Choosing Collaring "Shims" for DS0309

J. Strait
3/29/90

DS0307 and DS0308 preloads are substantially lower than predicted from the measured coil sizes, the measured collar dimensions and the elastic properties of the coils and collars. The current speculation is that this is because the effective collar cavity size is larger than expected either because of collar dimension errors or because the kapton ground insulation is flowing into the die break of the collars. This is suggested by the large sextupole moment in DS0308. (See e-mail 3/28/90 "DS0307 and DS0308 preloads explained?") To explain both the observed preloads and the observed sextupole require that the collar cavity be too large by 7 mils per quadrant in both the inner and outer coils. (This is in addition to the 1.5 mils that the outer coil cavity is oversize according to Cordax measurements.) Additional kapton must be added to the ground insulation to take up the extra space.

To achieve the desired prestress (10 kpsi) the coils must be 7.4 mils larger than the design size at 10 kpsi. (This is the amount by which the collars deflect under a load of 10 kpsi.) If the coils are smaller than this and additional amount of kapton must be added to build the coils up to the desired dimension. The amount of kapton is based on the average size of the series of coils cured under identical conditions. The inner coils for DS0309 (#108 and #109) were cured with the nominal cavity size. I had data from 6 coils cured under these conditions: 104 - 109. At 10 kpsi the average size of these coils ranges between +2.7 mils and + 7.0 mils with an average of +4.3 mils. Thus 3 mils of kapton is required to bring the coil package to the desired size. The outer coils were wound with the mold cavity increased by 8 mils from its nominal size. I hade data from 3 coils molded under these conditions: 308 - 310. At 10 kpsi the average size of these coils ranges from +7.0 to +7.8 mils with an average of +7.5 mils. Thus no additional kapton is required for these coils.

The total azimuthal kapton "shim" amount is 7 + 3 = 10 mils for the inner coil and 7 + 1.5 + 0 = 8.5 mils for the outer. The outer coil shim was rounded down to 8 mils because this will tend to increase the inner coil stress at the expense of a small loss of outer coil stress.

Attached are

1) A table of the average coil sizes on which this calculation was based,

2) The spread sheet used to calculate the expected DS0309 coil prestress and collar deflection using the specified shims and collar dimensions,

3) A graph of the expected prestress and collar deflection as a function of position along the coil, and

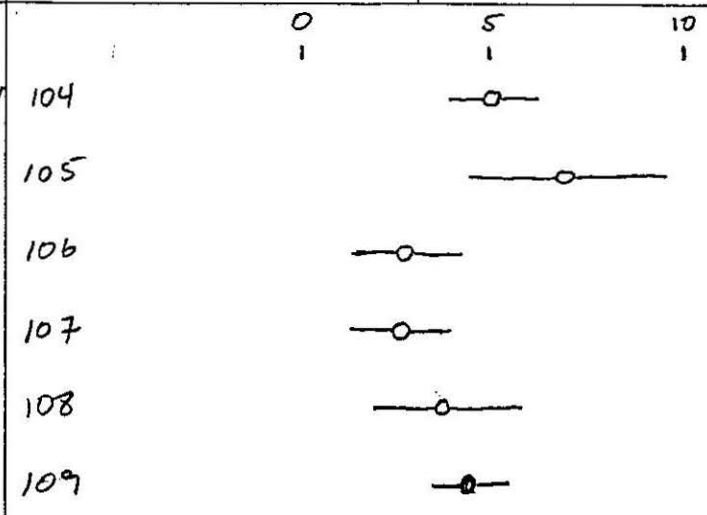
4) A copy of the memo instructing Imre Gonczy of the chosen shim thicknesses.

