

# Arapuca stability

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# Runs

Run	Day	ID
6848	Feb 20	1
7224	Mar 19	2
7447	Mar 31	3
7461	Apr 01	4
7475	Apr 02	5
7651	Apr 24	6
7726	May 02	7
7944	May 21	8

LED config: **0x577**

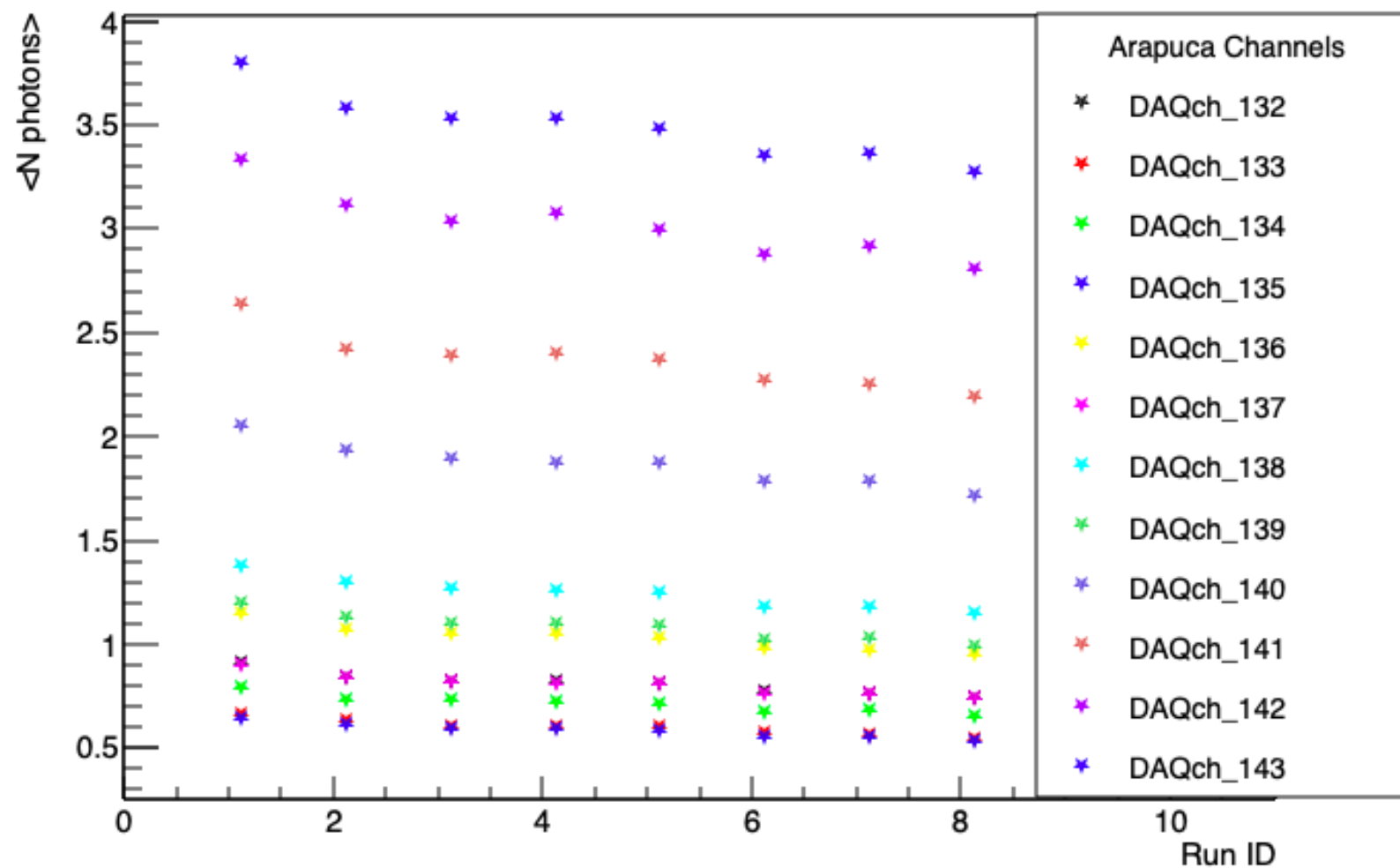
**Runs are the same showed by  
Chris for the SenseL**

**In plots runs are labeled with the ID in the table**

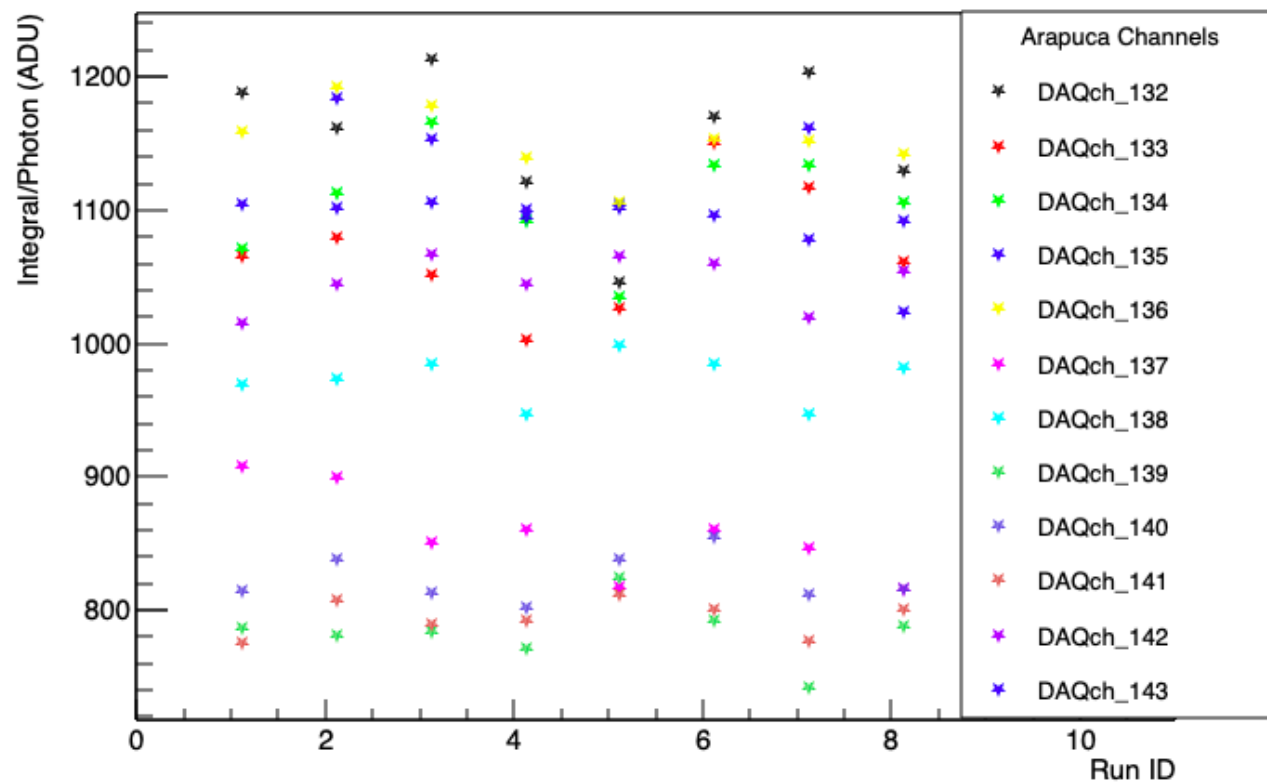
# Analysis

- Number of photons detected (estimated with Poisson).
- Charge measured.
- Charge per photon detected (calibration).
- From both charge and number of photons the background contribute has been subtracted.

