

Search for new physics at the LHC through the study of the electron- positron pair mass spectrum

Vincent Dero BND School 2009

Just me

- ▶ Vincent
- ▶ Age : 24
- ▶ Status : single
- ▶ Hair : brown
- ▶ Eyes : green
- ▶ Characteristics :
 - Tall
 - Fun
 - Sweet
 - Sportsman
- ▶ Height : 189 cm
- ▶ Don't hesitate : 0472945434



Just me

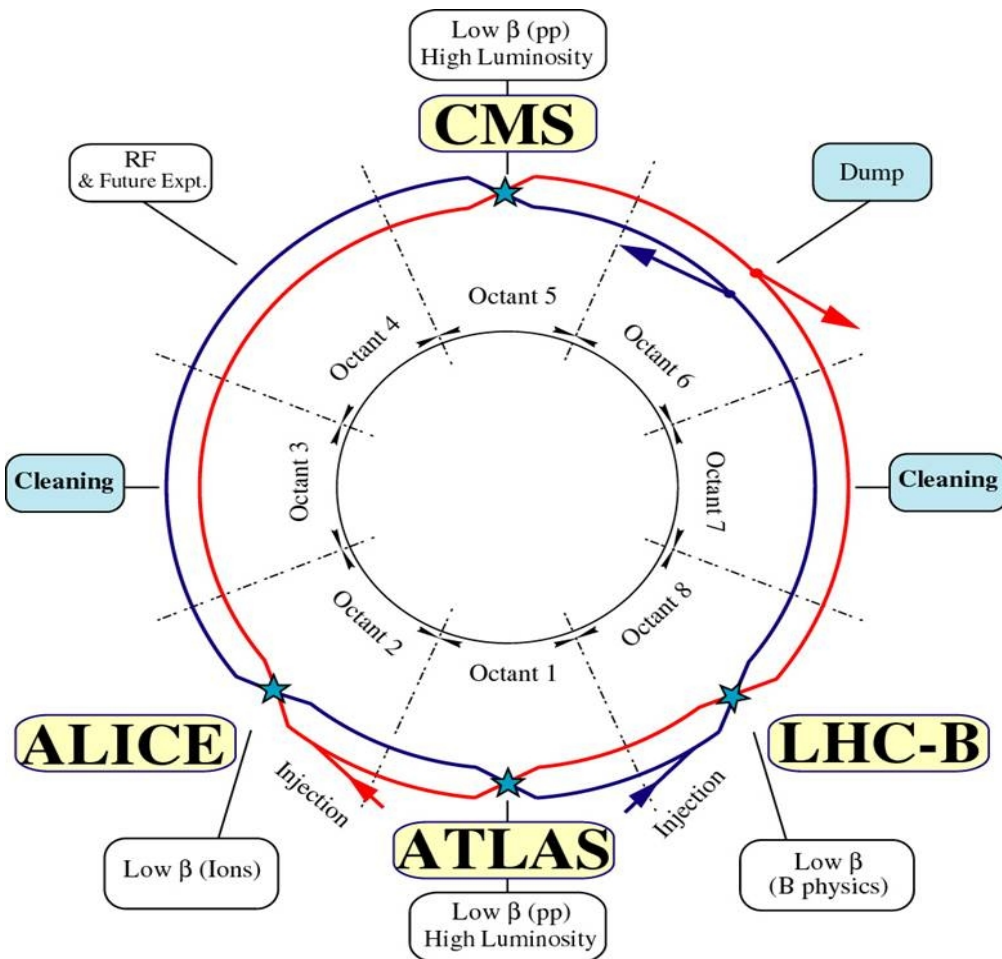
- ▶ Brussels institute (ULB)
- ▶ Collaboration : CMS
- ▶ Group : HEEP (High Energy Electron Pairs)
- ▶ Many cake partys at 3 pm

Join us!

Introduction

- ▶ The LHC, CMS... Everyone knows...

LHC



The LHC,
a discovery machine :

- very high energy : **14 TeV**

startup : ~november 2009
until ~april 2010 : **7 TeV**
(until ~ end 2010 : **10 TeV**)

