

# Top quark mass measurements with J/ $\psi$ and D mesons in the ATLAS experiment

F. Derue, LPNHE Paris

Top LHC France 2021 , 6-7th April 2021, Virtual world  
<https://indico.in2p3.fr/event/23801>

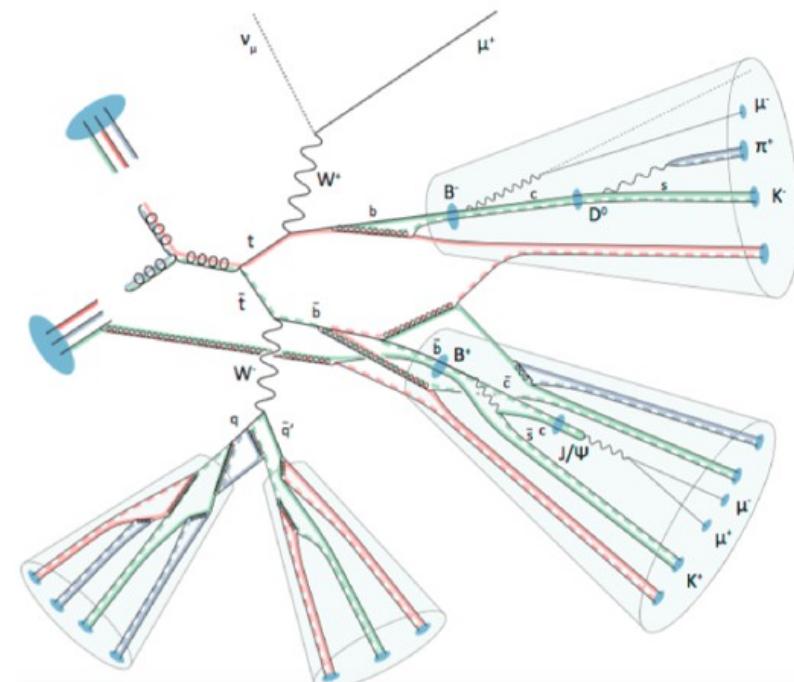
Studies of  $t\bar{t}$  pairs with in final state a B-hadron decaying either in  $J/\psi$  ( $b \rightarrow J/\psi \rightarrow \mu\mu$ ) or in  $(\mu)D^0 \rightarrow (\mu)K\pi$  or in  $D^*(2010)^+ \rightarrow D^0\pi$  mesons offer alternative methods to measure  $m(\text{top})$  using the sensitivity of  $m(IJ/\psi)$ ,  $m(I\mu D^0)$ ,  $m(ID^*(2010)^+)$  to  $m(\text{top})$

## ● Motivations

- purely leptonic/tracking observables less sensitive to JES than the ones from jet reco
- still sensitive to parton shower, hadronization, b-fragmentation effects...
- help to reduce the uncertainties in combination of all measurements

## ● Documentation

- main analysis on going
- HL-LHC prospects
- PhD of Jad Zahreddine, sept 2020



## ● Low BR final states

- $BR(b \rightarrow J/\psi \rightarrow \mu\mu) \sim 6.8 \times 10^{-4}$
- $BR(b \rightarrow (\mu)D^0 \rightarrow (\mu)K\pi) \sim 5.9 \times 10^{-3}$
- $BR(b \rightarrow D^*(2010)^+ \rightarrow D^0\pi) \sim 2.2 \times 10^{-2}$

