

SIS-18 machine experiment: Resonance scan

November 4, 2011

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Date and time: from October 30, 2011, 22 pm, to October 31, 2011, 6 am.

Goal of the experiment was to make the first experimental step towards compensation of resonances in SIS-18. In order to use the simplest possible scheme we excited a 3rd order resonance using the sextupoles of the KS1C family and tried to correct it with the sextupoles of the KS3C family. The resonance was excited with sextupoles of known locations and focusing strengths so that the strengths of the correcting sextupoles could be determined from the driving term of the resonance excited. In order to measure the resonance strength represented by its stop band width we changed dynamically the tune across the resonance and measured the time evolution of the beam current. The additional excitation of the resonance due to the KS1C sextupoles can clearly be seen from a strong reduction of the residual current after crossing the resonance: see in Fig. 1. Contrary, the correction could be accomplished only to a very low degree because the inclusion of the KS3C sextupoles yielded only a slight increase of the residual current.

A possible reason consists in uncertainties in the real sextupole settings. During the measurements, we found differences in the sextupole currents between desired (“Flattopwert Soll”) and real (“Flattopwert Ist”) values up to 0.75 A, see Fig. 2. That is not small compared to a maximum current of 3.3 A we used in our measurement. In particular, the real current in the sextupole S11KS1C **changed sign** when the focusing strength was changed in SIS-Expert from -8 mrad to -9 mrad or vice versa, whereas it was approximately proportional to the focusing strength in SIS-Expert otherwise. Therefore, we think that the calibration of the sextupoles should be checked.

Furthermore, several problems during operation occurred. For example, it was not possible to change the extraction energy or the ramp time without interrupting operation before, explicitly confirming the new energy to the system, and continuing afterwards. Changing energy or ramp time while SIS-18 kept running stopped the operation several times because of an error in the control system. This problem was known to the operators.

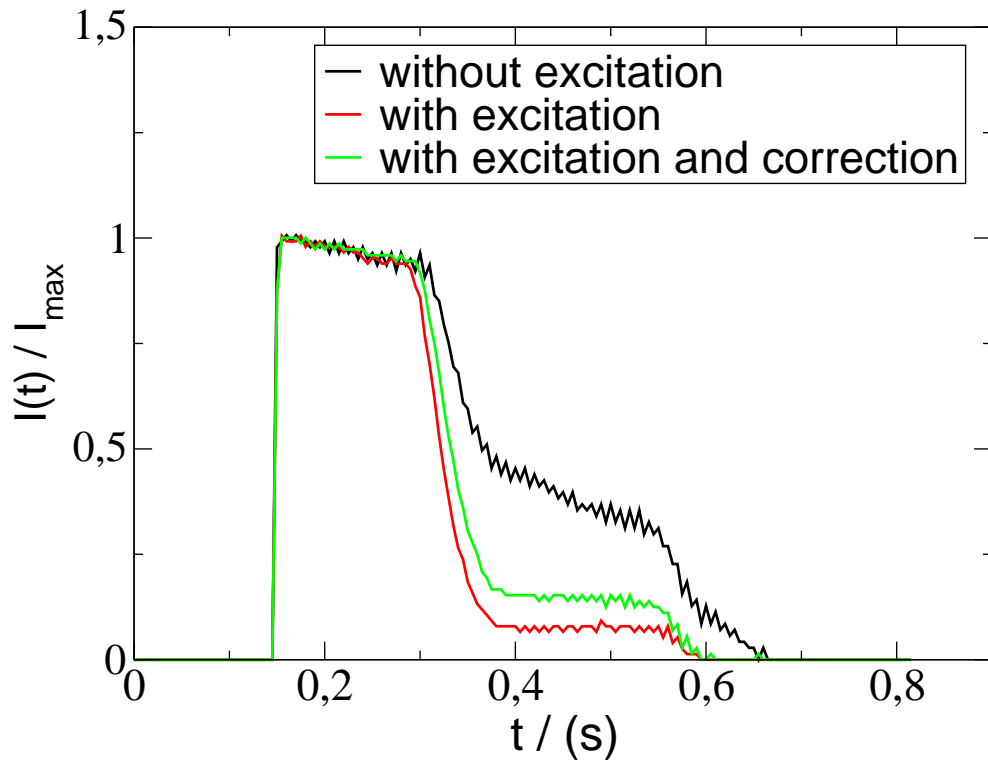


Figure 1: Beam current with all sextupoles switched off, excited only by sextupoles of the KS1C family, and excited by the KS1C sextupoles and, additionally, by the sextupoles of the KS3C family in order to correct the excited resonance.

