

NCSX Diagnostics

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**NCSX Research Forum
Princeton Plasma Physics Laboratory
December 7, 2006**



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

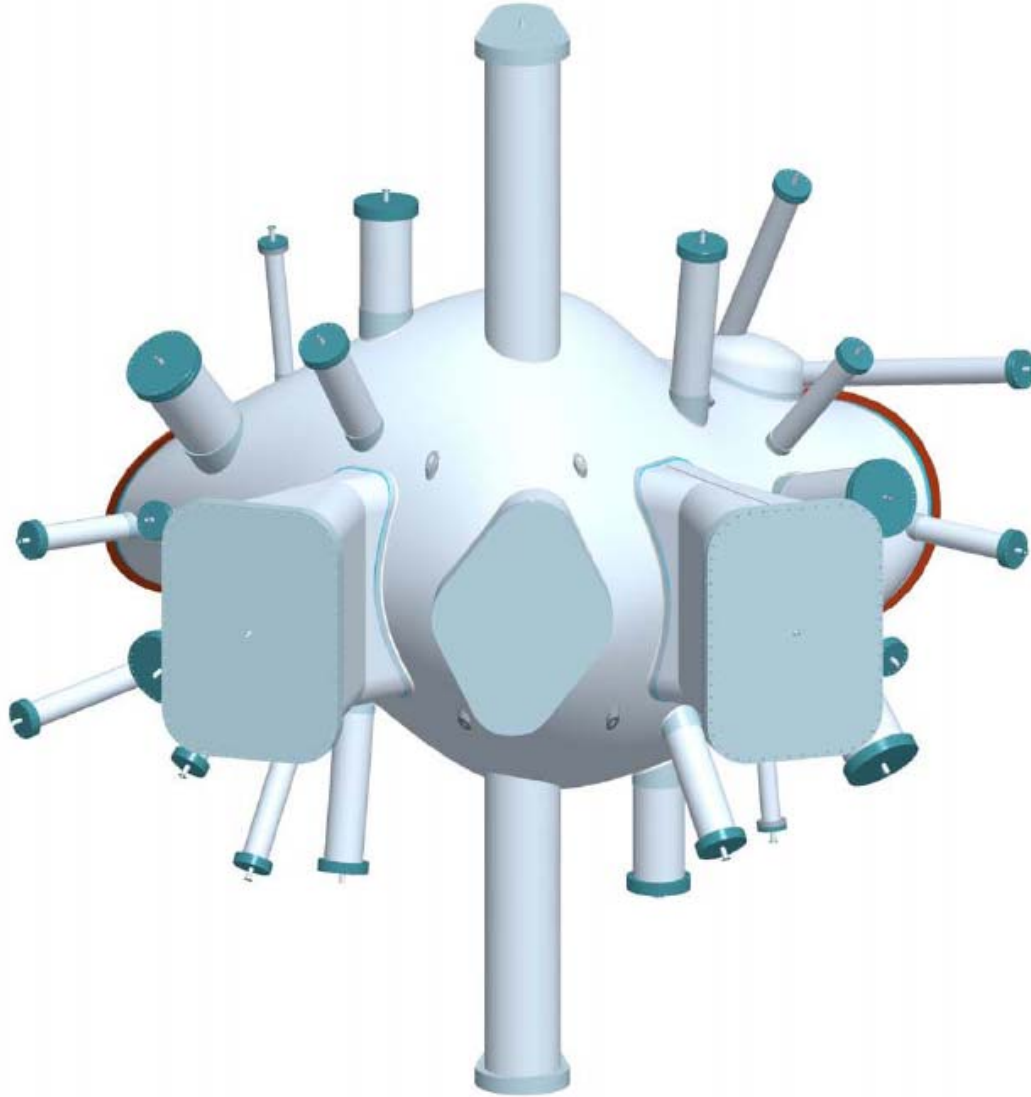
Candidate diagnostics for FY13 run

- 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

