PHOS calibration in CDB framework

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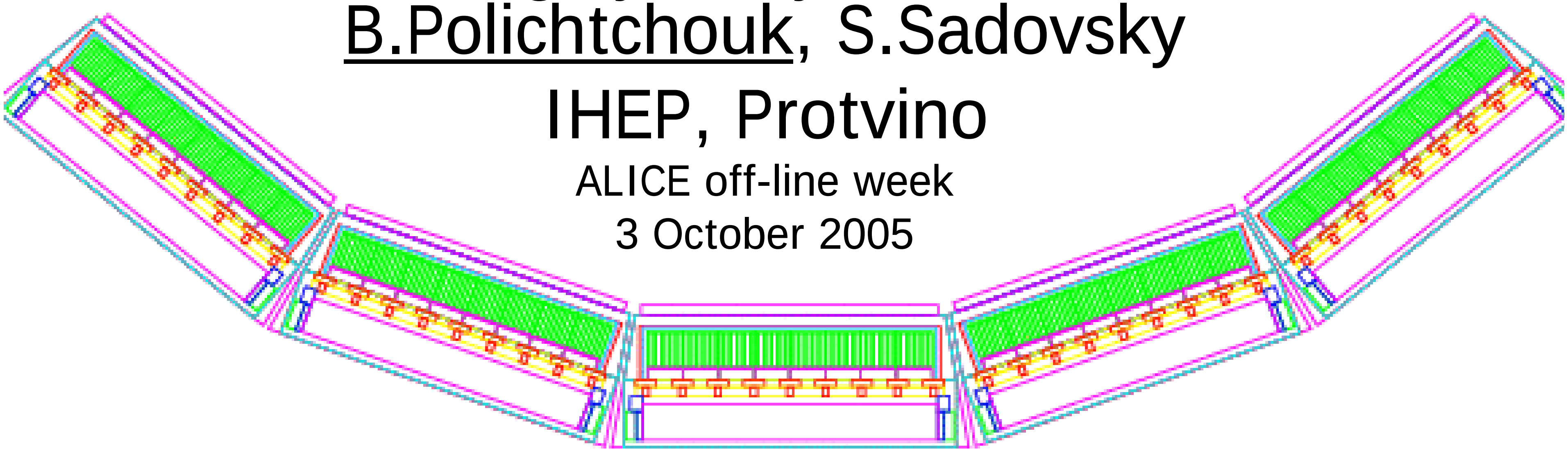

ALICE off-line week
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Outline

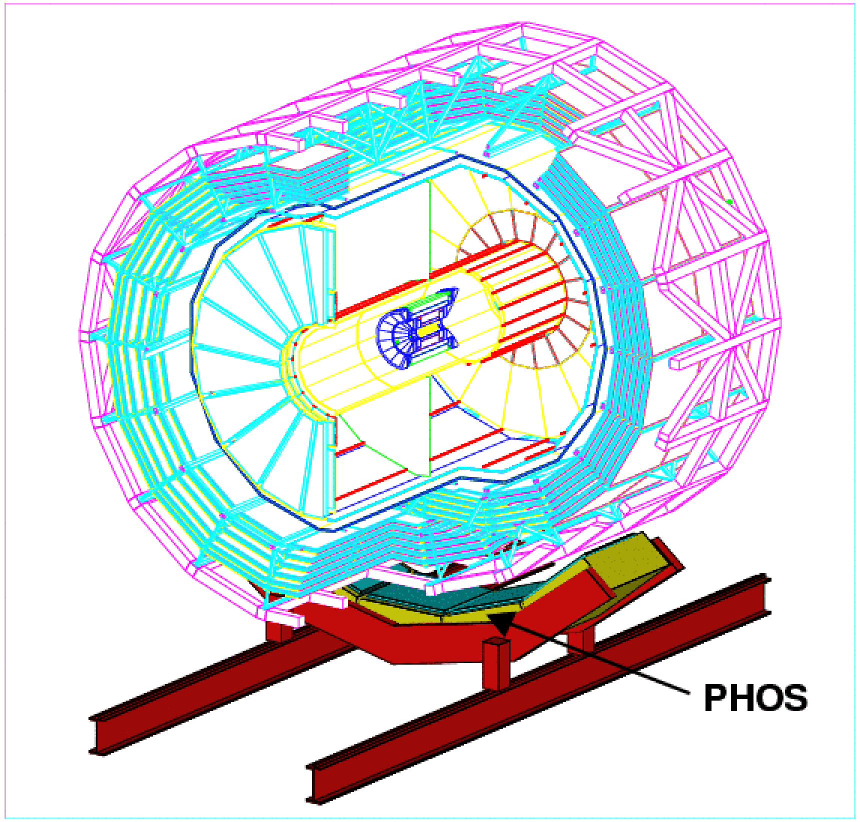
1. Review of PHOS calibration algorithms
2. Software description
3. Decalibration procedure
4. Calibration procedure

