Boundary Work –Egemen Kolemen

1. **SOL Width Scaling**
2. Snowflake vs X-Divertor
3. S parameter vs 3D coils

SOL Width Scaling: Goldston's Heuristic Drift Model vs Critical Pressure Gradient Model

- **SOL Width Scaling/Calculations:**
  - Goldston: Grad B and curv B drifts into the SOL are balanced against near-sonic parallel flows out of the SOL
  - Critical gradient, Ballooning limit: BALOO calculations by Makowski
  - More sophisticated: Balance between parallel losses and non-linearly saturated resistive ballooning mode turbulence driving anomalous perpendicular transport (Halpern).
- **Currently:**
  - NSTX/DIII-D data shows good match to Goldston's simple model.
  - Also, it matches the baloo calculations.
- **Devise an experiment to differentiate between these models and show which one should be used for ITER/ DEMO scalings.**

Orthogonal Scan: Goldston's Heuristic Drift Model vs Critical Pressure Gradient Model

- **Shape change:**
  - Rob's model does not depend on plasma shape parameters
  - Balooning limit does depend on the shape (triangularity, to a lesser degree squareness)
  - Change the triangularity to the extreme: from positive to zero to negative
  - Run in reverse-D configuration (Rob's suggestion) versus regular-D configuration
  - We can run in lower single null reverse-D. Double single null is harder (may not be feasible with measurements).
- **The second option Density Scan**
- **Third option Power Scans can be useful (but harder to distinguish)**
- **Ip is almost useless.**

