7th International Workshop on DEPFET Detectors and Applications

2011/05/09

Andreas Moll

Max-Planck-Institut für Physik

PXD Occupancy studies
from Machine and QED Background

- Touschek
- Radiative Bhabha scattering
- QED background

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

MAX-PLANCK-GESELLSCHAFT

Belle II

Excellence Cluster
Universe

Software used for the simulation

- Belle II software framework BASF2
- Geant4 Belle II detector simulation
- SVN head version of Peter Kvasnicka's PXD digitizer
- For the sake of speed, only the geometries for IR, PXD, SVD and CDC were enabled in the simulation

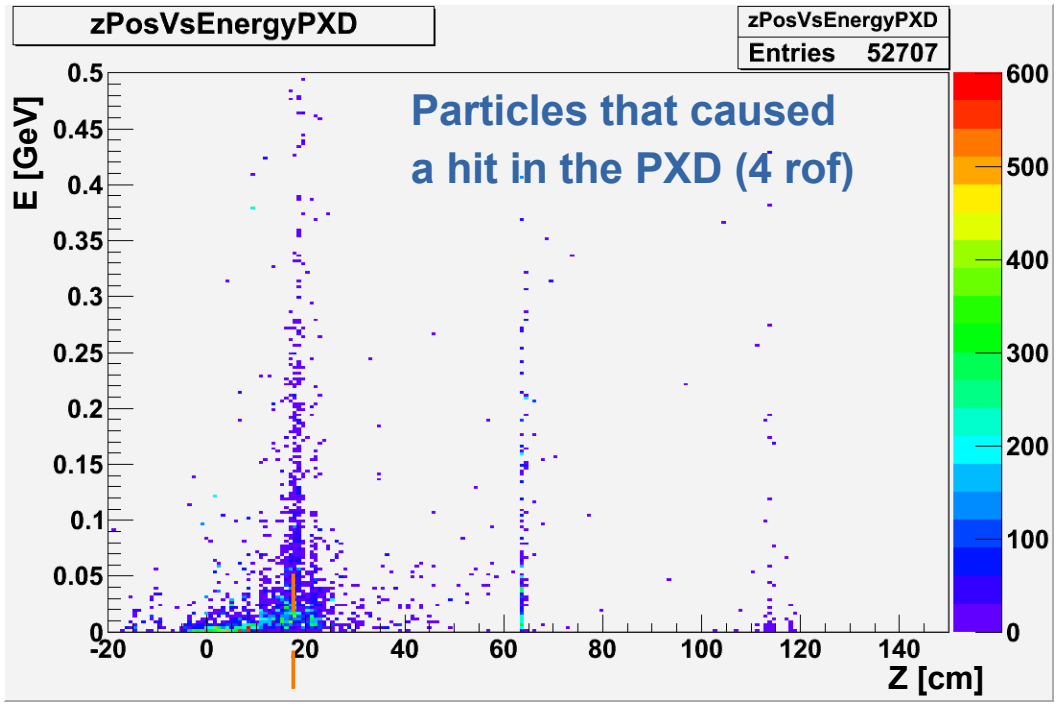
Specs and results

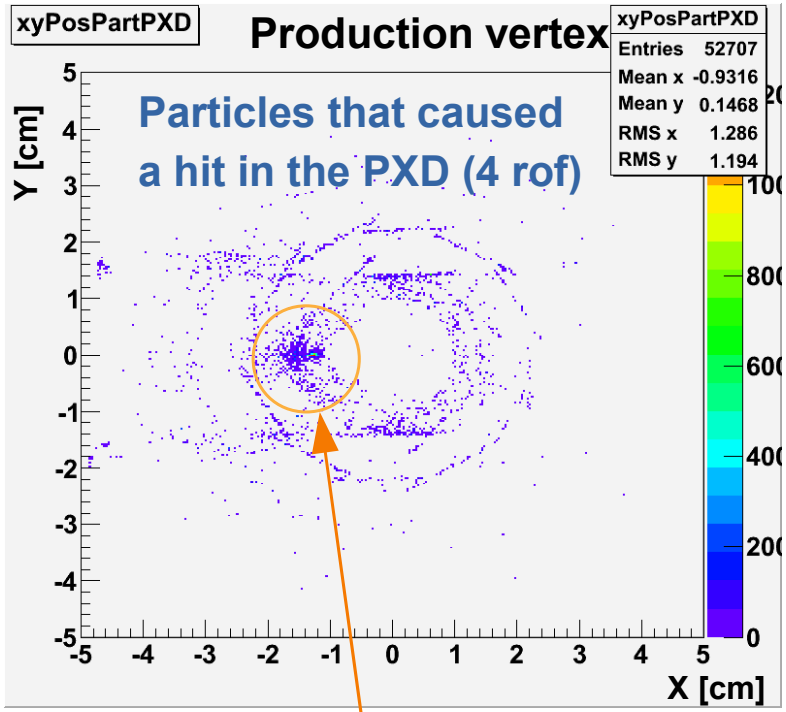
- The number of background events is estimated for the nominal luminosity of SuperKEKB: **$8 \cdot 10^{35}$ cm^2 · s^{-1}**
- The occupancies are given for one readout frame (**rof**) of the PXD

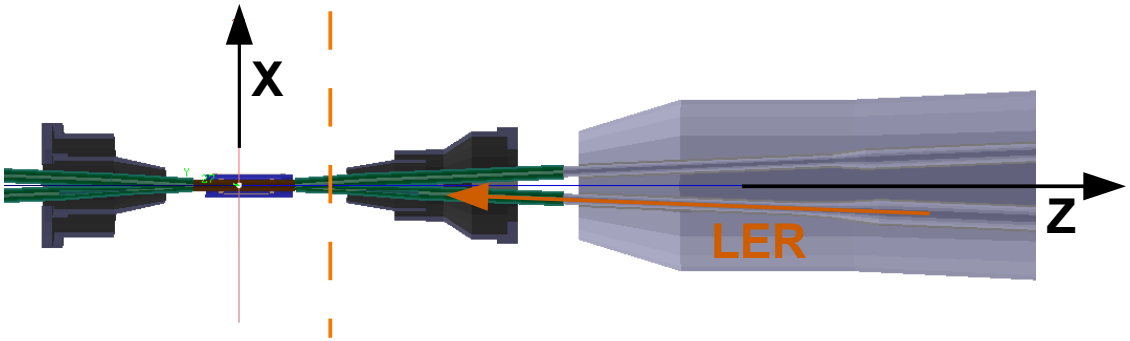
Touschek

from SAD

Generator:	**SAD**
Events per ROF:	**17870** ***in range [-3.9, 3.9] meters around IP***
Simulated:	**4 rof**
Ring:	**LER**

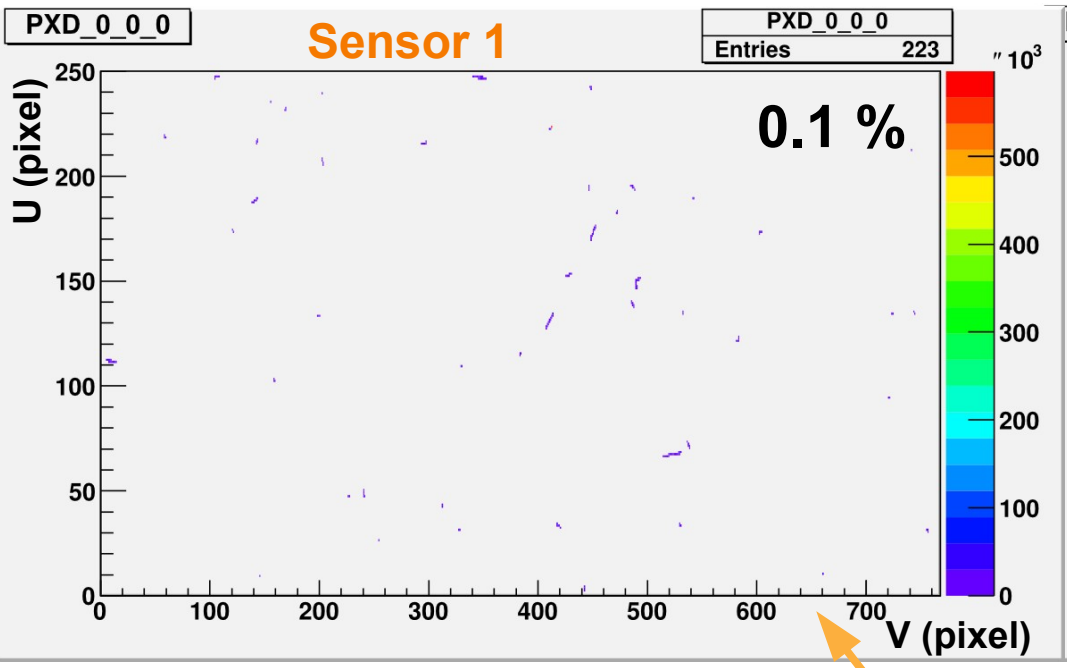


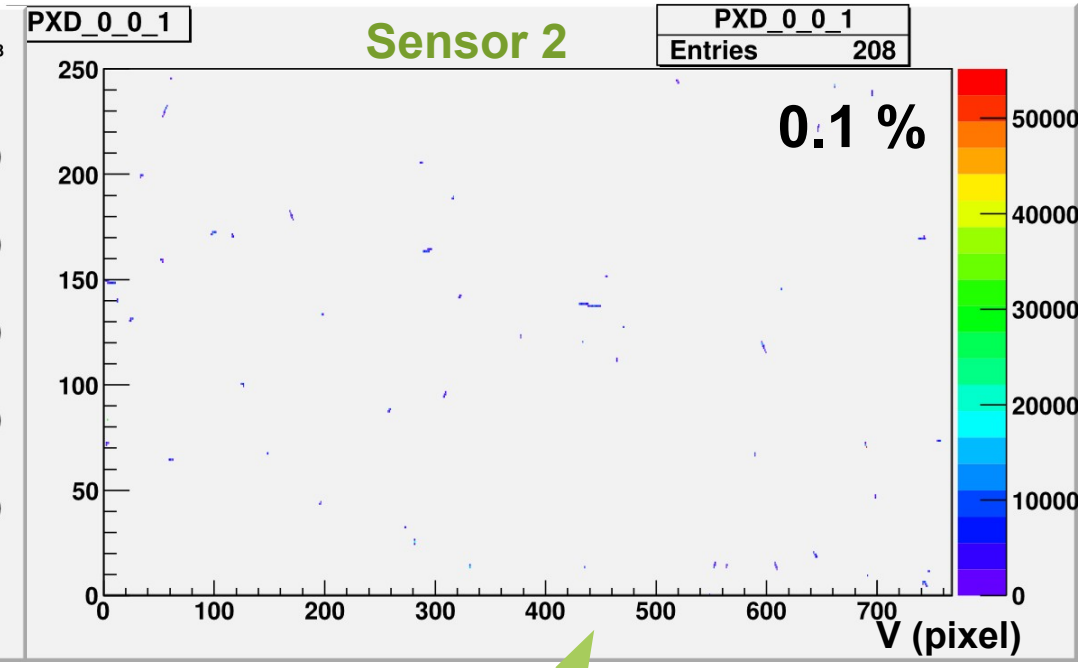




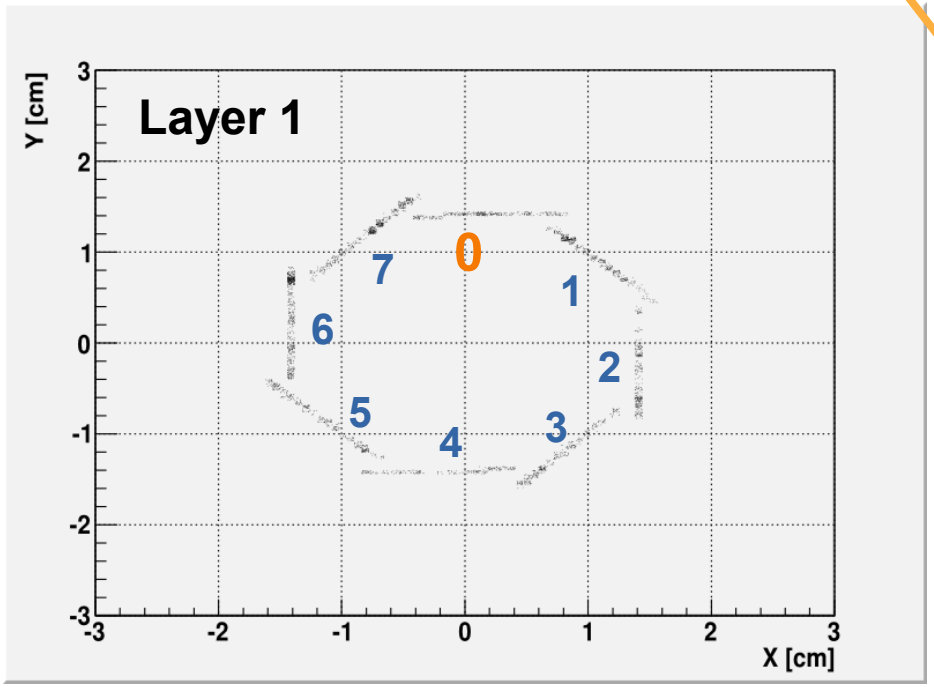
Most showers
are created here

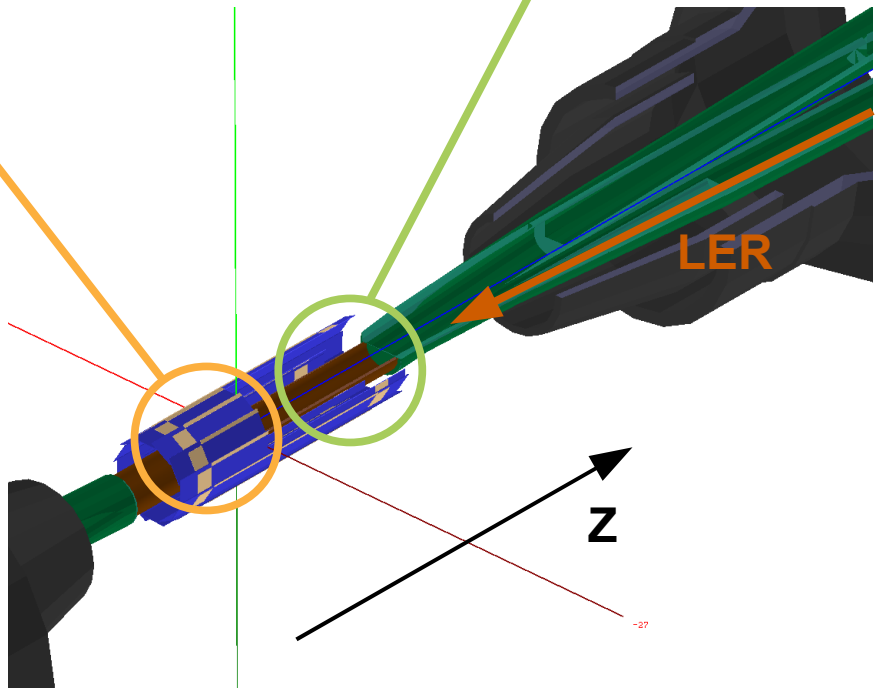
Touschek background – Pixel map (for one rof)



