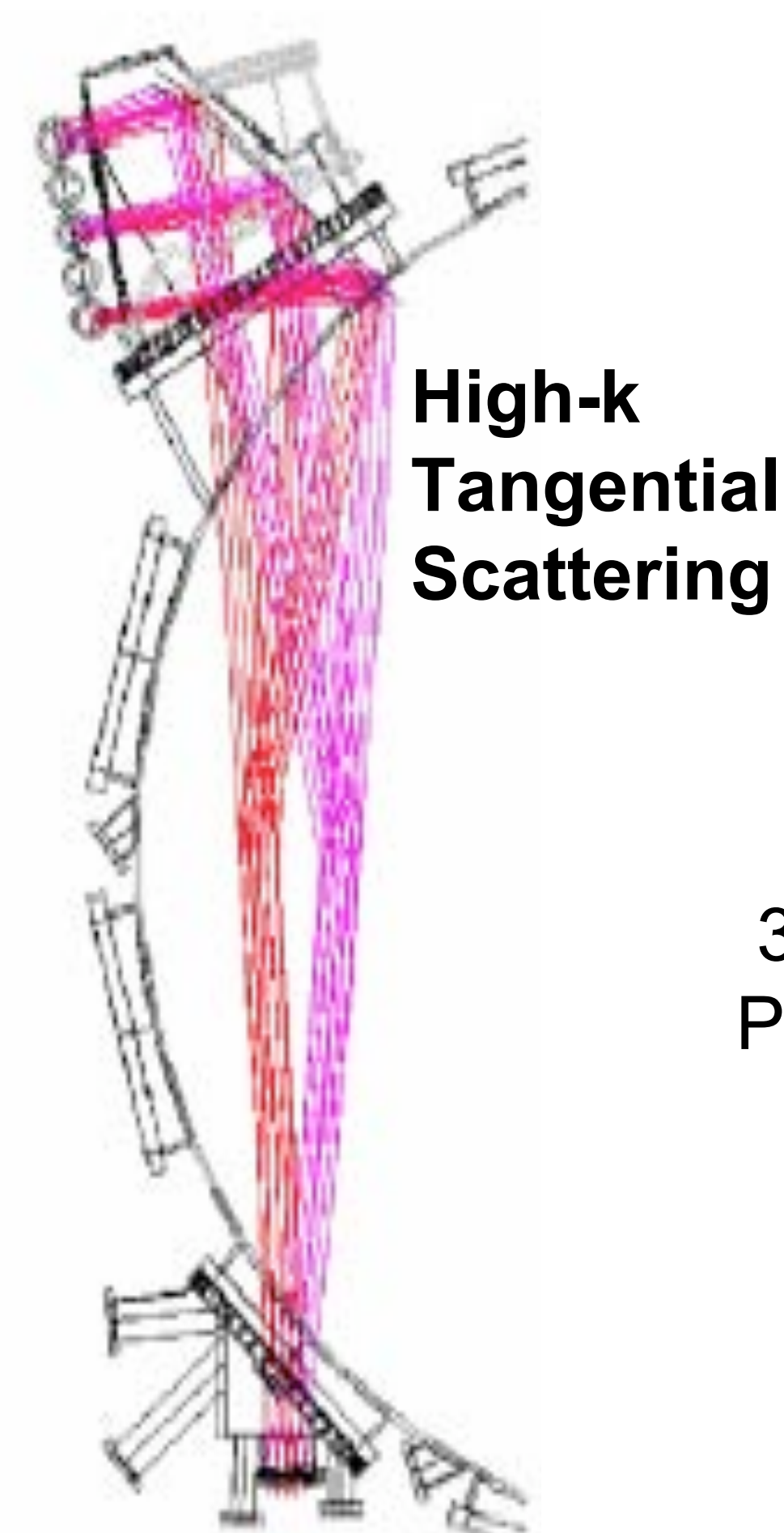


BES together with high-k to provide a comprehensive turbulence diagnostic set



High-k Tangential Scattering

Biased Electrodes

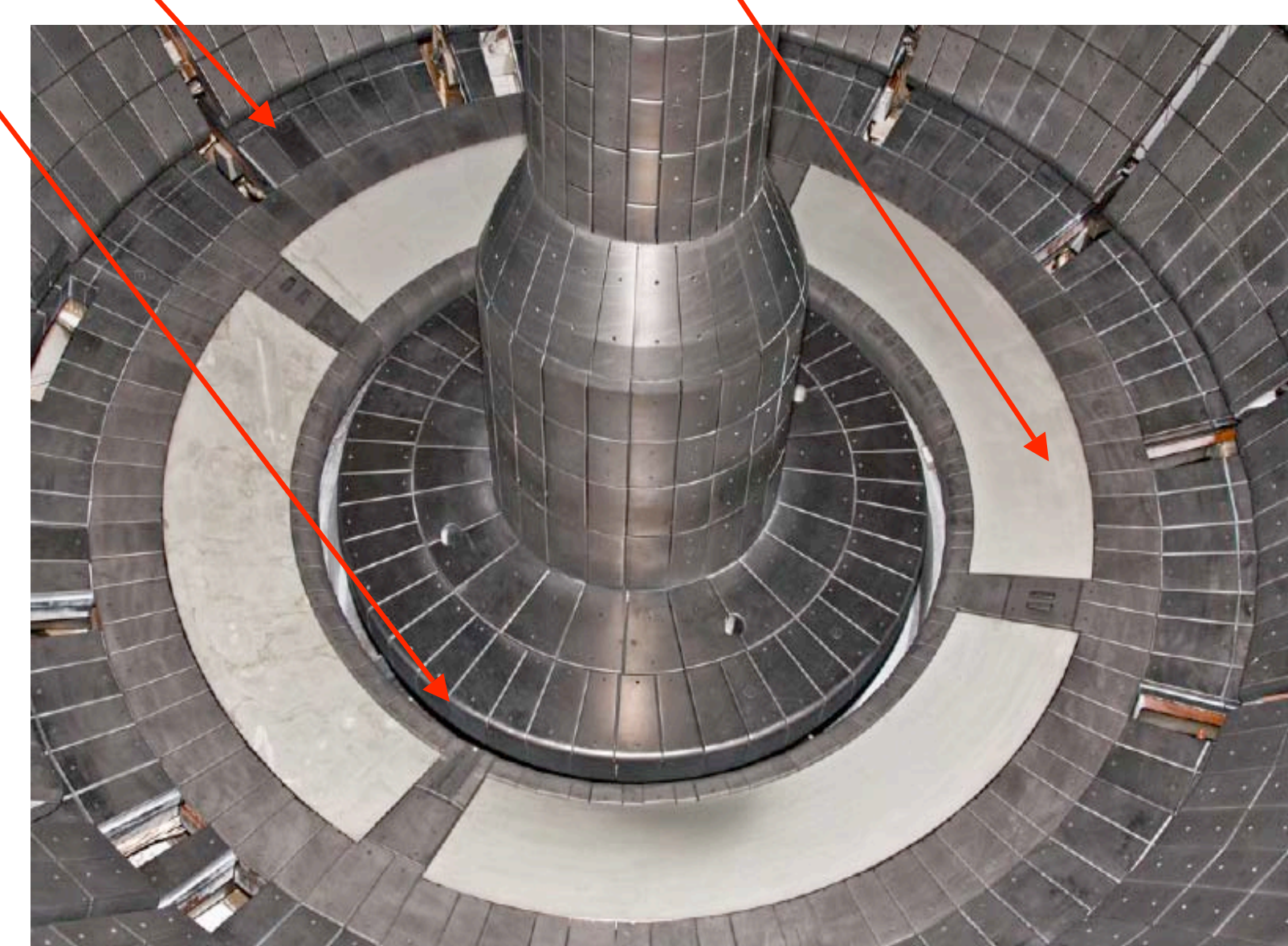
3x33 Langmuir Probe Array



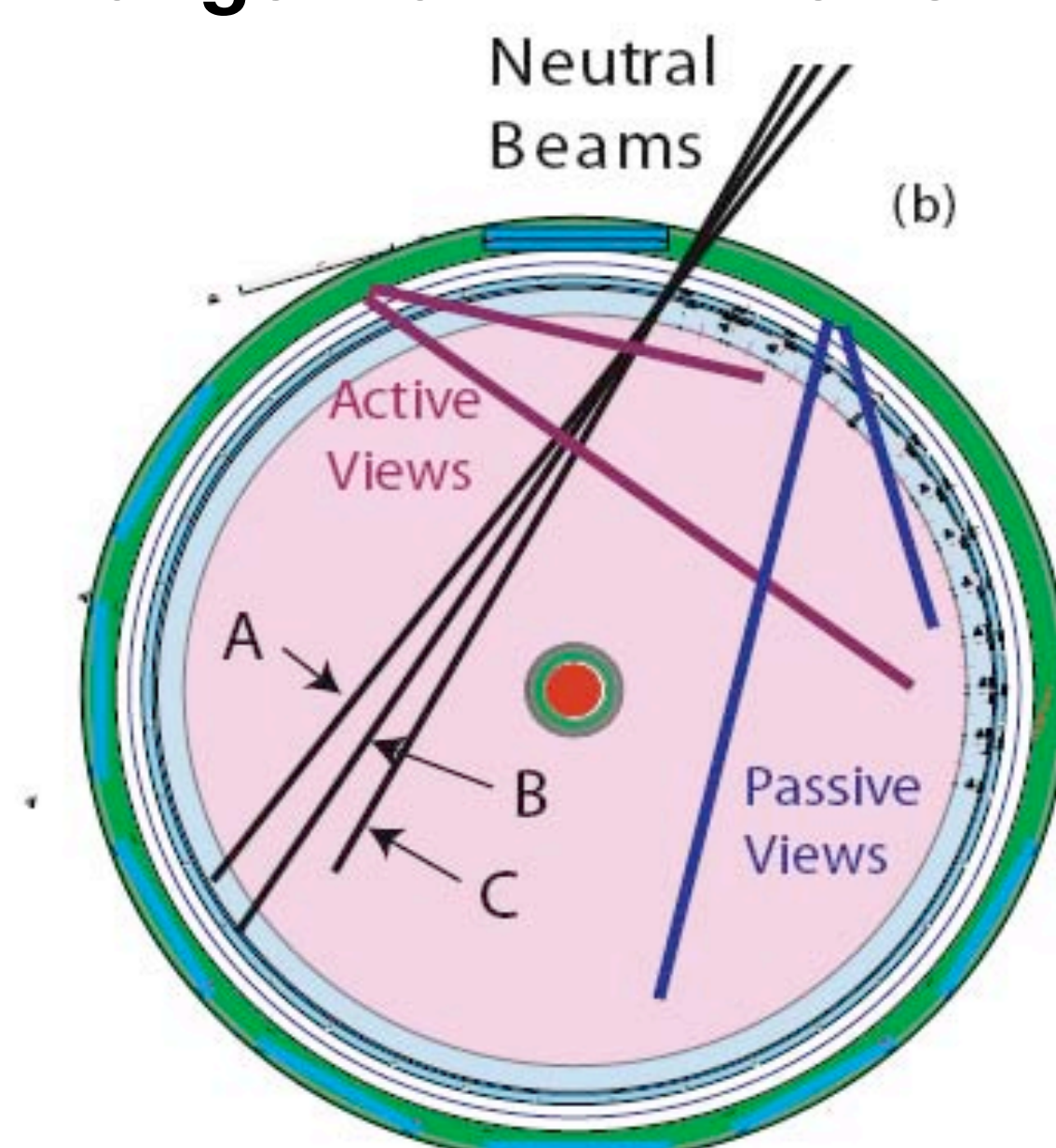
FY2010-12 milestones address key physics issues central to the mission of NSTX exploiting new facility diagnostic capabilities

	FY2010	FY2011	FY2012
Expt. Run Weeks:	15 w/ARRA	4	10
1) Transport & Turbulence		BES, High-k	BES, High-k
2) Macroscopic Stability		Assess fluctuations responsible for turbulent ion and electron energy transport	Compare measured turbulence fluctuations to theory & simulation
3) Boundary/Lithium Physics		BES, High-k, LLD	Snowflake, LLD, MPTS
4) Characterize HHFW heating, CD, and ramp-up in deuterium H-mode		Assess relationship between lithiated surface conditions and edge and core plasma conditions	Assess very high flux expansion divertor operation
5) Characterize HHFW heating, CD, and ramp-up in deuterium H-mode			CHI, HHFW, NBI
6) Advanced Scenarios & Control		Assess confinement, heating, and ramp-up of CHI start-up plasmas	Assess confinement, heating, and ramp-up of CHI start-up plasmas
Joint Research Targets (3 US facilities):	LLD, HHFW	LLD, HHFW, NBI	LLD, HHFW, NBI
Understanding of divertor heat flux, transport in scrape-off layer	MPTS, MSE-LIF	BES, High-k	
Characterize H-mode pedestal structure		Draft: Understand core transport and enhance predictive capability	

