Radiation tolerance tests and performance verification of pnCCD at high temperature for future satellite mission HiZ-GUNDAM

1. HiZ-GUNDAM and wide field view X-ray monitor

- Near-infrared telescope
- Wide field view X-ray monitor
- Lobster Eye Optics
- pnCCD

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<td><strong>Exposure time</strong></td>
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<td><strong>Mission year</strong></td>
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2. pnCCD

- One of back illuminated type CCD
- CCD which is capable of reading out all columns in parallel.
- Fast framerate is realized. (100Hz~10Hz)
- Pixel size: 75µm × 75µm
- Number of pixels: 75µm × 256 pixels
- Depletion layer’s depth: 450µm

X-ray

- Spec of pnCCD will be degraded by radiation in the space.
- I’ll introduce about degrade of the Spec
- Dark current.
- Energy resolution
- CTI

3. Radiation tolerance of pnCCD.

- Flux of radiation in the orbit
- Effective flux of radiation to pnCCD

- We determine to irradiate protons equivalent to 3month, 1year and 3years dose at HiZ-GUNDAM orbit.
- 10MeV protons was selected to radiation tolerance test.
- 10MeV proton’s Bragg peak

4. Radiation tolerance test

- The Wakasa Wan Energy Research Center
- 10 MeV proton, 0.9 rad (3yr in orbit)
- Flux: ~1×10^6 cm^-2/s

- Shield (Al jig) + Jig Stopper
- 10MeV protons
- Make dose gradation like below.

5. Dark noise distribution

- We calculated dark current at each area of pnCCD.
- Dark current is proportional to dose and temperatures.

<table>
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<td><strong>-50 deg C</strong></td>
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<td><strong>-35 deg C</strong></td>
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<td><strong>-20 deg C</strong></td>
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6. Spectrum

- We research Energy resolution by make spectrum.
- Energy resolution is proportional to dose and temperature

7. CTI (Charge transfer inefficiency)

- Signal charges are trapped by generated defect in the silicon lattice.

8. Conclusion and future plan

- We investigate radiation tolerance of pnCCD by irradiating protons.
- 3months, 1year and 3years dose at HiZ-GUNDAM orbit.
- We researched Dark current, Energy resolution and CTI.
- These results are important to future development.

9. Reference