Direct-Drive Fuel Assembly Experiments with Fast-Ignitor Cone Targets on OMEGA

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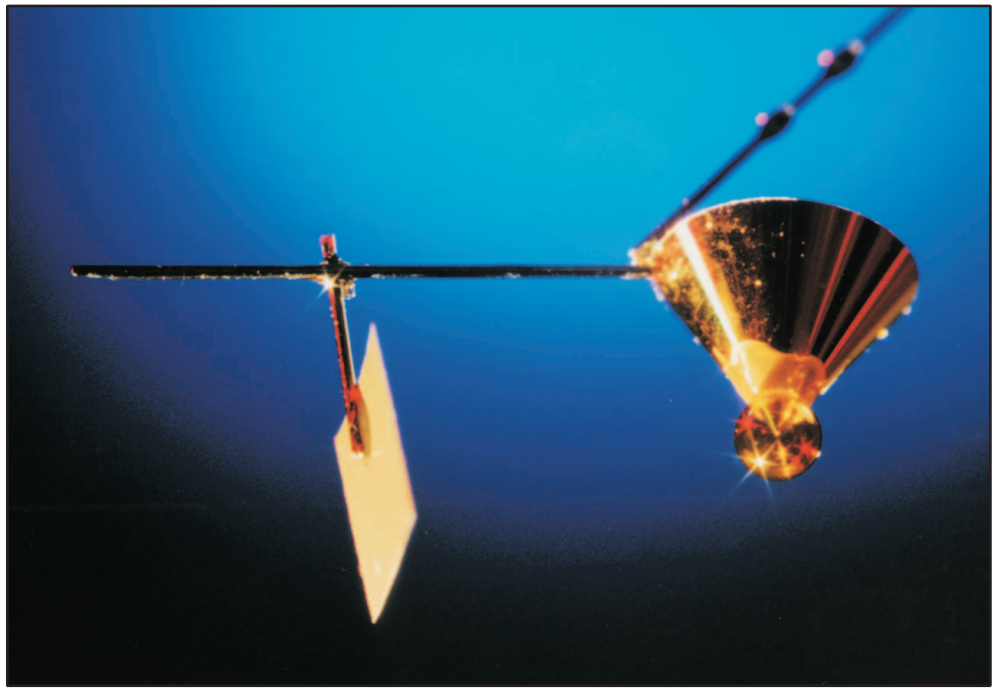
GENERAL ATOMICS

MIT

ILE OSAKA



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Summary

A substantial fraction of the expected core areal density was measured in fast-ignitor cone experiments

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- Gas-tight, direct-drive, cone-in-shell fast-ignitor targets, filled with up to 10 atm of D_2 or D^3He, were used to study fuel assembly.
- Time-resolved backlit images of the fuel assembly were obtained on a x-ray framing camera (XRFC) using a V or Fe backlighter.
- The downshift of the primary D^3He protons was used to estimate the assembled total areal density.
- Both the backlit images and the proton downshift data indicate an areal density of approximately 60 mg/cm^2.
- The measured total areal density is more that 50% of the 1-D calculated areal density of an equivalent spherical shell.

The two viable fast-ignition concepts share fundamental issues: hot-electron production and transport to the core

