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XP 1002: Core impurity density and P_{rad} reduction using divertor condition modifications

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NSTX Team Review
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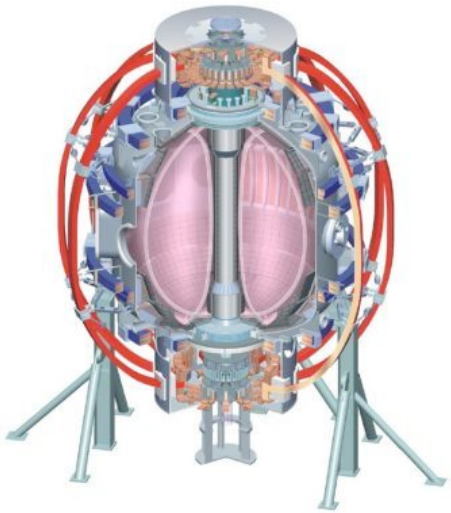

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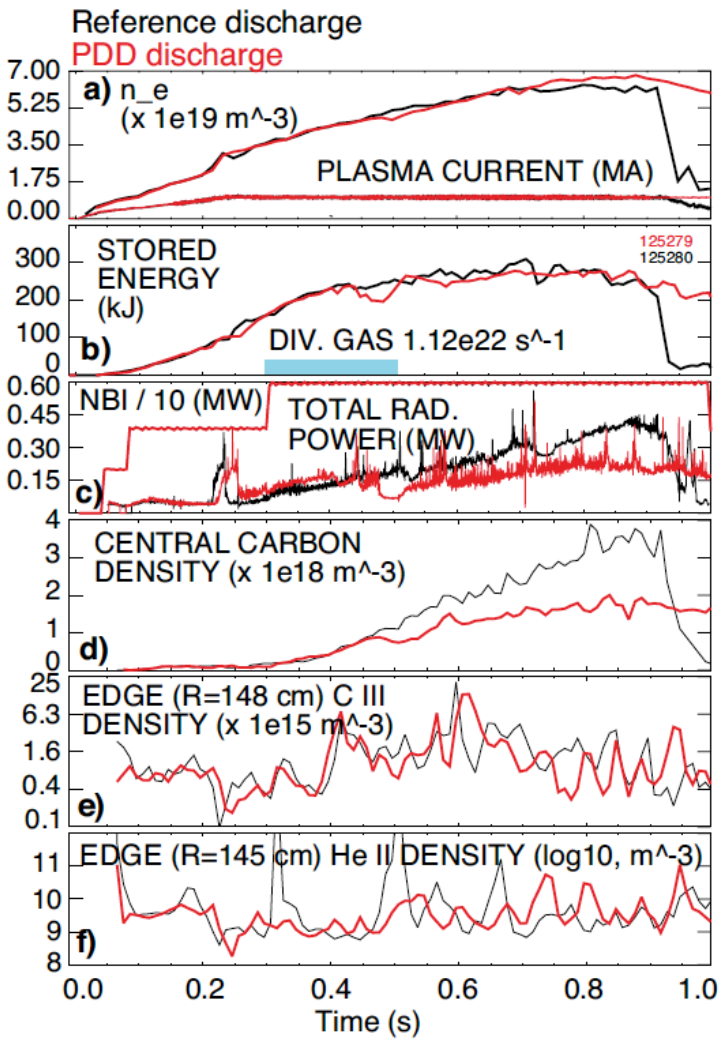
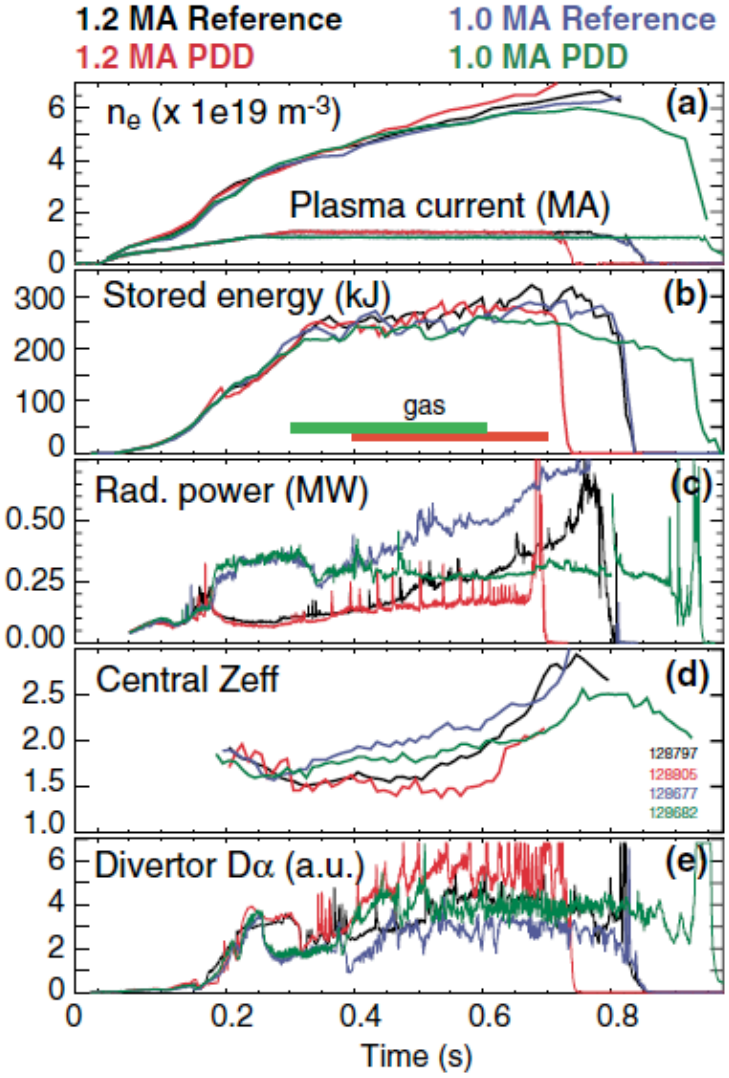
Significant core n_C and P_{rad} reduction observed in divertor heat flux mitigation experiments (w/o lithium)

