B-physics and low p_T analyses

the path to 2017

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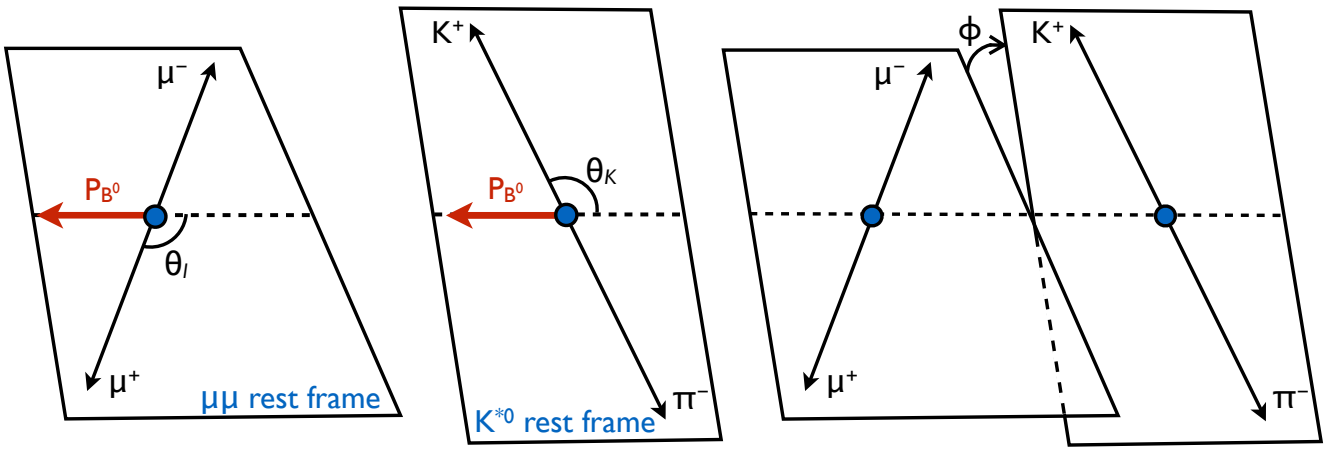
Riunione CMS Italia
14-16 Dicembre 2016

A lot of run I analyses ongoing

- $B \to K^{(*)}\mu\mu$ angular analyses
- Structure in 4μ final state
- Precision B hadrons lifetimes
- Double onia production
- Charmonium + jet production
- $B^*_{s2} \to BK$ study
- ...

$B^0 \to K^* \mu\mu$

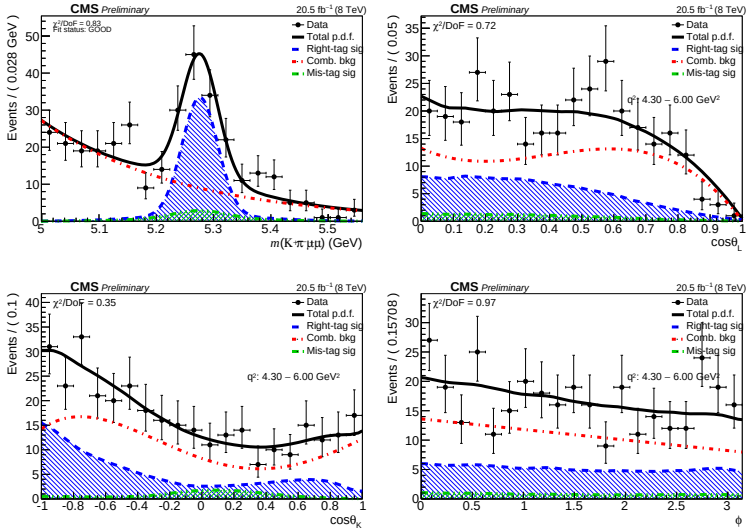


Four-particle final state topology

- three decay angles: θ_K, θ_l, ϕ
- the square of dimuon invariant mass: q^2

$B^0 \to K^* \mu\mu$

- Very complex 4D fit
- Angular PDF depends on 3 floating parameters (P_1, P_5', A_s^5)
- The real problem is that it can become negative for some values of these parameters
- The forbidden region can be found numerically, but not analytically
- Whenever MINUIT approaches the border, it fails or claims it as a minimum



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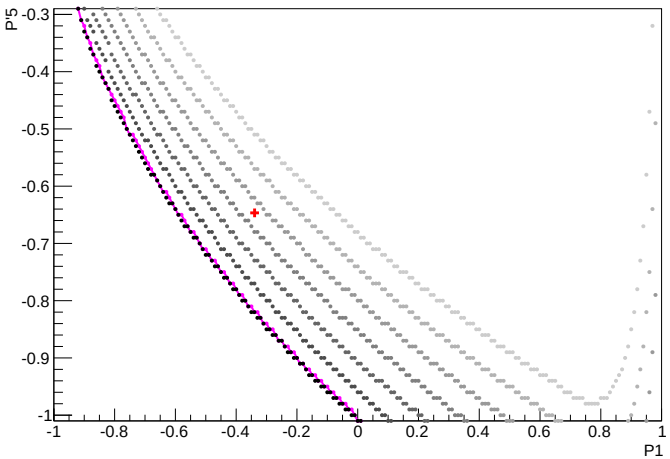
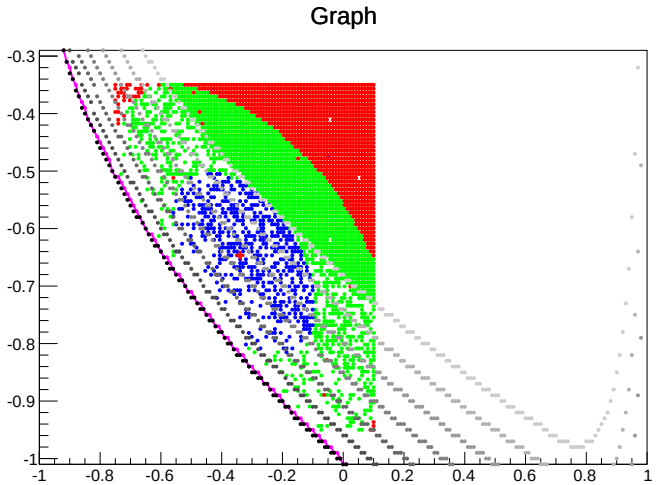


