

# Alternate (5 coil) PF design

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**21 June 2001**

## 5 coil PF option developed

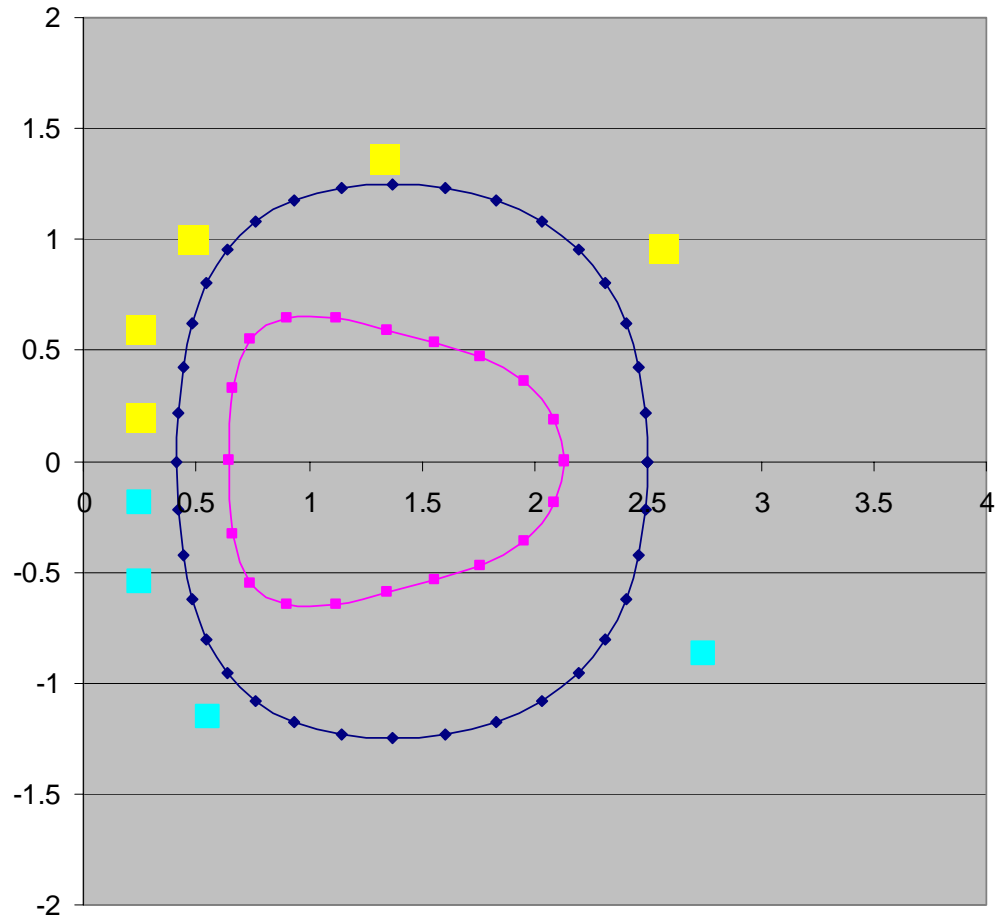
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- **Feedback from Pomphrey is that 4 PF coils were inadequate, octupole not required**
- **Developed coil positions by fitting...**
  - PF5 to minimize  $B_{1,0}$  (dipole-like)
  - PF4 to minimize  $B_{2,0}$  (quadrupole-like)
  - PF3 to minimize  $B_{3,0}$  (hexapole-like)
  - PF1 and PF2 to act as solenoid coils
    - Provide inductive flux swing
    - Almost identical to existing PF1 and PF2
- **PF coils were positioned outside reference TF coils**
  - Positions/envelopes to be checked by ORNL

# New coil positions

	R(m)	Z(m)
PF1	0.250	0.200
PF2	0.250	0.600
PF3	0.486	1.000
PF4	1.327	1.372
PF5	2.570	0.964

Significant difference is the addition of a PF coil at the major radius (positioned for quadrupole field)

