NCSX

Diagnostic Opportunities on NCSX

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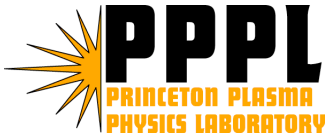
PPPL



15th HTPD Conference Satellite Session April 19, 2004 San Diego

Outline

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- Diagnostic implementation phased to meet needs of research plan
- Ports optimized for good diagnostic access
- Port map
- Diagnostic concepts used to guide port design
- Schedule and how to get involved
- See poster G08 (D. Johnson) on Thursday morning for details of diagnostics implementation
- NCSX diagnostics presentations at this conference and other documentation available at:
  http://ncsx.pppl.gov//Scientificconf/ScientificConf_2004.html

Diagnostics phased to research plan

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***Research program phase*/Measurement**	**Diagnostic technique**
1. Field Line Mapping to Check Machine Assembly (B=0.5 T, room temperature)	
Vacuum flux surfaces	E-beam, fluorescent probe & CCD camera
2. Initial Plasma Operation and Cold Field Line Mapping (B=0.5 T, cryogenics)	
I_p	Rowgowski coil
Wide-angle image of plasma/wall	Visible camera (1)
3. 1.5 MW Initial Experiments (1.5 MW NBI, B=1.2 T, partial PFCs)	
Boundary position and shape	Saddle loops, flux loops, B probes, V3FIT
Total stored energy	Diamagnetic loop
Wide-angle image of plasma/wall	Visible cameras with filters (2)
Core T_e	Basic Thomson scattering or filtered SXR diodes, & x-ray crystal spectrometer
n_e profile	FIR interferometer/polarimeter
Core T_i	X-ray crystal spectrometer
Total P_{rad}	Wide angle bolometer
Low m,n MHD modes (<100 kHz)	Compact soft x-ray arrays (8 20-channel arrays)
Magnetic axis position	Compact soft x-ray arrays & 3-D EFIT
Impurity identification	Visible spectrometer
VB, H_α & carbon line emission	Visible filterscopes
PFC temperature	Compact IR camera

Part of construction project

Diagnostics-continued

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4. 3 MW Heating (3 MW NBI, full PFCs, B=2.0 T, 350 C bake)	
T_e profile	Full Thomson scattering system
T_i, v_{ϕ} profiles	DNB & CHERS
Rotational transform profile	DNB & MSE, FIR inter./polar., V3FIT
Higher m,n MHD modes	Additional soft x-ray arrays (8 20-channel arrays)
High-frequency MHD (<5 MHz)	High-frequency Mirnov coils
Flux surface topology	Tangential SXR camera
Impurity concentrations	Absolute VUV spectroscopy
Z_{eff} profile	Thomson scattering detector system
P_{rad} profile	Core bolometer array
Fast ion loss	Fast ion loss probe, IR camera
Ion energy distribution	Neutral particle analyzer
Neutron flux	Epithermal neutron detector
SOL n_e and T_e	Movable Langmuir probe
Edge neutral pressure	Fast pressure gauges
5. Confinement & β push (3 MW NBI & 6 MW NBI or RF, divertor)	
Core n_e fluctuations	Fluctuation diagnostic (HIBP and/or BES)
Core helium density profile	DNB & He CHERS
Divertor P_{rad} profile	Divertor bolometer arrays
Divertor plate temperature	Fast IR camera & thermocouples
Target T_e & n_e	Plate-mounted Langmuir probes
Divertor recycling	Divertor filtered 1-D CCD camera
Divertor Impurity concentrations & flows	Divertor VUV spectroscopy
6. Long pulse (Existing heating & 3 MW long pulse NBI or RF)	
Divertor T_e & n_e profiles	Divertor Thomson scattering

