NCSX Diagnostics

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Outline

- Status of diagnostics in construction project
- Plans for diagnostics for Phase 3 of research program
- Plans for establishing diagnostics team and involving collaborators
- Summary

Status of diagnostics in construction project

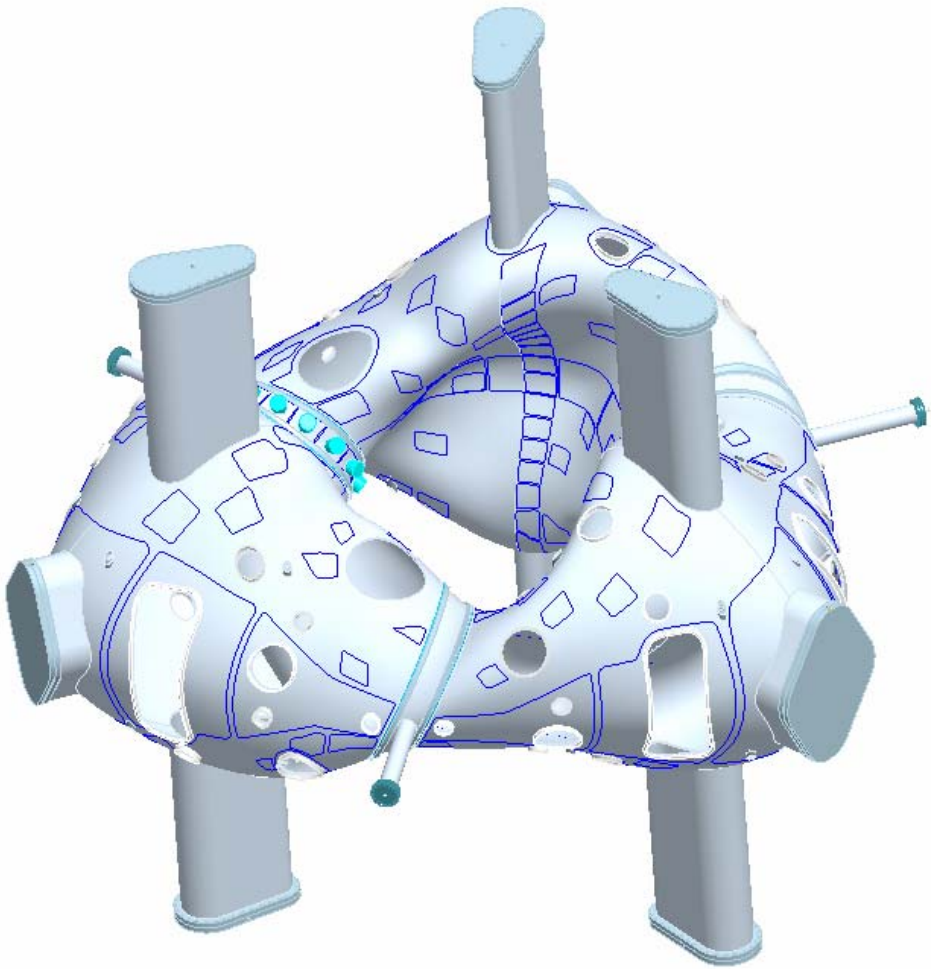
- Ex-vessel magnetics designed and being installed
  - Flux loops being installed on outer surface of first vacuum vessel subassembly (225 loops)
  - Co-wound loops being installed during modular coil fabrication (36 loops)
  - Co-wound flux loops for toroidal field coils being fabricated (18 loops)
  - Rogowski coil design underway (2 coils)
  - Plasma diamagnetism to be measured using signals from MC co-wound loops and measured MC and TF coil currents

