TS-SSC 90-002

From: FNAL::JBS 28-MAR-1990 22:31:00.77
To: BOSSERT,CARSON,HANFT,WKOSKA,MANTSCH,MAZUR,PEWITT
CC: MYSELF
Subj: DS0307 and DS0308 preloads explained?

From the measured coil sizes, collar size and amount of Kapton added to the standard ground wrap the expected prelodd for DS0308 is 8 kpsi in the inner coil and 11 kpsi in the outer coil. The actual prestresses are about 2 and 3 kpsi respectively. This may result from either the coil being smaller than we think it is or the collar cavity being larger than we think it is. The former would result from some as yet not understood systematic error in the coil size measurement. The latter might result from a mis-design or mis-measurement of the collars, poor tolerance on the thickness of the ground insulation or the Kapton ground insulation flowing into the die-break of the collars.

These would have different effects on the harmonics. If the coil is too small but the collar cavity is correct, the coil will require less than the expected prestress but will end up at or near the design location. If, on the other hand, the cavity is too large, the coil will occupy a larger azimuthal space than called for in the magnetic design and therefore the harmonics will be altered.

The measured body field sextupole moment of DS0308 (measurements taken today by Hanft, Koska, et al using the mole) is -6 units. Gerry Morgan calculates that increasing the inner (outer) coil collaring shim by 1 mil increases the sextupole moment by 0.49 (0.41) units. That is, if both the inner and outer coil cavities are 1 mil smaller than the design value, b2 will be +0.9 units. To generate -6 units would require the inner and outer cavities to be 7 mils too large (assuming an equal error in both).

I put such a collar size error into the spread sheet that is supposed to calculate prestresses from coil sizes. Lo and behold, the predicted prestresses are 2 and 3 kpsi on the inner and outer coils. On the final collaring of DS0307 the measured prestresses are about 5 and 7 kpsi in the inner and outer coils while the predicted prestresses are 11 and 13 kpsi. If I increase the collar cavity by the same 7 mils, the predicted prestresses drop to 5 and 5 kpsi.

The closeness of the agreement between calculation and measurement is probably somewhat fortuitous given all the fine points that I have ignored in this argument. Nonetheless, it suggests that the coil size measurements are more or less correct and that the collar cavity is to blame for the low preload. Stuffing more Kapton at the poles of DS0309 will probably not only increase the preload but also set the harmonics to the correct value. It had been my intention to set the amount of additional Kapton by seeing how much I would have to alter the collars on DS0307 and DS0308 to get the observed preloads. The mole measurement seems to have given me a good way to get the correct value on the first try.

DS0308

Coil# 106	Mag# DS0308 1/4 loc	Inner	Date 1/6/90					
Pos #	---- 6000 ----		---- 8000 ----		---- 10000 ----		---- 12000 ----	
	coil	master	coil	master	coil	master	coil	master
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0165	0.0152
2 up	0.0244	0.0193	0.0221	0.0180	0.0200	0.0167	0.0171	0.0152
2 dn	0.0217	0.0185	0.0201	0.0174	0.0185	0.0164	0.0171	0.0152
3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0179	0.0152
4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0190	0.0152
5 up	0.0264	0.0196	0.0240	0.0183	0.0214	0.0171	0.0188	0.0155
5 dn	0.0234	0.0191	0.0216	0.0180	0.0200	0.0167	0.0188	0.0155
6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0170	0.0152
7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0165	0.0152
8 up	0.0242	0.0192	0.0218	0.0180	0.0193	0.0168	0.0167	0.0153
8 dn	0.0215	0.0185	0.0195	0.0174	0.0180	0.0164	0.0167	0.0153
9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0160	0.0152
10	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0155	0.0152
11 up	0.0240	0.0192	0.0218	0.0180	0.0194	0.0168	0.0167	0.0152
11 dn	0.0213	0.0185	0.0195	0.0174	0.0180	0.0164	0.0167	0.0152
12	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0165	0.0152
13	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0175	0.0152
14 up	0.0246	0.0192	0.0221	0.0180	0.0196	0.0168	0.0174	0.0152
14 dn	0.0220	0.0185	0.0201	0.0174	0.0186	0.0164	0.0174	0.0152
15	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0186	0.0152
16	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0175	0.0152
17 up	0.0259	0.0192	0.0236	0.0180	0.0210	0.0168	0.0182	0.0153
17 dn	0.0233	0.0185	0.0214	0.0174	0.0197	0.0164	0.0182	0.0153
18	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0175	0.0152
19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0166	0.0152
20 up	0.0235	0.0192	0.0212	0.0180	0.0185	0.0168	0.0160	0.0152
20 dn	0.0209	0.0185	0.0190	0.0174	0.0173	0.0164	0.0160	0.0152
21	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0153	0.0152
22	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0160	0.0152
23 up	0.0226	0.0192	0.0208	0.0180	0.0179	0.0168	0.0148	0.0152
23 dn	0.0199	0.0185	0.0180	0.0174	0.0165	0.0164	0.0148	0.0152
24	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0154	0.0152

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	rv (collar)	str	avg str (inner)
1				0.0013	19.33	6.7	7.9	6.1
2 up	0.0051	0.0041	0.0033	0.0019	20.35	7.2	8.1	6.8
2 dn	0.0032	0.0027	0.0021	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
3				0.0027	21.72	7.3	9.3	7.9
4				0.0038	23.59	7.3	11.2	7.7
5 up	0.0068	0.0057	0.0043	0.0033	22.74	7.4	10.1	7.8
5 dn	0.0043	0.0036	0.0033	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
6				0.0018	20.18	7.5	7.5	7.5
7				0.0013	19.33	7.3	7.0	7.9
8 up	0.0050	0.0038	0.0025	0.0014	19.50	6.9	7.7	8.4
8 dn	0.0030	0.0021	0.0016	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
9				0.0008	18.48	6.9	6.7	8.2
10				0.0003	17.63	7.3	5.2	7.8
11 up	0.0048	0.0038	0.0026	0.0015	19.67	7.2	7.5	7.8
11 dn	0.0028	0.0021	0.0016	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
12				0.0013	19.33	6.9	7.5	7.7
13				0.0023	21.03		9.2	
14 up	0.0054	0.0041	0.0028	0.0022	20.86		8.7	
14 dn	0.0035	0.0027	0.0022	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXX			
15				0.0034	22.91		10.5	
16				0.0023	21.03		9.3	
17 up	0.0067	0.0056	0.0042	0.0029	22.06		10.2	
17 dn	0.0048	0.0040	0.0033	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXX			
18				0.0023	21.03		8.7	
19				0.0014	19.50		6.8	
20 up	0.0043	0.0032	0.0017	0.0008	18.48		5.9	
20 dn	0.0024	0.0016	0.0009	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXX			
21				0.0001	17.28		4.8	
22				0.0008	18.48		6.1	
23 up	0.0034	0.0028	0.0011	-0.0004	16.43		4.2	
23 dn	0.0014	0.0006	0.0001	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXX			
24				0.0002	17.45		6.0	

	6000	8000	10000	12000
UP:				
< 2-11>	0.0054	0.0044	0.0032	0.0020
sig	0.0009	0.0009	0.0008	0.0009
range	0.0020	0.0019	0.0018	0.0019
<14-23>	0.0050	0.0038	0.0025	0.0014
sig	0.0014	0.0014	0.0014	0.0015
range	0.0033	0.0033	0.0031	0.0033
< 2-23>	0.0052	0.0041	0.0028	0.0017
sig	0.0011	0.0011	0.0011	0.0012
range	0.0034	0.0034	0.0032	0.0037
DOWN:				
< 2-11>	0.0033	0.0026	0.0022	
sig	0.0007	0.0007	0.0008	
range	0.0015	0.0015	0.0017	
<14-23>	0.0030	0.0022	0.0016	
sig	0.0015	0.0015	0.0014	
	0.0034	0.0034	0.0032	
< 2-23>	0.0032	0.0024	0.0019	
sig	0.0011	0.0011	0.0011	
range	0.0029	0.0030	0.0032	

