TB 2022: Simulations & plans

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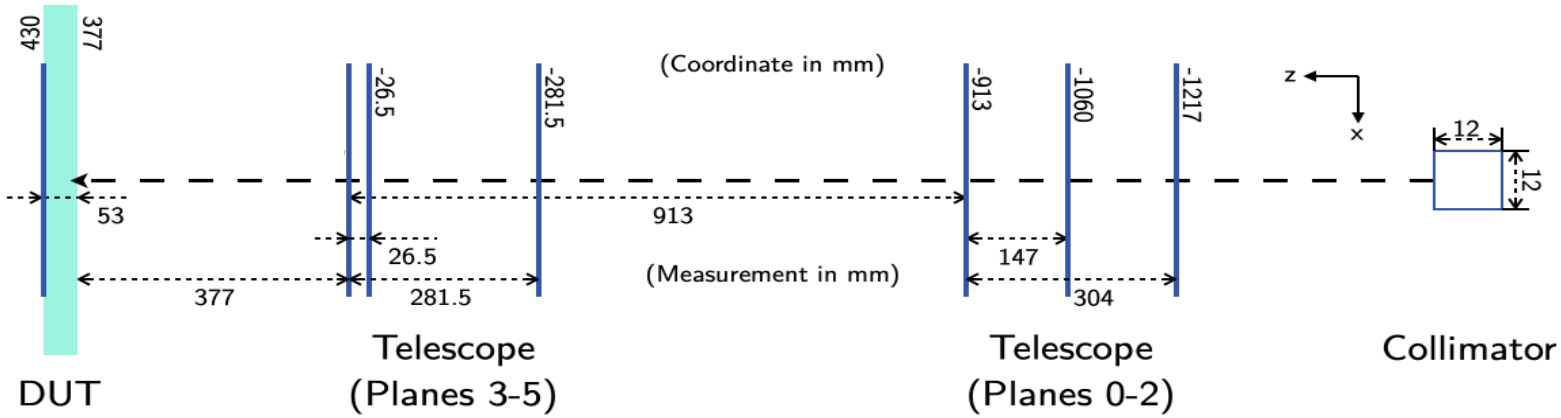
TB 2022: Geometry implementation in Geant4

2 case scenario: Anton1 (GaAs) & C74 (Si) sensors

- Simplest geometry
  - Sensor placed in 1st DUT slot
  - 6 telescope planes
  - all distances implemented as in test beam (thanks, Shan!)

goal: check energy deposition

- get energy deposited in each pad of sensor
- reconstruct hit map



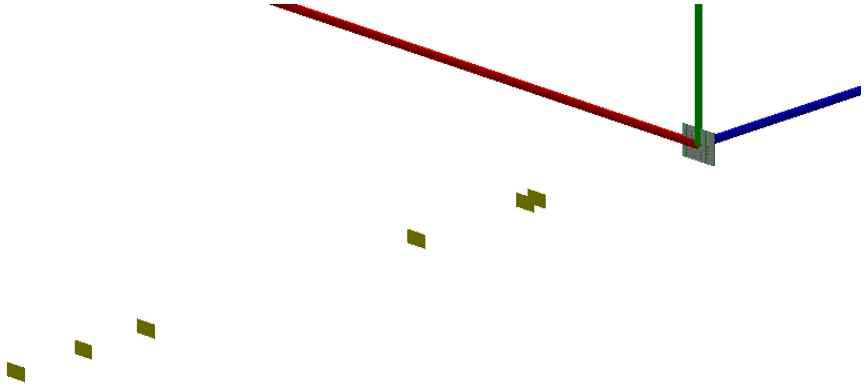
- **Ga-As sensor – Anton1**
  - Rectangular shape
  - X dimension: $\mathcal{L}$ = 4,7mm*15 (pad) + 0,3mm*14(gap) = 70,5mm + 4,2mm = 74,7 mm
  - Y dimension: ℓ = 4,7mm*10(pad) +0,3mm*9(gap) = 47mm + 2,7mm = 49,7 mm
  - **Thickness** 500 µm

- **Si sensor – C74**
  - **Squared shape: 18 cm x 18 cm**
  - **Separated in 1024 pads**
  - **Thickness**: 320 µm

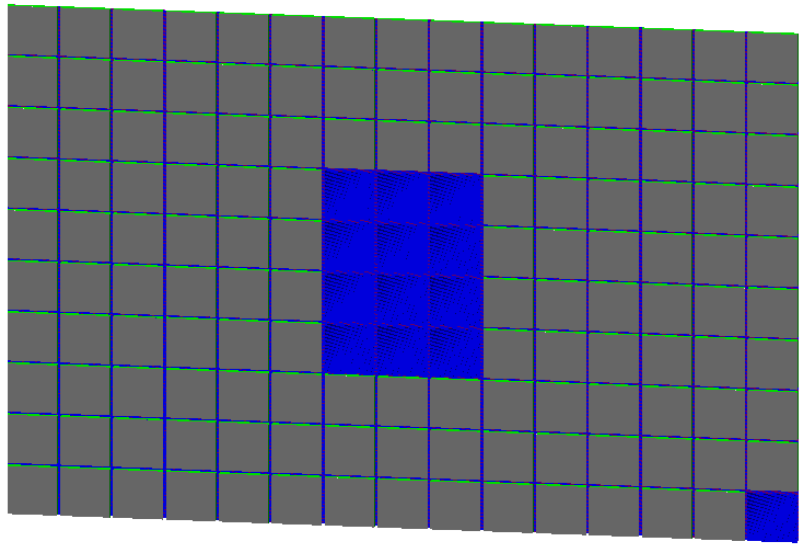
- **Physics list used: FTFP_BERT & FTFP_BIC**

