Projections for Non-SUSY Searches at the LHC for 200pb^{-1} and 1fb^{-1}

BLOIS2010, France

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On behalf of the ATLAS and CMS Collaboration

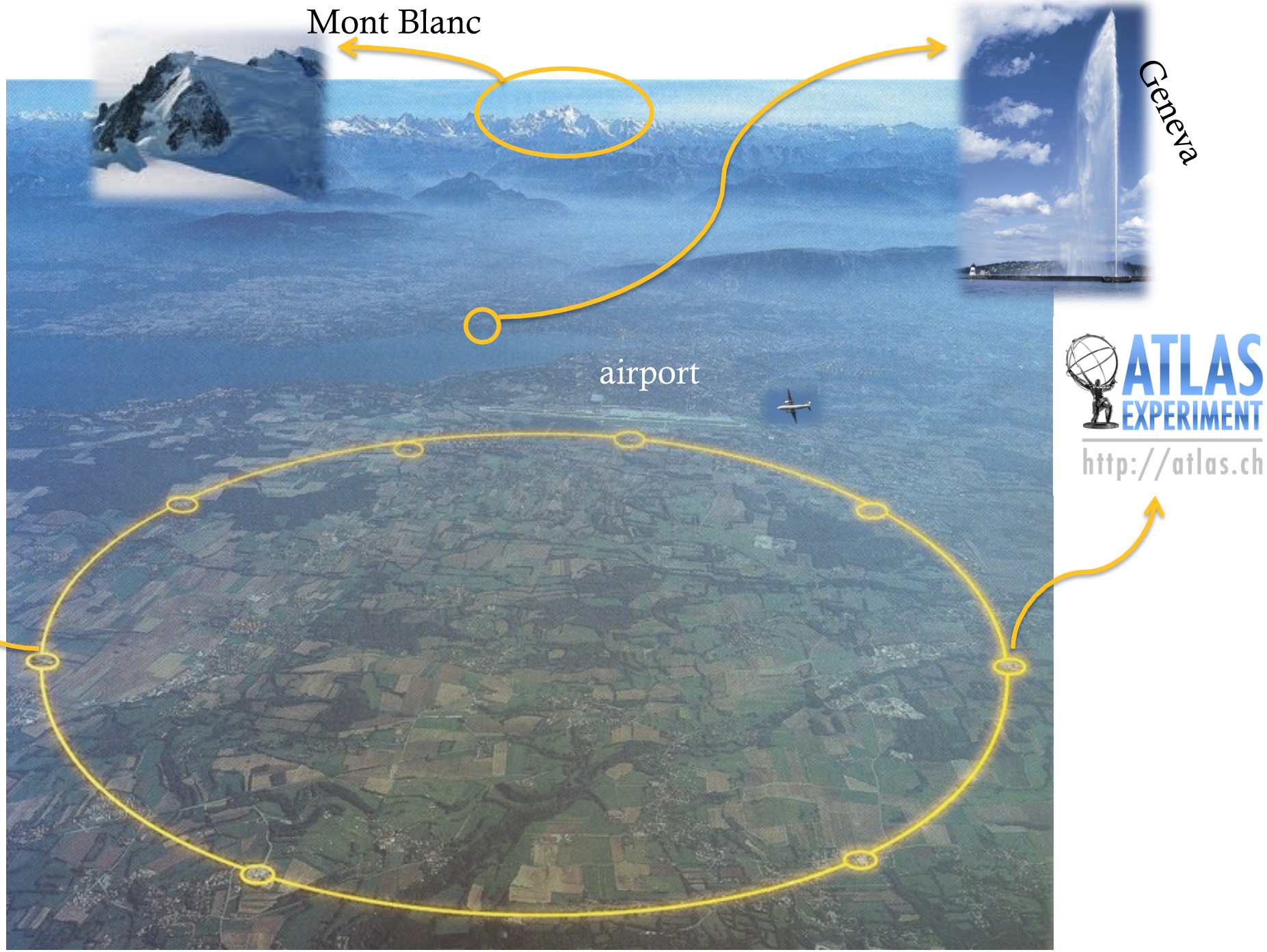
Outline

- Brief Description of The Detectors.

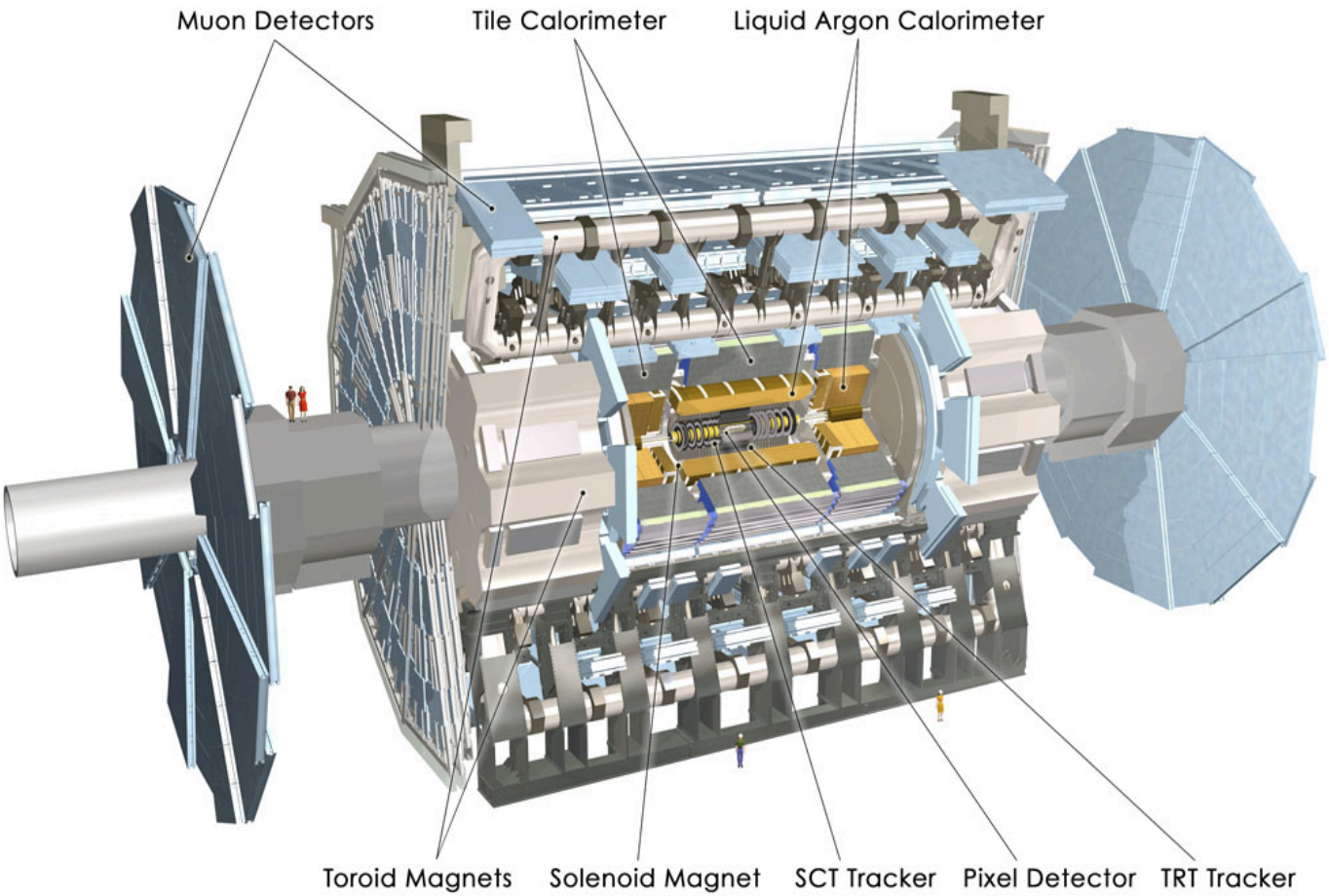
(Details were given in plenary talks by L. Rossi, M. Shapiro and A. De Roeck.)

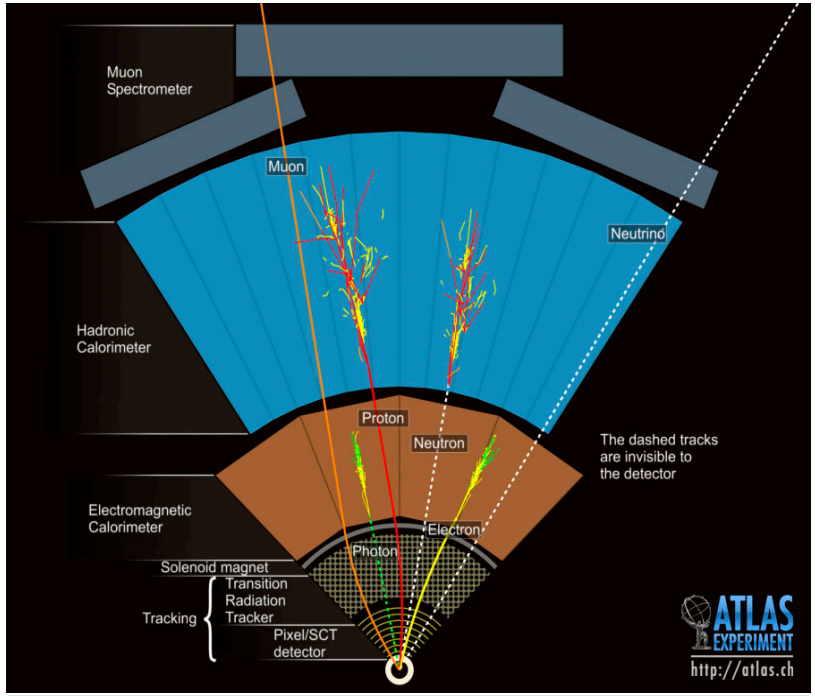
- LHC sensitive to a broad array of new physics.
- Discovery potential of some of these new physics final states.
- Give a general feeling of what LHC groups are doing.
  - Selection of few benchmark analyses.
  - Will try to cover topics involving different experimental challenges.

LHC


Mont Blanc
Geneva
airport
CMS
ATLAS
EXPERIMENT
http://atlas.ch

ATLAS





Tracker[1]

Si pixels, strips + TRT (pid)

$\sigma(1/p_T) \approx 0.34(1 \oplus 0.44\ \mathrm{TeV}/p_T)\mathrm{TeV}^{-1}$

EM Calorimeter[3]

Pb + Lar

$\sigma/E \approx 10\%\ \mathrm{GeV}^{1/2}/\sqrt{E} \oplus 0.2$

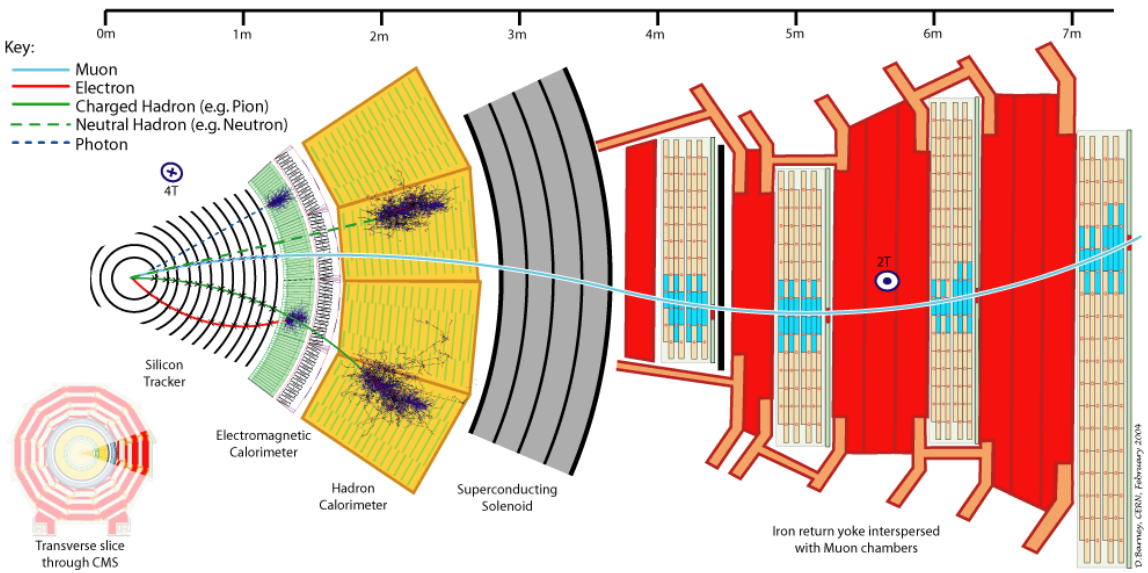
Had. Calorimeter[1]

Fe+scintillator / Cu + Lar

$\sigma/E \approx 60\%/\sqrt{E} \oplus 0.03$

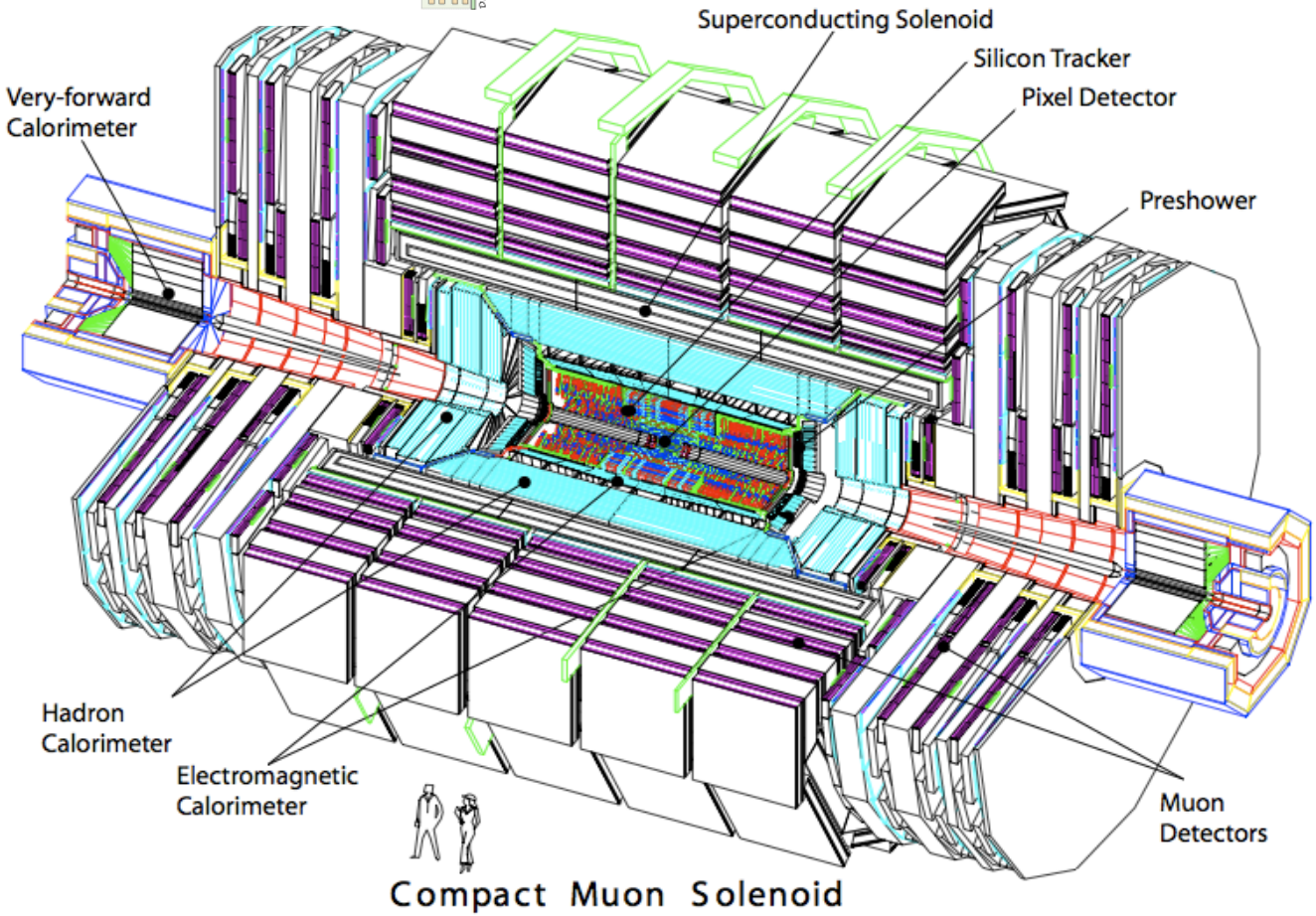
Combined Muons[1,2]

