

Results of the Transformer Effects Test BMA001 With and Without Beam Pipe

March 16, 2007
Craig Drennan

Figure I.1 shows the circuit associated with any two windings in the corrector package. The goal was to identify the mutual inductance, M , between each pair of coils. For the package of 6 individual coils, we wish to determine 15 mutual inductance values.

The approach is to use the power supplies to input a ramping current into the “primary” coil and then measure the waveforms across the other five “secondary” coils.

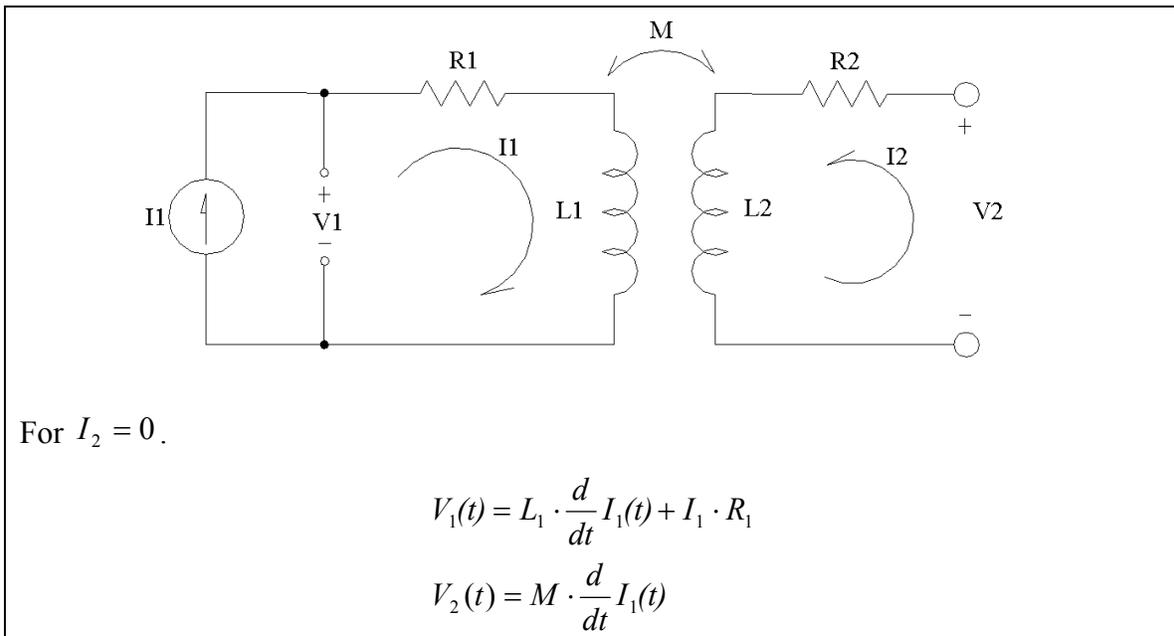


Figure I.1 Circuit for any two windings in the corrector package.

The current in the magnet being driven / ramped and the voltages across the magnets left unconnected were digitized by the DAQ system at a rate of 100 kHz. A large ascii data file was created. The first 10,000 points (rows) of this file were imported into a spreadsheet. A column was added to this array of data which was the change of current with respect to time (dI/dt). This was computed by computing the slope between points separated by 10 samples. The mutual inductance numbers in Table I.1 were the result of a linear regression performed using the computed dI/dt as the independent variable, X , and the particular coil voltage data as the dependent variable, Y .

Note:

1. *The largest coupling within BMA001 with the beam pipe in place exists between NS-HD and SS-VD.*
2. *See figures at end of this document for summary of largest mutual inductance numbers.*

Table I.1 Matrix of mutual inductances. Each row is the driven coil.