TB 2022: Visualization

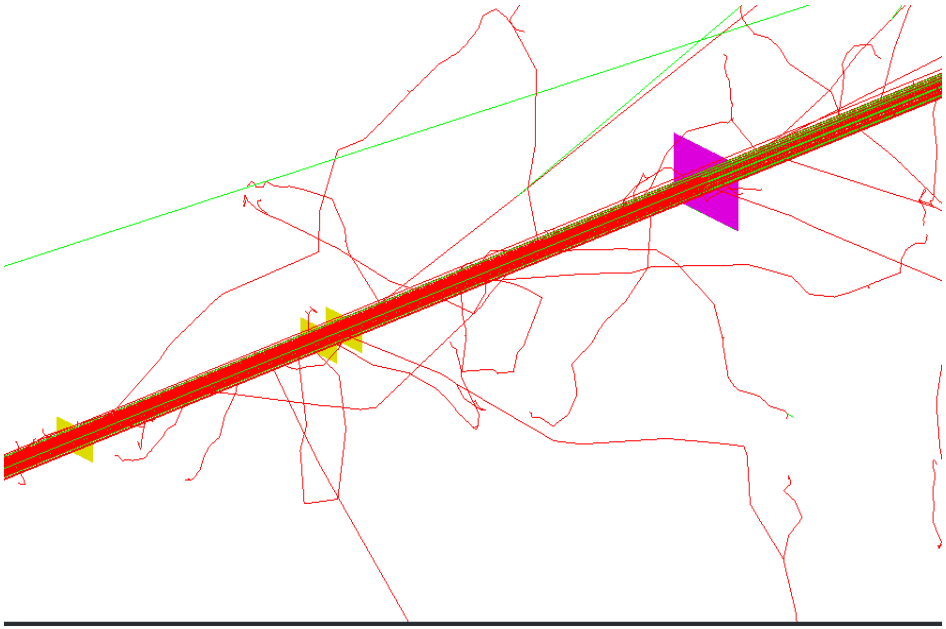
Test-beam setup

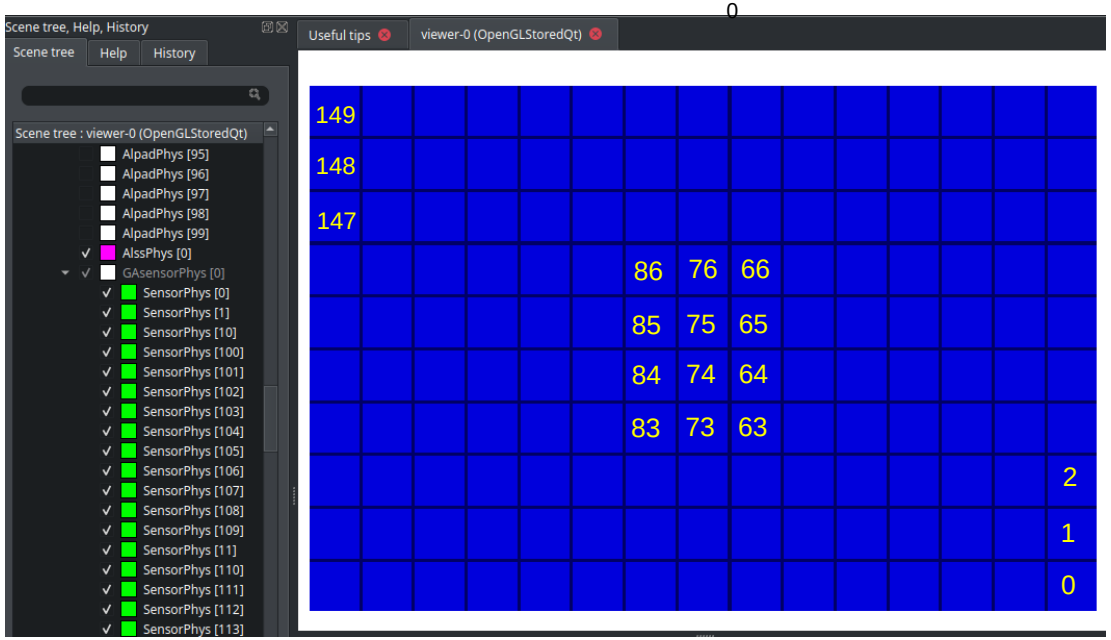


Anton1 sensor



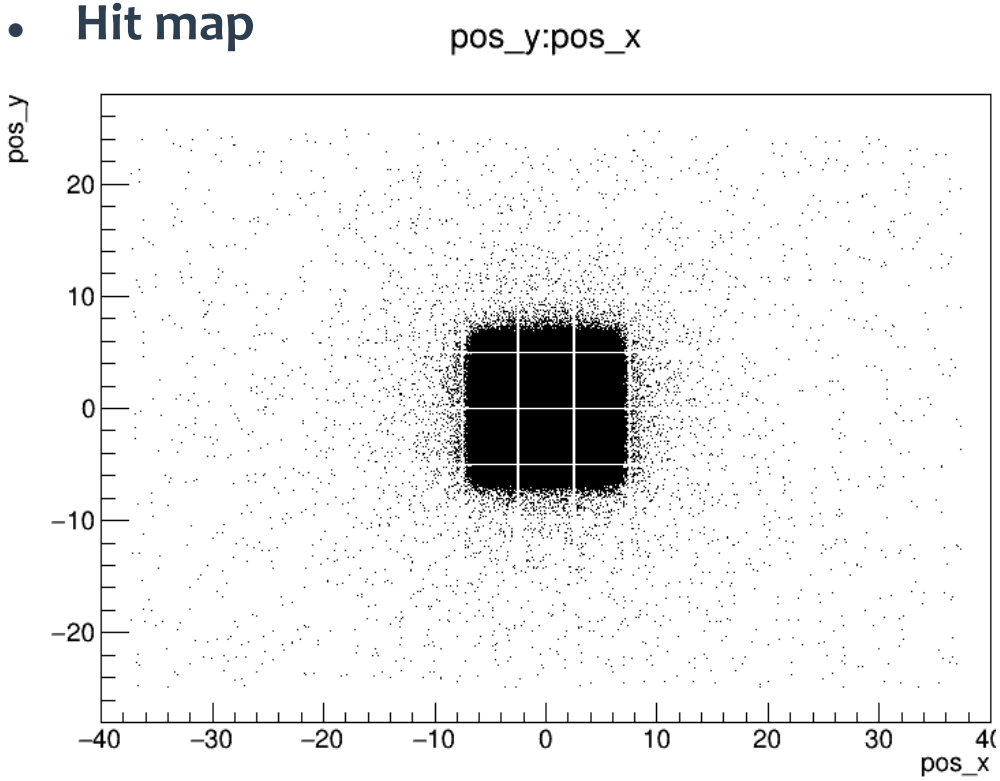
beamOn 100 events





TB 2022: Results - Anton1 sensor

- **Hit map**

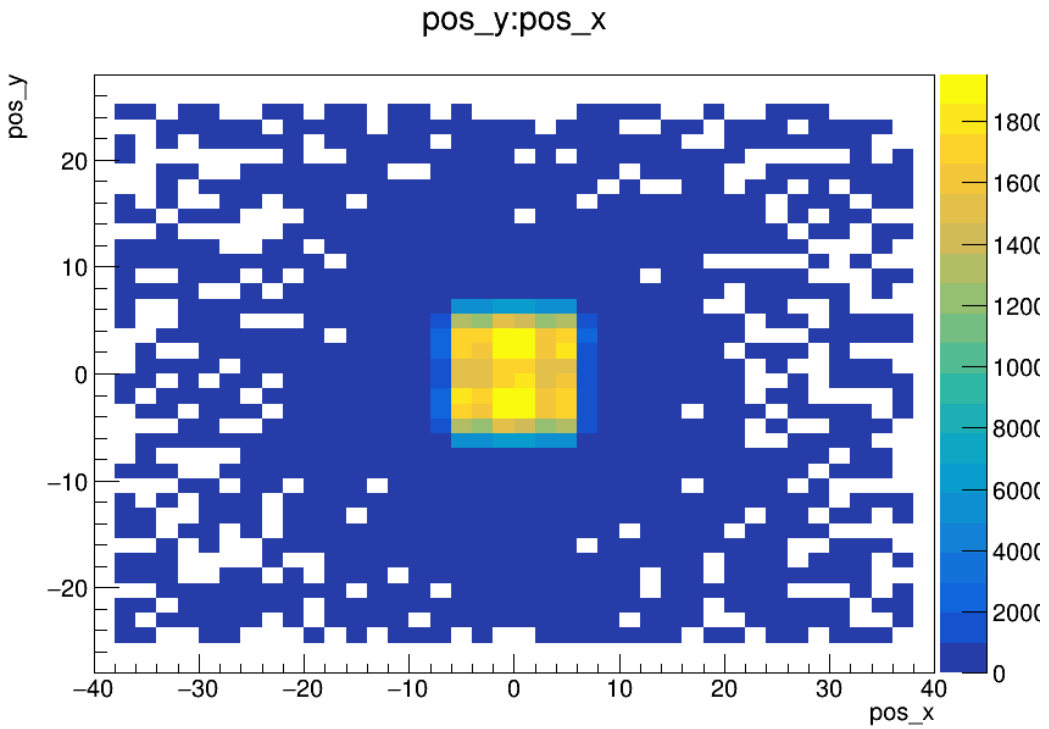


Simulation setup

- Primary particle: electron
- Primary particle energy: 5GeV
- Source type:
  - squared,
  - 12 mm x 12 mm
- Number of simulated events: 1 000 000