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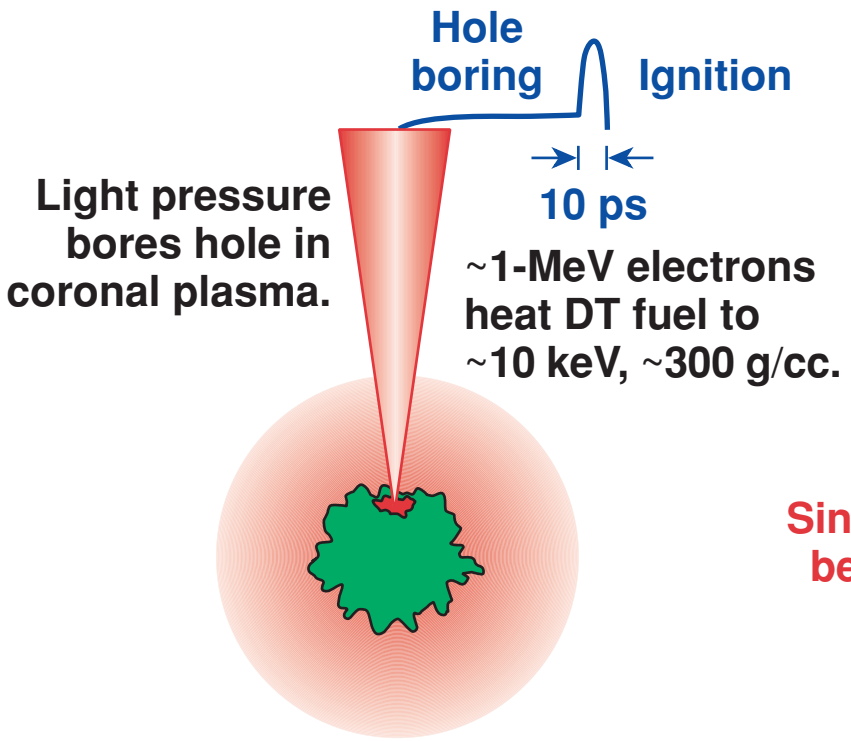
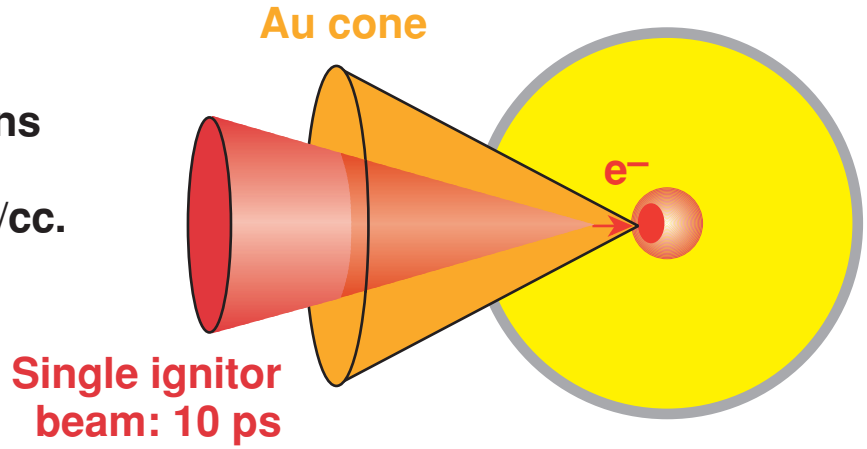
Channeling Concept



Cone-Focused Concept



E11710d

Gas-tight targets were developed to be able to use nuclear diagnostics for areal-density measurements

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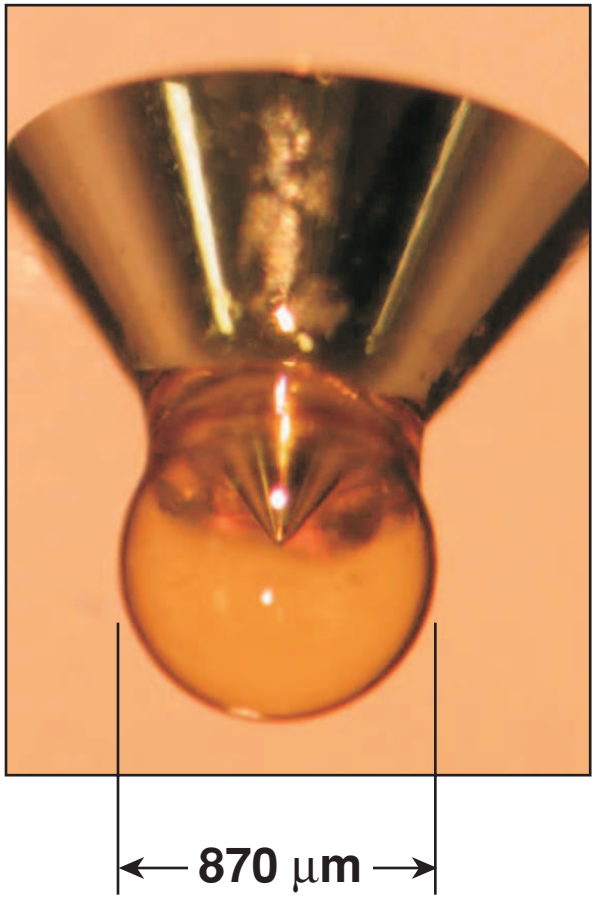
- 870-μm OD shell
- 24-μm wall
- ~10 atm D_2 or D^3He fill
- 35° half-angle gold cone
- Backlighting
  - 35 beams, 12 kJ, 1 ns on target
  - 15 beams, 6 kJ, 1 ns on backlighter
- Areal-density measurements
  - 55 beams, 22 kJ, 1 ns on target



