Mapping the Milky Way galactic arms in three spatial dimensions using data from Lichfield Radio Astronomy Ptarmigan Array 1420MHz Radio Telescope (LRO-H1)

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The Lichfield LRO H1 Radio Telescope

Lichfield Radio Observatory (LRO) is located at latitude 52.6815 north, longitude -1.8255 (1.8255 west) in Staffordshire, central England, UK, roughly 16 mi (26 km) north of Birmingham. The LRO H1 Radio Telescope is composed of a Ptarmigan Triffid ex-military 4x4 dipole array, measuring 86cm x 86cm in size. Filtering is two-stage using a 1400-1427MHz cavity filter, followed by a Nooelec SAWBird H1 LNA/filter. The system uses an RTL-SDR Blog V3 Software Defined Radio and data for this paper was recorded using Easy Radio Astronomy Software Suite (ezRA; Ted Cline; https://github.com/tedcline/ezRA).

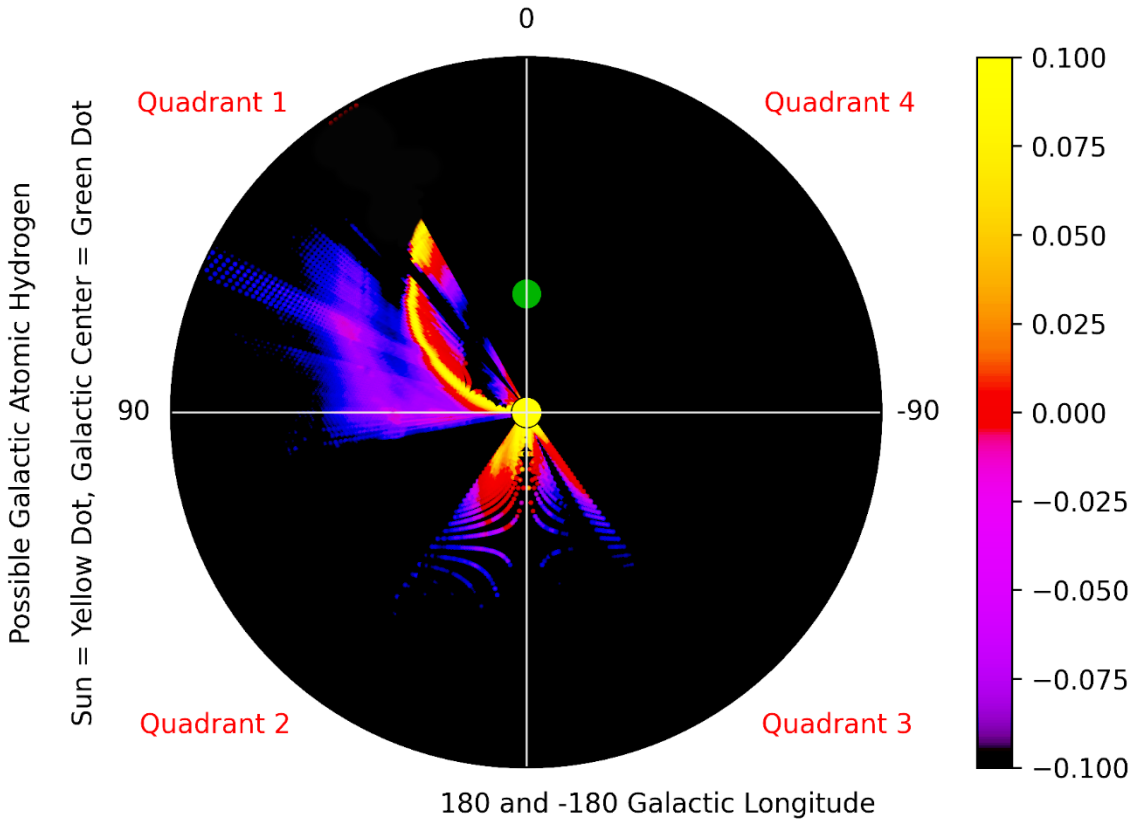
The telescope is mounted on a simple wooden mount that allows variation in elevation. It points at the same azimuth constantly – data is collected using 24-hour drift scans which allow individual azimuth points to be calculated by the software during the sidereal day.

Ptarmigan Triffid Band 3 Ex-Military Dipole Array on simple wooden mount (below):

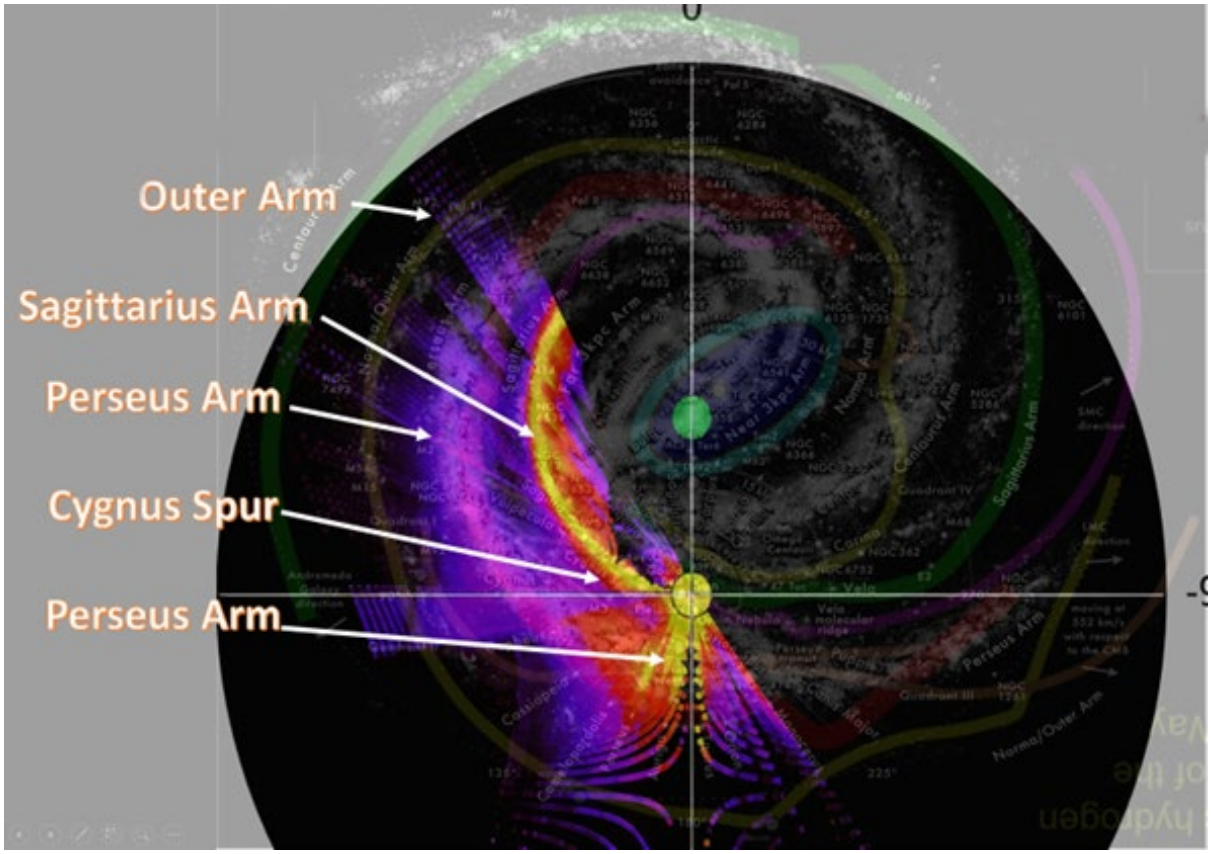
Data collected for this paper

Data was collected for this paper between 6th January 2024 and 16th November 2024. It is composed of 582,492 samples (approx. 2,500 hours of data). Most of the data is within Milky Way galactic longitudes 0-90 degrees. It demonstrates several galactic arm features.

