Synchrotron Radiation background simulation

Status

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DESY

Impact of Misalignment and
Beam Halo on PXD occupancy

Preamble

1. Generation of primary charged particle (beam) and simulation of SynchRad photon emission during propagation of initial particles through magnetic field (primary simulation, GEANT4 based) requires very large (unreal) CPU to get full picture of synchrotron radiation background (needs to generate hits in a few ROF to observe scattered photons).
  An idea to generate only SynRad photons using vertex and momentum information from primary simulation has been actualized (PV,YS) and speedup significantly the simulation.
   Primary simulation is performed every time when geometry (lattice,beam pipe design etc.) is changed. Output of primary simulation is transformed into HEPEVt file which is used as input for the next step of simulation (occupancy estimation,creation of the background files etc).

2. Estimation of PXD occupancy and creation of background files for ideal alignment of the central beam pipe has been performed. Cross check: PySynRad (AM python based) and GEANT4 based approaches gives similar results for PXD occupancy (with the same lattice files).
 Recently I have found the way how to modify geometry code, which I seem to have missed earlier, to include misalignment of central beam pipe in the simulation → PXD occupancy with misalignment.

3. Beam Halo.
Conservative assumption:
Uniform halo – 2D circular flat distribution of (X,X')/(Y,Y') in normalized coordinates with radius **$20*\sqrt{\varepsilon x/\varepsilon y}$** (half width = $20\sigma xy$ of the core).
 *Normalization factor - assuming that fraction of tails beyond $10\sigma xy$ = 1e-5 of the core.* (KEKB TDR)
The fraction of tails beyond $10\sigma x$ and beyond $30\sigma y$ estimated from beam-beam simulation for SuperKEKB ≤ 5e-7 of the core.

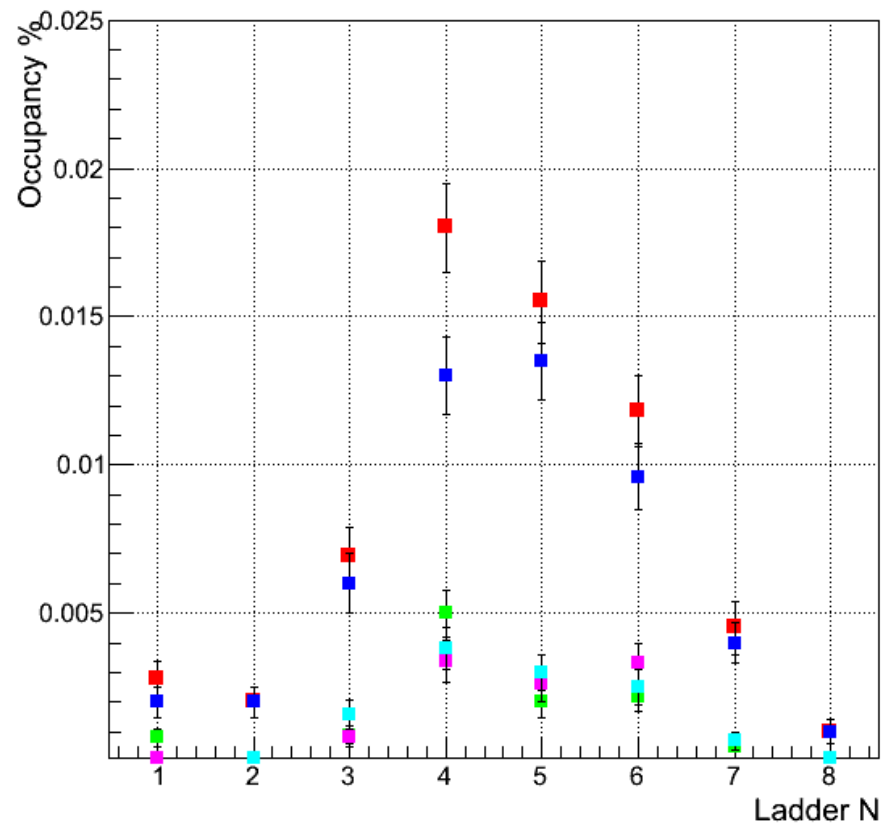 All results correspond to 4ROF (80μsec), for HER.

