Background Simulations

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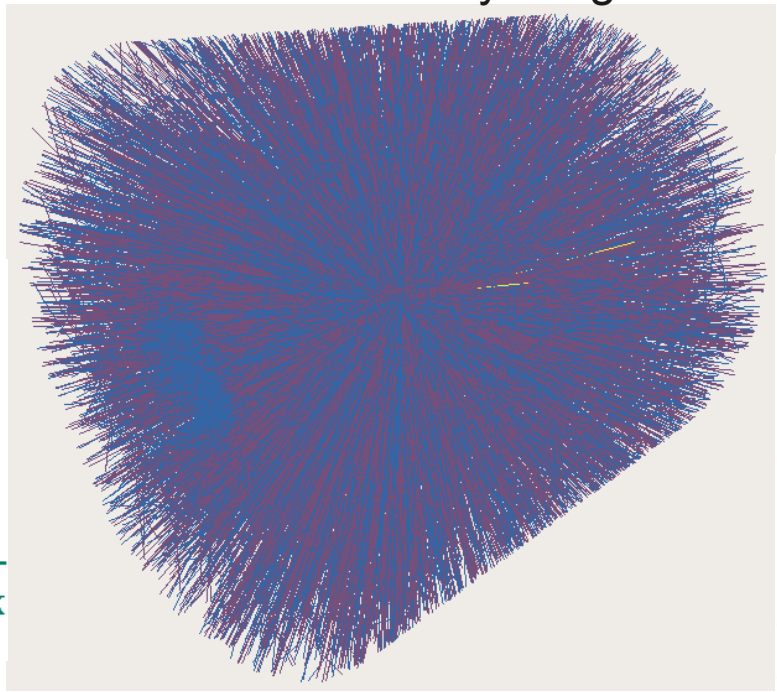
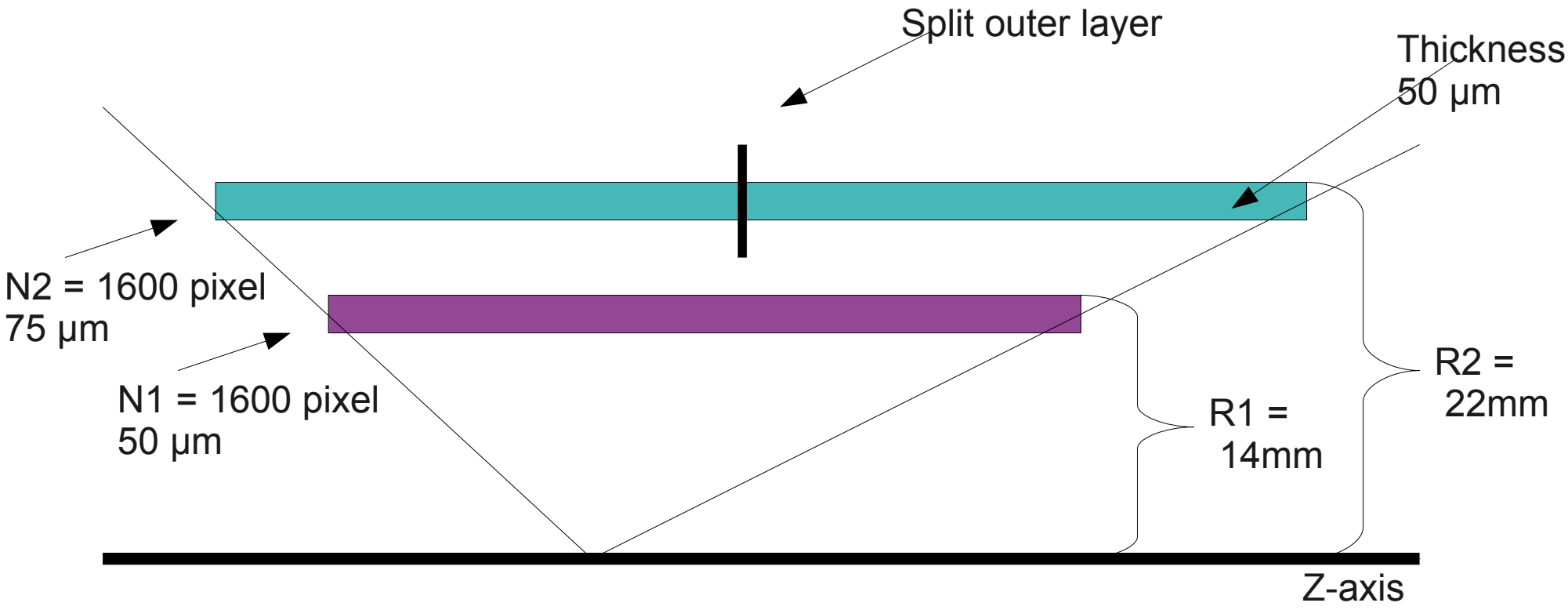


Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

Excellence Cluster
Universe

- Goals & Concept
- Implementation
- Results
- Summary & Outlook

- Performance of the PXD with Background?
- Which noise level is still tolerable?
- Reduction of readout time → increased pixel size
- Elongation of the readout time → decreased pixel size

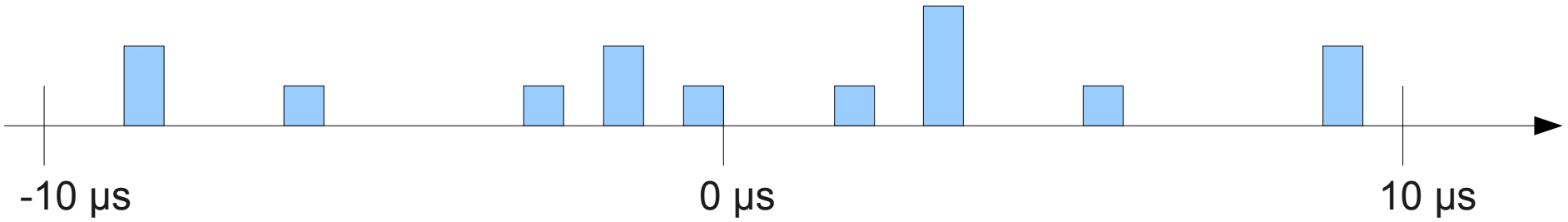

Split outer layer
Thickness
50 µm
N2 = 1600 pixel
75 µm
N1 = 1600 pixel
50 µm
R1 =
14mm
R2 =
22mm
Z-axis

- Sources of Background
  - Physics Background (see talks Christian Kiesling)
  - Machine Background
  - Electronics noise

