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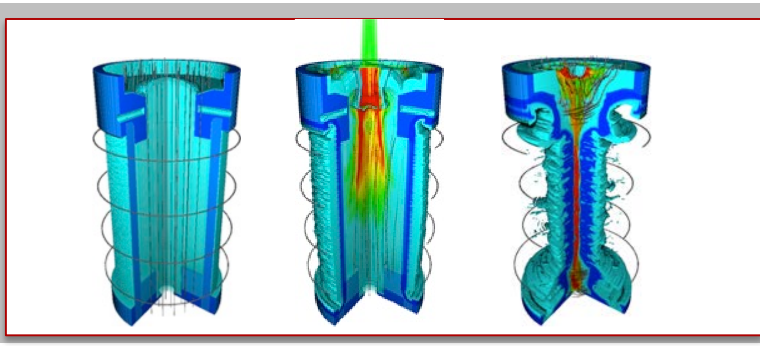

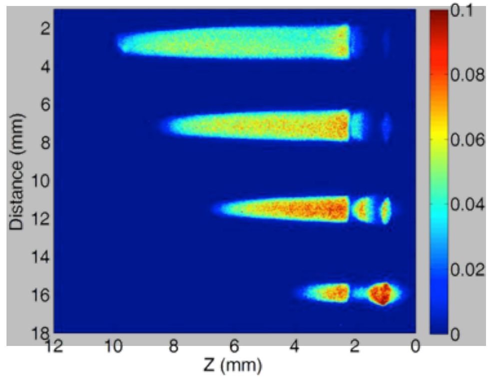

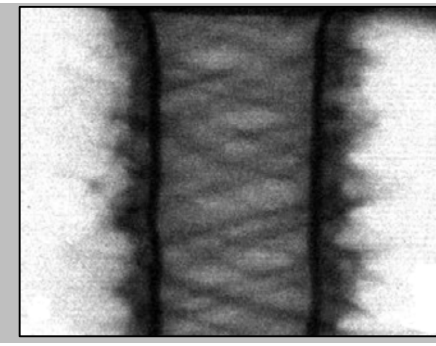

Consolidated Picture of MagLIF implosions & Current State of our Understanding

Kyle Peterson on behalf of the entire MagLIF team

Sandia National Laboratories,

Albuquerque, NM, USA

National Implosion Stagnation Physics Group

Livermore, CA, March 8, 2016

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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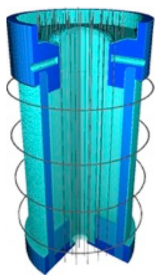
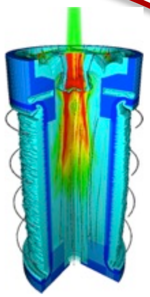
Consolidated picture of our current understanding of MagLIF implosions

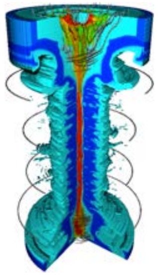
Magnetization



Preheating



Compression & Burn

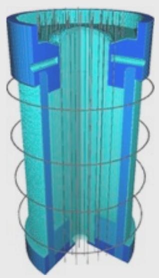


Understanding Level

- (green) High level of understanding and/or direct measurements
- (yellow) Some understanding, but significant questions remain; data inconclusive
- (red) Little or limited understanding and few if any direct measurements

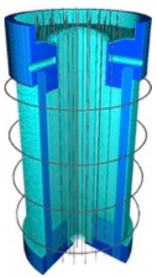
Consolidated picture of our current understanding of MagLIF implosions

Initial Conditions

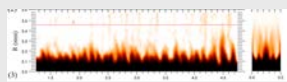


- Initial conditions of liner and fuel
- Liner surface features and imperfections
- Initial level and uniformity of magnetization
- Effect of B_z on power flow
- Physical state of liner and laser entrance hole/window (LEH) after magnetization pulse
- Pressurized LEH spatial profile

Consolidated picture of our current understanding of MagLIF implosions

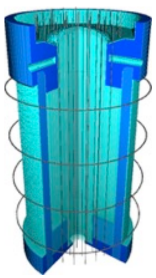


Start of Current Flow

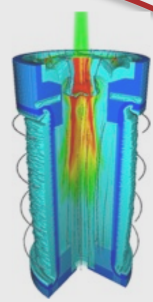


- Development and growth of ETI
- Effectiveness of ETI mitigation
- Initial formation of azimuthal correlation and helical perturbations
- Connection between early instability structure and stagnation performance
- Current delivered to the target

