



GEANT4 in ESA





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Space Environments and Effects Section

GEANT4 in ESA


- General comments
- ISS Columbus: DESIRE project
- Tool and application development
- Radiation monitoring
- Mars radiation environment modelling
- L2 Science Missions
- Ongoing and planned R&D activities




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GEANT4 in ESA: General Comments

- ESA has been a member of the GEANT4 Collaboration since 1998, and a formal Signatory of the GEANT4 Collaboration Agreement since end of 2005
- GEANT4 and its auxiliary space tools are used extensively for ESA mission support in various application domains (Science, Exploration, Telecom, Navigation, component and environment analyses...)
- ESA internal manpower is rather limited for direct GEANT4 kernel developments (see presentation on GRAS and other developments by Giovanni Santini)
- Instead, most of the R&D is carried out via collaborations and contracts with European Academia and Industry: BIRA (B), DH Consultancy (B), CSR (B), Univ. Bern (CH), SpaceIT (CH), Univ. Geneva (CH), eta max(D), Univ. Cologne (D), Univ. Kiel (D), INTA (E), IN2P3 (F), ONERA (F), TRAD (F), HIP (FIN), INFN (I), Alenia Spazio (I), KTH Stockholm (S), LIP (P), QinetiQ (UK), Imperial College (UK), Univ. Southampton (UK), CERN, ...
- GEANT4 Space Users' Workshops are an important venue for exchange of ideas and information on the latest developments in the space domain worldwide



