U.S. DEPARTMENT OF ENERGY | Office of Science

NSTX-U

n=1 ELM suppression with I+C-coil optimization in DIII-D

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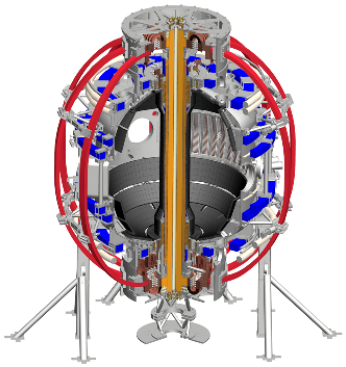
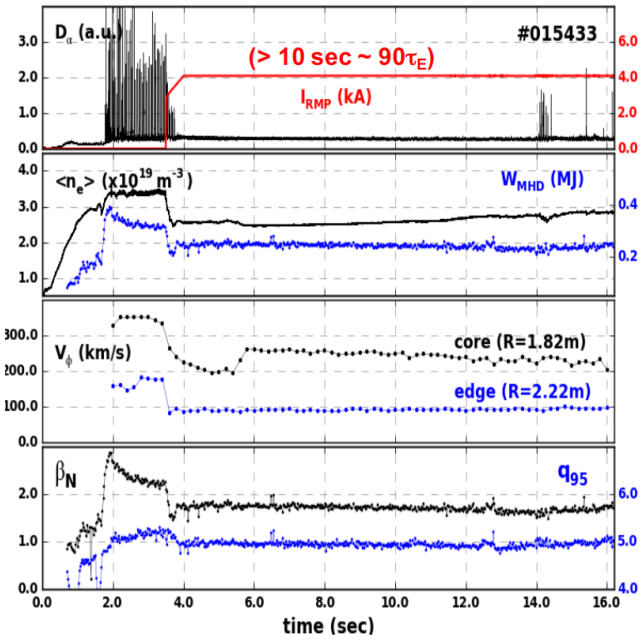
PPPL



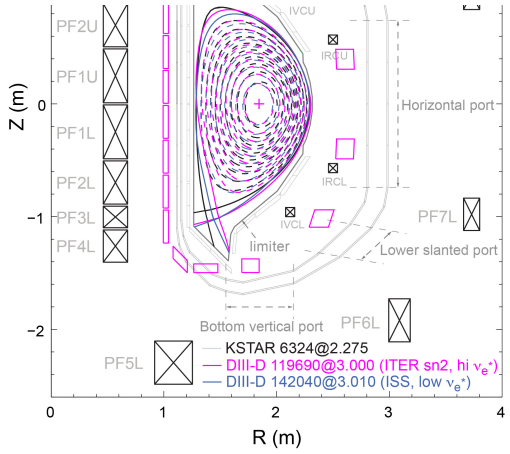
Background and Motivation

- This 0.5 day proposal was motivated by greatly successful n=1 RMP ELM suppression in 2016 KSTAR campaign
- Combined with T. Evans' n=2 KSTAR-DIIID comparison test and assigned in ELM Pedestal Group – Top in 2nd priority (still waiting for RC decision)

