Check a Birk saturation in MOKKA

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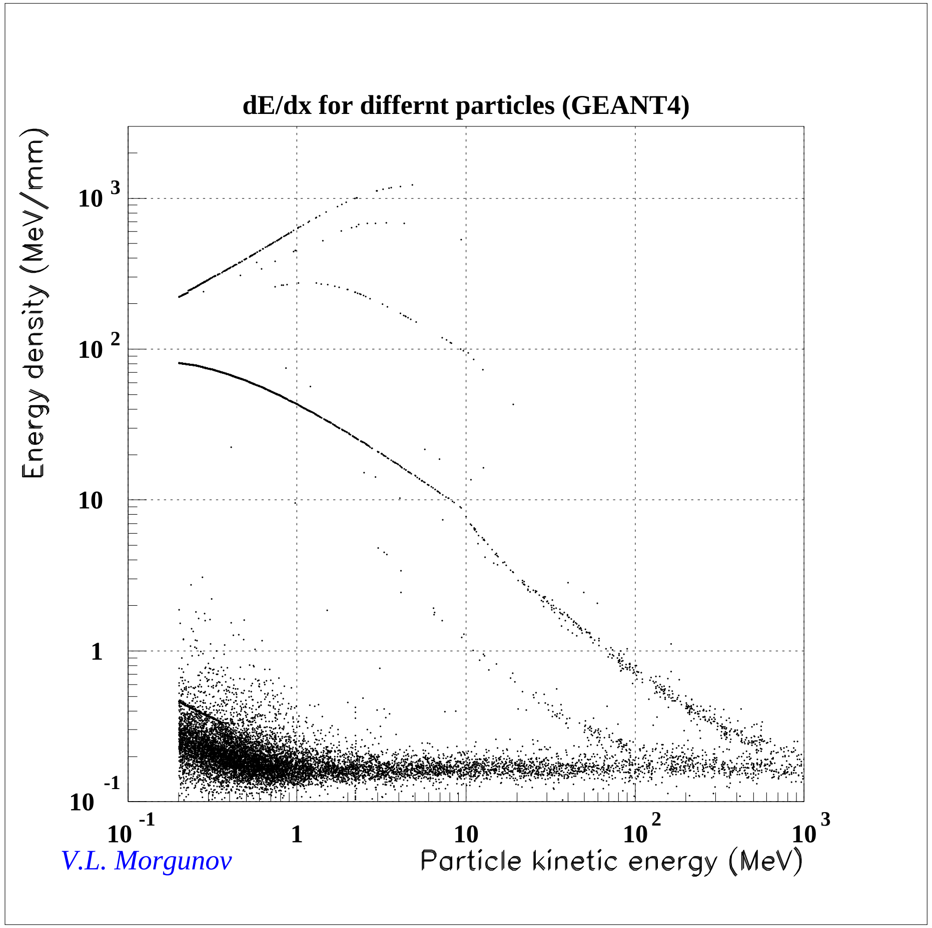
The copy of this talk one can find at the http://www.desy.de/˜morgunov