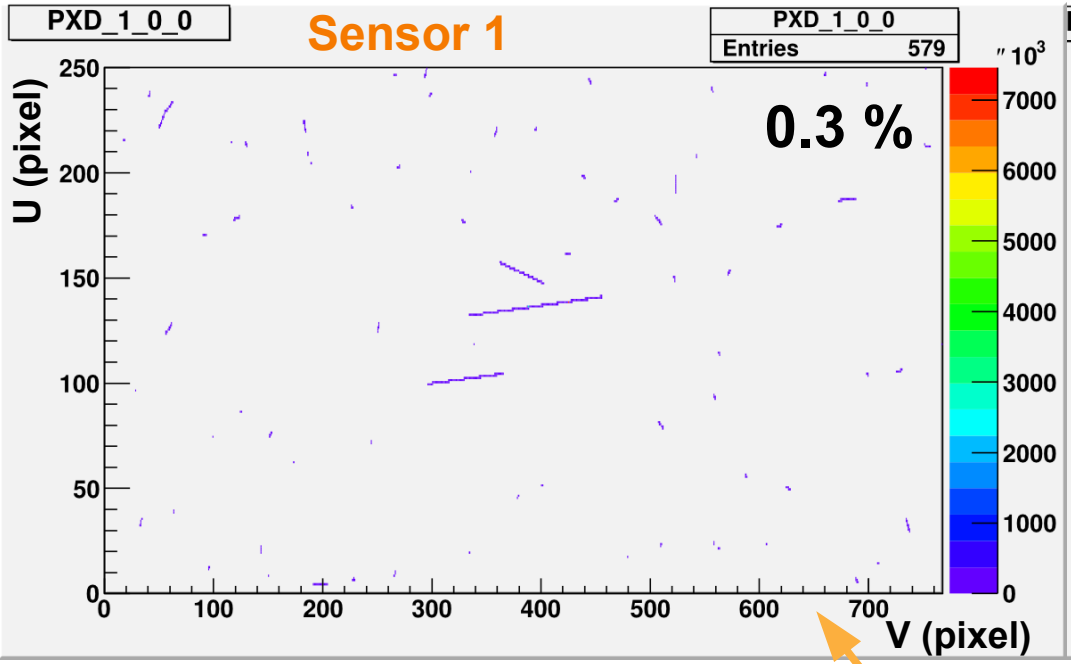


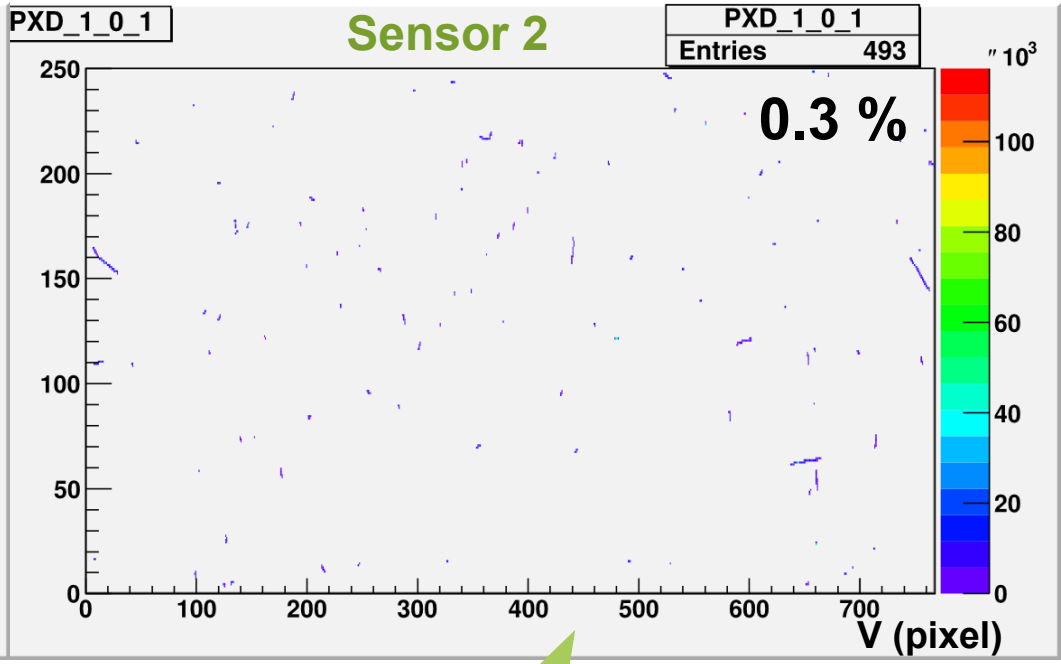
Layer 1 and Ladder 0 is shown here



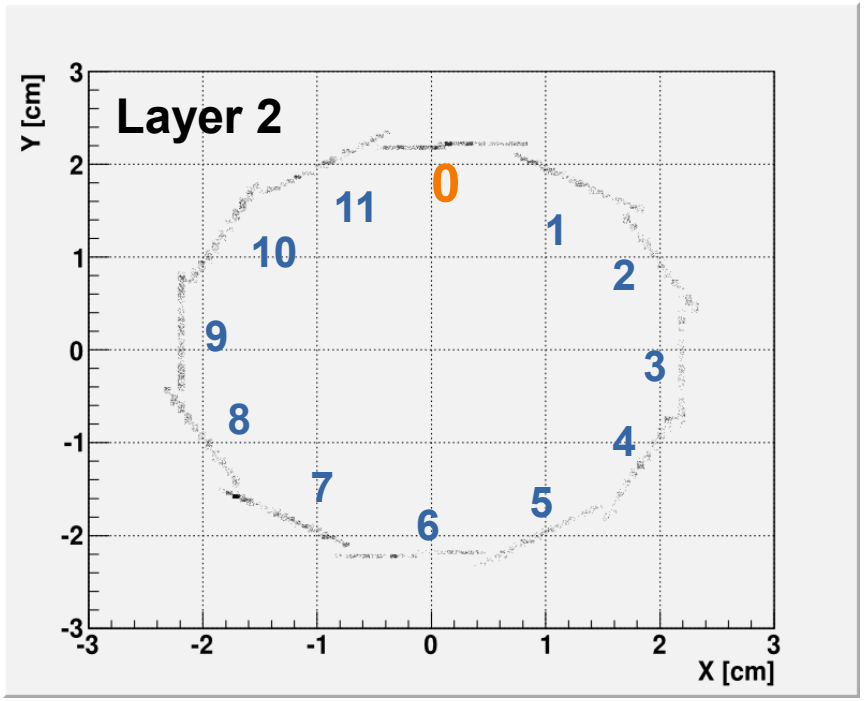


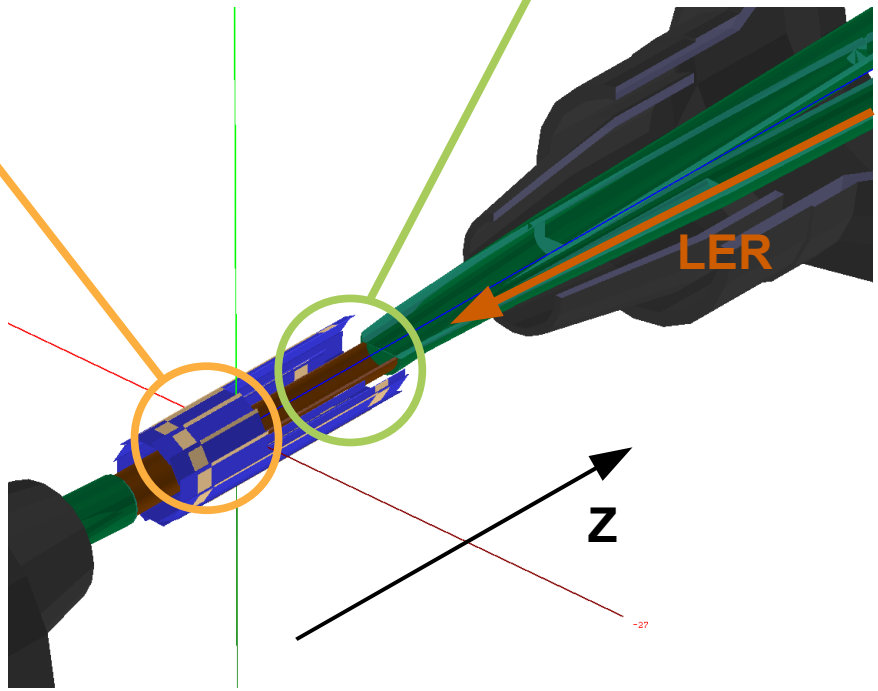
Touschek background – Pixel map



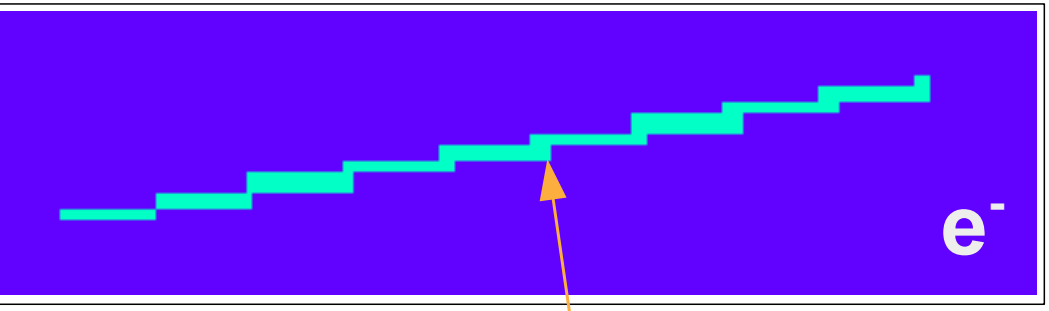


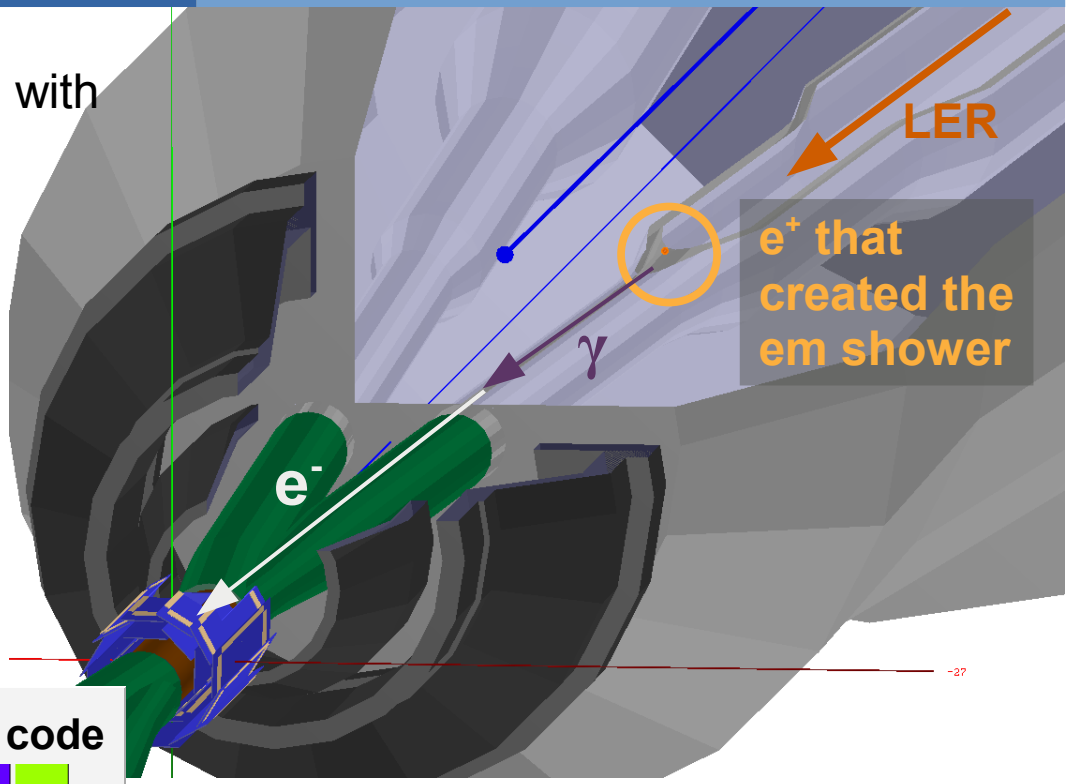
Layer 2 and Ladder 0 is shown here

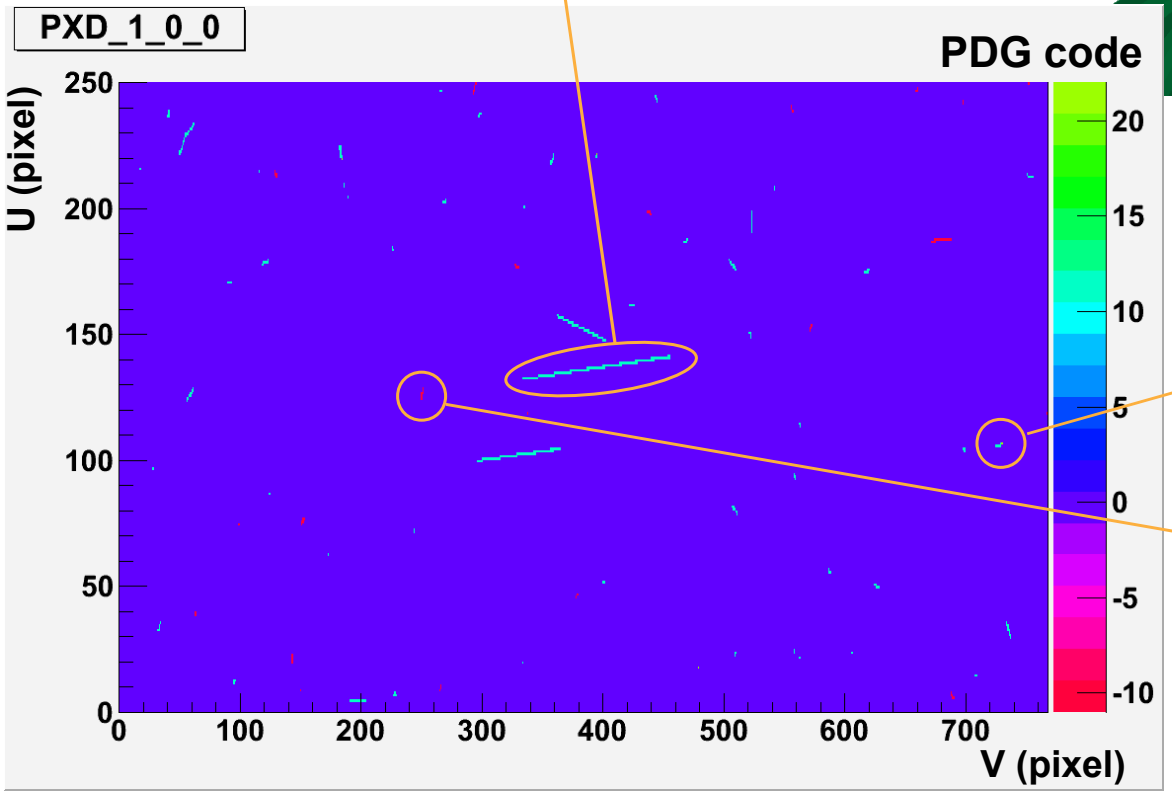


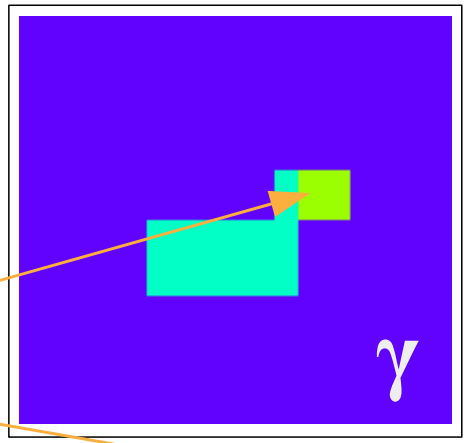


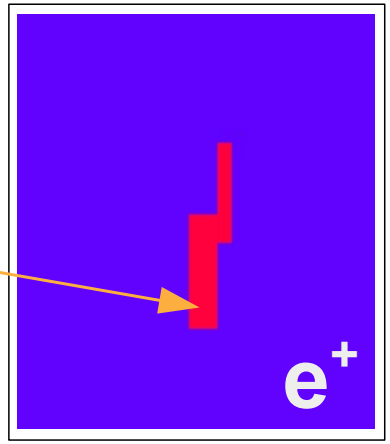
The long pixel cluster is created by an electron with momentum: $p(9\cdot10^{-2}, 7\cdot10^{-3}, -\mathbf{2.3})GeV$

