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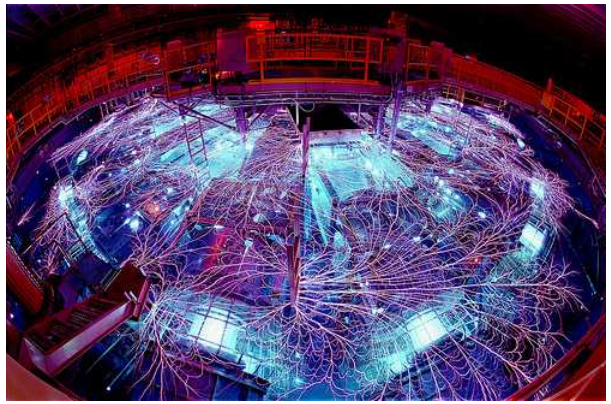

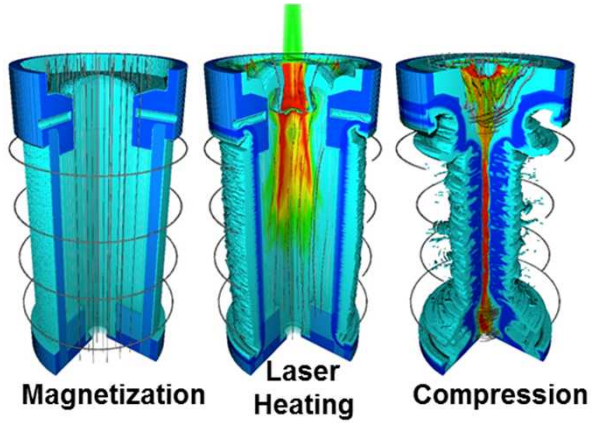

Present State of MagLIF Experiments

Matt Gomez for the MagLIF team

08/02/2016

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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MagLIF relies on three stages to produce fusion-relevant conditions

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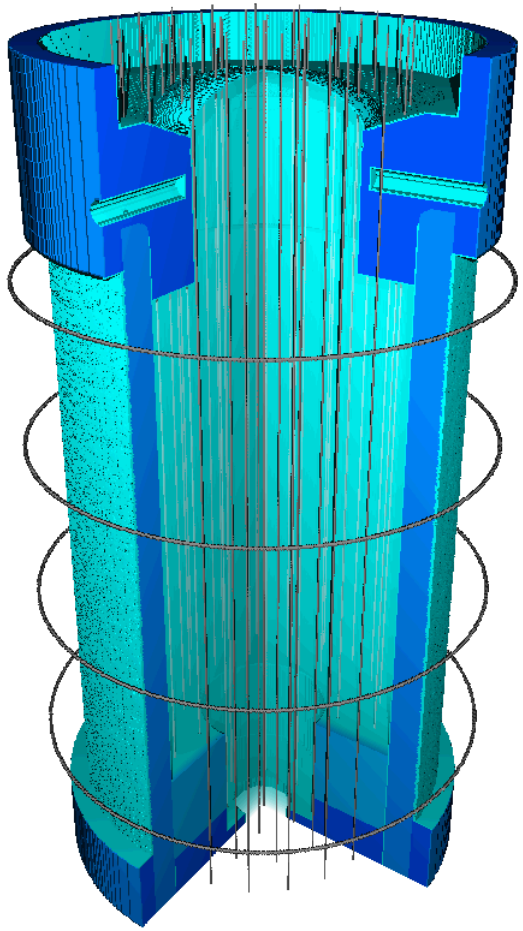
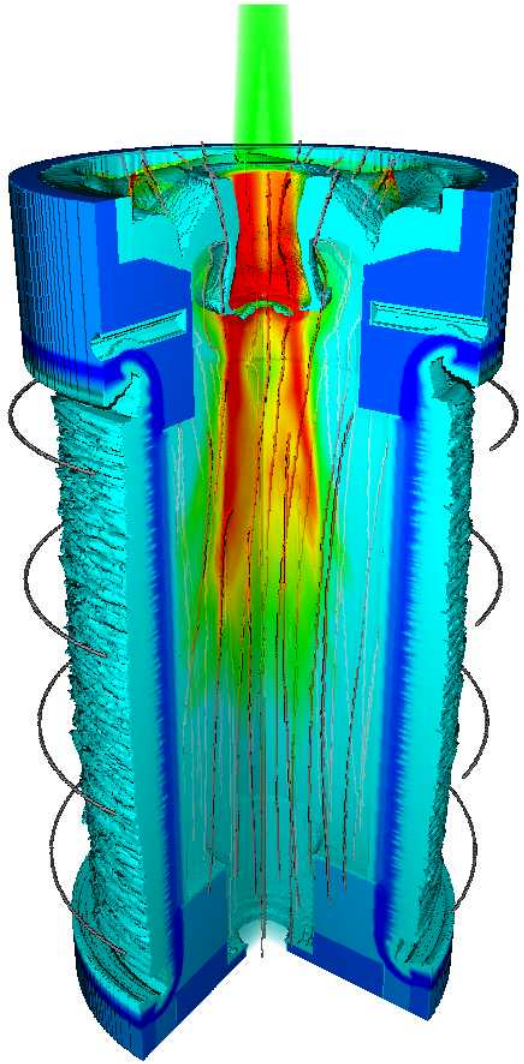
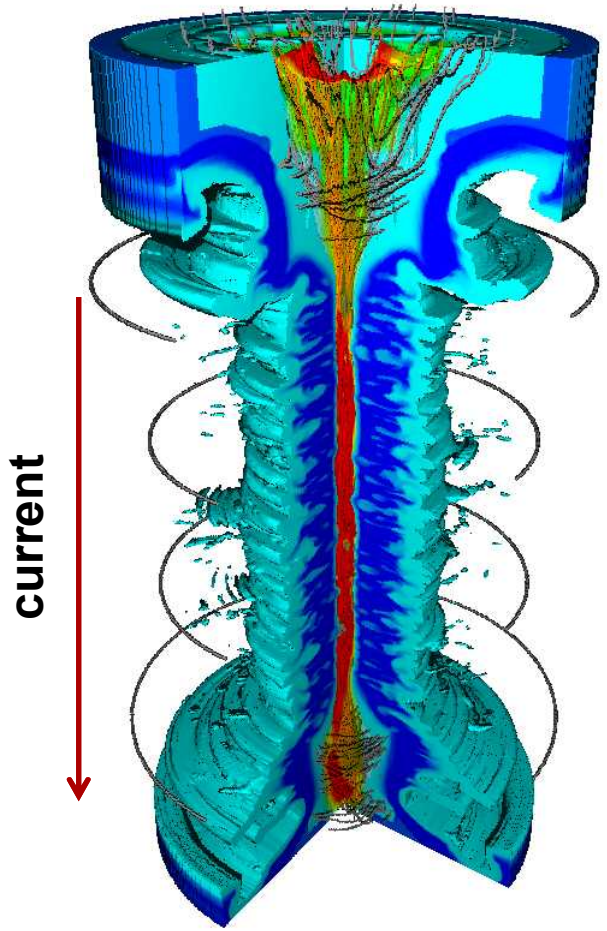