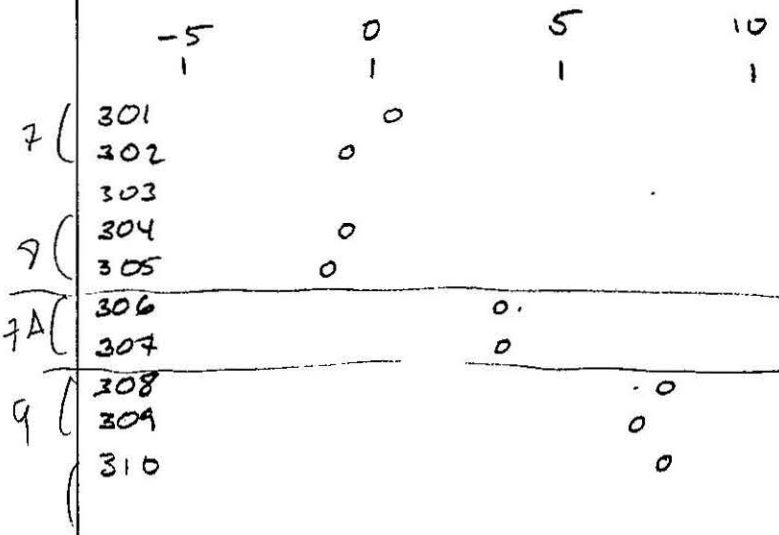
INNER

COIL #	MAGNET	@ 10 kpsi <SIZE>	σ	Range	12 kpsi <SIZE>	σ	Range
108	DS0309	+3.9	1.4	4.1	2.9	1.2	5.0
109	DS0309	4.4	0.8	1.8	3.1	1.2	4.5
104	DS0307(A)	5.1	0.7	2.2	4.0	0.9	3.7
105	DS0307(A)	7.0	2.2	5.3	5.3	2.0	7.3
106	DS0308	2.8	1.1	3.2	1.7	1.1	4.2
107	DS0308	2.7	1.2	3.0	1.5	1.5	5.7
		4.3±0.7					

OUTER

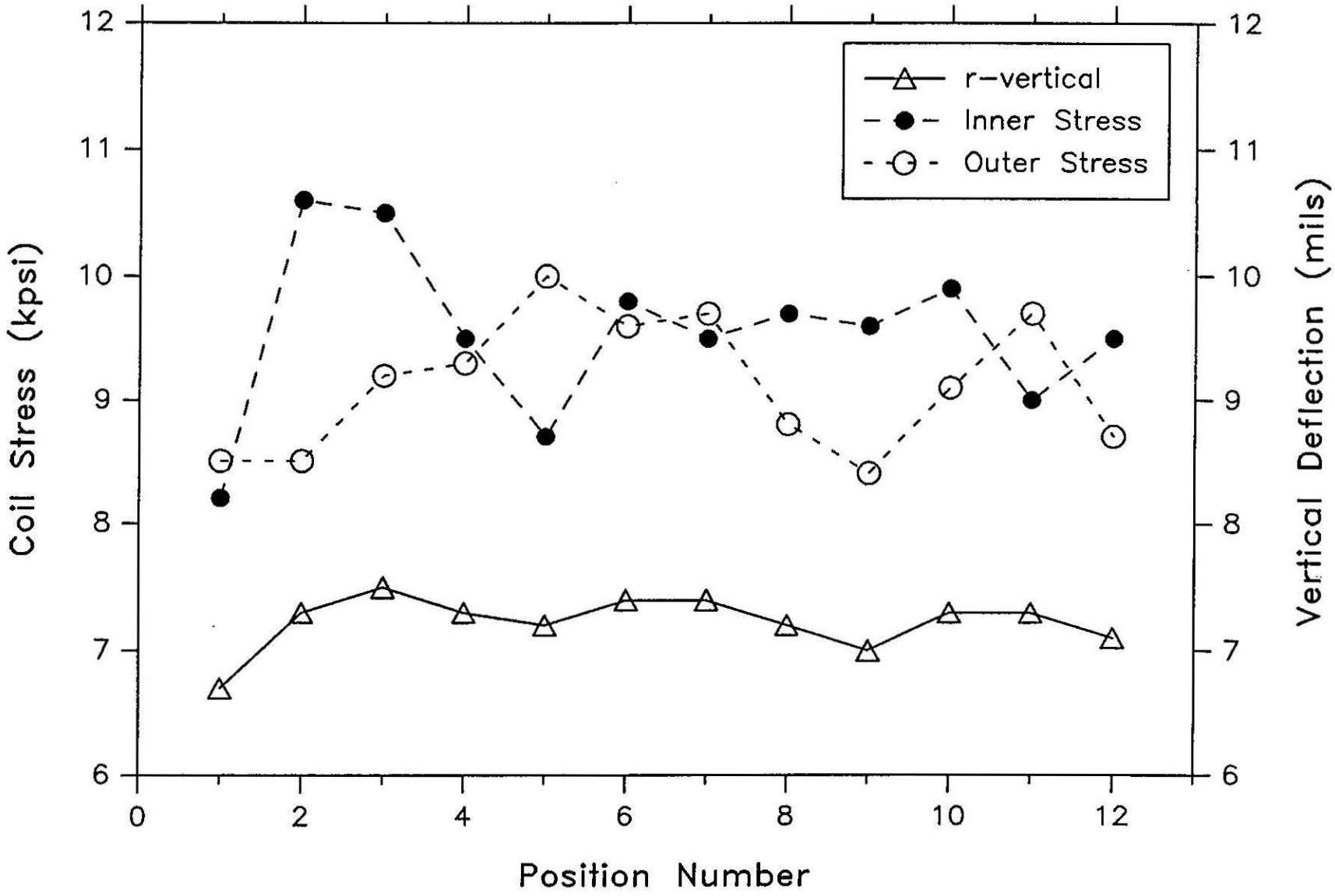
COIL #	Magnet	10 kpsi <SIZE>	σ	range	12 kpsi <size>	σ	range
308	DS0309	7.8	0.7	2.1	6.6	0.7	2.4
309	DS0309	+7.0 (7.5)	0.8	2.1	5.9	0.9	3.6
310	DS0310	7.7	0.9	2.6	6.7	0.5	2.5
301	DS0307	0.5	1.3	3.5	-1.7	1.3	5.0
302	DS0307	-0.7	1.6	3.9	-1.0	1.2	4.1
304	DS0308	-0.7	1.4	3.6	-1.5	1.3	4.2
305	DS0308	-1.1	1.0	3.4			
306	DS0307A	3.4	0.9	2.4	2.5	0.8	2.8
307	DS0307A	3.5	1.0	2.2	2.6	0.9	3.4





