A method for muon-electron discrimination in the LumiCal test-beam

Veta Ghenescu and Titi Preda

Institute of Space Science

Outline

- Motivation for a good discrimination of electrons from muons in test beam
- A few words about software
- Description of a method based on the number of hits and “center of gravity” of the shower projections
- Results of the method
- Conclusions

Motivation for a complementary electron muon discrimination method

- Drawbacks of a simple cut method of energy deposition in sensors
  - Resolution of the detector system
  - Human choices regarding the cut limits
  - Systematic errors
- Taking into account the additional quantities of the particular physics involved, like
  - Number of hits produced by muons in entire set-up (maximum 16, for four sensors planes) is really smaller than those produced by secondary electrons from an EM shower
  - the muon energy deposition spectra are identical in all sensors. The muon spectra are quite thin and we could determine with precision some sort of "center of gravity". The electron energy deposition spectra are much larger and depend on the sensor plane.

Event class

```
class DateADC
{
public:
    DateADC(aData*);

    void GetTrigger(vector<vector<vector<double> > > & adcOut, Long64_t ntrigger);
    void GetADCdata(int , vector<vector <vector <double> > > &);
    void SetSignals();
    void GetSignals(vector<TELSignal> & sig);
..............
    //////Calibratition
    ////Pedestal
    ////Noise & CMN
...............

private:
    vector<vector<vector<double> > > ADCVcorrected;
    vector<vector<vector<double> > >  ADCVreal;
    aData* aRawData;
    vector<TELSignal> sigPlane;
.....
};
```

Signal class

```
class TELSignal {
 public:
  TELSignal();
  ~TELSignal();
  int SizeSignal() const;
  void AddSignal(const adc&);
  void ClearSignal();
  adc operator[](int i) const;
  void SortSignal();
  int FindIndexSignal(const int&);

 private:
  vector<adc> signal;
};
```

Variables

- Number of hits that actually represents number of pads with signal from all silicon sensors
  - For muons, $N_{hits} > \sim 16$, for 4 sensors, if we take into account edge effects
  - For EM shower $N_{hits} \gg 16$

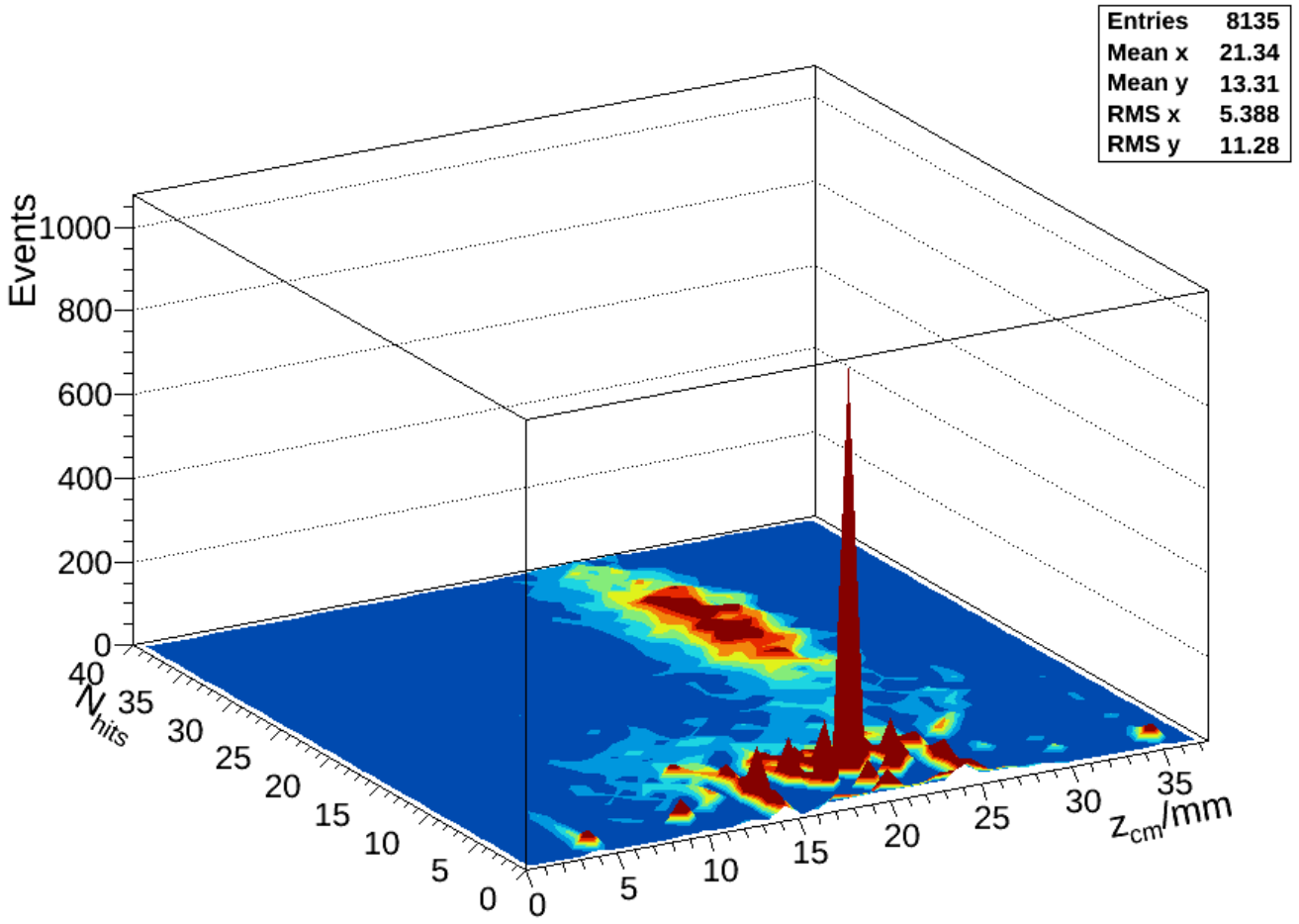
- Center of hits

$$X_{cm} = \left(\sum_{pl=0}^{n} X_{pl} * N_{pl}\right) / \sum_{pl=0}^{n} N_{pl}$$

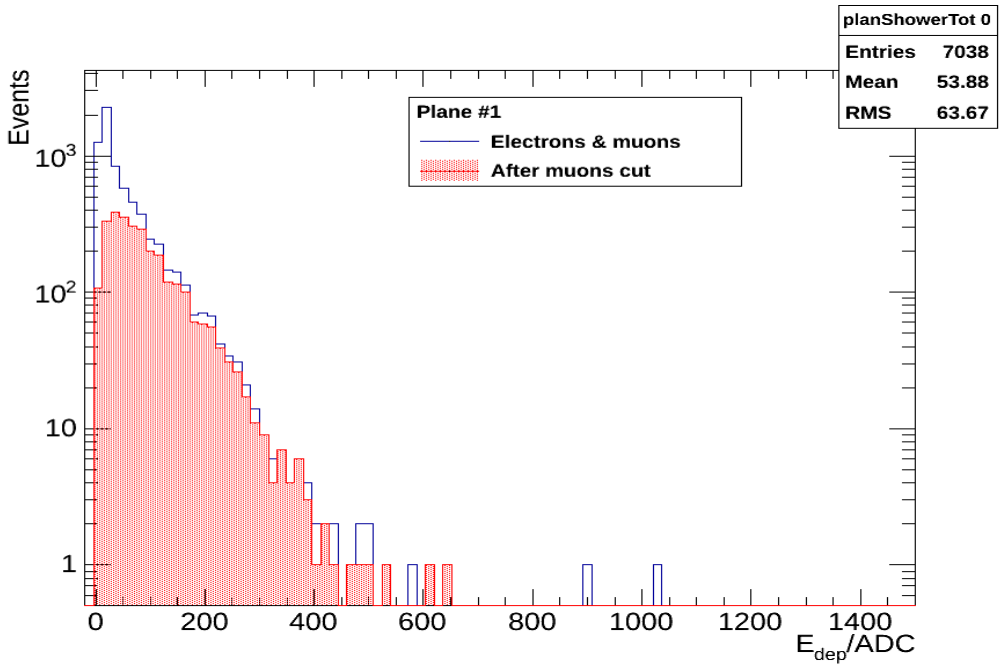
  - For muons the X_{cm} should be aproximatively in the center defined by silicon sensors
  - For shower depends of tungsten layers

