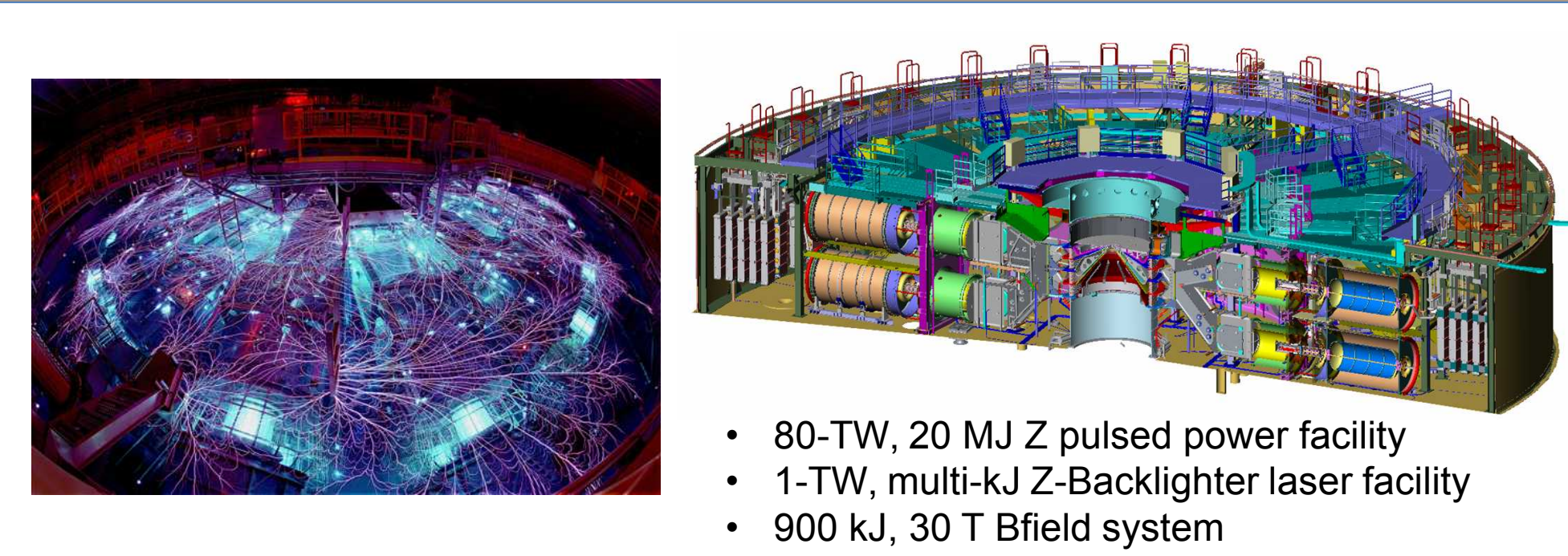


Exceptional service in the national interest



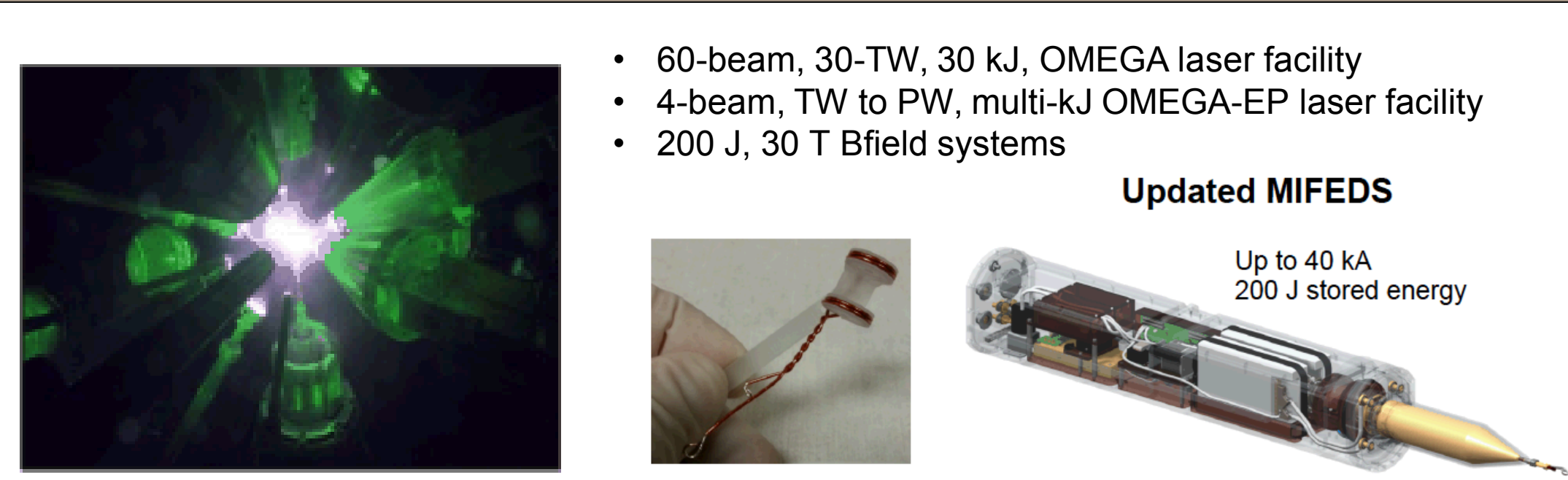
Demonstrating Fuel Magnetization and Laser Heating Tools for Low-Cost Fusion Energy

MagLIF on Z



- 80-TW, 20 MJ Z pulsed power facility
- 1-TW, multi-kJ Z-Backlighter laser facility
- 900 kJ, 30 T Bfield system

