

The OMERE radiation environment and effects engineering tool

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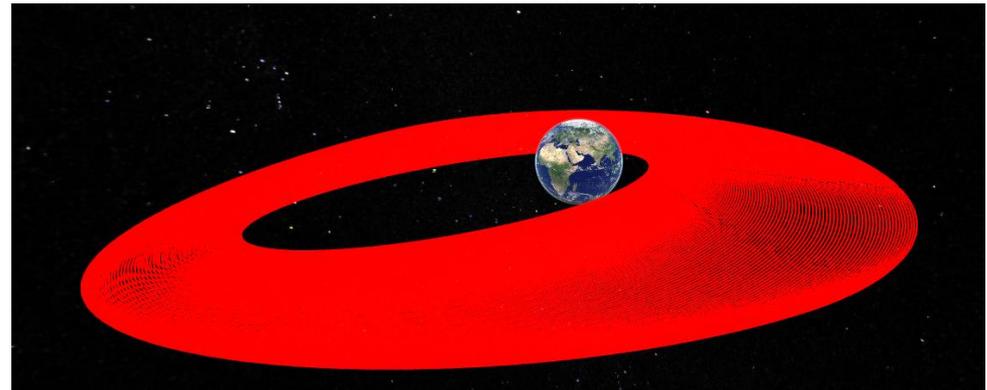
Guy Rolland, Robert Ecoffet and Denis Standarovski, CNES

- To specify the radiation environment for a space mission:
 - ▶ Particle fluxes
 - ▶ Dose-depth curve
 - ▶ Non-Ionising dose and equivalent fluence depth curve
 - ▶ LET and transported behind shielding proton fluxes

- To estimate SEE rates for components for a space mission

- The space mission is defined by orbital parameters and duration or by directly importing a trajectory file

Electrical Orbital Rising transfer
from a GTO orbit with a perigee
of 200 km (200 km x 35486 km,
inclination = 7 deg)



- Possible calculations include:
 - ▶ Particle flux (electrons, protons, ions): average over mission, along the orbit, peak flux, mapping, transport and LET behind spherical shielding or FASTRAD® sector file
 - ▶ Ionising dose depth curve for mission, along the orbit dose rate for specific shielding (spherical or FASTRAD® sector file)

■ Possible calculations include:

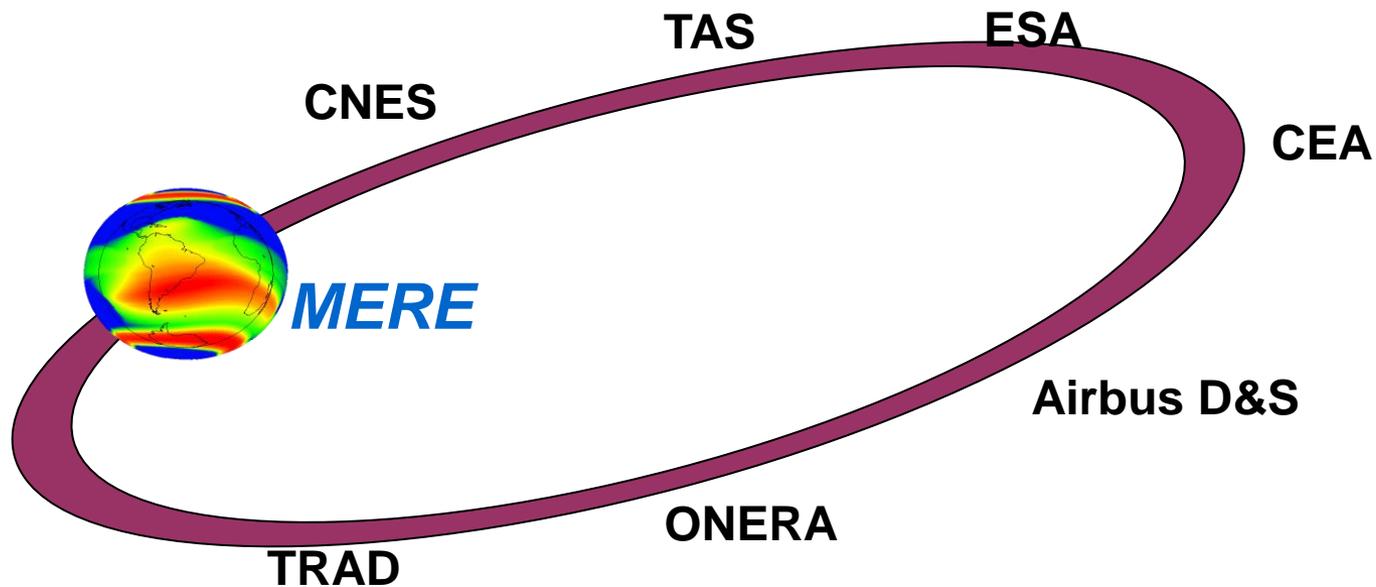
- ▶ Non-ionising dose/equivalent fluence depth curve & conversion tools (one E to another, one particle to another...) for defined NIEL values also using the ONERA NEMO code
- ▶ Single event rate: average over mission, along the orbit, peak in the SAA or during solar particle events, component database, SAA mapping, cross section definition methods: Weibull, Bendel, SIMPA, PROFIT, SEE “report” output format
- ▶ LET equivalent: LET in sensitive area behind multiple layers of different materials (Al, Cu and SiO₂)
- ▶ Solar cell degradation
- ▶ Multiple tools to help user: batch mode and post-processing tools, multithreading, plotting, 2D and 3D views, excel outputs, mission file