Axial magnetization



Laser Heating



Magnetically-driven compression

S. A. Slutz, et al., Phys. Plasmas, 17 056303 (2010).

We demonstrated key aspects of magneto-inertial fusion in the initial experiments

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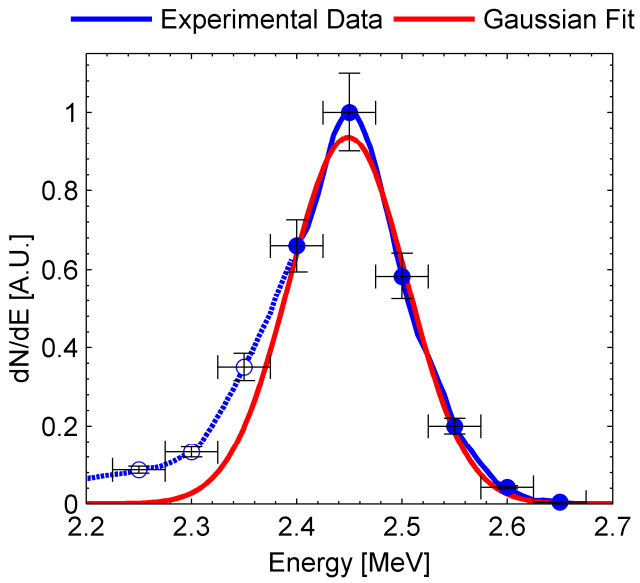
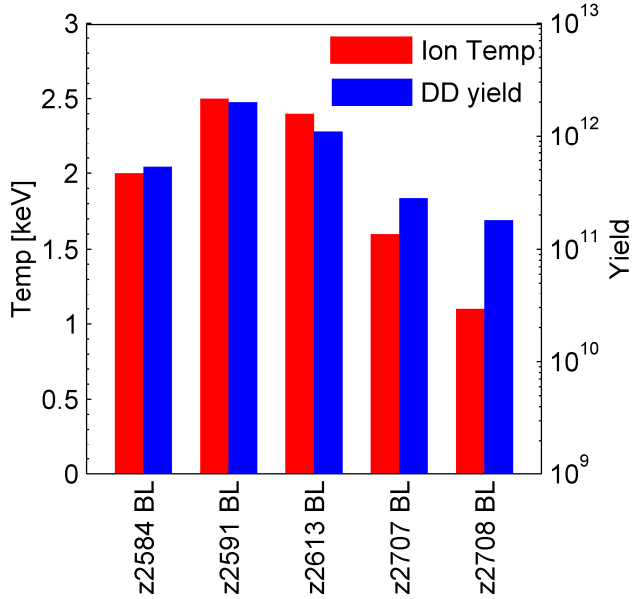
Thermonuclear neutron generation



