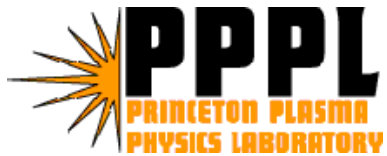
NDCX-1A parameter optimization simulations: Moving towards 1-eV target heating for WDM experiments*



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…and many others…

Workshop on Accelerator-Driven Warm Dense Matter Physics
February 22-24, 2006

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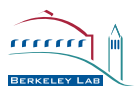
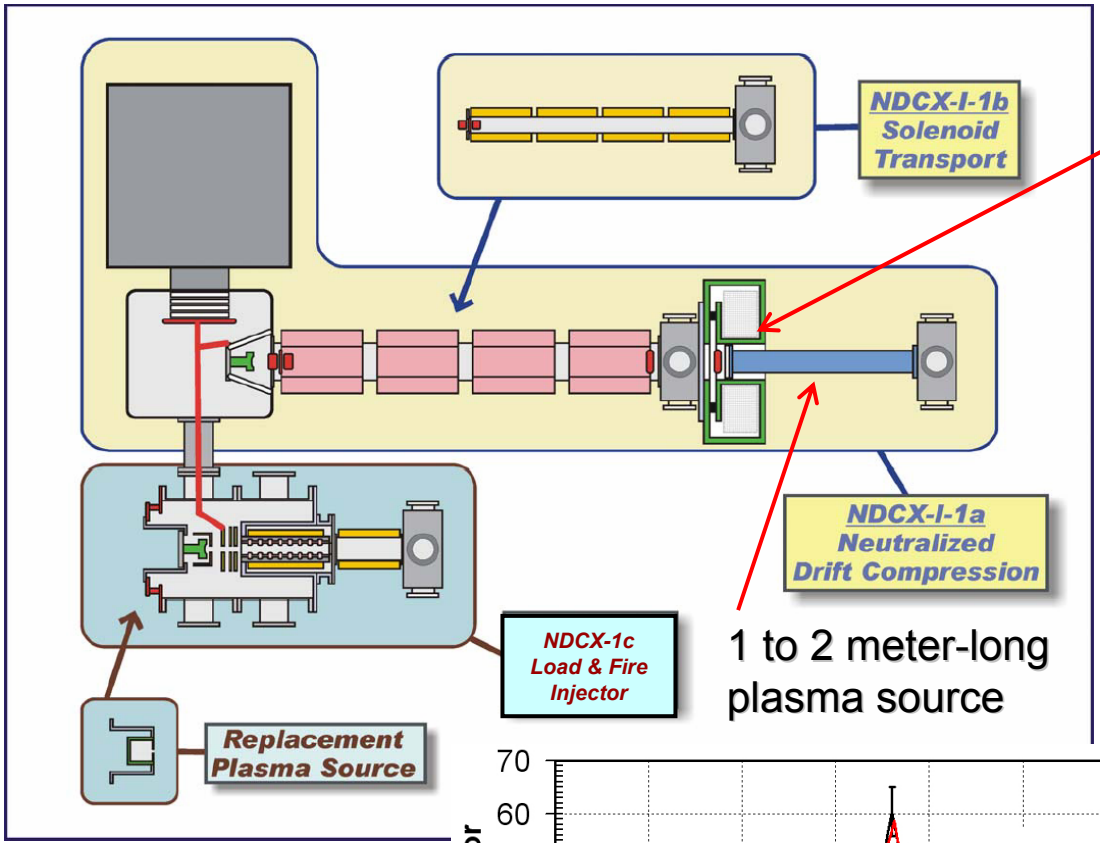
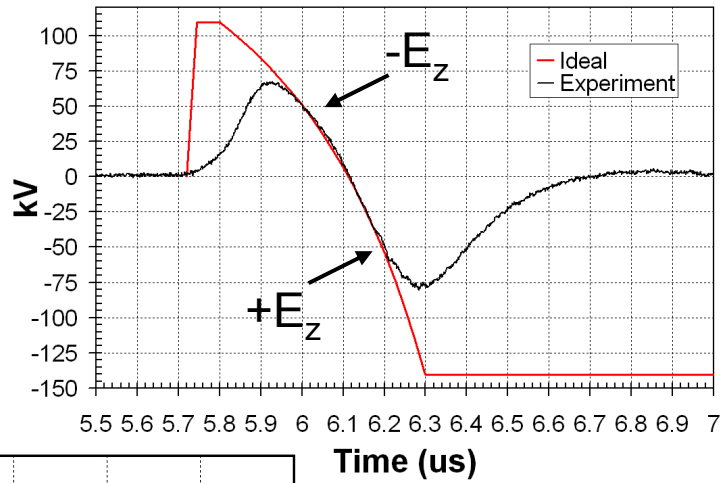
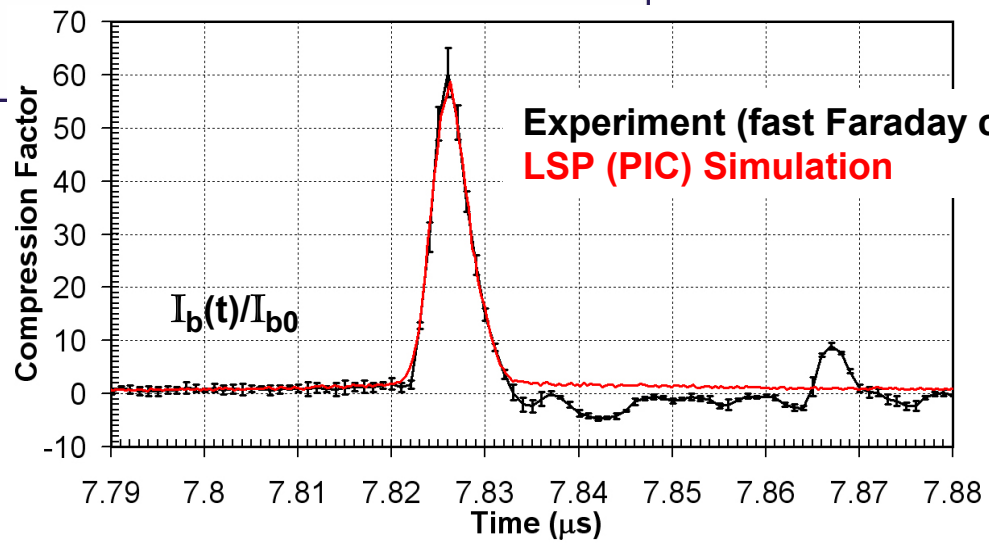


