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Re-establishing gas puff radiation sources on the Z Generator: Characterizing the Gas Profile and MHD Modeling of the Source

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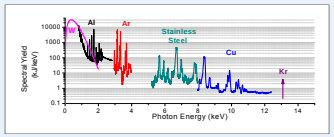
Work on MHD Model Circuit Coupling to Z completed under a New Employee LDRD

Z-pinches are extremely bright x-ray sources, with significant utility for Radiation Effects testing (see presentations by B. Jones, N.W. Moore, T. Flanagan)

Gas-Puffs produce photons in spectral ranges unavailable from wire array z-pinches



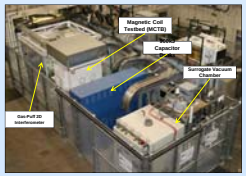
Compared to wire arrays, gas puffs offer the potential to control instability growth through:
- **Azimuthally symmetric thick mass shells (large aspect ratio to impede disruption)**
- **Multiple Nozzles and different pressures (tailored radial mass profiles to control growth)**

However:
- **To design mass distribution the initial conditions NEED to be well known, so measurement of gas profiles is crucial**
- **There are a LOT of design variables, so with finite shots available, simulations can be invaluable in source optimization**

Systems Integration and Test Facility (SITF)

(D.C.Lamppa, M. Jobe)

Systems Integration and Test Facility (**SITF**) has been developed to provide fabrication, assembly, and performance characterization of gas-puff nozzles

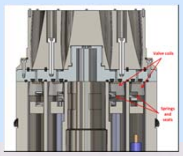


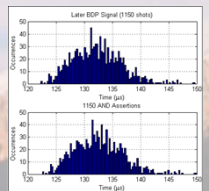
The SITF Testbed provides a surrogate Z-Machine environment to enable development and maturation of new experimental capabilities prior to integration into 983 facility

SITF Provides Working Gas-Puff Testbed for Reliability Testing, Z-Bound Nozzle Characterization

- **Over one thousand shots performed in SITF before first Z shot will ever occur**
  - 120 shot commissioning campaign (Dec10-Jan11)
  - 85 shot grid interferometer campaign (Jun11)
  - 75 shot no-grid interferometer campaign (Nov11)
  - 1,150 shot BDP reliability campaign (Dec11-Jan12)
  - 210 shot BDP variability campaign (Feb12)
  - 100's of undocumented configuration shots
  - 200,000+ simulated shots for AND/OR reliability study
- **Rapid-response to experimenter's needs for interferometry and reliability data**
- **Each nozzle will be characterized and understood before being delivered to Z**

First Z shot will be most understood and characterized Argon gas-puff in recorded history!

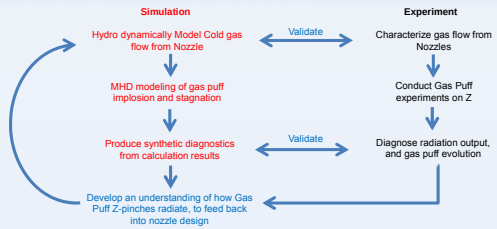




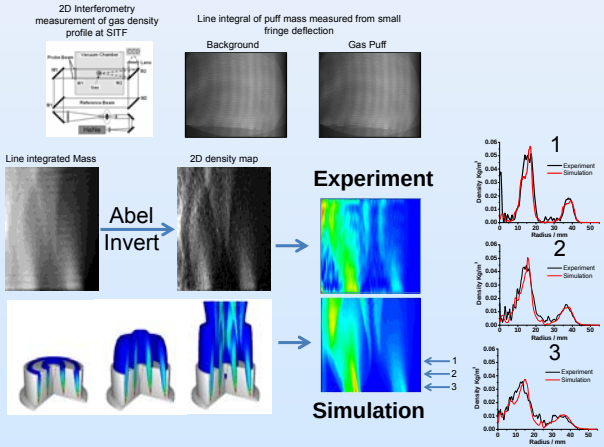
Gas-puff system permissive system demonstrated to be 99.9% reliable at SITF

