

TF Joint Operations Review Commissioning Plan

- ✓ Test Shots
- ✓ Instrumentation
- ✓ Benchmarking

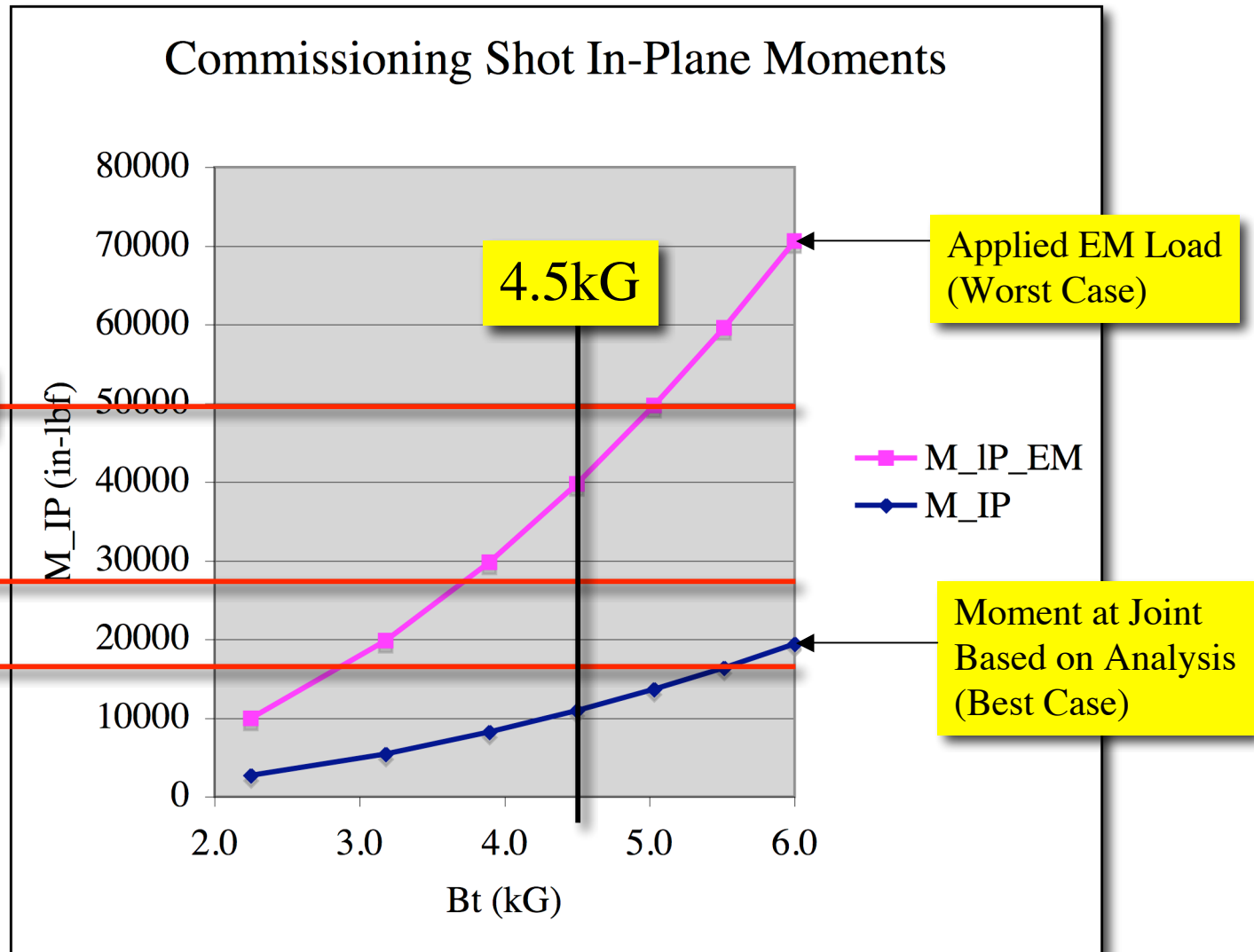
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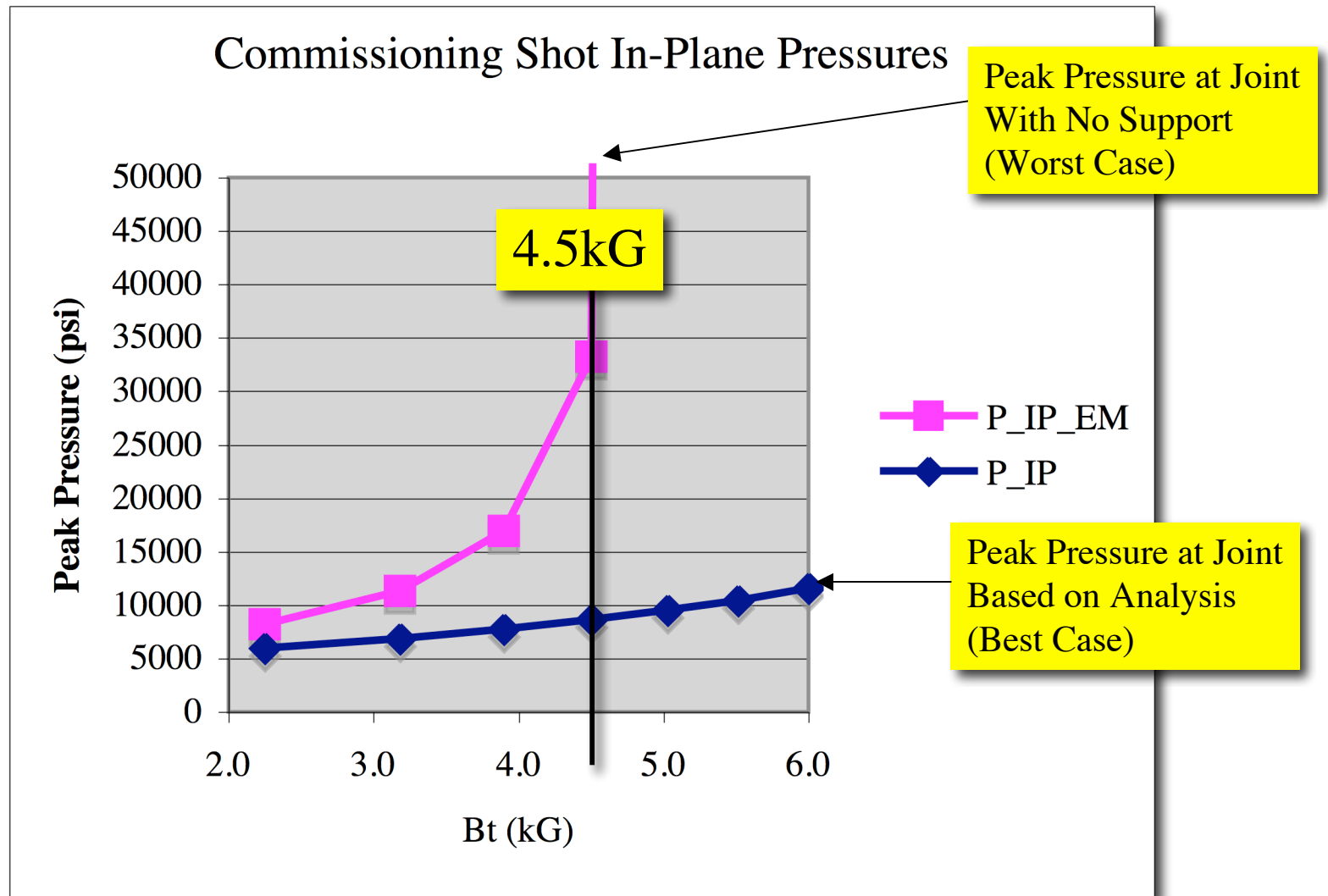
Shot List (Initial Phase to 4.5kG)

