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Pioneering research
and skills

Investigating the accuracy of SNB nonlocal model

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York Plasma Institute

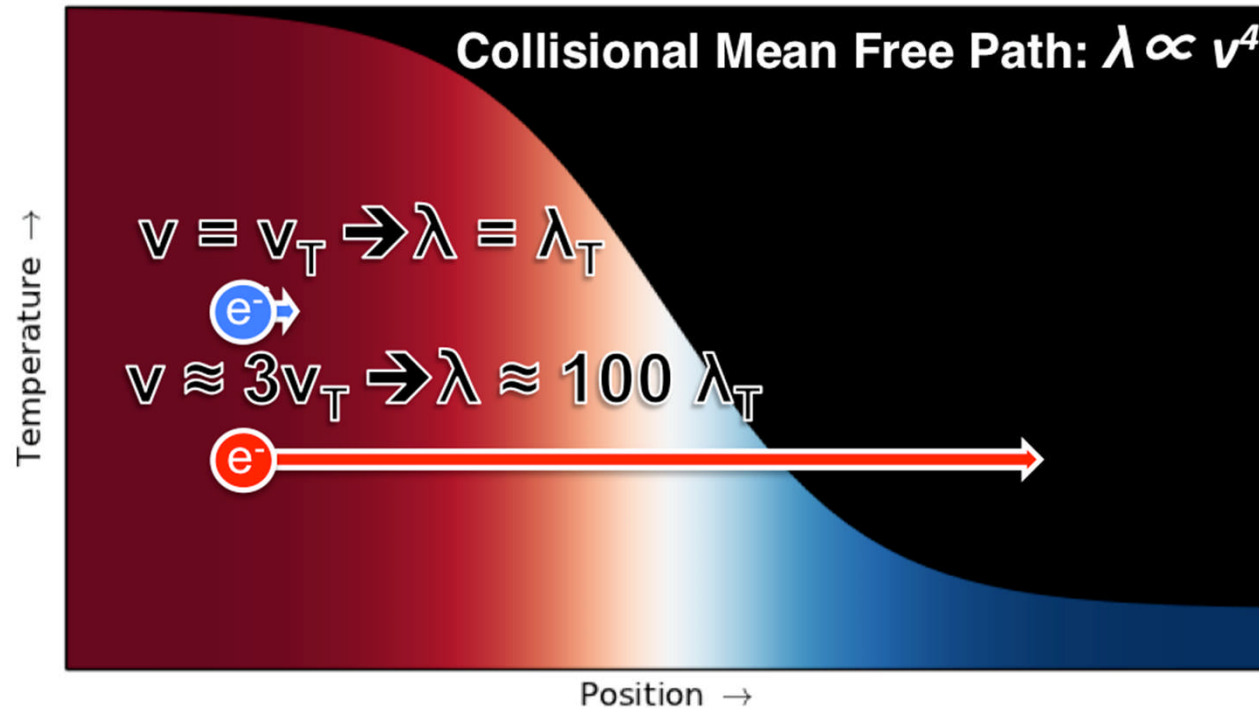


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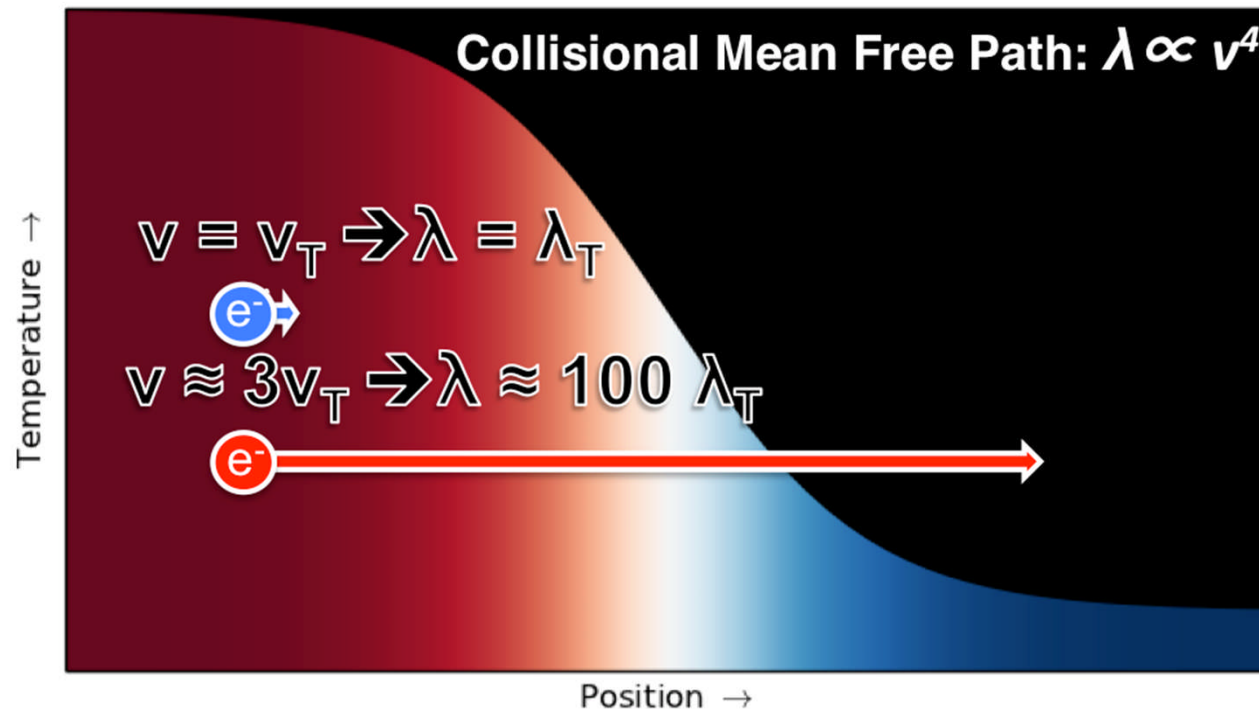
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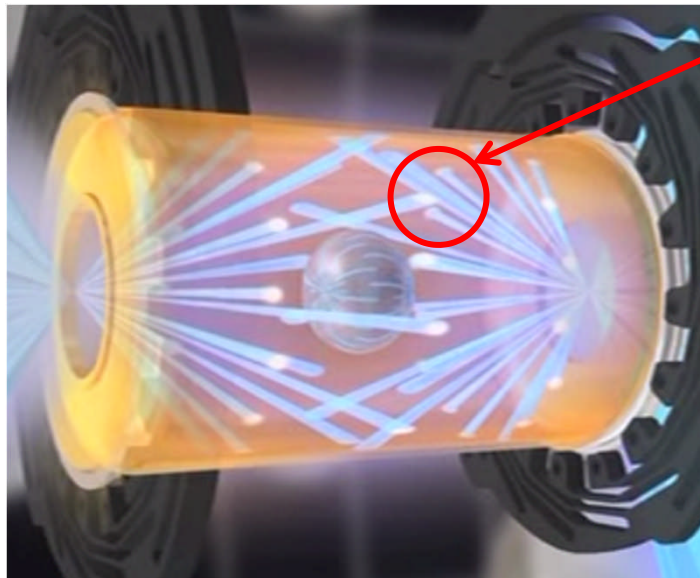




