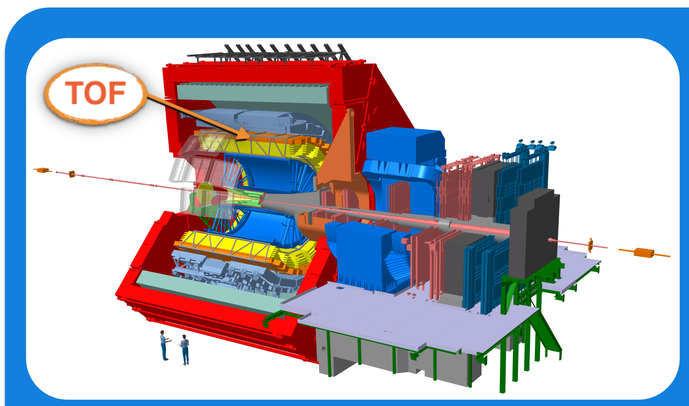
Performance of the large Time-Of-Flight detector of ALICE

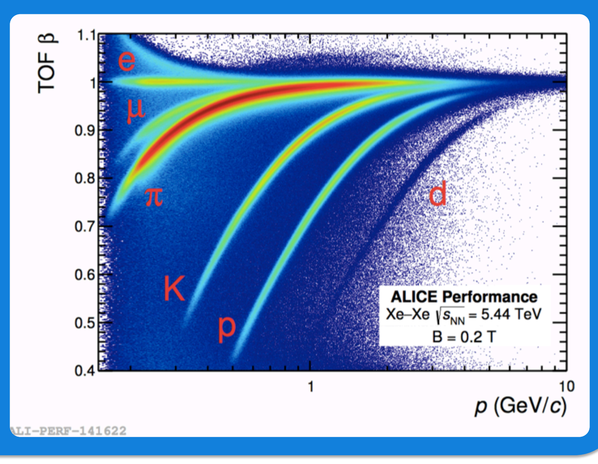
Francesca Carnesecchi*
on behalf of the ALICE collaboration
*University and INFN Bologna, Centro Fermi Roma

Quark Matter 2018 Venice



TOF: • full φ,18 SuperModules(SM) • 5 Modules each SM	• 19(15) MRPCs per Modules • total of 1593 MRPCs • 152928 readout channels

- The main task of the ALICE experiment at the LHC is to study the properties of the strongly interacting, dense and hot matter created in high-energy heavy-ion collisions: the QGP.
- Many physics analyses are based on the capability of the ALICE detector to perform Particle IDentification (PID) using different and complementary techniques, (0.15 - 20) GeV/*c*.
- In the intermediate momentum range (from 0.3 to 4-5 GeV/*c*) this task is mainly accomplished using the Time Of Flight (TOF) detector.
- The TOF is based on the Multigap Resistive Plate Chambers (MRPC) technology; the base element is a double–stack MRPC of 5+5 gas gaps.
- We present improved performance achieved during LHC Run2. Time resolution reached 56 ps, close to performance achieved in beam tests.



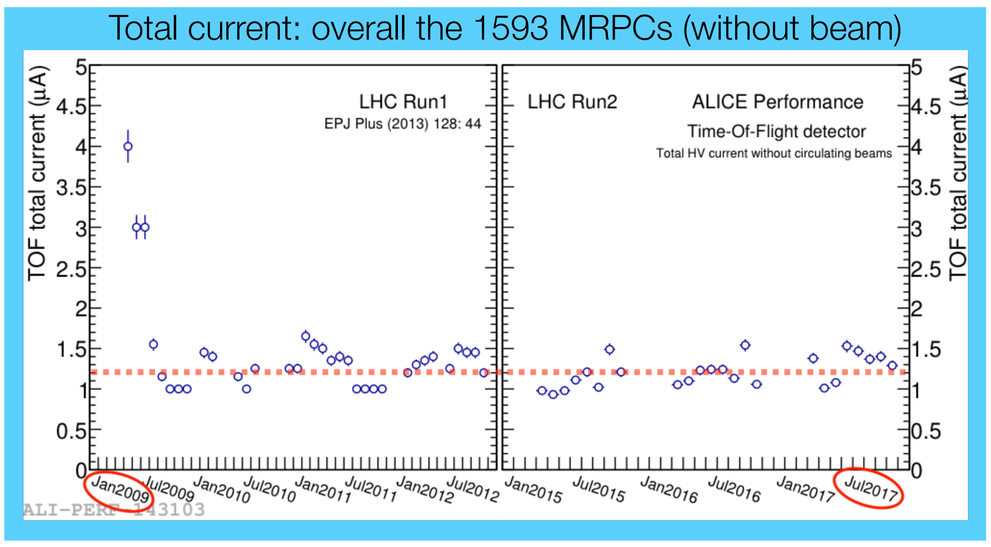
The largest area (144 m^2) MRPC application in experiments at colliders, installed in 2008

