LHC 1fb-1で物理

野尻美保子

LHC

- LHC starts from 1fb-1 and 7 TeV (level of 10nb-1 for each experiments at early June.
- Still some discovery modes
- discovery and model independent studies.
  - 実験のハイライト
  - pole の物理
  - missing の物理

Expected physics reach with $1fb^{-1}$

In 2010/11 we expect to record up to $1fb^{-1}$ of integrated luminosity at 7 TeV

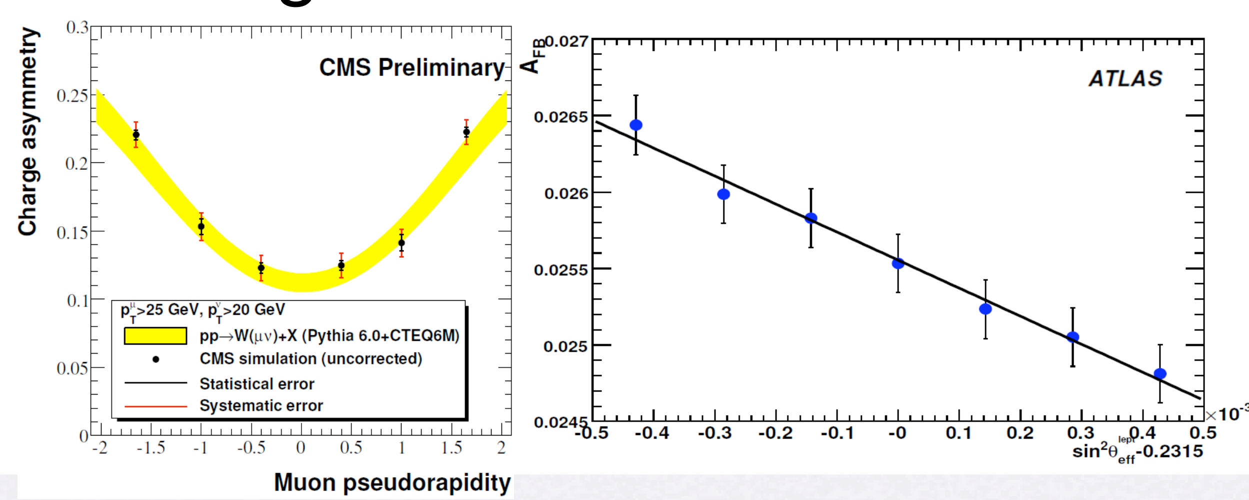
Standard Model

- $W \rightarrow l+\nu$ (4M events)
- $Z \rightarrow ll$ (400k)
- ttbar$\rightarrow l$+jets (6k)
- ttbar dilepton (2.5k)

Detector Commisioning
Std Model measurements

Discovery Potential

- Susy 5σ discovery above Tevatron limit with a few $100pb^{-1}$
- $Z' \rightarrow \mu\mu$: sensitive up to 1.5TeV
- Higgs: 3σ evidence in the mass range 145-180GeV



たとえばPDF→

Figure 6: The reconstructed W charge asymmetry including estimated statistical and systematic uncertainties for $100\,pb^{-1}$ of simulated luminosity at 10 TeV from CMS (left) [42] and the forward backward asymmetry A_{FB} versus the weak mixing angle $\sin^2\theta_{eff}^{lept}$ at the Z pole for $100\,fb^{-1}$ of integrated luminosity at 14 GeV from ATLAS (right) [11].