new reel of cable

mold cavity increased by 8 mils


DS0309 Prestress and Collar Deflections
Predicted from Coil Size Measurements
r-vertical
Inner Stress
Outer Stress
Coil Stress (kpsi)
Vertical Deflection (mils)
Position Number
12
11
10
9
8
7
6
0
2
4
6
8
10
12

Coil# 108 Mag# [redacted] 1/4 loc Inner Date 2/3/90

Pos #	8000 coil	8000 master	9000 coil	9000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0181	0.0151
2 up	0.0272	0.0192	0.0249	0.0180	0.0225	0.0166	0.0198	0.0151
2 dn	0.0246	0.0185	0.0228	0.0173	0.0212	0.0163	0.0198	0.0151
3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0205	0.0151
4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0198	0.0151
5 up	0.0266	0.0192	0.0242	0.0180	0.0220	0.0166	0.0198	0.0151
5 dn	0.0241	0.0185	0.0222	0.0175	0.0207	0.0164	0.0198	0.0151
6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0192	0.0151
7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0184	0.0151
8 up	0.0255	0.0192	0.0231	0.0180	0.0207	0.0166	0.0182	0.0151
8 dn	0.0230	0.0185	0.0206	0.0175	0.0195	0.0164	0.0182	0.0151
9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0179	0.0151
10	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0186	0.0151
11 up	0.0259	0.0192	0.0236	0.0180	0.0211	0.0166	0.0189	0.0151
11 dn	0.0238	0.0185	0.0215	0.0175	0.0200	0.0164	0.0189	0.0151
12	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0184	0.0151
13	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0171	0.0151
14 up	0.0236	0.0192	0.0214	0.0180	0.0192	0.0166	0.0169	0.0151
14 dn	0.0213	0.0185	0.0196	0.0175	0.0181	0.0164	0.0169	0.0151
15	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0177	0.0151
16	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0178	0.0151
17 up	0.0243	0.0192	0.0216	0.0180	0.0195	0.0166	0.0172	0.0151
17 dn	0.0216	0.0185	0.0198	0.0175	0.0184	0.0164	0.0172	0.0151
18	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0175	0.0151
19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0176	0.0151
20 up	0.0226	0.0192	0.0207	0.0180	0.0184	0.0166	0.0161	0.0151
20 dn	0.0210	0.0185	0.0190	0.0175	0.0176	0.0164	0.0161	0.0151
21	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0170	0.0151
22	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0173	0.0151
23 up	0.0250	0.0192	0.0226	0.0180	0.0202	0.0166	0.0177	0.0151
23 dn	0.0225	0.0185	0.0206	0.0175	0.0190	0.0164	0.0177	0.0151
24	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0155	0.0151

