Observations on Monte Carlo simulations for 2022 Test Beam

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LUXE

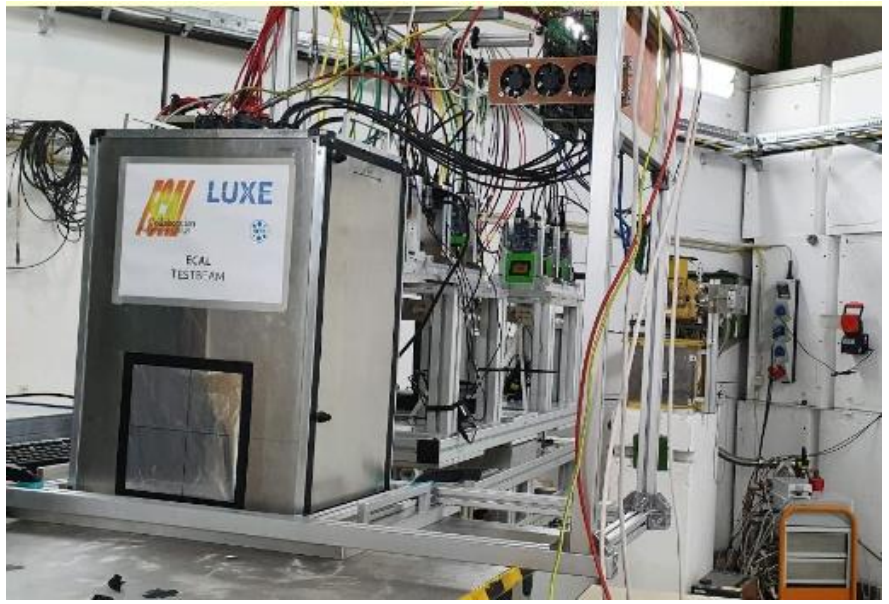
Test Beam @ DESY in 2022

Testing New Sensor Prototypes

- Test beam goal:
  - Studies of sensor response of Si and GaAs pad sensors prototype, with up-to-date development of FLAXE FE and FPGA read-out, to electrons with energy in the range of 1 to 5 GeV in the DESY II electron beam

- Simulations goals:
  - replicating various experimental configurations
  - define the primary particle characteristics
  - verify the physics list influence
  - collect quantities of interest (eg. pad hits, energy deposition)
  - cross-check with experimental data

  - *Resolution:* correlate the sensor response to the hit position.
  - *Efficiency:* the sensors should have registered a hit



This talk presents the overall simulations.

Monte Carlo simulations and data analysis workflow

FreeCAD, Geant4, Root

- ***30 experimental setups*** generated and exported using simple computer-aided design – **FreeCAD**

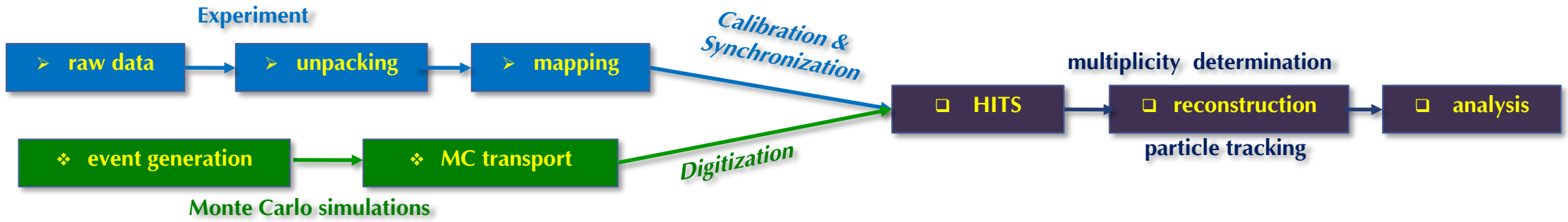
  challenge: export to a format readable by simulation tool

- ***full response of the sensor*** and the test beam setup with high statistics is simulated with **Geant4.11.06**

  challenge: choose/construct physics list, write data to file

- ***data analysis*** of the test beam sensors is performed using **ROOT** framework

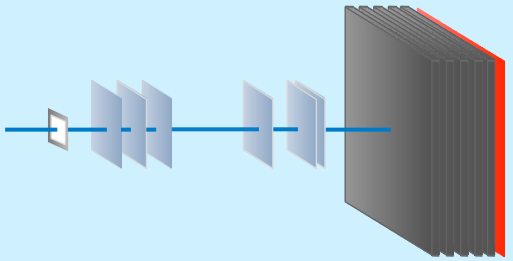
  challenge: extract physical quantities matching experimental data



Monte Carlo simulations and data analysis workflow

Build Geometry

[FreeCADBuilder]
[DetectorConstruction]



FreeCAD

Create source

[PrimaryGeneratorAction]

Geant4

Transport Particles

[PhysicsList]

Geant4

Hits collection

[SensitiveDetector]

Geant4

Write Data To File

[RunAction]
[EventAction]

Geant4

Digitization

[G4VDigitizerModule]

ROOT

Create histograms

[Root Macros]

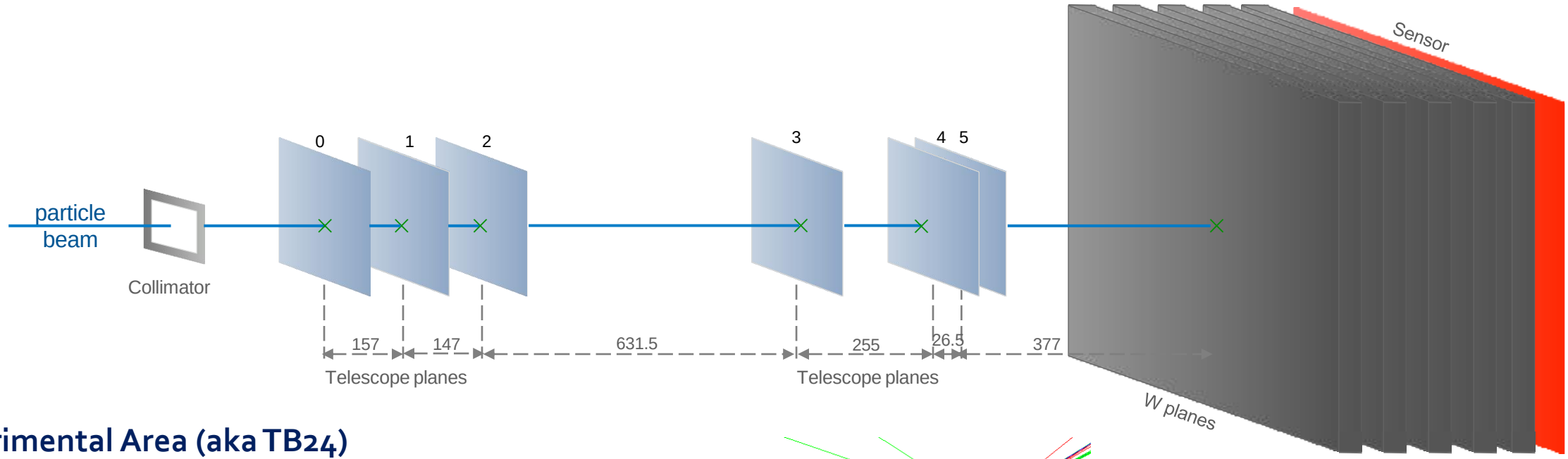
ROOT

FurtherAnalysis

[Root Macros]

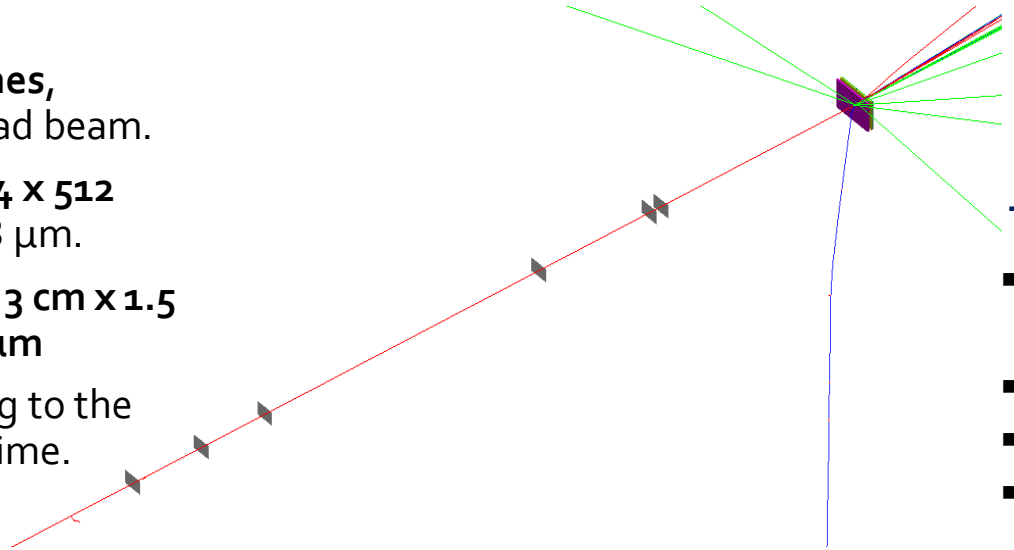
- Detector alignment
- Clustering
- Track reconstruction
- …

Test beam general setup



Experimental Area (aka TB24)

- **telescope** consist of **6 parallel planes,** perpendicular to a e^- gaussian spread beam.
- each telescope plane consist of **1024 x 512 pixels,** pixel pitch 29.24 µm x 26.88 µm.
- the **active area** is roughly of the size **3 cm x 1.5 cm;** the thickness of the chip is **~50 µm**
- telescope planes **position** according to the **real measurements** during beam time.



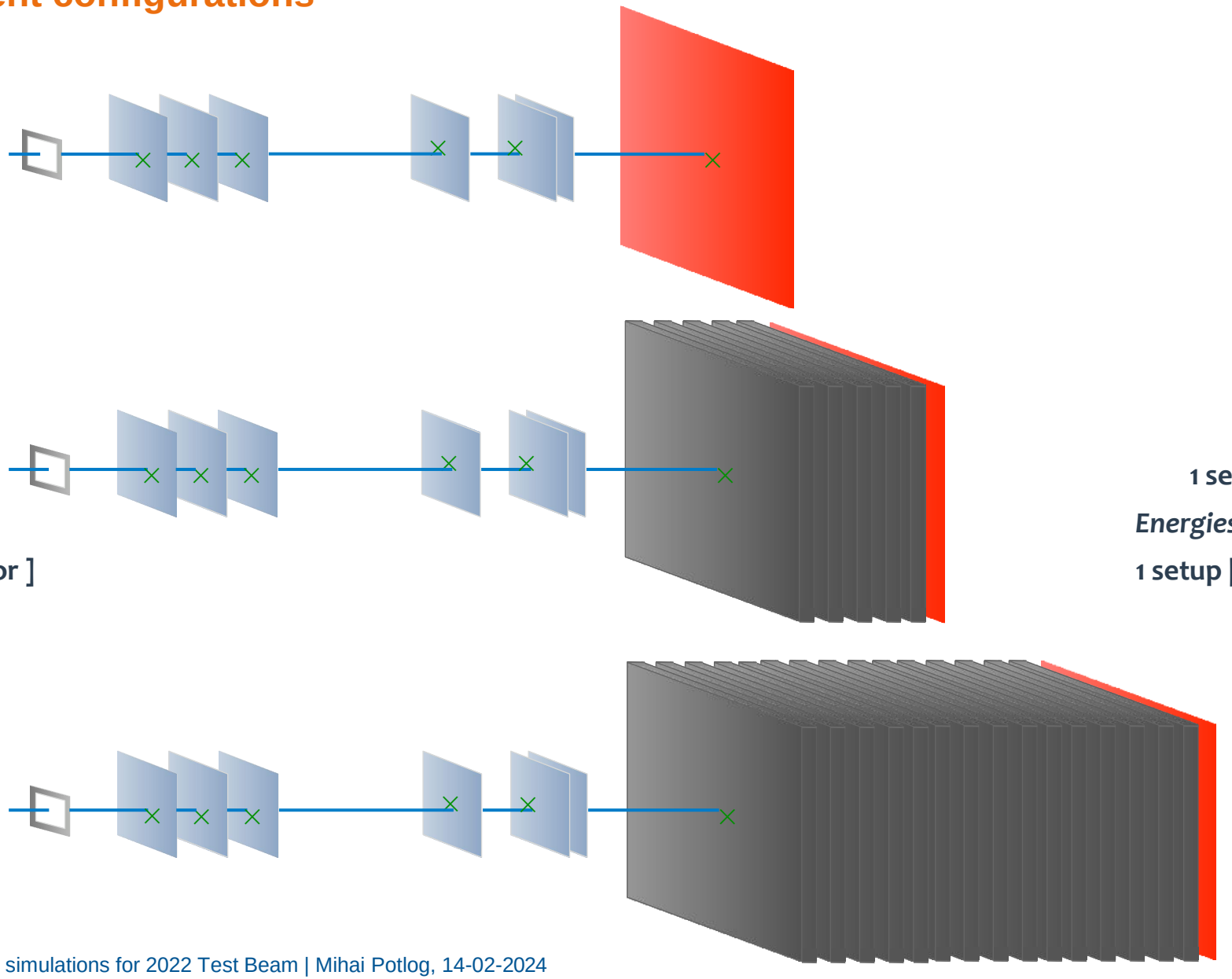
TestBeam box frame

- **sensors enclosure** is simulated as a box with an **Al foil** for entrance window.
- **W plates** with various compositions/thickness
- sensors of various types (3 Si & 2 GaAs)
- **each geometry object** is checked for **misalignment** and **an alignment correction** for position and orientation is included.

Test Beam configurations

10 setups - 38 different configurations

- **Ga-As sensor – Anton1**
  - 1 setup only with sensor
    - *Energies: 5 GeV*
- **Ga-As sensor – Yan1**
  - 1 setup only sensor
    - *Energies: 5 GeV*
  - 1 setup [5 W plates + sensor]
    - *Energies: 1 GeV, 3 GeV, 5 GeV*
  - 1 setup [15 -> 1 W plates + sensor]
    - *Energies: 5 GeV*
- **Ga-As sensor – BeamCal**
  - 1 setup only with sensor
    - *Energies: 5 GeV*



- **Si sensor – C72**
  - 1 setups only with sensor
    - *Energies: 5 GeV*
- **Si sensor – C74**
  - 1 setup only with sensor
    - *Energies: 5 GeV*
  - 1 setup [5 W plates + sensor]
    - *Energies: 1 GeV, 3 GeV, 5 GeV*
  - 1 setup [15 -> 1 W plates + sensor]
    - *Energies: 5 GeV*
- **Si sensor – C75**
  - 1 setup only with sensor
    - *Energies: 5 GeV*

Investigated layouts

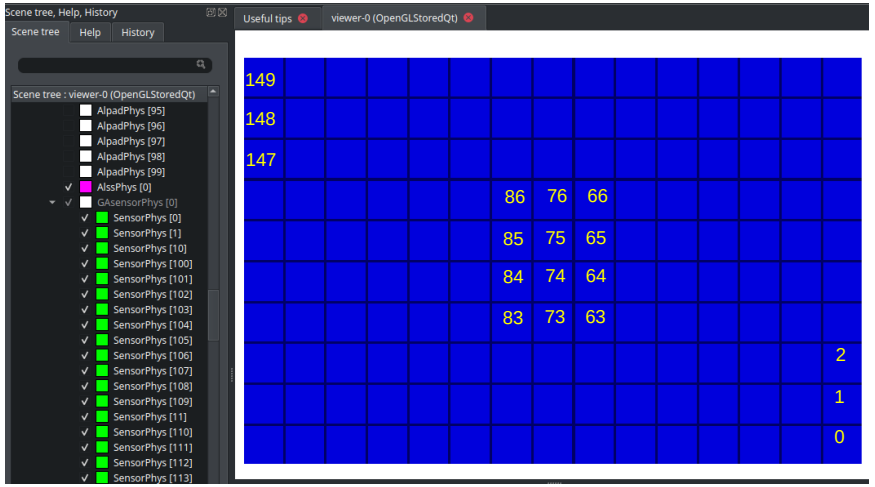
sensors, converter

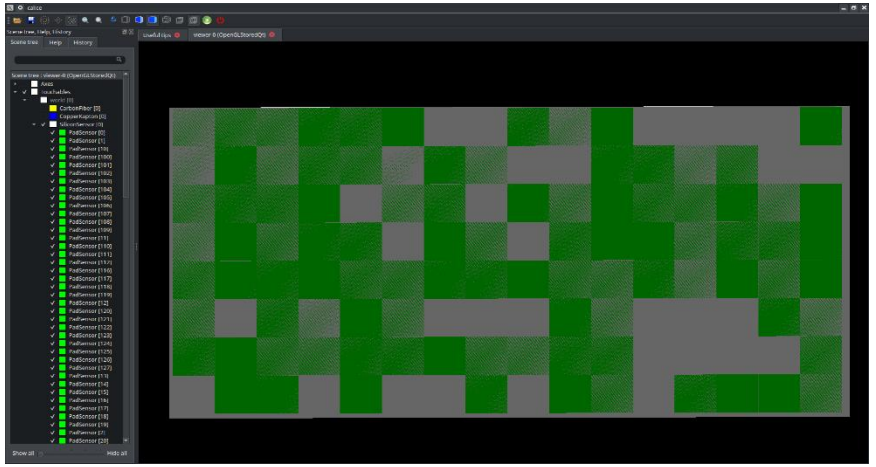
- **Ga-As sensor – Anton1, Yan1 & BeamCal**
  - **rectangular shape:** 7.47 cm x 4.97 cm
  - **pad size:** 4.7 mm x 4.7 mm
  - **gap between pads** 0.3 mm
  - **number of pads**: 15 x 10
  - **thickness** 500 µm

- **Si sensor – C72, C74 & C75**
  - **rectangular shape:** 9 cm x 4.5 cm
  - **pad size:** 5.5 mm x 5.5 mm
  - **number of pads**: 16 x 8
  - **thickness**: 320 µm

Tungsten plates

- 2 different compositions:
  - 7 with 93% W
  - 8 with 95% W
- Various thickness:
  - from 3.470 to 3.645 mm





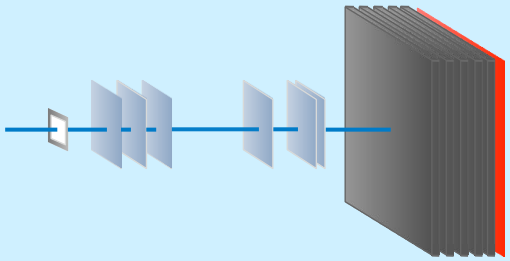
Stack configuration				
V beam V				
Slot 1	Plane "1"	tungsten	3,505	abs95
Slot 2	Plane "3"	tungsten	3,520	abs95
Slot 3	A5	tungsten	3,528	abs95
Slot 4	A2	tungsten	3,550	abs95
Slot 5	Plane "4"	tungsten	3,475	abs95
Slot 6	B12	tungsten	3,550	abs95
Slot 7	A8	tungsten	3,558	abs95
Slot 8	B23	tungsten	3,543	abs95
Slot 9	B21	tungsten		
Slot 10	1 (A3)	tungsten		
Slot 11	B19	tungsten		
Slot 12	B14	tungsten		
Slot 13	7 (MGS2)	tungsten	3,521	abs93
Slot 14	10 (MGS5)	tungsten	3,645	abs93
Slot 15	11 (MGS6)	tungsten	3,470	abs93
Slot 16	---	gap		
Slot 17	Calice 74	sensor		
Slots 18--end	---	empty		

- **complete implementation of all type of sensors – Anton1, Yan1, BeamCal, C72, C74, C75**
- **re-numbered the pads to correspond to channels from real sensors**
- **macro with commands for easily geometry change**

Monte Carlo simulations and data analysis workflow

Build Geometry

[FreeCADBuilder]
[DetectorConstruction]