Consolidated picture of our current understanding of MagLIF implosions



Preheating

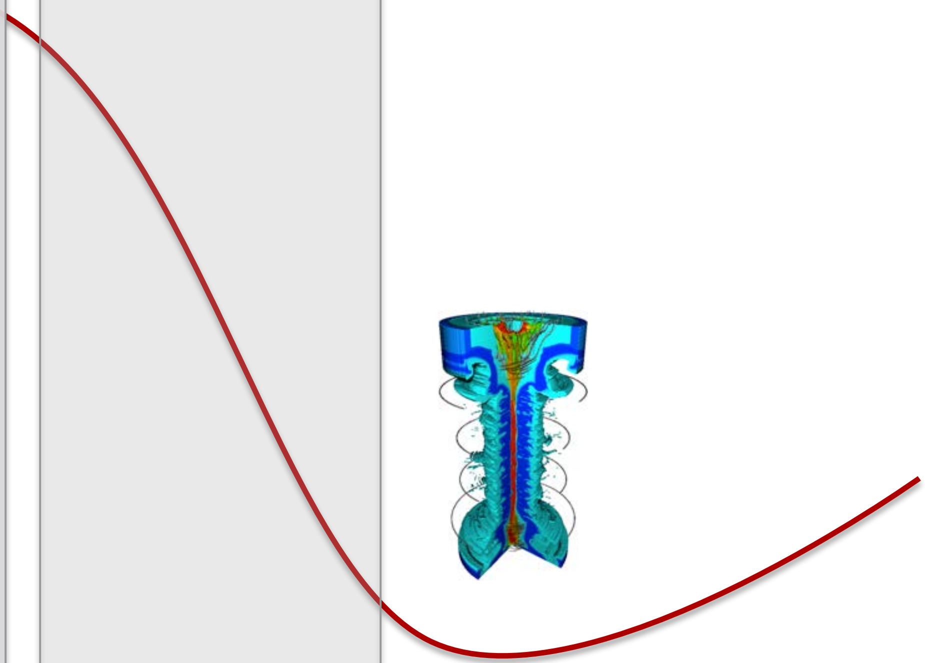


- Laser configuration on target
- Laser energy coupled to fuel
- Level and effect of LPI
- Depth of laser penetration
- Amount of laser induced mix/contaminants
- Source location of laser induced mix
- State of liner wall upon blast wave interaction

Consolidated picture of our current understanding of MagLIF implosions

- Growth of MRT instabilities
- Fuel vorticity and impact
- Stability of liner during implosion
- Magnetic flux conservation (Nernst)
- Fuel temperature and radiative cooling
- Wall instability & mitigation
- Deceleration Instabilities

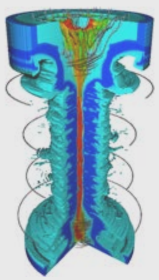
Implosion



Consolidated picture of our current understanding of MagLIF implosions

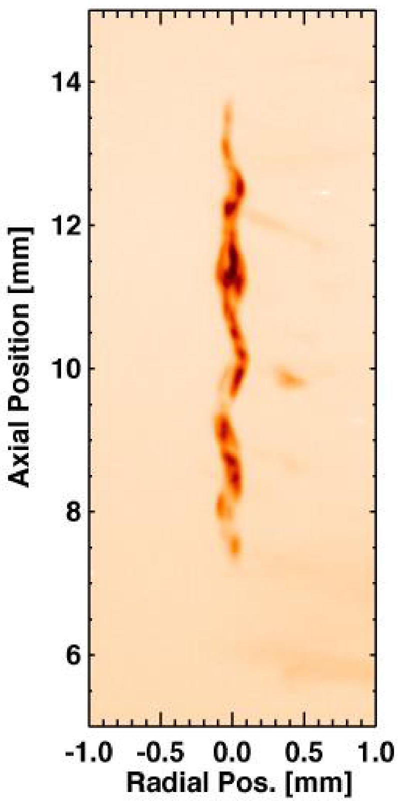
- Stagnated fuel & liner conditions (magnetization, temperature, etc.)
- The connection between observed 3D structure and stagnation performance
- Liner mix at stagnation, continuity of field and fuel volume
- Efficiency of thermalization
- Time evolution of stagnation
- Failure analysis and diagnostic return on poor performing shots

