PELLET DROPPER DEVICE FOR ELM CONTROL ON DIII-D

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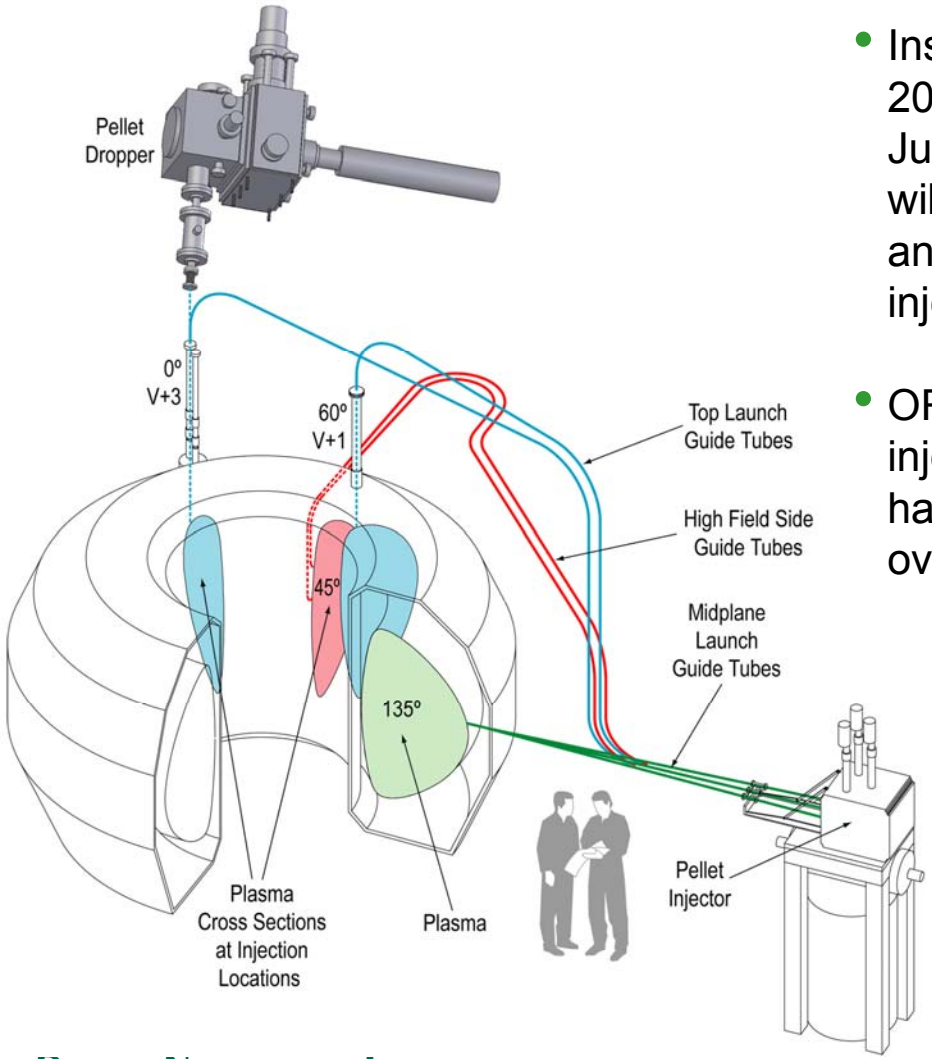
VLT Conference Call – Technical Highlight
Oak Ridge National Laboratory
Oak Ridge, Tennessee
July 18, 2007

ORNL Has Developed New Pellet Dropper Device for DIII-D



- Installation of the dropper was initiated in May 2007 with the final hardware fitted during June 2007; complete checkout of the system will be carried out after some upgrades to I&C and data acquisition systems of existing pellet injector
- ORNL three-barrel repeating pneumatic pellet injector was installed on DIII-D in 1994 and has been used in many plasma experiments over the last 13 years

