ATF2

Magnets

Information on technique chosen to enlarge the bore of the QC3 style quads.
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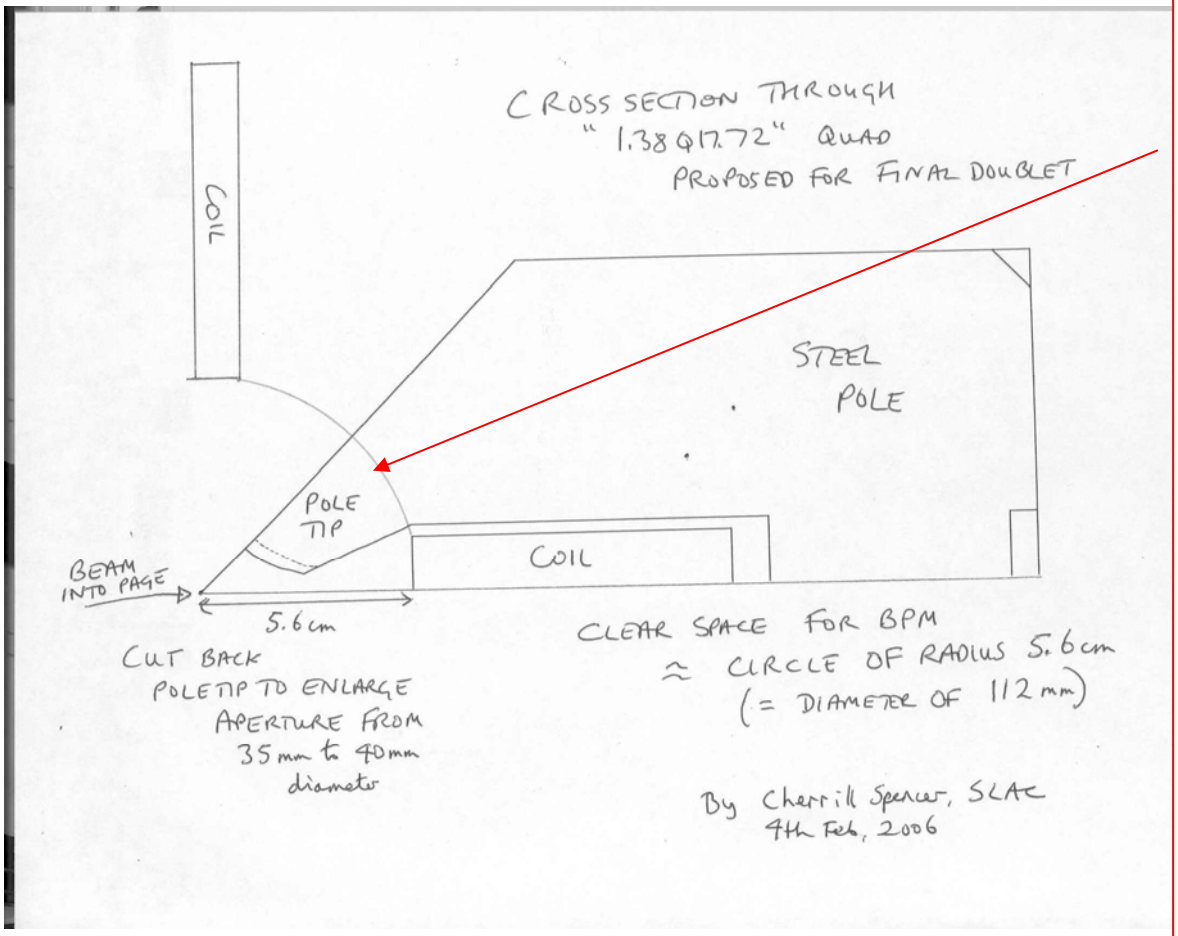
Shape of pole tip and coil in the 1.38Q17.72 quad. Will machine pole tip to make larger aperture



"Dog-eared" shape of coil ends starts at 56mm, but have also G10 coil support, uses ~25.4mm of the 56mm space. This is not enough for the S band BPM, so adapter needs to be designed.

The 35 mm aperture is not compatible with S band BPM or shape of beam in QF1 and QD0.

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Compare predictions of multipole content with tolerances from James Jones & S. Kuroda

Magnet Name	Tolerance 6 pole/quad At r=1cm	Tolerance 12 pole/quad	POISSON Prediction 12pole/quad	Tolerance 20pole/quad	POISSON Prediction 20pole/quad
QF1	9.5×10^{-5}	2.46×10^{-4}	1.08×10^{-4}	1.19×10^{-3}	2.57×10^{-6}
QD0	5.26×10^{-5}	3.08×10^{-3}	1.08×10^{-4}	5.98×10^{-1}	2.57×10^{-6}

ABOVE TABLE IS FOR A 50mm diameter bore.

