

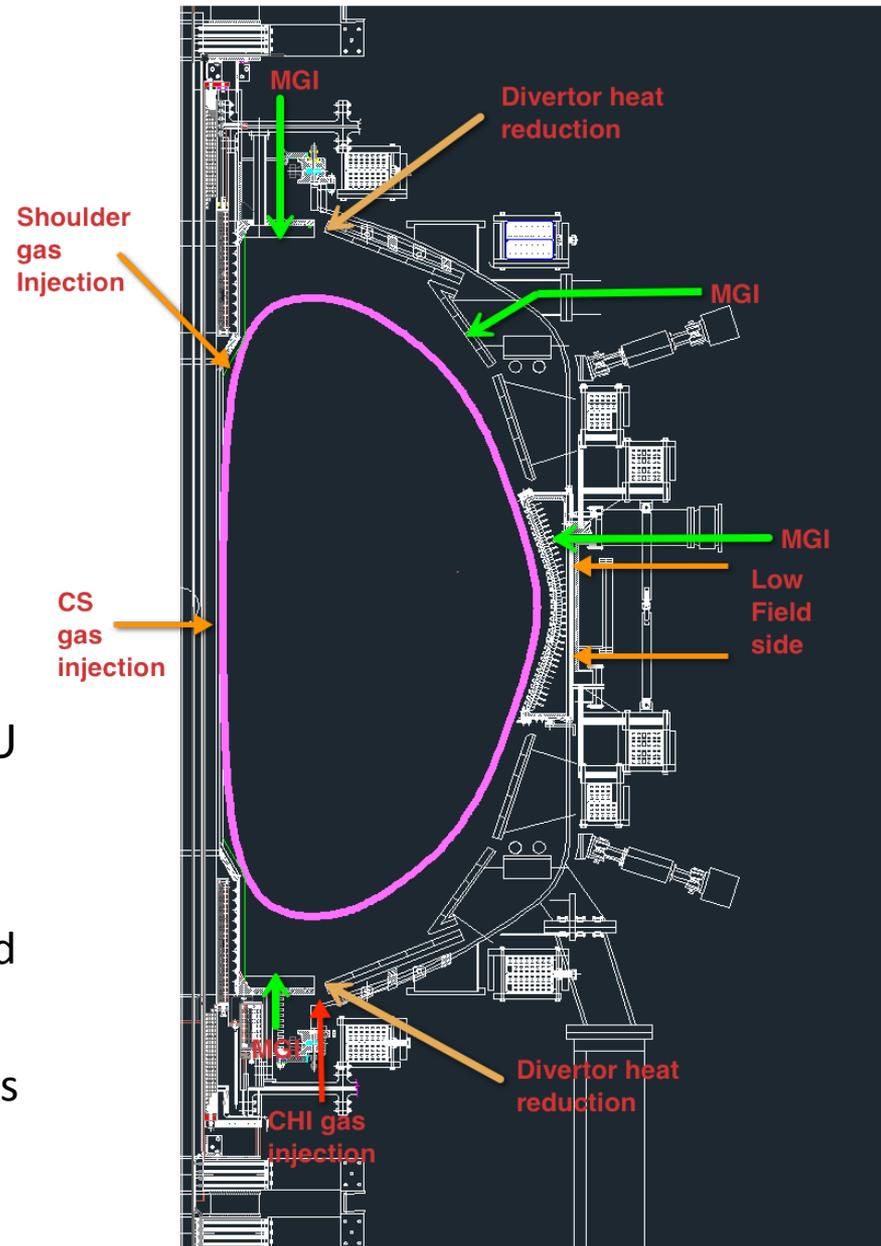
First Peer Review for New MGI Valves for NSTX-U

