Status report from JAXA 2014

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Outline

1. Aspects of space-related Geant4 activities
2. Geant4-using activities in Japan (update)
3. Conclusion

Aspects of space-related Geant4 activities in Japan

- Mission
  - Scientific satellites (HISAKI, ERG, ASTRO-H, HAYABUSA2)
  - Commercial satellites (GCOM series, …)
  - Scientific simulations (astrophysics, …)
- Purposes
  - Satellite system design (Dose estimation, shield planning)
  - Payload design (Sensor shielding, output simulation)
  - EEE parts evaluation (SEE tolerance)
  - Radiation transfer simulation in astrophysical scale
- Tools
  - Bare Geant4 (for order-made simulation)
  - SPENVIS (for system shielding design/estimation)
  - CRÈME-MC (for SEE simulation)

Activities in Japan (update)

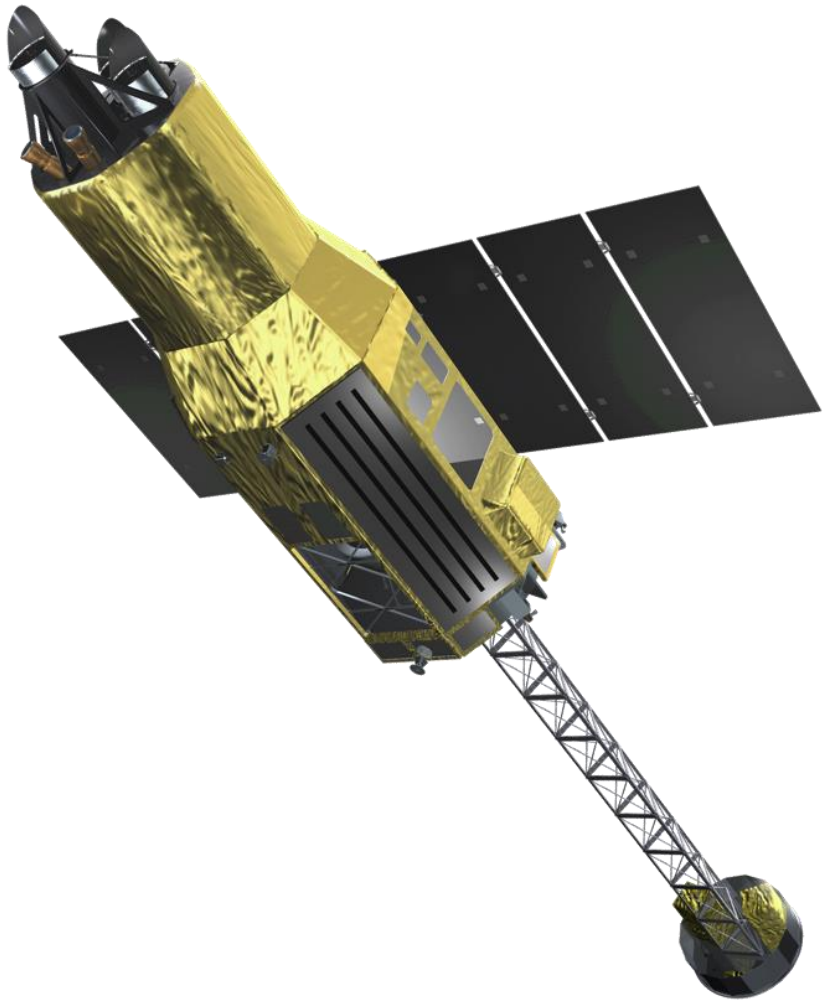
Basically, very similar to Y2013.

- Geant4 seems to become a major tool in Japan.
- Light users seem not to use Geant4 directly, but via SPENVIS or CRÈME-MC.
  - Satellite system design by NEC (SPENVIS)
  - SEE estimation by JAXA QA section (CRÈME-MC)
- Direct Geant4 users seem to be in (not engineering but) scientific community.
  - ASTRO-H (see another presentation) and X-ray polarization detection groups are still active. (Scientists)
  - ERG group uses Geant4 for detectors design. (Scientists)
  - Space Environment Group of JAXA is using Geant4 for most of developing components. (ENGINEERS!)