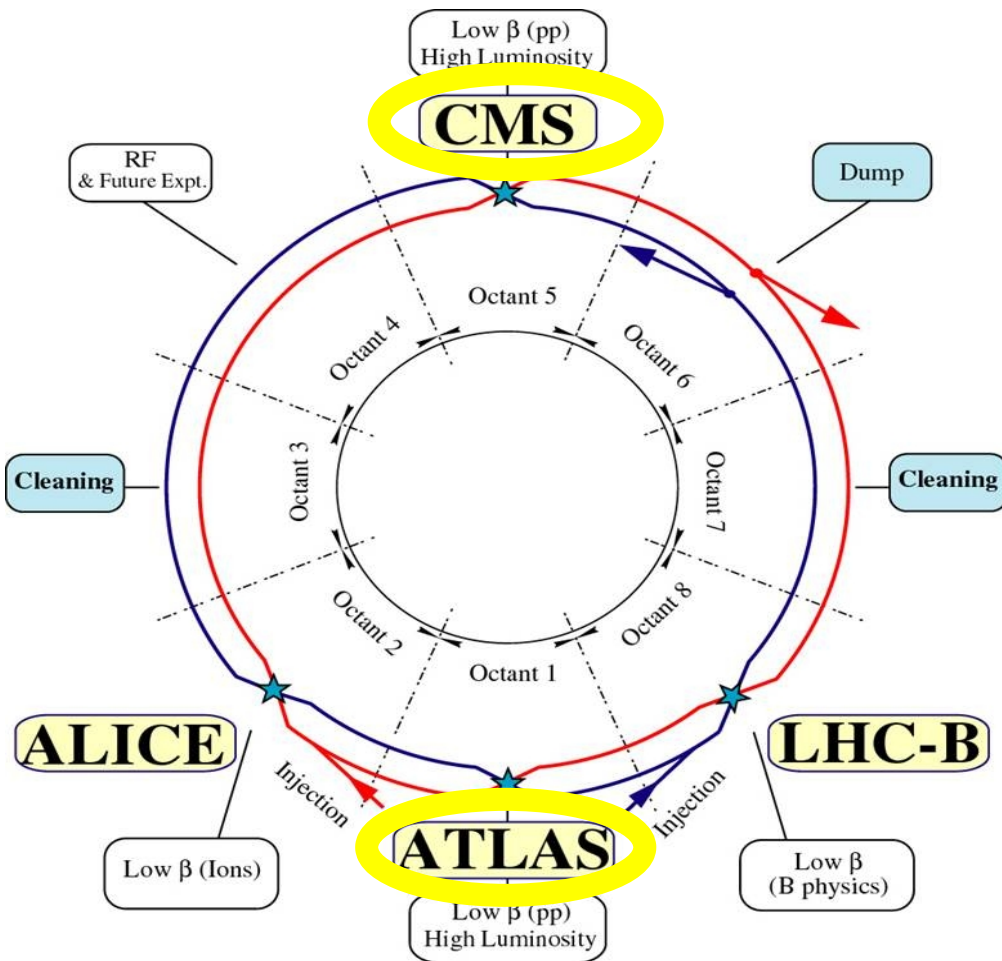
-> *a new range in energy is explored*

- very high luminosity

$\sim 10^2 \times$ Tevatron lumi

-> *very rare process can be measured*

LHC



2 general purpose experiments :

CMS and **ATLAS**

The goal of my work

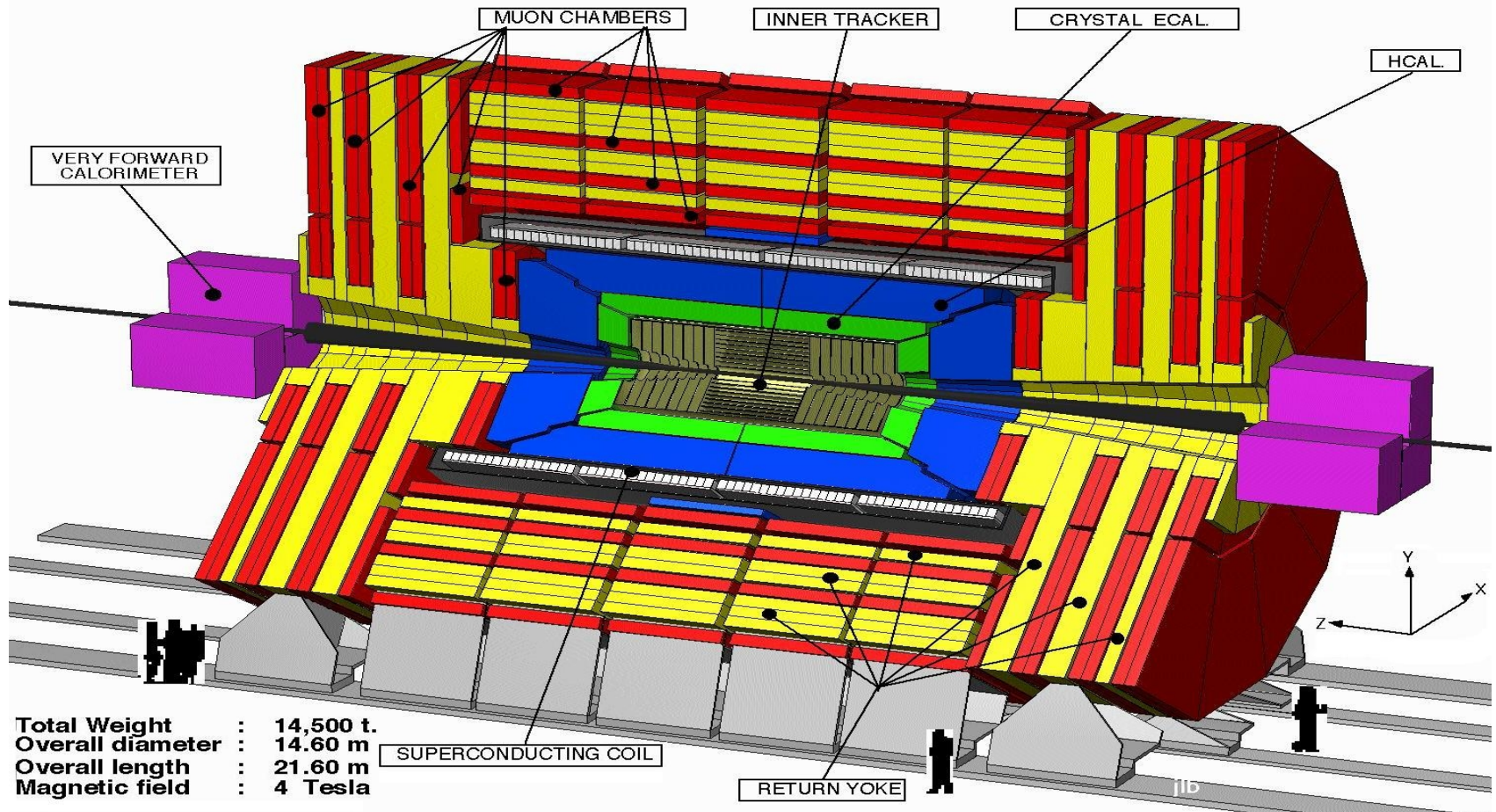
- ▶ Hu... Get my PhD?
- ▶ Study physics, of course! And most precisely *new physics*
- ▶ *Numerous model of new physic describing process with final states into leptons and quarks*
 - Looking for quarks? *No!*
 - Looking for leptons? *Yes!*

