Beam self-focusing and electron transport effects in magnetised laser-plasmas

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Talk Outline

- Motivation: B-fields in HED plasmas
- Magnetised e^- transport physics
- Results from CTC and IMPACT simulations

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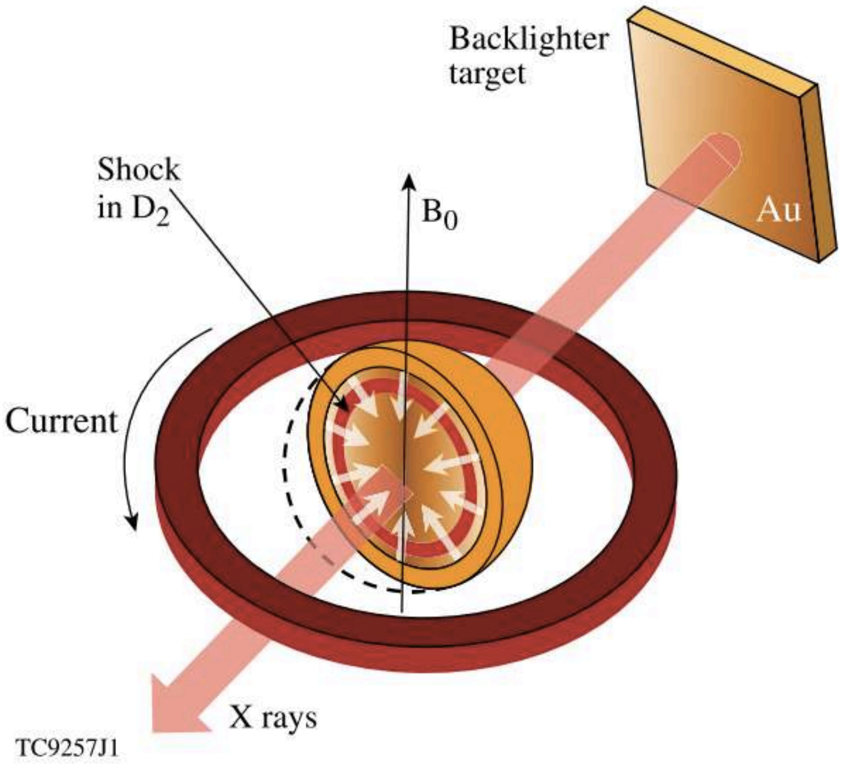
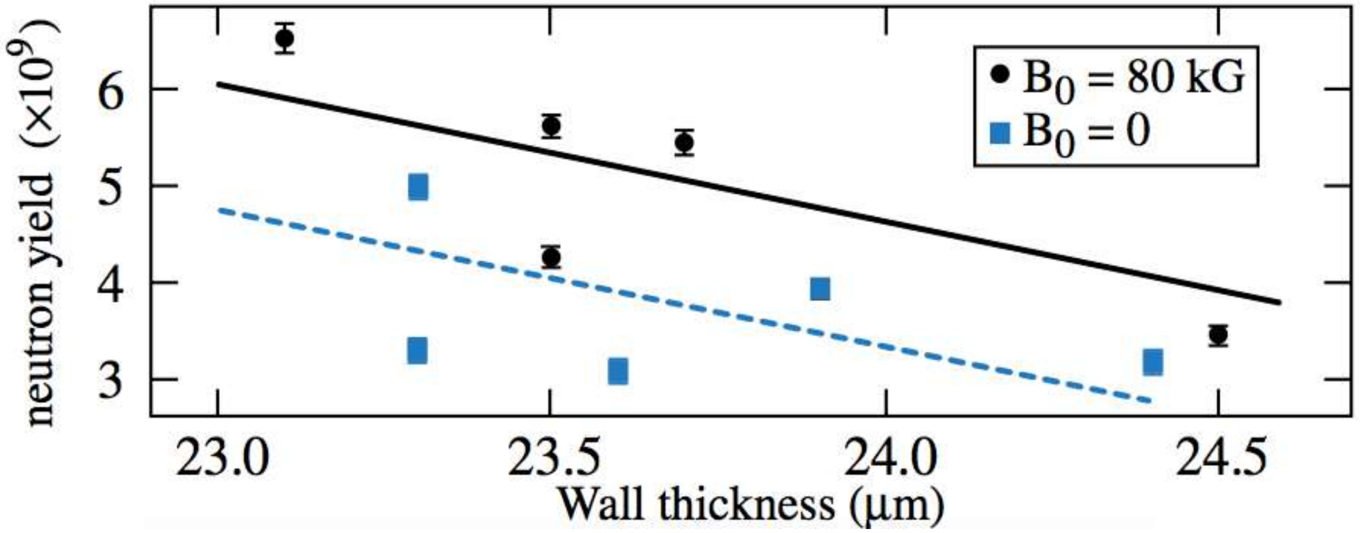
- 30% increase in neutron yield with 8 kT field [1]





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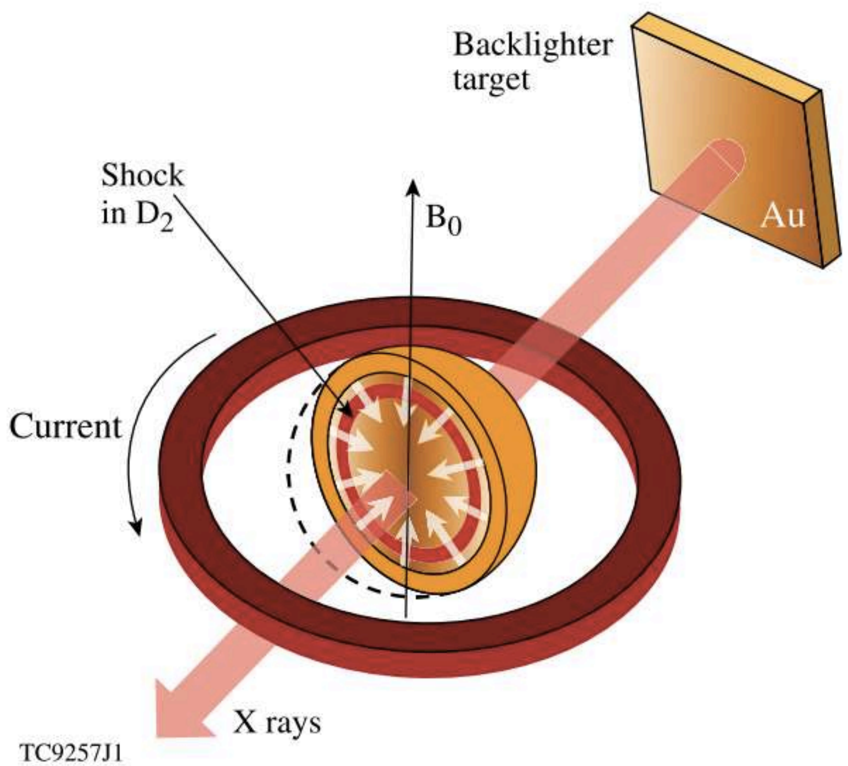

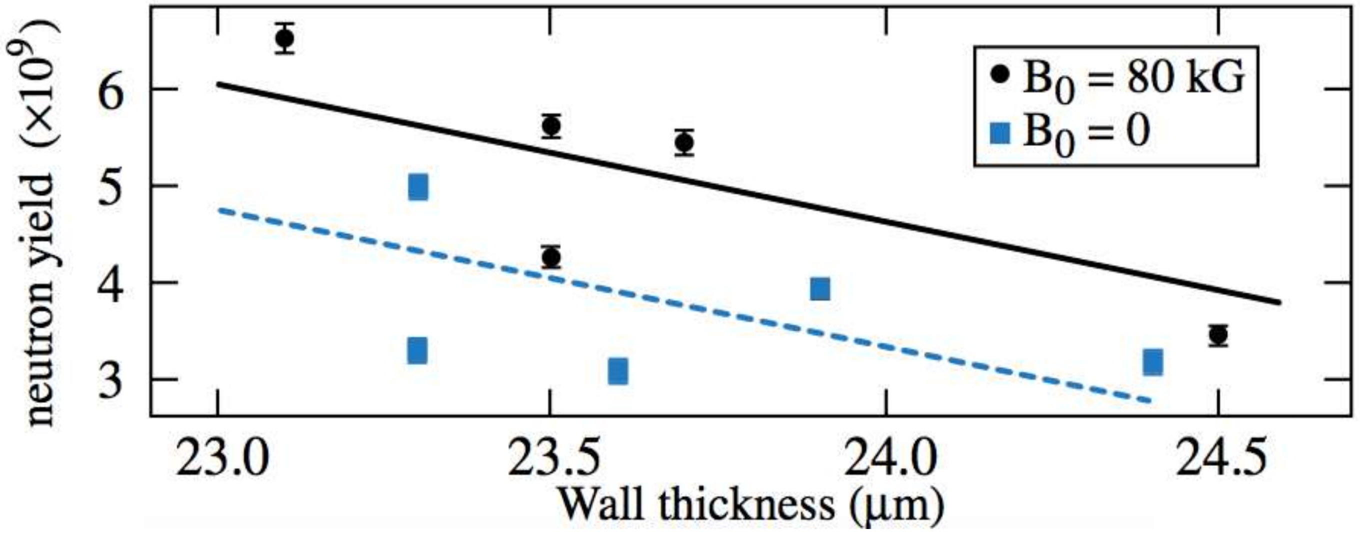

- Flux-limited Nernst advection required to match simulations to experiment [2]

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[2] Davies et al., Phys. Plas. **22** (2015)

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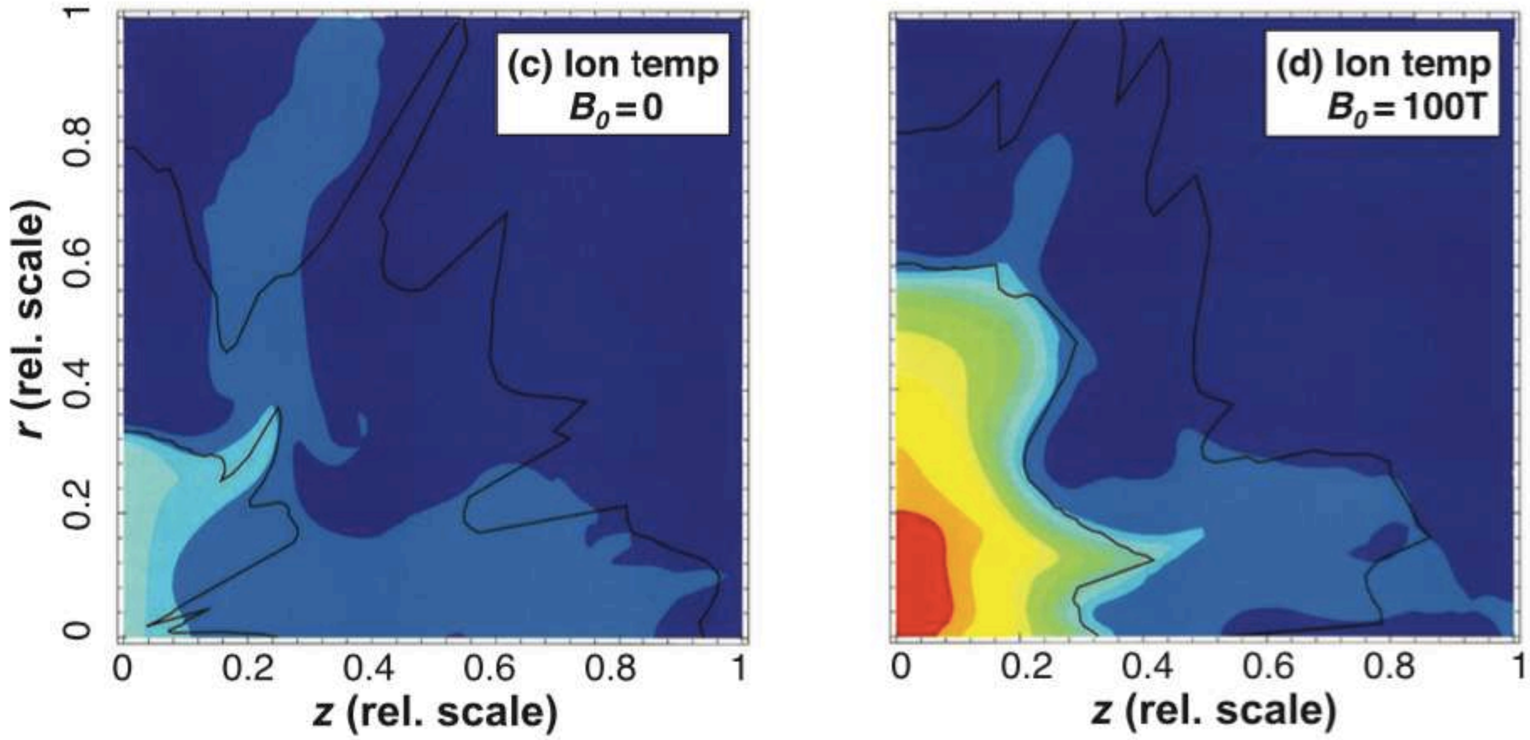