Stagnation and Burn



Our current physical picture of the stagnated fuel and liner is based on a series of x-ray and neutron diagnostics

X-ray image of MagLIF plasma



Stagnating plasma

<Te> = 3 ±1 keV

<Ti >= 2.5 +/- 0.5 keV

$T(r) = T_0[1 - (r/R)^2]$

t_{burn} = 1.5 ± 0.5 ns

f_{mix} ~ 1 %

R = 50 ± 20 μm

ρ_D = 0.3 ± 0.1 g/cm^3

P(z) = 1 ± 0.2 Gbar

ρR ~ 1.5 mg/cm^2

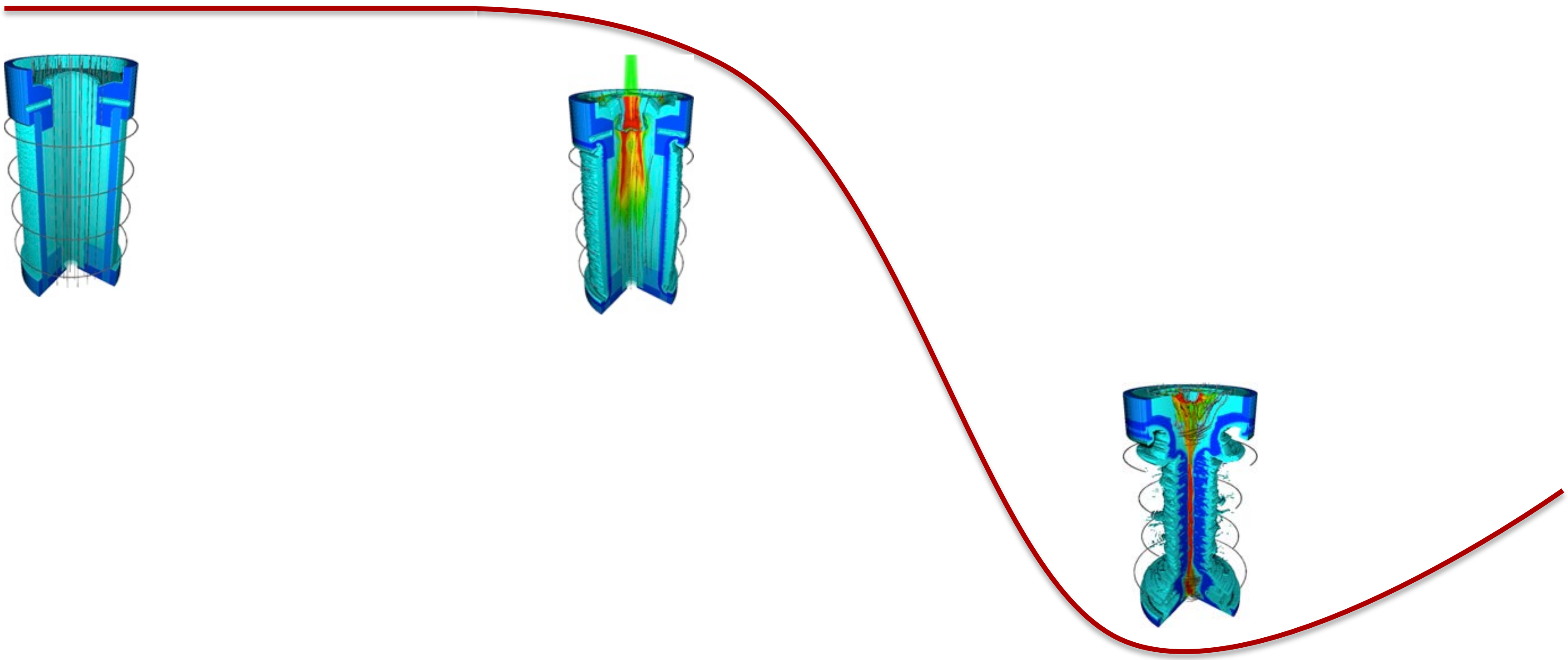
BR ~ 0.4 MG·cm

Confining liner

ρr_{liner} = 1 g/cm^2

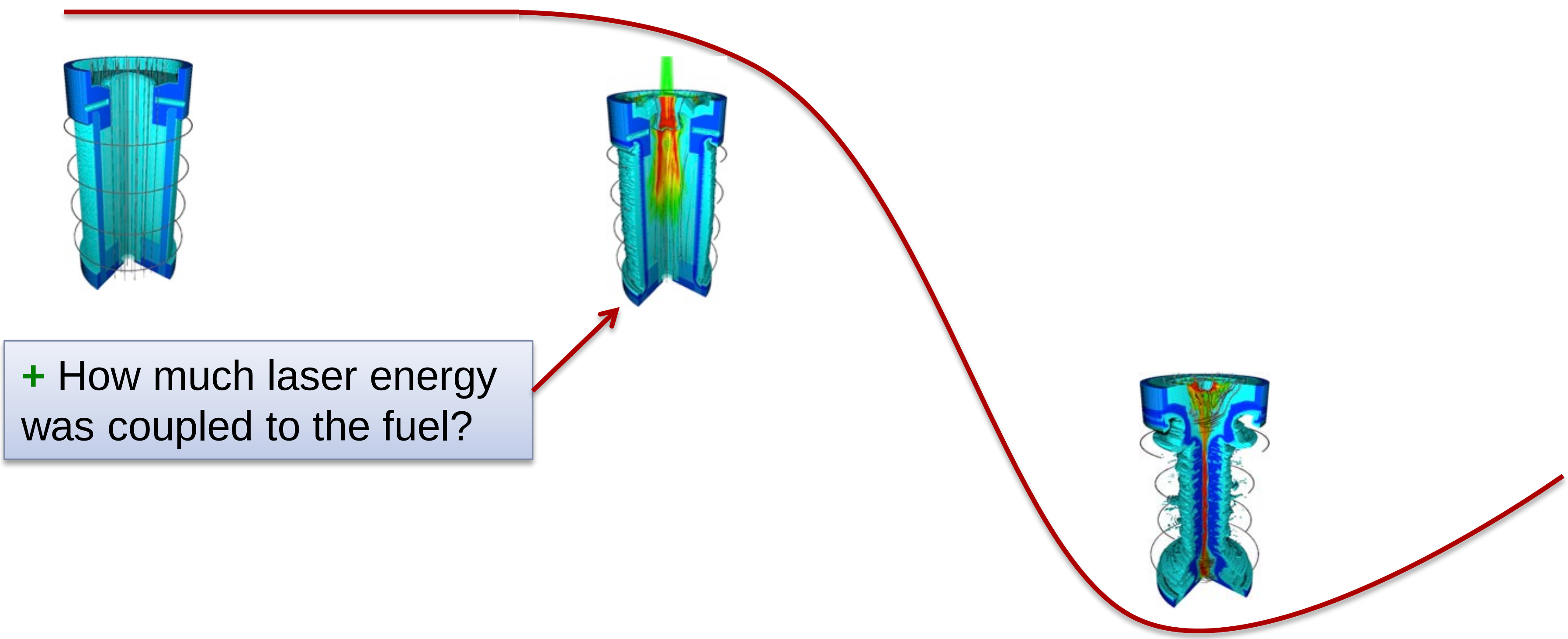
- Stagnation (DD) column is weakly helical and contiguous in z along most of the length of target (although significant temperature variations can exist)
- Stagnated DD is highly magnetized (BR ~ 0.4 MG-cm) with 25-55% magnetic flux conservation
- ~40-50% (sim) of the fuel mass is conserved in the implosion, ~10-20% inferred from *hot-spot* emission volume
- Relatively slow (70 km/s) and stable (Δdr(z)<<r) Be liner. Outer liner material stagnates on fuel 5 ns after peak neutron production of the DD fuel
- High CR, could be as high as 45!

Most of our ***stagnation/performance*** hypotheses are all related to energy balance.



Why do our simulations, in general, predict higher performance than observed?

Most of our ***stagnation/performance*** hypotheses are all related to energy balance.



