The PLANETOCOSMICS Geant4 application

L. Desorgher
Physikalisches Institut, University of Bern

Outline

Description of the code
Simulation results for the Earth + validation
Simulation results for Mars
Simulation results for Mercury
First results for Jupiter and Europa

Motivation to model the interactions of energetic particles with planets

- Atmosphere ionisation
- Sputtering of atmosphere and surface
- Production of cosmogenic nuclides
- Measurements of the soil composition

- Quantify the radiation environment of planets
  - Albedo, CRAND process
  - Dose for aircrew and space mission
  - Dose vs depth in soil

GEANT4 Monte Carlo Toolkit

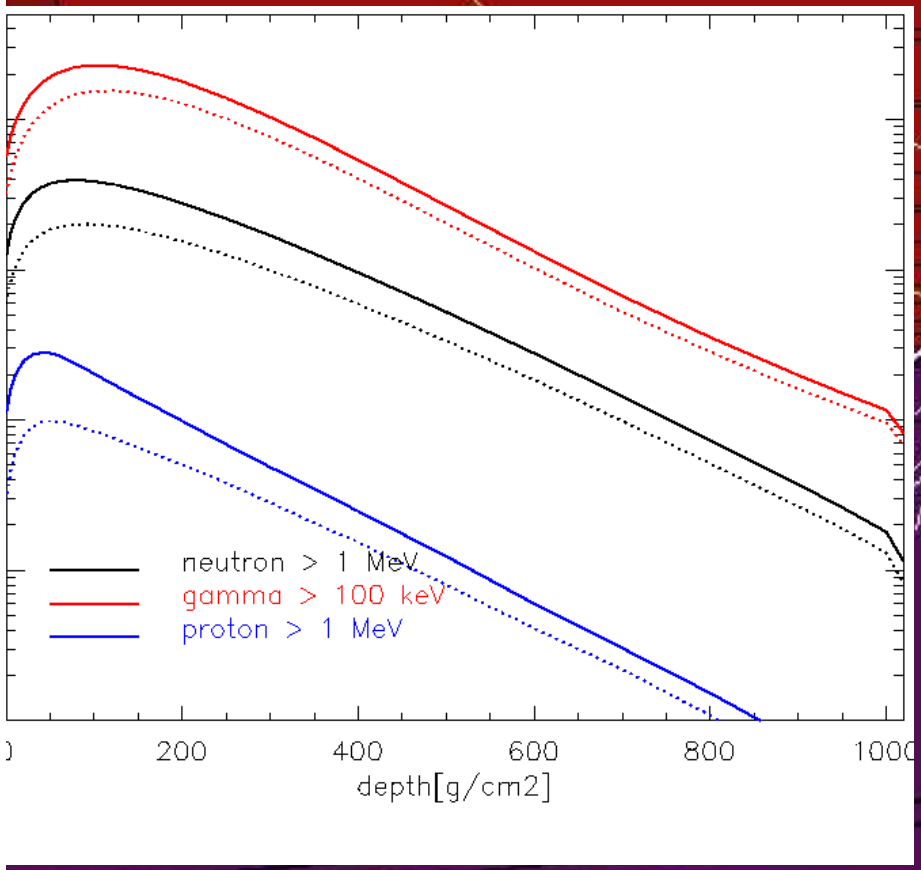
C++ library for computing by Monte Carlo simulation the electromagnetic and hadronic interactions of energetic particles (250 eV -10 TeV) with matter.

Effect of the magnetic and electric fields can be taken into account

Developed by a world-wide collaboration of physicists

PLANETOCOSMICS GEANT4 Application

Interaction of energetic particles with Planet Atmospheres and



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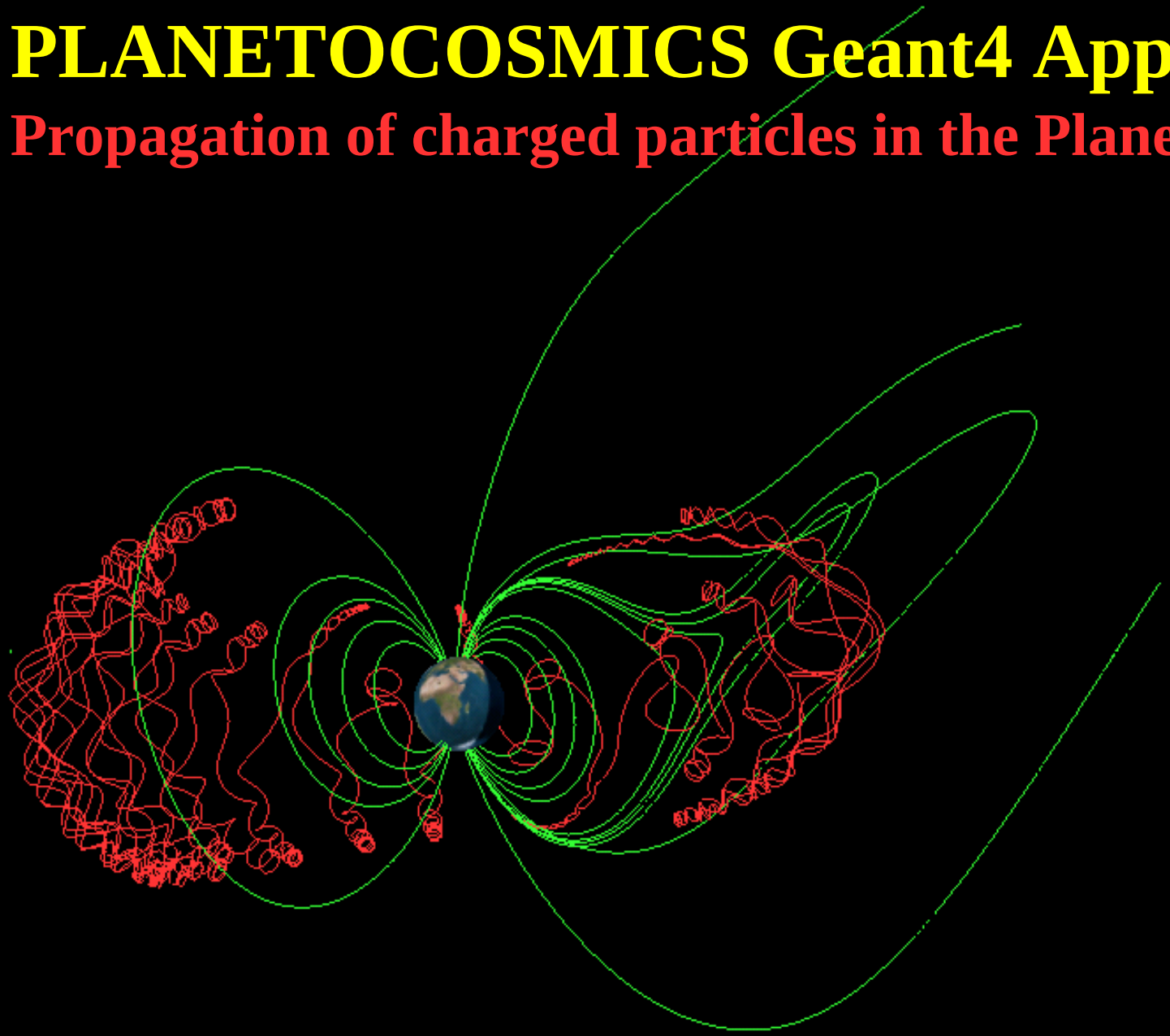
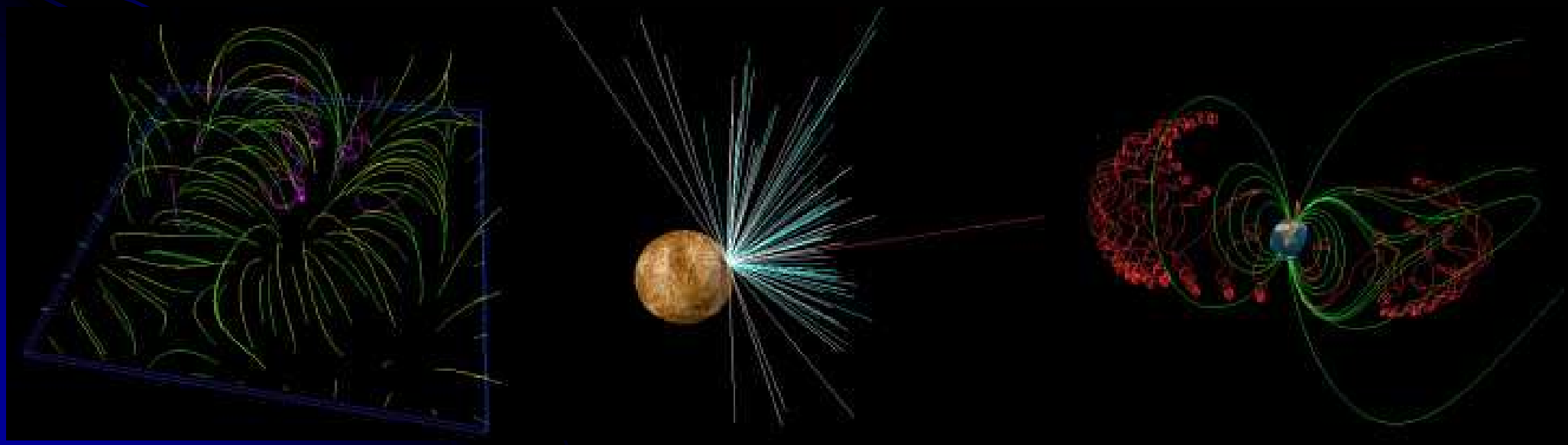
Propagation of charged particles in the Planet Magnetosphere

