NSTX-MAST
Collaboration Opportunities

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OFES meeting

October 4, 2010

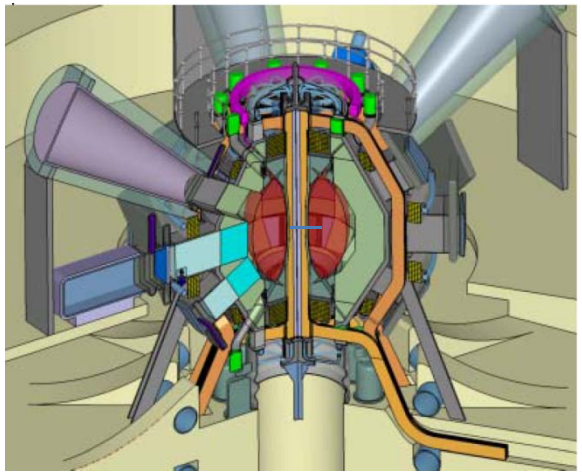
NSTX-MAST collaboration will emphasize 2 main thrusts:

1. Develop common understanding, vision, and design of ST-based FNSF/CTF

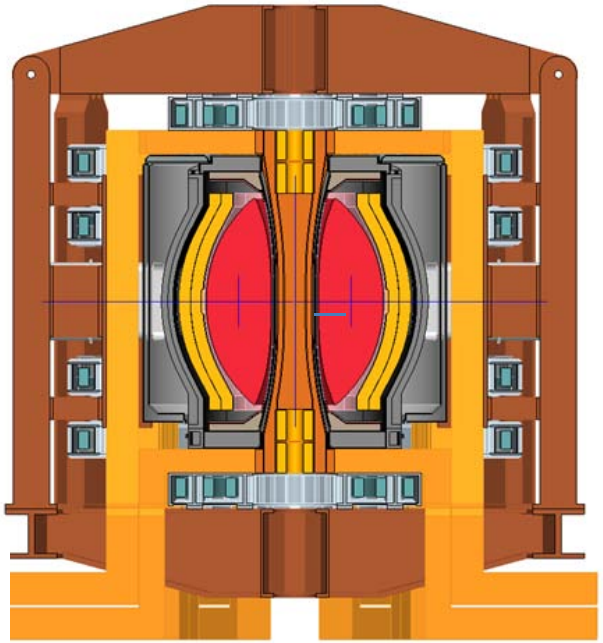
2. Collaborate on physics topics important to ST, FNSF, also ITER & Demo

1. Develop common understanding, vision, design of ST-based FNSF/CTF

- Materials, fusion nuclear science, PMI emerging as major themes in U.S. fusion program
- ST can play important role in materials/PMI and FNS facility
- CCFE and PPPL are lead labs investigating, advancing ST concept
- Both labs agree it would be beneficial to work more closely
  - Developing PPPL position & strategy via FNSF-Pilot Plant studies
  - Challenge: both sides very busy with ops of existing machines + prep for major Upgrades



Culham ST-CTF



PPPL ST-FNSP

1. Develop common understanding, vision, design of ST-based FNSF/CTF

- What is mission scope?
  - Limited to test modules with small total surface area?
  - Try for TBR = 1?
  - Aim for net electricity production?
- What are wall loading requirements, assumptions?
  - How does this drive assumed physics scenarios?
  - How does this impact ongoing research on NSTX and MAST?
- What are best design, maintenance approaches?
  - Sharing of engineering and design expertise most valuable
  - Could be good project as Upgrade design activities reach closure

Resources needed: ~1-2 FTE total: design, mechanical engineering, physics input

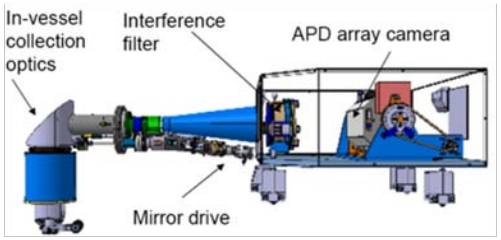
2. Collaborate on physics topics important to ST, FNSF, also ITER & Demo

Through discussions with several MAST physicists + managers in September 2010, identified these topics of mutual interest:

- Steady-state, high performance scenarios
  - Turbulent ion and electron transport
  - Longer term – advanced divertors
- Energetic particle physics
  - NBI current redistribution
- 3D physics
  - Perturbed 3D equilibria