Tightest 12pole/quad tolerance is for QF1. POISSON often under-predicts multipole value, we have 2.3 times margin. But if 12pole is too large we have at least 2 ways to reduce it: by chamfering poletip ends or by adding steel buttons on poletip end; Determine the button size and position by experiment :more on Spencer's experience with this below.

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PREDICTIONS USING HALBACH's 1969 "perturbations" paper

	Sextupole	Octupole	Decapole (10-pole)	12-pole
ATF2 Tolerances QF1 QD0	9.56E-05 -5.26E-05	1.01E-04 -1.58E-04	2.46E-04 -1.10E-03	2.46E-04 -3.08E-03
Single Poletip 1 mil Radial misplacement	8.15E-05 -8.15E-05 skew	-1.33E-21 1.08E-05 skew	4.89E-06 4.89E-06 skew	1.14E-06 2.09E-22 skew
Single Poletip 2 mil Radial	1.63E-04 -1.63E-04 skew	-2.65E-21 2.16E-05 skew	9.78E-06 9.78E-06 skew	2.28E-06 4.19E-22 skew
Single Poletip 1 mil Azimuthal	-8.15E-05 -8.15E-05 skew	-3.41E-05 -4.18E-21 skew	-4.89E-06 -4.89E-06 skew	-1.35E-22 7.35E-07 skew
Single Poletip 2 mil Azimuthal	-1.63E-4 -1.63E-4 skew	-6.82E-05 -8.35E-21 skew	-9.78E-06 9.78E-06 skew	-2.70E-22 1.47E-06 skew
All 4 Poletips ->Sextupole. Worst Case 1 mil Rad, Azi	-6.52E-04 -2.40E-19 skew	-1.06E-20 0.0 skew	-3.91E-05 -3.26E-20 skew	1.08E-21 4.05E-21 skew
All 4 Poletips ->Sextupole. Worst Case 2 mil Rad, Azi	-1.30E-03 -4.80E-19 skew	-2.12E-20 0.0 skew	-7.82E-05 -6.52E-20 skew	2.16E-21 8.09E-21 skew
All 4 Tips Oct. Worst Case 1 mil Azimuthal	-7.99E-20 1.28E-19 skew	-1.36E-4 -6.68E-20 skew	1.92E-21 -2.88E-21 skew	-2.07E-21 0.0 skew
All 4 Tips 12-pole Worst Case 2mm Radial	-5.12E-18 -1.13E-17 skew	4.24E-19 0.0 skew	1.84E-19 3.68E-19 skew	3.65E-04 2.68E-19 skew

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Conclusion from perturbation calculations

- Sextupole component is very sensitive to poletip being at wrong radius or the poletip being offset “azimuthally”
- Appears that errors of size 0.001” (=25 microns) are significant for producing unwanted sextupoles.