# $t\bar{t}$ event reconstruction

## Trigger

- standard isolated leptons

## Jets

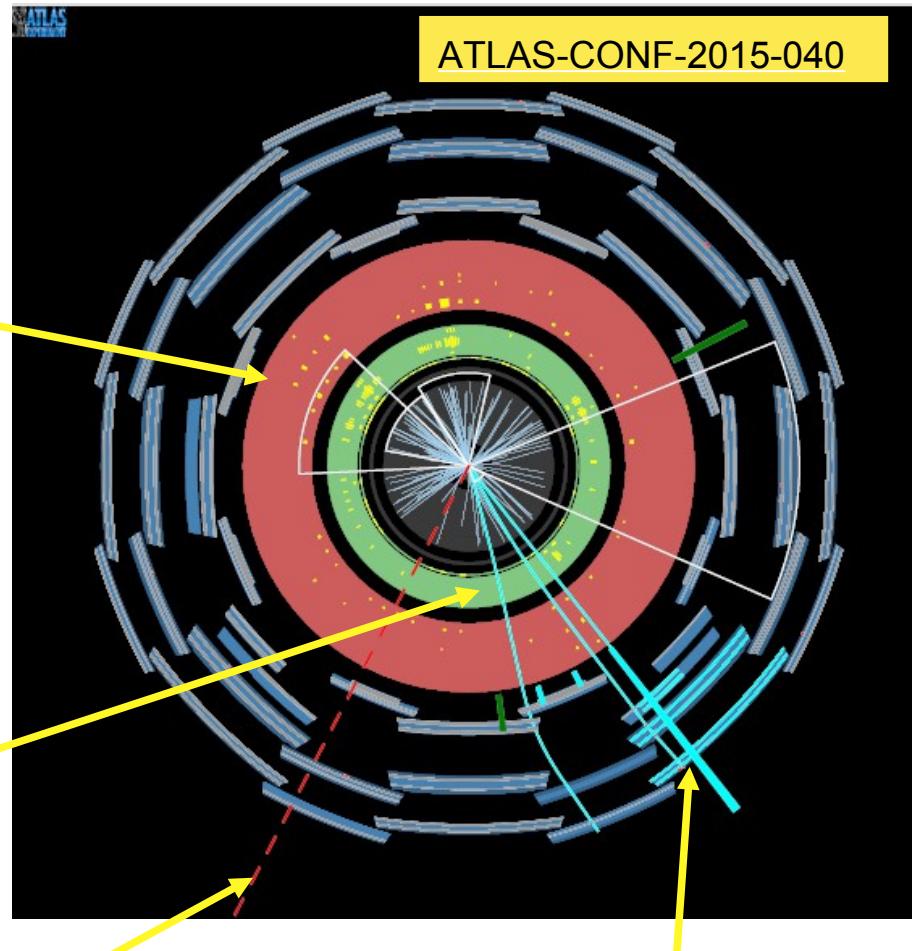
- anti-kt R=0.4
- $\geq 4$  jets with  $p_T > 25 \text{ GeV}$ ,  $|\eta| < 2.5$
- EMTopo/EMPlow jets
- b-jet selection can be used also

## Isolated lepton

- pid: LHTight for electrons, Medium for muons
- e- $\mu$ -isolation required
- exactly one lepton with  $p_T > 25 \text{ GeV}$  for 2015  
with  $p_T > 27 \text{ GeV}$  for 2016-2018

$E_T^{\text{miss}}$

- no cut (by default)
- MET>20 GeV, MTW>40 GeV



## Tracks in jets

- Loose
- $p_T > 1 \text{ GeV}$ ,  $|\eta| < 2.5$

## soft- $\mu$

- pid : LowPt
- $p_T > 3.5 \text{ GeV}$  in barrel  
 $2.5 \text{ GeV}$  in end-caps
- $\Delta R(\mu, \text{jet}) < 0.4$
- $|\Delta z_0| < 10$

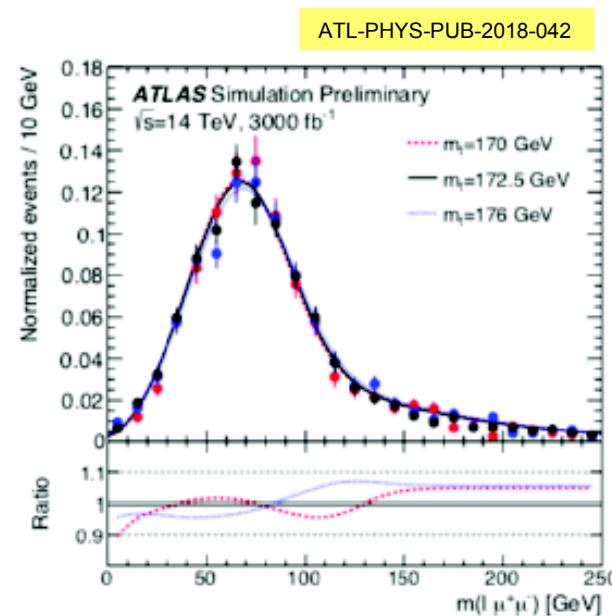
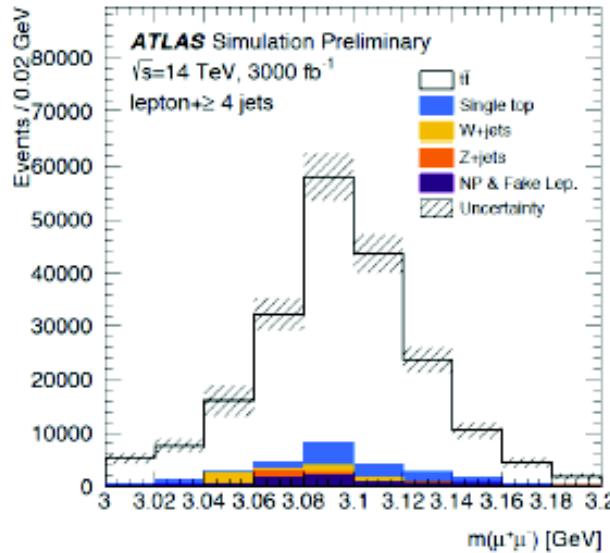
# Prospects for the HL-LHC

