



# Geant4 at JAXA 2013

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# Outline

1. Geant4-using activities in Japan (update)
  - General status
  - PoGOLite
  - ERG
  - others
2. Voices from novice users
3. Summary

# Activities in Japan (update)

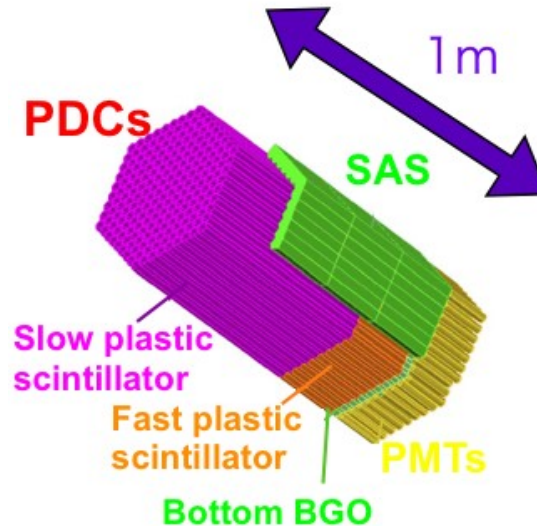
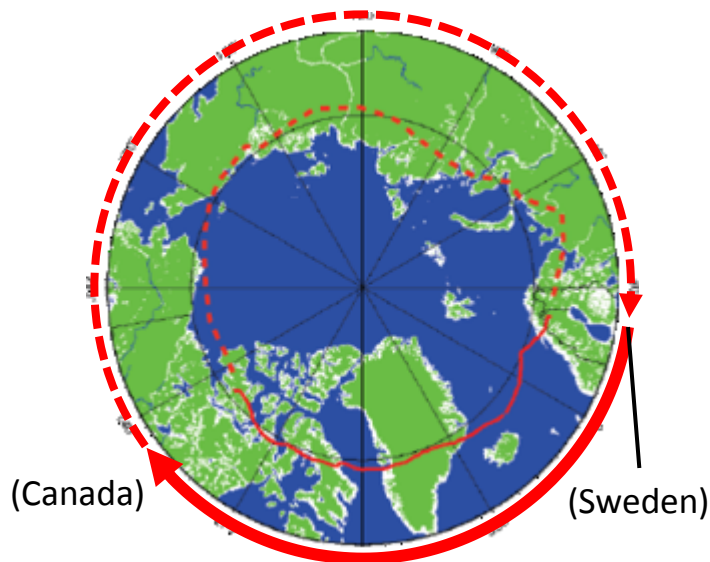
- Geant4 seems to have been used mainly for detector components design works.
- Most of “visible” users are in (not engineering but) scientific community.
  - ASTRO-H (see another presentation) and X-ray polarization detection group are still active.
  - ERG is the new comer as a serious user.
  - **A good news:** Space Environment Group of JAXA is now using Geant4 for most of developing components. ERG/XEP is an example.



# PoGO Lite balloon experiment

(by courtesy of T. Kawano@Hiroshima-U)

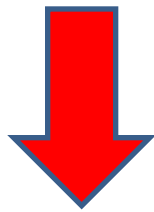
- X-ray polarization measurement in **25-80 keV** band from Crab Nebula and Cyg X-1.
- Necessary calibrations already conducted.
- 2-week balloon flight around the North Pole planned in 2013 summer.