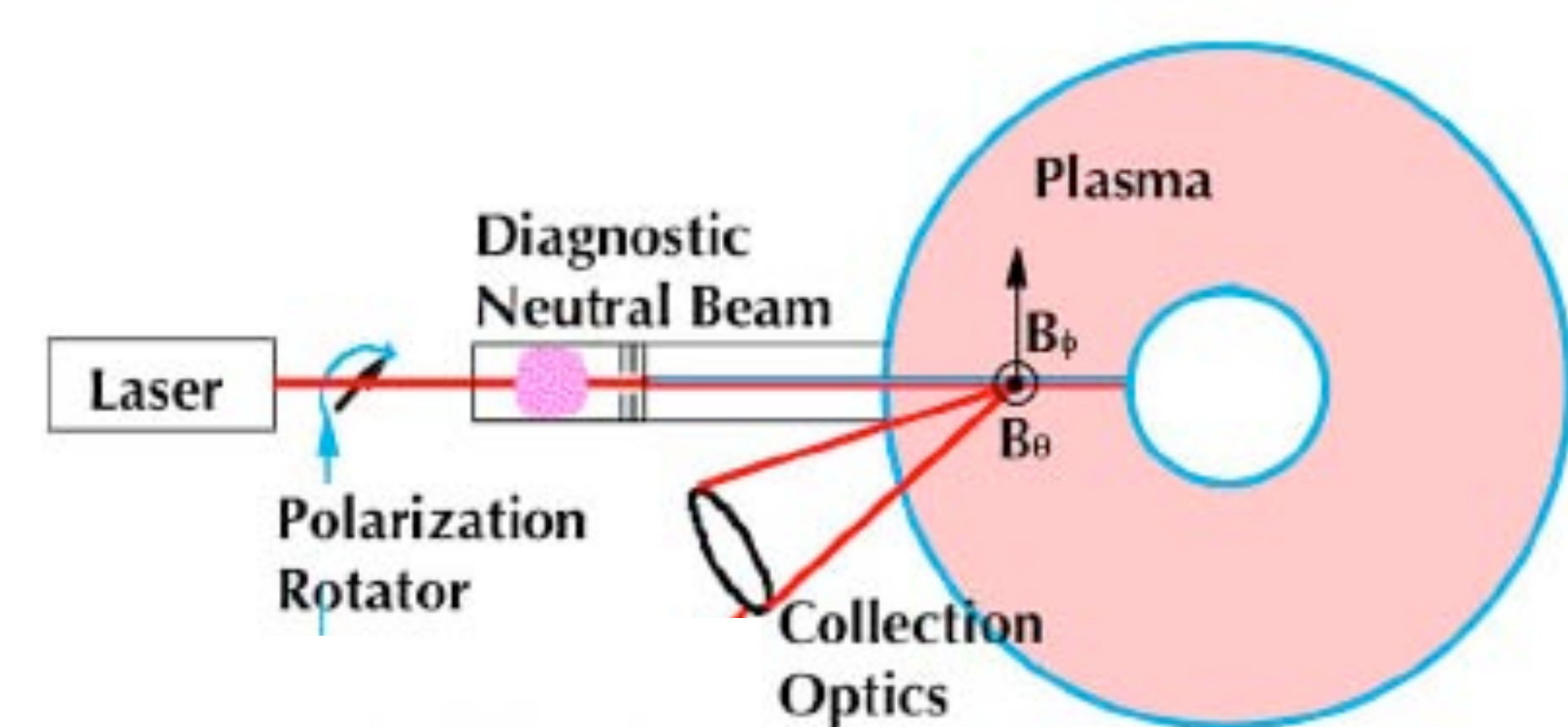
Liquid Lithium Divertor (LLD) Operated



Tangential FIDA Views



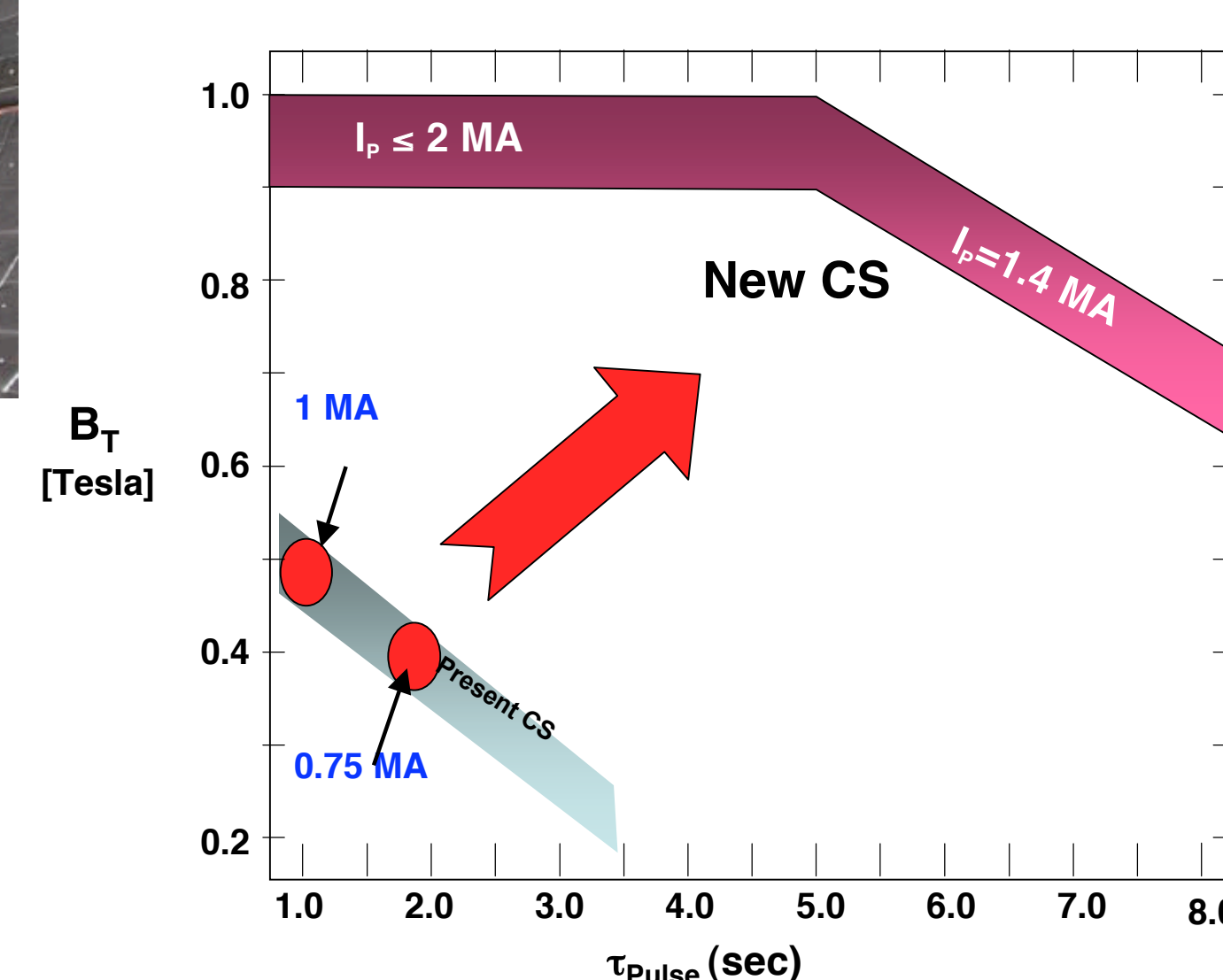
MSE-LIF to Measure $E_r(r)$, $B(r)$



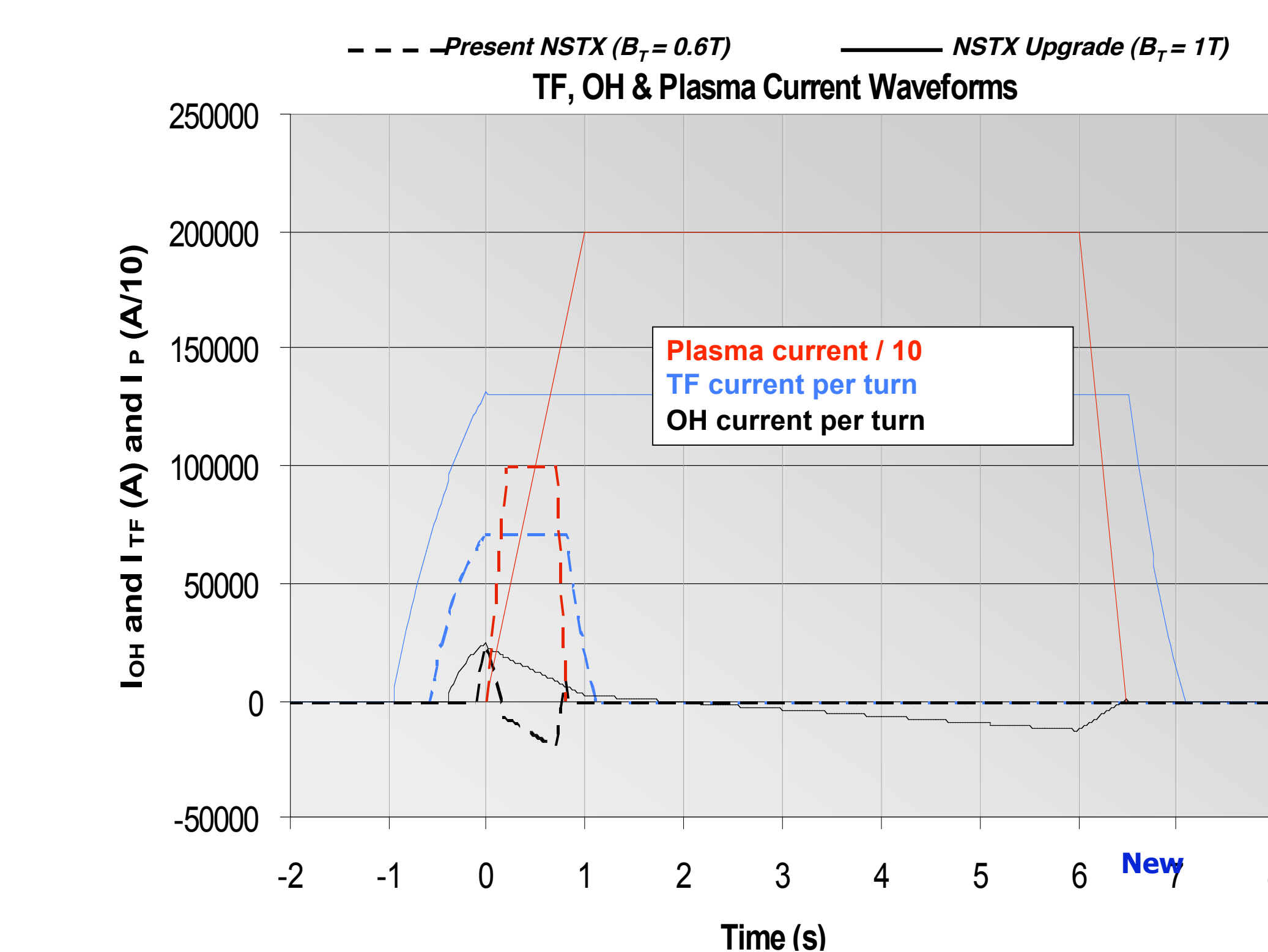
	FY 10	FY 11	FY 12
ARRA Run Weeks	1 1 4	1 0	1 2
Heating & CD	● HHFW Antenna Upgrade	● HHFW ELM Avoidance	Upgrade Outage FY 2012-14
MHD and ASC	● β control (NBI)	● 2nd SPA Supplies	New Center-stack