R. Raman, et al.

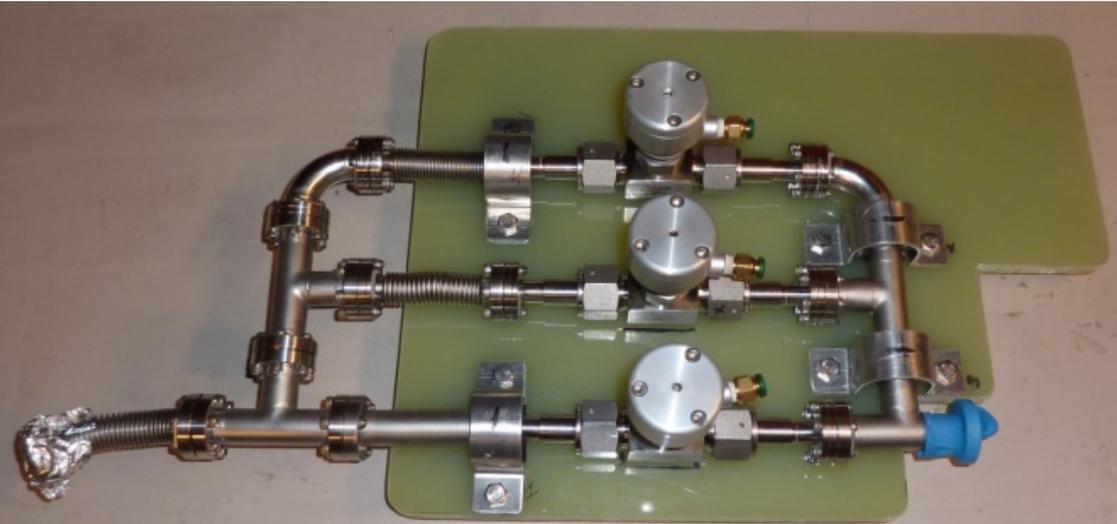
March 6, 2013

Valve & System Requirements

- Empty most of the plenum in $<2\text{ms}$ after valve is triggered
 - Requires large orifice (limited by physical size limitations)
 - Rapid opening of the vacuum seal (coil voltage/current limits, PS size)
- Compatible with external magnetic fields
 - Conventional solenoid valves not suitable
- Compact in size so it can be installed on NSTX-U organ pipe flanges
- High reliability
 - Few and simpler systems for operation
- 4 – 5 identical systems needed for NSTX-U
 - Top & bottom organ pipe, 2 in mid-plane location (toroidally displaced) and one above mid-plane
 - Mid-plane valves need same diameter and length piping as organ pipe locations (one with length of tube ending at vessel & second in which the same length tube gets as close as reasonably possible to the plasma)



Old MGI Valves on NSTX



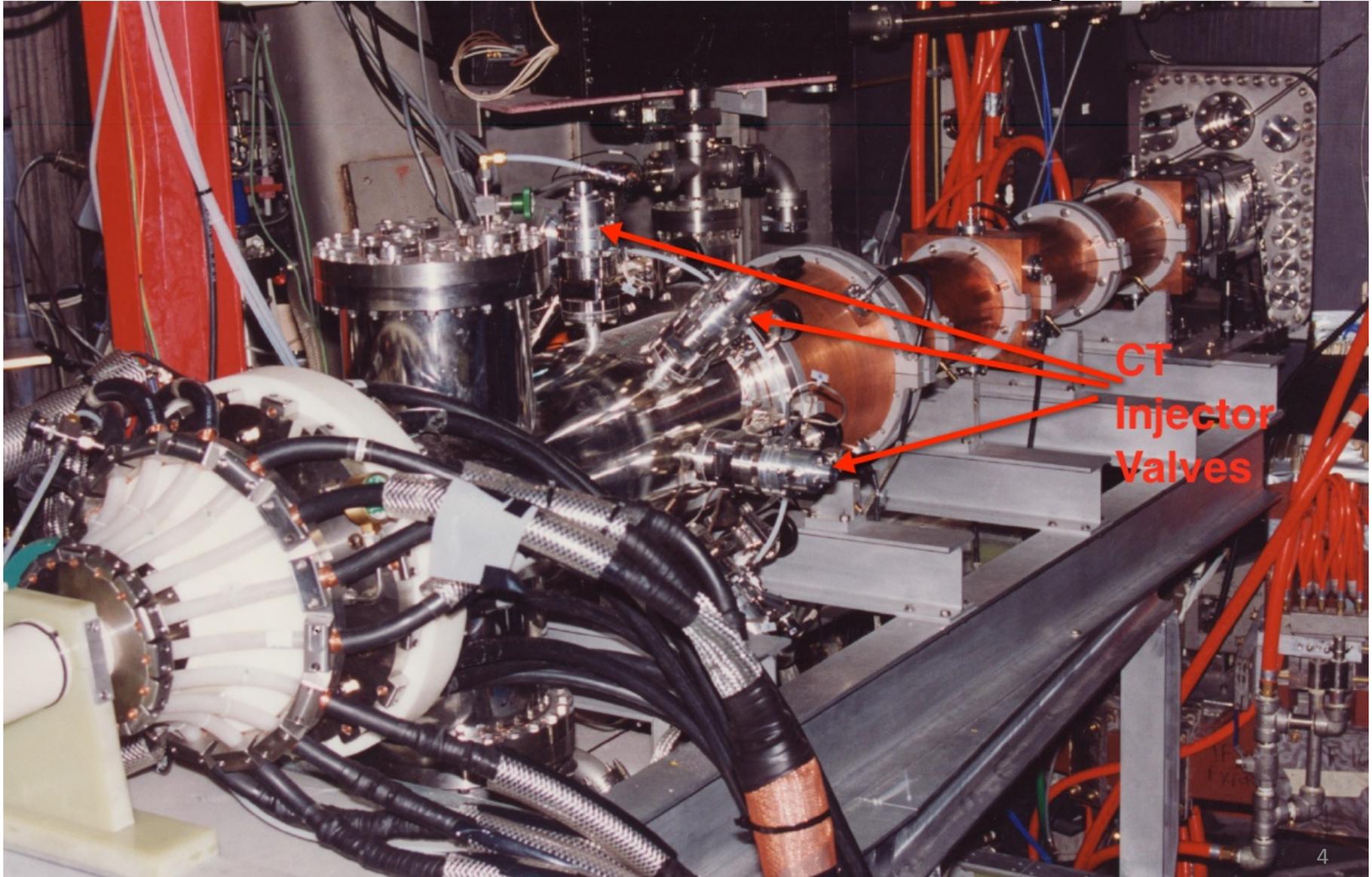
- 3 pneumatic valves in parallel installed at the end of a long tube just inside the lower umbrella structure