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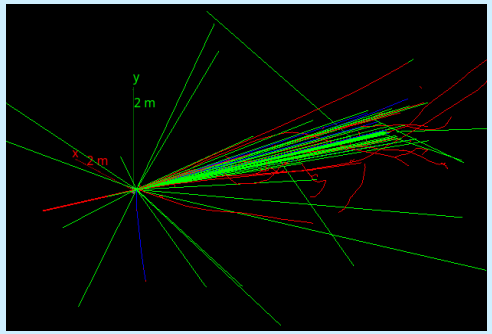

GEANT4

Transport Particles

[PhysicsList]

GEANT4

Hits collection

[SensitiveDetector]

GEANT4

Write Data To File

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GEANT4

Digitization

[G4VDigitizerModule]

ROOT

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Primary particle generation

particleGun, GPS

Create 'diverging' beam

- when firing an accelerator based beam, the beam will have some divergence and shape
- 12 x 12 mm² collimator -> square source
- **gaussian energy distribution** with 0.1% spread
- 0.752 mrad **divergence**

particleGun

```
G4int n_particle = 1;
fParticleGun = new G4ParticleGun(n_particle);

G4ParticleTable* particleTable = G4ParticleTable::GetParticleTable();
G4String particleName;
fParticleGun->SetParticleDefinition(particleTable->FindParticle(particleName="e-"));

G4double theta, phi;
G4double px, py, pz;
G4double sigmaAngle = 0.752;
theta = G4RandGauss::shoot(0.0, (sigmaAngle*pi) / 180.);
phi = twopi * G4UniformRand();
px = -std::sin(theta) * std::cos(phi);
py = -std::sin(theta) * std::sin(phi);
pz = -std::cos(theta);
fParticleGun->SetParticleMomentumDirection(G4ThreeVector(px, py, pz));
G4double zur = -3270.0*mm, x = 18.*mm, y = 12.*mm;
G4double xur = x *(2*G4UniformRand()-1);
G4double yur = y *(2*G4UniformRand()-1);
fParticleGun->SetParticlePosition(G4ThreeVector(xur,yur,zur));

//Energy
G4double beamEnergy = 5000.*MeV;
G4double energySigma = 0.01;
G4double finalEnergy = G4RandGauss::shoot(beamEnergy,beamEnergy*energySigma);
fParticleGun->SetParticleEnergy(finalEnergy);
fParticleGun->GeneratePrimaryVertex(anEvent);
```

GPS

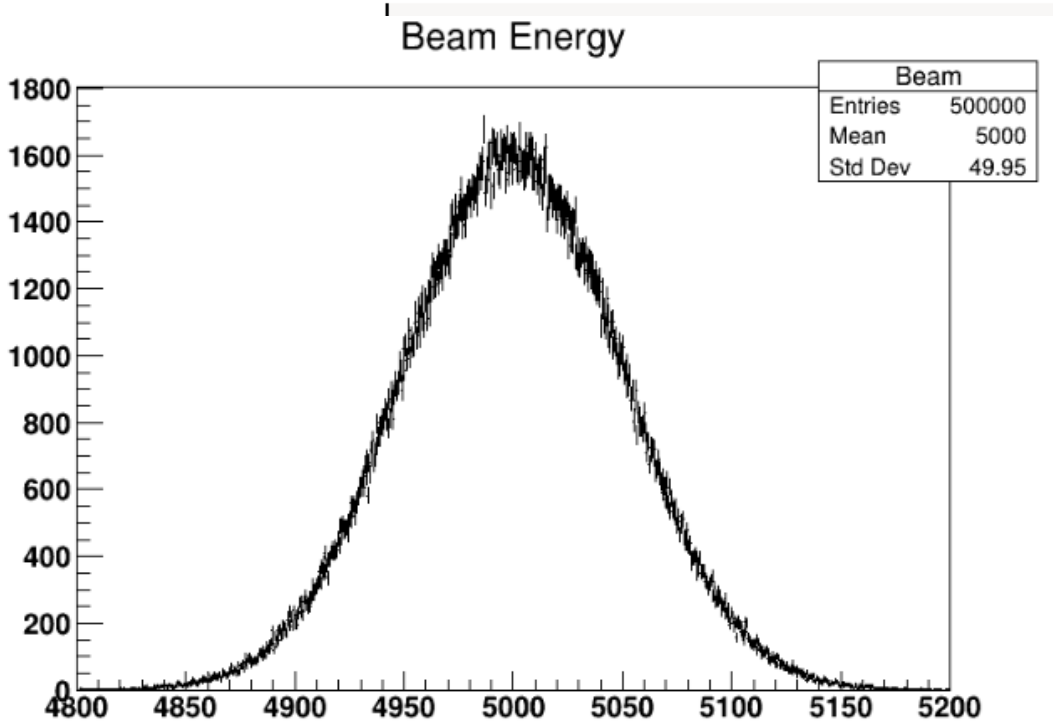
```
/control/verbose 1
/run/verbose 1
/run/initialize

/gps/particle e-                    // primary particle type

/gps/pos/type Beam
/gps/pos/shape Rectangle            // reproduce collimator
/gps/pos/halfx 0.6 cm               // 12 mm
/gps/pos/halfy 0.6 cm               // 12 mm
/gps/pos/centre 0. 0. -200. cm      // distance to sensor position
/gps/direction 0 0 1

/gps/ene/type Gauss                 // gaussian distribution
/gps/ene/mono 5000. MeV             // beam energy
/gps/ene/sigma 50. MeV              // beam energy spread
/gps/ang/sigma_r 0.752 deg          // divergeance

/run/beamOn 5                       // number of events
```



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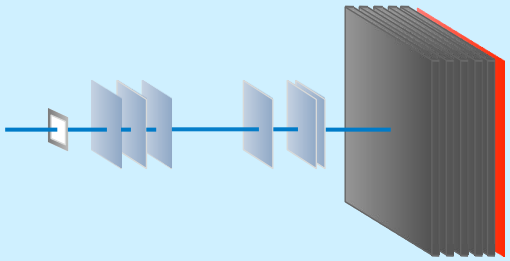

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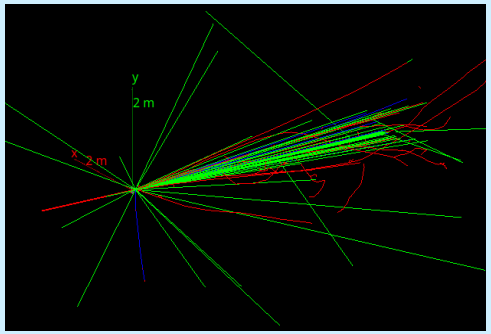
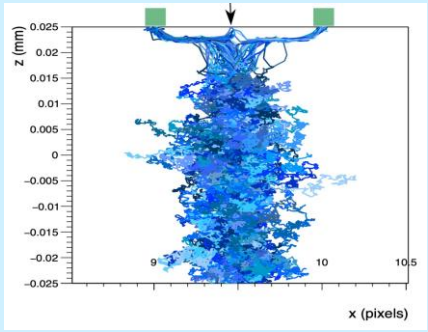


GEANT4

Transport Particles

[PhysicsList]



GEANT4

Hits collection

[SensitiveDetector]

GEANT4

Write Data To File

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Physics list

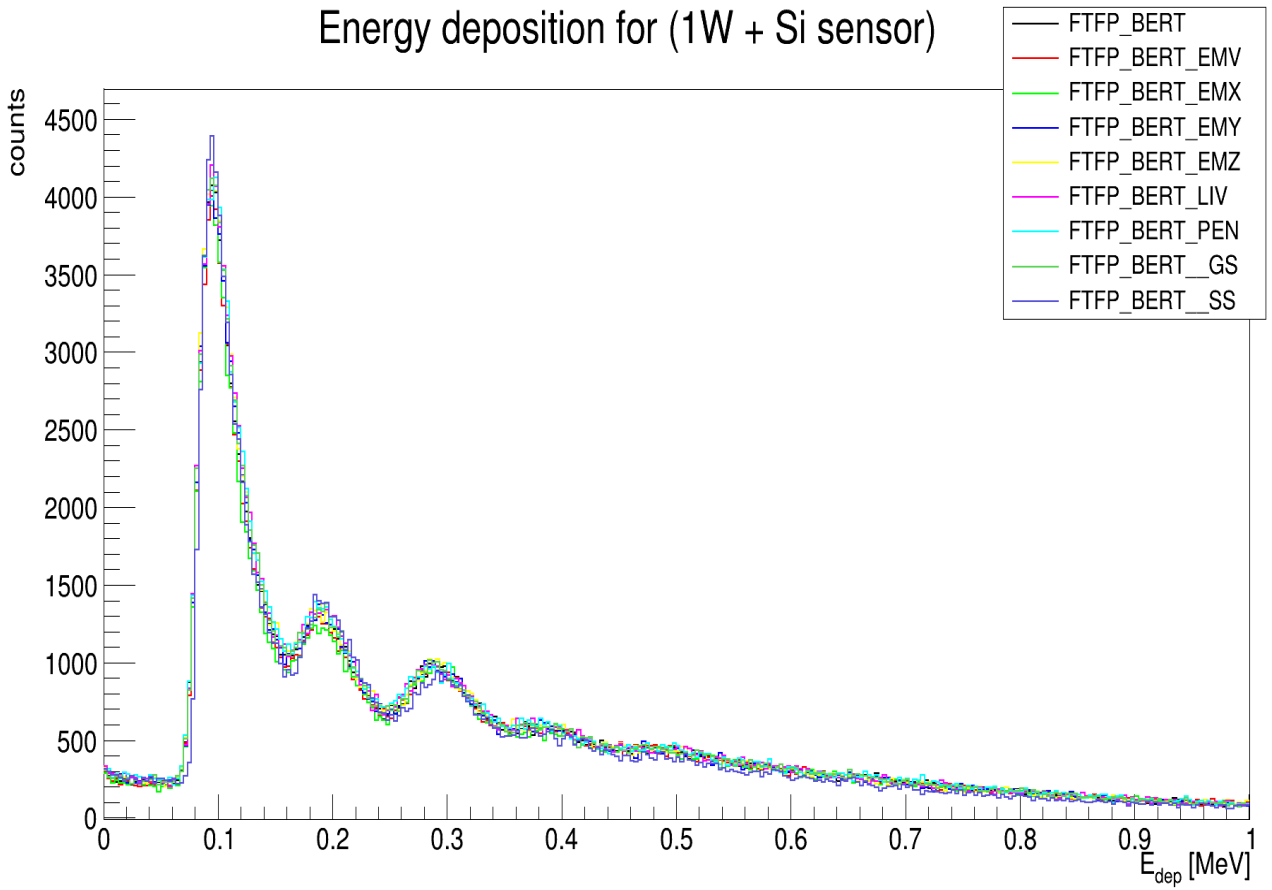
G4VUserPhysicsListPhysics, G4VModularPhysicsList

Name of most physics list follows name of physics constructor for hadronic inelastic, optionally followed by EM option

- **Name of this hadronic physics constructor indicates models in use from high to low energies**
  - High energy /string model: QGS or FTF, used above few (tens) of GeV
    - Extension P in QGSP/FTFP: Precompound & De-excitation model used to de-excite remnant nucleus
  - Intermediate energies: BERT, BIC, INCLXX, used up to O(10) GeV
  - Low energy neutron/particle transport: HP,
  - Various shortcuts to indicate special variants, like TRV or LEND

- **Option of electromagnetic physics:**
  - EMV – use Opt1 EM physics
  - EMX – use Opt2 EM physics
  - EMY – use Opt3 EM physics
  - EMZ – use Opt4 EM physics
  - plus specific DNA, GS, Liv, Pen, LE, WVI, SS

- **Exceptions to naming scheme are Shielding, LBE, and NuBeam physics lists**



- FTF_BIC
- FTFP_BERT
- FTFP_BERT_HP
- FTFP_BERT_TRV
- FTFP_BERT_ATL
- FTFP_INCLXX
- FTFP_INCLXX_HP
- FTFP_QGSP_BERT
- LBE
- NuBeam
- QGSP_BERT
- QGSP_BERT_HP
- QGSP_BIC
- QGSP_BIC_HP
- QGSP_BIC_AllHP
- QGSP_FTFP_BERT
- QGSP_INCLXX
- QGSP_INCLXX_HP
- QGS_BIC
- Shielding
- ShieldingLEND

Monte Carlo simulations and data analysis workflow

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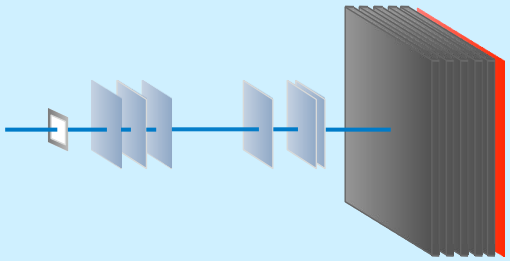

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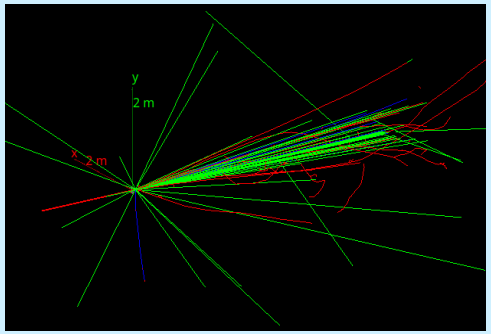

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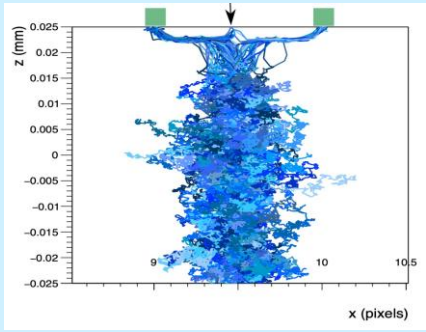

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Hits collection

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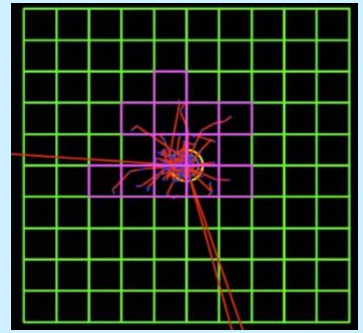

GEANT4

Write Data To File

[RunAction]
[EventAction]

GEANT4

Digitization

[G4VDigitizerModule]

ROOT

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[Root Macros]

ROOT

FurtherAnalysis

[Root Macros]

- Detector alignment
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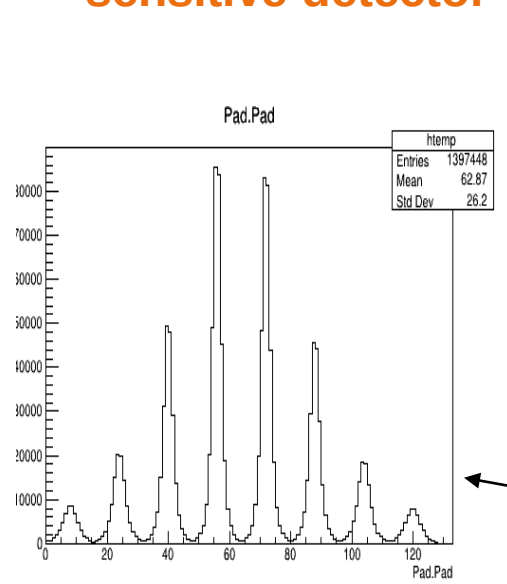
- …

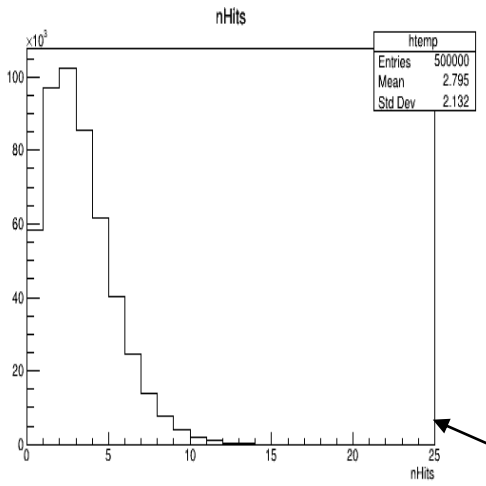
Hits collection

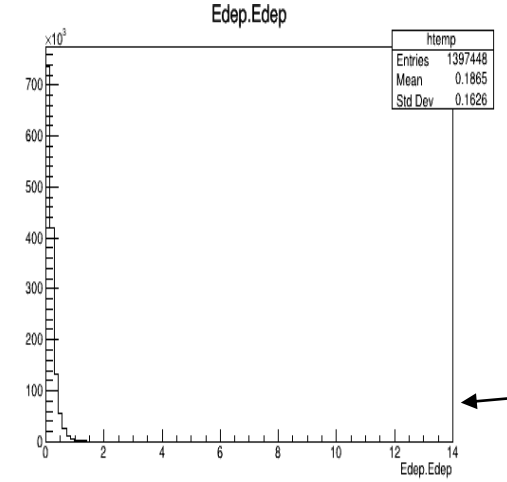
sensitive detector

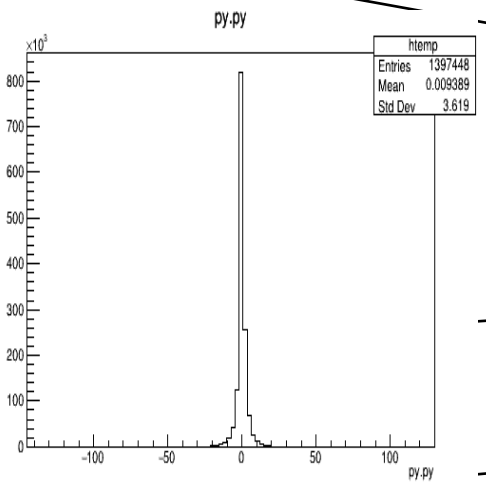
7 observables

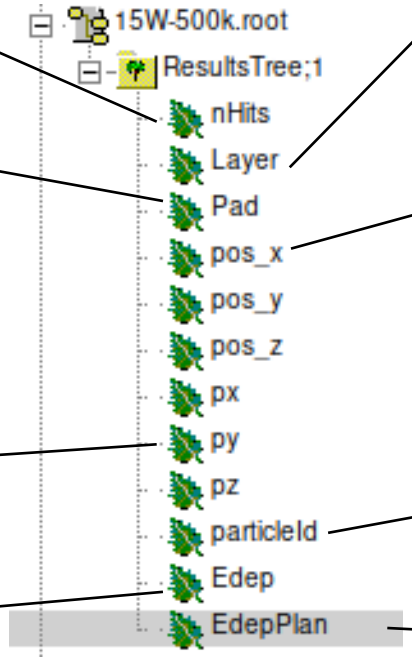
- Number of hits
- Pads hits
- Position of hits (x, y, z)
- Hits momentum (px, py, pz
- Particle identification
- Total energy per event
- Total energy of hits

