

# **Central Neutron Detector: settings/calibrations/performances**

P. Chatagnon, S. Niccolai, R. Wang – IPN Orsay CLAS12 workshop - 3/6/2018



## **Central Neutron Detector in CLAS12**



- **Installation** completed at the end of September
- Cabling completed and CND switched on at the end of October
- Tests with **solenoid field** showed no effect on PMTs signals



Thanks to J. Bettane, P. Chatagnon, G. Hull, M. Imre, D. Marchand, B. Mathon, D. Sokhan



# **CND readout chain and settings**



Channel-by-channel adjustments will be done after finalization of HV gain matching

### **CND single-event display: neutron candidate**

File TriggerBits



Direct signal

# **CND recent debugging**



Inspecting the fADC waveforms with CNDmon we observe some distorted distributions

- Mainly due to bad charge-outputs of the splitters (all signals are ok just out of PMTs)
- Most of them have been fixed by changing splitter channels
- One ugly channel remains (tried changing cable, connector, and splitter channel, it stays the same)
- One spare splitter module in Orsay to be tested and maybe brought over to replace the worse one

One hot ADC channel was fixed by replacing faulty fADC board (thanks Sergei!)

# **Cosmics:** gain-matching calibration

ADCR - S18 L2 C1

- Cosmic data were used so far
- Background was removed by requiring L-R coincidence + 2 layers coincidence
- Most ADC spectra show nice direct/indirect peaks
- Indirect hits are selected by cutting on the TDCs
- Reiterated with 5 different HV settings so far



But this procedure doesn't work for the « side » sectors, as vertical hits are predominant, and produce direct hits in both coupled paddles.

Removing such events kills the statistics in those sectors.

### **Examples of HV calibration fits**



Bad fits for some channels – due to lack of statistics for double coincidence hits → not used, approximate HV settings

#### ADC L vs R for layer 3, all sectors, before the last cosmics-based HV calibration



#### ADC L vs R for layer 3, all sectors, after the last cosmics-based HV calibration



## **New HV calibration procedure for CND**

So far HV calibration relied on cosmics data  $\rightarrow$  it gave a good starting point for HV BUT slow iterative procedure, and requires taking frequent cosmics data

 $\rightarrow$  CTOF algorithm, based upon beam data, has been adapted to CND

Log ratio
$$LR = \log\left(\frac{ADCR}{ADCL}\right)$$
Geometric Mean $GM = \sqrt{ADCL \cdot ADCR}$ Delta Gain $\Delta = GM \exp ected - GM$  where  $GM \exp ected$  set to 2000 ADCHV setting $HVnew = HVold + HVold \cdot \Delta \cdot \frac{\sqrt{LR}}{GM \cdot \alpha}$ For left paddles $HVnew = HVold + HVold \cdot \Delta \cdot \frac{1}{GM \cdot \sqrt{LR} \cdot \alpha}$ For right paddles

Where  $\alpha$  is set to 10

#### Fitted geometric mean with Landau + exponential



New HV file uploaded today – results soon

## **Issue with beam data**

With beam data, the **TDC distributions** are used to select direct and indirect hits – and this is necessary for HV calibrations and many other calibration steps

At first, we could not understand our time spectras with real data

When Sergei corrected an offset between the trigger and the CTOF and CND TDCs, we finally saw more meaningful spectras



## « Direct-Direct » hits in beam data

These events corresponds to hits in both coupled paddles due to charged particles with a small radius of curvature



#### This was confirmed analyzing NO-SOLENOID-FIELD data (2.2 GeV)



#### L-R time offset calibration from no-field data



## **First attempts of v\_eff calibrations**



**Calibration algorithm for v\_eff (and most of the other steps) relies on SVT tracking** so far poor statistics as matching works poorly

## **CND Reconstruction Software**

- Fully operating and implemented in COATJAVA
- Some minor bugs need to be fixed for the next release
- Good results for neutrons on simulations

Reconstruction: **Pierre Chatagnon** Validation with MC, neutron ID: **Rong Wang** 

See R. Wang's DPWG talk next Thursday



## **To-do list**

- Finalize HV gain matching calibration, work ongoing using cosmics and beam data
- Once the HVs are recalibrated, we can study the effect of different discriminator thresholds on the data
- Work is necessary to manage to use SVT information to remove « direct-direct » hits from data with solenoid field on
- Current calibrations algorithms rely heavily on SVT tracking
- Other options: calibrate offsets and u-turn time using neutrals; take some no-solenoid data
- Low-energy data could also be beneficial, to have more pions in the CD
- Next calibration steps will follow quickly once the detector settings are stable and SVT matching works
- Neutron ID procedure for the CND is ready it should be implemented in the Event Builder
- Study of neutron detection efficiency using the  $ep \rightarrow en\pi^+$  channel