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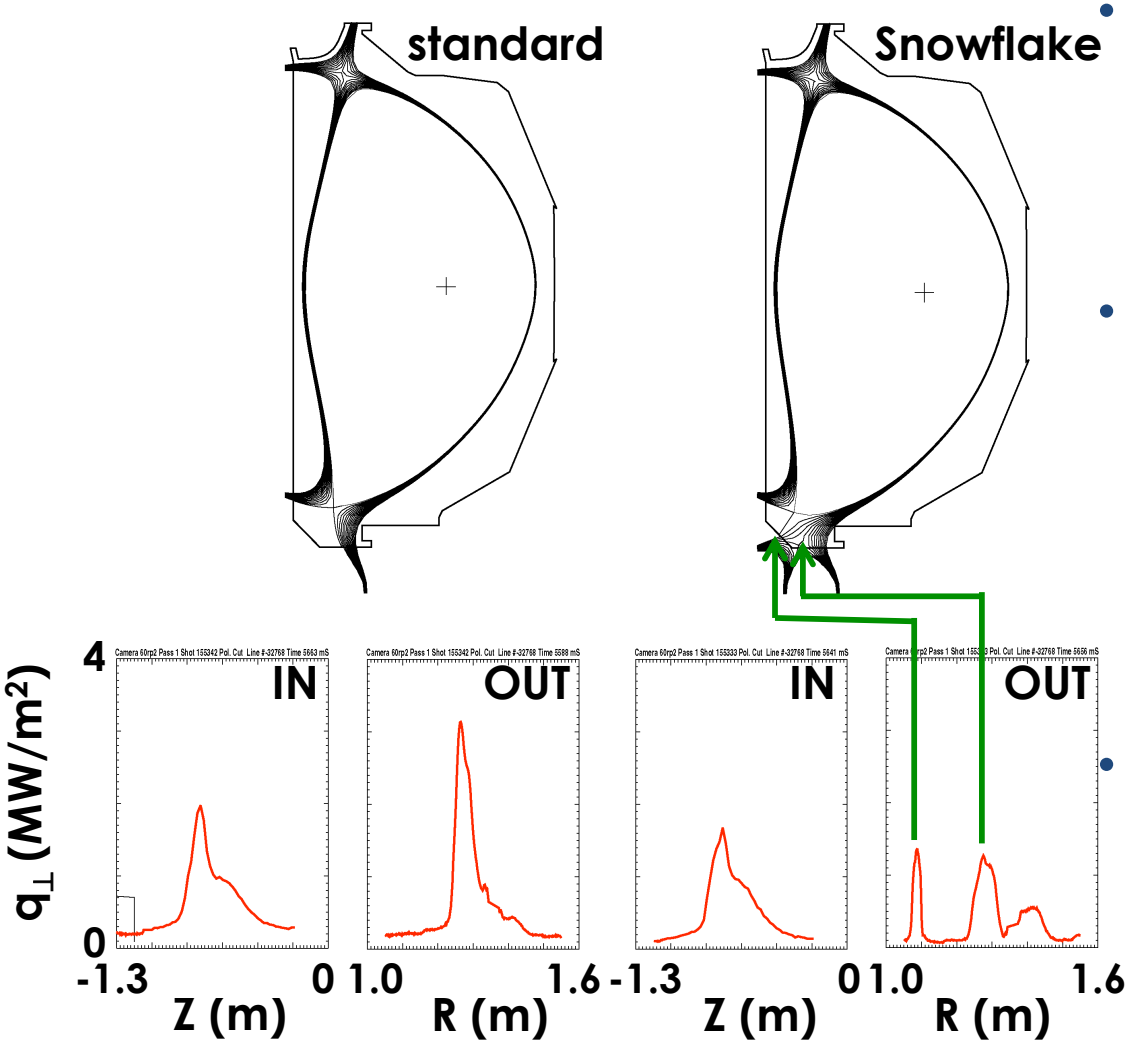
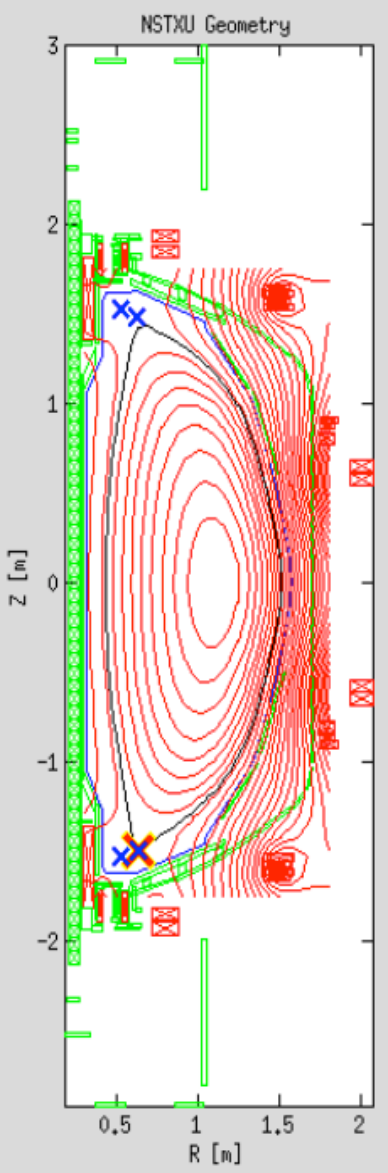