ASTRO-H

(SUWS7, 2010)

- 6th Japanese X-ray astronomy satellite
- Scheduled for launch in 2015
- 1.7t mass, 14m length
- LEO of 550 km altitude, ~30 deg inclination angle



BGD and activation simulation reports will be shown in other presentation.

ASTRO-H: detectors

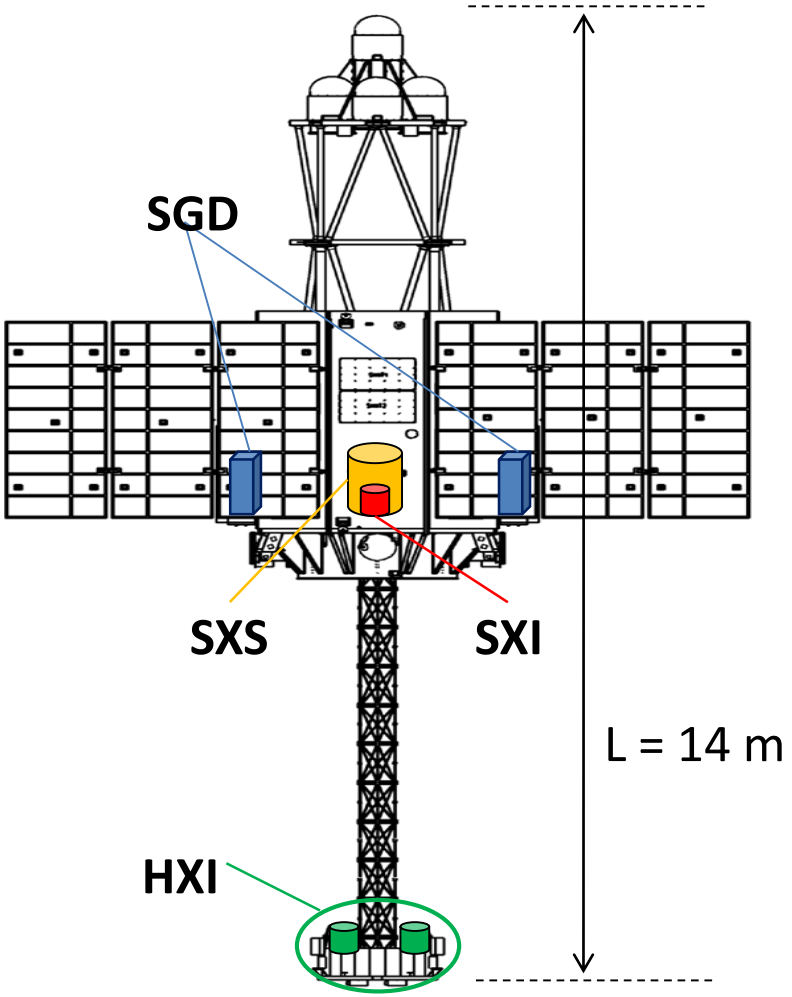
(SUWS7, 2010)

Four kinds of detectors:

- **SXS**: X-ray micro calorimeter, with a few hundred Kg aluminum alloy
- **SXI**: X-ray CCD camera with thick Al shield for < 10 keV band
- **HXI**: Si-strip and CdTe-pixel cameras for > 10 keV band, also sensitive for atmospheric neutron backgrounds
- **SGD**: Compton kinematics telescopes with BGO active shields for a few hundred keV band