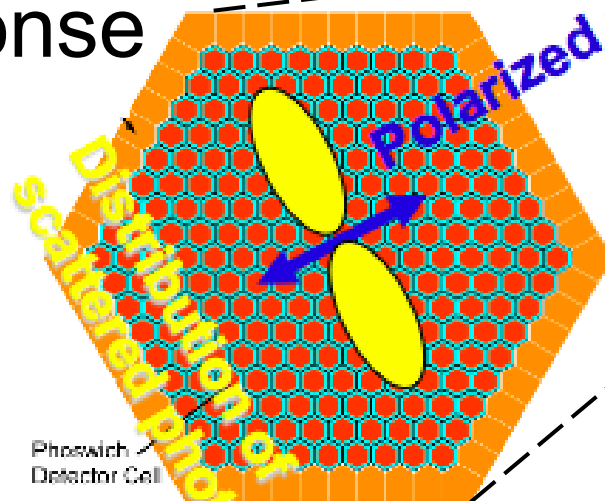
# PoGOLite simulation

(by courtesy of T. Kawano@Hiroshima-U)

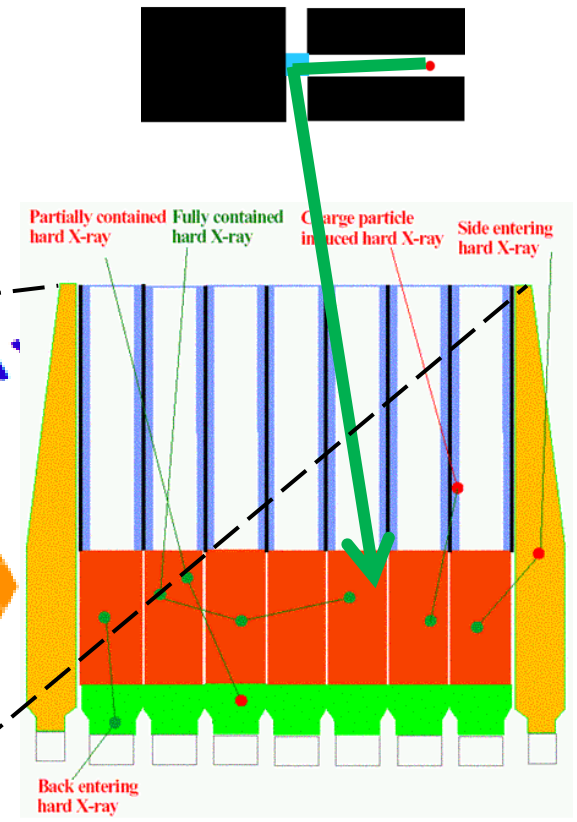
## Calibration with polarized gamma-ray ( $^{241}\text{Am}$ and scatter) v.s. Geant4 simulation