	ALL
<1-24>	0.0017
sig	0.0011
range	0.0042

Coil# 107 Mag# DS0308 1/4 loc Inner Date 1/8/90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0148	0.0152
2 up	0.0239	0.0190	0.0215	0.0179	0.0190	0.0166	0.0163	0.0152
2 dn	0.0210	0.0183	0.0192	0.0173	0.0177	0.0163	0.0163	0.0152
3	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0165	0.0152
4	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0158	0.0152
5 up	0.0234	0.0190	0.0211	0.0180	0.0187	0.0167	0.0164	0.0152
5 dn	0.0207	0.0185	0.0189	0.0175	0.0175	0.0163	0.0164	0.0152
6	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0160	0.0152
7	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0156	0.0152
8 up	0.0221	0.0190	0.0198	0.0180	0.0174	0.0166	0.0146	0.0152
8 dn	0.0193	0.0185	0.0177	0.0173	0.0162	0.0163	0.0146	0.0152
9	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0141	0.0152
10	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0157	0.0152
11 up	0.0232	0.0190	0.0210	0.0180	0.0185	0.0165	0.0160	0.0152
11 dn	0.0205	0.0185	0.0186	0.0174	0.0172	0.0163	0.0160	0.0152
12	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0154	0.0152
13	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0170	0.0152
14 up	0.0250	0.0190	0.0225	0.0180	0.0199	0.0166	0.0174	0.0152
14 dn	0.0222	0.0185	0.0203	0.0175	0.0186	0.0163	0.0174	0.0152
15	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0180	0.0152
16	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0198	0.0152
17 up	0.0264	0.0191	0.0241	0.0179	0.0215	0.0166	0.0187	0.0151
17 dn	0.0236	0.0184	0.0216	0.0174	0.0201	0.0163	0.0187	0.0151
18	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0186	0.0152
19	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0185	0.0152
20 up	0.0246	0.0187	0.0222	0.0174	0.0198	0.0164	0.0173	0.0151
20 dn	0.0220	0.0181	0.0202	0.0171	0.0186	0.0160	0.0173	0.0151
21	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0175	0.0151
22	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0177	0.0151
23 up	0.0244	0.0190	0.0220	0.0180	0.0196	0.0165	0.0169	0.0151
23 dn	0.0217	0.0185	0.0198	0.0173	0.0182	0.0163	0.0169	0.0151
24	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0148	0.0151

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str
1				-0.0004	16.34	5.1
2 up	0.0049	0.0036	0.0024	0.0011	18.84	6.8
2 dn	0.0027	0.0019	0.0014	XXXXXXX	XXXXXXX	XXXXXXX
3				0.0013	19.17	7.0
4				0.0006	18.00	5.8
5 up	0.0044	0.0031	0.0020	0.0012	19.00	6.7
5 dn	0.0022	0.0014	0.0012	XXXXXXX	XXXXXXX	XXXXXXX
6				0.0008	18.34	5.9
7				0.0004	17.67	5.6
8 up	0.0031	0.0018	0.0008	-0.0006	16.00	4.4
8 dn	0.0008	0.0004	-0.0001	XXXXXXX	XXXXXXX	XXXXXXX
9				-0.0011	15.17	3.7
10				0.0005	17.84	5.7
11 up	0.0042	0.0030	0.0020	0.0008	18.34	6.4
11 dn	0.0020	0.0012	0.0009	XXXXXXX	XXXXXXX	XXXXXXX
12				0.0002	17.34	5.8
13				0.0018	20.00	8.4
14 up	0.0060	0.0045	0.0033	0.0022	20.67	8.7
14 dn	0.0037	0.0028	0.0023	XXXXXXX	XXXXXXX	XXXXXXX
15				0.0028	21.67	9.5
16				0.0046	24.67	13.2
17 up	0.0073	0.0062	0.0049	0.0036	23.01	11.4
17 dn	0.0052	0.0042	0.0038	XXXXXXX	XXXXXXX	XXXXXXX
18				0.0034	22.67	10.6
19				0.0033	22.51	10.1
20 up	0.0059	0.0048	0.0034	0.0022	20.67	8.3
20 dn	0.0039	0.0031	0.0026	XXXXXXX	XXXXXXX	XXXXXXX
21				0.0024	21.01	8.8
22				0.0026	21.34	9.2
23 up	0.0054	0.0040	0.0030	0.0018	20.00	8.0
23 dn	0.0032	0.0025	0.0019	XXXXXXX	XXXXXXX	XXXXXXX
24				-0.0003	16.50	5.3

	6000	8000	10000	12000
UP:				
< 2-11>	0.0042	0.0029	0.0018	0.0006
sig	0.0008	0.0008	0.0007	0.0008
range	0.0018	0.0018	0.0016	0.0018
<14-23>	0.0062	0.0049	0.0037	0.0025
sig	0.0008	0.0009	0.0009	0.0008
range	0.0019	0.0022	0.0019	0.0018
< 2-23>	0.0052	0.0039	0.0027	0.0015
sig	0.0013	0.0013	0.0012	0.0012
range	0.0021	0.0024	0.0030	0.0018
DOWN:				
< 2-11>	0.0019	0.0012	0.0009	
sig	0.0008	0.0006	0.0007	
range	0.0019	0.0015	0.0015	
<14-23>	0.0040	0.0032	0.0027	
sig	0.0009	0.0007	0.0008	
	0.0020	0.0017	0.0019	
< 2-23>	0.0030	0.0022	0.0018	
sig	0.0013	0.0012	0.0012	
range	0.0019	0.0015	0.0015	

	ALL
<1-24>	0.0015
sig	0.0015
range	0.0057

Coil#	304	Mag#	DS0308 1/4 loc	Outer	Date	1/22/90	

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0120	0.0140
2 up	0.0211	0.0184	0.0187	0.0167	0.0165	0.0154	0.0141	0.0139
2 dn	0.0193	0.0178	0.0171	0.0163	0.0156	0.0150	0.0141	0.0139
3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0129	0.0140
4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0113	0.0140
5 up	0.0185	0.0184	0.0161	0.0167	0.0140	0.0153	0.0113	0.0140
5 dn	0.0166	0.0178	0.0145	0.0162	0.0129	0.0150	0.0113	0.0140
6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0117	0.0140
7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0112	0.0140
8 up	0.0180	0.0185	0.0155	0.0169	0.0133	0.0156	0.0107	0.0140
8 dn	0.0161	0.0178	0.0139	0.0162	0.0122	0.0151	0.0107	0.0140
9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0107	0.0140
10	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0131	0.0140
11 up	0.0183	0.0185	0.0161	0.0169	0.0131	0.0156	0.0114	0.0140
11 dn	0.0162	0.0178	0.0146	0.0162	0.0130	0.0151	0.0114	0.0140
12	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0111	0.0140
13	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0130	0.0140
14 up	0.0200	0.0185	0.0175	0.0169	0.0155	0.0156	0.0130	0.0140
14 dn	0.0180	0.0178	0.0160	0.0162	0.0140	0.0151	0.0130	0.0140
15	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0132	0.0140
16	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0117	0.0140
17 up	0.0190	0.0185	0.0172	0.0169	0.0150	0.0156	0.0128	0.0140
17 dn	0.0180	0.0178	0.0160	0.0162	0.0142	0.0151	0.0128	0.0140
18	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0142	0.0140
19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0149	0.0140
20 up	0.0215	0.0185	0.0189	0.0168	0.0168	0.0155	0.0145	0.0140
20 dn	0.0198	0.0178	0.0175	0.0162	0.0159	0.0150	0.0145	0.0140
21	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0144	0.0140
22	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0131	0.0140
23 up	0.0189	0.0185	0.0164	0.0168	0.0146	0.0155	0.0121	0.0140
23 dn	0.0172	0.0177	0.0151	0.0162	0.0136	0.0150	0.0121	0.0140
24	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0117	0.0140

