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Particle transport studies on NSTX using supersonic gas injector

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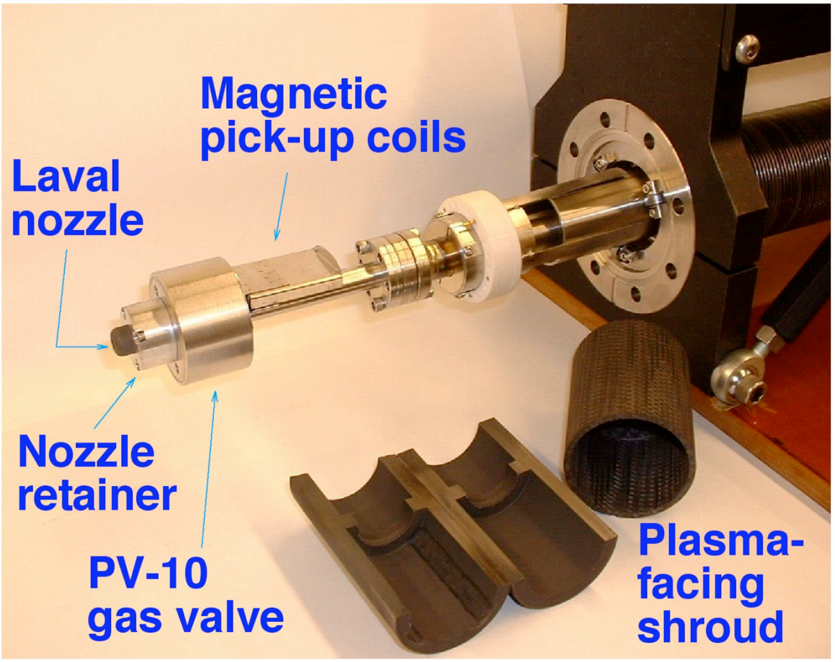
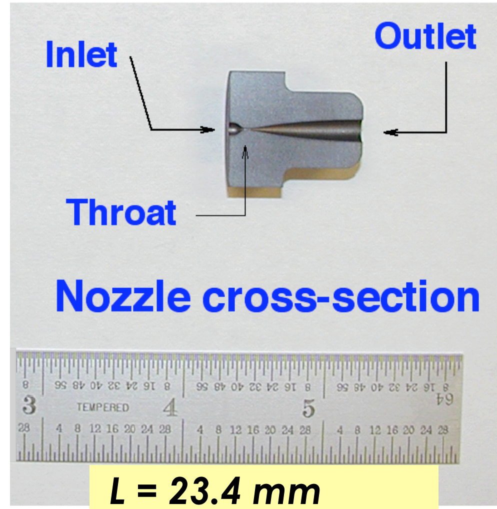
Proposed particle transport studies take advantage of many unique NSTX capabilities

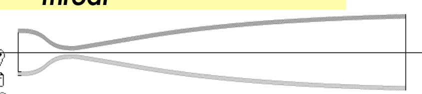
- Diagnostics - SXR arrays, multichannel FIReTIP, high-k scattering, reflectometry, MPTS, CHERS and pCHERS
- Inject D_2, impurity gases (CD_4, N_2, noble gases) from SGI - produce isolated intense particle source on *ms* timescale
- Study SOL impurity transport and turbulence (D_{imp}, v_{imp}, $\delta n/n$, ...) using BOUT for analysis (M. Umansky, NSTX RF FY 2007)
- If ionization profile can be measured - infer D_i, v_i using TRANSP
- Study impurity transport in pedestal (D_{imp}, v_{imp}) (JHU)
- Study cold pulse propagation through pedestal and core (χ_e) (JHU)
- Study role of neutral viscosity on rotation damping and E_r formation

H-mode fueling optimization and density control are studied on NSTX using supersonic gas jet