The goal of my work

- ▶ Hu... Get my PhD?
- ▶ Study physics, of course! And most precisely *new physics*
- ▶ *Numerous model of new physic describing process with final states into leptons and quarks*
 - Looking for quarks? *No!*
 - Looking for leptons? *Yes! electrons?*

CMS

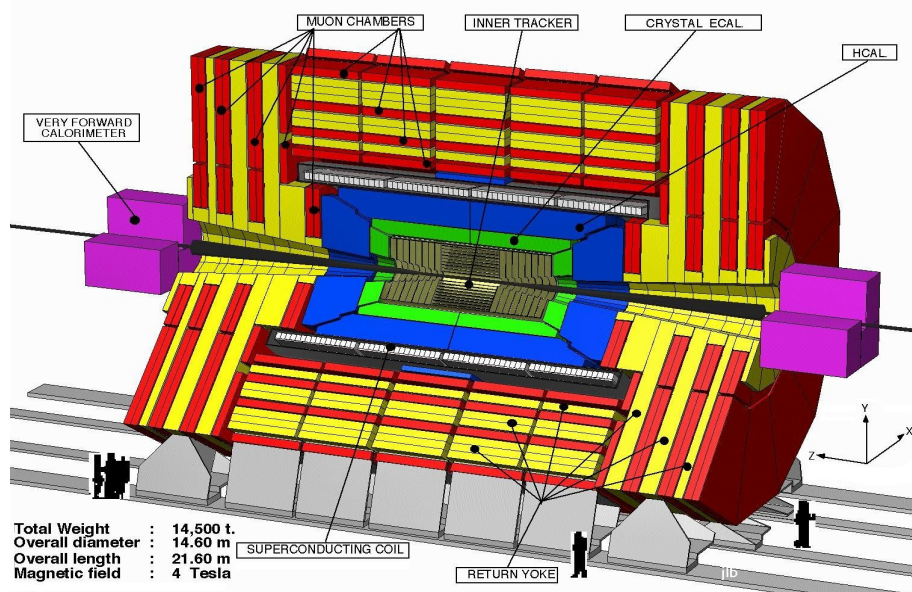
A Compact Solenoidal Detector for LHC



CMS

Compact Muon Solenoid

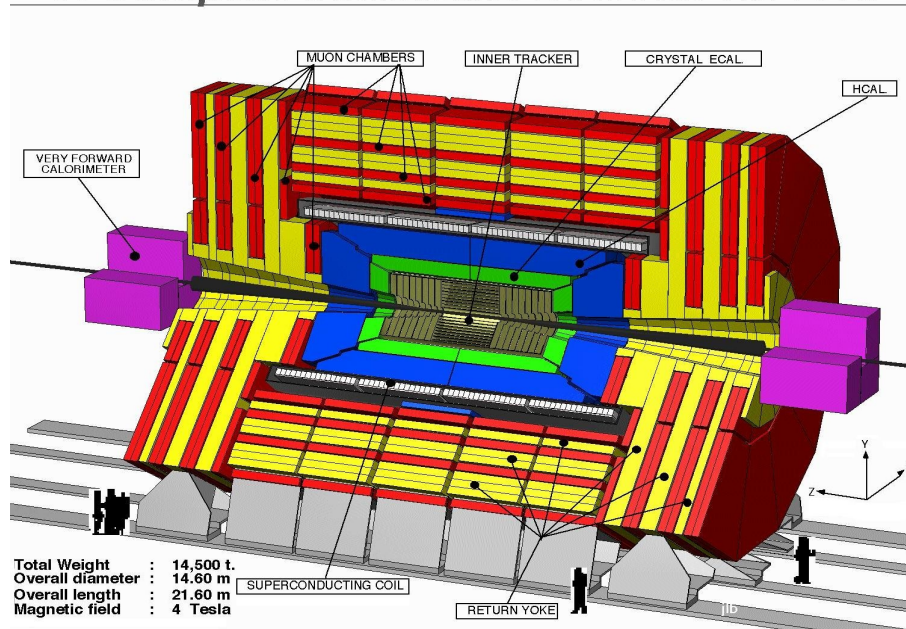
A Compact Solenoidal Detector for LHC



CMS

Compact Muon Solenoid

A Compact Solenoidal Detector for LHC



