Electron heating scales in quasi-perpendicular shocks

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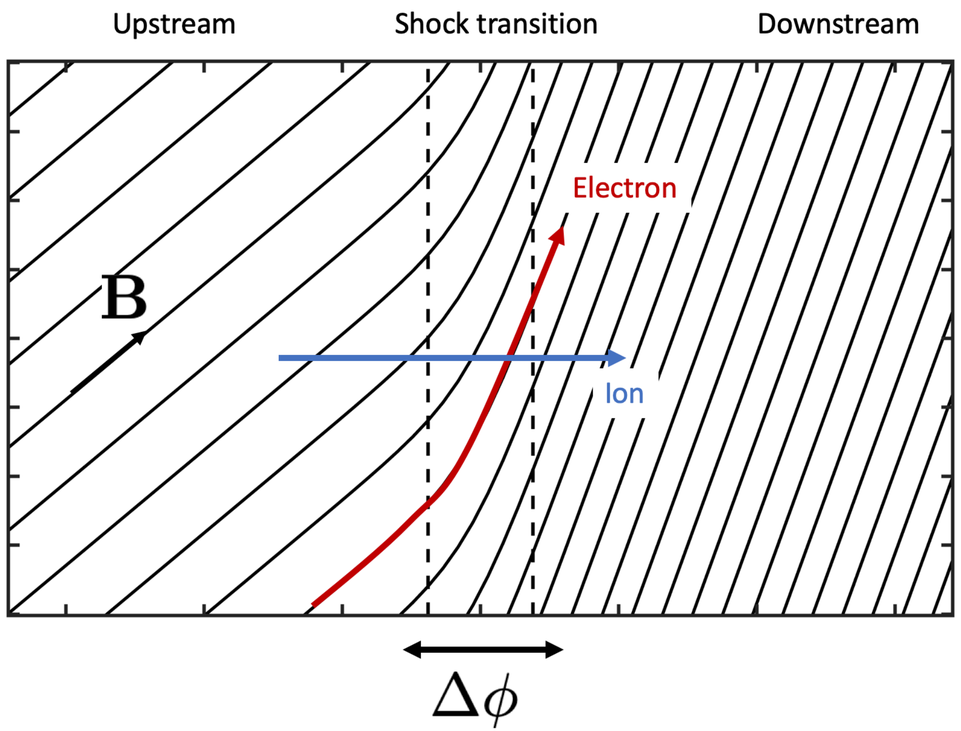
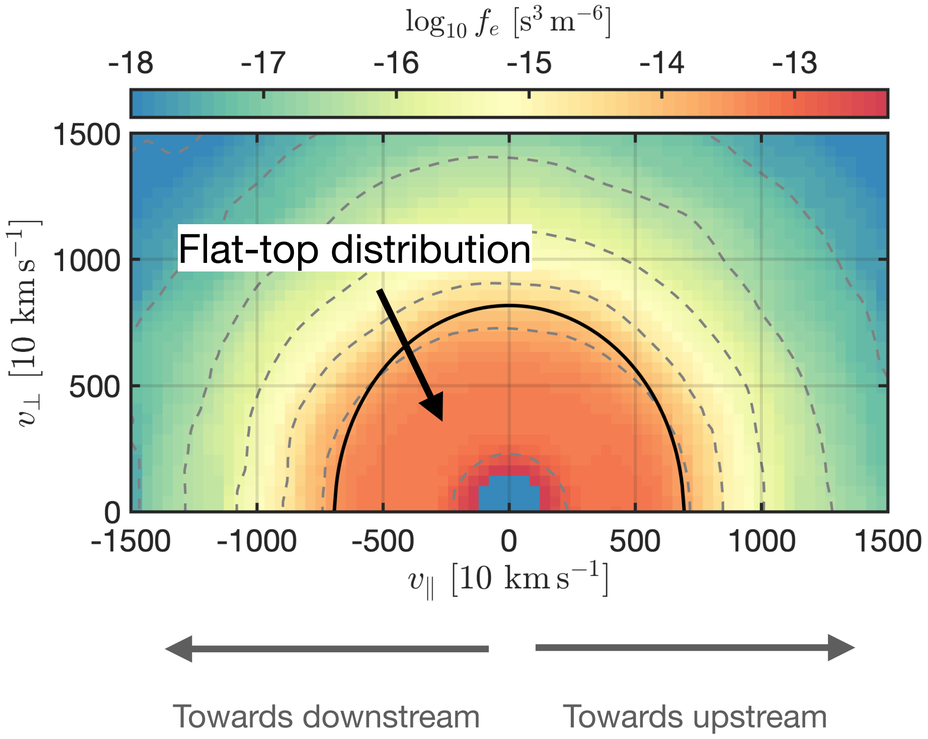
Electron heating at shocks

