ETH Institute for Particle Physics

ECAL chi2 impact on energy resolution: preliminary studies

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Chi2 definition

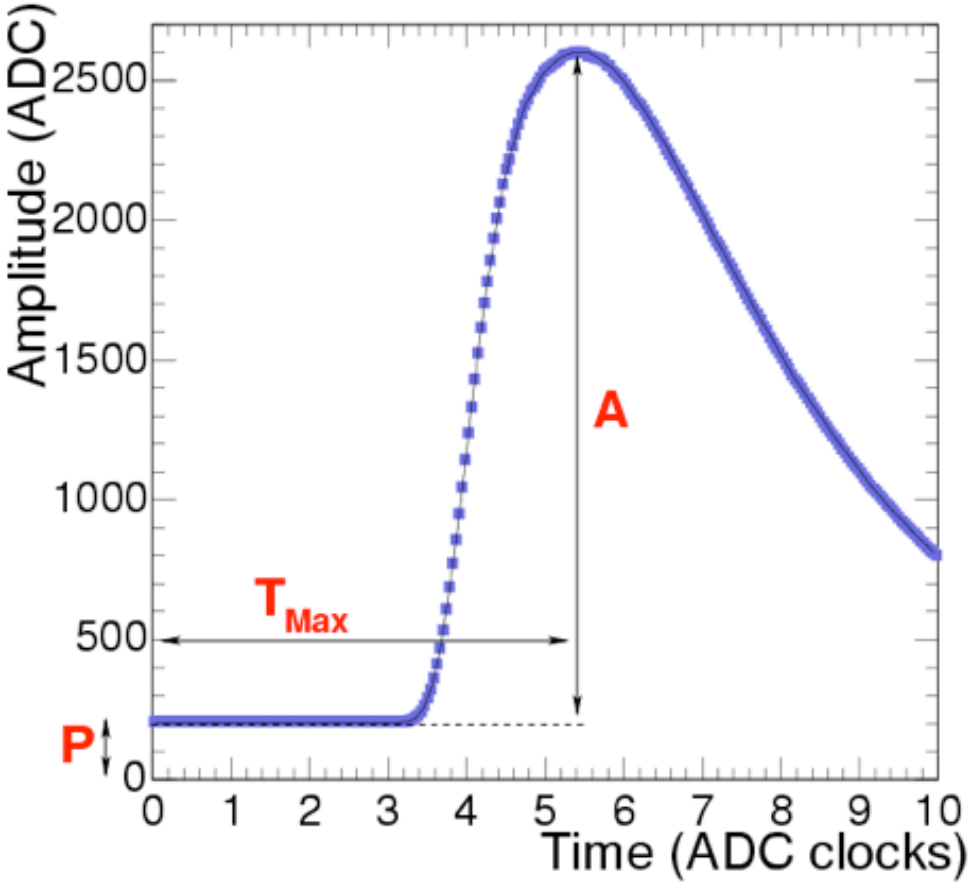
Chi2 compatibility test of the **MGPA digitized pulse** with the **digital MGPA shape** measured in 2004 H4 test-beam

$$\chi^2 = \sum_i \frac{R_i}{\delta R_i}, \qquad R_i = S_i - A f_i - P$$

A amplitude
S_i digitized sample i
f_i test-beam shape at i
P pedestal

$$\delta R_i^2 = N^2 + C^2.A^2$$

N noise term, pedestal fluctuations
C constant term, systematic error on the shape
Measured from MC : N=2.3 ADC, C=2.2E-2



See e.g. :
https://twiki.cern.ch/twiki/pub/CMS/EcalSpikeAnalysisNote2010/AN-10-357_temp.pdf
https://indico.cern.ch/getFile.py/access?subContId=1&contribId=1&resId=0&materialId=slides&confId=105063

Chi2 definition

- So the following parameterization is used : $$\chi^2/ndf = \sum_{i=0}^{9} \frac{S_i - Af_i - P}{N^2 + C^2.A^2}$$

- For practical reasons, we use : $$7.log(3 + \chi^2/ndf)$$

- The parameterization of N and C is fine in the barrel but would have to be retuned in the endcap
- **Chi2 is implemented in CMSSW, accessible for each rechit**

Practical use :

- Initially ECAL chi2 was foreseen to kill **spikes**, which have a different shape and a different timing