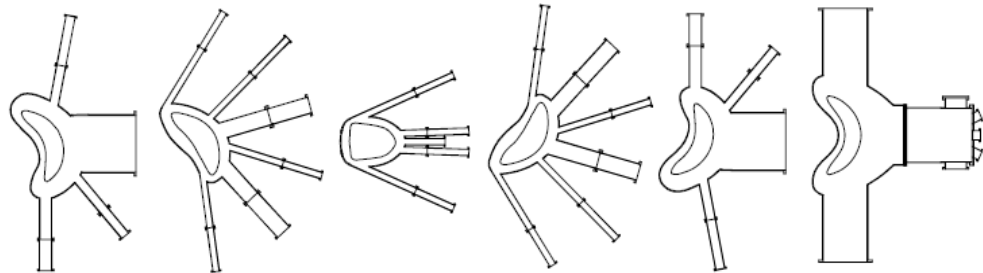
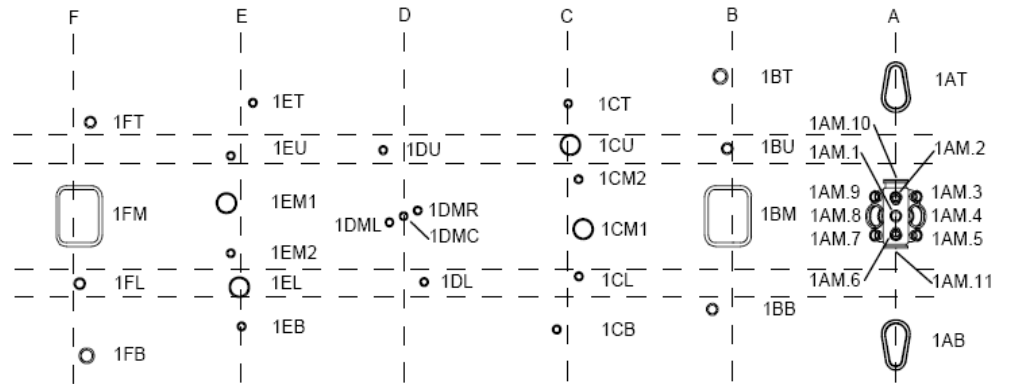
Vacuum vessel ports provide good access



Preliminary diagnostic port assignments

Period 1

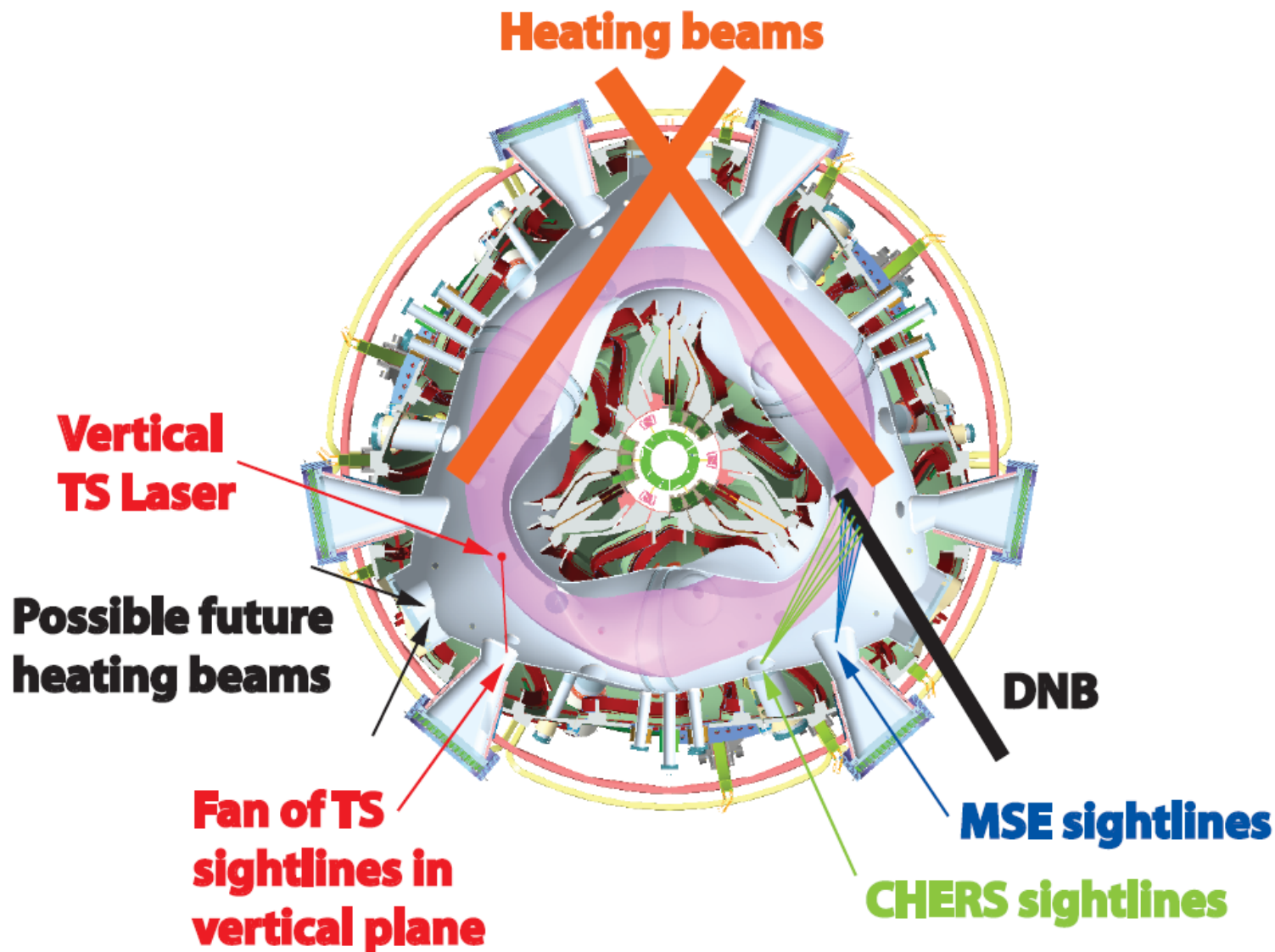
- Port map includes diagnostics and non-diagnostic systems
- Many open ports



