Dead crystal impact on energy reconstruction

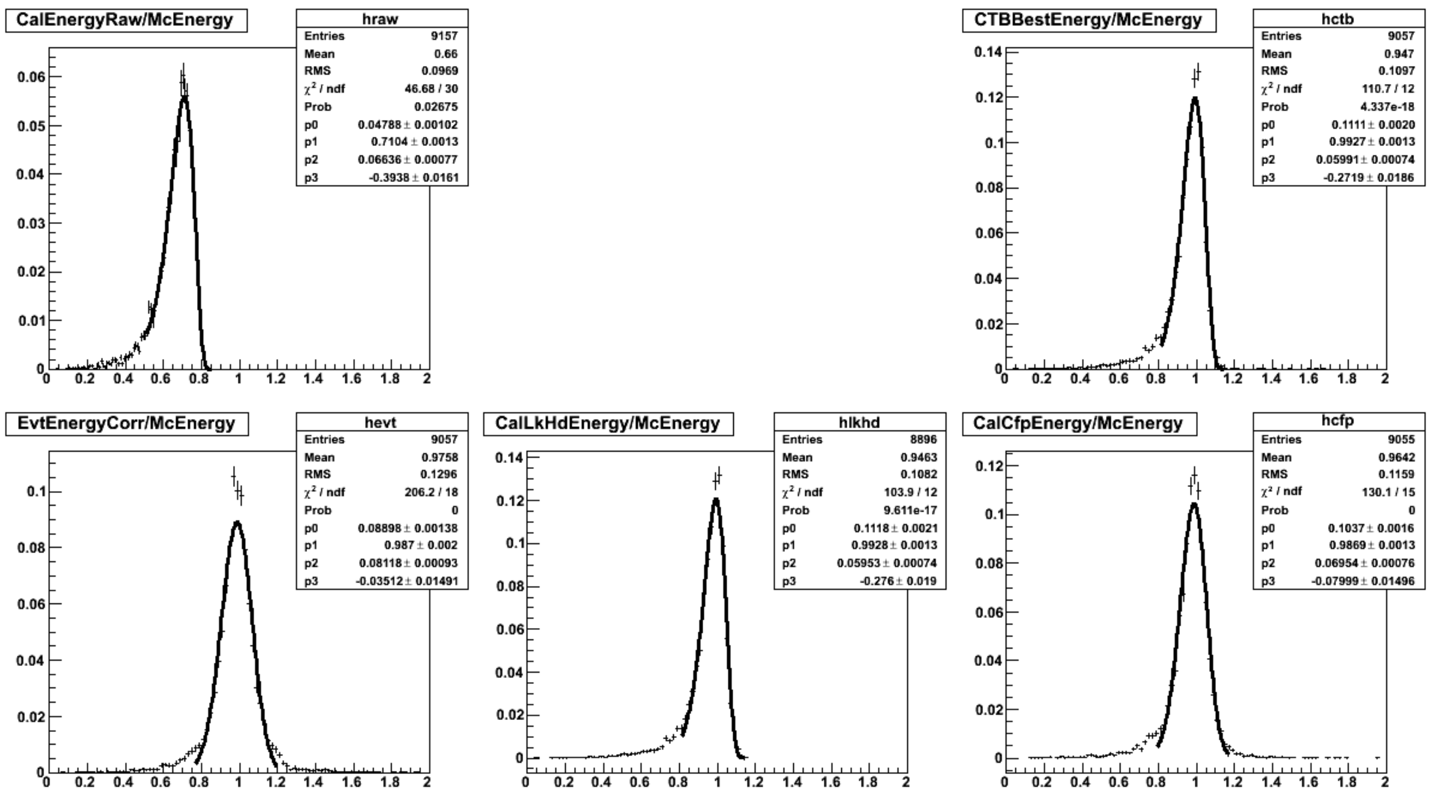
- Introduction
- Impact on energy reconstruction algorithms
- Estimating the fraction of events passing 'close' to a crystal