Energy density in scintillator

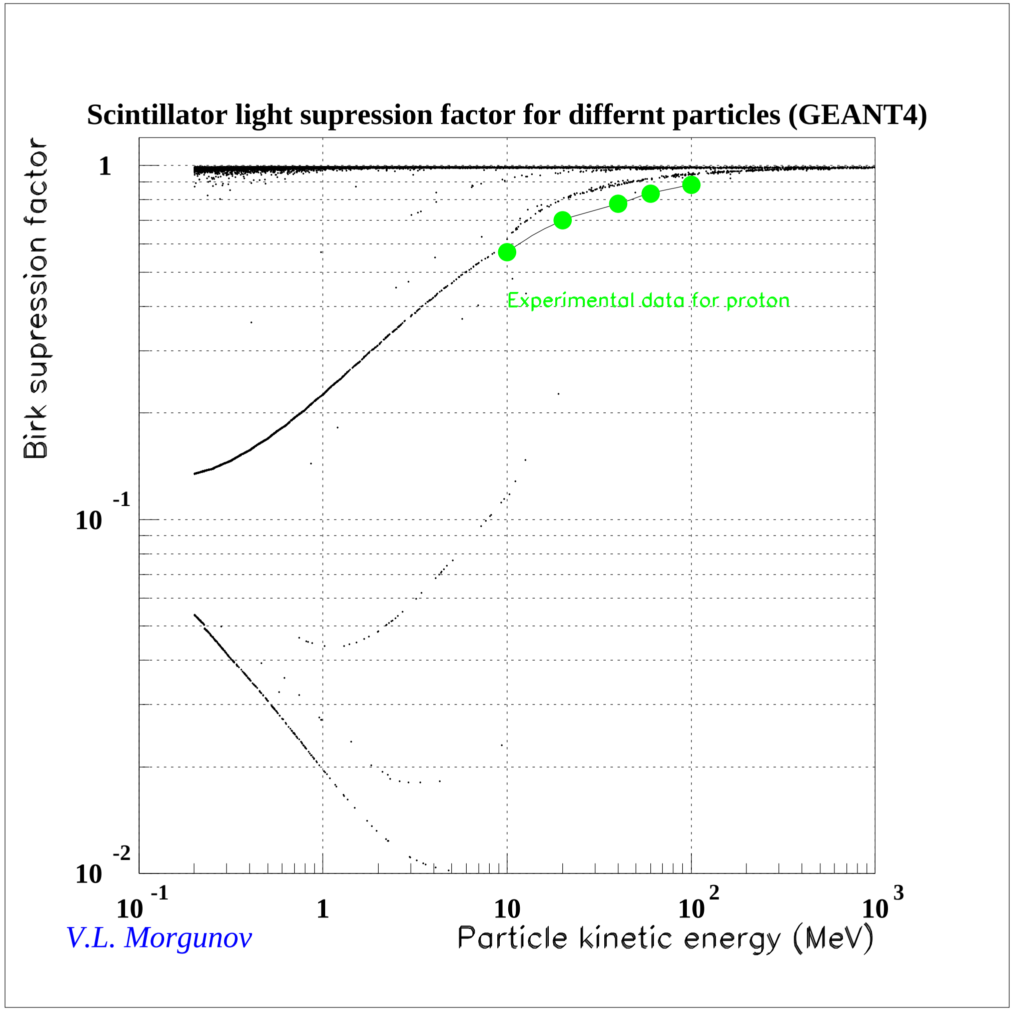


This plot was extracted using a new Mokka HCAL Super Driver

$$E_{kin} = aStep \rightarrow GetPreStepPoint() \rightarrow GetKineticEnergy()/MeV$$

$$dE/dx = aStep \rightarrow GetTotalEnergyDeposit()\ /\ MeV\ /\ aStep \rightarrow GetStepLength();$$