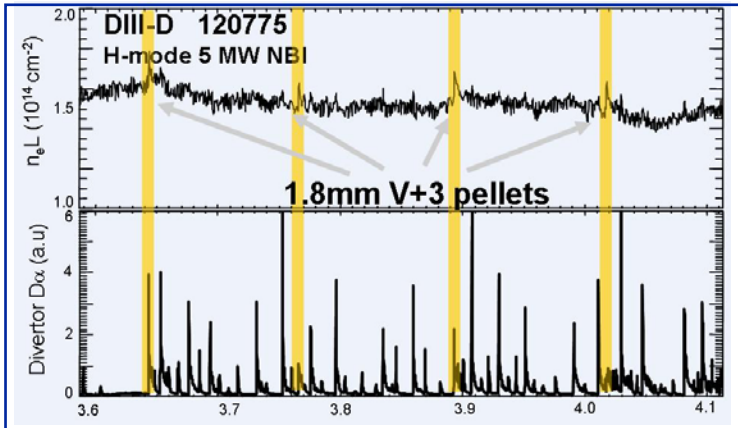
Larry Baylor proposed DIII-D experiments that require this equipment and has taken the lead scientific role for this task

Motivation – ELM Triggering by Pellet Injection

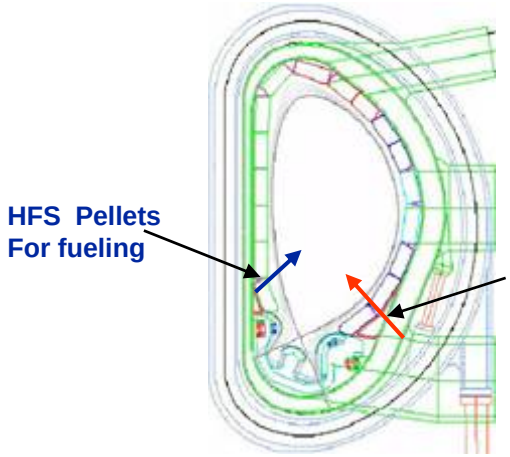
- New application for pellet injection was identified on ASDEX-Upgrade with small high-repetition-rate pellets shown to cause ELM events to synchronize with the pellets and produce a reduced ELM perturbation size

- Key for success appears to be small pellets that penetrate just beyond the separatix, enough to trigger an ELM, but not enough to strongly fuel the plasma

- Experimental studies of “pellet ELM-pacing” technique are scheduled on DIII-D and JET (ORNL will collaborate with JET)