Different photon detection mechanism and sensitivity for background radiation

-> **MC simulation is essential**

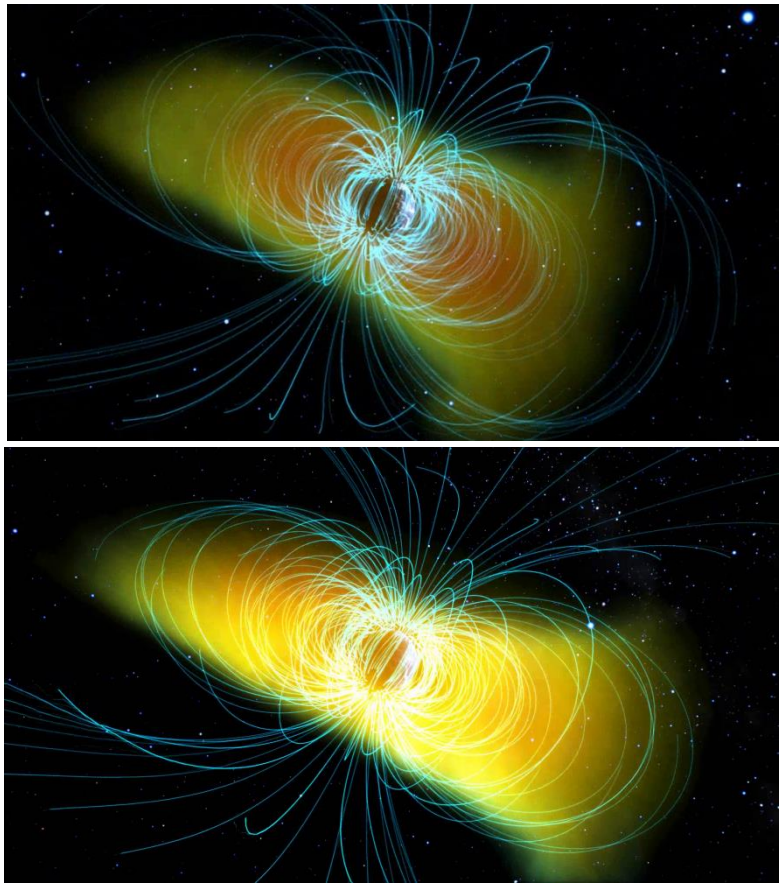


ERG

(by courtesy of S. Kasahara@JAXA)

Energization and Radiation in Geospace

- Mission to study the acceleration and dissipation mechanism of high energy electrons by geomagnetic disturbances in the Van-Allen belt.
- Scheduled to be launched in 2015, by Epsilon rocket (ISAS/JAXA)
- 350 kg mass
- Elliptical orbit
  - 31-deg inclination
  - 300 km perigee, 30,000 km apogee