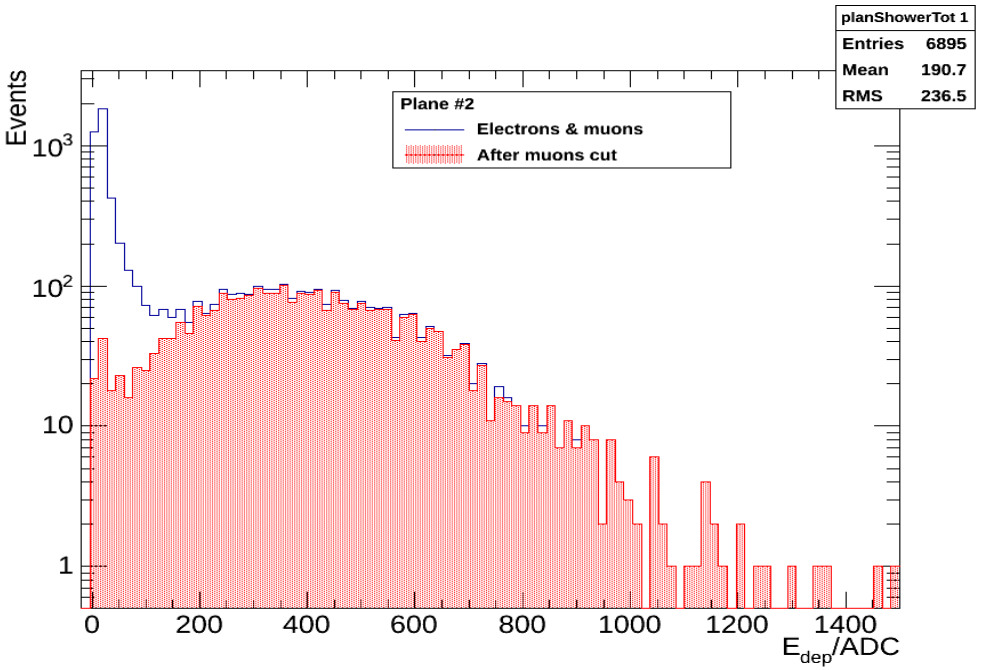
N_{hits}, z_{cm} event scatter plot in e&μ beam (1^{st} config)

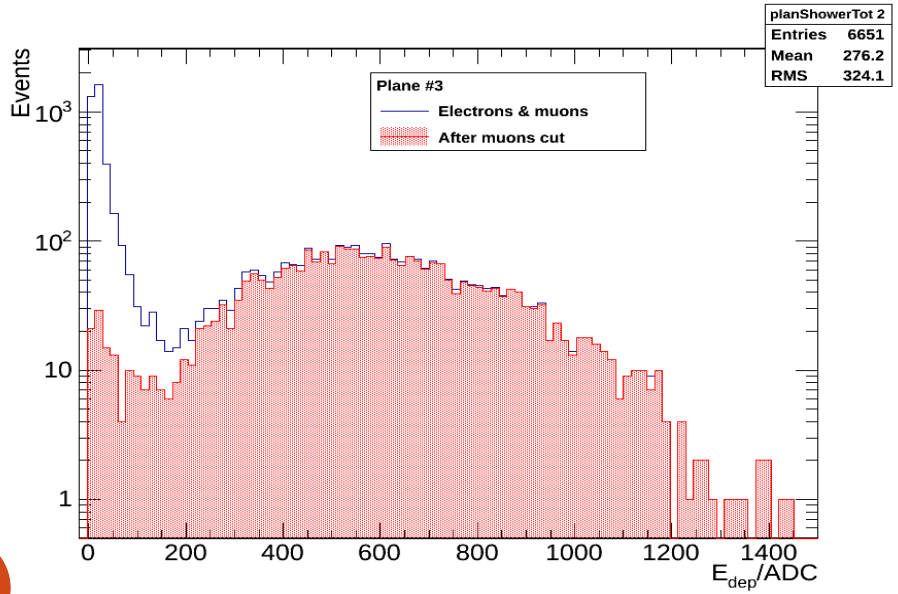
- Z origin was taken on the first tungsten plate
- Signal has been obtained using a complex procedure; an improvement of the STL container method already used for the BeamCal test beam
- A clear separation between electrons and muons, as we expected

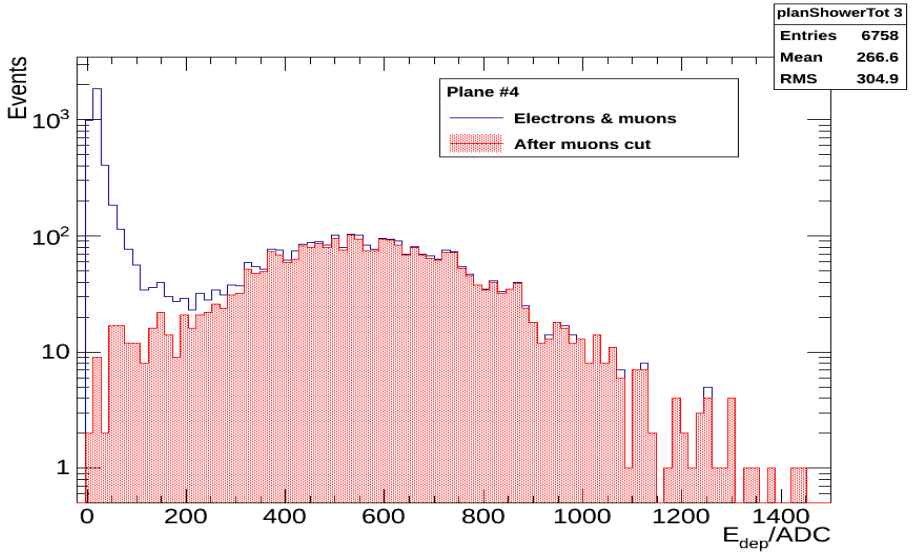


μ&e and electron spectra after e/μ discrimination (1st config)

