

Injection machine parameter measurement

L. Ahrens

June 1983

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 9 June 1983Time 1500Experimenters L. Ahrens, J.W. GlennReported by L. AhrensSubject Injection Machine Parameter MeasurementOBSERVATIONS AND CONCLUSION

As part of the injection steering instrumentation, signals from a few sets of "conversion" pick up electrode pairs are amplified in the ring and available in the MCR in analogue form for forming difference signals using scope amplifiers and hence give position information for injected beam pulses of less than one turn duration. The resulting waveform is primarily used to tune the injection steering by nulling the observed oscillations; but to better understand the information a particular unsteered radial situation (C2 PUE) was photographed (Fig. 1) and the first 35 passes measured by hand and then fit to a certain hypothesis. The reduced data and fit are shown in Fig. 2.

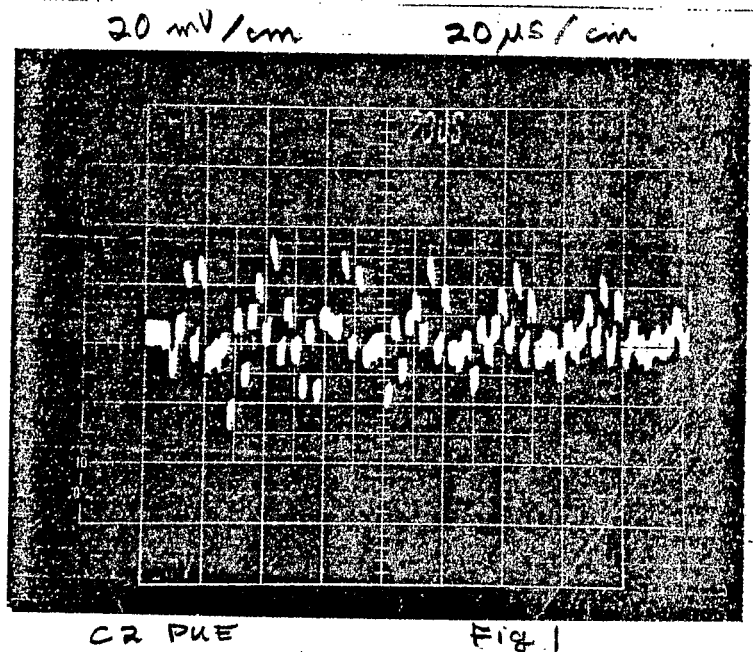


Fig. 1. C2 PUE

The function fit was:

$$A \cos [2\pi k (B + Ck) + D] \left(\frac{\sin 2\pi k E}{2\pi k E} \right) + F + kG$$

B is the initial radial tune

C the change in tune per turn

D the initial phase

E the tune spread in the beam which causes the signal to decrease with time

F an offset

G the radial shift per turn.

- 2 -

The naive interpretation of the results from the fit are as follows:

1. The initial tune is $8.809 \pm .0005$
2. The tune spread is $.011 \pm .0005$
3. The tune change/turn is $(5.3 \pm .15) \times 10^{-4}$
4. The radial shift/turn is $-(.014 \pm .002)$ cm/turn.

The last uses the PUE sensitivity of $6 \text{ cm} \left(\frac{V_1 - V_2}{V_1 + V_2} \right)$ and the observation that the sum for the above situation was 100 mV.

Point 4 is explained by the \dot{B} at injection, (4.5 kG/sec) B at injection (250 Gauss) so $\frac{\Delta B}{B}/\text{turn} = 8.6 \times 10^{-5}/\text{turn}$; $\frac{\Delta R}{R} = \alpha \left(\frac{\Delta p}{p} \right) = \alpha \left(\frac{\Delta B}{B} \right)$; $\alpha \approx \frac{1}{2}$; $\rightarrow \frac{\Delta R}{R} = -1.1 \times 10^{-6}/\text{turn}$ or $\Delta R/\text{turn} = -1.43 \times 10^{-2}$ cm then 3 and 4 together give $\Delta v/\Delta R = (.038 \pm .007) \text{ cm}^{-1}$ or if we use the \dot{B} calculation = $(.037 \pm .001) \text{ cm}^{-1}$ and a horizontal chromaticity $\xi = \frac{\Delta v}{\Delta p/p} = \left(\frac{\Delta v}{\Delta R} \right) \Delta p = -6.4 \pm 1$.