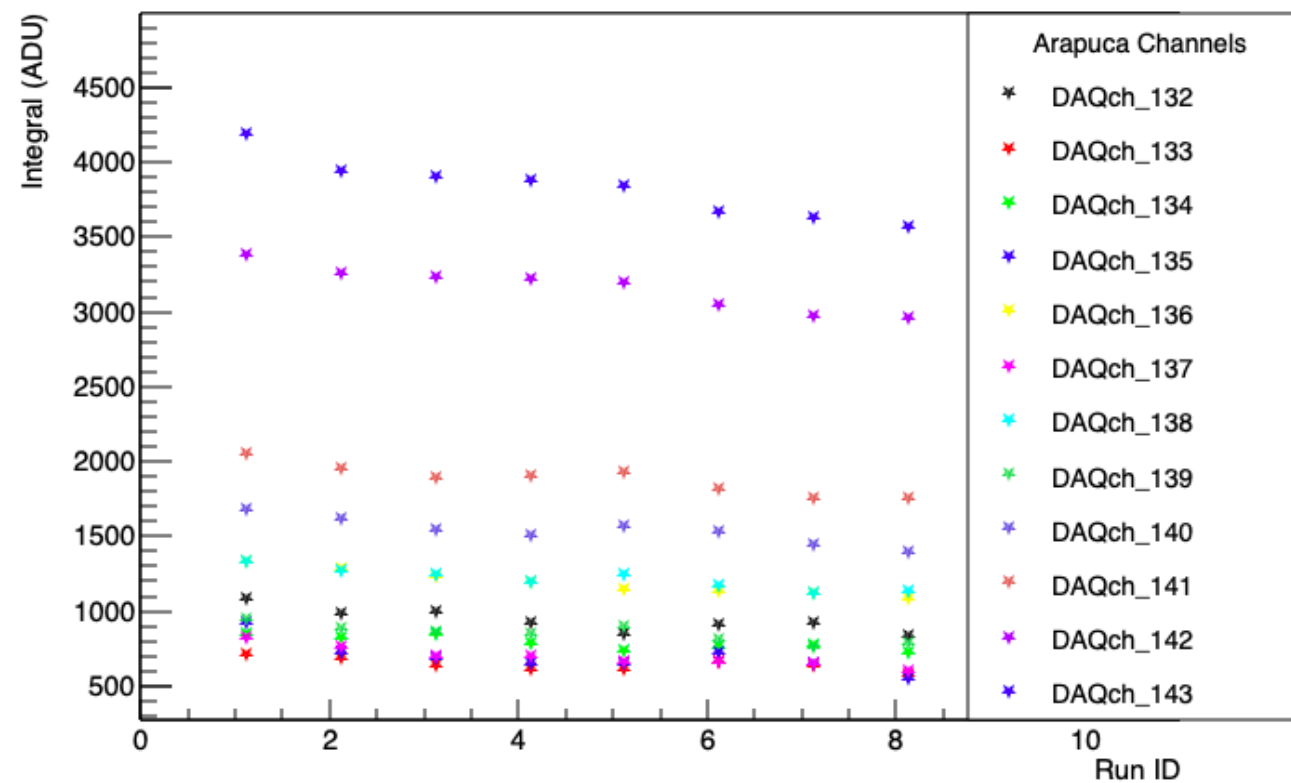
Average number of photons detected Arapuca Apa 3



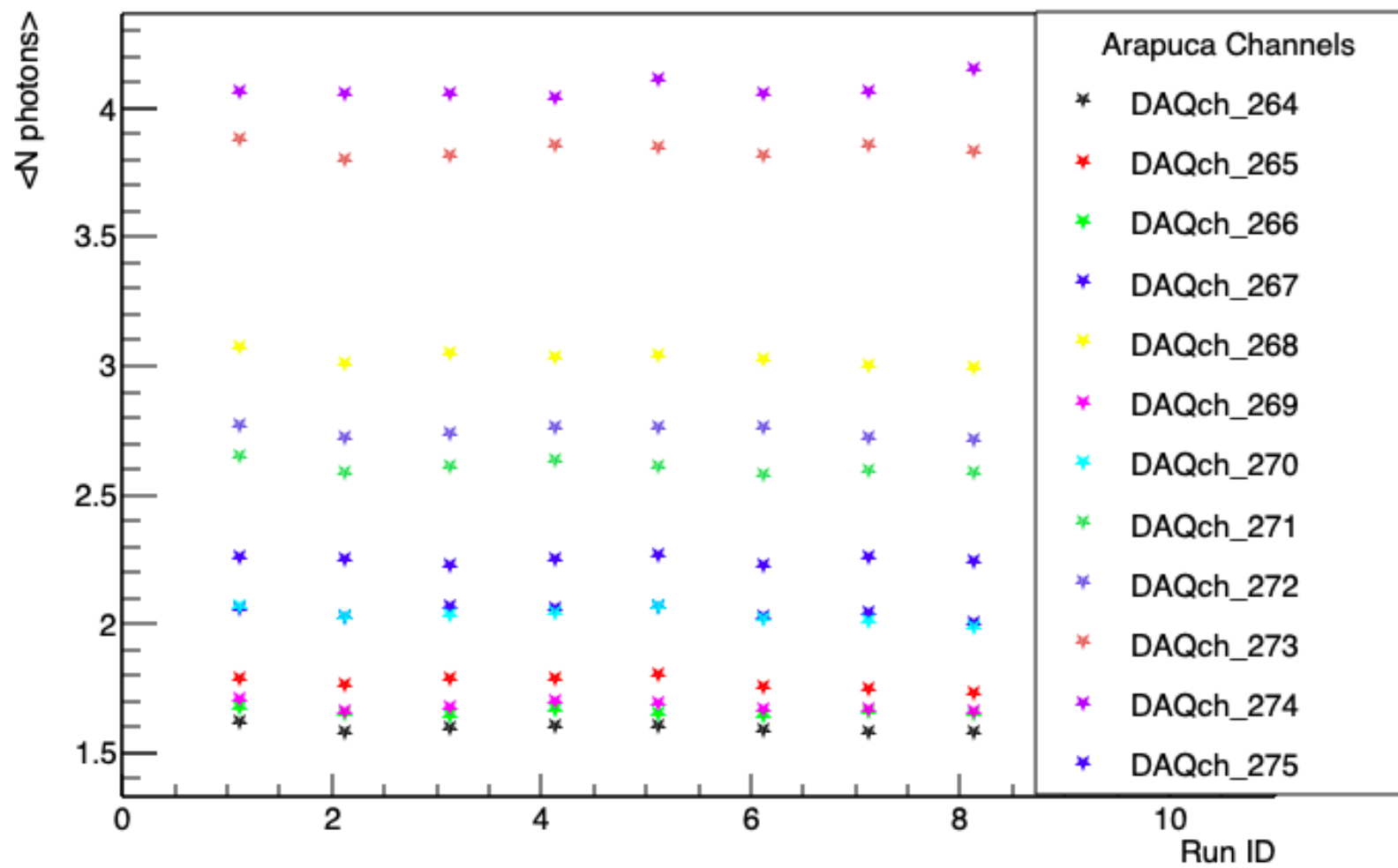
Average charge per photon detected Apa 3



