New SimHit/TrueHit Implementation for basf2

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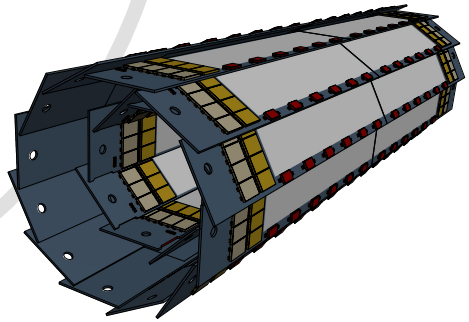
DEPFET
Active Pixel Detector



PXD/SVD Simulation in basf2

Energy deposition is simulated by Geant4

- step length is limited to 5 µm
- information on step position and energy deposition saved
- we save two types of objects: SimHits and TrueHits

SimHit Information about a single step

- used for digitization
- start position, end position, time and energy deposition.
- many SimHits per sensor traversal

TrueHit Information about sensor traversal

- useful for tracking studies
- entry, exit and midpoint position and momentum
- at most one per sensor traversal

- pro: high precision, landau fluctuation done by Geant4
- con: large file size if SimHits written to disk, SimHits needed for background overlay

New Implementation

ILC Implementation

- save one object per sensor traversal
- information on energy deposition fluctuation is lost, has to be recreated in digitization
- changes in flight direction are lost, always one straight step

New Implementation in basf2

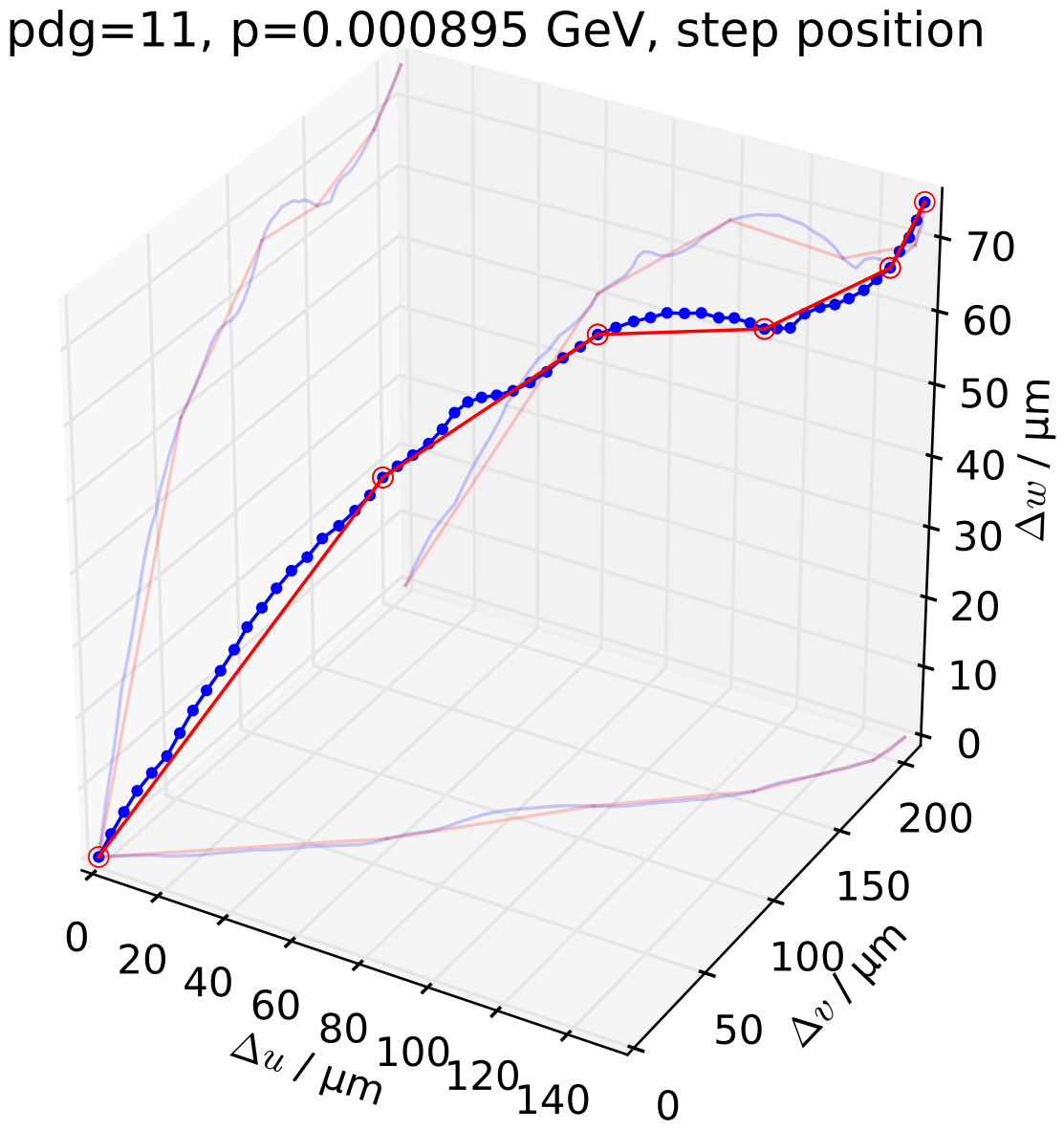
- collect all steps for sensor traversal
- find minimum amount line segments needed to describe flight path (usually 1), save one SimHit per segment
- per SimHit: find minimum amount of line segments to describe cumulative energy deposition profile
- encode energy deposition as number of electrons along step fraction
- TrueHit interface unchanged, slightly different memory representation