- Potential for B-field aided ignition of targets [4]

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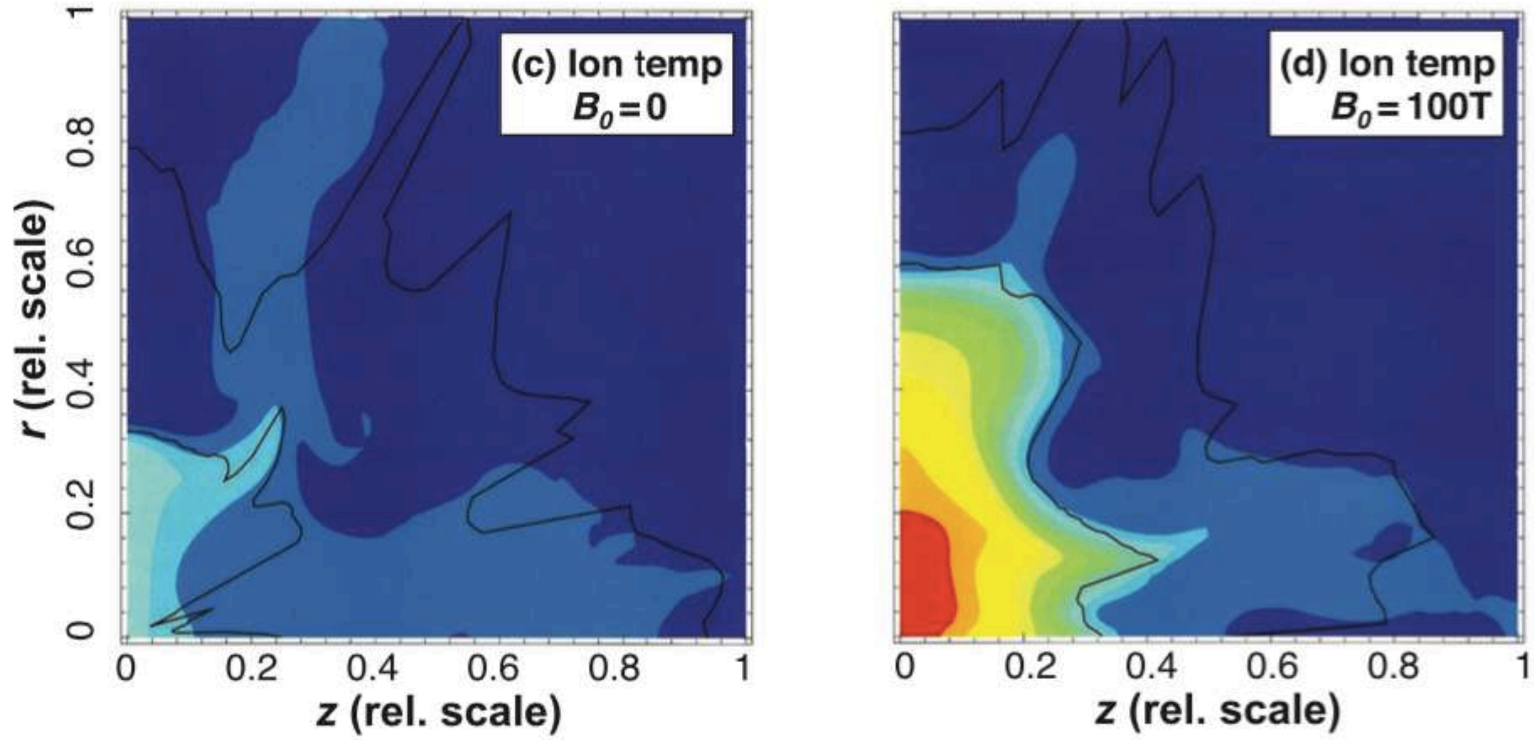

- Potential for B-field aided ignition of targets [4]
- But Nernst advection can reduce hohlraum T_e [5]

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[5] Farmer et al., Phys. of Plasmas **24** (2017)

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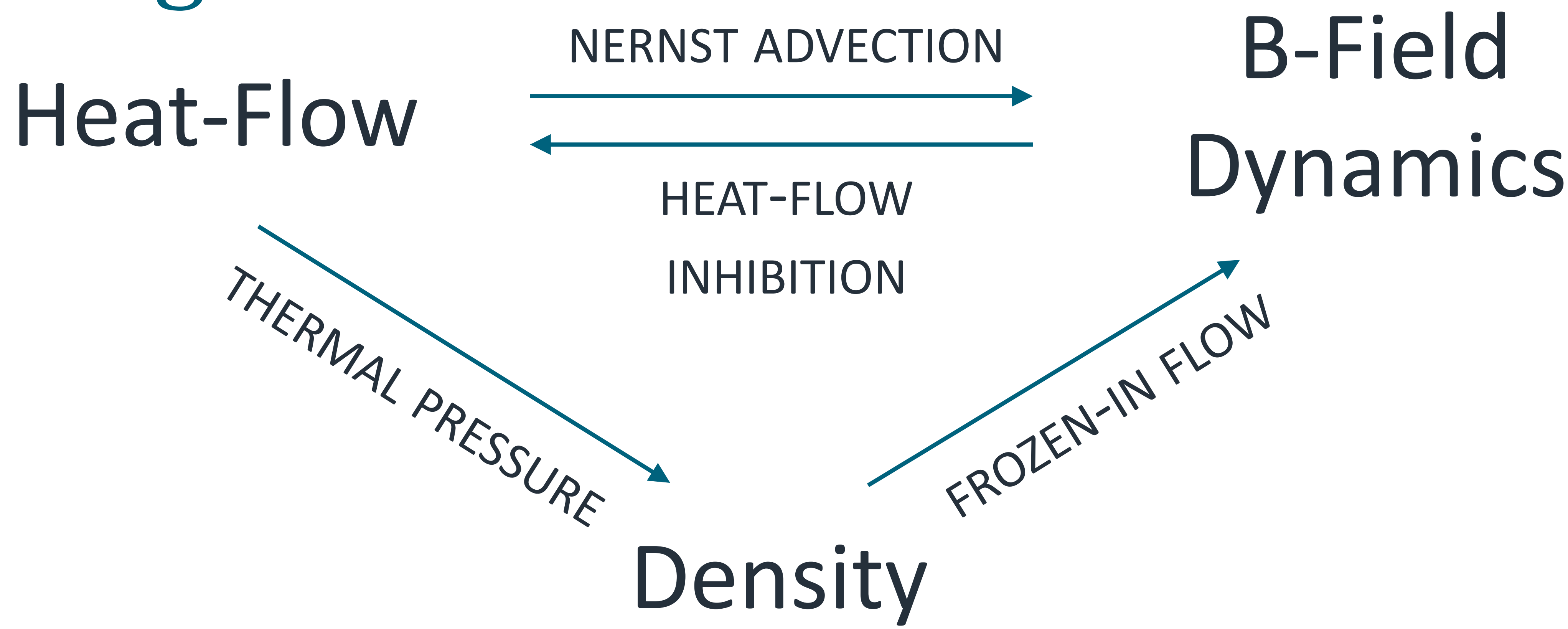

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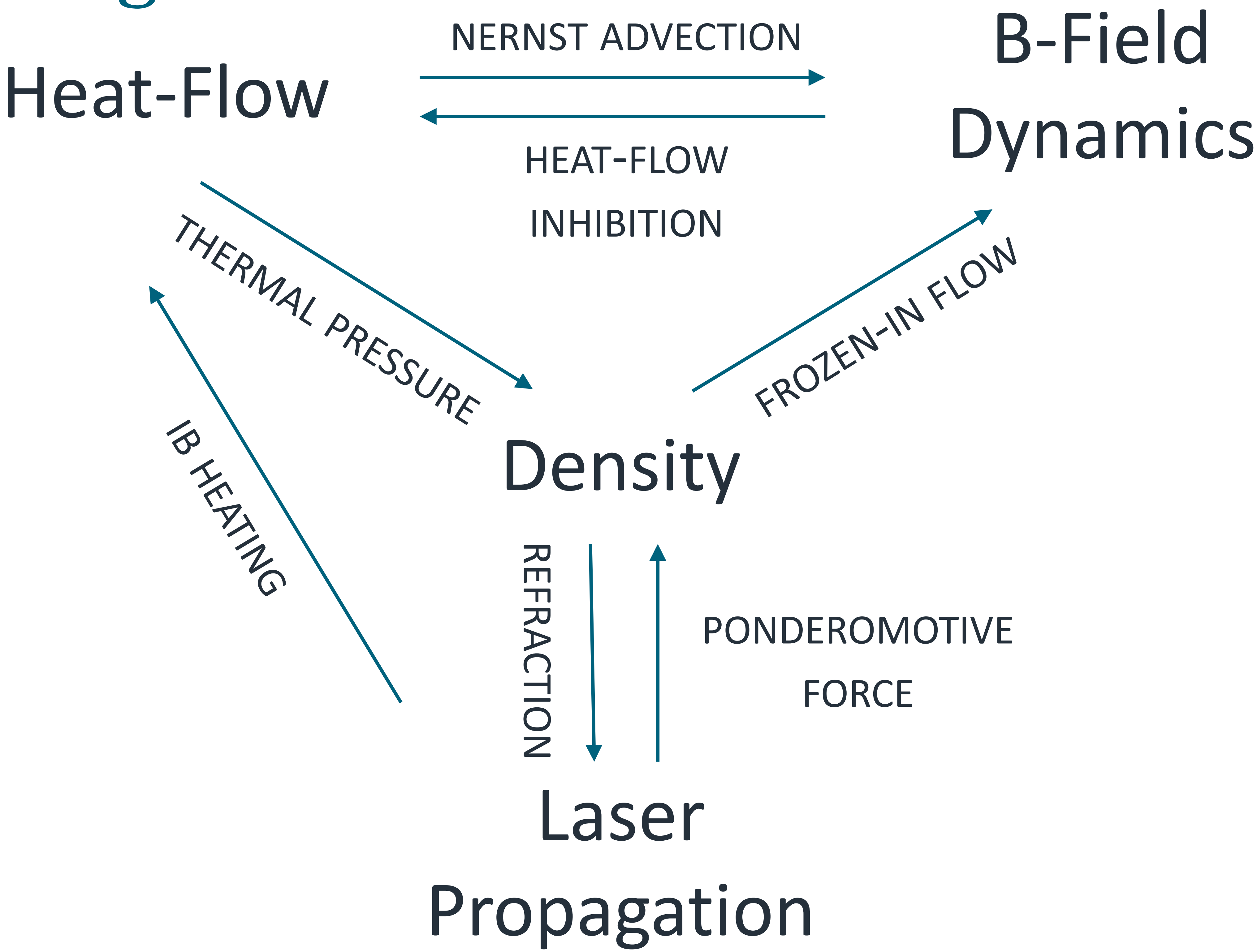

