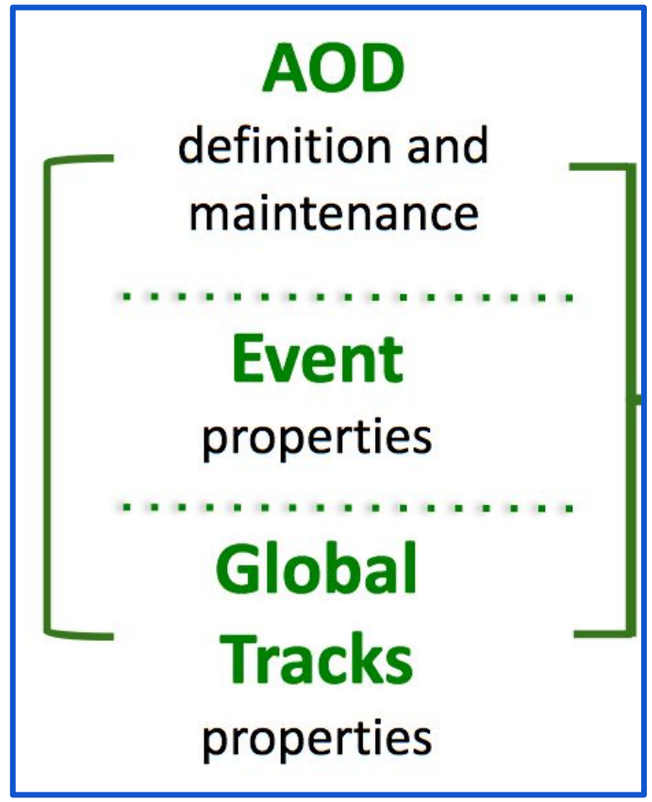
Analysis Object Tools: Events and Tracks Activities in 2018 and plans for PbPb 2018

Cristina Terrevoli, Ionut Arsene, Andrea Dainese
for the AOT-Event and Track group

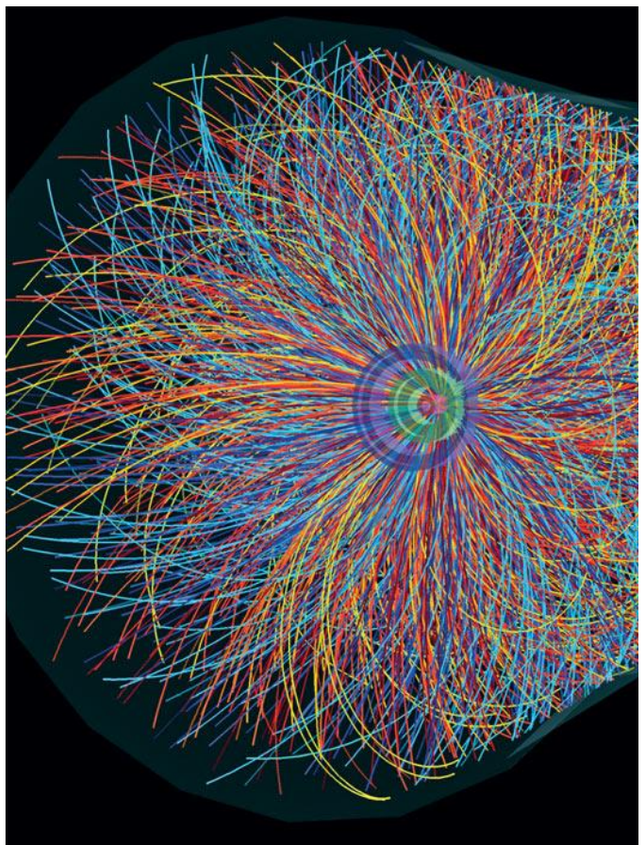
Offline Week
6 December 2018

DPG Analysis Objects and Tools

- **Goal** of the Track/Event Selection and Properties groups (**AOT-tracks, AOT-events**)
  - **provide common tools**, **instructions** and **ingredients** related to **track/event selection** and **systematics evaluation**, trying to give general guidelines to the different analyses in ALICE
- **AOT-tracks**: examples of activities
  - track reconstruction efficiencies and systematics
    - MC data driven correction for primary and secondary fraction observed in data
  - primary charged particle efficiency with data-tuned particle abundances
  - tuning of track impact parameter distribution in MC
  - AOD QA monitoring of different ppass
- **AOT-events**: examples of activities
  - Multiplicity calibration
  - Physics Selection
  - Event selection
  - Pileup removal



Track Reconstruction Efficiency: Systematics evaluation



Track reconstruction efficiency

- Systematic uncertainty on tracking efficiency covers the possible biases from

a. **Track quality selection in the TPC: Comparison of the corrected p_T spectra obtained with different track selection cuts:** by varying selection cuts of interest (analysis oriented) among cuts applied in StandardITSTPCTrackCutsXXX

b. **Track propagation from the TPC to the ITS**

Updated procedure for ITS-TPC matching efficiency w.r.t. Run1:

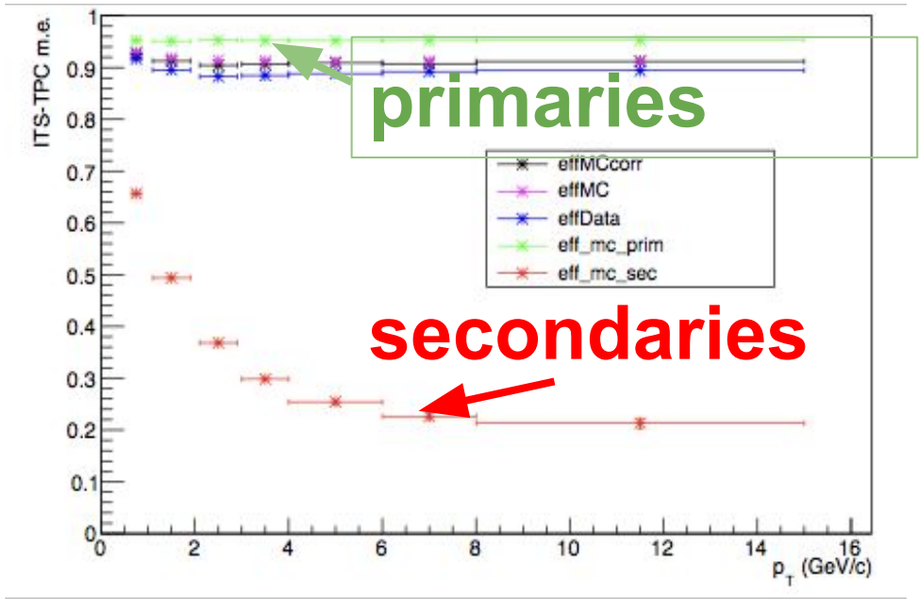
Definition: Matching Efficiency (m.e.) = (# tracks TPC-ITS) / (# tracks TPC)

Motivation: ***syst. unc. originates from possible discrepancies in efficiency between data and MC***

Differences in m.e. between data and MC originates also from **different abundances** of primary and secondary particles

- m.e. for primary tracks is larger than for secondaries
  - sec. vertices likely outside SPD, originated from strangeness decay, from interaction with material

The **new procedure** evaluates the **real fraction of secondary and primary tracks in data** to **re-weight respective MC efficiencies** to obtain a corrected inclusive MC efficiency

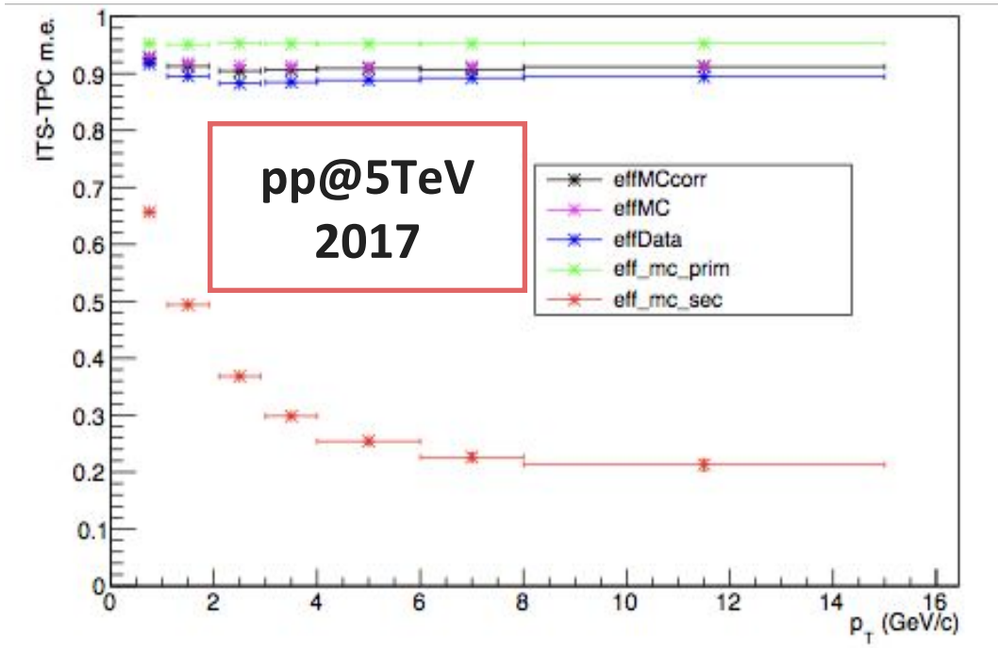


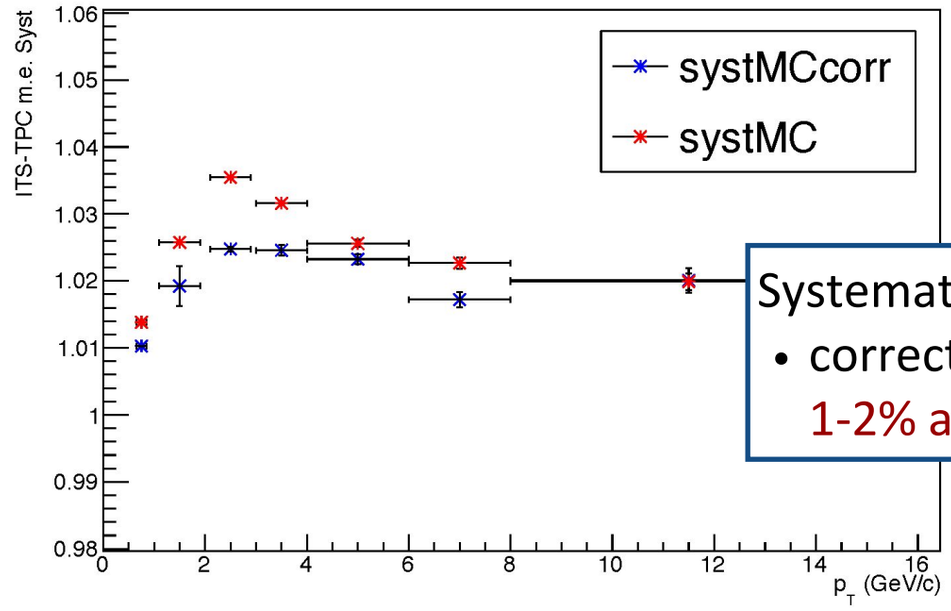
General approach: described in **AOT-tracks TWiki**