$$\frac{1}{\Gamma_{full}}\frac{1}{dq^2 d\cos\theta_l d\cos\theta_k d\phi} = \frac{9}{8\pi}\left\{\frac{2}{3}\left[(Fs + As\cos\theta_k)\left(1-\cos^2\theta_l\right) + A_s^5\sqrt{1-\cos^2\theta_k}\sqrt{1-\cos^2\theta_l}\cos\phi\right]\right.$$
$$+ (1-Fs)\left[2F_L\cos^2\theta_k\left(1-\cos^2\theta_l\right) + \frac{1}{2}\left(1-F_L\right)\left(1-\cos^2\theta_k\right)\left(1+\cos^2\theta_l\right)\right.$$
$$+ \frac{1}{2}P_1(1-F_L)(1-\cos^2\theta_k)(1-\cos^2\theta_l)\cos 2\phi$$
$$\left.\left.+2P5'\cos\theta_k\sqrt{F_L\left(1-F_L\right)}\sqrt{1-\cos^2\theta_k}\sqrt{1-\cos^2\theta_l}\cos\phi\right]\right\}$$

$B^0 \to K^* \mu\mu$

- To understand and solve the issue the 2D profile likelihood has been scanned in the $P_1 - P_5'$ space
- In the result the colored regions highlight the $2\Delta NLL = 1$ and $2\Delta NLL = 4$ borders
- The missing points corresponds to failed fits



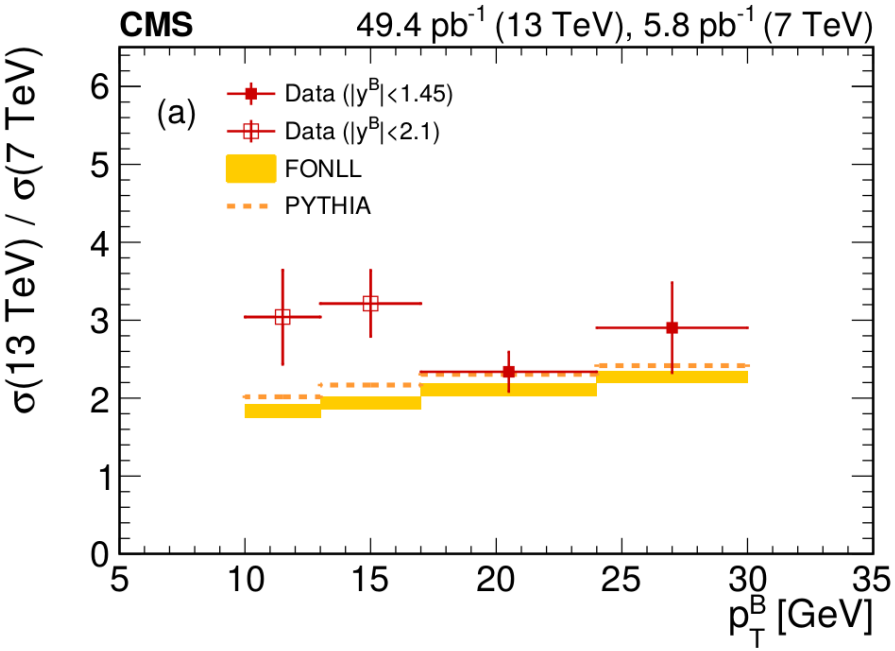
- A Feldman-Cousins approach has been required by the statistical committee, due to possible physical-boundary effects
- Anyway the 2D application of the approach to extract 1D intervals is very CPU intensive
- Now we are applying an approximated form, using parameter correlations from the likelihood

