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SEC Response to beam halo

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AGS Technical Note

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Introduction

Data from the various foil calibration runs during 1981 SEB running show large variations in SEC response at the C3 station. This is probably due to variations in beam "halo" causing large changes in background signals from the SEC. This model fits the C3 SEC response and $\bar{p}$ flux in the C line. A "background" of this type would make the optimization of the C3 line impossible.

Halo Sensitivity

During the 1981 running of the Slow Beam the C and C3 SEC calibrations were checked with foil irradiations[1]. The results[2], given in Table I, show variation in response for the C3 SEC of more than a factor of 2. The records are incomplete as to which device was installed at C station for each of the first two runs. This variation in response is related to beam "halo" or background foil counts normalized to beam core foil counts as seen in Figure I. Included in this plot is a datum point from the calibration of the C3 SEC in the FEB. Zero background is assumed as this beam line is carefully tuned to eliminate halo. The large error bars are due to low foil count rates and relatively large well counter empty rates. The area of the background foil is one tenth the sensitive area of the SEC while the signal produced per background foil count is one-hundred times as great. Thus it appears that the halo signal is large compared to the halo's proton flux.

TABLE I

SEC Collaboration Runs

DATE	SERIAL #	C SEC Counts/TP	SERIAL #	C3 SEC Counts/TP	REMARKS
2/26/81	?	8688	#3	931	CH_4 foils. Bad vacuum in C SEC.
3/12	?	987			
3/16			#3	934	6% of beam hitting C target.
3/31	#4	864	#3	1042	
5/19	#4	845	#3	2132	
5/27			#3	2450	
7/?			#3	745	Calibration in FEB line[3] assuming 90% delivery from the ring.

Scanning the beam a quarter of an inch about the C Flag caused large signals from the upstream radiation monitors due to scraping of the beam in the small aperture magnets. Also a factor of 3 increase in SEC signal was observed presumably caused by beam halo generated by scraping. A scan of the C3 SEC plus and minus one inch across the Fast Beam showed a factor of 2 increase in signal on one side[3] although the aperture is three and a half inches. Scanning the C3 beam plus and minus one inch about the C3 Flag with down-stream benders caused a small decrease in signal indicating that there was little local scraping and possibly some halo removal. This indicates the halo at C3 is generated well upstream. The following discussion assumes it is generated by the C target. Also the lower calibration (845 counts/10^{12} protons) is used for C station as the higher result is probably from a small amount of scraping.

<u>C3 SEC Calibration as a Function of C Targeting</u>

The following symbols are defined:

C_C & C_{C3} are the SEC counts from the C and C3

P_C & P_{C3} are the number of Terraprotons (10^{12} protons) traversing the the C and C3 stations

G_C & G_{C3} are the gains of the SEC's in counts per terraproton ($G_C = \frac{C_C}{P_C} = 845$) ($G_{C3} = \frac{C_{C3}}{P_{C3}}$)

K_{C3} is the gain of the C3 SEC to protons traversing it with no added signal from the C target.

K_C is the gain of the C3 SEC to protons hitting the C target.

ε is the fraction of protons hitting the C target. (CTEL/CSEC "Normalized").

R is the fraction of proton transported from C to C3. $\left(R = P_{C3}/P_C\right)$

T is the apparent transmission from C to C_3 as displayed by "CLYDE"[4] $\left(T = C_{C3}/1.2 \times C_C\right)$

The count from the C3 SEC is expected to be:

$$C_{C3} = K_{C3}\ P_{C3} + K_C\ P_C\ \varepsilon$$

or

$$G_{C3} = C_{C3}/P_{C3} = K_{C3} + K_C\ \varepsilon/R$$

The values of K_{C3} and K_C are obtained by matching to three foil runs assuming an ε of .06 for the 2/26/81 run and an ε of 1.0 for the 5/19 and 5/27 runs averaged. The other foil runs were not used for fitting as the ε's were not known. Thus;

$$G_{C3} = 912 + 276\ \varepsilon/R \qquad (1)$$

This curve is plotted (using values of ε calculated from Eq. (4)) in Figure 2 along with the data from Table I. Also included are two calibrations from 1980 for the "L&D" SEC used at C3. The error bars are generated assuming a ±2% error in foil area and the resultant 3% error in the ratio of C_3 to C (R).

