Update on Depfet Optimization Studies & Material Budget Studies

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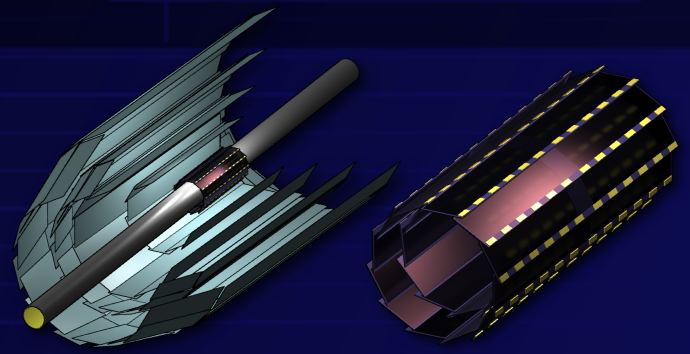
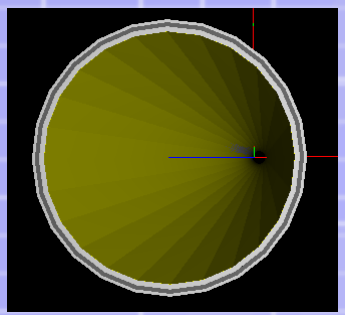


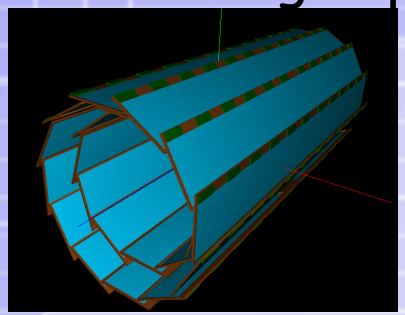
Outline

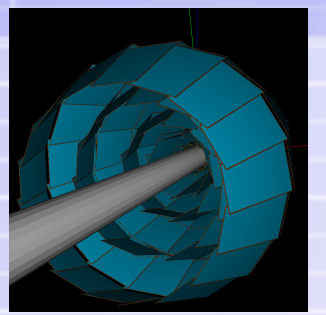
- Update on Mokka (Geant4) simulations - material budget studies for Belle II experiment
- Update on SiPxlDigi (Marlin digitization) – new clustering procedure implemented
- Single particle optimization studies with different noise levels set & different clustering parameters ...
  - "Effective efficiency" studies
  - Spatial resolution studies
  - Cluster size studies

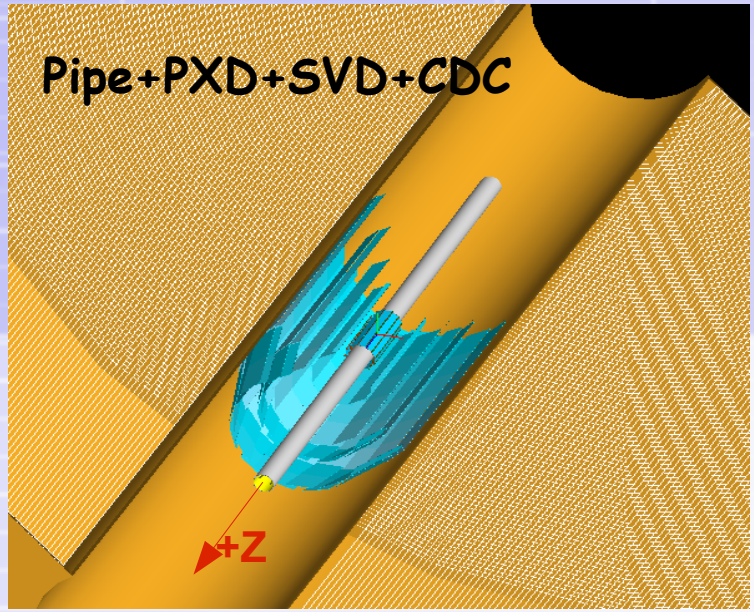
Update on Mokka (Geant4)

- Implemented an option to switch on/off material budget studies → study how much material is "seen" by a particle
- **Mokka** configuration & output:
  - /Mokka/init/materialStudies true (steering file configuration)
  - /gun/particle/geantino (geantinoCharged) (steering file configuration)
  - LCIO file – for each event hits generated:
    - MBBPCollection → 1 hit with beam pipe material
    - MBPXDCollection → 1 hit with PXD material
    - MBSVDCollection → 1 hit with SVD material
    - MBCDCCollection → 1 hit with CDC material
- **Marlin**: AnalyseMatBudget processor