T&T	● Upgraded FIRETIP (UCD)	● Real Time Rotation Diagnostic	● Real Time Rotation Control
Boundary / Li	● BES (U. Wisconsin)	● MPTS Extra channels	● MSE-LIF (Nova Photonics)
Energetic Particles	● LLD (SNL)	● Enhanced LLD	● Materials Analysis Particle Probe (MAPP) (Purdue)
Start-Up	● PMI Probe	● Tangential FIDA(UCI)	● CHI Absorber Control Coils (U. Washington)

New Center-Stack

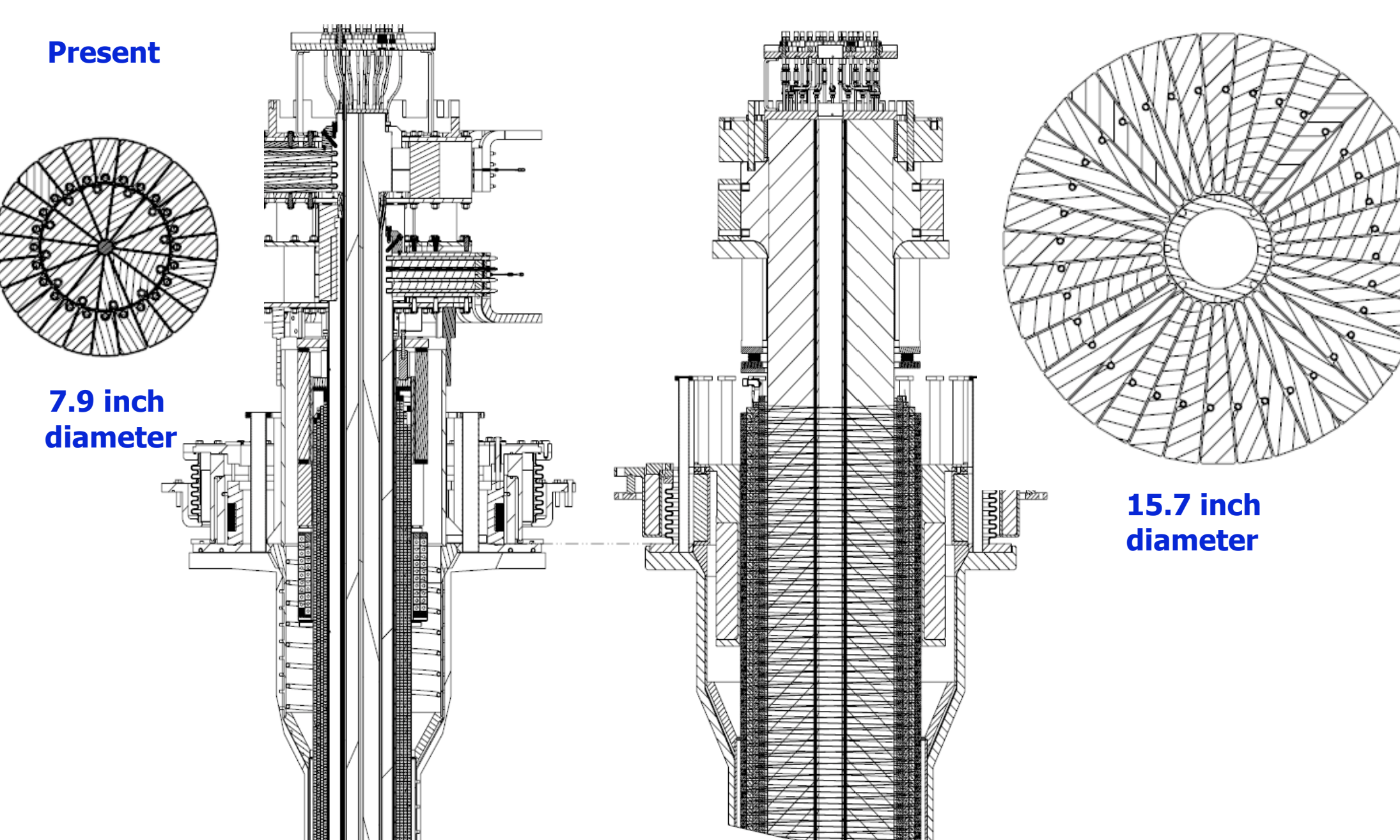
New center stack for 1T, 2MA, 5s to access reduced ν^* , 100% non-inductive ST plasmas



