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DRAFT by Dr Erik Heijne/CERN+NIKHEF; Supervisors Prof Els Koffeman, dr Niels van Bakel NIKHEF/UvA

Could one identify very high energy (~TeV) particles in silicon voxel detectors ?
A study in practice and in theory of energy transfers in a highly segmented silicon detectors.

The energy loss of elementary particles as a function of momentum is described for a thick absorber by the Bethe-Bloch equation. Beyond the point of 'minimum ionization', the particles loose an increasing amount of energy through energetic transfers to electrons of the absorber medium and 'radiative' transfers, which also can result in energetic electrons close to the parent. This is described as the 'relativistic rise', and is illustrated for muons in Fig.1. In practice, in very thin silicon detectors one does not observe such an increase of energy deposition, although the frequency of energetic 'delta' electrons should clearly become higher with higher momentum of the parent particle. While this is taken into account in simulations such as GEANT, little study has been done on negative effects (bad position data) or useful opportunities for exploiting this.

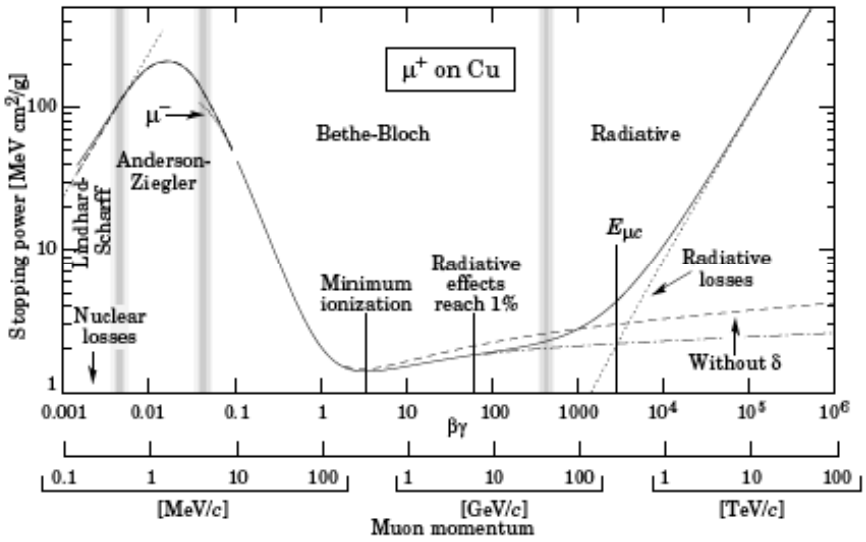

Fig. 1.

The proportion of energy loss into various types of energetic electrons becomes very high (>80%) in the TeV region. Would it be possible to design a detector that recognizes and processes these 'delta' electrons so that (with a reasonable probability) one could assign a minimum momentum to very stiff tracks in the experiment? A detector would need some minimum thickness of silicon, to achieve the production of a given transfer with sufficient probability.

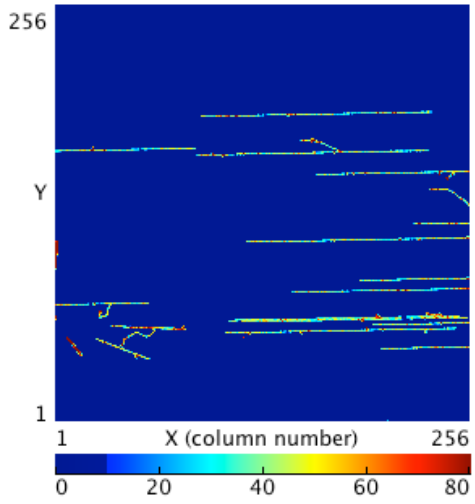

Fig 2.

The detector needs voxelization that allows the transfers to be recognized and classified. With the Timepix detector one can achieve already such a recognition, as shown in Fig. 2 where a few delta rays are clearly seen in a beam test with 120GeV/c pions. The detector was exposed under glancing angle in the H6 beam, with pion trails of ~7mm in Si. A thicker detector, or a stack of detectors may be needed to have enough resolving power in 3 dimensions.

Beam testing at CERN will be a part of the work, besides theory and analysis of the data. Some prior experience with ROOT is required.