Geant4 in ASTRO-H observatory Development

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Outline

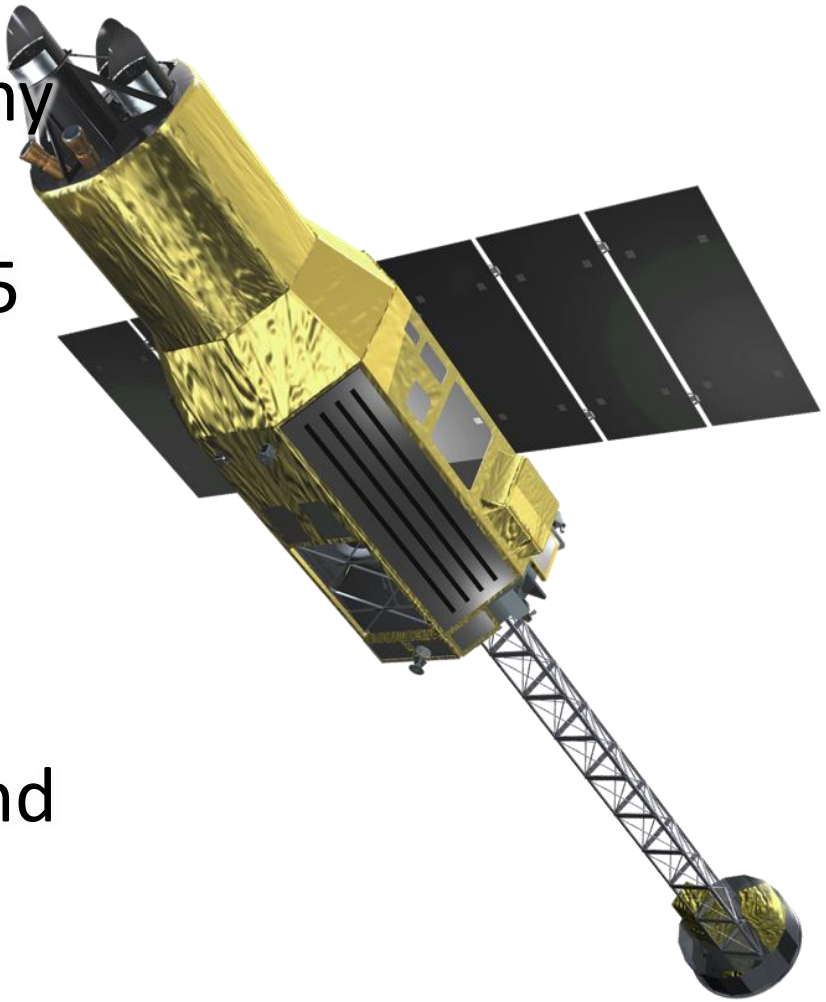
1. ASTRO-H observatory
2. This year's highlights
   - Shielding Study
   - Activation Simulation
3. What's Next?

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

- 1st end-to-end integration and test campaign in progress.



ASTRO-H: detectors

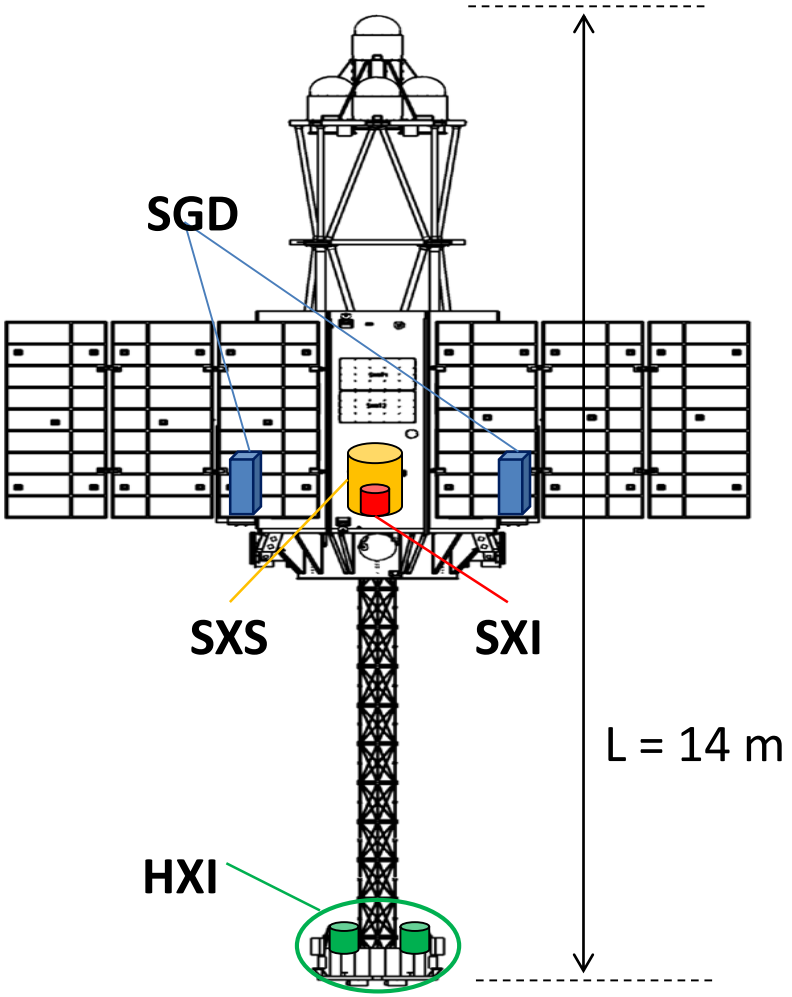
(SUWS7, 2010)