   - Step 1 – calculation of per-cell coefficients using mean amplitudes in crystals and writing them to CDB

   - Step 2 – reading of the coefficients from CDB and using them in PHOS reconstruction

Summary

PHOS geometry

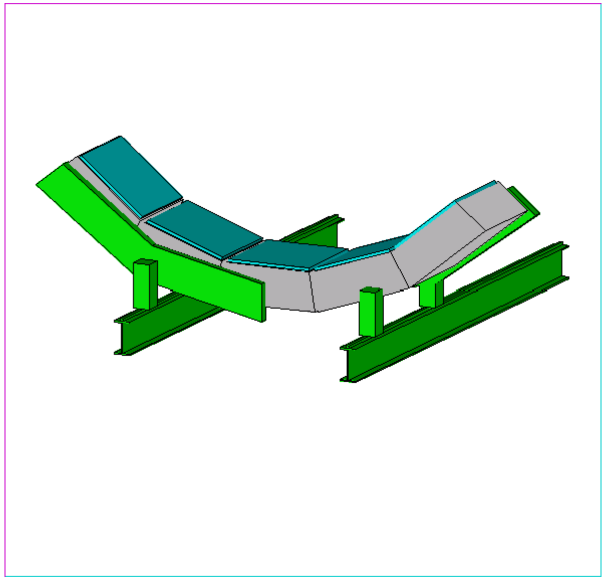


PHOS has 5 modules

Each module consists of EMC and CPV

1 EMC module contains 3584 crystals

1 CPV module contains 7168 pads



Requirements for calibration precision

- 0.5% uncertainty of energy reconstruction results in 2% of prompt photons spectrum uncertainty at Pt=50 GeV

Calibration algorithms: by wide e^- beam calibration (beam test 2003)

PHOS module should be exposed by a wide electron beam at fixed known energy E_0

Calibration coefficients α_i are found from minimization of the functional

$$F(\alpha) = \sum_{n=1}^{N_{ev}} \left[\sum_{i \in clust} \alpha_i A_i - E_0 \right]^2$$

