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# Particle Motion and Energy Gains in 2½D Collapsing Magnetic Trap Models

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## Introduction

Reconnecting coronal loops can form collapsing magnetic traps (CMTs) (see Fig. 1).

CMTs have been suggested to take part in flare particle acceleration (e.g. Somov & Kosugi, 1997; Karlicky & Kosugi, 2004; Giuliani et al., 2005).

Studies of particle acceleration in CMTs have been carried out for the Earth's magnetotail (e.g. Birn et al., 1997, 1998).

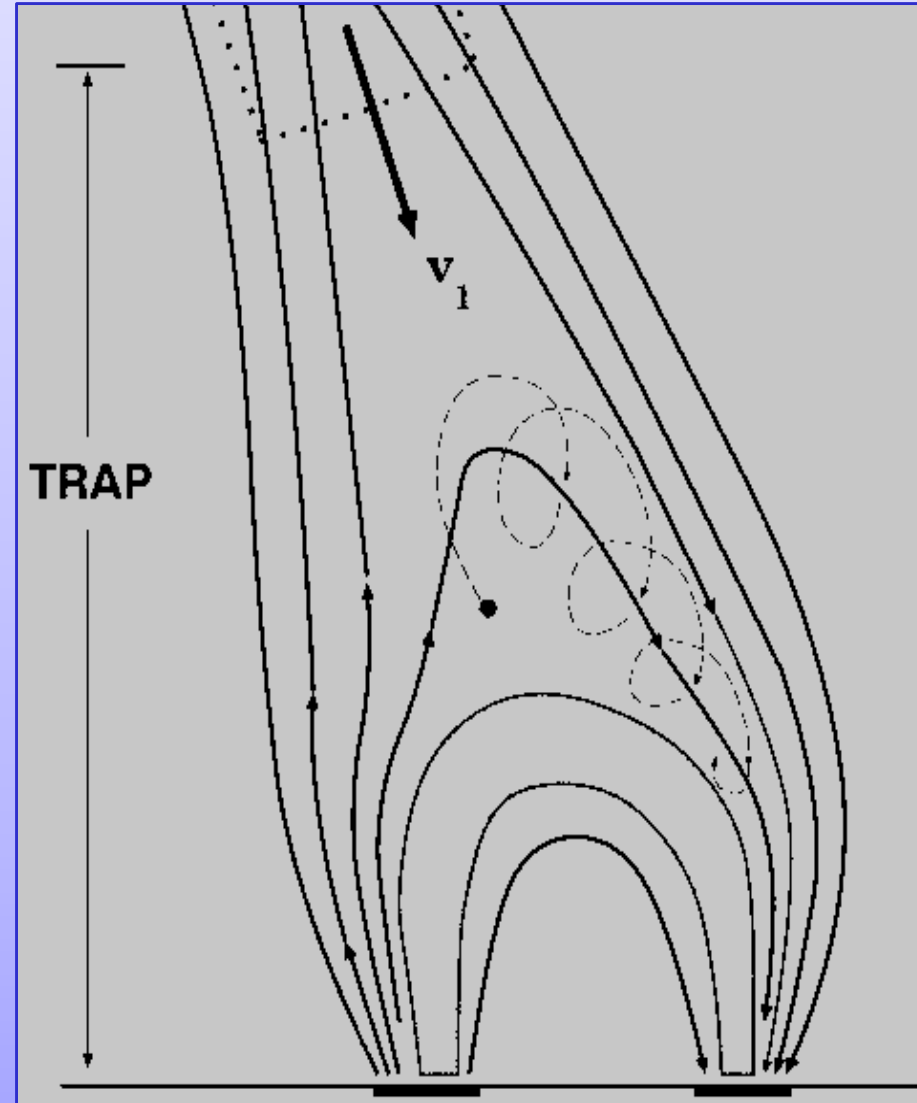


Fig. 1: Cartoon of CMT (adapted from Somov & Kosugi, 1997)

## Background Work by Giuliani et al. (2005)

Downflow generates strong electric field in central parts of CMT – this is expected to help trap and accelerate particles – fields that enhance this effect will be looked into in further work.