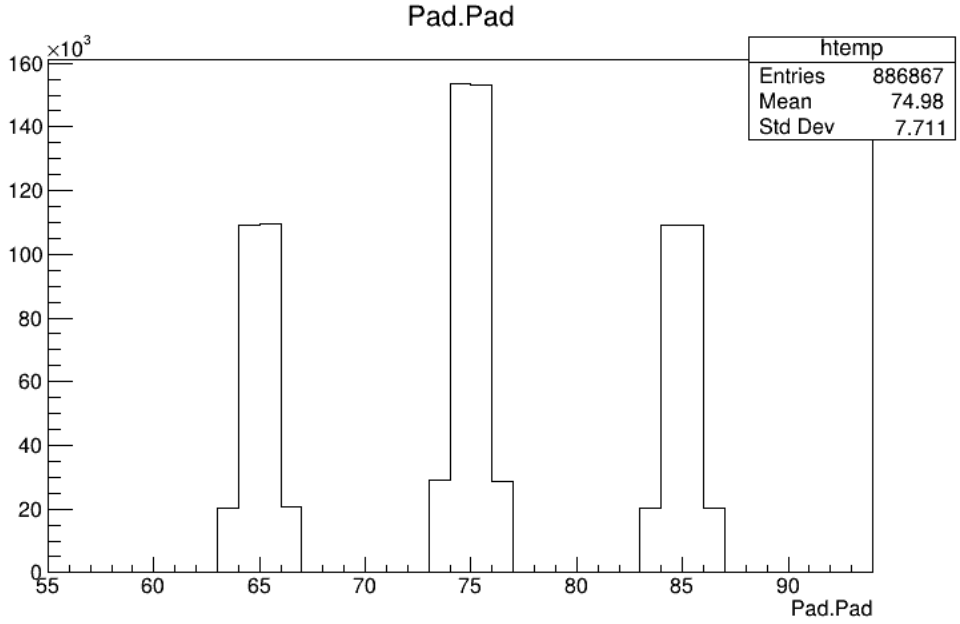
Hits registered position

- Squared shape
- Centered on pads 64, 65, 74, 75 , 84, 85



TB 2022: Results – Anton1 sensor

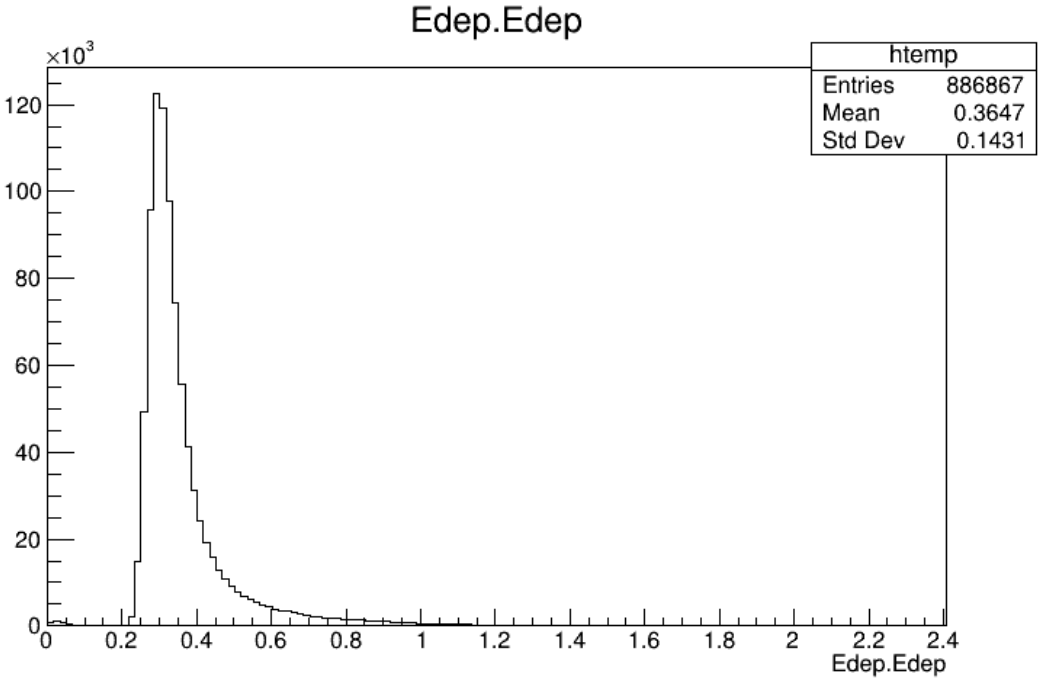
- **Pad hits**



Hits recorded in pads

- centered on 2 pads in a row
- hits in adjacent pads
-

- **Energy deposition**