Total deposited energy is summed over 5x5 area around the max. cell

Calibration algorithms: EMC run-time calibration by electrons

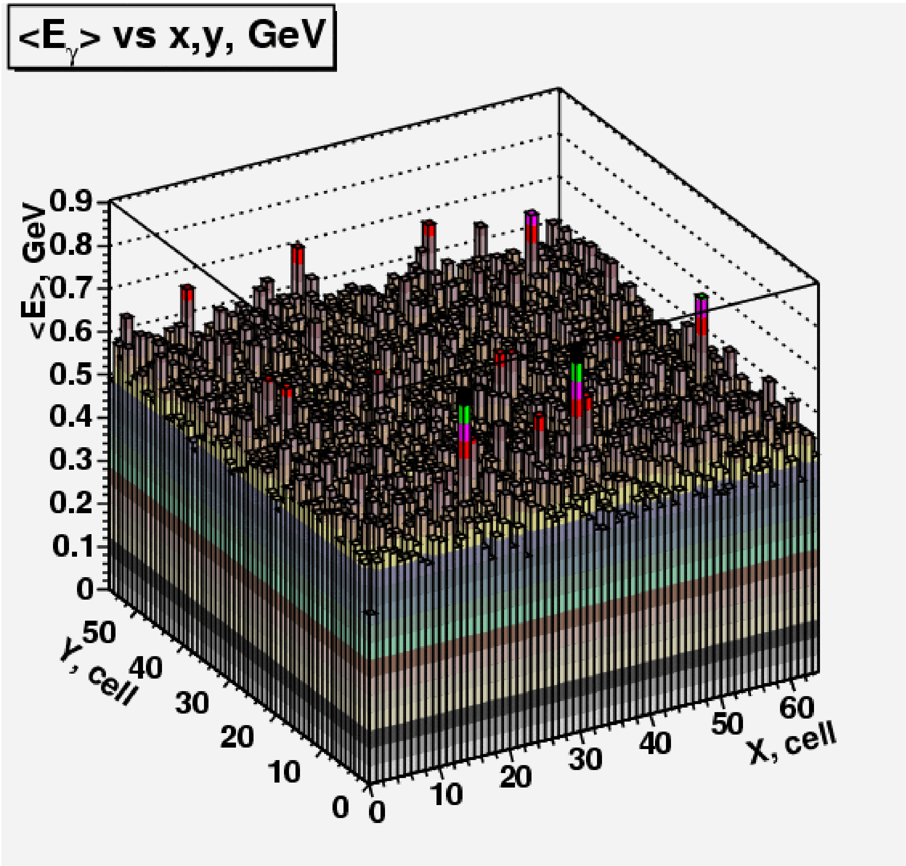
EMC can be calibrated by tracks found by the global tracking procedure and identified as electrons (similar to calibration by e^- beam)

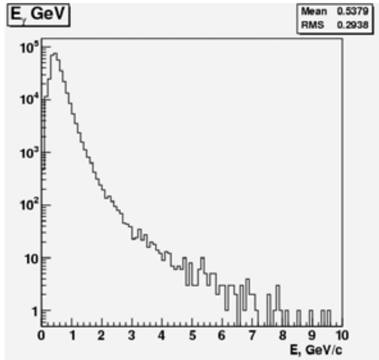
$$F(\alpha) = \sum_{n=1}^{N_{ev}} \left[\sum_{i \in clust} \alpha_i A_i - E_i \right]^2$$

Where E_i is electron energy in event i.

Needed statistics is to be estimated yet.

Calibration algorithms: EMC run-time calibration by mean energy





PHOS will be polulated by photons distributed uniformly vs X,Y.

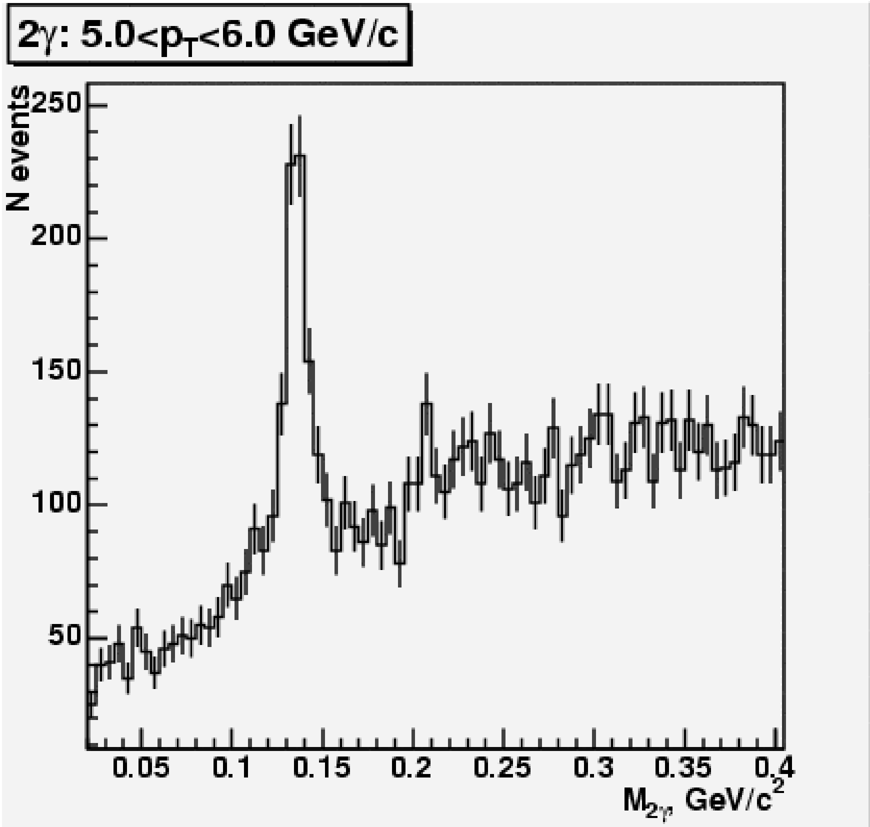
On average there will be 10 reconstructed photons per module per one central Pb-Pb collision.