- Mid-plane and lower dome valve assemblies were not identical

- Installed in a hurry due to limited time available to incorporate new designs
 - For final NSTX run, programmatic decision to only use what was previously used on NSTX (nothing of new design allowed)



New MGI valve design based on previous design of similar valves used on CT injector



J.C. Thomas, D.Q. Hwang, R.D. Horton, J.H. Rogers, R. Raman, RSI 64 (6) 1410 (1993)

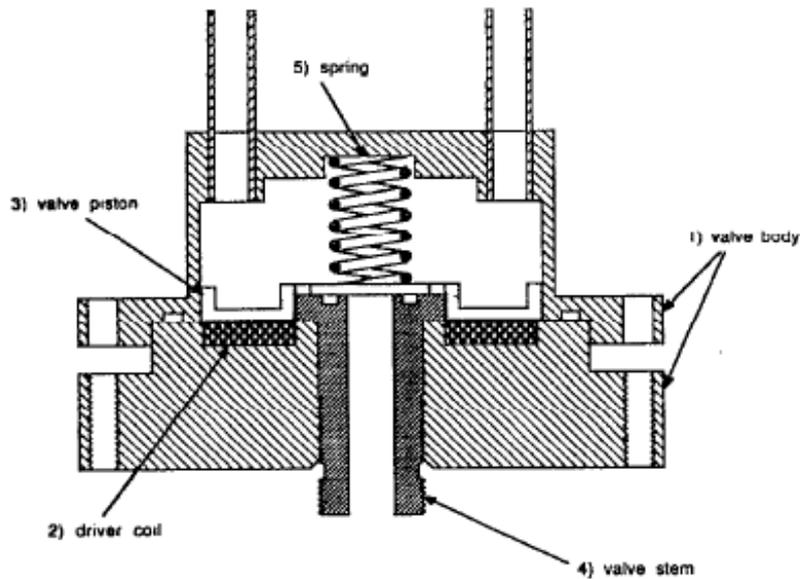


FIG. 1. Schematic of the valve assembly: (1) valve body, (2) driver coil, (3) valve piston, (4) valve stem, (5) spring used to ensure a positive seal for any valve orientation.

