF VERTEX = 1.60485

Y COORDINATE OF VERTEX = -7.77434

Z COORDINATE OF VERTEX = -0.60552

ROTATION ABOUT X AXIS = -0.0001829

ROTATION ABOUT Y AXIS = -0.0000715

ALL LENGTH UNITS ARE CONSISTENT WITH INPUT

ROTATION UNITS ARE RADIANS

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

140 FT SURVEY OCT 17-22 RUN #1 (Case II)

ORIGINAL FOCAL LENGTH = 18272.0000 NO. POINTS IN ANALYSIS = 2388

INPUT DISTORTIONS OBTAINED ANALYTICALLY - OPTION 1

MINIMIZATION OF RMS WITH RESPECT TO RIGID BODY MOTION

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.207677

DEVIATION OF THE MEAN - 1/2 LAMBDAS = -0.00221
SUM-UNIT AREA*1/2 LAMBDA = -1.8330
SUM-UNIT AREAS = 415.1500 Ref (13) of Engr Memo #125

X COORDINATE OF VERTEX = 24.95435

Y COORDINATE OF VERTEX = -10.62933

Z COORDINATE OF VERTEX = -0.50002

ROTATION ABOUT X AXIS = -0.0002519

ROTATION ABOUT Y AXIS = -0.0006190

MINIMIZATION OF RMS WITH RESPECT TO FOCAL LENGTH CHANGE

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.207306

NEW FOCAL LENGTH = 18272.4063

DEVIATION OF THE MEAN - 1/2 LAMBDAS = 0.00000
SUM-UNIT AREA*1/2 LAMBDA = 0.0000
SUM-UNIT AREAS = 415.1500

X COORDINATE OF VERTEX = 24.95483

Y COORDINATE OF VERTEX = -10.62945

Z COORDINATE OF VERTEX = -0.46083

ROTATION ABOUT X AXIS = -0.0002519

ROTATION ABOUT Y AXIS = -0.0006191

ALL LENGTH UNITS ARE CONSISTENT WITH INPUT

ROTATION UNITS ARE RADIANS

BEST FIT PARABOLOID WITH MINIMUM PATH LENGTH IN LEAST SQUARES SENSE

140 FT SURVEY OCT 17-22 RUN #2 (Case II)

ORIGINAL FOCAL LENGTH = 18272.0000 NO. POINTS IN ANALYSIS = 2388

INPUT DISTORTIONS OBTAINED ANALYTICALLY - OPTION 1

MINIMIZATION OF RMS WITH RESPECT TO RIGID BODY MOTION

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.284501

DEVIATION OF THE MEAN - 1/2 LAMBDAS = 0.00058
SUM-UNIT AREA*1/2 LAMBDA = 0.4807
SUM-UNIT AREAS = 415.1500 Ref. (13) of ENGR MEMO #125

X COORDINATE OF VERTEX = 8.70041

Y COORDINATE OF VERTEX = -6.58186

Z COORDINATE OF VERTEX = -0.59092

ROTATION ABOUT X AXIS = -0.0001513

ROTATION ABOUT Y AXIS = -0.0002508

MINIMIZATION OF RMS WITH RESPECT TO FOCAL LENGTH CHANGE

RMS OF 1/2 LAMBDA WEIGHTED BY AREAS = 1.284477

NEW FOCAL LENGTH = 18271.8934

DEVIATION OF THE MEAN - 1/2 LAMBDAS = 0.00000
SUM-UNIT AREA*1/2 LAMBDA = 0.0000
SUM-UNIT AREAS = 415.1500

X COORDINATE OF VERTEX = 8.70032

Y COORDINATE OF VERTEX = -6.58181

Z COORDINATE OF VERTEX = -0.60119

ROTATION ABOUT X AXIS = -0.0001513

ROTATION ABOUT Y AXIS = -0.0002508

ALL LENGTH UNITS ARE CONSISTENT WITH INPUT

ROTATION UNITS ARE RADIANS

NATIONAL RADIO ASTRONOMY OBSERVATORY

Engineering Memo No. 131

FOCUS LOCATIONS FOR 140 FOOT TELESCOPE MEASUREMENTS

L. J. King

July 17, 1979

The focus coordinates of the best fit paraboloids of 140 foot telescope surface are obtained based on the data measured between Oct. 17 and Oct. 22, 1978, ref Eng Memo #129 by J. Findlay dated 3-23-1979. Two sets of measurements were made and identified as Run #1 and Run #2, respectively.

