B Physics

measurements, searches, organization & prospects

Nuno Leonardo, LIP

Jornadas LIP 2016

Braga, Feb 19th, 2016

introduction

- Flavor physics
  - indirect searches for New Physics
    - via precision measurements and rare decays
  - study QCD
    - production mechanisms, search for new particles, explore different media
- CMS coordination by LIP
  - B Physics Analysis Group (B PAG) coordination by LIP (2014-2016)
  - First time LIP have been entrusted with L2 responsibilities in the Physics Coordination of the experiment
- Current focus areas at LIP
  - B and quarkonium production measurements
  - Rare decay searches

CMS Physics Coordination

POGs
Physics Object Groups

- b-tagging
- Electron/photon
- Jet/MET
- Luminosity
- MC generators
- Muon
- Taus
- Tracking

PAGs
Physics Analysis Groups

- B physics
- Higgs
- Beyond 2 Gen
- Standard Model
- Exotica
- SUSY
- Forward/QCD
- Top
- Heavy Ions

CMS Physics Coordination

POGs
Physics Object Groups

- b-tagging
- Electron/photon
- Jet/MET **(LL)**
- Luminosity
- MC generators
- Muon
- Taus
- Tracking

PAGs
Physics Analysis Groups

- B physics — **NL**/LIP — **(JS,PF,DV,BG)**
- Higgs — **AD**/CERN — **(PV,AT)**
- Beyond 2 Gen
- Standard Model
- Exotica **(NL)**
- SUSY **(PB,LL,CS)**
- Forward/QCD — **JH**/LIP
- Top — **PS**/CERN — **(MG,PV,PB,LL,VV)**
- Heavy Ions — **(JS,PF,NL)**

CMS B Physics Coordination

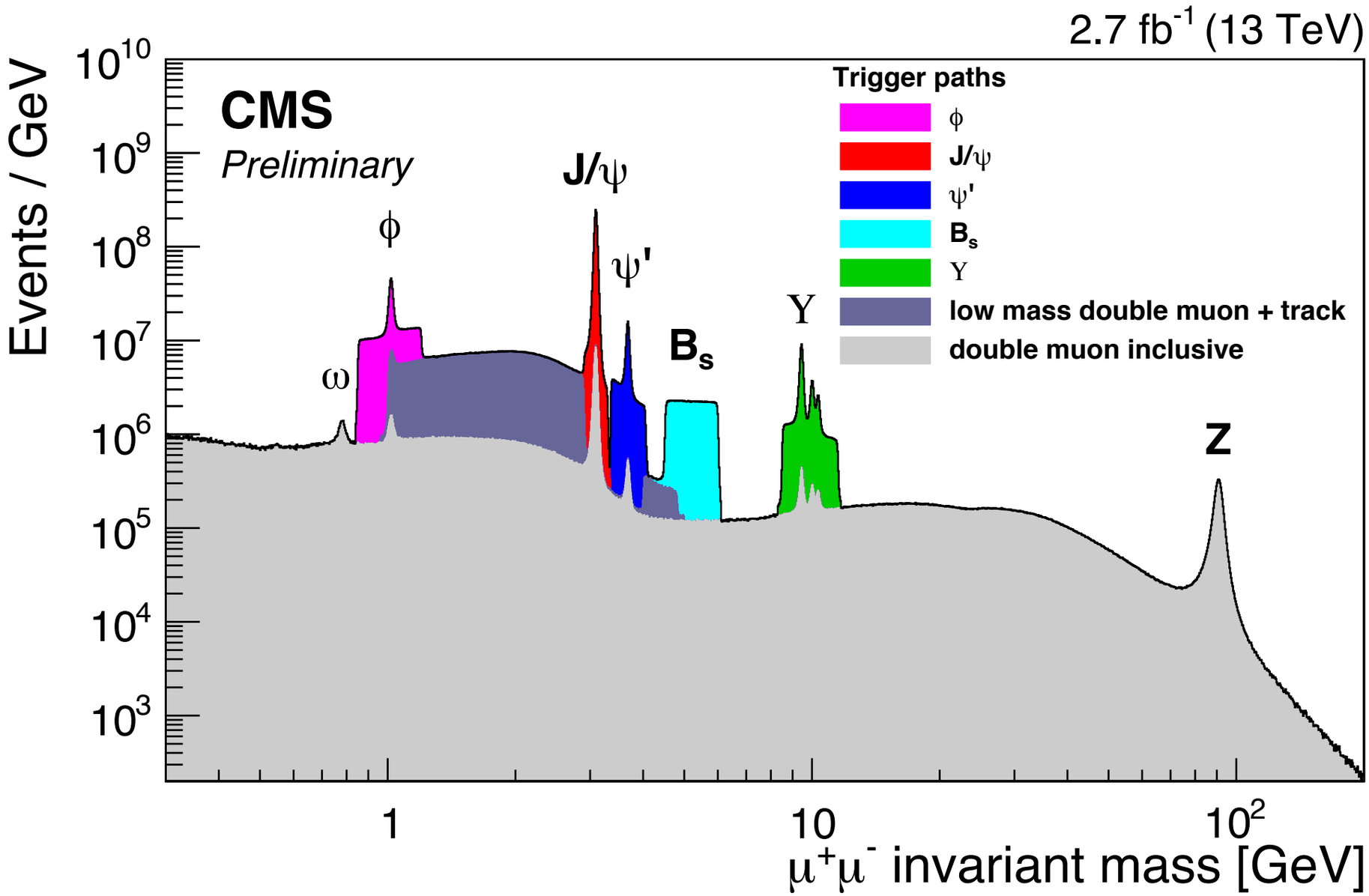
N.Leonardo with
S.Malvezzi (2015/6)
F.Palla (2014/5)

- Contacts
  - Analysis tools
  - Muons
  - Tracking
  - Trigger
  - MC Generators
  - Physics Operations, Validation, Datasets
  - Publication & Conferences **(JS)**
- Physics Subgroups
  - Early analyses
  - **Production** **(PF;JS,BG,NL)**
  - Multileptons
  - **Spectroscopy**
  - Amplitude analyses
  - Angular analyses
  - **Properties** **(NL)**
  - Lifetimes & CPV
  - **Rare Decays** **(NL;DV,BG)**
  - Upgrades

Run2!

- Since last year's Jornadas... we have gathered 13 TeV data!

the di-muon spectrum signature plot revisited (at 13 TeV)

