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Polarities and Connections of High Field Straight Section Magnets in AGS Ring

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AGS STUDIES REPORT

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Reported by D. Barge

Subject Polarities and Connections of High Field Straight Section Magnets in AGS Ring

OBSERVATIONS AND CONCLUSION

Throughout the long history of the AGS, many modifications to this device have been made. Thus, it was deemed desirable, at this point in time, to check on the wiring of the high field straight section magnets whose semi-flexible power feeders can be shuffled around in trenches relatively easily (compared, say to the effort required to modify the main magnet bus work).

1) Voltage Measurements

In order to check polarities of SEB drive sextupoles, (B5,E5,K5), vertical quads (all no. 3's), horizontal quads (all no. 17's), vertical sextupoles (all no. 7's), horizontal sextupoles (all no. 13's), skew quads (A15, D15, G15, J15), a d.c. power supply was used to individually energize the above assumed series strings, and voltage drops were measured with a DVM+ (checked against another DVM for several measurements). The polarity of this test power supply was chosen to correspond to the polarities of the actual power supplies used under "normal"* SEB running. The test supply was placed at remote locations corresponding to the locations of the supplies used in actual SEB operation, i.e., multipole room and F10 house. J. Funaro attended to the matter of polarity adjustment there, and was in communication with the parties in the ring, by radio, as the test supply was switched on and off.

In all measurements (except drive sextupole measurements) the power supply was turned off after the voltage drop had been measured. In all cases a DVM reading near zero was observed. We summarize these measurements as follows:

+ The convention was adopted that the red probe was placed on the top bus feed of each element.

* Note exception, vertical sextupoles not used for "normal" SEB running.

St. Scn.	Device	Test p.s. Volts	Test p.s. Amps	At Device (Volts)**	Ω Per Device
3	vert. quad	-	15	-0.156 ± 0.003	0.0104
B5	drive sex.			-0.243	0.0162
E5	drive sex.	2	15	+0.241	0.0161
K5	drive sex			+0.242	0.0162
7	vert. sex.	-	15	-0.282 ± 0.004	0.0188
13	hor. sex.	2	15	-0.287 ± 0.006	0.0191
A15	skew quad.			-1.127	0.0451
D15	skew quad.	-	25	-1.15	0.0460
G15	skew quad.			-1.142	0.0457
J15	skew quad.			-1.12	0.0448
17	hor. quad.	2.9	15	+0.151 ± 0.008	0.0101

It was found that no sextupoles exist at A5, C5, F5, H5, I5 and L5, but there are sextupoles at D5, G5 and J5, although the G5 sextupole is not connected to any bus work.

When the drive sextupoles (B5, E5, K5) were powered (voltage noted on E5), it was found that no voltage existed on D13 or E7. Thus we, may safely assume that (at low voltages at least) the drive sextupoles are electrically isolated from the no. 7 and the no. 13 string. In addition, no excitation of the D5 sextupole was found with the drive sextupoles energized.

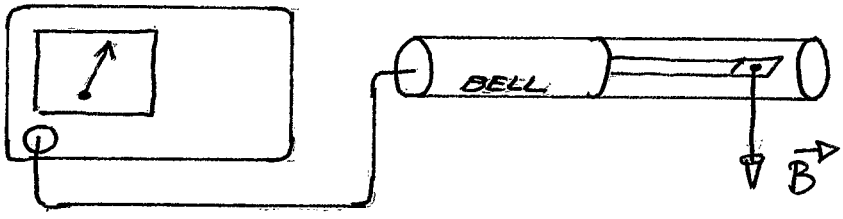
It was also noted that elements at G3 and G7 are electrically connected from the outside of the ring, whereas all other elements are fed from the inside. With our DVM convention the top terminal of the G3 element was found to be plus. Since all elements in the ring are electrically fed at the upstream end, the observation of a plus G3 top terminal is consistent with the assumption that this quadrupole, relative to the others, has been rotated by 180 degrees about an axis parallel to the beam. For purposes of averaging in the table, a minus voltage at G3 was assumed. The G7 sextupole top terminal was found to have a minus voltage (as the other no. 7 sextupoles) which is again consistent with the notion that this sextupole was rotated by 180° relative to the other no. 7's.