| 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

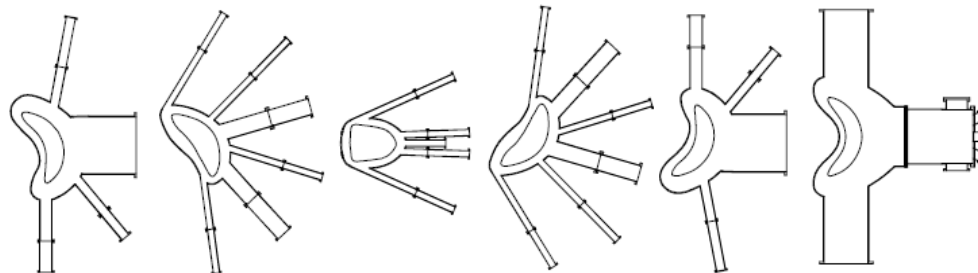
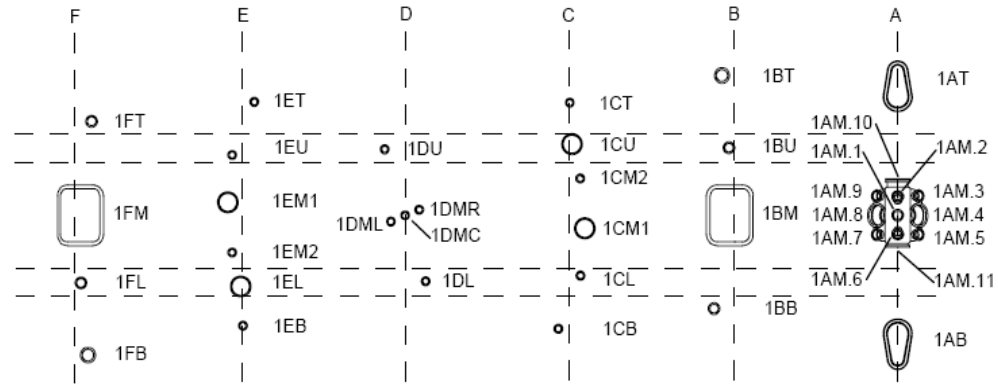
- Have made initial selection of diagnostics set for first three years of research program
- Your input on diagnostic priorities and possible collaborations desired

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

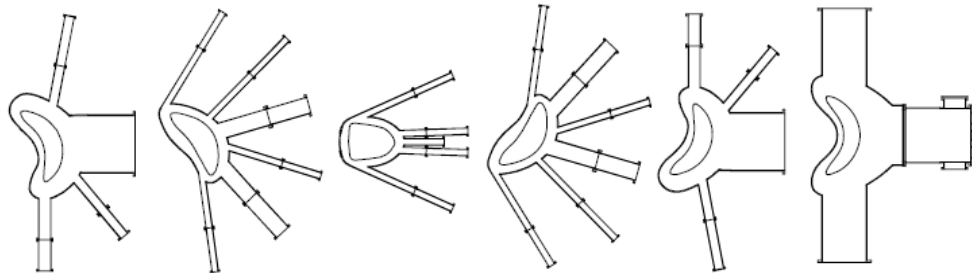
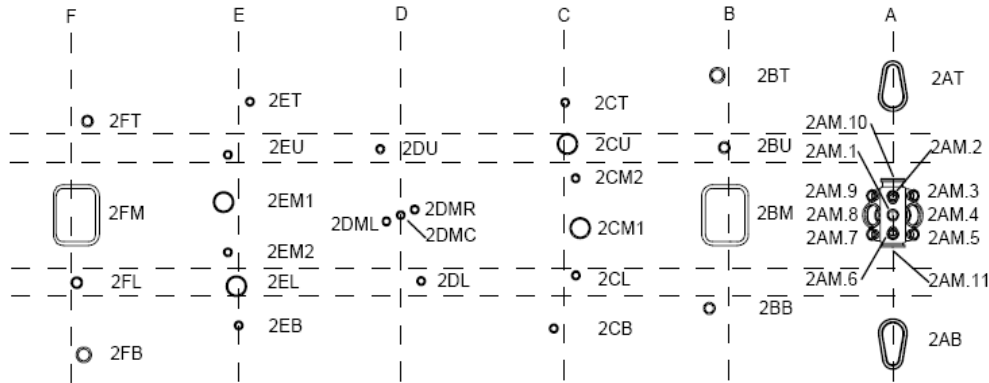