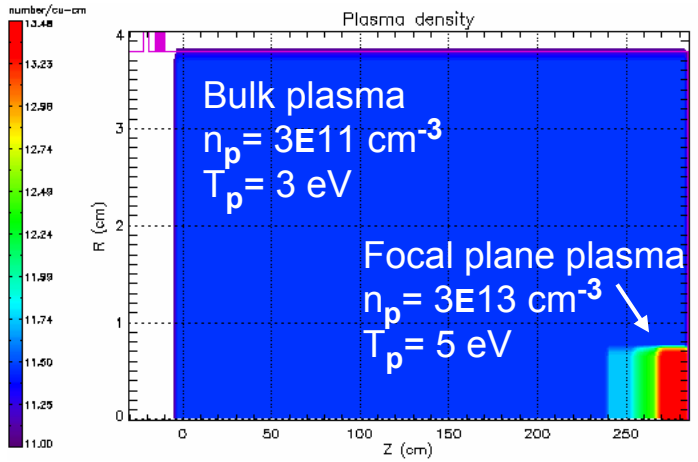


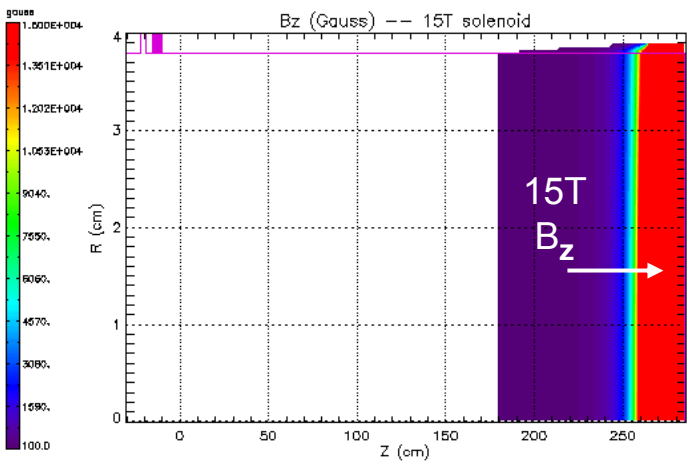
Single-gap linear induction accelerator (induces pulsed E(t) along axis of beam), also called the "tiltcore" because it imposes a head-to-tail velocity tilt on the passing ion beam via a time-dependent voltage waveform applied across the gap.

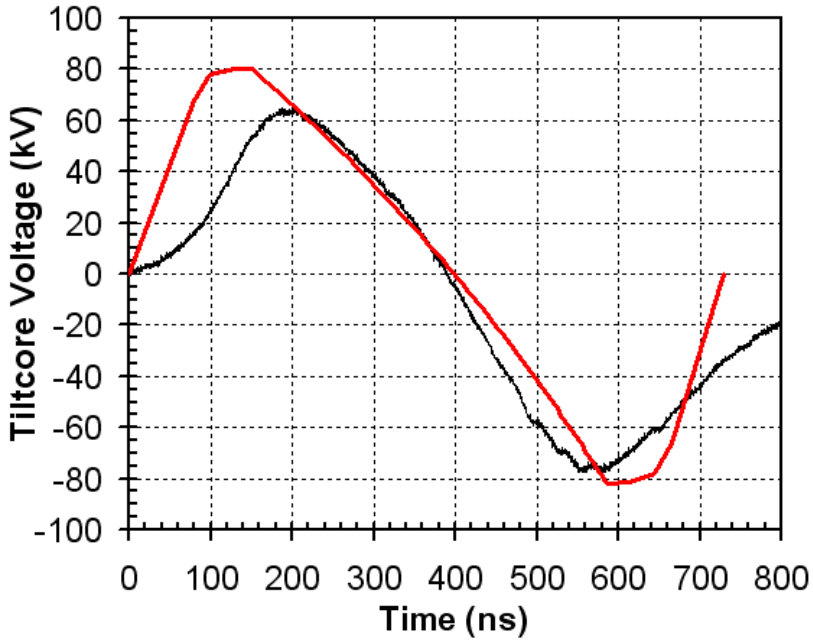




- 400 keV K^+, 80 mA, r = 1.9 cm, T = 0.2 eV
- 0.6 μs initial pulse length
- 2.90 m focal length, 21.2% tilt (in red, on right)
- B = 15 T for transverse focusing
- n_p = 3E11 cm^{-3} bulk to 3E13 cm^{-3} in focal region
- EM kinetic simulation, conserves energy well



