The Monte Carlo simulation framework of the ASTRO-H X-ray observatory

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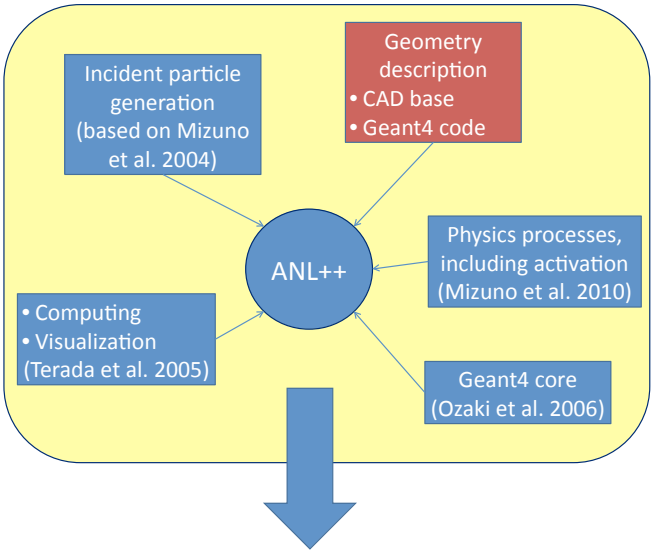
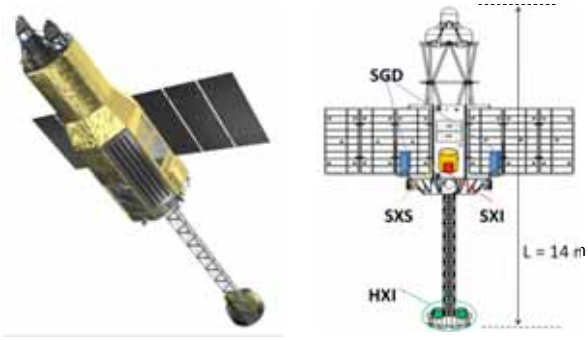
ASTRO-H is the 6th Japanese X-ray astronomy satellite, which is scheduled to be launched in 2014 and will be operated as an observatory open to the global astronomy community. We are developing the data analysis framework with the Geant4-based Monte Carlo simulation core and the numerical models of the on-orbit environmental radiation and the full-satellite mass structure. In addition to them, the framework has the mechanism to connect and control data processing modules developed independently and data communication channel among them, which has been technically proven by simulations and analysis of Suzaku HXD, many other detectors and astrophysical issues.

The development strategy:

Use the heritages of previous missions, such as *Suzaku*, to reduce the development cost and make the outputs as reliable as possible.

- Use the object oriented analysis framework "ANL++" (sometimes pronounced or written as "ANL plus"), which is the successor of the official *Suzaku* software framework "ASTE_ANL" and have been proven its usability and reliability by adopted to some experiments and astrophysical data analysis.
- The core Monte Carlo engine is Geant4.
- Active collaborations with nearby projects.
- Use the geometry and radiation computation tools external of (or maybe redundant to) the Geant4 functions, such as CAD geometry and external activation library, in order to effective development by the collaborators.





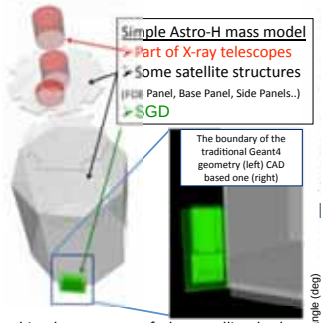
Geometry (mass model) description:

As ASTRO-H is a large scale and complex satellite, its parts shall be supplied from many constructors. Some of them are scientific instruments, whose supplier might be able to supply geometry information suitable for Geant4 simulation; others are, however, not familiar with such simulations and the geometries are expected to be supplied as CAD format such as STEP.

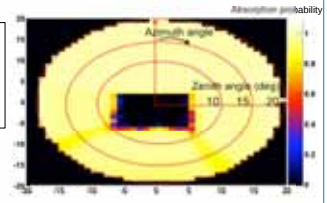
- We, thus, began developing geometry importing method by converting STEP file to GDML (Geometry Description Markup Language) supported by Geant4 toolkit.
- GDML can supply Geant4 geometry from outside of the executable image: this means that the geometry update no more requires the software update and the geometries can be maintained as independent data sets.
- Traditional Geant4 geometry can be converted to a GDML by Geant4 itself, and we can merge that to CAD-based ones.

A demonstration of STEP + traditional geometry and its application:

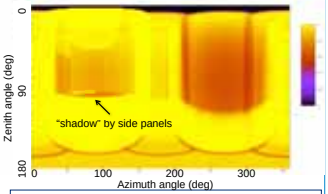
- As the first step of the geometry generator, we built simplified mass models of the ASTRO-H satellite body with GDML and a SGD with traditional Geant4 code, and merged them into one GDML.



Combined geometry of the satellite body (STEP source) and a SGD (Soft Gamma-ray Detector: Geant4 source). The STEP (-> GDML) model is very preliminary, and all the material is assumed as Al while CFRP-Al honeycomb will be used in real.



FOV clearance map from SGD center.



4π Transparency map for 1000 keV photon

References:

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- T. Mizuno et al., *SPIE* 7732-118 (2010)
- Y. Terada et al., *IEEE TNS* vol. 52, Issue 4, pp.902-909 (2005)
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ToDo's:

- Sophisticated and automated STEP to GDML conversion
- Implementation of "geometry selector"
- Introduction of geometry and component name management to GDML