TEMPORAL AND SPATIAL DISTRIBUTION OF HIGH ENERGY ELECTRONS AT JUPITER

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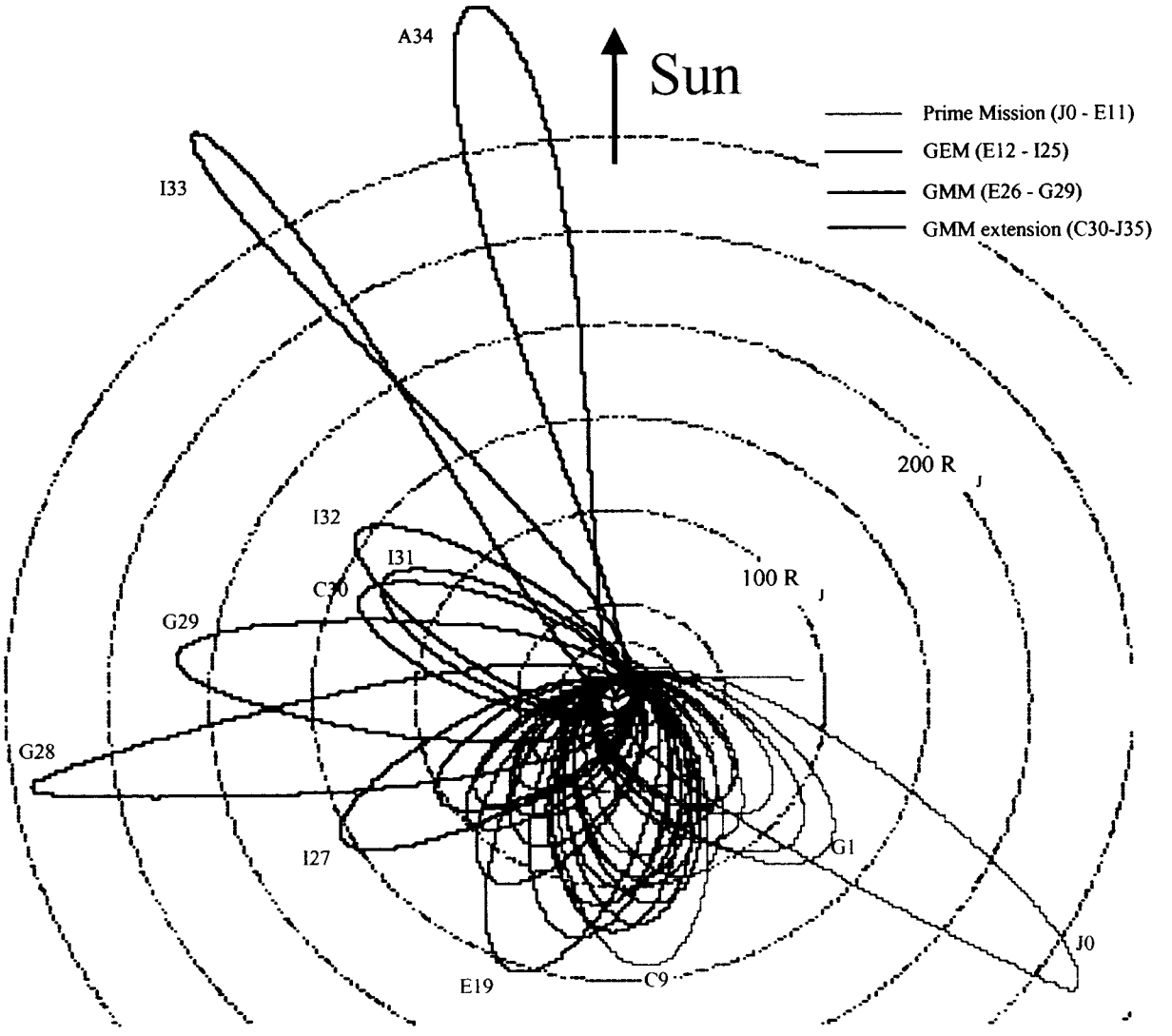
Introduction

- Galileo has orbited Jupiter since 1995
  - 34 orbits as of today
  - Extensive scientific data return
- Energetic Particle Detector (EPD) onboard Galileo has measured high energy electron environment around Jupiter