Mean rec.photon energy can serve as a measure of calibration.

To store statistics of 1000 events per channel needed for calibration, one needs 5 minutes of LHC run.

Calibration algorithms: EMC run-time calibration by π^0 mass

200,000 central Pb-Pb events
(4 minutes of LHC run)



Calibration coefficients can be found by minimization of π^0 mass.

It requires low combinatorial background $\Rightarrow$ high p_T $\Rightarrow$ longer exposition.

p_T>5 GeV is a lower limit for this calibration.

To calibrate each cell with 1000-event statistics one needs 10 days.

Calibration algorithms: CPV run-time calibration by mean charge

CPV responds to charged particles passing through CPV gas volume. On average there will be 100 charged particles per module per one central Pb-Pb collision.

Similar to PHOS EMC, CPV fired pads will be distributed uniformly vs X,Y.

Pad response function (induced charged) can serve as a measure of calibration.

To store statistics of 1000 events per pad needed for calibration, one needs <1 minute of LHC run.

Software package

- Classes used/modified:

- CDB storage classes (cvs version 1.1)
- AliPHOSCalibData (PHOS calibration object)
- AliPHOSGetter (+Set/Get calibration obj.)
- AliPHOSDigitizer (+read (de)calibration coeff. per crystal)
- AliPHOSClusterizerv1 (+read calibration coeff per crystal)

Calibration object structure

AliPHOSCalibData:

```
Float_t fADCchannelEmc [5][56][64];      // convertion from ADC counts to GeV
Float_t  fADCpedestalEmc [5][56][64];   // ADC pedestals
```

These class contain the methods to set and to get the calibration parameters by the relative channel number (module, column, row).

The actual dimension of arrays fADCchannelEmc and fADCpedestalEmc correspond to the number of crystals in PHOS (nEmc=17920).

"Decalibration" procedure ($ALICE_ROOT/PHOS/macros/CalibrationDB/AliPHOS/SetCDB.C)

```
void SetDB()
{
 TString DBFolder="deCalibDB";   // create local directory
 AliPHOSCalibData *calibda=new AliPHOSCalibData("PHOS"); // create new calibration object
 TRandom rn;

 for(Int_t module=1; module<6; module++) {
  for(Int_t column=1; column<57; column++) {
   for(Int_t row=1; row<65; row++) {
     fADCchanelEmc=rn.Uniform(0.00075,0.00375); // random ADC gain factors (Cmax/Cmin = 5)
     fADCpedestalEmc=rn.Uniform(0.0045,0.0055); //  random ADC pedestals (+-10% spread from 0.005)
     calibda->SetADCchannelEmc(module,column,row,fADCchanelEmc);
     calibda->SetADCpedestalEmc(module,column,row,fADCpedestalEmc);
   }
  }
 }

 AliCDBMetaData md("PHOS/Calib/GainFactors_and_Pedestals", ...); // create metadata object for calibration data
 AliCDBLocal *loc = new AliCDBLocal(DBFolder.Data());
 AliCDBStorage::Instance()->Put(calibda, md);  // write calibration object into DB!
}
```

