LIGHT LOSS IN FOS AS A FUNCTION OF POINTING ERROR

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ABSTRACT

Target acquisition errors in acquiring point source targets cause a loss of signal in FOS spectra. Several sets of peak-up acquisitions are analyzed for the most commonly used apertures: A1 (4.3"), B3 (1"), B2 (0.3"), and the 0.25" wide slit. The fall-off in signal is gradual except when the target is within about 0.1" of the edge of the aperture. As expected, the light loss is roughly 50% when the target lies on the aperture edge.

DATA ANALYSIS

One of the many contributions to the error budget for spectrophotometry with FOS is light loss due to imperfect target acquisitions. In order to quantify this uncertainty, several target acquistions in the peakup mode are examined to measure the relative throughput at the well defined locations of the target with respect to the final precise determination of position of the peak. FOS target acquisition scenarios in the peakup mode (ACQ/PEAK) proceed through 3 or 4 stages of progressively smaller offset steps on the sky in smaller entrance apertures in order to zero in on the exact location of the target. The data sets in Table 1 are analyzed to find the position of the target in the most finely stepped stage with the smallest aperture. This position determines the pointing offset of each step of each stage of the acquisition, since the relative offsets between stages is known. The details of the different ACQ/PEAK scenarios are in the footnotes to Table 1.

RESULTS

Figures 1-4 plot the measured pointing offset vs. transmission relative to the peak countrate for each of the four most commonly used FOS entrance apertures. If the peak countrate for a larger aperture is not well defined because the centering in the aperture was not perfect, then the peak countrate for that aperture is computed from the peak in a smaller, well-centered aperture and the transmission of the small aperture from Neill, Bohlin, and Hartig (1992). Most of the scatter in the Figures is intrinsic in the sense that the pointing error is computed only as the radius of the offset from aperture center, while the actual aberrant point spread function (PSF) is not azimuthally symmetric (cf. Evans 1993).

In Figure 1 for the 4.3" square target acquisition aperture, the effective aperture size in the Y direction perpendicular to the dispersion is defined by the 1.43" FOS diode height. Thus, the pointing error in Y is much more important than the X error; and the pointing error in Figure 1 is intended to represents the Y error only. Even though the two blue side observations of G191B2B have X-axis pointing errors as large as 1.8", the X offset errors are ignored in the 4.3" aperture, since an offset of 0.72" in Y places the star on the aperture edge, while an error of 2.15" in X is needed to reach the edge.

In Figure 2 for the 1" circular aperture, the apparently discrepant point at (.12,.92) could be low by 0.08 in the transmission due to a 3 sigma variation in the total counts of only about 1400. All other transmissions have counting statistics that reduce the uncertainty to sigma less than about 0.01.

The increase in scatter of Figure 3 for the 0.3" circular aperture relative to the scatter in Figure 2 is probably caused by the increased importance of azimuthal asymmetry close to the core of the PSF.

The lack of information for large pointing errors for the 0.25" wide slit in Figure 4 is because a slit peakup always follows a peakup in the 0.3" aperture. Only a small pointing tweak is required for precise centering and only a small coverage parallel to the dispersion in X is needed. Any miscenter in Y for the slit is negligible, so that the pointing error in Figure 4 represents only an X error.

REFERENCES

Evans, I. 1993, FOS Instrument Science Report CAL/FOS-0??, in preparation.

Lindler, D., Bohlin, R., Hartig, G., and Keyes, C. 1993, FOS Instrument Science Report CAL/FOS-088.

Neill, J. D., Bohlin, R. C., and Hartig, G. 1992, FOS Instrument Science Report CAL/FOS-077.