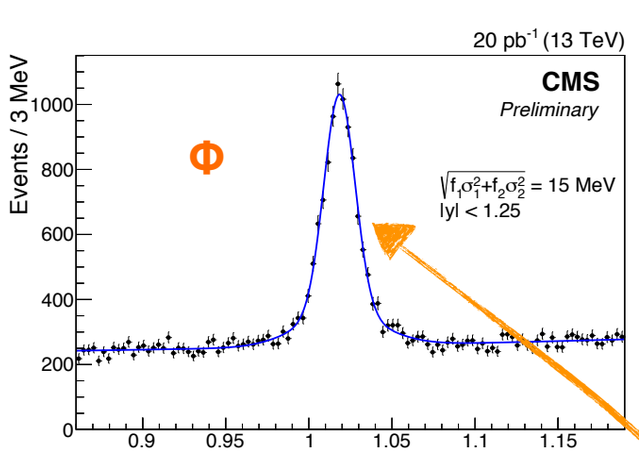


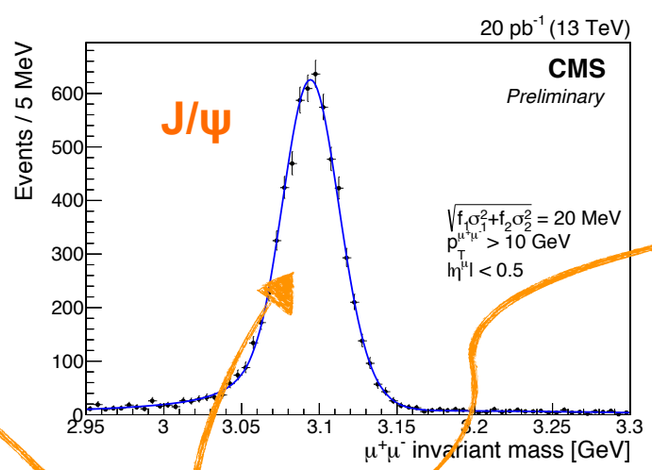
Z.Hu, NL

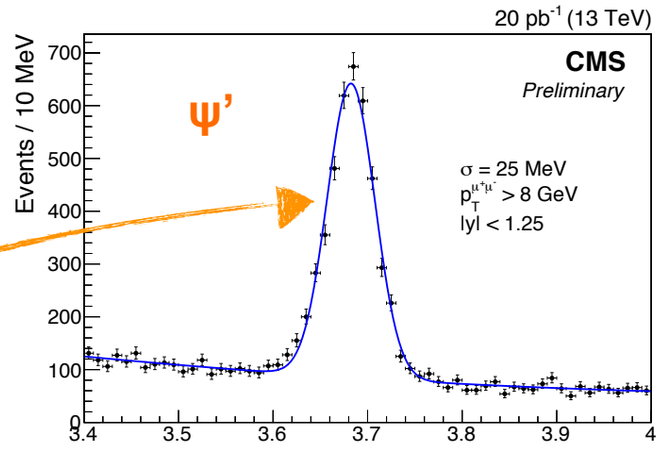
CMS-DP-2015-055

Run2 early data

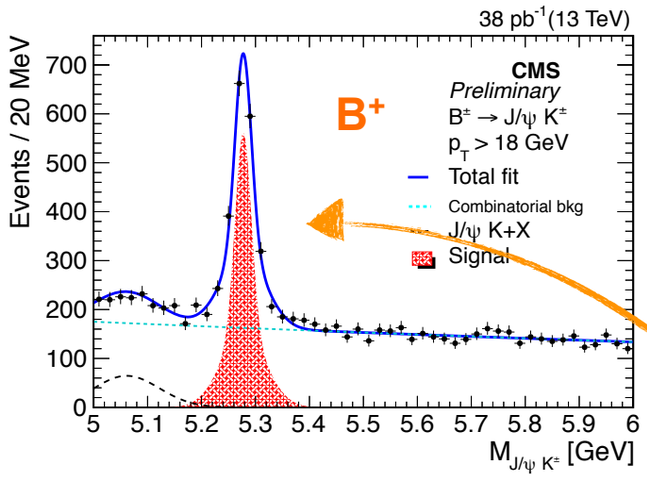
- performance plots shown at EPS last summer (50ns run)