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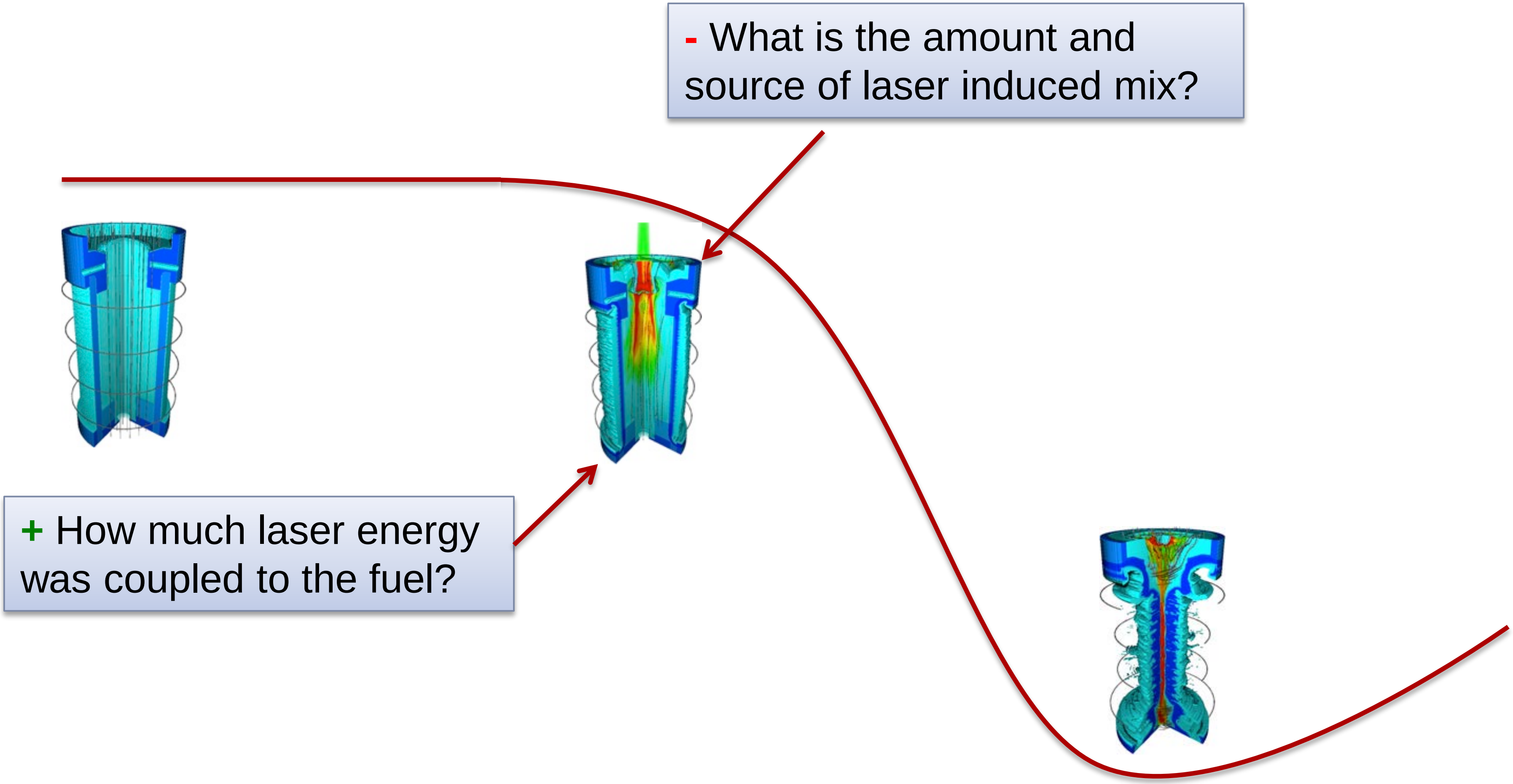