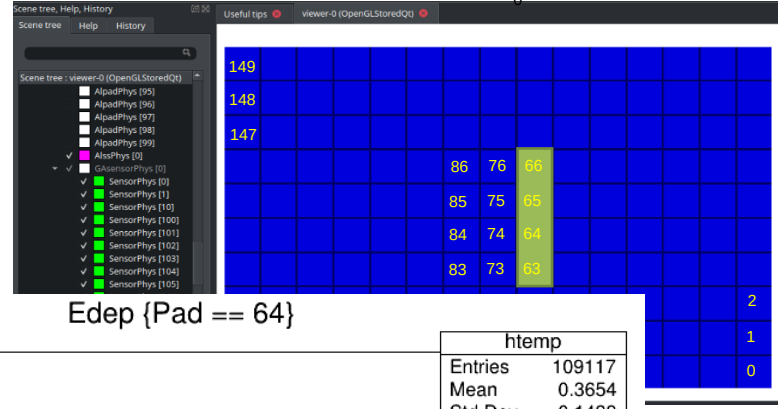


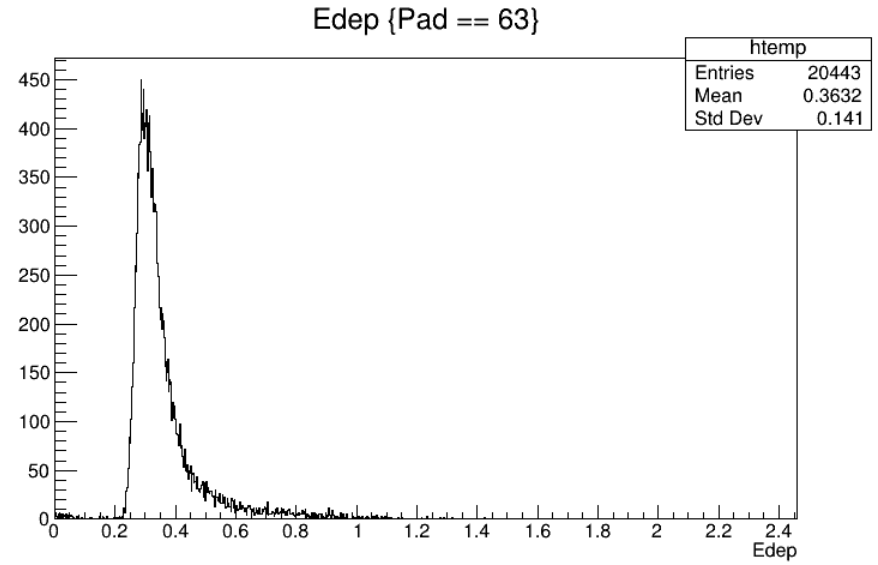
Total energy deposition

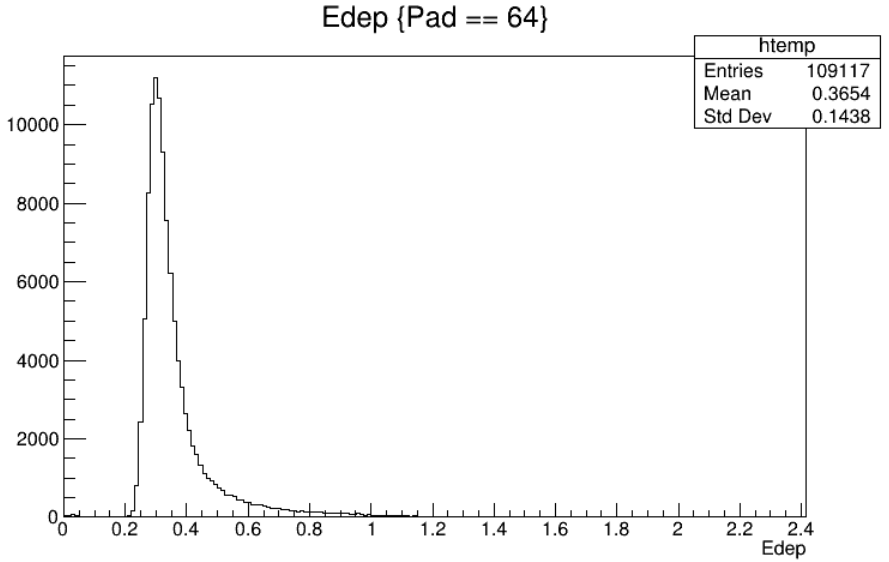
- Landau lookalike distribution

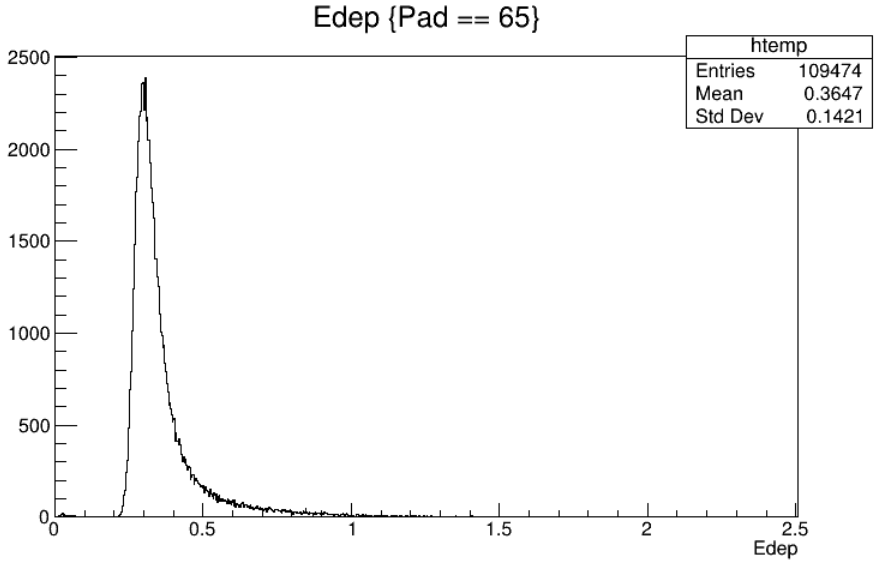
TB 2021: Results - Anton1 sensor

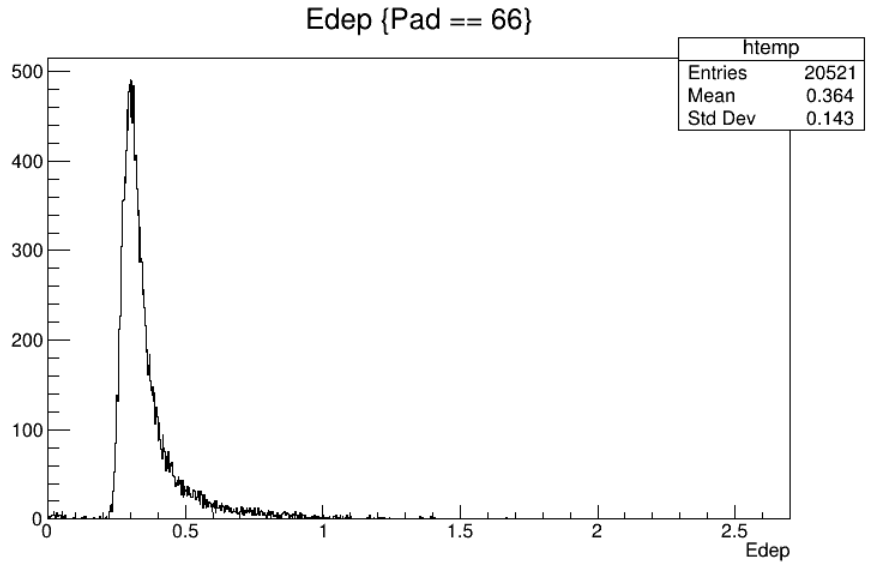
- Energy deposition on beam direction pads





