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# Investigating at-scale MagLIF preheat on the NIF

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LLNL-PRES-XXXXXX

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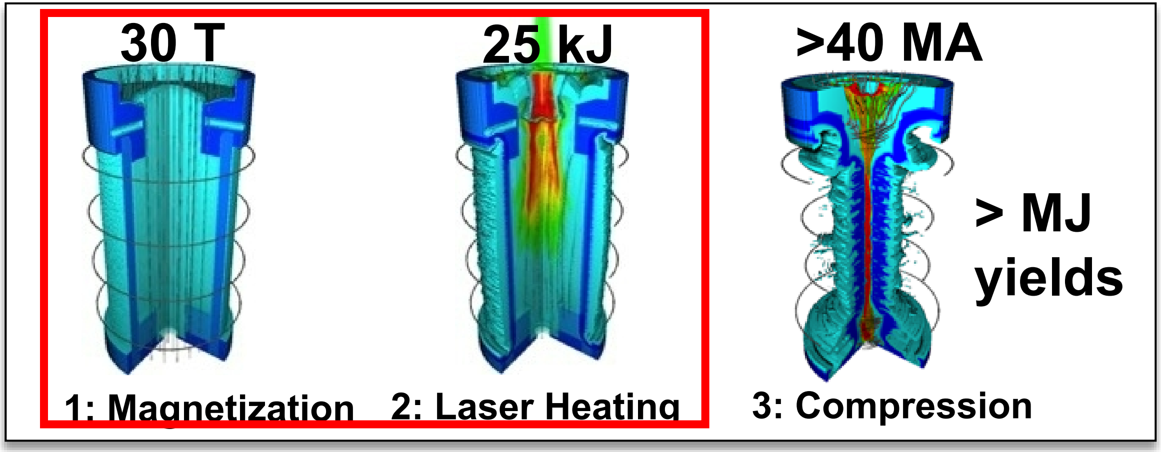
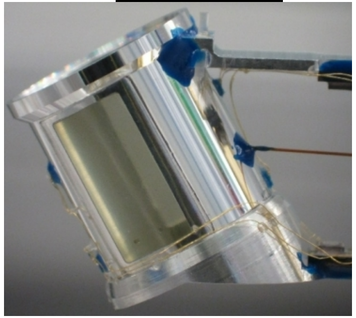
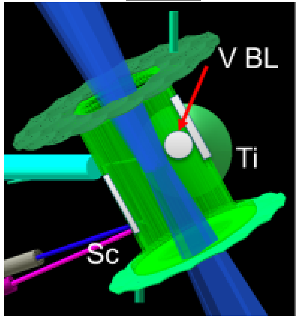
# NIF is uniquely capable of addressing preheat scaling to next-gen pulsed power facilities for MagLIF