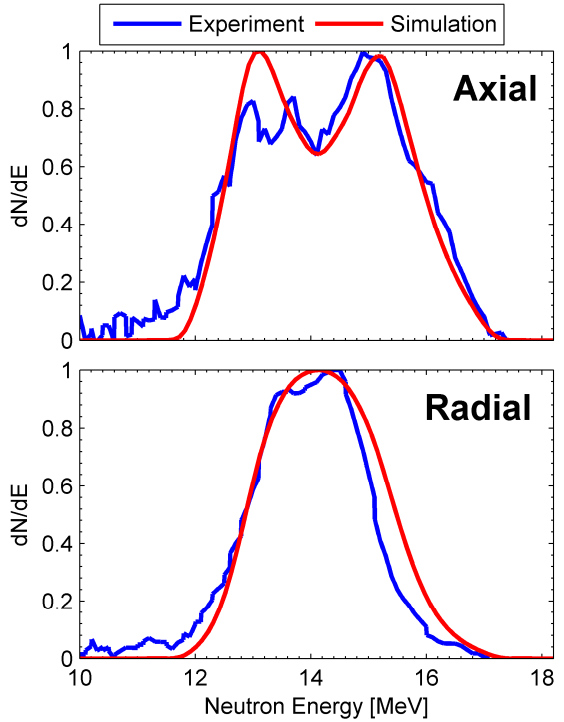
Isotropic, Gaussian DD neutron spectra

High yields and temperatures



Max yield = 2e12
Max ion temp = 2.5 keV

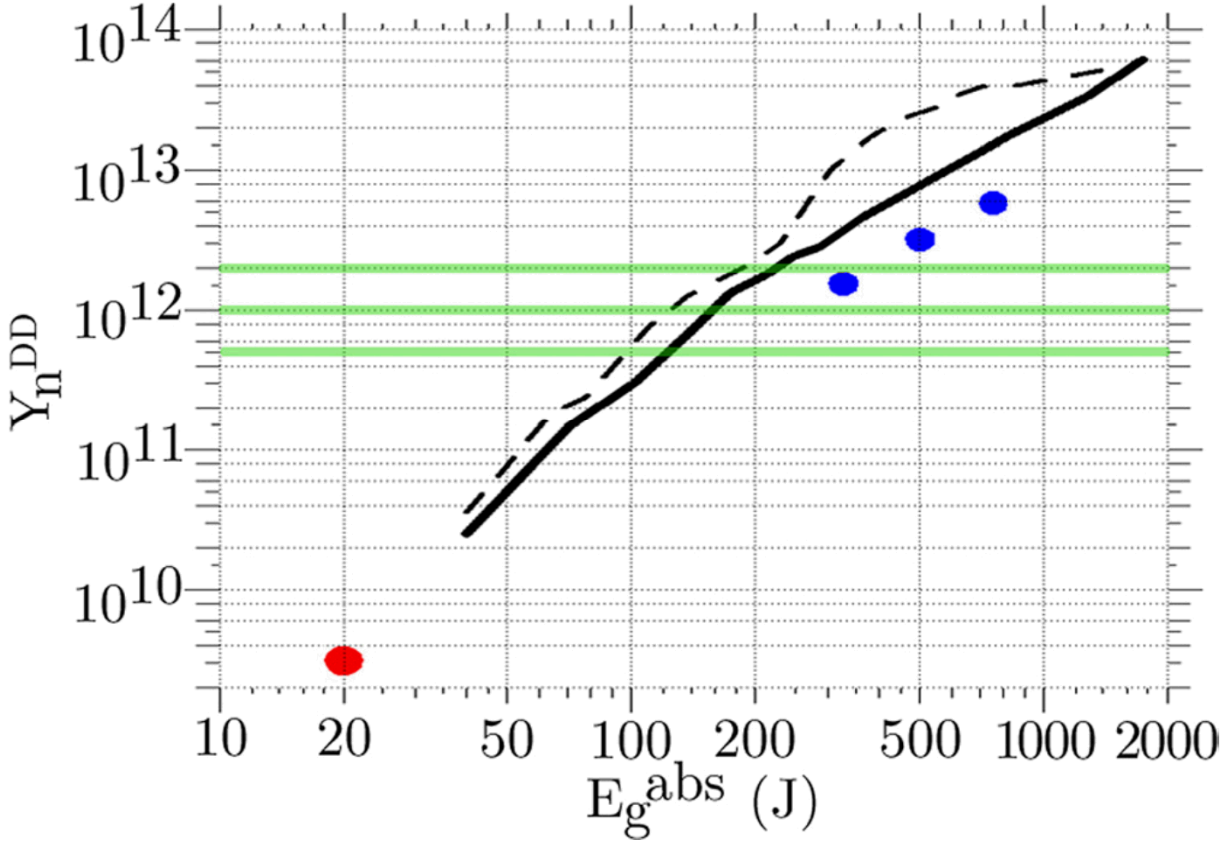
Magnetic flux compression



BR = 30-40 T-cm

M. R. Gomez, et al., Phys. Rev. Lett. 113, 155003 (2014). P. F. Schmit, et al., Phys. Rev. Lett. 113, 155004 (2014).