How can you see an electron in CMS?

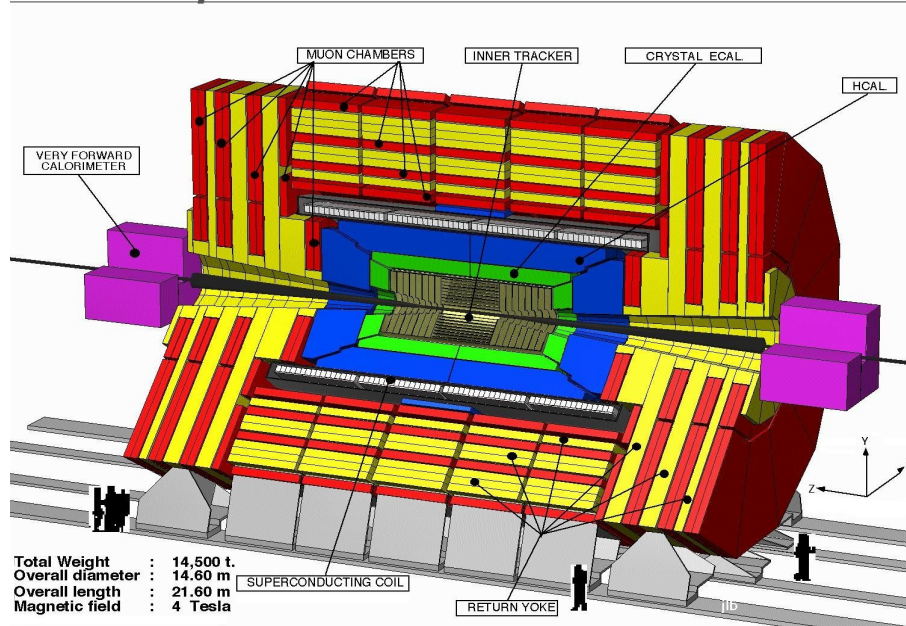
Charged particle :
give a track

Strong interacting particle :
give an energy deposition in calorimeters

CMS

Compact Muon Solenoid

A Compact Solenoidal Detector for LHC



So we need...

- Tracker : good
- Electromagnetic CALorimeter
 - granularity : OK
 - resolution : *fantastic* !
- Hadronic CALorimeter : OK
- Muon chamber : forget about!

electrons are easy to tag and well reconstructed, *let's go!*

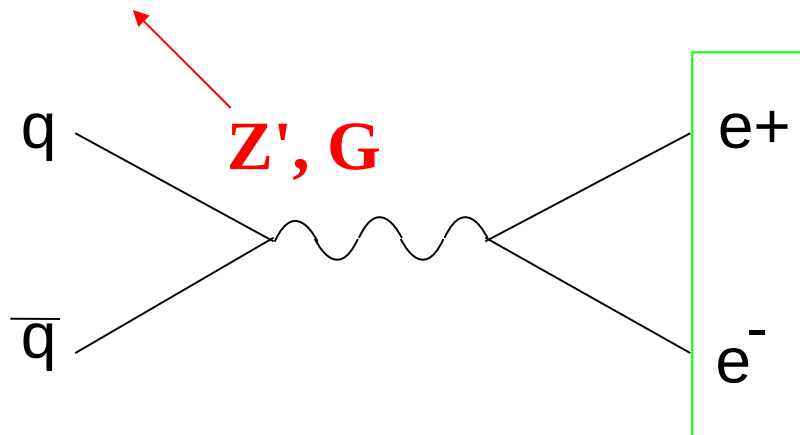
What channel?