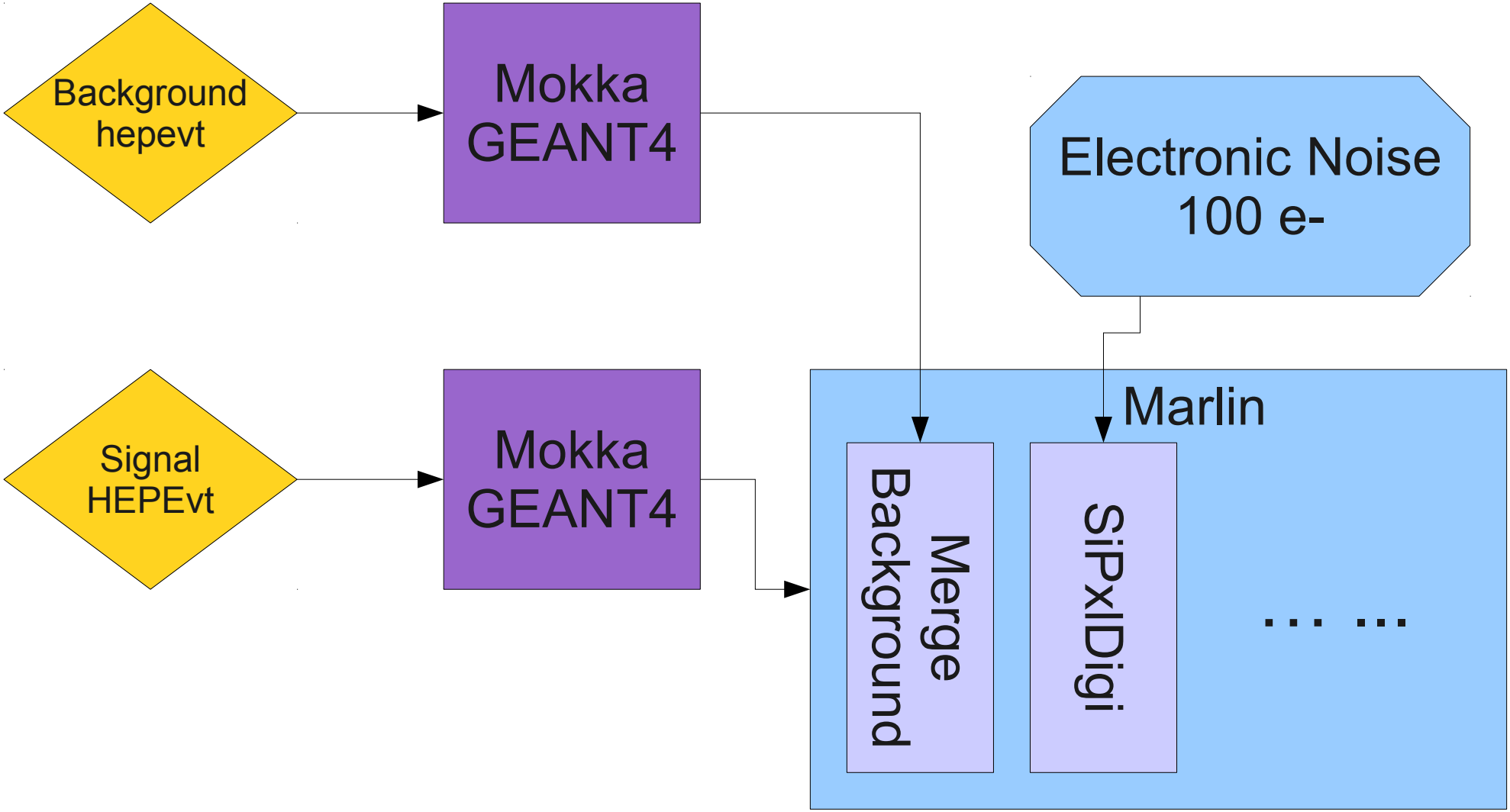
- Physics Background
  - Event generator (KoralW)
  - Full Geant4 simulation
  - Timed to the bunch crossing

- Electronic noise
  - Implementation in the PXD digitizer

- Integration time of the PXD with 1600 pixel ~ 20 µs
- Event generator KoralW: 5000 tracks in acceptance
- Event distribution according to bunch crossing time
  - Poisson distributed events
- Gaussian smearing in time (around bunch crossings)
- Gaussian smearing of the interaction point (IP)



- Introduction of lund7 hepevt file format
  - Can handle timestamps
- Modification to Mokka to keep timestamp
- SimTrackerHits including timestamp → Digitizers


Background
hepevt
Mokka
GEANT4
Electronic Noise
100 e-
Signal
HEPEvt
Mokka
GEANT4
Marlin
Merge
Background
SiPxlDigi
... ...

- Modification to the digitzier
  - 100 electron noise is assumed
  - Electronic noise digits (energy depositions in the pixels) are generated
  - Digits are generated from the signal and the background physics

- Modifications to the clusterizer
  - Clusters are build from all digits
  - Seed pixel requires 5 times the noise
  - Joined pixel is requires 3 times the noise

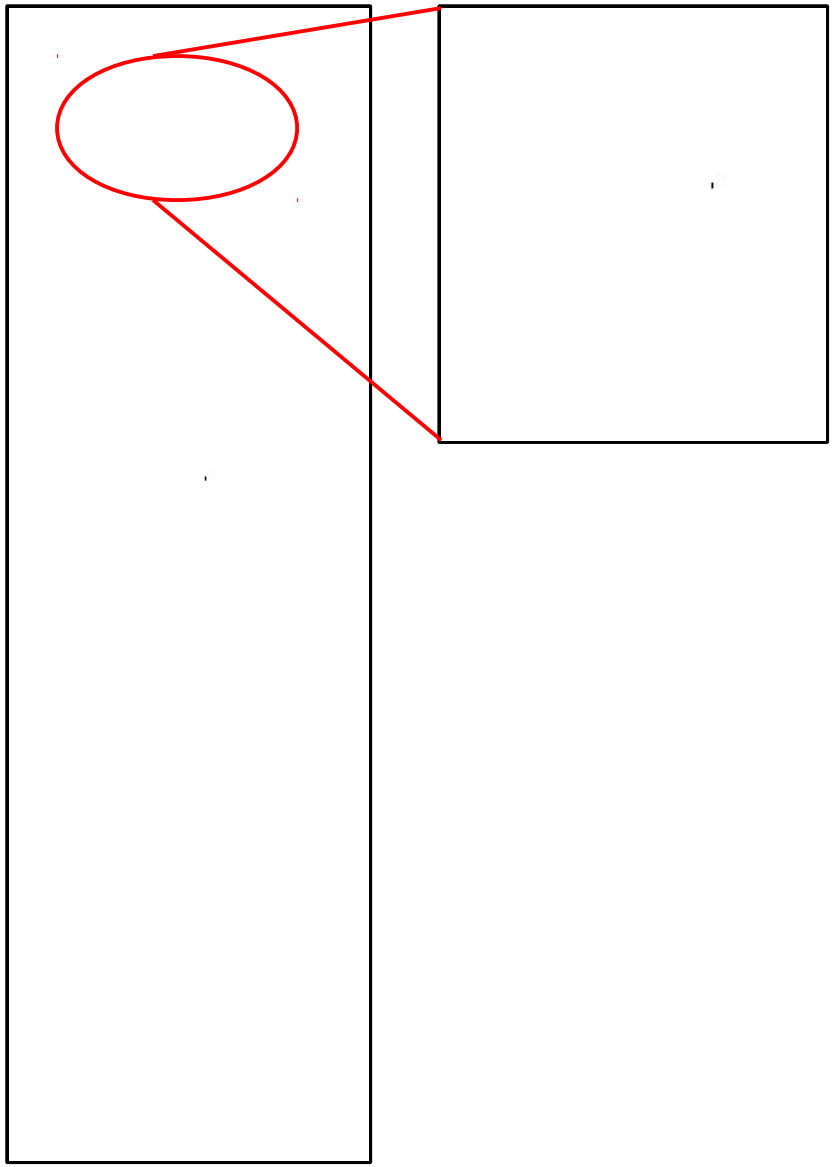
→ More information see talk of Zbynek Drasal