PXD occupancy Layer1

Color Code:
Ideal alignment
Misalignment -0.5mm
Misalignment +0.5mm
Uniform Beam Halo
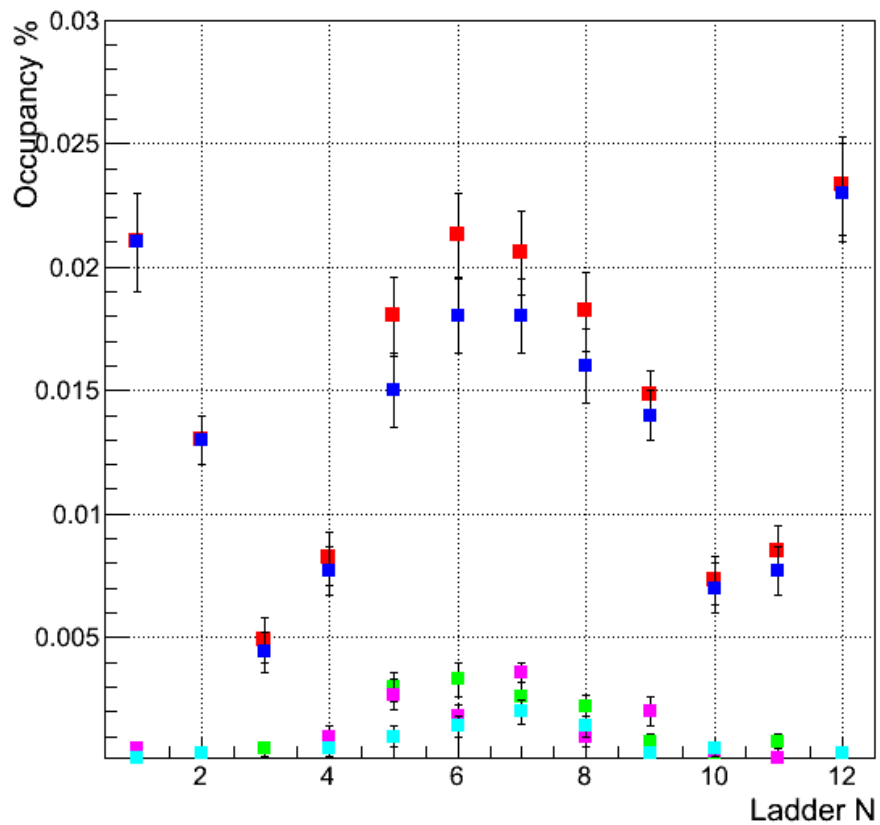Total =Ideal + Uniform Halo

