Status of Hall Probe Assembly and Calibration
PHENIX Note 311

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1 Introduction

A team of two undergraduates under the guidance of R. Prigl of BNL are in the process of assembling and calibrating 125 Hall Probes to be used in the mapping of the PHENIX central magnet. The following is a brief summary of the assembly and calibration of the probes.

2 Assembly

- The probes consist of 100 American-made probes and 25 Russian probes. All of the Russian probes have been mounted to their Aluminum mounting blocks, wired to a 100 mV amplifier board, and fitted with a seven pin wire connection that can mount to any of the electrical leads on the final measurement frame. There have been no problems with assembly of the Russian probes.
- 86 of the American probes have been epoxied into their three sided Aluminum blocks, attached to a 100 mV amplifying board, and fitted with the standard seven pin electrical connection. Two American probes were irreversibly damaged in the initial epoxying process, as a mis-epoxied probe cannot be removed. Further, one of the prototype American probes was broken during normal use. The wire leads into the American probes are very fragile compared to the robust, larger diameter leads of the Russian probes. Careful handeling and opportune use of plastic shrink wrap has been used to improve the strength and flexibility of the American probes.
- Finally, in order for the seven electrical wires to be mounted in the seven pin plastic male end connector, the wires must be crimped into conducting metal pins. Early experience showed that the crimping process did not produce a sufficient connection in approximately one of three attempts. Since then, every conncection is tested immediately after assembly to ensure that a faulty connection does not damage the sensitive amplifier boards.

3 Calibration

The voltage output of a Hall Probe in a Magnetic Field is given by:

$$V = V_0 + \kappa_1 B_\perp + \kappa_1 \epsilon B_\top \sin(\phi + \phi_1) + \kappa_2 B_\top^2 \sin(2\phi + \phi_2) \quad (1)$$

where

$B_\perp$:	perpendicular field component
$B_\top$:	tangential field component, parallel to Hall plate
ϵ:	angular misalignment of probe in epoxy ($\epsilon \simeq$ 1E-3)
ϕ:	angle which $B_\top$ makes with the current in the Hall plate
ϕ_1 and ϕ_2:	phase constants
V_0:	offset
κ_1:	sensitivity for the $B_\perp$ (standard) Hall effect
κ_2:	a constant of the planar Hall effect

By inserting the probe plane perpendicular to a varying magnetic field of 100 - 12000 gauss one can easily and accurately find the offset V_0 and κ_1 by knowing $B_\perp$ and measuring V. However, measurement of κ_2 has been more challenging due to unceartinty in the angle ϕ.

- 40 probes have been calibrated for the perpendicular effect at a rate of about 20 probes per day.
- In the perpendicular calibration, a small third order term has surfaced that is not explained by the above equation.
- As of yet, no standardized method of Planar Hall Effect calibration has been found. In principle, one could find κ_2 and ϕ_2 by simply varying ϕ over 2 pi for one specific field value. Tests are currently being performed to test the accuracy of such a method.

4 Timeline

- All of the probes should be assembled and working by Monday, 7-21.
- All of the probes should be calibrated for the perpindicular effect by the following Friday, 7-25.
- All of the probes will hopefully be calibrated for a planar effect by approximately 8-31.

5 Concerns

When the probes are finally mounted upon the rectangular aluminum frame between the center magnet poles, there are several problems which may arrise:

- Once again, the American probes are very fragile. Excessive care will be needed to protect the current leads to the probes themselves.
- V depends roughly linearly upon temperature. There should be thermometers mounted at several locations on the frame to ensure that there is not a systematic error due to temperature fluctuations.
- The 100 mA supply current is run in series through all 125 probes. The circuit is easily broken. If this happens, the current source voltage goes to infinity, quickly burning 125 amplifier boards. We recommend a saftey device which would immediately shut-off input current to all probes if a voltage spike is recorded.