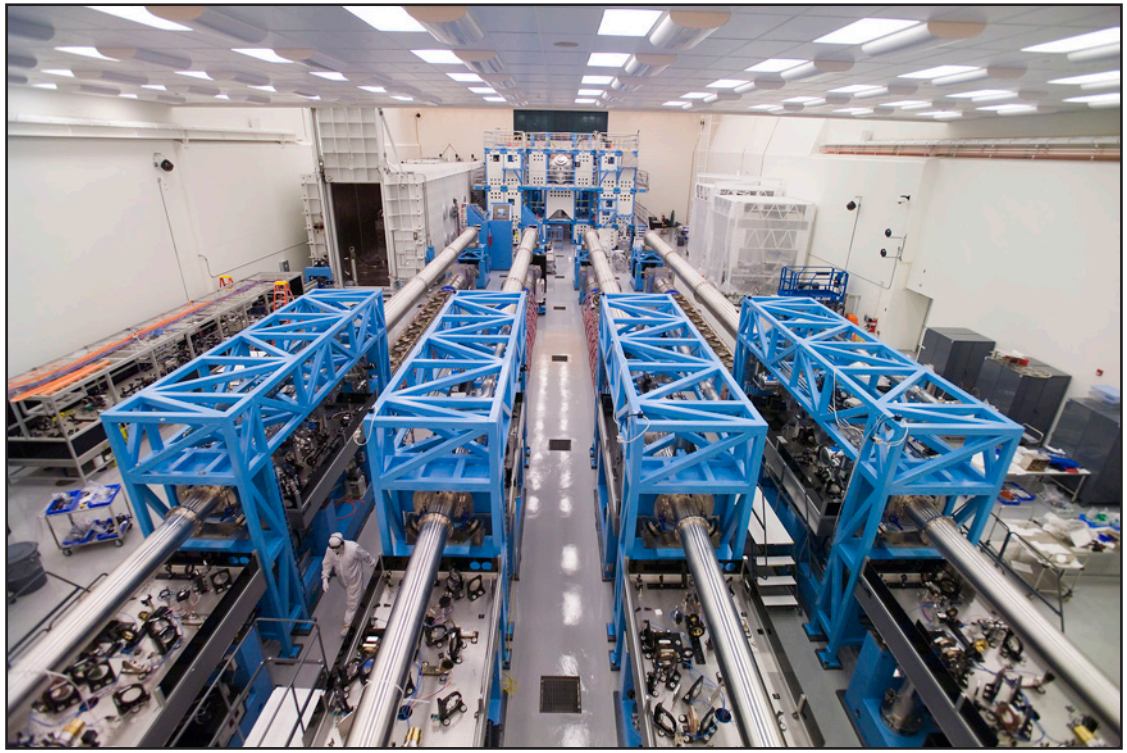
Initial Experiments Using the OMEGA EP Laser System



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Summary

OMEGA EP is complete and experiments have begun

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- The OMEGA EP Laser System was completed 25 April 2008.
- This four-beam system is a flexible addition to the OMEGA Laser System, including
  - two to four 1 ~ 10 ns, ultraviolet beams, with up to 6.5 kJ each
  - one or two high-energy-petawatt beams (HEPW), with up to 2.6 kJ in 1 to 10 ps
  - the HEPW beams can be directed into the OMEGA target chamber
- System performance is being ramped to design levels in FY09
  - an HEPW beam has produced >1.4 kJ in a 10-ps pulse—2× higher than any short-pulse laser system
- Initial HEPW target experiments show
  - bright Al spectra
  - significant numbers of energetic protons
  - first integrated fast ignition experiment

