# Part I

# The **C**entral **N**eutron **D**etector of CLAS12

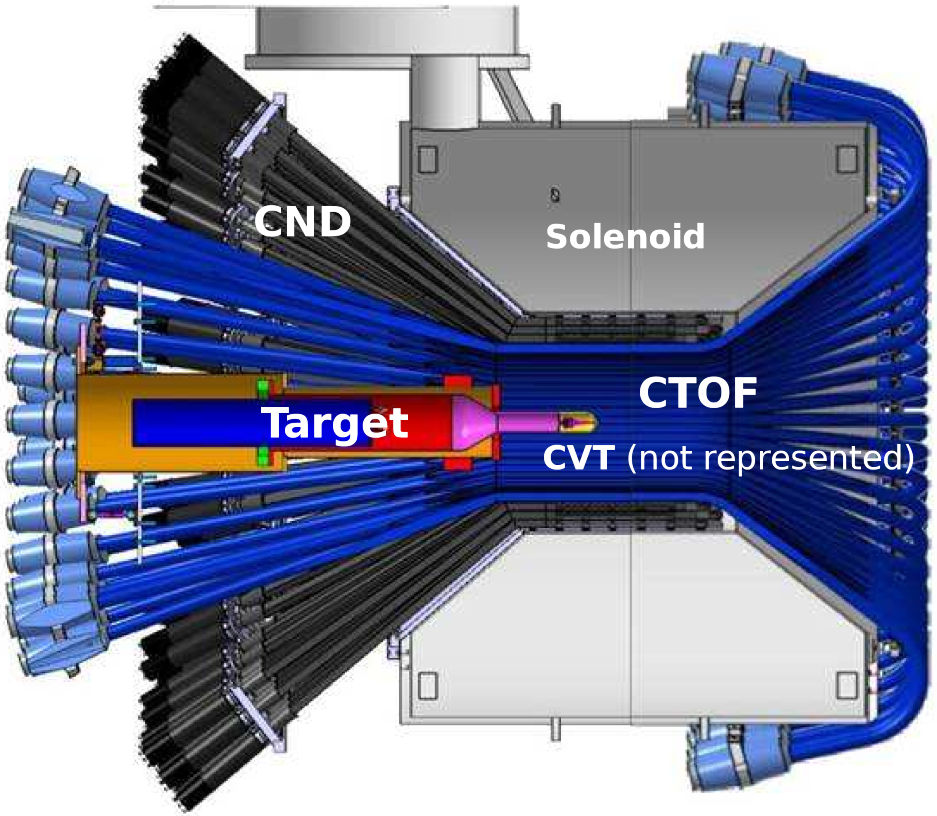
# The Central Neutron Detector

## DVCS on neutron to separate GPDs flavour, using isospin symmetry

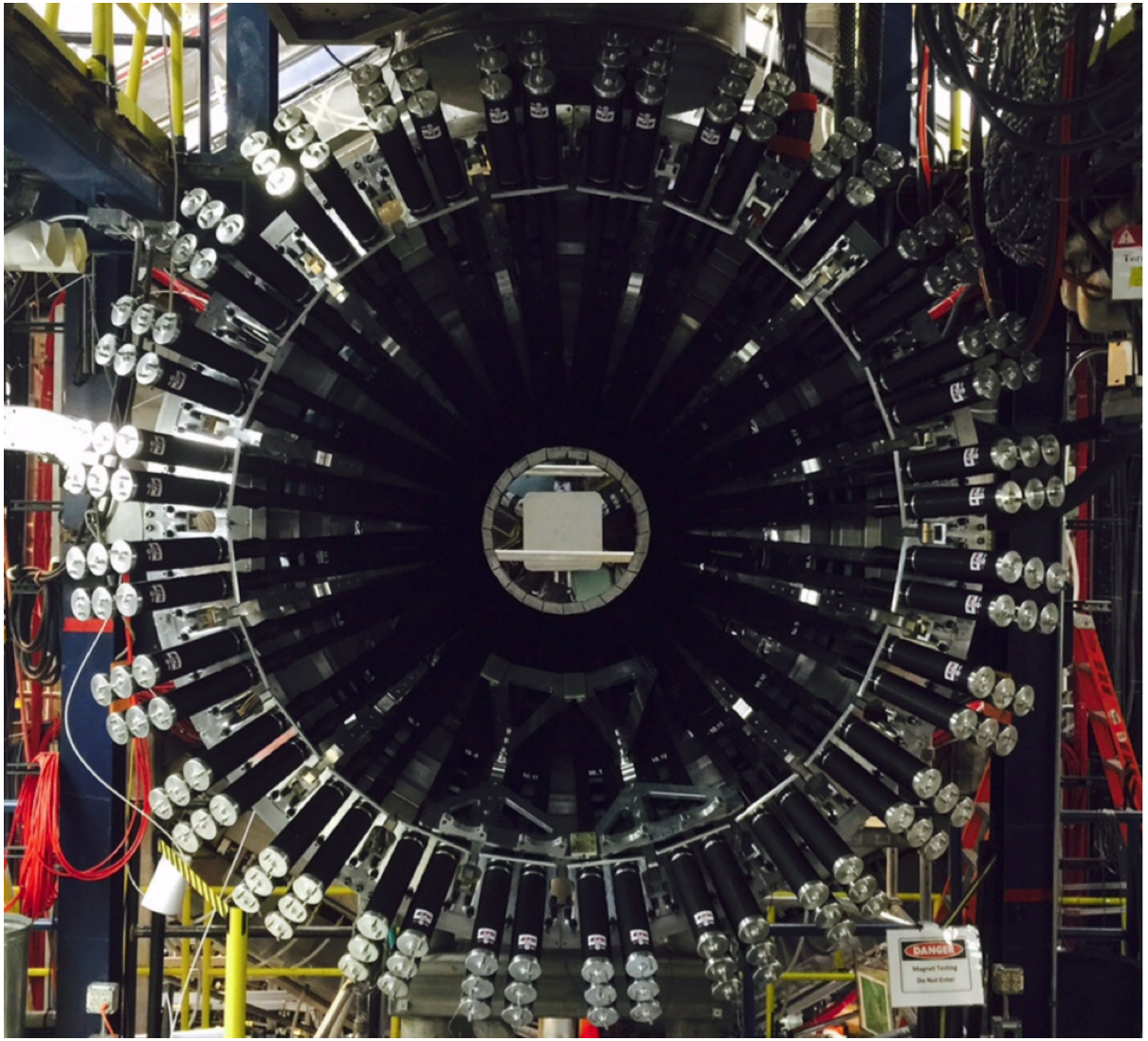
$$H^p = \frac{4}{9}H^u + \frac{1}{9}H^d,$$

$$H^n = \frac{4}{9}H^d + \frac{1}{9}H^u.$$

- Neutrons from DVCS are mainly emitted at large angle ($> 40°$)
- Neutron PID, measurement of momentum and deposited energy
- CTOF neutron detection efficiency is too low
- Little space left in the CLAS12 CD