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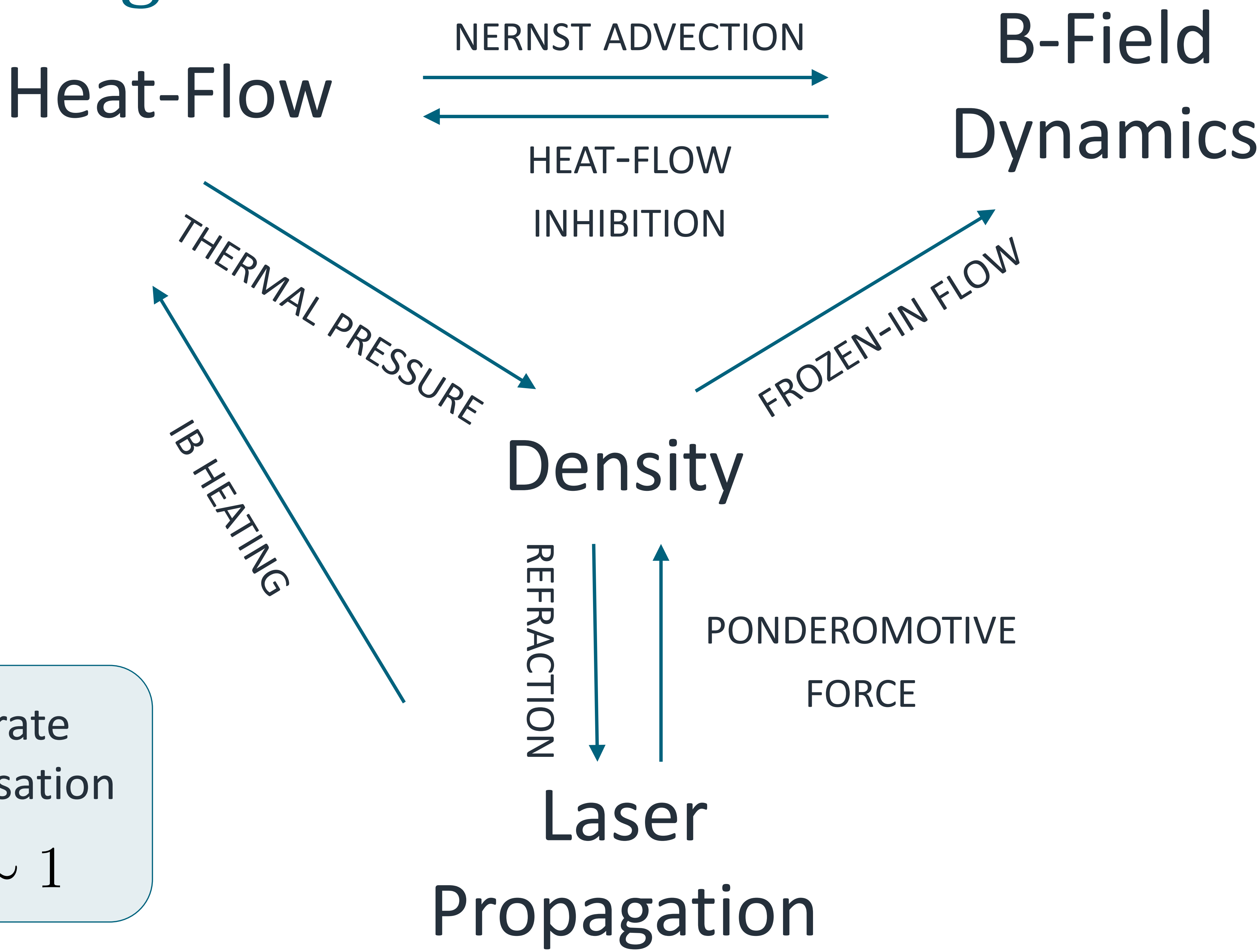

moderate magnetisation

$\omega\tau \sim 1$

Magnetised transport processes

- Heat-flow

$$\mathbf{q} = -\frac{n_e \tau_B T_e}{m_e} \underline{\underline{\kappa}}^c \cdot \nabla T_e - \underline{\underline{\beta}}^c \cdot \mathbf{j} \frac{T_e}{e}$$

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- Ohm's law

$$e n_e \left(\mathbf{E} + \mathbf{C} \times \mathbf{B} \right) = -\nabla P_e + \mathbf{j} \times \mathbf{B} + \frac{m_e}{e\tau} \underline{\underline{\alpha}}^c \cdot \mathbf{j} - n_e \underline{\underline{\beta}}^c \cdot \nabla T_e$$

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frozen-in flow — Nernst advection

- Nernst advection - B-fields advect with heat-flow

$$\frac{\partial \mathbf{B}}{\partial t} = -\nabla \times \left(\frac{\beta_\wedge}{e|B|} \nabla T_e \times \mathbf{B} \right) = \nabla \times \left(\mathbf{v}_{\mathrm{N}} \times \mathbf{B} \right)$$

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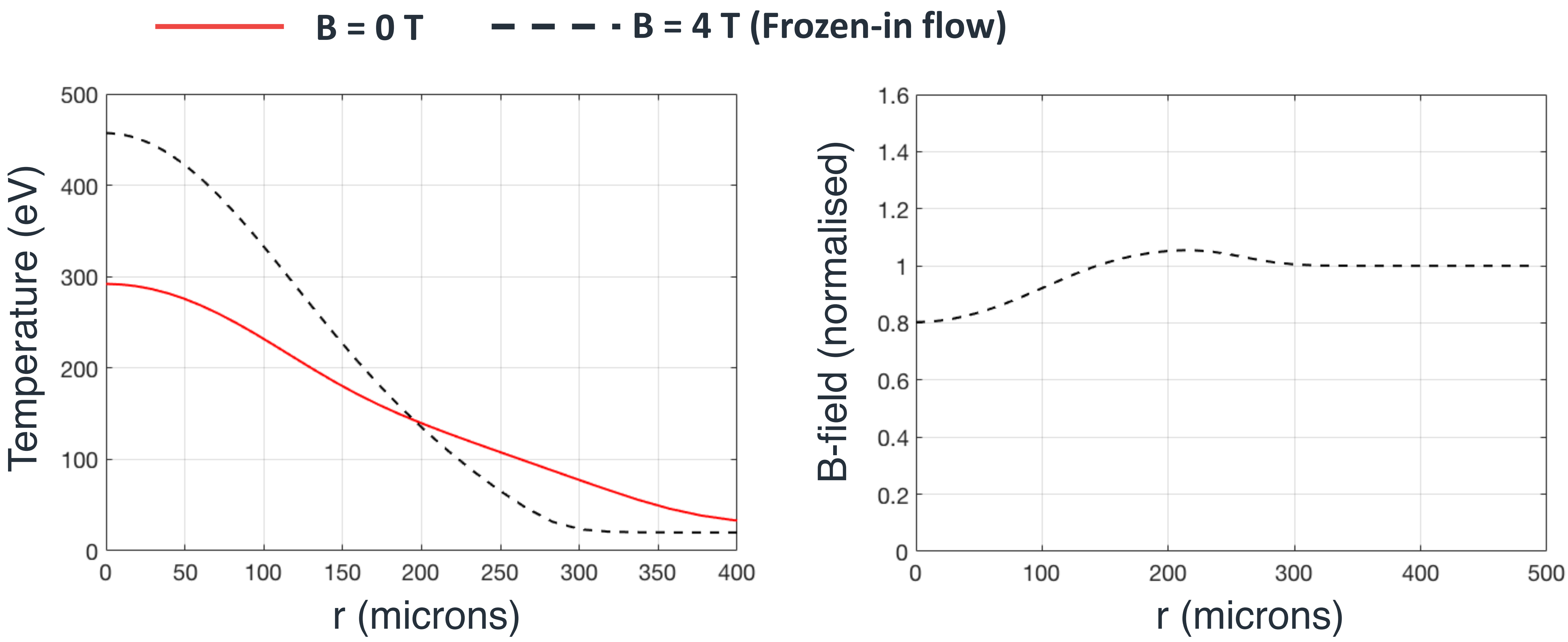

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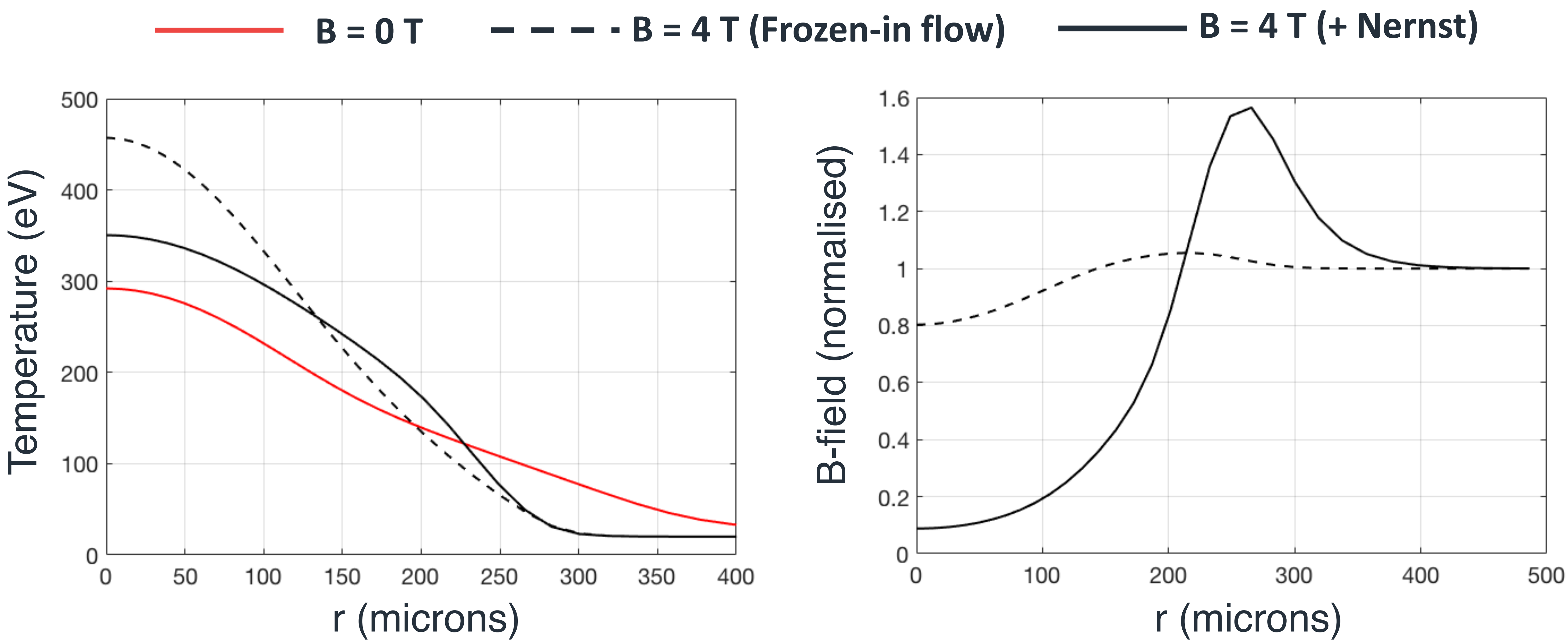

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[9] Ridgers *et al.*, Phys. Rev. Lett. **100** (2008)