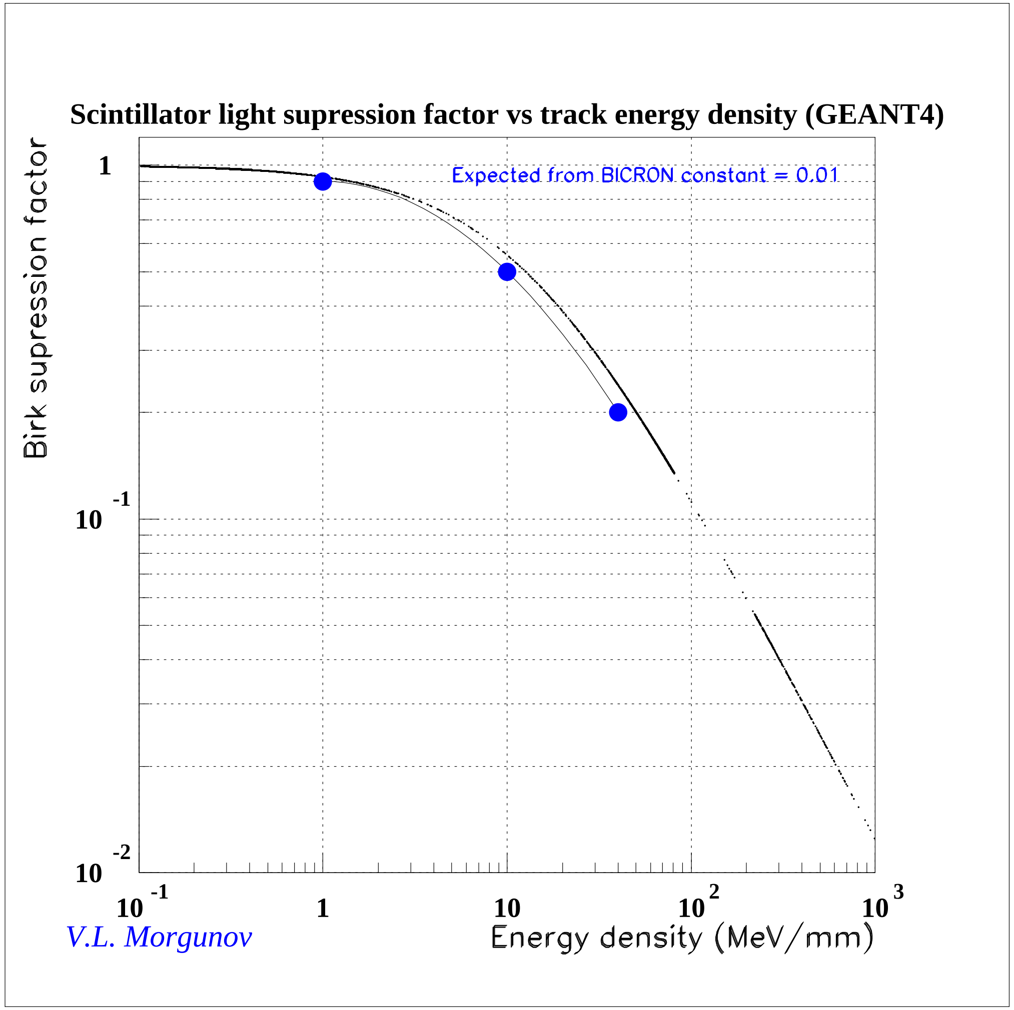
Suppression factor vs E_{kin}



Factor is: energy after saturation divided by energy lost at the step.

Experimental data were taken from Akimov, " Scintillation methods of registration of high energy particles"