ITS-TPC matching efficiency: systematics

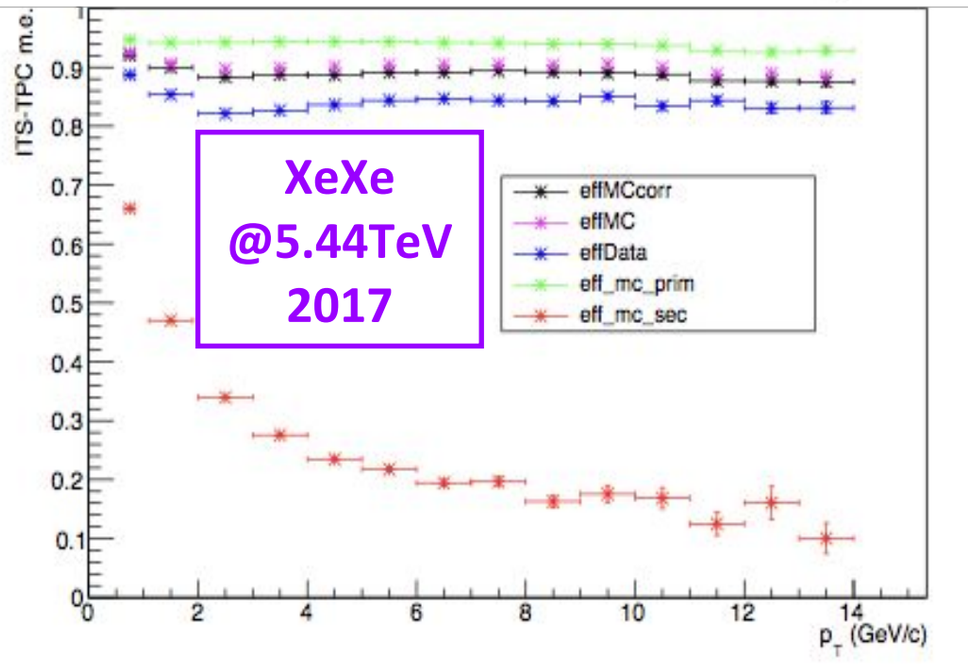
Results in TWiki available for:

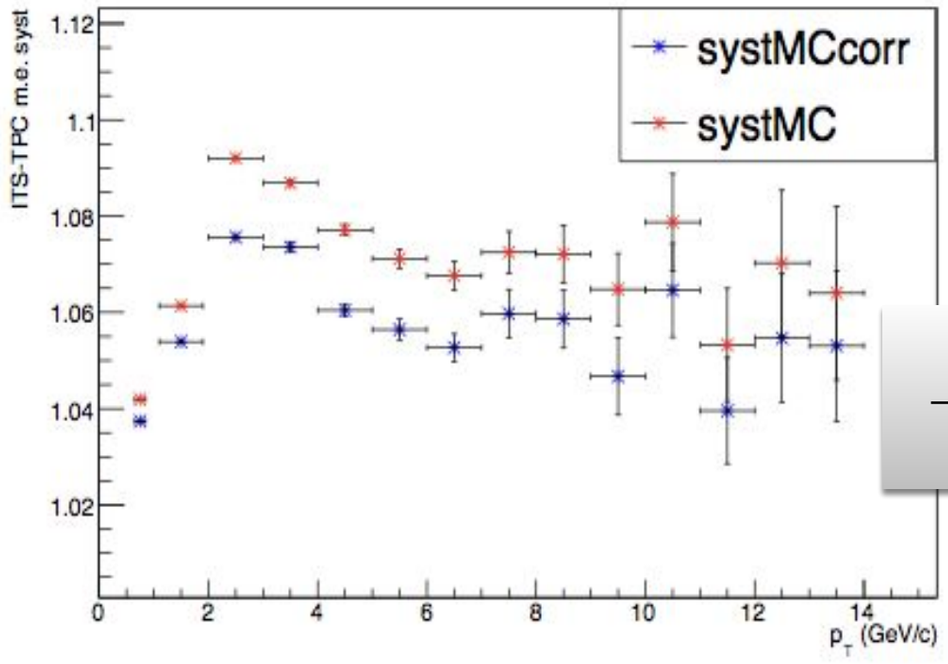
- ➔ Run1: LHC10b,c,d,e pass4 (pp@7TeV);
- ➔ Run2: LHC15n (pp@5TeV), LHC16q,r (pPb@5TeV), LHC15o (PbPb@5TeV), several periods for pp in LHC16, LHC17 (pp@13TeV, pp@5TeV) and LHC17n (Xe-Xe@5.44TeV)





Systematic uncertainty
- corrected MC vs Data m.e.:
  1-2% at single track level



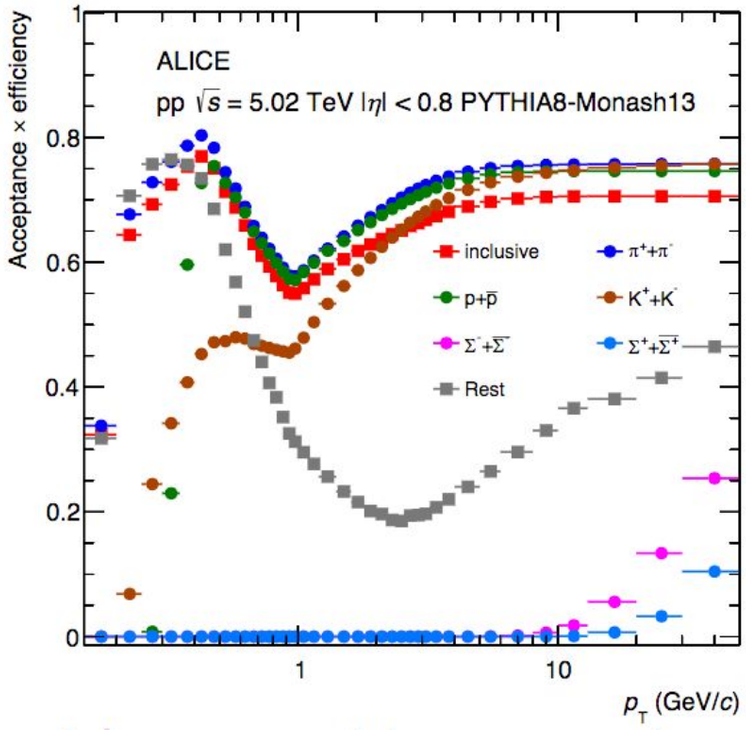


service task:
→ Sushanta Tripathy
→ Mattia Faggin

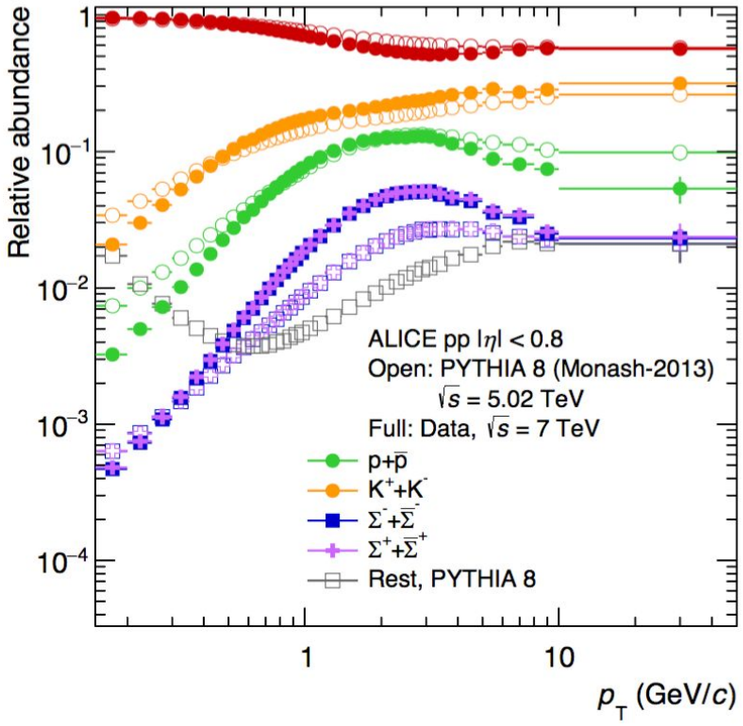
Reweighting of MC particle spectra to match data abundance

MC corrections for abundancies

Reconstruction efficiency of charged physical primary particles depends on the **MC particle composition**



Relative fraction of particle species **differ in MC and in Data**



➔ <u>Goal</u>: provide a **general (flexible for ESDs and AODs) tool to re-weight the particle species in MC** in order to match their abundances in data. This tool could be used by all analyses that apply a tracking efficiency correction for (unidentified) charged particles

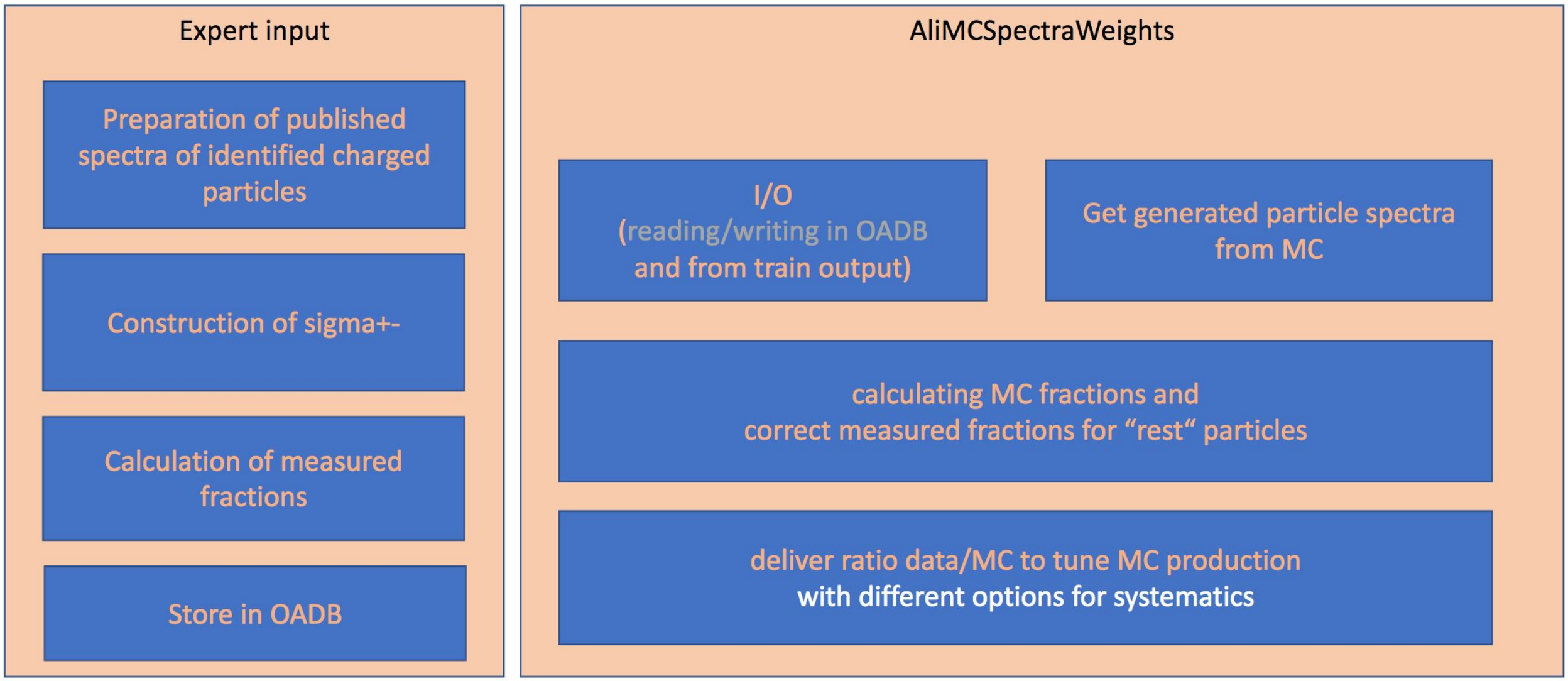
➔ The procedure would involve:

- ✦ Expert: store an OADB object with the composition measured in data
- ✦ User: run two times on a given MC
  - ➢ first time, to retrieve particle spectra related to a specific MC
  - ➢ second time, to compute weighted efficiencies

method details: <u>slides</u>

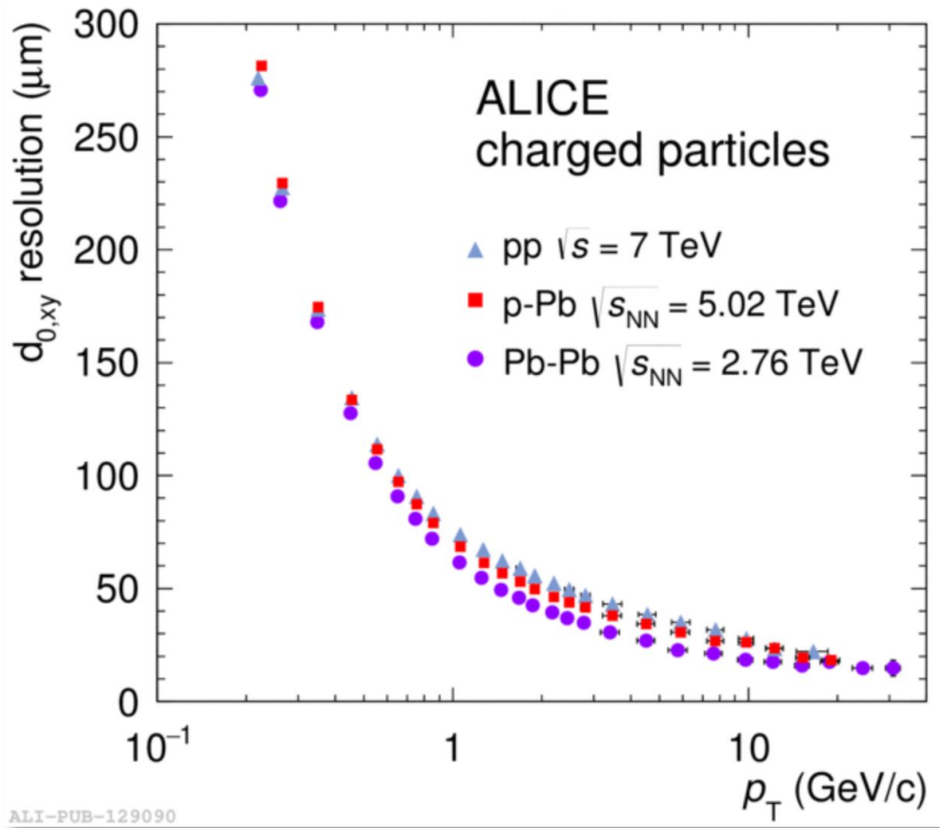
Planned workflow

service task:
Patrick Huhn



Goal: minor modification to user code, all through AliMCSpectraWeights interface

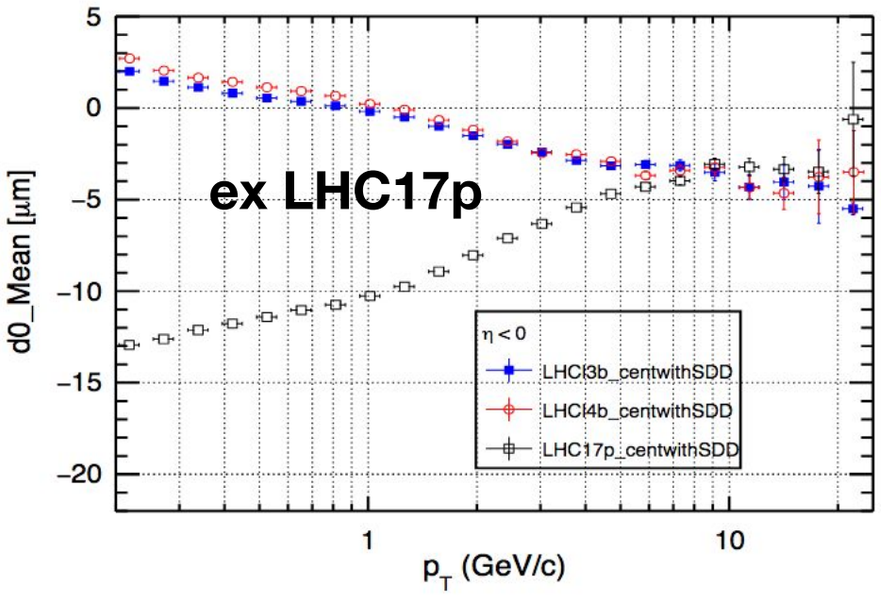
MC tuning for impact parameter mean and resolution observed in data

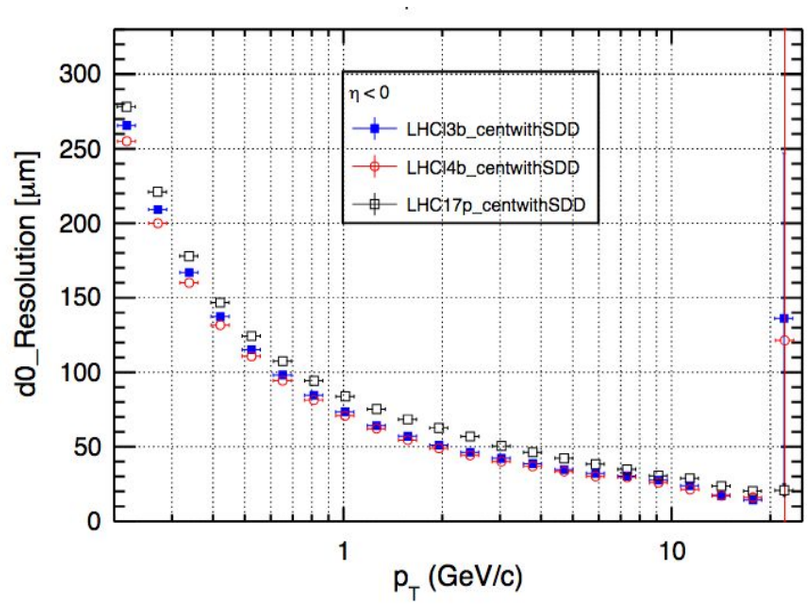


Impact Parameter in Data vs MC

Run2: shift of charged particle impact parameter mean towards negative values (~10μm) observed in data not reproduced in MC and worst resolution in data (5-10 μm)

new in Run2





- Shift in data is probably due to a misalignment

Consequence on analyses: it may affect tracks from HF decays close to the primary vertex

Goal: reliable description of the selection efficiencies for cuts that use both the absolute d_0 and the normalised d_0 (or derived quantities)
This requires tuning in MC (to data) the mean, the resolution and the pull of d_0

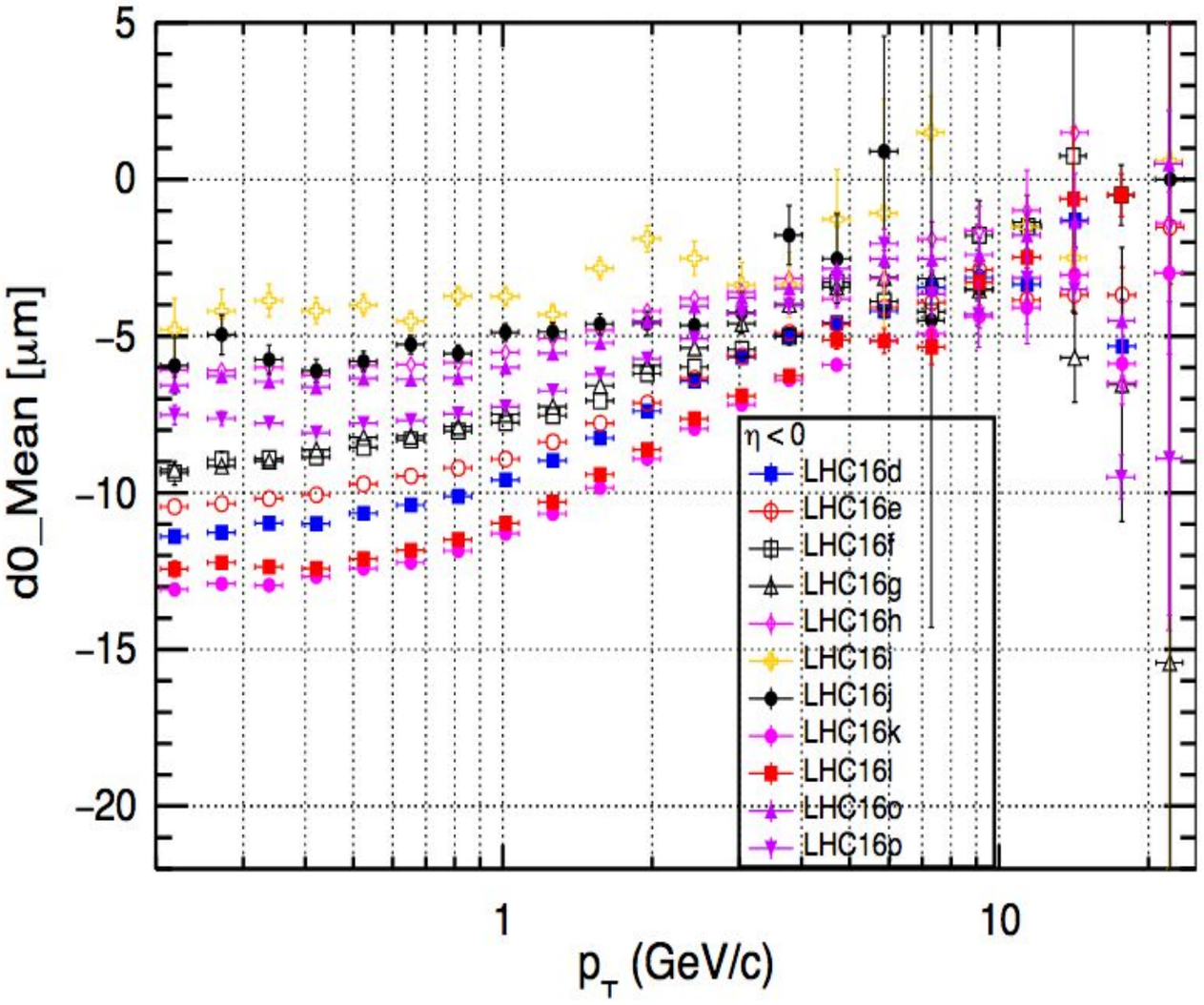
Corrections with PWGHF/vertexingHF/AliAnalysisTaskSEImproveITS (Improver Task)

The resolutions for data and MC are taken from the files stored in
alien:///alice/cern.ch/user/p/pwg_hf/common/Improver/<period_name>/central/