- Start of the project in 1999
- Developed by TRAD with CNES support
- Freely distributed by TRAD
- Motivation:
 - Make a widely used tool that corresponds to industry requirements and needs
 - Calculation methods and results that are accepted (and can be verified!) by project partners, primes, subcontractors, Agencies => everybody is using the same tool!

The OMERE project

Make a widely used tool that corresponds to industry requirements and needs:

- ▶ Stand alone software = confidentiality is respected
- ▶ Multi-partnership = developments are driven by industrial needs and feedback

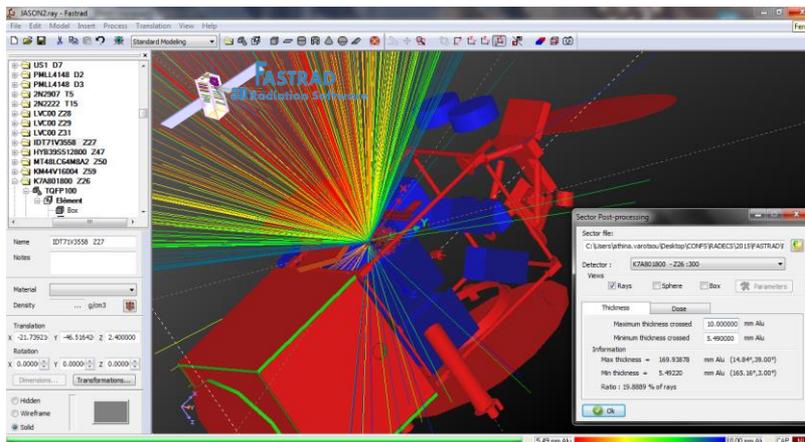


- ▶ User friendly interface = can be easily used

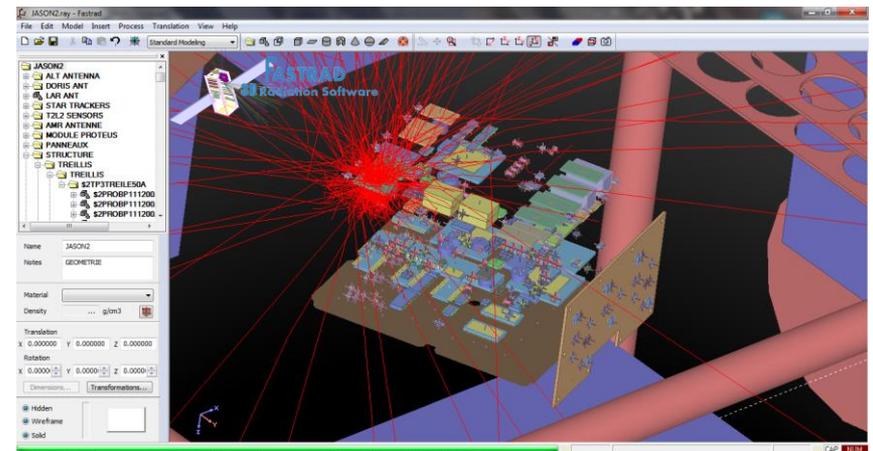
- Also:

- ▶ A platform for diffusion of radiation environment models and effects calculation methods
 - Especially outcomes of Research and Technology projects financed by the CNES, like ONERA radiation belt models (IGE2006, MEOv2, slot region, OPAL)
- ▶ Coupling with FASTRAD®.