See http://wwweth.cern.ch/theofil/Ecal/ecalChi2.pdf

- By cleaning out of time deposits, chi2 could also improve the **energy resolution**
- And maybe improve the **isolation** rejection power under OOT pile-up

Testing chi2 on MC

Sample :

- Summer11 (PU S4) MC : gg→H→γγ mH=120 GeV
- **In-time and out-of-time pile-up are correlated**

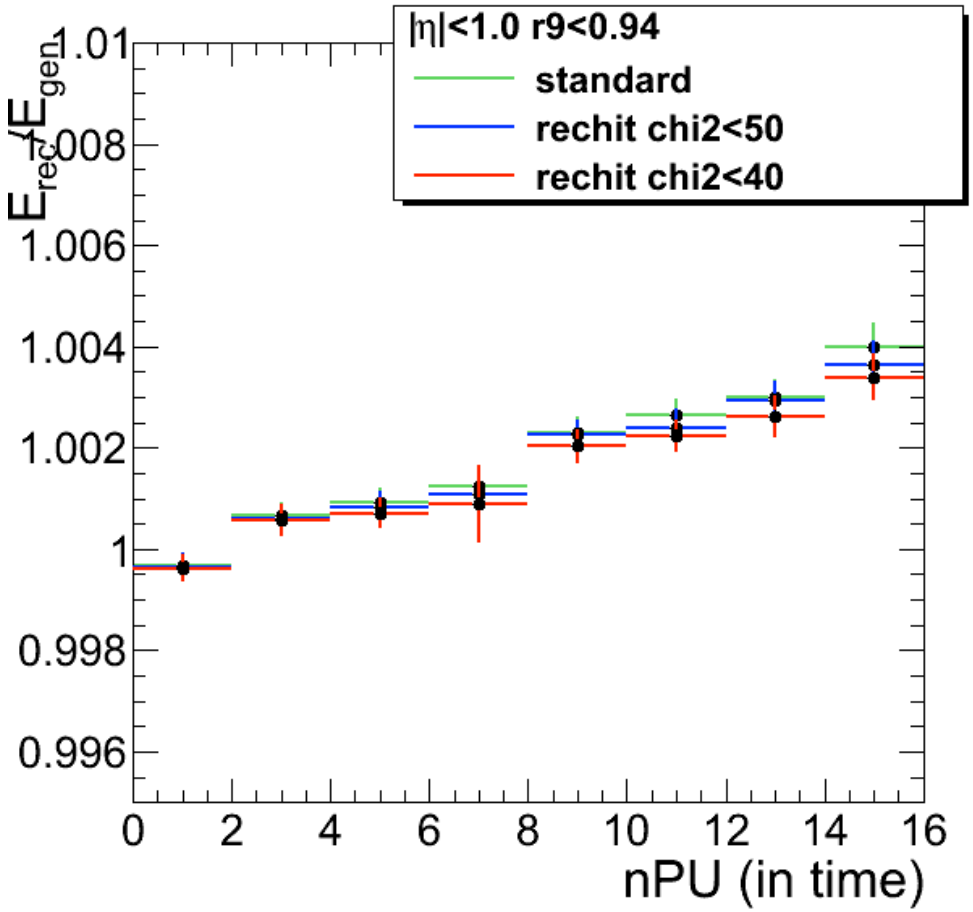
Implementation of chi2 cut

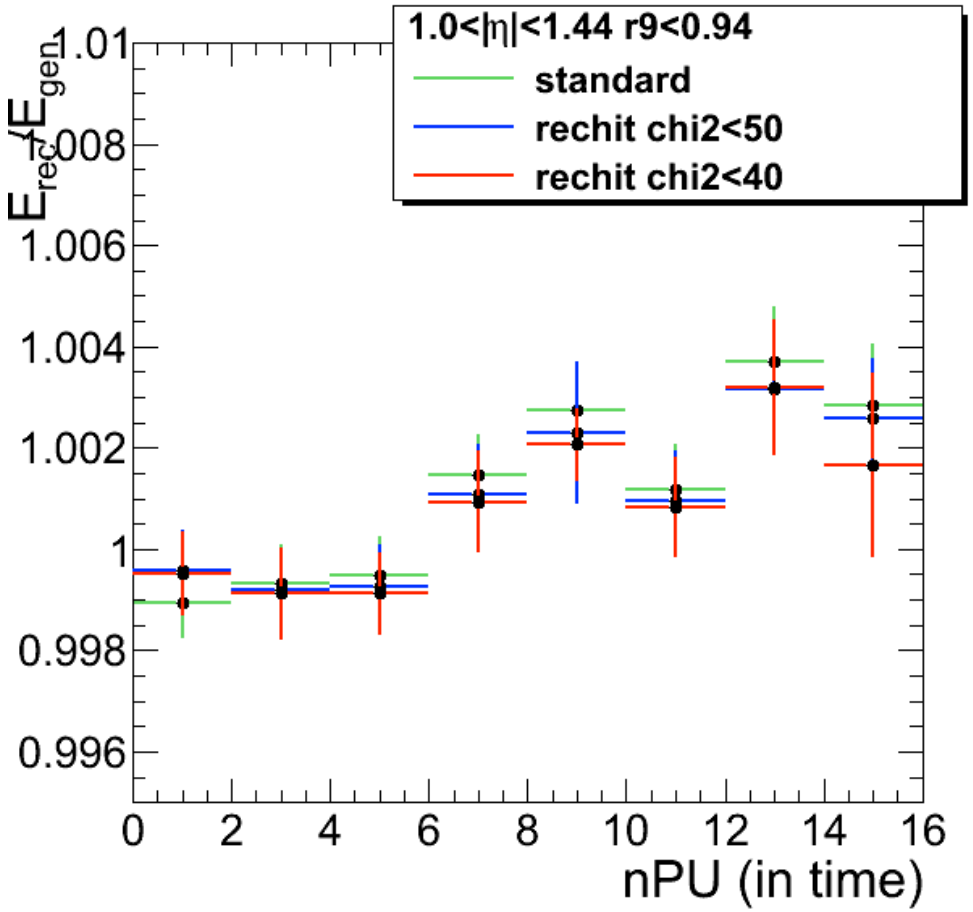
- Access the chi2 value of each rechit in the SC