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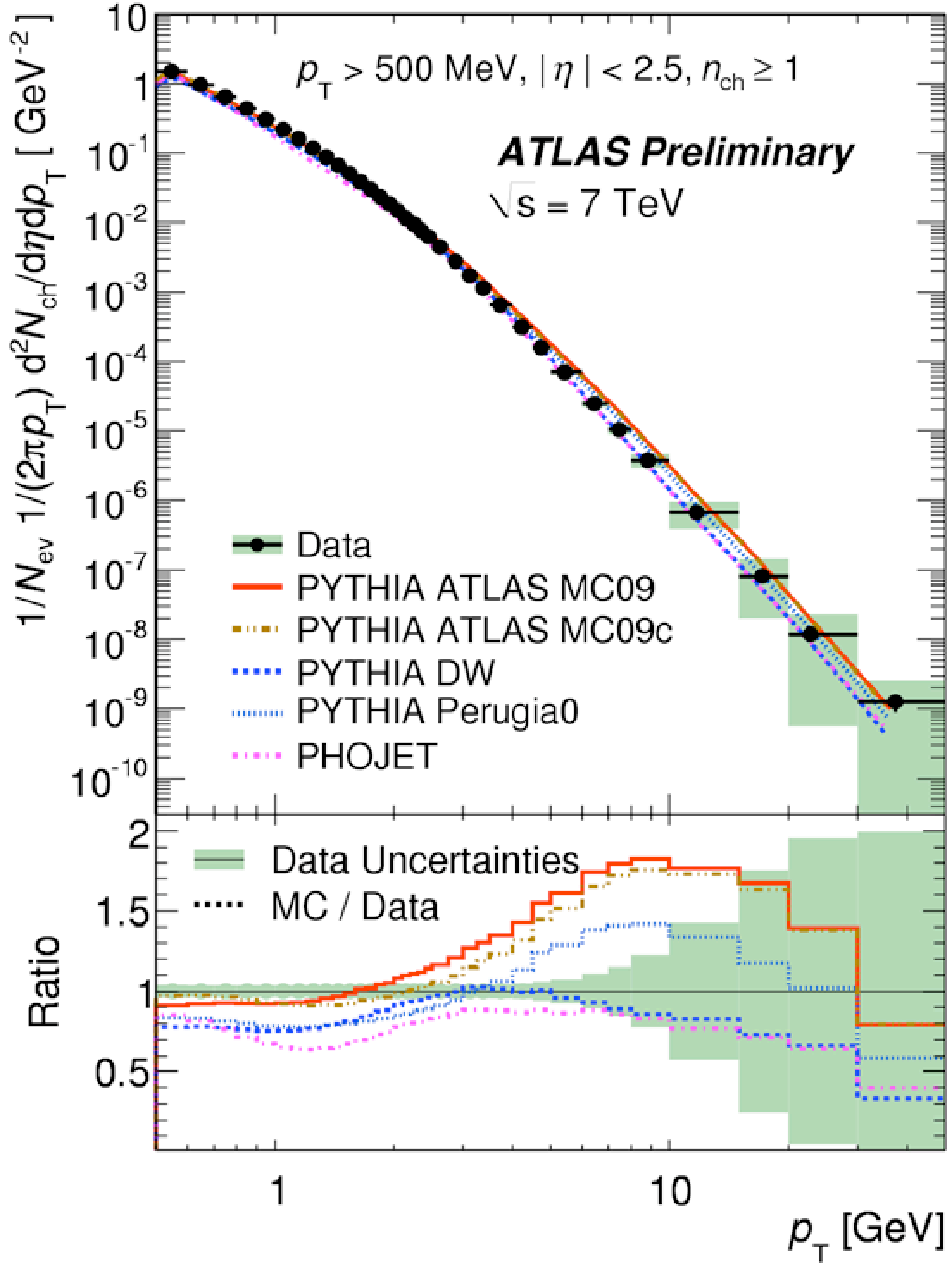
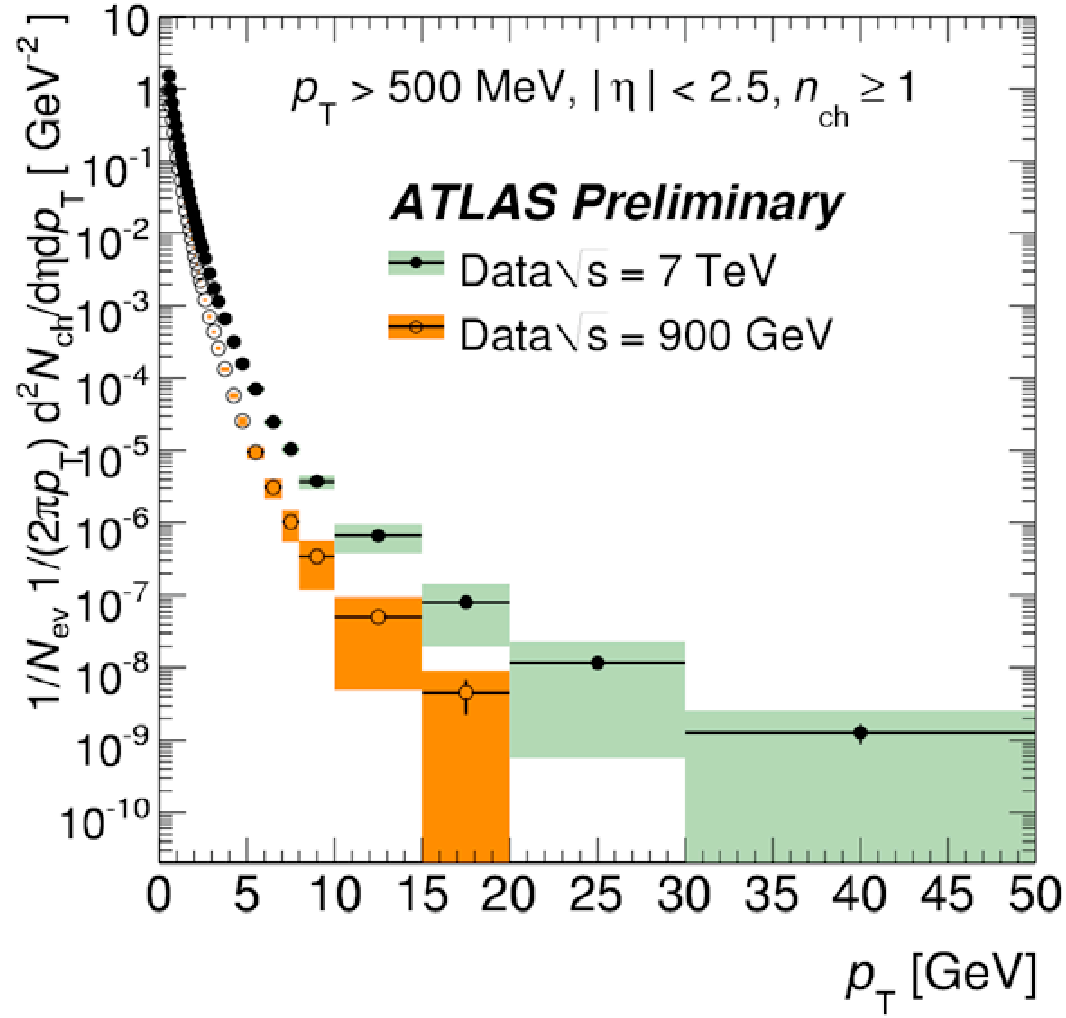
Start to feel the effect to be at high energy