	Bt (kG)	TF_dT (degC)	TF_Tflat (sec)	PF	Event	Time (sec)	ITF (kA)	IOH (kA)	IPF1A (kA)	IPF1B (kA)	IPF2 (kA)	IPF3 (kA)	IPF4 (kA)	IPF5 (kA)
1	2.25	11	1	0%	TF_SOFT	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	1.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	3.18	22	1	0%	TF_SOFT	0.0	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	1.0	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	3.90	35	1	0%	TF_SOFT	0.0	46.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	1.0	46.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	4.50	48	1	0%	TF_SOFT	0.0	53.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	1.0	53.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4a	4.50	48	1	OH Only				-/+12						
4b				PF1a Only					-7.5/ +2.5					
4c				PF1b Only						-5				
4d				PF2 Only							-5			
4e				PF3 Only								-2.5/ +7.5		
4f				PF5 Only										+10
5	2.25	11	1	50%	TF_SOFT	0.0	26.7	-12.0	2.5	0.0	0.0	-2.5	0.0	0.0
				50%	OHSS	0.5	26.7	12.0	-7.5	-5.0	-5.0	7.5	0.0	10.0
				50%	TF_EOFT	1.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	4.50	48	1	100%	TF_SOFT	0.0	53.4	-24.0	5.0	0.0	0.0	-5.0	0.0	0.0
				100%	OHSS	0.5	53.4	24.0	-15.0	-10.0	-10.0	15.0	0.0	20.0
				100%	TF_EOFT	1.0	53.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	5.03	41	0.5	0%	TF_SOFT	0.0	59.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	0.5	59.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	5.51	53	0.5	0%	TF_SOFT	0.0	65.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	0.5	65.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	6.00	71	0.5	0%	TF_SOFT	0.0	71.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0%	TF_EOFT	0.5	71.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	6.00	71	0.5	50%	TF_SOFT	0.0	71.2	-12.0	2.5	0.0	0.0	-2.5	0.0	0.0
				50%	OHSS & TF_EOFT	0.5	71.2	12.0	-7.5	-5.0	-5.0	7.5	0.0	10.0
11	6.00	71	0.5	100%	TF_SOFT	0.0	71.2	-24.0	5.0	0.0	0.0	-5.0	0.0	0.0
				100%	OHSS & TF_EOFT	0.5	71.2	24.0	-15.0	-10.0	-10.0	15.0	0.0	20.0