Diagnostic status-continued

- 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

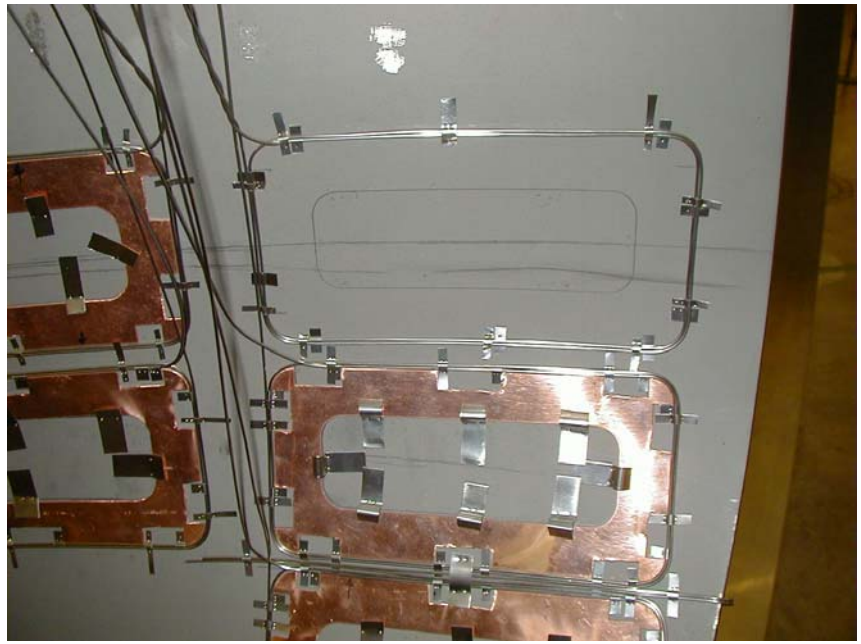
Ex-vessel flux loops for reconstruction

- Measure stellarator-symmetric fields for reconstruction (n=3, 6…) and non-symmetric field errors and instabilities
- Loop locations determined by SVD analysis of signals predicted from 2500 free-boundary equilibria
- Loops ranked according to effectiveness in constraining reconstructions
- 225 loops/151 distinct locations/shapes



N. Pomphrey & E. Lazarus

VV flux loop installation is underway



- Copper templates cut to specified loop shapes
- Templates accurately positioned on vessel using Laser Tracker
- Mineral-insulated cable wound around templates and secured with thin stainless steel straps
- As-built loop positions measured
- Installation technique developed on prototype vessel segment

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
  - Estimates based on discussions of pre-conceptual designs with diagnostic physicists and engineers
  - Use or modify existing designs where possible
  - Plan on sharing of diagnostics with NSTX where practical
- PAC input on diagnostic priorities requested

Diagnostics envisioned for FY11 run

- Thomson scattering (T_e, n_e)
  - 15 spatial channels (10 core, 5 edge), 50 Hz rep rate laser
- Charge exchange recombination spectroscopy (T_i, v_{rot})
  - 25-50 spatial channels, single high-throughput spectrometer viewing DNB
- Installation of diagnostic neutral beam
  - 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:
  - 50 in-vessel magnetic sensors: B-probes, segmented Rowgowski coils, and Mirnov coils.
  - Integrators and data acquisition for 300 in- and ex-vessel sensors

FY11 Diagnostics -continued

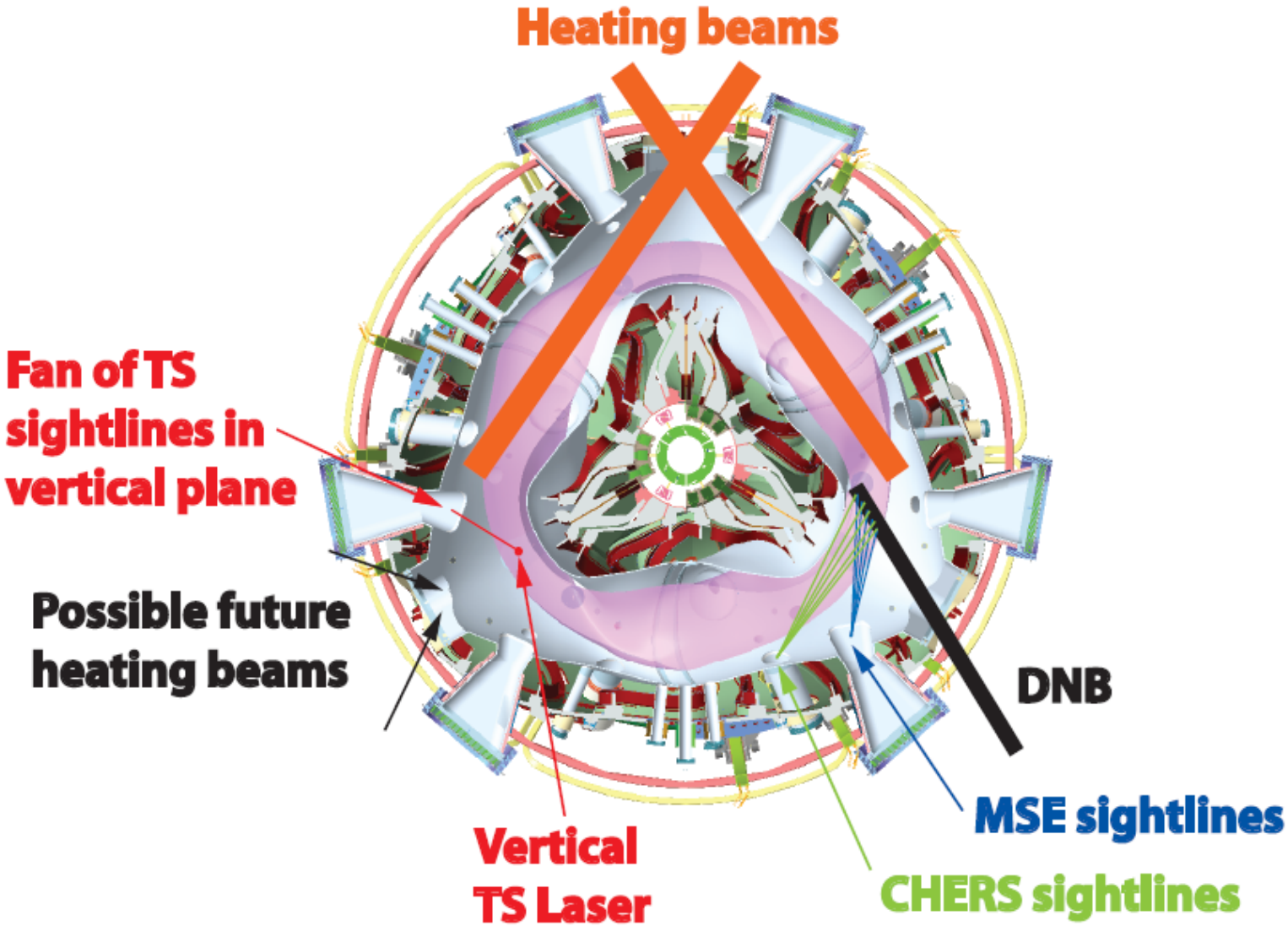
- 1 mm interferometer ($n_e l$): *shared with NSTX*
- Single soft x-ray array (MHD mode identification)
  - 20 spatial channels, in- or ex-vessel
- VUV spectrometer (impurity inventory): *shared with NSTX*
- Core bolometer array (P_{rad} profile): *shared with NSTX*
  - 20 spatial channels
- 10 PFC-mounted Langmuir probes (edge T_e, n_e)
- Cameras: *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): *detectors, filters, and electronics shared with NSTX*