Results below are based on a 2.5D ideal kinematic MHD model (Giuliani et al., 2005).

## Example Collapsing Magnetic Trap

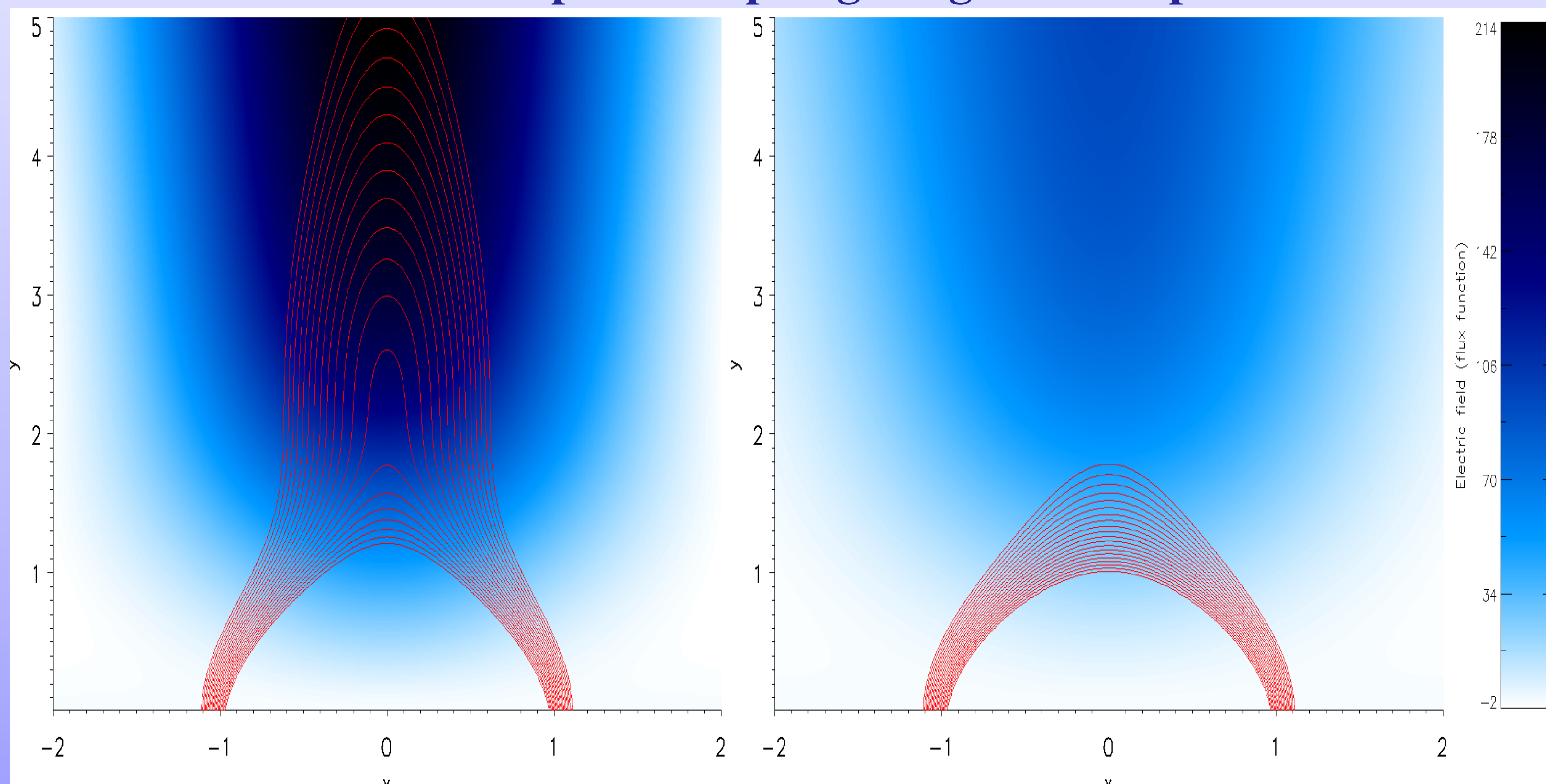


Fig 2: Magnetic field lines (red) show the trap collapsing. Blue scale shows electric field (dark is strong field) Left figure is trap before collapsing, right after an arbitrary time (95 seconds). Lengths are normalized to 10Mm.