TABLE 1

PEAKUP DATA ANALYZED

Obs Rootname	Prop ID	Date	Star	Side	Grating	A1 cts/sec	Scenario
Y0VH0201-3T	2821	1992.14	G191B2B	RED	H27	219,000	1
Y0VH0301-3T	2821	1992.47	BD+28 4211	RED	H27	669,000	1
Y0VH0401-3T	2821	1992.47	BD+28 4211	RED	H27	669,000	1
Y0VH0501-3T	2821	1992.18	G191B2B	BLUE	H13	28,000	1
Y0VH0601-3T	2821	1992.17	G191B2B	BLUE	H13	28,000	1
Y0VH0701-3T	2821	1992.49	BD+28 4211	BLUE	H13	110,500	1
Y0VH0801-3T	2821	1992.51	BD+28 4211	BLUE	H13	110,500	1
Y13F0101-4T	4211	1992.77	BD+28 4211	BLUE	H57	10,600	2
Y13F010HT	4211	1992.77	BD+28 4211	BLUE	H57	10,600	3
Y13F010LT	4211	1992.77	BD+28 4211	RED	H78	15,500	4
Y13F010YT	4211	1992.77	BD+28 4211	RED	H78	15,500	5

SCENARIO DESCRIPTIONS:

1-Three stage peakup with 3 Y steps of 1.4" in A1 at 1 sec exposure/step,
6x2 steps of 0.7" in B3 at 1 sec exposure/step,
and 4x4 steps of 0.2" in B2 at 2 sec exposure/step.
The stepping is in a boustrophedon pattern with direction starting toward negative X and alternately toward negative Y. The somewhat more robust ACQ/PEAK standard scenario uses a 5x5 pattern at the third stage. These acquisitions are for proposal 2821, which determined the FOS flats from super spectra (Lindler, et al. 1993). An eighth peakup on the Red side for G191B2B failed.

2-Four stage peakup with 3 Y steps of 1.4" in A1 at 1 sec exposure/step,
6x2 steps of 0.7" in B3 at 0.25 sec exposure/step,
5x5 steps of 0.2" in B2 at 0.45 sec exposure/step,
and 5x5 steps of .05" in B2 at 2.25 sec exposure/step.
These acquisitions are in proposal 4211, which determined throughput for a few apertures (Bohlin 1993, in preparation.)

3-A tweakup in the slit (C2) that is linked to the above four stage peakup. The pattern is 7 steps of 0.05" in X only at 2.25 sec exposure/step. The Blue side slit is concentric with the B2 aperture to 0.02" in X, the direction parallel to the dispersion.

4-A tweakup with 5x5 steps of .05" in B2 at 2.25 sec exposure/step that is linked to the above scenarios 2-3 and follows a side switch from Blue to Red. Unfortunately, the offset between the Red and Blue apertures is greater than the 0.1" allowed for in this ACQ/PEAK, and the true peak is outside the scan pattern in the X direction. The actual X peak position is estimated by the X offset needed to make the Red side data from proposal ID 4211 match the rest of the points in Figure 3. The best guess for the offset between the small Red and Blue side apertures is .2" in X and less than .05" in Y. A more precise measure of the aperture offset between the two FOS sides is needed.

5-A tweakup in the Red side slit (C2) that follows the above scenarios 2-4 for proposal ID 4211. The pattern is 7 steps of 0.05" in X only at 2.25 sec exposure/step. The Red side slit is concentric with the Red side B2 aperture to 0.05" in X.

FIGURE CAPTIONS

Fig. 1--Relative aperture transmission vs. pointing error for the A1 (4.3") FOS target acquisition aperture. Open symbols represent data obtained by the Red side detector, while filled symbols are from the Blue side. There is no obvious systematic difference between Red and Blue side measurements. The star G191B2B (WD0501+527) is the target for the first red and first two Blue side observations in proposal ID 2821, while BD+28 4211 is the light source for the remaining 2821 and all 4211 observations. The pointing errors can be determined to a typical accuracy of 0.06" in the 3-stage peakups and about 4 times better in the 4-stage peakups that have a final fine step size of 0.05". The cross at the 50% transmission level is at a pointing error which corresponds to the distance from the aperture center to edge.

Fig. 2--Same as Fig. 1 for the B3 (1") aperture.

Fig. 3--Same as Fig. 1 for the B2 (0.3") aperture.

Fig. 4--Same as Fig. 1 for the C2 slit (0.25" wide). The step size of the slit tweakups is 0.05".

