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NSTX-U

3-D fields for ELM control in snowflake configuration in DIII-D

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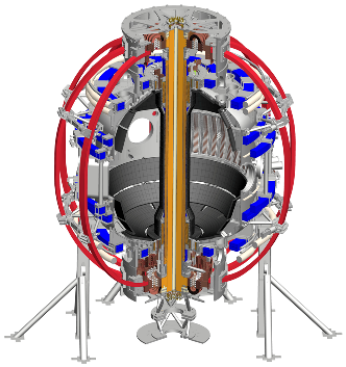
OAK RIDGE National Laboratory

PPPL



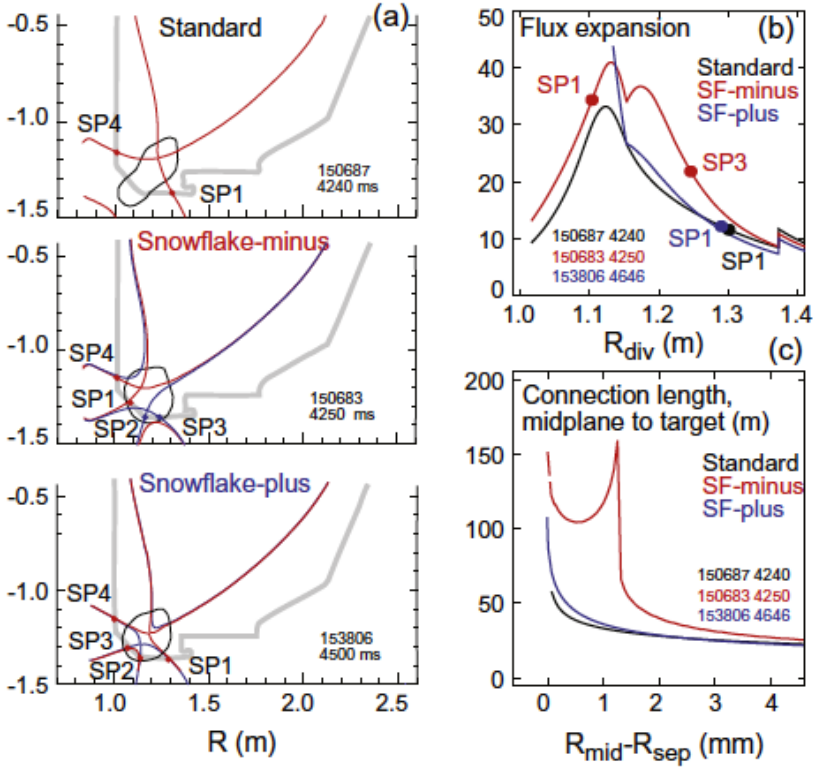
Motivation

- Conventional detachment and RMP ELM suppression are hard to be combined
  - Unavoidable pedestal collisionality rise by gas puffing → incompatible with low ν_e^* like in ITER

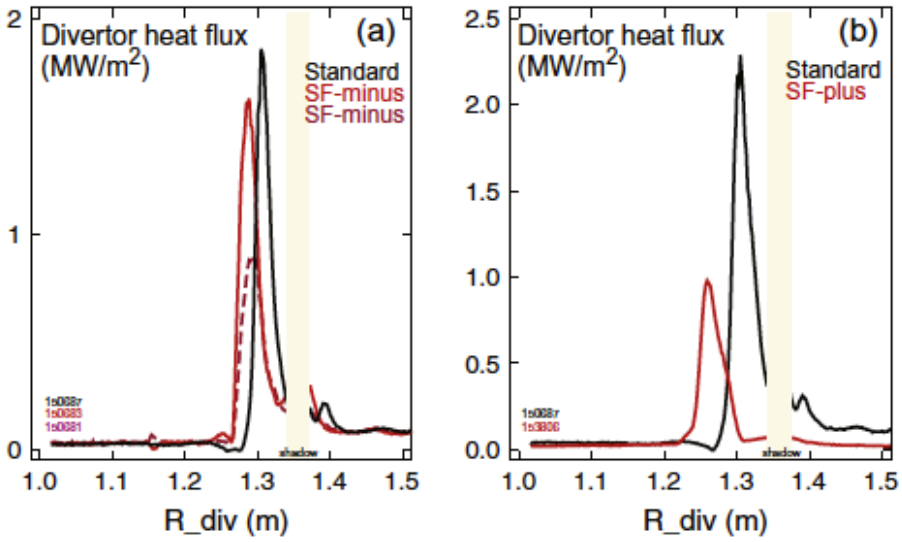
- Snowflake divertor is a leading advanced divertor concept for steady state heat flux management
  - Detachment was achieved w/o gas puffing in NSTX
  - ~x2 peak heat flux reduction achieved in DIII-D