## Detector Response



- source ( $^{241}\text{Am}$ : 59.5 keV)
- plastic scattering piece
- lead

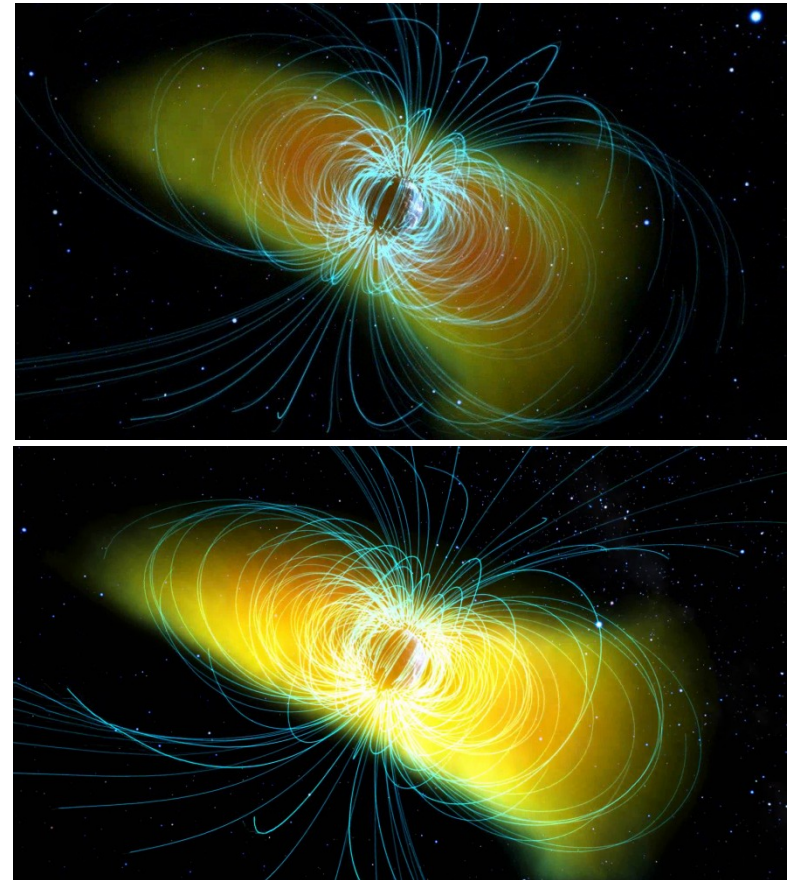


