Voyager PLS Analysis

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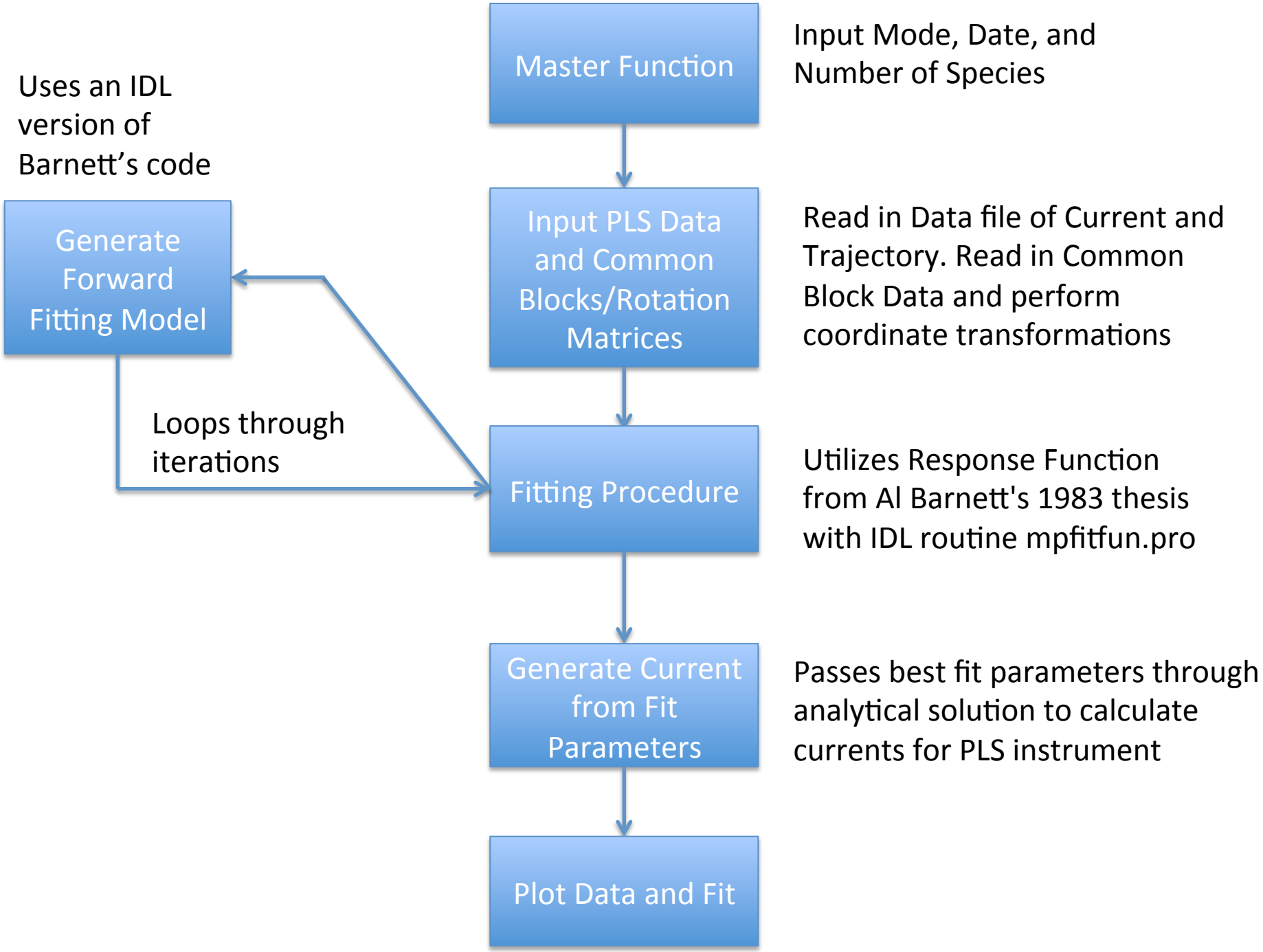
The Code

- Our code uses an IDL version of the Fortran code written by Alan Barnett in his March 1984 Thesis: "The Response Function of the Voyager Plasma Science Experiment"
- Assumes a convected Maxwellian plasma flow of Mach greater than 5 to utilize a cold response function.
- Accounts for up to 7 various mass to charge ratios: 1, 8, $10^2/_3$, 16, 23, 32, and 64.
- Fits densities, thermal speeds (or 1 Thermal temperature), and flow of the plasma.