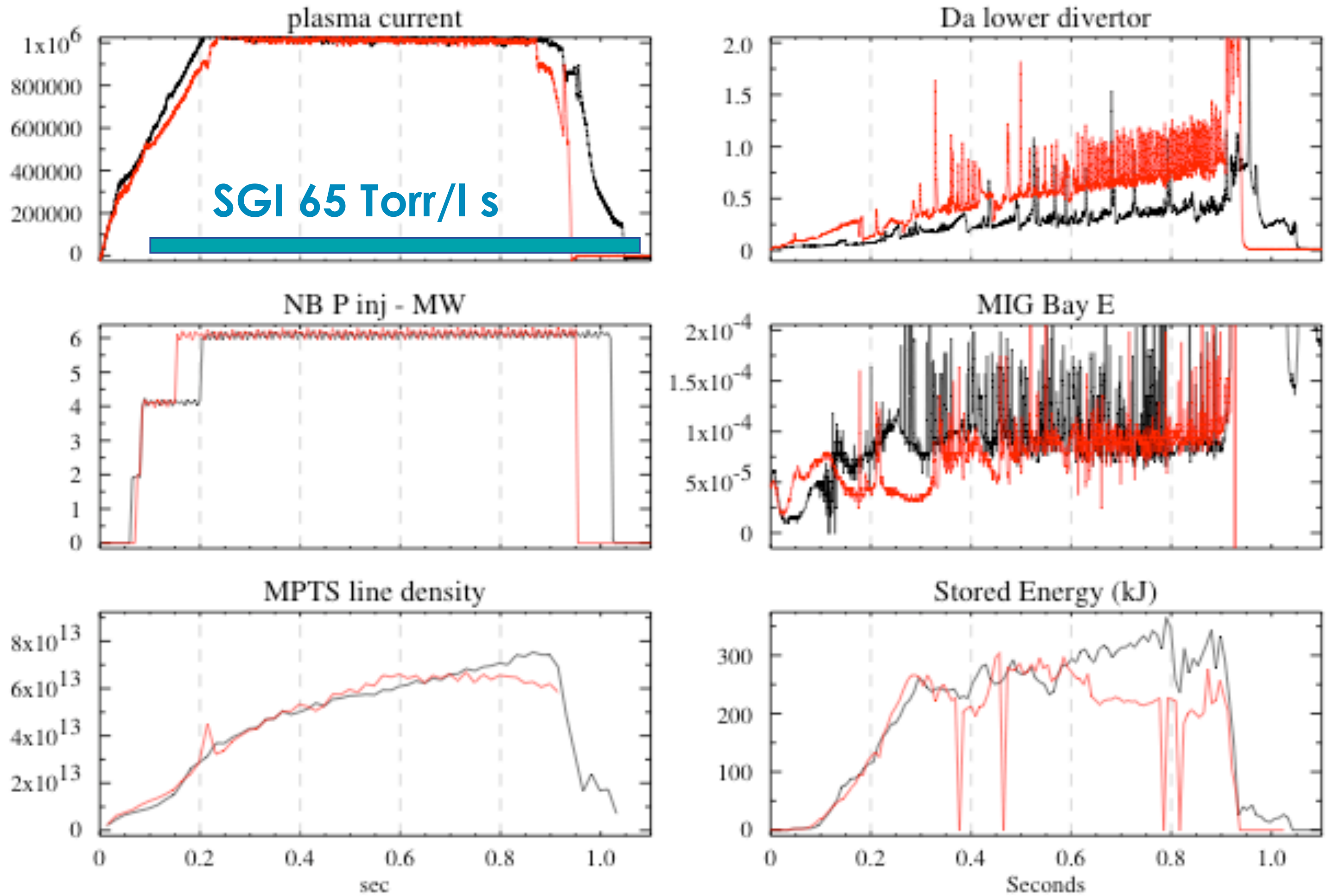
L = 23.4 mm
d_{throat} = 0.254 mm



Supersonic gas injector installed on NSTX in 2004, experiments conducted in 2005-2006

- NSTX SGI is operated at flow rates 20-65 Torr l /s (1.5 - 4.5×10^{21} s^{-1}) - unique fueling tool
- Supersonic deuterium jet:
  - ✓ Jet divergence half-angle: 6° - 25° (measured)
  - ✓ Mach number $M = 4$ (measured)
  - ✓ Estimated: T ~ 60 - 160 K, $n < 5 \times 10^{23}$ m^{-3}, $Re = 6000$, $v_{flow} = 2400$ m/s , $v_{therm} \sim 1100$ m/s

Encouraging initial results obtained toward the goal of reducing uncontrolled HFS fueling



- Shown two discharges with full **HFS fueling** and **reduced HFS + SGI fueling**
- HFS fueling rate reduced up to a factor of 20
- Experiment was run when multi-pulse SGI capability was not yet available - further optimization is to be done

- With SGI fueling ELMs change from small and type I to type III
- H-mode power threshold lower with SGI than with conventional LFS gas

Supersonic gas jet can be used for weak and not so weak plasma edge perturbations

During supersonic gas injection at S < 30-60 Torr l /s

✓ In ohmic plasmas edge density rise is often observed

✓ In H-mode plasmas, n_e "ear" height and width often increase, edge/pedestal and/or core T_e decrease by < 15 %

- SGI Langmuir probe does not typically show T_e reduction or I_{sat} increase
- Magnetic sensors on SGI do not show any EM perturbations
- Plasma turbulence filaments ("blobs") or ELM perturbations traverse through gas jet plasmoid
- SGI remains at room temperature
- In ohmic plasmas, SGI-LCFS distance held at 2-15 cm
- In NBI-heated plasmas, SGI-LCFS distance held at 6-8 cm

- **FY 2007 Upgrade - S = 120 Torr l / s**