Improving the HART Simulation

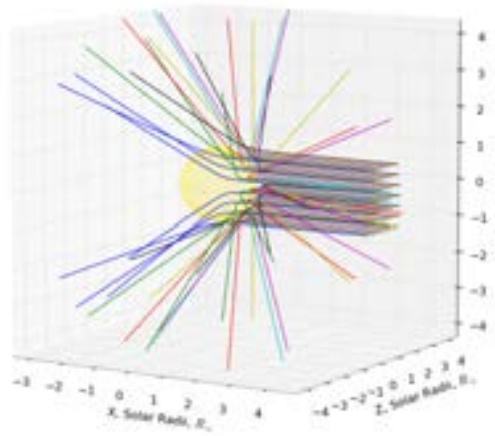
Increasing Speed, Science, and Ease of Use

Mark Benjamin

MIT Haystack Observatory & Princeton University
mdbenjam@princeton.edu

The HART Simulation

- H - Haystack
- A - AOSS
- R - Ray
- T - Tracer



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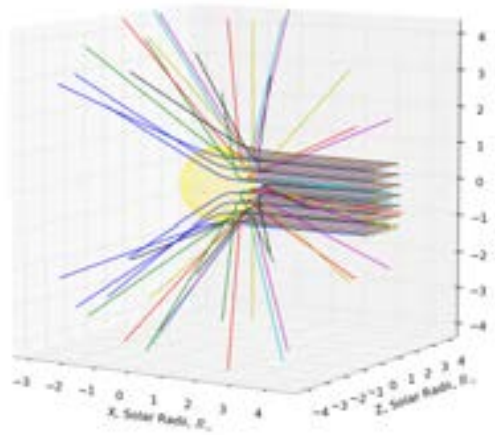

Created by Leonid Benkevich in order to assemble a comprehensive package to perform raytracing of the Sun.

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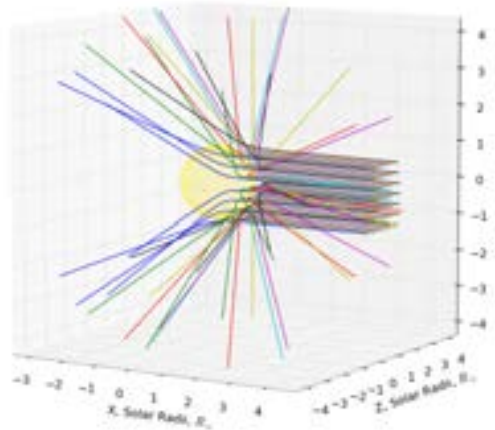

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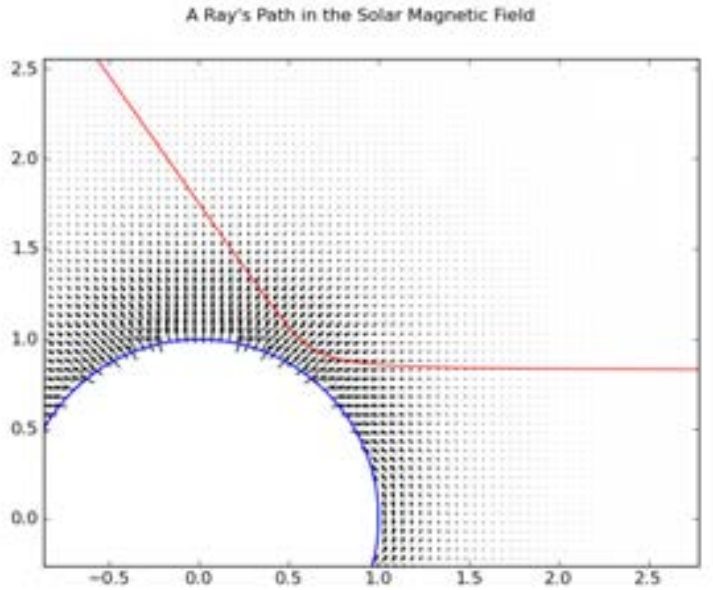
Goal

To improve this package in terms of speed, scientific capability, and usability.