NCSX Facility Layout

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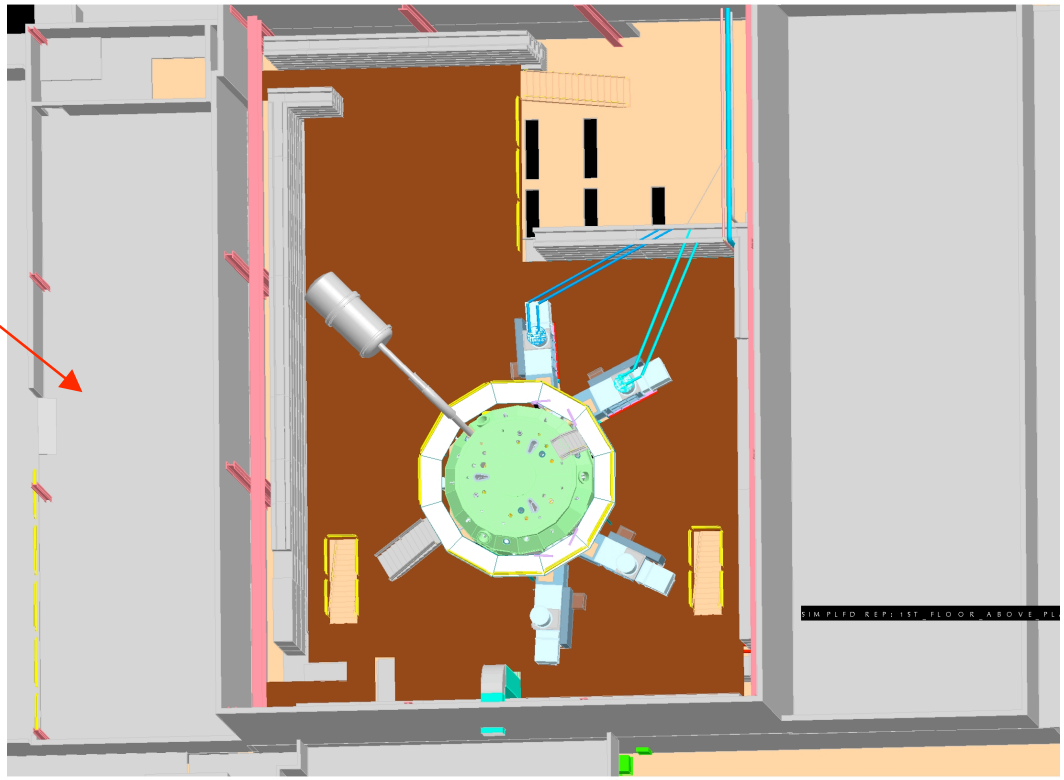

- Good space availability around NCSX
- Space for diagnostics reserved in nearby rooms

