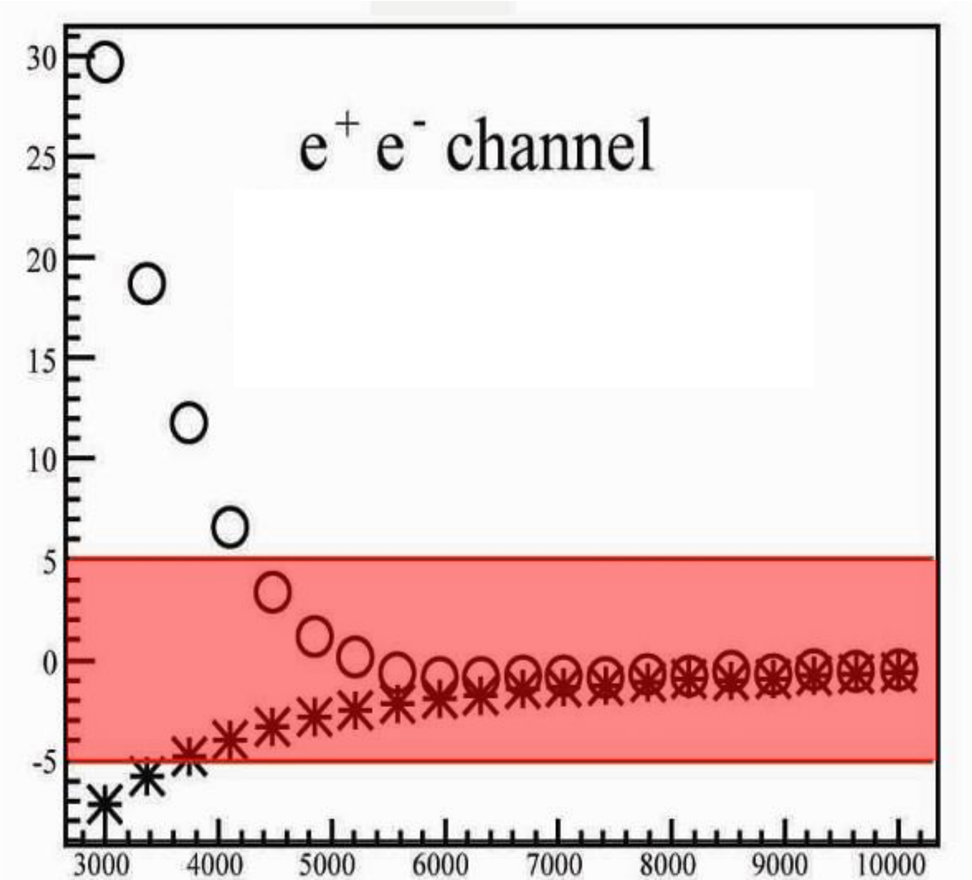
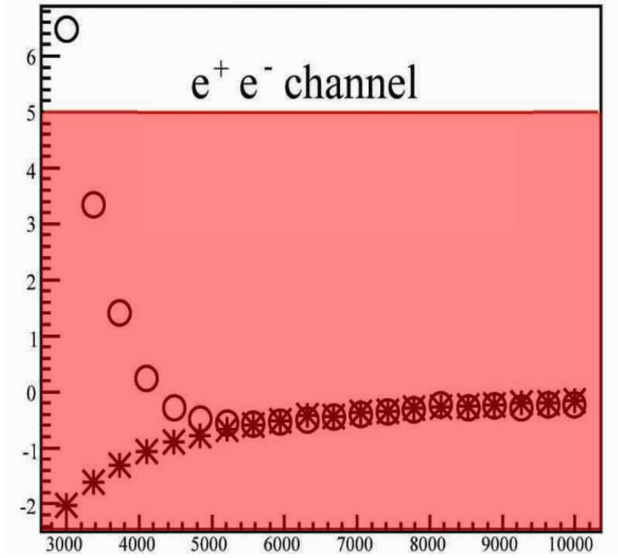
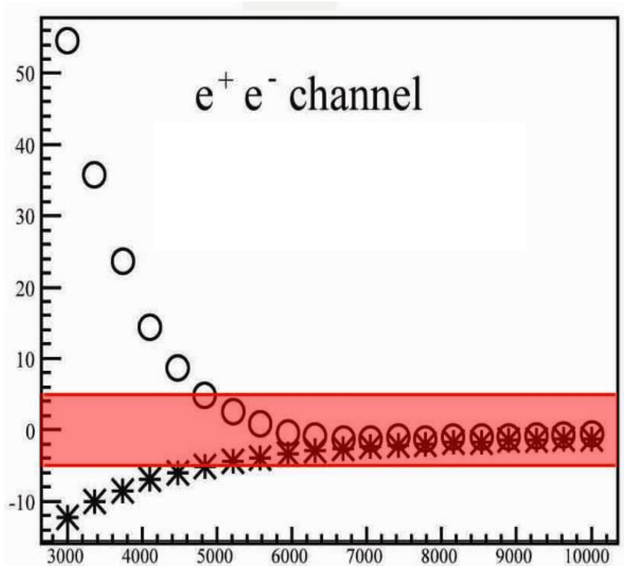
Z'$_{RS}$ discovery potential - RS model : Point A





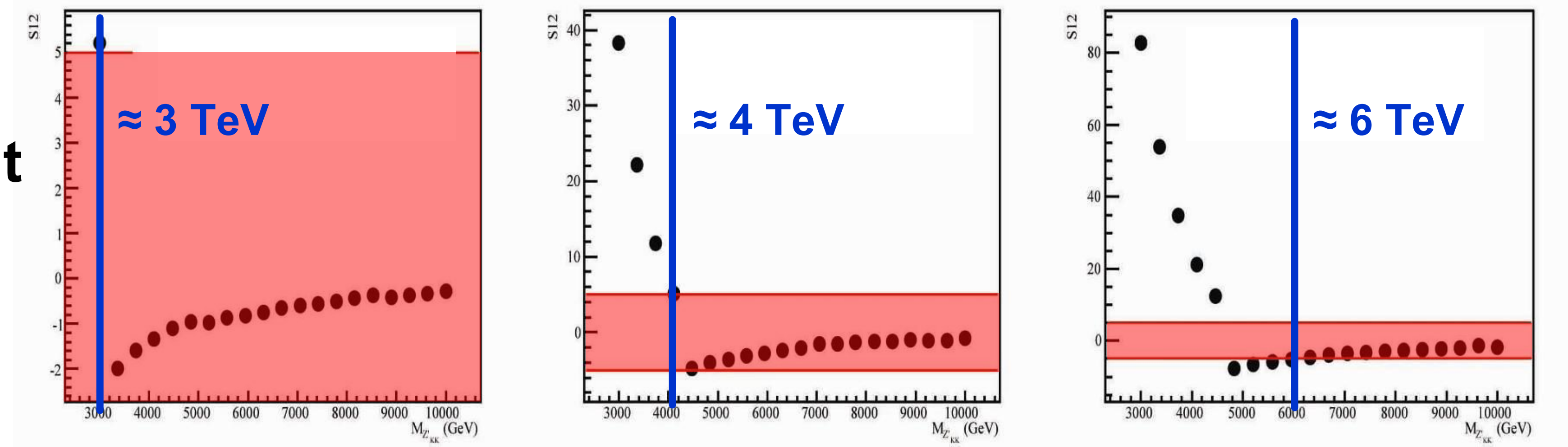


Z'_{RS} discovery potential - RS model : Point A

We combined :

- the two analyses (interference and resonance)
- the two channels (e^+e^- and $\mu^+\mu^-$)

Point A



Z'_{RS} discovery potential

- We can discover up to 3 TeV with 10 fb^{-1} **(already excluded)**
- We can discover up to 6 TeV or 4 TeV with 300 or 100 fb^{-1}
- We can discover point B up to 10 TeV with 100 fb^{-1}

Conclusion on the Z' discovery

We have studied the ATLAS discovery potential

Assuming we have
100fb^{-1} and a Z' signal

⇓

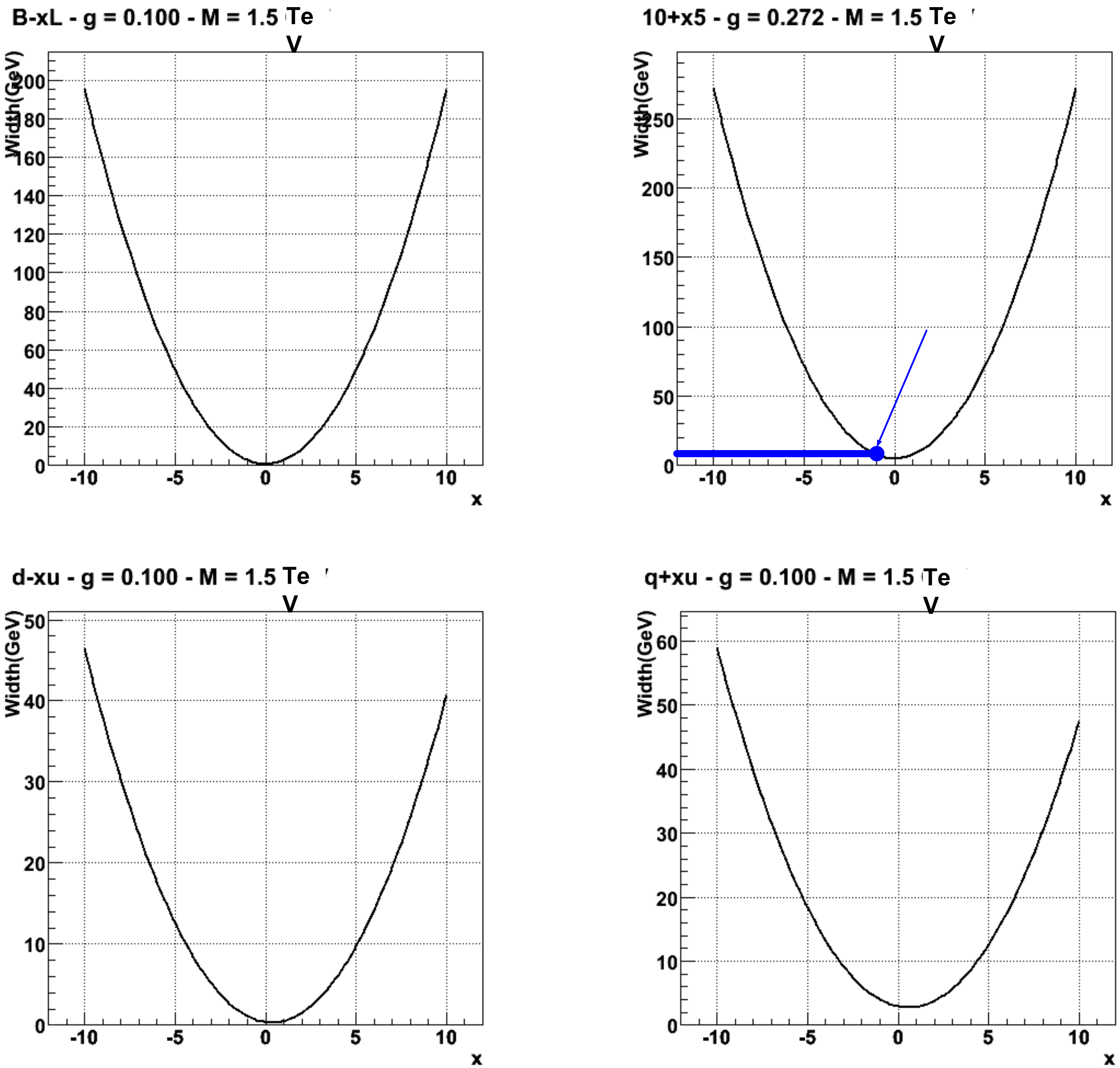
How can we infer the underlying theory ?

