TOF performance in Run 3 - paper update

ALICE-ePIC meeting

https://agenda.infn.it/event/43350/

25/09/2024

Nicolò Jacazio (Bologna University and INFN) for the PC

Antefatto

Rationale:

- Discuss the efforts of the commissioning of the TOF detector
- Document the calibration procedure (goal inherited from Run2)
- Set a milestone in timing Performance that we can refer to in all future papers
- Be the first paper of Run3

https://alice-publications.web.cern.ch/node/10784

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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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CERN-EP-To be specified-ALICE-ANA-2022-xxx
September 25, 2024 To be specified

Time resolution of the ALICE Time-Of-Flight detector with the first Run 3 pp collisions at $\sqrt{s} = 13.6$ TeV

ALICE Collaboration*

Abstract

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Antefatto

Timeline:

- Effort started in 2023
- Approved at the forum
- Approved at the PB Nov 30 2023
- First draft Feb 05 2024
- First IRC review Apr 11 2024
- Second draft Jun 04 2024
- Second IRC review Aug 02/20 2024
- Third (and final) draft 02 Oct 2024?

Target for the new draft next week (2 months duty cycle)

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Nicely presented by Sofia in https://alice-conferences.web.cern.ch/node/68119

Paper outline

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Exploded paper

Content:

- ➢ Focus on the readout details
- ➢ Leave the discussion about efficiency to future papers
- ➢ Focus on time calibration
- ➢ Focus on time performance
- ➢ Provide the double-delta approach that to our knowledge would be new