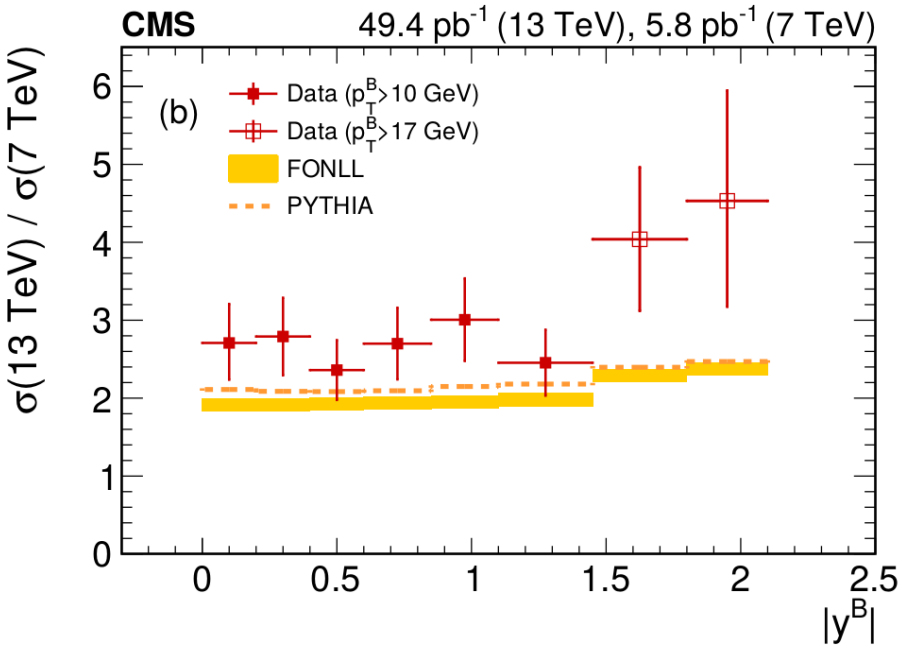
Run II ongoing analyses

- Angular analyses are already putting efforts to look at Run II data, as well
- New channels investigated: $B_s^0 \to \phi\mu\mu$ and $\Lambda_b \to \Lambda\mu\mu$
- Several cross-section measurements done with early 13 TeV data
- Double onia but also a more general low energy multi-lepton investigation
  - tetra quark, exotica, BSM hints
- The XPAG SMP-BPH first search for the $Z \to \ell\ell J/\psi$ decay is joining
- Early trigger studies are also ongoing for the $\tau \to 3\mu$ search
- these first analyses are precious to understands the needs for the 2017 trigger and the PU effects

Differential B^+ cross section

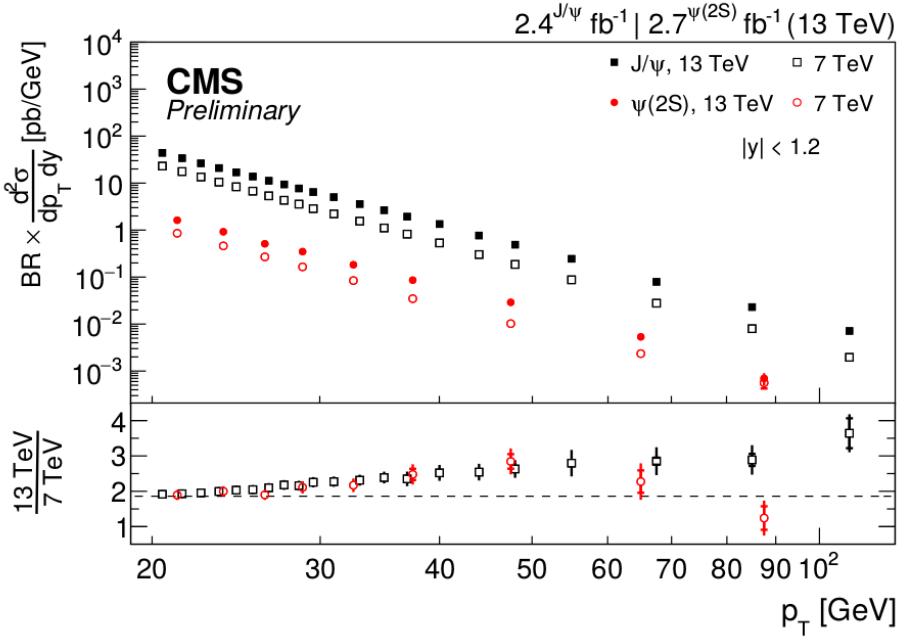
- Differential inclusive B^+ cross section measured with early 13TeV data
- The ratio between the cross sections at 13 TeV and 7 TeV computed
- A discrepancy with FONNL and pythia predictions was observed in some bins