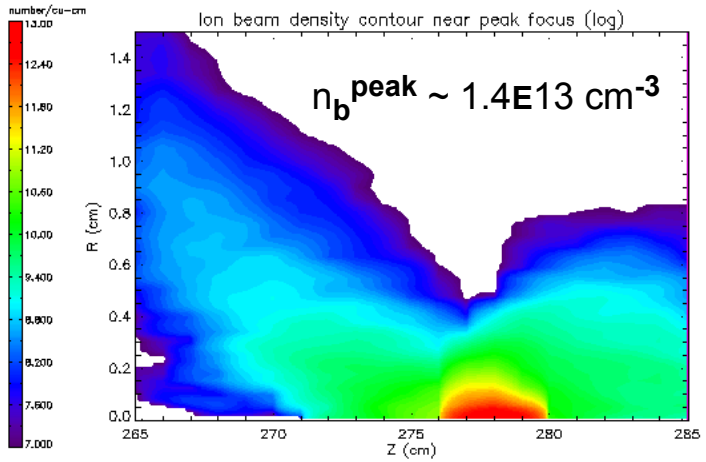




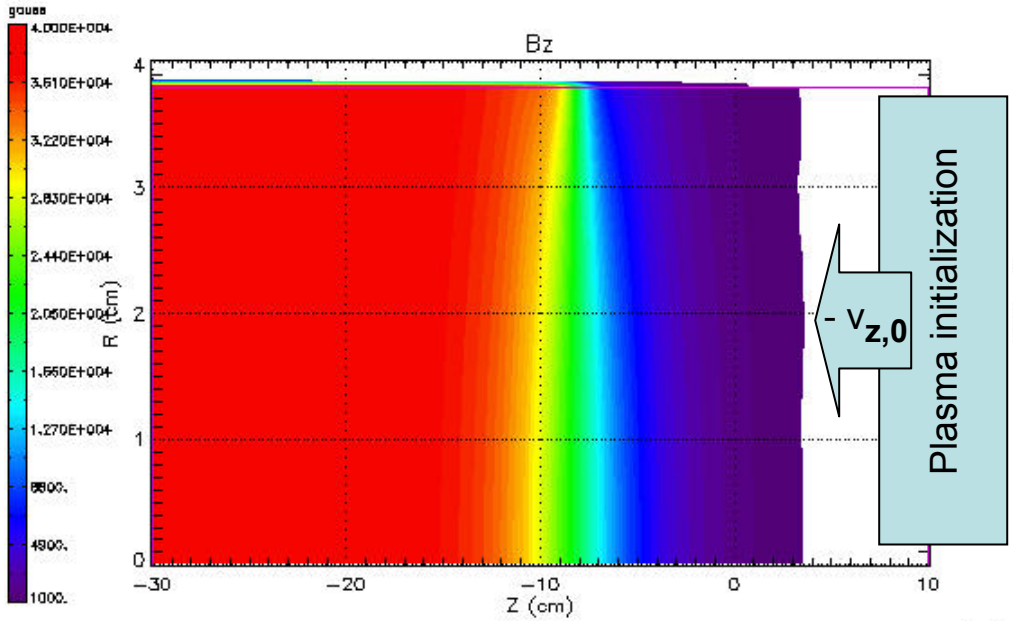
Induction module waveform (above):

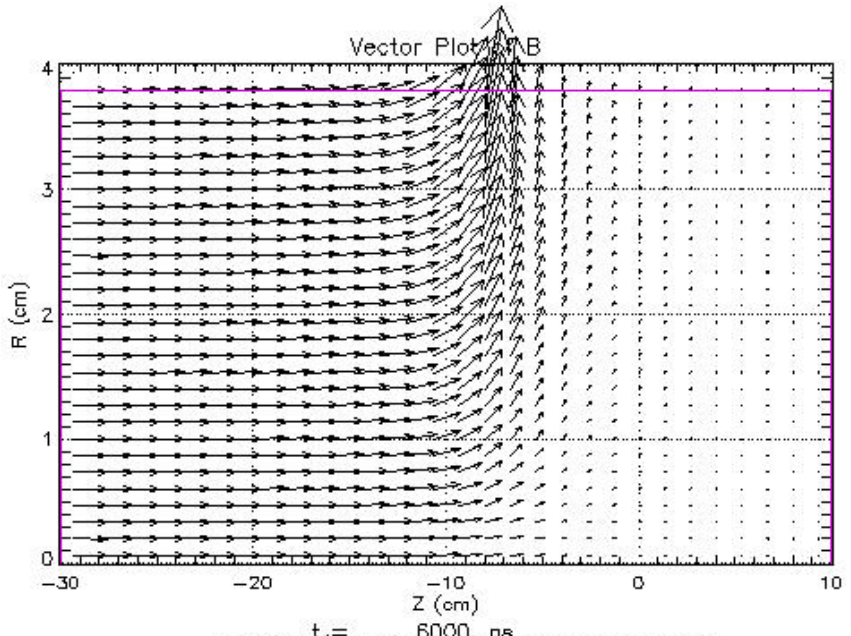
Experimental: 320 keV K^+, 20mA → **60X**, *4.3ns* (f=2.34m)