Charged-particle multiplicities in pp interactions at √s= 0.9 and 7 TeV

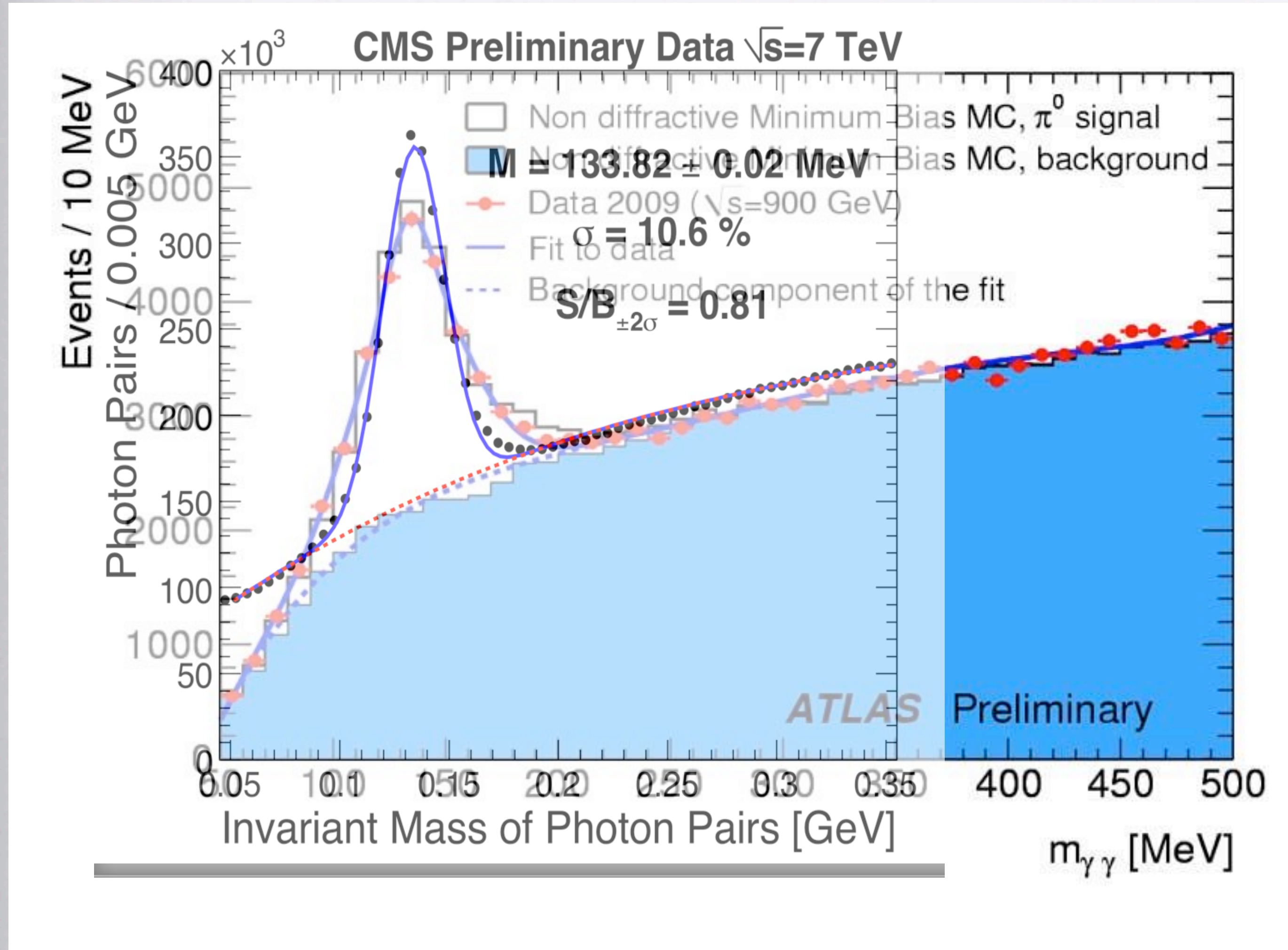


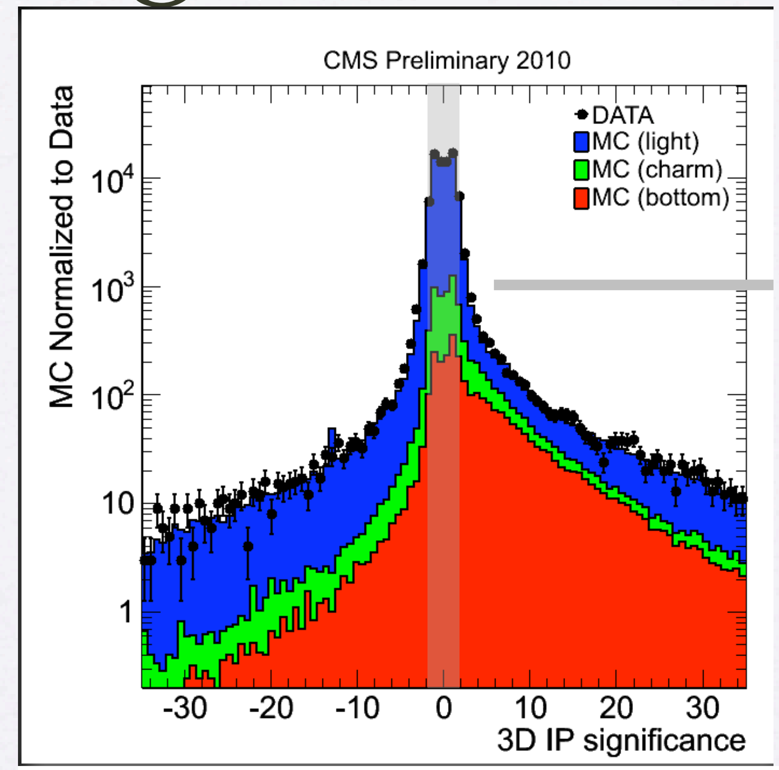


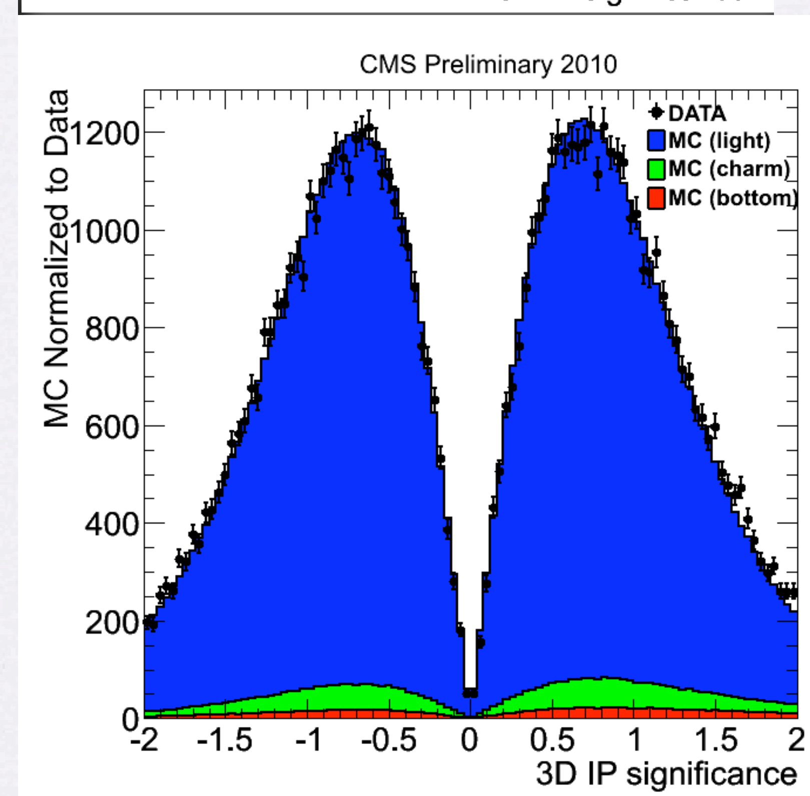
Charged-particle momenta for events with nch≥1 within the kinematic range pT> 500 MeV and |η| < 2.5 at √s = 7 TeV compared to MC predictions (left) and to the published results at √s = 900 GeV (right PLB 688,1,21-42).

