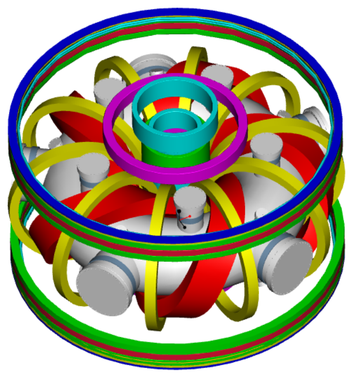
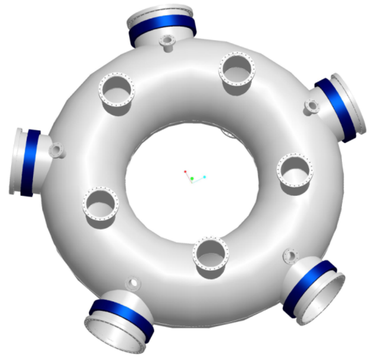
Island Divertor Modeling and Design for the Compact Toroidal Hybrid

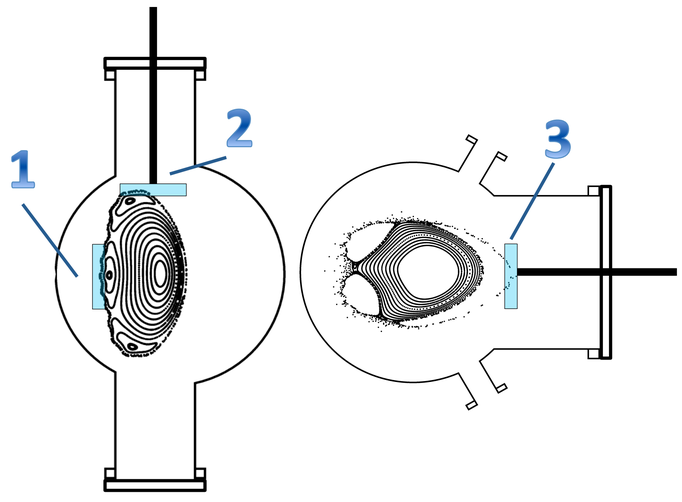
D. A. Maurer, M. C. Archmiller, M. Cianciosa, D. A. Ennis, J. D. Hanson, J. Hebert, J. Herfindal, G. J. Hartwell,
S. F. Knowlton, X. Ma, S. Massidda, M. Pandya, N. Roberds, and P. Traverso
Auburn University, Auburn, Alabama, USA