Line Segment finding

Ramer–Douglas–Peucker algorithm:

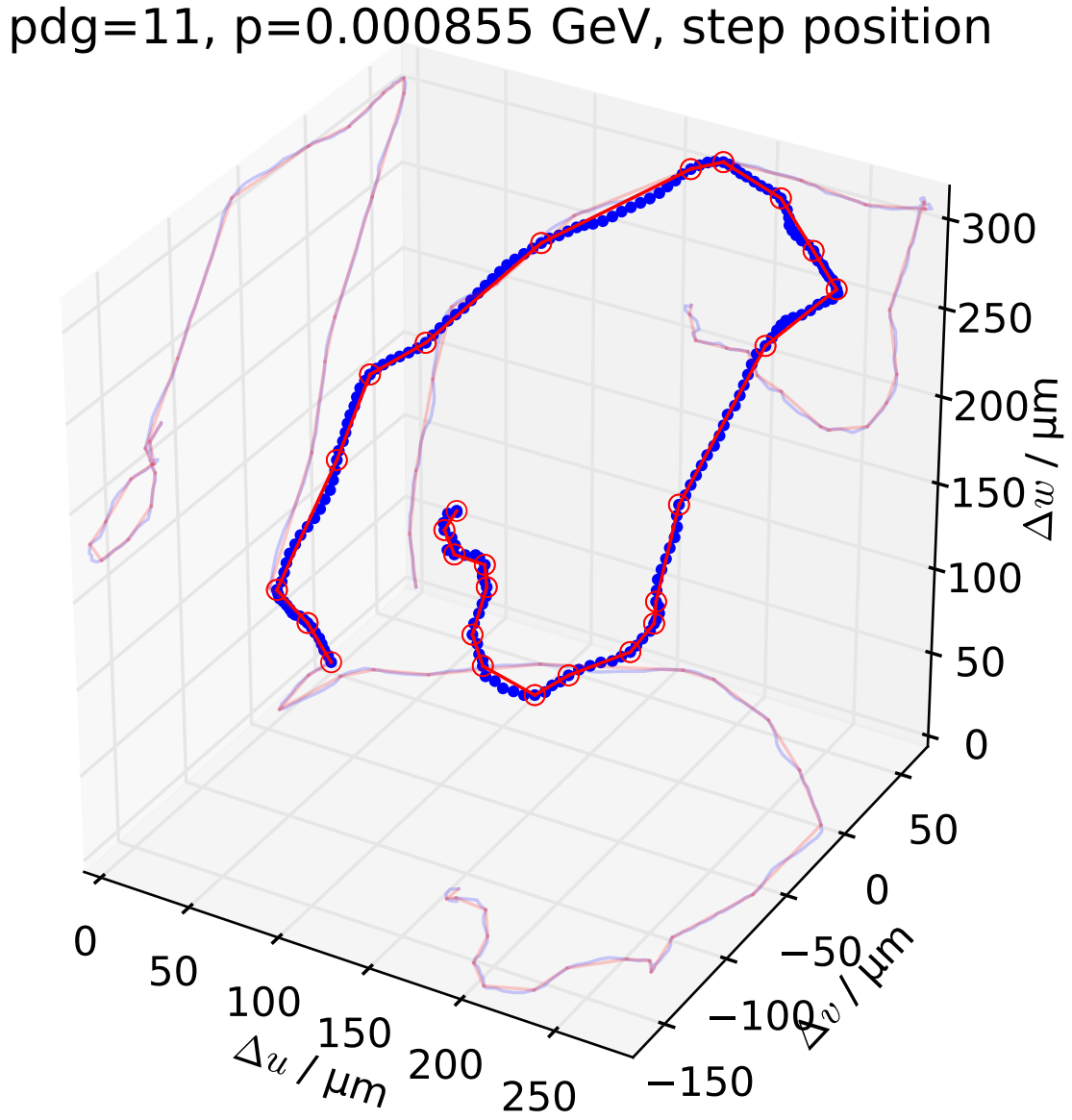
1. define tolerance (e.g. 5 µm)
2. create one line segment from first to last point
3. find point with maximum distance to segment
4. if distance $>$ tolerance, add midpoint creating two segments
5. repeat from 3 for new segments