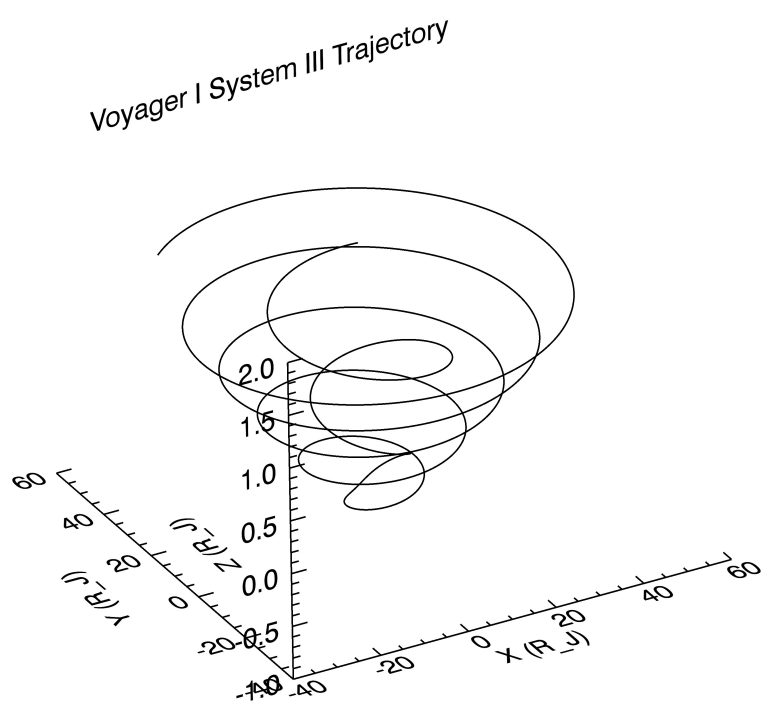

Master Function
Input Mode, Date, and Number of Species
Input PLS Data and Common Blocks/Rotation Matrices
Read in Data file of Current and Trajectory. Read in Common Block Data and perform coordinate transformations
Fitting Procedure
Utilizes Response Function from Al Barnett's 1983 thesis with IDL routine mpfitfun.pro
Generate Current from Fit Parameters
Passes best fit parameters through analytical solution to calculate currents for PLS instrument
Plot Data and Fit
Generate Forward Fitting Model
Uses an IDL version of Barnett's code
Loops through iterations

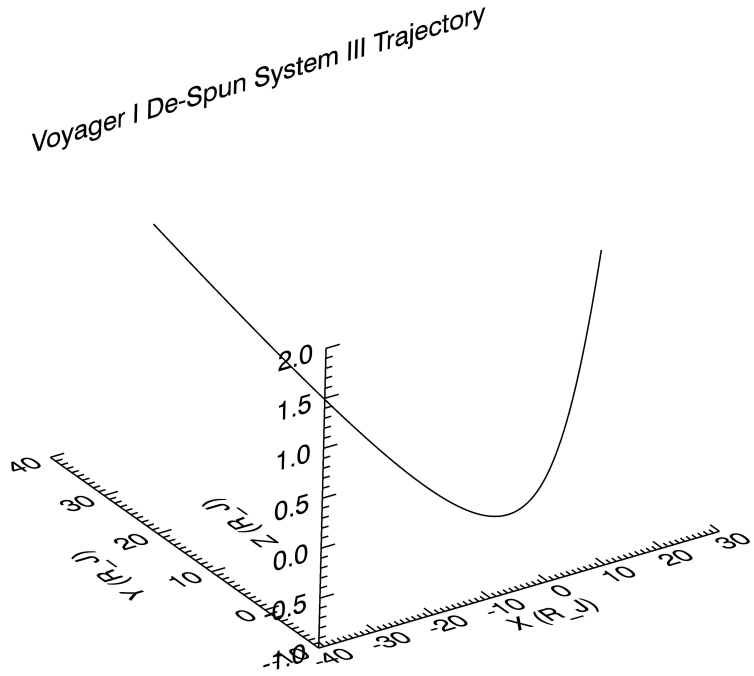
Modes

For each mode, it reads in the date (time stamp) and the number of species (5 or 7)