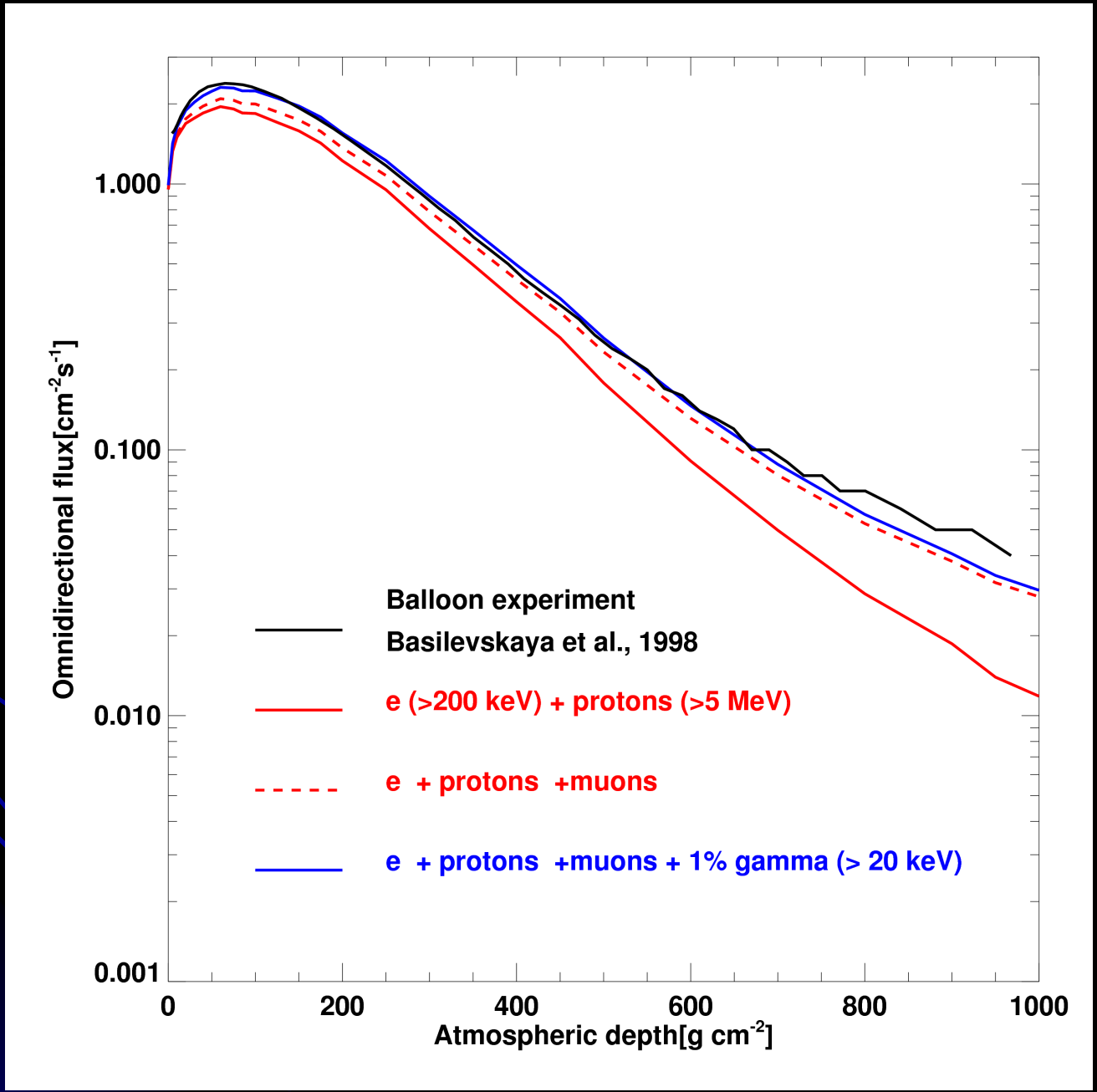


PLANETOCOSMICS

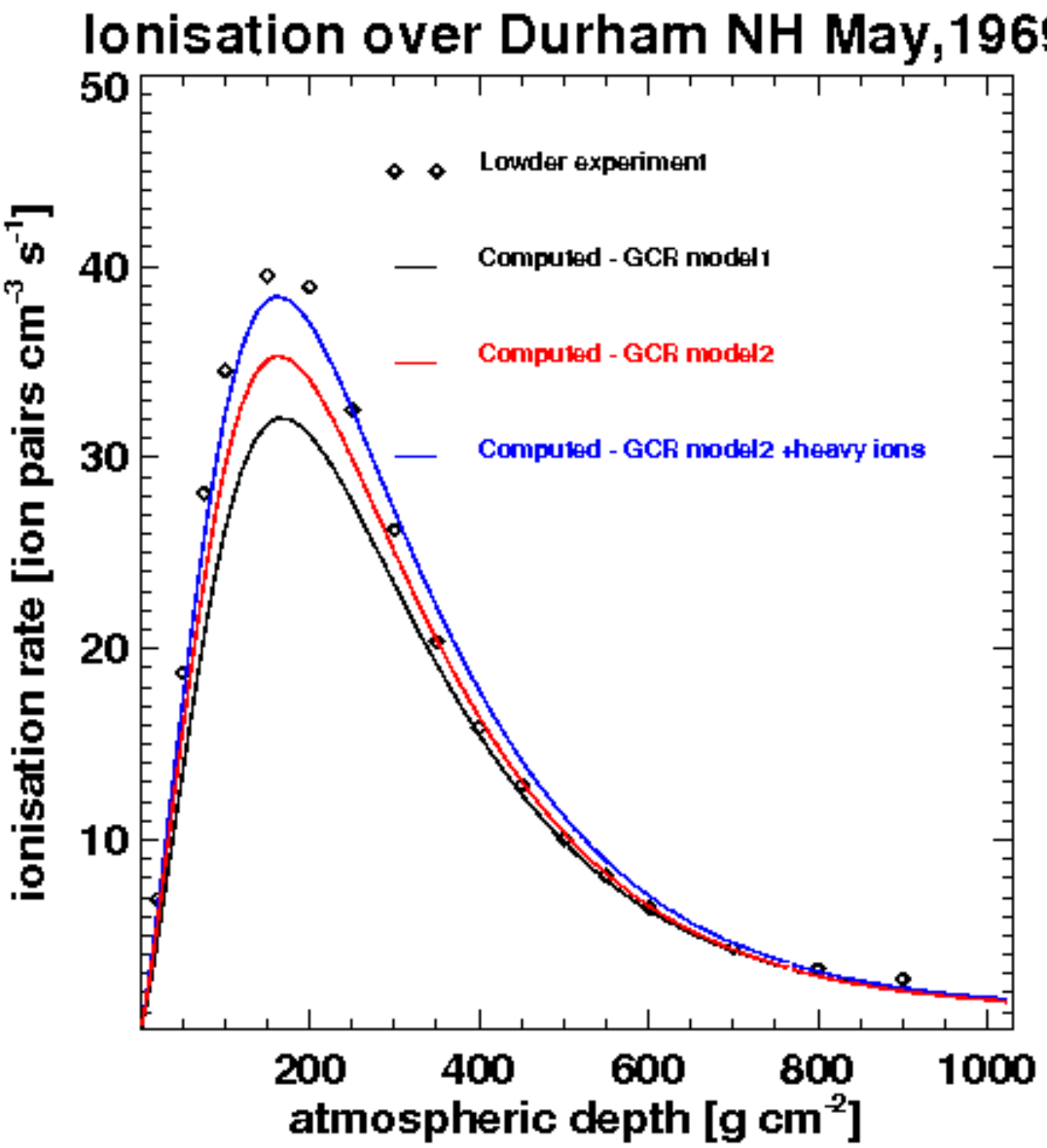
- Interaction of energetic particles with Earth, Mars, Mercury
- Fluxes of secondary particles at user defined altitudes atmospheric depths, and soil depths
- Energy deposited vs atmospheric depth and vs soil depth
- Propagation in magnetic field
- Different coordinate system relative to planets
- Visualisation of particle trajectories and field lines