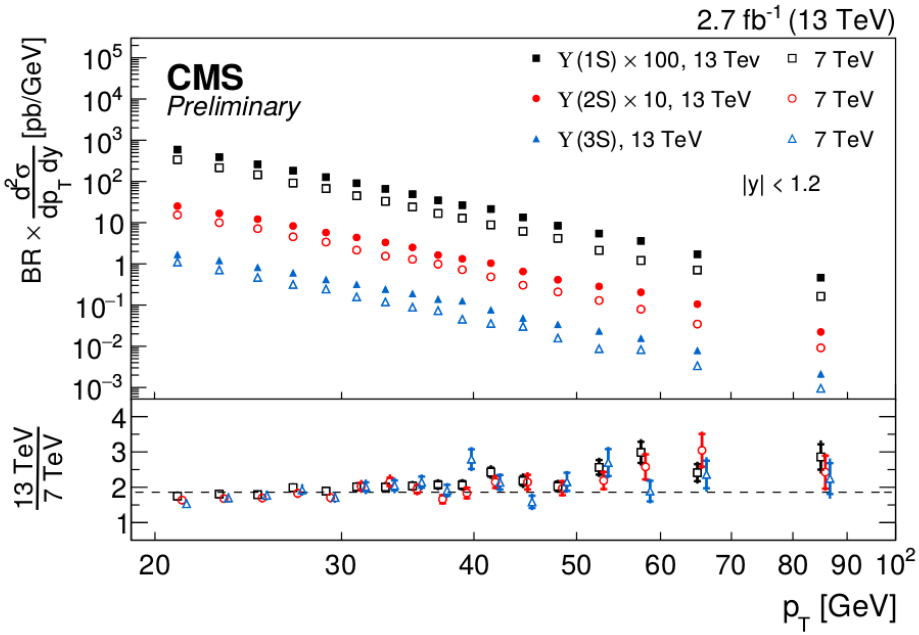




Quarkonium production cross section

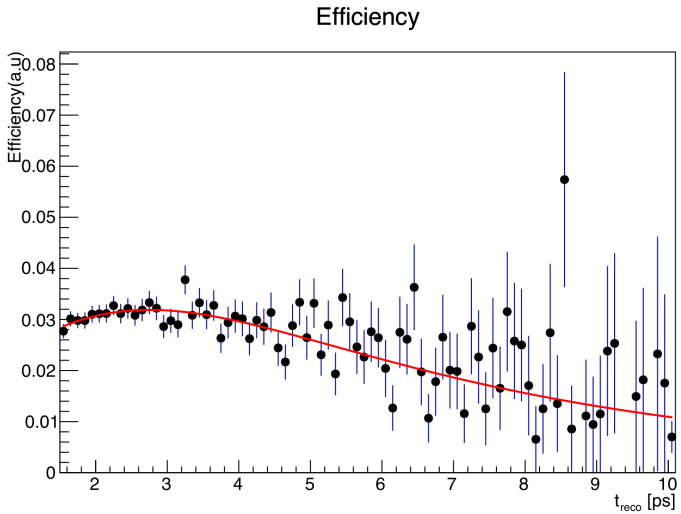
- Double differential quarkonium cross section measured with 2015 data
- Ratio with 7 TeV cross section calculated
- p_T dependence is observed

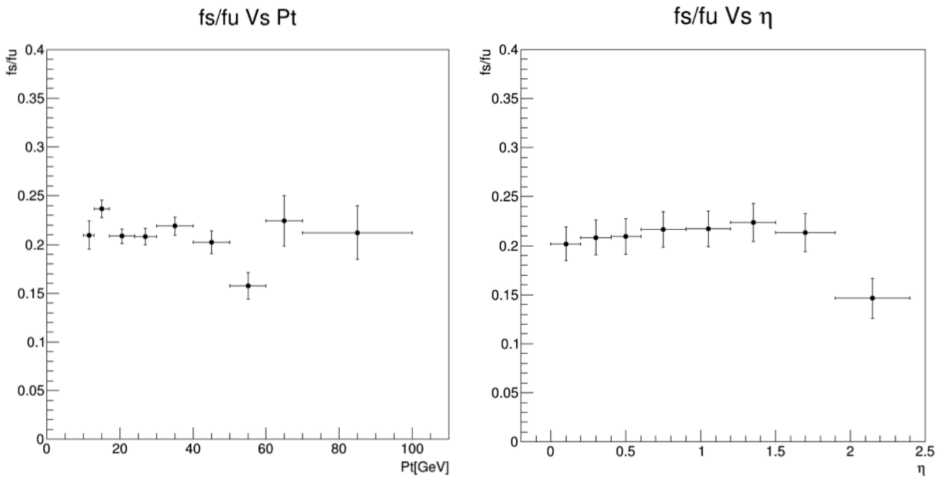




$B^0_{(s)} \to \mu\mu$

- Great expectation for the first result at 13 TeV
- Analysis on 2016 data aiming Moriond
- Three goals:
  - Cross section $B^0_s \to \mu\mu$
  - Lifetime $B^0_s \to \mu\mu$
  - Cross section $B^0 \to \mu\mu$



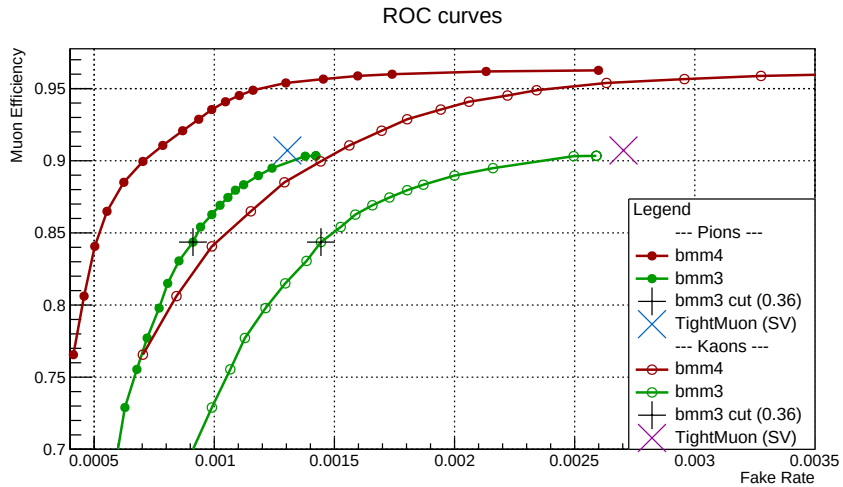


- Effort involved to measure the differential f_s/f_d ratio
- Avoid dependence on LHCb measurement