Data from the morning "CLYDE" printouts is given in Figure 3. The program uses a the C Telescope calibration of 161.3 counts per terraproton and a C_{C3}/C_C count ratio of 1.2 for 100% transmission. The upper points are fitted as lower ones may be due to poor tuning. The slight nonlinearity may be due to the beam hitting the C target at a slight angle and that multiple scattering increases as the square root of material traversed while the telescope counts increase linearly or faster.

The curve is:

$$T = .92 - .81\varepsilon + .34\varepsilon^2 \qquad (2)$$

Also note:

$$T = \frac{G_{C3}}{1.2 \times G_C} R \qquad (3)$$

Equating (1), (2) and (3) gives:

$$R = 1.02 - 1.20\ \varepsilon + .38\ \varepsilon^2 \qquad (4)$$

Figure 4 shows this curve with $\bar{p}$ fluxes logged during Ex 708's run normalized to the C SEC. It is assumed that one terraproton will produce a thousand $\bar{p}$'s. Low points are again presumably due to poor tuning.

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Figure 5 shows the curve of G_{C3} versus ε with the foil runs plotted. The abscissa for these points are calculated from the measured R's and eq. (4). Also plotted, as an independent check, are the crude calibration points obtained using the $\bar{p}$ flux as a measure of C3 proton intensity. Figure 6 shows the expected real transmission (R) versus the displayed transmission (T). These two curves may be of some help interpreting past C3 SEC data if the C SEC and/or C Telescope counts had also been recorded. These curves may well be off by 10%.

Conclusions

Even though the values of the various relations are only approximate due to large statistical uncertainties and lack of controlled conditions as the data were collected, the pattern seems clear. The C3 SEC (and presumably the A3 SEC) signal is dominated by a background caused by upstream targeting. This phenomena makes it difficult to measure, with the SEC, the flux on the C3 target. Also the real transmission from C to C3 is one half the expected 40% when fully targeting at C. It is impossible to optimize real transmission, as the tendency would be to maximize the dominating halo counts even at the expense of real beam counts.

This indicated sensitivity of the SEC's to beam halo should be confirmed early in the next FEB run. If verified, the possibility of subtracting the background signal with a foil having the center cut out should be investigated. This system was used in the old "L&D" SEC's but the relative sensitivity of the background to signal foil arrays was not carefully checked near the support rings.

REFERENCES

[1] B.G. Eweng, R.K. Koleda, and S. Naase; private communications.

[2] All results using Al foils are referenced to the standard 8 mb cross-section. Normal SEB displays use 7.77 mb which is consistent with the circulating Beam Monitor and the Ring Loss Monitor.

[3] J.M. Sandberg, private communication.

[4] The program "CLYDE" monitors and displays on the TV system the operating performance of SEB delivery. Printouts of this performance are logged daily.

Figure 1. C3 SEC calibration versus normalized background.