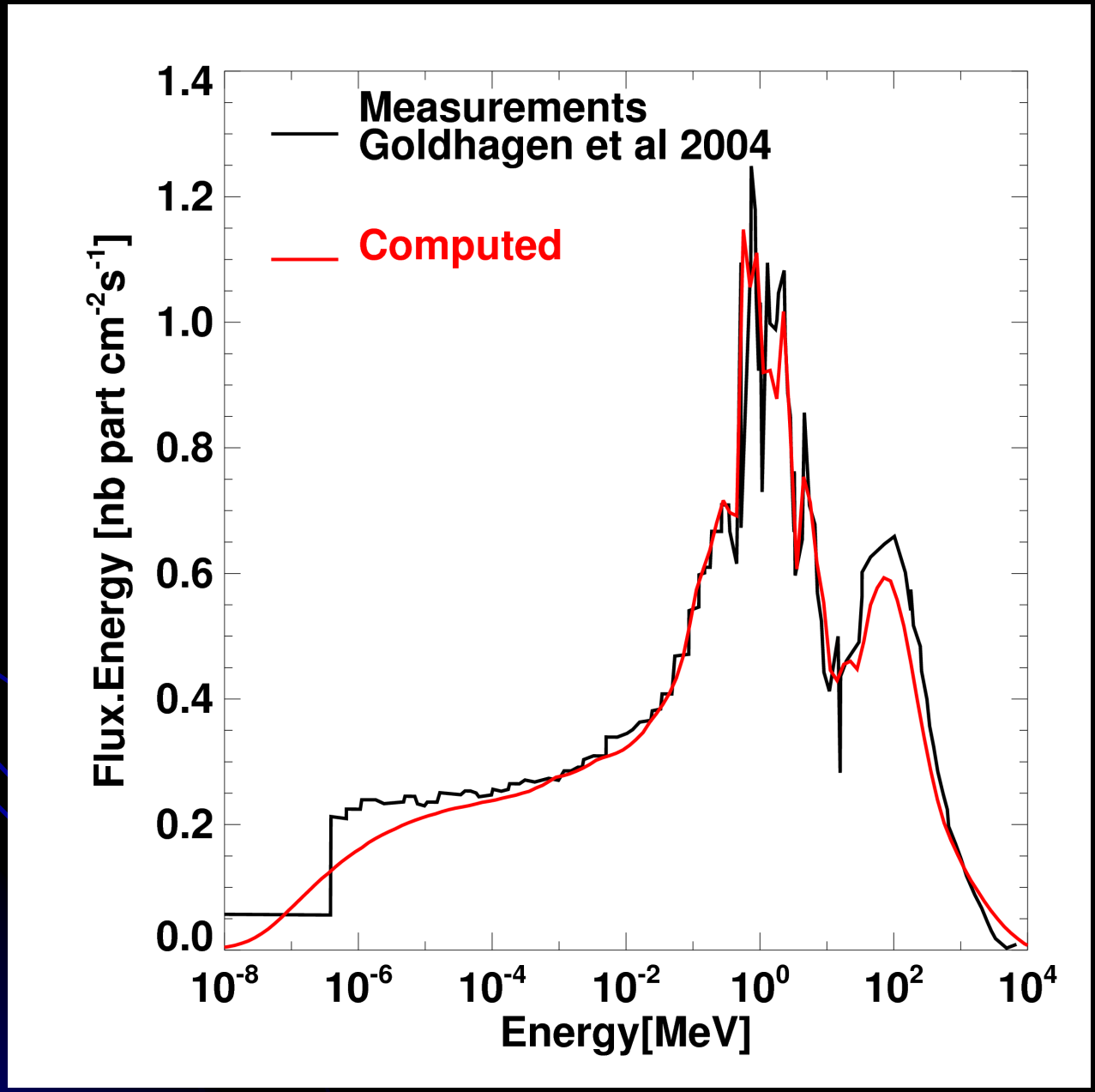
Flux of ionising particles over Moscow in 2000