MC shows significant excess in several GeV momentum range, also seen at 900 GeV. Large impact on modeling rate for low PT objects (EM clusters, muons, jets) in data.

Detector is working OK







CMS の E cal はうまく動いている。

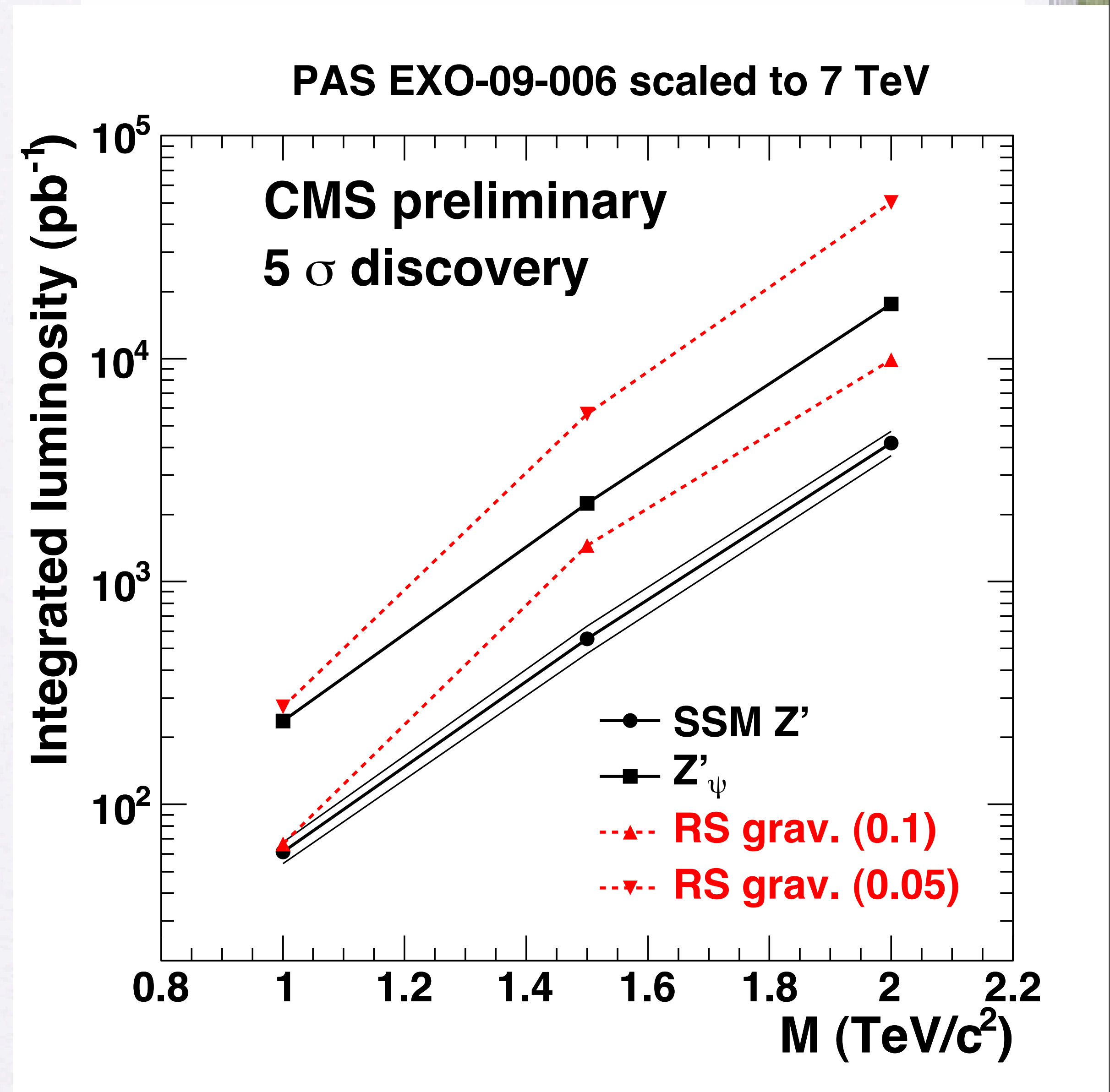
b-tag も問題なし。

O(100nb) になるとtop がみえてくる。

Z' model

Table 1: Charges of Standard Model fermions in canonical Z' models.

