

Advanced Visualization of Vector Field Data

Allen R. Sanderson
Xavier Tricoche



Research Topics

- Detection of critical points (B Field and velocity).
- Tracking of critical points (B Field and velocity).
- Detection of closed field lines (B Field only).
- Tasked for completion at one per year.

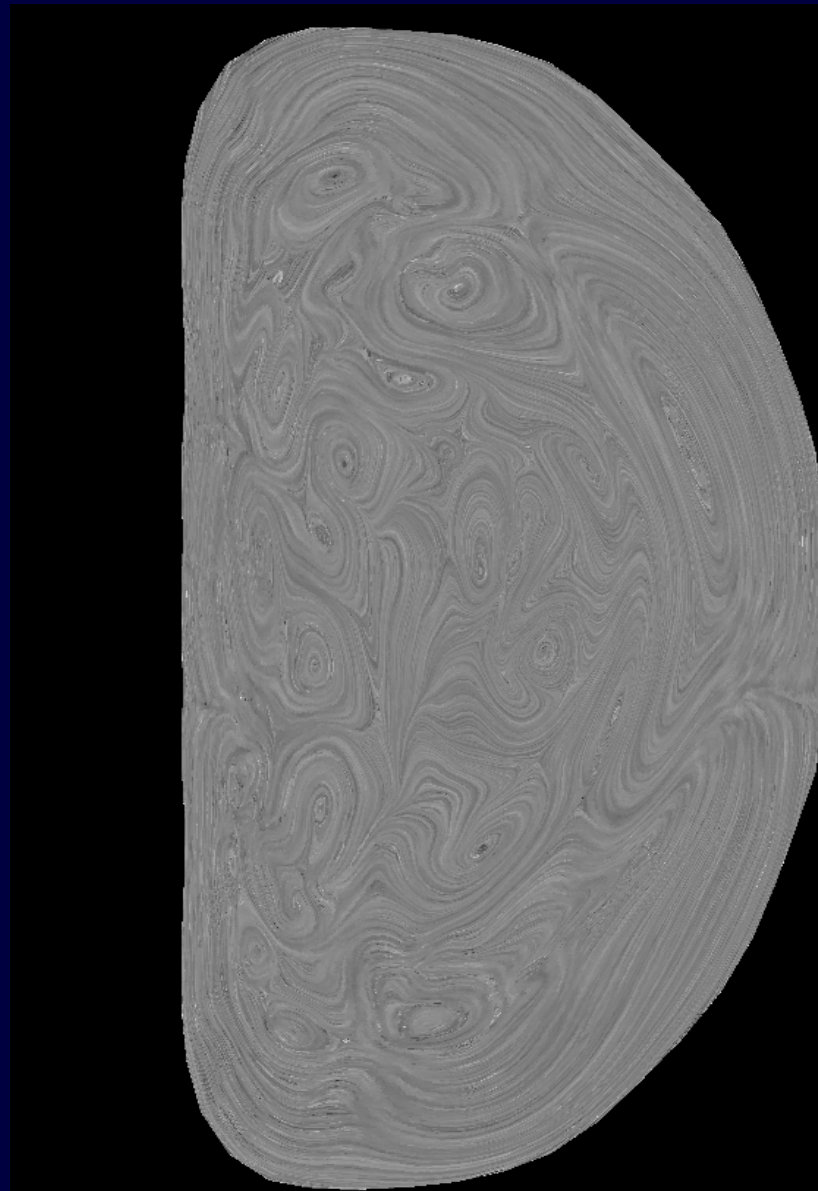


Critical Points - Plasma Velocity

LIC - Line integral
Convolution

Captures the 2D flow
orientation.

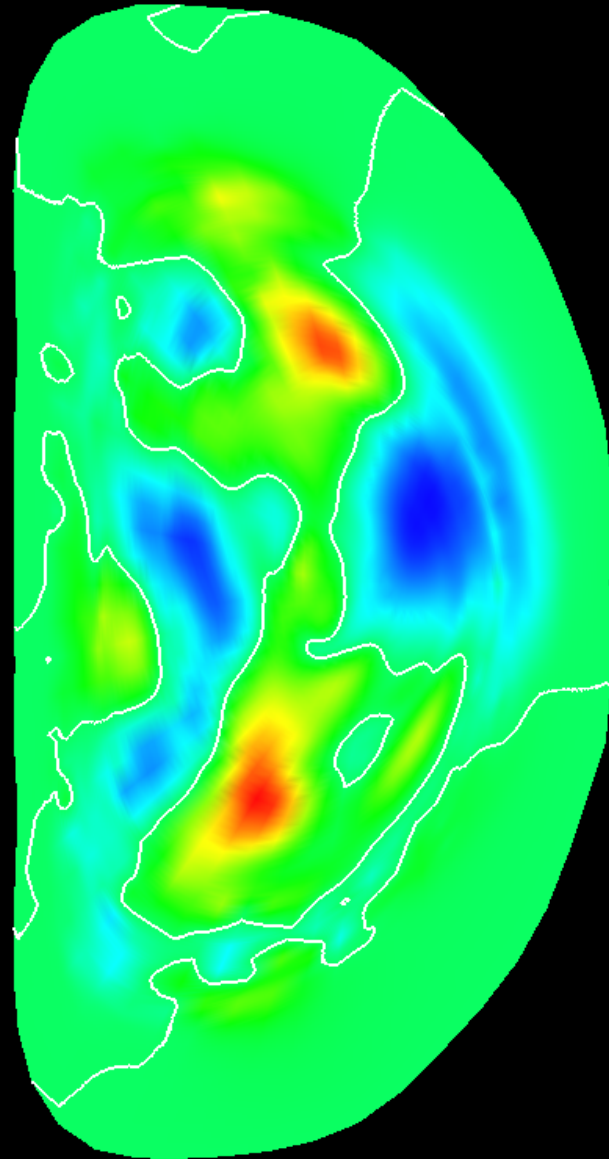
Does not show
direction or
magnitude.