Dose-depth curve for RT analysis



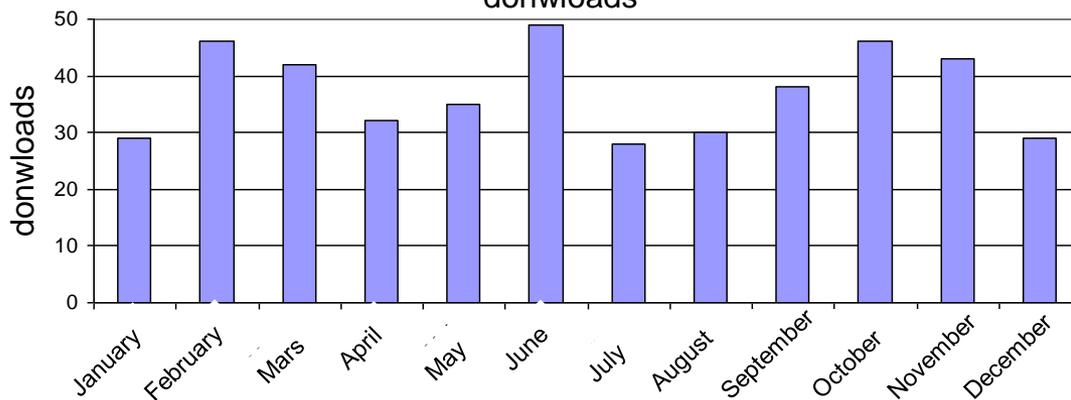
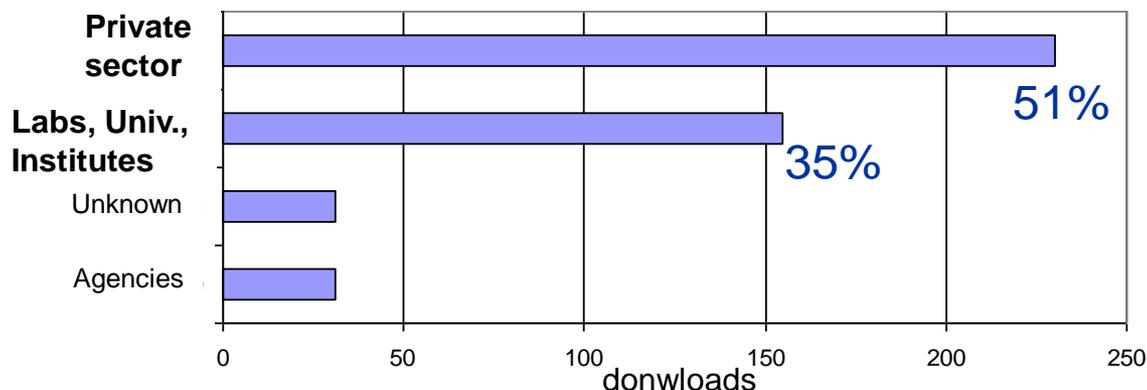
Particle fluxes for RMC calculations



- **OMERE is used for**
 - ▶ System engineering (can be a client requirement)
 - ▶ Electronic component engineering
 - ▶ Equipment and scientific instrument conception
 - ▶ Research and development
 - ▶ Education

■ Statistics

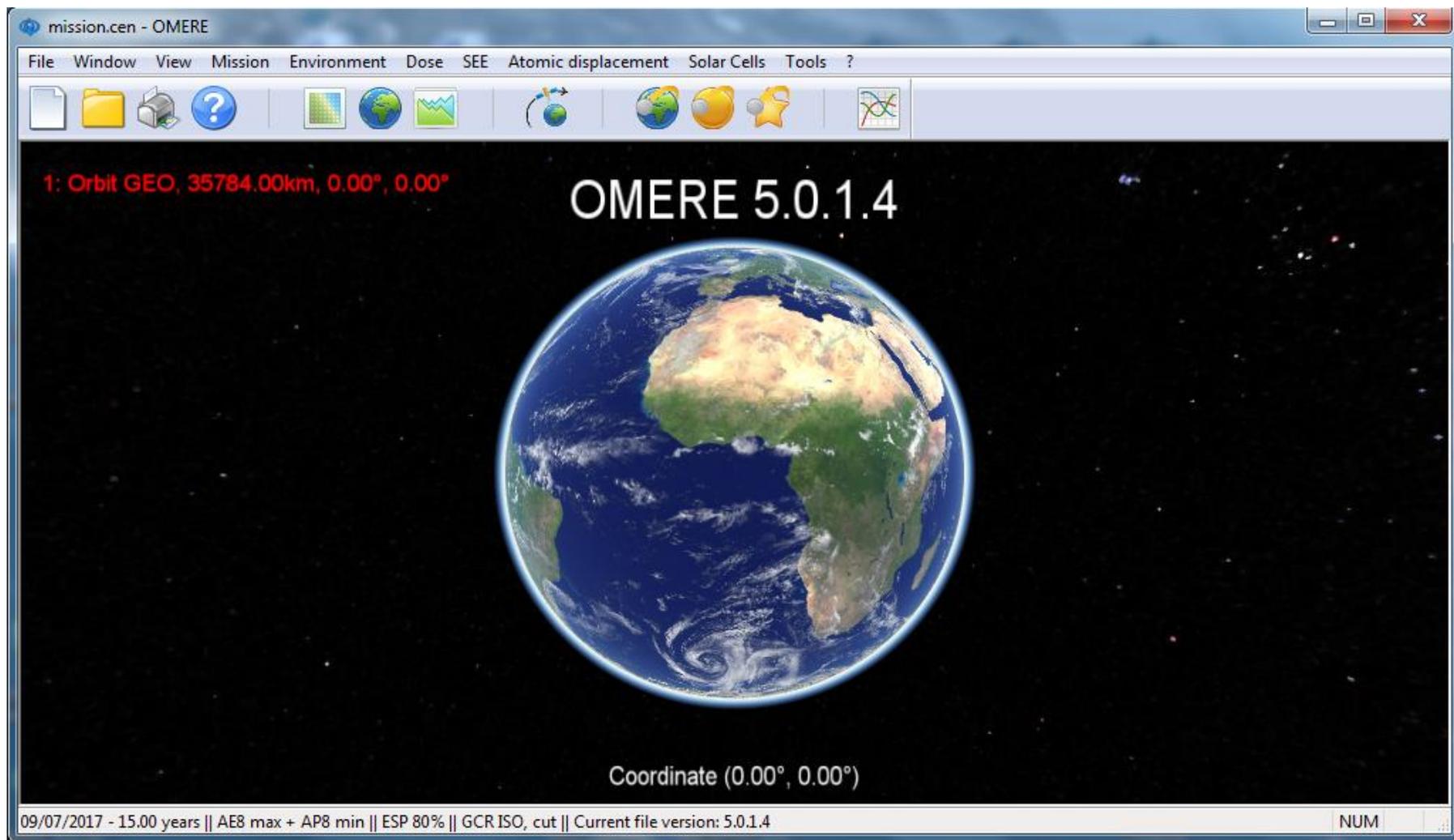
- ▶ 450 downloads in 2016
- ▶ From 40 different countries: 1st France, 2nd USA