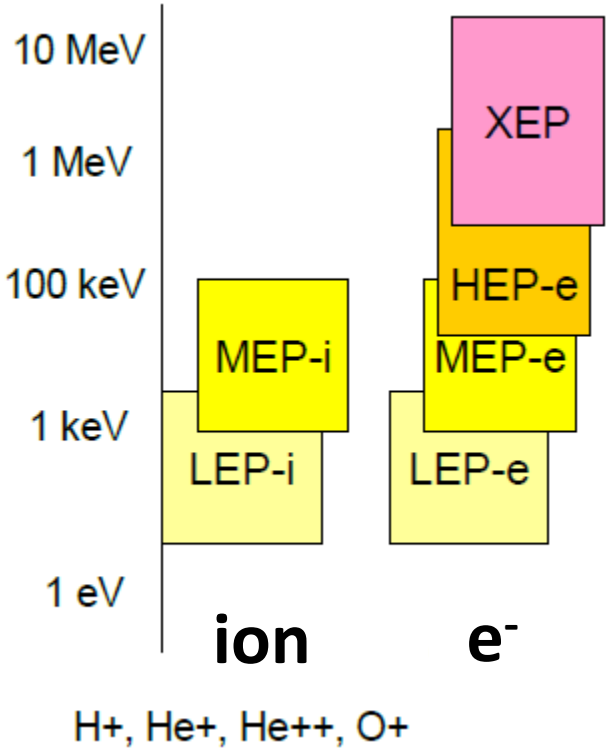


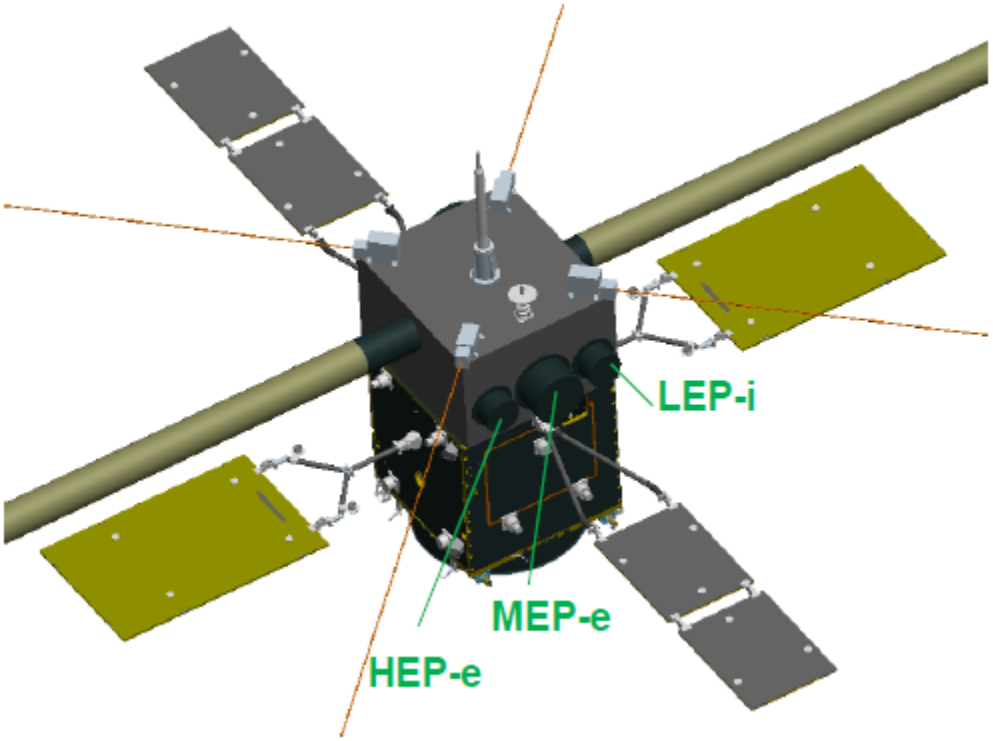
ERG/PPE

(by courtesy of S. Kasahara@JAXA)

Plasma and Particle Experiment

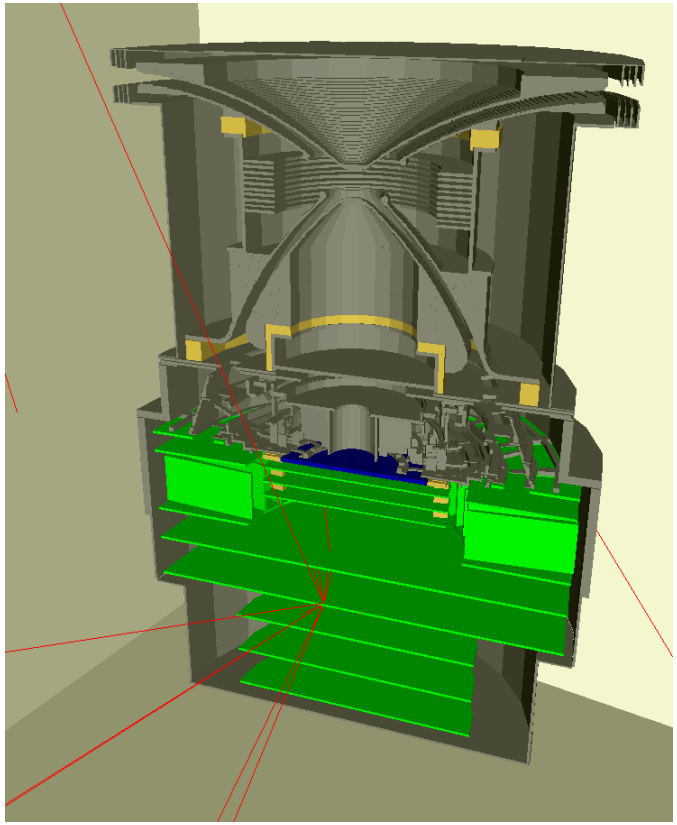
- Observes from eV to relativistic energy particles in the inner magnetosphere.
- Geant4 is used for design and BGD estimation purposes for *ALL* the detectors.