Ports optimized to provide good access

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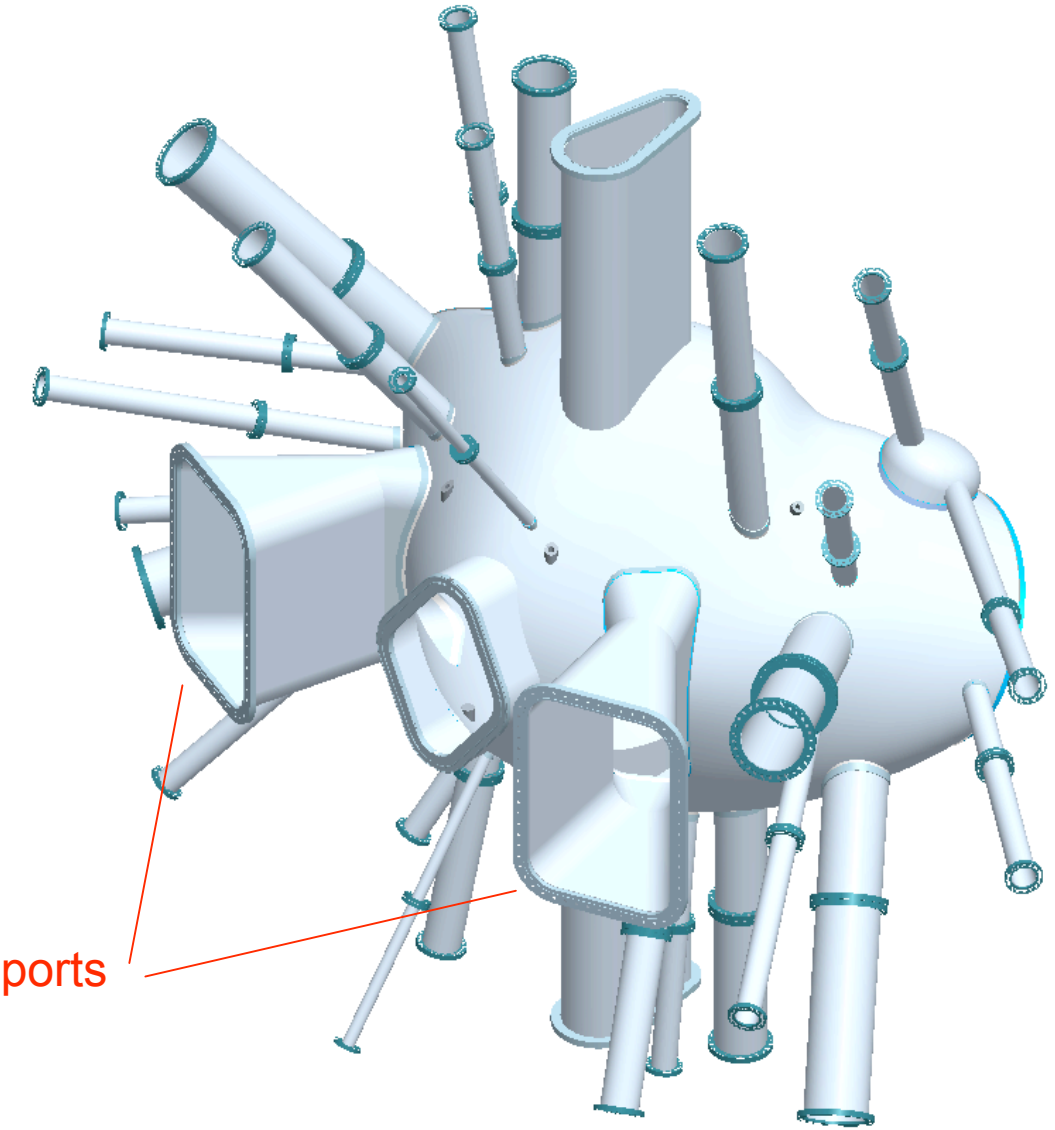

Preliminary diagnostic port assignments

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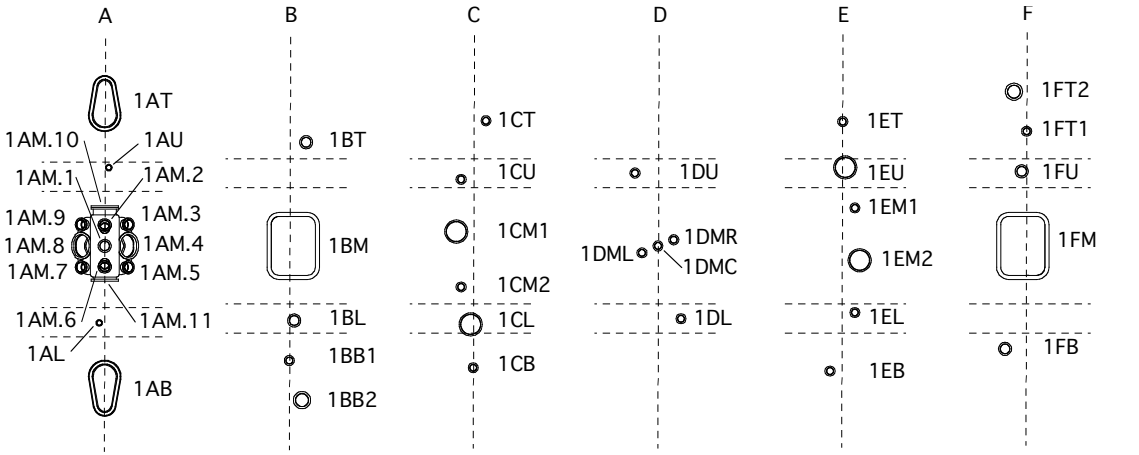
Period 1



