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Supersonic gas injector on NSTX - Upgrade for FY 2007

**W. Blanchard
V.A. Soukhanovskii**

Acknowledgements:

**M. G. Bell, D. A. Gates, R. Gernhardt, R. Kaita, H. W. Kugel,
D. Mueller, T. Provost, A. L. Roquemore, P. Sichta**

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MOTIVATION

Good results obtained in FY04 - FY06 experiments with SGI. Also learned of limitations.

- Low field side (LFS) supersonic gas injector (SGI) has been used for fueling of ohmic and 2-6 MW NBI-heated L- and H-mode plasmas
- Developed H-mode scenario with SGI fueling and reduced (x 20) high field side (HFS) fueling rate. Demonstrated the possibility of density control, with reliable H-mode access, and different (improved) ELM regime
- SGI injects deuterium at $S < 65$ Torr l /s in quantities 0.1 - 0.3 of NSTX plasma inventory in a multi-pulse, continuous fashion with measured fueling efficiency 0.1 - 0.4
- SGI has been used “commercially” in several XPs
- Learned of apparent limitations:
 - Flow rate is limited to 65 Torr l /s - need higher flow rate
 - Gas jet pressure may be too low for good SOL penetration
 - Fueling efficiency is a function of gas jet (i.e. plenum) pressure

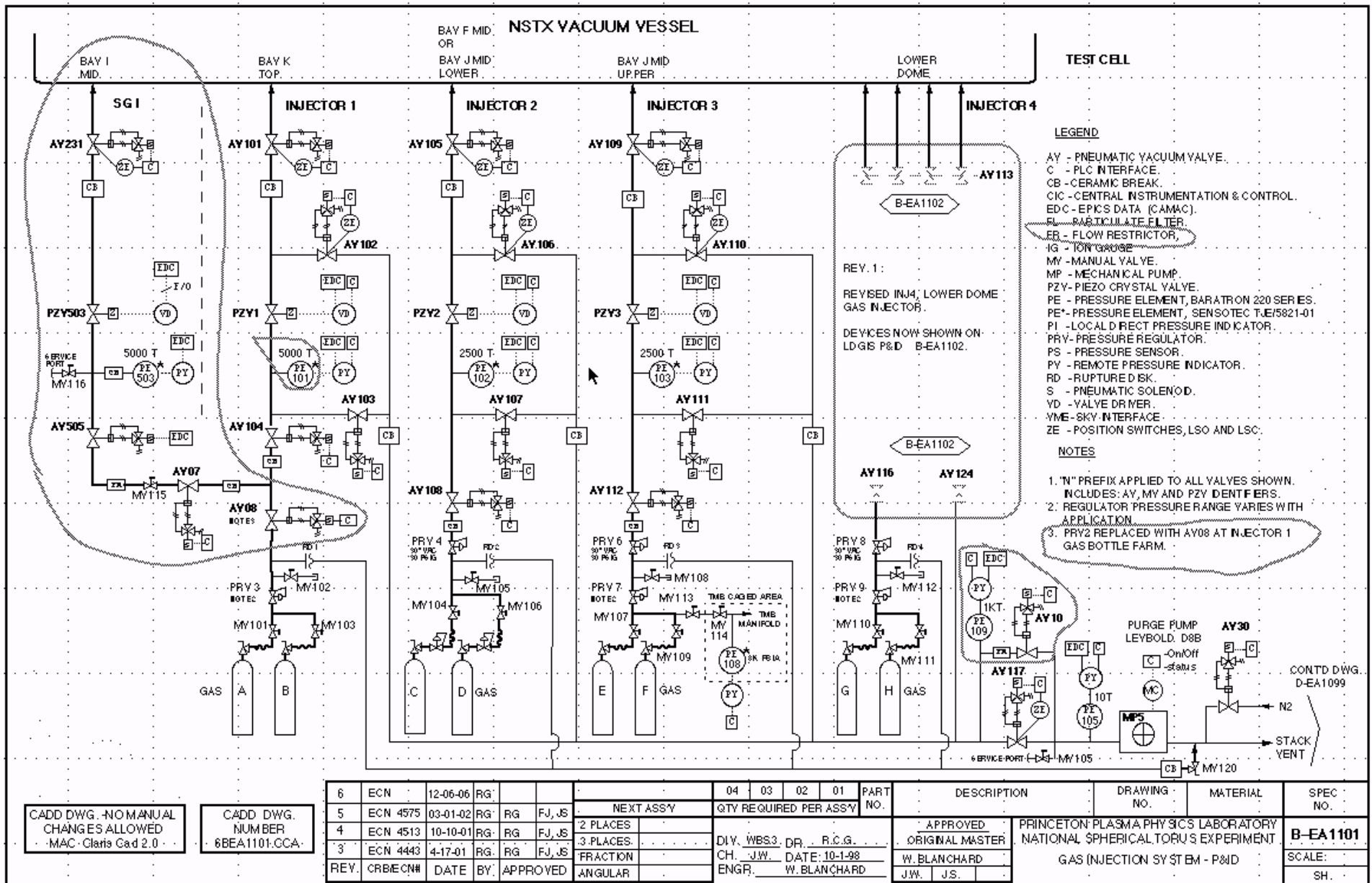
Both physics and engineering benefits are expected from proposed upgrades