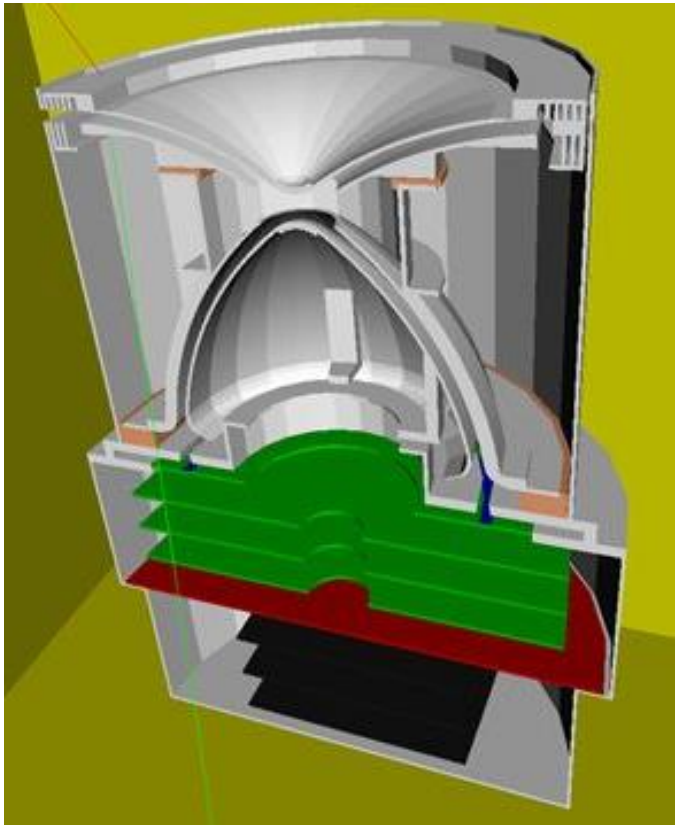


ERG/MEPi and ERG/MEPe

(by courtesy of S. Kasahara@JAXA)



10-180 keV/q ion



10-80 keV electron

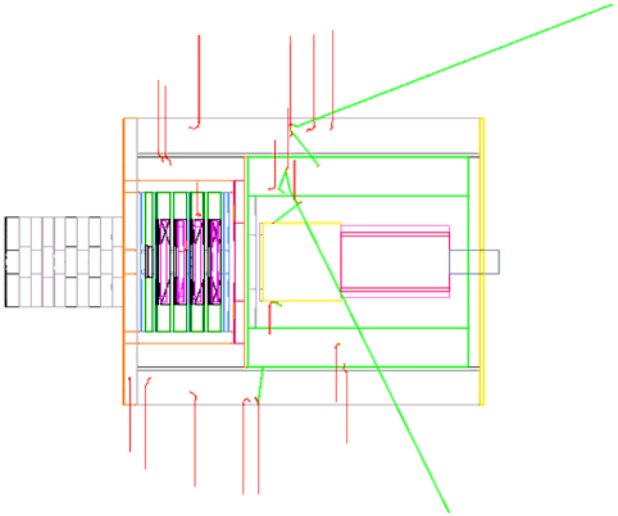
G4 is used for BGD estimation from MeV electrons and >30 MeV protons in the radiation belt.

(Kasahara+2012 PSS, “Radiation background and dose estimates for future X-ray observations in the Jovian magnetosphere”)

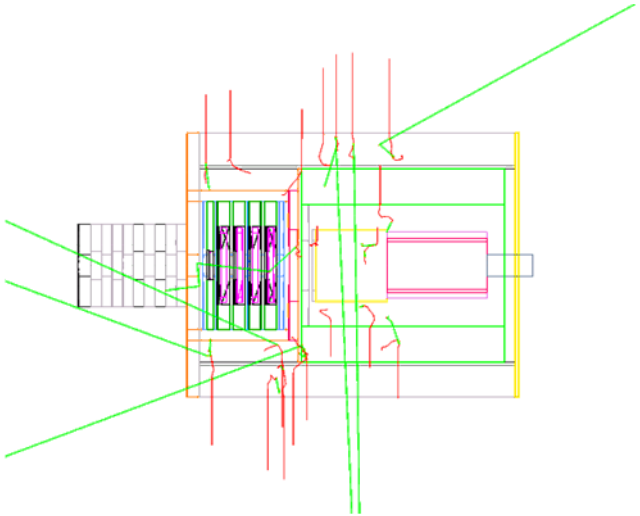
ERG-XEP

(by courtesy of N. Higashio@JAXA)

- Developed by Space Environment Group of JAXA.
- Relativistic electron (200 keV – 20 MeV) detector.
- Assumed BGD: <40 MeV p, out-of-view e^-
- The main detector is guarded by anti-co scintillater (active shield) and heavy materials (passive shield).
- Geant4 is used for the shielding and FOV collimator design.