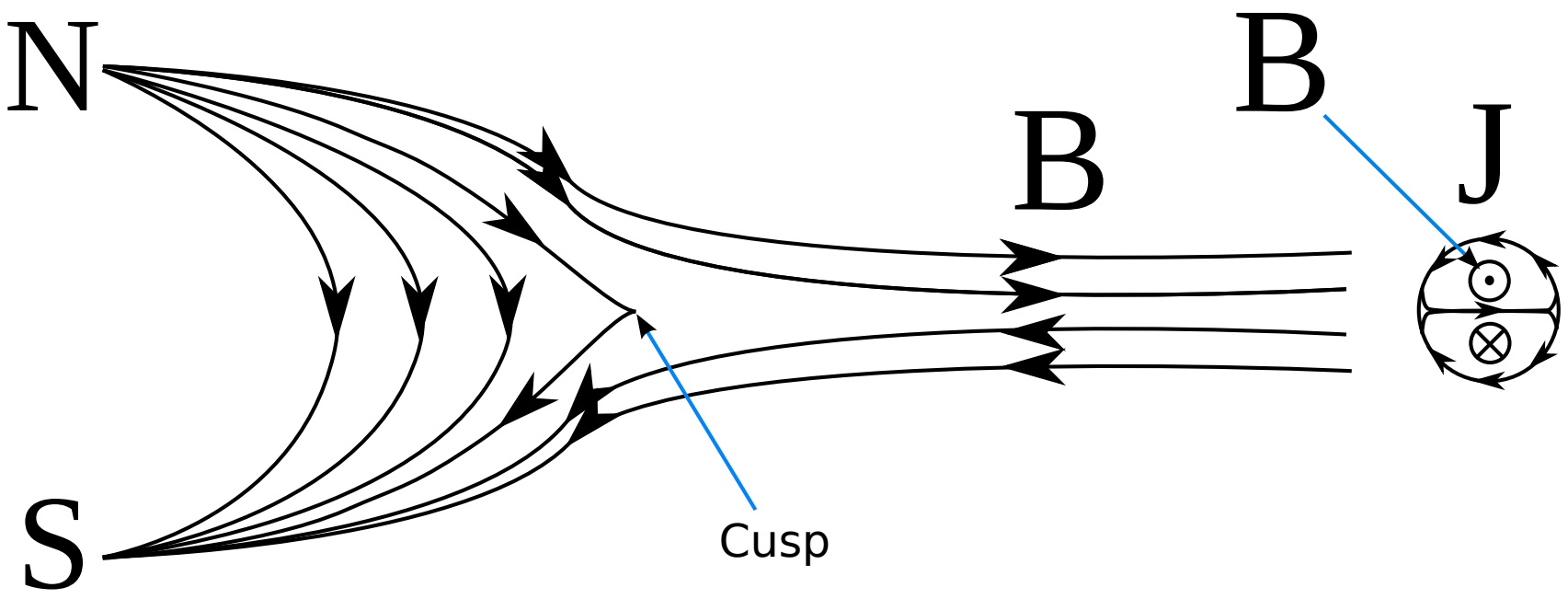
HART Basics



HART makes changing the solar model easy, allowing a user to quickly compare his own model with actual results from MWA.

Helmet Streamers

Helmet Streamers



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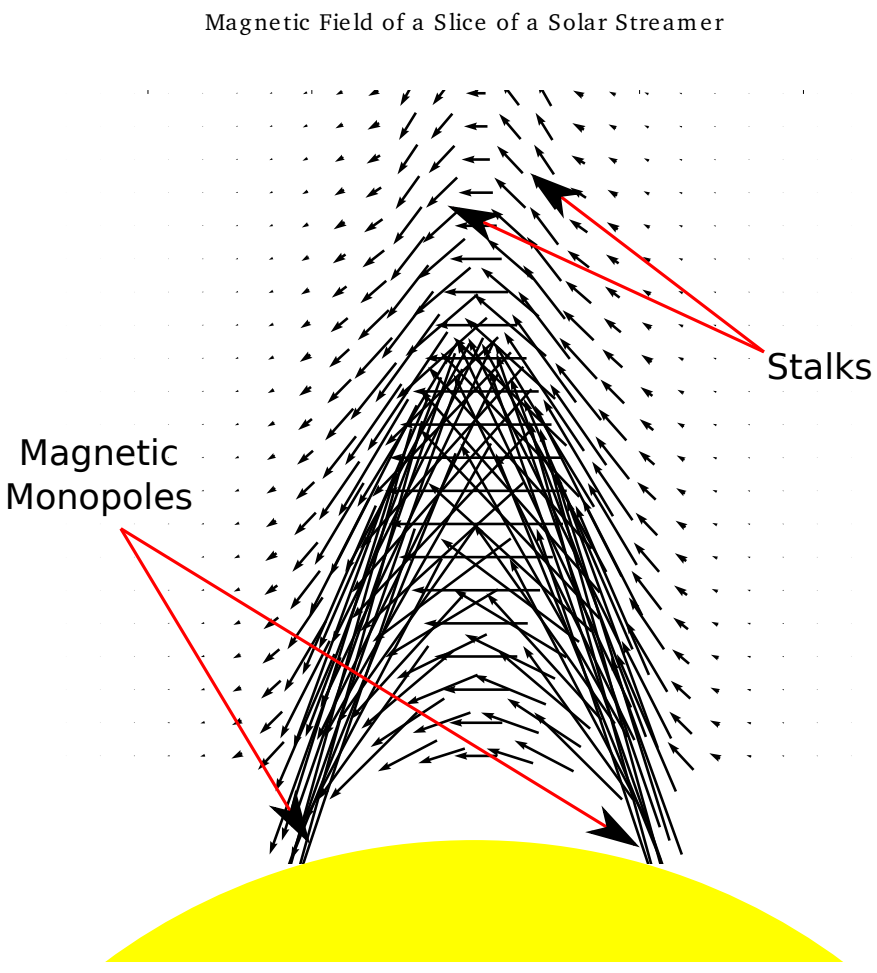
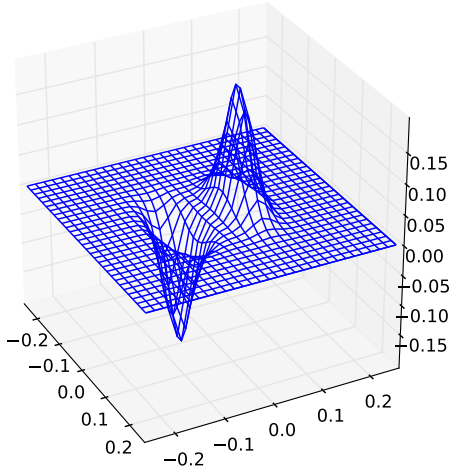


Magnetic Field of the Monopoles:

$$B \propto \frac{1}{{r_+}^3} - \frac{1}{{r_-}^3}$$

B-field in stalks falls off as a Gaussian.