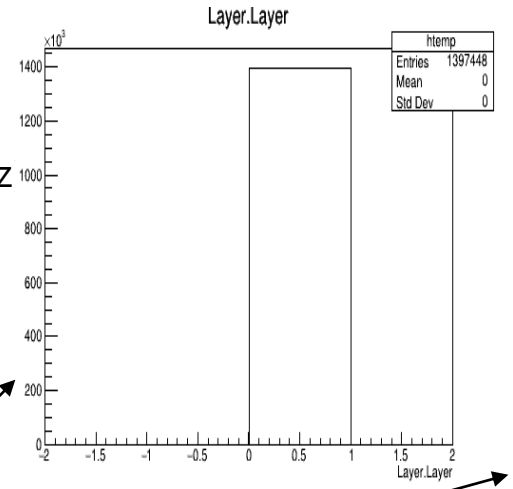


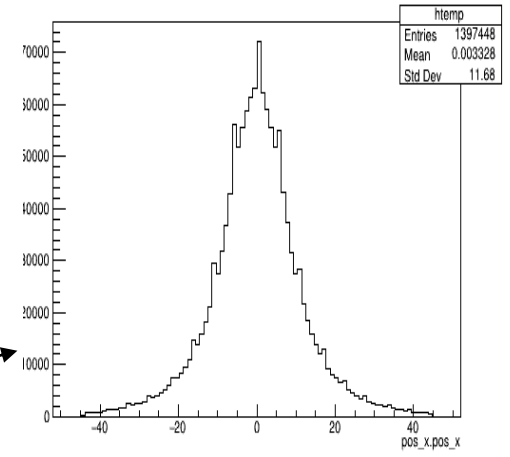


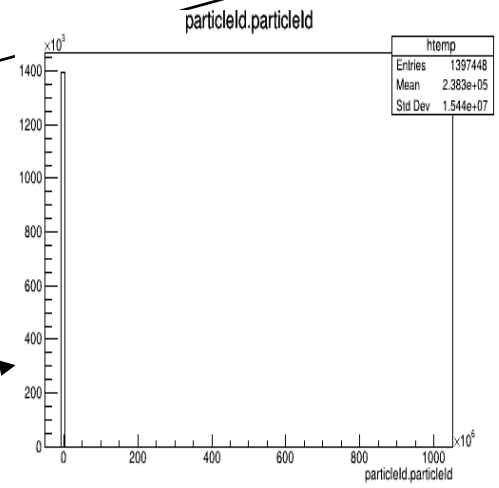


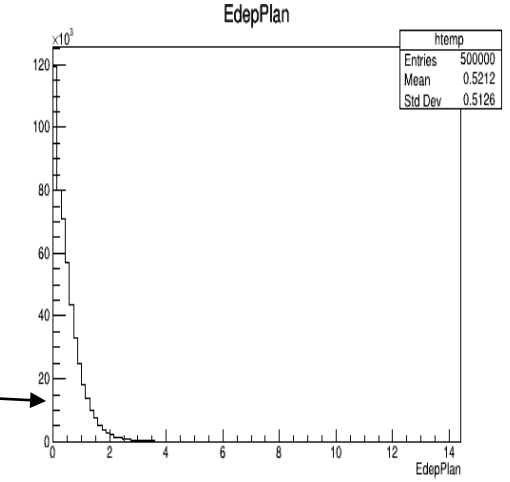












Monte Carlo simulations and data analysis workflow

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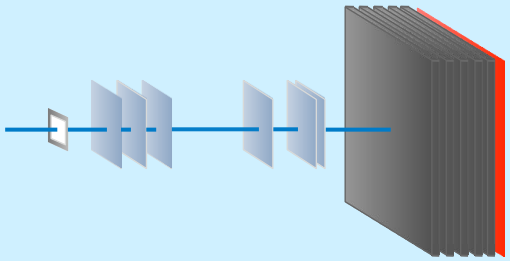

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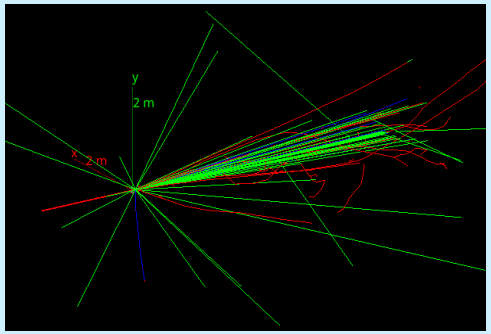

GEANT4

Transport Particles

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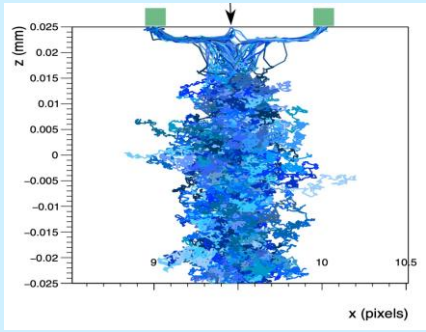
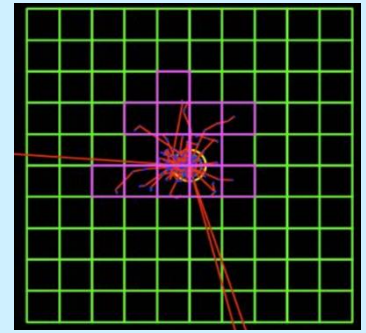


GEANT4

Hits collection

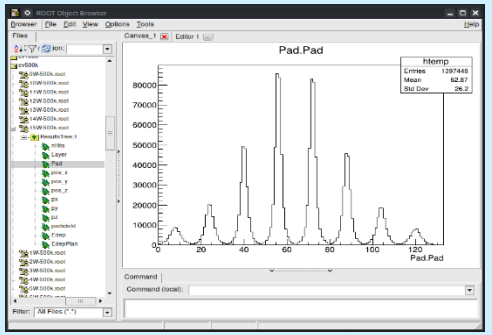
[SensitiveDetector]



GEANT4

Write Data To File

[RunAction]
[EventAction]



GEANT4

Digitization

[G4VDigitizerModule]

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Create histograms

[Root Macros]

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[Root Macros]

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Write data to file

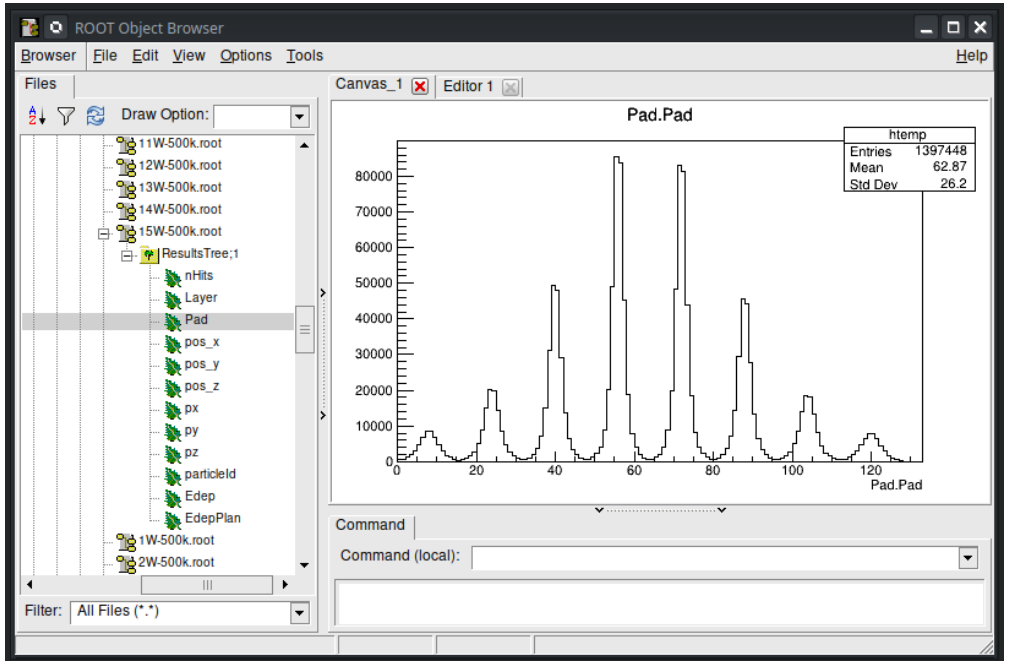
g4root, G4AnalysisManager

RunAction

```
// Default settings
analysisManager->SetVerboseLevel(1);
analysisManager->SetFileName("ecal-luxe.root");

// Creating ntuples
if ( fEventAction ) {
    analysisManager->CreateNtuple("ResultsTree", "Calice simulted data");
    analysisManager->CreateNtupleIColumn("nHits");
    analysisManager->CreateNtupleIColumn("Layer",  fEventAction->fCalLayer);
    analysisManager->CreateNtupleIColumn("Pad",  fEventAction->fCalPad);
    analysisManager->CreateNtupleDColumn("pos_x", fEventAction->fCalX);
    analysisManager->CreateNtupleDColumn("pos_y", fEventAction->fCalY);
    analysisManager->CreateNtupleDColumn("pos_z", fEventAction->fCalZ);
    analysisManager->CreateNtupleDColumn("px", fEventAction->fCalPx);
    analysisManager->CreateNtupleDColumn("py", fEventAction->fCalPy);
    analysisManager->CreateNtupleDColumn("pz", fEventAction->fCalPz);
    analysisManager->CreateNtupleIColumn("particleId", fEventAction->fCalpID);
    analysisManager->CreateNtupleDColumn("Edep", fEventAction->fCalEdep);
    analysisManager->CreateNtupleDColumn("EdepPlan");

    analysisManager->CreateH1("Beam","Beam Energy",1000,4800*MeV,5200*MeV);
    analysisManager->FinishNtuple();
}
```

EventAction

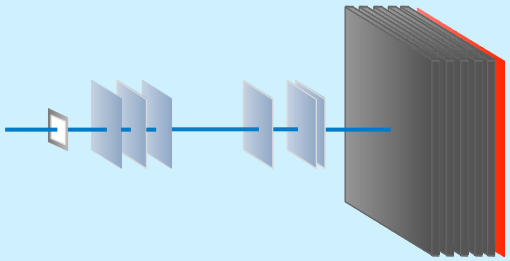
```
for (unsigned long i = 0; i < luxeHC->GetSize(); ++i)
{
   auto hit = static_cast<LuxeHit*>(luxeHC->GetHit(i));
   if(hit->fEdep <= 0.) continue;
   hitsNb++;

   fCalLayer.push_back(hit->fLayer);
   fCalPad.push_back(hit->fPad);
   fCalX.push_back(hit->fX);
   fCalY.push_back(hit->fY);
   fCalZ.push_back(hit->fZ);
   fCalPx.push_back(hit->fPx);
   fCalPy.push_back(hit->fPy);
   fCalPz.push_back(hit->fPz);
   fCalpID.push_back(hit->fpID);
   fCalEdep.push_back(hit->fEdep);
   Edepo += hit->fEdep;
}
   analysisManager->FillNtupleIColumn(0, hitsNb);
   analysisManager->FillNtupleDColumn(11, Edepo);

   G4double temp=event->GetPrimaryVertex()->GetPrimary()->GetKineticEnergy();
   analysisManager->FillH1(0,temp);

   analysisManager->AddNtupleRow();
```



Monte Carlo simulations and data analysis workflow

Build Geometry

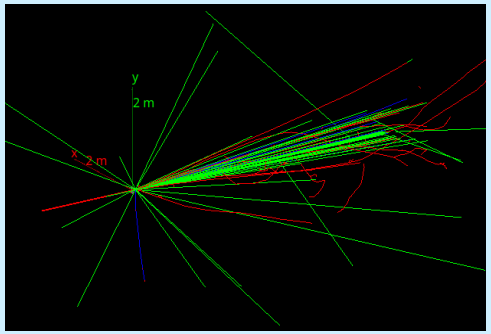
[FreeCADBuilder]
[DetectorConstruction]



FreeCAD

Create source

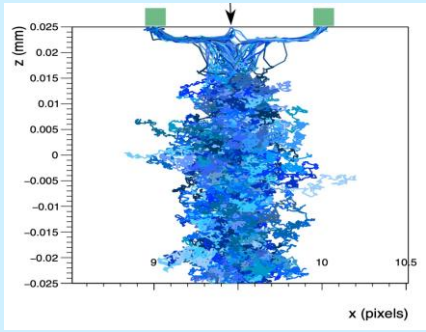
[PrimaryGeneratorAction]



GEANT4

Transport Particles

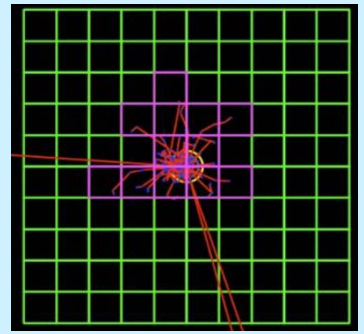
[PhysicsList]



GEANT4

Hits collection

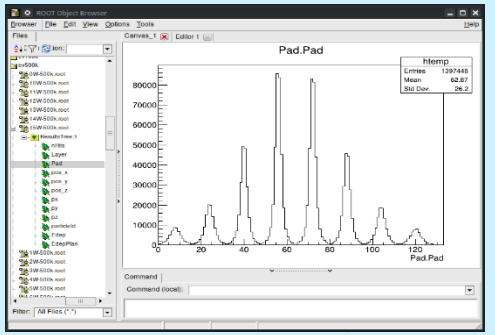
[SensitiveDetector]



GEANT4

Write Data To File

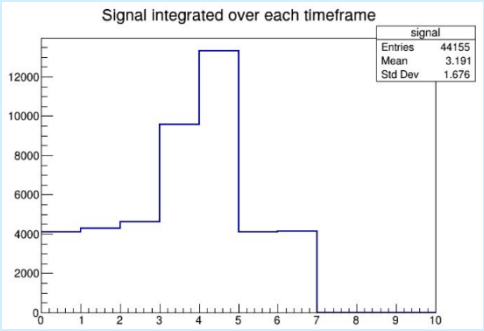
[RunAction]
[EventAction]



GEANT4

Digitization

[G4VDigitizerModule]



ROOT

Create histograms

[Root Macros]

ROOT

FurtherAnalysis

[Root Macros]

- Detector alignment
- Clustering
- Track reconstruction
- …

Hits versus digits

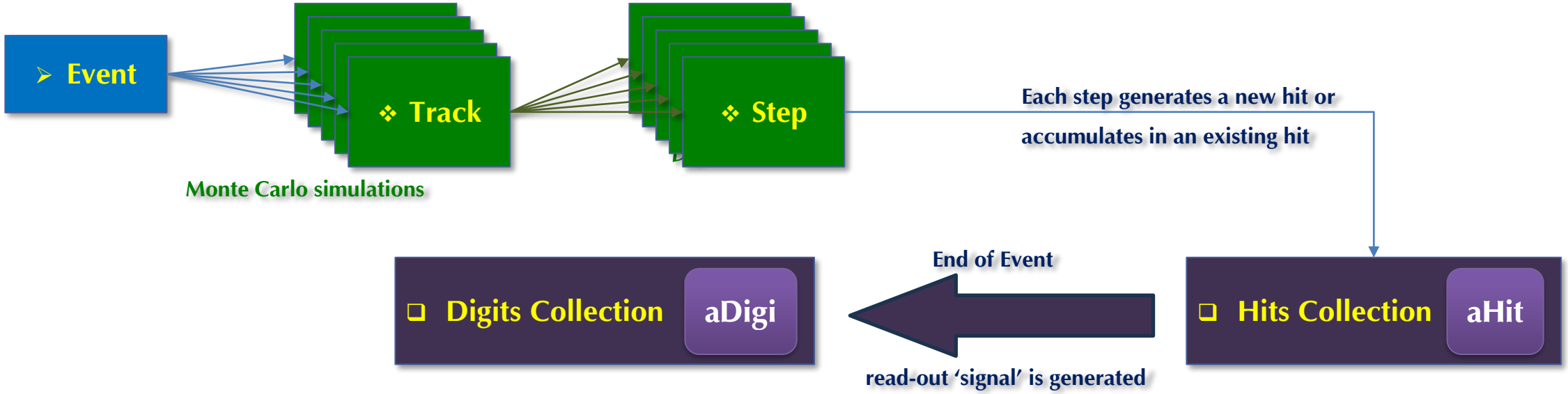
sensitiveDetector, DigitizerModule

G4VHit

- **Hits** are a "snapshot" of the physical interaction of a track (step) or an accumulation of interactions of tracks in the sensitive region of the detector, thus hits represent the "true" energy deposited in the detector

G4VDigitizerModule

- **Digits** are instead intended to be used to simulate the process of reading-out of the signal: for example "true" energy is transformed into collected charge, electronic noise can be applied together with all instrumental effects

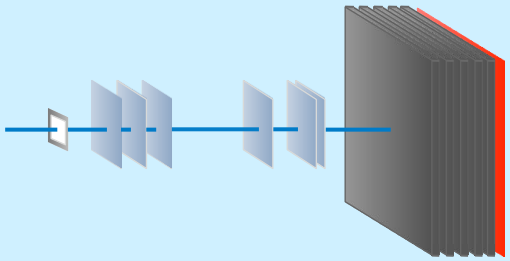


No digitization has been applied to simulations performed for this task

Monte Carlo simulations and data analysis workflow

Build Geometry

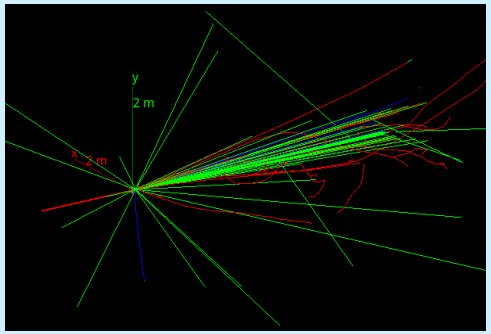
[FreeCADBuilder]
[DetectorConstruction]



FreeCAD

Create source

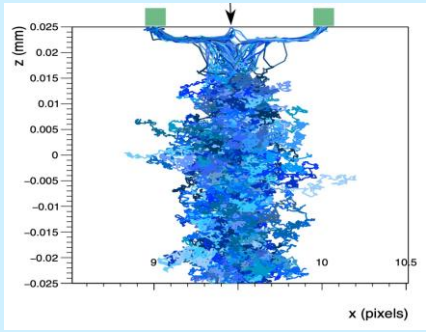
[PrimaryGeneratorAction]



GEANT4

Transport Particles

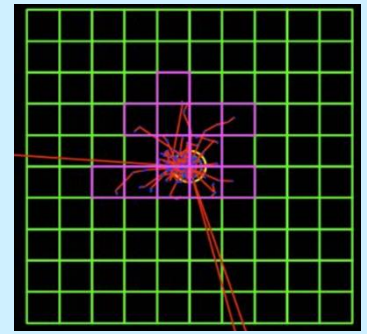
[PhysicsList]



GEANT4

Hits collection

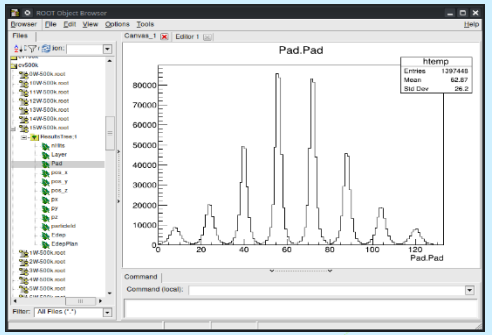
[SensitiveDetector]



GEANT4

Write Data To File

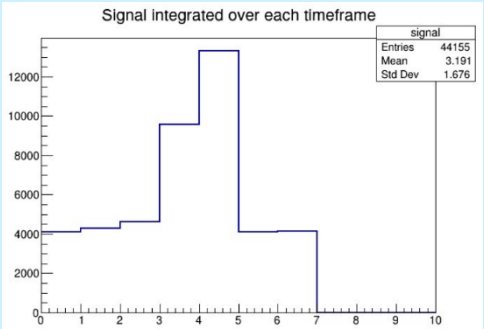
[RunAction]
[EventAction]



GEANT4

Digitization

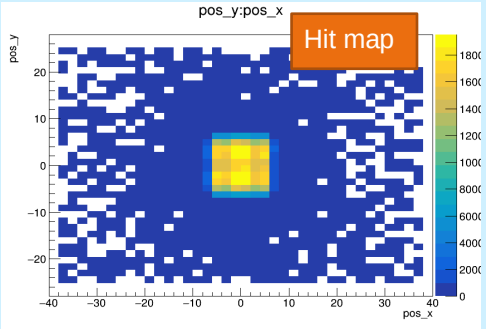
[G4VDigitizerModule]



ROOT

Create histograms

[Root Macros]



ROOT

FurtherAnalysis
[Root Macros]