2%@50GeV to 10%@1TeV



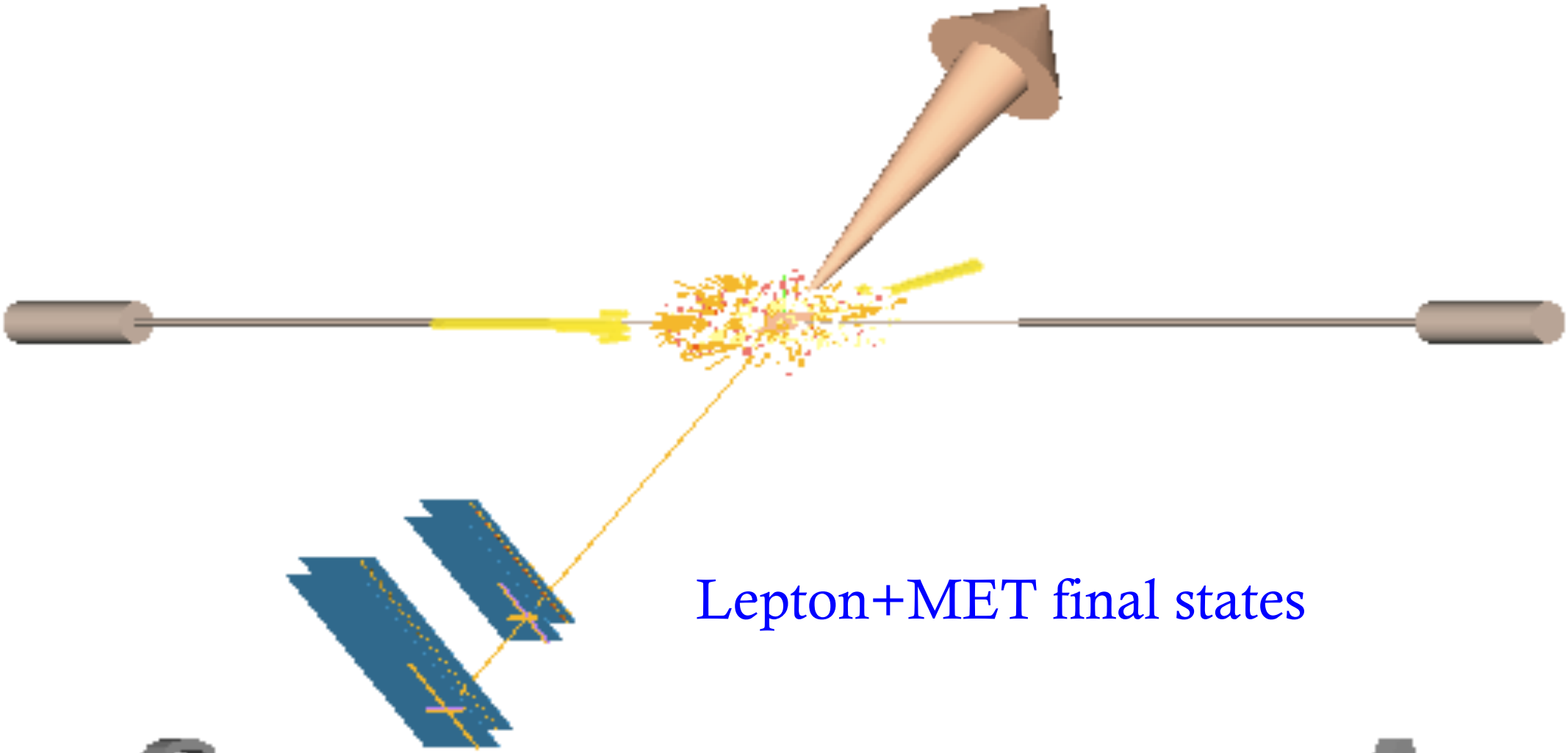
CMS

CMS
Tracker[5] Si Pixels, strips $\sigma(p_T)/p_T \approx 0.17\ p_T \oplus 0.05(p_T \text{ in GeV/c})$
EM Calorimeter[4] $PbW0_4$ crystals $\sigma/E \approx 2.8\%/\sqrt{E} \oplus 125\ \text{MeV}/E \oplus 0.3\%$
Had. Calorimeter[6] Cu+scintillator $\sigma/E \approx 100\%/\sqrt{E}$
Combined Muons[6] 1%@50GeV to 5%@1TeV



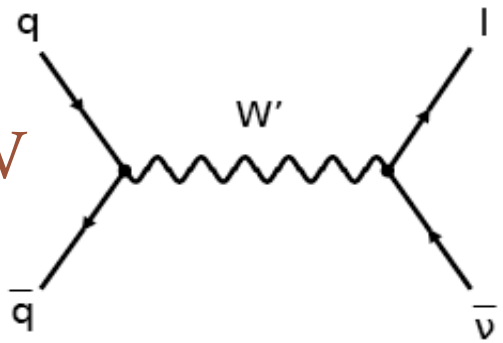
Selection of few benchmark analyses

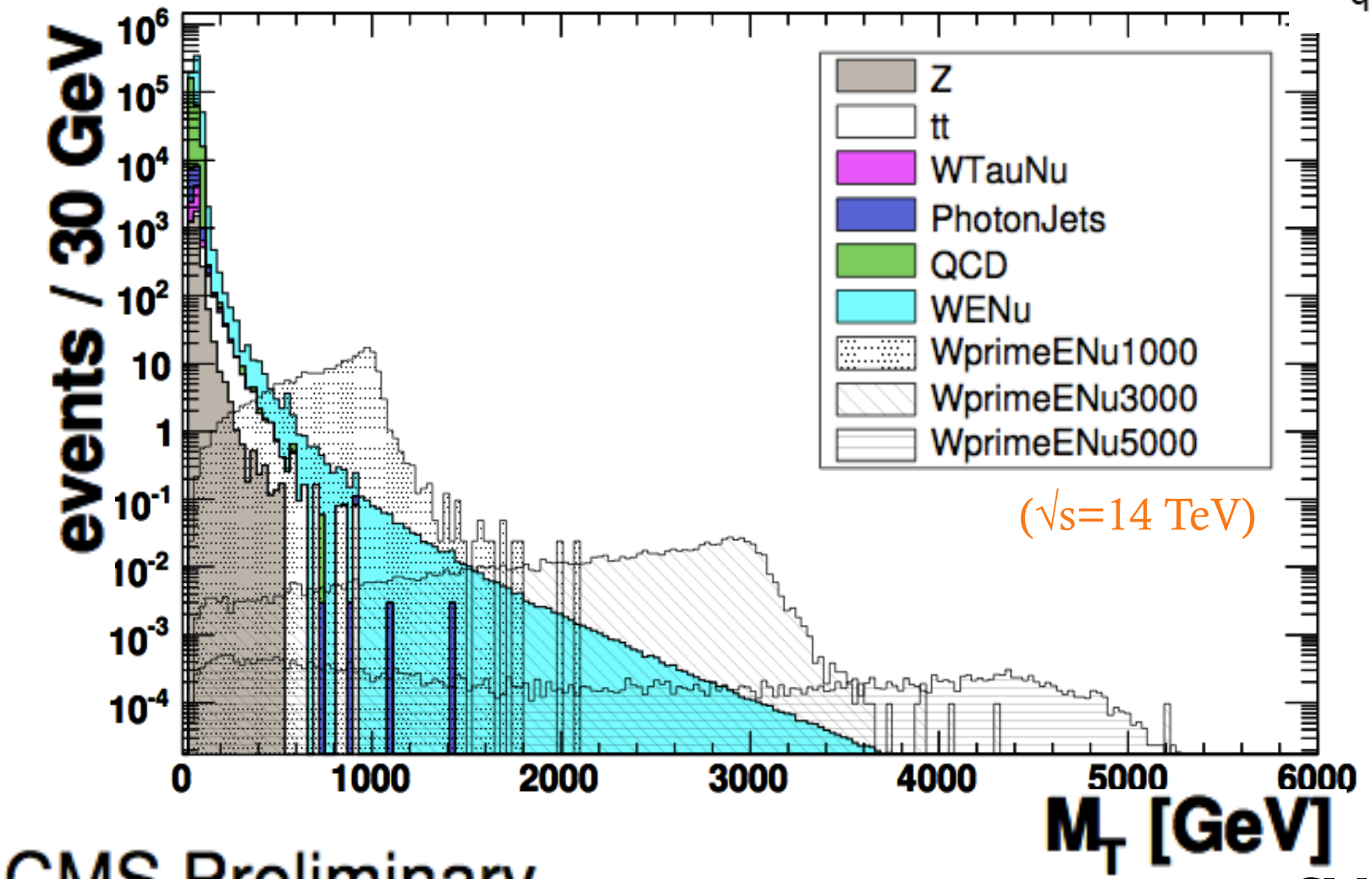
- Lepton Plus Missing Energy Final States
- Di-lepton Final States
- Lepton Plus Jets Final States.



Lepton+MET final states

- W' in the Sequential Standard Model:
  - Lower bound on W' mass (direct searches): ~1TeV

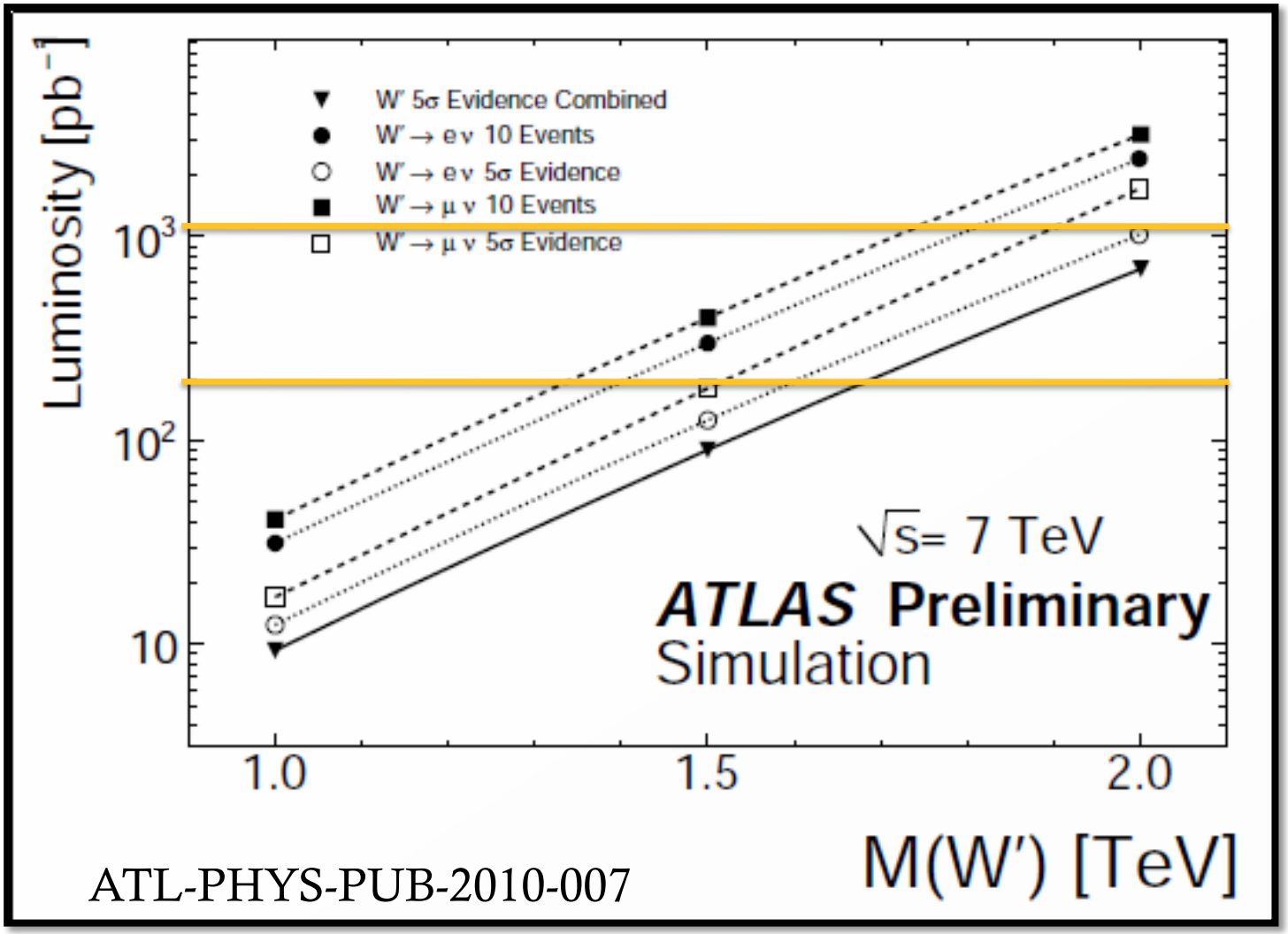




CMS Preliminary

CMS PAS EXO-08-004

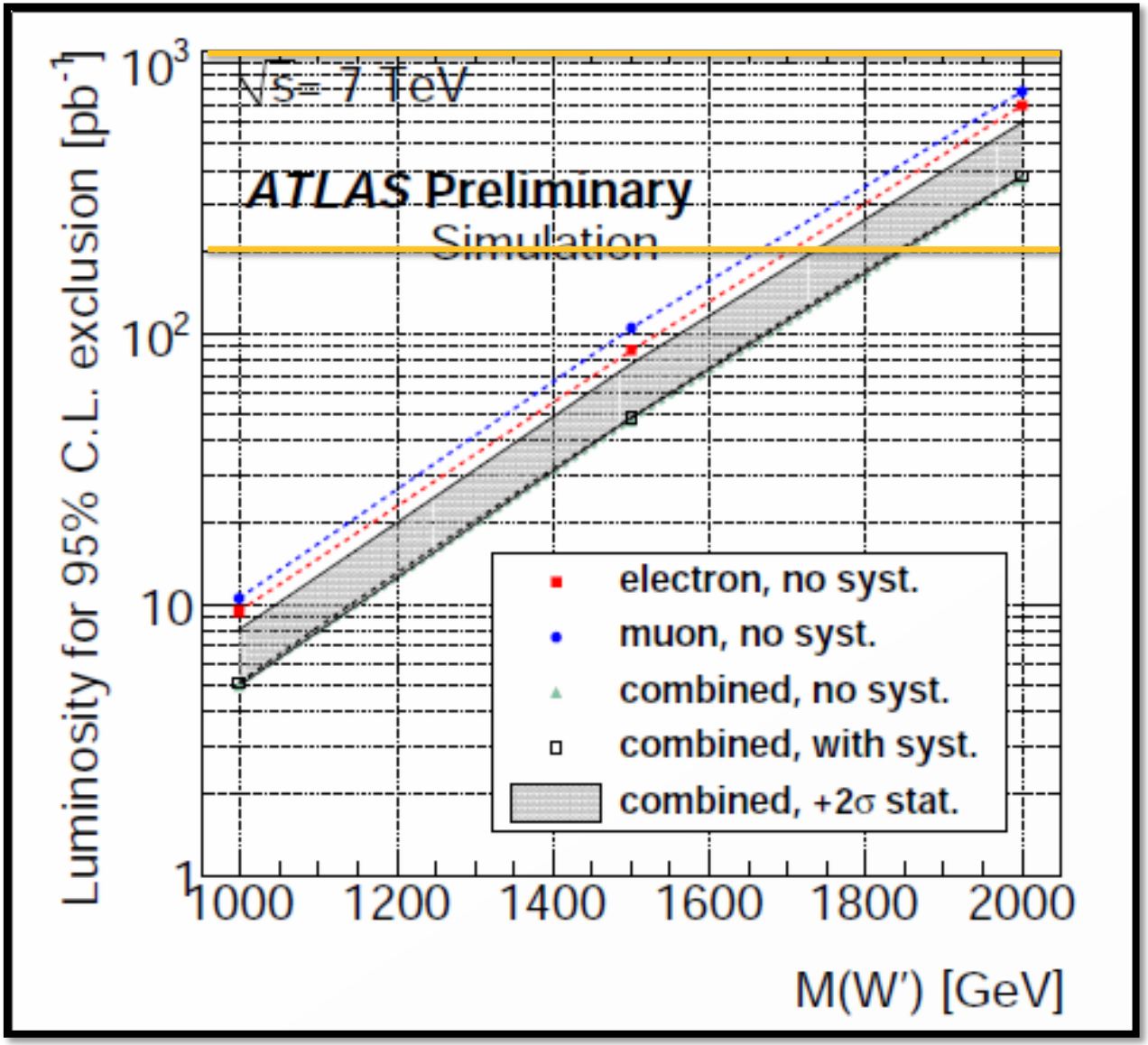
Discovery Potential for W'



ATL-PHYS-PUB-2010-007

Exclusion Limits forW'

- Exclusion
- O(200pb^{-1}) up to ~1.8 TeV.
- O(1fb^{-1}) up to ~2.5TeV.



