Etude du taux d'électrons dans des événements multi-jet simulés pour le détecteur ATLAS auprès du LHC

Dans le cadre du sujet de thèse: ***" Mesure de la section efficace de production de paires top-antitop auprès de l'expérience ATLAS au LHC "***

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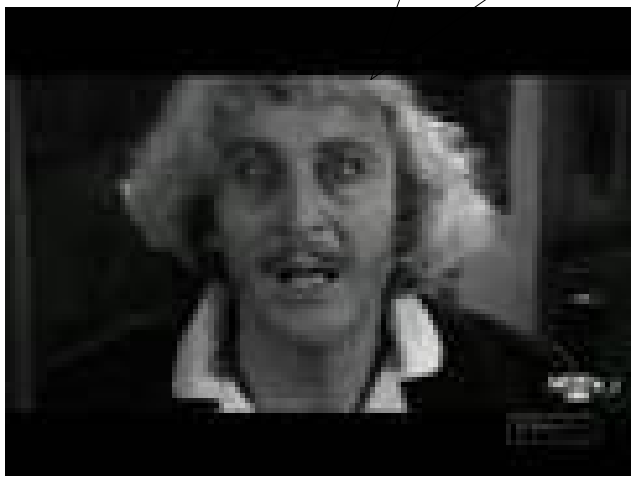
Preamble

The LHC is back !



	CME	*Luminosity*
Design	**14 TeV**	**10^{34} cm^{-2} s^{-1}**
first collisions	**900 GeV**	
b.C.	**2.2 TeV**	
a.C.	**7 TeV**	

Only 3 days after the LHC start-up !!

A cross section measurement

The measurement of the top-antitop cross section will be in the same time a standard candle and a direct test of the detector knowledge (ATLAS)

$$\sigma_{ttbar} = \frac{N_{ttbar}^{Reco} - N_{bkg}}{\epsilon L}$$

where:

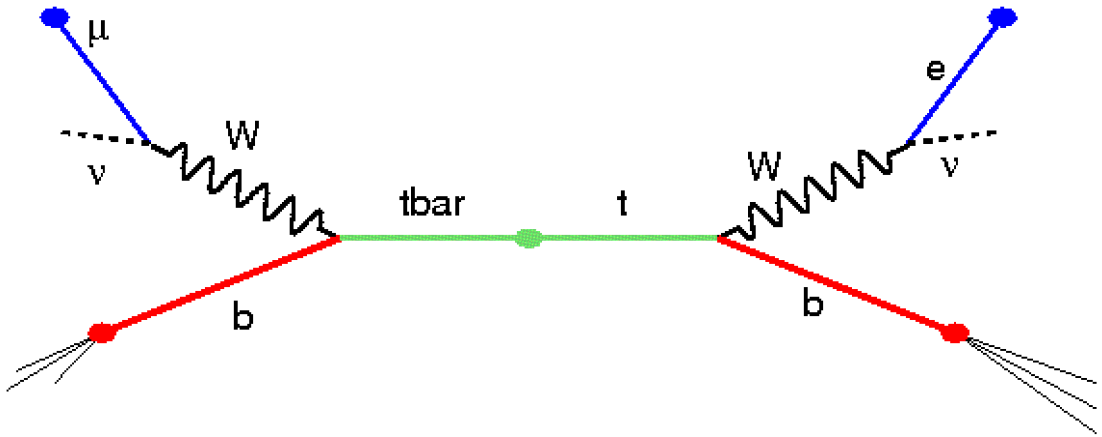
- ϵ : efficiency (geometry, reconstruction, identification, trigger)
- L : integral luminosity

- Requirements: a good event selection for the signal and a deep knowledge of the background events

→ Study of the major source of background for top–antitop (ttbar) events at LHC.