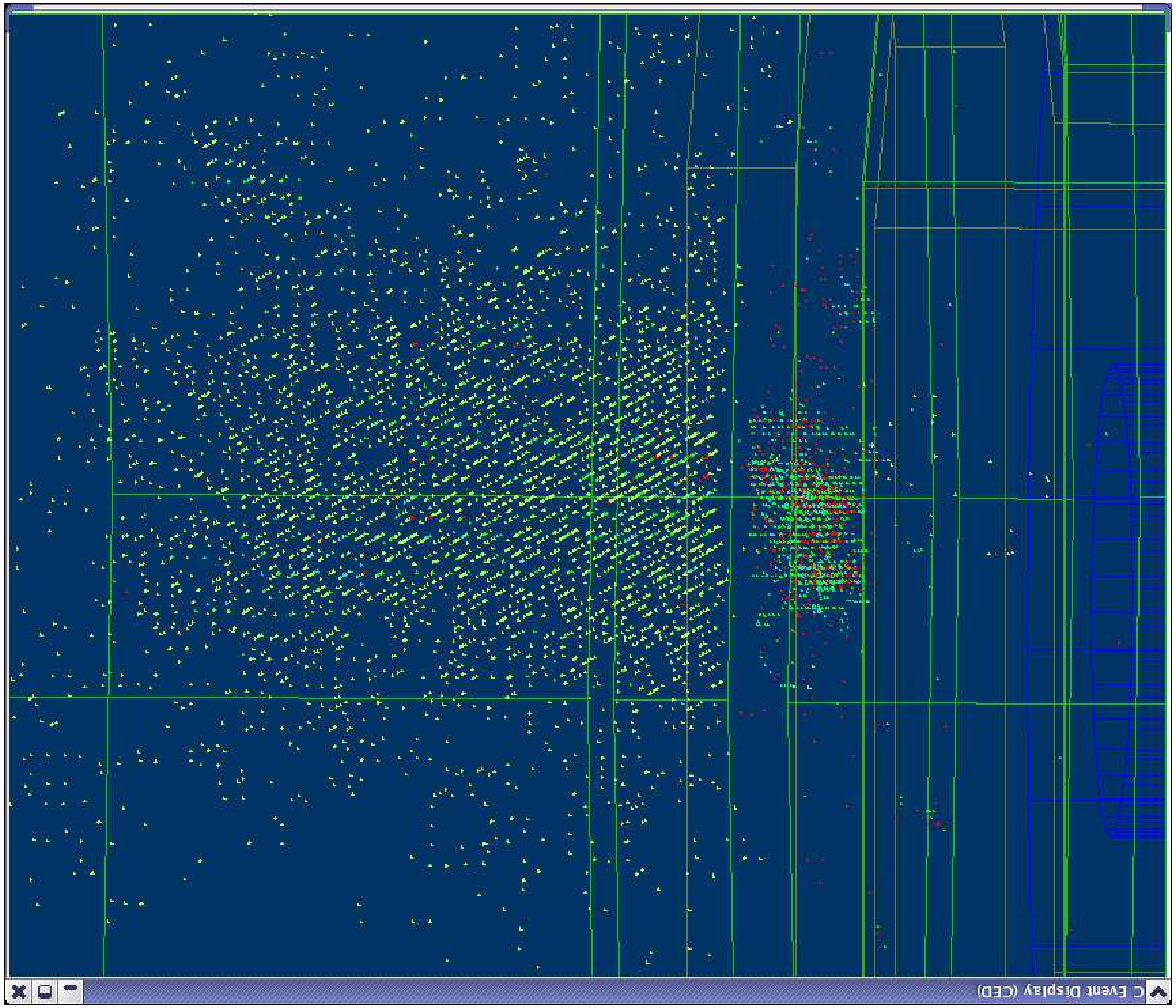
Suppression factor vs Energy density



G4EmSaturation::FindBirksCoefficient Birk's coefficient for G4-POLYSTYRENE = 0.07943 mm/MeV

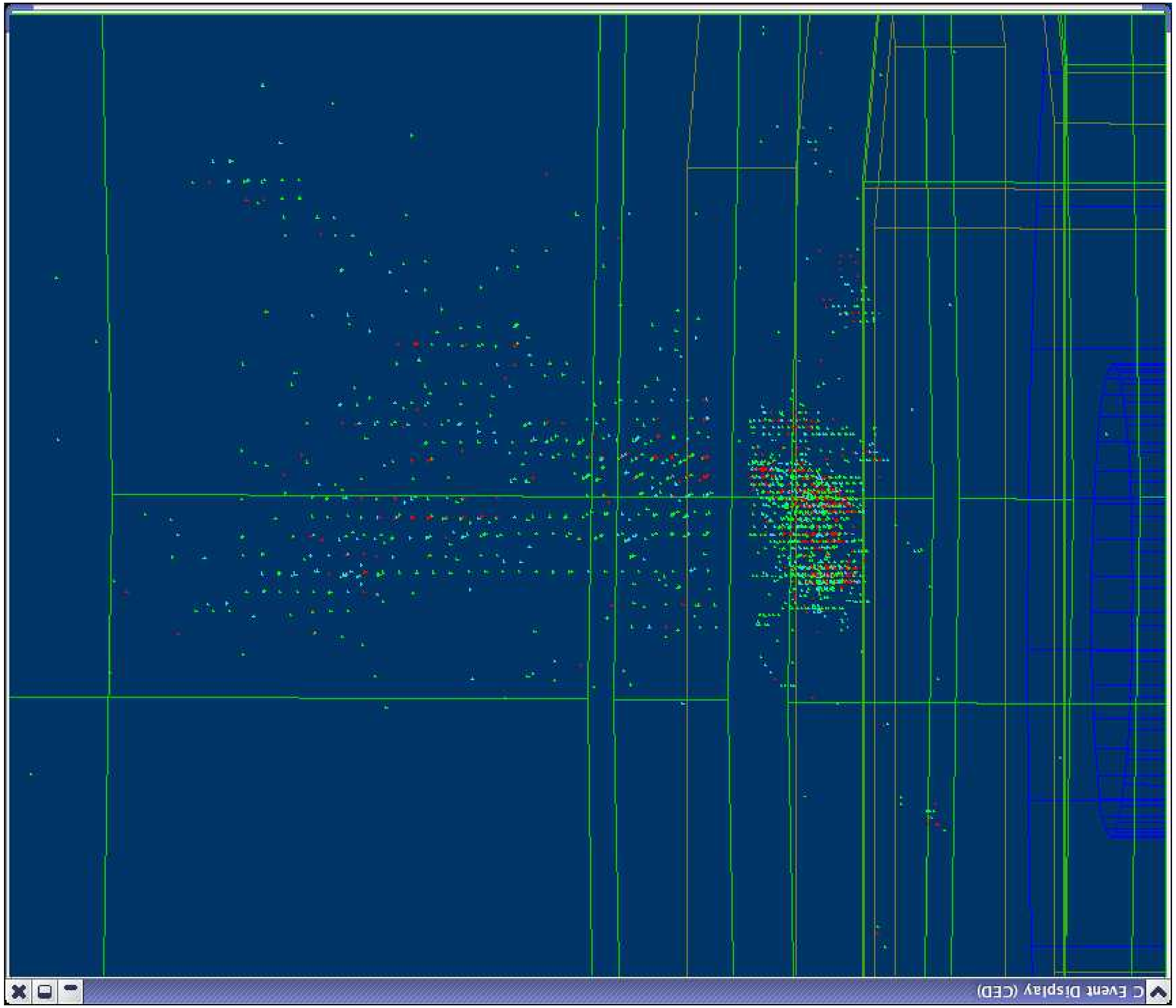
A few years ago BICRON had given us k=0.01 $g/MeV/cm^2$ $\Rightarrow$ that is in a good agreement.