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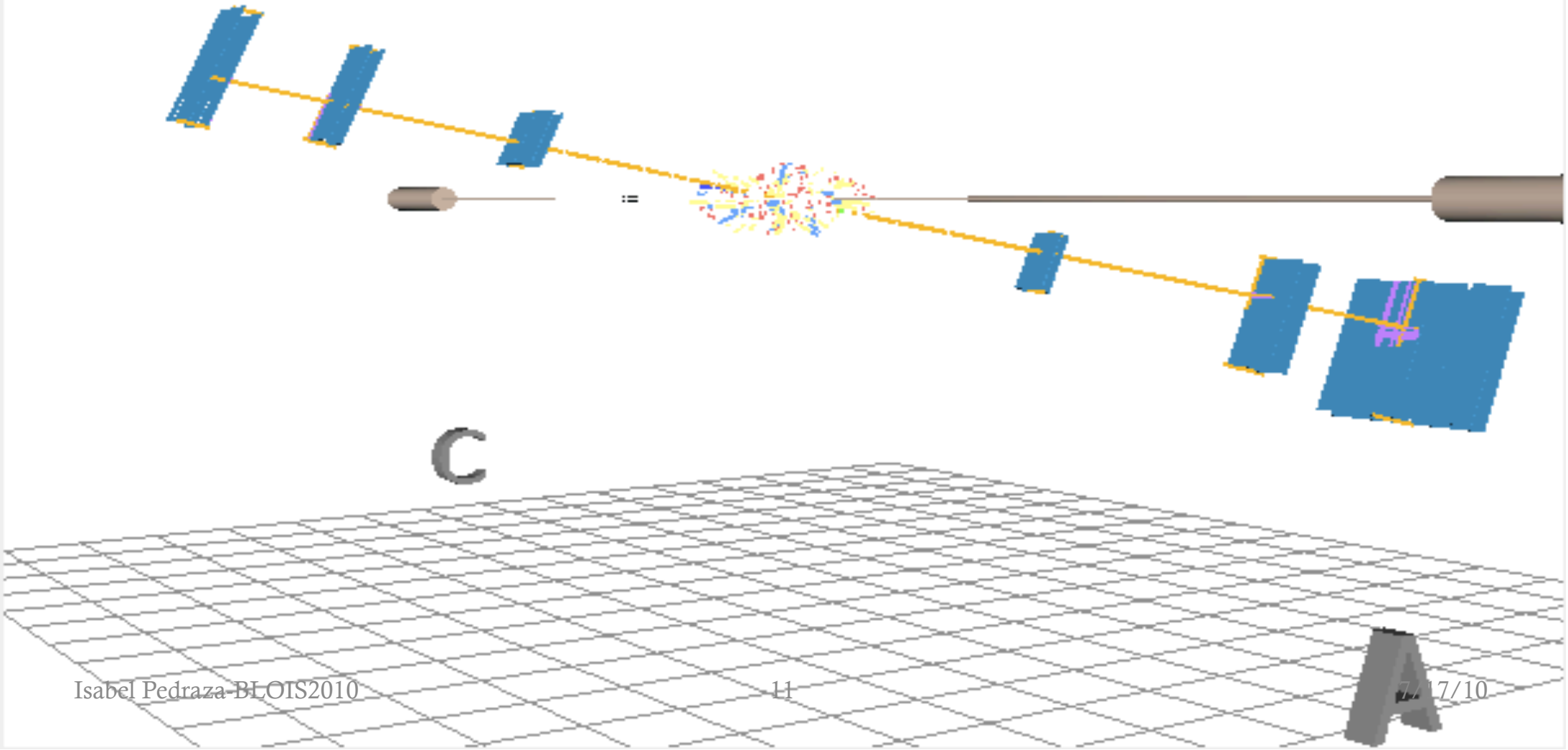
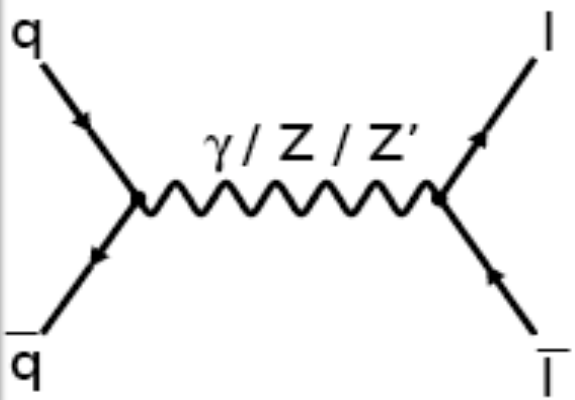
Narrow Resonances in Di-lepton final states



Z'
(mentioned by Yuri Gershtein in today's plenary talks)

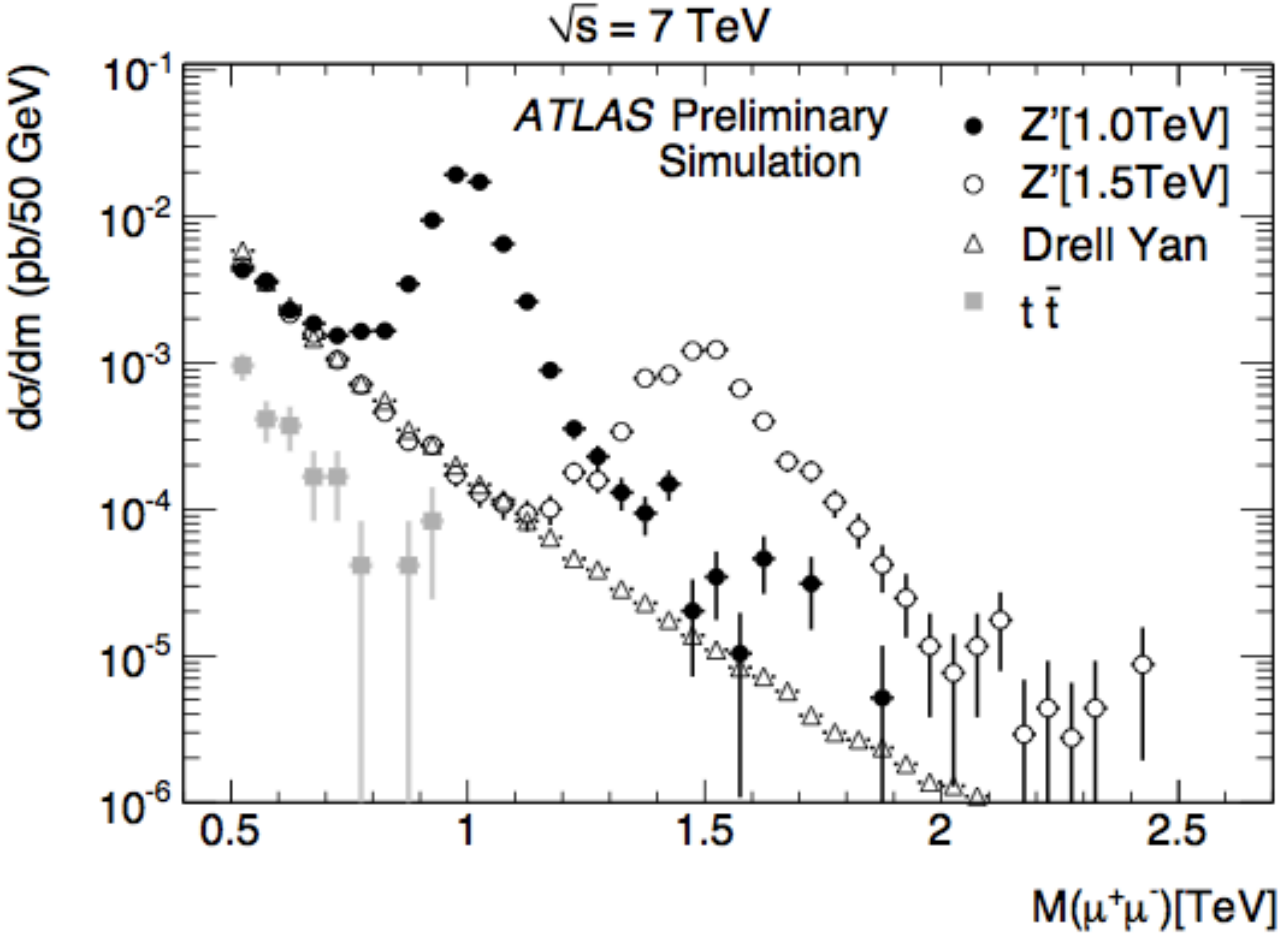
- Z' in some representative models:

Z' Model	Indirect Searches (GeV) [7][8]		Direct Searches (GeV) [8][9]
	Electroweak	LEP	$p\bar{p}$ Colliders
Z'_χ	680	781	930
Z'_ψ	137	481	917
Z'_η	619	515	938
Z'_{LRSM}	860	804	–
Z'_{SSM}	1500	1787	1071



- Standard Model backgrounds
  - For Z' → ee, μ μ
    - Drell-Yan
- For Z' → τ τ
  - ttbar
  - QCD
  - W+jets

Z'



- Z' → ee
  - 2 well recontructed electrons
  - p_T>20GeV (ATLAS)
  - Tracking Normalized Isolation < 5% (<2% CMS)
- Z' → μ μ
  - Two well recontructed muons
  - Tracking Normalized Isolation < 5% (ATLAS)
  - Opposite charged (CMS)

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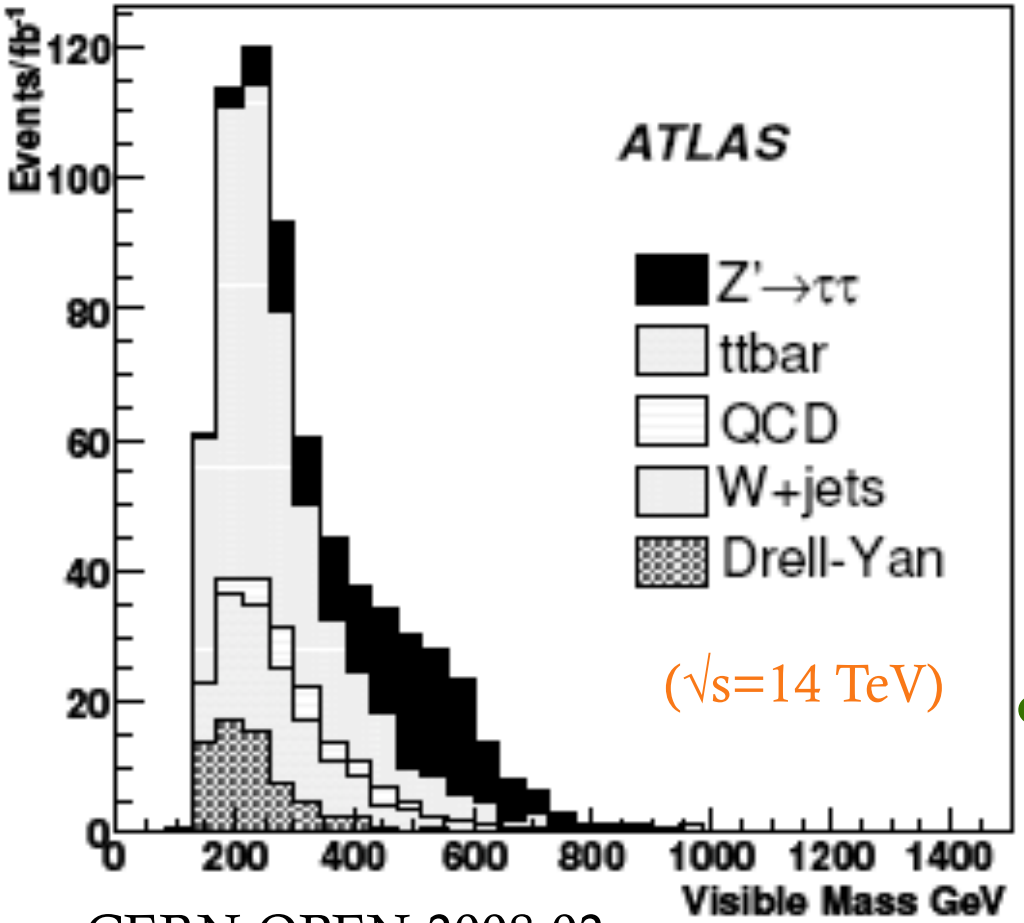
Z'



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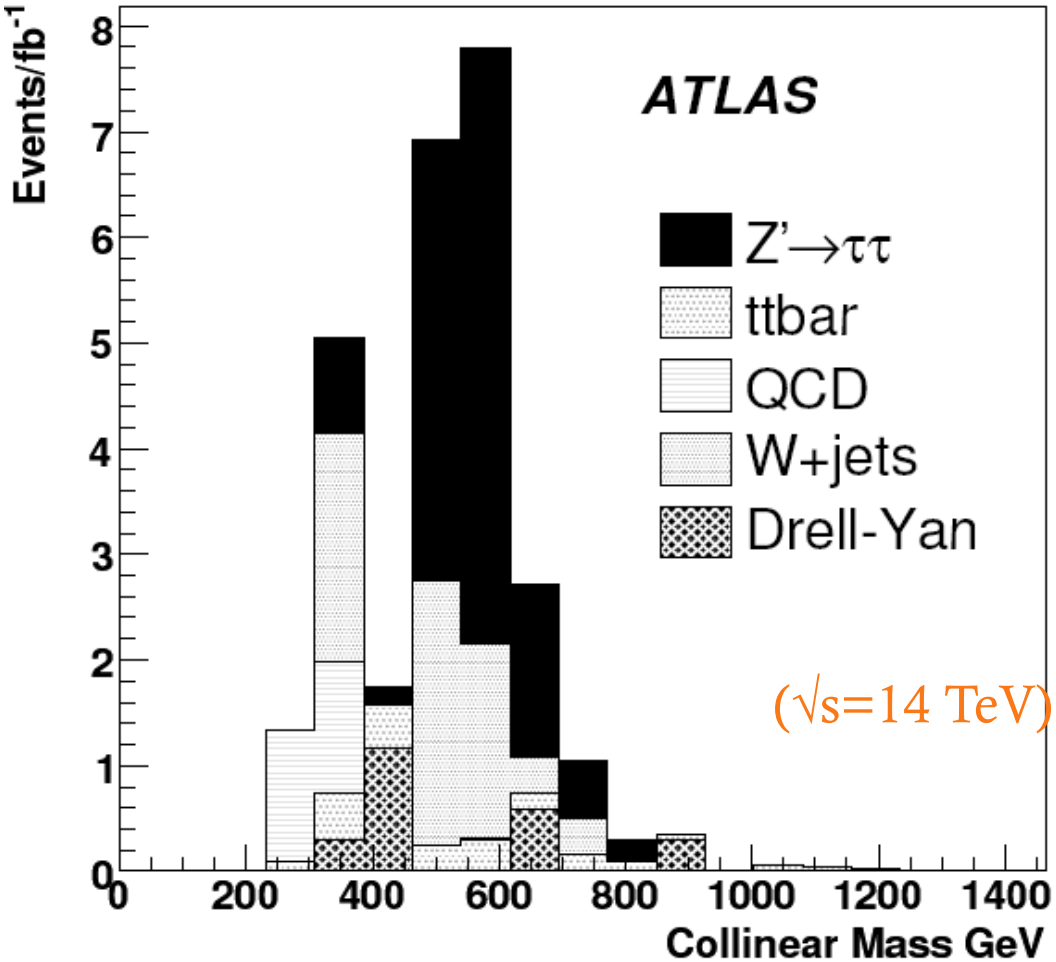
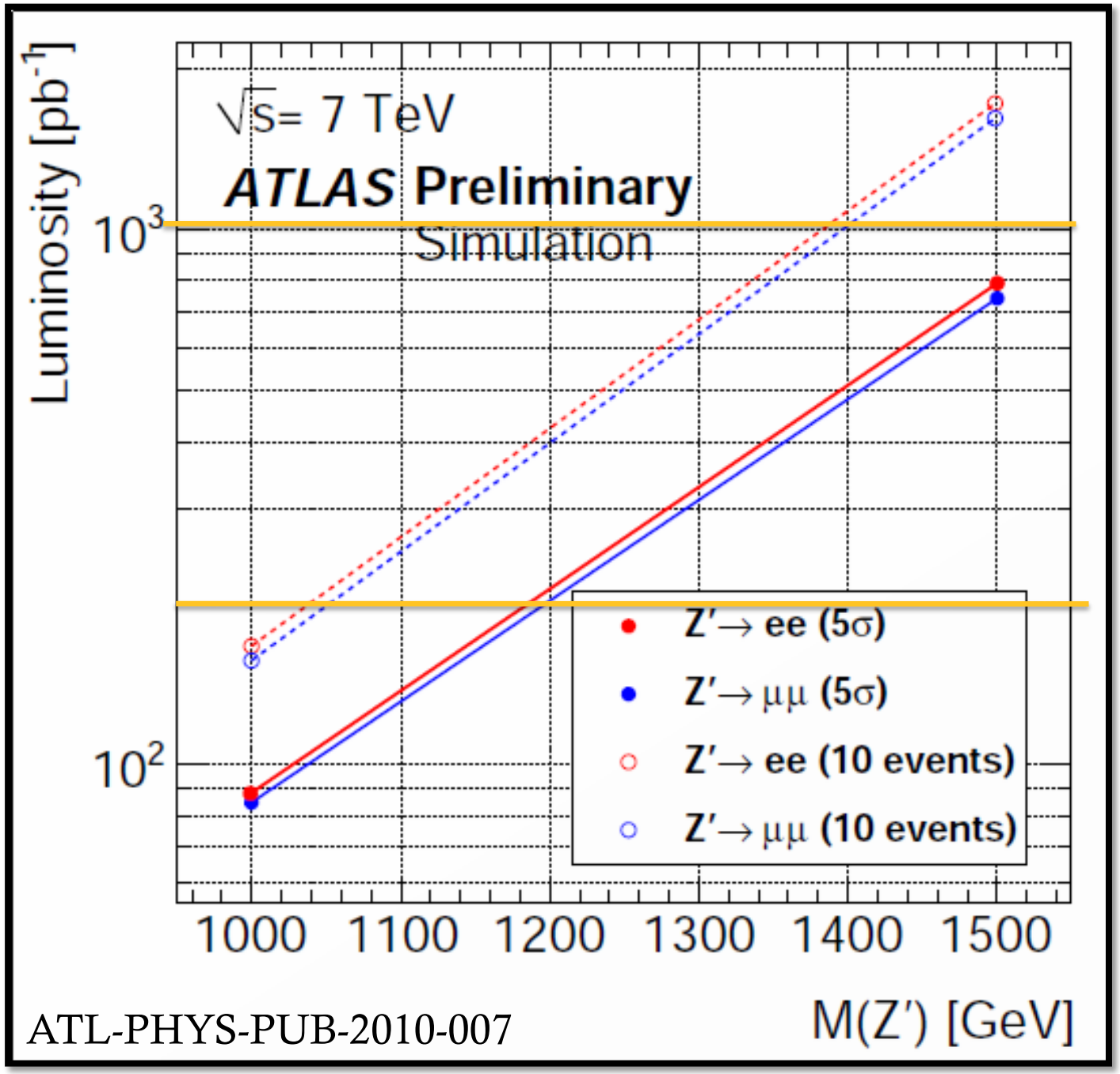


- $Z' \rightarrow \tau\ \tau$
- τ selection
- Opposite charge
- E_t^{miss}>30GeV
- m_T>300GeV
- p_T^{tot}<70GeV
- m_{vis}>300GeV
- $\cos\Delta\phi_{lh}$>-0.99

Discovery Potential Z'_{SSM}

- O(200pb^{-1})
  - Z' at ~ 1.2 TeV.
- O(1fb^{-1})
  - Z' at ~ 1.55 TeV.