2D map of Milky Way from LRO using data collected between 6th January 2024 and 16th November 2024:



Features of the structure of the galactic arms of the Milky Way demonstrated in the data (below):



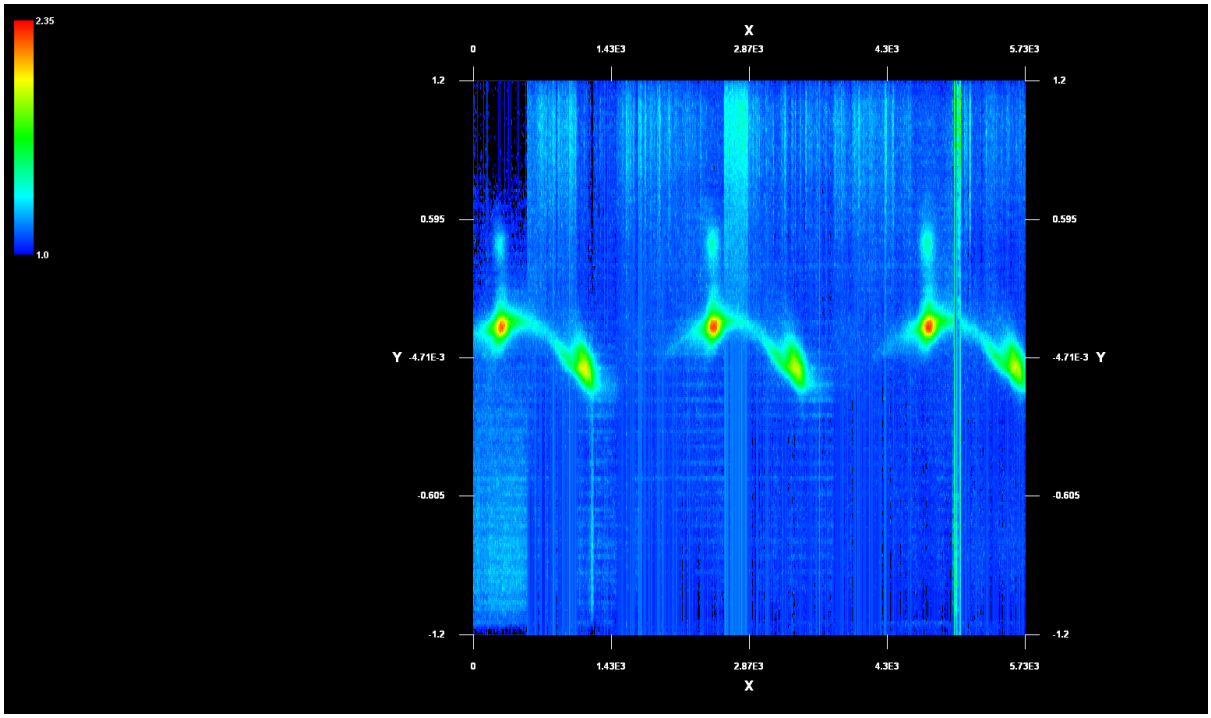
Mapping the Milky Way in 3 spatial dimensions:

Revisions to the Easy Radio Astronomy Suite (ezRA) have allowed the production of CSV files compatible with Rinearn3D software (https://www.rinearn.com/en-us/graph3d/). This software allows data to be plotted in three spatial dimensions, and, using a process developed by Ted Cline, the author of Easy Radio Astronomy, maps of the Milky Way arms can be produced using this software.

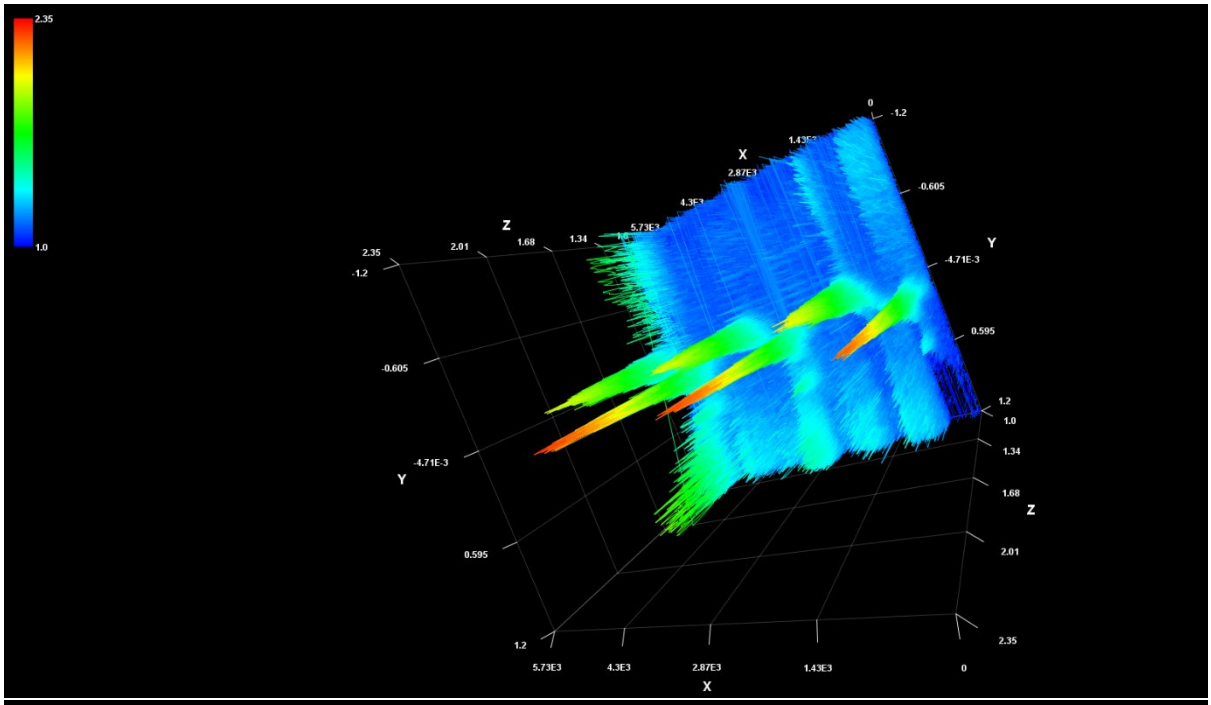
Results.

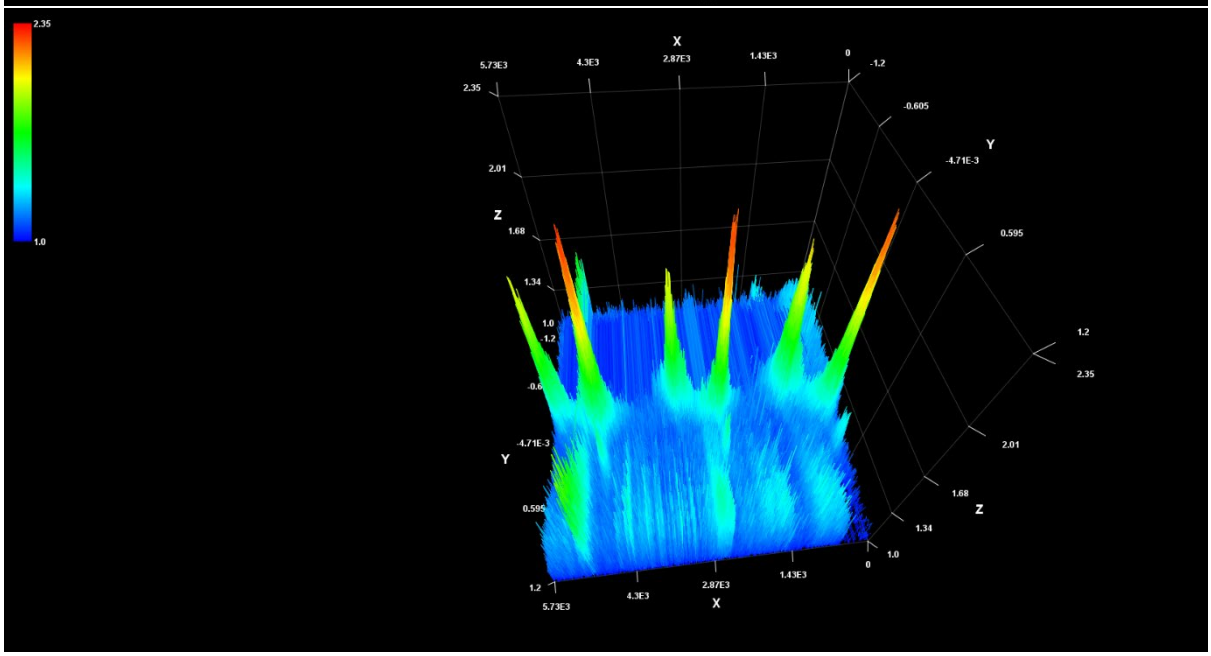
The following plots are produced using Rinearn3D, using data from LRO-H1.