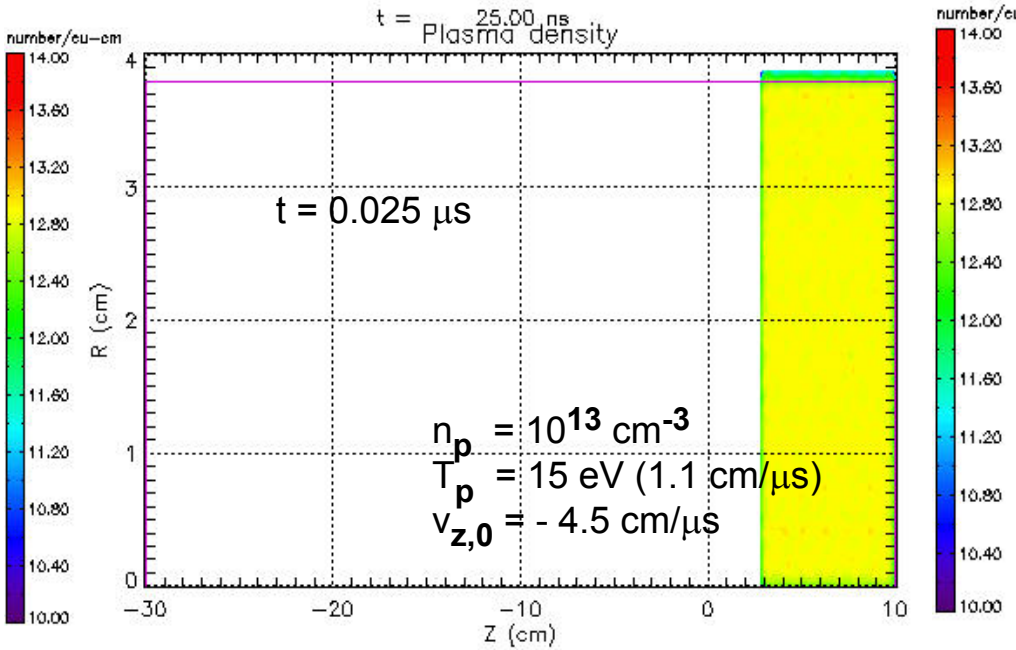
Simulation: 400 keV K^+, 80mA →**125X**, *3.0ns* (f=2.90m)