Introduction

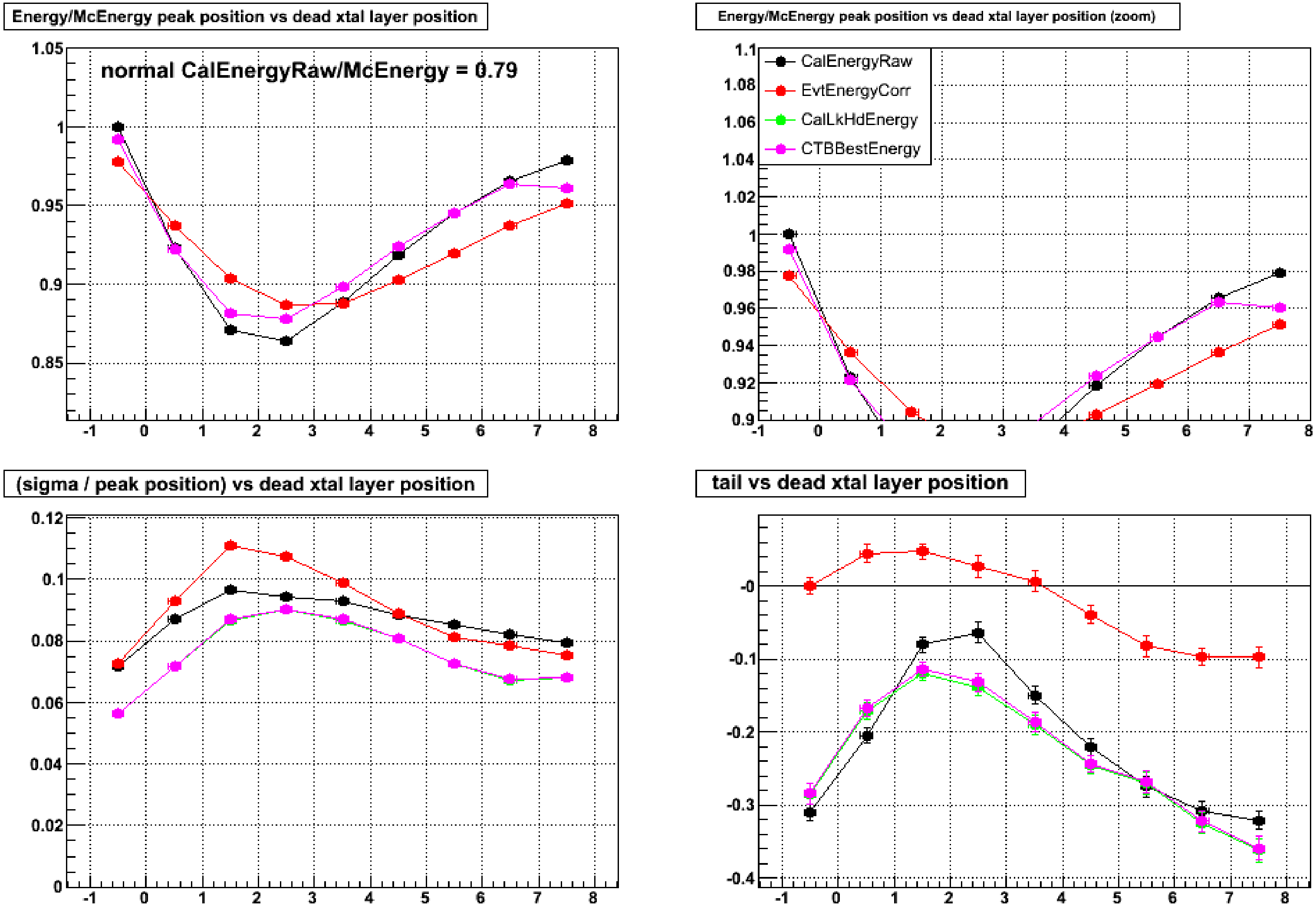
- Why studying the 'one dead crystal' case ?
  - We have two ends.
  - But if one end is dead, then it is not possible to measure the energy without any position estimation (that can be derived by tracker extrapolation or/and neighbour crystals information)
- Gleam simulation (v10r6 based)
  - 1, 10, 100 GeV pencil on-axis gammas beam, centered on (x=201.17,y=201,17), i.e. centered on odd xtals 6 and even xtals 6
  - 7 configurations :
    - -1 : no dead xtals
    - i>-1 : xtal 6 of layer i is put to 0

