“Fisica elettrodebole nella regione in avanti a LHCb”

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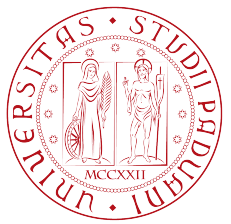
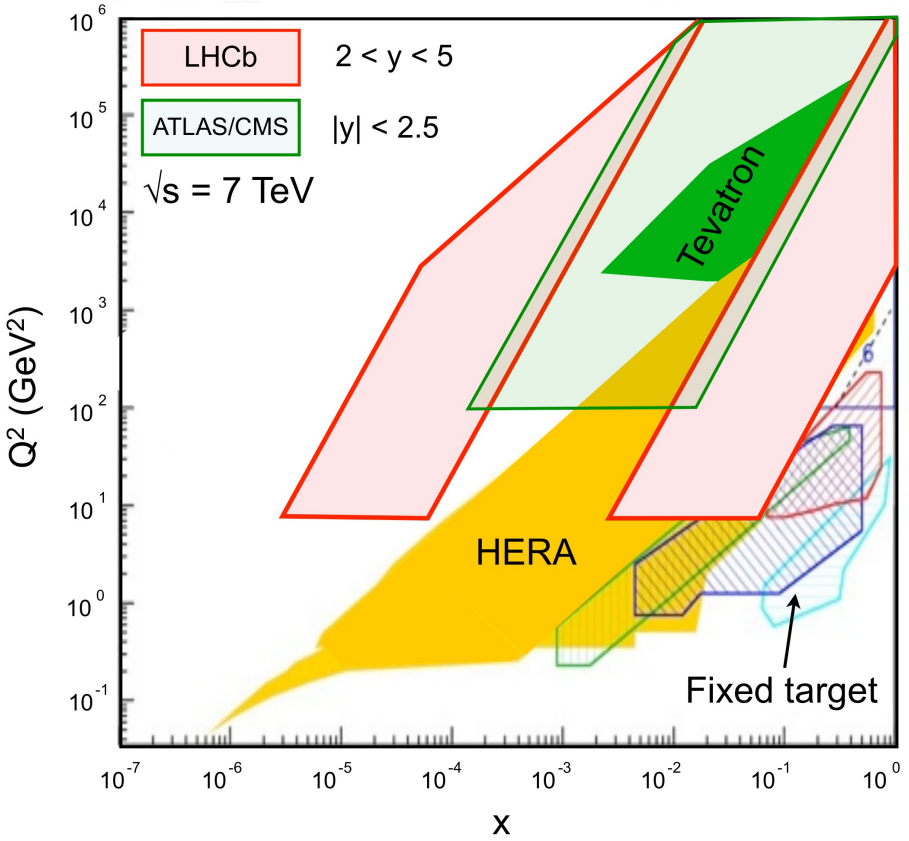
on behalf of the LHCb collaboration



101º Congresso SIF, Università La Sapienza di Roma, 24-9-2015

Motivation

- **LHCb** offers a **complementary phase space region** for electroweak and jets measurements respect to ATLAS and CMS:
  - **Unique acceptance**: $2 < \eta < 5$
  - **Cleanest LHC events**: <Pile-Up> ~ 2
  - **Very large bandwith trigger** for events with b jets and displaced vertices, efficient even at very low p_T.



- Measurement in the forward region **provide unique access to PDFs (x,Q^2). Precision measurements of $\sigma_{W(Z)}$ in this region are important tests** of perturbative QCD and EWK theory.