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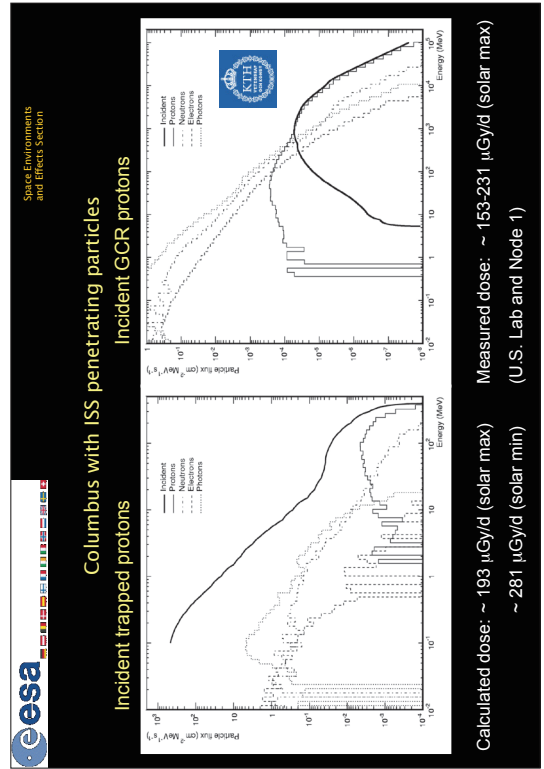
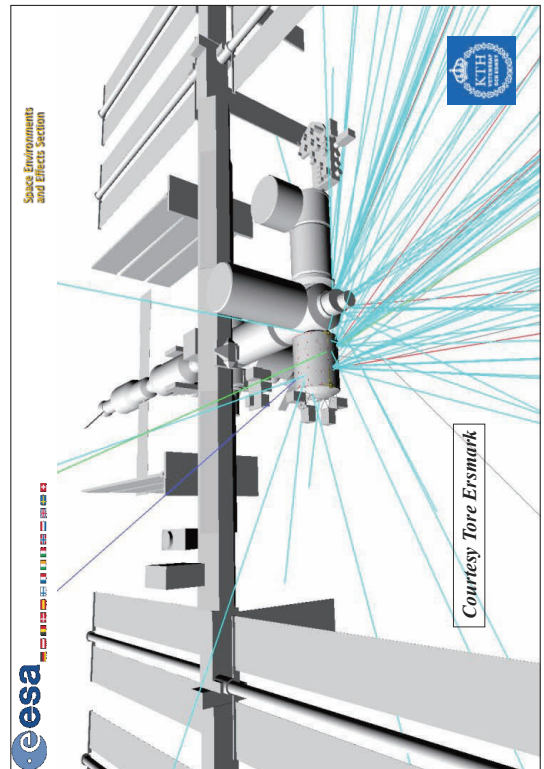
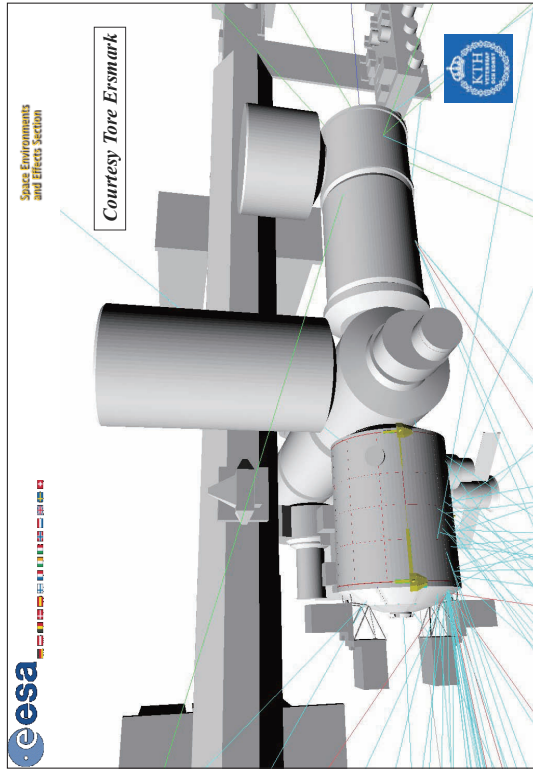
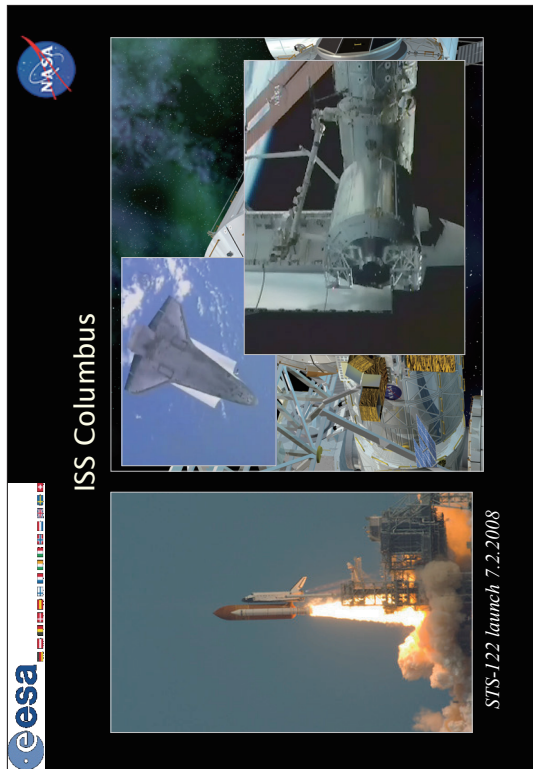
DESIRE