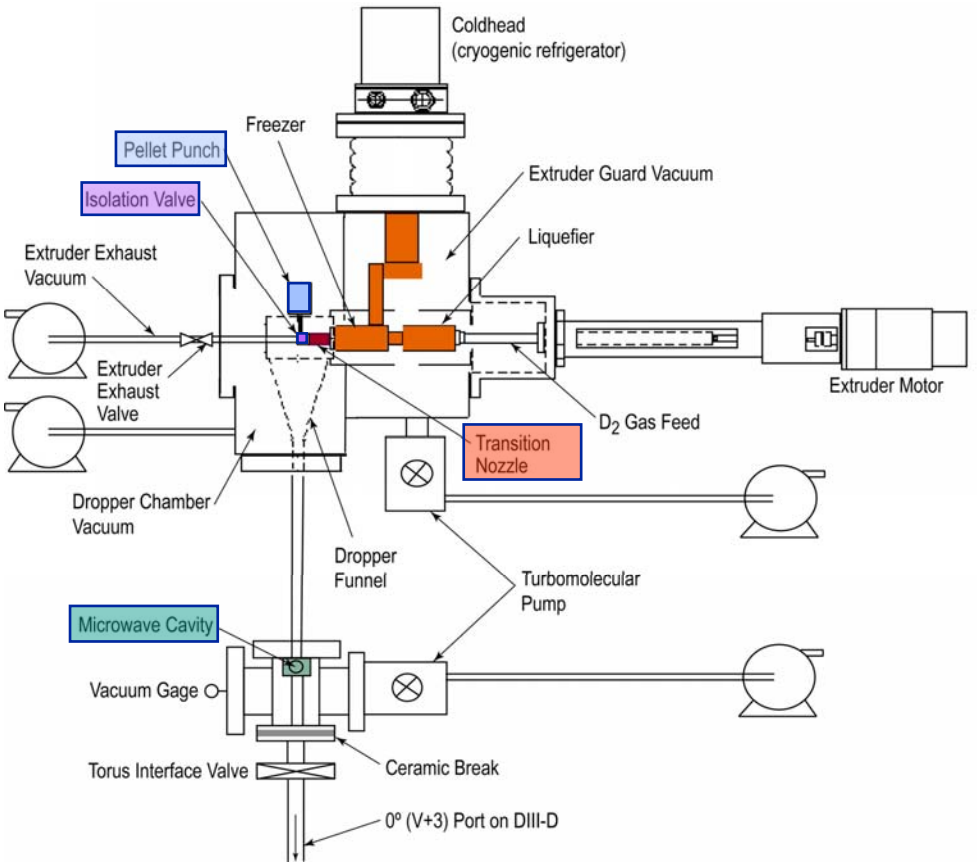


Vertical pellet injection on DIII-D has been shown to trigger ELMs



ITER plans to use 3 mm size pellets for ELM triggering from a LFS location

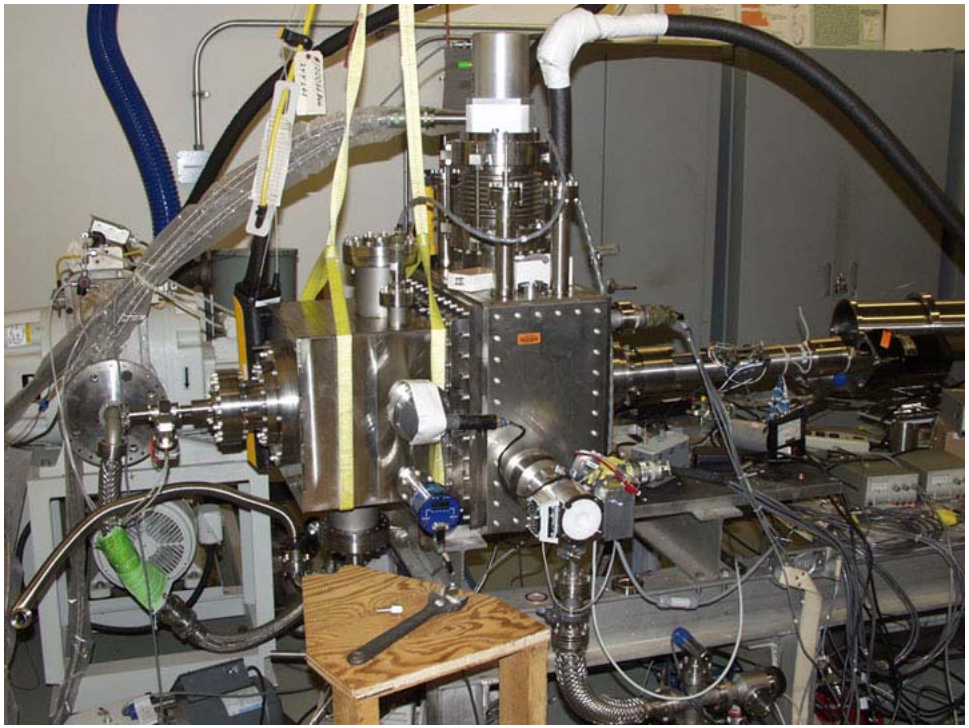
Pellet Dropper Design



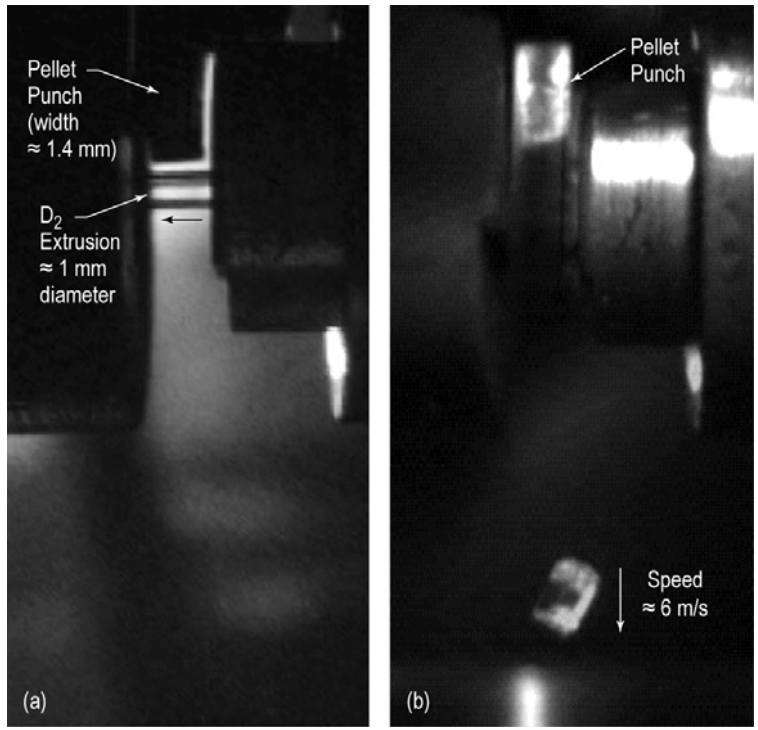
- Batch-wise extruder cooled by cryogenic refrigerator provides solid 1-mm-diam D_2 extrusions at 13–16 K
- Pellets are punched from high-speed extrusions at frequencies of up to 50 Hz
- Special isolation valve had to be developed for reliable operation
- Microwave cavity mass detector provides pellet speeds (≈6 m/s) as well as pellet masses