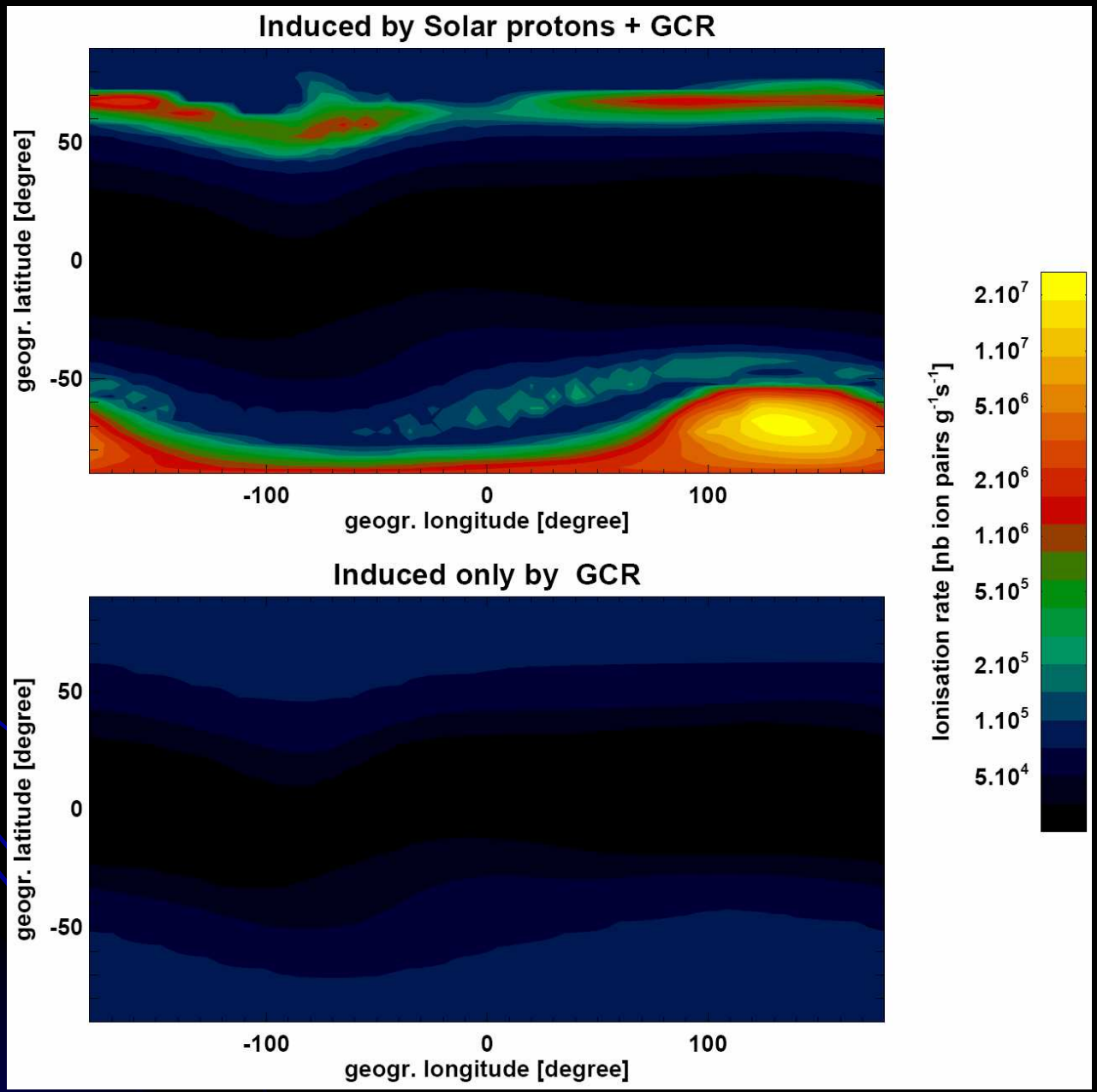
Atmosphere ionisation induced by GCR



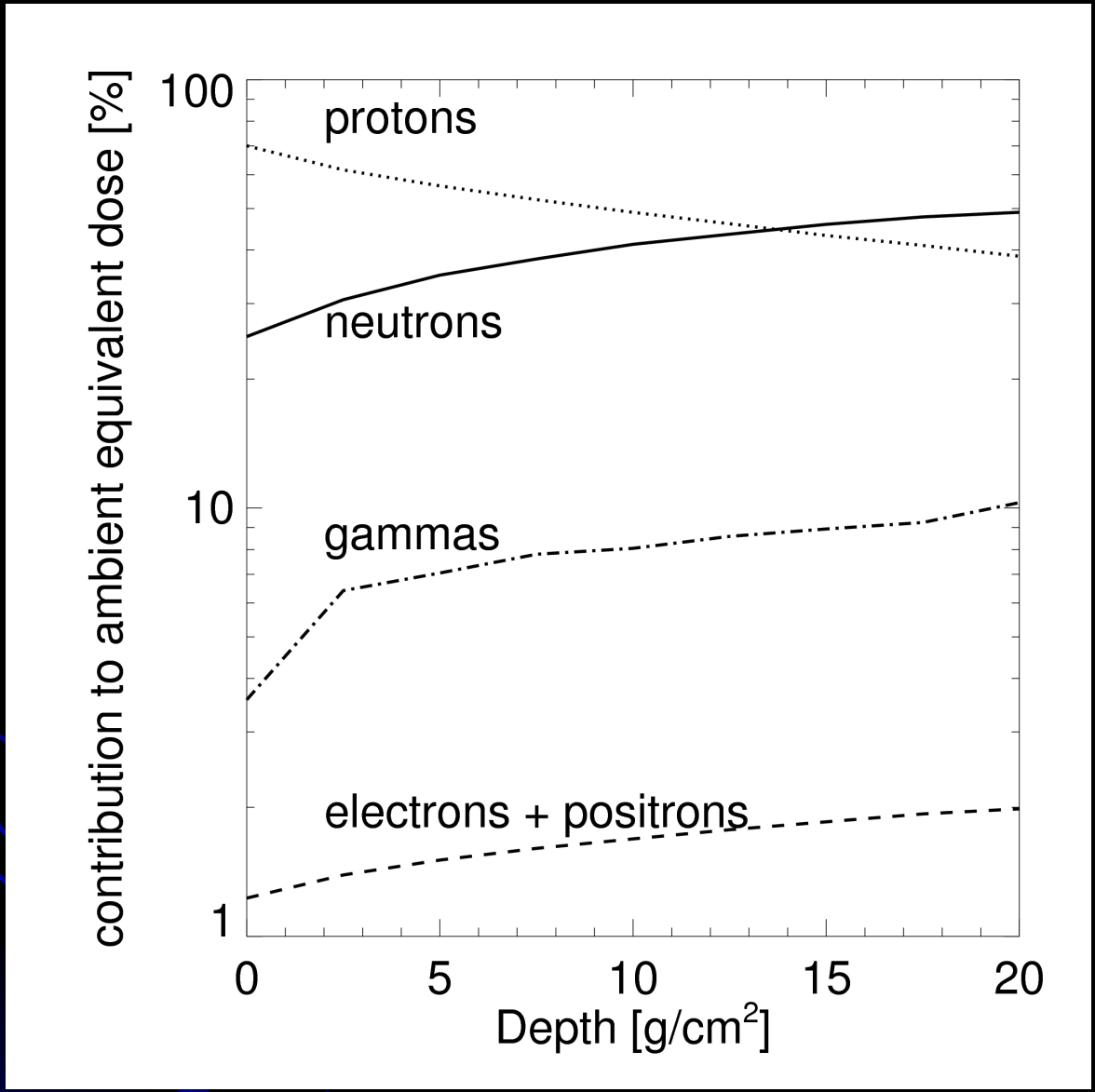
Neutron flux at 56 g cm^{-2} R_c =0.8 GV in June 1997



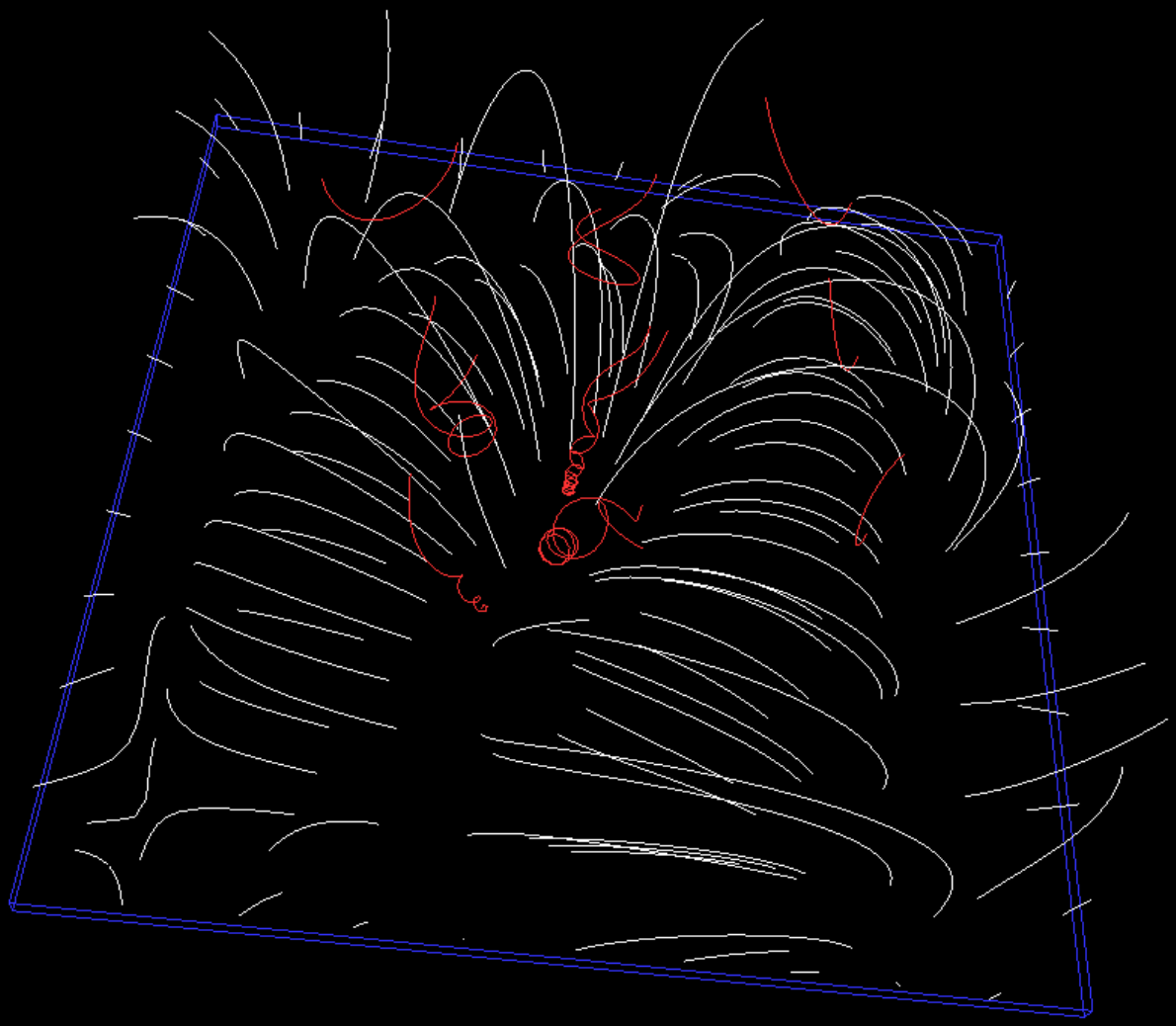
Atmospheric ionisation at 300 g cm^{-2} at 06:57 on January 20th , 2005



