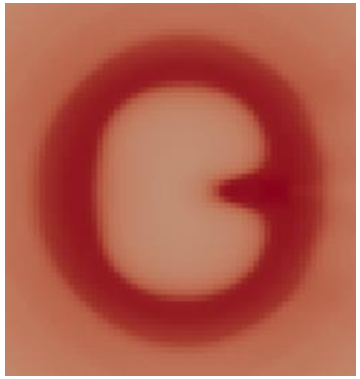
Imperial College London

Effect of Imposed Magnetic Fields on Hot-spot Shape

C.A.Walsh, J.P.Chittenden, K.McGlinchey, J.K.Tong, B.D.Appelbe, A.J.Crilly
Centre for Inertial Fusion Studies
Imperial College London

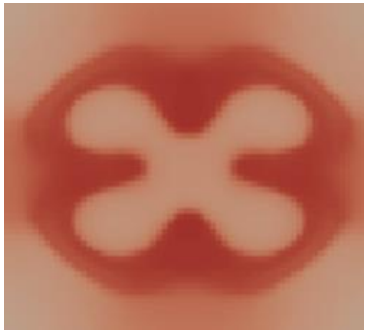
3 perturbation types:

- Fill-tube ➔ HDC
- Radiation asymmetry ➔ High-foot
- Multi-mode ➔ All ICF



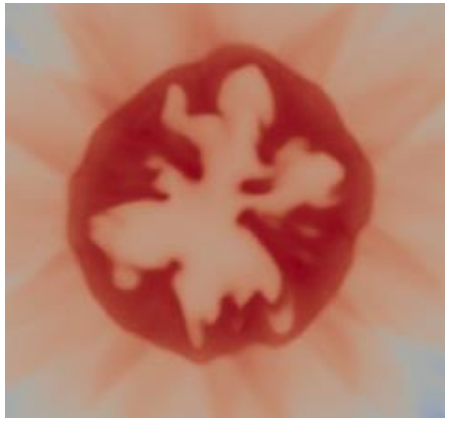
3 field strengths:

- 0T ➔ Unmagnetised base case
- 5T ➔ Similar to OMEGA shots
- 50T ➔ Predicted best improvement



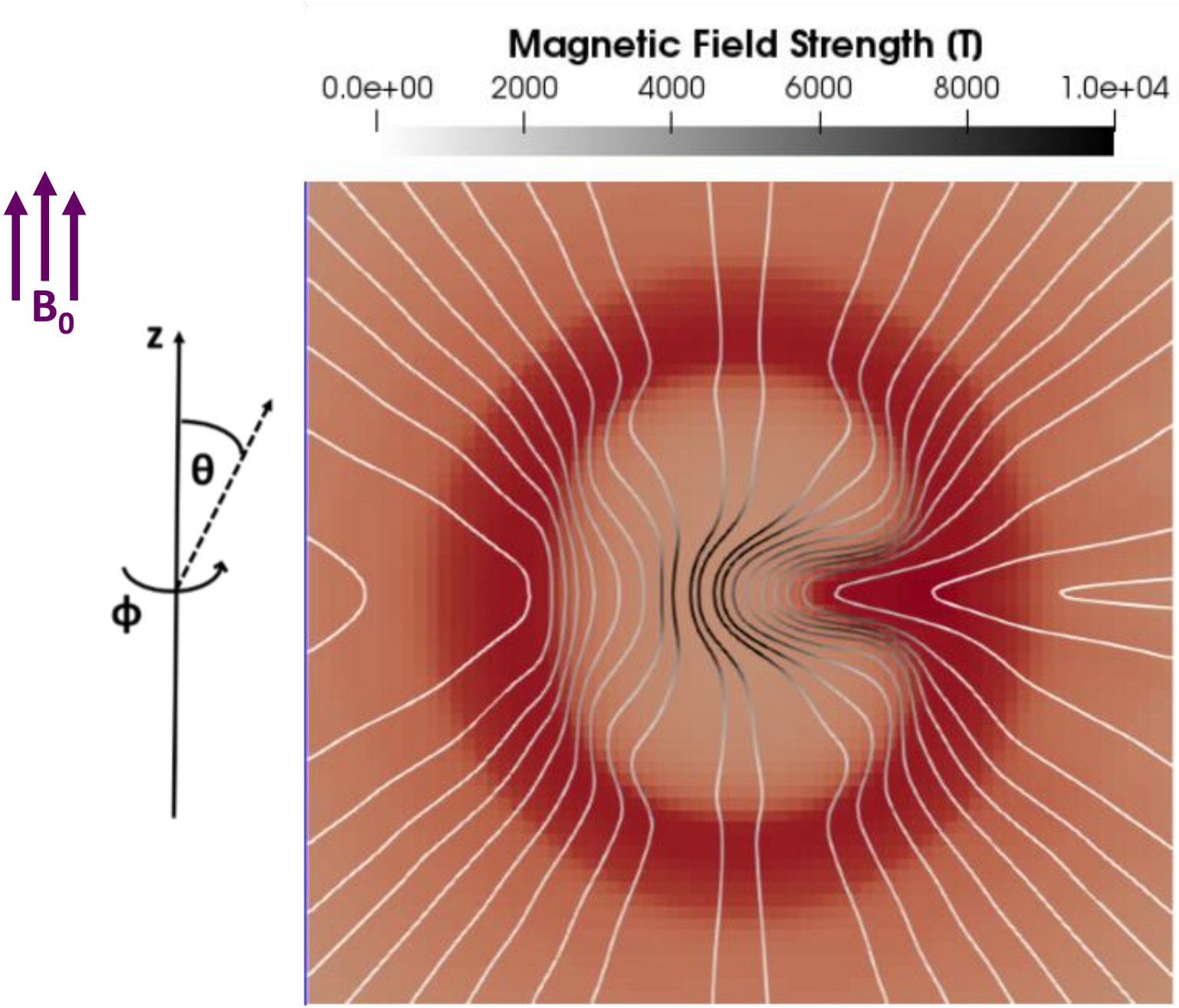
3 Magnetic Effects:

- Thermal conduction
- Magnetic pressure ➔ 50T only
- Magnetised α transport ➔ 50T only

