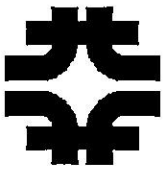


Fermilab

TS-SSC 90-041

Modifications to the Collar for the Vertically Split Yoke SSC Collider Dipole Magnet

Jim Strait
Fermilab
19 July 1990

In two recent notes[1,2] I specified the shapes of the inner and outer surfaces of the collars for the vertically split yoke version of the 50 mm SSC collider dipole magnet. Two modifications to the design specified there have been made and are described in this note. The "final" collar design is shown in Fig. 1, taken from drawing 102-ME-292059.

The yoke-collar interface design calls for 5.5 mils of radial horizontal interference and 18 mils of vertical clearance between the yoke and the (undeflected) collar. In Ref. 1 this was accomplished by setting the collar radius to 10 mils larger than the yoke radius and offsetting its center down by 28 mils. This is represented by the dashed line in Fig. 2. (The collar is drawn only above 10° because the collars are designed to clear the yoke in the in the region of the keys.) As is clear from this figure and from Fig. 3 in Ref. 1, this shape will give a non-uniform stress in the yoke-collar contact area and the stress just above 10° may be very large. The new design has the radius of the outer surface of the collar equal to the yoke radius, but between 10° and 30° the center is shifted to the right by 5.5 mils and between 30° and 90° the center is shifted down by 18 mils. This is represented by the lighter solid line in Fig. 2. The maximum skin tension required to close the mid-plane gap is 24 kpsi[1], implying a maximum yoke-collar force of 24 kpsi x 0.188" = 4500 lbs/in. The arc length of the contact region is 0.93". Assuming a 50% die break for both the yoke and the collar, the actual contact area is about 25%. Thus the maximum contact stress is approximately 19 kpsi, well below the 40-50 kpsi yield of the yoke material. At 4 K and 8 T, the maximum yoke-collar force is about 6400 lbs/in, giving a contact stress of about 27 kpsi. In the original design the area of contact was approximately one-half as large and the contact was very non-uniform, resulting in the possiblities of local yielding.

The pole angle of the outer coil has been modified slightly following a suggestion by Ramesh Gupta (see attached e-mail) to set $b_2 = 0$. After the cross section was "fixed" and a considerable amount of tooling and parts had been ordered, particularly at BNL, the final dimensions of the cable were set at values slightly different from those assumed in the magnetic design. In particular, the inner cable width increased by 9 mils from the original design and by 6 mils from the first samples and the outer cable thickness was decreased by 0.4 mils. The increased inner cable width was handled by keeping the inner coil outer radius and pole angles fixed and reducing the inner radius by 9 mils. We (FNAL) had decided to handle

the decreased outer cable thickness by leaving the the mold and collar dimensions the same and counting on the epoxy to fill the extra 0.4 mils between cables. This would result in no change in the harmonics generated by the outer coil. BNL has apparently decided to mold the coil to a smaller size to maintain the same amount of turn-to-turn epoxy and add a 10 mil shim at the outer coil pole. Gupta has calculated the that the FNAL solution gives $b_2 = -1.0$ unit and the BNL solution gives $b_2 = +1.3$ units. The intermediate situation, adding a 5 mil shim, gives $b_2 = 0.2$ units and decreases the amount of "extra" turn-to-turn epoxy to 0.2 mils. We have now adopted this solution by moving the collar pole surface by 5 mils. (We also have a version of the collar which was designed to use a 25 mil pole shim on both the inner and outer coils; it now calls for a 30 mil outer coil shim.)

References

[1] J. Strait, Design of a Vertically Split Yoke and Associated Collar for the 50 mm SSC Collider Dipole: Yoke-Collar Interface, TS-SSC 90-033, 6/25/90.

[2] J. Strait, Design of a Vertically Split Yoke and Associated Collar for the 50 mm SSC Collider Dipole: Collar Interior Dimensions, TS-SSC 90-034, 6/25/90.

