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ZDC migrations

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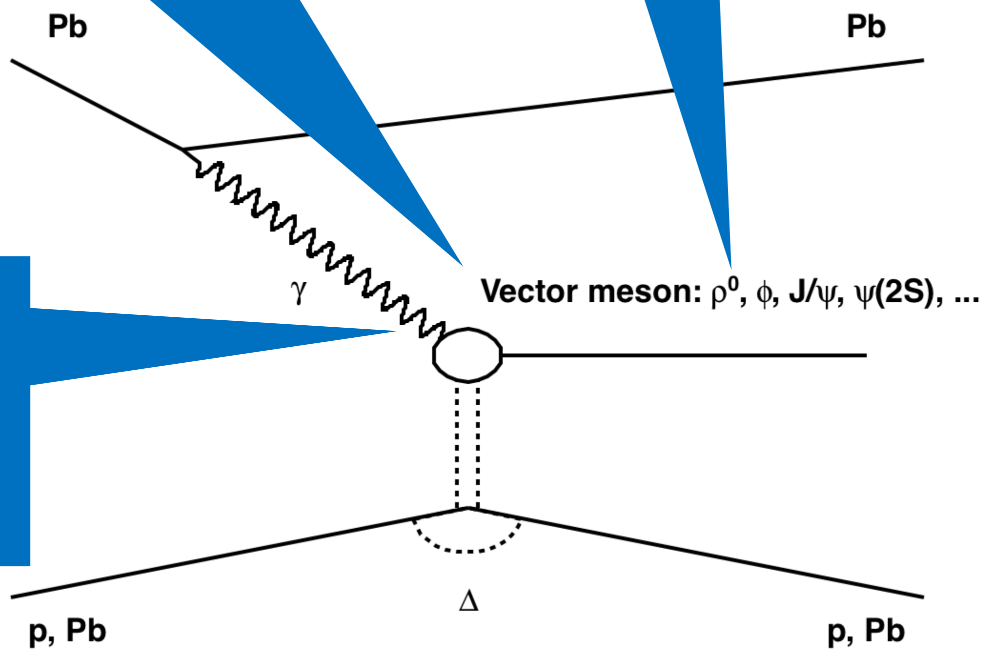
Forward neutrons in UPC