TF magnet operation at ~1T (vs. 0.55T) within a factor of 2 of next-step STs



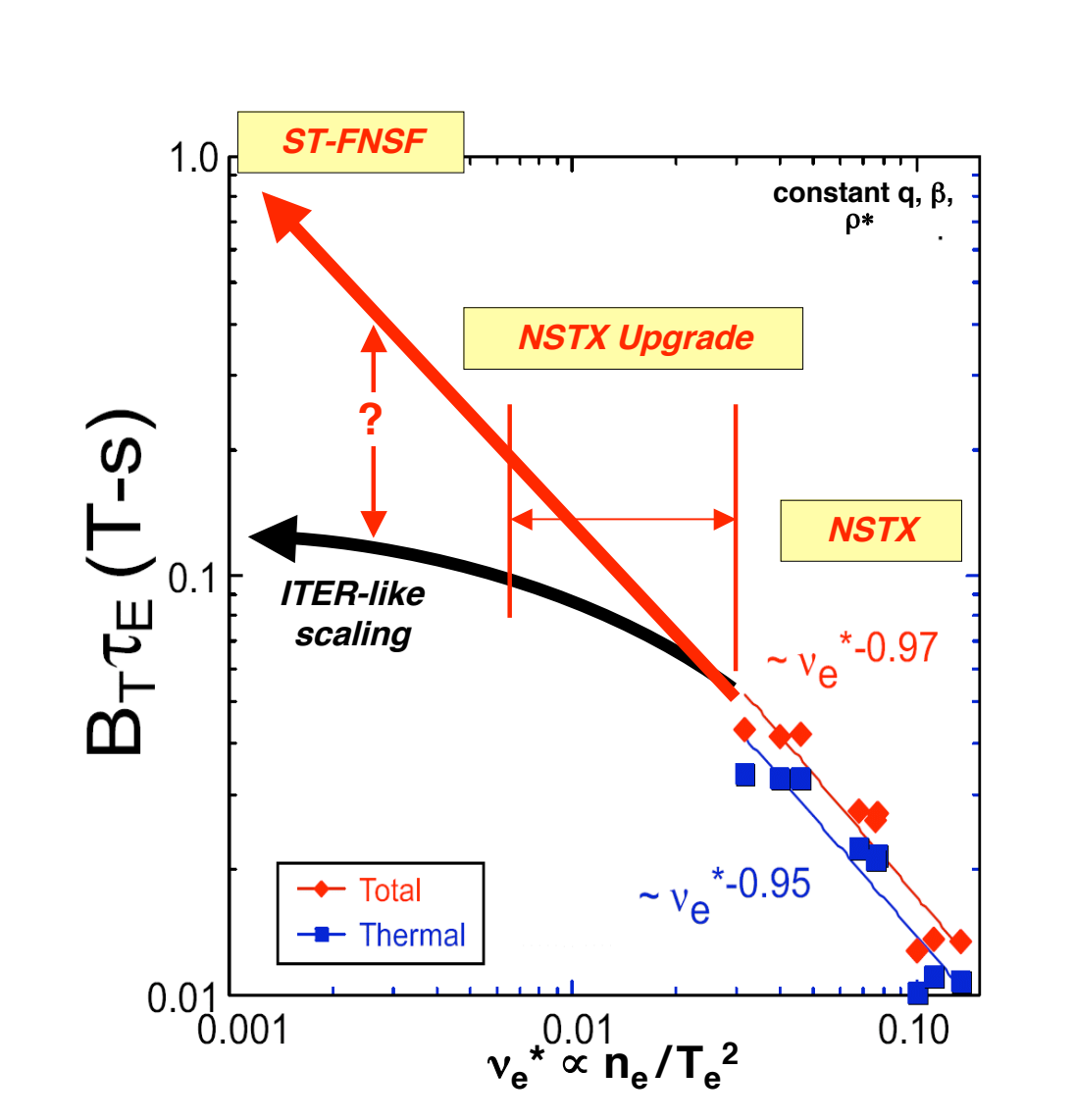
	Base NSTX	NSTX Upgrade
R_0 [m]	0.854	0.934
Min. aspect ratio	1.28	1.5
I_p [MA]	1	2
B_T [T]	0.55	1
τ_{pulse} [s]	1	5
$\tau_{repetition}$ [s]	600	1000
$R_{center_stack} = R_0 + a$ [m]	0.185	0.315
$R_{antenna} = R_0 + a$ [m]	1.574	1.574
Total OH flux [Wb]	0.75	2.1



New TF Bundle contains 36 identical conductors with one-layer joint design - Present TF bundle contains two types of conductors and two-layer joints
New bolted joints are located at larger radius enabling lower joint current density and lower magnetic field at the joint than the present design.

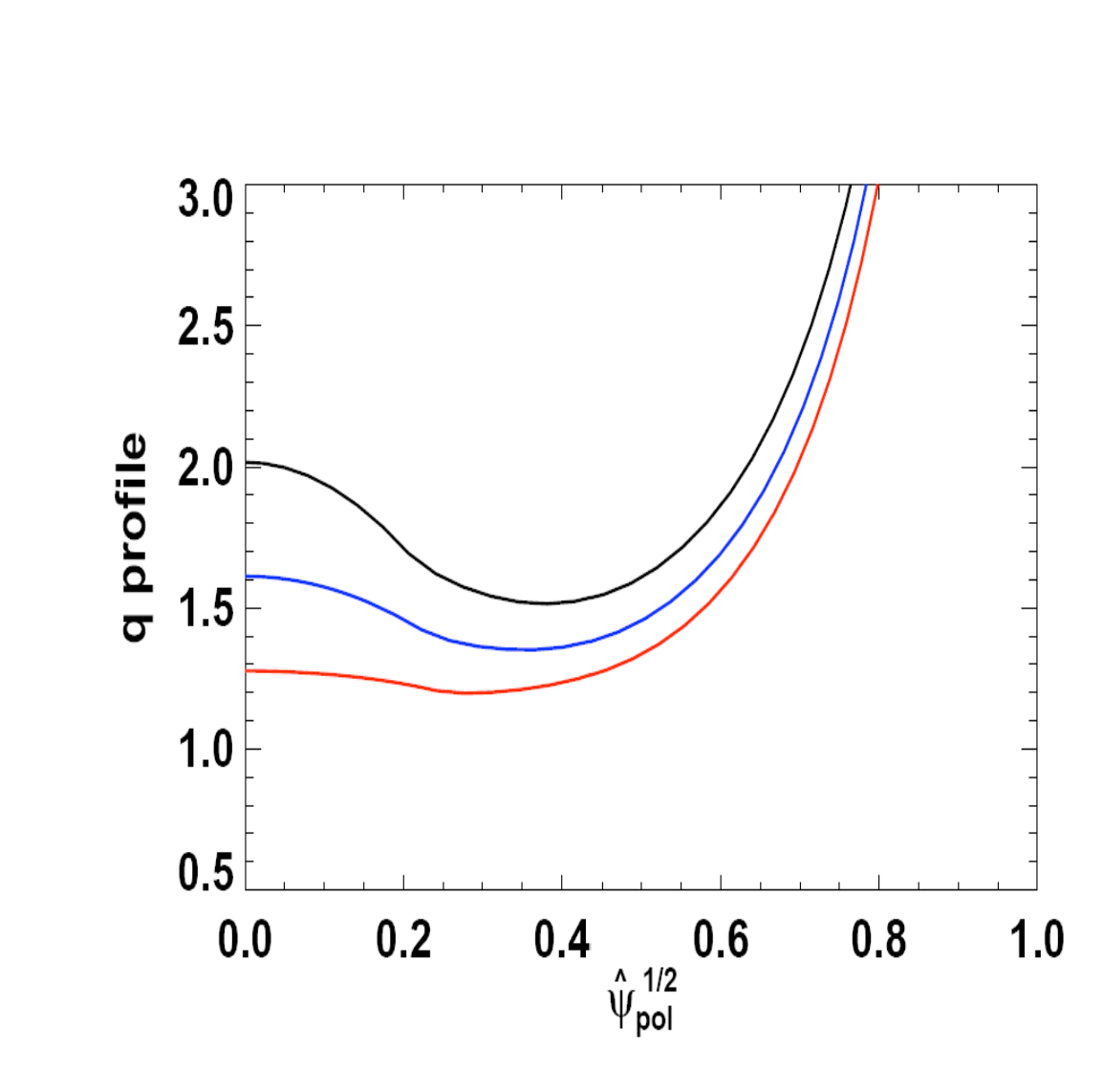
NSTX Upgrade will address many important questions for fusion

How does confinement vary with normalized temperature, pressure?



