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Low density plasma experiments investigating laser propagation and proton acceleration

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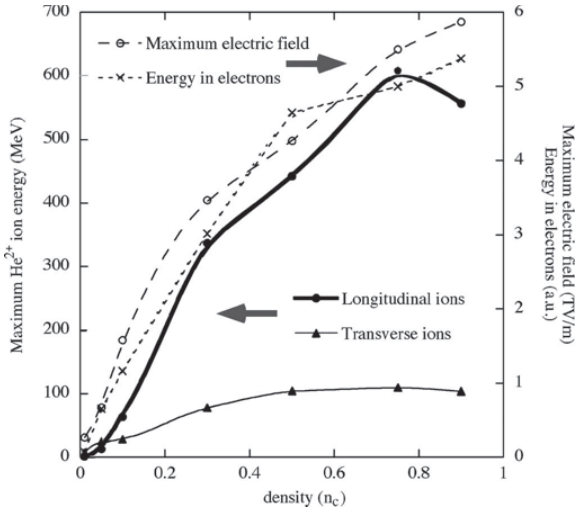
Motivation

- Laser propagation and channeling in near critical densities is important for the **hole boring fast ignition scheme**
- Ion acceleration at near-critical densities has been shown to be an interesting regime for producing **high energy ion beams**



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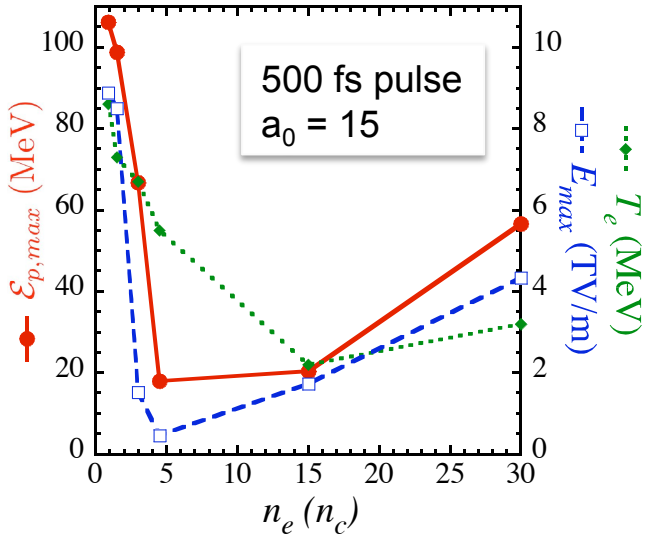
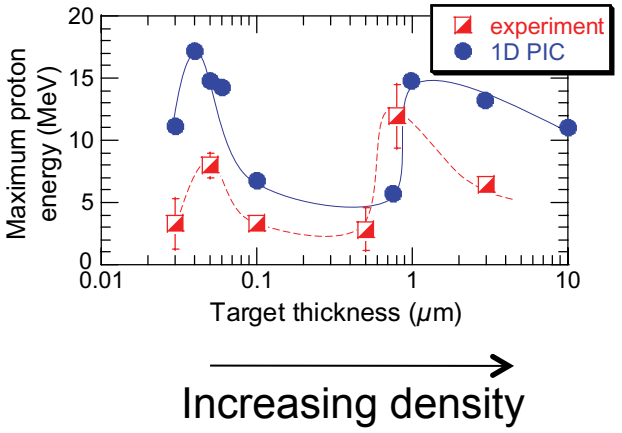


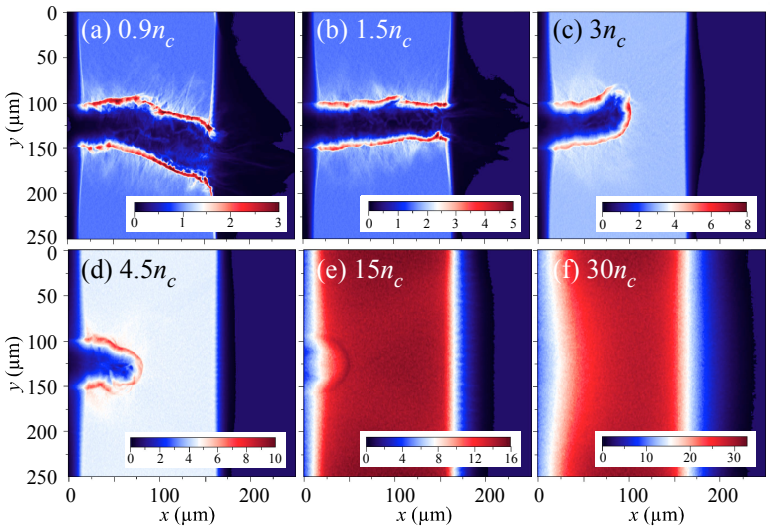
L Willingale *et al*, PRL, **102**, 125002 (2009)