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str	avg str (outer)
1				-0.0020	27.82	11.5	10.7
2 up	0.0027	0.0020	0.0011	0.0002	33.18	15.7	11.7
2 dn	0.0015	0.0008	0.0006	XXXXXXX	XXXXXXX	XXXXXXXXXXXXXXX	
3				-0.0011	30.01	12.3	11.0
4				-0.0027	26.12	8.4	11.2
5 up	0.0001	-0.0006	-0.0013	-0.0027	26.12	8.1	11.5
5 dn	-0.0012	-0.0017	-0.0021	XXXXXXX	XXXXXXX	XXXXXXXXXXXXXXX	
6				-0.0023	27.09	8.9	12.0
7				-0.0028	25.88	8.2	10.8
8 up	-0.0005	-0.0014	-0.0023	-0.0033	24.66	7.7	9.2
8 dn	-0.0017	-0.0023	-0.0029	XXXXXXX	XXXXXXX	XXXXXXXXXXXXXXX	
9				-0.0033	24.66	7.9	9.2
10				-0.0009	30.50	12.8	11.1
11 up	-0.0002	-0.0008	-0.0025	-0.0026	25.36	8.9	10.6
11 dn	-0.0016	-0.0016	-0.0021	XXXXXXX	XXXXXXX	XXXXXXXXXXXXXXX	
12				-0.0029	25.68	8.7	9.9
13				-0.0010	30.26	13.4	
14 up	0.0015	0.0006	-0.0001	-0.0010	30.26	12.8	
14 dn	0.0002	-0.0002	-0.0011	XXXXXXX	XXXXXXX	XXXXXXX	
15				-0.0008	30.74	13.0	
16				-0.0023	27.09	10.3	
17 up	0.0005	0.0003	-0.0006	-0.0012	29.77	12.9	
17 dn	0.0002	-0.0002	-0.0009	XXXXXXX	XXXXXXX	XXXXXXX	
18				0.0002	33.18	15.5	
19				0.0009	34.88	16.7	
20 up	0.0030	0.0021	0.0013	0.0005	33.91	15.9	
20 dn	0.0020	0.0013	0.0009	XXXXXXX	XXXXXXX	XXXXXXX	
21				0.0004	33.67	15.9	
22				-0.0009	30.50	12.8	
23 up	0.0004	-0.0004	-0.0009	-0.0019	28.07	10.6	
23 dn	-0.0005	-0.0011	-0.0014	XXXXXXX	XXXXXXX	XXXXXXX	
24				-0.0023	27.09	10.8	

UP:

	6000	8000	10000	12000
< 2-11>	0.0006	-0.0002	-0.0013	-0.0021
sig	0.0015	0.0015	0.0017	0.0016
range	0.0032	0.0034	0.0036	0.0035
<14-23>	0.0014	0.0007	-0.0001	-0.0009
sig	0.0012	0.0011	0.0010	0.0010
range	0.0026	0.0025	0.0022	0.0024
< 2-23>	0.0009	0.0002	-0.0007	-0.0015
sig	0.0013	0.0013	0.0014	0.0014
range	0.0032	0.0034	0.0036	0.0035

DOWN:

	6000	8000	10000
< 2-11>	-0.0008	-0.0012	-0.0016
sig	0.0015	0.0014	0.0015
range	0.0032	0.0031	0.0035
<14-23>	0.0005	-0.0001	-0.0006
sig	0.0011	0.0010	0.0010
	0.0025	0.0024	0.0023
< 2-23>	-0.0001	-0.0006	-0.0011
sig	0.0014	0.0013	0.0013
range	0.0032	0.0031	0.0035

	ALL
<1-24>	-0.0015
sig	0.0013
range	0.0042

Coil# 306 Mag# DS0308 1/4 loc Outer Date 1/23/90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0117	0.0140
2 up	0.0192	0.0184	0.0164	0.0167	0.0144	0.0153	0.0118	0.0140
2 dn	0.0169	0.0177	0.0148	0.0161	0.0133	0.0150	0.0118	0.0140
3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0125	0.0140
4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0132	0.0140
5 up	0.0201	0.0185	0.0178	0.0168	0.0157	0.0154	0.0133	0.0140
5 dn	0.0185	0.0177	0.0164	0.0162	0.0148	0.0150	0.0133	0.0140
6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0132	0.0140
7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0132	0.0140
8 up	0.0187	0.0185	0.0162	0.0168	0.0142	0.0154	0.0117	0.0140
8 dn	0.0168	0.0177	0.0147	0.0162	0.0130	0.0150	0.0117	0.0140
9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0113	0.0140
10	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0123	0.0140
11 up	0.0197	0.0185	0.0172	0.0168	0.0152	0.0154	0.0124	0.0140
11 dn	0.0178	0.0177	0.0156	0.0162	0.0140	0.0150	0.0124	0.0140
12	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0122	0.0140
13	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0100	0.0140
14 up	0.0185	0.0185	0.0161	0.0168	0.0139	0.0154	0.0115	0.0140
14 dn	0.0166	0.0177	0.0144	0.0162	0.0127	0.0150	0.0115	0.0140
15	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0109	0.0140
16	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0112	0.0140
17 up	0.0172	0.0185	0.0145	0.0168	0.0123	0.0154	0.0100	0.0140
17 dn	0.0151	0.0177	0.0129	0.0162	0.0113	0.0150	0.0100	0.0140
18	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0104	0.0140
19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0120	0.0140
20 up	0.0186	0.0185	0.0161	0.0168	0.0140	0.0154	0.0116	0.0140
20 dn	0.0166	0.0177	0.0146	0.0162	0.0130	0.0150	0.0116	0.0140
21	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0110	0.0140
22	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0109	0.0140
23 up	0.0188	0.0185	0.0165	0.0166	0.0146	0.0151	0.0122	0.0140
23 dn	0.0177	0.0177	0.0155	0.0162	0.0136	0.0150	0.0122	0.0140
24	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0113	0.0140