Extensive Testing of Device Was Carried Out in Laboratory

(1) Pellet Dropper During Testing at ORNL

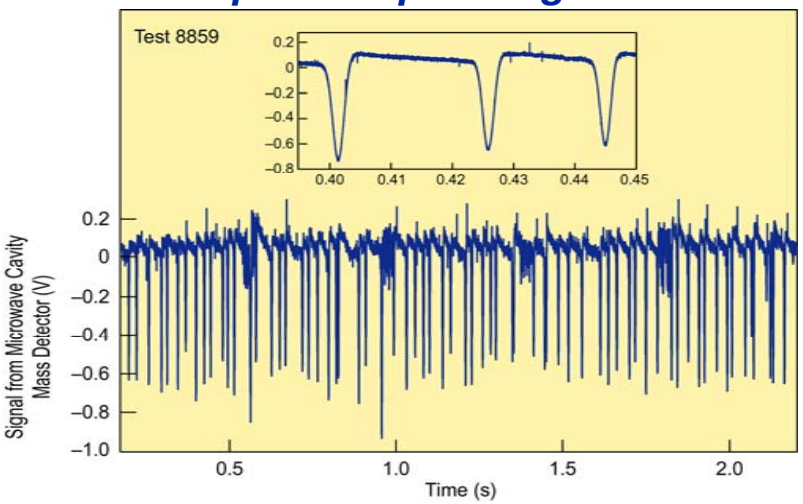


(2) Extrusion and Punched Pellet



Microwave Cavity Data for Typical Pellet Test Sequences

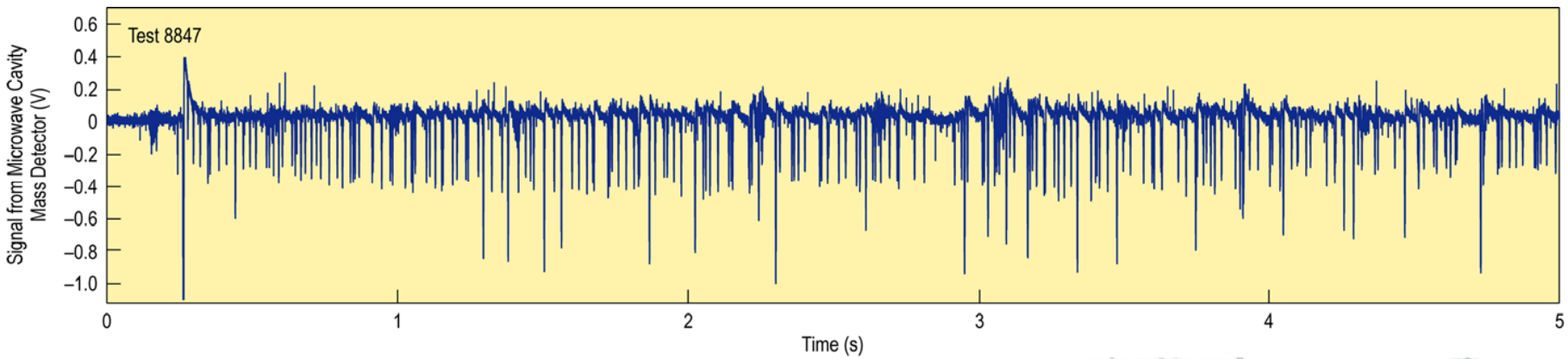
Mass detector data for 2-s sequence with punch operating at 33 Hz