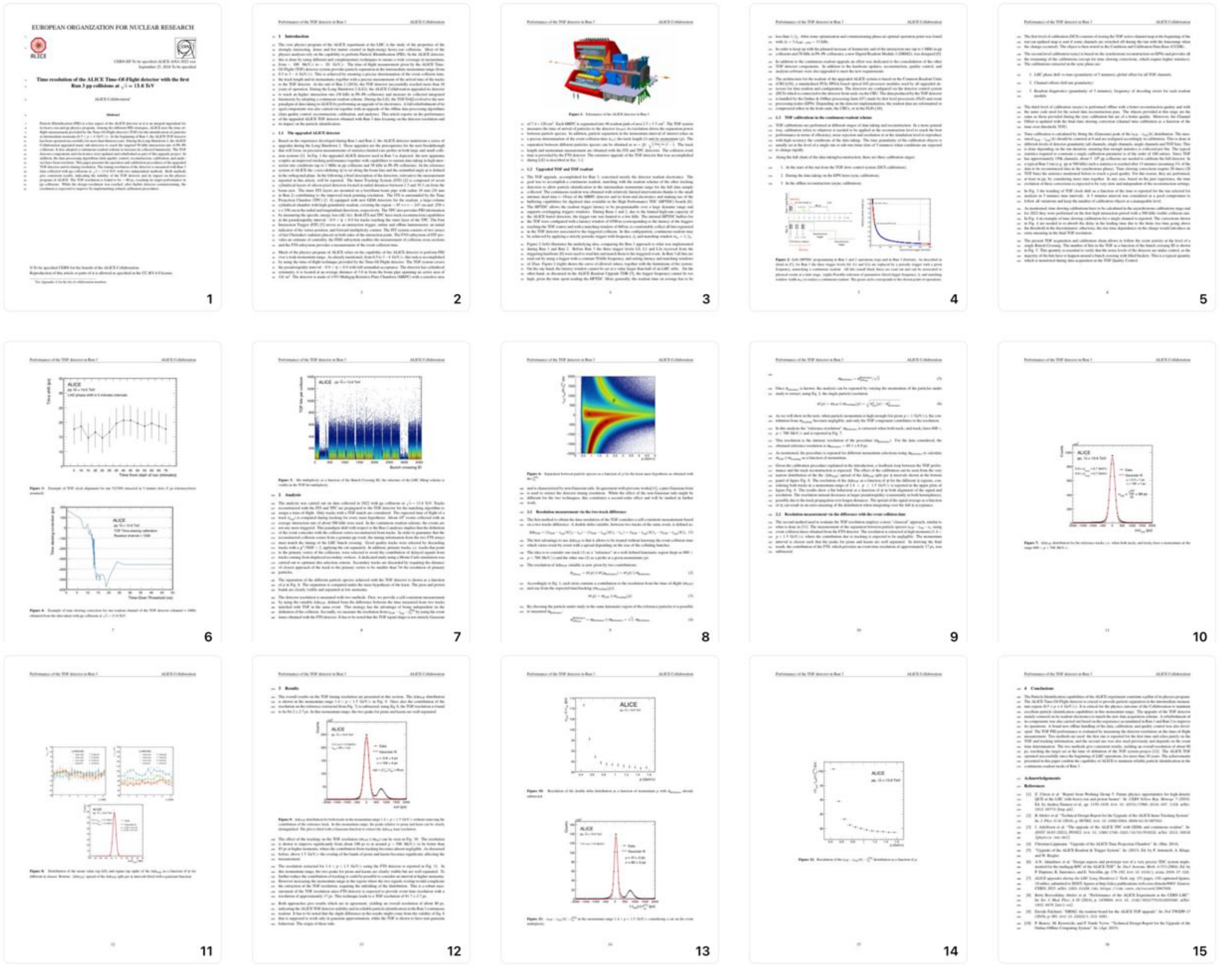
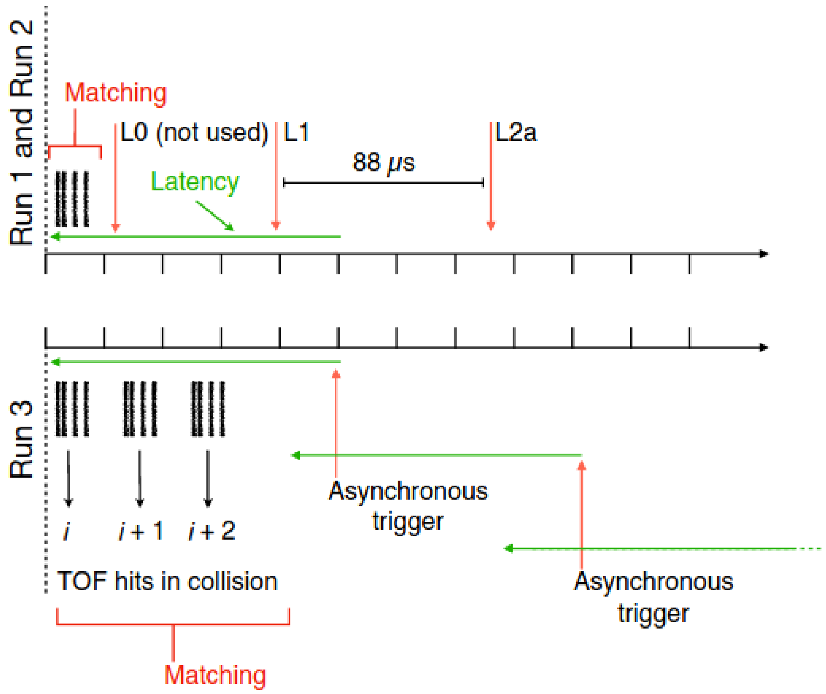
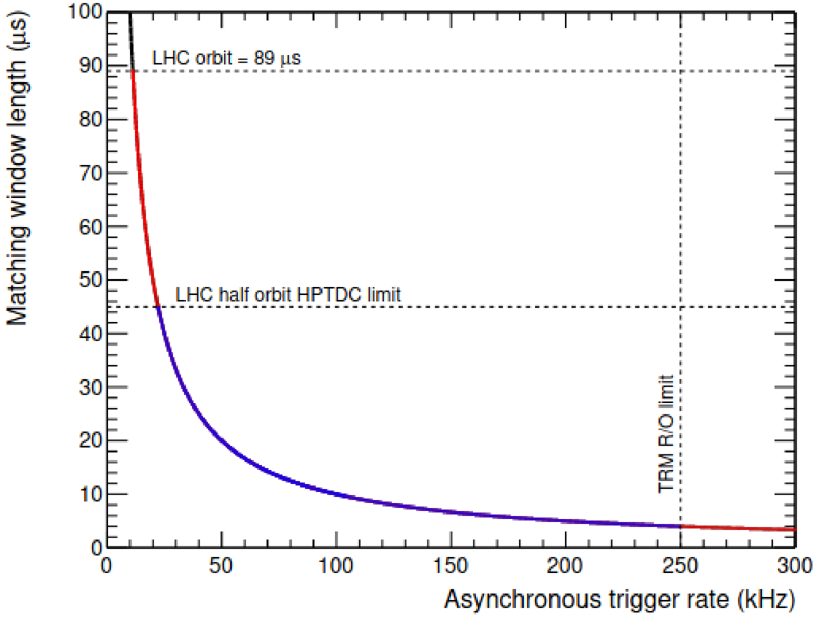