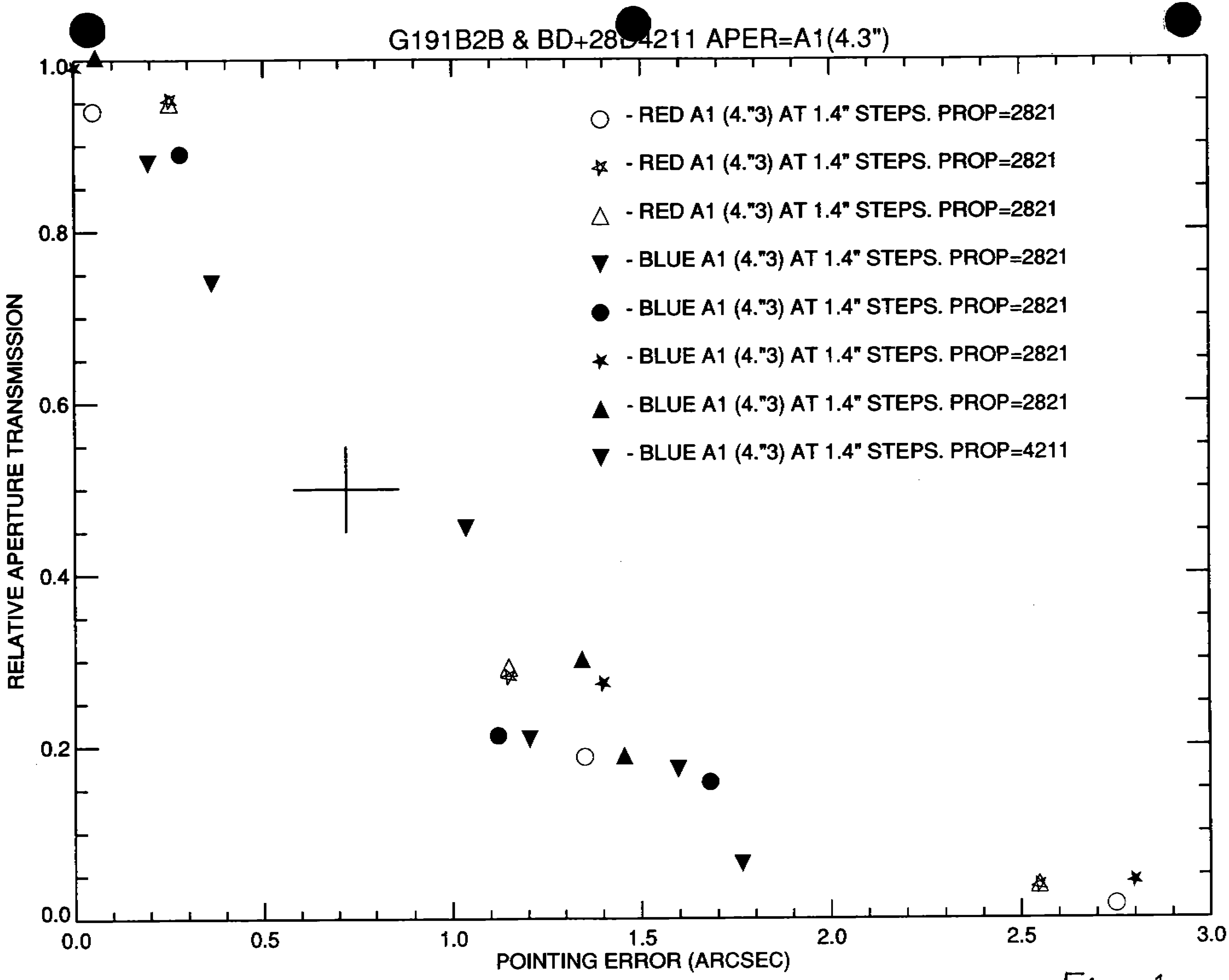
G191B2B & BD+28D4211 APER=A1(4.3")
RELATIVE APERTURE TRANSMISSION
POINTING ERROR (ARCSEC)
0.0
0.2
0.4
0.6
0.8
1.0
0.5
1.5
2.0
2.5
3.0
- RED A1 (4."3) AT 1.4" STEPS. PROP=2821
- RED A1 (4."3) AT 1.4" STEPS. PROP=2821
- RED A1 (4."3) AT 1.4" STEPS. PROP=2821
- BLUE A1 (4."3) AT 1.4" STEPS. PROP=2821
- BLUE A1 (4."3) AT 1.4" STEPS. PROP=2821
- BLUE A1 (4."3) AT 1.4" STEPS. PROP=2821
- BLUE A1 (4."3) AT 1.4" STEPS. PROP=2821
- BLUE A1 (4."3) AT 1.4" STEPS. PROP=4211