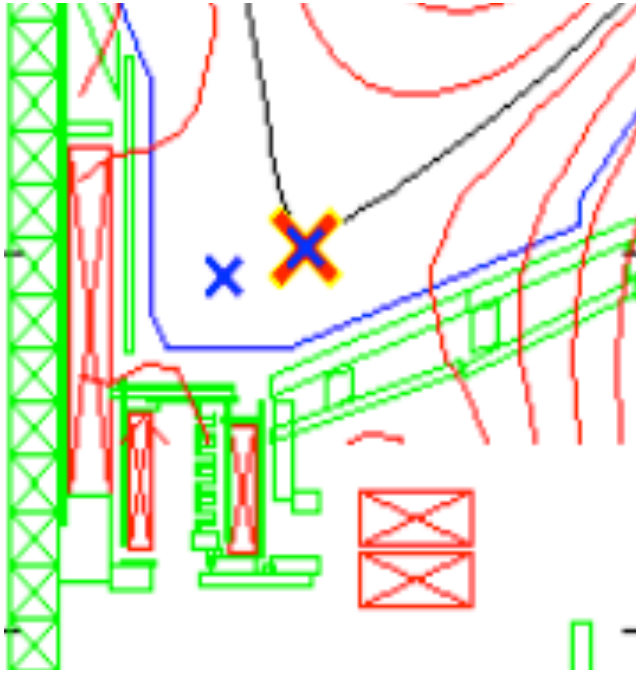
DIII-D Snowflake with 2.5x Reduced Heat Flux Compatible with High Performance Plasmas