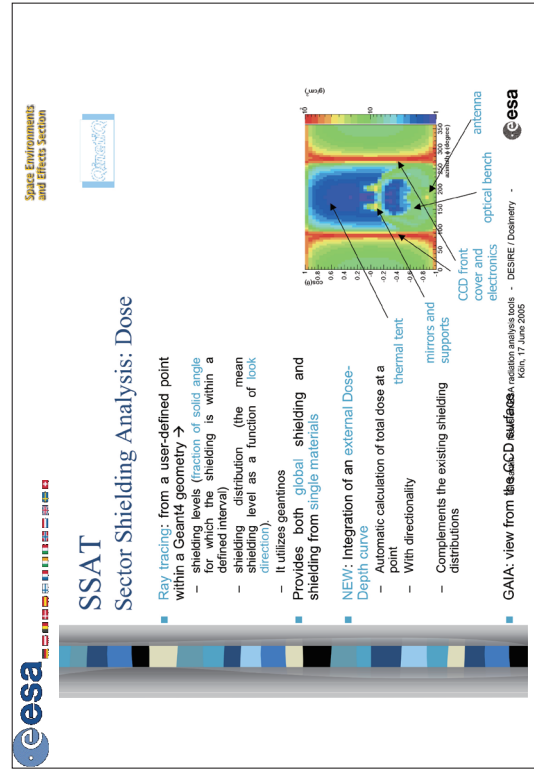
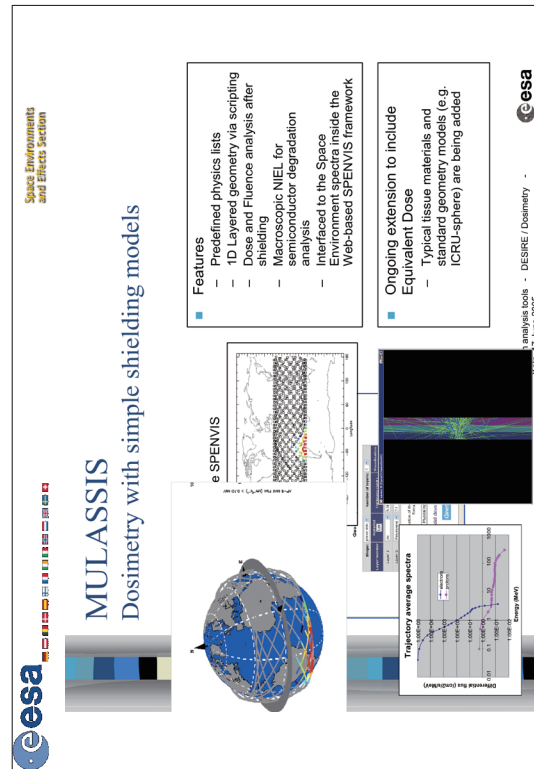
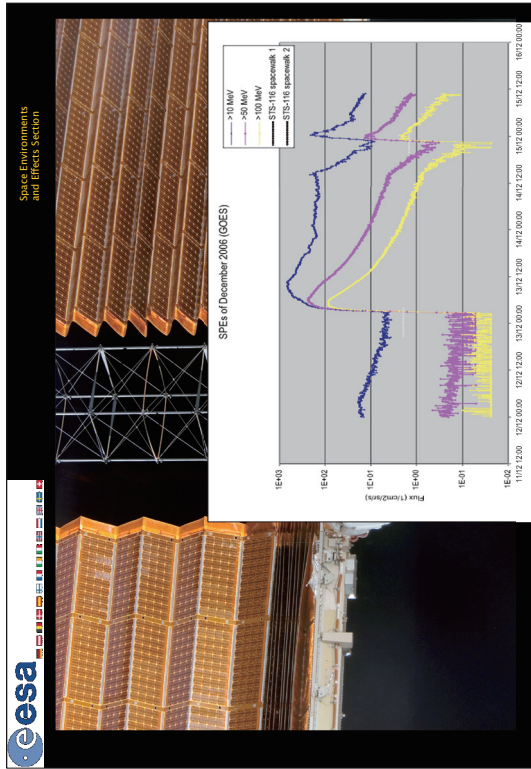
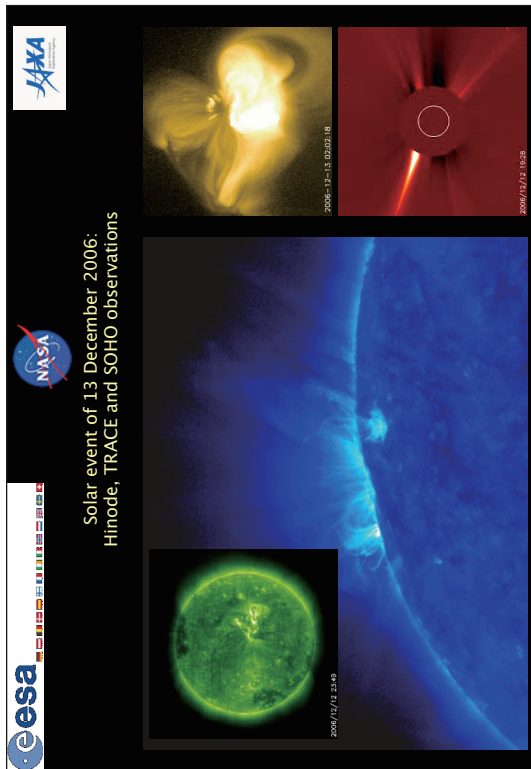
Dose Estimation by Simulation of the ISS Radiation Environment

