NSTX

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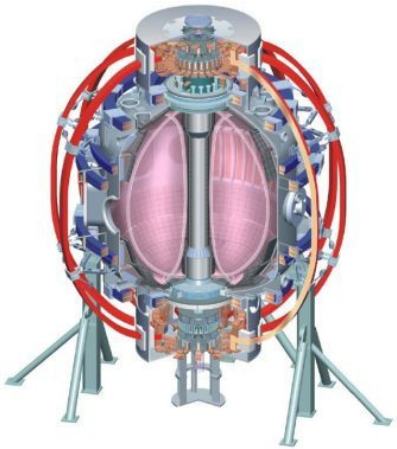

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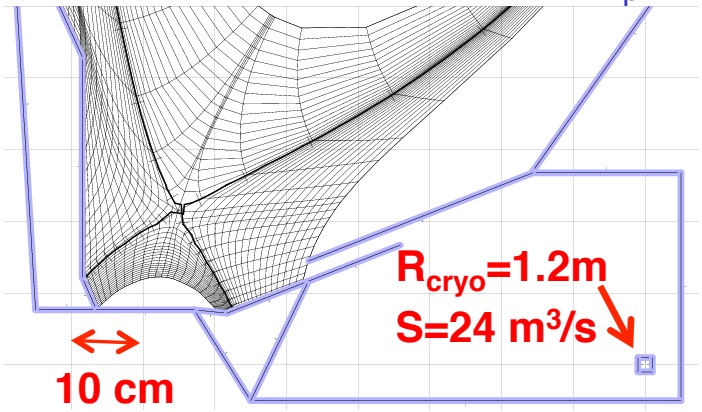
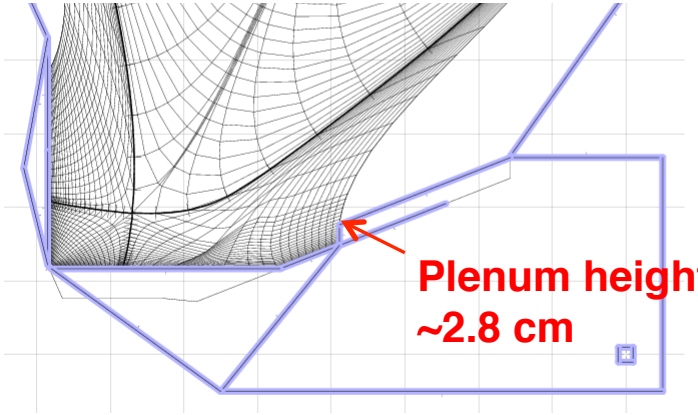
Preliminary assessment of cryopump for NSTX-U has started

- Two calculations: SOLPS (2-D fluid plasma, Monte Carlo neutrals), and analytic model
- Four different geometries examined with SOLPS; entire pump plenum modeled
  - Standard divertor with three different plenum geometries, and one snowflake equilibrium
- Analytic first flight model with standard divertor
  - Plenum pressure computed from plenum geometry, equilibrium and divertor n_e, T_e, and Γ profiles
- Peliminary conclusion: plenum pressure needed to exhaust NBI fueling should be achievable over range of SOL/pedestal n_e

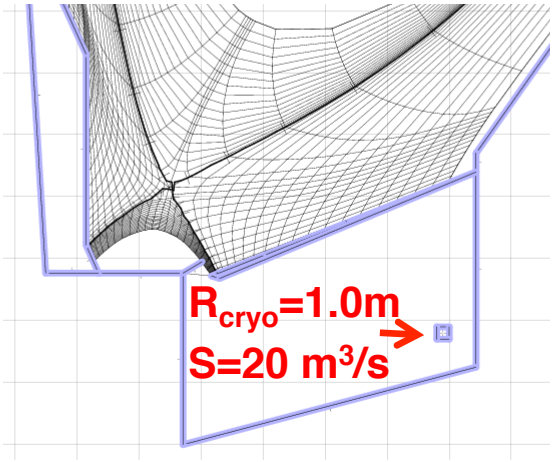
Four geometries scoped with SOLPS for NSTX-U shapes, but with fictitious pump plenums

- Pumping in SOL: standard and snowflake geometries
  - n_e scan simulated by varying target recycling coefficient R_p
  - Pumping simulated by using R_p=1.0 and pump sticking fraction=1





- Pumping in PFR: horizontal and vertical targets (near OSP)