- Introducing time cuts

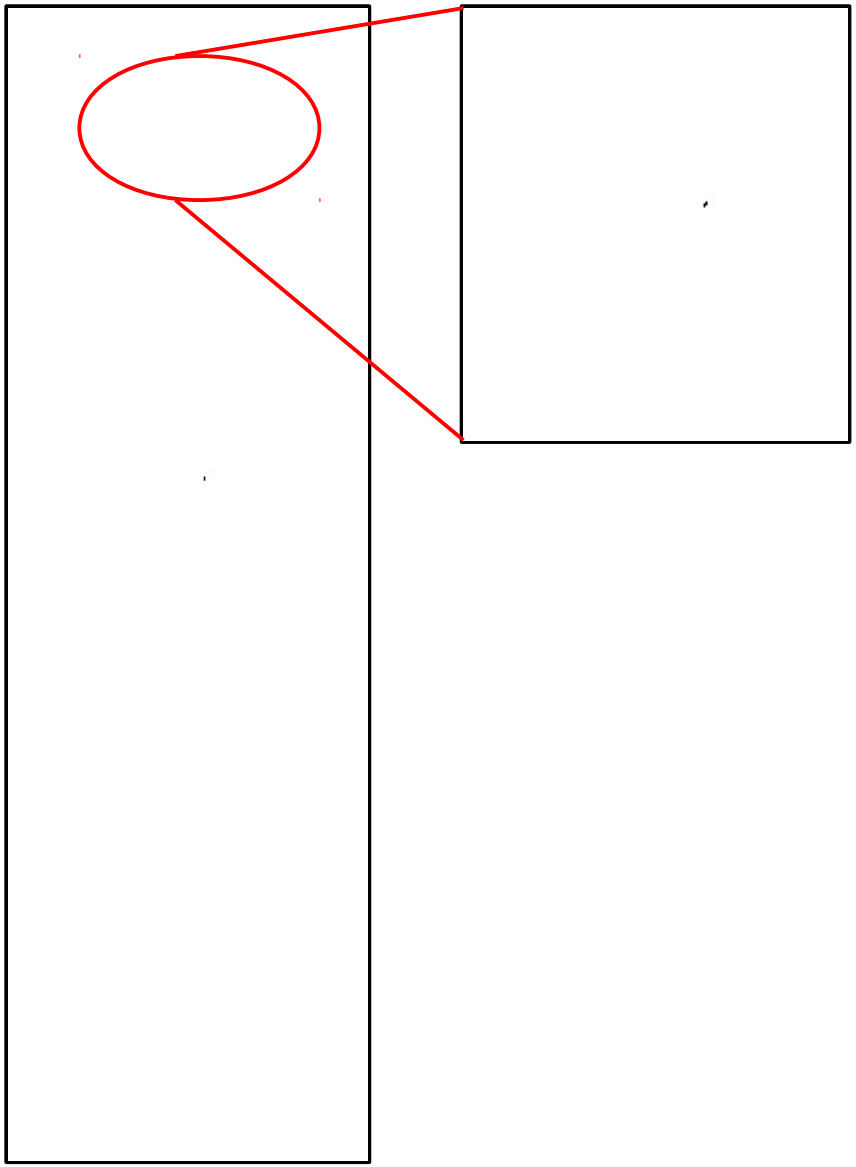
- PXD Digitizer
  - 20 000 ns integration time
- SVD Digitizter
  - 20 ns integration time
- CDC Digitizer
  - 200 ns integration time