Al + Ta composite shield,
2 MeV incident electrons

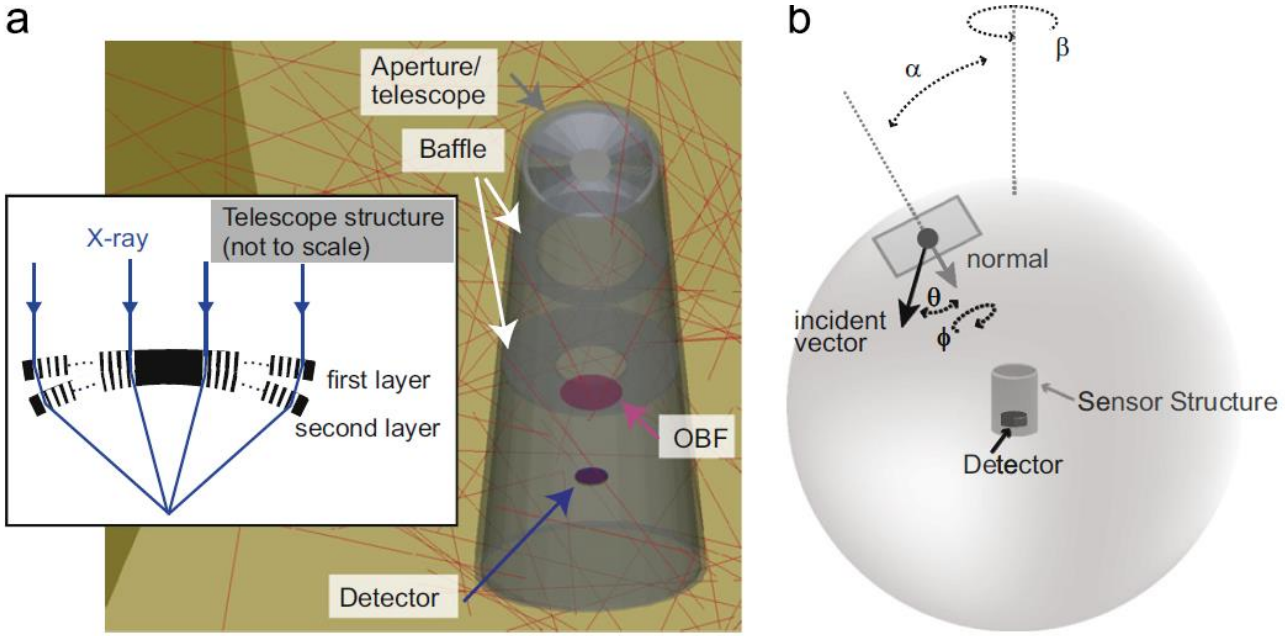


Al + Ta composite shield,
5 MeV incident electrons

Other projects

- SELENE2 dose monitor is designed with Geant4 by Space Environment Group of JAXA.
- Some people are evaluating the BGD particle effects in Jovian magnetosphere for future mission.

JUXTA: Jovian magnetosphere X-ray detector



- Target
  - 0.3-2 keV X-ray
  - Ezoe+, “X-ray observations of Jupiter and beyond”, In Proceedings of international symposium on planetary science in 2011, in press.
- Geant4 is used for the BGD estimation by MeV electrons in Jovian magnetosphere
  - Kasahara+2012 PSS, "Radiation background and dose estimates for future X-ray observations in the Jovian magnetosphere"