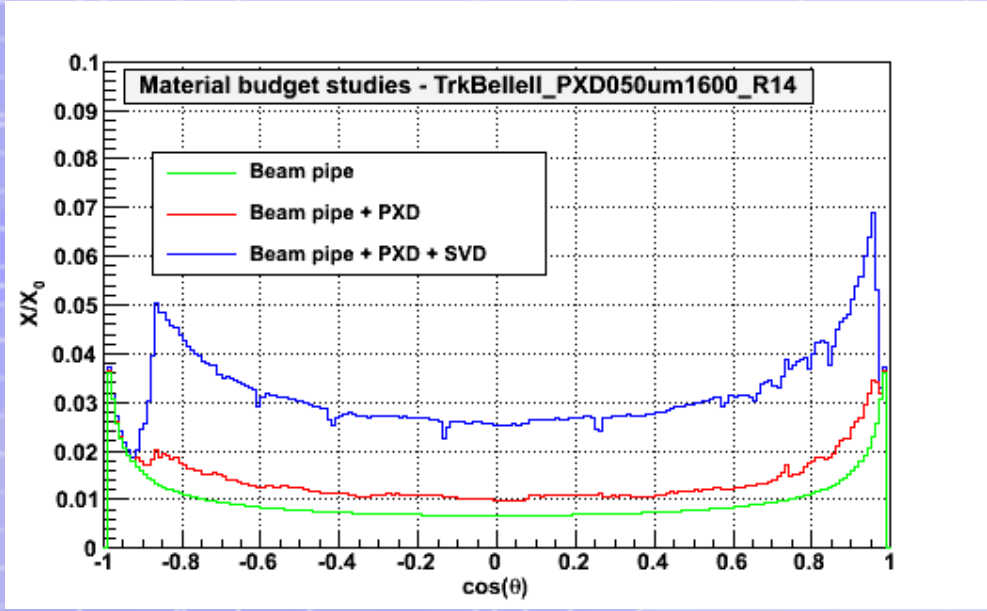




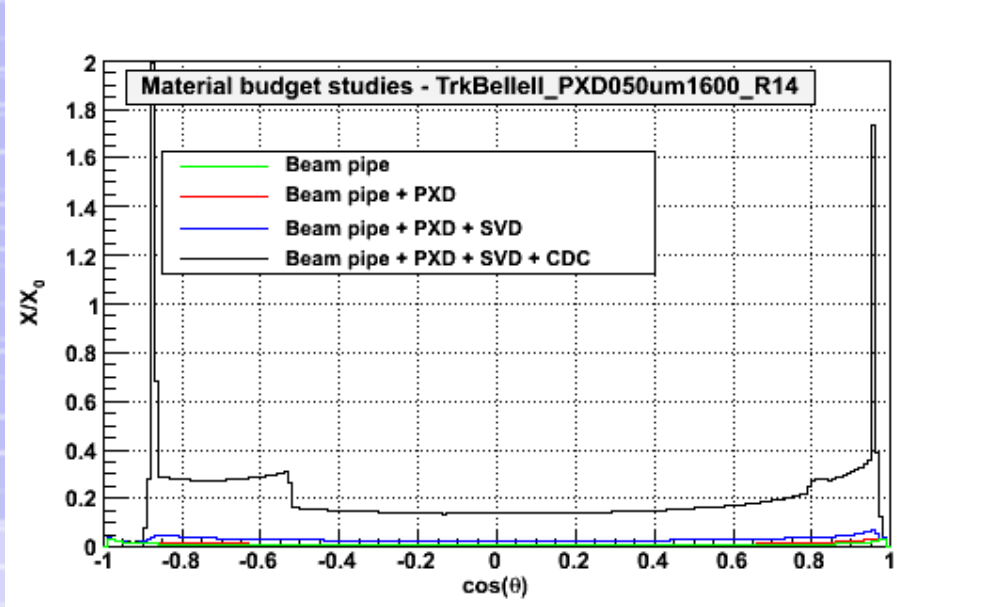


Material Budget Studies I

- Studies for Belle II experiment – **PXD** baseline with **50µm** thick active sensors, 1600 pixels in 1st (R14mm) & 2nd (R22mm) layer; **SVD** with forward slanted, but still, only active sensors **300 µm** thick implemented (missing one order of SVD X/X_0, see E. Gfall's talk)



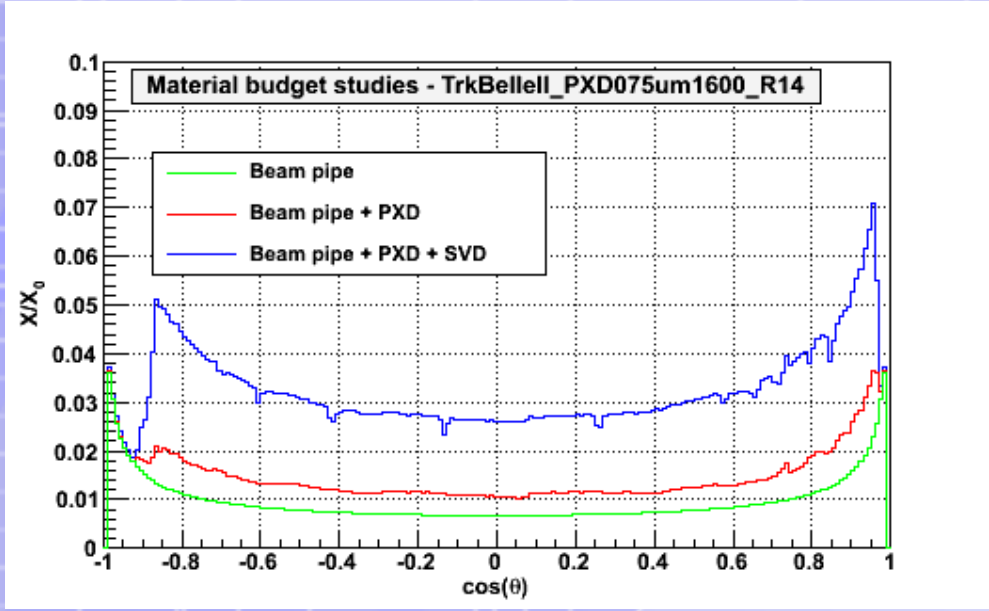
"Real"



