



# The Cassini Enceladus encounters in the view of energetic particles



<sup>1</sup>N. Krupp, <sup>1</sup>E. Roussos, <sup>3</sup>G.H. Jones, <sup>2</sup>D.G. Mitchell, <sup>2</sup>S.M. Krimigis, <sup>4</sup>K.K. Khurana, <sup>1</sup>P. Kollmann, <sup>5,6</sup>R. Srama, <sup>5</sup>S. Kempf, <sup>2</sup>A. Rymer, <sup>3</sup>C. Arridge, <sup>1</sup>A. Lagg

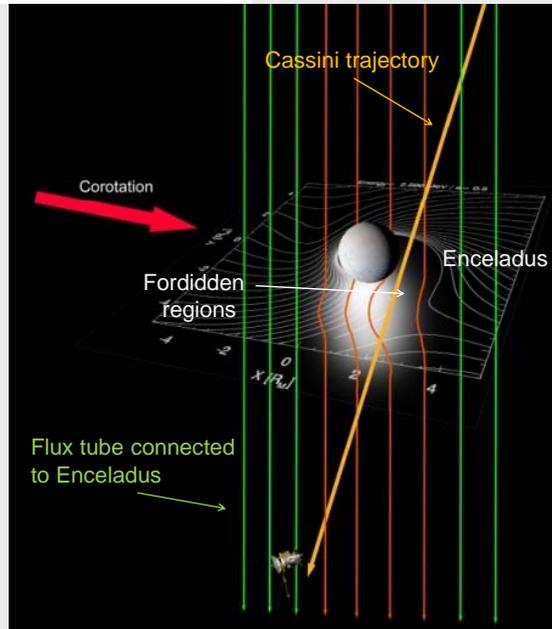
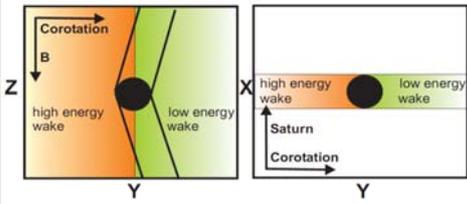
1 MPS, 2 JHUAPL, 3 MSSL, 4 UCLA, 5 MPI-K, 6 University of Stuttgart

## Introduction

- Cassini flew by the moon Enceladus six times. This moon is embedded in Saturn's radiation belts.
- The particle spectrometer MIMI/LEMMS performed detailed measurements during those flybys.
- Absorption signatures in the intensity of energetic electrons bouncing along field lines connecting the moon with the spacecraft indicate clearly the interaction between the material released from the moon and the magnetosphere.

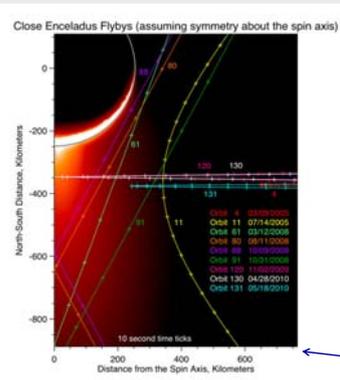
## Magnetospheric interaction between particles and moons

- The charged particle population drifts and corotates with the planet perpendicular to the magnetic field direction.
- Electrons and ions drift in opposite directions while the corotation is independent on energy and charge sign.
- Dependent on the energy a high-energy and a low-energy wake around the moon is formed.



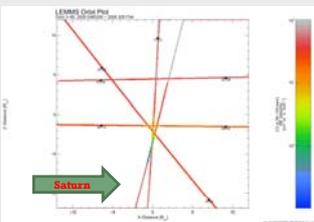
## Observations

- close flybys of Cassini at Enceladus between 2005 and 2008
- Enc 1 (equatorial flyby)
- Enc 2, 3, 4, 5, 6 (high latitude flybys)