Scattering

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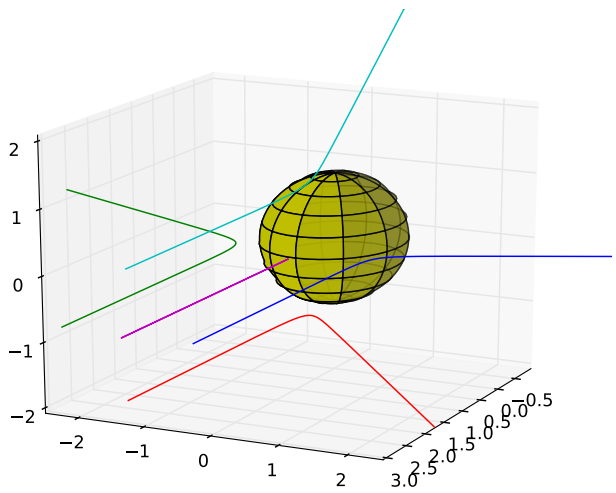

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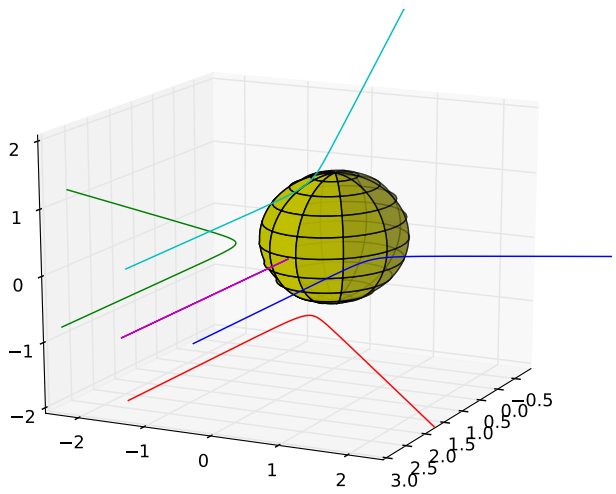

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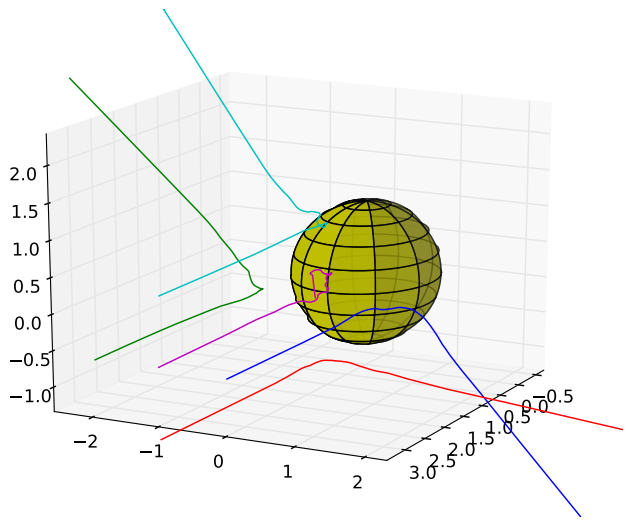