CRÈME-MC: new gateway for Geant4

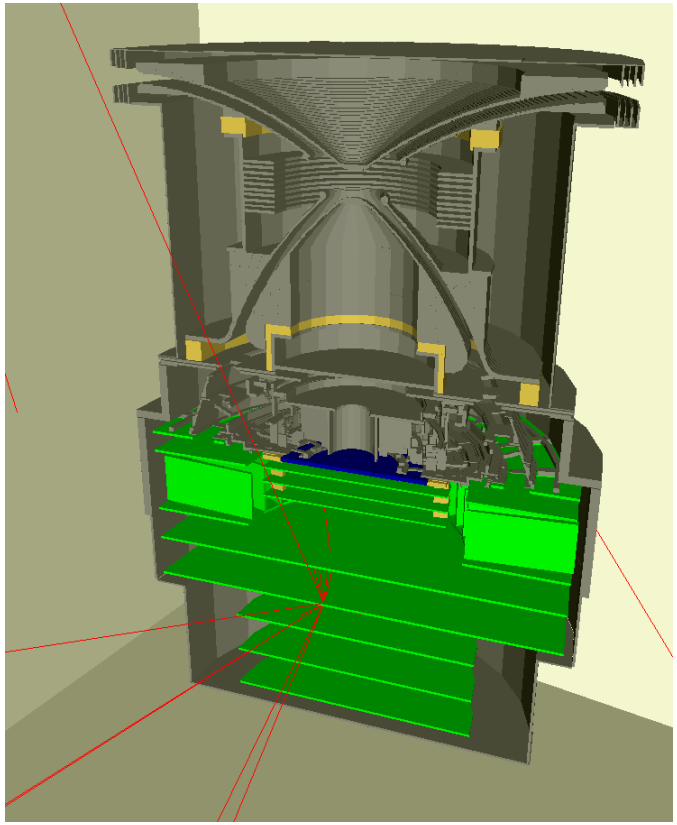
- EEE-parts section begins to use CRÈME-MC for SEE evaluation purpose.
- Problem:
  - Hard to obtain the 3D structure information of the target chips *from manufacturers (chip venders)*

Conclusion

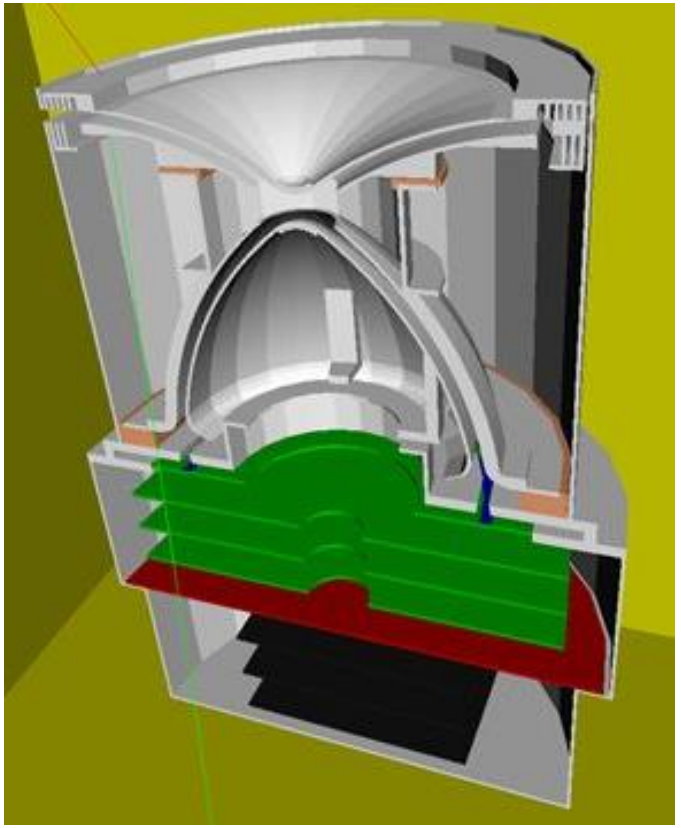
- Situation is basically as same as the previous WS.
- Geant4 is probably the main radiation environment MC simulation tool in JAXA, while most users have been rarely visible even in SUWS.
- One of the difficulties has been still the 3D geometry construction: sometimes due to its complex structure, sometimes due to disclosure problems.

(Backup slides)