Critical Points - Plasma Velocity

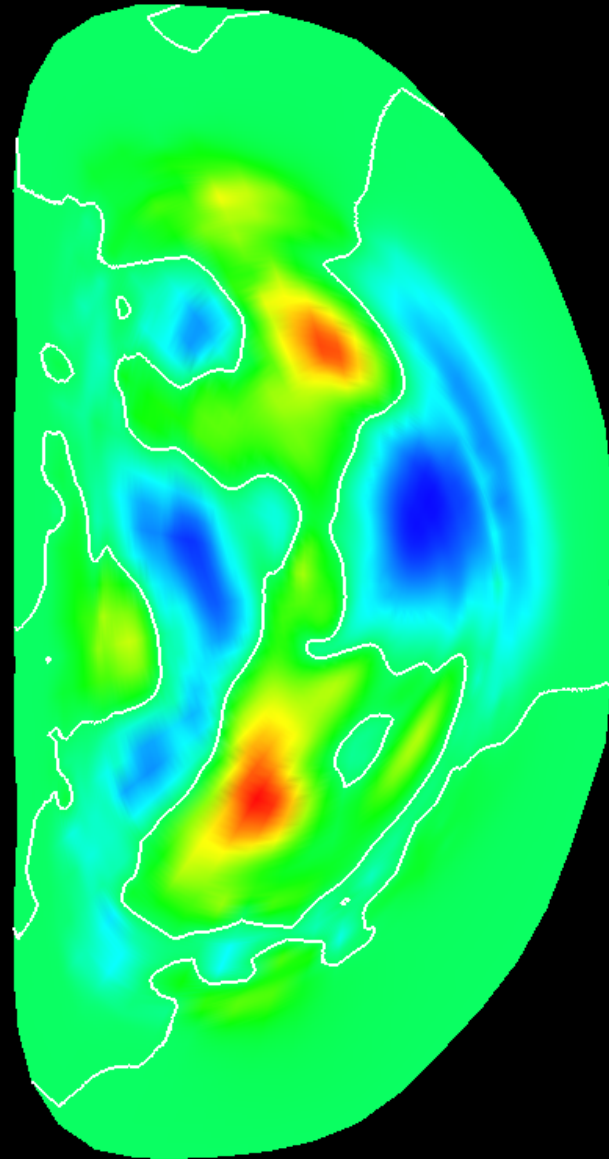
Color mapping shows the flow into (red) and out of blue) the plane.

White contours are locations where the flow is solely in the plane.



Critical Points - Plasma Velocity

Combination - late in the simulation difficult to gather information.

