

NCSX Diagnostics

Brent Stratton
for the NCSX Team

*Princeton Plasma Physics Laboratory
Oak Ridge National Laboratory*

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Outline

- Diagnostics in construction project
- Diagnostics for Phase 3 of research program (FY11 run)
- Plans and schedule for implementing diagnostics
- Summary

Diagnositics in construction project

- Ex-vessel magnetics sensors:
 - Flux loops on outer surface of vacuum vessel (225 loops)
 - Co-wound flux loops on modular coils, TF coils, and PF coils
 - Rogowski coils (2 coils)
- Initial e-beam field line mapping will be done in collaboration with Auburn University
- Visible TV camera for first plasma to be borrowed from NSTX
- Nearly all diagnositics will be implemented after first plasma in FY09

Plan for first three years of research program

- Upgrade diagnostics to be designed, constructed, and installed in FY09 and FY10
- Diagnostics to be commissioned and provide useful data in FY11
- Have identified highest priority diagnostics for the research goals of the FY11 run that fit the projected budget
- Selection based on physics requirements and estimates of diagnostic costs
- Plan on sharing of diagnostics with NSTX where practical
- Final choices will depend on DOE funding level and updated estimates at CDR and/or proposal stage
- Your input on diagnostic priorities requested

Diagnostics envisioned for FY11 run

Systems that need to be designed, fabricated, and installed in FY09 and FY10 to be ready for FY11 run:

- Thomson scattering (T_e, n_e): *host*
 - 15 spatial channels (10 core, 5 edge), 50 Hz rep rate laser
- Charge exchange recombination spectroscopy (T_i, v_{rot}, n_c): *host*
 - 25-50 spatial channels, single high-throughput spectrometer viewing DNB
- Installation of diagnostic neutral beam: *collaborator*
 - DNB being developed by Nova Photonics and LBL under a phase II STTR contract from DOE
 - 40 keV, 5 Amps, 8 X 12 cm at extraction grid, can be modulated at up to 500 Hz for total on-time of 1 sec.
- Magnetics: *host*
 - 50 in-vessel magnetic sensors: B-probes, segmented Rowgowski coils, and Mirnov coils.
 - Integrators and data acquisition for 300 in- and ex-vessel sensors
- 10 PFC-mounted Langmuir probes (edge T_e, n_e): *collaborator/host*

FY11 Diagnostics -continued

Systems to be implemented in FY10 and FY11:

- 1 mm interferometer ($n_e I$): *collaborator, shared with NSTX*
- Single soft x-ray array (MHD mode identification): *collaborator*
 - 20 spatial channels, in- or ex-vessel
- VUV spectrometer (impurity inventory): *host, shared with NSTX*
- Core bolometer array (P_{rad} profile) (*Host*): *host, shared with NSTX*
 - 20 spatial channels
- Cameras: *collaborator/host, cameras shared with NSTX*
 - Three 2-D cameras and one 1-D camera (plasma images in H_α and impurity light):
 - Two IR cameras (PFC temperature)
- Filterscopes (time evolution of VB and H_α , He, B, C, and O lines):
collaborator/host, detectors, filters, and electronics shared with NSTX