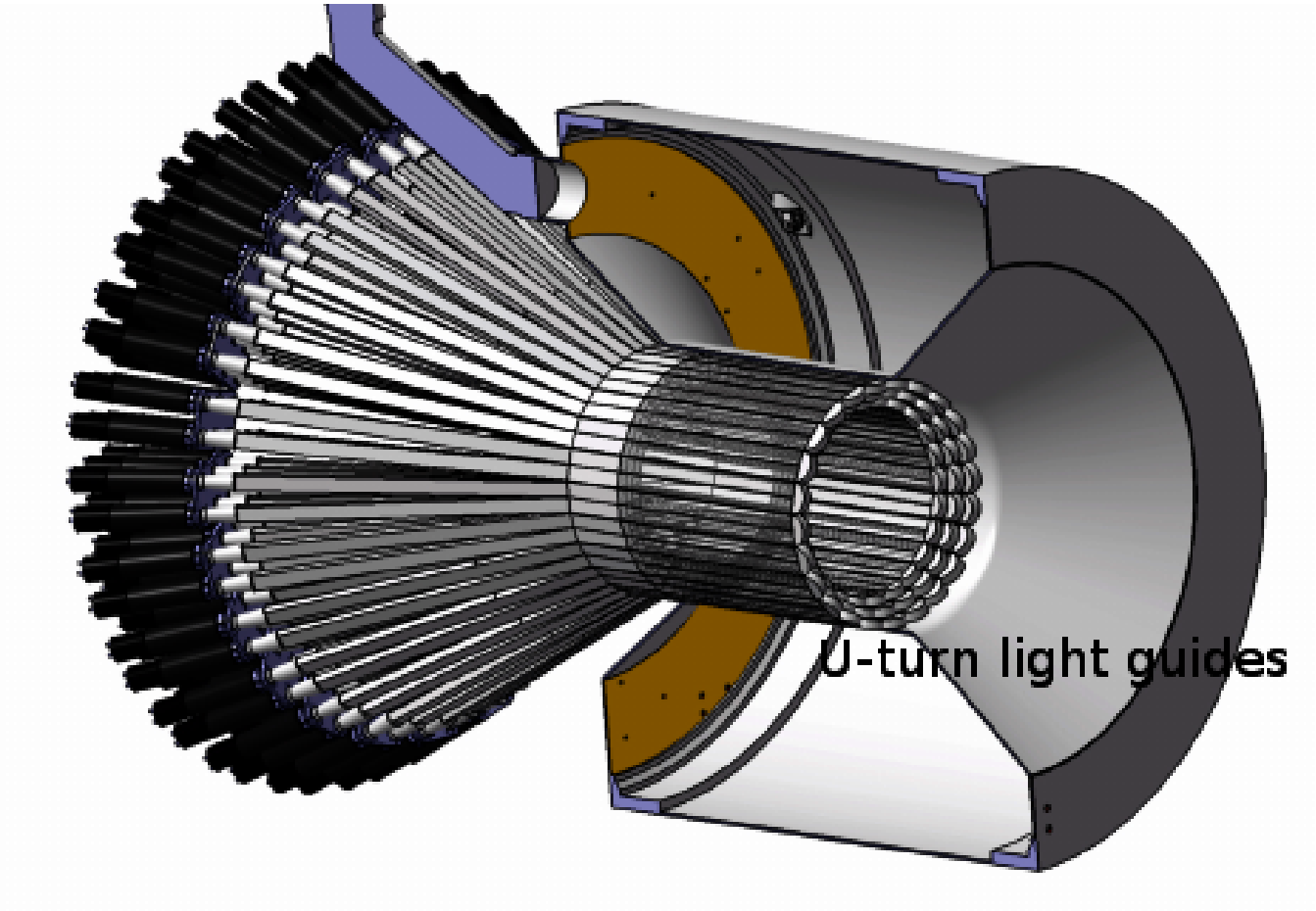
# The Central Neutron Detector




CND from upstream

- 3 layers x 2 components x 24 sectors = 144 plastic scintillators
- 144 PMTs coupled to 144 light guides
- 72 u-shape light guides