With all the xtals alive

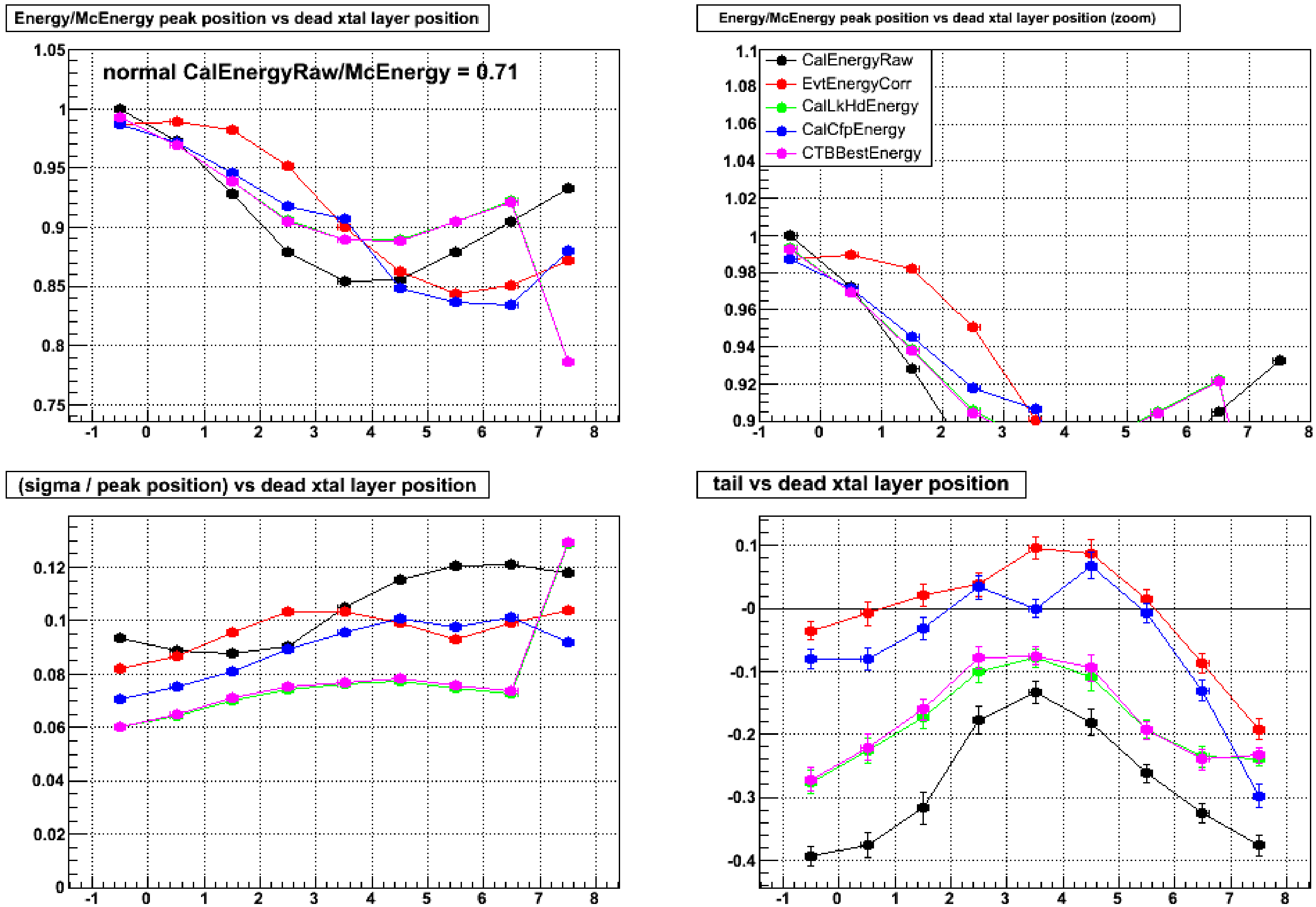
- Fit with a lognormal distribution -> peak position, sigma and tail