Mico-Henries	NQ	SQ	HD	VD	NS	SS
NQ	BMA000 With Pipe	-23 -12	-27 -12	-1 -9	-48 -30	21 17
	BMA001 With Pipe	4 7	-6 -5	12 13	-17 -16	2 2
SQ	-21 -11	--	47 63	31 105	-12 -72	-31 -34
	134 7		1 13	23 23	1 1	-1 -10
HD	-29 -13	59 63	--	-26 -23	22 27	52 28
	-6 -5	9 13		-10 -9	-22 -116	-22 -23
VD	-1 -9	53 115	-26 -23	--	-157 -71	6 5
	13 14	14 25	-1 -9		-18 -20	-17 -116
NS	-47 -30	-13 -73	19 25	-126 -70	--	1 30
	-17 -17	1 1	-1 -114	-18 -19		-2 -3
SS	22 18	-43 -36	47 29	5 4	1 31	--
	3 2	-6 -11	-1 -22	-15 -111	-2 -3	

For reference the self-inductance and resistance of each magnet measured just previous to the prototypes delivery to MTF is included here in Table I.2 and Table I.3. The values for the magnets without the beam pipe are on top and the values with a beam pipe are below.

Table I.2 Inductances and Resistances for BMA000

Magnet	Inductance, Henries	Resistance, Ohms
Horizontal Dipole, HD	0.0134	0.272
	0.0104 (with pipe)	
Vertical Dipole, VD	0.0133	0.267
	0.0103 (with pipe)	
Normal Quadrupole, NQ	0.0021	0.0915
	0.0018 (with pipe)	
Skew Quadrupole, SQ	0.0043	1.18
	0.0036 (with pipe)	
Normal Sextupole, NS	0.0025	0.211
	0.0023 (with pipe)	
Skew Sextupole, SS	0.0024	0.211
	0.0023 (with pipe)	

Table I.3 Inductances and Resistances for BMA001

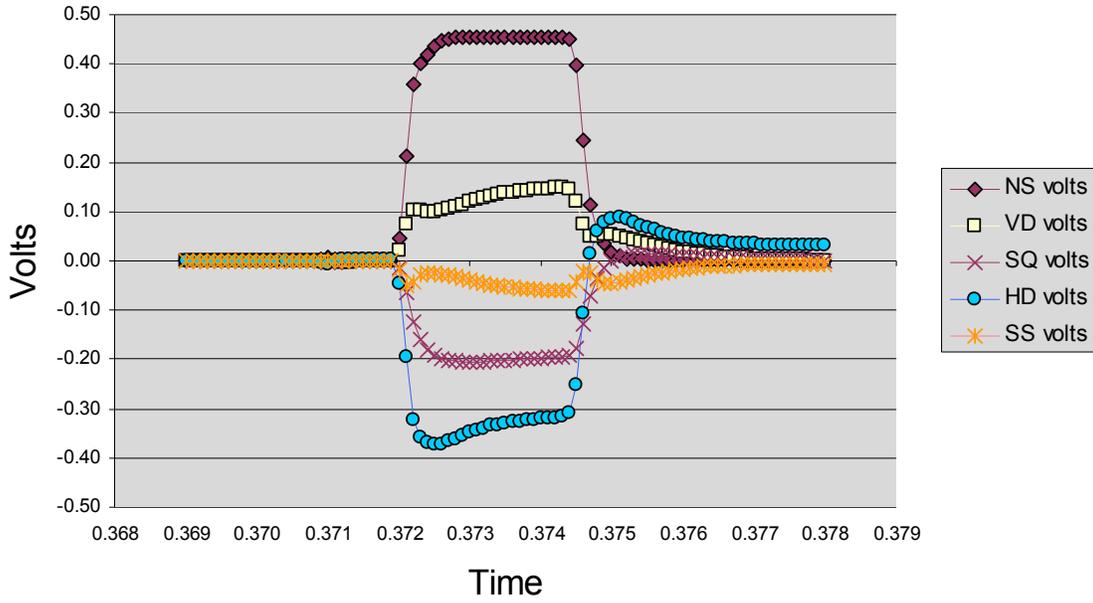
Magnet	Inductance, Henries	Resistance, Ohms
Horizontal Dipole, HD	0.0135	0.268
	-- (with pipe)	
Vertical Dipole, VD	0.0136	0.267
	-- (with pipe)	
Normal Quadrupole, NQ	0.0021	0.0897
	-- (with pipe)	
Skew Quadrupole, SQ	0.0041	1.16
	-- (with pipe)	
Normal Sextupole, NS	0.0025	0.210
	-- (with pipe)	
Skew Sextupole, SS	0.0025	0.210
	-- (with pipe)	