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	rv (collar)	str	avg str (inner)
1				0.0080	24.17	6.7	10.6	8.2
2 up	0.0080	0.0069	0.0059	0.0047	27.52	7.8	12.8	10.6
2 dn	0.0061	0.0055	0.0049	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
3				0.0054	29.04	7.5	13.9	10.5
4				0.0042	26.60	7.8	11.9	9.5
5 up	0.0074	0.0062	0.0054	0.0042	26.60	7.2	11.9	8.7
5 dn	0.0056	0.0047	0.0048	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
6				0.0041	26.40	7.4	11.8	9.8
7				0.0033	24.78	7.4	9.9	9.5
8 up	0.0053	0.0051	0.0041	0.0031	24.37	7.2	9.8	9.7
8 dn	0.0045	0.0031	0.0031	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
9				0.0028	23.76	7.0	9.5	9.6
10				0.0035	25.18	7.3	10.3	9.9
11 up	0.0067	0.0056	0.0045	0.0038	25.79	7.3	11.1	9.0
11 dn	0.0049	0.0040	0.0036	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
12				0.0033	24.78	7.1	10.4	9.5
13				0.0020	22.14		7.7	
14 up	0.0044	0.0034	0.0026	0.0018	21.74		7.0	
14 dn	0.0028	0.0021	0.0017	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX			
15				0.0026	23.36		9.5	
16				0.0027	23.56		9.3	
17 up	0.0051	0.0036	0.0029	0.0021	22.34		7.8	
17 dn	0.0031	0.0023	0.0020	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX			
18				0.0024	22.95		8.0	
19				0.0025	23.15		8.1	
20 up	0.0034	0.0027	0.0018	0.0010	20.11		5.4	
20 dn	0.0025	0.0015	0.0012	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX			
21				0.0019	21.94		7.2	
22				0.0022	22.55		7.3	
23 up	0.0058	0.0046	0.0036	0.0026	23.36		9.5	
23 dn	0.0040	0.0031	0.0026	XXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX			
24				0.0004	18.90		5.4	

UP:				
⟨ 2-11⟩	0.0071	0.0060	0.0050	0.0040
sig	0.0008	0.0008	0.0008	0.0007
range	0.0017	0.0018	0.0018	0.0016
⟨14-23⟩	0.0047	0.0036	0.0027	0.0019
sig	0.0010	0.0008	0.0007	0.0007
range	0.0024	0.0019	0.0018	0.0016
⟨ 2-23⟩	0.0059	0.0048	0.0039	0.0029
sig	0.0015	0.0015	0.0014	0.0013
range	0.0045	0.0042	0.0041	0.0037
DOWN:				
⟨ 2-11⟩	0.0058	0.0048	0.0040	
sig	0.0007	0.0010	0.0008	
range	0.0018	0.0024	0.0018	
⟨14-23⟩	0.0031	0.0023	0.0019	
sig	0.0006	0.0007	0.0006	
	0.0015	0.0016	0.0014	
⟨ 2-23⟩	0.0042	0.0033	0.0029	
sig	0.0013	0.0014	0.0013	
range	0.0036	0.0040	0.0037	

	ALL
⟨1-24⟩	0.0029
sig	0.0012
range	0.0060

Coil# 109 Mag# DS0309 1/4 loc INNER Date 2/8/90

Pos #	8000 coil	8000 master	9000 coil	9000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0177	0.0151
2 up	0.0268	0.0192	0.0245	0.0180	0.0220	0.0166	0.0195	0.0151
2 dn	0.0241	0.0184	0.0225	0.0173	0.0210	0.0162	0.0195	0.0151
3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0205	0.0151
4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0189	0.0151
5 up	0.0251	0.0192	0.0227	0.0180	0.0205	0.0166	0.0180	0.0151
5 dn	0.0226	0.0184	0.0210	0.0173	0.0194	0.0162	0.0180	0.0151
6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0177	0.0151
7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0172	0.0151
8 up	0.0245	0.0189	0.0222	0.0178	0.0200	0.0164	0.0178	0.0149
8 dn	0.0219	0.0183	0.0202	0.0171	0.0185	0.0161	0.0178	0.0149
9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0159	0.0150
10	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0182	0.0150
11 up	0.0239	0.0191	0.0220	0.0177	0.0202	0.0168	0.0179	0.0150
11 dn	0.0225	0.0182	0.0208	0.0171	0.0193	0.0161	0.0179	0.0150
12	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0185	0.0150
13	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0176	0.0151
14 up	0.0245	0.0191	0.0224	0.0177	0.0202	0.0168	0.0176	0.0151
14 dn	0.0222	0.0182	0.0204	0.0171	0.0190	0.0161	0.0176	0.0151
15	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0188	0.0151
16	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0201	0.0151
17 up	0.0272	0.0191	0.0246	0.0177	0.0222	0.0168	0.0197	0.0151
17 dn	0.0245	0.0182	0.0226	0.0171	0.0210	0.0161	0.0197	0.0151
18	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0197	0.0151
19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0192	0.0151
20 up	0.0250	0.0191	0.0225	0.0177	0.0202	0.0168	0.0172	0.0150
20 dn	0.0224	0.0182	0.0207	0.0171	0.0191	0.0161	0.0172	0.0150
21	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0171	0.0150
22	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0170	0.0150
23 up	0.0252	0.0191	0.0230	0.0177	0.0207	0.0168	0.0177	0.0150
23 dn	0.0225	0.0182	0.0208	0.0171	0.0193	0.0161	0.0177	0.0150
24	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						0.0151	0.0150