Hist in Calorimeter, no cut



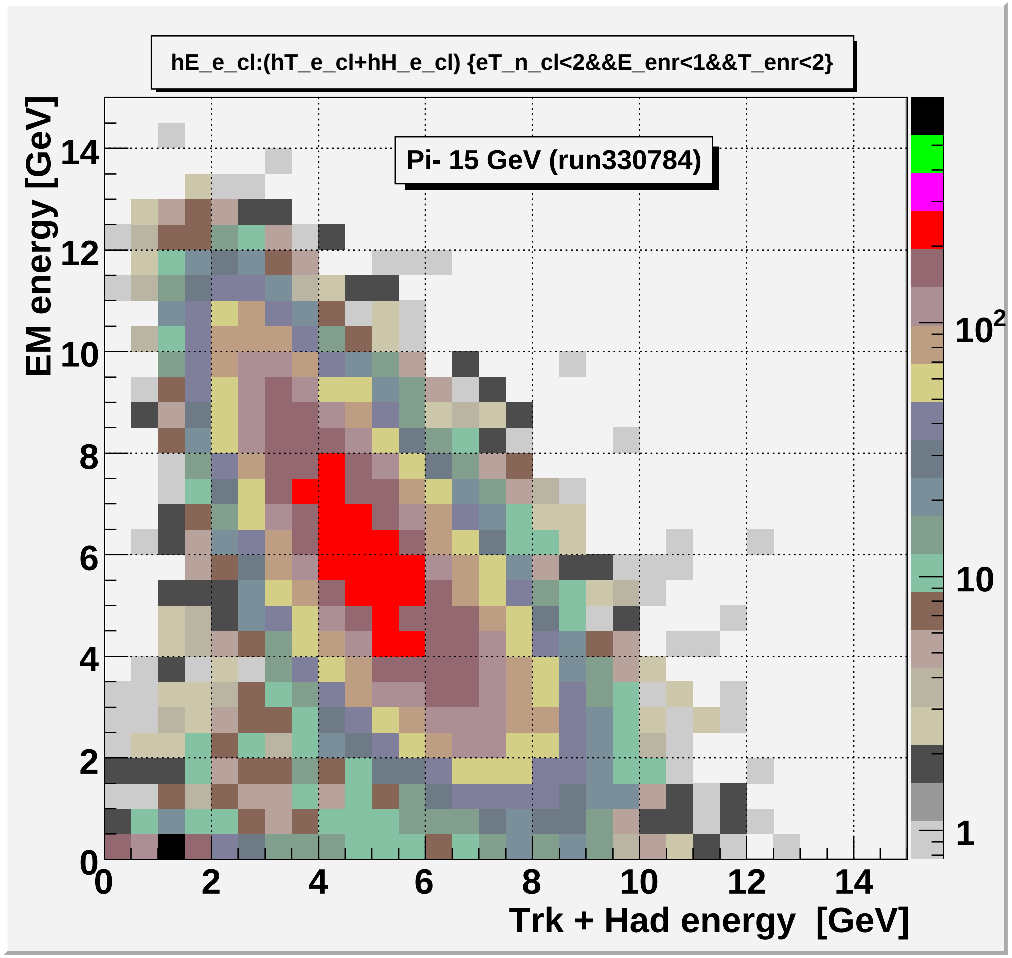
Mokka/init/detectorModel LDC01-06Sc-p01, /Mokka/init/physicsListName QGSP-BERT-HP