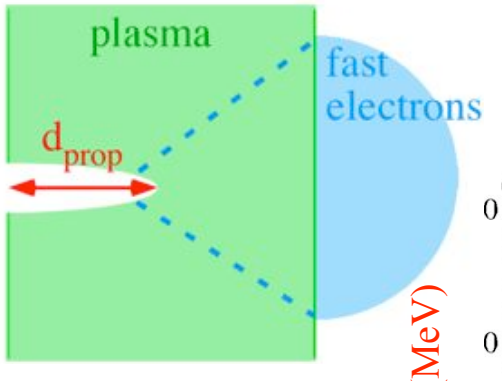


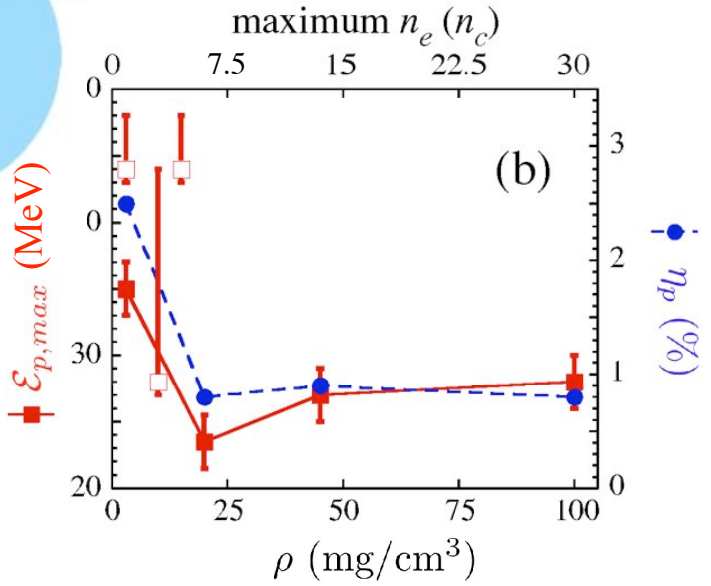
P Antici *et al*, New Journal of Physics, **11**, 023038 (2009)

Previous work – using proton acceleration to diagnose laser propagation

- Vulcan experiments investigated laser propagation in the relativistic transparent regime, a_0 = 35, (500 J, τ_L = 600 fs, 5 μm focal spot) using proton acceleration as a diagnostic.







Increasing plasma density = decreasing propagation distance

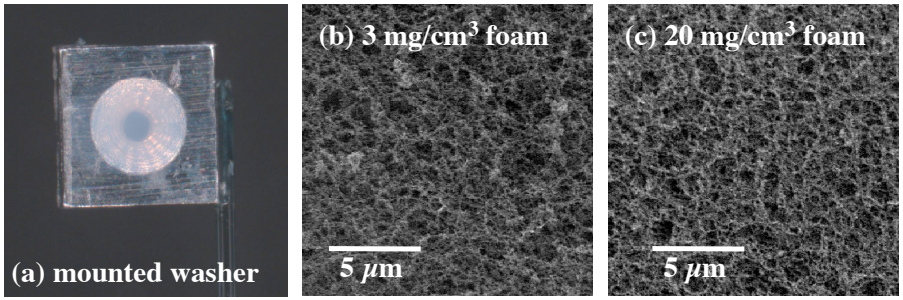
=> Less proton acceleration

- Omega EP experiment is lower intensity, a_0 = 3, but longer pulse length, τ_L = 10 ps, where hole boring through the plasma is expected to be important for the channel formation and laser propagation.

Experimental setup

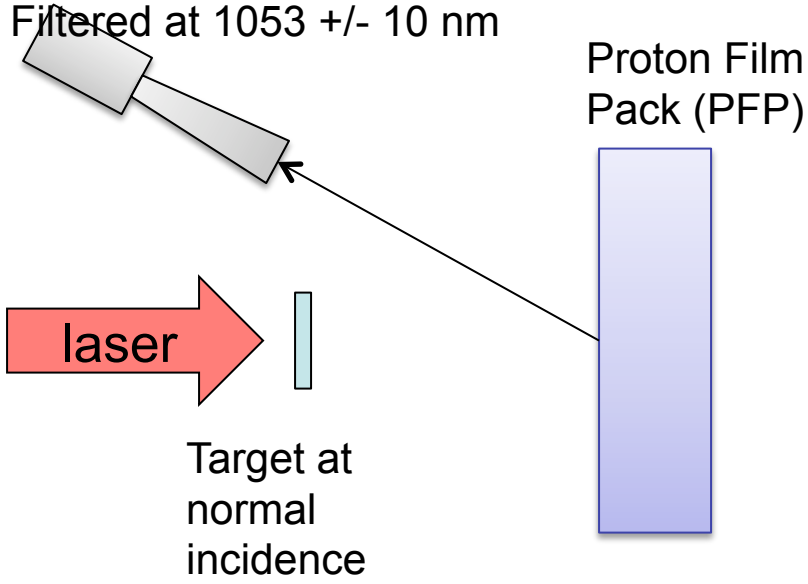
Targets:
Low density foam, CHO
Mounted in 1mm x 1mm x 250μm washers
Made by Wigen Nazarov

Backlighter beam: 1000 J, 10 ps
Focus: 80% of energy within 22 μm radius
Peak intensity = 1.3 X 10^{19} Wcm^{-2}
$a_0 \approx 3$