Cryo $D_2$

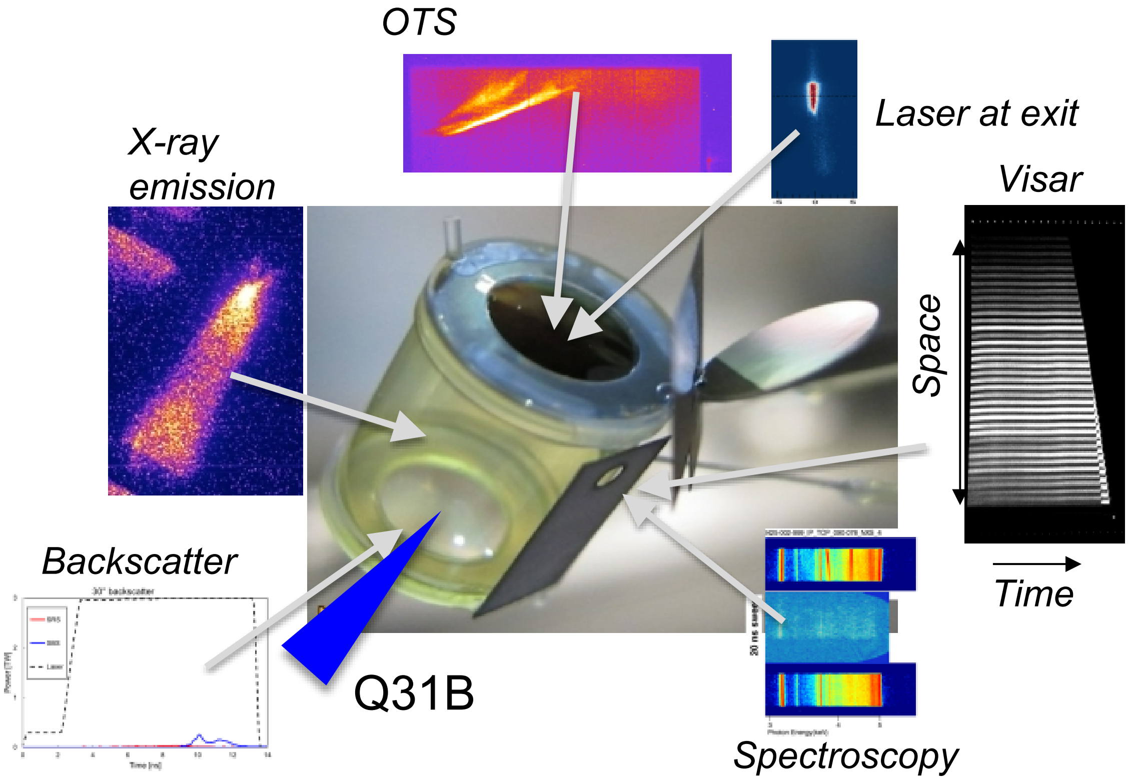


Mix




- Achieving high level goals reduces risks for scaled MagLIF:
  - Assess viability of laser preheating as a scaling path for magnetized liner inertial fusion (MagLIF)
  - Determine laser requirements for next-gen pulsed-power facility
  - Assess our capability to model preheat “at-scale” and address deficiencies in our codes
- This project is called out in the 2020 ICF report as key to addressing MDD scaling risks

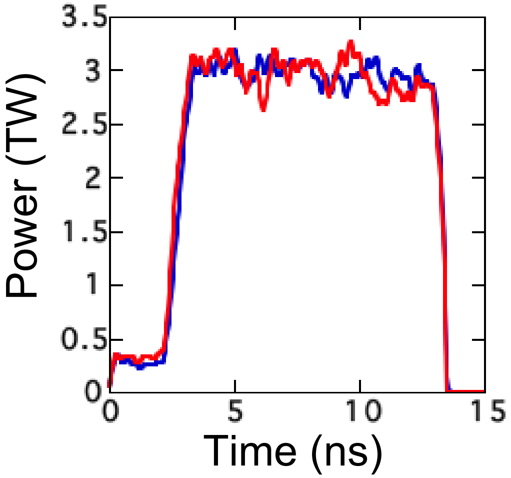
# The extensive suite of NIF diagnostics enables experimental studies of many physics processes relevant to MagLIF



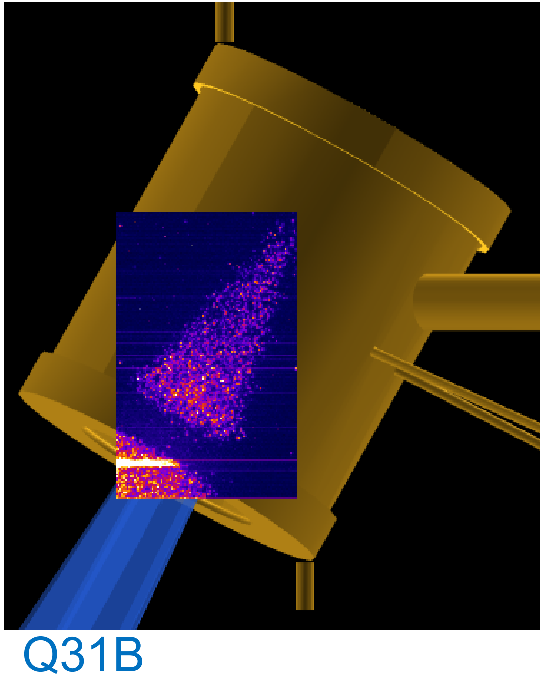

- LPI and laser energy coupling
  - BS and laser propagation
  - Laser transmission
  - Visar
- Thermal conduction and heat transport
  - X-ray imaging
  - Spectroscopy
  - OTS
- Impurity transport
  - Spectroscopy