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

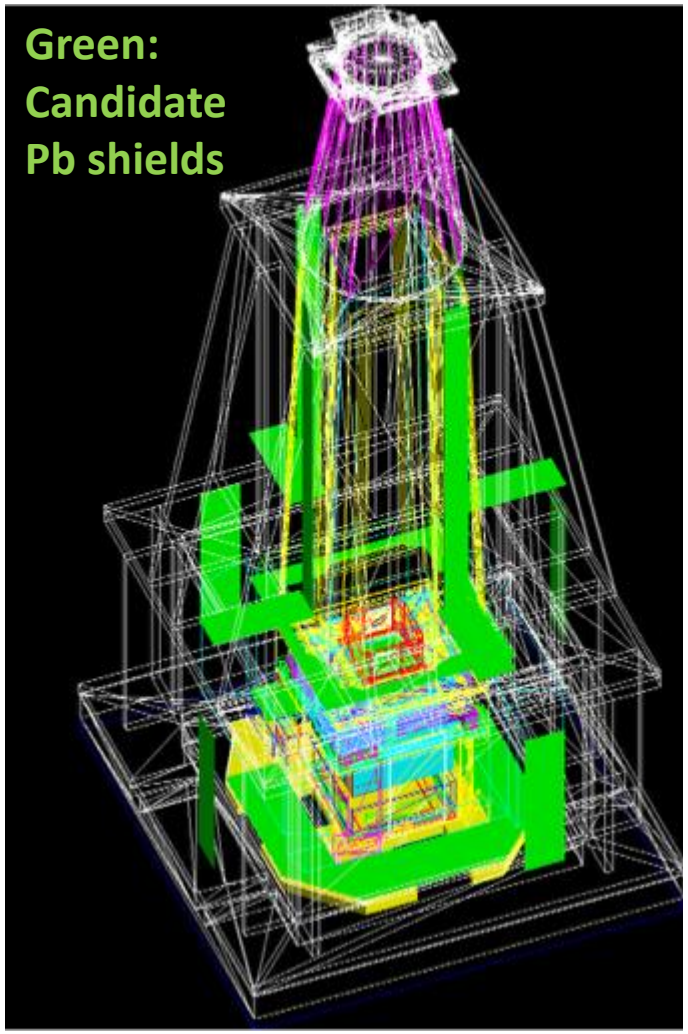
-> **MC simulation is essential**

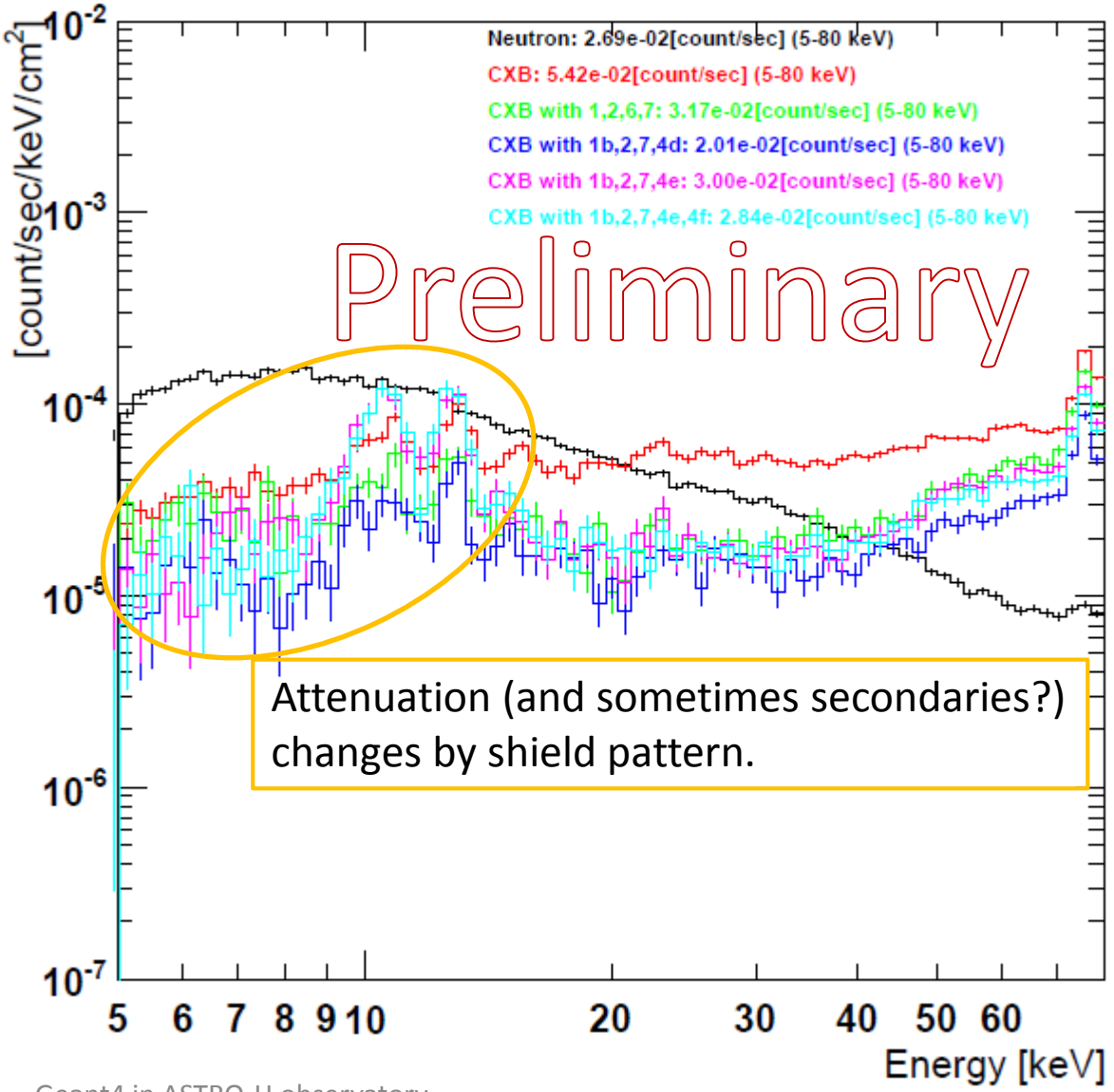


This year's highlights.