Due to the unsystematic differences between the measurements of Run #1 and Run #2 in the northern region of the surface, focus coordinates with and without those radii are calculated. Figure 6 of Eng Memo #129 is reproduced on p.4 for reference. Three cases are calculated:

CASE I serves as a check of the input data. Entire measurement data are used. Weight factor $w(r)=1.0$ applies to each data point. The results are in good agreement with that given in table 1 of Eng Memo #129. Minor differences are due to the computer round-off error, a double precision version of RMS2244 is used here.

CASE II The weight factor of each measurement point is a founction of its location and aperture illumination, and is represented by

$w(r) = r\ e^{-2.60r^2}$, see S. von Hoerner's Eng Memo #125, dated 9-8-1978. All 2244 data points are considered.

CASE III Measurement data on radii #2, #3, #4, and #59 thru #65 are omitted. No. of points calculated is 2244-10x33 = 1914. Weight factors used are the same as in Case II.

For each calculation, the best fit RMS error and the best fit parameters are first calculated, then followed by a coordinate transformation to obtain the location of the focus.

Let the best fit parameters are:

FN = new focal length

(vx, vy, vz) = coordinates of the new vertex

(α, β) = rotations about X- and rotated Y-axes.

The relations between the parameters and focus coordinates are shown in the figures on p.5, and given as follows:

$$\begin{cases} XF = FN \sin\beta + VX \\ YF = -FN \cos\beta \sin\alpha + VY \\ ZF = FN \cos\beta \cos\alpha + VZ \end{cases}$$

The results are tabulated on the following page.

PARAMETERS OF THE BEST FIT PARABOLOIDS

CASE	RUN	FN (mm)	VERTEX (mm)			AXIS (min of arc)	
			VX	VY	VZ	α	β
I	#1	18272.30	18.99	-11.31	-0.48	-0.93	-1.61
	#2	18271.85	1.60	-7.77	-0.61	-0.63	-0.25
II	#1	18272.41	24.95	-10.63	-0.46	-0.87	-2.13
	#2	18271.89	8.70	-6.58	-0.60	-0.52	-0.86
III	#1	18273.69	29.87	-11.35	-0.44	-0.98	-2.61
	#2	18272.84	18.99	-3.95	-0.59	-0.35	-1.74

LOCATIONS OF BEST FIT FOCUS

CASE	RUN	FOCUS (cm)			RMS (mm)
		XF	YF	ZF	
I	#1	1.04	-0.64	1827.18	1.24
	#2	0.03	-0.44	1827.12	1.29
II	#1	1.36	-0.60	1827.19	1.21
	#2	0.41	-0.38	1827.13	1.28
III	#1	1.60	-0.61	1827.32	1.12
	#2	0.97	-0.21	1827.23	1.14