<http://www.particle.kth.se/desire/>

Courtesy Tore Ersmark

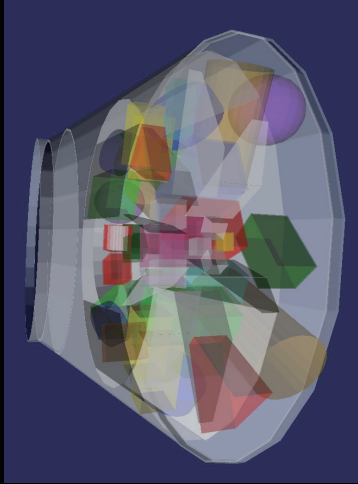




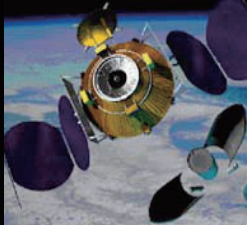


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ConeXpress



GEANT4 modelling by R. Lindberg, ESA/ESTEC (TEC-EES)

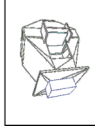


Electric propulsion to GEO, rendezvous with client spacecraft

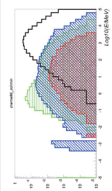
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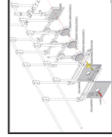
GRAS Geant4 Radiation Analysis for Space

- Detector / Component effects
 - Dose, Fluence, NIEL, ... for support to activation and scientific design
- Human dosimetry
 - Dose Equivalent, Equivalent Dose, ... for ESA exploration initiative
- Ready-To-Use tool
 - Different analyses types without re-compilation
- 3D geometry
 - GDML format, or existing C++ class, ...
- Full Geant4 physics

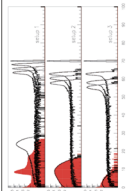


JWST
- Big rate during quiet time and solar events

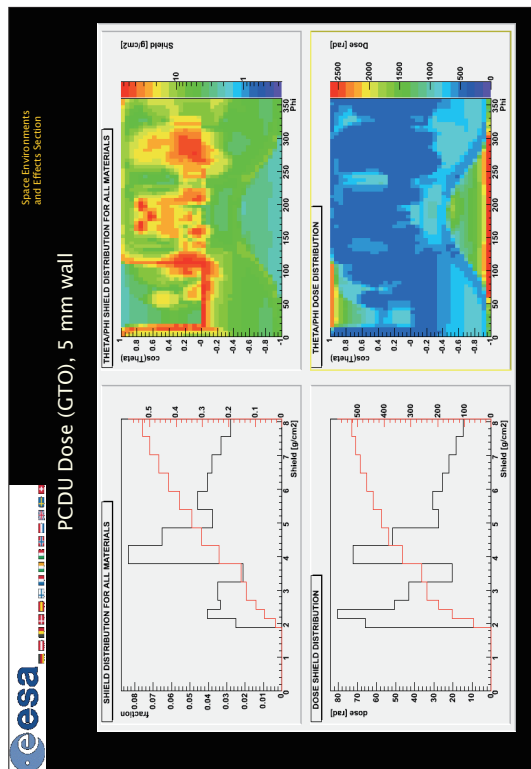
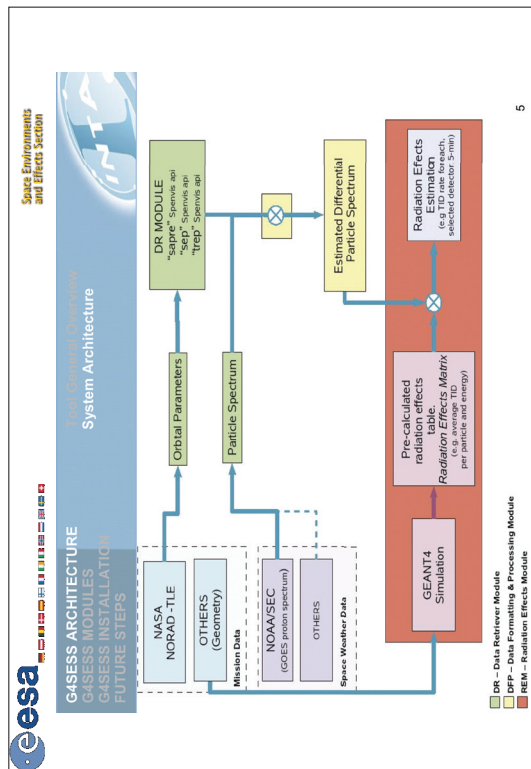


