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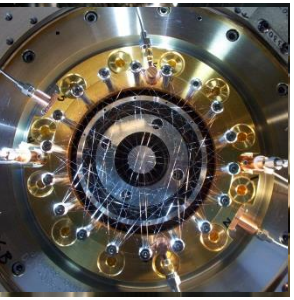

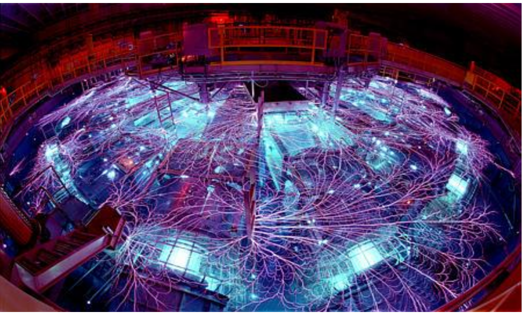

Breakout discussion:
Science enabled by tritium on Z

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Z Fundamental Science Workshop
Stagnation Breakout Session
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Sandia National Laboratories

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Fielding tritium on Z will open the door to valuable collaborative MagLIF physics studies, but is nontrivial

- Tritium is not presently fielded on Z
  - Vacuum chamber is open every day, MITL grinding, tanks of oil and water

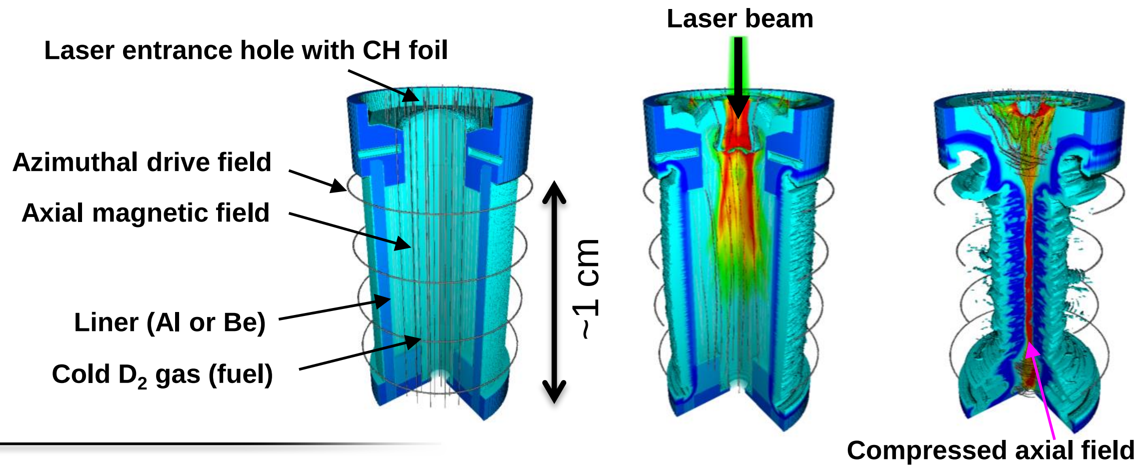
- Community needs to assess the cost-benefit of using tritium at Z

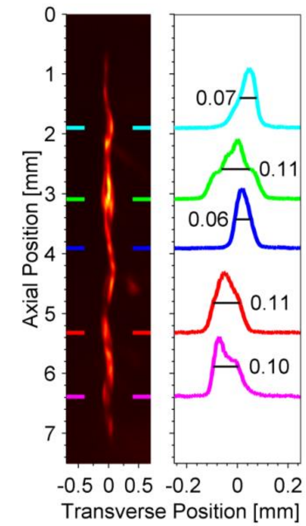
- Tritium would open the door to nuclear diagnostic techniques and target physics studies not presently possible

- These opportunities would encourage collaboration on Z with the broader HED community

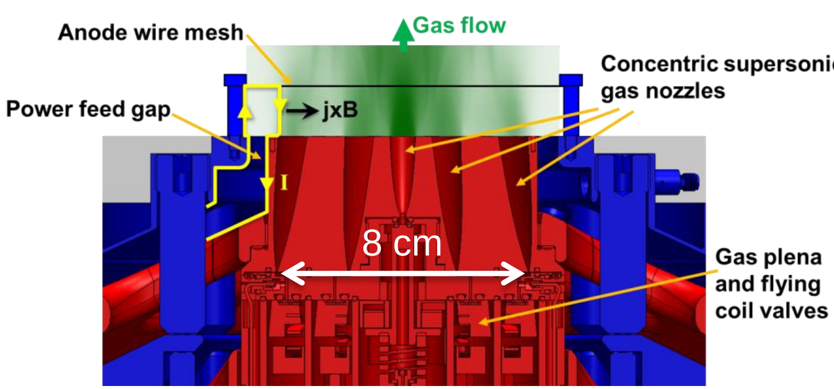
ICF neutron sources at Z can have very different implosion dynamics and plasma conditions