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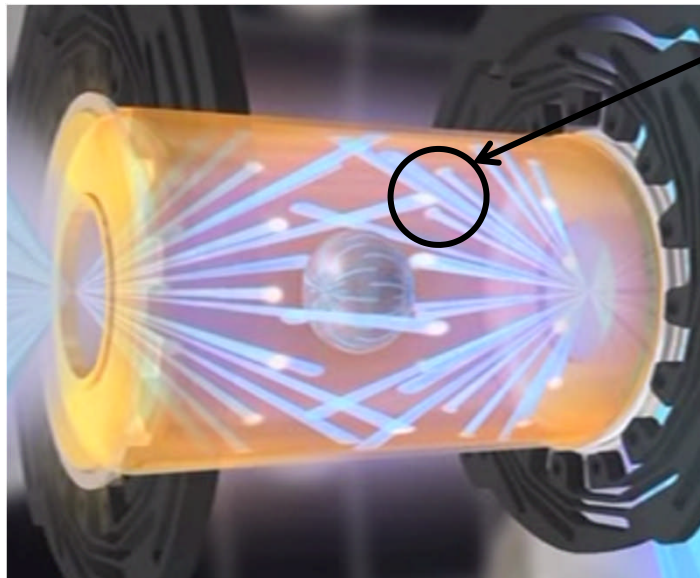
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Source: lasers.llnl.gov/media/video-gallery/ride-the-beamline

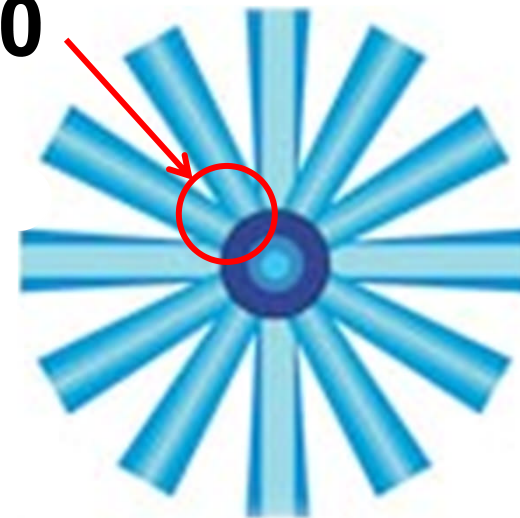


Importance in Inertial Fusion

- Steep temperature gradients induced near critical density where laser energy is absorbed.
- A major unknown in hohlraum energetics.