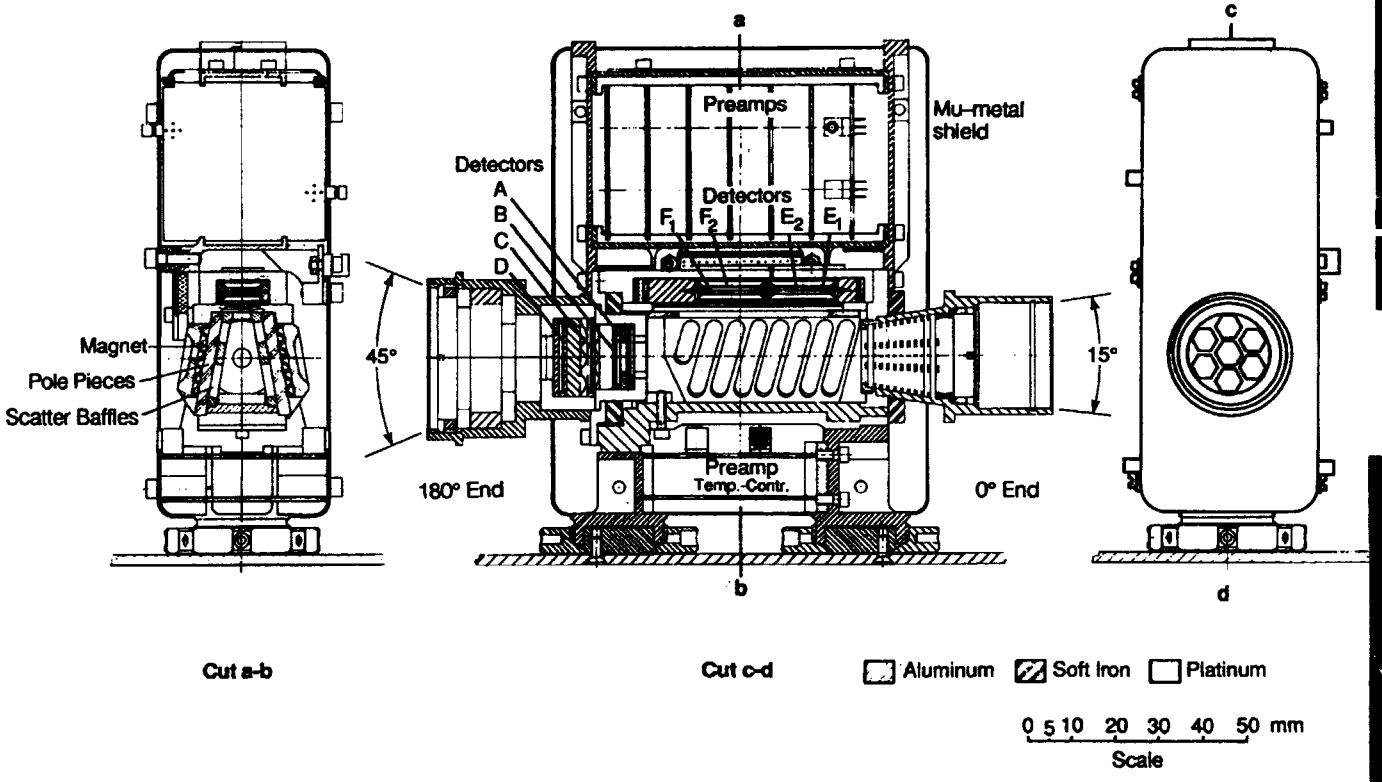
Objective

- The main objective of this study is to use the EPD data to examine temporal and spatial distributions of high energy electrons within inner Jovian magnetosphere (<20Rj, where 1 Rj= 1 Jovian radius = 71,400 km)