Hardware improvements under consideration (FY 2007)	Derived benefit
Increased plenum pressure to 5000 Torr (presently limited to 2500 Torr)	<ol style="list-style-type: none"> 1. Increase flow rate 2. Possibly increase penetration 3. Improve fueling scenario flexibility, density control
Independent gas handling system	Inject other than D ₂ gases, such as He and CD ₄
Density feedback with SGI using Plasma Control System (future)	Density control with SGI
New supersonic nozzles (future)	Optimize / improve supersonic gas jet

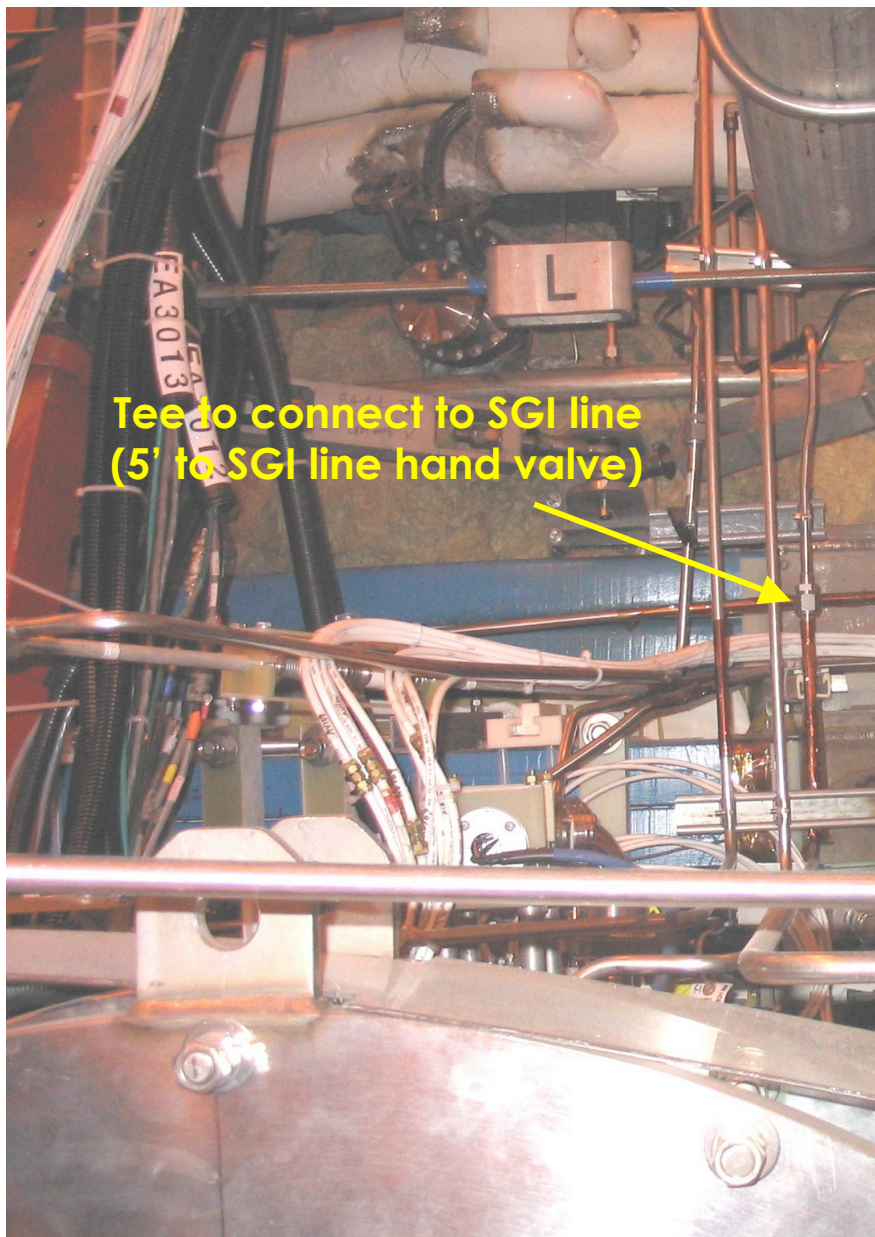
Switching SGI gas feed from LDGIS to Bay K is viewed as the most viable option for SGI upgrade