Plot of data intensity over time, showing periodic daily cycle:



Above plot with intensity plotted on third axis. These plots still include two spatial dimensions:


2.35
1.0
X
Z
Y
5.73E3
4.3E3
2.87E3
1.43E3
0
-1.2
-0.605
-4.71E-3
0.595
1.2
1.0
1.34
1.68
2.01
2.35


2.35
1.0
X
Z
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5.73E3
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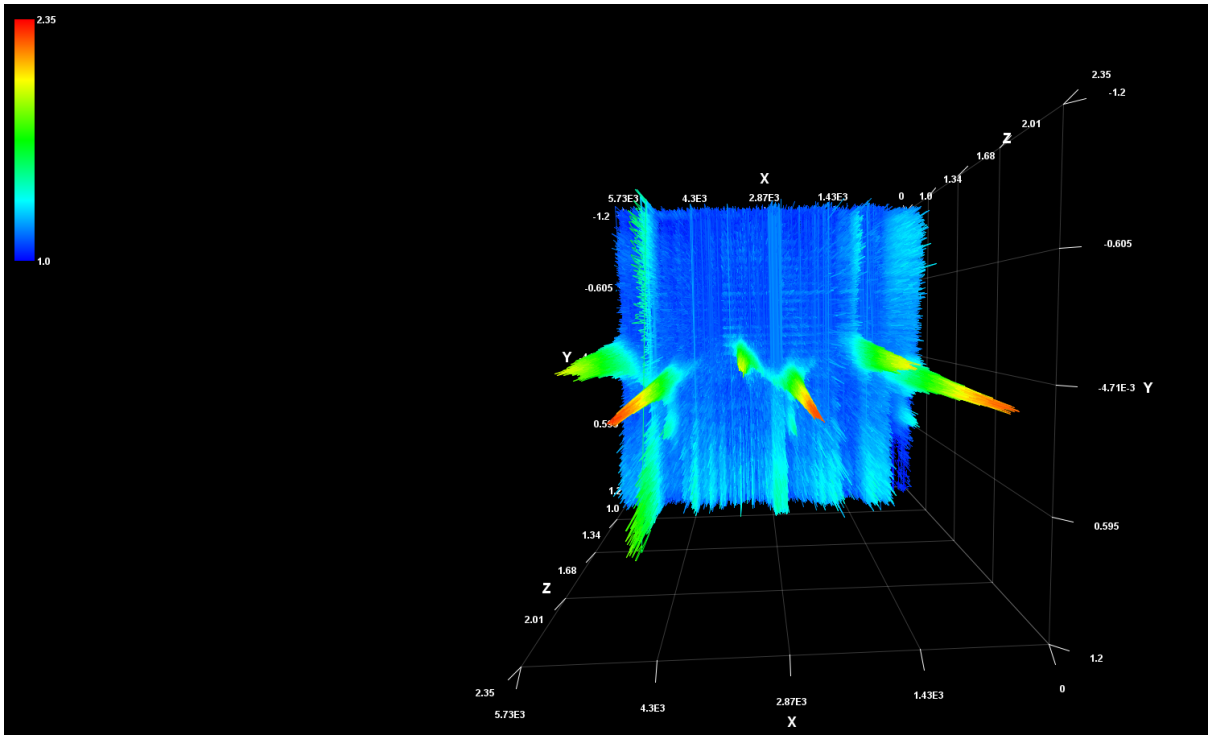
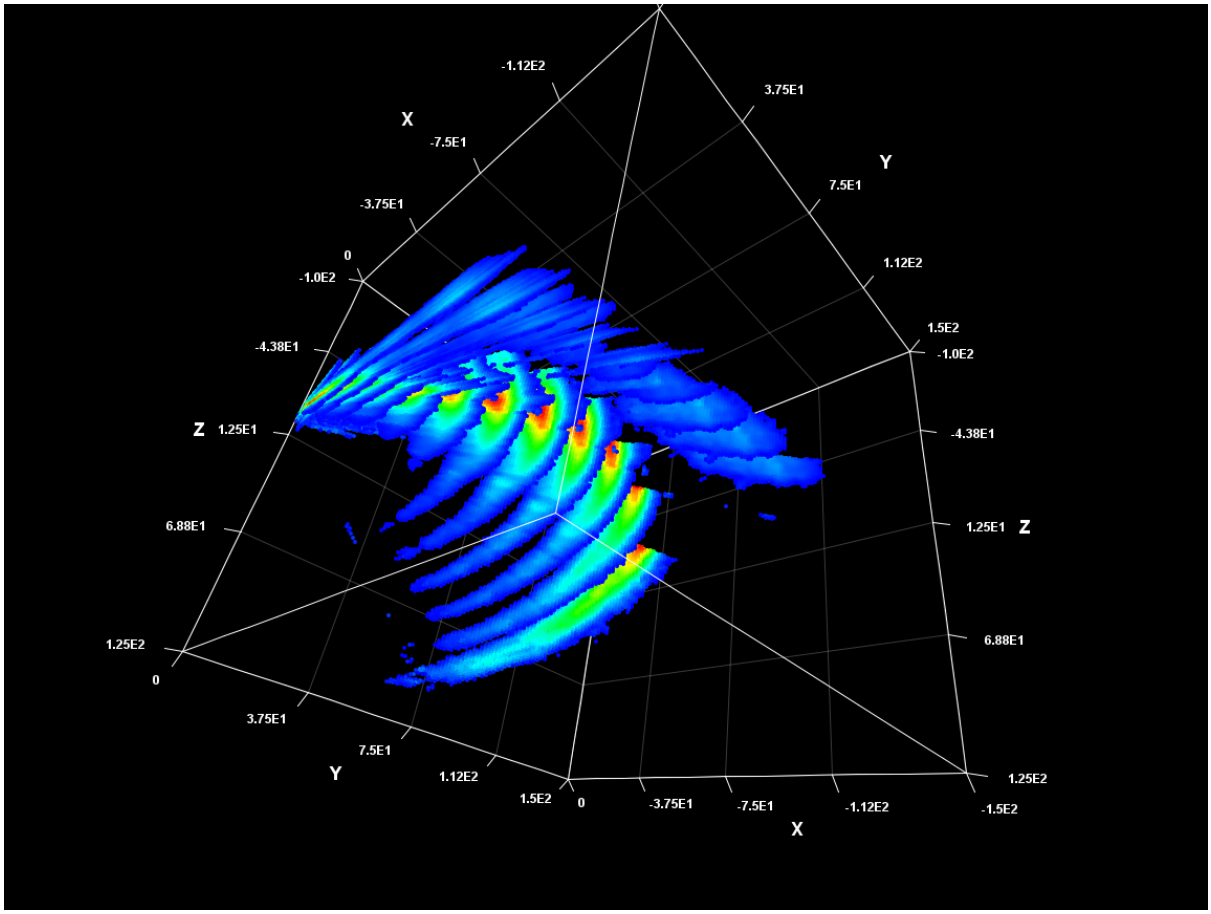


The following plots demonstrate two galactic arms (higher intensity closer to Milky Way centre, lower intensity further away from centre). Our solar system is located at one end of the inner arm (top left on next plot).

