UNR activities in FSC

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$40K from FSC to support a graduate student,
Brian Chrisman, “Numerical modeling of fast ignition physics”.

List of activities

- Modeling of cone-guiding fast ignition by PICLS.
- Hot electron temperature scaling by changing the cone target density. (B. Chrisman)
- Modeling of nail target experiment. (Collaboration with UCSD)
- Perfect energy conservation scheme of relativistic collision between weighted particles. (previous model conserves energy and momentum statistically.)

Summary of Cone-Guiding Fast Ignition Simulation

- The Weibel instability occurs below and around $100n_c$ density. No magnetic filament appears around the core.
- The dominant core heating mechanism is identified as drag heating between hot and bulk electrons and consequent energy cascading from the bulk electrons to the core ions.
- Hot electron temperature is inversely proportional to the square root of the cone target density,
  T_h [MeV] ~ $(I/10^{19}\ \mathrm{W/cm^2} \bullet \lambda_{\mu m}{}^2) \bullet (\gamma n_t/n_c)^{1/2}$, n_t: target density,
  after preplasma is blown off by the laser pressure. Hot electron temperature is tunable by changing the cone target density.

Cone-Guiding Fast ignition simulation

Laser intensity: 10^{20} W/cm^2

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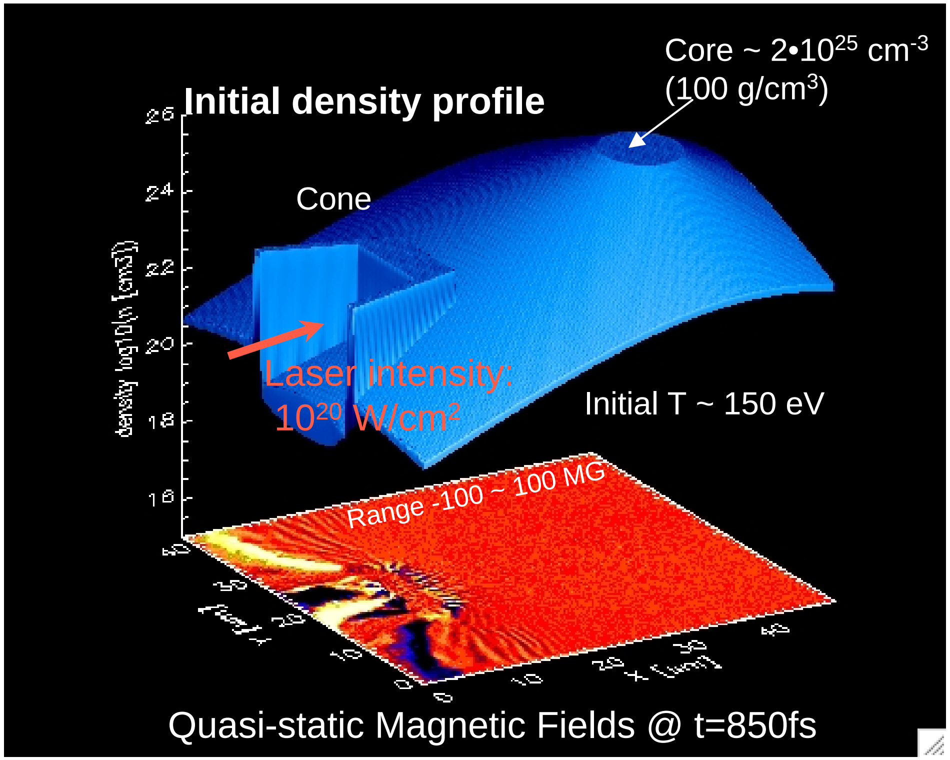
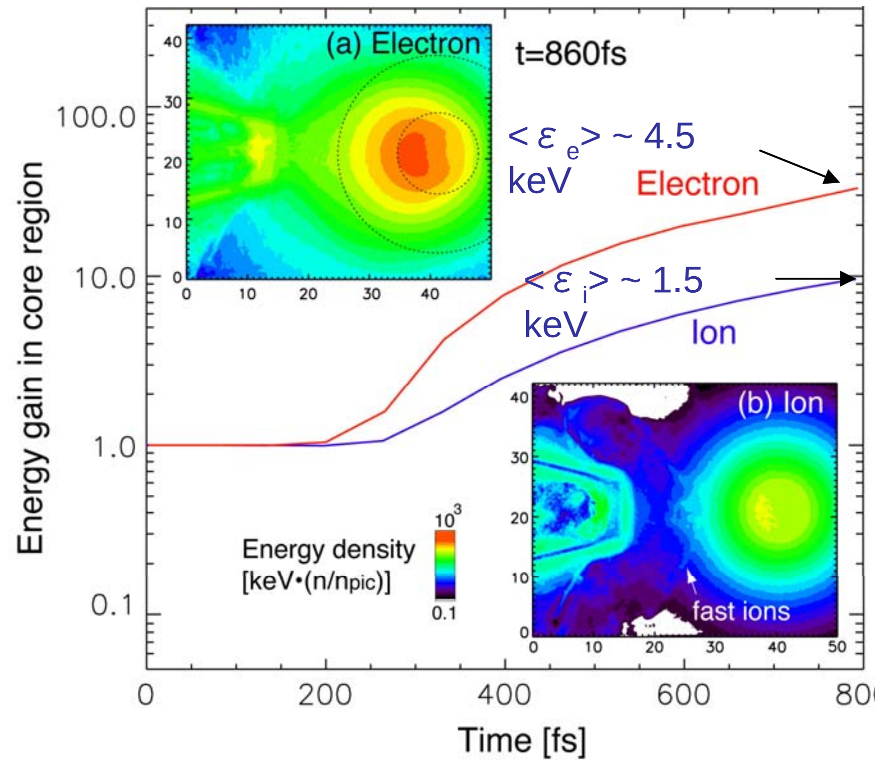
Electron energy density evolution