- ▶ New physics: promissing models
 - GUT : Z'
 - Gravitons : Randal Sundrum, Kaluza-Kein
- ▶ ?

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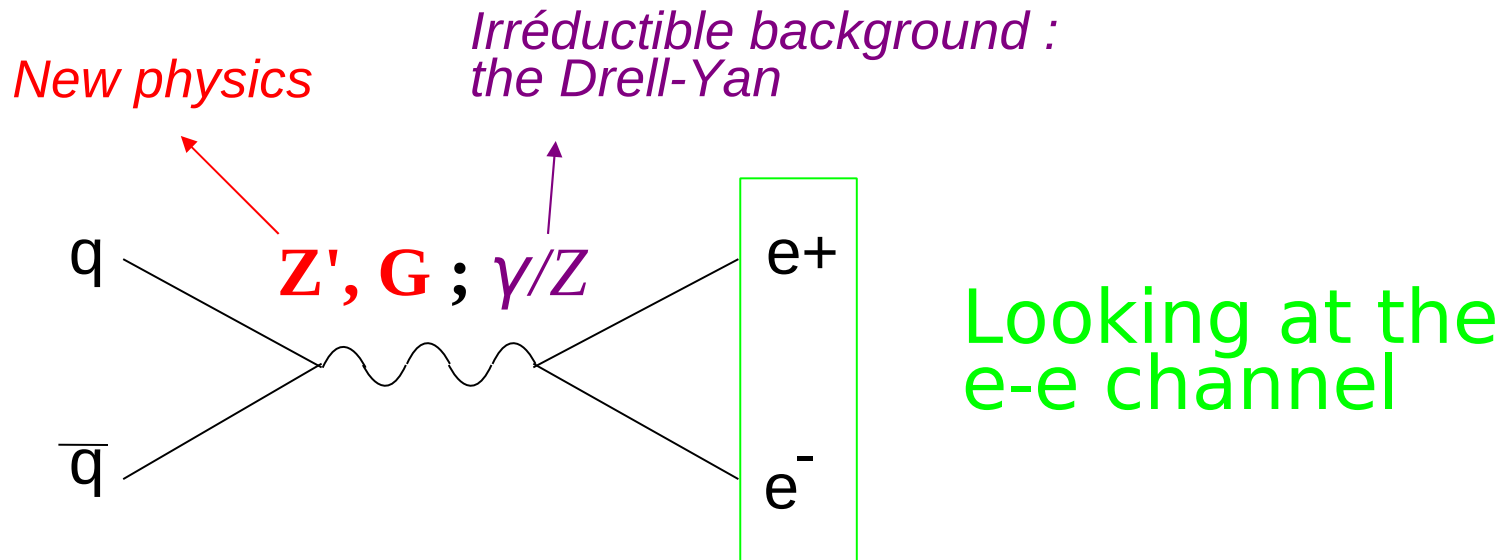
New physics