Electrons are heated to a lesser extent than ions in collisionless shocks

Electron heating is due to an interplay between large scale fields and wave-particle interaction

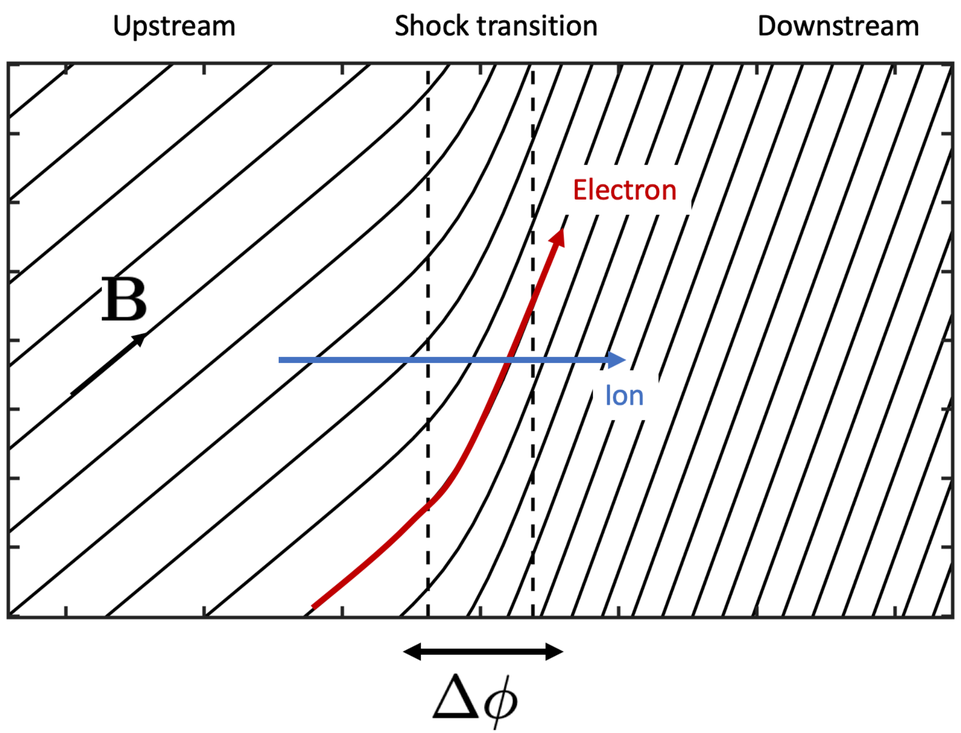


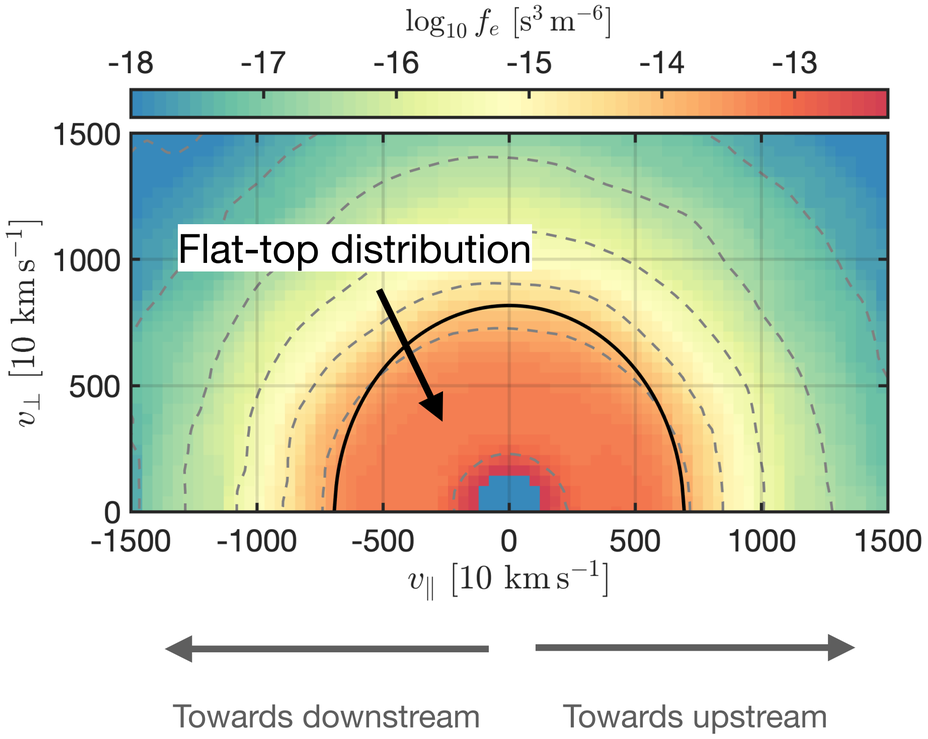


Ions and electrons take different paths through the shock

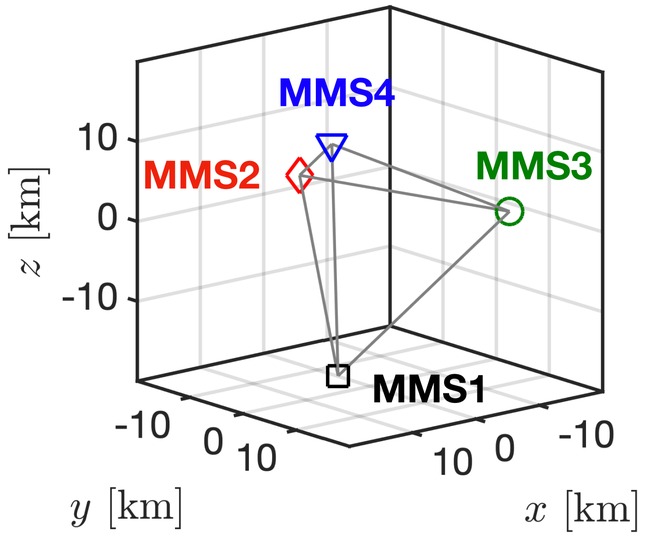
Electron heating at shocks

Over which scales does electron heating take place in quasi-perpendicular shocks?