Baseline no noise no background

Layer 0

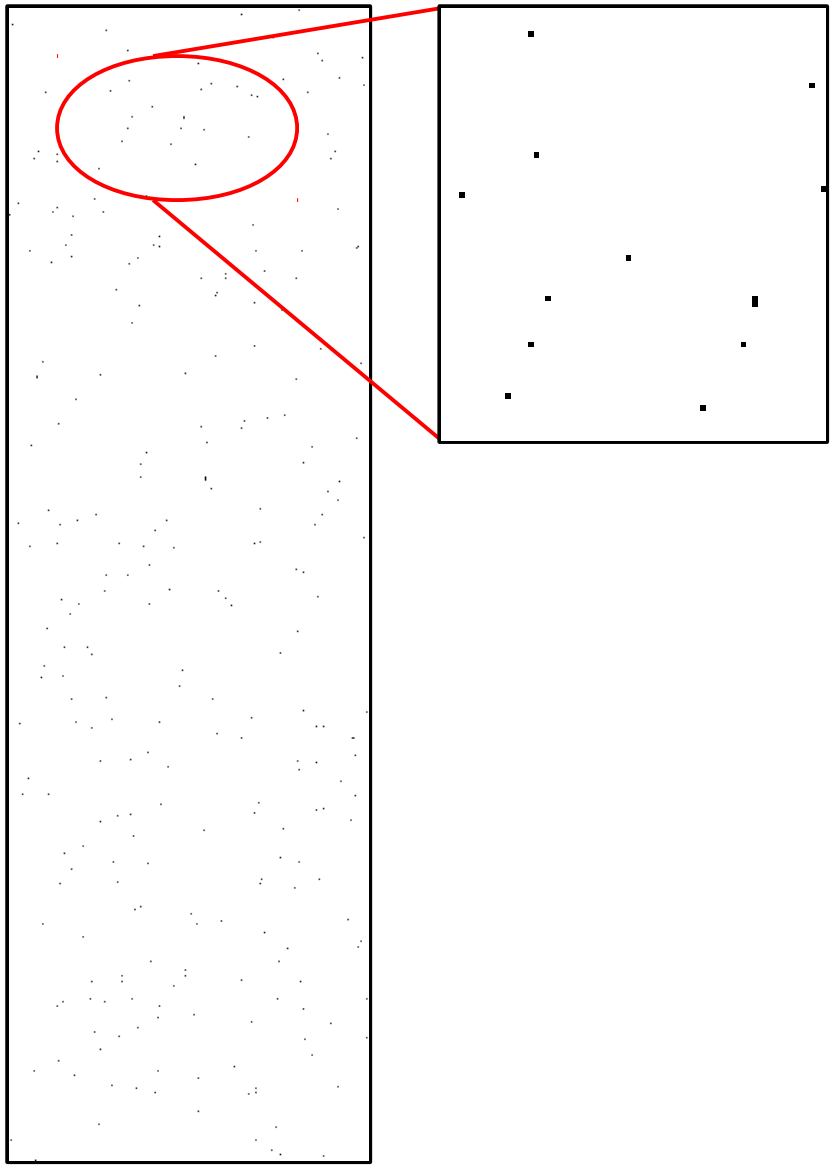


Layer 1

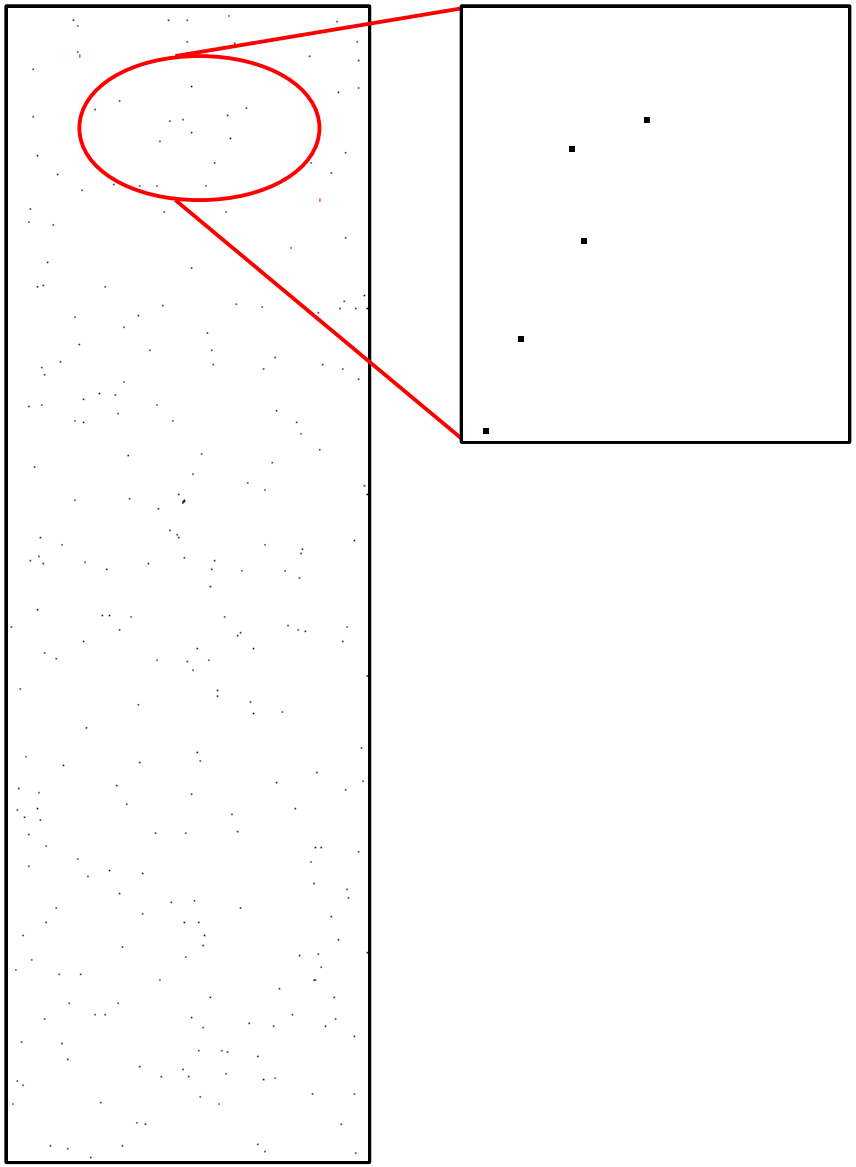


Baseline with Noise no Background

Layer 0

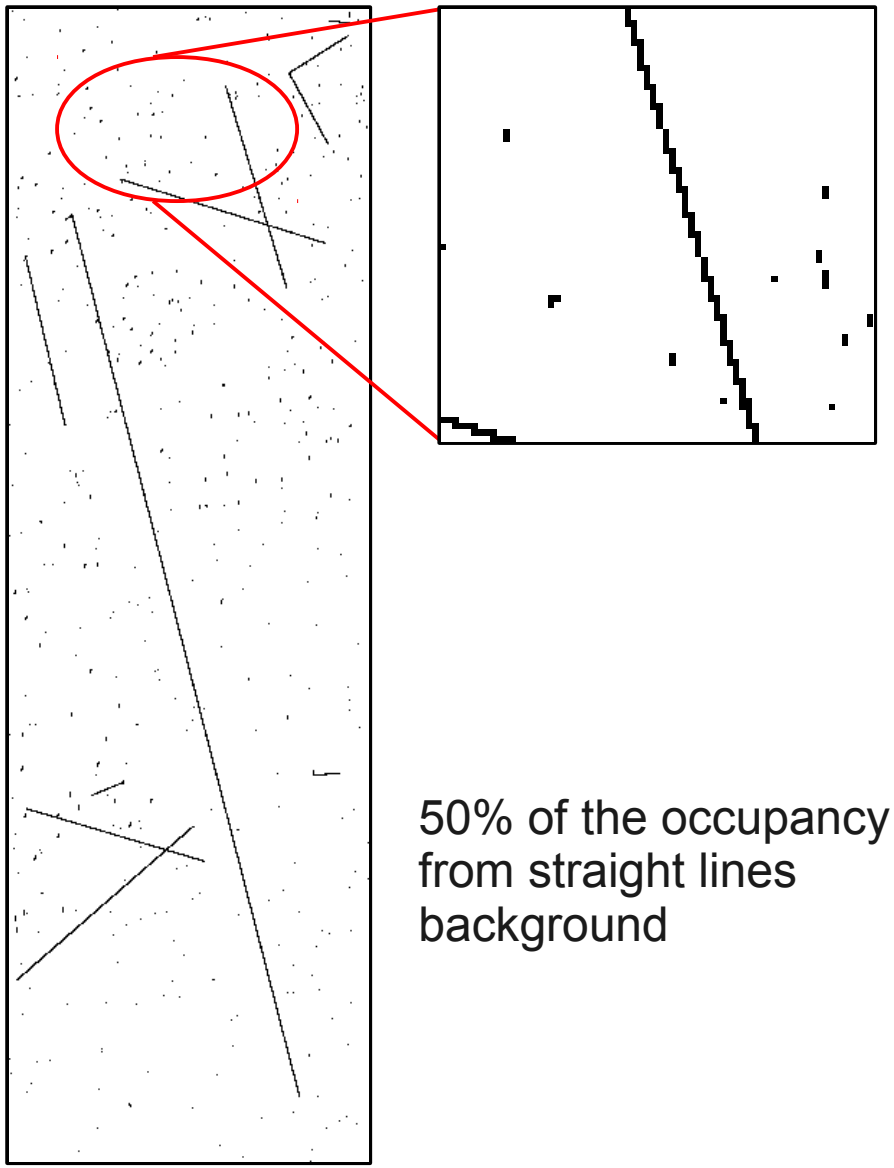