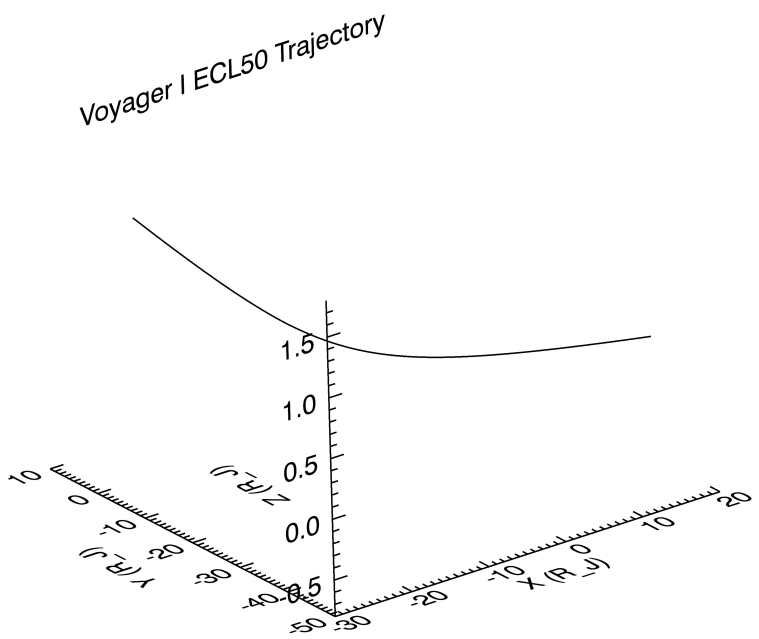
- Mode 0.1
  - Densities allowed to vary
  - Individual thermal speeds allowed to vary
  - Flow speeds allowed to vary
- Mode 0.2
  - Densities allowed to vary
  - Individual thermal speeds allowed to vary
  - Flow Speed Fixed to a constant
- Mode 1.1
  - Densities allowed to vary
  - Common temperature allowed to vary
    - Thermal speeds determined from temperature
  - Flow Speeds allowed to vary
- Mode 1.2
  - Densities allowed to vary
  - Common temperature allowed to vary
    - Thermal speeds determined from temperature
  - Flow Speeds Fixed to a Constant

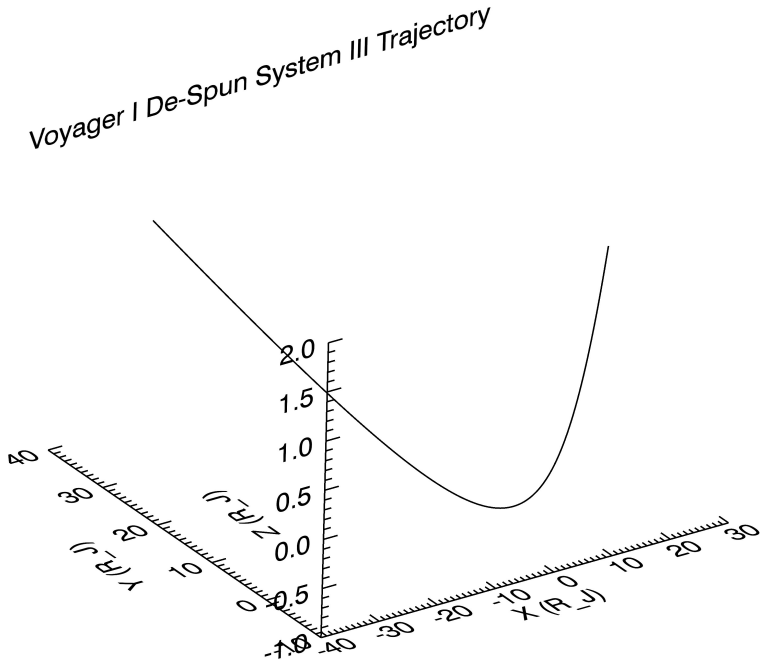
Example Input: Result = Master(1.1 , 579, 7) ; Mode – 1.1, Date – 579, Number of Species – 7