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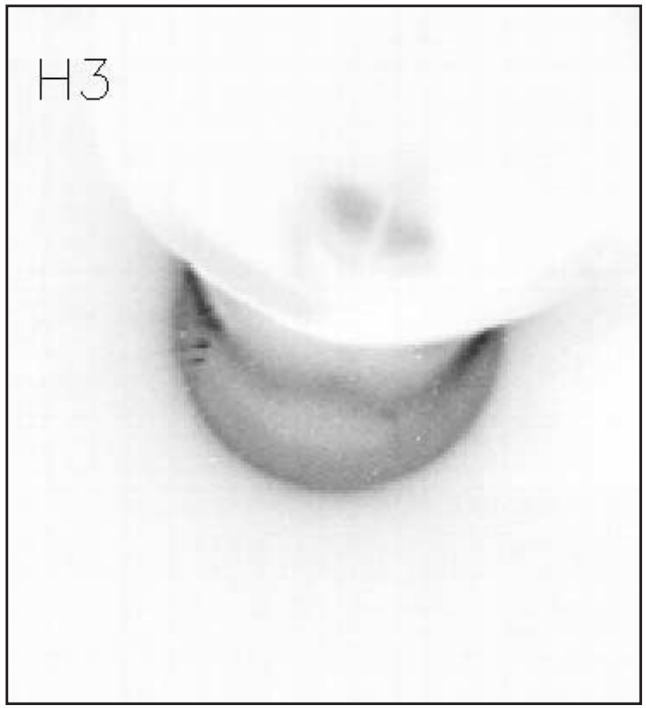
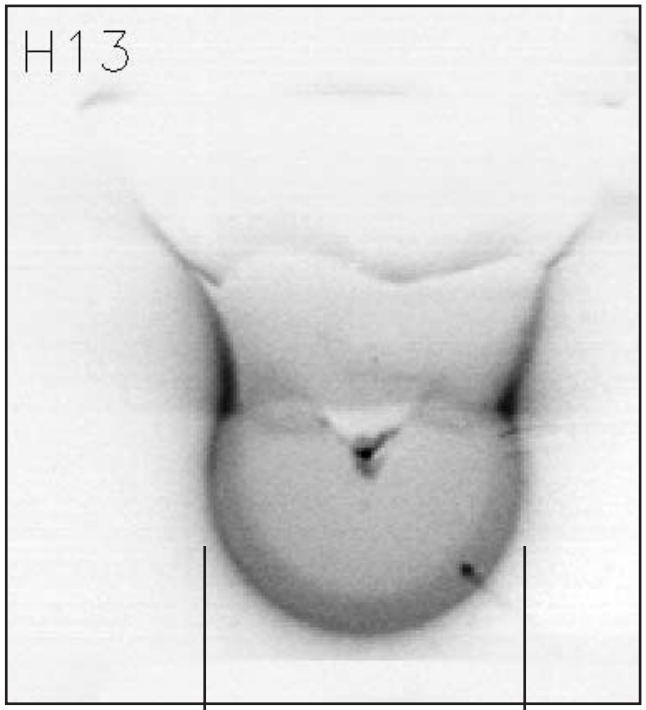
Time-integrated x-ray pinhole camera images show the effect of the glue joint