Signal and background

Signal: ttbar in **di-leptonic** channel



Signal signature:

- 2 isolated leptons
- 2 b-quark
- E_TMiss

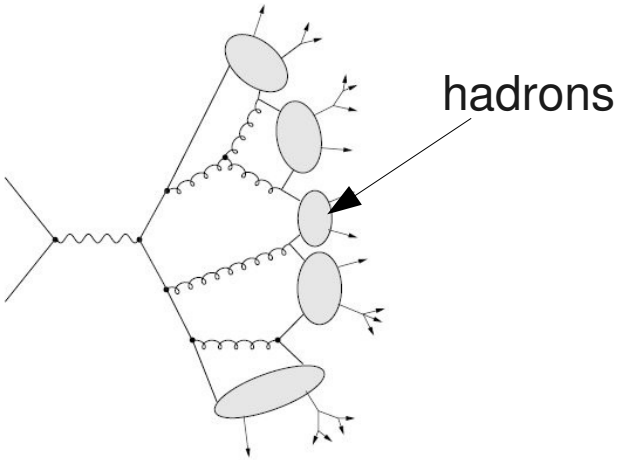
This channel is characterized by a very good significance (very clean signal): the 2 isolated leptons and the large amount of E_TMiss allow to trigger the event

The main source of background will be the **QCD background**

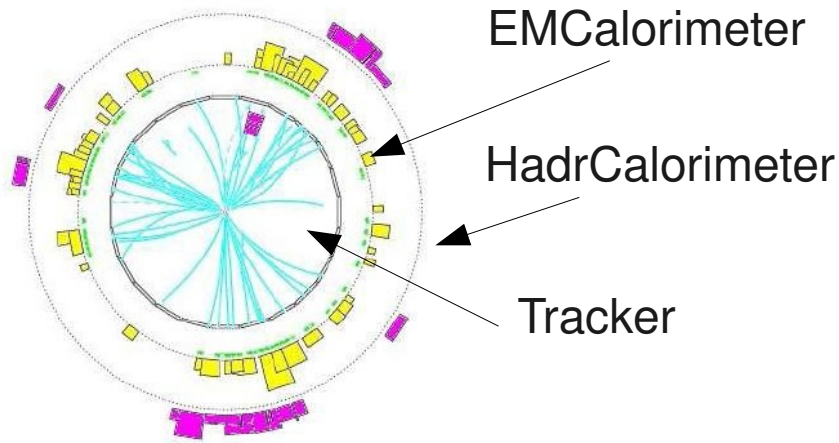
The QCD background

Due to the hadronization process, quarks become complicated objects: **jets**.

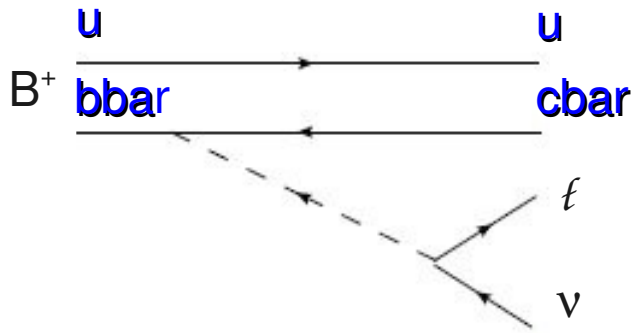
Hadronization process



Detector response



- Sometimes a quark can decay leptonically.
  The out-coming lepton can be reconstructed by the detector as an isolated lepton



