

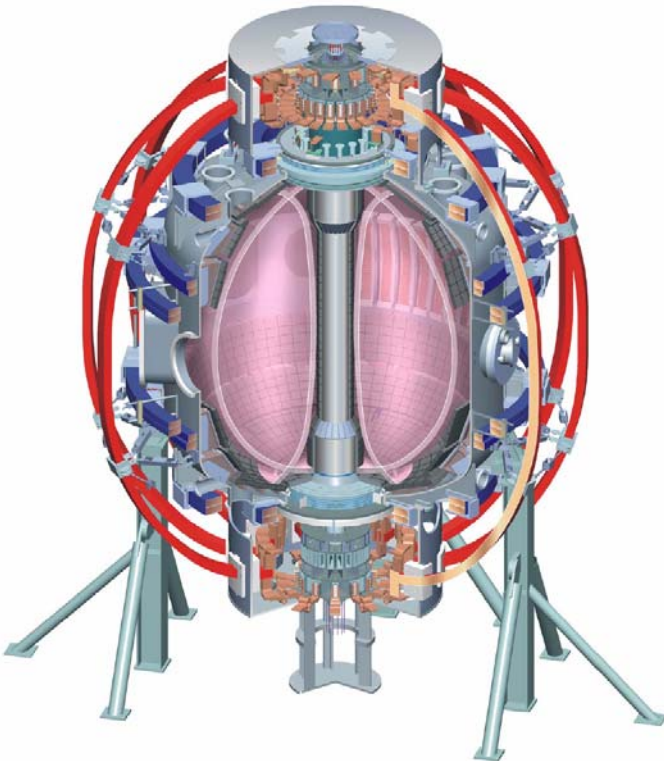
Status of Error Field Determination on NSTX

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**NSTX Results Review
for FY2004 Run**

**Princeton Plasma Physics Laboratory
Princeton, NJ
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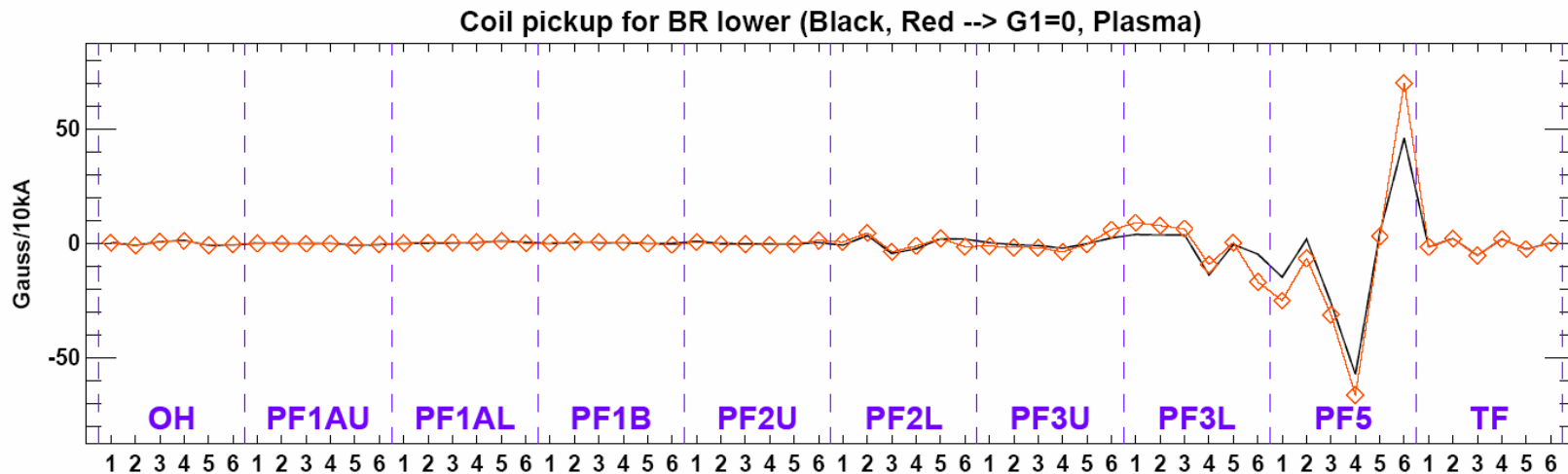
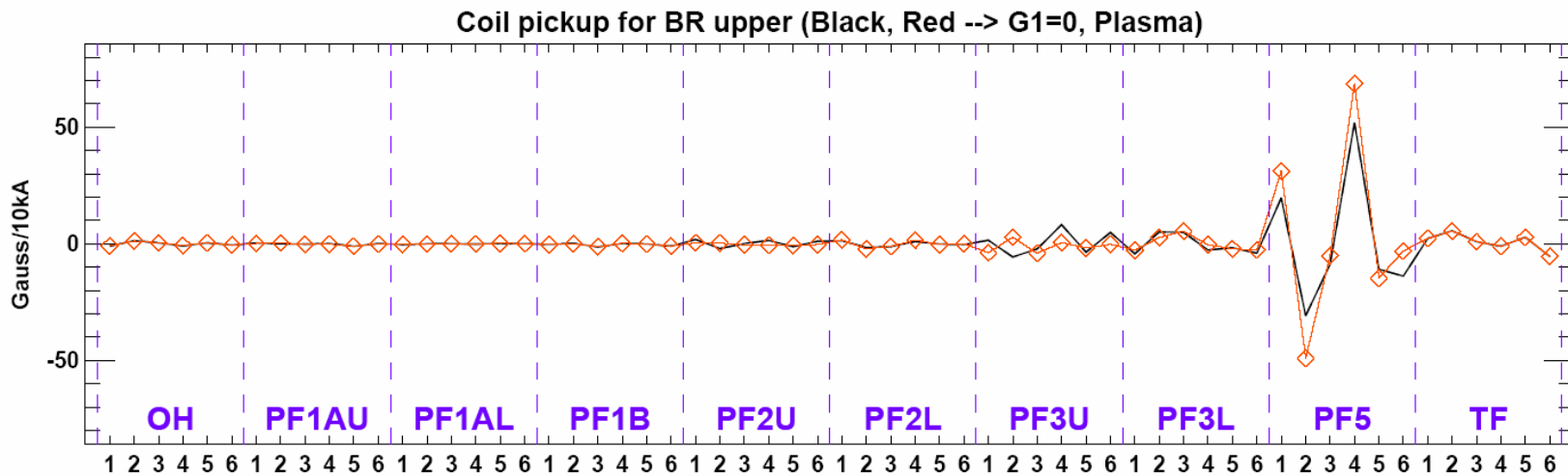