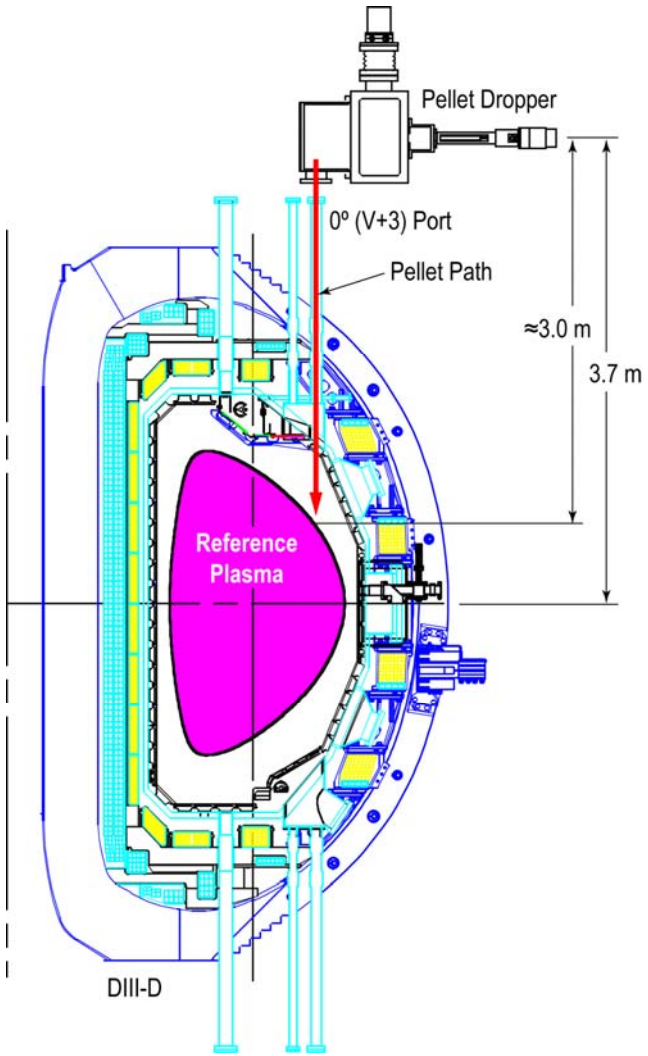
Operating Issues

- The relatively light pellets (<0.2 mg) can occasionally stick together
- Significant pressure rise in the dropper chamber can result in excessive heat transfer to solid D_2 and localized melting/vaporization; isolation valve and adequate pumping minimize this effect