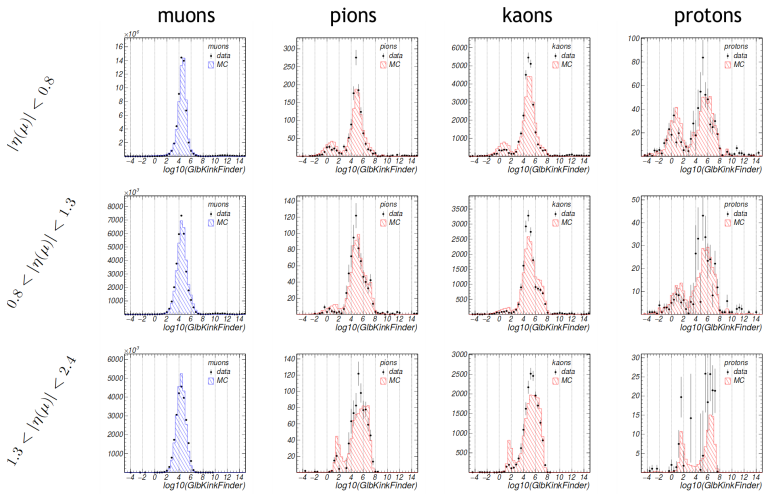
$B^0_{(s)} \to \mu\mu$

New MVA-based muon ID

- Increased number of input variables
- ROC curve with old and new discrimination performances
- Discrimination power improved
- The idea is to use two different working points for $B^0_s \to \mu\mu$ and $B^0 \to \mu\mu$



Global kink finder (global muon)