- HXI shielding study
- Activation study using Geant4 v.10

CXB Shielding design for HXI

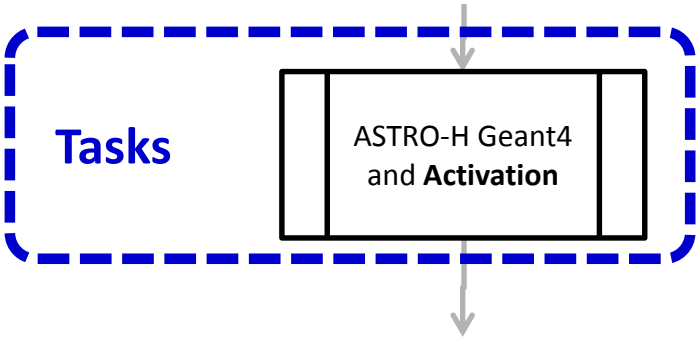


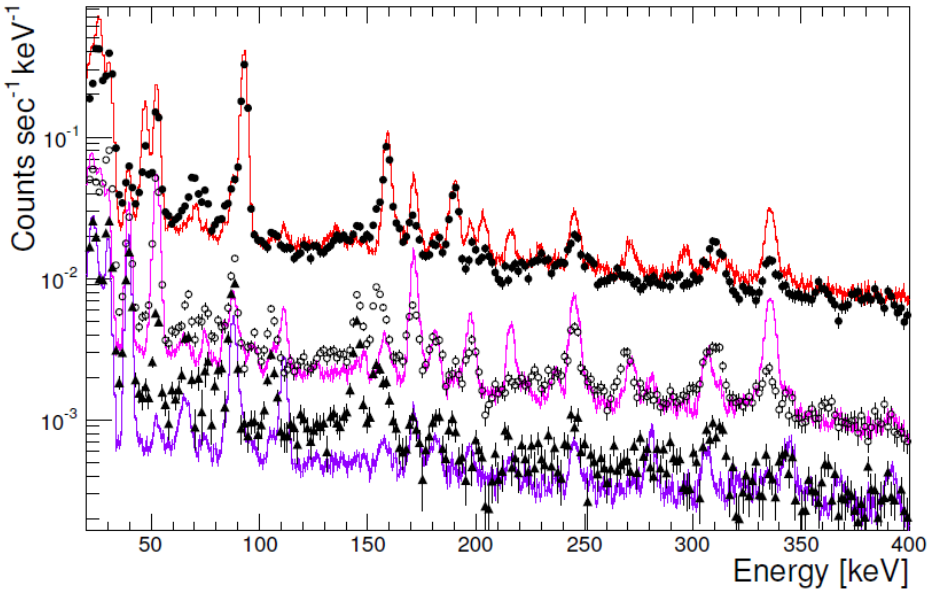


Activation Simulation

(SUWS8, 2011)

- We succeeded in reproducing the activation by accelerator beam tests, using Geant4 database, without external library.
  - Much simpler structure than past, and easy to maintenance in future.