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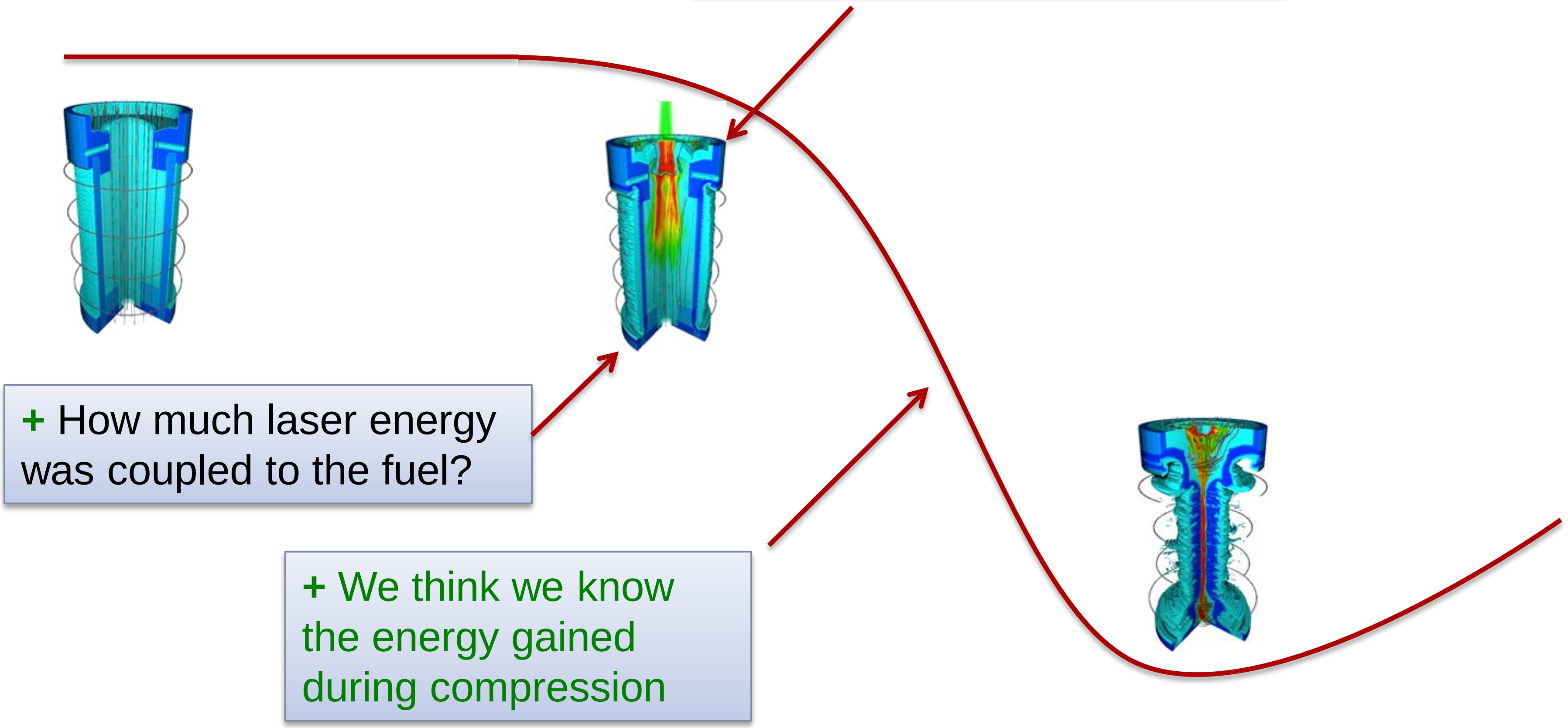

