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The ToF CMOS Visual Cortex Project

Different thermal neutron detection techniques exist and many of them are based upon individual particle detection techniques, while others are using “integrating”or “continuous”flux measurements, such as imaging cameras combined with scintillators. Each class of techniques has its advantages and proper limits. Thermal neutron detection moreover has a very specific application, which is “time of flight”measurements of which the time resolution needed is of the order of a few microseconds. It is a very accurate, and often the only, way of determining the low energies of thermal neutrons with high resolution. If we could have CMOS type cameras with an acquisition rate of 100 000 fps or more, continuously, with on-system image analysis in order to turn each image on-line into a “neutron count histogram”, we would have the best of both worlds (counting and integrating). In order to achieve this, one would need to speed up the current CMOS column-parallel readout about a 1000-fold, which is possible if we replace the current, slow Wilkinson-type on-chip ADCs by potentially off-chip ADCs, which transmit their data stream directly into a matrix of FPGA and/or GPU still to be defined, to do the front line image treatment. A camera which has a continuous frame rate of 100 000 fps or more, with on-board image treatment and extraction of useful information, can have potentially a lot of spin off applications beyond the original neutron detection goal. Cameras with much higher frame rates exist today, but they can only handle a few hundred frames in a “one shot”or in a “stroboscopic”application, and are read out at a much slower pace. To our knowledge, no camera exists which can sustain a 100 000 fps rate, and without accumulating very large amounts of raw image data which have to be analyzed off-line. The challenges will be on the CMOS sensor fabric itself and its noise behavior, the analogue connectics, the development of massively parallel ADC systems, and the feeding of the converter data flow in suited image treatment systems.

Summary

We propose the development of a CMOS camera with 100000 fps sustained frame rate and online image processing for ToF thermal neutron detection.

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