Galileo Orbits



APL/JHU EPD

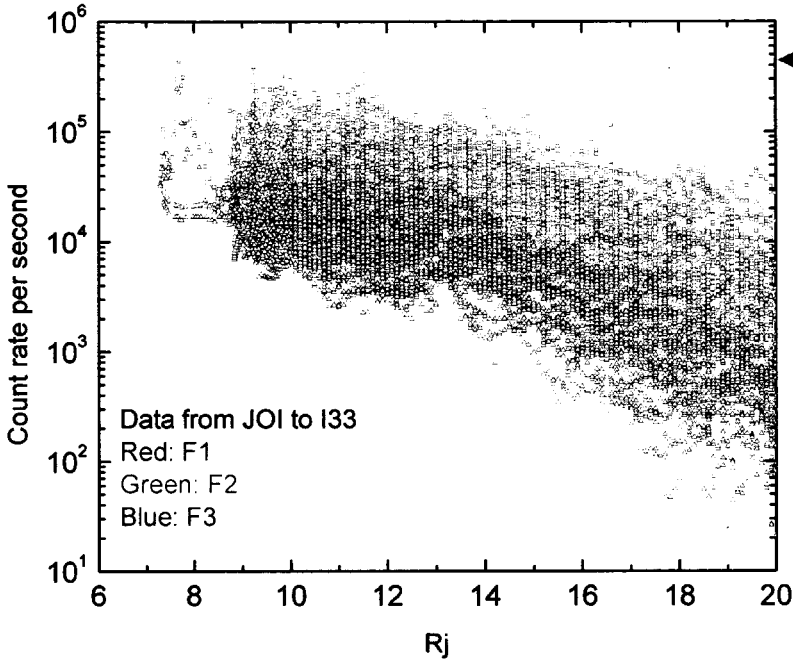

a
c
Preamps
Mu-metal shield
Detectors
A
B
C
D
Detectors
F1
F2
E2
E1
Magnet
Pole Pieces
Scatter Baffles
45°
15°
180° End
Preamp
Temp.-Contr.
0° End
b
d
Cut a-b
Cut c-d
Aluminum
Soft Iron
Platinum
0 5 10 20 30 40 50 mm
Scale

EPD Electron Channels

[illegible]	[illegible]
F1	0.174-0.304
F2	0.304-0.527
F3	0.527-0.884
B1	1.5-10.5
DC2	≥ 2.0
DC3	≥ 11.0

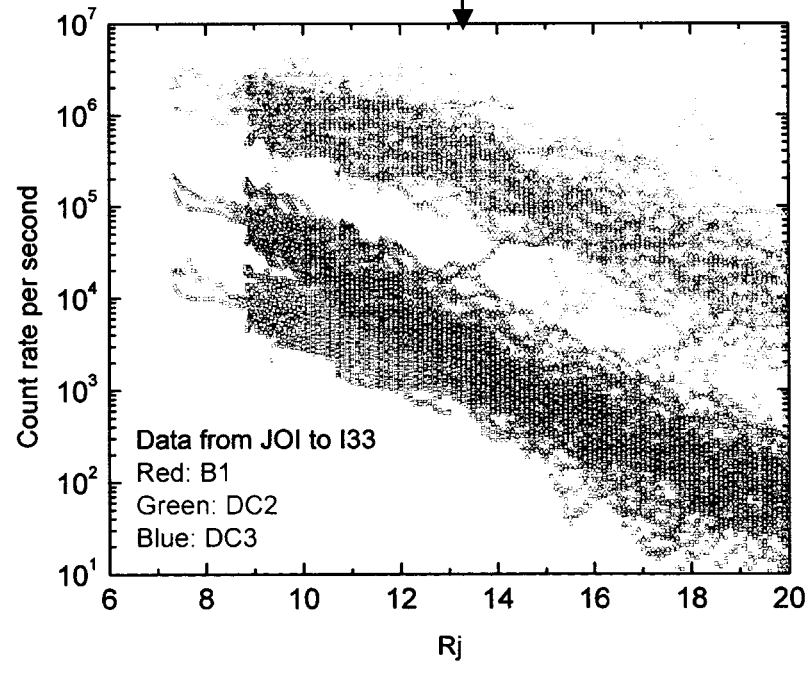
We will focus on study of DC3

EPD Counts Rates from JOI to I33



F1, F2, and F3

B1, DC2, and DC3



As a function of Rj

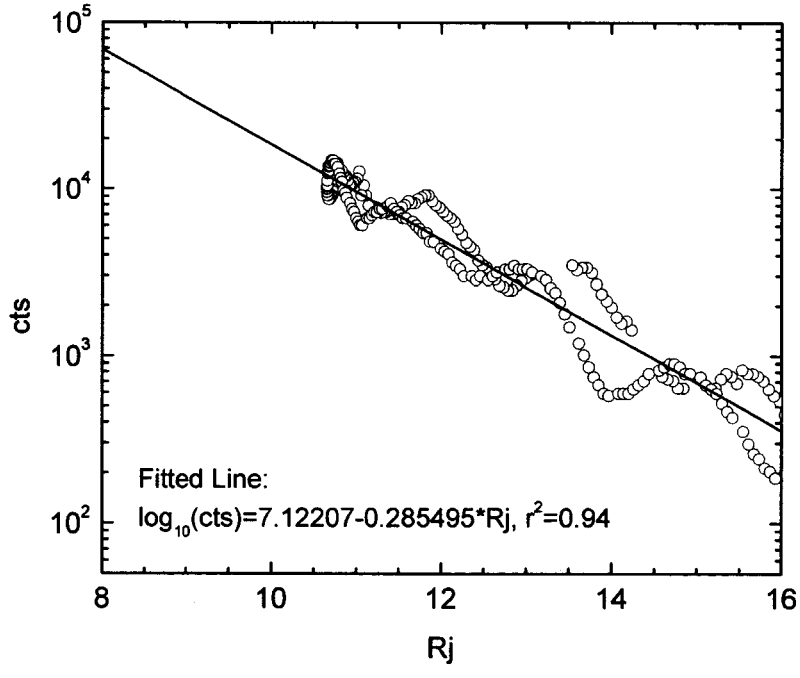
(1 Rj= 71,400 km)