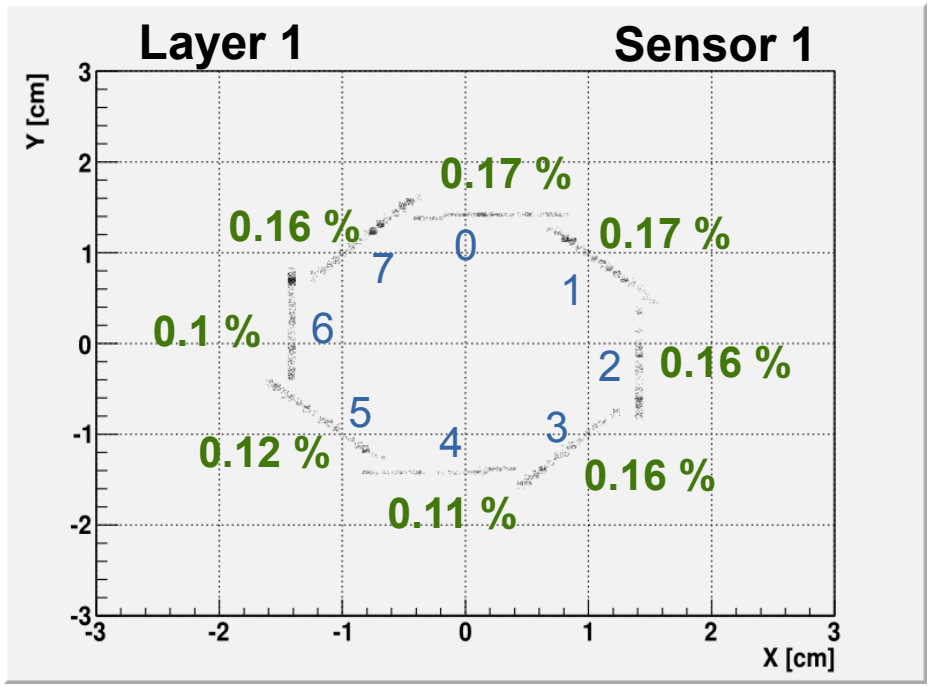











Layer 1
Sensor 1
Y [cm]
X [cm]
0.17 %
0.16 %
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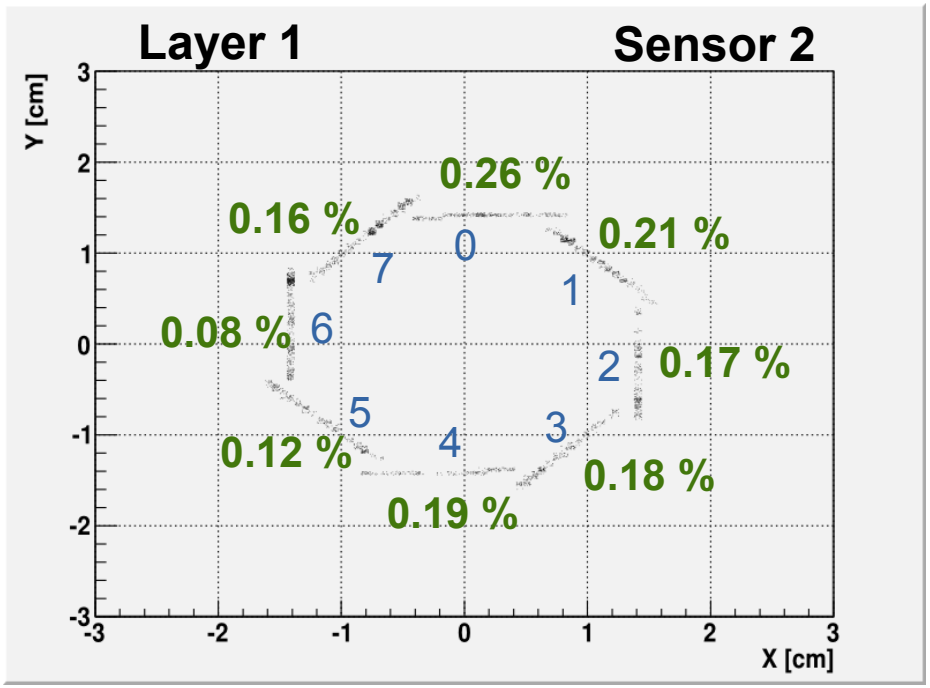
Layer 1
Sensor 2
Y [cm]
X [cm]
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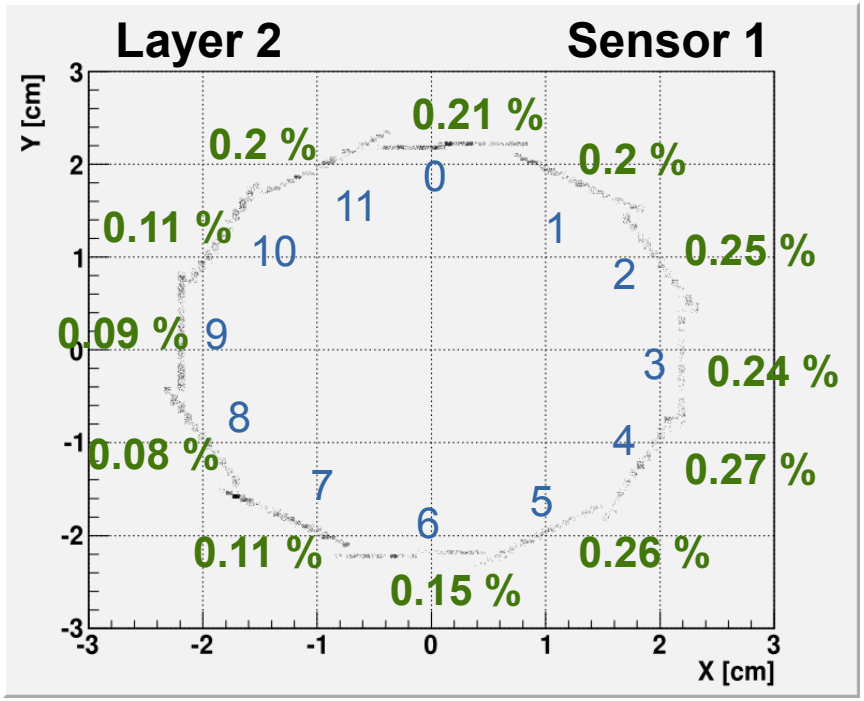
Layer 2
Sensor 1
Y [cm]
X [cm]
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0.2 %
0.2 %
0.11 %
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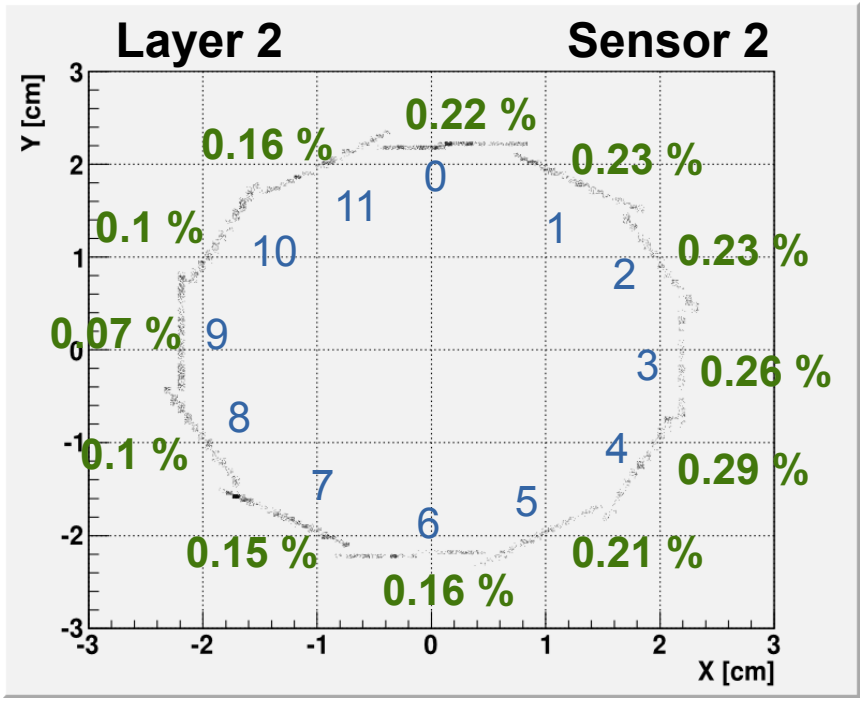
Layer 2
Sensor 2
Y [cm]
X [cm]
0.22 %
0.16 %
0.23 %
0.1 %
0.23 %
0.07 %
0.26 %
0.1 %
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0.15 %
0.21 %
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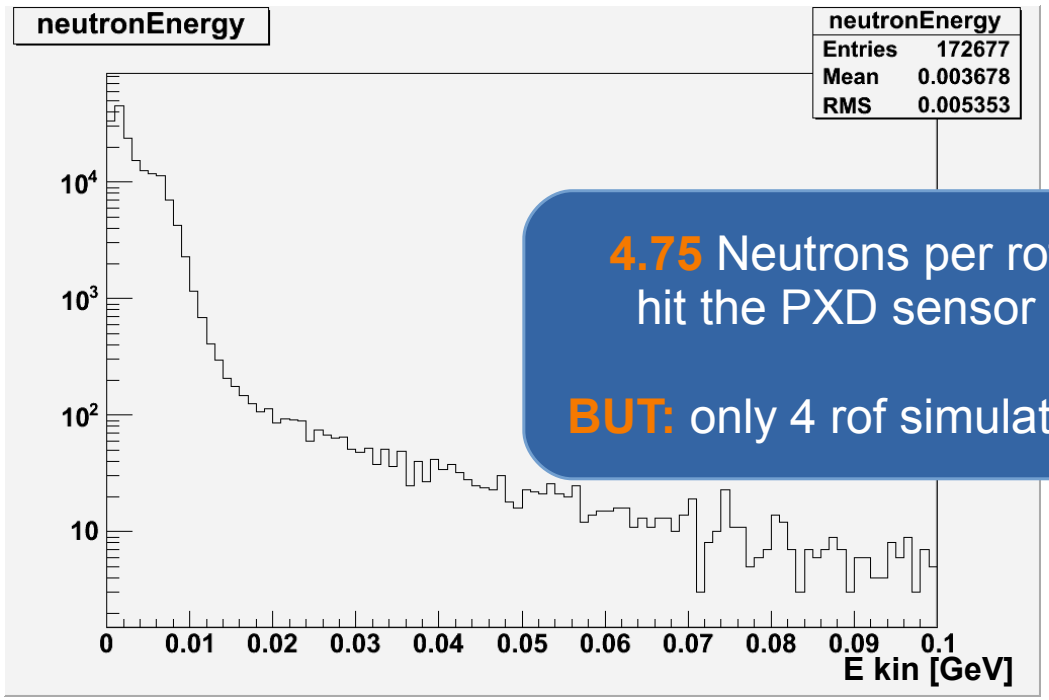
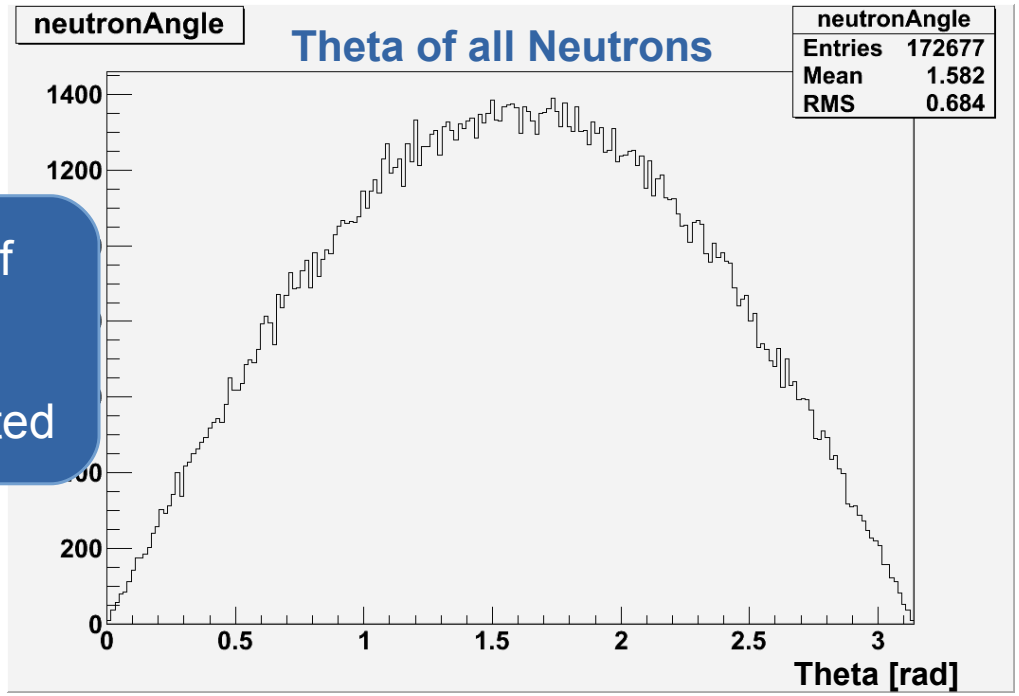
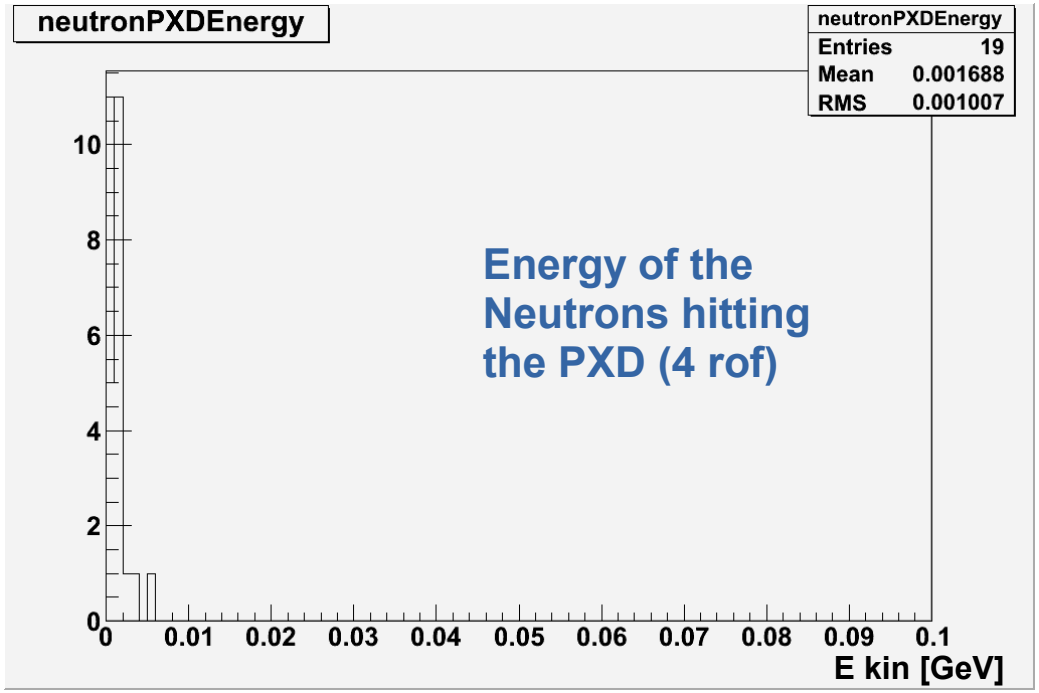
Touschek background – Neutrons (for 4 rof)

