The Europa Plasma Environment

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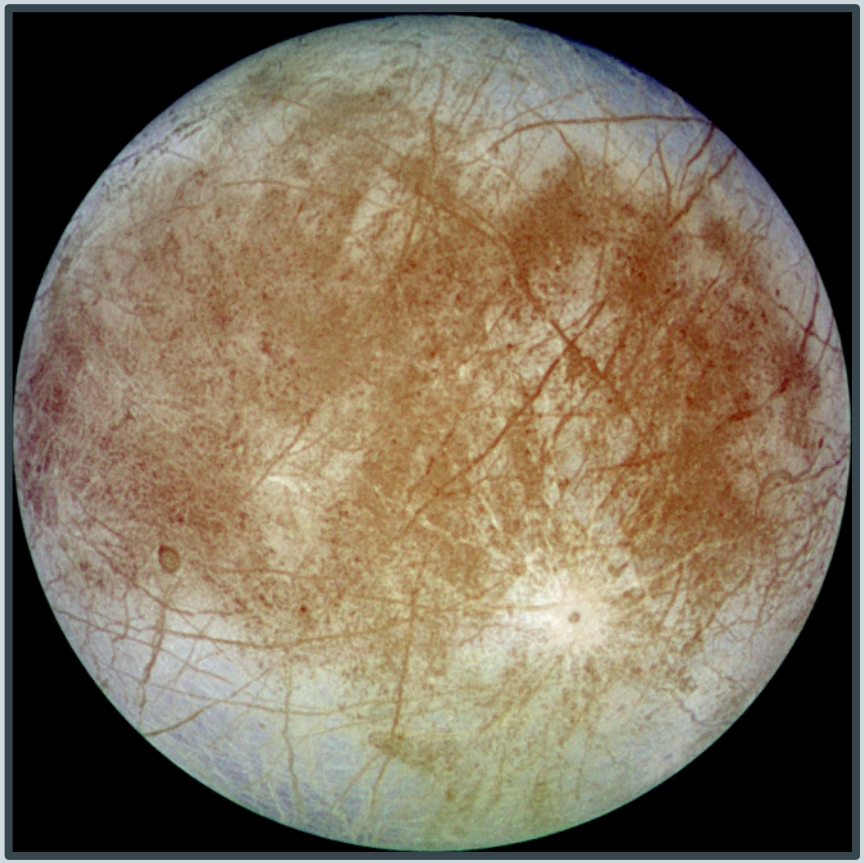
Fran Bagenal, Robert Wilson, Vincent Dols

Europa Overview

- Our interest in Europa
- Our current understanding
- Success/Limitations of our data
- Refinement/Compilation of the data
- Future improvements for the study of Europa

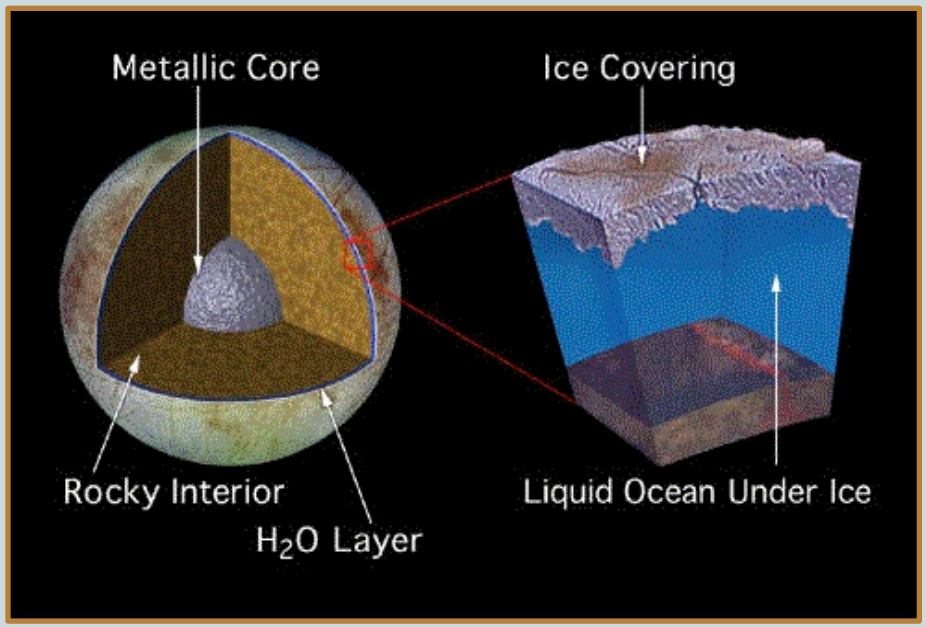


http://photojournal.jpl.nasa.gov/catalog/PIA00502

Interest in Europa

- Europa is "the first step in understanding the potential of the outer solar system as an abode for life" (Space Studies Board 2011, p.1)

- Enough energy and water to sustain life



Our Current Set of Data

Variety of sources

Ground Based

Galileo

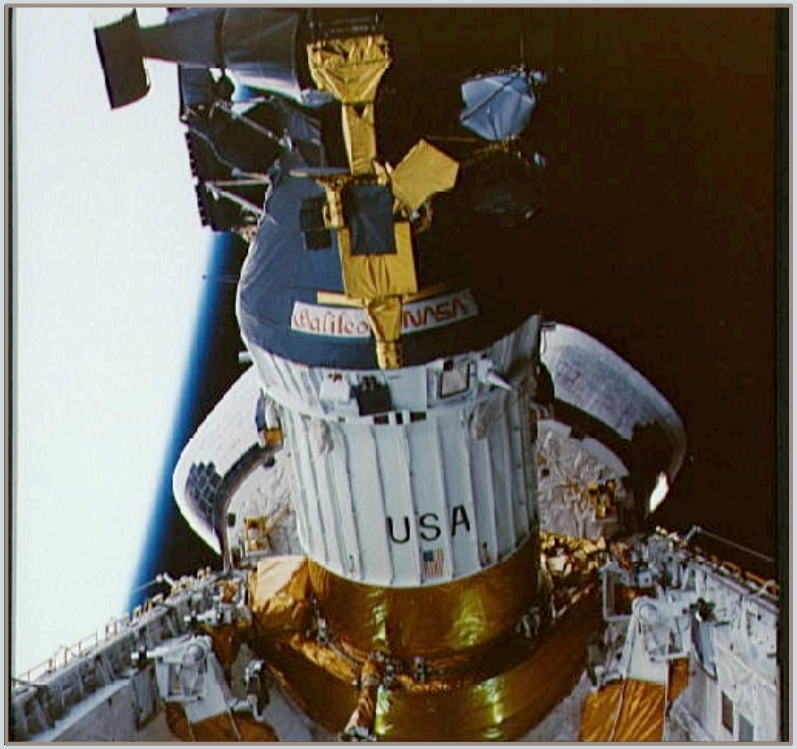
Voyager

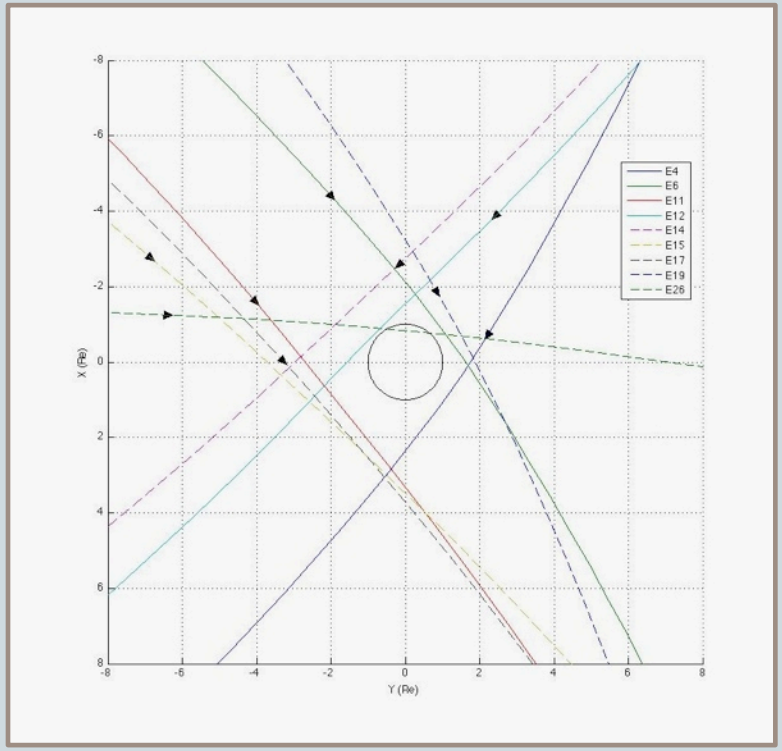
1. http://solarsystem.nasa.gov/galileo
2. http://www.cfa.harvard.edu/sma/
3. http://voyager.jpl.nasa.gov/

Galileo

-Failed Antenna Deployment

-Lack of data resolution





-Large range of trajectories

-Wide spread of data if we could analyze it

What We Know So Far

Water Oceans

Ice on surface shown from ground-based observations

-Changing Magnetic Field
Induces Currents

-Seen by *Galileo*

Hard to separate from Ionosphere

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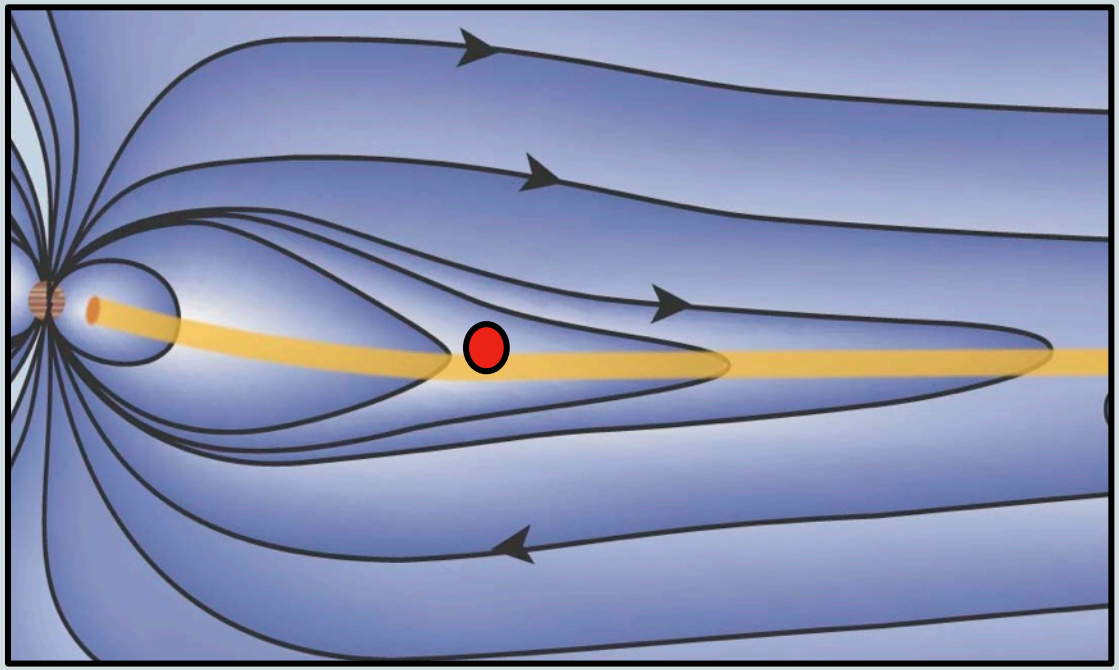

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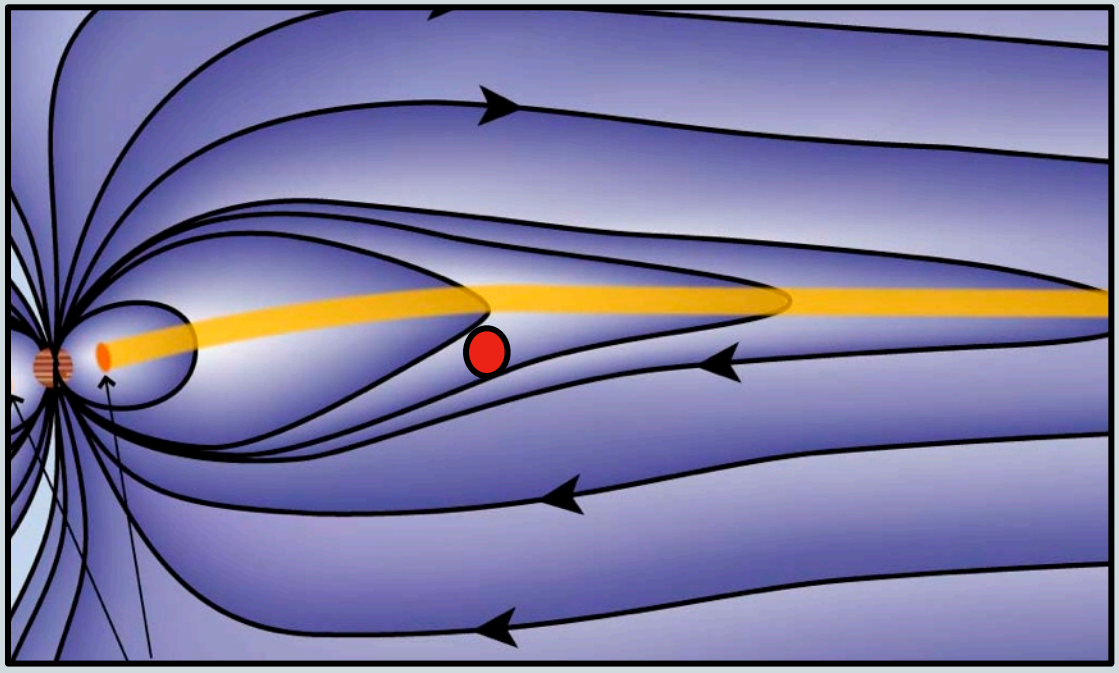