From: BNLDAG::GUPTA "Ramesh Gupta, BNL, UPTON NY 11973.
To: FNAL::JBS
CC: JNET%"palmer@slacvm",GUPTA
Subj: Field harmonics for wider inner and thinner outer cables

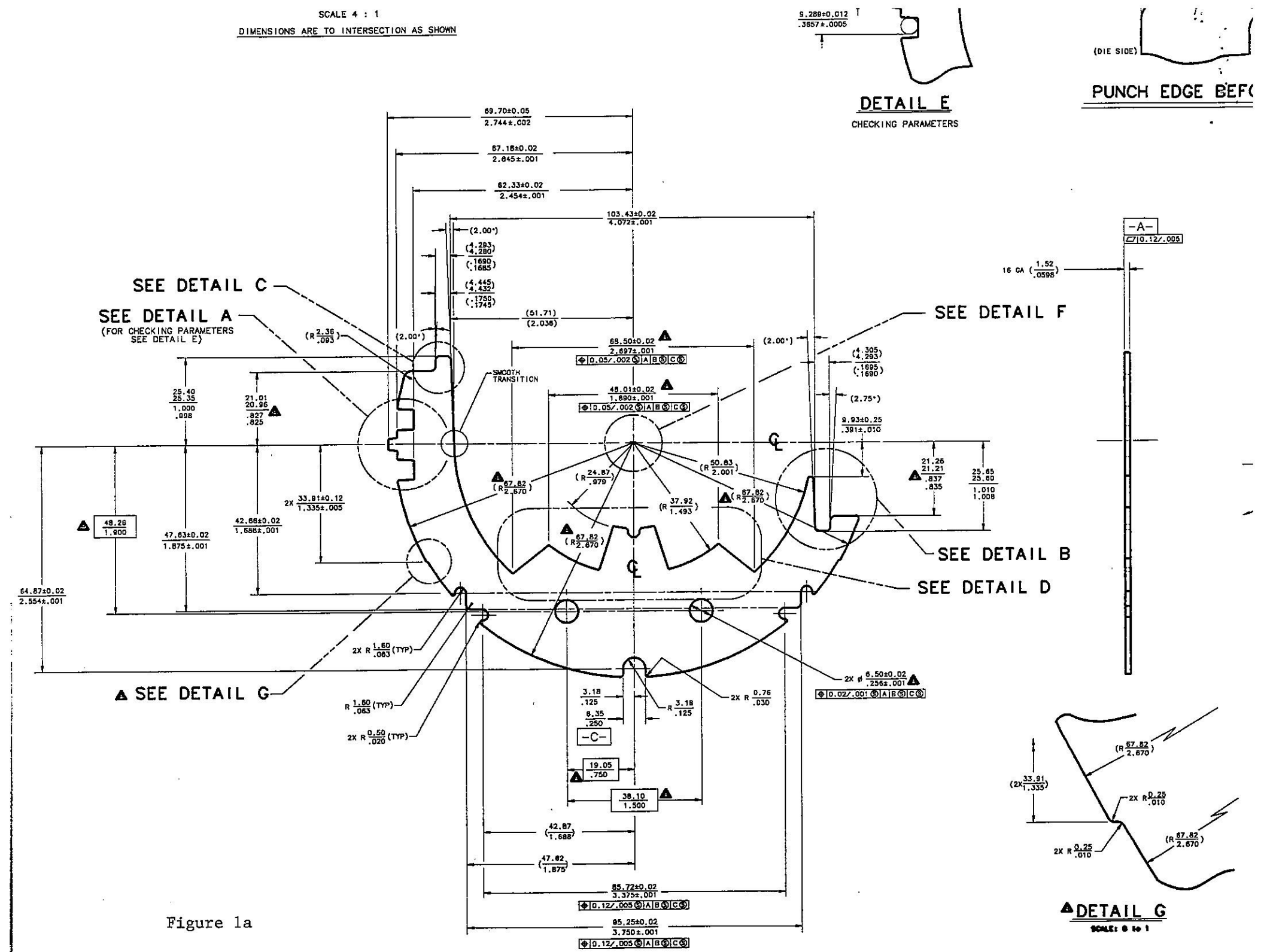
Jim,
As discussed before regarding the change in the thickness of outer cable, initial thinking at BNL is using 10 mil shim (for minimum change in mechanical properties) and at FNAL is using extra epoxy (for minimum change in magnetic properties) to fill up the extra space created by 4 mil thinner cable. However, from b_2 consideration alone, there is an intermediate solution where half the space is filled by 5 mil shim and half by epoxy. I am listing these three cases below:

Case/Details	b_2	b4	b6	b8	b10
1. BNL :: 10mil Shim 3.45+3.45 mil Insulation (top+bottom)	1.29	0.08	-0.024	0.043	0.015
2. FNAL :: No Shim 3.65+3.65 mil Insulation	-0.96	0.06	-0.017	0.043	0.015
3. Alternate, 5 mil Shim 3.55 + 3.55 mil Insulation	0.16	0.07	-0.021	0.043	0.015

---Ramesh Gupta.

SCALE 4 : 1

DIMENSIONS ARE TO INTERSECTION AS SHOWN



DETAIL E

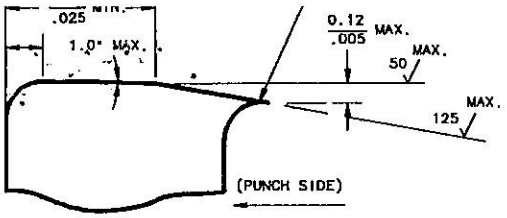
CHECKING PARAMETERS

PUNCH EDGE BEFO

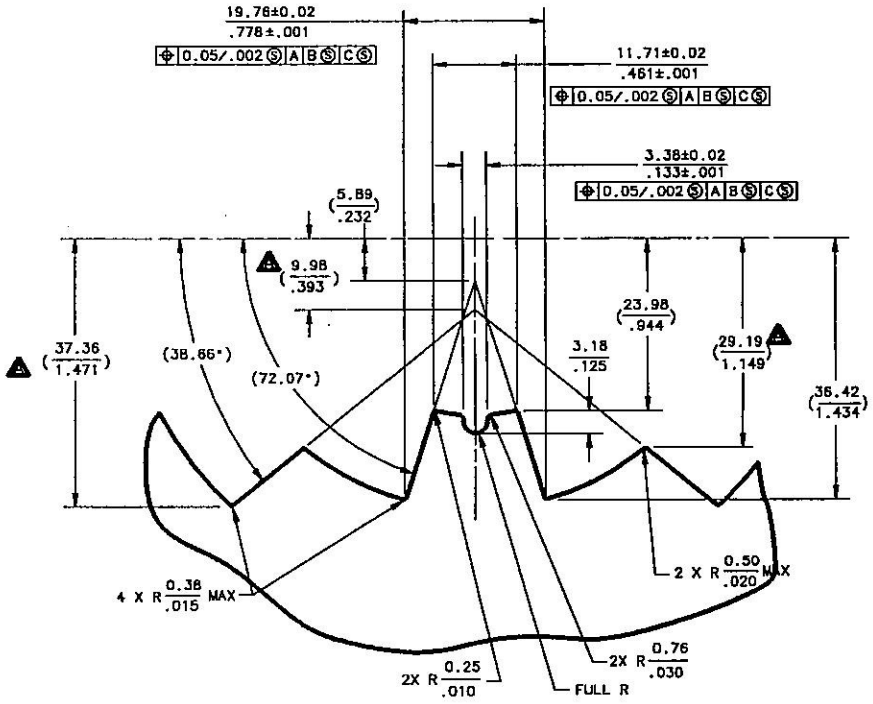
DETAIL G

SCALE: 8 to 1

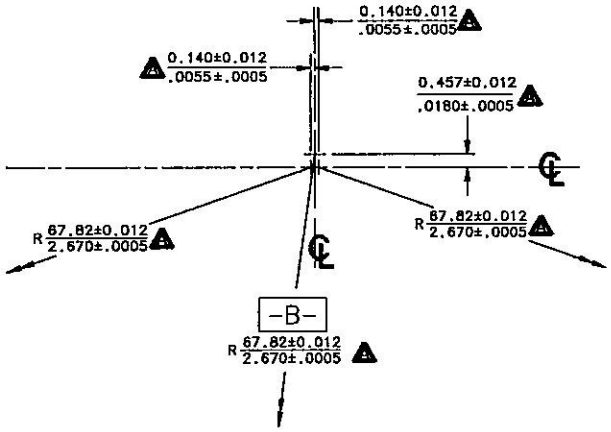
Figure 1a



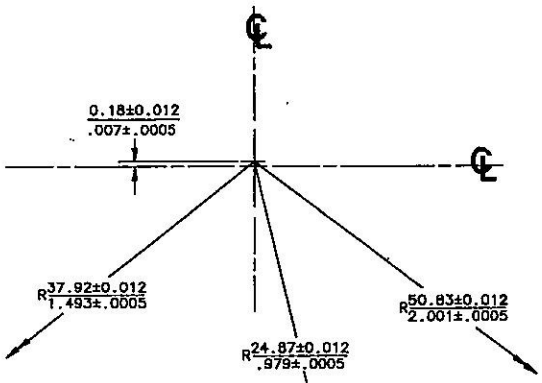
H EDGE BEFORE DEBURRING



DETAIL D



OUTER RADIUS
DIMENSION LOCATIONS



INNER RADIUS
DIMENSION LOCATIONS

DETAIL F

SCALE: 4 to 1

Figure 1b

NOTES:

1-MATERIAL: #16GA.(.0598)NITRONIC-40 ASTM A-412 GR.XM-11.
2-ALL DIMENSIONS ARE TO TRUE CORNER INTERSECTIONS
3-DIMENSIONS SHOWN ARE ON DIE SIDE.