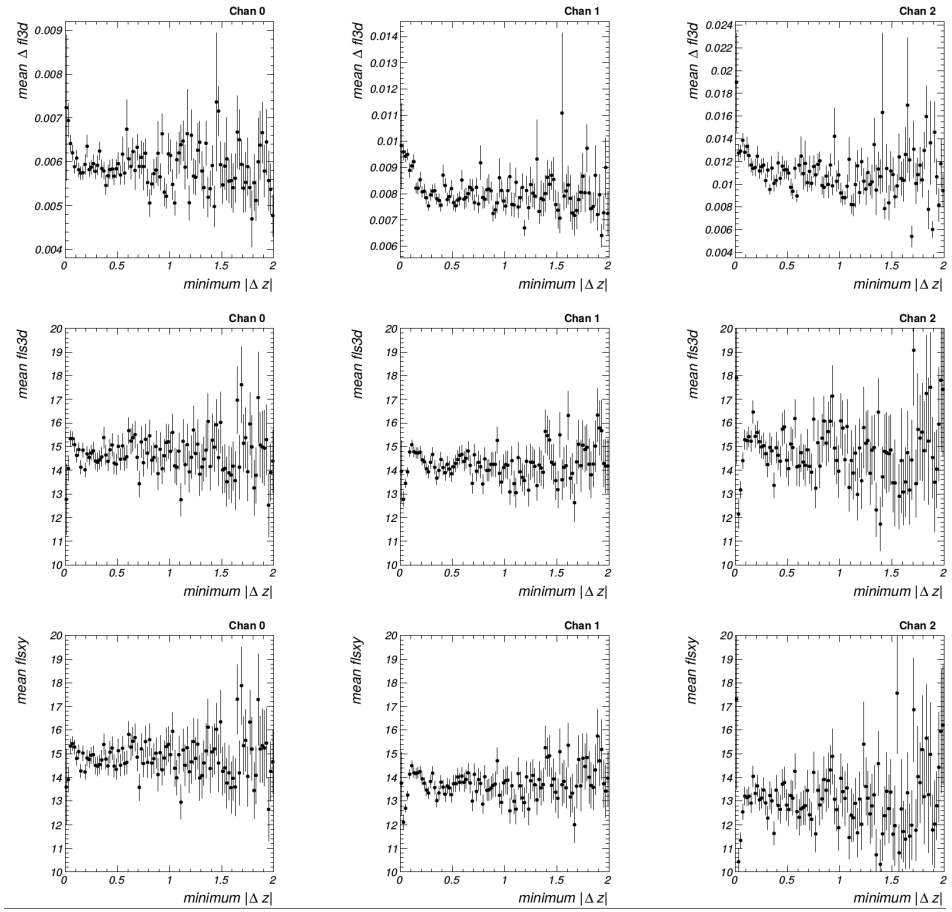


MVA validations ongoing

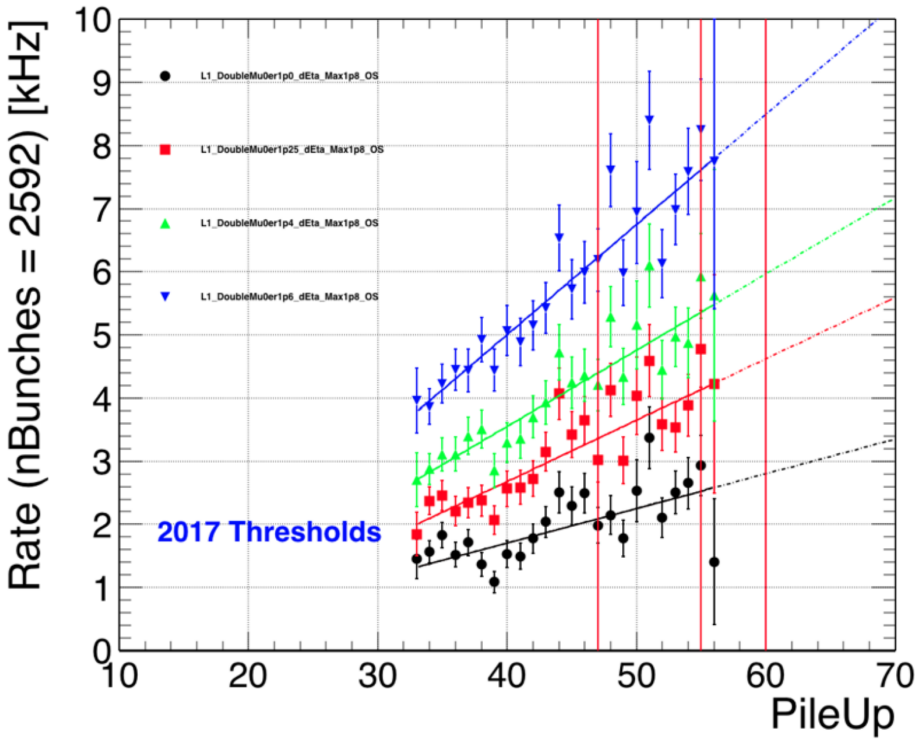
- Input variables and MVA output validated on data control channel
- Some discrepancies are under study
- Muon double-fake rate carefully studied

$B^0_{(s)} \to \mu\mu$

- A study is ongoing to understand if the error on the flight-length is affected by pileup
- Instead of N_{PV}, the mean result is plotted as a function of the Δz between the reconstructed momentum of the candidate and the closest PV
- First results indicate that there is no dependence



$B^0_{(s)} \to \mu\mu$ L1 seed



- The main L1 seed used was L1_DoubleMu0er1p4_dEta_Max1p8_OS
- At higher PU, the eta range is expected to be reduced
- Alternative cuts have to be studied

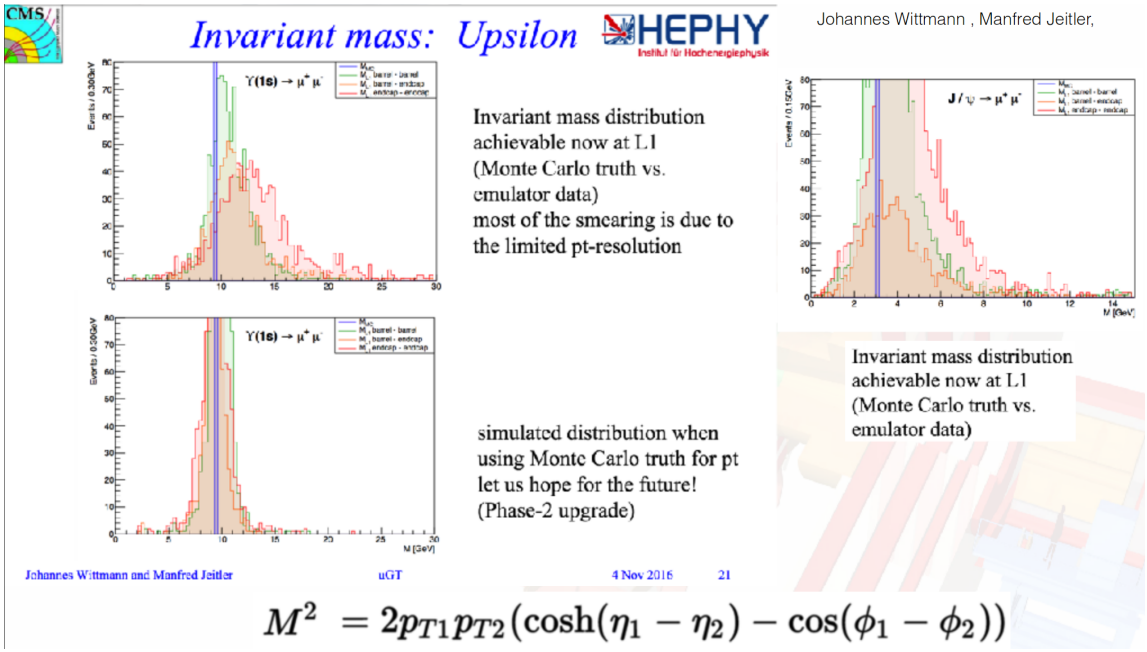
TripleMu L1 seed

- During the run moved from L1_TripleMu0 to L1_TripleMu5_0_0
- Seed used by:
- spectroscopy analyses
  - using a resonant J/ψ or Υ plus one other meson
  - the efficiency loss due to the p_T cut will be tested
- $\tau \rightarrow 3\mu$ search
  - penalised by any muon p_T cut
  - a ΔR or invariant mass cut could be considered

Preparazione del trigger 2017

L1 trigger

- Nel 2016 l'alta luminosita' ha imposto tagli sempre piu' duri su p_T e η dei seed muonici
- Per il prossimo anno c'e' l'idea di cambiare strategia e sfruttare intensivamente la possibila' di tagli in massa invariante e ΔR
- Primi studi in svolgimento per testarne la risoluzione e l'efficacia dei tagli
- Questo aumenterebbe il numero di seed necessari



