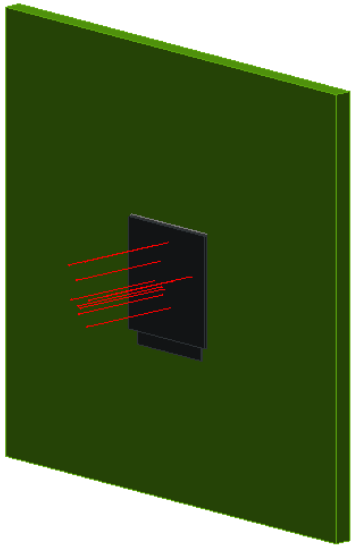
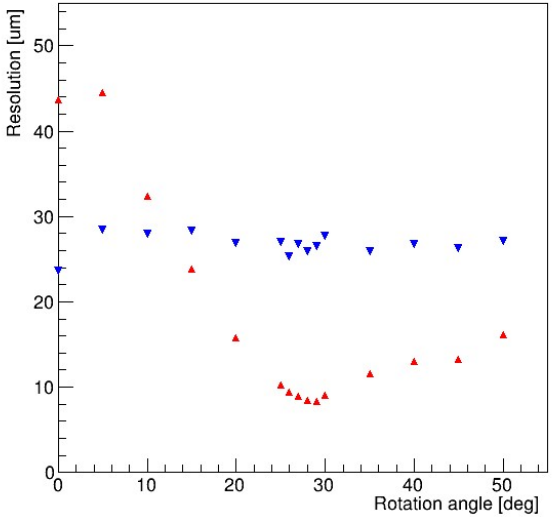
Exercise #20

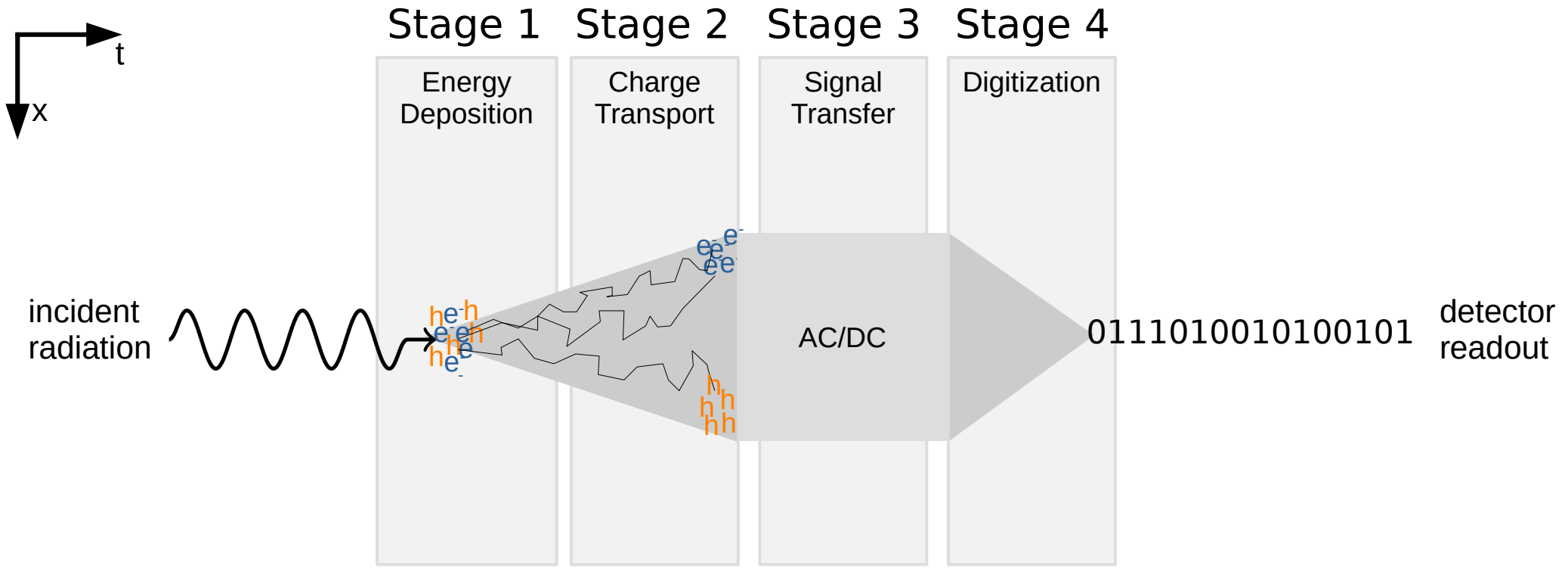
Monte Carlo Simulations of Silicon Pixel Detectors