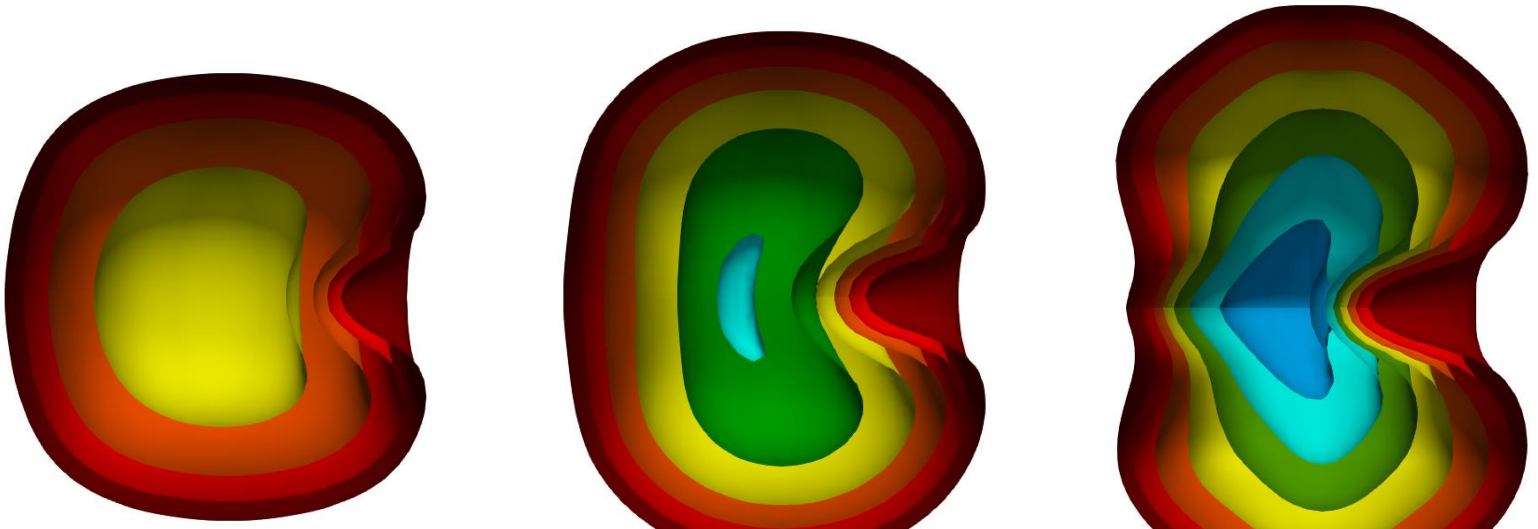


Chimera:

- 3-D Extended-MHD
  - OMEGA experiments matched well- ask for more info
- Anisotropic thermal conduction
- Radiation transport (non-diffusive)
- Magnetised α-transport (PIC)
- Synthetic diagnostic suite


Magnetic Field Strength (T)
0.0e+00
2000
4000
6000
8000
1.0e+04
B0
z
θ
ϕ

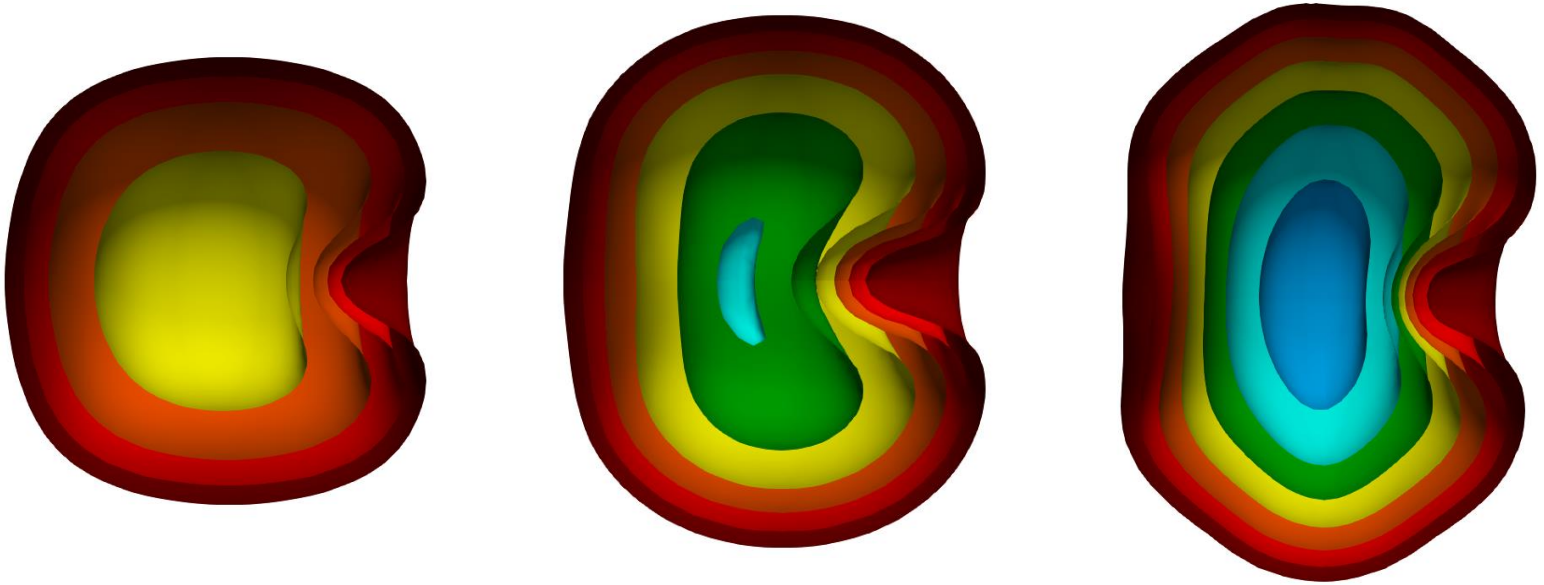
T_i keV contours:



B_0 = 0T 5T 50T

Magnetised thermal conduction only

T_i keV contours:

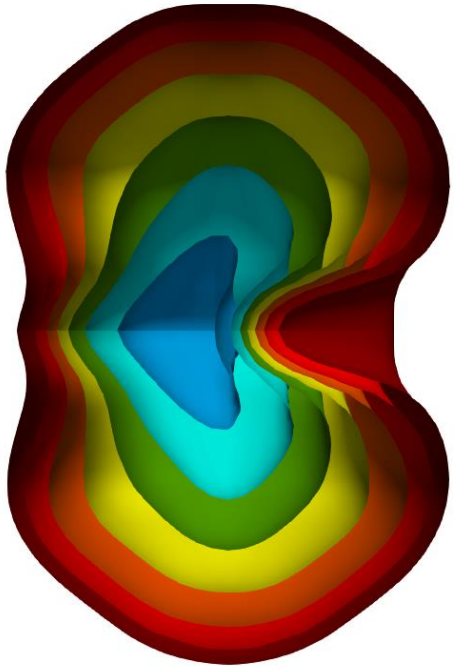


B_0 = 0T 5T 50T

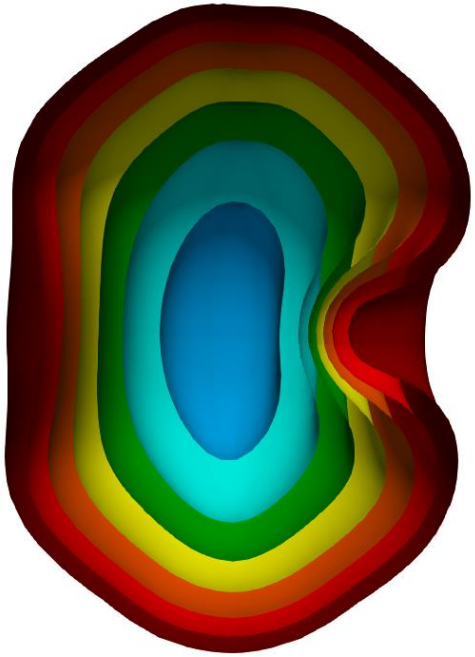
Magnetic Pressure

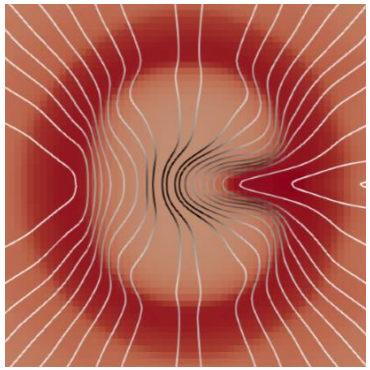
Magnetised thermal conduction

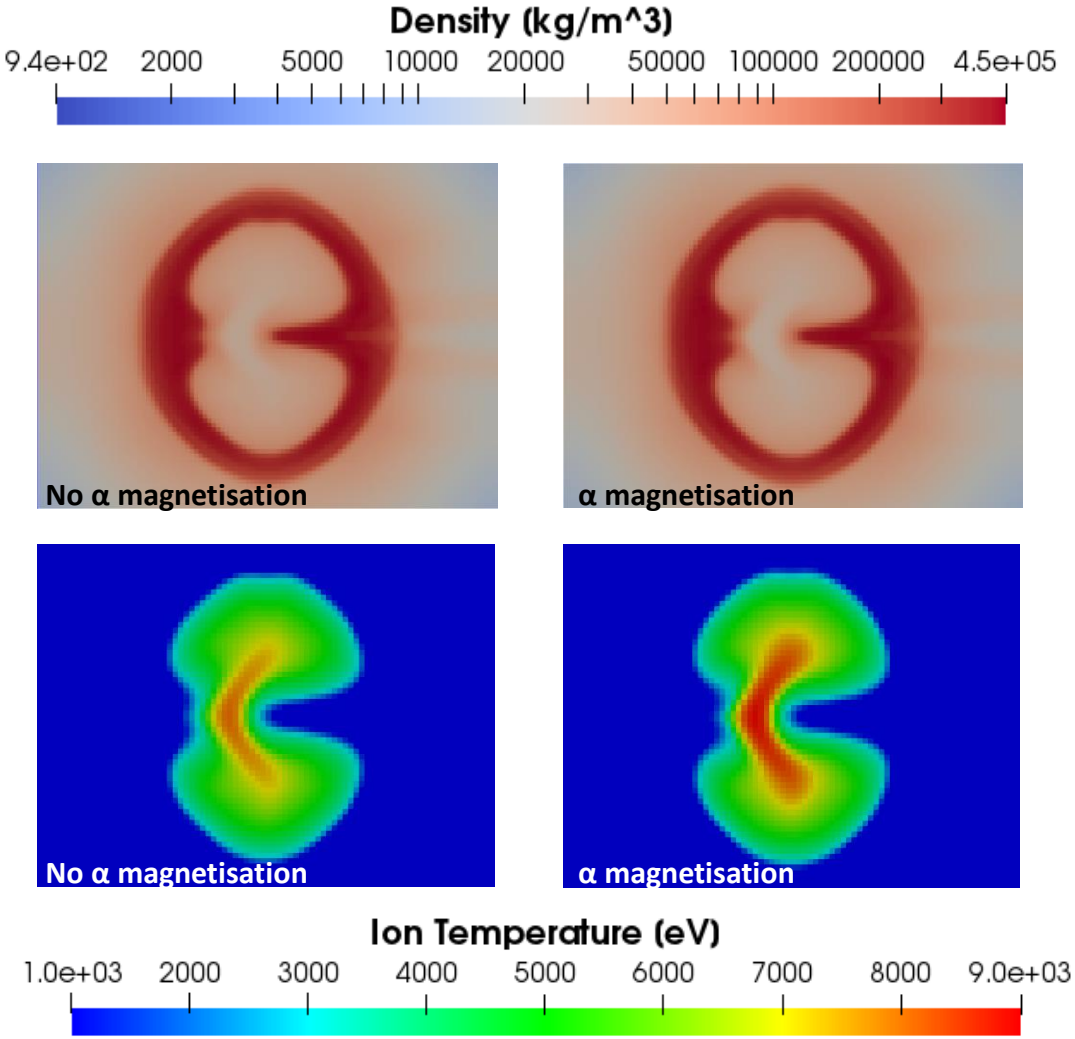
T_i keV contours:



Magnetic force

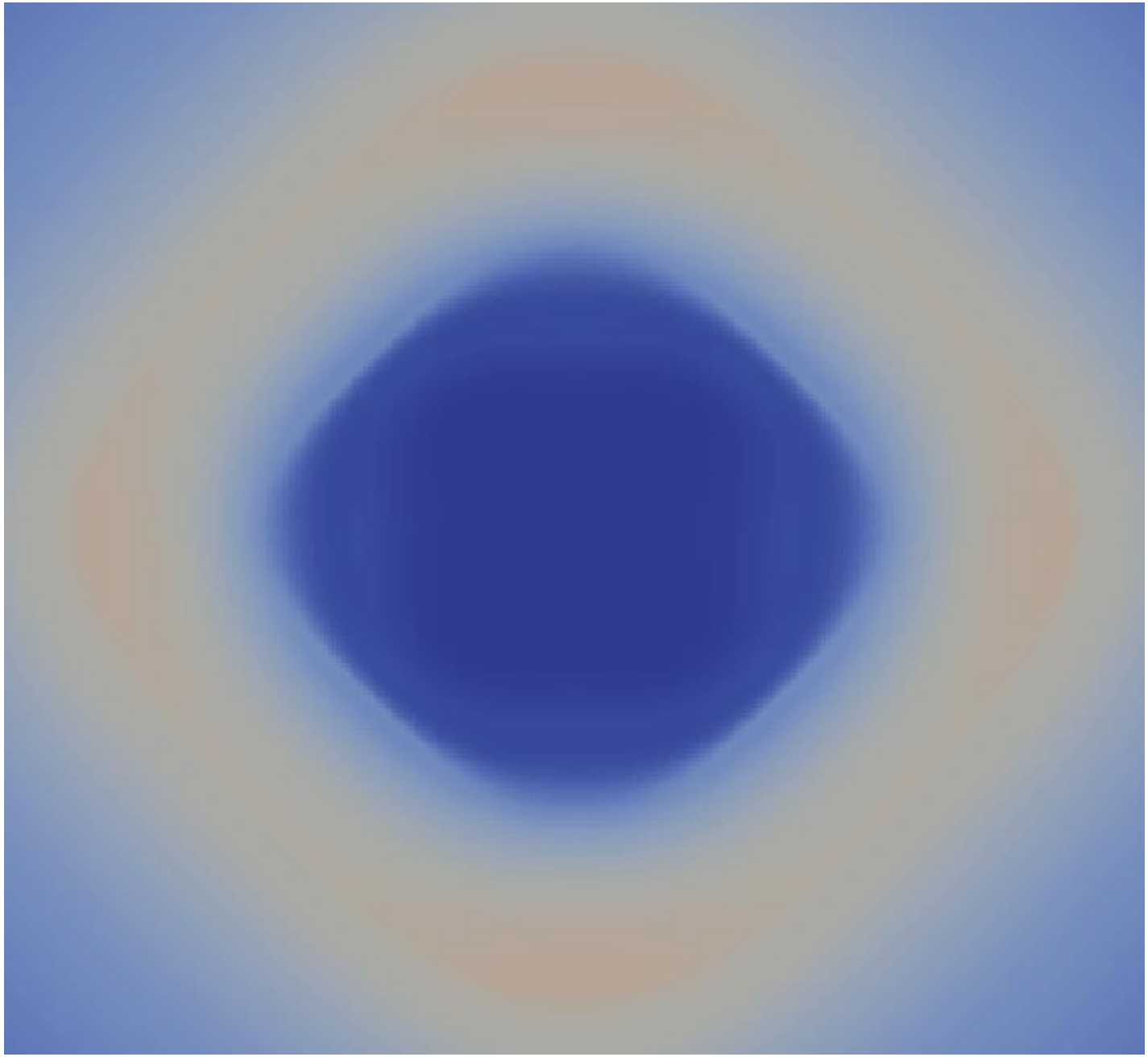




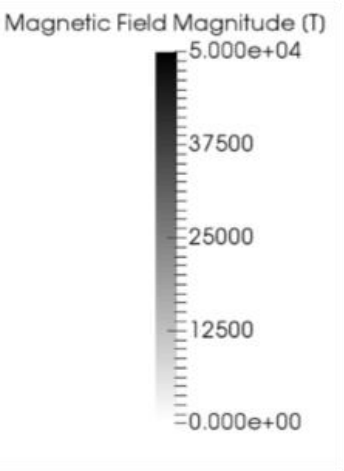


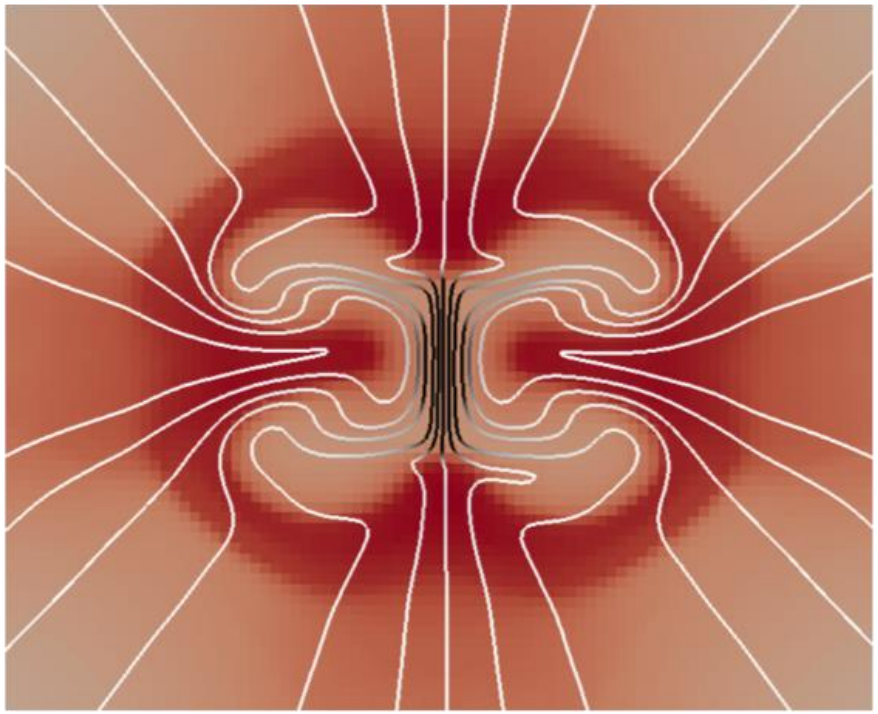
Magnetisation of α-particles does not change shape, but does increase temperature