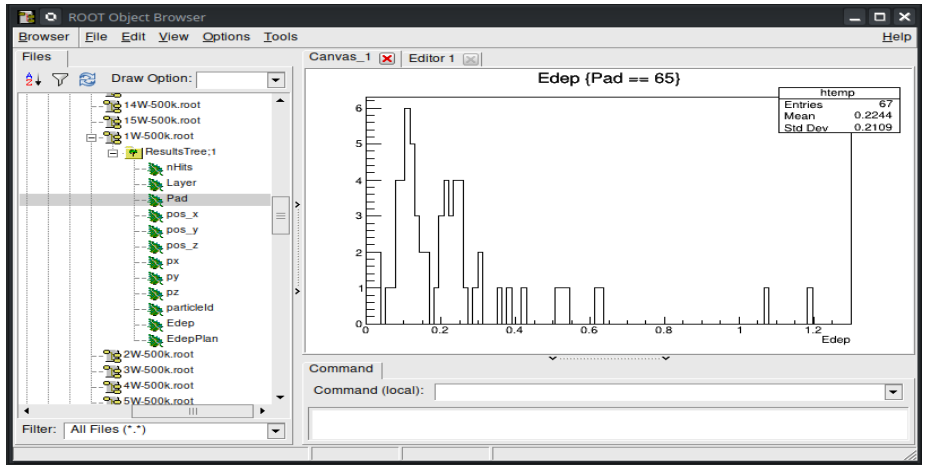
- Detector alignment
- Clustering
- Track reconstruction
- …

Plotting first histograms

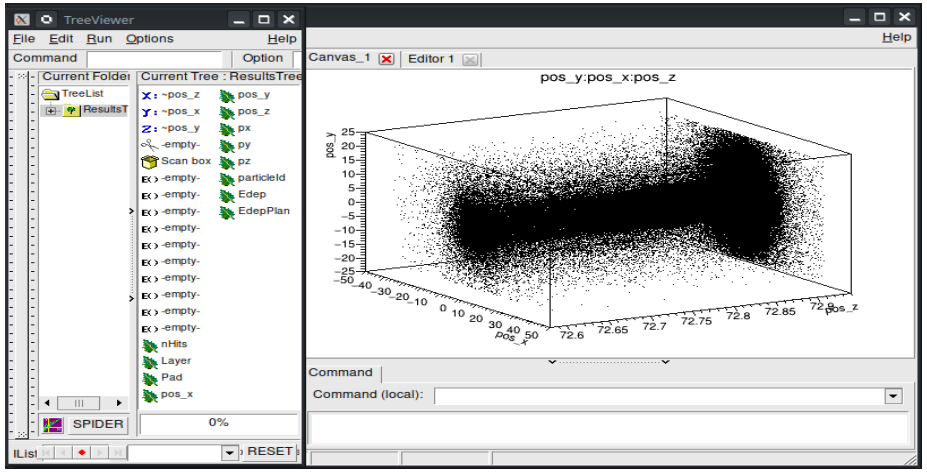
.root commands

Root command

```
root [3] ResultsTree->Draw("Edep","Pad == 65")
```

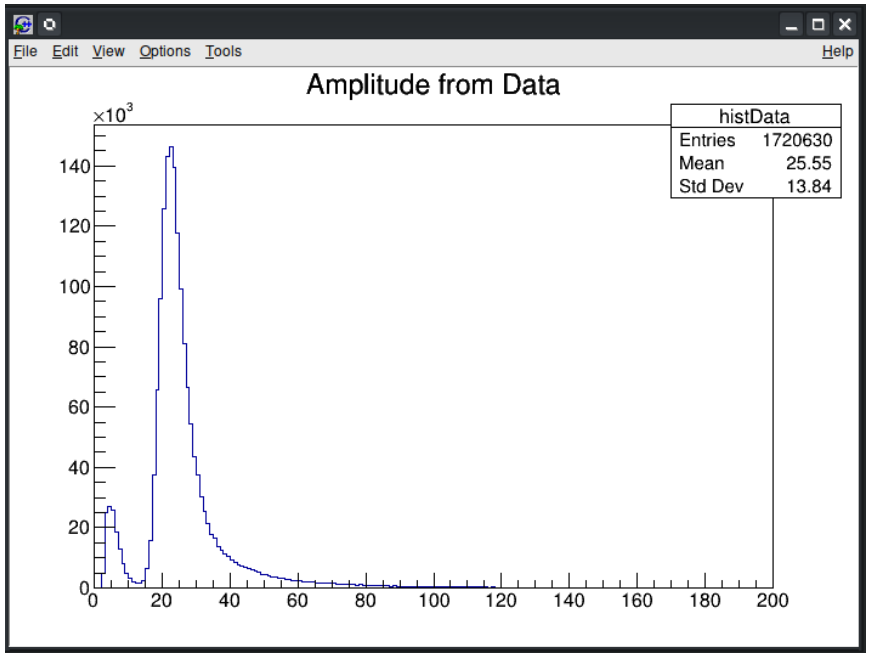


StartViewer



Root macros

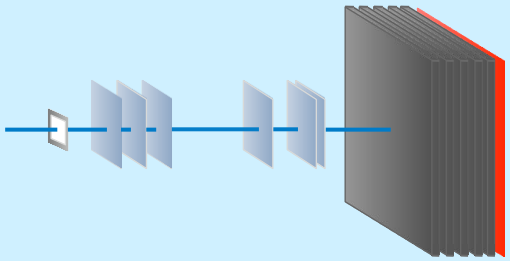
```
#include "plane.h"

void save_hist_data()
{
  TFile *file2  = new TFile("TB_FIRE_4436.root");
  TTree *tree2  = (TTree*)file2->Get("TreeOnFire");

  TCanvas *c = new TCanvas("c","");

  Int_t nentries2 = (Int_t)tree2->GetEntries();

  Plane *plane[3] {};
  for(int iPlane=0; iPlane < 3; iPlane++) { tree2->SetBranchAddress(Form("Plane_%d",iPlane), &(plane[iPlane])); }

  Plane *planePtr;
  TimeFrame singleTimeFrame;

  TH1F* histData = new TH1F("histData","Amplitude from Data", 200, 0, 200);

  for (signed int iEvent = 0; iEvent < nentries2 ; iEvent++)
    {
    tree2->GetEntry(iEvent);
    for(signed int iPlane=0; iPlane < 1 ; iPlane++)
      {
      planePtr = plane[iPlane];
      for(unsigned int iTime = 0; iTime < (planePtr->time_frame).size(); iTime++)
        {
        singleTimeFrame = (planePtr->time_frame)[iTime];
        for(int iSample = 0; iSample < singleTimeFrame.nb_of_samples ; iSample ++)
          {
          std::cout << "event:" << iEvent << std::endl;
          //if( (iTime == 3 || iTime == 4) && (singleTimeFrame.amp[iSample] > 10.) && (singleTimeFrame.amp[iSample] < 900.))
          histData -> Fill(singleTimeFrame.amp[iSample]);
          }
        }
      }
    }

  histData->Draw();

  TFile result("histData.root","UPDATE");
  histData->Write();
}
```



Monte Carlo simulations and data analysis workflow

Build Geometry

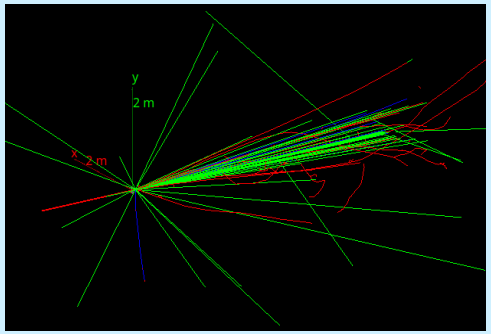
[FreeCADBuilder]
[DetectorConstruction]



FreeCAD

Create source

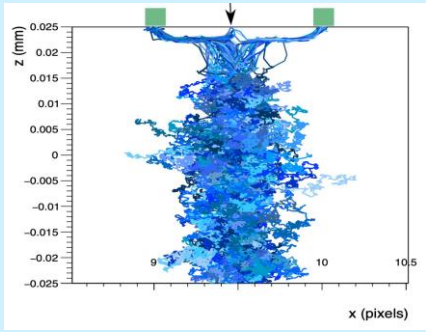
[PrimaryGeneratorAction]



GEANT4

Transport Particles

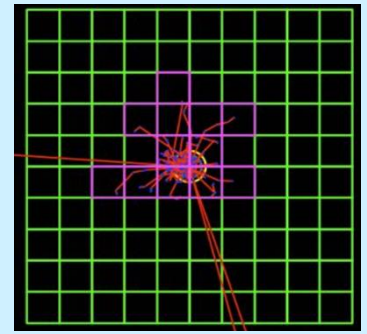
[PhysicsList]



GEANT4

Hits collection

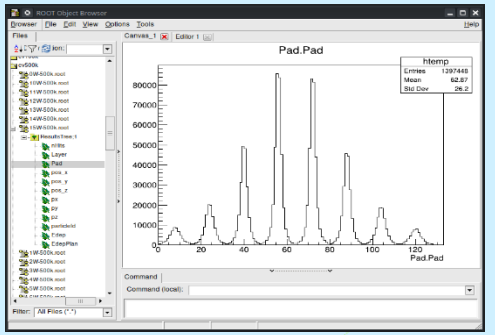
[SensitiveDetector]



GEANT4

Write Data To File

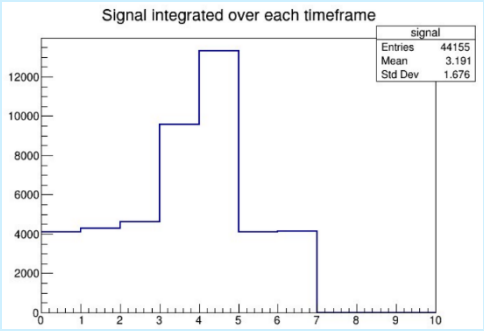
[RunAction]
[EventAction]



GEANT4

Digitization

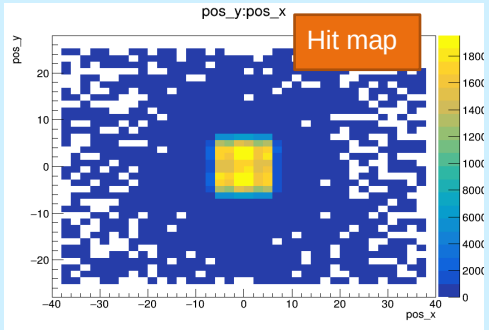
[G4VDigitizerModule]



ROOT

Create histograms

[Root Macros]



ROOT

FurtherAnalysis
[Root Macros]

- Detector alignment
- Clustering
- Track reconstruction
- …

Simulations: Number of e-h pairs created

GaAs sensor – Anton1

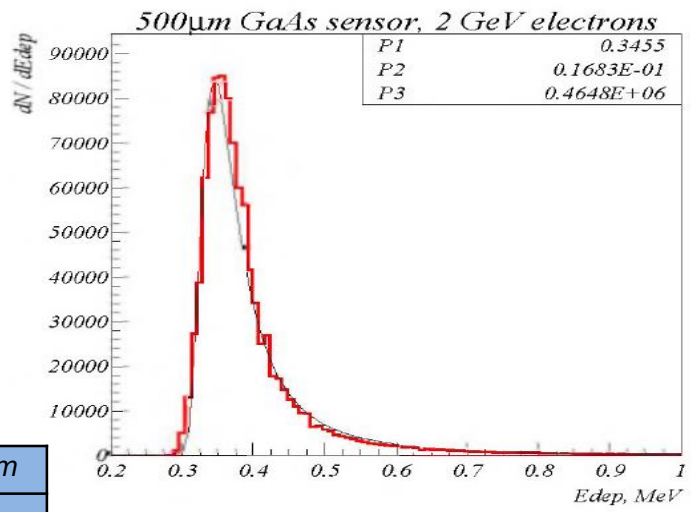
Olga Novgorodova's Thesis:

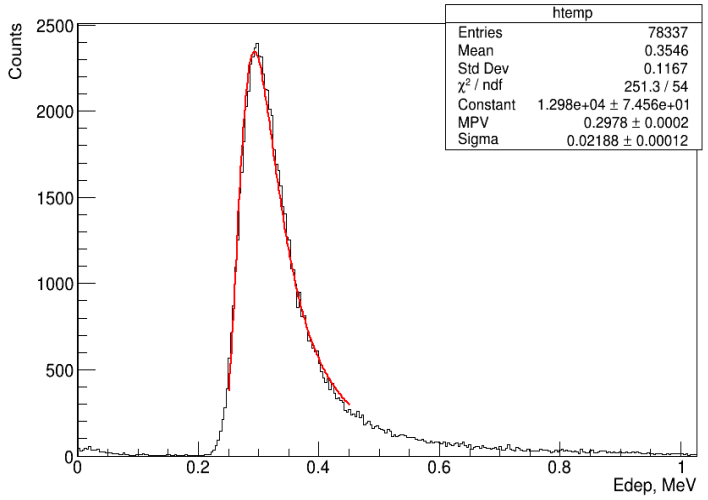
- energy deposition in GaAs sensor
- 500 µm thickness
- ^{90}Sr, and 2, 4 & 4.5 GeV mono-energetic e-
- triggered by 2 / 3 scintillators

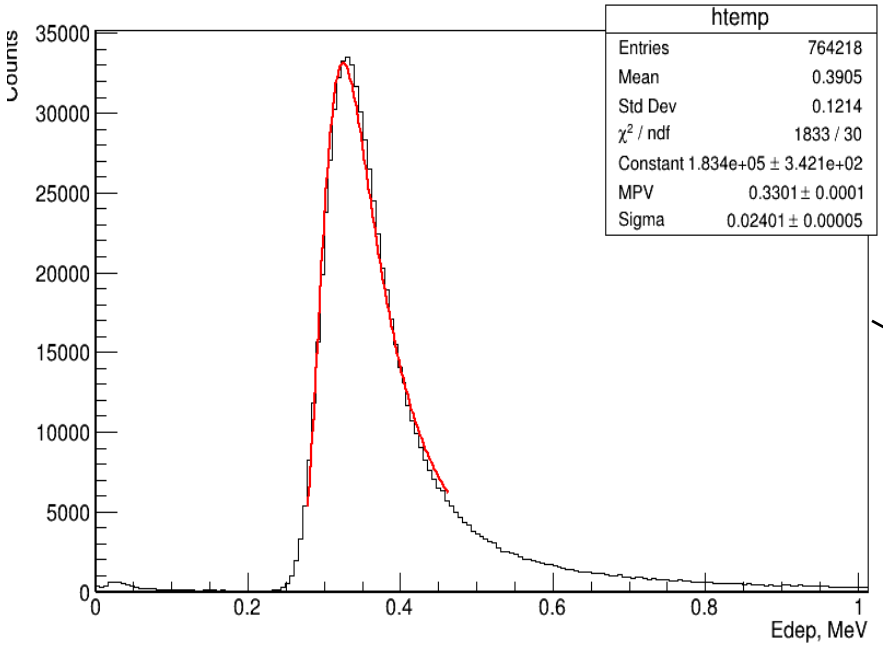
Setup	*Dep. En. (MeV)*	*e-h pairs / µm*	*Dep. En. (MeV)*	*e-h pairs / µm*
^{90}Sr	0.3512	163.4	0.3555	165.34
2 GeV	0.3455	160.7	0.3546	168.86
4 GeV	0.3513	163.4	0.3588	170,86
4.5 GeV	0.3526	164.0	0.3594	171.14
5 GeV			0.3608	171.66

Why differences?

- **which are the characteristics of triggers: dimensions, positions, etc.**
- **Landau fit parameters**







- **Thickness: 550 µm**
- **E_{e-} = 5 GeV**
- **E_i = 4.3 eV**

Dep. en. (MeV) 0.3905

e-h pairs / µm 165.12

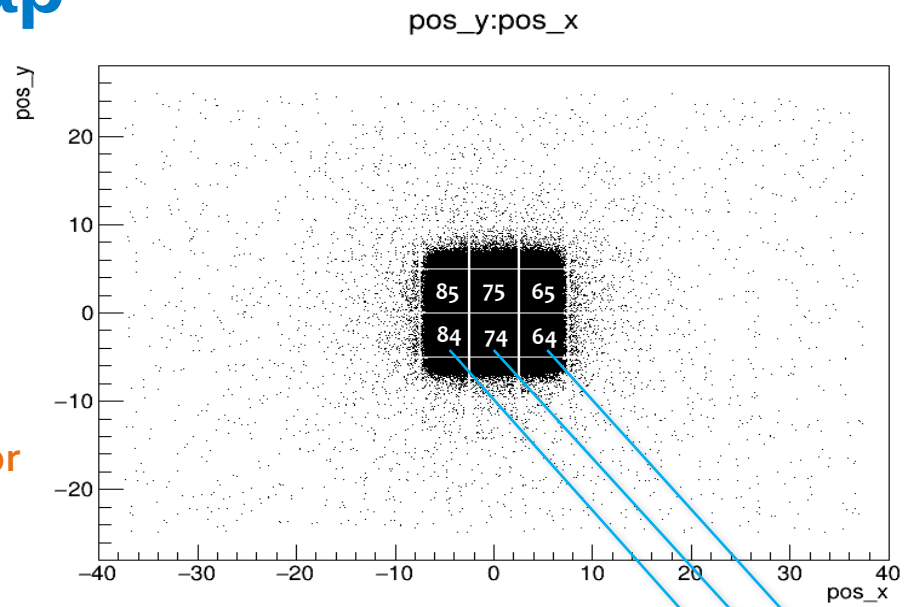
Physics list used: FTFP_BERT_EMZ

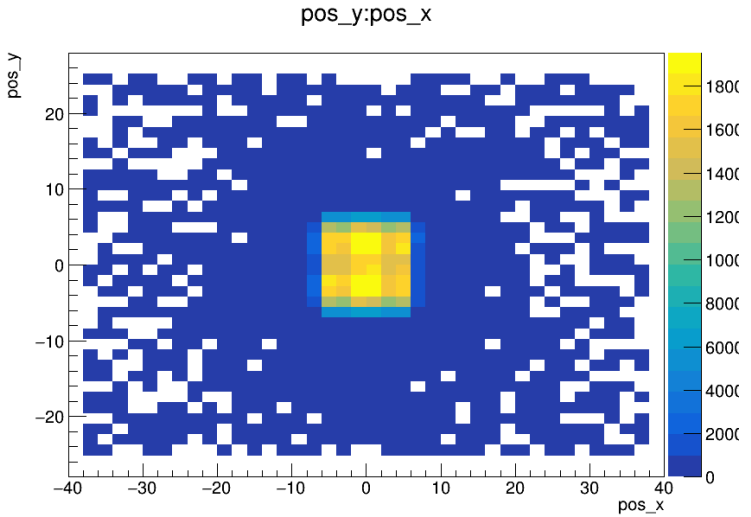
Simulations: Hit map

GaAs sensor – Anton1

Hits registered position:

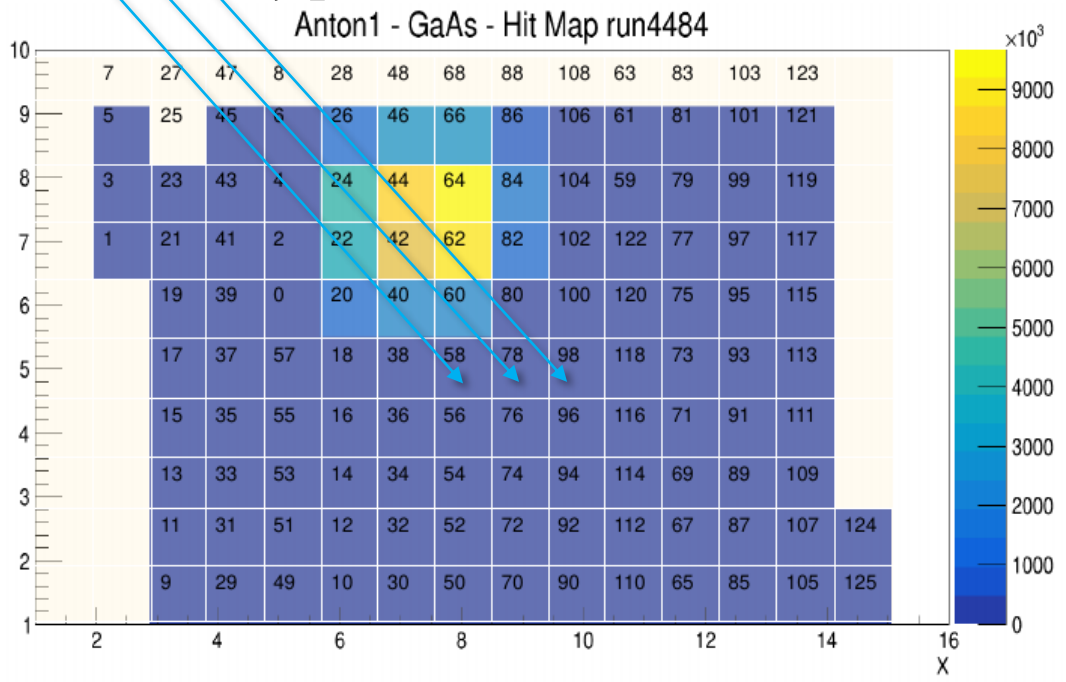
- Primary particle energy: 5GeV
- Number of simulated events: 1 000 000
- Centered on pads 64, 65, 74, 75 , 84, 85
- Converted to channel number from sensor





Similar with run 4484

159	7 149	27 139	47 129	8 119	28 109	48 99	68 89	88 79	108 69	63 59	83 49	103 39	123 29	19	9
158	5 148	25 138	45 128	6 118	26 108	46 98	66 88	86 78	106 68	61 58	81 48	101 38	121 28	18	8
157	3 147	23 137	43 127	4 117	24 107	44 97	64 87	84 77	104 67	59 57	79 47	99 37	119 27	17	7
156	1 146	21 136	41 126	2 116	22 106	42 96	62 86	82 76	102 66	122 56	77 46	97 36	117 26	16	6
155	145	19 135	39 125	0 115	20 105	40 95	60 85	80 75	100 65	120 55	75 45	95 35	115 25	15	5
154	144	17 134	37 124	57 114	18 104	38 94	58 84	78 74	98 64	118 54	73 44	93 34	113 24	14	4
153	143	15 133	35 123	55 113	16 103	36 93	56 83	76 73	96 63	116 53	71 43	91 33	111 23	13	3
152	142	13 132	33 122	53 112	14 102	34 92	54 82	74 72	94 62	114 52	69 42	89 32	109 22	12	2
151	141	11 131	31 121	51 111	12 101	32 91	52 81	72 71	92 61	112 51	67 41	87 31	107 21	124 11	1
150	140	9 130	29 120	49 110	10 100	30 90	50 80	70 70	90 60	110 50	65 40	85 30	105 20	125 10	0



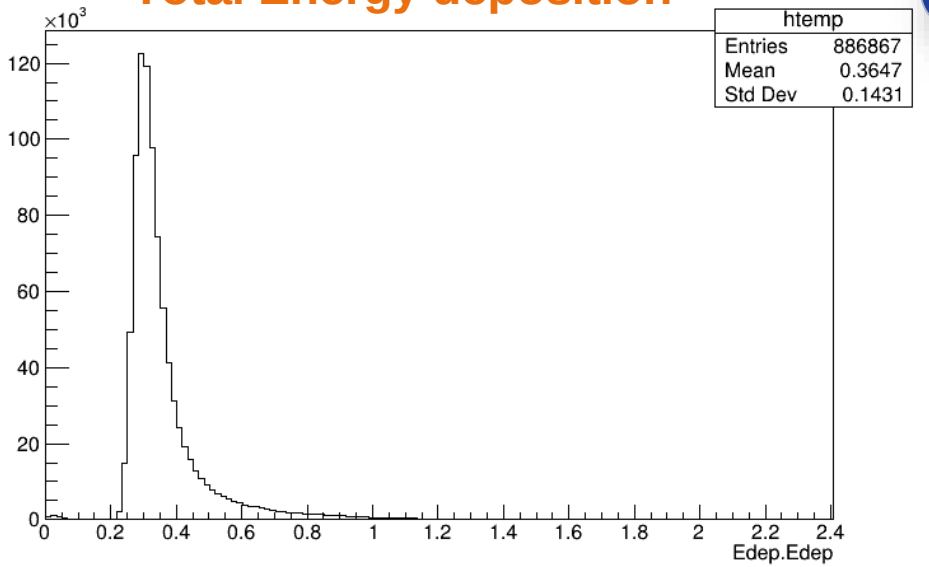
Simulations: Pad Hits

GaAs sensor – Anton1

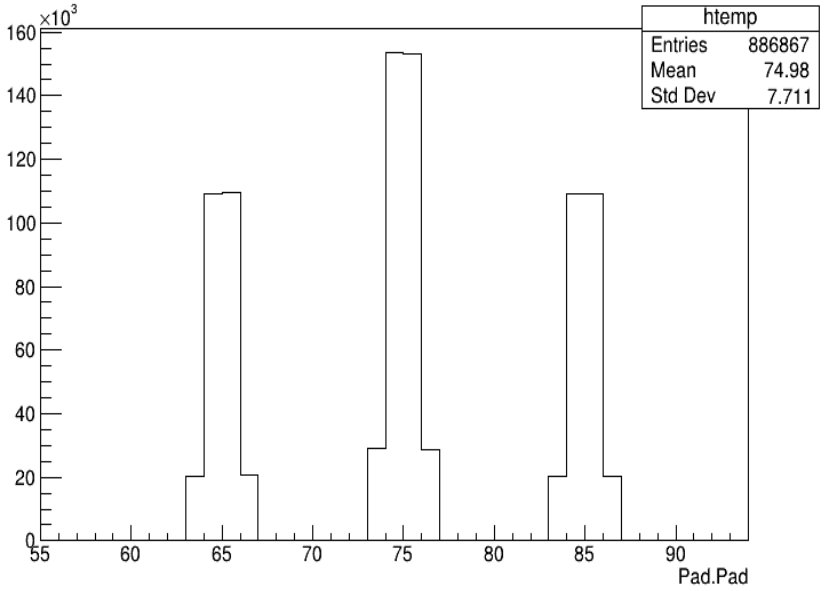
Hits registered position:

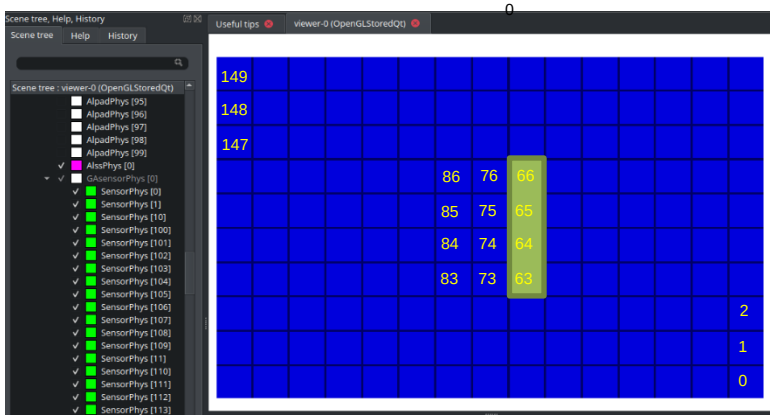
- Primary particle energy: 5GeV
- Number of simulated events: 1 000 000
- Centered on pads 64, 65, 74, 75 , 84, 85
- **Converted to channel number from sensor**

Total Energy deposition

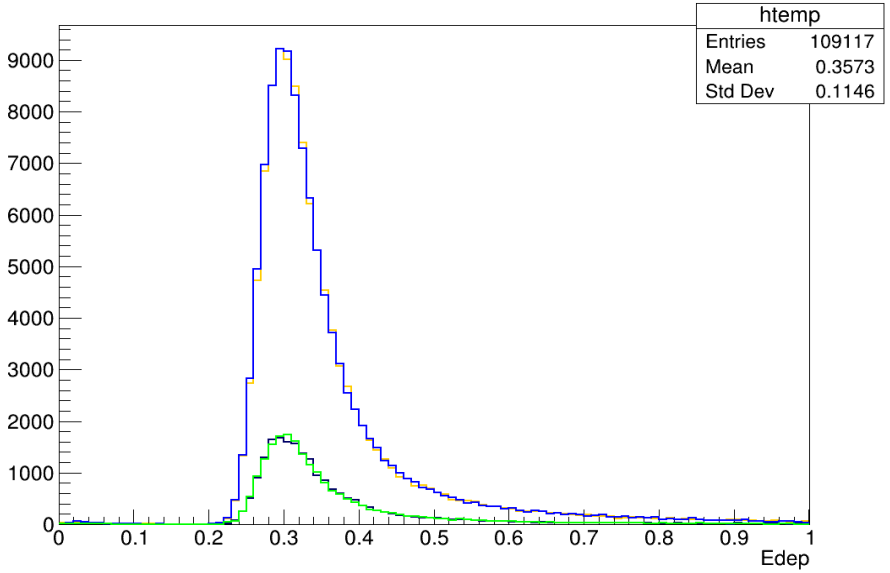


Pad hits





Energy deposition in central pads

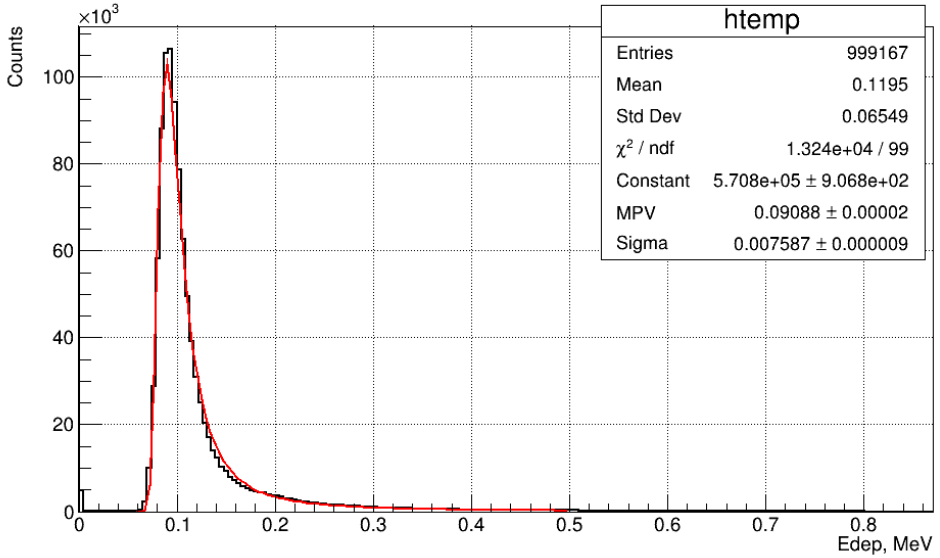


Simulations: Number of e-h pairs created

Si sensor C74 & others

Energy deposition:

- 320 µm thickness
- 5 GeV mono-energetic e-
- triggered by 3 scintillators

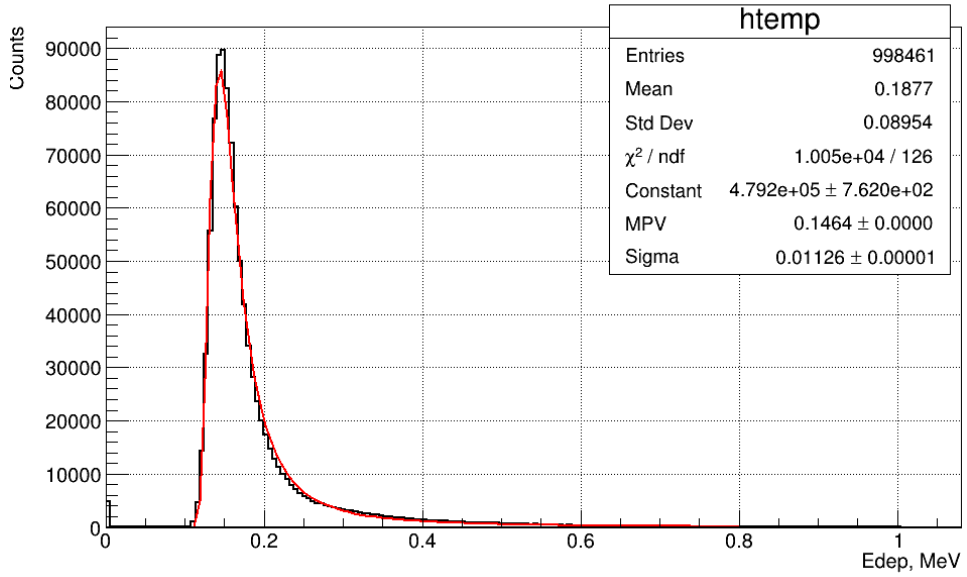


- **Thickness: 320 µm**
- **E_{e-} = 5 GeV**
- **E_i = 3.62 eV**

78.45 e-h pairs per µm

Energy deposition:

- 500 µm thickness
- 3 GeV mono-energetic e-
- triggered by 3 scintillators



- **Thickness: 500 µm**
- **E_{e-} = 3 GeV**
- **E_i = 3.62 eV**

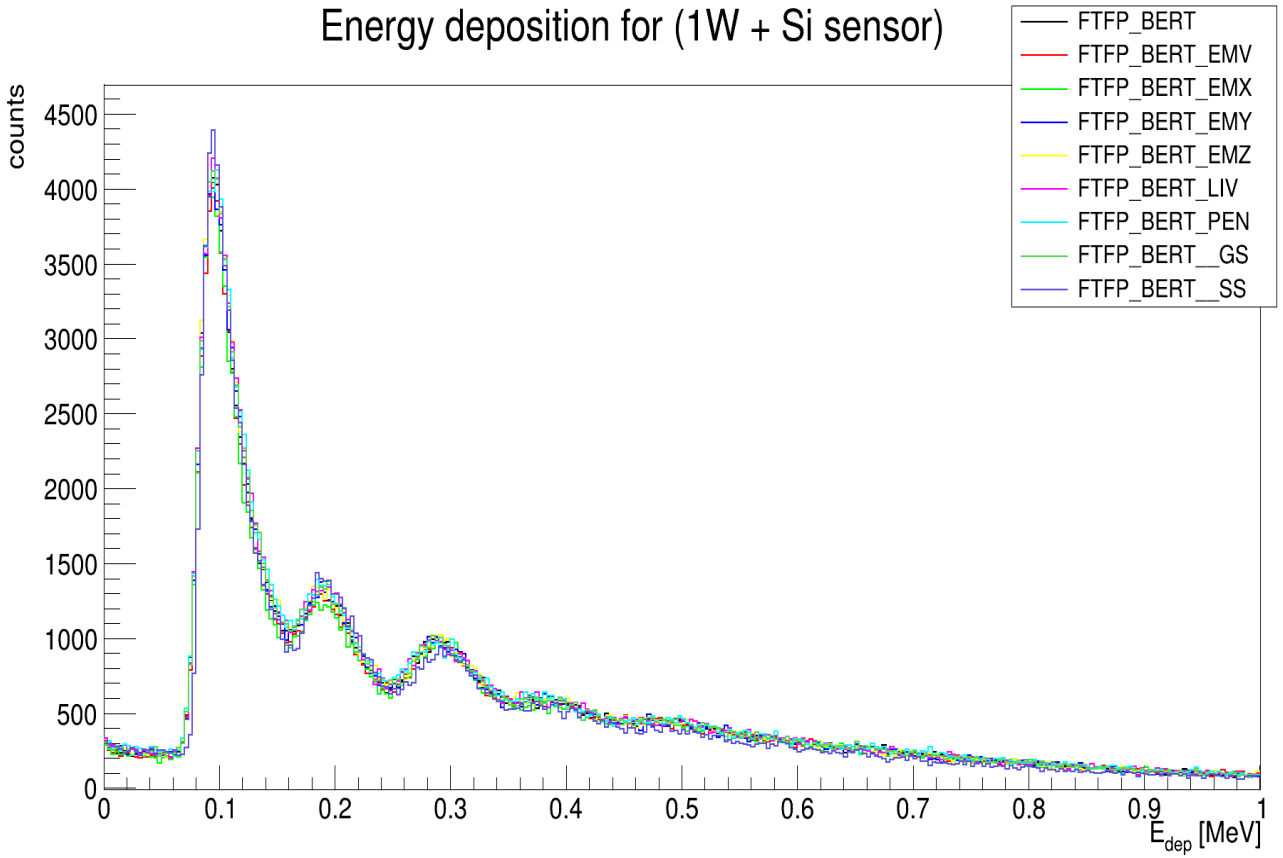
80.88 e-h pairs per µm

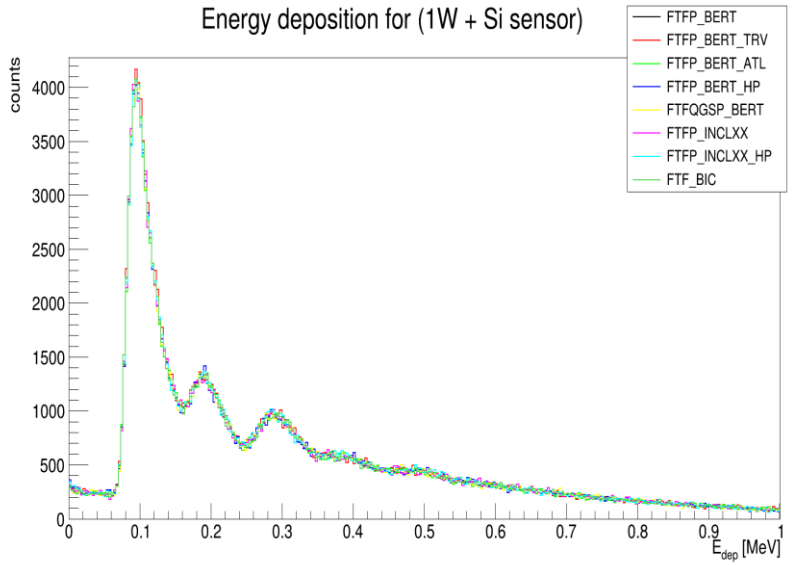
Physics list used: FTFP_BERT_EMZ

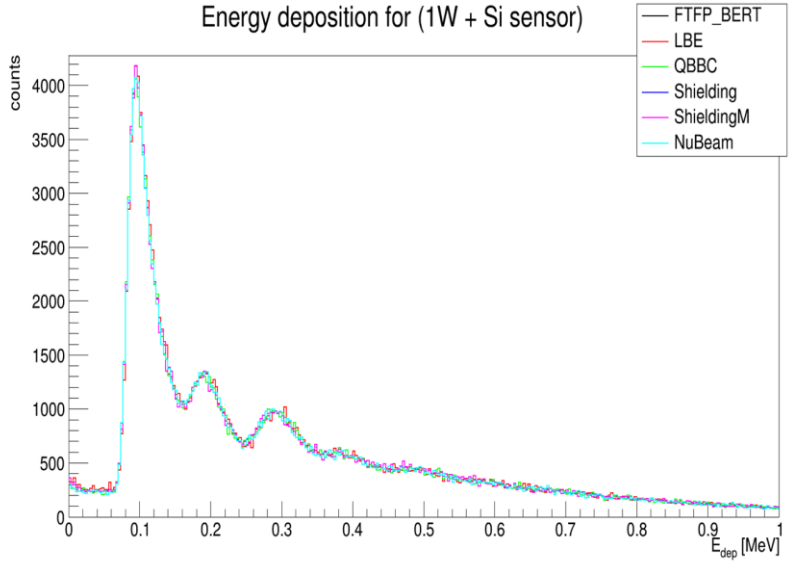
Simulations: Physics list comparison

Si sensor: W + C74

- FTF_BIC
- FTFP_BERT
- FTFP_BERT_HP
- FTFP_BERT_TRV
- FTFP_BERT_ATL
- FTFP_INCLXX
- FTFP_INCLXX_HP
- FTFP_QGSP_BERT
- LBE
- NuBeam
- QGSP_BERT
- QGSP_BERT_HP
- QGSP_BIC
- QGSP_BIC_HP
- QGSP_BIC_AllHP
- QGSP_FTFP_BERT
- QGSP_INCLXX
- QGSP_INCLXX_HP
- QGS_BIC
- Shielding
- ShieldingLEND