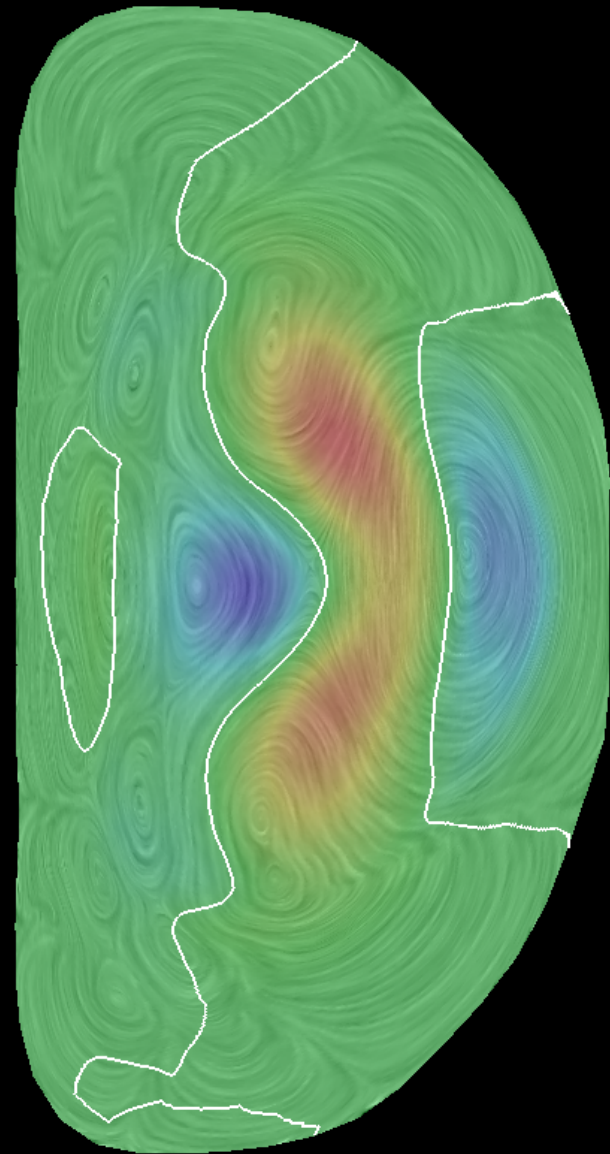


Critical Points - Plasma Velocity

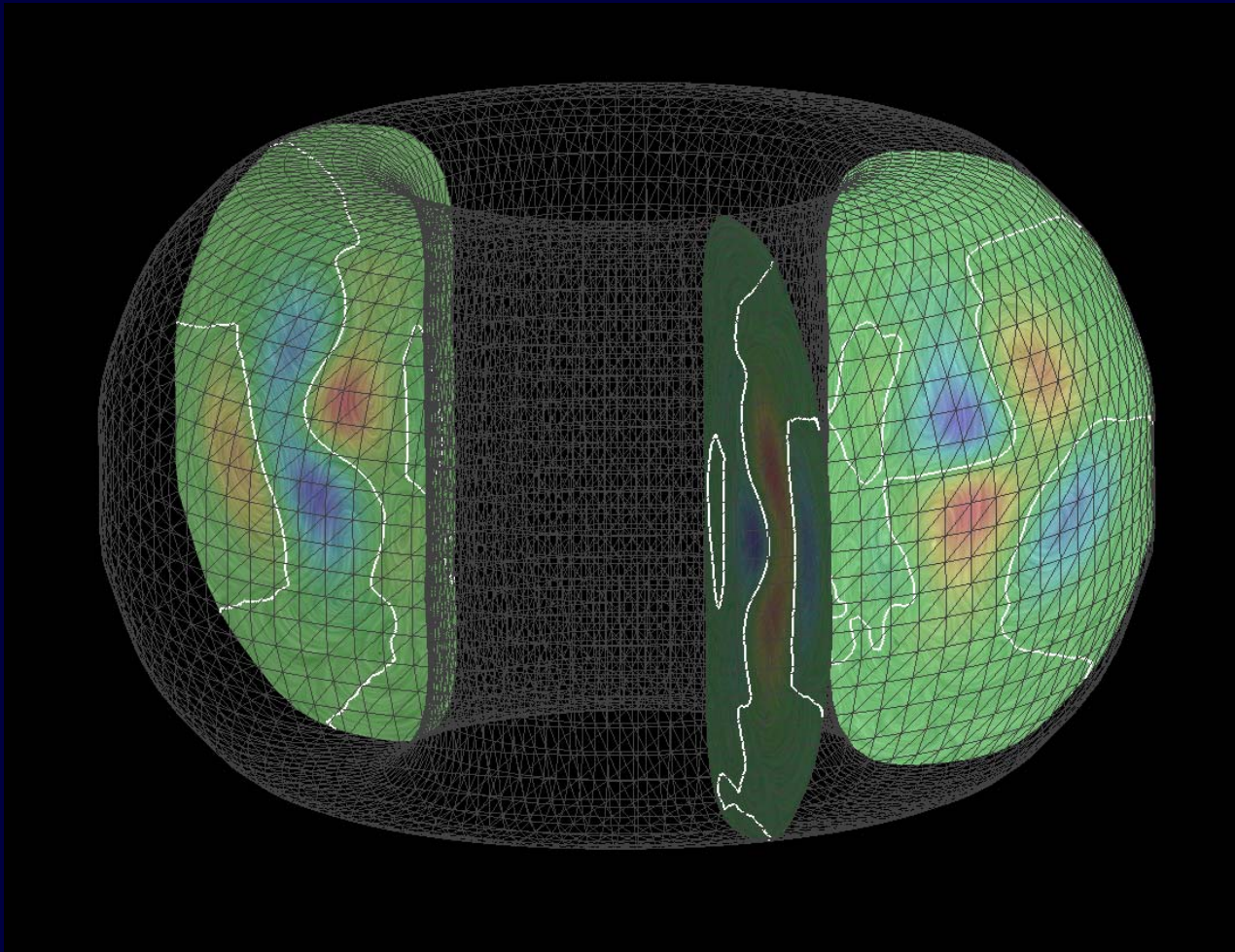
LIC - Line Integral Convolution in the plane shows the swirling nature of the flow.

Color mapping shows the flow into (red) and out of (blue) the plane.

White contours are locations where the flow is solely in the plane.