Collaborators

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OMEGA EP

The Extended-Performance (EP) addition to OMEGA has five primary missions

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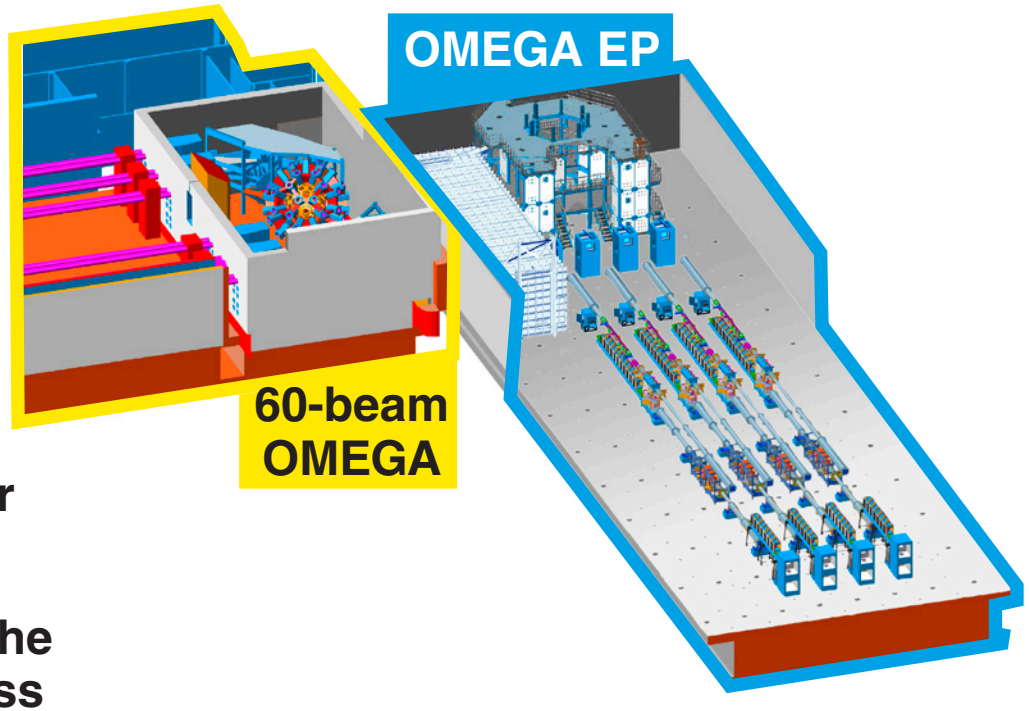
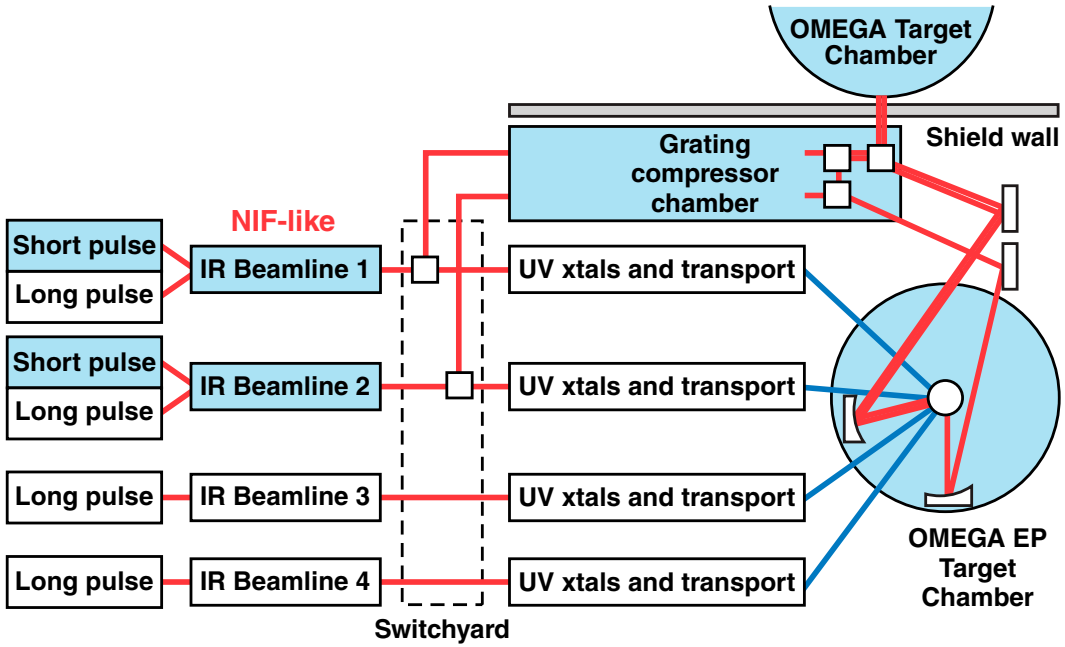
1. Extend HED research capabilities with high-energy and high-brightness backlighting
2. Perform integrated advanced-ignition experiments
3. Develop advanced backlighter techniques for HED physics
4. Provide a staging facility for the NIF to improve its effectiveness
5. Conduct ultrahigh-intensity laser–matter interactions research