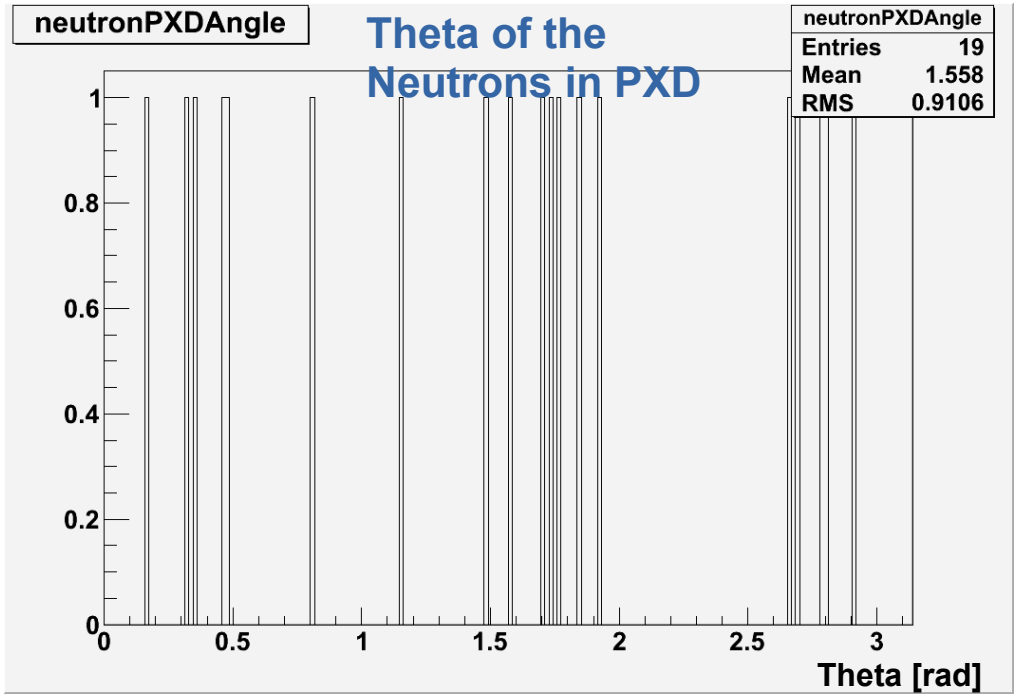


4.75 Neutrons per rof hit the PXD sensor

BUT: only 4 rof simulated







Radiative Bhabha scattering

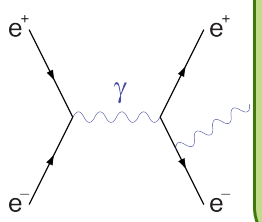
from BBBrems and BHWide

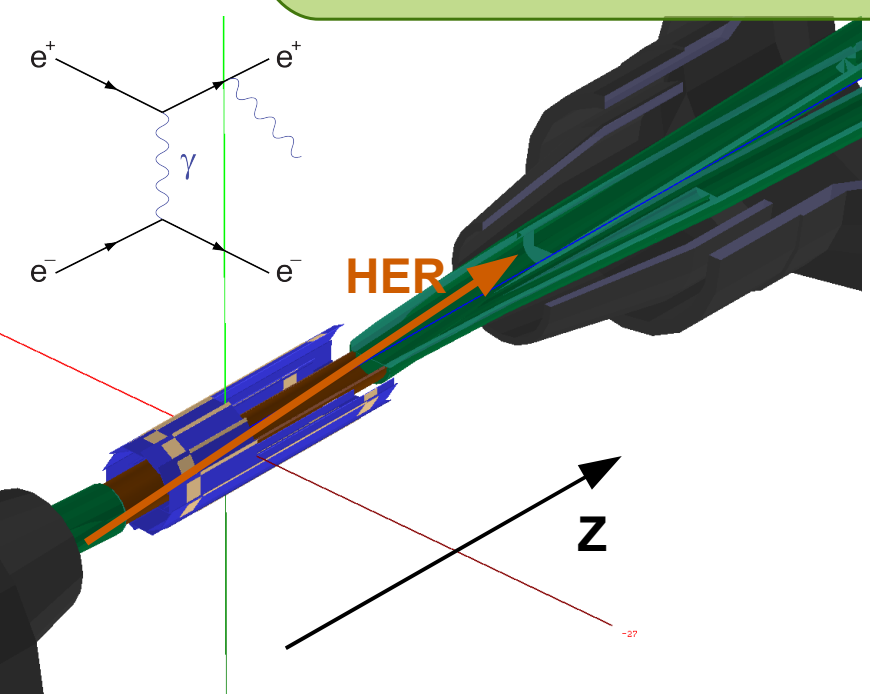
Low angle scattering

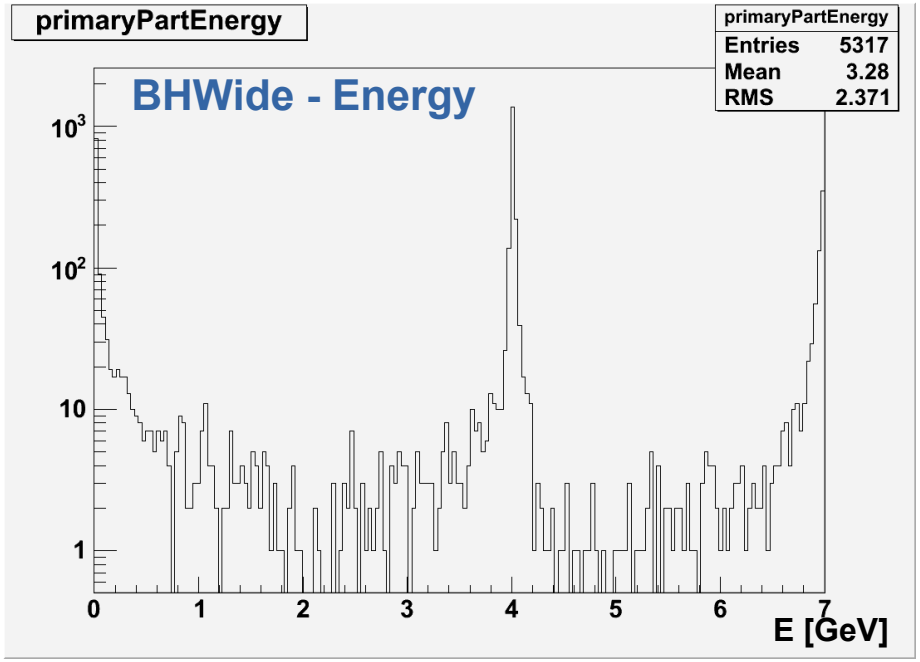
Generator:	**BBBrems**
Cross section:	**$\sigma = 1 \cdot 10^3$ mb**
Events per ROF:	**$16 \cdot 10^6$**
Simulated:	**1 rof**

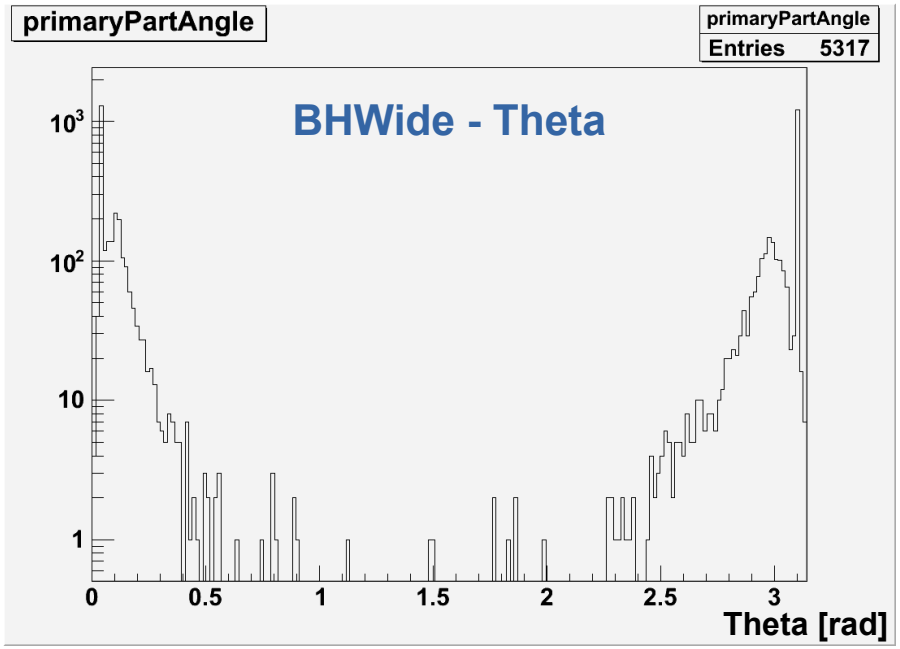
Large angle scattering

Generator:	**BHWide**
Cross section:	**$\sigma = 1.1$ µb**
Events per ROF:	**17.8**
Simulated:	**56 rof**