	Y	T_{3R}	$B-L$	$\sqrt{24}Q_\chi$	$\sqrt{\frac{72}{5}}Q_\psi$	Q_η
ν_L, e_L	$-\frac{1}{2}$	0	-1	$+3$	$+1$	$+\frac{1}{6}$
ν_R	0	$+\frac{1}{2}$	-1	$+5$	-1	$+\frac{5}{6}$
e_R	-1	$-\frac{1}{2}$	-1	$+1$	-1	$+\frac{1}{3}$
u_L, d_L	$+\frac{1}{6}$	0	$+\frac{1}{3}$	-1	$+1$	$-\frac{1}{3}$
u_R	$+\frac{2}{3}$	$+\frac{1}{2}$	$+\frac{1}{3}$	$+1$	-1	$+\frac{1}{3}$
d_R	$-\frac{1}{3}$	$-\frac{1}{2}$	$+\frac{1}{3}$	-3	-1	$-\frac{1}{6}$



- E6->SO(10)xU(1)ψ SO(10)->U(1)xSU(5) U(1)が２つの模型
- Z_SSM is a toy model (scaled Z boosn.
- model independent approach with signle U(1), next page.

mass は決まっている.

cross seciton は？

single U(1) model

charge assignment

	(u,d)	u^c	d^c	(ν,e)	ν^c	e^c
T_{3L}	$(+\frac{1}{2},-\frac{1}{2})$	0	0	$(+\frac{1}{2},-\frac{1}{2})$	0	0
Y	$+\frac{1}{6}$	$-\frac{2}{3}$	$+\frac{1}{3}$	$-\frac{1}{2}$	0	$+1$
$B-L$	$+\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	-1	$+1$	$+1$
$Q_{Z'}$	$\frac{1}{6}\widetilde{g}_Y+\frac{1}{3}\widetilde{g}_{BL}$	$-\frac{2}{3}\widetilde{g}_Y-\frac{1}{3}\widetilde{g}_{BL}$	$\frac{1}{3}\widetilde{g}_Y-\frac{1}{3}\widetilde{g}_{BL}$	$-\frac{1}{2}\widetilde{g}_Y-\widetilde{g}_{BL}$	$\widetilde{g}_{BL}$	$\widetilde{g}_Y+\widetilde{g}_{BL}$

Table 1: The charges of left-handed fermions controlling the electroweak neutral currents.

$$\widetilde{g}_Y=\frac{g_Y}{g_Z}\,,\qquad \widetilde{g}_{BL}=\frac{g_{BL}}{g_Z}\,.$$

interaction

$$J^{\mu}_{Z'^0}=\sum_f\left[g_Y\,Y(f)+g_{BL}\,(B-L)(f)\right]\overline{f}\gamma^\mu f$$
$$=\sum_f g_Z\,Q_{Z'}(f)\,\overline{f}\gamma^\mu f\,.$$

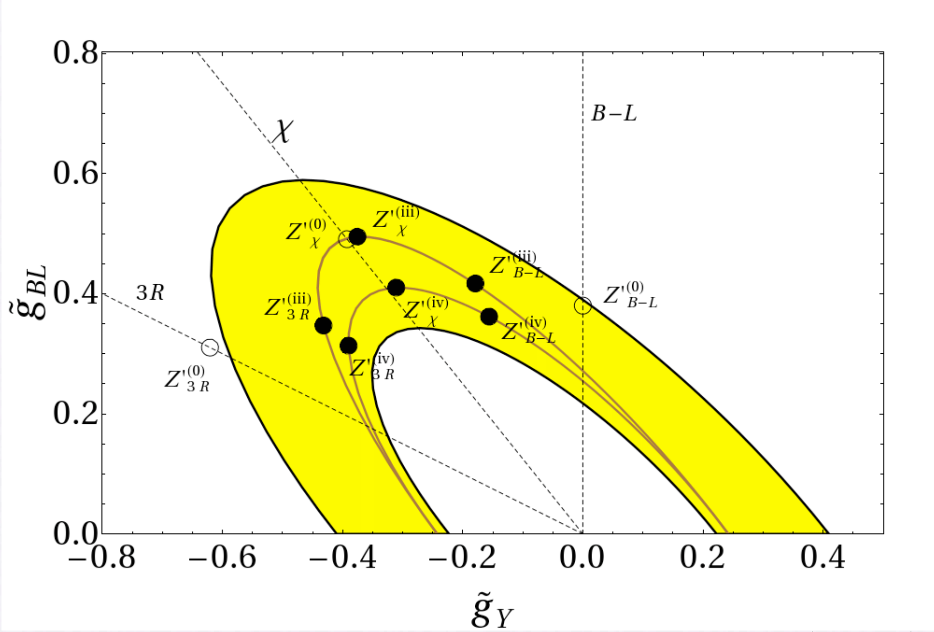


Figure 1: GUT-favored region and some representative models in the $(\widetilde{g}_Y,\widetilde{g}_{BL})$ plane, see the text for details.

- yellow region (GUT prefered)

Physics at 7 TeV 1fb-1 (prospect not so great)