- Compute the new **SC energy with rechits satisfying chi2 criterion** (clustering is not redone, just energy is recomputed)
- Do it only for low R9 photons (high R9 photons needs to recompute E5x5 - not yet done)
- Apply new f(Brem,η)xF(E_T) energy corrections on top of the new SC energy

Energy resolution

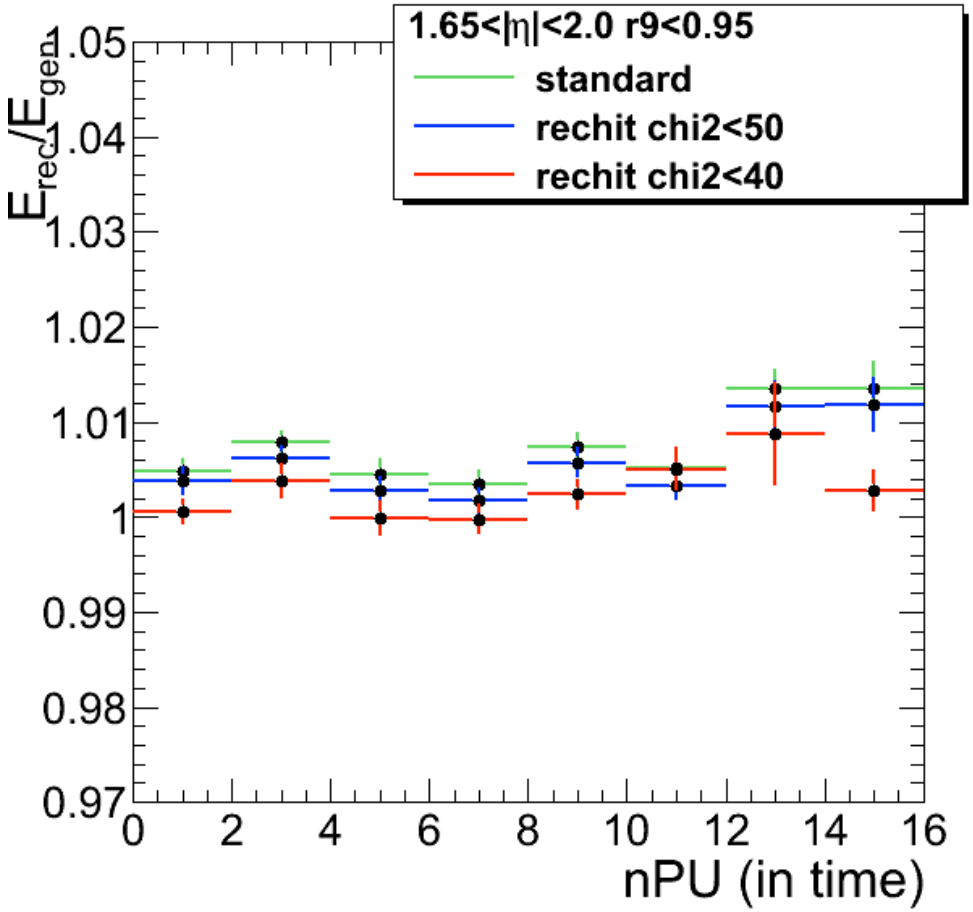
- Compute Erec/Egen (cristal ball most probable value) as a function of the number of PU interactions