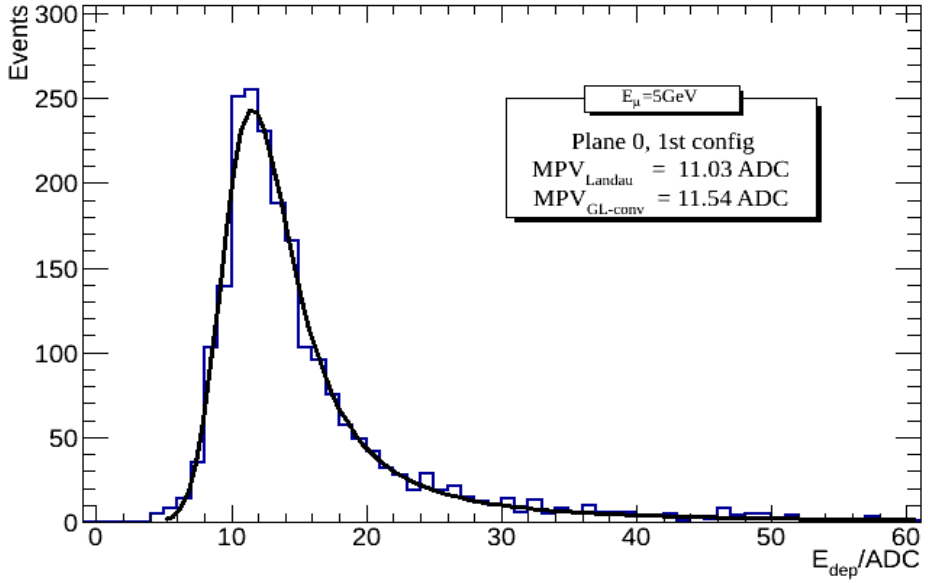


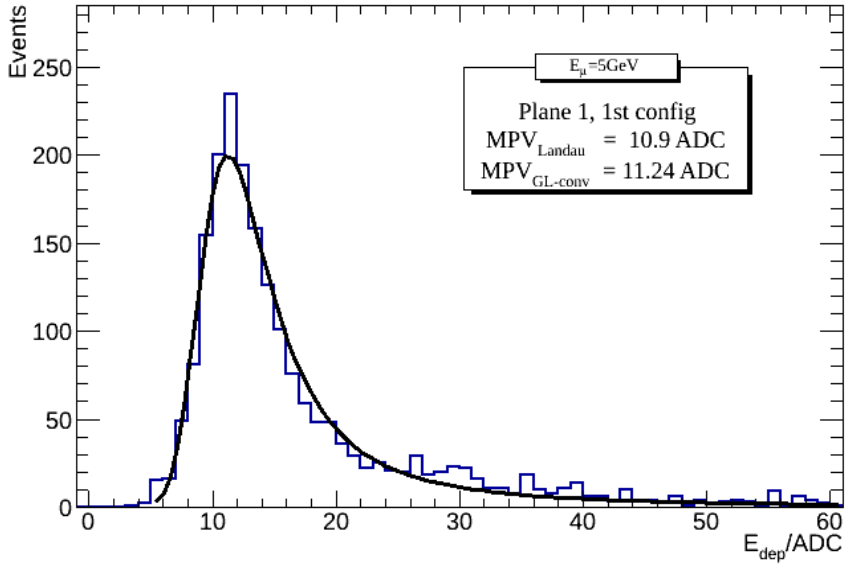


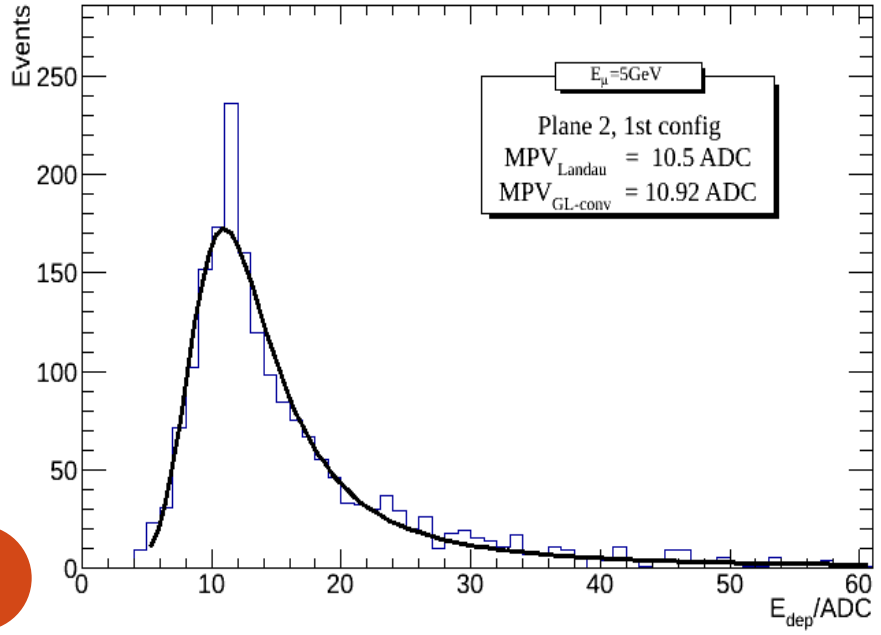


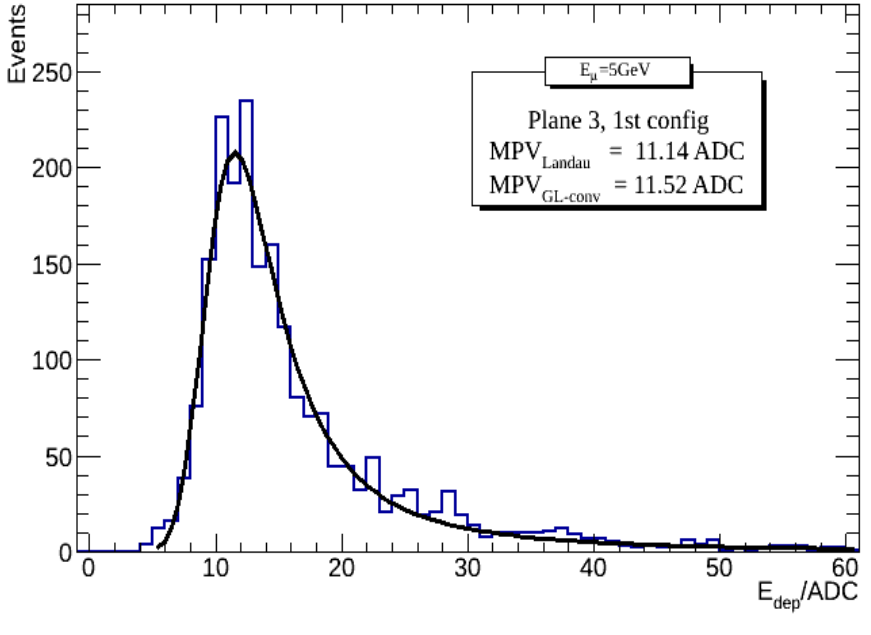


μ spectra after μ/e discrimination (1st config)