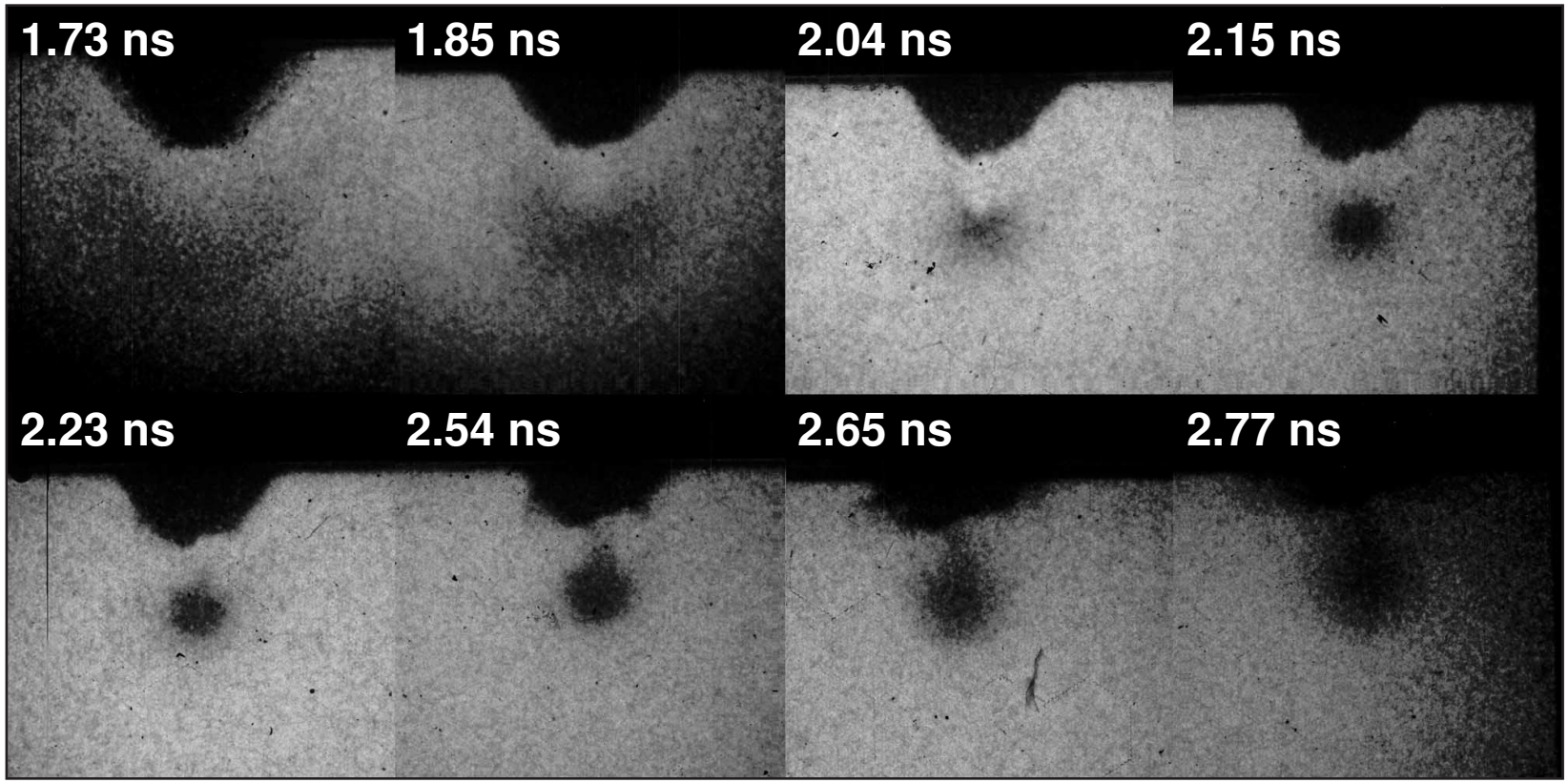




Shot 32381, D_2 fill,
yield = 6.23×10^6

E12574

