Gas-Puff Z-pinch Experiments on COBRA


*Naval Research Laboratory
Puff-on-wire: Experimental Setup
Motivation:
- Gas puffs have been shown to be good sources of soft x-rays (< 3keV), but aren't useful for producing harder radiation
- Switching current quickly from a gas-puff into another load can produce voltage spikes (by $V = LdI/dt$), potentially increasing the x-ray yield.

Goals:
- To confirm that current can be switched from the gas puff shell into an axial wire
- To gauge the feasibility of developing this configuration into a tunable hard x-ray source
Puff-on-wire: XUV Quad Cam Images

**Shot 3640:**
- 2.0 psi Argon (outer)
- 100 um Aluminum wire (center)

**Shot 3646:**
- 1.0 psi Argon (outer)
- 100 um Aluminum wire (center)
Puff-on-wire: XUV Quad Cam Images

**Shot 3650:**
0.8 psi Argon (outer)
100 um Aluminum wire (center)

**Shot 3747:**
0.6 psi Argon (outer)
50 um Gold wire (center)
Puff-on-Wire: X-Ray Yields Pure Argon vs. Argon on Wire

Shot 3751:
0.8 psi Argon (outer)

Shot 3740:
1.0 psi Argon (outer)
50 um Tantalum wire (center)
Puff-on-Wire: X-Ray Yields Decreasing Argon Mass

**Shot 3743:**
- 0.8 psi Argon (outer)
- 50 um Gold wire (center)

**Shot 3752:**
- 0.7 psi Argon (outer)
- 50 um Gold wire (center)

**Shot 3747:**
- 0.6 psi Argon (outer)
- 50 um Gold wire (center)
Puff-on-Wire: X-Ray Yields Wire Material Comparison

**Shot 3743:**
0.8 psi Argon (outer)
50 um Gold wire (center)

**Shot 3749:**
0.8 psi Argon (outer)
50 um Tantalum wire (center)
Conclusions:
- Current can be switched from a gas-puff into an axial wire.
- The timing of this current switch can be tuned by adjusting the Argon backing pressure.
- This configuration is able to produce substantially more x-rays with a wire than without, including >8 kev radiation not seen in pure Ar puff.

Future Work:
- To compare x-ray yields to those measured in a single wire explosion.
- Further investigations on COBRA in collaboration with NRL (December)
Gas-Puff Radiation Measurements: Motivation & Goals

Motivation:
- We've seen differences in RT instability growth for Ar on Ne vs. Ne on Ar implosions.

  - One hypothesis for this discrepancy is a difference in radiation between these configurations during run-in phase.

Goals:
- To measure radiation from gas-puff well before pinch using bolometer and Si-diode diagnostics.

  - To compare results for these two configurations, and identify any measurable differences in the radiative output during run-in phase.
Gas-Puff Radiation: Bolometer

Bolometer Calibration: 412 J/V

Shot 3771: 1 psi Ar (outer)
6 psi Ne (inner)
8 psi Ar (center)
Measured ΔV: 10.8V
10.8V(412J/V) = 4.5 kJ

Shot 3772: 2 psi Ne (outer)
3 psi Ar (inner)
8 psi Ar (center)
Measured ΔV: 10.0V
10.0V(412J/V) = 4.1 kJ
Gas-Puff Radiation: Si-diode w/ glass Ne on Ar

**Shot 3772:** (White) {2 psi Ne:3 psi Ar:8 psi Ar}

**Shot 3773:** (Red) {2 psi Ne:3 psi Ar:8 psi Ar}
Gas-Puff Radiation: Si-diode w/ glass
Ar on Ne vs. Ne on Ar

**Shot 3771:** (White) {1 psi Ar:6 psi Ne:8 psi Ar}

**Shot 3772:** (Red) {2 psi Ne:3 psi Ar:8 psi Ar}
Gas-Puff Radiation: Conclusions & Future Work

Conclusions:
- Bolometer can be used for absolute measurement of gas-puff soft x-ray production, but is not sensitive enough to measure early time radiation.

- Si-diode can measure radiation during run-in phase, but two configurations show similar emission up until peak current.

Future Work:
- Attempt to increase resolution of Si-diode at early times by moving closer to load, using mylar filter.

- Compare radiation measurements to PERSEUS simulations.