Results for Magnet Package BMA001 Without the Beam Pipe

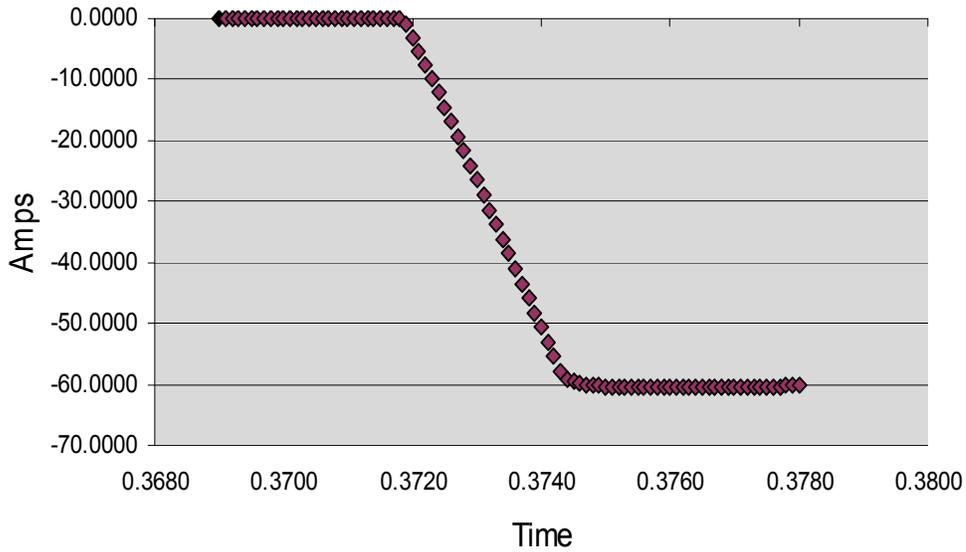
The first plots in each of the following pairs of plots are of the coupled magnet voltages for a selected current ramp found in the data. The current in the driven magnet is shown in the second plot of each pair.