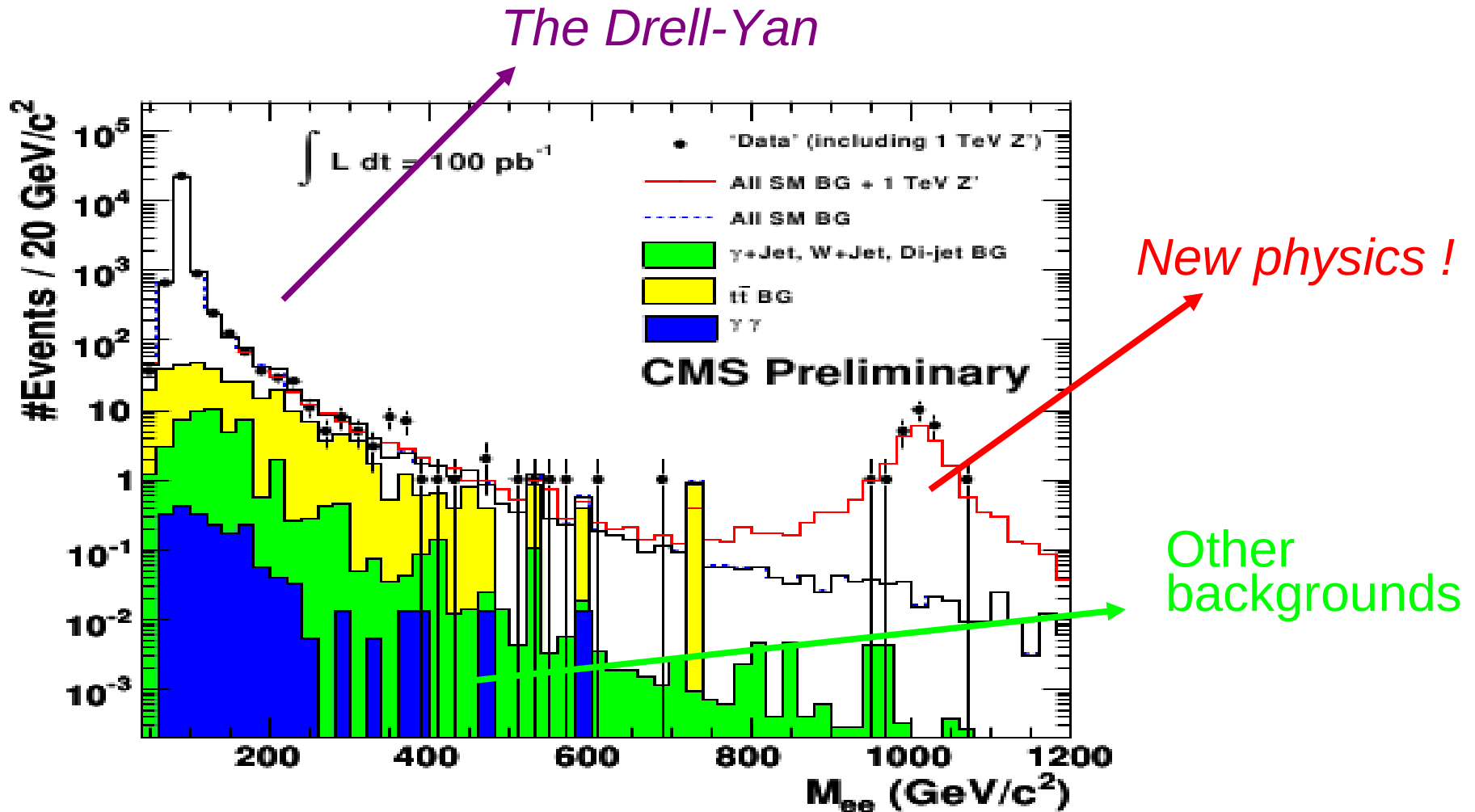
Looking at the
e-e channel

What channel?

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Mass distribution



Can we believe our result if we see a pic at 1 TeV ?

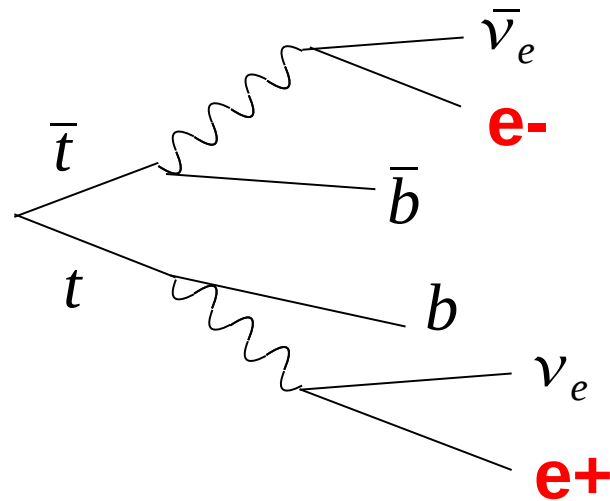
- ▶ *Idea* : measure the Drell-Yan X-section and compare with the expected value
- ▶ Things to study carefully :
 - *Efficiencies* of electrons reconstruction and selection
 - *Backgrounds* rejection and estimation
 - *Calibration* and *energy resolution*
 - *Systematics*

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My analysis : backgrounds

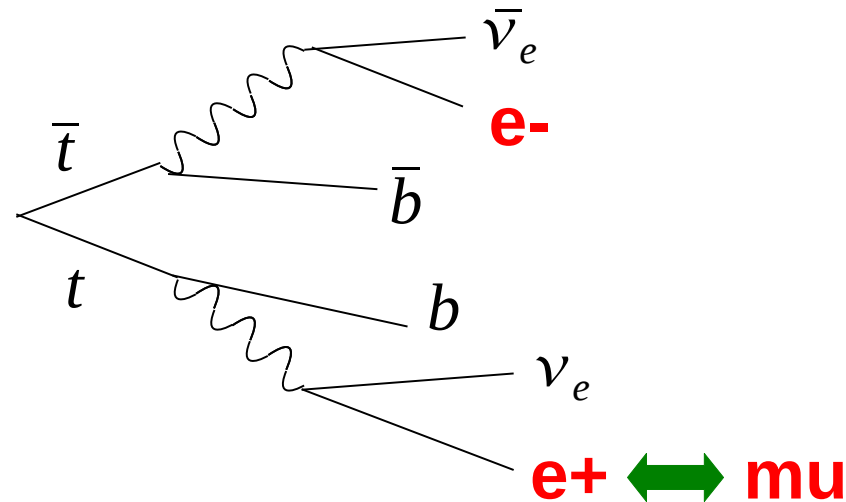
- Main background : the $t\bar{t}$ background :



- In a few case, the final state is the same!

