

## D-Line Study

G. Bunce

August 1981

Collider Accelerator Department  
**Brookhaven National Laboratory**

**U.S. Department of Energy**

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

## **DISCLAIMER**

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

AGS STUDIES REPORTDate April 28, 1981Time 1400 - 1700Experimenters H. Brown, G. Bunce, J.W. Glenn and S. NaaseReported by G. BunceSubject D-Line StudyOBSERVATIONS AND CONCLUSION

On 31 March and 27 April 1981, we extracted beam to the D line, testing the extraction system and the beam size in preparation for construction of the downstream section of the line. Following the D line from extraction from the AGS<sup>1</sup>,

- (1) The electrostatic splitter AB1 splits DA from BC, in the horizontal plane.
- (2) The electrostatic splitter DB2 splits D from A in the horizontal plane. It was installed for the D line and is not used for ABC running.
- (3) The thin Lambertson AP1 kicks D and A upward 8 milliradians.
- (4) The thin Lambertson CP1 kicks ABC down 5.9 milliradians.

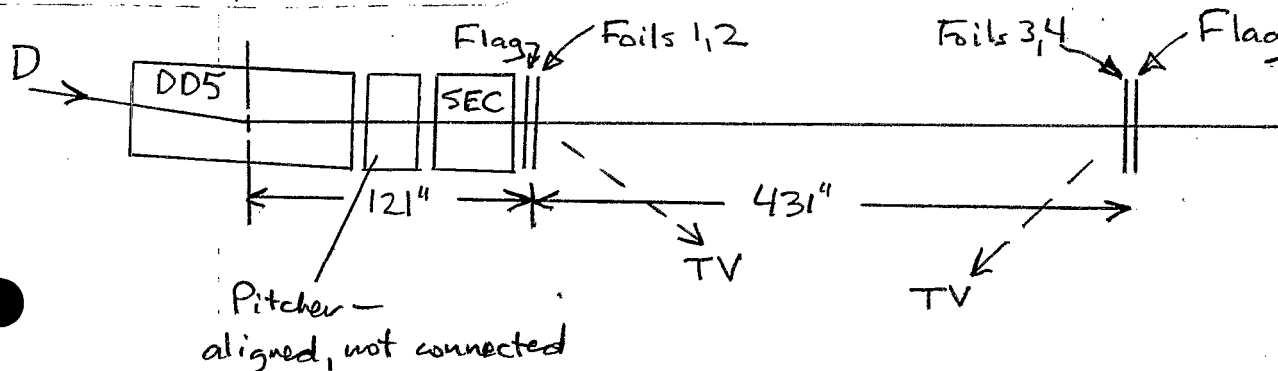
At this point, a flag at CF100 displayed the four separated beam spots.

- (5) Two thick Lambertsons, AD2 and AD3, further separated A and D from BC horizontally.

A flag after AD3 displayed the A and D beam spots.

- (6) Two thick Lambertsons, DD4 and DD5, further separate D from A horizontally.

DD5 was followed by a secondary emission chamber (SEC) and a scintillation flag viewed by a TV camera (in the March test, these were only roughly aligned). In April, a second flag was added 431" downstream from the first, in order to observe the beam growth, and four foils were exposed, two at each flag, to measure the beam size:



The SEC monitored both halo (beam outside a 2" diameter hole) and total beam, about  $10^{12}$  ppp. First we scanned the beam horizontally to check the halo/total beam response of the SEC and to roughly center the beam horizontally. In this position, without optimization, we observed halo/total = 4%, after correcting for the different electronic sensitivity of the halo (50x). The four foils were mounted as shown in the diagram and were exposed to beam for  $1.007 \times 10^5$  SEC counts.

Figure 1 shows film exposed to the upstream and downstream foils overnight. In both positions, the beam is tilted from the horizontal- $36^\circ$  upstream and  $47^\circ$  downstream with a few degree placement error. (The upstream film is observed looking upstream and the downstream film looking downstream.) The tilt is caused by second order horizontal magnetic fields seen by the protons in the thick Lambertsons which depend in magnitude and sign on the horizontal position of the protons. One of the purposes of the test was to determine whether or not correction by skew quadrupoles would be necessary for this tilt. It is.

The foils were cut into 1/2 cm wide strips along the major and minor axes of the ellipse over an area 3.5 cm x 6.5 cm. The activity of each strip was counted, following standard procedure, with the resulting histograms shown in Figure 2. A background strip, out of the beam region, was counted for each foil.

The observed beam size (FWHM) was

	<u>Major Axis (x)</u>	<u>Minor Axis (y)</u>
Upstream	1.5 cm	$\leq .8$ cm
Downstream	2.5 cm	1 cm

with conservative errors of .3 cm. The expected full intensity beam size at the upstream position would be  $x = .74$  cm and  $y = .62$  cm, FWHM. Thus, this is consistent with observations in other beam lines that the AGS extracted beam is twice as large horizontally as expected and correct vertically.<sup>3</sup>