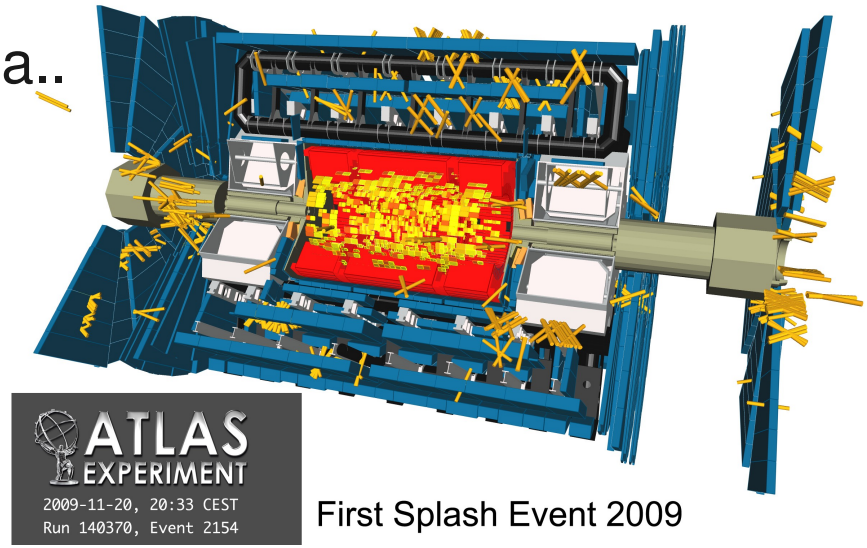
- Sometimes a jet can be reconstructed as an electron

A good estimate of extra lepton rate will give an estimate of QCD background

Which kind of data?

Atlas has just been started to recorder data..
but analysis have to be prepared...

Monte Carlo simulation



First Splash Event 2009

How does it work?

Simulation

Event generation → Simulation of the detector response → Offline reconstruction

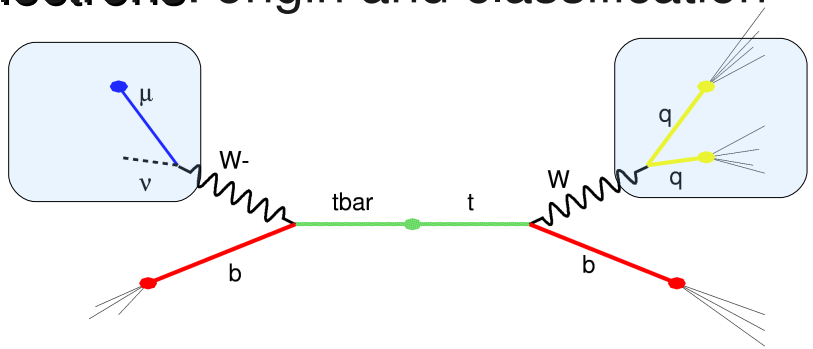
truth

Reconstructed events

The direct access to the generated events allow to investigate the origin and the properties of the reconstructed particles

Extra leptons' rate prediction method step by step

1. Full study of multi-jet events with a topology similar to signal **(semi-leptonic ttbar)**
   → study of **extra electrons**: origin and classification



2. Method to predict the rate of extra electrons for other multi-jet samples

3. Validation of the prediction method on a sample with a similar topology
   (full hadronic ttbar)

4. Test of the prediction method on a sample with a different topology
   (di-jet sample)

Classification of extra electrons in the simulation

- **signal electrons:**
  true electrons originated from W decays → Signal

- **true electrons:**
  true electrons originated from different sources than W
  i.e. b-decays, photon conversions,..

- **fake electrons:**
  off-line reconstructed object and identified as electrons that have not been associated to any true electron

→ Extra electrons

- The first step is to distinguish true (irreducible) by fake electrons.

- The origin of extra electrons is given by an association with the closest jet:
  if this closest reconstructed jet matches a b-parton the jet is labeled as “b-jet”, otherwise, as “light-jet” (u,d,s,c).

First results

Extra electrons' details in semi-leptonic events:

extra electrons		
origin	**true**	**fake**
from b jet	223	8
from light jet	42	115
overall	265	123

rate :

extra electrons		
extra/jet	**$* 10^{-5}$**	73 ± 4
fake/ jet	**$* 10^{-5}$**	23 ± 2

Remark:

Only the study of electrons coming from a light jet is presented here because in QCD events only a small number of b-jet is expected.