- β_N = 3.0 and H98(y,2) ≅ 1.35 conditions kept the same with SF with *no adverse effects*
- Outer:
  - SF bifurcating targets
  - Peak heat flux outer reduced by 2.5x for the SF AT
- Inner:
  - Similar heat flux profiles at the inner target
  - SF: $q^P_{\perp,in} > q^P_{\perp,out}$

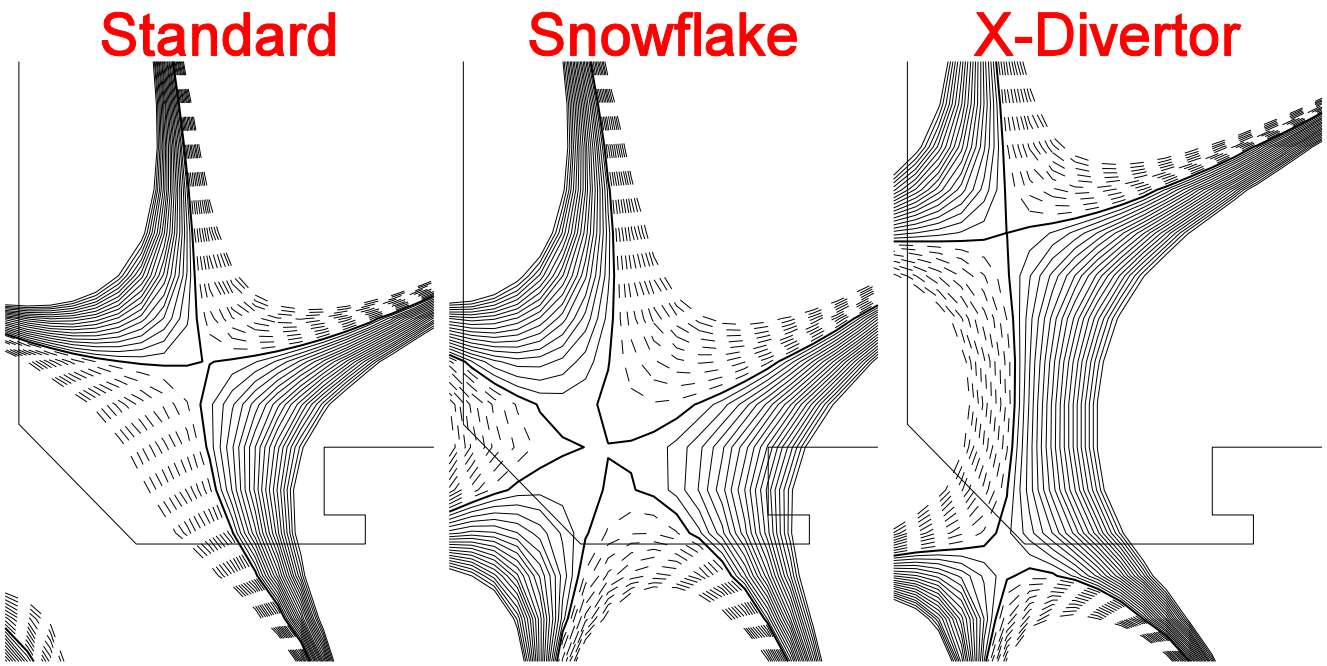
NSTX-U Snowflake





- **We will achieve snowflake at NSTX-U.**
- **Toksys for NSTX-U is mostly working**
- **Pat Vail is helping with the development.**

Snowflake vs X-Divertor



- At D3D, obtained X-Divertor ➔ NSTX-U obtain X-Divertor
- Compare the flux expansion, peak heat flux vs the XD Configuration parameter (X-point location, distance from the plate, angle)
- Compare to Standard Divertor, SFD, and X-Divertor
- Obtain the best scenario for stable low heat operations, stability, and for detachment threshold