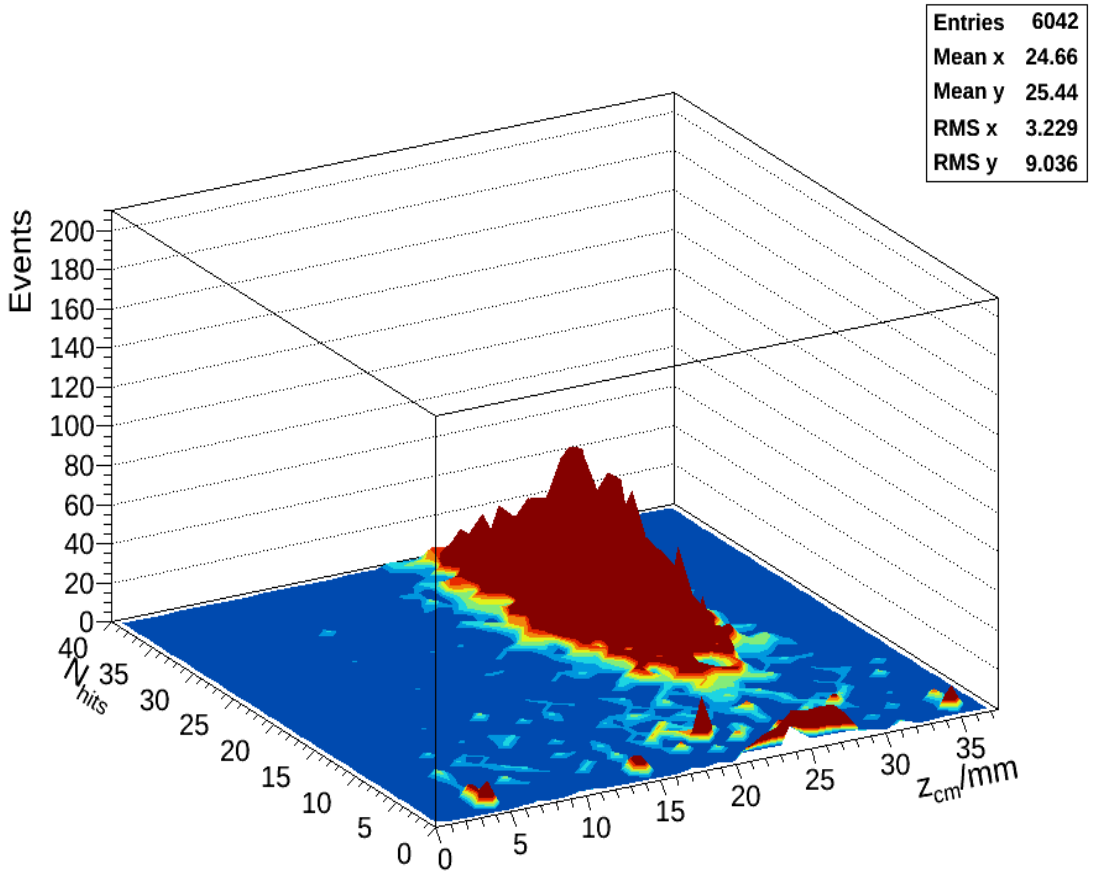


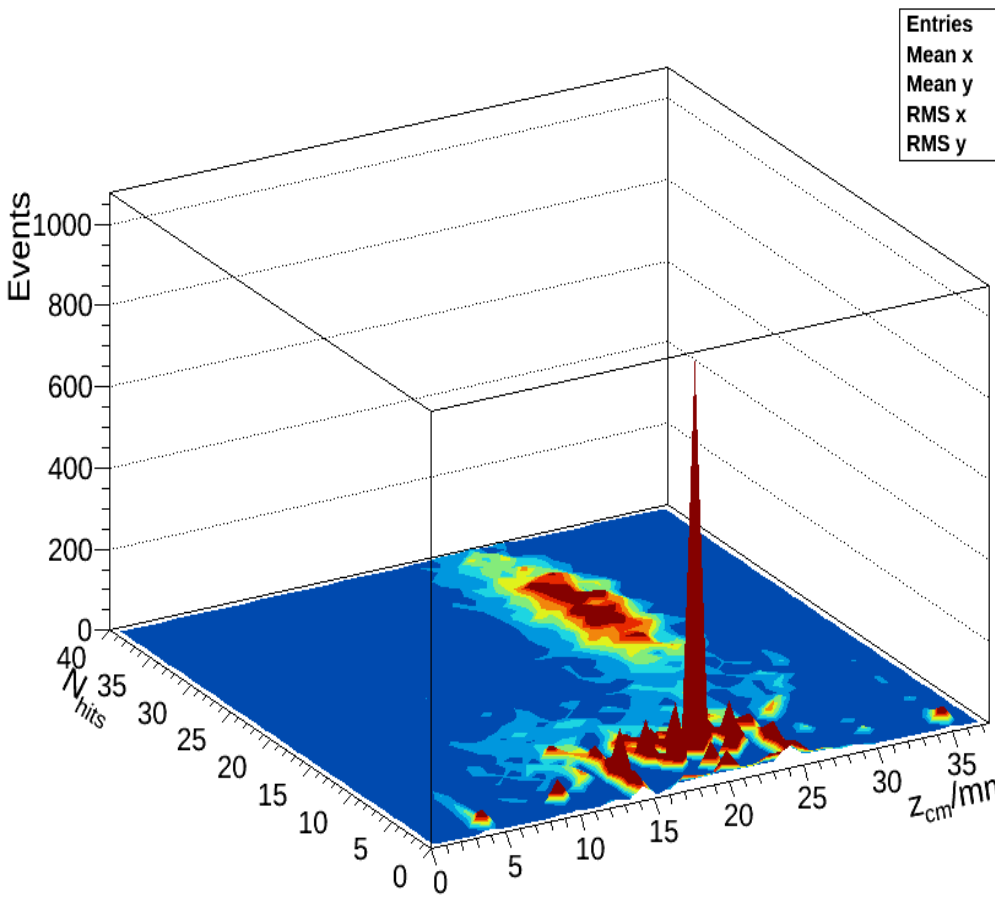






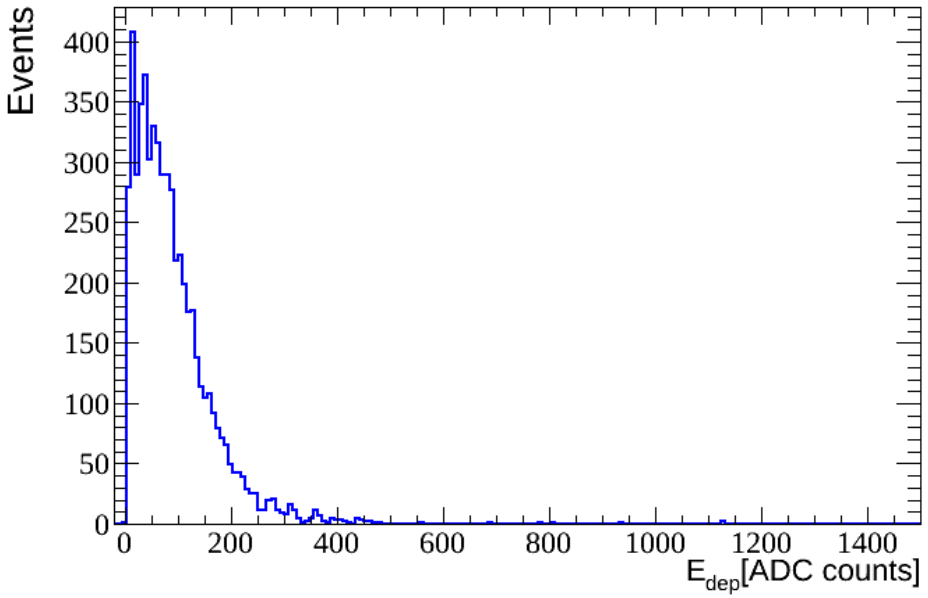
N_{hits}, z_{cm} event scatter plot in a "pure" electron beam

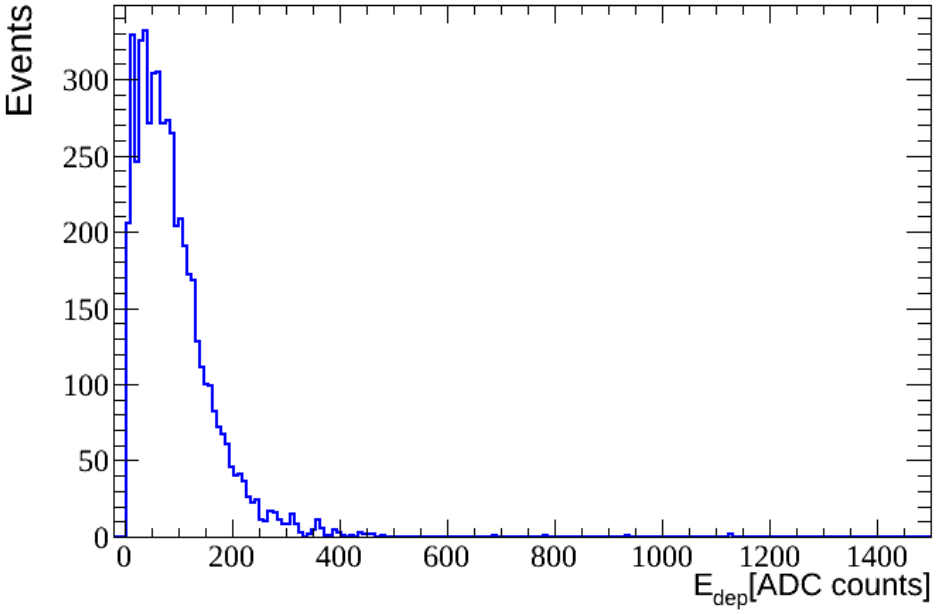




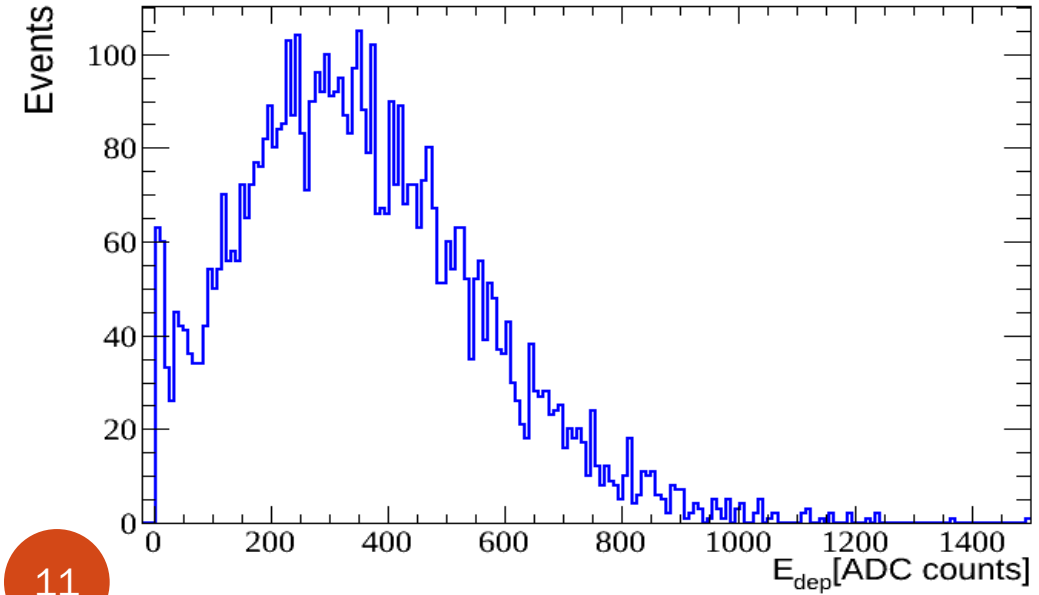
Electron spectra in a pure "electron" beam (1)

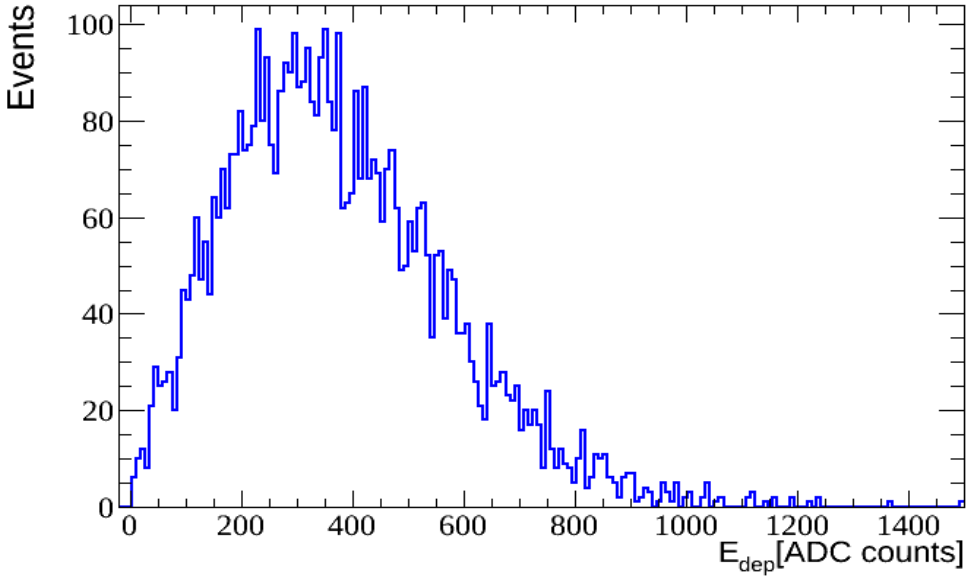
Plane 0 before and after μ/e discrimination





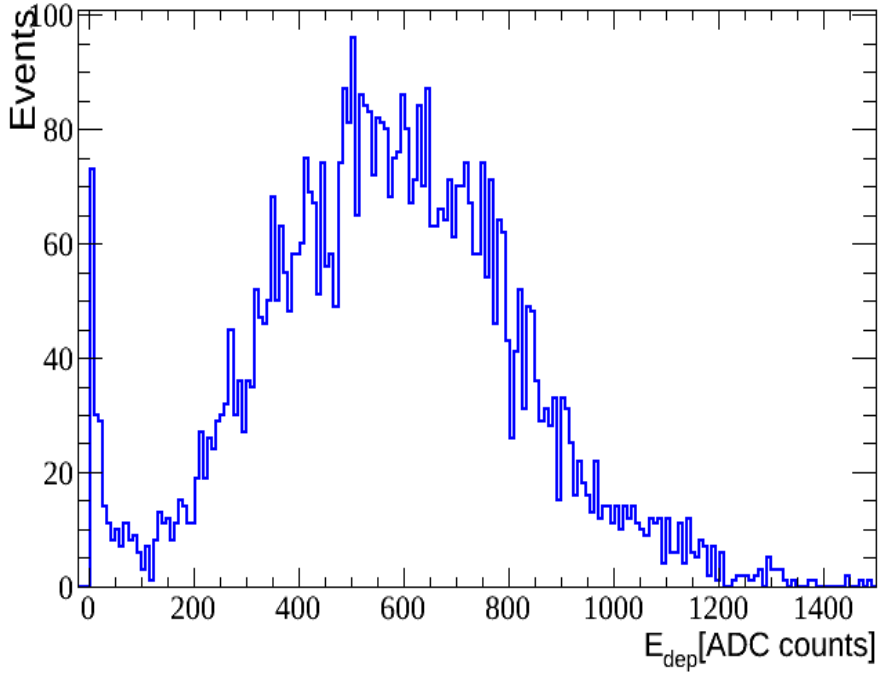
Plane 1 before and after μ/e discrimination

