

# Use of a High Multiplicity Trigger for the ALICE Data in proton-proton Interactions at $\sqrt{s} = 13$ TeV



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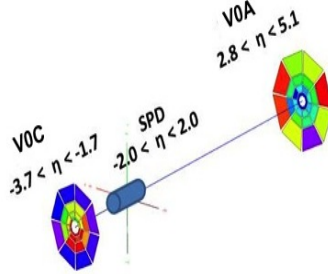
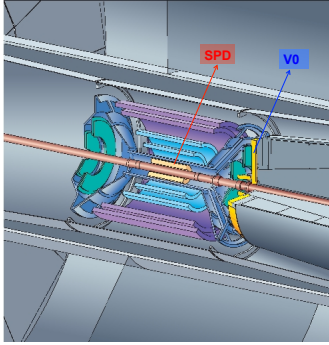
## Introduction

- ALICE is collecting proton-proton collision data at a center of mass energy of 13 TeV. In order to collect a significant statistics of High Multiplicity (HM) data a specific HM trigger has been implemented which relies on Silicon Pixel and VZERO detectors<sup>[1]</sup>.
- The HM triggers are designed to provide a sample of low pile-up data for rare pp interactions having a multiplicity around ten times higher than the average, with the goal of collecting an integrated luminosity of 10 pb<sup>-1</sup> during LHC Run II.

## Goal

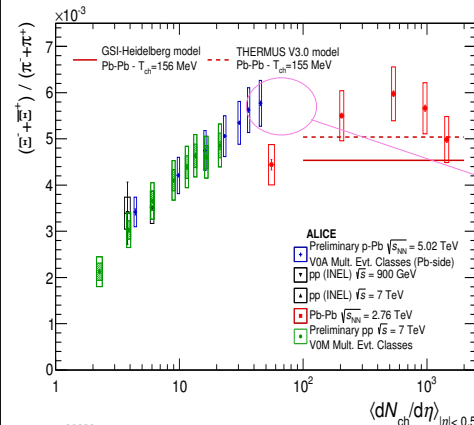
- Some of the most interesting results in the LHC Run I deal with the study of HM events in small systems. The unexpected observation of ridge structures in pp and pPb triggered a systematic investigation of the HM events in order to understand the origin of these flow-like effects<sup>[2,3]</sup>.
- The unique pp sample that ALICE is going to collect at 13 TeV in LHC Run II will significantly extend the reach of the benchmark HM studies<sup>[4]</sup>.

## ALICE Trigger Detectors



- The ALICE Silicon Pixel Detector (SPD) is a part of Inner Tracking System consisting of two layers in the barrel region, at the radii of 4 and 7 cm. The Fast-OR (FO) SPD trigger consists of the logical combination of 1200 signals each produced by at least one fired pixel in the chips of SPD.
- The VZERO (V0) is a small angle detector made of two independent arrays of fast scintillator counters, V0A and V0C, located at 320 cm and -90 cm respectively from the interaction point. The V0A and V0C are segmented into 4 rings along the radial direction and each ring is segmented in 8 channels along the azimuthal direction, contributing with 32 channels for each array. Based on the arrival time of the particles, V0 triggers rejects the events online if the interaction is outside the beam-beam window and the number of beam-gas interaction flags exceed a certain threshold.

## Results from Previous Multiplicity Studies

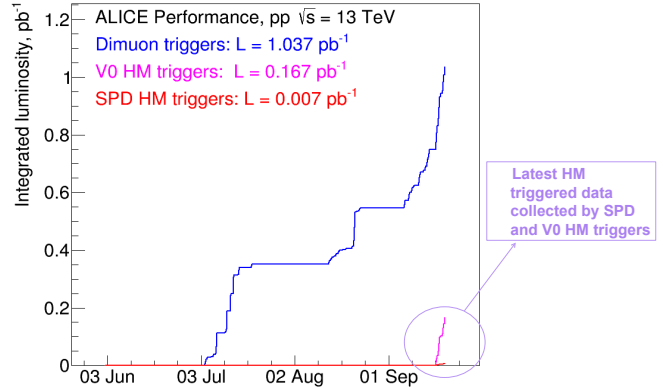


We expect to reach an average multiplicity density of nearly ~40 in 13 TeV Run II data

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- Variation of the Cascades/Pion yield ratio with respect to the charged multiplicity density in  $|\eta| < 0.5$ . (Check out *Livio Bianchi's* presentation/slides on September 29, at 15:20 in "QGP in Small Systems II" session)

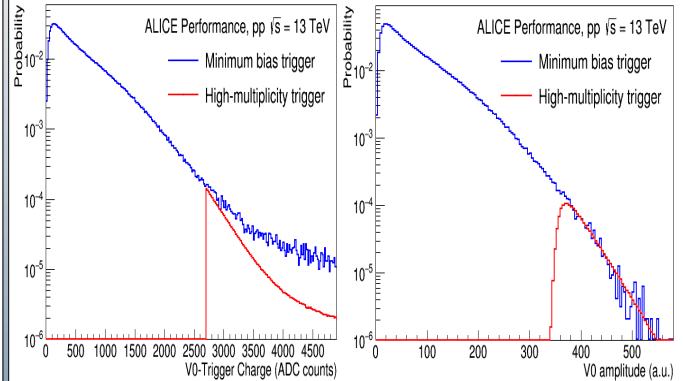
## SPD and V0 HM Trigger Statistics



- This plot shows the integrated luminosity for the data collected by SPD and V0 HM triggers and also the Di-muon trigger (not discussed here). A reduction factor of  $\sim 10^{-3}$  is used online on SPD and V0 trigger to collect HM events.
- The HM triggered data are collected by requiring a large charge in the V0 detector or a large number of fired FO SPD chips above the threshold values.

## V0 HM Trigger Performance

- Since some of the ALICE trigger detectors are sensitive to more than one bunch, we use a Past Future (PF) protection based on out of bunch pileup rejection on V0s. The Minimum Bias (MB) data is collected using a trigger requiring at least one charged particle in both, V0A and V0C.



- V0 charge distributions online (left) and offline V0 amplitude distribution (right) for 13 TeV data with MB trigger and V0 HM trigger are shown in the plot above.
- The HM events are triggered when the V0 charge distribution reaches the threshold value of about ~2700, which corresponds to the offline V0 multiplicity of ~340.

## Conclusions

- The High Multiplicity triggers are in operation, preliminary results indicate performance consistent with the expectations.
- We look forward to make further measurements of collectivity effects in small systems with the high statistics HM sample in 13 TeV data.

## References

- [1] The ALICE Collaboration, "Upgrade of the ALICE Read-out & Trigger System", CERN-LHCC-2013-019, (2013)
- [2] The ALICE Collaboration, "Multiplicity dependence of jet-like two-particle correlations in p-Pb collisions at  $\sqrt{s_{NN}} = 5.02$  TeV", Phys. Lett. B 741, (2015).
- [3] Yuji Hirono and Edward Shuryak, "Femtoscopic signature of strong radial flow in high-multiplicity pp collisions", Phys. Rev. C 91, 054915 (2015).
- [4] The ALICE Collaboration, "Charged-particle multiplicity measurement in proton-proton collisions at  $\sqrt{s} = 7$  TeV with ALICE at LHC", Eur. Phys. J. C 68 345-354, (2010).