- **Simplicity**
 - ✓ Upgrade only few hardware items
 - ✓ Minimize needed labor
 - ✓ Take advantage of existing infrastructure
 - Gas delivery system
 - Pumpout system
 - PLC control/interlock
 - Electrical isolation and grounding
- **Existing Bay K injector system capability and hardware retained**
 - ✓ Bay K system can be used concurrently along with SGI

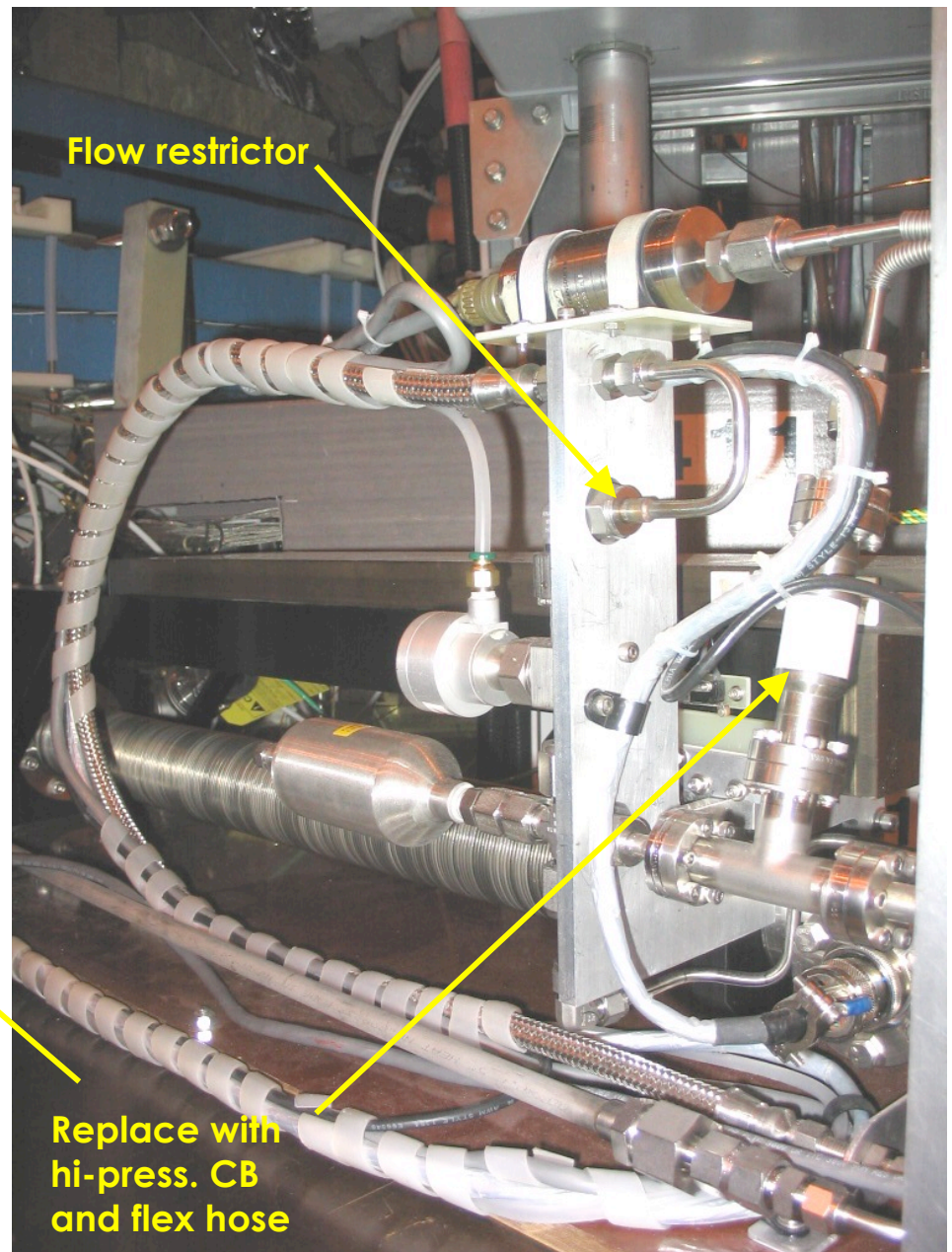
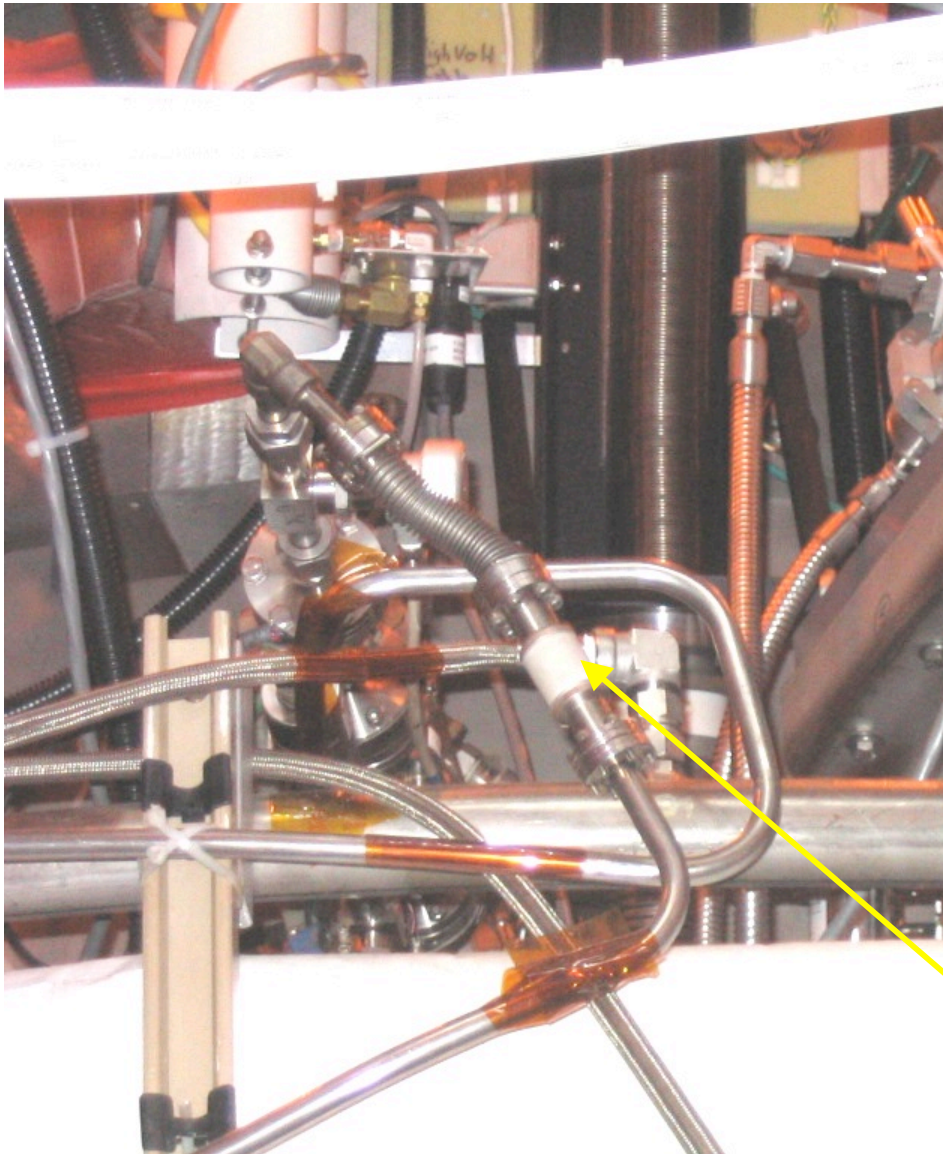
Gas Injection System P&ID