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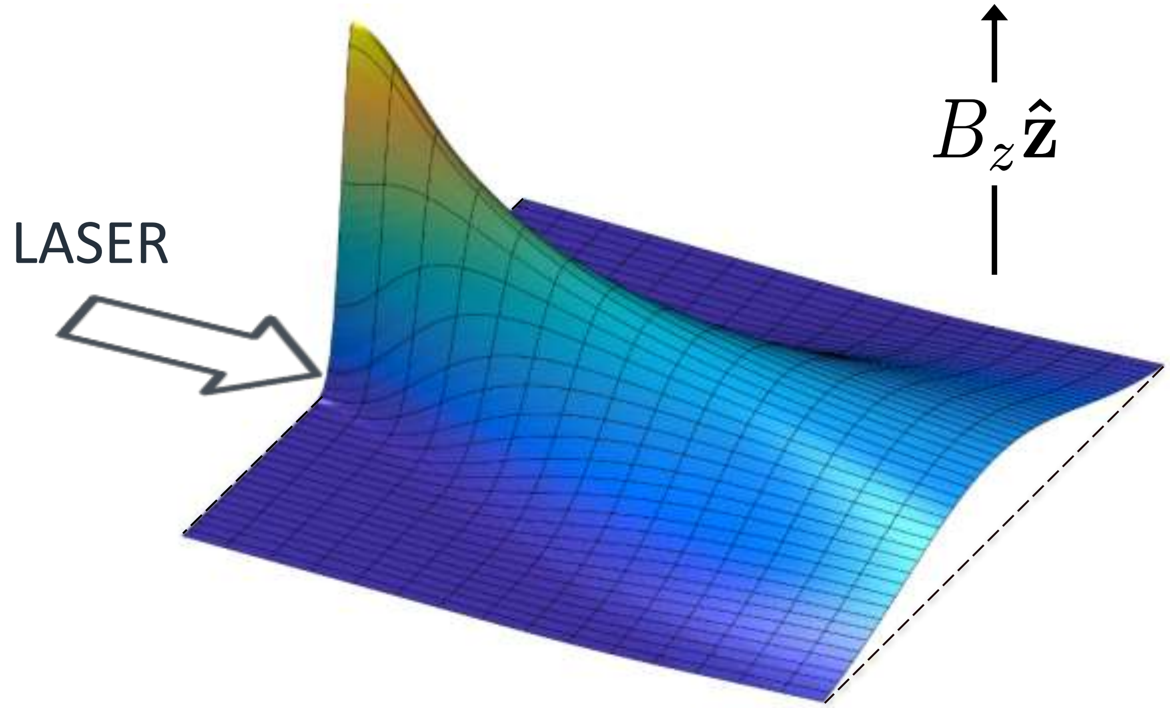

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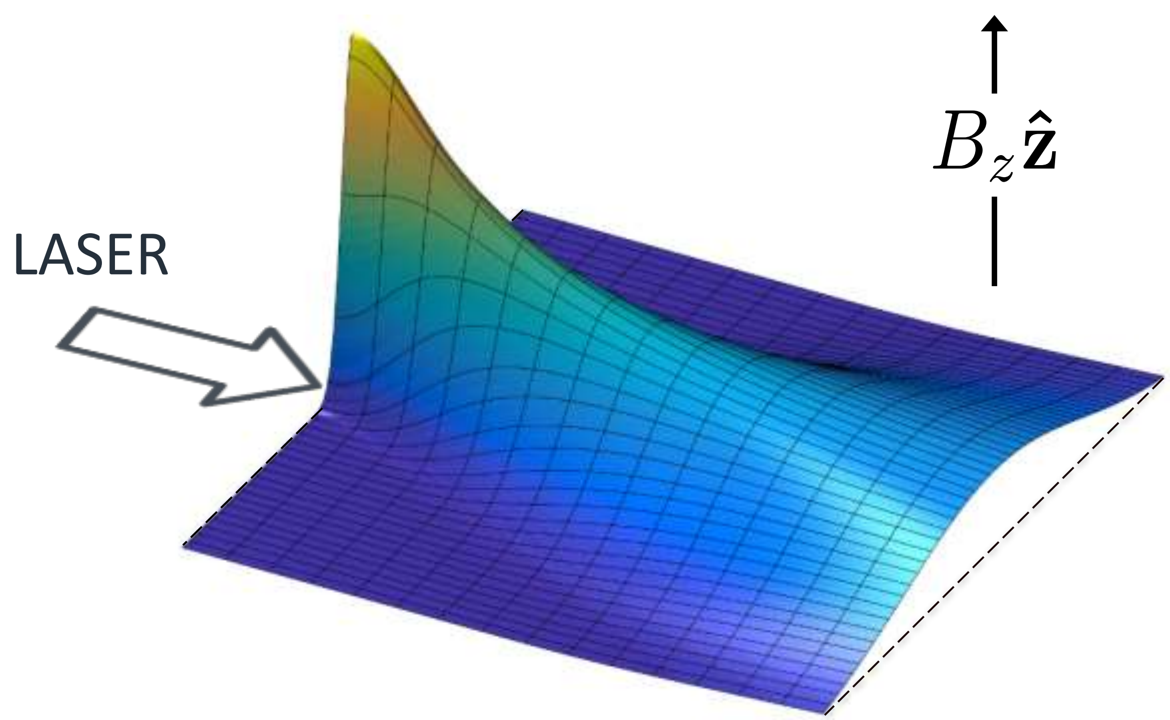

n_{e0}	$(0.75\,,1.5\,,7.5)\times 10^{19}\,\mathrm{cm}^{-3}$
T_{e0}	$20\,\mathrm{eV}$
Z	$2\,(\mathrm{He}),\,7\,(N)$
B_0	$0\,,3\,,6\,\mathrm{T}$
I_0	$3.9\times 10^{14}\,\mathrm{Wcm}^{-2}$
λ_l	$1.054\,\mu\mathrm{m}$
ϕ	$10.0\,\mu\mathrm{m}$

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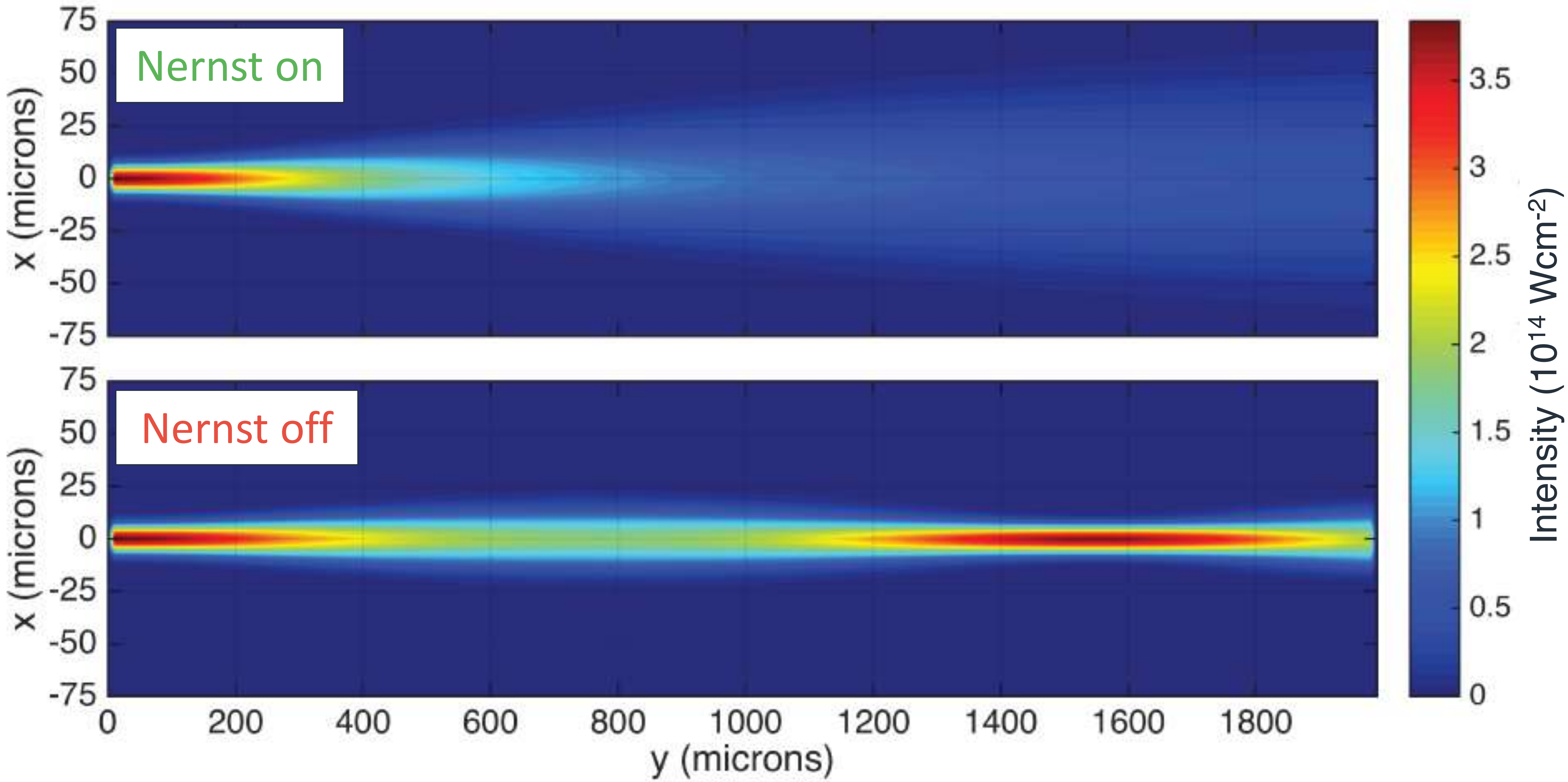

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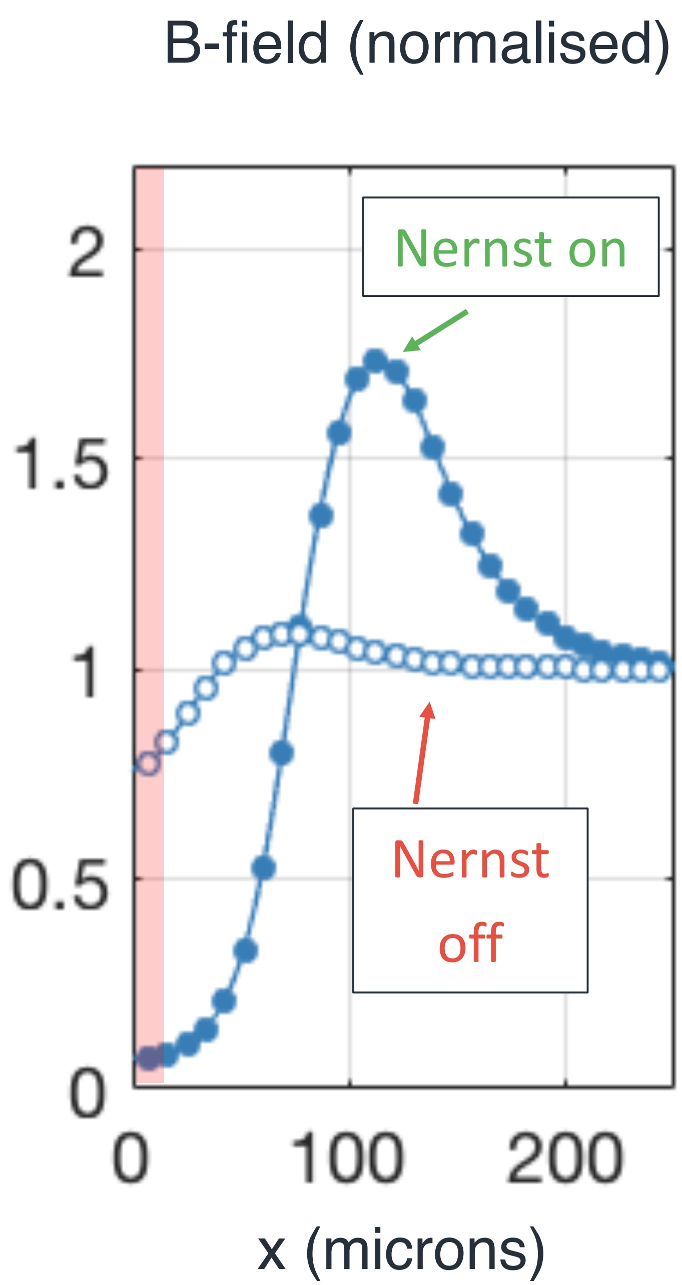