Figure 1

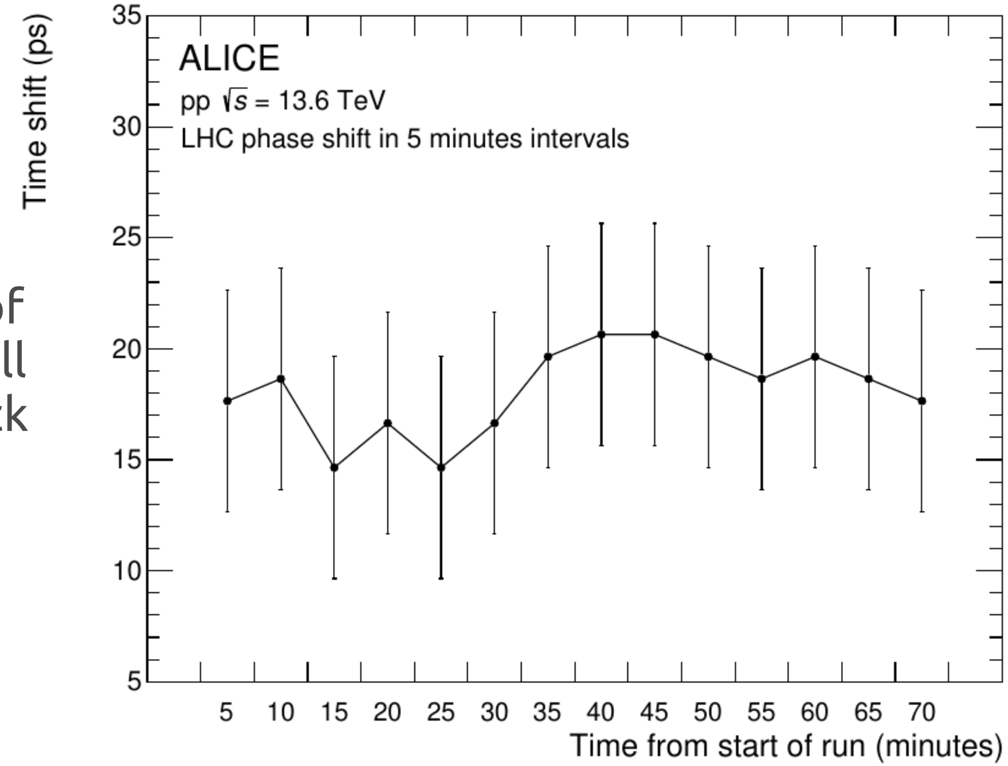




Explain the continuous readout implementation

- Message here: the readout paradigm of the detector was updated to match the high interaction era (and the performance and calibration are kept)

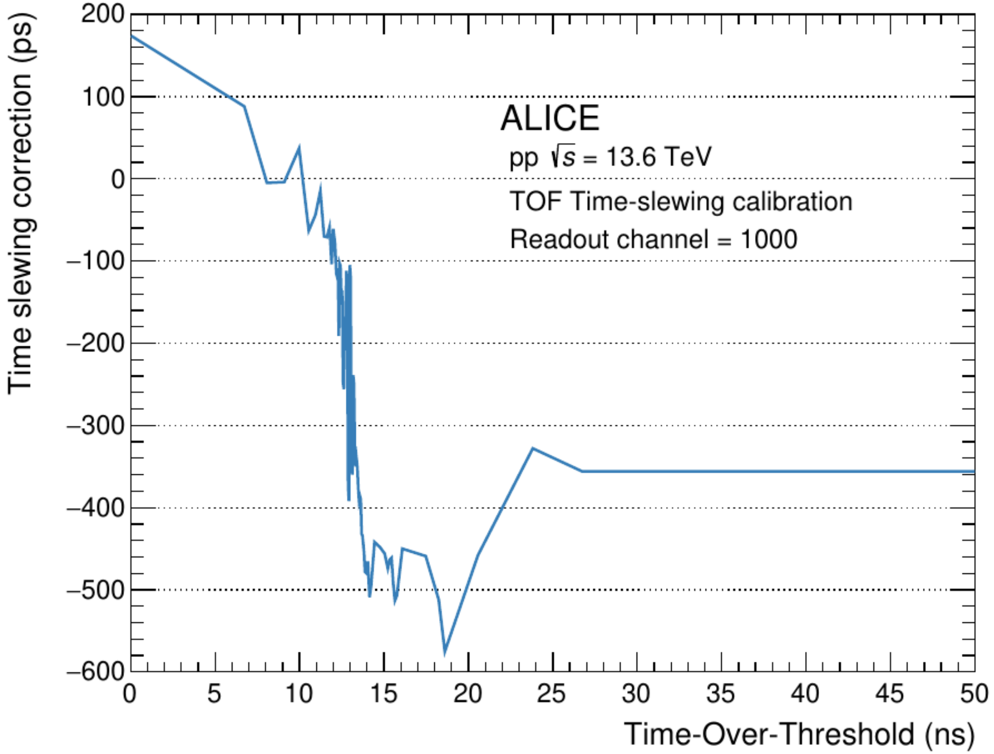
Figure 2



LHC phase drift vs time (granularity of 5 minutes), i.e. the global offset for all TOF channels to align to the LHC clock (online calibration)