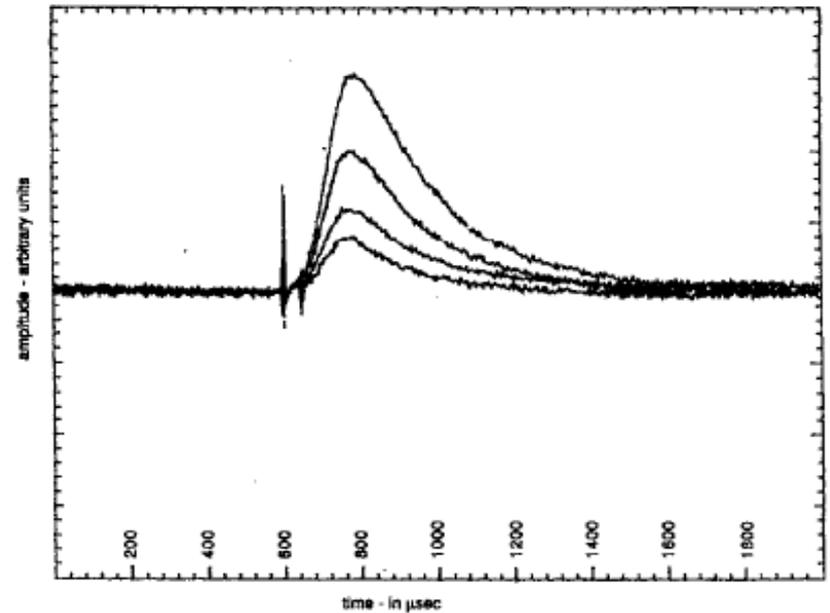
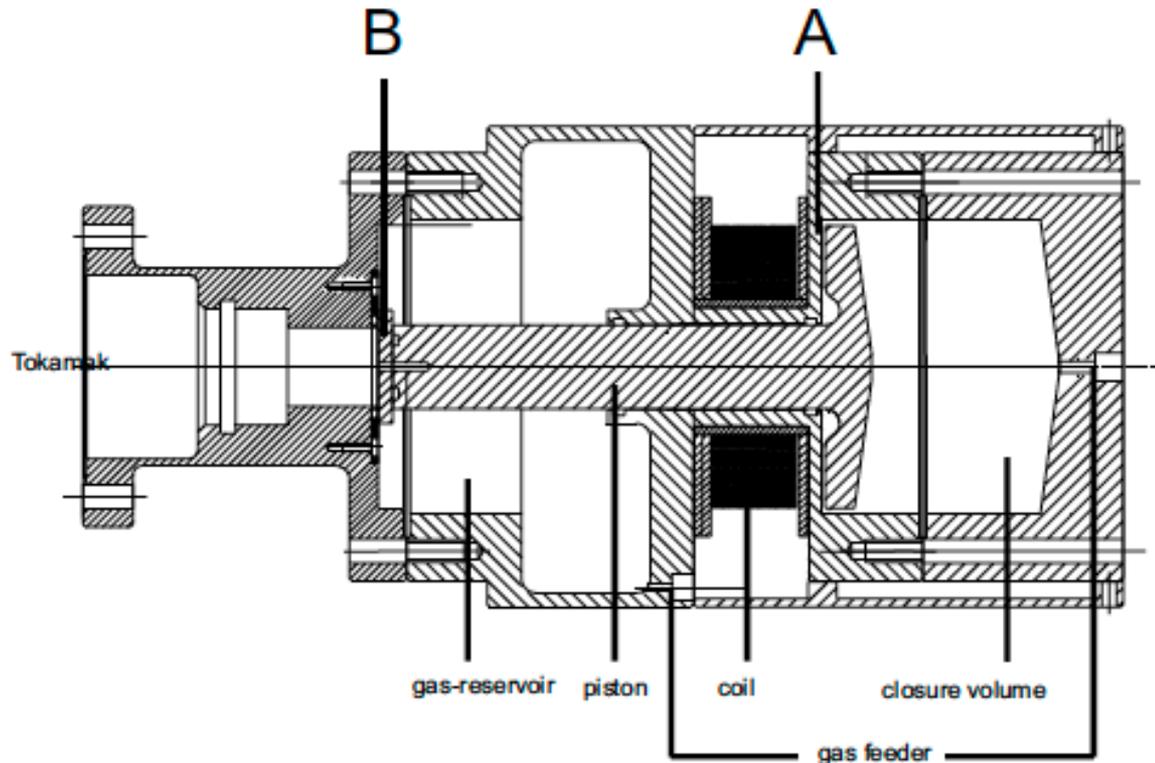


FIG. 3. Four overlaid traces shown correspond to the photodetector signal (and by inference the piston displacement) vs time for four consecutively larger valve driver voltages.