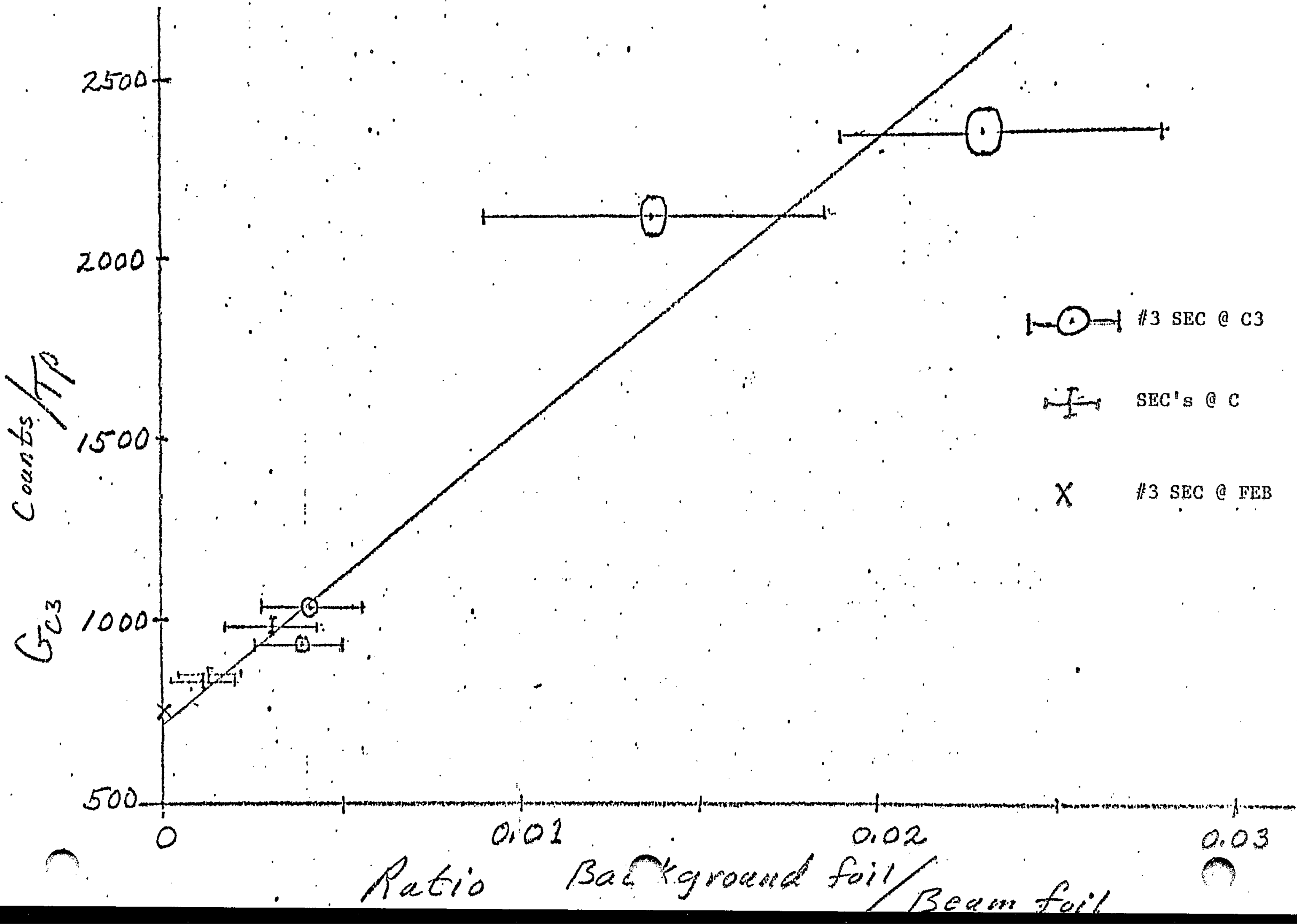

Figure 2. C3 SEC calibration versus fraction of beam transmitted from C to C3.