Integrated MagLIF on OMEGA

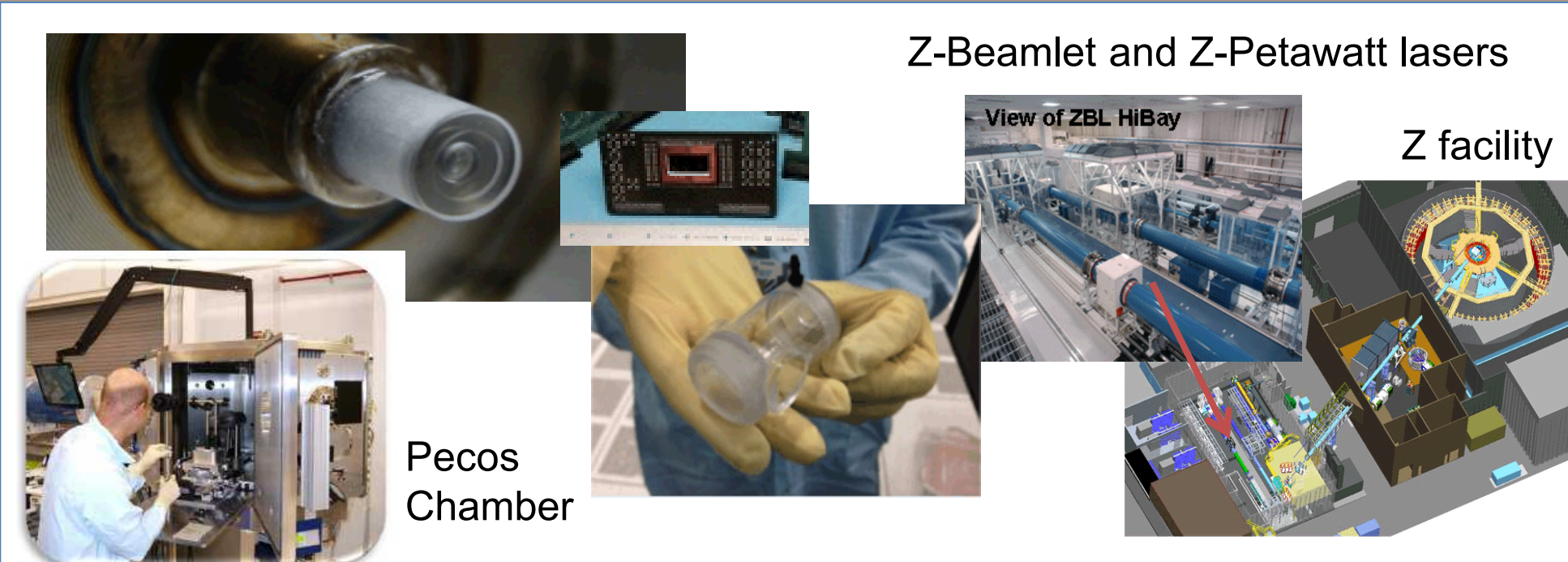


- 60-beam, 30-TW, 30 kJ, OMEGA laser facility
- 4-beam, TW to PW, multi-kJ OMEGA-EP laser facility
- 200 J, 30 T Bfield systems