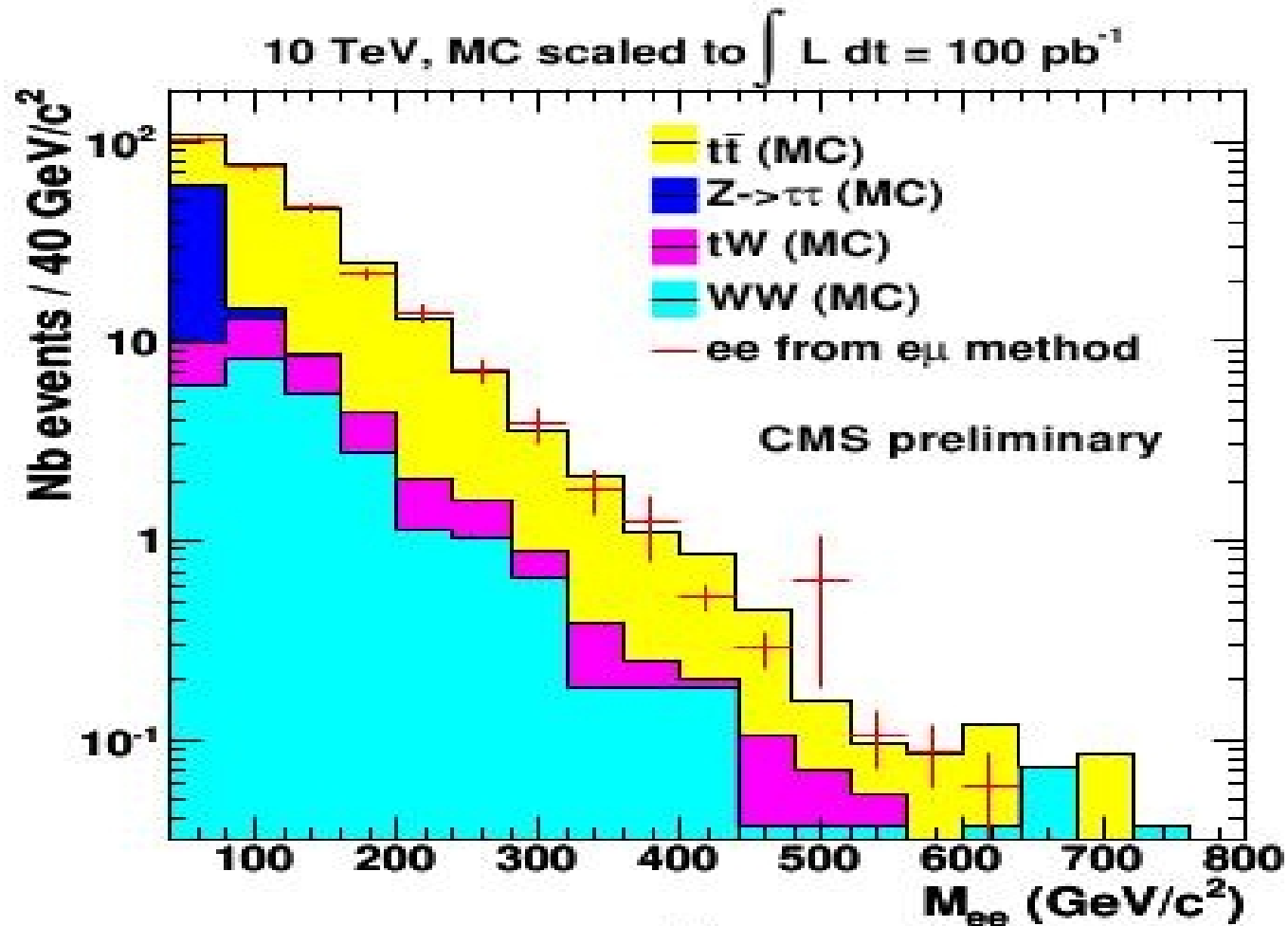
My analysis : backgrounds

- ▶ Main background : the ttbar background :



