# High Resolution Wide-band Photon-Counting Detector with Scintillator-Deposited Charge-Coupled Device

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We report here a newly developed wide-band photon-counting detector for 0.5−100 keV X-rays possessing high spatial resolution, to be employed as the focal plane detector of a hard X-ray telescope: the scintillator-deposited CCD (SD-CCD). The design concept of the SD-CCD is shown in Fig. 1. We employ the CCD itself as a soft X-ray detector. The scintillator is directly coupled to the back surface of the CCD. The majority of X-rays having energy of above 10 keV cannot be absorbed by the CCD and pass through it. However, they can be absorbed by the scintillator and emit hundreds or thousands of visible photons. The visible scintillation light photons can be absorbed by the same CCD. In order to maximize the number of visible photons detected by CCDs, the surface of the scintillator is coated by a reflector, such as aluminum, which leads to a better energy resolution. We employed the needlelike structured CsI(Tl) scintillators that provides a superior combination of stopping power, high spatial resolution, and high light yields.

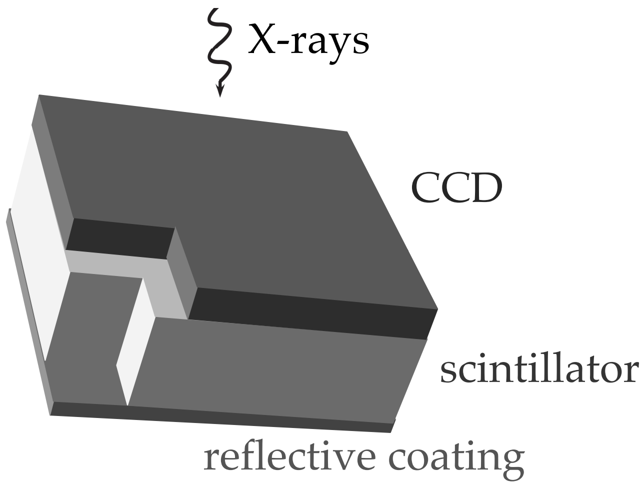


Figure 1: Design concept of the SD-CCD. The scintillator is directly coupled to the back surface of the CCD which enables us to collect high-energy X-rays in the scintillator. Since the CCD possesses high detection efficiency for visible photons, visible photons generated in the scintillator can be detected by the same CCD.

We coupled the needlelike CsI(Tl) on the fully-depleted backside illuminated CCD to fabricate the SD-CCD. The thickness of the needlelike CsI(Tl) was 300 $\mu$m. We evaluated hard X-ray responsivities at the synchrotron facility, SPring-8. We irradiated monochromatic X-ray beam from 20−80 keV and measured the energy dependences of the pulse heights and the energy resolution. The linear relationship between the incident X-ray energy and the pulse height can be obtained with a maximum deviation from a linear function of 6%. The energy resolution can be well described by an inverse square-root of the incident X-ray energy and is 20±1% at 80 keV. The spatial resolution can be achieved 10±3 $\mu$m at 17.4 keV.