Plotting data in three spatial dimensions using Rinearn3D: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-4.38E1
Z
1.25E1
6.88E1
1.25E2
0
3.75E1
7.5E1
Y
1.12E2
1.5E2
3.75E1
Y
7.5E1
1.12E2
1.5E2
-1.0E2
-4.38E1
1.25E1
Z
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1.25E2
0
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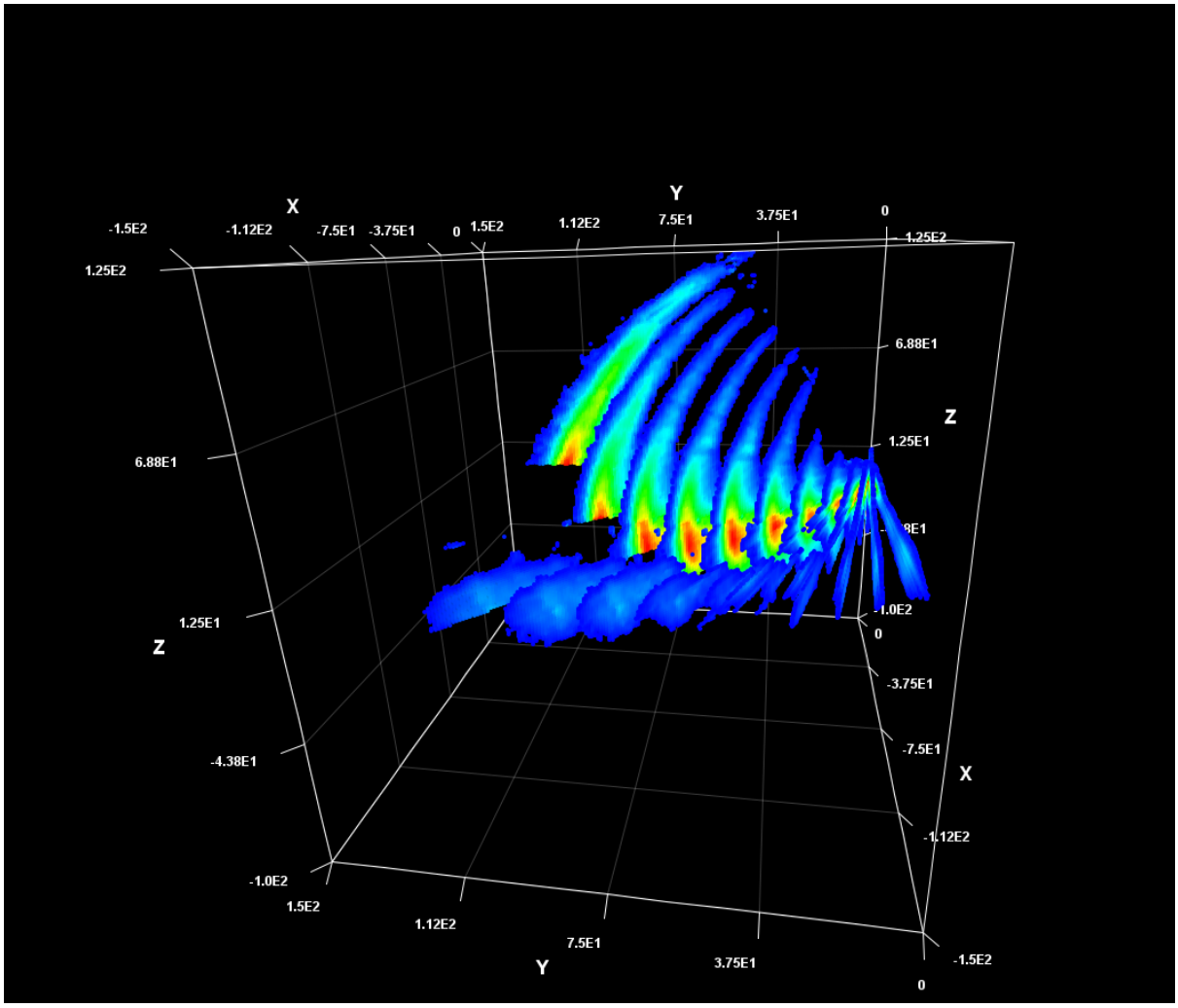
-7.5E1
-1.12E2
-1.5E2
X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7.5E1
3.75E1
0
Y
1.25E2
6.88E1
1.25E1
-4.38E1
-1.0E2
Z
1.5E2
1.12E2
7.5E1
3.75E1
0
Y
-1.25E2
6.88E1
1.25E1
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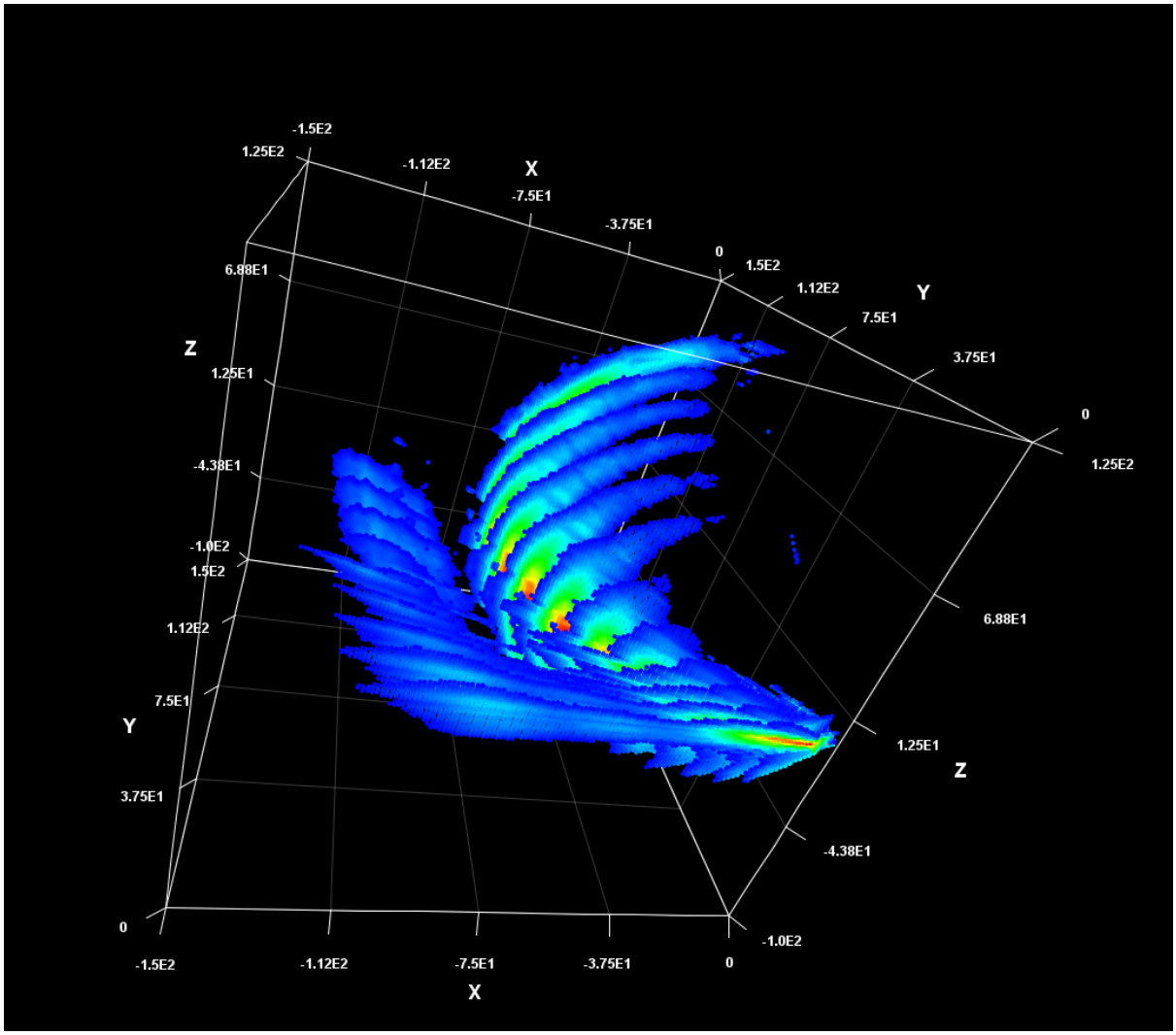
-1.5E2
Z
X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-3.75E1
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1.5E2
1.12E2
Y
7.5E1
3.75E1
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1.25E2
6.88E1
Z
1.25E1
-4.38E1
-1.0E2
1.5E2
1.12E2
7.5E1
Y
3.75E1
0
-1.5E2
-1.12E2
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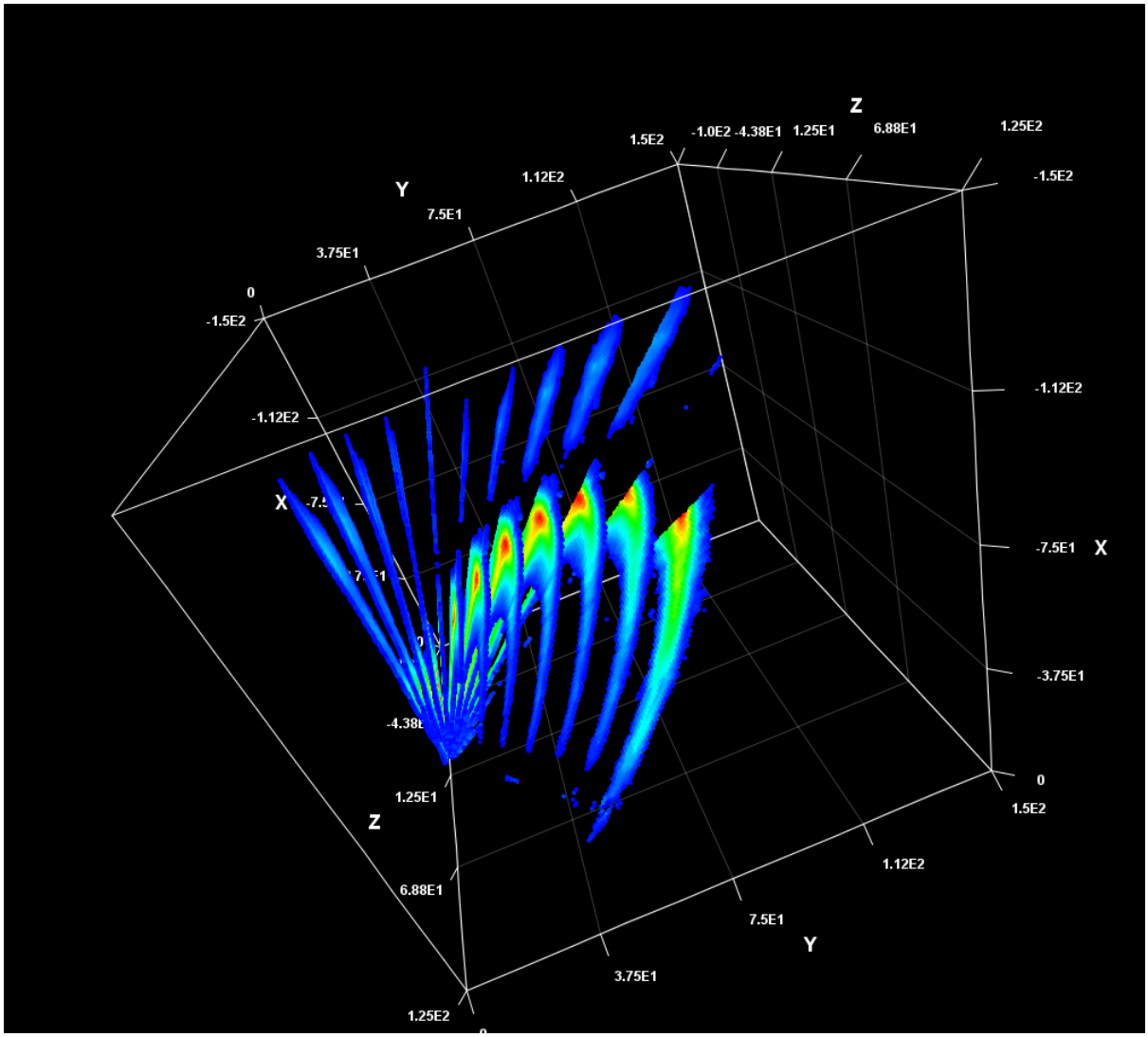
-4.38E1
1.25E1
Z
6.88E1