In-Plane Moments Corresponding to Bt Levels in Shot List

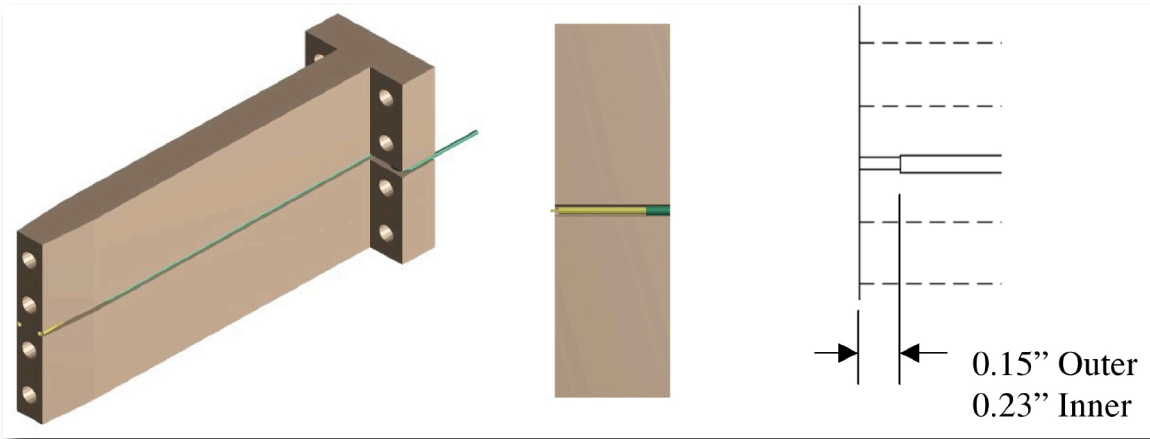
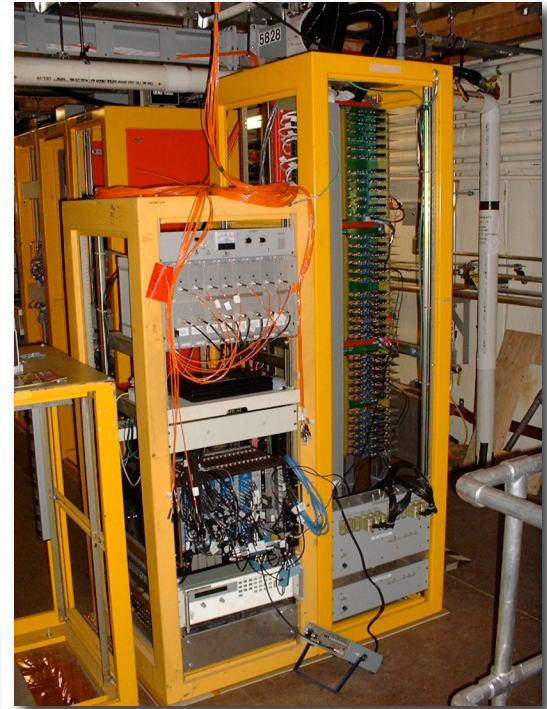