AUBURN UNIVERSITY

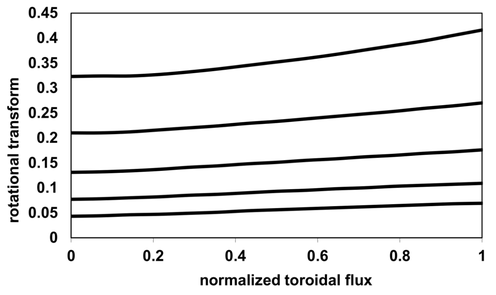
CTH Compact Toroidal Hybrid



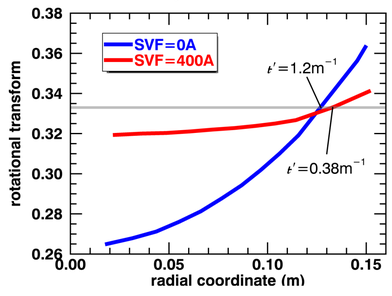


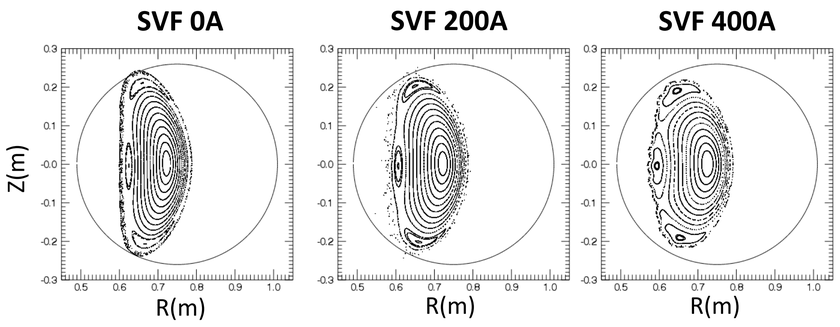


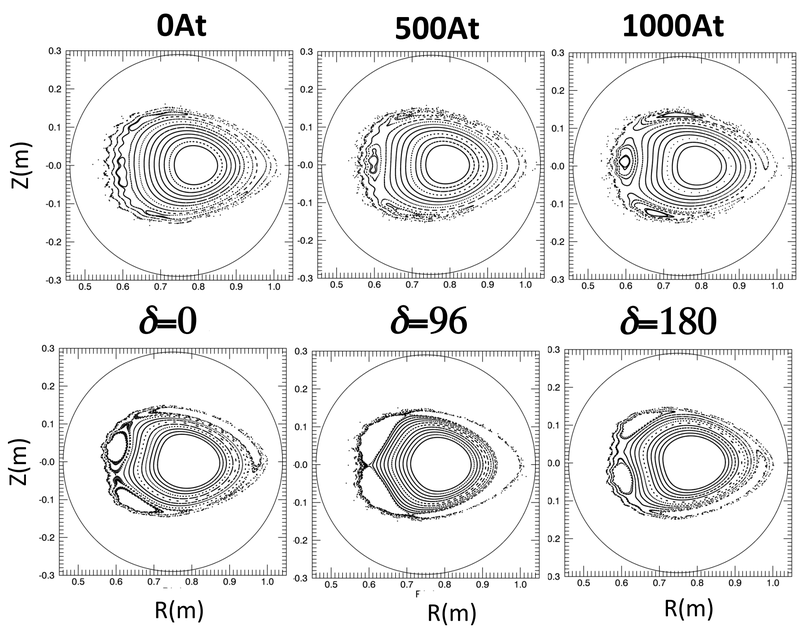
I_{TF}/I_{HF} ratio modifies rotational transform profile



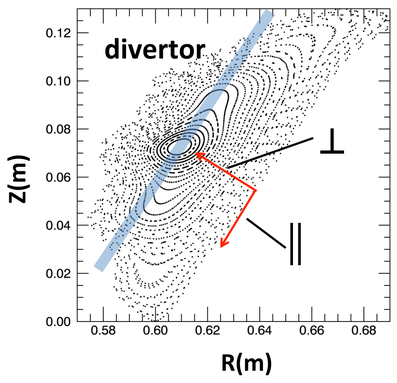
SVF coil modifies shear/island width



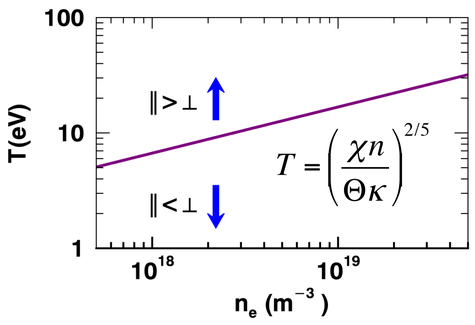




Parallel and perpendicular transport estimates



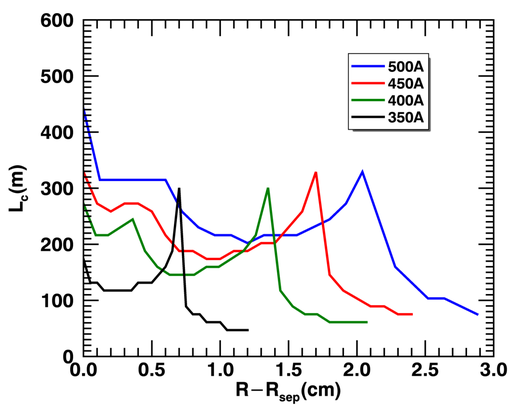
Boundary between dominating effects (from Feng[1])



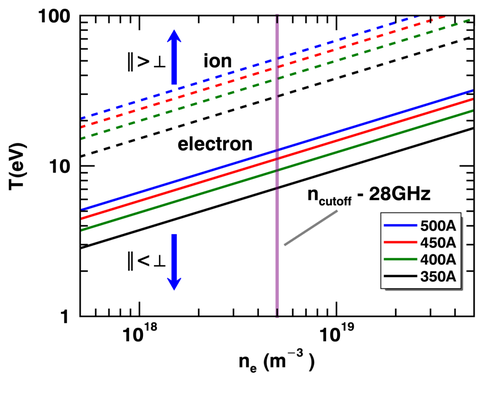
χ - Perpendicular thermal diffusivity ~ $2m^2s^{-1}$

κ - Parallel thermal conductvity coefficients κ_e ~ 2000, κ_i ~ 60 Stangeby[2]