# ERG

(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

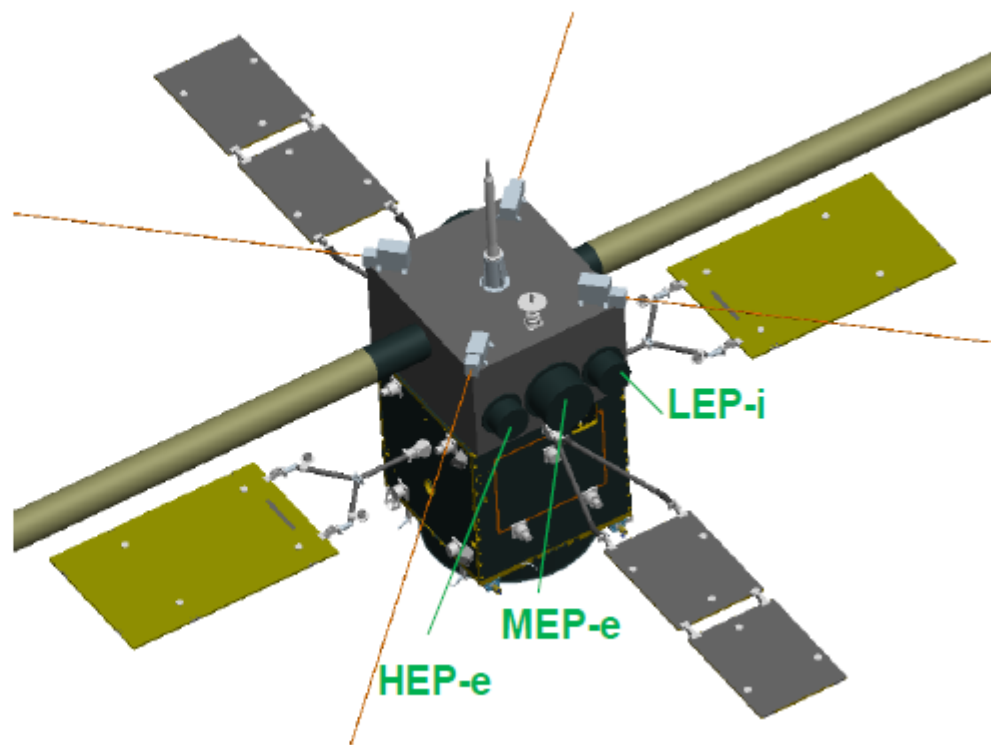
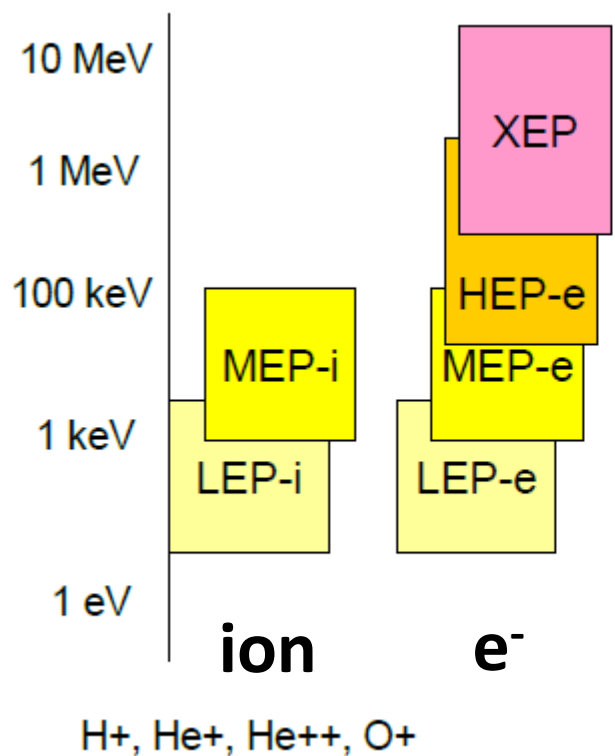


