Luminosity calculation tool

Miniworkshop difrakce a UPC 2019

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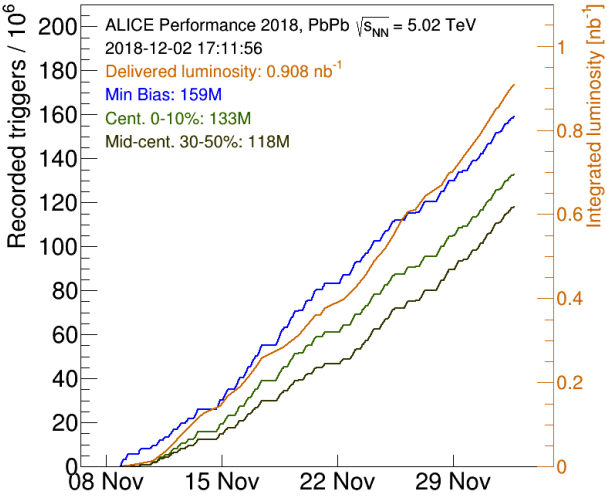
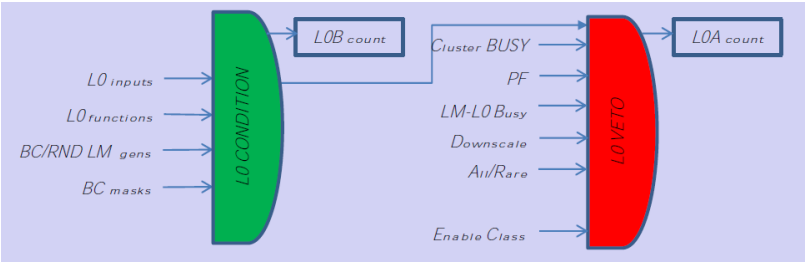
Content



Theory

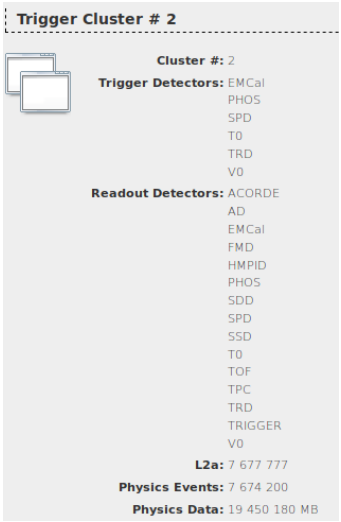
Trigger system

- triggering detectors
- trigger inputs
- CTP (Central Trigger Processor)
- trigger decisions
  - 4 levels of decisions
  - LM, L0, L1 and L2
  - depend on the speed of propagation of the signal to CTP
- readout detectors



Clusters

- Groups trigger and readout detectors.
- Max 6 per run.



Classes

- Groups several trigger info (including trigger inputs).
- Max 100 per run.

Trigger Classes								Counters							
ID	Name	BC Mask	Down Scaling	Cluster	Group	Time (s)	Duration	LMb	LMa	L0b	L0a	L1b	L1a	L2b	L2a
0	CTRUE-B-NOPF-CENTNOTRD	B	0.000%	1	0	0	06:33:15	586 579 644	586 579 644	391 052 883	46 505	46 505	46 505	46 505	46 505
1	CTRUE-A-NOPF-CENTNOTRD	A	0.000%	1	0	0	06:33:15	90 304 134 8	90 304 134 8	60 202 709 2	11 867	11 867	11 867	11 867	11 867
2	CTRUE-C-NOPF-CENTNOTRD	C	0.000%	1	0	0	06:33:15	90 304 134 9	90 304 134 9	60 202 846 4	12 067	12 067	12 067	12 067	12 067
3	CTRUE-E-NOPF-CENTNOTRD	E	0.015%	1	0	0	06:33:15	529 643 020	529 643 020	529 643 020	11 813	11 813	11 813	11 813	11 813
4	CTRUE-T-NOPF-CENTNOTRD	T	0.000%	1	0	0	06:33:15	222 450 068	222 450 068	222 450 068	0	0	0	0	0
5	CTRUE-B-SPD1-CENTNOTRD	B	0.000%	1	0	0	06:33:15	586 579 644	586 579 644	391 052 883	41 981	41 981	41 981	41 981	41 981
6	CCUP13-B-SPD1-CENTNOTRD	B	0.500%	1	0	0	06:33:15	586 579 644	586 579 644	27 339 595 9	49 995	49 995	49 995	49 995	49 995
7	CCUP25-B-SPD1-CENTNOTRD	B		1	0	0	06:33:15	586 579 644	586 579 644	2 608 046 30	714 872	714 872	714 872	714 872	714 872
8	CCUP25-A-NOPF-CENTNOTRD	A	0.000%	1	0	0	06:33:15	90 304 134 8	90 304 134 8	25 075 739	0	0	0	0	0
9	CCUP25-C-NOPF-CENTNOTRD	C	0.000%	1	0	0	06:33:15	90 304 134 9	90 304 134 9	82 324 579	0	0	0	0	0
10	CCUP25-E-NOPF-CENTNOTRD	E	0.000%	1	0	0	06:33:15	529 643 020	529 643 020	1 755	0	0	0	0	0
11	CCUP25-U-SPD1-CENTNOTRD	U		1	0	0	06:33:15	293 157 411	293 157 411	1 471 498 44	366 028	366 028	366 028	366 028	366 028