Coherent photoproduction of vector mesons

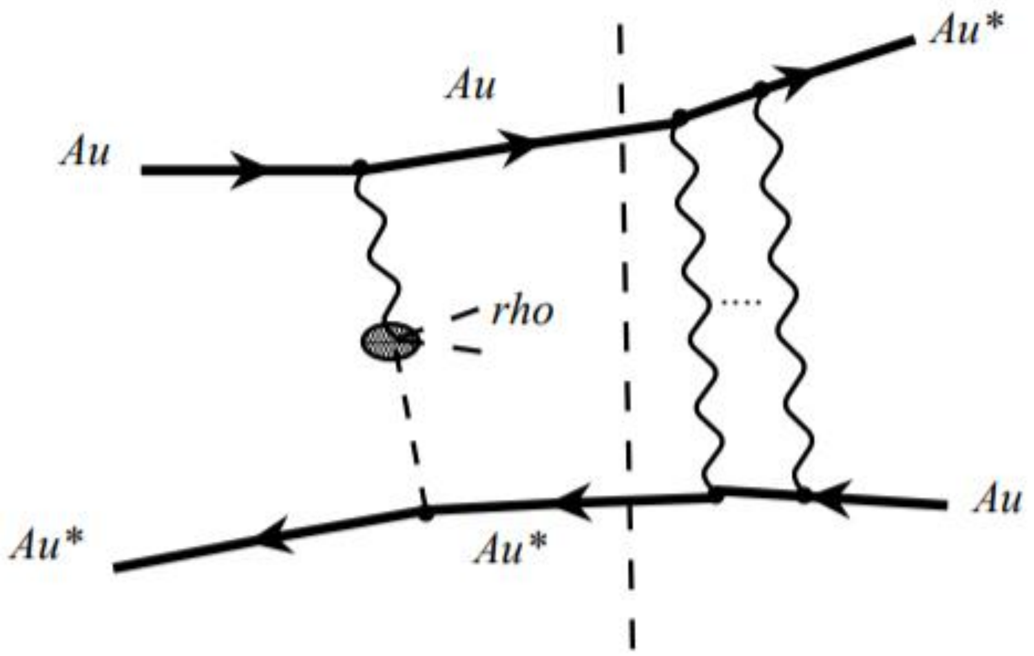
Decay products in the detector

In LO pQCD, the cross section is proportional to the gluon density squared

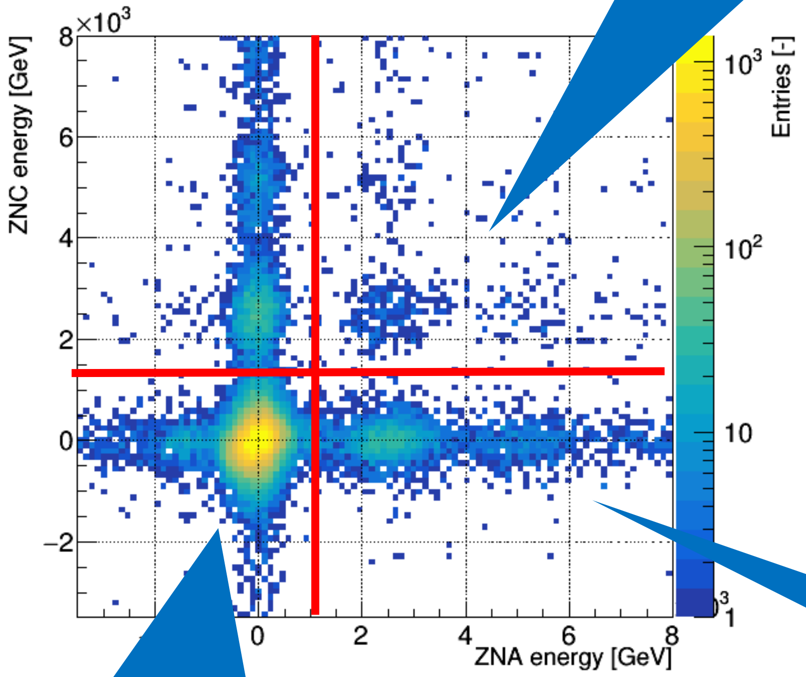


$$\left.\frac{\mathrm{d}\sigma_{\gamma A\to J/\psi A}}{\mathrm{d}t}\right|_{t=0} = \frac{M^3_{J/\psi}\Gamma_{ee}\pi^3\alpha_s^2(Q^2)}{48\alpha_{\mathrm{em}}Q^8}\left[xg_A(x,Q^2)\right]^2$$

Possible forward neutrons from nucleus excitation (electromagnetic dissociation)