RWM sensor calibration dominated by PF5 “pickup”



This pickup is subtracted from difference signals to give null vacuum response

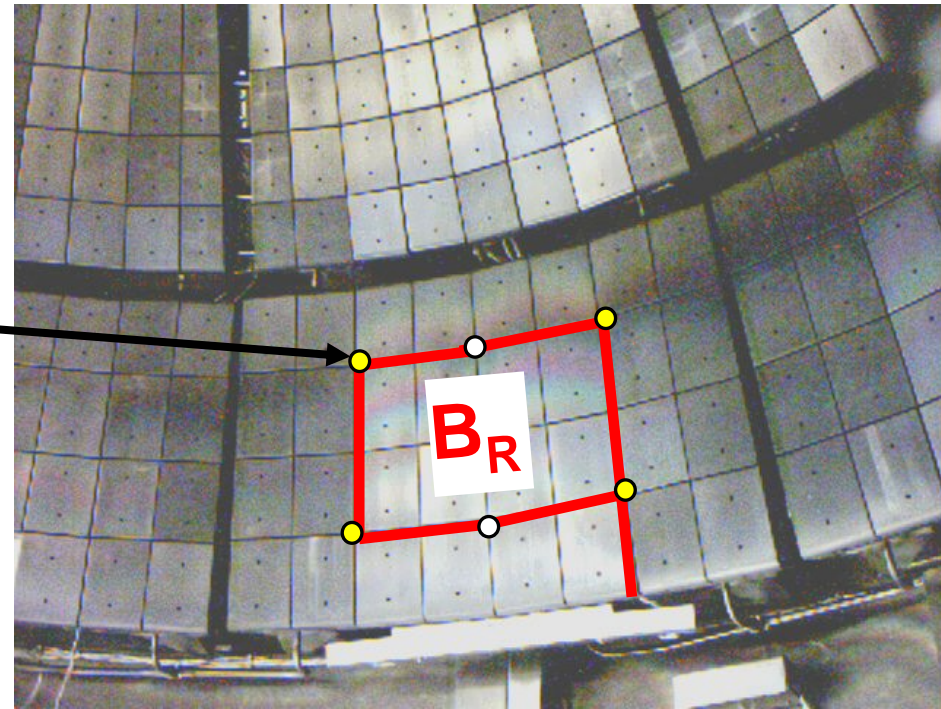
Is this a sensor gain/alignment problem, or a real error field?