"Real"

Material Budget Studies II

- Studies for Belle II experiment – **PXD** baseline with **75µm** thick active sensors, 1600 pixels in 1st (R14mm) & 2nd (R22mm) layer; **SVD** with forward slanted x straight (model), but still, only active sensors **300 µm** thick impl. (missing one order of SVD X/X_0, see E. Gfall's talk)



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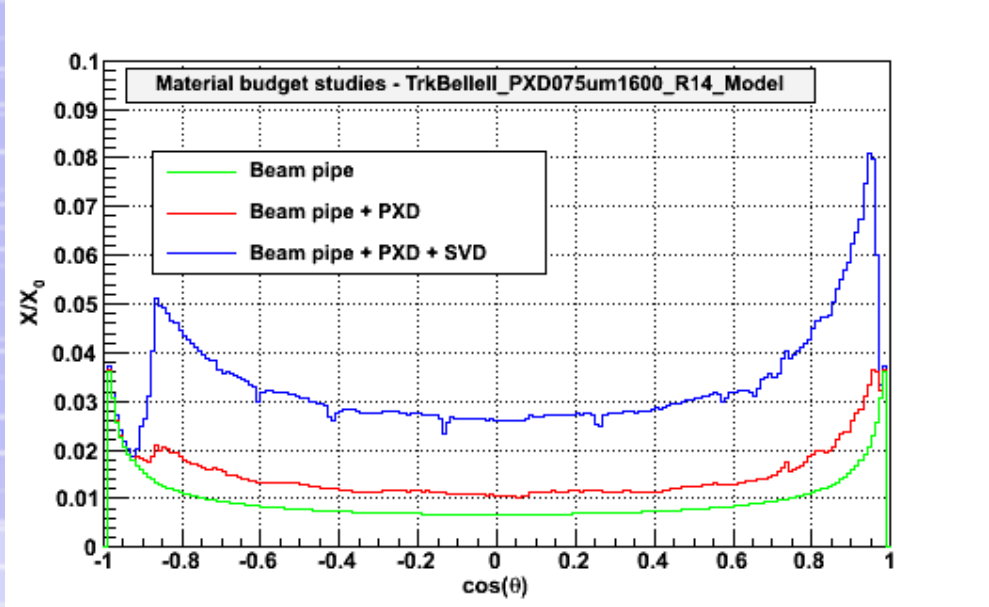