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31. 10. 2011 0:48:11

SIS-Control		S1 V376		238U 37+		11.4 MeV/u - 11.5 MeV/u schnell_1HA										Programm ENDE			
31.10.2011 00:47:50		Sextupole																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AEK	Inj	Ext	HF	Sext
Gerät	Netz	Aktiv	Reset	Flattopwert Soll	Flattopwert Ist	Zeit- Stempel	Tafel	Intlk	Power	Fehler	Bit-Nr. 7 bis 0 S W I E - - R P	Kue1	Kue2	TFS	KoMu	Korr			
S01KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= 0.31 I= 0.28	00:47:47											11111111		
S03KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.44 I= 0.74	00:47:47											11111111		
S05KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.11 I= -0.12	00:47:47											11111111		
S07KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= 0.21 I= 0.21	00:47:47											11111111		
S09KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.39 I= -0.39	00:47:47											11111111		
S11KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.57 I= -0.55	00:47:47											11111111		
S01KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.55 I= -0.56	00:47:47											11111111		
S03KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.57 I= -0.54	00:47:47											11111111		
S05KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.23 I= -0.23	00:47:47											11111111		
S07KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.57 I= -0.56	00:47:47											11111111		
S09KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.50 I= -0.50	00:47:47											11111111		
S11KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.50 I= -0.46	00:47:47											11111111		

31. 10. 2011 0:48:11

Figure 2: Current in the sextupoles when all focusing strengths were set to zero.

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SIS-Control		S1 V376		238U ³⁹⁺		11.4 MeV/u		11.5 MeV/u		Schnell_1HA		Programm ENDE		
31.10.2011 00:53:53						Sextupole								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Gerät	Netz	Aktiv	Reset	Flattopwert Soll	Flattopwert Ist	Zeitstempel	Bit-Nr. 7 bis 0 S U I E - - R P	AEG Kue1	Inj Kue2	Ext TFS	HF KoMu	Sext Korr	Fehler	
S01KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= 0.28 I= 0.28	00:53:49	11111111							
S03KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.48 I= 0.74	00:53:49	11111111							
S05KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.11 I= -0.11	00:53:49	11111111							
S07KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= 0.21 I= 0.20	00:53:49	11111111							
S09KS1C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.40 I= -0.40	00:53:49	11111111							
S11KS1C	Ein	Aktiv		I= 0.67 I= 0.67	I= -0.57 I= -0.61	00:53:49	11111111							
S01KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.55 I= -0.60	00:53:49	11111111							
S03KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.57 I= -0.57	00:53:49	11111111							
S05KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.21 I= -0.23	00:53:49	11111111							
S07KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.55 I= -0.57	00:53:49	11111111							
S09KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.50 I= -0.51	00:53:49	11111111							
S11KS3C	Ein	Aktiv		I= 0.00 I= 0.00	I= -0.45 I= -0.48	00:53:49	11111111							

31.10.2011 0:53:59

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Figure 3: Current in the sextupoles. S11KS1C was set to -8 mrad, Soll and Ist currents are similar in strength but have different signs. All other sextupoles were set to zero.

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SIS-Control		S1 V376		238U 39+		11.4 MeV/u		11.5 MeV/u		schnell_1H4		Programm ENDE		
31.10.2011 00:53:53						Sextupole								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Gerät	Netz	Aktiv	Reset	Flattopwert Soll		Flattopwert Ist		Zeitstempel		Bit-Nr. 7 bis 0 S W I E - - R P		HF Sext		
S01KS1C	Ein	Aktiv		I= 0.00	I= 0.00	I= 0.28	I= 0.28	00:54:39	11111111					
S03KS1C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.44	I= 0.74	00:54:39	11111111					
S05KS1C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.12	I= -0.11	00:54:39	11111111					
S07KS1C	Ein	Aktiv		I= 0.00	I= 0.00	I= 0.21	I= 0.21	00:54:39	11111111					
S09KS1C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.44	I= -0.40	00:54:39	11111111					
S11KS1C	Ein	Aktiv		I= 0.76	I= 0.75	I= 0.89	I= 0.93	00:54:39	11111111					
S01KS3C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.57	I= -0.60	00:54:39	11111111					
S03KS3C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.57	I= -0.57	00:54:39	11111111					
S05KS3C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.21	I= -0.23	00:54:39	11111111					
S07KS3C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.57	I= -0.55	00:54:39	111111					
S09KS3C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.50	I= -0.50	00:54:39	111111					
S11KS3C	Ein	Aktiv		I= 0.00	I= 0.00	I= -0.50	I= -0.45	00:54:39	111111					

SIS

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Alle Sextupole auf null geschlt, nur S01KS3C auf -9mrad, S03KS3C auf -8mrad, S05KS3C auf -8mrad, S07KS3C auf -8mrad, S09KS3C auf -8mrad, S11KS3C auf -8mrad, Vorzeichen, siehe ④

Figure 4: Current in the sextupoles. S11KS1C was set to -9 mrad, Soll and Ist currents have the same sign but the sign of the Ist current differs from that obtained for the focusing strength -8 mrad, see Fig. 3. All other sextupoles were set to zero.