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Muons and neutrinos colimation in extensive air shower cores

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Detailed simulations of EAS have been carried out with CORSIKA program in order to evaluate the energy brought by different shower components at ground level and transmitted underground. A special attention is given to the angular distributions and to the collimation of beams penetrating deep underground or underwater. The natural collimation of high energy particles in EAS cores results mainly from the ratio between the transverse and the longitudinal momenta of secondary particles generated in the earliest interactions. This collimation is partly conserved by high energy muons and neutrinos. It is comparable to magnetic focusing of charged pions and kaons decaying in tunnels of suitable length after production in accelerators. Such is the case for neutrino beams of KEK J-PARC/T2K (300 km to Kamiokande), OPERA (730 km to Gran Sasso) and MINOS (735km to Irvine Mine).

Near three decades ago, De Rujula, Glashow, Wilson and Charpak advocated in CERN the employment of a new generation of proton synchrotron to explore the Earth with neutrino beams and we shall examine if the core of giant air showers can give any preliminary information for such purpose. We also consider another aspect of high energy physics, the asymmetry observed recently in p-A and A-A collisions at $\sqrt{s}=7$ TeV which could be reflected in families of very high energy muons in very inclined EAS.

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