Simulation of "decalibrated" data

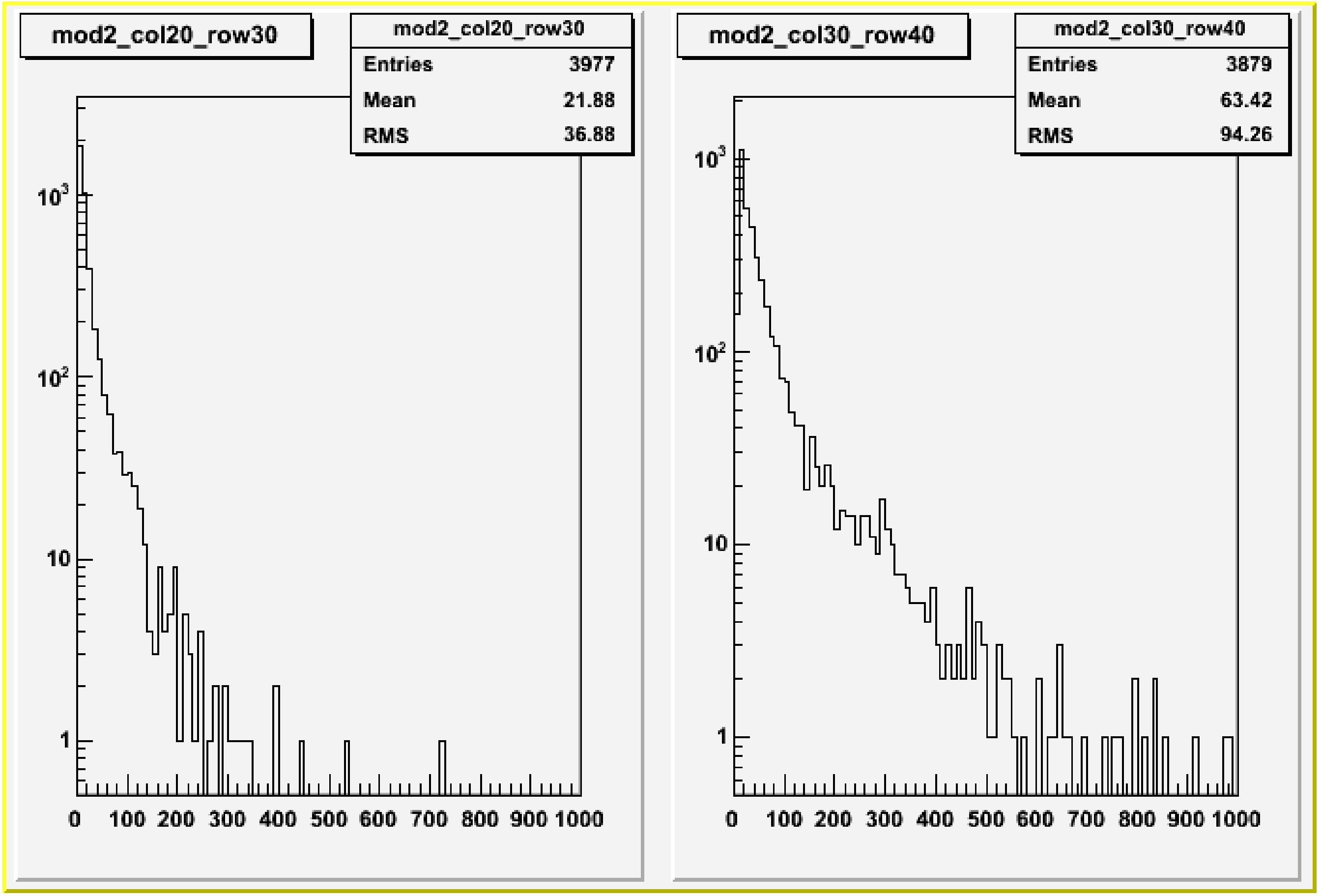
- ~200K Hijing min. bias events were generated into PHOS aperture and transported using aliroot.

