FIT detector as Luminometer for RUN3

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ALICE luminometers in RUN2

- **V0 (pp, p-Pb, Pb-Pb)**
  - two scintillator arrays on opposite side (A and C) of the IP
  - coincidence of A and C side for pp and p-Pb collisions
  - amplitude trigger for Pb-Pb collisions
- **T0 (pp, p-Pb)**
  - two Cherenkov detector arrays on opposite sides of the IP
  - coincidence of A and C side
    - with hardware cut on the signal arrival time difference
- **Neutron Zero Degree Calorimeters ZN (p-Pb, Pb-Pb)**
  - two spaghetti calorimeters on opposite sides of the IP, at ±114 m
  - single-arm (remnant side for p-Pb) or OR-trigger
- **ALICE Diffractive detector AD (pp)**
  - two scintillators on opposite sides of the IP,
  - coincidence of A and C side

The stability and consistency of two main luminometers is evaluated via the ratio of T0- to V0-based luminosities
What have we learned from RUN2?

- interaction time with T0 & V0

OTVX trigger – clean, no after-pulses, not sensitive to collisions with gas

but was affected by pile-up of two events hitting T0A and T0C separately due to the limited T0 acceptance

OTVX – the main luminometer for 2012-2018 pp data taking
Fast Interaction Trigger for RUN 3 replaces 3 detectors in ALICE: T0,V0 and FMD


FIT = FT0 and FV0 for ALICE after LS2

FV0
Large acceptance

Old V0A (2.8 < \eta < 5.1)
Old T0A (4.61 < \eta < 4.92)

FT0
Excellent timing

Increase the active area for FV0 and FT0
Increase the number of channels

Old T0A -3.28 < \eta < -2.97
News from MB
18/04/2019

- FIT/V0/FDD integrated into one FIT project (to use the same type of electronics).
Fully integrated system based on an amplifier, a CFD, on-board TDC/ADCs and FPGA processors; digital trigger processing and GBT based read-out. **FIT** -> trigger decision based on digitized data (after TDCs & ADCs)

**Relevant to FDD:**
No problem foreseen in the procession of timing information, but ADC integration is terminated after 20 ns (but it could resume after 5 ns).
FIT electronics architecture

FIT electronics structure (FT0)

TCM cards for FV0 and FDD will be the same as for FT0, but custom FPGA firmware is needed for each detector (trigger decisions).

**Limitation:**
- 5 triggers at the same time per detector
- Trigger outputs only for Beam-Beam window for FT0
FIT trigger requirements from Physics Coordination (13 Dec 2016)(1)

- **TRIGGER WITH CHARGE-AMPLITUDE RANGE:** FT0 and FV0A should have a trigger with programmable lower and upper charge-amplitude limits (as we have now in V0). -> **being commissioned as luminometer**

- **TRIGGER ON FIRED CELLS IN GIVEN TIME WINDOW:** It should also be possible to have, at trigger levels L0 and LM, the information of how many CELLS (both for FV0A and FT0) saw a hit, in a given BC, in the time windows corresponding to beam-beam (BB-flag) and beam-gas (BG flags) interactions. The current V0 allows one to use a trigger signal of the type \( (n < BB < N \&\& m < BG < M) \), where \( n, N, m, M \) are integer numbers and can be set via DCS.

  **Limitation:** - With new electronics not possible to have BG time windows for FT0 triggers;
  - BG time windows FV0 and FDD are under discussion
  - Not possible to change BB windows (+-2,5 nc)
FIT trigger requirements (2)

- **MASKING CELLS FROM THE TRIGGER**: It should be possible to mask out one or more channels from the trigger logic.

- **TRIGGER WITH CHARGE-AMPLITUDE RANGE FROM INDIVIDUAL FV0A RINGS**: It would be very useful if the FV0A+ had the possibility to trigger using the signal (or absence of signal) from individual rings; this would open new possibilities, like triggering pp events with high multiplicity in different eta intervals (using the 5 rings).

- **OTHER USEFUL IMPROVEMENTS**: As possible further improvement it would be worth to look into the possibility of storing, in case of multiple hits, the times of all hits for a given cell (for FV0A and FT0). In the present V0, only the leading time is stored. Another interesting possibility would be to decrease the integration time to below 25 ns, again in order to catch multiple hits (as of now, in case of pile-up the measured charge is given by the sum of all hits). All of this is of course subject to what will be the actual detector time resolution.
FT0 & T0 efficiency as a function of number of contributors in ITS vertex

Pythia8, 14TeV; FIT, ITS

Run 289830, LHC18l, 13TeV
25ns_2556b_2544_2215_2332_144bpi_20injV3

Rate 138Hz

Pythia8, 14TeV; FIT, ITS

The T0 vertex trigger (0TVX) rate was affected by pile-up of two events hitting T0A and T0C separately due to the limited T0 acceptance.
FIT luminometer in RUN3

• FV0A (pp, p-Pb, Pb-Pb)
  - One scintillator array on side A of the IP (sensitive to the beam-gas)?
  - Amplitude trigger
  - Amplitude ring triggers

• FT0 (pp, p-Pb)
  - Two Cherenkov detector arrays on opposite sides of the IP
  - Coincidence of A and C side
    - With hardware cut on the signal arrival time difference (like OTVX)
  - Amplitude triggers

• ALICE Diffractive detector FDD (pp)
  - Two scintillators on opposite sides of the IP,
  - Coincidence of A and C side

• FT0& FV0A (pp, p-Pb, Pb-Pb)
  - Logical conditions (OR / AND) between detectors can be done by CTP
Conclusions

• FIT will be ready to deliver the following triggers at LM level as luminometer:
  – Online Vertex determination (like OTVX)
  – charge amplitude in range (FV0 and/or FT0)
  – charge amplitude from individual FV0 rings (new, to be discussed in detail).
  – Only 5 triggers at the same time per detector

• FDD triggers to be discussed later
Thank you for your attention!