ATLASPix and MuPix8 in aH18

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ATLASPix and MuPix sensor chips are the result of the sensor development in AMS H18 HVCMOS technology that started in 2011. At the beginning there were two development paths. The first development concentrated on monolithic sensors i.e. sensors with zero suppressed readout on chip. These chips were developed primarily for the experiment Mu3e. Radiation hardness was not specially addressed, standard design was used. From 2011 – 2014 six sensor chips were submitted, design have been done at University of Heidelberg. The second development concentrated on the radiation hard HVCMOS sensors for ATLAS in AMS H18 process. From 2011 till 2016 six chips were submitted. These sensors can be connected to the readout ASIC FEI4 and readout capacitively. These sensors are referred to as CCPD. Performances, such as detection efficiency, radiation tolerance, time-resolution have been improved from submission to submission, leading to the versions that show efficiency and timing after irradiation comparable to the standard planar sensors. All prototypes until 2016 used standard 20 Ohm cm substrate. The development has been done in wide collaboration of ATLAS groups: Heidelberg (later KIT), CPPM, Geneva, CERN, Bonn, Göttingen. Chip design has been done by Heidelberg (later KIT) and CPPM.

Sensors ATLASPix and MuPix8 are the result of the merge of MuPix- and CCPD-ATLAS development series. Readout architecture is taken from MuPix designs and the radiation hard pixel design from CCPD. ATLASPix and MuPix8 are implemented on the standard substrate and two high resistivity substrates. In some pixel flavours, the fully CMOS option – isolated PMOS in deep p-well – has been used.

ATLASPix and MuPix8 has been produced within an engineering run in AMS aH18 technology, which was adjusted for the use in high energy physics by the high resistive substrate- and deep p-well-options.

We are testing the ATLASPix and MuPix8 since September 2017, the first results are very nice.

The tested chips have been implemented on a substrate with 50-100 Ohm cm resistivity.

MuPix8 (Figure 1) has an area of 1 cm x 2 cm, 128 x 200 pixels, pixel size is 80um x 81um. Zero suppressed signals (hits) are readout and transmitted via 3 + 1 digital links that operate at rate of about 1.25-1.6 GBit/s. Design is radiation hard. MuPix8 has been designed by KIT and Heidelberg, the production has been financed in part by BMBF (German Federal Ministry of Science and Research) project HVMAPS. Test used system has been developed at KIT within the AIDA project (Figure 2). So far we have tested: Response of single pixels to Fe-55 and Sr-90 signals, noise of the pixels. The measured signal to noise ratio derived from the Sr-90 most probable value (about 4500e) and base line noise is 80. Signal amplitude for the Fe-55 peak is ~ 130mV (Figure 3) and sigma value of the noise determined from base line histogram is 4.4mV (corresponds to ~ 56e). Time walk of about 20ns has been measured by varying the test signal injected into the pixel from 2000e to 7000e and by measuring the comparator output. The power consumption of the chip is about 240mW or 120mW/cm^2. Digital readout has been also tested.

ATLASPix has been submitted in three flavours. The project has been financed by the HVCMOS collaboration of ATLAS groups, the chips have been designed by KIT and Geneva. The used test system has been developed at KIT. The tested chips belong to the flavor “S”, they have column drain utriggered readout. One of the “S” chips uses the standard NMOS-based comparator in pixel. Another “S” chip uses the isolated PMOS option (known also as “fully CMOS”) inside the pixel. The comparator is of CMOS type.

The area of each chips is 0.3 cm x 2 cm, they contain 25 x 400 pixels each, pixel size is 130 um x 40 um. We have measured the response of single pixels to test injection signals. Measured was the amplifier output and the comparator output. Also here, a time walk of 20ns has been measured. Both pixel types with and without fully CMOS work well.

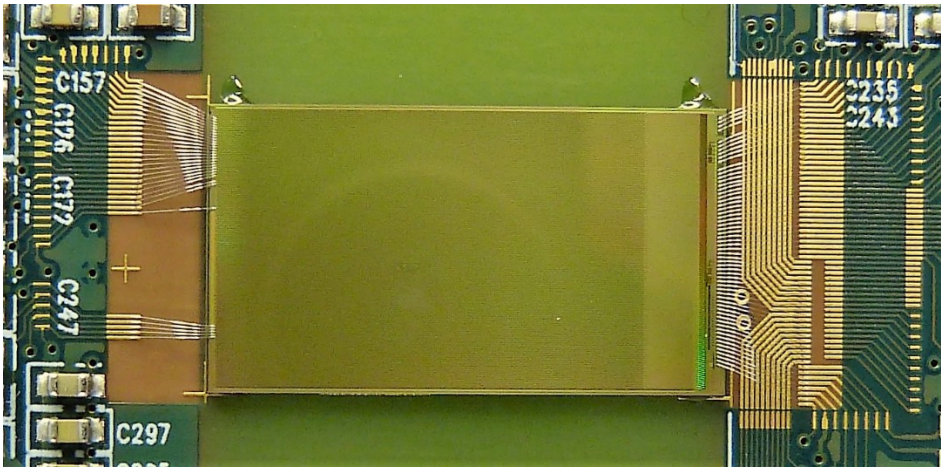

Figure 1: MuPix8 sensor chip bonded to the test system developed in Heidelberg

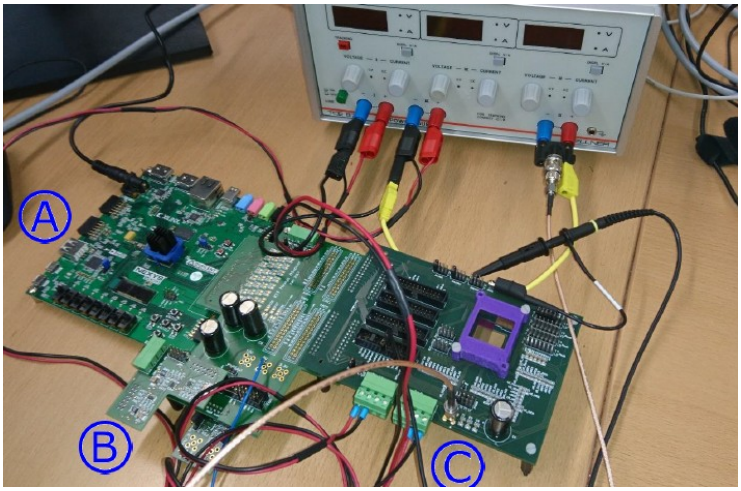

Figure 2: Test system developed at KIT.

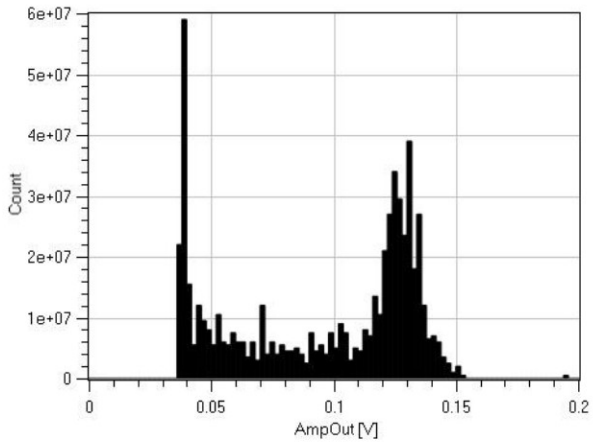

Figure 3: Spectrum of photons irradiated by Fe-55 source measured with a MuPix8 pixel.