Simulations: MeV to ADC

GaAs sensor – Anton1

Energy deposition:

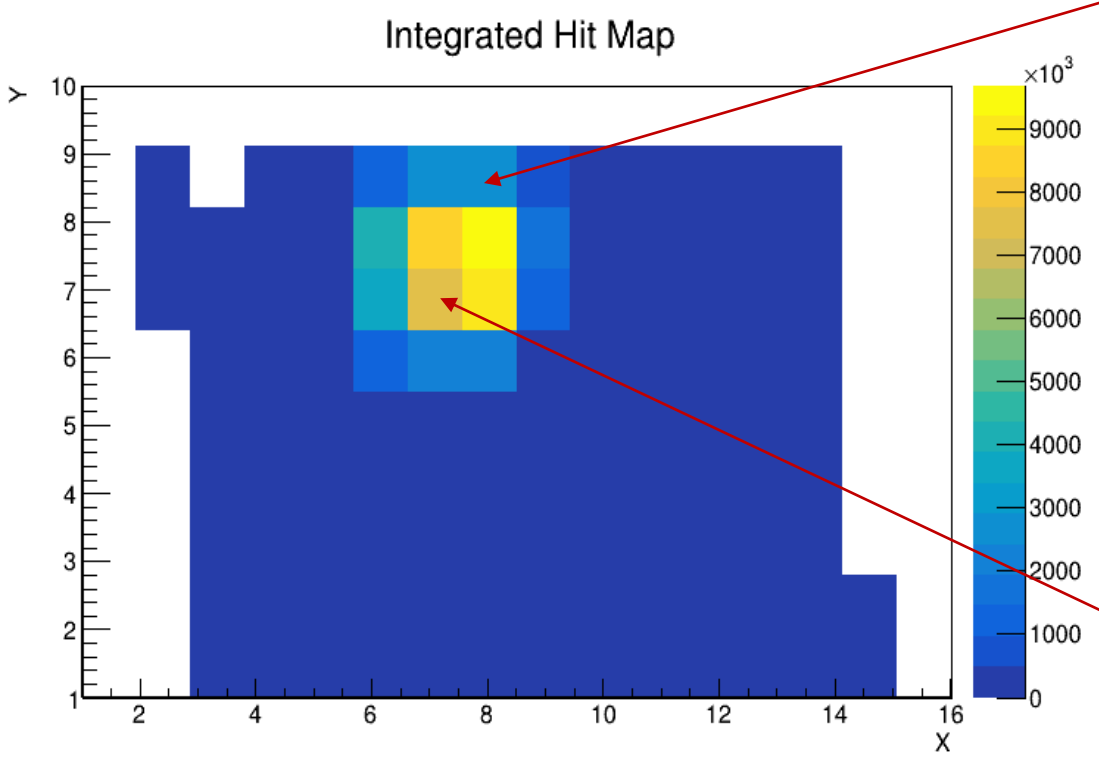
- for each pad a (Landau & Gauss) function was fitted to energy spectrum

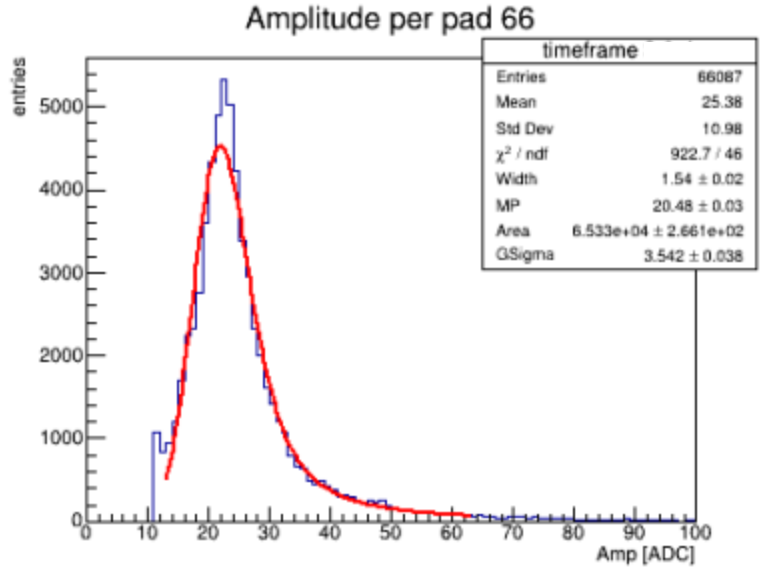
Analysis conditions

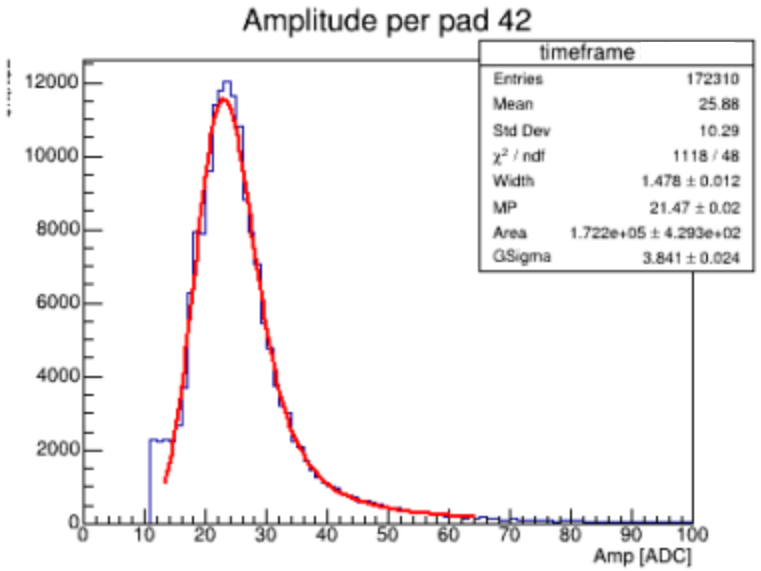
- Kept all timeplanes
- Cut on amplitude < 900
- dead channels masked
- langaus fit [12-64] ADC

Data from run4484

- Beam on pads 42, 44, 62, 64
- Converted to channel numbe[illegible]





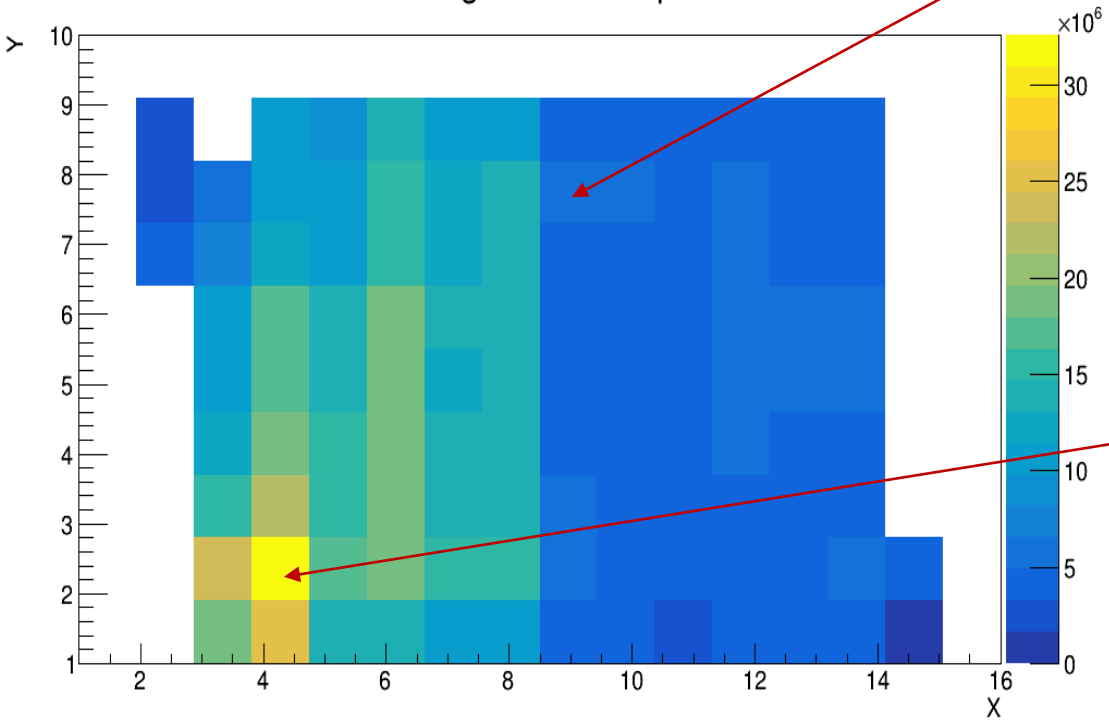


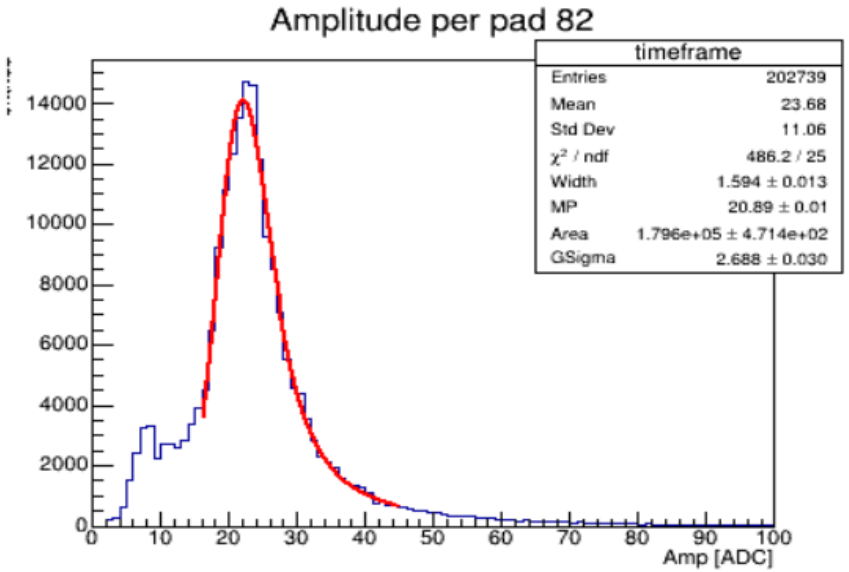
Simulations: MeV to ADC

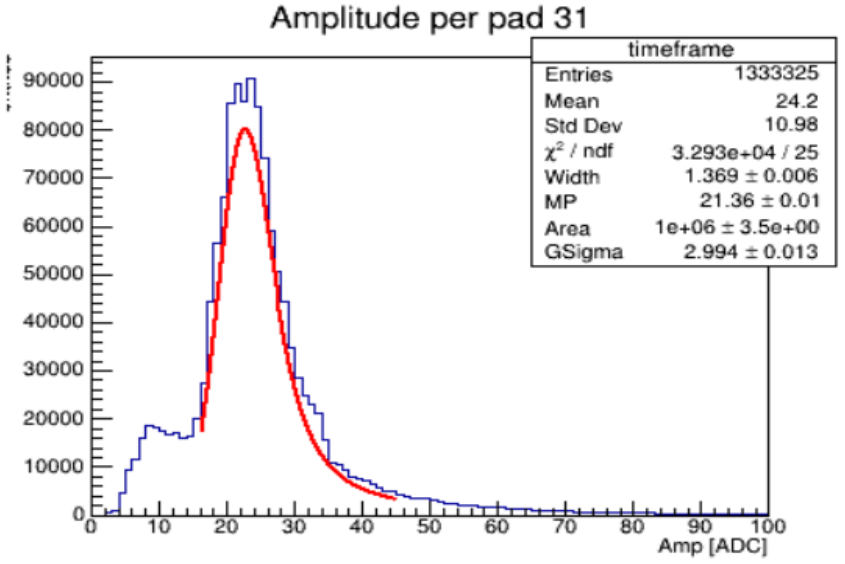
GaAs sensor – Anton1 , merged runs

Energy deposition:

- **merged all data from run4459 till run4491**
- runs with Debug-data-ON or test runs not taken into account
- beam energy: 5 GeV
- greater number of runs and events for the left side of sensor







Simulations: MeV to ADC

GaAs sensor – Anton1 , merged runs

Energy deposition:

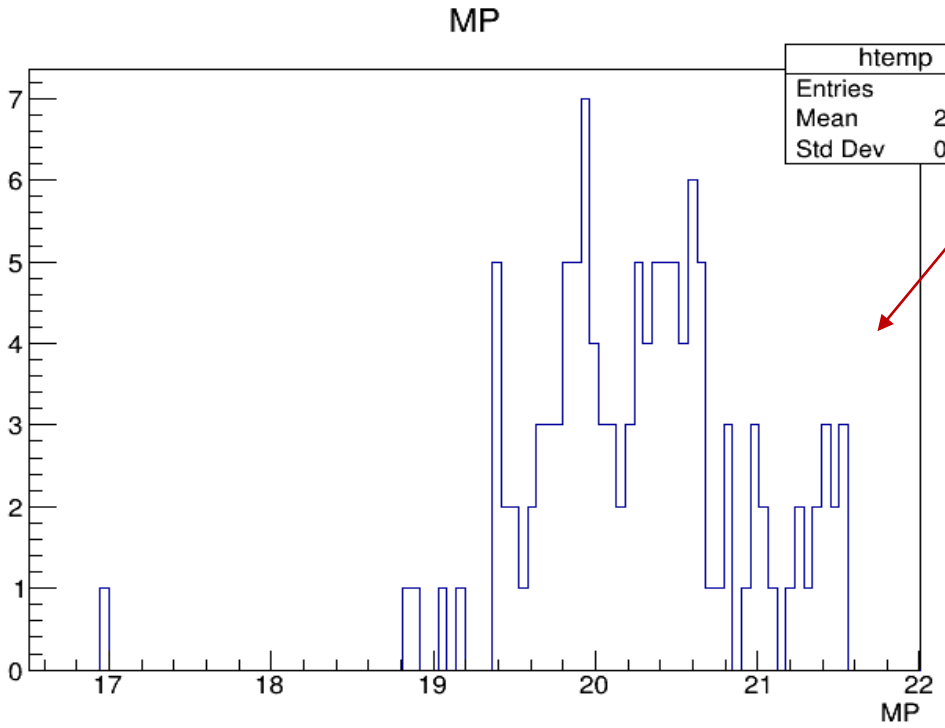
- 2 cases investigated: **[run 4484]** & **[run 4459 – run 4491]**
- fit with (Landau & Gauss) function all channels in [12-64] ADC range

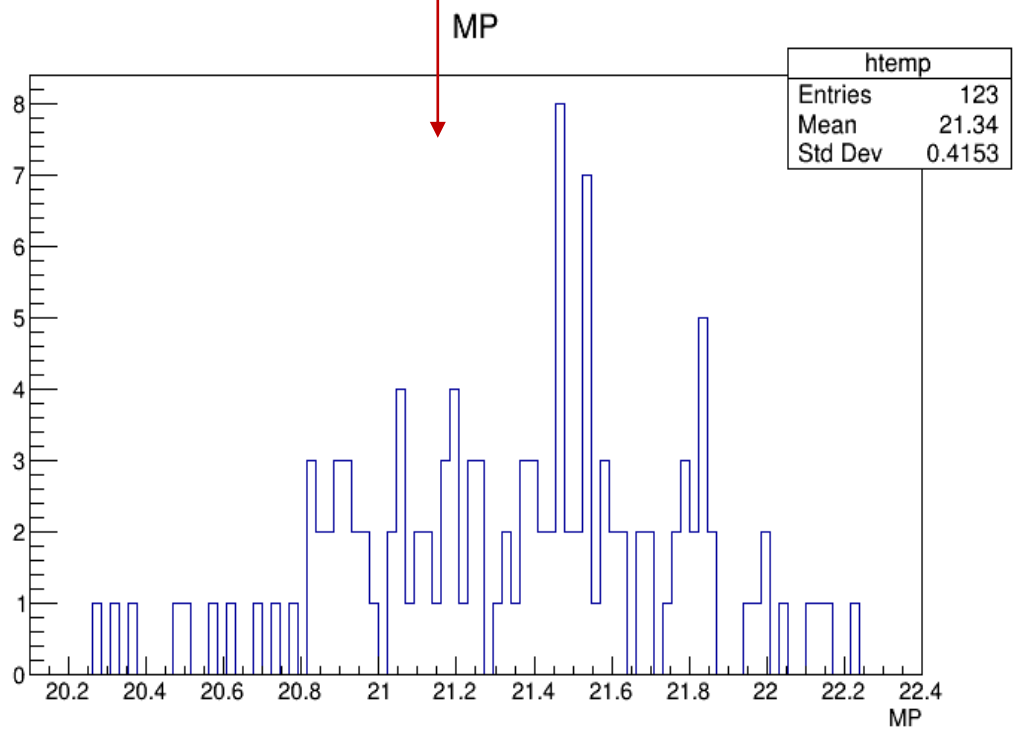
Data from run4484

- Beam on pads 42, 44, 62, 64
- **MPV = 20.26 ± 0.68 [ADC]**

Data from merged runs

- **MPV = 21.34 ± 0.42 [ADC]**





Simulations vs Data

GaAs sensor – Anton1, run 4484

- 1 MeV = 56.77 ADC

Energy deposition:

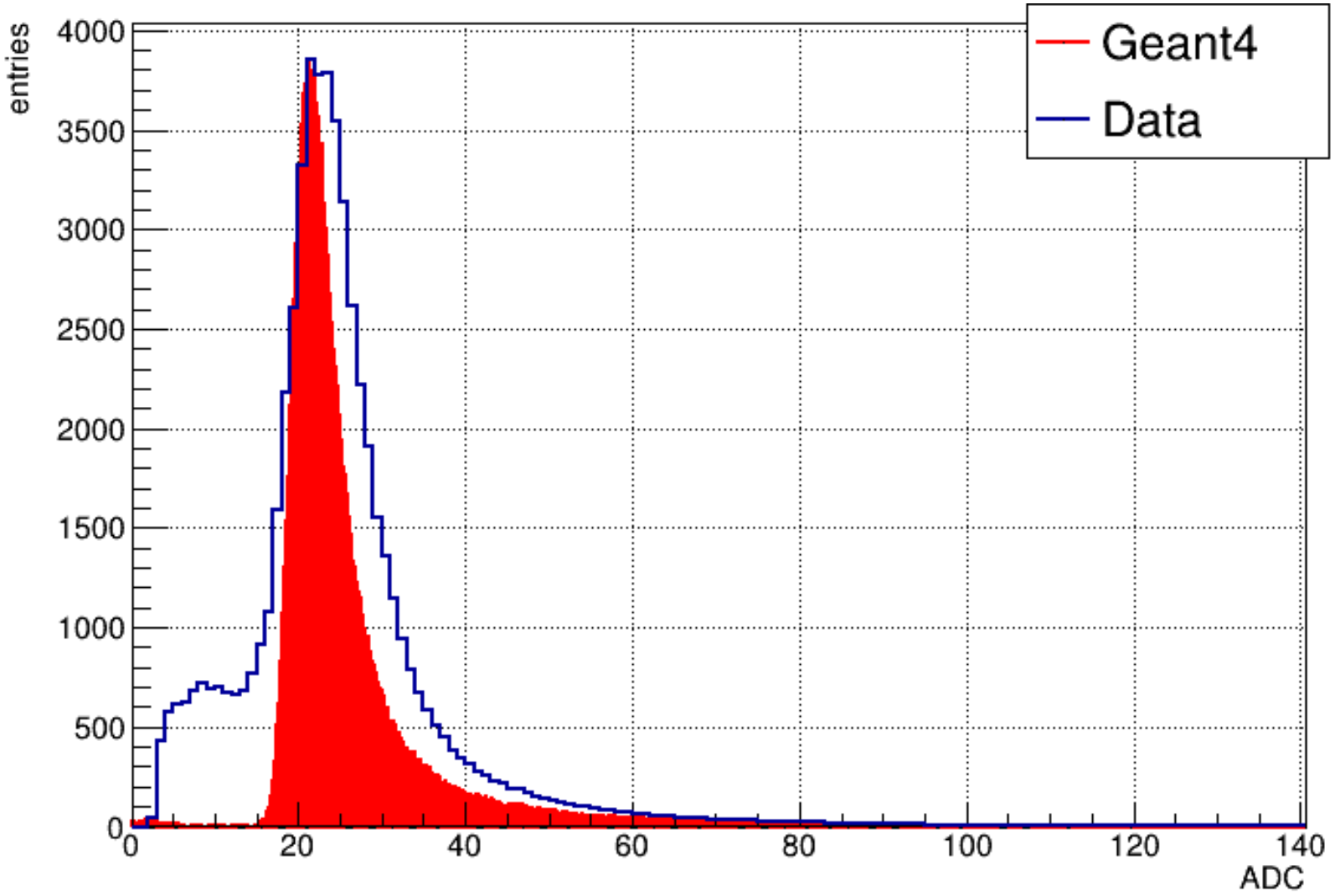
- Goal: compare simulations with data

from data, run4484

- 1 MIP = 20.26 ± 0.68 [ADC]

from simulations

- 1 MIP = 0.3569 ± 0.12 MeV

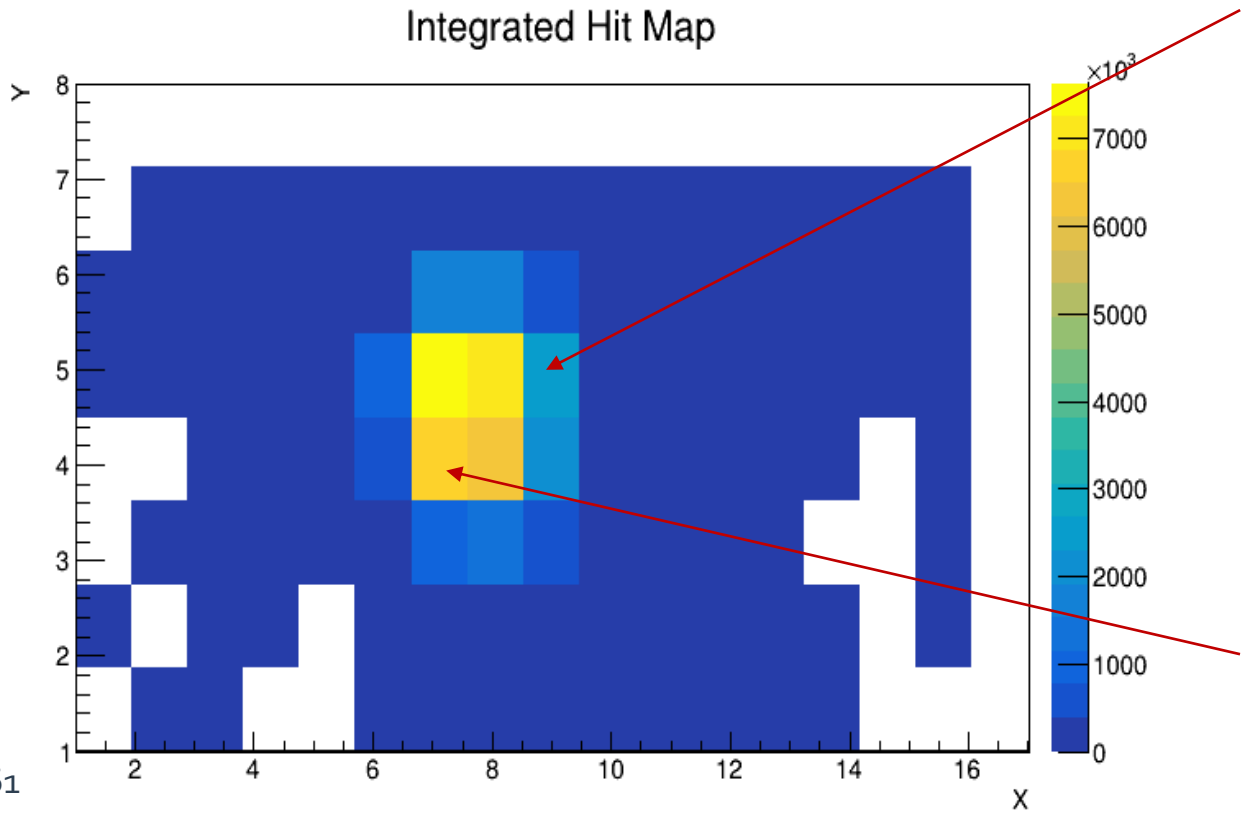


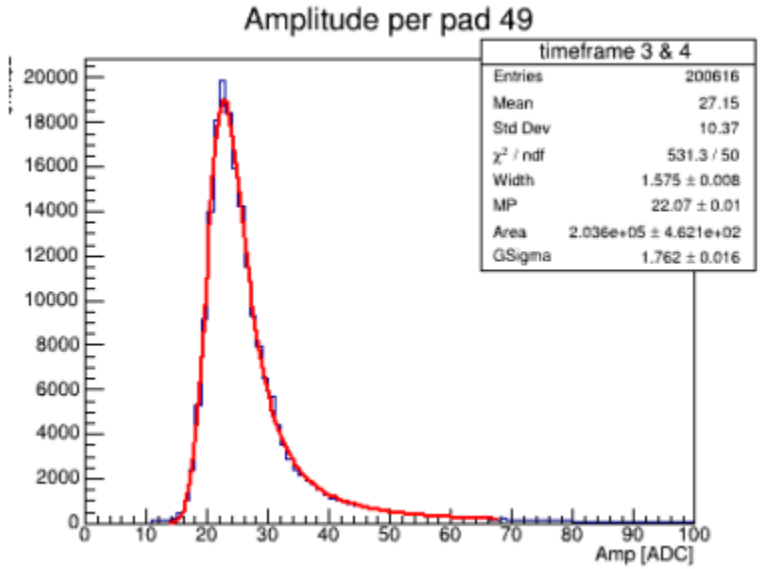
Simulations: MeV to ADC

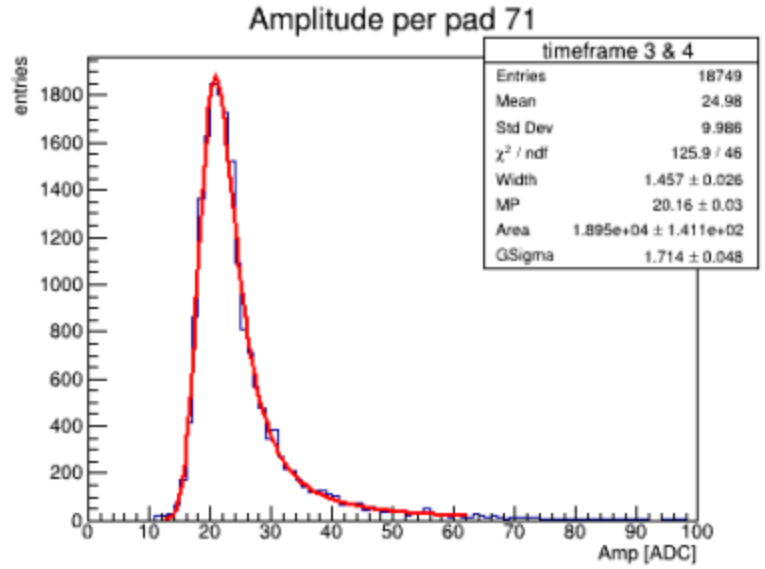
Si sensor – C75

Energy deposition:

- for each pad a (Landau & Gauss) function was fitted to energy spectrum
- a lot of channels are dead or unresponsive







Analysis conditions

- Kept all timeplanes
- Cut on amplitude < 900
- dead channels masked
- langaus fit [12-64] ADC

Data from run4436

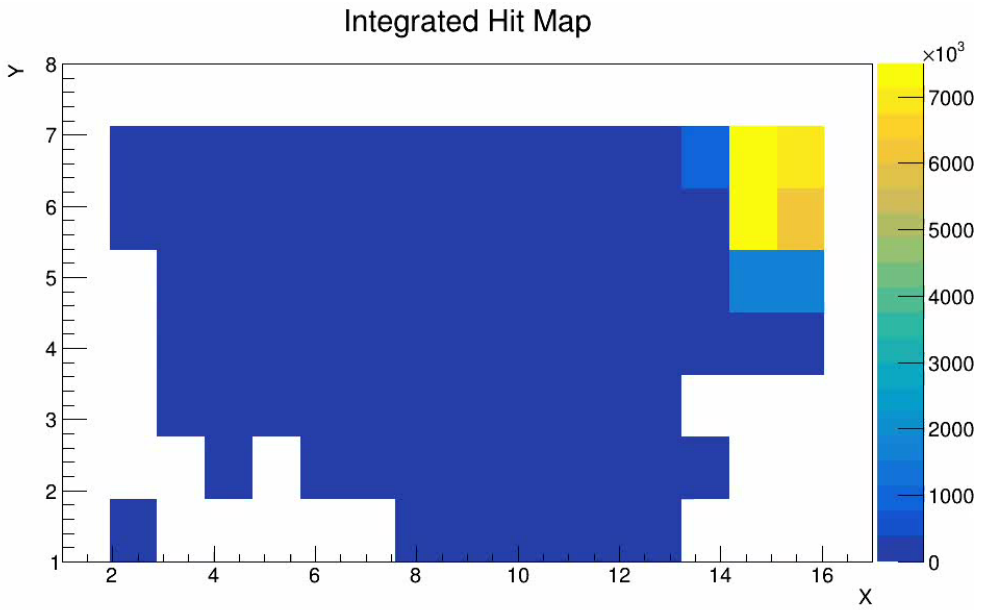
- Beam on pads 49, 51, 59, 61
- Converted to channel number from sensor

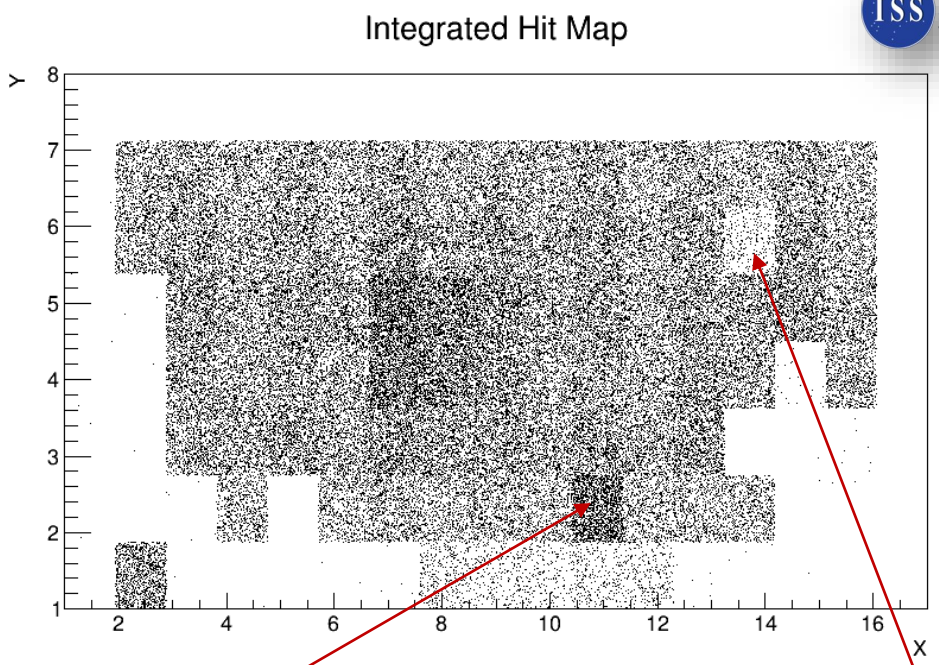
Simulations: MeV to ADC

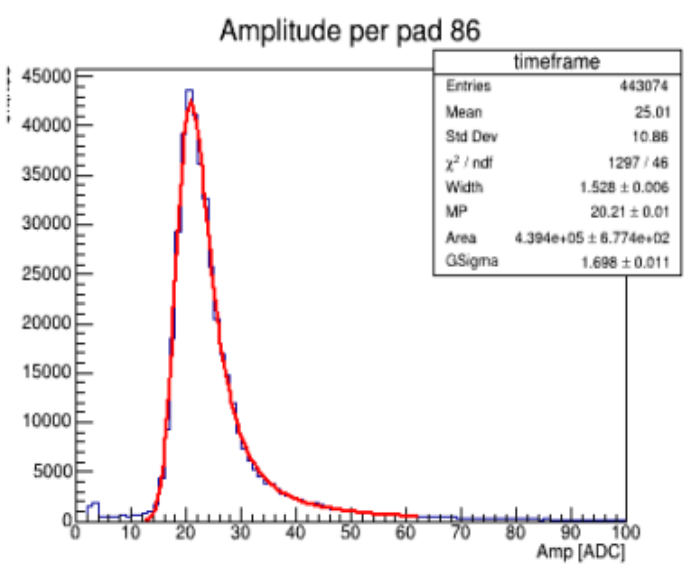
Si sensor – C75

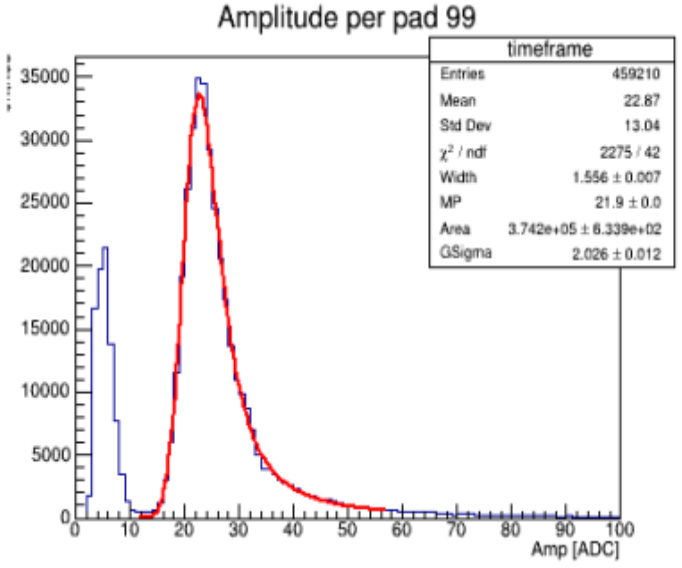
Energy deposition:

- **merged all data from run4422 till run4447**
- runs with Debug-data-ON or test runs not taken into account
- beam energy: 5 GeV
- many dead or unresponsive pads









Simulations: MeV to ADC

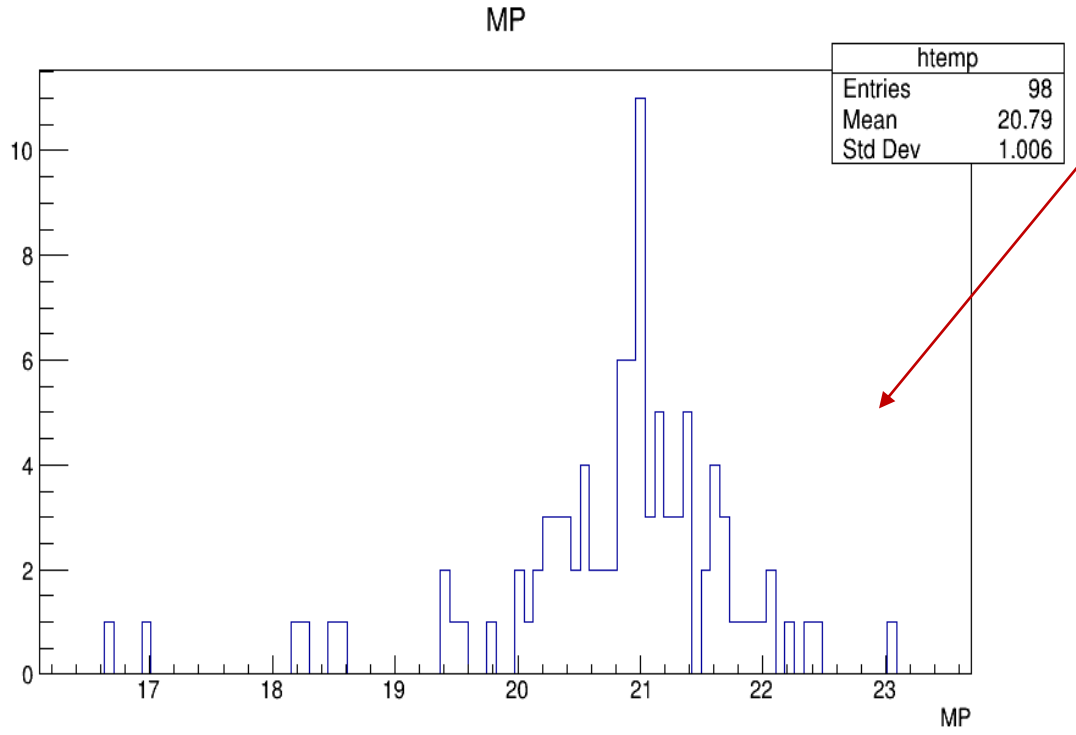
Si sensor – C75

Energy deposition:

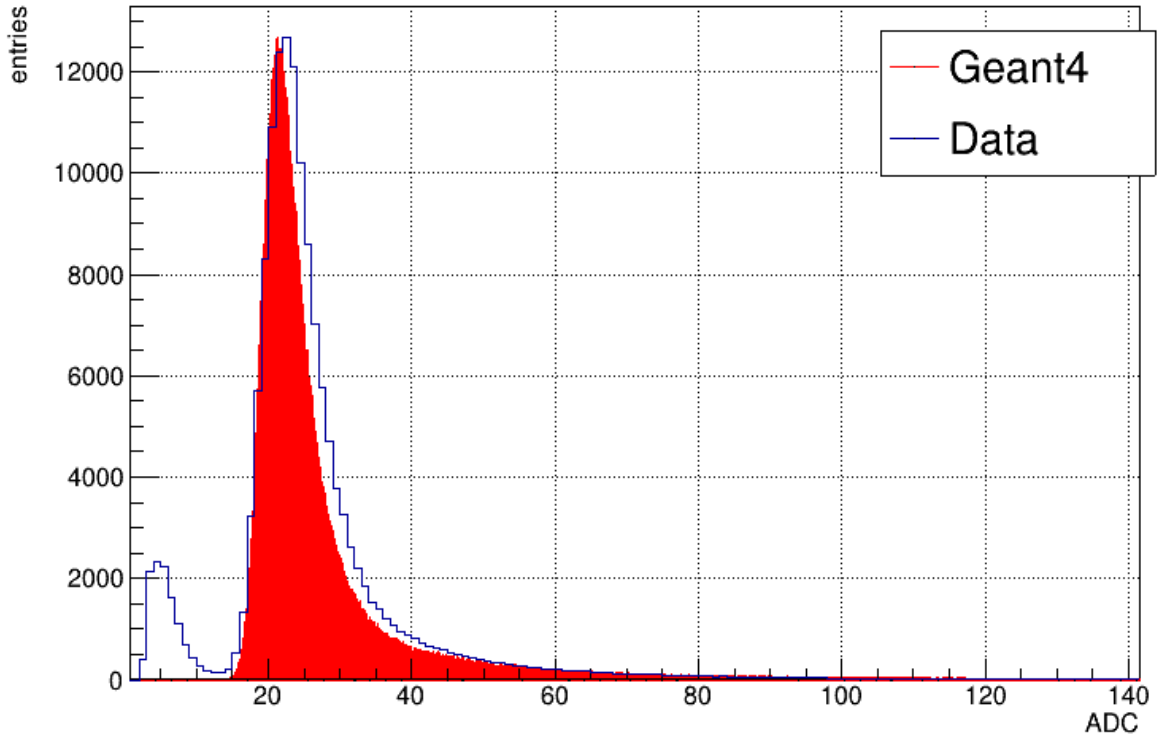
- 2 cases investigated: **[run 4436]** & **[run 4422 – run 4447]**
- fit with (Landau & Gauss) function all channels in [12-64] ADC range

