

Neutral gas beam injector for improved fueling and plasma diagnostic

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NSTX FY 2002 Forum
26 - 29 November 2001
Princeton, NJ

Motivation

Fueling methods of NSTX

- Gas puff (present)
- Neutral beam injection (present)
- Pellet injection (future)
 - u Edge (near future)
 - u Core (future?)
- Compact toroid injection (future)

Assesment of NSTX fueling

- Gas puff fueling efficiency $\eta < 10 \%$
- NBI fueling efficiency $\eta < 60 \%$
- Gas puff neutrals dominate other boundary sources during gas puff
- Recycling frequently dominates
- HHFW antenna frequently causes neutral influx from center stack
- Impurity fueling efficiency is small

1 Density control (profile, peaked ness, central value) and pressure profile control (for HHFW and H-mode target, for MHD mode and transport control), automated feedback

1 NSTX long pulse fueling methods

1 Requirements to fueling method: high fueling efficiency, minimal contact of neutrals with PFC's, ionization source inside LCFS

Physics of fueling

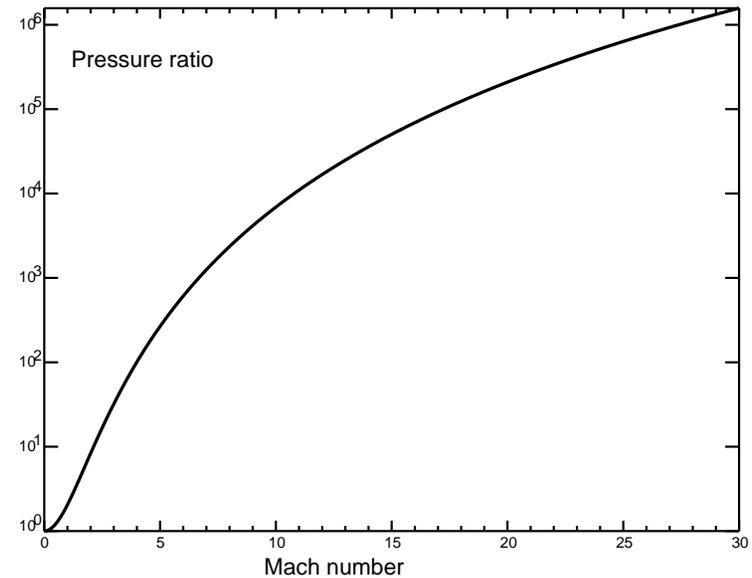
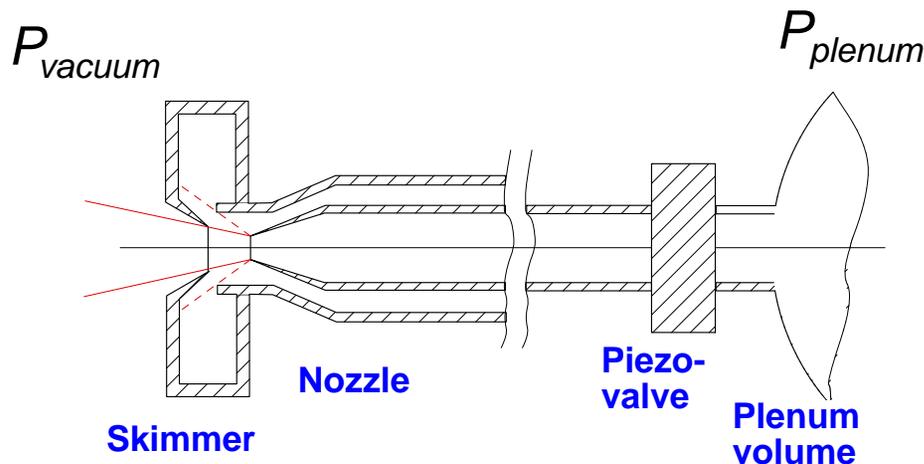
- 1 Gas puff and recycling fueling: ionization source outside or at LCFS. Involves neutrals transport and ion transport through SOL and edge
- 1 NBI, pellet injection fueling: ionization source well inside LCFS

- 1 If ionization source is put inside LCFS: high efficiency, neutral transport less important

- 1 Neutrals ionization mean free path for NSTX:

$$\lambda_i = \frac{V_t}{n_e \langle \sigma v \rangle} \approx 2 - 4 \quad cm$$

Injector design and parameters



- 1 Supersonic gas puff through nozzle : compressible flow of collimated beam of gas particles
- 1 Estimated parameters: fueling rate 1 - 2 Torr l / s through mm nozzle (for pressure in plenum 2000 Torr) - Optimizations possible
- 1 Similar designs have been used on TJ-1U torsatron (Madrid, Spain), HT-7, HL-1M tokamaks (China)

Applications

- Fueling and density control
Main ionization source inside LCFS, collimated particle beam
- Particle transport studies
 - Impurity transport (**inexpensive and simple** alternative to laser blow-off system)
 - Cold pulse propagation experiments
Delta function -like spatial and temporal deposition profile
- SOL diagnostics: helium line intensity ratios for measuring electron temperature and density in the SOL (will work well with existing spectroscopy)