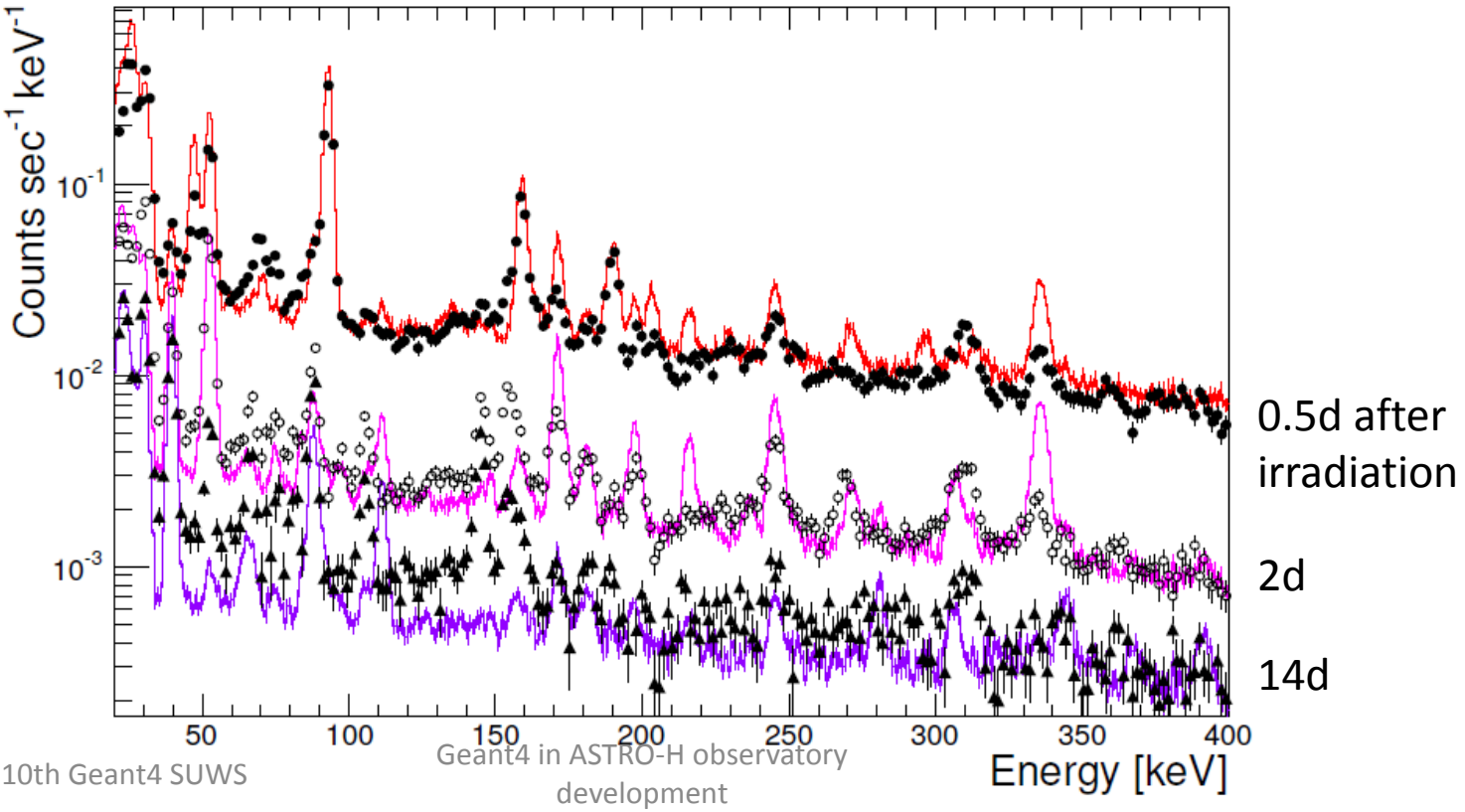




Activation progress

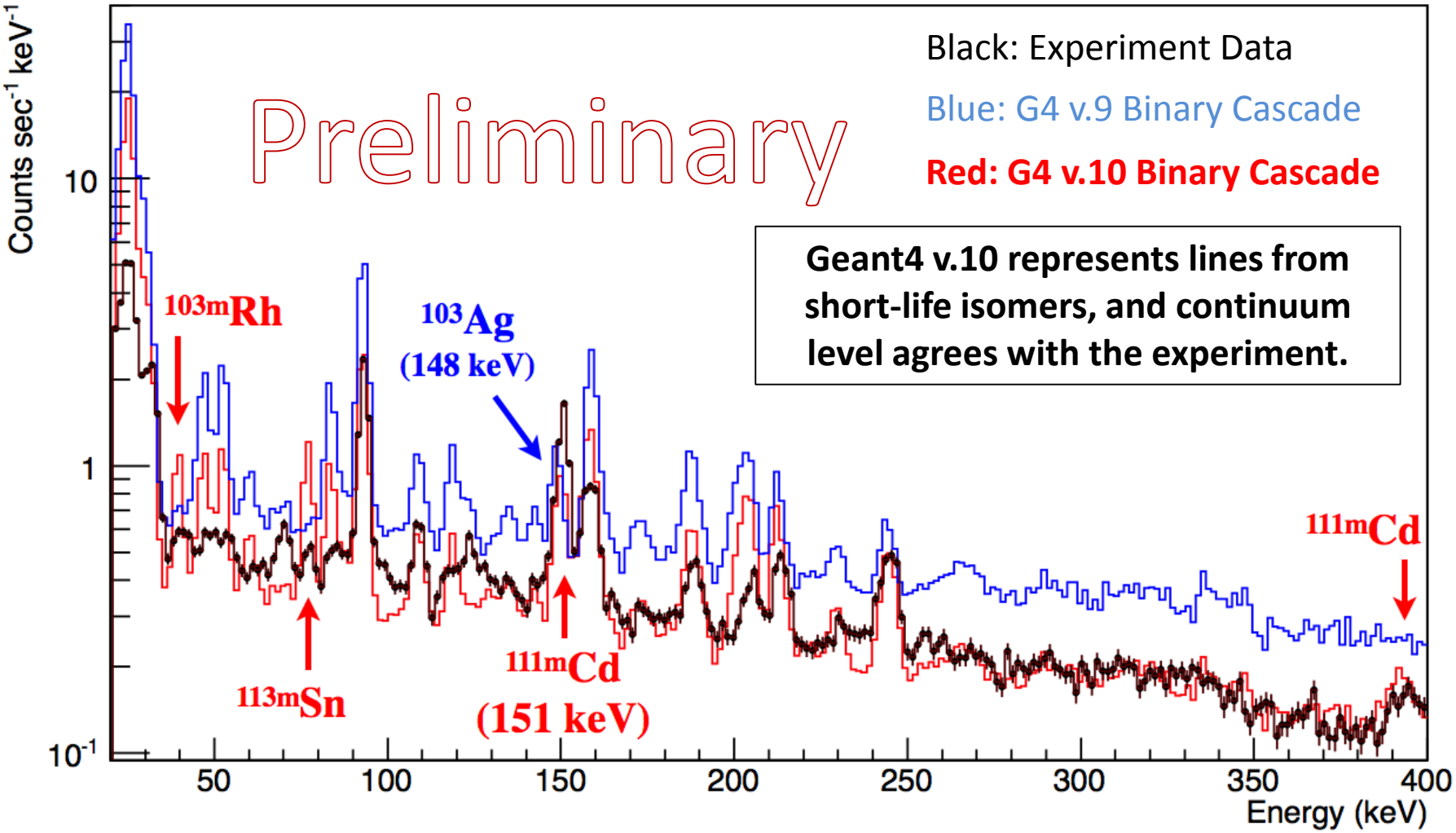
(SUWS9, 2013)

- We confirmed that the CdTe activation simulation, especially for continuum level, agrees quite well with the experiments. This should support to make the in-orbit BGD simulation reliable.
- Isomer lines were not represented well: Geant4 v.9 Hadronic processes don't generate them.



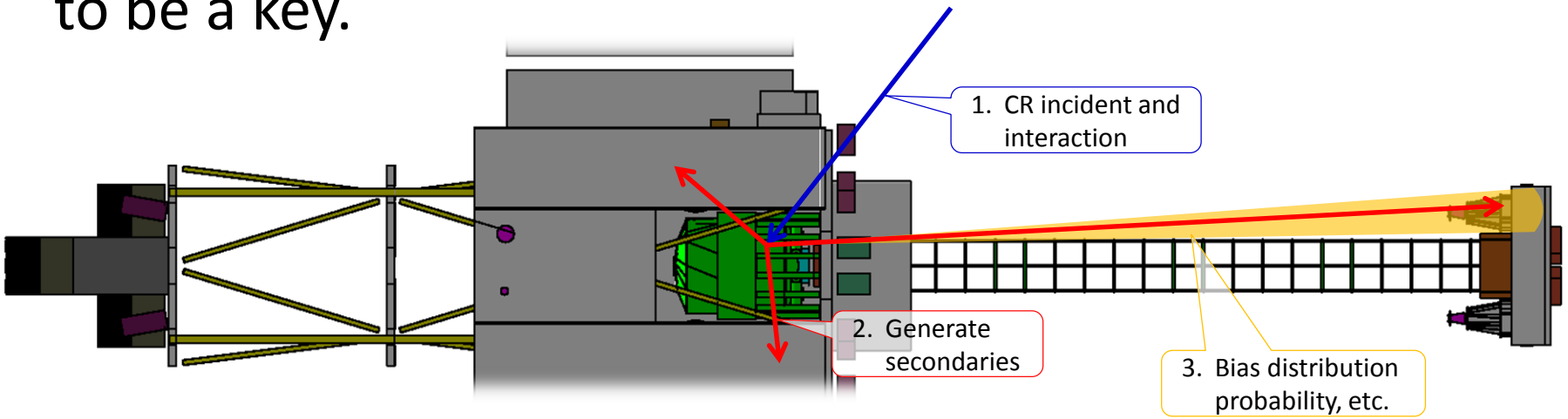
Activation from CdTe detector

1-20 min after irradiation



What's Next?