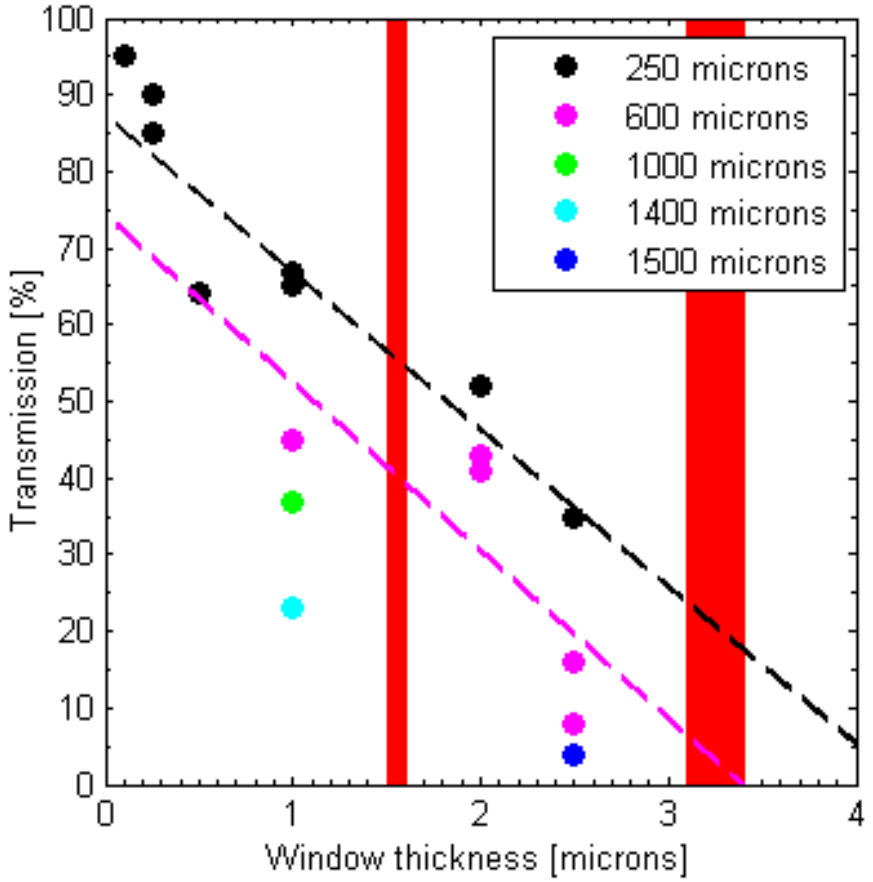
Initial 2D simulations predicted higher performance than observed experimentally



- 2D Hydra with 100-200 J of laser energy matched observables
  - 3.5 micron thick windows and unconditioned beam
- 3D Gorgon simulations demonstrate experimental conditions could be reproduced with a combination of reduced laser coupling, laser induced mix, and 3D effects

