Kataoka laboratory

Next innovation for Space Science, Nuclear Medicine, Radiation Physics

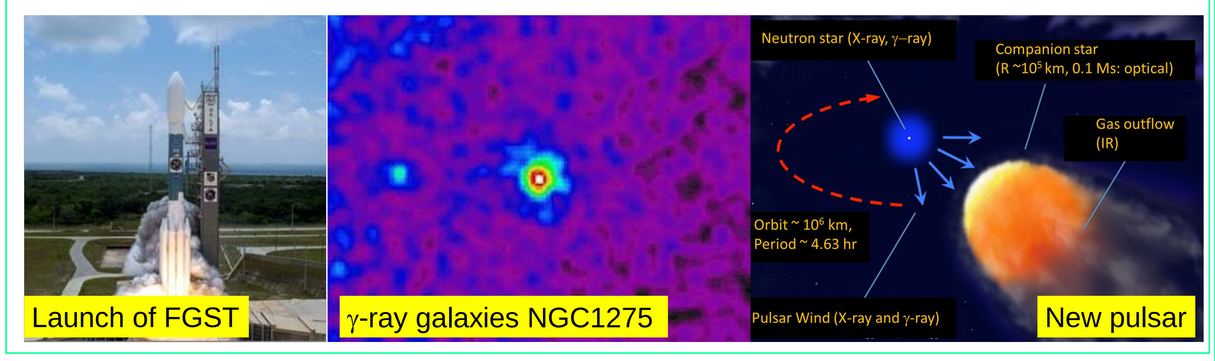
Jun KATAOKA (Assoc. Prof.): **kataoka.jun@waseda.jp**

Introduction: *"Innovation to the next radiation physics"* is our slogan, covering varieties of fields in both pure and applied physics. We are working for the frontiers of X-ray and gamma-ray astronomy searching for new X-ray and gamma-ray sources and high energy phenomena in the universe using various space astronomy missions. Also working as a key member of hardware team for the Astro-H mission, the sixth Japanese X-ray astronomy satellite to be launched in 2015. Moreover, our technology can be used for the future nuclear medicine, such as the ultra-high speed, high resolution Positron Emission Tomography (PET). We are also making handy Compton camera weighing only ~1kg but featuring high sensitivity and wide field-of-vision of 180 deg. This camera provides "real-time" gamma-ray image and highly useful to find radiation hotspots and for decontamination operation in Fukushima.

1. High Energy Astrophysics

● **Gamma-ray observation with FGST (20MeV-300GeV)**

FGST (Fermi γ-ray space telescope) is developed by the international collaboration of Japan, USA and EU. After successful launch in 2008, more than 2,000 gamma-ray sources have been discovered. Especially, Waseda team found new-type of γ-ray emitting galaxy and millisecond pulsars. *(NASA/Waseda press release in 2009; Kataoka et al. 2012)*



2. "New" Photo-sensor for Future Space Mission

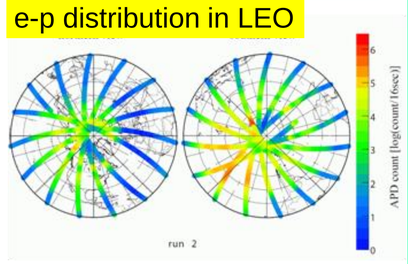
● **APD; performance verification**

Due to limited space and power consumption, compact, high performance photo-sensor is strongly awaited to replace traditional PMT. We demonstrated the perform- of avalanche photodiodes (APDs) for the first time in space in 2008. Thanks to this successful verification tests, the same APD will be also used as a light sensor for the future astronomy/geophysics missions like Astro-H, CALET and ERG.

✓ *Cute1.7+APD II ; only 5kg, 15x10x20cm ³ in size (Kataoka et al. Journal of Geophys. Res. 2010)*

Pico-satellite Cute1.7+APDII

e-p distribution in LEO



3. Future: Astro-H and CTA Projects

● **X-ray astronomy satellite Astro-H**

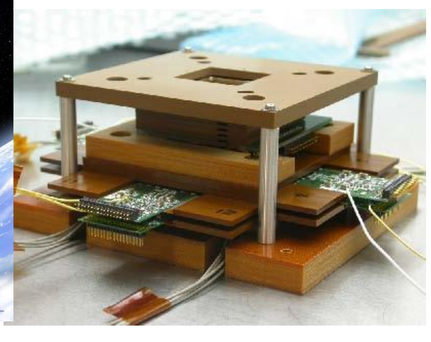
To be launched in 2015, Astro-H covers wide energy band of 0.5-300 keV with unprecedented sensitivity. Waseda team is developing APD and analog systems for hard X-ray imager (HXI) and soft γ-ray detector (SGD) onboard the Astro-H.

● **CTA: Cherenkov Telescope Array**

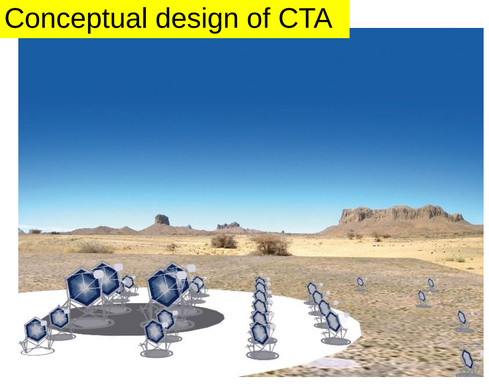
CTA is the next generation atmospheric cherenkov telescope covering 10 GeV and 100 TeV. CTA is scheduled to be operated in 2020 and we, Waseda team also starting research and development for future prototype testing.