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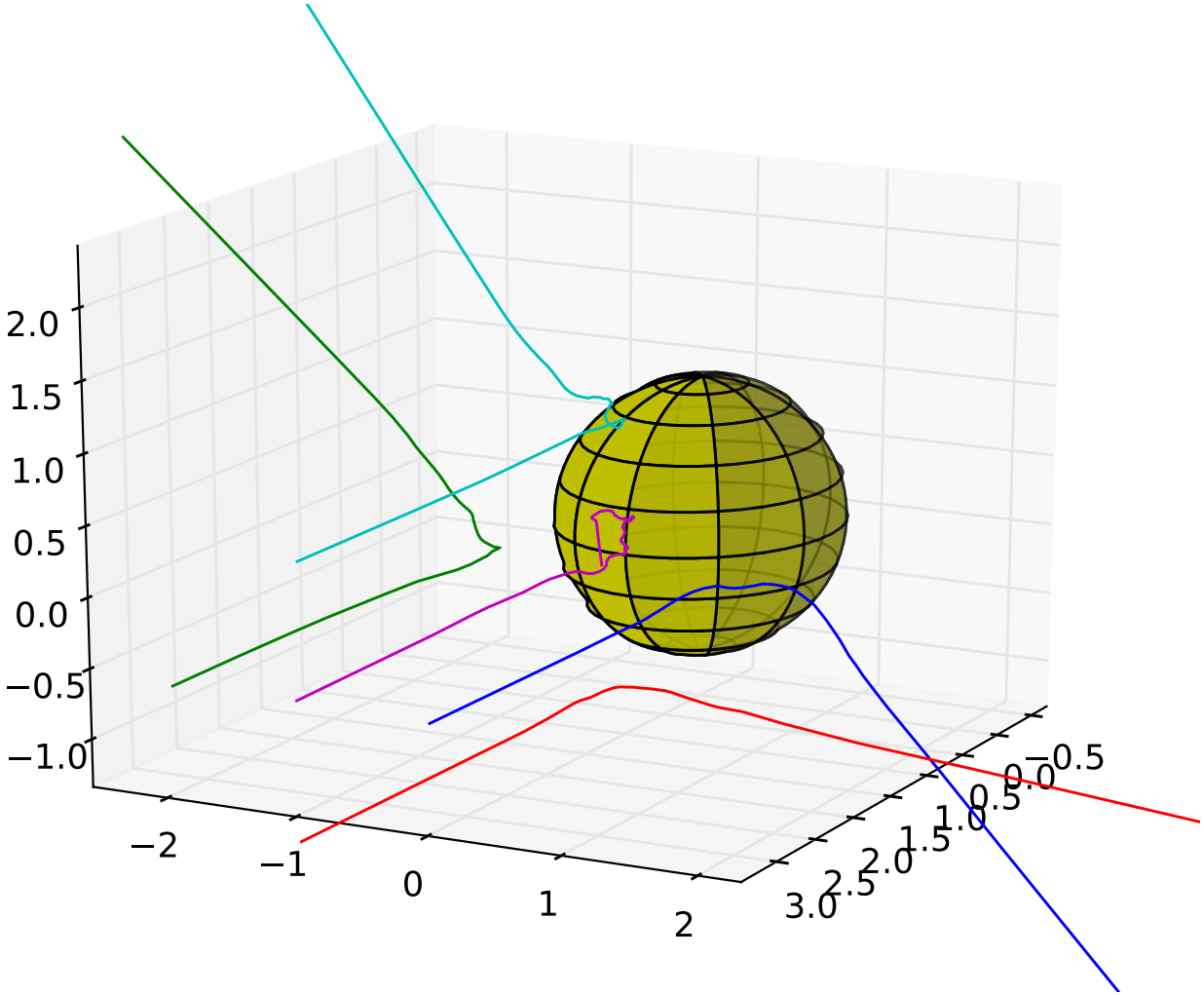
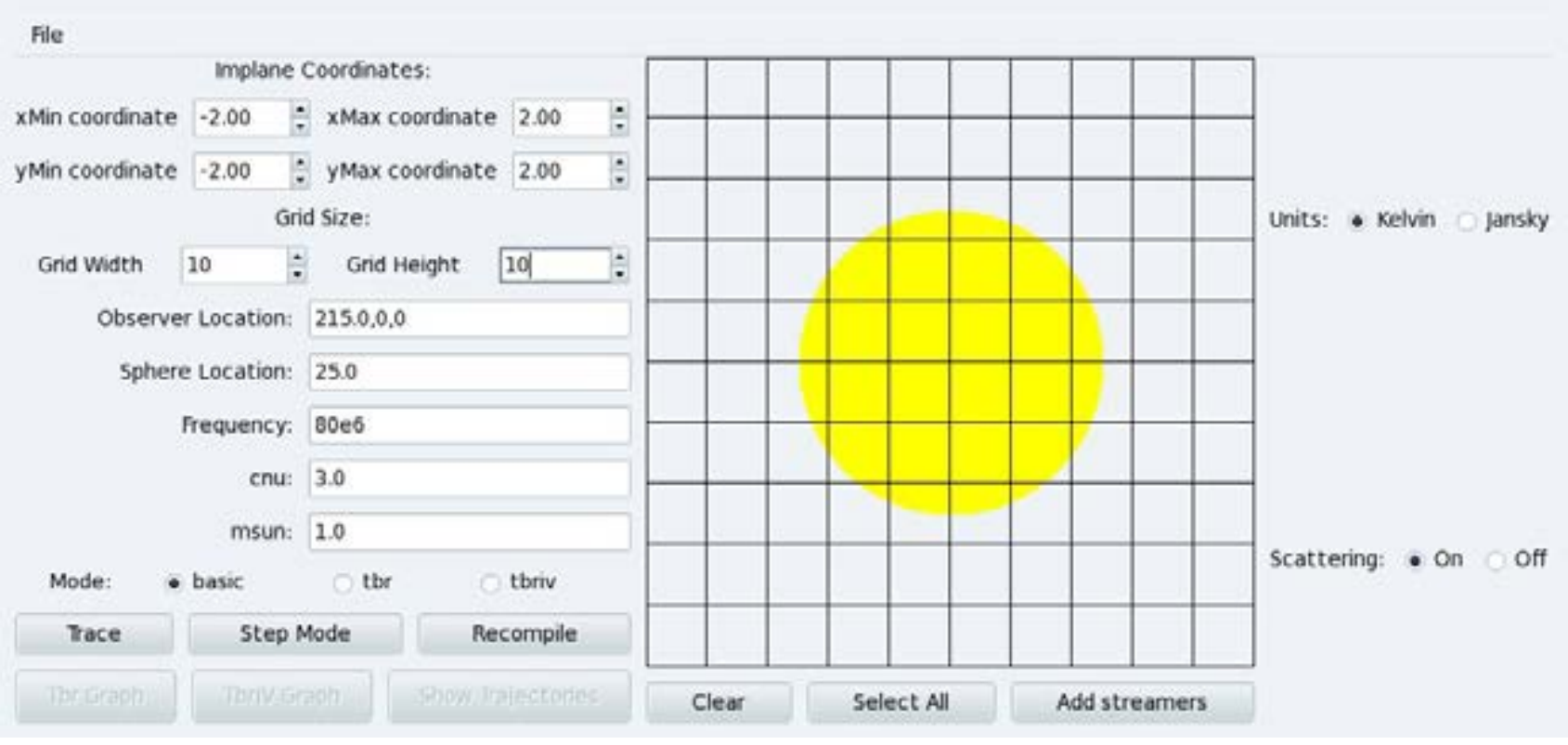