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str
1				-0.0023	26.73	10.8
2 up	0.0008	-0.0003	-0.0009	-0.0022	26.97	9.9
2 dn	-0.0008	-0.0013	-0.0017	XXXXXXX	XXXXXXX	XXXXXXX
3				-0.0015	28.63	11.3
4				-0.0008	30.30	13.0
5 up	0.0016	0.0010	0.0003	-0.0007	30.53	13.0
5 dn	0.0008	0.0002	-0.0002	XXXXXXX	XXXXXXX	XXXXXXX
6				-0.0008	30.30	12.6
7				-0.0008	30.30	13.1
8 up	0.0002	-0.0006	-0.0012	-0.0023	26.73	10.2
8 dn	-0.0009	-0.0015	-0.0020	XXXXXXX	XXXXXXX	XXXXXXX
9				-0.0027	25.78	9.4
10				-0.0017	28.16	10.9
11 up	0.0012	0.0004	-0.0002	-0.0016	28.40	11.4
11 dn	0.0001	-0.0006	-0.0010	XXXXXXX	XXXXXXX	XXXXXXX
12				-0.0018	27.92	11.4
13				-0.0040	22.69	6.2
14 up	0.0000	-0.0007	-0.0015	-0.0025	26.26	9.2
14 dn	-0.0011	-0.0018	-0.0023	XXXXXXX	XXXXXXX	XXXXXXX
15				-0.0031	24.83	7.6
16				-0.0028	25.54	9.2
17 up	-0.0013	-0.0023	-0.0031	-0.0040	22.69	6.2
17 dn	-0.0026	-0.0033	-0.0037	XXXXXXX	XXXXXXX	XXXXXXX
18				-0.0036	23.64	6.4
19				-0.0020	27.44	9.7
20 up	0.0001	-0.0007	-0.0014	-0.0024	26.49	8.9
20 dn	-0.0011	-0.0016	-0.0020	XXXXXXX	XXXXXXX	XXXXXXX
21				-0.0030	25.07	7.7
22				-0.0031	24.83	7.5
23 up	0.0003	-0.0001	-0.0005	-0.0018	27.92	10.8
23 dn	0.0000	-0.0007	-0.0014	XXXXXXX	XXXXXXX	XXXXXXX
24				-0.0027	25.78	9.8
UP:					26.8308	9.84454
< 2-11>	0.0010	0.0001	-0.0005	-0.0017		
sig	0.0006	0.0007	0.0007	0.0007		
range	0.0014	0.0016	0.0015	0.0016		
<14-23>	-0.0002	-0.0010	-0.0016	-0.0027		
sig	0.0007	0.0009	0.0011	0.0009		
range	0.0016	0.0022	0.0026	0.0022		
< 2-23>	0.0004	-0.0004	-0.0011	-0.0022		
sig	0.0009	0.0010	0.0010	0.0009		
range	0.0029	0.0033	0.0034	0.0033		
DOWN:						
< 2-11>	-0.0002	-0.0008	-0.0012			
sig	0.0008	0.0008	0.0008			
range	0.0017	0.0017	0.0018			
<14-23>	-0.0012	-0.0019	-0.0024			
sig	0.0011	0.0011	0.0010			
	0.0026	0.0026	0.0023			
< 2-23>	-0.0007	-0.0013	-0.0018			
sig	0.0010	0.0010	0.0010			
range	0.0034	0.0035	0.0035			

	ALL
<1-24>	-0.0023
sig	0.0010
range	0.0033

ASSUMING ALL COMPONENTS ARE "AS MEASURED"

Coil# 106 Mag# DS0808 1/4 loc Inner Date 1/6/90
Shim: 0.008 Collar error: 0

stress	6000	8000	10000	12000
size	0.0082	0.0071	0.0058	0.0047

linear fit stress = f(size)
s(0) = 19.98 kpsi ds/dx = -1.706 kpsi/mil
collared stress
7.7

Coil# 107 Mag# DS0808 1/4 loc Inner Date 1/8/90
Shim: 0.008 Collar error: 0

stress	6000	8000	10000	12000
size	0.0082	0.0069	0.0057	0.0045

linear fit stress = f(size)
s(0) = 19.54 kpsi ds/dx = -1.668 kpsi/mil
collared stress
7.6

Coil# 804 Mag# DS0808 1/4 loc Outer Date 1/22/90
Shim: 0.010 Collar error: -0.0015

stress	6000	8000	10000	12000
size	0.0094	0.0087	0.0078	0.0070

linear fit stress = f(size)
s(0) = 29.08 kpsi ds/dx = -2.484 kpsi/mil
collared stress
11.6

Coil# 806 Mag# DS0808 1/4 loc Outer Date 1/23/90
Shim: 0.010 Collar error: -0.0015

stress	6000	8000	10000	12000
size	0.0089	0.0081	0.0074	0.0068

linear fit stress = f(size)
s(0) = 27.24 kpsi ds/dx = -2.376 kpsi/mil
collared stress
10.2

Collar compliance (in terms of average inner+outer coil stress)
Collar vertical offset (individual collar away from magnet center)
dx/ds = 0.56 mils/kpsi x(0) = 2 mils

Coil average stress = f(collar deflection)
s(0) = -8.57 kpsi ds/dx = 1.786 kpsi/mil

Average of 4 coils:
s(0) = 28.96 kpsi ds/dx = -2.05 kpsi/mil

Collar vertical radius:
7.2 mils

Average inner stress = 7.6
Average outer stress = 10.9

Average coil stress = 9.8

ASSUMING COLLAR CAVITY IS 7 MILS LARGER

```
   Coil#   106        Mag# DS0308  1/4 loc  Inner     Date  1/6/90
  Shim:    0.003  Collar error:    -0.007
stress      6000     8000   10000   12000
  size    0.0012  0.0001 -0.0012 -0.0023

linear fit stress = f(size)
  s(0) =    8.05 kpsi    ds/dx =  -1.705 kpsi/mil
collared stress
     2.2

   Coil#   107        Mag#  DS0308 1/4 loc  Inner     Date  1/8/90
  Shim:    0.003  Collar error:    -0.007
stress      6000     8000   10000   12000
  size    0.0012 -0.0001 -0.0013 -0.0025

linear fit stress = f(size)
  s(0) =    7.87 kpsi    ds/dx =  -1.668 kpsi/mil
collared stress
     2.1

   Coil#   304        Mag#  DS0308 1/4 loc  Outer     Date 1/22/90
  Shim:    0.010  Collar error:  -0.0085
stress      6000     8000   10000   12000
  size    0.0024  0.0017  0.0008  0.0000

linear fit stress = f(size)
  s(0) =   12.04 kpsi    ds/dx =  -2.434 kpsi/mil
collared stress
     3.6

   Coil#   305        Mag#  DS0308 1/4 loc  Outer     Date 1/23/90
  Shim:    0.010  Collar error:  -0.0085
stress      6000     8000   10000   12000
  size    0.0019  0.0011  0.0004 -0.0007

linear fit stress = f(size)
  s(0) =   10.60 kpsi    ds/dx =  -2.376 kpsi/mil
collared stress
     2.4

Collar compliance (in terms of average inner+outer coil stress)
Collar vertical offset (individual collar away from magnet center)
 dx/ds =    0.56 mils/kpsi          x(0) =       2 mils

Coil average stress = f(collar deflection)
  s(0) =   -3.57 kpsi    ds/dx =   1.786 kpsi/mil

Average of 4 coils:
  s(0) =    9.64 kpsi    ds/dx =   -2.05 kpsi/mil

Collar vertical radius:
     3.4 mils

Average inner stress =       2.1
Average outer stress =       3.0

Average  coil stress =       2.6
```

DS0307A

Coil# 104 Mag# DS0307A 1/4 loc LI Date 1/30/90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0180	0.0152
2 up	0.0267	0.0193	0.0248	0.0180	0.0218	0.0167	0.0194	0.0152
2 dn	0.0242	0.0185	0.0223	0.0175	0.0203	0.0164	0.0194	0.0152
3	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0196	0.0152
4	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0208	0.0152
5 up	0.0279	0.0193	0.0225	0.0180	0.0232	0.0167	0.0206	0.0152
5 dn	0.0254	0.0185	0.0235	0.0175	0.0220	0.0164	0.0206	0.0152
6	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0194	0.0152
7	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0190	0.0152
8 up	0.0261	0.0193	0.0239	0.0180	0.0215	0.0167	0.0191	0.0152
8 dn	0.0239	0.0185	0.0220	0.0175	0.0204	0.0164	0.0191	0.0152
9	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0186	0.0152
10	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0200	0.0152
11 up	0.0277	0.0193	0.0257	0.0180	0.0227	0.0167	0.0203	0.0152
11 dn	0.0250	0.0185	0.0231	0.0175	0.0215	0.0164	0.0203	0.0152
12	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0201	0.0152
13	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0201	0.0152
14 up	0.0261	0.0193	0.0237	0.0180	0.0214	0.0167	0.0188	0.0152
14 dn	0.0236	0.0185	0.0217	0.0175	0.0200	0.0164	0.0188	0.0152
15	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0181	0.0152
16	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0182	0.0152
17 up	0.0262	0.0193	0.0238	0.0180	0.0210	0.0167	0.0185	0.0152
17 dn	0.0234	0.0185	0.0215	0.0175	0.0199	0.0164	0.0185	0.0152
18	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0193	0.0152
19	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0196	0.0152
20 up	0.0276	0.0193	0.0242	0.0180	0.0216	0.0167	0.0197	0.0152
20 dn	0.0241	0.0185	0.0223	0.0175	0.0205	0.0164	0.0197	0.0152
21	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0187	0.0152
22	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0185	0.0152
23 up	0.0263	0.0193	0.0239	0.0180	0.0215	0.0167	0.0190	0.0152
23 dn	0.0241	0.0185	0.0222	0.0175	0.0204	0.0164	0.0190	0.0152
24	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	0.0171	0.0152