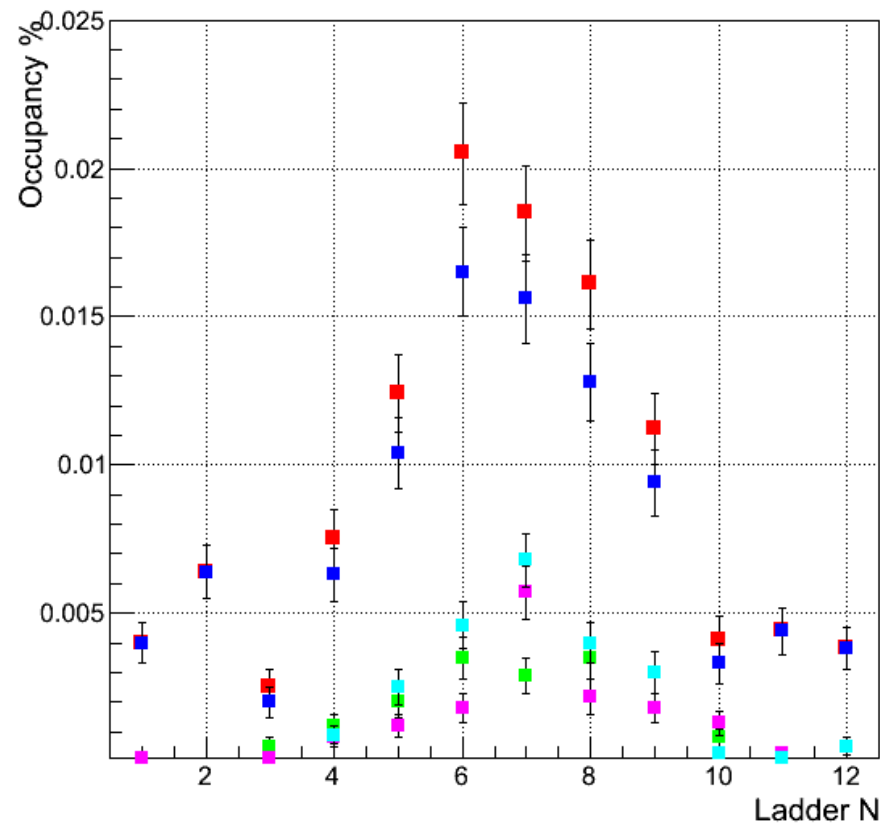PXD Occupancy Layer1 Sensor1
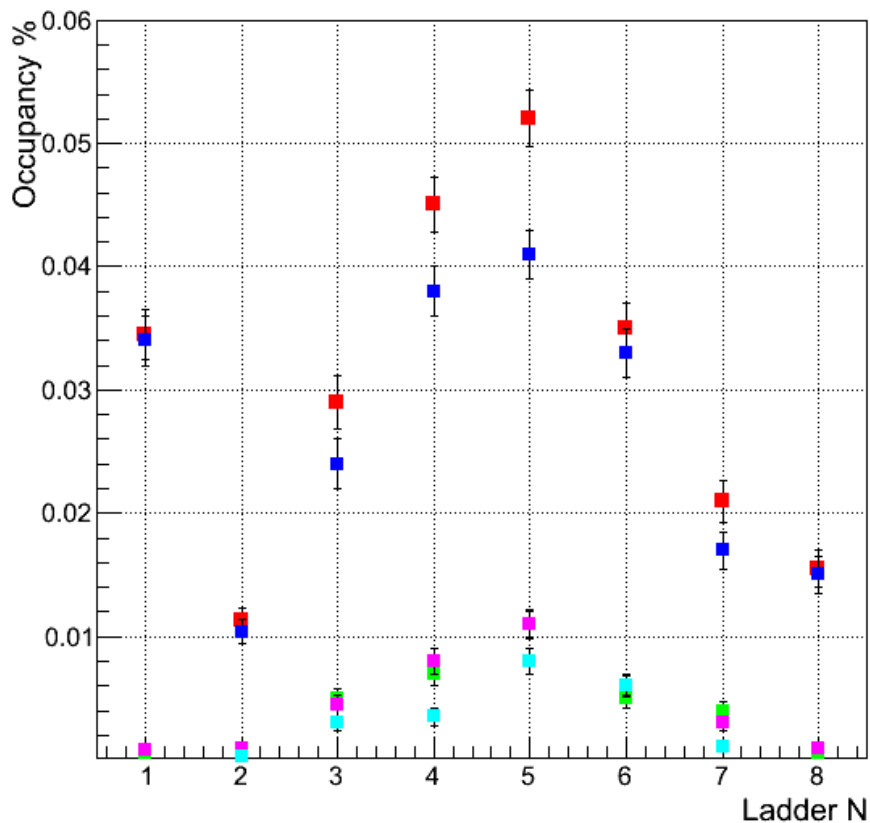
PXD Occupancy Layer1 Sensor2

PXD occupancy Layer2

Color Code:
Ideal alignment
Misalignment -0.5mm
Misalignment +0.5mm
Uniform Beam Halo
Total =Ideal + Uniform Halo

PXD Occupancy Layer2 Sensor1

PXD Occupancy Layer2 Sensor2

# Conclusion

Maximum expected occupancy

1. PXD occupancy for the beam core - **~(0.011 ± 0.001)%** at φ ~ π,both for ideal and misalignment cases.

2. Contribution of Beam Halo tails :
   (0.041 ± 0.002)% , assuming fraction of tails beyond 10σxy = 10e-5 (KEKB TDR), (conservative estimation).
   (0.0021 ± 0.0001)%, fraction of tails beyond 10σxy = 5e-7 (beam-beam simulation) at φ ~ π.