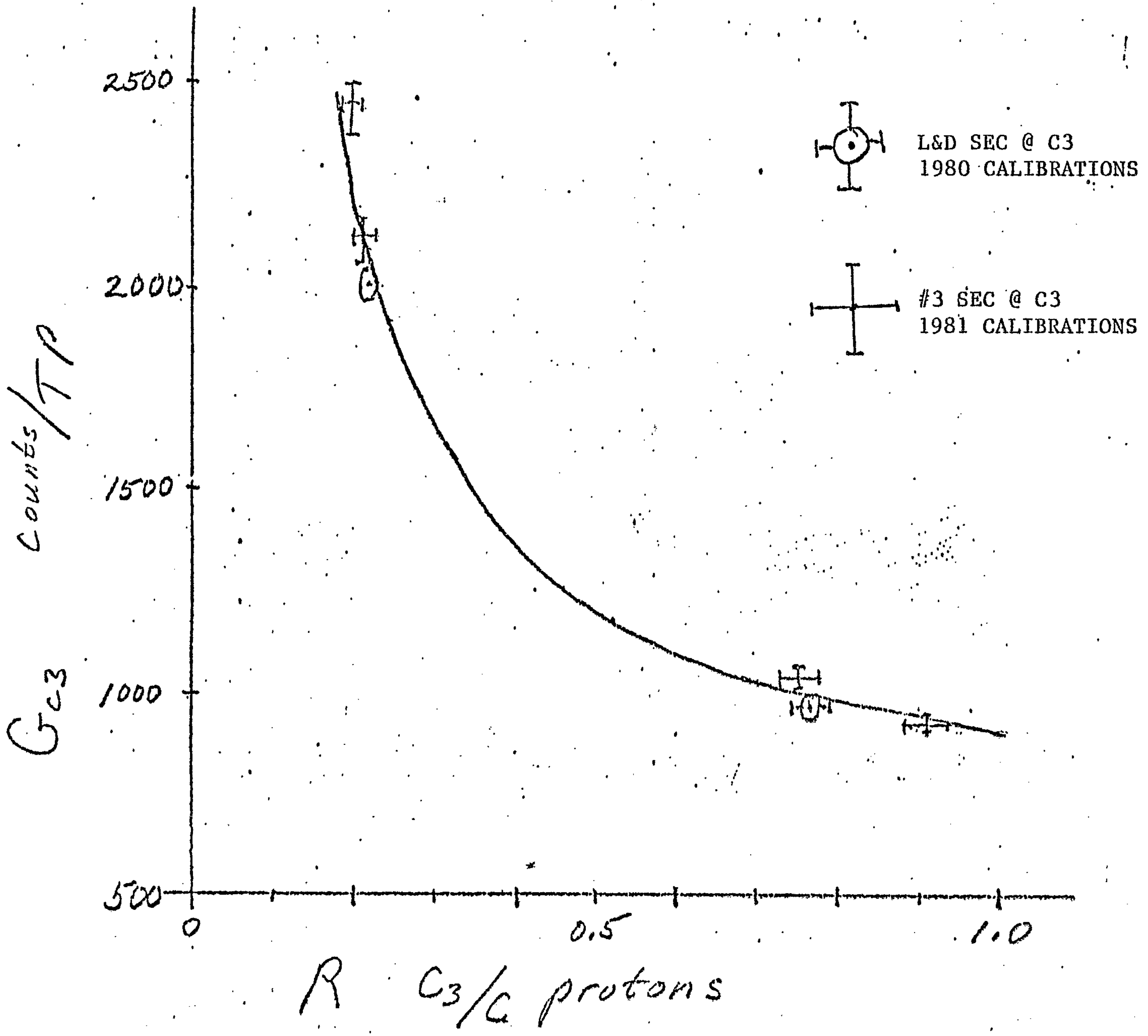

Figure 3. Displayed transmission versus C targeting.