Class naming

CCUP8-B-NOPF-CENTNOTRD

Class naming - identification

CCUP8-B-NOPF-CENTNOTRD

- Some shortcut, which can give a hint about the purpose of this class.
- Usually starts with C - means class...
- Here, CUP is an abbreviation for Central Ultra-Peripheral.
- Number at the end specifies it (timeline ordered).
  - (i.e. 8 is designed for trigger on J/ψ in central barrel firstly used in 2015 PbPb...)
- Other UPC important class - MUP = Muon Ultra-Peripheral.

Class naming - mask

CCUP8-B-NOPF-CENTNOTRD

- Tells about type of beam crossing.
- B-mask stands for Beam-Beam collision.
- i.e. A-mask is a Beam-Gas collision with beam from A-direction.
- Others: C, E, T, U...

Class naming - protection

CCUP8-B-NOPF-CENTNOTRD

- Tells about protection on other bunch crossings.
- NOPF - no past/future protection.
- Example from 2018 PbPb - SPD2:
  - Protection of SPD on 6 previous bunch crossing.
  - Due to high collision rate.

Class naming - cluster

CCUP8-B-NOPF-CENTNOTRD

- Tells about the cluster of detectors used.
- CENT means central barrel.
- Others: ALL, FAST, MUON...
- Usually with addition NOTRD, meaning TRD is NOT necessary.
  - (TRD quite often crashed and excluding it from trigger matrix helped to improve data taking)

Class example

- CCUP8 = !0VBA & !0VBC & !0UBA & !0UBC & 0STP & 0OMU
  - !0VBX - veto on V0 detector (A or C side)
  - !0UBX - veto on AD detector (A or C side)
  - 0STP - back-to-back event according to SPD topology
  - 0OMU - back-to-back event according to TOF topology
- UPC trigger class definitions at UPC Twiki.

Luminosity

- In theory:

$$L = \frac{R}{\sigma} \tag{1}$$

- In the ALICE (real) world:

$$L_{Class} = L_{Seen} \cdot LT_{Class} \tag{2}$$

Reference class

$$L_{Class} = L_{Seen} \cdot LT_{Class} \tag{3}$$

$$L_{Seen} = \frac{L^{B}_{REF}}{\sigma_{REF}} F(\mu_{REF}) \tag{4}$$

- You do not know the cross section (CS) of (most of) your class.
- You compare trigger counts (B)efore veto of your class to trigger counts (B)efore veto of some class with known CS (i.e. C0TVX in pp system).
- You known this CS (firstly) from MC estimates and later from Van der Meer scan.
- You also have to apply a correction on pileup $F(\mu_{REF})$.
- NOTE 1: Trending.root files are set to μb^{-1}
- NOTE 2: You should also correct on background - not implemented in trending.root.

Pile-up correction

$$L_{Seen} = \frac{L^{B}_{REF}}{\sigma_{REF}} F(\mu_{REF}) \tag{5}$$

$$F(\mu_{REF}) = \frac{\mu_{REF}}{1 - exp(-\mu_{REF})} \tag{6}$$

$$\mu_{REF} = -\log\left(1 - \frac{L^{B}_{REF}}{\text{total bunch crossings}}\right) \tag{7}$$

- μ_{REF} is an average number of collisions per bunch crossing.
- From the Poisson distribution.
- Number of triggers in a bunch crossing (hits in T0A or T0C).

$$P(AC > 0) = 1 - P(0) = 1 - e^{-\mu} \tag{8}$$

Class lifetime (LT)

$$L_{Class} = L_{Seen} \cdot LT_{Class} \tag{9}$$

$$LT_{Class} = \frac{L^{A}_{Class}}{L^{B}_{Class}} \tag{10}$$

- Ratio of triggers (A)fter the CTP veto and (B)efore.
- Not precise for all classes!!!
- i.e. in UPC triggers L^{B}_{Class} suffers from afterpulse and late-activity effects.
- In theory, all triggers from the same cluster should have the same LT.
- Therefore, you look for a non-affected class from the same cluster and use its LT instead.