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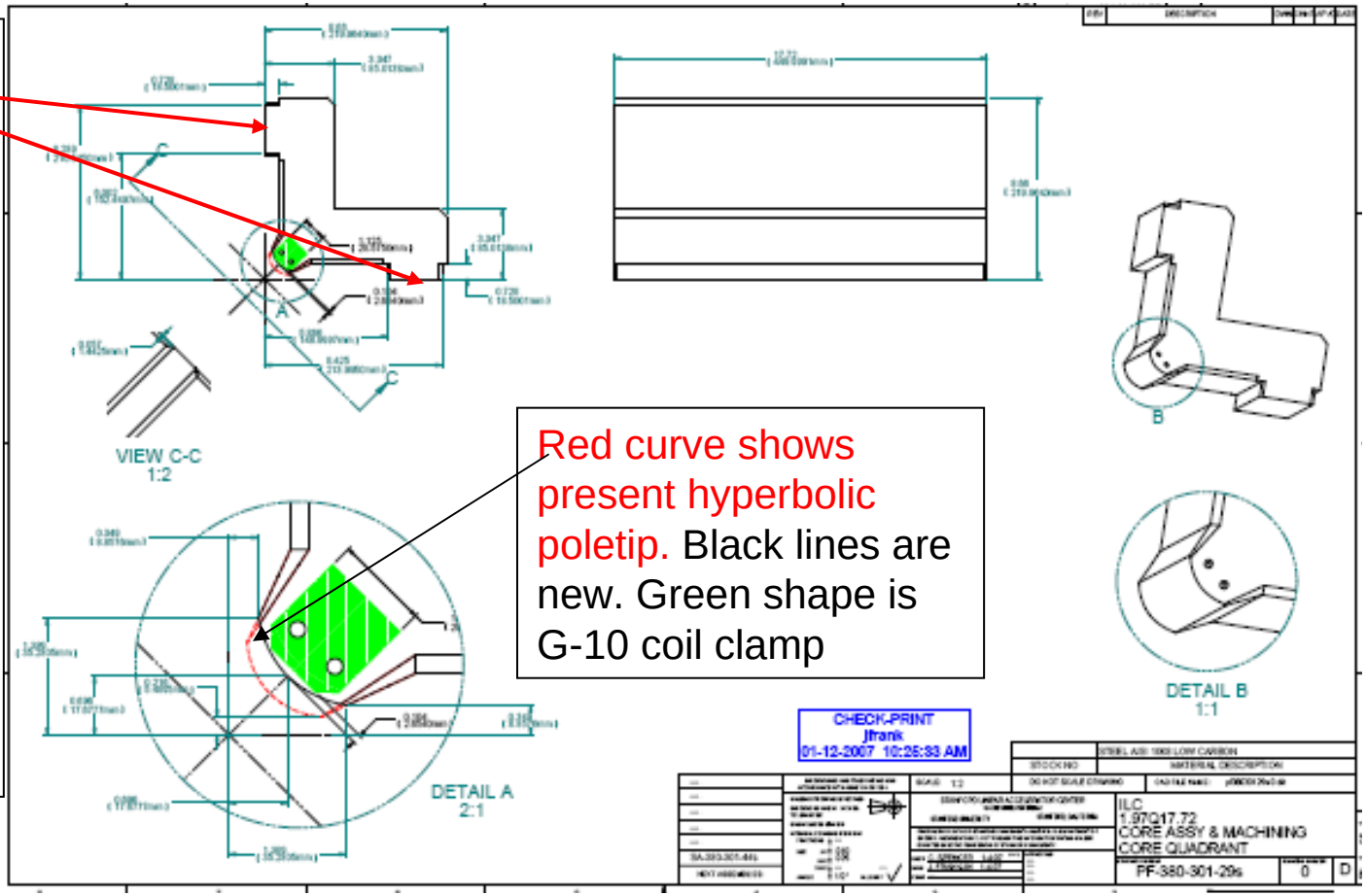
Not finished drawing showing how much of poletip needs to be removed, if we were to machine the poletips. VERY EXPENSIVE TO DO!

2 Split planes here determine origin for machining.

Spencer reckons they were made to 0.02mm flatness & 0.02mm perpendic.



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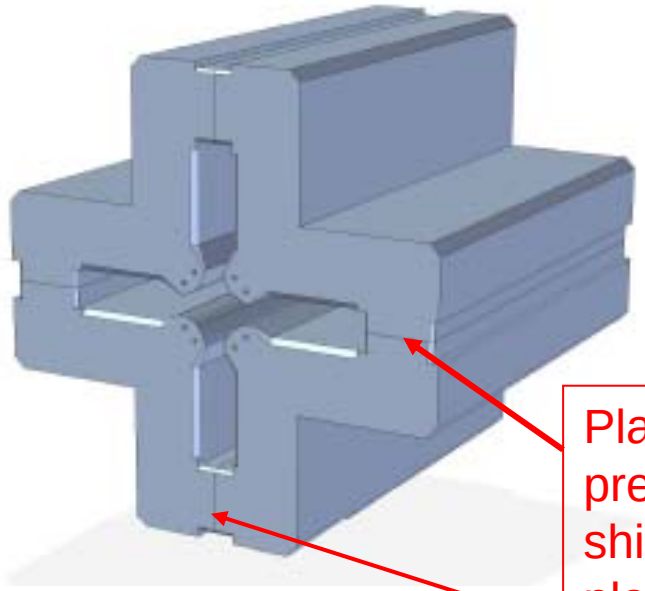
Chosen method for enlarging the "QC3" quad's bore diameter

Shim will be low carbon steel, ground to 0.0005" flatness



Place a very flat and precise thickness shim in each split plane to "explode" the quad and enlarge the bore diameter.

