**Fermilab**

May 11, 1990

MEMO TO: Rodger Bossert, John Carson, Wayne Koska, Paul Mantsch,
Gale Pewitt

FROM: Jim Strait

SUBJECT: DS0309 Yoking

DS0309 was yoked and skinned twice. On the first attempt the yokes "chevroned" in the press when the second pass weld was about 90% complete. The skin was cut off, and the magnet was reassembled with new yoke packs and the original skin. The second yoking was successful. In this note I summarize the yoke chevroning incident and the modification in procedures for the second attempt, and display and discuss the collar pack strain gage data.

That the yoke laminations are unstable against chevroning (a column buckling type instability) when compressed in the yoking press and by the skin tension is obvious and was demonstrated during test assemblies of DSS012. In the base line design the end yoke blocks are epoxy bonded to stabilize them against chevroning. On the first assembly of DS0309 the end blocks were stabilized by several fusion welds on the outer circumference. This clearly proved inadequate. Epoxy bonded end blocks were used on the second attempt.

At the time the yokes chevroned, the press hydraulic pressure was set at 7000 psi (14000 lb/in or about 50% greater than the clamping force due to skin tension at room temperature). The press pump was valved off and the hydraulic system was closed off. When the yoke chevroned the hydraulic pressure dropped by about 1000 psi. Before completing the weld the press pressure was restored to 7000 psi. From the elastic properties of the press tie rods it was estimated that a 1000 psi pressure loss corresponds to the tie rods shortening by about 10 mils, meaning the press vertical opening decreased by this amount also. This corresponds to a longitudinal motion of the yoke mid-plane relative to the pole of about 200 mils. This was verified by rough measurements. Because the end clamp radius is about one half that of the yoke, if the yoke were tightly packed, the end clamps would be forced apart by about 100 mils. When the yoke was removed it was found that at the lead end there was a gap between the end clamp and the end of the collars that varied from roughly 1/32" on one side to 3/32" on the other side. There is no evidence of a gap between the coil end saddles and the face plate of the end clamp, indicating that most of the motion was the coil being stretched relative to the collars.

The collar pack strain gage data are summarized in Figure 1 and Table I. In the first assembly data were recorded before pressing, at full press load before welding, after the first pass weld, after the second pass weld (after the chevroning incident and the press load was restored to its full value) and after the press load was removed. Data were also recorded after the skin was cut and the old yoke blocks were removed. On the second assembly data were recorded at the same points except none were taken between the two weld passes. As discussed in an earlier note [1] the stress-strain calibrations for these gages are considered to be reliable; a generic calibration of 5.7 psi/ $\mu\epsilon$ was used.

It is not understood why the coil stress increase under press load is larger in the second assembly than in the first even though a smaller press pressure (5000 psi vs 7000 psi) was used. In the first assembly coil stress decreased by about 500 psi following the yoke chevroning. This presumably results from the decreased skin tension due to the decreased yoke circumference. On the second assembly there is a net increase of 2.0 and 1.1 kpsi in the inner and outer coil stress due to clamping by the skin.

Between collaring and the first yoking attempt and between the two yoke assemblies are two periods in which short term creep can be observed. The creep rates are summarized in Table II.

[1] "Preliminary Analysis of DS0309 Collaring Data" - April 9, 1990, (TS-SSC 90-008)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3													
4						GAGENO.	Gage Factor	RO(Ohms)		A0	A1	A2	A3
5						70	2.02	350.242		0.0	5.70000	0.0	0.0
6						53	2.02	349.941		0.0	5.70000	0.0	0.0
7						249	2.02	350.099					
8						87	2.02	350.627		0.0	5.70000	0.0	0.0
9						88	2.02	350.351		0.0	5.70000	0.0	0.0
10						244	2.02	349.948					
11						71	2.02	350.423		0.0	5.70000	0.0	0.0
12						76	2.02	350.212		0.0	5.70000	0.0	0.0
13						248	2.02	350.135					
14						266	2.02	350.394					
15						263	2.02	350.489					
16						262	2.02	350.412					
17						68	2.02	350.030		0.0	5.70000	0.0	0.0
18						77	2.02	350.408		0.0	5.70000	0.0	0.0
19													
20													
21	Seq. No.		Date										
22				Press	Hydraulic Pressure			Average Coil Stress				d(Stress)/dPv	
23	1		4/4/90	Bench	Vertical Horizontal			Inner Outer All		Inner	Outer	All	
24	2		4/5/90	Collaring	0 0			-216 -11 -113					
25	3		4/5/90	Collaring	0 0			-227 0 -114					
26	4		4/5/90	Collaring	400 0			150 552 351	0.94	1.38	1.16		
27	5		4/5/90	Collaring	1000 0			606 1563 1085	0.76	1.69	1.22		
28	6		4/5/90	Collaring	2000 0			1366 3440 2403	0.76	1.88	1.32		
29	7		4/5/90	Collaring	3000 0			2070 5122 3596	0.70	1.68	1.19		
30	8		4/5/90	Collaring	4000 0			2897 6557 4727	0.83	1.44	1.13		
31	9		4/5/90	Collaring	5000 0			3438 7972 5705	0.54	1.42	0.98		
32	10		4/5/90	Collaring	6000 0			4218 9052 6635	0.78	1.08	0.93		
33	11		4/5/90	Collaring	7000 0			5018 10420 7719	0.80	1.37	1.08		
34	12		4/5/90	Collaring	8000 0			5812 11421 8617	0.79	1.00	0.90		
35	13		4/5/90	Collaring	9000 0			6472 12332 9402	0.66	0.91	0.79		
36	14		4/5/90	Collaring	9000 1000			6661 12886 9774					
37	15		4/5/90	Collaring	4000 400			5954 10964 8459					
38	16		4/5/90	Collaring	0 0			4818 8339 6579					
39	17		4/17/90	Bench	0 0			4211 7685 5948					
40	18		4/23/90	Yoking	0 0			4213 7568 5890					
41	19		4/23/90	Yoking	7000 0			5089 9707 7398					
42	20		4/23/90	Yoking	7000 0			5156 9835 7496					
43	21		4/23/90	Yoking	7000 0			4686 9367 7026					
44	22		4/23/90	Yoking	0 0			4453 7935 6194					
45	23		4/24/90	Un-yoked	0 0			4290 7596 5943					
46	24		4/30/90	Yoking	0 0			3964 7519 5741					
47	25		4/30/90	Yoking	5000 0			6075 10111 8093					
48	26		4/30/90	Yoking	5000 0			6692 10959 8826					
49			4/30/90	Yoking	0 0			5938 8638 7288					
50													
51													
52													
53													
54													
55													
56													
57													
58													
59													
60													