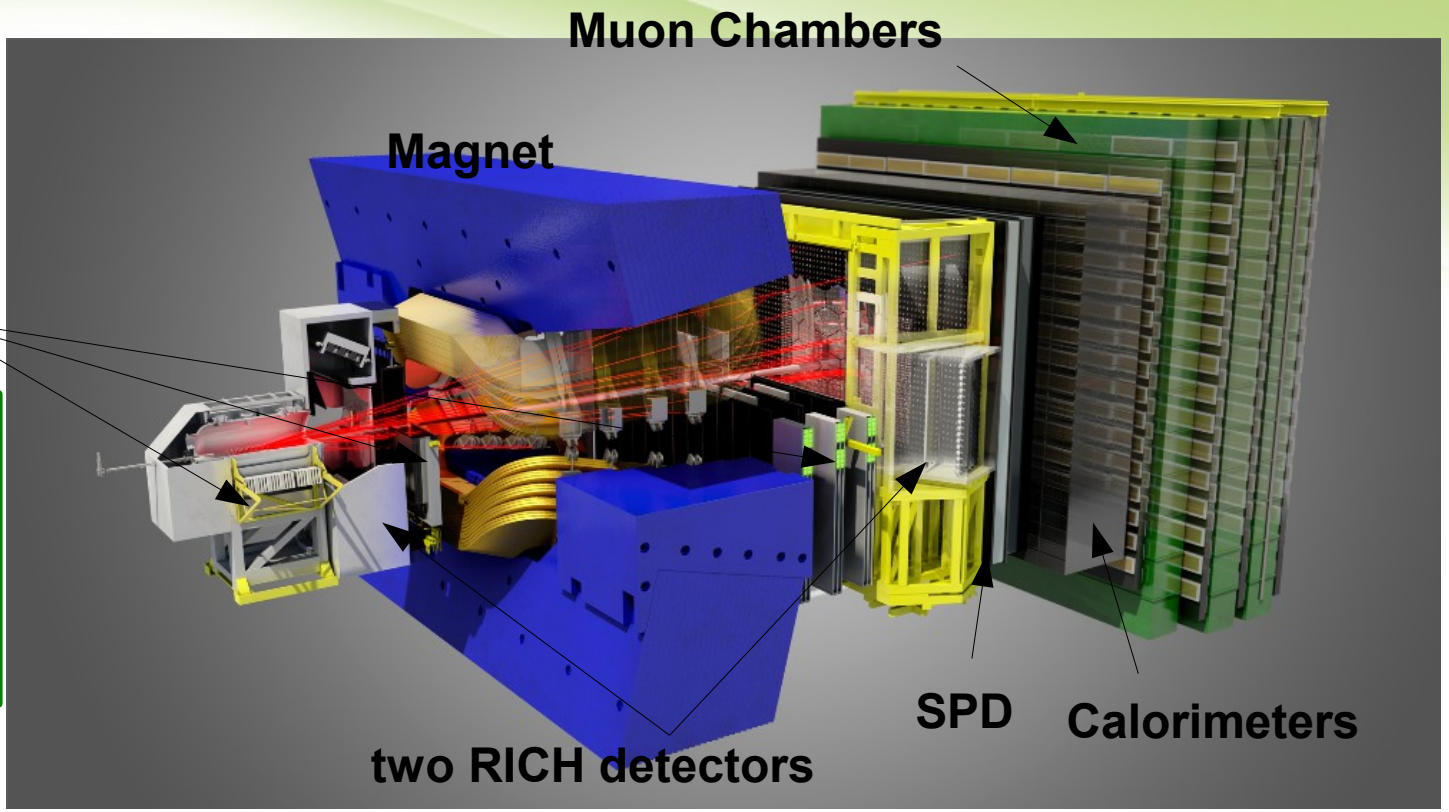
$$x_{1,2} = \frac{M}{\sqrt{s}} e^{\pm y}$$

LHCb detector

Vertex Locator and tracking system: precise vertex (primaries and secondaries) and tracking reconstruction (direction, momenta, invariant masses)

IP resolution: 20 μm

Δ p / p = 0.4 % at 5 GeV/c
to 0.6 % at 100 GeV/c



Particle ID performances

kaon ID efficiency:
~ 95 % for ~ 5 % π→K mis-id probability
muon ID efficiency:
~ 97 % for 1-3 % π→μ mis-id probability

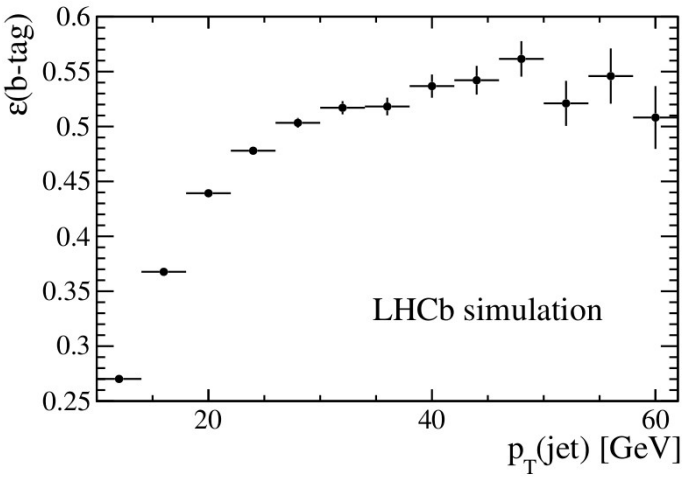
Calorimeters performances

ECAL resolution:
1 % + 10 % / √(E[GeV])
HCAL resolution:
9 % + 69 % / √(E[GeV])

Not the best for jets physics...