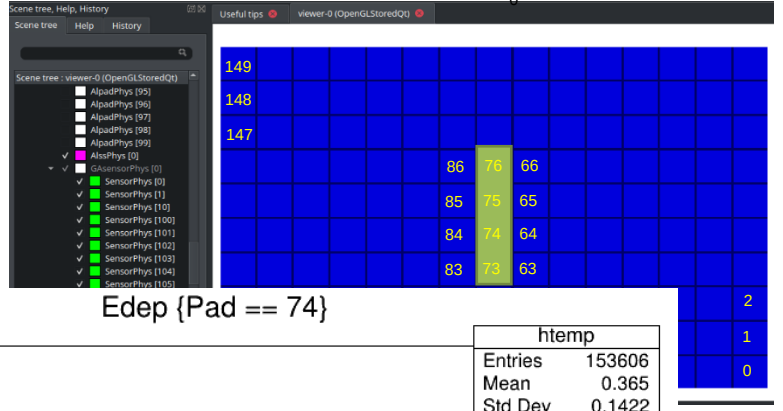


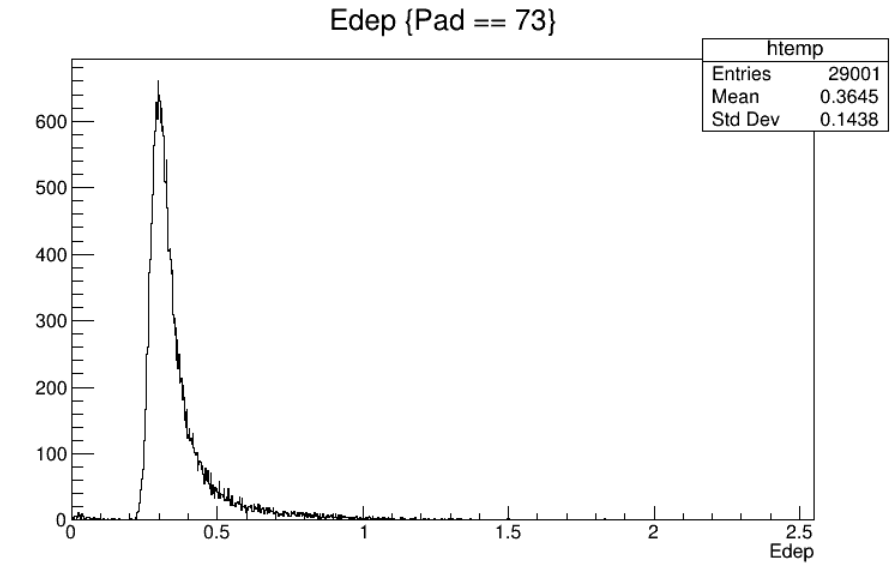


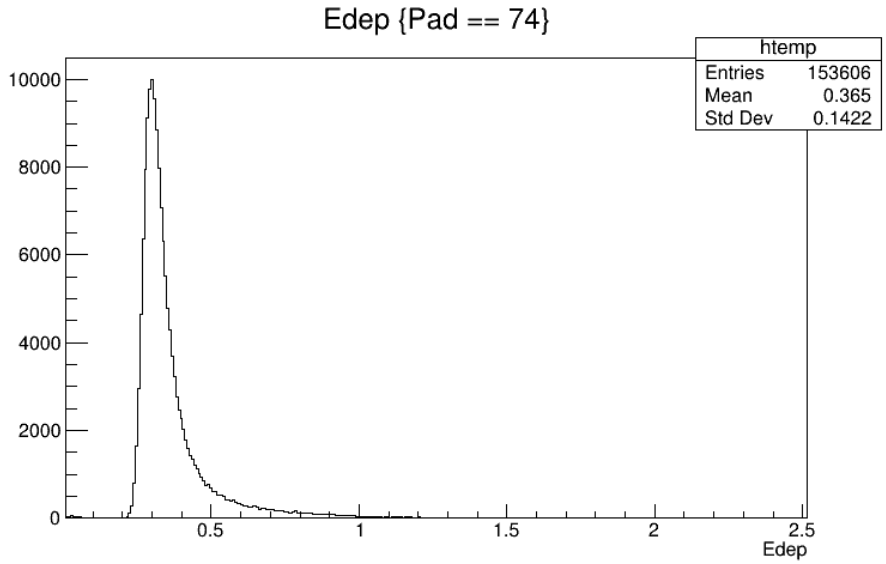


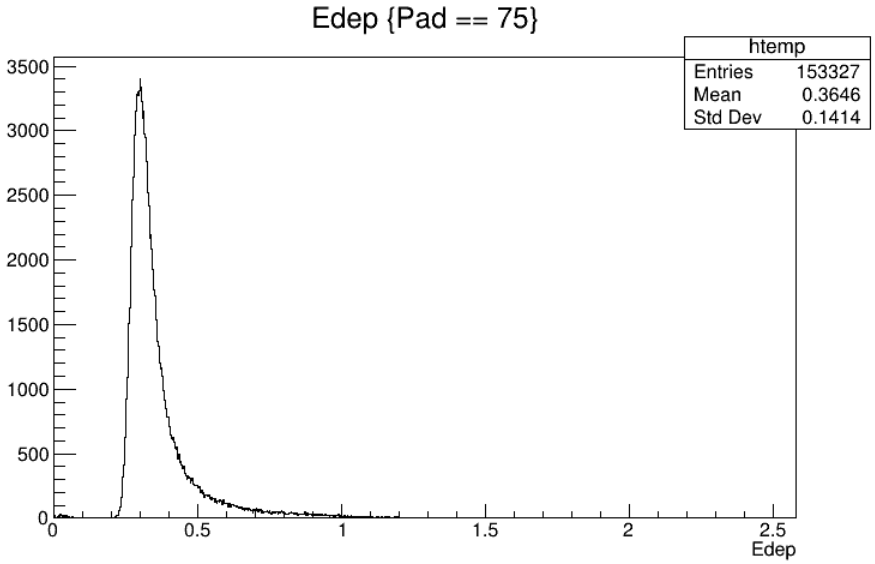
TB 2021: Results - Anton1 sensor

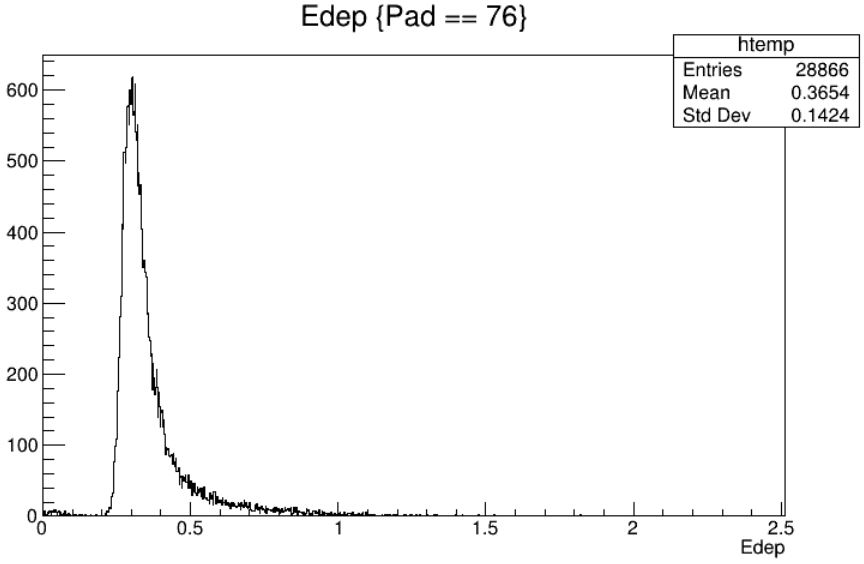
- **Energy deposition on beam direction pads**