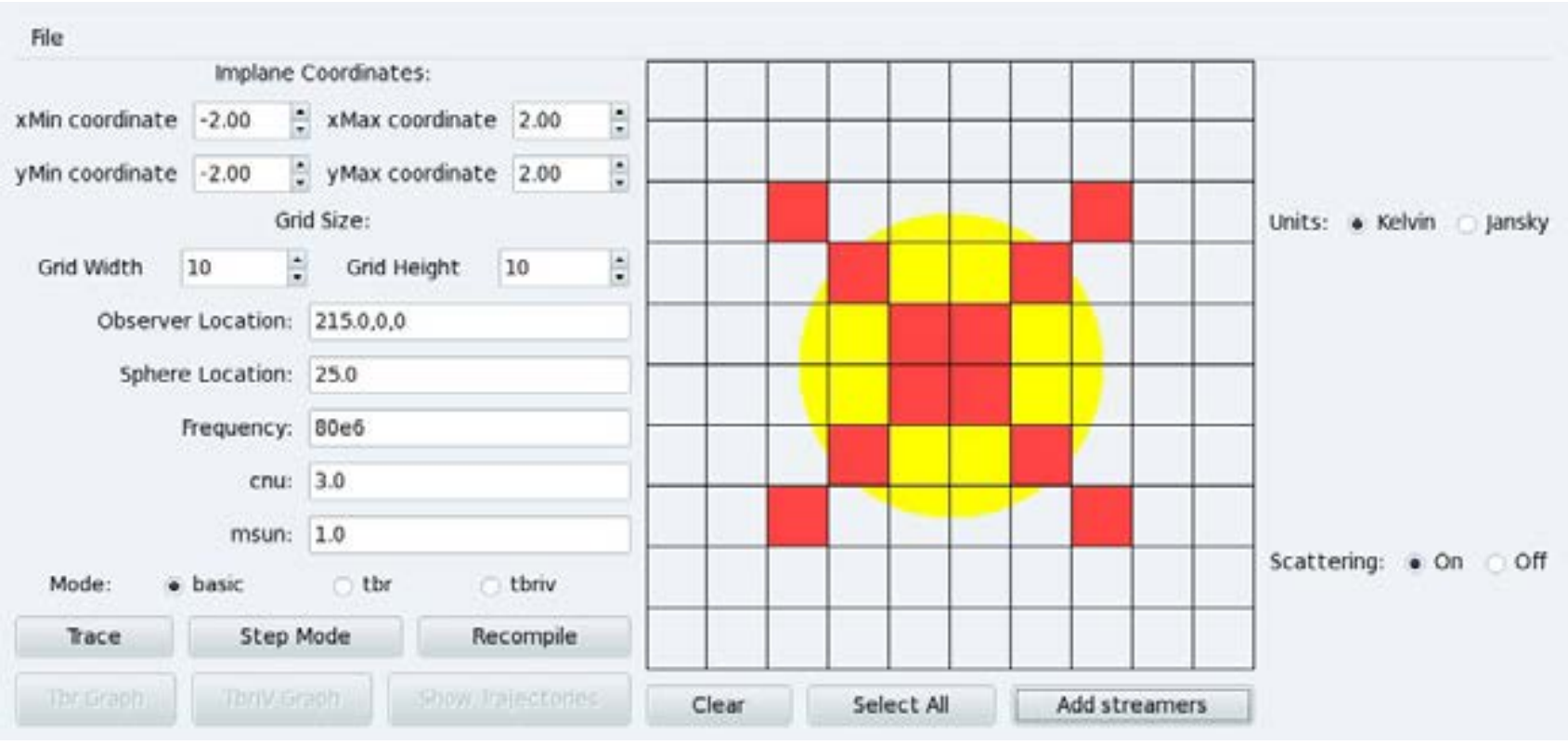
GUI

The standard GUI:



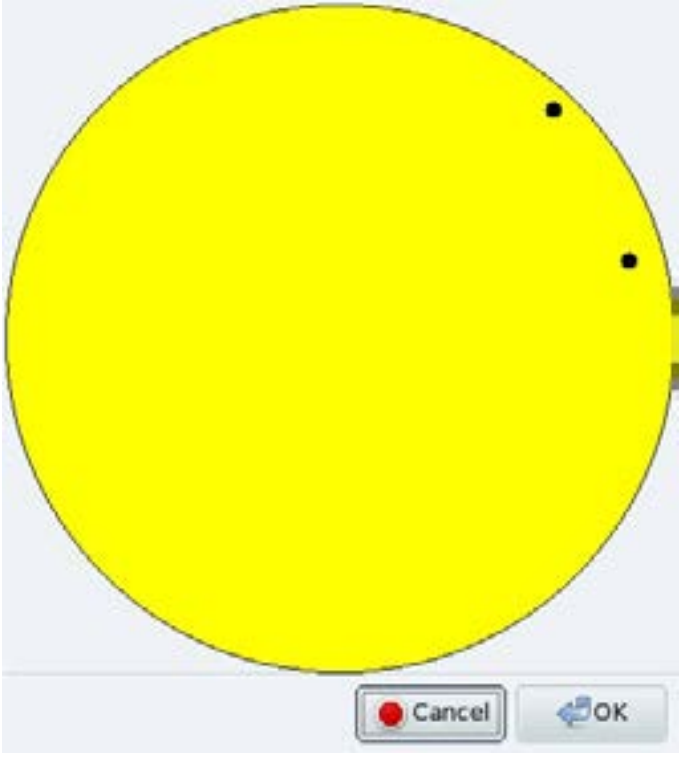
GUI

Selecting Rays to Find Trajectories:



GUI

Adding Streamers:



FITS Files

Because the FITS file format is so widely accepted in the astronomy community, the application must support its output. This facilitates the comparison of this model with real data.