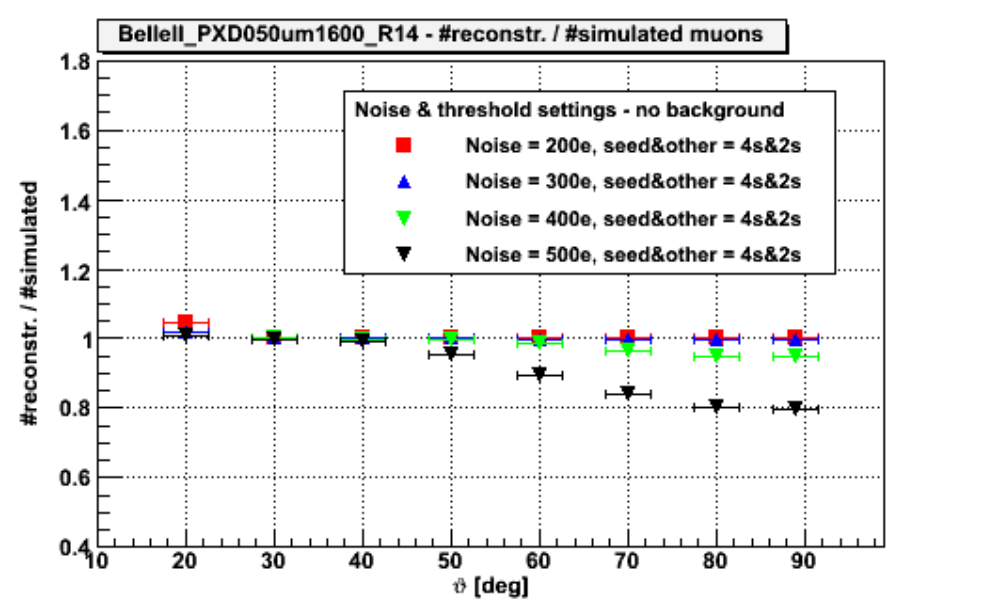
Model

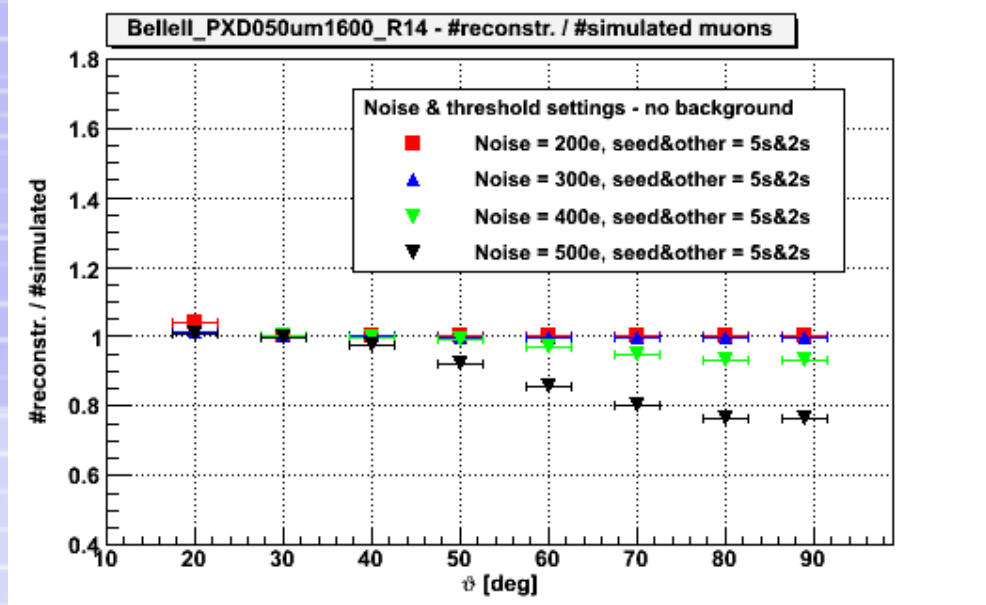
Update on SiPxlDigi – New Clustering

- New clustering algorithm implemented – each SimTrkHit is not "digitized" step-by-step into TrkHit as before, but ...
  - All hits are saved in memory
  - Based on S/NAdjacent cut (2 sigma) noise hits are generated (only in sensors, where signal(s) already is(are) – to save CPU time)
  - Cluster seeds based on S/NSeed cut (5 sigma) are found + surroundings are searched → central part of new cluster defined
  - For each cluster other adjacent pixels are found (based on S/NAdjacent cut) and added
  - R-Phi & Z projected positions calculated – 2 algorithms implemented:
    - Cluster size <= 2 → COG (center of gravity – no etha correction)
    - Cluster size > 2 → Analog head-tail algorithm
  - 3D position calculated, MC information + weight on each particle saved
  - TrkHit created

Digitization & Clustering Studies: Effective "Efficiency" for 50 µm Si

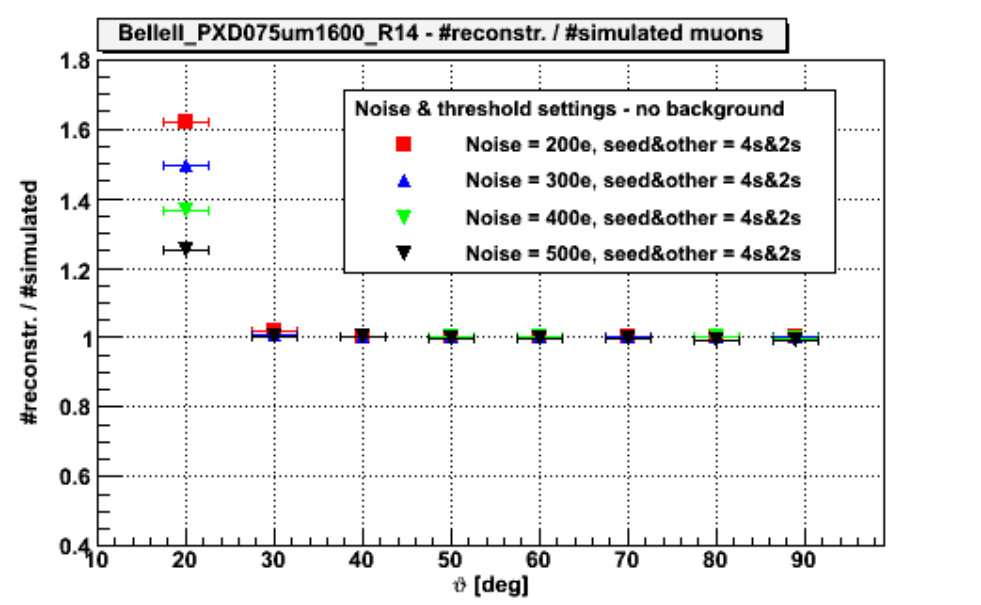
- Single muon particle studies performed (no background) – influence of different settings of noise level & clustering parameters studied
  - **Geometry:** Belle II experiment – **PXD** baseline with **50µm** thick active sensors, 1600 pixels in 1st (R14mm) & 2nd (R22mm) layer
  - **Seed: 4** sigma x **5** sigma; **Other: 2** sigma