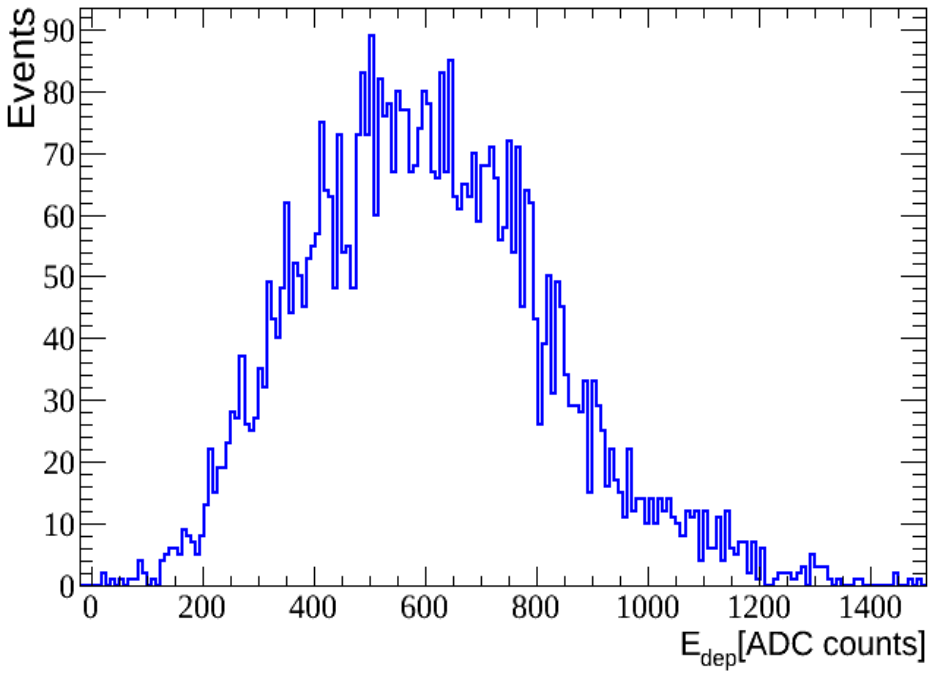




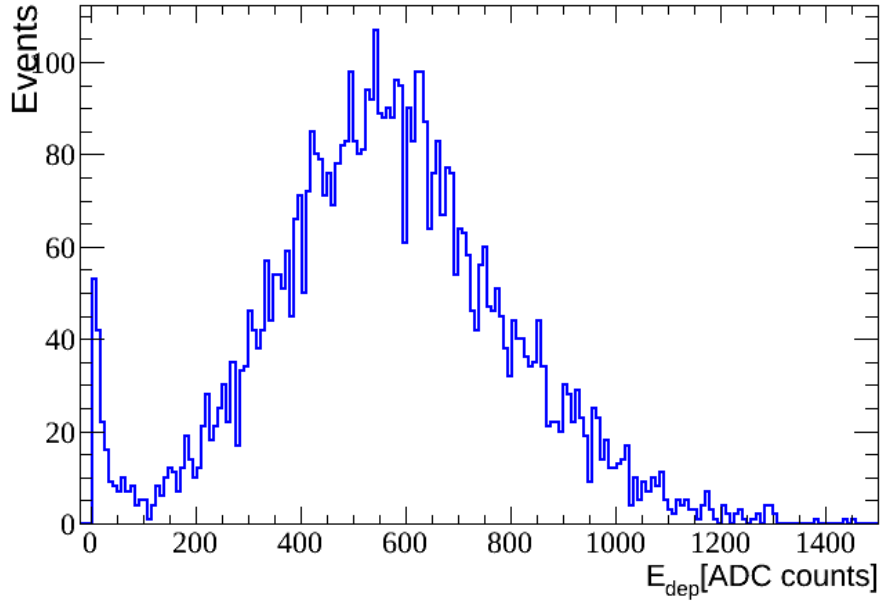
Electron spectra in a pure "electron" beam (2)

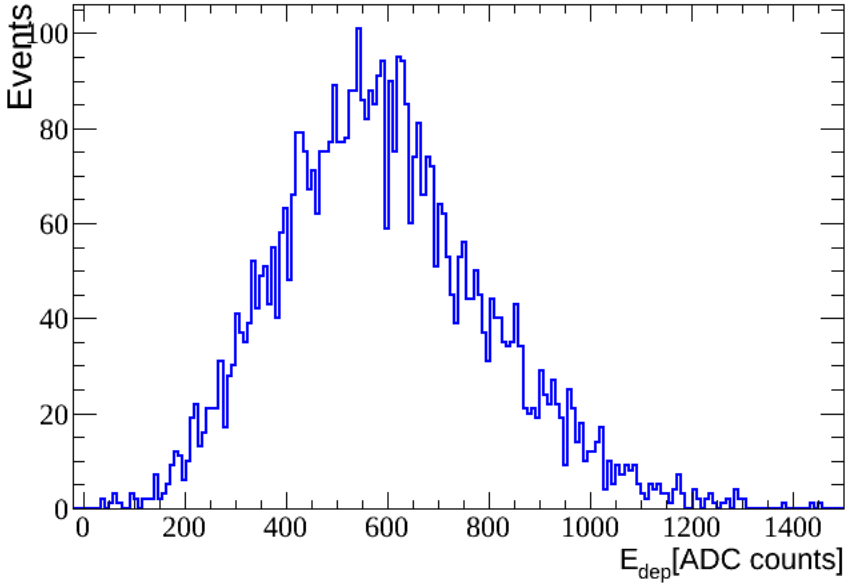
Plane 2 before and after μ/e discrimination