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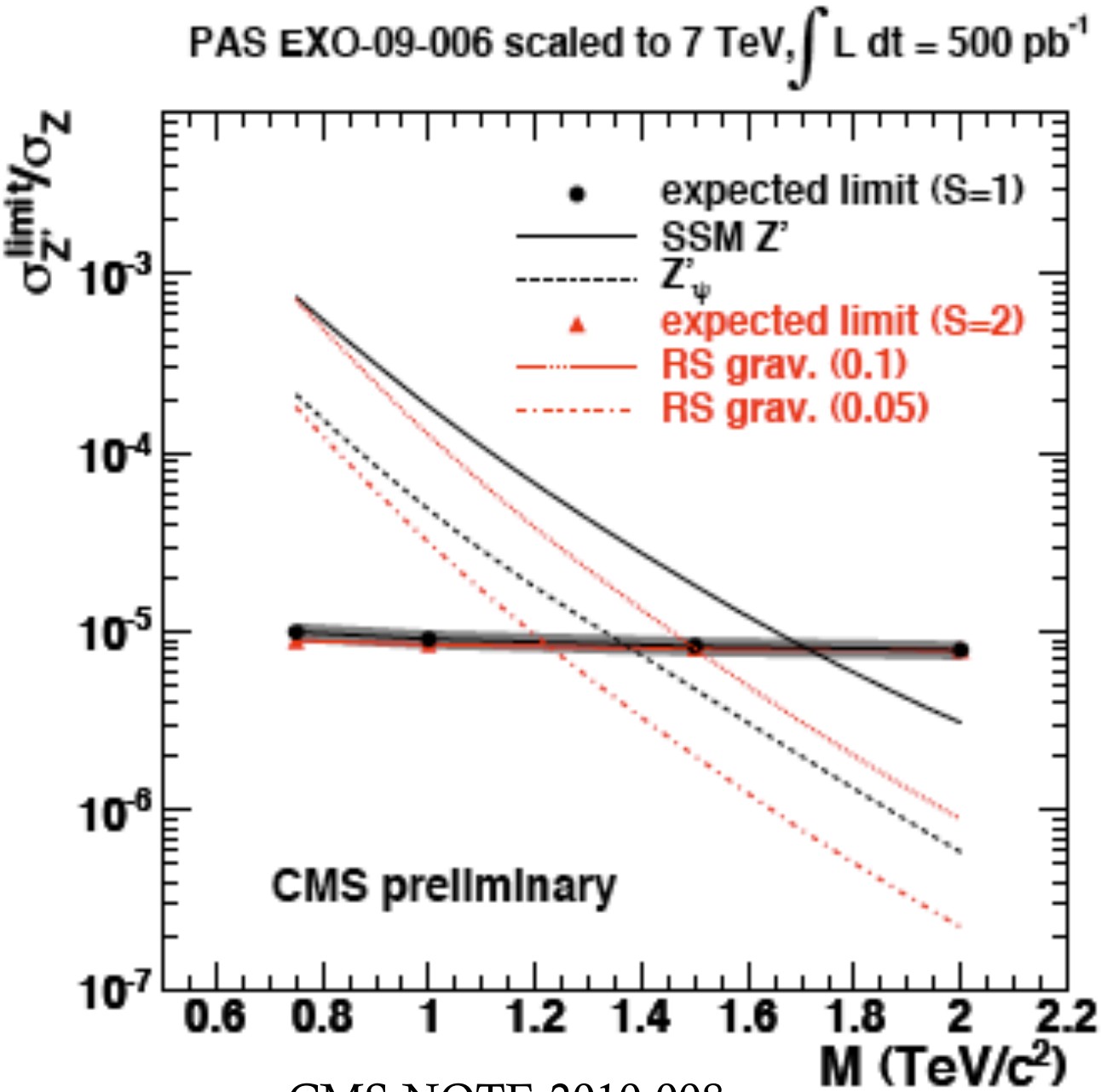
Exclusion Potential Z'

- O(200pb^{-1})
  - Z' at ~ 1.2 TeV.
- O(1fb^{-1})
  - Z' at ~ 1.55 TeV.

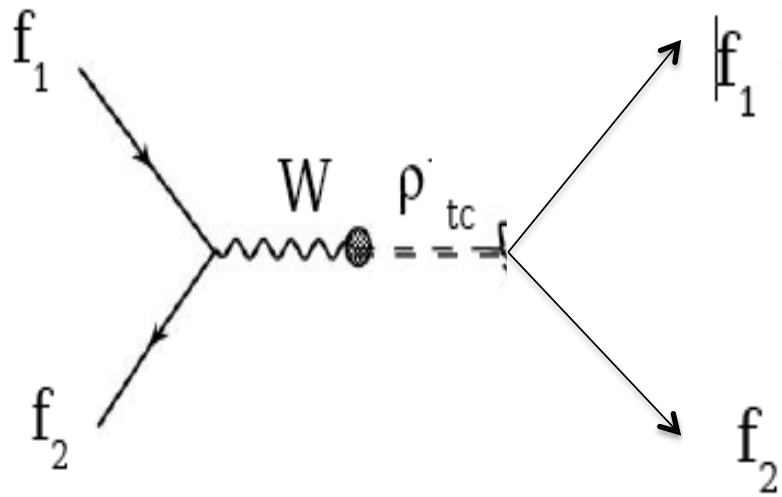


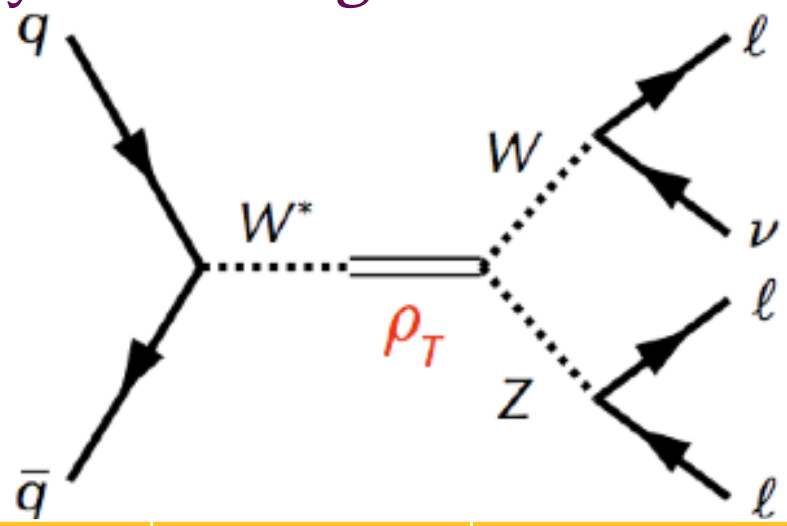
CMS-NOTE-2010-008

ρ_{TC} and ω_{TC}

(mentioned by Benjamin Grinstein in today's plenary talks)

- The "Technicolor Strawman Model" or TCSM is used as a benchmark model for generic strongly interacting theories.

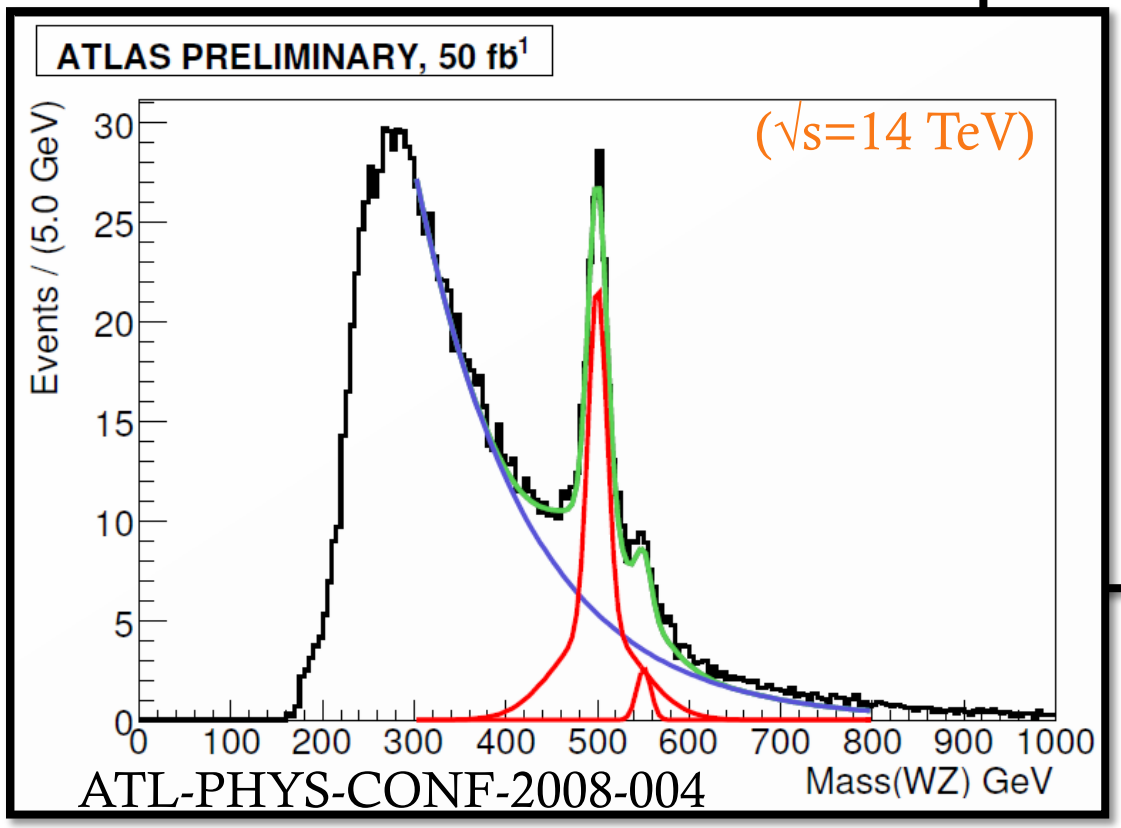




$m_{\rho TC, \omega TC}$	400	600	800	1000
Peak mass(GeV)	403	603	804	1004
σ (m) (GeV)	13	22	34	46

- Current Limit ρ_{TC} and ω_{TC} masses below 280 GeV [10]

ρ_{TC} and ω_{TC}



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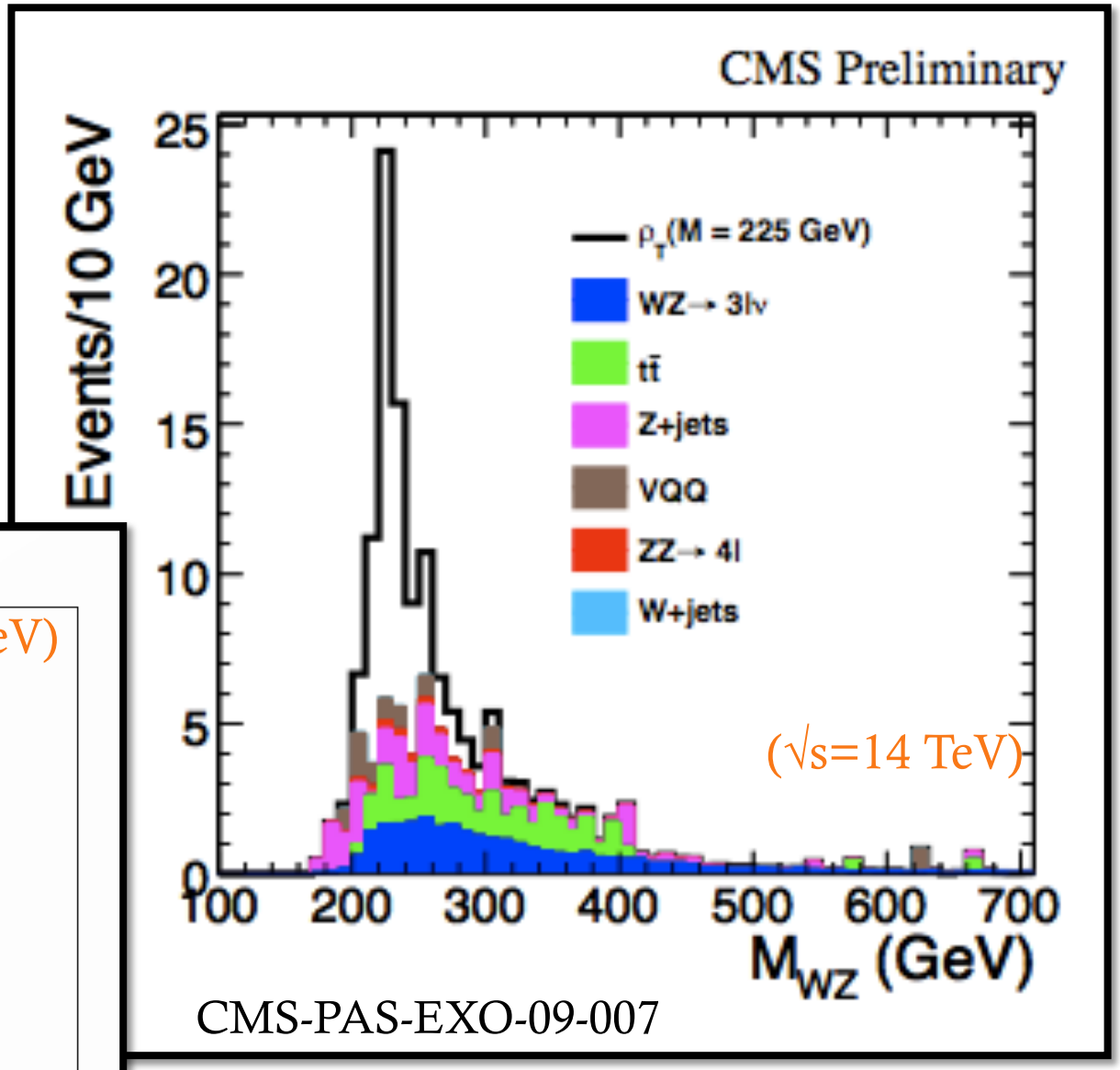
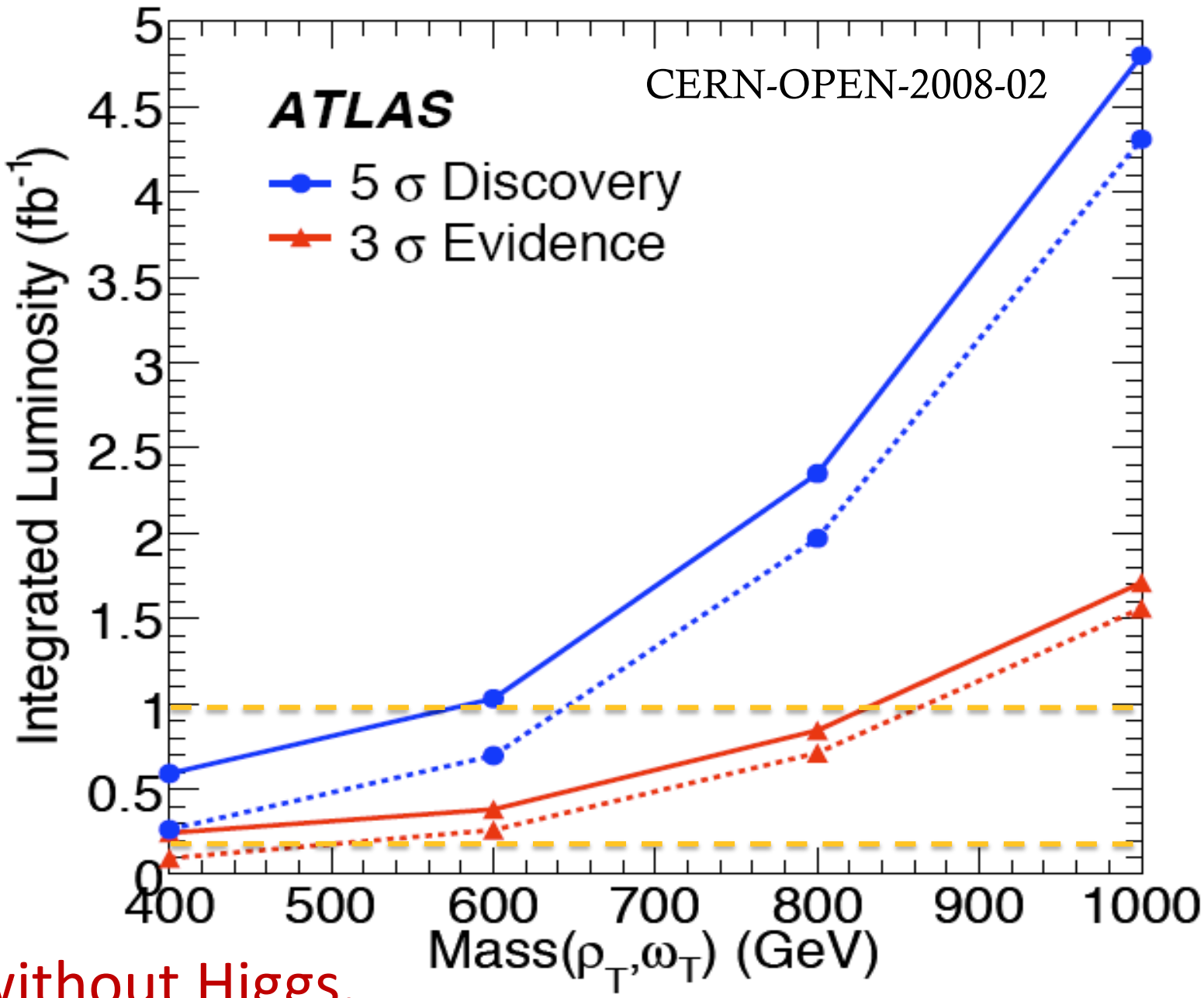


CMS-PAS-EXO-09-007

Discovery Potential ($\sqrt{s}$=14 TeV)

ρ_{TC} and ω_{TC}



- 1 fb^{-1} ->world without Higgs.