Astro-H satellite

HXI onboard Astro-H



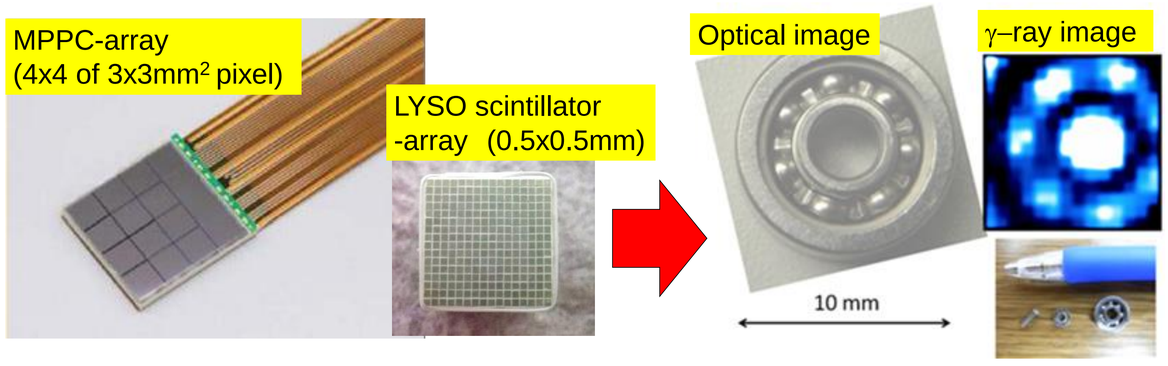
Conceptual design of CTA



4. Application to Nuclear Medicine: PET

● **MPPC sensor as a high-resolution gamma-camera**

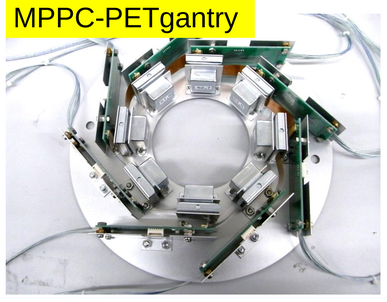
MPPC (multi-pixel photon counter) is a high performance Geiger mode APD recently developed by Hamamatsu Photonics. By coupling the MPPCs with fine-pixel scintillator arrays, compact gamma camera having sub-mm resolution has been developed.



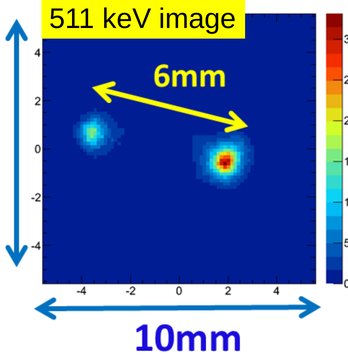
● **MPPC-PET gantry for small animals**

We fabricated the 8ch MPPC-PET gantry for small animals. By measuring a brain phantom and mouse at medical center in Osaka university, excellent spatial resolution of 0.9 mm was obtained, comparable with theoretical limit of PET scanner.

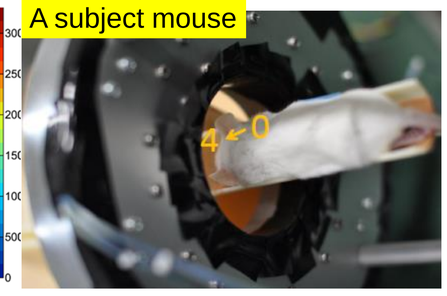
MPPC-PETgantry



511 keV image



A subject mouse



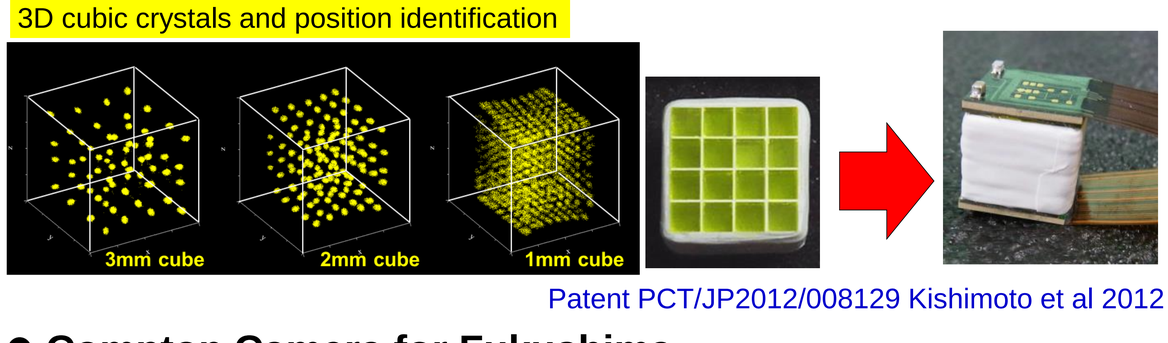
Kato et al. 2011; 2012 NIM-A, Kishimoto et al. 2012, IEEE-TNS

5. Handy Gamma Camera

● **A novel "3D" imaging of γ-rays**

We develop a novel method of measuring depth of interaction of γ-rays, by measuring the pulse height ration of double-sided MPPC arrays optically coupled with 3D cubic crystal arrays.

3D cubic crystals and position identification



Patent PCT/JP2012/008129 Kishimoto et al 2012

● **Compton Camera for Fukushima**

Release of radio active isotopes from the crippled Fukushima Daiichi Nuclear Plant is still being a serious problem in Japan. We are developing a novel Compton camera weighting only 1kg!

Prototype Compton camera
Developed with Hamamatsu Photonics

Kataoka et al 2013, NIM-A