A Calibration Algorithm to Solve the Pixel's Inconsistency for the Imaging of the HEPS

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1. INTRODUCTION

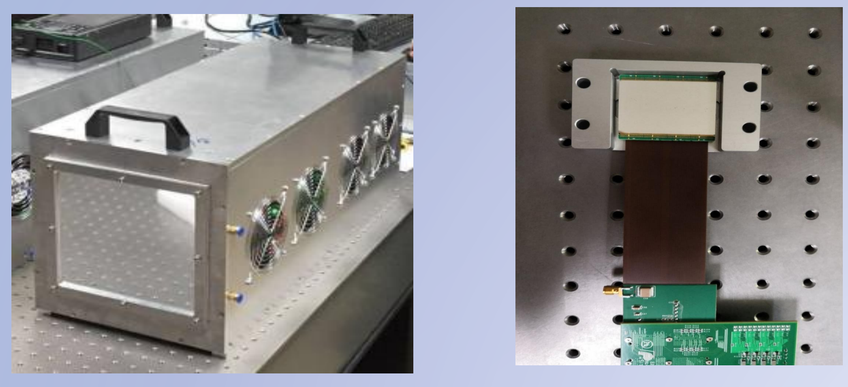

Fig. 1. HEPS-BPIX readout electronics system and one of its sensor module

HEPS is a readout electronics system based on the BPIX pixel array detector readout chip. The prototype of the detector consists of 16 sensor modules. In order to complete the basic function of the pixel detector, the readout system needs to be set up the configuration of the BPIX readout chip. Due to various factors such as the process non-uniformity and voltage drop, the thresholds of the pixels are not completely identical. It needs to be calibrated to make the inconsistent thresholds of the array pixels reach a corresponding level. The readout chips of the array pixel detector configure the threshold of the pixel with 5 bits data, meaning that 32 sets of different values can be modified for one pixel's threshold .

2. IMPLEMENTATION

Calibration:

(1) The inputs are 1kHz square waves starting at 60mV to 600mV stepping by 20mV to reach the count from 0 to the full count of pixel per seconds.

(2) For a pixel, there are 32 different thresholds for one signal amplitude of inputs.

(3) Taking the counts as the ordinate and the input amplitudes as the abscissa, this test can obtain 32 sets of curves each pixel.

(4) To find the appropriate curve from the 32 curves through making the pixel curve be close to the average of whole pixels, and the threshold corresponding to the curve is the pixel's threshold.

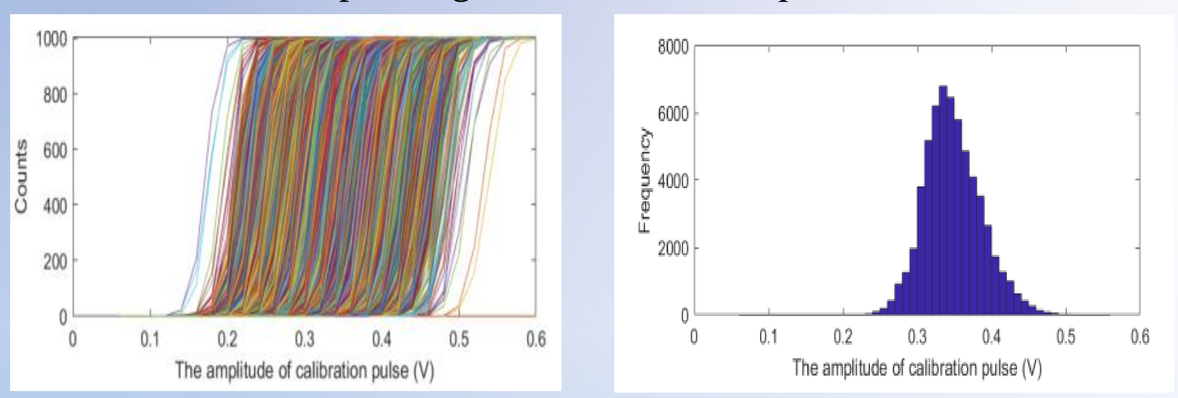

Fig. 2. The S-curve and threshold distribution before the inconsistent Calibration

If the pixel has a inappropriate threshold, there will be bright noise and dark noise in the imaging. (the former is caused by the lower threshold, and the latter is caused by the higher threshold and appears during detecting the synchrotron radiation or the X-ray).

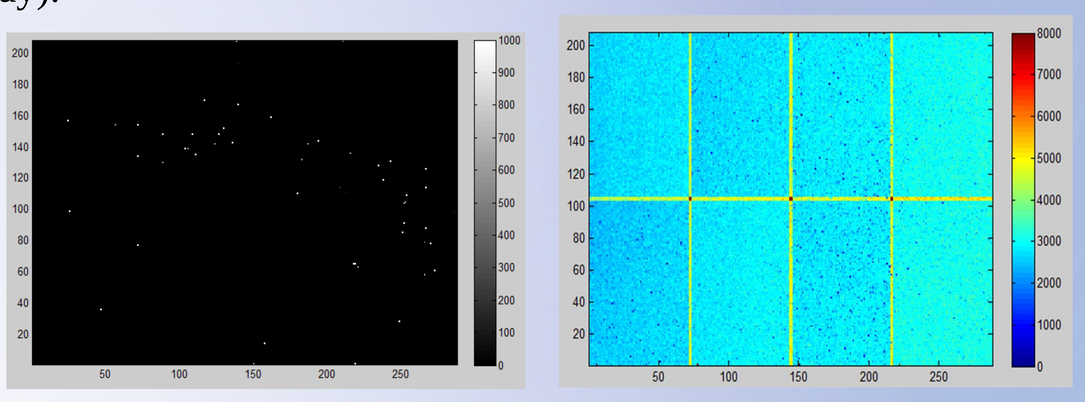

Fig. 3. The imaging with the bright noise and dark noise before the inconsistent Calibration