Phys. Plasmas **16**, 022501 (2009)

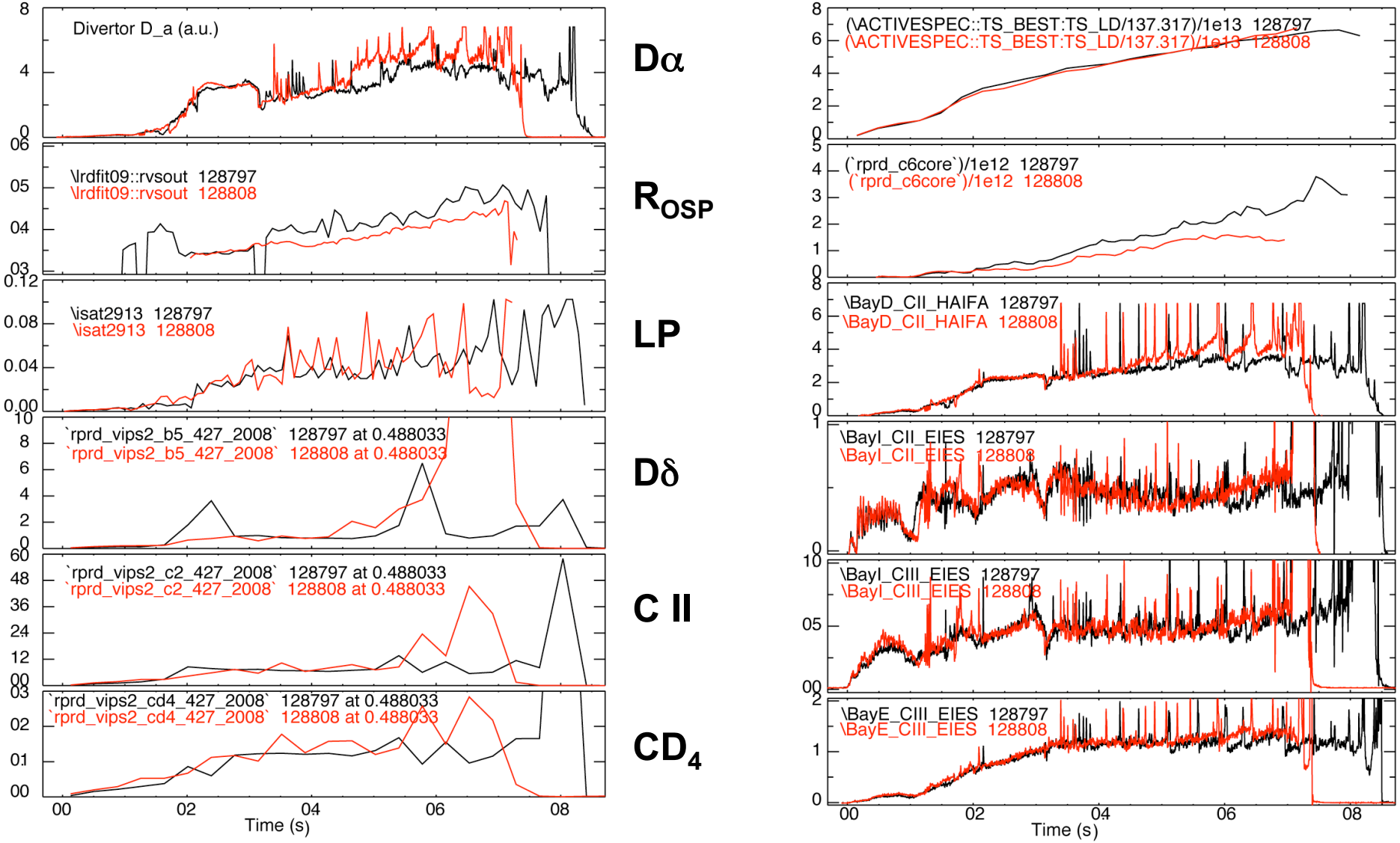


Nucl. Fusion **49** (2009) 095025



Due to more frequent ELMs? or source reduction?

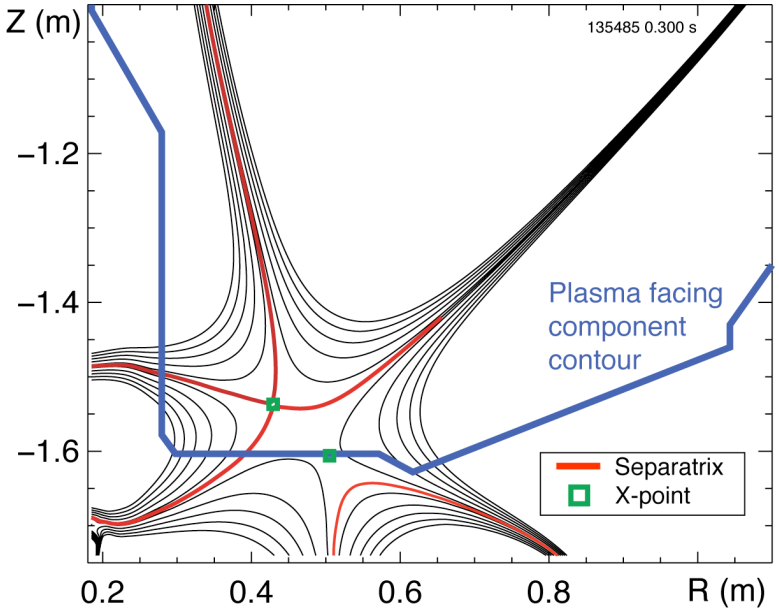
Divertor carbon source evaluation in PDD discharges was inconclusive