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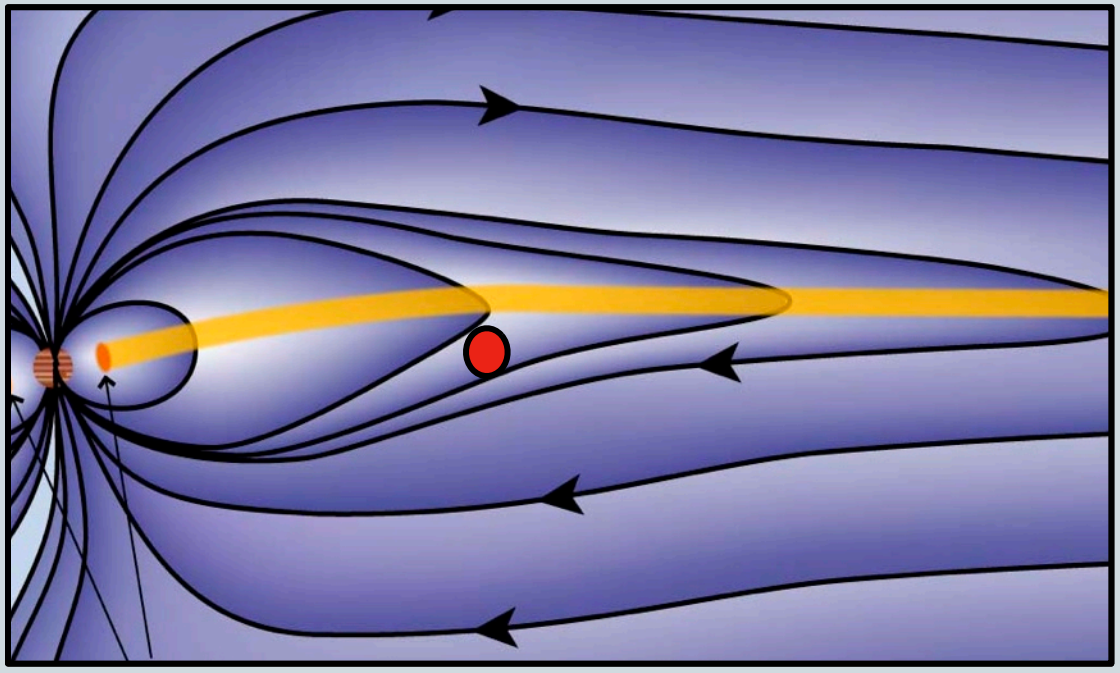
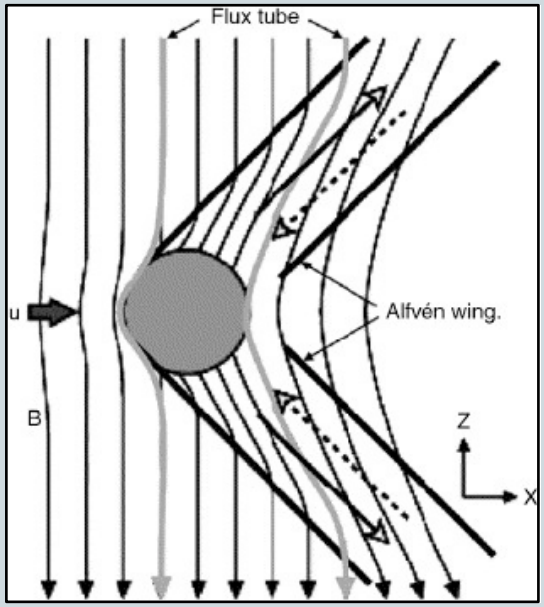
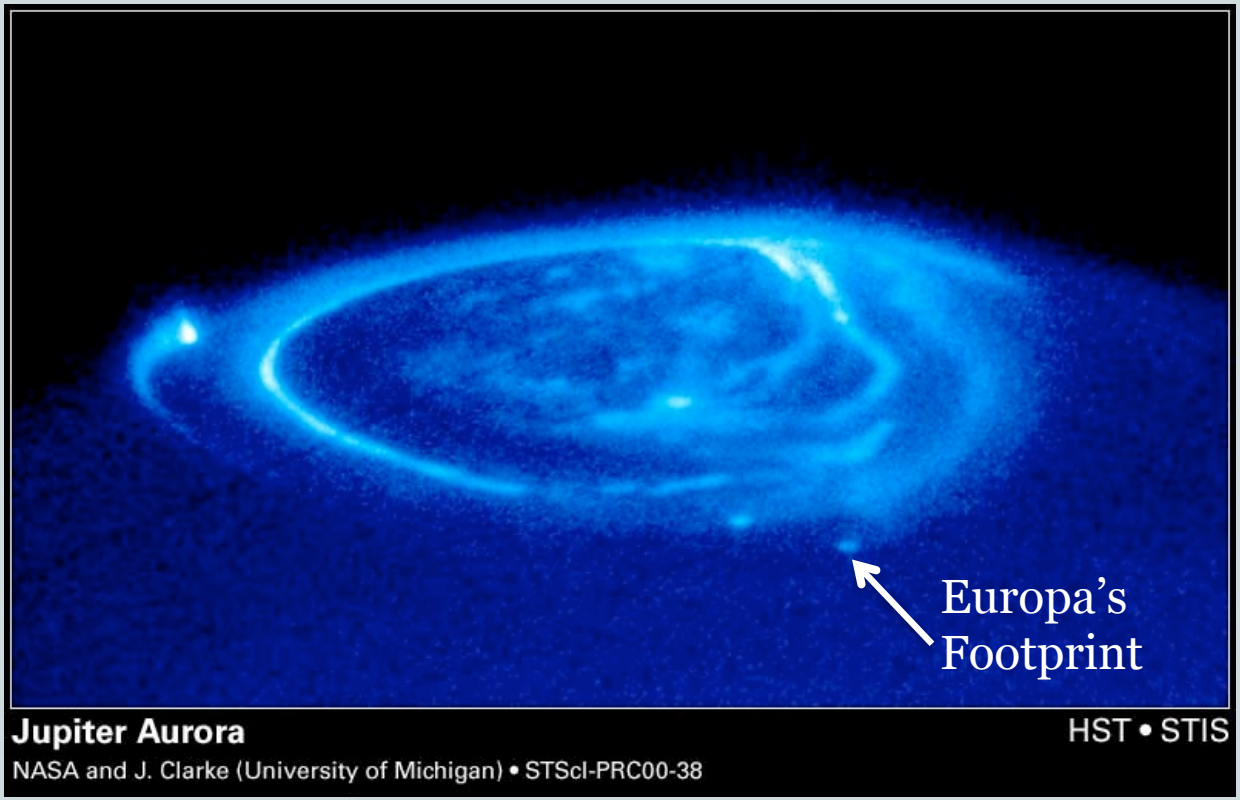


What We Know So Far

Alfvén Wings





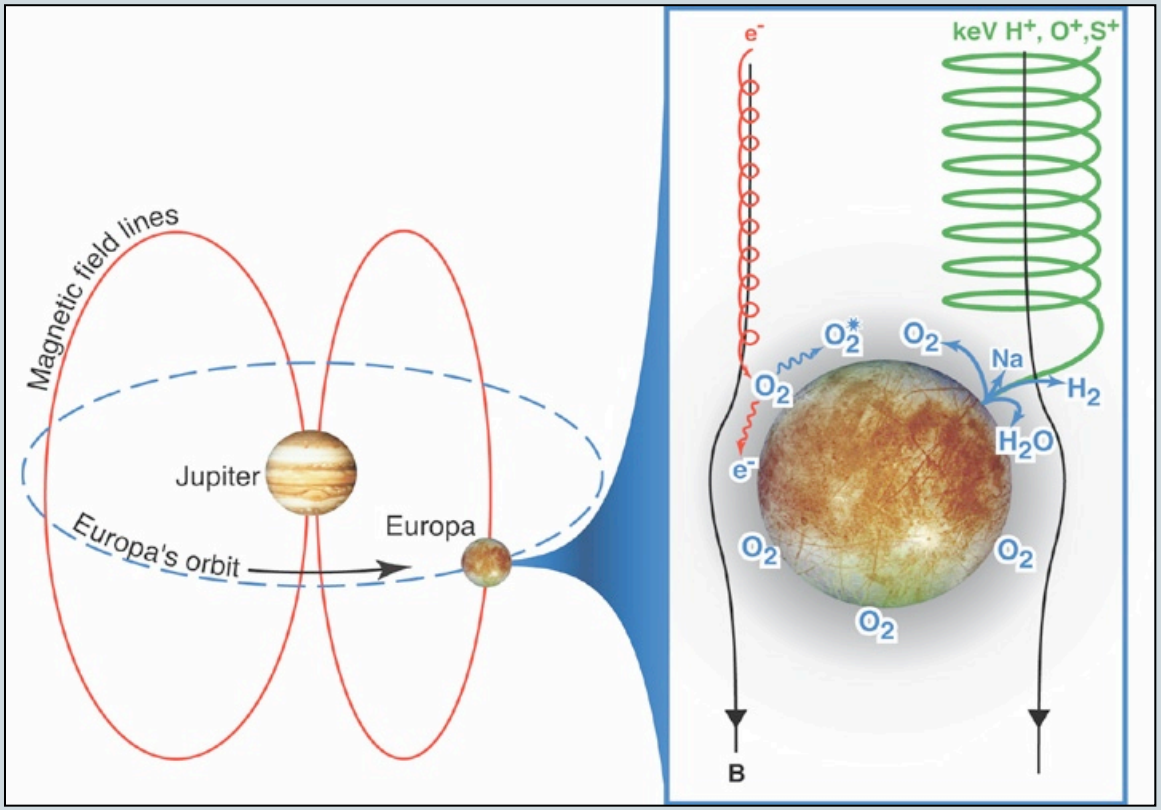
What We Know So Far

Sputtered Atmosphere

-Radiolysis embeds incoming particles and ejects others

-Oxygen Atmosphere

-Sulfur Deposits



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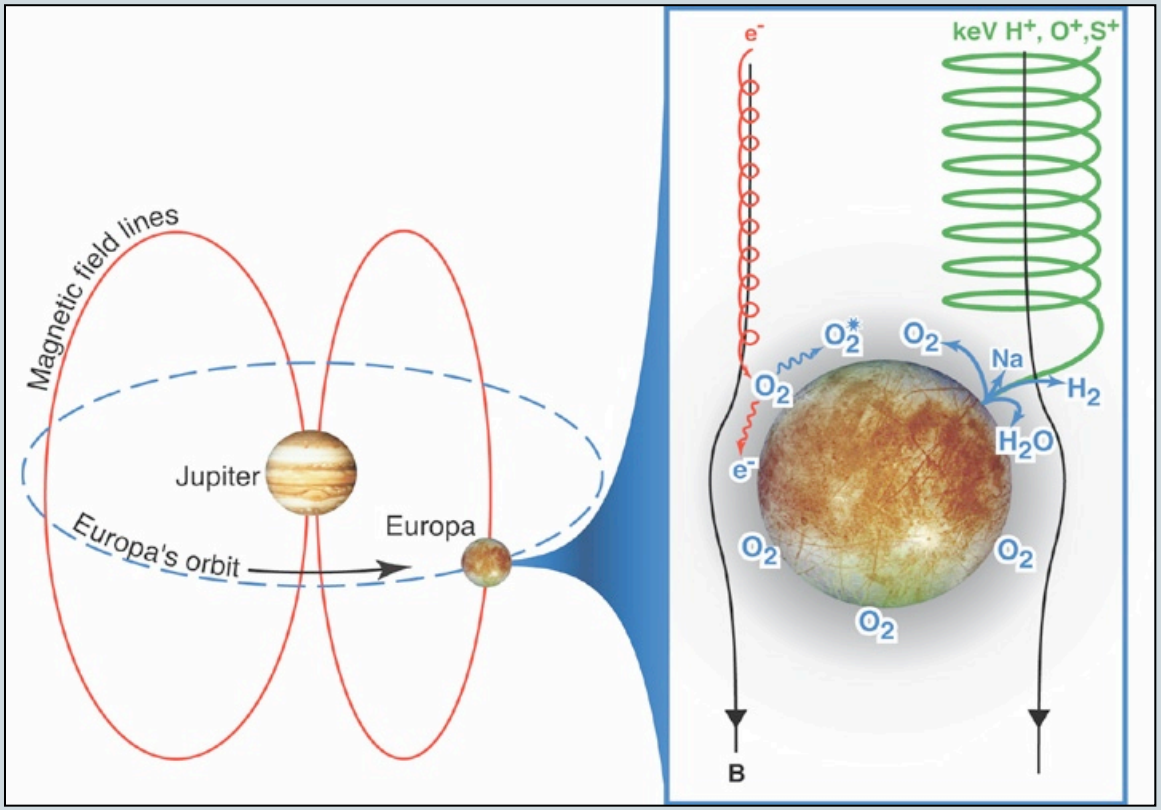
-Mostly Observed through Spectroscopy

-Direct data has issues...



Modeling

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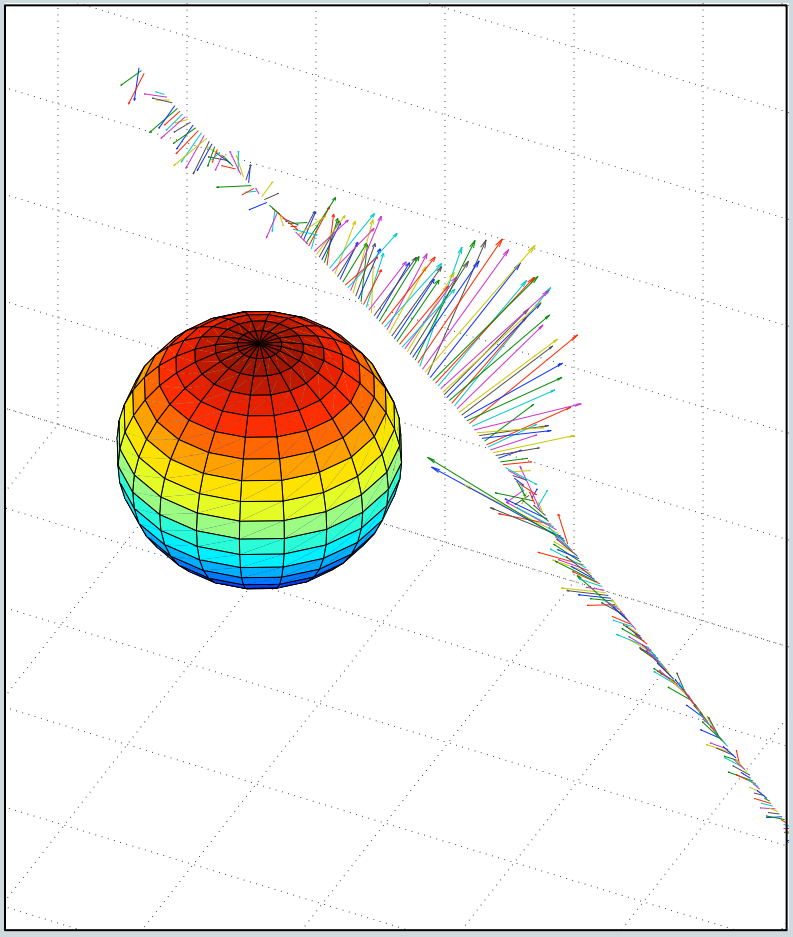
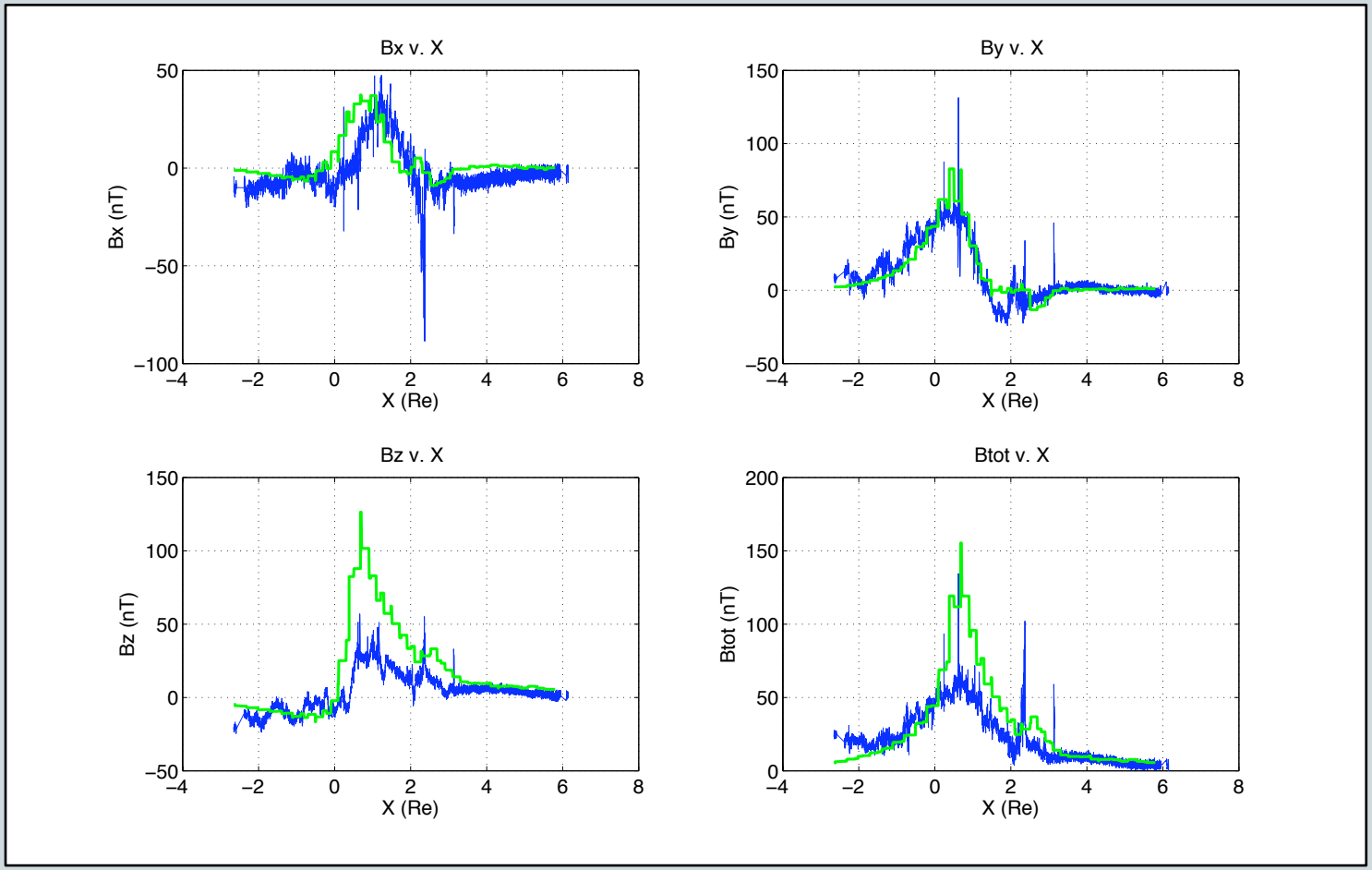