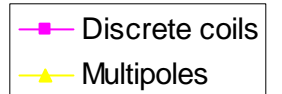
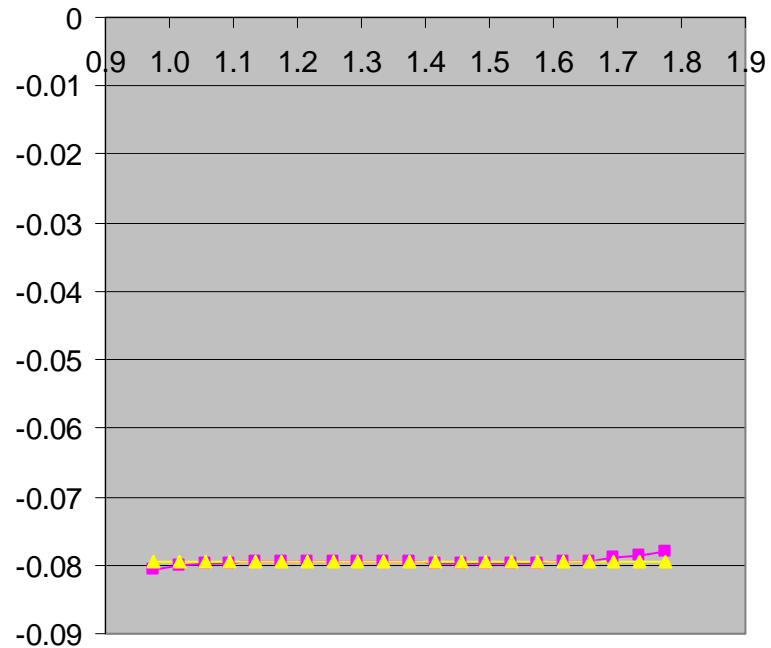
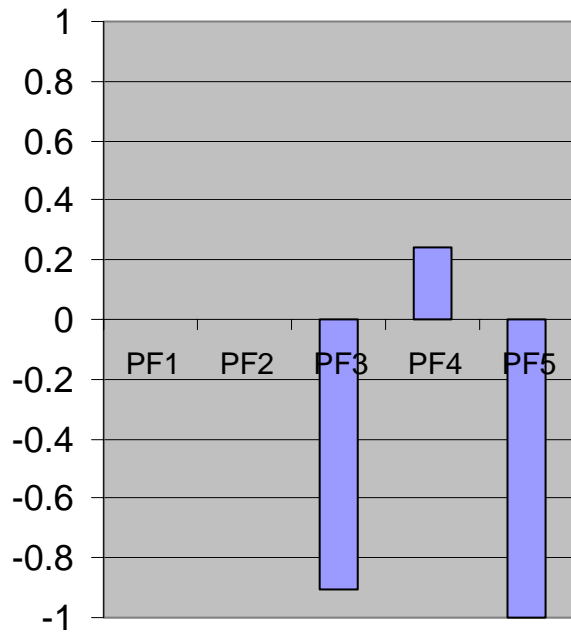