黄色 LHC で見えないところ

青 Tevatron で exclude されていないところ

赤　EWPT でOK

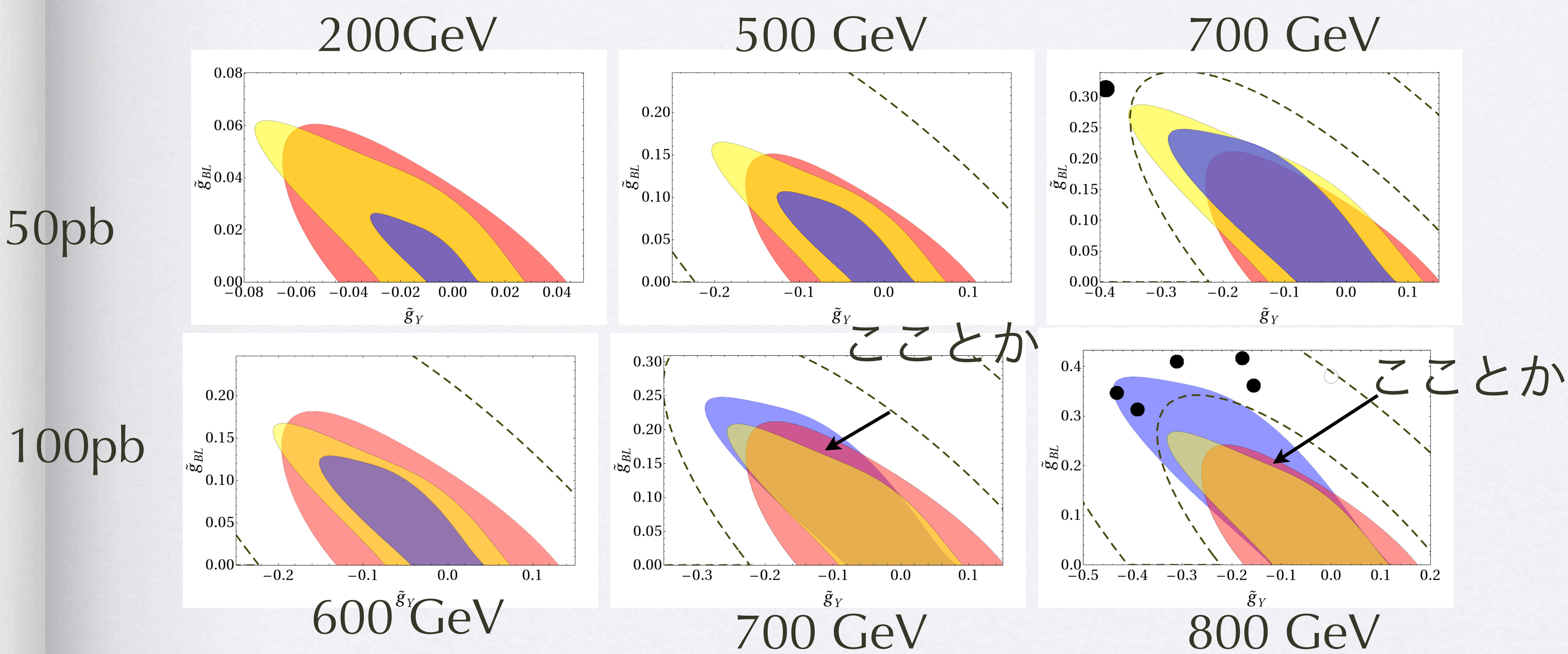


Figure 7: The LHC 5σ discovery potential in the $(\tilde{g}_Y, \tilde{g}_{BL})$ plane for $\sqrt{s} = 7$ TeV. The red and blue regions are those allowed by EWPT and Tevatron bounds respectively; the yellow region is the one not within 5σ discovery reach at the LHC. Thus the region accessible by the LHC is the one formed by points that are both in the red and blue regions but not in the yellow one. Plots in the first row refer to 50 pb^{-1} of data and $M_{Z'} = 200$, 500, 700 GeV respectively; plots in the second row are for 100 pb^{-1} of data and $M_{Z'} = 600$,