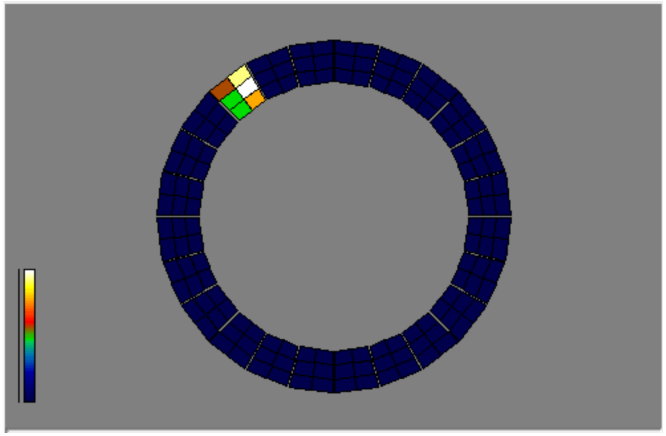
# The Central Neutron Detector



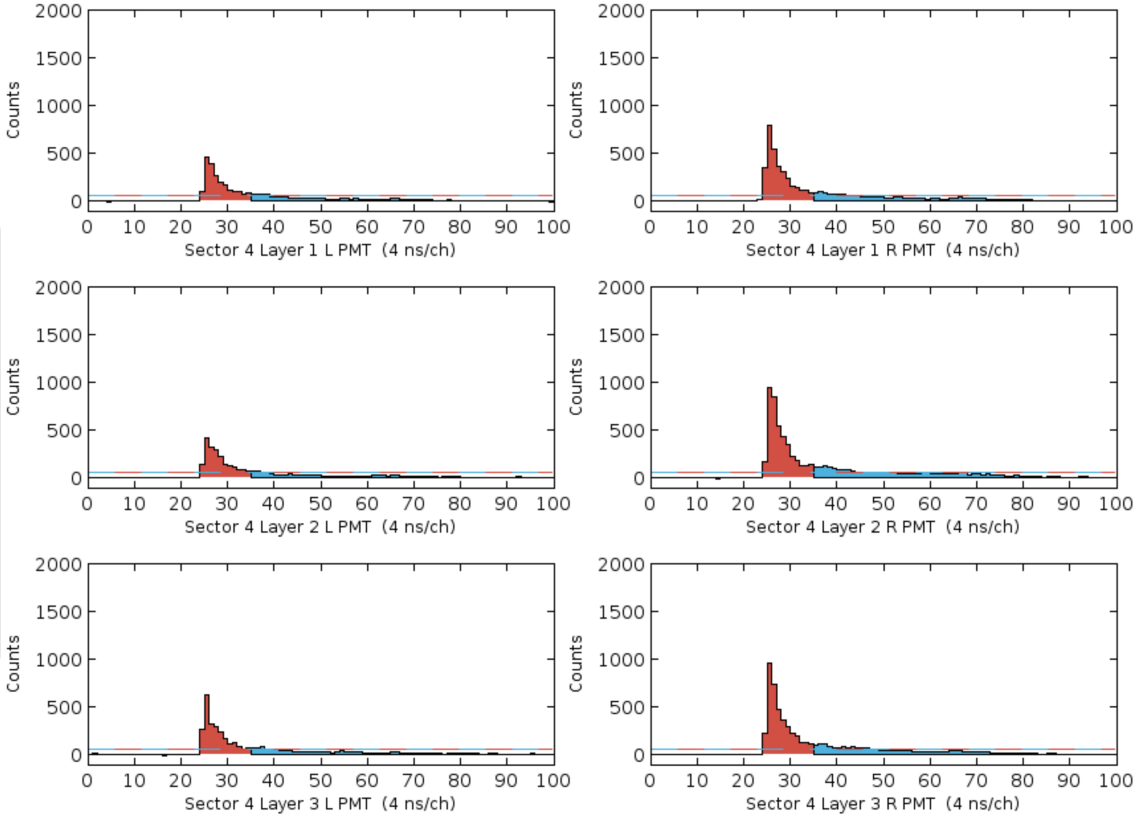

CND from downstream

- 3 layers x 2 components x 24 sectors = 144 plastic scintillators
- 144 PMTs coupled to 144 light guides
- 72 u-shape light guides

# CND data chain



Event in the CND




Signals associated to the particle interaction in the CND

- Integral of the peak (ADC) related to the deposited energy
- Value of the peak (TDC) related to the time and position of the hits
- 1 hit $\rightarrow$ 2 ADC ($ADC_L$, $ADC_R$) and 2 TDC ($TDC_L$, $TDC_R$)

# Time and position calibration

From TDC to time:

$$t_{L/R} = TDC_{L/R} \cdot TDC_to_time \tag{1}$$

For a hit in a **L**eft component:

$$t_L = t_{tof} + \frac{z}{v_{effL}} + t_{off} + t_{offL} + Stt + TDC_{jitter} \tag{2}$$