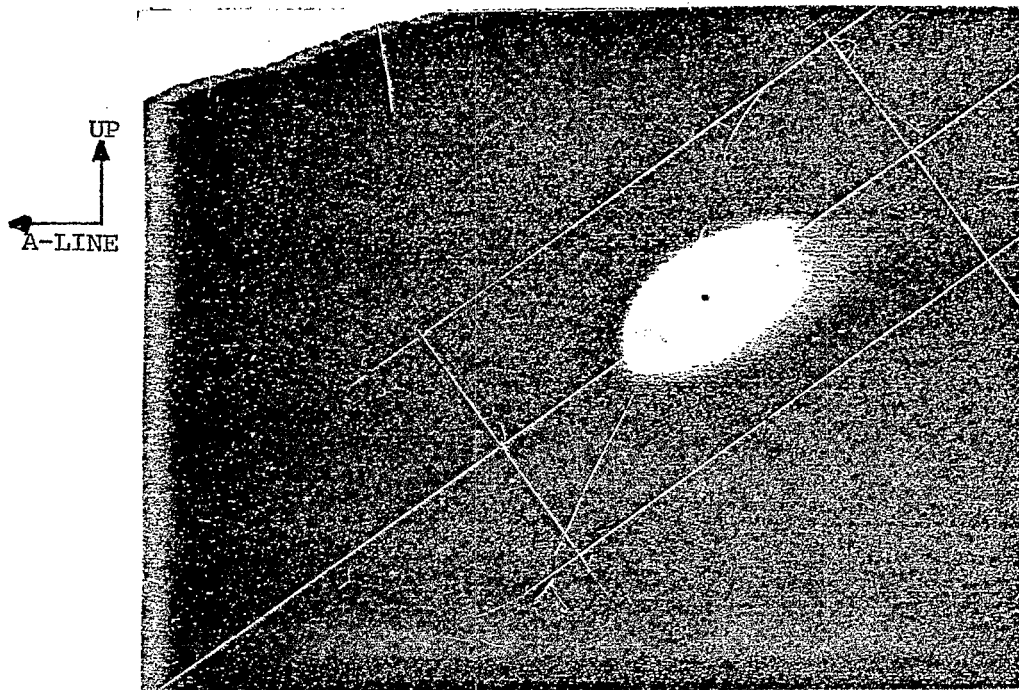
The downstream foil position corresponds roughly to the position of DD11 in the 20° bend string, to be constructed in D following the last Lambertson magnet. The 20° dipoles will be shimmed to an aperture of 1-1/2". This test shows that, after rotation of the ellipse by a skew quad, there is adequate clearance.

By adding the activity measured for the strips, we checked the consistency of the foil measurements and calibrated the SEC. The number of protons seen by the foils was  $1.13 \pm_{.04}^{.06} \times 10^{14}$ , or  $1.12 \times 10^9$  protons per SEC count.

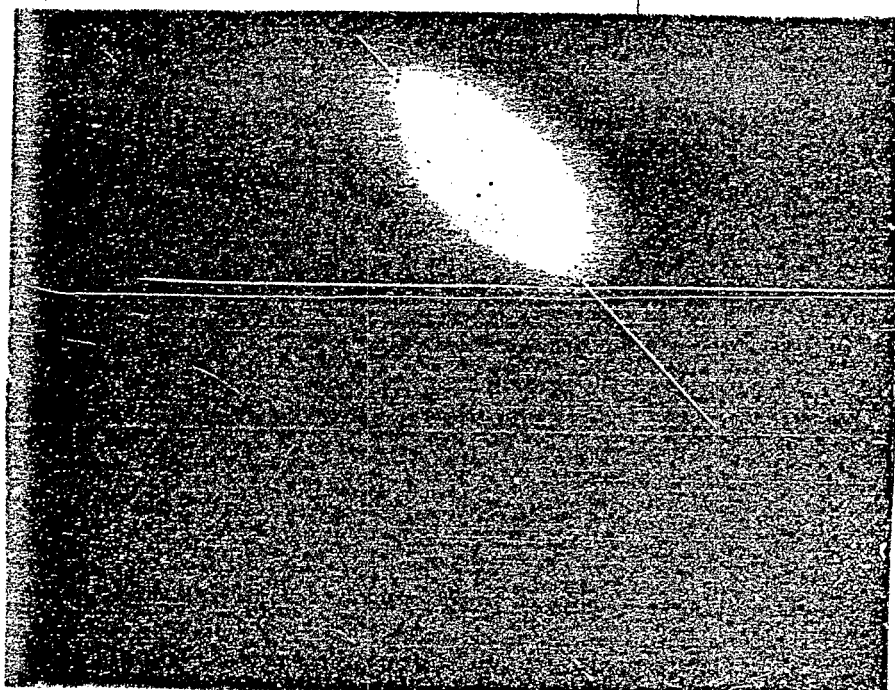
#### References

1. L. Blumberg, H. Brown, et al., "The AGS Slow External Beam Switchyard", BNL 24508R (1978).
2. V. Agoritsas, "Measurements of High Energy Proton Fluxes Using Foil Activation Techniques", AGS Technical Note 135 (1977).
3. H. Weisberg, "More SEB Emittance Measurements", AGS Technical Note 168, (1981).

Figure 1. Film exposures to foil runs in the D Line. The outlined box indicates the area of the foil used for the activation measurements in the next figure.



Upstream position, looking upstream. The beam is tilted  $36^\circ$  from horizontal.



Downstream position, looking downstream. The beam is tilted  $47^\circ$  from horizontal.

Figure 2. Foil profiles. Schematics indicate position of 1/2 cm strips.