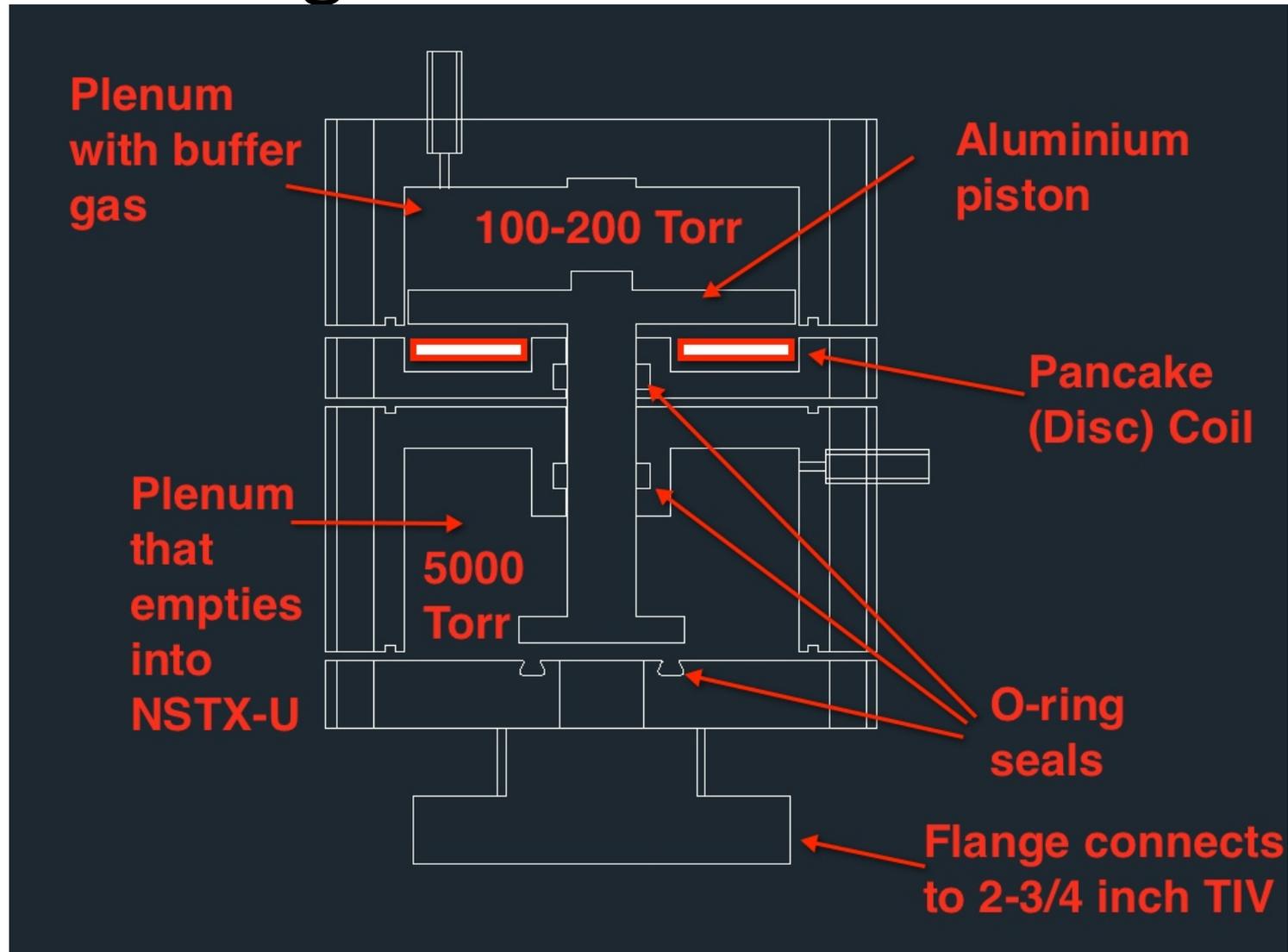
Based on Valve Design adopted by ITER (NSTX-U data on valve reliability will be useful for ITER R&D)