# ERG/PPE

(by courtesy of S. Kasahara@JAXA)

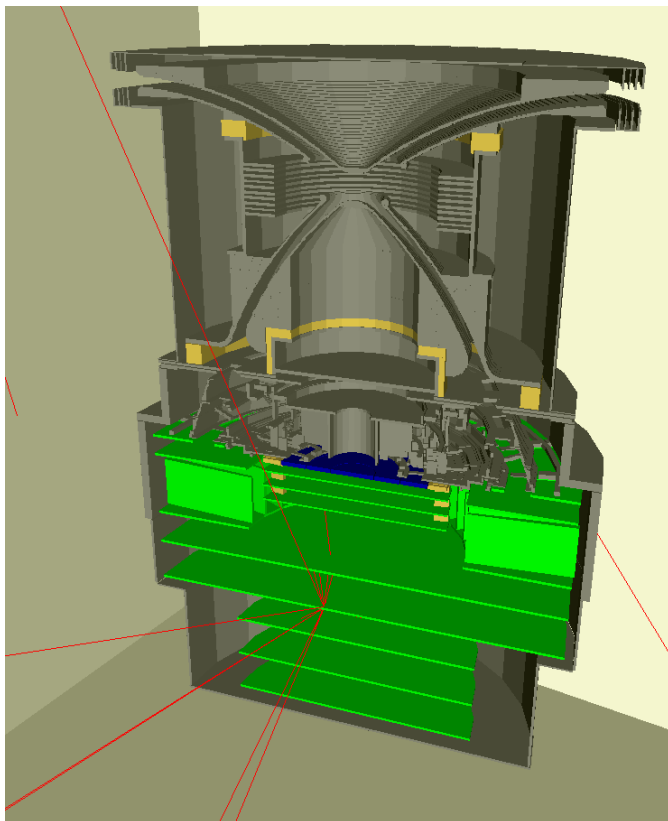
## Plasma and Particle Experiment

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

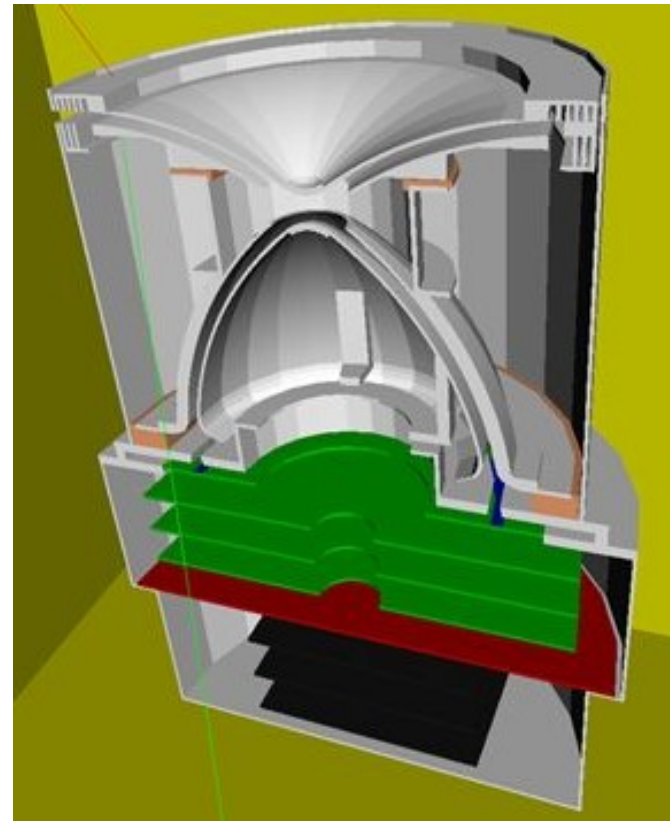


# ERG/MEPi and ERG/MEPe

(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.

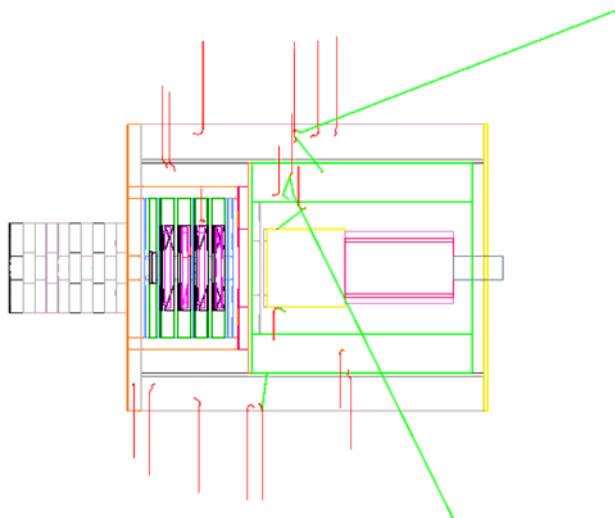
(Kasahara+2012 PSS, “Radiation background and dose estimates for future X-ray observations in the Jovian magnetosphere”)



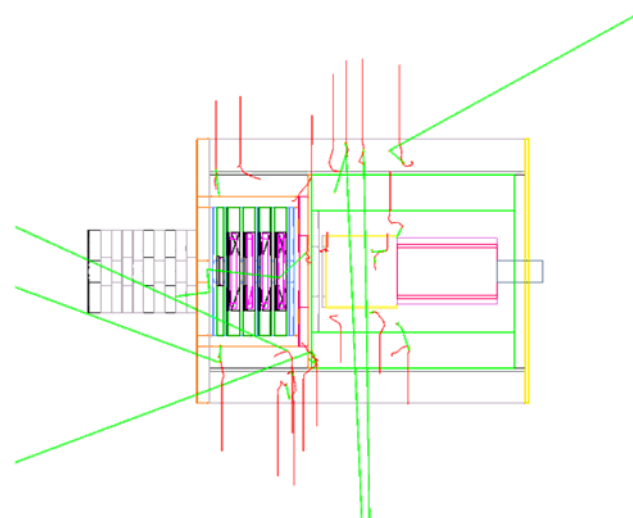
# ERG-XEP

(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<sup>-</sup>
- The main detector is guarded by anti-co scintillator (active shield) and heavy materials (passive shield).
- Geant4 is used for the shielding and FOV collimator design.