A			B	C	D	E	F
	1AT div. bolometer div. camera		1BT	1CT		1ET equilib. magn. (120 MI)	1FT2 inboard gas or pellet inj.
	1AU				1DU Mirnov coils (90 tp)		1FT1
	1AM.10			1CU		1EU gas inj. (reg. & supersonic)	1FU Mirnov (20 tp) thermo (15 tp)
1AM.9 thermocouples (45 tp)	1AM.2	1AM.3 ion gauge		1CM1	1DMR SXR arrays (90 tp)	1EM1	
1AM.8 heating neutral beam	1AM.1 1 mm interferometer	1AM.4 heating neutral beam	1BM fluctuation diag. (BES)		1DMC SXR arrays (90 tp)	1EM2 1-D filtered (H□, C) camera	1FM CHERS/MSE & He CHERS
1AM.7 fast pressure gauges	1AM.6 divertor UV spectrometer	1AM.5		1CM2	1DML SXR arrays (90 tp)		
	1AM.11 vacuum pump, ion gauge		1BL core UV spectroscopy	1CL visible spectroscopy		1EL	
	1AL		1BB1		1DL fast pressure gauges		1FB
	1AB div. Bolometer div. IR camera		1BB2 glow probe & 2 filaments (5 c)	1CB equilib. magn. (120 MI)		1EB	

Active spectroscopy uses flared port

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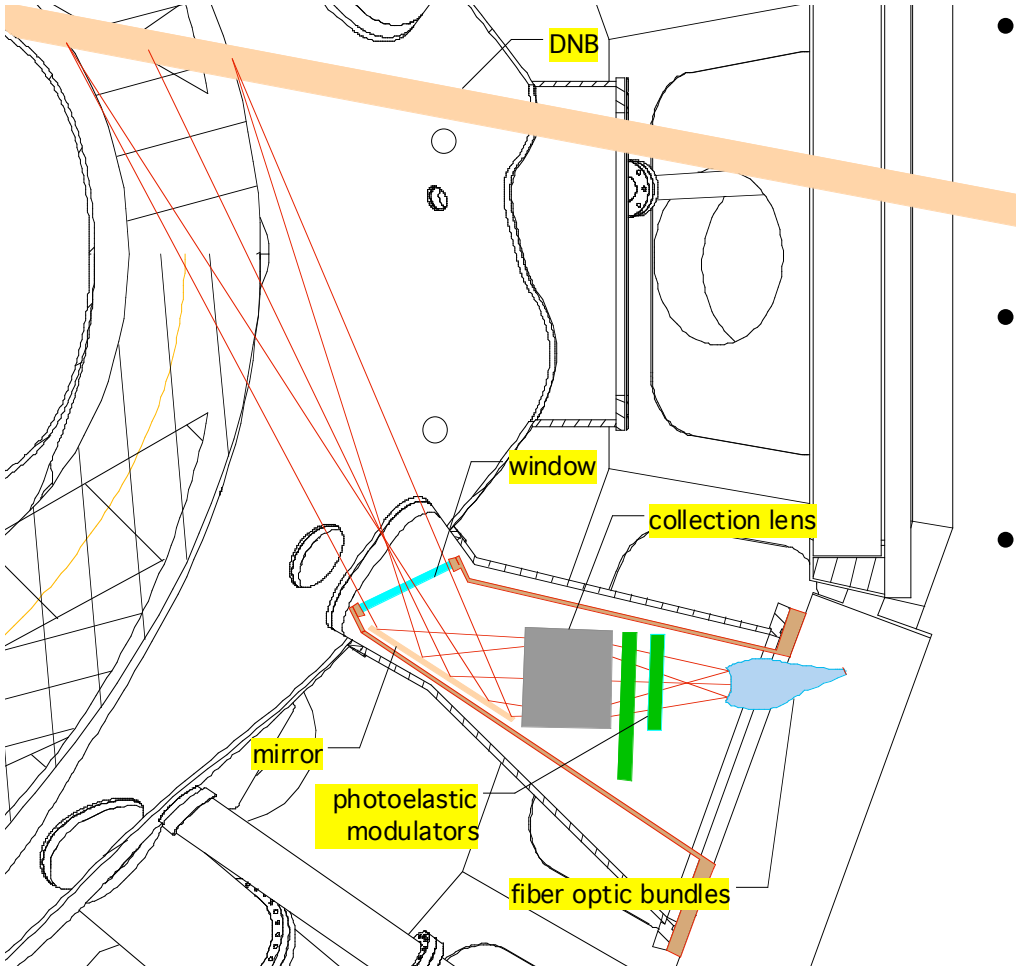