After 10 years of operation TOF continues to ensure stable operations (2116 hours of data taking in 2017)

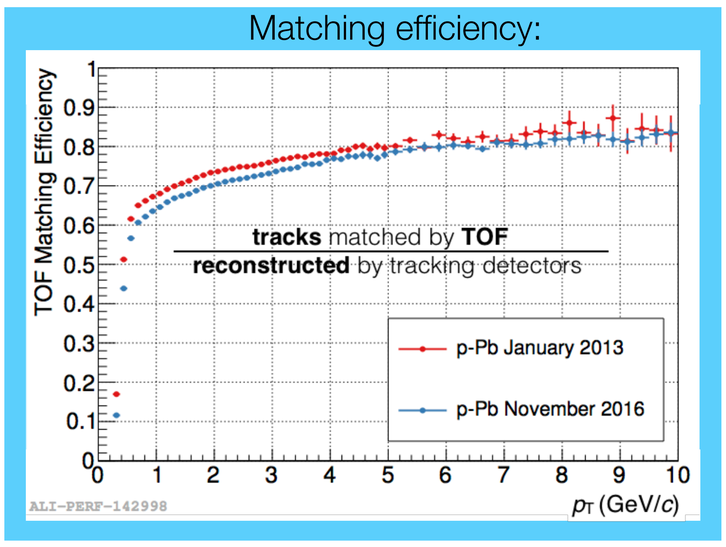
~99% total time availability
~93% average active channels (the missing 7% is due to electronics and connectors , not to MRPC)

No degradation during these years and a very good stability was found in current, trigger rate and in matching efficiency with ALICE reconstructed tracks (TPC+ITS)

Total current: overall the 1593 MRPCs (without beam)

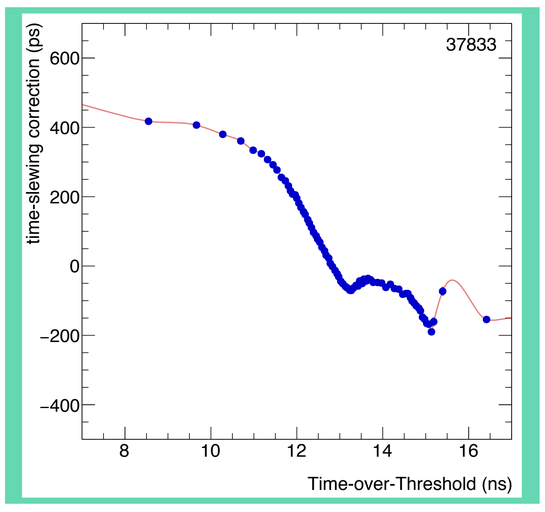


Matching efficiency:



Contributions to matching efficiency:
- MRPC efficiency (~98-99%)
- TOF algorithmic inefficiency
- TOF geometrical acceptance
- Budget material (in front of TOF)
- Track extrapolation

Performance stable during Run1 and Run2 (deviations due to last 2 bullets)



The time slewing corrections are needed to disentangle the time from the charge information. **In 2017 the algorithm has been improved, with a new channel by channel calibration.**

ALICE-TOF time resolution:

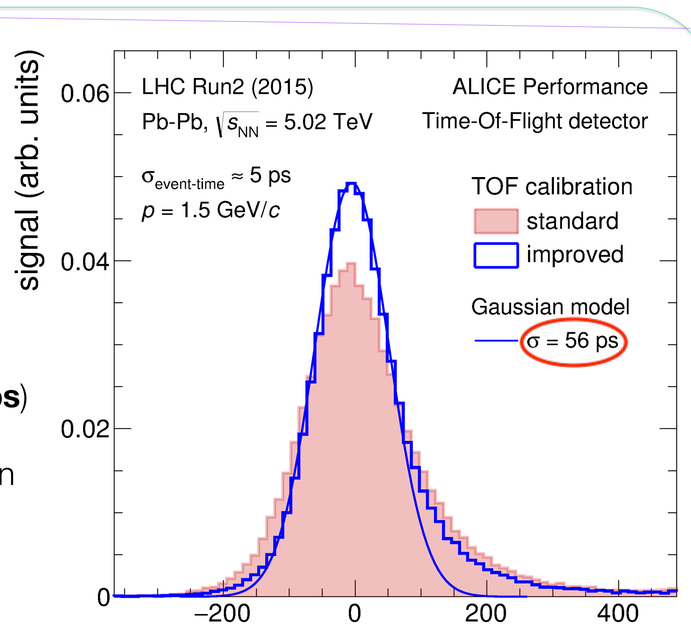
$$\sigma^2_{TOF} = \sigma^2_{MRPC} + \sigma^2_{TDC} + \sigma^2_{FEE} + \sigma^2_{Cal}$$