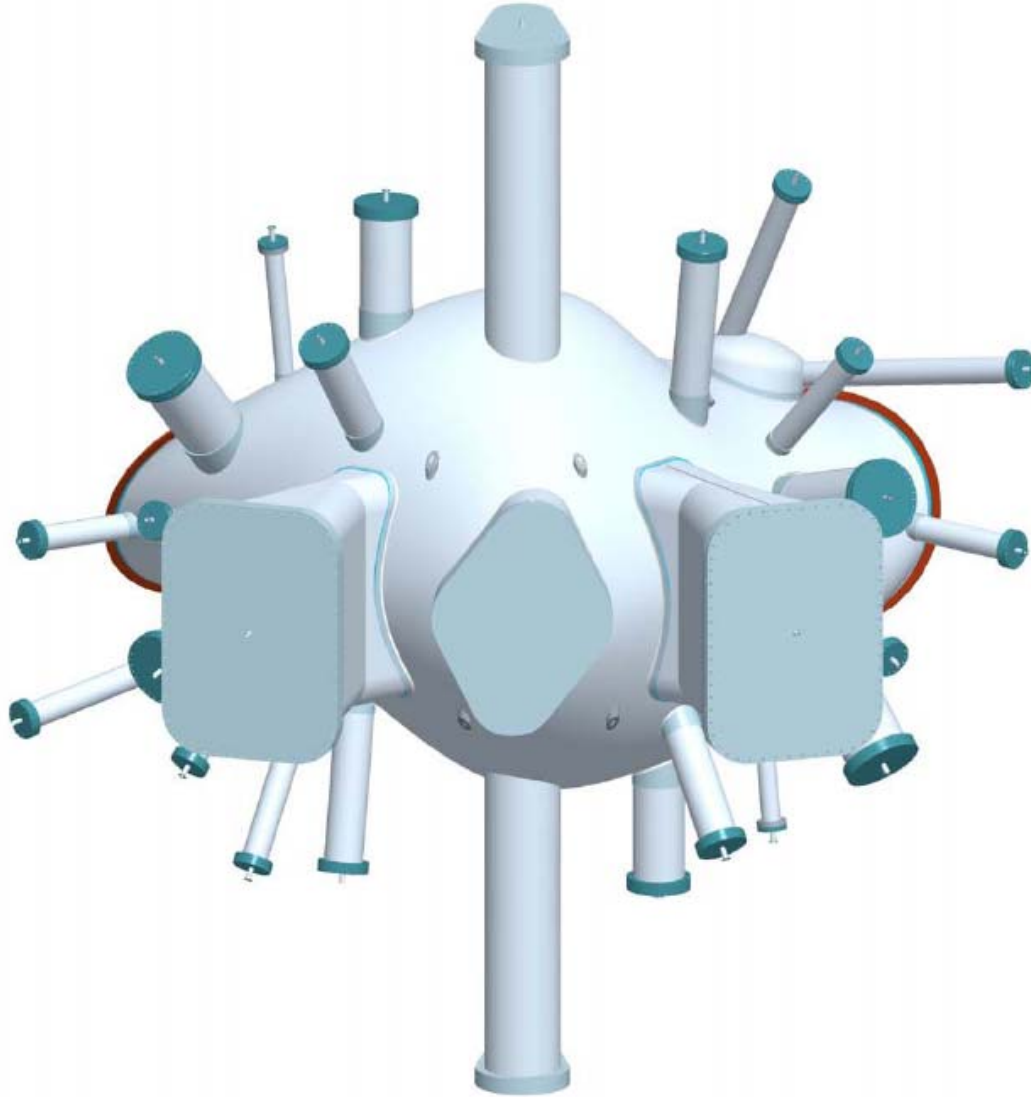
Candidate diagnostics for FY13 run

- MSE
- Heavy ion beam probe (NIFS collaboration?)
- Additional Thomson Scattering spatial channels
- Soft x-ray tomography
- Fast ion diagnostics
- Reciprocating Langmuir probe
- Reflectometer
- Other fluctuation diagnostic

Plan for diagnostic implementation

- Diagnostic work will be shared by PPPL & ORNL (hosts), and collaborators
- Diagnostic planning should be consistent with alternating-year operation of NCSX and NSTX starting in FY10
- Call for proposals in FY08
- Funding for collaborator proposals starting in FY09
- Four year funding cycle agreed to by DOE to facilitate collaboration on both NCSX and NSTX.
- Would like to start discussions of possible collaborator proposals now