➡ save SimHit for each final segment

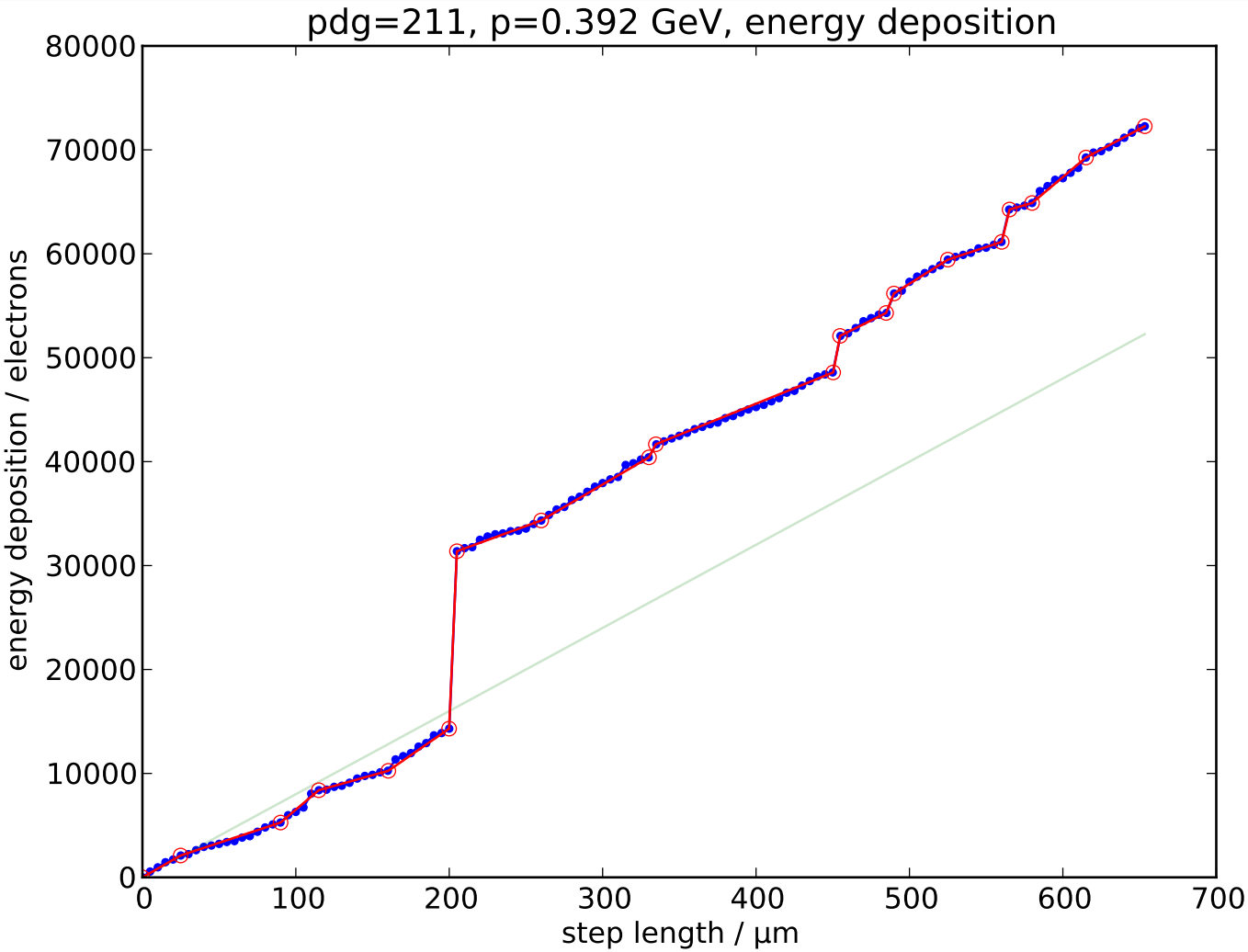


Line Segments

- most particles produce a single SimHit (5 µm tolerance)
- secondaries might create many SimHits
- tolerance can be set independently for PXD and SVD
- setting tolerance to zero will revert to old behaviour



Energy Deposition



- use same algorithm to simplify energy deposit along step length
- tolerance given in electrons,
- step length converted to electrons assuming MIP (80 eh pairs per µm)

Energy Deposition

- tolerance can be set independently for PXD and SVD
- setting tolerance to zero will revert to old behaviour (almost)
- SimHit class provides functionality to sample energy deposition along fixed distance or number of electrons

Energy deposition encoded:

- 10 bit for the relative position along the step (0 to 1)
- 22 bit for the number of electrons (max. 12.5 GeV)

Conclusions

New Implementation for SimHits in basf2

- compromise between accuracy and file size
- adjustable tolerances to achieve required precision
- zero tolerances revert to old behaviour

Implementation is finished

- restructured common PXD/SVD simulation code
- low level testing complete
- everything modified to work with the new SimHits (PXD/SVD/Testbeam)
- TODO: higher level testing of digitization, adjustment of tolerances

Thank you
for your attention