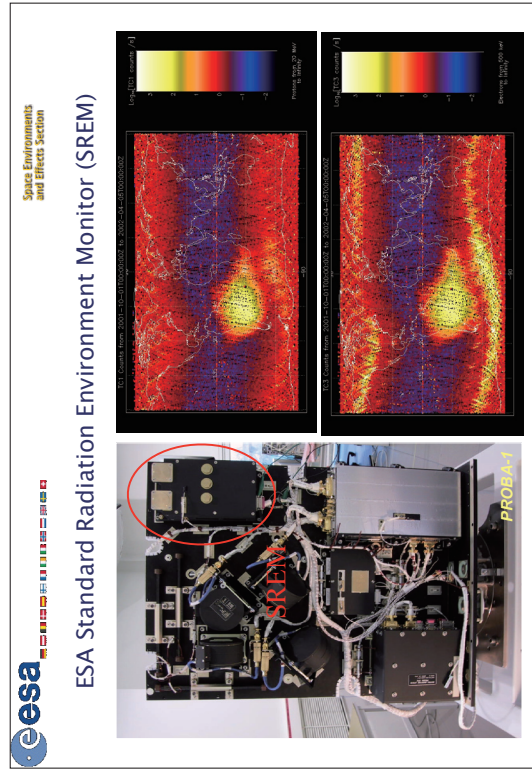
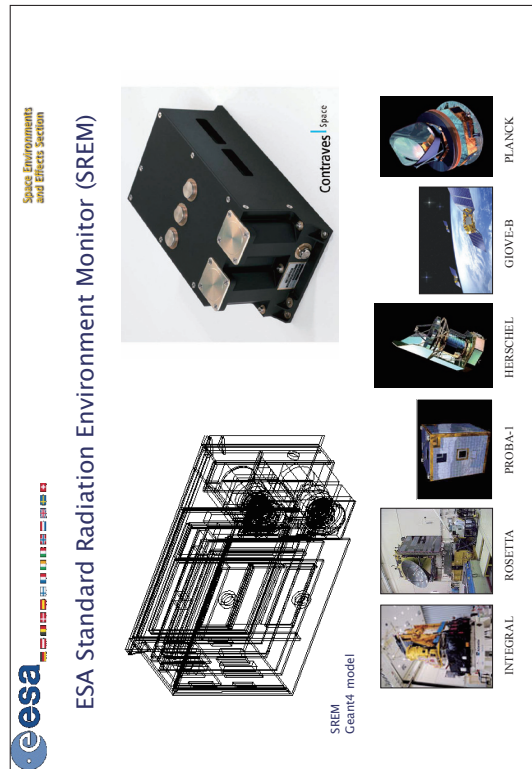
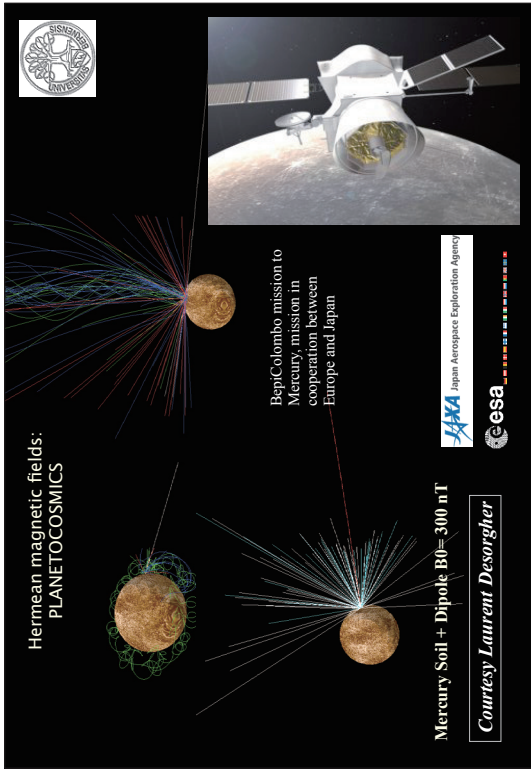
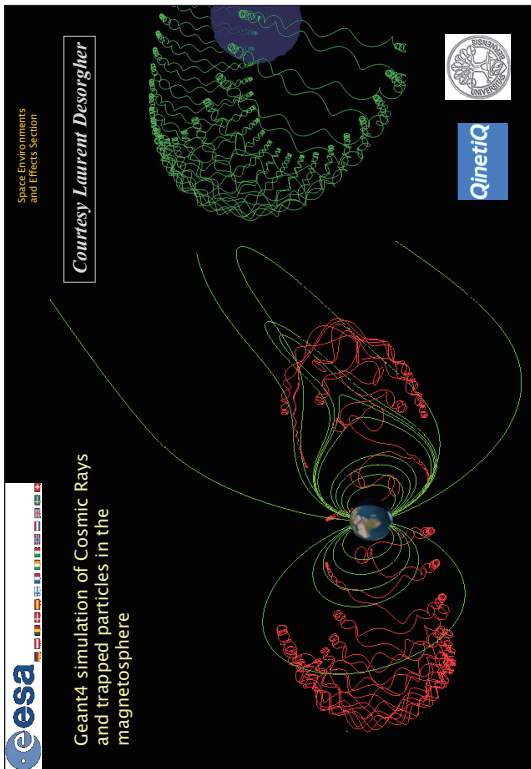