Forward W + b/c production at 7 and 8 TeV

- **Measurement**: **W (→ μν) + b/c jet production cross section, Phys. Rev. D 92, 052001 (2015)**
- **Motivations**: Test perturbative QCD predictions. Probe the capability of LHCb to jets physics.
- **Data**: 1 fb^{-1} and 2 fb^{-1} respectively from pp collisions at 7 and 8 TeV
- **Selection**:
  - High PT muon (PT > 20 GeV) and at least one jet (PT > 20 GeV).
  - ΔR(μ,jet) > 0.5.
  - Veto on Z → dimuon events.
- **Benchmark measurement**:
  - Sensitive to **proton PDF**.
  - Constraints **SM Higgs and BSM background**.
- **Jet reconstruction and tagging**:
  - **Particle flow**: charged track and calo clusters.
  - **Anti – K_t** clustering algorithm, R = 0.5.
  - **b-tagging**: observables related to secondary vertices, reconstructed using tracks in the jet. **Excellent performances in LHCb thanks to precise SV reconstruction.**

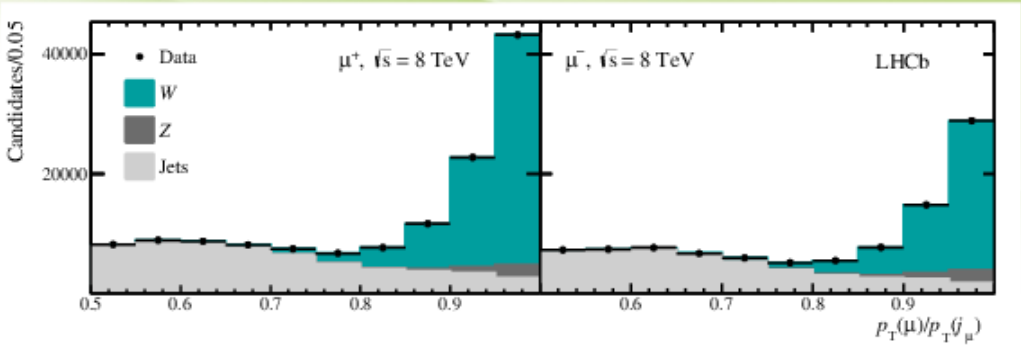


b-tag efficiency obtained from simulation

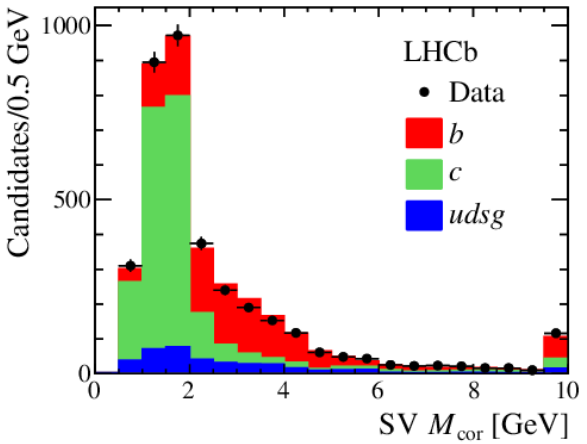
Forward W + b/c production at 7 and 8 TeV

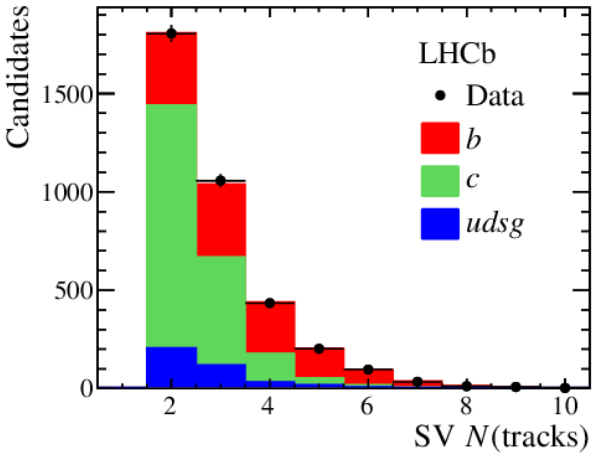
- **W (and Z) yield extraction**:

  $p_T(\mu)/p_T(\mu\ \text{jet})$ distribution fit



- **Simultaneous fit to the jet SV tag mass and track multiplicity to obtain the b and c yields:**





- **Measured W+b/c cross sections (normalized to W+jet) are in good agreement with SM**

	Results		SM prediction	
	7 TeV	8 TeV	7 TeV	8 TeV
$\frac{\sigma(Wb)}{\sigma(Wj)} \times 10^2$	$0.66 \pm 0.13 \pm 0.13$	$0.78 \pm 0.08 \pm 0.16$	$0.74^{+0.17}_{-0.13}$	$0.77^{+0.18}_{-0.13}$
$\frac{\sigma(Wc)}{\sigma(Wj)} \times 10^2$	$5.80 \pm 0.44 \pm 0.75$	$5.62 \pm 0.28 \pm 0.73$	$5.02^{+0.80}_{-0.69}$	$5.31^{+0.87}_{-0.52}$

First observation of top in the forward region

- **Measurement**: **first observation of top in the forward region, in the W+b final state, Phys. Rev. Lett. 115, 112001 (2015)**

- **Motivations**:

  - The enhancement at forward rapidities of $t\bar{t}$ production via gg and qg scattering, respect to gg fusion, may result in a **large charge asymmetry,** sensitive to physics beyond the SM.

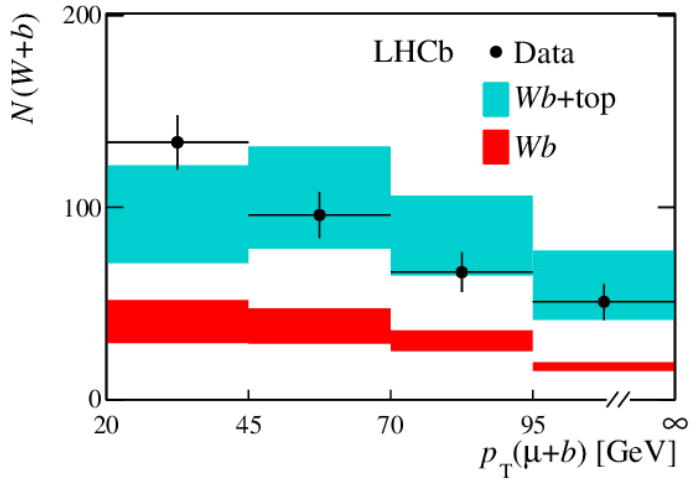
  - Forward $t\bar{t}$ events can be used to constraint PDFs at large momentum fraction.

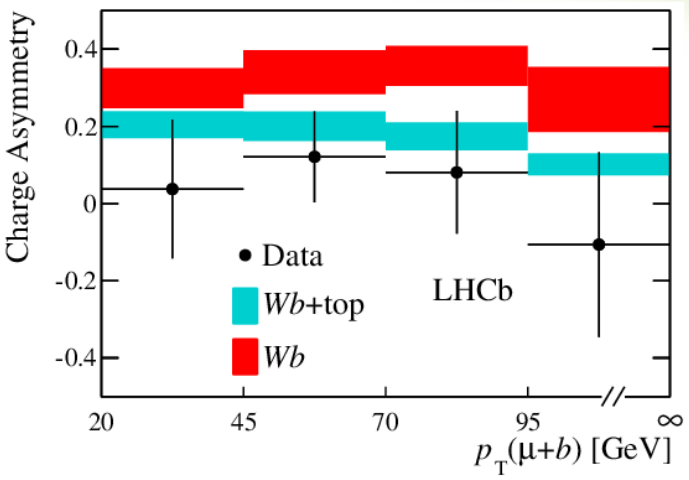
- **Data**: 1 fb^{-1} and 2 fb^{-1} respectively from pp collisions at 7 and 8 TeV

- **Selection**: Same selection of the W + b/c sample!