Contribution of different particle types to Ambient equivalent dose on Mars



10 MeV e^- in the most magnetized region of Mars

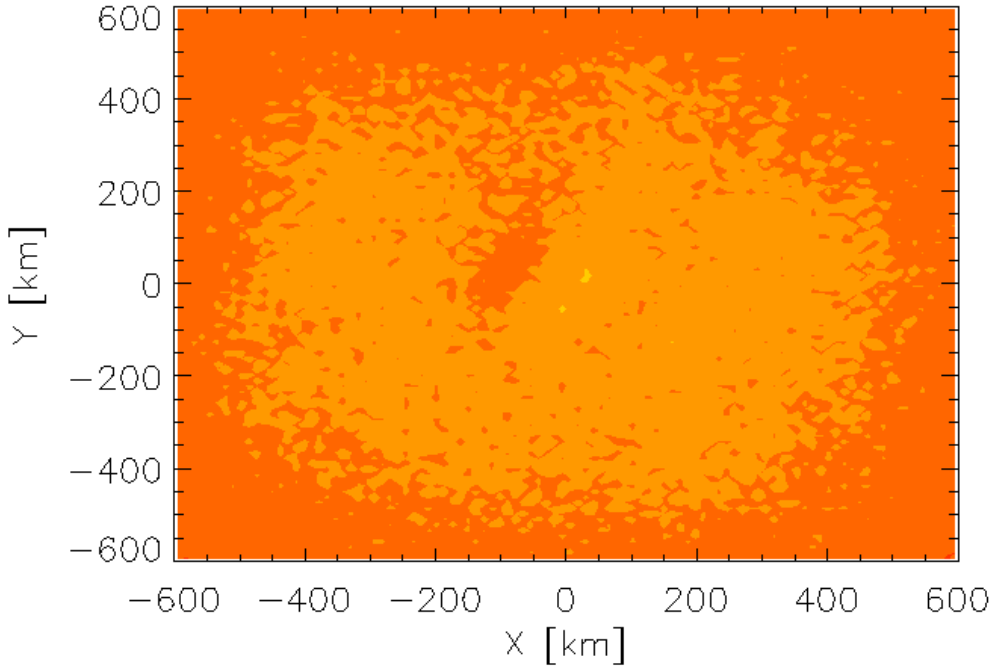


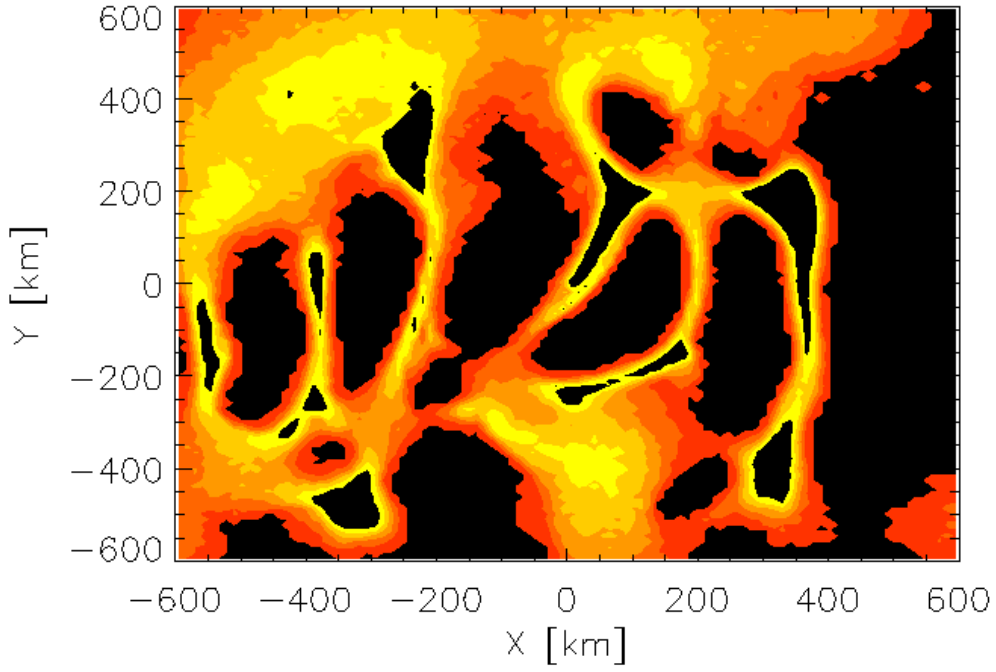
Magnetic shielding on Mars at -47.8 N and 174 E

Tracking of 10^7 downward mono-energetic particles starting at 300 km altitude

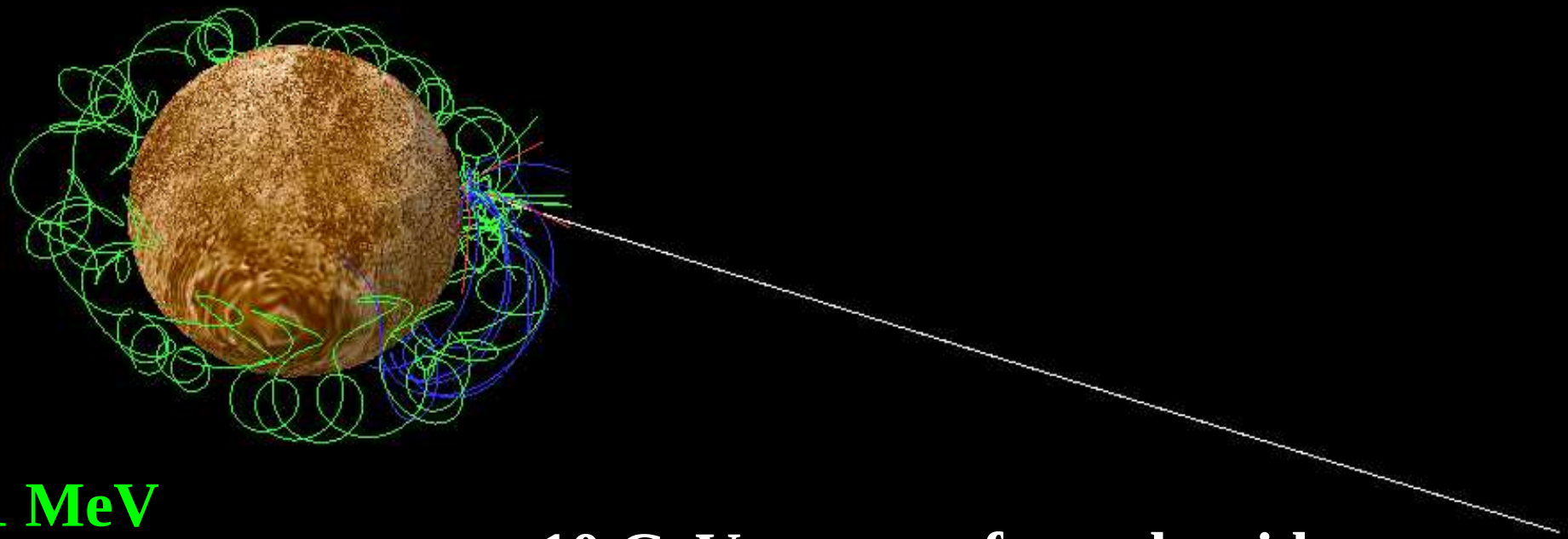
Detection of number of particles that hits the ground in function of position