Useful observables :

- Total decay width
- Forward-Backward asymmetry

- Introduction and motivations
- The different theoretical Z' models
- The LHC and the ATLAS experiment
- The ATLAS Z' discovery potential
- How can we infer the underlying theory ?
- Conclusions and outlook

The total decay width - CDDT parameterization

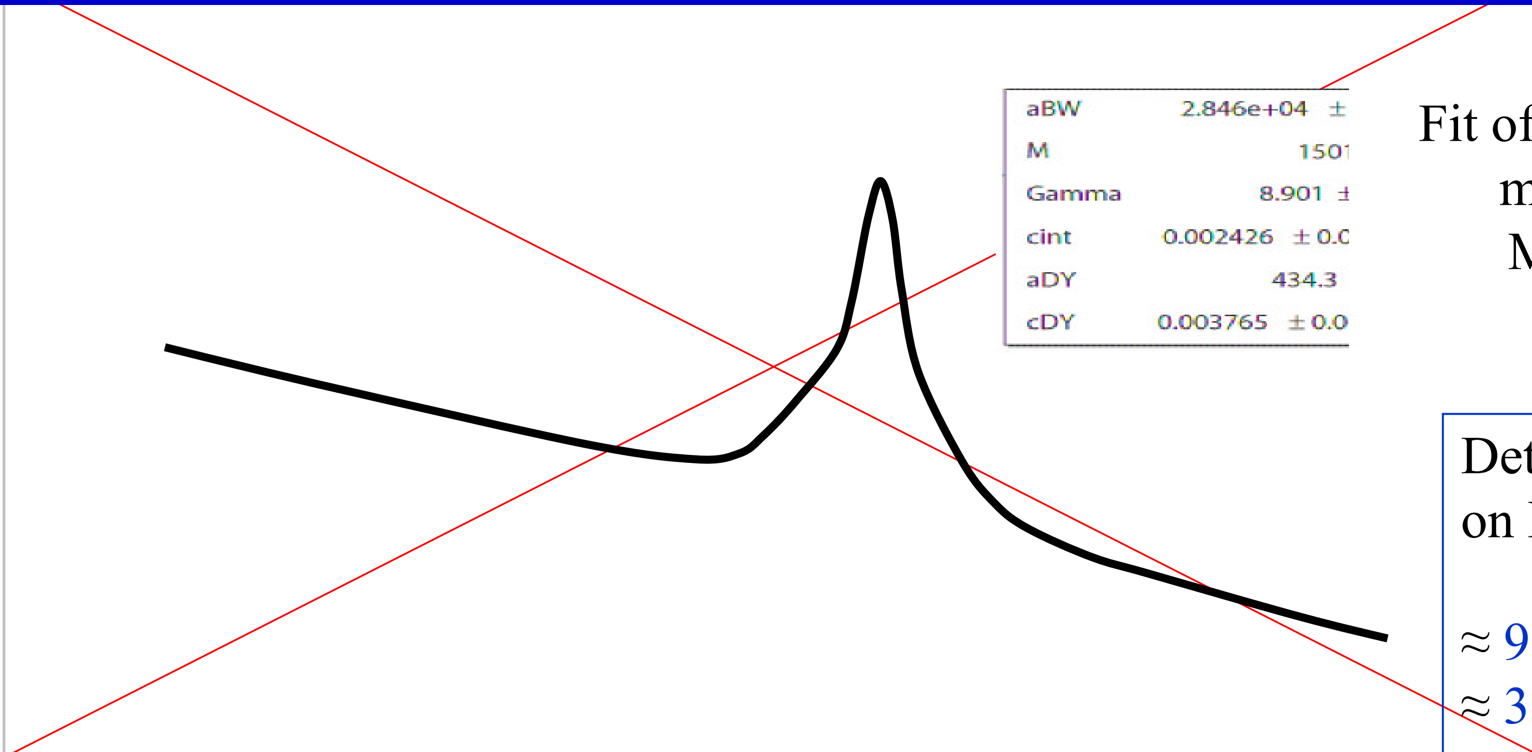


Estimated at tree level

With the formula :

Strong dependence on model parameter

Reconstructed total decay width



Fit of the Z'_η invariant mass spectrum
M=1500 GeV
(500 fb-1)

Detector resolution on M_{ll}:

≈ 9 GeV at 1.5 TeV
≈ 30 GeV at 4 TeV

Fit function for the invariant mass spectrum :

Resonance peak **DY-Z' interference** **DY**

Result for the total decay width

		M_{Fit} (GeV)	Γ_{Fit} (GeV)	$\Gamma_{theo.}$ (GeV)
$M =$ 1.5 TeV GUT	ψ	1500.2± 0.3	7.8± 0.6	8.0
	χ	1500.8± 0.4	17.1± 0.9	17.6
	η	1500.6± 0.3	8.9± 0.6	9.5
	LR	1499.5± 0.6	29.7± 1.3	30.6
$M =$ 4 TeV X-dim	ADD	3982. ± 6.	168. ± 14.	168.
	RS	3983. ± 1.	211.6 ± 0.1	-

•Fully simulated events for GUT models and ADD

•Generated events for RS model

Total decay width

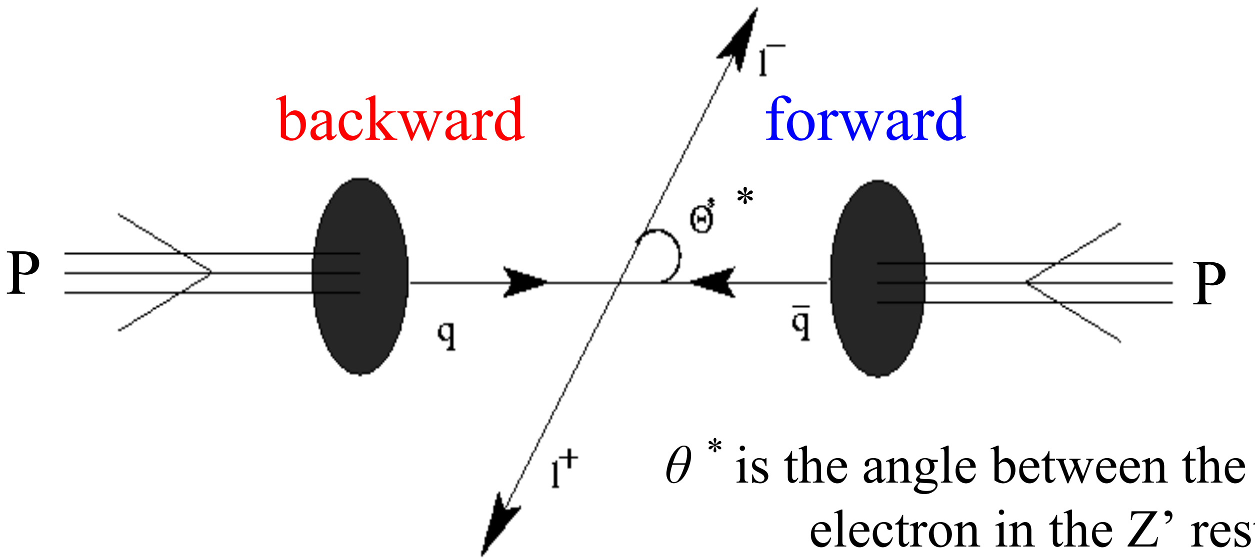
•Well mesured with high accuracy

•The different values provide a model discrimination

Forward-Backward asymmetry

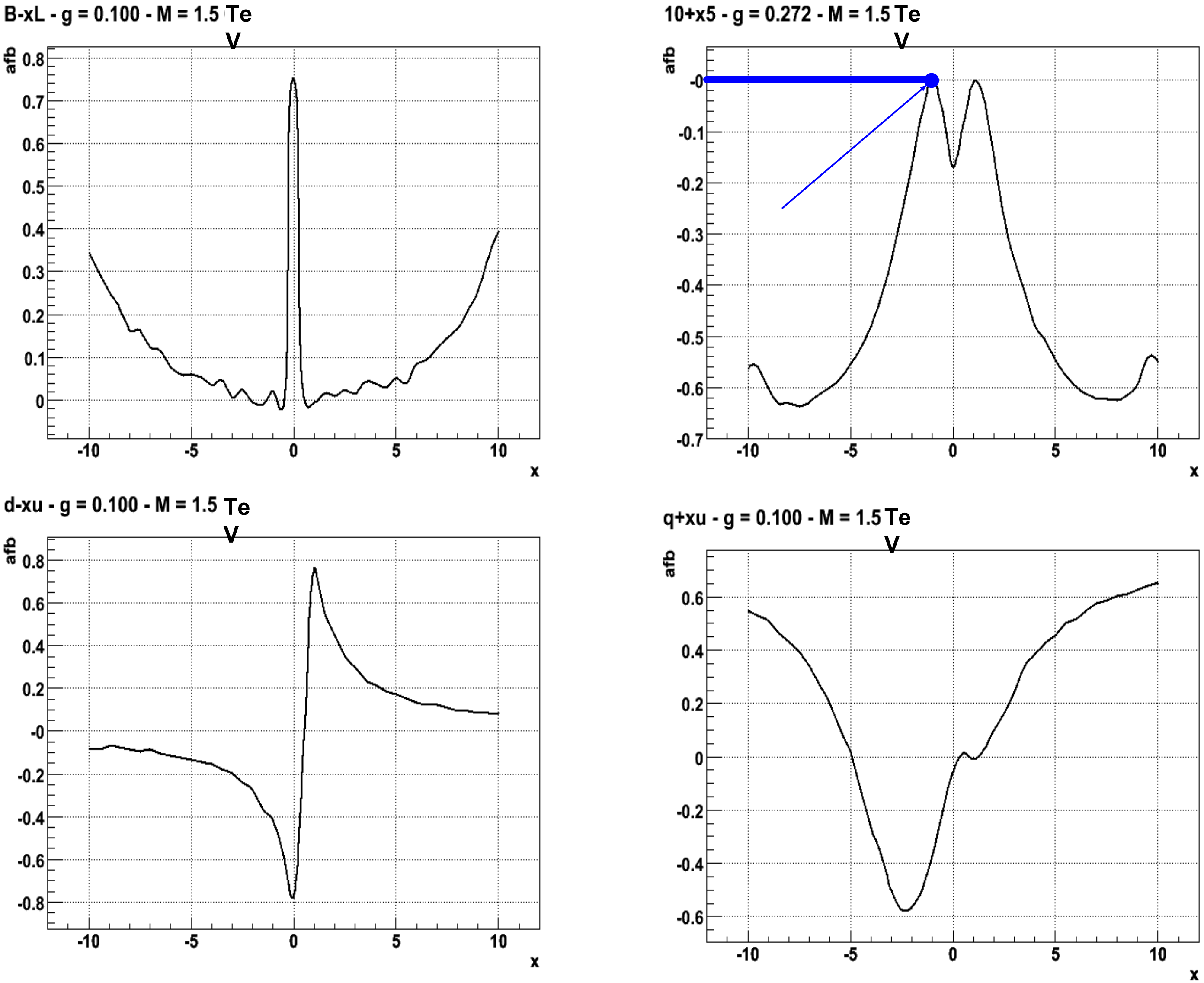
The forward-backward asymmetry is defined by :