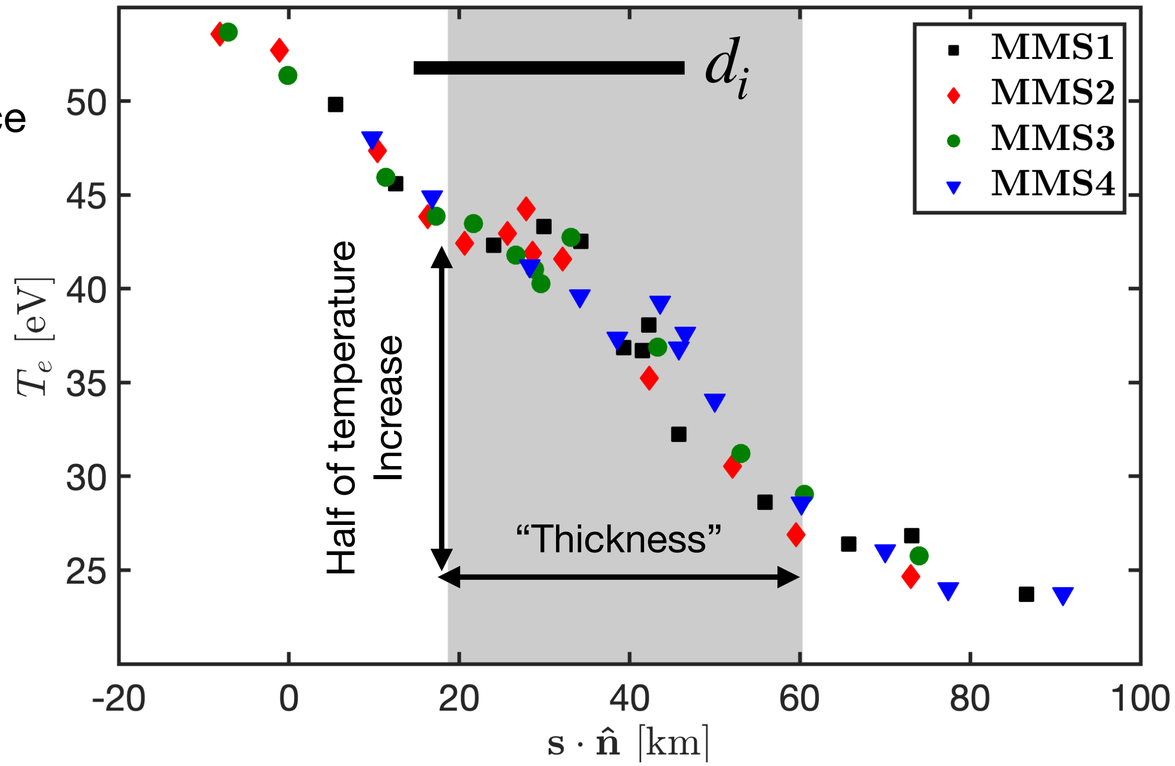


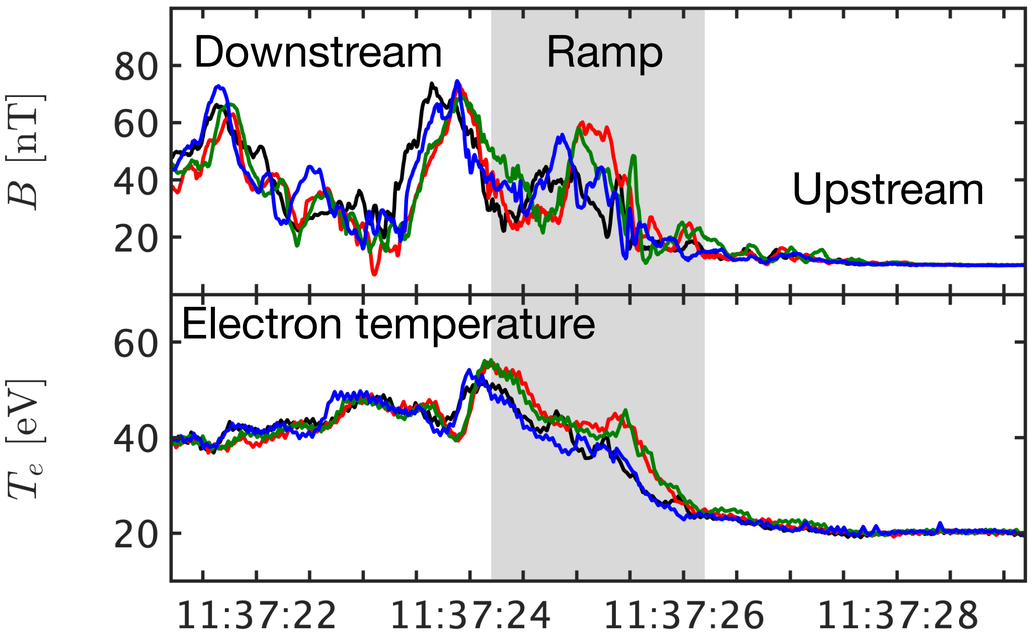


Measuring the temperature scales with MMS