In-Plane Pressures Corresponding to Bt Levels in Shot List



Voltage Probes

- Same as last run except 8 channels have A&B monitoring
- Allows monitoring of out-of-plane loading
- Web page developed to archive probe vs. channel assignments (instead of reliance on notebook records)



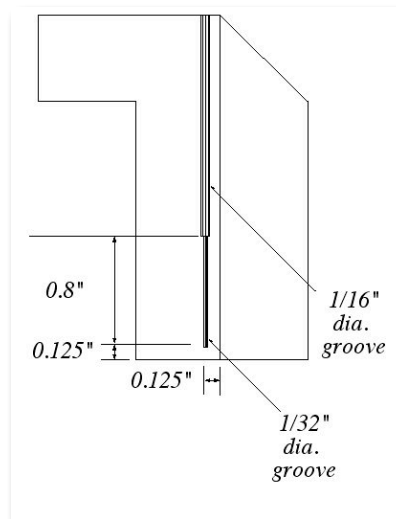
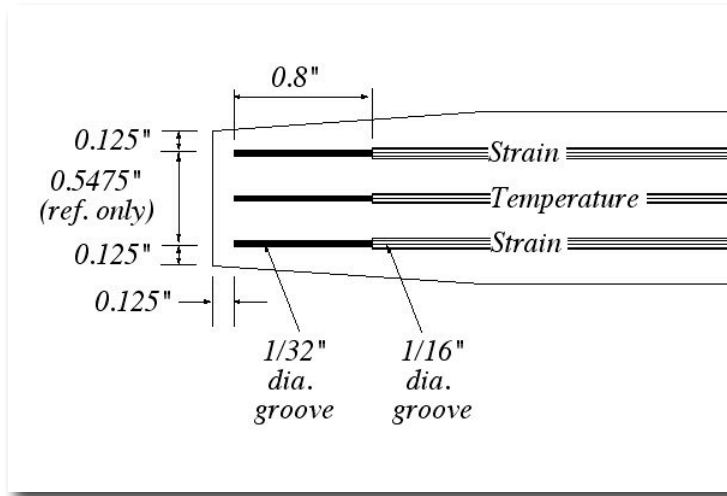
Fiber Optic Temperature, Strain, and Displacement

- Flags (inner, outer/top, bottom)
 - ✓ 4 flags x 3 strain/flag = 12 strain
 - ✓ 4 flags x 1 temp/flag = 4 temp
- Hub and Flag twist angle (top, bottom)
 - ✓ 2 displacement
- Flag end ΔZ & $\Delta\phi$ motion (top, bottom)
 - ✓ 4 displacement
- Hub (top only)
 - ✓ 1 displacement