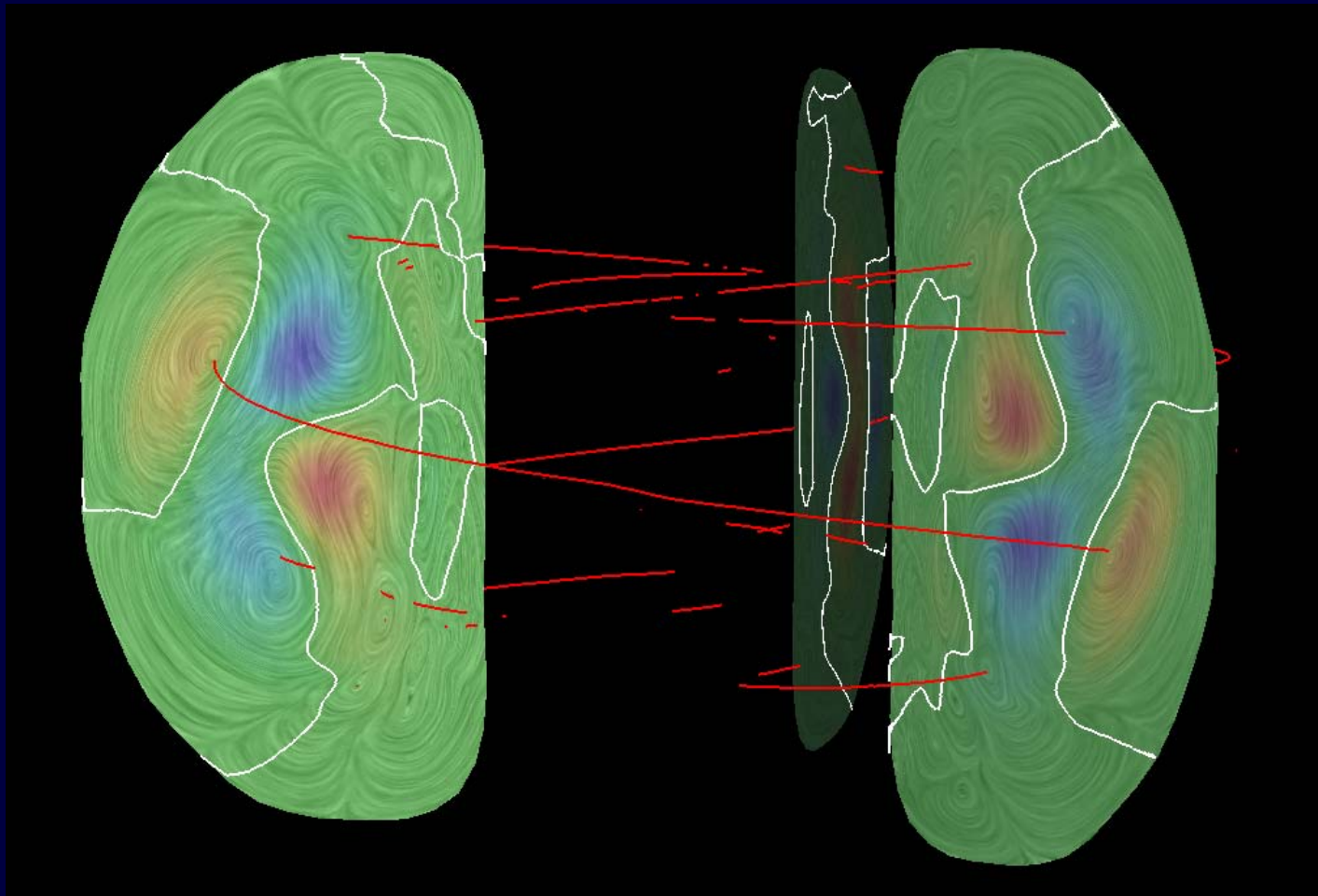


Critical Points - Plasma Velocity



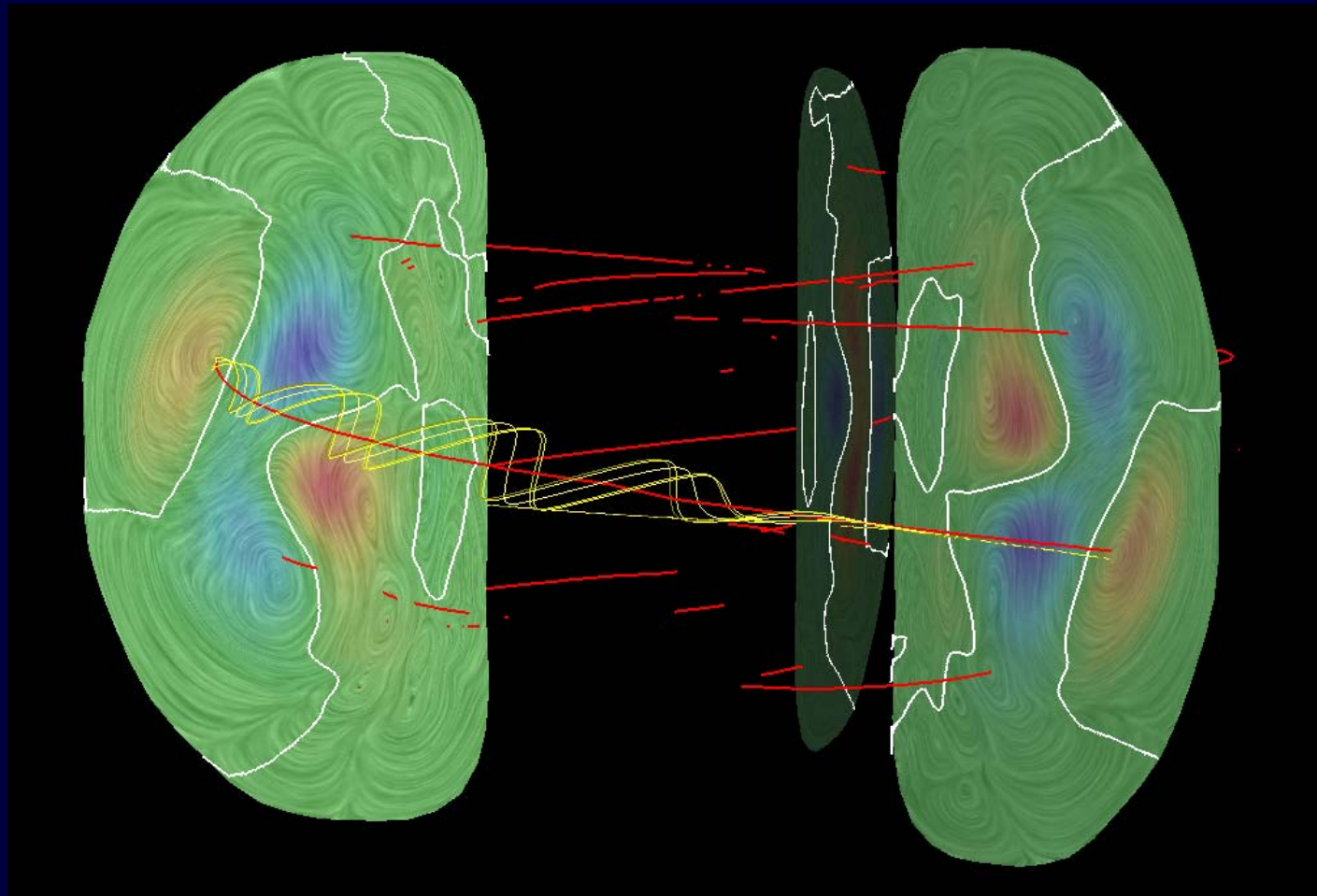
Critical Points - Plasma Velocity

Calculation of vortex cores.