E04 Flyby - 1996

Modeling



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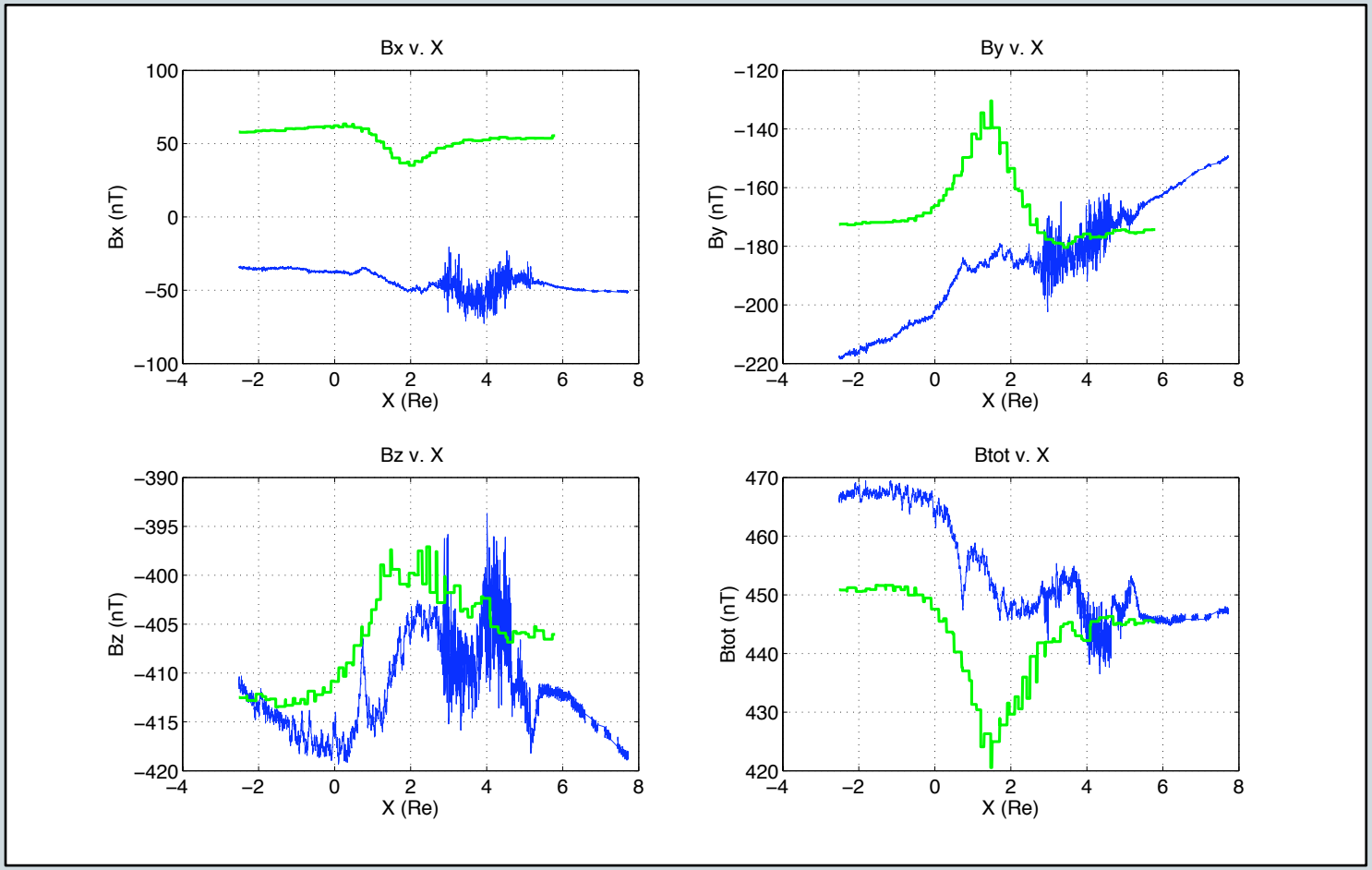
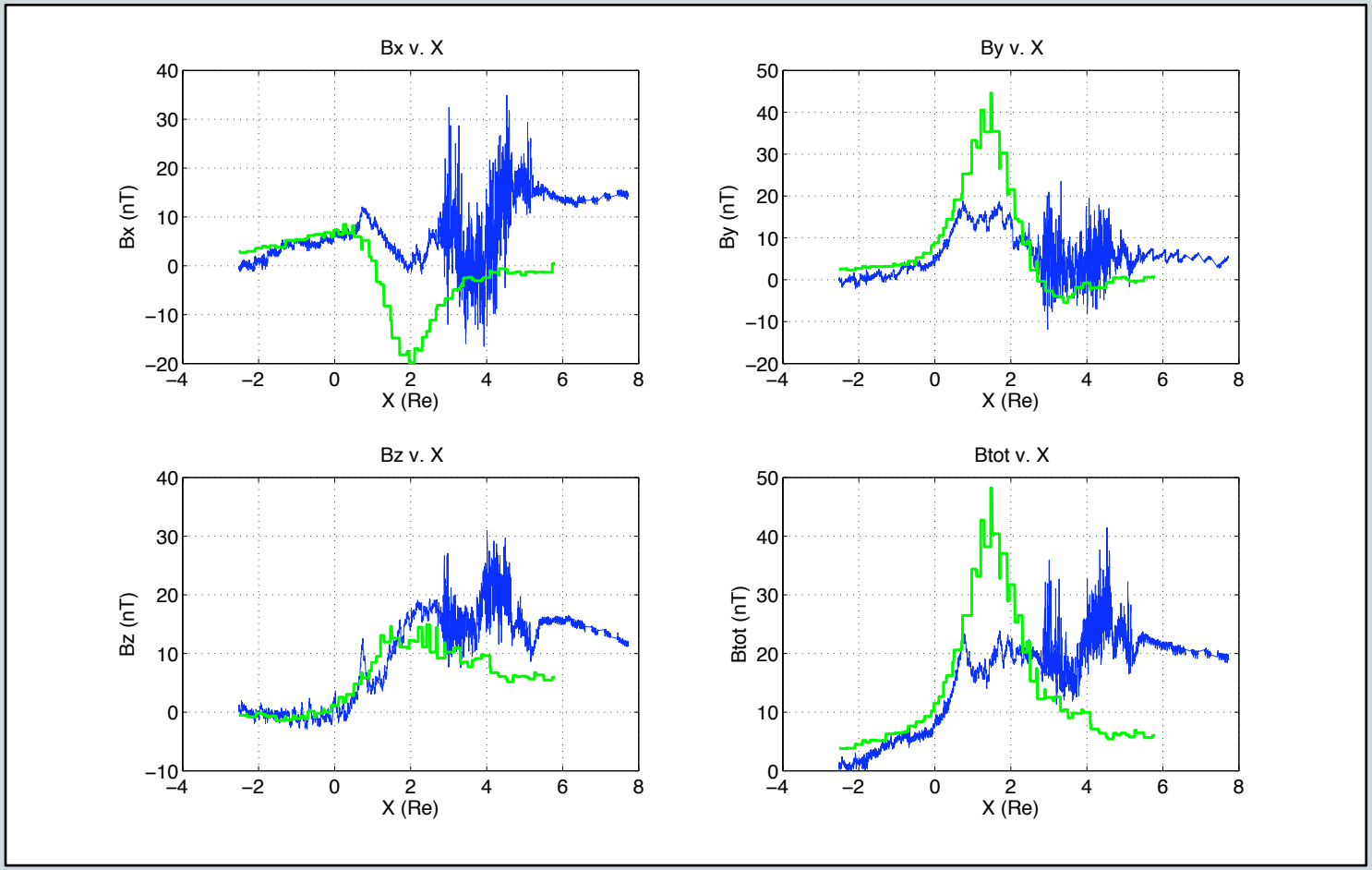


E11 Flyby - 1997

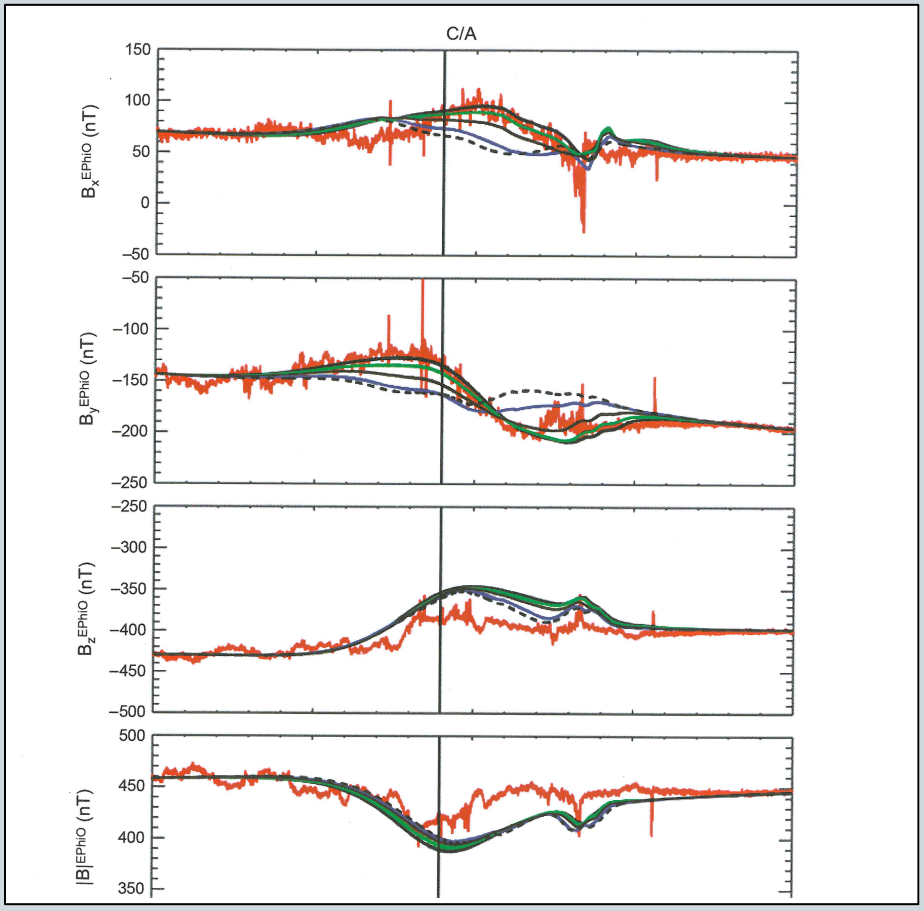
Modeling



E11 Flyby - 1997

Modeling

- Magnetic Field Modeling has been fairly successful
- See Effects of Induced Currents and Alfvén Wings
- Kivelson et al. (1997)



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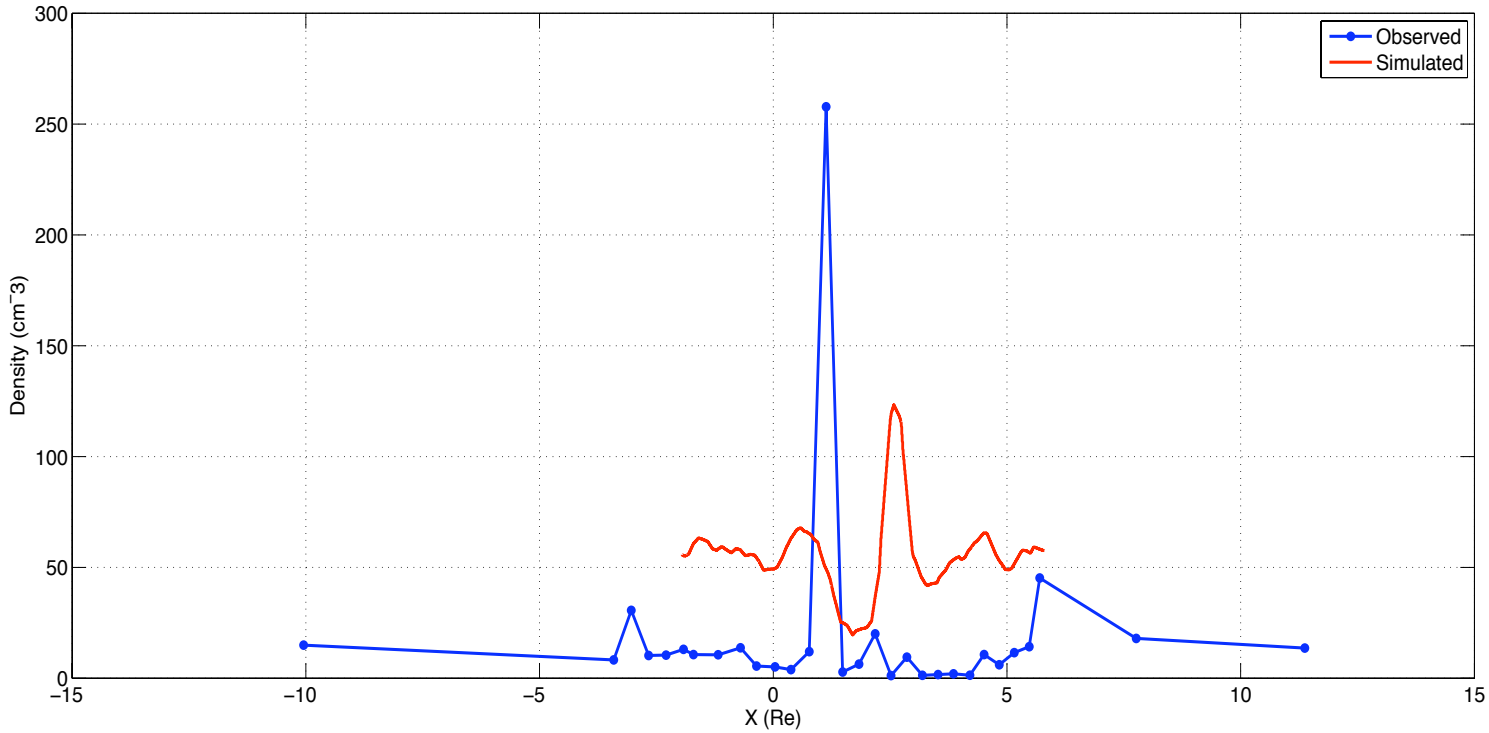

