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AGS STUDIES REPORT

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Subject A Measurement of HEBT Momentum Spread for a 20 mA H^- Beam

OBSERVATIONS AND CONCLUSION

Purpose

This measurement was carried out as part of a general study of the tume characteristics of the HEBT line. The value of the momentum spread is needed for proper analysis of optics measurements and for evaluation of rf capture studies in the AGS.

Method

A 1 mm wide slit was inserted in HEBT for this measurement. The slit is located at the HEBT5 instrument box in which a SEM single-wire scanning unit is also located. With this slit in the beam, a horizontal profile was measured at the middle of the achromatic bend section (HEBT6 SEM) where the dispersion function is maximal.

The transport matrix from the slit to the profile monitor has significant angle and position terms. This is different from the previous situation with the line tuned for protons. In that case, an approximate point-to-point focus meant the resolution function was simply determined by the slit size.

In order to provide the necessary angular data in the resolution function, the emittance parameters of the beam were obtained by a fit to the RMS profile widths measured at the five SEM monitors located upstream of the slit. A series of raytracing runs were made using the program TURTLE with various values of the momentum spread. The program generated rays according to uncorrelated horizontal and vertical phase space distributions with the previously determined Twiss-parameters. The distribution of momentum deviations, $\Delta P/P$, was assumed Gaussian and uncorrelated to transverse phase space.

Results

The result of the scan at HEBT6 is shown in Figure 1. The data points are taken in 1/2 mm steps. There is no normalization to beam current, but conditions during this period showed less than ±2% variations pulse-to-pulse. The long, low tail at the right hand side of the distribution was subtracted as a

background, although it may indeed be indicative of an asymmetry of the linac bunch. Figure 2 gives the results of the TURTLE study and shows that the measurement at HEBT6 yields an estimate of the RMS momentum spread (1/2 width) of 0.068 ± 0.003%.

The procedure has intentionally not been carried out at the 90-95% emittance level, which has often been more traditional, because of the distinctly non-Gaussian character of the tails of the profile measurements. If the momentum distribution of the beam were Gaussian, then the full-width at the 90% level extrapolated from our RMS measurement would be: 0.22 ± 0.01%.

The errors given here are those attributable to counting statistics in the Monte Carlo and reading error in the data. There has been no estimate made of systematic errors in the following: TRANSPORT (TURTLE) model, emittance parameter fit, non-Gaussian distribution of $\Delta P/P$.

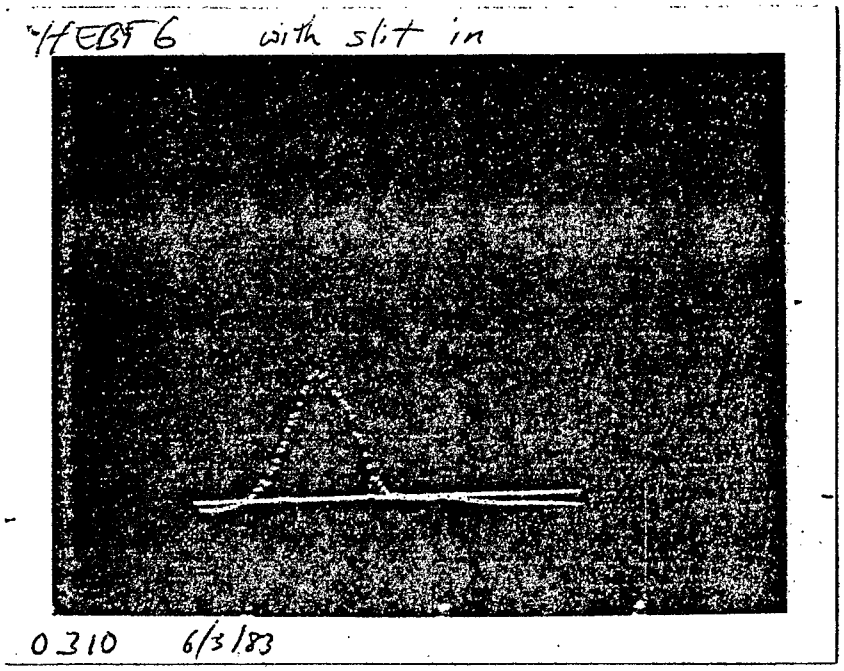
HEBT 6 with slit in
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Fig. 1.