where * * * *



θ^* is the angle between the quark and the electron in the Z' rest frame

Forward-Backward asymmetry – CDDT parameterization



On peak asymmetry

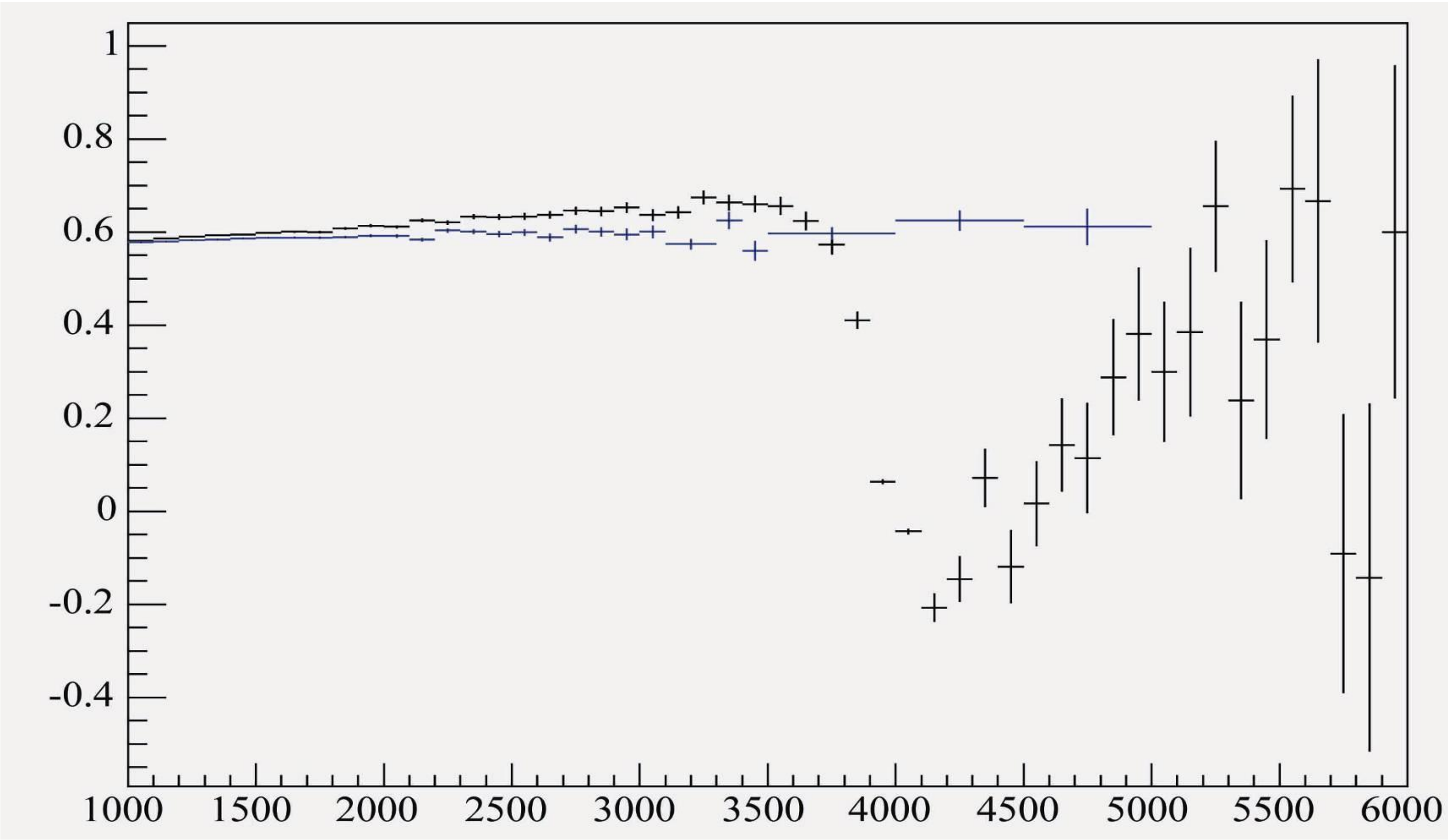
computed with only events in the window [M-4Γ;M+4Γ]

M=1.5 TeV

Strong dependence on model parameter

Forward-Backward asymmetry – Generated events - GUT

Huge statistic : 6M events



Big deformation of the forward backward asymmetry in the resonance region

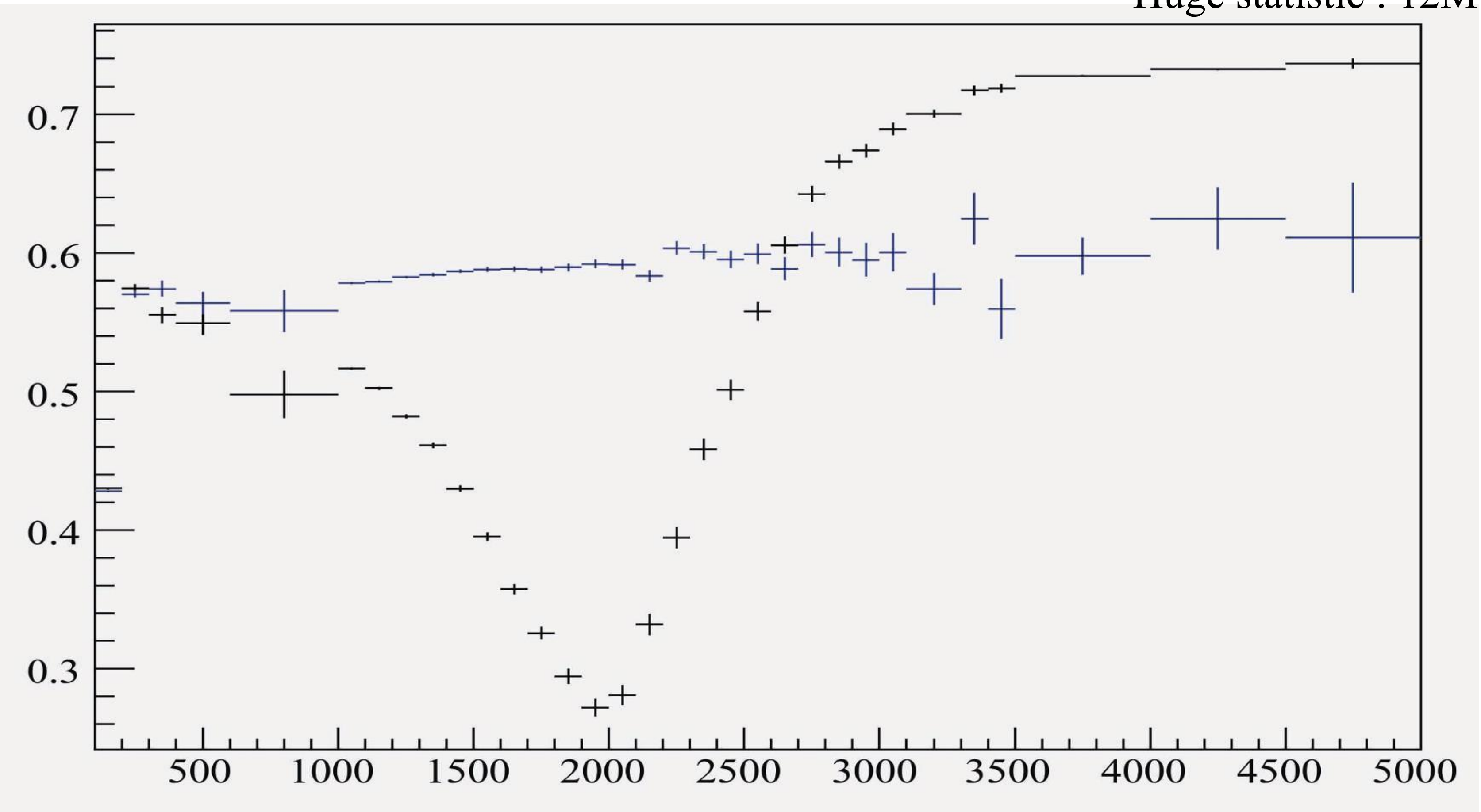
Forward-Backward asymmetry – Generated events – X-dim (ADD)

Huge statistic : 6M events

Deformation of the forward backward asymmetry on the resonance

Forward-Backward asymmetry – Generated events – X-dim (RS)

Huge statistic : 12M events



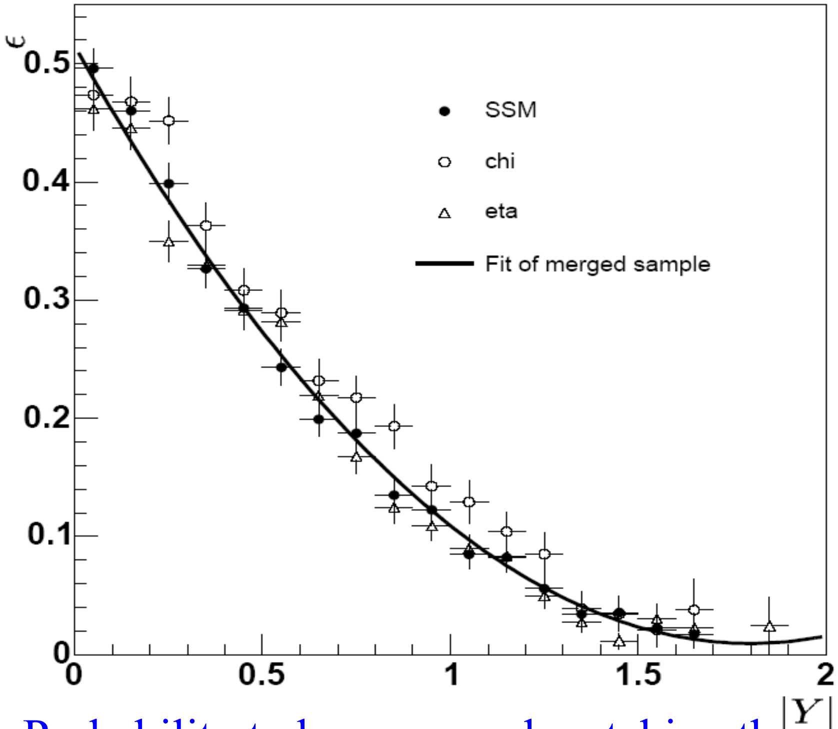
Deformation of the forward backward asymmetry down to ≈ 600 GeV