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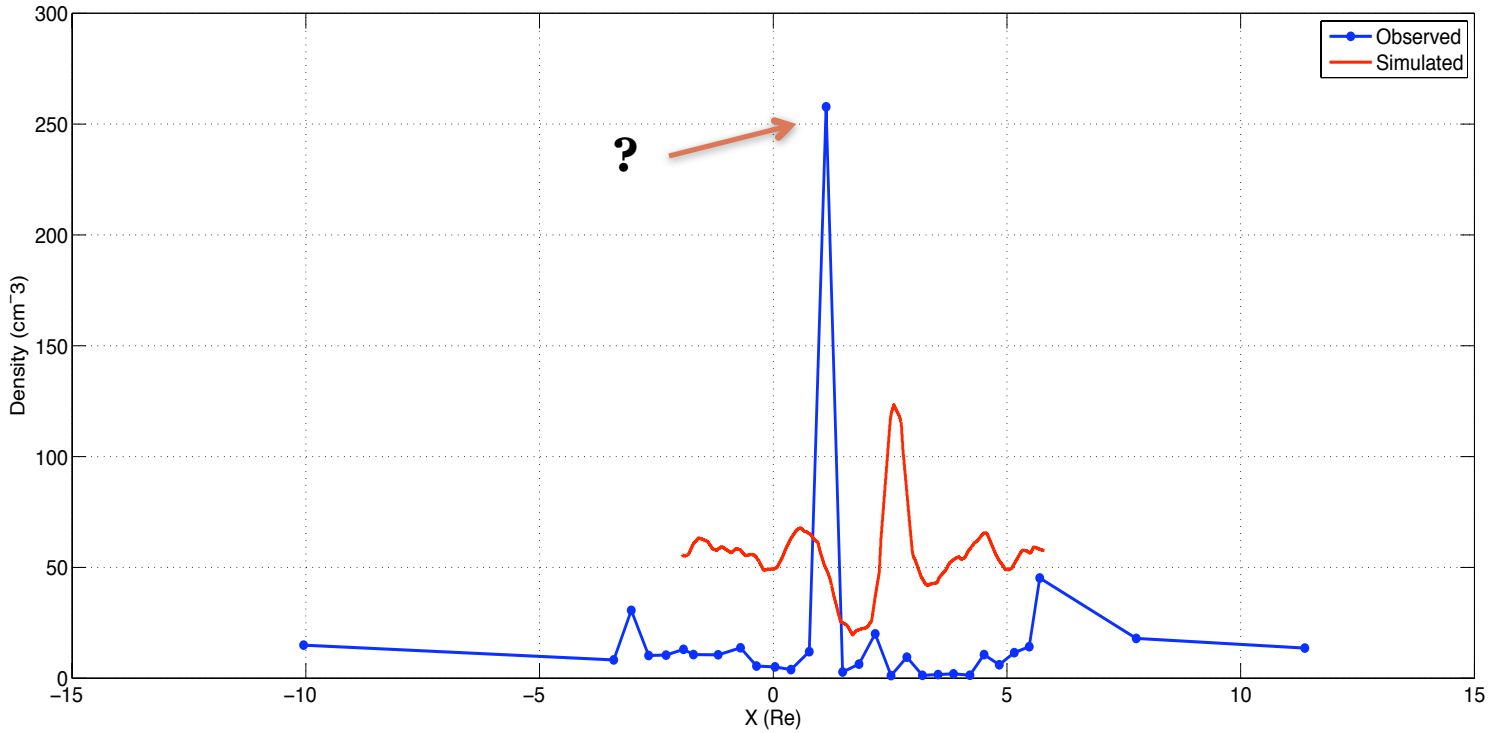
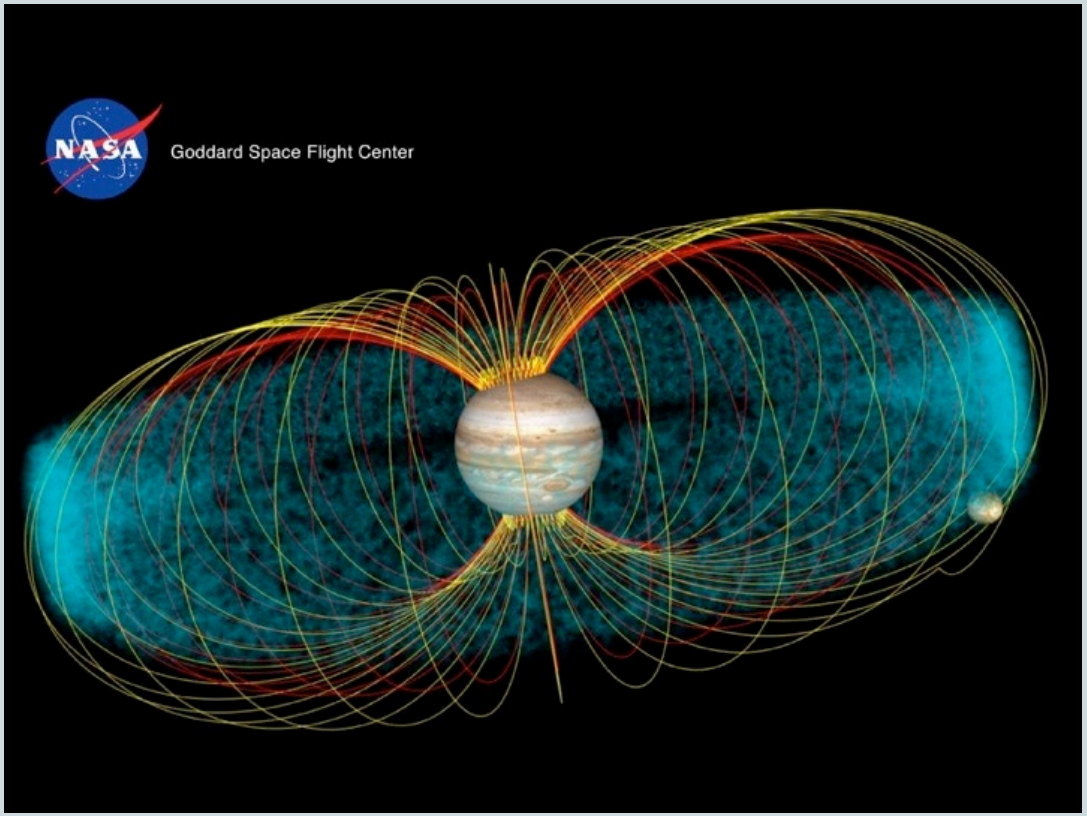


Problems with the PLS data

- Fitting routine originally designed for full magnetosphere.



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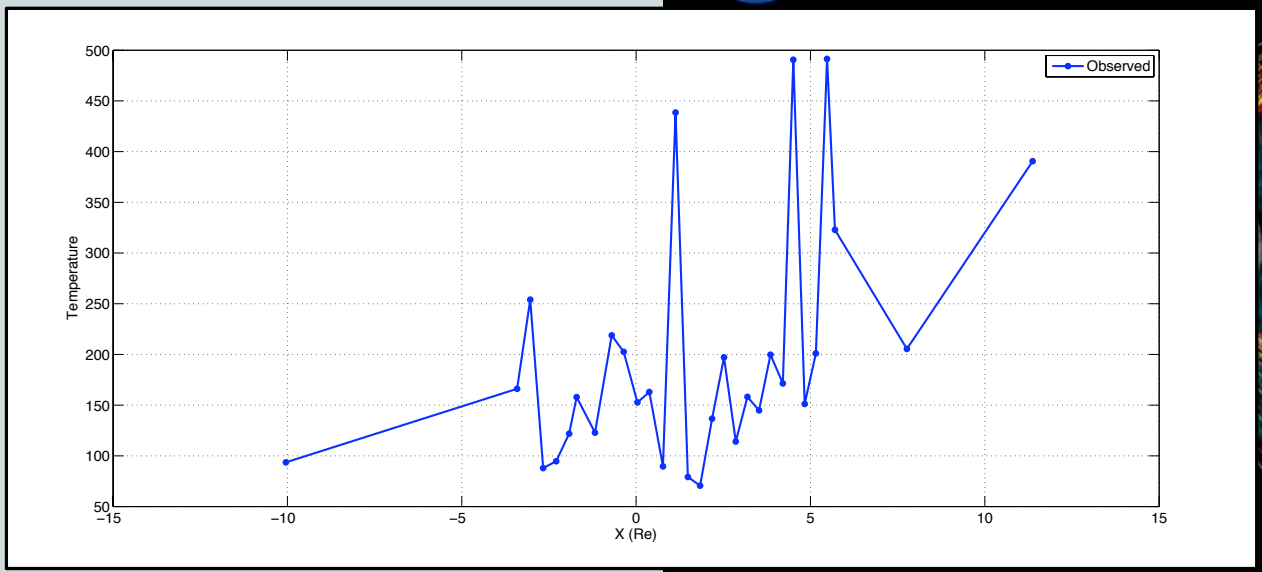
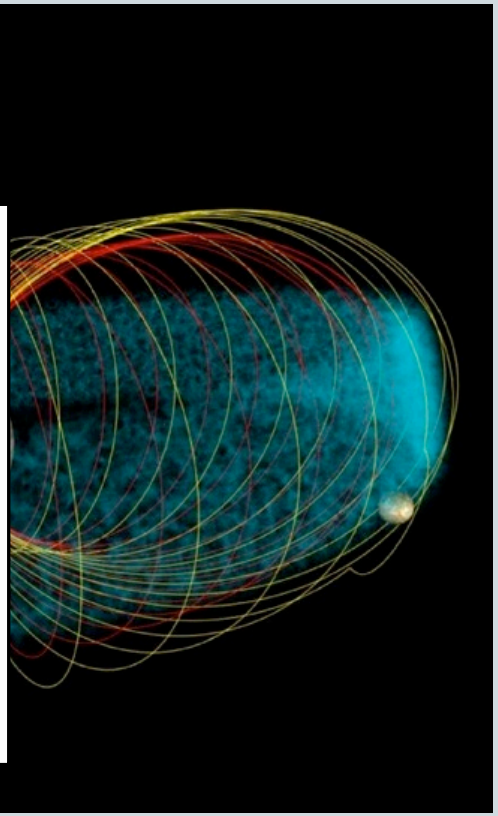
At moon encounters, the plasma might be changing too quickly to find a fit

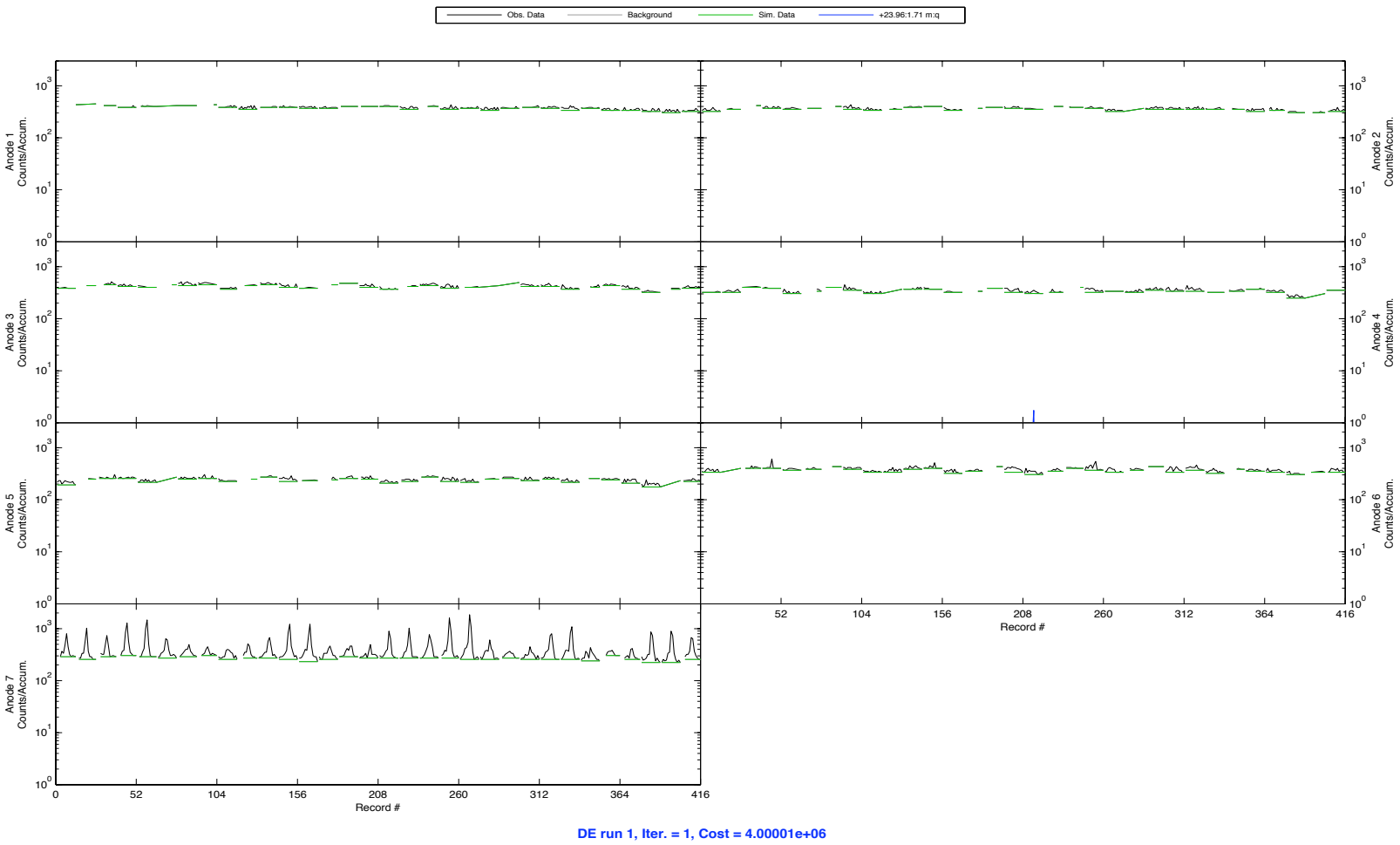




A Possible Remedy

- If the issue is over-averaging, edit the fitting to only run each spin individually
- Danger of not having enough appreciable detections.