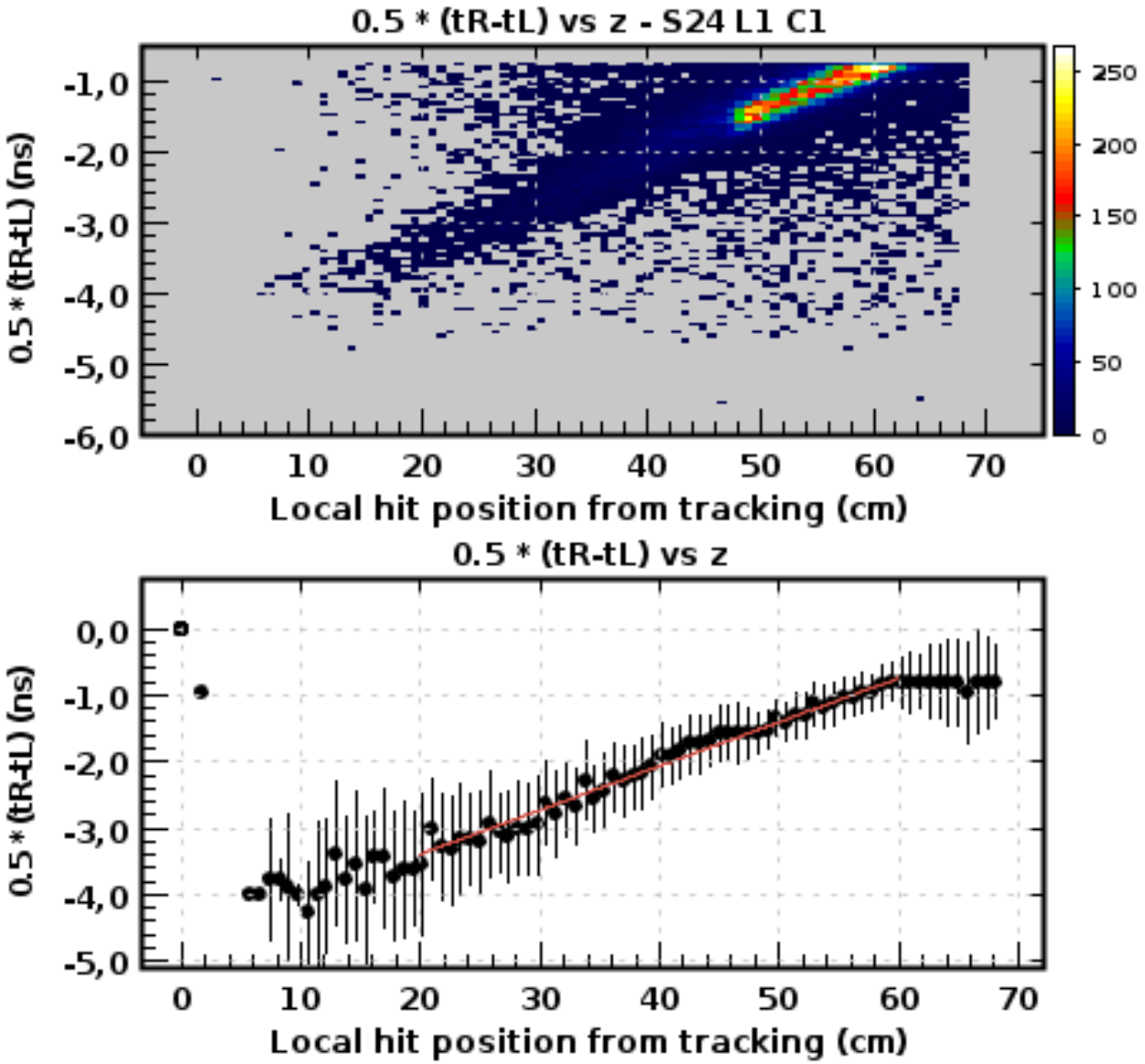
$$t_R = t_{tof} - \frac{z}{v_{effL}} + \frac{L}{v_{effL}} + \frac{L}{v_{effR}} + u_{tloss} + t_{off} + t_{offR} + Stt + TDC_{jitter} \tag{3}$$