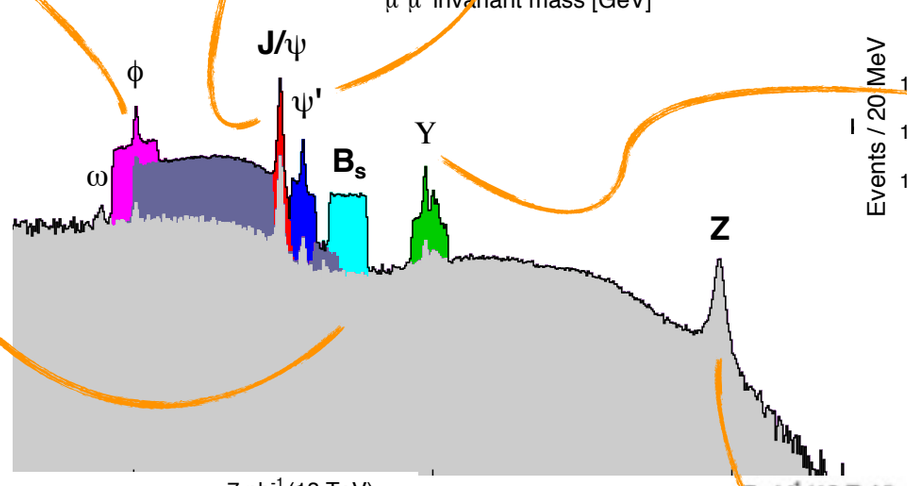


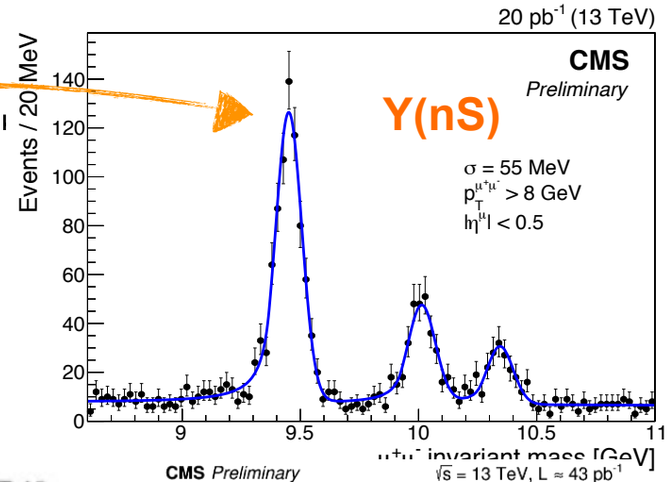


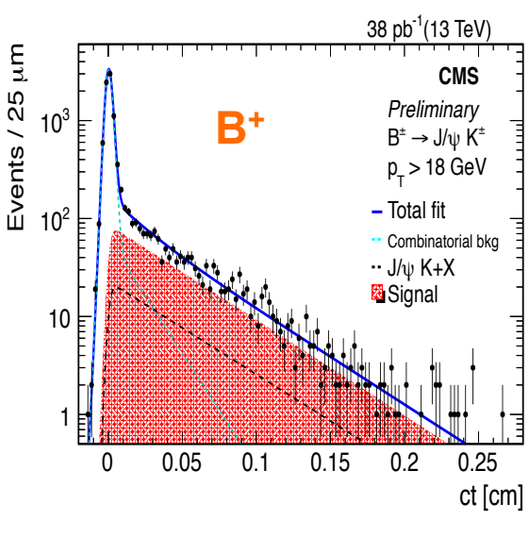


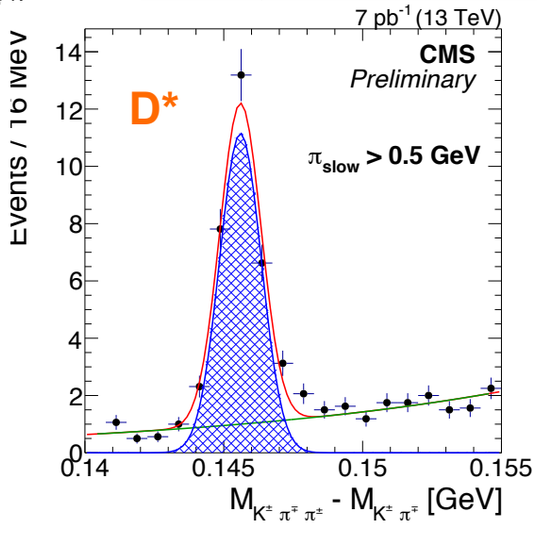
CMS-DP-2015-018

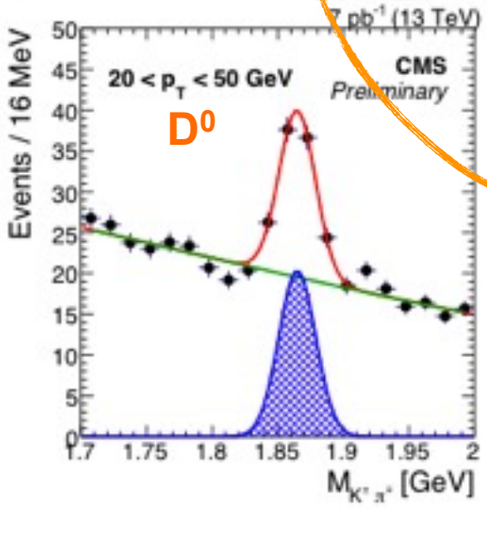


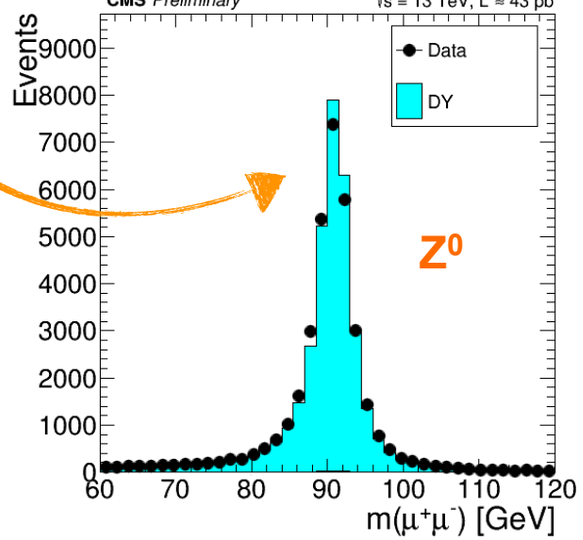






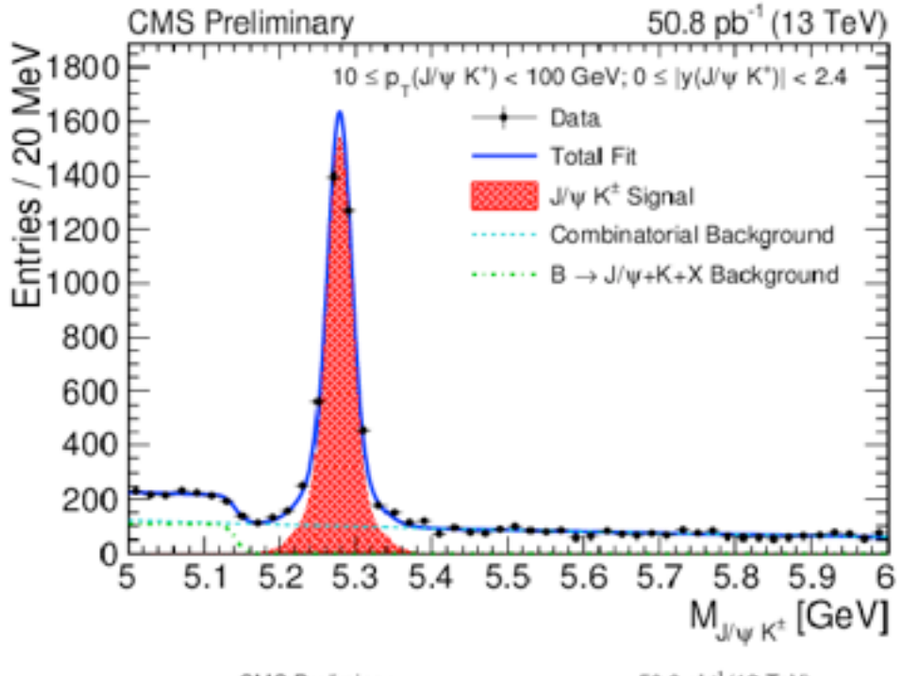


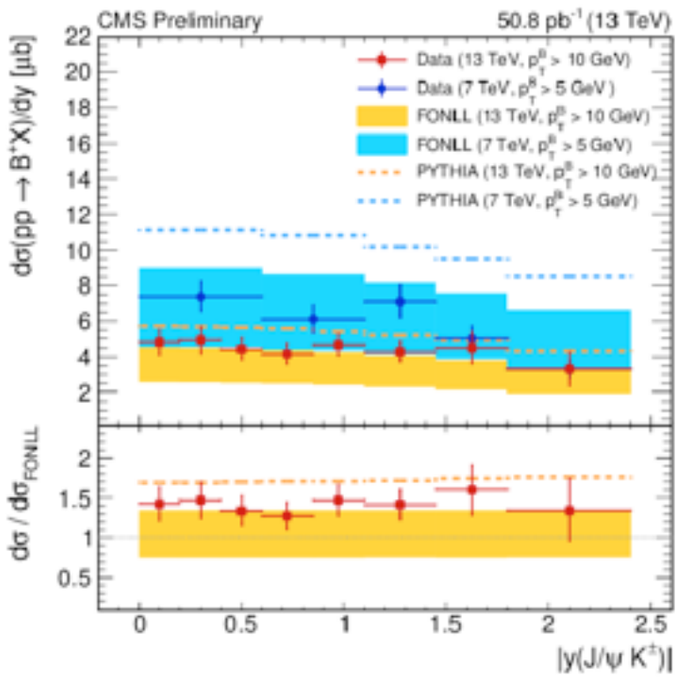