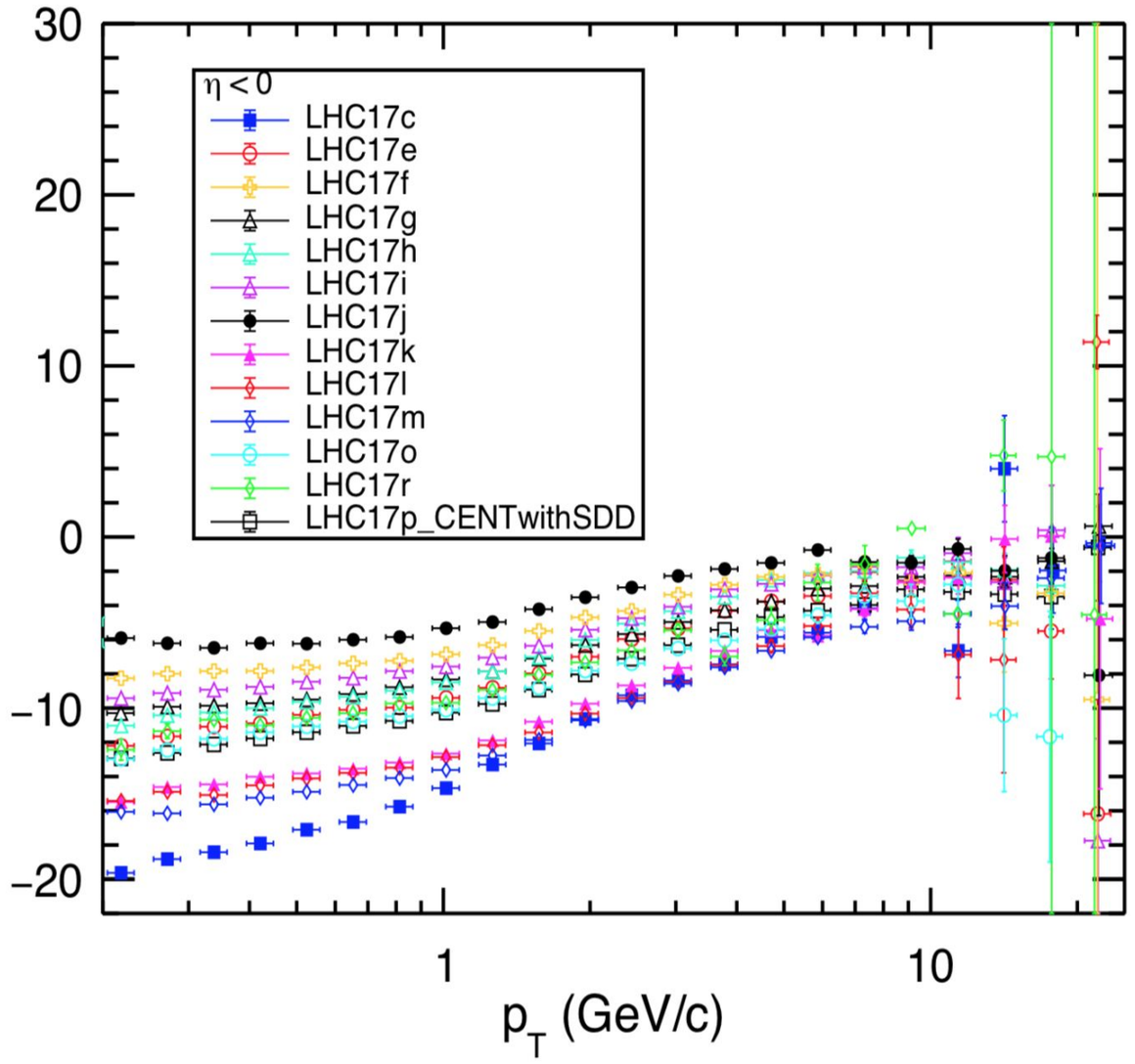
Details in
https://twiki.cern.ch/twiki/bin/viewauth/ALICE/AliDPGtoolsImpactParameterResolution

Tuning track impact parameter in MC to data

pp@13TeV periods from 2016 data



pp@13TeV periods from 2017 data



service task:
← Sushanta Tripathy
→ Mattia Faggin

The resolutions for data and MC are taken from the files stored in
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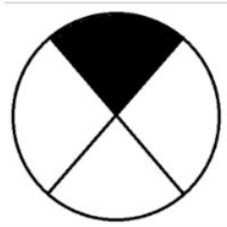
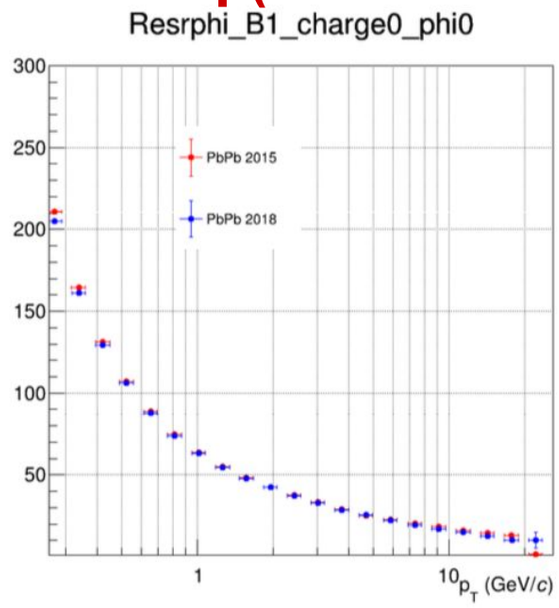
- available at the moment for 15n, 15o, 16d,e,g,h,k,j,l,o,p 16q,t, 17e,g,h,i,k,l 17p,q

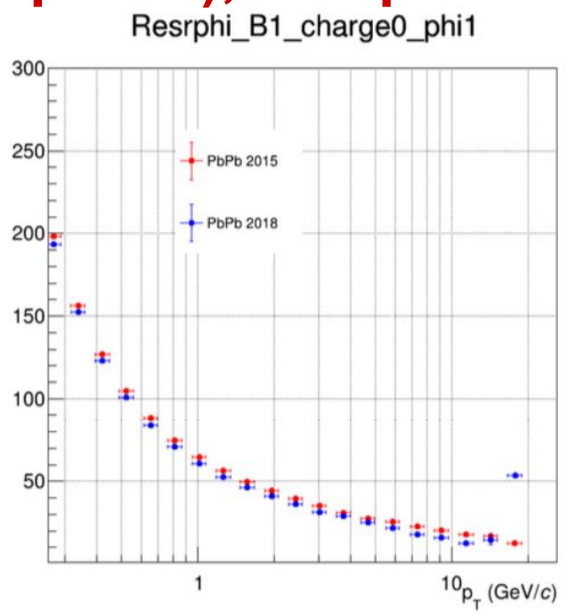
Tuning track impact parameter in MC to data

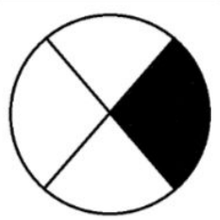
very first look at PbPb LHC18q (uncalibrated pass1), comparison with PbPb 2015

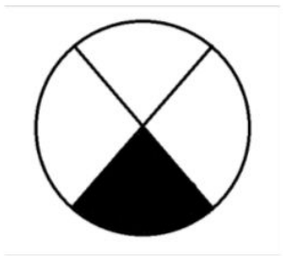
d0 resolution

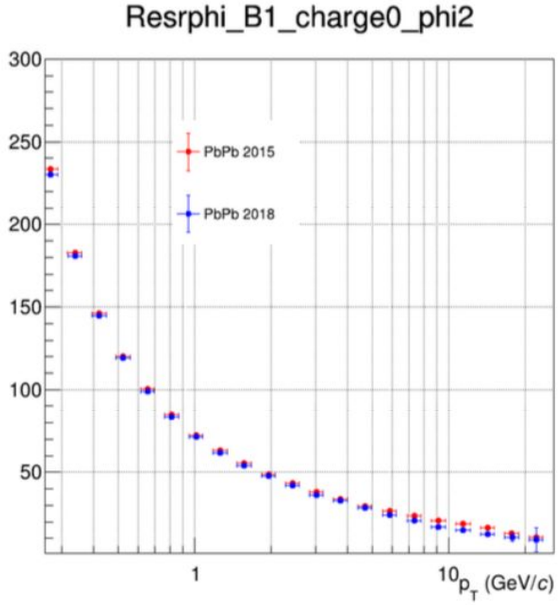


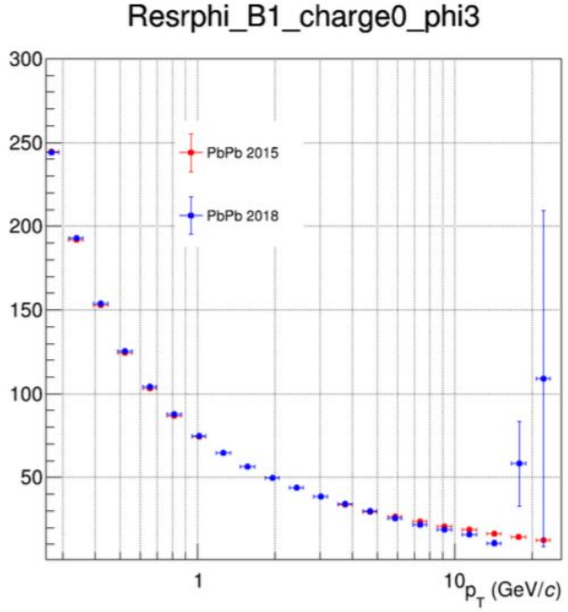




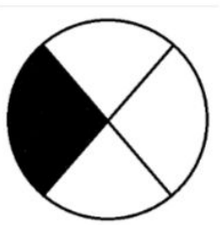








Negative charges



service task:
← Sushanta Tripathy
→ Mattia Faggin

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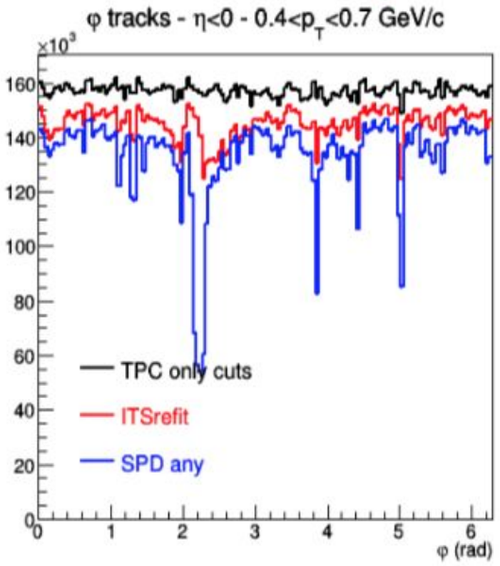
- available at the moment for 15n, 15o, 16d,e,g,h,k,j,l,o,p 16q,t, 17e,g,h,i,k,l 17p,q

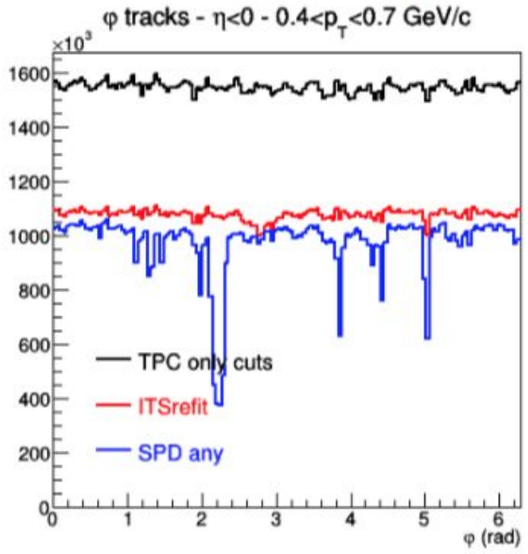
AOD QA monitoring: pp, PbPb
pt, phi distributions, filter bit selections, mass spectra V0, SPD/track vertex