2D integrated cone-guiding FI simulations with PICLS

(Including laser-plasma interaction, fast e-&ion generation, energy transport through large density scale corona, energy deposition in core)

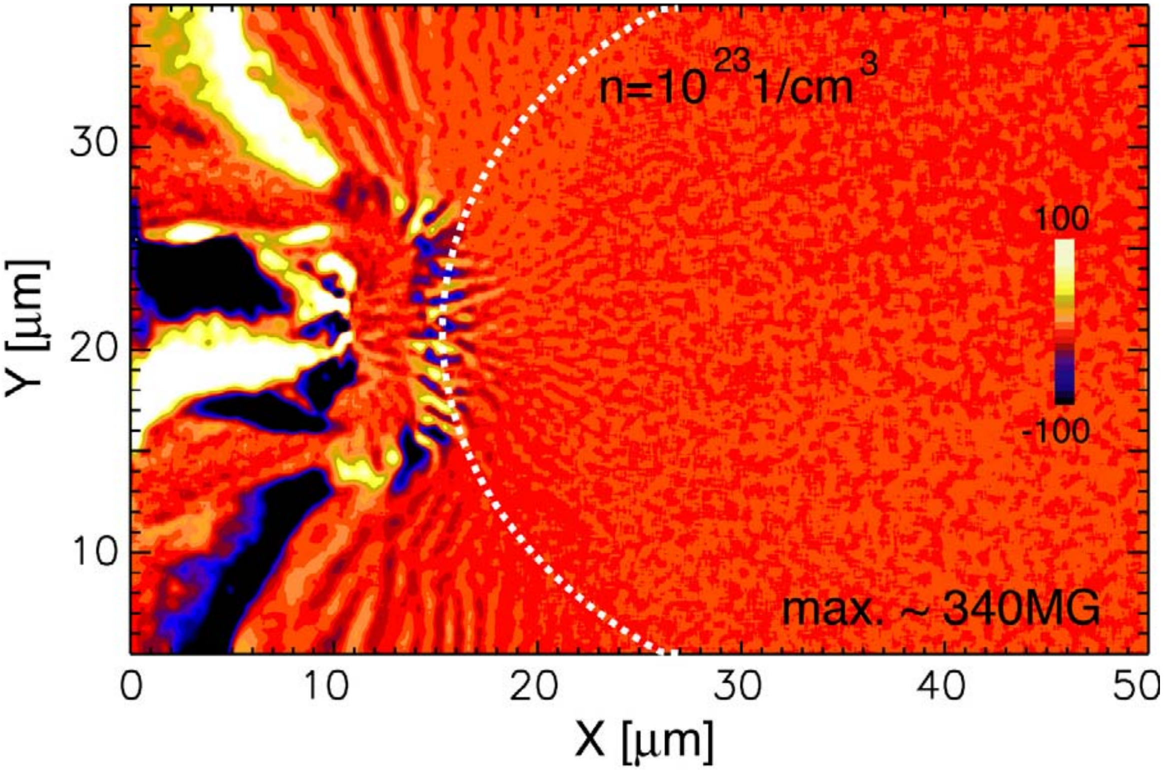




- The Weibel instability occurs below and ~ $100n_c$ density. No magnetic filament appears around the core.
- The dominant core heating mechanism is identified as direct collision between hot and bulk electrons and consequent energy cascading from the bulk electrons to the core ions. Anomalous heating is important below a density of $100n_c$.
- Relatively low energy electrons generation after preplasma is blown away by the laser photon pressure. Simulation shows the hot electron temperature scaling, $T_h \propto (1/n_{cone})^{1/2}$, n_{cone}: cone target density