- Diagnostic neutral beam required to obtain good spatial resolution for CHERS and MSE.
- Viewing a DNB as shown provides optimum spatial resolution.
- There are six flared ports on the vessel. Thomson scattering will also use one to view a vertically-injected laser beam.

Multi-channel FIR interferometer/polarimeter

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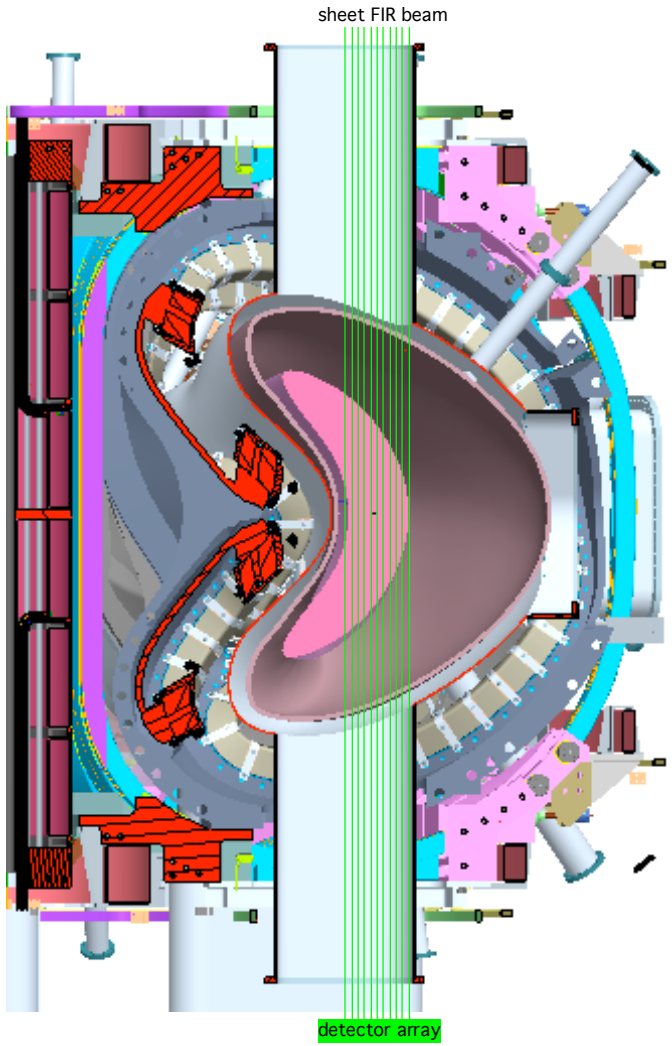
- Measures $n_e(R)$, $j(R)$, and $B_p(R)$ fluctuations.
- Uses radially elongated top and bottom ports at the v=0 symmetry plane.
- System uses sheet laser beam similar to systems used on TEXT and MST
- Achieves 1.0 - 1.5 cm radial channel spacing with 20 - 30 channels.



Schedule and how to get involved

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- Diagnostics needed for first plasma and field-line mapping as well as some equilibrium magnetics are part of construction project and will be done by PPPL/ORNL
- Significant non-PPPL/ORNL participation planned, similar to NSTX
- First call for diagnostic proposals in FY06 for funding starting in FY06/07
- Additional calls for proposals in FY07 and FY08
- Basic and profile diagnostics to be installed in late 2008 and mid-2009
- Diagnostic design/fabrication will start 1-2 years before installation
- First NCSX research forum in winter/spring 2005-please participate
- Contact us if you are interested