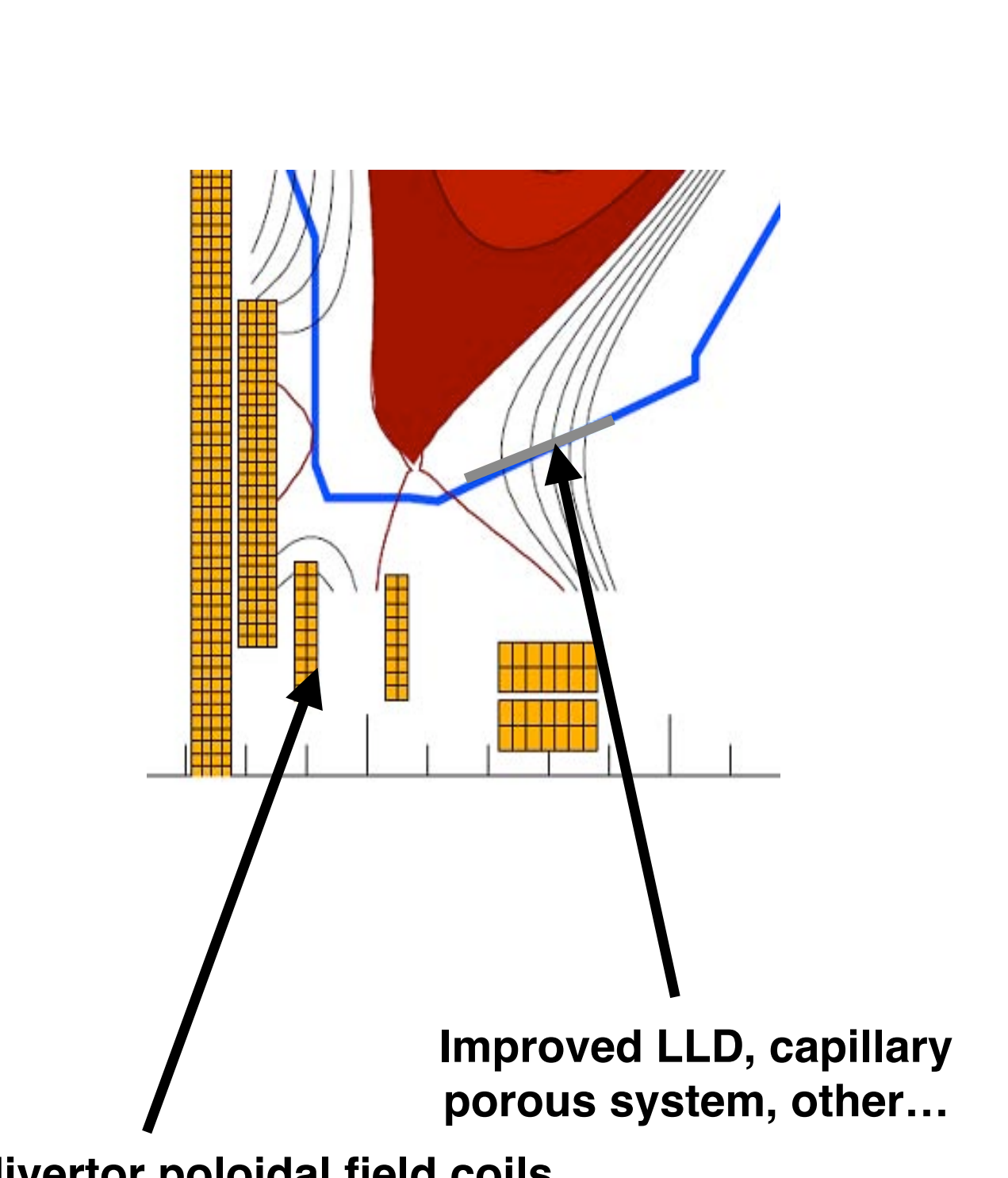
Normalized electron collisionality reduction from higher temperature from higher field, current, heating

Can we create, sustain, and control high β , low I_p ST plasmas without induction?



q profile control in 100% non-inductive plasma using mix of existing and additional NBI sources

