Warm Dense Matter analysis through hydrodynamics and stopping power

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Abstract and motivation

- The evolution of a plasma in WDM conditions is studied with an hydrodynamic code.
- Once temperature, density and ionization profiles are known stopping power calculations are performed with several models.
- The simulation corresponds to a proposed experiment [1] in which a carbon foil is heated by a laser into WDM state to measure the energy loss of a proton beam at energies close to the Bragg peak.

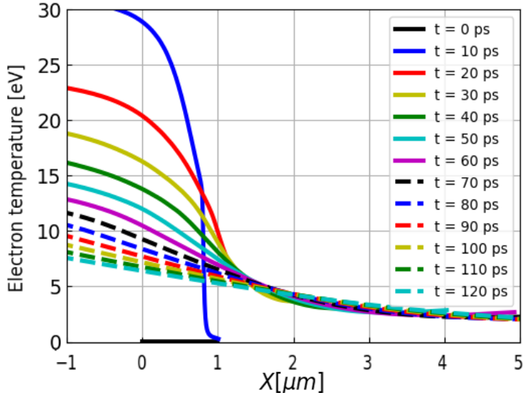
Introduction

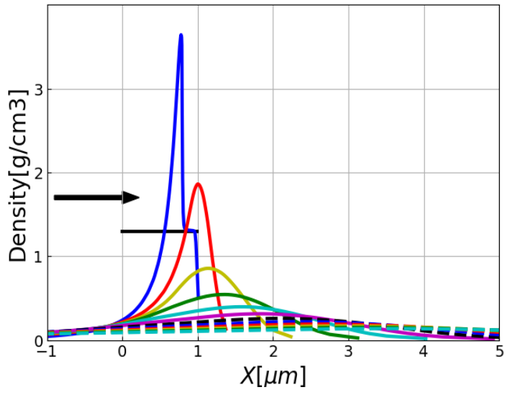
In laser generated WDM experiments, plasma conditions are not static neither uniform through the target. As direct measurements are difficult to obtain, hydrodynamic codes are a useful tool to determine the temporal and spatial evolution of the plasma. Furthermore, many stopping power models use density, ionization and temperature as input parameters. As energy loss in partially ionized matter is not completely understood yet, different theoretical models show high variations, especially in the Bragg peak region. A precise knowledge of the plasma evolution may serve to perform better predictions and help to distinguish between models.

Here, we study the evolution of a carbon plasma in WDM state and its interaction with a proton beam at 0.1 MeV, comparing different stopping power models and making an energy loss prediction.

Hydrodynamic simulations

- **Target:** Carbon thin foil
- **Laser:** λ = 800 nm, τ = 200 fs, I = $3 \cdot 10^{16}$ W·cm^{-2}

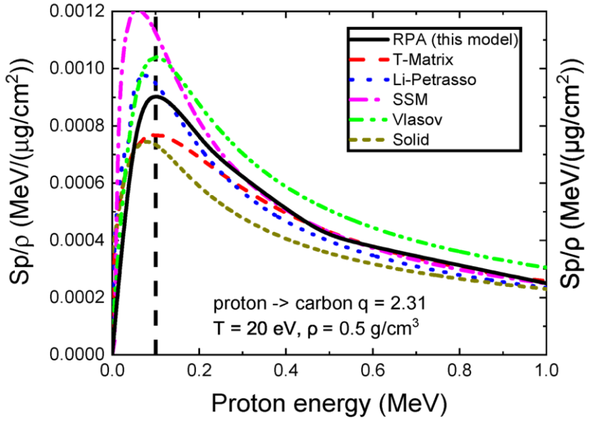




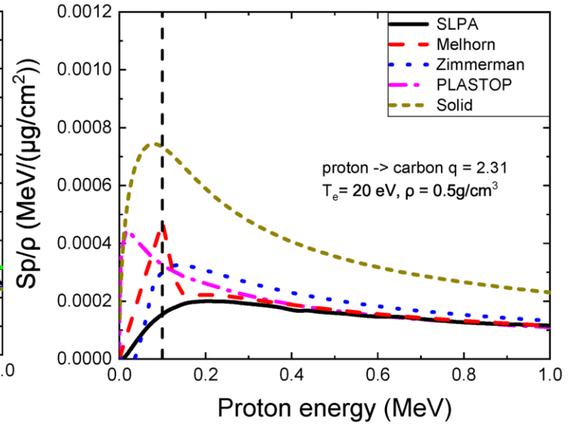
Stopping power

Our model: RPA (free) + SLPA (bound)

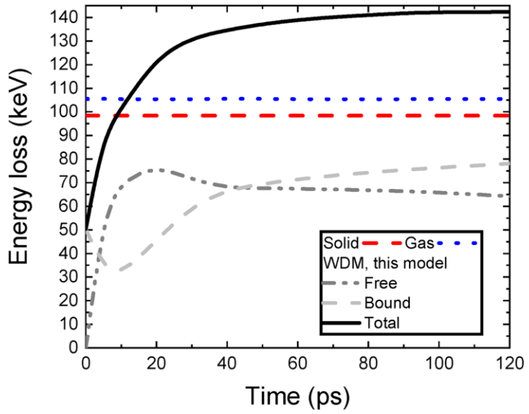
Free electrons



Bound electrons



Energy loss



Conclusions

- The simulation confirms that it is possible to reach the desired WDM conditions.
- To distinguish between stopping power models in WDM it is necessary to explore the Bragg peak region.
- Predicted energy loss shows the enhanced stopping power of plasmas.

Bibliography

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Acknowledgments

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