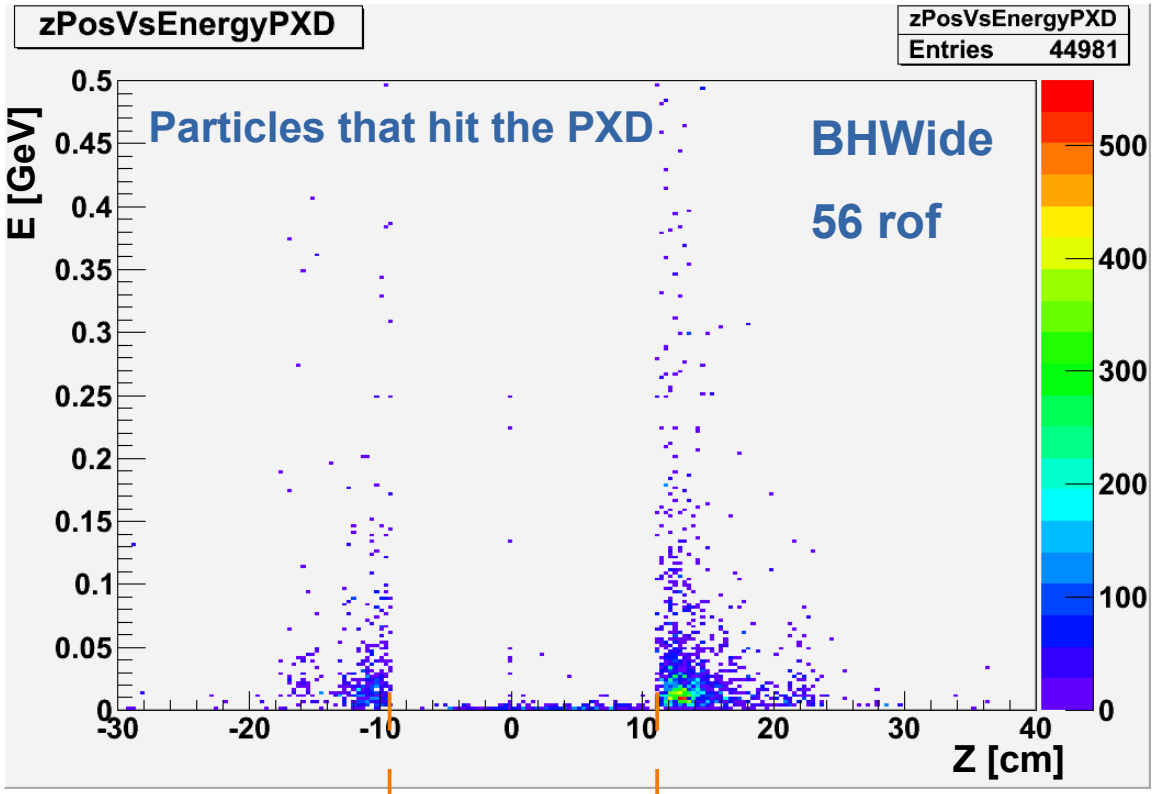


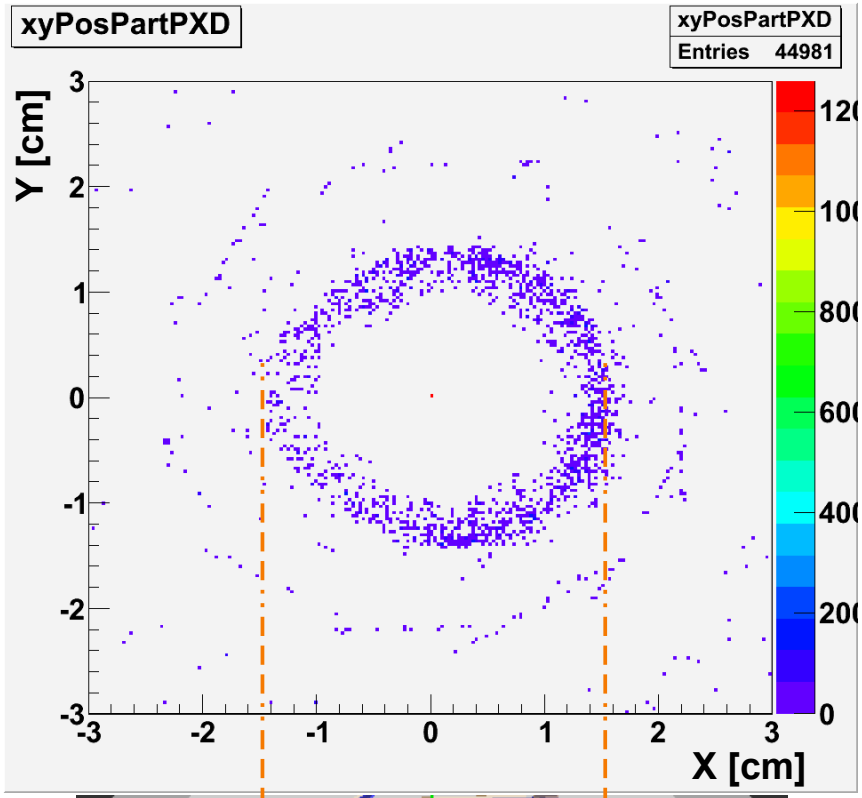


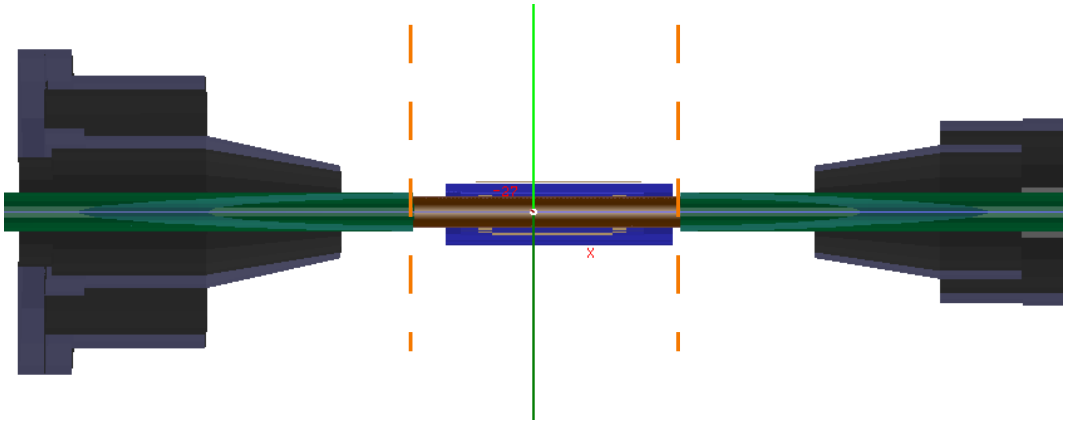


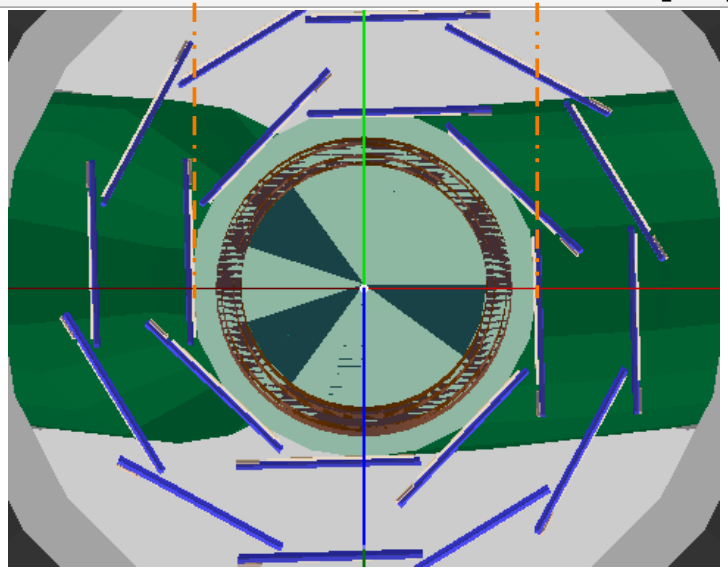


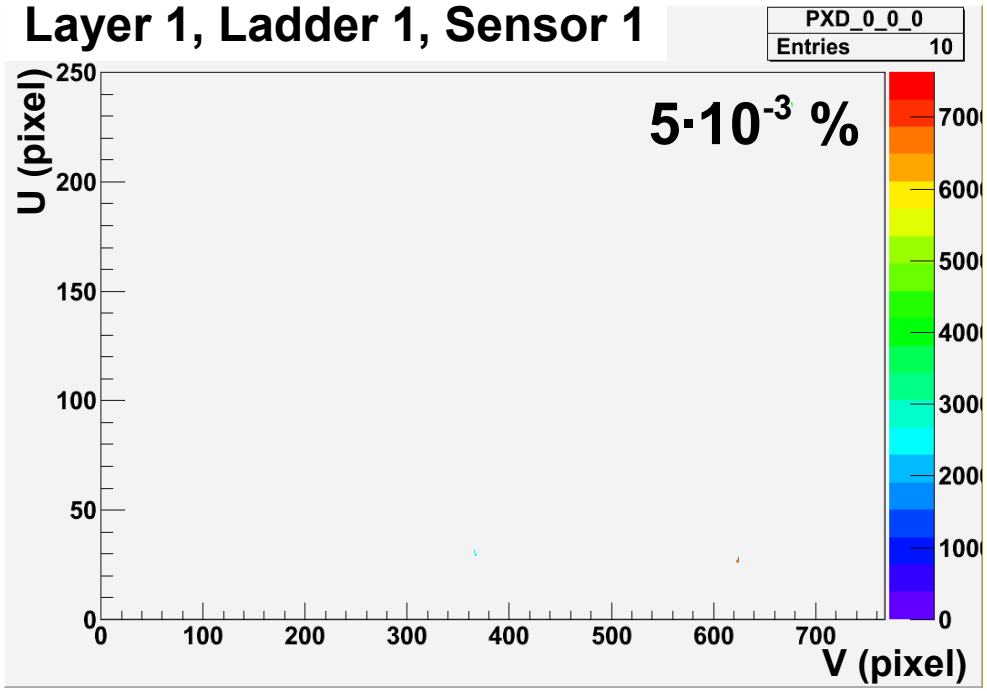
Where do the particles hitting the PXD come from ?

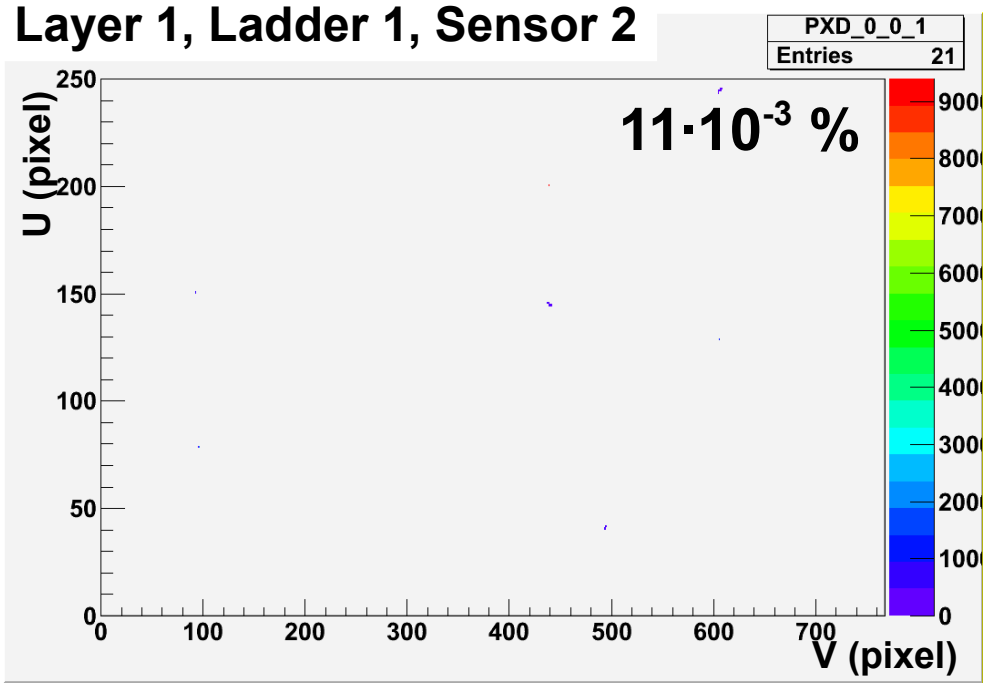









Layer 1, Ladder 1, Sensor 1
PXD_0_0_0
Entries 10
5·10-3 %
U (pixel)
V (pixel)


Layer 1, Ladder 1, Sensor 2
PXD_0_0_1
Entries 21
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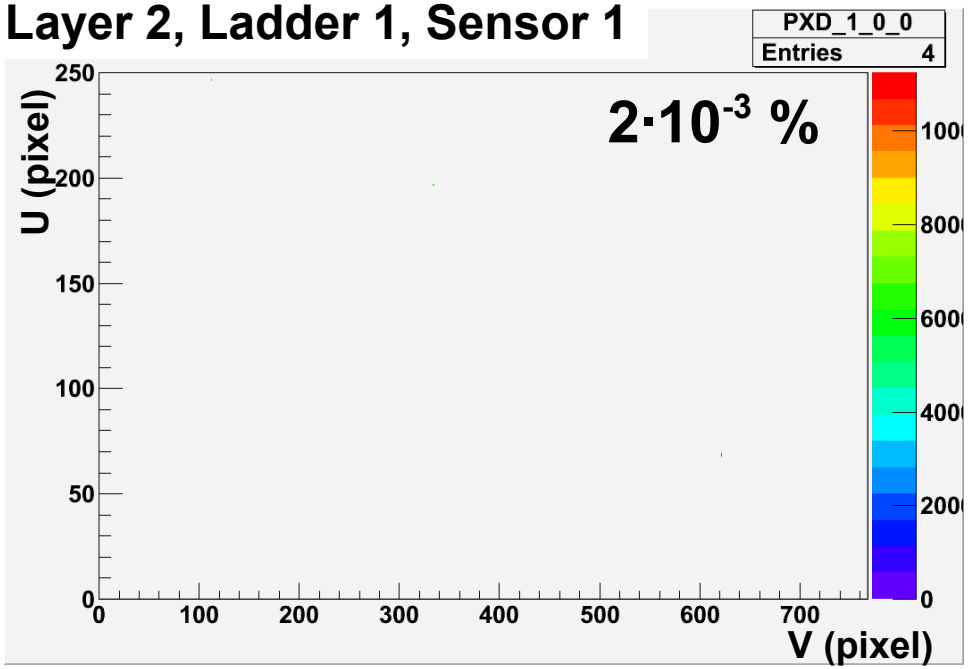
V (pixel)


Layer 2, Ladder 1, Sensor 1
PXD_1_0_0
Entries 4
2·10-3 %
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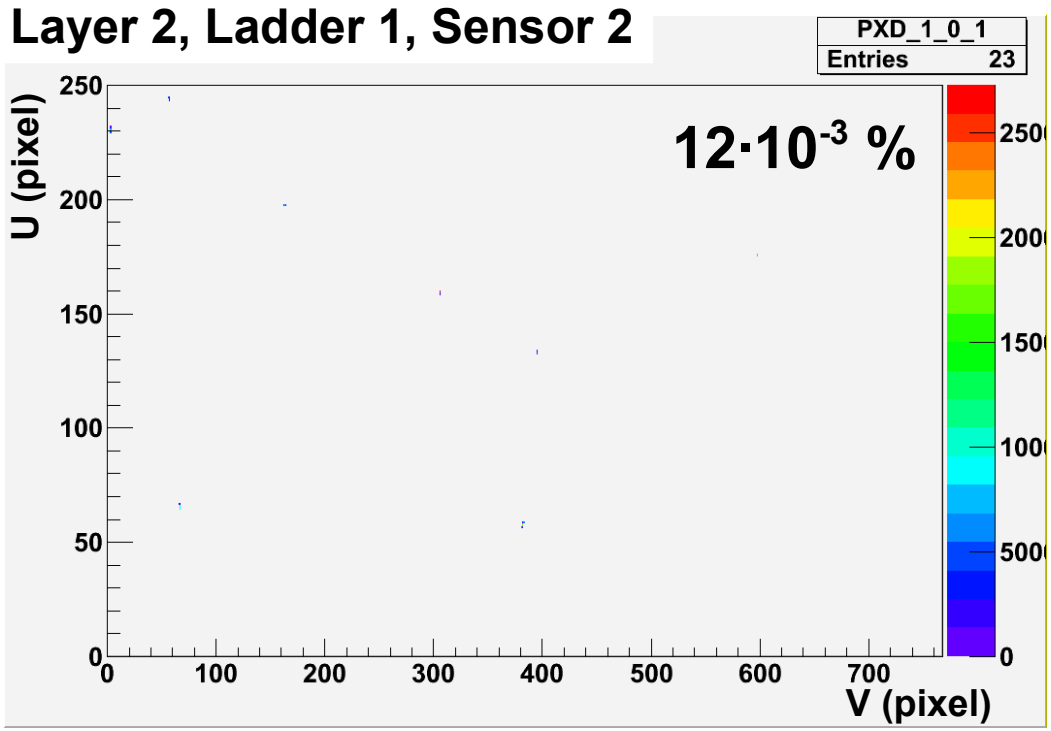
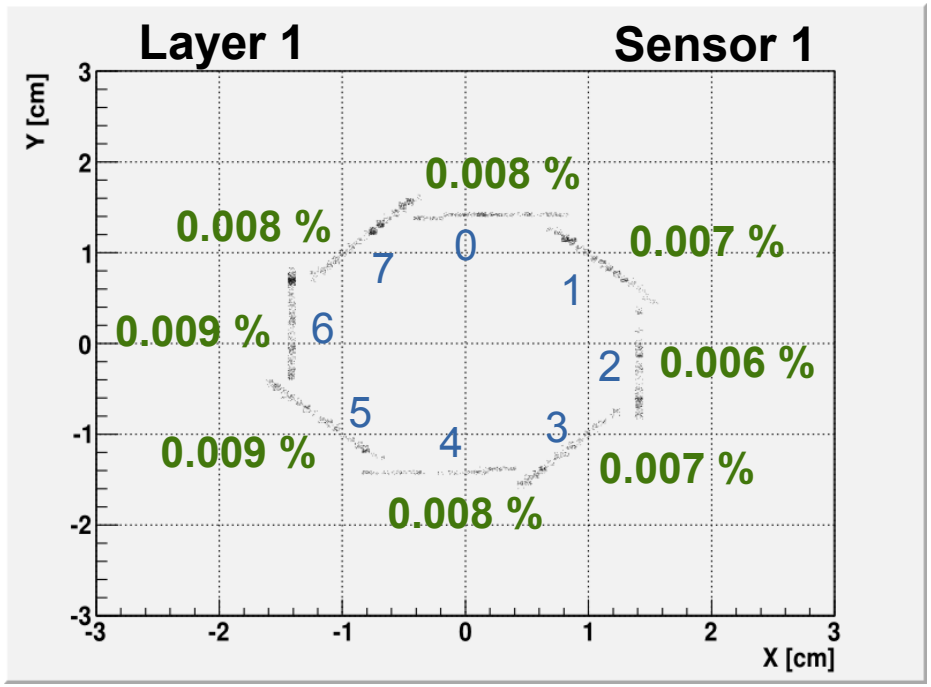
V (pixel)