Observation 1:

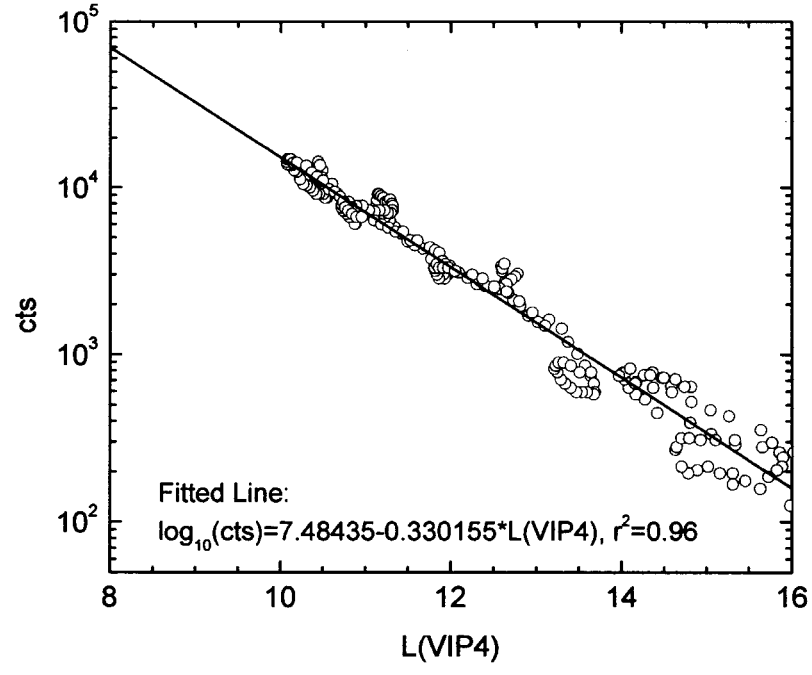
Temporal variations within an orbit (short term, ~few days) are small. Therefore, variations within an orbit are readily characterized in terms of distance from the planet, or better by the magnetic L parameter.

Example:DC3 for G2

In terms of Rj

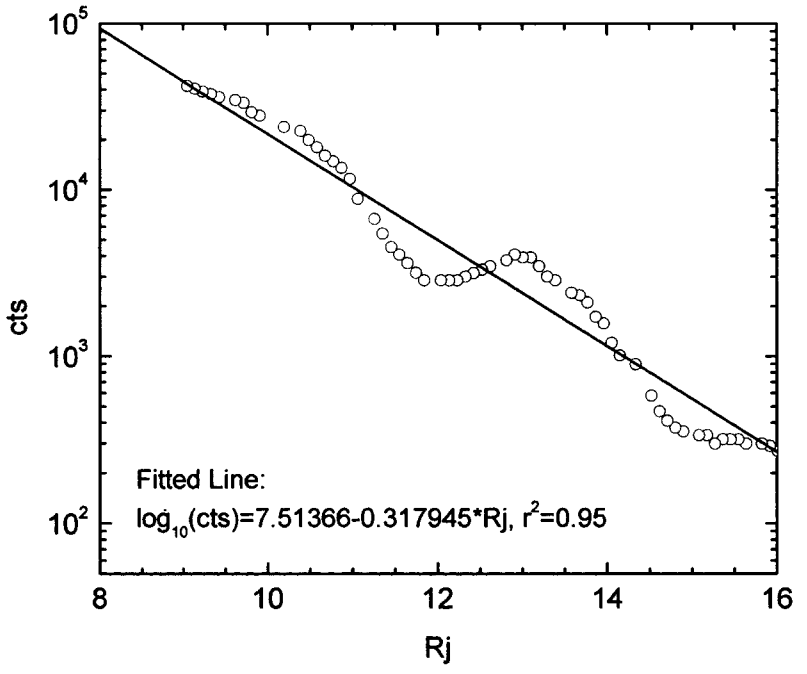


In terms of L(VIP4)

