Overview of the HSX Program and Plans for Upgrade

D.T. Anderson & the HSX Team

HSX Plasma Laboratory, Univ. of Wisconsin, Madison, USA;

Overview

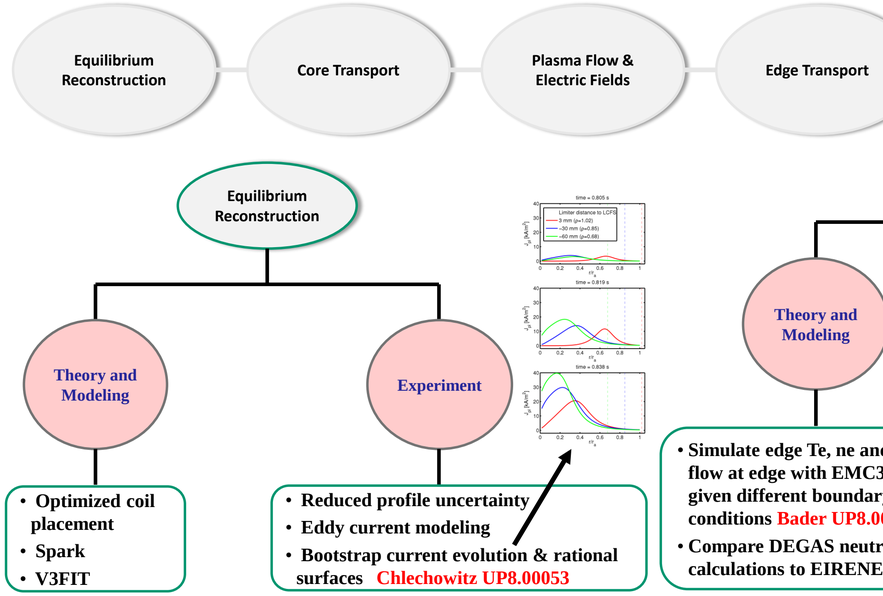
• Present experimental program concentrated on 4 main areas: 1) equilibrium reconstruction, 2) core transport, 3) plasma flows and electric fields and 4) edge transport.

• Experimental and theoretical results illuminate physics issues that impact Wendelstein 7-X, which comes on-line in 2015.

- ❑ Equilibrium reconstruction demonstrates time evolution of bootstrap current, critical to proper functioning of W7-X divertor.
- ❑ Heat pulse propagation experiment demonstrates lack of stiffness in heat transport, in agreement with 3-D gyrokinetic calculations using two kinetic species
- ❑ Improvement in neoclassical theory are being benchmarked and demonstrated experimentally.
- ❑ Work has begun on using motional stark effect to measure radial electric field and bootstrap current profile in HSX.
- ❑ Edge studies show electric field in edge island which could impact W7-X divertor and is not included in EMC3-EIRENE modeling.

• Proposal submitted by Prof. O. Schmitz as PI investigates 3-D equilibrium reconstruction and impact on edge transport and island divertor performance in W7-X involving HSX, CTH (Auburn) and small plasma device.

• HSX upgrade planned to focus on hotter ion temperatures, ion root transport, turbulent transport mitigation and divertor optimization .



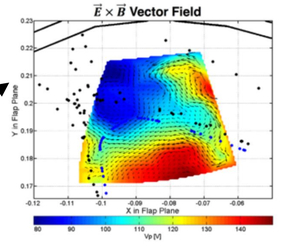
Proposed Collaboration with W7X

• Joint proposal with Auburn University aims at investigating 3-D equilibrium effects on edge transport and divertor performance at Wendelstein 7-X. P.I.: O. Schmitz, UW-Madison

• Domestic activities include HSX, CTH, helicon linear device, EMC3-EIRENE and V3FIT.

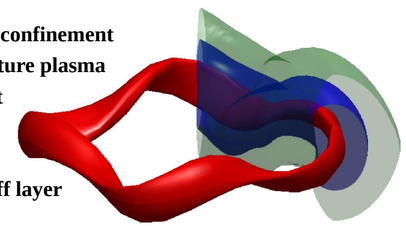
- •Activities on HSX center on validation and testing of EMC3-EIRENE, implement and test line ratio spectroscopy on helium as a divertor diagnostic, and explore helium exhaust.

• Proposal takes advantage of HSX strength in examining core-edge coupling.



HSX Upgrade

- Increase ion temperature with neutral beams:
  - •Study role of high-effective transform (i_{eff} ~ 3) on ion confinement with tangential injection into high-electron temperature plasma
  - •Explore transport with E_r in reactor-relevant ion root
  - •Study low-collisionality ion transport
- Higher density operation with neutral source control:
  - •Higher density core plasma and interface to scrape-off layer
  - •Study impurity transport and exhaust in ion root E_r
  - •Reduce neutral source in core to facilitate density and exhaust control
- Explore feasibility of optimizing for reducing turbulent transport
  - •Builds on quasisymmetric magnetic topology which is optimized for improved neoclassical transport
- Upgrades needed for physics program:
  - •New vacuum vessel and type #1 coils for NBI and diagnostic access, improved conditioning, larger plasma/wall separation, more room for flexible divertor configurations
  - •ECH: 500 kW, 0.3 s, 56 GHz; energetic electron transport and beam target
  - •NBI: 2 X 300 kW 40 keV 0.3s systems (Budker Inst./ Compass D units)
  - •Infrastructure upgrades to accommodate new capabilities



Bader UP8.00061, Talmadge (UP8.00052)

56th Annual Meeting of the Division of Plasma Physics, October 27 – October 31, 2014, New Orleans, LA