Diagnostics not envisioned for FY11 run

- MSE
- HIBP
- Additional Thomson Scattering spatial channels
- Soft x-ray tomography
- Fast ion diagnostics
- Reciprocating Langmuir probe
- Reflectometer
- FIR interferometer/polarimeter

- Diagnostic choices and strategy for FY11 run will be discussed and refined at Research Forum
- Final choices will depend on DOE funding level and updated estimates at CDR and/or proposal stage
- Diagnostics not implemented for FY11 run are candidates for FY13 run

DNB, CHERS, MSE & Thomson Scattering Layout



Plan for diagnostic implementation

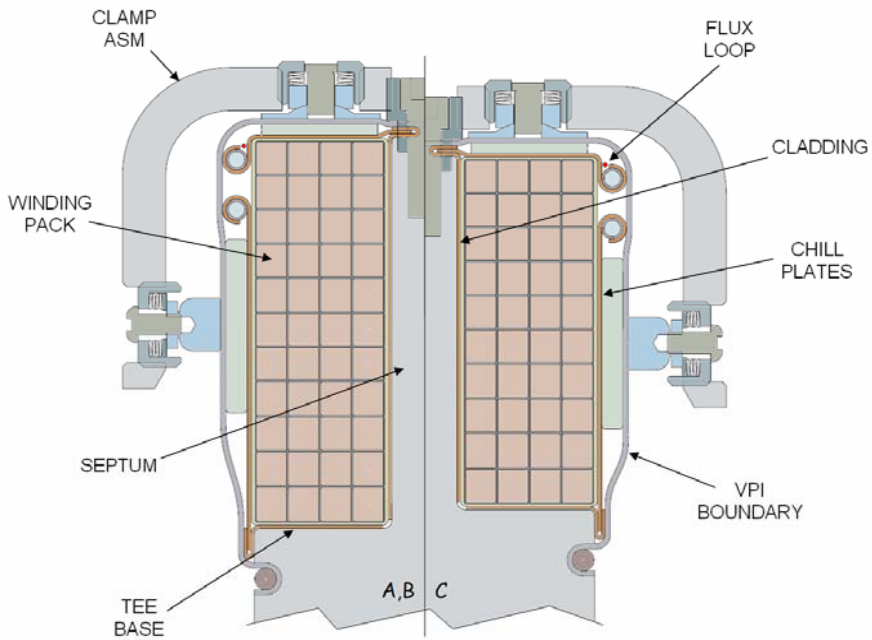
- Diagnostic work will be shared by PPPL, ORNL, and collaborators
- Funding for collaborator proposals starting in FY09
- Discussion at first NCSX Research Forum, Dec. 7-8
- Diagnostic planning must be consistent with alternating-year operation of NCSX and NSTX starting in FY10

Summary

- Design and fabrication of diagnostics included in construction project is proceeding well
- Have made initial selection of diagnostics set for first three years of research program
- Will engage community to refine diagnostics plan at Research Forum and in individual discussions
- PAC input on diagnostic priorities desired

Additional slides

Modular coil co-wound flux loop installation



- Two loops located on plasma-facing side of windings on each coil
- Mineral-insulated cable (0.8 mm diameter) insulated with Teflon heat-shrink tubing and woven glass fiber tubing
- Loops held in place by coil VPI epoxy
- As-built loop locations measured with Romer Arm
- Similar design for TF and PF co-wound loops