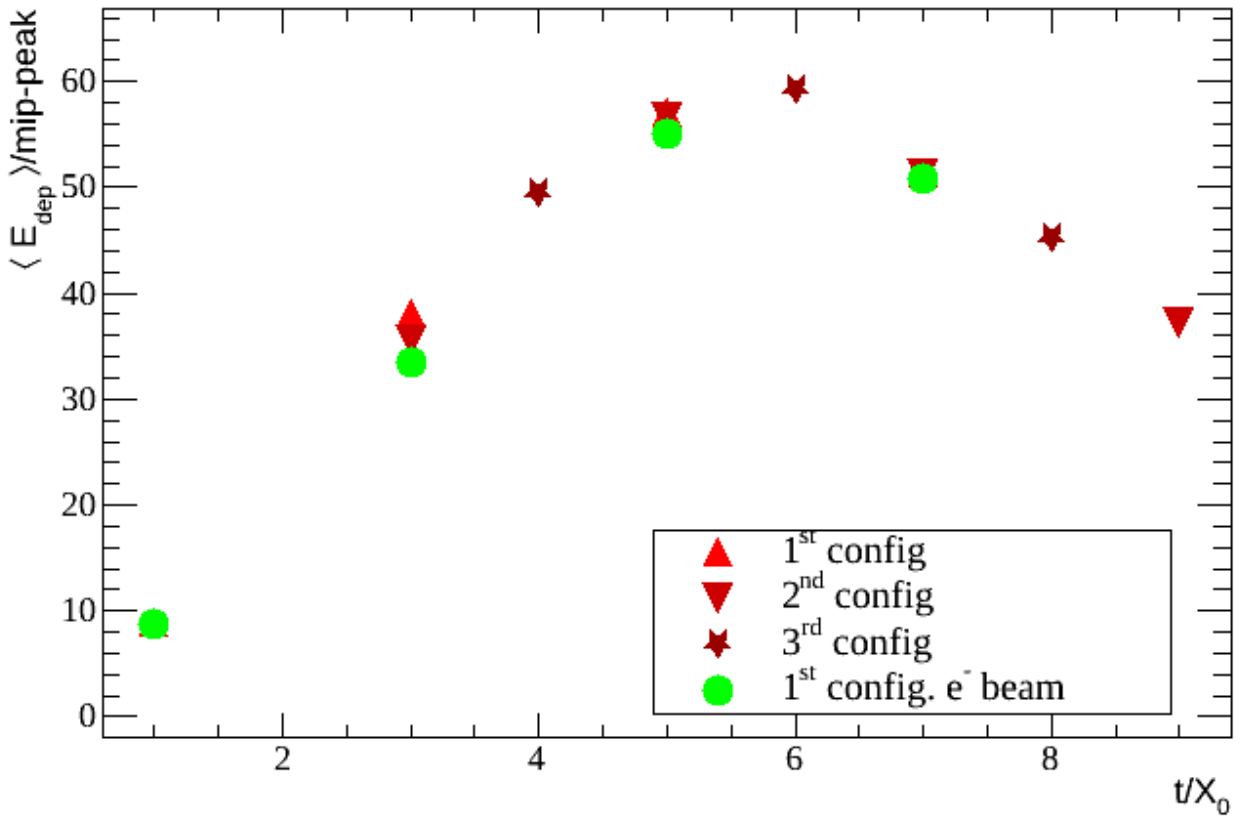


Plane 3 before and after μ/e discrimination





Longitudinal development of EM shower

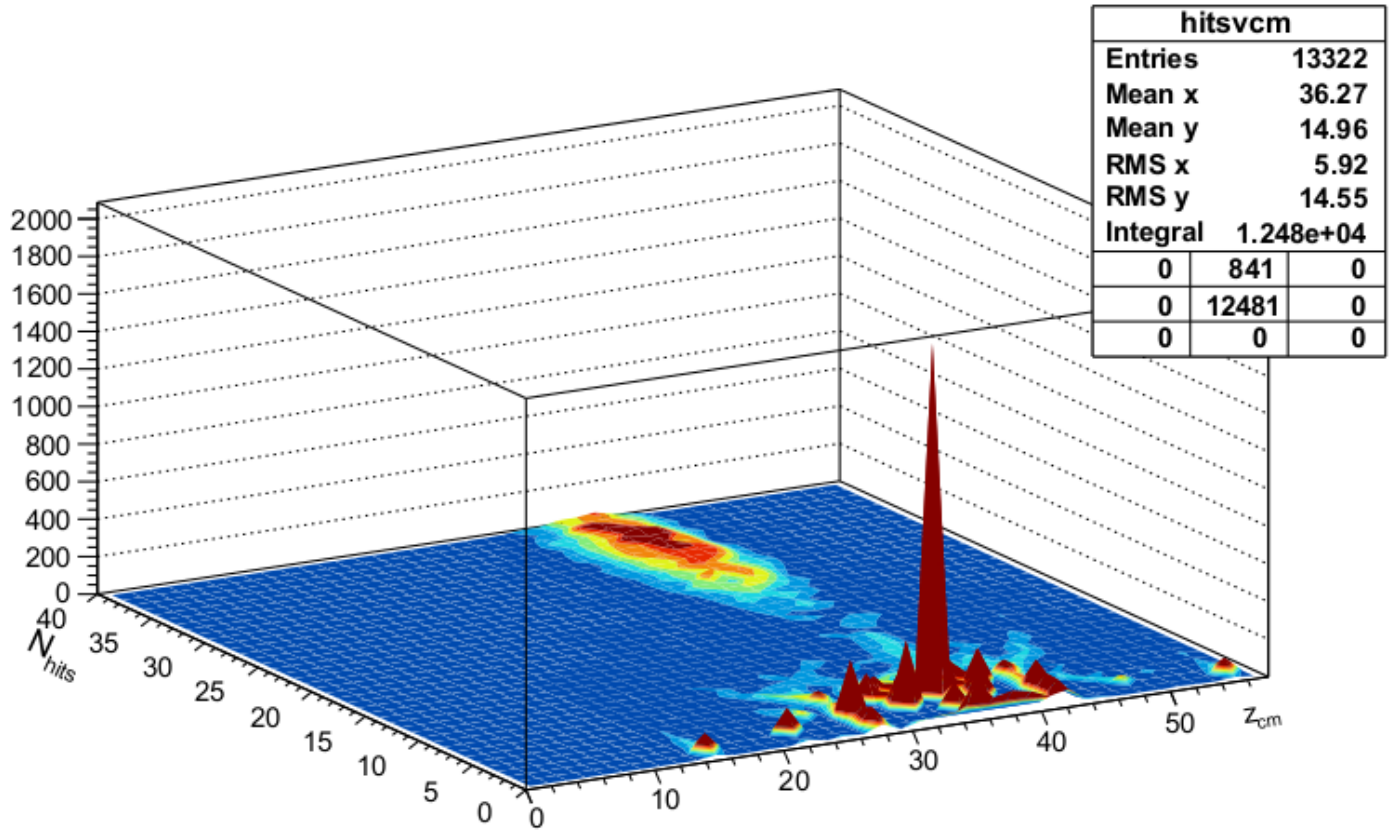


Conclusions

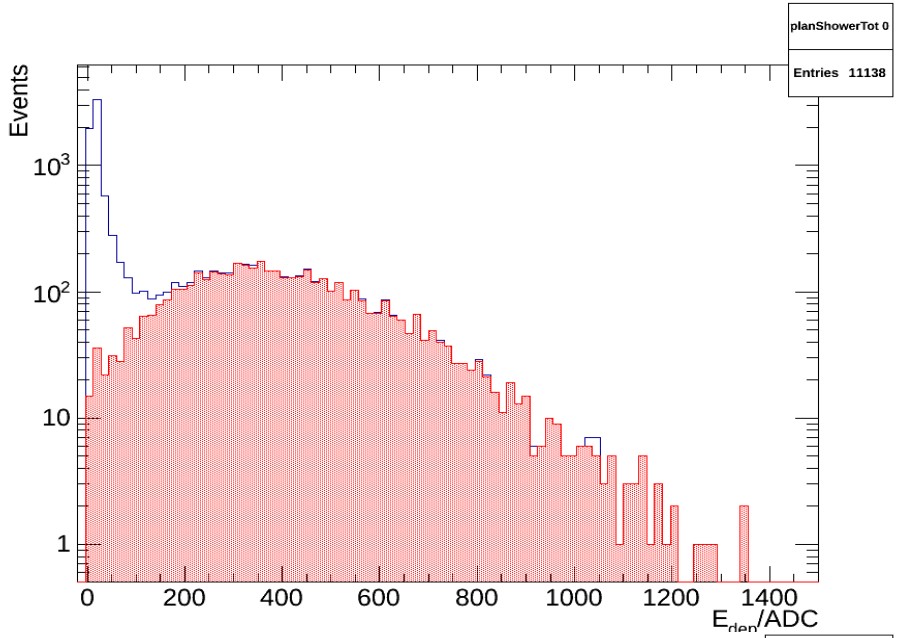
- The “center of gravity” method for electron-muon discrimination works well for the LumiCal prototype
- Muon spectra look good and their MPV are stable along configurations
- The method give nice results for the longitudinal shower evolution with small systematic errors

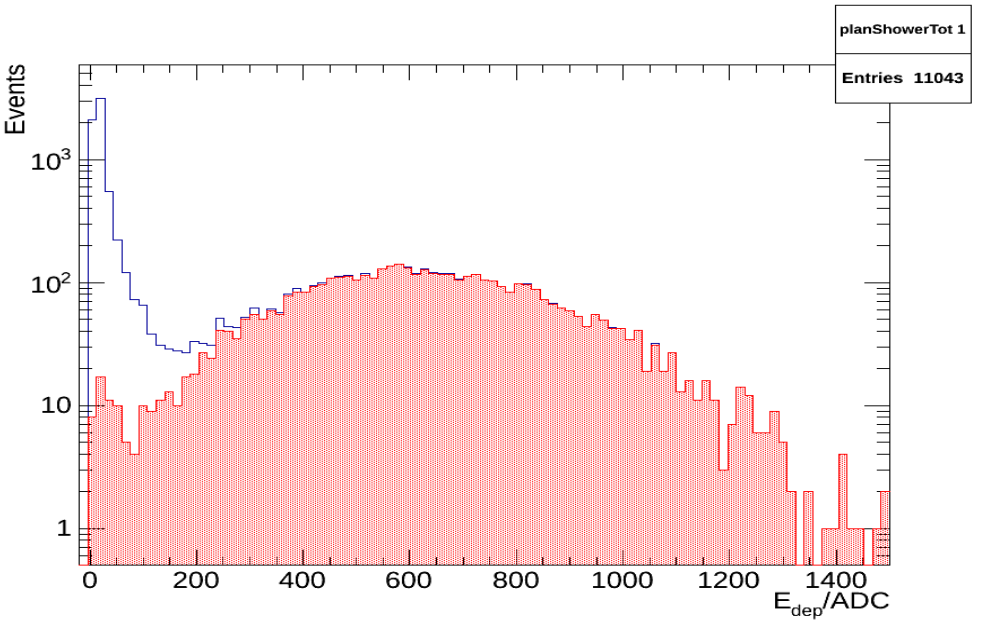
Spare slides

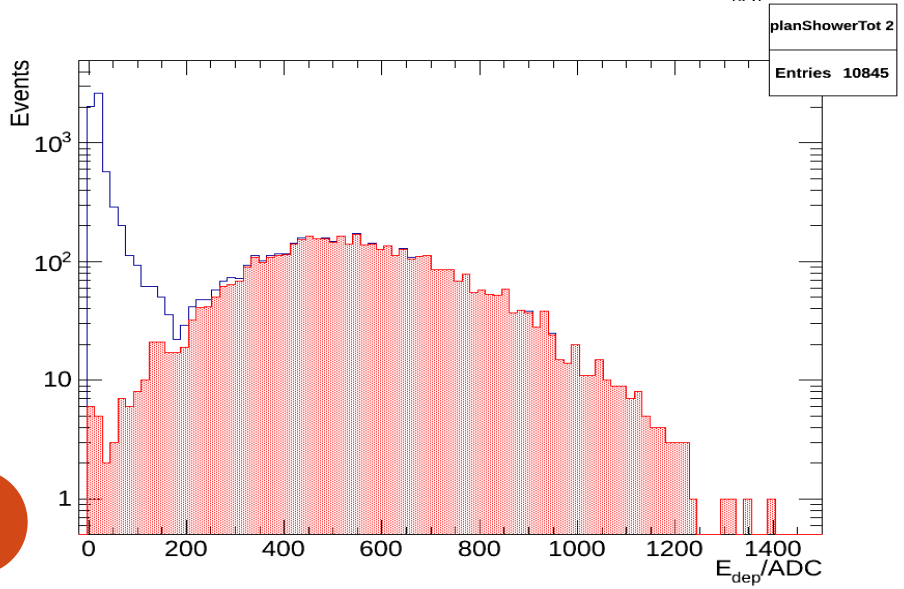
N_{hits}, z_{cm} event scatter plot in the e&μ beam (2^{st} config)