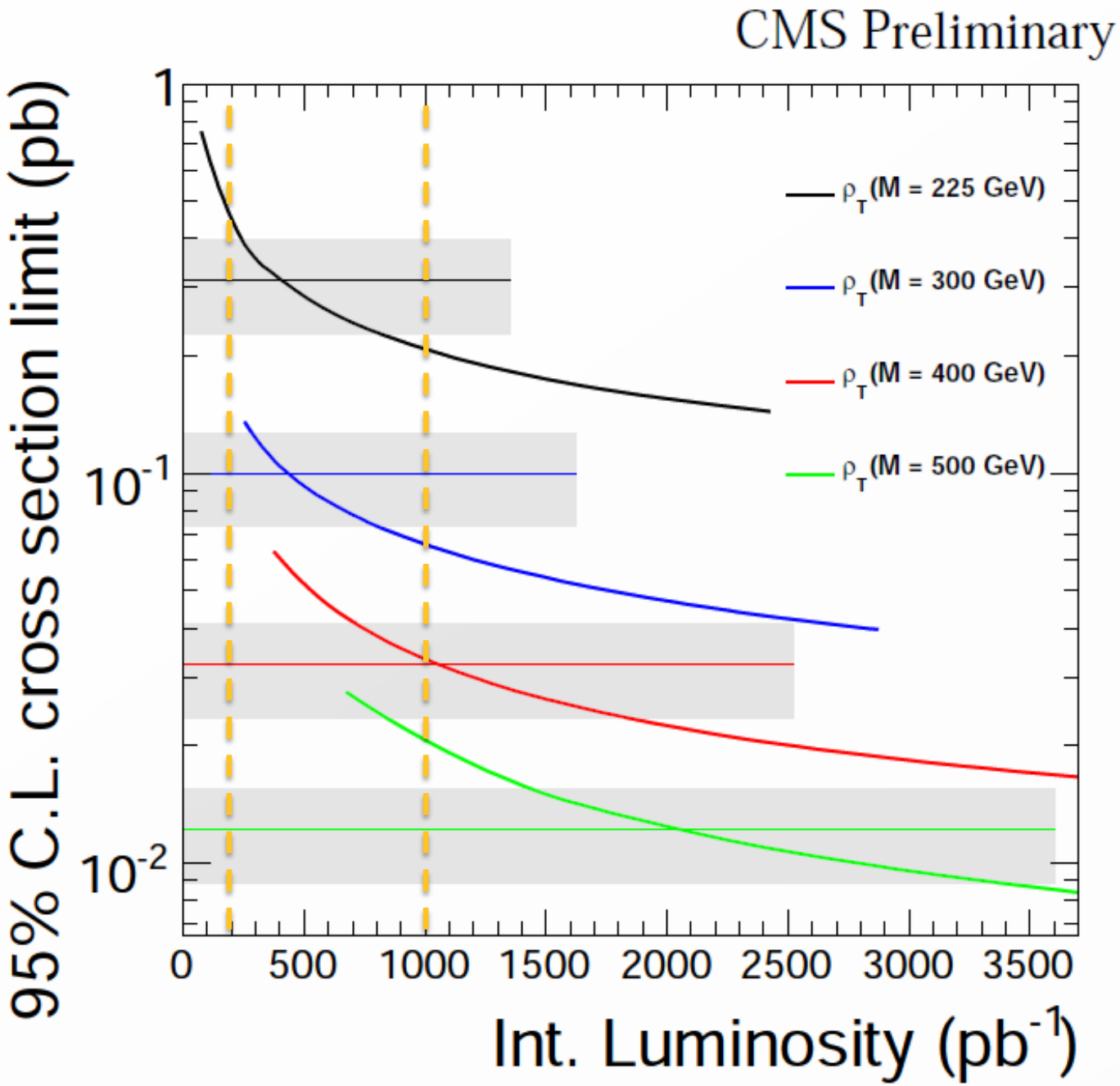
(Considering the scaling of the production cross section for √s=7 TeV)

Exclusion Limits ρ_{TC} and ω_{TC}

$\sqrt{s}$= 10 TeV

- 1 fb^{-1} would allow to go beyond Tevatron Limits

(Considering the scaling of the production cross section for $\sqrt{s}$=7 TeV)

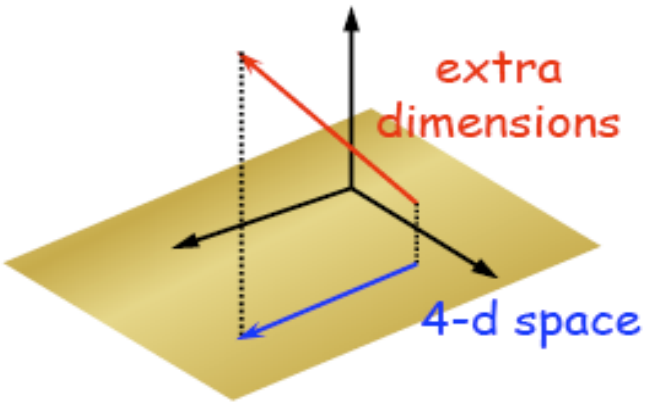


CMS-PAS-EXO-09-007

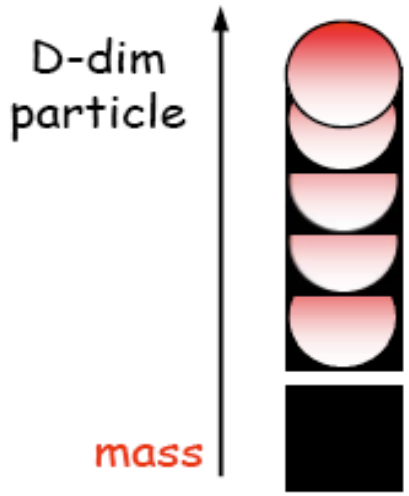
Graviton

(Some description given in Carlos Wagner talk, and Yuri Gershtein)

- Randall-Sundrum model addresses the hierarchy problem by adding one extra-dimension. It predicts the existence of a tower of Kaluza-Klein exitations of the graviton.



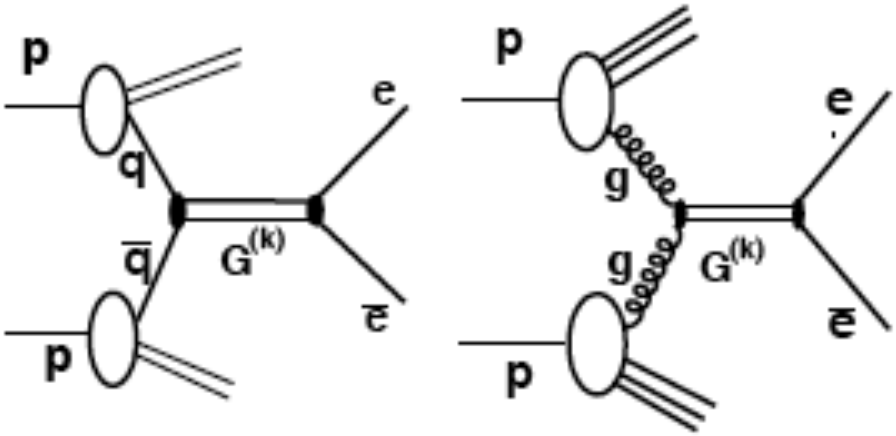
$$E^2 = \vec{p}^{\,2} + \underbrace{p^2_{extra} + m^2}_{\text{KK mass}}$$



Graviton

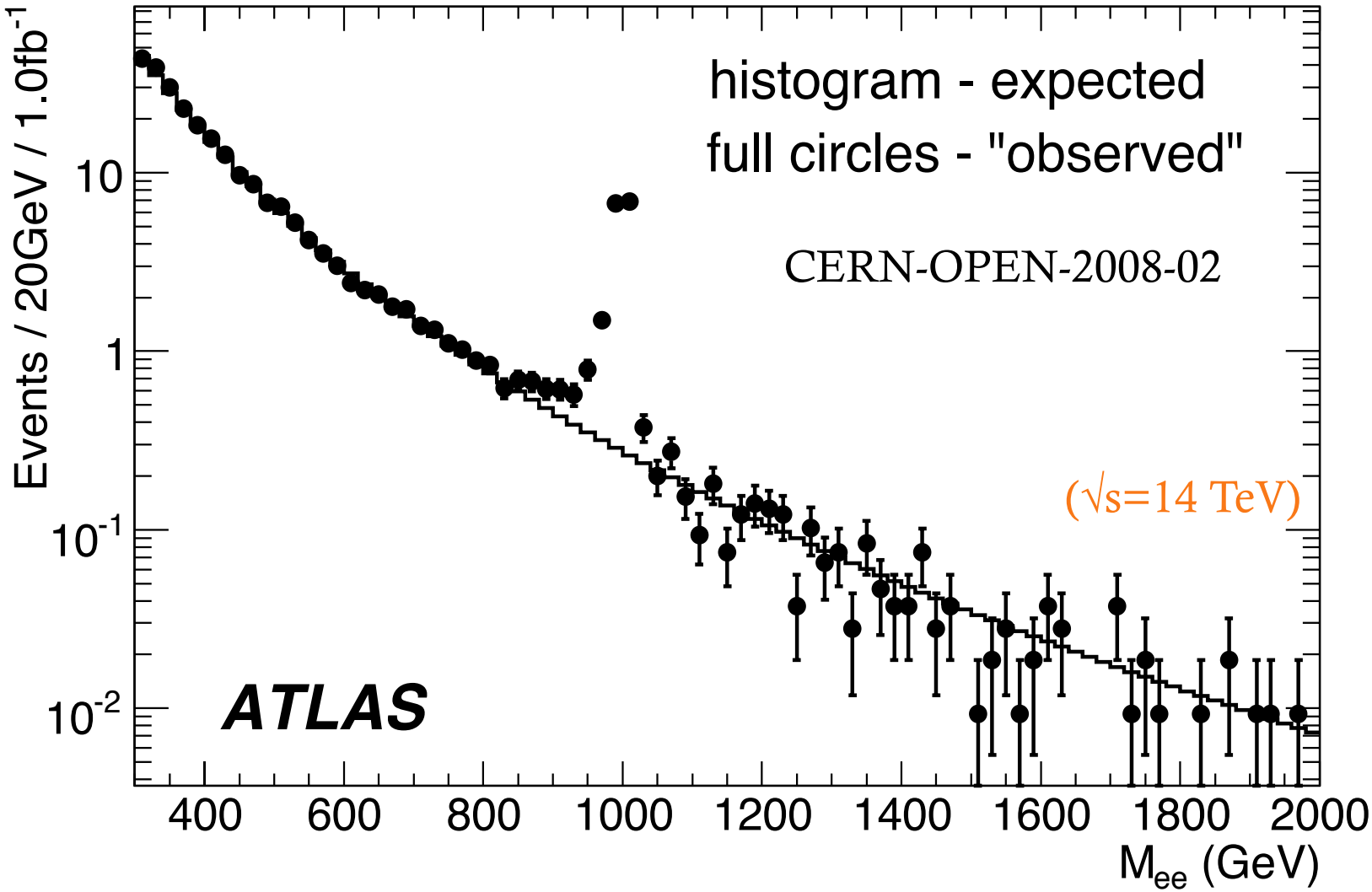
Model Parameters		Γ_G	σ_m	$\sigma \cdot BR(G \to e^+e^-)$
m_G	$k/\bar{M}_{pl}$	[GeV]	[GeV]	[fb]
500 GeV	0.01	0.08	4.6	187.4
750 GeV	0.01	0.10	6.4	27.7
1.0 TeV	0.02	0.57	7.9	26.0
1.2 TeV	0.03	1.62	10.3	22.4
1.3 TeV	0.04	2.98	11.4	25.3
1.4 TeV	0.05	5.02	13.1	26.8

- Standard Model backgrounds
  - For G →ee
    - Drell-Yan
    - All other backgrounds are expected to be small.



G→ee

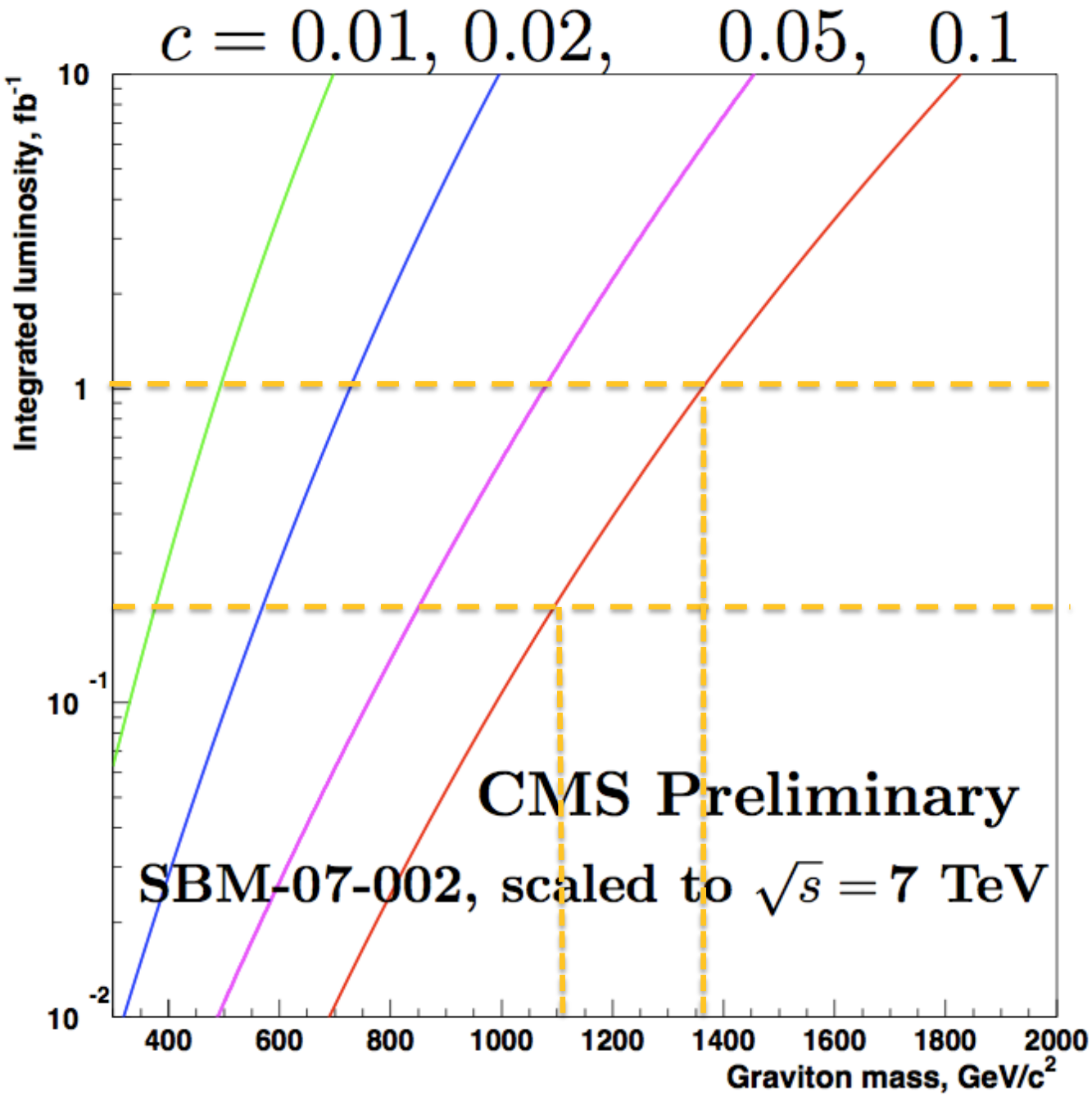
- Two electrons
- p_T >= 65 GeV
- $\cos\Delta\phi_{ee}<0$