A_{FB} is a useful observable

Reconstructed forward-backward Asymmetry

A_{FB} is defined with the angle θ^* between the quark and electron directions

In a pp collider we don't know the quark direction. → **We assume that the Z' and the quark are in the same direction**



Probability to be wrong when taking the Z' direction as the quark one

At high rapidity : The assumption is good

At low rapidity : We are wrong once out of two

The forward-backward asymmetry is diluted due to this effect

Reconstructed forward-backward Asymmetry

We can correct the diluted forward-backward asymmetry ( )

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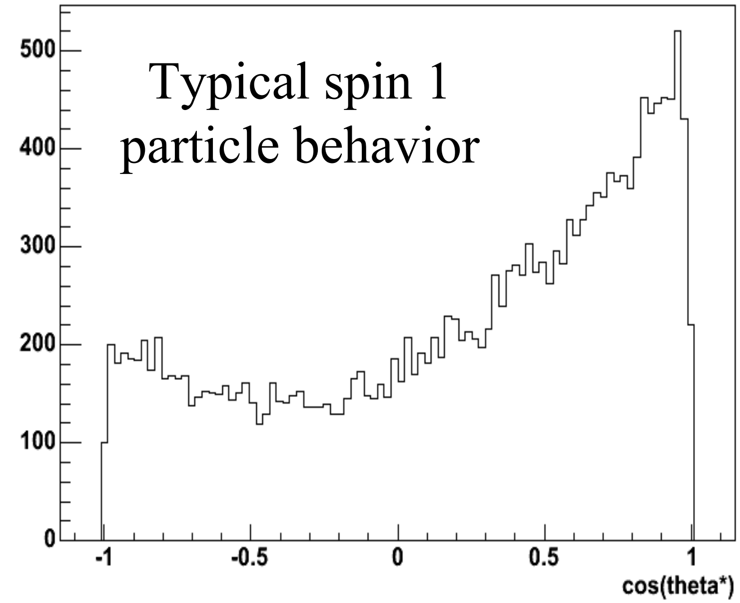
ε = probability to be wrong

Detector independent

We lose the angular information

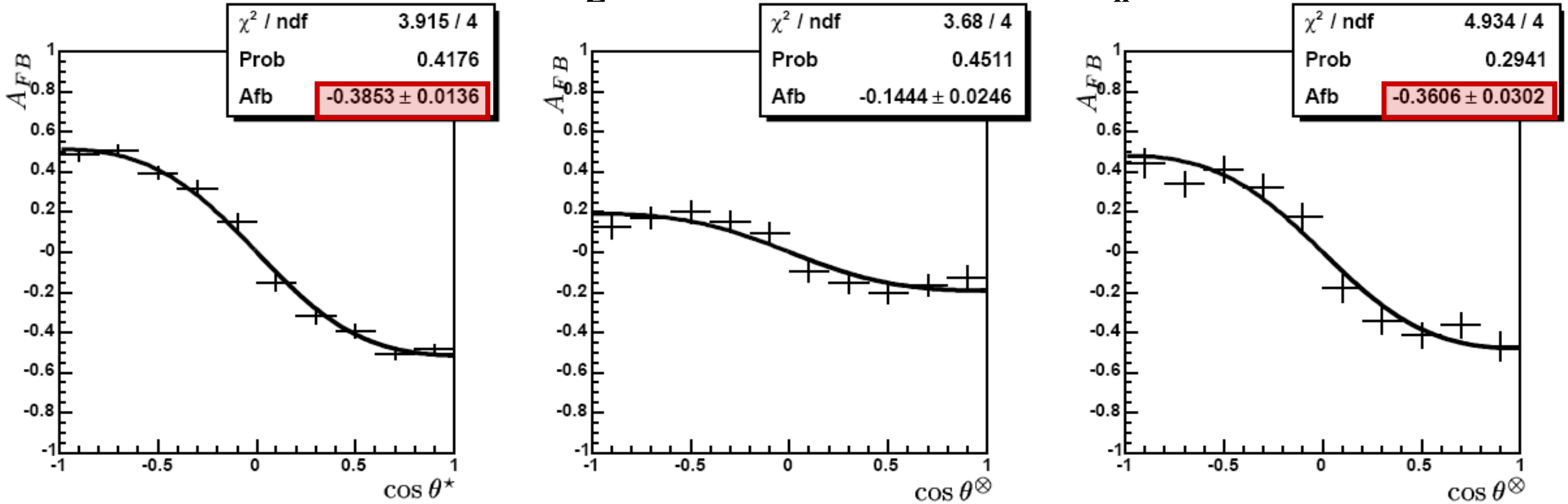


Reconstructed forward-backward Asymmetry

An attractive method consisted in fitting the cos(θ) evolution of the A_{FB}

The theoretical behavior is :

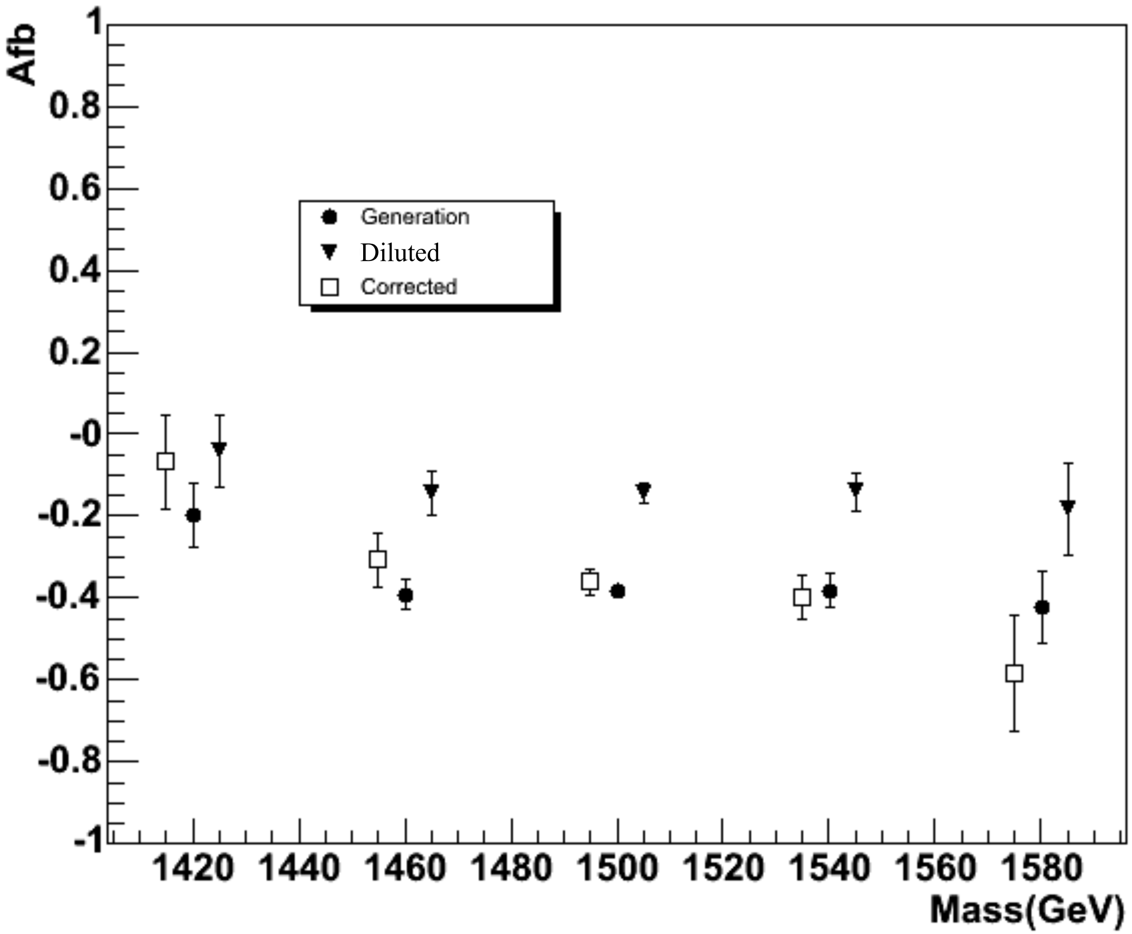
Example for the χ model ($M_{Z'}$=1500 GeV, 1.48 TeV < M_{ll} < 1.52 TeV) :



(a) *At generation level* (b) *Diluted* (c) *Corrected*

Result on the reconstruction of the forward-backward asymmetry

For the χ model ($M_{Z'}$=1500 GeV) :



- The correction method gives good results
- We are able to reconstruct with good accuracy the forward-backward asymmetry

- Introduction and motivations
- The different theoretical Z' models
- The LHC and the ATLAS experiment
- The ATLAS Z' discovery potential
- How can we infer the underlying theory ?
- Conclusions and outlook

Conclusion

- **We study Z' from different kinds of models**
  - ➢Grand Unified Theory → **Model independent parameterization**
  - ➢Extra-Dimension Theory → **ADD like** / **RS like**

- **The ATLAS discovery potential is high**
  - ➢Computed using a **model independent method** to take into account the **detector efficiency**

- **We are able to reconstruct properly useful observables for the model discrimination**
  - ➢The total decay width
  - ➢The forward-backward asymmetry

Outlook

•For the Z' study

Study other realistic points for the RS model

•For the ATLAS discovery potential

Improve the high energy electron identification

Study the systematic uncertainties due to :

- energy scale and linearity
- parton distribution functions
- radiative corrections
- …

•For the model discrimination

Study other observables : Z' rapidity, BR, …

Study other particles : W', 2^{nd} KK excitation, …

Backup

Backup

How can we infer the underlying theory ?