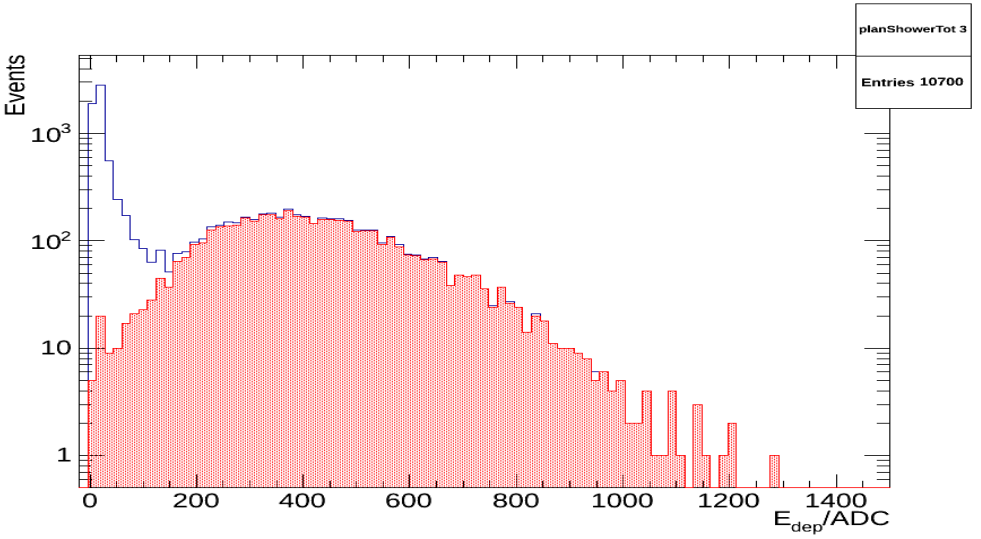


μ&e and electron spectra after e/μ discrimination (2nd config)

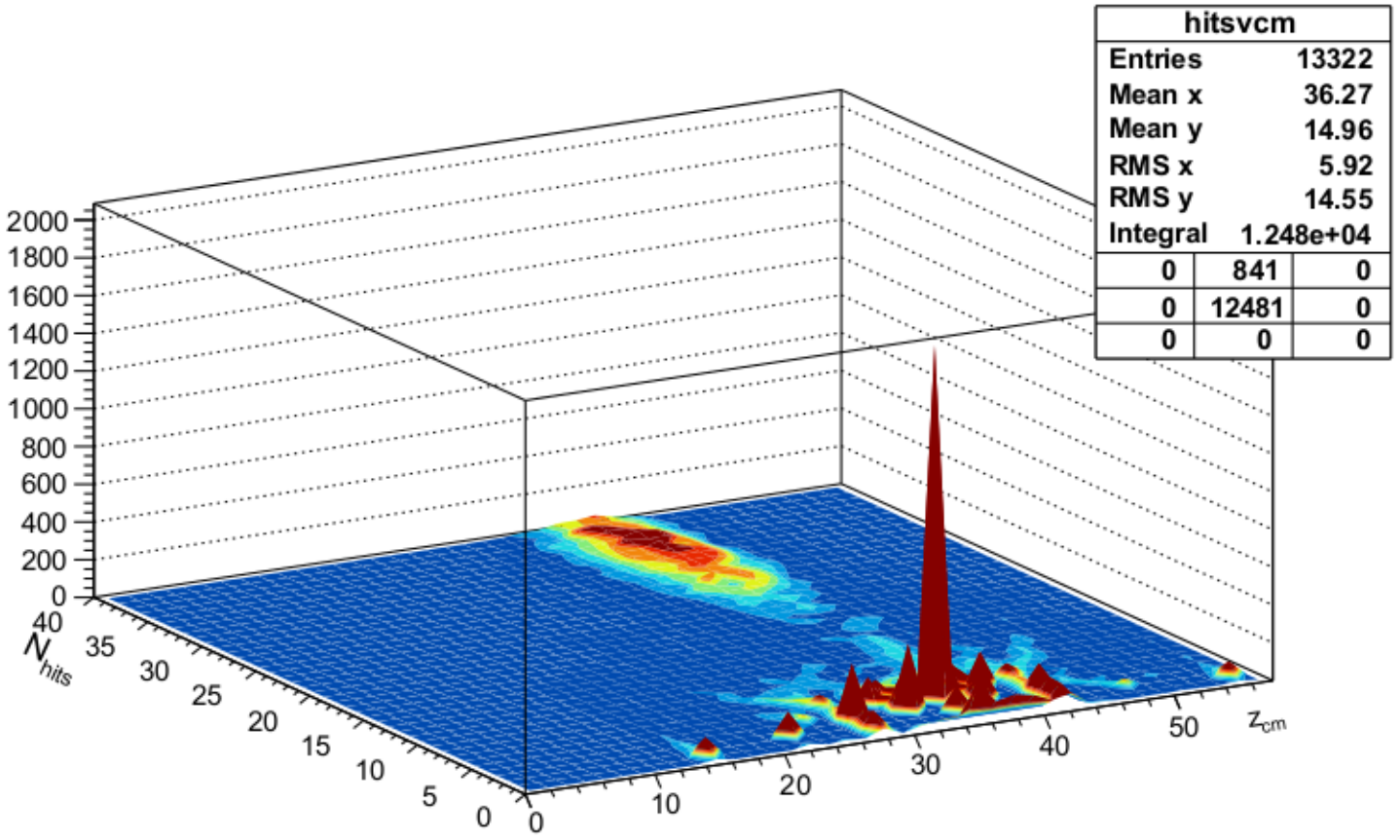




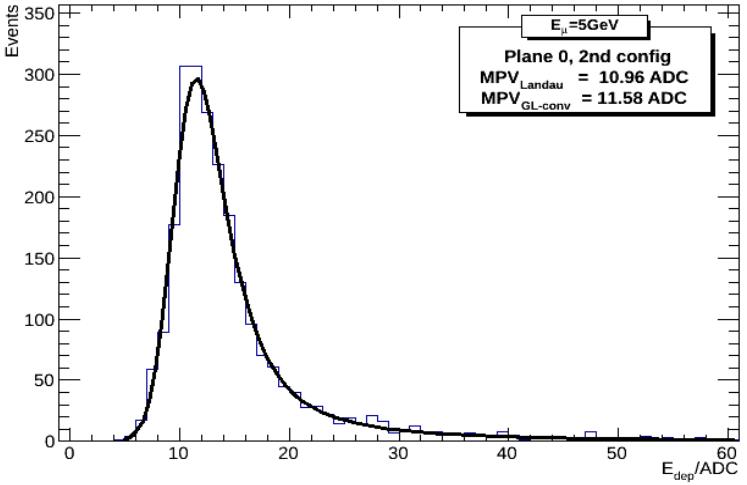


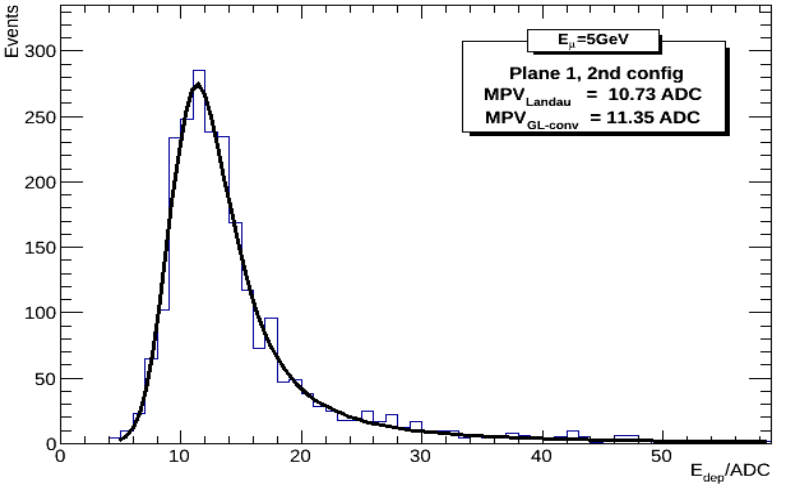


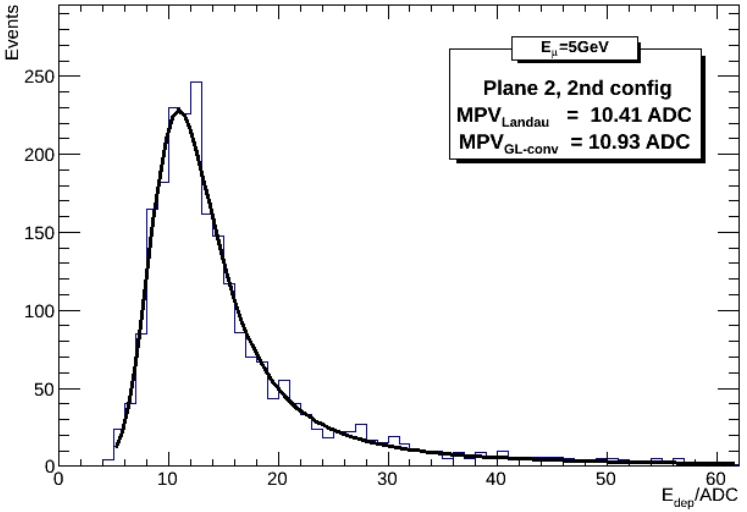
μ&e and electron spectra after e/μ discrimination (2nd config)