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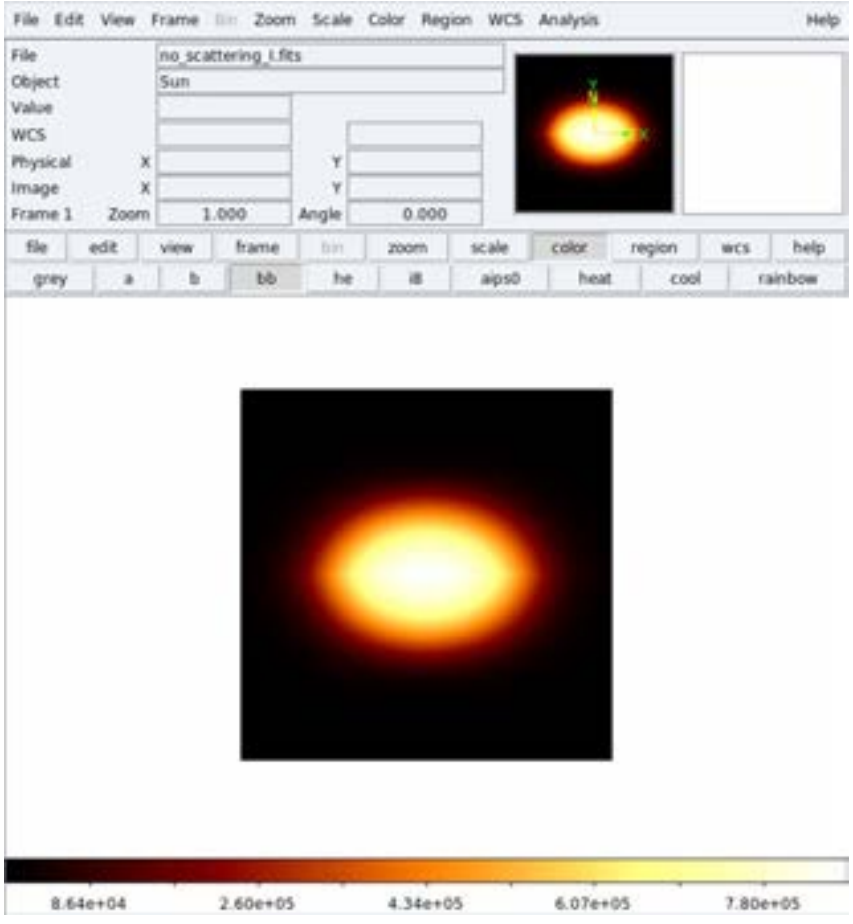

Multi-Threading

Raytracing algorithms are inherently parallelizable.

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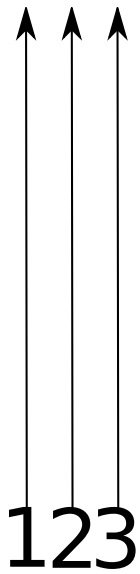
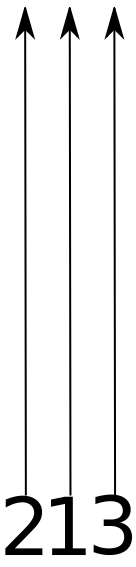
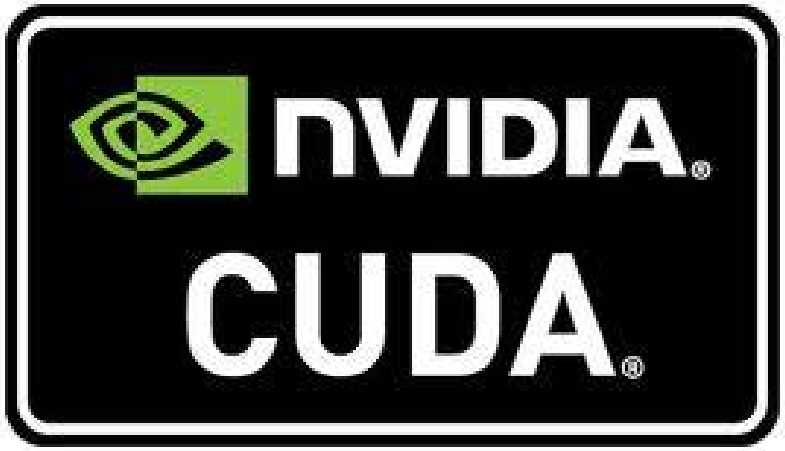




The order in which these rays finish is unimportant. We get the same answer either way.

CUDA

CUDA has become an incredibly popular way to see huge speed improvements at a relatively low cost.



CUDA

CUDA has become an incredibly popular way to see huge speed improvements at a relatively low *monetary* cost.