| F | E | D | C | B | A |
|----------------------------------|----------------------------------|----------------------------|--------------------------|------------------------------------|--------------------------------------|
| 1FT inboard gas or pellet inj. | 1ET equilib. magn. (120 M) | | 1CT Mimovcoils (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 | 1AM.10 thermocouples (45 tp) |
| 1FM fluctuation diag. (HIBP?) | 1EM1 (H ₂ , C) camera | 1DMC SXR arrays (90 tp) | 1CM1 | 1BM fluctuation diag. (BES) | 1AM.9 heating neutral beam |
| | 1EM2 fast pressure gauges | 1DML SXR arrays (90 tp) | | | 1AM.8 heating neutral beam |
| 1FL Mimov (20 tp) thermo (15 tp) | 1EL | 1DL RF antenna feedthrough | 1CL visible spectroscopy | | 1AM.7 fast pressure gauges |
| | | | | | 1AM.6 vacuum pump, ion gauge |
| 1FB | 1EB | | 1CB magn. (120 M) | 1BB glow probe & 2 filaments (5 c) | 1AM.5 compact IR camera |
| | | | | | 1AM.4 heating neutral beam |
| | | | | | 1AM.3 ion gauge |
| | | | | | 1AM.2 |
| | | | | | 1AM.1 |
| | | | | | 1AM |
| | | | | | 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

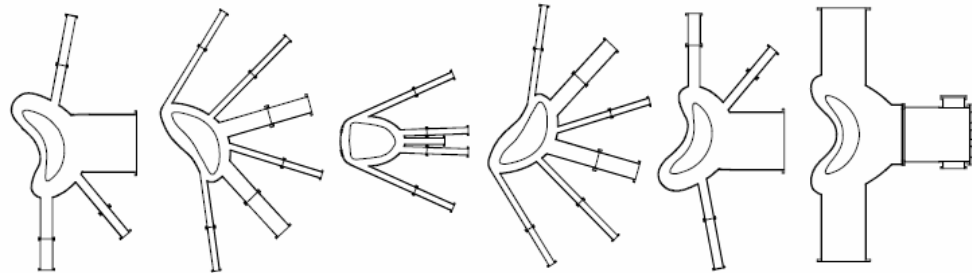
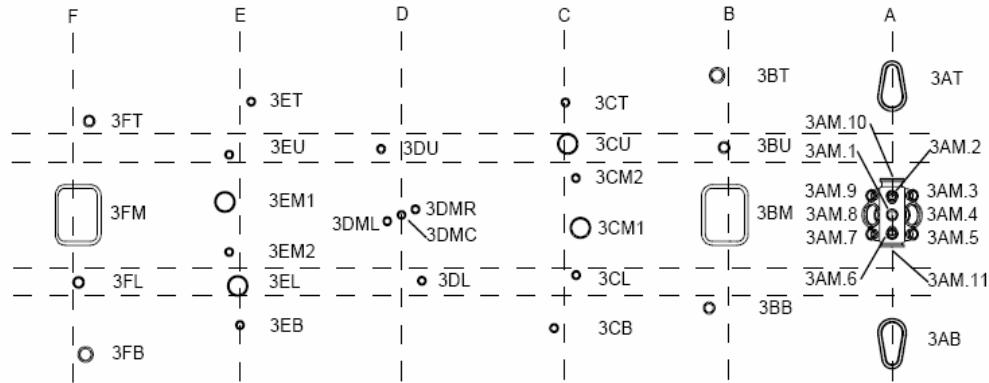


| F | | E | | D | | C | | B | | A | | | | | |
|-----|---------------------------|------|------------------------------|------|------------------------|------|--------------------------|-----|--------------------------------|------|-------------------------|--------|-----------------------------|-------|-------------------------|
| 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 | | | | 2AM9 | 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 | 2AM8 | diagnostic neutral beam | 2AM.1 | | 2AM.4 | visible camera |
| | | 2EM2 | fast pressure gauges | 2DML | SVR arrays (90 tp) | | | | | 2AM7 | 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 |
| 3FL | Mimov coils (20 tp) | 3EL | | 3CL | Langmuir probe | | | 3AM.7 | fast pressure gauges |
| | | 1DL | RF antenna feedthroughs | | | | | 3AM.6 | vacuum pump, ion gauge |
| 3FB | | 3EB | | 3CB | equilib. magn. (120 M) | 3BB | glow probe & 2 filaments (5 c) | 3AB | TS dump |
| Electrical feedthroughs: tp=twisted pair, M=metal insulated cable, c= single conductor | | | | | | | | | |

NCSX port dimensions drawing