AOD QA monitoring: pp and PbPb plots

compare: LHC18q_pass1_uncalibrated With LHC18g & LHC18p



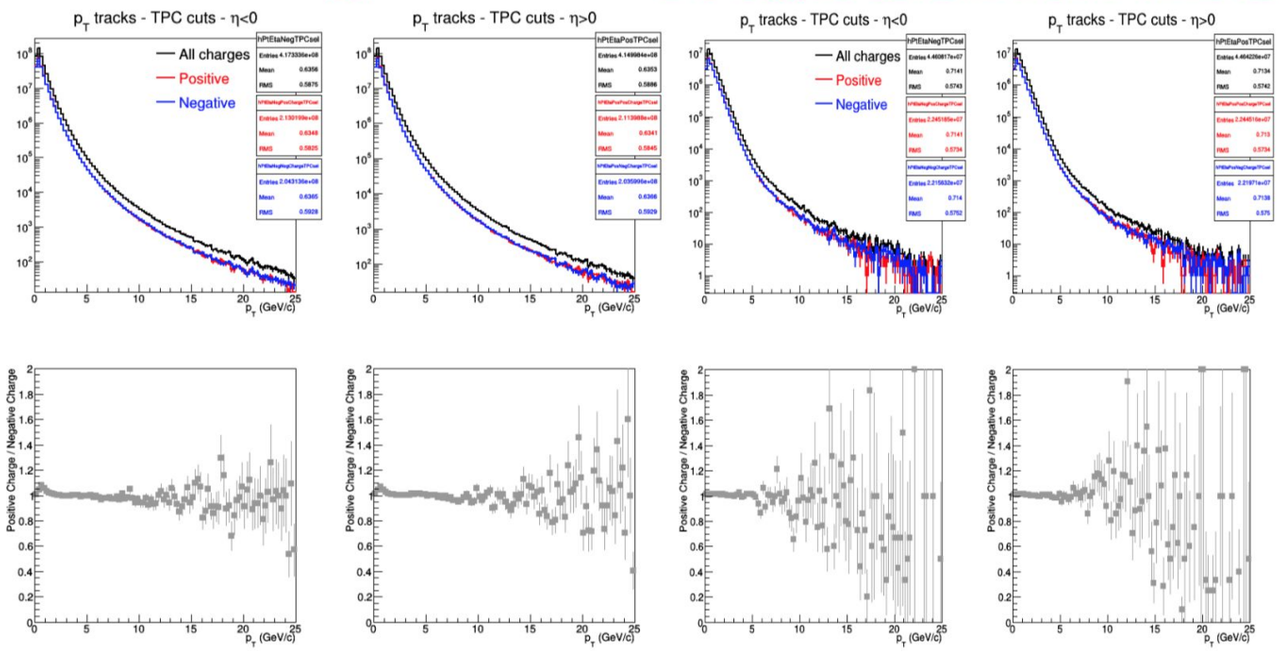
18q
IR 1-8 kHz

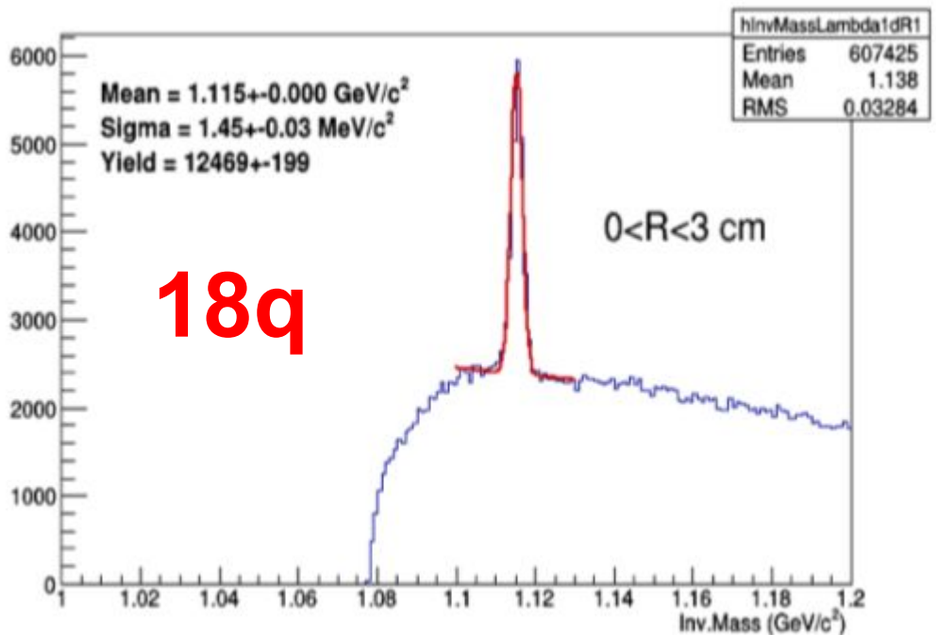


18p
IR 250kHz

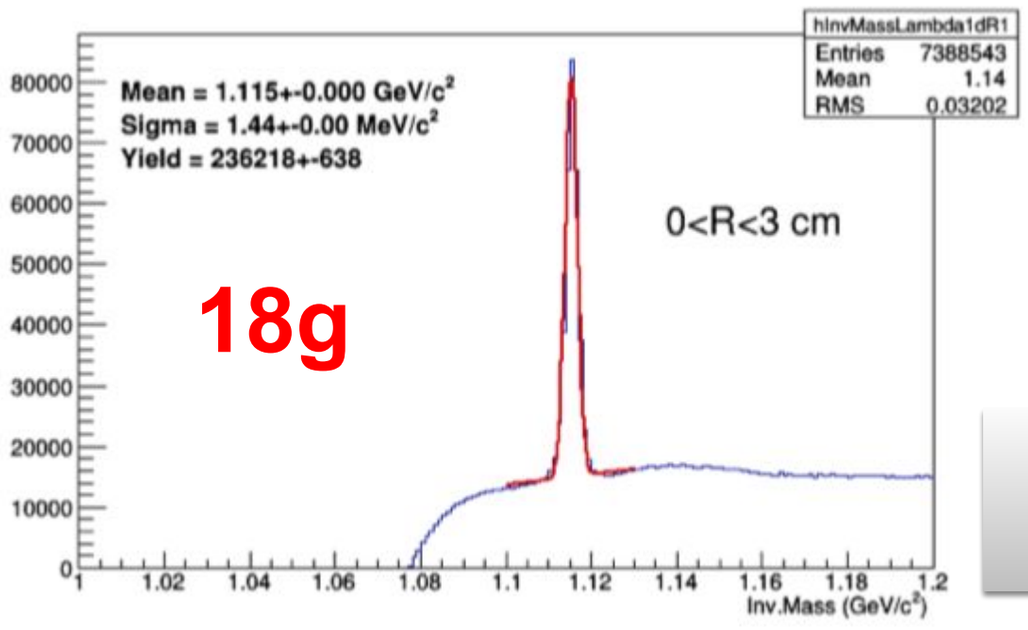
LHC18p_pass1

LHC18q_pass1_uncalibrated for run:295585





18q



18g

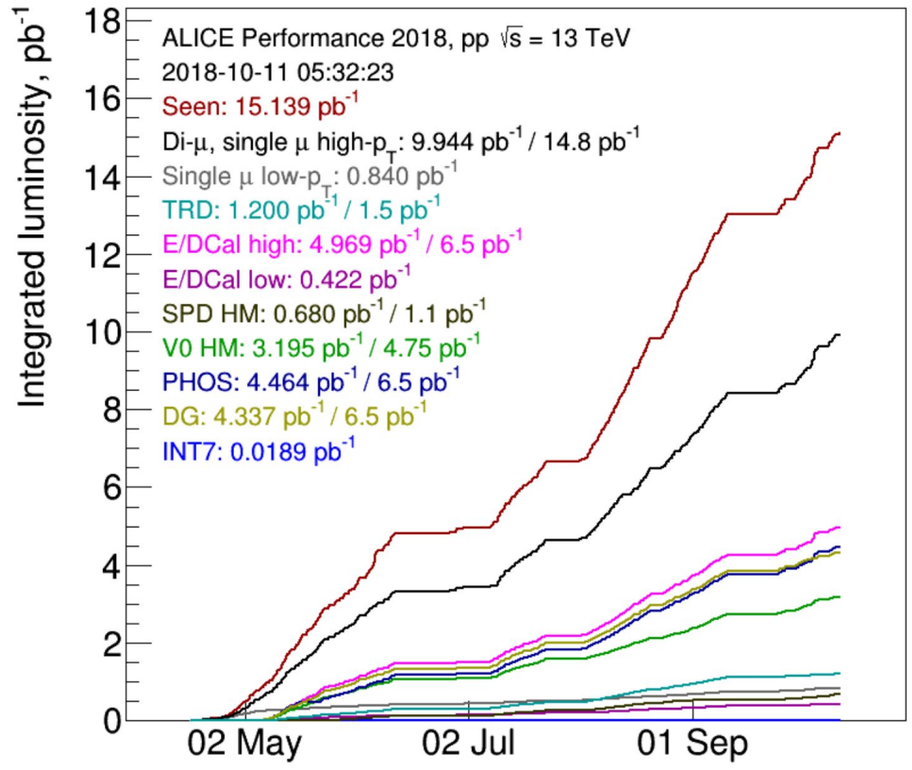
service task:
Ranjit Nayak,
Anjali Sharma and
Baydianath Sahoo

Event Selection, Pile Up removal

Event selection

- Physics selection
  - QA repository (link)

```
// in your macro:
gROOT->ProcessLine(".L $ALICE_PHYSICS/OADB/macros/AddTaskPhysicsSelection.C");
AliPhysicsSelectionTask*physSelTask=AddTaskPhysicsSelection(isMC,enablePileupCuts);
// in your UserExec:
UInt_t fSelectMask= fInputHandler->IsEventSelected();
Bool_t isINT7selected = fSelectMask & AliVEvent::kINT7;
Bool_t isHMV0selected = fSelectMask & AliVEvent::kHighMultV0;
```



- Large samples of min bias and triggered samples collected
- Event selection class: OADB/AliEventCuts.h/cxx
  - Configure event selection, pileup removal, histogramming for accepted/rejected events

```
// in your analysis class declaration:
AliEventCuts fEventCuts; /// Event cuts
// in your AliAnalysisTask::UserCreateOutputObjects
fEventCuts.AddQAplotsToList(fList); /// fList is your output TList
// in your UserExec:
AliVEvent *ev = InputEvent();
if (!fEventCuts.AcceptEvent(ev)) {
  PostData(1, fList);
  return;
}
```

