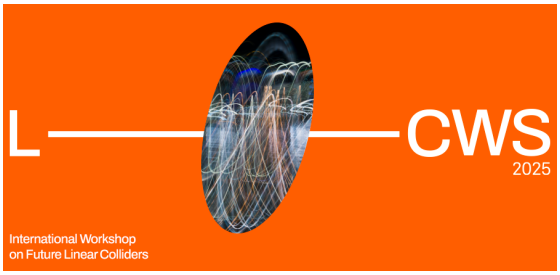

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Dedicated front-end electronics and data pre-processing for a granular electromagnetic calorimeter (remote)

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Highly compact and granular electromagnetic calorimeters are necessary for luminometers in experiments at future electron-positron colliders, or for the measurement of the positron multiplicity and energy distribution in the laser-electron scattering experiment LUXE, investigating strong field QED. In the former, Bhabha scattering is used as a gauge process. Using for its measurement a highly compact calorimeter, i.e. with a small Moli\"{e}re radius, the fiducial volume is well defined, and the space needed is relatively small. In addition, the measurement of the shower of a high energy electron on top of widely spread low energy background is improved. In the laser-electron scattering case, the number of secondary electrons and positrons per bunch crossing varies over a wide range, and both the determination of the number of electrons and positrons and their energy spectrum per bunch crossing favours a highly compact calorimeter.
The concept of a sandwich calorimeter made of tungsten absorber plates, interspersed with thin sensor planes, is developed. The sensor planes comprise a silicon pad sensor, flexible Kapton printed circuit boards for bias voltage supply and signal transport to the sensor edge, all embedded in a carbon fibre support. The calorimeter concept has been proved in a test-beam campaign using 11 layers.

Each sensor plane is read out by front-end (FE) ASICs called FLAME (Fcal Asic for Multiplane rEadout), positioned at the edge of the sensor. FLAME comprises 32 readout channels, each one composed of an analogue front-end and a 10-bit SAR ADC, working at nominal sampling rate of 20 MSps, followed by two fast data serializers. The ASIC extracts, filters and digitizes analogue signals from the sensor, performs fast serialization and transmits serial output data. The 32-channel ASIC is designed as a pair of two identical 16-channel blocks, each equipped with its own 5.2 Gbps serializer and data transmitter so that during operation, 10.4 Gbps serial data stream is continuously sent to an external data acquisition system from each ASIC. For the standard asynchronous readout mode, FPGA performs the raw ADC samples pre-processing using pedestal and common mode subtraction, followed by the fast deconvolution procedure to reconstruct the pulse amplitude from three samples around the peak. Eight FLAME ASICs (16 serial streams) are processed by a single FPGA, i.e. 256 sensor channels being read simultaneously, requiring 83.2 Gbps processing bandwidth. In a recent test-beam the overall data acquisition system bandwidth exceeded 0.9 Tbps. Results on the performance of FLAME from laboratory and test-beam measurements are presented.

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