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	rv (collar)	str	avg str (inner)	Pos #
1				0.0028	22.54	8.3	7.4	9.9	1
2 up	0.0074	0.0068	0.0051	0.0042	25.08	8.7	9.3	10.0	2
2 dn	0.0057	0.0048	0.0039	XXXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
3				0.0044	25.45	8.7	9.7	9.8	3
4				0.0056	27.63	8.7	11.8	10.4	4
5 up	0.0086	0.0045	0.0065	0.0054	27.26	8.9	11.1	11.7	5
5 dn	0.0069	0.0060	0.0056	XXXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
6				0.0042	25.08	8.9	8.8	10.9	6
7				0.0038	24.86	8.7	8.6	10.5	7
8 up	0.0068	0.0059	0.0048	0.0039	24.54	8.4	9.2	11.2	8
8 dn	0.0054	0.0045	0.0040	XXXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
9				0.0034	23.68	8.2	8.7	10.3	9
10				0.0048	26.17	8.5	10.7	9.9	10
11 up	0.0084	0.0077	0.0060	0.0051	26.72	8.5	11.3	9.7	11
11 dn	0.0065	0.0056	0.0051	XXXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
12				0.0049	26.85	8.3	11.3	9.7	12
13				0.0049	26.85		11.3		
14 up	0.0068	0.0057	0.0047	0.0036	23.99		8.6		
14 dn	0.0051	0.0042	0.0036	XXXXXXX	XXXXXX	XXXXXX	XXXXXX		
15				0.0029	22.72		7.3		
16				0.0030	22.90		8.0		
17 up	0.0069	0.0058	0.0043	0.0033	23.45		8.1		
17 dn	0.0049	0.0040	0.0035	XXXXXXX	XXXXXX	XXXXXX	XXXXXX		
18				0.0041	24.90		9.1		
19				0.0044	25.45		9.2		
20 up	0.0083	0.0062	0.0049	0.0045	25.63		9.4		
20 dn	0.0056	0.0048	0.0041	XXXXXXX	XXXXXX	XXXXXX	XXXXXX		
21				0.0035	23.81		8.0		
22				0.0033	23.45		7.7		
23 up	0.0070	0.0059	0.0048	0.0038	24.86		8.5		
23 dn	0.0056	0.0047	0.0040	XXXXXXX	XXXXXX	XXXXXX	XXXXXX		
24				0.0019	20.90		5.8		

	6000	8000	10000	12000
UP:				
< 2-11>	0.0078	0.0061	0.0056	0.0047
sig	0.0008	0.0013	0.0008	0.0007
range	0.0018	0.0032	0.0017	0.0015
<14-23>	0.0073	0.0058	0.0047	0.0038
sig	0.0007	0.0004	0.0003	0.0006
range	0.0015	0.0009	0.0006	0.0012
< 2-23>	0.0075	0.0059	0.0051	0.0042
sig	0.0008	0.0009	0.0007	0.0007
range	0.0018	0.0032	0.0022	0.0021
DOWN:				
< 2-11>	0.0061	0.0052	0.0047	
sig	0.0007	0.0007	0.0008	
range	0.0015	0.0015	0.0017	
<14-23>	0.0053	0.0044	0.0038	
sig	0.0004	0.0004	0.0003	
	0.0007	0.0008	0.0006	
< 2-23>	0.0057	0.0048	0.0042	
sig	0.0007	0.0007	0.0007	
range	0.0020	0.0020	0.0021	

	ALL
<1-24>	0.0040
sig	0.0009
range	0.0037

Coil# 106 Mag# DS0307A 1/4 loc UI Date 1/30/90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0200	0.0151
2 up	0.0267	0.0190	0.0243	0.0176	0.0217	0.0163	0.0191	0.0151
2 dn	0.0233	0.0182	0.0221	0.0171	0.0208	0.0160	0.0191	0.0151
3	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0183	0.0151
4	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0176	0.0151
5 up	0.0258	0.0190	0.0234	0.0176	0.0210	0.0163	0.0184	0.0151
5 dn	0.0233	0.0182	0.0214	0.0171	0.0198	0.0160	0.0184	0.0151
6	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0189	0.0151
7	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0190	0.0151
8 up	0.0288	0.0190	0.0269	0.0176	0.0244	0.0163	0.0219	0.0151
8 dn	0.0267	0.0182	0.0247	0.0171	0.0232	0.0160	0.0219	0.0151
9	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0204	0.0151
10	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0200	0.0151
11 up	0.0251	0.0190	0.0232	0.0176	0.0208	0.0163	0.0184	0.0151
11 dn	0.0234	0.0182	0.0214	0.0171	0.0197	0.0160	0.0184	0.0151
12	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0178	0.0151
13	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0186	0.0151
14 up	0.0273	0.0190	0.0249	0.0176	0.0226	0.0163	0.0198	0.0151
14 dn	0.0250	0.0182	0.0230	0.0171	0.0213	0.0160	0.0198	0.0151
15	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0197	0.0151
16	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0205	0.0151
17 up	0.0288	0.0190	0.0265	0.0176	0.0240	0.0163	0.0212	0.0151
17 dn	0.0264	0.0182	0.0244	0.0171	0.0227	0.0160	0.0212	0.0151
18	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0227	0.0151
19	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0242	0.0151
20 up	0.0318	0.0190	0.0297	0.0176	0.0274	0.0163	0.0249	0.0151
20 dn	0.0296	0.0182	0.0283	0.0171	0.0258	0.0160	0.0249	0.0151
21	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0228	0.0151
22	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0219	0.0151
23 up	0.0291	0.0190	0.0267	0.0176	0.0241	0.0163	0.0216	0.0151
23 dn	0.0262	0.0182	0.0242	0.0171	0.0227	0.0160	0.0216	0.0151
24	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.0222	0.0151

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str
1				0.0049	25.89	11.3
2 up	0.0077	0.0067	0.0054	0.0040	24.30	9.0
2 dn	0.0051	0.0050	0.0048	XXXXXXX	XXXXXXX	XXXXXXX
3				0.0032	22.90	7.7
4				0.0025	21.67	6.3
5 up	0.0068	0.0058	0.0047	0.0033	23.07	7.4
5 dn	0.0051	0.0043	0.0038	XXXXXXX	XXXXXXX	XXXXXXX
6				0.0038	23.96	8.2
7				0.0039	24.13	8.9
8 up	0.0098	0.0093	0.0081	0.0068	29.22	14.4
8 dn	0.0085	0.0076	0.0072	XXXXXXX	XXXXXXX	XXXXXXX
9				0.0053	26.59	12.2
10				0.0049	25.89	11.0
11 up	0.0061	0.0056	0.0045	0.0033	23.07	8.2
11 dn	0.0052	0.0043	0.0037	XXXXXXX	XXXXXXX	XXXXXXX
12				0.0027	22.02	7.4
13				0.0035	23.42	8.8
14 up	0.0083	0.0073	0.0063	0.0047	25.53	10.6
14 dn	0.0068	0.0059	0.0053	XXXXXXX	XXXXXXX	XXXXXXX
15				0.0046	25.36	10.4
16				0.0054	26.76	12.4
17 up	0.0098	0.0089	0.0077	0.0061	27.99	13.1
17 dn	0.0082	0.0073	0.0067	XXXXXXX	XXXXXXX	XXXXXXX
18				0.0076	30.63	15.4
19				0.0091	33.27	17.5
20 up	0.0128	0.0121	0.0111	0.0098	34.50	18.8
20 dn	0.0114	0.0112	0.0098	XXXXXXX	XXXXXXX	XXXXXXX
21				0.0077	30.81	15.5
22				0.0068	29.22	14.0
23 up	0.0101	0.0091	0.0078	0.0065	28.70	13.4
23 dn	0.0080	0.0071	0.0067	XXXXXXX	XXXXXXX	XXXXXXX
24				0.0071	29.75	15.1