Updated MIFEDS

Up to 40 kA
200 J stored energy

Target Preconditioning



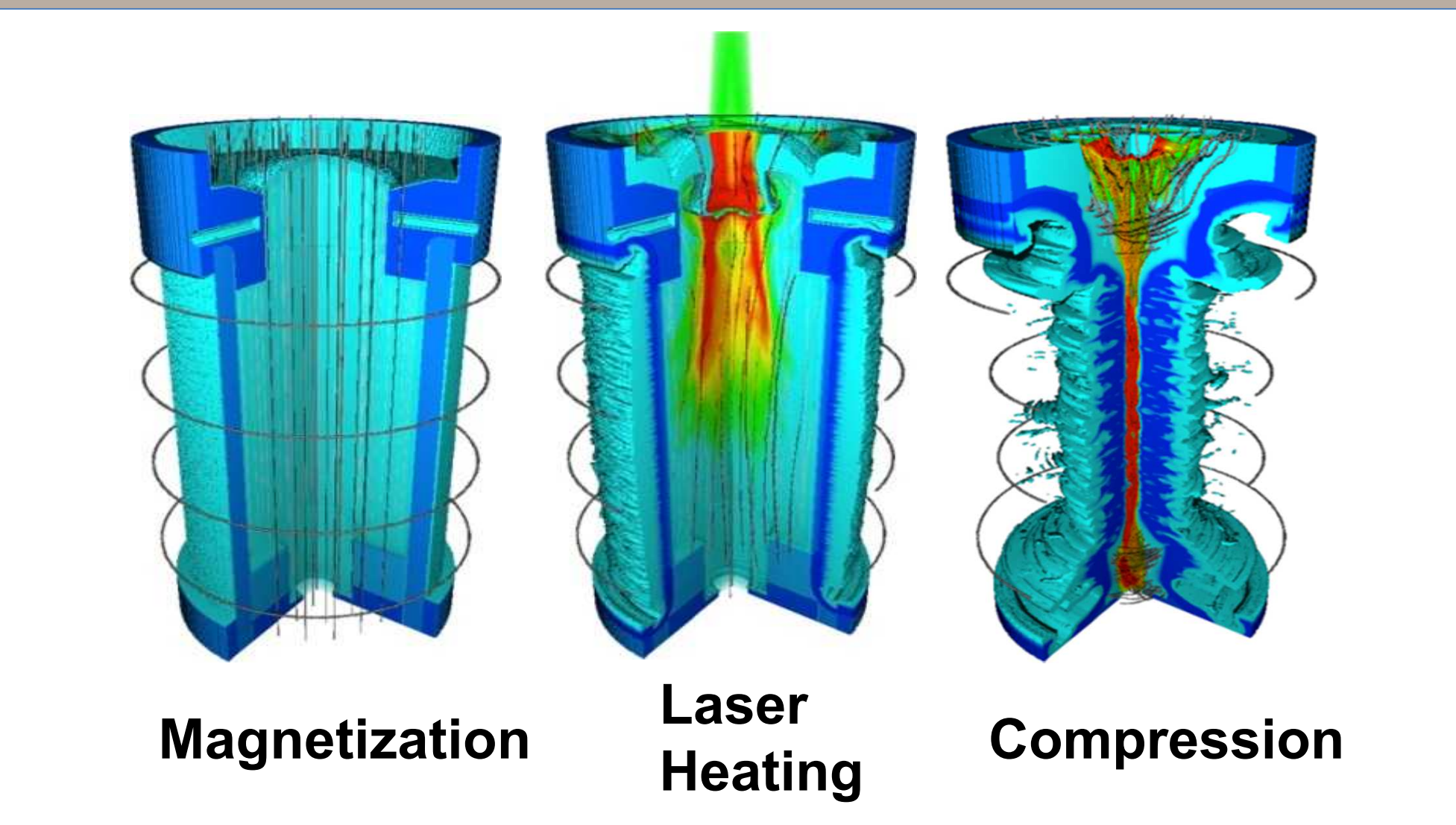
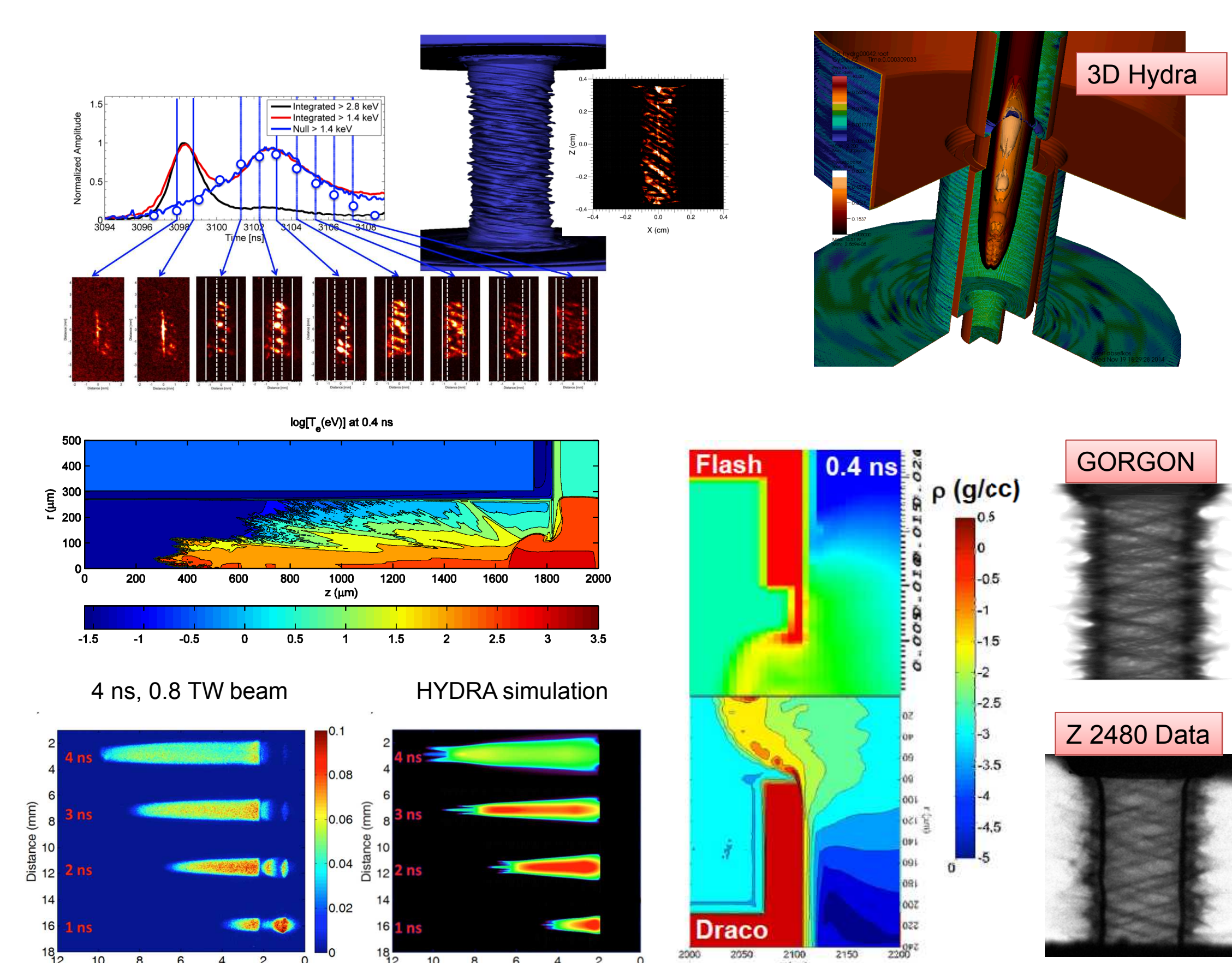
Pecos Chamber