# Reasonable fits found to multipole fields

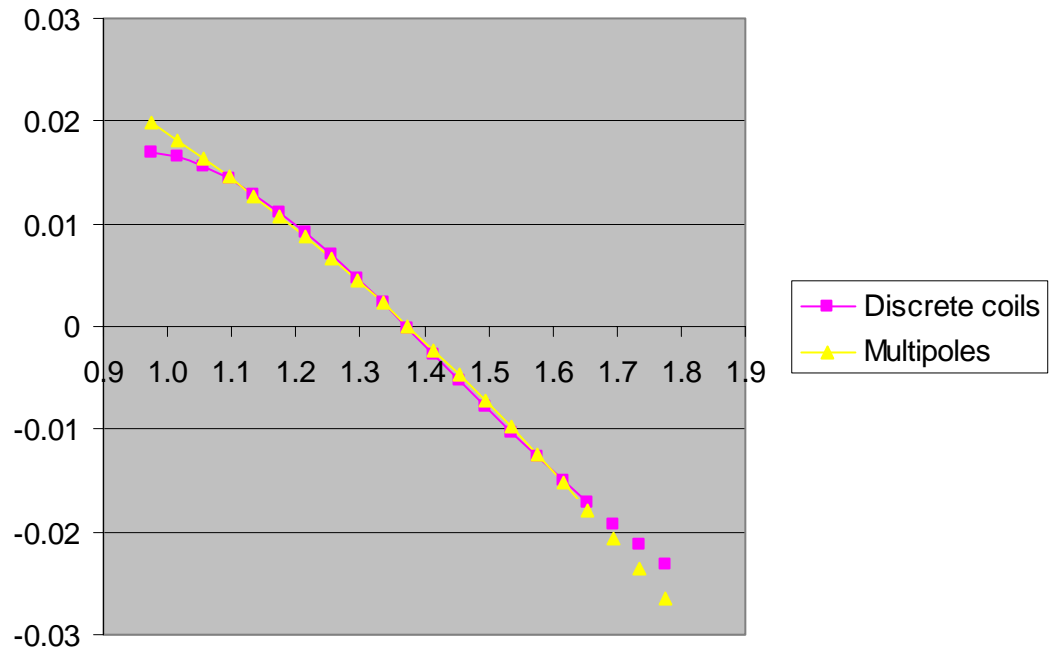
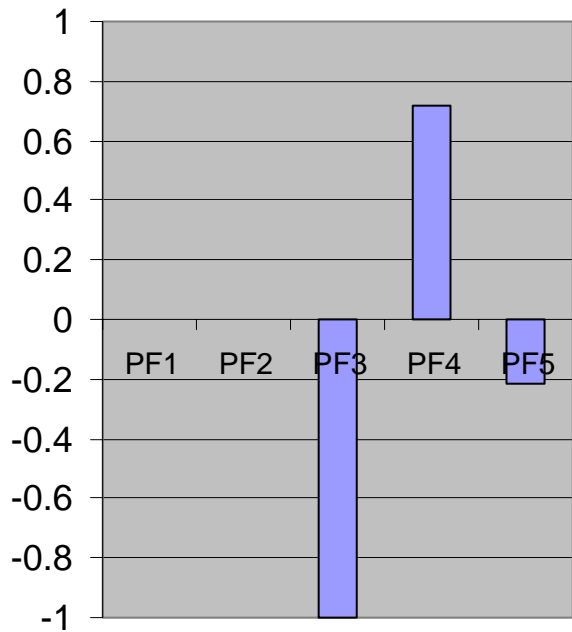
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- **Good fits within  $\pm 0.3\text{m}$  of magnetic axis (1.075-1.675m)**
- **Better fits to lower order multipoles (dipole, quadrupole) than high order multipoles (hexapole, octupole)**
- **Better fits using all coils can be obtained**
- **Good OH distribution found**