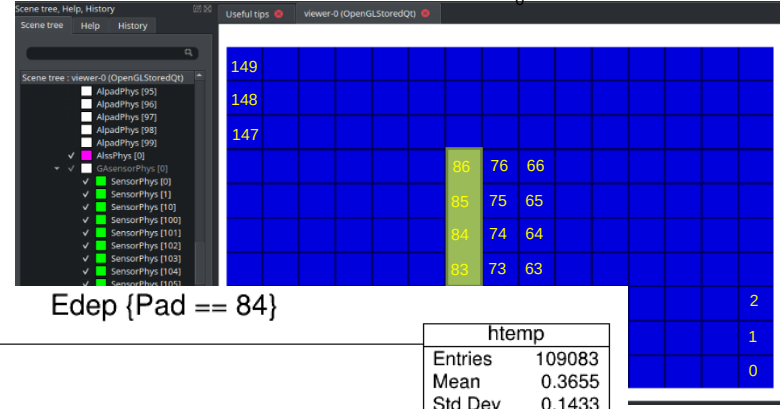


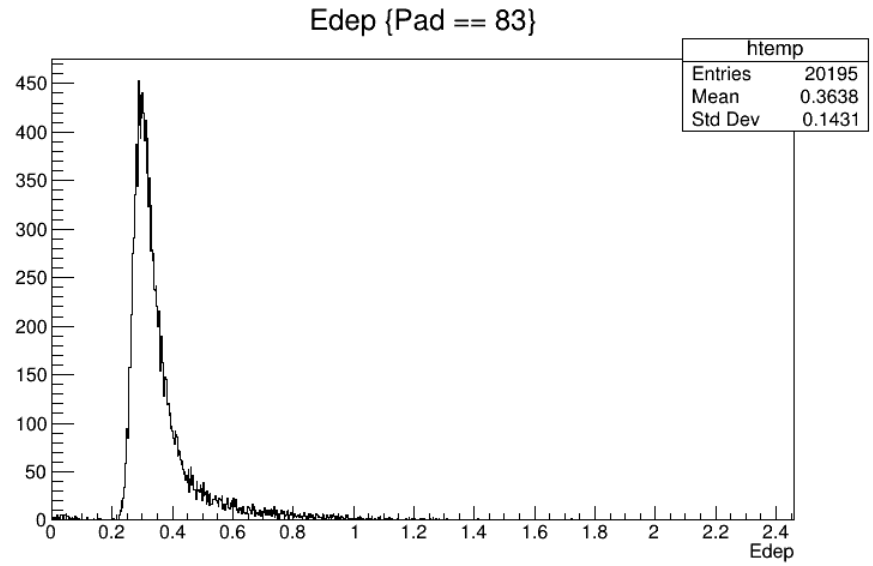


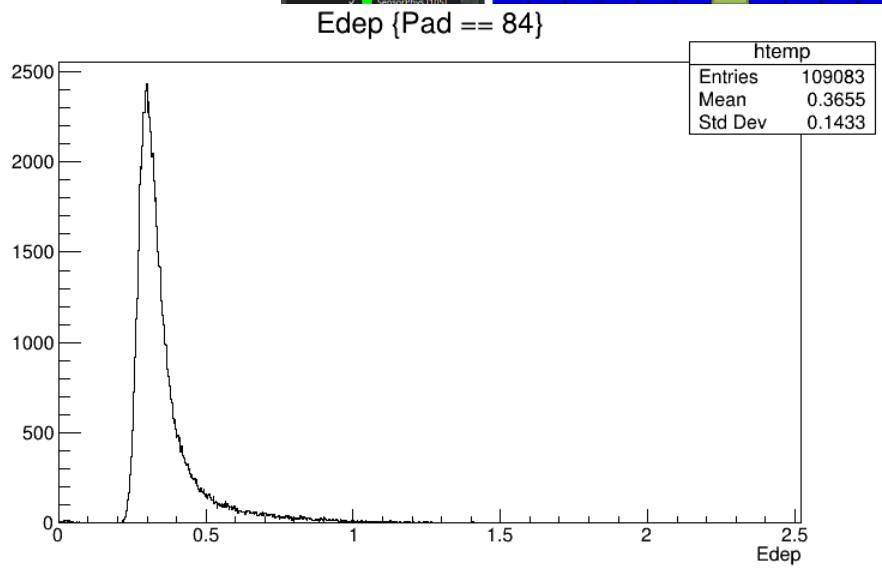


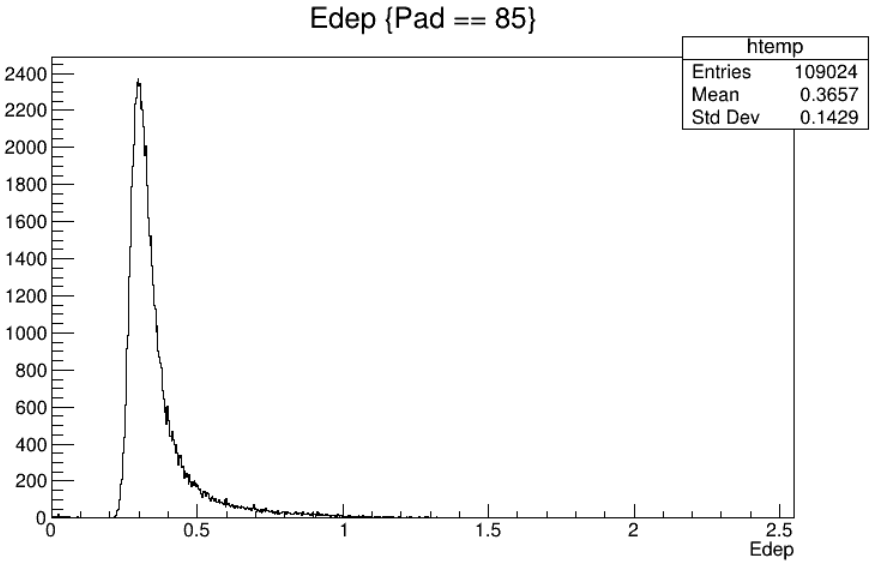
TB 2021: Results - Anton1 sensor

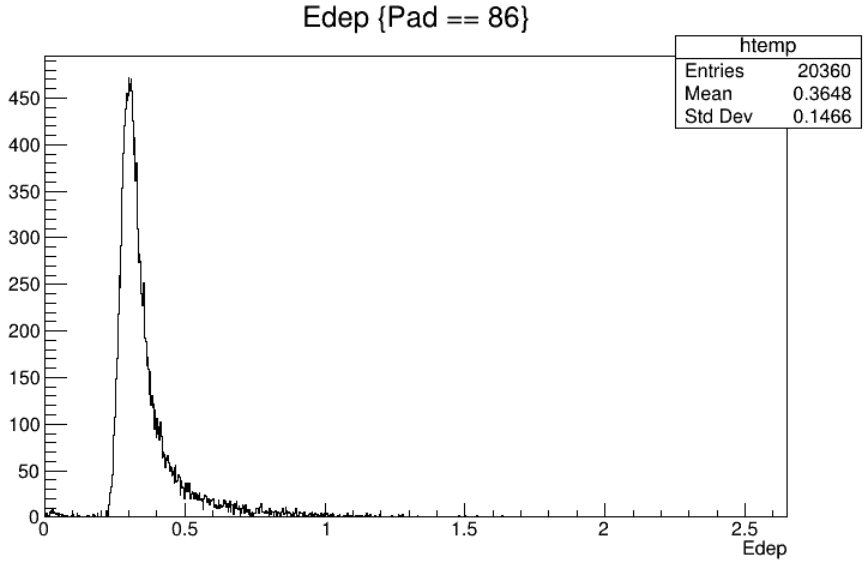
- Energy deposition on beam direction pads