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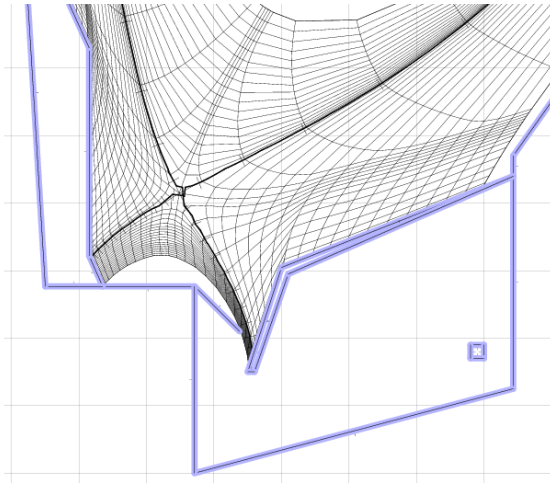
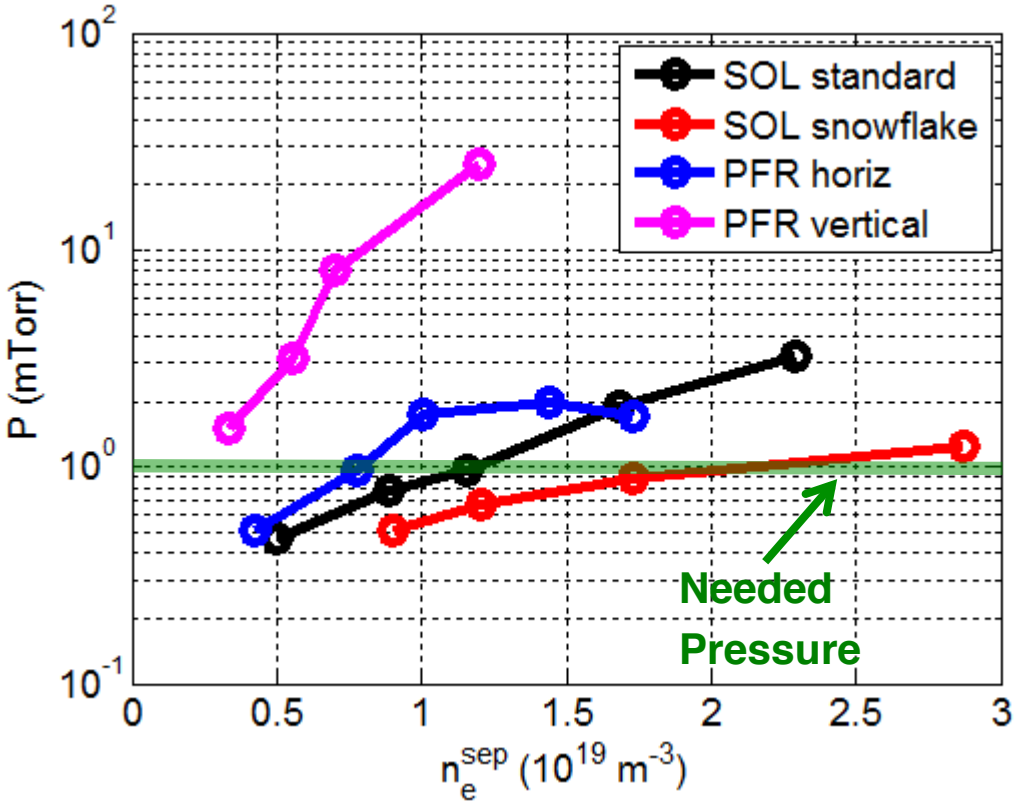


Neutral pressure needed to exhaust NBI fueling sets the minimum achievable separatrix n_e

- Γ_{NBI}=7.5x10^{20} D+ /s (6 MW)
  - S_{NBI}~12 torr-L/s
- D=0.5, χ=1.0 m^2/s in all cases
- Divertor recycling coefficient varied to yield a density scan
- D_2 pressure at cryo pump monitored
- To pump NBI flux at 6 MW, ~ 1 mTorr is needed in plot
  - S_{pump}=24,000 L/s

SOLPS (no pumping)