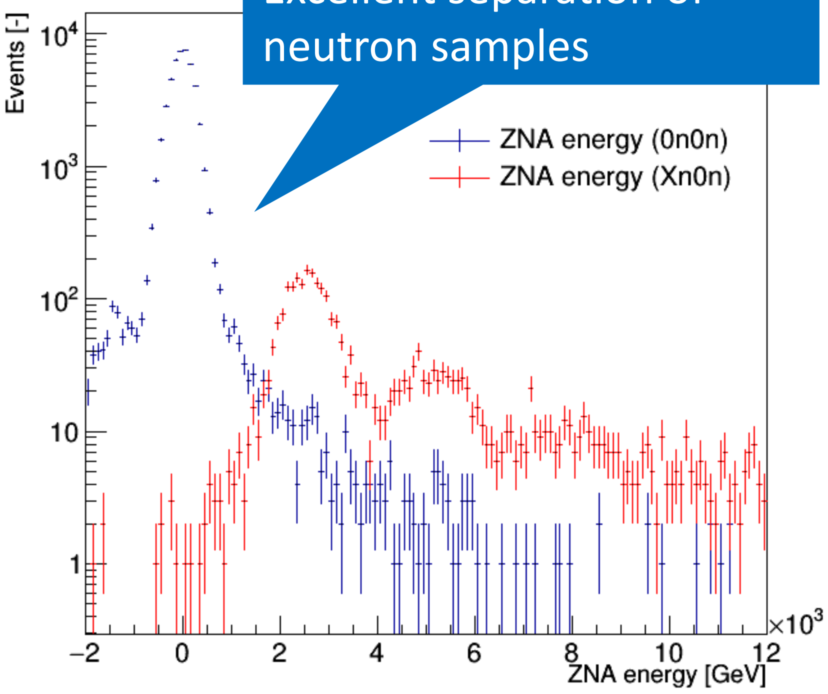
Forward neutron samples



XnXn – at least one neutron detected on each side

0n0n – no neutrons are detected at both sides of the detector

0nXn (0nXn + Xn0n) – at least one neutron is detected on one side but none on the other side



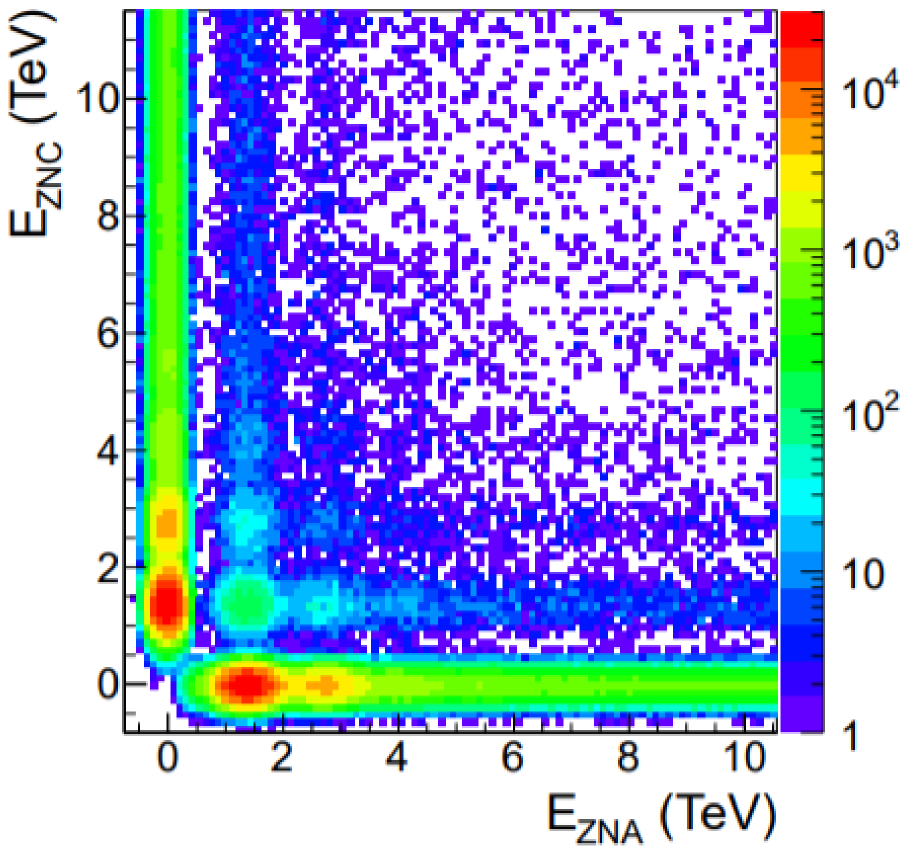
Excellent separation of neutron samples

What‘s the problem???

1) Acceptance and efficiency of the ZDC

Acceptance and efficiency of the ZDC

- Estimated by measuring electromagnetic dissociation (EMD) cross section and comparing to models (RELDIS)
  - Single EMD (0nXn)
  - Mutual EMD (XnXn)
- For 2015 data the efficiency is about $\varepsilon = 0.93 +/- 0.01$ for each ZDC
  - => 7% of 0nXn samples are identified as 0n0n!



What‘s the problem???