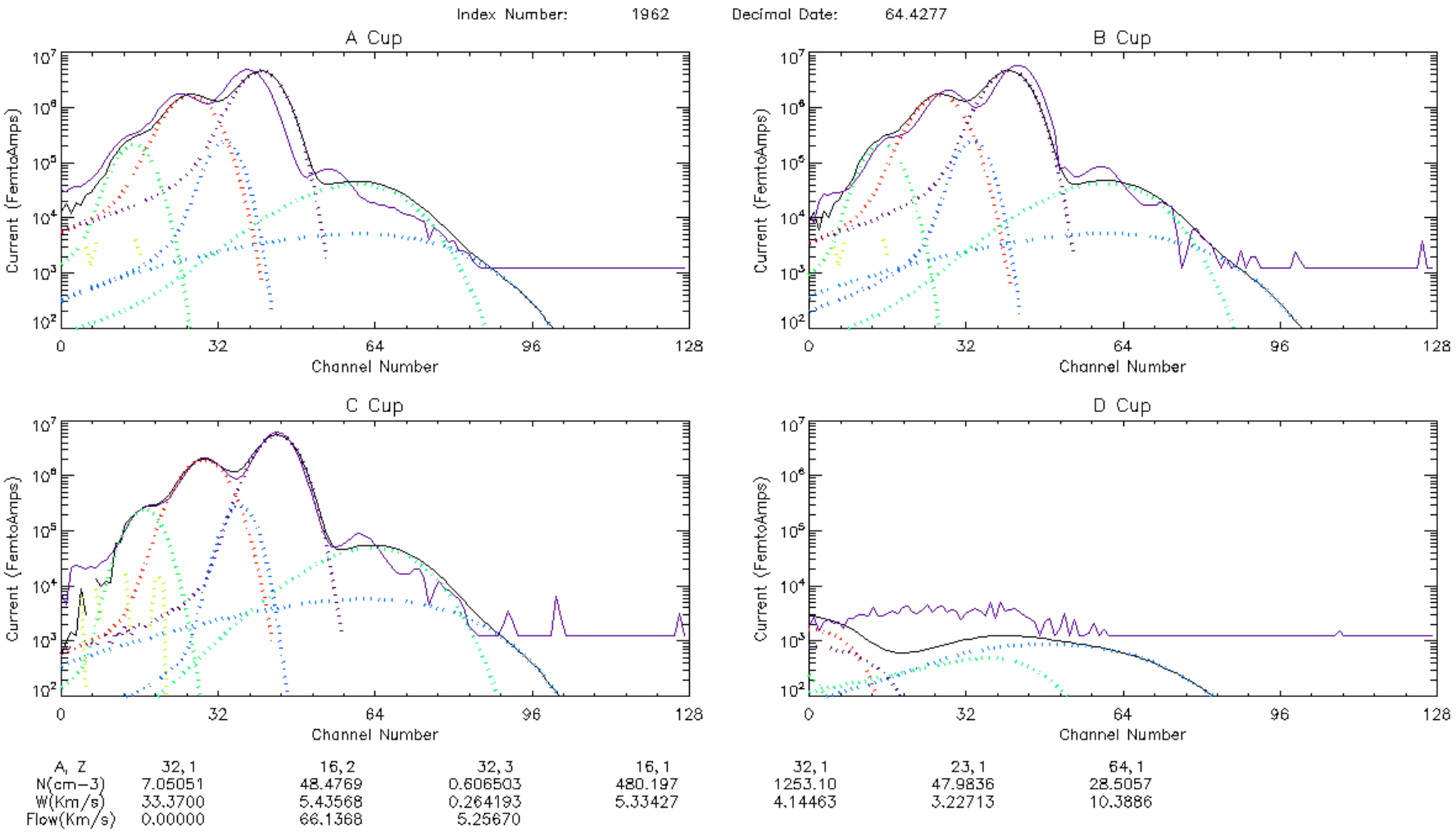
Voyager 1 Trajectory for Days 62-65 of 1979 on its closest approach to Jupiter. System III is a Jupiter based coordinate system that is tilted along the axis of Jupiter and is constantly corotating with the planet itself. The De-Spun System III adds in a rotation matrix rotating in the opposite direction taking the initial point to be the same to get a trajectory in a non-rotating frame. The flow of the plasma should be corotational, so it is possible to calculate the flow of the plasma into the Spacecraft using the De-Spun system.