On average 1 new download/day

- **User feedback is very important**
 - ▶ Collected throughout the year
 - ▶ Workshop organized last May in Toulouse to introduce the new 5.0 version (CCT organized by CNES & TRAD)
- **Feedback**
 - ▶ Helps communication between clients, primes and subs, leading to project success
 - ▶ Easily obtained inputs for more detailed component level and material analysis (RT, MC)
 - ▶ Support is greatly appreciated
 - ▶ But also: easy to use does not mean simple! It is a radiation engineer kind of work and still one needs to understand the mission definition + environment + effects parameters definition...

- Since 2015, important efforts to improve interface and optimize code
- Calculations are faster – approximate factor of x2 less time needed
- The first version reflecting this work is the v5.0, released on the TRAD web page on April 18, 2017



mission.cen - OMERE

File Window View Mission Environment Dose SEE Atomic displacement

1: Orbit GEO, 35784.00km, 0.00°, 0.00°

OMERE

03/07/2017 - 15.00 years || AE8 max + AP8 min || ESP 80% || GCR ISO, cut || Current file ver

Mission definition

Mission launch date

Date of launch : 03/07/2017

Time of launch : 02:01:25

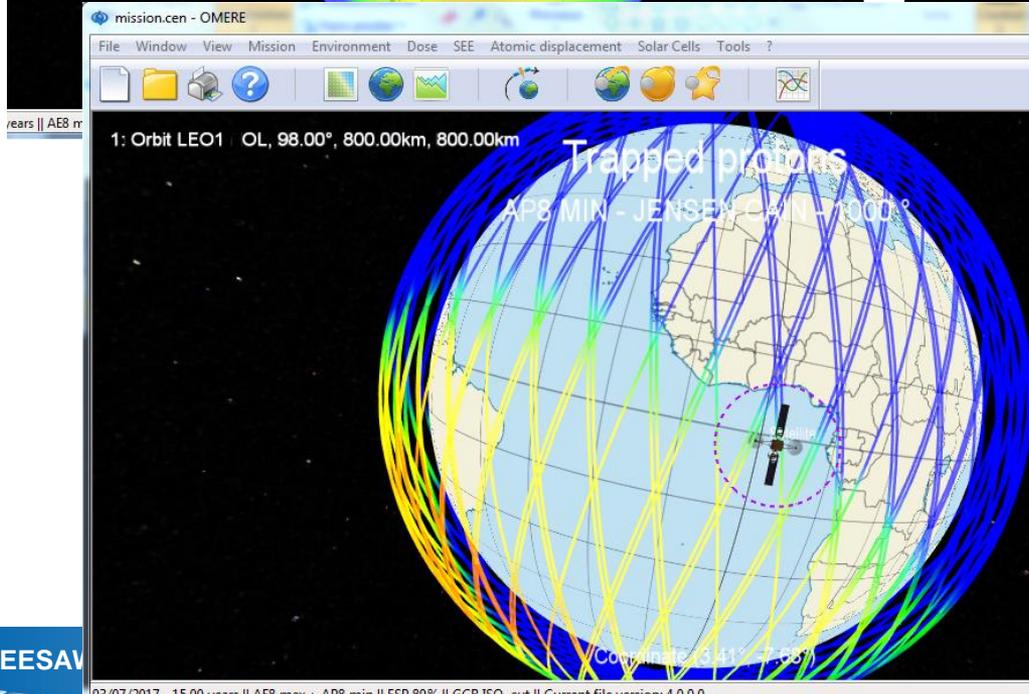
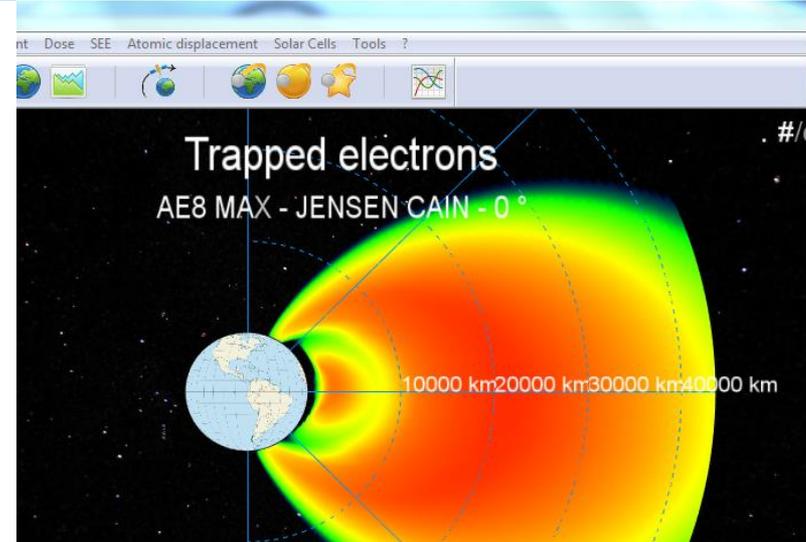
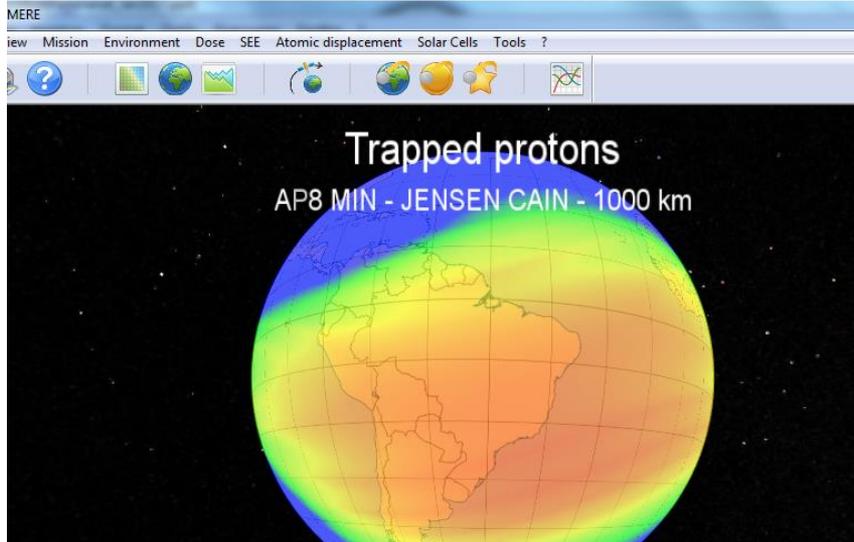
Solar Cycle

Orbit(s)

Orbit name	Inclination	Apogee	Perigee
Orbit GEO	0.0°	35784.0km	35784.0km

Output File: C:\OMERE\orbit.dat

Ok Cancel



Satellite position

Parameters

07/03/2017 -- 02:01:25

Size km

Resolution ² points

mission.cen - OMERE

File Window View Mission Environment Dose SEE Atomic displacement Solar Cells Tools ?

1: Orbit GEO, 35784.00km, 0.00°, 0.00°

SINGLE EVENT UPSET DATA

Part Type : HM0000000B Function : 256 M-bit SDRAM
 Manufacturer : HITACHI Capacity (cells) : 450000
 Technology : CMOS

HEAVY IONS TEST DATA	PROTONS TEST DATA
Reference Report : SEE/001	Reference Report : SEE/002
LET threshold = 4.0 MeV.cm ² /mg	E threshold = 23.0 MeV
Device Cross Section = 9.91e-002 cm ² /device	Device Cross Section = 2.55e-008 cm ² /device
W = 19.84	W = 0.26
S = 1.53	S = 0.23

SEU RATES - Galactic Cosmic Rays @ 1.0 g.cm-2	SEU RATES - Trapped Protons @ 1.0 g.cm-2
Mean Rate = 2.3e-002 seu/device day	Mean Rate = 1.8e-001 seu/device day
Max Rate @ 90° = 6.3e-002 seu/device day	Max Rate @ SAA = 9.8e+000 seu/device day