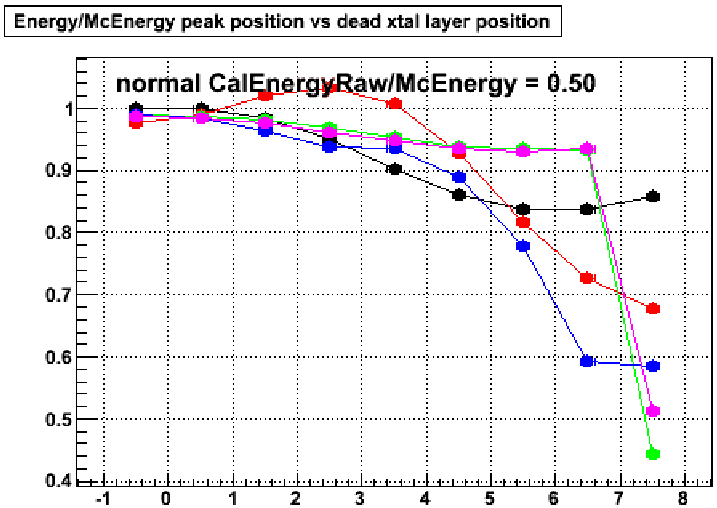
Results at 1 GeV

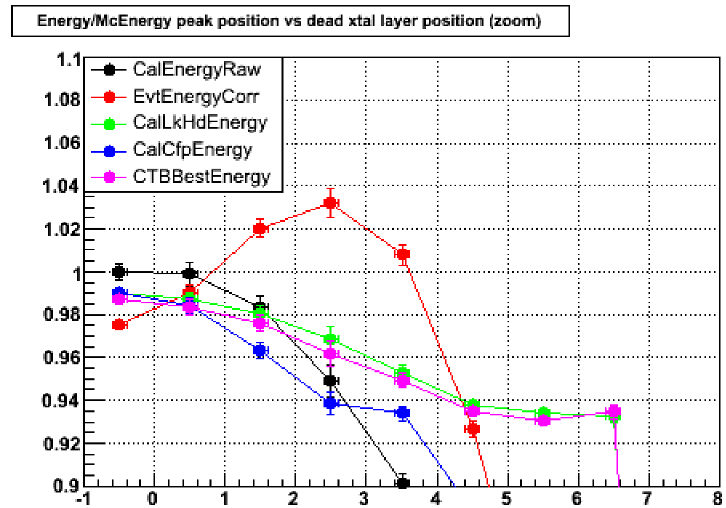


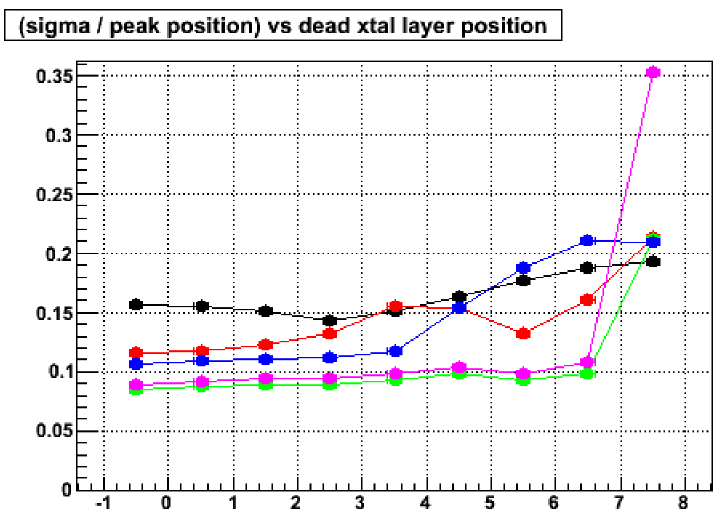
Results at 10 GeV

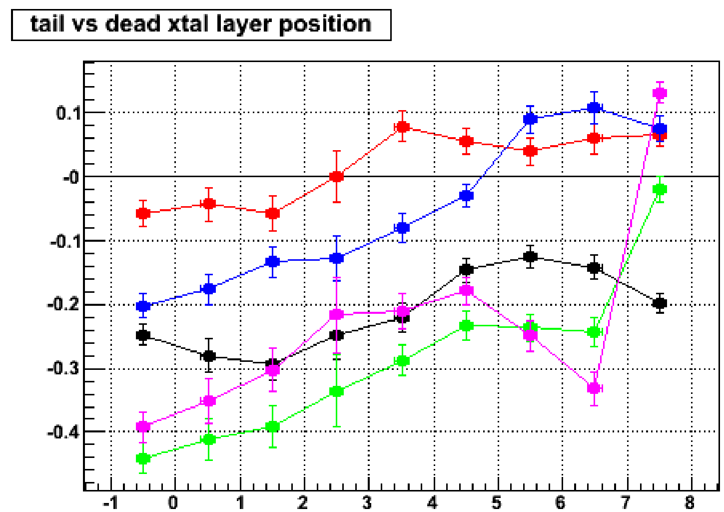


Results at 100 GeV





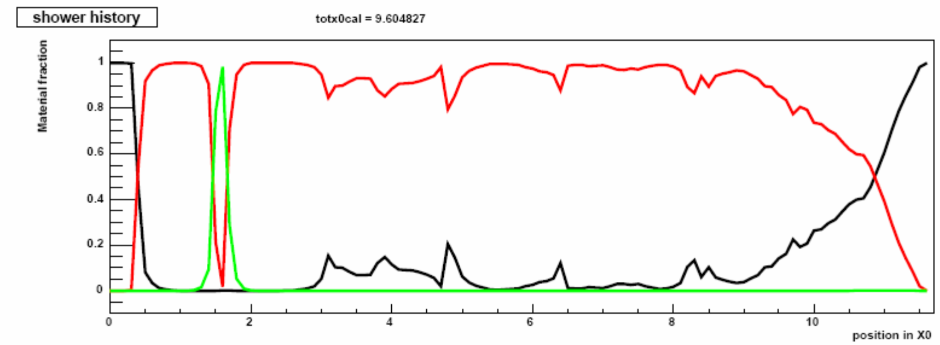


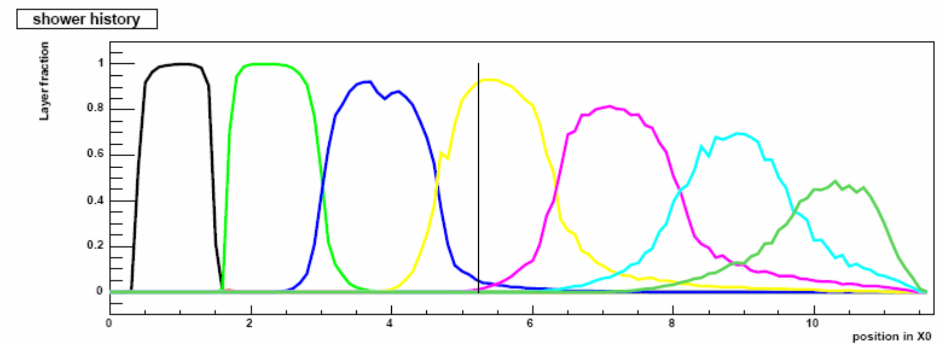


Full profile correction

How does the full profile alg work ?

