SSC DETECTOR SOLENOID DESIGN NOTE #5

TITLE: Preliminary Coil Design: 10 m I.D. x 2 T

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I. Ampere-turns

Assume

$NI\,(\text{total}) = 28 \times 10^6$ A-t

A coil of this excitation will make 1.8T w/o iron (Design Note #4) and should get 2T with iron flux return.

Assume

Eight coil modules, 4 per 8-m half.

So $NI\,(\text{module}) = 3.5 \times 10^6$ A-t

II. Coil current density - Coil Area

Assume

A coil (pack) current density = 2500 A/cm²

This current density should have the same q_ℓ (heat flux) as MFTF solenoids, 0.22 W/cm² (Design Note #3).

$$\text{So Area of coil pack} = \frac{3.5 \times 10^6 \text{ A-t}}{2.5 \times 10^3 \text{ A/cm}^2}$$

$$= 1400 \text{ cm}^2$$

III. Center coil modules

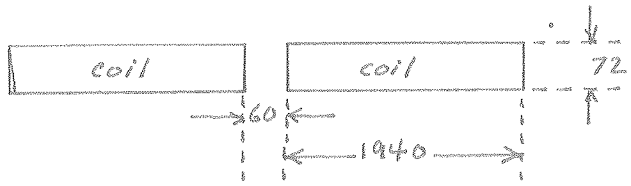
Assume: (1) Vacuum vessel module length = 2 m
(2) He vessel end flange thickness = 30 mm
(3) He vessel module length = 2 m

Then: Coil length = 2000 − (2)(30) mm
= 1940 mm
= 1.94 m

And: Coil radial thickness = $\frac{1400\ cm^2}{194\ cm}$

= 7.2 cm (2.8 in)
= 0.072 m

So: Coil geometry



(units: mm)

IV. End coil modules

Assume: (1) Vac. vessel module length = 2 m
(2) Vac. & He vessel end flange thickness = 30 mm
(3) He vessel module length = 2 m
(4) Outside end vacuum space = 60 mm

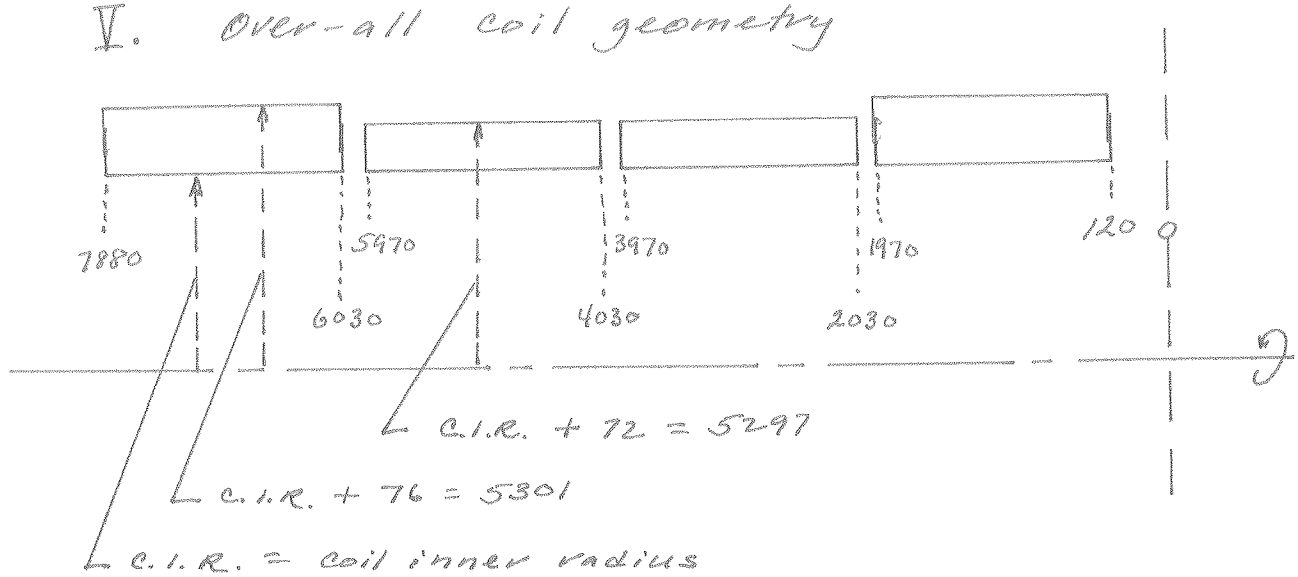
Then: Coil length = 2000 − (30 + 60 + 30 + 30) mm
= 1850 mm
= 1.85 m

And: Coil radial thickness = $\frac{1400 \text{ cm}^2}{185 \text{ cm}}$

= 7.6 cm (3 in)
= 0.076 m

Note: I have not looked at how you accomplish this; perhaps the conductor for the end modules is slightly different from that in the center modules.

V. Over-all coil geometry



(units – mm)

Assume these are all <u>cold</u> dimensions.

The coil inner radius (C.I.R.)
= Vac. vessel inner radius (VVIR)
+ Inner vac. shell thickness (IVST)
+ Vacuum space - inner (VS)
+ Inner He shell thickness (IHST)

Let: VVIR = 5m = 5000mm

Also: IVST = 30 mm (Design Note #2)

The VS is derived by <u>assuming</u> the radial space budget of 500 mm from the 1987 Berkeley report and subtracting the vacuum & He shell thicknesses:

IVST = 30mm IHST = 50mm
coil = 75 mm
OHST = 20mm (Design Note #2)
OVST = 32 mm

and $VS_T = 500 - (30 + 50 + 75 + 20 + 32)$
$= 293$ mm

assume split 50-50 between inner & outer space, 145 mm each

Therefore: C.I.R. = 5000 + 30 + 145 + 50 mm
= 5225 mm

Center coil O.D. = 5297 mm
End coil O.D. = 5301 mm