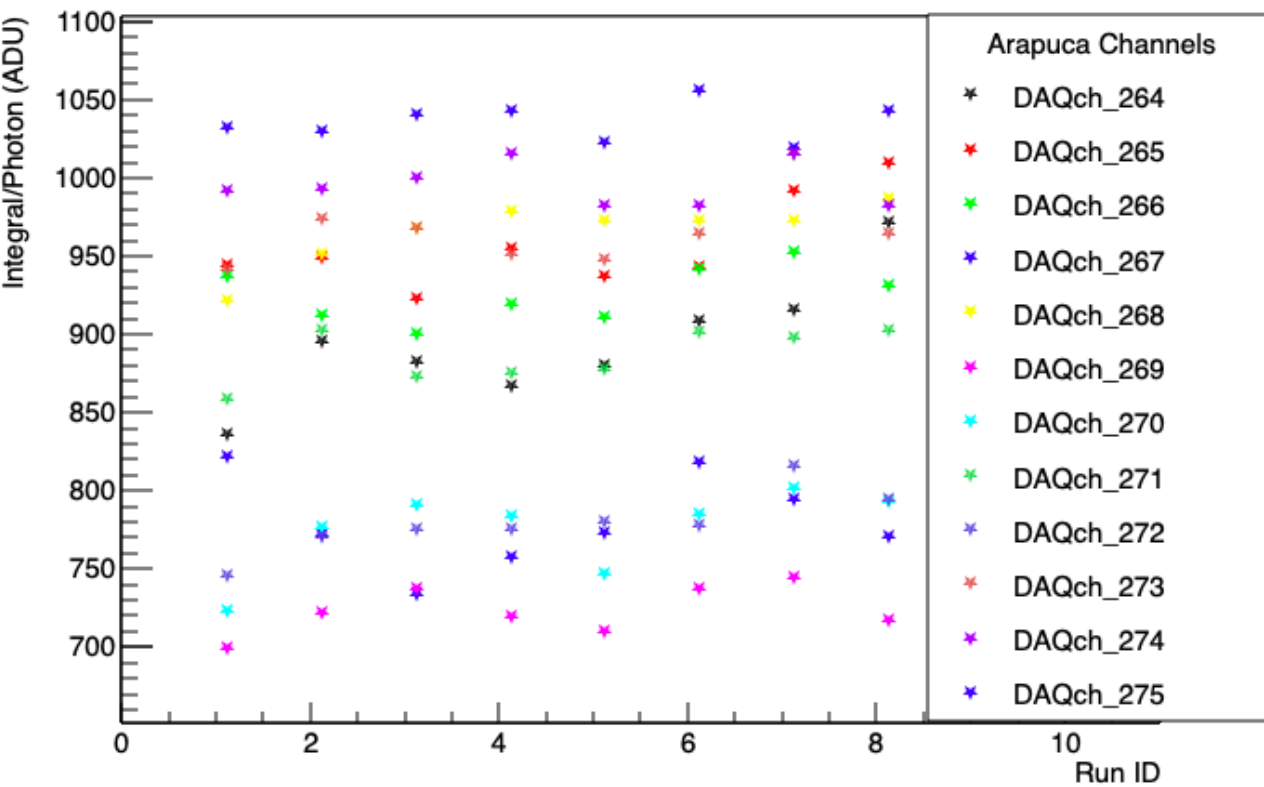
Average charge measured Apa 3



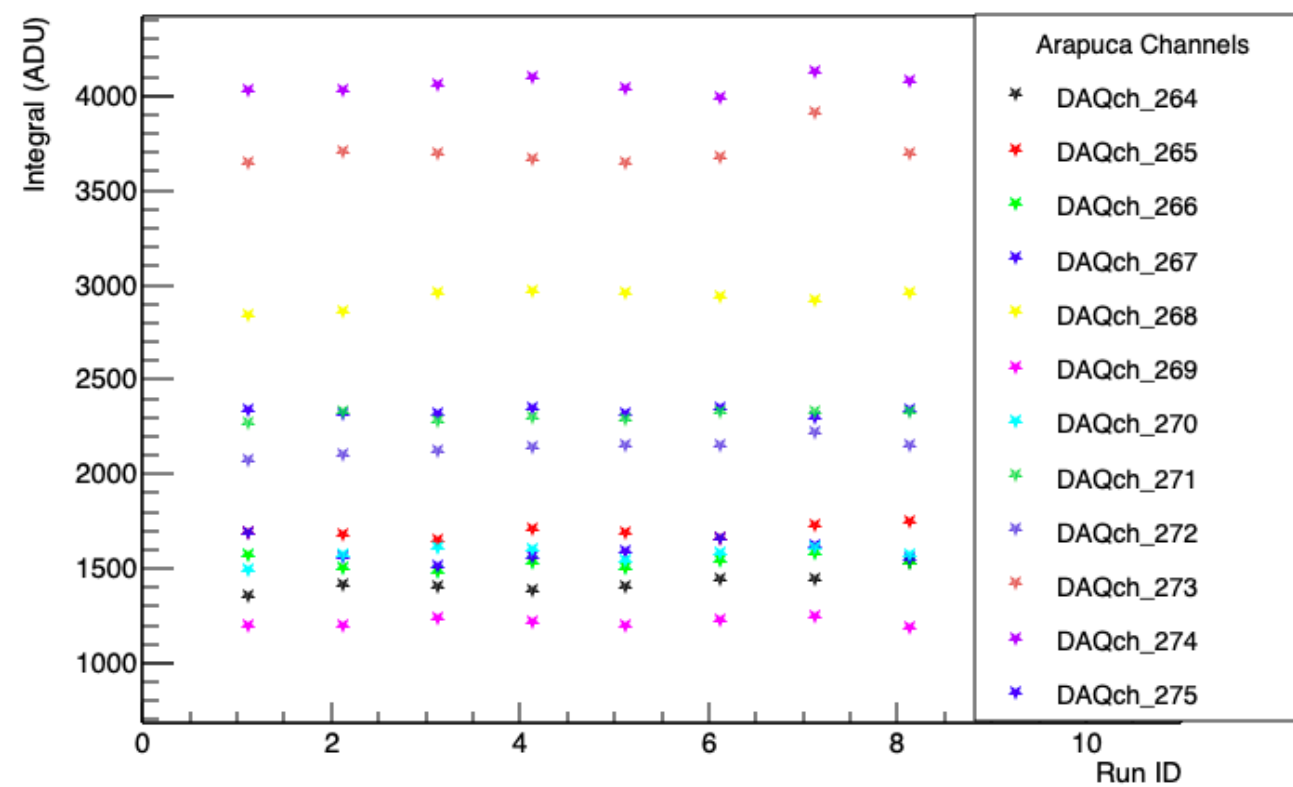
### Average number of photons detected Arapuca Apa 6