Z-Beamlet and Z-Petawatt lasers

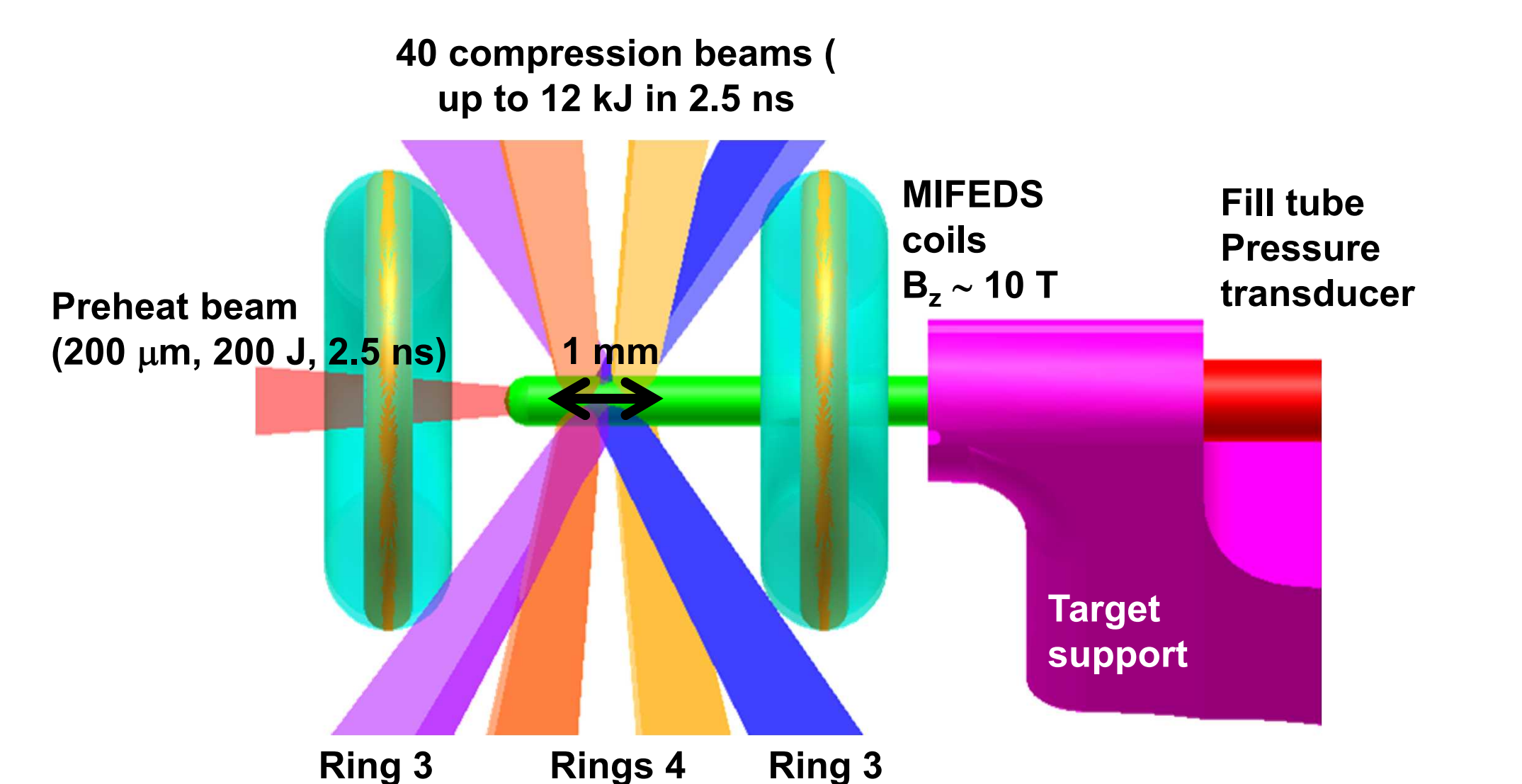
Z facility

Numerical Simulation & Modeling

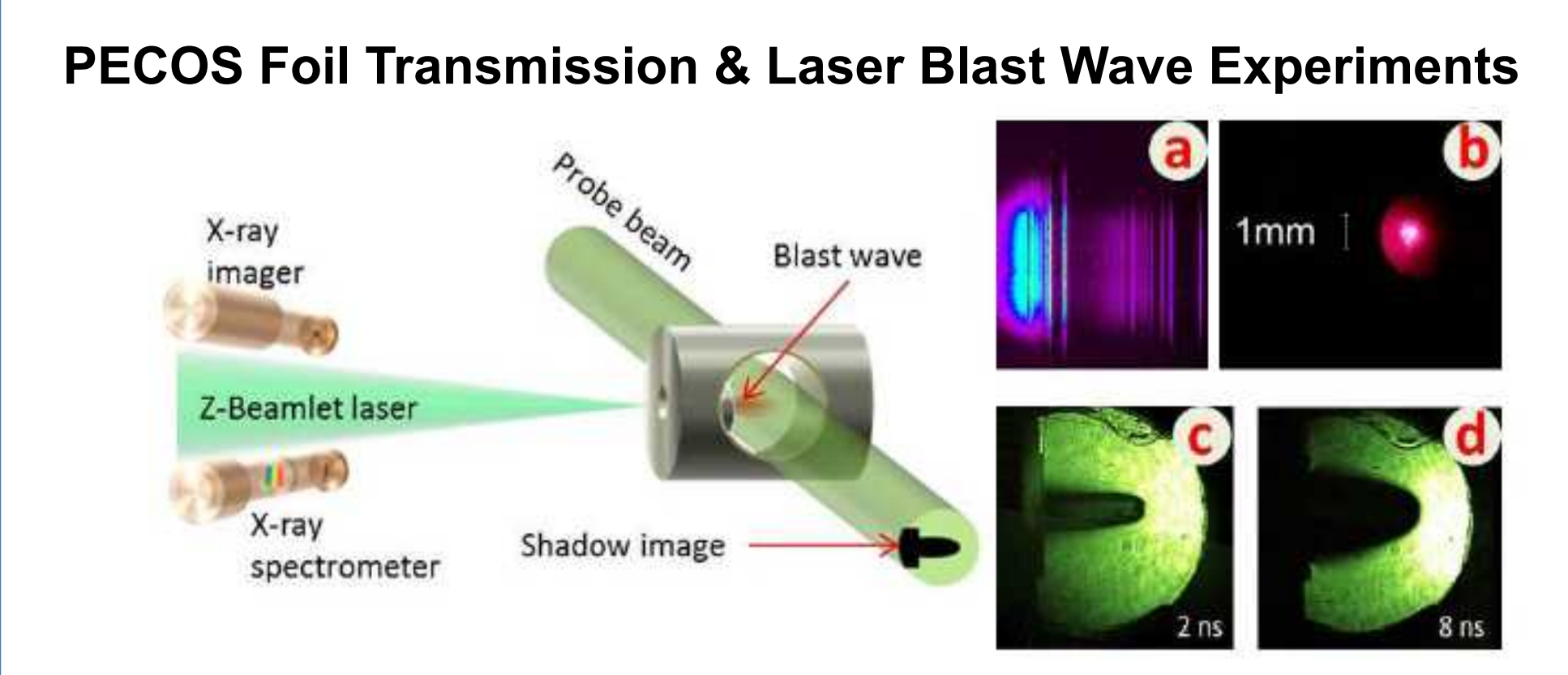
Verification & Validation of High Fidelity Simulations