Z
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6.88E1
1.25E2
Y
1.12E2
-1.5E2
7.5E1
3.75E1
0
-1.5E2
-1.12E2
-1.12E2
X
-7.5E1
X
-3.75E1
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Z
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7.5E1
Y
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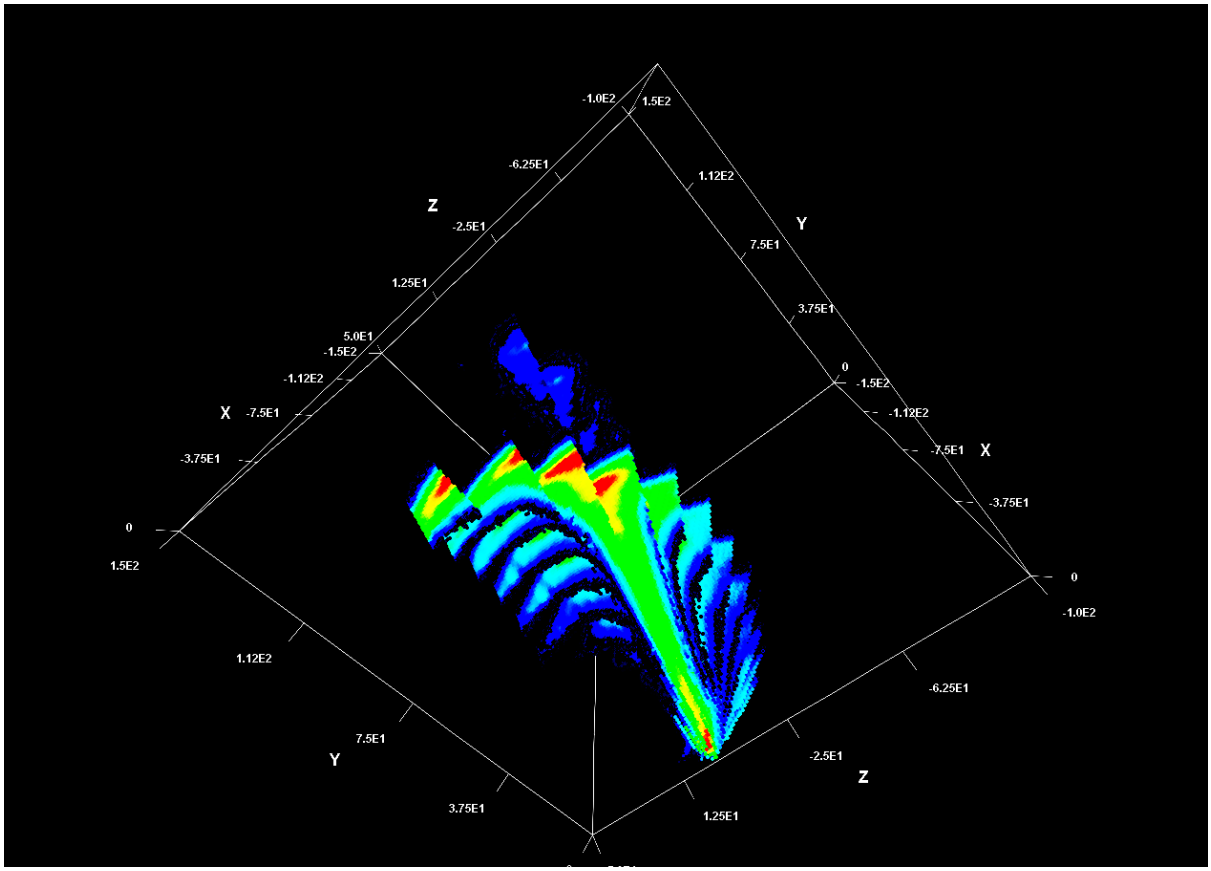
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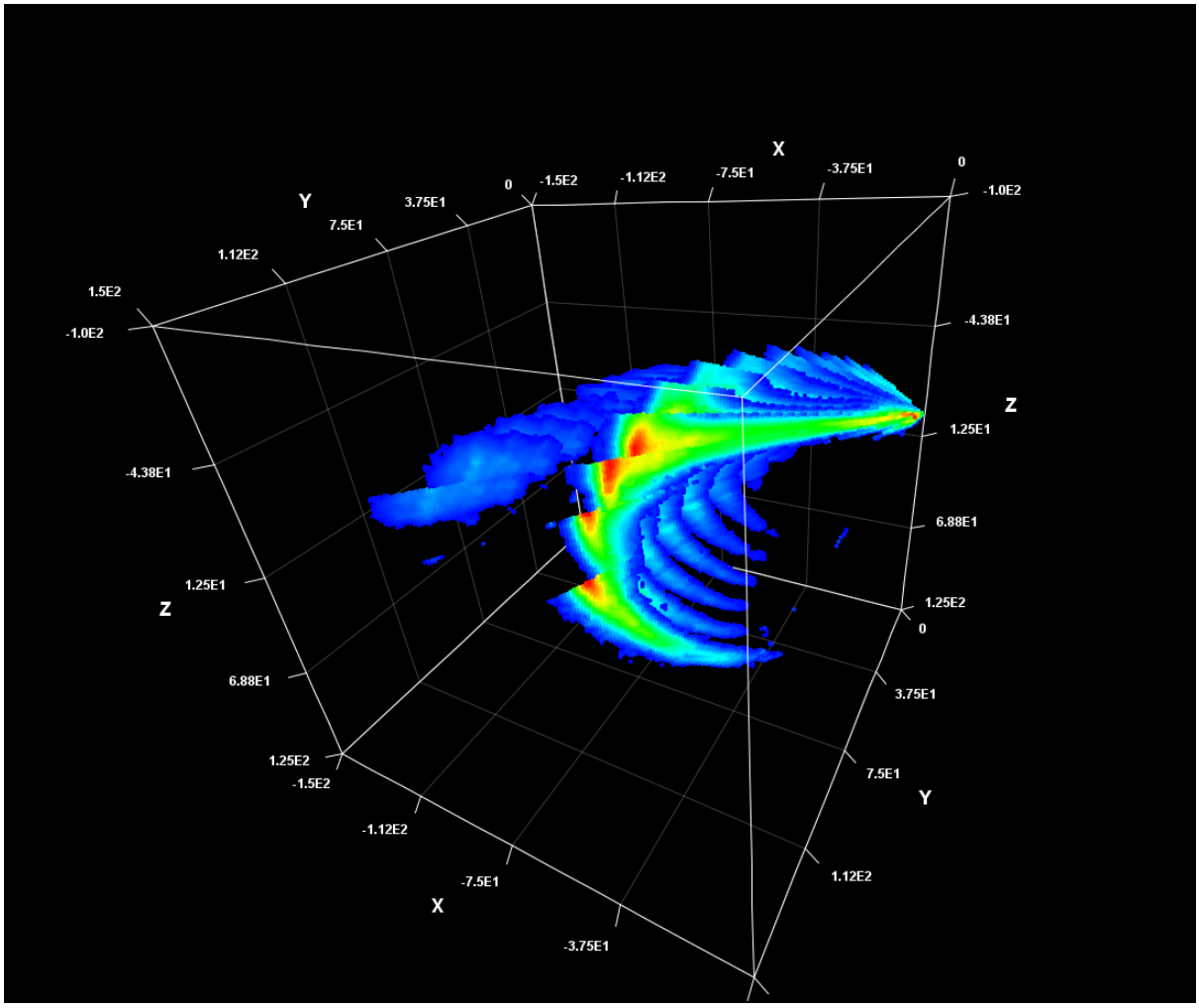