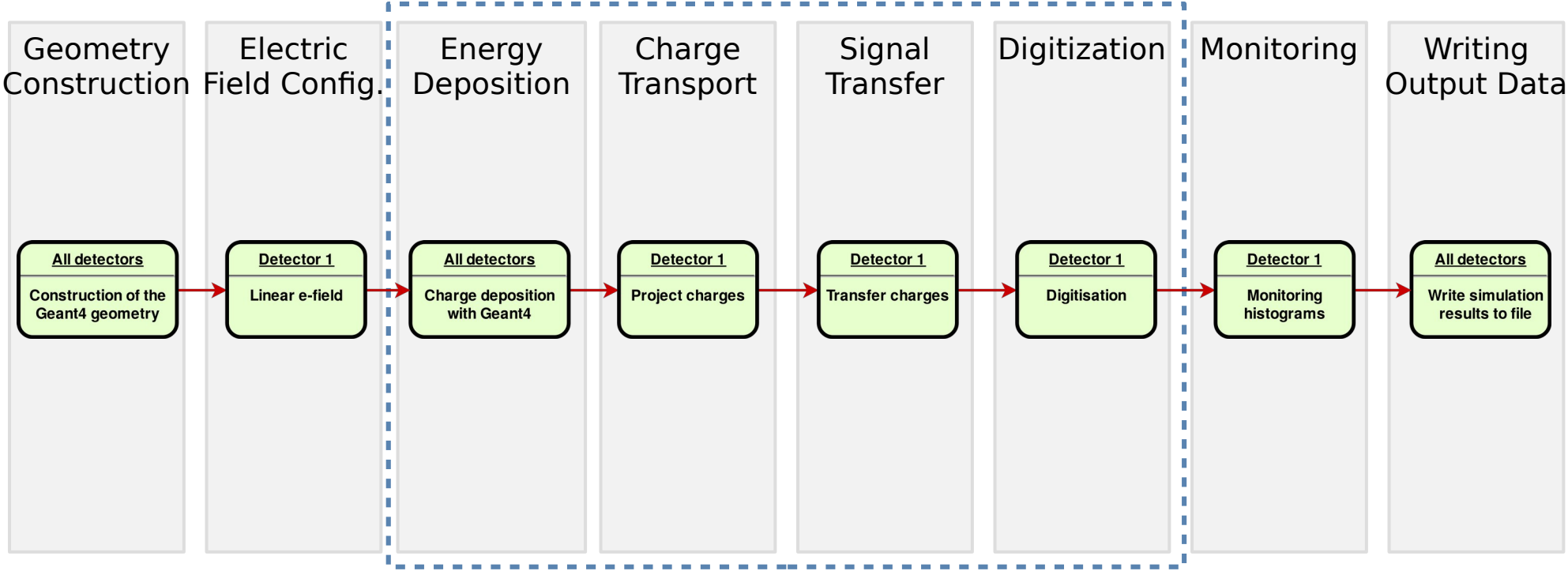
P. Schütze, S. Spannagel
CREMLINplus OC Meeting
22.02.2022

Particle Detection in Silicon Sensors



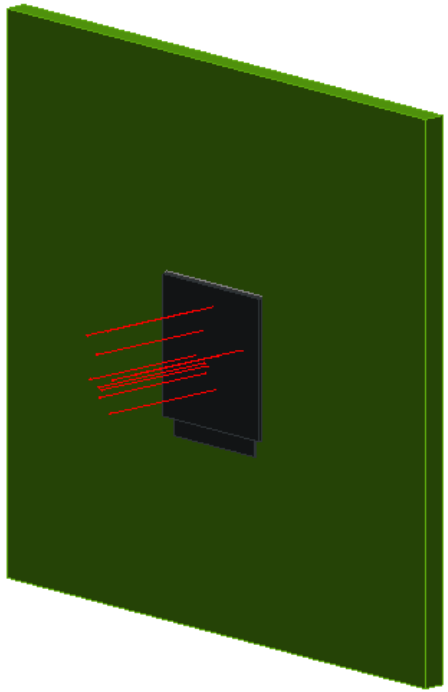
Monte Carlo Simulations – Allpix²

- Building blocks follow individual steps of the signal formation in detectors
- Available algorithms with different complexity can be chosen independently per step