Spatio-temporal difference method (Shi+, 2006)





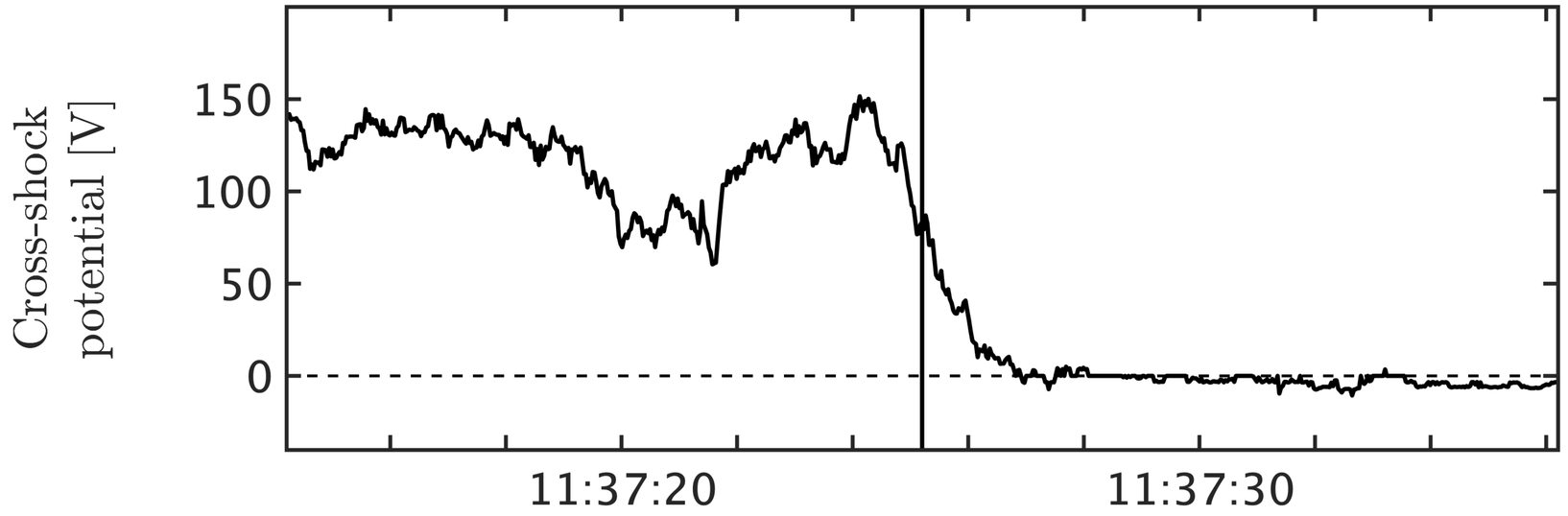
(Johlander et al., *in prep.*)