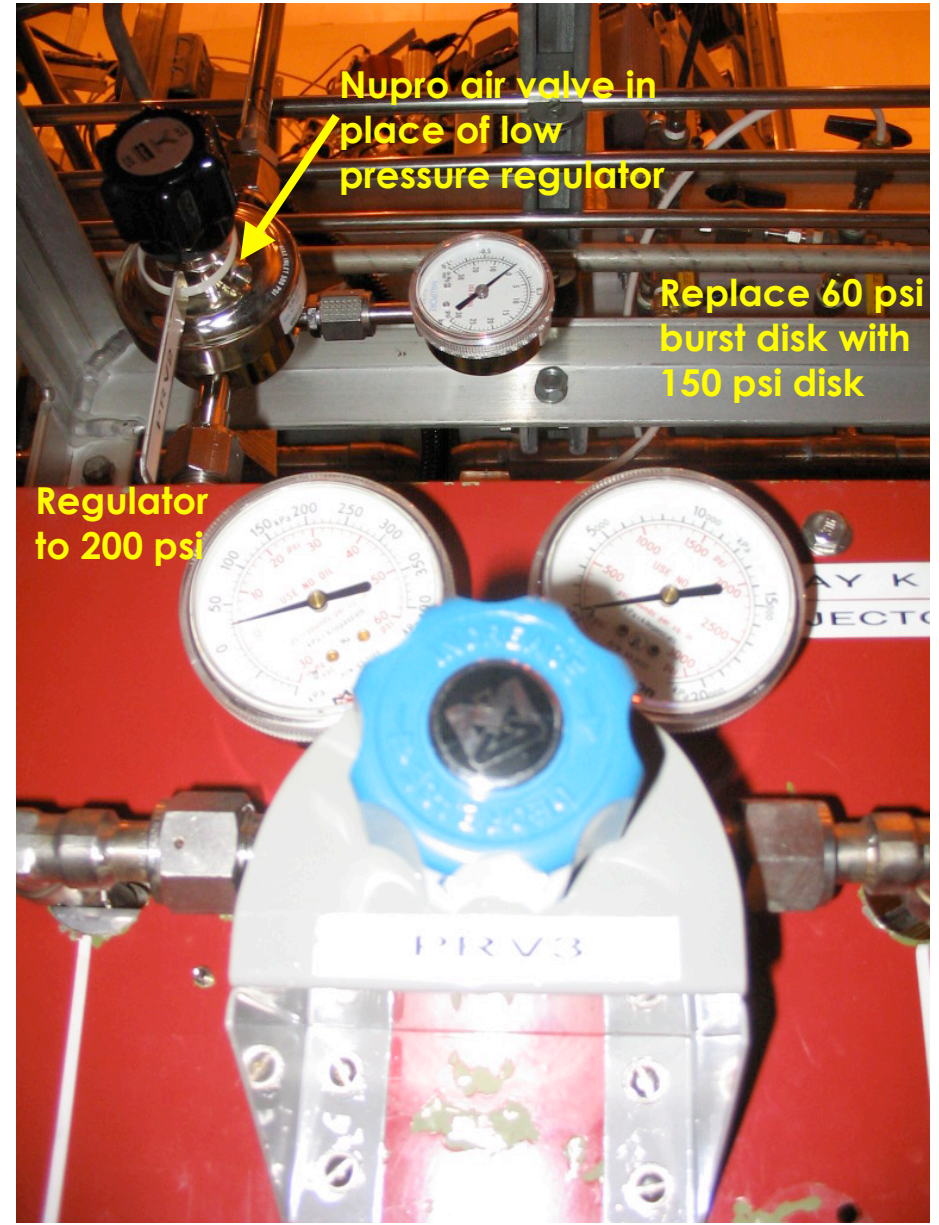