$$t_{TOF} - t_{event} - t_{exp_i}$$

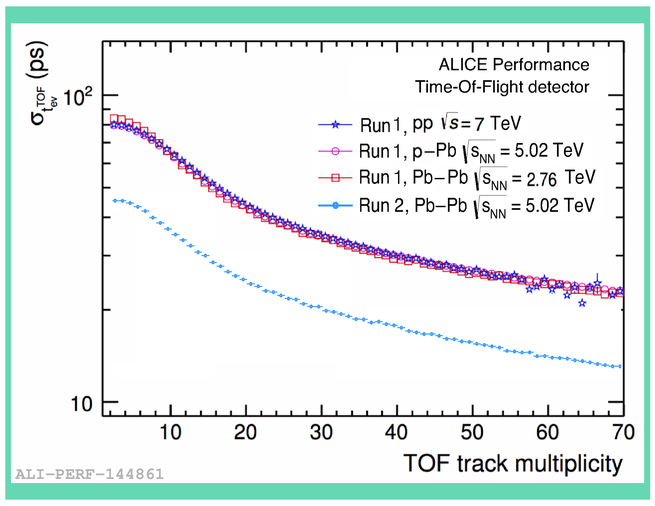
$$\sigma^2_{TOT} = \sigma^2_{TOF} + \sigma^2_{trk} + \sigma^2_{event}$$

(negligible for p> 1 GeV/c)

- σ_{TOT} improved thanks to 2017 calibrations (**from ~80 ps to ~60 ps**)
- TOF time calibration is based on 3 components: global offset (common to all channels, clock), channel-by-channel offset (e.g. cables), time-slewing correction.

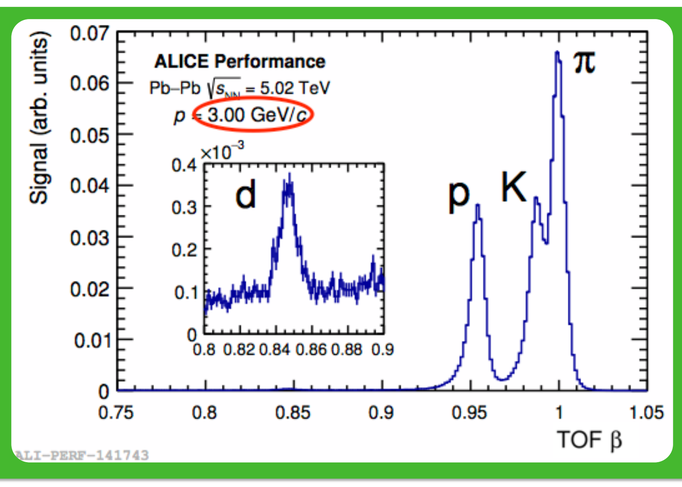


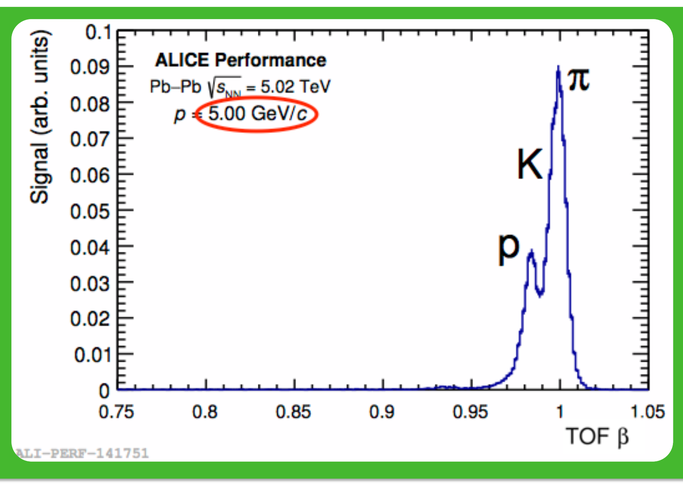
Other factors that can lead to a deterioration in the ALICE-TOF time resolution are: hit multiplicity (cluster), time walk, asymmetric tails.