Table I

Table II

Date	--- σ (psi) ---		--- $\Delta\sigma$ (psi) ---		- $\Delta\sigma/\Delta t$ (psi/day) -	
	Inner	Outer	Inner	Outer	Inner	Outer
4/5	4818	8339				
4/17	4211	7685	-607	-654	- 51	- 55
4/23	4213	7568	+ 2	-117	0	- 20
4/24	4290	7596				
4/30	3964	7519	-326	- 77	- 54	- 13

DS0309 Collaring and Yoking

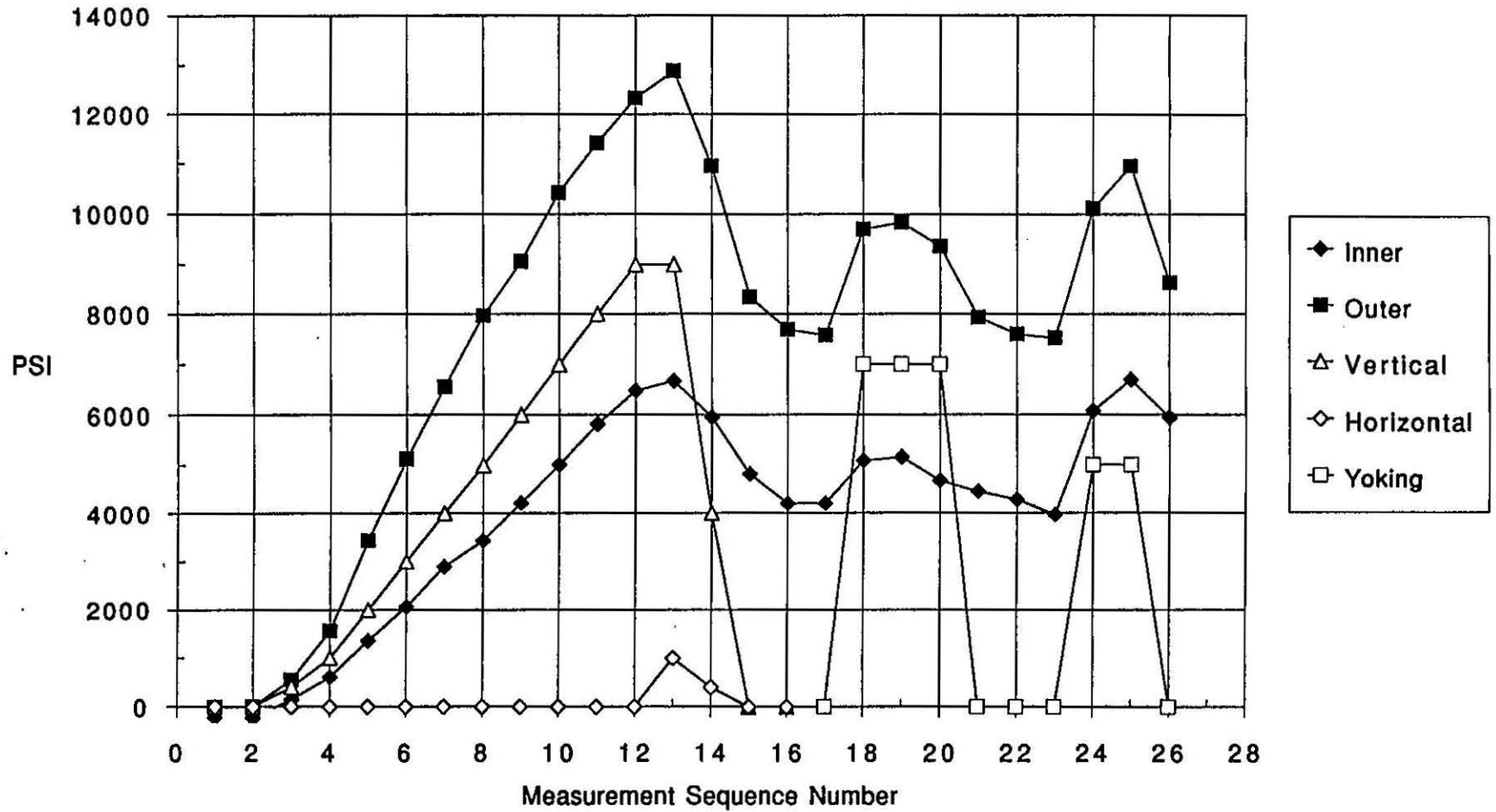


Figure 1