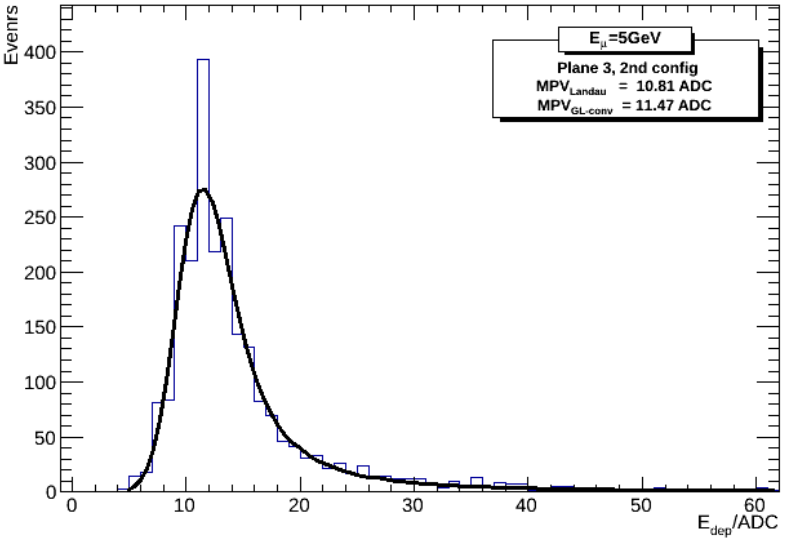


μ spectra after μ/e discrimination (2nd config)

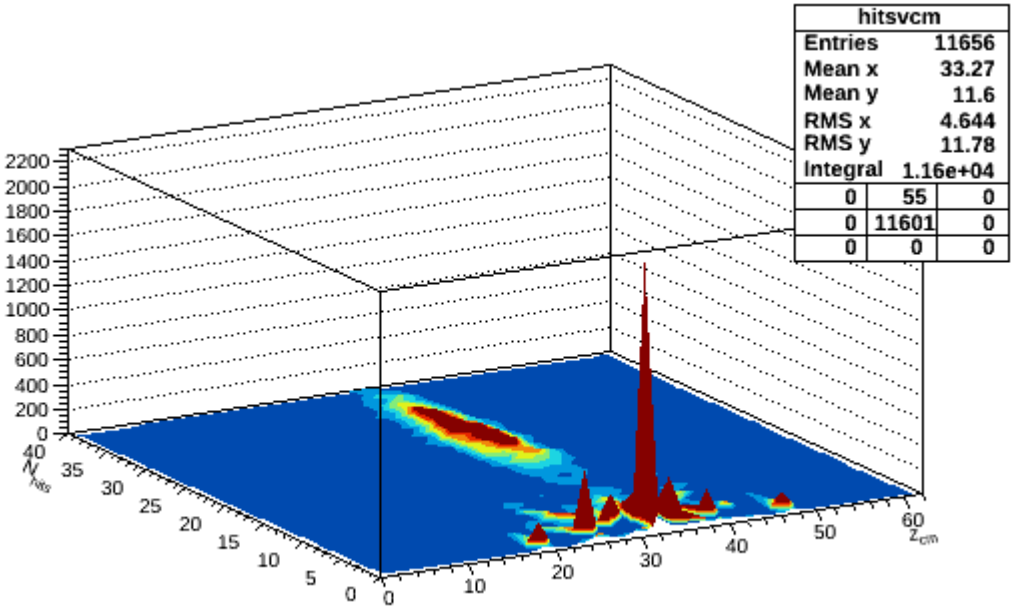




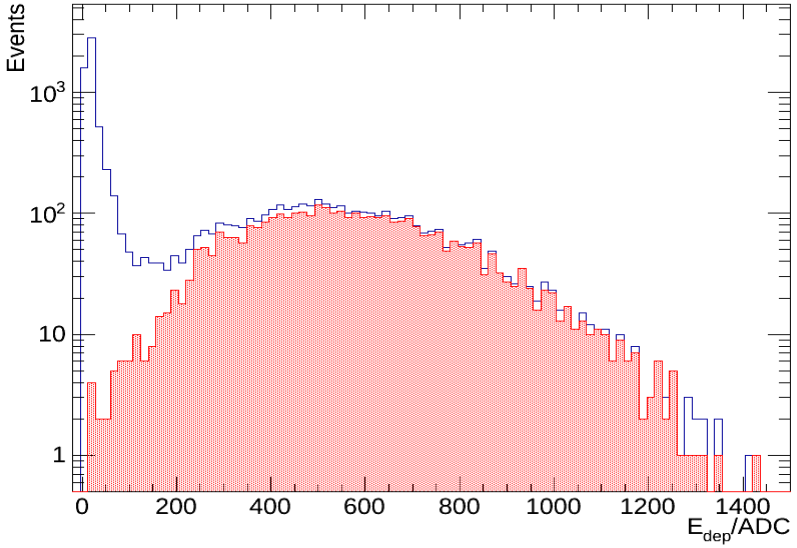


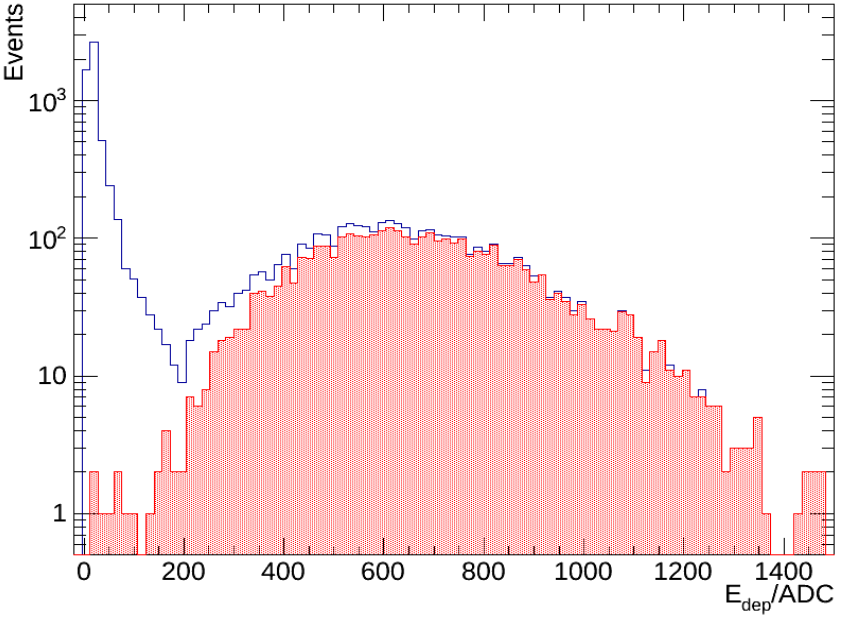


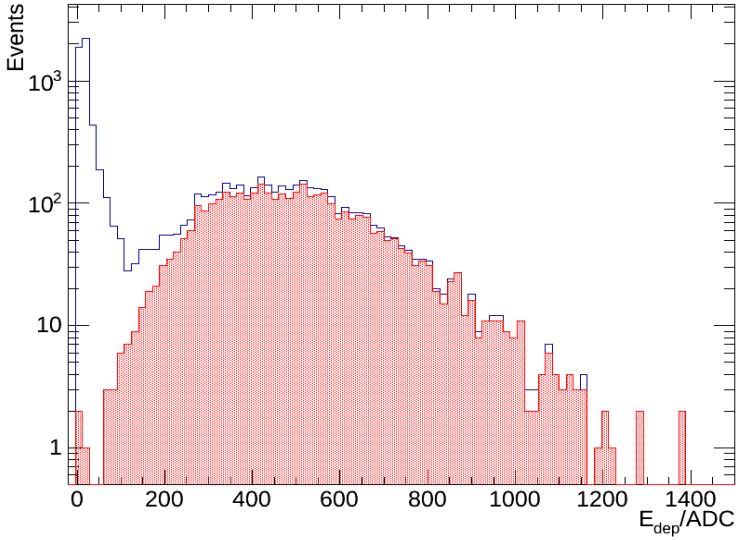
μ&e and electron spectra after e/μ discrimination (3rd config)



μ&e and electron spectra after e/μ discrimination (3rd config)







μ spectra after μ/e discrimination (3rd config)