# These full-scale gas pipe targets are driven by a single quad of NIF, delivering ~35 kJ of laser energy to the target

N200310-001 (11.5% crit)
N200310-002 (15% crit)

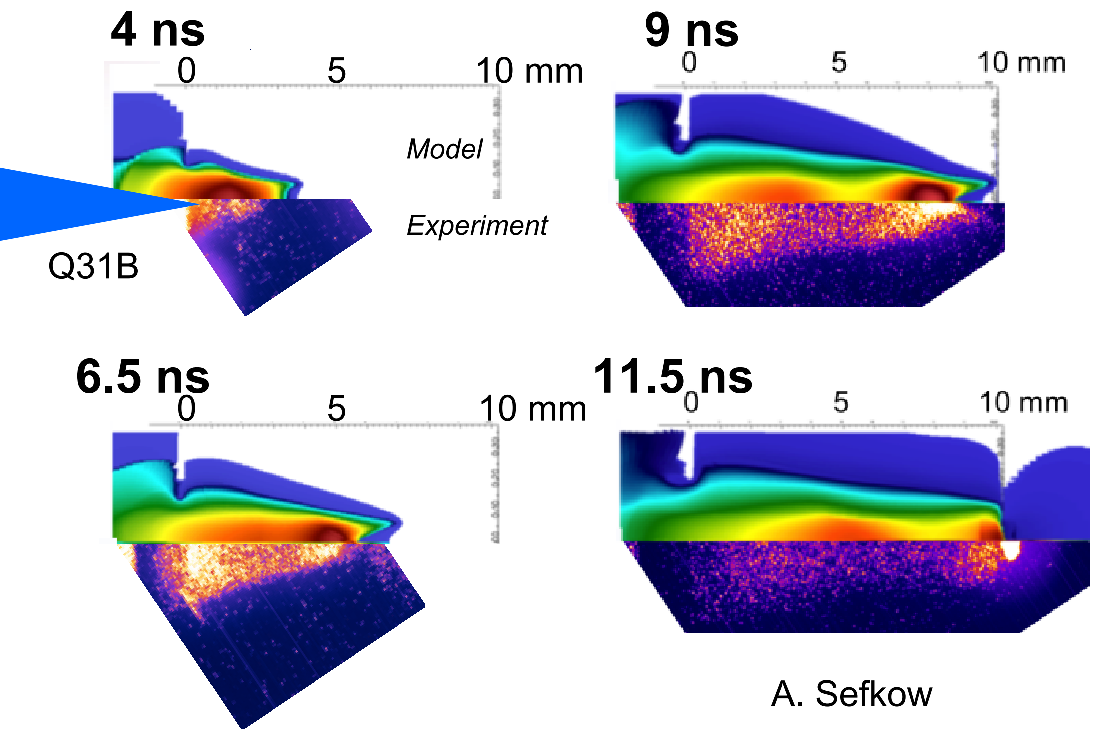



View from GXD in 90-315




- 1 cm-long epoxy gas pipe cylinder
- 150 um wall thickness
- 1-1.4 atm C5H12/C3H8 (with 1% Ar)
- 1.5 um thick kapton windows
- 1.2x1.6 mm laser spot from CPP
- Emission imaged onto x-ray framing cameras