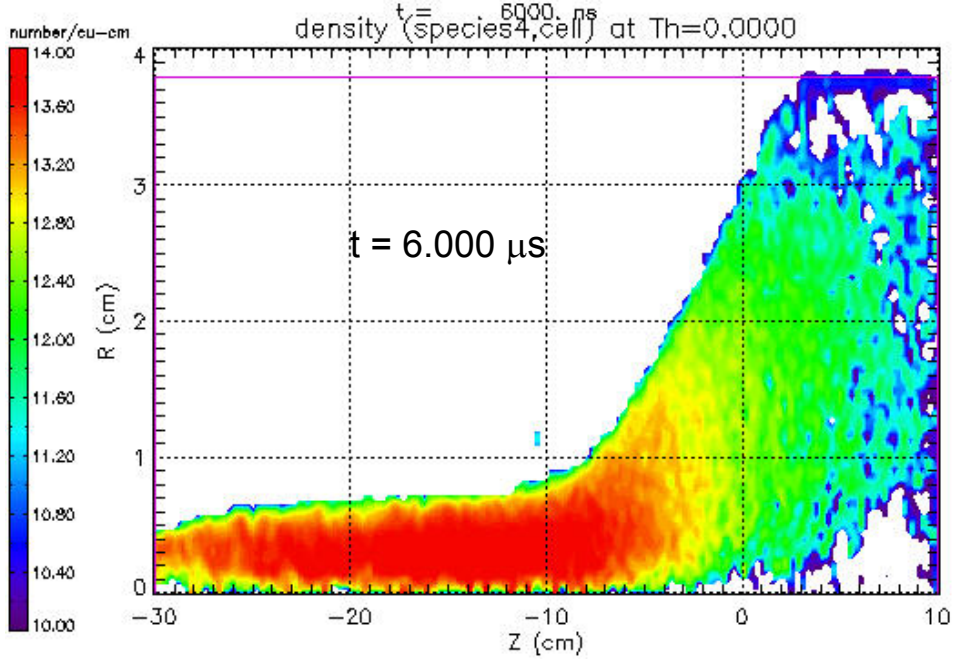


Solenoid simulations: Plasma is able to penetrate into high B field region



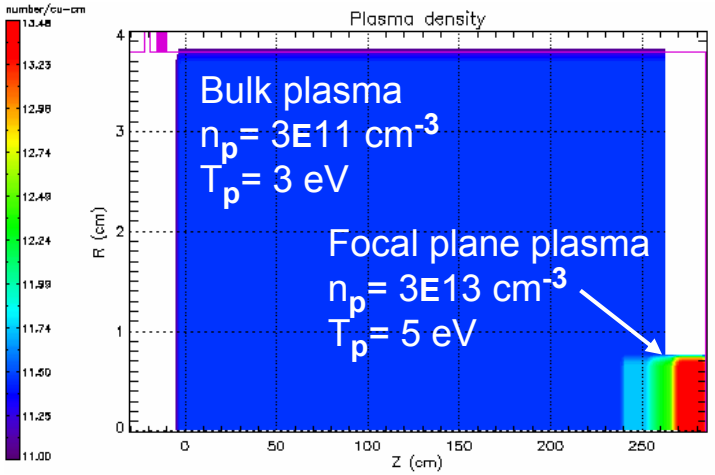


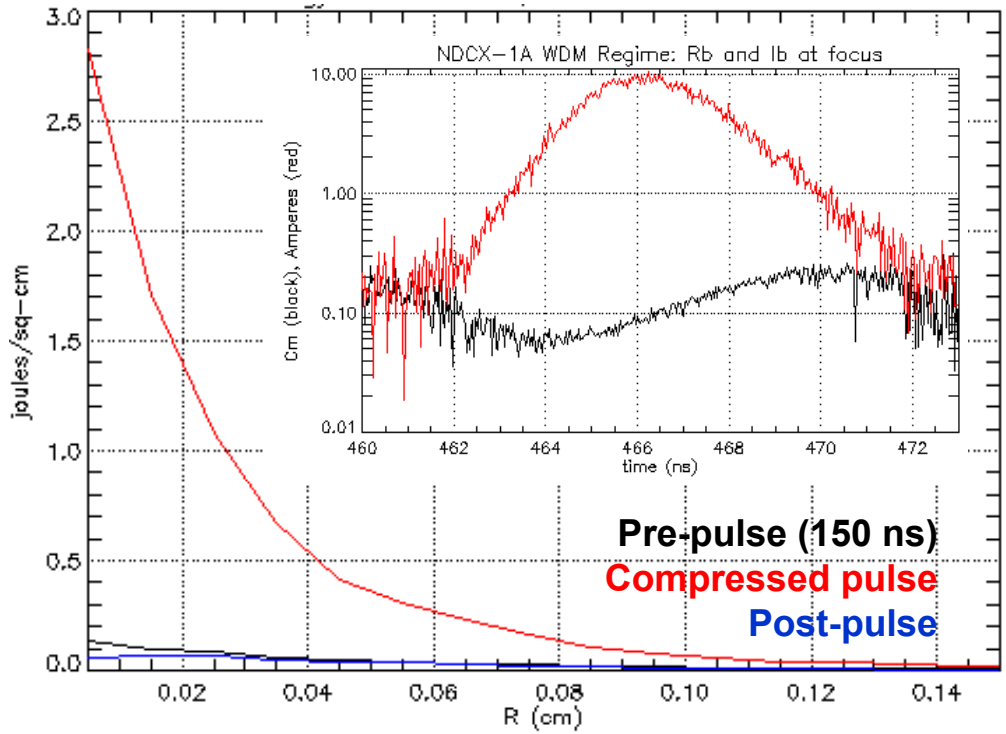


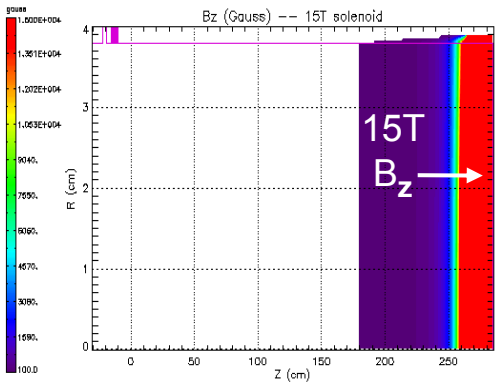


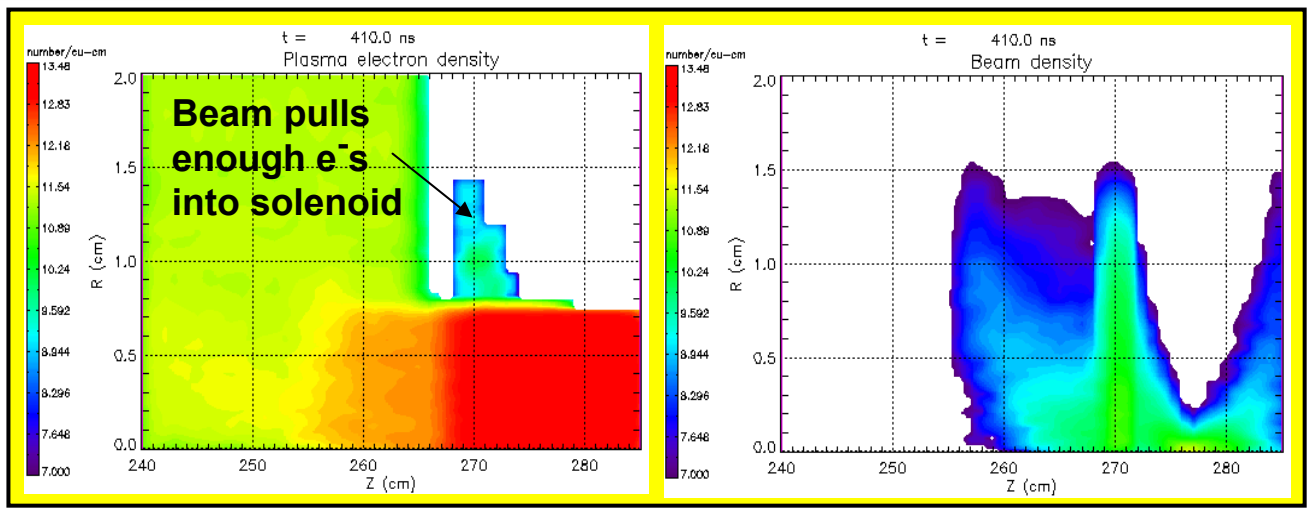
No compression difference between partially-filled and fully-filled solenoid