### Average charge per photon detected Apa 6



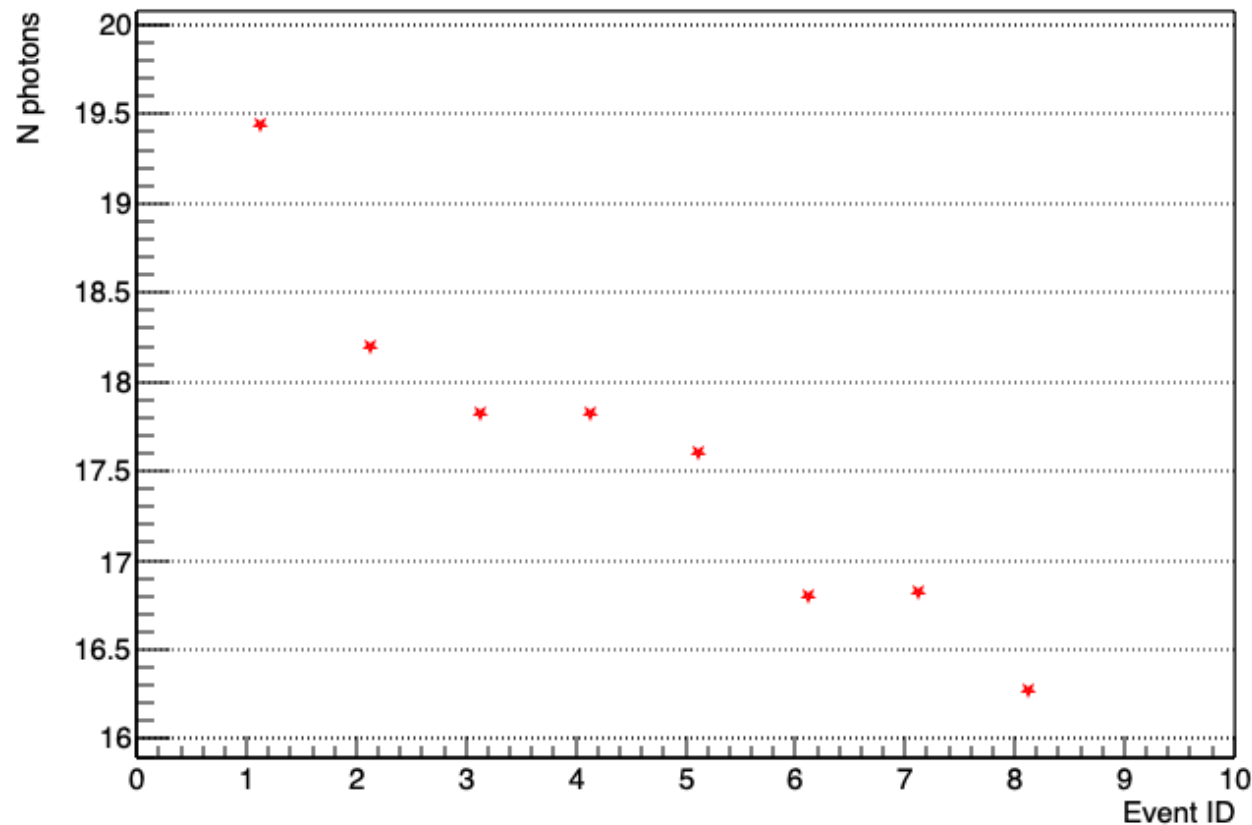
### Average charge measured Apa 6



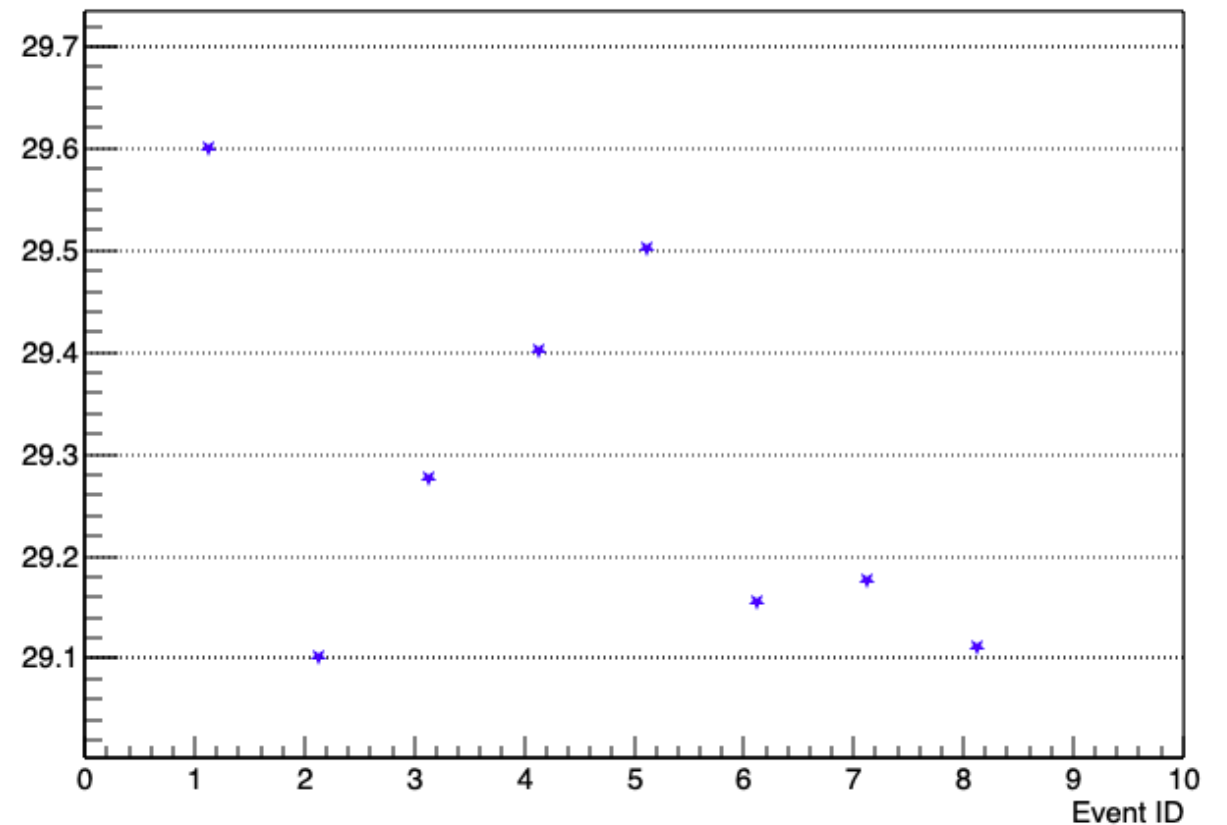
# Average number of photons detected summing all channels per