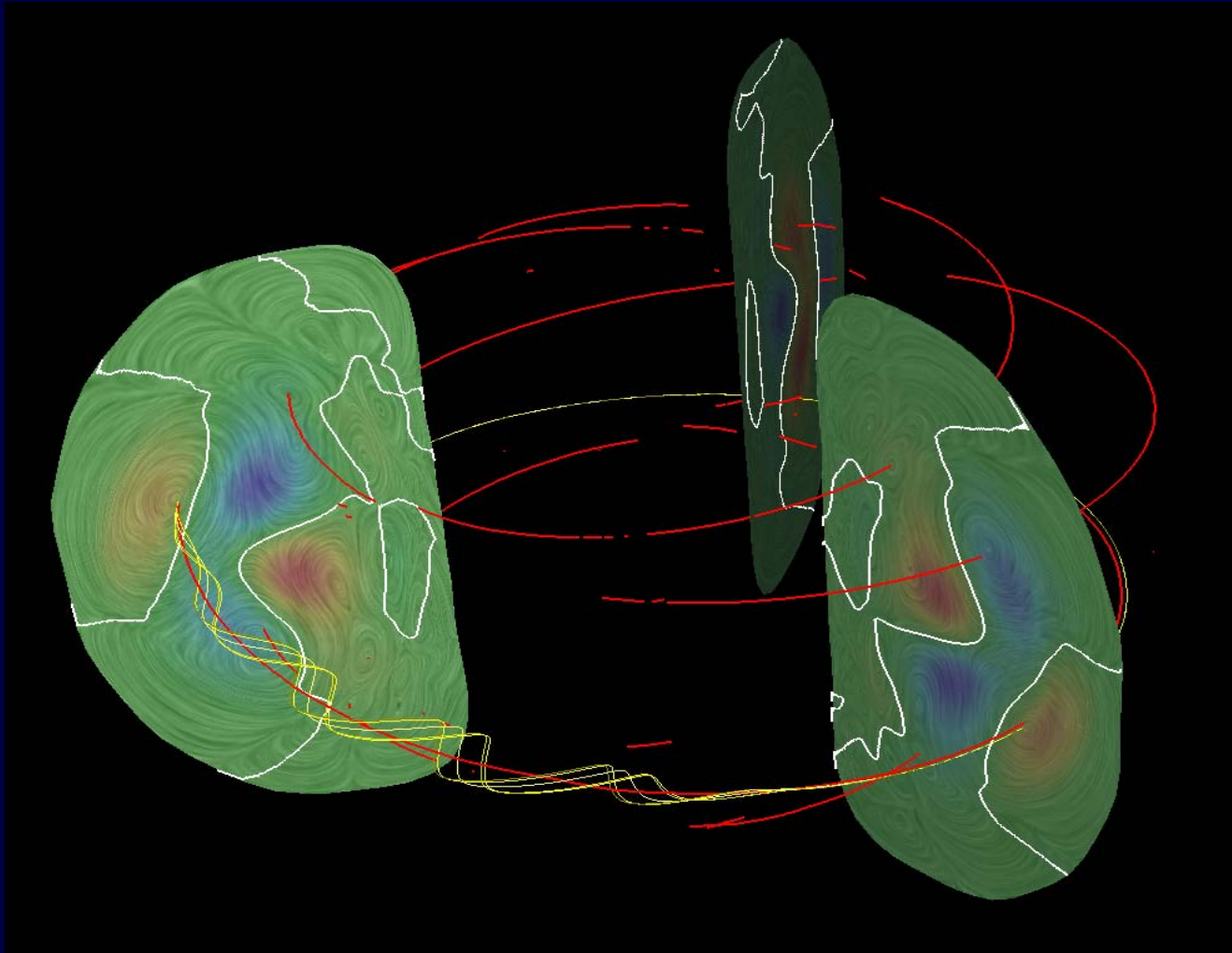
Critical Points - Plasma Velocity

Calculation of vortex cores with streamlines.



Critical Points - Plasma Velocity

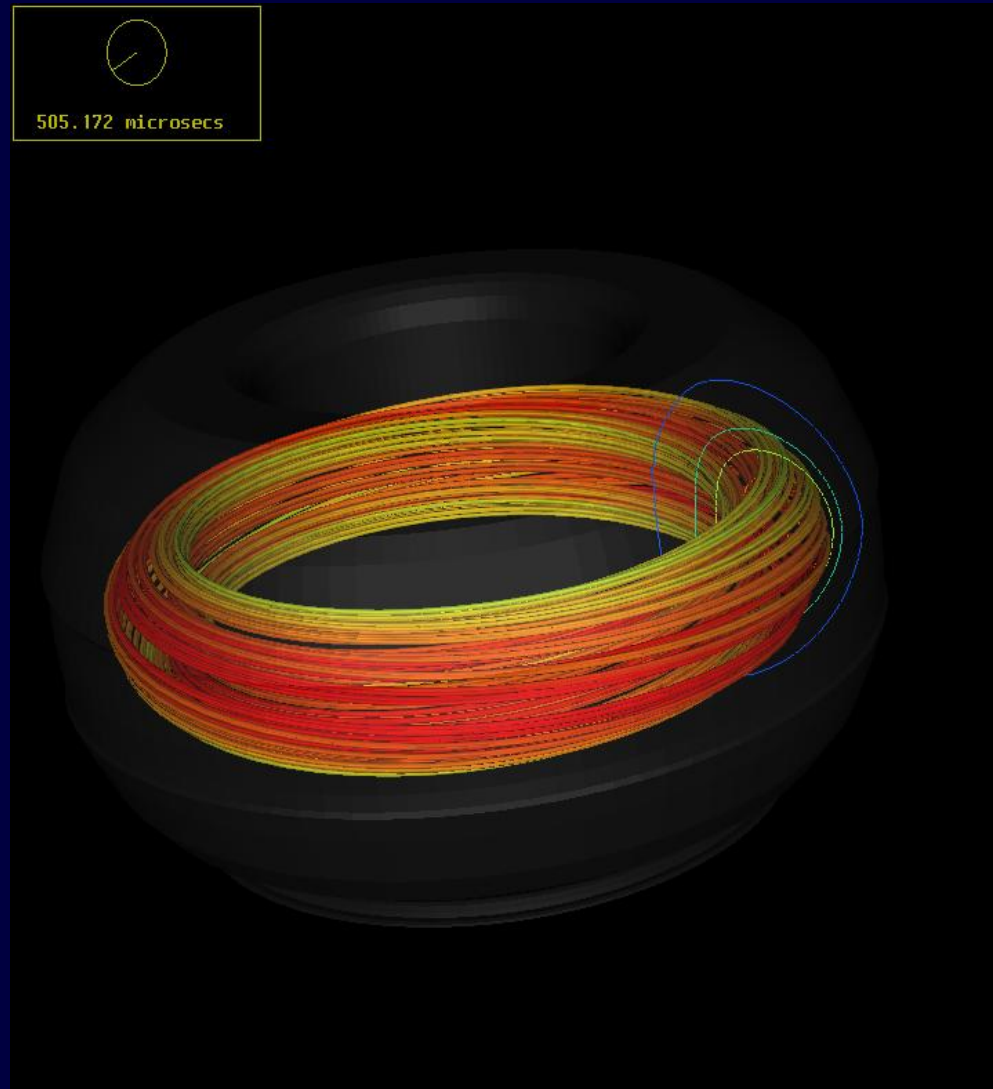
Calculation of vortex cores with streamlines.