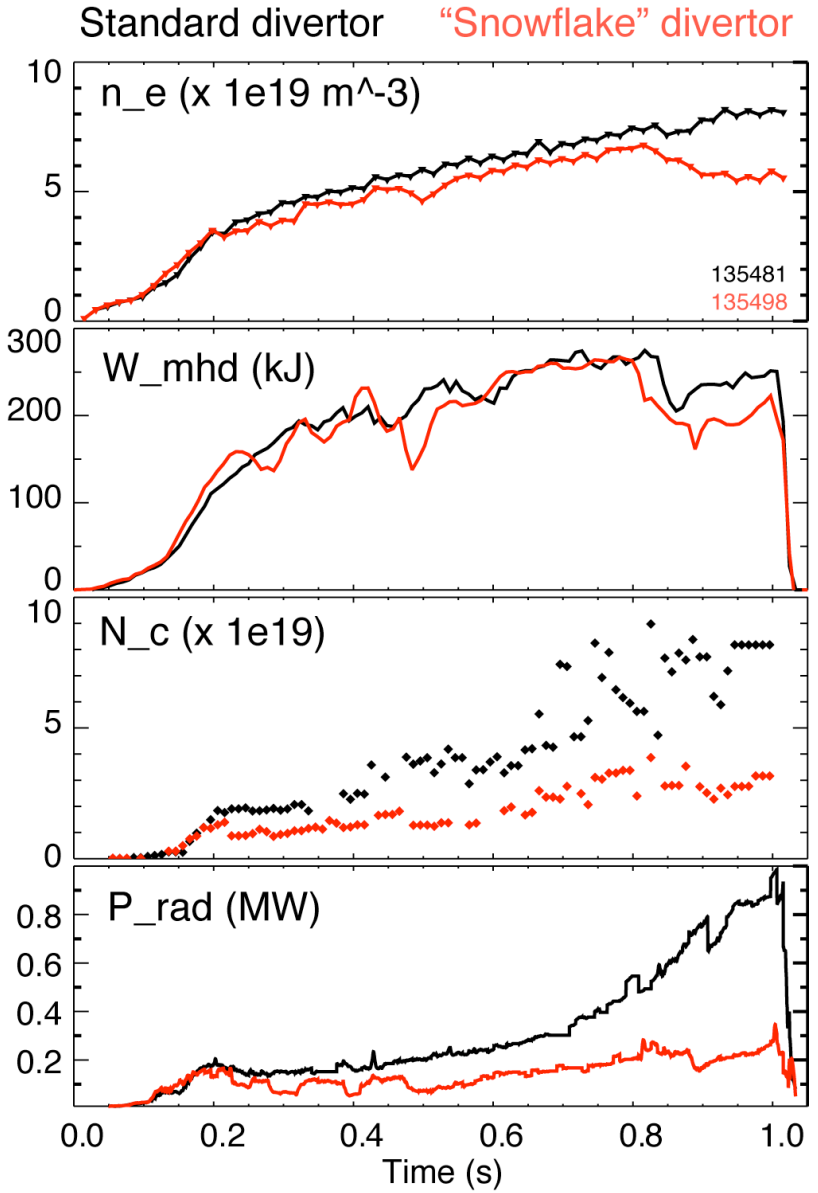


red-PDD, black - reference

Significant core n_C and P_{rad} reduction observed in snowflake divertor experiments

- Medium-δ 0.9 MA 4-6 MW NBI discharge (standard divertor, black)
- "Snowflake" divertor with detached outer strike point region (red)
- Used lithium at ~ 8-10 mg/min
- First detachment observation in NSTX without gas puffing





Use deuterium divertor injection to study effects on core impurity density

- In a discharge with gas puffing
  - T_e-dependent physical and chemical carbon sputtering rates are reduced
    - reduced impurity source ?
  - neutral pressure increased in SOL and divertor
    - preferentially decreased wall impurity source?
    - increased impurity compression in divertor due to D flow?
    - parallel momentum balance (viscosity), E_r, SOL flows (both drift and source) changed → change SOL radial impurity transport ?
    - n_0-dependent neoclassical convention in confined edge plasma?
    - collisional thermalization of fast ions?
- In lithium discharges inner divertor is attached (while it is detached in no-lithium discharges)
  - Inner divertor a significant carbon source?
- Generally ELM-free H-modes present a unique opportunity to study impurity sources and SOL impurity transport

Run plan focuses on developing a scenario with minimum divertor gas rate and no core impurity accumulation

- Obtain a reference discharge, 3-5 MW NBI, high triangularity shape w/ PF1A, LITER rate 10-20 mg/min (100-200 mg), R_{OSP}=0.40-0.55 m, nearly ELM-free H-mode, long pulse (~ 1s), HFS fueling
  - 1 MA, similar to discharges 138178, 138180
  - Optional, time permitting - 0.8 MA, similar to discharges 138239-1380241
  - If available, use PCS strike point control
- Use Bay E divertor gas injector at 5000 Torr (up to 200 Torr l /s) for divertor gas injections. Gas delay in respect to the valve opening time is about 100 ms.
- Injection in the initial phase of discharge – use best injector rate and start at t=0.100-0.150 ms
- Optional, time permitting – obtain data for lower-end NBI power (2-3 MW) and higher-end NBI power (4-5 MW)
- Optional, time permitting, pending administrative approval – use a medium-d discharge target with OSP at R=1.75 m to take advantage of the Langmuir probe array
- Optional, time-permitting – use CD_4 injection instead of D_2

Backup

XP-scope