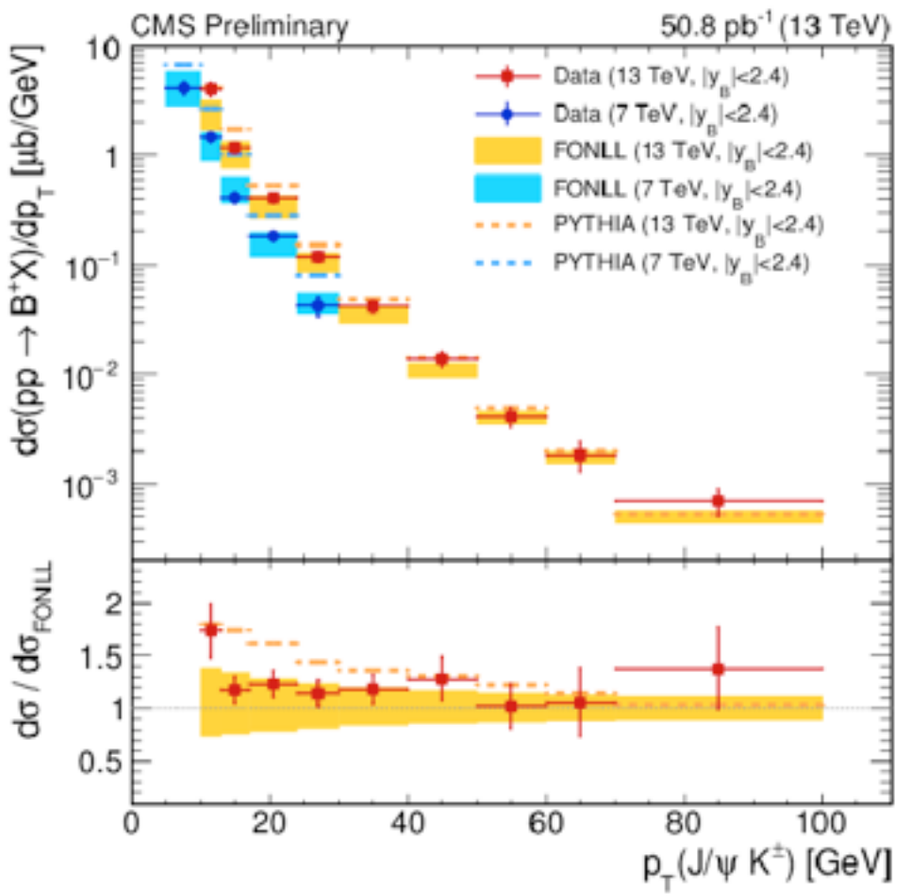


Run2 early measurements

- Preliminary results shown at CERN Jamboree last december







CMS-PAS-BPH-15-004

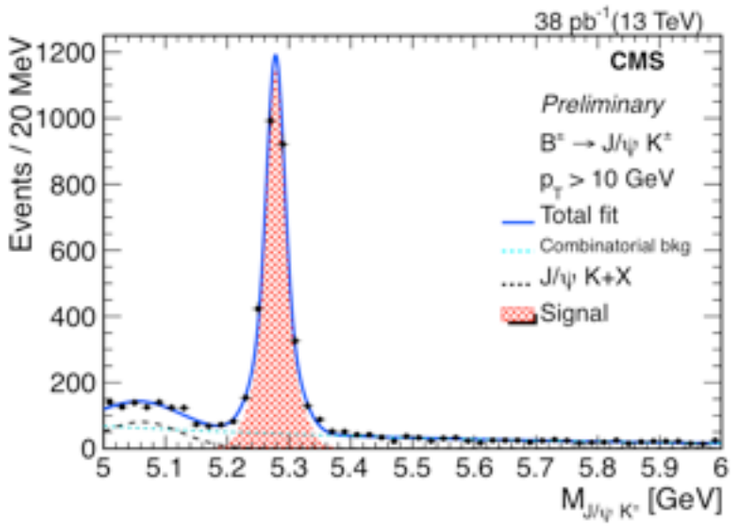
- more results to come for Moriond and spring and summer conferences

hadron production

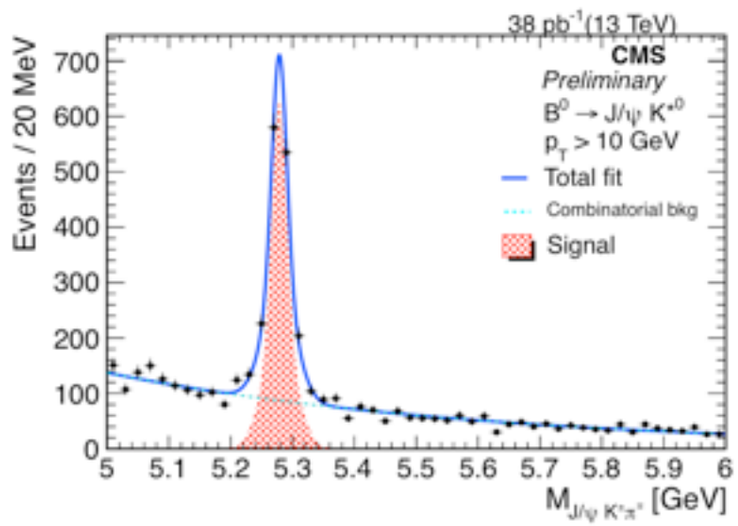
50ns Run
(~40 pb^{-1})