## Arapuca PD module $\langle N_{ph_{tot}} \rangle = \sum \langle N_{ph} \rangle_i$

Total number of photons detected from Arapuca module in APA 3



Total number of photons detected from Arapuca module in APA 6



$\langle N_{ph_{tot}} \rangle$  in APA 3 decreases from 19.5 to 16.3

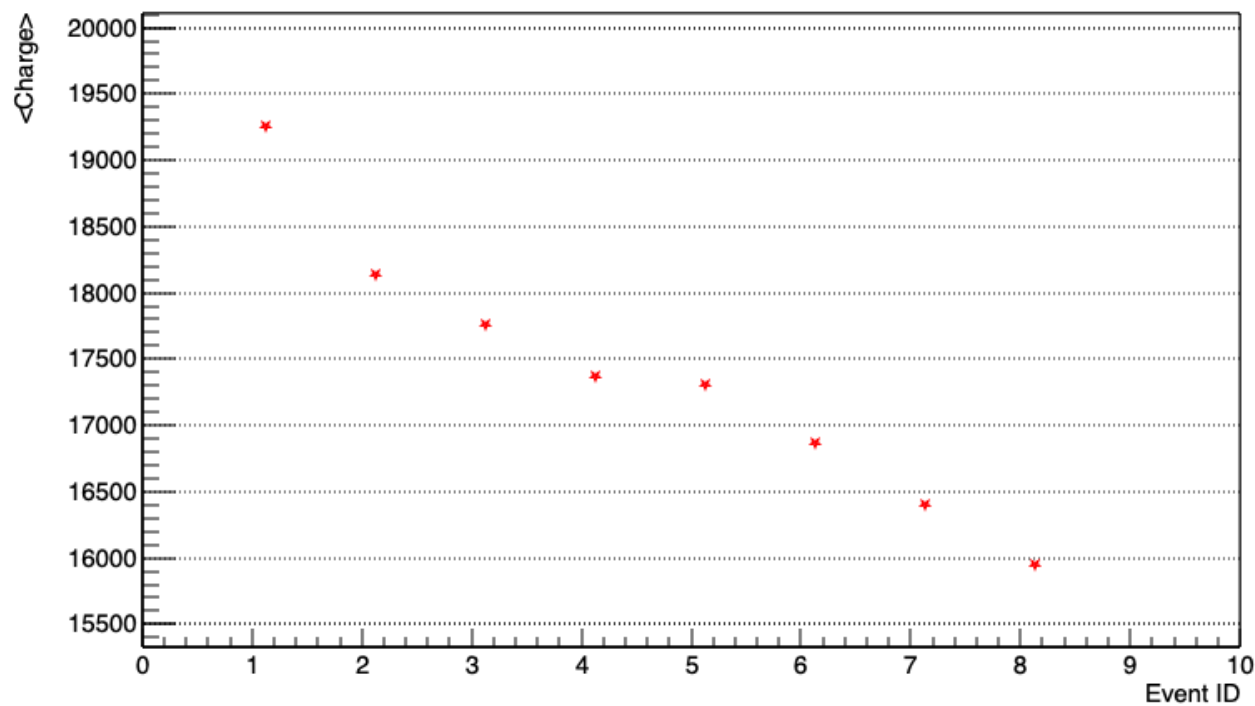
$\Delta \sim 18\%$

$\langle N_{ph_{tot}} \rangle$  in APA 6 is in a range between 29.1 and 29.6

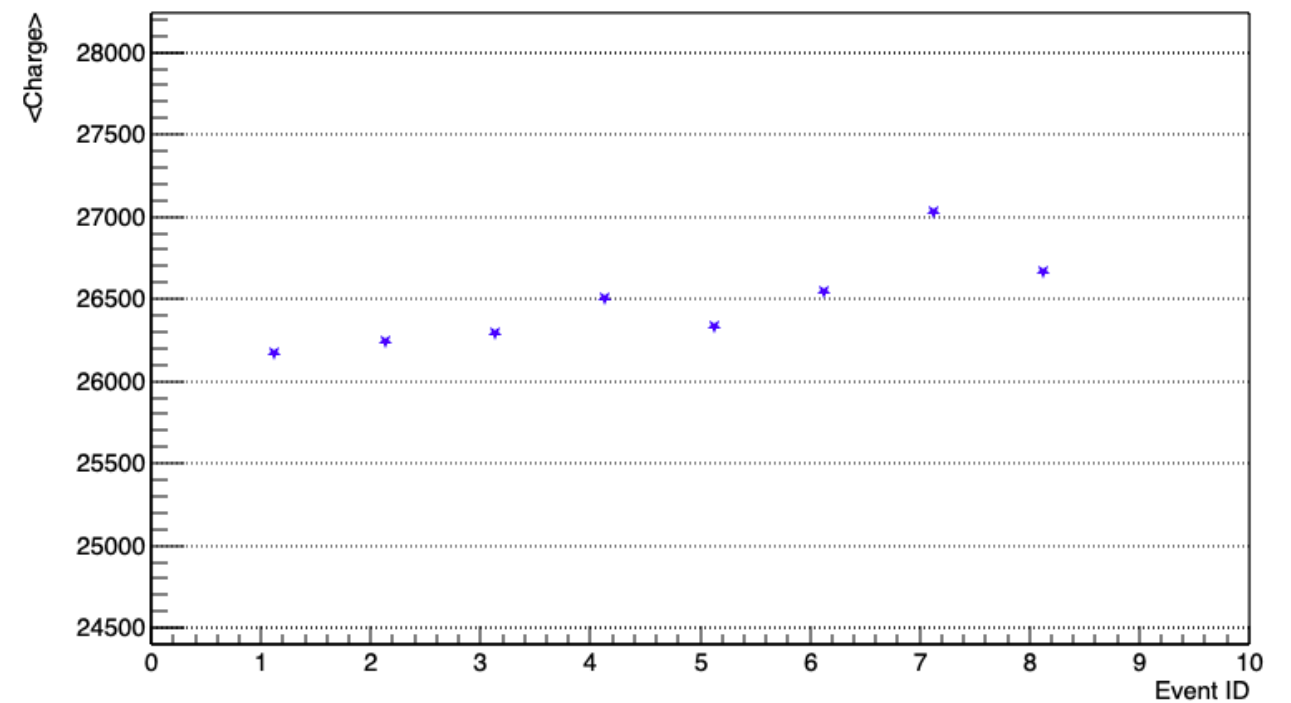
$\Delta \sim 1.6\%$

# Average charge measured summing all channels per Arapuca PD module

Total charge Arapuca module in APA 3



Total charge Arapuca module in APA 6

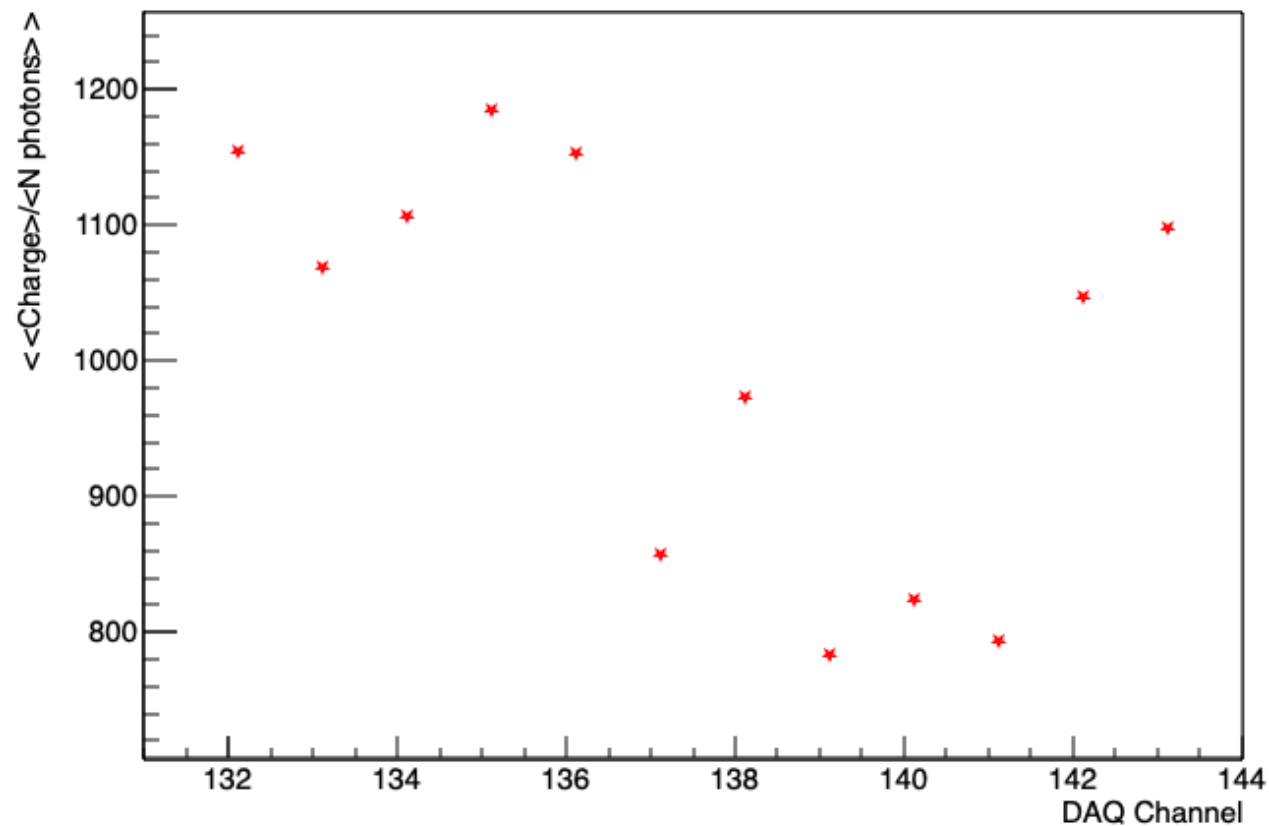


**This quantity is directly proportional to the number of photons, it is expected to behave in the same way (since the calibration is stable)**

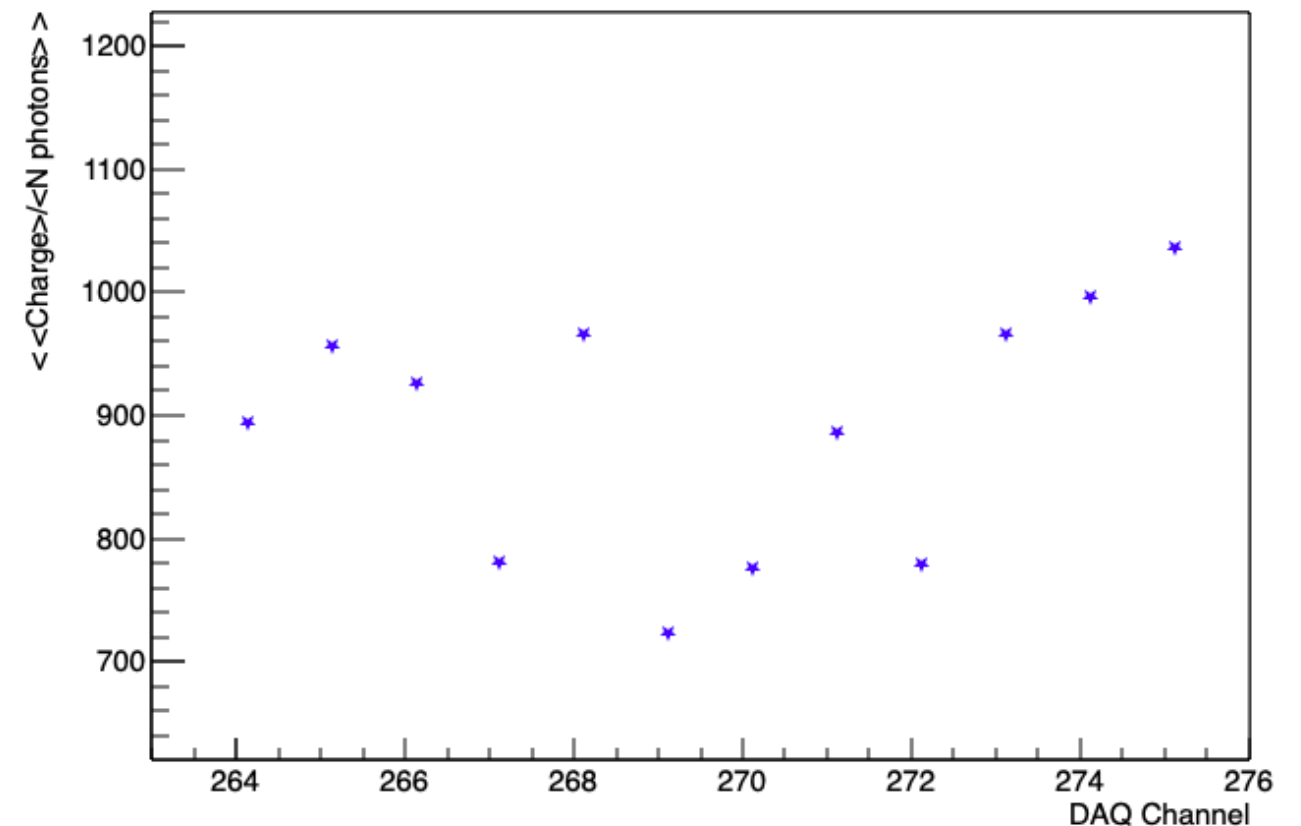
# Mean values for the calibration $\left\langle \frac{\langle charge \rangle}{\langle N_{ph} \rangle} \right\rangle$