Layer 1



Baseline with Noise with Background

Layer 0



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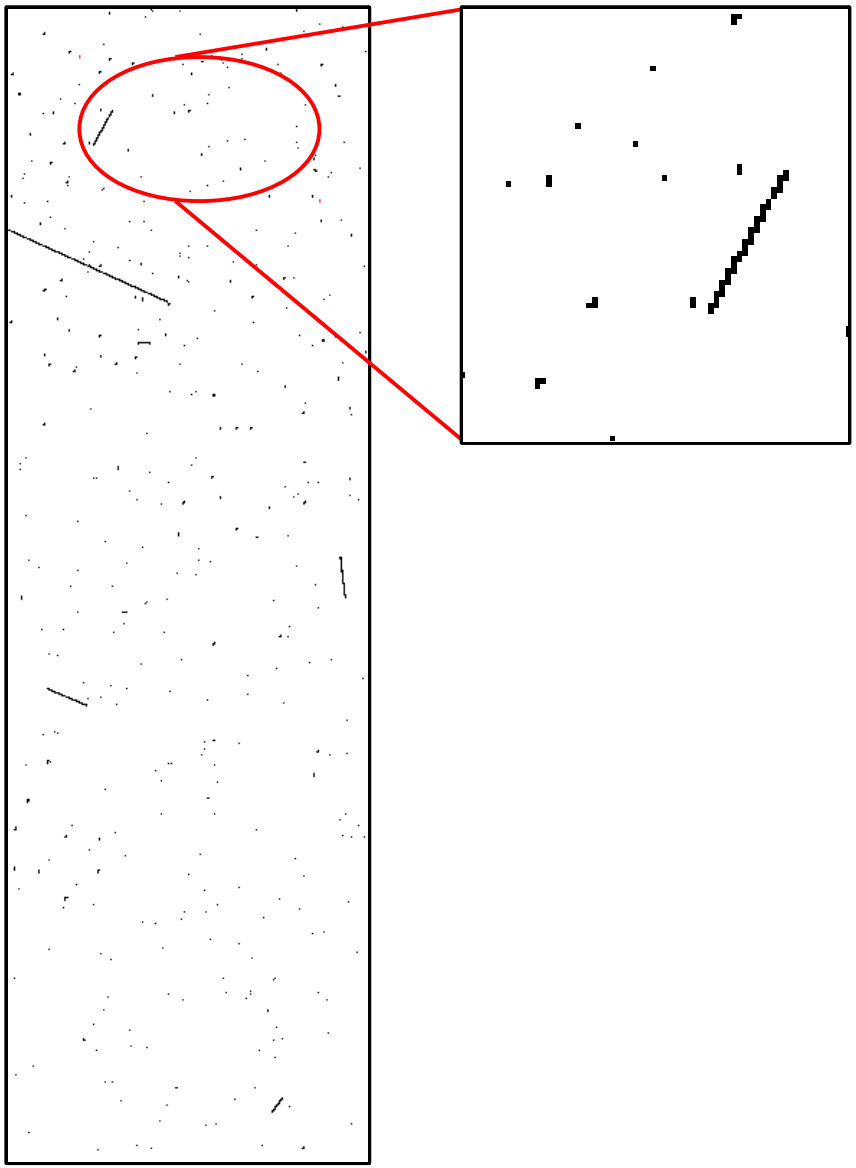
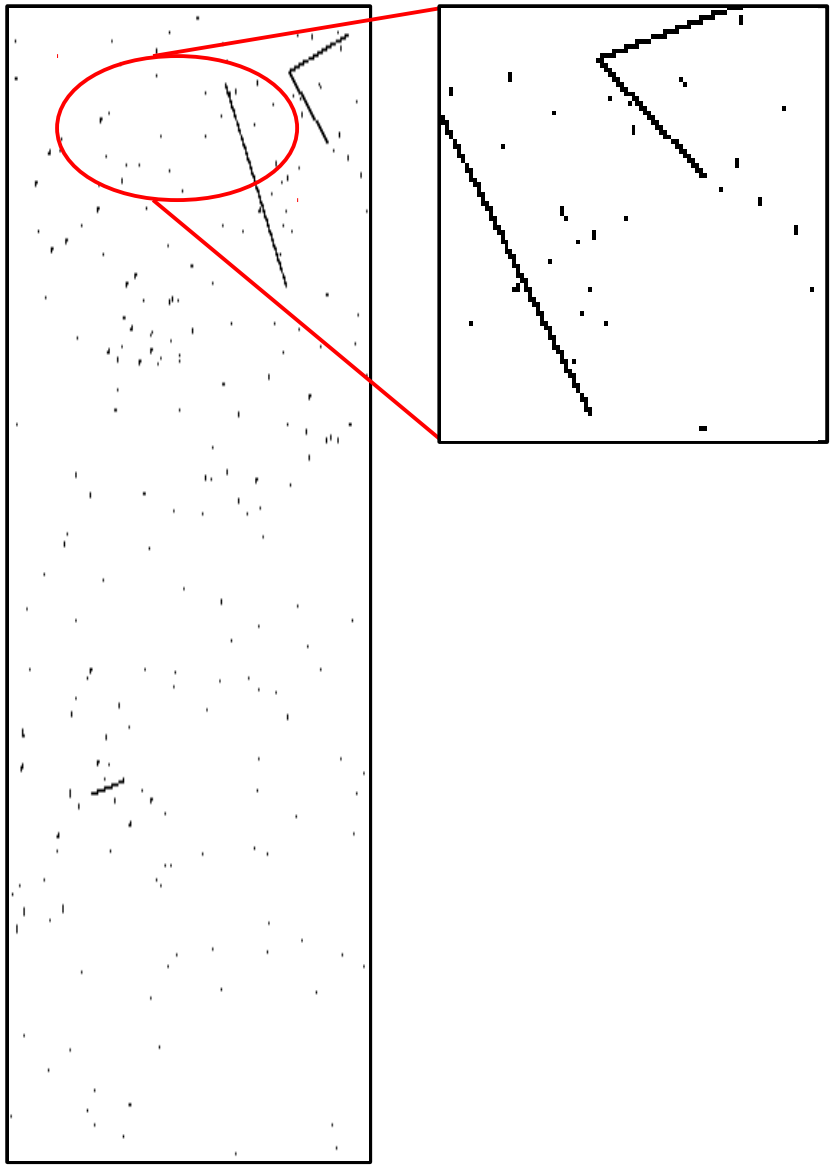