MagLIF

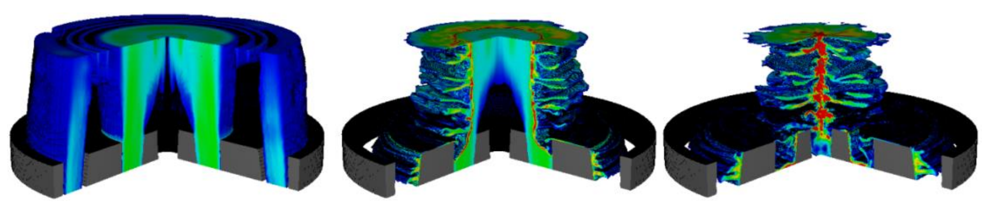




D_2 gas puff



MagLIF: M. R. Gomez *et al.*, accepted to PRL (2014).
D_2 gas puff: C. A. Coverdale *et al.*, PoP **14**, 022706 (2007).



	Y_n(DD)	Y_n(DT)	T_e (keV)	T_i (keV)	n_i (cm^{-3})	Δt (ns)	Diameter
MagLIF	$2x10^{12}$	$5x10^{10}$	~3	2.5	~ 10^{23}	< 2	~50 μm
D_2 gas puff	$4x10^{13}$	$<4x10^{9}$	2.2	~10	$2x10^{20}$	~30	6 mm

Several key physics issues could be addressed with DT experiments

		Tritium fuel content		
Physics	Measurement	<0.1%	0.1%	1%
Behavior of tritium in the Z pulsed power environment	Sampling of tritium contamination, migration			
Scaling of yield to DT—thermonuclear?	DT yield			
Ion temperature and non-thermal population	Precision nTOF and DT/DD yield ratio			
Liner/fuel mix	DT yield with tritiated gas fill and deuterated liner			
Fuel morphology	Neutron imaging			
Thermonuclear reaction history	Gamma Ray History/GCD, Thompson parabola			
Liner/fuel density, non-thermal effects (peak shifts)	Compact/Magnetic Recoil Spectrometer (CRS/MRS), precision nTOF			

Diagnostic Capabilities enabled by tritium use will open new physics understanding for MagLIF

- Better SNR, higher dynamic range n-spectral measurements
  - More precise ion temperature
  - High precision Be down scatter measurements for liner ρR
  - MRS or CRS measurements both axially and radially
- Neutron imaging enabled by higher yields
  - Is the neutron producing volume the same as the x-ray producing volume?
  - Down-scatter image for liner ρR uniformity measurements
- γ reaction history enabled by higher yields and preferable γ–branching ratio
  - Is the x-ray history the same as the γ-history?
  - Does the reaction history have structure indicating multiple isolated burn regions?
- Novel mix studies are enabled by separated reactant experiments using tritium or tritiated hydrogen gas
  - Deuterated window to study window mix
  - Deuterated coating on liner interior to study liner mix
  - Deuterated top/bottom caps to study mix from laser interactions
  - Combine w/ neutron imaging to study transport of mix material

Gradual increase in MagLIF tritium fuel content will provide increasing scientific opportunities

Proposed Z Timeline

FY15	FY16	FY17	FY18	FY19

Tritium Surrogates D_2, ^3He

Trace Tritium ES&H <0.1%

Trace Tritium 10x DT Yield ~0.1%

Minority Tritium $>10^{13}$ DT Yield ~1%

Tritium Operations 10-50%

DT yield scaling, ion temperature and non-thermal population

Nuclear tracers for liner/fuel mix

Neutron imaging, high sensitivity for DD MagLIF, mixed DD/DT imaging (CR-39?)

Brems background measurements for GCD, shielding studies

GRH/GCD, Thompson parab., CVD dia.

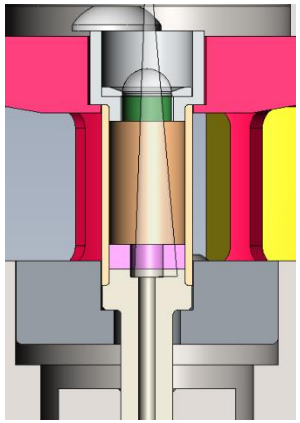
Wedge range filter, CRS design

MRS neutron spectroscopy

Our ability to minimize the impact on the facility depends on the ability to purge the tritium from the Z target chamber