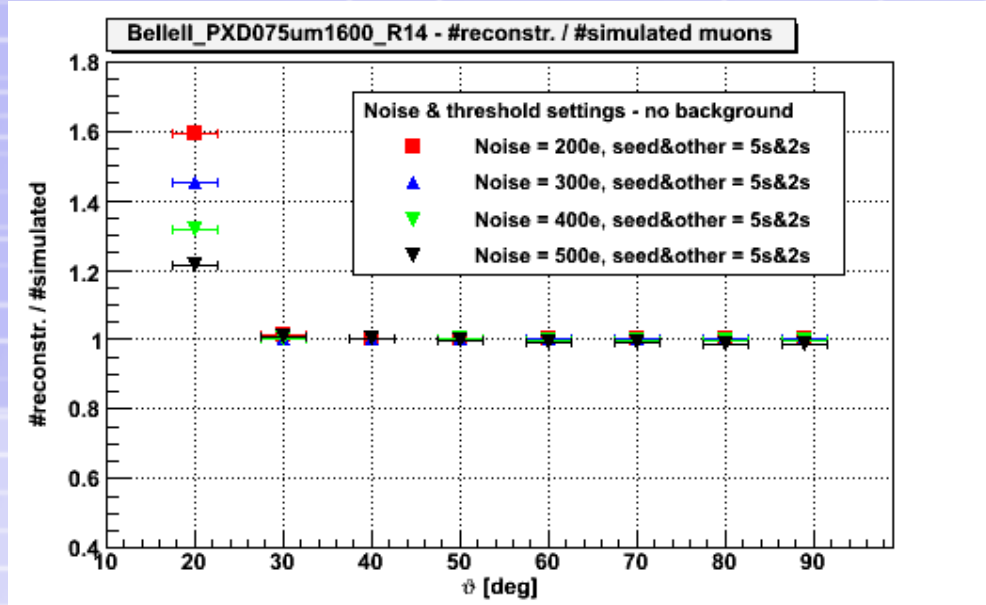




Digitization & Clustering Studies: Effective "Efficiency" for 75 µm Si

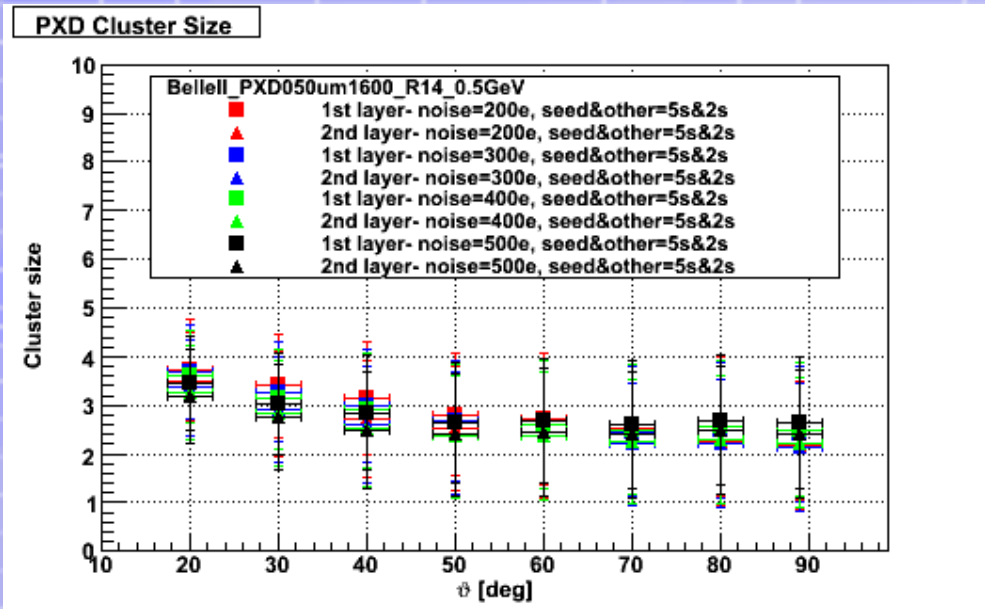
- Single muon particle studies performed (no background) – influence of different settings of noise level & clustering parameters studied
  - **Geometry:** Belle II experiment – **PXD** baseline with **75µm** thick active sensors, 1600 pixels in 1st (R14mm) & 2nd (R22mm) layer
  - **Seed: 4** sigma x **5** sigma; **Other: 2** sigma

