Analysis of D-h and D-e angular correlations with ALICE, and perspectives for the upgrade

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Motivation

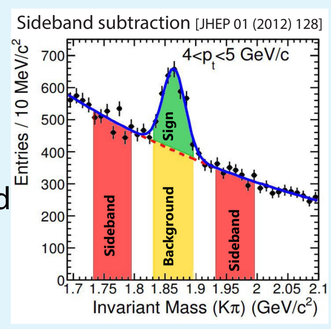
- Heavy-flavour (HF) quarks (charm and beauty) are effective probes for studying the quark gluon plasma (QGP)
  - »Created early in collision => experience full evolution of the medium
- Increase knowledge of the production processes of HF quark pairs
- Pb-Pb: Study collisional and radiative energy loss mechanisms
  - Energy loss dependence on path length
  - Medium modifications of charm fragmentation and hadronization
- p-Pb: Study cold nuclear matter effects
  - Investigate if double ridge structure, two long-range ridge-like structures in the near and away side observed for light hadrons, is present in the HF sector
- pp: Study heavy flavour azimuthal correlations as reference for Pb-Pb
- Various D meson azimuthal angular correlation analyses to study:
  - »D-$\bar{D}$: Close to quark kinematics, huge statistics needed, has potential after 2018 upgrade
  - »D-e: Both D and e originate from heavy quarks. Need high purity HF decay electron (HFE) sample and high statistics
  - »D-h: Information about charm jet and underlying event structure

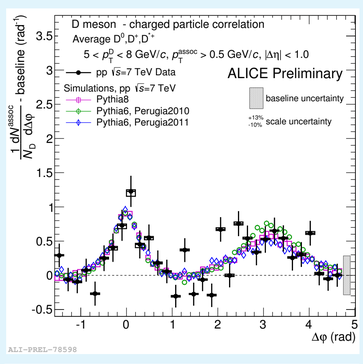
D-hadron correlation analysis

- Analysis performed on the $\sqrt{s} = 7$ TeV pp sample from 2010 (3.1x10^{8}events) and the $\sqrt{s_{NN}} = 5.02$ TeV p-Pb sample from 2013 (10^8 events)

Analysis strategy:

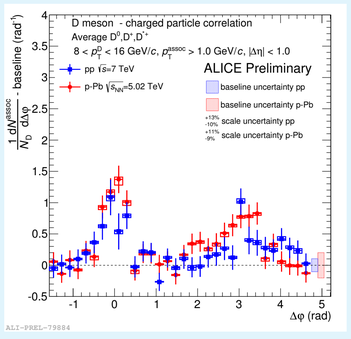
- Identification of D meson and selection of associated particle candidates
  - »Trigger particles: D^0, D^+ and D^{*+} mesons reconstructed in the central barrel from their hadronic decays, and selected exploiting the displaced decay vertex topology of the decay products
  - »Associated particles: Charged tracks reconstructed in the central barrel
- Efficiency corrections for D meson and associated particles
- Correlation of D meson candidates with associated tracks
- Subtraction of the correlations coming from background D meson candidates via side-band method
  - »Peak region defined as ±3σ. Consists of signal and background
  - »Background contribution estimated from sideband regions, defined as [-9σ, -4σ] and [4σ, 9σ], and subtracted
- Correction for detector limited acceptance and detector inhomogeneities with event mixing method, where associated track candidates are correlated with candidates from another event
- Study of the final corrected Δφ distribution

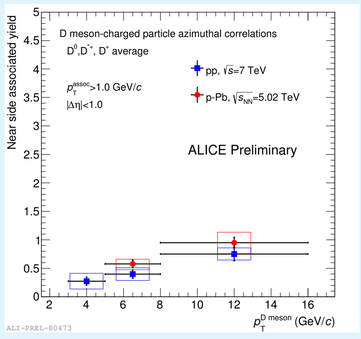




Analysis results:

- The results from pp collisions after baseline subtraction are in agreement with expectations from PYTHIA simulations
- The resulting distributions after baseline subtraction are compatible within uncertainties between pp and p-Pb collisions