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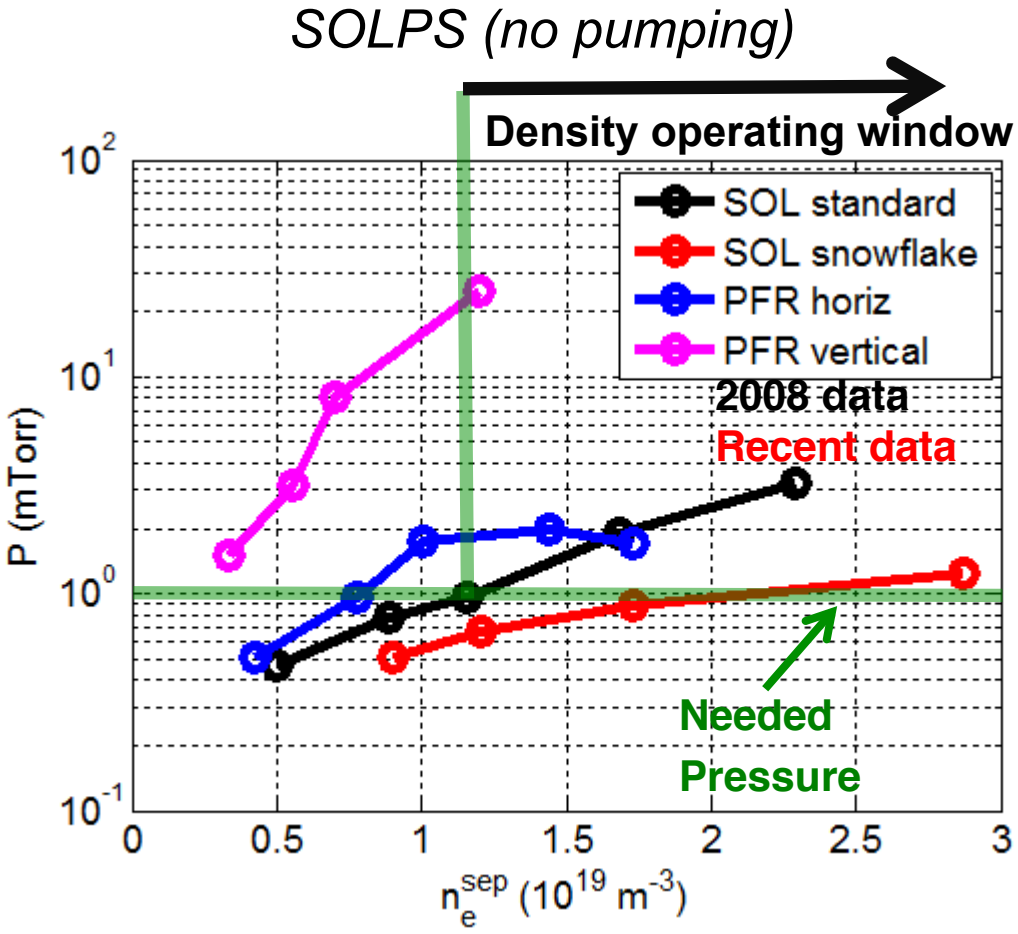
Neutral pressure needed to exhaust NBI fueling sets the minimum achievable separatrix n_e

- *Pressures shown are with no pumping*
  - *With pumping, pressure will be reduced by C/(C+S) ~ 50%*
- n_e operating window obtained by additional gas puffing
- Relation to scenarios

Scenario	n_{max}/n_{GW}	n_{max}^{ped}	n_{max}^{sep}
Long pulse	≤1	9e19	4.5e19
High NI	≤1	7e19	3.5e19
Max I_p	≤0.7 - 1	1.3e20	6.5e19

- P_{NBI}=10 MW case in progress



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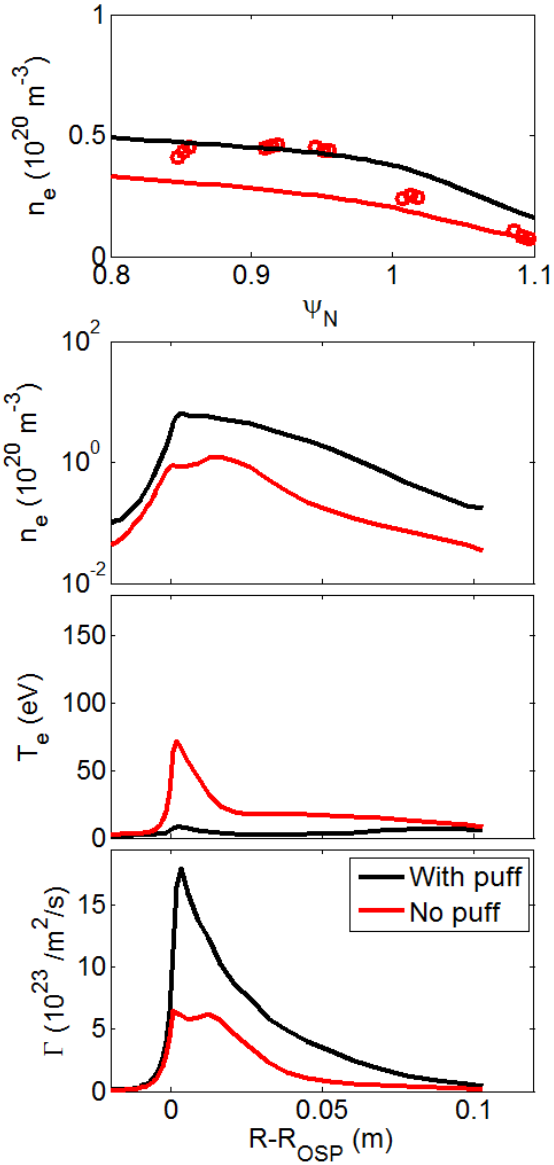
Detailed cryopump design calculations with 2D plasma/neutrals codes planned for NSTX-U