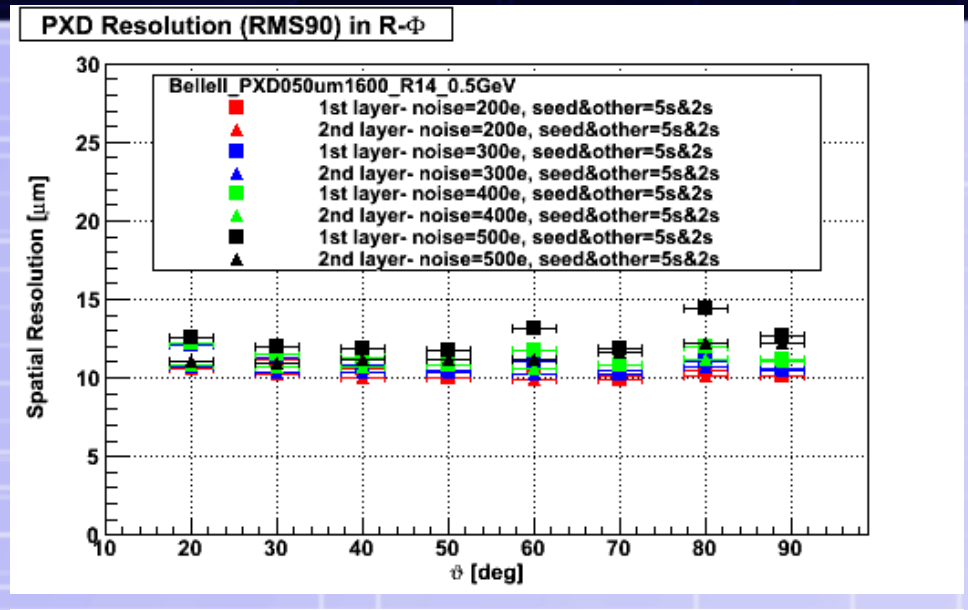


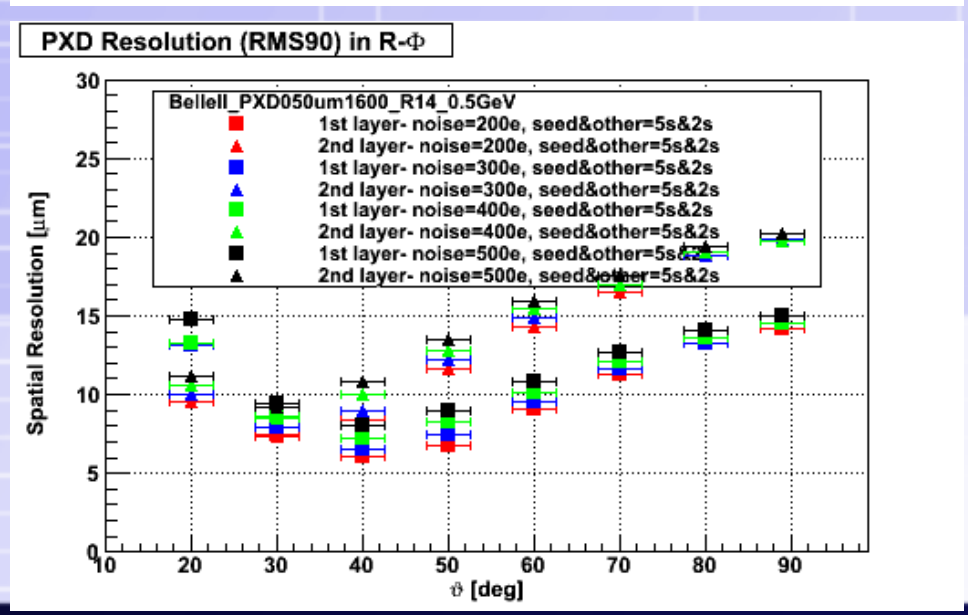


Spatial Resolution & Cluster Size for 50 μm Si

- Single muon particle studies performed (no background) …
  - seed = 5 sigma, 50 μm Si