More details in the TWiki

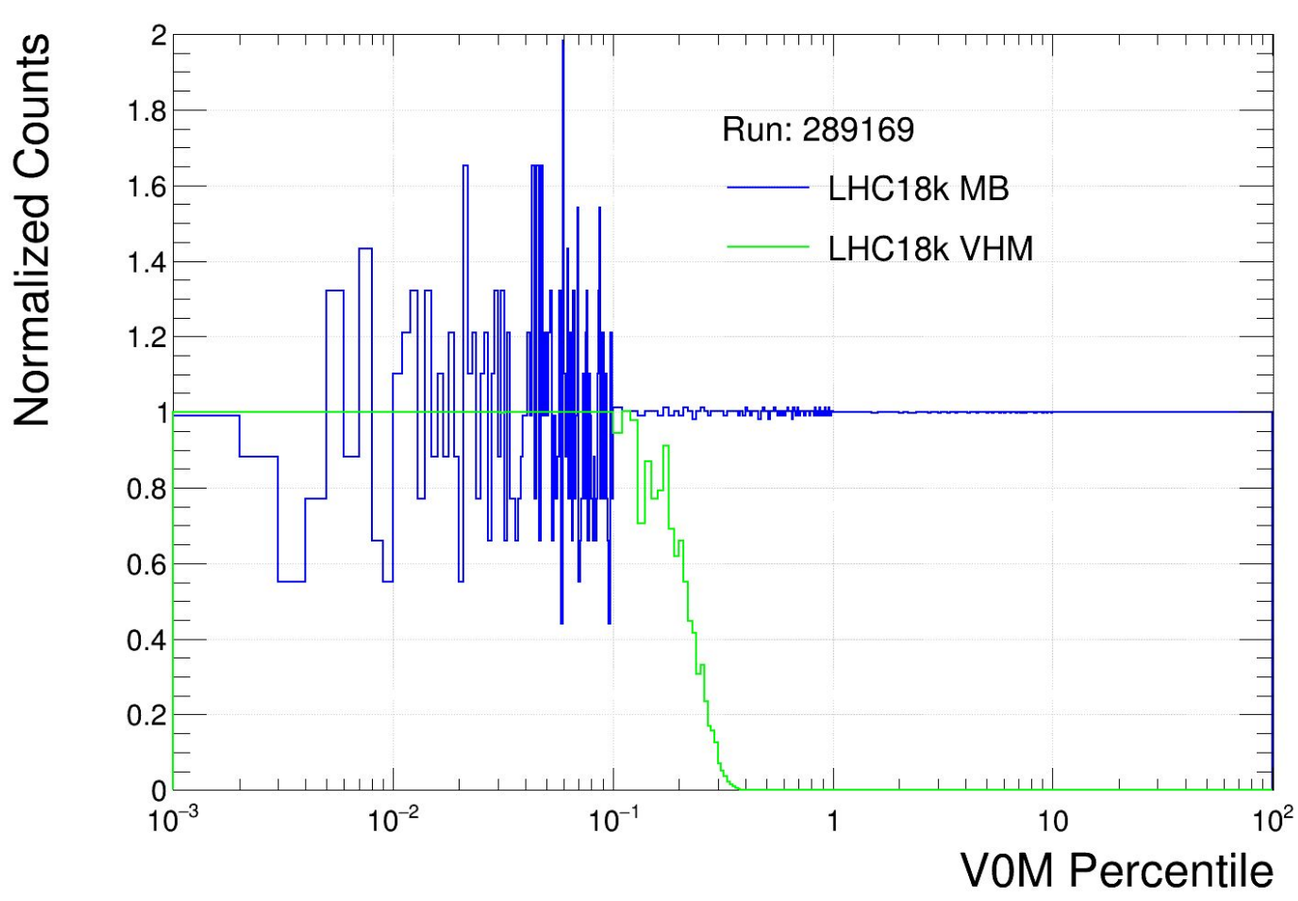
Multiplicity/centrality selection

- Setup

```
// in your macro:
gROOT->LoadMacro("$ALICE_PHYSICS/OADB/COMMON/MULTIPLICITY/macros/AddTaskMultSelection.C");
AliMultSelectionTask * task = AddTaskMultSelection();
// in your UserExec:
AliMultSelection* multSelection = (AliMultSelection *) fEvent->FindListObject("MultSelection");
Float_t lPercentile = MultSelection->GetMultiplicityPercentile("V0M");
```

- Default OADB calibrations loaded automatically
- Multiplicity calibration objects available for Run-2 periods up to LHC18k

Link for **multiplicity calibration status**

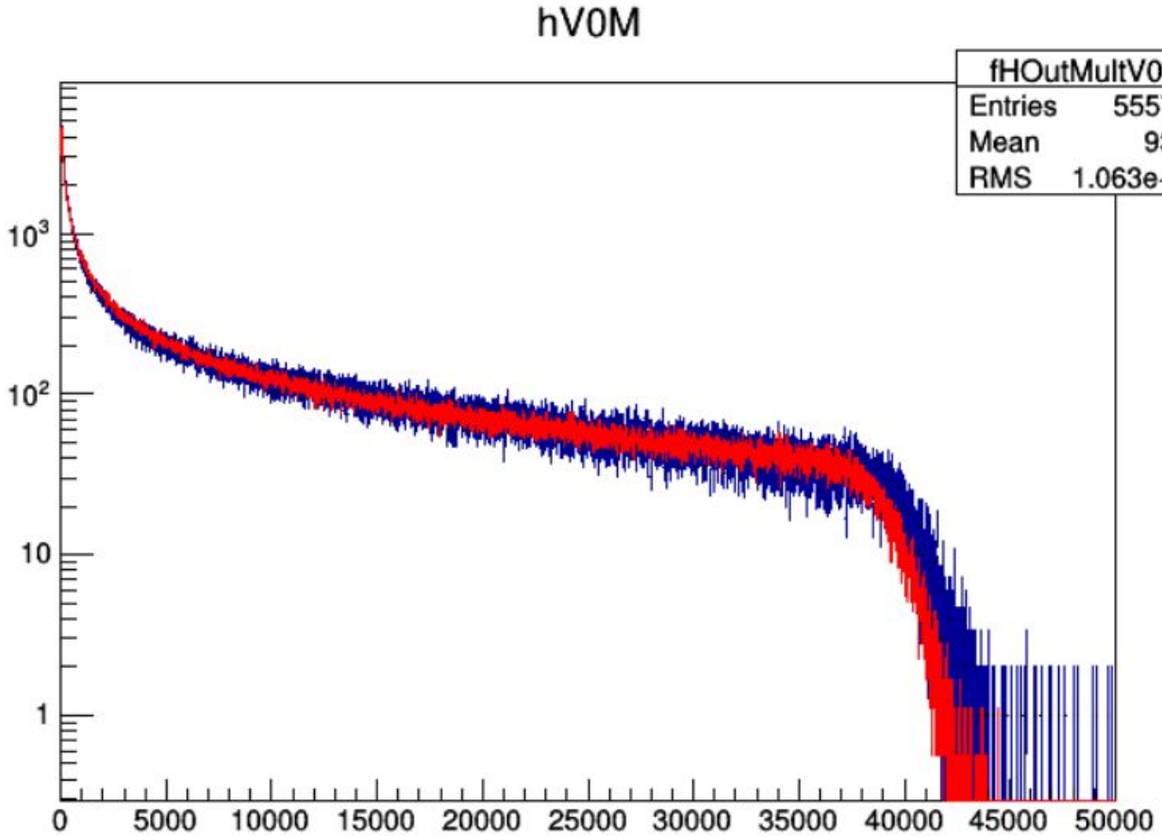


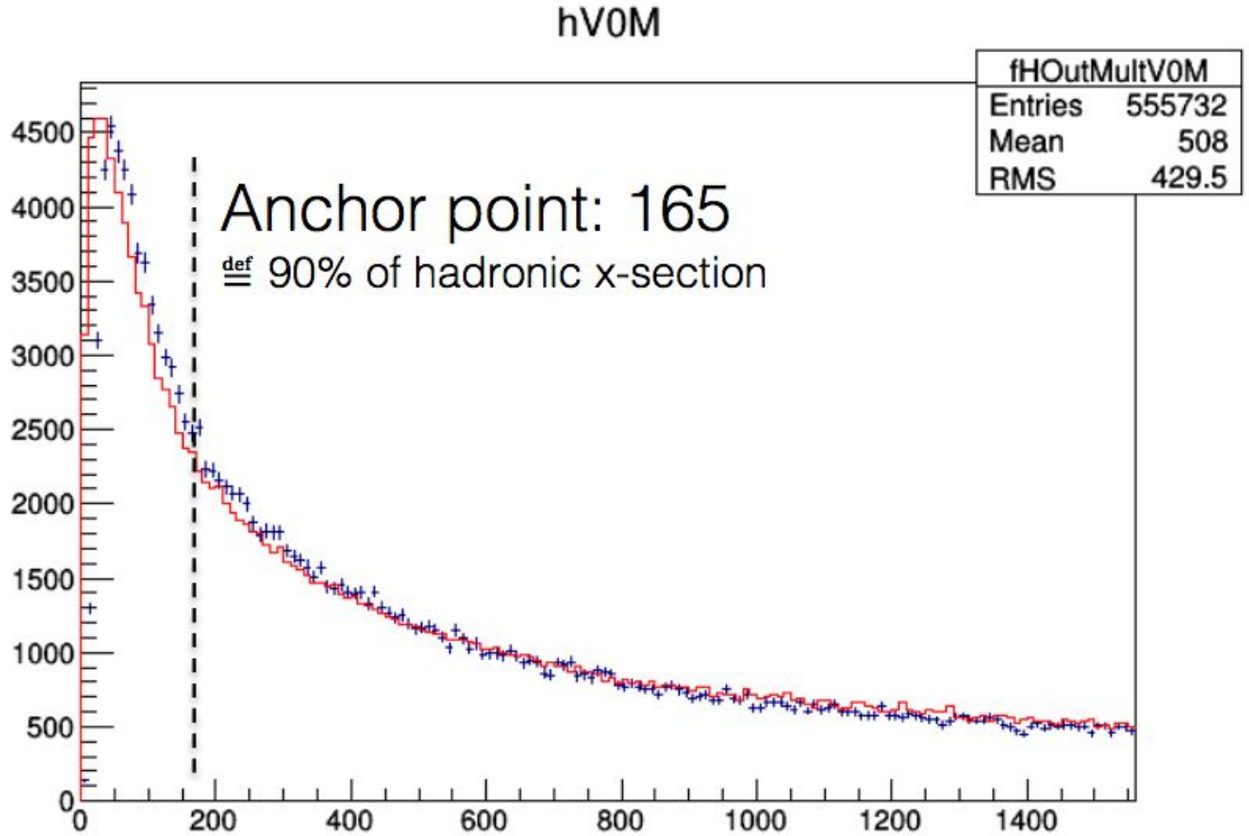
Pb-Pb centrality: first step of calibration

LHC18q, pass1_uncalibrated

Edgar Perez Lezama,
David Chinellato,
Alberica Toia

from presentation at Analysis QA Meeting:
https://indico.cern.ch/event/777487/contributions/3234437/attachments/1763103/2861228/DDChinellato-Centrality-Report-01.pdf



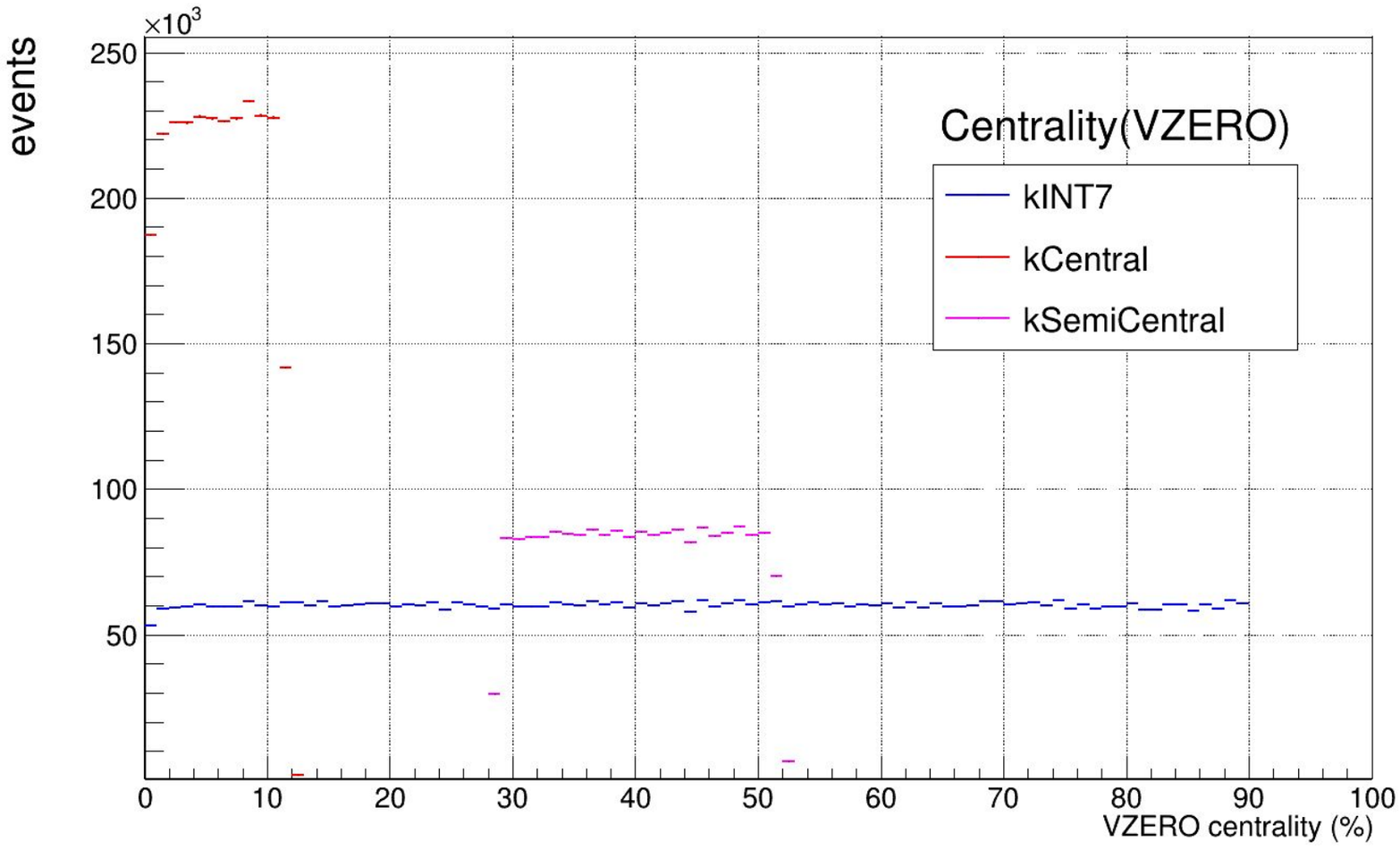


Anchor determined with offline Glauber fit framework (Edgar, Alberica)
Further tuning still to be done, but main features captured