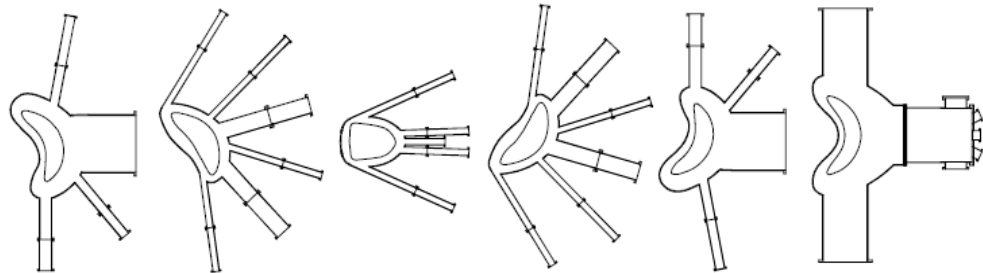
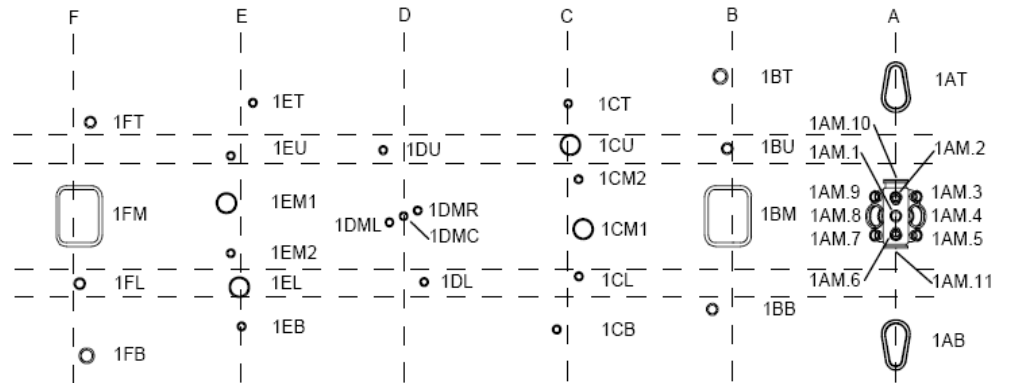
Vacuum vessel ports provide good access



Preliminary diagnostic port assignments

Period 1

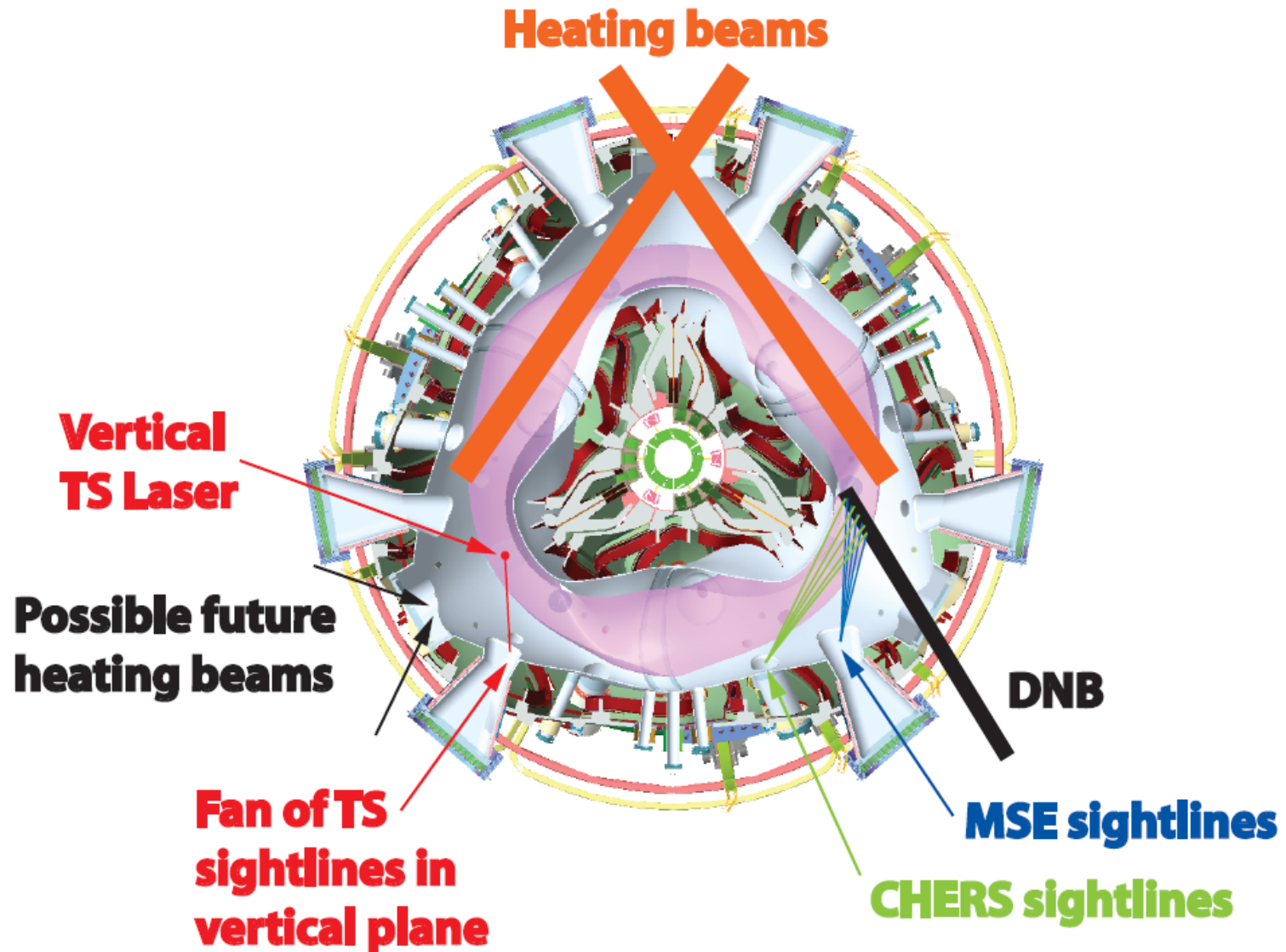
- Port map includes diagnostics and non-diagnostic systems
- Many open ports