3. Total occupancy: **(0.052 ± 0.002)% (**conservative estimation).

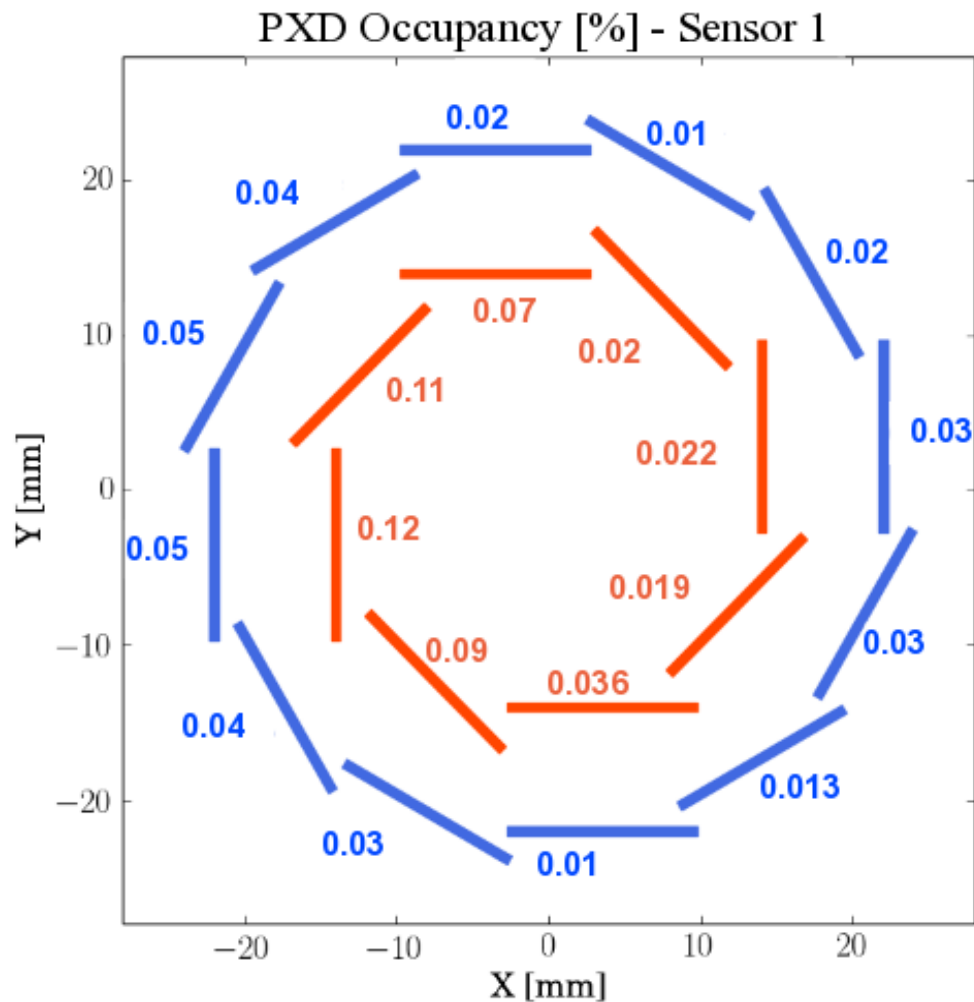# Thank you for your attention
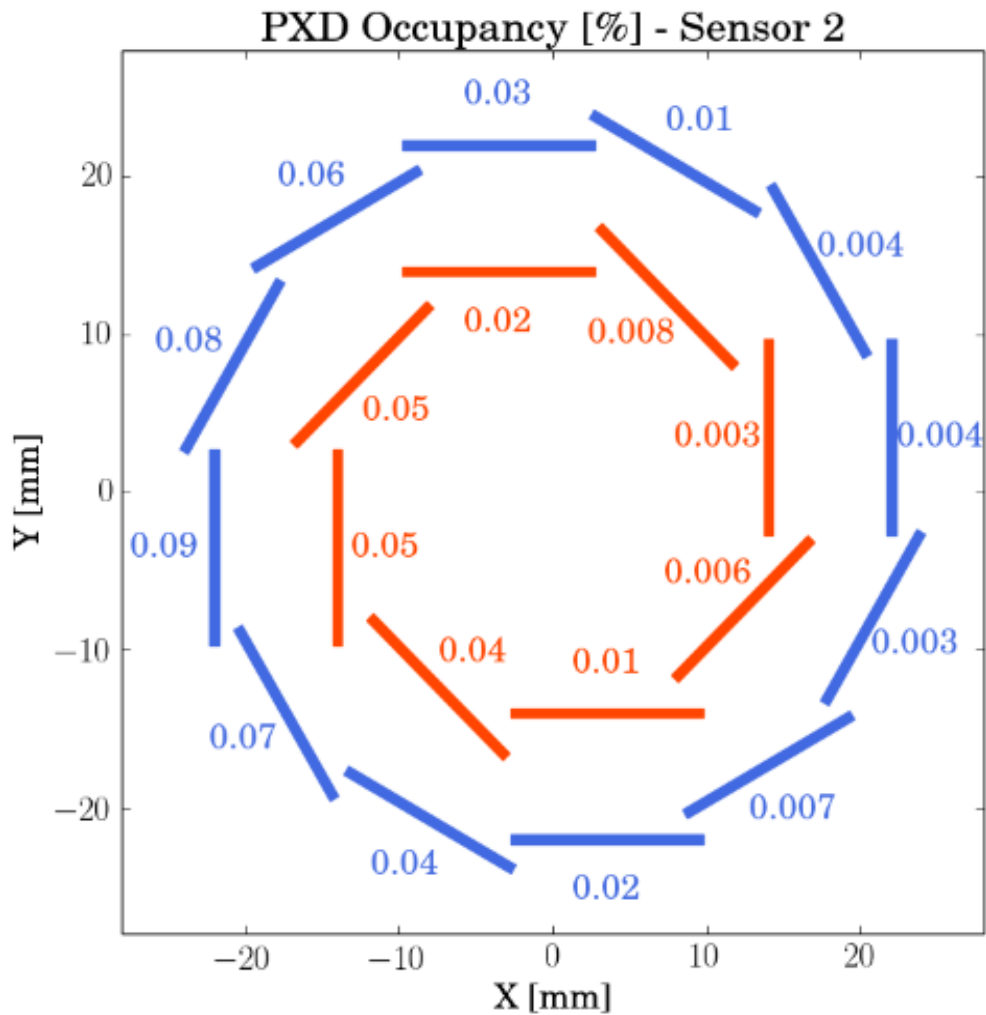
Additional material