Pb-Pb centrality: first step of calibration

Edgar Perez Lezama,
David Chinellato,
Alberica Toia

LHC18q, pass1_uncalibrated

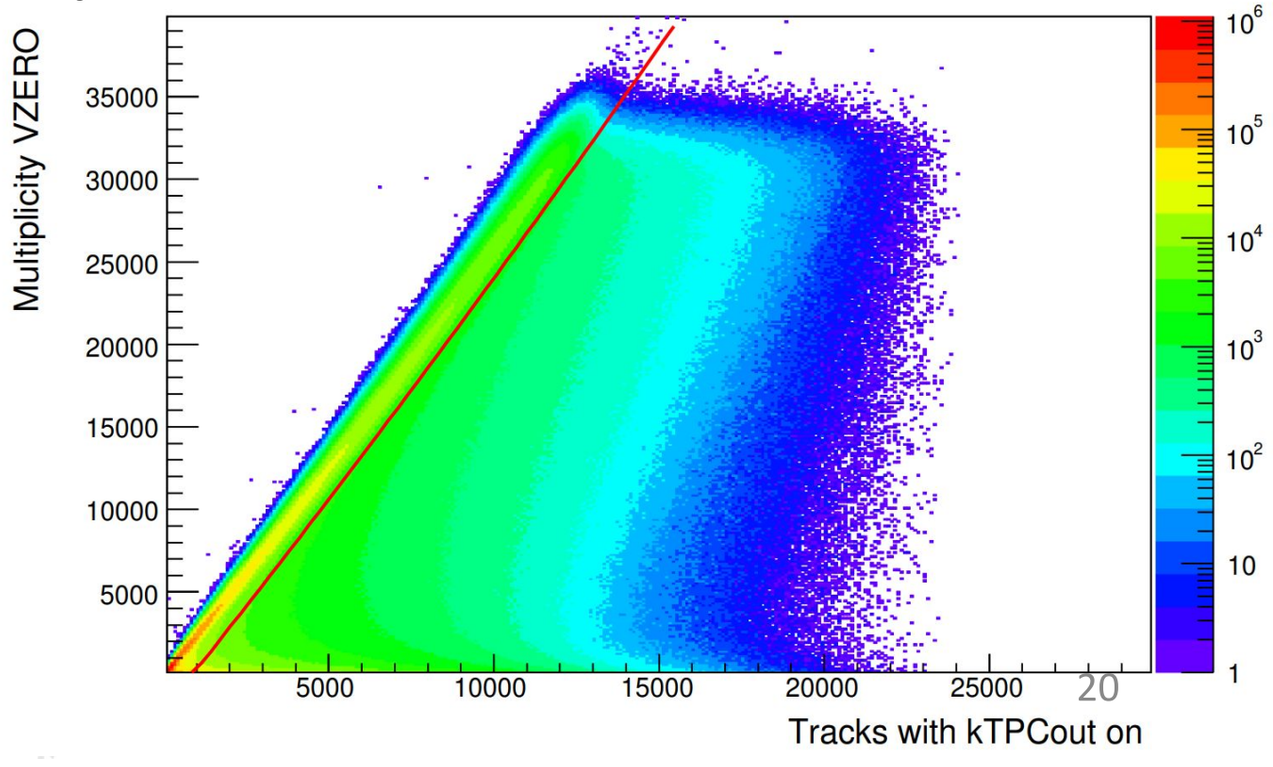


Centrality distribution for the min bias, central and semi-central triggers

Pileup removal

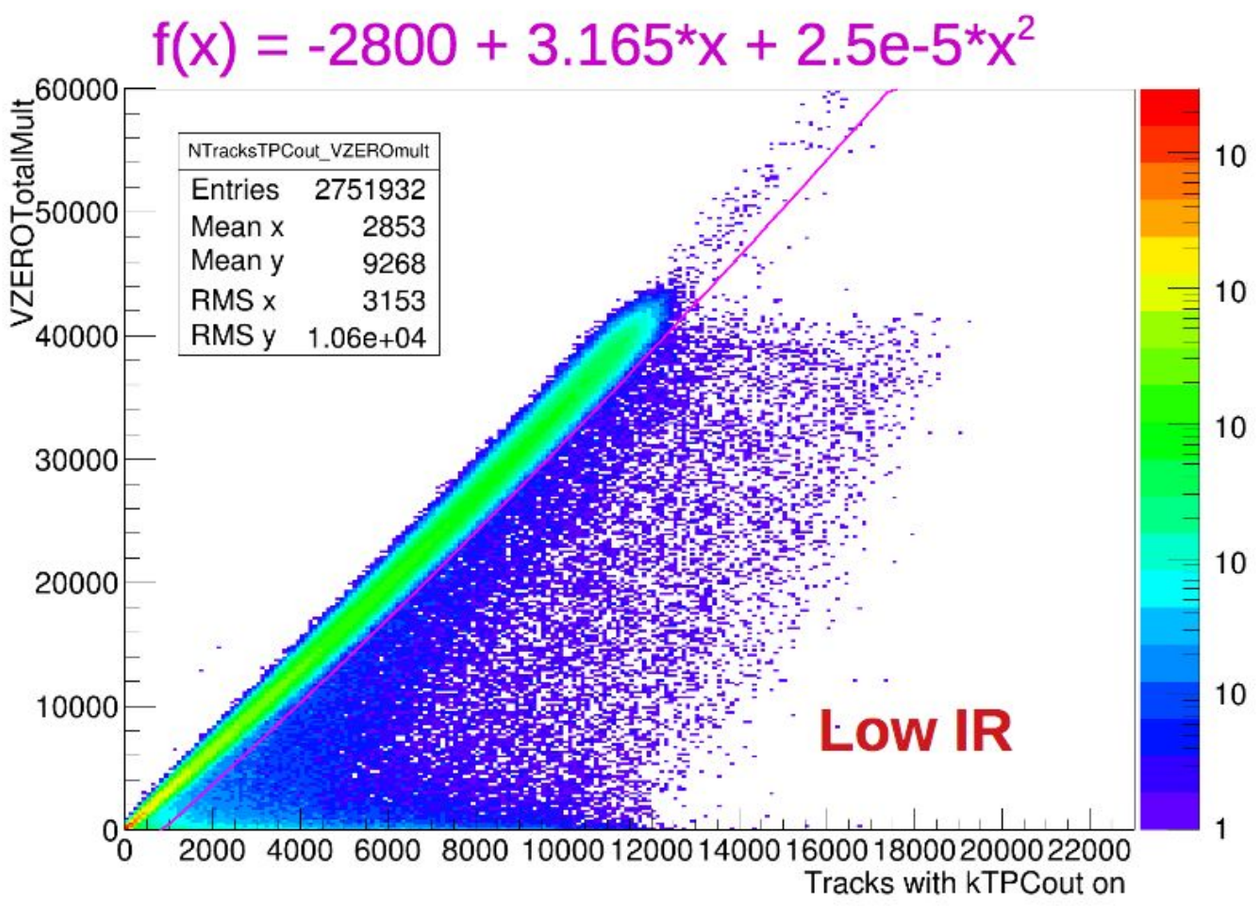
- Two types of pileup: from the same bunch and out-of-bunch pileup
- Past-future protection (rejects events in a given time window before and after the triggered events)
  - Direct detection of pileup events using a fast detector (V0)
  - Correlation between quantities from detectors with different timing window
  - Applied at the physics selection level (**should be always used in pp and p-Pb**)
    - AliPhysicsSelectionTask*physSelTask= AddTaskPhysicsSelection(isMC,**enablePileupCuts**);
- Reconstruction of multiple vertices
  - Multiple vertices with SPD
  - Multiple vertices with tracks
  - Analysis tools: AliAnalysisUtils and AliEventCuts classes
    - AliEventCuts uses the track vertexer by default for events with a vertex found
    - SPD vertexer used otherwise
- Further pileup removal based on correlations
  - E.g.
    - ESD tracks vs TPConly tracks
    - TPC+ITS tracks vs TOF tracks
    - V0 multiplicity vs TPCout tracks
    - SPD tracklets vs SPD clusters

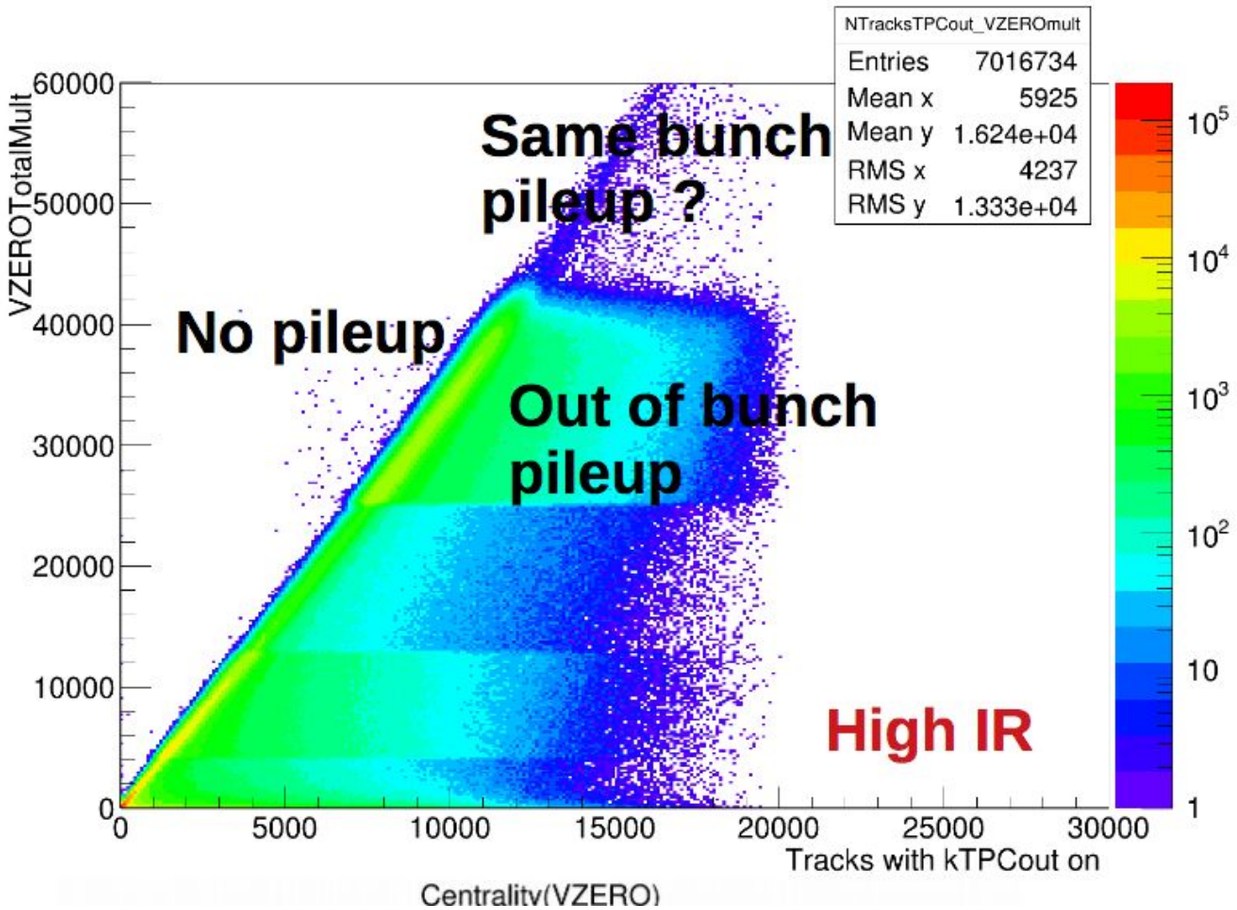
More details in the TWiki



First look at Pb-Pb 2018: pile-up in the TPC

from presentation at Analysis QA Meeting:
https://indico.cern.ch/event/777487/contributions/3234299/attachments/1763110/2861412/IArsene_AnalysisQA_2018Nov30.pdf