Pos #	8000 coil-master	9000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str
1				0.0026	22.93	9.9
2 up	0.0076	0.0065	0.0054	0.0044	26.45	12.1
2 dn	0.0067	0.0052	0.0048	XXXXXXXX	XXXXXXXX	XXXXXXXX
3				0.0054	28.40	18.7
4				0.0038	25.28	11.1
5 up	0.0069	0.0047	0.0039	0.0029	23.52	9.4
5 dn	0.0042	0.0037	0.0032	XXXXXXXX	XXXXXXXX	XXXXXXXX
6				0.0026	22.93	8.4
7				0.0021	21.96	7.6
8 up	0.0056	0.0046	0.0036	0.0024	22.54	8.5
8 dn	0.0086	0.0081	0.0024	XXXXXXXX	XXXXXXXX	XXXXXXXX
9				0.0009	19.61	5.9
10				0.0032	24.10	9.8
11 up	0.0048	0.0048	0.0039	0.0029	23.52	9.4
11 dn	0.0048	0.0037	0.0032	XXXXXXXX	XXXXXXXX	XXXXXXXX
12				0.0035	24.69	10.8
13				0.0025	22.74	8.9
14 up	0.0054	0.0047	0.0039	0.0025	22.74	8.6
14 dn	0.0040	0.0033	0.0029	XXXXXXXX	XXXXXXXX	XXXXXXXX
15				0.0037	25.08	10.8
16				0.0060	27.62	18.9
17 up	0.0081	0.0069	0.0059	0.0046	26.84	12.8
17 dn	0.0068	0.0055	0.0049	XXXXXXXX	XXXXXXXX	XXXXXXXX
18				0.0046	26.84	12.4
19				0.0041	25.96	11.3
20 up	0.0059	0.0048	0.0039	0.0022	22.15	8.0
20 dn	0.0042	0.0036	0.0030	XXXXXXXX	XXXXXXXX	XXXXXXXX
21				0.0021	21.96	7.8
22				0.0020	21.76	7.1
23 up	0.0061	0.0053	0.0044	0.0027	23.18	8.8
23 dn	0.0043	0.0037	0.0032	XXXXXXXX	XXXXXXXX	XXXXXXXX
24				0.0011	20.00	7.0

UP:				
⟨ 2-11⟩	0.0060	0.0050	0.0042	0.0082
sig	0.0012	0.0010	0.0008	0.0009
range	0.0028	0.0022	0.0018	0.0020
⟨14-23⟩	0.0064	0.0054	0.0045	0.0080
sig	0.0012	0.0010	0.0009	0.0011
range	0.0027	0.0022	0.0020	0.0024
⟨ 2-23⟩	0.0062	0.0052	0.0044	0.0081
sig	0.0011	0.0010	0.0008	0.0009
range	0.0028	0.0022	0.0018	0.0022
DOWN:				
⟨ 2-11⟩	0.0045	0.0039	0.0084	
sig	0.0009	0.0009	0.0010	
range	0.0021	0.0021	0.0024	
⟨14-23⟩	0.0047	0.0040	0.0035	
sig	0.0011	0.0010	0.0009	
	0.0028	0.0022	0.0020	
⟨ 2-23⟩	0.0046	0.0040	0.0085	
sig	0.0009	0.0009	0.0009	
range	0.0021	0.0021	0.0024	