The average is made over the eight runs.

Average charge per photon per channel in APA 3



Average charge per photon per channel in APA 6



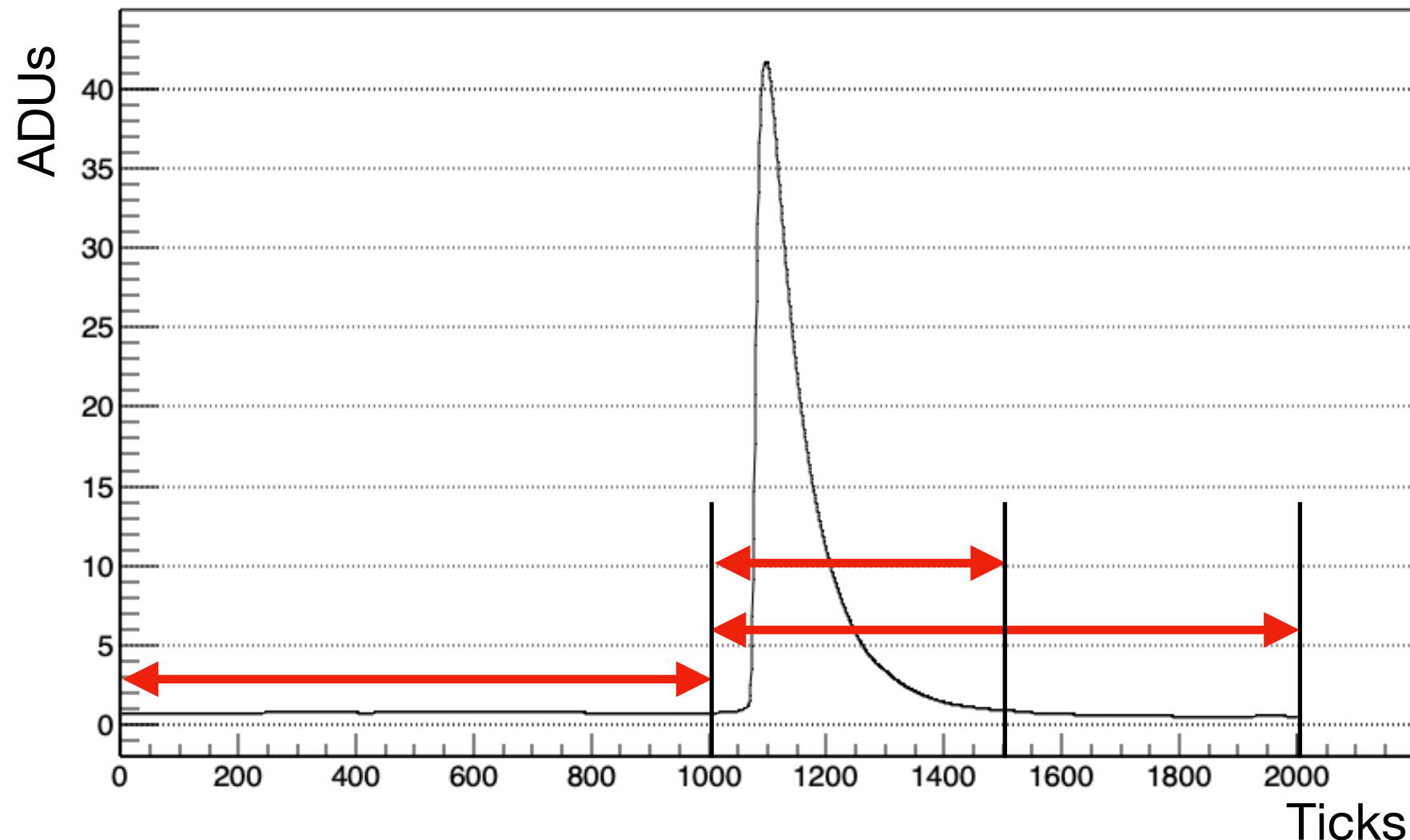
This quantity shows how uniform are the MPPCs in the photons detection. **It is NOT expected a good uniformity** since from previous studies we know the break down voltage is not uniform.



# Background considerations

- The average charge was evaluated using two window: a smaller ones of 500 ticks [1000:1500] and a larger of 1000 ticks [1000:2000]
- The average background charge was evaluated integrating in a window of 1000 ticks [0:1000]

**Average waveform ch 264**



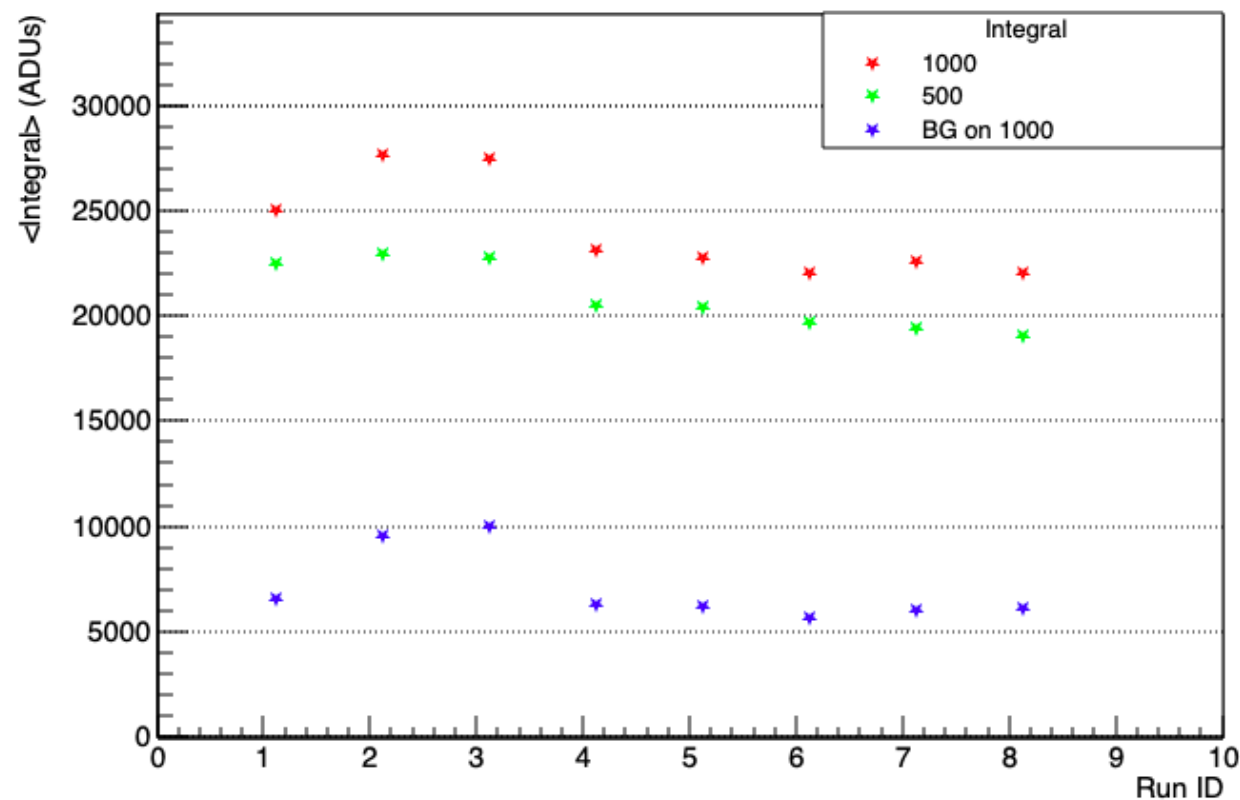
# Background considerations

The light measured from LED events is heavily affected by the background contribute, since the LED intensity is low.