B_R sensors used to diagnose fields from coils

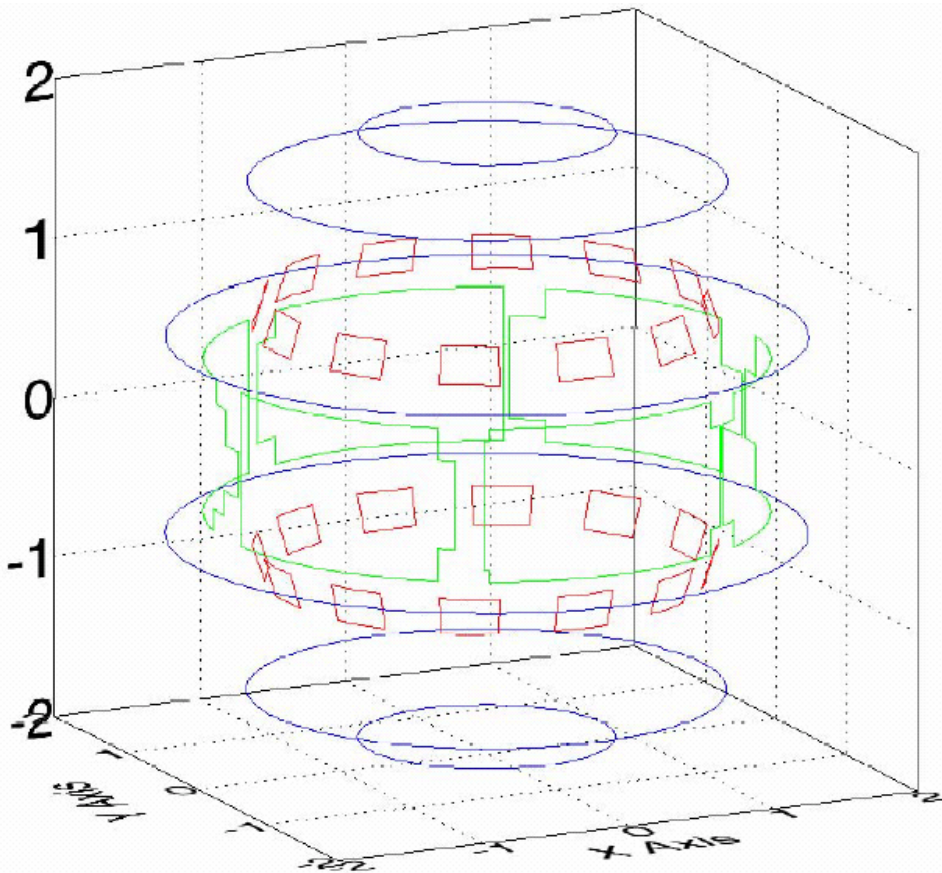


- B_p sensors subject to larger $n \cdot A$ and orientation variation
- 4 outer coordinates of each B_R sensor tile corner measured with FARO during last outage
 - Middle 2 points inferred from plate drawings and plane angles
 - Project along normal into tiles for 6 vertices of sensor winding
 - Constructed 3D filament model of sensor winding for each sensor for Biot-Savart calculations



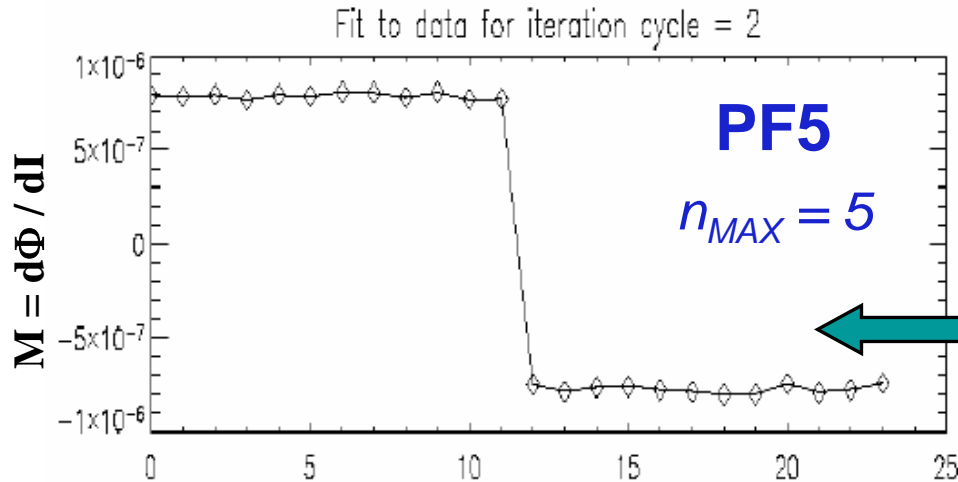
Filament model of sensors and PF coils

(RWM coils not used yet in this analysis)