Magnetised α-transport



t = Peak Burn

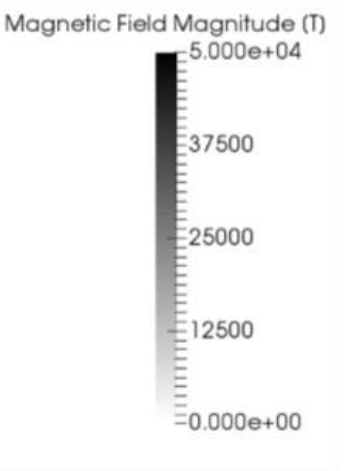


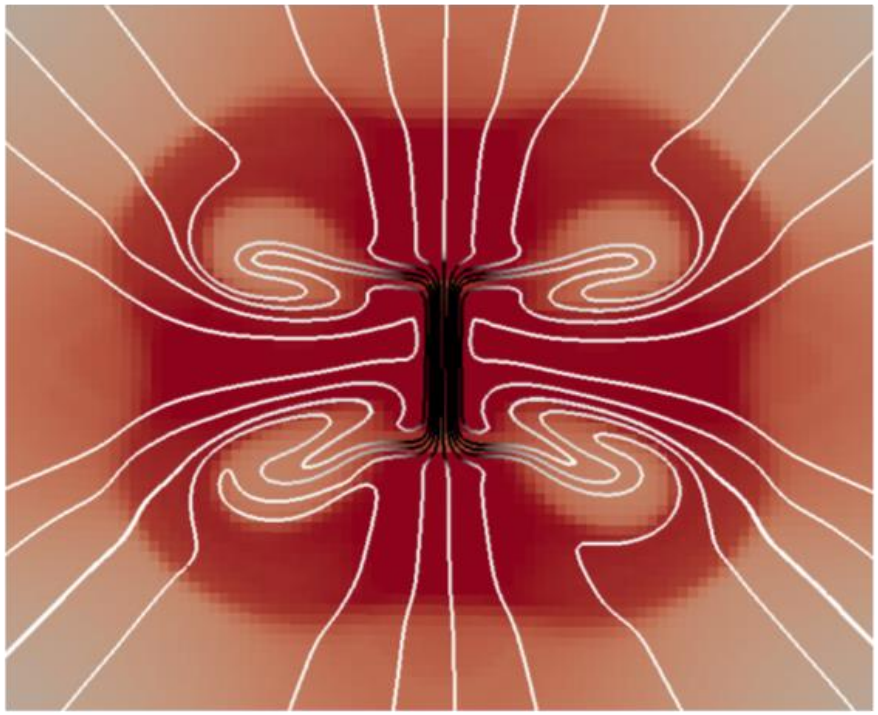


$\underline{B_0}$ = 5T

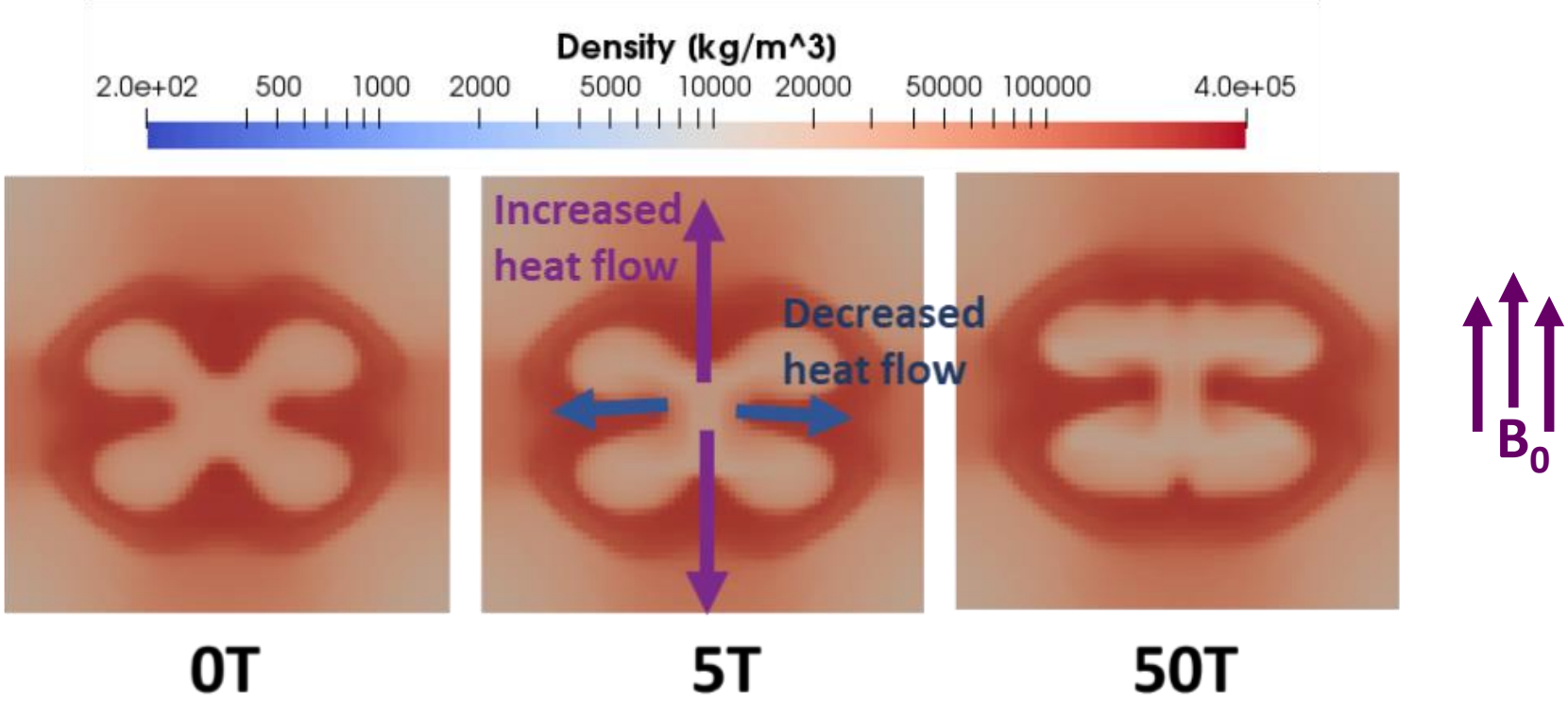
t = Peak Burn

+ 20ps



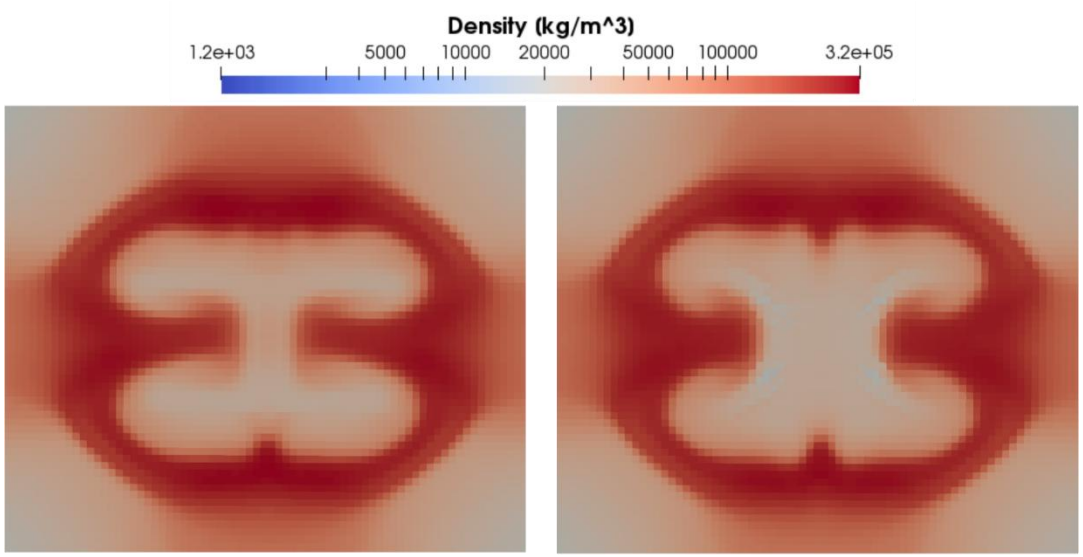


$\underline{B_0}$ = 5T



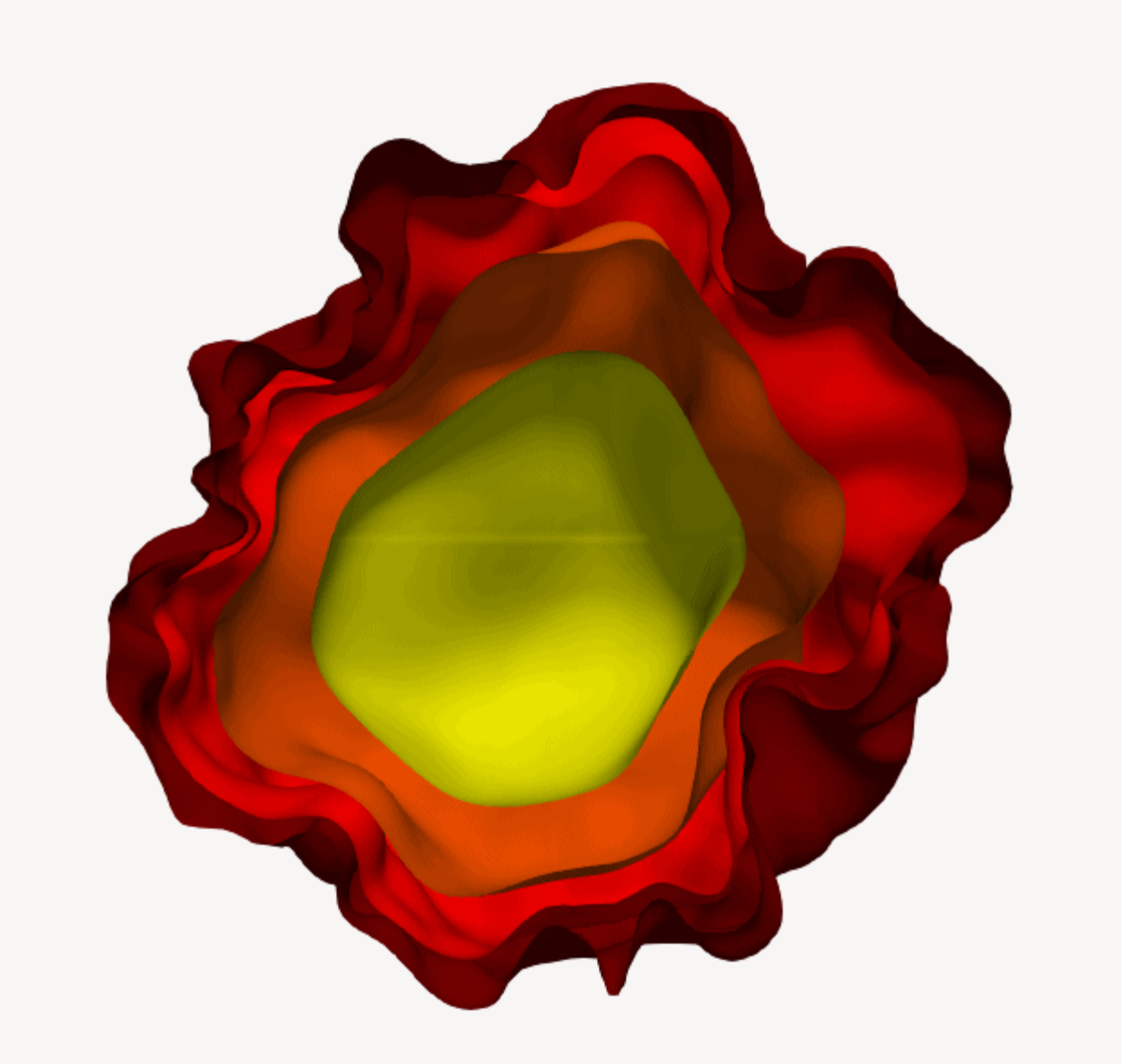
Magnetised thermal conduction only

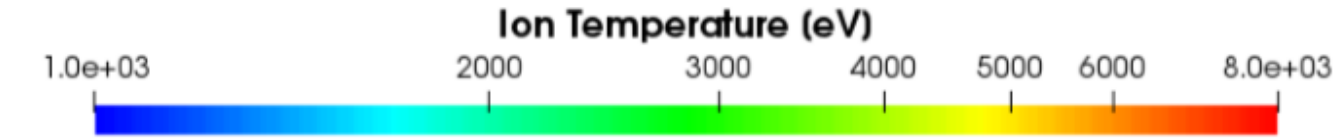
B_0= 50T

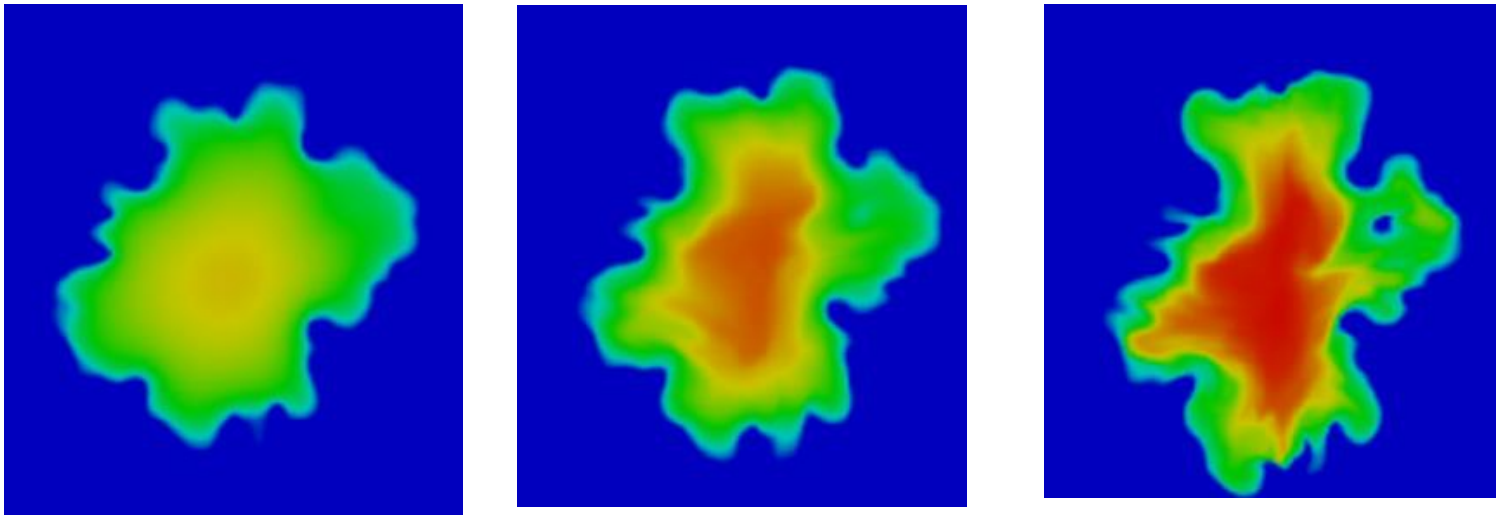


Magnetic Pressure

Magnetised thermal conduction