## Time evolution of $E_{\perp} \nu E_{\parallel}$ kinetic energy (eV)

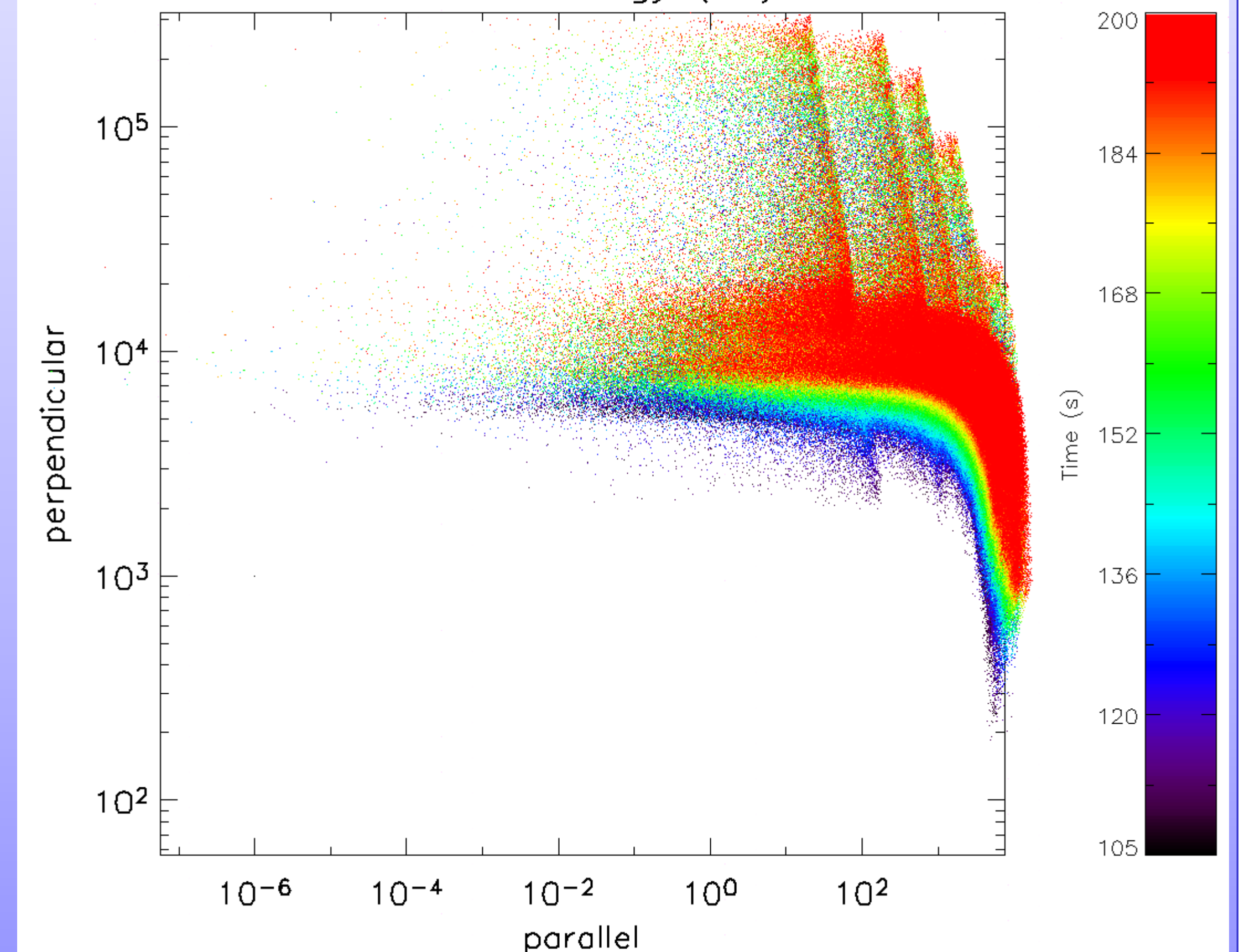


Fig 3: For trapped particles, the kinetic energies parallel and perpendicular to the magnetic field lines change as the trap collapses. Colour shows the time evolution of the energies for each particle. Both perpendicular and parallel energies increase for trapped particles, with perpendicular energy increasing more.