K.H. Finken,
M. Lehnen,
S.A. Bozhenkov,
Nuclear Fusion 51
(2011) 033007

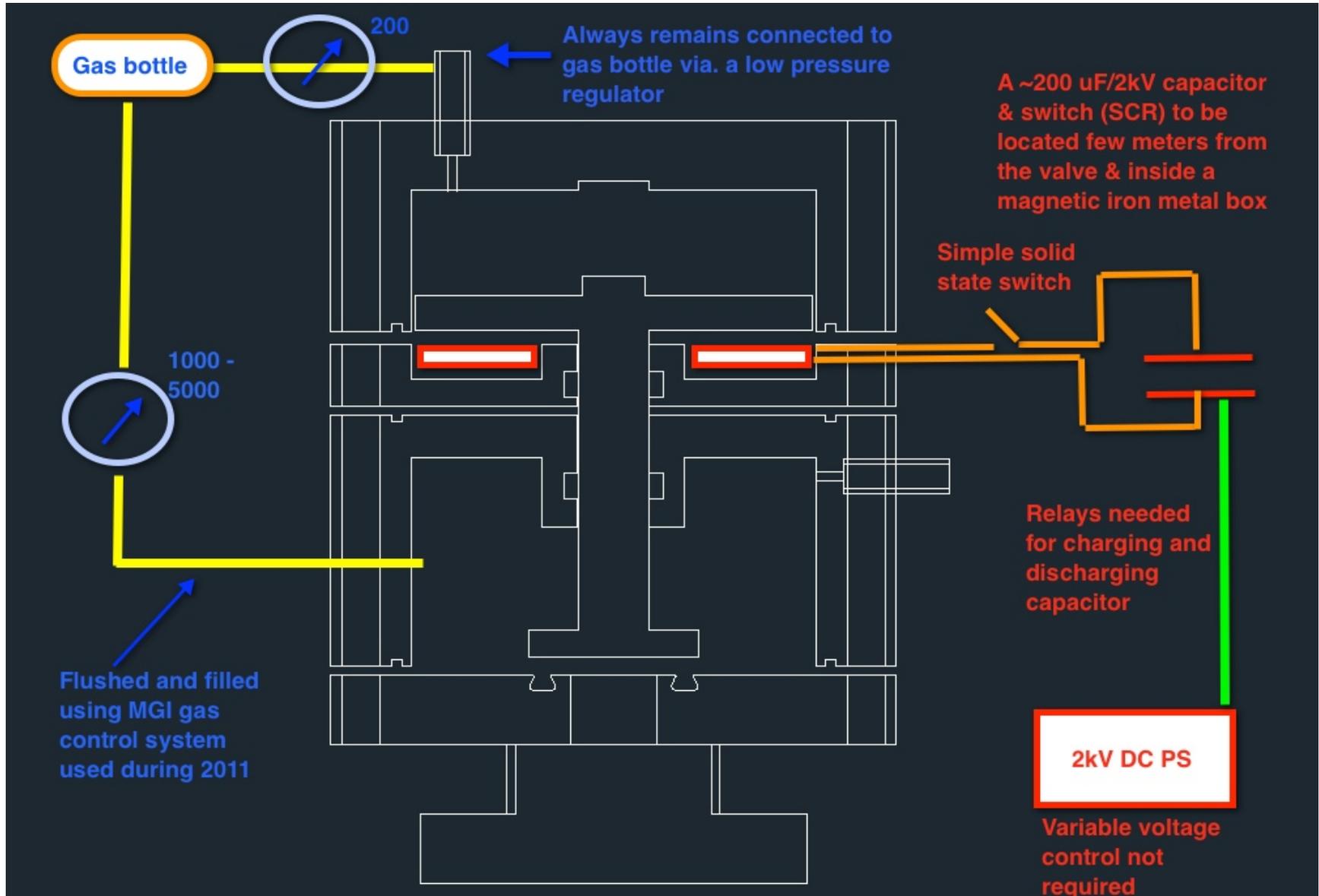
Figure 2. Sketch of the DMV-30. As compared with the previous designs, the gas reservoir of the working gas is enhanced to 1.3 L, the opening orifice is enhanced to 28 mm (position B) and the valve is totally enclosed in stainless steel (part A) such that the coil is now outside of the closure valve.