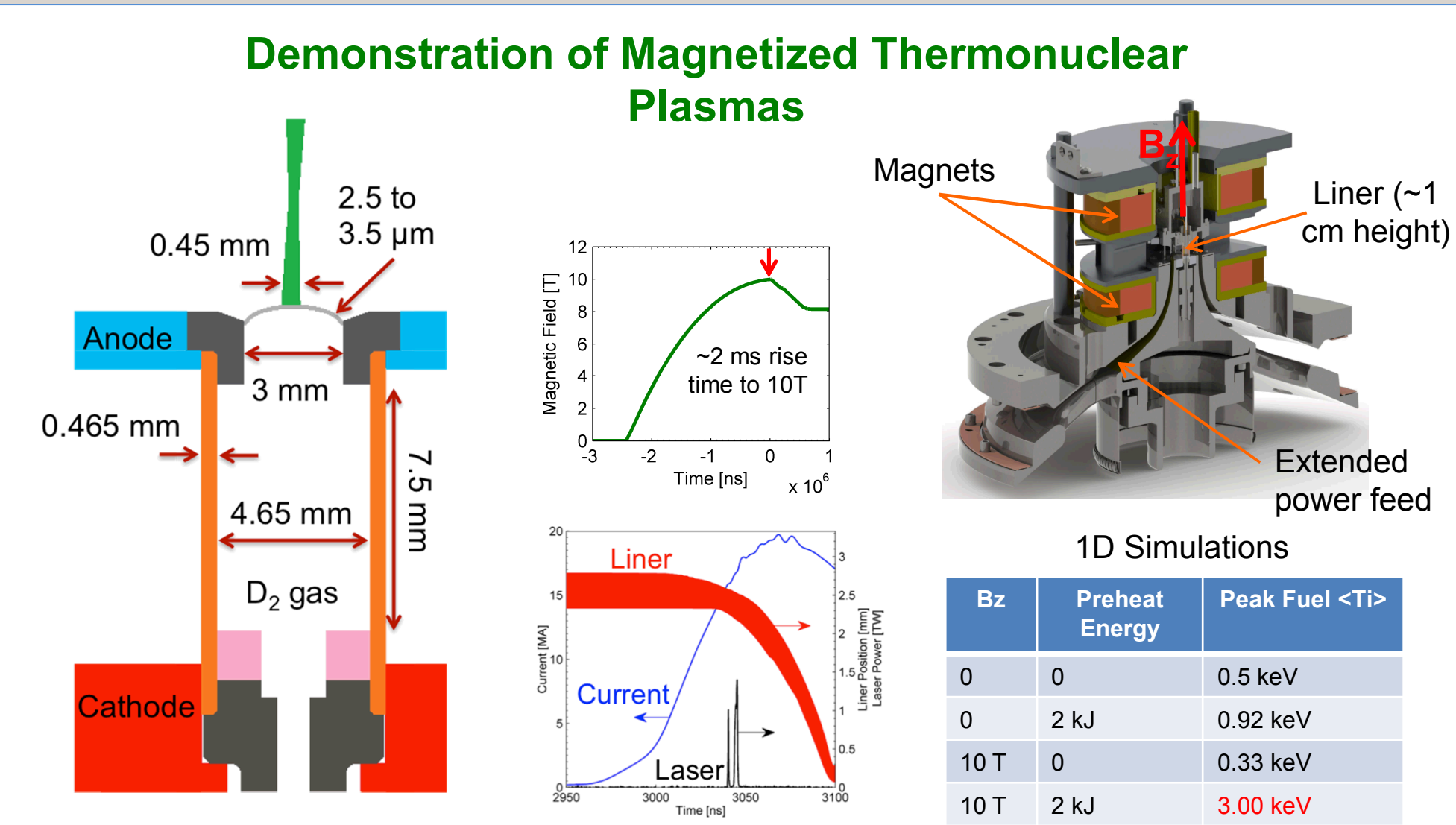
Magnetization Laser Heating Compression



40 compression beams (up to 12 kJ in 2.5 ns)
Preheat beam (200 μ m, 200 J, 2.5 ns)
MIFEDS coils $B_z \sim 10$ T
Fill tube Pressure transducer
Target support
Ring 3 Rings 4 Ring 3

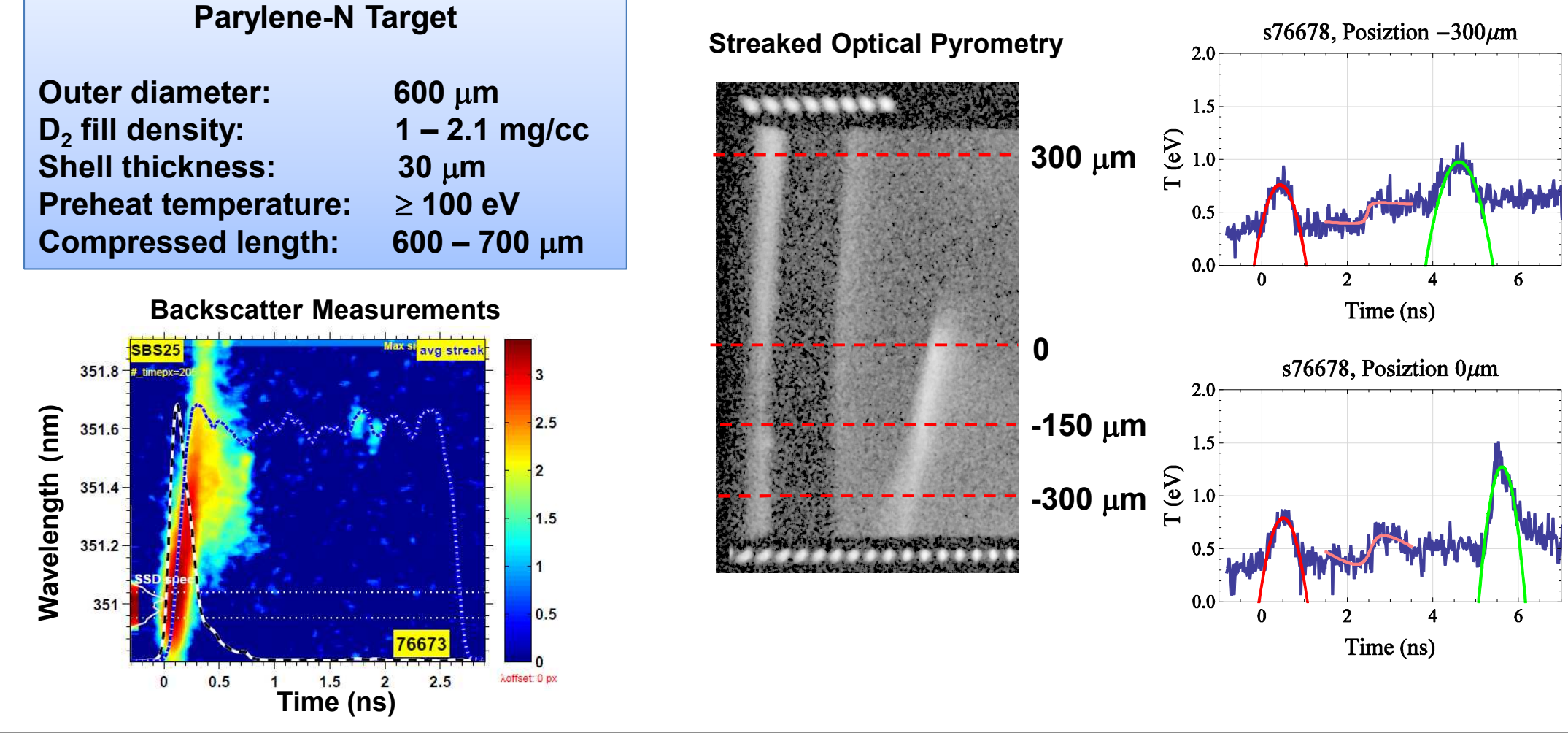


PECOS Foil Transmission & Laser Blast Wave Experiments
X-ray imager Probe beam Blast wave
Z-Beamlet laser X-ray spectrometer Shadow image
a 1mm b
c 2 ns d 8 ns