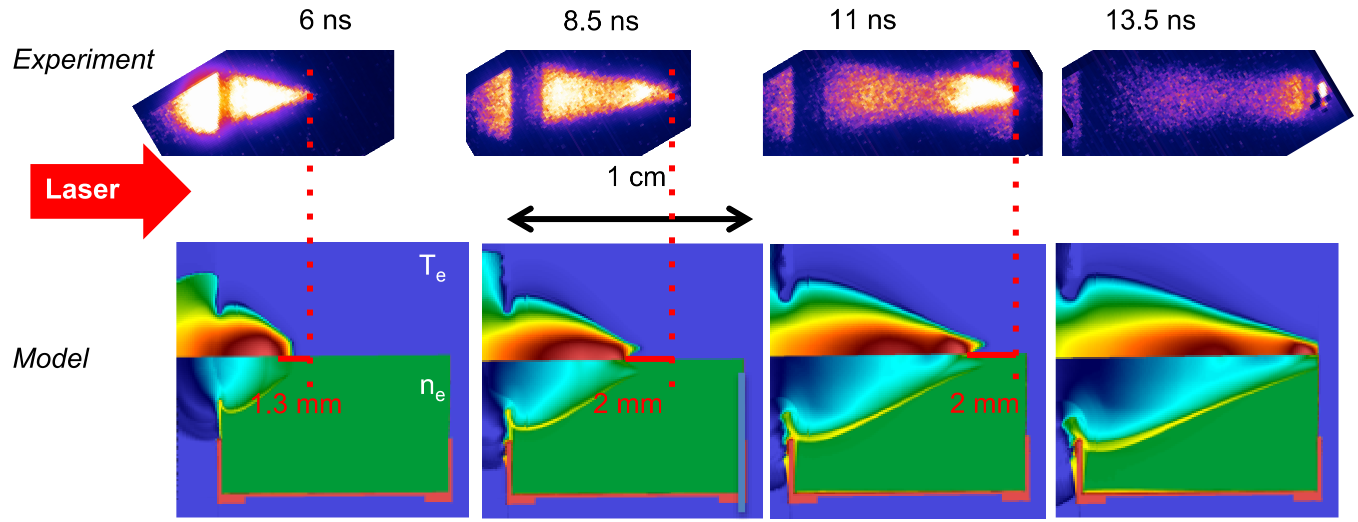
# The laser propagation at 11.5% $n_{crit}$ in $C_5H_{12}$ is in good agreement with 2D HYDRA simulations




A. Sefkow

- Measurements of the time required for the laser to burn through the target bound the energy coupled
- For these conditions, the laser burnthrough is ~10.8 ns, and the energy coupling is ~24 kJ
- This includes energy into the plasma and the entrance window

# At 15% $n_{crit}$ the data leads these simulations for the entire propagation

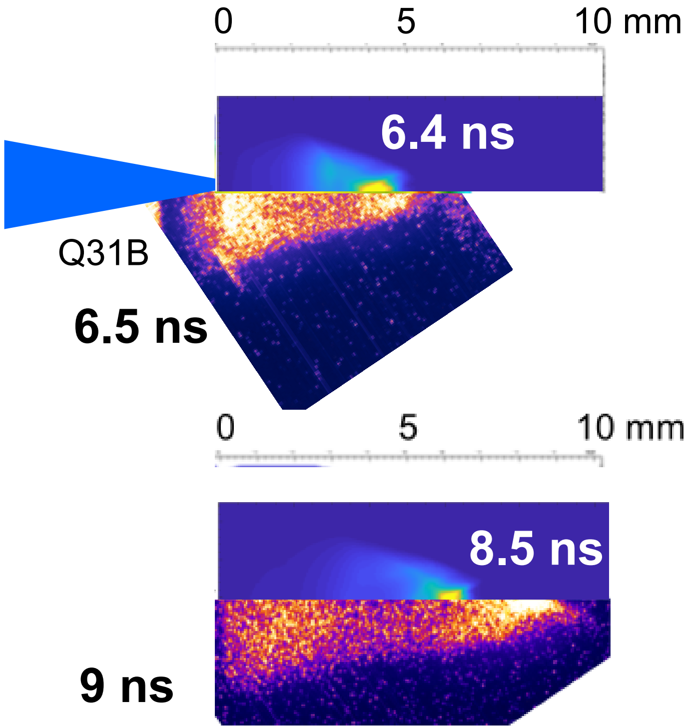



- At this density the laser burnthrough is delayed to 12.9 ns, with ~31 kJ of energy coupling

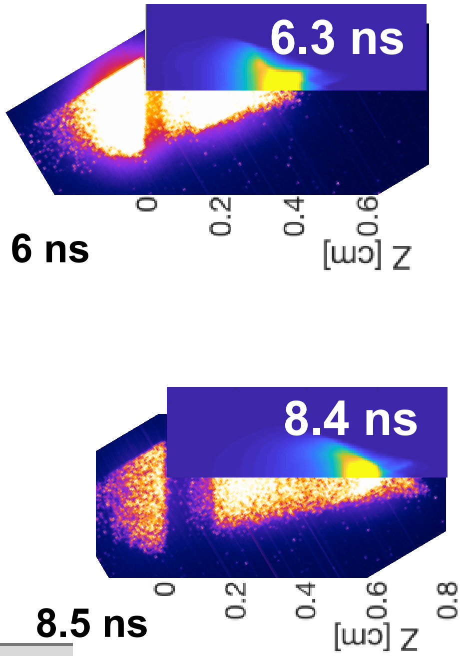
The choice of flux limiter is unable to compensate for these discrepancies