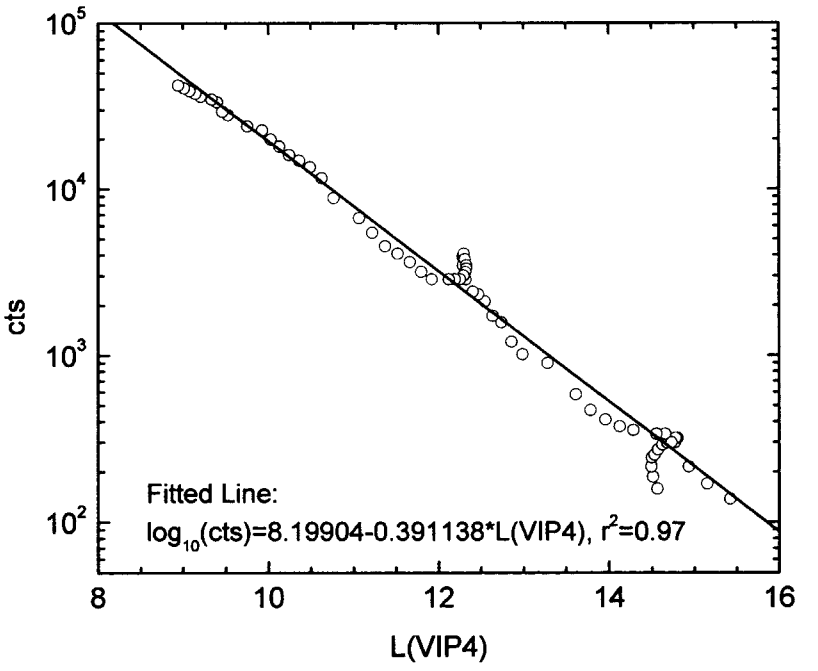


Example:DC3 for I32

In terms of Rj



In terms of L(VIP4)

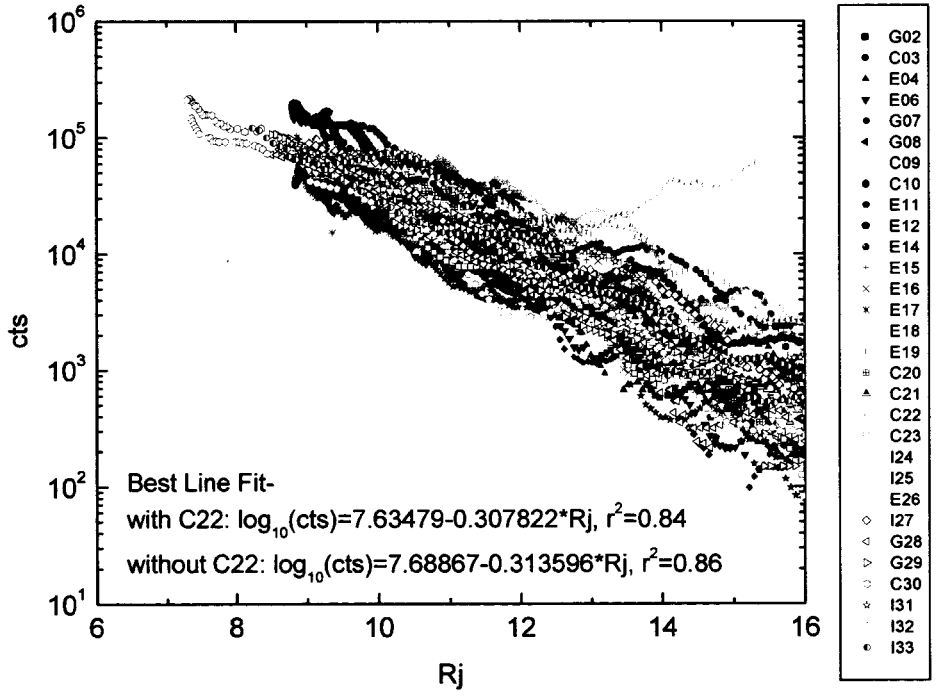


Observation 2:

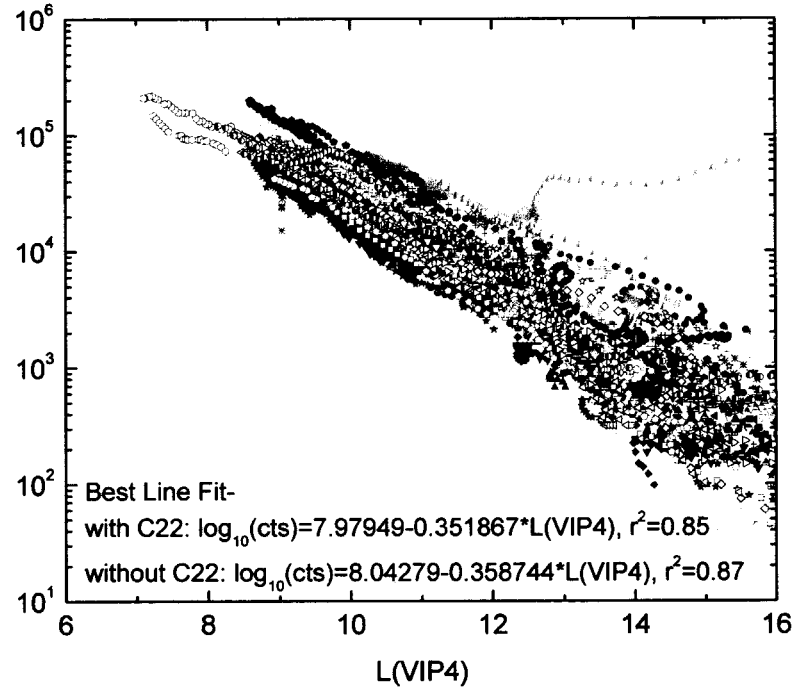
On the other hand, long term variations (>2~3 months between the orbits) can be as large as a factor of 2.

Example:DC3 from G02 to I33

In terms of Rj



In terms of L(VIP4)



Excluding C22 does not improve the overall correlation very much.

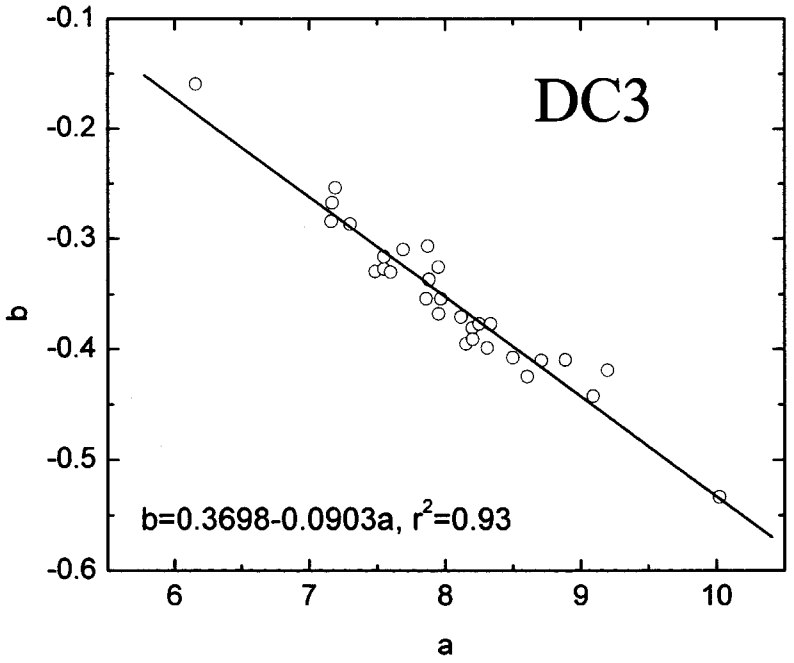
Observation 3:

Orbit-to-orbit variations appear to be explainable by a single parameter. As yet, we are not able to determine what physical phenomenon is responsible for this parameter.