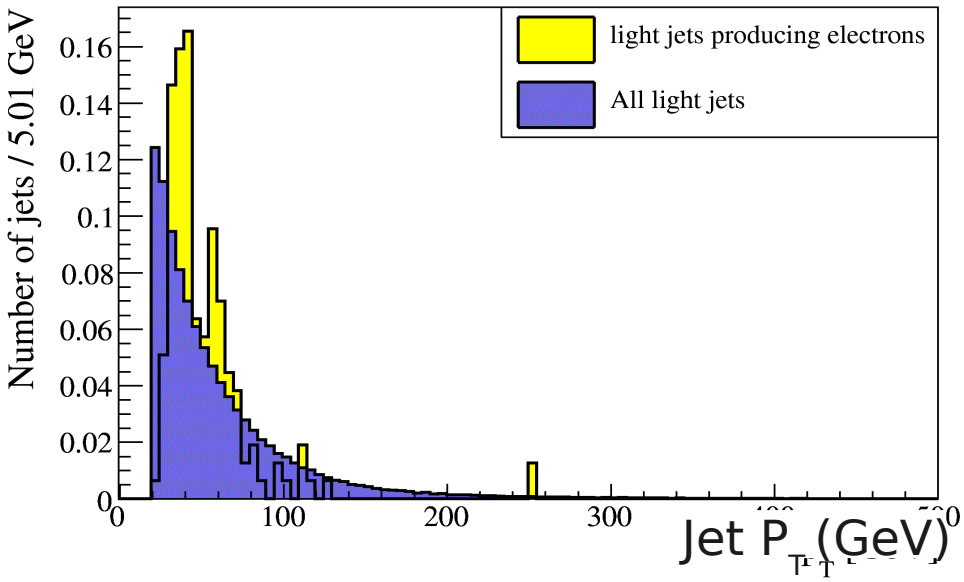
Prediction method

The semi-leptonic sample results allow to predict :

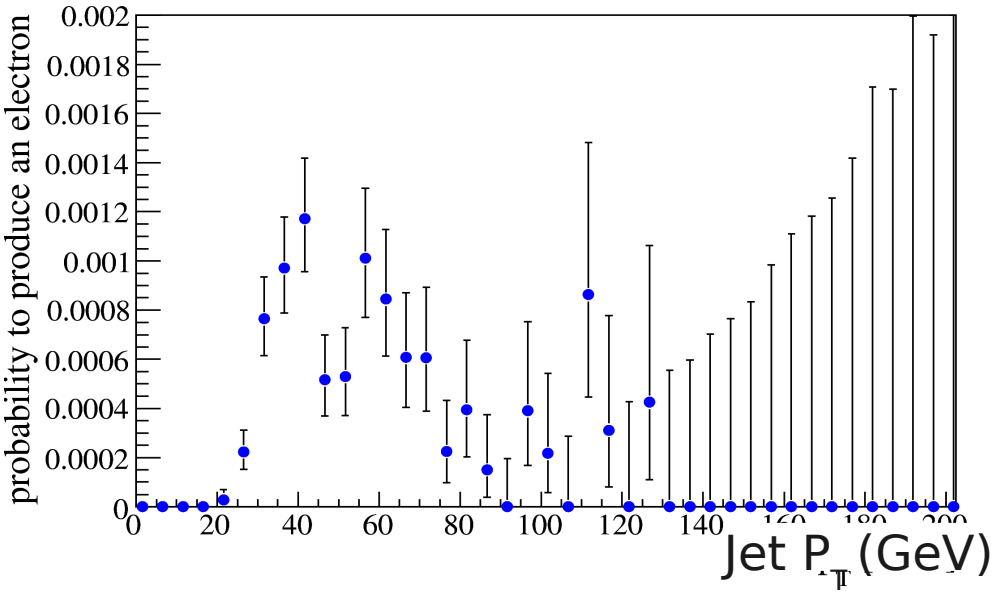
- the P_T spectrum of the jets giving an extra electron