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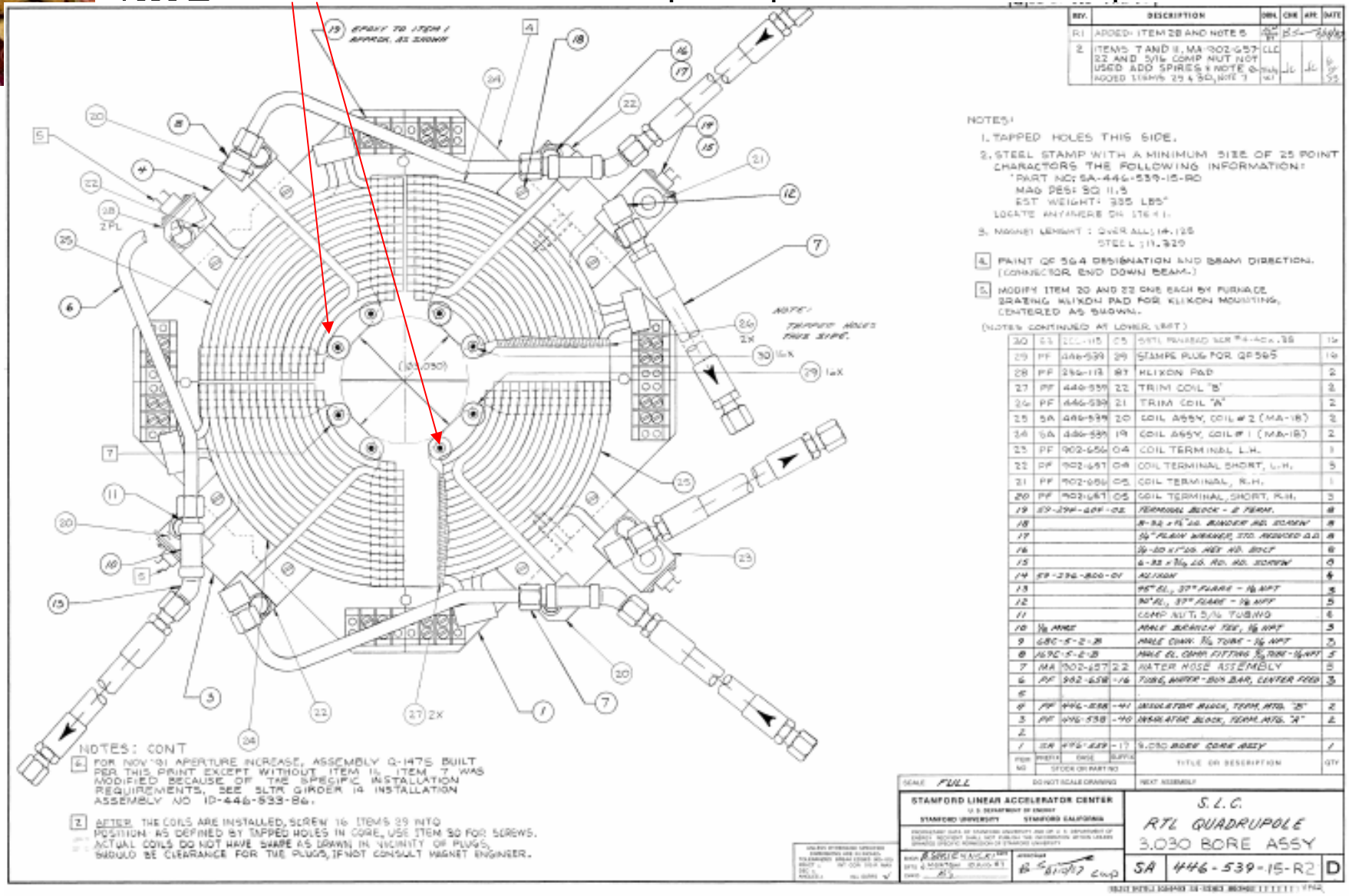
Multipoles predicted if pull back the hyperbolic poletip by adding shims at split planes

- COMPARE POISSON PREDICTIONS WITH JAMES JONES TOLERANCES :
- Tolerances for QD0 : 12pole/quad < 3.08 x10(-3) and 20pole/quad < 5.98 x10(-1) at radius= 1cm .
- Poisson predictions (same values at the different currents):
  - 12pole/quad: 1.86x10(-3)
  - 20pole/quad: 4.18x10(-6)
- SO HAVE SATISFIED BOTH 12 pole and 20 pole tolerances.
- TOLERANCES FOR QF1 : 12pole/quad < 2.46 x10(-4) and 20pole/quad < 1.19x 10(-03) at r= 1cm,
- So have not satisfied QF1's 12 pole tolerance, although have satisfied the 20 pole tolerance.
- DECIDED that this shimming method was easier and cheaper to try first than actually machining back the poletips and the larger-than-we-want 12 poles can be reduced by putting buttons on the ends; or chamfering the ends.

ATF2 Buttons added to an SLC quadrupole to reduce its 12 pole content



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Effect of 8 buttons on one end of RTL quadrupole

- Bore diameter = 3.03” = 77 mm
- At r= 17.9mm
  - 12pole/quad without buttons = 0.148% = 1.48x 10(-3)
  - 12pole/quad with buttons = 0.017% = 1.7x10(-4)
  - BUT sometimes the octupole went UP with the buttons.
  - Effect of buttons on sextupole needs to be studied more- by Spencer- has data.