- "Products" from the simulator have not been released yet, while expected from last year. At that time, the simulation efficiency, such as event biasing, was thought to be a key.



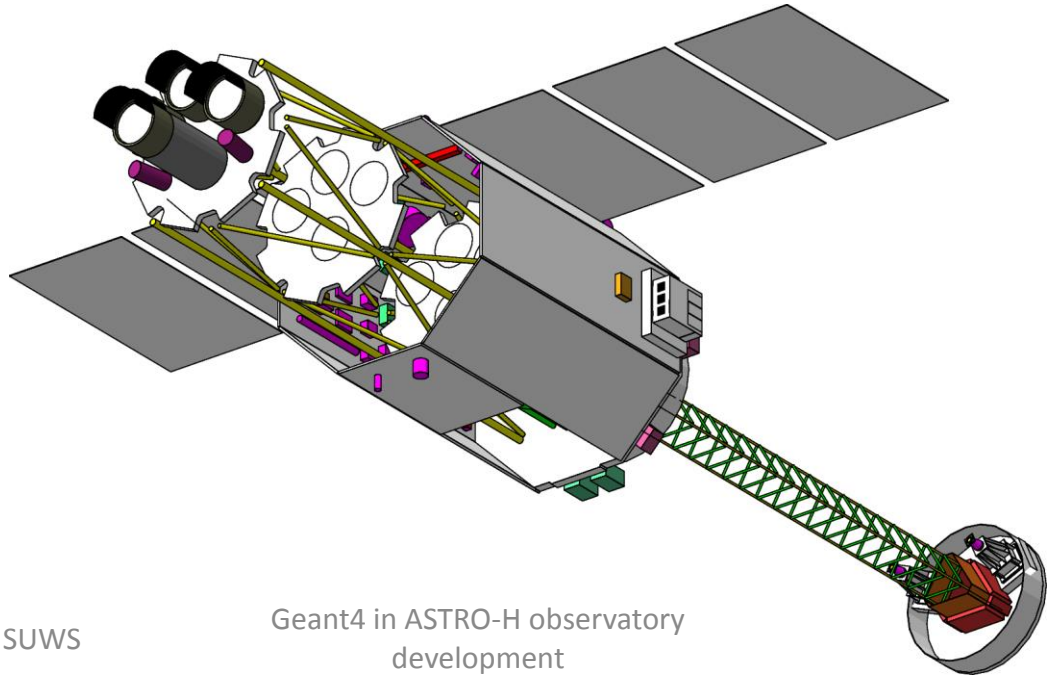
- Now, however, resources (of both human and computing) organization seems most important. This is not a technical but a management issue.

(backup slides)

Geometry Description

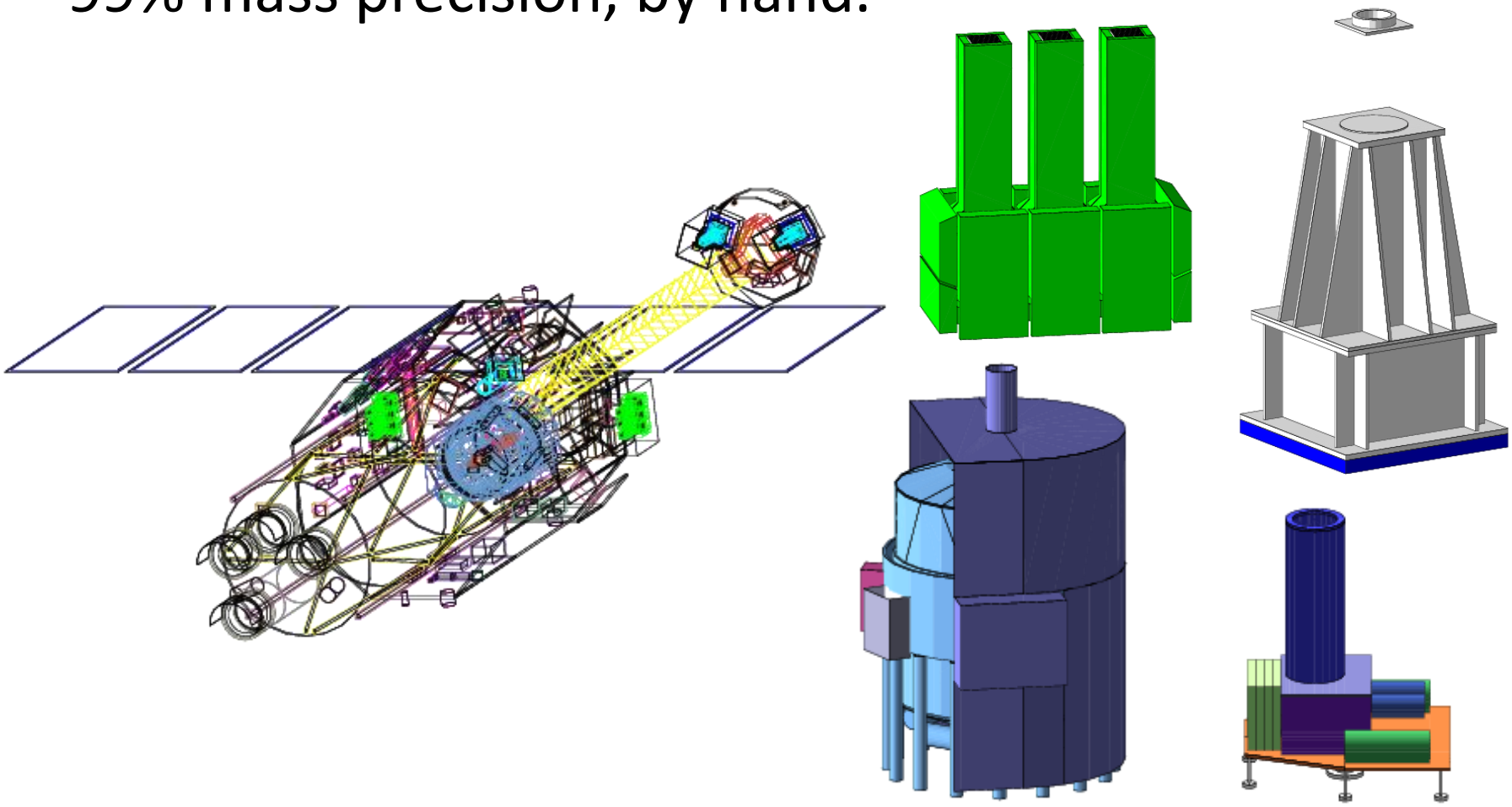
(SUWS8, 2011)