Mass detector data for 5-s sequence with punch operating at 50 Hz

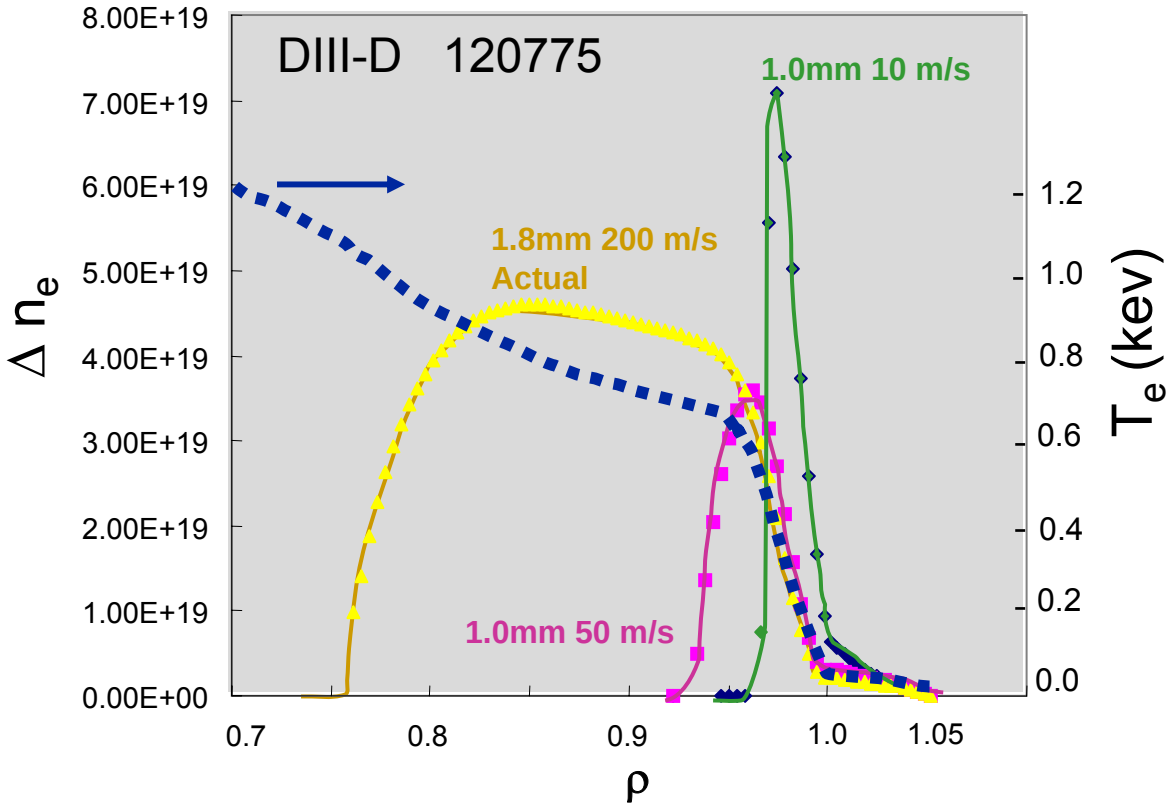


Test Configuration for Initial Experiments on DIII-D



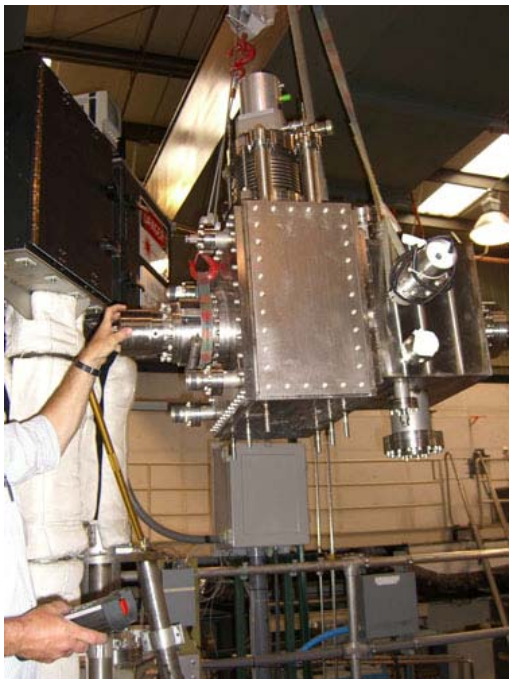
- Small pellets (≈1 mm) will be injected vertically downward via the V+3 port at 0° (low field side) and will travel ≈3 m to the edge of the plasma
- Dropper can be relocated to inject pellets via the V+1 port at 60° (high field side) if needed
- Key Diagnostics
  - Fast Camera (J. Wu)
  - Pellet Hα – V+3 & R105
  - Photodiodes/Filterscopes (N. Brooks / R. Colchin)
  - IR Camera (C. Lasnier)
  - Fast Reflectometer (UCLA)

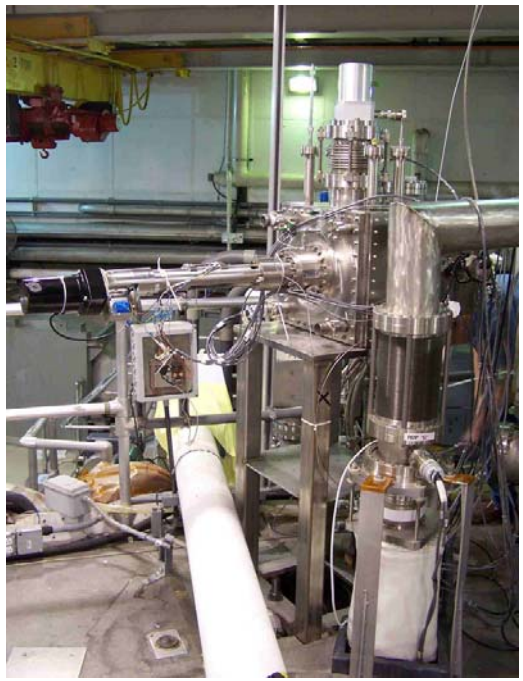
Expected Density Perturbations from Vertical LFS Pellets



- Calculation of different pellet size density perturbations for DIII-D from V+3 location overlayed with the measured pre-pellet edge electron temperature profile using NGS model in PELLET code [Parks, Houlberg]; no mass drift is included in the density perturbation calculation
- The 1 mm dropper pellets are predicted to reach at least the pedestal half radius

Installation of Pellet Dropper Device on DIII-D





Commissioning of the pellet dropper will be completed as soon as possible with experiments to follow at the earliest possible date