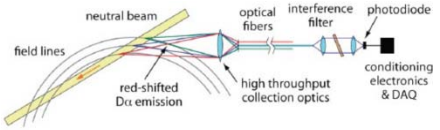
Turbulent transport has important implications for size of ST as FNSF, and for ITER, Demo

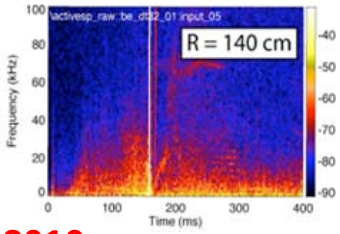
MAST



2D BES to be used 2011

NSTX





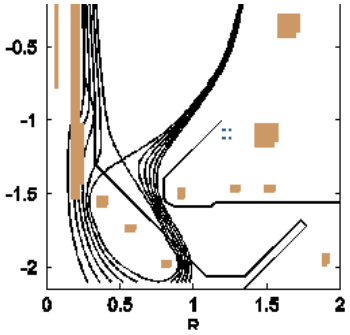
Initial 2D BES data obtained 2010
(+ existing high-k scattering)

- NSTX, MAST observe similar confinement scaling that differs from conventional A – strong ~ $1/\nu^*$ scaling – what is underlying physics?
- Both devices now have similar ion turbulence diagnostics – 2D BES
- MAST expressed particular interest in PPPL/NSTX experiment-theory comparison expertise
- Potential collaborators:
  - NSTX: S. Kaye, D. Smith, Y. Ren, W. Guttenfelder
  - MAST: A. Field, C. Roach, M. Valovic
  - GK theory: G. Hammett, W. Dorland, C. Roach, A. Schekochihin, H. Wilson

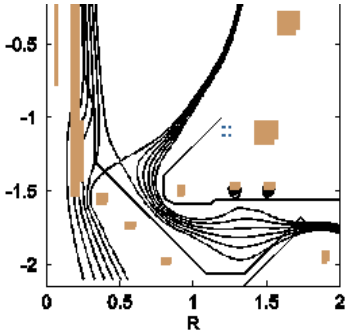
Advanced divertors will be needed for heat flux mitigation in Upgrades, FNSF, Demo