Time event is the event collision time: for $N_{track} \geq 2$,TOF can measure it independently. For Run 2 the resolution on t_{event} is below 30 ps for 15 tracks. The improvement in Run 2 is due to the new calibrations of the TOF detector.

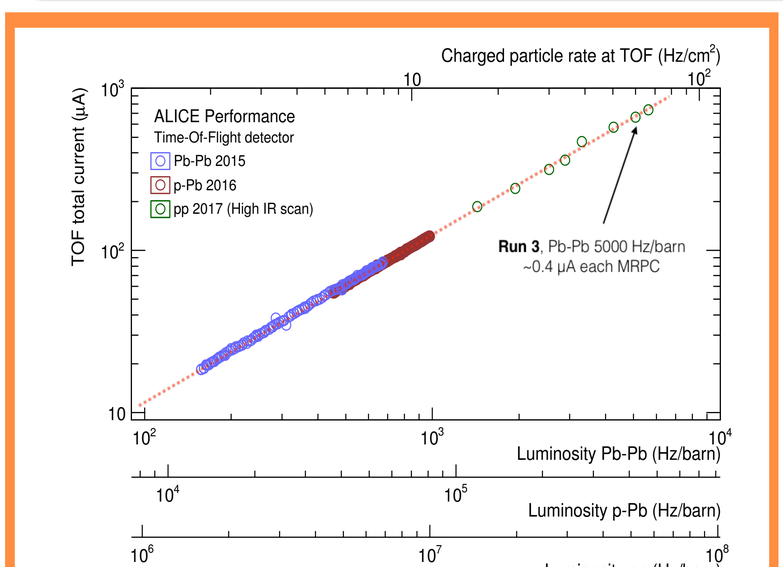
Thanks to the improved time resolution **K/π** are now **separated up to 3 GeV/*c*** (instead of 2.5 GeV/*c*) and **p/K up to 5 GeV/*c*** (instead of 4 GeV/*c*)





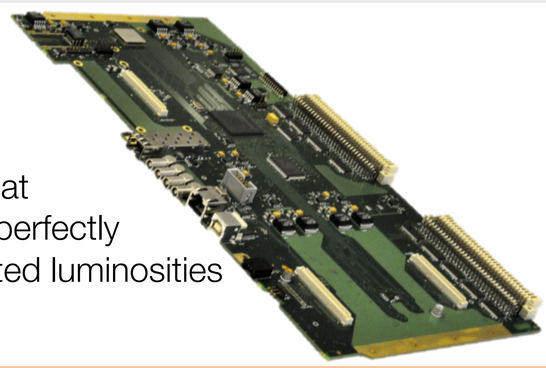
The TOF-PID is extensively and successfully exploited in many analyses in ALICE. See for example other contributions at QM 2018

- Constraining production models with light (anti-)nuclei measurements in small systems with ALICE at the LHC, M. Colocci, Talk 15 May 2018, 15:40
- Energy dependence of particle production and R_{AA} in Pb-Pb collisions with ALICE, N.Jacazio, Poster THD-06
- TMVA methods to reconstruct $\Lambda_c \rightarrow pK^0_S$ in p-Pb collisions with ALICE at the LHC, J.Wilkinson, Poster OHF-50



ALICE Upgrade

Tests with pp collisions at high rate demonstrated that the MRPC detectors can perfectly operate also at the expected luminosities of Runs 3 and 4.



- TDC readout based on HPTDC unchanged
- New Data Readout Module with new optical links (GBTx) for trigger/data transmission being produced
- TOF readout software will be upgraded to sustain continuous readout mode

Conclusions:
- The ALICE-TOF detector, after 10 years of operation, shows no degradation, very stable operations, no performance losses. No changes in operations are foreseen during Run 3 and 4.
- The time resolution has been improved reaching the record value of 56 ps.
- The event collisions, t_{event}, can be determined by the TOF itself with a resolution below 30 ps with 15 tracks.
- K/π separation up to 3 GeV/*c* and a p/K up to 5 GeV/*c* is provided by the TOF.
- During Run3, in continuous mode, TOF will record all hits reaching the detector with 60 ps resolution!