The full configuration of OMEGA EP provides an extraordinary flexible high-energy, high-power laser facility



Beam 1 (IR)	2.6 kJ (τ > 10 ps) 0.4 kJ (τ = 1 ps)
Beam 2 (IR)	2.6 kJ (τ > 10 ps) 1.0 kJ (τ = 1 ps)
Beam 1~4 (UV)	2.5 kJ (τ = 1 ns) 6.5 kJ (τ = 10 ns)

- OMEGA EP delivers two separate kilojoule-level, picosecond-pulse beamlines to the OMEGA EP target.
- The two short-pulse beams can be co-propagted and sent to either the OMEGA or OMEGA EP target chamber.
- OMEGA EP delivers nanosecond UV pulses in four beamlines to the OMEGA EP target chamber.
- The kilojoule-level, nanosecond UV beams can be used together with the short pulse beams.

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The capabilities of the OMEGA EP Laser System continue to improve

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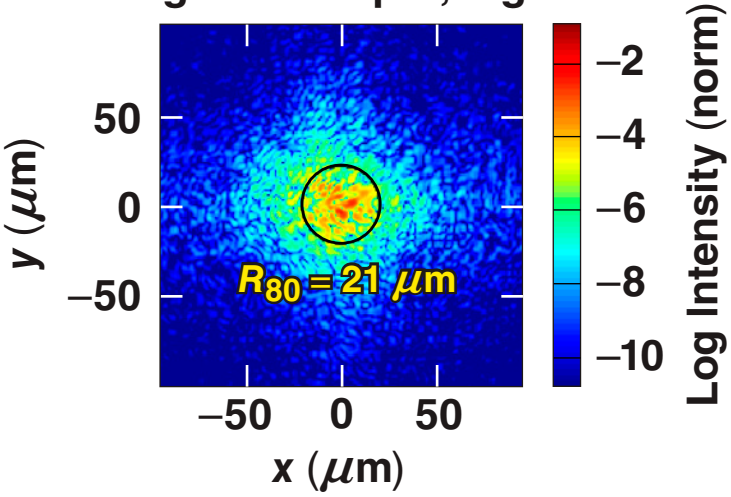
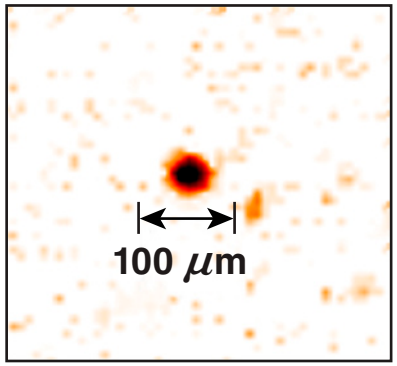
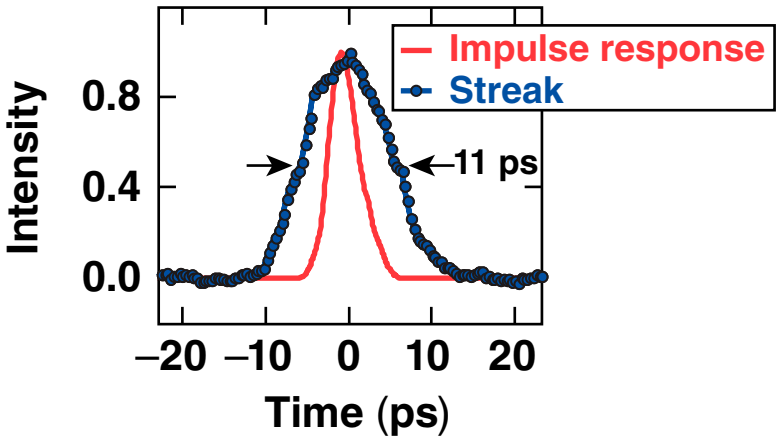
Target focal spot, log scale