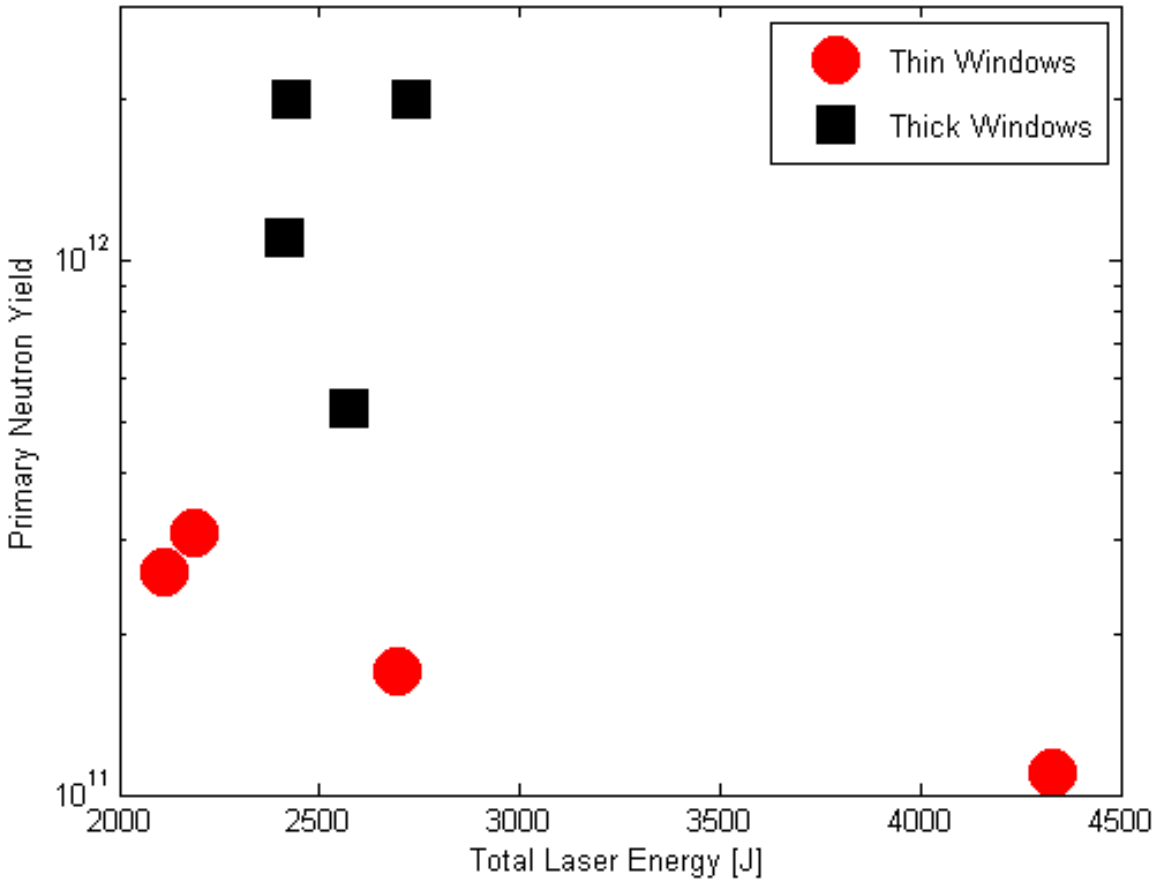
A. B. Sefkow, et al., Phys. Plasmas 21, 072711 (2014).

Under the assumption of poor laser coupling, we reduced the window thickness



Thinner windows have increased transmission

This does not include scatter outside of laser cone



The targets performed worse with thinner windows

We thought mix might be an issue, so we forced all fuel-facing components to be low Z