Digitization of “decalibrated” data

```
void Dig(Int_t nevents=1)
{

  //Dititize events assuming SDigits already produced.

 //Load calibration database into aliroot session
 //and set it to AliPHOSGetter.
 AliCDBLocal *loc = new AliCDBLocal("deCalibDB");

 AliPHOSCalibData* clb = (AliPHOSCalibData*)AliCDBStorage::Instance()
   ->Get("PHOS/Calib/GainFactors_and_Pedestals",gAlice->GetRunNumber());   // retrieve calibration object!

 AliPHOSGetter* gime = AliPHOSGetter::Instance("galice.root");
 gime->SetCalibData(clb); // make calibration object available for digitizer

  AliSimulation sim ;
 sim.SetRunGeneration(kFALSE) ;
 sim.SetMakeSDigits("") ;
 sim.SetMakeDigits("PHOS") ;
 sim.Run(nevents) ;
}
```

Amplitudes in cells

Mean amplitudes in cells differ a lot => relative calibration coefficients are necessary to adjust channels to the same mean value.



Step 1: adjustment of mean amplitudes in cells

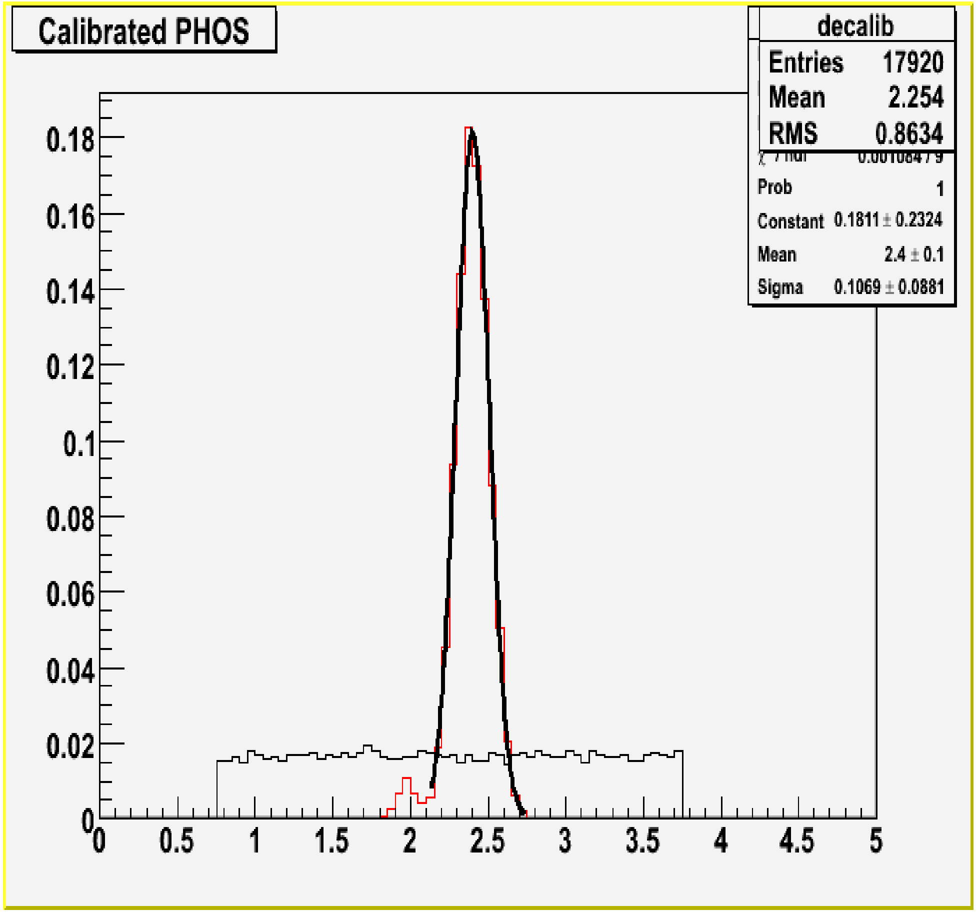
Adjustment coefficient for i-th crystal C[i]=<A[i]>/A0,

where A0 – mean amplitude in arbitrary chosen "reference" cell.

Measure of adjustment:

width of C[i]*α[i] distribution (red line),

where α[i] - "decalibration" coefficient.