4-TOLERANCES ARE NON-CUMULATIVE.
5-TUMBLE TO REMOVE ALL SHARP EDGES AND BURRS.
6-FINISHED LAM. MUST BE FREE OF ALL FOREIGN MATTER, OIL, GREASE, METAL PARTICLES, ETC. PRODUCED DURING DIE PUNCHING OR TUMBLING.
7-THIS COLLAR IS MADE TO BE USED WITH VERTICALLY SPLIT YOKE LAMINATION #0102-ME-292123
8-ALL TOLERANCES ±.12mm (.005 inch) UNLESS OTHERWISE SPECIFIED; ANGLES ±.25°.

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.

PARTS LIST

UNLESS OTHERWISE SPECIFIED:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. TOLERANCES:SEE NOTE 8.
3. DIMENSIONS BASED UPON ANSI Y14.5M-1982.
4. INCH DIMENSIONS ARE FOR REFERENCE ONLY.
5. BREAK ALL SHARP EDGES.
6. DO NOT SCALE DRAWING.
7. MAX. ALL MACH. SURFACES 125
8. DIMENSION IDENTIFICATION: MILLIMETER/INCH

ORIGINATOR	J. STRAIT	
DRAWN	RICK DIXON	5/23/90
CHECKED		
APPROVED		
USED ON		
MATERIAL	SEE NOTE 1	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
SSC