10 MeV protons **10 MeV e^-**





Mercury Soil + Dipole B0= 300 nT



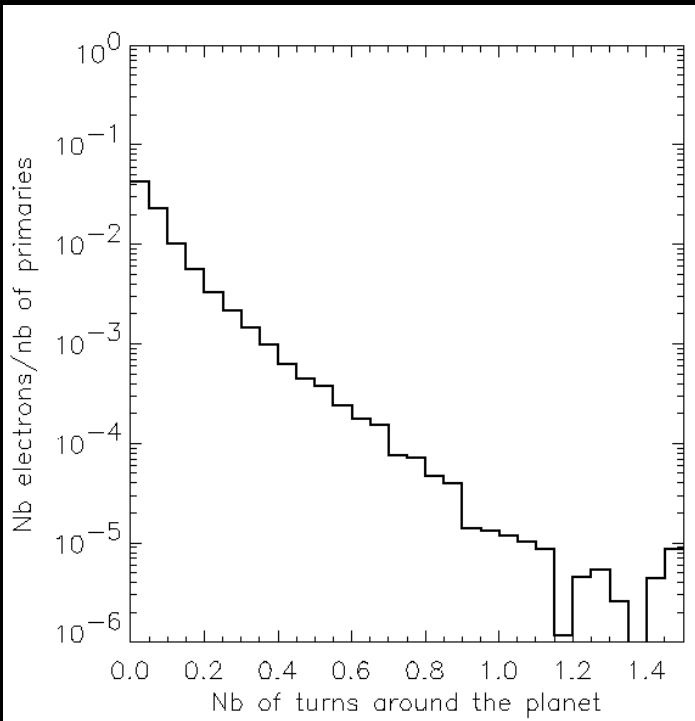
e- >1 MeV

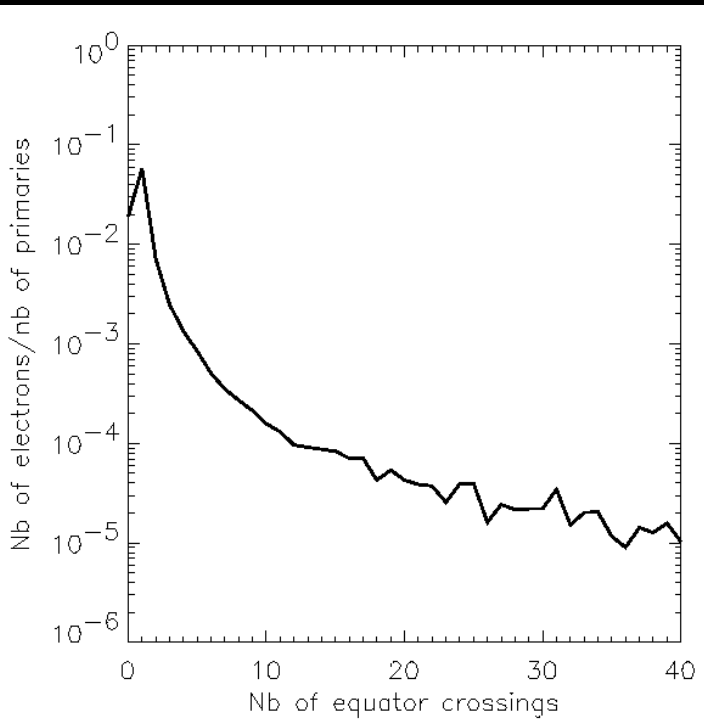
e+ > 1 MeV

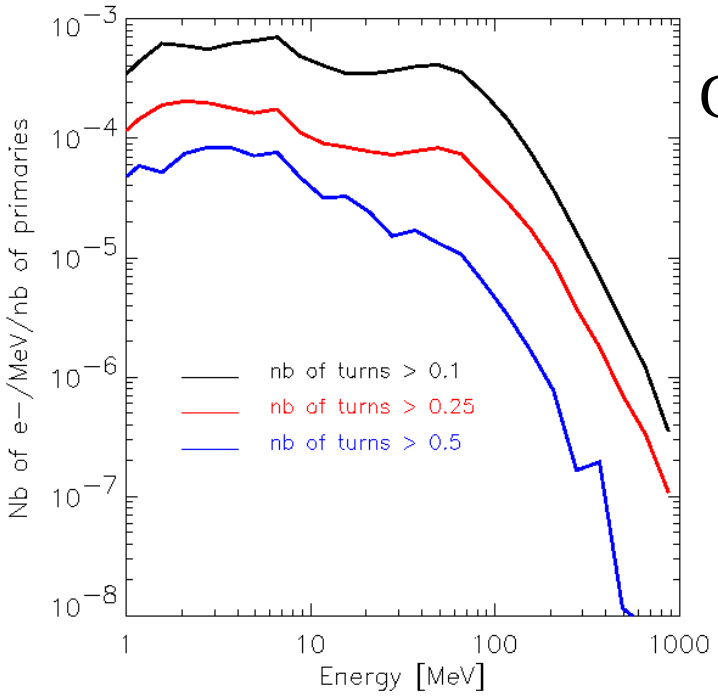
proton > 10 MeV