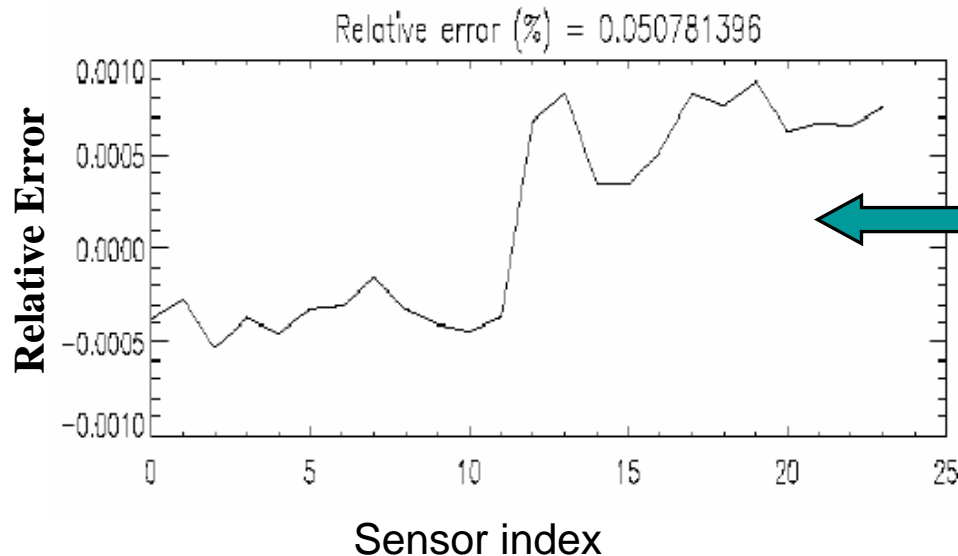


- Allow X,Y shift of coil center + $n=2-3$ elliptical deformation
 - $n > 3$ also tried - only PF5 is close enough to B_R sensors to possibly trust the results.
 - Only shift allowed for PF2
- Mean R of coils constrained to match measured values
- No Z-variation of coils allowed
 - Coils assumed to all be co-planar based on how supports on vessel were originally machined

Absolute calibration of B_R sensors good to $< 0.3\%$



- Iterative SVD solution required to minimize fit error
- Very good match between predicted and measured mutuals from vacuum shots