2) Pile-up from EMD

EMD pile-up

- Due to large EMD cross section there is a big probability to have another UPC collision producing an EMD event
  - This will lead to misidenfication of the ZDC class (e.g. an event will be identified as 0nXn even if it was originally 0n0n)

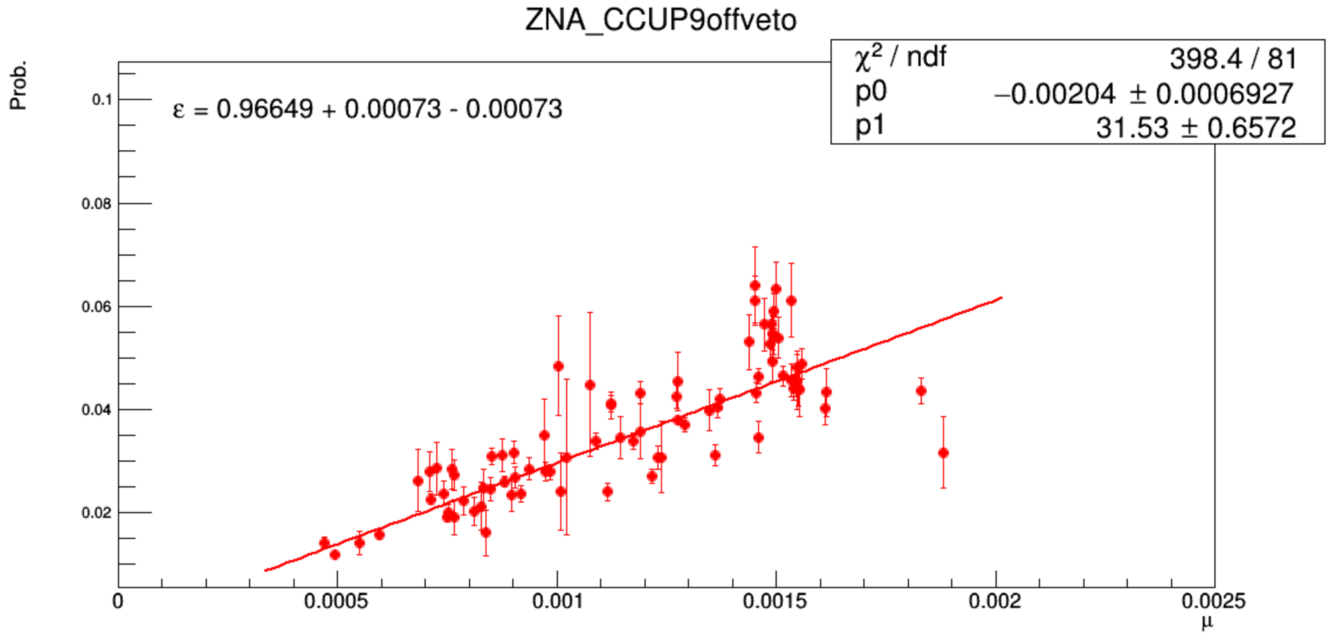
- => We have to deal with the same physical and experimental process but from another collision in the same bunch-crossing…
- This effect is even enhanced by a slow detector readout (which is several bunch-crossings!)

- How to distinguish these two contributions?

How to obtain pile-up correction factor?

- We can compute it, if we know the probability to have an EMD on top of the studied process
  - In other words, what is the probability to have an EMD signal in the otherwise empty detector
  - At ALICE it can be studied using CTRUE events (special trigger that is fired at each bunch-crossing)

- We can find probabilities that only ZDC detector is fired and everything else is empty



Migration formulas

- From Guillermo (thanks!)