A Possible Remedy



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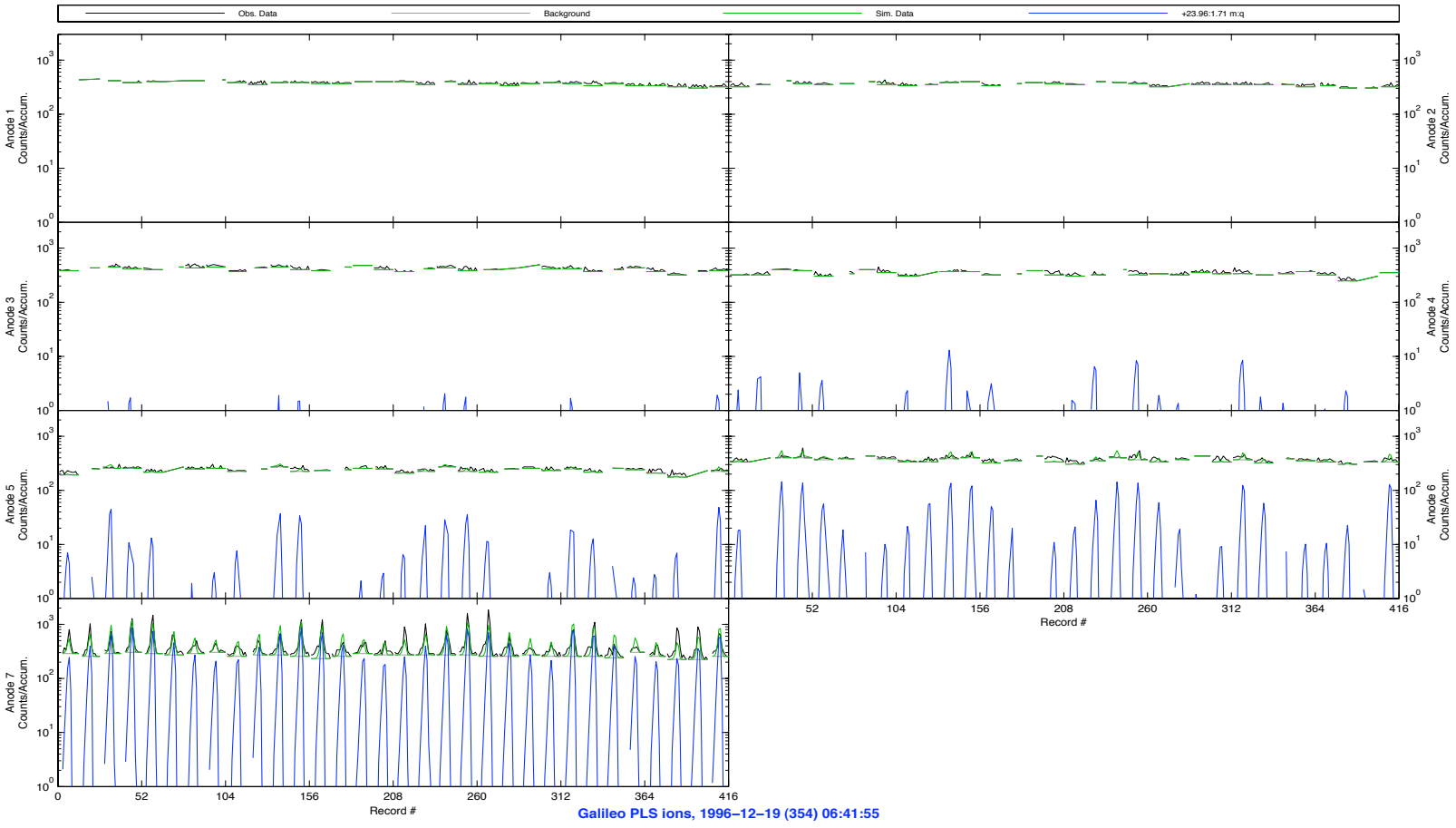

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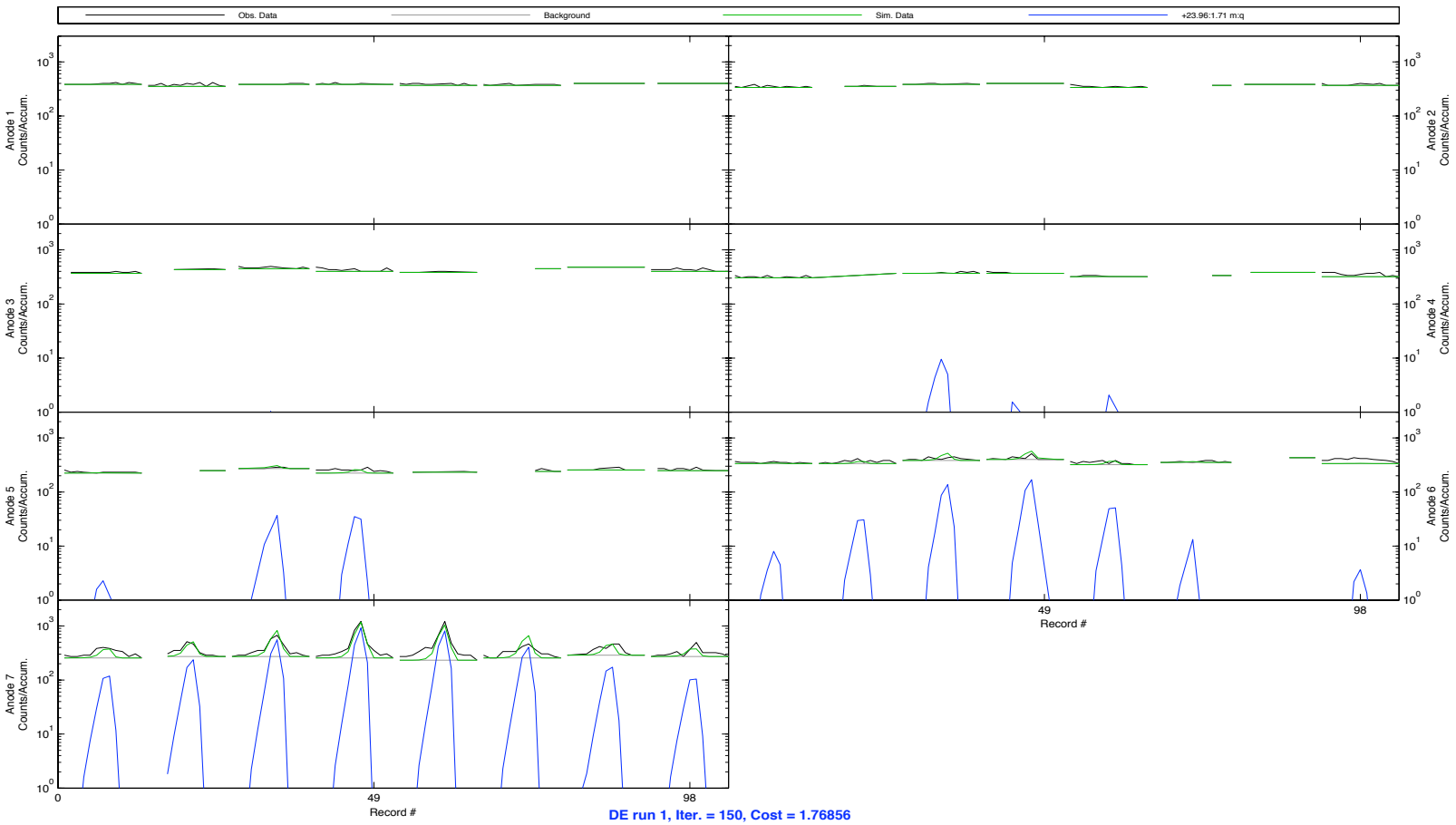
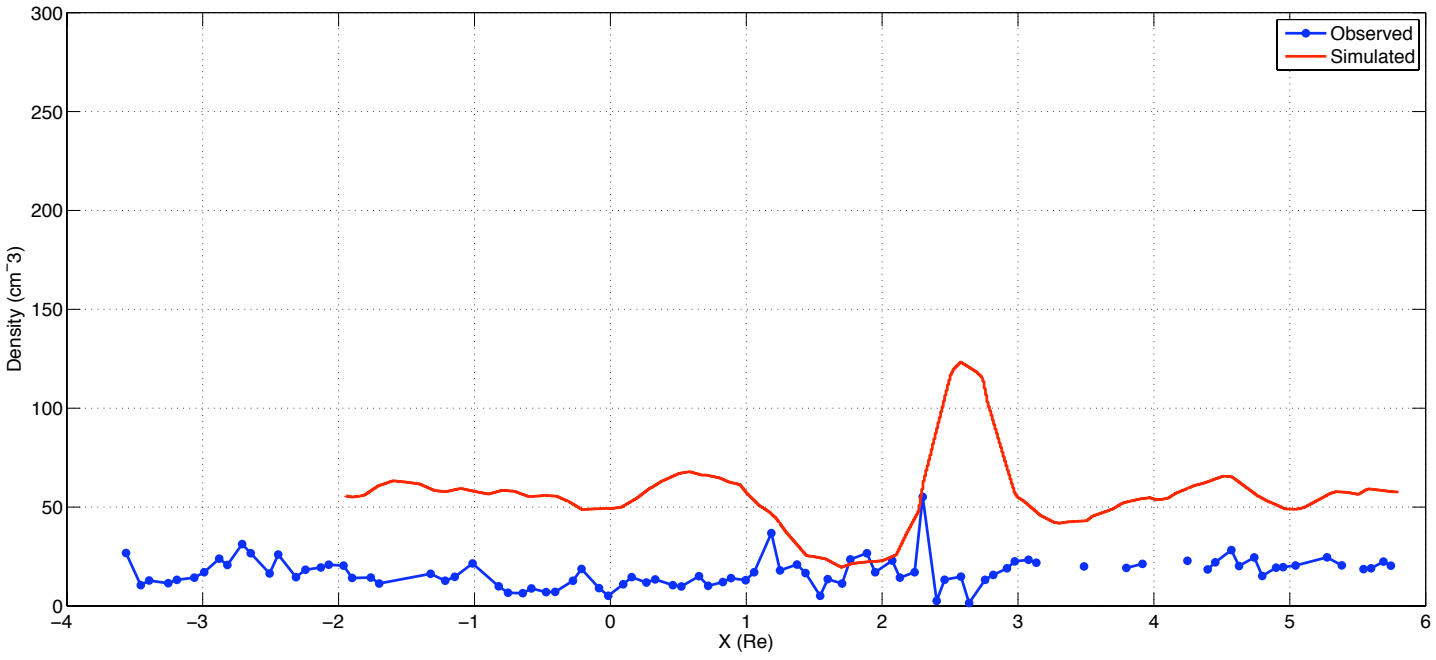


New PLS Results

- Very Mixed – Several unreasonable features removed



New PLS Results

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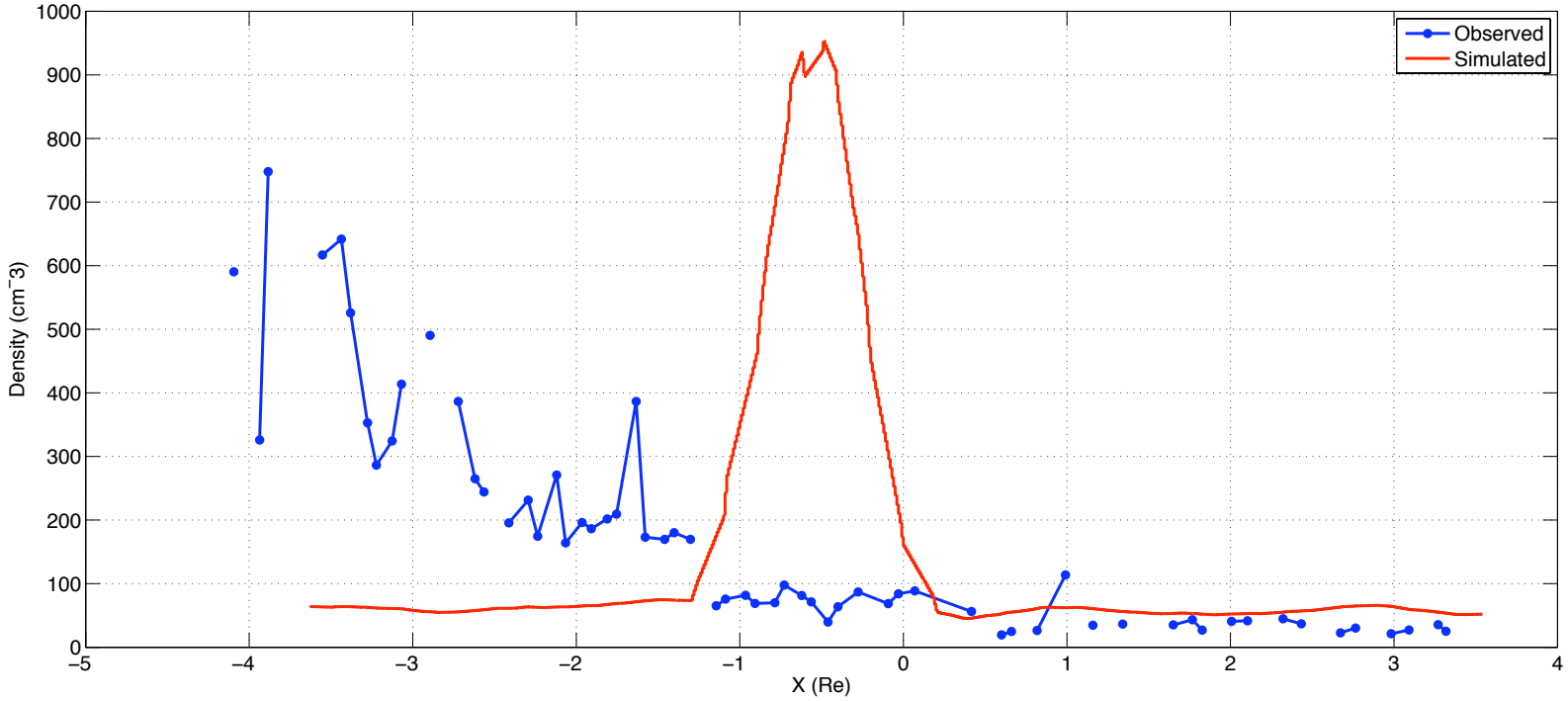

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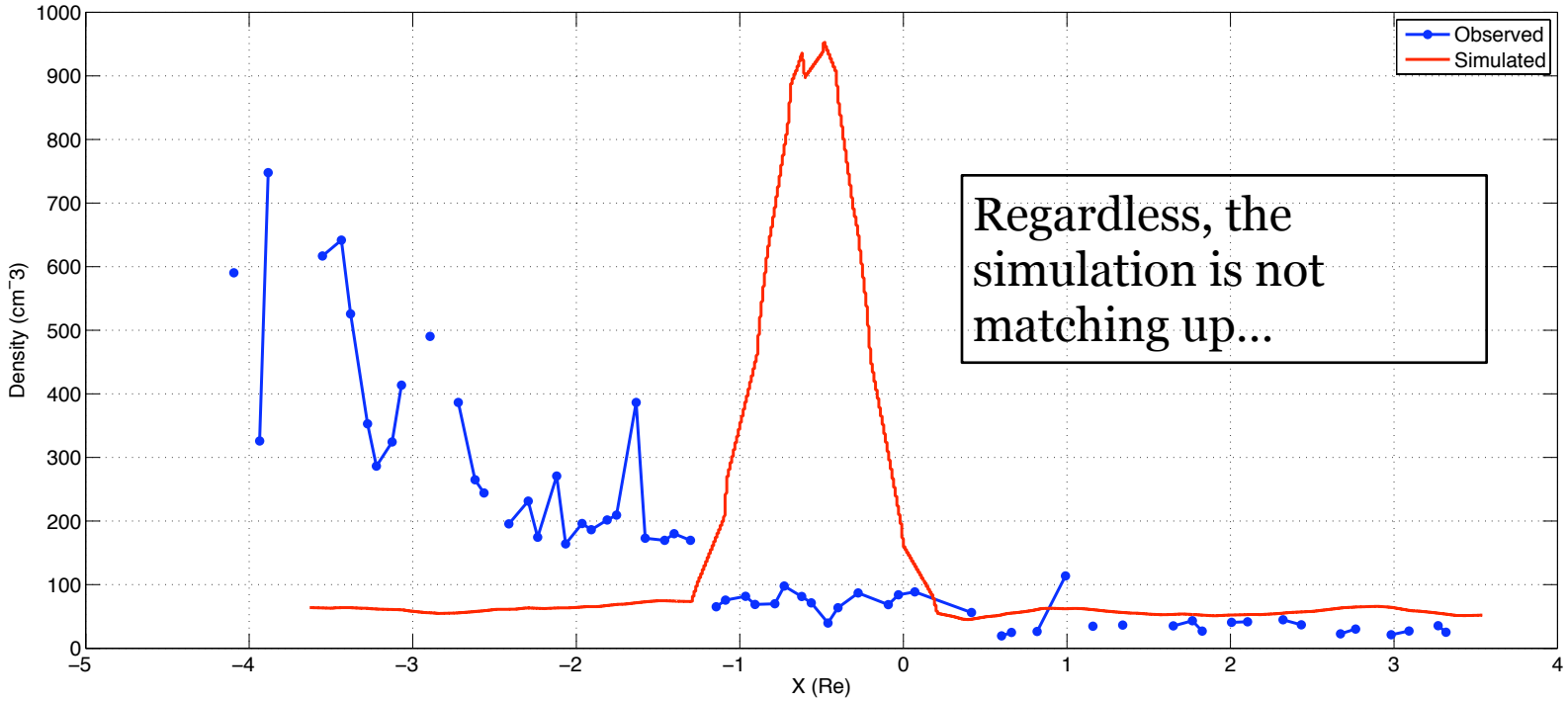
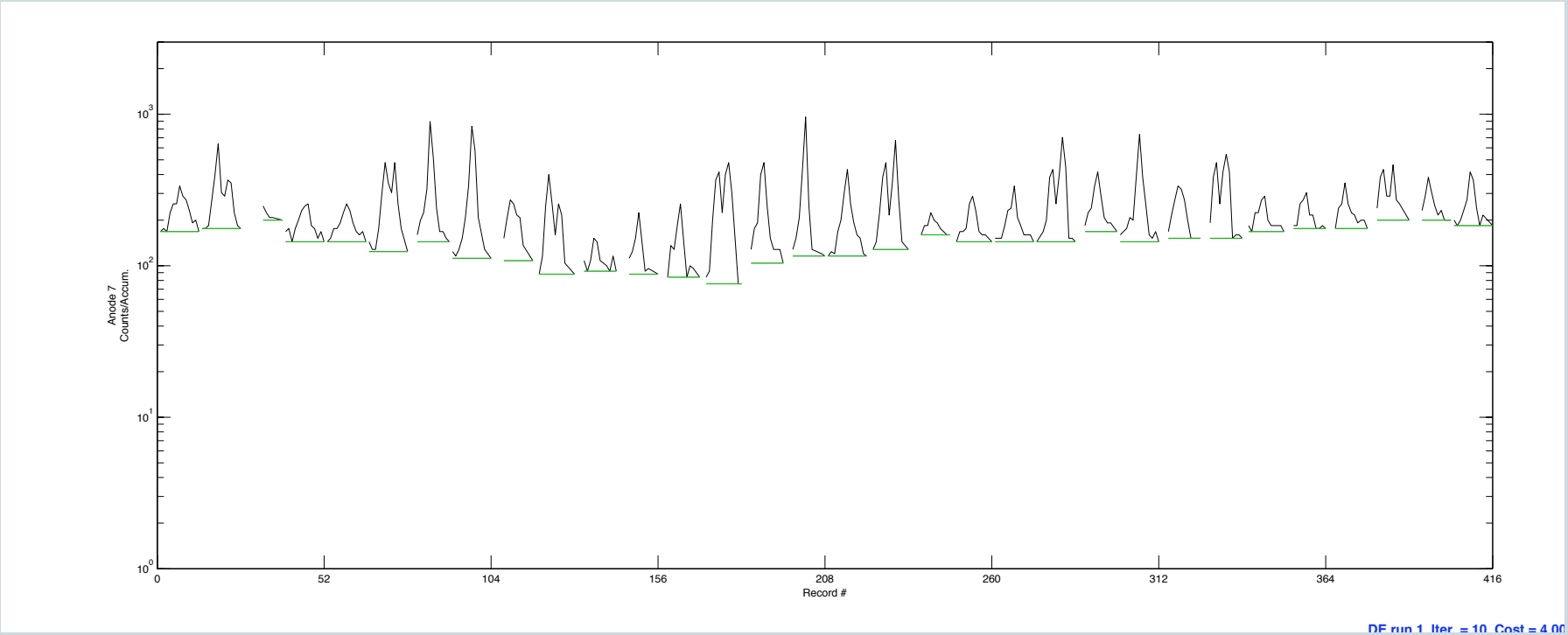