Bruno
Galinhas

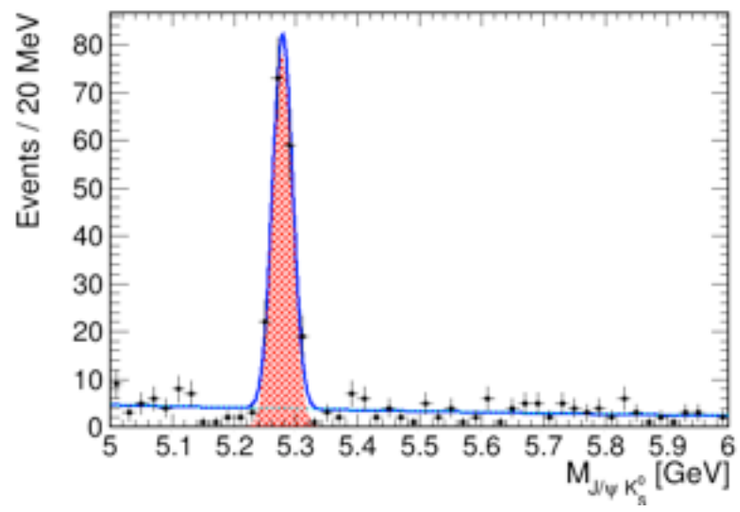
$B^+ \rightarrow J/\psi K^+$



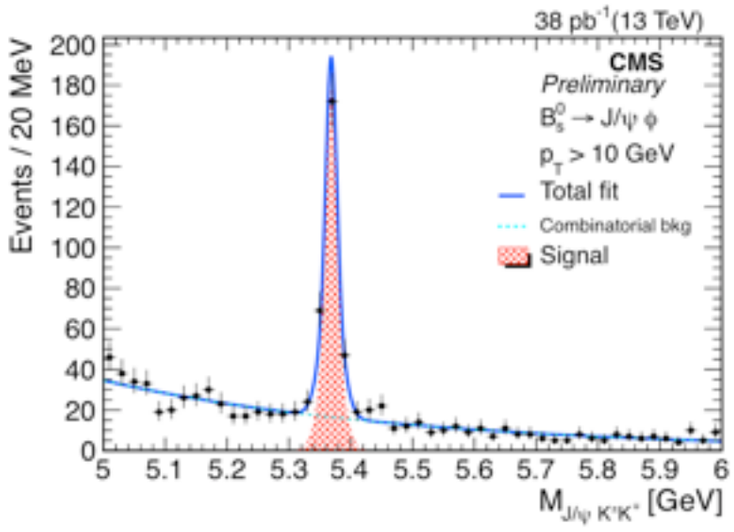
$B^0 \rightarrow J/\psi K^{*0}$



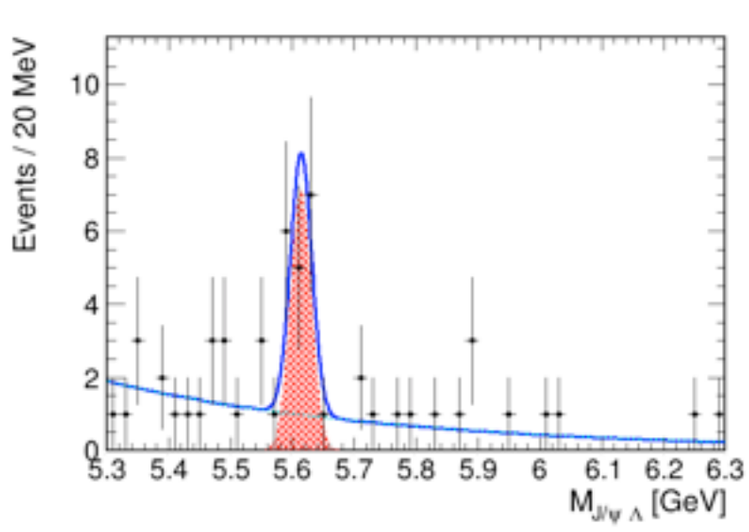
$B^0 \rightarrow J/\psi K_S$



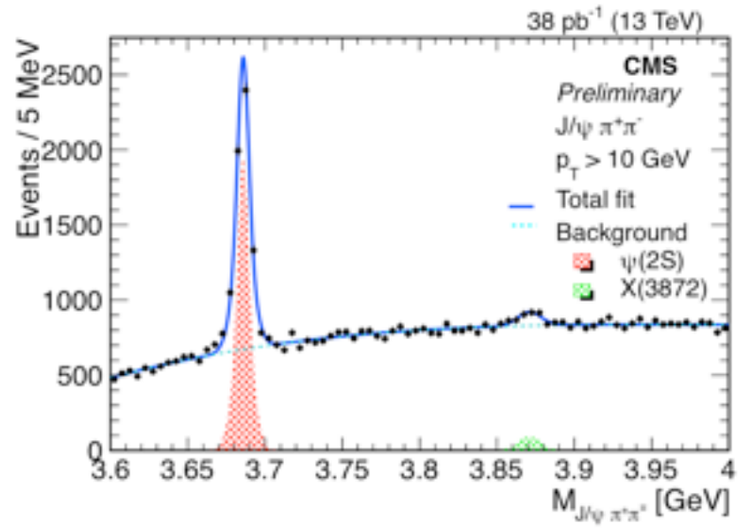
$B_s \rightarrow J/\psi Phi$



$\Lambda_b \rightarrow J/\psi\Lambda^0$



$\psi(2S), X(3872) \rightarrow J/\psi\pi\pi$

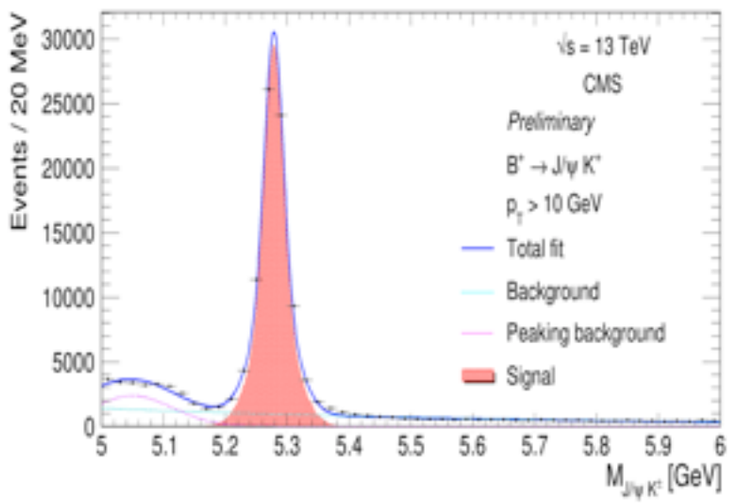


hadron production

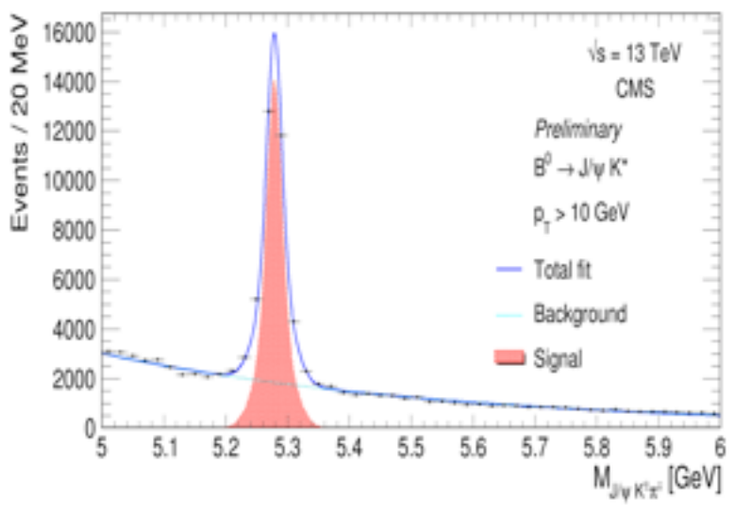
25ns Run
(<2 fb^{-1})