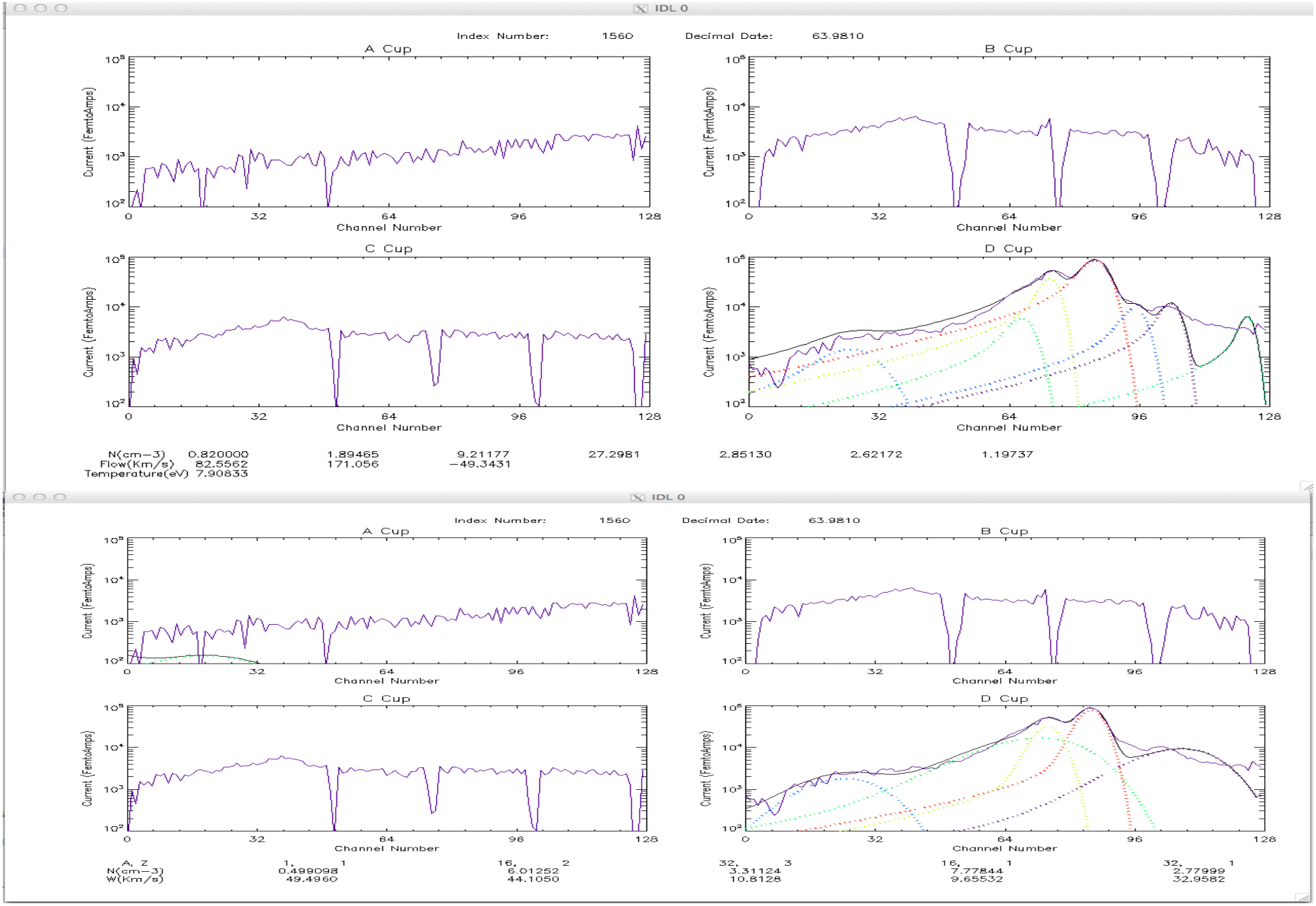
The Rotation matrix to translate to Spacecraft coordinates, and thus Cartesian coordinates with respect to the cups, goes from the ECL50 frame to the Spacecraft frame. So first the plasma must be rotated from the De-Spun system into the ECL50 system before the flow of the plasma can be determined exactly, given the fact that corotation of the plasma may break down past 10 Jupiter Radii.