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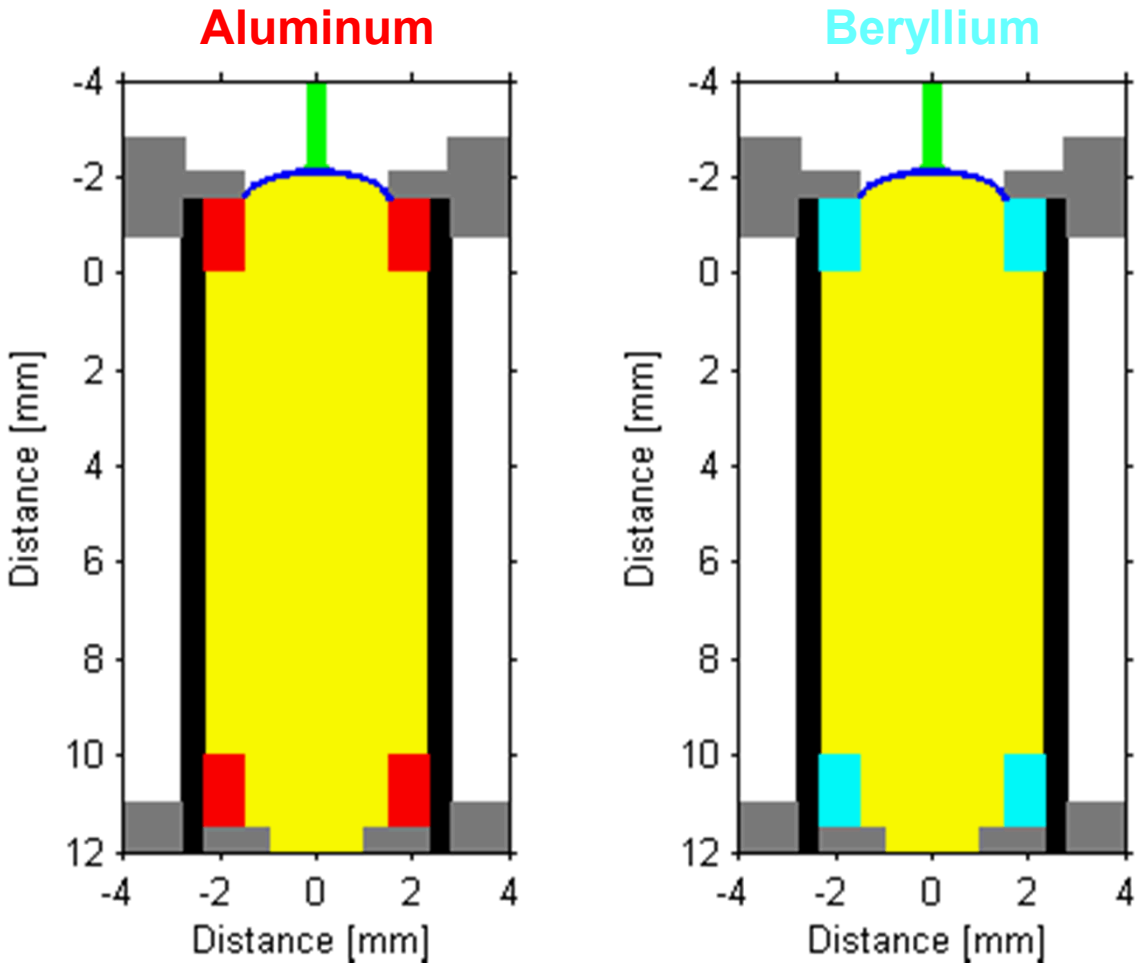
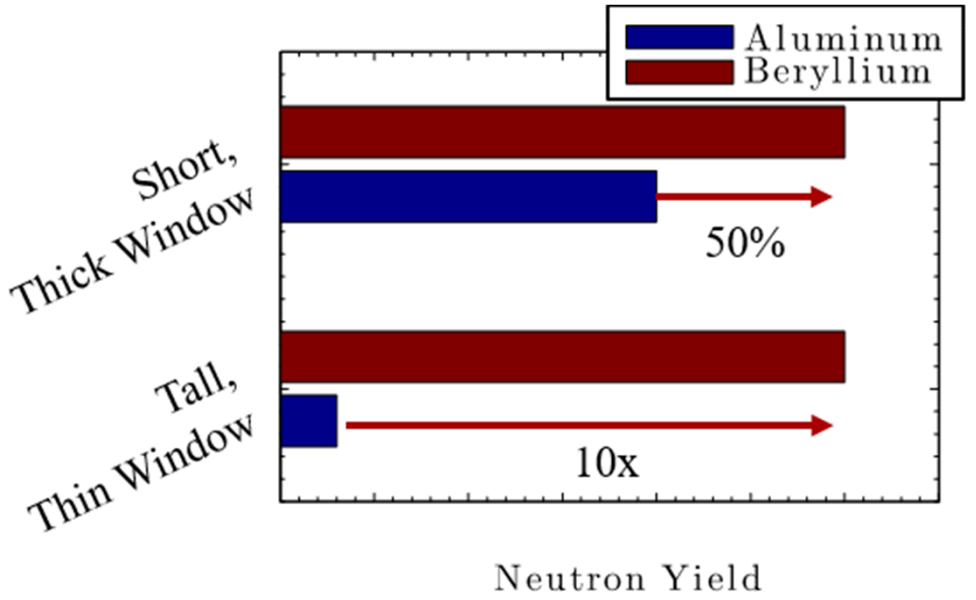