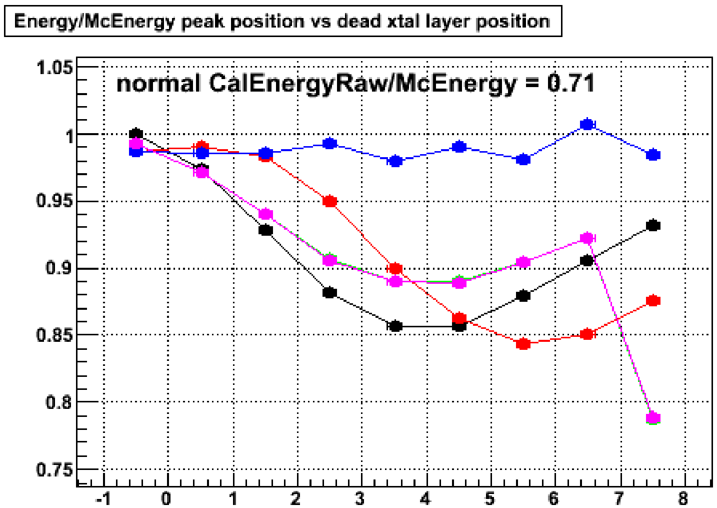
- Uses the tracker direction if available
- Goes along the trajectory by steps in units of mm
- For each step, determines the fractions of energy deposited in
  - 'nothing'
  - Dead material (grid, cracks)
  - Each layer of CsI
- Translates this history in radiation length unit
- Performs the profile fit

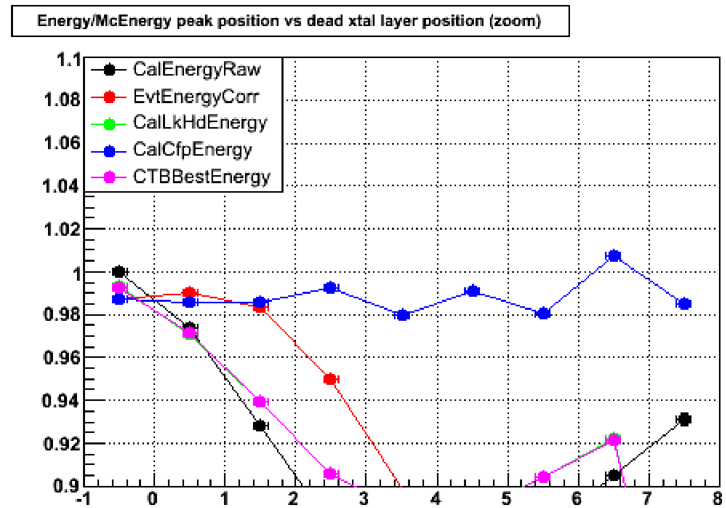


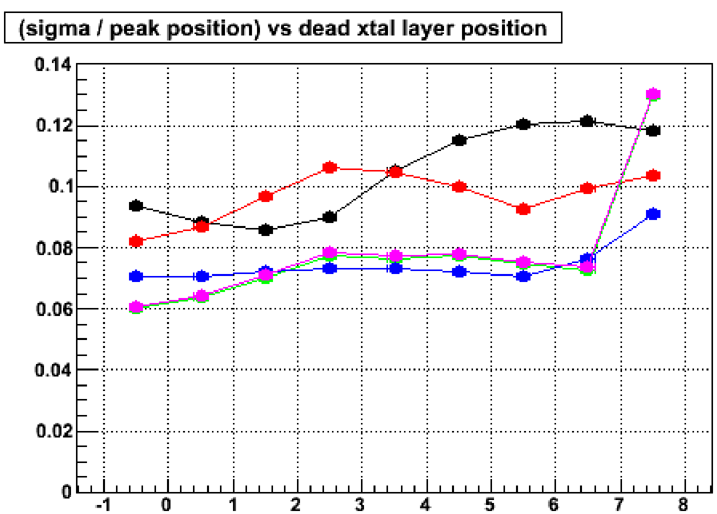


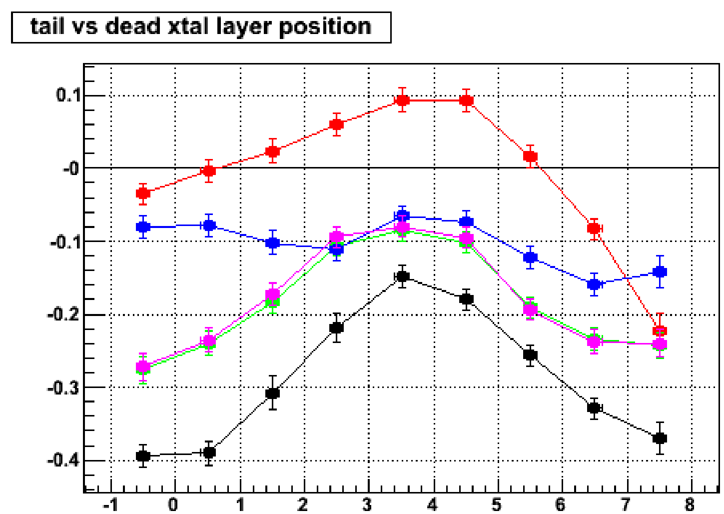
- Taking into account a dead crystal is straightforward since the only thing to do is to consider the dead crystal as dead material