- ▶ Idea : estimate *on data* the number of ttbar using *the e-mu channel!*

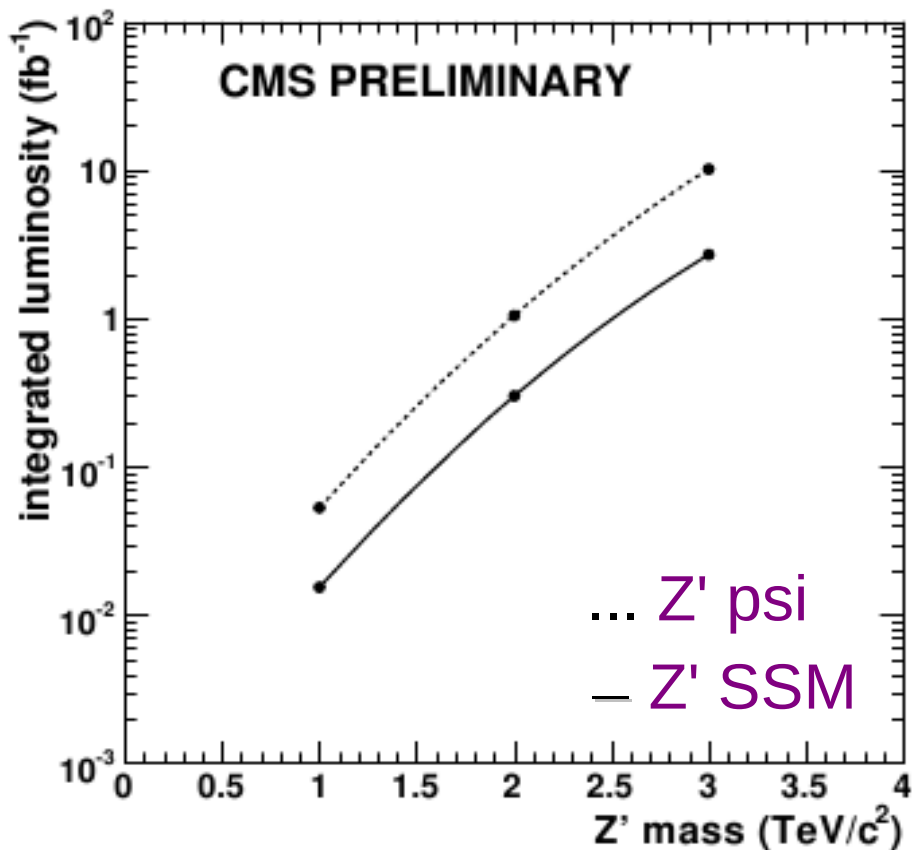
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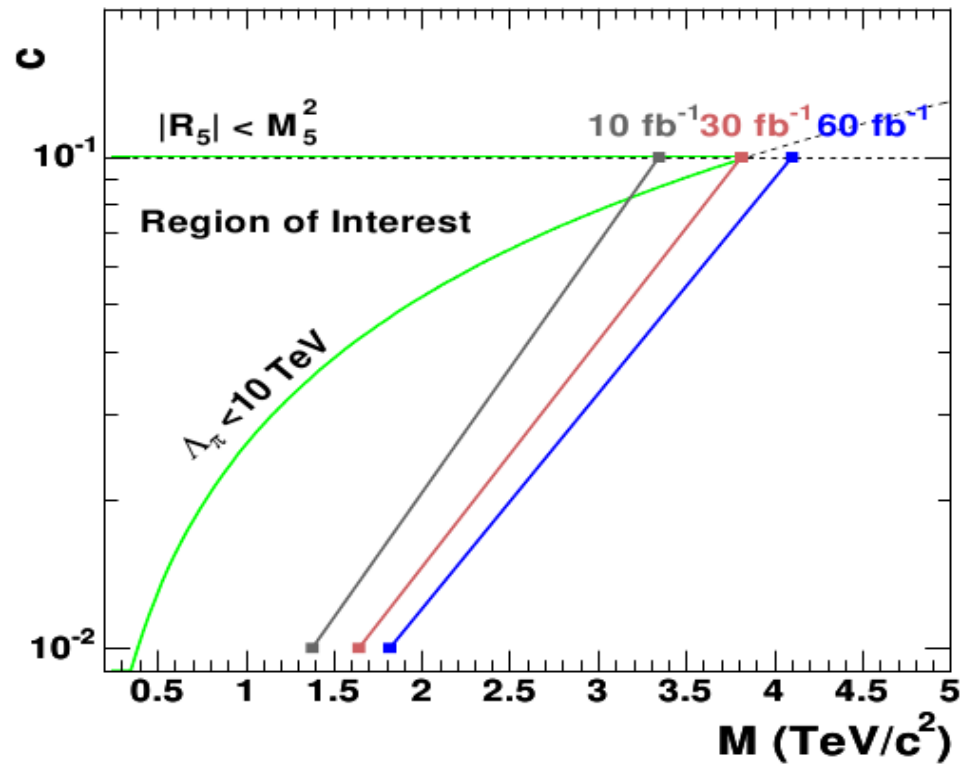
Other study

- ▶ Using the Transverse Missing Energy (MET)
 - **Idea** : cutting on the MET for rejecting $t\bar{t}$ background and backgrounds with real neutrinos
- ▶ Need to redefine the proper coordinates for us
 - Parallel MET and Perpendicular MET
- ▶ Idea to parametrize the MET in terms of the hadronic activity of the event
- ▶ In good shape!

Discovery potential



Lumi needed for 5 σ significance



Discovery potential for KK graviton in fonction of the coupling constant