Preparazione del trigger 2017

High level trigger

- Da riscrivere from scratch
- Ottima occasione per coinvolgere manpower nella pulizia e retuning dei path
- Gli analisti son stati contattati all'interno del PAG per prendersi carico degli studi necessari
- Soprattutto studi basati sui path del vecchio menu, ma anche alcune proposte per path originali stanno arrivando:
  - Path per analisi di $B_s^0 \to J/\psi\phi$, con $J/\psi \to \mu\mu$ senza displacement e opposite-side tag (muone, elettrone o b-jet)
  - Path per cross sections e analisi angolari con $J/\psi \to \mu\mu$ e long-living particle (K_s o Λ)

Contributi italiani

Analisi

- Lifetime MIB
- P5' MIB+PD (anche per Run2)
- onia TO+BA
- Amplitude analyses BA
- Upsilon(nS) production vs. charged particle multiplicity (BO)

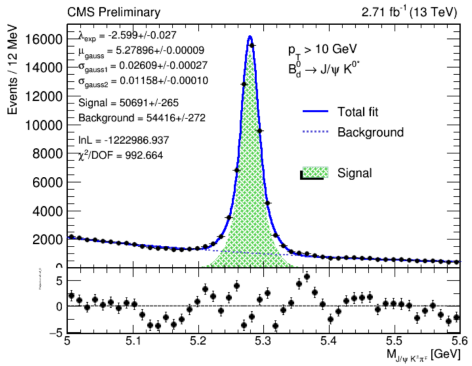
Impegni e responsabilita'