LHC starts from 7TeV and 1fb-1

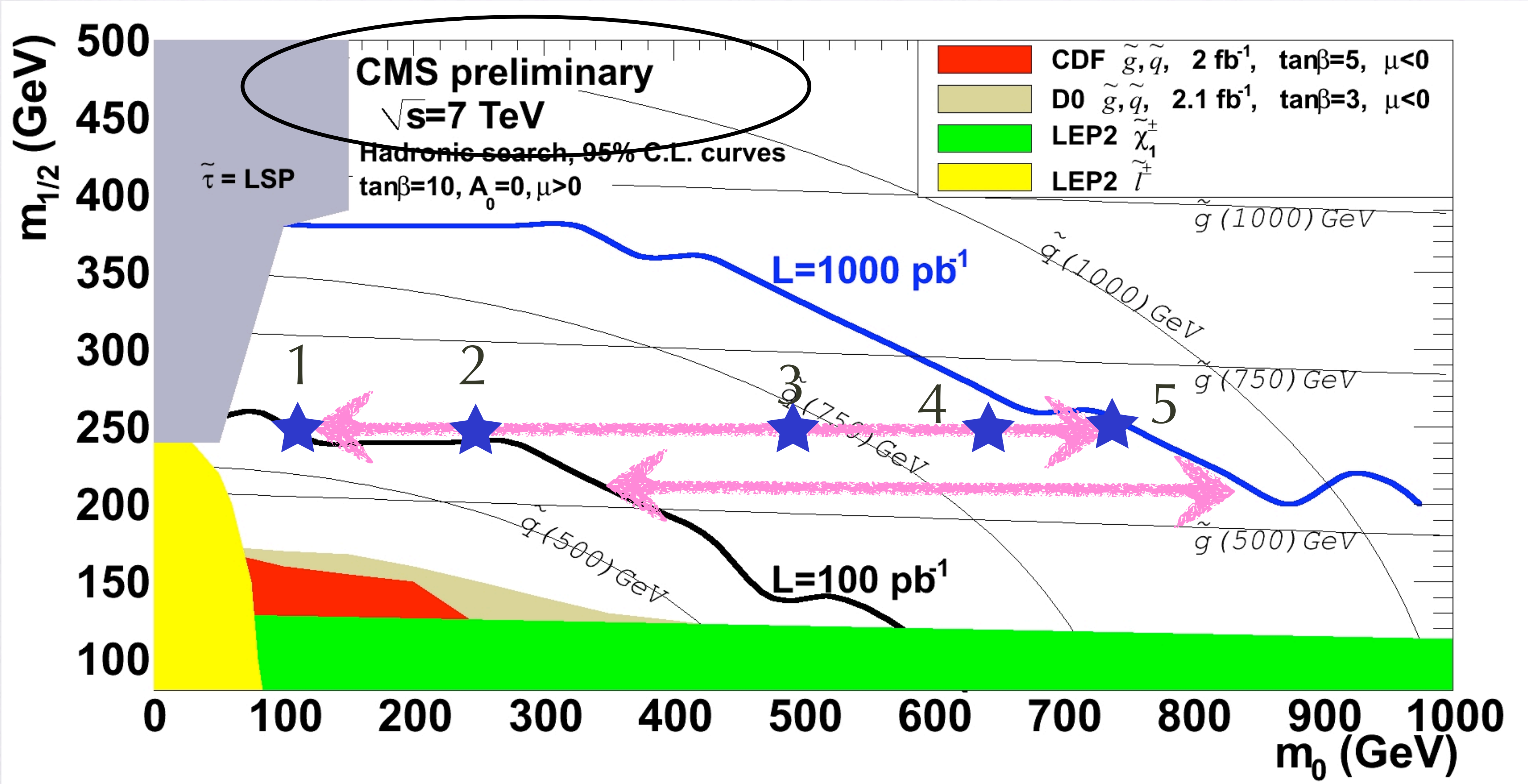


Figure 13: Estimated 95% C.L. exclusion limits for the all-hadronic SUSY search, expressed in mSUGRA parameter space.

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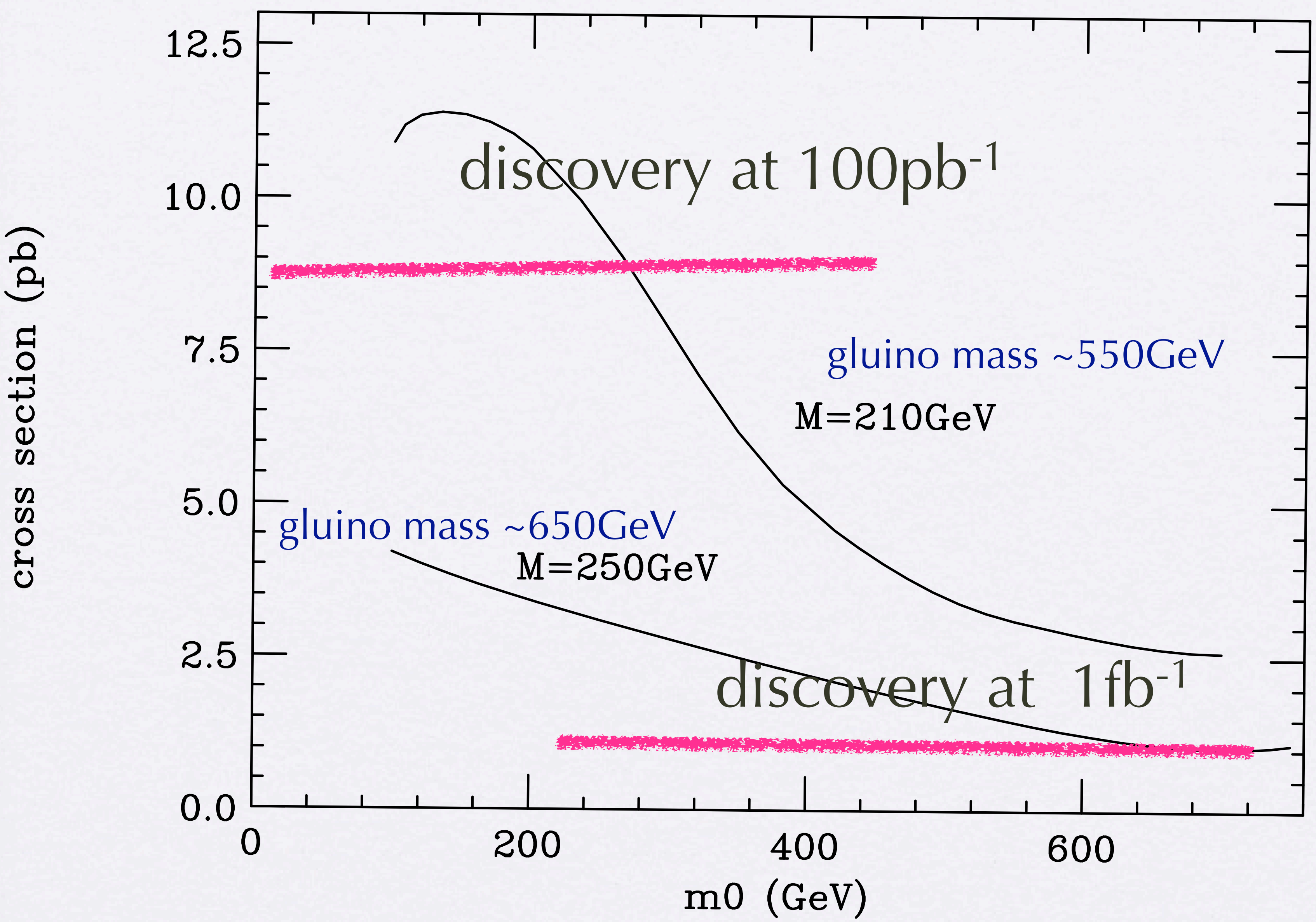
cross section for discovery