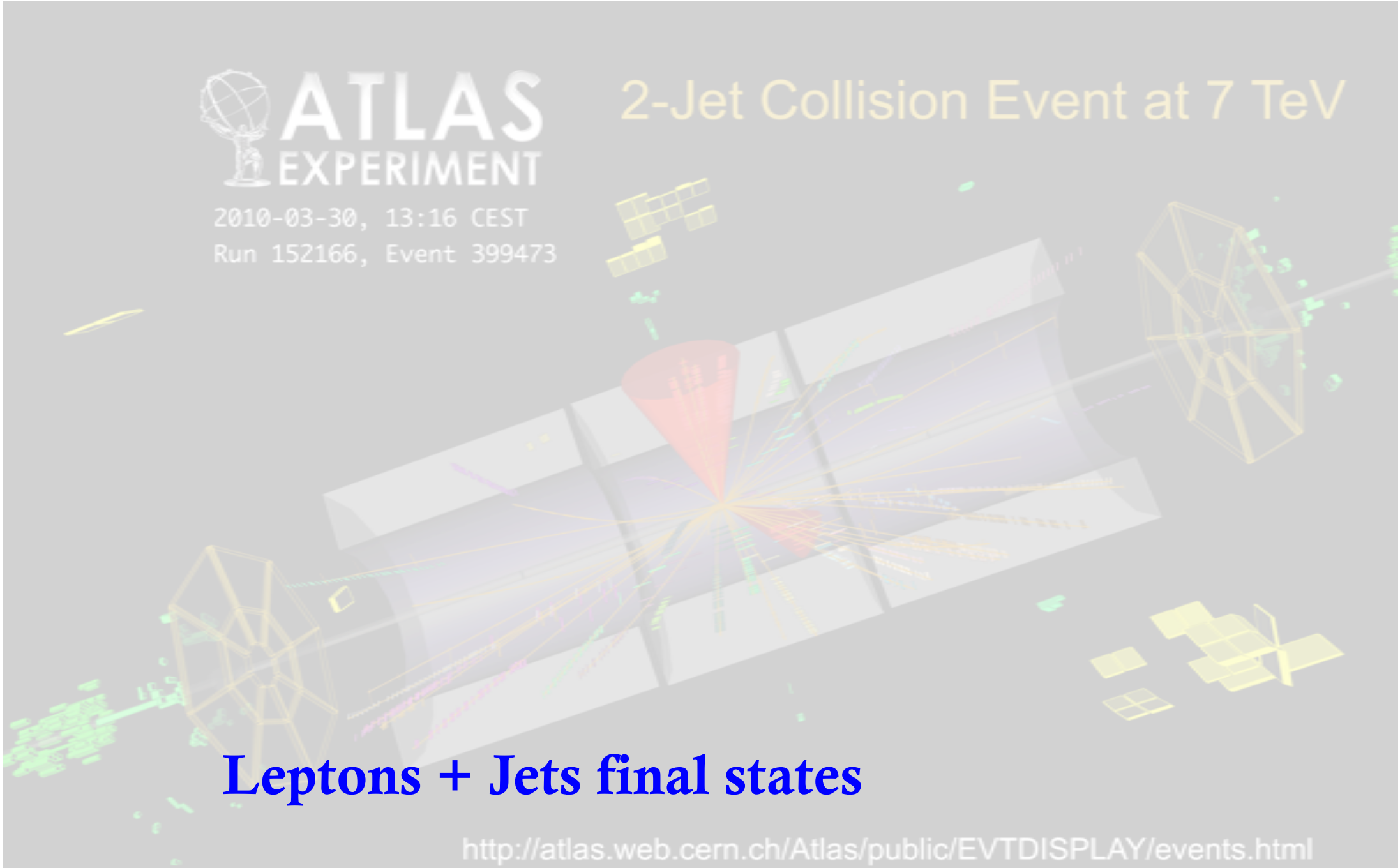
•The observed distribution includes a graviton with mass 1 TeV and coupling κ / M_{pl}=0.02.

Discovery Potential (G➔ μ μ)

- 200 pb^{-1} -> Graviton with a up to 1.1 TeV,
- 1 fb^{-1} up to 1.35 TeV.



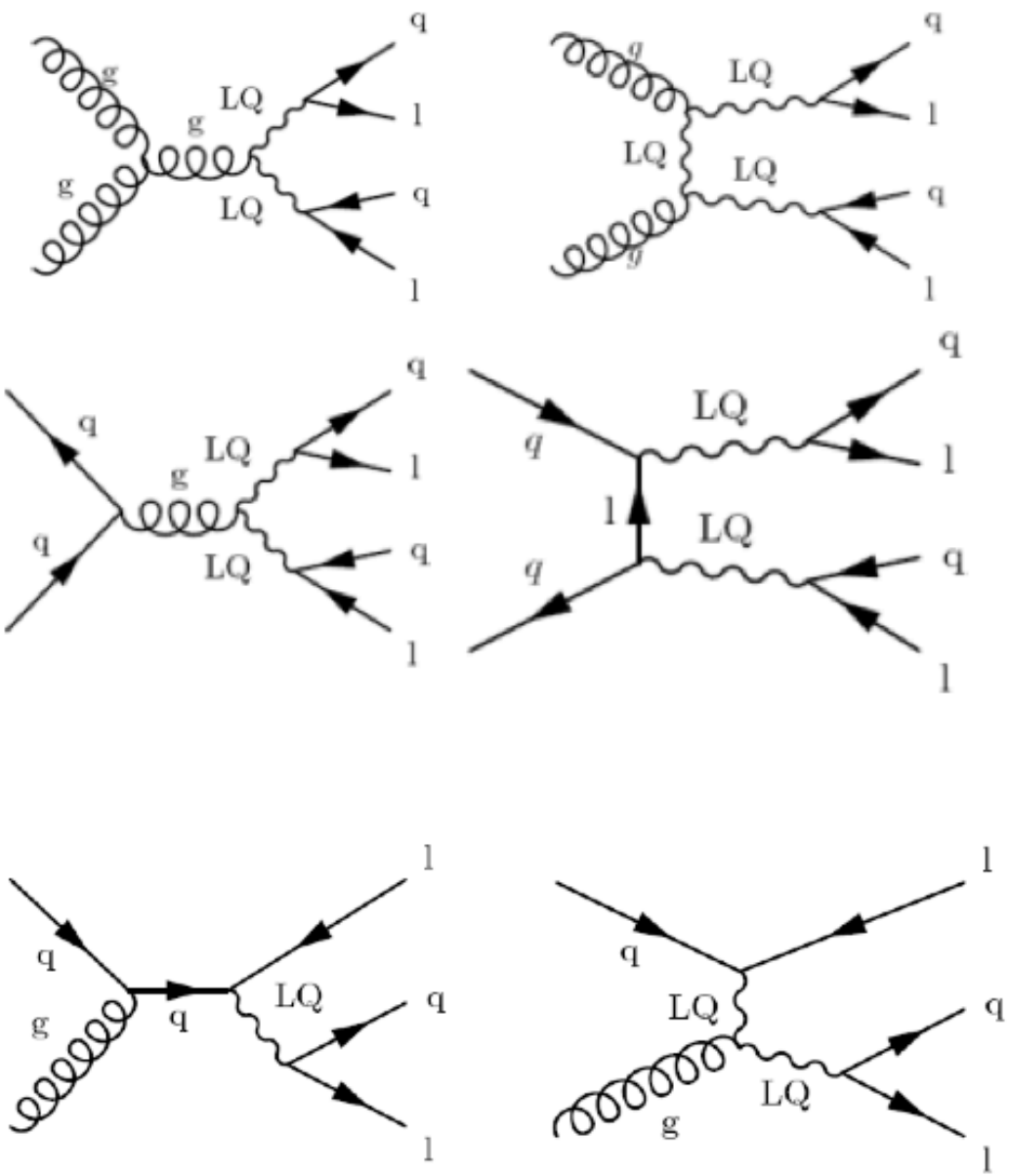
CMS-NOTE-2010-008



Leptons + Jets final states

http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

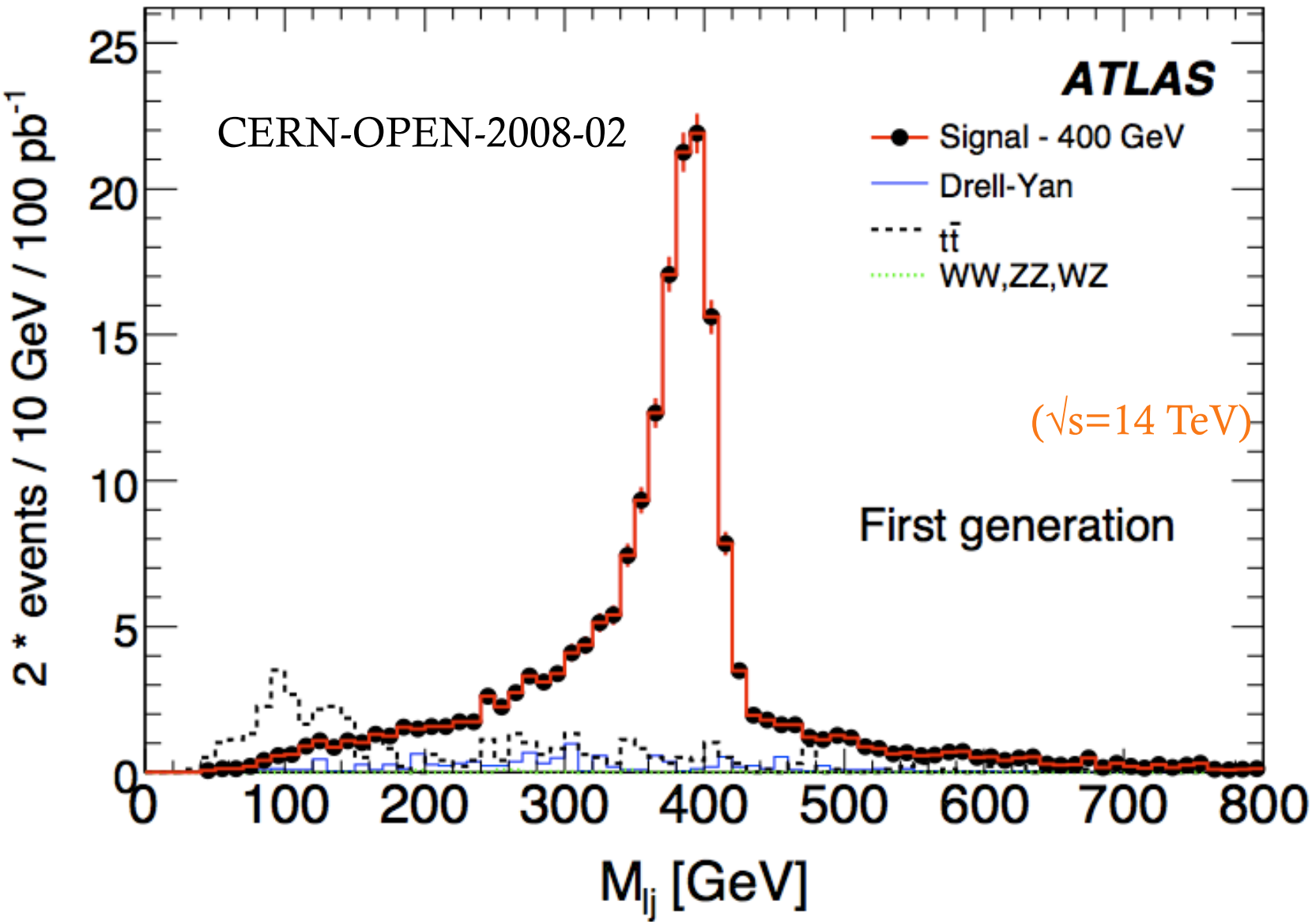
Leptoquarks



LIMITS[8]	
First Generation	**> 256 GeV**
Second Generation	**> 251 GeV**
Third Generation	**> 229 GeV**

- Standard model background
  - Drell-Yan
  - ttbar
  - DiJets

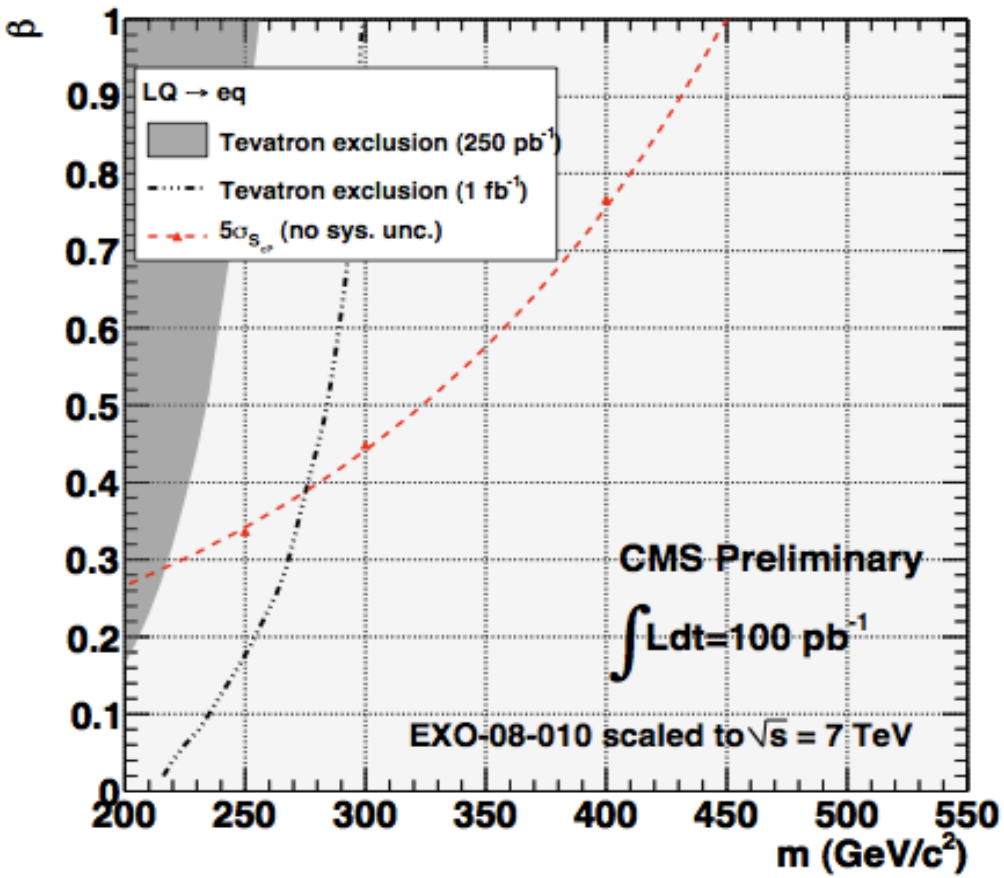
Leptoquarks

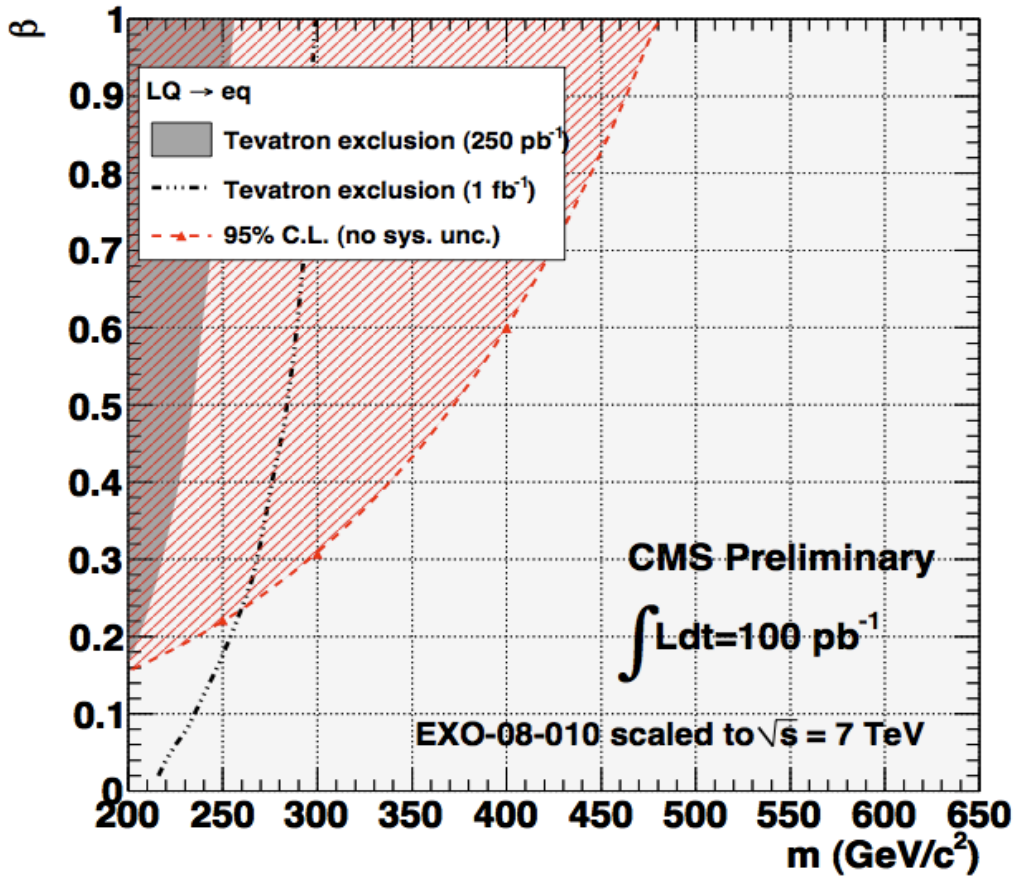


CMS-NOTE-2010-008

Leptoquarks

- Exclusion and discovery potential /100pb^{-1} for the first generation.