With Beam Pipe

Voltage on Secondary Coils (other magnets)
Current on NQ Magnet

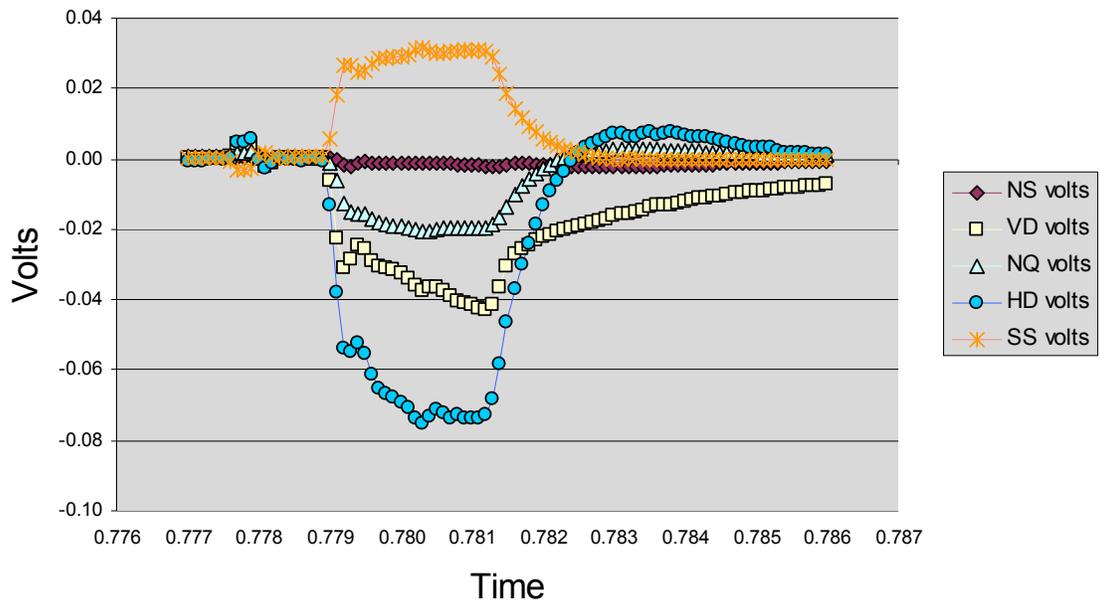


Current Slew in the NQ Magnet

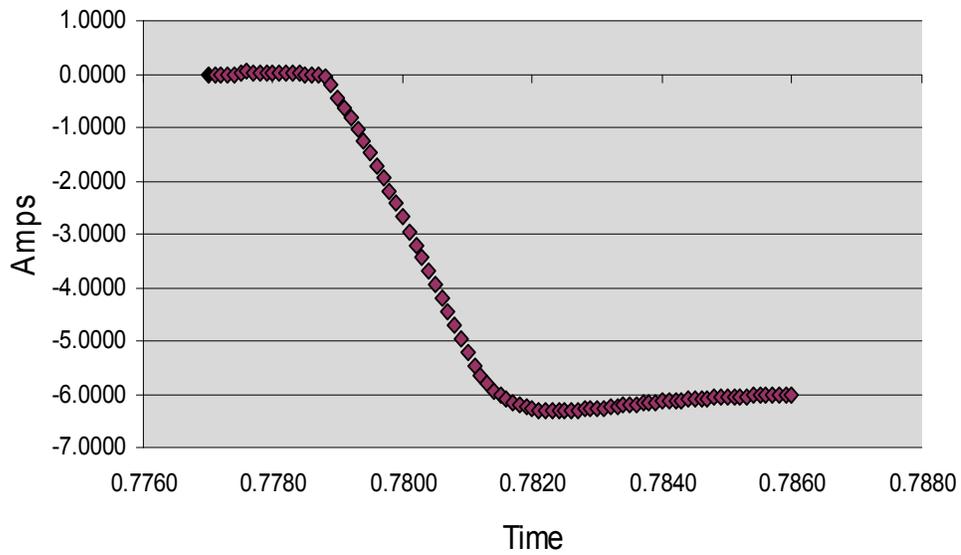


With Beam Pipe

Voltage on Secondary Coils (other magnets)