Bruno
Galinhas

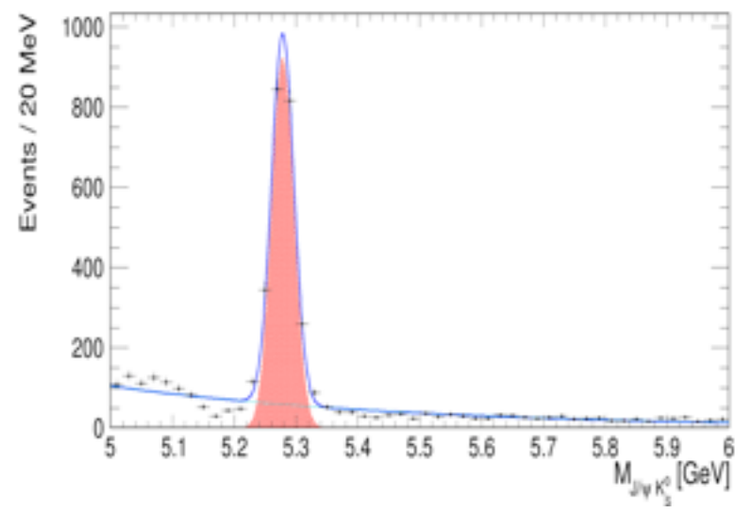
$B^+ \rightarrow J/\psi K^+$



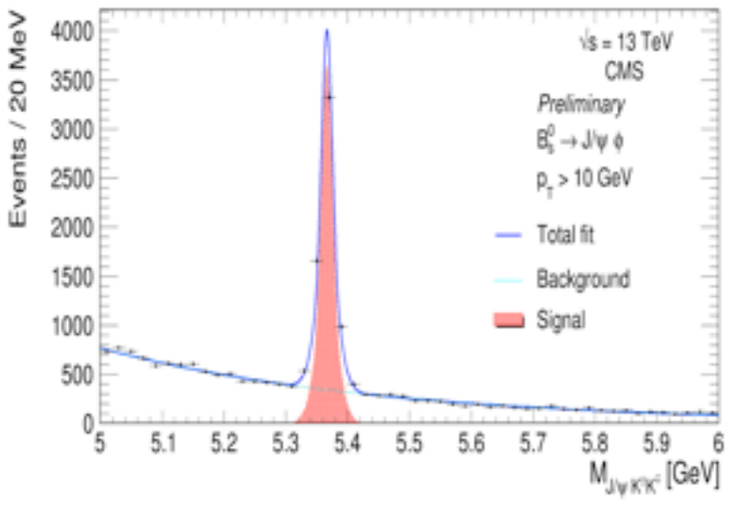
$B^0 \rightarrow J/\psi K^{*0}$



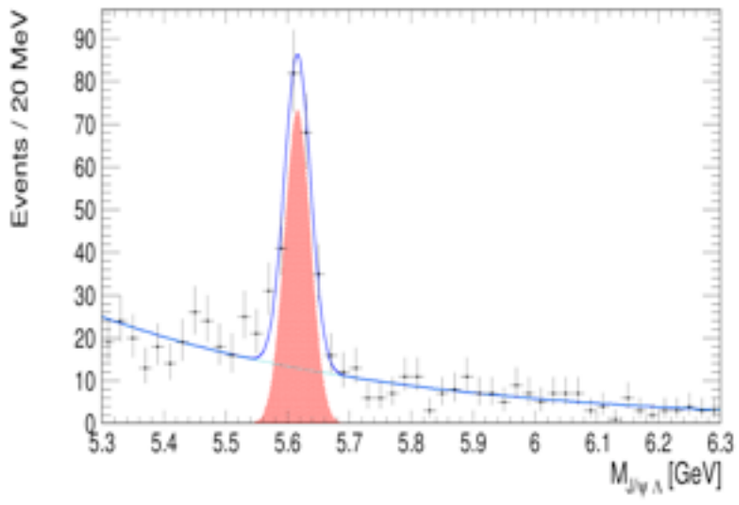
$B^0 \rightarrow J/\psi K_S$



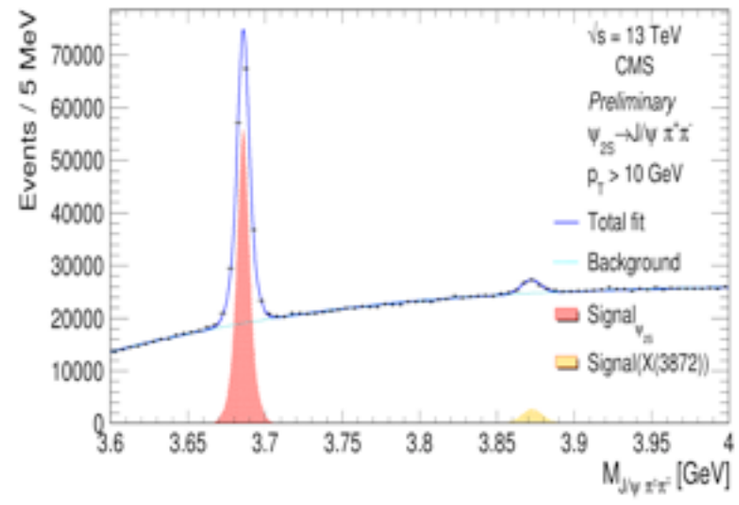
$B_s \rightarrow J/\psi Phi$



$\Lambda_b \rightarrow J/\psi\Lambda^0$



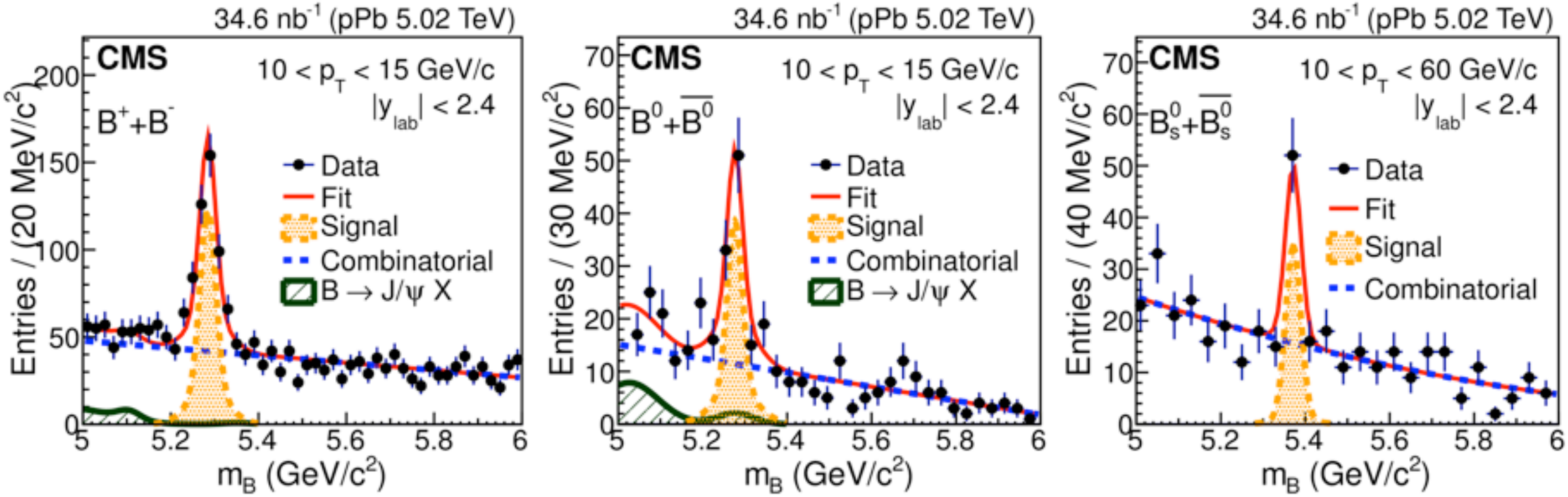
$\psi(2S), X(3872) \rightarrow J/\psi\pi\pi$



hadron production

in heavy ion collisions?

$B^+ \rightarrow J/\psi K^+$ **$B^0 \rightarrow J/\psi K^{*0}$** **$B_s \rightarrow J/\psi Phi$**