- Detectors and mirrors are placed in different logical spaces (“parallel world”) from the spacecraft structure.
  - This allows the geometry overlaying between two spaces, and makes it easy to develop each component/structure incrementally.



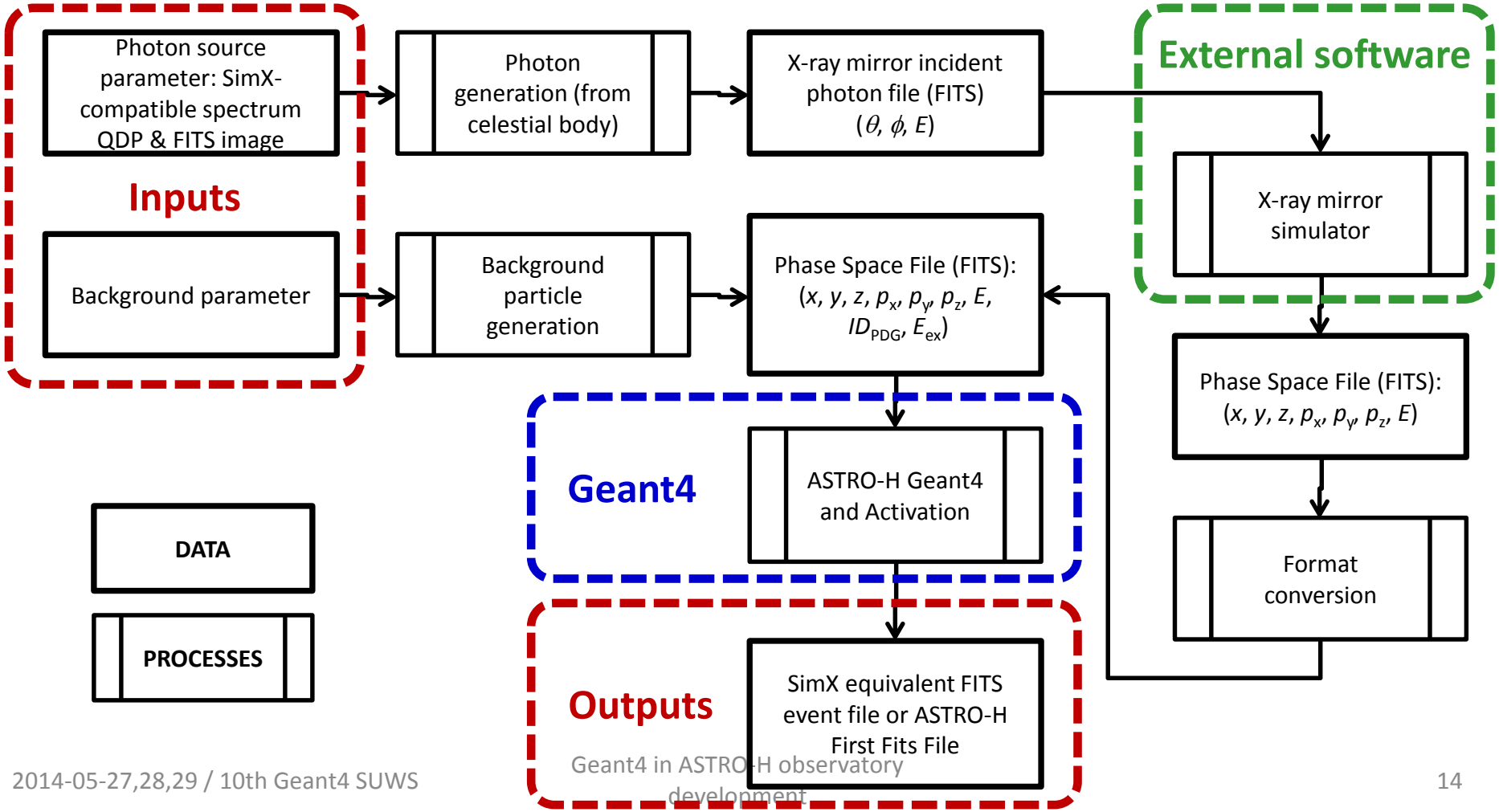
Geometry Status

- Now most of components are implemented with 95-99% mass precision, by hand.