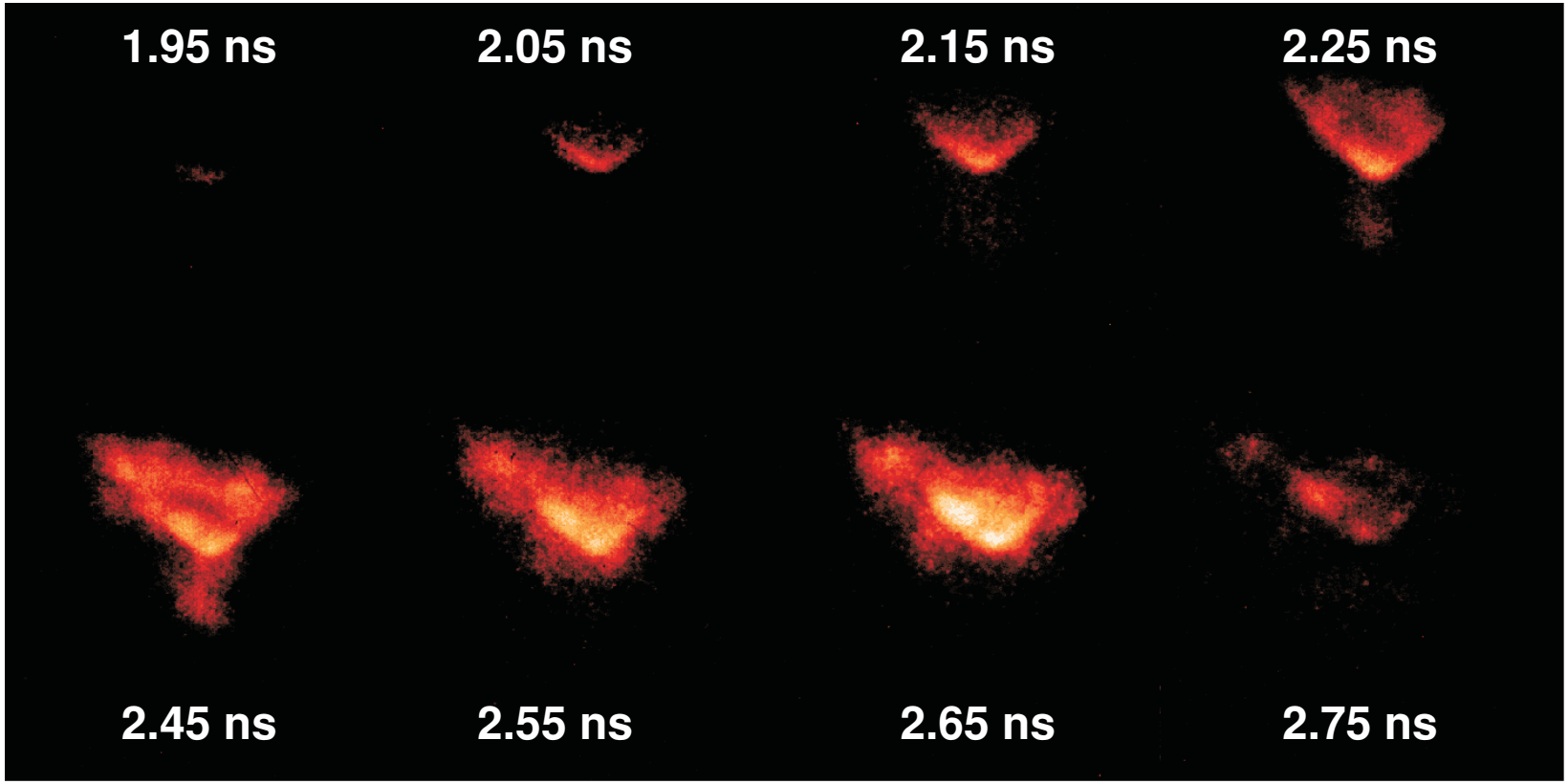
The backlit framing camera images show the core assembly and cone reaction in great detail