	ALL
⟨1-24⟩	0.0081
sig	0.0012
range	0.0045

Coil# 309 Mag# DS0309 1/4 loc OUTER Date 3-16-90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXX						1.0030	0.9975
2 up	1.0092	1.0000	1.0071	0.9992	1.0053	0.9985	1.0033	0.9975
2 dn	1.0071	0.9970	1.0054	0.9989	1.0042	0.9983	1.0033	0.9975
3	XXXXXXXX						1.0034	0.9975
4	XXXXXXXX						1.0030	0.9975
5 up	1.0108	1.0000	1.0082	0.9920	1.0065	0.9985	1.0046	0.9975
5 dn	1.0081	0.9997	1.0065	0.9989	1.0054	0.9983	1.0046	0.9975
6	XXXXXXXX						1.0047	0.9975
7	XXXXXXXX						1.0036	0.9975
8 up	1.0091	1.0000	1.0071	0.9991	1.0055	0.9984	1.0037	0.9975
8 dn	1.0071	0.9996	1.0055	0.9988	1.0045	0.9982	1.0037	0.9975
9	XXXXXXXX						1.0045	0.9975
10	XXXXXXXX						1.0050	0.9975
11 up	1.0103	1.0000	1.0083	0.9991	1.0067	0.9984	1.0048	0.9975
11 dn	1.0082	0.9996	1.0066	0.9988	1.0055	0.9982	1.0048	0.9975
12	XXXXXXXX						1.0039	0.9975
13	XXXXXXXX						1.0021	0.9975
14 up	1.0086	1.0000	1.0066	0.9991	1.0047	0.9984	1.0029	0.9975
14 dn	1.0065	0.9996	1.0048	0.9988	1.0037	0.9982	1.0029	0.9975
15	XXXXXXXX						1.0028	0.9975
16	XXXXXXXX						1.0014	0.9975
17 up	1.0085	1.0000	1.0065	0.9991	1.0046	0.9984	1.0029	0.9975
17 dn	1.0065	0.9996	1.0048	0.9988	1.0037	0.9982	1.0029	0.9975
18	XXXXXXXX						1.0036	0.9975
19	XXXXXXXX						1.0035	0.9975
20 up	1.0086	1.0000	1.0071	0.9991	1.0054	0.9984	1.0035	0.9975
20 dn	1.0072	0.9996	1.0057	0.9988	1.0044	0.9982	1.0035	0.9975
21	XXXXXXXX						1.0033	0.9975
22	XXXXXXXX						1.0038	0.9975
23 up	1.0085	1.0000	1.0067	0.9991	1.0049	0.9984	1.0029	0.9975
23 dn	1.0067	0.9996	1.0050	0.9988	1.0038	0.9982	1.0029	0.9975
24	XXXXXXXX						1.0024	0.9975

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str	avg str (outer)
1				0.0055	20.26	9.2	8.5
2 up	0.0092	0.0079	0.0068	0.0058	20.75	8.7	8.5
2 dn	0.0101	0.0065	0.0059	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
3				0.0059	20.92	8.5	9.2
4				0.0055	20.26	8.3	9.3
5 up	0.0108	0.0162	0.0080	0.0071	22.90	10.9	10.0
5 dn	0.0084	0.0076	0.0071	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
6				0.0072	23.06	10.8	9.6
7				0.0061	21.25	9.1	9.7
8 up	0.0091	0.0080	0.0071	0.0062	21.41	9.6	8.8
8 dn	0.0075	0.0067	0.0063	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
9				0.0070	22.73	11.1	8.4
10				0.0075	23.56	11.5	9.1
11 up	0.0103	0.0092	0.0083	0.0073	23.28	11.3	9.7
11 dn	0.0086	0.0078	0.0073	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
12				0.0064	21.74	10.0	8.7
13				0.0046	18.77	7.1	
14 up	0.0086	0.0075	0.0063	0.0054	20.09	8.1	
14 dn	0.0069	0.0060	0.0055	XXXXXXX	XXXXXXX	XXXXXXX	
15				0.0053	19.92	7.8	
16				0.0039	17.61	6.0	
17 up	0.0085	0.0074	0.0062	0.0054	20.09	8.2	
17 dn	0.0069	0.0060	0.0055	XXXXXXX	XXXXXXX	XXXXXXX	
18				0.0061	21.25	9.1	
19				0.0060	21.08	8.8	
20 up	0.0086	0.0080	0.0070	0.0060	21.08	9.1	
20 dn	0.0076	0.0069	0.0062	XXXXXXX	XXXXXXX	XXXXXXX	
21				0.0058	20.75	8.8	
22				0.0063	21.58	9.2	
23 up	0.0085	0.0076	0.0065	0.0054	20.09	8.0	
23 dn	0.0071	0.0062	0.0056	XXXXXXX	XXXXXXX	XXXXXXX	
24				0.0049	19.26	8.3	