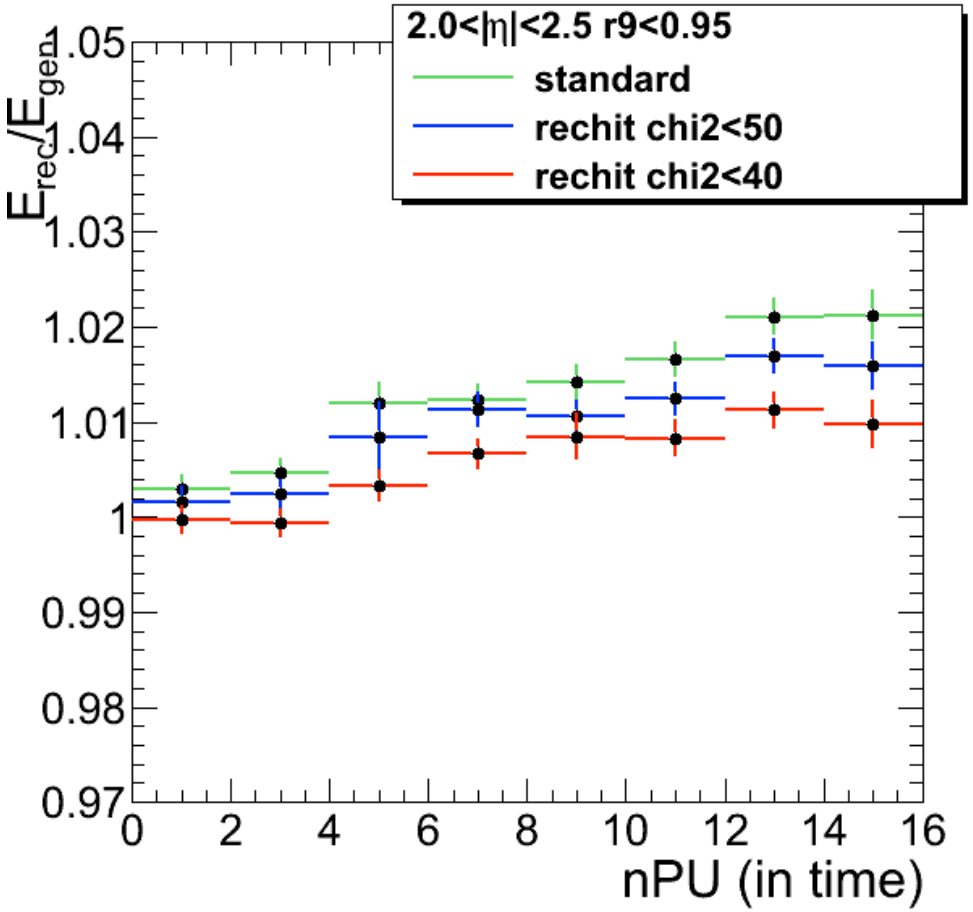
In-time pile-up : barrel



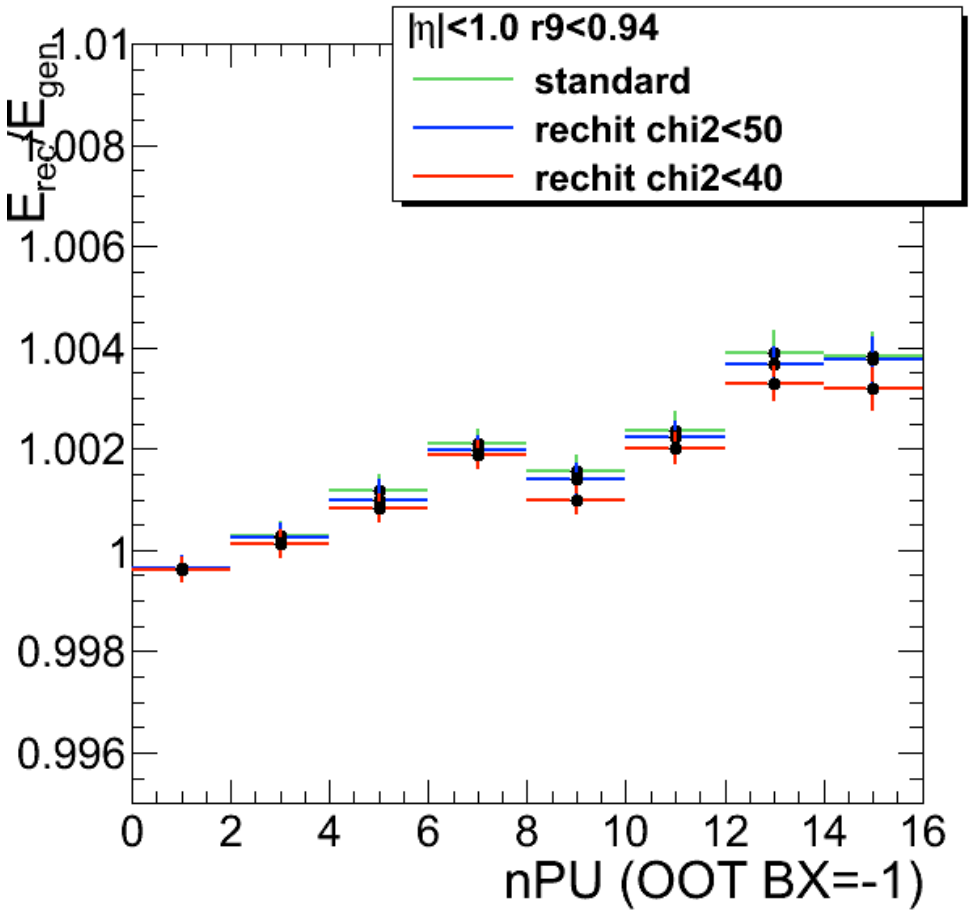


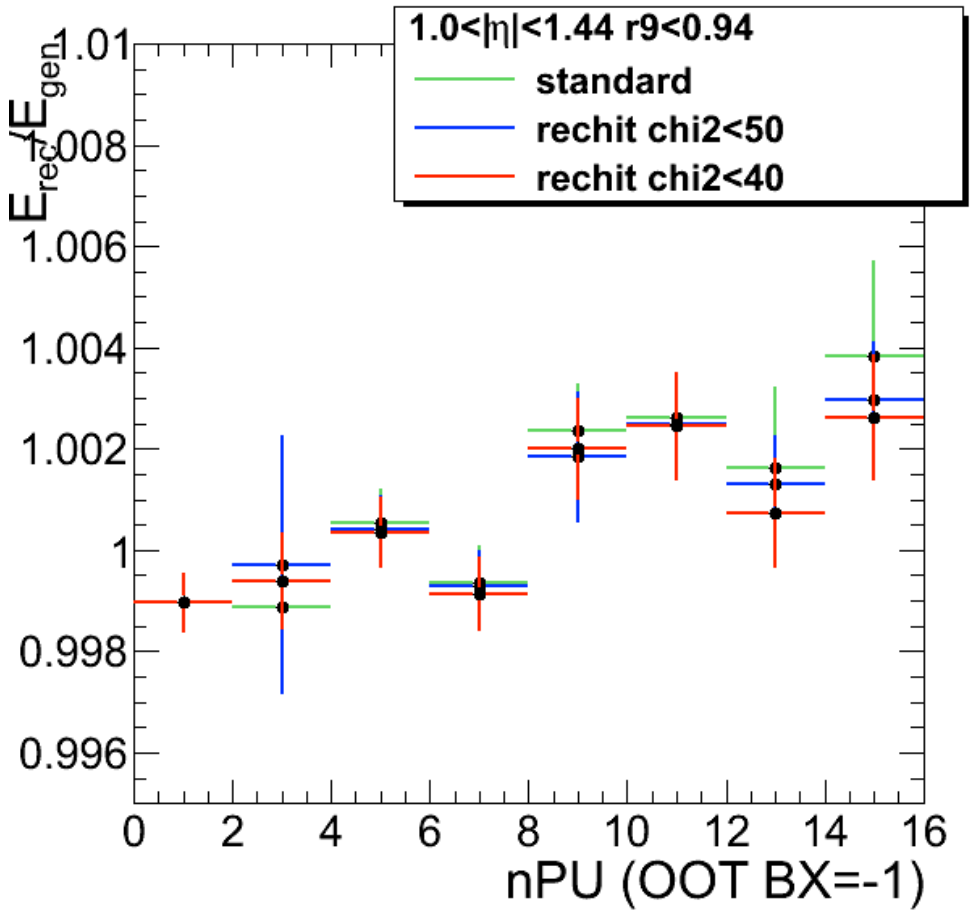
In-time pile-up : endcap