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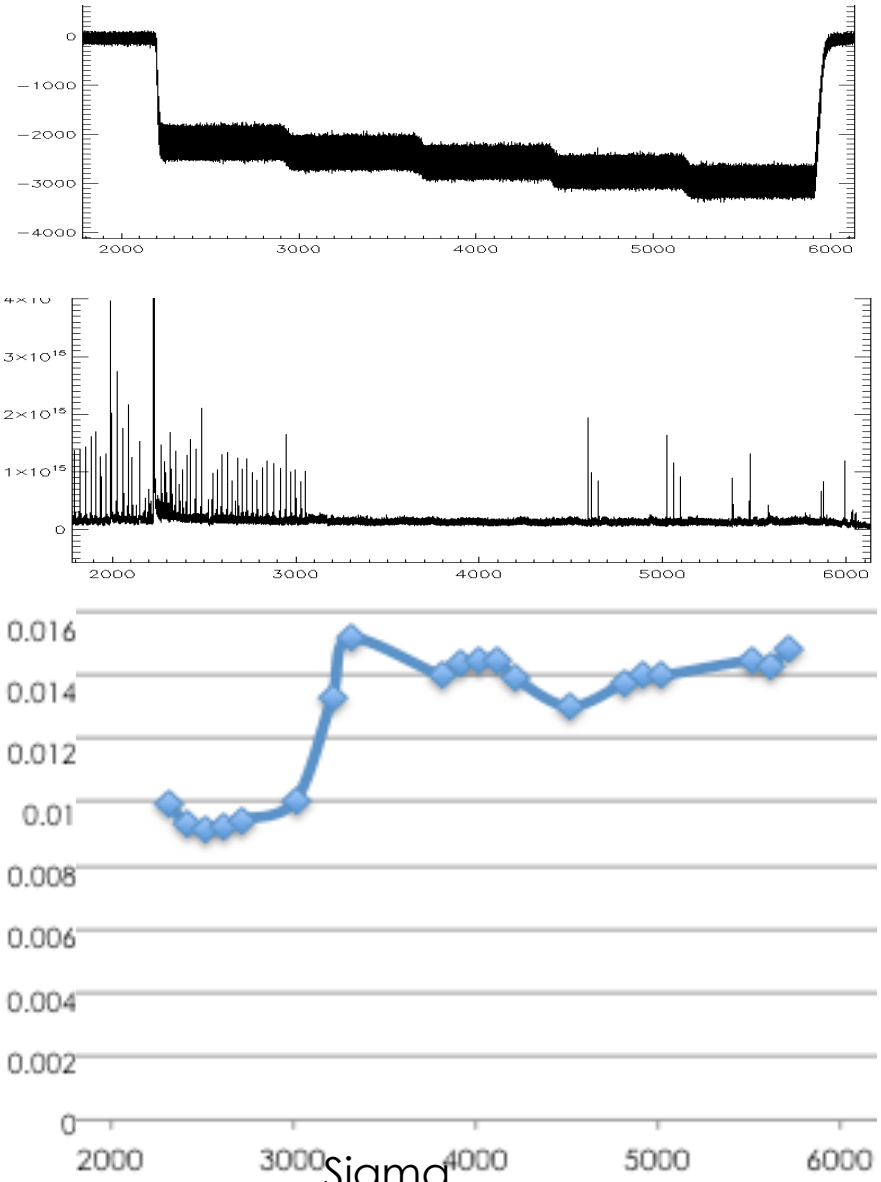
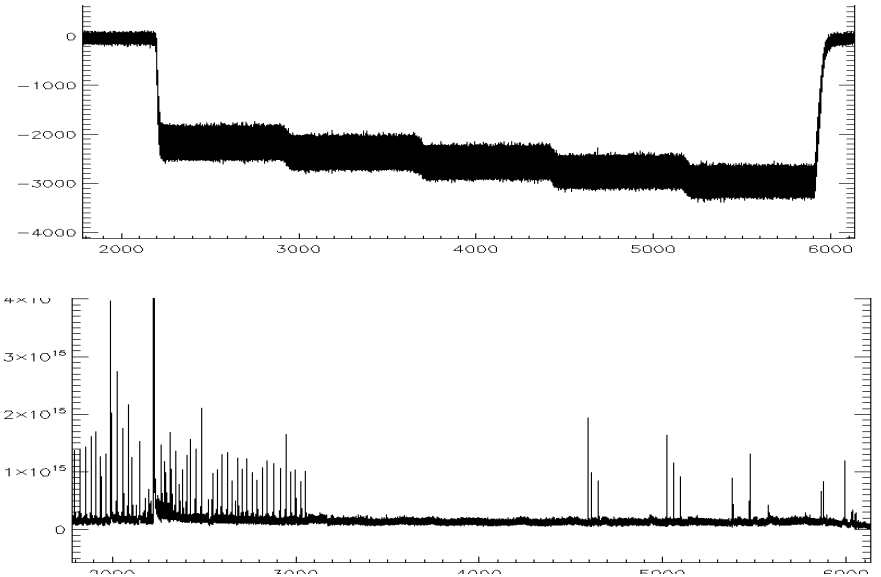
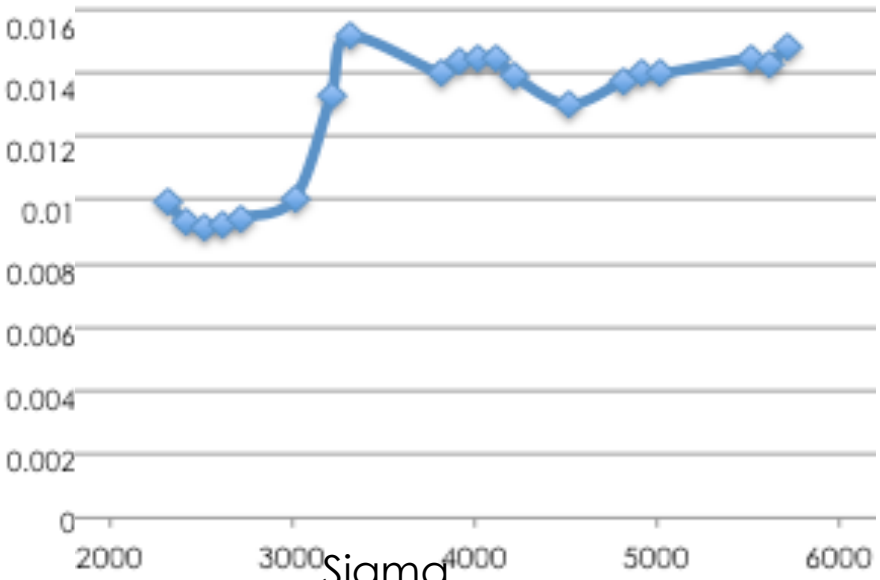
S parameter vs 3D coils