Current on SQ Magnet

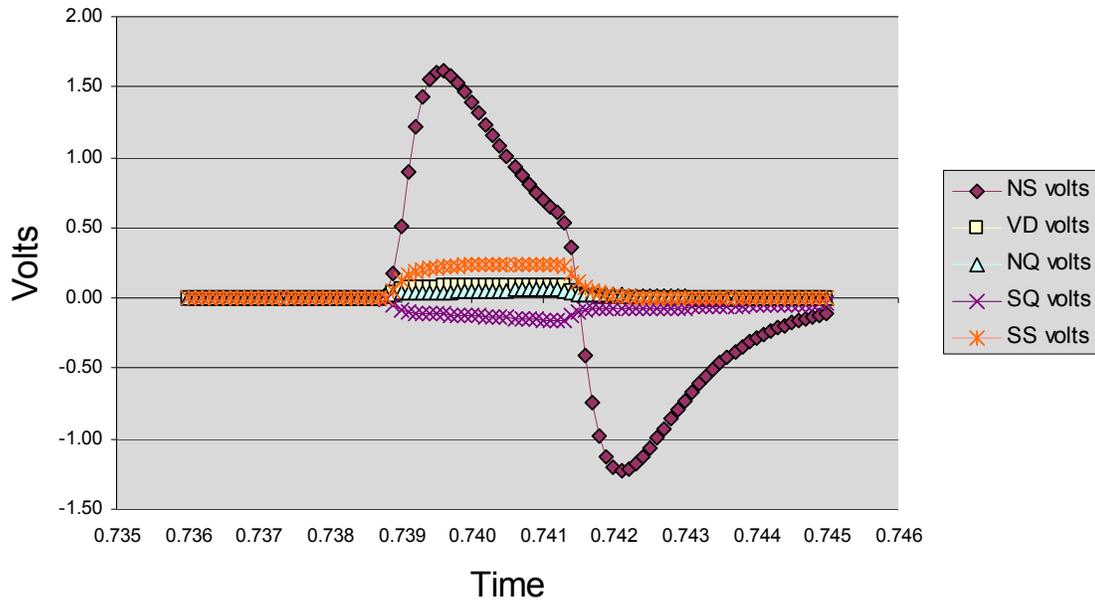


Current Slew in the SQ Magnet

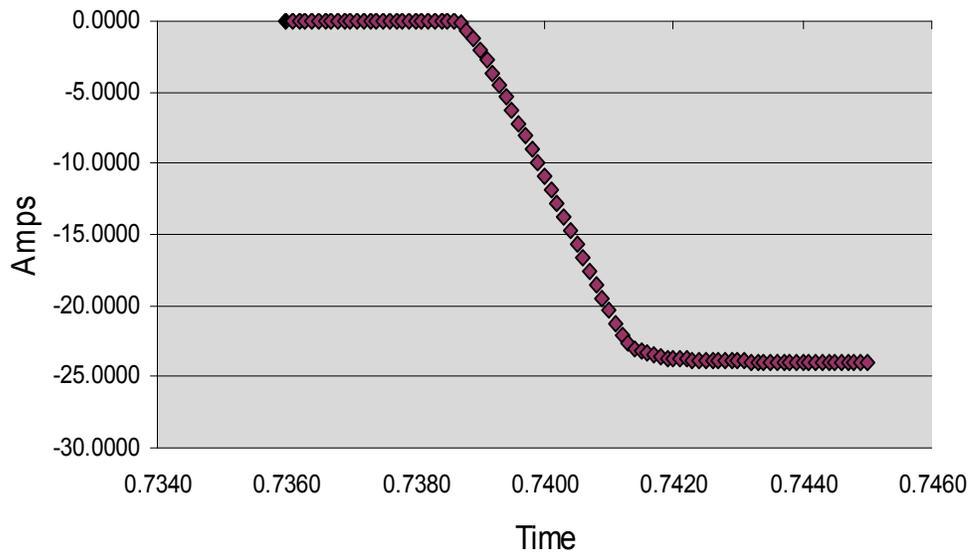


With Beam Pipe

Voltage on Secondary Coils (other magnets)
Current on HD Magnet