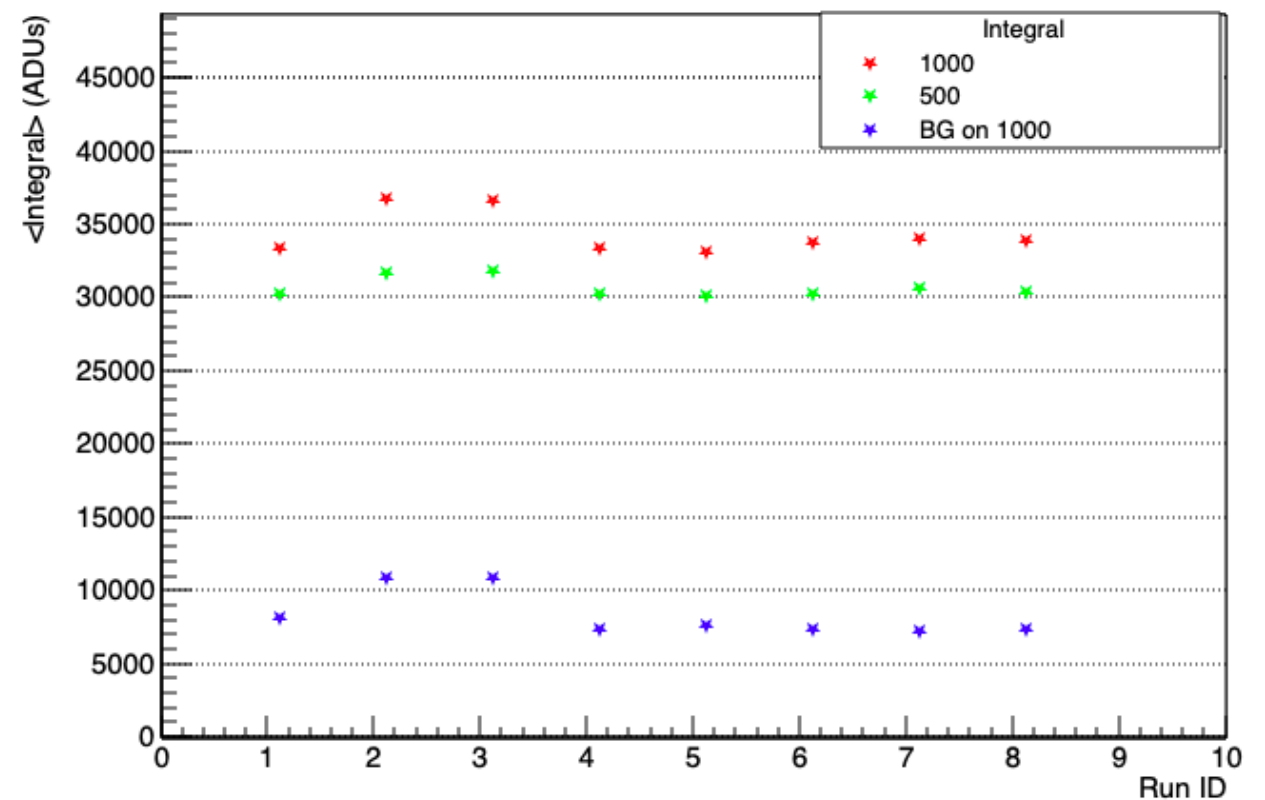
Moreover the background changes a lot for some runs. In some cases a factor of 2.

Light from background ~ 25%-30% of the total light in LED events.

$\sum \langle charge \rangle_i$  Arapuca module in APA 3



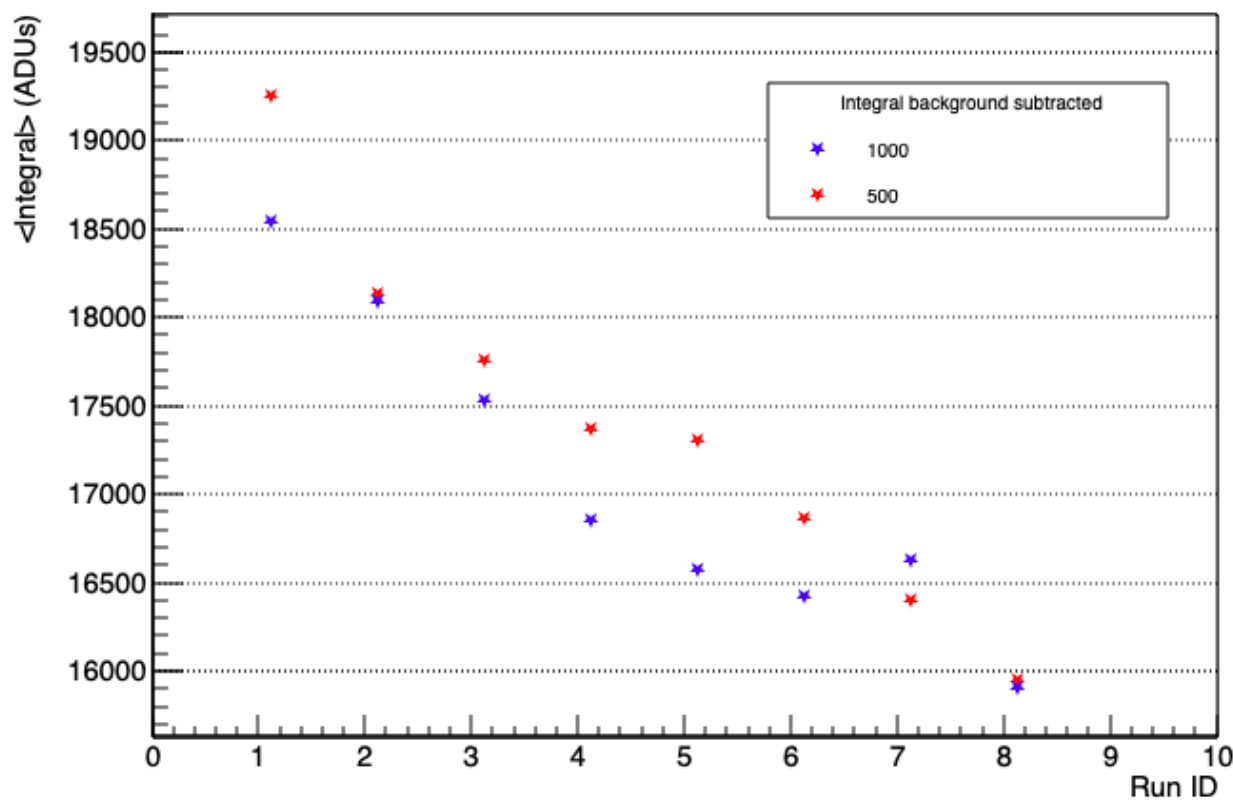
$\sum \langle charge \rangle_i$  Arapuca module in APA 6



