



BNL-104082-2014-TECH

AGS.SN206;BNL-104082-2014-IR

# Measurement of Chromaticities and Eddy Current Effects at Low Fields

L. Ahrens

June 1986

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 Report

Date(s) June 14, 1986 Time(s) 1500-2300  
 Experimenter(s) L.A. Ahrens, W.K. van Asselt  
 Reported by W.K. van Asselt  
 Subject Measurement of Chromaticities and Eddy Current Effects  
at Low Fields

Observations

We have measured the chromaticity early in the cycle for different values of  $B$ , by measuring the horizontal and vertical tunes as a function of radius. Starting with the normal magnetic cycle, we measured at  $P = 0.65, 1.0$  and  $3.0$  GeV/c (4, 4, and 15 ms Gauss respectively). Next we extended the front porch by 100 ms, allowing a measurement at 3 GeV/c with  $B = 4$  Gs/ms. Finally, we decreased the rate of the field rise on the injection porch to 2 Gs/ms and measured the chromaticity at 0.65 and 1.0 GeV/c. The result of the measurements is given in Figures 1-3. The chromaticities, as determined from the measurements, are calculated according to  $\xi = 20 \Delta Q / \Delta R$ , with  $\Delta R$  in centimeters as determined by the PUE system. Eventually, the numbers should be corrected for a small calibration error in the PUE system (Ref. 1). The results are summarized in Table I.

Table I

$\frac{P}{\text{GeV/C}}$	$\frac{B}{\text{Gs/ms}}$	$\xi_H$	$\xi_V$
0.65	4	-1.5	-1.4
	2	-2.2	-0.75
1.0	4	-2.3	-0.9
	2	-3.2	-0.45
3.0	15	-2.0	-1.25
	4	-3.0	-0.65

### Evaluation of the Measurements

The results at  $P = 0.65$  GeV/c may be compared with numbers obtained with PIP (Ref. 2),  $\xi_H = -1.5$  and  $\xi_V = -0.9$  for  $\dot{B} = 4.3$  Gs/ms,  $P = P_{inj} = 0.644$  GeV/c, and with results obtained with BEAM (Ref. 3),  $\xi_H = -2.4$  and  $\xi_V = +0.2$  for  $\dot{B} = 0$ .

Comparison with with a measurement at a 1.7 GeV/c flattop,  $\xi_H = -4.0$  and  $\xi_V = 0$  (Ref. 4) by interpolating and extrapolating the results from Figures 2 and 3 also shows a reasonable agreement.

Assuming that the chromaticity is composed of the following components (Ref. 5):

- The natural chromaticity  $\xi_N$ , assumed to be constant (Ref. 5)
- The remanent field chromaticity  $\xi_R$ , which attenuates as  $1/B$  or  $1/P$
- A term caused by eddy currents  $\xi_E$ , attenuated as  $\dot{B}/B$  or  $\dot{B}/P$

We arrive at

$$\xi = \xi_N + \xi_R \cdot 1/P + \xi_E \cdot \dot{B}/P.$$

Analysis of the data, using this expression, has yielded the following results, see Table II ( $P$  in GeV/c,  $\dot{B}$  in Gs/ms).

Table II

	<u>Horizontal</u>	<u>Vertical</u>
$\xi_N$	$-3.64 \pm 0.30$	$-0.29 \pm 0.16$
$\xi_R$	$0.21 \pm 0.37$	$0.12 \pm 0.17$
$\xi_E$	$0.32 \pm 0.09$	$-0.20 \pm 0.24$

### Conclusions and Remarks

- The horizontal measurement at 1 GeV/c is mainly responsible for the large errors bars in the horizontal results. Using only the measurements at 0.65 GeV/c and 3.0 GeV/c the horizontal numbers read:

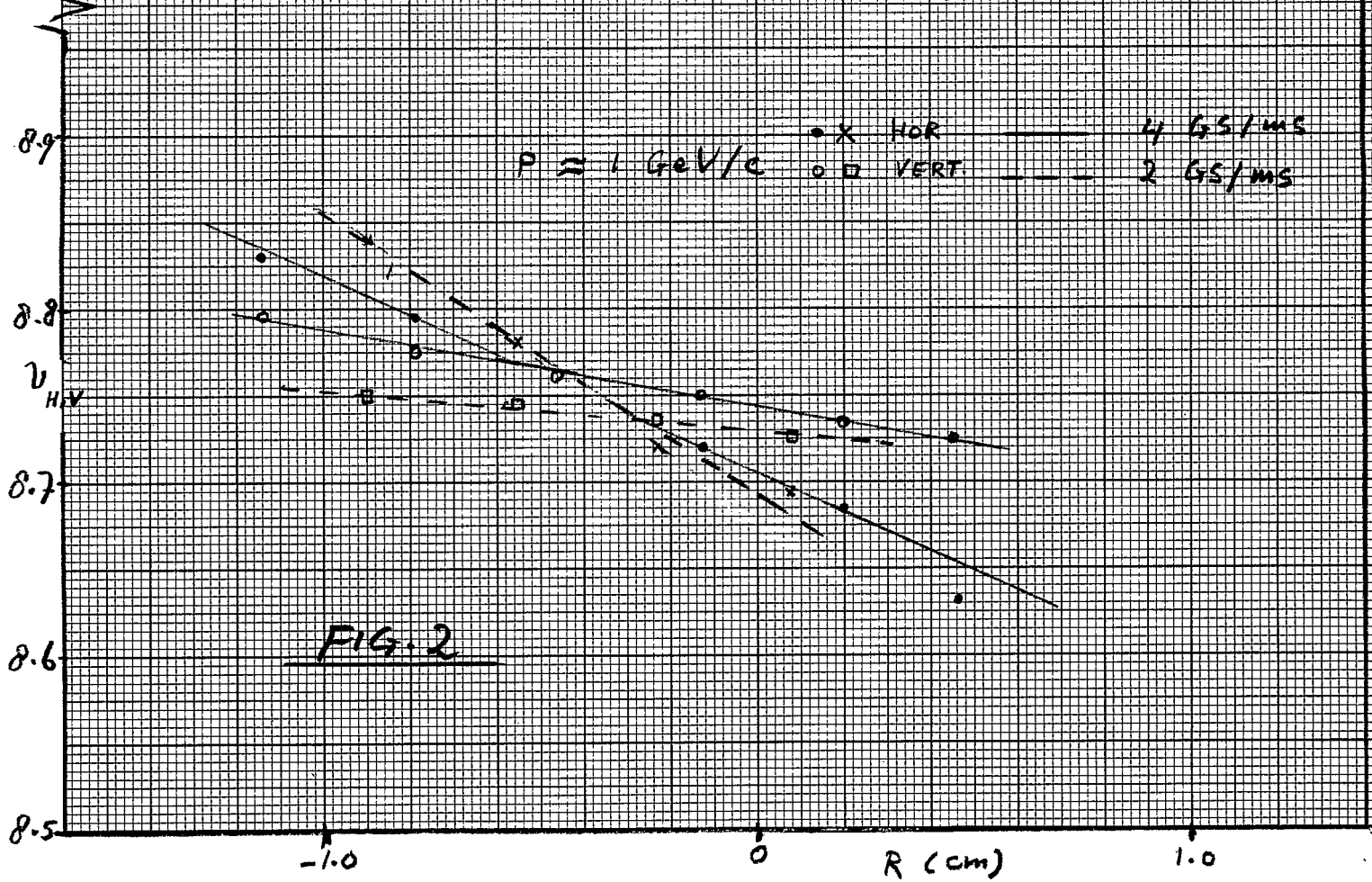
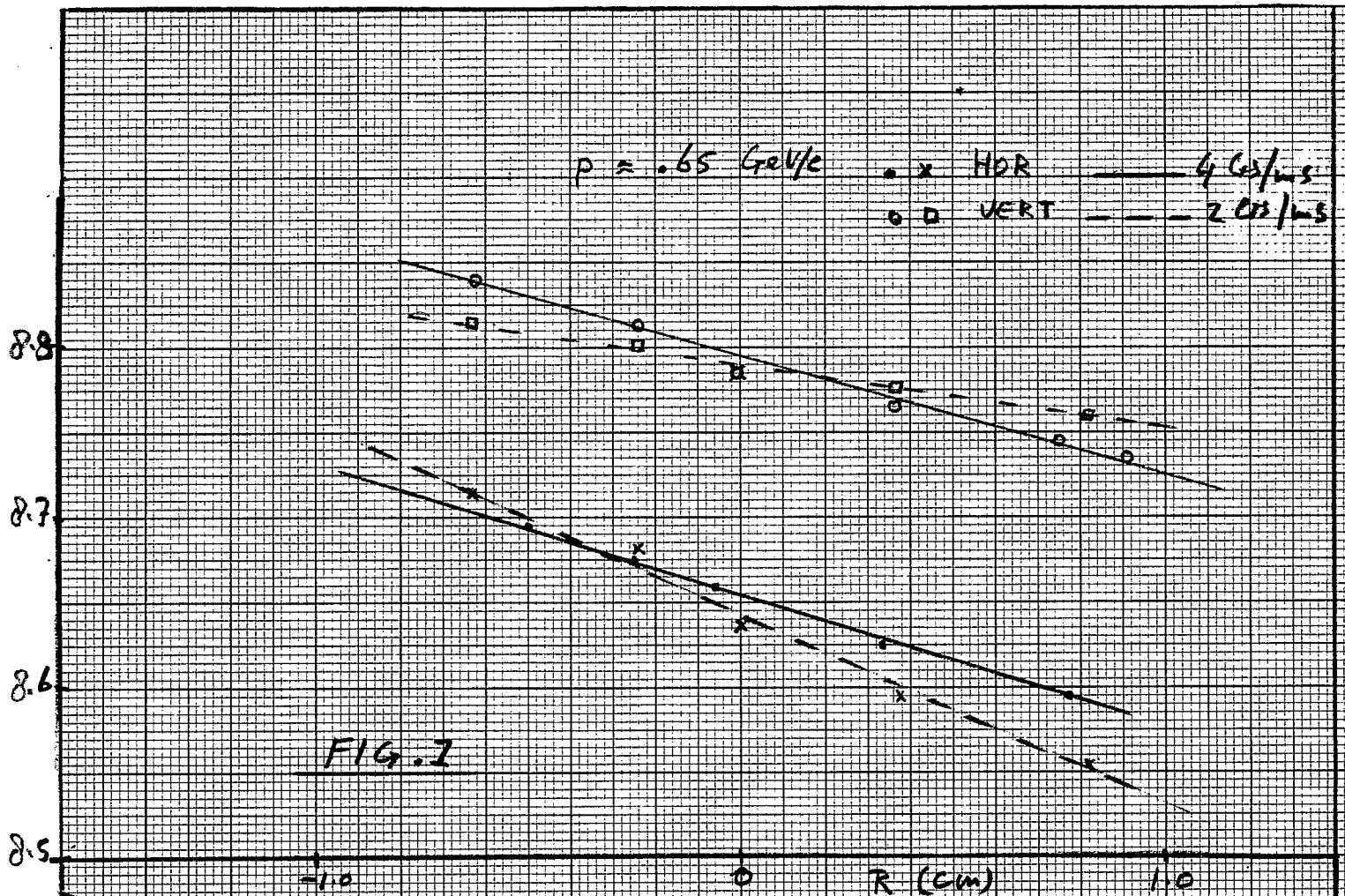
$$\xi_N = -3.33 \pm 0.10, \xi_R = 0.2 \pm 0.06, \text{ and } \xi_E = 0.25 \pm 0.02$$

- The contribution of the remanent field is small in both planes. Because of the large error bars, however, the extrapolation of the results to heavy ion injection field (90 Gauss) yields poor precision.
- The evaluation of the natural chromaticity gives encouraging results.

### References

1. E. Bleser, AGS Studies Report No. 202.
2. C. Gardner, L. Ahrens, IEEE-NS32 (1985), 1888.
3. C. Gardner, private communication.
4. L. Ahrens, AGS Studies Report No. 201.
5. E.J.N. Wilson, CERN 77-13, p. 111.

mvh



$p \approx 3 \text{ GeV/c}$

• x HOR

o □ VERT

— 15 GTS/mcs

- - - 4 GTS/mcs