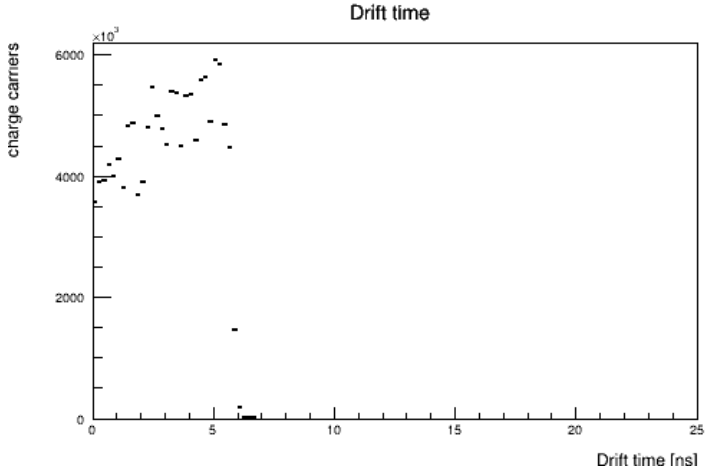


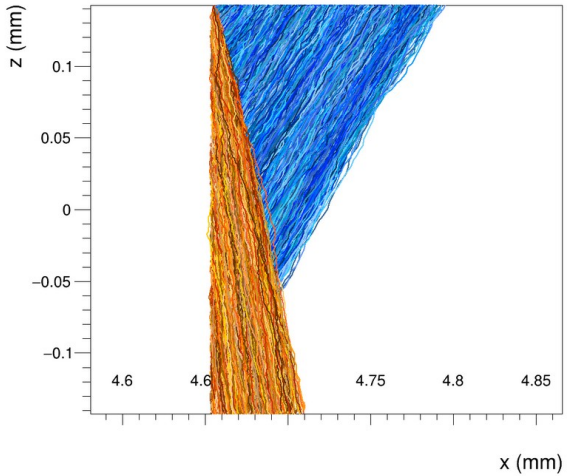
Exercise 20: Silicon Sensor Resolution

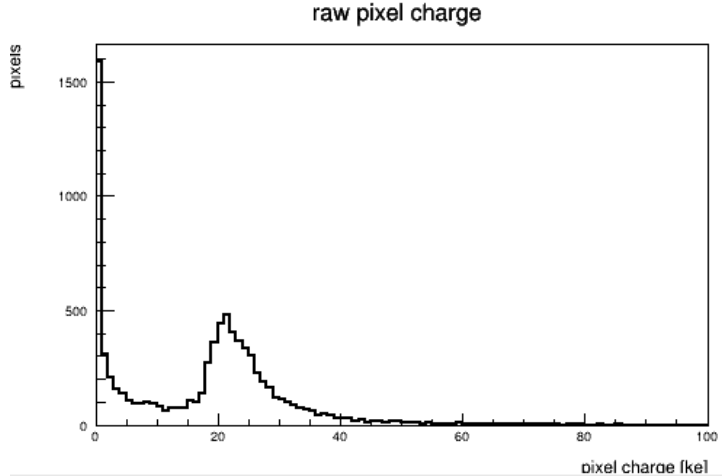
- Initial set of configuration files provided to participants
- Simulation of a CMS Pixel Detector prototype
  - Number of pixels: 52 x 80
  - Pixel pitch: 150 x 100 µm
- Particles: 5 GeV electron beam