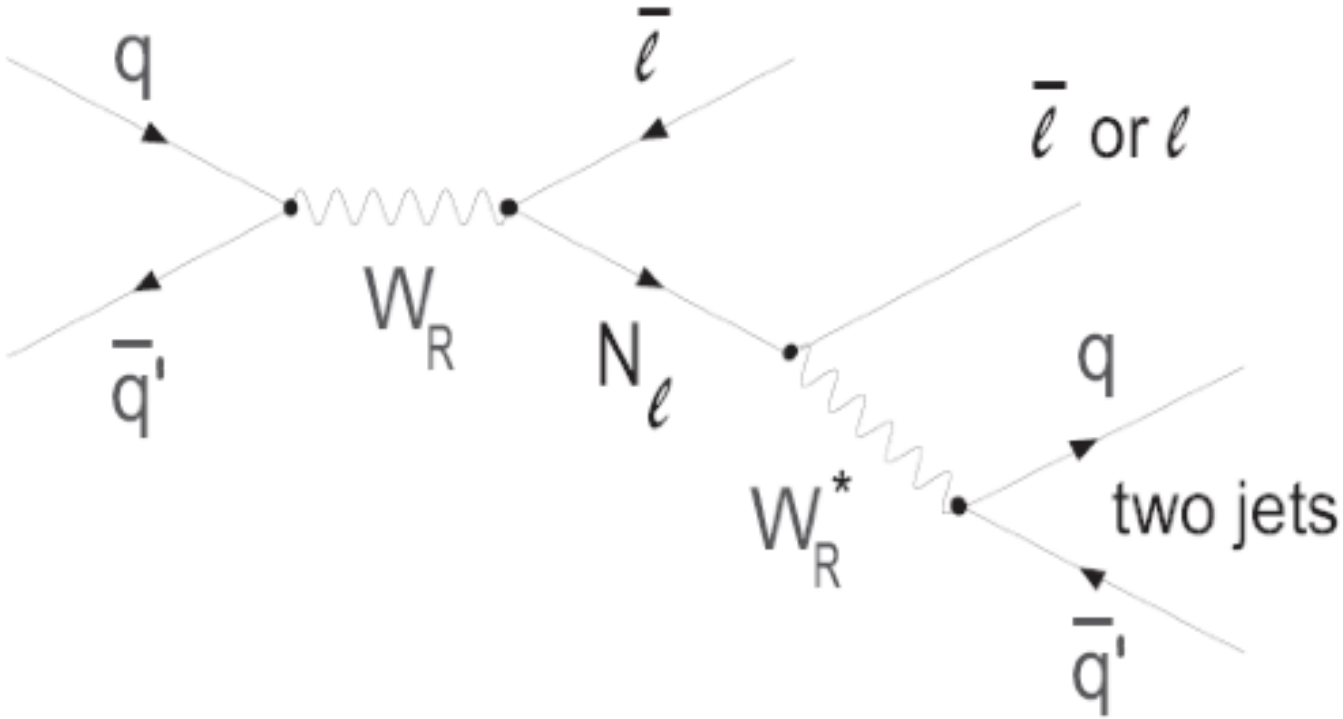




With 200pb^{-1} would be possible to go well beyond the Tevatron limits.

Left-Right Symmetric Models

- Right-handed Majorana neutrinos would required the existence of a right-handed new heavy gauge bosons.

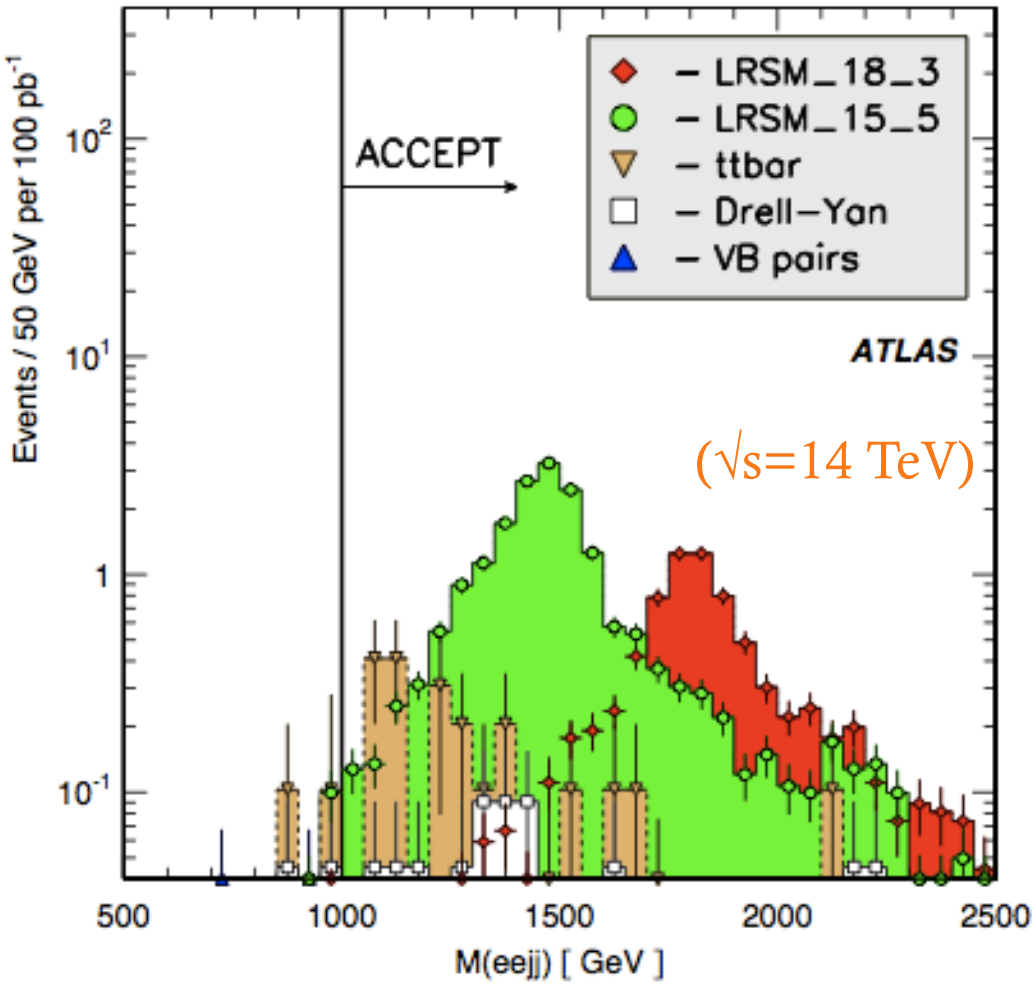


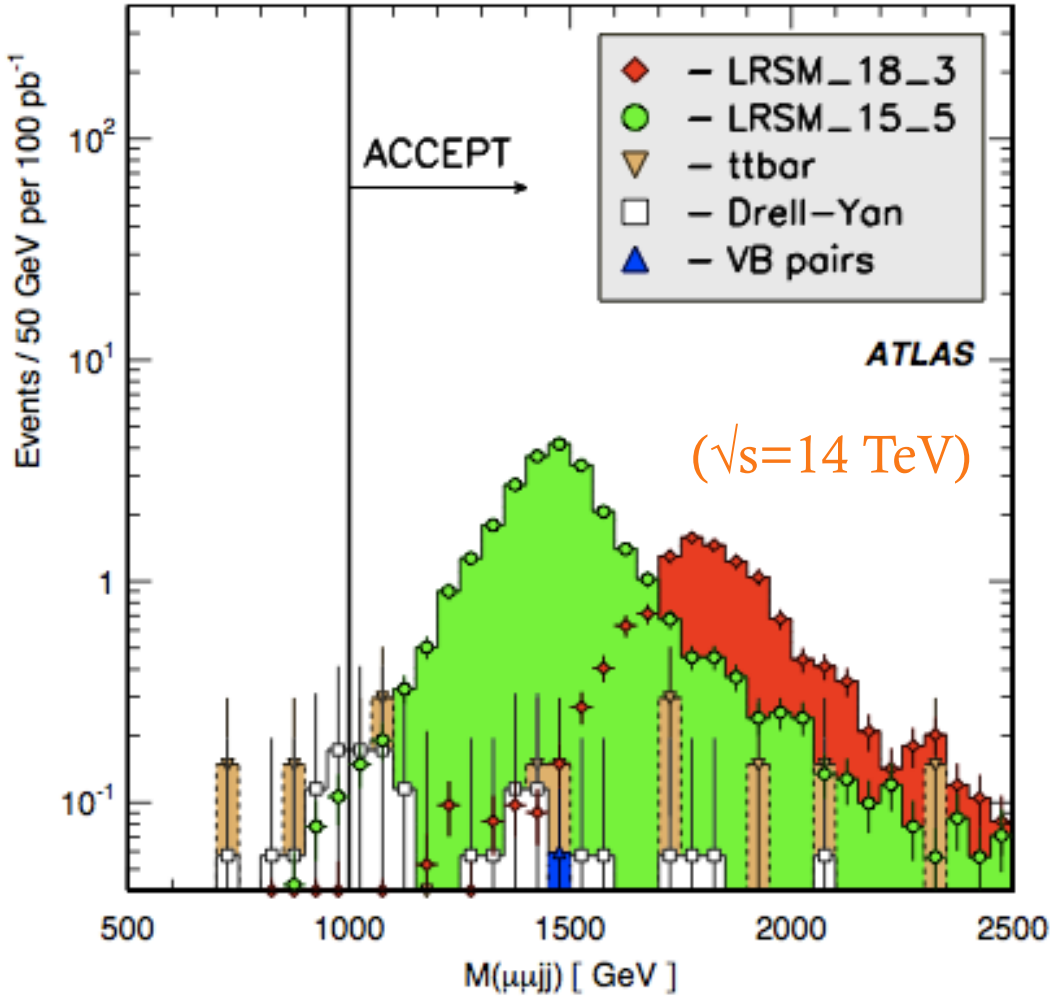
The current limit for the mass of the W_R is 715[8]

- Standard model background
  - Drell-Yan
  - ttbar
  - VB pair

Left-Right Symmetric Models

- The observed correspond to the invariant mass for the W_R->enu and W_R->munu





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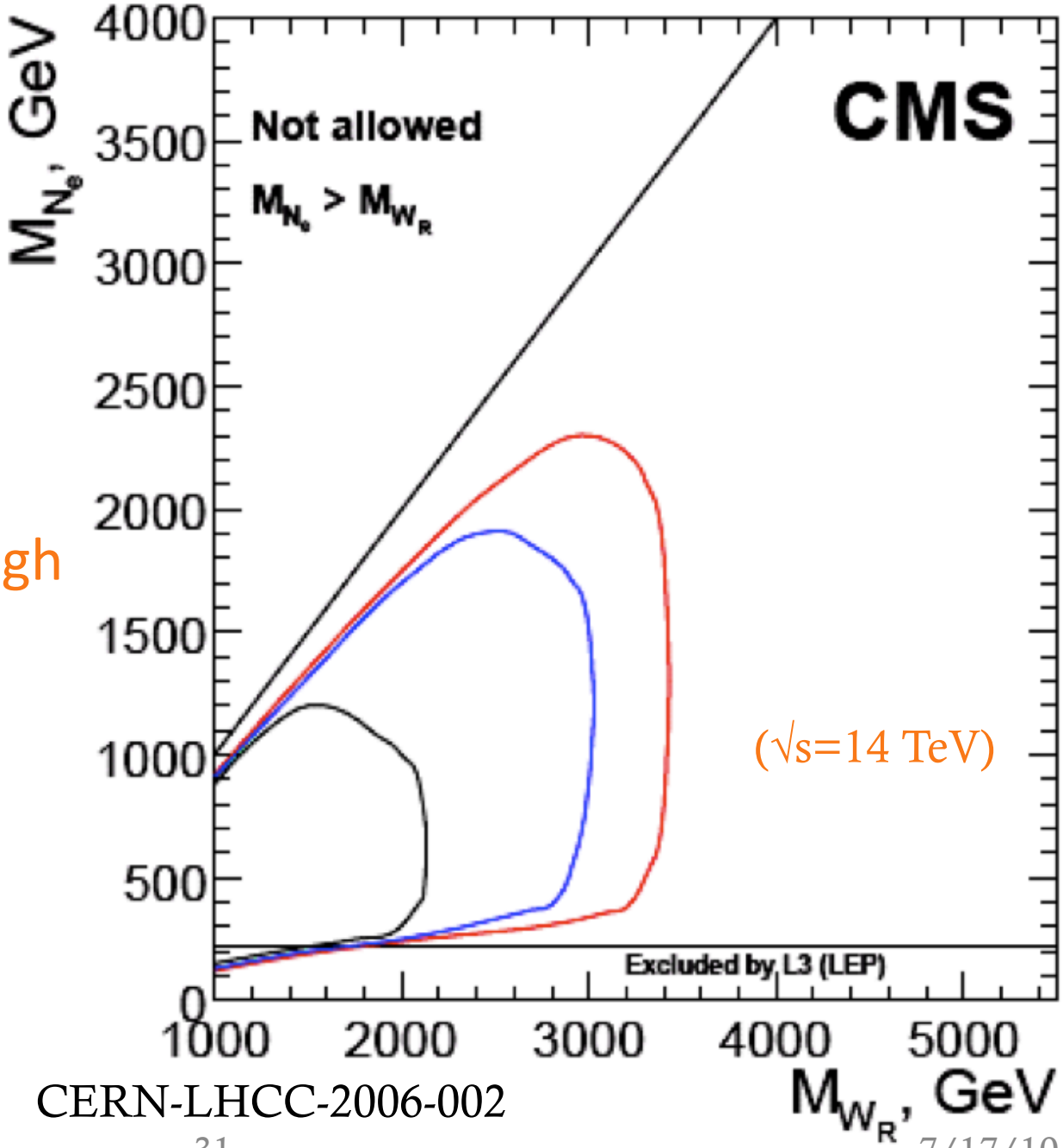
Left-Right Symmetric Models

Exclusion at 95% C.L. for 1 , 10 and 30 fb^{-1} for $\sqrt{s}$=14 TeV.