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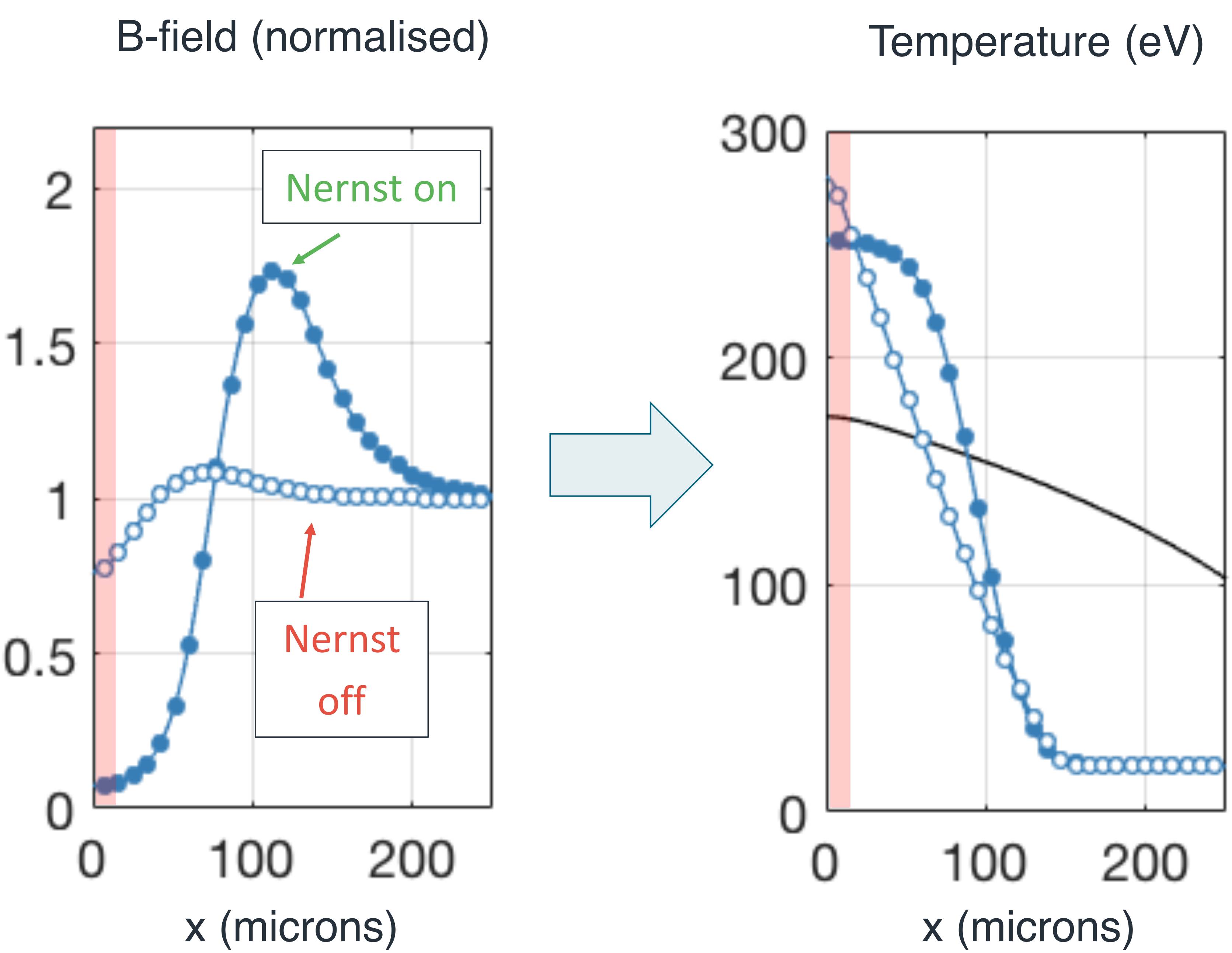

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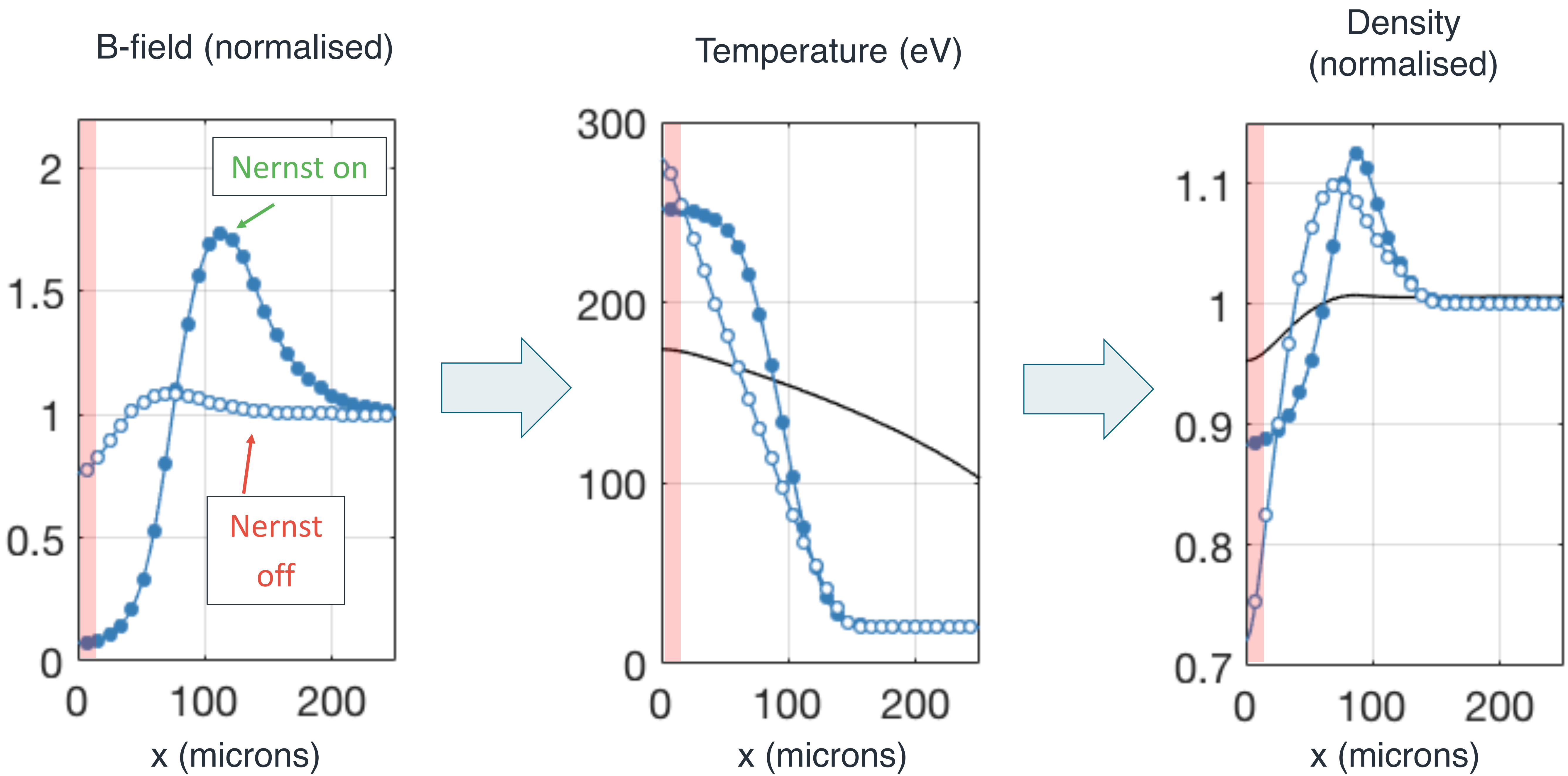
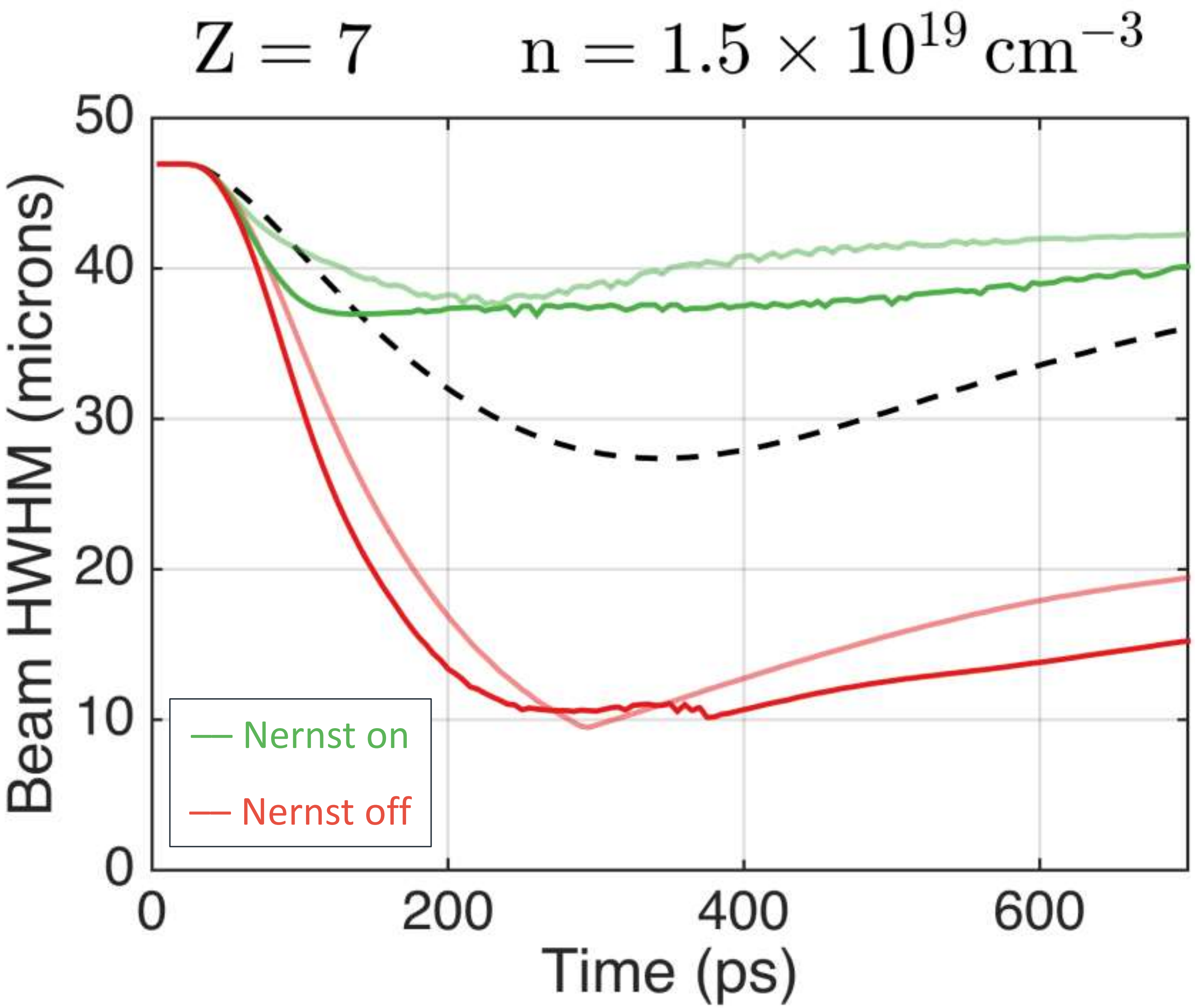