	6000	8000	10000	12000
UP:				
< 2-11>	0.0076	0.0069	0.0057	0.0044
sig	0.0016	0.0017	0.0017	0.0017
range	0.0037	0.0037	0.0036	0.0035
<14-23>	0.0103	0.0094	0.0082	0.0068
sig	0.0019	0.0020	0.0020	0.0022
range	0.0045	0.0048	0.0048	0.0051
< 2-23>	0.0089	0.0081	0.0070	0.0056
sig	0.0021	0.0022	0.0022	0.0022
range	0.0063	0.0066	0.0053	0.0035
DOWN:				
< 2-11>	0.0060	0.0053	0.0048	
sig	0.0017	0.0016	0.0017	
range	0.0034	0.0033	0.0035	
<14-23>	0.0086	0.0079	0.0071	
sig	0.0020	0.0023	0.0019	
	0.0046	0.0053	0.0045	
< 2-23>	0.0073	0.0066	0.0059	
sig	0.0022	0.0023	0.0021	
range	0.0034	0.0033	0.0035	

	ALL
<1-24>	0.0053
sig	0.0020
range	0.0073

Coil# 306 Mag# DS0307A 1/4 loc 0 Date 3/2/90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9997	0.9975
2 up	1.0049	1.0000	1.0033	0.9991	1.0021	0.9984	1.0003	0.9975
2 dn	1.0035	0.9995	1.0022	0.9987	1.0010	0.9981	1.0003	0.9975
3	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0005	0.9975
4	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0002	0.9975
5 up	1.0055	1.0000	1.0038	0.9991	1.0024	0.9984	1.0008	0.9975
5 dn	1.0041	0.9996	1.0027	0.9987	1.0016	0.9981	1.0008	0.9975
6	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0010	0.9975
7	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0011	0.9975
8 up	1.0045	1.0000	1.0029	0.9991	1.0016	0.9984	0.9998	0.9975
8 dn	1.0031	0.9996	1.0018	0.9987	1.0007	0.9981	0.9998	0.9975
9	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9995	0.9975
10	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0008	0.9975
11 up	1.0061	1.0000	1.0042	0.9991	1.0028	0.9984	1.0011	0.9975
11 dn	1.0044	0.9996	1.0029	0.9987	1.0019	0.9981	1.0011	0.9975
12	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0009	0.9975
13	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9983	0.9975
14 up	1.0039	1.0000	1.0023	0.9992	1.0007	0.9985	0.9991	0.9976
14 dn	1.0023	0.9997	1.0008	0.9989	0.9998	0.9982	0.9991	0.9976
15	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9998	0.9976
16	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9992	0.9976
17 up	1.0038	1.0000	1.0022	0.9992	1.0005	0.9985	0.9988	0.9976
17 dn	1.0021	0.9998	1.0005	0.9989	0.9996	0.9982	0.9988	0.9976
18	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9995	0.9976
19	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0003	0.9976
20 up	1.0050	1.0000	1.0033	0.9991	1.0019	0.9984	1.0001	0.9976
20 dn	1.0034	0.9997	1.0020	0.9989	1.0009	0.9982	1.0001	0.9976
21	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0004	0.9976
22	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	1.0004	0.9976
23 up	1.0059	1.0000	1.0038	0.9991	1.0025	0.9984	1.0006	0.9976
23 dn	1.0039	0.9997	1.0025	0.9989	1.0014	0.9982	1.0006	0.9976
24	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	0.9996	0.9976

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str	avg str (outer)
1				0.0022	33.76	13.0	12.6
2 up	0.0049	0.0042	0.0037	0.0028	35.26	13.5	13.9
2 dn	0.0040	0.0035	0.0029	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
3				0.0030	35.76	14.1	14.1
4				0.0027	35.01	13.2	13.6
5 up	0.0055	0.0047	0.0040	0.0033	36.51	14.2	13.0
5 dn	0.0045	0.0040	0.0035	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
6				0.0035	37.01	14.6	13.9
7				0.0036	37.26	15.5	13.4
8 up	0.0045	0.0038	0.0032	0.0023	34.01	12.9	11.8
8 dn	0.0035	0.0031	0.0026	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
9				0.0020	33.26	12.7	11.8
10				0.0033	36.51	15.3	13.3
11 up	0.0061	0.0051	0.0044	0.0036	37.26	16.1	13.4
11 dn	0.0048	0.0042	0.0038	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
12				0.0034	36.76	15.0	12.8
13				0.0008	30.25	9.5	
14 up	0.0039	0.0031	0.0022	0.0015	32.01	10.8	
14 dn	0.0026	0.0019	0.0016	XXXXXXX	XXXXXXX	XXXXXXX	
15				0.0022	33.76	12.5	
16				0.0016	32.26	11.7	
17 up	0.0038	0.0030	0.0020	0.0012	31.25	10.1	
17 dn	0.0023	0.0016	0.0014	XXXXXXX	XXXXXXX	XXXXXXX	
18				0.0019	33.01	11.3	
19				0.0027	35.01	12.6	
20 up	0.0050	0.0042	0.0035	0.0025	34.51	12.2	
20 dn	0.0037	0.0031	0.0027	XXXXXXX	XXXXXXX	XXXXXXX	
21				0.0028	35.26	13.5	
22				0.0028	35.26	13.6	
23 up	0.0059	0.0047	0.0041	0.0030	35.76	14.0	
23 dn	0.0042	0.0036	0.0032	XXXXXXX	XXXXXXX	XXXXXXX	
24				0.0020	33.26	12.5	

	6000	8000	10000	12000
UP:				
< 2-11>	0.0053	0.0045	0.0038	0.0030
sig	0.0007	0.0006	0.0005	0.0006
range	0.0016	0.0013	0.0012	0.0013
<14-23>	0.0047	0.0036	0.0030	0.0021
sig	0.0010	0.0008	0.0010	0.0008
range	0.0021	0.0017	0.0021	0.0018
< 2-23>	0.0050	0.0041	0.0034	0.0025
sig	0.0009	0.0008	0.0009	0.0008
range	0.0023	0.0021	0.0024	0.0024
DOWN:				
< 2-11>	0.0042	0.0037	0.0032	
sig	0.0006	0.0005	0.0005	
range	0.0013	0.0011	0.0012	
<14-23>	0.0032	0.0026	0.0022	
sig	0.0009	0.0010	0.0009	
	0.0019	0.0020	0.0018	
< 2-23>	0.0037	0.0031	0.0027	
sig	0.0009	0.0009	0.0008	
range	0.0025	0.0026	0.0024	

