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Supersonic gas injector upgrade discussion

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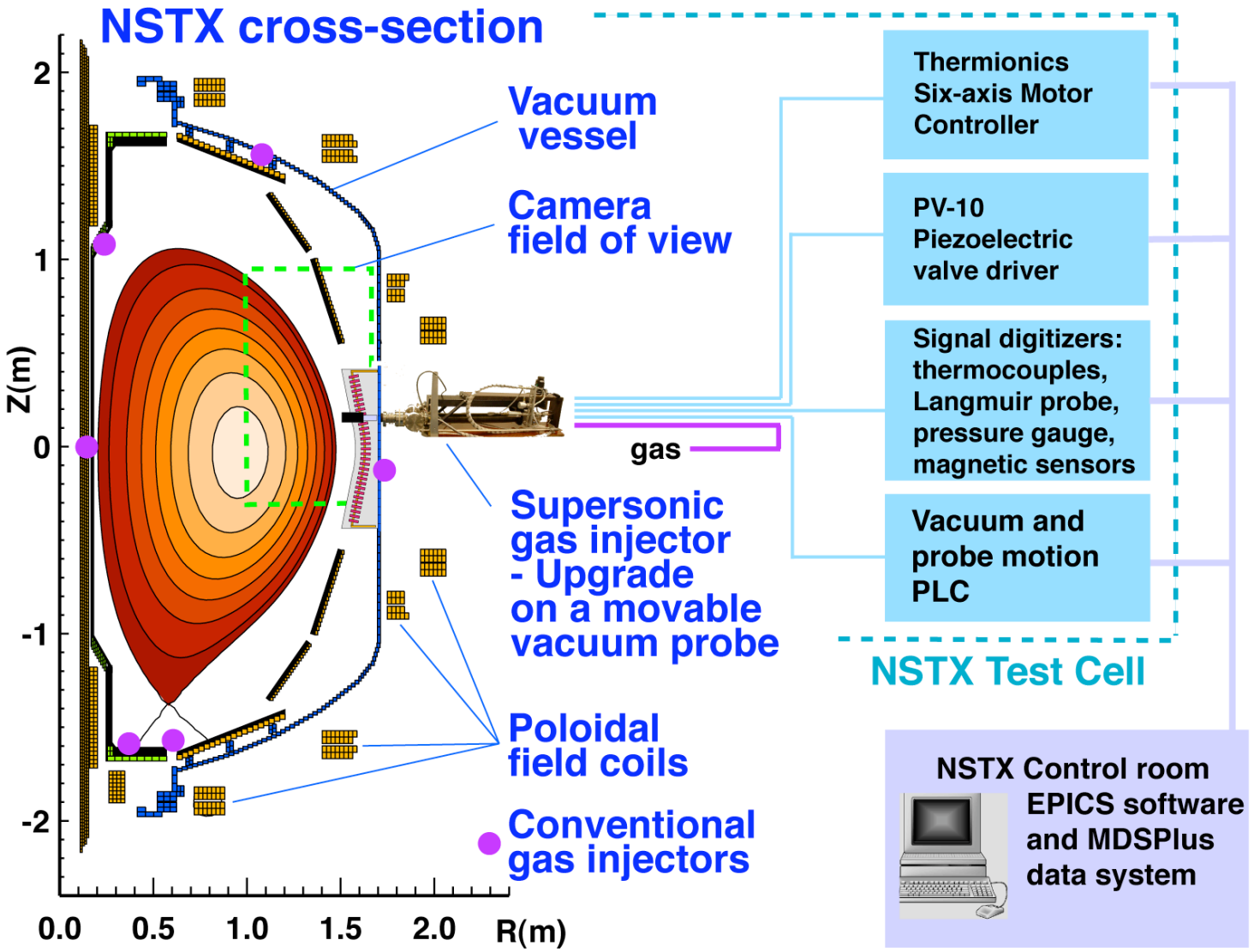
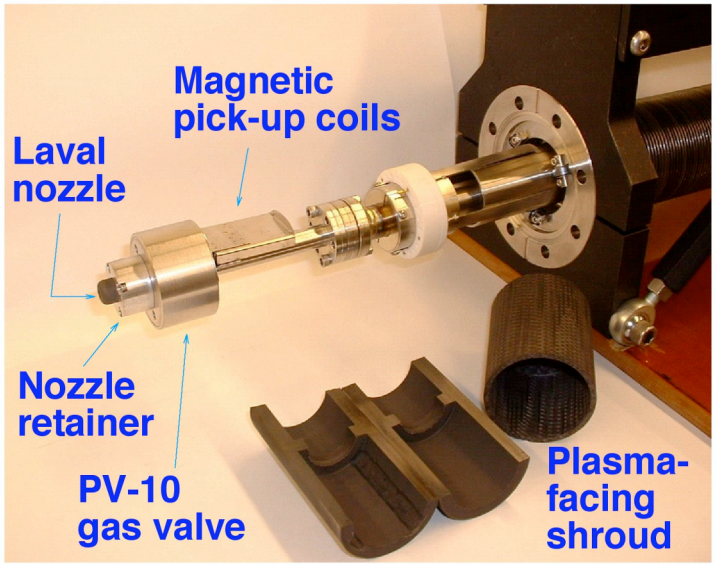
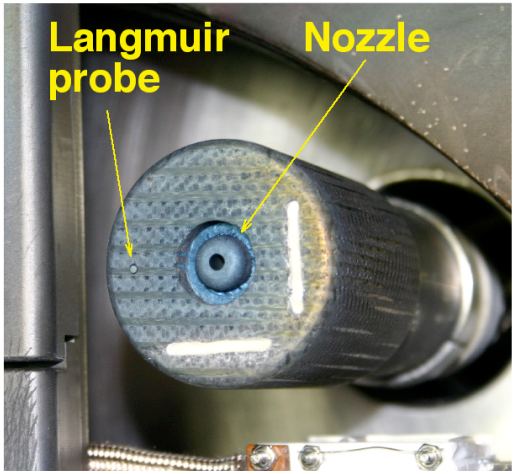
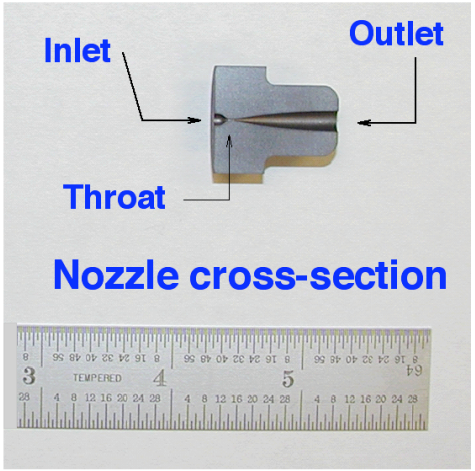
Supersonic gas injector is a complex computer-controlled high gas pressure apparatus