New

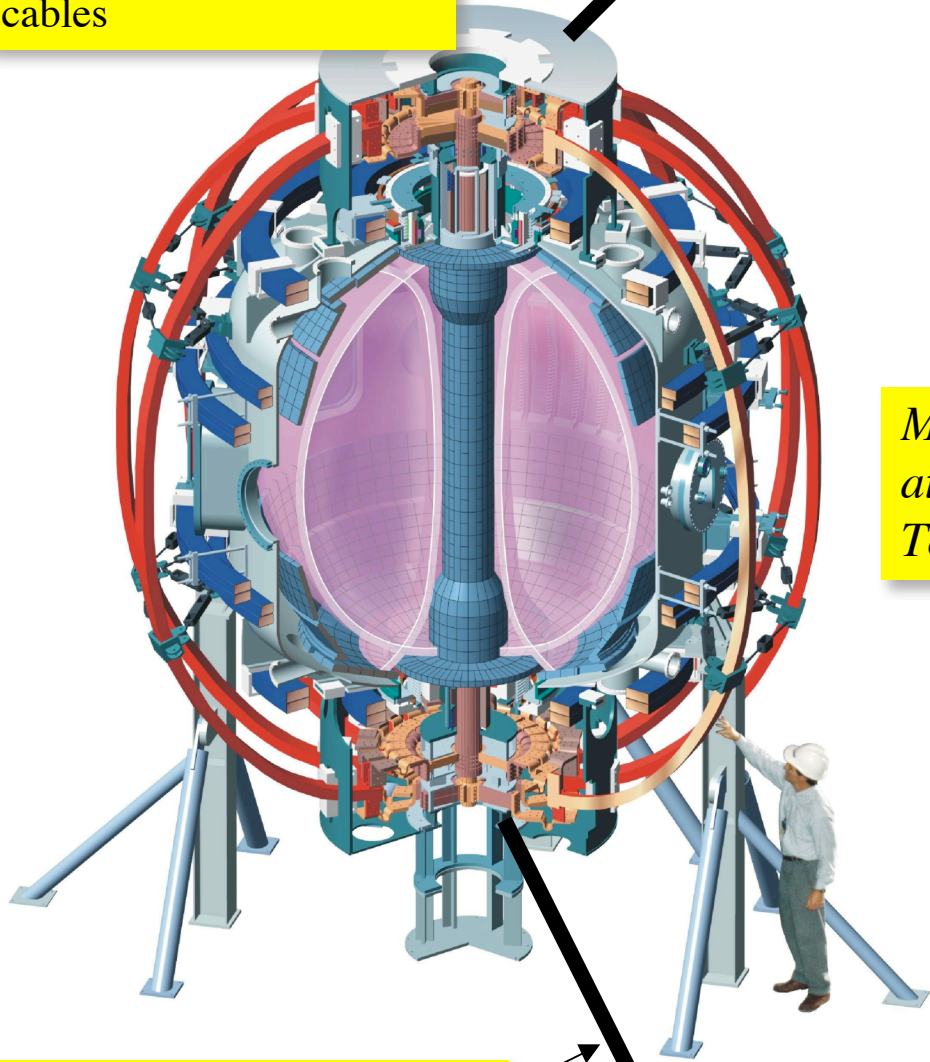
Total 23 transducers

8 conditioner channels



FISO Technologies, Inc.