Layer 2, Ladder 1, Sensor 2
PXD_1_0_1
Entries 23
12·10-3 %
U (pixel)
V (pixel)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X [cm]
0.008 %
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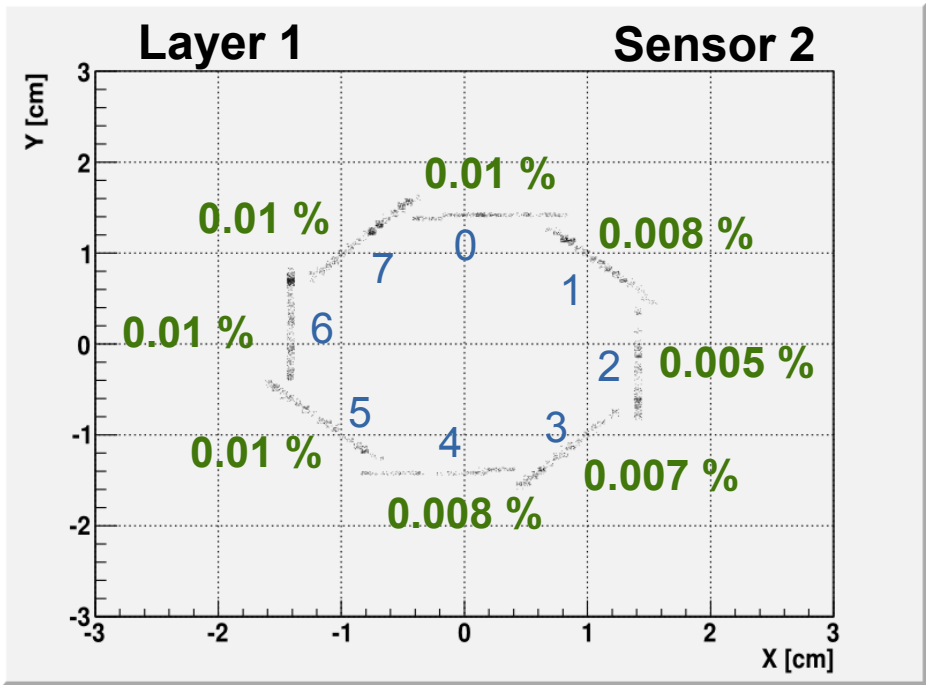
Layer 1
Sensor 2
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X [cm]
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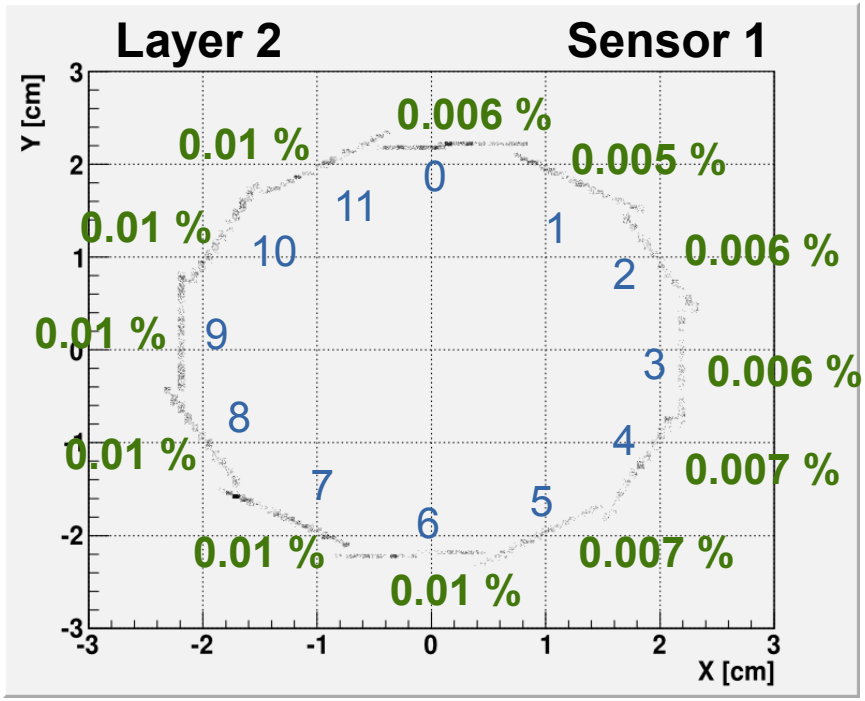
Layer 2
Sensor 1
Y [cm]
X [cm]
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0.006 %
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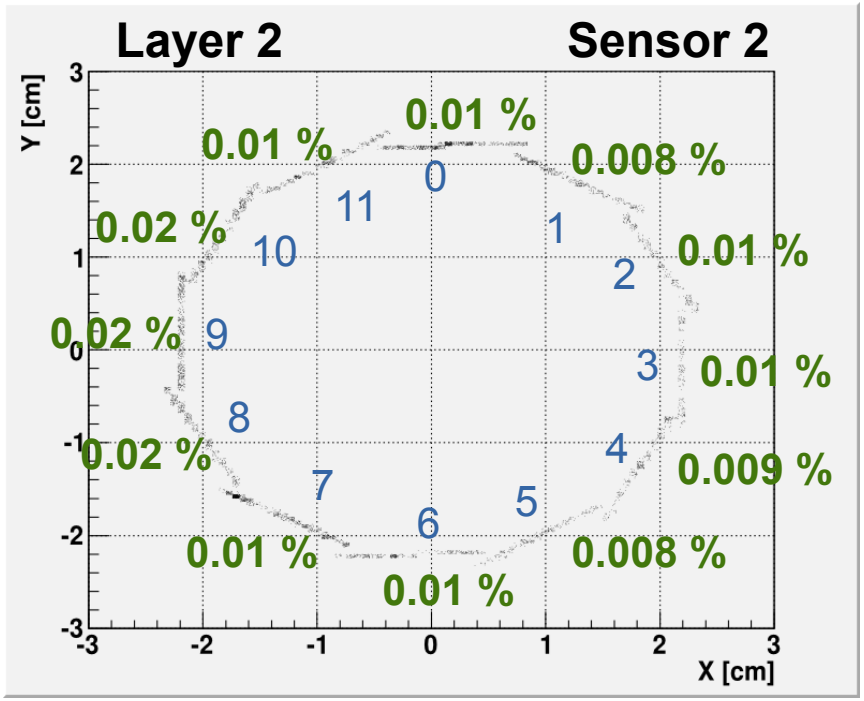
Layer 2
Sensor 2
Y [cm]
X [cm]
0.01 %
0.01 %
0.008 %
0.02 %
0.01 %
0.02 %
0.01 %
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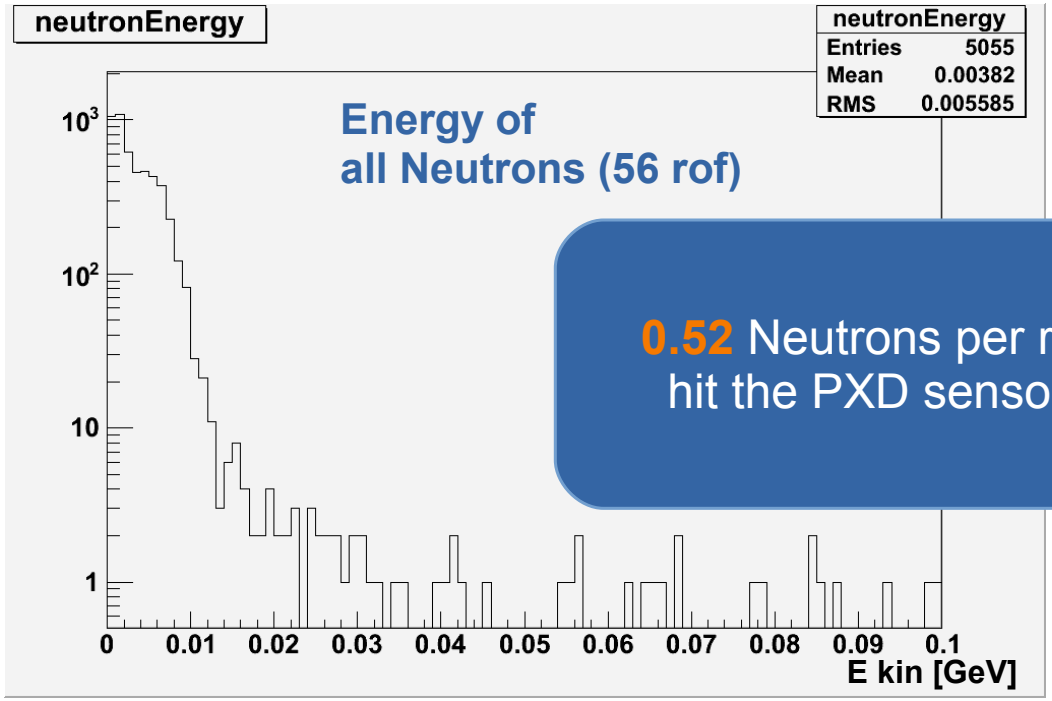
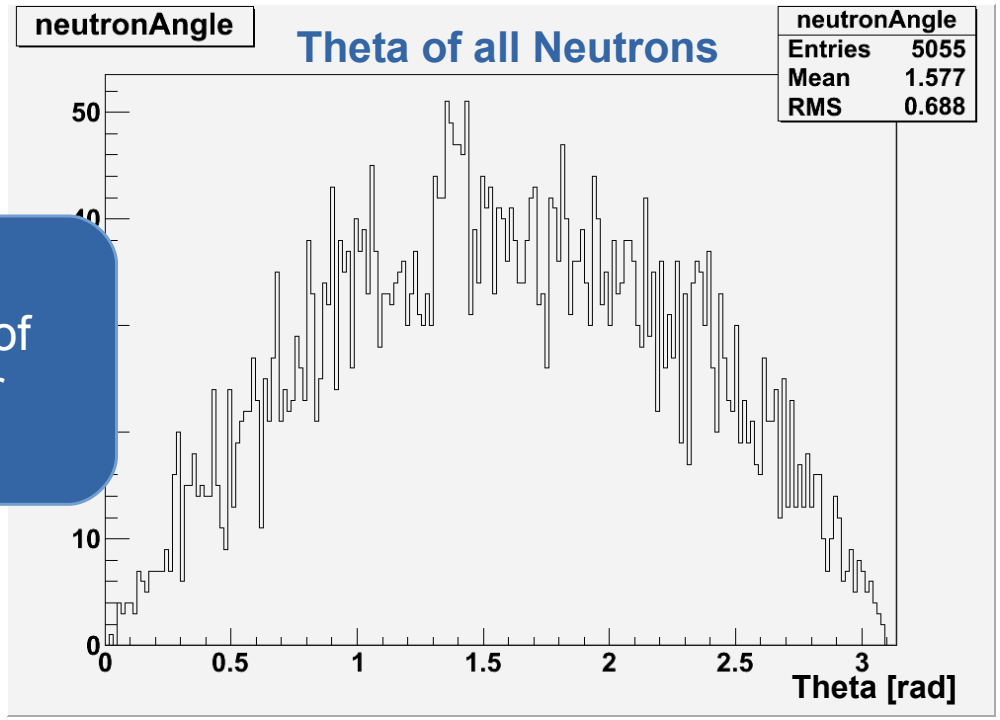
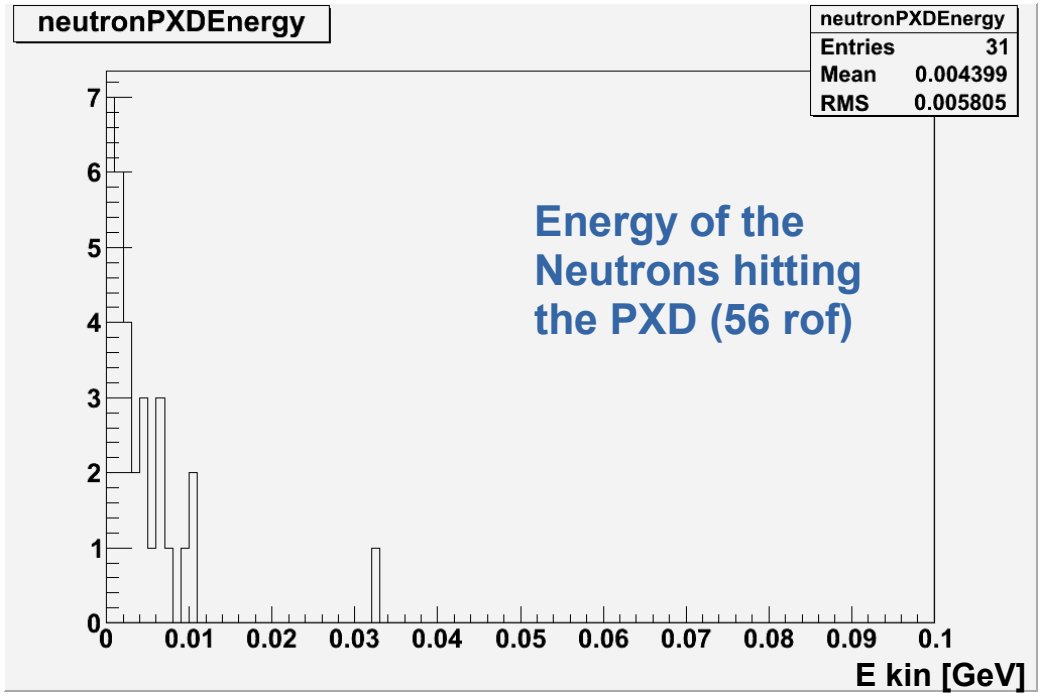
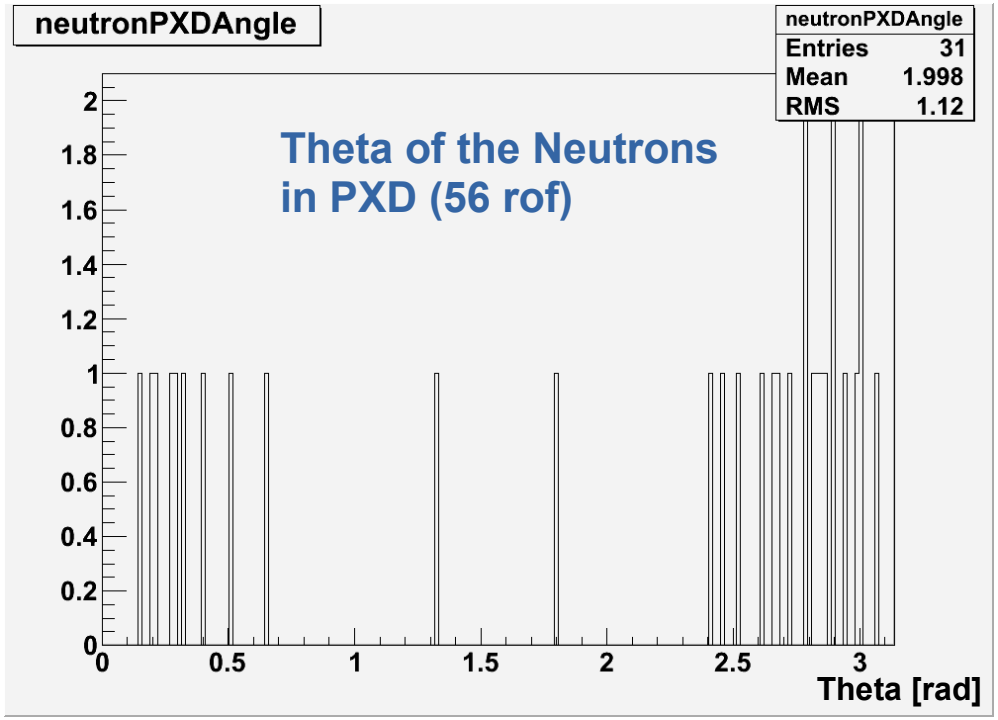


0.52 Neutrons per rof hit the PXD sensor







- Simulated 10^6 events
- Corresponds to **0.625** rof

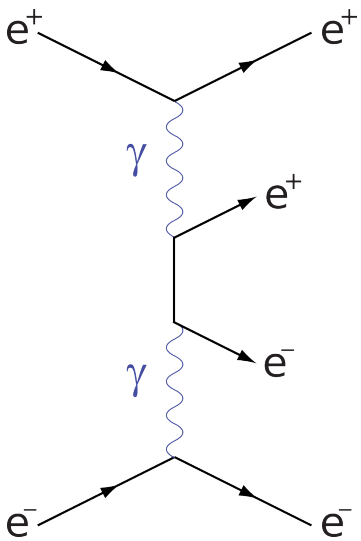
Occupancies:

Layer	Ladder	Sensor1	Sensor2	Layer	Ladder	Sensor1	Sensor2
1	1	*0 %*	*0 %*	2	1	*0 %*	*0 %*
1	2	$4 \cdot 10^{-9}$ %	$2 \cdot 10^{-9}$ %	2	2	$2 \cdot 10^{-9}$ %	$2 \cdot 10^{-9}$ %
1	3	$3 \cdot 10^{-9}$ %	$10 \cdot 10^{-9}$ %	2	3	$5 \cdot 10^{-9}$ %	$3 \cdot 10^{-9}$ %
1	4	$4 \cdot 10^{-9}$ %	$2 \cdot 10^{-9}$ %	2	4	$1 \cdot 10^{-9}$ %	$7 \cdot 10^{-9}$ %
1	5	*0 %*	*0 %*	2	5	$2 \cdot 10^{-9}$ %	$5 \cdot 10^{-9}$ %
1	6	*0 %*	*0 %*	2	6	$7 \cdot 10^{-9}$ %	$2 \cdot 10^{-9}$ %
1	7	$1 \cdot 10^{-9}$ %	*0 %*	2	7	*0 %*	*0 %*
1	8	$4 \cdot 10^{-9}$ %	*0 %*	2	8	*0 %*	*0 %*
				2	9	*0 %*	*0 %*
				2	10	*0 %*	*0 %*
				2	11	*0 %*	*0 %*
				2	12	*0 %*	*0 %*

Expected result. But more statistics is required.