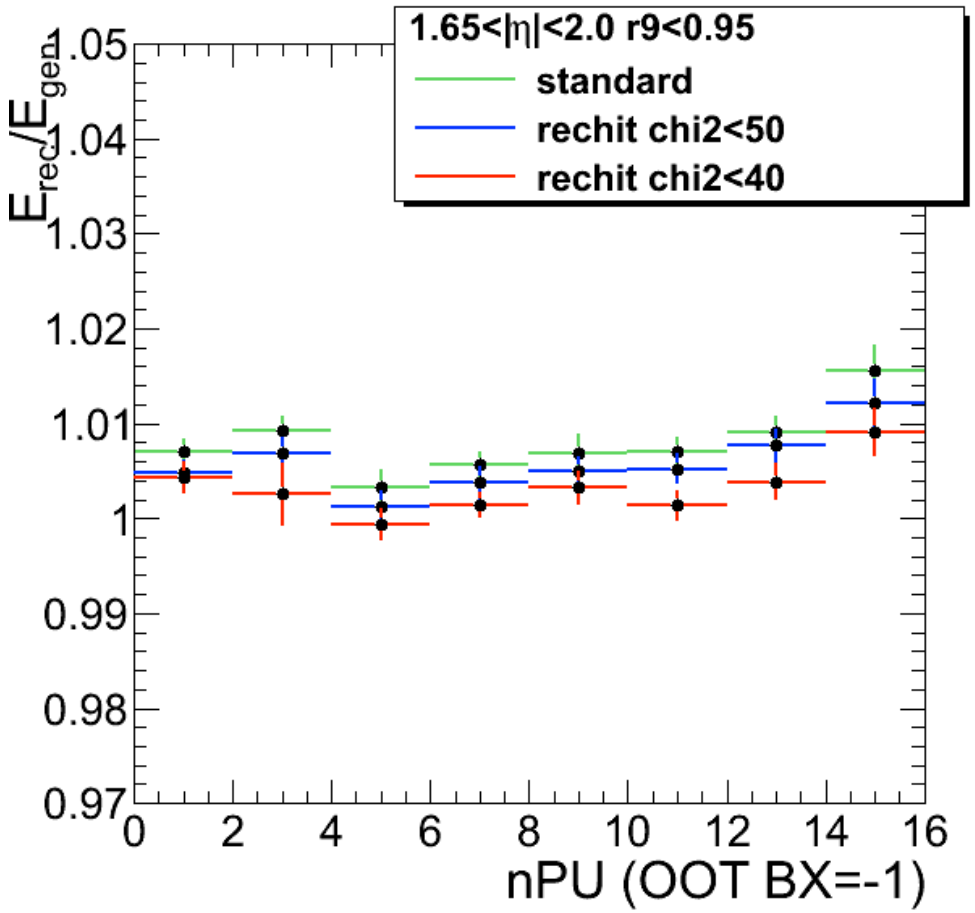


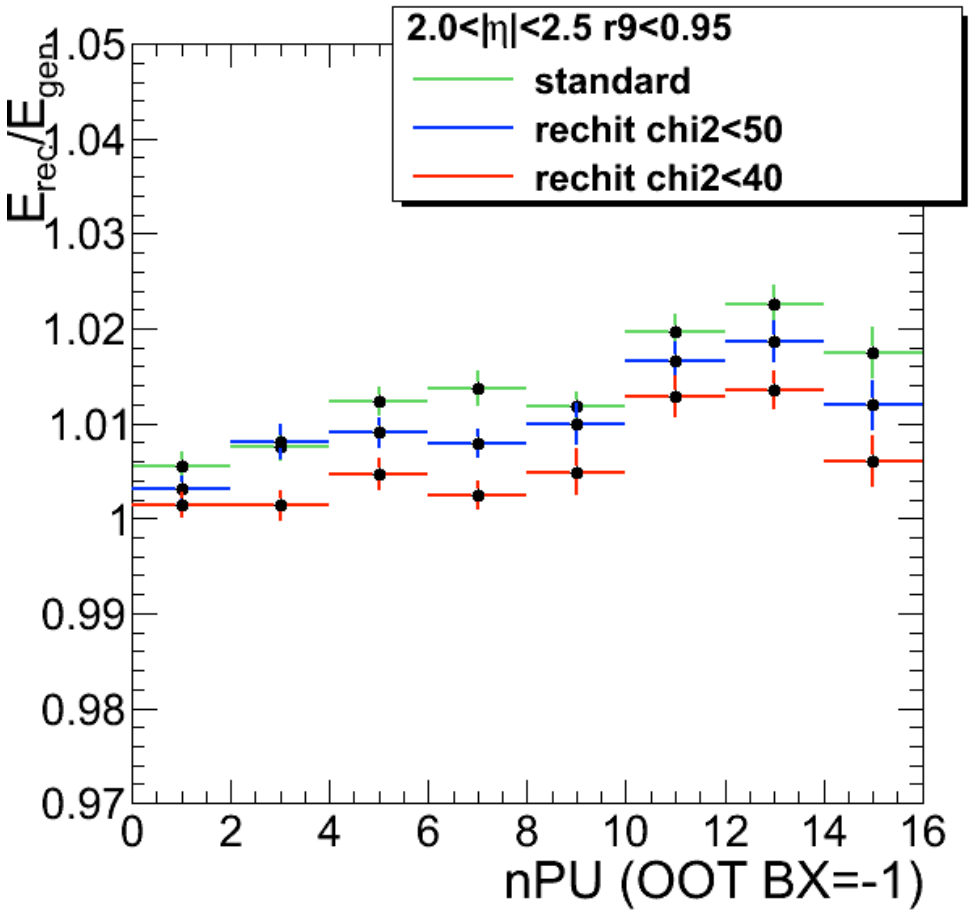
out-of-time pile-up : barrel





out-of-time pile-up : endcap





Conclusions

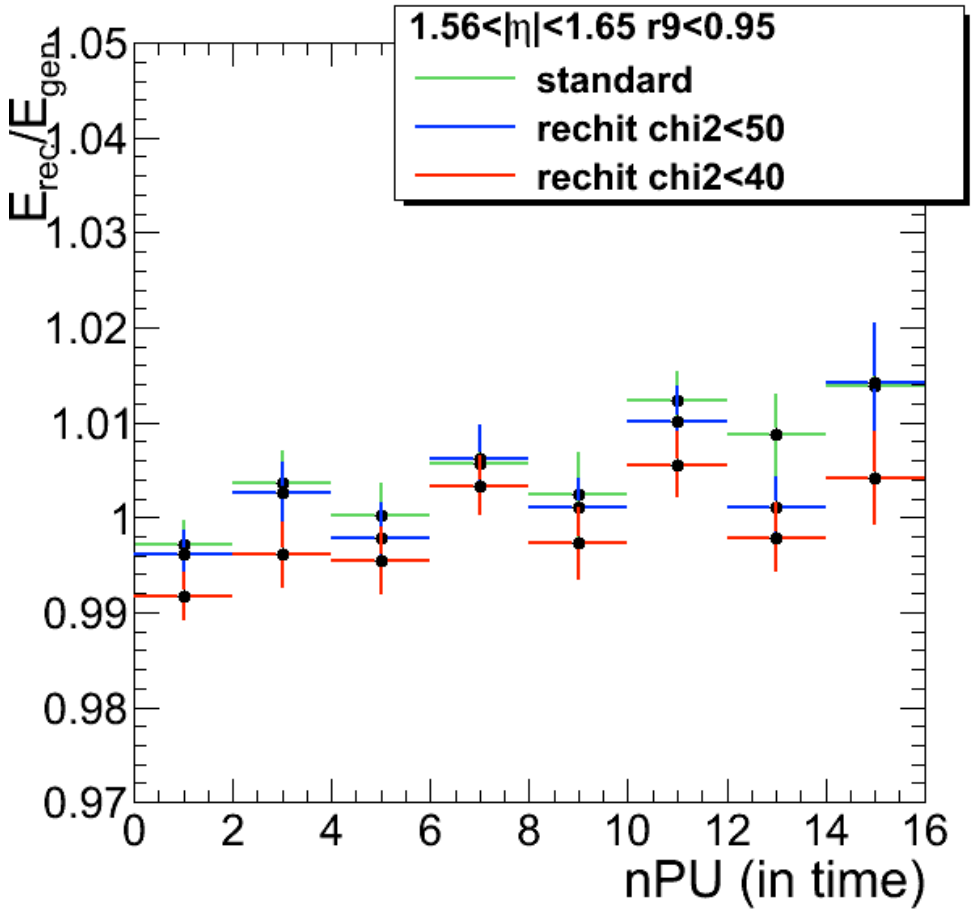
Conclusion