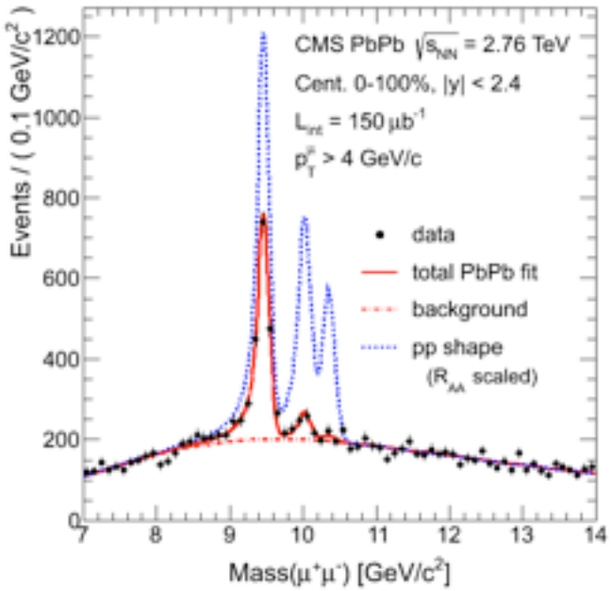


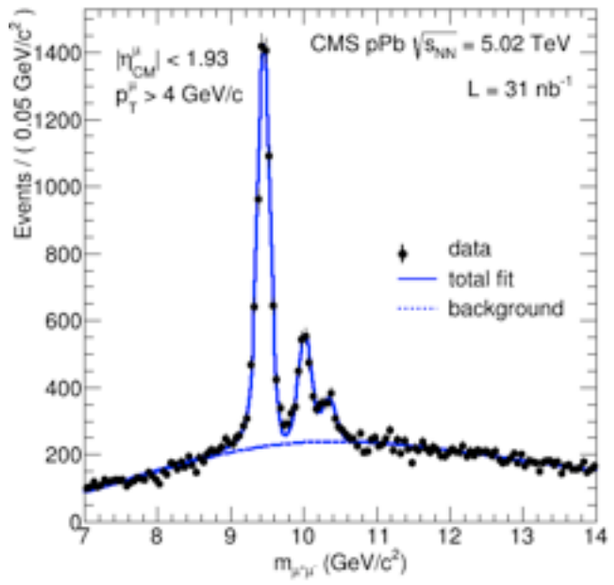
PRL 116 (2016) 032301

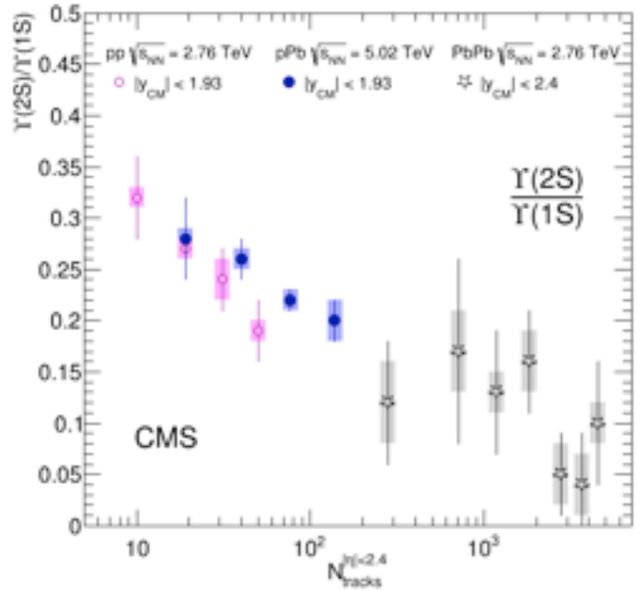
- first measurements of exclusive b-hadrons in pPb collisions
  - in past, heavy-ion experiments have tried to access HF via inclusive decays b→lX
- plan to reconstruct the various b-hadron states in pp (at 13 but also 5TeV) and in collisions involving heavy ions (pPb but also PbPb)
- study energy and flavor dependence of suppression

quarkonia in heavy ions

- in RunI we extended cross section measurements from pp to PbPb







JHEP 1205 (2012) 063
citations: 250+

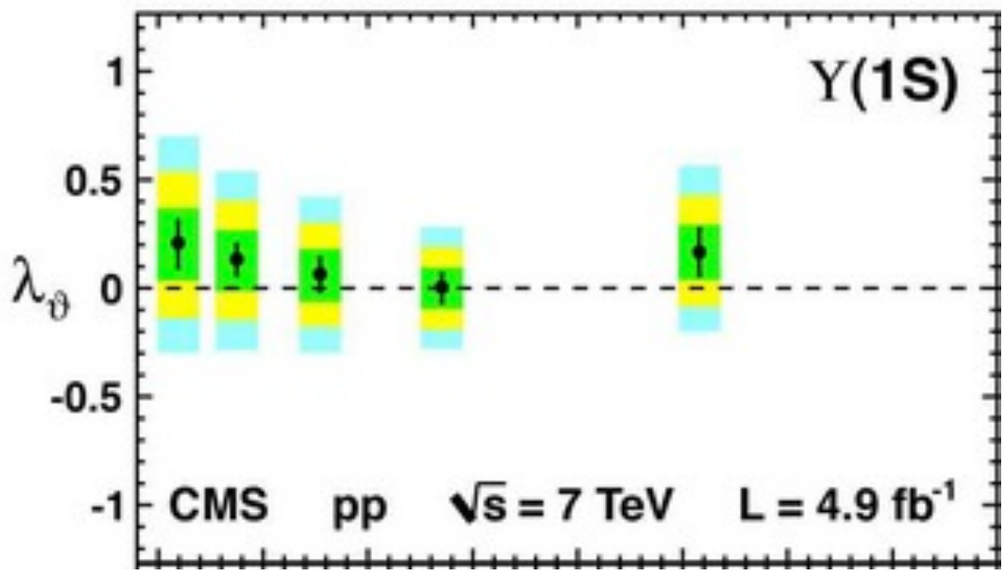
PRL 109 (2012) 222301
citations: 150+

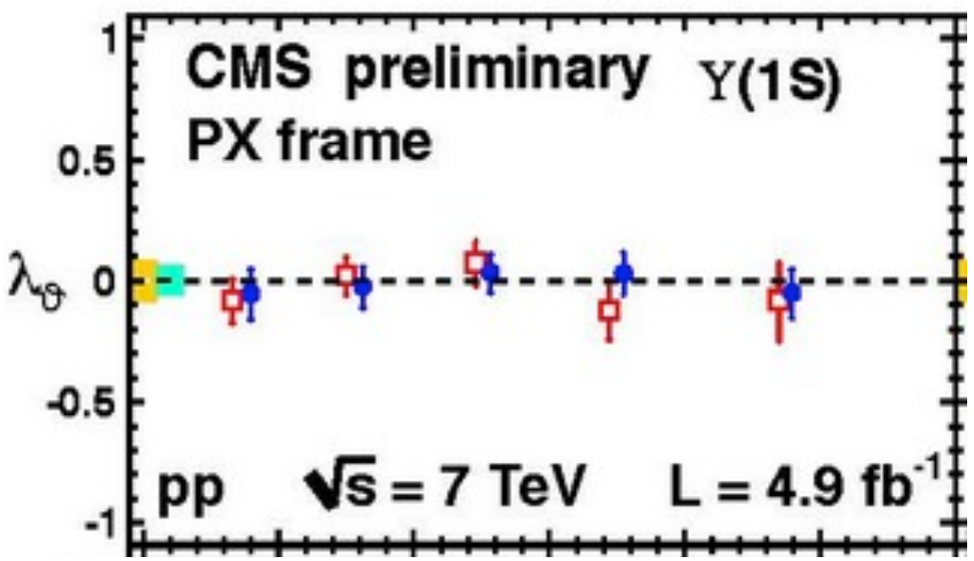
PRL 109 (2012) 222301
citations: 150+

PRD 83 (2011) 112004
citations: 100+

NL
P.Faccioli
J.Seixas

- we're now extending polarization measurements, too



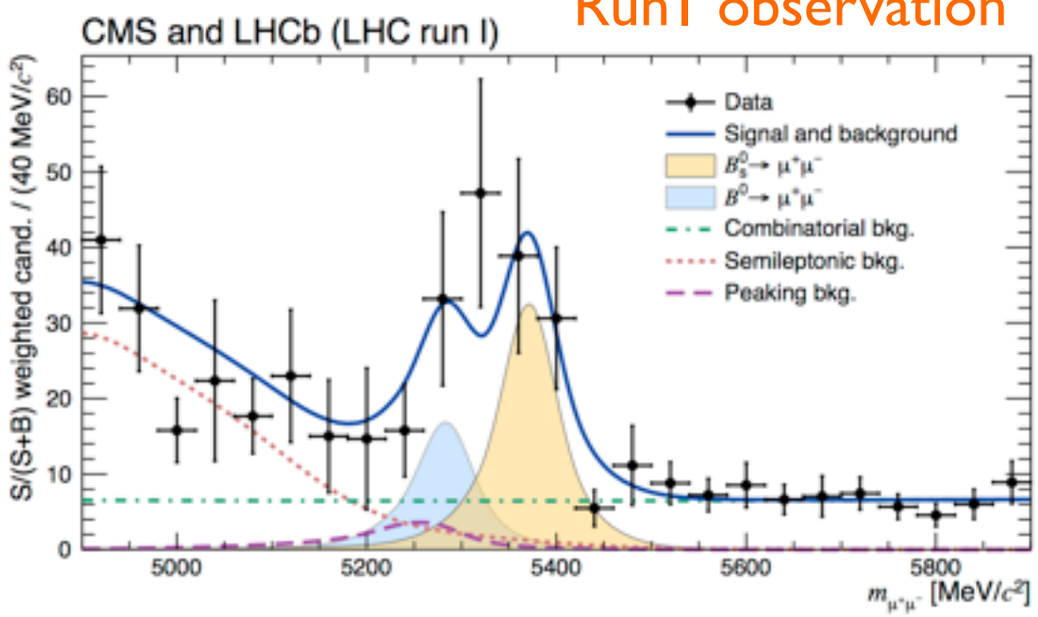


CMS-HIN-15-003

Rare decays B→μμ

- In Run1, we've observed the long sought rare decay $B_s \to \mu\mu$
  - strong constraints in regions (low tanβ) of SUSY/NP phase space
- and a hint of the decay $B^0 \to \mu\mu$
  - from combined CMS+LHCb data
  - but analyses optimized for B_s not B^0
- in Run2
  - pursue search for B^0 channel
  - measure effective lifetime of B_s
- current work
  - explore normalization channels with 2015 data ($B \to J/\psi[\mu\mu]X$)
  - explore f_d/f_s (main syst.) and B lifetimes