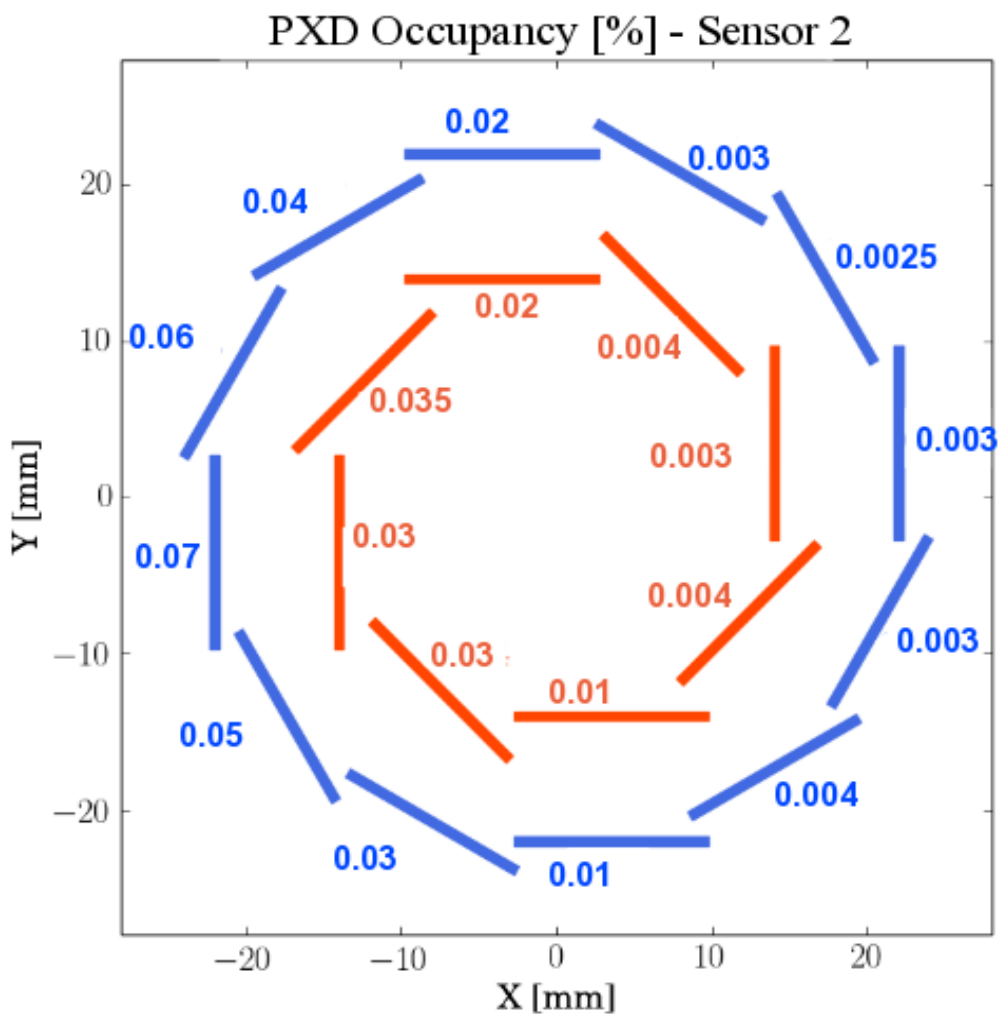# Forward sensors

PySynRad
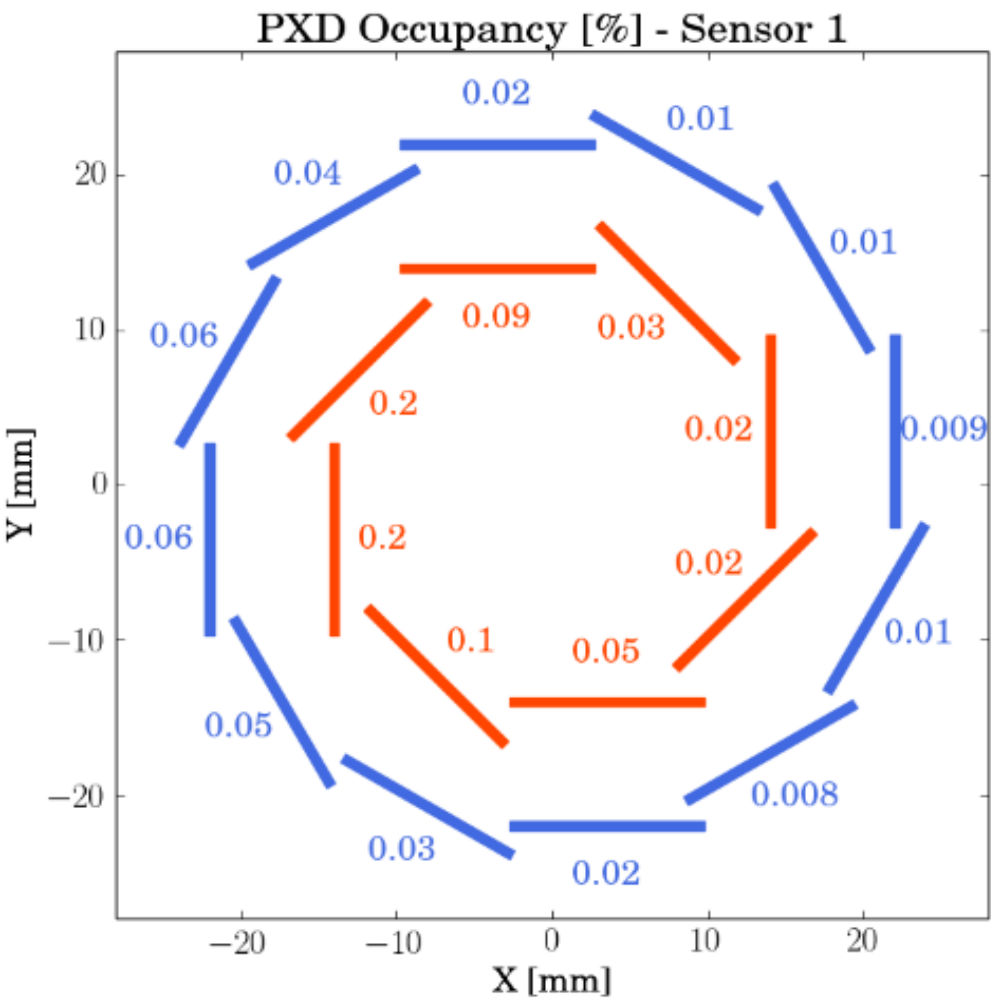
