Heavy flavour meson production in pp, pPb, and PbPb collisions with the CMS detector

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Why heavy-flavour measurements?
- in pp collisions, they provide an important test for perturbative QCD calculations at LHC energy regimes
- in nucleus-nucleus collisions, they are effective probes to study the effects of in-medium parton energy loss
- proton-nucleus studies provide baseline for PbPb analyses and allow one to study cold nuclear matter effects (e.g. shadowing)

A focus on heavy-ion collisions:
- heavy quarks experience the full evolution of the medium
- once produced, they strongly interact with the deconfined medium via radiative and collisional processes
- flavour-dependence of radiative energy loss:
  - larger for gluons than for quarks
  - dead-cone effect: gluon radiation suppressed at small angles for massive quarks

B-meson reconstruction in CMS
- 7/13 TeV: B-meson production cross sections in pp
- 2.76 TeV: B-jet measurement in PbPb collisions at 2.76 TeV

FONLL predictions at the two energies →

D-meson reconstruction
- D-meson reconstruction by vertexing displaced track pairs/triplets with proper charge combination
- Candidate selection based on multi-variate cut optimisation procedure

B-meson production cross sections in pp collisions at 7 and 13 TeV:
- B⁺, B⁰, B⁻, p_T and y-differential cross sections measured in pp collisions at 7 and 13 TeV
- Very important reference for pQCD calculations → well described within uncertainties by FONLL predictions at the two energies

b-jet measurement in PbPb collisions at 2.76 TeV:
- Evidence of b-jet suppression in central PbPb events
- b-jet RAA favours pQCD models that include strong jet-medium coupling
- no evidence of strong flavour dependence of in-medium energy loss when compared to inclusive jet RAA

D-meson HLT algorithms in pp and PbPb collisions
- D⁺, D⁰ algorithms implemented in the HLT to tag events with high p_T D mesons:
  - Events selected at L1 trigger level using calorimeter-based jet seeds
  - Global tracking performed at HLT
  - Secondary vertex reconstruction and D⁺ meson reconstruction and selection

D-meson production cross section in pPb collisions at 5.02 TeV:
- measurement of B⁺, B⁰, B⁻ in pPb collisions at 5.02 TeV vs p_T and rapidity
- Nuclear modification factors obtained using FONLL to build the proton-proton reference → R^PONLL consistent with unity → compatible with binary scaling

New results with the 2015 HI runs:
- 2015 HI runs was a big success for CMS!
  - 350+28/qp in pp collisions at 5.02 TeV
  - 6.0+0.6/nb in PbPb collisions at 5.02 TeV
  - 2.5 billions MB events collected in pp and ~200 millions MB events in PbPb
  - Dedicated heavy flavour HLT algorithms to trigger on D mesons and HF-Jets!

 invariant mass plots of D and B mesons at 5.02 TeV in pp and pPb
- (Left) Invariant mass spectra of D mesons extracted in PbPb collisions using MB events in the range 8<p_T<20 GeV/c and using D-triggered events in 40<p_T<50 GeV/c
- (Right) Invariant mass spectrum of B⁺ mesons in pp collisions at 5.02 TeV using di-muon triggered sample

Efficiency of HLT D⁺ tagging evaluated in pp collisions at 5.02 TeV using MB events
- Very sharp turn on curve vs D⁺ p_T
- Efficiency in the plateau ~100%
- Possibility to measure D⁰ meson production in pp and pPb up to ~100 GeV/c