(- the P_T spectrum of the extra electron)

light jet Pt spectrum



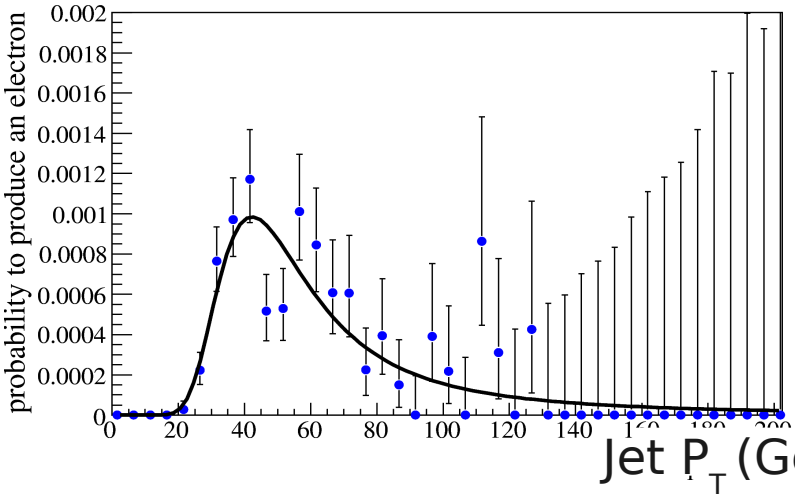
Probability for a jet of a given P_T to create an extra electron



Validation in full hadronic ttbar channel (1/2)

How to predict the spectrum of the jets giving an extra electron:

Probability for a jet of a given P_T to create an extra electron (ttbar semi-leptonic channel)



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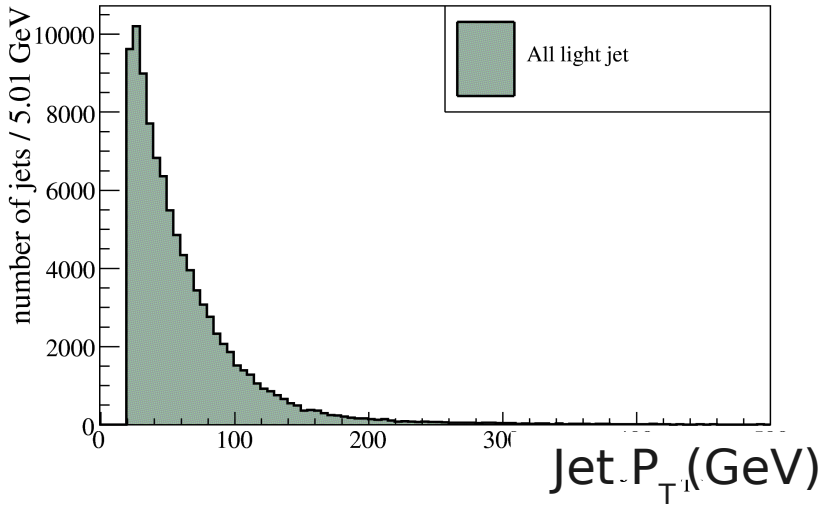
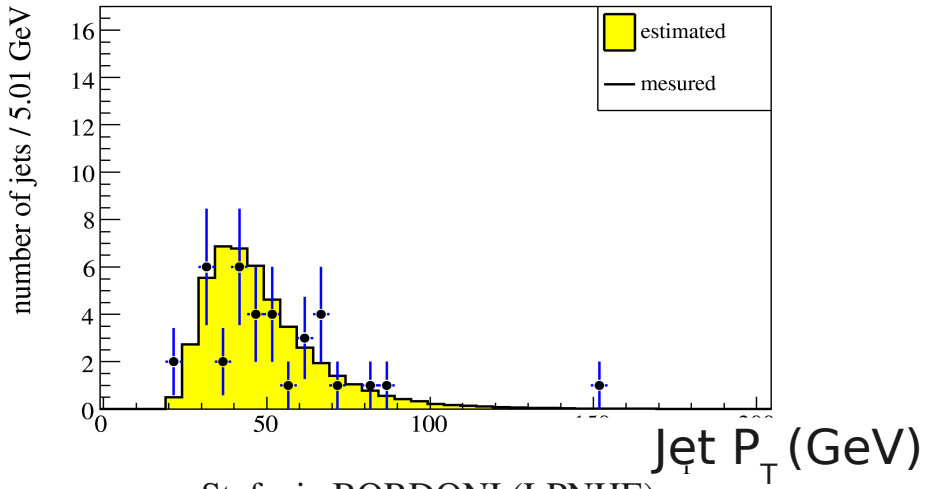
Jet P_T spectrum of all light-jets (ttbar full- hadronic channel)