- 3-D fields to be combined with snowflake to control transient heat flux from ELMs
  - Role of plasma response
  - Phasing of applied 3-D fields and current ratio

Heat flux reduction by snowflake in DIII-D

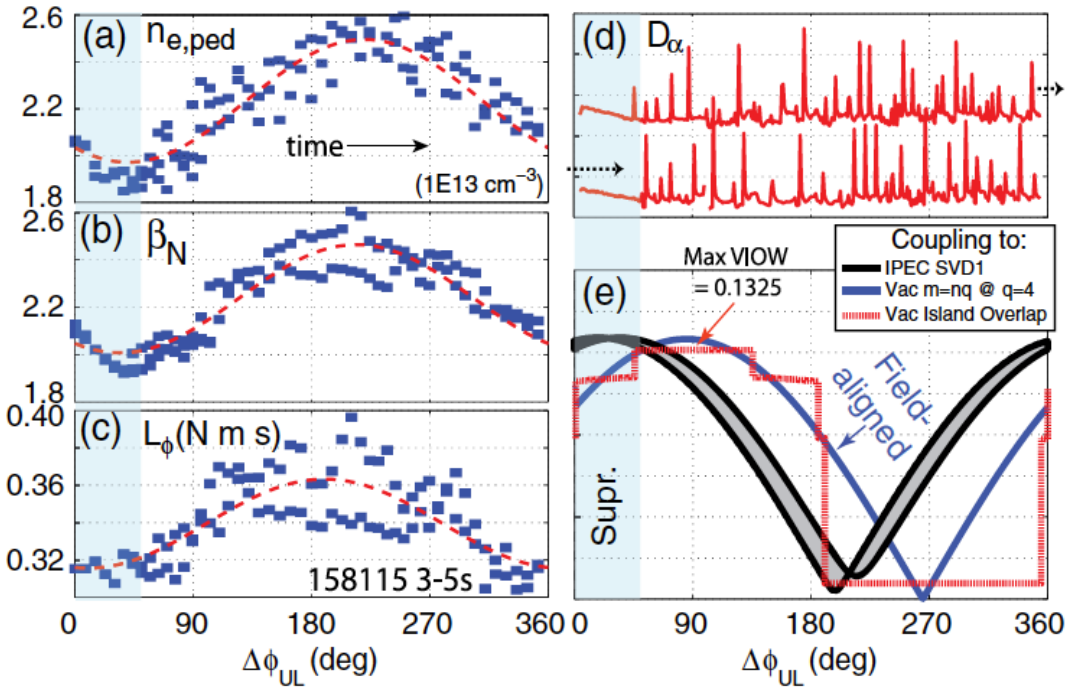


Soukhanovskii, JNM 2015



- Various snowflake configurations have been tested in DIII-D (Soukhanovskii)
  - Typically x2-3 of q_{peak} achieved by geometric effect