- Initial study of experiments at DIII-D show the sol S parameter (the Gaussian width or the diffusion part of the sol fit) varies with 3D perturbations.
- More interesting observation from the RMP ELM suppression experiment was the big jump in S during ELM suppression phases - RFA.
- Study the connection between the diffusion and restriction of the formation of very high pedestal needed for H-mode crash.
- Not much dependent on I-coil current
- Need better/more data. Most of the shots have the SP covered at D3D.

S parameter vs 3D coils

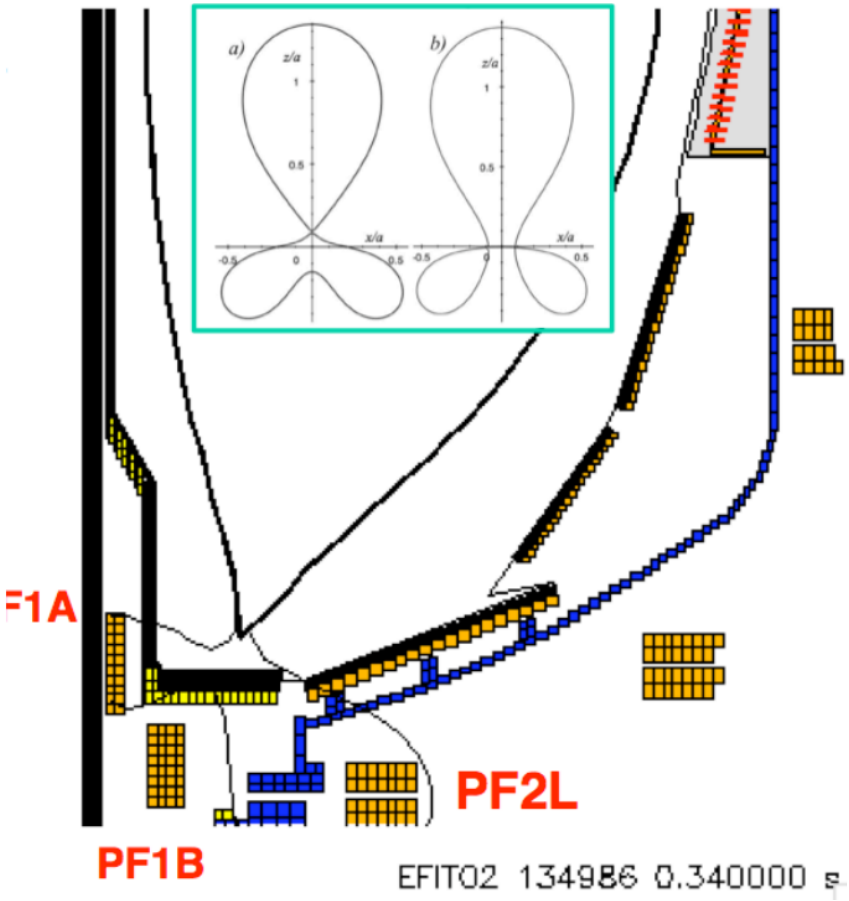




- This experiment will examine 3d perturbation with the sol in ELMy and ELM free (Lithium) discharges. The main goal would be to try to get to the ELM suppression or mitigation regime with the RMP. Study the ELM threshold with 3D coil. Connect the S and pedestal properties.

1. Scan 3D coil current for ELMy, ELM mitigated and ELM free (Lithium) discharge
2. Rotate the RMP to get good averaged heat flux data.
3. Collect S variation with respect to 3D current. Most importantly during the ELMy to RMP ELM suppressed (or mitigated) regime.
4. Try to tie the jump to the ELM mitigation