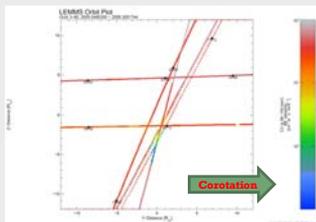


E0, 2005.048  
 E1, 2005.068  
 E2, 2005.195  
 E3, 2008.072  
 E4, 2008.224  
 E5, 2008.283  
 E6, 2008.305

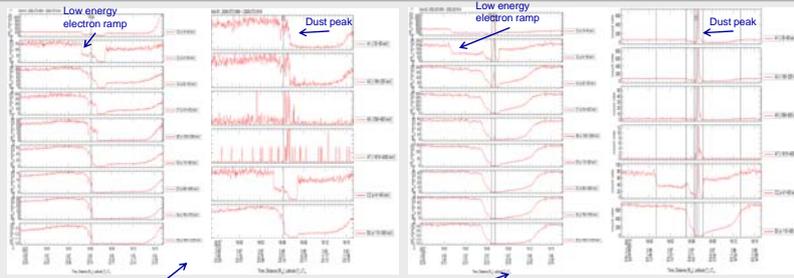
Trajectory of Cassini during the Enceladus close flybys



Enceladus-centered plane containing the direction of the planet and rotation axis. The various lines show the Cassini paths close to Enceladus. Color-coded are the electron intensities measured by MIMI/LEMMS.

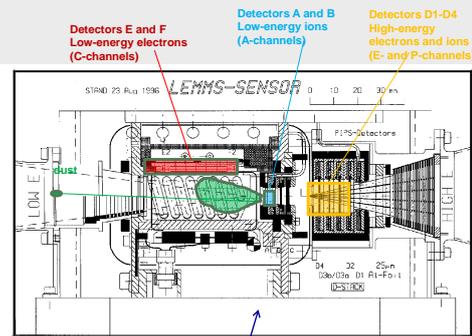
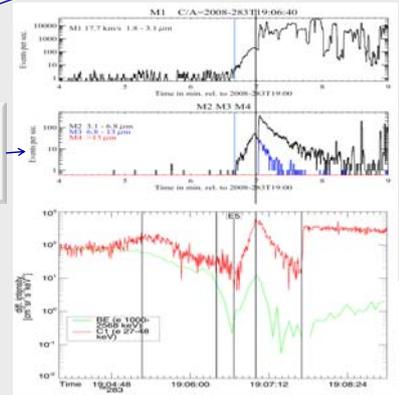


Enceladus-centered plane containing the corotation direction and rotation axis of the planet. The various lines show the Cassini paths close to Enceladus. Color-coded are the electron intensities measured by MIMI/LEMMS.



Observation of energetic electrons and ions as measured by MIMI/LEMMS during polar Enceladus flybys 3 (left two panels) and 5 (right two panels). On both flybys a low-energy electron ramp and a dust peak have been observed.

Electron measurements from MIMI/LEMMS (bottom panel) together with CDA dust measurements (upper two panels). It is clearly visible that the MIMI/LEMMS peak correlates with the CDA dust peak (M2 3.1-6.8 μm).



Detector MIMI/LEMMS cutaway. Incoming dust through the low-energy aperture can create a plasma cloud on detectors A and B detectable by the E and F electron detectors. Dust through the high-energy end is not detectable in the D- detectors of MIMI/LEMMS.

## Results and Conclusions

- Features in the data indicated that the spacecraft was connected to the plume material along field lines way before the entrance into the high density region.
- Energetic particle absorption upstream (high-energy electrons) and downstream (low-energy electrons) from Enceladus.
- Abrupt absorption signature  $4 R_{enc}$  during Enc 3 and  $24 R_{enc}$  during Enc 5 from the moon in low-energy electron intensities (18-92 keV) → might be related to the first magnetic connection with the plume, blocking particles along their bounce motion
- During the close flybys Enc 4 and Enc 5 a peak in electron and ion intensities near the center of the plume was observed in addition
- Peak near center of the plume in **low-energy** electrons during Enc 3 and 5 correlates with Dust
- Some of the absorption signatures can be explained by "forbidden regions" in particle motion with field gradients and perturbed flow around the moon