Explain the calibration procedure, example from the run under study
- Message here: document the way that the calibration gets done, separating each contribution and explaining the granularity

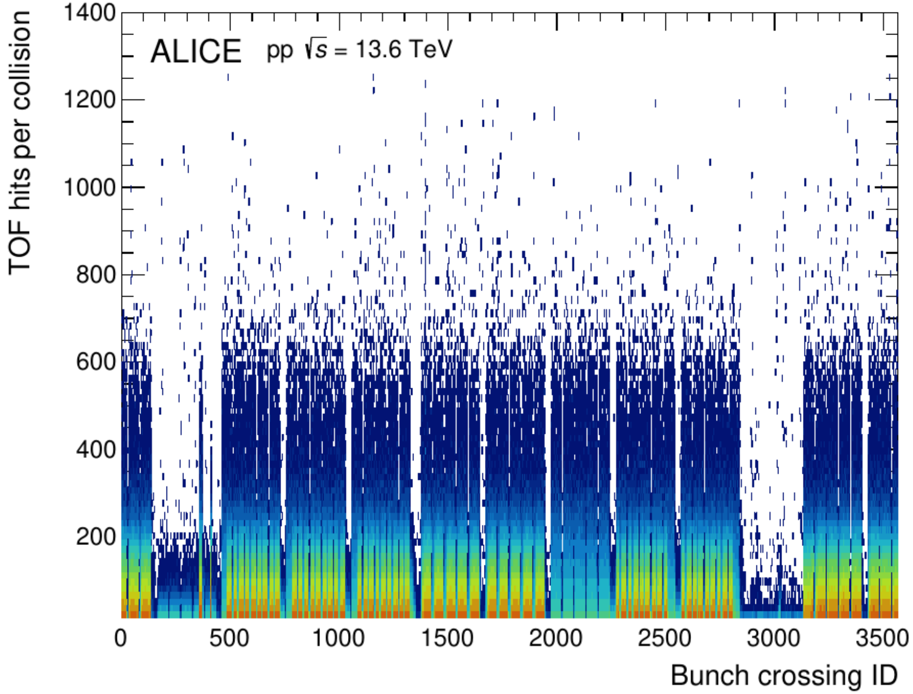
Figure 3



Explain the calibration procedure, example from the run under study

- Message here: give an example of the time slewing calibration (wish from Run 2)

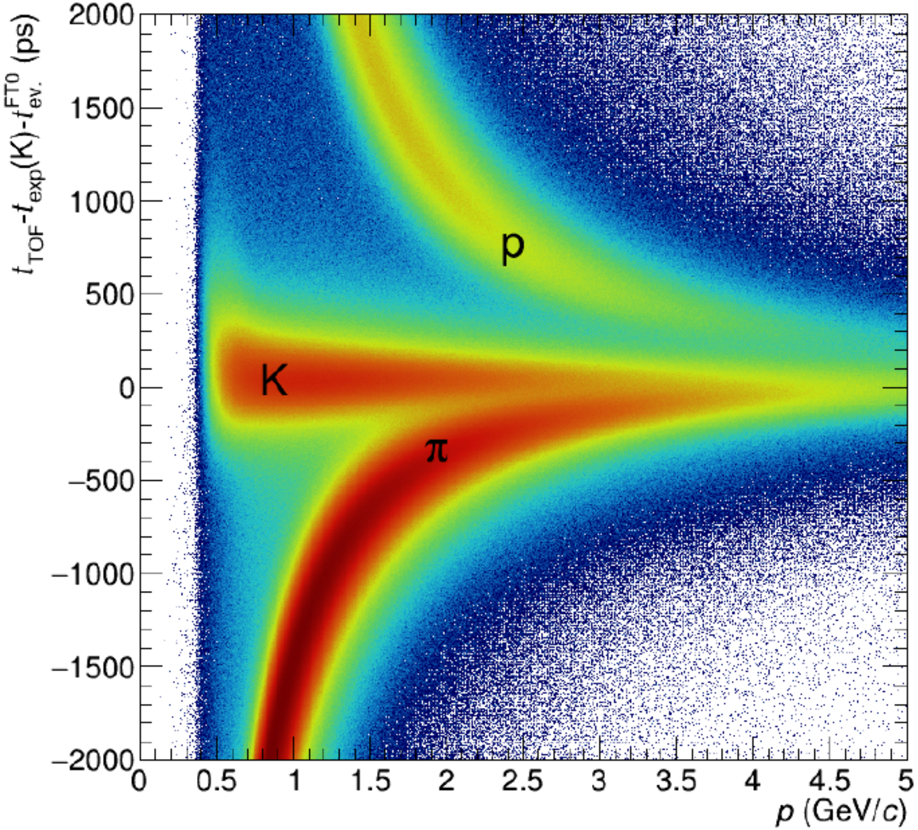
Figure 4



Show the continuous readout as seen from the TOF

- Message here: in a continuous readout scheme the TOF sees all collisions, might be useful if at some point we want to refer to this in a "luminosity-paper" as discussed ~2 years ago