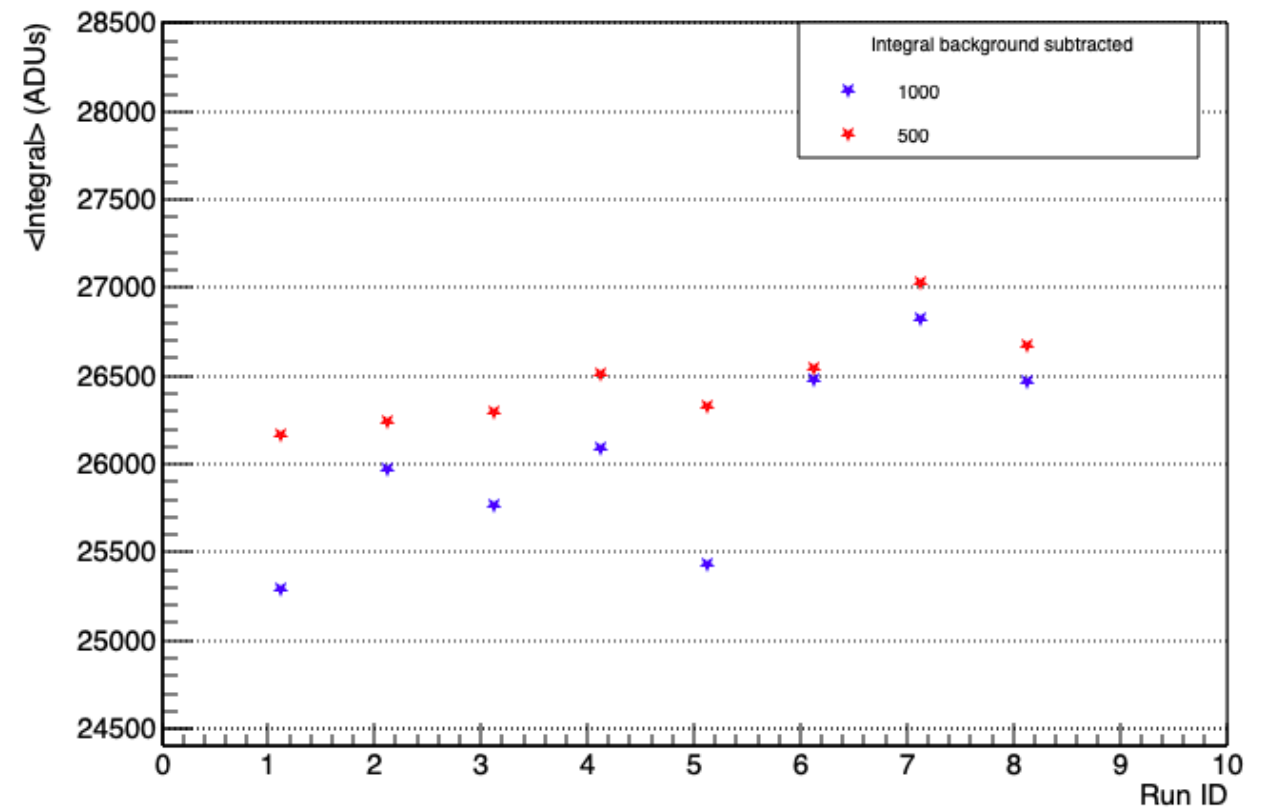
# Background subtraction

Taking into account the background is fundamental for the measurement of the average charge detected. Here we can see the sum of the average charge measured from all the Ararpuca channels using the two windows of integration, after the background subtraction.

$\sum \langle charge \rangle_i$  Arapuca module in APA 3



$\sum \langle charge \rangle_i$  Arapuca module in APA 6



# Analysis

- The two Arapuca modules shows a different behavior.
- The average number of photons detected from the Arapuca in APA 3 decrease in time, instead for Arapuca in APA 6 remain stable.
- The charge per photon detected remain stable in both Arapuca PD modules.

# Interpretation

- Since the charge per photon detected remains stable there is no change in the MPPCs gain and in the after pulses and cross talks contribute.
- About the average number of photons detected, no change in Arapuca PD module in APA 6, the combination LED - Arapuca PDE remains stable
- In APA 3 the average number of photons detected decreases in time.

# Arapuca PD module APA 3

The average number of photons detected decreases in time, that means a deterioration in the combination

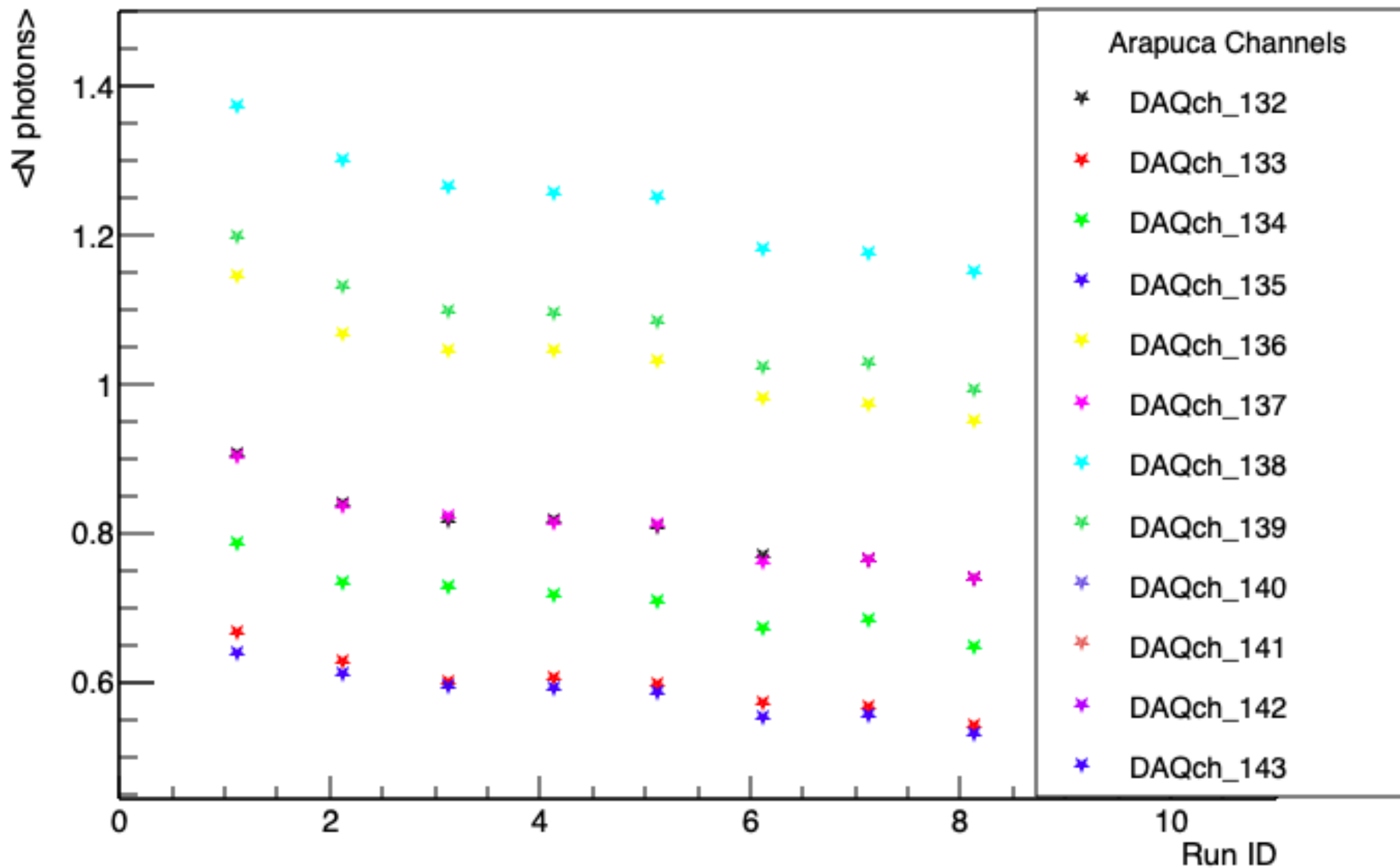
LED - Arapuca PDE (wavelength shifter)

From my point of view the most valuable hypothesis is that the LED intensity is going down in time, because the following:

- Arapuca PD module in APA 6 is not affected by the same deterioration.
- The decrease in the average number of photons detected is uniform in all the channels

# Zoom on Arapuca in APA 3 channels

Average number of photons detected Arapuca Apa 3



# Zoom on Arapuca in APA 3 channels (2)

Average number of photons detected Arapuca Apa 3