Channel disruption in CTC is consistent



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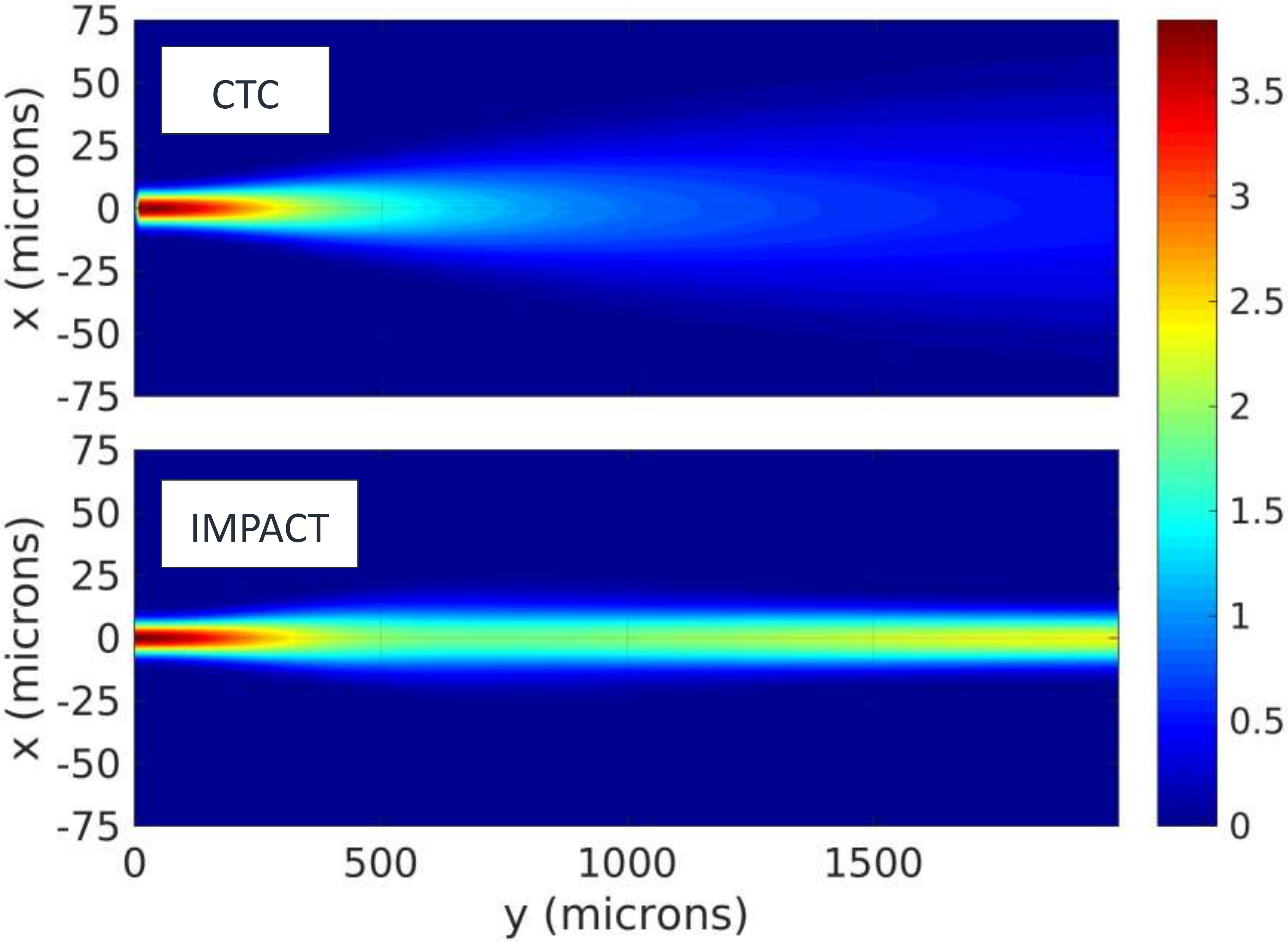
Intensity (10^{14} Wcm^{-2}) at t = 350 ps



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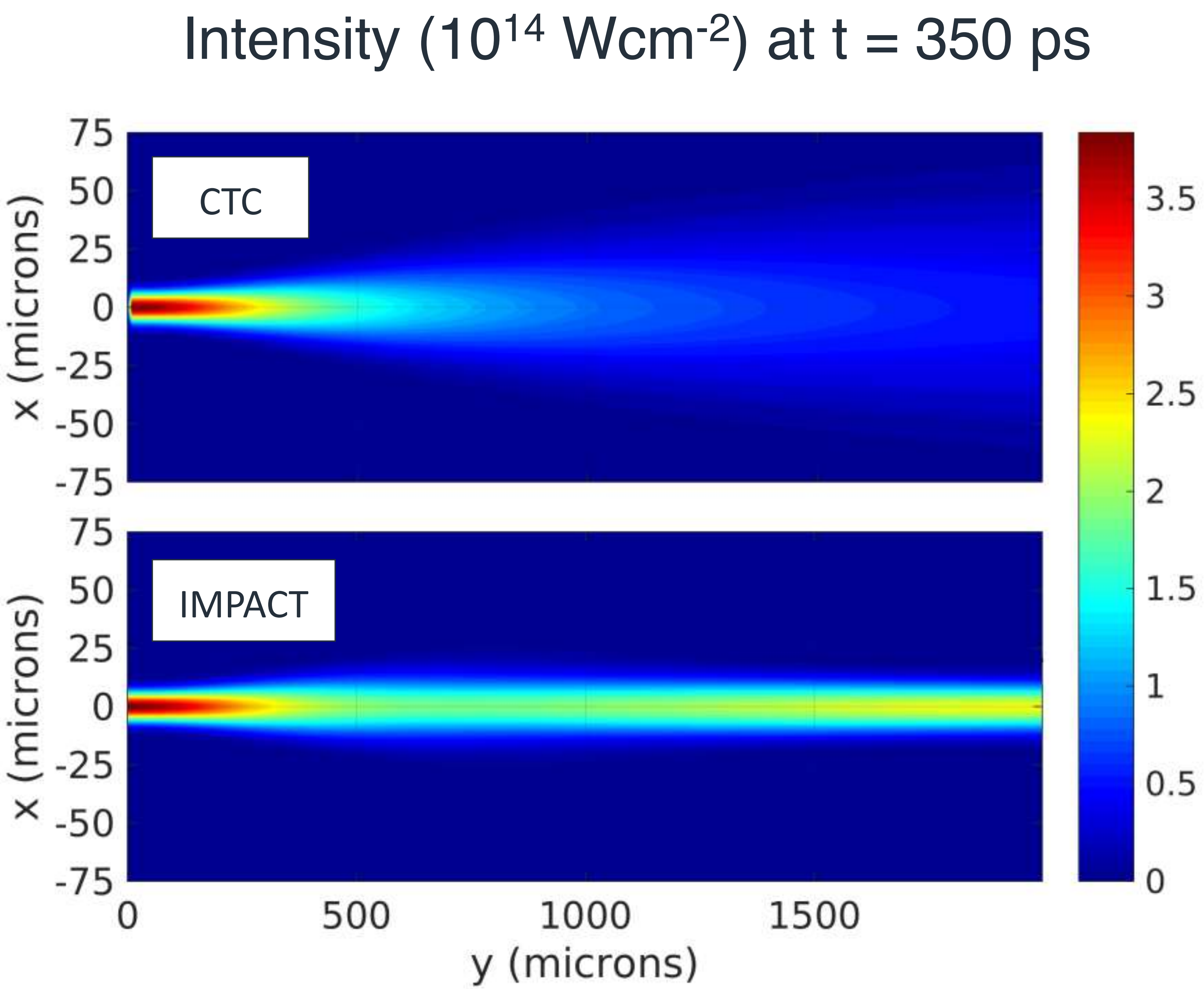

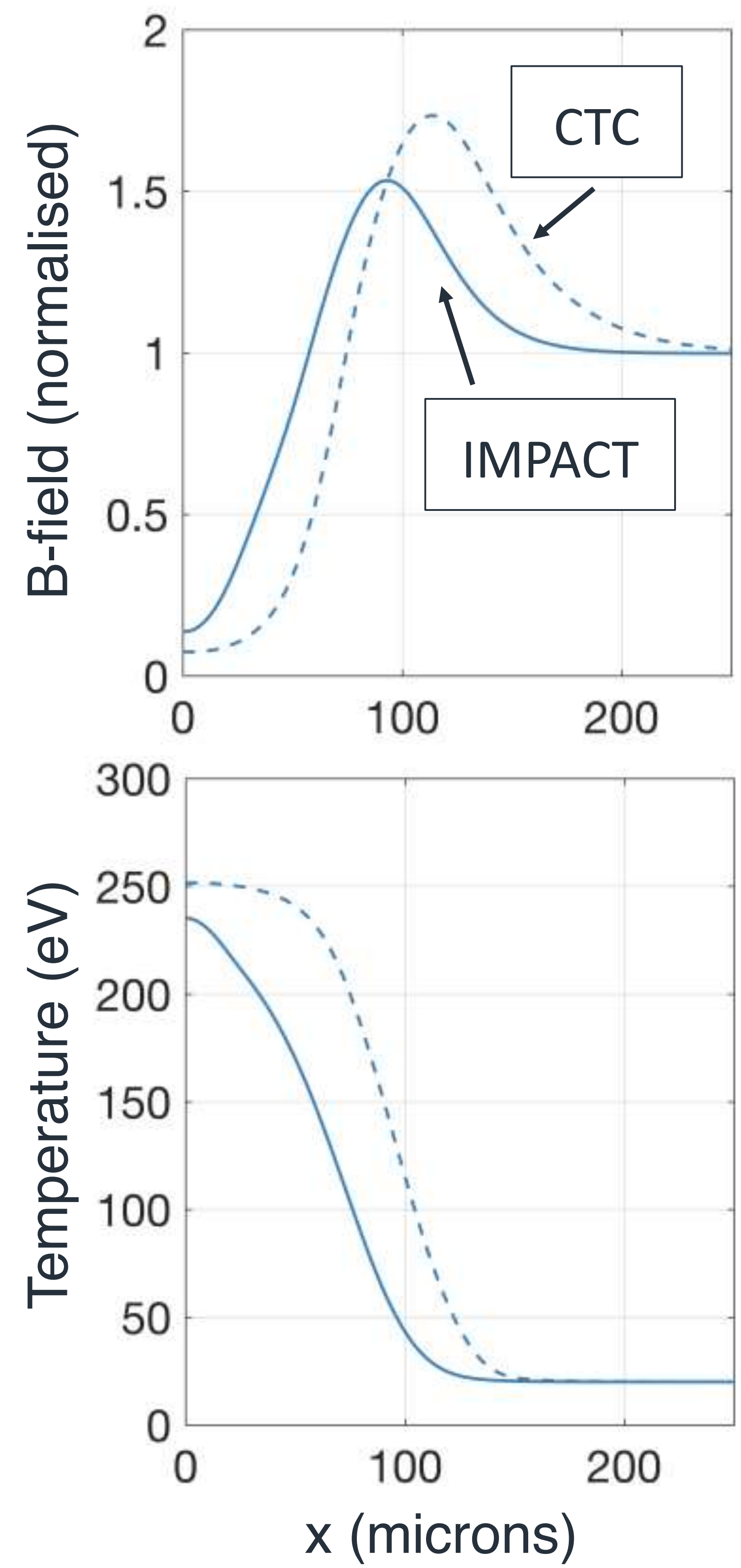

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  - Super-Gaussian transport can reduce Nernst advection by 5x under similar conditions [12]