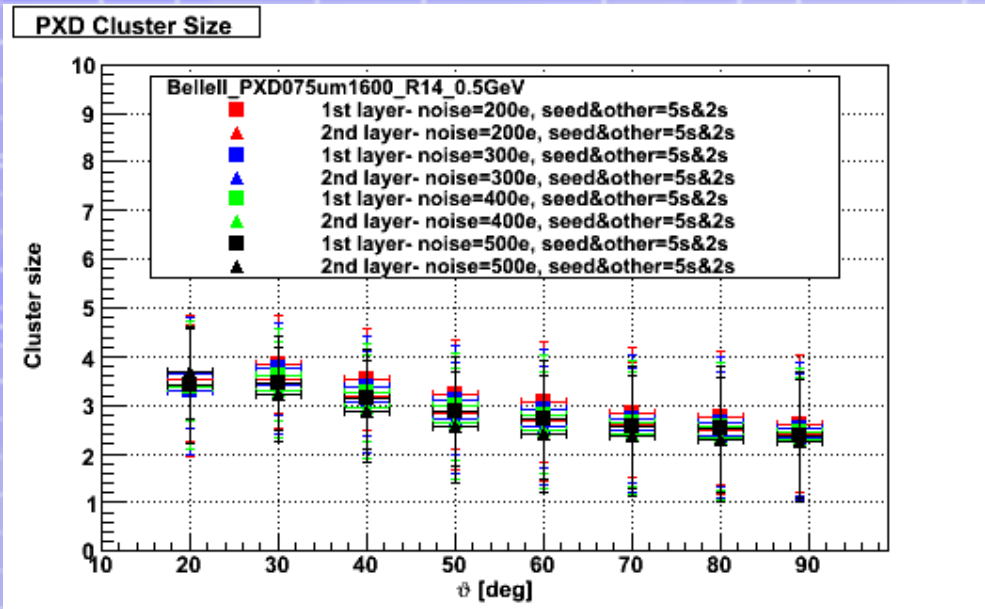


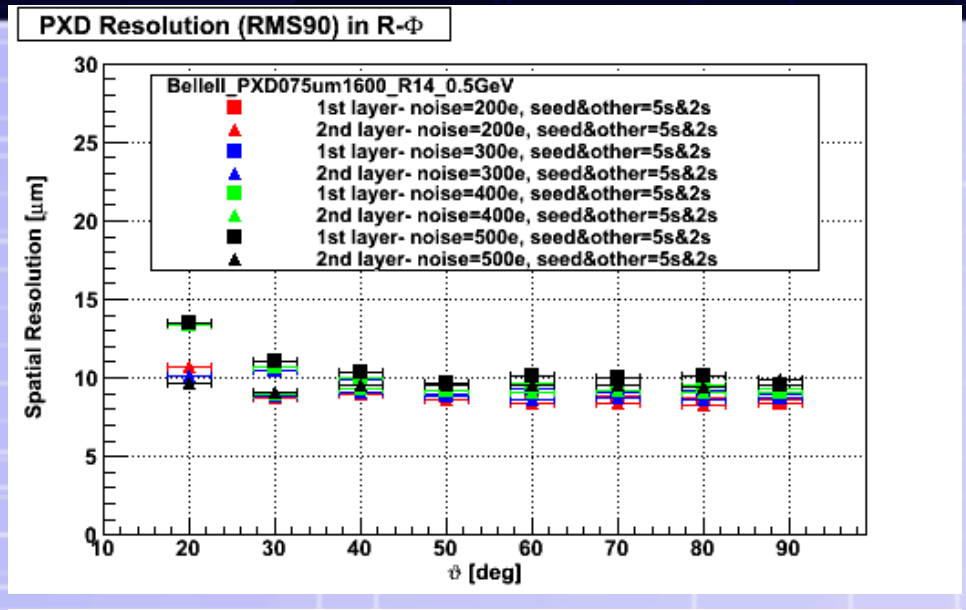


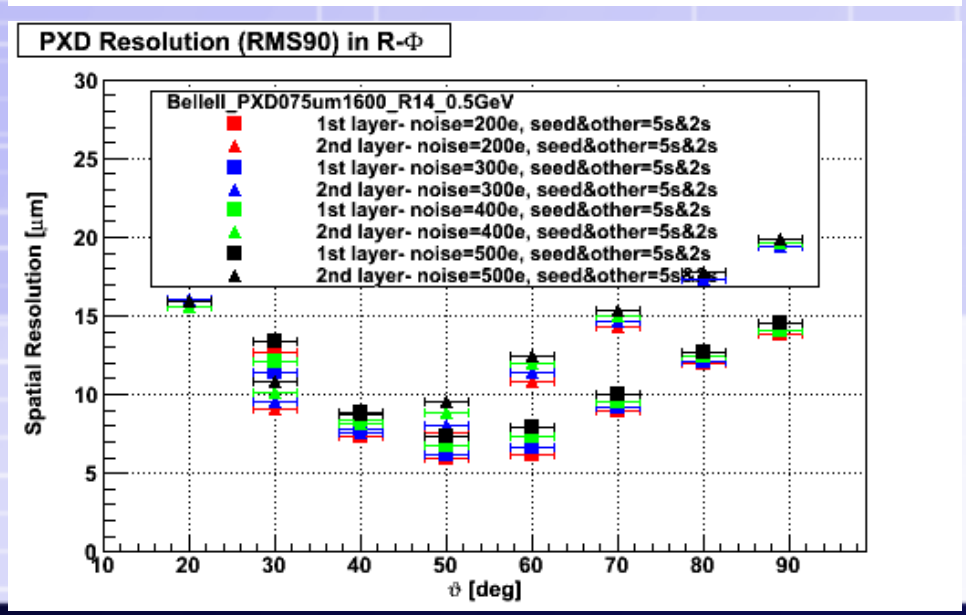


Spatial Resolution & Cluster Size for 75 μm Si

- Single muon particle studies performed (no background) …
  - seed = 5 sigma, 75 μm Si





