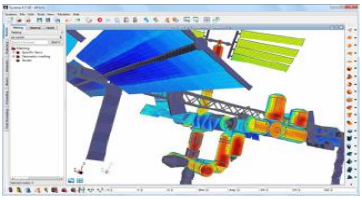
SYSTEMA DEBRIS

Satellite system-level MMOD impact risk assessment tool

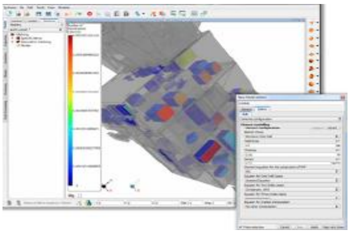
Meggie Vilaranda

Airbus Defence and Space, 31 rue des cosmonautes, 31402, Toulouse cedex 04
Tel: +33 (0)5 31 96 95 67
mail : meggie.viaranda@airbus.com

The numbers of debris in space is continuously increasing, it is thus necessary to assess the probability of spacecraft damage or failure due to a MMOD impact during its mission lifetime. The aim of a risk assessment is to identify the SC components sensitive to MMOD, provide inputs to assess the SC reliability and, if necessary, support the implementation of shielding to improve spacecraft survivability. Systema-Debris proposes a complete process to assess the MMOD impact risk with a computation time suitable for system analysis.



Systema interface



Debris user interface panel in Systema

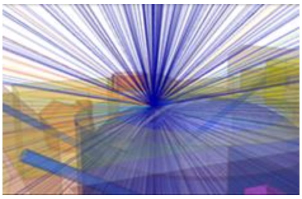
Generation of a realistic satellite model: Systema 3D graphical user interface allow an adapted modelling from CAD files.

Generation of realistic debris/ micrometeoroid environment: Various type of environment can be used, ranging from detailed to simplified isotropic environment on 4 π steradian. The STENVI format, recommended standard from the IADC, is used to feed the computation module.

```
#-----------------------------< Flux Contribution >----
#          Azi  Ele  Vel  Dia  Lat  Den          Flux
DISTSET      1   10    3    2    1    3   0.46710E-07
DISTSET      1   11    3    2    1    3   0.85784E-08
```

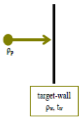
STENVI file extract

Backward ray tracing as a support to physical equation: fluxes from environment model are projected onto the satellite geometry allowing a tracing of each particle path through the satellite structure. It tracks which layer of which material has been met by the particle before impacting the equipment. On each ray, application of standard IADC and ECSS recommended ballistic equations allow the software to check whether or not the particle being traced penetrate the sensitive element.



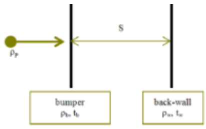
Several Ballistic Limit Equations (BLE):

- Single Wall BLE (parametric equation)



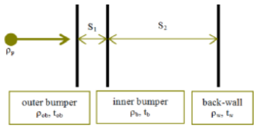
$$d_c = \left[\frac{t_t}{K_f \cdot K_1 \cdot V^{\gamma} \cdot (\cos\theta)^{\xi} \cdot \rho_p^{\beta} \cdot \rho_t^{\kappa}}\right]^{1/\lambda}$$

- Double Wall BLE (parametric equation)



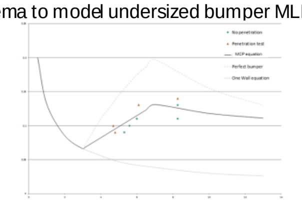
$$d_{p,crit} = \left[\frac{t_w + K_2 \cdot t_b^{\mu} \cdot \rho_b^{\nu_2}}{K_1 \cdot \rho_p^{\beta} \cdot v^{\gamma} \cdot (\cos\theta)^{\xi} \cdot \rho_w^{\kappa} \cdot S^{\delta} \cdot \rho_b^{\nu_1}}\right]^{\frac{1}{\lambda}}$$

- Triple Wall BLE (SRL)



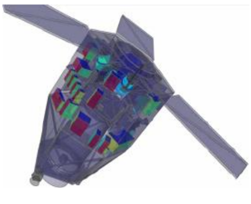
- Cour-Palais/Christiansen damage equations:

The use of this equation on Systema to model undersized bumper MLI was validated by HIV test.

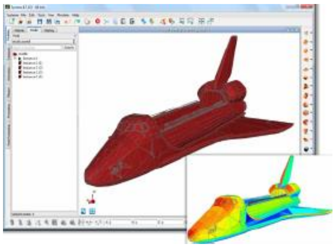


Penetration flux and PNP:

- Number of impacts and penetrations on a meshed surface
- Number and area ratio of craters
- Associated probabilities on selected elements



Number of penetrations on the equipment



Computation using an imported STEP file

AIRBUS