# Fit to dipole field with 3 coils (PF3-5)

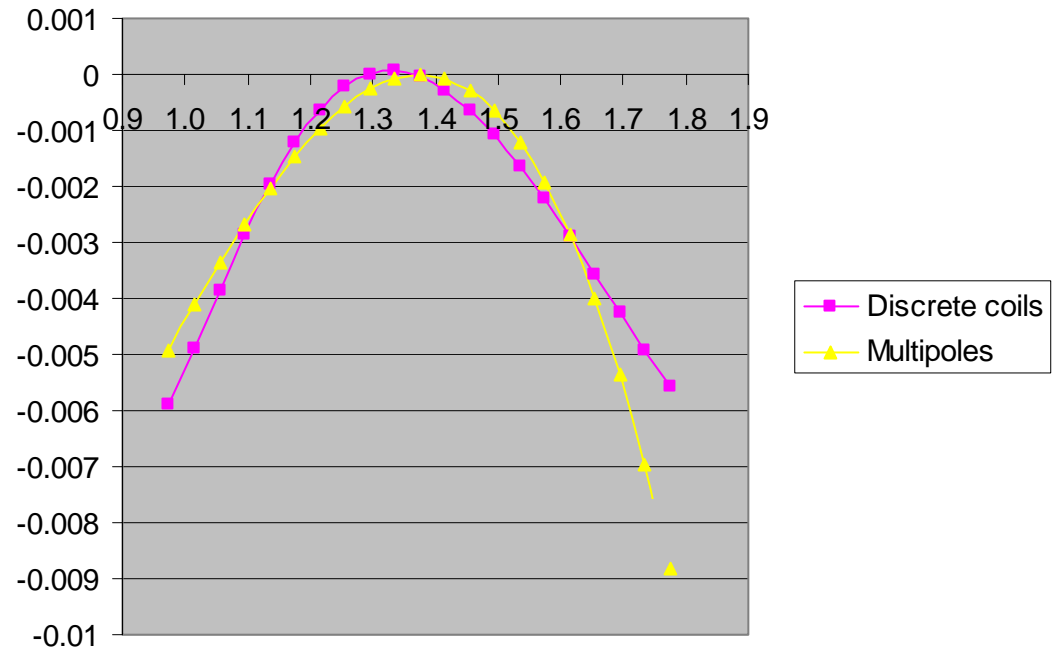
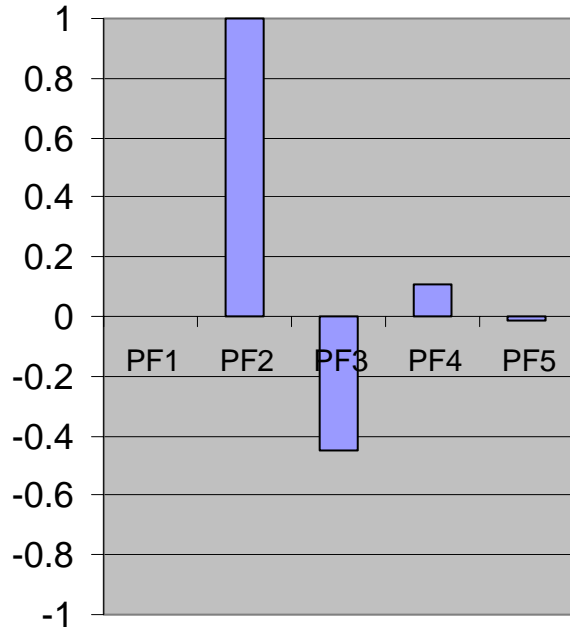


