ISR-ES/NS/11 6.5.1971

ISR RUNNING-IN

Run 46 - 7 April 1971 - Ring 2

4 bunches, 22 GeV/c

Influence of the fringe field of the septum magnet of experiment R 202 (Argonne-Michigan-Bologna) on Ring 2 of the ISR

This experiment was performed to determine the influence of the fringe field of the current septum magnet of R 202 in intersection 2 on Ring 2 of the ISR and to investigate the way of operating the magnet such as to give least interference with the ISR beams.

The experiment was done in two parts. During the first part, repetitive injection with 4 bunches at 22 GeV/c was set up in Ring 2 and the closed orbit and subsequently the Q values were measured for different excitations of the magnet coils. During the second part, a beam of nearly 1 Amp was stacked in Ring 2 and the stack was monitored while the currents in the magnet coils were changed.

Characteristics and position of septum magnet

The magnet has a core length of 1.2 m. The maximum current in the main coil is 800 Amp. The magnet has an auxiliary winding consisting of several turns placed in different positions around the yoke. The current in this winding is adjusted for each value of the main current such as to minimize the fringe field of the magnet. The maximum current in this auxiliary coil is 160 Amp. Both coils are fed by separate power supplies. Their interlocks are connected such that a failure condition on any of them will trip both supplies simultaneously.

The magnet is placed near the downstream arm of Ring 2 in intersection 2 and such that the median plane of the air gap is at beam height.

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The septum side is facing the ISR vacuum chamber and is at an angle of 80 mrad with respect to the ISR beam line. The distance between the crossing point and the center line of the magnet (⊥ to the septum side), measured along a line at 135 mrad with respect to the beam line of Ring 2 is of 3 m.

The magnet can be displaced on its support along the mentioned center line by 0.5 m. In its position nearest to the ISR, the corner of the septum side nearest to the crossing point is at about 2 mm from the ISR vacuum chamber (This position is defined by mechanical stops on the support. The displacement must be done by hand by means of a crank).

<u>Influence on closed orbit and Q values of Ring 2</u>

The working point was DANA, 2.9, 0.05. The Q values of the undisturbed machine were $Q_H = 8.772$ and $Q_V = 8.546$. The closed orbit and the Q values were then measured for 3 settings of the current in the correction coil keeping the current in the main coil constant at 550 Amp.(Maximum value which could be obtained with the existing, provisional water cooling conditions $\Delta p = 5$ atm).

The settings of the correction coil current were: 42 A, which gives minimum fringe field, (normal working condition of magnet for I main = 550 Amp) OA and - 42 A, corresponding to inversed polarity in the current setting.

The results are shown in the table below:

Measurement	I_{main} (Amp)	$I_{corr.}$ (Amp)	Q_H	Q_V	Measurement of closed orbit (H+V)
1	0	0	8.772	8.546	yes
2	550	42	8.773	8.545	yes
3	550	0	8.774	8.545	yes
4	550	- 42	8.776	8.545	yes

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Q_V remained unchanged within 0.001, for the four measurements Q_H changed by 0.001. For measurement 2 these changes are within the measuring accuracy for measurements 3 and 4. The change in Q_H is + 0.002 and 0.004 respectively, as compared to the undisturbed machine.

The closed orbit measurements in the horizontal plane n° 2, 3 and 4 show a periodical perturbation, compared with measurement n° 1. The amplitudes of the perturbation is less than 1 mm for measurement 2 (normal operating condition of the magnet). The maximum amplitudes observed in measurements 3 and 4 are 1.8 mm and 2.7 mm respectively.

The closed orbit perturbations in the vertical plane are in the average less than 0.5 mm. Only one pick up station (measurement 3) indicated a perturbation larger than 1 mm.

Beam losses in a stack produced by variations in the septum magnet currents

A stack of 0.9638 Amp was set up in Ring 2, with a current of 550 Amp in the main coil and of 42 Amp in the correction coil. Subsequently the currents in the coils were switched on and off as shown in the table below and the change in beam current was recorded.

The beam current indicated in the table below was read a short time after the change of the magnet current had taken place. The variation of beam current (ΔI stack) was obtained from the graph of the beam monitor.

Measurement	I_{main} Amp	$I_{corr.}$ Amp	Stacked current Amp	ΔI_{stack} %	
1	550	42	0.9638	-	Initial stack
2	550	0(1)	0.9638	0.0	
3	0(1)	0	0.9555	0.85	
4	0	42(1)	0.9554	0.0	
5	550(2)	42	0.9500	0.52	
6	0 (3)	0 (3)	0.946	< 0.4	

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(1) The change in current was obtained by switching on or off the corresponding power supply at set current.

(2) Current increased in steps of about 16 Amps.

(3) Both power supplies tripped simultaneously.

Results and conclusions

It appears from this experiment that switching on or off the correction current does not produce an observable beam loss on the 1 Amp stack.

The rapid change in the main current (measurement 3) produced the largest observed beam loss. When the main current was turned on again in steps, the graph of beam current shows that most of the beam loss occurred at once, approaching the end of the change. This may be due to larger steps in the current increase at that moment.

When both power supplies were tripped simultaneously, the beam loss was less than 0.4% and occurred during the few seconds following the change. This may be due to eddy currents circulating in the steel core of the magnet.

From these results, it can be concluded that fast changes in the main current must be avoided during operation of the ISR: if the requirement arises to change the current during operation of the ISR, then the current variation should be done slowly. During a change in the main current, the correction current should be adjusted continuously or alternatively follow closely the value giving minimum fringe field. A test to find the best way of operating these changes can be made when the remote control system for this magnet is in operation, which will permit slow and fast changes in the magnet current.

For consultation or copies of the records concerning this experiment, please contact N. Siegel.

N. Siegel

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