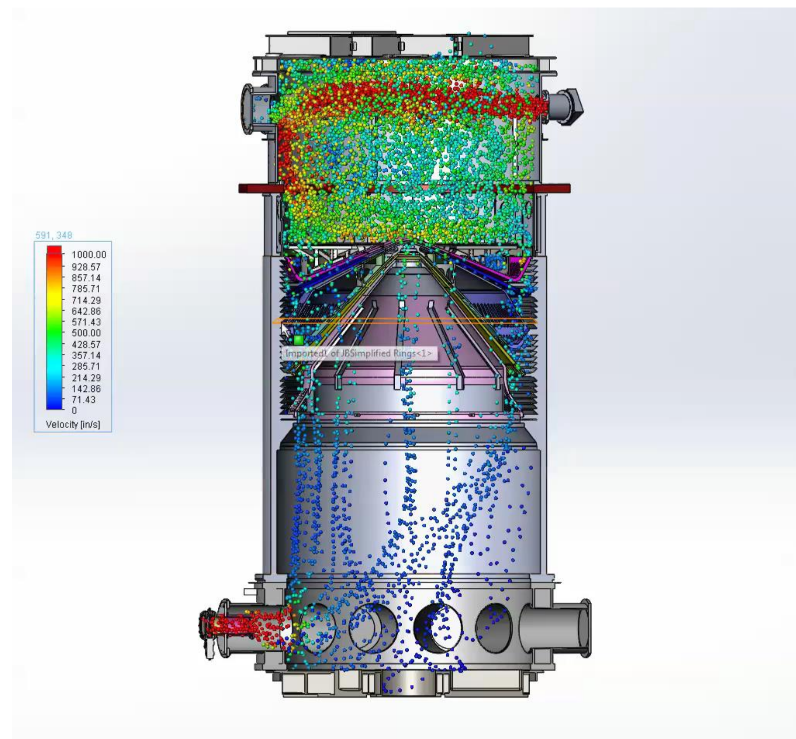
$h = 10$ mm
$r_{fuel} = 2.75$ mm
$V = 238\ mm^3$
$\rho = 1.5$ mg / cc
1 % T = 41.1 mCi

MagLIF target



Flow analysis of the Post Shot Air Exchange System for Z center section

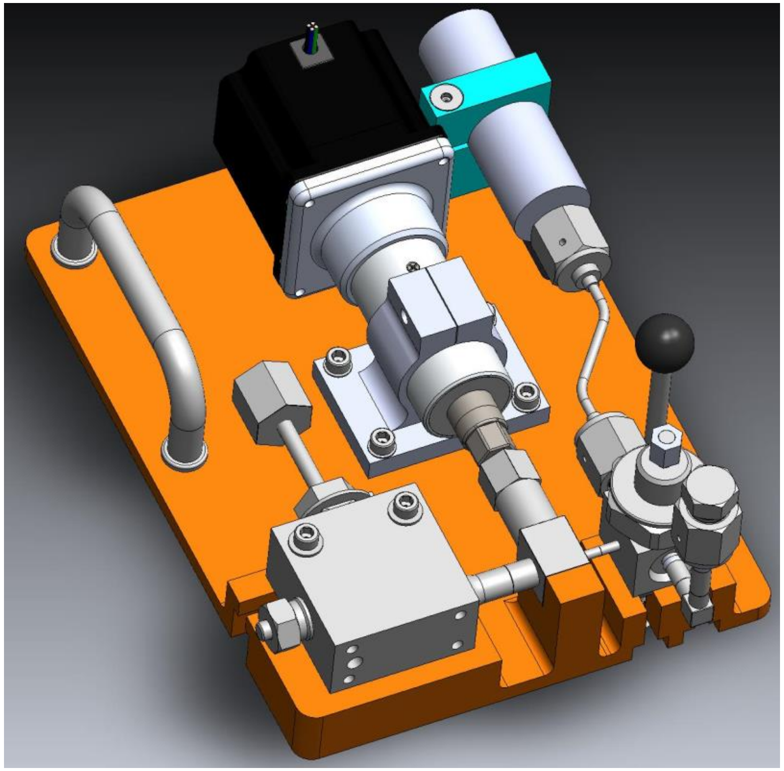
Volume = 66 m^3
Total surface area = 464 m^2



- Purge efficiencies required to keep Z below control limits for tritium
  - Assuming entire surface area
  - 99.5 % for 10,000 dpm / 100 cm^2 (Contaminated area)
  - ~ 50 % for 1 e6 dpm / 100 cm^2 (Highly contaminated area)

We recently completed development of the Z Gas Transfer System (ZGTS) capable of filling MagLIF targets in-situ on Z

ZGTS



- Robust tritium capable gas transfer system
  - Uses metal diaphragm puncture valve
  - Minimizes tritium inventory
  - Controls when and where tritium is used
  - Fills target in-situ just prior to shot