The predicted jet spectrum:



Validation on the full hadronic ttbar channel (2/2)

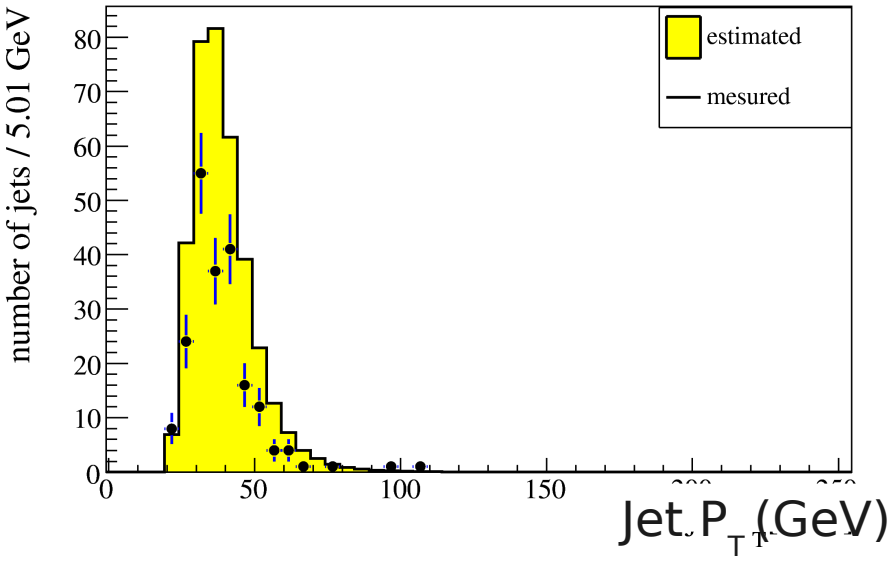
results for the full hadronic ttbar sample			
	electrons from b	**electrons from light**	**total**
predicted	43^{+7}_{-10}	44^{+11}_{-12}	87^{+13}_{-16}
measured	**44**	**36**	**80**

Some comments :

- The predicted and measured spectrum presented in the previous slide, are in good agreement even if the available statistics is not very high.
- The agreement is also confirmed by the numerical results (shown in the table)

The prediction method is validated by those results and ready to test to the di-jet sample