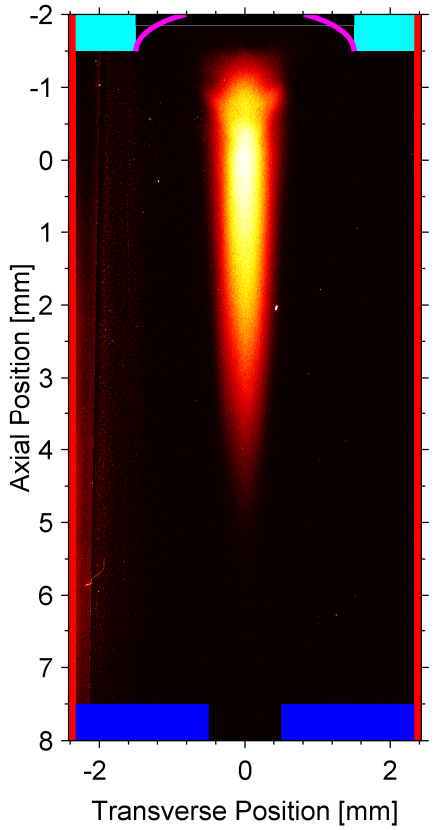


The change to all beryllium components had a positive effect on both target types but it was more profound for the thin windows

More endcap mix with thinner windows?

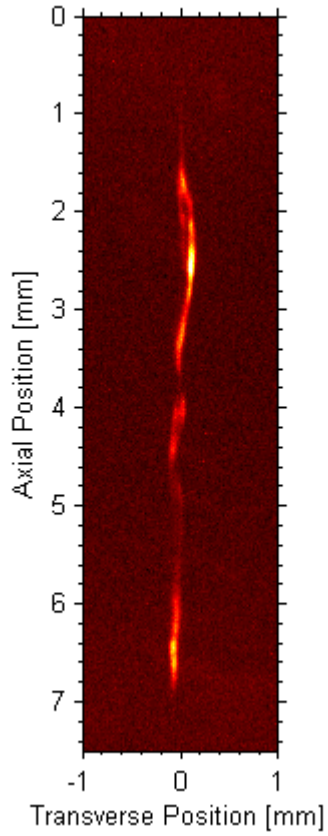
We obtained phase plates to improve laser beam quality and coupling to fuel

Argon line emission image from laser heating experiment



- Experiment produced a diagnosable stagnation, but yield and temperature were reduced
  - Only a single test, need a repeat
- Some indications of increased window mix, but need more experiments to verify
- Lead to a concentrated effort to develop a new laser heating platform

Stagnation emission image from integrated experiment



We have demonstrated increased current delivery to the target through power flow modifications