# Fit to quadrupole field with 3 coils (PF3-5)



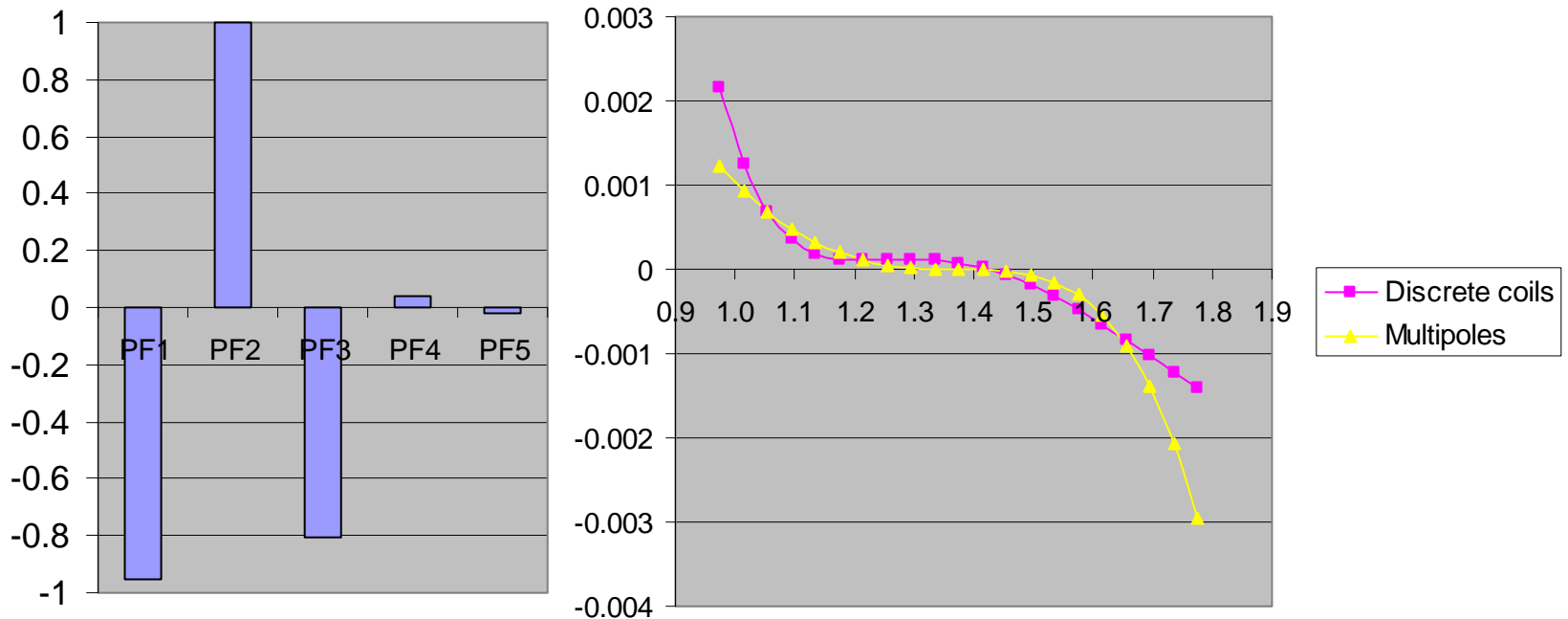
# Fit to hexapole field with 4 coils (PF2-5)