- 400 keV K^+, 80 mA, r = 1.9 cm, T = 0.2 eV
- 0.6 μs initial pulse length
- B = 15 T for transverse focusing
- n_p = 3E11 cm^{-3} bulk to 3E13 cm^{-3} in focal region
- **I_b(t) compressed to 10A (125X), FWHM 3 ns**
- **R_b(t) focused to 0.26 mm (1/e), 0.60 mm (rms)**







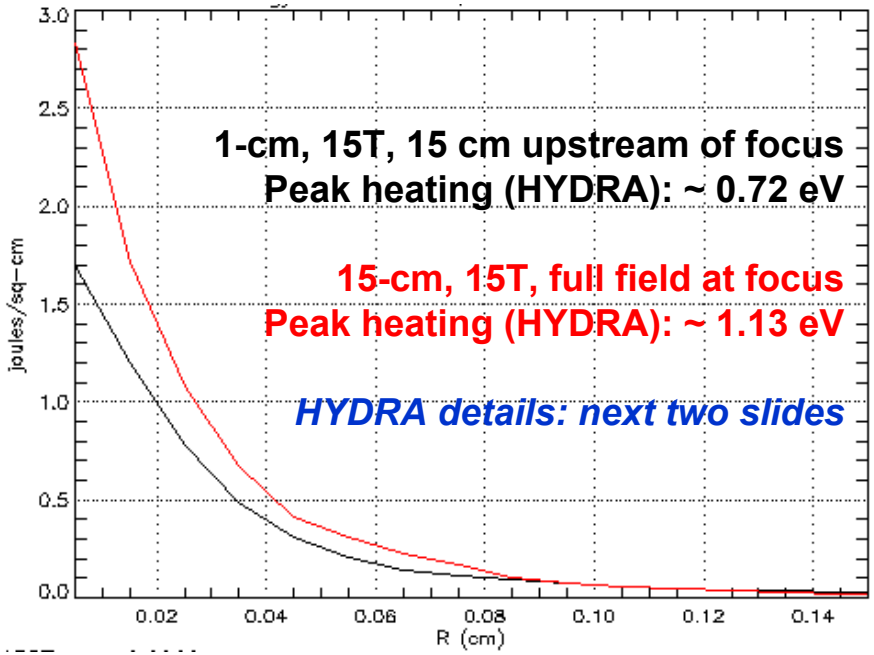


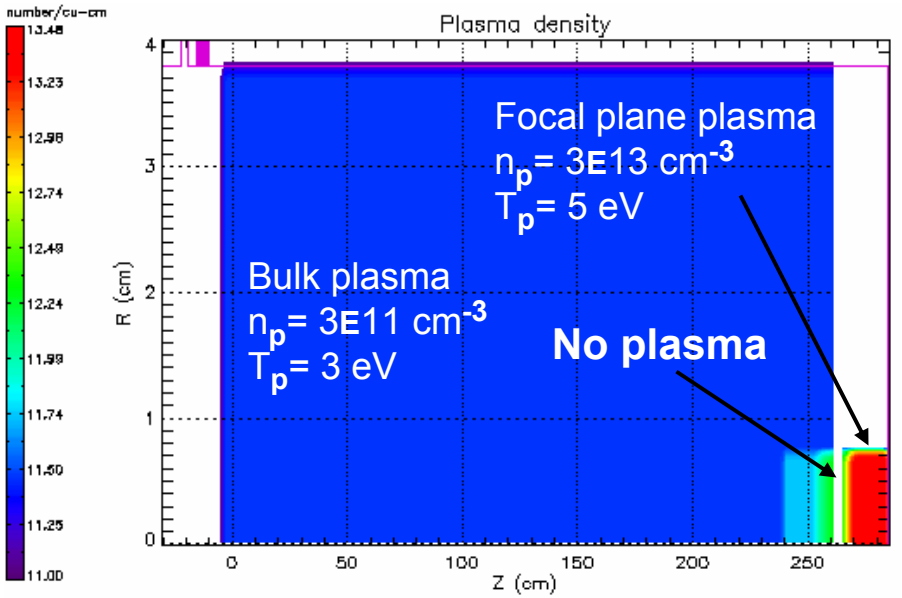
Some difference: Target immersed in B = 15T vs. B = 0.03T

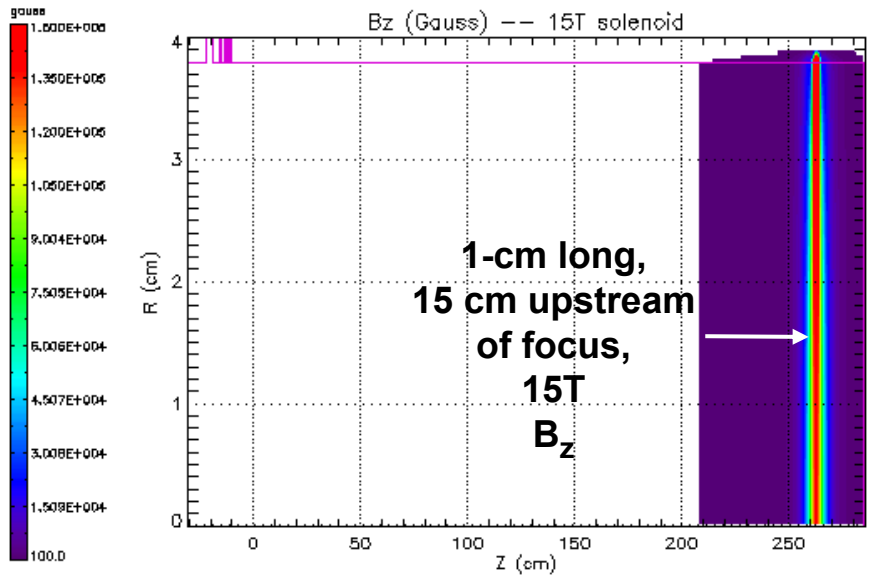
- 400 keV K^+, 80 mA, r = 1.9 cm, T = 0.2 eV
- 0.6 μs initial pulse length
- B = 15 T for transverse focusing
  → B_z 15T at focal plane vs. 300G at focal plane