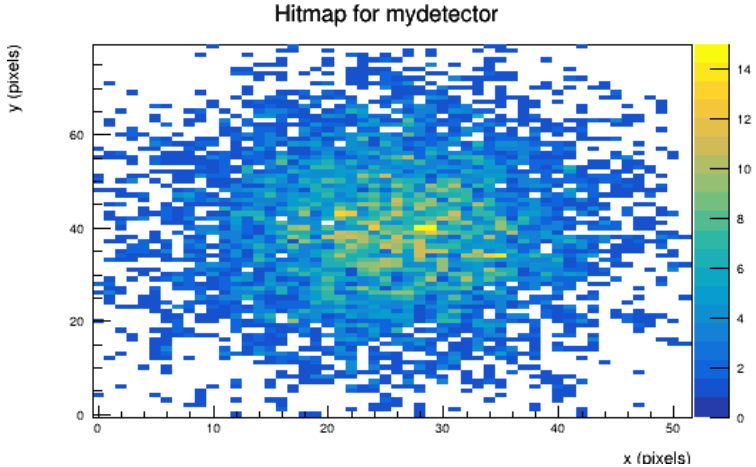


Exercise 20: Silicon Sensor Resolution

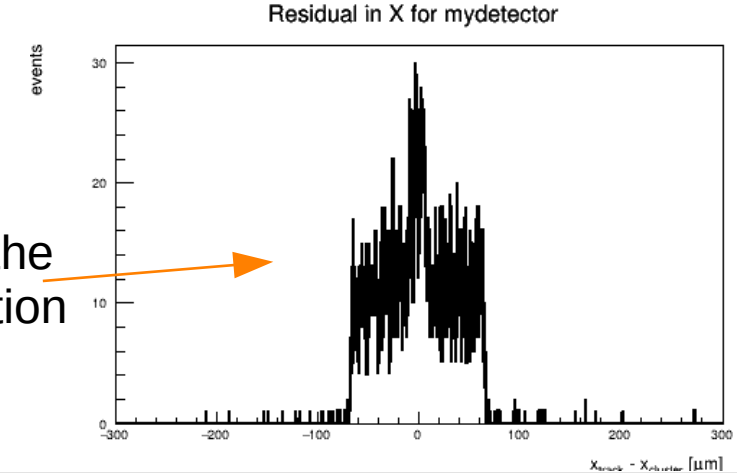








Determine the resolution

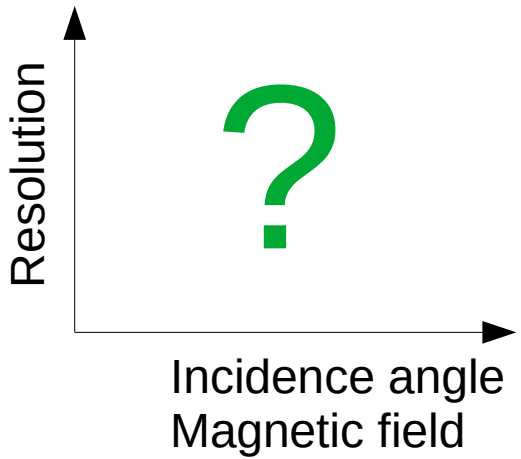


Exercise 20: Silicon Sensor Resolution

- Exercise: Determine the resolution and improve it by …
  - Switching from a binary to a charge sensitive readout (*qdc_resolution*)
  - Changing the incidence angle of particles (*orientataion*)
  - Changing the magnetic field (*magnetic_field*)

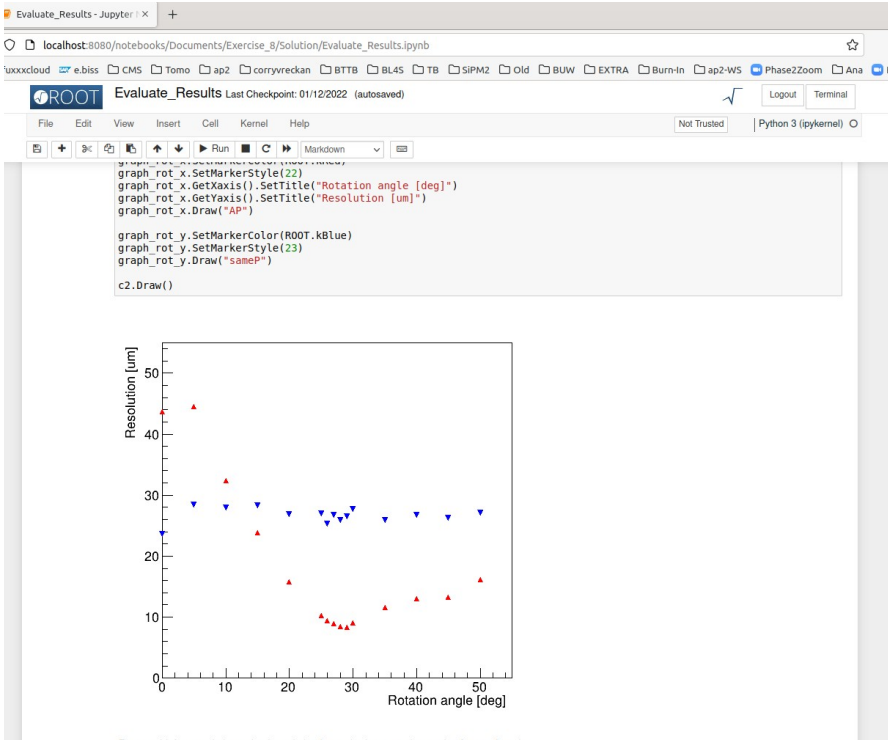
```
[DefaultDigitizer]
electronics_noise = 110e
threshold = 500e
threshold_smearing = 30e

qdc_smearing = 200e
qdc_slope = 200

qdc_resolution = 1

output_plots = true
output_plots_scale = 100ke
```

```
[mydetector]
type = "cmsp1"
position = 0mm 0mm 0mm
orientation = 0deg 0deg 0deg
```



Learning Achievements

- Functionality of silicon pixel detectors
  - Charge transport
  - Front-end
- Intrinsic resolution of silicon pixel detectors
  - Mechanisms to improve this resolution
- Computing:
  - Command line
  - Simulation software (Allpix², Geant4)
  - Analysis (ROOT, python)



Technical Realisation

- Allpix² installation required
- Several options:
  - ~~Local installation per student~~
  - Distribution of a virtual machine
  - Installation on CVMFS (reachable e.g. via lxplus → require access)
  - Preparation of available PCs