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-7.5E1
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1.5E2
-1.0E2
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6.88E1
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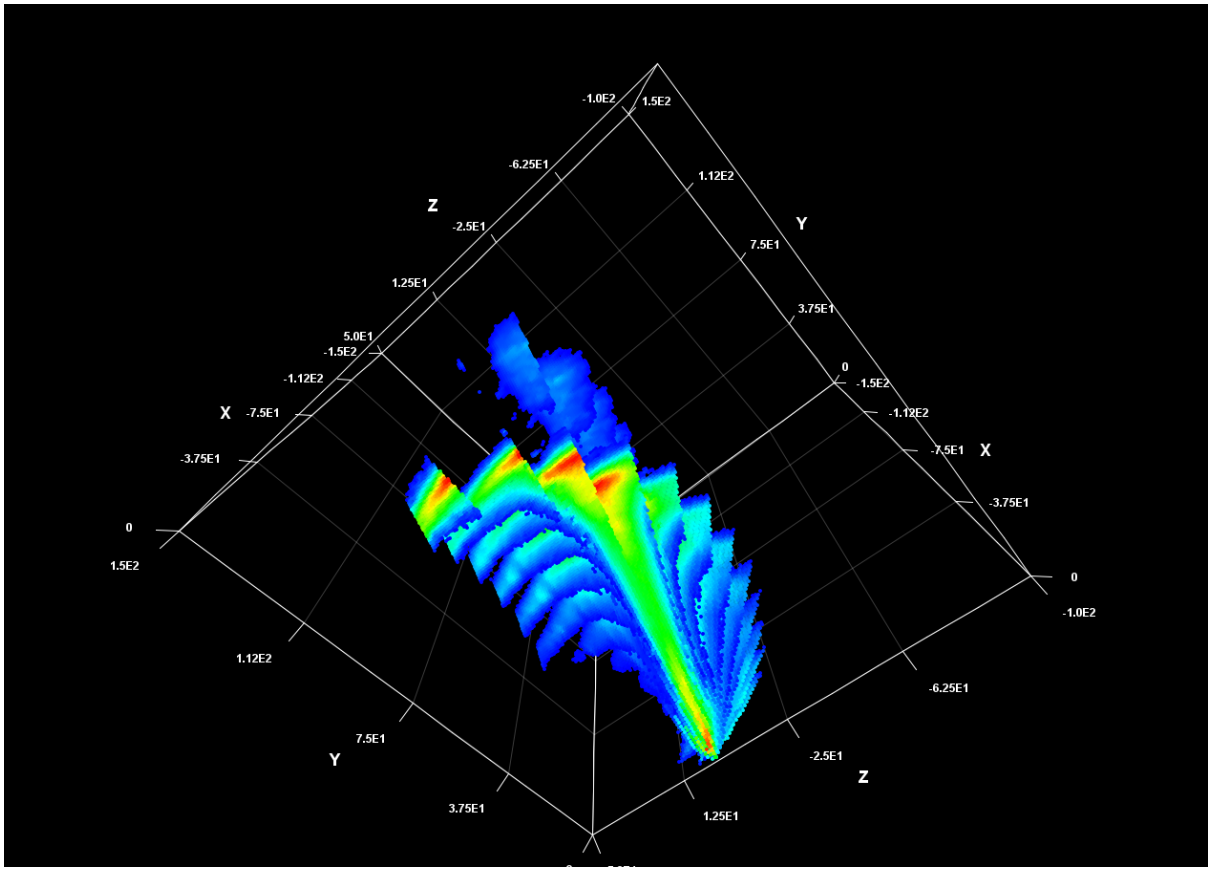
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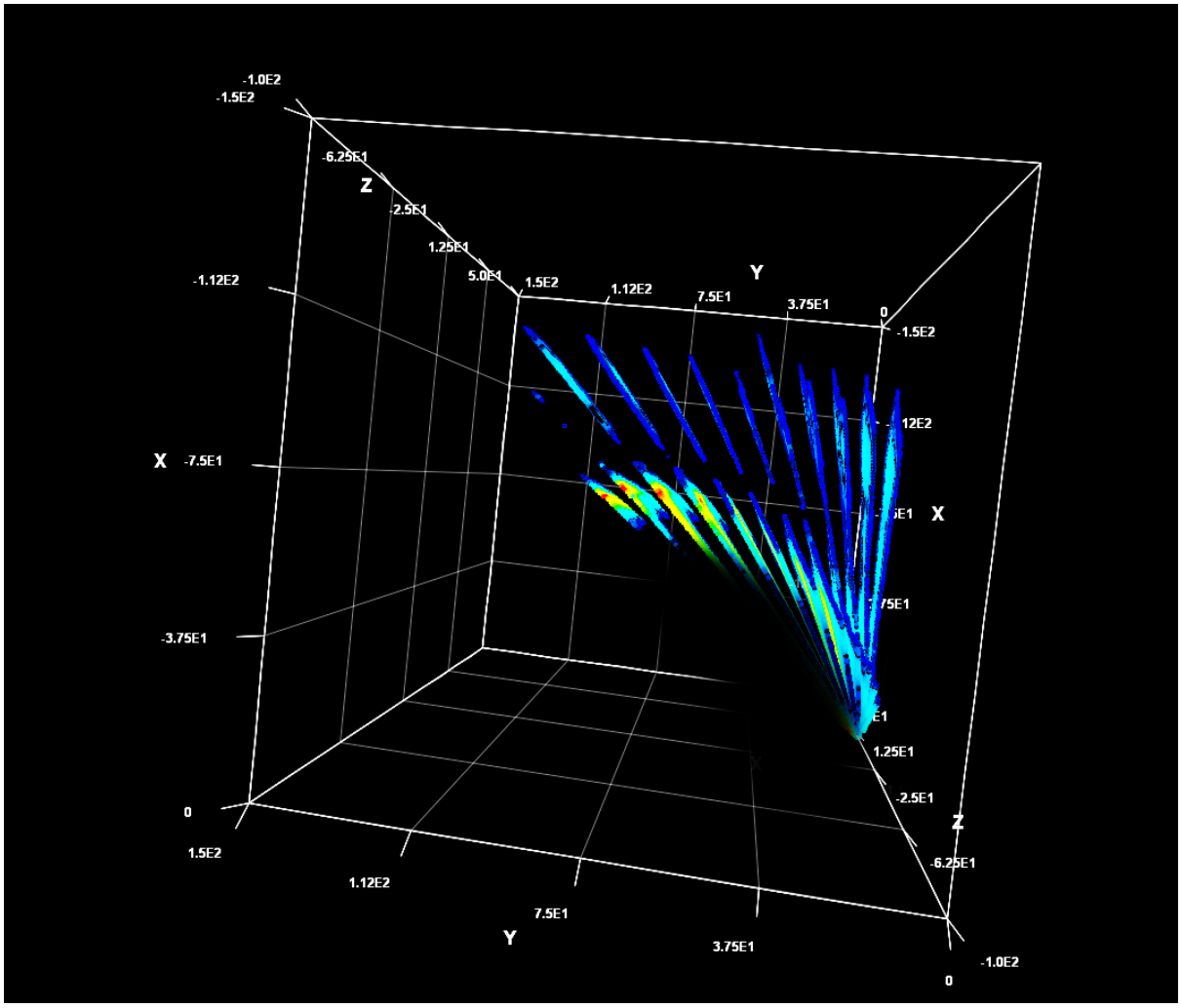
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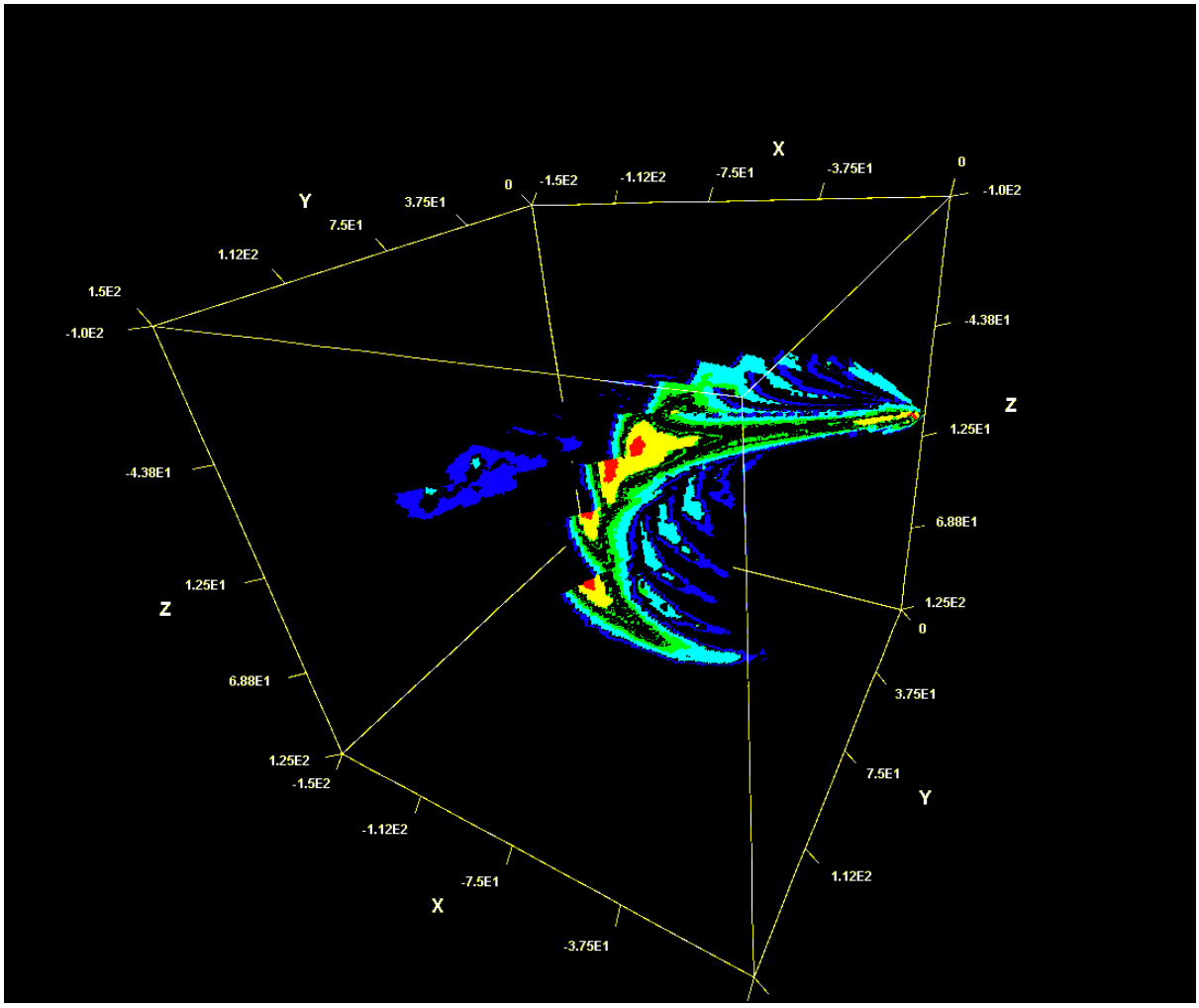