	6000	8000	10000	12000
UP:				
< 2-11>	0.0097	0.0103	0.0076	0.0066
sig	0.0007	0.0040	0.0007	0.0007
range	0.0012	0.0083	0.0015	0.0015
<14-23>	0.0086	0.0076	0.0065	0.0056
sig	0.0001	0.0003	0.0004	0.0003
range	0.0001	0.0006	0.0008	0.0006
< 2-23>	0.0091	0.0090	0.0070	0.0061
sig	0.0008	0.0030	0.0008	0.0008
range	0.0018	0.0088	0.0021	0.0019
DOWN:				
< 2-11>	0.0087	0.0072	0.0067	
sig	0.0011	0.0006	0.0007	
range	0.0026	0.0013	0.0014	
<14-23>	0.0071	0.0063	0.0057	
sig	0.0003	0.0004	0.0003	
	0.0007	0.0009	0.0007	
< 2-23>	0.0079	0.0067	0.0062	
sig	0.0011	0.0007	0.0007	
range	0.0032	0.0018	0.0018	

	ALL
<1-24>	0.0059
sig	0.0009
range	0.0036

Coil# 308 Mag# DS0309 1/4 loc OUTER Date 8-18-90

Pos #	6000 coil	6000 master	8000 coil	8000 master	10000 coil	10000 master	12000 coil	12000 master
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0038	0.9975
2 up	1.0105	1.0000	1.0088	0.9991	1.0066	0.9984	1.0045	0.9974
2 dn	1.0081	0.9995	1.0066	0.9988	1.0053	0.9981	1.0045	0.9974
3	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0043	0.9974
4	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0043	0.9974
5 up	1.0100	1.0000	1.0079	0.9991	1.0062	0.9984	1.0042	0.9974
5 dn	1.0080	0.9995	1.0064	0.9988	1.0052	0.9981	1.0042	0.9974
6	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0043	0.9974
7	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0044	0.9974
8 up	1.0090	1.0000	1.0070	0.9991	1.0051	0.9984	1.0033	0.9974
8 dn	1.0071	0.9995	1.0056	0.9988	1.0043	0.9981	1.0033	0.9974
9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0032	0.9974
10	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0043	0.9974
11 up	1.0011	1.0000	1.0088	0.9991	1.0071	0.9983	1.0051	0.9975
11 dn	1.0089	0.9997	1.0072	0.9989	1.0060	0.9982	1.0051	0.9975
12	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0050	0.9975
13	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0027	0.9975
14 up	1.0096	1.0000	1.0074	0.9991	1.0057	0.9983	1.0038	0.9975
14 dn	1.0074	0.9997	1.0057	0.9989	1.0046	0.9982	1.0036	0.9975
15	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0034	0.9975
16	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0037	0.9975
17 up	1.0100	1.0000	1.0079	0.9991	1.0061	0.9983	1.0042	0.9975
17 dn	1.0077	0.9997	1.0062	0.9989	1.0050	0.9982	1.0042	0.9975
18	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0049	0.9975
19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0044	0.9975
20 up	1.0106	1.0000	1.0088	0.9991	1.0067	0.9983	1.0046	0.9975
20 dn	1.0084	0.9997	1.0067	0.9989	1.0055	0.9982	1.0046	0.9975
21	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0045	0.9975
22	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0047	0.9975
23 up	1.0090	1.0000	1.0070	0.9991	1.0052	0.9983	1.0033	0.9975
23 dn	1.0069	0.9997	1.0052	0.9989	1.0040	0.9982	1.0035	0.9975
24	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX						1.0029	0.9975