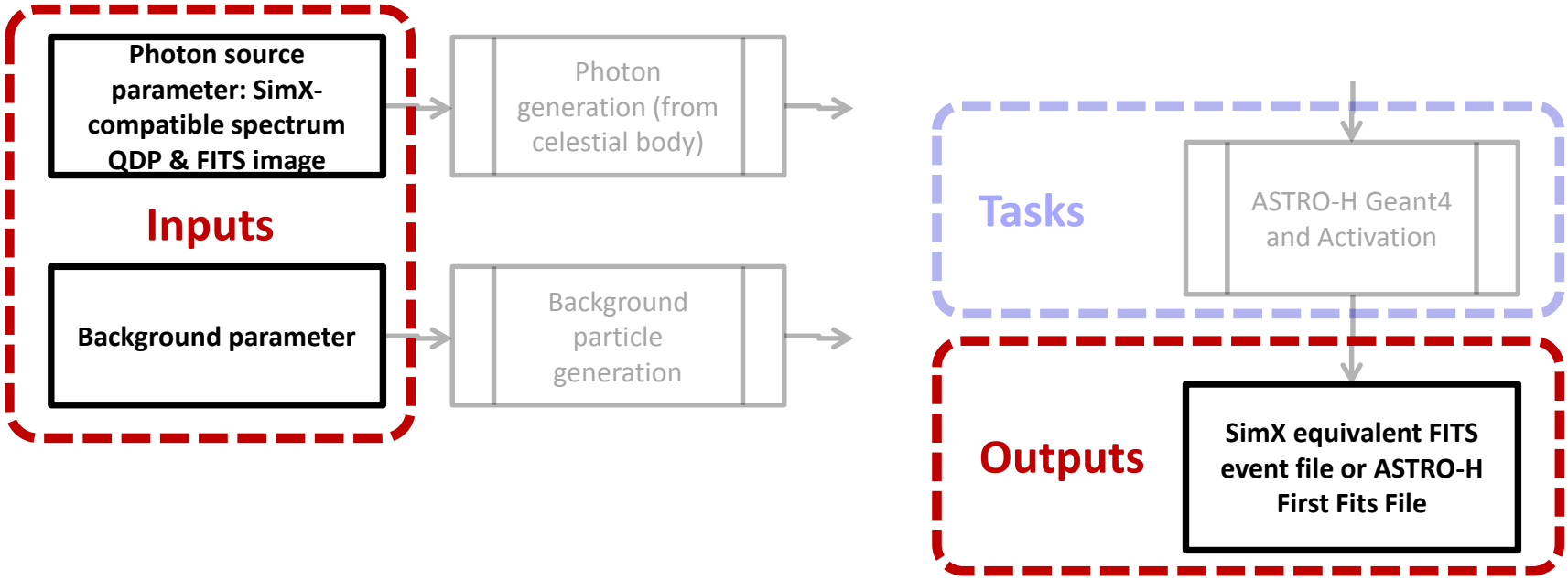
Simulator Dataflow

- I/O compatible with existing software
- Using external heritage: X-ray mirror ray tracing software



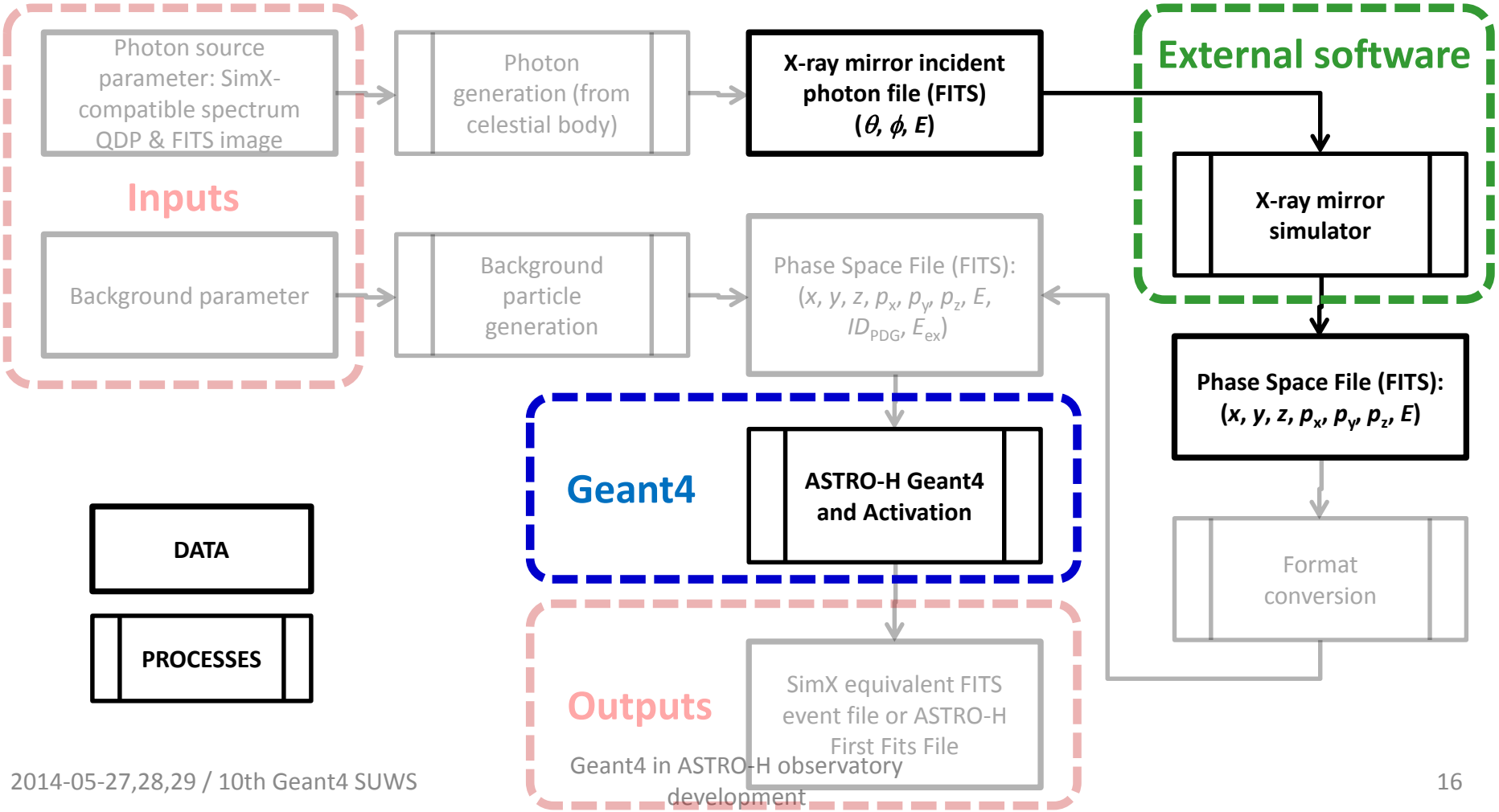
I/O compatibility

- Charged particle background sources are separately described from photons.
- Accepts existing software's celestial body description.
- Outputs high energy astronomy's standard format "event FITS".