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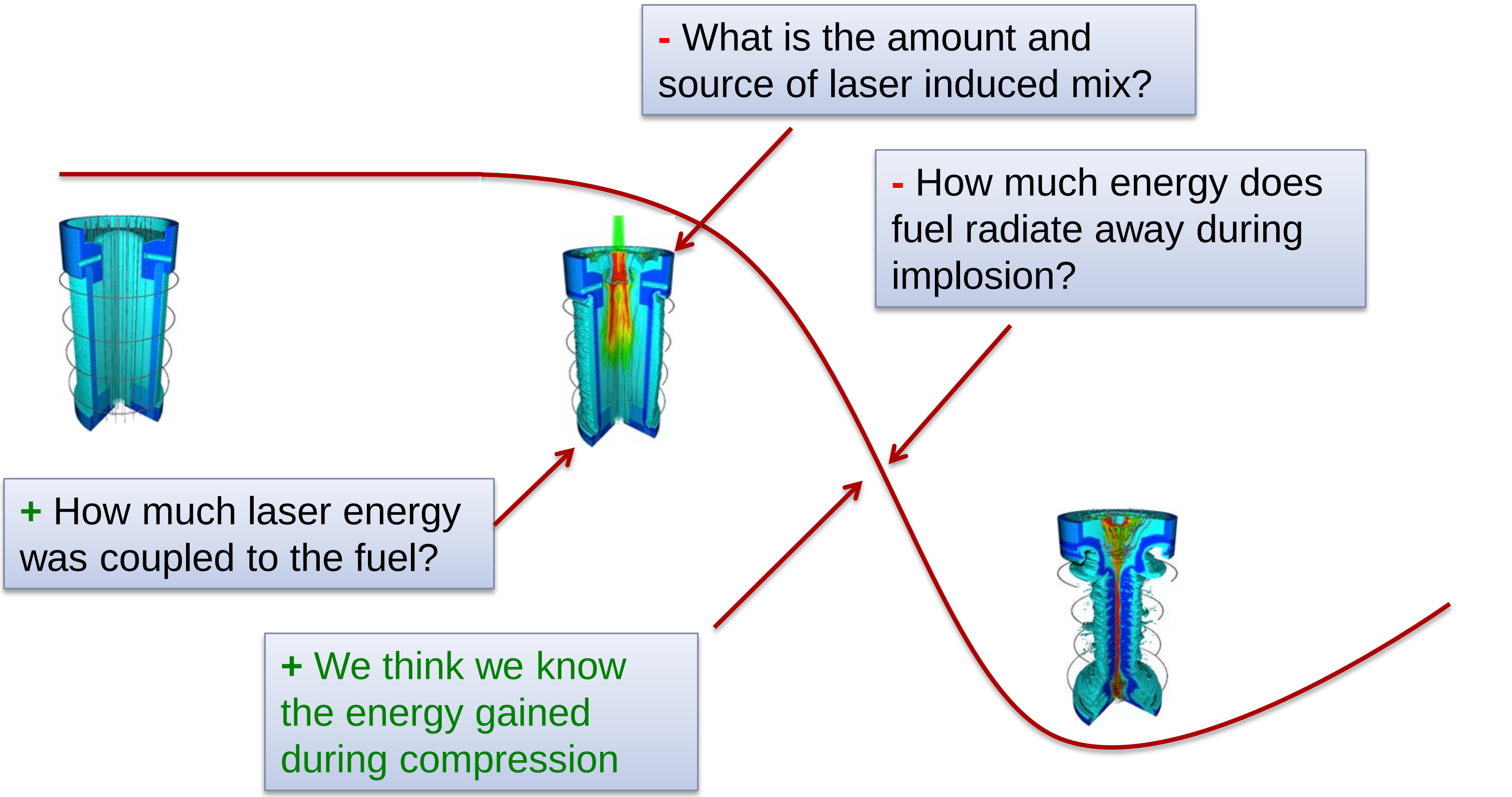
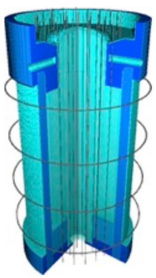
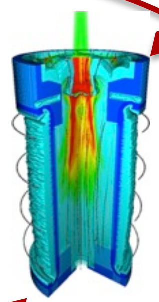


Most of our ***stagnation/performance*** hypotheses are all related to energy balance.

- What is the amount and source of laser induced mix?

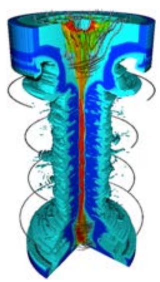
- How much energy does fuel radiate away during implosion?





+ How much laser energy was coupled to the fuel?

+ We think we know the energy gained during compression



- We think we reasonably know flux and end losses

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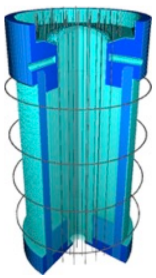
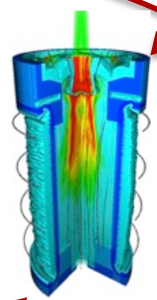
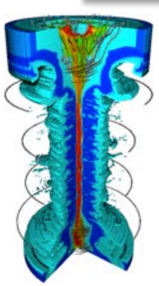




- What is the effect of 3D structure on stagnation?