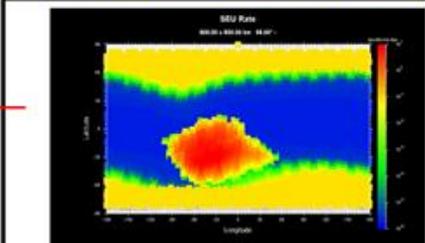
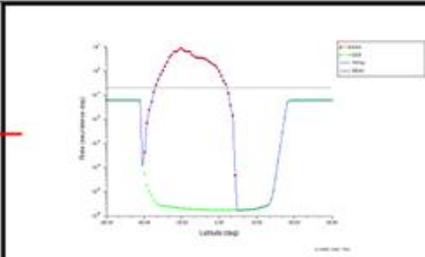
GEOGRAPHICAL DISTRIBUTION OF INSTANTANEOUS SEU RATES > MEAN SEU RATE

Mean SEU Rates	SEU device.day
Cosmic Rays : 2.3e-002	
Trapped Protons : 1.8e-001	
Total : 2.1e-001	

# SEU /	device,12.5 years
Galactic Cosmic Rays : 1.1e+002	11.29%
SAA Trapped Protons : 8.3e+002	89.71%
Total : 9.4e+002	

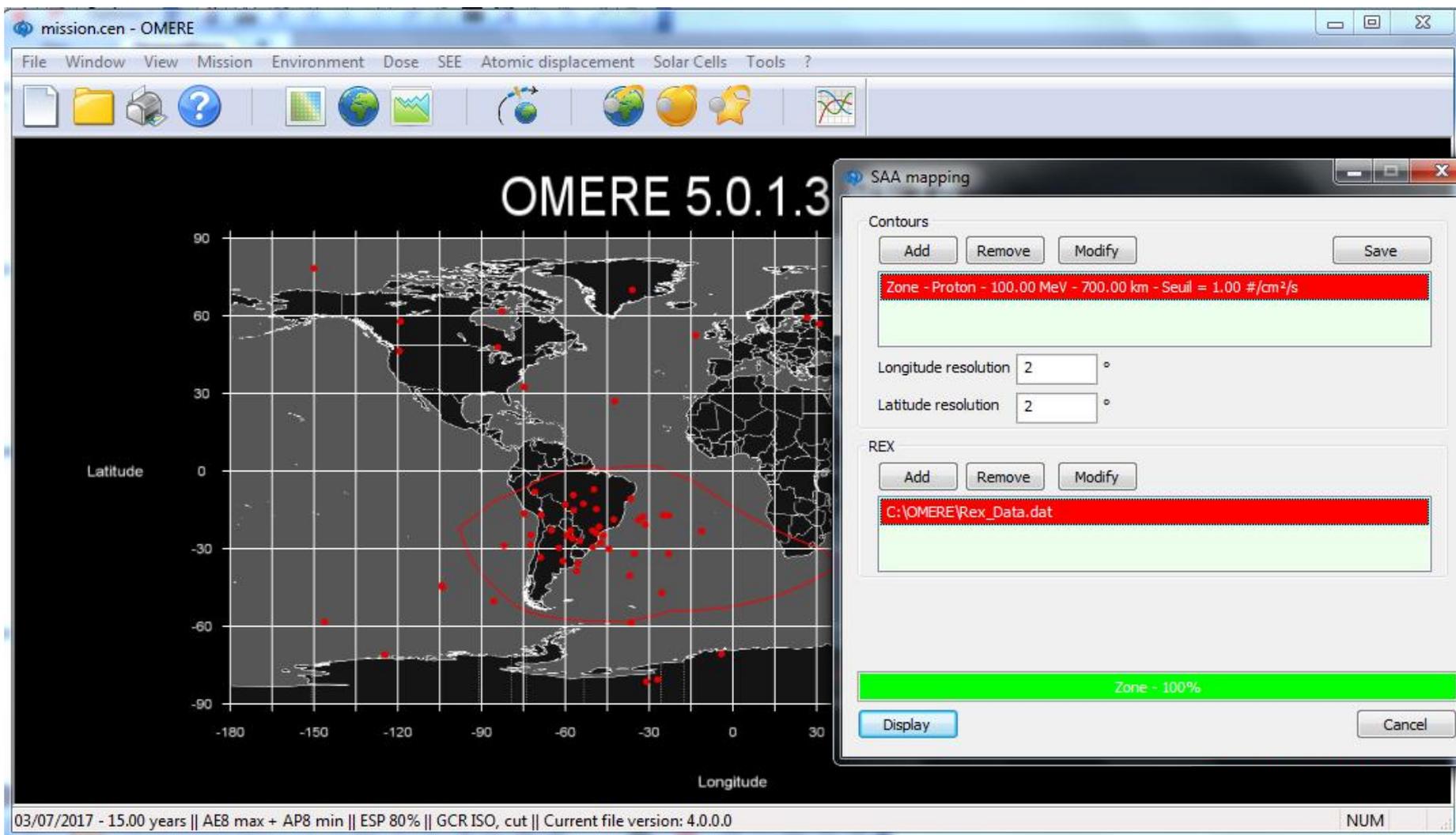
Orbit Characteristics

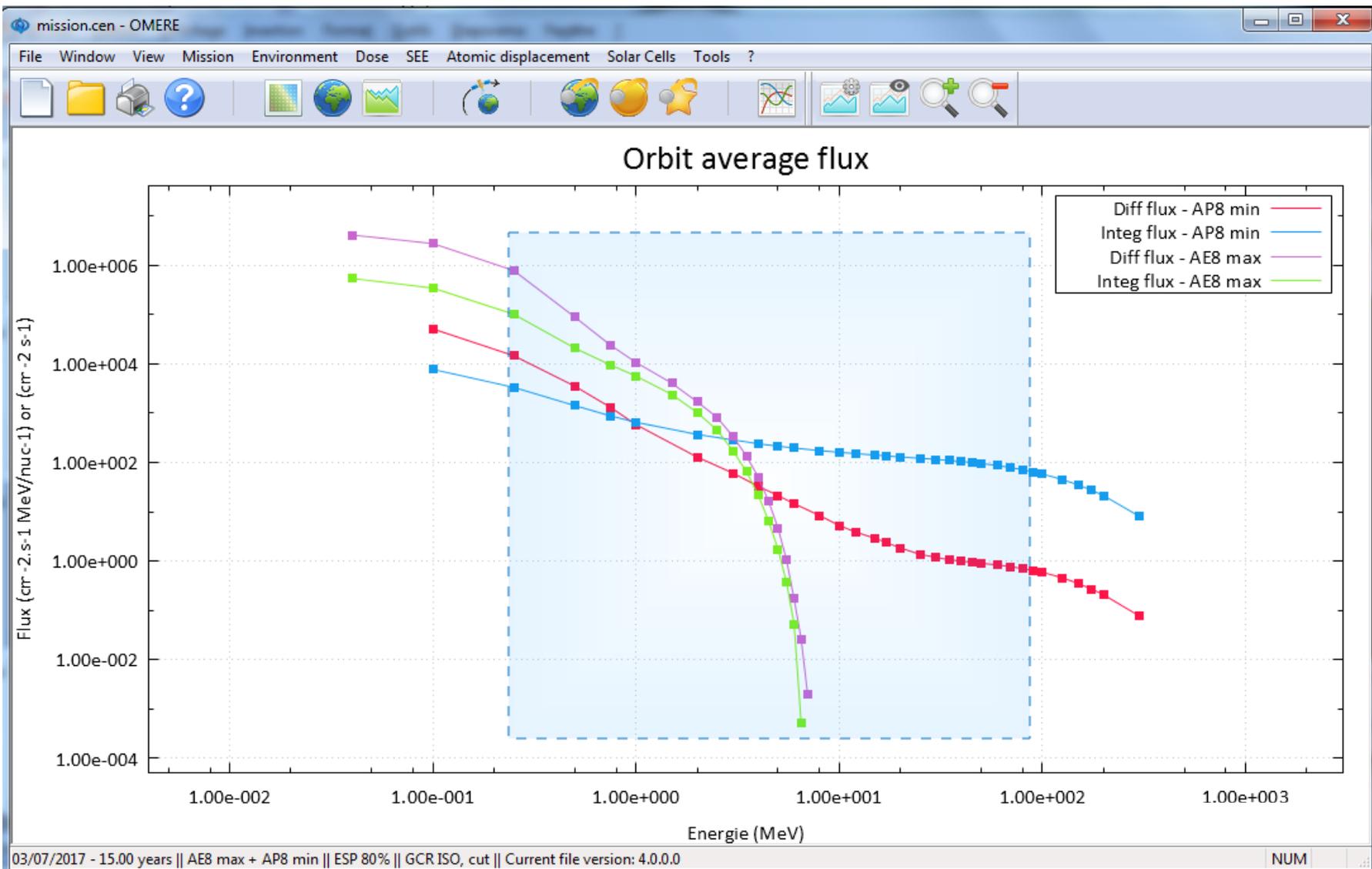
- Altitude : 800.0 (km)
- Inclination : 98.0 (degree)
- Cosmic Rays : GCR ISO (SOL MIN)
- Trapped Protons : AP8 MIN (SOL MIN)
- Orbit Period : 100.87 (min)
- Mission Duration : 12.5 (years)
- SAA max location : -30° latitude/ -31° longitude