Figure 5



TOF is a PID detector that does PID

- Message here: show that we are indeed able to separate particles with the expected performance, rely on the FT0 event time determination to A) have a smaller uncertainty on the event time and B) avoid discussing the event time procedure with TOF (with pp only)

Figure 6

A **self-consistent measurement** by employing

$\Delta\Delta t_{TOF} = (t_{TOF}-t_{exp}^{\pi})_2-(t_{TOF}-t_{exp}^{\pi})_{1=ref}$

by **correlating two tracks matched to TOF in the same event** (independent of the definition of collision) → using **tracks in a specific kinematic region (reference) to provide the "event time"** information

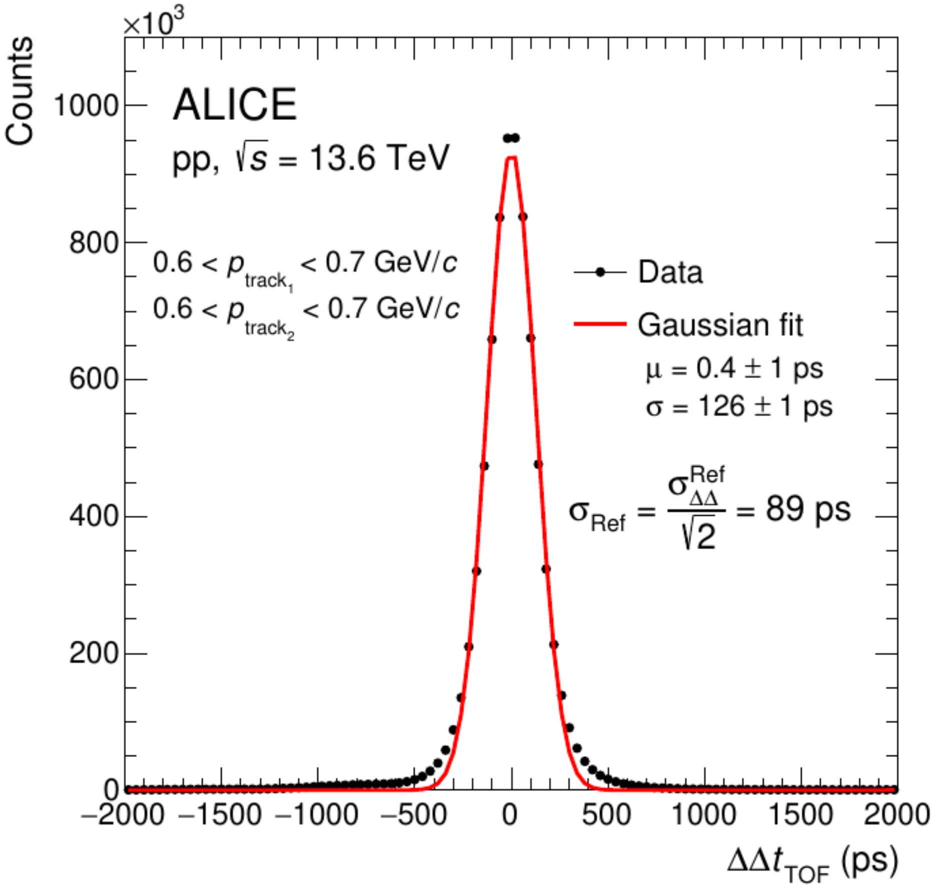
$\sigma^{PID}_{TOF} = \sigma_{TOF} \oplus \sigma_{trk,expTime} \oplus \sigma_{ref}$