- Convener & co-convenre
- Trigger office
- Tracking contact
- ARC

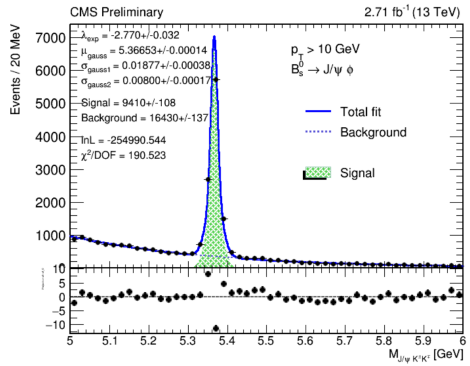
Backup

Double differential B^0 and B_s^0 cross section

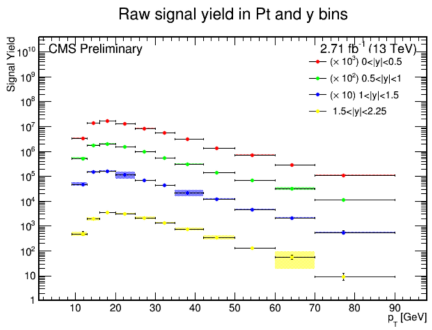
$B^0 \to J/\psi\ K^{*0}(K^+\ \pi^-)$



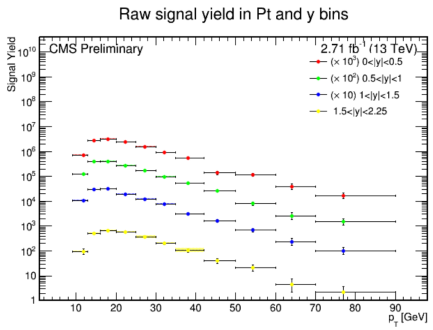
$B_s^0 \to J/\psi\ \phi(K^+\ K^-)$



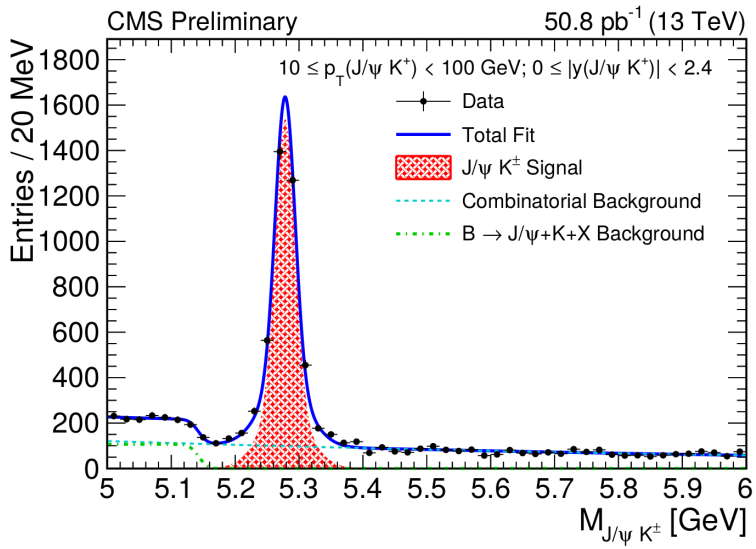
$B^0 \to J/\psi\ K^{*0}(K^+\ \pi^-)$

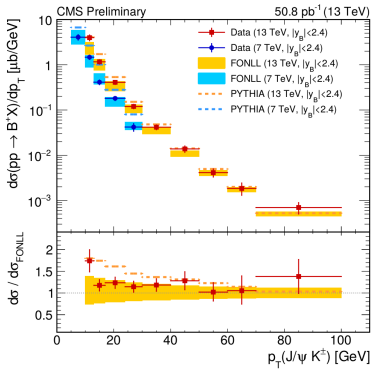


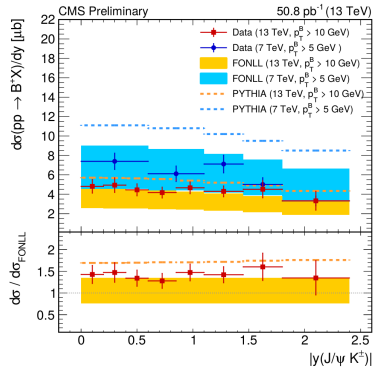
$B_s^0 \to J/\psi\ \phi(K^+\ K^-)$



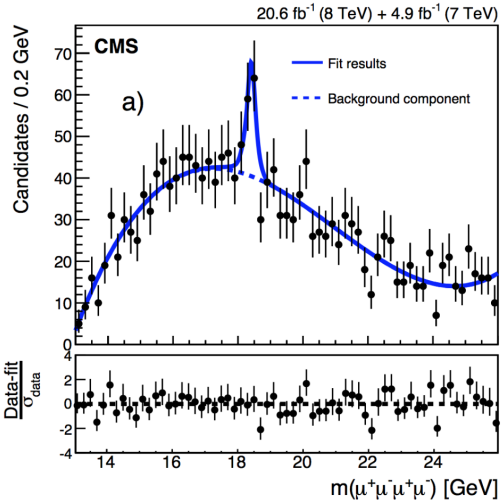
B^+ cross section

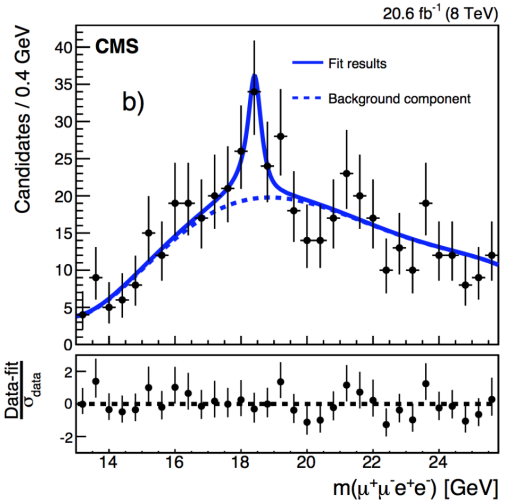


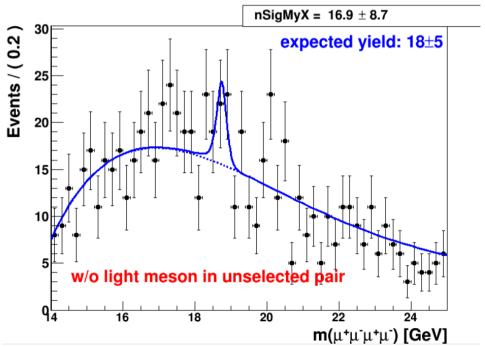


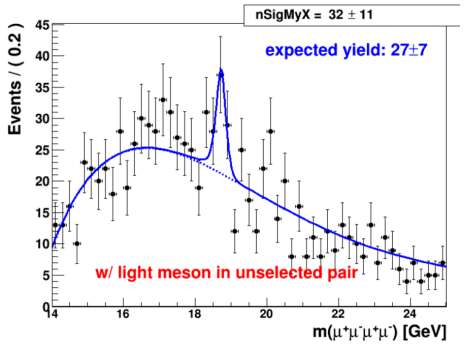


Evidence of $\mu\mu\mu\mu$ resonance in $\Upsilon\mu\mu$ channel

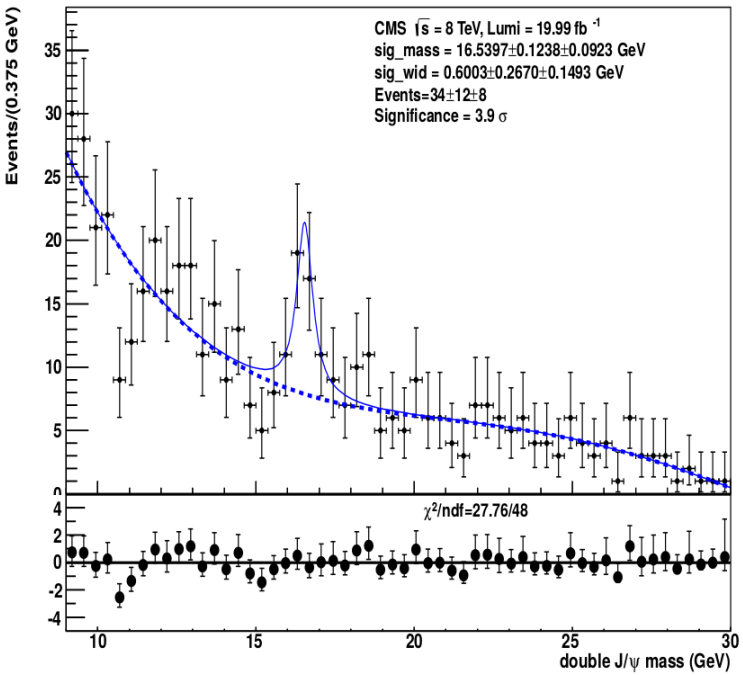








$\Upsilon\Upsilon$ and $J/\psi J/\psi$ production



$Z \to J/\psi \ell^+ \ell^-$