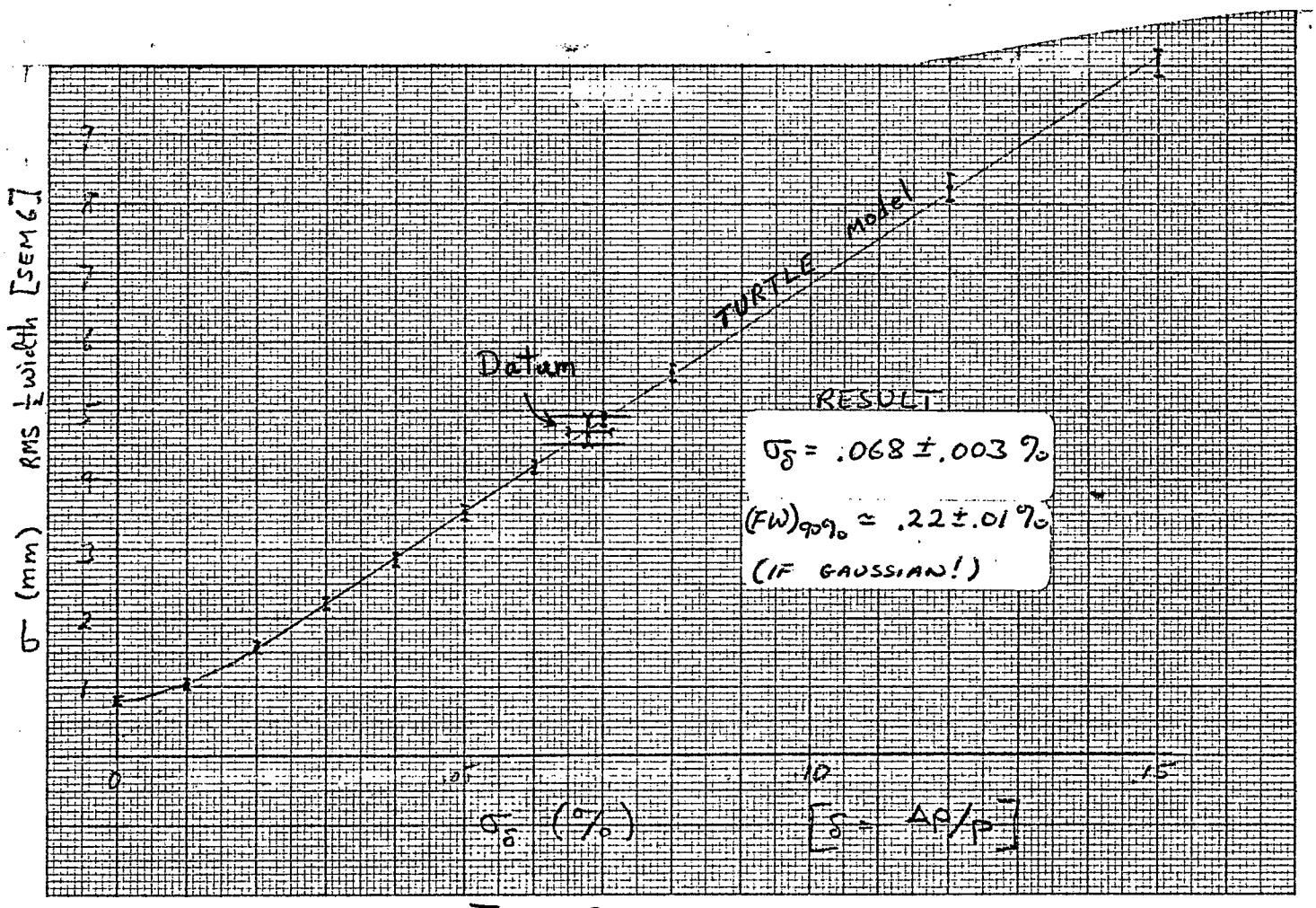
σ (mm) RMS ½ width [SEM6]
TURTLE model
Datum
RESULT
σ_δ = .068 ± .003 %
$(FW)_{90\%}$ ≈ .22 ± .01 %
(IF GAUSSIAN!)
σ_δ (%)
[δ = Δp/p]
0
.05
.10
.15

Fig. 2