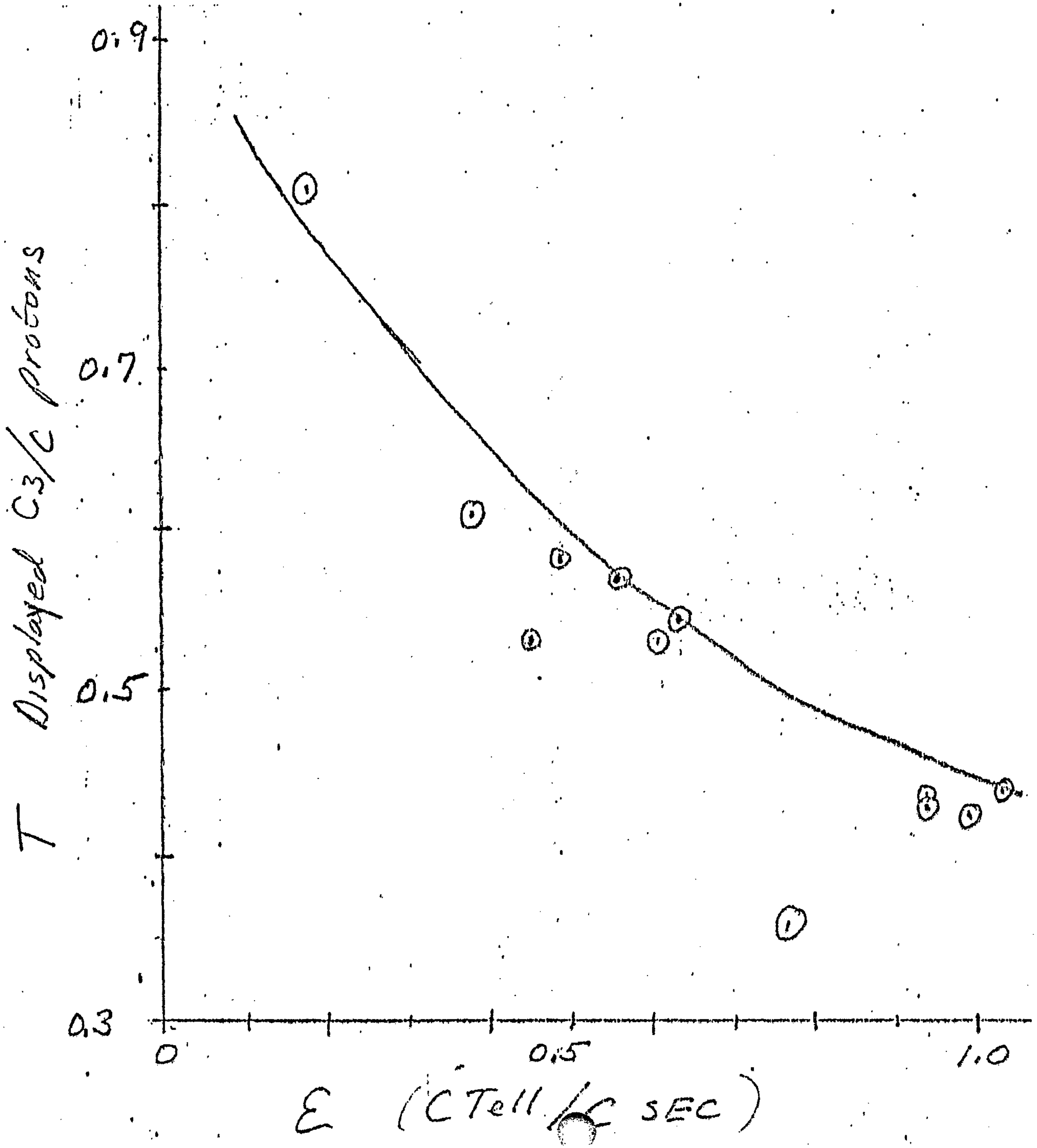

Figure 4. Transmission and Ex. 708's $\bar{p}$ flux normalized versus C targeting.

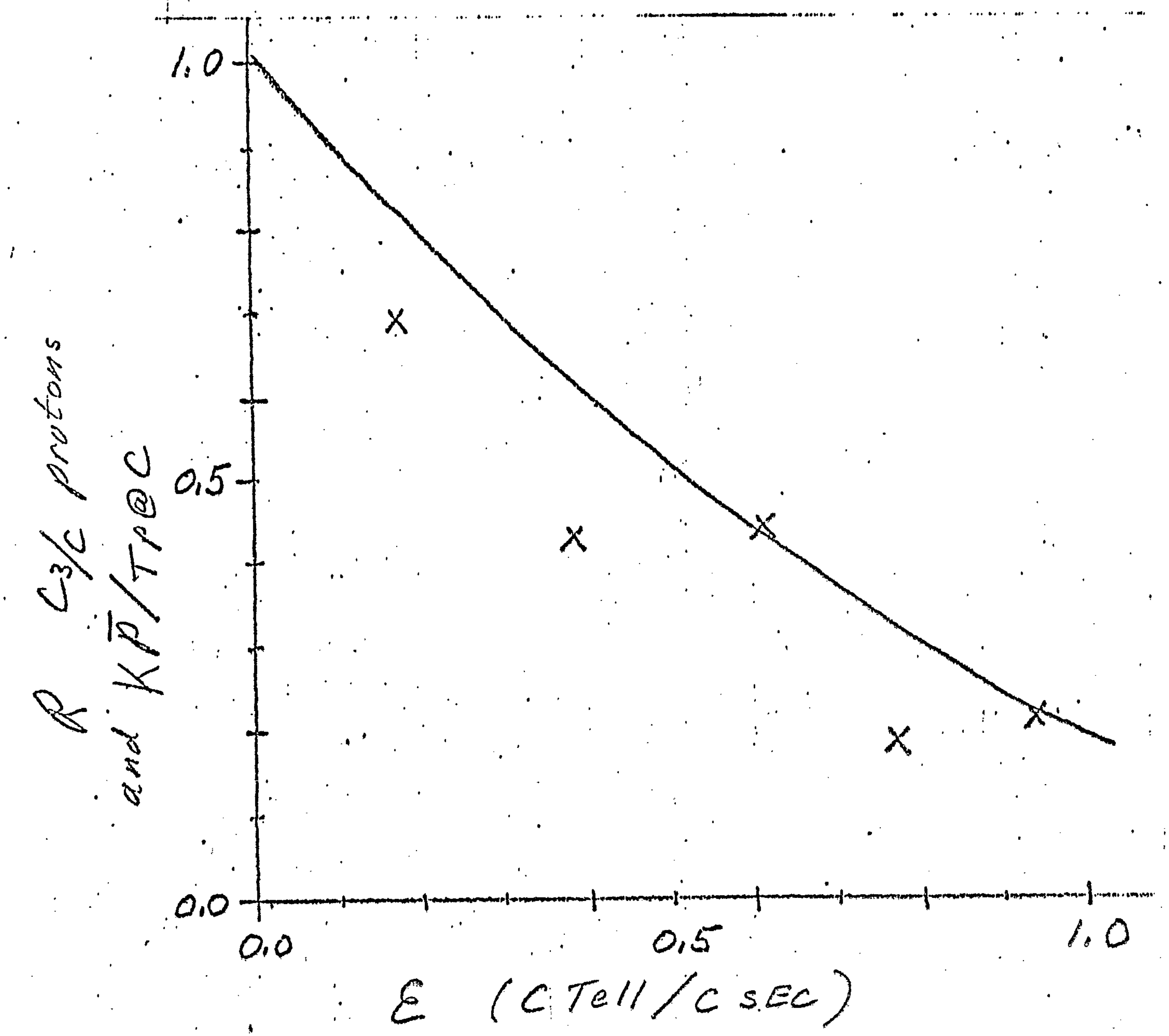

Figure 5. C3 SEC calibration versus C targeting.