	ALL
<1-24>	0.0025
sig	0.0008
range	0.0028

Coil# 307 Mag# DS0307A 1/4 loc 0 Date 3/3/90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9991	0.9974
2 up	1.0043	1.0000	1.0026	0.9991	1.0012	0.9984	0.9996	0.9974
2 dn	1.0027	0.9994	1.0014	0.9987	1.0004	0.9980	0.9996	0.9974
3	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0001	0.9974
4	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9995	0.9974
5 up	1.0042	1.0000	1.0025	0.9991	1.0010	0.9984	0.9994	0.9975
5 dn	1.0026	0.9994	1.0012	0.9987	1.0001	0.9981	0.9994	0.9975
6	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9997	0.9975
7	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9999	0.9975
8 up	1.0037	1.0000	1.0021	0.9991	1.0004	0.9984	0.9987	0.9975
8 dn	1.0021	0.9996	1.0005	0.9988	0.9994	0.9981	0.9987	0.9975
9	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9986	0.9975
10	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9994	0.9975
11 up	1.0056	1.0000	1.0036	0.9991	1.0023	0.9984	1.0006	0.9975
11 dn	1.0038	0.9996	1.0025	0.9988	1.0015	0.9981	1.0006	0.9975
12	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0004	0.9975
13	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9989	0.9975
14 up	1.0046	1.0000	1.0028	0.9991	1.0013	0.9984	0.9996	0.9975
14 dn	1.0030	0.9996	1.0015	0.9989	1.0004	0.9982	0.9996	0.9975
15	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0002	0.9975
16	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9993	0.9975
17 up	1.0052	1.0000	1.0034	0.9991	1.0020	0.9984	1.0003	0.9975
17 dn	1.0037	0.9996	1.0023	0.9989	1.0011	0.9982	1.0003	0.9975
18	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0008	0.9976
19	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0021	0.9976
20 up	1.0063	1.0000	1.0043	0.9992	1.0029	0.9985	1.0012	0.9975
20 dn	1.0047	0.9996	1.0031	0.9989	1.0021	0.9982	1.0012	0.9975
21	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0014	0.9975
22	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	1.0011	0.9975
23 up	1.0065	1.0000	1.0045	0.9992	1.0031	0.9985	1.0015	0.9975
23 dn	1.0049	0.9996	1.0034	0.9989	1.0024	0.9982	1.0015	0.9975
24	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX	0.9999	0.9975

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str
1				0.0017	31.15	11.7
2 up	0.0043	0.0035	0.0028	0.0022	32.33	12.0
2 dn	0.0033	0.0027	0.0024	XXXXXXX	XXXXXXX	XXXXXXX
3				0.0027	33.50	13.2
4				0.0021	32.09	11.7
5 up	0.0042	0.0034	0.0026	0.0019	31.63	10.8
5 dn	0.0032	0.0025	0.0020	XXXXXXX	XXXXXXX	XXXXXXX
6				0.0022	32.33	11.4
7				0.0024	32.80	12.5
8 up	0.0037	0.0030	0.0020	0.0012	29.99	10.3
8 dn	0.0025	0.0017	0.0013	XXXXXXX	XXXXXXX	XXXXXXX
9				0.0011	29.75	10.6
10				0.0019	31.63	11.8
11 up	0.0056	0.0045	0.0039	0.0031	34.43	14.6
11 dn	0.0042	0.0037	0.0034	XXXXXXX	XXXXXXX	XXXXXXX
12				0.0029	33.95	14.5
13				0.0014	30.45	11.1
14 up				0.0021	32.09	12.3
14 dn				XXXXXXX	XXXXXXX	XXXXXXX
15				0.0027	33.50	13.7
16				0.0018	31.39	12.2
17 up	0.0052	0.0043	0.0036	0.0028	33.73	14.0
17 dn	0.0041	0.0034	0.0029	XXXXXXX	XXXXXXX	XXXXXXX
18				0.0032	34.85	14.4
19				0.0045	37.70	16.8
20 up	0.0063	0.0051	0.0044	0.0037	35.83	15.0
20 dn	0.0051	0.0042	0.0039	XXXXXXX	XXXXXXX	XXXXXXX
21				0.0039	36.30	15.9
22				0.0036	35.60	15.3
23 up	0.0065	0.0053	0.0046	0.0040	36.53	16.2
23 dn	0.0053	0.0045	0.0042	XXXXXXX	XXXXXXX	XXXXXXX
24				0.0024	32.80	13.4
					33.1751	13.1444

	6000	8000	10000	12000
UP:				
< 2-11>	0.0045	0.0036	0.0028	0.0021
sig	0.0008	0.0005	0.0008	0.0008
range	0.0019	0.0015	0.0019	0.0019
<14-23>	0.0060	0.0049	0.0042	0.0032
sig	0.0007	0.0006	0.0005	0.0009
range	0.0018	0.0010	0.0010	0.0019
< 2-23>	0.0052	0.0043	0.0035	0.0026
sig	0.0011	0.0009	0.0010	0.0009
range	0.0019	0.0015	0.0022	0.0019
DOWN:				
< 2-11>	0.0033	0.0027	0.0023	
sig	0.0007	0.0008	0.0009	
range	0.0017	0.0020	0.0021	
<14-23>	0.0046	0.0040	0.0037	
sig	0.0006	0.0006	0.0007	
	0.0012	0.0011	0.0013	
< 2-23>	0.0041	0.0033	0.0030	
sig	0.0010	0.0010	0.0010	
range	0.0017	0.0020	0.0021	

	ALL
<1-24>	0.0026
sig	0.0009
range	0.0034

ASSUMING ALL COMPONENTS ARE "AS MEASURED"

Coil#	104	Mag#DS0307A	1/4 loc	LI	Date 1/30/90
Shim:	0.008	Collar error:	0		
stress	6000	8000	10000	12000	
size	0.0106	0.0089	0.0081	0.0072	

linear fit stress = f(size)
s(0) = 24.82 kpsi   ds/dx = -1.817 kpsi/mil
collared stress
9.1

Coil#	106	Mag#DS0307A	1/4 loc	UI	Date 1/30/90
Shim:	0.008	Collar error:	0		
stress	6000	8000	10000	12000	
size	0.0119	0.0111	0.0100	0.0086	

linear fit stress = f(size)
s(0) = 27.25 kpsi   ds/dx = -1.758 kpsi/mil
collared stress
12.1

Coil#	306	Mag#DS0307A	1/4 loc	O	Date 3/2/90
Shim:	0.008	Collar error:	-0.0015		
stress	6000	8000	10000	12000	
size	0.0115	0.0106	0.0099	0.0090	

linear fit stress = f(size)
s(0) = 34.61 kpsi   ds/dx = -2.501 kpsi/mil
collared stress
13.0

Coil#	307	Mag#DS0307A	1/4 loc	O	Date 3/8/90
Shim:	0.008	Collar error:	-0.0015		
stress	6000	8000	10000	12000	
size	0.0117	0.0108	0.0100	0.0091	

linear fit stress = f(size)
s(0) = 33.31 kpsi   ds/dx = -2.387 kpsi/mil
collared stress
13.1

Collar compliance (in terms of average inner+outer coil stress)
Collar vertical offset (individual collar away from magnet center)
dx/ds = 0.56 mils/kpsi   x(0) = 2 mils

Coil average stress = f(collar deflection)
s(0) = -3.57 kpsi   ds/dx = 1.796 kpsi/mil