Fig. 1

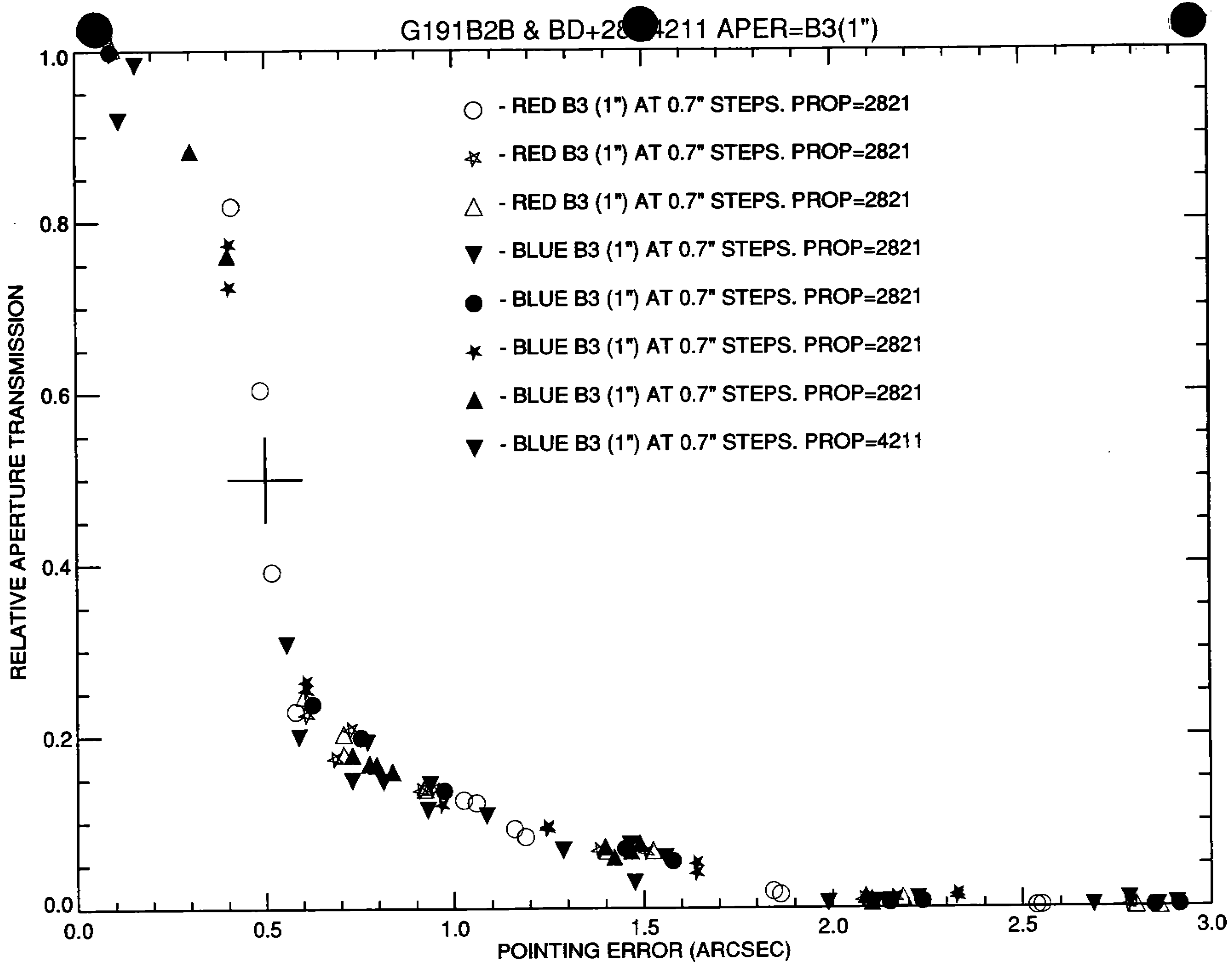

Fig. 2