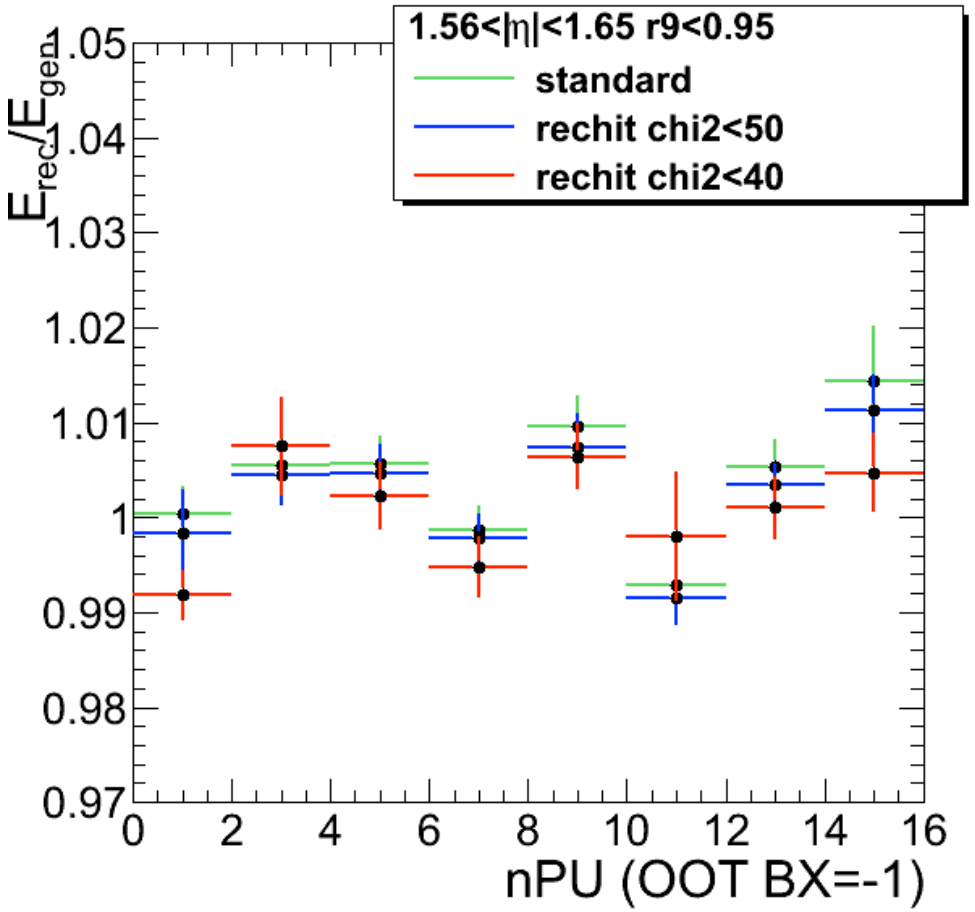
- Chi2 seems promising to improve energy resolution in the endcap (and especially far endcap)

Future plans

- Need to adjust the parameterization for the endcap
- Disentangle in-time/OOT PU : need to generate pure in-time and OOT samples
- Look at data (high PU runs from 2011)
- Look at high R9 (recompute E5x5) and electrons
- Prepare code to re-reco with chi2 on all the rechits

Back-up


1.56<|η|<1.65 r9<0.95
standard
rechit chi2<50
rechit chi2<40
E_rec/E_gen
nPU (in time)


1.56<|η|<1.65 r9<0.95
standard
rechit chi2<50
rechit chi2<40
E_rec/E_gen
nPU (OOT BX=-1)