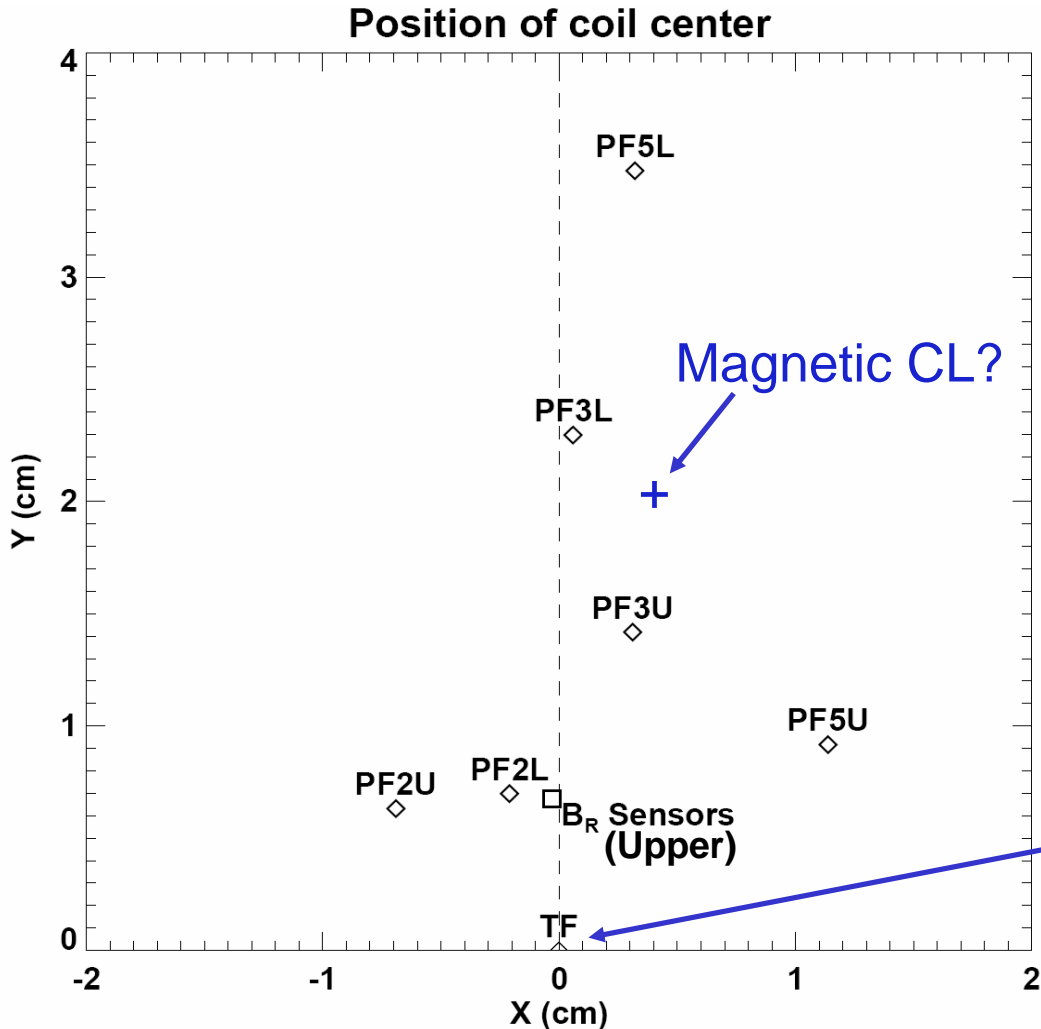


- Data can be matched to $< 0.1\%$ relative error for $n = 5$
 - Relative error increases to 0.3-1.5% for maximum $n = 2$
- **Coil center varies little with n**