→ **0 for large p_T**

$\sigma_{TOF} = \sqrt{(\sigma^{PID}_{TOF}{}^2 - \sigma_{ref}{}^2)}$

Obtained by fitting the signal

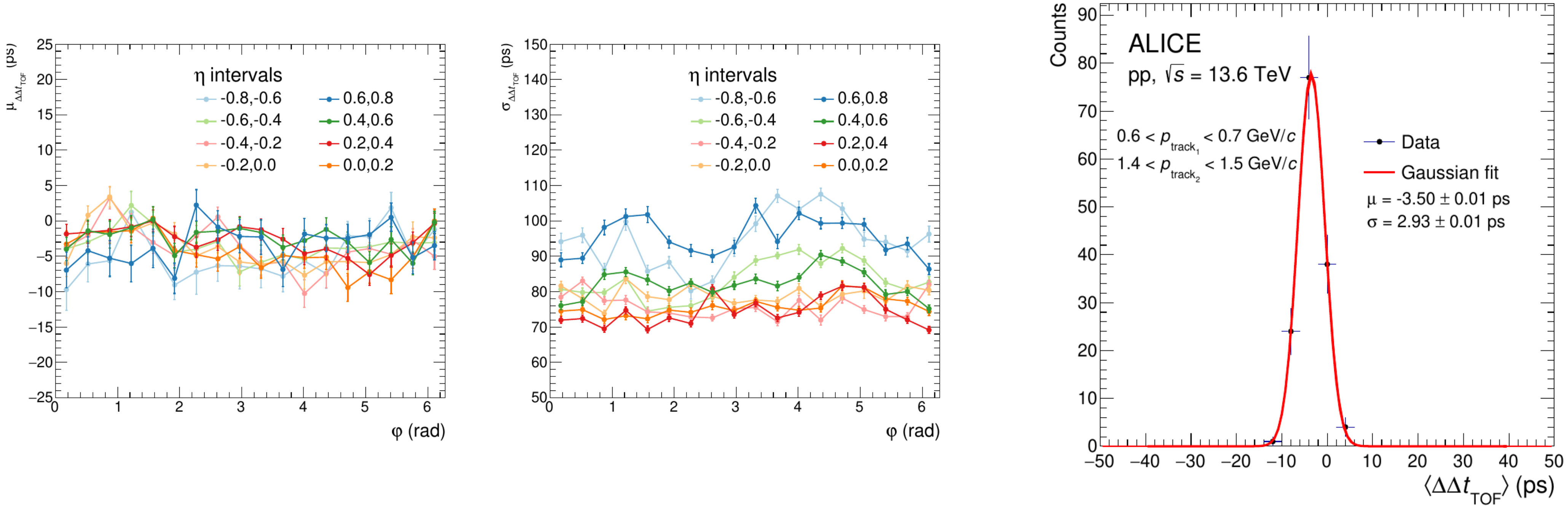
Measured with high precision (only tracks in the reference kinematic region, 1=ref)



Introduce the double delta method

- Message here: explain the new method with the double delta for TOF resolution estimation (new afaik)