Poincare Plots and Surfaces - Magnetic Field

Tracing of fieldlines to create a Poincare plot.

How to seed for the fieldlines?



Poincare Plots and Surfaces - Magnetic Field

Tracing of fieldlines to create a Poincare plot.

Currently, investigating whether it is possible to use the temperature profile changes for seeding field lines.

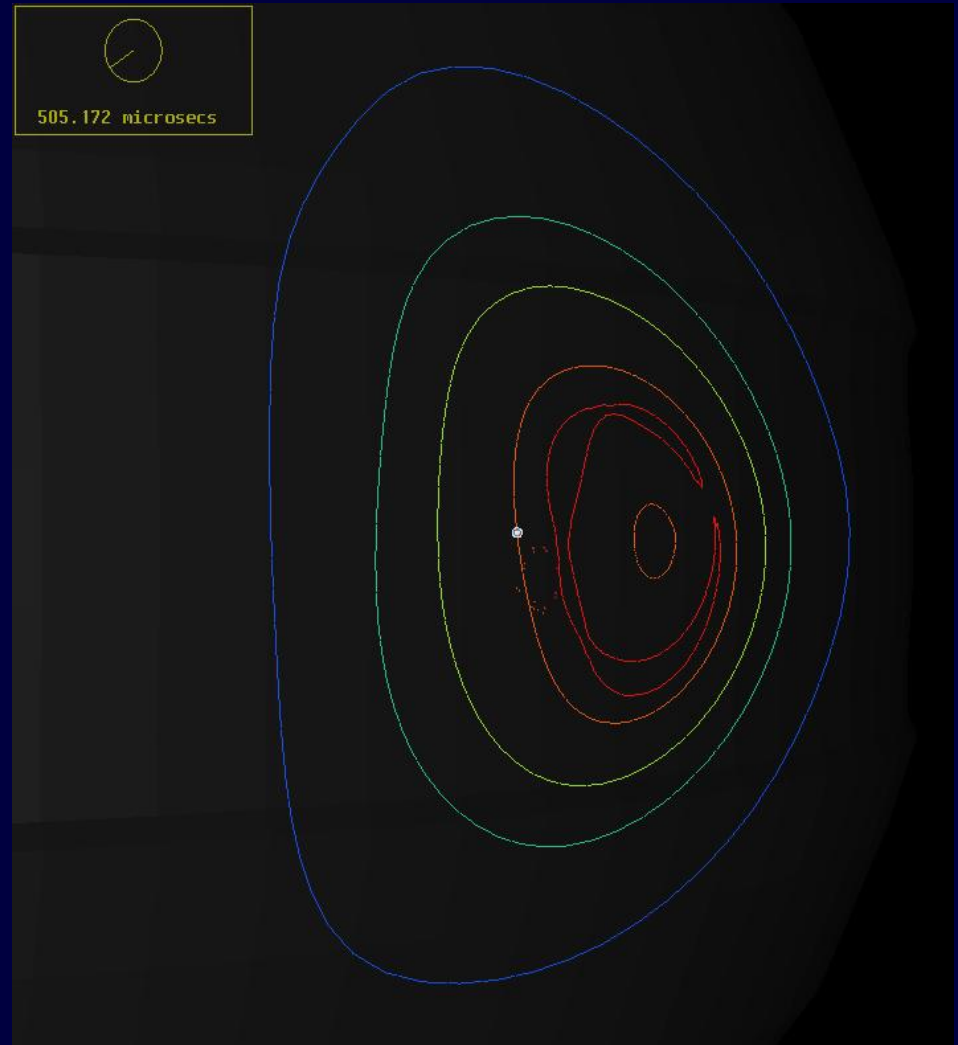
Possible for NIMROD questionable in general.

QuickTime™ and a YUV420 codec decompressor are needed to see this picture.