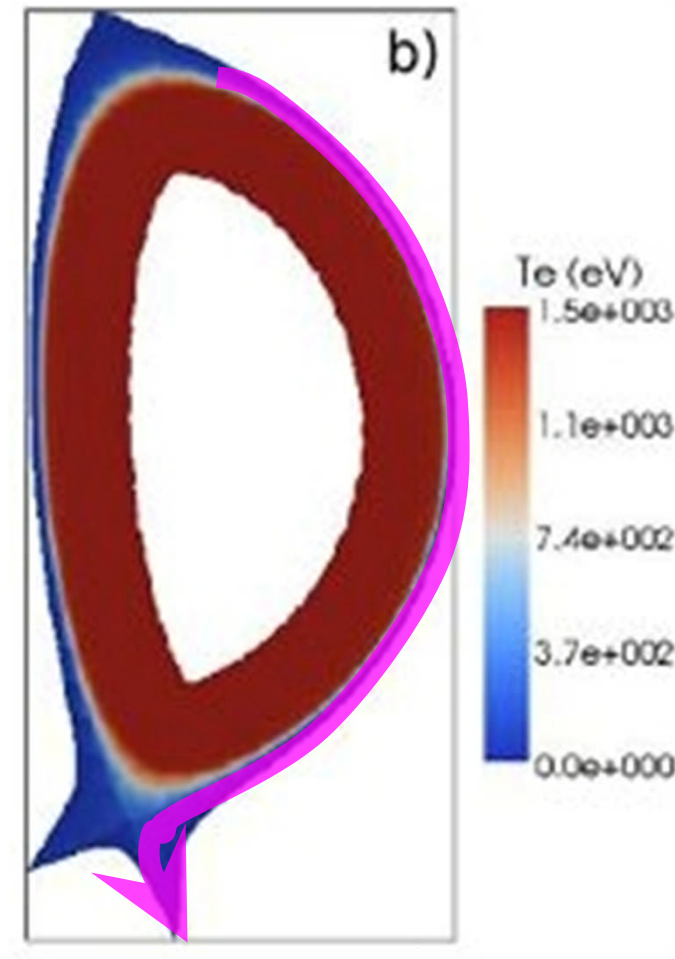
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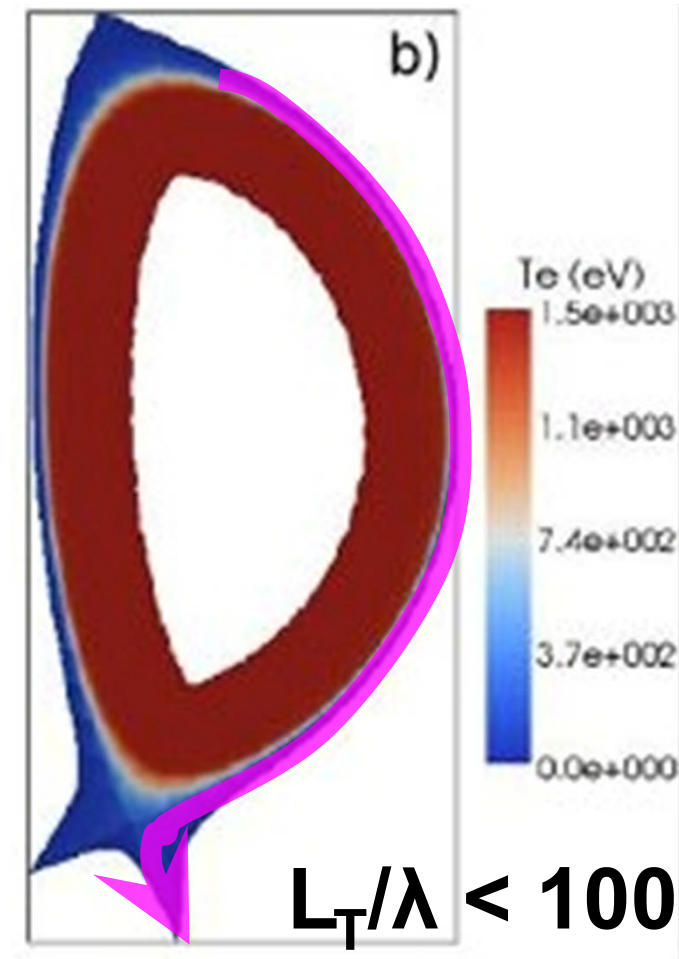
- Parallel transport in the Scrape-Off Layer (SOL) no longer limited by gyroradius.



Source: www3.imperial.ac.uk/plasmaphysics/research/dustyplasmas/tdt



- Parallel transport in the Scrape-Off Layer (SOL) no longer limited by gyroradius.
- Mean free path can be larger than connection length.
- Predicting divertor conditions critical to reactor design.



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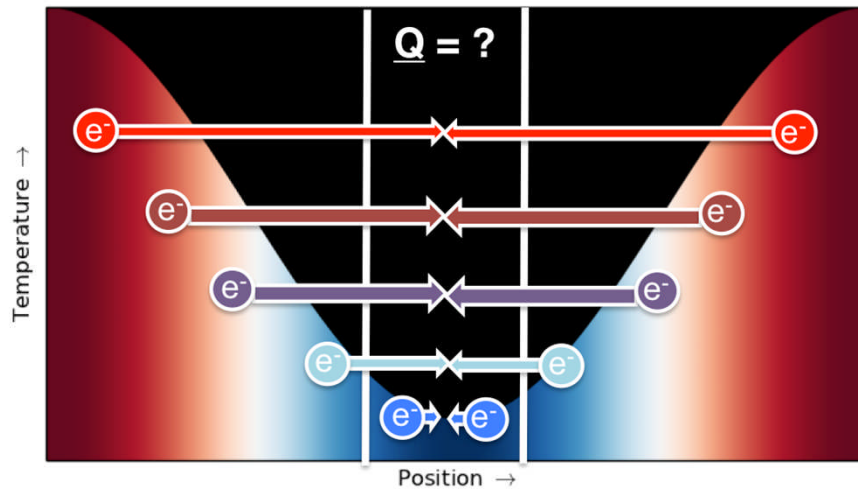