SSC 50mm COLD MASS DSX201A (W6733A)
COLLAR LAMINATION W/O SHIMS
FOR VERTICALLY SPLIT YOKE

SCALE	FILMED	DRAWING NUMBER	REV.
2 : 1 AND NOTED		0102-ME-292059	A

CREATED WITH I-DEAS 4.1 | USER NAME: SPUD

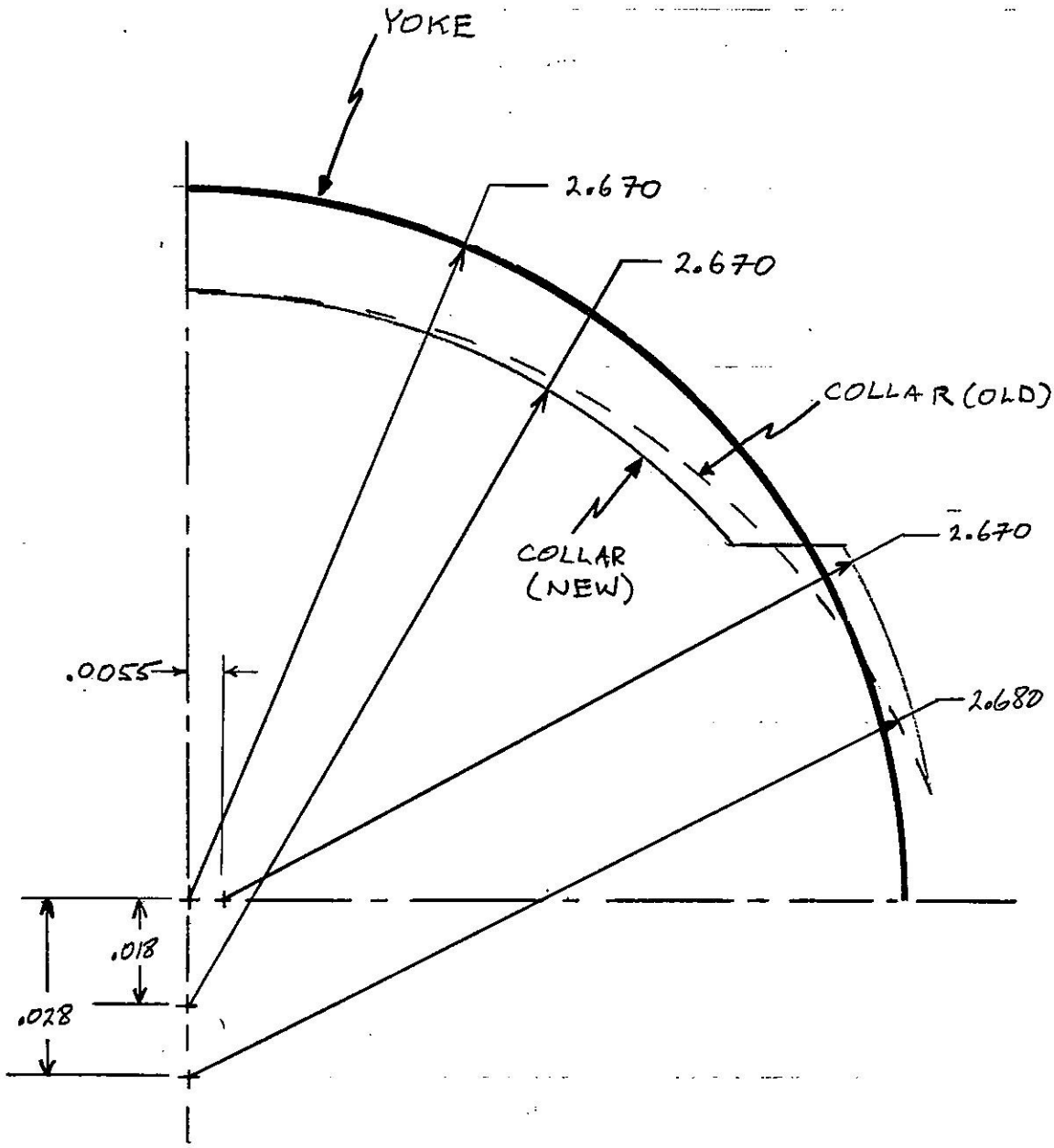


Figure 2

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Distribution:

FNAL
- R. Bossert
- J. Carson
- J. Kerby
- W. Koska
- P. Mantsch
- G. Pewitt

SSCL
- T. Bush
- R. Coombes
- C. Goodzeit
- J. Jayakumar
- R. Palmer
- P. Sanger