F	E	D	C	B	A		
1FT inboard gas or pellet inj.	1ET equilb. magn. (120 M)		1CT Mmov coils (80 tp)	1BT		1AT div. bolometer div. camera	
		1DU RF antenna feedthrough					
	1EU gas inj. (reg. & supersonic)		1CU	1BU core UV spectroscopy		1AM10	
		1DMR SXR arrays (80 tp)	1CM2		1AM9 thermocouples (45 tp)	1AM2	1AM3 ion gauge
1FM fluctuation diag. (HBP?)	1EM1 (H _α , C) camera	1DMC SXR arrays (80 tp)	1CM1	1BM fluctuation diag. (BES)	1AM8 heating neutral beam	1AM1	1AM4 heating neutral beam
	1EM2 fast pressure gauges	1DML SXR arrays (80 tp)			1AM7 fast pressure gauges	1AM6	1AM5 compact IR camera
1FL Mmov (20 tp) thermo (15 tp)	1EL		1CL visible spectroscopy			1AM11 vacuum pump, ion gauge	
		1DL RF antenna feedthrough					
1FB	1EB		1CB magn. (120 M)	1BB glow probe & 2 filaments (5 c)		1AB div. UV Spect. div. IR camera	

Electrical feedthroughs: tp=twisted pair, M=mineral insulated cable, c= single conductor

DNB, CHERS, MSE & Thomson Scattering Layout



Summary

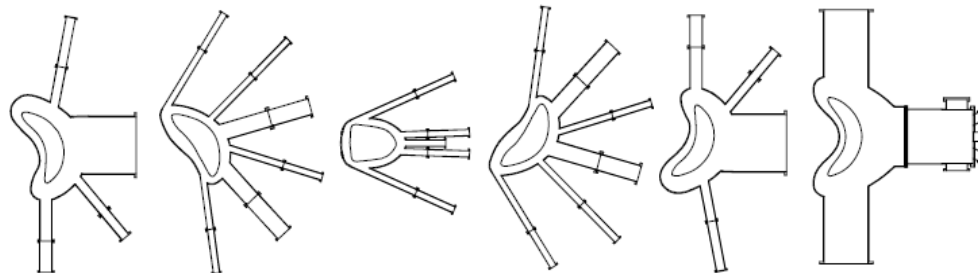
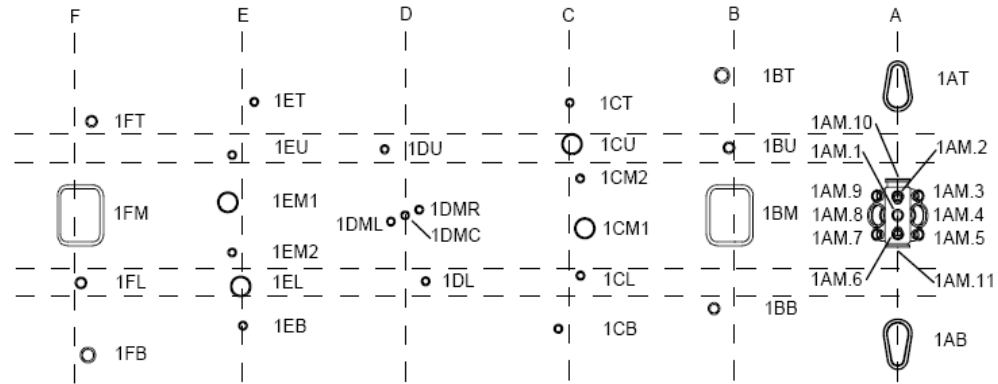
- Have made initial selection of diagnostics set for first three years of research program
- Your input on diagnostic priorities and possible collaborations desired