- Improved fit can be obtained using all 5 coils



# Fit to octupole using all coils

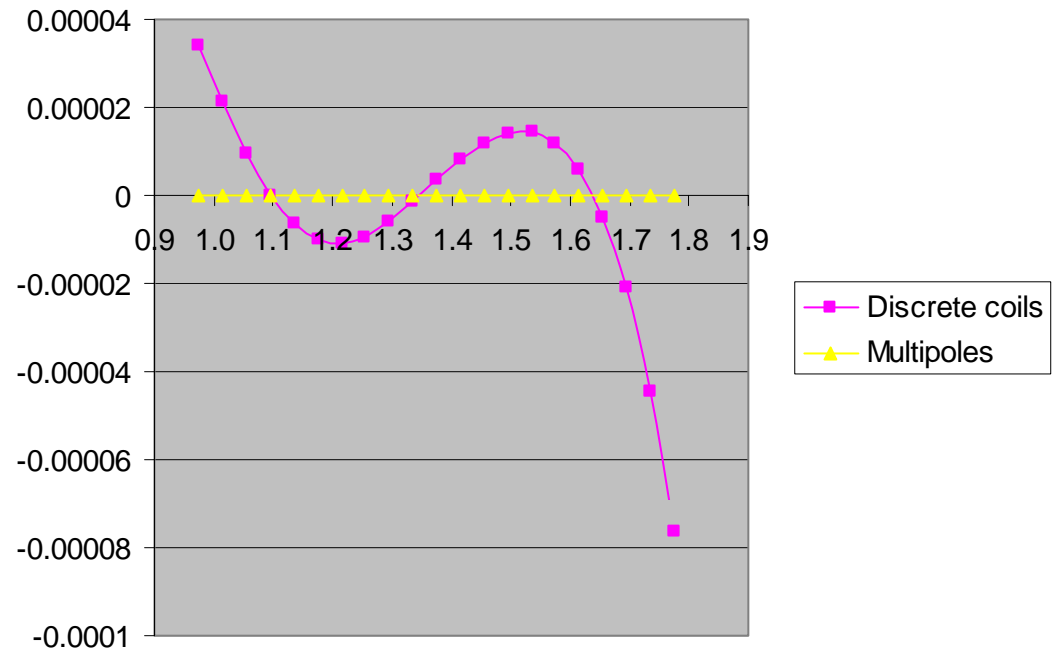
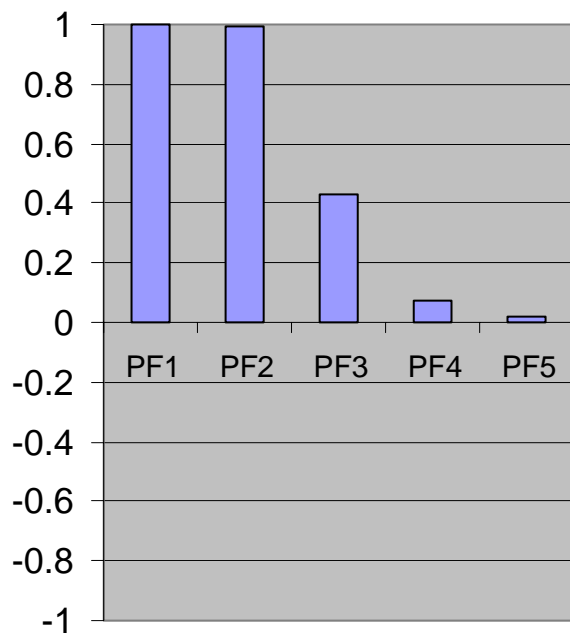
- Fit gets rough for  $R < 1.05$  and  $R > 1.65$





# 1 Vs OH distribution

- $|B_p|$  less than 0.2 gauss between 1.0-1.7m



# Alternate PF substantially improves OH and quadrupole fits

- Deficiencies in reference PF attributable to lack of “quadrupole” coil

	Relative Error	Relative Jmax	Relative Amp-m	Comments
<b>Alternate PF</b>				
Dipole	<b>20</b>	1.13	1.10	<b>3 coils (alternate) v. 4 coils (reference)</b>
Quadrupole	<b>0.30</b>	<b>0.08</b>	<b>0.54</b>	
Hexapole	0.74	0.74	<b>0.51</b>	
Octupole	<b>1.30</b>	0.73	0.92	
Nullapole	<b>0.002</b>	0.87	0.98	<b> B &lt;0.2 gauss for 1.1&lt;R&lt;1.7m (v. 5 gauss for the reference PF)</b>
<b>Reference PF with 5th coil added</b>				
Quadrupole	<b>0.18</b>	<b>0.07</b>	<b>0.54</b>	
Nullapole	<b>0.002</b>	1.12	1	<b> B &lt;0.3 gauss for 1.1&lt;R&lt;1.7m</b>

# Summary

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- **An alternate 5 coil PF design has been developed**
- **ORNL will “tweak” coil locations ( $r_c$ ,  $z_c$ ) and establish envelope sizes**
- **Physics will assess physics performance relative to the reference 4 coil PF design**
- **Reiersen will develop a 5 coil non-circular PF design for comparison with this 5 coil circular option**

# Postscript

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- **Williamson has reviewed the PF coil locations and envelopes and recommends the following:**

	Rc	Zc	dR	dZ
PF1	0.25	0.2	0.1	0.36
PF2	0.25	0.6	0.1	0.36
PF3	0.486	1.075	0.24	0.24
PF4	1.327	1.379	0.2	0.2
PF5	2.57	0.964	0.06	0.24