Shot 32381, V backlighter, D_2 fill,
yield = 6.23×10^6

E12558

The framing camera images in self-emission show the cone lighting up first



Shot 32387, D_2 fill, yield = 1.72×10^7,
logarithmic intensity scale

200 μm

E12559

The size of the dense core as seen in the backlit images can be used to infer the areal density

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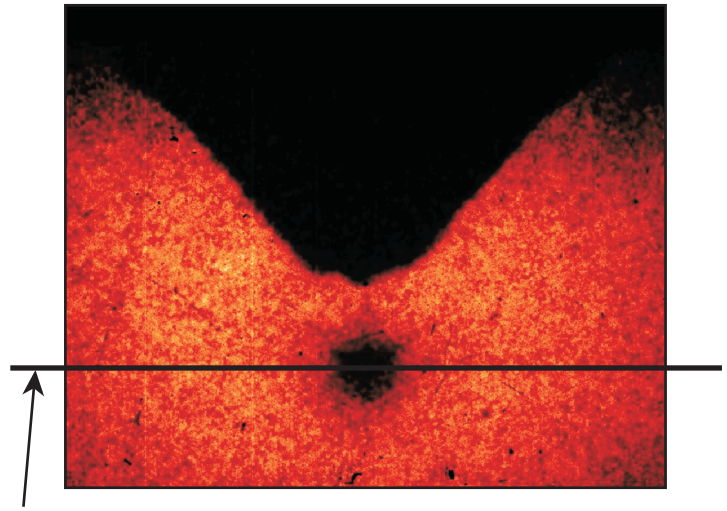
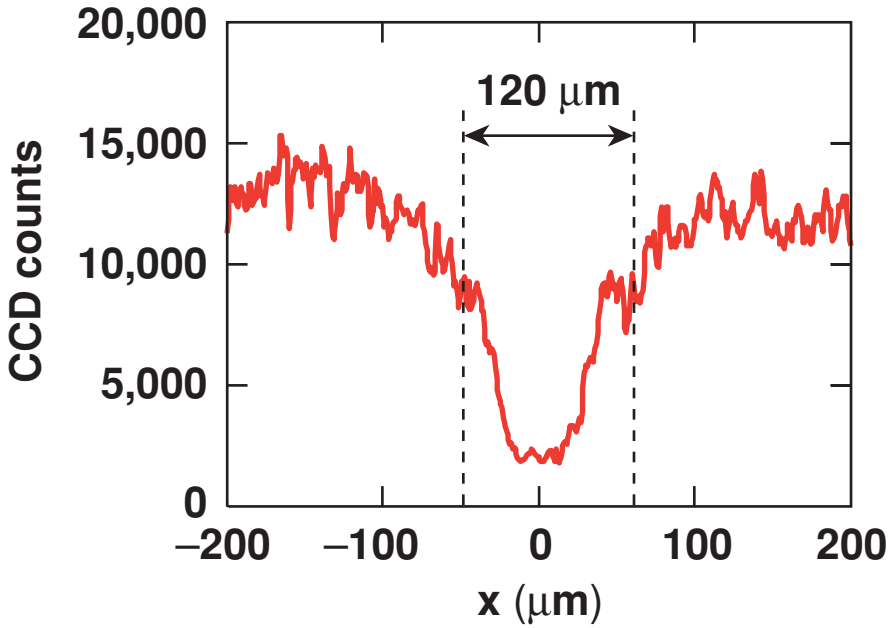
Backlit image