GEANT4
with lattice from PySynRad
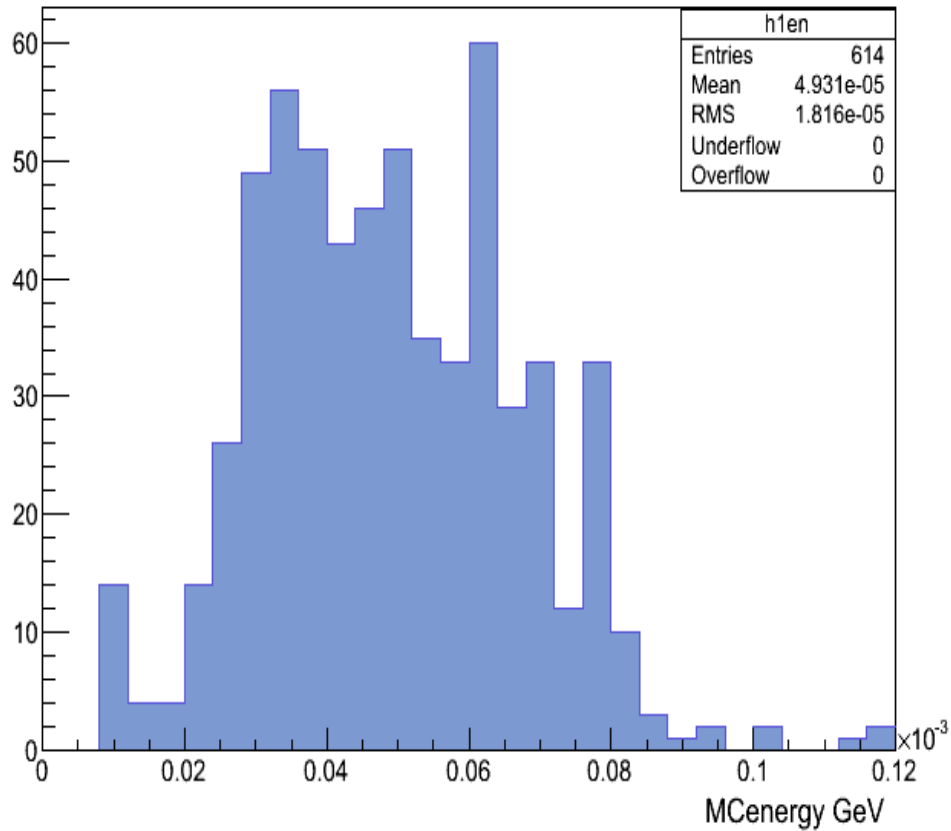