Considerations for a Radioactive Source for Quality Assurance and Characterization of the Belle II PXD Modules

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- Pixel Vertex Detector with almost 8 million DEPFET pixels
- consists of 40 modules in two layers
- control and readout ASICs right next to the matrices





The PXD is built as a device for detecting ionizing particles. Therefore, we need ionizing radiation to test it.

What we want to do:

- quality assurance: getting response from all pixels, finding not working ones
- characterization and optimization of the DEPFET matrices and its voltages
- characterization of the ASICs and optimization of their configurations



Signals of a 480 MBq Cd-109 source measured with module W30_OB1





Ref. date: 15 Apr 15, Activity: 740 MBq



Dependence between the size of the irradiated area and the distance between matrix and source.



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Source Measurements so far: Distance Dependence



Number of measured hits per 1000 frames vs distance:



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Scetch of the source geometry and guess of the radius of the irradiated area.



width of the matrix: 12.5 mm \rightarrow max. radius 6.25 mm max. distance "collimator opening - matrix" before losing hits: 5.6 mm



- activity of HLL source at the time we took data: 480 MBq
- $480 \cdot 10^6 \, s^{-1} \cdot 20 \cdot 10^{-6} \, s = 9600$ decays per readout
- $\sim \frac{1}{1000}$ decays results in a hit in the matrix as long as d < 5mm



- We want a statistic of 100 hits per pixel: 100 hits \cdot 192000 pixel per module $\approx 2 \cdot 10^7$ hits per module $\rightarrow 2 \cdot 10^{10}$ decays required
- According to Dima it is possible to read 35 000 frames/s with 20 · 10⁻⁶s per frame → we use 70 % of the time.
- At a distance of \sim 27 mm, where we irradiate about a quarter of the matrix, we lose about half of the hits.
- $\frac{2 \cdot 10^{10}}{0.5 \cdot 0.7}$ decays = 5.7 \cdot 10¹⁰ decays
- This amount of decays could be provided by a Cd source with an activity of **1 GBq** within **one minute**.
- The big difference compared to previous estimations results from the drastically increased frame frequency: 100 Hz vs 35 000 Hz



The maximal total amount of activity, which is allowed at the institute, is determined by the so called "Sum Rule":

 $\frac{\textit{activity}}{\textit{exemption limit}} \stackrel{!}{<} 5 \cdot 10^5$

current value = $1.2 \cdot 10^5$

exemption limits:	Am-214	1 · 10 ⁴ Bq
	Sr-90	1 · 10 ⁴ Bq
	Cd-109	1 · 10 ⁶ Bq

An additional Cd-109 source with an activity of 1 GBq will add $0.01 \cdot 10^5$ to the institute sum.

At the MPP there is a Cd-109 source with an current activity of 5 MBq At the HLL there is still the Cd-109 source we used. Current activity: 350 MBq (31 Aug 2016)



- feasability of taking 35 000 frames/s
- availability of HLL Cd source and possibility of transport to MPP
- necessity to buy a new source (geometry, activity)