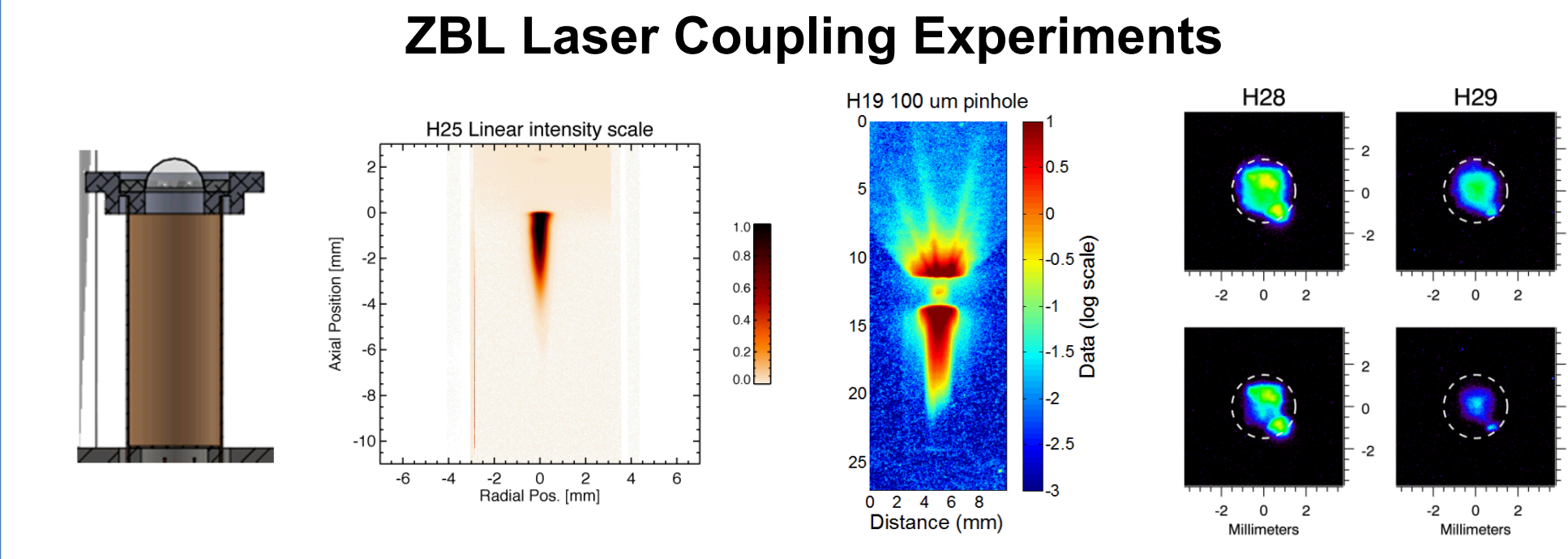


Demonstration of Magnetized Thermonuclear Plasmas

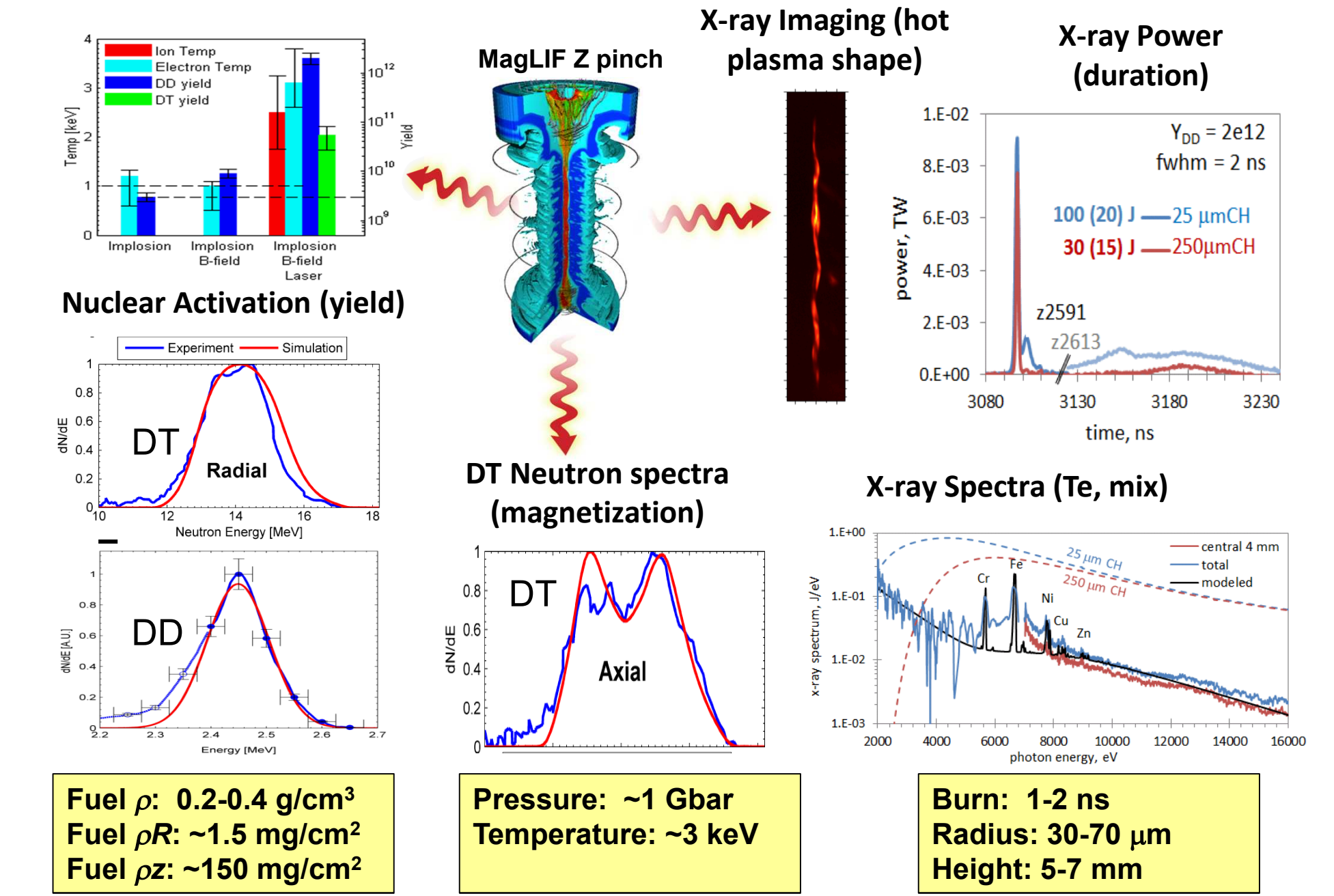
B_z	Preheat Energy	Peak Fuel $\langle T \rangle$
0	0	0.5 keV
0	2 kJ	0.92 keV
10 T	0	0.33 keV
10 T	2 kJ	3.00 keV



Parylene-N Target
Outer diameter: 600 μ m
 D_2 fill density: 1 – 2.1 mg/cc
Shell thickness: 30 μ m
Preheat temperature: ≥ 100 eV
Compressed length: 600 – 700 μ m