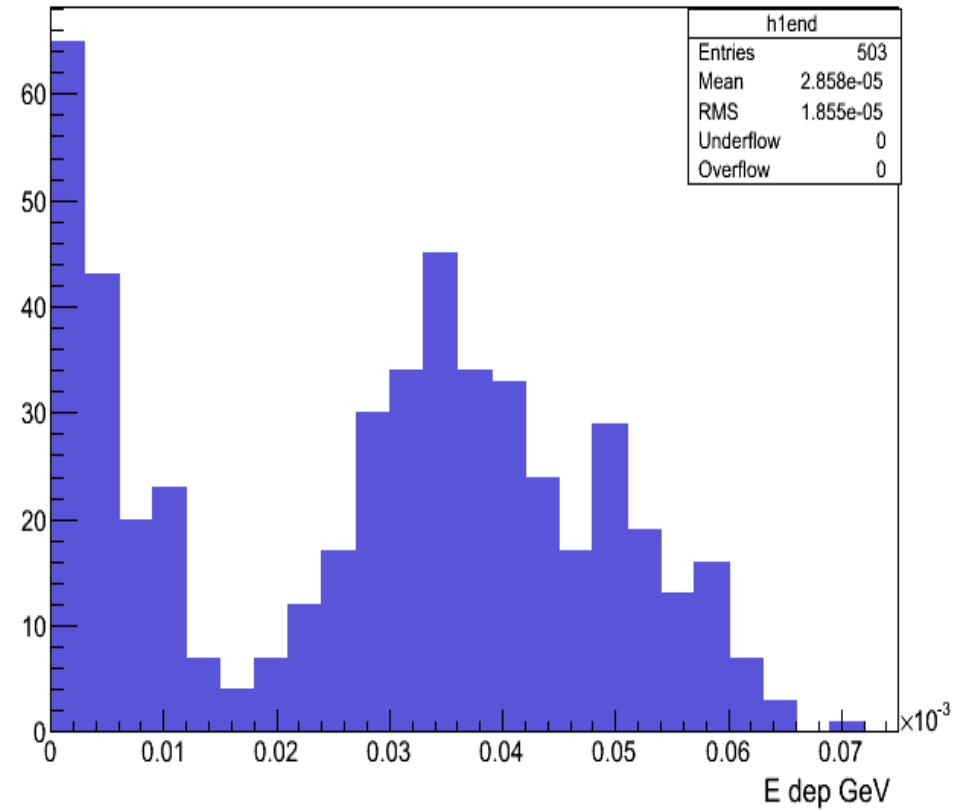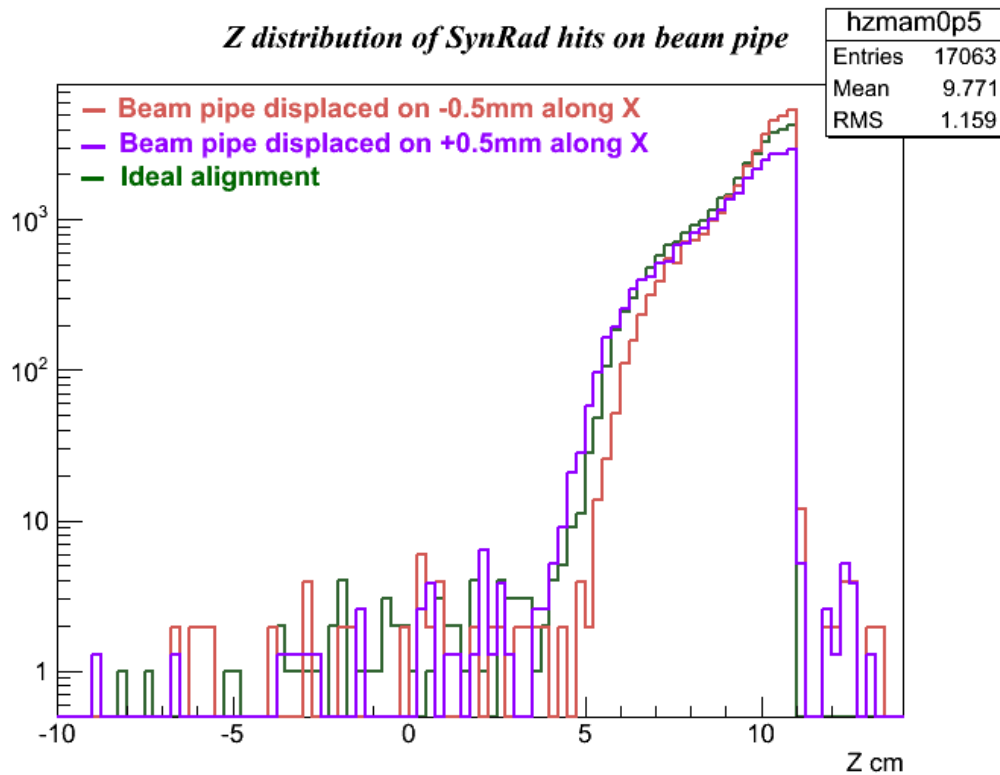
Backward sensors