Top Voltage Probe Cable
Tray + 8 f/o extension
cables



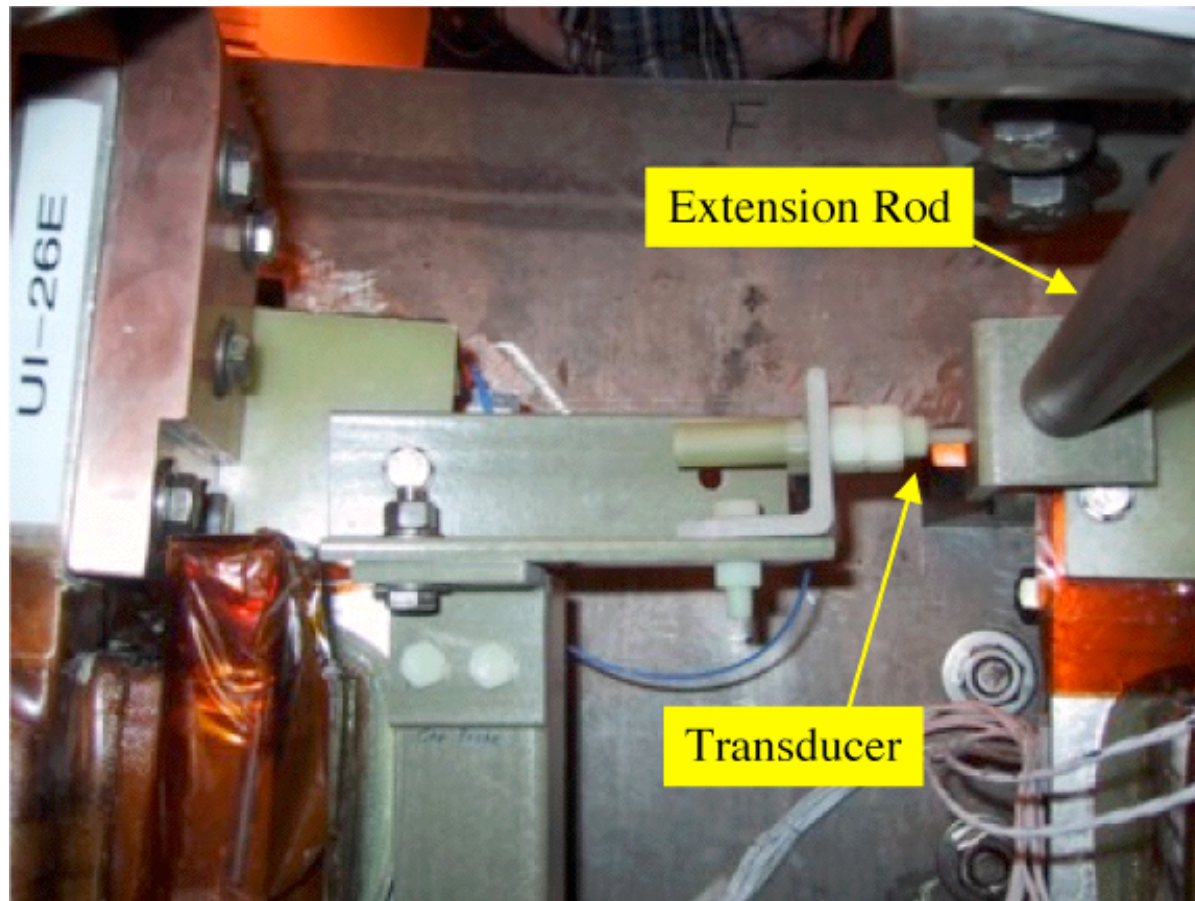
*Max 8 signals
at a time from
Top or bottom*