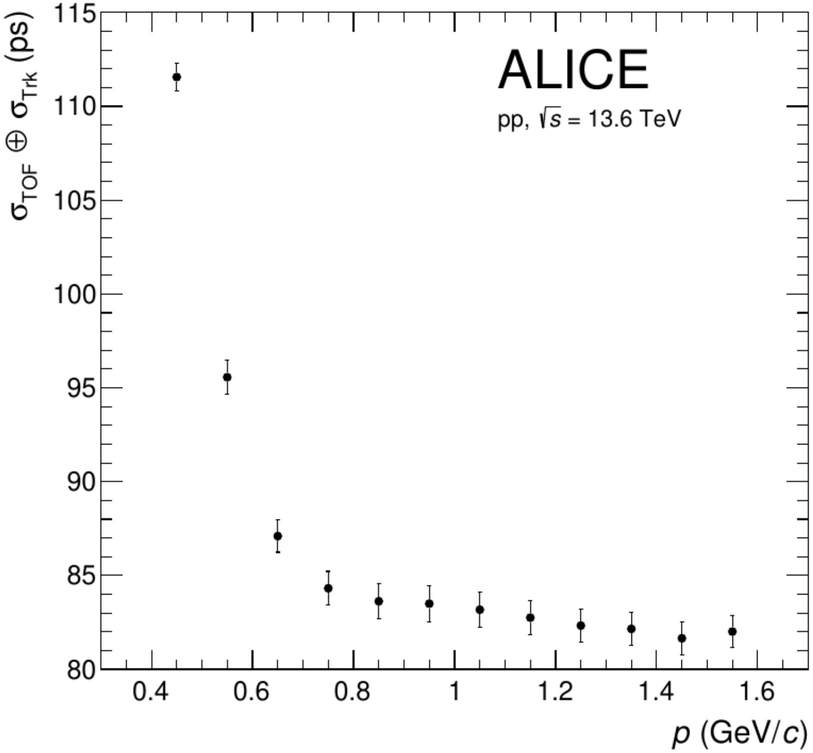
Figure 7

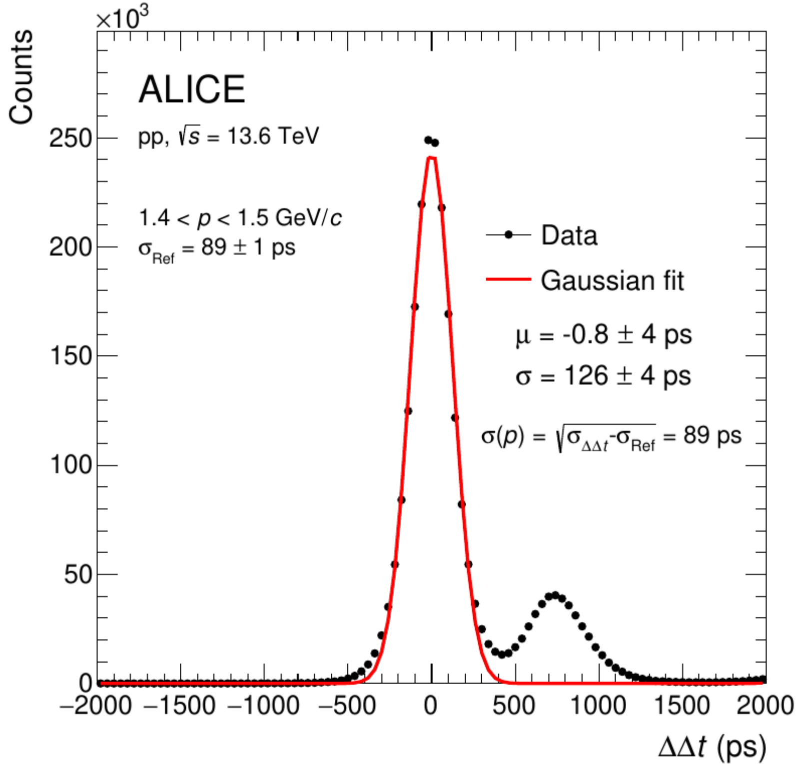


Show stability of the resolution across the geometrical acceptance of the detector

- Message here: this has also historical reasons, we understood how the reconstruction calibration and the TOF async calibration are interlinked and by showing that there is no shift among different eta slices we prove that we are in line with expectations