## Effects of particle initial conditions on energy gains

Use the guiding centre approximation (Northrop, 1963; Giuliani et al., 2005) to calculate particle orbits.

As shown in fig 4, injection position, energy and pitch angle have an effect on the trapping time, mirror points and thus the energy of the particles once they escape from the trap.

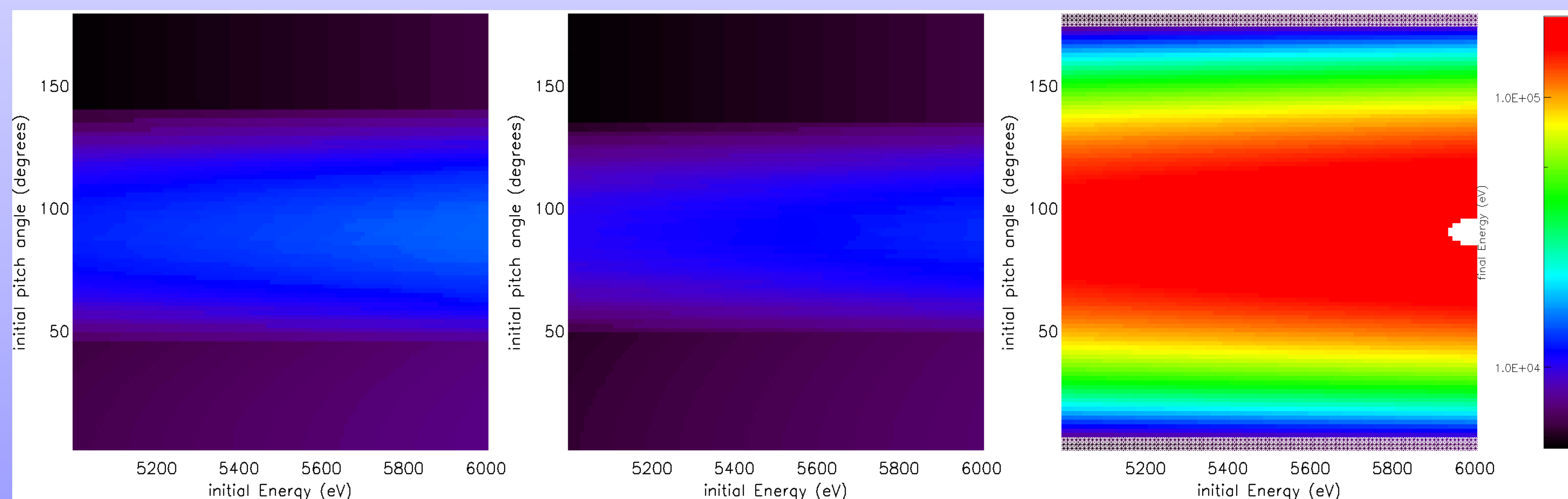


Fig 4: Graphs showing effect of initial energy and pitch angle on escape energy (shown as colour). Each frame shows particles starting at a different point. Left to right,  $x=1, y=1$ ;  $x=1, y=2$ ;  $x=0, y=2$ . All particles in the left and centre figures escape. Particles that escape in the right hand figure are indicated with hatching.

## Positions of high energy particles at later times

Trapped particles are accelerated by grad B and curvature drifts.