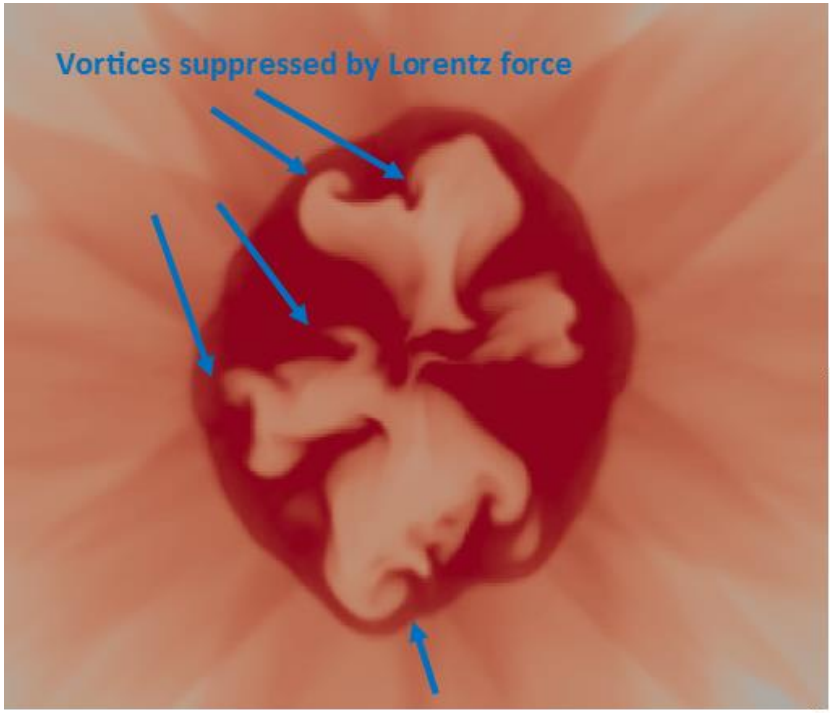
B_0 =

0T

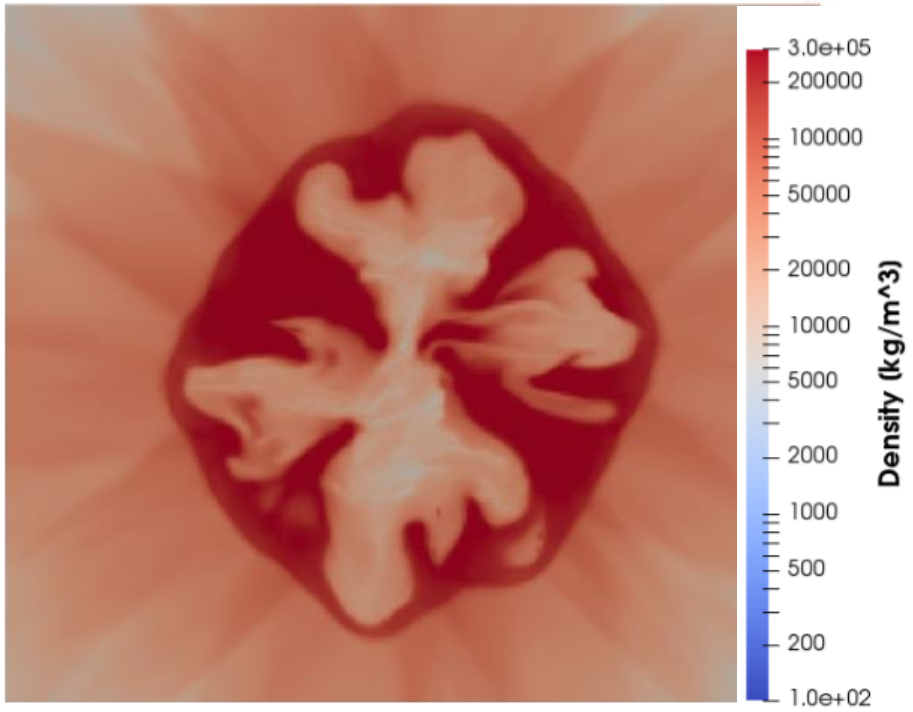
5T

50T

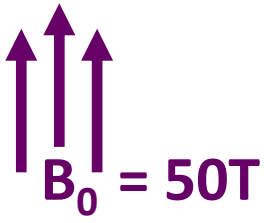
Magnetised thermal conduction only



No Lorentz Force

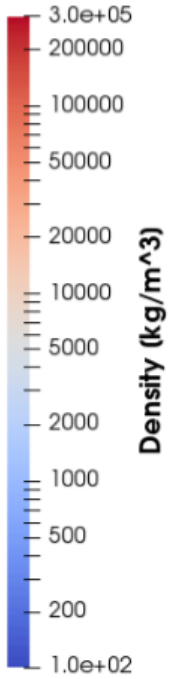


With Lorentz Force



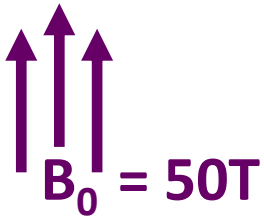
Magnetic Pressure

Magnetised thermal conduction



No Lorentz Force

With Lorentz Force



Magnetic Pressure

Magnetised thermal conduction

Summary – Hot-spot Shape

Magnetised thermal conduction

- Hot-spot elongation