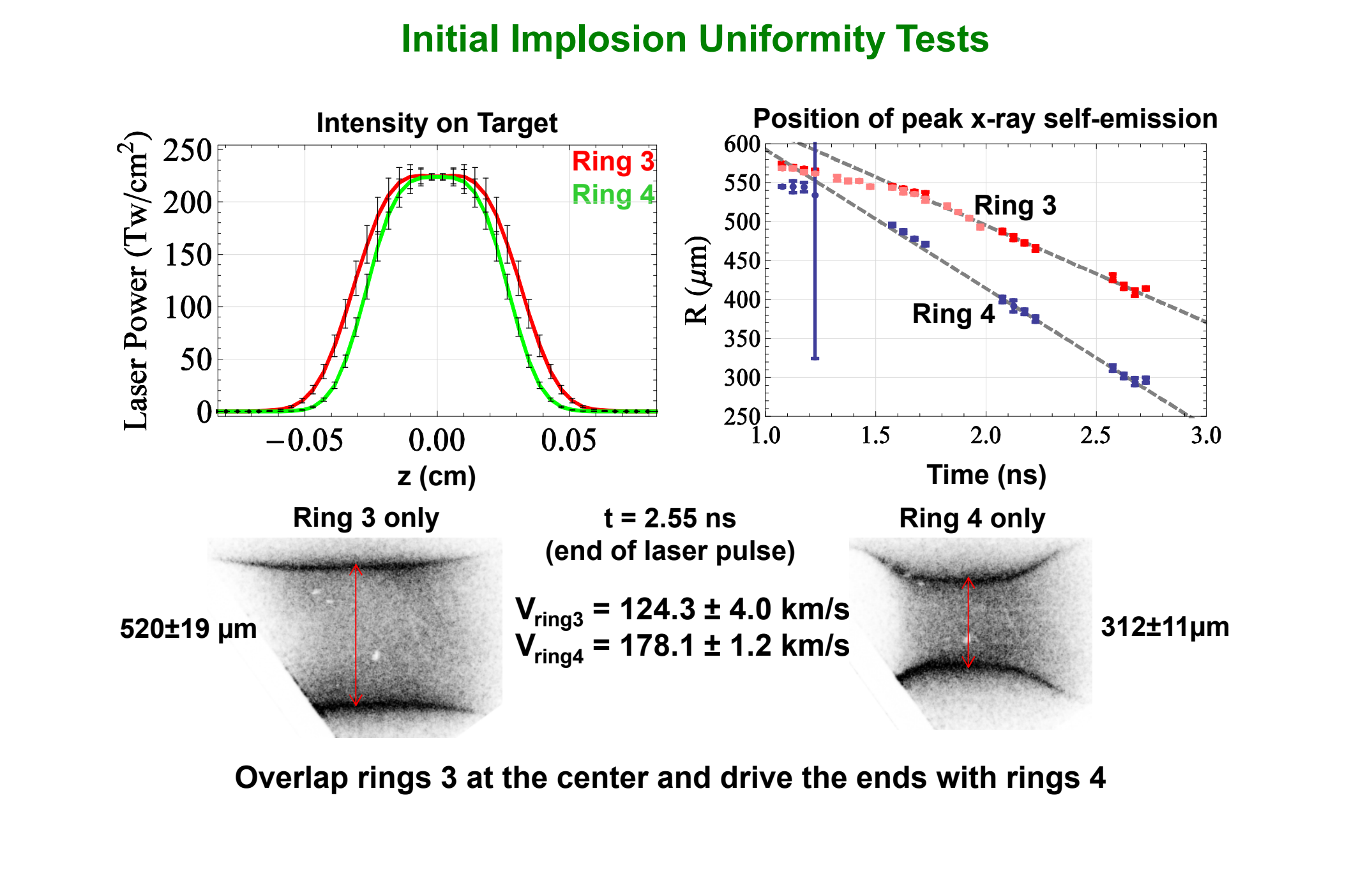


ZBL Laser Coupling Experiments
H25 Linear Intensity scale
H19 100 μ m pinhole
H28 H29