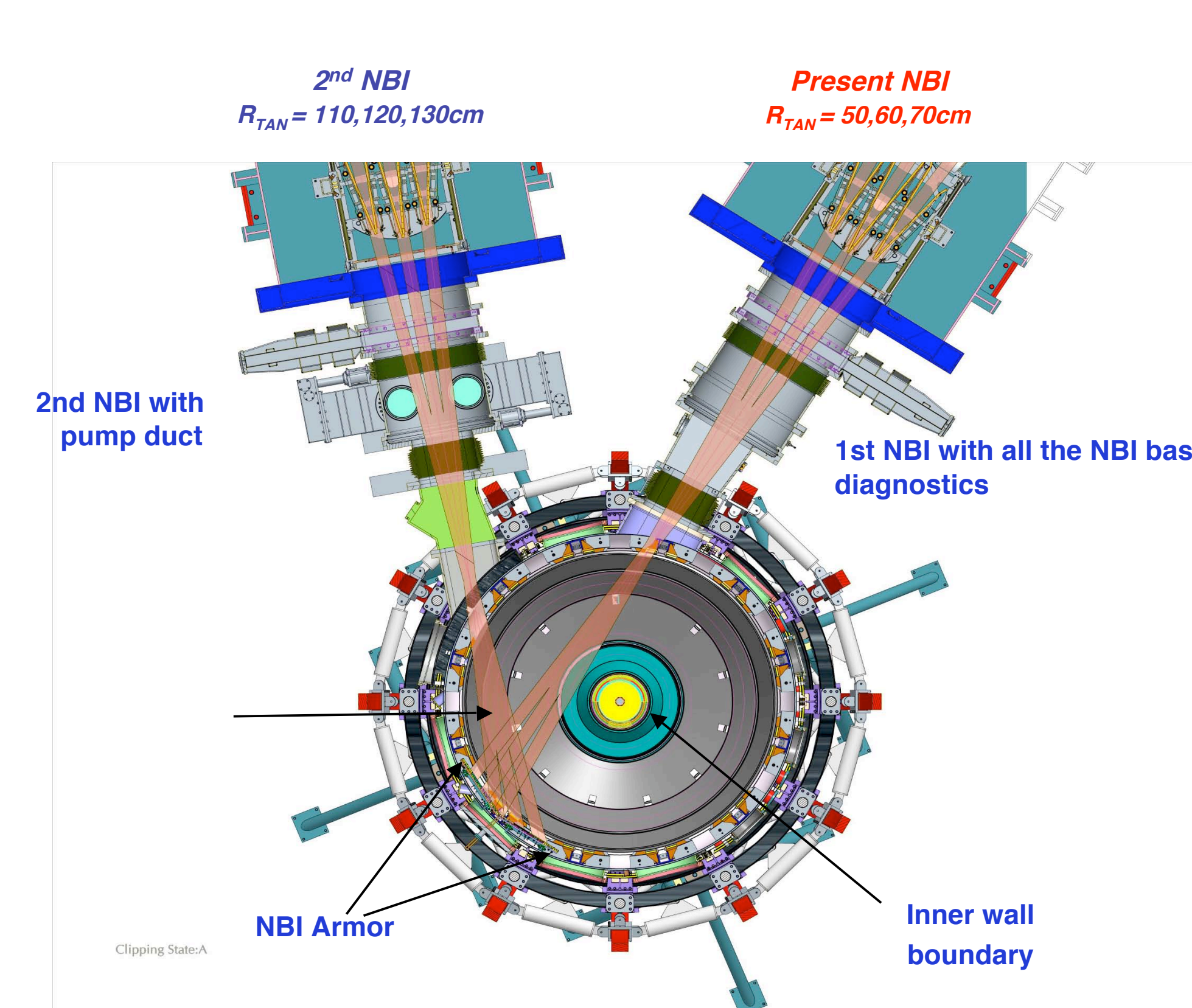
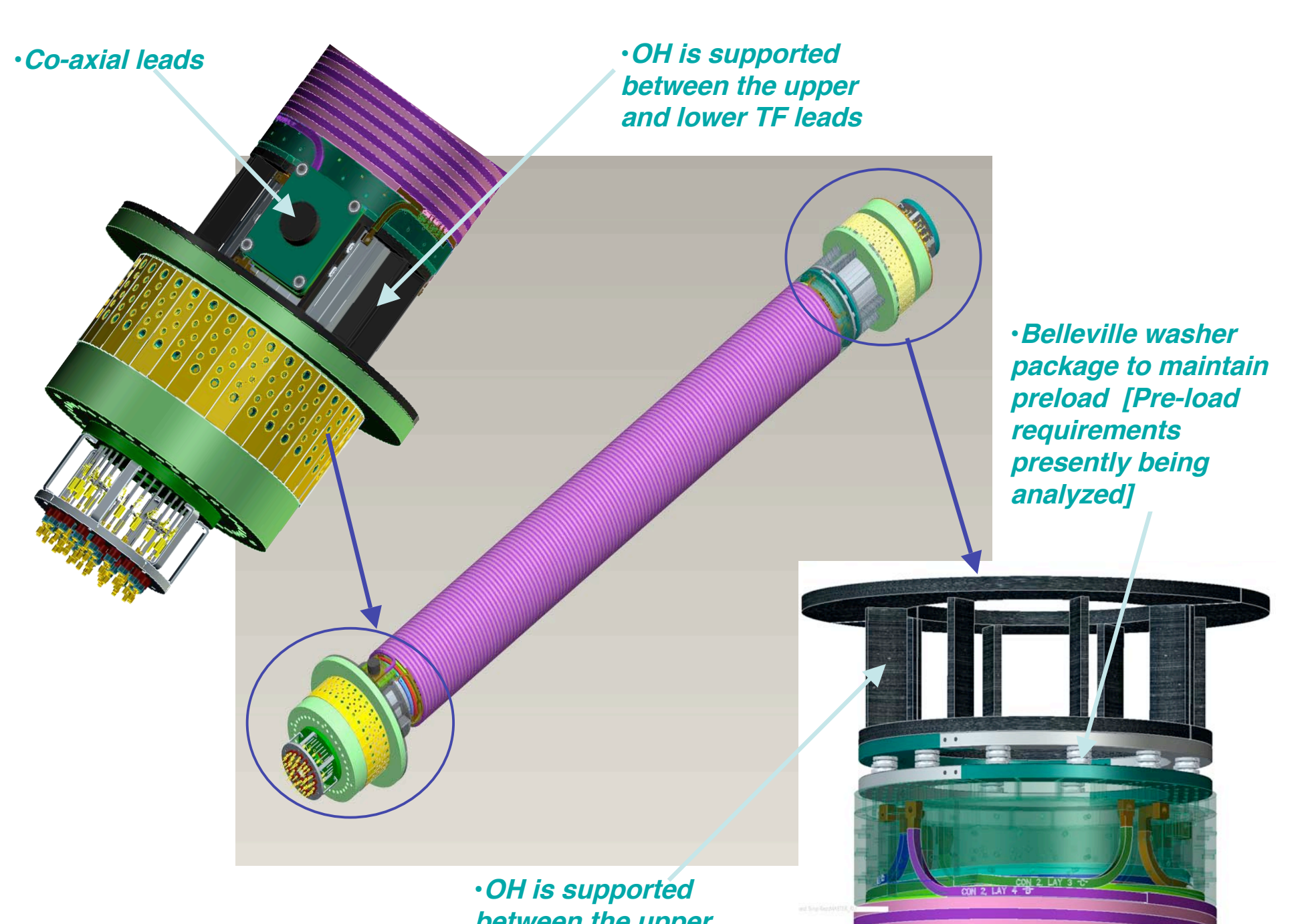
Can we manage the power & particle exhaust of high-performance plasmas?



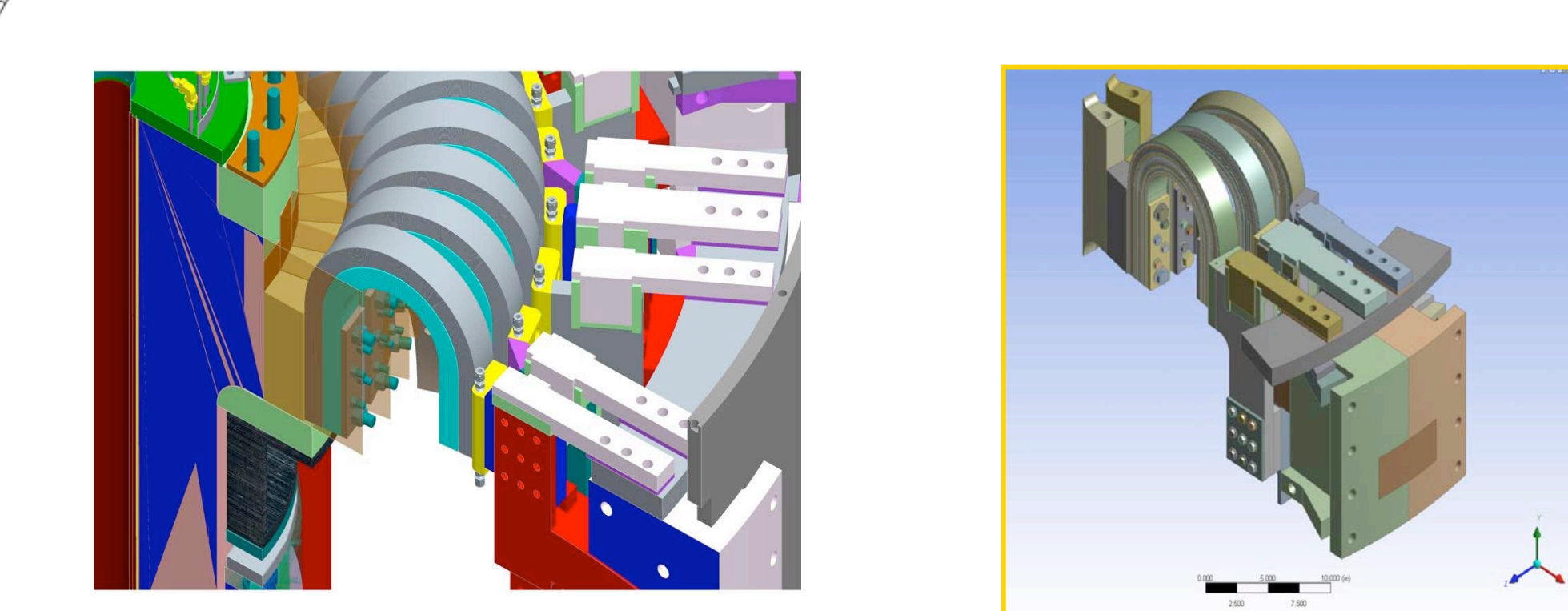
Improved LLD, capillary porous system, other...
New divertor poloidal field coils