Herschel
- PACS photoconductor left beam



G. Samin - News on ESA radiation analysis tools - DESIRE/ Dosimetry - Köln, 17 June 2005





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Issues for Mars:

- SPE and GCR fluxes at 1.5 AU
- Broad range of altitudes
- Seasonal, diurnal and local variations of atmospheric pressure
- For UV and X rays: dust storms
- Surface backscattering and neutrons ⇒ local geology
- Local magnetic fields in the southern hemisphere

Terby crater as seen by Mars Express

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Altitude → Surface pressure variations

Image credit: G. Neukum, FU Berlin, Germany

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Aim

- * Merge and extending MarsREC & Mars-Planetocentric models for the Mars, Phobos and Deimos, including treatment of surface topology and composition, subsurface, atmospheric composition and density (including diurnal and annual variations), and local magnetic fields.
- * Create a user-friendly engineering tool [based on QARM]
- * Interface with SPENVIS
- * New ion physics
- * SEP (different models), GCR (alpha, proton, HD) and X-ray

15/11/07

EMSEC-ESTEC

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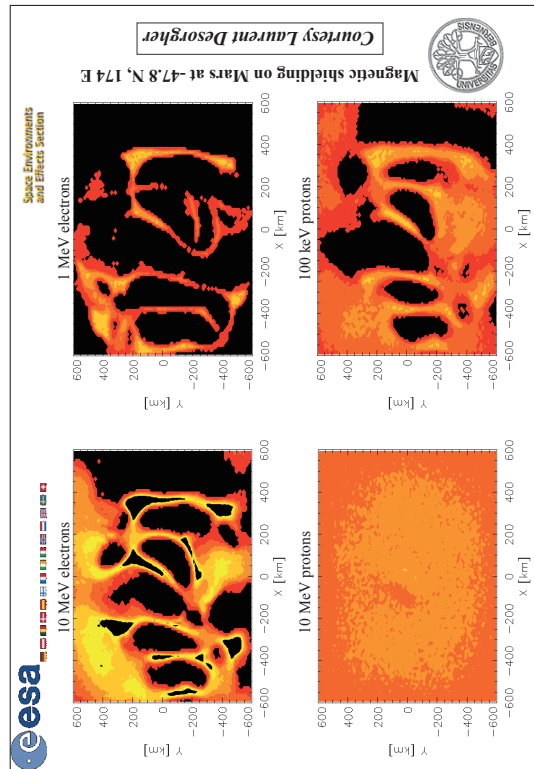
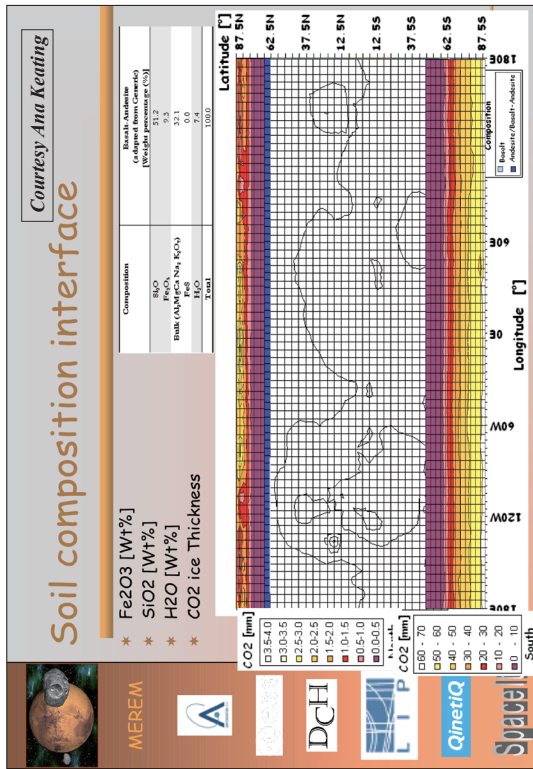
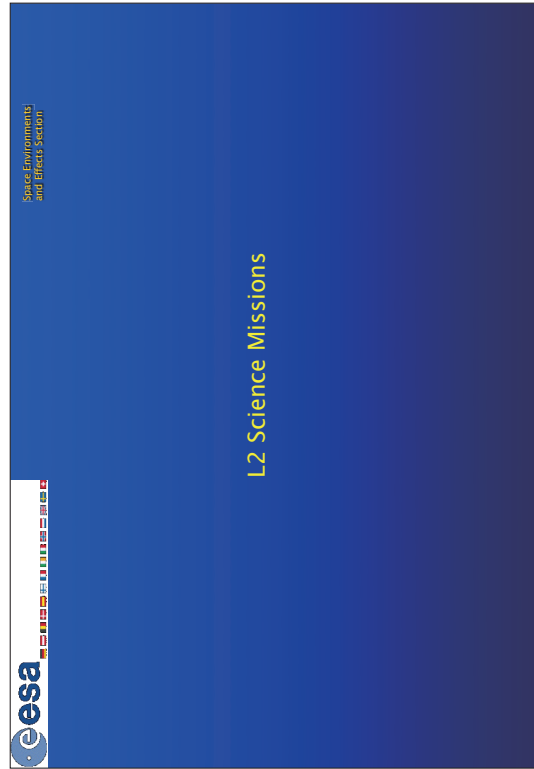
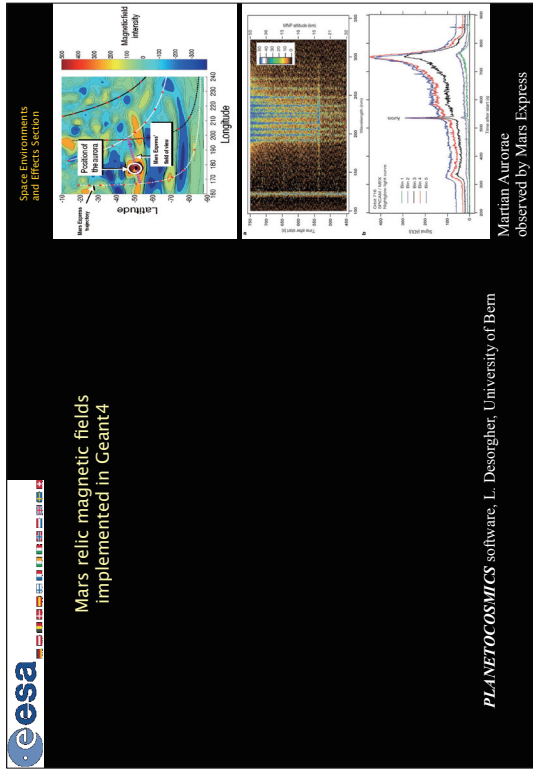
Mars Energetic Radiation Environment Model