## • Motivations

- "Standard Model Physics at the HL-LHC and HE-LHC", CERN Yellow Report, [arXiv:1902.04070v2 \[hep-ph\]](https://arxiv.org/abs/1902.04070v2)
- projections for the top quark mass measurement accuracy using  $t\bar{t} \rightarrow \text{lepton+jets}$  events with  $J/\psi \rightarrow \mu^+\mu^-$  in the final state at  $\sqrt{s}=14$  TeV at the High-Luminosity LHC with 3000  $\text{fb}^{-1}$  of proton-proton collisions

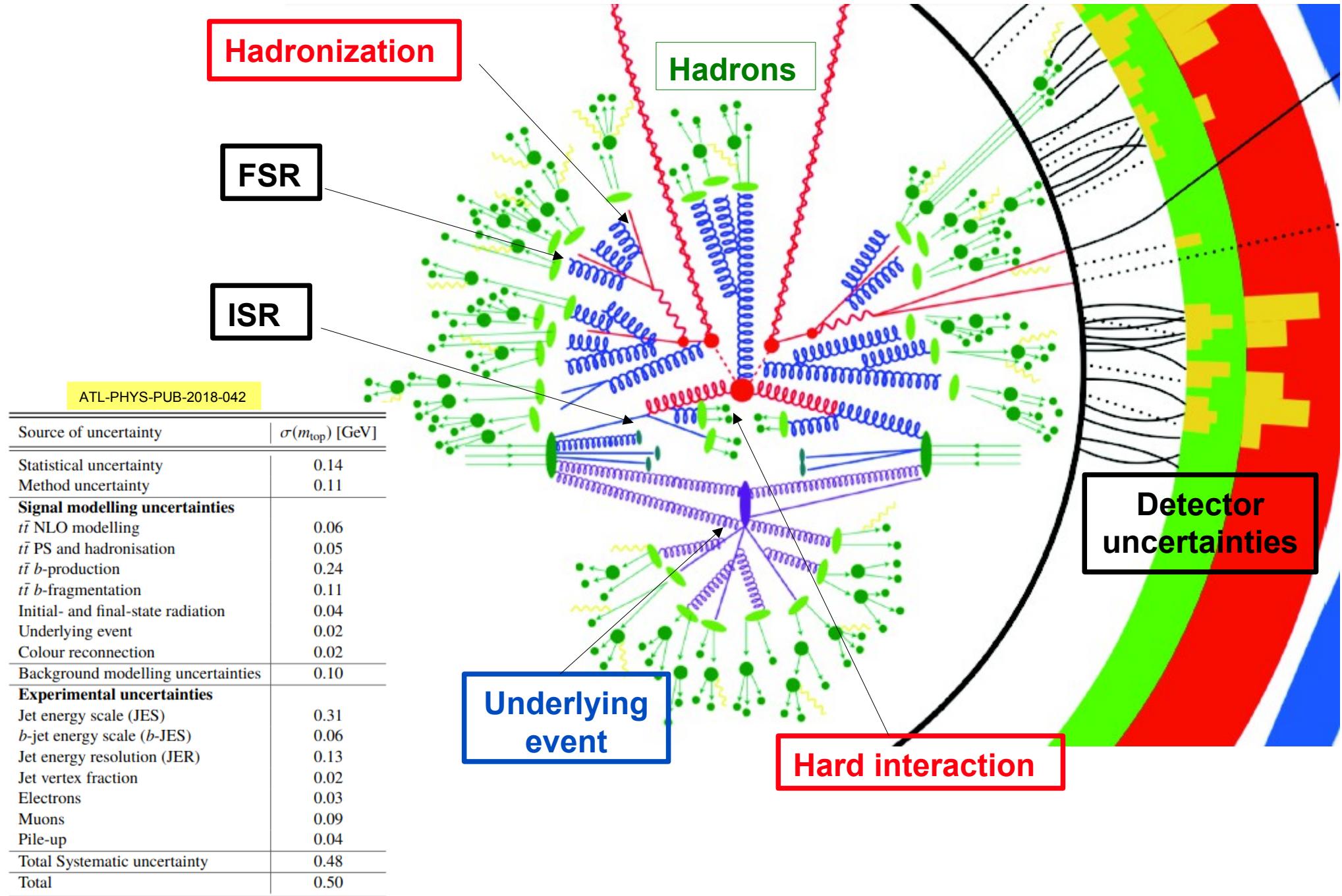
## • Results

- expected number of events  $\sim 2*10^5$
- 18% increase due to higher cross section, 10% increase due to larger coverage  $|n|<4$



$$\sigma(m_{top}) = 0.14 \text{ (stat.)} \pm 0.48 \text{ (syst.) GeV} = 0.5 \text{ GeV}$$