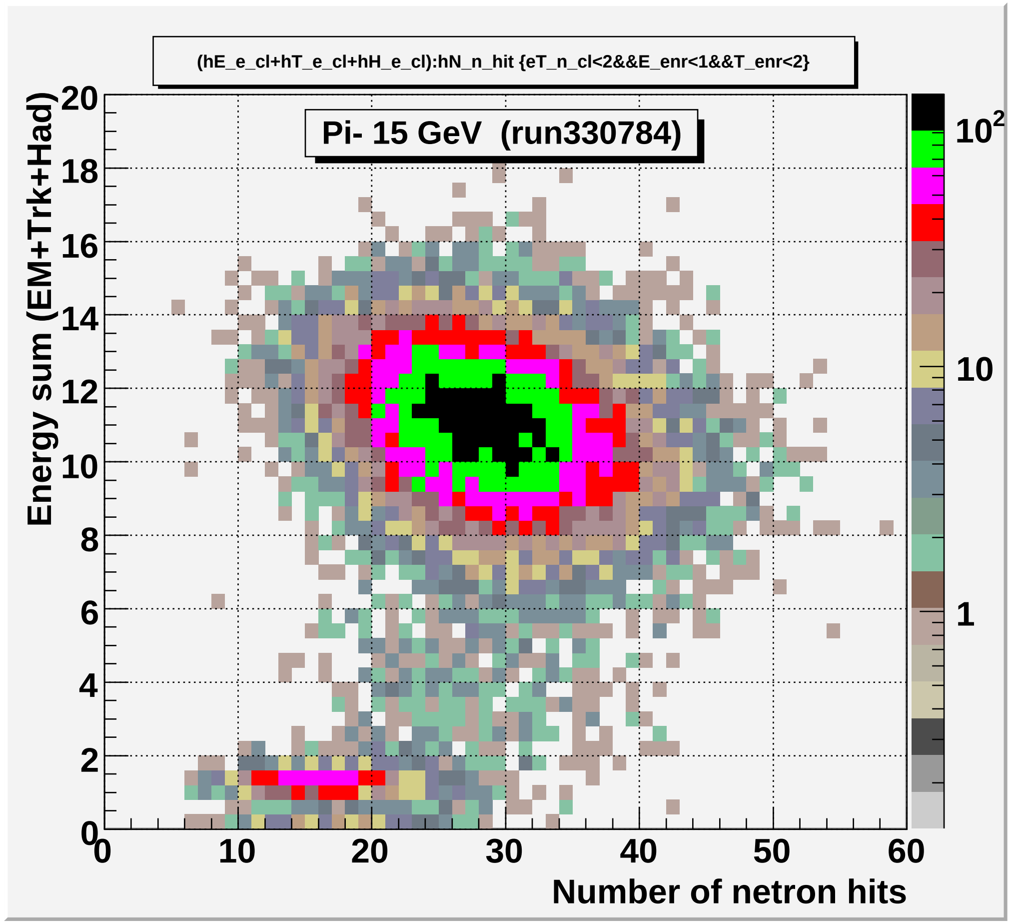
Hist in Calorimeter, over threshold 0.5 MIP



Mokka/init/detectorModel LDC01-06Sc-p01, /Mokka/init/physicsListName QGSP-BERT-HP

Two kind of energy correlations





Standard software correction $c_1 \times f_{em}$ vs $c_2 \times (1 - f_{em})$

Binding energy correlation

Lost of neutral signal due to Birk saturation leads to almost fully smoothing of second and most interesting correlation.

Conclusion

1. Now we have a correct scintillator response to the energy lost by particles.

2. The effect of this correction is rather big, it makes influence on the main reconstruction and PFA.

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Raw Calorimeter Energy = 496.07 (23820) = 322.234 (8546) + 173.836 (15274)
    Calorimeter Energy = 482.381 (8387) = 320.166 (6685) + 162.215 (1702)
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Number of hits over threshold 0.5 MIP (3x3 cell) in the full detector simulation is reduced of about factor 10 !!!
in compare with number of all recorded HCAL hits, with significant energy difference
(Mokka/init/detectorModel LDC01-06Sc-p01, /Mokka/init/physicsListName QGSP-BERT-HP).

3. Comparison of shower size between Analog and Digital calorimeter was done incorrectly,
because of Birk saturation was not used at the time of comparison.

4. New requirements for photo–detector (SiPM?) if we will use scintillator in ILC detector HCAL.

Threshold is down to 0.1 MIPs and of course 20–50 times less noise frequency at this level.

If this will be the case we can read a neutron signal.

This effect should be very carefully checked on the existing CALICE data.