Hot electron temperature is tunable for optimum energy coupling by changing the cone interiar density.

The Weibel instability occurs below and around $100n_c$ density. No magnetic filament appears around the core.

Laser intensity: 10^{20} W/cm^2

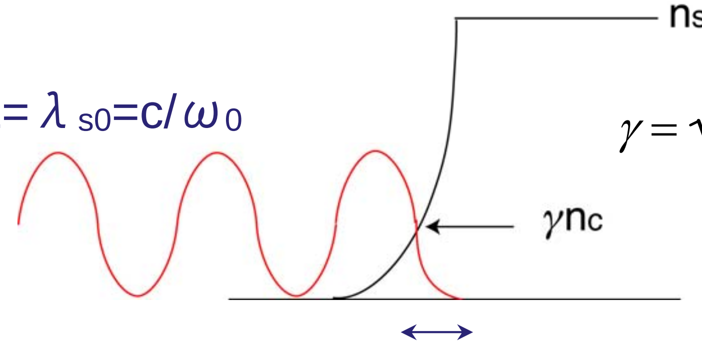


Kinetic instabilities are collisionally dumped in high density region > $100n_c$.

Electron acceleration distance shrinks after pre-plasma blown off by super intense laser irradiation

(a) Preplasma ($L>\lambda_{s0}$)

Interaction (acceleration) length $L=\lambda_{s0}=c/\omega_0$



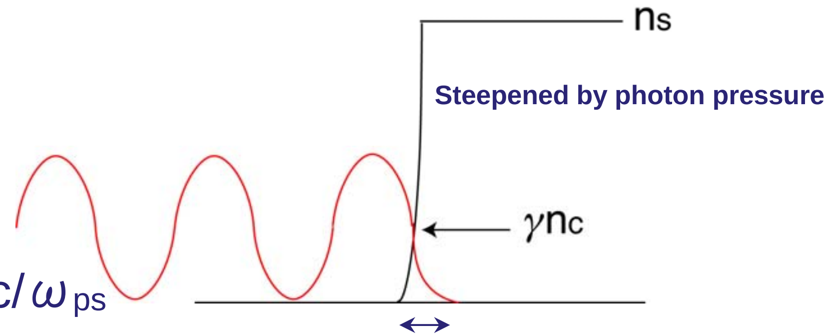
$$\gamma=\sqrt{1+a^2/2}$$

plasma skin length at cut-off: λ_{s0}

Ponderomotive scaling

$$<\varepsilon_h>\sim\left(\frac{I\cdot\lambda_{\mu m}^2}{10^{19}\mathrm{W/cm^2}}\right)^{1/2} \text{ [MeV]}$$