Appendix

- Complete port map
- Port dimensions drawing
- Available at
http://ncsx.pppl.gov/Research_Forum/ResFor_index.html

NCSX port map-period 1

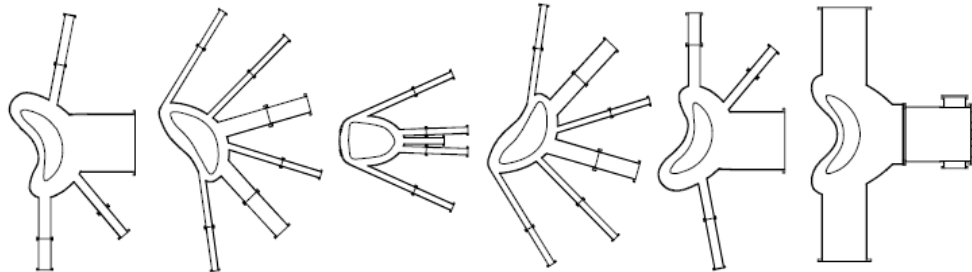
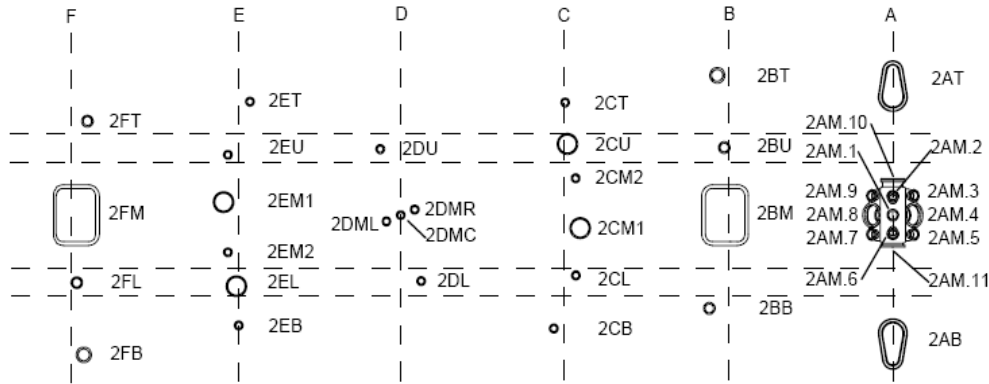
Period 1



F	E	D	C	B	A
1FT inboard gas or pellet inj.	1ET equilib. magn. (120 M)		1CT Mimovcoils (90 tp)	1BT	1AT div. bolometer div. camera
		1DU RF antenna feedthrough			
	1EU gas inj. (reg. & supersonic)	1DMR SXR arrays (90 tp)	1CU	1BU core UV spectroscopy	1AM10
		1DMC SXR arrays (90 tp)	1CM2		1AM9 thermocouples (45 tp)
1FM fluctuation diag. (HIBP?)	1EM1 (H ₂ , C) camera	1DML SXR arrays (90 tp)	1CM1	1BM fluctuation diag. (BES)	1AM8 heating neutral beam
	1EM2 fast pressure gauges	1DL RF antenna feedthrough			1AM7 fast pressure gauges
1FL Mimov (20 tp) thermo (15 tp)	1EL		1CL visible spectroscopy		1AM6 vacuum pump, ion gauge
					1AM5 compact IR camera
1FB	1EB		1CB magn. (120 M)	1BB glow probe & 2 filaments (5 c)	1AM1 ion gauge
					1AB div. UV Spect. div. IR camera
Electrical feedthroughs: tp=twisted pair, M=mineral insulated cable, c=single conductor					