Average of 4 coils:
s(0) = 30.00 kpsi   ds/dx = -2.10 kpsi/mil

Collar vertical radius:
8.6 mils

Average inner stress = 10.6
Average outer stress = 13.1

Average coil stress = 11.8

ASSUMING COLLAR CAVITY IS 7 MILS OVERSIZE

```
   Coil#   104      Mag#DS0807A  1/4 loc   LI        Date 1/30/90
  Shim:    0.008  Collar error:   -0.007
stress      6000    8000   10000   12000
  size    0.0035  0.0019  0.0011  0.0002

linear fit stress = f(size)
  s(0) =   12.10 kpsi     ds/dx =  -1.817 kpsi/mil
collared stress
     3.3

   Coil#   106      Mag#DS0807A  1/4 loc   UI        Date 1/30/90
  Shim:    0.008  Collar error:   -0.007
stress      6000    8000   10000   12000
  size    0.0049  0.0041  0.0030  0.0016

linear fit stress = f(size)
  s(0) =   14.95 kpsi     ds/dx =  -1.758 kpsi/mil
collared stress
     6.4

   Coil#   306      Mag#DS0807A  1/4 loc    O        Date  3/2/90
  Shim:    0.008  Collar error:  -0.0085
stress      6000    8000   10000   12000
  size    0.0045  0.0036  0.0029  0.0020

linear fit stress = f(size)
  s(0) =   17.10 kpsi     ds/dx =  -2.501 kpsi/mil
collared stress
     5.0

   Coil#   307      Mag#DS0807A  1/4 loc    O        Date  3/3/90
  Shim:    0.008  Collar error:  -0.0085
stress      6000    8000   10000   12000
  size    0.0047  0.0038  0.0030  0.0021

linear fit stress = f(size)
  s(0) =   16.95 kpsi     ds/dx =  -2.387 kpsi/mil
collared stress
     5.6

Collar compliance (in terms of average inner+outer coil stress)
Collar vertical offset (individual collar away from magnet center)
 dx/ds =   0.56 mils/kpsi          x(0) =       2 mils

Coil average stress = f(collar deflection)
  s(0) =  -3.57 kpsi    ds/dx =  1.786 kpsi/mil

Average of 4 coils:
  s(0) =  15.28 kpsi    ds/dx =  -2.10 kpsi/mil

Collar vertical radius:
     4.8 mils

Average inner stress =        4.9
Average outer stress =        5.3

Average  coil stress =        5.1
```

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Magnet Systems Division
Business Management Group

MEMORANDUM

To: R. Briggs and T. Bush

From: R.B. Palmer

Date: March 26, 1990

Subject: MAGNET TASK FORCE, INTERIM REPORT #3

This report reflects discussion of the Task Force at its meeting on 3/21/90, held at SSCL, and other discussions.

Modification to previous recommendation

The recommendation (1) in report #1 on the od yoke (13 in.) should be modified to define the OD of the shell. The OD of the shell should be 13-3/8 in. or 340 mm.

Recommendations:

1) the ratio of copper to superconductor for the cables should be:

inner: 1.5:1 outer: 1.7:1

These choices give: short sample field, field margin, and copper current densities at 6.6 and 7.2 Tesla of:

inner:	7.26 T	10%	712 A/mm sq	782 A/mm sq
outer:	7.46 T	13%	866 A/mm sq	953 A/mm sq

The copper current densities in the outer cable are higher than some of us would like, but the observed rarity of training quench in the outer layer, in current SSC magnets, suggests that this should not be a problem.

In addition, the development of an outer cable with ratio of 2.0 :1 (which would have matched the margins in inner and outer layers) was considered to be a significant task, and not worth the possible small improvement in first quench field.

The cost savings in further raising the copper ratio (eg about 5 m$ for a change from 1.5: 1 to 1.7: 1) were not considered to be worth the loss in field margin.

Note that this field margin of 10% will probably be reduced by subsequent decisions (see, for instance, recommendation #3).

2) An intermediate temperature Beam Tube Liner should be inserted within the bore of the magnet. Cooling, at around 20 degrees. should have the potential capacity of removing at least 10 times the present design synchrotron radiation loss.

Such a liner will allow future upgrades of machine luminosity, by allowing an order of magnitude higher currents.

Such a liner will also allow operation of the magnets at lower than design temperature, this increasing either the operating field or operating margin.

If such a liner is not designed in at this time, it will be either impossible, or very expensive to retrofit it later.

A study of the design of this bore tube liner should be initiated, at once, jointly by the magnet and accelerator departments.

3) The quadrupole aperture should be raised to 5 cm.

The change will make it possible to insert, within the bore of the quadrupoles (as is now possible in the dipoles), the intermediate temperature beam tube liner.

It will reduce the contributions to field errors from the quadrupoles and make the contribution per meter, or per magnet end, approximately the same as those from the dipoles. Note that the effects on aperture, per meter, or per magnet end, will still be greater for the quadrupoles than for the dipoles, because the beta functions are at their maxima in the quads.

The change will ease the possible problems in winding the pole turns with the wide cable.

The change will make the tooling radii the same for quadrupoles and dipoles. It will also ease the design of interconnects between quadrupoles and dipoles.

4) The new quadrupole design should use the same cable as specified for the outer layer of the dipole. The iron yoke should be allowed to come relatively close to the coil, in order to maximize the gradient and match, as nearly as possible, the droop in the transfer function of the dipole. The field margin should not be less than that in the dipole inner (now 10%) at operating energy.

It is recognized that the resulting quadrupole will have a somewhat lower gradient than that of the present 4 cm design. It will, as a result, have to be somewhat longer. The dipoles will have to be a little (perhaps of the order of 1%) shorter, and will have to operate at a sightly higher field. This, in view of the current design field margin, seems reasonable.

5) A priority engineering study is needed on the vertically split yoke design. In order to specify the shell thickness, and thus yoke outside diameter, the loss of stress in the shell during cool down must be calculated. The differential coefficients of expansion and the changing yield strength of the aluminum must be tracked with temperature, and, the effects of friction between the shell and yoke must be included. It might be useful to construct and instrumented short section to observe the behavior of this design.

It is recognized that calculations on the fast track horizontal split yoke must have the highest priority, in as far as they may effect the yoke or collar specifications. But studies on that design, beyond those required for the specification, should give way to those needed for the vertically split yoke.\

6) For the moment, all 5 cm magnets should use kapton and epoxy fiberglass insulation (the standard insulation).

Nevertheless, the BNL studies of alternatives should be continued, and FNAL should try, within reason, to make their tooling capable of using them.

7) In order to allow continuing study of alternatives (all kapton insulation, aluminum bar yoke, aluminum collars etc.), and to have a real horizontally split yoke, BNL end, backup design; the BNL program should be expanded to include full length 5 cm magnets.

The FNAL program will be hard pressed to produce the required magnets for the string test, and does not have the capability to simultaneously pursue possible serious improvements.

If the alternatives are not pursued actively, and with full length magnets, it will not be possible to incorporated them without significant later delay. To try and pursue these alternatives only in industry, or at SSCL, will be too late, and will lack the BNL experience.

If problems should arise in the FNAL magnets, due to any of the changes that they are introducing, a serious delay will be introduced unless we have a real, and tested, backup. For FNAL not to adopt these changes, because there is no backup, would mean accepting serious compromises.

We need, and will continue to need, all the expertise we can get. The BNL group has built all the currently tested full length 4 cm coils and associated yokes. They have their 5 cm work to short magnets will greatly reduce their overall involvement and commitment, and limit our access to their expertise.

Recommended Studies

1) Study of the aluminum collar, aluminum bar, vertically split iron yoke, should continue with relatively high priority. This is a very attractive possibility, but will have to be rapidly developed if it is to be available for use in time. The magnetic design of the yoke is being studied at BNL. If a reasonable solution is found, then a stress analysis should be done as soon as possible. This has less priority than that needed for the BNL or FNAL track specifications, but a higher priority than analysis of those designs, after they are specified.

2)Studies (already in progress at BNL and LBL) of alternative methods of correcting the saturation sextupole (with holes, shims, elliptical or other yoke shapes should also continue).

3) Study of the fishbone an and quench venting problem should continue, but this does not now seem to be a high priority question.

4) Studies should also continue of alternative coil arrangements to lower peak fields, simplify construction, and have wedge in the inner layer opposite the pole shim of the outer layer. But these too can continue with relatively low priority. They can be incorporated with little perturbation at a later time.

Subjects For Next Task Force :

slip planes, teflon and shoes.

End questions: iron, clamping, splice, spacers, interconnects etc.

Review of ongoing studies

Future Meetings:

April 10, 1990	at SSCL	10:00 am to 6:00 pm	Building 1, Suite 285
May 3, 1990	at LBL	9:00 am to 4:00 pm	
May 9-10, 1990	at SSCL		

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