First observation of top in the forward region

- **Strategy**: Study the W+b fitted yield and W charge asymmetry in function of PT(muon +b) → fit the top cross section





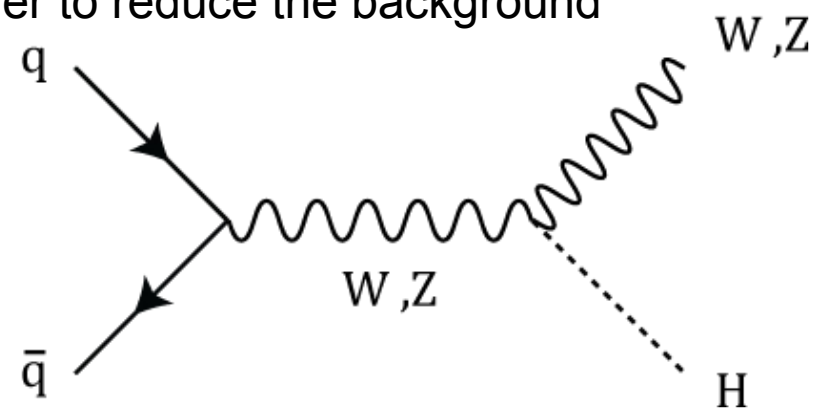
- **Results:**

$$\sigma(\text{top})[7\,\text{TeV}] = 239 \pm 53\,(\text{stat}) \pm 38\,(\text{syst})\,\text{fb}$$
$$\sigma(\text{top})[8\,\text{TeV}] = 289 \pm 43\,(\text{stat}) \pm 46\,(\text{syst})\,\text{fb}$$

- **Good agreement with SM prediction:** $180^{+51}_{-41}(312^{+83}_{-68})\,\text{fb at } 7(8)\,\text{TeV}$

Moving on: search for b $\bar{b}$ resonances

- **Jet-capability** at LHCb demostrated: **Z + b** (JHEP 01 (2015) 064), **W+b/c**, **forward-central b$\bar{b}$ asymmetry** (LHCb-CONF-2012-014), **b$\bar{b}$ cross section** (LHCb-CONF-2013-002).
- **H → b$\bar{b}$** decay not yet "discovered" at ATLAS and CMS (significance < 3 σ)
- We can search for the **H → b$\bar{b}$ production in the forward region**:
  - **Higgs production associated to a vector boson** in order to reduce the background



- **Backgrounds studies ongoing**:
  - $W^{\pm}$ b $\bar{b}$
  - Z b $\bar{b}$
  - t$\bar{t}$
  - QCD combinatorial

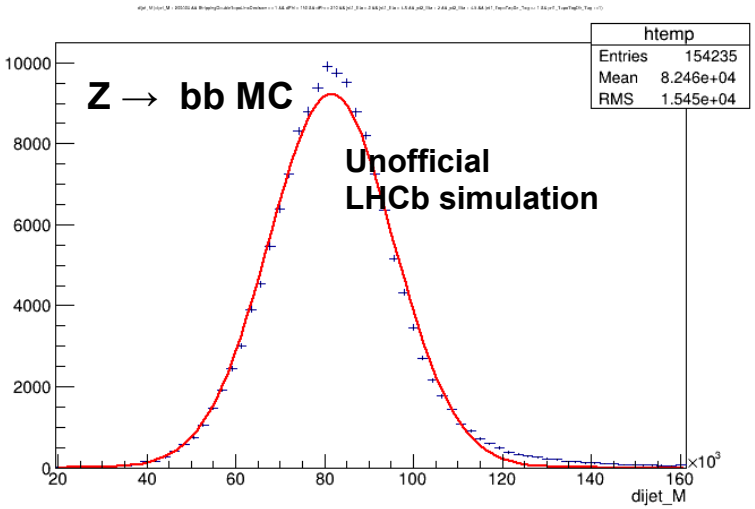
Search for b $\bar{b}$ resonances

- The possibility to search for the inclusive H → b $\bar{b}$ is currently under studying. LHCb not so much penalized in acceptance respect to General Purpose Detectors.

- In general, b$\bar{b}$ resonances are considered preferred channels in the search for New Physics

- The first step is identify and reconstruct the **Z → b $\bar{b}$** decay. In this way we can validate the jet energy scale and improve if necessary.

- **Peak resolution** estimated on LHCb simulation (≃ 11 GeV with R=0.5 and both jets b-tagged).



Dijet mass (GeV)

Conclusions

- LHCb is continuing with success its **electroweak program**.
- LHCb is able to **complement with ATLAS and CMS** for EW and QCD measurements.
- We are successfully branching into **jets physics**.
- The excellent performances of the **b-jet tagging** have been demonstrated.
- In the next months several preliminary measurements needed for **$b\bar{b}$ resonances searches** are expected.