ε^A	Efficiency to detect ZNA activity.
ε^C	Efficiency to detect ZNC activity.
P^A	Probability of pile-up in ZNA (measured with CTRUE, it includes ZN efficiency)
P^C	Probability of pile-up in ZNC (measured with CTRUE, it includes ZN efficiency)
σ^{fit}_{0n0n}	cross section of the 0n0n class from the fit; that is, before corrections for ZDC pile-up and efficiency
σ^{fit}_{0nXn}	cross section of the 0nXn class from the fit; that is, before corrections for ZDC pile-up and efficiency
σ^{fit}_{Xn0n}	cross section of the Xn0n class from the fit; that is, before corrections for ZDC pile-up and efficiency
σ^{fit}_{XnXn}	cross section of the XnXn class from the fit; that is, before corrections for ZDC pile-up and efficiency
σ^{M}_{0n0n}	cross section of the 0n0n class after correction for ZDC pile-up and efficiency
σ^{M}_{0nXn}	cross section of the 0nXn class after correction for ZDC pile-up and efficiency
σ^{M}_{Xn0n}	cross section of the Xn0n class after correction for ZDC pile-up and efficiency
σ^{M}_{XnXn}	cross section of the XnXn class after correction for ZDC pile-up and efficiency

$\sigma^{fit}_{0n0n} = \sigma^{M}_{0n0n}$

$- \sigma^{M}_{0n0n}[P^A(1-P^C)+P^C(1-P^A)+P^AP^C]$	Loses due to pile-up in 0n0n
$+ \sigma^{M}_{Xn0n}(1-\varepsilon^A)(1-P^A)(1-P^C)$	gains due to efficiency losses in Xn0n
$+ \sigma^{M}_{0nXn}(1-\varepsilon^C)(1-P^A)(1-P^C)$	gains due to efficiency losses in 0nXn
$+ \sigma^{M}_{XnXn}(1-\varepsilon^A)(1-\varepsilon^C)(1-P^A)(1-P^C)$	gains due to efficiency losses in XnXn

$\sigma^{fit}_{0nXn} = \sigma^{M}_{0nXn}$

$- \sigma^{M}_{0nXn}(1-\varepsilon^C)(1-P^C)[(1-P^A)+P^A]$	Loses into 0n0n+Xn0n
$- \sigma^{M}_{0nXn}[\varepsilon^C P^A + (1-\varepsilon^C)P^AP^C)$	Loses into XnXn
$+ \sigma^{M}_{0n0n}(P^C)(1-P^A)$	gains due to pile-up in 0n0n
$+ \sigma^{M}_{Xn0n}(1-\varepsilon^A)(1-P^A)P^C$	gains due to efficiency losses in Xn0n
$+ \sigma^{M}_{XnXn}(1-\varepsilon^A)(1-P^A)[\varepsilon^C+(1-\varepsilon^C)P^C]$	gains due to efficiency losses in XnXn