If we observe a signal

↓

We can study :

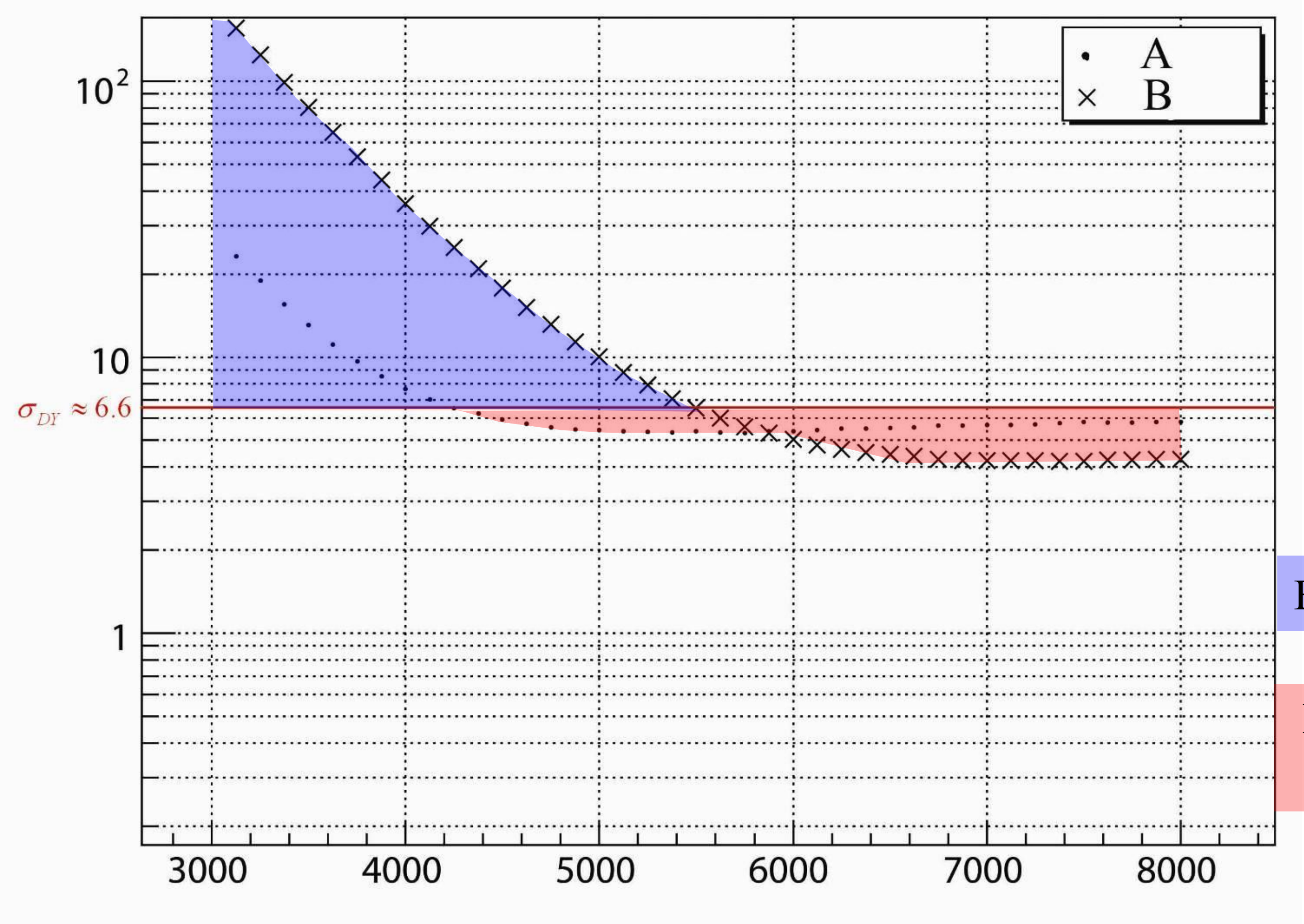
- **The total decay width**
- **The forward-backward asymmetry**