**What we want** , **Given by other CLAS12 sub-system** , **To calibrate**

Example: Light effective velocity calibration

$$z = (t_L - t_R) \cdot \frac{v_{effL}}{2} + cst$$

# Light effective velocity calibration




- Plot $(\frac{T_L - T_R}{2})$ vs z
- z is extrapolated from track measured by CVT
- Gradient of the slice fit gives $v_{eff}$

# Energy calibration

For a hit in a **L**eft component:

$$ADC_L = \frac{E}{E_0} \cdot MIP_D \cdot e^{\frac{-z}{Att_L}} \tag{4}$$

$$ADC_R = \frac{E}{E_0} \cdot MIP_I \cdot e^{\frac{-(L-z)}{Att_L}} \tag{5}$$

where

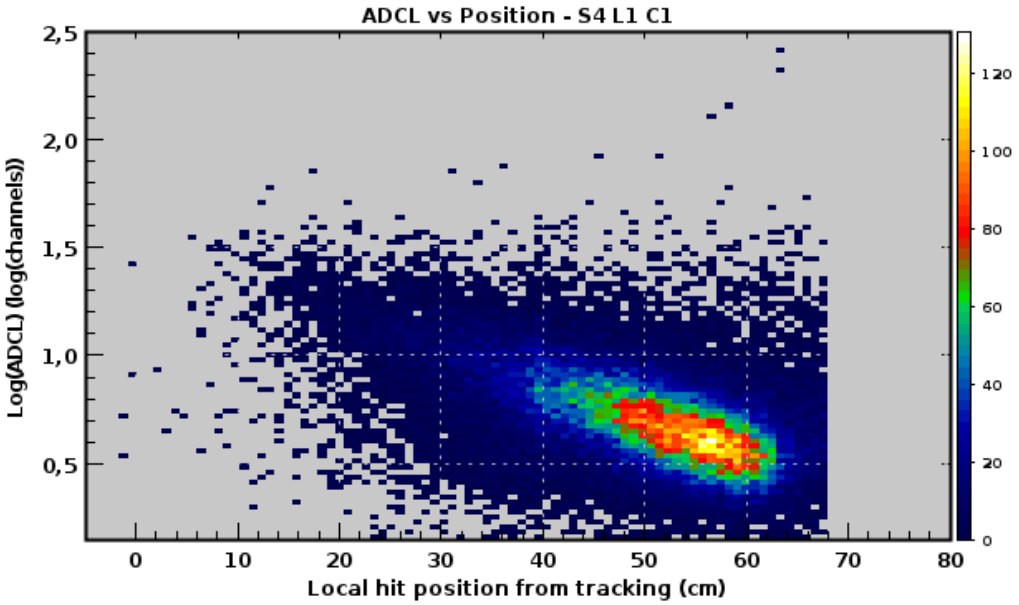
$$E_0 = \frac{h \cdot 0.1956\ mm^{-1}}{2} MeV \tag{6}$$

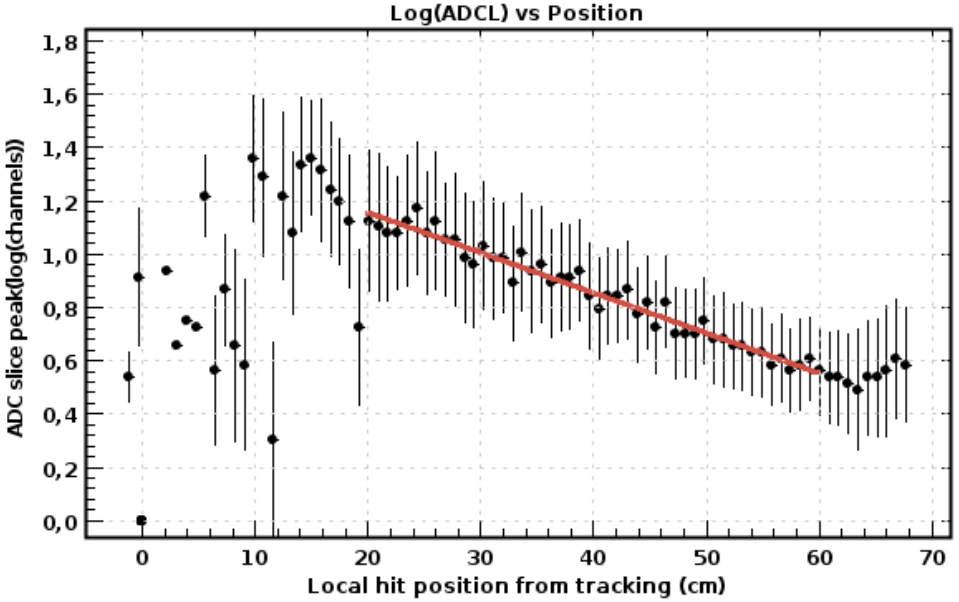
**What we want , Given by the geometry , To calibrate**