[12] Bissell *et al.*, New J. Phys. **15** (2013)

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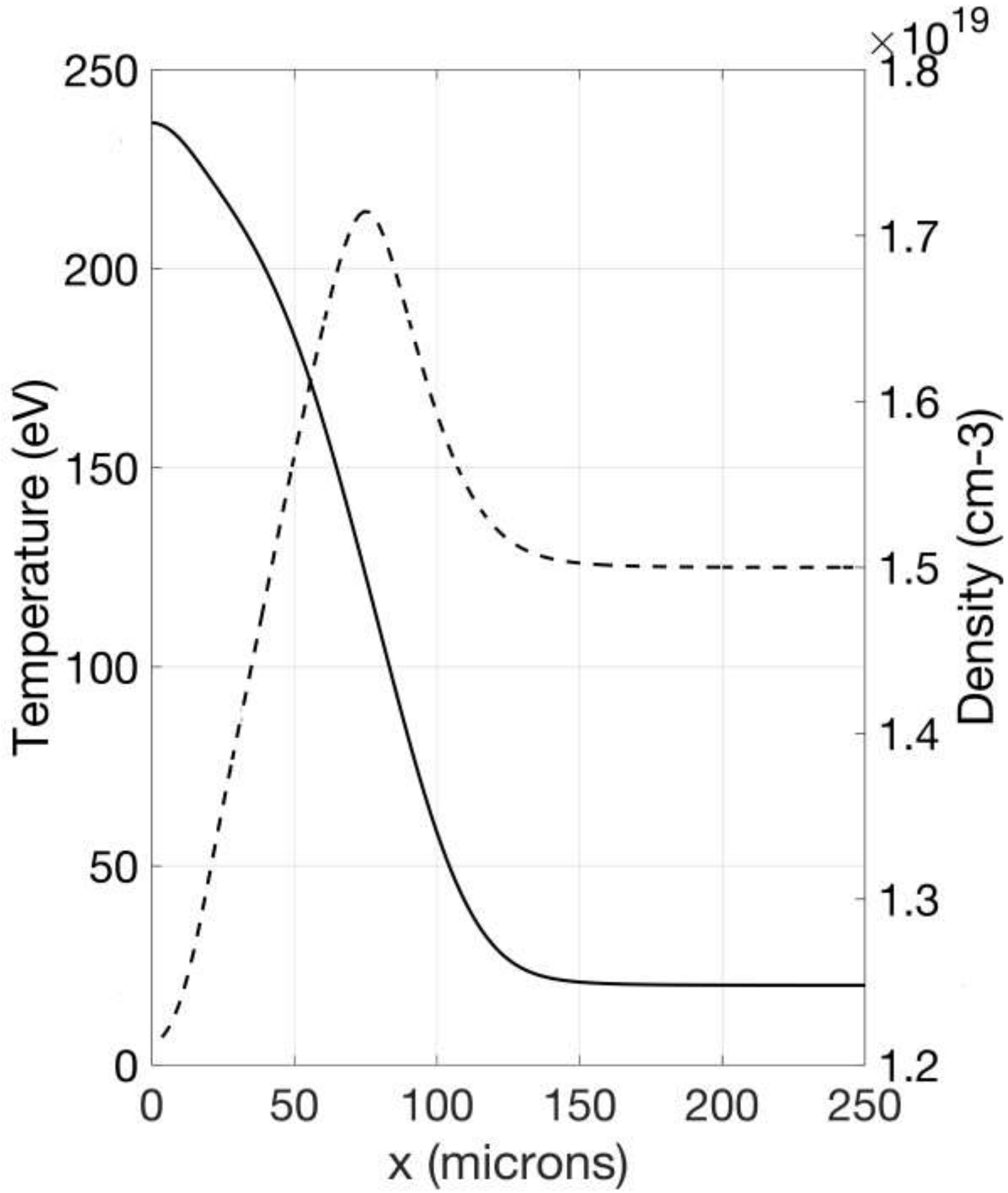

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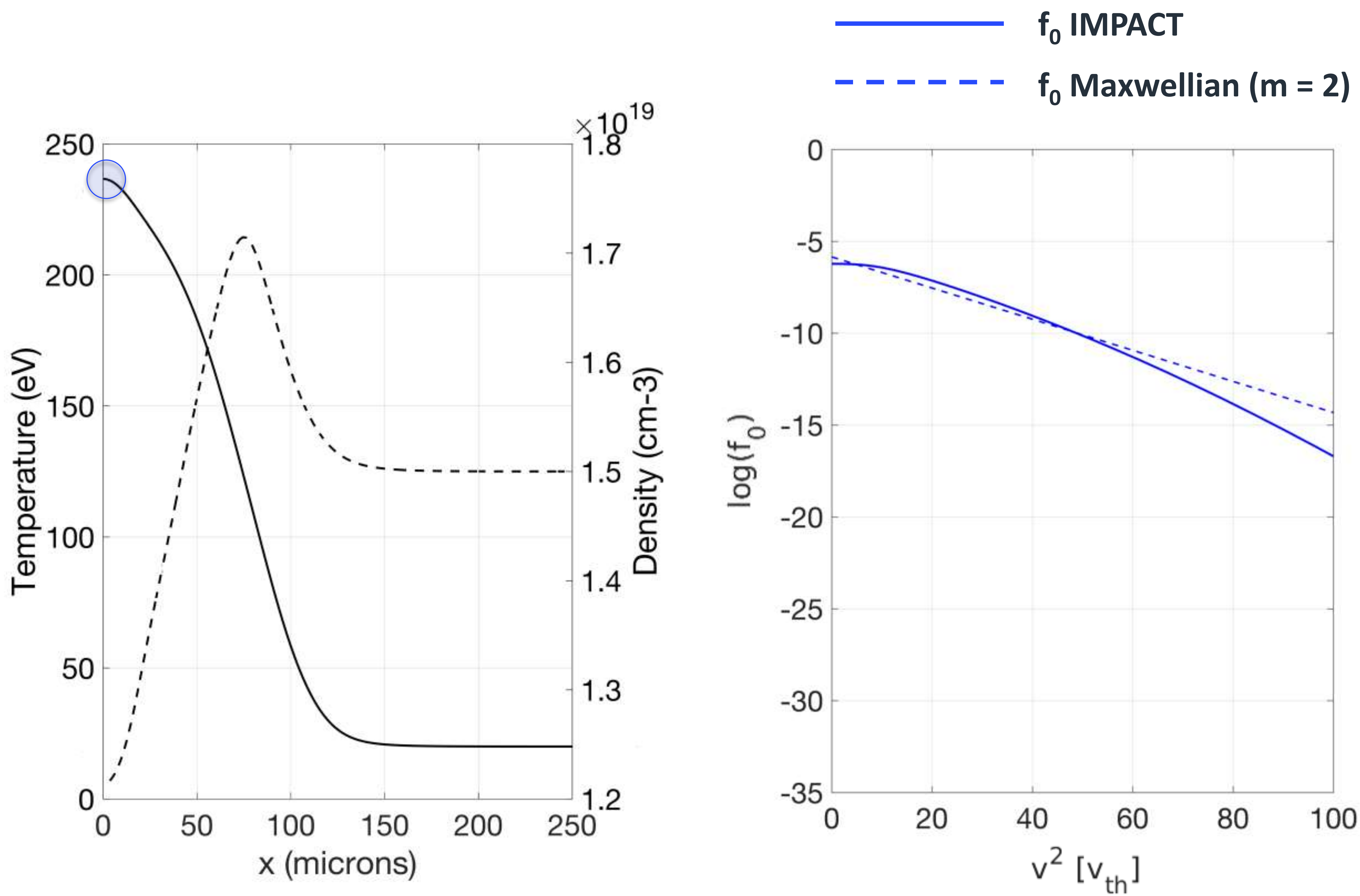

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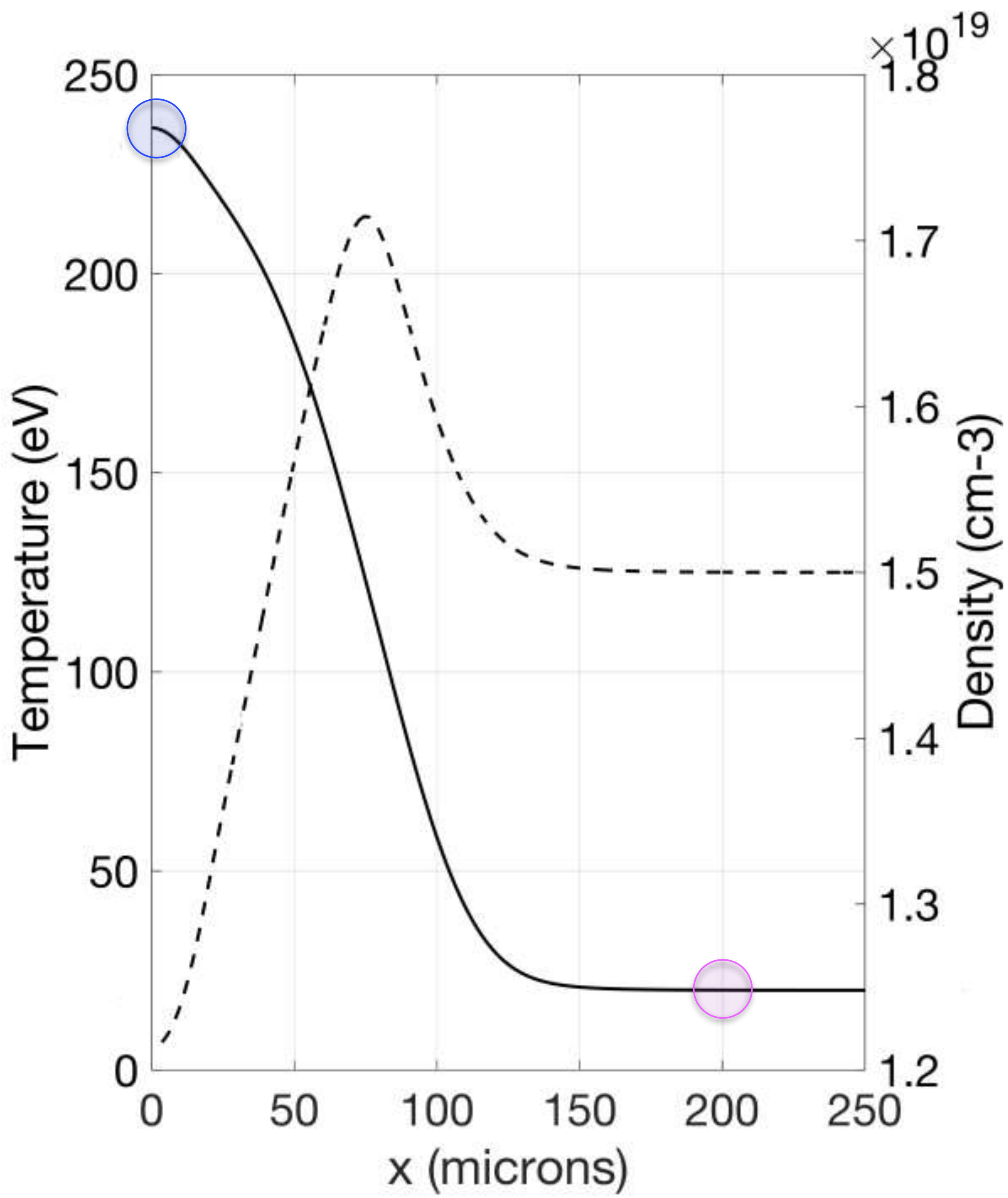