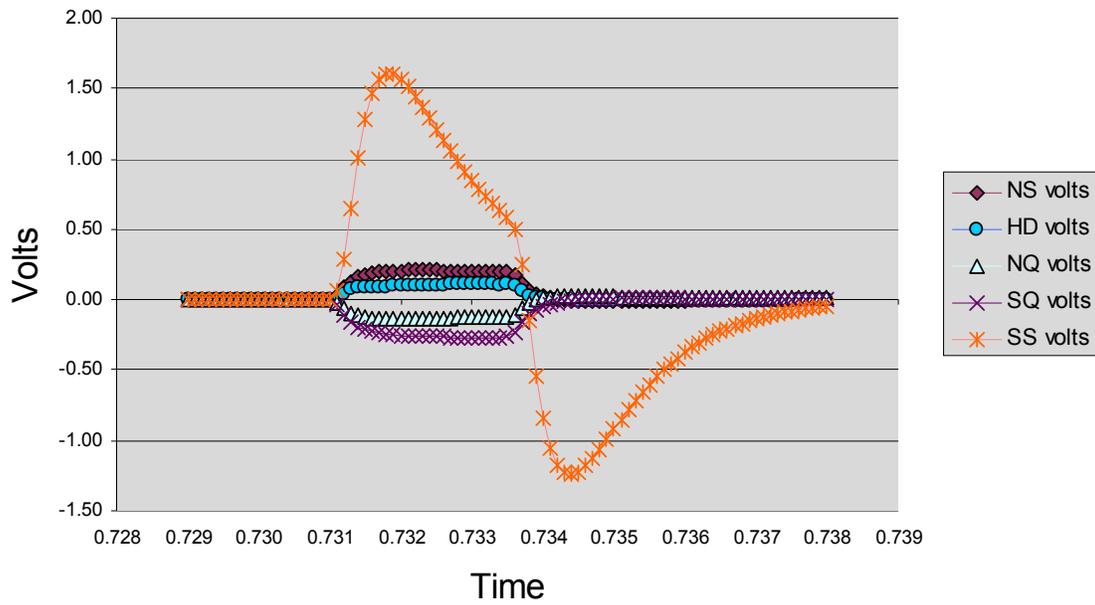


Current Slew in the HD Magnet

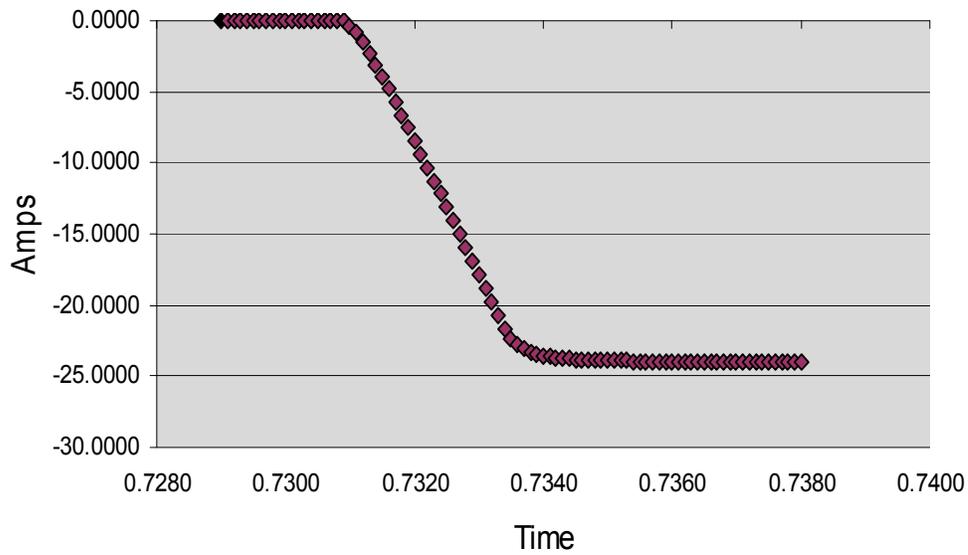


With Beam Pipe

Voltage on Secondary Coils (other magnets)
Current on VD Magnet

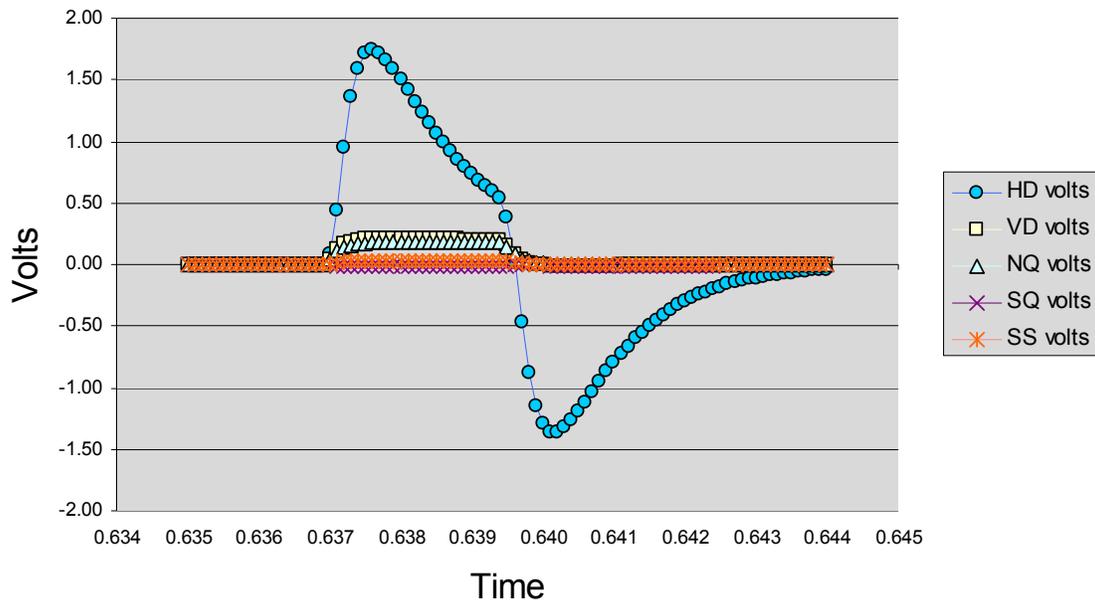