Example: Attenuation length

$$ln(ADC_L/ADC_R) = cst - \frac{2 \cdot z}{Att_L}$$

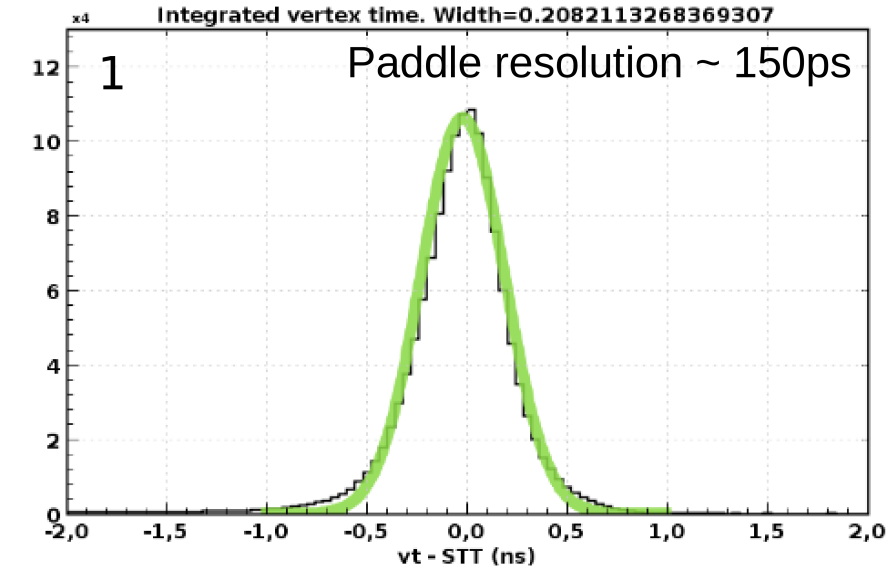
# Attenuation length calibration

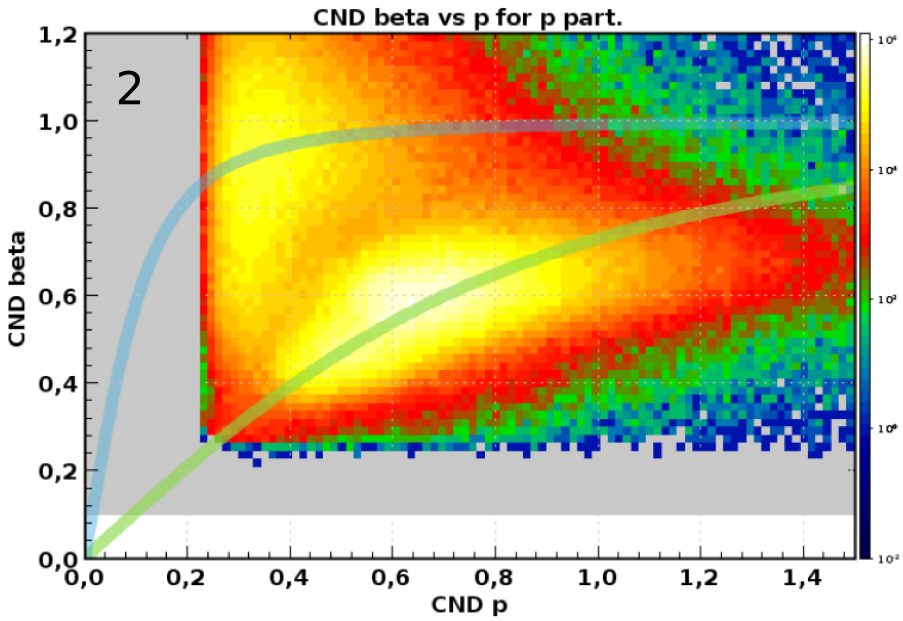


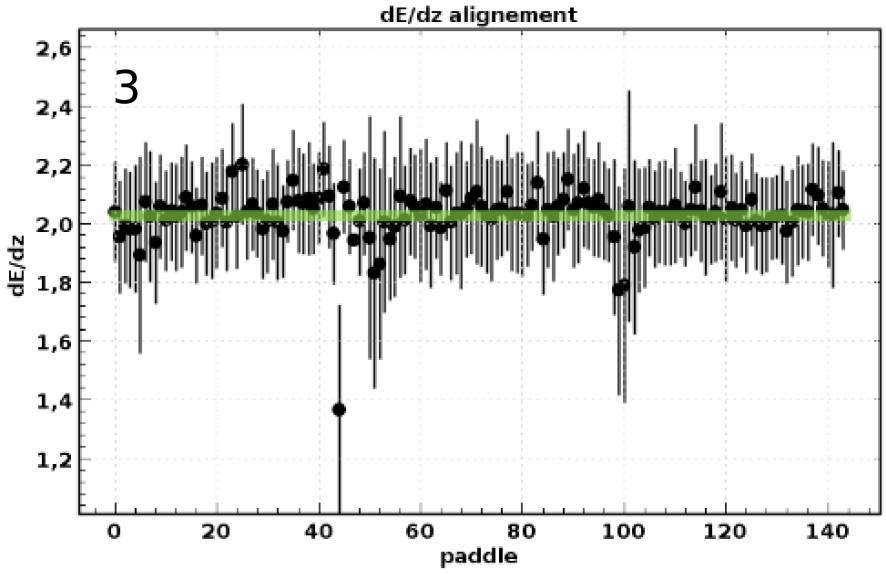



