We propose a calorimetry approach unconventional and innovative. The method is based on the measurement of the lateral distribution of charged particles around the shower axis, it has been used for the first time in the energy determination of Extensive Air Showers at very high energy (> 100 TeV) with single layer detector [1], providing an energy determination with resolution of about 10% for energies above 100 TeV. It has some peculiar characteristics which can be summarized in the following three points: 1) measurement of the shower energy by means of a single sampling; 2) calorimetry which renounces the classic concept of containment of the shower; 3) possibility to separate primary masses. In order to validate and extend this technique at lower energies, specific simulation have been performed through GEANT4 in the energy range 100 GeV - 10 TeV for different particles. A simple geometry has been simulated, namely an Iron block with square section (1x1 m²) orthogonal to the beam and depth varying from 5 cm to 1 m. After analysis of the simulated shower events, we got to positive conclusions in favor of the method application at low energies.

Sample a shower at a fixed depth (Upper Left), and build the lateral distribution of particles (Right).

Calculate the truncated size $P_{xx}$, which is the number of particles within a $xx$ distance from the axis, and the lateral age $s'$ parameter by fitting the lateral distribution of particles with a Nishimura-Kamae-Greisen (NKG) like function:

$$f(r, s') = K \left( \frac{r}{r_m} \right)^{2(1 - \frac{r}{r_m})^{4.5}}$$

Calculate $Y(s', P_{xx})$, as

$$Y(s', P_{xx}) = s' + 0.8 \log(P_{xx})$$

$Y$ has a linear relation with the logarithm of the energy shower

$$Y(s', P_{xx}) = A + B \log(E),$$

Therefore the shower energy can be calculated

$$\log(E_{true}) = (Y(s', P_{xx}) - A)/B$$

A and B are from MC simulations.

MC events produced by GEANT4 using the hadron interaction model FTFP_BERT in a sampling calorimeter of dimensions 1mx1mx1m in which 4.9 mm of absorber (Iron) and 0.1 mm of sensitive material (liquid argon) are alternated along the arrival direction of the impinging particle. In total, therefore, there are 200 samples. Of these 200 samples, only 20 were used, that is the particles sampled every 50 mm from the primary entry point. Showers belonging to 6 primaries and 5 energies have been analyzed: specifically protons, pions+, pions-, helium nuclei, carbon nuclei and iron nuclei at the energies of 100 GeV, 300 GeV, 1 TeV, 3 TeV and 10 TeV. A statistics of 100 events has been generated for each particle and each energy. According to MC events best $xx$ was 100 mm.