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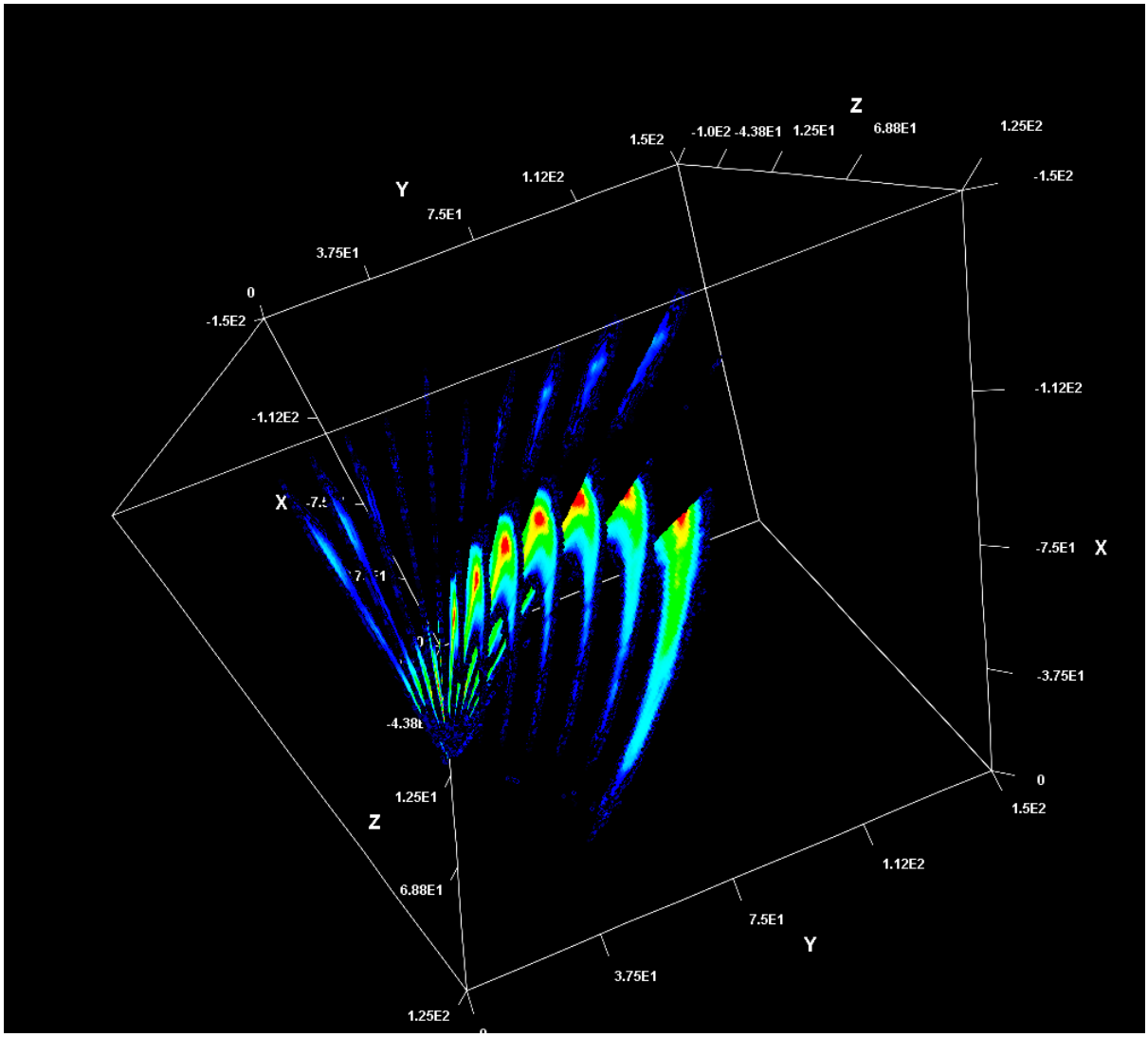
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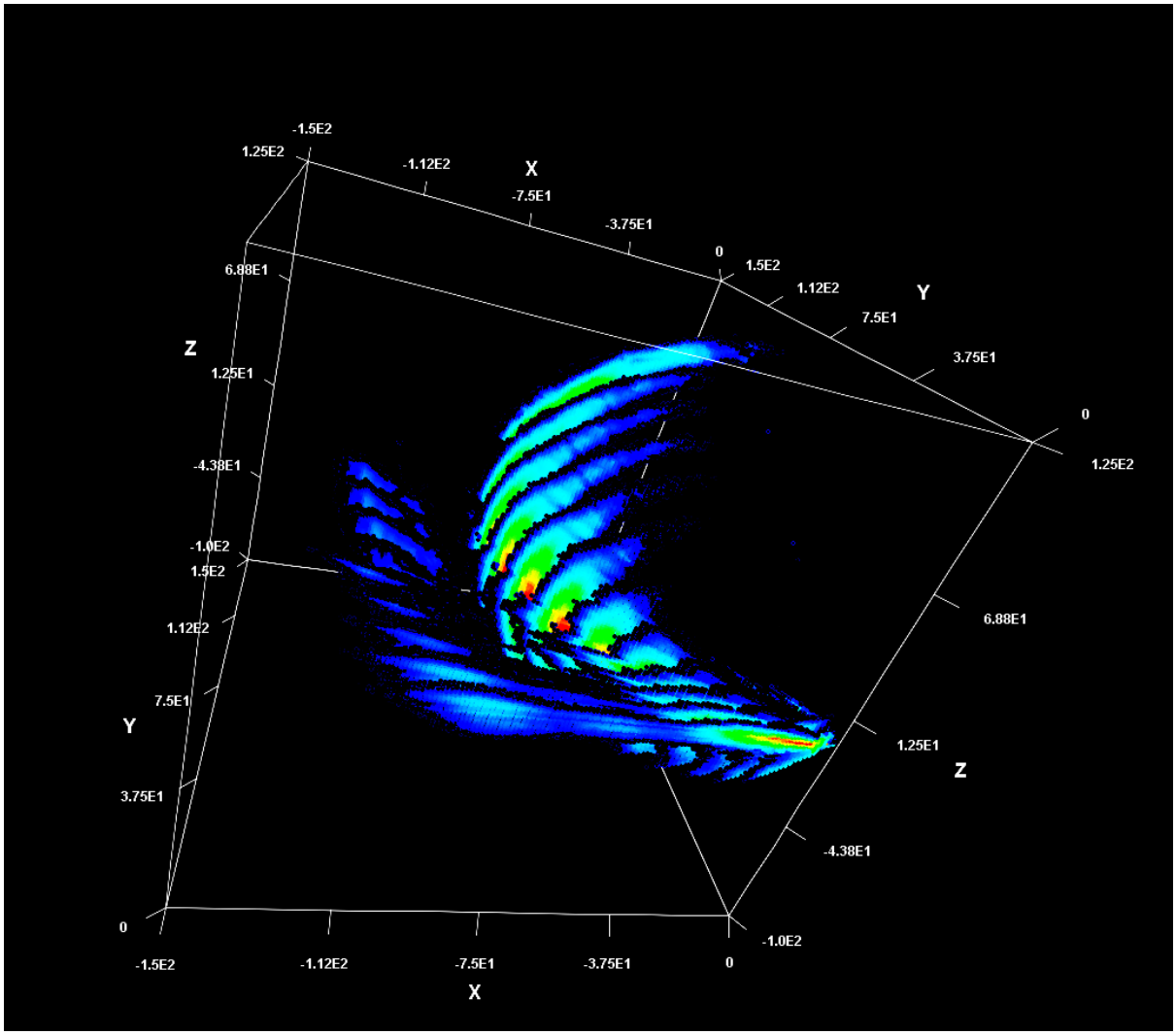
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3.75E1
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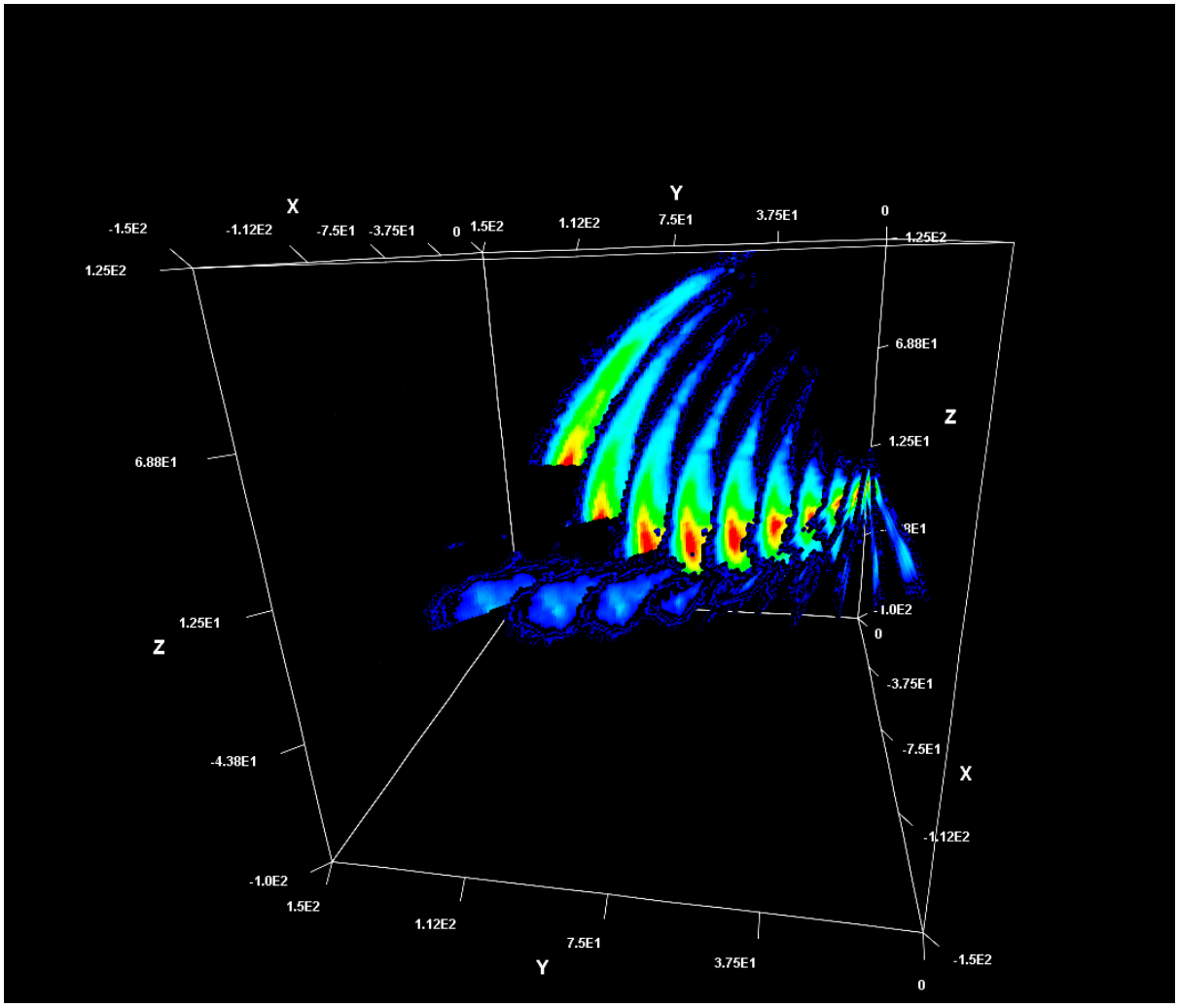
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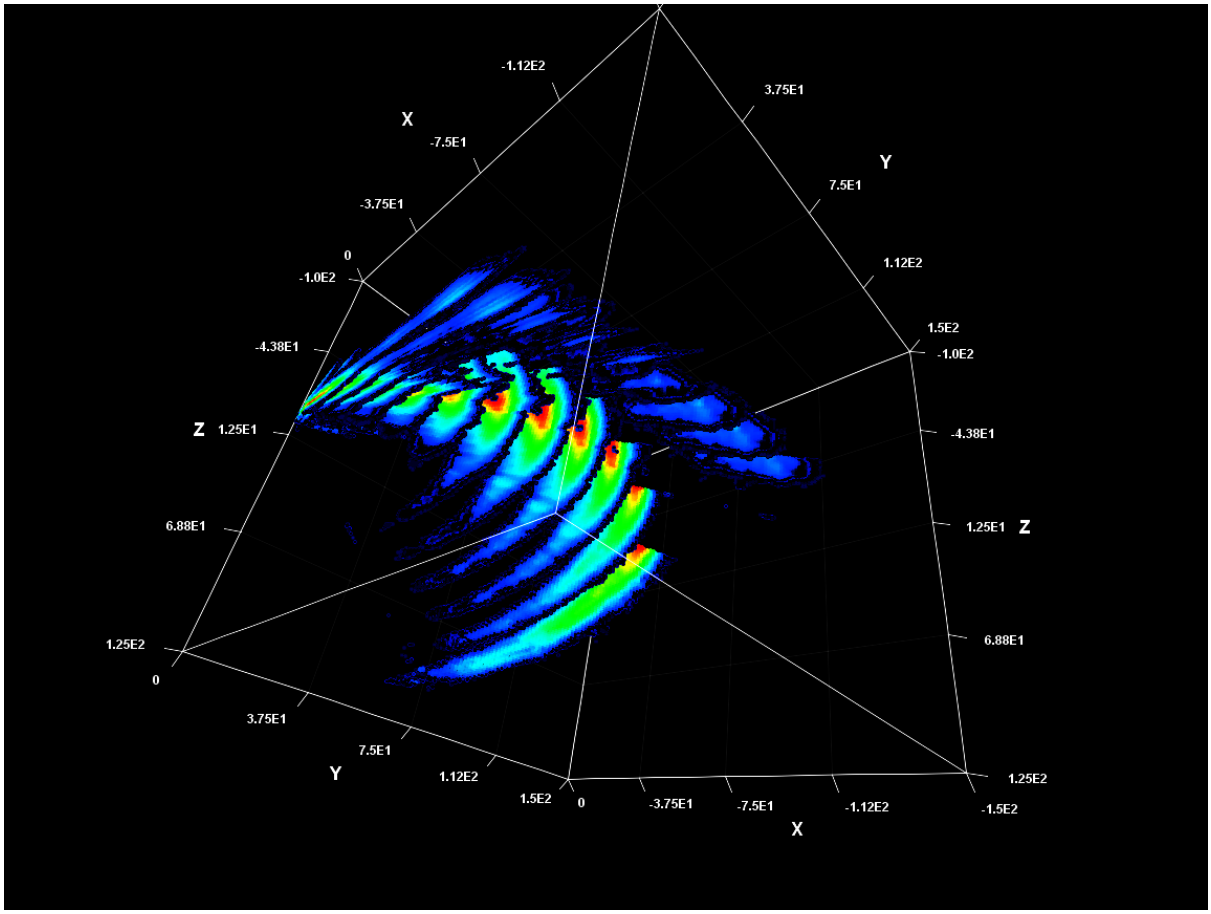

Animation of Milky Way arms in 3 spatial dimensions.

Animations of the Milky Way arms in 3 spatial dimensions can be viewed at https://www.astronomy.me.uk/rinearn3d-4d-plots-and-animations-of-lro-ptarmigan-hydrogen-data-jan-2024-nov-2024-processed-10-11-12-2024

Further information.

Further information about this project is available on the www.astronomy.me.uk website or by contacting me using the “contact us” page on that website.