Plasma response plays a key role in ELM suppression



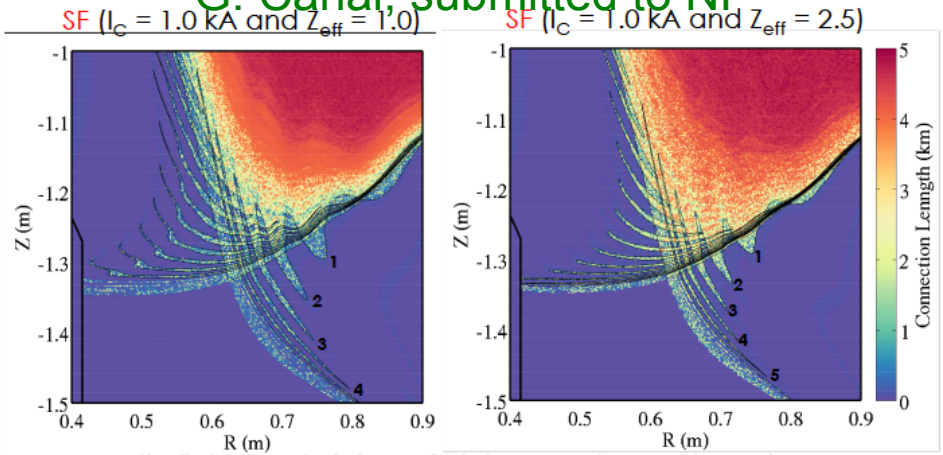
Paz-Soldan, PRL 2015
Nazikian, PRL 2015

- Recent n=2 ELM suppression result in DIII-D demonstrates importance of maximum resonant current drive by plasma response for ELM suppression

- ELM suppression experiment in KSTAR this year strongly supports the importance of resonant edge fields by plasma response

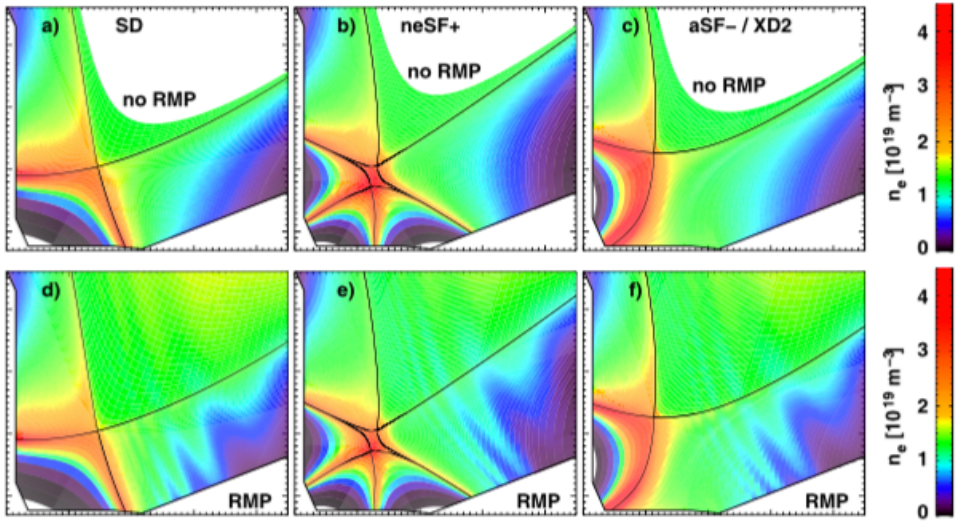
Snowflake modeling in progress on NSTX-U and will be transferable to DIII-D

G. Canal, submitted to NF



Magnetic field lines in lobes of higher Z_{eff} plasmas have longer L_C

H. Frerichs, PoP 2016



- Resistive plasma response from M3D-C1 (G. Canal)
- EMC3-Eirene run for vacuum B-fields and plasma response case is in progress (H. Frerichs)
- Simulation on DIII-D will be readily available

How to apply 3-D fields to snowflake configuration?

- No previous experience
- ELM suppression/mitigation conditions could be different for snowflake
  - Resonant response is a key
  - Optimal RMP spectra → q95, $\Delta\phi_{UL}$, plasma shape, etc
  - n=2? n=3? Or both?
  - Pedestal stability analysis w/ and w/o 3-D fields
- Plasma response modeling for snowflake equilibrium
  - Ideal modeling (IPEC)
  - Resistive modeling (M3D-C1)
- Understanding particle pump out in LSN vs. Snowflakes and the impact of the aspect ratio (O. Schmitz, UW-Madison)
- Plasma control is an urgent issue to be resolved before the run