2nd Neutral Beam Injection System

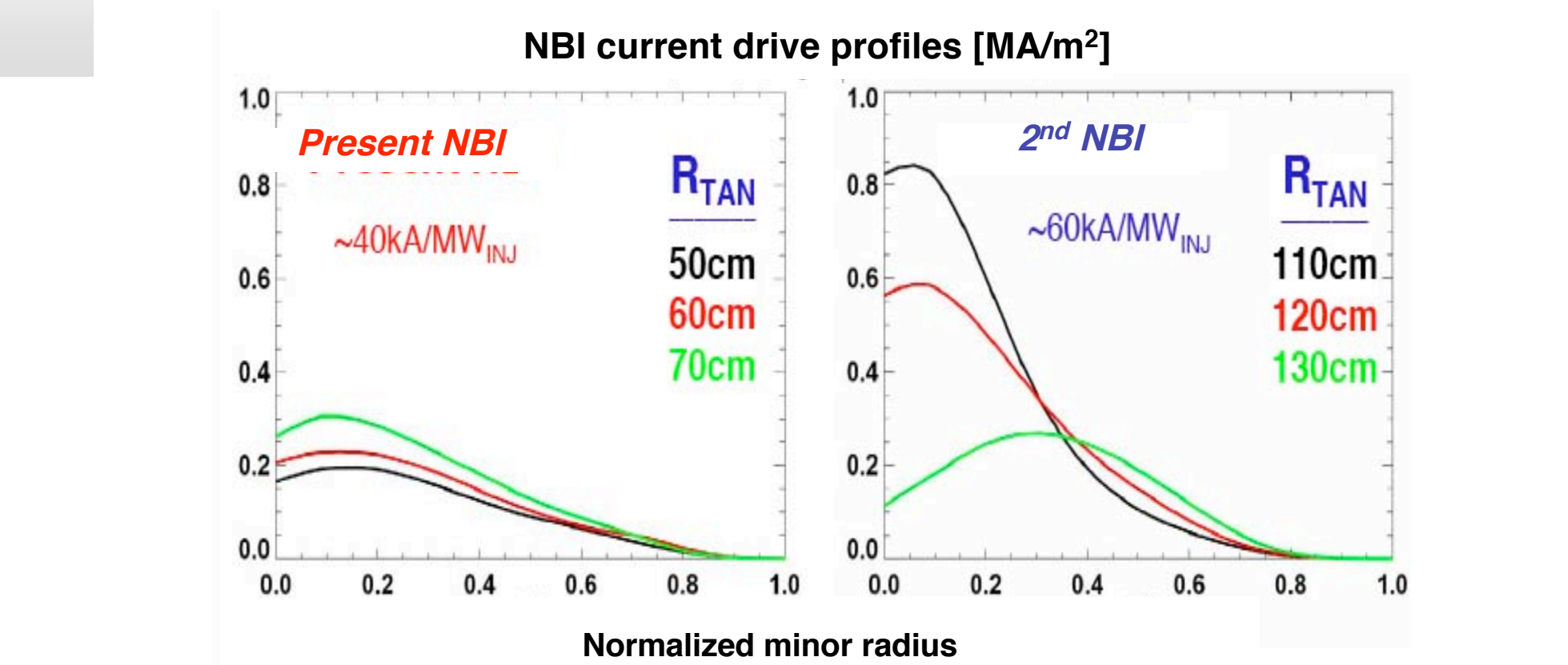
OH Flux Increased x 3 to Support 2 MA, 5 s Pulses (Present ~0.7 Vs \Rightarrow 1 MA, ~1 s)



Single Segment 3-Strap Assembly with Supports
New Design Simplifies Joint and Eliminates Lift-Off



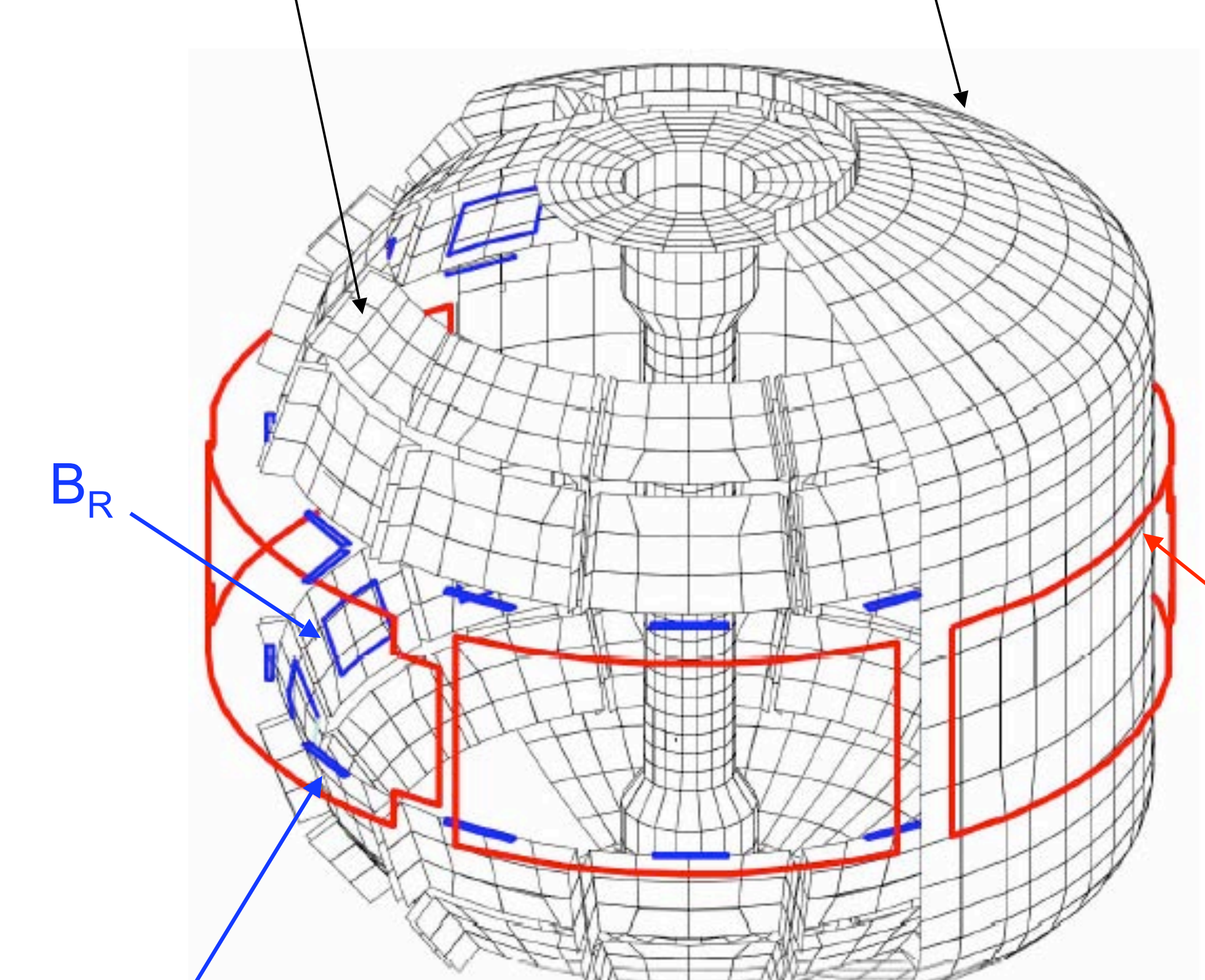
2nd NBI with larger tangency radius for sustained and controllable 100% NICD and high β at low ν^*



Up to 2 times higher NBI current drive efficiency, and current profile control

Copper passive conductor plates

SS Vacuum Vessel



B_p sensor

6 ex-vessel midplane control coils

2nd Switching Power Amplifier