# Recent 3D simulations better match the propagation at high density, but not at low density

**11.5%**

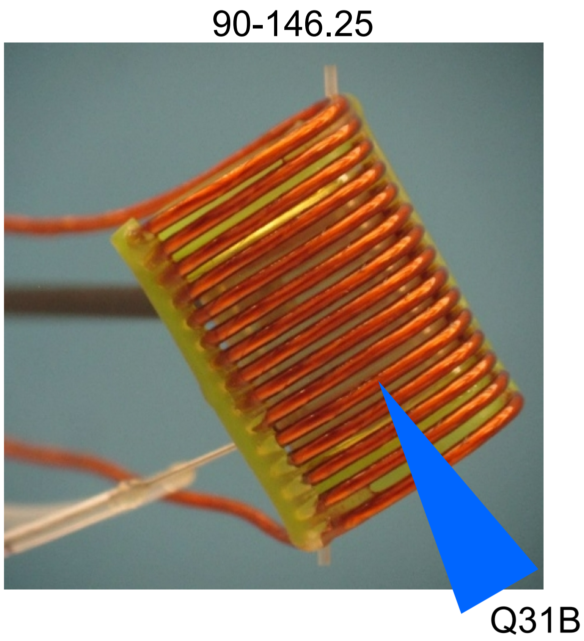


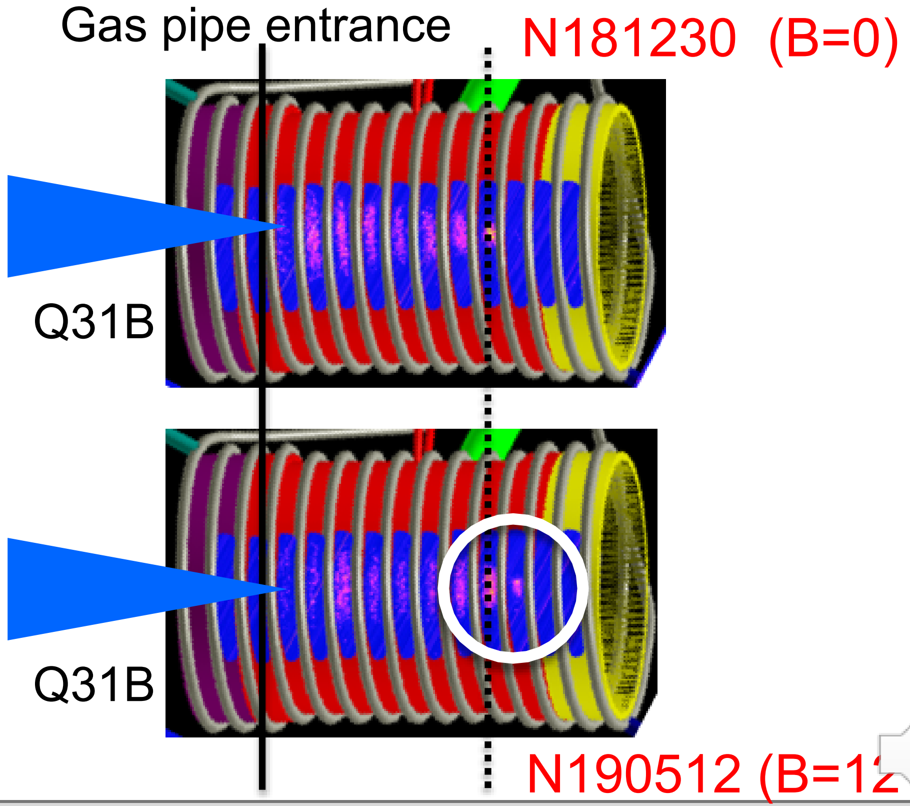

**15%**



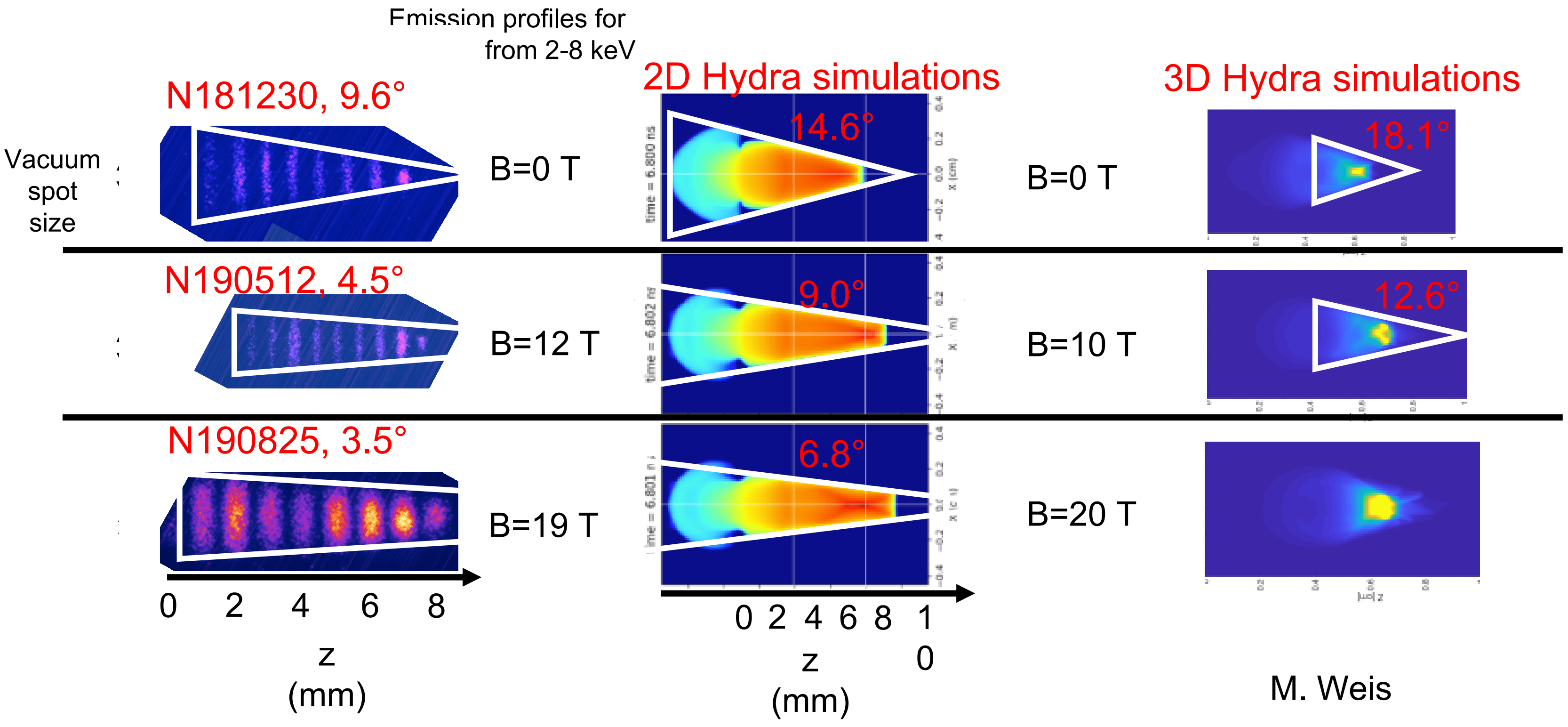

M. W

# Pre-imposed axial magnetic fields up to 24 T have also been applied for both fill densities

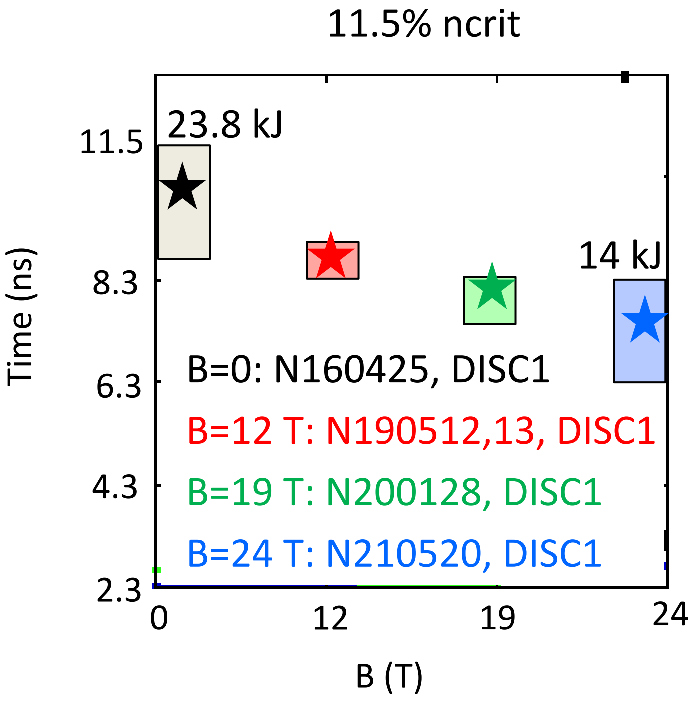


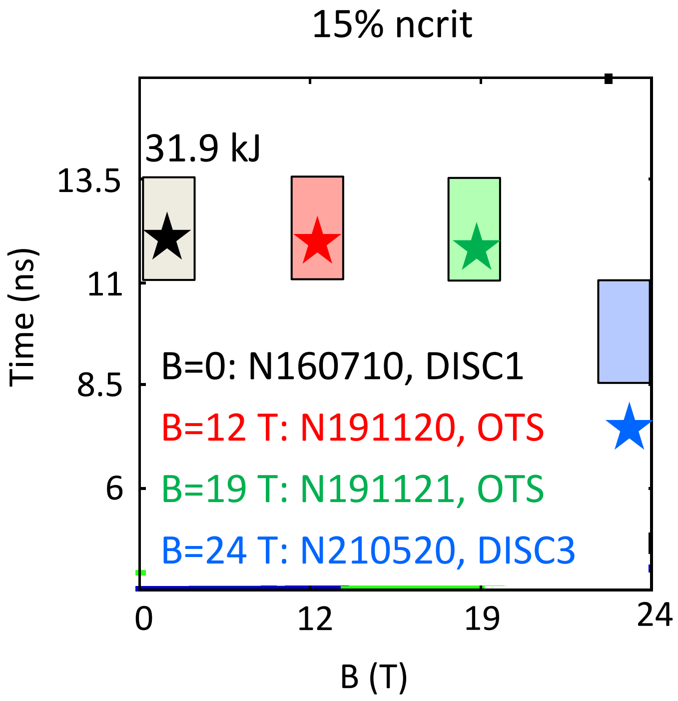