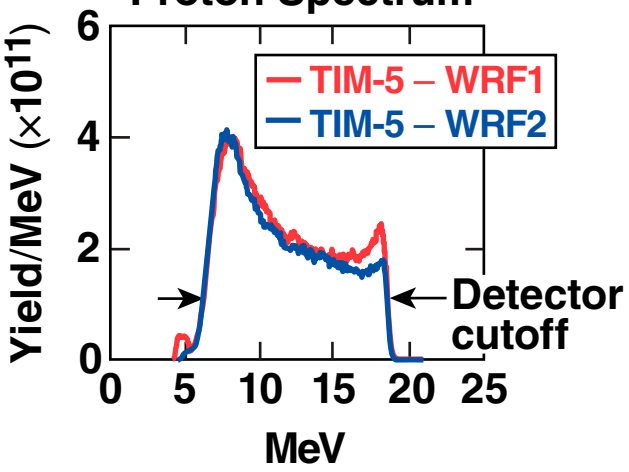
X-ray pinhole camera



460-J target shot



Proton Spectrum



In September 2008, OMEGA EP delivered 1.4 kJ in 10 ps to a target.

An Al spectrum was recorded on OMEGA EP with an ~10-ps, 200-J short pulse on a 500 × 500 × 10-μm Al target

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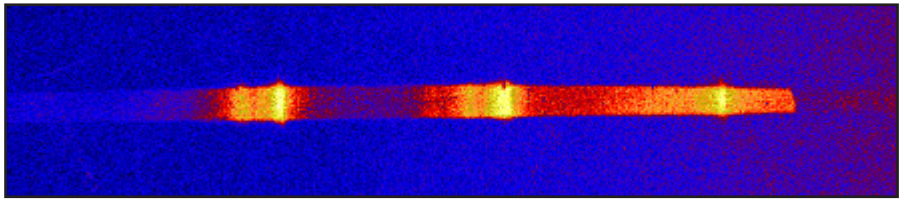
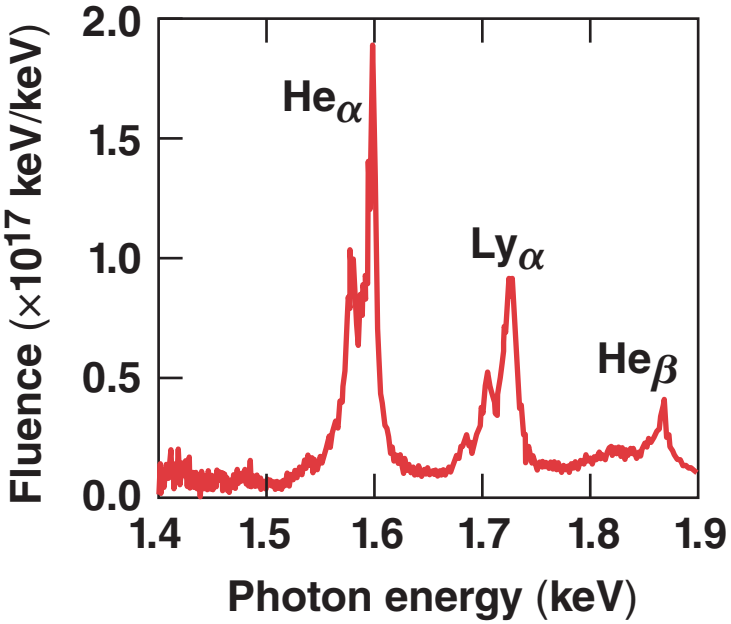