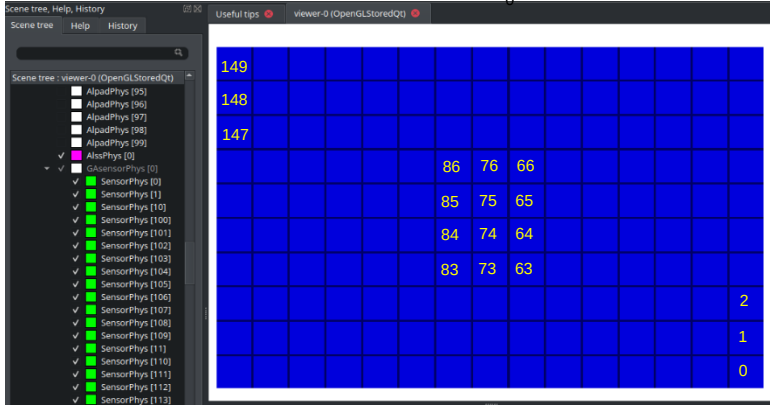




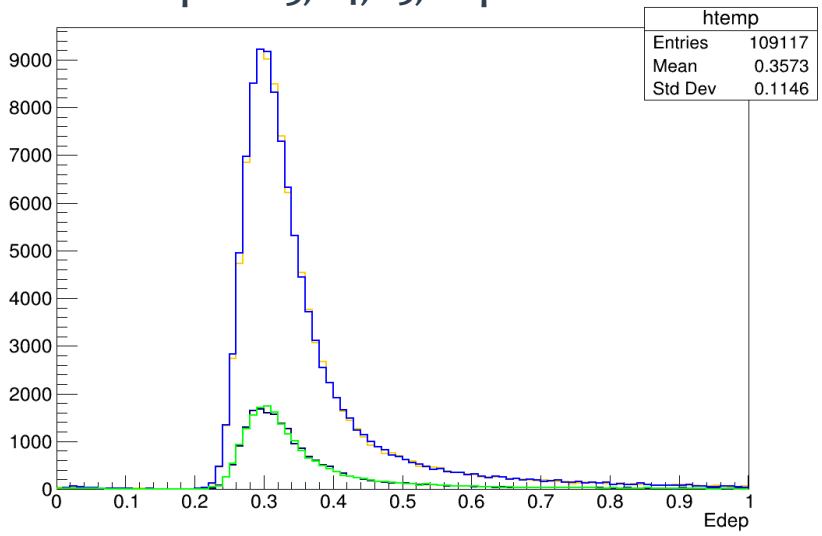




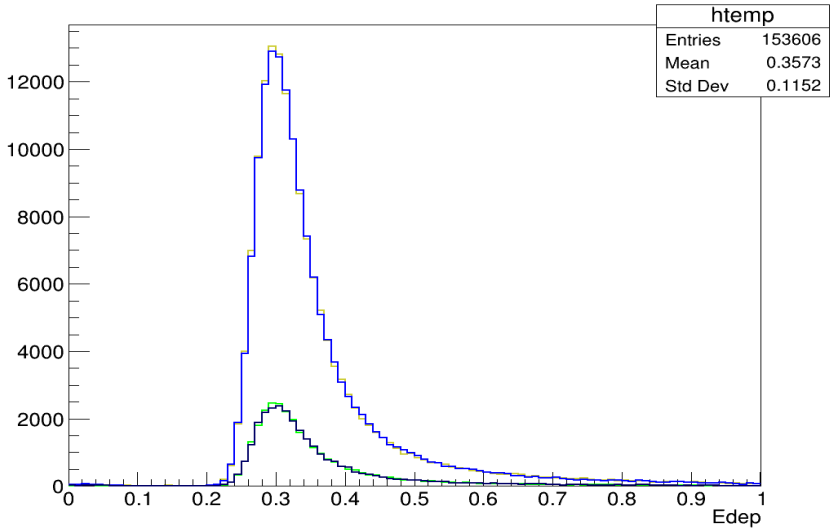
TB 2021: Results - Anton1 sensor



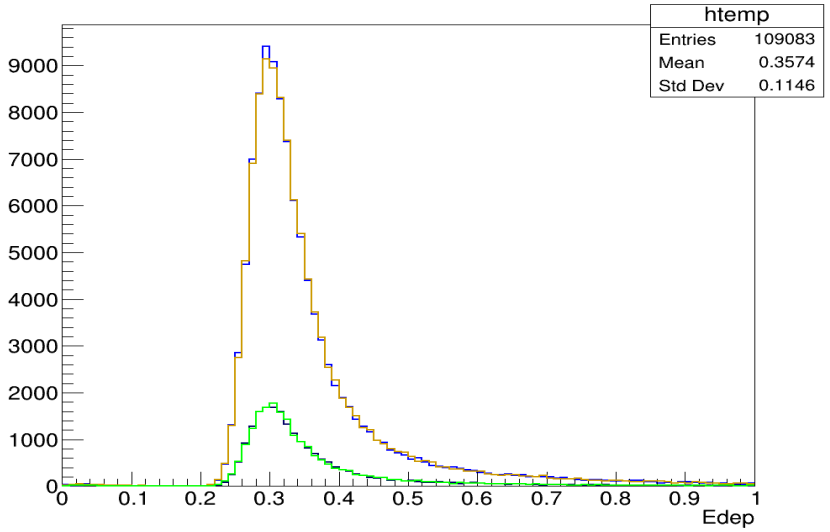
- **Energy deposition on beam direction pads**
  - Edep for 63, 64, 65, 66 pads