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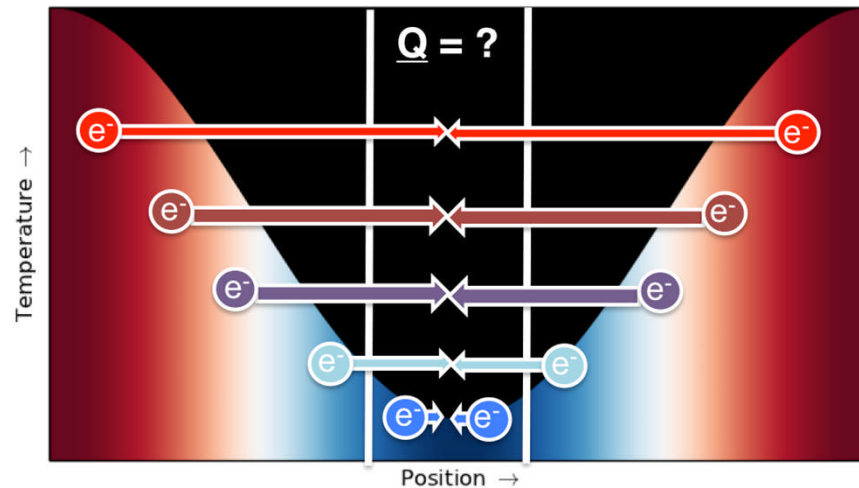
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- **Kinetic Codes** – Computationally intensive
- **Reduced models** - Efficient, predictive, easy to incorporate into fluid code

- **Convolution Models** – Sum up weighted heat flux from external regions.



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- **Multigroup Diffusion (SNB⁴)** – Recast integral as differential equation to enable efficient extension to multiple dimensions.



- Differential equation split over energy or velocity groups.

$$\left(\frac{1}{\lambda_g(\mathbf{r})} - \nabla \frac{\lambda'_g(\mathbf{r})}{3} \nabla \right) H_g = -\nabla \cdot \mathbf{U}_g$$