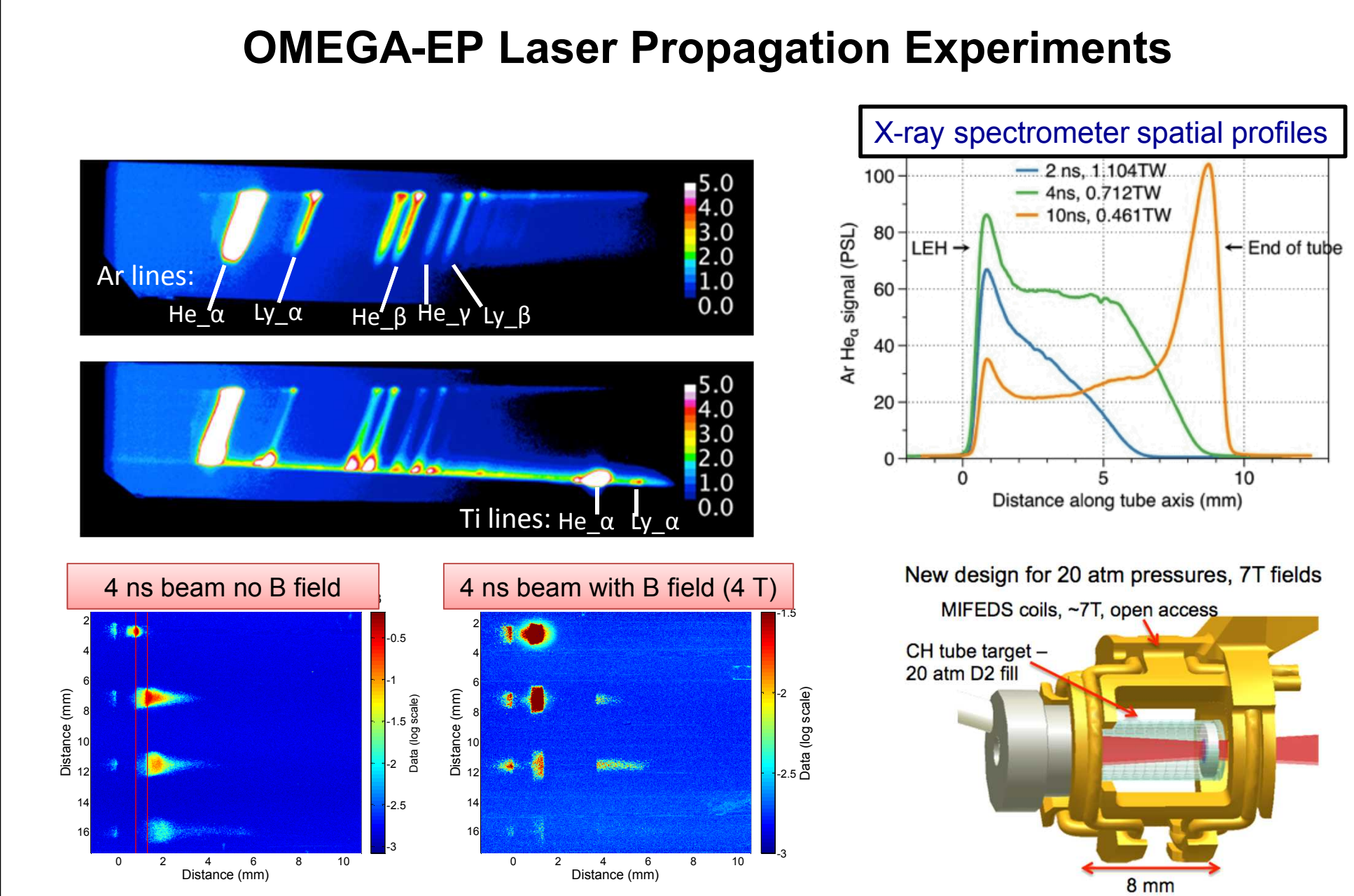


MagLIF Z pinch

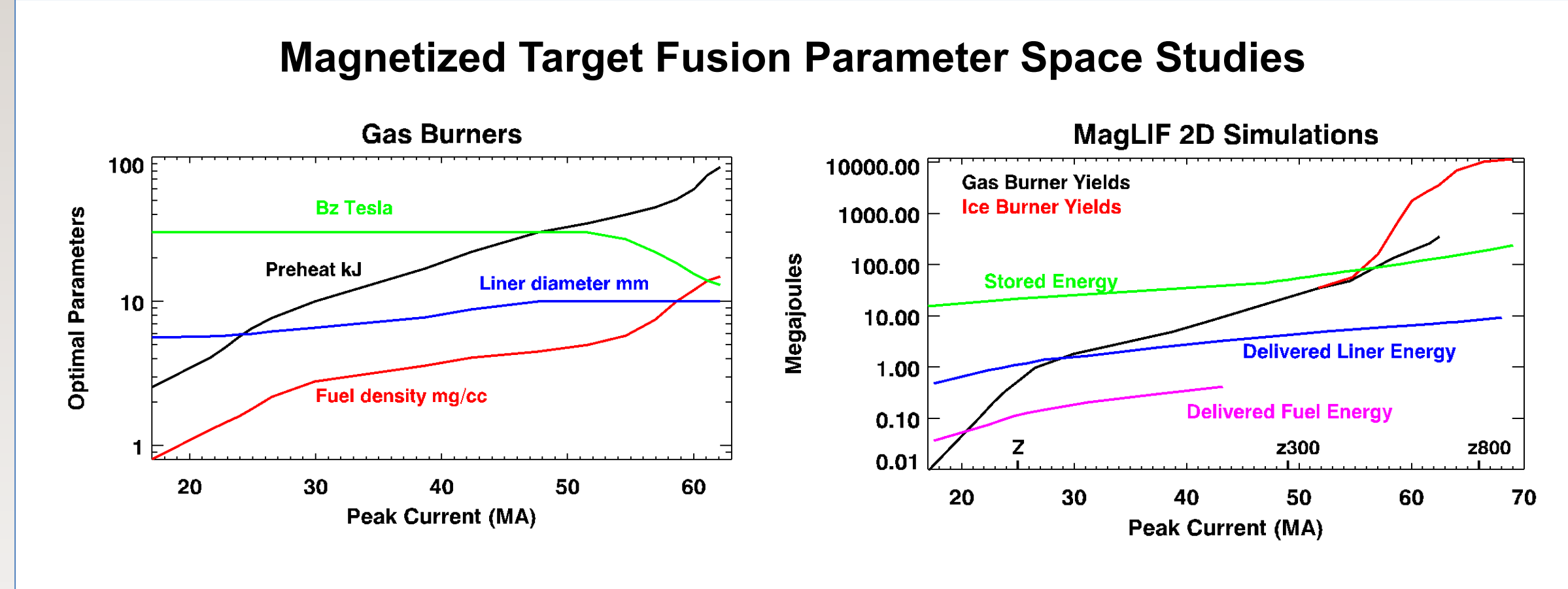
X-ray Power (duration)
 $Y_{DD} = 2 \times 10^{12}$
 $fwhm = 2$ ns
100 [20] J \rightarrow 25 μ m CH
30 [15] J \rightarrow 250 μ m CH
X-ray Spectra (T_e , mix)
Burn: 1-2 ns
Radius: 30-70 μ m
Height: 5-7 mm



Initial Implosion Uniformity Tests
Intensity on Target
Position of peak x-ray self-emission
 $t = 2.55$ ns (end of laser pulse)
 $V_{ring3} = 124.3 \pm 4.0$ km/s
 $V_{ring4} = 178.1 \pm 1.2$ km/s
520 \pm 19 μ m
312 \pm 11 μ m
Overlap rings 3 at the center and drive the ends with rings 4



OMEGA-EP Laser Propagation Experiments
X-ray spectrometer spatial profiles
Ar lines: He- α Ly- α He- β He-V Ly- β
TI lines: He- α Ly- α
4 ns beam no B field
4 ns beam with B field (4 T)
New design for 20 atm pressures, 7T fields
MIFEDS coils, -7T, open access
CH tube target - 20 atm D_2 fill



Magnetized Target Fusion Parameter Space Studies

Gas Burners
MagLIF 2D Simulations
Optimal Parameters
Peak Current (MA)
Preheat kJ
Liner diameter mm
Fuel density mg/cc
Delivered Liner Energy
Delivered Fuel Energy
Gas Burner Yields
Ice Burner Yields
Stored Energy

Project Goals & Milestones

- Target pre-conditioning experiments (Z, ZBL, OMEGA, OMEGA-EP)
- Demonstrate a set of functional laser pre-heating parameters (laser pulse shape, focal spot size, window thickness) to provide >1 kJ of laser heating to the fusion fuel in an integrated MagLIF shot on Z.
- Determine the time-dependent T_e history in a Z MagLIF experiment
- Laser-driven MagLIF experiments (OMEGA)
- Confirm effective (>100 eV) and low mix preheat
- Symmetrically implode cylindrical target containing preheated fuel with 10 kJ/cm of kinetic energy
- Demonstrate >30% increase in T_e (as compared to unmagnetized target) in axially symmetric target compression over >0.6 mm length
- Numerical Modeling & Theory (Sandia, U. Rochester)
- Results for integrated OMEGA experiments agree with Flash and Hydra to within 20% of key observables and 2x in yield
- Report on key dependencies across the MIF parameter space for generalized scaling laws, and highlight most promising regimes. Analysis to include both near-term and long-term fusion power cases

- Provides much needed credibility to MIF concepts and simulation models as alternative to MCF and ICF.
- Motivates new investments in MTF and IFE technologies