** Plus/minus signs indicate average over 12 elements and $\sigma = \sqrt{\sum_i (V_i - \bar{V})^2/(N-1)}$.

2) Hall Probe Measurements

These measurments, made concurrently with those described in 1), were made on magnets G3, H3; B5, E5, K5; G7, I7 and A15, D15, G15, J15, to determine the direction of the magnetic field. No attempt was made to obtain quantitative field strengths.

The direction of the magnetic field, as observed by a Bell Model 610 battery powered Gaussmeter was, determined by a calibration done in two ways, i) placing the probe in the appropriate orientation (one of two ways with $\perp$ to plane of probe in the vertical) to provide + meter indication, this being done on outer edge of tunnel. The Bell (trade mark on plastic collar) was then rotated to be on the bottom and taped to probe. From the assumed fact that the Earth's B field is directed downward, one may state that the field passes into the probe and "out of the Bell", ii) using DVM, direction of current flow was established using Ohm's Law in a bus reasonably far away from a magnet, the right hand rule for B field around a conductor showed that the B field was directed into the probe and "out of the Bell." (Same meter deflection sense as i)



Showing $\vec{B}$ relative to taped probe

Since the sextupoles are fairly well filled up with beam pipe, it was necessary to examine the fringe fields at the ends of these elements.

The results of these measurements, in the cases mentioned above, gave field directions that are consistent with the DVM readings.

In particular, it was verified with the Hall probe that

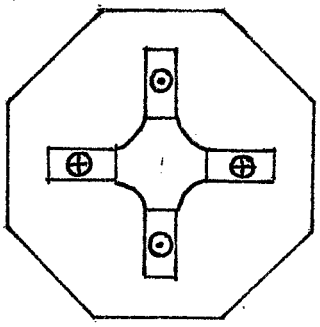
a) the skew quads, A15, D15, G15, J15 are definitely "zero-theta",

b) the field directions in the G7 sextupole are the same as the field directions in the I7 sextupole,

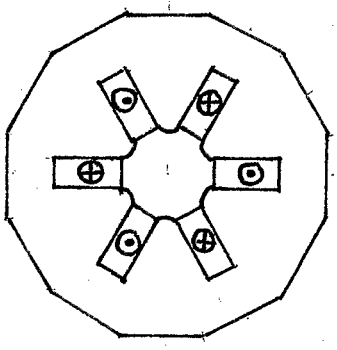
c) the field directions in the G3 quadrupole are the same as the field directions in the H3 quadrupole, and

d) the B5, E5, K5 sextupoles are of -, +, + strengths respectively (+ for outward kick of beam).

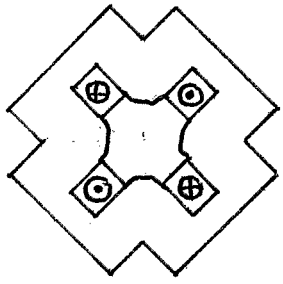
Shown below are currents (positive) which would yield measured field directions.



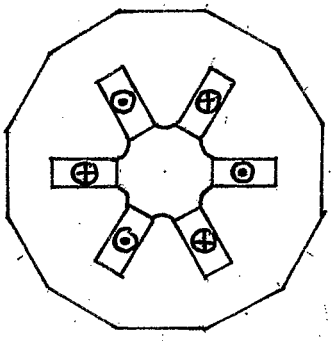
No. 3 quads



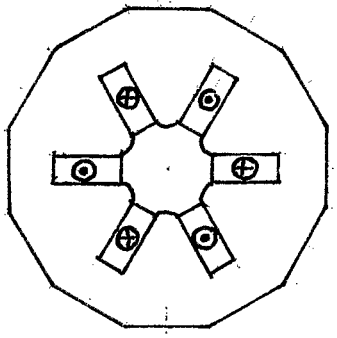
No. 7 sextupoles



A15,D15,G15,J15



B5



E5,K5

⊕ beam direction

Weaknesses and oversights in the above texts are obvious. The reporter assumes responsibility for these omissions and further tests are obviously necessary.