A Final Issue/Interest



Double peaks show two plasma species – in this case we have pickup ions

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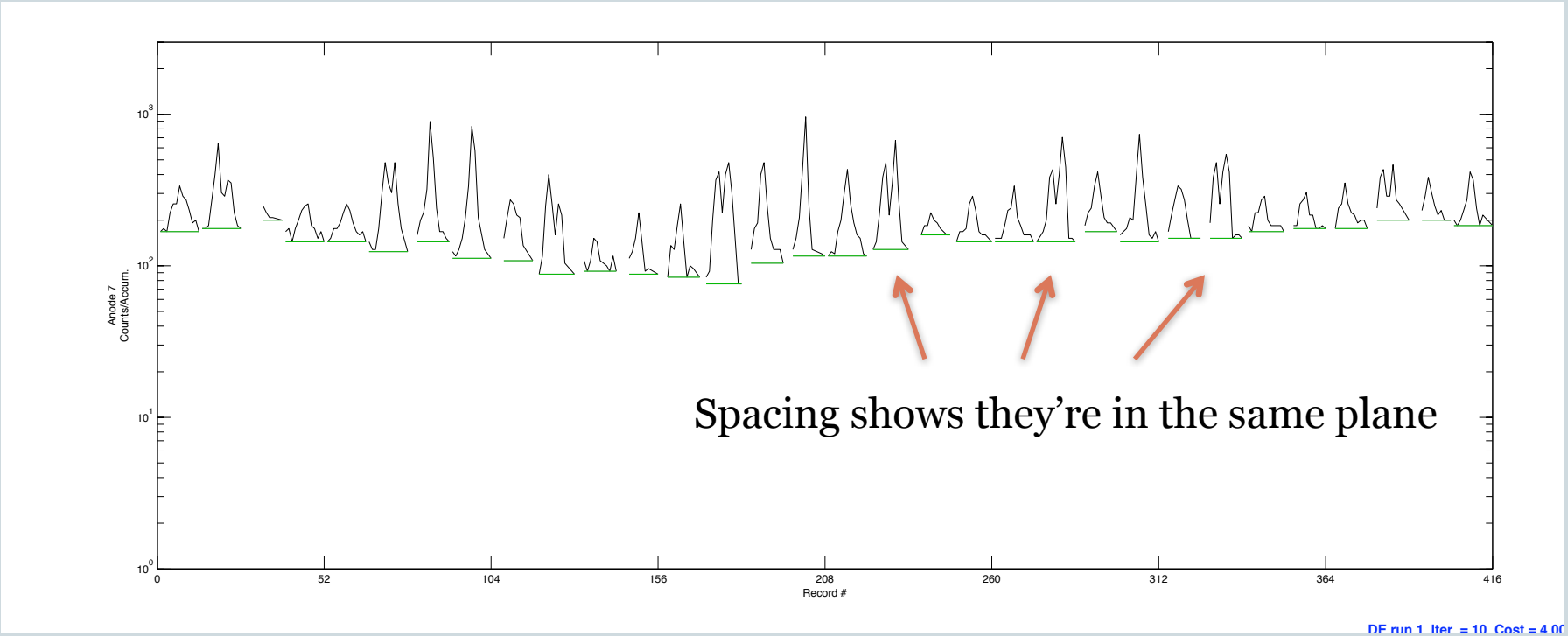

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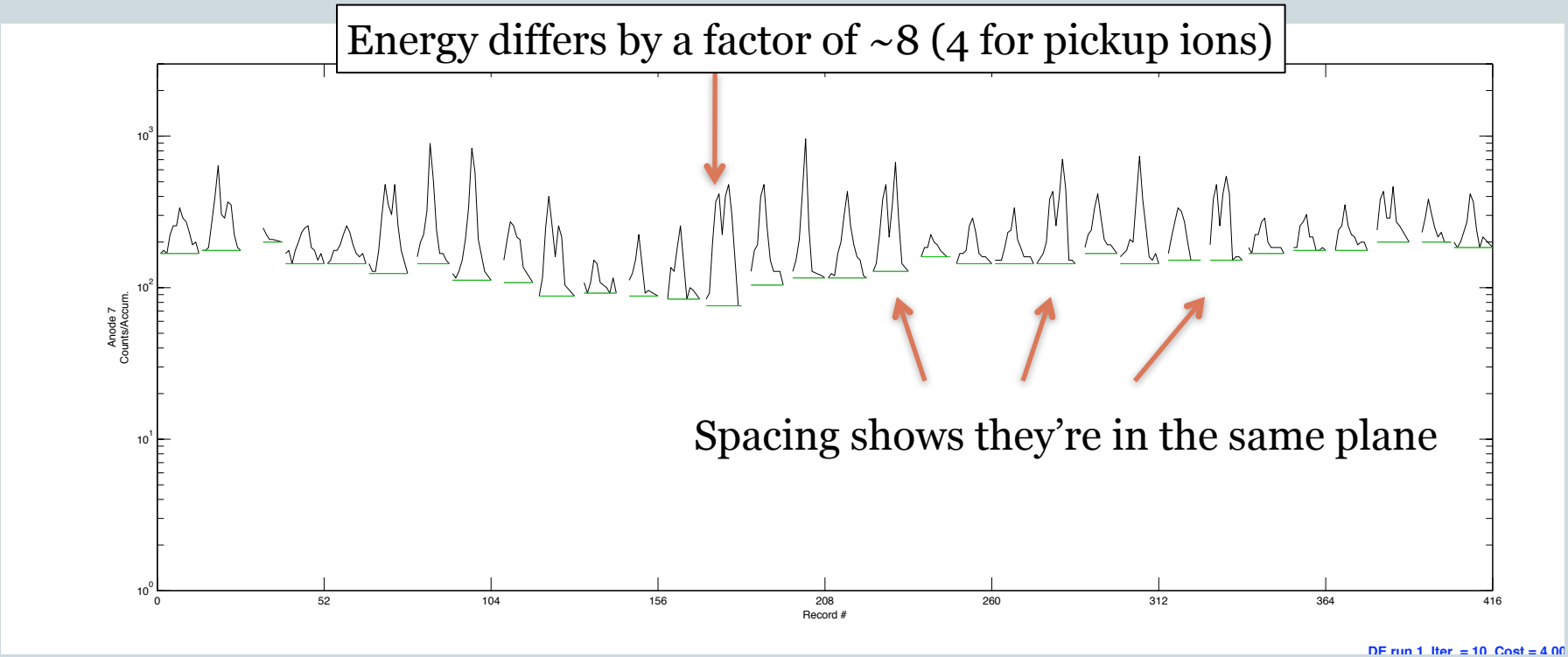

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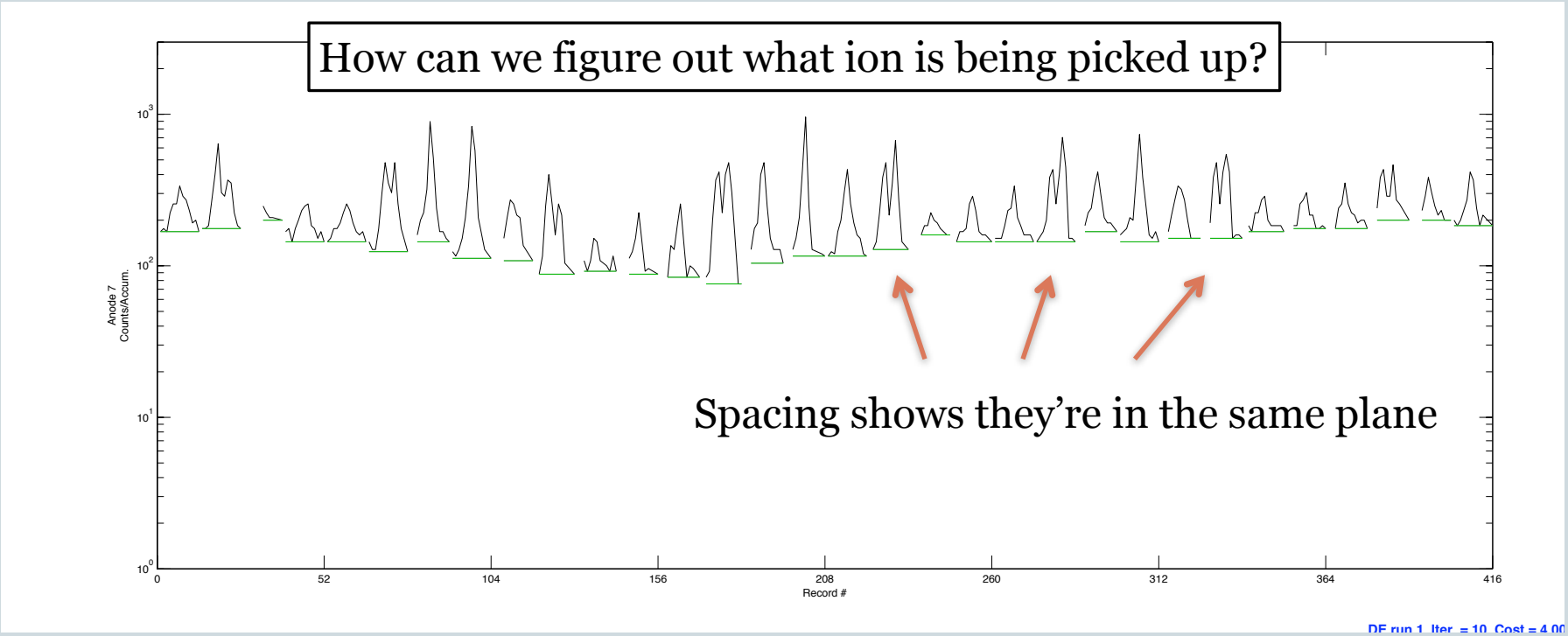

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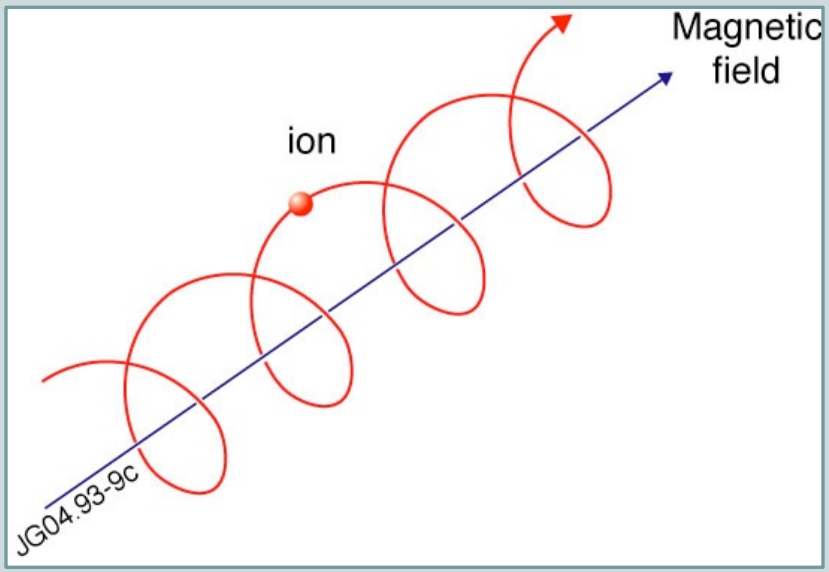
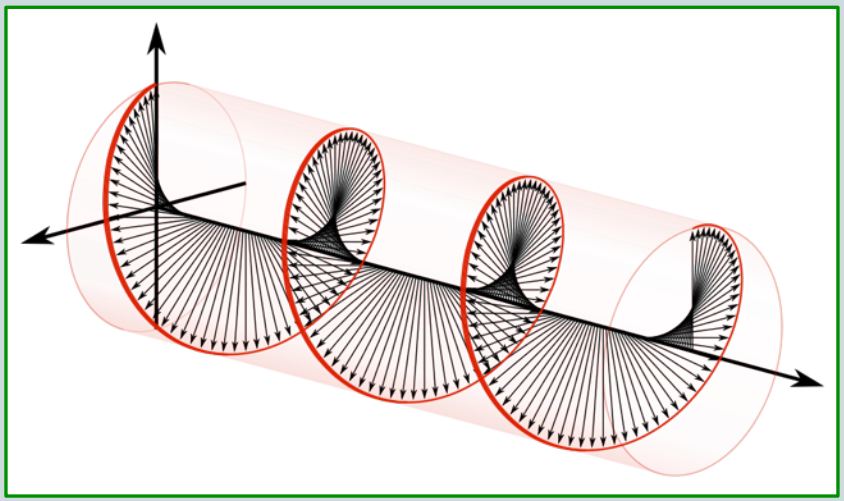
Ion Cyclotron Waves

- Resonance between gyrofrequency and magnetic waves.