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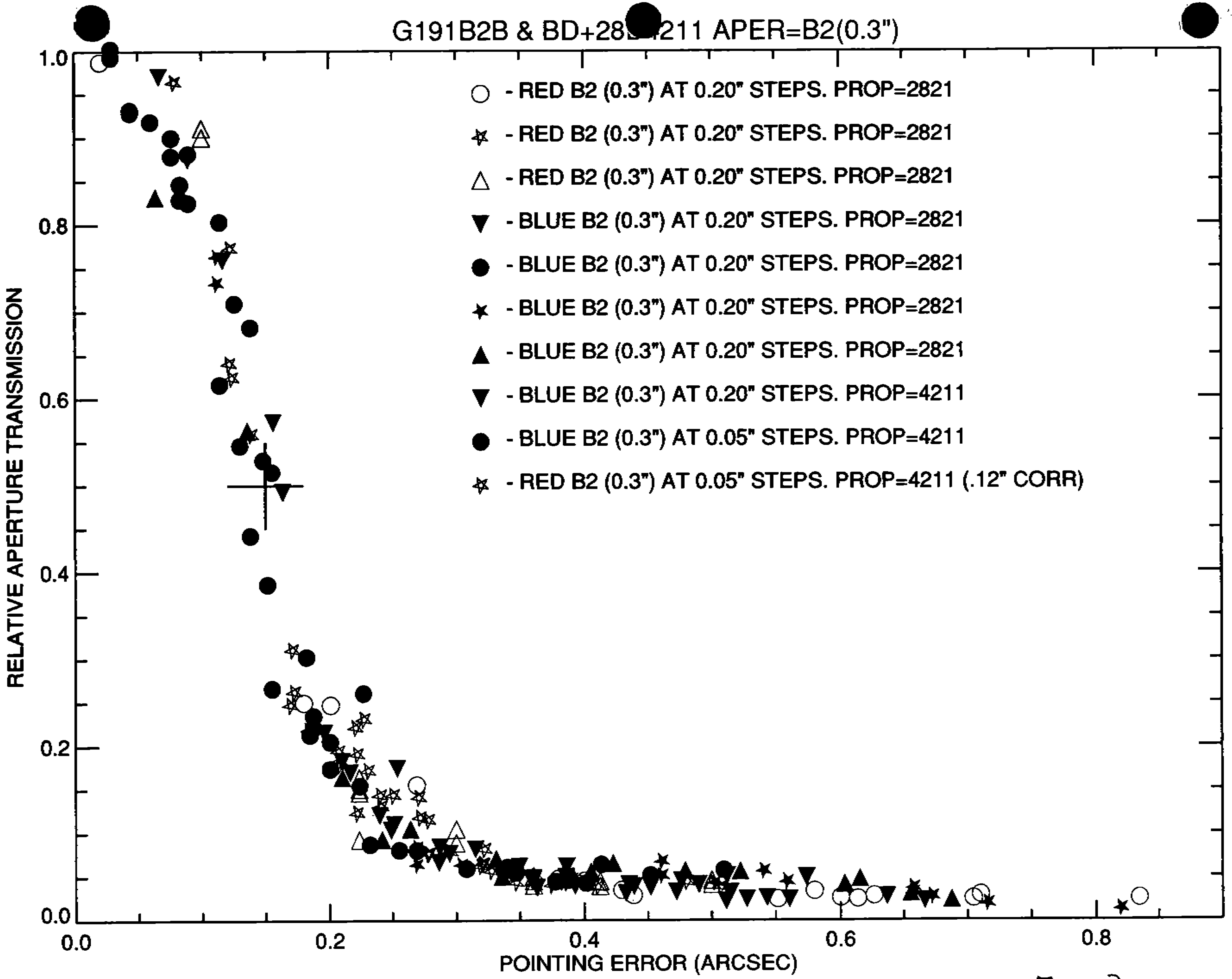