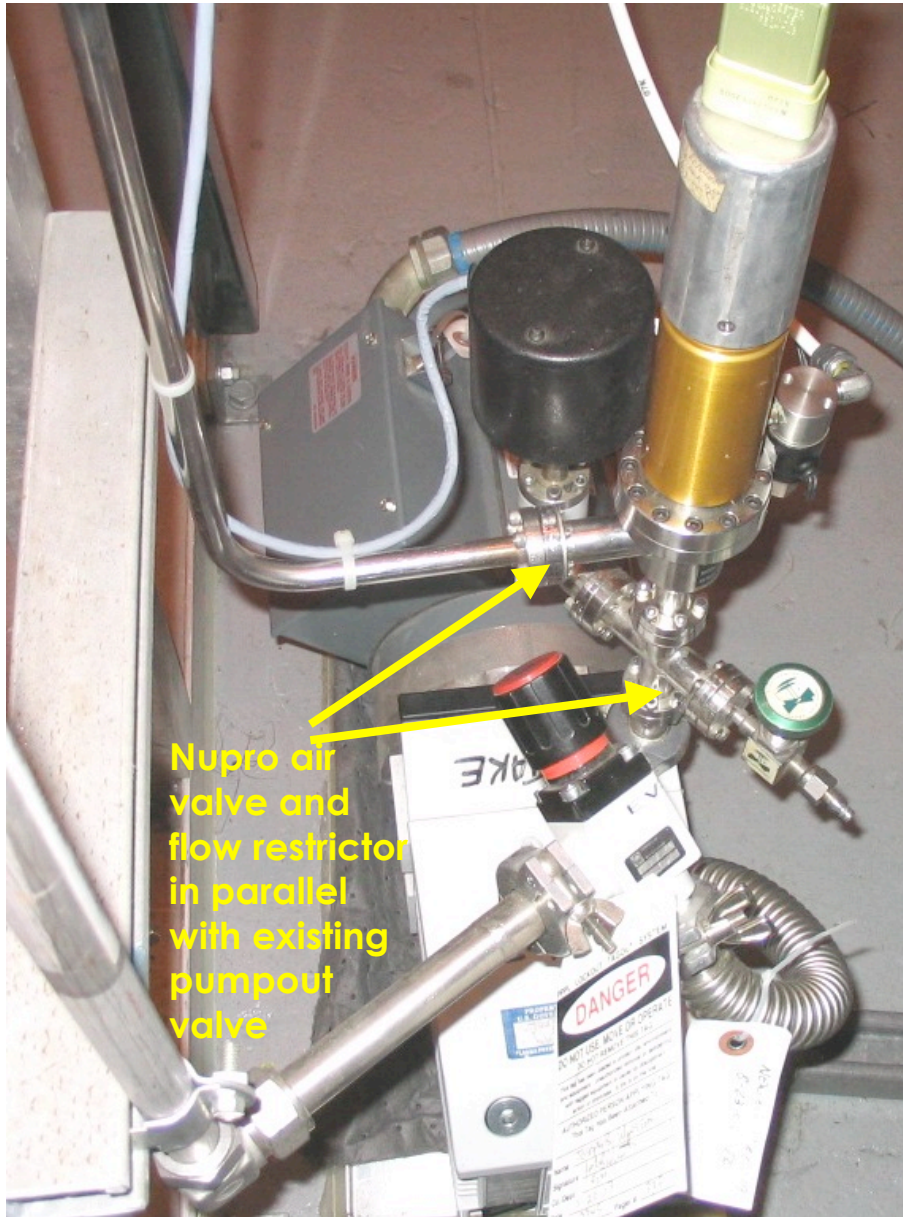
Gas delivery routing for SGI Upgrade