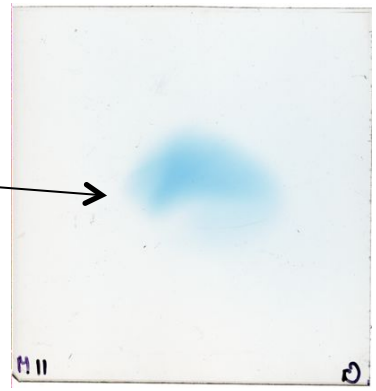
Foam density (mg/cc)	n_e (n_c)
3	0.9
10	3
20	6
45	13.5
100	30

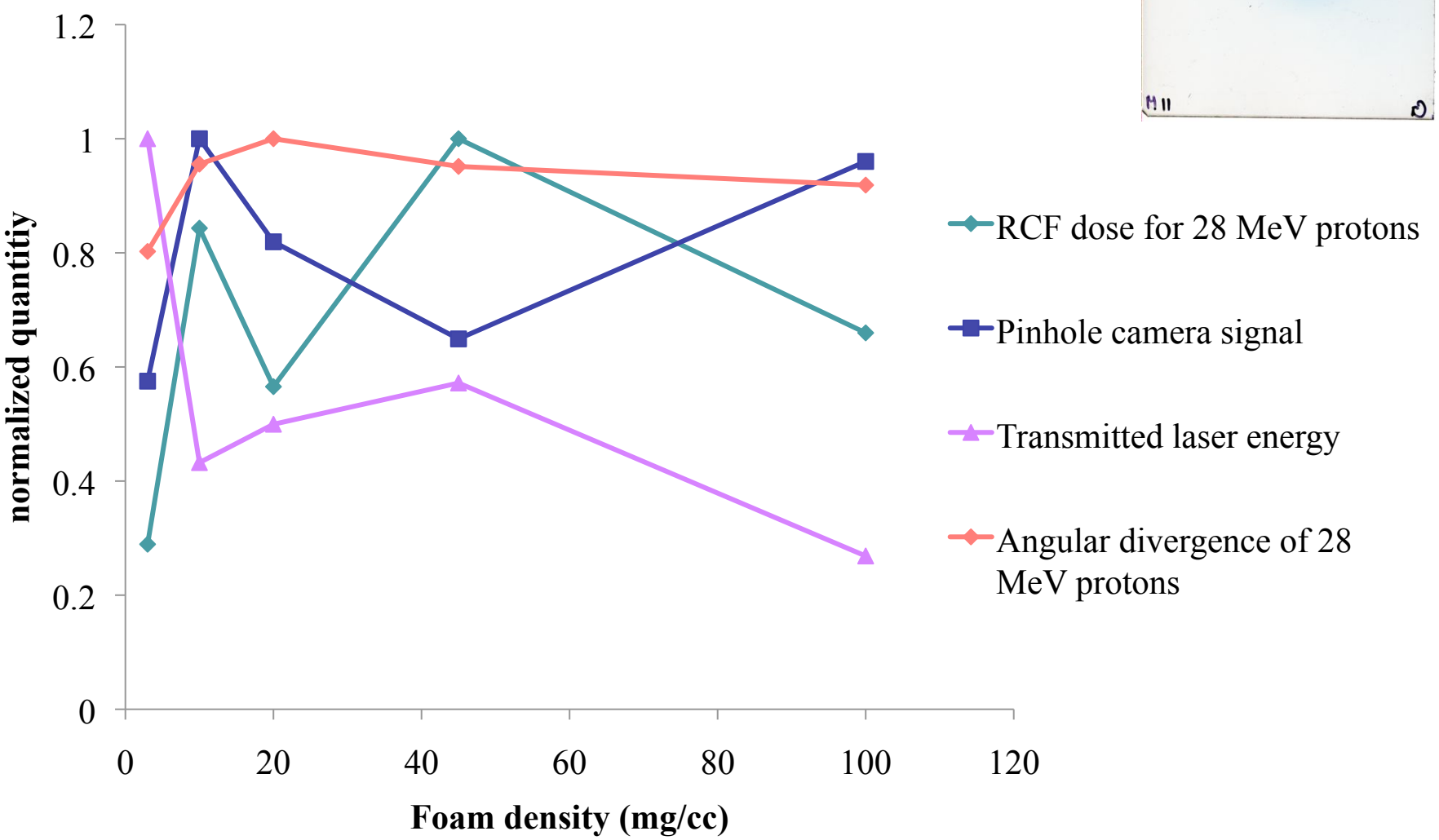
Transmitted Scattered Light Imaging diagnostic
TSLID
Filtered at 1053 +/- 10 nm



Preliminary results
Normalized data

Maximum proton energy observed = 51 MeV





Summary and Future work

- Summary of data so far:
  - Density scan around the critical density has been shot on Omega EP
  - High energy proton beams were measured
  - Consistent trends observed with different diagnostics

- Future work:
  - Run 2D particle-in-cell (PIC) code for Omega EP conditions
  - Investigate the how much laser energy is transmitted through the foam, but shifted out of the bandwidth of the filter