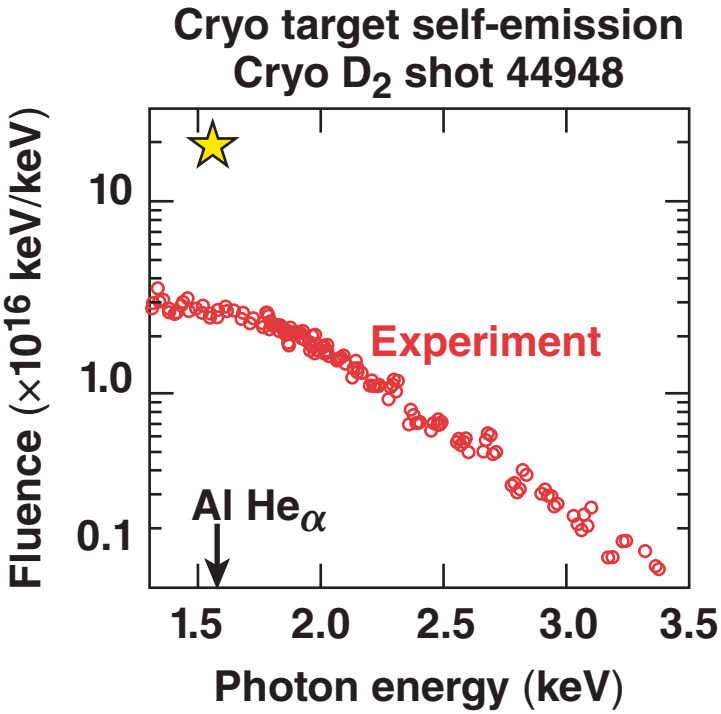
Image of film from spectrometer







The OMEGA EP-generated Al emission is bright enough to backlight cryogenic targets.

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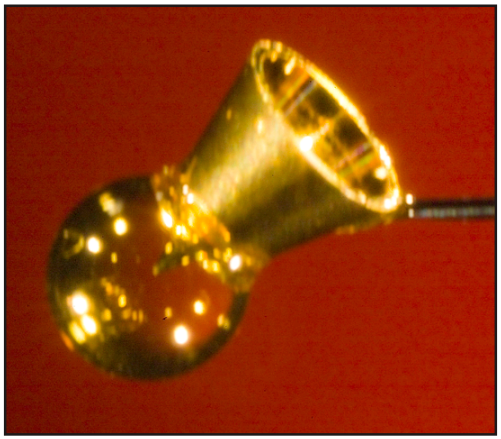
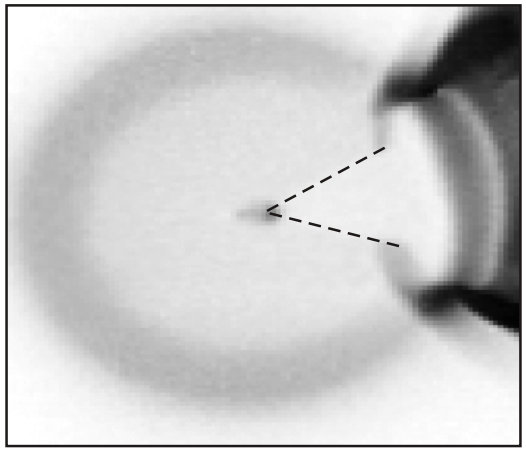
Integrated FI experiments with cone-in-shell targets have started on OMEGA