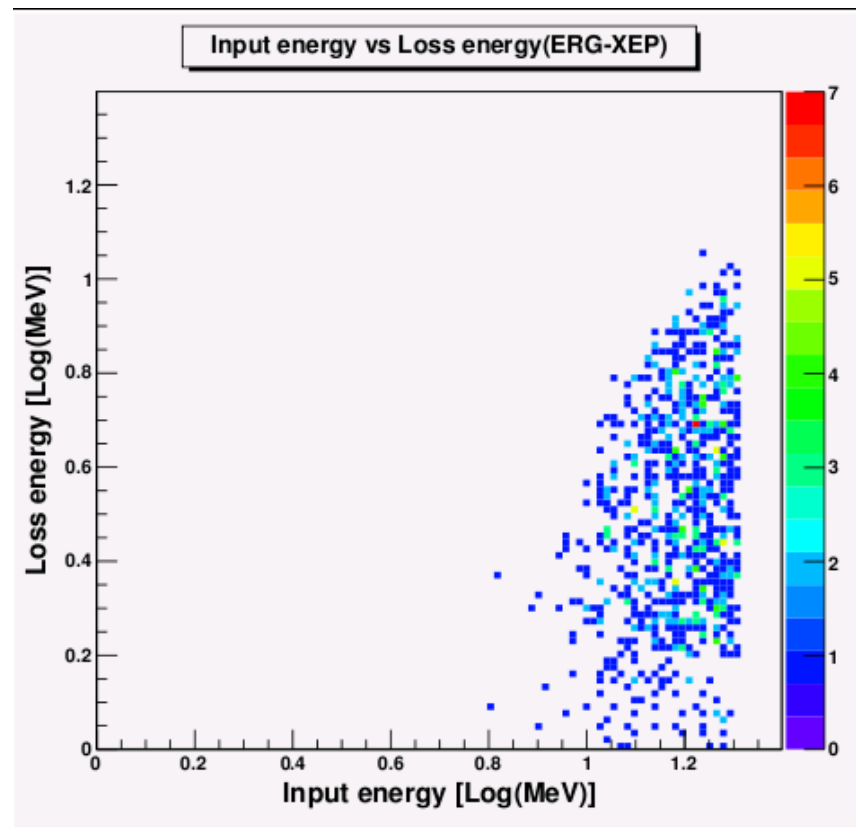
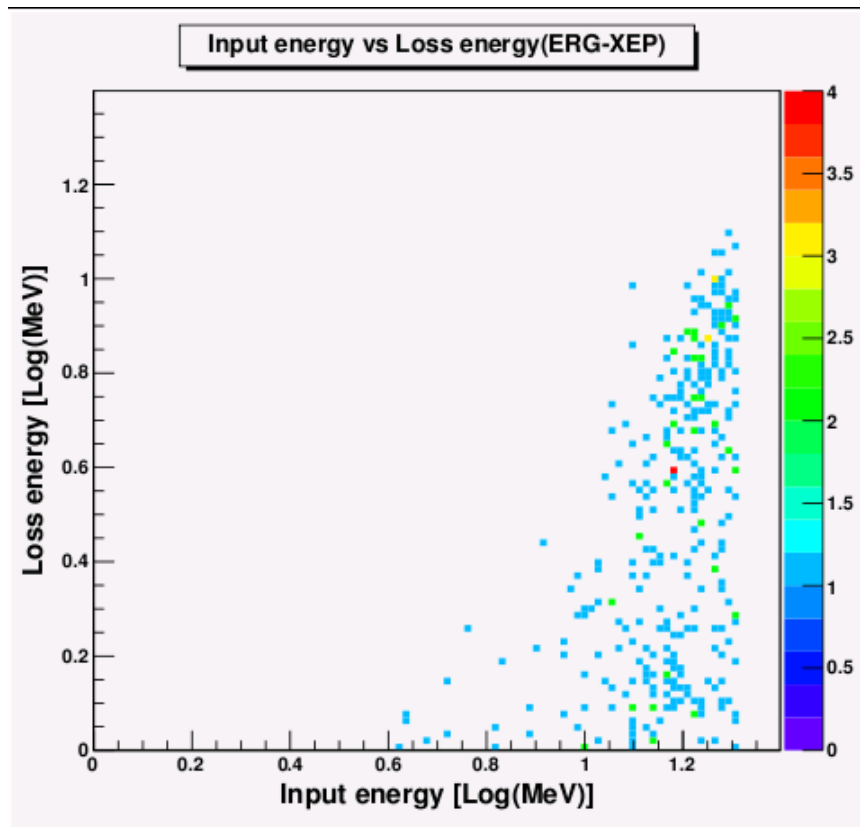
Al + Ta composite shield,  
2 MeV incident electrons