MAST Upgrade

Conventional

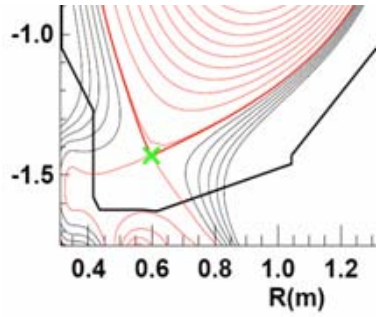


Super-X

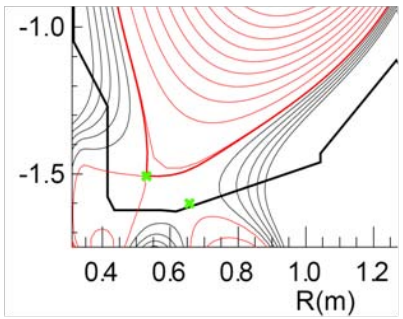


NSTX, NSTX Upgrade

Conventional



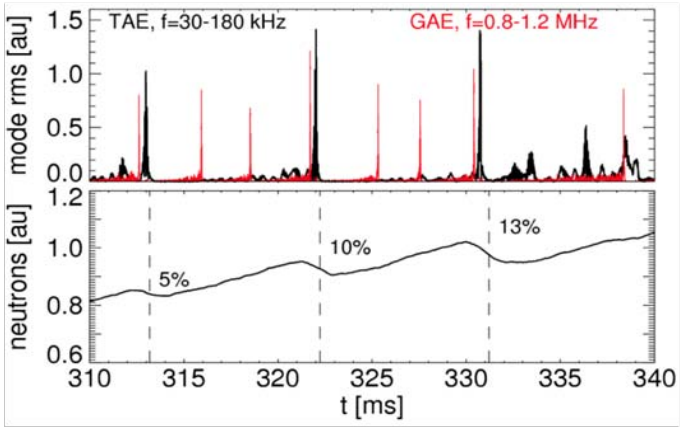
Snowflake



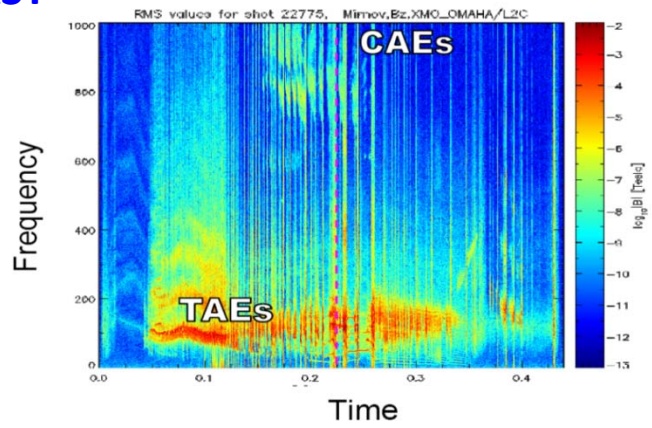
- MAST: effect of line-length on H-mode, NSTX: snowflake, LLD
- MAST-U: Super-X + cryos, NSTX-U: snowflake + Li pumping
  - Both will access substantial flux expansion, variation of line-length, pumping
  - Complementary: open vs. closed divertor, different pumping techniques
  - Will need advanced boundary control (example: control of multiple X-points)
- Potential collaborators:
  - NSTX: V. Soukhanovskii, R. Maingi, J. Canik, D. Stotler, E. Kolemen
  - MAST: G. Fishpool, A. Kirk, H. Meyer, G. Cunningham

Energetic particle transport has important implications for NBI-CD, alphas for FNSF, ITER BP

NSTX



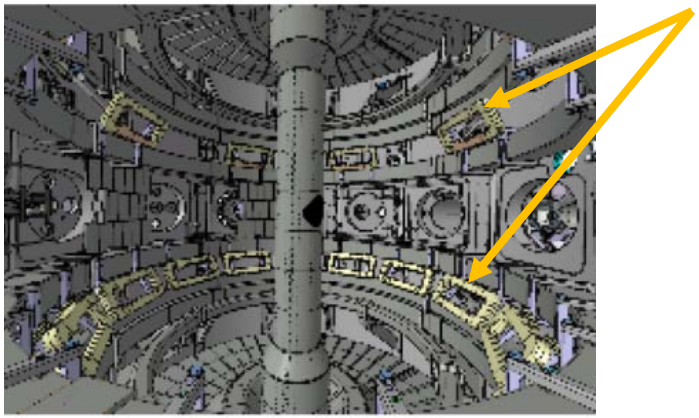
MAST



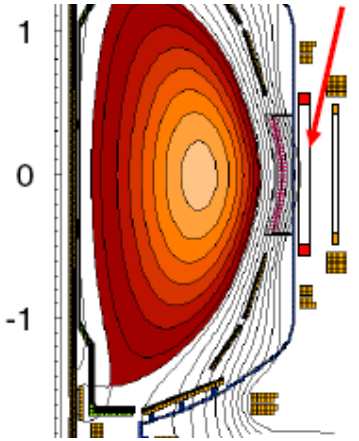
- NSTX, MAST observe multi-mode *AE, fast-ion transport
- NSTX has FIDA, NPA, … MAST has neutron collimator
  - Both also have BES for *AE eigen-function measurement
- MAST expressed particular interest in improving models for “anomalous diffusion” from *AE (for TRANSP analysis)
- Potential collaborators:
  - NSTX: E. Fredrickson, N. Gorelenkov, G. Fu, A. Bortolon, S. Gerhardt
  - MAST: R. Akers, S. Pinches, M. Turnyanskiy

Improved 3D plasma response models needed to understand RMP ELM suppression for ITER, FNSF

MAST – in-vessel off-midplane RMP coils



NSTX – ex-vessel mid-plane RMP coils



- MAST, NSTX modify edge transport and ELMs with 3D fields
  - Have not yet suppressed ELMs with 3D fields
  - Both observe transport/plasma response to 3D fields sensitive to q_{95}
- MAST, NSTX have complementary 3D coil capabilities
- Collaboration initiated on perturbed equilibria, NTV rotation damping
  - US: DCON, IPEC codes → resistive DCON, GPEC code, UK: MARS, T7
- Collaborators:
  - U.S.: J.-K. Park + A. Glasser (visited Culham late Sept 2010), A. Boozer, S. Sabbagh
  - Culham/UK: I. Chapman, Y. Liu, C. Gimblett, H. Wilson

MAST-NSTX Collaboration Summary

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