Example Fits



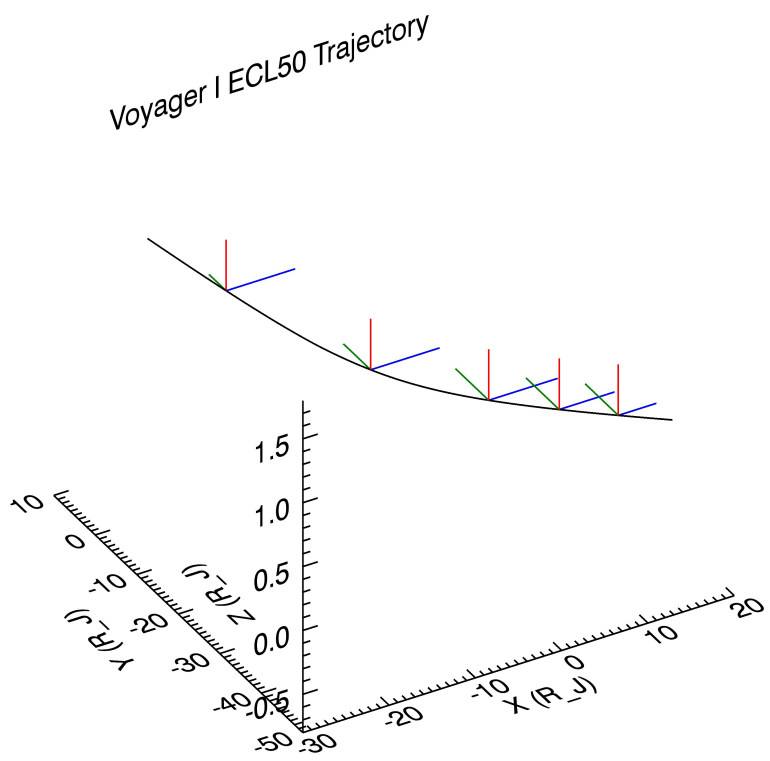
A, Z	32, 1	16, 2	32, 3	16, 1	32, 1	23, 1	64, 1
N(cm-3)	7.05051	48.4769	0.606503	480.197	1253.10	47.9836	28.5057
W(Km/s)	33.3700	5.43568	0.264193	5.33427	4.14463	3.22713	10.3886
Flow(Km/s)	0.00000	66.1368	5.25670				

Example of Mode 0.1 Fitting 7 Species on Day 64 at time 10:16



Comparison between 7 species fit (above) and 5 species fit (below) on day 63

Determining Plasma Flow



- The Plasma flow should be mainly corotational. In order to determine the general flow into the cups, we are attempting to plot vectors of the Spacecraft, and Cup, orientation at different points along the orbit to know how much of the plasma flow should be going into each of the sensors.

Preliminary Vectors that match the Axes shown. Need to rotate the axes to match S/C coordinates and plot vectors of the corotational plasma flow around Jupiter.

Conclusion

- With more physical constraints on some of the parameters and an accurate rotation matrix to determine the flows into the PLS sensors, it will be possible to accurately determine the densities and temperature(s) of the ion species as well as the flow of the Plasma.