10 GeV protons from dayside

Quasi trapped e^- in Mercury dipole

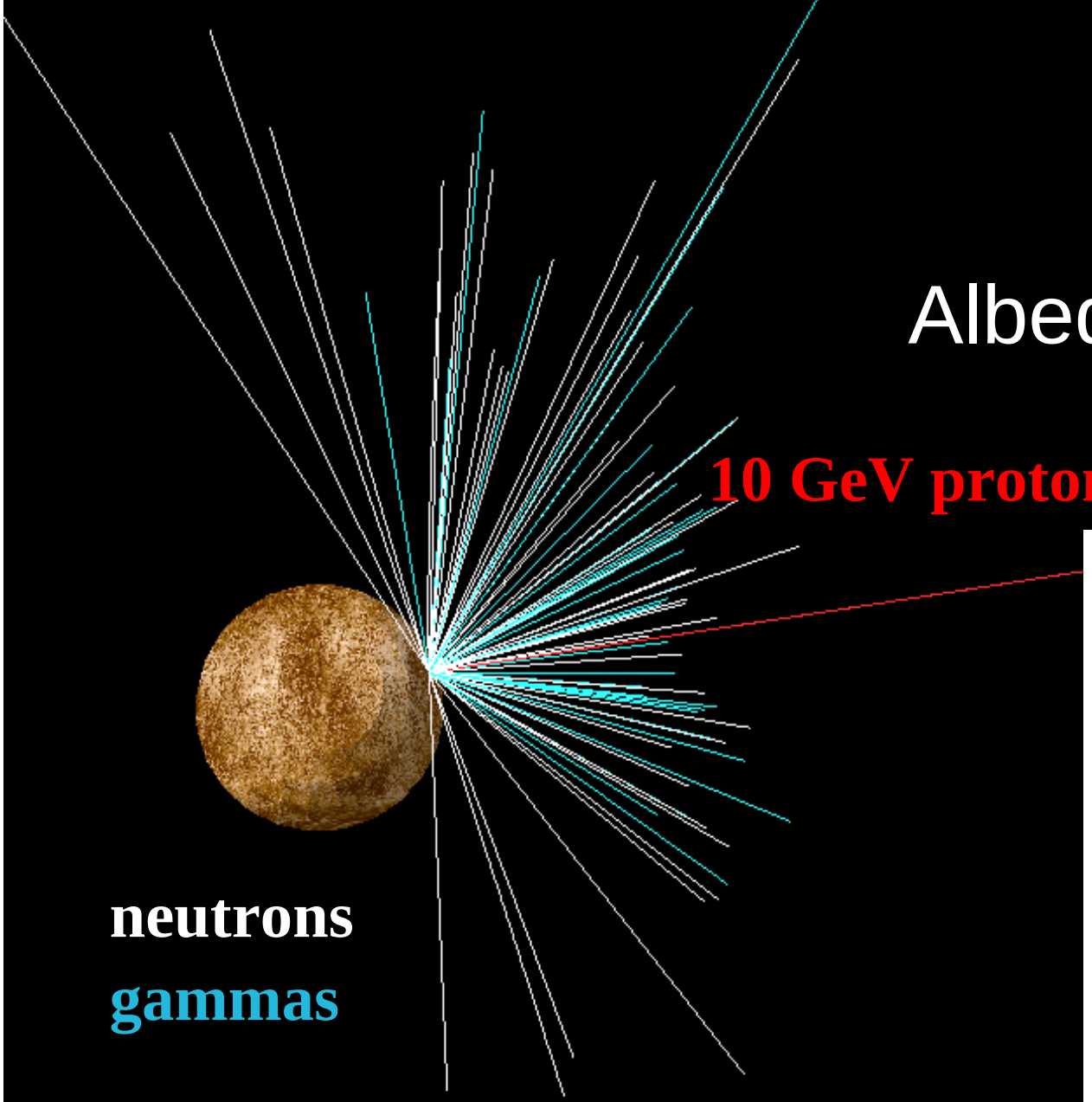


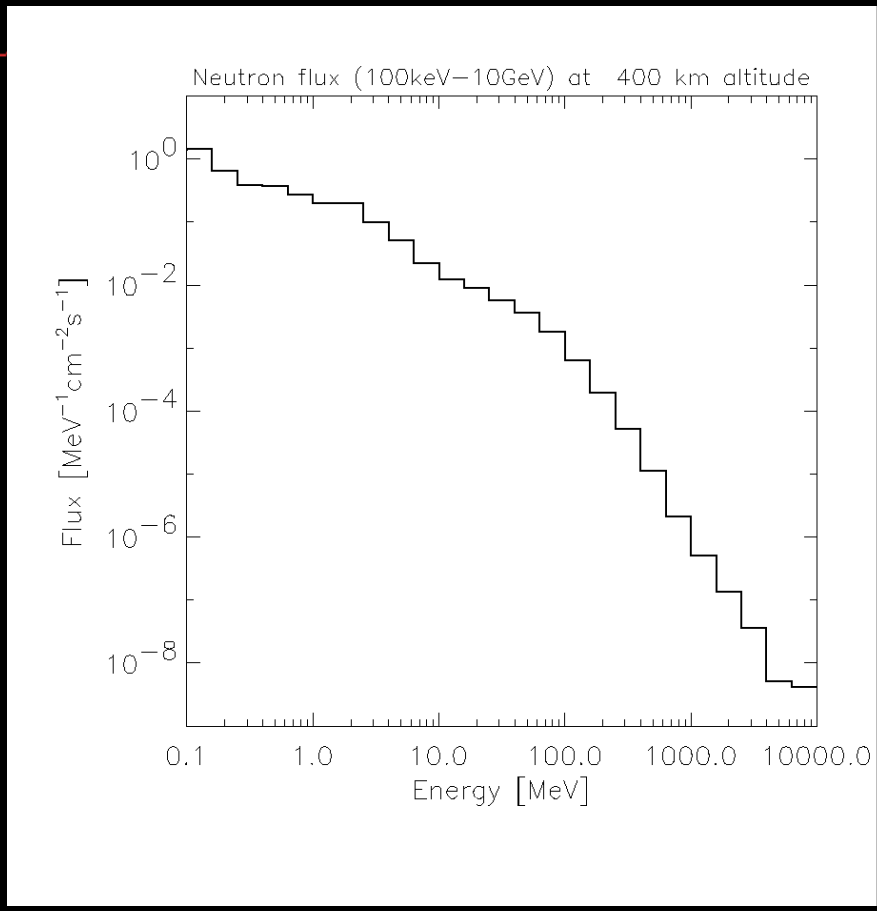




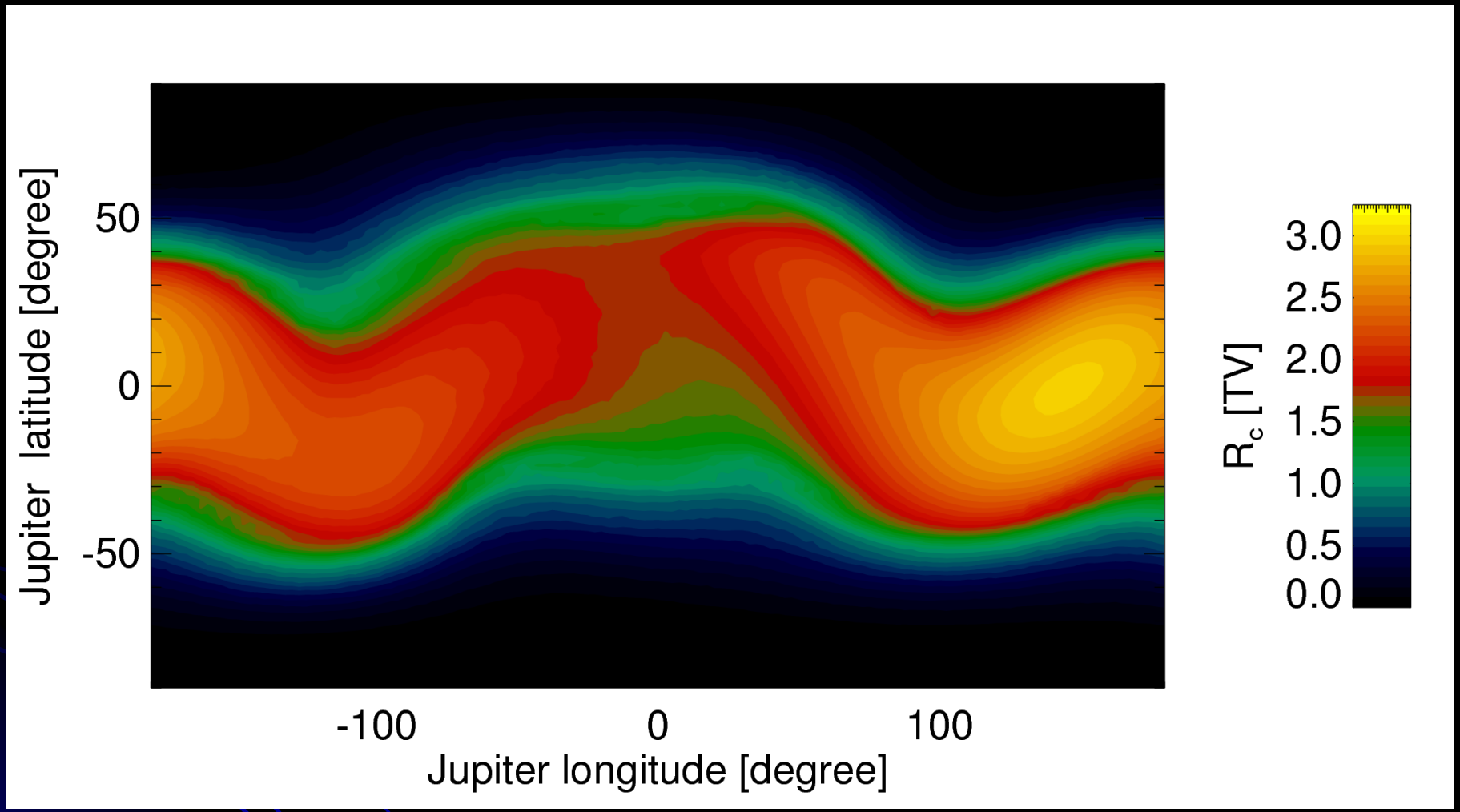
Gurtner et al, 2006

Albedo Neutral radiation