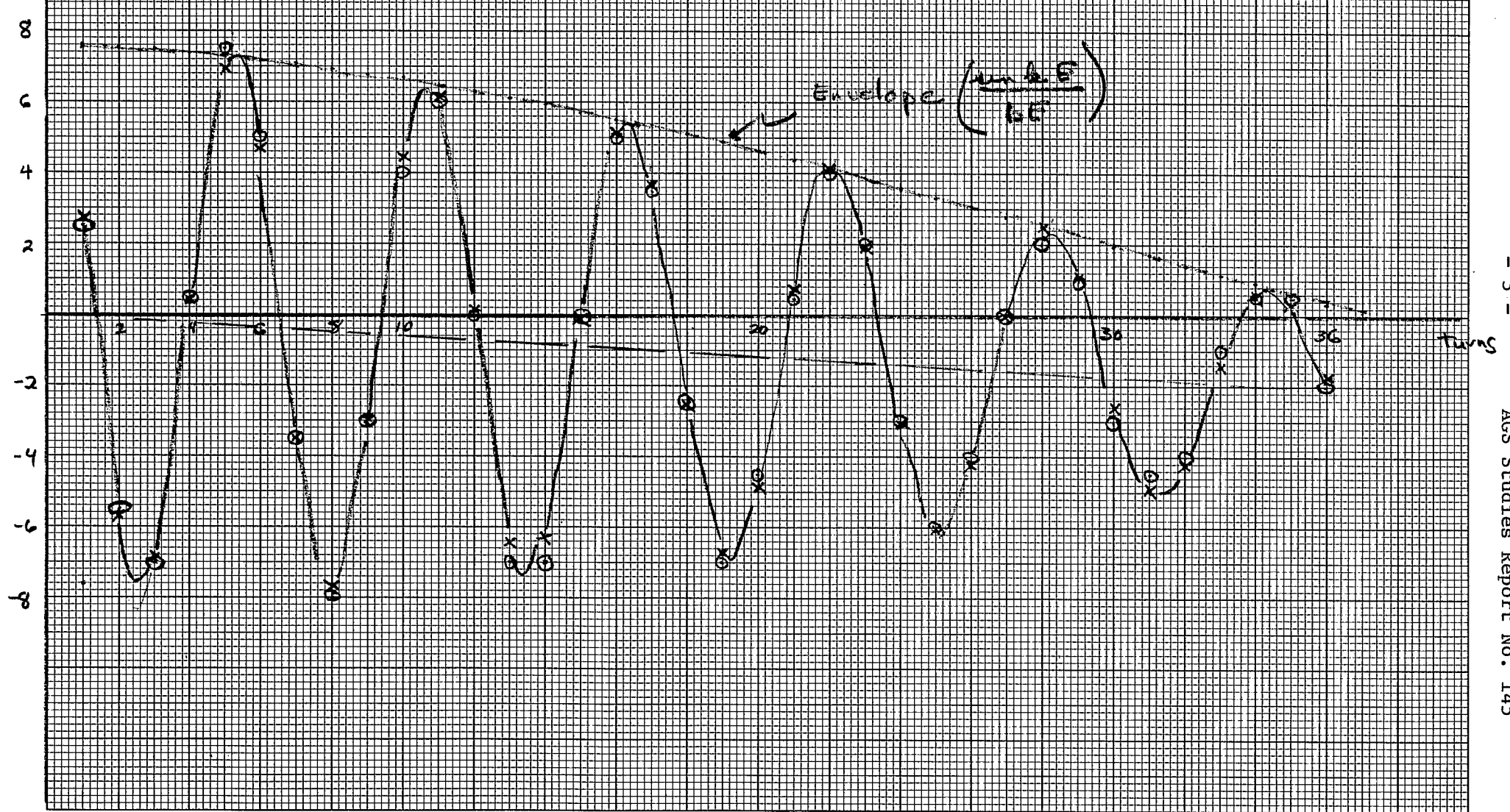
Alternately (2) taken with a value for $\frac{\Delta p}{p} = .2\%$ from the Linac gives $|\xi| = \frac{(.011)}{2 \times 10^{-3}} = 5.5 \pm 2$. The tune spread is deduced from the attenuation of oscillations--which could be "faked" by a real beam loss (none seen).

The value of chromaticity is very near that expected for a pure linear machine ($\xi \approx -v$).

The fit χ^2 per degree of freedom was 1 for a measurement error (RMS) on the points of Fig. 1 of .3 units ~ 1 mV.

As a check, the fit was applied to the first 18 points (half the sample) with little change in the parameters.

radial position
units = 4 mV = .24 cm
outside



C2 horizontal PUE

Fig 2