- n_p = 3E11 cm^{-3} bulk to 3E13 cm^{-3} in focal region
  → No plasma initialized in 4 cm area near solenoid

- **I_b(t) compressed to 10A (125X), FWHM 3 ns**
  → Same as other case
- **R_b(t) focused to 0.30 mm (1/e), 1.00 mm (rms)**
  → 0.04 mm greater (1/e), 0.40 mm greater (rms)

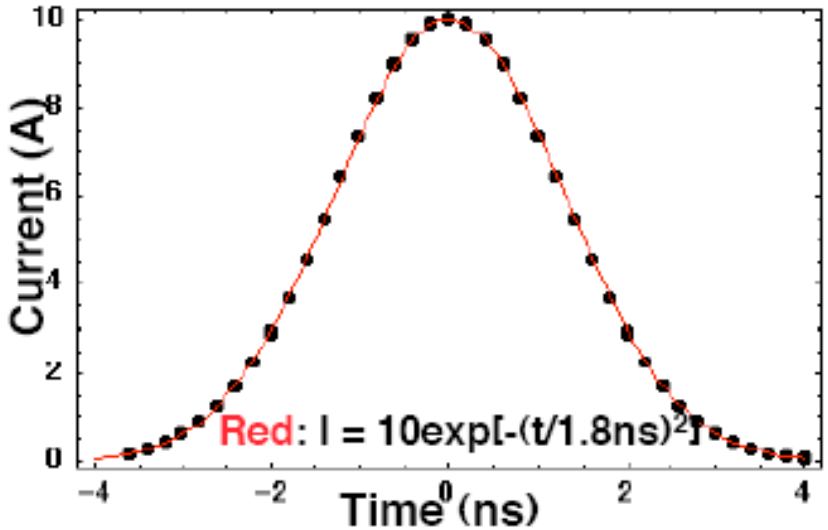


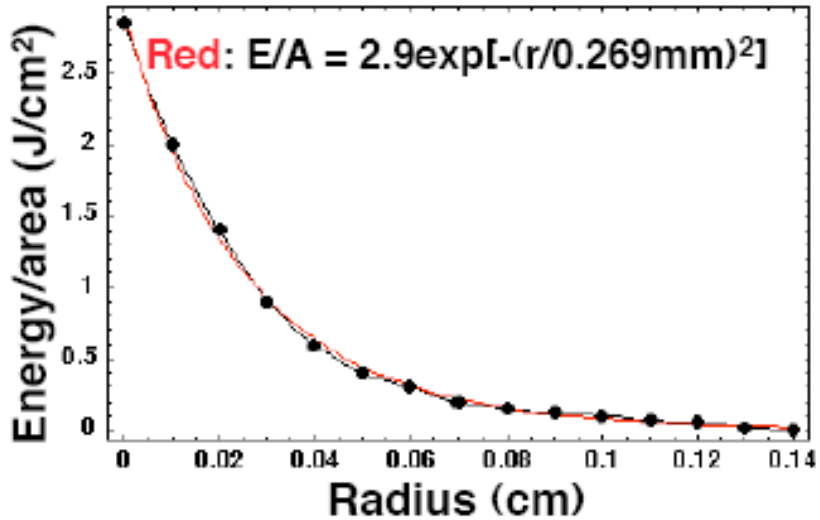




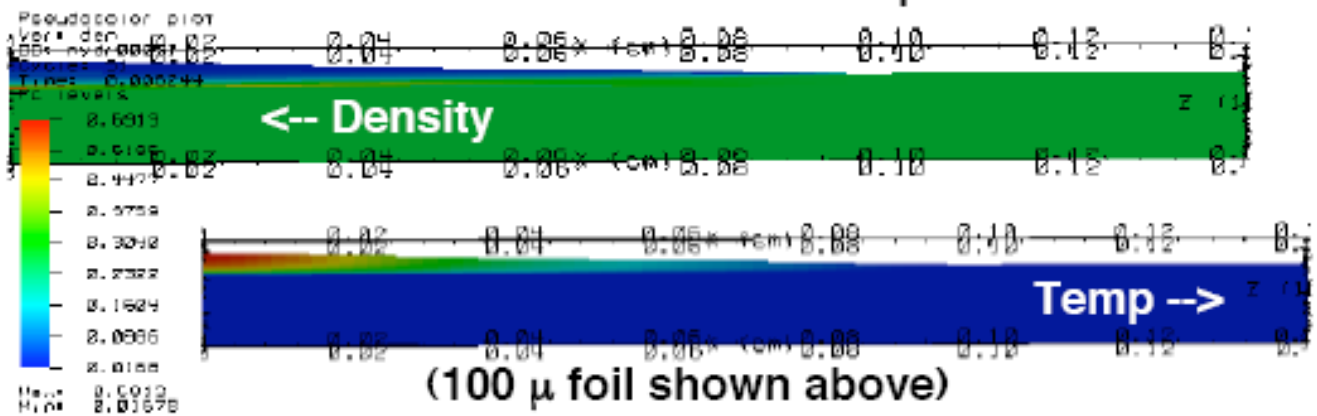
HYDRA simulations of 400 keV K+ incident on Aluminum foam (10% solid density) (ρ = 0.27 g/cm^3)

