BNL-104115-2014-TECH

AGS.SN239;BNL-104115-2014-IR

# P Quad - E.O. Position. Measurementÿ II.

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March 1988

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**U.S. Department of Energy**

USDOE Office of Science (SC)

4/19/88

Number 239

## AGS Studies Report

Date(s) 3/25/88 Time(s) 1200 - 1600

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Subject P Quad - E.O. position. Measurement II

### Objectives

This parasitic study measured the amount by which the Ferrite Quads (10 of these, located in the No. 15 straight sections) were offset from the Equilibrium Orbit. This is essentially a repeat of the measurements reported in SN 230.

### Procedure

The procedure is described in that document. In summary, the Equilibrium Orbit (E.O.) acquisition system is used to measure the change in E.O. when a given quad is energized. From the orbit distortion, the quad-E.O. offset is derived.

These measurements were made at 21000 Guass clock counts (~10.5 GeV/c) at a radial position (average of the 72 PUE values) of -0.33 cm which corresponds to "RO", the nominal quad survey position, to within 0.1 cm. Each quad was pulsed in both polarities with 2000 A. Difference orbits were taken in each situation and these fitted to the expected distortion from a dipole kick. The free parameters in the fit were amplitude, tune and an overall offset. The amplitude of that distortion (A) is proportional to the undistorted quad-E.O. offset ($X_o$), namely

$$X_o = A.(F)$$

where F depends on the tune, momentum, quad current, and quad geometry (see S.N. 230). The PUE data was analyzed (fit) on line using the "hook" Agnes Abola has built into NORB ("F") and picking up the fitting program FTC from Ahrens' area. If the tune found in the fit did not lie between 8.5 and 9.0, the data was refitted fixing the tune at 8.75.

## Results

The tunes were not explicitly measured (an oversight) but can be derived from this or past measurements. In the following we take (using S.N. 182 and the measured radius) the nominal tunes to be $\nu_H$= 8.70, $\nu_\nu$ = 8.76 and the tune shift due to the quad to be $\pm$0.02 horizontally and $\pm$0.04 vertically. Table 1 gives the fit amplitude for the two signs of quad current. Table 2 gives the calculated amplification factor F. Table 3 gives the final results - the offsets - this should be redundant information for each plane and can be used to estimate the accuracy of the procedure. The results are also given in Figure 1.

## Conclusions - Summary

The independent measurements of quad - equilibrium orbit offsets agree to about 0.5 mm. To reduce this error a larger quad pulse, a lower momentum, or cleaner PUEs are necessary. However the data is good enough to provide input for repositioning these quads. The planned procedure is to repeat this study somewhat prior to the next polarized proton run and carefully reposition the quads.

TABLE 1: Amplitude (cm)

| | Horizontal | | Vertical | |
|---|---|---|---|---|
| | $+\Delta\nu_H$ | $-\Delta\nu_H$ | $+\Delta\nu_H$ | $-\Delta\nu_H$ |
| A | -0.033 | 0.035 | -0.014[a] | +0.019 |
| B | -0.03[a] | 0.021 | -0.011[a] | 0.037 |
| C | +0.031 | -0.018[a] | -0.007[a] | 0.004[a] |
| D | +0.052 | -0.046 | +0.017 | -0.02[a] |
| G | +0.096 | -0.075 | -0.026 | +0.053 |
| H | +0.048 | -0.036 | +0.007[a] | -0.022 |
| I | -0.032 | +0.033 | +0.026 | -0.03[a] |
| J | +0.018 | -0.025 | -0.032 | +0.067 |
| K | -0.018 | -0.003 | -0.028 | +0.042 |
| L | -0.062 | +0.037 | -0.005[a] | +0.034 |

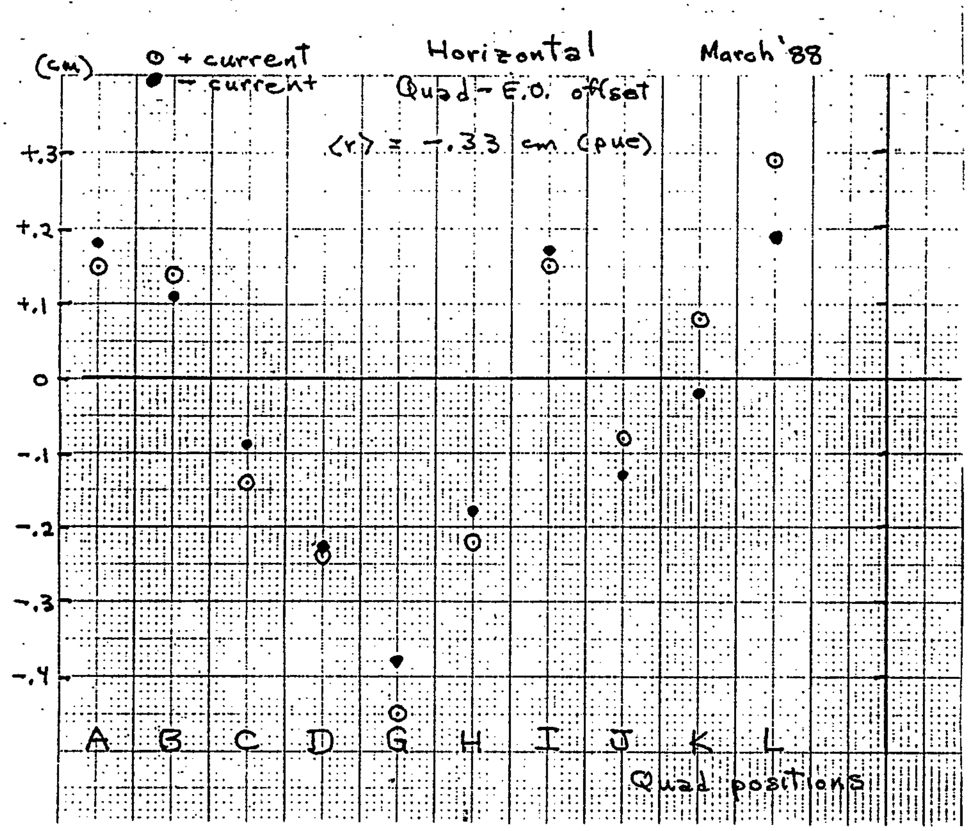
[a] 3 parameter fit gave unphysical tune; refitted with tune fixed.