QED Background

from KoralW

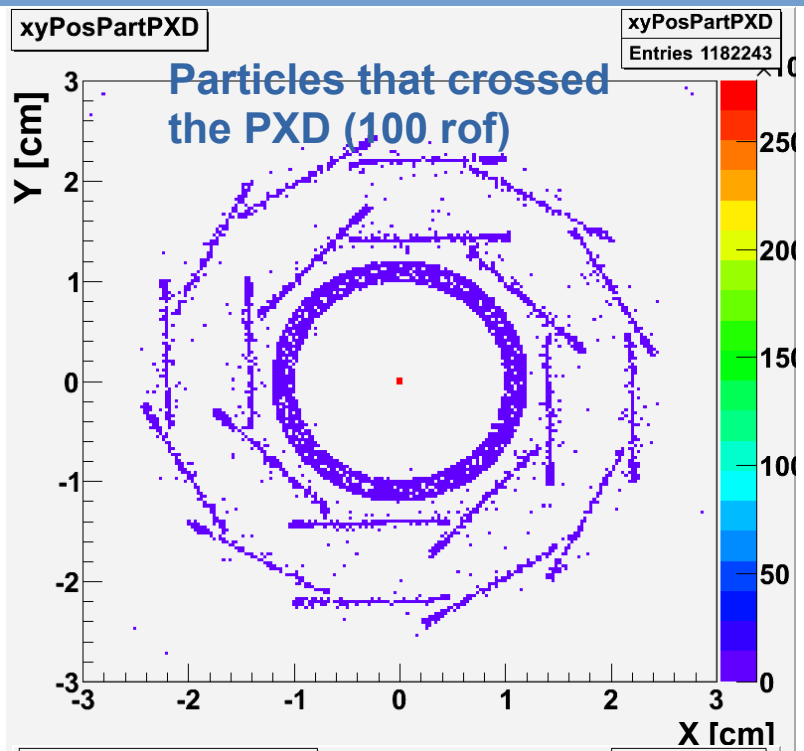


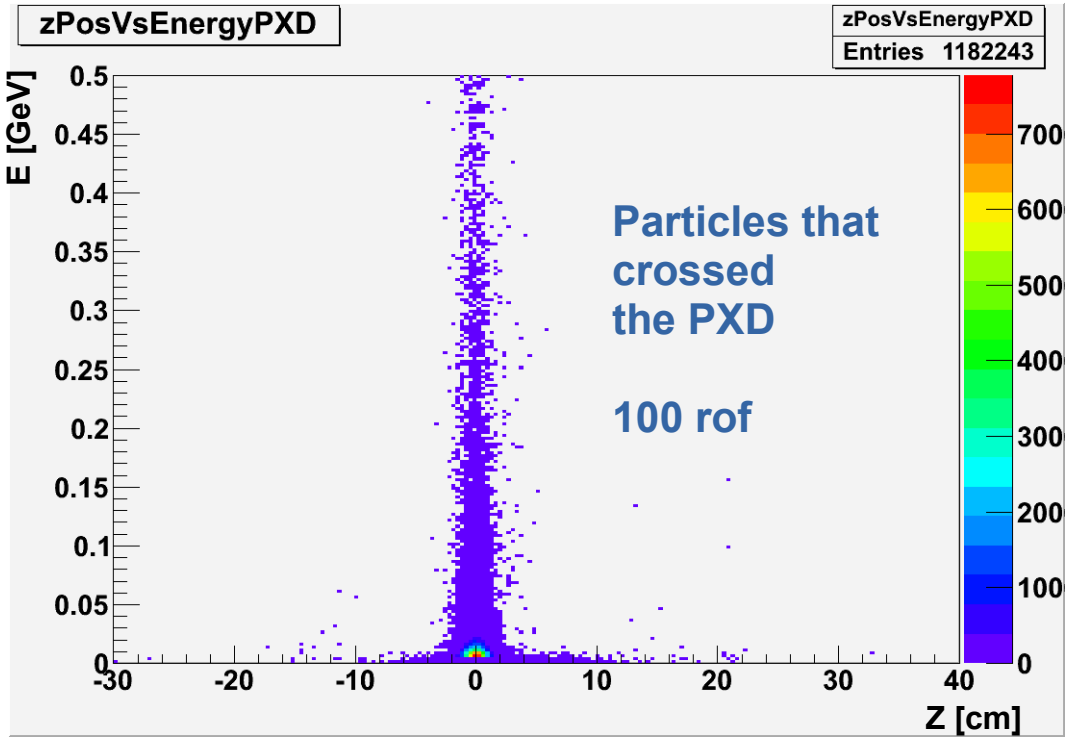
Two photon process

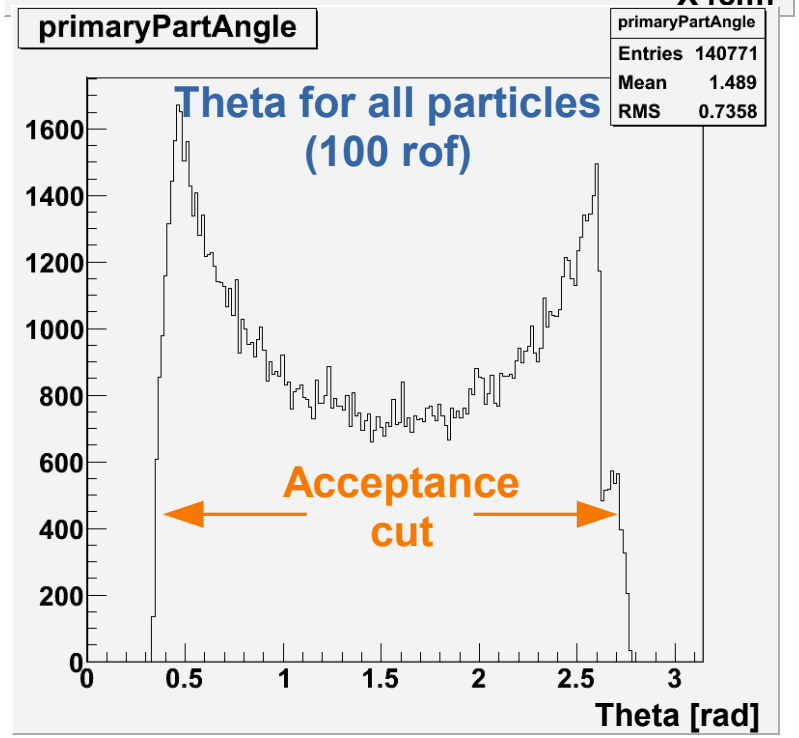
Generator: **KoralW**

Simulated: **100 rof**

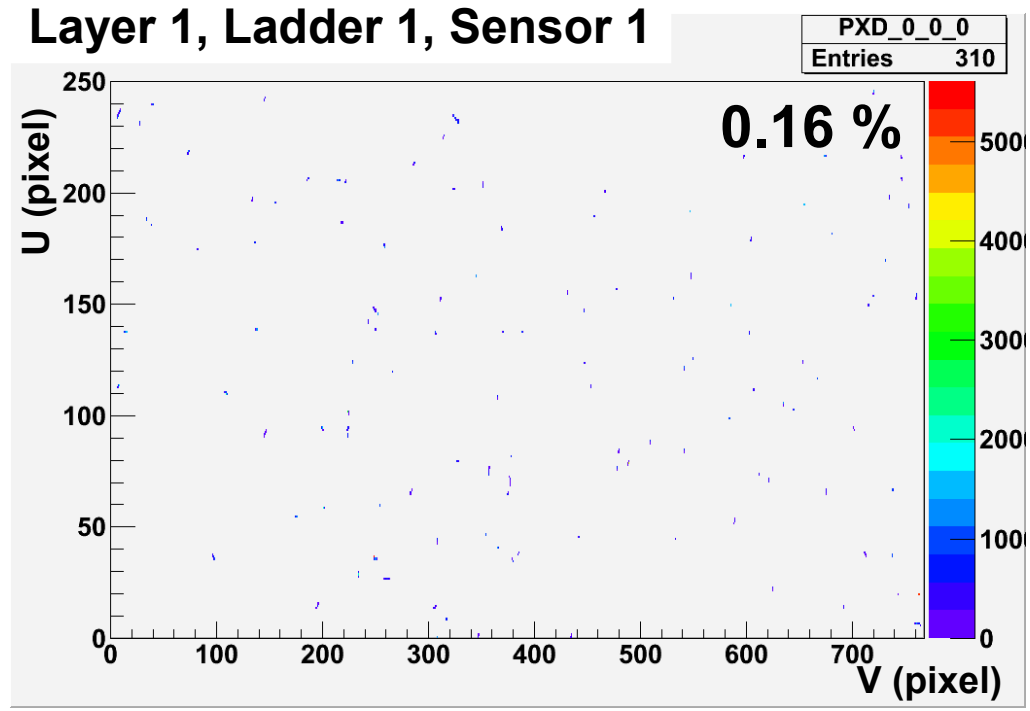
See talk by Elena Nedelkovska last DEPFET workshop *(7. - 9. Feb. 2011)*

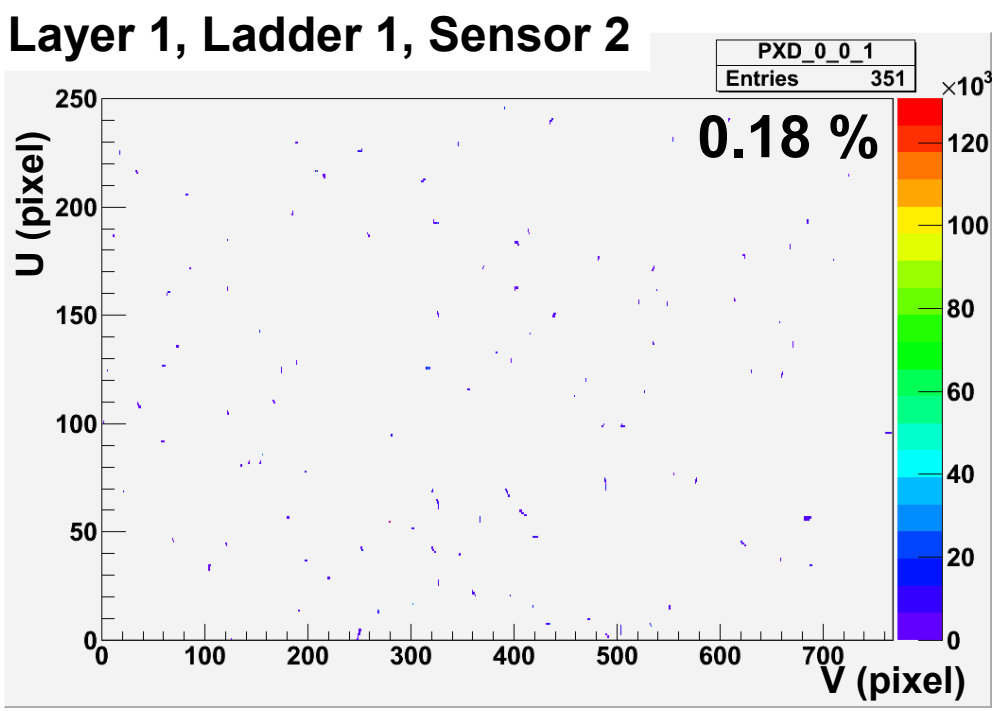


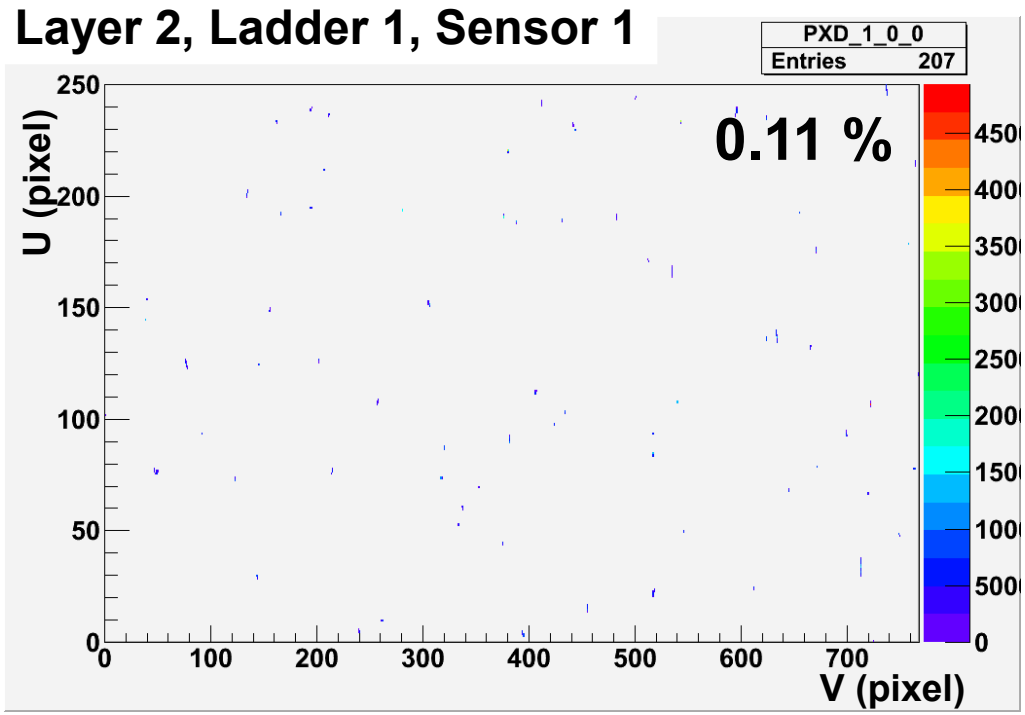


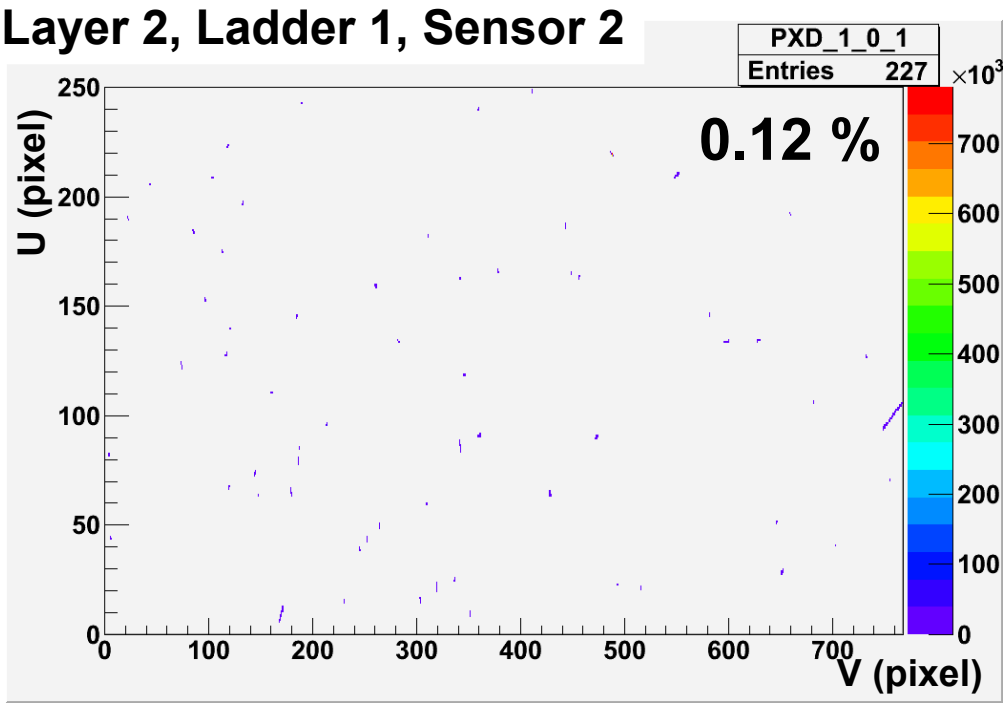


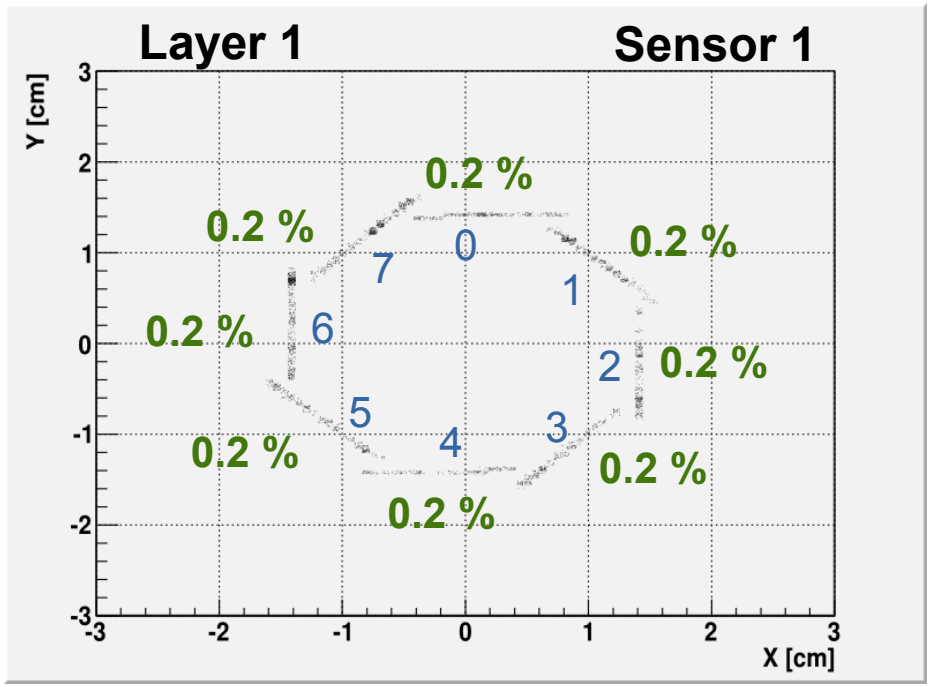
KoralW – Pixel map (for one readout frame)