- Higher heating: P_{NBI}=10 MW
- D, χ consistent with I_p = 2 MA, B_t = 1 T operation
  - Present values from 1.2 MA, 0.55 T, 6 MW case
- Up/down symmetric double-null calculation
  - Only lower divertor considered presently
- Compatibility with power exhaust and snowflake divertor operation
- Actual NSTX-U PFC geometry and space constraints
- Iterate for compatibility with core scenario calculations

BACKUP

SOLPS simulations with cryo-pumping: SOL standard

- Particle balance
  - Input with puff: 1.85e21 D+/s ~29 torr l-s (of D_2)
    - Pressure in plenum: 1.1 mTorr
    - Pumped flux: 26.4 torr l-s
  - Input w/o puff: 7.5e20 D+/s ~ 11.7 torr l-s
    - Pressure in plenum: 0.53 mTorr
    - Pumped flux: 12.7 torr l-s
- Separatrix densities
  - 2.0×10^{19} m^{-3} without puff
  - 3.7×10^{19} m^{-3} with puff
  - Beam input (for 6 MW) can be pumped at a reasonable nesep, but no much leeway for having a strong density pedestal and keeping low Greenwald fraction



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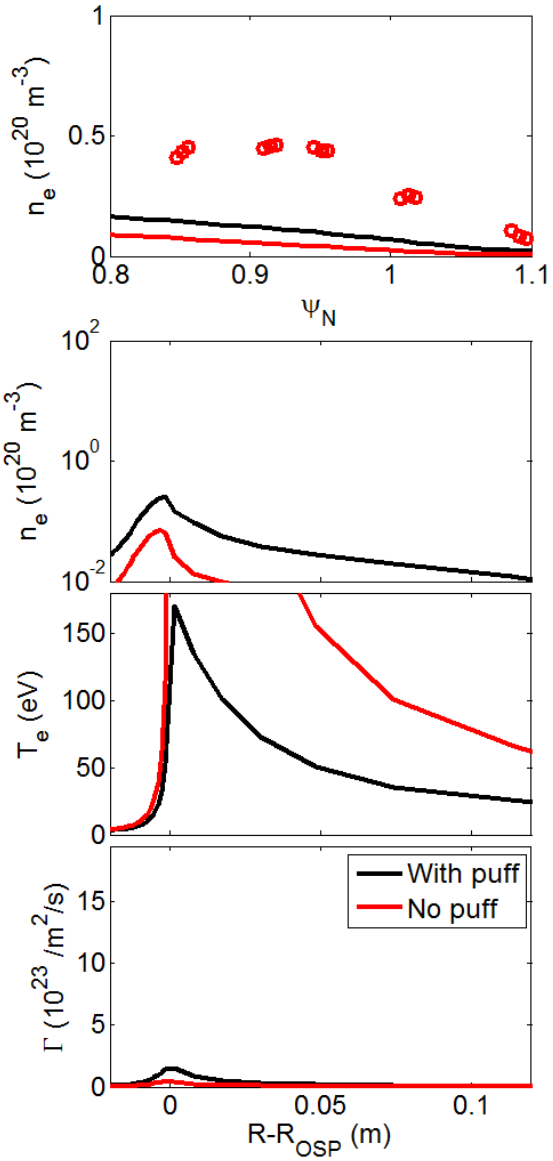
SOLPS simulations with cryo-pumping: PFR vertical

- Particle balance
  - Input with puff: 1.85e21 D+/s ~29 torr l-s (of D_2)
    - Pressure in plenum: 1.5 mTorr
    - Pumped flux: 29.7 torr l-s
  - Input w/o puff: 7.5e20 D+/s ~ 11.7 torr l-s
    - Pressure in plenum: 0.61 mTorr
    - Pumped flux: 12.1 torr l-s
- Separatrix densities
  - 0.23×10^{19} m^{-3} without puff
  - 0.67×10^{19} m^{-3} with puff
  - Much more room for having good pumping at low densities



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