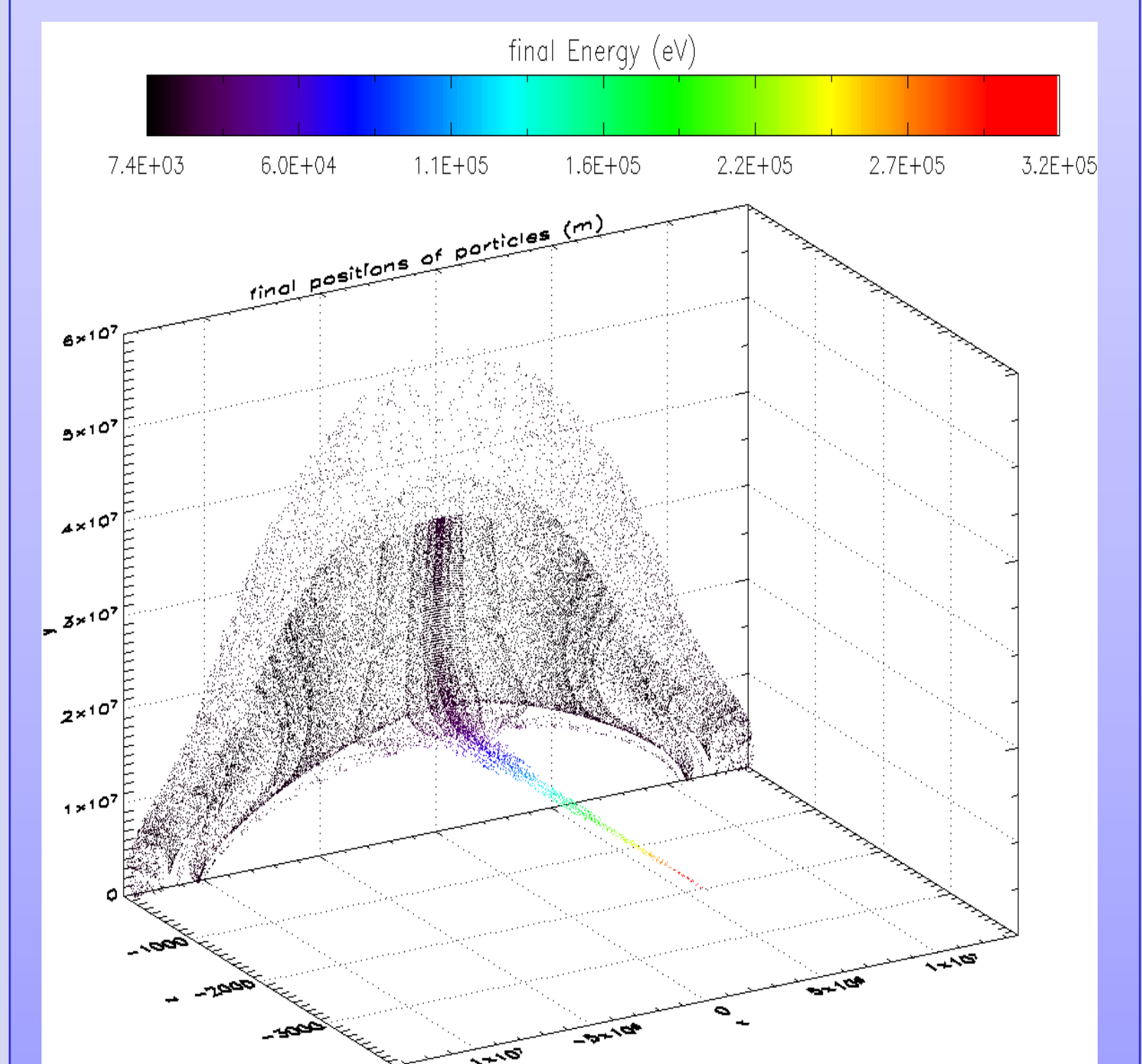


Fig 5: Particles (coloured) that gain most energy are trapped at the loop top and pushed in the invariant direction

## Discussion and Conclusions

Highest energy particles are seen to be trapped at the loop top.

For trapped particles, both  $E_{\perp}$  and  $E_{\parallel}$  increase, with  $E_{\perp}$  increasing more.

Strong magnetic fields, pitch angles close to  $0^{\circ}$  or  $180^{\circ}$  and higher initial energies trap particles for longer, allowing them to gain more energy.

Future work: more realistic CMT models, e.g. 3D; calculation of particle orbits including Coulomb collisions; calculations of distribution functions.

## References

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