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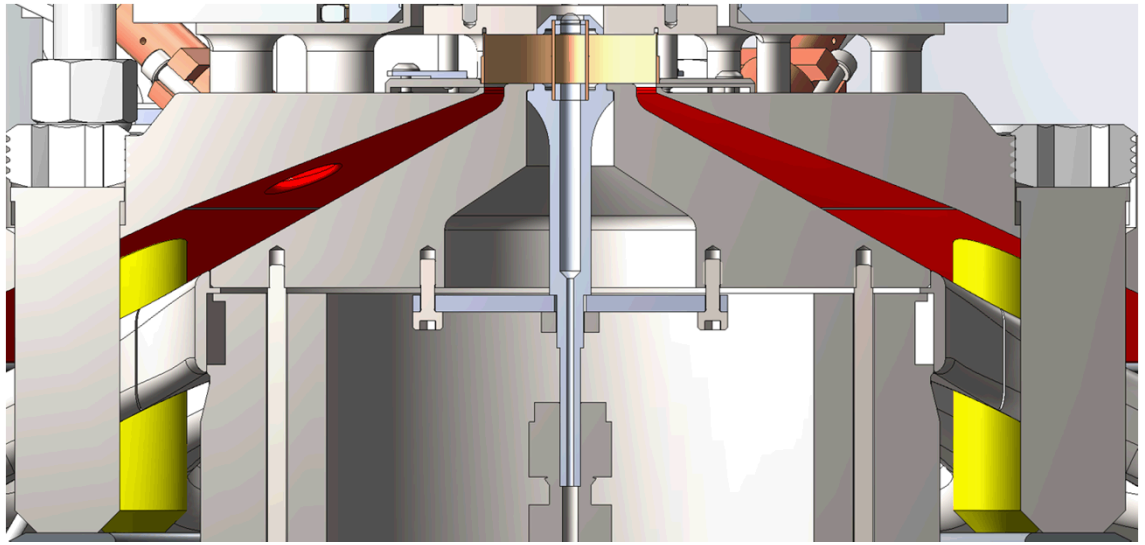
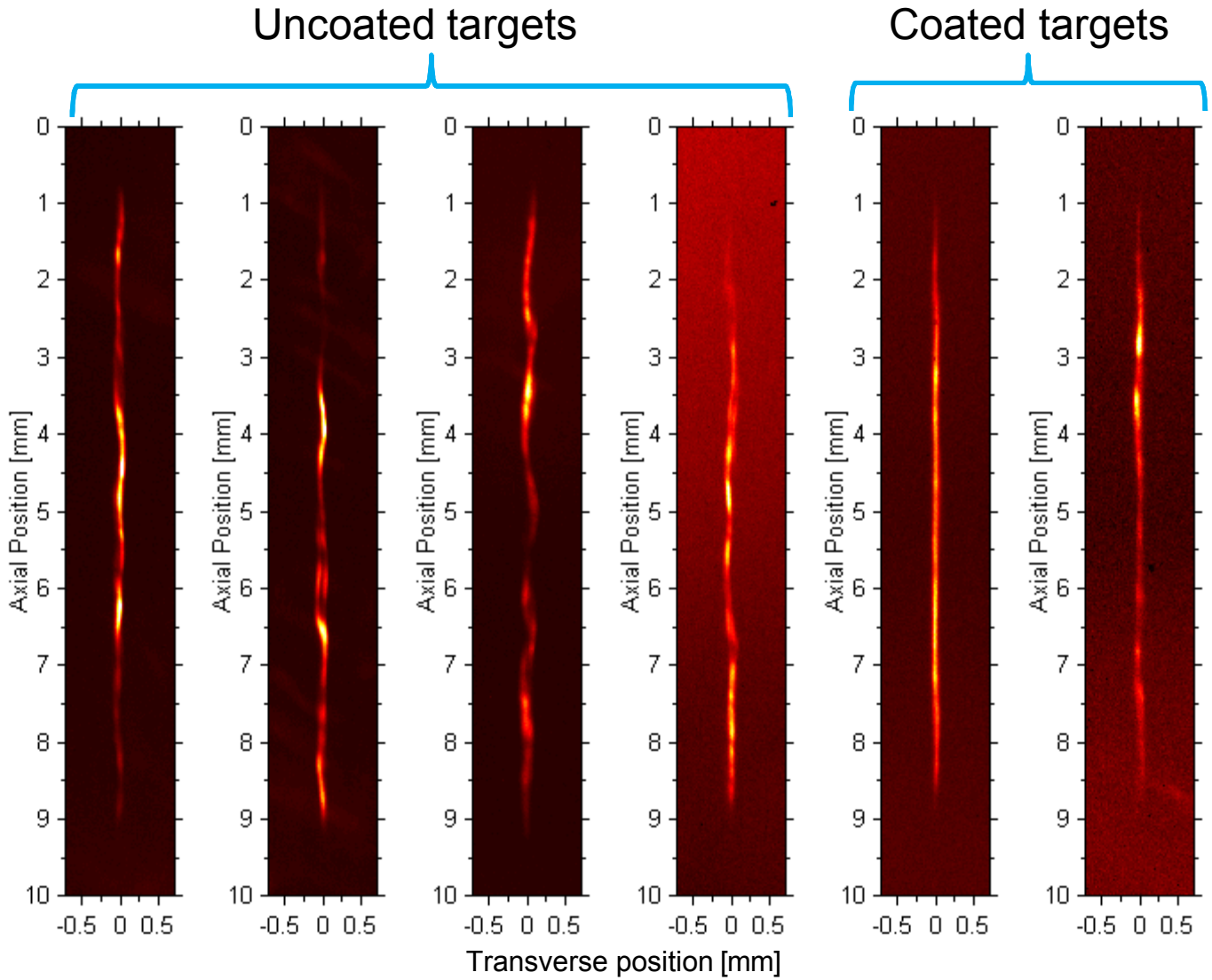
- More robust convolute design
- Reduced inductance transmission line designs
- Both individually demonstrated ~2 MA (10%) increase in peak current
- Another 3-8 MA increase may be possible depending on other constraints



New inner-MITL design reduced inductance from 6.5 nH to 4.6 nH inside the convolute

Targets were not redesigned to take advantage of increased current and performance was similar to other MagLIF experiments

More uniform stagnation column observed with dielectric coated targets



- 2D stagnation performance may be better for future scaling arguments
- Yield was a little low compared to similar targets
- We are interested in understanding the implosion trajectory and position of the dielectric coating at stagnation

MagLIF has demonstrated some promise… but there is still a lot left to investigate

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- Optimized laser configuration
  - Laser pulse shape
  - Laser spot size
  - Initial fuel density
- Laser induced mix
  - Laser and/or blastwave interacting with walls and/or endcaps
  - Laser-accelerated window material
- Temporally- and spatially-resolved stagnation conditions
  - Stagnation morphology
  - Cause for helical stagnation column and impact on performance
- Power flow
  - Improved current delivery
  - Impact of dielectric coating on current delivery to small radius

We need to improve existing diagnostics and develop new ones, and we need to engage more with universities on smaller-scale experiments that will improve our understanding