$$\frac{\mathrm{d}T_e}{\mathrm{d}t} = -\mathbf{V}_\mathrm{r} \cdot \nabla T_e$$

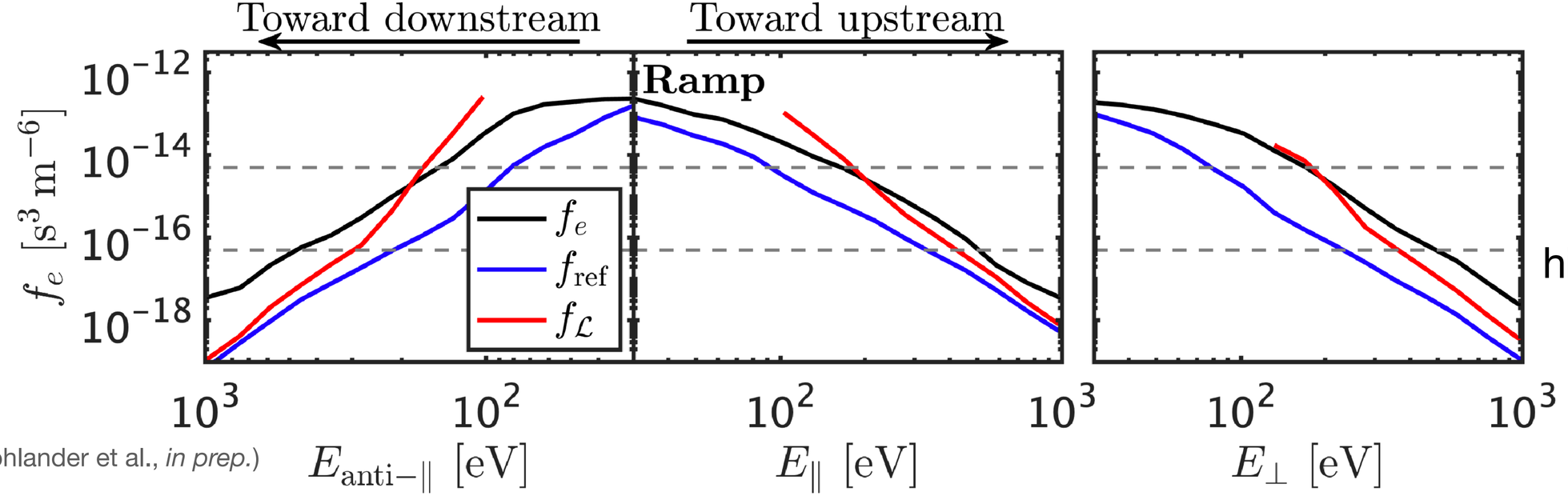
Observed change

Shock ramp velocity

How are the electrons heated?



We obtain the cross-shock potential in the deHoffmann-Teller frame by Liouville mapping



The electron distributions show that the heating is highly **non-adiabatic**

(Johlander et al., *in prep.*)

Conclusions

- Electron heating takes place on **ion scales** in shocks
- Time series do not correspond to spatial profiles
- Highly **non-adiabatic heating** at high-Mach shocks