NCSX port map-period 2

Period 2

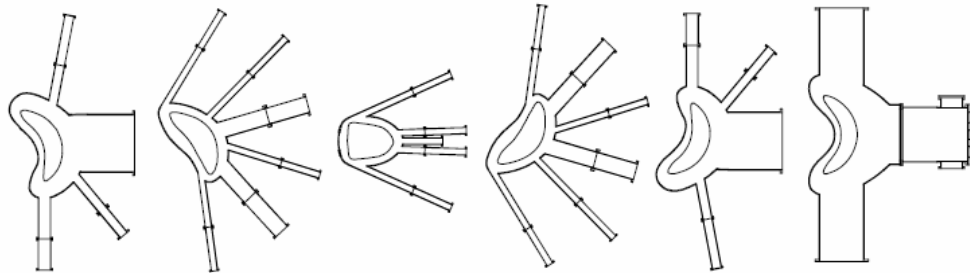
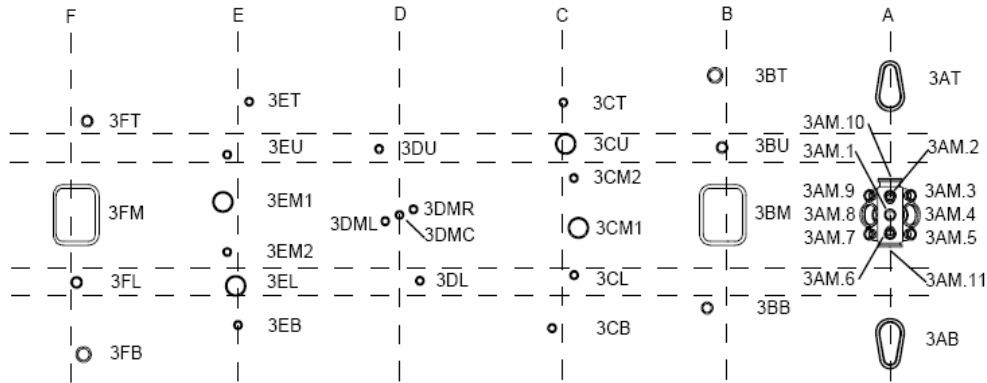


F		E		D		C		B		A					
2FT	HIBP?	2ET	magn. (120 M)			2CT	Mimovcoils (90 tp)	2BT	bolometer array			2AT	FIR int./polar. 1-mm inter.		
				2DU	RF antenna feedthrough										
		2EU	gas inj. (reg. & supersonic)			2CU	mapping probe	2BU				2AM.10			
				2DMR	SVR arrays (90 tp)	2CM2				2AM.9	thermocouples (15 tp)	2AM.2	visible filterscope	2AM.3	ion gauge
2FM	TS view	2EM1	visible filterscopes	2DMC	SVR arrays (90 tp)	2CM1	CHERS	2BM	MSE	2AM.8	diagnostic neutral beam	2AM.1		2AM.4	visible camera
		2EM2	fast pressure gauges	2DML	SVR arrays (90 tp)					2AM.7	fast pressure gauges	2AM.6	visible filterscopes	2AM.5	divertor visible camera
2FL	Mimovcoils (20 tp)	2EL				2CL	fast scanning edge probe					2AM.11	vacuum pump, ion gauge		
				2DL	RF antenna feedthrough										
2FB	inboard gas or pell. inj.	2EB				2CB	equilib. magn. (120 M)	2BB	glow probe & 2 filaments (5 c)			2AB	FIR int./polar. 1-mm inter.		

Electrical feedthroughs: tp=twisted pair, M=mineral insulated cable, c= single conductor

NCSX port map-period 3

Period 3



F	E	D	C	B	A				
3FT	Inboard gas or pellet Inj.	3ET	magn. (120 M)	3CT	Mimov (90 tp) thermo. (30 tp)	3BT	3AT	TS laser	
		1DU	RF antenna feedthroughs						
	3EU	gas Inj. (reg. & supersonic)		3CU		3BU	fast ion loss probe	31M.10	TS laser
		1DMR	SXR arrays (90 tp)	3CM2		3AM.9	thermo. (15 tp) Lang. Pr. (50 c)	3M.2	
3FM	mapping target	3EM1	fluctuation diagnostic	1DMC	SXR arrays (90 tp)	3CM1		3BM	neutral particle analyzer
		3EM2	fast pressure gauges	1DML	SXR arrays (90 tp)			3AM.8	visible camera
		3EL		3CL	Langmuir probe			3AM.7	fast pressure gauges
3FL	Mimov coils (20 tp)			1DL	RF antenna feedthroughs			3AM.6	vacuum pump, ion gauge
		3EB		3CB	equilib. magn. (120 M)	3BB	glow probe & 2 filaments (5 c)	3AM.11	
								3AB	TS dump
Electrical feedthroughs: tp=twisted pair, M=metal insulated cable, c= single conductor									

NCSX port dimensions drawing