↓

Toward a model discrimination

This implies a lot of statistics

Z'RS cross section

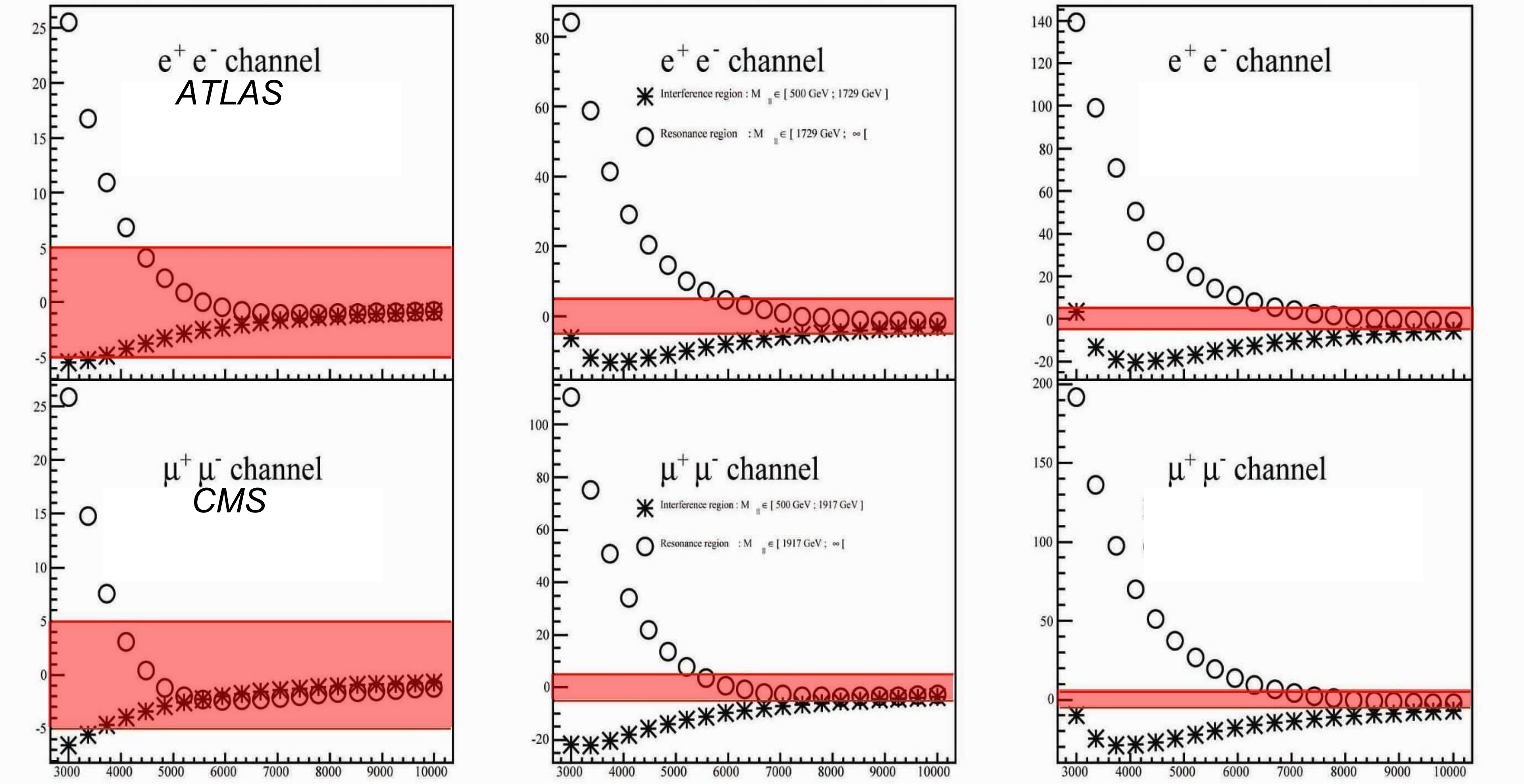


ISR ON

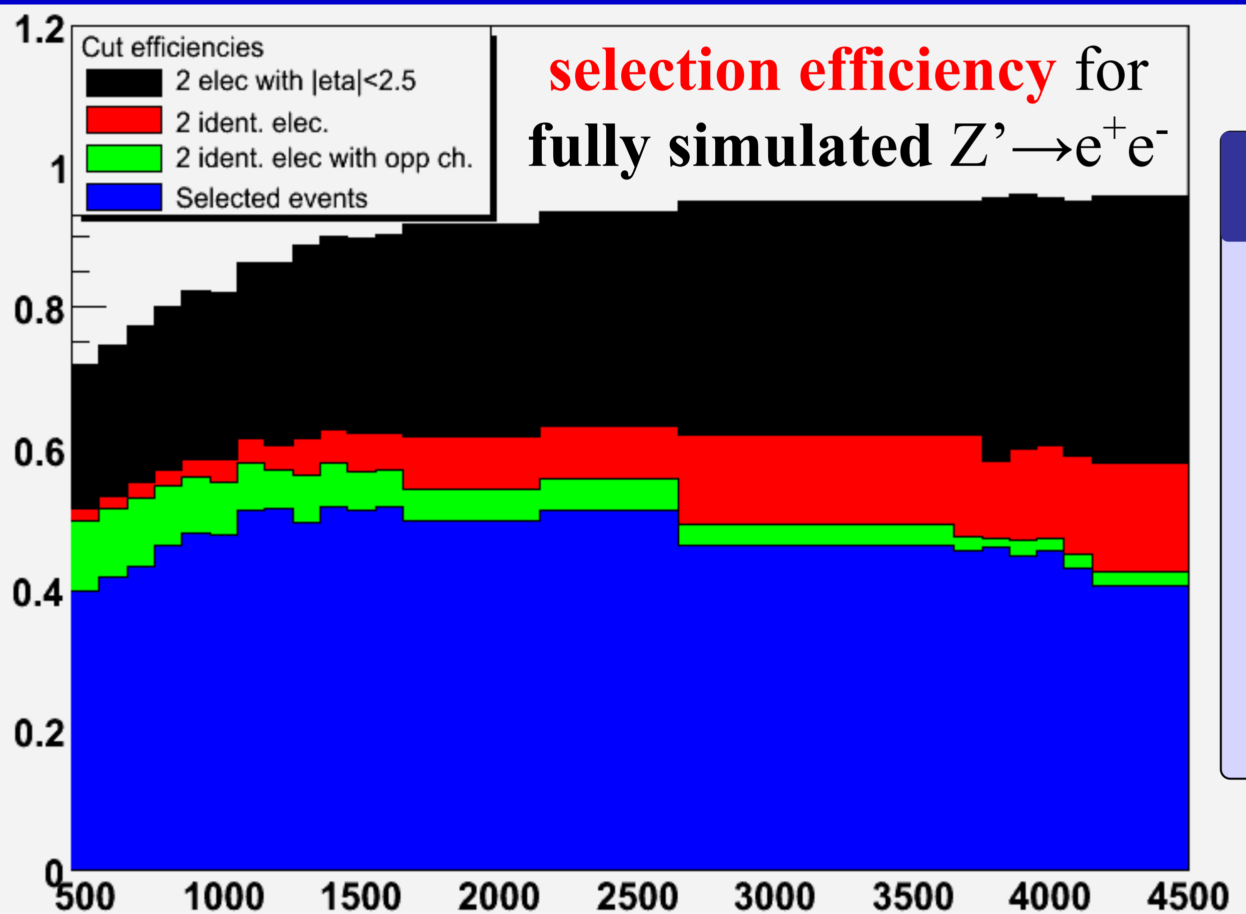
Effect due to resonance

Effet due to destructive interference

Z'_{RS} discovery : Point B



In our simulations we take into account detector acceptance …



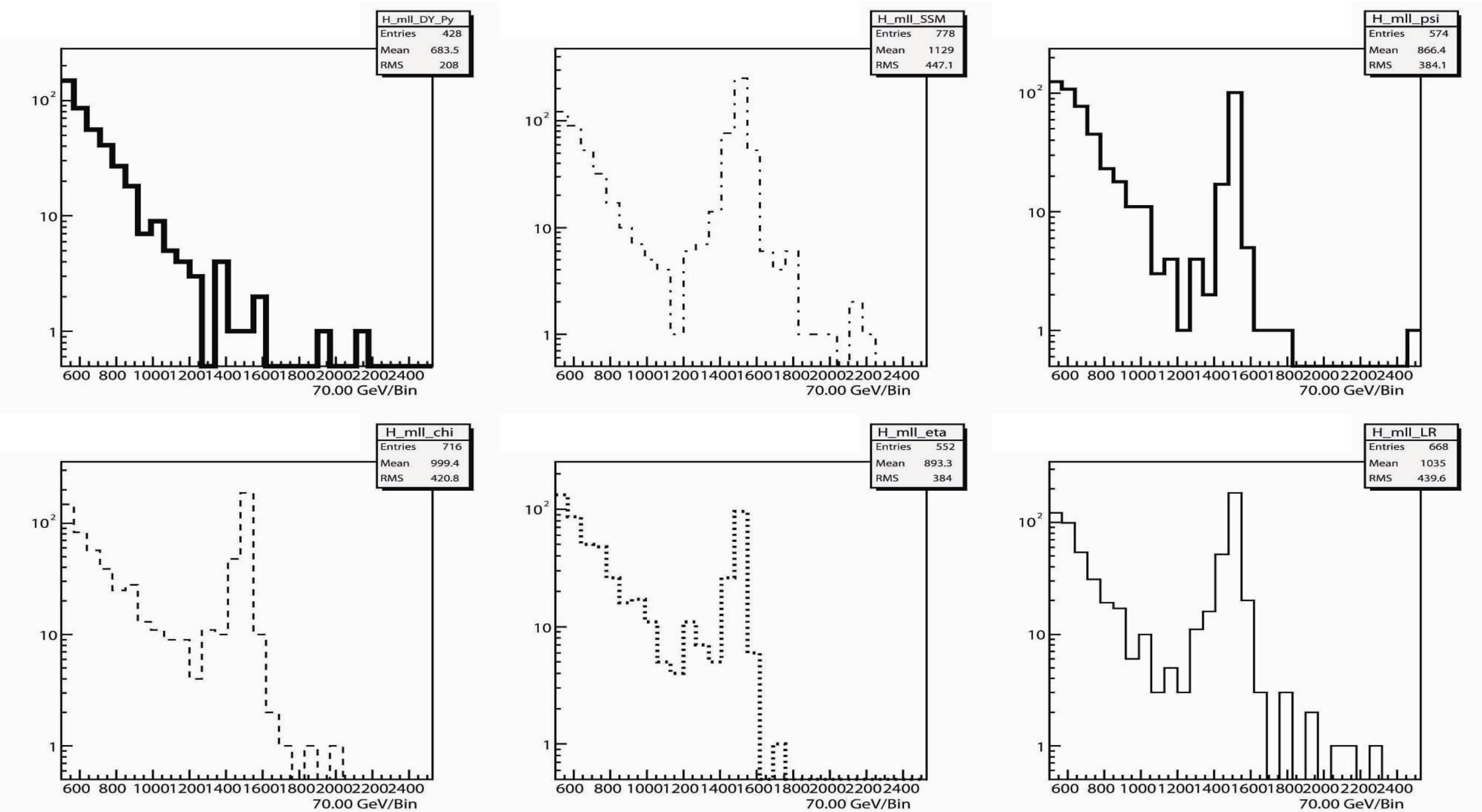
Selection criteria:

- 2 $e^{\pm}$ with $|\eta|<2.5$
- 2 identified $e^{\pm}$
- Opposite charges
- ≈back to back

- Geometrical acceptance *increases* with mass (boost effect).
- **Opposite charge** selection efficiency *decreases* with mass.
- We have to optimize electron identification at very high p_T

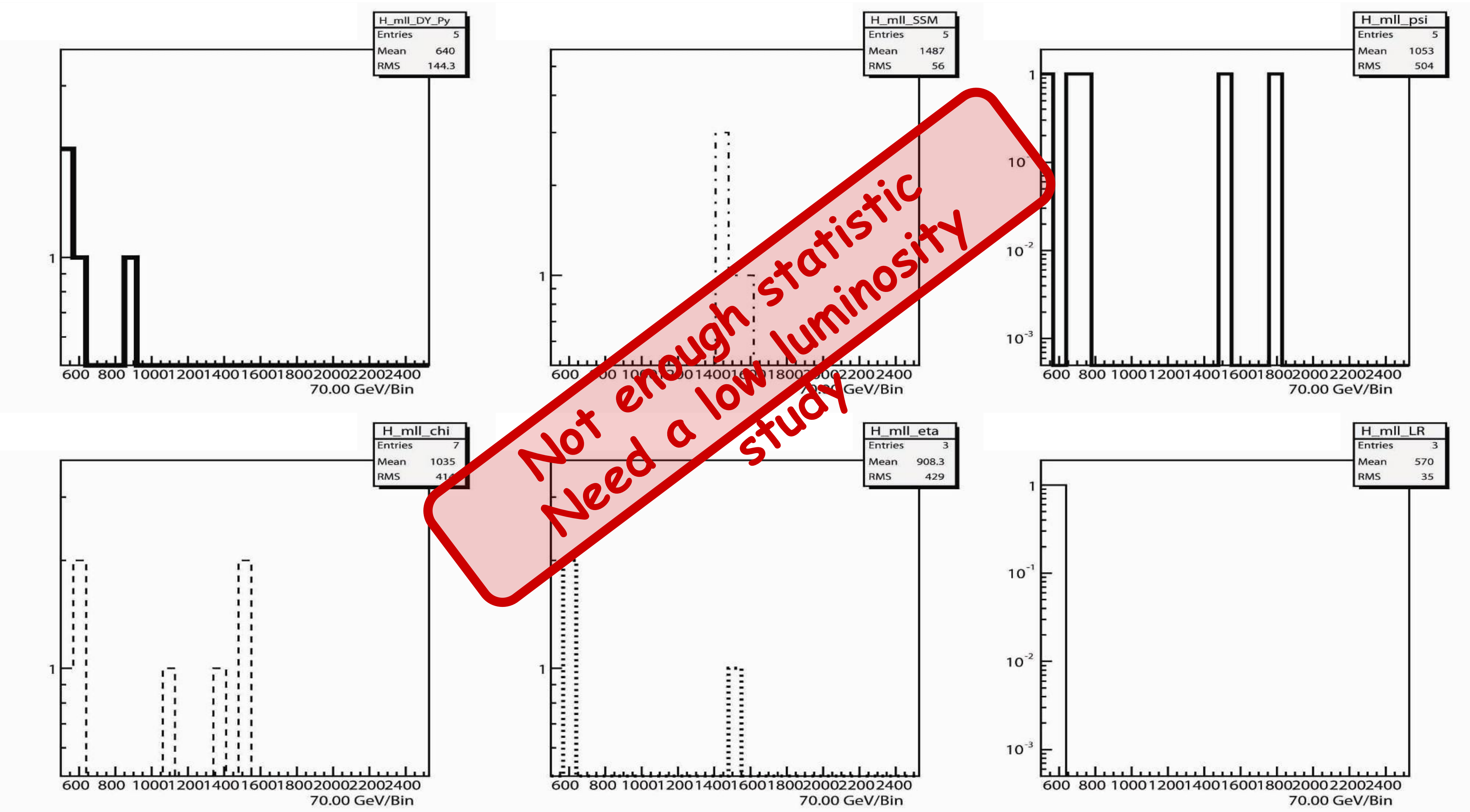
GUT Z’ at realistic luminosity

Reconstructed events



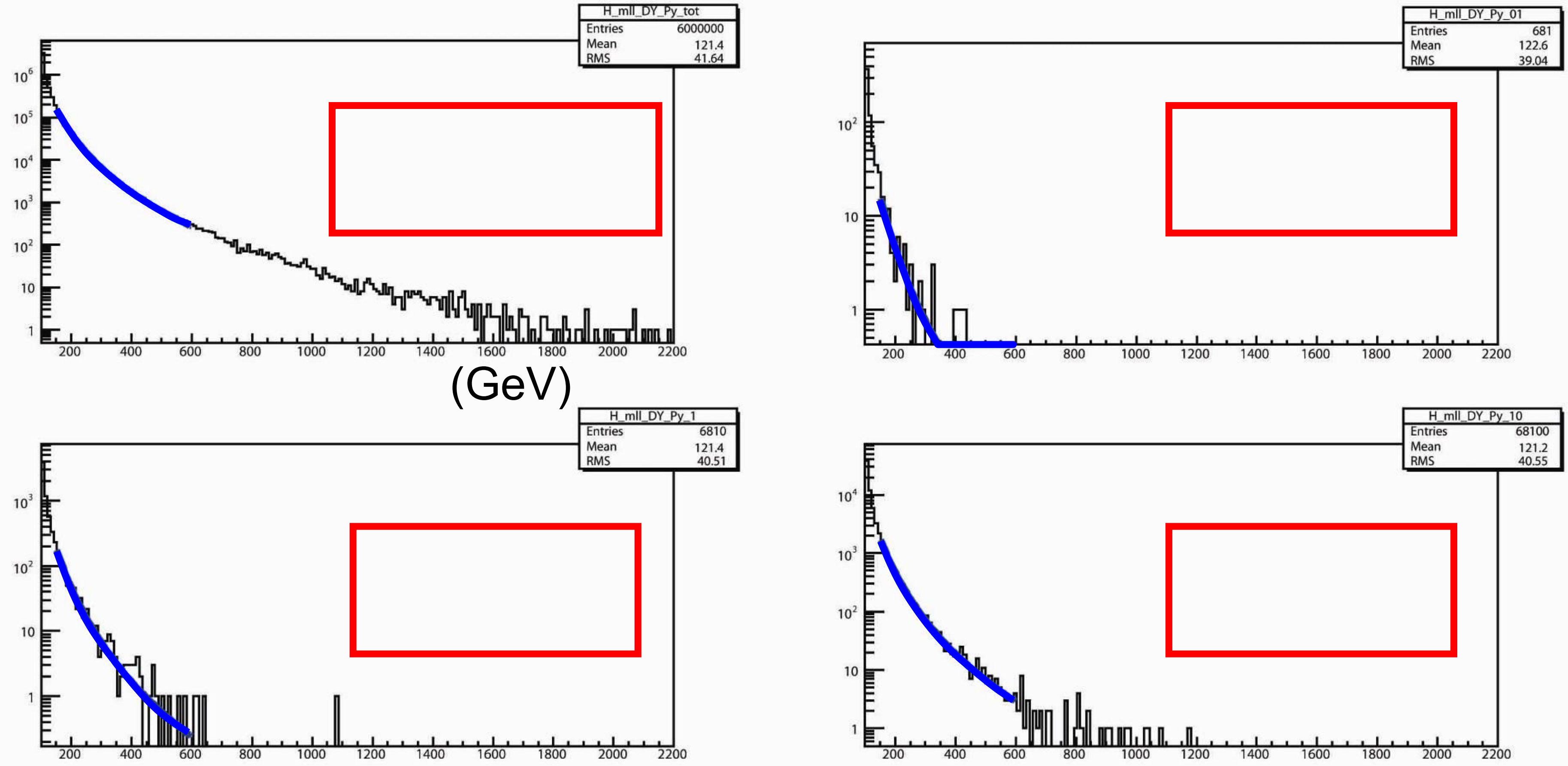
GUT Z' at realistic luminosity

Reconstructed events



How can we use the low luminosity data in our Z’ study ?