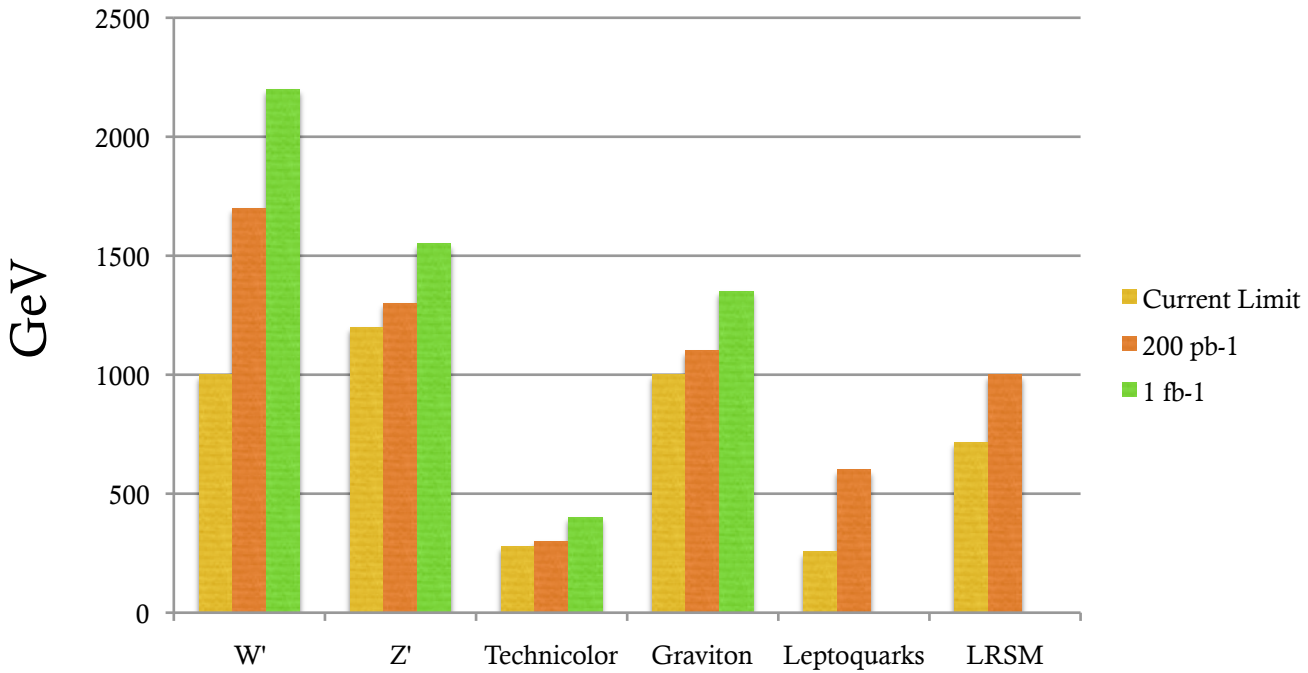
(√s=14 TeV)

CERN-LHCC-2006-002

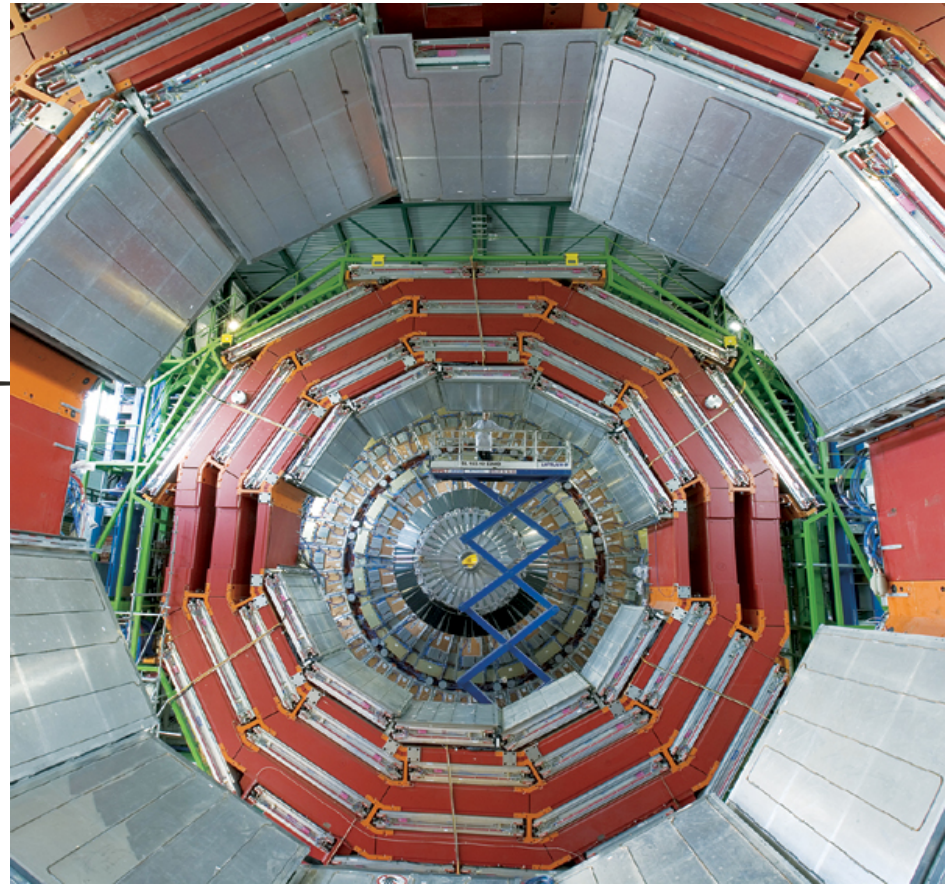
At 200pb^{-1}, the sensitivity with √s=7 TeV will be enough to go beyond the current limits.

Conclusions

- A selection of analyses on new predicted particles with Di-lepton, Lepton+MET and Leptons+Jets final states was presented.
- LHC detectors constitute a powerful tool to discover or exclude new particles.
- 7 TeV studies have shown that the existence of a W' and Z' could be established at the 5 sigma level even with O(100pb^{-1}) of integrated luminosity.
- The initial run of few tens of pb^{-1} at 7TeV would be enough to go beyond Tevatron limits in most of these models.



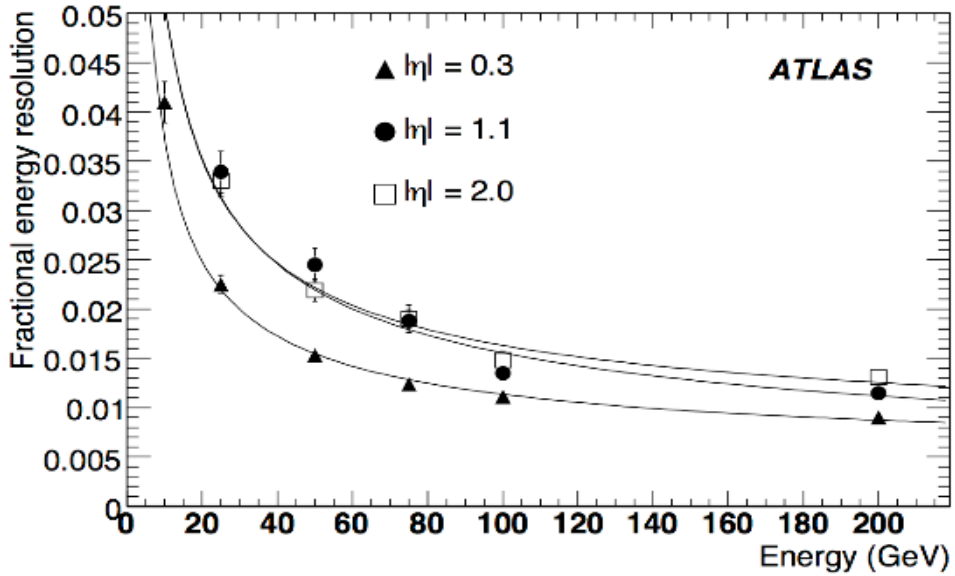
BACKUP

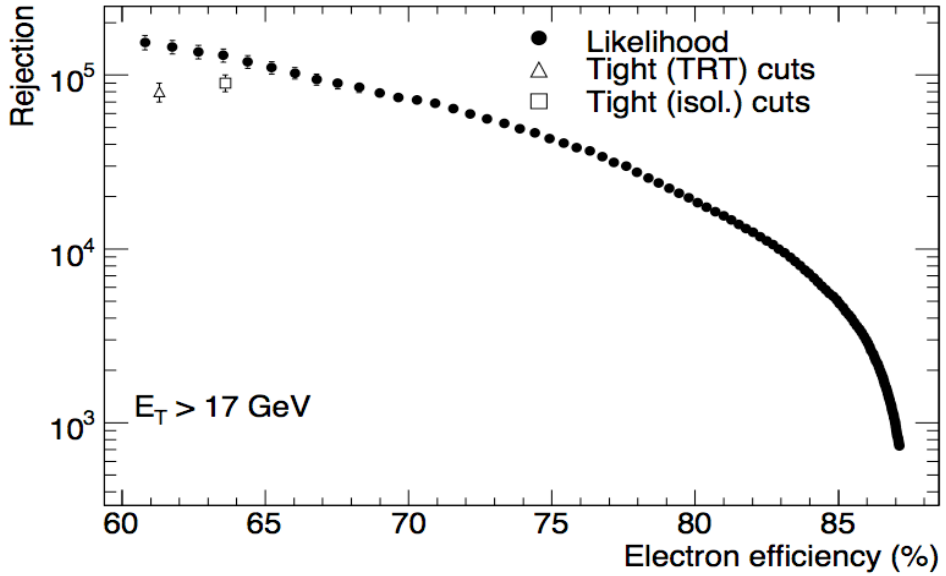


	ATLAS	CMS
Weight	7000 tons	12,500 tons
Diameter	22 m	15 m
Length	46 m	22 m
Peak B Field	2T solenoid, 3.9T (peak) BA toroid, 4.1T (peak) EC toroids	4T solenoid

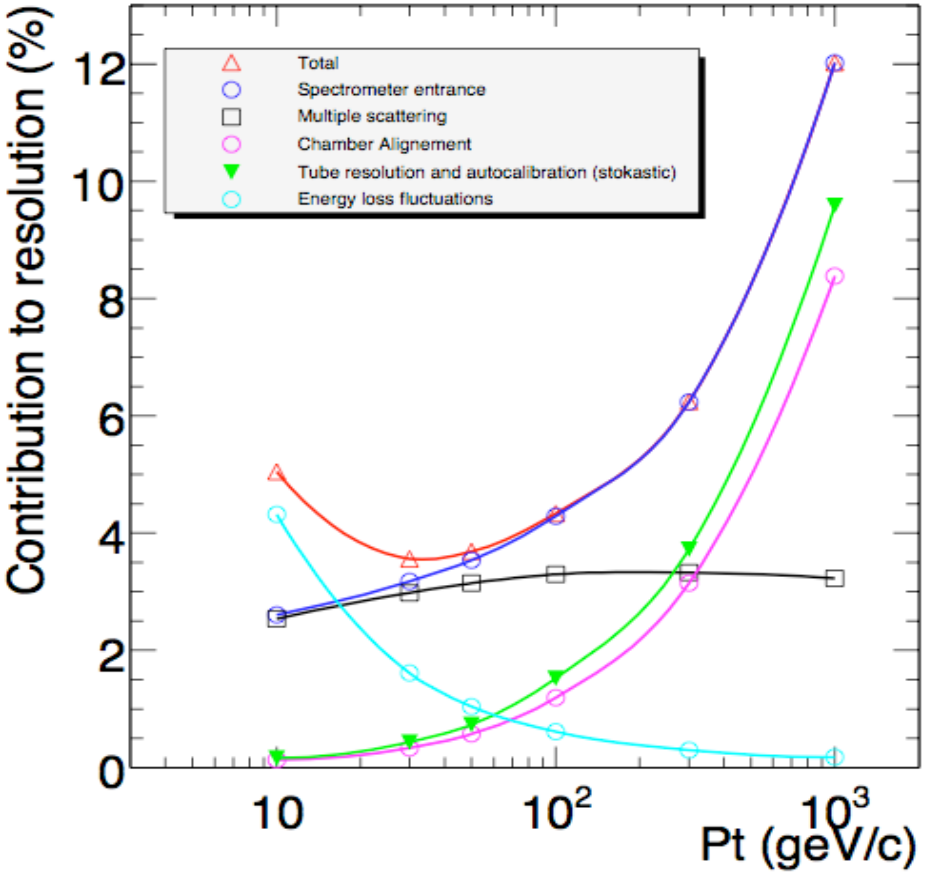
Electrons

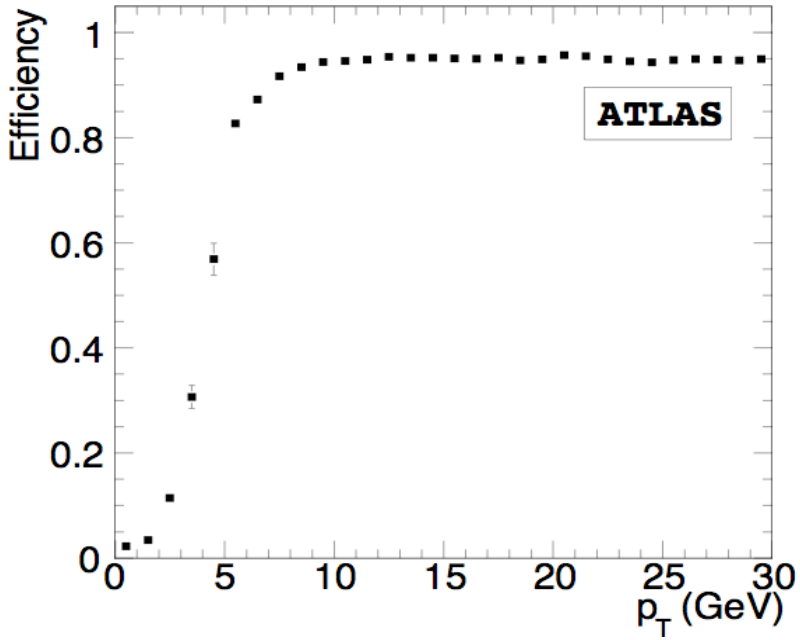
- The QCD cross sections at LHC are 10 to 100 times higher than at the Tevatron





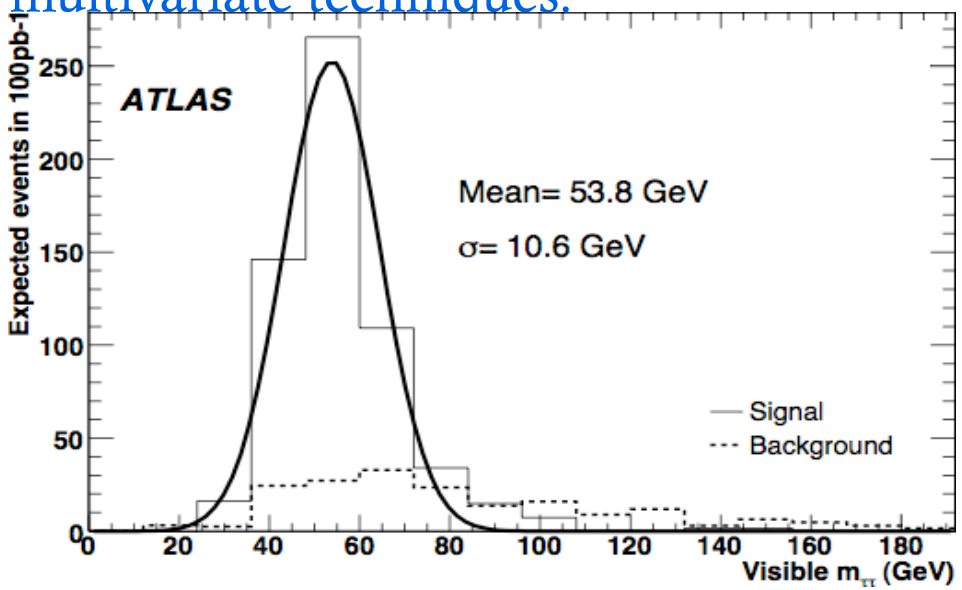
Muons

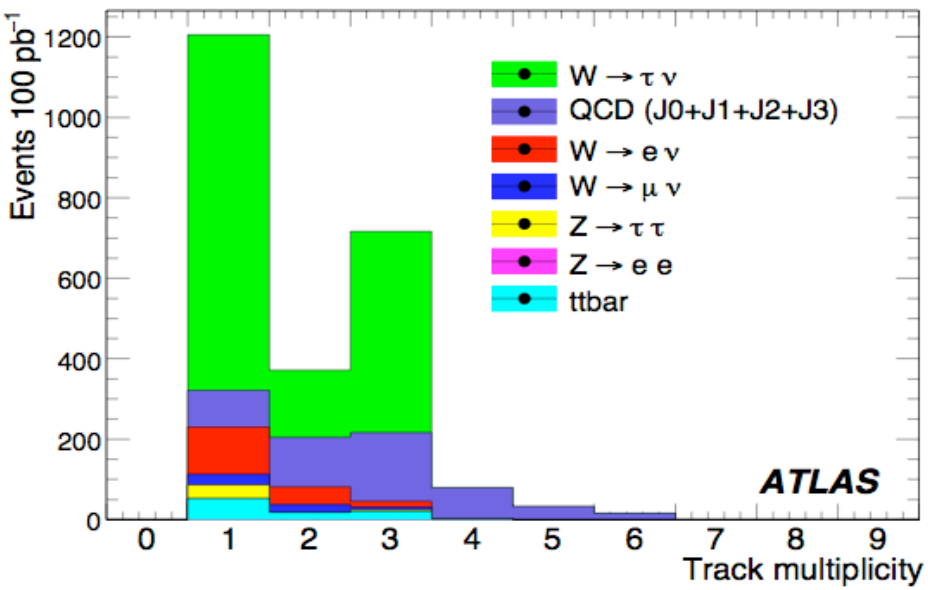

Contribution to resolution (%)
Pt (geV/c)
Total
Spectrometer entrance
Multiple scattering
Chamber Alignement
Tube resolution and autocalibration (stokastic)
Energy loss fluctuations


Efficiency
ATLAS
p_T (GeV)

Tau leptons

- With 100 pb-1, clear signals for W and Z in τ channels
- Z→ τ τ can then be used to set the ET miss scale to a few %
- τ reconstruction is tricky and relies (not for very first data but soon after) on multivariate techniques.





REFERENCES

1. CERN-OPEN-2008-02
2. ATL-PHYS-PUB-2010-007
3. ATL-PHYS-PROC-2009-014
4. J. Phys. : Conf. Ser.160 (2009) 012044
5. CMS-NOTE2006-026
6. CERN-LHCC-2006-001
7. ALEPH, DELPHI and L3 Collaborations, arxiv:hep-ex/0612034
8. Particle Data Group, Phys. Lett. B667, 1 (2008).
9. CDF/PHYS/EXO/PUBLIC/10165
10. CDF Collaboration, Phys. Rev. Lett. 95, 252001 (2005)