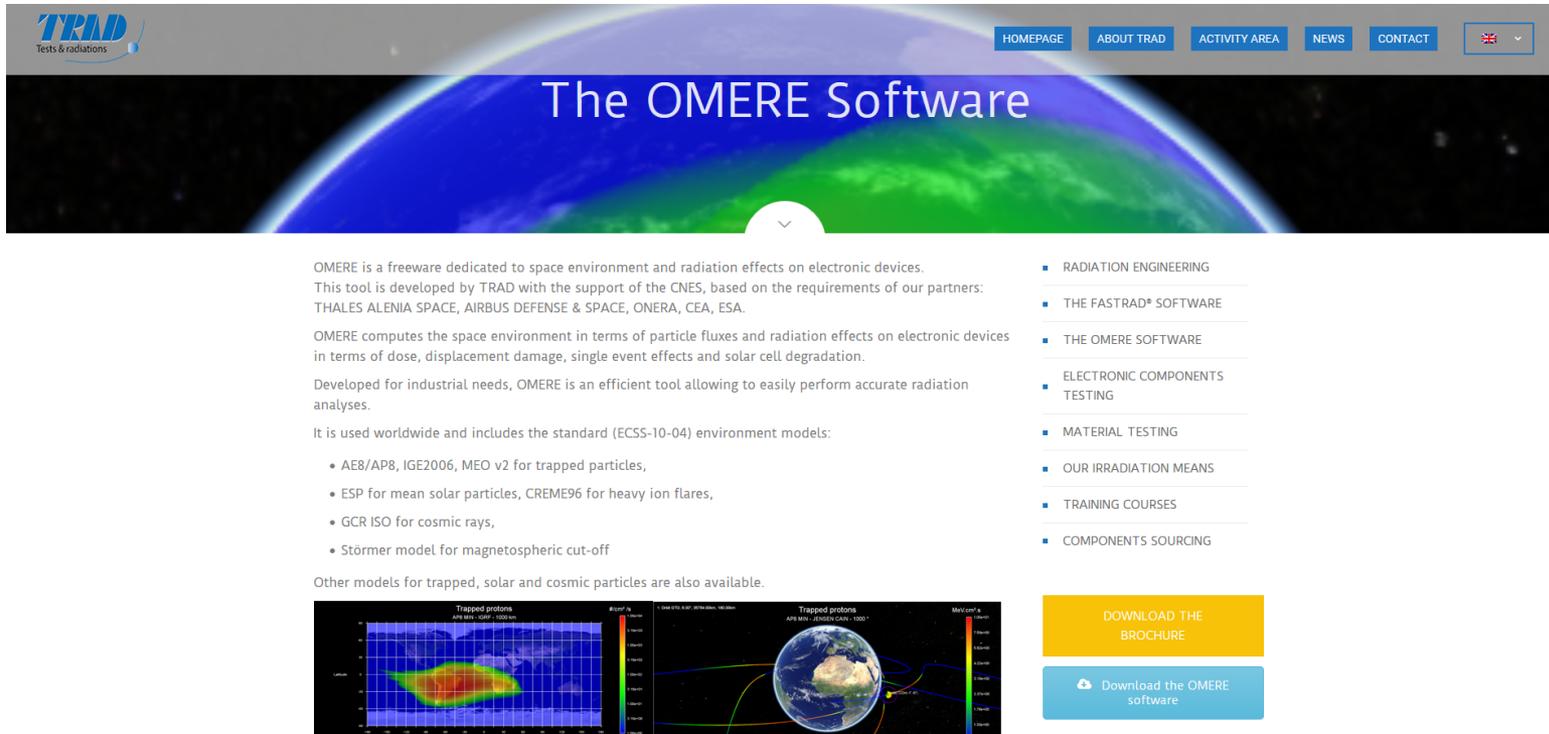
03/07/2017 - 15.00 years || AEB max + AP8 min || ESP 80% || GC

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- Download OMERE at the TRAD website



TRAD Tests & radiations

HOME PAGE ABOUT TRAD ACTIVITY AREA NEWS CONTACT

The OMERE Software

OMERE is a freeware dedicated to space environment and radiation effects on electronic devices. This tool is developed by TRAD with the support of the CNES, based on the requirements of our partners: THALES ALENIA SPACE, AIRBUS DEFENSE & SPACE, ONERA, CEA, ESA.

OMERE computes the space environment in terms of particle fluxes and radiation effects on electronic devices in terms of dose, displacement damage, single event effects and solar cell degradation.

Developed for industrial needs, OMERE is an efficient tool allowing to easily perform accurate radiation analyses.

It is used worldwide and includes the standard (ECSS-10-04) environment models:

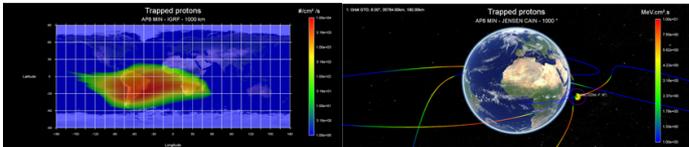
- AE8/AP8, IGE2006, MEO v2 for trapped particles,
- ESP for mean solar particles, CREME96 for heavy ion flares,
- GCR ISO for cosmic rays,
- Störmer model for magnetospheric cut-off

Other models for trapped, solar and cosmic particles are also available.

- RADIATION ENGINEERING
- THE FASTRAD* SOFTWARE
- THE OMERE SOFTWARE
- ELECTRONIC COMPONENTS TESTING
- MATERIAL TESTING
- OUR IRRADIATION MEANS
- TRAINING COURSES
- COMPONENTS SOURCING

DOWNLOAD THE BROCHURE

Download the OMERE software



- Write to us: omere@trad.fr or athina.varotsou@trad.fr
- Ask for a training