Based on the calibration, the thresholds of the bright and dark noise points are set separately according to the characteristics of the scanned S-curve curve. After excluding the s-curve of this inappropriate threshold, set the threshold to the max value 32 for the bright noise, set the threshold to the lowest value of the plateau which can reach full count with the max input amplitude 600mV for the dark noise.

3. RESULTS

(1) The final S-curve spread and the threshold distribution of the array pixel detector is minimized.

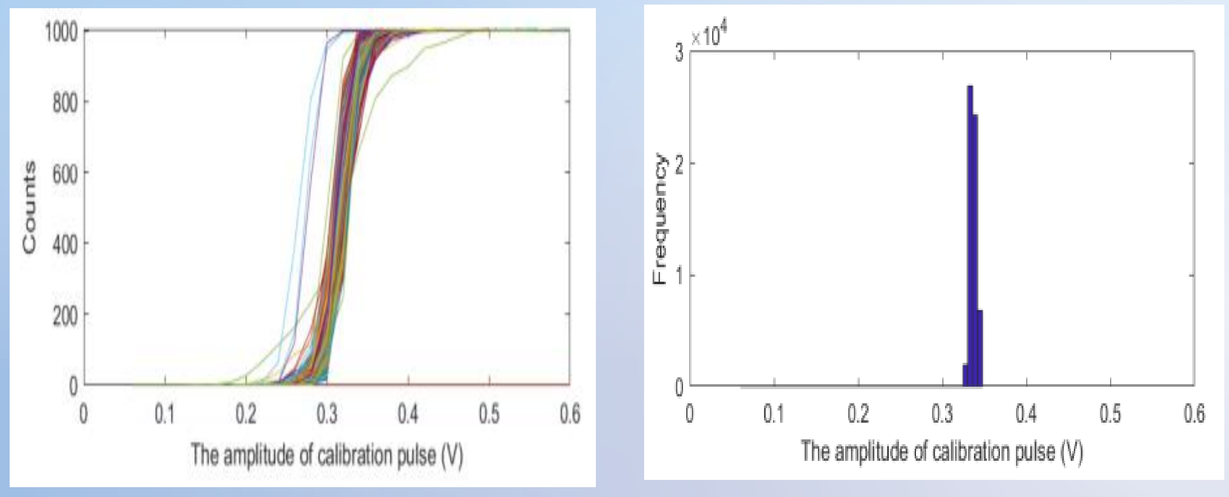

Fig. 4. The S-curve and threshold distribution after the inconsistent Calibration

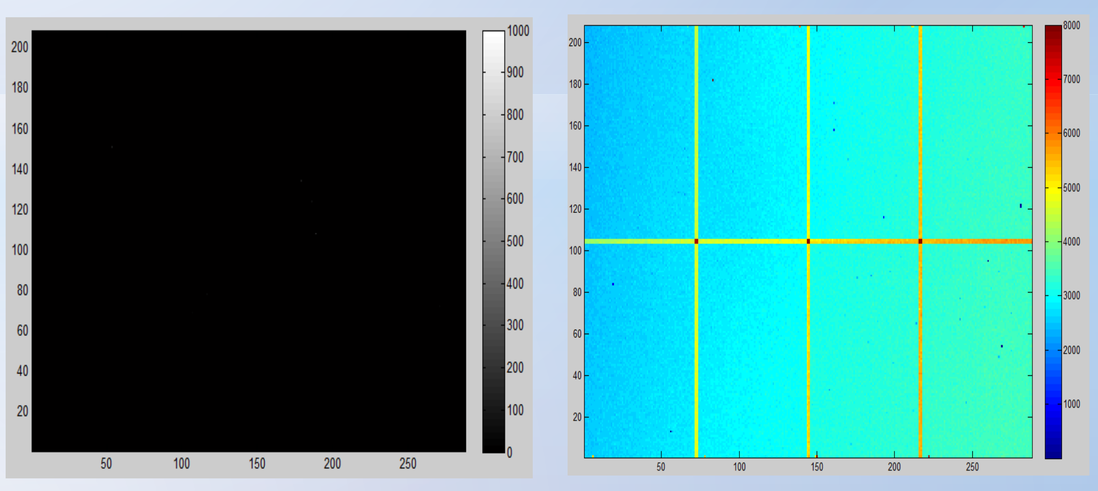

Fig. 5. The imaging without the bright noise and dark noise after the inconsistent Calibration

(2) Both the bright and dark noise points disappear. Although it affects the inconsistency, the points to be set separately are the few and have a count. It can be corrected by an algorithm later.

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