Pos #	6000 coil-master	8000 coil-master	10000 coil-master	12000 coil-master	S(X=0)	str
1				0.0068	24.94	8.7
2 up	0.0105	0.0092	0.0082	0.0071	28.12	10.2
2 dn	0.0086	0.0078	0.0072	XXXXXXXX	XXXXXXXX	XXXXXXXX
3				0.0069	27.68	9.8
4				0.0069	27.63	9.9
5 up	0.0100	0.0088	0.0078	0.0068	27.39	9.7
5 dn	0.0085	0.0076	0.0071	XXXXXXXX	XXXXXXXX	XXXXXXXX
6				0.0069	27.63	9.5
7				0.0070	27.87	9.9
8 up	0.0090	0.0079	0.0067	0.0059	25.19	7.7
8 dn	0.0078	0.0068	0.0062	XXXXXXXX	XXXXXXXX	XXXXXXXX
9				0.0058	24.94	7.7
10				0.0069	27.63	9.8
11 up	0.0011	0.0097	0.0086	0.0076	29.84	11.6
11 dn	0.0092	0.0083	0.0078	XXXXXXXX	XXXXXXXX	XXXXXXXX
12				0.0075	29.10	11.8
13				0.0062	28.48	6.1
14 up	0.0096	0.0088	0.0074	0.0061	25.68	8.0
14 dn	0.0077	0.0068	0.0064	XXXXXXXX	XXXXXXXX	XXXXXXXX
15				0.0059	25.19	7.8
16				0.0062	25.92	8.7
17 up	0.0100	0.0088	0.0078	0.0067	27.14	9.6
17 dn	0.0080	0.0073	0.0068	XXXXXXXX	XXXXXXXX	XXXXXXXX
18				0.0074	28.85	10.9
19				0.0069	27.63	9.5
20 up	0.0106	0.0092	0.0084	0.0071	28.12	10.4
20 dn	0.0087	0.0078	0.0073	XXXXXXXX	XXXXXXXX	XXXXXXXX
21				0.0070	27.87	10.2
22				0.0072	28.86	10.0
23 up	0.0090	0.0079	0.0069	0.0058	24.94	7.0
23 dn	0.0072	0.0068	0.0068	XXXXXXXX	XXXXXXXX	XXXXXXXX
24				0.0054	28.97	7.7
UP:					26.8565	9.20967
⟨ 2-11⟩	0.0077	0.0089	0.0079	0.0069		
sig	0.0044	0.0008	0.0009	0.0007		
range	0.0094	0.0018	0.0021	0.0017		
⟨14-23⟩	0.0098	0.0086	0.0076	0.0064		
sig	0.0007	0.0006	0.0006	0.0006		
range	0.0015	0.0013	0.0015	0.0013		
⟨ 2-23⟩	0.0087	0.0087	0.0078	0.0066		
sig	0.0031	0.0006	0.0007	0.0006		
range	0.0094	0.0018	0.0021	0.0018		
DOWN:						
⟨ 2-11⟩	0.0085	0.0076	0.0071			
sig	0.0007	0.0006	0.0007			
range	0.0015	0.0015	0.0015			
⟨14-23⟩	0.0079	0.0071	0.0066			
sig	0.0006	0.0006	0.0006			
	0.0015	0.0015	0.0015			
⟨ 2-23⟩	0.0082	0.0078	0.0068			
sig	0.0007	0.0007	0.0007			
range	0.0020	0.0020	0.0020			

	ALL
⟨1-24⟩	0.0066
sig	0.0007
range	0.0024

```
   Coil#   108      Mag#  DS0809 1/4 loc  Inner     Date  2/3/90
  Shim:    0.010  Collar error:   -0.007
stress      6000    8000   10000   12000
  size    0.0089  0.0078  0.0069  0.0059

linear fit stress = f(size)
  s(0) =   23.91 kpsi    ds/dx =  -2.028 kpsi/mil
collared stress
     9.2

   Coil#   109      Mag#  DS0809 1/4 loc  INNER     Date  2/8/90
  Shim:    0.010  Collar error:   -0.007
stress      6000    8000   10000   12000
  size    0.0092  0.0082  0.0074  0.0061

linear fit stress = f(size)
  s(0) =   24.05 kpsi    ds/dx =  -1.952 kpsi/mil
collared stress
     9.9

   Coil#   809      Mag#  DS0809 1/4 loc  OUTER     Date 8-16-90
  Shim:    0.008  Collar error:  -0.0065
stress      6000    8000   10000   12000
  size    0.0086  0.0085  0.0065  0.0056

linear fit stress = f(size)
  s(0) =   21.06 kpsi    ds/dx =  -1.651 kpsi/mil
collared stress
     9.1

   Coil#   808      Mag# DS0809  1/4 loc  OUTER     Date 8-18-90
  Shim:    0.008  Collar error:  -0.0065
stress      6000    8000   10000   12000
  size    0.0092  0.0082  0.0078  0.0061

linear fit stress = f(size)
  s(0) =   27.22 kpsi    ds/dx =  -2.442 kpsi/mil
collared stress
     9.5

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) =   24.06 kpsi    ds/dx =   -2.02 kpsi/mil

Collar vertical radius:
     7.8 mils

Average inner stress =       9.5
Average outer stress =       9.3

Average  coil stress =       9.4
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Fermilab

3/29/90

To: Imre Gonczy
From: Jim Strait
Subject: DS0309 Collaring Shims

In addition to the normal ground insulation 10 mils of Kapton should be added to the pole faces of the inner coil and 8 mils to the outer coil. This Kapton should be extended as far into the end as possible. The Kapton will consist of two layers whose ends should be staggered by about 1/2".

cc: Rodger Bossert
John Carson
Wayne Koska