Figure 8 + 9

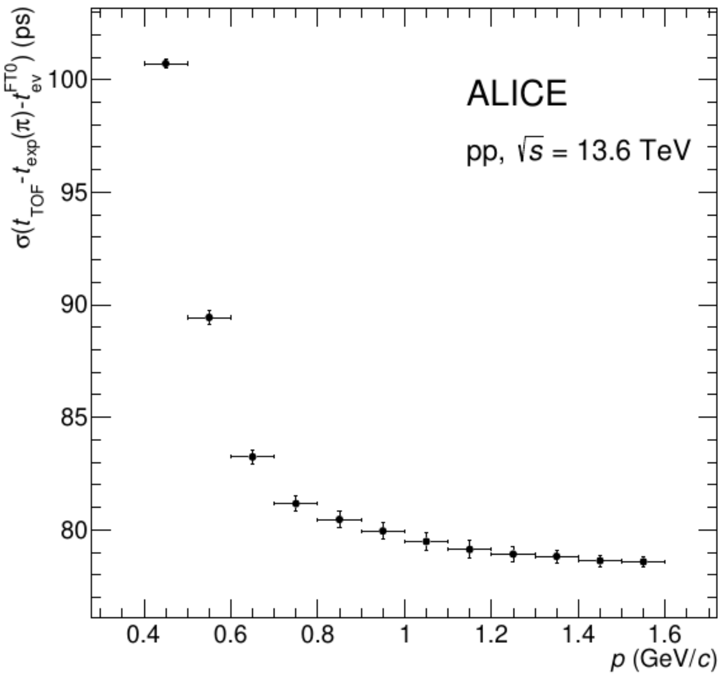


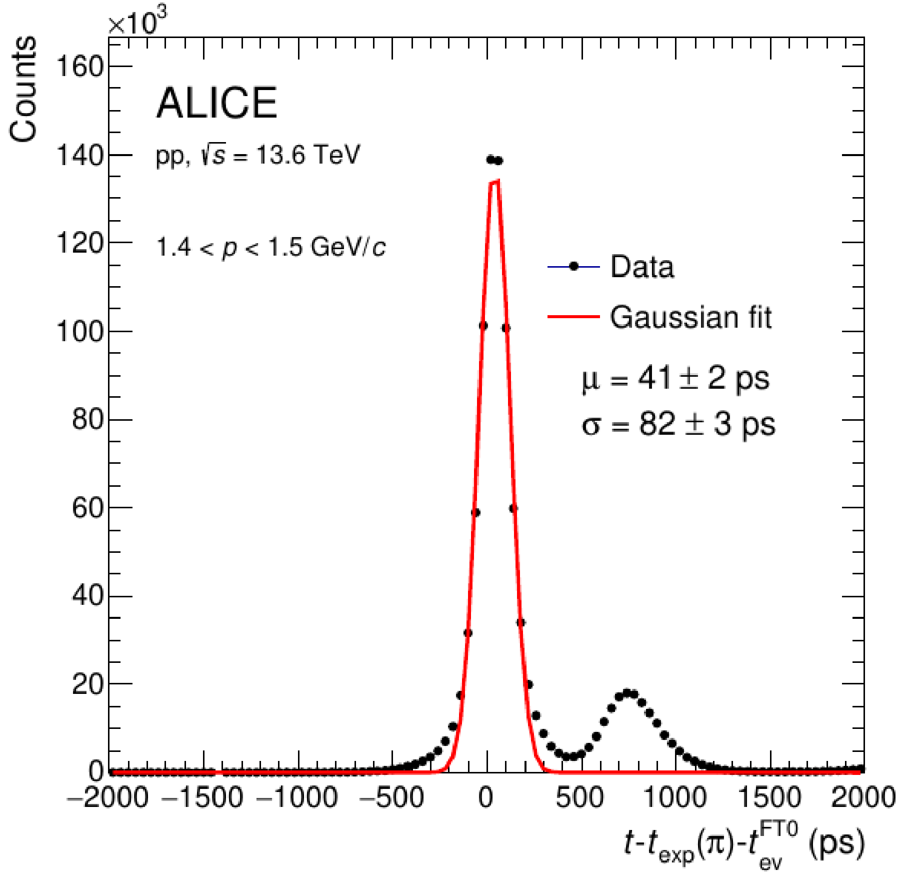


Show the asymptotic behavior of the resolution with the double delta

- Message here: extract the resolution from the double delta to be able to compare with the one obtained with the FT0 event time

Figure 10 + 11

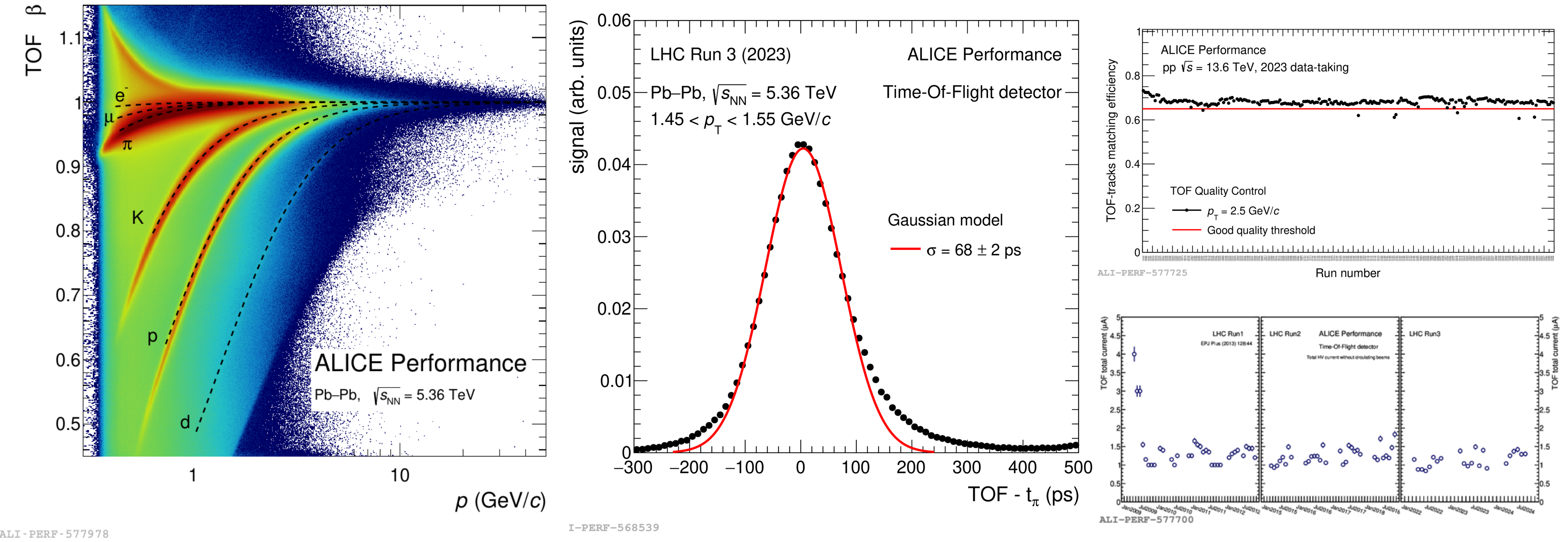




Introduce the double delta method

- Message here: extract the resolution from the double delta to be able to compare with the one obtained with the double delta

Outlook, another paper?



Time is flowing

- The performance shown in the current paper can be (is) improved with more recent data
- Use the Pb-Pb sample to address the even time determination as well as the efficiency of the detector and compare it to the MC and to the Run2 performance to address the (non-)aging