http://www.efda.org/fusion

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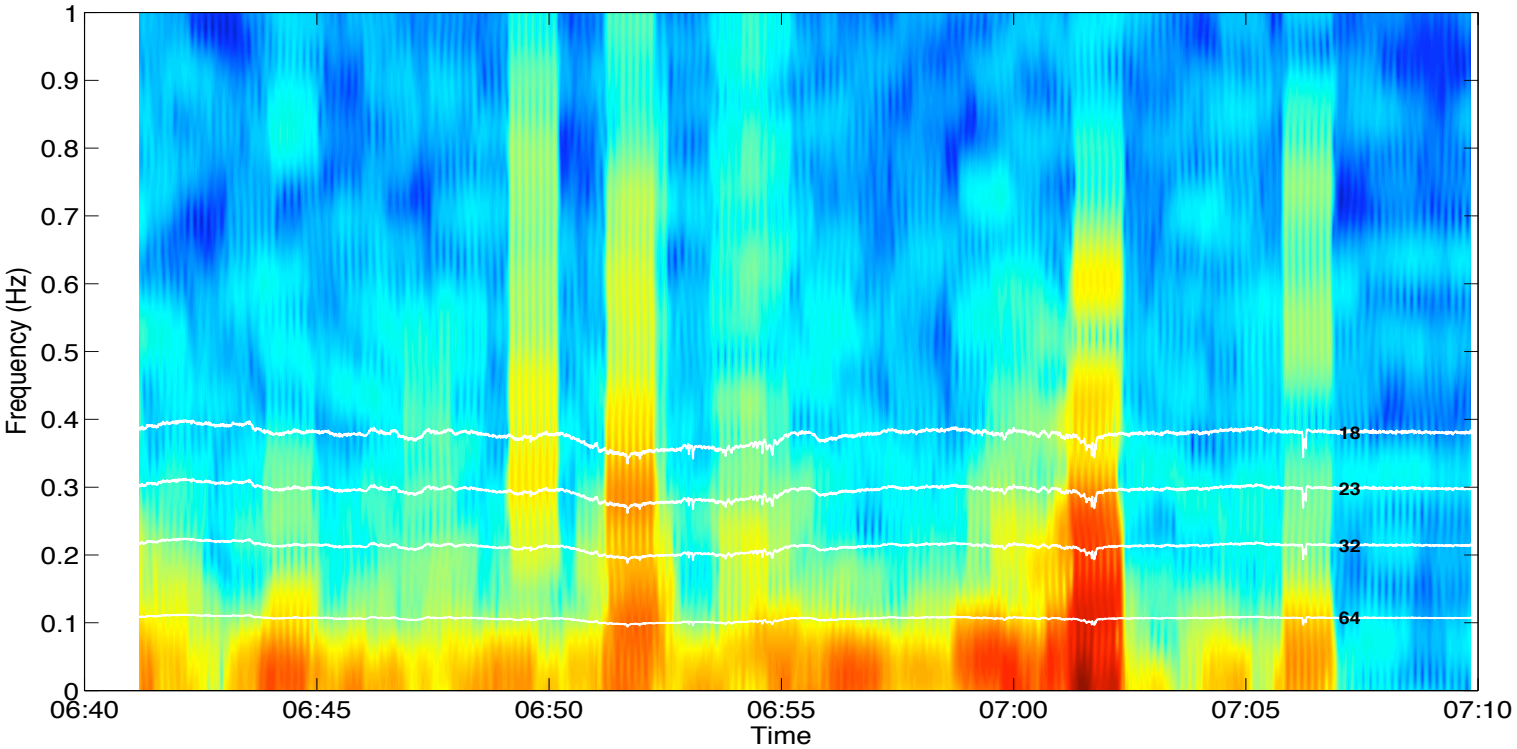
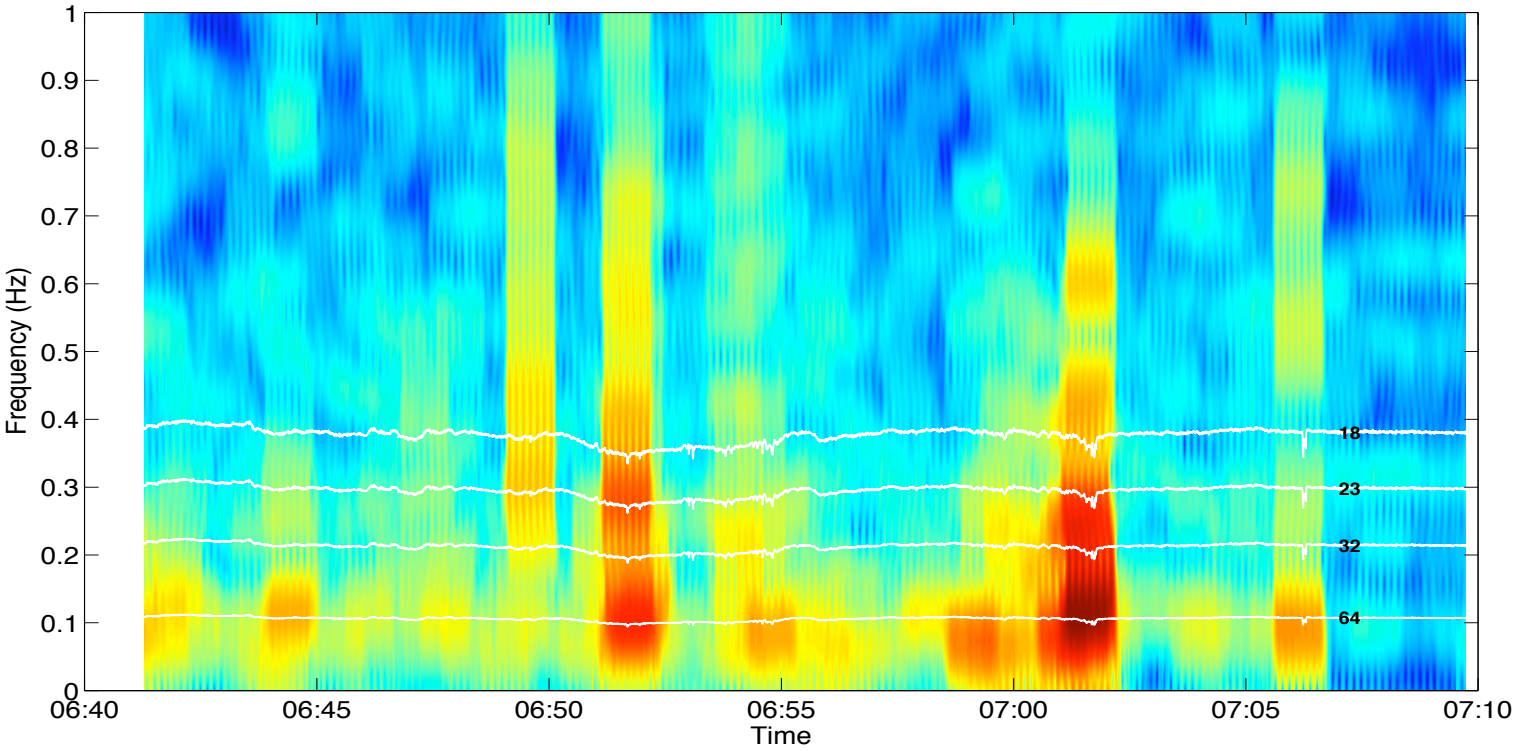


Ion Cyclotron Waves

- Remove the background magnetic field



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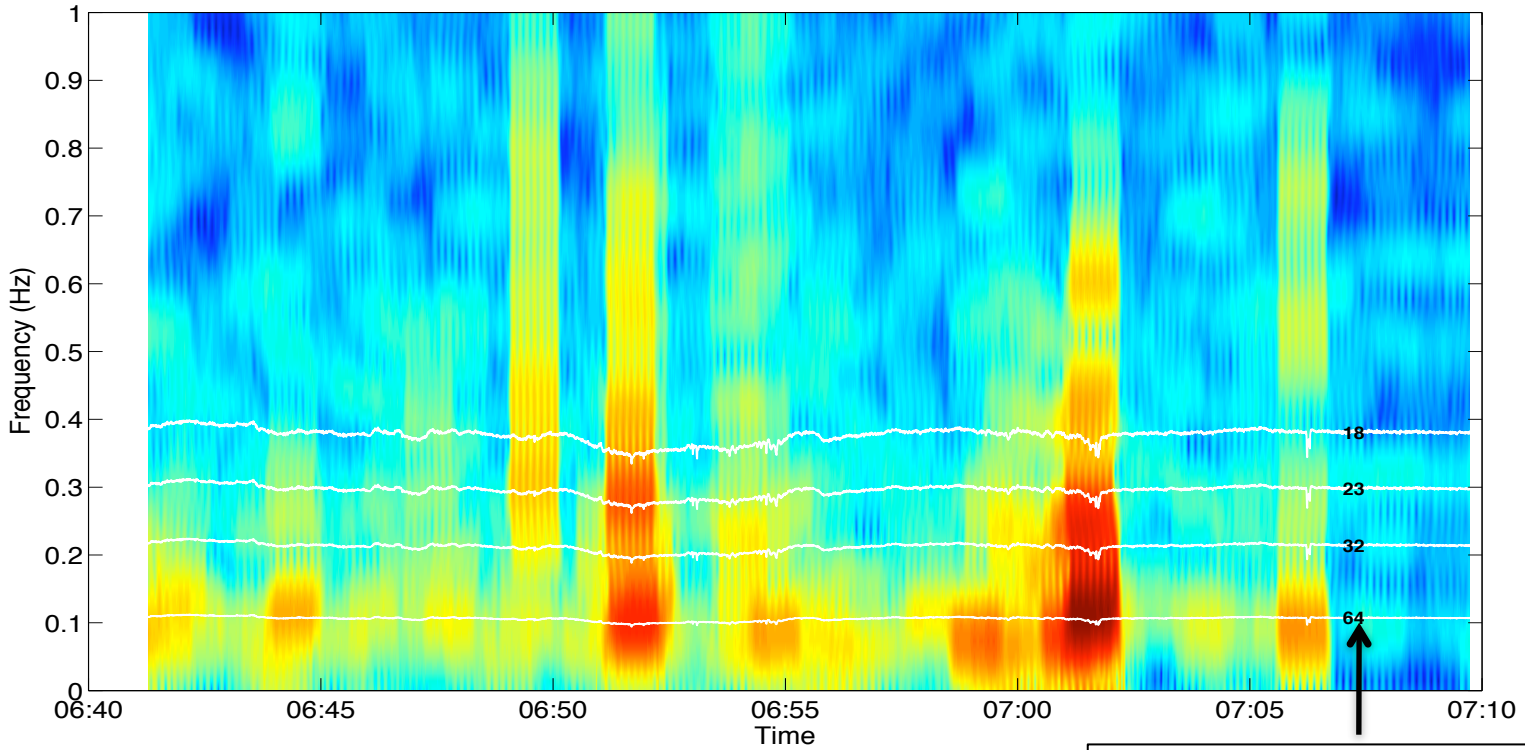

Is this actually a result?

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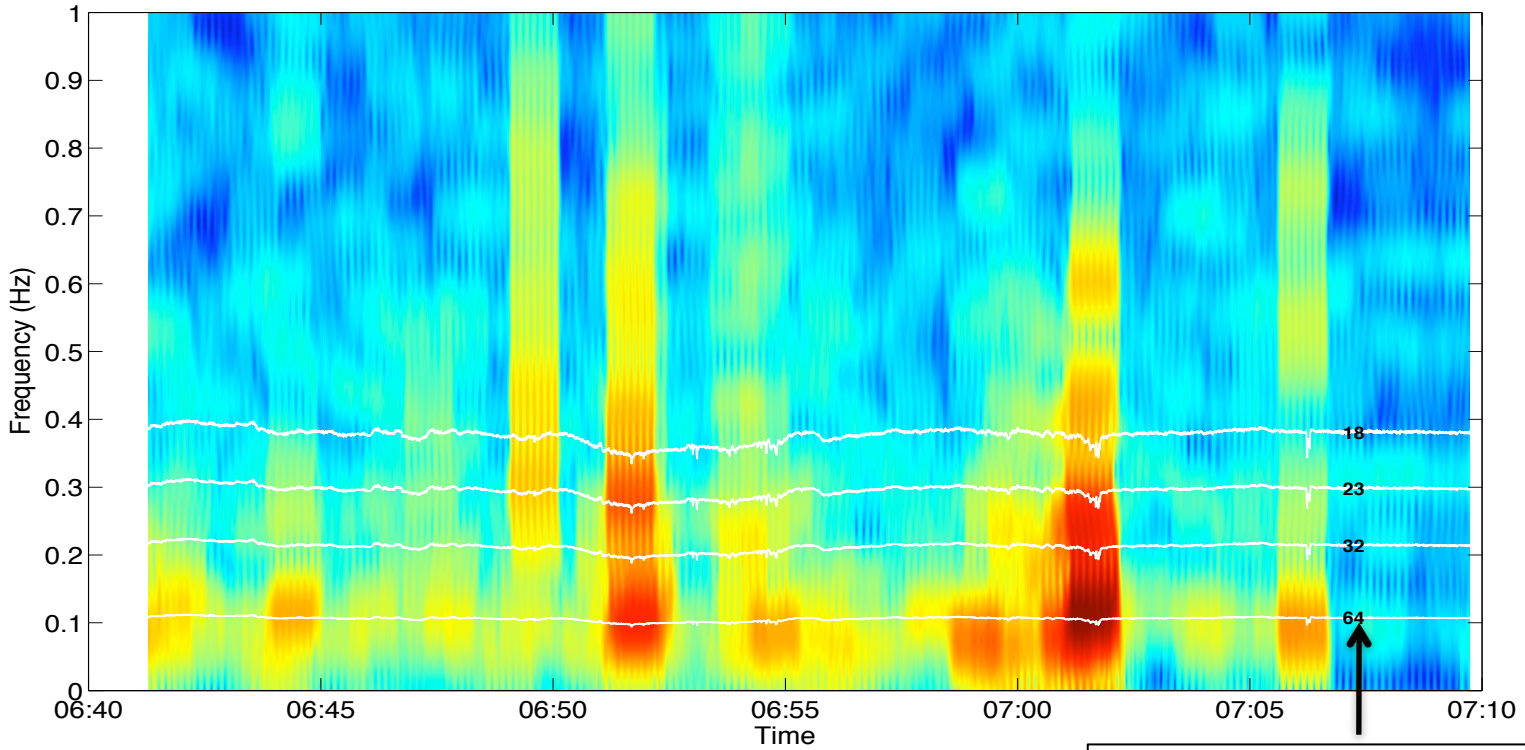
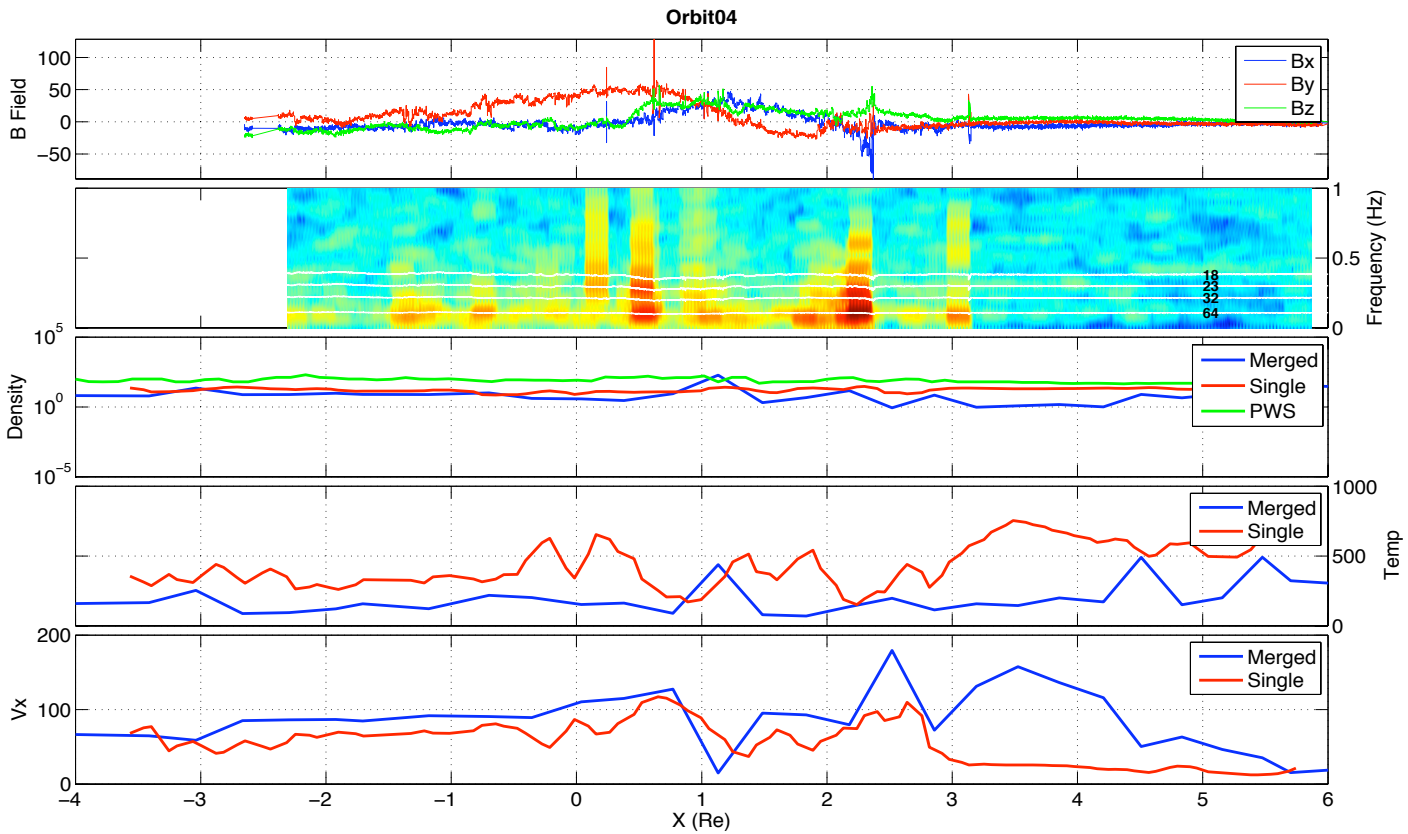


Is this actually a result?