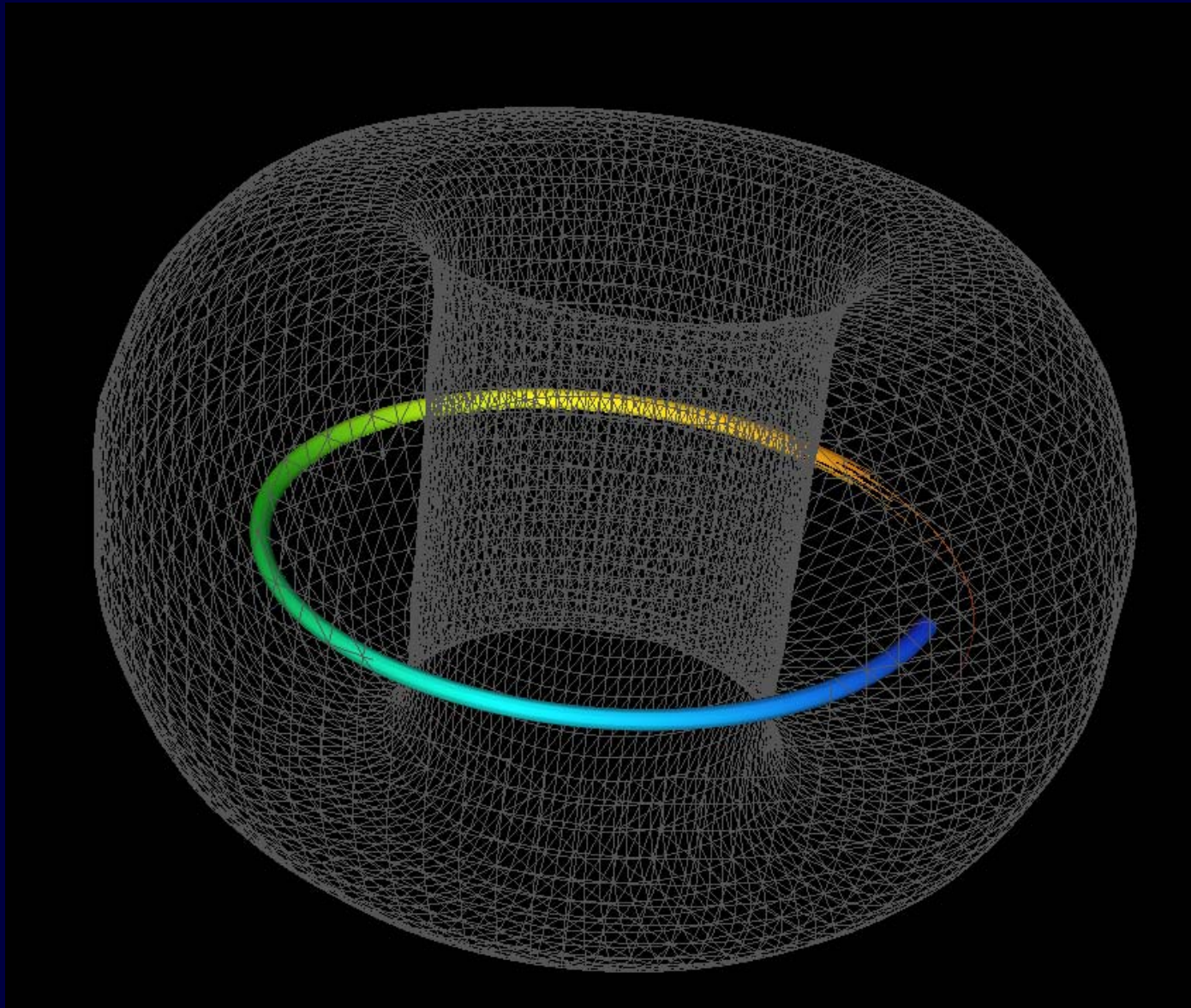


Poincare Plots and Surfaces - Magnetic Field

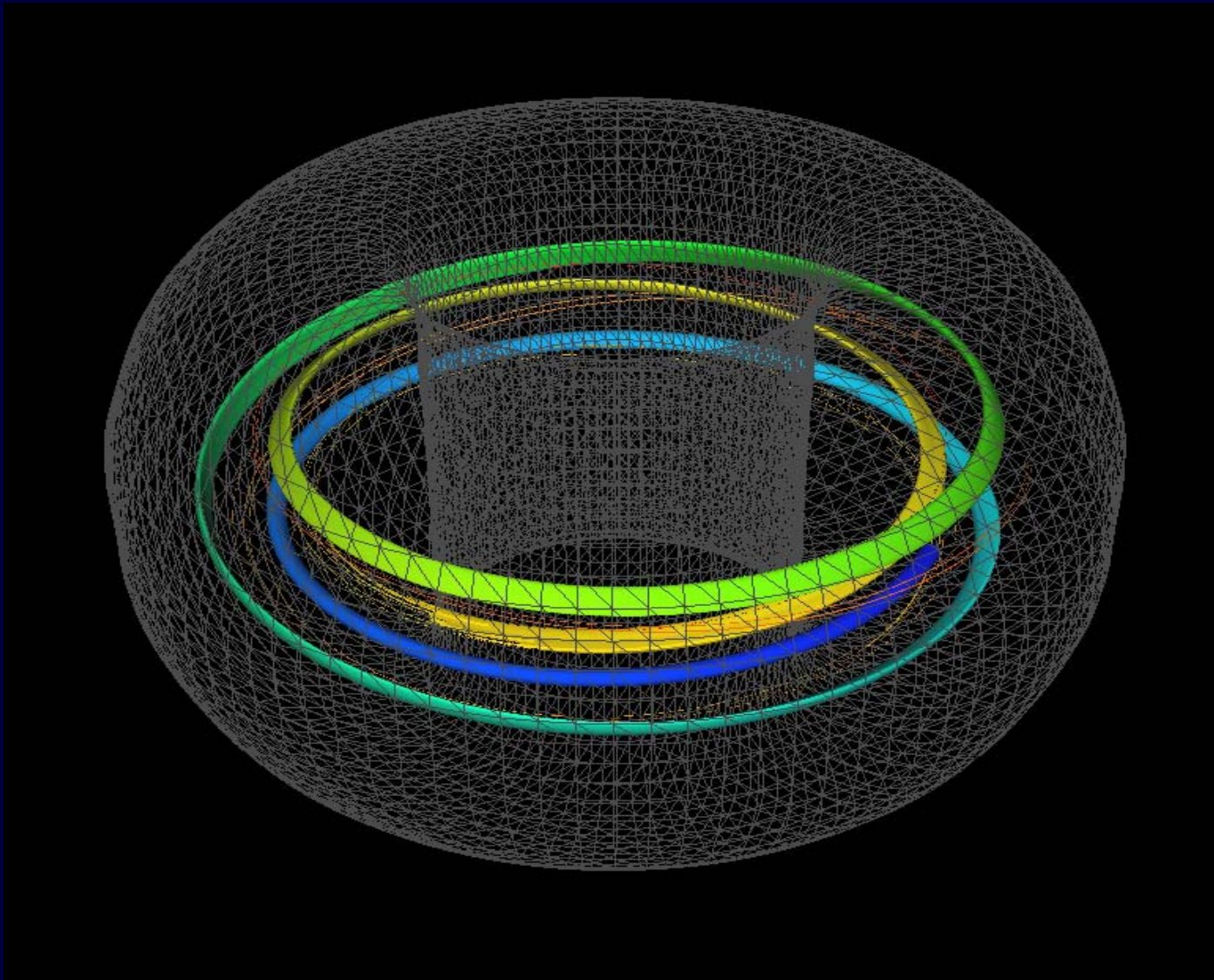
Using the points from the poincare plot a surface can be defined.