PySynRad

GEANT4
with lattice from PySynRad

Energy of generated SR photon that hit PXD

h1en	
Entries	614
Mean	4.931e-05
RMS	1.816e-05
Underflow	0
Overflow	0

Energy deposit in PXD

h1end	
Entries	503
Mean	2.858e-05
RMS	1.855e-05
Underflow	0
Overflow	0

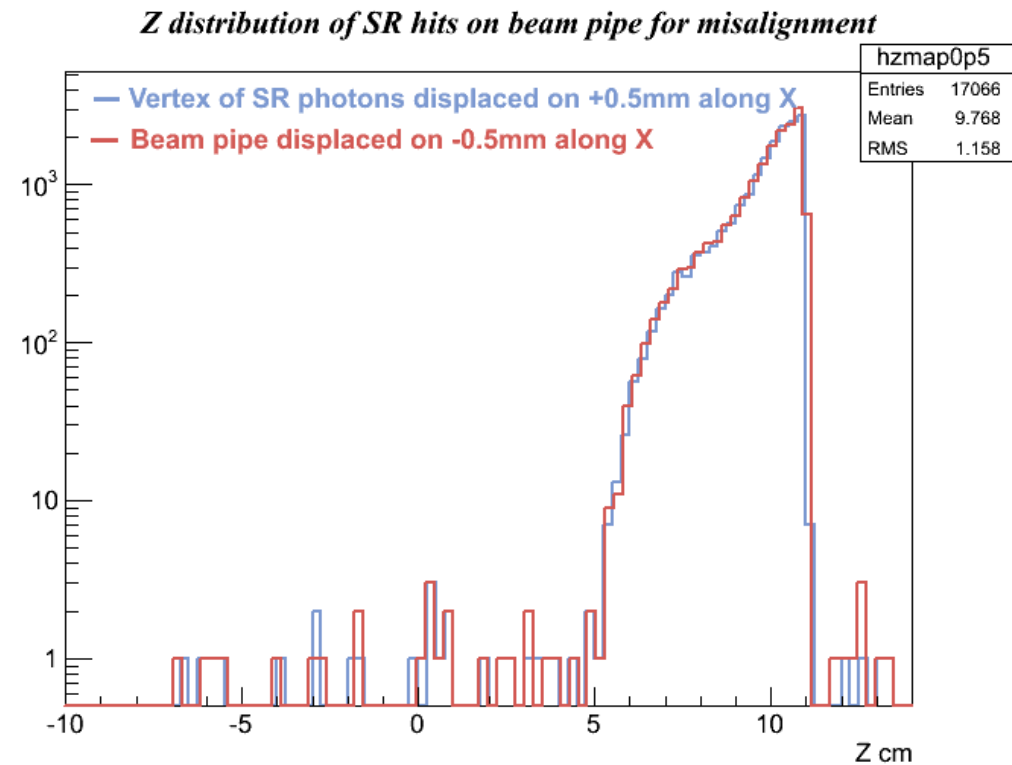# Misalignment – Z distribution of hits

Ideal alignment versus misalignment

Control plot