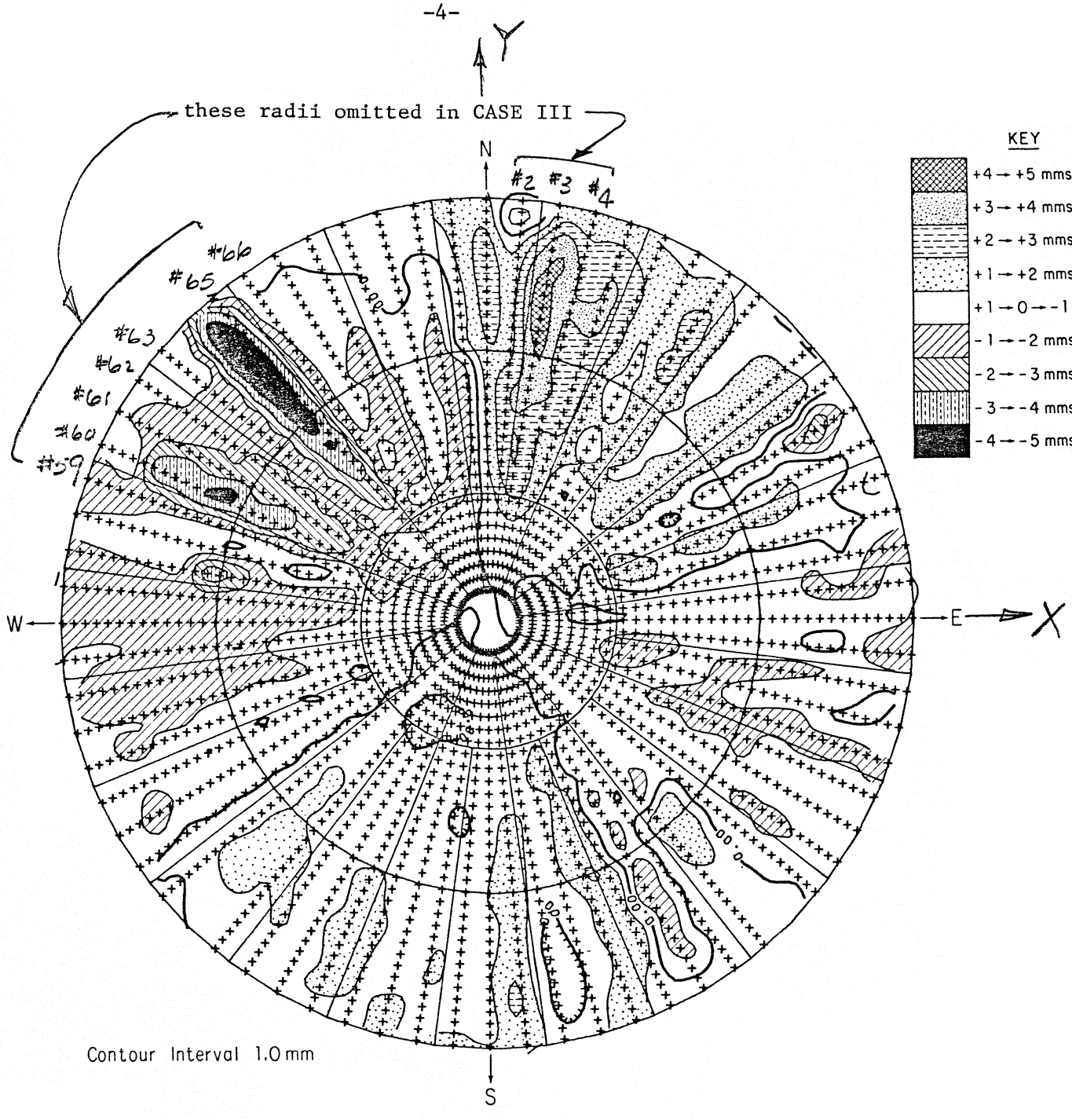
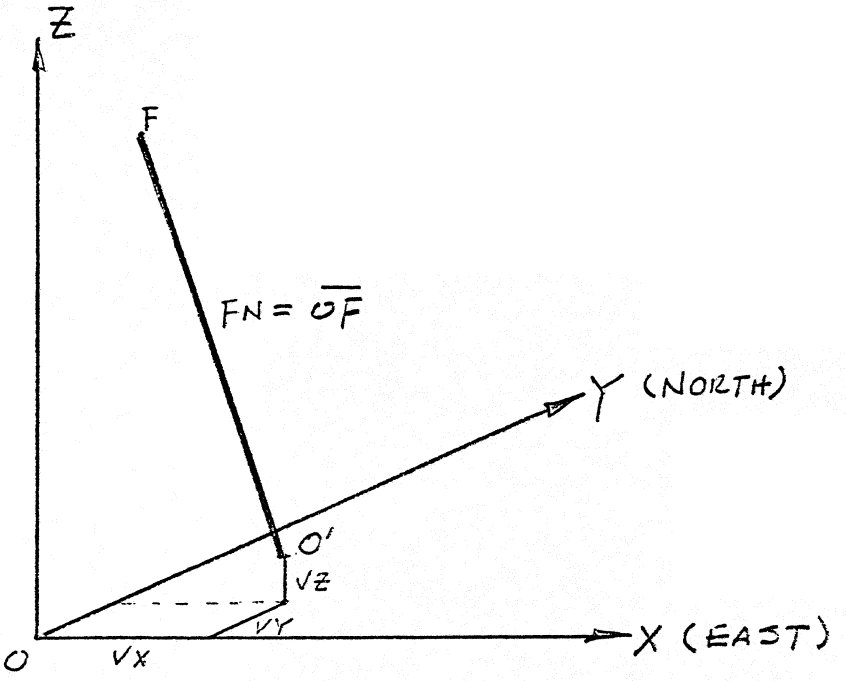
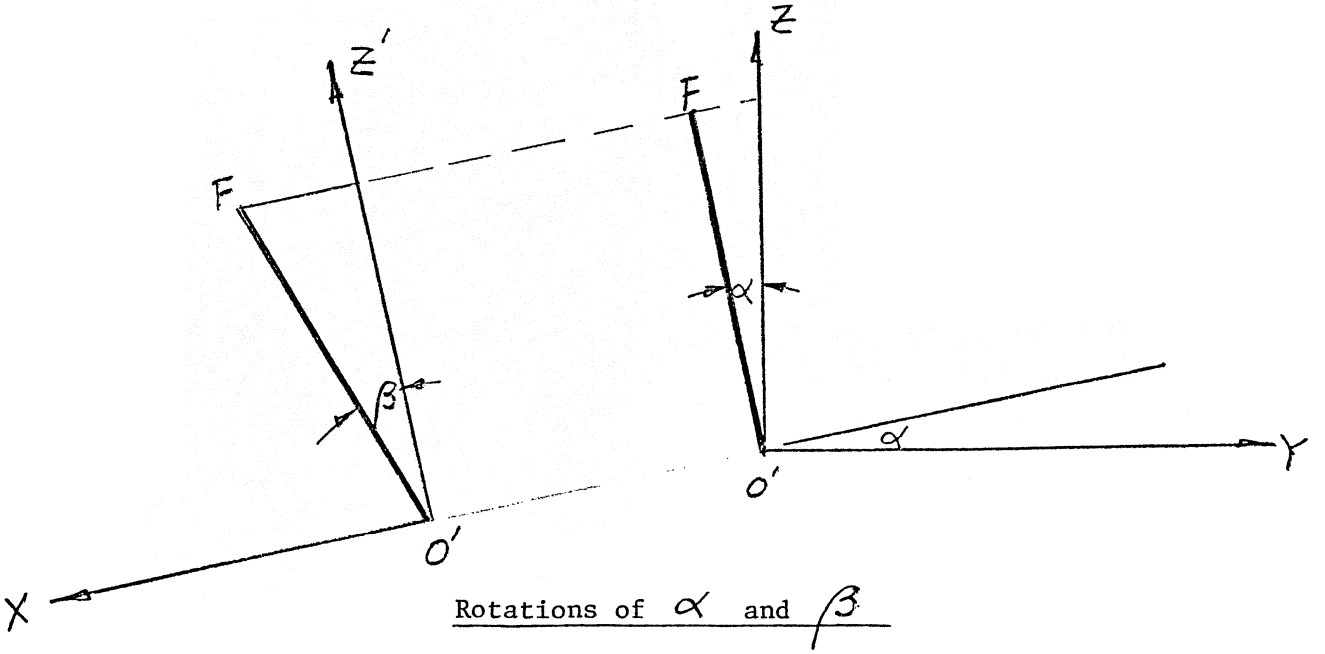


Fig. 6 Differences in Z Values, (Run # 2 - Run # 1)



Coordinate System for RMS Calculations



Rotations of α and β