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X [cm]
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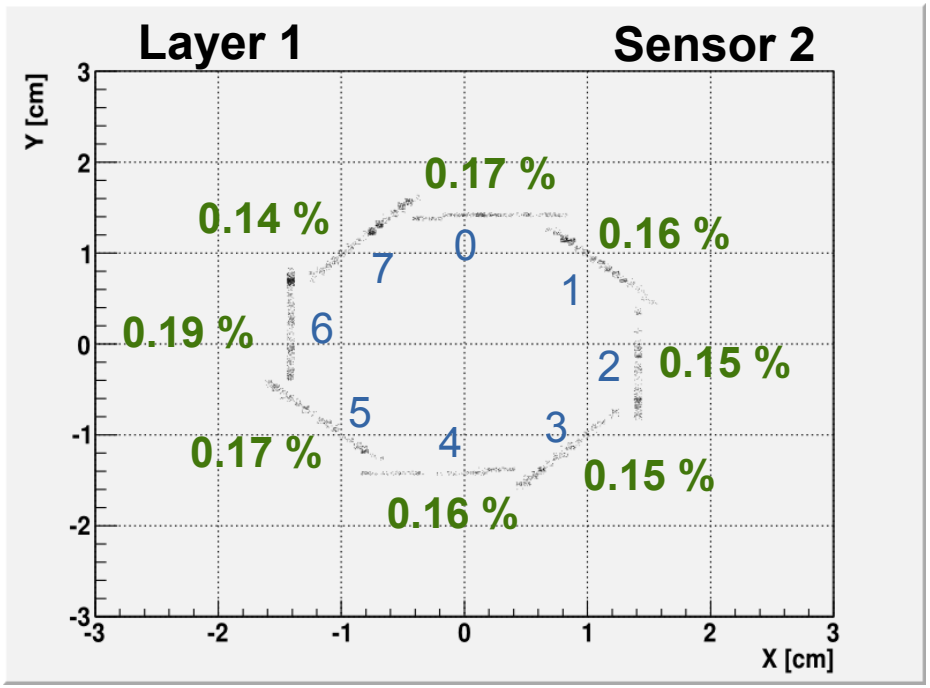
0.2 %
0.2 %
0.2 %
0.2 %
0
1
2
3
4
5
6
7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X [cm]
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0.14 %
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0
1
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3
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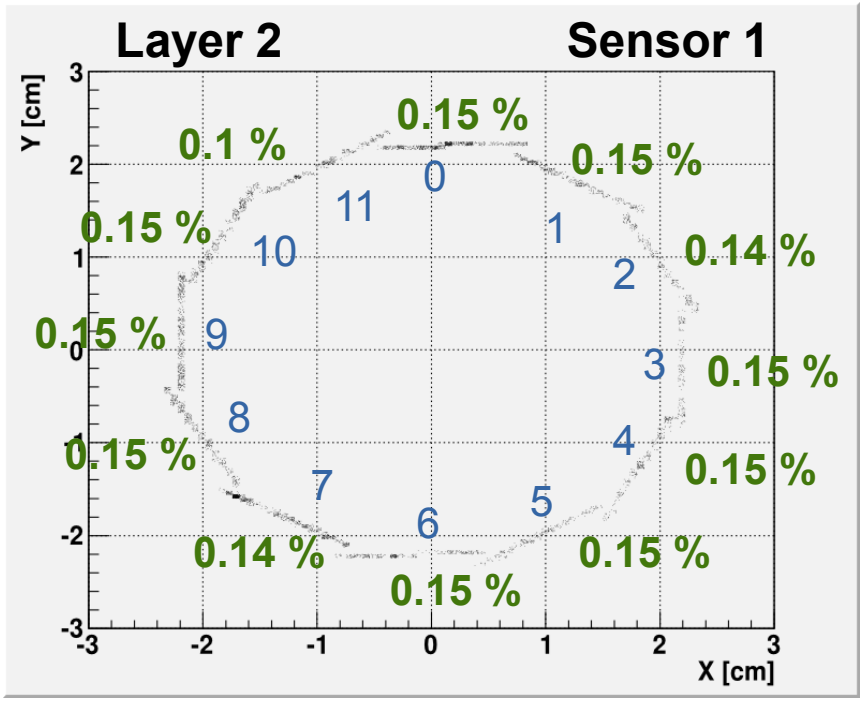
5
6
7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X [cm]
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0.1 %
0.15 %
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0.14 %
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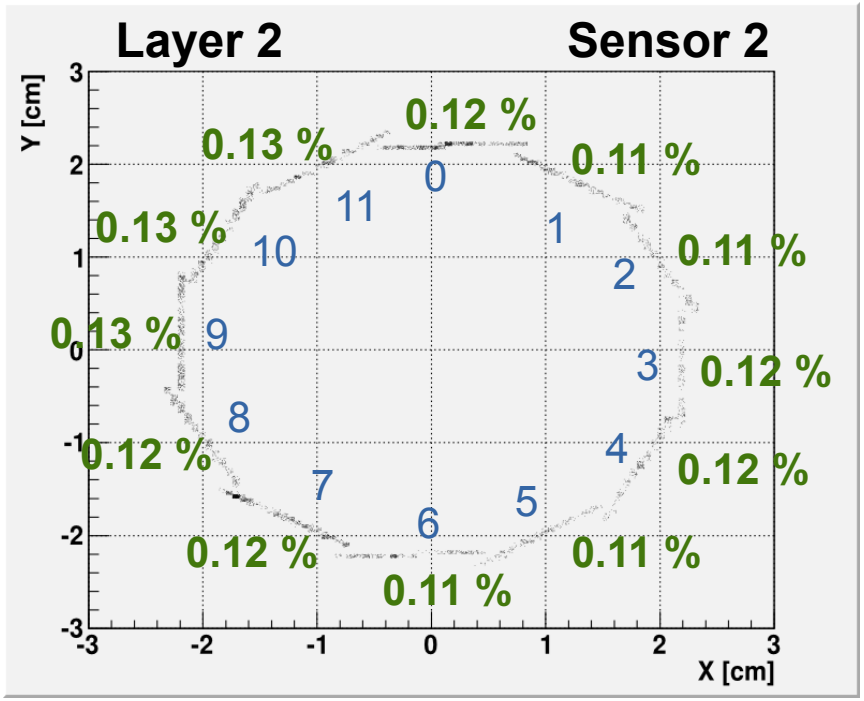
Layer 2
Sensor 2
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X [cm]
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0.11 %
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0.12 %
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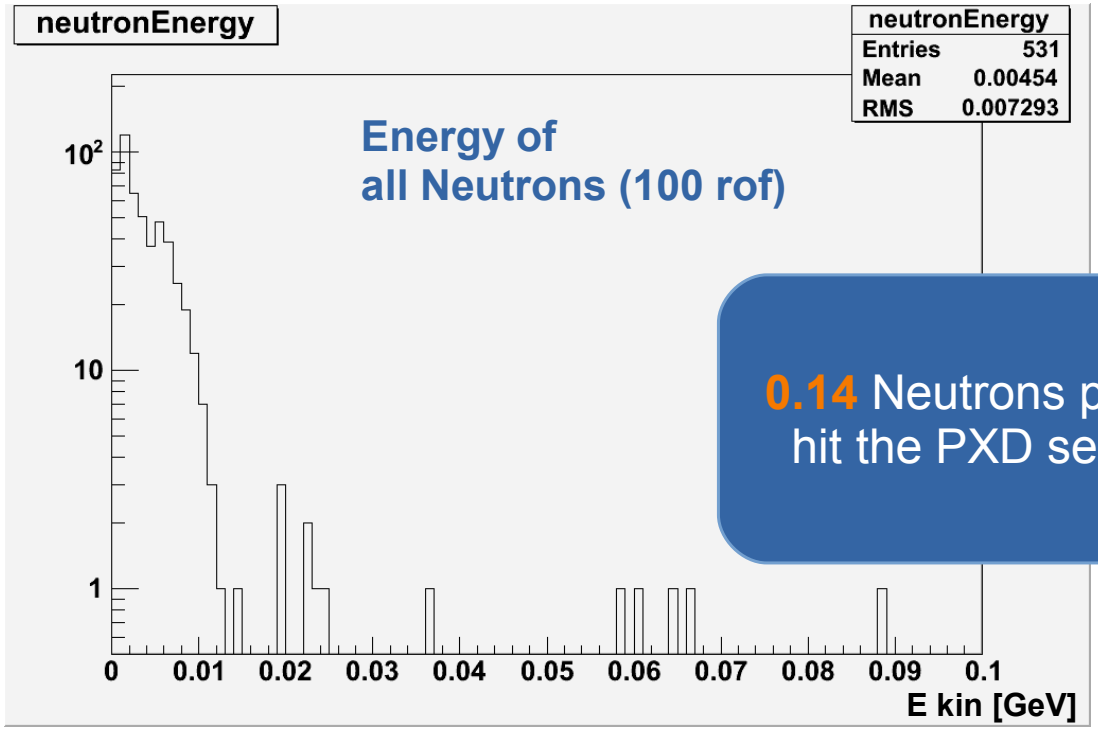
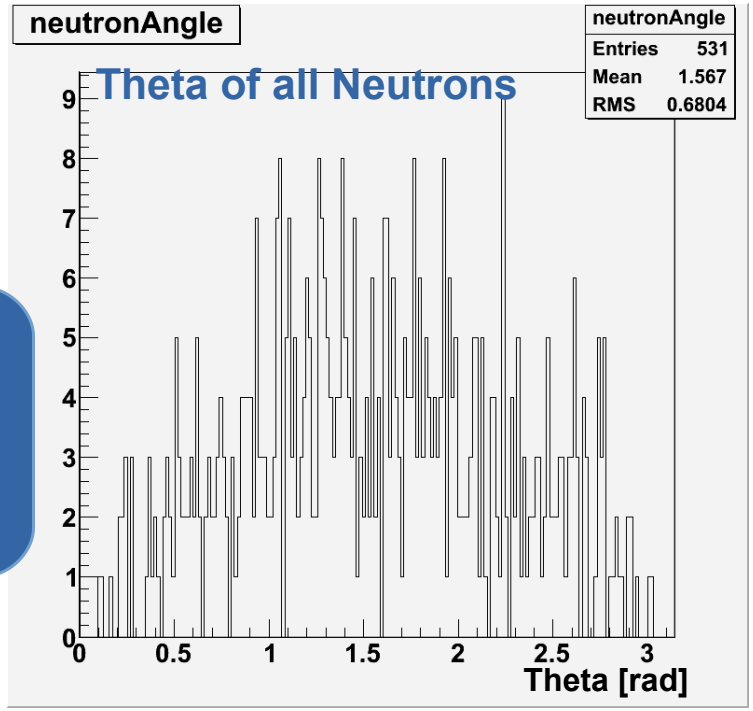
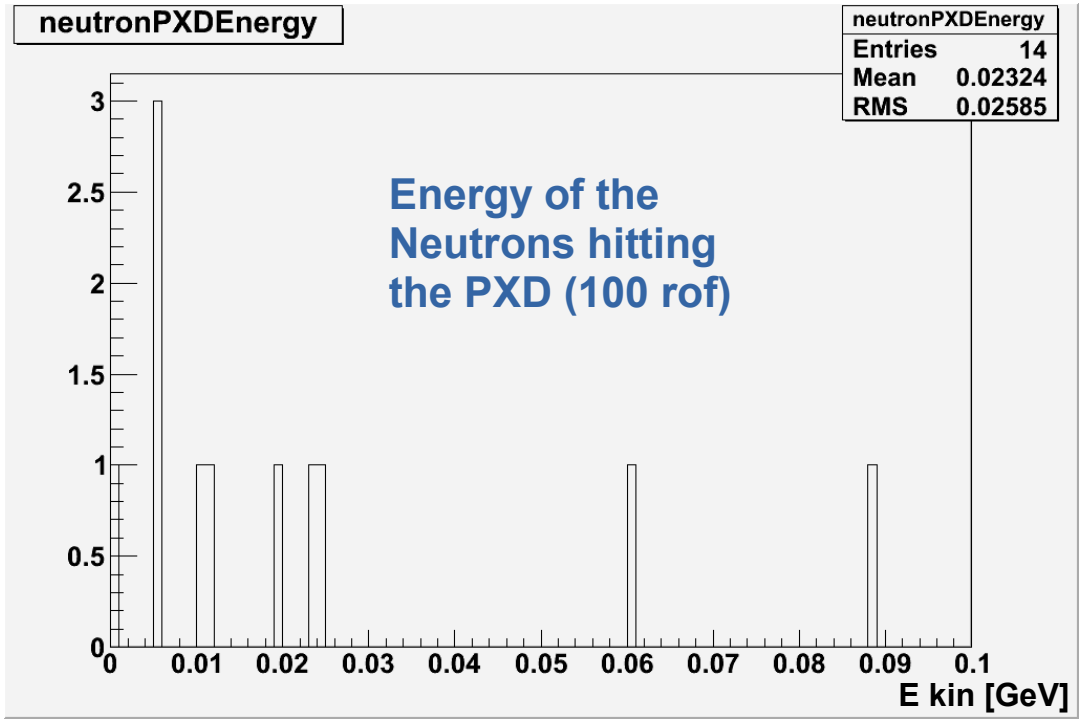
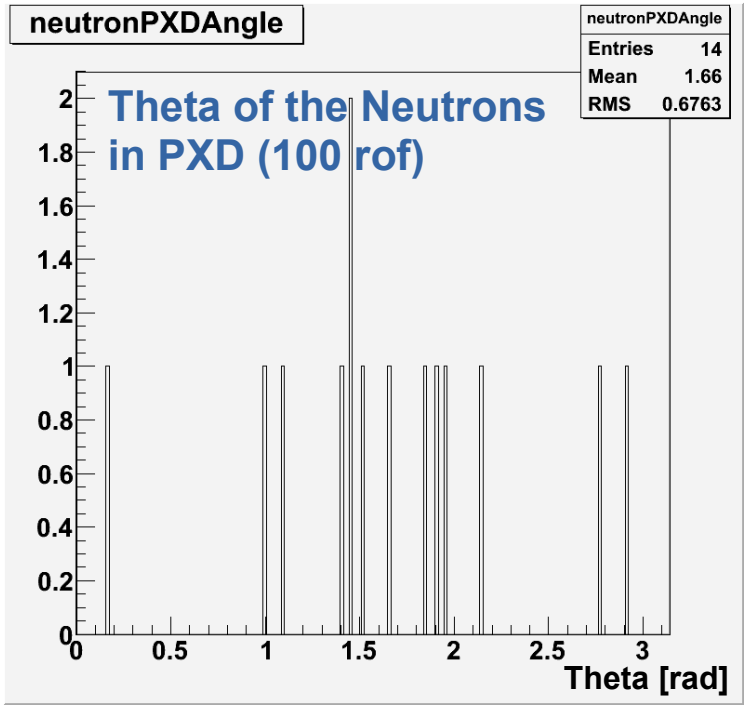


0.14 Neutrons per rof hit the PXD sensor







Summary

and Outlook

Process	Generator	Occupancy	Uncertainty
Touschek	SAD	0.17 %	0.6 % (HER unknown)
Radiative Bhabha scattering	BHWide	0.01 %	0.05 %
	BBBrems	$1.3 \cdot 10^{-9}$ %	
QED	KoralW	0.15 %	0.2 %
Total		0.33 %	

- PXD occupancies for Touschek SAD, BHWide, BBBrems and KoralW
- First analysis of beam and QED background contributions
- Touschek is biggest background in Belle II

- The occupancy values are preliminary. More statistics is required.
- Synchrotron radiation is missing
- HER contribution of Touschek SAD is unknown
- Cross check the SAD with the TURTLE simulation