Results at 10 GeV with corrected CalCfpEnergy

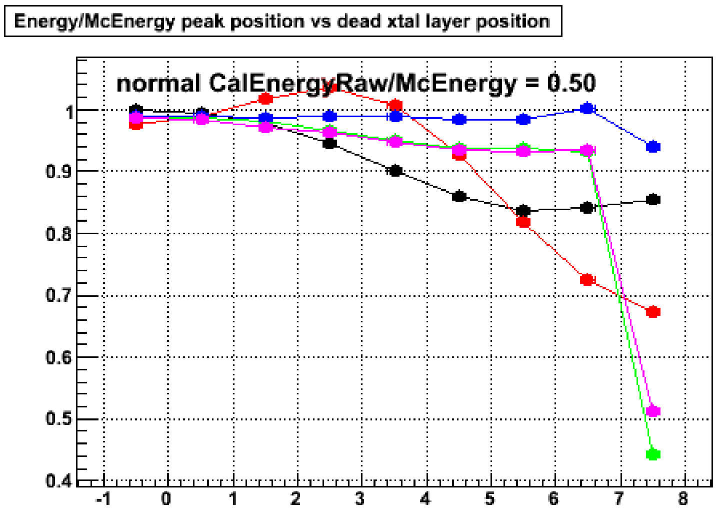


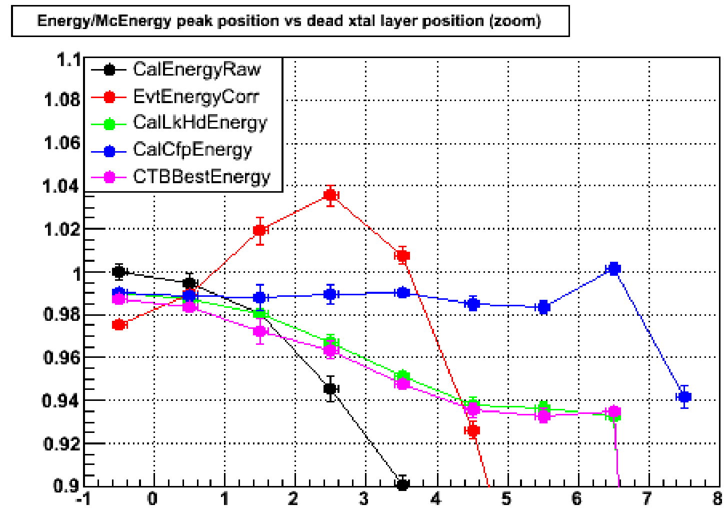


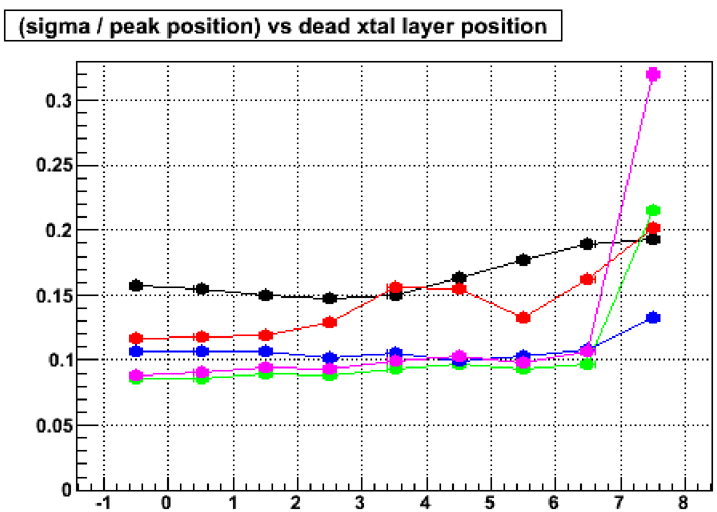


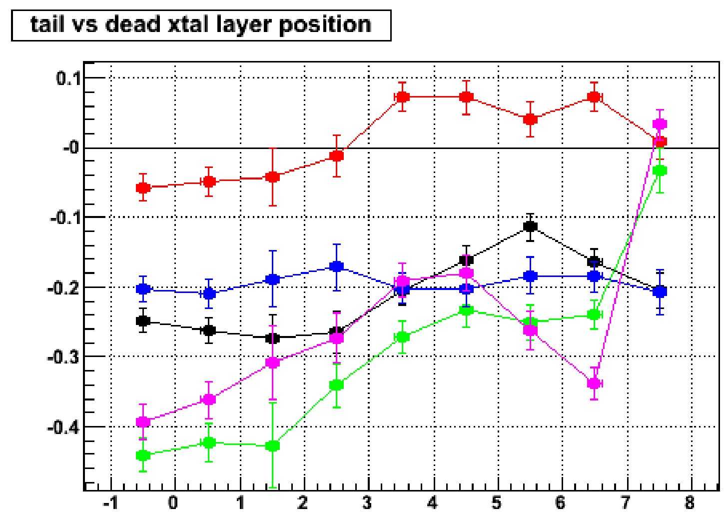


Results at 100 GeV with corrected CalCfpEnergy





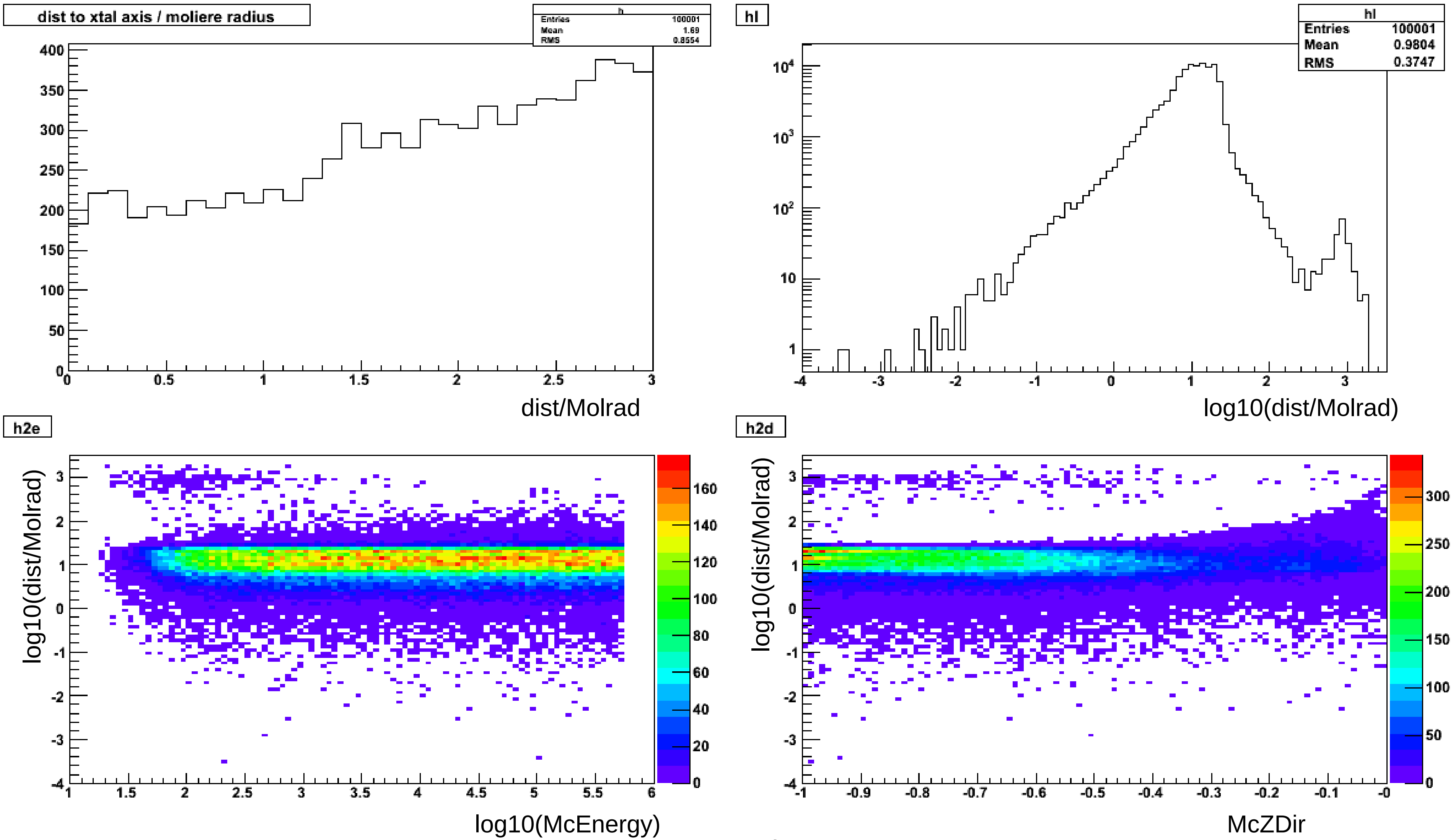




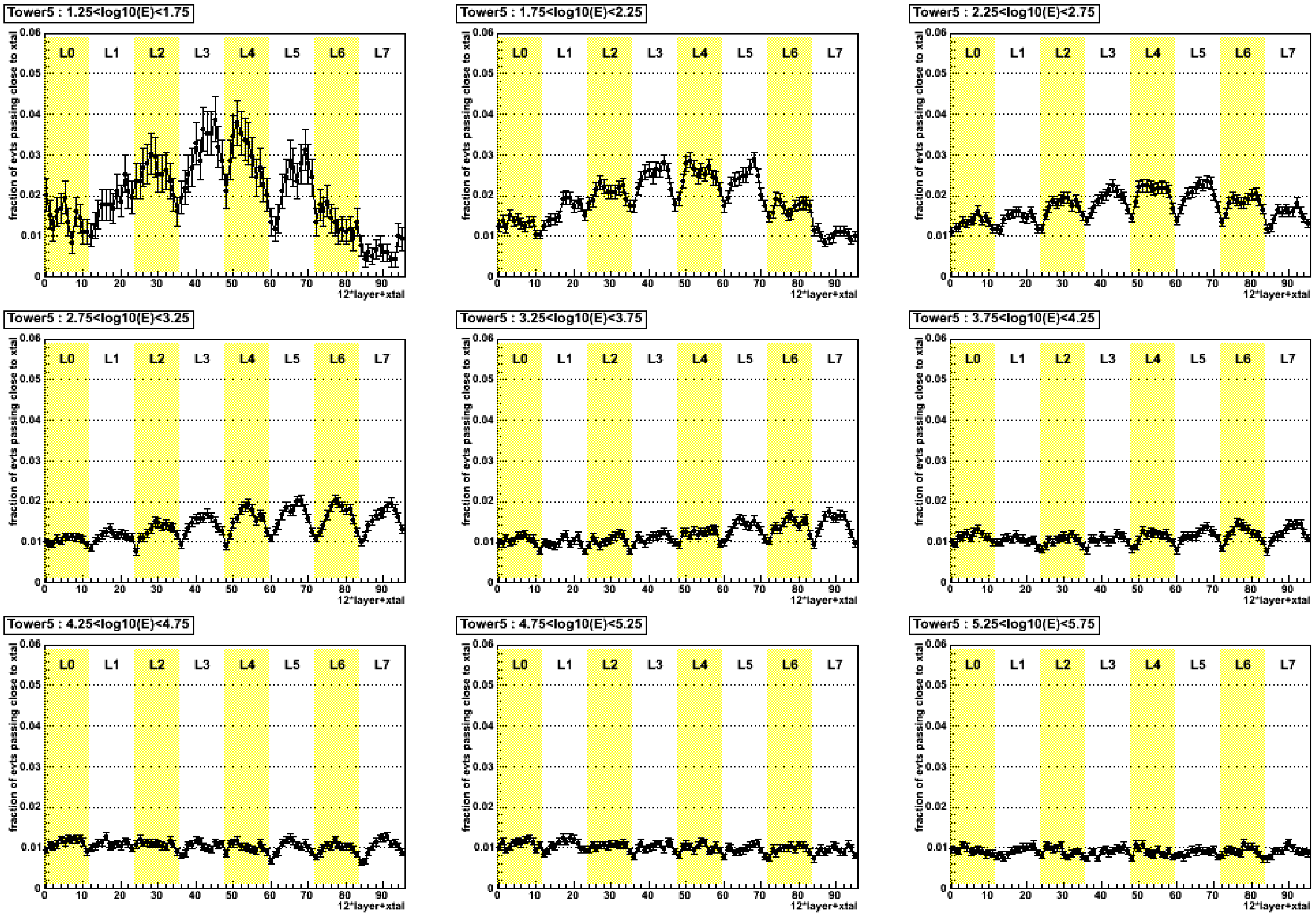
How often a dead xtal can have an impact

- Use a allGamma file (v10r6 18MeV->562GeV)
  - Simple cuts :
    - Tkr1Z0>0
    - Tkr1ZDir<-0.2
    - CalEnergyRaw>0
    - CalCsIRLn>6
  - calculate the distance between the MC trajectory and the xtal axis
    - Define two points : one on the MC trajectory and one on the xtal axis
  - When the point on the xtal axis is not within the xtal volume, take the distance to the closest end