Effect of varying shear with SVF coil set

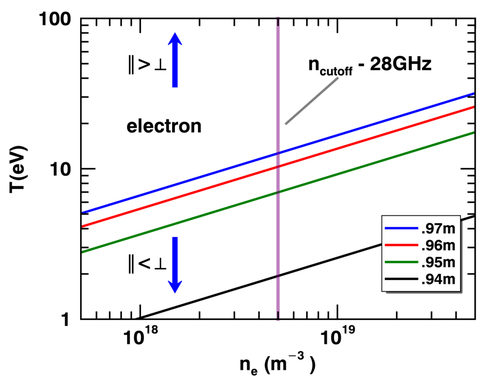


$$\Theta = \frac{2\pi a}{N\langle L_c\rangle}$$

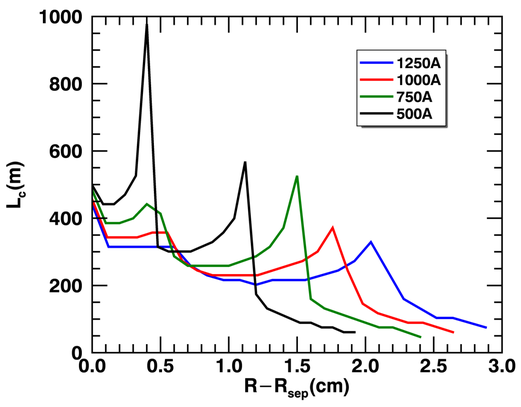


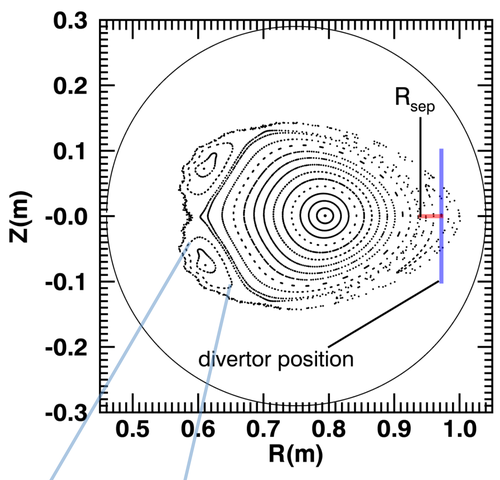
- $\langle L_c \rangle$ is calculated for each magnetic field condtion and related to the field line pitch through the local rotational transform, λ
- Perpendicular conduction will dominate for cold CTH ions
- Parallel and Perpendicular conduction effects will compete in CTH, and the boundary is somewhat adjustable

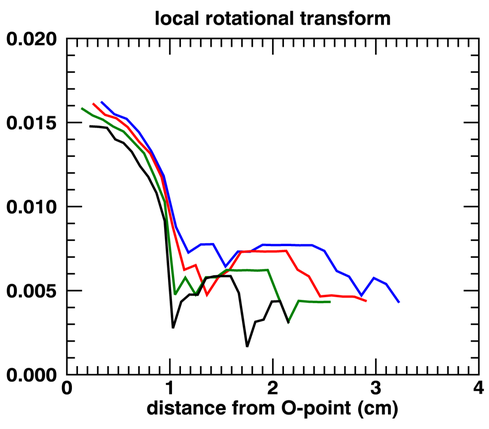
Effect of moving divertor position

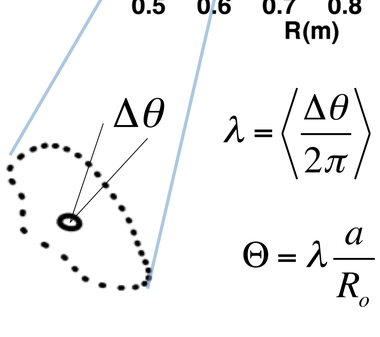


Connection length measured from stagnation plane (red) to the divertor (blue)







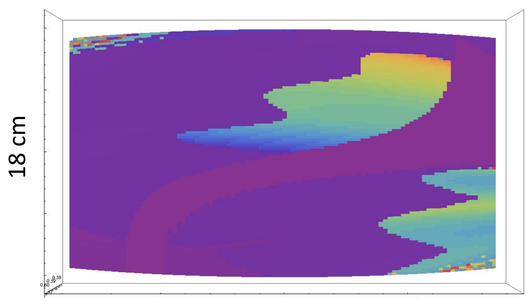


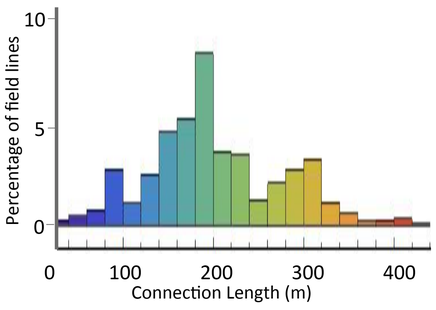
$$\lambda = \left\langle \frac{\Delta\theta}{2\pi} \right\rangle$$ Local rotational transform