- Similar pile-up probability as in Pb-Pb 2015 high-rate runs (~20-30%)
- Pile-up tracks are TPConly: largely removed when requiring ITS matching, or TOF matching with TOF bunch crossing = 0
- Performance degradation in some analyses (J/ψ->ee, multi-strange) was observed in 2015 events with pile-up
  - Will be studied in detail for 2018, together with possible remedies

Conclusions

- **Analysis objects and tools** preparation
  - **DPG-AOT tracks/events** aims providing general tools and recipes to characterize data samples and to assure coherent procedures and data and MC studies between the different analyses
    - tracking efficiency systematics, MC tuning, AOD monitoring of all periods
    - event selection, centrality calibration, pile up removal recipe

All Run2 periods systematically checked.

Material available in DPG twiki pages:

- Main DPG TWiki From here you can get to all DPG TWiki pages
  - AOT tracks, AOT events
- Weekly news (sent on Friday as mail to analyzers as well)

We try to keep documentation up-to-date and try to reach all analyzers with our news in the most efficient ways (TWiki's, mails, meetings)

- The input and feedback from the analyzers is a key element in the success of the DPG activities

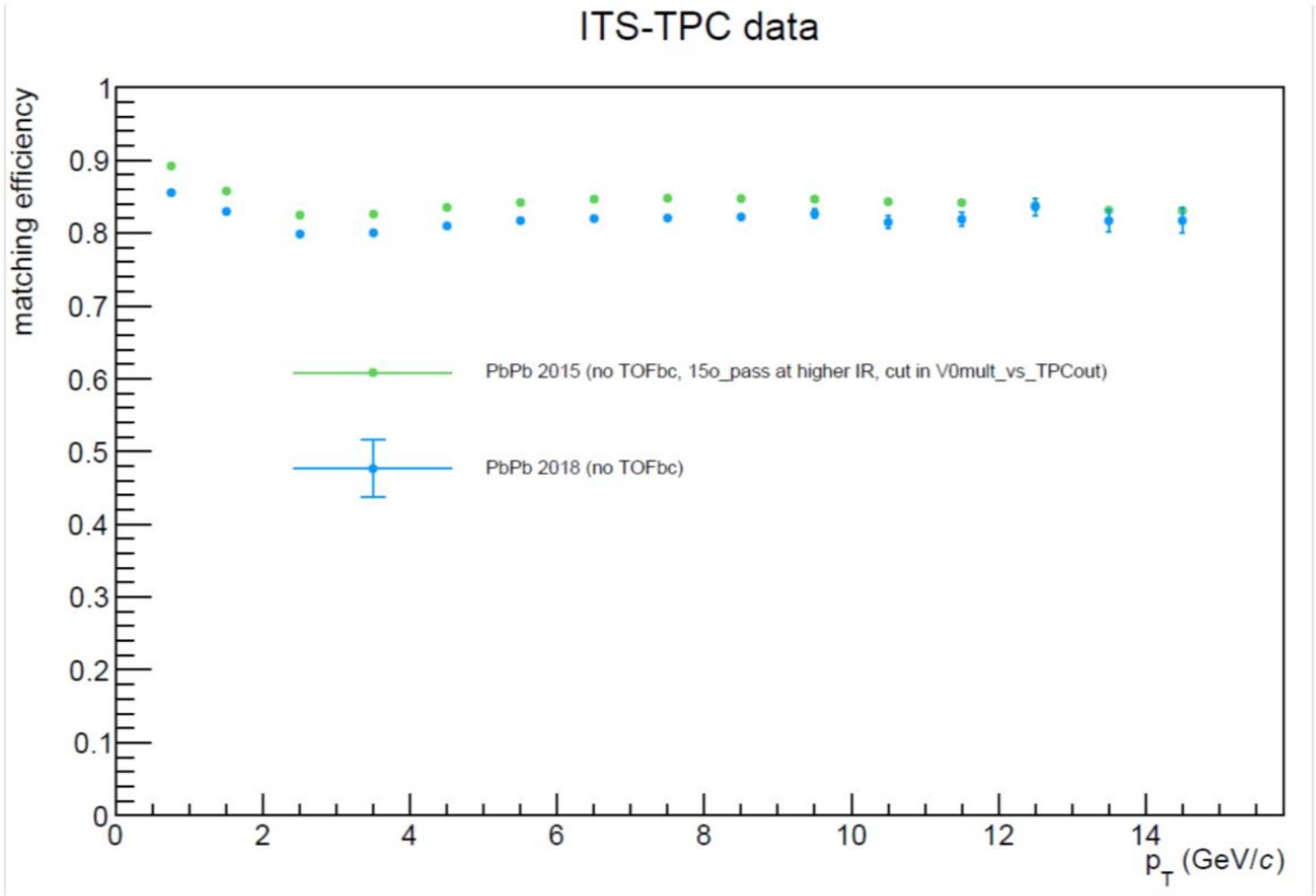
DPG

ALICE · Data Preparation Group

Backup

ITS-TPC matching efficiency

ITS-TPC matching efficiency – comparison with PbPb 2015



Lower efficiency in 2018

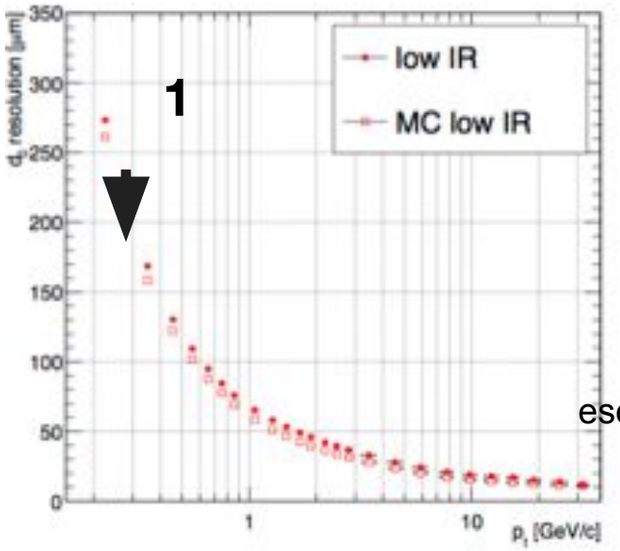
→ Different conditions (see the legend)

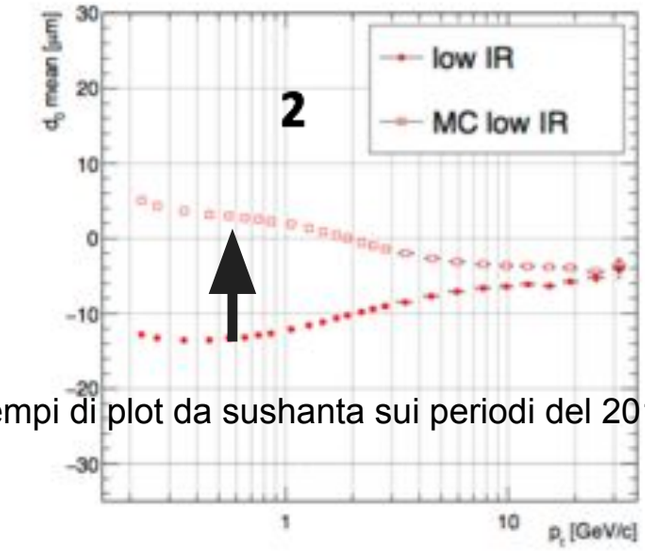
service task:
← Sushanta Tripathy
→ Mattia Faggin

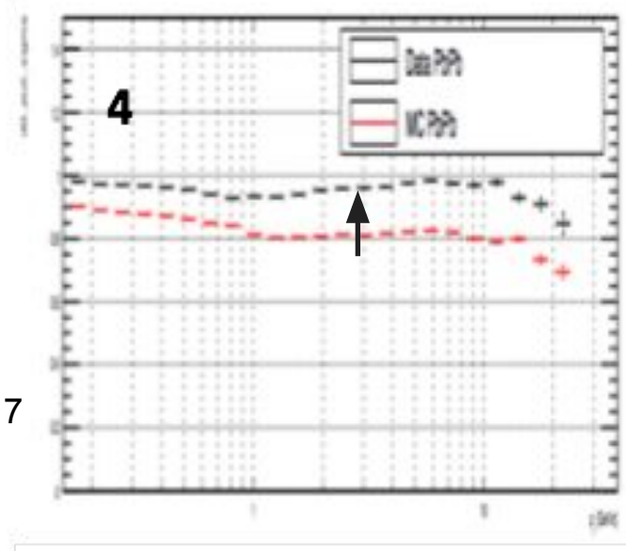
Tuning track impact parameter in MC to data

Details of corrections:

1. Increase the d_0 (scale d_{0rec}-d_{0MC}): brings MC resolution on data resolution
2. Shift the d_0: brings MC mean on data mean
3. Increase the track cov. matrix (thus, σ_{d0}) by the same factor as in point 1.
   - At this point, however, the pulls in MC are the same as in original MC, i.e. lower than in data
4. Scale the track cov. matrix by ratio of d0 pull in Data/MC since MC pull on data pulls







esempi di plot da sushanta sui periodi del 2017

service task:
← Sushanta Tripathy
→ Mattia Faggin

Systematics Uncertainties matching efficiency

- **Matching Efficiency = (# tracks TPC-ITS) / (# tracks TPC)**
- Systematic uncertainty originates from possible **discrepancies between efficiency on data and MC**
- Efficiency expected to be higher for primary particles than for secondaries (secondary vertices likely to be far outside SPD)
- Idea: **re-weight MC efficiencies** with fractions of primary and secondary particles from data, as already been done in the 5 TeV pp analysis (https://aliceinfo.cern.ch/Notes/node/472)

3 main ingredients:

1) Matching efficiencies for particle types: $Eff^{MC}_{primaries}$, $Eff^{MC}_{secondaries}$, $Eff^{Data}_{inclusive}$
2) Primary fraction from data: $f'_{primaries}$
3) Combine into inclusive efficiency:
   $Eff^{MC}_{inclusive} = f'_{primaries} \times Eff^{MC}_{primaries} + (1 - f'_{primaries}) \times Eff^{MC}_{secondaries}$

Systematic uncertainty: $(Eff^{Data}_{inclusive} - Eff^{MC}_{inclusive})/Eff^{Data}_{inclusive}$

- **Efficiency studied as a function of: p_t, phi, eta**