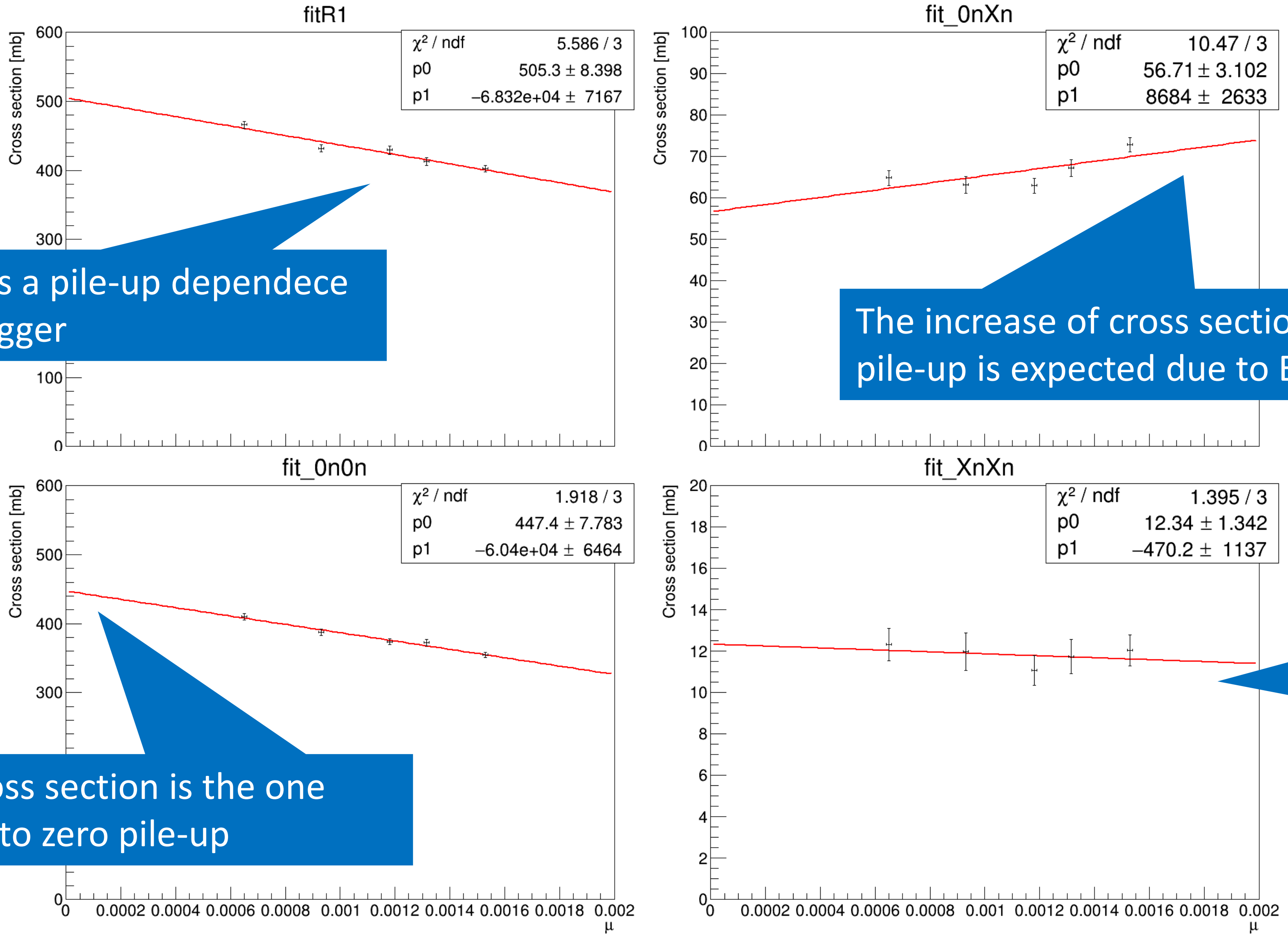
$\sigma^{fit}_{XnXn} = \sigma^{M}_{XnXn}$

$- \sigma^{M}_{XnXn}(1-\varepsilon^A)(1-P^A)[\varepsilon^C+(1-\varepsilon^C)P^C]$	Loses due to efficiency in 0nXn
$- \sigma^{M}_{XnXn}(1-\varepsilon^C)(1-P^C)[\varepsilon^A+(1-\varepsilon^A)P^A]$	Loses due to efficiency in Xn0n
$- \sigma^{M}_{XnXn}(1-\varepsilon^A)(1-\varepsilon^C)(1-P^A)(1-P^C)$	Loses into 0n0n
$+ \sigma^{M}_{0n0n}(P^AP^C)$	gains due to pile-up in 0n0n
$+ \sigma^{M}_{0nXn}[(\varepsilon^C P^A+(1-\varepsilon^C)P^AP^C]$	gains due to pile-up in 0nXn
$+ \sigma^{M}_{XnXn}[(\varepsilon^A P^C+(1-\varepsilon^A)P^AP^C]$	gains due to pile-up in Xn0n

The other way…

Is it possible to study the migration effect with our data sample?

Pile-up dependence of the cross section



The total cross has a pile-up dependece because of the trigger

The increase of cross section in 0nXn sample with pile-up is expected due to EMD contamination

„Physical“ cross section is the one extrapolated to zero pile-up

They are in agreement with cross section obtain by computation

New corrections?

- Assumption that photonuclear excitation only produces neutrons. (not true!)
- For example, a nucleon in one lead nucleus may be excited to a Δ^+ resonance, and emit a pion when the Δ^+ decays.
- This pion might be detected in the AD detectors, causing veto and therefore reducing number of events in our samples.
- *What is the probability to have a signal in AD and ZDC together in otherwise empty detector?*