A CUDA Story

Carl Palmer Ulysses

A CUDA Story

Carl Palmer Ulysses

Greg Patrick Ulysses

A CUDA Story

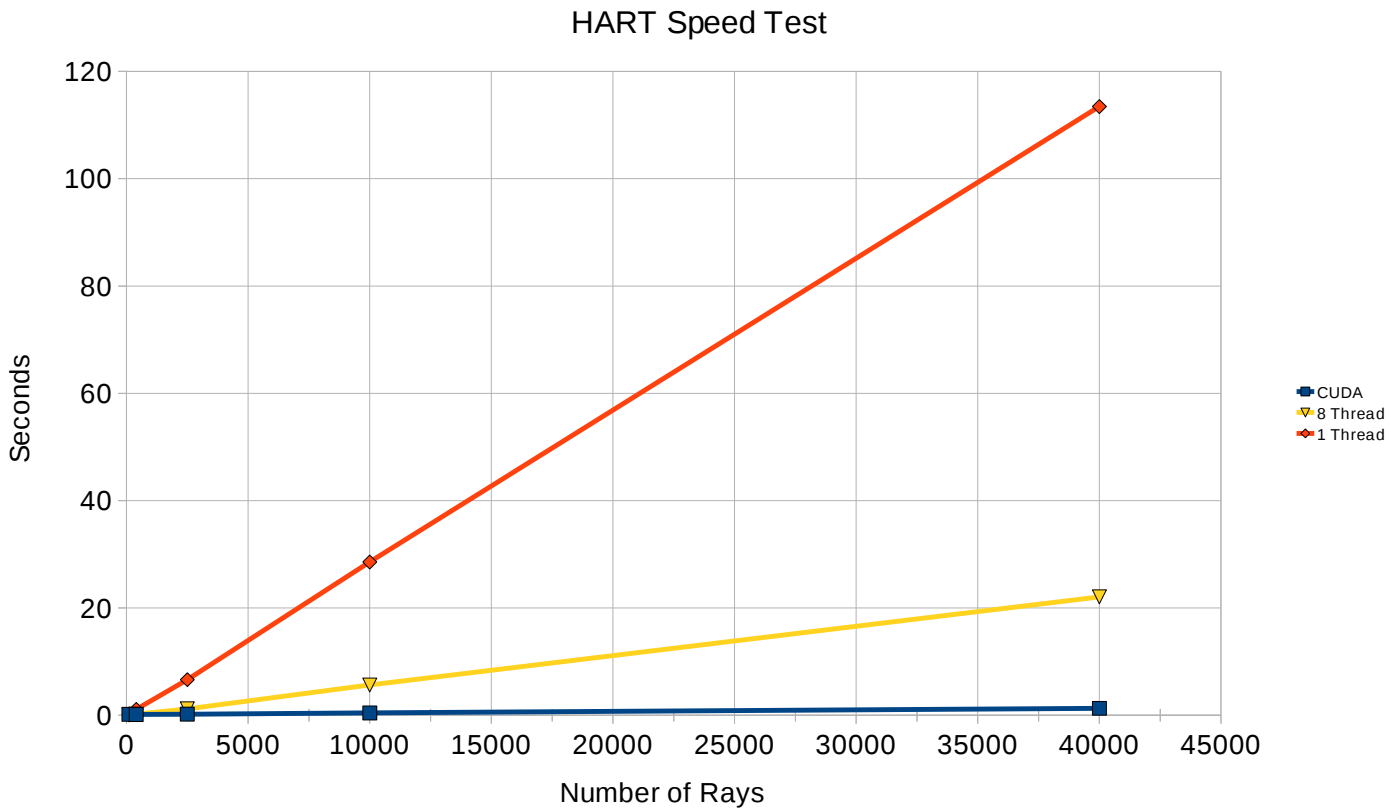
Carl Palmer Ulysses

A.K.A. The Brains

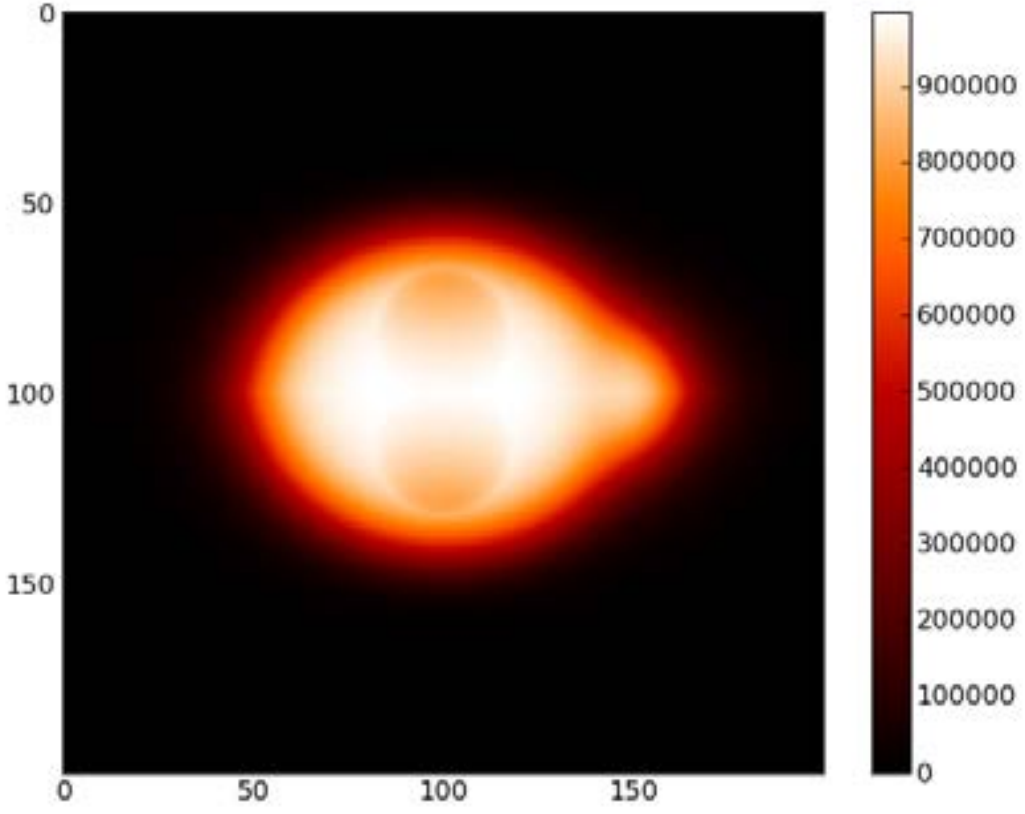
Greg Patrick Ulysses

A.K.A. The Calculator

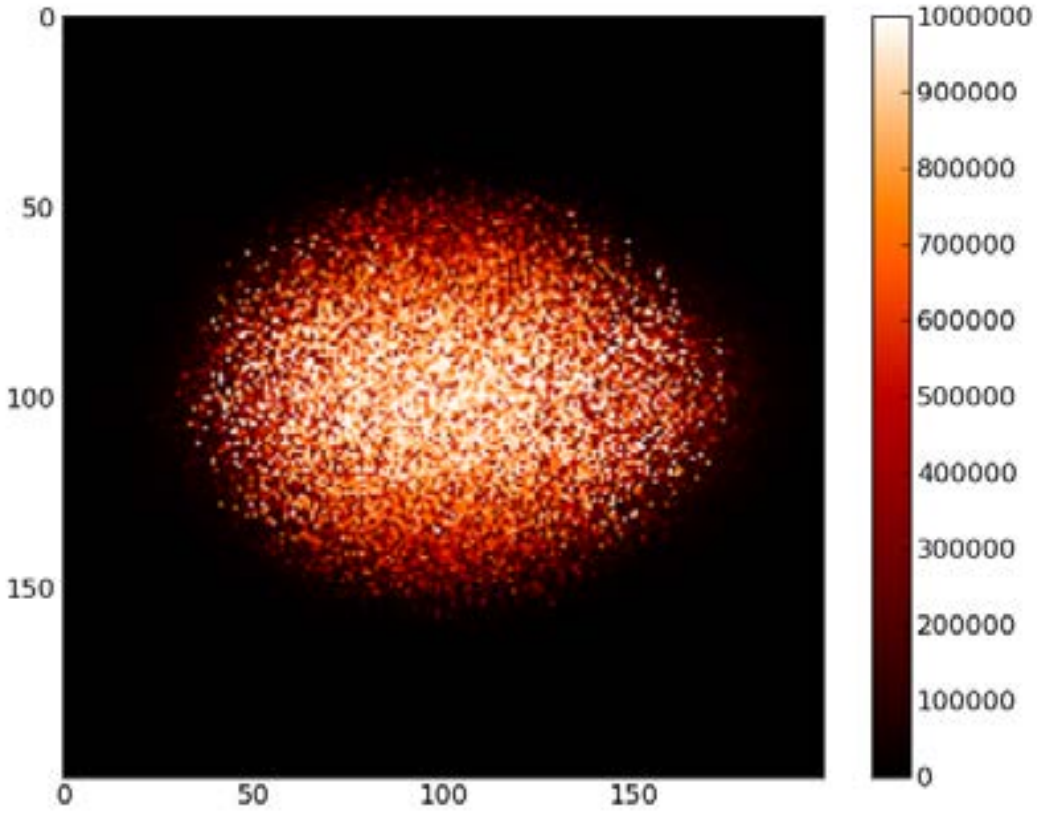
Speed Increase

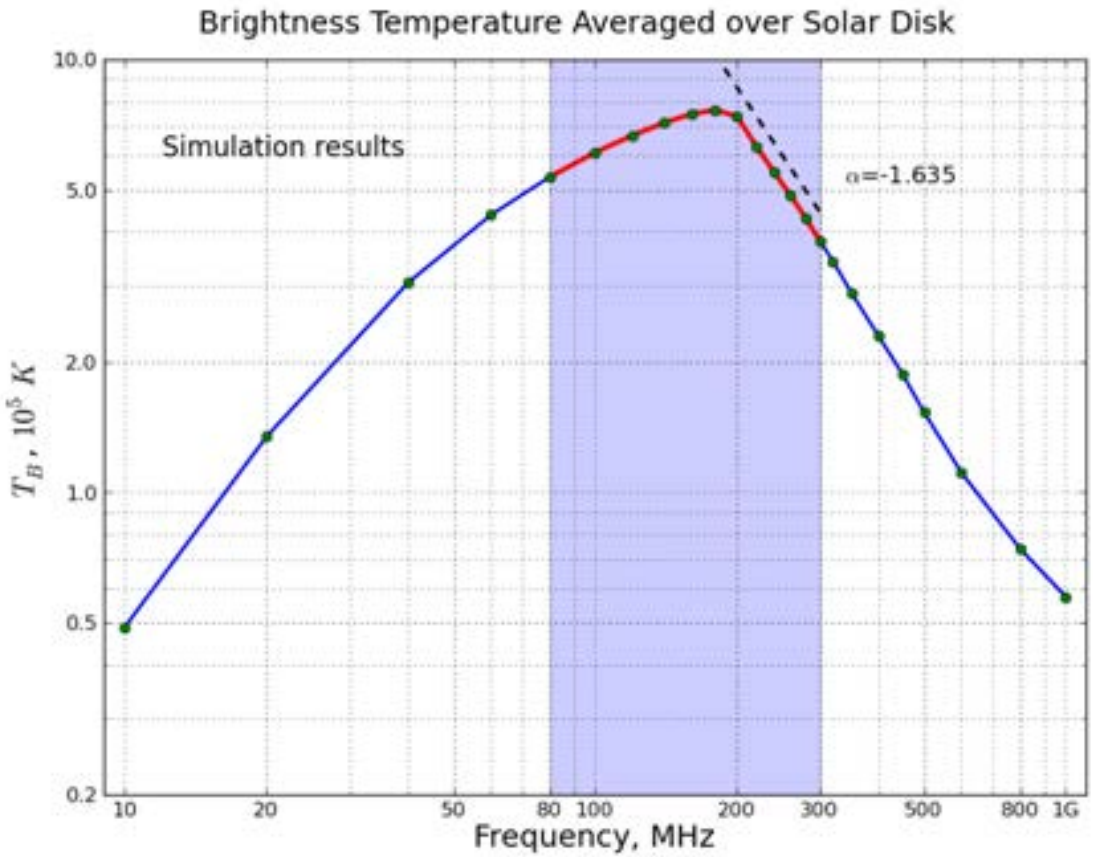


Brightness temperature at 180MHz with a helmet streamer at (90°,90°)



Brightness temperature at 200MHz with scattering and a helmet streamer at (90°,90°)




Brightness Temperature Averaged over Solar Disk
Simulation results
α=-1.635
T_B, 10^5 K
10.0
5.0
2.0
1.0
0.5
0.2
10
20
50
80
100
200
300
500
800
1G
Frequency, MHz

Conclusion

In these past ten weeks we have:

- Improved the scientific capabilities of the raytracer by adding solar streamers and scattering.
- Improved the usability of the program by adding a GUI and enabling output to FITS files.
- Improved the speed by integrating multi-threading and CUDA.

These improvements have moved HART towards its ultimate goal, a powerful raytracer that can be easily used to test solar hypotheses.

Acknowledgments

I'd like to give my thanks to:

- Leonid Benkevitch
- Divya Oberoi
- Lynn Matthews
- Mark McCurry
- David Packard