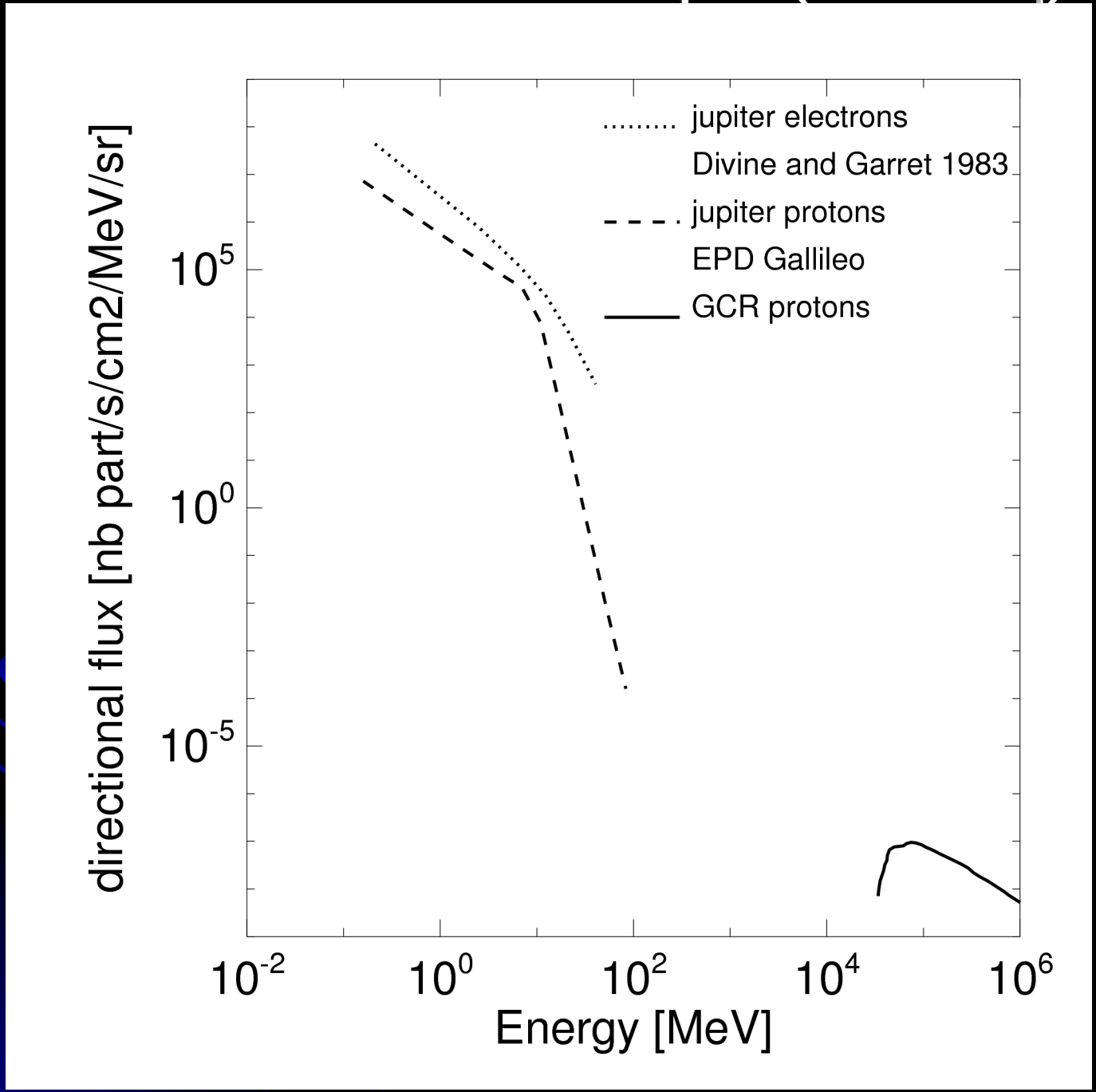




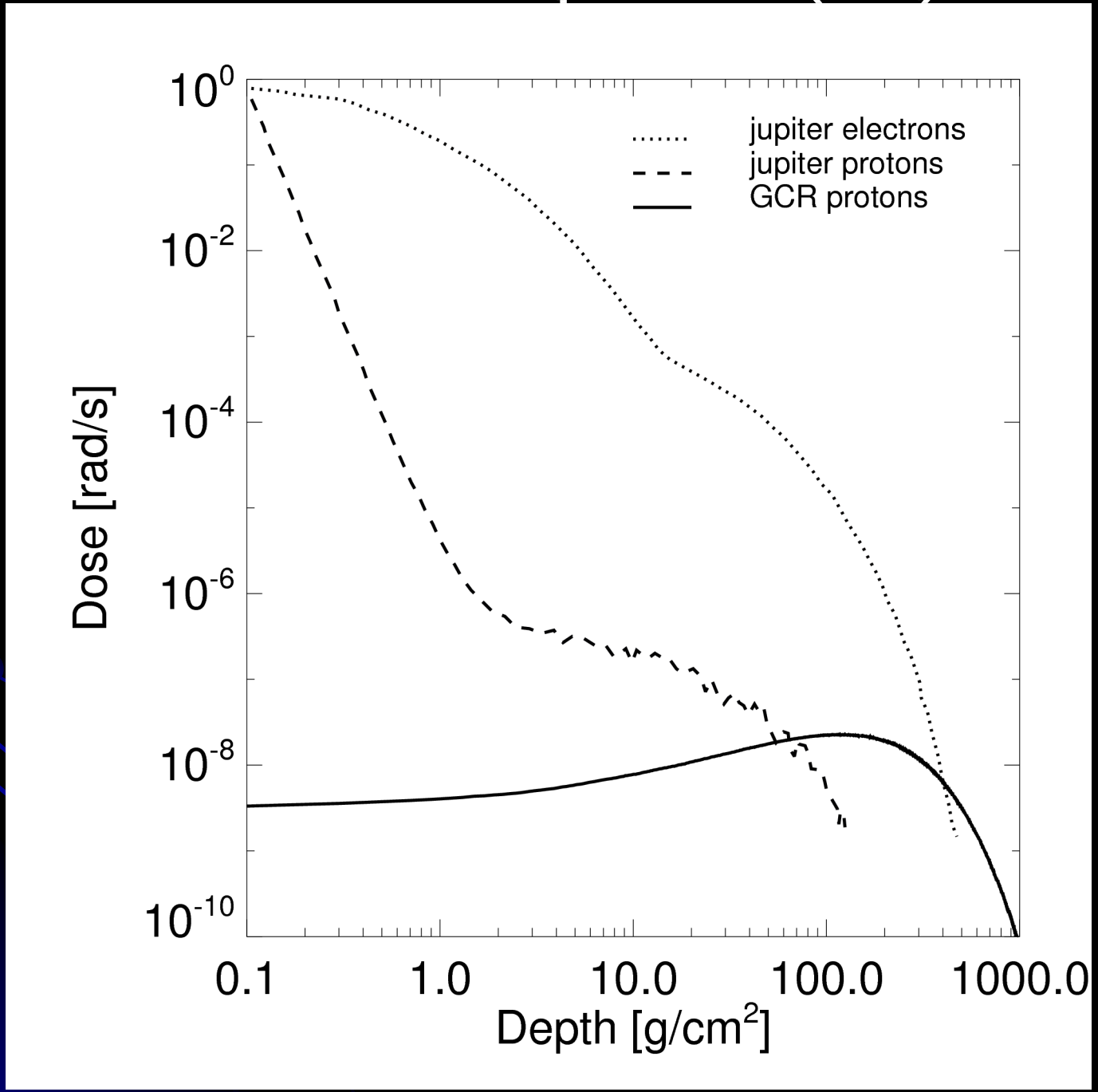
Effective Vertical Cut-off Rigidity at Jupiter



Radiations at Europa (~9.4 R_j)



Dose in Europa soil (ice)



More informations on

cosray.unibe.ch/~laurent/planetocosmics