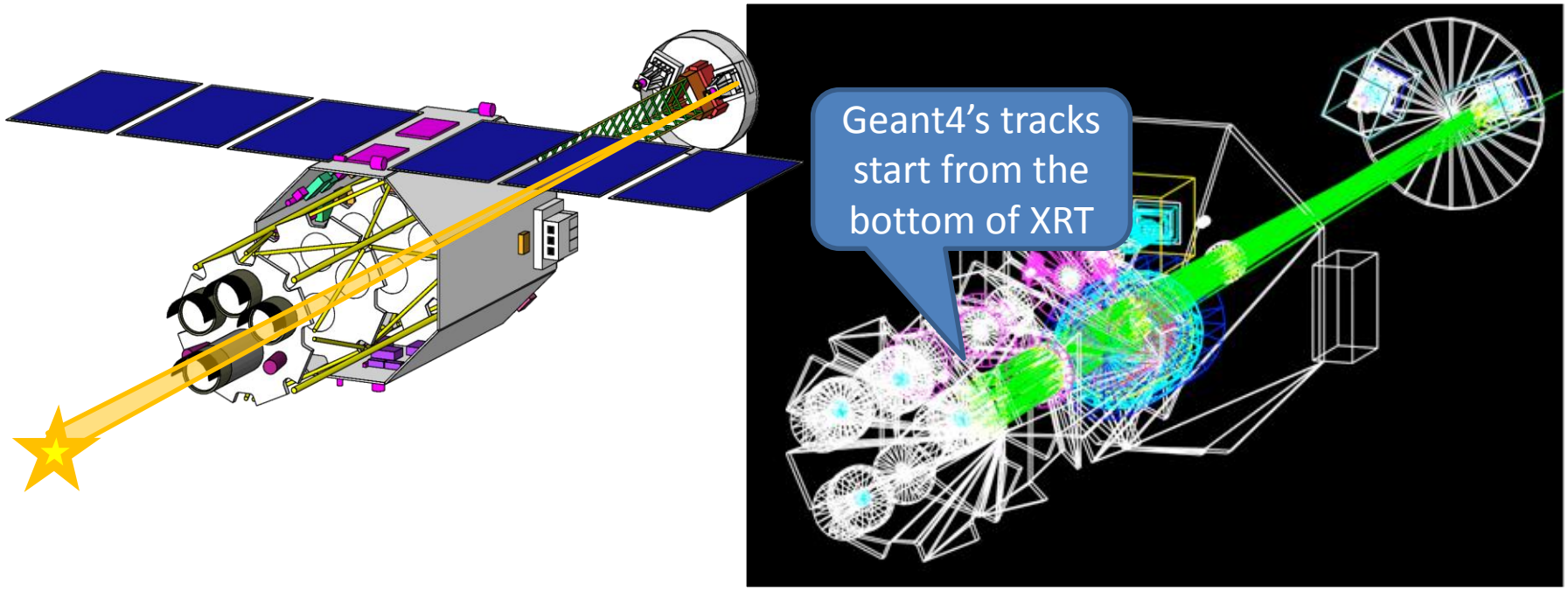
External software and Geant4

- We decided to use heritage for X-ray telescopes' ray tracing, because of strong request from the hardware developers.



External software and Geant4

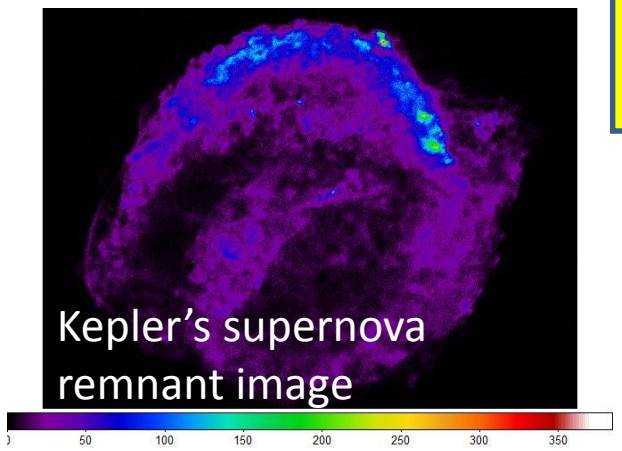
- The simulation uses external heritage ray tracing software for the mirror X-ray transportation.
  → Consistency between official user tools and Geant4 simulation is automatically ensured.

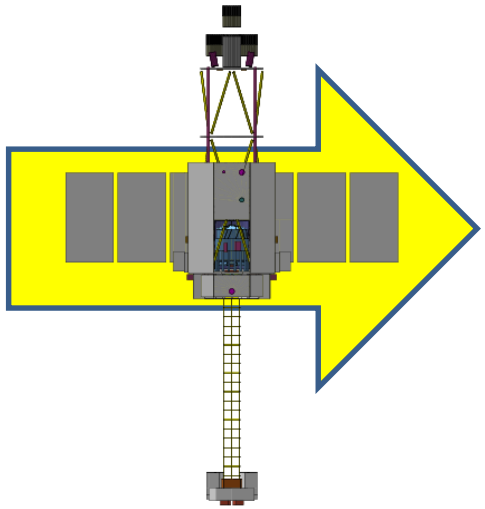


Beta release

- Beta version will be released to ASTRO-H science community, which is not familiar with Geant4.
- Beta version should
  - work on most of Mac OS X and Linux,
  - have simX 2.0 compatible I/O,
  - simulate all the detectors, and
  - be ready in one week or so.

X-ray spectrum





the simulator