  - Use the point on the MC trajctory to estimate the age of the shower (in X0)
  - Use the age of the shower to estimate
    - The effective lateral radius (80% containment) :
      - 0.5 Moliere radius at the start of the shower
      - 2.5 Moliere radius when age = 2 x maximum position
    - The fraction of energy already deposited
  - Consider that the dead xtal has an impact if :
    - distance<effective Moliere radius
    - the fraction of energy already deposited < 0.9

Example for one xtal



Tower 5


Tower5 : 1.25<log10(E)<1.75
Tower5 : 1.75<log10(E)<2.25
Tower5 : 2.25<log10(E)<2.75
Tower5 : 2.75<log10(E)<3.25
Tower5 : 3.25<log10(E)<3.75
Tower5 : 3.75<log10(E)<4.25
Tower5 : 4.25<log10(E)<4.75
Tower5 : 4.75<log10(E)<5.25
Tower5 : 5.25<log10(E)<5.75
L0 L1 L2 L3 L4 L5 L6 L7
fraction of evts passing close to xtal
12*layer+xtal

Conclusions

- For on-axis gammas, the bias :
  - is correlated with the energy loss due to the dead xtal
  - can be ~10-15%
  - more important if in the last layer for the 'last layer' algorithm
- CalCfpEnergy can easily be corrected
- EvtEnergyCorr and CalLkHdEnergy could be corrected if the energy and the position of the dead xtal were approximated with the neighbour xtals information. I've tried by simply averaging :
  - It works for the position (in the on-axis case)
  - It does not work for the energy because the shower is narrow
- Requirement : one has to be able to access the list of dead xtals in Gleam
- The fraction of events sensitive to one xtal is ~1-3%
- One xtal is ok, but 10 xtals ?