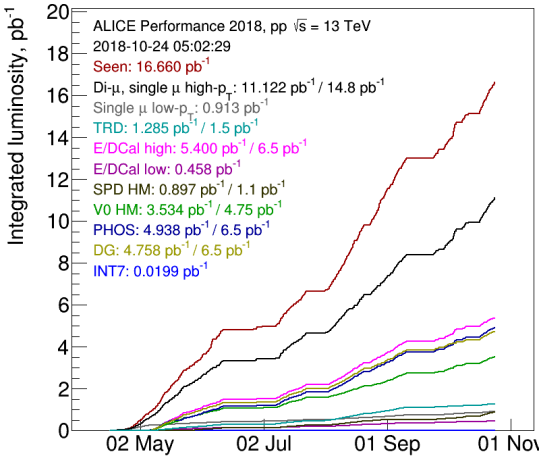
Downscaling factor (DS)

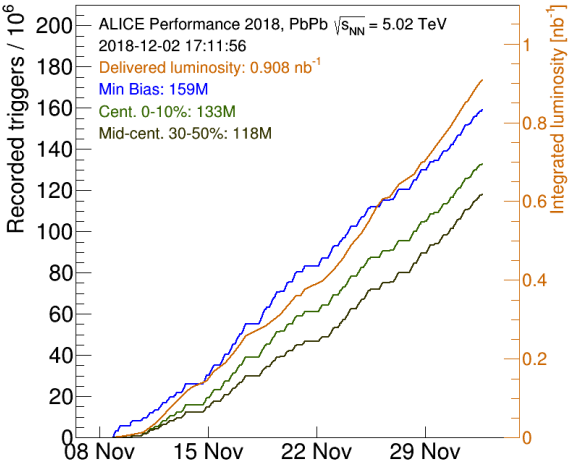
- Sometimes, classes are downscaled (due to i.e. high trigger rate...).
- Does not play a role, when your class LT is correct.
- When you use a LT of other class, you have to take into account possible different DS.

$$LT_{Class} = LT_{Cluster} \frac{DS(Class)}{DS(Cluster)} \tag{11}$$

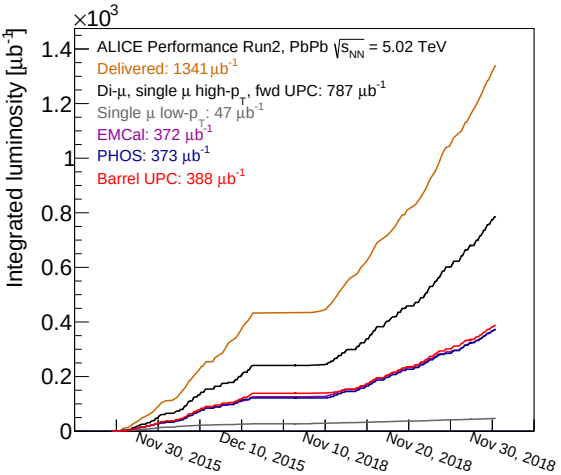
Output

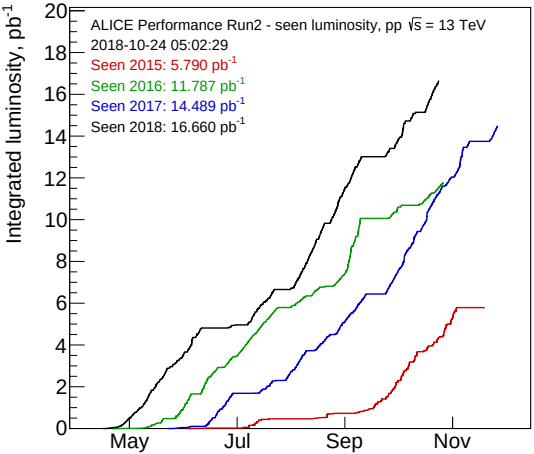
Some nice figures I





Some nice figures II





How I can take advantage of this? I

- Everything taken from OCDB files stored at alice-ocdb.cern.ch
- For codes, go to AliPhysics/PWGPP/EVS/ on GitHub.
- Validated luminosity figures are in ALICE figure repository.
- All trending.root files, which contain calculated luminosity for every trigger class in every run, are in aliqaevseos.web.cern.ch/aliqaevseos/data/
- This was periodically updated during data takings and you could see, how we are doing.
- You can find some custom macros and many figures there as well.

How I can take advantage of this? I

- If you want to easily calculated lumi for your analysis, do this steps:
  - Download the trending.root
  - The luminosity of your analysed sample is usually smaller than the maximum available (Error during reconstruction, offline cuts...), so you can not simply take the luminosity from the file.
  - Get N seen events of your trigger from the tree, you want to analyse.
  - Get l2a info from trending.root file and get N events of your trigger.
  - Make ratio of these for each run you want to analyse.
  - Take luminosity of your trigger for each run.
  - Scale it with the ratio.
  - Add any other corrections you think are necessary.
  - In case of troubles, you can try to ask me.

BACK UP