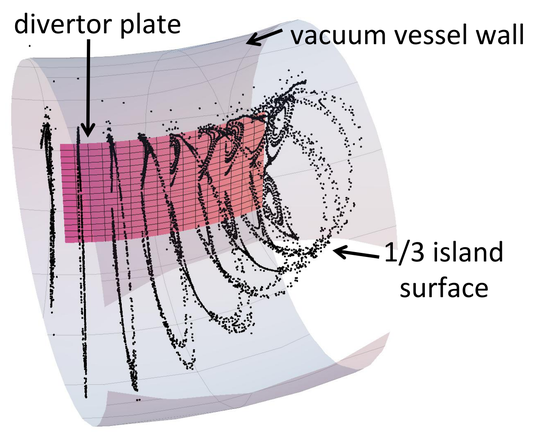
$$\Theta = \lambda \frac{a}{R_o}$$ Field line pitch

$$L_c = \frac{2\pi R_o}{N\lambda}$$ Connection Length

Modeling of divertor plate geometry and 3D transport underway

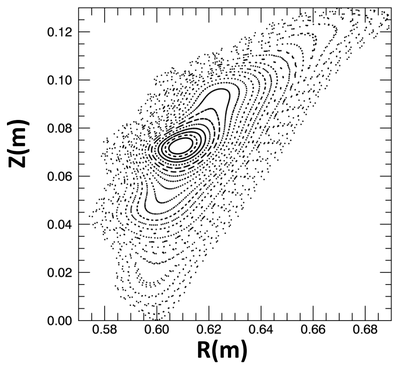




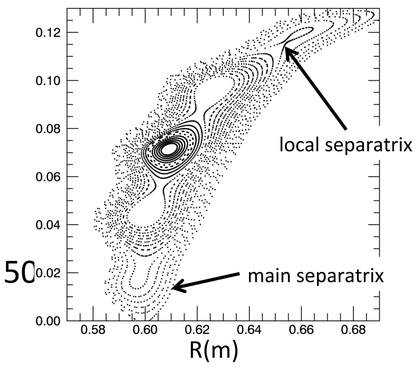


- Fixed position inner divertor plate
- Field Lines started on plate.
- Connection length is the distance field line travels before re-intersecting the plate
- Island structure rotates clockwise in toroidal direction
- One island o-point is leaving divertor surface in the upper right corner

strong perturbation

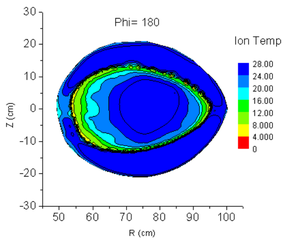


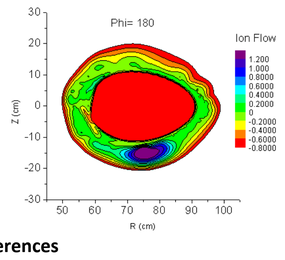
weak perturbation

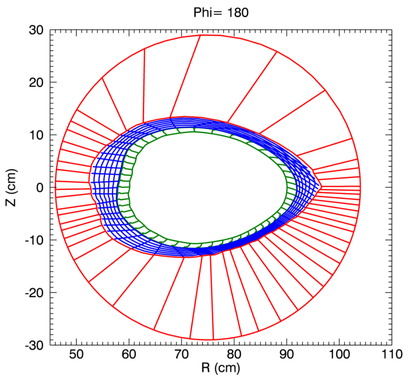


Influence of local separatrix surfaces causes longer than expected connection lengths

EMC3-Eirene grid developed and initial code test runs underway







References
[1] Y. Feng, M. Kobayashi, T. Lunt, and D. Reiter, *Plasma Phys. Control. Fusion*, **53** (2011) 024009
[2] P. Stangeby, *The Plasma Boundary of Magnetic Fusion Devices*, IOP Publishing (2000)

Supported by US DOE Grant DE-FG02-00ER54610