  - Edep for 73, 74, 75, 76 pads

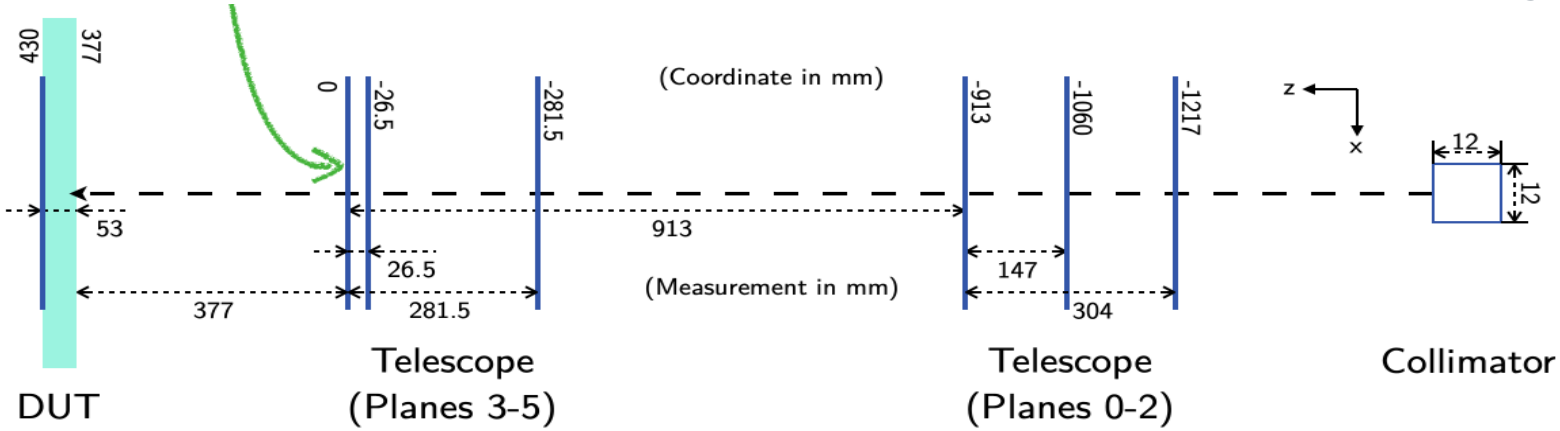


  - Edep for 83, 84, 85, 86 pads



TB 2022: Configurations

- **Geometry implementation in Geant4 - 10 experimental setups - 38 different configurations**



- Ga-As sensor – Anton1
  - 1 exp. setups without any W plates
    - Energies: 5 GeV c
- Ga-As sensor – Yan1
  - 1 exp. setup without W plates
    - Energies: 5 GeV
  - 1 exp. setup with 5 W plates
    - Energies: 1 GeV, 3 GeV, 5 GeV
  - 1 exp. setups with decreased no of plates 15 -> 1 W
    - Energies: 5 GeV
- Ga-As sensor – BeamCal
  - 1 exp. setups without any W plates
    - Energies: 5 GeV
- Si sensor – C72
  - 1 exp. setups without any W plates
    - Energies: 5 GeV
- Si sensor – C74
  - 1 exp. setups without any W plates
    - Energies: 5 GeV
  - 1 exp. setup with 5 W plates
    - Energies: 1 GeV, 3 GeV, 5 GeV
  - 1 exp. setups with decreased no of plates 15 -> 1 W
    - Energies: 5 GeV
- Si sensor – C72
  - 1 exp. setups without any W plates
    - Energies: 5 GeV

TB 2022: Configurations

- ## Geometry implementation in Geant4

General test-beam setup

- 38 different configurations
- expandable for whatever no we want without changing the code
- Easy customizable for future test beam configurations

```
for (( j=0; j < 10; j++ ))
  do
   #num=$((($i-1)*13+$j))
   num=$(($j*2+$i*10))
  let "runnum = $num"
  echo "/control/verbose 1" > "run_setup_"$num".mac"
  echo "/run/verbose 1" >> "run_setup_"$num".mac"
  echo "/event/verbose 0" >> "run_setup_"$num".mac"
  echo "/tracking/verbose 0" >> "run_setup_"$num".mac"
  echo "/process/verbose 0" >> "run_setup_"$num".mac"
  echo "/run/initialize" >> "run_setup_"$num".mac"
  echo "#set geometry"
  echo "/ecal/detector/setSensorType GaAs" >> "run_setup_"$num".mac"
  echo "/ecal/detector/setNoSensor 10" >> "run_setup_"$num".mac"
  echo "/ecal/detector/setNoW 10" >> "run_setup_"$num".mac"
  echo "/ecal/detector/setNoPads 0" >> "run_setup_"$num".mac"
  echo "/gps/run/setRunNumber "$runnum >> "run_setup_"$num".mac"
  echo "/gps/particle e-" >> "run_setup_"$num".mac"
  echo "/gps/ene/type Mono" >> "run_setup_"$num".mac"
  echo "/gps/ene/mono 5000 MeV" >> "run_setup_"$num".mac"
  echo "/gps/pos/type Plane" >> "run_setup_"$num".mac"
  echo "/gps/pos/shape Rectangle" >> "run_setup_"$num".mac"
  echo "/gps/pos/halfx 0.6 cm" >> "run_setup_"$num".mac"
  echo "/gps/pos/halfy 0.6 cm" >> "run_setup_"$num".mac"
  echo "/gps/pos/centre 0. 0. -327. cm" >> "run_setup_"$num".mac"
  echo "/gps/direction 0 0 1" >> "run_setup_"$num".mac"
  if [ $j -eq 10 ]
    then
        echo "/run/beamOn 1000000" >> "run_setup_"$num".mac"
  else
        echo "/run/beamOn 100000" >> "run_setup_"$num".mac"
  fi
  done
```

```
for ((i=0; i < 100; i++ ))
  do
   # echo "runset_setup_"$i".sh"
    for ((j=0; j < 10; j++ ))
      do
        num=$((($i-1)*2+$j))
        if [ $j -eq 1 ]
            then
                echo "./ecal run_setup_"$num".mac" >> "runset_setup_"$i".sh"
        else
                echo "./ecal run_setup_"$num".mac" >> "runset_setup_"$i".sh"
        fi
      done
```

.bash script *runset_setup_xxx.mac*

creates 10 runset_setup_xxx.sh files

each file starts 10 runs of 100 000 events

macro *run_setup_xxx.mac*

creates 10 files with simulations files

allow to customize runs without changing the Geant4 code

TB 2022: Future steps

- geometry
  - complete implementation of all type of sensors – Yan1, BeamCal, C72, C74
  - maybe telescope pixels for better tracking
  - re-numbering the pads to correspond to ones from real sensors
- physics list
  - check results with another physics list suggested by Geant4
  - start / stop hadronic processes to investigate their influence on results
  - implement specific physics list - one developed by Alina a few years ago for FCal
- analysis
  - 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)