50% of the occupancy from straight lines background

Half the readout time with Noise with Background

Layer 0



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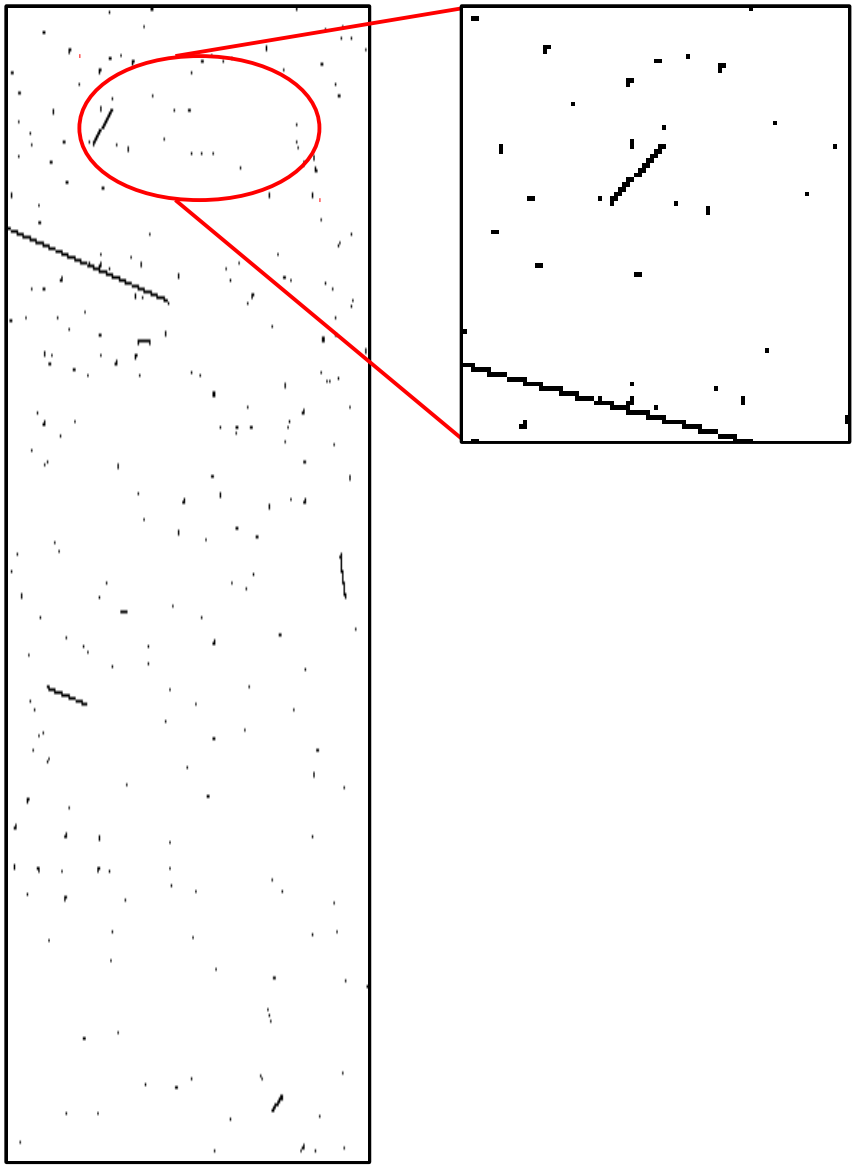
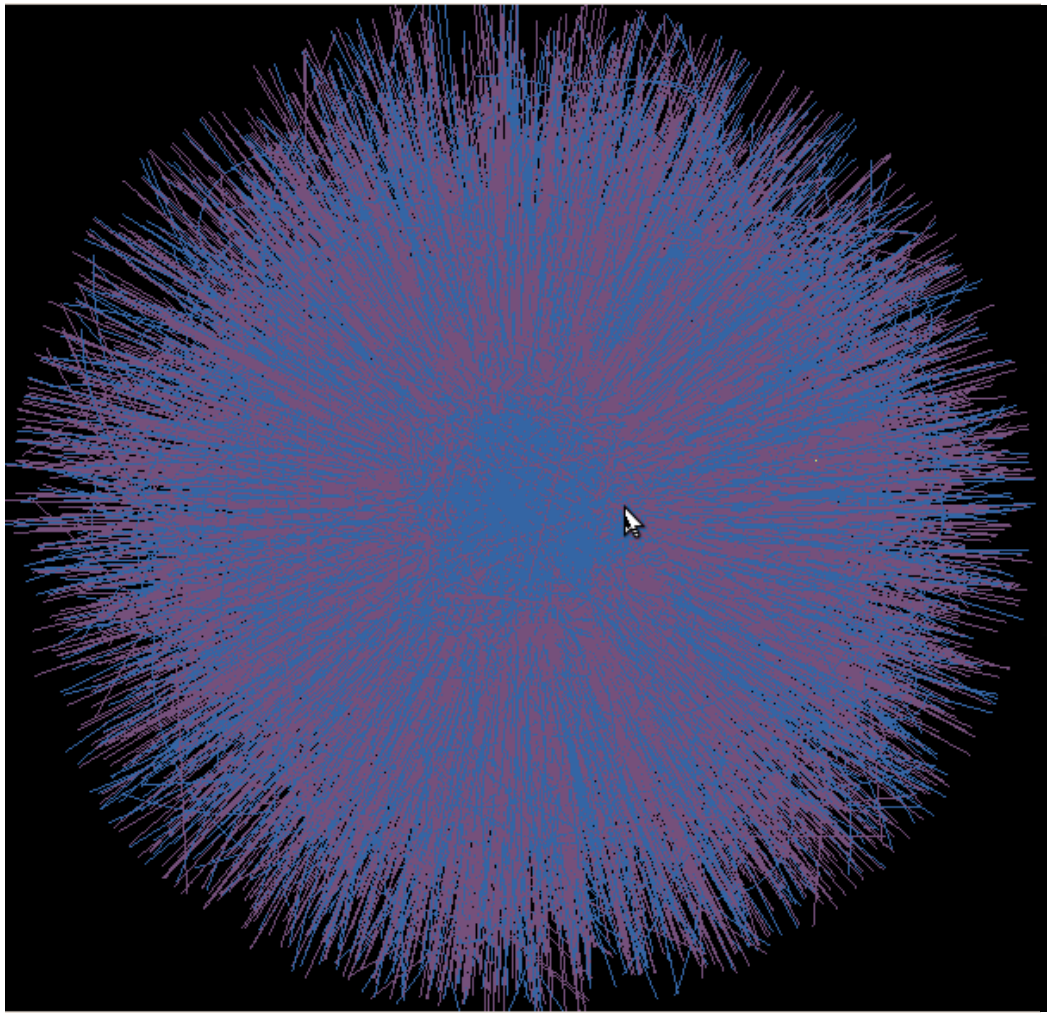
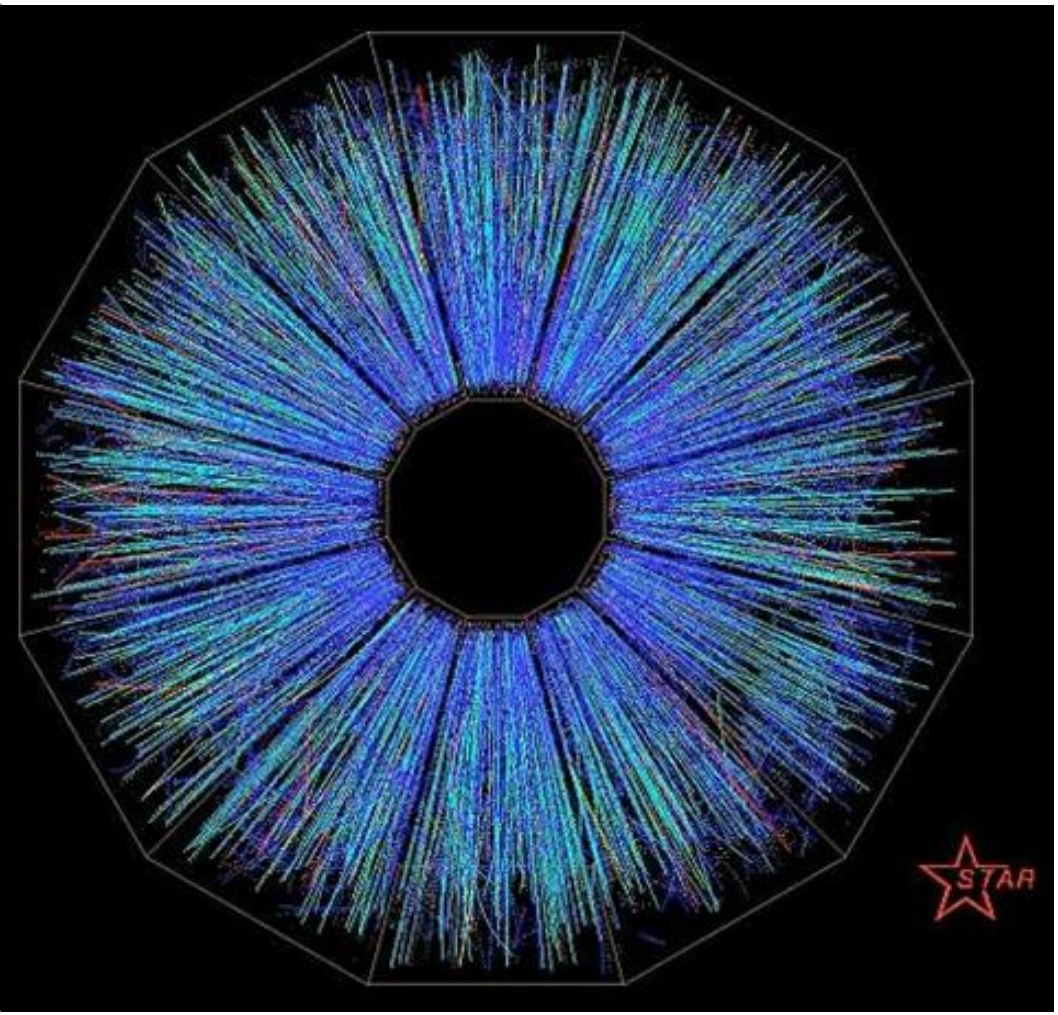