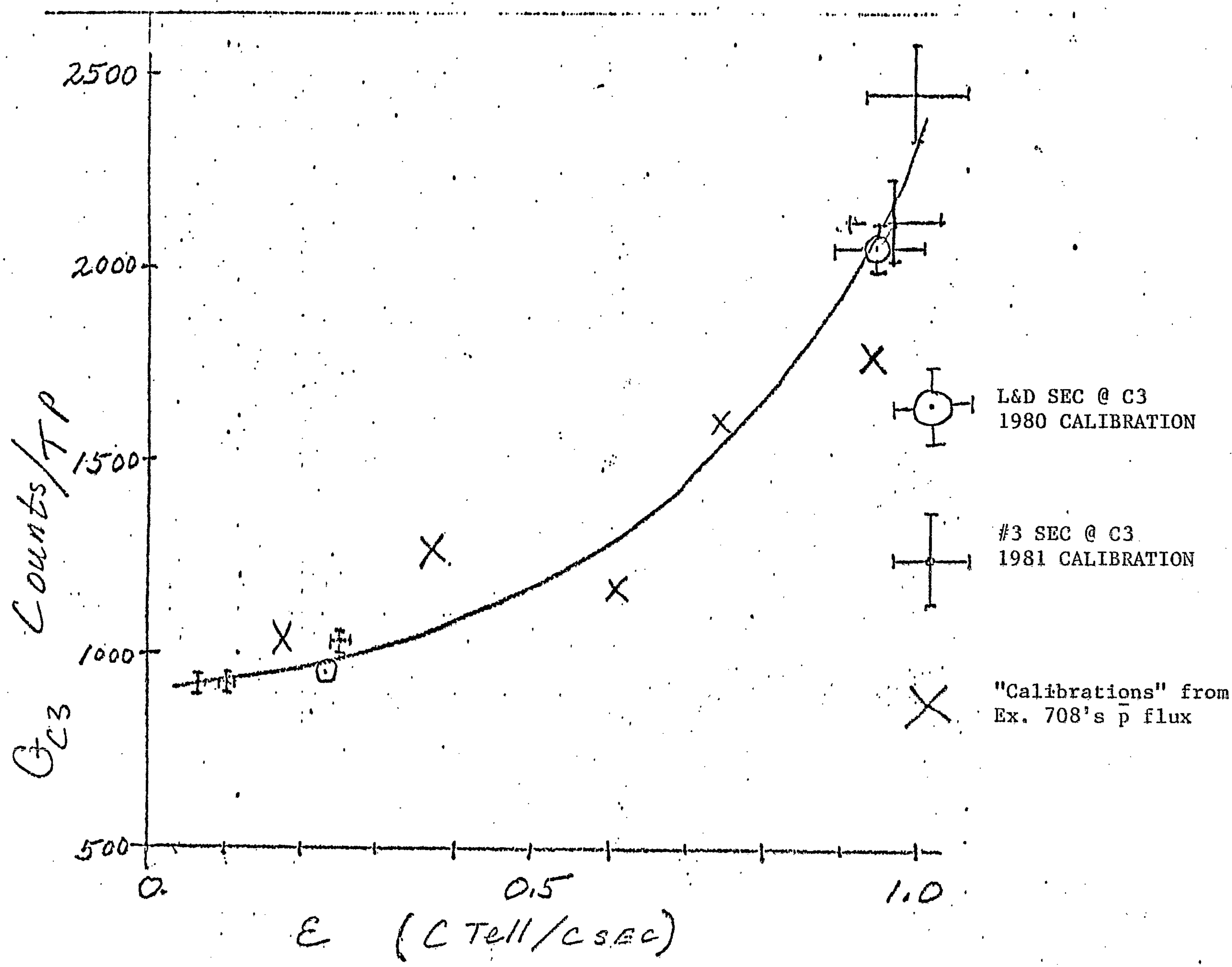

Figure 6. Real transmission versus displayed transmission.