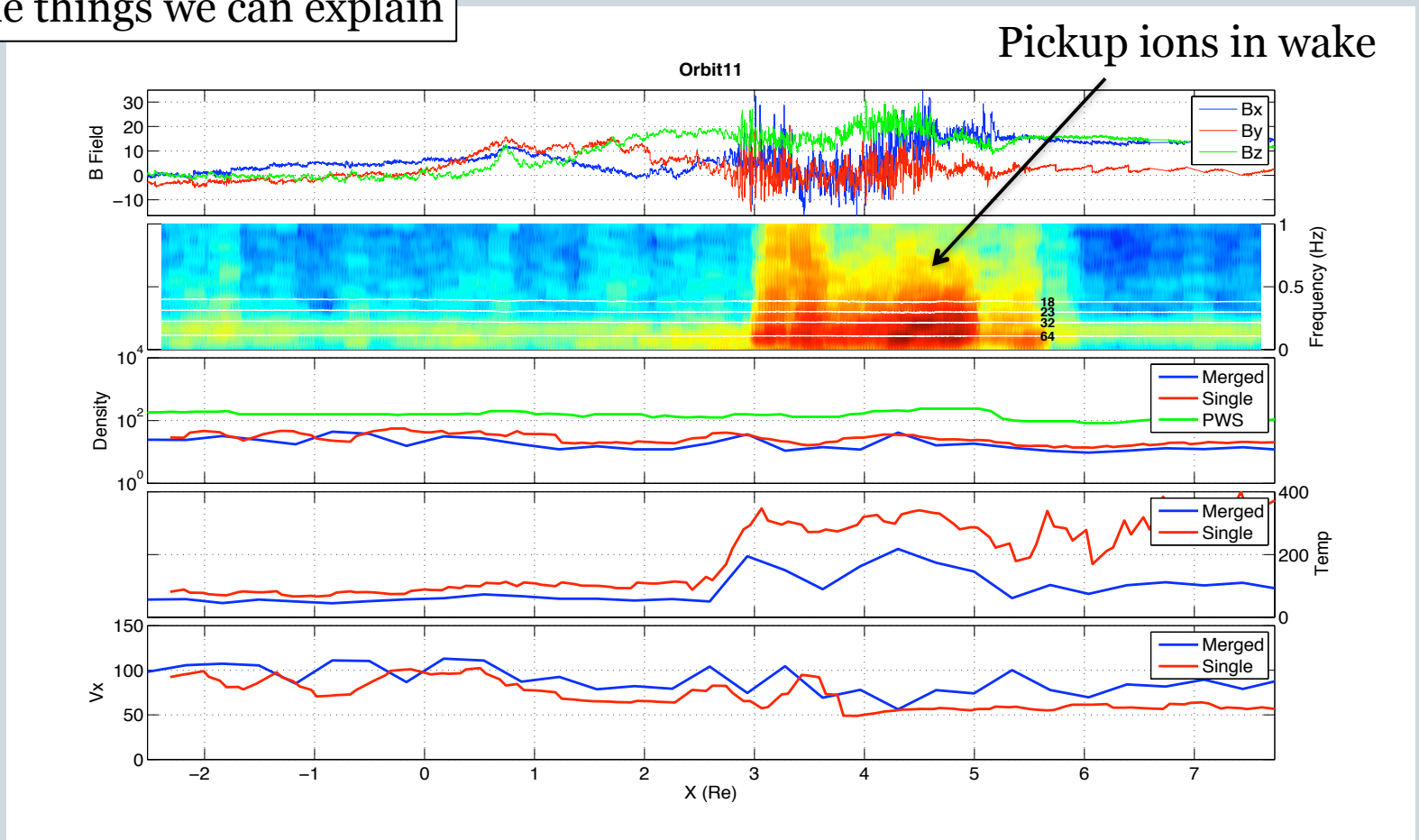
Probably Not

Final Compilations – Where We Are



Final Compilations – Where We Are

Some things we can explain



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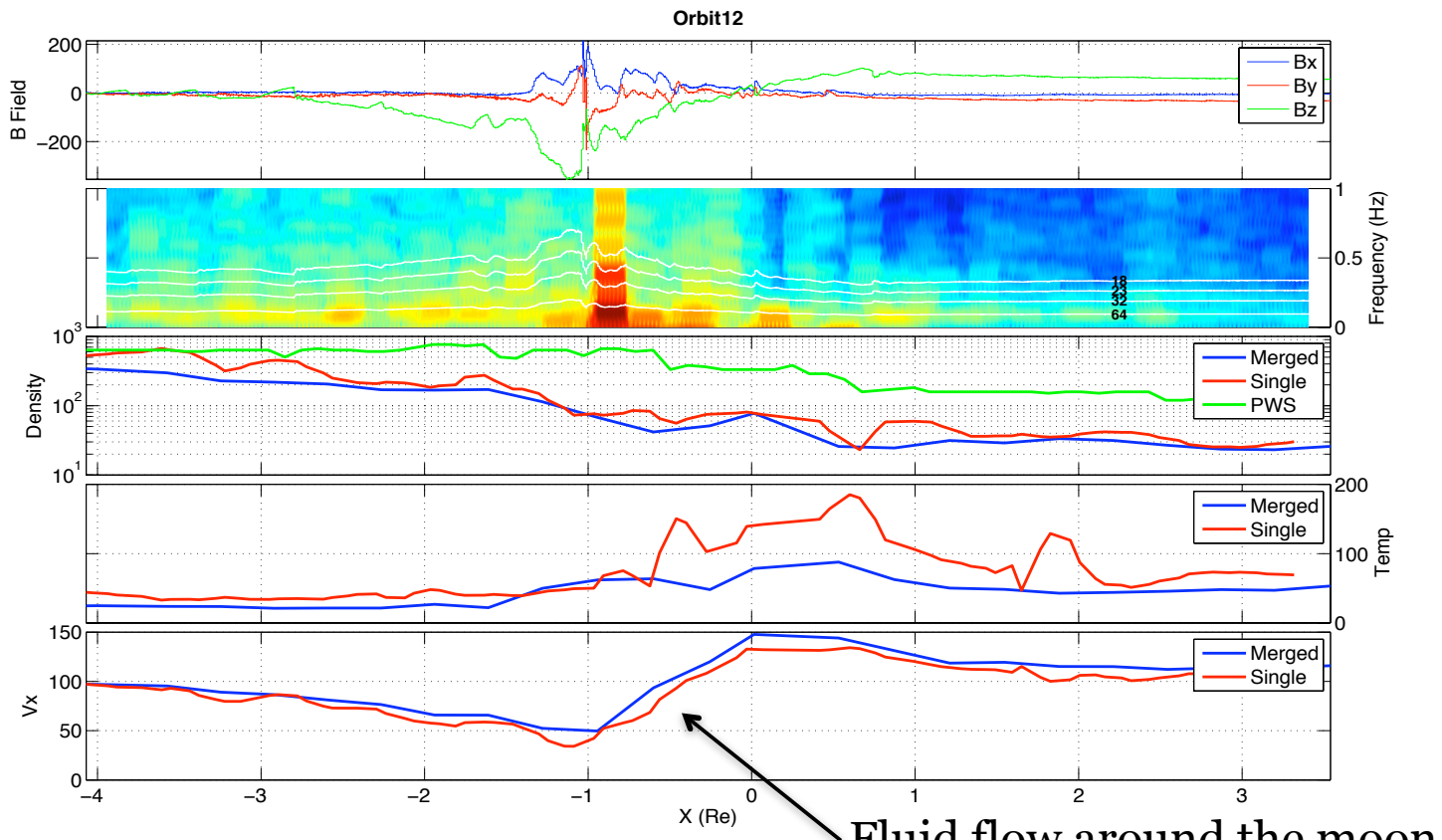
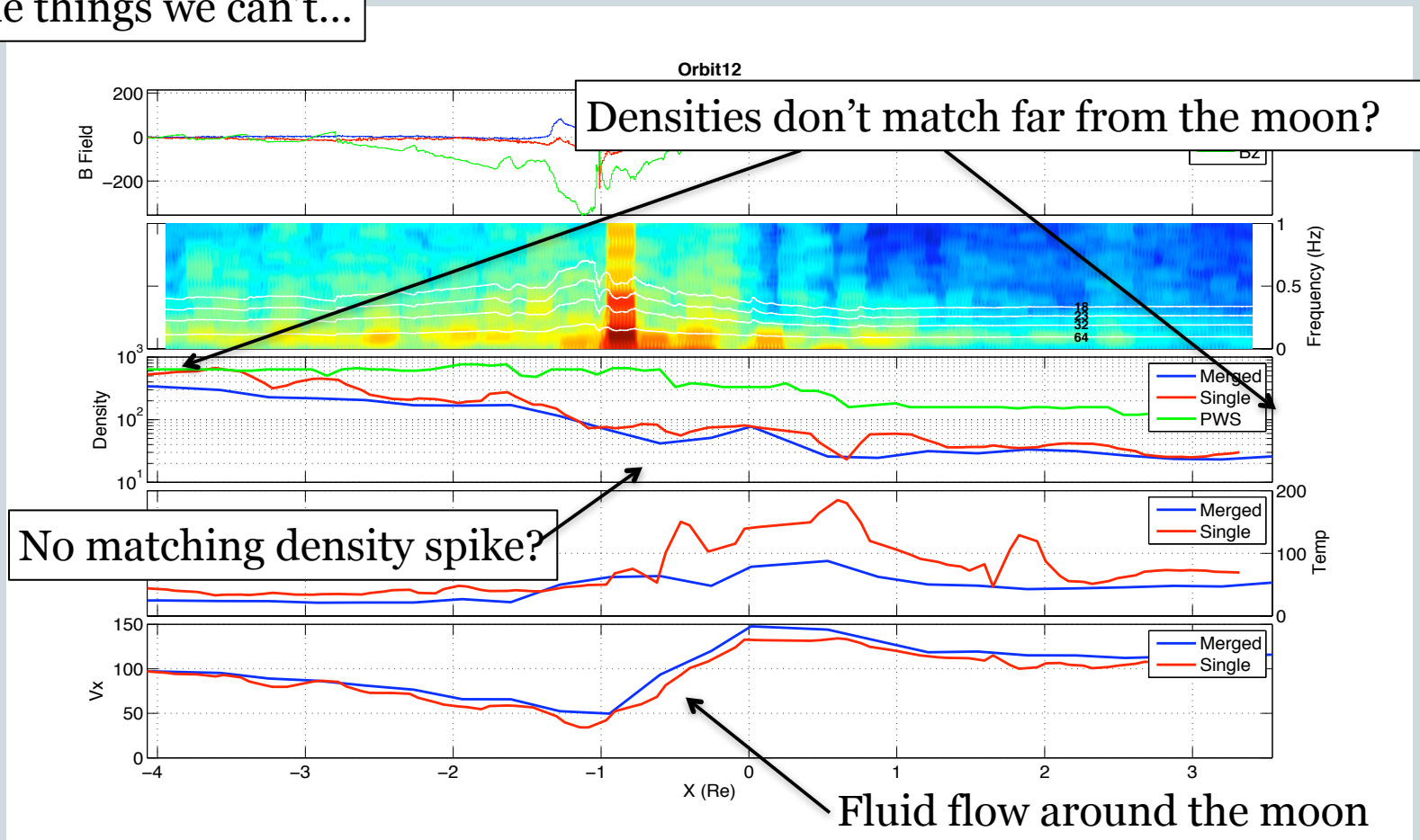


Fluid flow around the moon

Final Compilations – Where We Are

Some things we can't…



Densities don't match far from the moon?

No matching density spike?

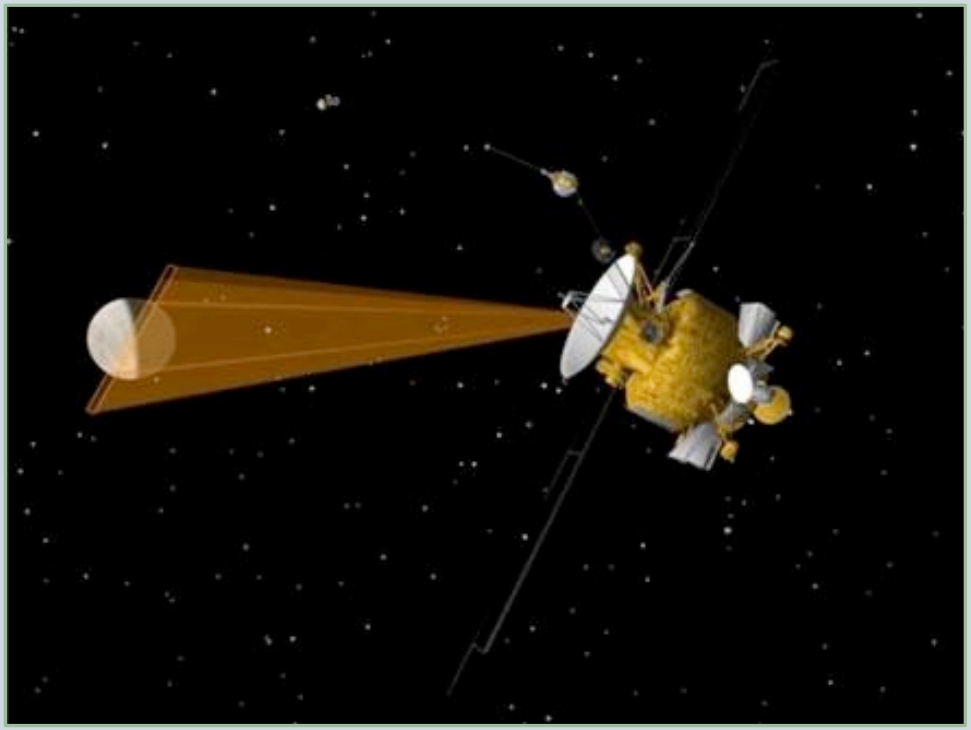
Fluid flow around the moon

The Future For Europa Data

- Hope in the Europa Clipper

-Higher resolution MAG data?

-Better plasma data?



Hope to better understand the induced fields and the surface composition.

http://www.jpl.nasa.gov