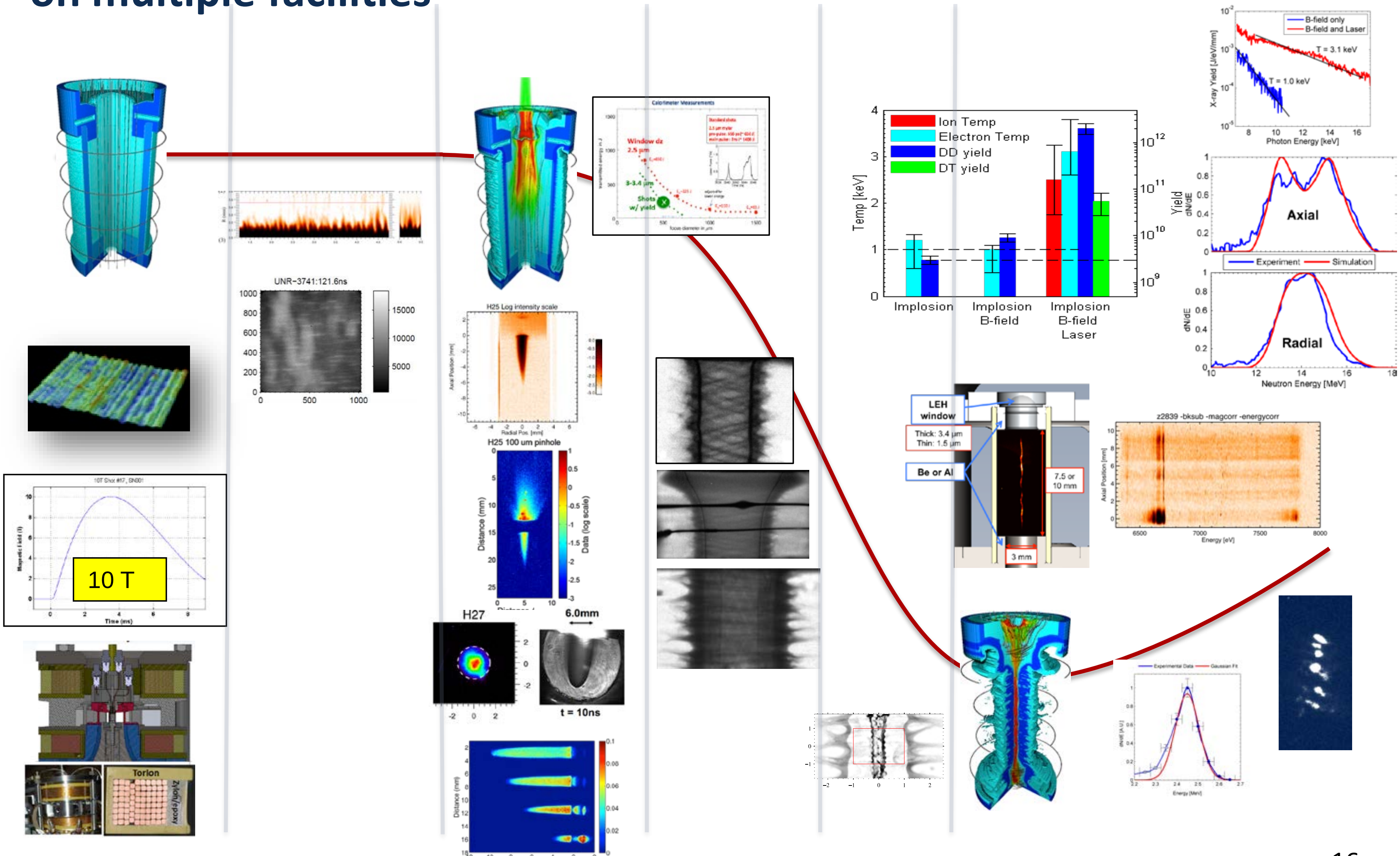
+ How much laser energy was coupled to the fuel?



+ We think we know the energy gained during compression

- We think we reasonably know flux and end losses

We are collecting data on all phases of MagLIF implosions, on multiple facilities



Our current focus is on better understanding of fuel preheating and mix

Backups