TABLE 2: Amplification Factor

| Plane: | Horizontal | | Vertical | |
|---|---|---|---|---|
| Current (A) | $\Delta\nu_H$ | F | $\Delta\nu_V$ | F |
| +2000 | +0.02 | -4.65 | -0.04 | 3.67 |
| -2000 | -0.02 | +5.03 | +0.04 | -3.10 |

TABLE 3: Offsets (cm)

| | Horizontal | | Vertical | |
|---|---|---|---|---|
| | + current | - current | + current | - current |
| A | 0.15 | +0.18 | -0.05 | -0.06 |
| B | 0.14 | +0.11 | -0.04 | -0.12 |
| C | -0.14 | -0.09 | -0.03 | -0.01 |
| D | -0.24 | -0.23 | +0.06 | +0.06 |
| G | -0.45 | -0.38 | -0.10 | -0.16 |
| H | -0.22 | -0.18 | +0.03 | +0.07 |
| I | +0.15 | +0.17 | +0.10 | +0.09 |
| J | -0.08 | -0.13 | -0.12 | -0.21 |
| K | +0.08 | -0.02 | -0.10 | -0.13 |
| L | +0.29 | +0.19 | -0.02 | -0.11 |


(cm)
⊙ + current
● − current
Horizontal
March '88
Quad − E.O. offset
⟨r⟩ = −.33 cm (pue)
+.3
+.2
+.1
0
−.1
−.2
−.3
−.4
A B C D G H I J K L
Quad positions

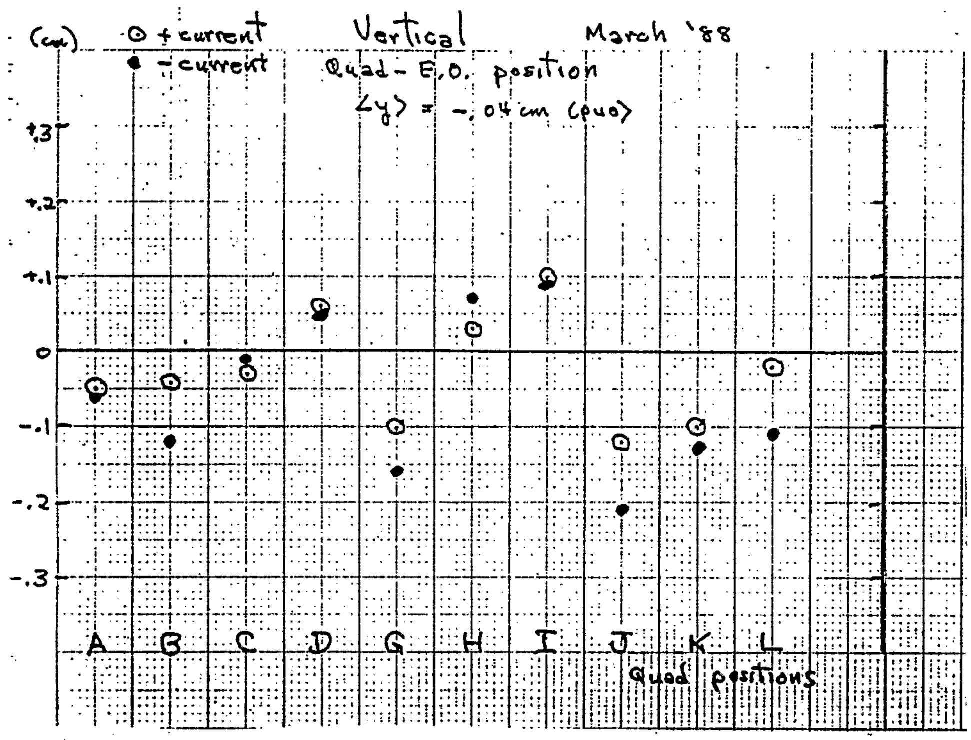

(cm)
⊙ + current
● − current
Vertical
March '88
Quad − E.O. position
⟨y⟩ = −.04 cm (puo)
+.3
+.2
+.1
0
−.1
−.2
−.3
A B C D G H I J K L
Quad positions

Fig 1