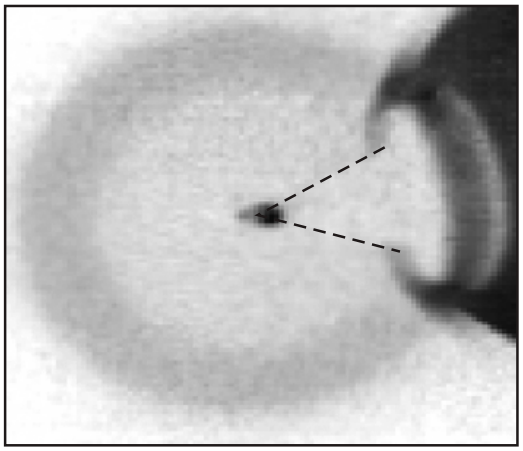


CD Shell	~ 870-μm diam
Driver Energy	~ 18 kJ
Short Pulse	~ 1.3 kJ
Pulse Duration	~ 10 ps
Focus	~ 40-μm diam

No short pulse



With short pulse



The hard x-rays produced by the short pulse interaction saturate the current neutron detectors.

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Radiochromic film (RCF) was used to record the spatial distribution of the protons from the target's back side

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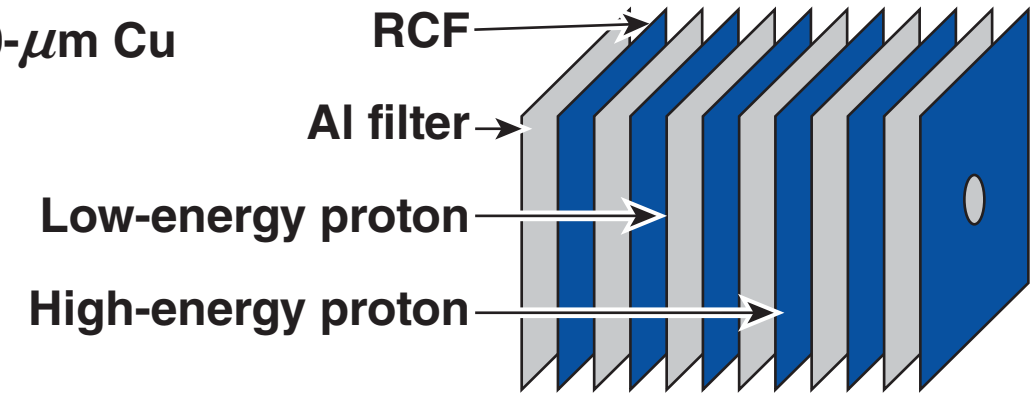
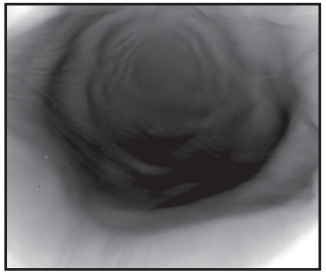
Target 500 × 500 × 20-μm Cu