# Systematic uncertainties



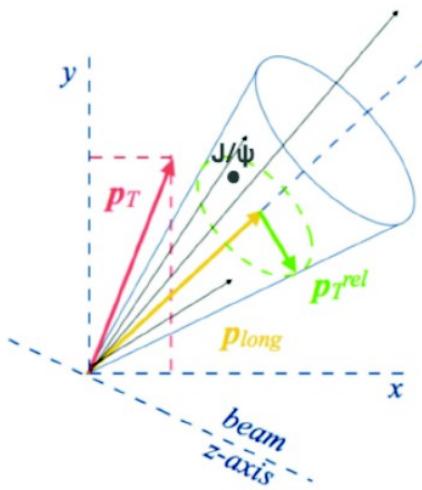
# b-fragmentation studies

## • Motivations

- use  $t\bar{t}$  events with  $b \rightarrow J/\psi$
- check our knowledge of hadronization of b-quarks in hadron collider
- today's partonic shower generators tuned to LEP results based on  $ee \rightarrow Z \rightarrow bb$

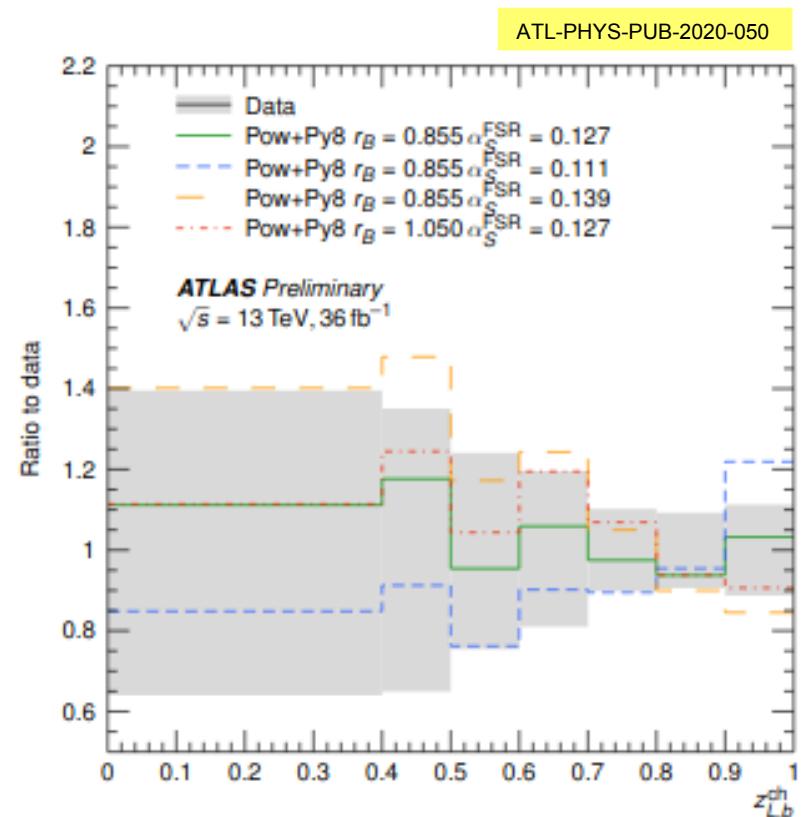
## • Analysis

- use of LHC events :  $t\bar{t}$  dilepton events (published)
- several observables can be defined



Scheme of  $b \rightarrow J/\psi$  system to define the different observables

$$z_{T,b}^{\text{ch}} = \frac{p_{T,b}^{\text{ch}}}{p_{T,\text{jet}}^{\text{ch}}} \quad z_{L,b}^{\text{ch}} = \frac{\vec{p}_b^{\text{ch}} \cdot \vec{p}_{\text{jet}}^{\text{ch}}}{|p_{\text{jet}}^{\text{ch}}|^2}$$



Comparison of particle-level observables between Powheg+Pythia8 A14 variations and unfolded data