Fit of the DY invariant mass between 150 and 600 GeV



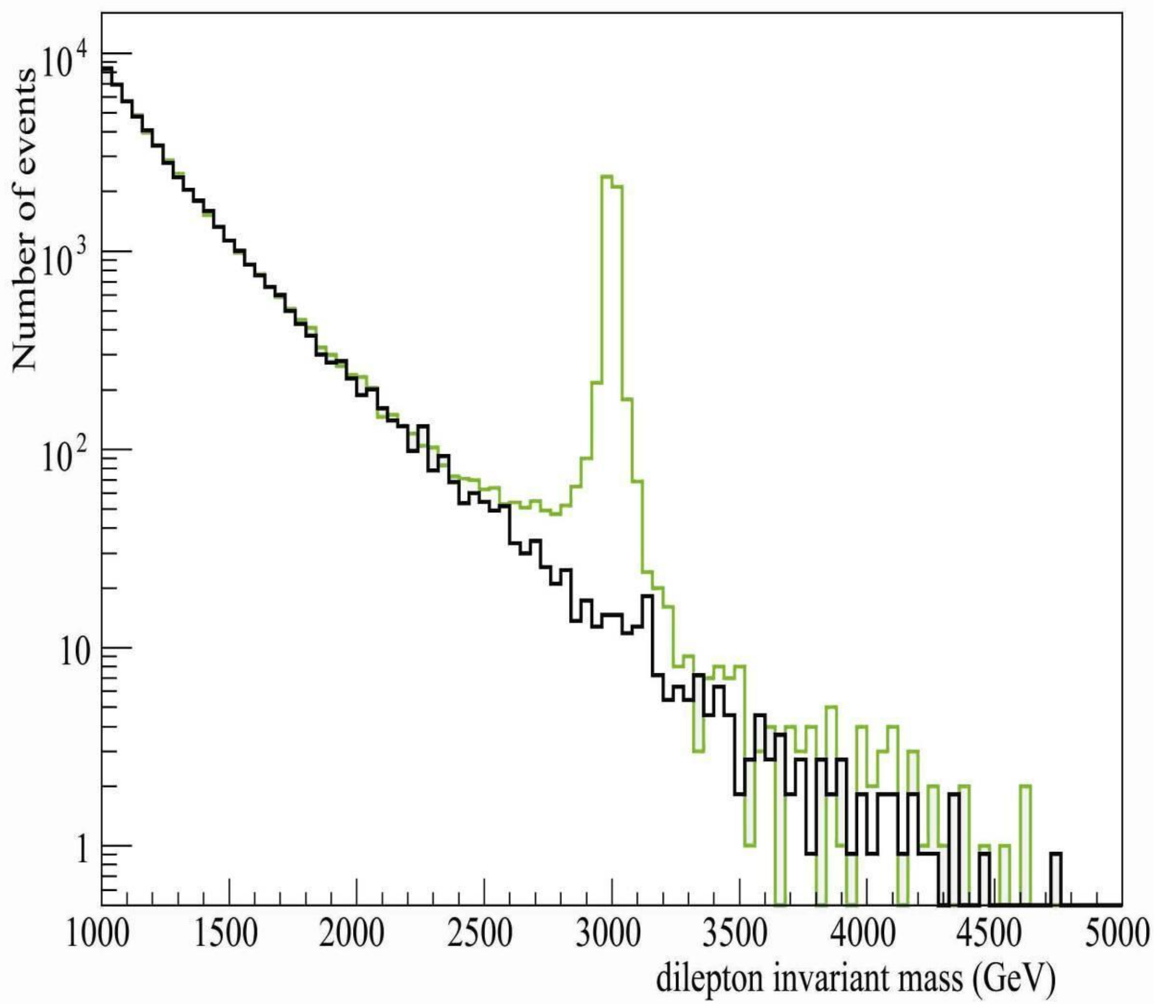
Good fit for luminosity equal to few fb^{-1}

A study of the fit parameters may give us informations even at low luminosity

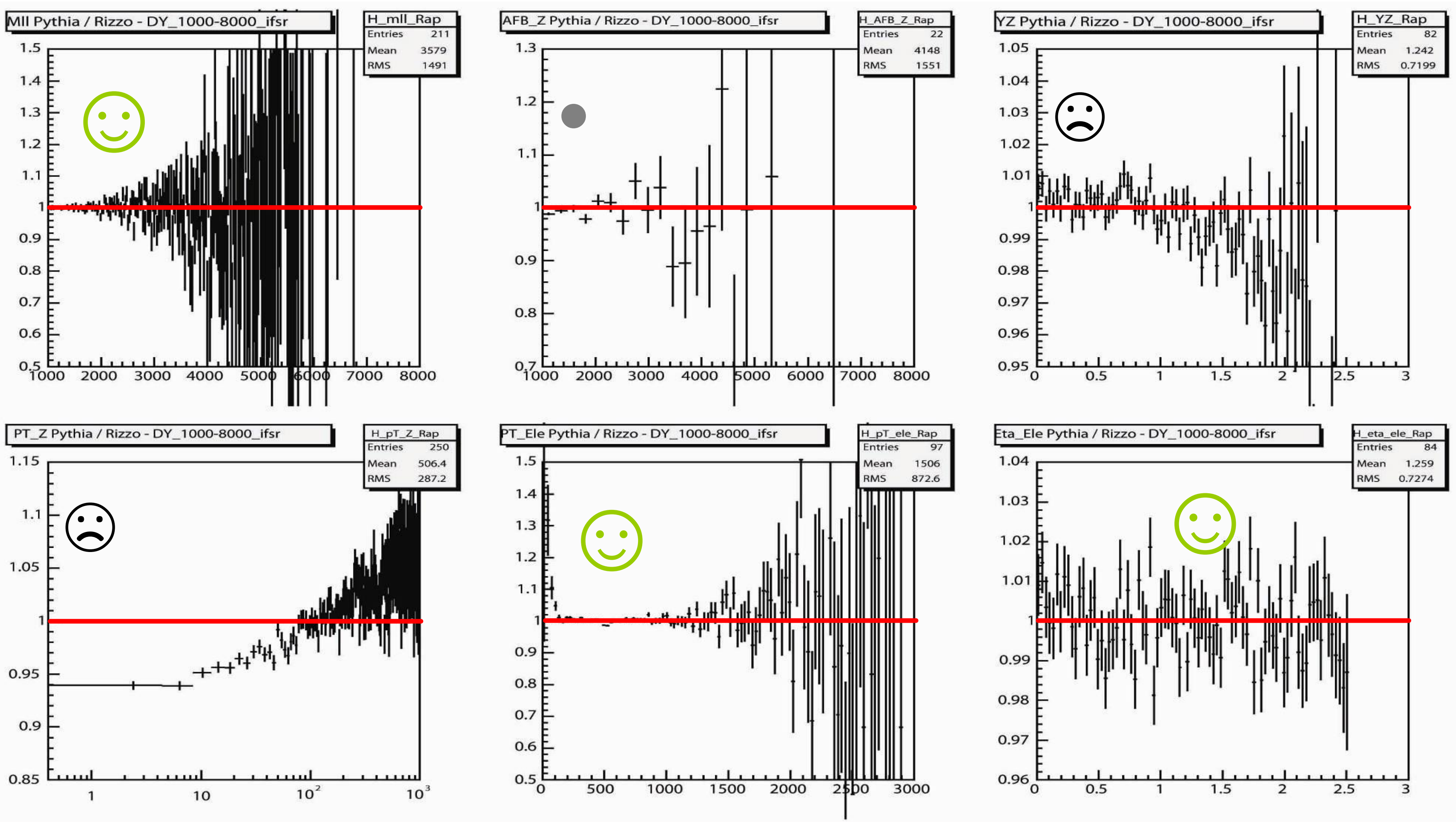
ATLAS Discovery potential

Signal = Z'

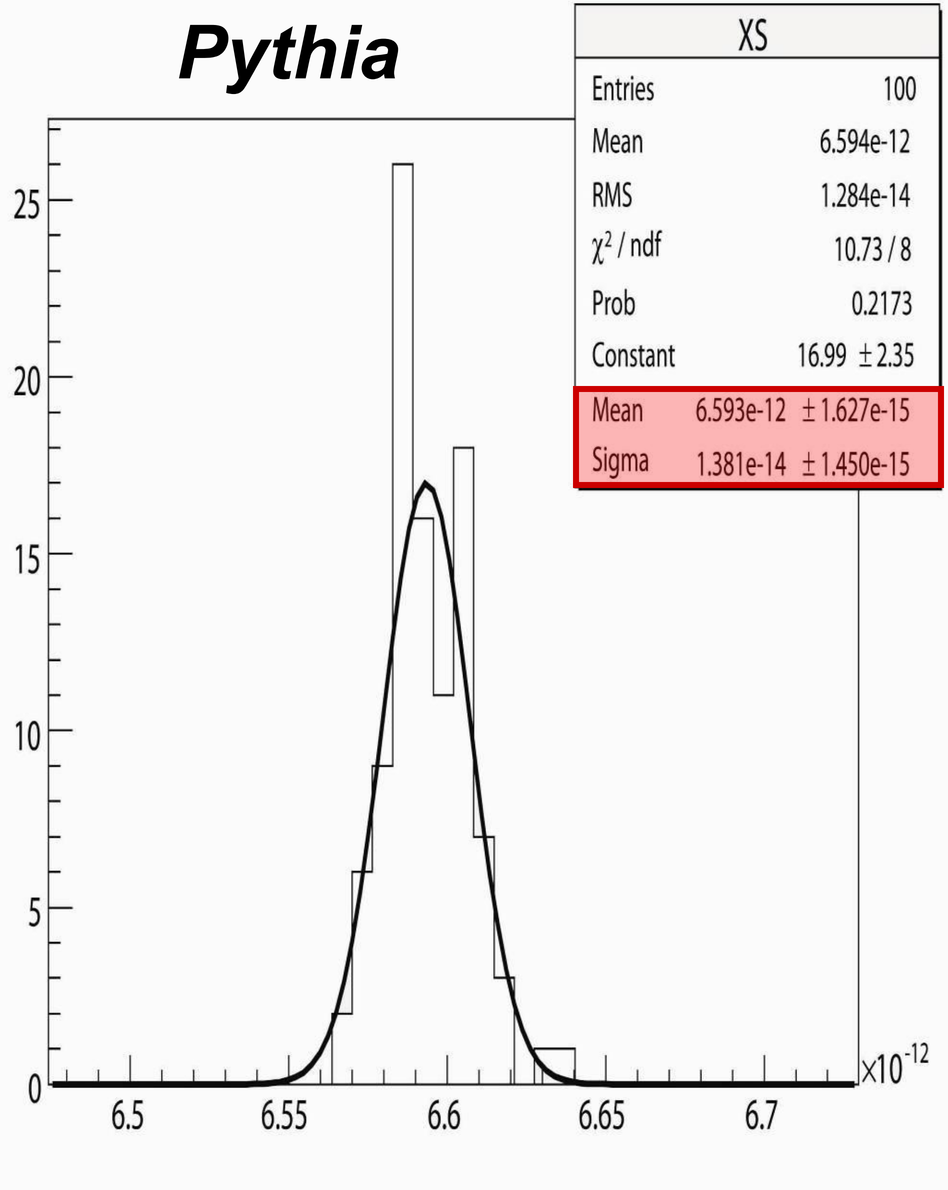
background = Drell-Yan (γ/Z MS)