Current Slew in the VD Magnet

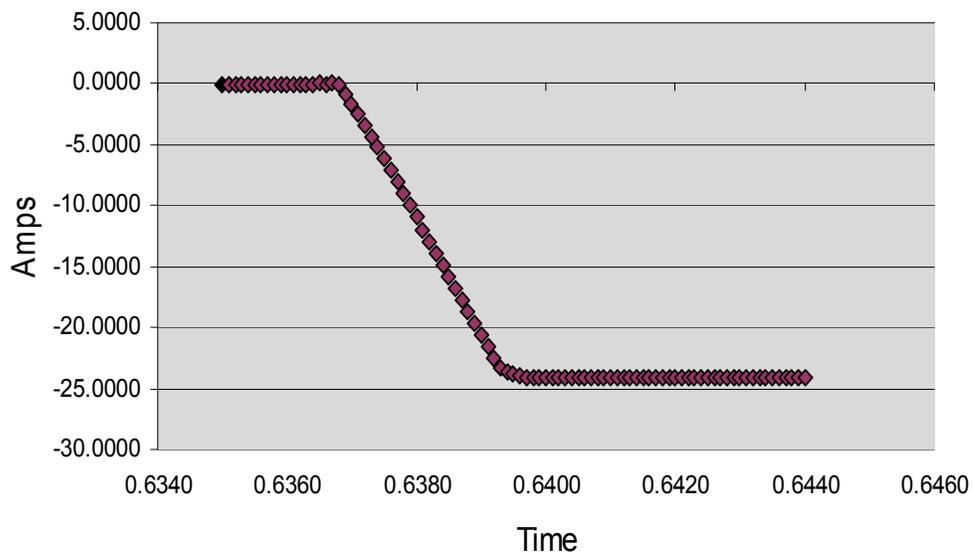


With Beam Pipe

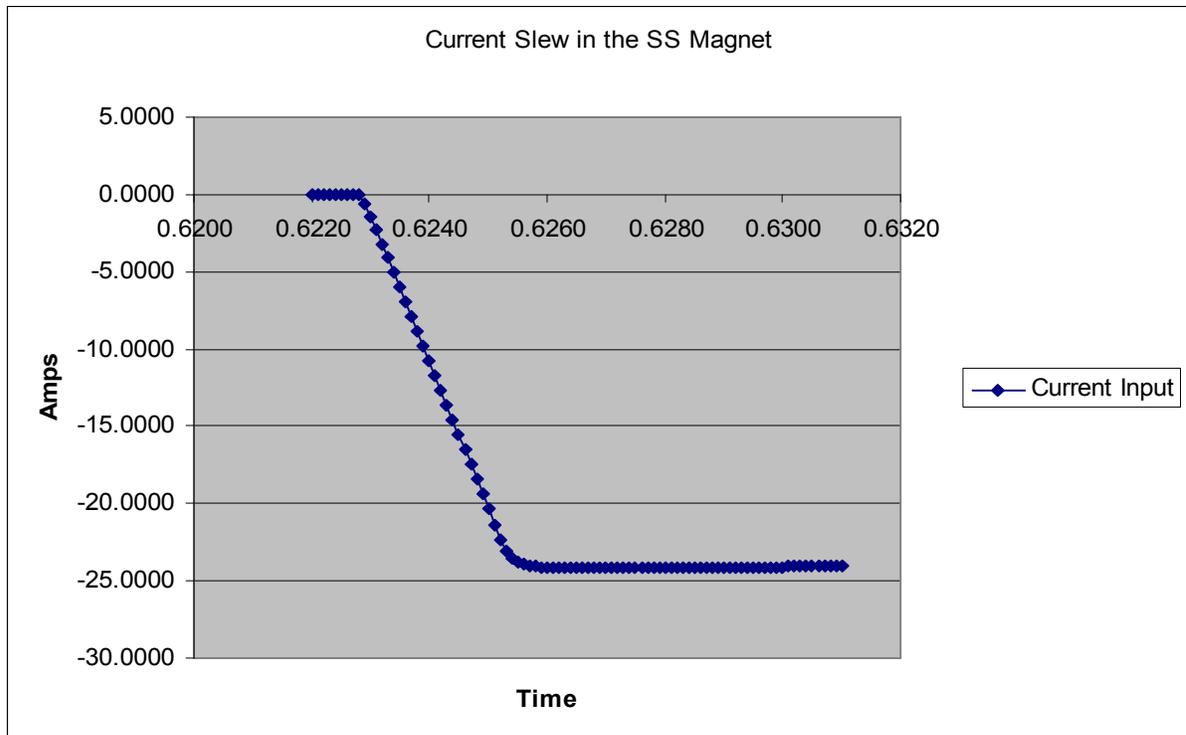
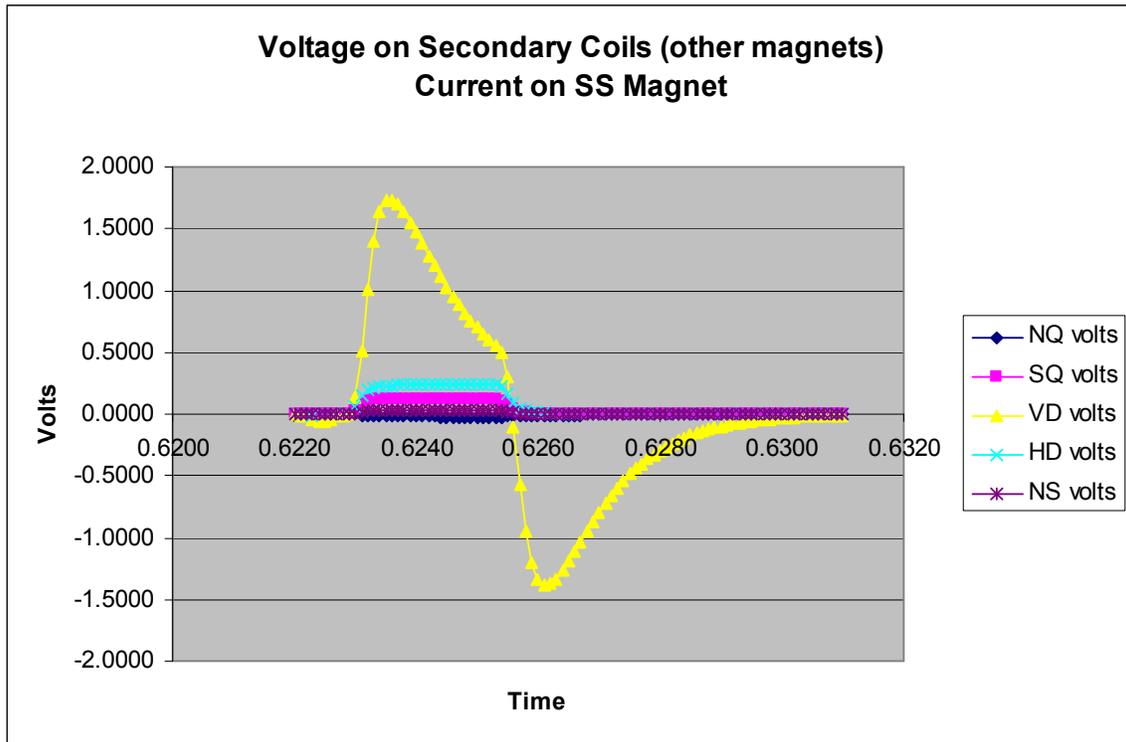
Voltage on Secondary Coils (other magnets)
Current on NS Magnet



Current Slew in the NS Magnet



With Beam Pipe



BMA000 with pipe
Largest M's (> 50 micro H)



Table I.1 Matrix of mutual inductances. Each row is the driven coil.

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