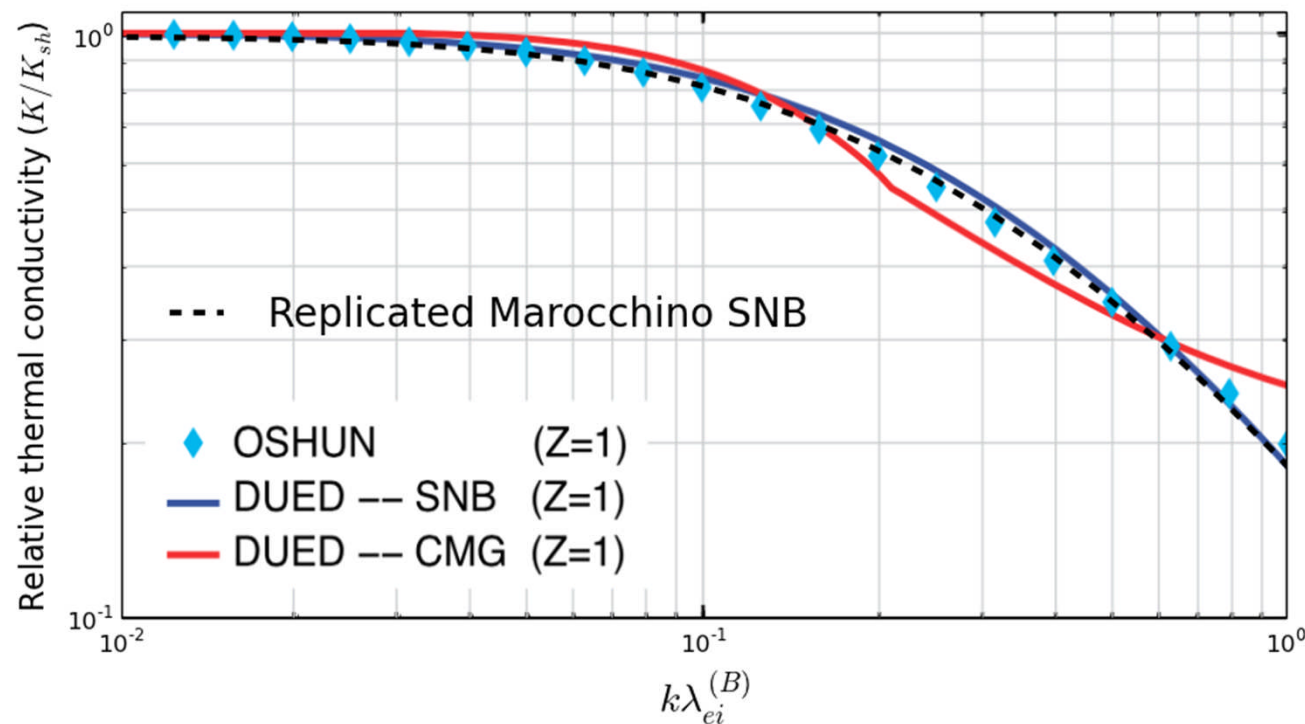
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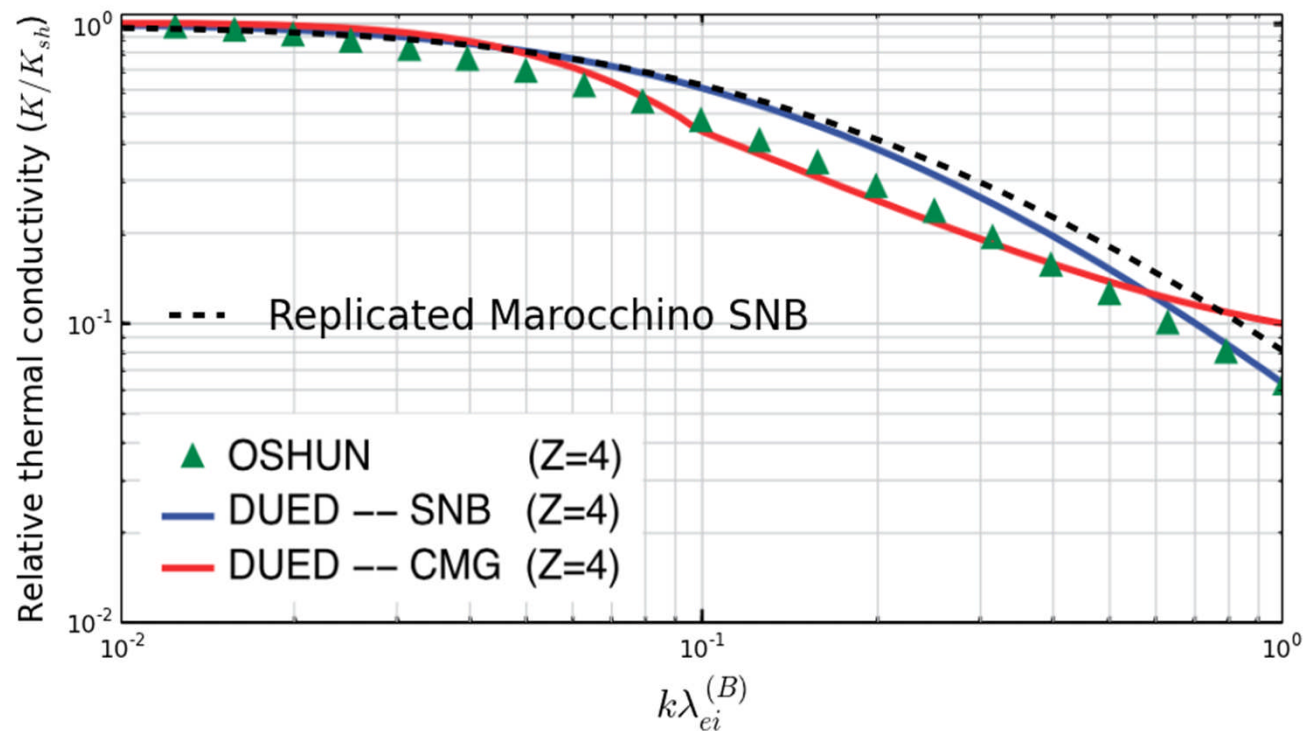
- Heat flow then given by:

$$\mathbf{Q}_t = \mathbf{Q}_{\text{sh}} - \sum_g \lambda'_g \nabla H_g$$

- Marocchino *et al.* showed that the SNB model worked well for the linearised case of a temperature sinusoid when $Z = 1^5$.

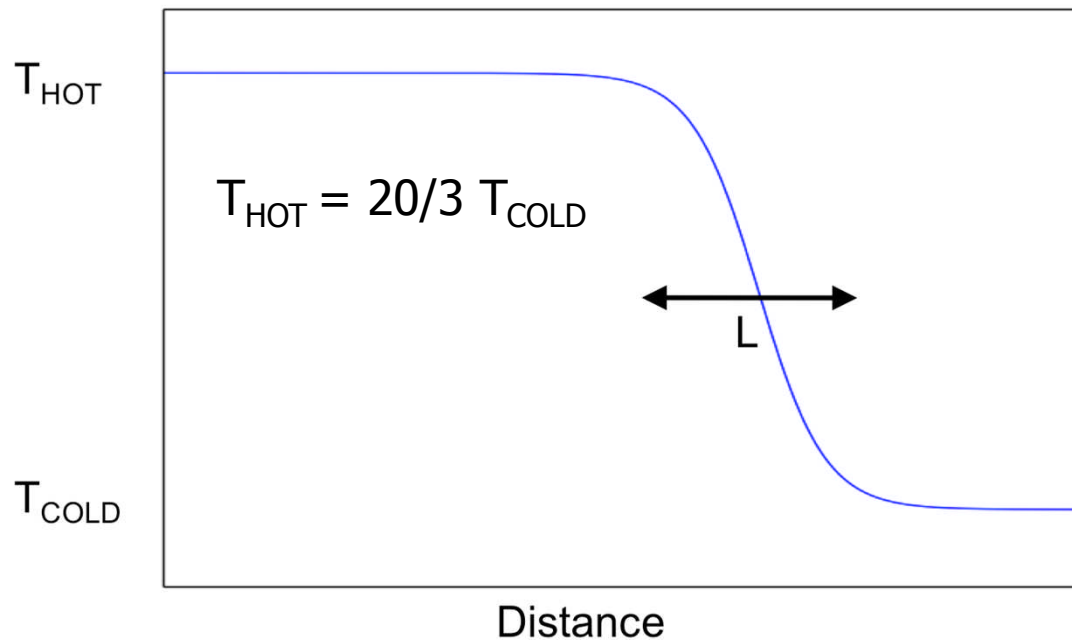


- However, the model was observed to work progressively worse for higher Z.





- Start with an initial Helium plasma with a *tanh* temperature profile.



- Compare SNB to kinetic code IMPACT



- **Kinetic Codes – IMPACT**
- Solves exact Vlasov-Fokker-Planck equations for the distribution function.

$$\frac{\partial f}{\partial t} + \mathbf{v} \cdot \frac{\partial f}{\partial \mathbf{r}} + \frac{\mathbf{F}}{m} \cdot \frac{\partial f}{\partial \mathbf{v}} = \left(\frac{\partial f}{\partial t} \right)_c$$