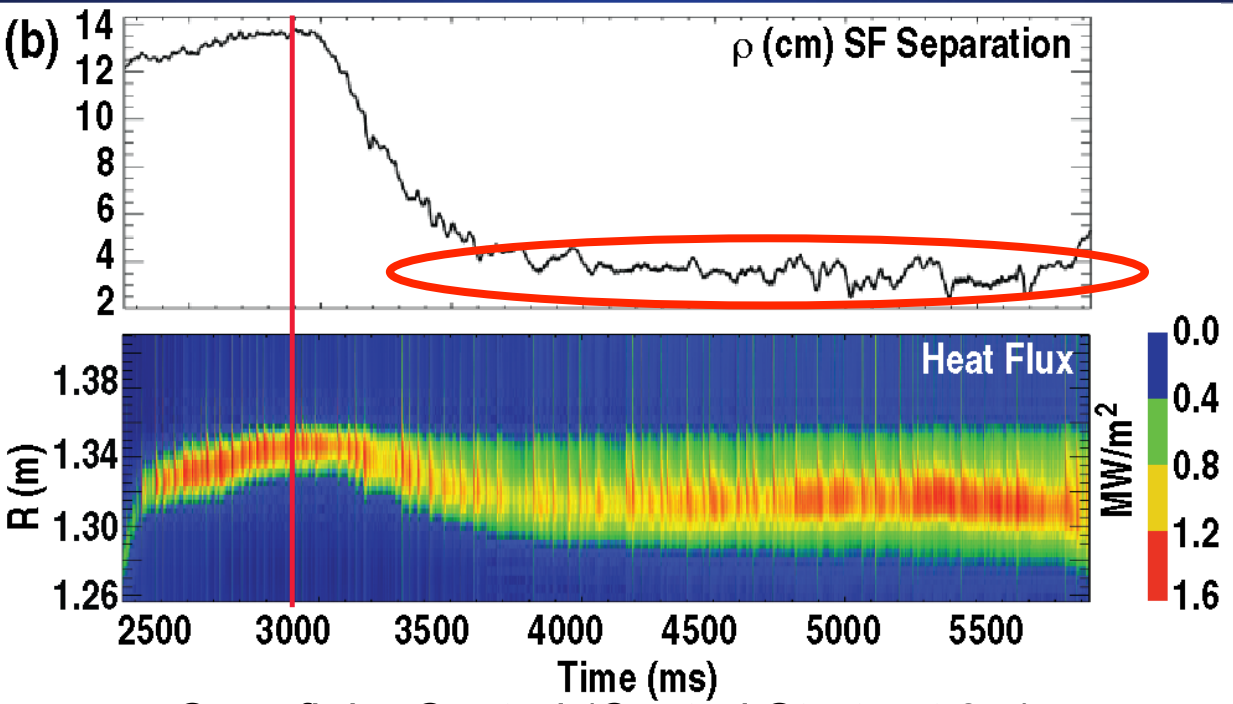
Snowflake Development and Control



Example "snowflake" divertor configuration in NSTX.

- Three options
  - Feedforward coil currents
  - Strike point control with + feedforward
  - Full Snowflake Control
- Develop the stages of control needed for NSTX-U

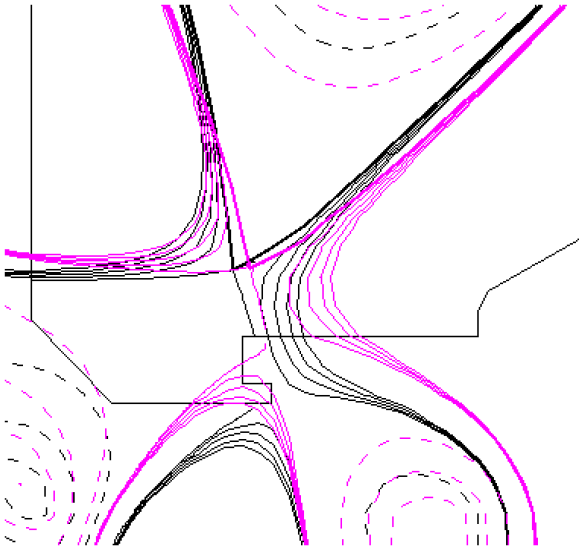
Snowflake Control: Obtaine Optimize Snowflake at NSTX-U (Exact, + and -)

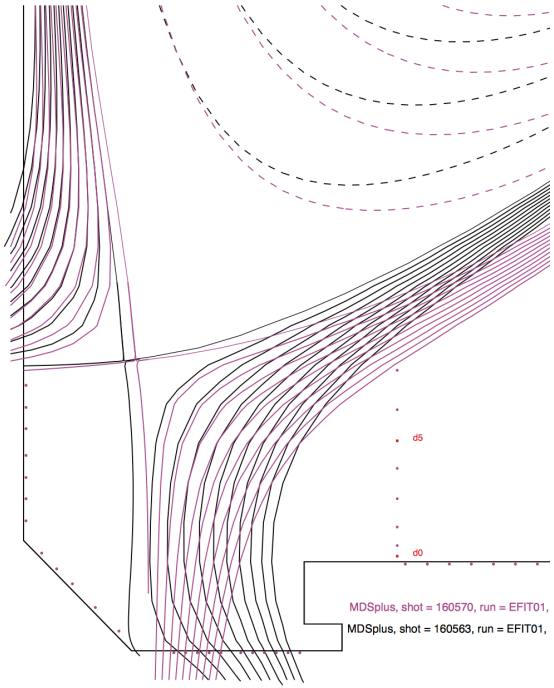


Snowflake Control (Control Starts at 3 s)

- Obtained long stable SF/-/+ at D3D (SF- at NSTX)
- At NSTX-U obtain Snowflake
- Compare the flux expansion, peak heat flux vs the SFD Configuration paramenter (distance, angle, centroid)
- Obtain the best scenario for stable low heat operations

Snowflake vs X-Divertor





MDSplus, shot = 155470, run = EFIT01, time = 3200.00
MDSplus, shot = 160181, run = EFIT01, time = 4000.00

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