- Increased penetration ⍰ B
  - Reduced ablative stabilisation
  - Pinching around waist
- Reduced penetration // B
  - Increased ablative stabilisation
- Increases high-mode structure

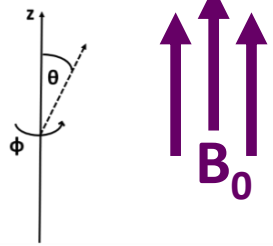
Magnetic Pressure

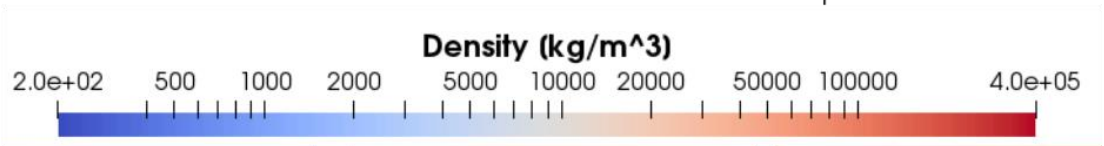
- 50T only
- Reduced penetration ⍰ B
- Prevents hot-spot severing at waist
- Suppresses vortices ➔ mix?

Magnetised α-transport

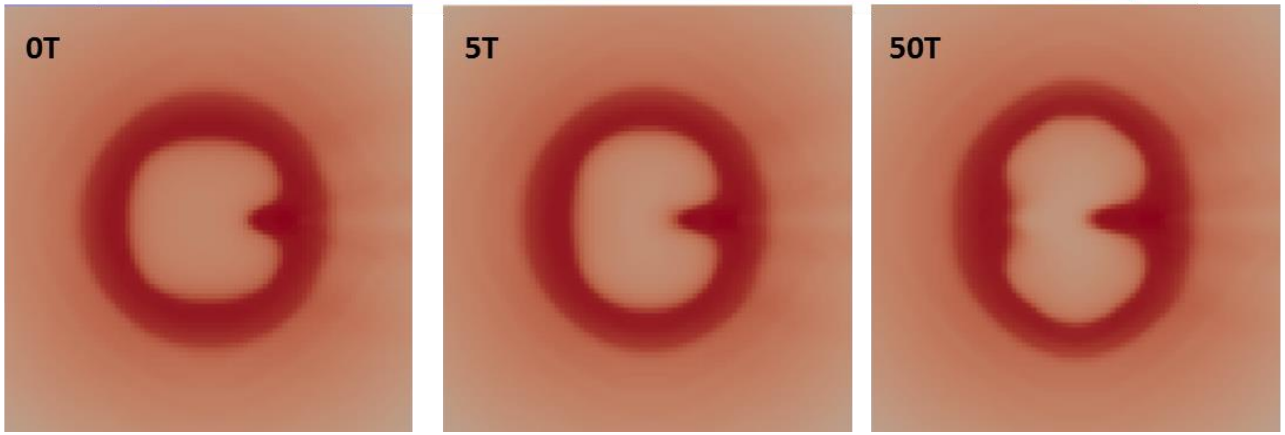
- 50T only
- Negligible effect on shape
- Increases temperature & yield