Key Components of New Electromagnetic MGI Valve for NSTX-U

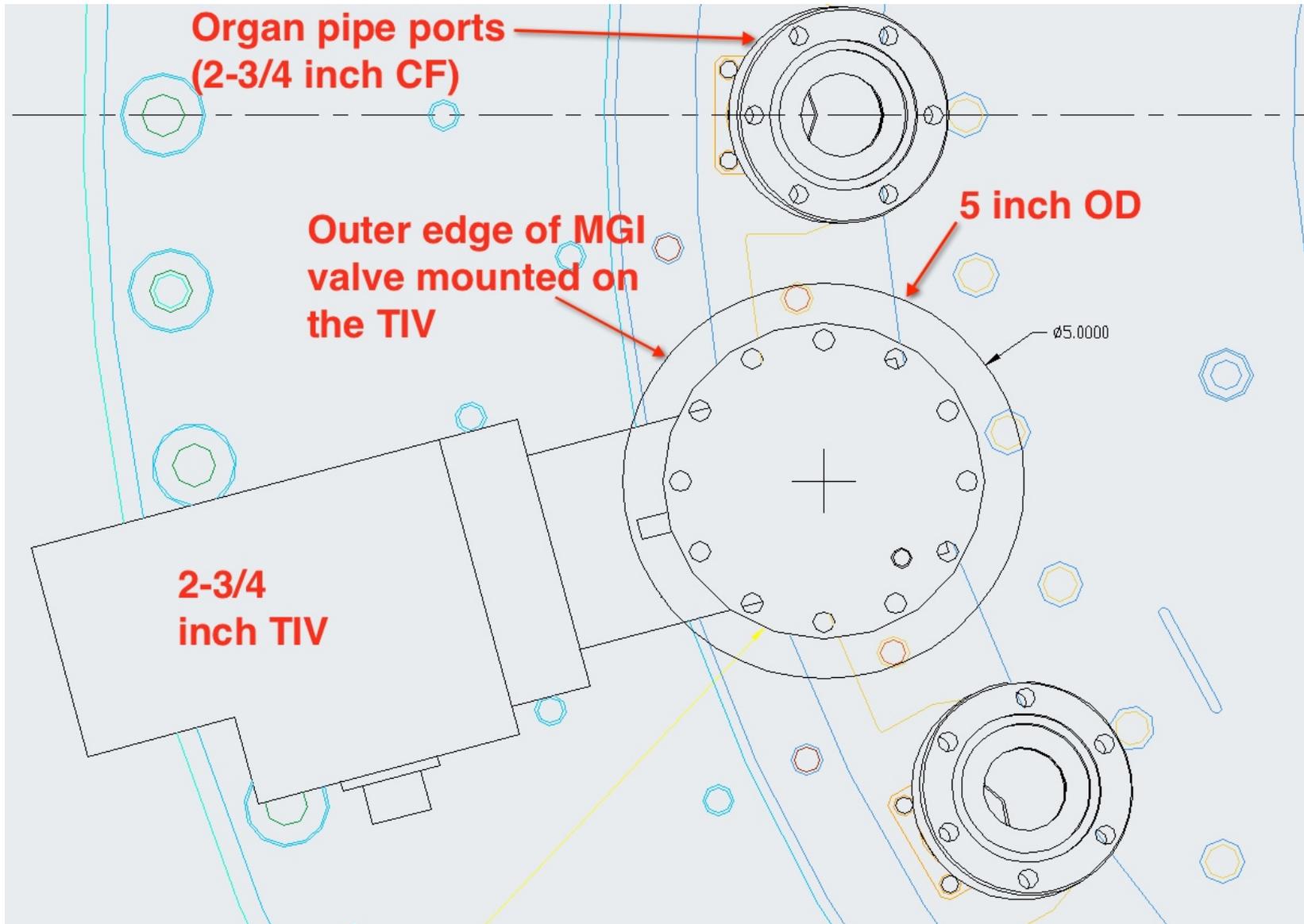


(Not to scale)