Poincare Plots and Surfaces - Magnetic Field



Poincare Plots and Surfaces - Magnetic Field



Critical Points

Nulls can be found by looking at the locations where the field is zero within a cell.

Calculate the Jacobian as a series of linear equations.

$$\mathbf{A}p_{ij} + \vec{b} = \vec{v}_{ij}$$



Critical Points

Given \mathbf{A} and \vec{b} find the location of the zero vector

$$\mathbf{A}p + \vec{b} = \vec{v} = 0$$

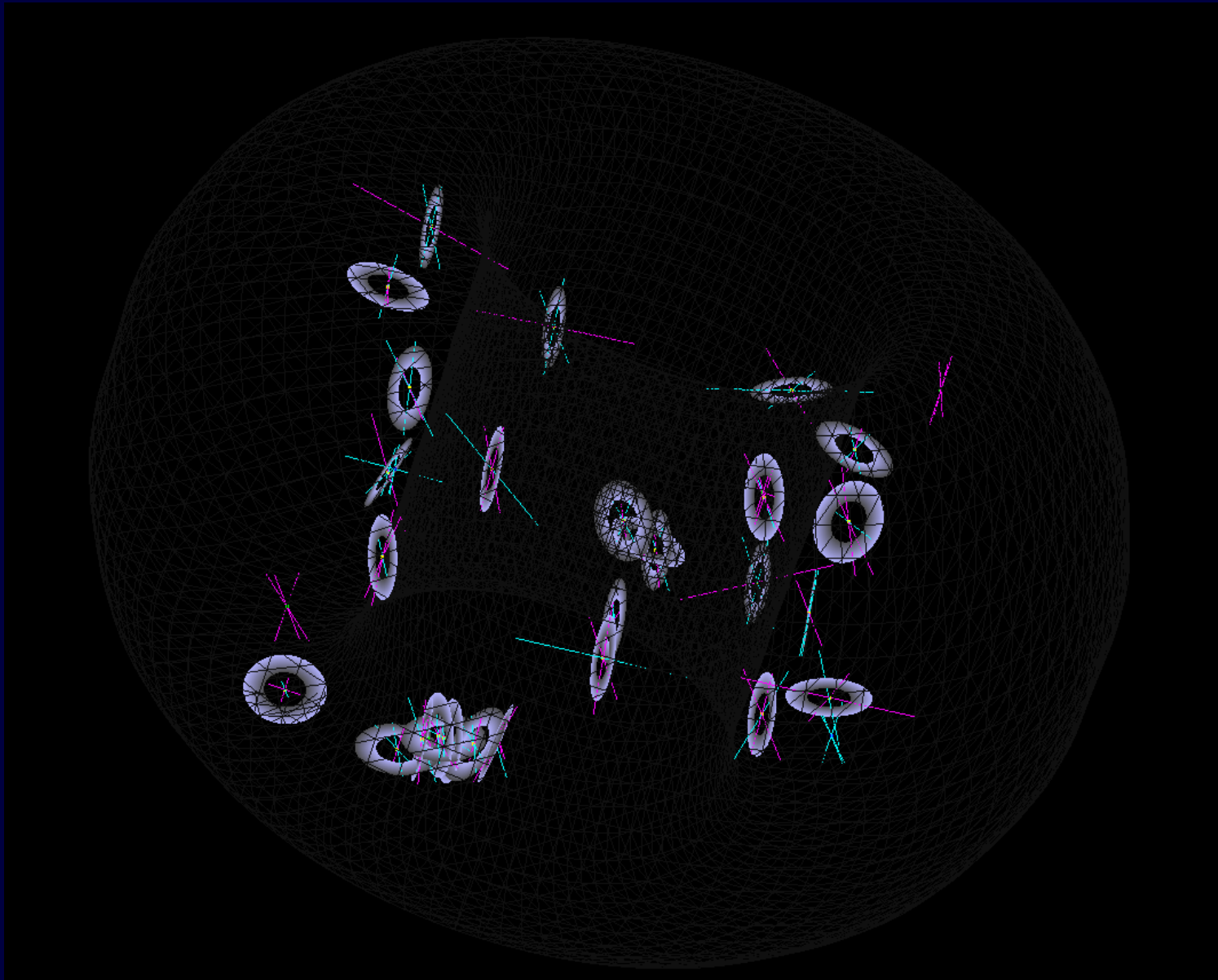
$$\mathbf{A}^{-1}\vec{b} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

If $\begin{pmatrix} x & y & z \end{pmatrix} \in Cell$

then cell contains a zero.



Critical Points



Summary

Initial work towards

- Vortex Cores
- Stream surfaces
- Critical Points