Bottom Voltage Probe Cable
Tray + 8 f/o extension
cables



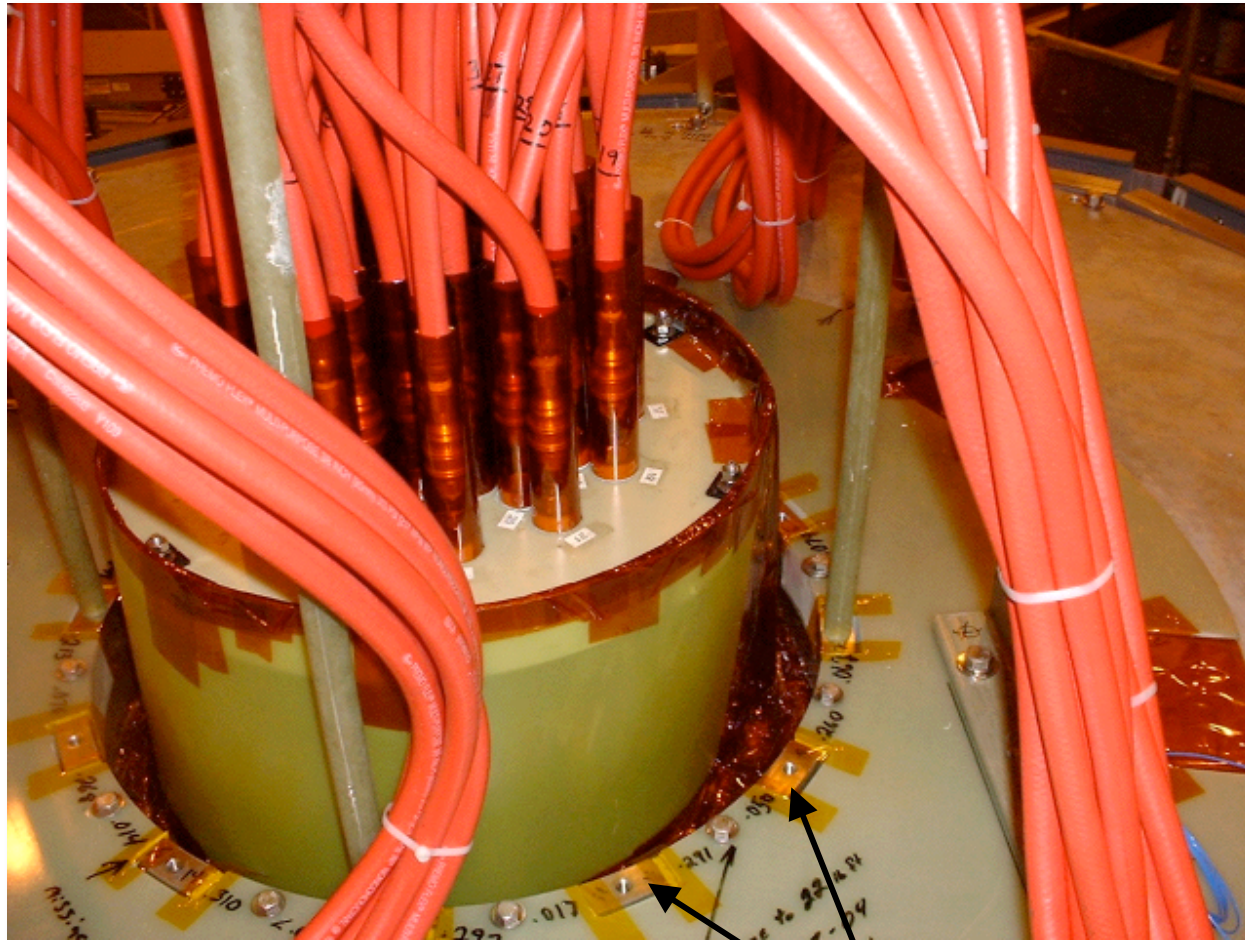
Fiber Optic Displacement Mounting

- Monitor Flag End Motion Same As Last Time



Fiber Optic Displacement Mounting

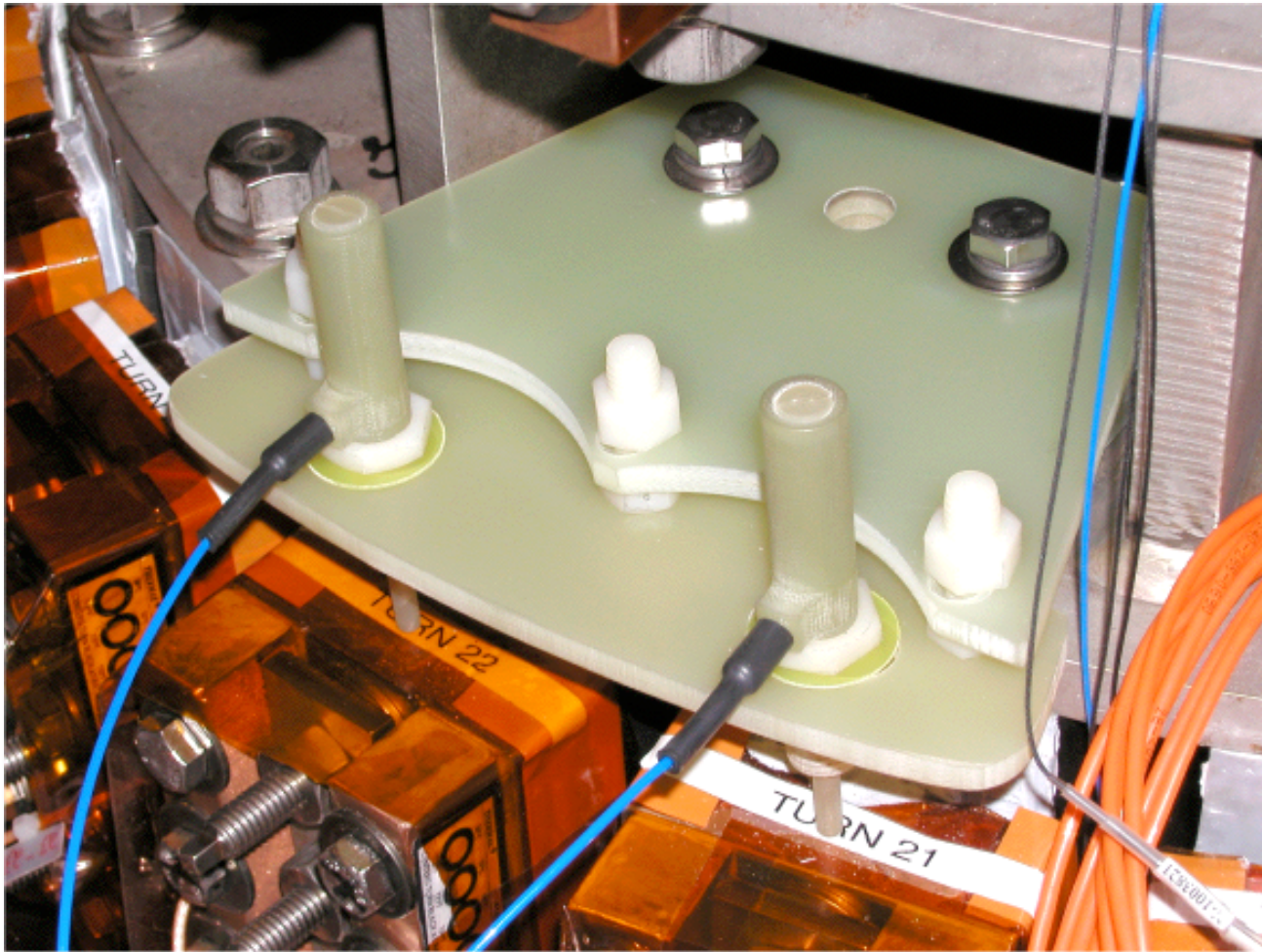
- Relocate Hub/Spline Twist on to Hub



Top Hub Plate Connections

Fiber Optic Displacement Mounting

- Modify for ΔZ & $\Delta\phi$ motion on a single flag
- Extend over new insulating boots



Benchmarking Measurements

			#1		#2		#3		#4		#5			#6		
			SOFT	EOFT	SOFT	EOFT	SOFT	EOFT	SOFT	EOFT	SOFT	OHSS	EOFT	SOFT	OHSS	EOFT
Outer Flag	delta T (degC)	ANSYS														
	Flag Strain A (μ S)	ANSYS														
	Flag Strain B (μ S)	ANSYS														
	Shoe Strain B (μ S)	NASTRAN														
	Flag End Toroidal Motion (mils)	NASTRAN														
	Flag End Poloidal Motion (mils)	NASTRAN														
	Flag End Toroidal Twist (degrees)	NASTRAN														
	Apparent Resistance (nohm)	ANSYS														
Inner Flag	delta T (degC)	ANSYS														
	Flag Strain A (μ S)	ANSYS														
	Flag Strain B (μ S)	ANSYS														
	Shoe Strain B (μ S)	NASTRAN														
	Flag End Toroidal Motion (mils)	NASTRAN														
	Flag End Poloidal Motion (mils)	NASTRAN														
	Flag End Toroidal Twist (degrees)	NASTRAN														
Bundle	twist angle (degrees)	NASTRAN														
Hub	twist angle (degrees)	NASTRAN														

Info to be extracted from analysis

- In addition, IP and OOP moments will be backed-out from voltage probe data for one-PF-at-a-time shots to benchmark against influence matrix generated from NASTRAN

Procedure

- Initial phase will commission up to 4.5kG
- Test shots will be conducted and data compared to predictions after each shot
- Performance of system vs. predictions will be judged
- Modeling coefficients and protection limits will be iterated including additional NASTRAN runs as necessary
- Operating envelope will be adjusted accordingly
- Later phase of commissioning toward 6kG will be performed at future date pending results at 4.5kG and when needed for NSTX research program