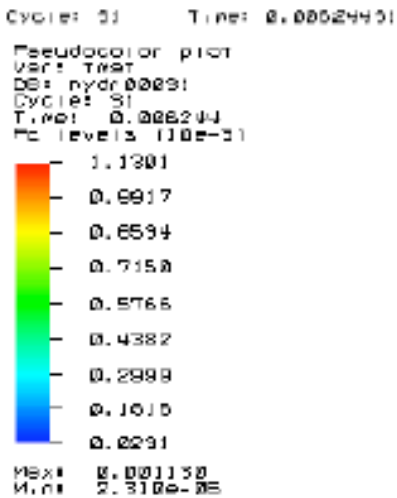
Black points on curves are A. Sefkow's LSP output; Red curves are inputs to HYDRA



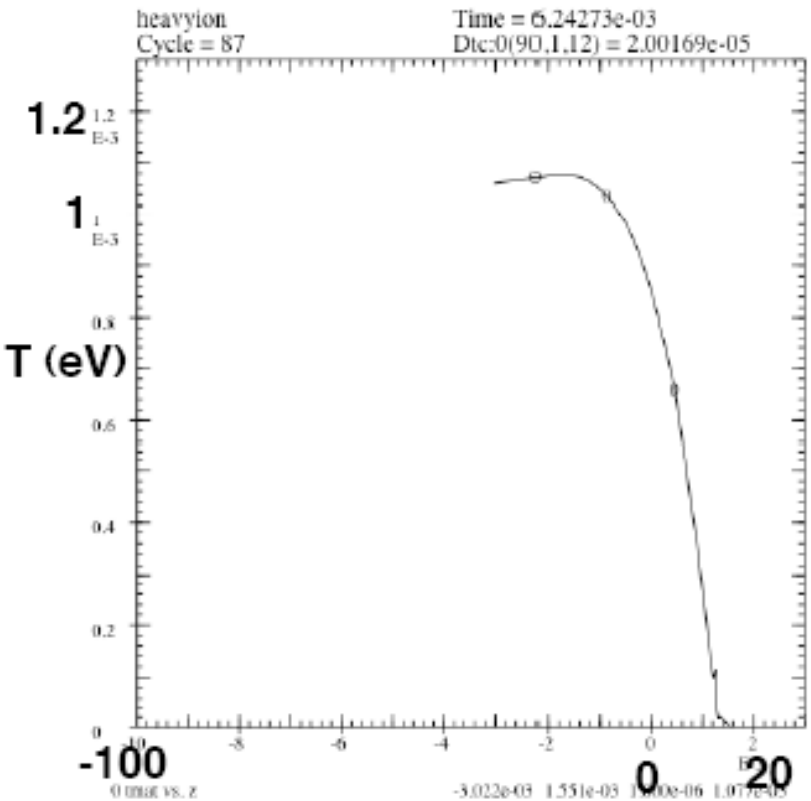


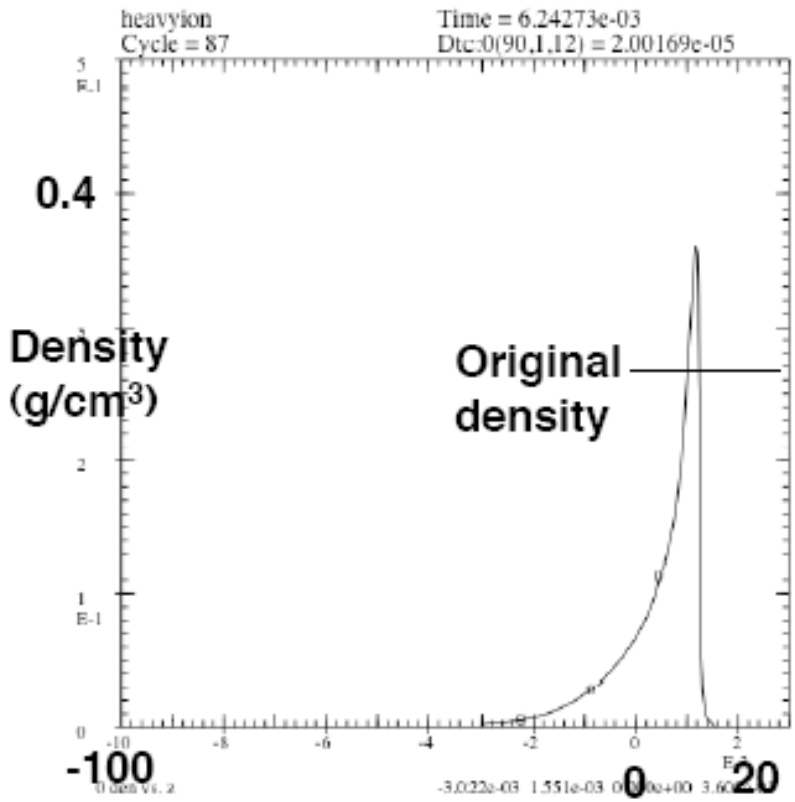
At +2 ns (6 ns after start) maximum temperature is reached:





HYDRA shows a maximum temperature of 1.1 eV at 6.2 ns (for a 10 μ thick, 10% density Al foil)





Two-stream instability: Can become an issue if the plasma is too cold