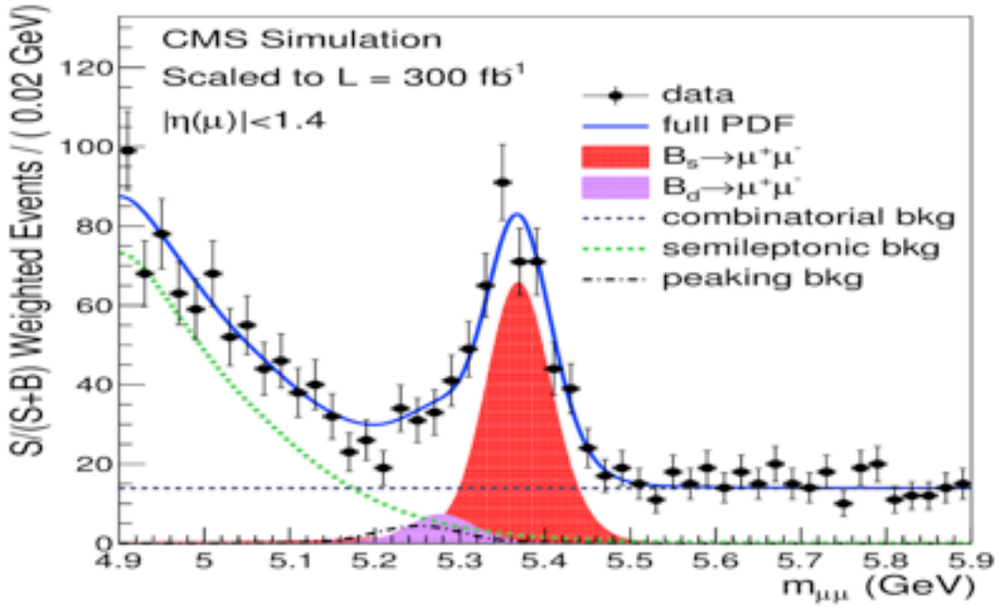
Run1 observation



PRL 111 (2013) 101804 citations: 250+

Nature 522 (2015) 68 citations: 100+

Run2 prospects

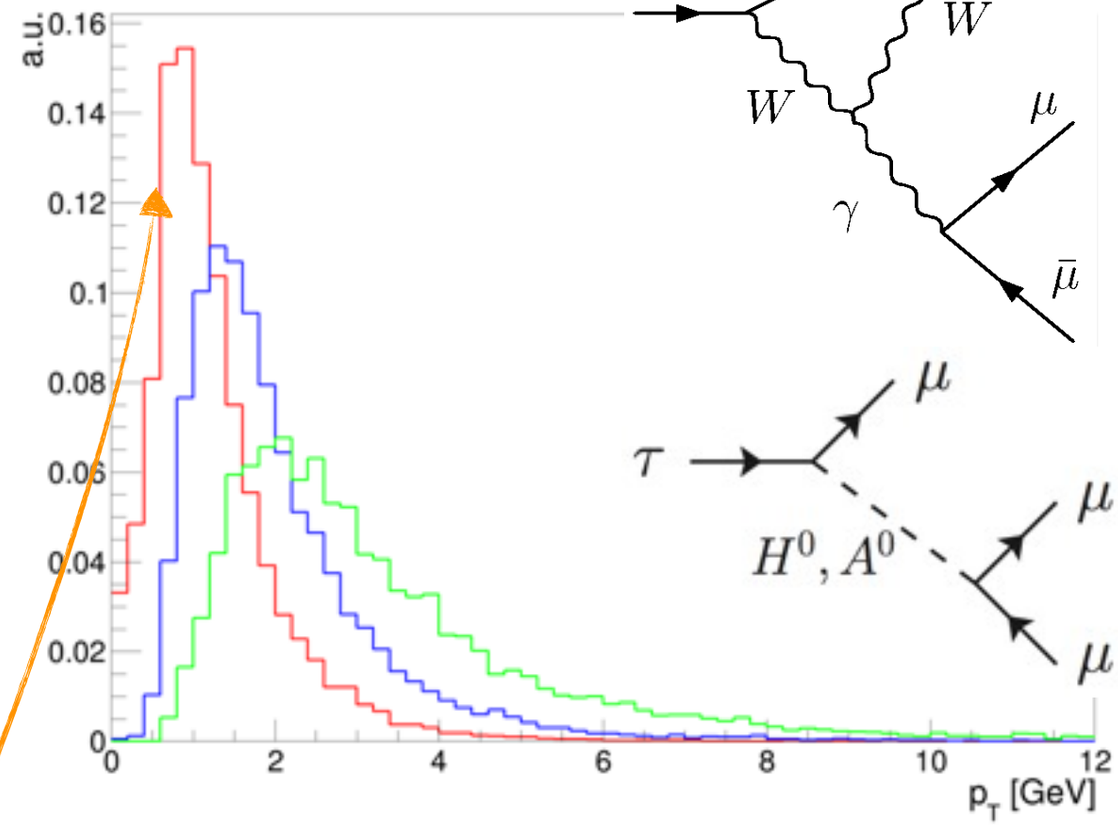


Lepton Flavor Violation

Daniele Vadruccio

- charged LFV not forbidden by any fundamental symmetry
  - allowed by neutrino oscillations
  - tiny branching fractions in SM
  - various New Physics scenarios allow for observable rates
- two channels
  - $D_s \rightarrow \tau \rightarrow \mu\mu\mu$
  - $W \rightarrow \tau \rightarrow \mu\mu\mu$
- designing dedicated trigger
  - challenge: soft trailing 3rd muon
- physics channel being also explored in benchmark studies for HL-LHC

$\tau \rightarrow \mu\mu\mu$



- current BF (90% c.l.) limits
  - 2.1×10^{-8} BELLE (best limit, 2010)
  - 3.3×10^{-8} BaBar
  - 4.6×10^{-8} LHCb
  - 3.8×10^{-7} ATLAS

Summary

- leading involvement of the LIP group in B physics at CMS
  - coordinating the overall experiment-wide B PAG activity
- exploring early Run2 data
  - first production measurements at new energy
- heavy flavor measurements in ion collisions
  - extend pp analyses to collisions involving heavy ions
- preparing rare decay searches for probing new physics
  - $B \rightarrow \mu\mu, \tau \rightarrow \mu\mu\mu$
- coming events organized by LIP
  - CMS B physics Run2 workshop, April 11th (TBC)
  - 7th INFIERI Workshop, April 12-15th, 2016