Plates and coils appear shifted in +Y direction



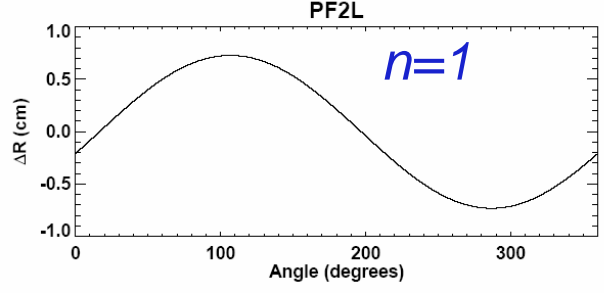
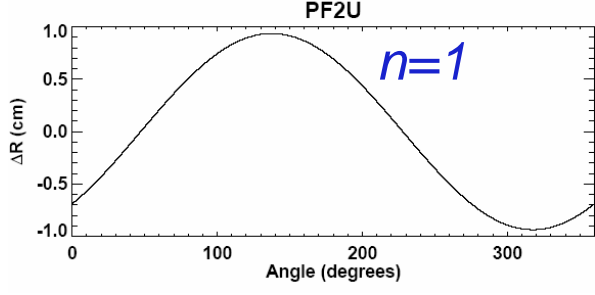
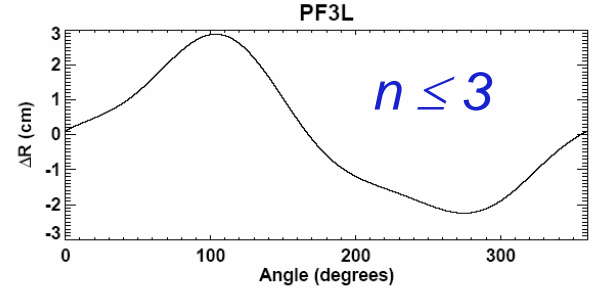
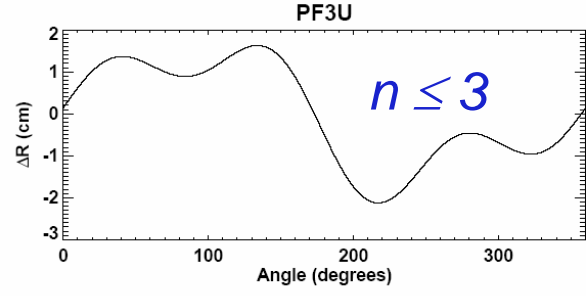
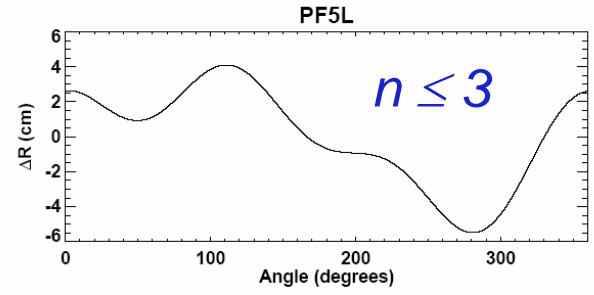
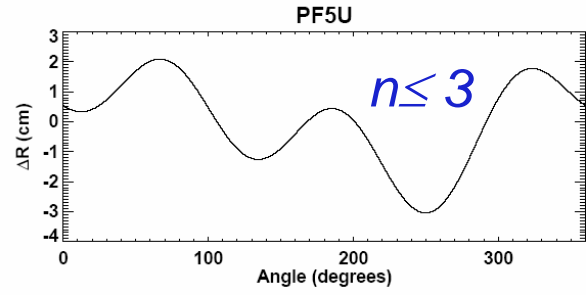
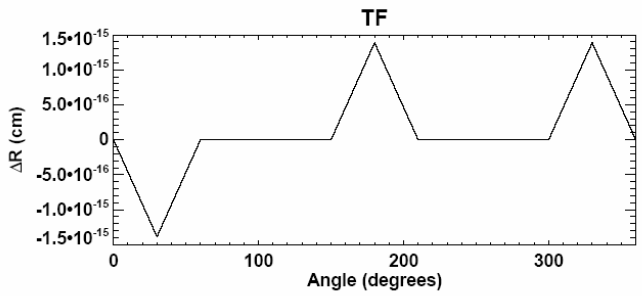
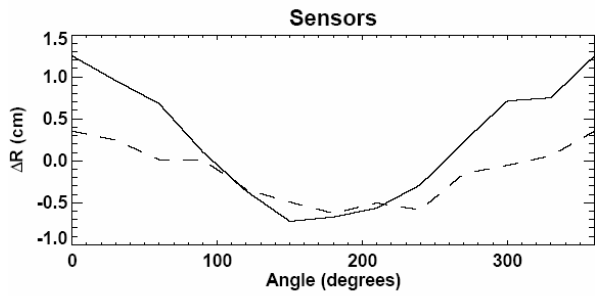
Uses relative sensor coords. from last year + **updated origin**
(new sensor data taken 9/17/04)



- PF5 & PF3 center coordinates are clustered within $\pm 2\text{cm}$...
 - Consistent with reduced mode locking since PF5 moved
 - PF2 system may be shifted relative to PF5 & 3
- **Coil feeds corrupting data?**

Machine CL taken to be axis of CS

“Best-fit” ΔR versus toroidal angle for sensors & coils



FARO arm measurement plans:



GOAL: Measure position and 3D shape of vessel, PP plates/sensors, and PF coils relative to true centerline of device, or CL as defined by CS tiles inside vessel

- Needed for accurate error field calculations
 - Another point: various profile diagnostics may not be viewing where we think they are relative to the true magnetic boundary, and/or from the reconstructions....
1. Measure X,Y vs. toroidal angle ϕ of CS at top and bottom inside vessel, and compare to the centerline of device measured with CS out of vessel (**#1 DONE**)
 - This defines the position of the CS centerline and the magnetic field from OH & TF
 2. Re-measure X,Y,Z of 6 points on PPP tiles that define each B_R sensor (**DONE**)
 - Eliminates any error from inferring position of middle 2 points
 3. Measure X,Y vs. ϕ of vessel wall ID on the inside of the machine at Z-positions above and below mid-plane as far from mid-plane as possible
 - Get full PF5 position using this data + external wall/coil distance measurements.
 - Plates and vessel carry current – this data finds magnetic center of vessel.
 4. Measure PF5 coil X,Y,Z directly where possible with arm inside vessel
 - Take advantage of any access through large open ports during opening