Al + Ta composite shield,  
5 MeV incident electrons

# 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.

# 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.

# Voices from novice users

- As shown, now Geant4 is (*at last!*) becoming popular inside JAXA.
- The requests (or concerns) from them are what we have heard for over 10 years:

**“Are we using Geant4 effectively?”**

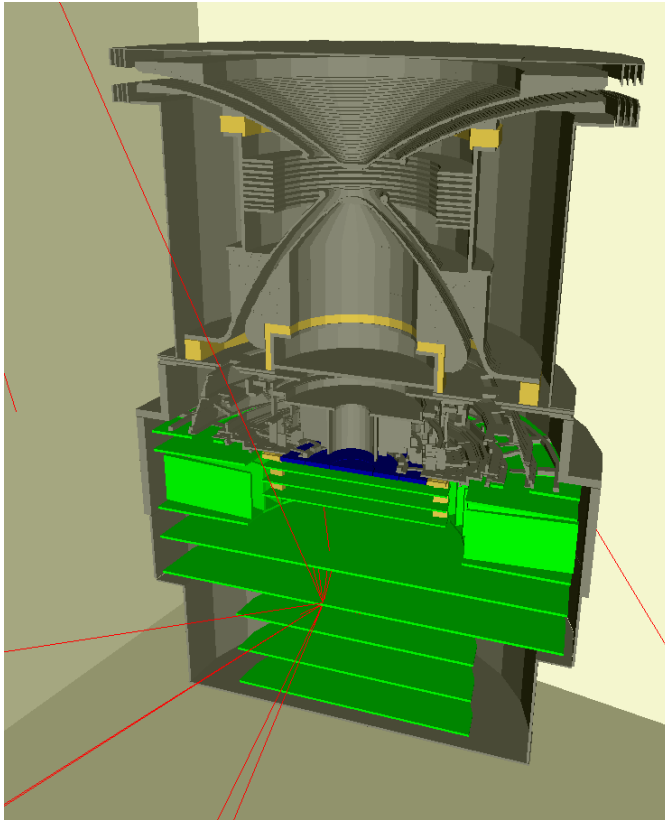
- Better (faster, cheaper, easier) way to implement a geometry?
  - Better way to output necessary information to down flow?
  - Are we using appropriate physics processes?
  - Better usage? (multi thread, reverse MC, biasing, ...)
- Maybe a set of “real” space use cases with good annotations should be organized and announced.

# Conclusion

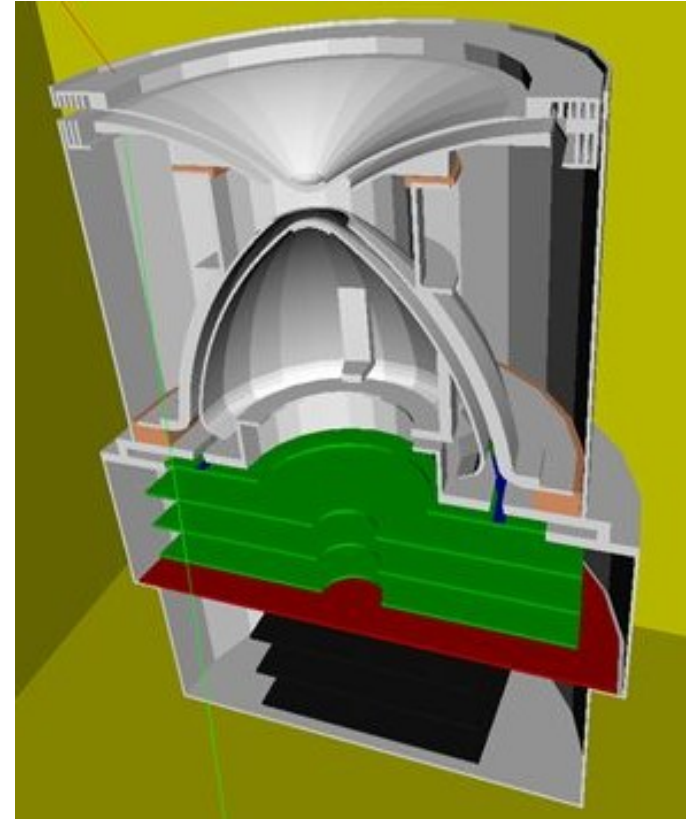
- Geant4 seems to become the majority in JAXA for the radiation environment MC simulation, while most users are rarely visible even in SUWS!
- The main users are probably detector developers, and most of them are struggling for better geometry implementation and selecting appropriate physics processes.
- Informal information exchange might be a key to get synergies among increasing users and projects.