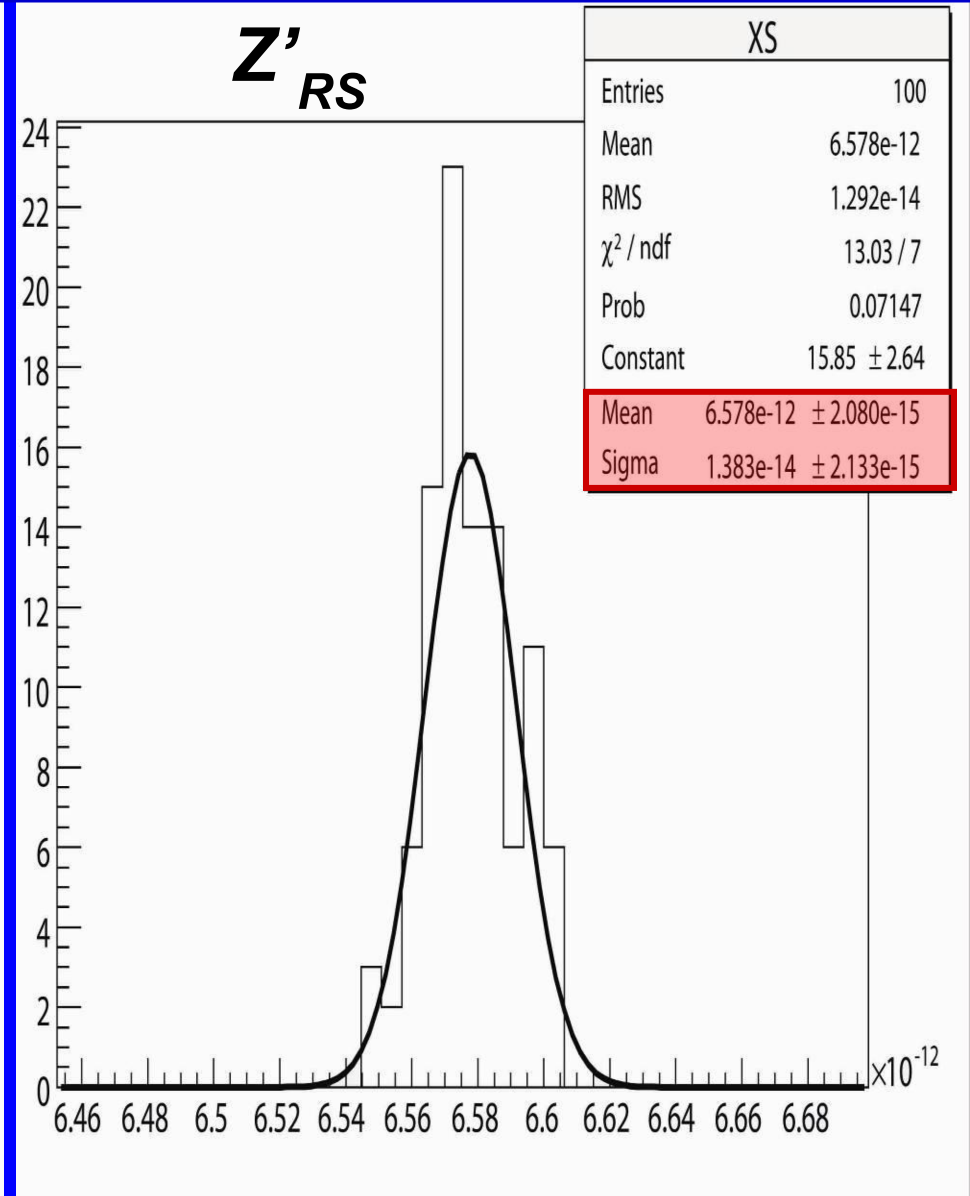


Comparison between standard Pythia and our generator



Cross section comparison





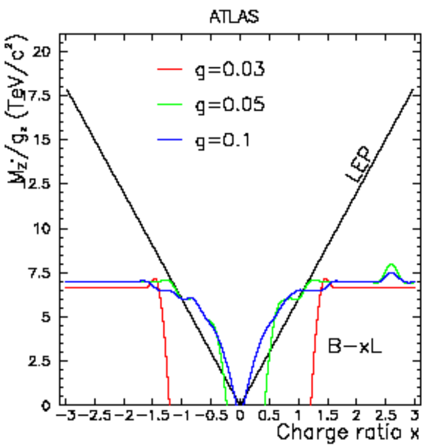
Results from our test

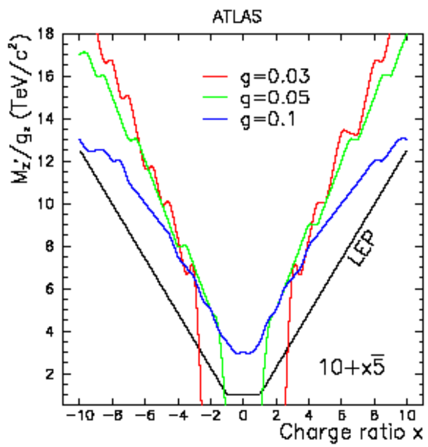
- We have to be careful with the Z'_{RS} p_T and rapidity when the ISR is switched ON.

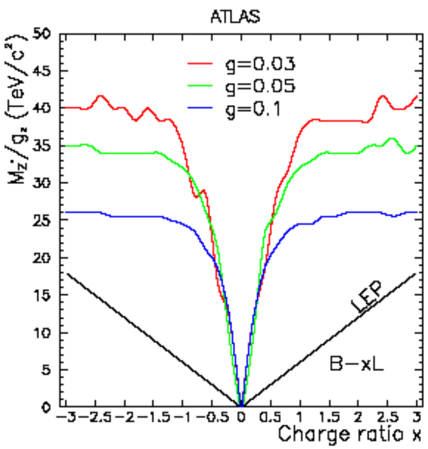
- The two generators give compatible results for the standard model process.

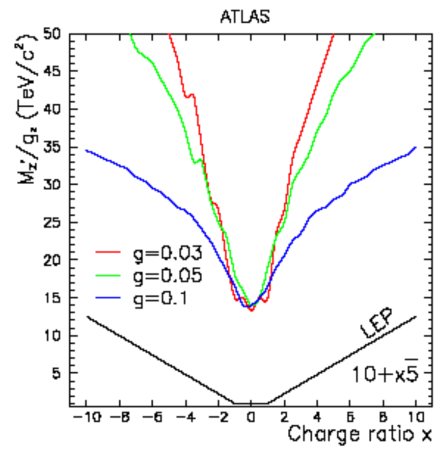
⇒ **We can generate Z'_{RS} events**

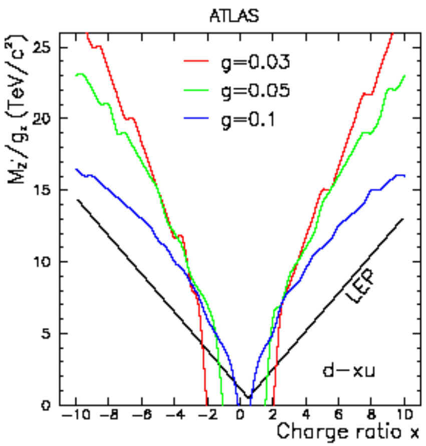
Z'$_{GUT}$ discovery potential - CDDT parameterized

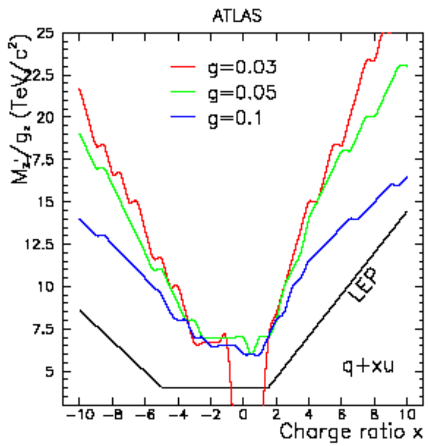


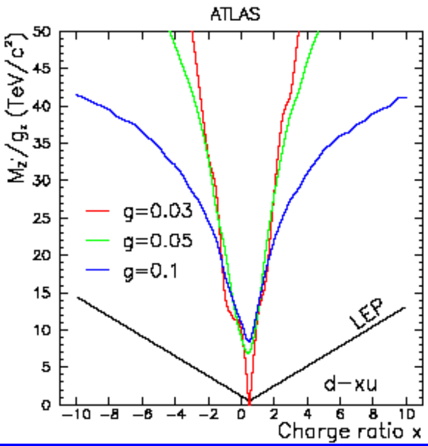


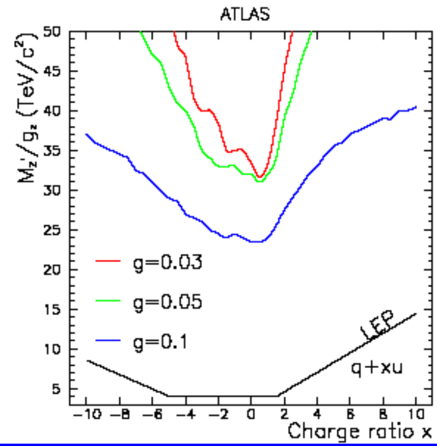












ATLAS discovery potential goes beyond the LEP limits in most scenarii, already with 400 pb^{-1}

Z'_{RS} discovery : the two channels and the two analyses are combined