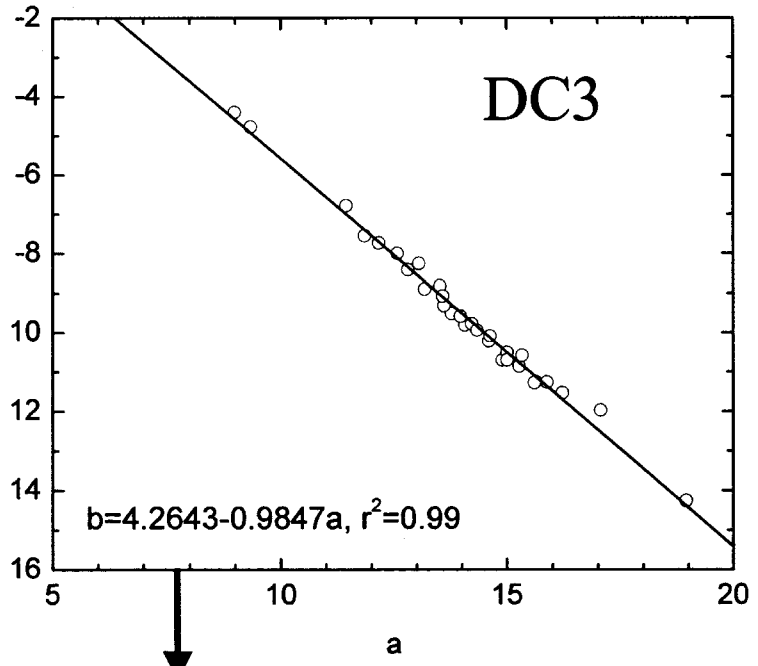
Orbit-to-Orbit Variations

For each orbit, $\log_{10}(cts)$ are linearly fitted as a function of L or $\log_{10}(L)$. Then, the fitting coefficients for each orbit are plotted against each other.

$\log_{10}(cts)=a+b*L$



$\log_{10}(cts)=a+b*\log_{10}L$

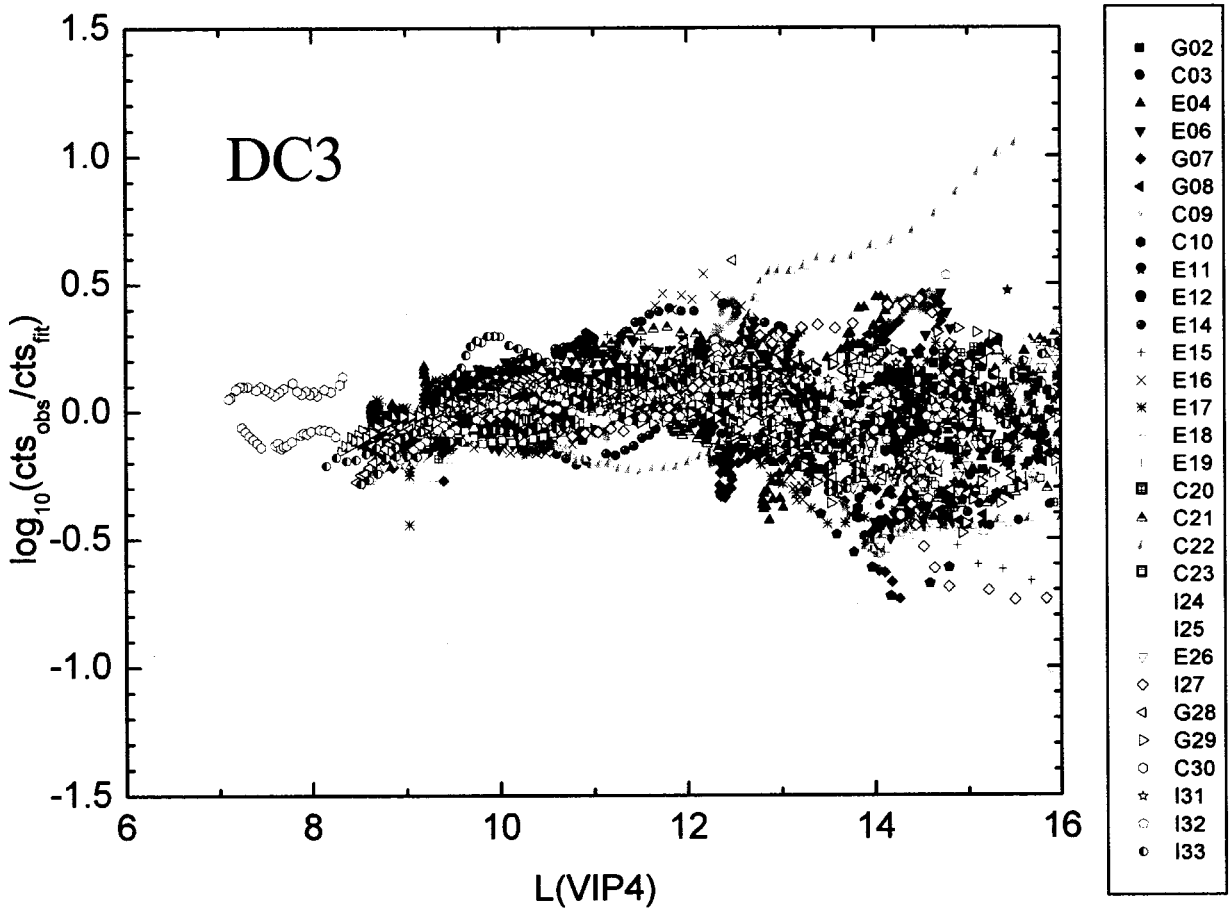


$\log_{10}(cts)$ vs. $\log_{10}(L)$ results in better correlation.