(Backup slides)

# ERG/MEP geometry



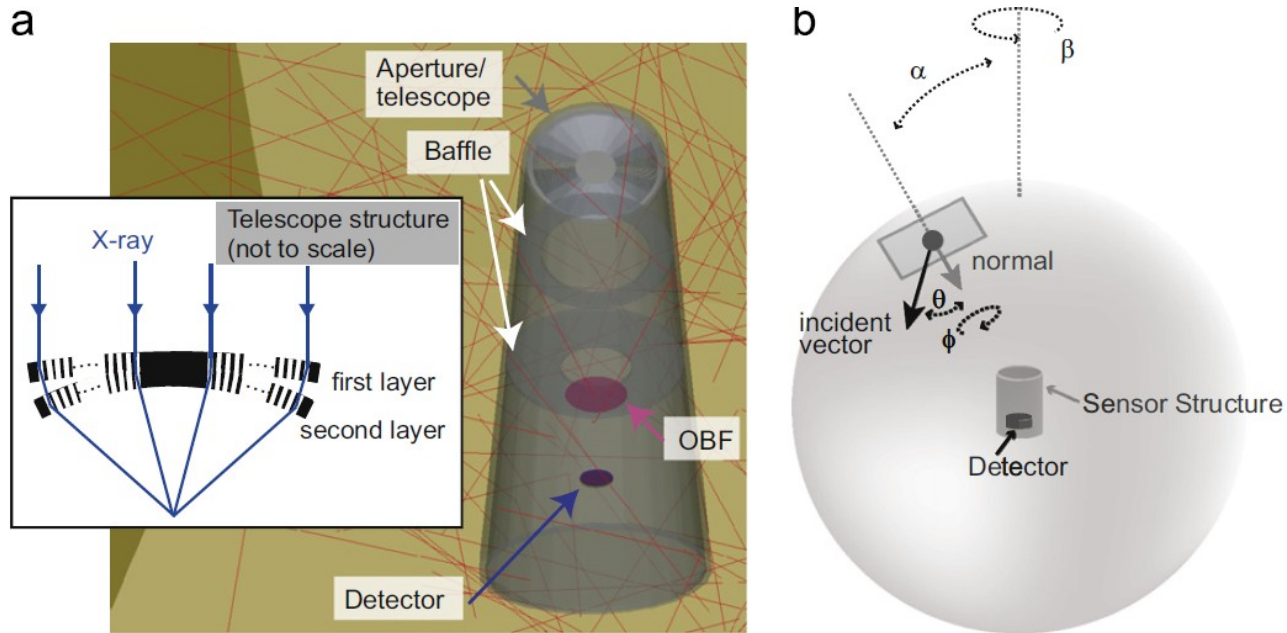
10-180 keV/q ion



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.

# JUXTA: Jovian magnetosphere X-ray detector



- Target
  - 0.3-2 keV X-ray
  - Ezo+ , “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"