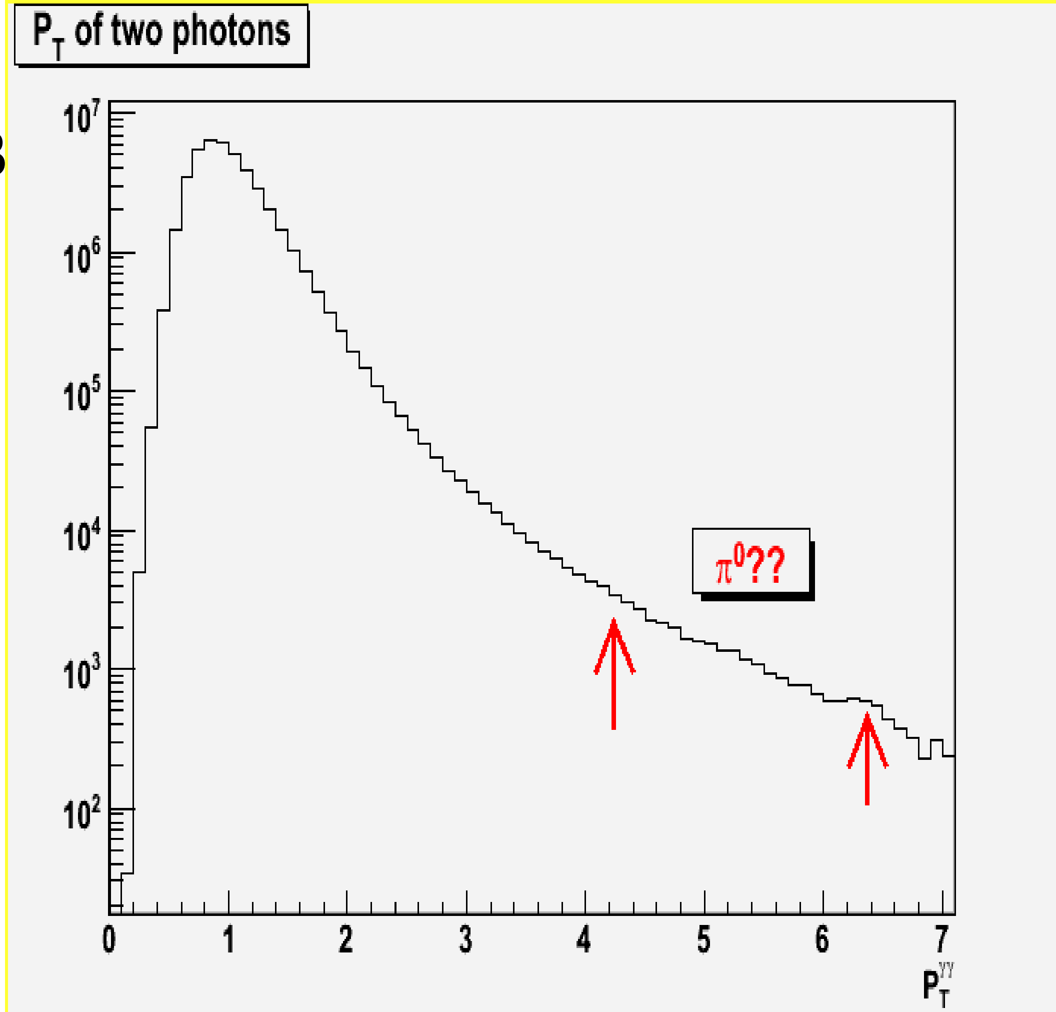


Step 2: reconstruction using adjustment coefficients

- Adjustment coefficients of Step 1 were read from CDB and applied on the clusterization stage:

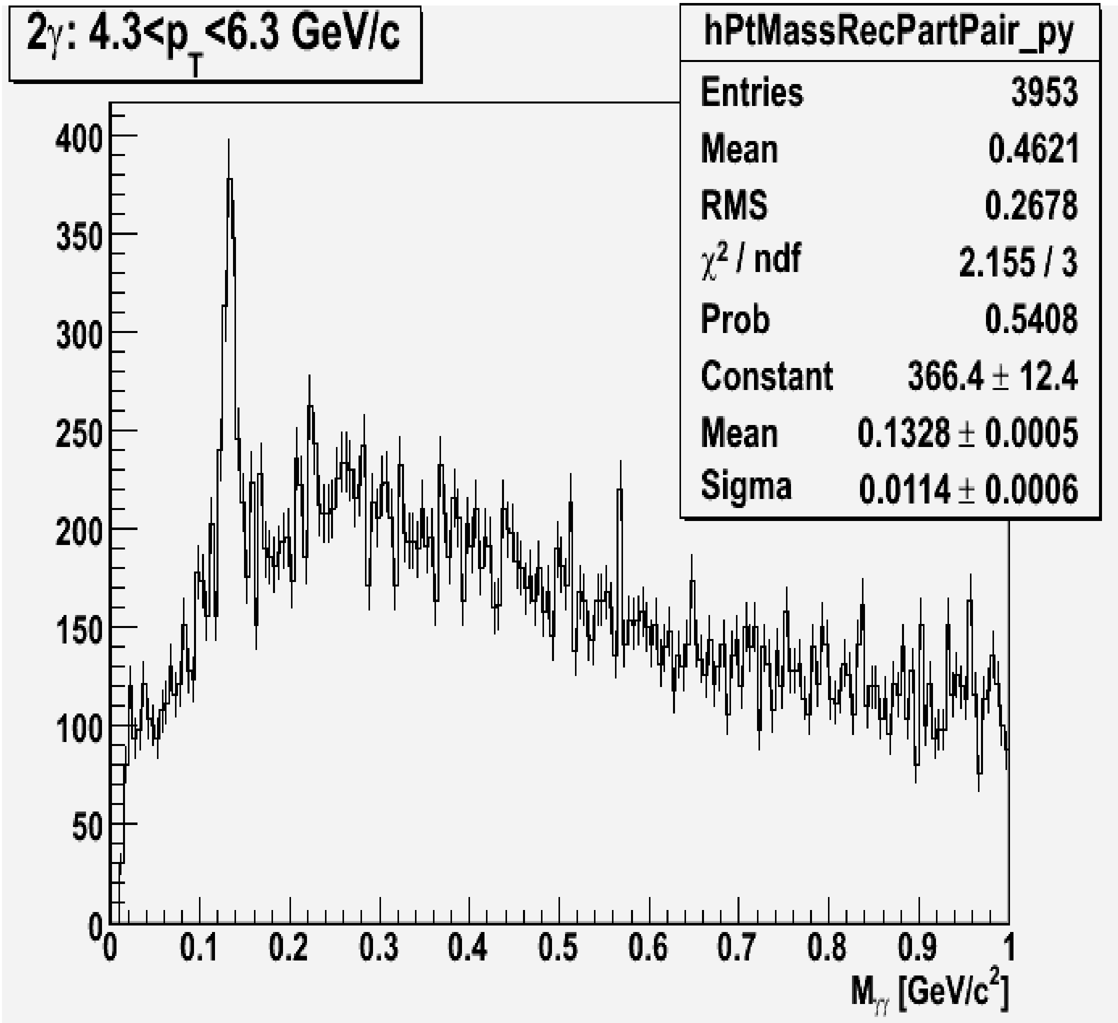
fADCchanel[i] = 0.0024/C[i]

ADC counts -> GeV
subject of fine tuning!



Pi0 mass

- Pi0 mass gives energy scale
- Comparison: Pi0 width obtained with hardcoded identical calibration coefficients was 6 MeV



Conclusion

- PHOS run-time calibration procedure is “in the first approximation” implemented within the CDB framework.
- Crude calibration procedure using mean amplitudes alignment gives approx. 5% calibration accuracy.
- Alignment of mean amplitudes gives pretty good start guess about the calibration coefficients, however, more refined calibration procedure based on pi0 mass minimization is necessary
- To explore: stability of results in dependence of “reference cell” choise (noisy channel? dead?)