ERG/MEP geometry



10-180 keV/q ion

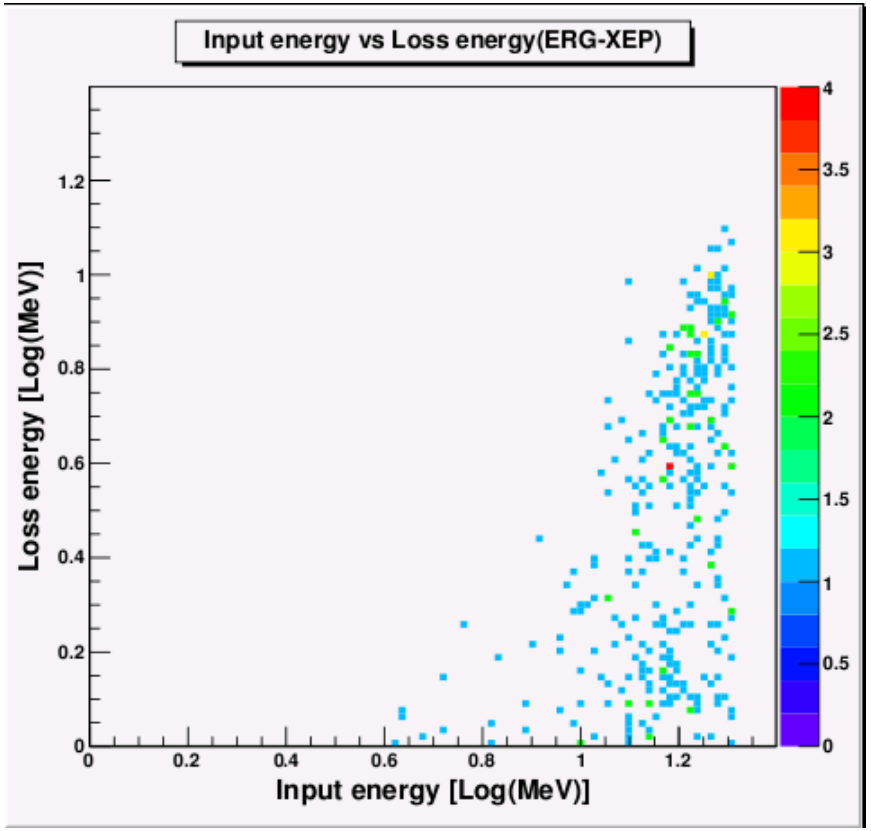


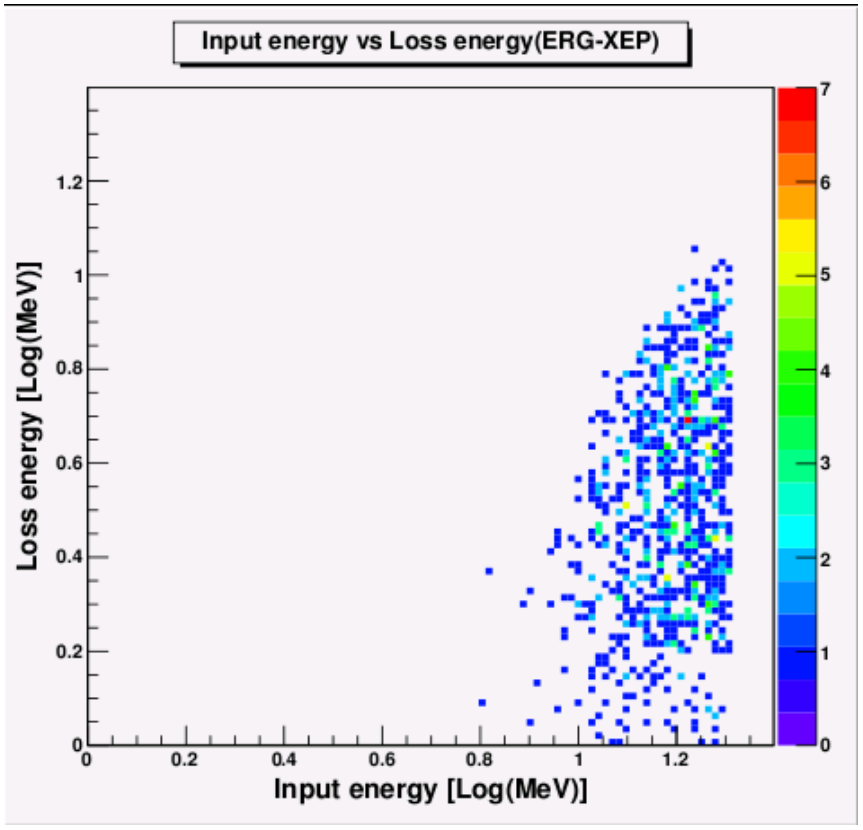
10-80 keV electron

- Geometries are described as accumulated sliced volumes (like 3D-printer objects)
- MEPe is hand coded, while MEPi is a byproduct of electric field simulation.

ERG/XEP Geant4 example

(by courtesy of N. Higashio@JAXA)





- Energy depositions in detector and anti-co scintillaters for 4-20 MeV out-of-view electrons.