AHCAL MC from SJTU & Comparison

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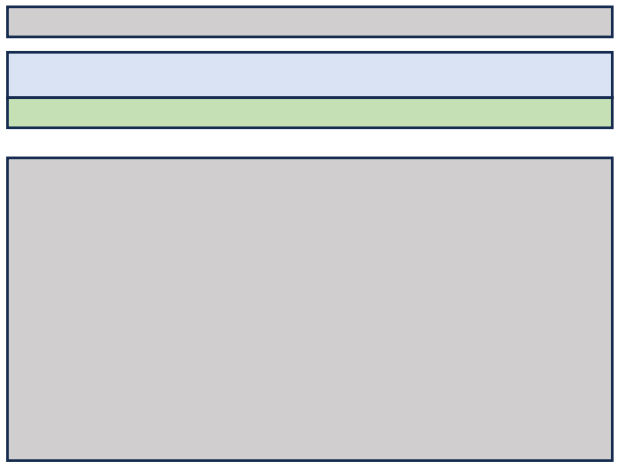
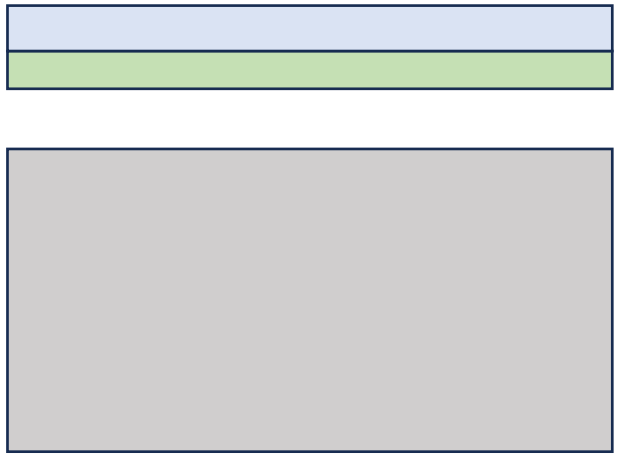
Geometries

- In z direction:
  - Thickness per layer: 30 mm.
  - Altogether 40 layers.
- In xOy plane:
  - Cell width: 40 × 40 mm^2;
  - Gap: 0.3 mm; filled with air (SJTU) or ESR (IHEP).
  - Altogether 18 × 18 cells per layer.

SJTU



IHEP



Digitisation (SJTU)

- The parameters for all the channels are the same, i.e. the mean value.
- The parameters are (possibly) the same as the old version from Baohua.
- High-gain saturation is not considered.
- Threshold: 0.5 MIP (~ 0.233 MeV).
- Detailed parameters: See screenshot.

Charge terms

ADC response

MIP response

```
Double_t EventAction::SiPMDigi(const Double_t& edep) const
{
    Int_t sPix = 0;
    sPix = gRandom->Poisson(edep / 0.466 * 20);
    sPix = 7396.0 * (1 - TMath::Exp(-sPix / 7284.0));
    Double_t sChargeOutMean = sPix * 29.4;
    Double_t sChargeOutSigma = sqrt(sPix * 5 * 5 + 3 * 3);
    Double_t sChargeOut = -1;
    while (sChargeOut < 0)
        sChargeOut = gRandom->Gaus(sChargeOutMean, sChargeOutSigma);
    Double_t sAdc = -1;
    while (sAdc < 0)
        sAdc = gRandom->Gaus(sChargeOut, 0.0002 * sChargeOut);
    Double_t sMIP = sAdc / 29.4 * 0.05;
    if (sMIP < 0.5)
        return 0;
    return sMIP * 0.466;
}
```

Digitisation (IHEP) (1)

- The parameters for the channels are different.
- The new parameters (Baohua):
  - Most of them are from the energy deposition of MIP events;
  - MIP photon numbers are from measurements;
  - The saturation formula of SiPM is only theoretical, with the pixel number as parameter;
  - Gain and error are also from measurements;
  - The uncertainty of charge is from estimation (very small).
- High-gain saturation is considered.
- Threshold: 0.5 MIP (~ 0.23 MeV).
- Use the calibration data from Yukun for digitisation (Dejing).

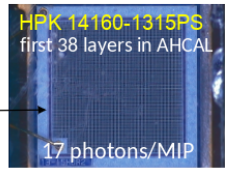
Digitisation (IHEP) (2)

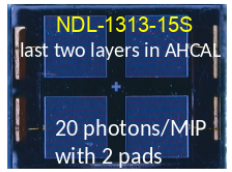
- Detailed processes are shown below (provided by Baohua).

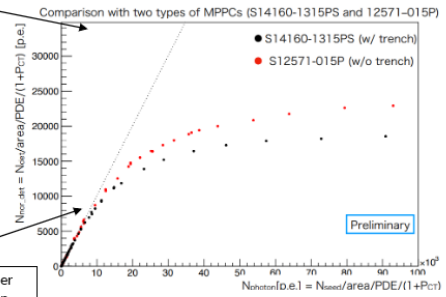
Data digitization method

- Digitization:
  - Energy deposition
  - Incident photons
  - SiPM response
  - Charge output
  - ADC tics
  - Digitized energy

Edep
↓ Poisson distribution
Nphoton
↓ $Nfired = Npixel \times e^{-\frac{Nphoton}{Npixel}}$
Nfired
↓ SiPM gain and its error
Charge
↓ ADC error and saturation
ADC
↓ MIP calibration and MIP cut
Edigi







Severer saturation effect observed in higher energy TB data, actually piecewise function has been used. When #photons>2500, there will be a more non-linear description.

https://indico.cern.ch/event/818783/contributions/3598507/attachments/1951212/3239232/CHEF2019_SiPMsaturation_NTsuji.pdf

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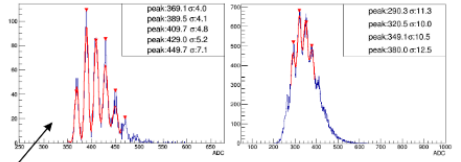
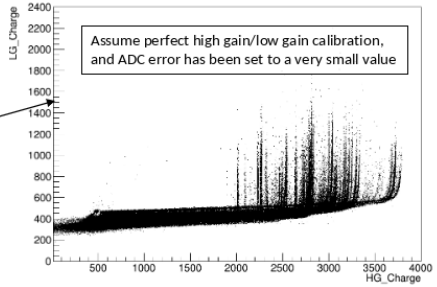


LG_Charge:HG_Charge



Perfect MIP calibration and 0.3 MIP cut