Conclusions and Outlook:

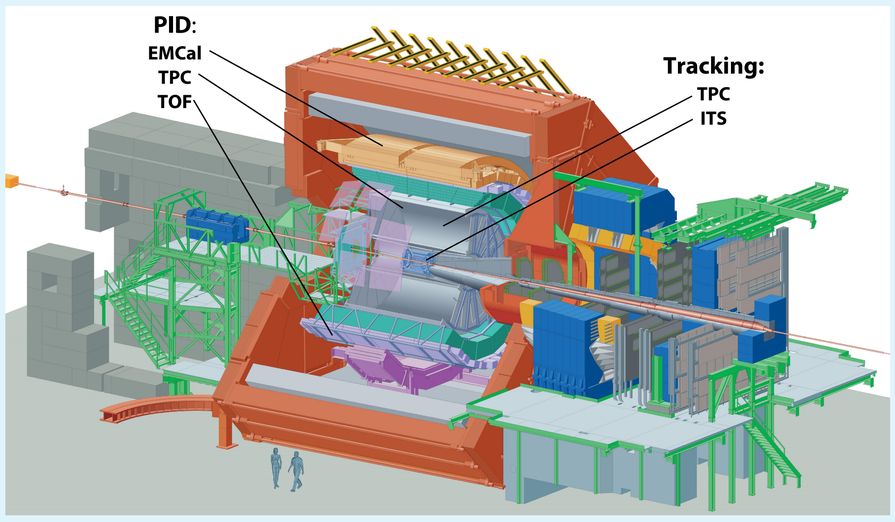
- Studies of the azimuthal correlations between D mesons and hadrons in pp and p-Pb collisions are compatible within uncertainties, and show good agreement with MC predictions (pp).
- The D-h and D-e analyses with improved detectors and statistics have great potential for precise measurements of azimuthal correlations
- Run 2 starts in 2015 and will allow for a higher luminosity and collision energy, improving current measurements before the 2018 upgrades

References:

- Letter of Intent for the Upgrade of the ALICE Experiment, CERN-LHCC-2012-012 ; LHCC-I-022
- Upgrade of the ALICE Inner Tracking System, CERN-LHCC-2013-024 ; ALICE-TDR-017
- Hege A. Erdal (2014), D0-electron correlations in pp collisions at $\sqrt{s} = 7$TeV, (PhD dissertation)
- Sandro Bjelogrlić, parallel talk, Monday 16:30: Heavy-flavour correlations in pp, p-Pb and Pb-Pb collisions
- Phys. Lett. B719 (2013) 29-41, Long-range angular correlations on the near and away side in p-Pb [...]

The ALICE Detector

The central barrel of the ALICE detector has been used for this analysis.



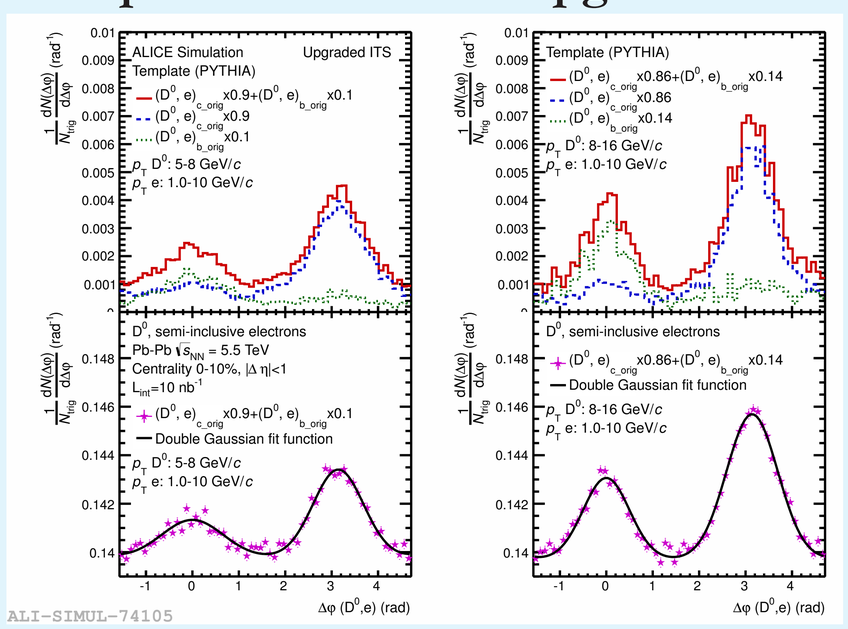
Upgrade:

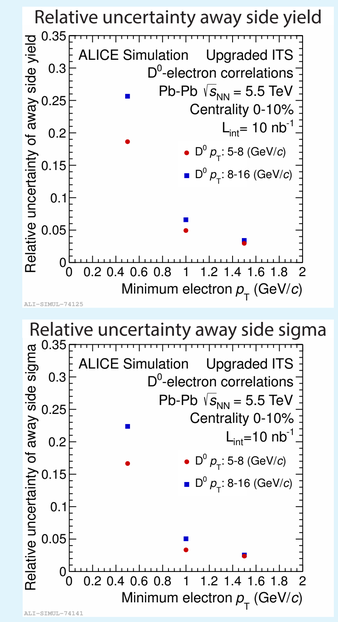
- Higher collision rate in ALICE: 50 kHz minimum bias Pb-Pb
- Upgrades of the detector are planned during the long shutdown in 2018
  Most relevant for this analysis: New Inner Tracking System (ITS)
  - »Improved position resolution of tracks
  - »Reduced material budget and new ITS layers closer to beam pipe
    - »Less conversion electrons, higher purity HF electron (HFE) sample
  - »Higher D meson reconstruction efficiency
  - »Significant increase of statistics for the analysis is expected, L_{int}=10 nb^{-1}

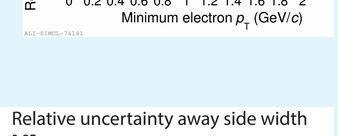
D^0-e & D^0-h performance after upgrade, Pb-Pb

- HIJING simulation, heavy flavour signal is injected with Pythia (Perugia 2011)
- Expected D^0 meson signal extracted from simulation including realistic description of the upgraded detector
- Baseline estimated with a correlation analysis on HIJING, and added to the signal correlations
- HFE efficiency and S/B for D^0 (shown on the right) expected with the upgraded ITS are used
- Realistic template of final correlation is produced

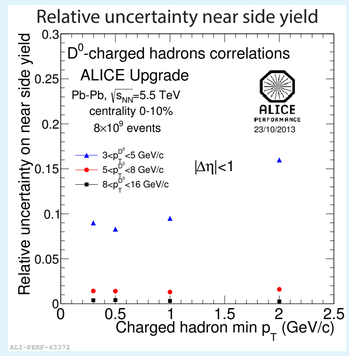
D^0-e performance after upgrade

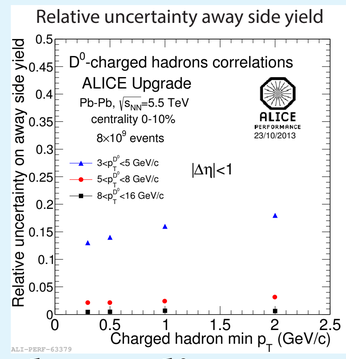


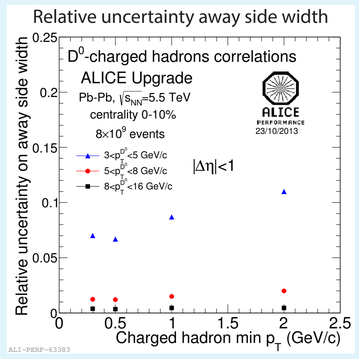




D^0-h performance after upgrade







Results from upgrade studies:

- The statistical uncertainty estimated to be lower than:
  ~7% for away side yield and away side sigma, $p_{T,e} > 1$GeV/c, for D^0-e
  ~1% for near and away side yield, and away side σ for high $p_{T,D0}$, for D^0-h
- Higher statistics and an improved detector will allow for precise measurements of D-h and D-e azimuthal angular correlations