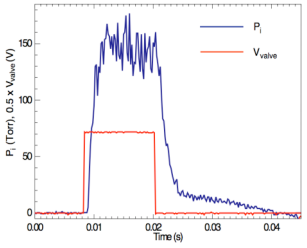
Supersonic gas injector consists of Laval nozzle and piezoelectric valve

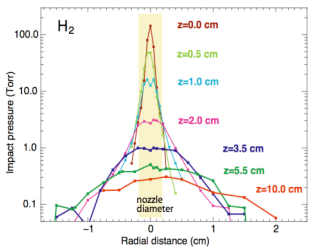






- SGI-U is operated at flow rates 20-130 Torr l /s ($1.5 - 9.0 \times 10^{21}$ s^{-1})
- Supersonic deuterium jet properties:
  - Jet divergence half-angle: 6^o - 25^o (measured)
  - Mach number $M = 4$ (measured)
  - Estimated: T ~ 60 - 160 K, $n < 5 \times 10^{23}$ m^{-3}, $v_{flow} = 2.4$ km/s, $v_{therm} \sim 1.1$ km/s
  - Nozzle $Re = 6000$





Proposed upgrades

- Use present valve / nozzle for stationary SGI mounted on the wall in the shadow of limiter
- Use movable probe for prototype cryogenic SGI
- For cryogenic SGI:
  - Design and make new metal nozzle
  - Use non-piezo valve (EM, pneumatic, others)
  - Design cryogenic cooling system (liquid N_2)
- Present limit on reservoir pressure (5000 Torr = 96 PSI) seems sufficient for fueling with present nozzle ~ 160 Torr l / s