Data from run4436

- Beam on pads 49, 51, 59, 61
- **MPV = 20.79 ± 1.07 [ADC]**



- **1 MeV = 228.79 ADC**



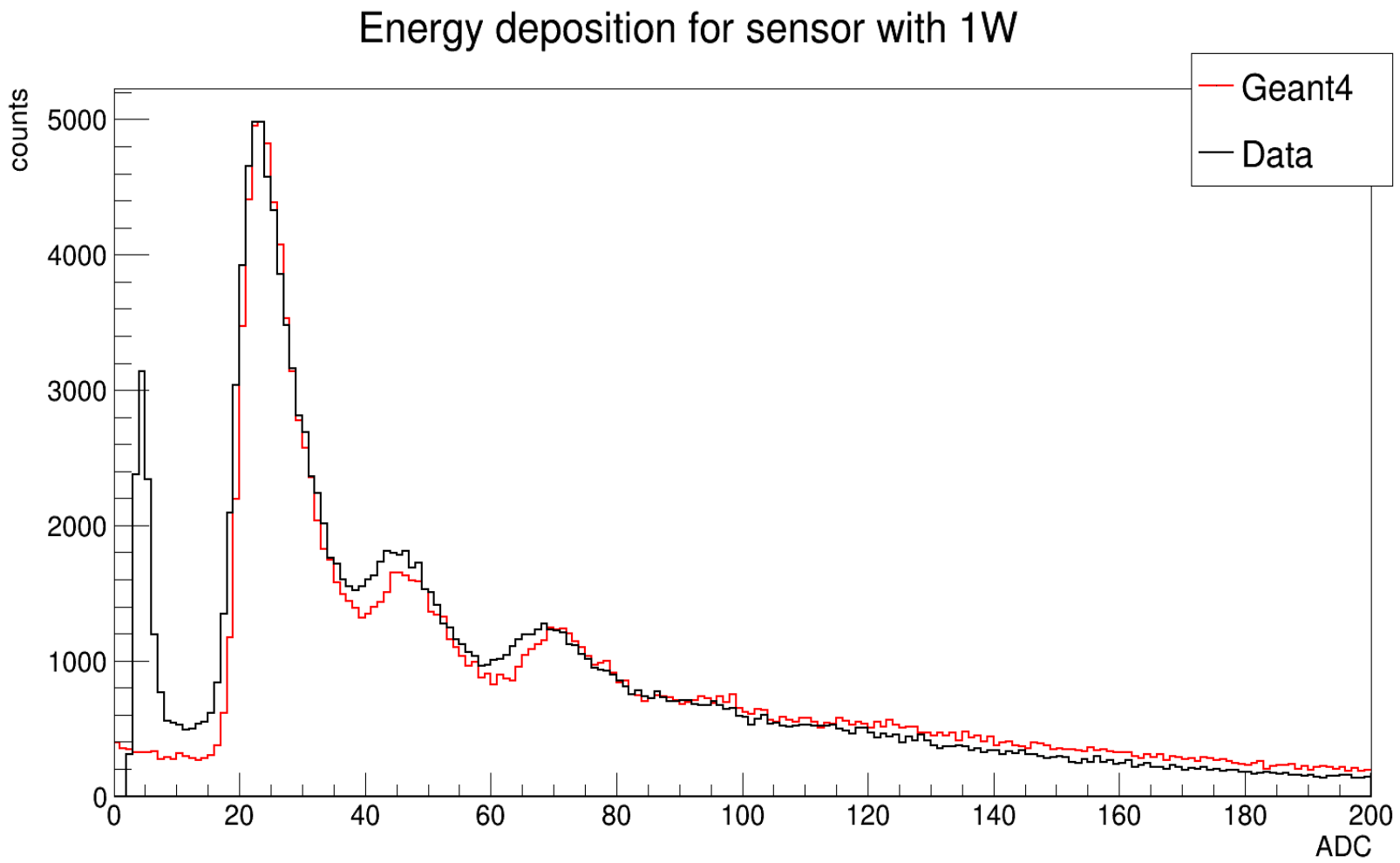
Simulations vs Data

Si sensor – C74 + W

Energy deposition:

- experimental data: **[run 4749]**
- C74 sensor with 1 tungsten plate in front

Physics list used: FTFP_BERT_EMZ

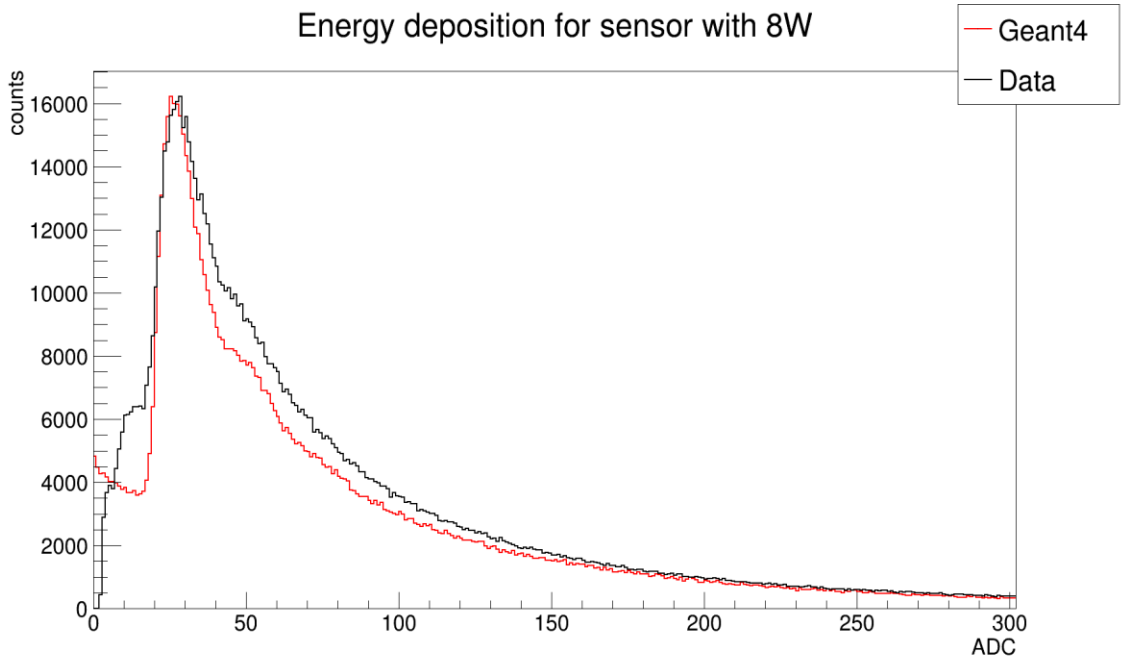


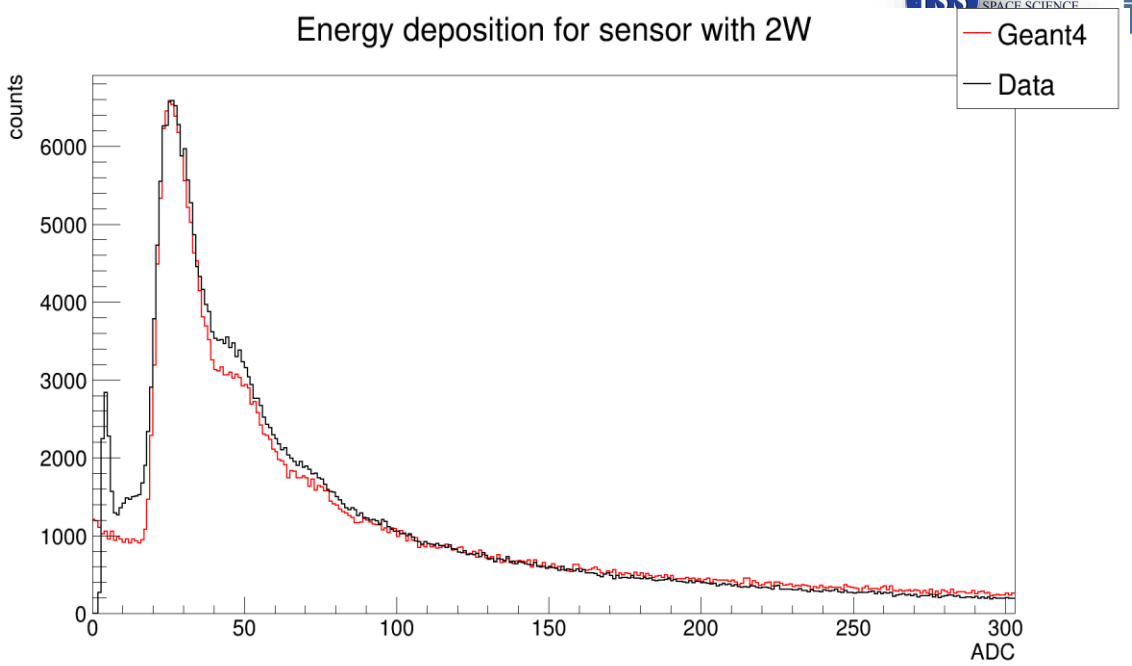
Simulations vs Data

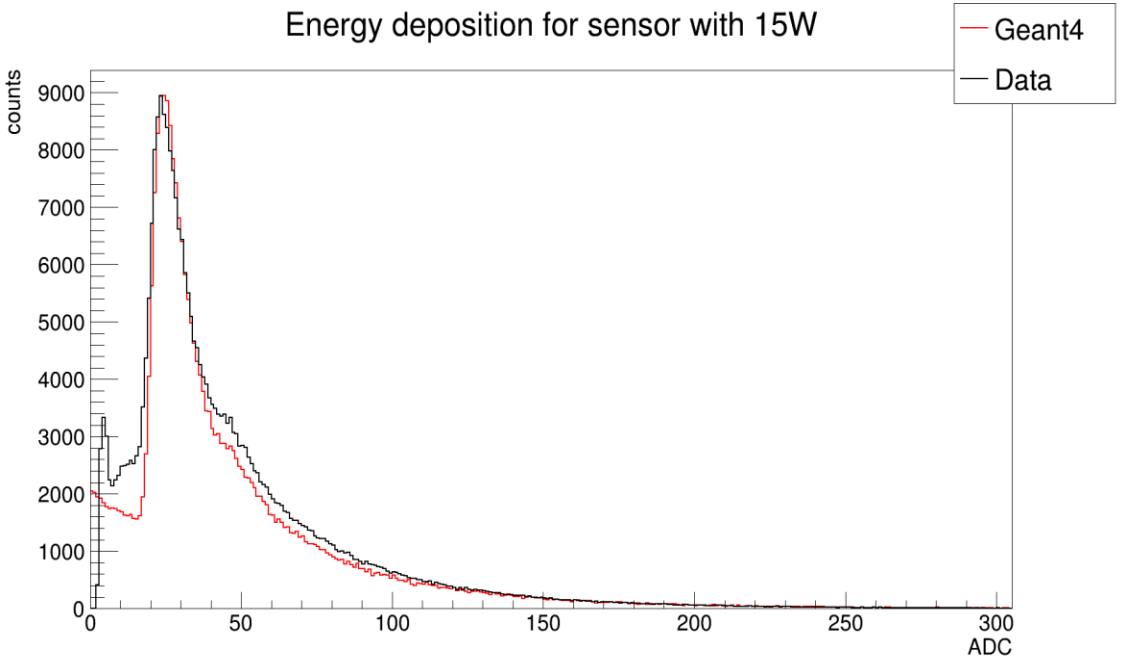
Si sensor – C74 + *n*W

Energy deposition:

- C74 sensor with tungsten plates in front
- experimental data: **[run 4748] – 2W**
  [run 4742] – 8W
  [run 4735] – 15W







Physics list used: FTFP_BERT_EMZ

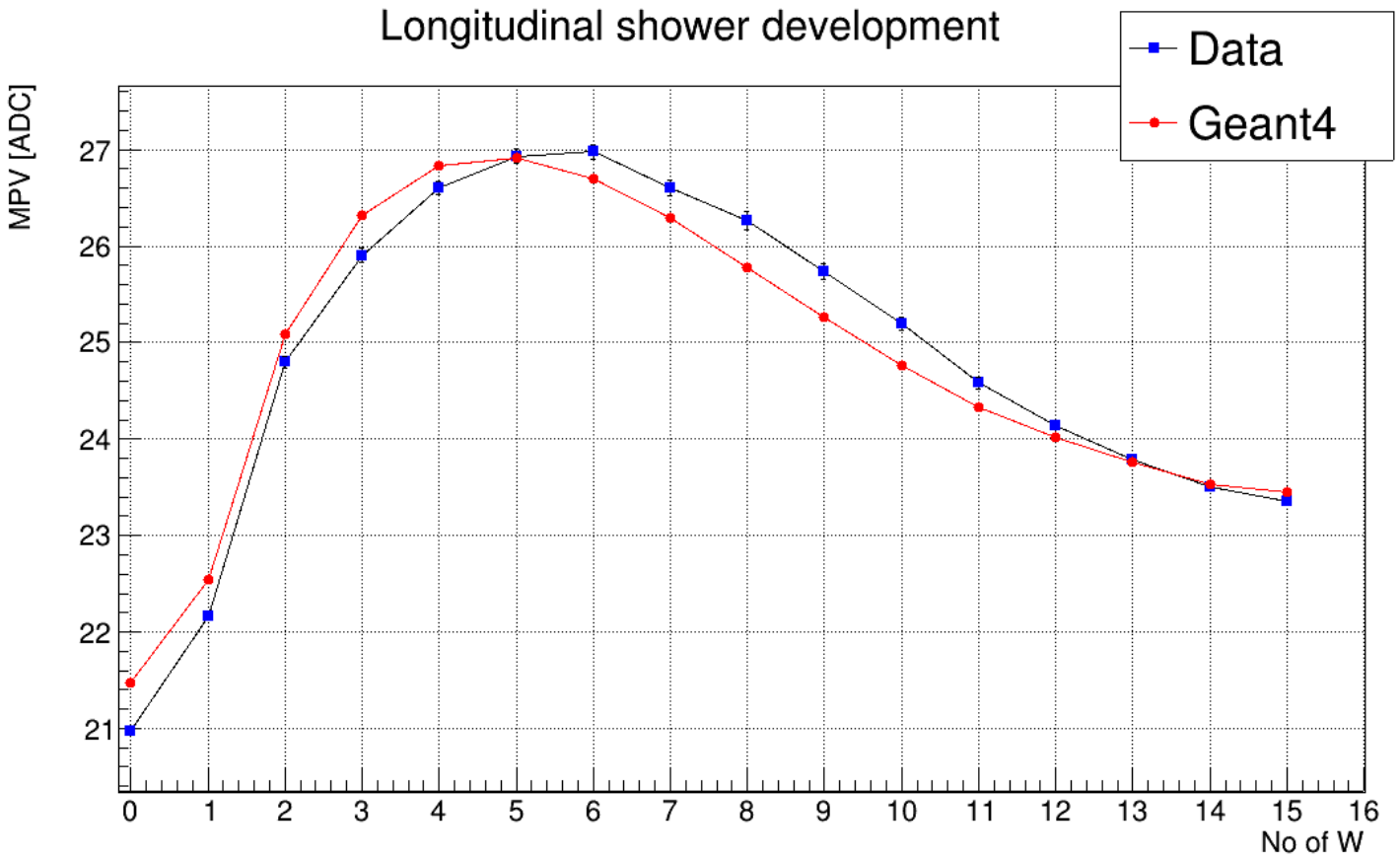
Simulations vs Data

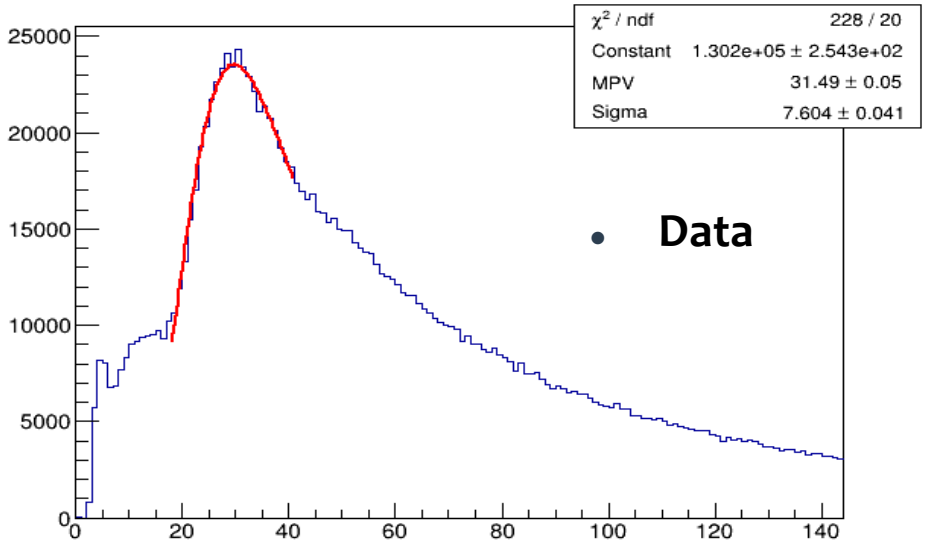
Si sensor – C74 + *n*W

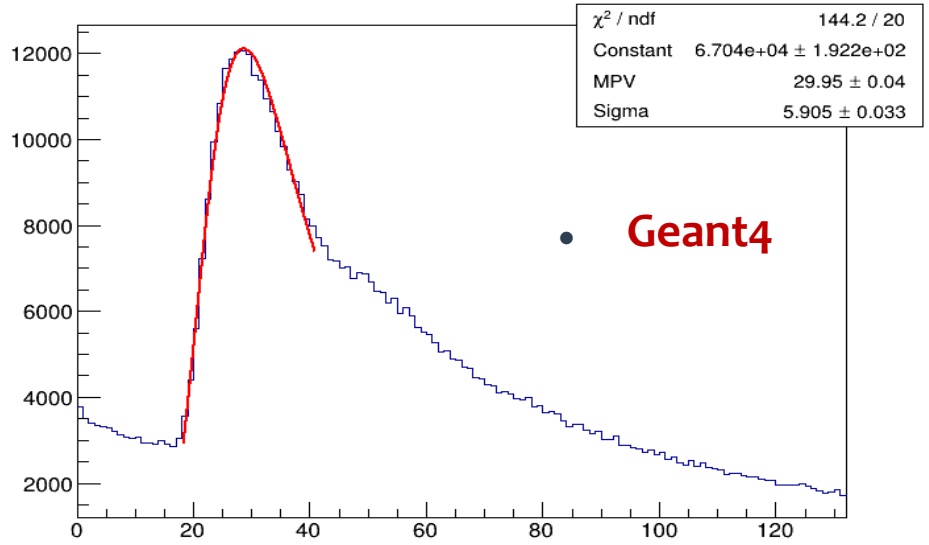
Energy deposition:

- C74 sensor with tungsten plates in front
- experimental data: **[run 4748 - run 4735]**

Physics list used:
FTFP_BERT_EMZ







Analysis - done and *to be done*

- evaluate each pad energy deposition
- fit the energy deposition histograms to get the MPV
- evaluate MPV for different setup configurations
- compare simulation results with data from test beam
- find the longitudinal shower distribution for different configurations (e.g. 1 to 15 W plates in front of sensor)
- *move beam position on x-y directions to compare with different runs*
- *add digitization of the signal*
- *telescope is only 1.5 cm height (compared to 4.5 cm Si or 5 cm GaAs) -> is this an explanation of empty events?*

Thank you!