For DC3: [redacted] → [redacted] → [redacted]

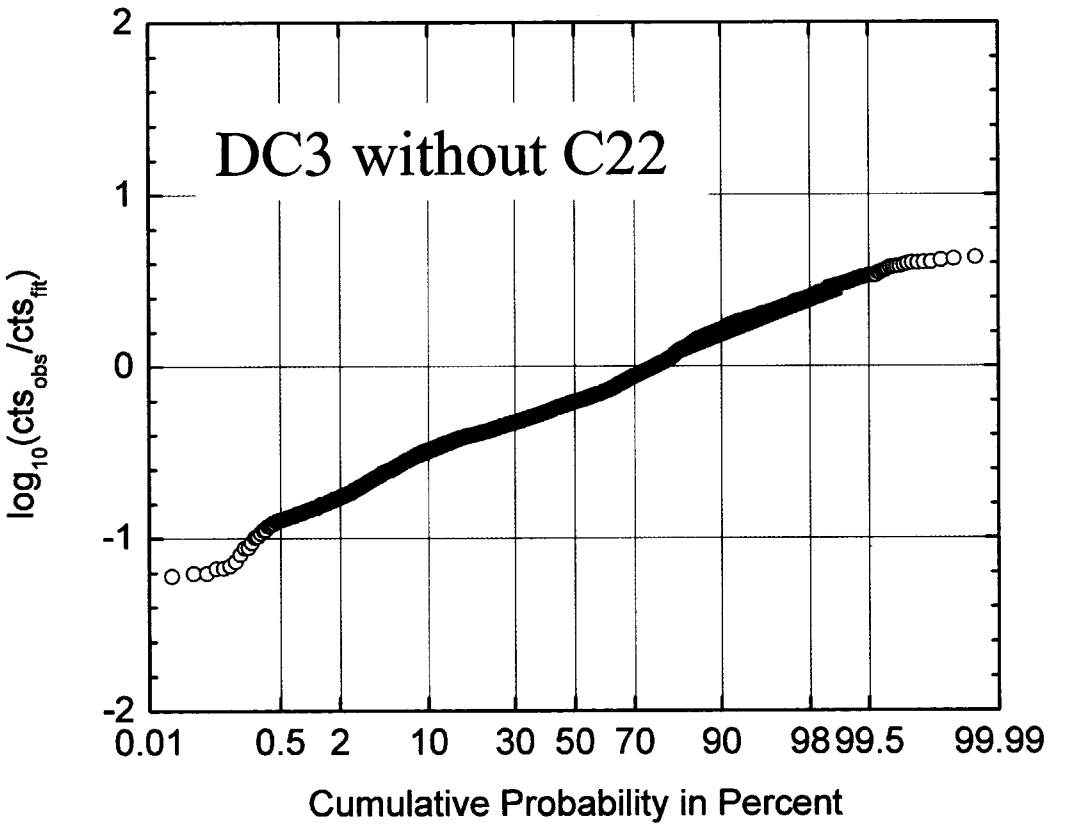
Repeat the process for other energy channels to obtain each channel's count rate mapping as a function of L, which can be fitted to obtain flux mapping as a function of L. The fact that the single quantity (i.e. a or b) can describe the high energy trapped electron environment leads us to believe that the b (or a) parameter is related to a physical quantity, which is yet to be found.

$\log_{10}(cts_{obs}/cts_{fit})$



$\log_{10}(cts_{fit})=a+b*\log_{10}(L)$, where a and b are fitting parameters for each orbit.

Log-normal Gaussian fit



The plot is prepared so that a log-normal distribution appears as a straight line

Summary

- The EPD data were successfully used to study temporal and spatial distribution of the Jovian high energy electron environment.
  - Spatial variations within an orbit are well described by the magnetic parameter L.
  - Orbit-to-orbit variations (long term or >2~3 months) seem to be explainable by the "b" (or "a") parameter and L.

Future Plan

- Search for a physical phenomenon responsible for the "b" (or "a") parameter.
- Incorporate statistical model into the GIRE average model:
  - The distribution of $\log_{10}(cts_{obs}/cts_{fit})$ for DC3 follows Gaussian.
  - We can develop a GIRE statistical model using a method similar to Feynman's solar proton model.