(b) After preplasma blown off ($L<\lambda_{s0}$)



Interaction (acceleration) length $L=\lambda_s=\gamma^{1/2}\bullet c/\omega_{ps}$

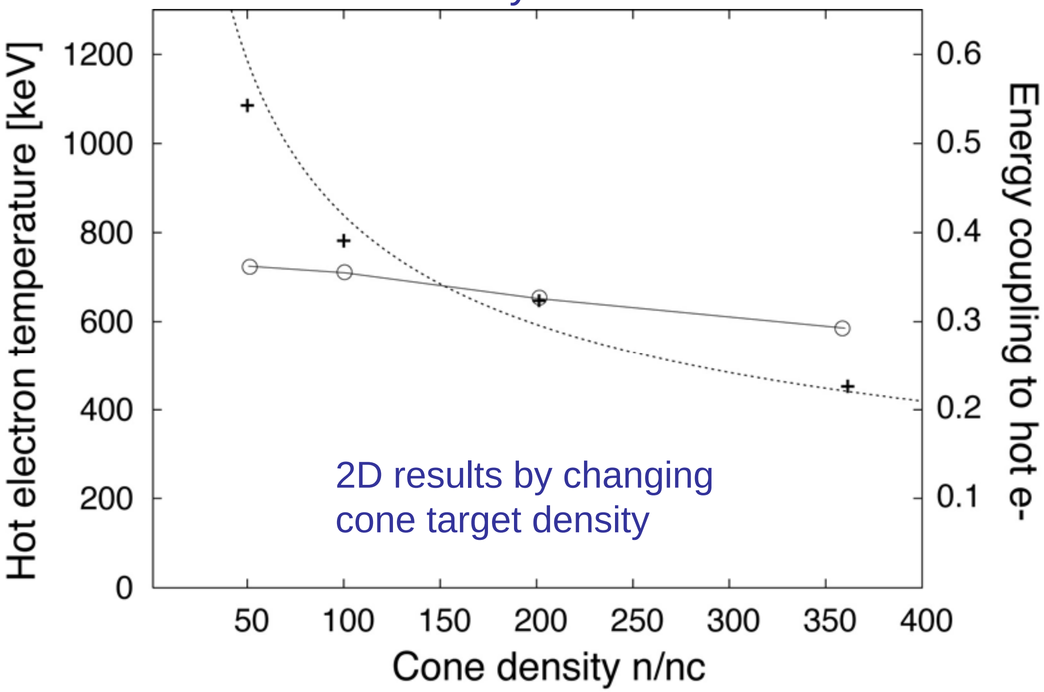
plasma skin length of solid density: λ_s

Acceleration distance will be $(\gamma n_c/n_s)^{1/2}$ shorter in the steep case, then

Modified Ponderomotive scaling $$<\varepsilon_h>\sim\left(\frac{I\cdot\lambda_{\mu m}^2}{10^{19}\mathrm{W/cm^2}}\right)^{1/2}\left(\frac{\gamma n_c}{n_s}\right)^{1/2}$$

Demonstration of Modified T_h scaling by PIC
- $T_h \propto 1/\mathrm{sqrt}(n)$ -

Laser intensity: 10^{20} W/cm^2



Energy coupling is calculated in 2.5μm spot along the laser-axis behind the cone target.

After the pre-plasma has been blown away, the hot electron temperature drops, though energy coupling from the laser to hot e- stays almost constant.