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Comparison of Energy Reconstruction Schemes and Different Granularities in the CALICE Scintillator-Steel Analogue Hadron Calorimeter

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The CALICE collaboration develops different high-granularity hadronic calorimeter technologies for a future linear collider. These technologies differ in active material, granularity and their readout and thus their energy reconstruction schemes. The Analogue Hadron Calorimeter (AHCAL), based on scintillator tiles with Silicon Photomultiplier readout, measures the signal amplitude of the energy deposition in the cells of at most $3 \times 3\,\mathrm{cm}^2$ size. The Digital, Resistive Plate Chamber (RPC) based, HCAL (DHCAL) detects hits above a certain threshold by firing pad sensors of $1 \times 1\,\mathrm{cm}^2$. A 2 bit readout is provided by the, also RPC based, Semi-Digital HCAL (SDHCAL), which counts hits above three different thresholds per $1 \times 1\,\mathrm{cm}^2$ cell. All three calorimeter concepts have been realised in a $1\,\mathrm{m}^3$ prototype with interleaved Steel absorber and tested at various test beams.

This study investigates the impact of the readout, granularity and active medium on the energy resolution individually by applying the reconstruction procedures on AHCAL data, that can also be processed in a way which emulates a (semi-) digital readout system. The difference in granularity is studied via simulations of an AHCAL with $1 \times 1\,\mathrm{cm}^2$ cell sizes.

Additionally, a so-called Software Compensation algorithm is developed to weight hits dependent on their energy content and correct for the difference in the response to the electromagnetic and hadronic sub-showers ($\frac{e}{h} \neq 1$) and thus reduce the influence of fluctuations in the π^0 generation. The impact on the energy resolution will be discussed and compared to the other energy reconstruction schemes.

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