# The emission profile becomes more cylindrical with B-fields applied, consistent with 2D r-z and 3D Hydra simulations



# The burnthrough time is more significantly reduced with increasing B-field for 11.5% than for 15% density

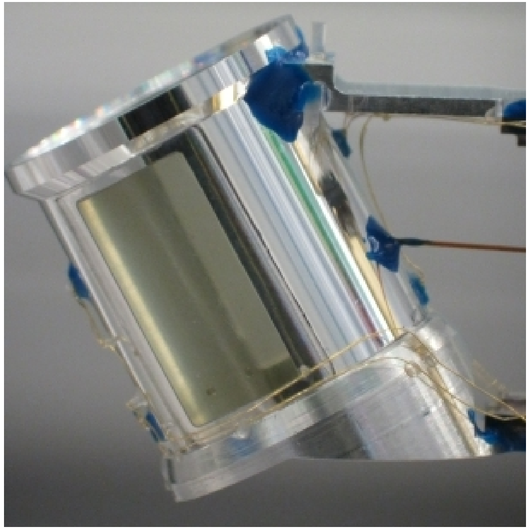


# The at-scale MagLIF pre-heat experiments at NIF are showing good energy coupling in warm hydrocarbons

- In FY22 we will be emphasizing a cryogenic version of the target with D2 fills up to 5 mg/cc
- The combination of B-fields and cryo targets at NIF is being developed, likely available in FY23
- Additional measurements of energy coupling using Visar with and without B-fields are underway (Glinsky 2O-C-02)
- Studies of material mixing from the windows and the walls are also being performed (Tubman 2O-C-03)

Cryogenic targets with D2 fills



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