Breakdown gins have been demonstrated to be 99.9% reliable as a gas detection method for permissive generation

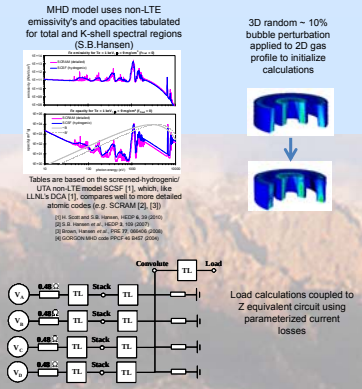
Integrating Simulations and Experiments



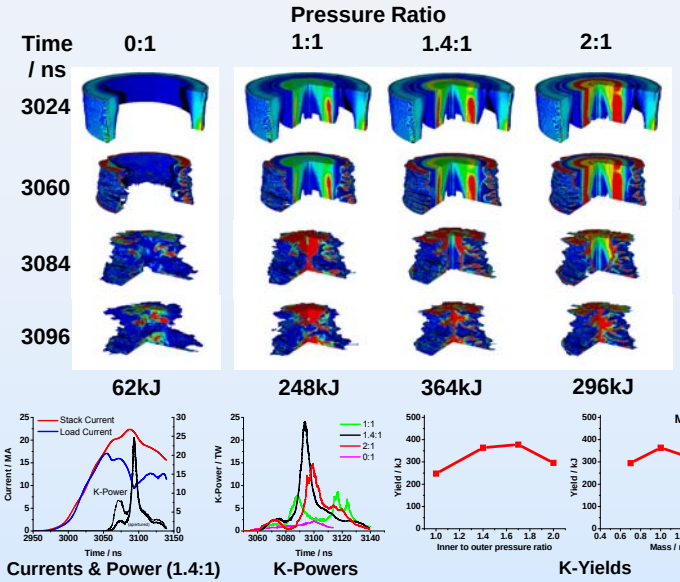
SITF Gas flow characterization used to benchmark cold gas flow calculations to provide a validated, flexible tool for assessing different gas puff configurations



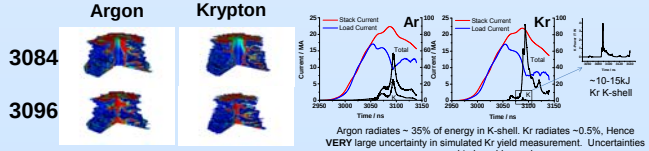
Full circumference 3D resistive MHD calculations using non-LTE radiation treatment, coupled to Z equivalent circuit initialized from cold gas flow calculations



Variation of Argon K-shell Yield with inner to outer nozzle pressure ratio through modification of instability growth

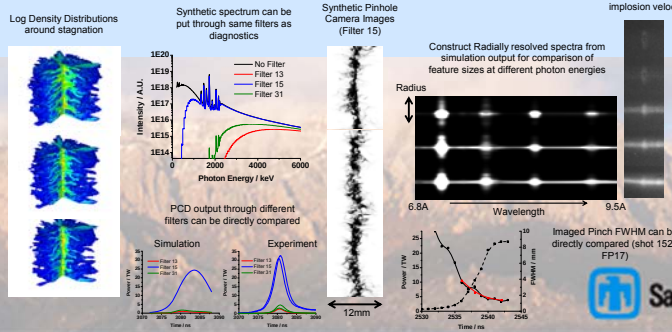


Comparison of Ar / Kr for 1.4:1 gas flow (1mg/cm)



Argon radiates ~ 35% of energy in K-shell. Kr radiates ~0.5%, Hence **VERY** large uncertainty in simulated Kr yield measurement. Uncertainties need to be addressed

Simulated diagnostics being constructed for effective model validation (example from 40mm nested Al array shots 1520 & 1907)



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