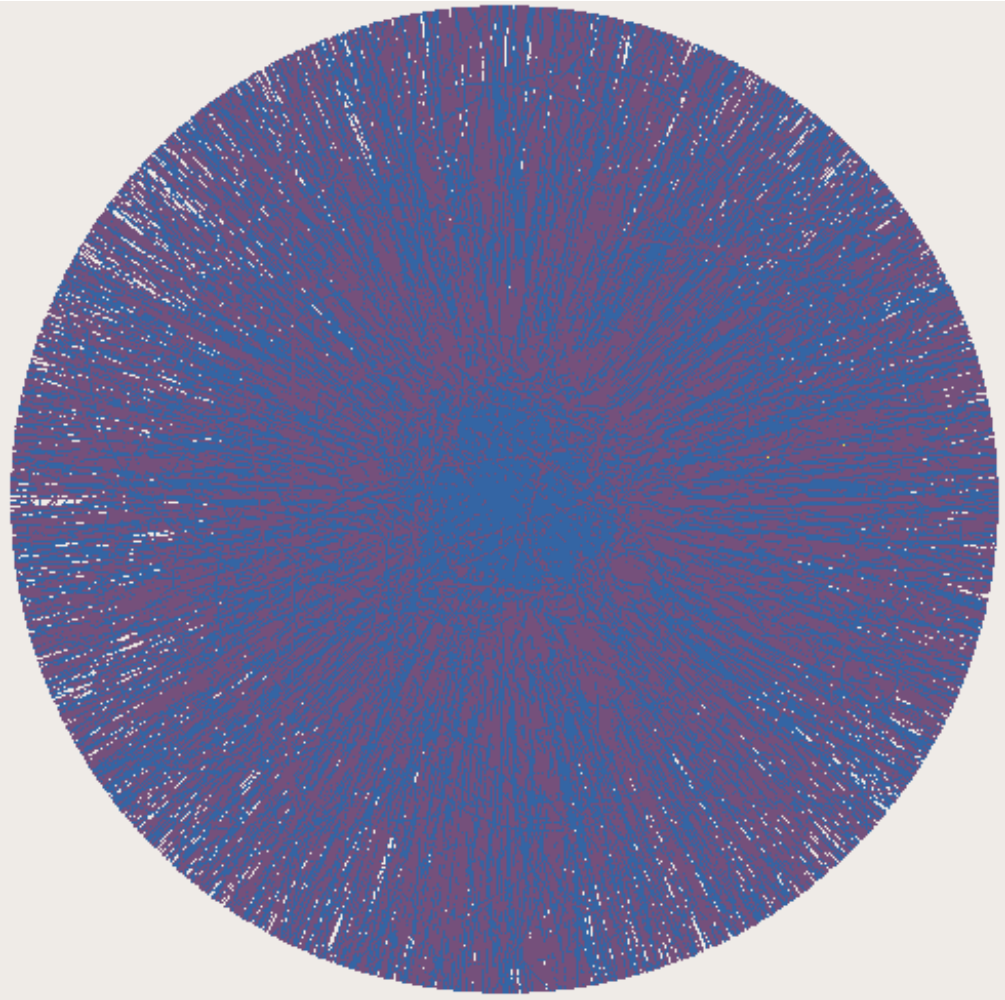
Belle II Background 20 µs
~5000 primary particles