Test on the di-jet sample



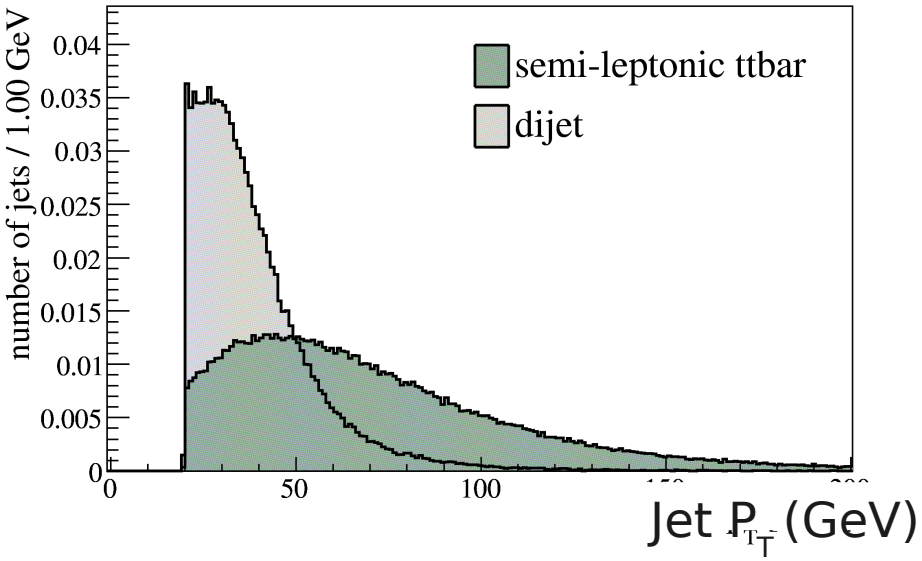
results for thedi-jet sample			
	electrons from b	**electrons from light**	**total**
predicted	21^{+6}_{-4}	364^{+153}_{-131}	385^{+153}_{-131}
measured	**51**	**205**	**256**

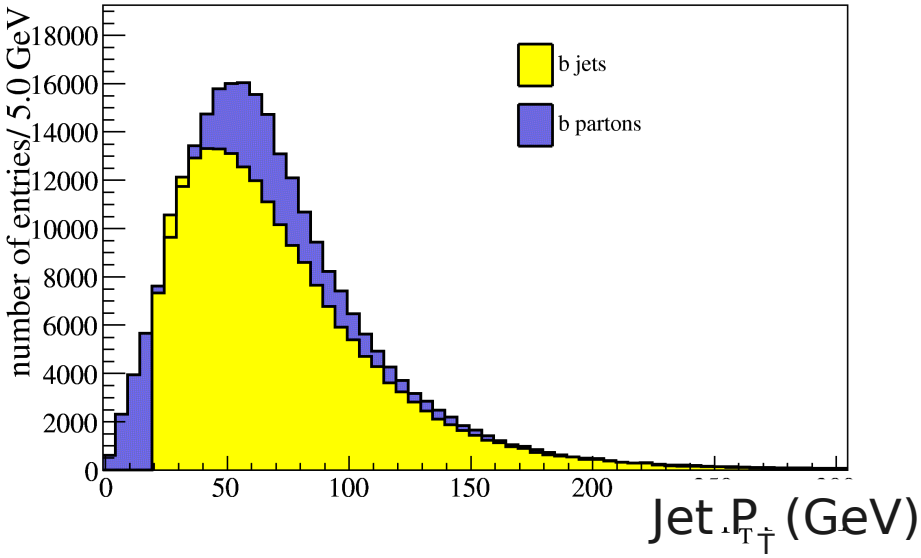
The predicted number are underestimated for b-jets and overestimating for light-jets. **What happens?**

Di-jet sample 2/2:

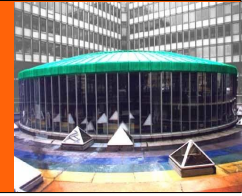
The method developed to predict the extra electron number take in account the characteristics of P_T spectrum of the samples that we want to predict.

But jets are complicated objects and they have a different spectrum from the original parton... ***is it the answer?***





Conclusion and outlook:



- The cross section measurement will be a standard candle and a veritable test of the knowledge of the detector response.
- The main source of background of a di-leptonic ttbar processes is the QCD background
- A good estimation of extra electron rate will give a good estimation of this background. To do that we developed a method to predict the P_T spectrum of jets creating an extra electron.
- The prediction method has been validated but the test on the di-jets sample is not satisfactory and more detailed studies are in progress
- A prediction method, based on a data driven approach, will be then developed

data are coming soon...