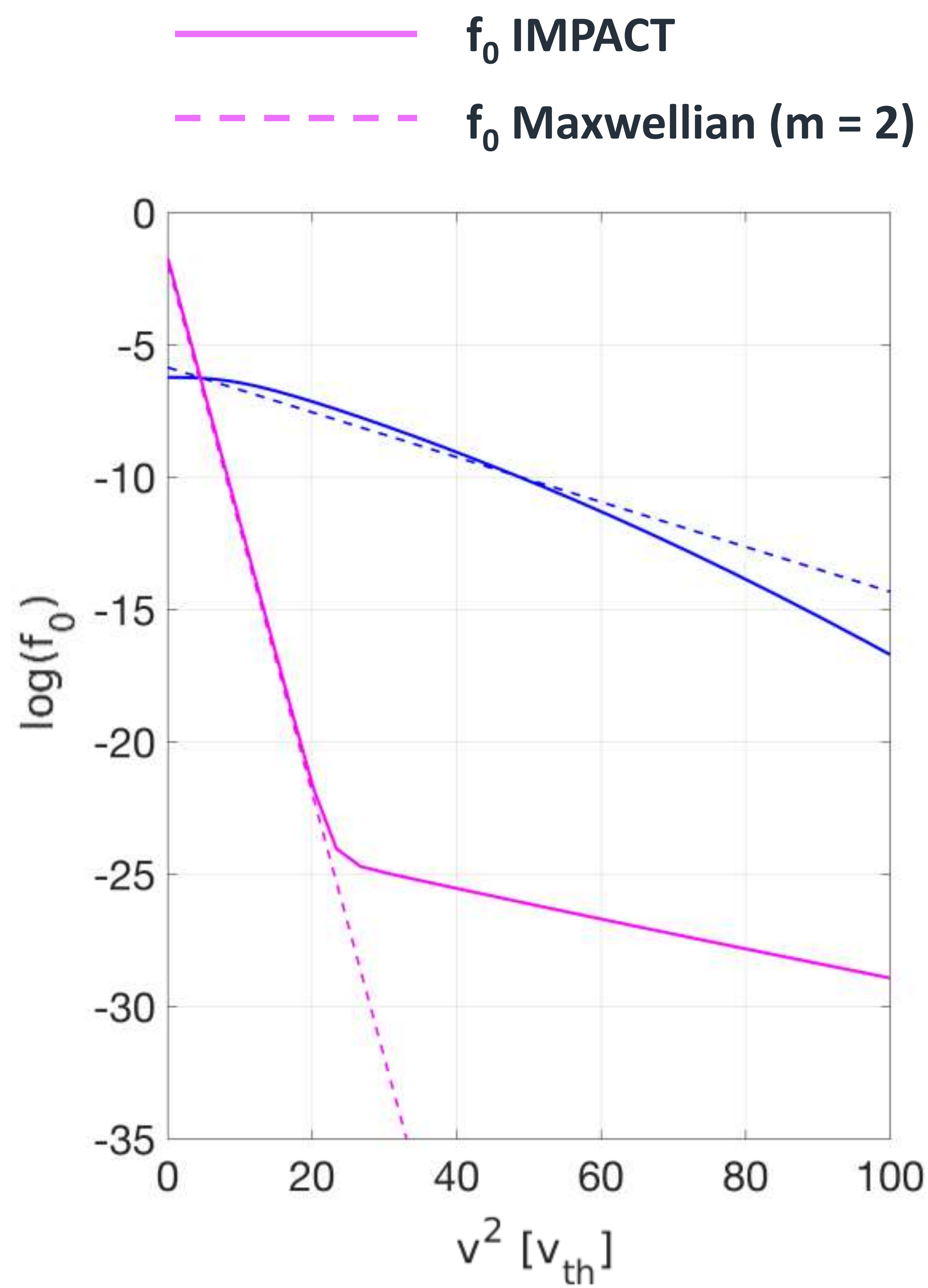

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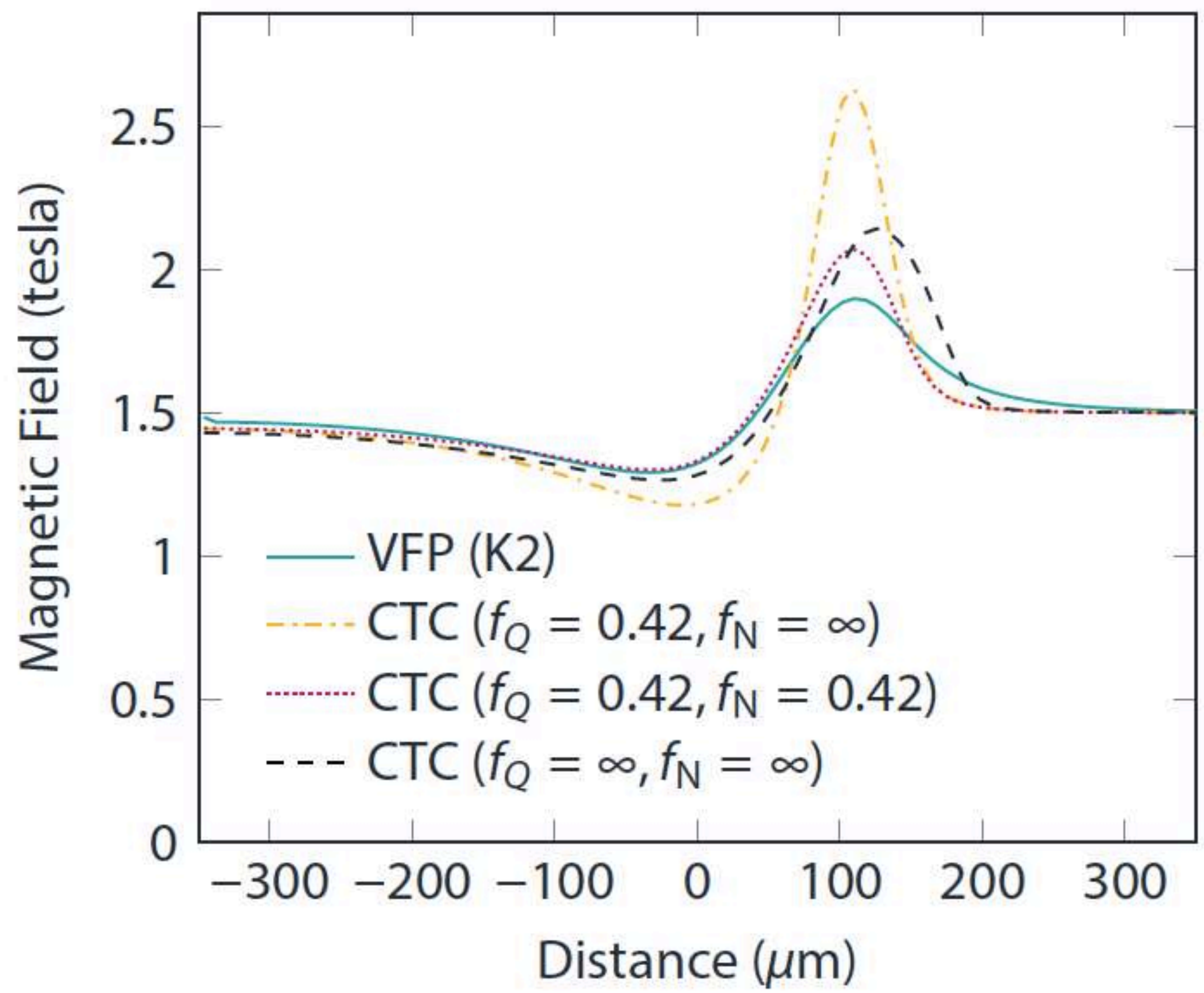
Result courtesy of J.P. Brodrick



[13] Brodrick *et al.* - 47th Annual Anomalous Absorption Conference (2017)

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- May require non-local model ultimately

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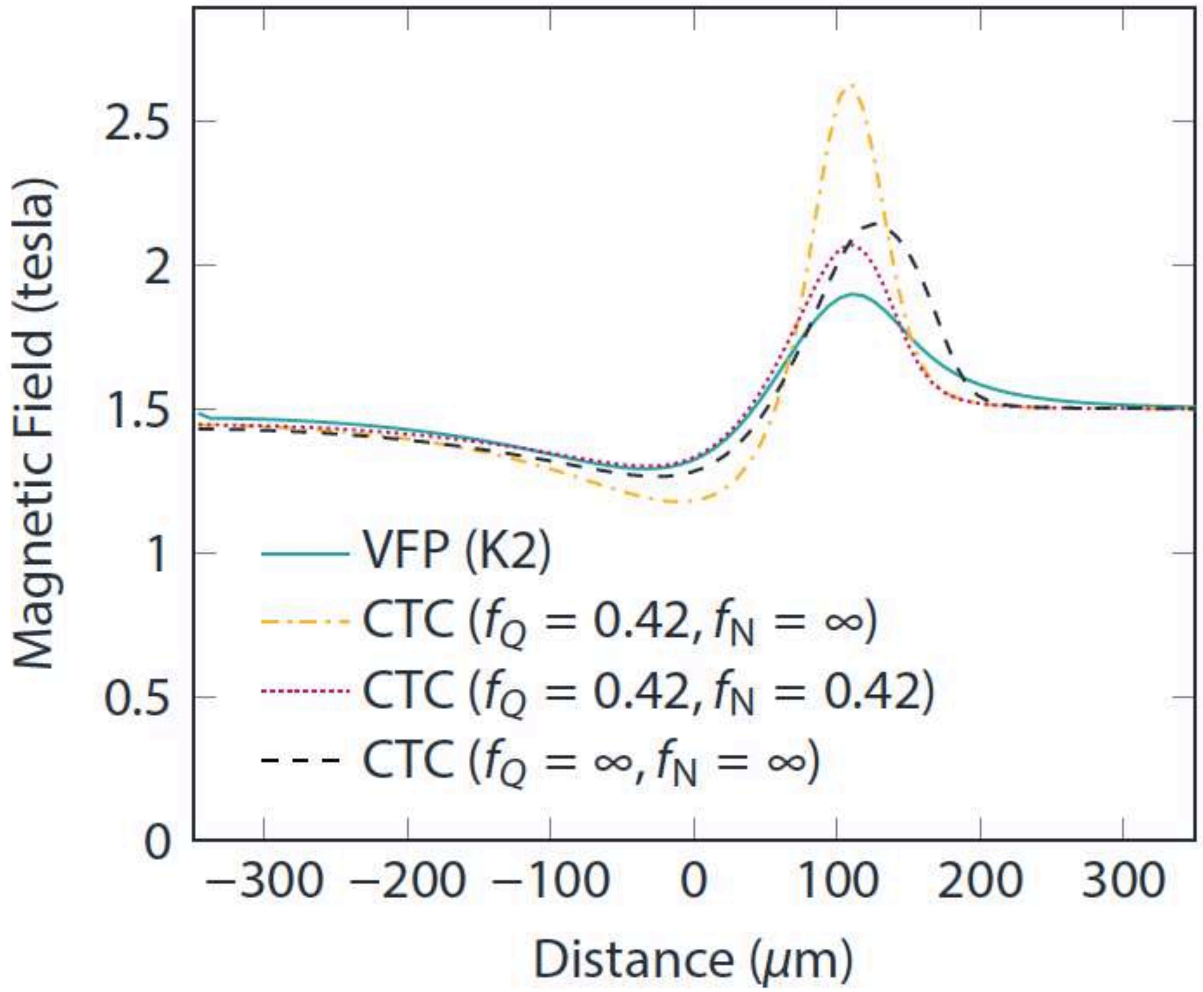

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- Reproducing VFP results using a fluid code under these conditions requires careful choice of thermal and magnetic flux limiters