Y.M.Jeon, J.-K. Park et al, FEC2016

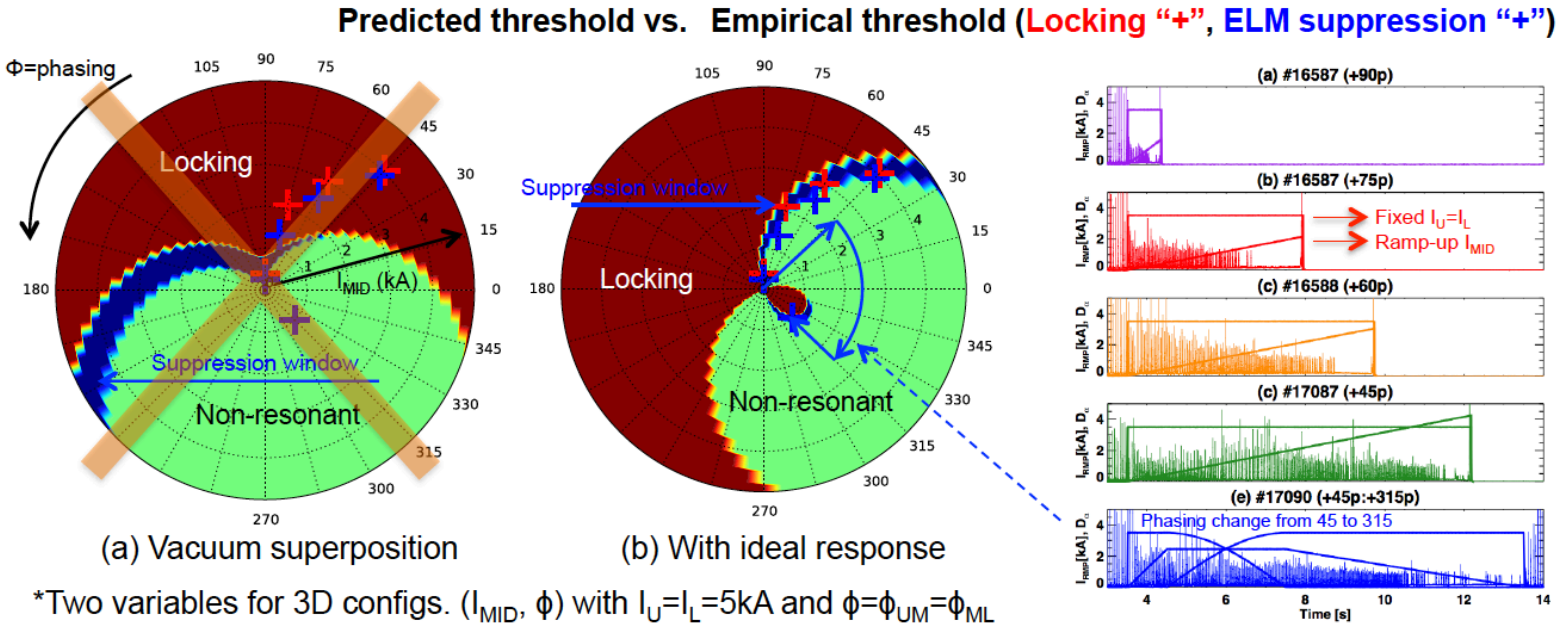


- Additional motivations (for n=1) for DIII-D National Campaign
  - Remarkable predictability and flexibility for ELM suppression window in KSTAR
  - Test physics capability of multiple rows for NSTX-U NCC and ITER RMP



Motivation from KSTAR (2016)

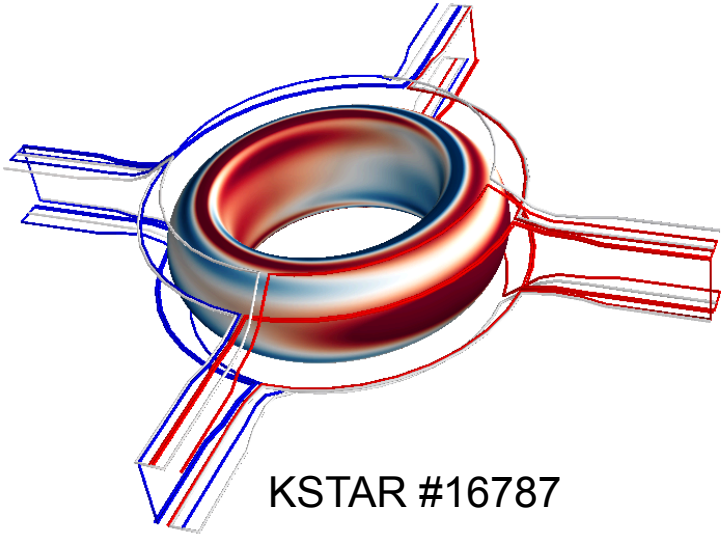
- 3 rows of coils provide great flexibility for 3D spectrum
  - Reason why n=1 ELM suppression is possible in KSTAR
  - No reason why DIII-D (I+C-coil) or future NSTX-U (NCC) can't achieve n=1 ELM suppression when optimized
- Remarkable predictability in complex 3D map was demonstrated using plasma response modeling



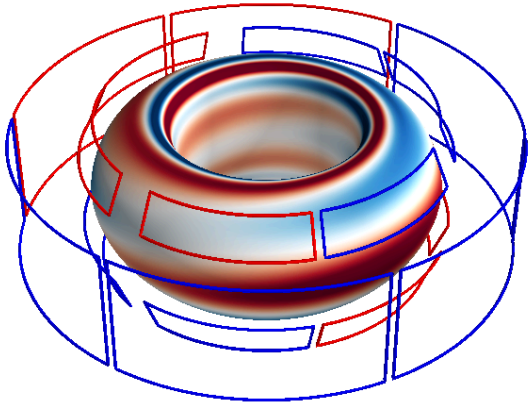
*Two variables for 3D configs. (I_{MID}, ϕ) with I_U=I_L=5kA and ϕ=ϕ_{UM}=ϕ_{ML}

Motivation for DIII-D and NSTX-U

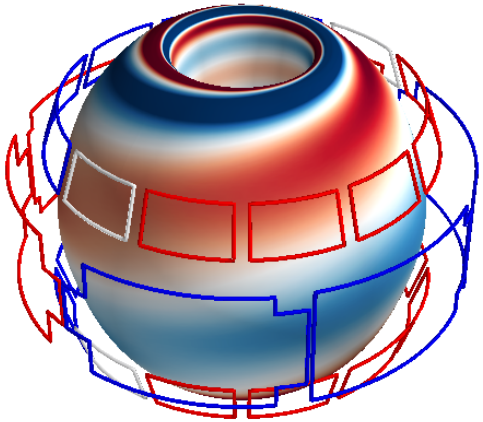
- DIII-D never achieved n=1 ELM suppression, but never explore all 3 rows of coils. Great chance now with super SPAs and 3D SXR
- NSTX-U also never achieved ELM suppression. Greater physics capability is anticipated with NCC, which will give effectively 3 rows of internal coils



KSTAR #16787



DIIID #128463 (model)



NSTXU 2MA (model)

Experimental Approach

- Investigate n=1 coupling as a function of (I_U=I_L, I_C, φ_{UL}, φ_{UC}, φ) to maximize edge coupling, while minimizing core coupling and still leaving sizable edge field
  - Unlike KSTAR, n=1 error field must be considered meaning another variable for reference toroidal phase φ
  - Reduce variables that we can handle with super SPAs
- Try q_{95}>5 as found in KSTAR and reproduce conditions as much as possible, slightly LSN, P_{NBI}=3-4MW, β_N<2, T_e=2-3keV, n_e~3x$10^{19}m^{-3}$, possibly with (R_x,Z_x)
  - R. Buttery explored φ_{UL}, but only q_{95}<5 and many other differences from KSTAR target
- Run time required > 0.5 day