Star detector central ion collision
~3000 Tracks

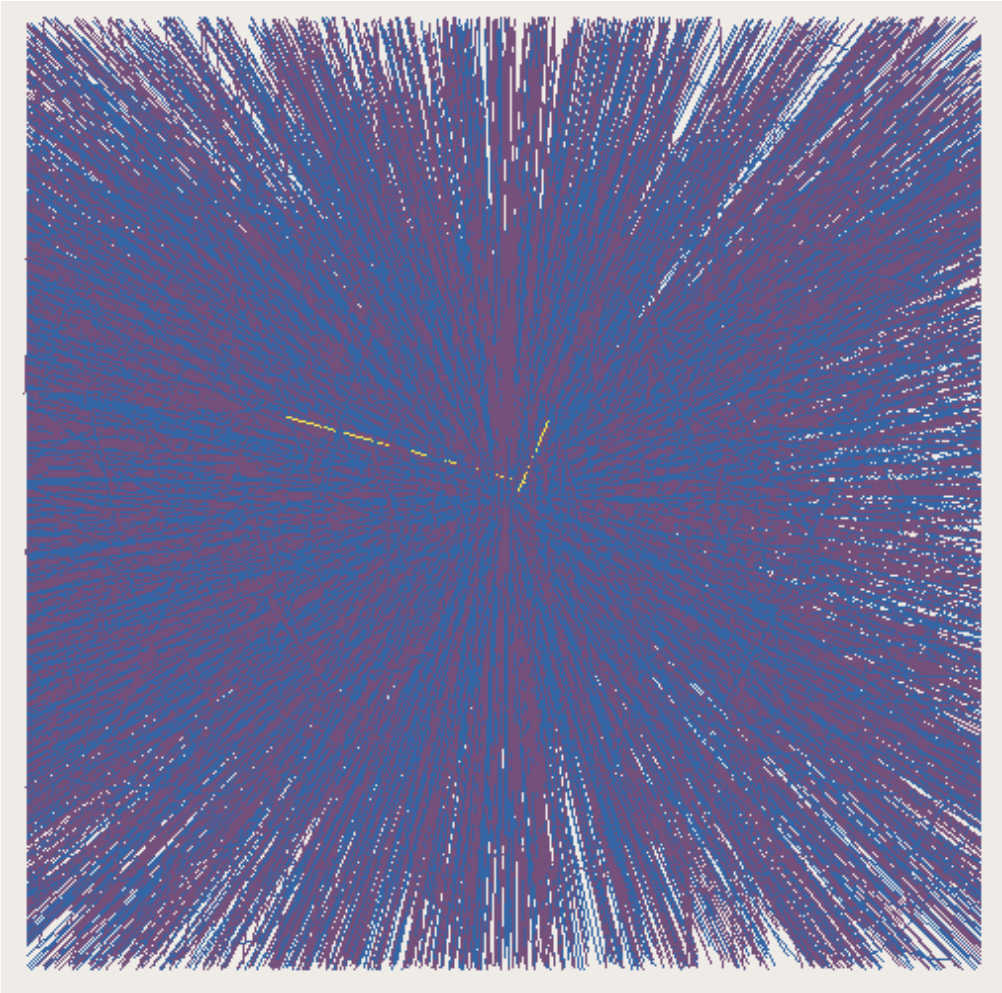




Projection on X/Y Plane

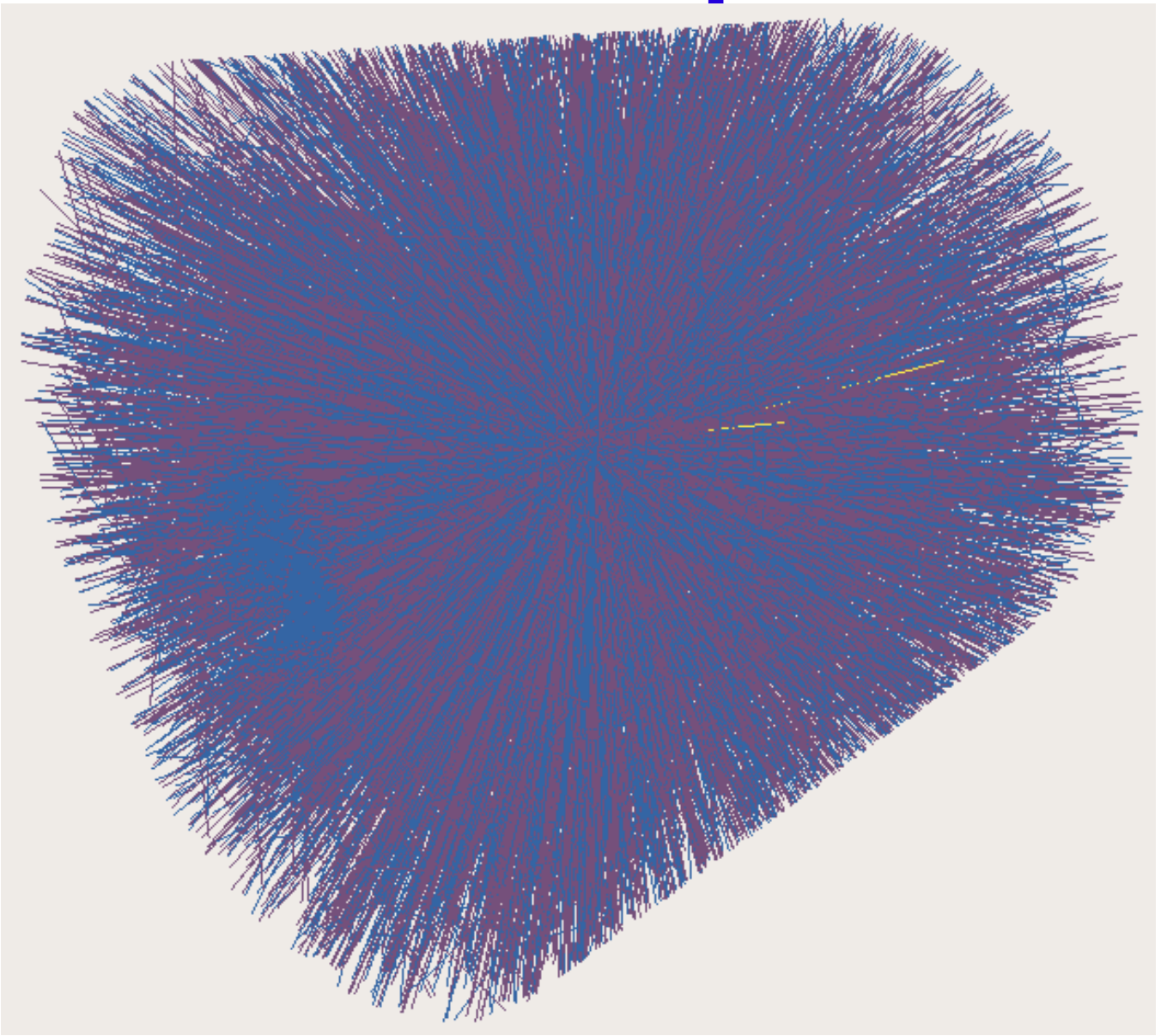


Projection on Y/Z Plane



- Status
  - Background simulation are work in progress
  - Results on small datasets are available
  - Merging background into reconstruction toolchain is working
    - But: still problems heading to large scale simulation
- Outlook
  - Next step: divide SiPxlDigi
    - Digitizer
    - Clusterizer
  - Possibility to use Datareduction Processor on digit level

Backup



Baseline: R1=14; R2=22; Thickness=50um; N1=N2=1600

- Study 1: (variation of inner radius)
  - R1 = 13 mm
- Study 2: (variation of sensor thickness)
  - Thickness = 75 um
- Study 3a: (variation of number of pixels and readout speed)
  - N1 = 800 pixel
- Study 3b: (variation of number of pixels and readout speed)
  - N1 = N2 = 800 pixel
- Study 4: (break the inner layer)
- Study 5: (Optimal but still conceivable PXD)
  - R1 = 13mm; N1 = N2 = 2000 pixel

Baseline with 2X Noise with Background

Layer 0

Layer 1