Lineout

Lineout



Areal density: $\rho R = CR^2 \times \rho R_0 \times \eta_{abl} \cong 60\ mg/cm^2$

$$CR = \frac{D_{init}}{D_{final}} = \frac{820\ \mu m}{120\ \mu m}$$

Convergence ratio

$\rho R_0 = 2.4\ mg/cm^2$

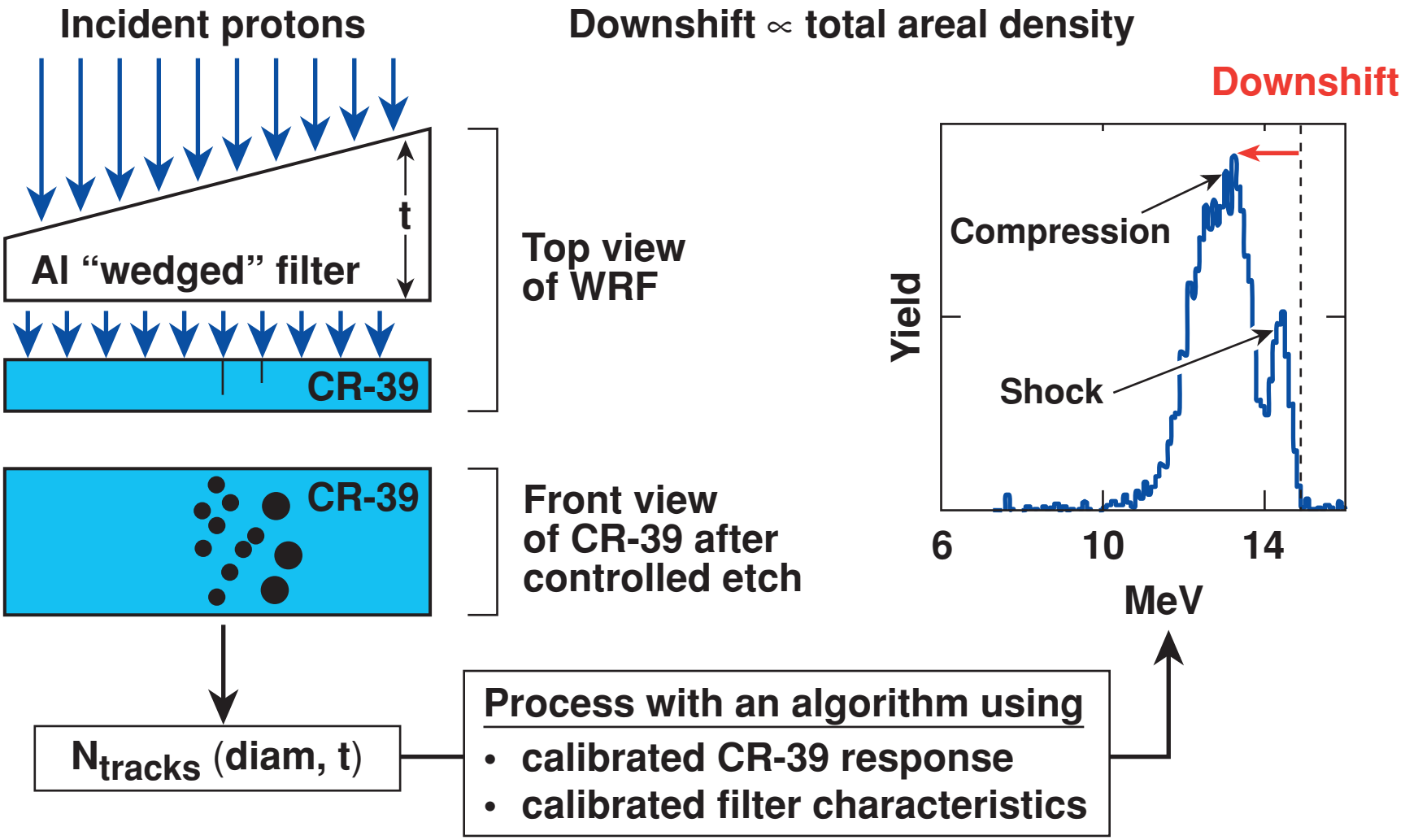
Initial areal density

$\eta_{abl} = 0.5$

Ablation fraction

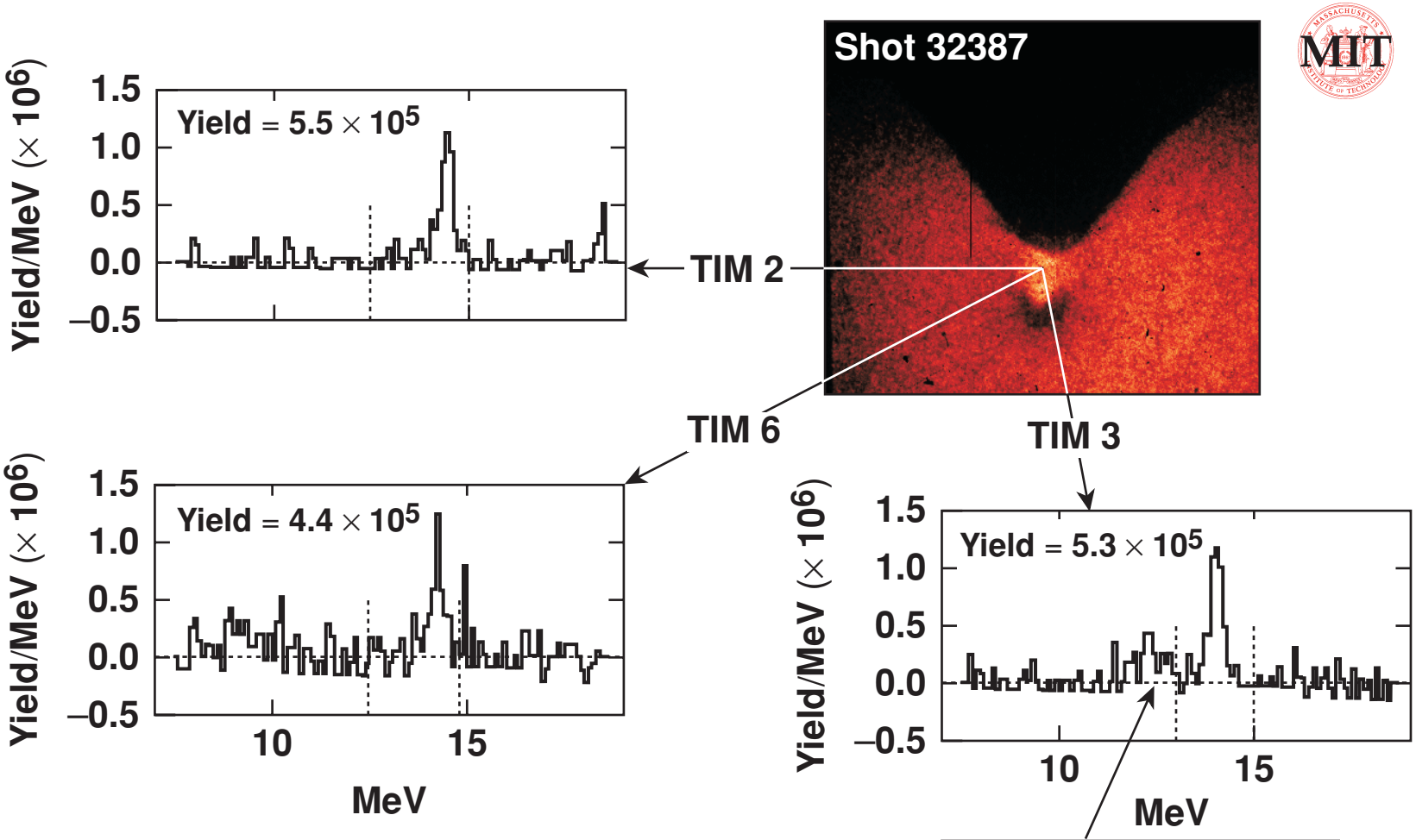
E12680

"Wedged-range-filter" spectrometers (WRF's) record the primary D^3He proton spectrum to measure areal density



E12685

A total areal density of ~60 mg/cm^2 can be inferred from the primary D^{3}He proton spectrum



Shot 32425, D^{3}He fill, yield = 8.48 × 10^7

E12686

Summary/Conclusions

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