Fig. 3

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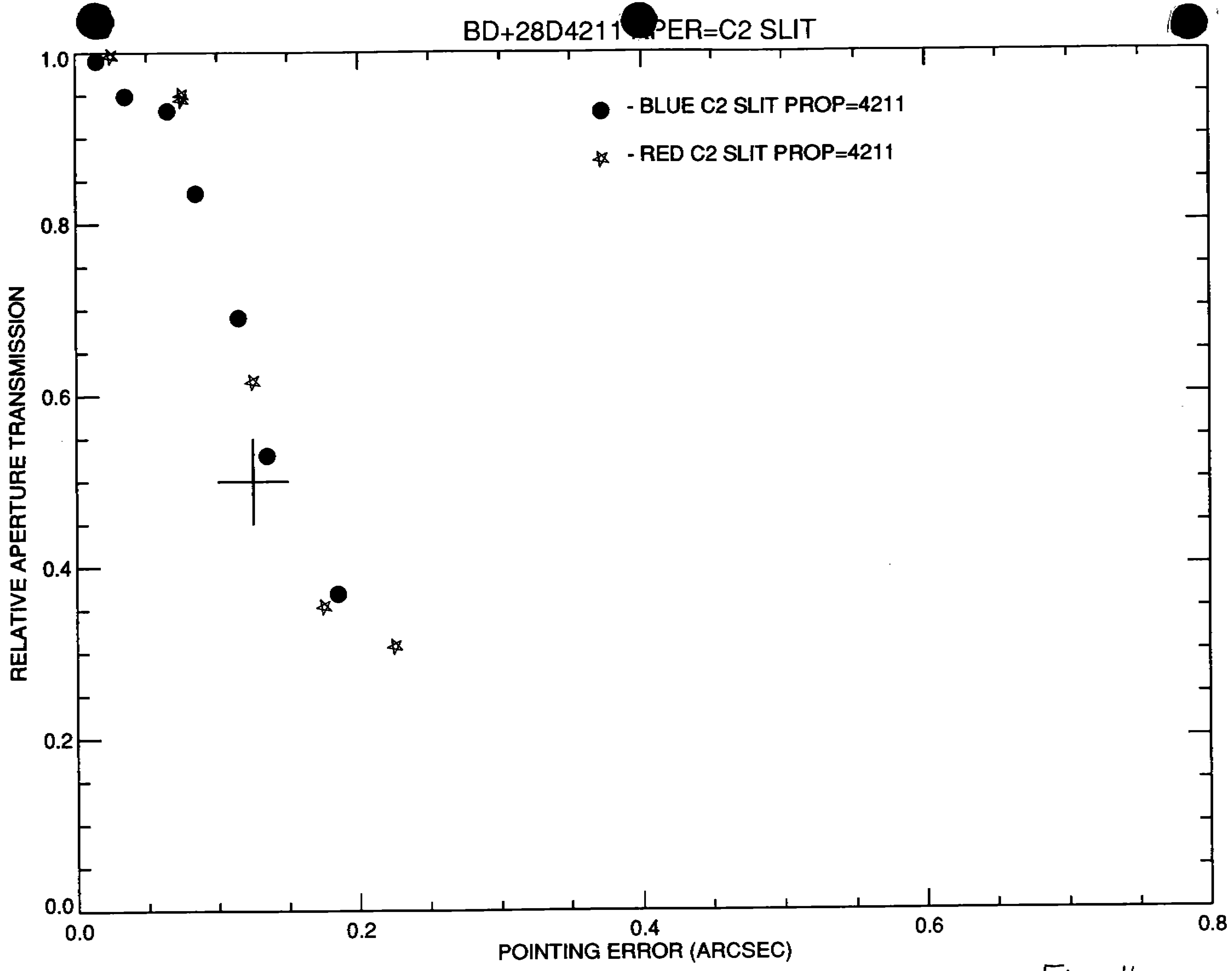

Fig. 4

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