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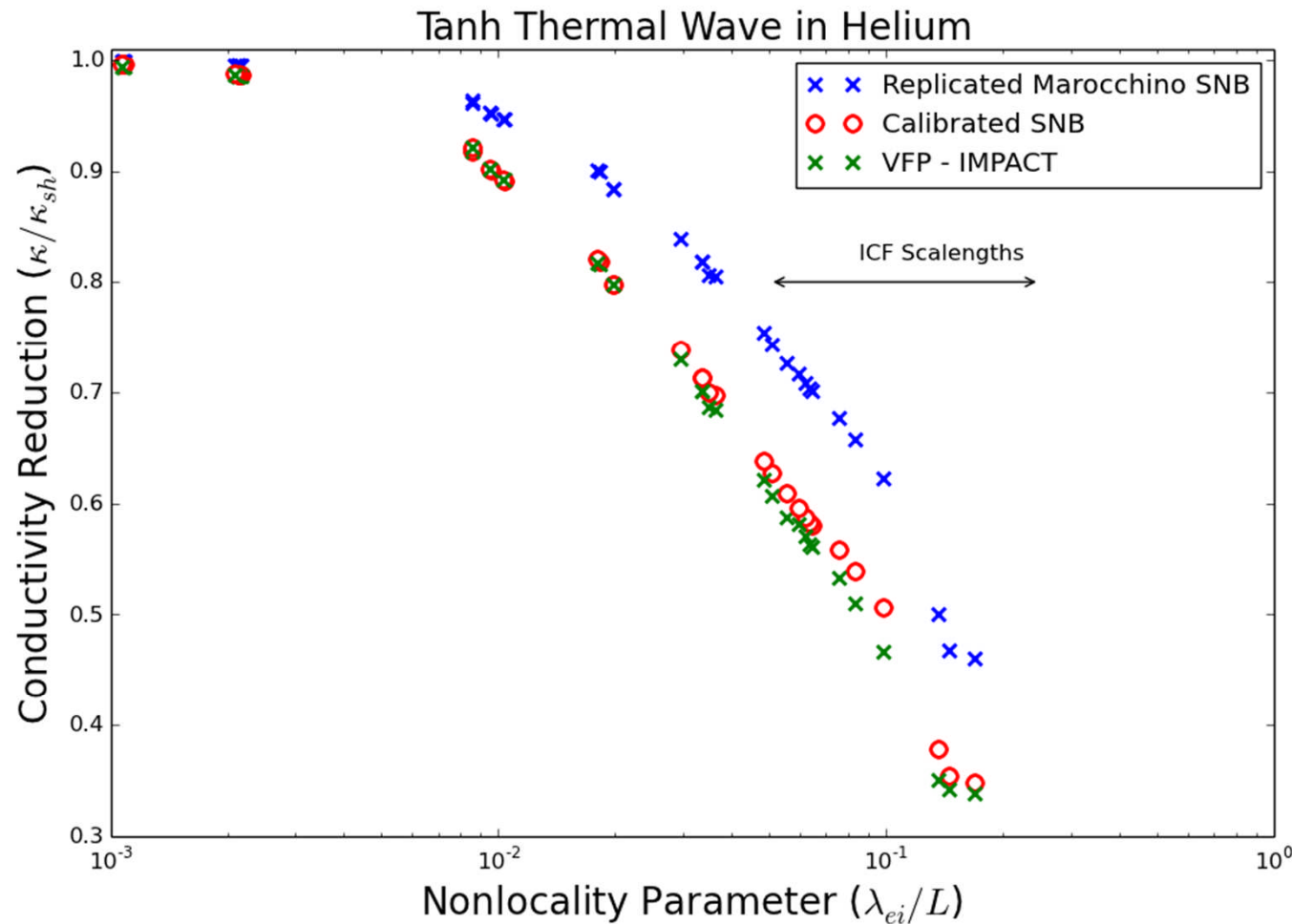


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- Difficult to incorporate ‘multiphysics’ such as radiation transport and equation of state.

- Apply calibration to mean-free-path $\lambda \rightarrow \lambda/2.4$





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