Bay K and SGI systems



GDS pump and GDS #1 modifications



GDS PLC Page

Gas Delivery_sgi - Display

NSTX GAS DELIVERY SYSTEM

TVPS PUMPING
 RGA PUMPING
 GDC
 GIS CONTROL
 SHUTTER PAGE 1
 SHUTTER PAGE 2
 TIV CTRL
 GROUND FAULT M.
 LITER1 CONFIG.

12 / 6 / 06 WDT ON
11:01:34 A

Injector Status:

- INJECTOR #1 BAY K TOP: PE101 735.7 T (5 KT), AV101-104, AV07, AV08, PZV1, AV102, AV103, AV104, AV04 Orifice, AV01 HVV, IG3A ON 9.48E-9
- INJECTOR #2 BAY J LOWER: PE102 743.0 T (2.5 KT), AV105-108, AV106, AV107, PZV2, AV102, AV103, AV104, AV07, AV08
- INJECTOR #3 BAY J UPPER: PE103 741.8 T (2.5 KT), AV109-112, AV110, AV111, PZV3, AV102, AV103, AV104, AV07, AV08
- INJECTOR #4 LOWER DOME: PE108, AV113-116, AV124, AV127, AV127A, AV116, AV124

Control Panels:

- LDGIS/CSTK CONTROL PAGE:** PE106 774.7 T (2.5 KT), Inj 4 Slc't OFF
- Vessel Press.:** PENNING IG 1 1.0E-11, IG 2 OFF, MIG/INP OFF, PE02 > 1 T (1T), PE17 > 10 T (10T), PE16 764.0 T (1KT)
- Smart Gauge:** PE111 0.000 V, IG110 OFF, Penning Micro Ion Fil OFF
- PURGE BYPASS:** Disabled

System Status:

- GDC TIME Remaining: GDC OFF MIN
- Fill Valve Operation: Manual
- Valve Driver Arm: DISARMED
- Injection Mode: TIMED
- Real Time Control: NOT VALID
- Plasma Permissive: NOT IN USE
- SOP: T-10
- FILAMENTS AND BIAS VOLTAGE: Bay G Filament OFF, Bay K Filament OFF, Bias Voltage 115 AC OFF, Hi Volt OFF
- NB TIV: Disabled
- NB VAC. INTL'K: Normal

Print Screen

SGI Upgrade cost is modest, scope of work is minor, and schedule is feasible

■ Components

- High-pressure ceramic break, \$ 210 x 3
- New Sensotec pressure transducer, \$ 620 x 2
- 100 psi Baratron \$744
- High-pressure dual-stage brass gas regulator (0-200 psi), \$ 321
- Swagelock/VCR hardware, flex hoses, 150 psi burst disk, ~\$1K
- 3 Nupro air valves

Total: Approx. \$3.9K

■ Scope of work:

1. Procure needed hardware items (12/31/2006)
2. Implement hardware modifications (01/15/2007)
3. Implement electronic and computer control for SGI fill-up (01/31/2007)
4. Minor impact on existing Bay K and SGI interlocks (01/31/2007)
5. Conduct **commissioning** and testing (**02/15/2007**)