Courtesy Ana Keating

A. Keating
S. Valente
P. Gonçalves
M. Pimenta
P. Nieminen
L. Desorgher
P. Truscott
F. Lei
D. Heynderickx
N. Crosby
H. De Witte
G. Degreef

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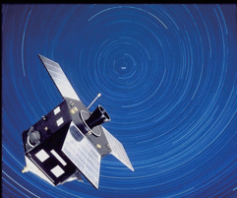
Non image courtesy of ESA Portal
Illustration: Jaxa





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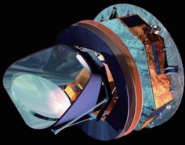
GAIA: Follow-on to Hipparcos astrometry mission



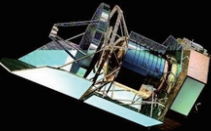
Hipparcos

100 x 100 x 100 µm stars have been discovered in 2000 years.
Hipparcos pinpointed 100000 stars, 200 times more accurately than before.


© John Morgan (Univ. Sydney)



Planck

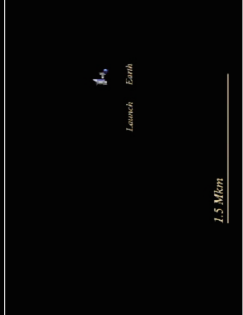


Herschel




JWST

GAIA




1.5 Mkm
Launch Earth



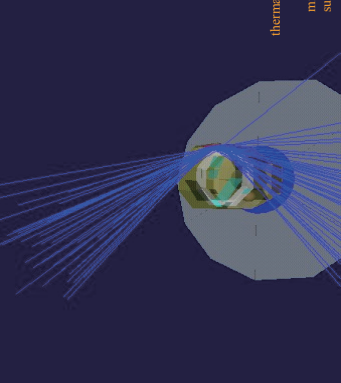
ESA Herschel / Planck

© NASA WMAP

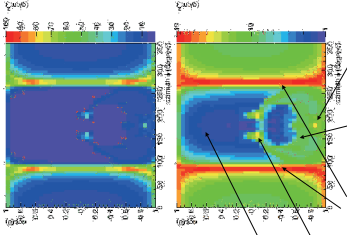


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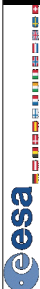
GAIA Geant4 simulations



2 MeV protons impinging on the CCD focal plane through the thermal cover windows

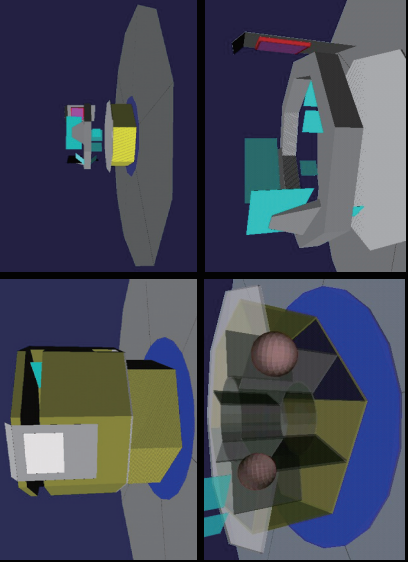


thermal lens
mirrors and supports
antenna
optical bench
CCD front cover and electronics





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GAIA Geant4 geometries



G. Santin (ESA)

Space Environments
and Effects Section

Ongoing and Planned R&D Activities

- MARSREM: DPMJET 2.5 implementation ongoing; active shielding methods studied
- REAI-MS: Geant4 interface to industrial radiation tools; prototype of Reverse MC
- Rapid Reverse Monte Carlo and Ion Physics for Dose and SEE, KO imminent
- Jupiter Radiation Environment and Effects Tools, KO imminent
- Investigation and Analysis of Very High Energy Accelerators for Radiation Simulation, AO 1st quarter of 2008
- Energetic Electron Shielding, Charging and Radiation Effects, AO 1st half of 2008
- Physics Models for Biological Effects of Radiation and Shielding, AO 2nd half of 2008
- Dose Enhancement in High Electron Environment as a Source of Underprediction, AO 1st half of 2008
- Internal call for ESA Cosmic Vision 2015-2025 R&D proposals, 1st quarter of 2008
- ESA General Studies Programme internal call for proposals, 1st half of 2008
- And, continued support to new missions => Source of new R&D