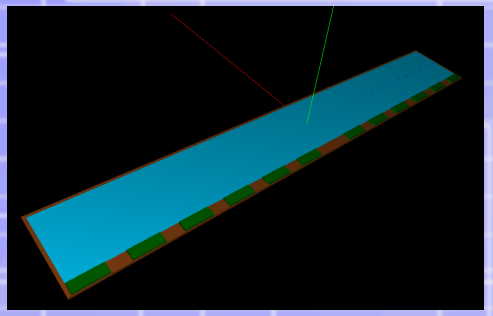


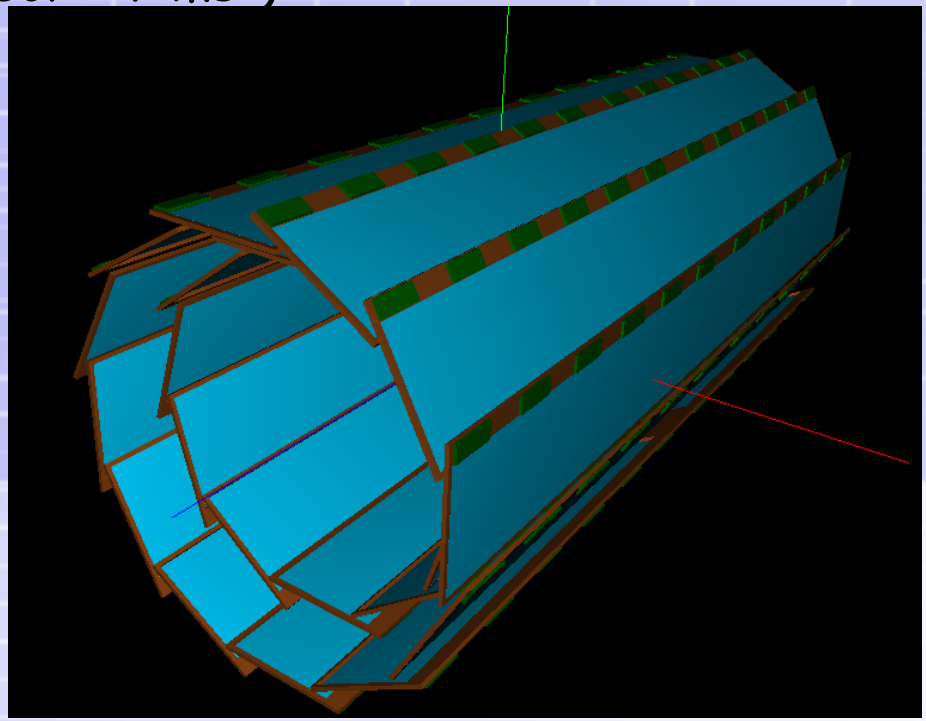
Summary & Plans

- Material budget studies & Mokka
  - Plan to implement 2 full options of SVD to see impact on PXD, tracking, ...
- SiPxlDigi
  - Plan to merge digitizer ver. validated on TB with full sim. ver. (B. Schwenker)
  - Plan to provide study on diffusion x Landau (Geant4 changes)
- Current studies
  - Summary:
    - clustering and its parameters (cuts & noise level) have visible effect on all results
    - effective efficiency degrades for 50μm option for noise level >= 400e, for 75μm Ok
    - spatial resolution degrades for higher noise level ~ by several microns (1-4μm)
    - spatial resolution in R-Phi increases for 75μm option by ~ 15%
    - if one goes from 50μm to 75μm, best values of spatial resolution in Z shift from Θ[deg] 30 – 50 to 45 – 65 (full physics studies have to decide, what's better)
    - cluster sizes for 75μm increase at most by 15% (Θ=30deg)
  - Plan to perform all the studies in background environment too

Backup - Simulation BelleII - Mokka

- **Beam pipe:** cylindrical, "onion-like structure"
  - inner Au layer (10 μm), inner Be layer, paraffin (active cooling), outer Be layer
- **PXD:** 2 layers of DEPFET detectors organized in "wind-mill" structure ("layer" → "ladder" → "sensor + rims")



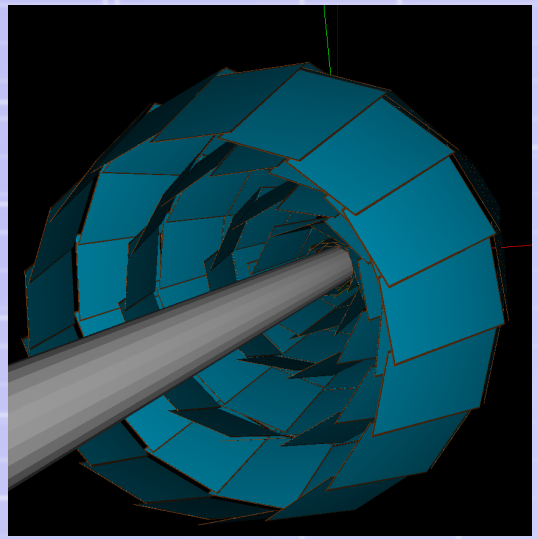


	R [mm]	# ladders	support
Pxl layer 0	14.00	8	no
Pxl layer 1	22.00	12	yes

Backup - Simulation Belle II- Mokka 2

- **SVD:** 4 layers of DSSDs in central part, 2 in forward

	R [mm]	# ladders	# DSSDs
Strip layer 31 – barrel	38	8	2
Strip layer 41 – barrel	80	10	2
Strip layer 42 – barrel-slante	66	14	3
Strip layer 51 – barrel	115	17	4
Strip layer 52 – barrel-slante	95.5	10	1
Strip layer 61 – barrel	140	14	1
Strip layer 62 – barrel-slante	114	17	1



- **CDC:** Central Drift Chamber
  - Al cylindrical chamber - with cone-shaped inner parts
  - filled with a mixture of He and C_2H_6 (50%/50%)