E_L = 80 J

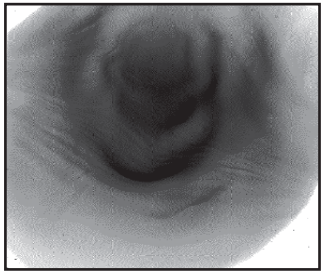
t_L ~ 10 ps



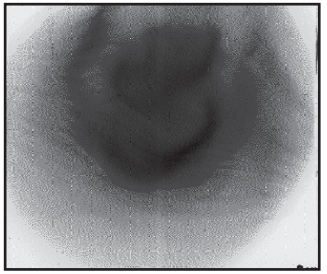
5 Mev



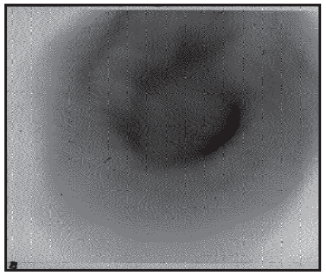
7 Mev



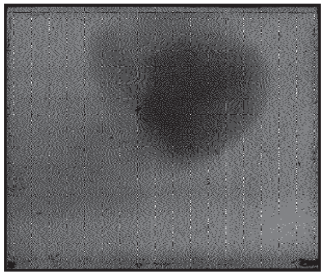
9 Mev



11 Mev



15 Mev



18 Mev

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A proton spectrum from a target shot with a 10-ps, 300-J OMEGA EP beam was recorded using wedged range filters

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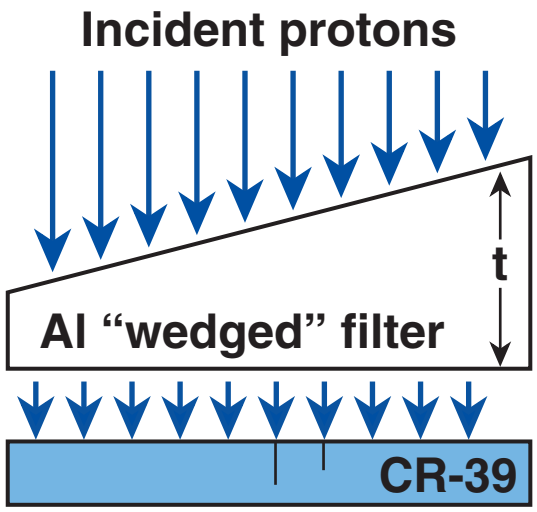
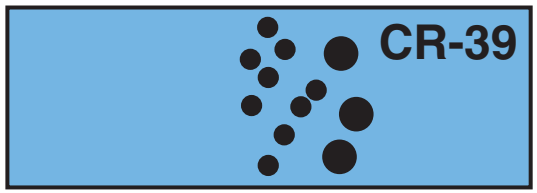
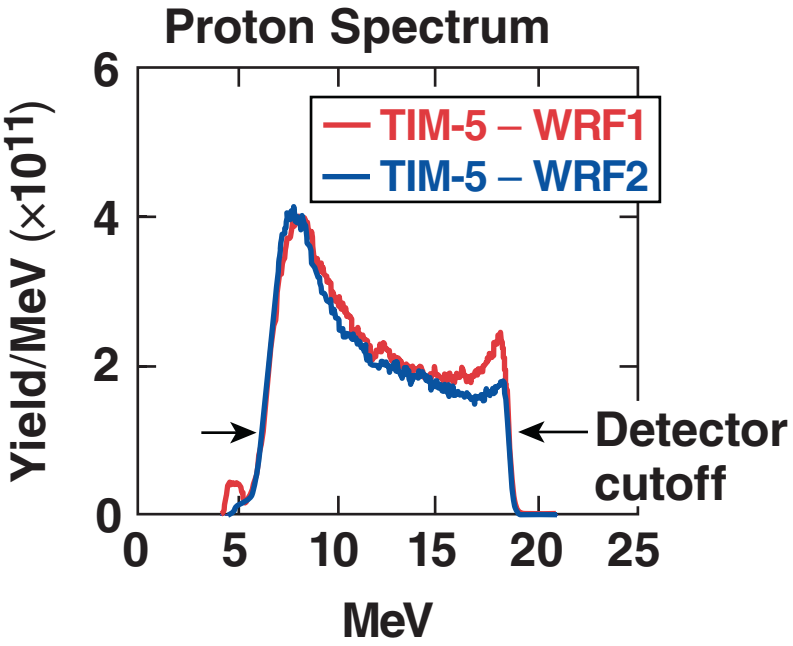


Top view of WRF



Front view of CR-39 after controlled etch



N_{tracks} (diam, t)

Process with an algorithm

- calibrated CR-39 response
- calibrated filter characteristics

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