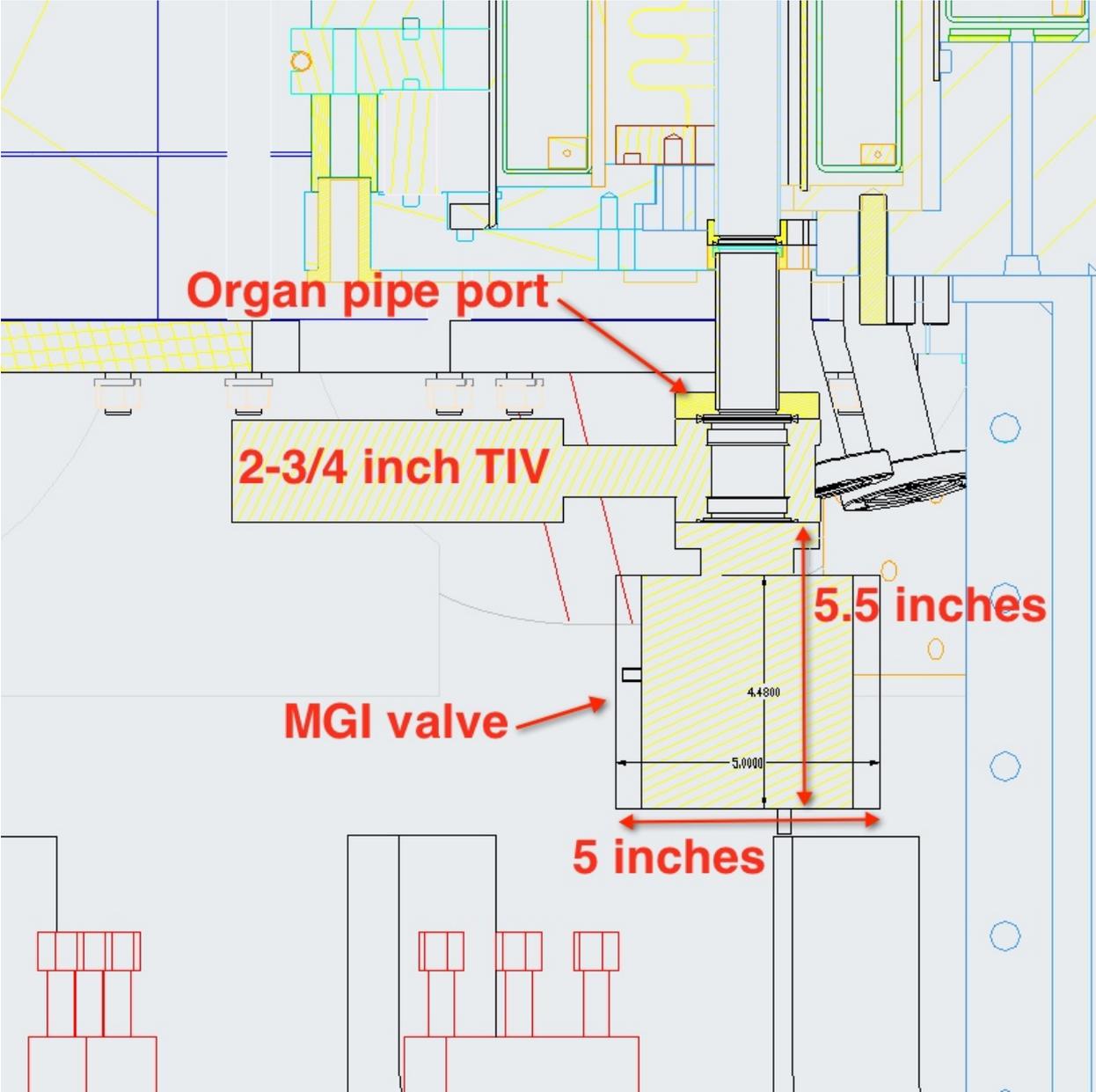
Valve Operation Sequence



Up/Down view of MGI valve on Organ Pipe



Horizontal view of valve on Organ Pipe



Questions

- Is 18-8 stainless steel allowed near machine?
- A 1/8 inch OD tube (0.035 wall thickness) could be used to connect the valve plenums to a solenoid valve (for fill/vent operation).
 - 4 meter long tube has volume of ~6cc << 100cc plenum volume (no need to locate other valves near MGI valve)
 - The present MGI gas control system could be used without much modification (almost in its present state)
- The capacitor may measure around 10cmx10cmx30cm – the SCR would measure (4 inches in diameter x 2 inches high) – how close can these be positioned near the machine? – we already have the CHI snubber capacitor (700 uF/2kV) near the machine
 - May need to shield capacitor and SCR from magnetic fields