Comparing fill-tube orientations

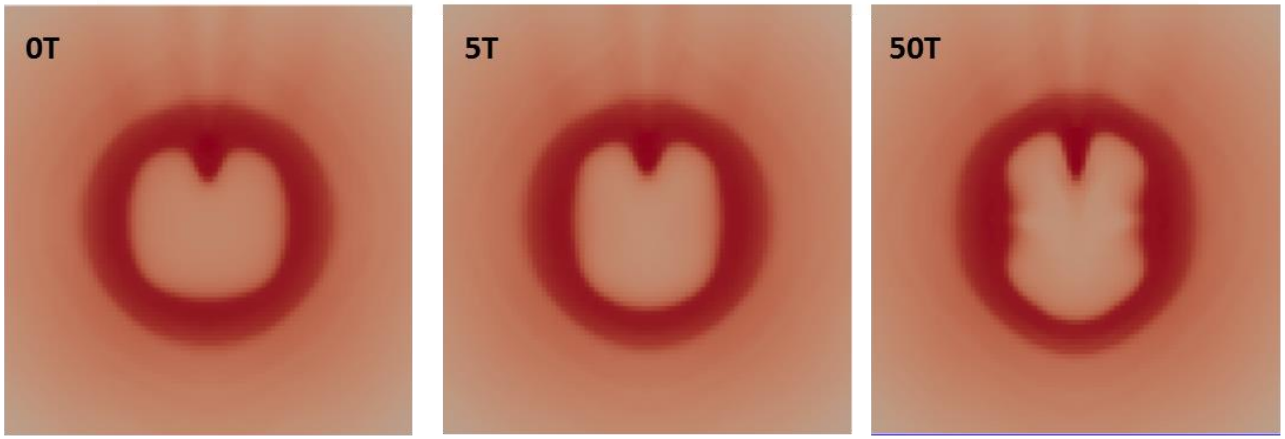




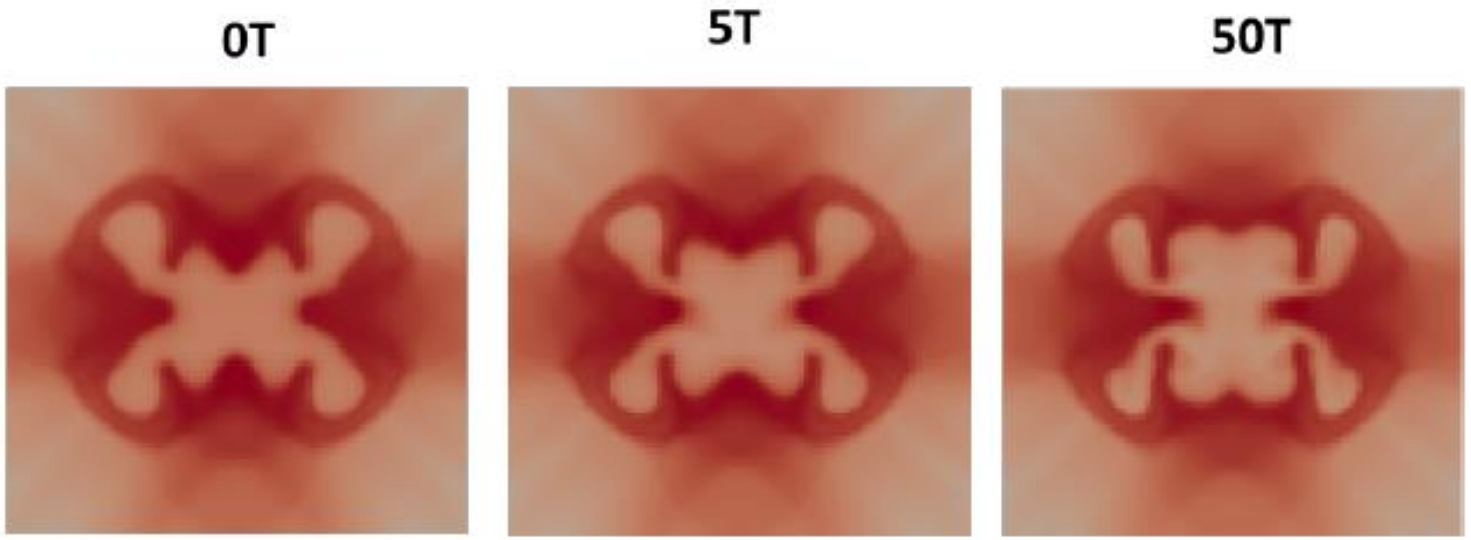
Fill-tube ⍰ to field:

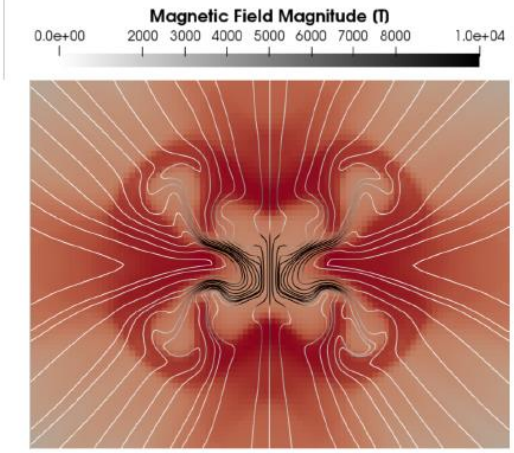


Fill-tube // to field:



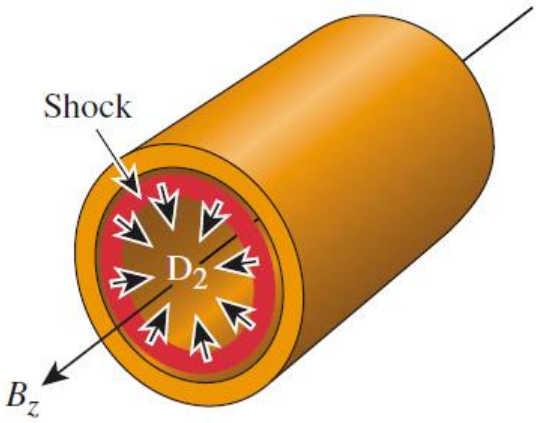
Tent + radiation asymmetry





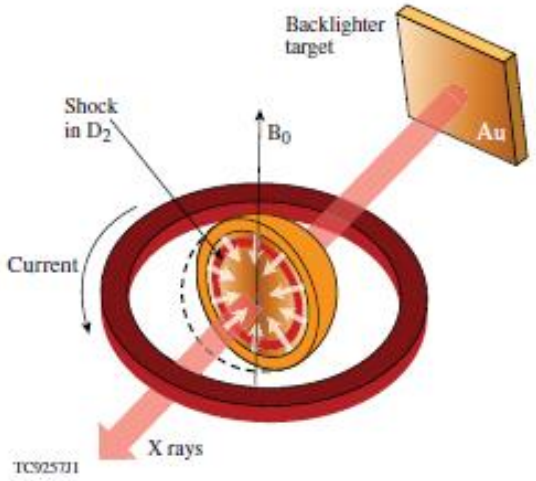
Experiments on OMEGA

Flux Compression:



Knauer et. al. PoP (2010)

Fusion Performance:



Chang et. al. PRL (2011)

- Gorgon replicates peak proton deflection and therefore peak field strength

	T_i % Change	Yield % Change
Experiment	+15	+30
3-D Gorgon	+11	+33