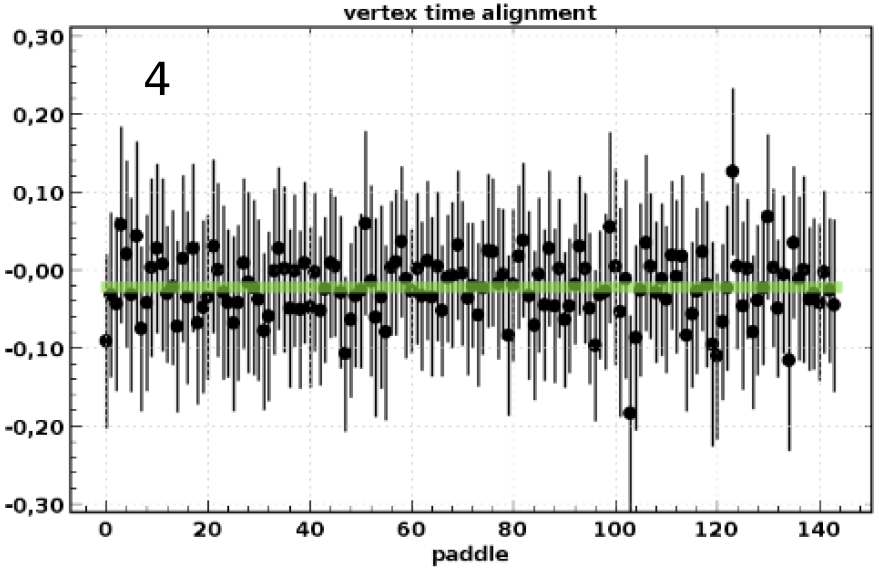

- Plot $(ln(ADC_L/ADC_R))$ vs z
- z is extrapolated from track measured by CVT
- Gradient of the slice fit gives $Att_L$

# Calibration performances




Plots 1,3 and 4 use MIP particles, selected as negative charge particles ($\pi^-$).