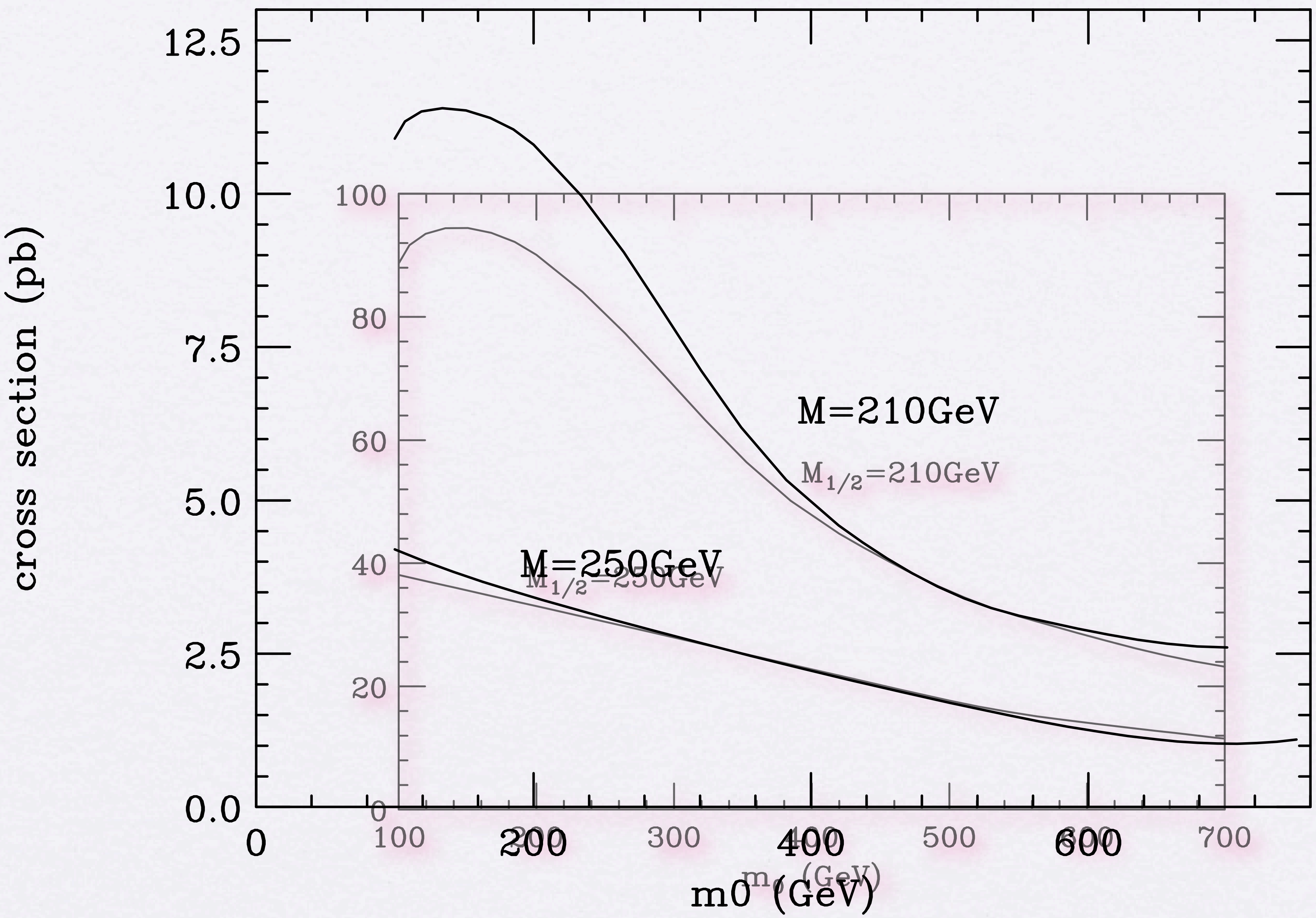
$100pb^{-1} \sim \sigma_{SUSY} > 9pb$ $1fb^{-1} \sim \sigma_{SUSY} > 1pb$



Comparing with 14 TeV

cross section は10倍になる。

luminosity も１０倍を予定



ISR に配慮した分布の解析

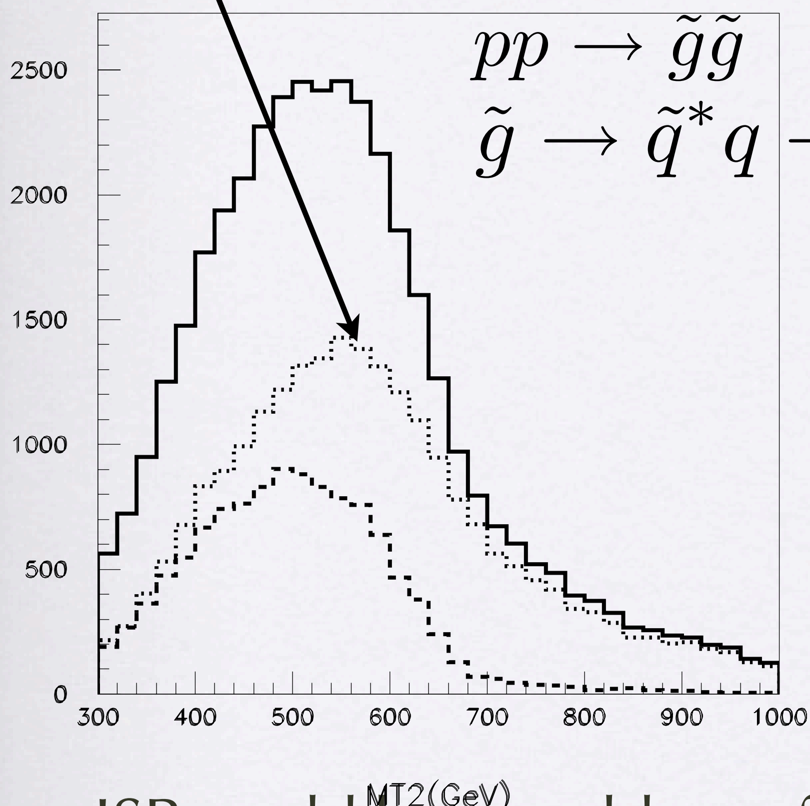
Alwall, Hiramatsu, Nojiri, Shimizu (2009)

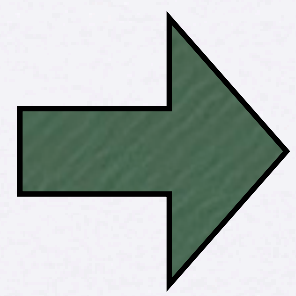
jet level

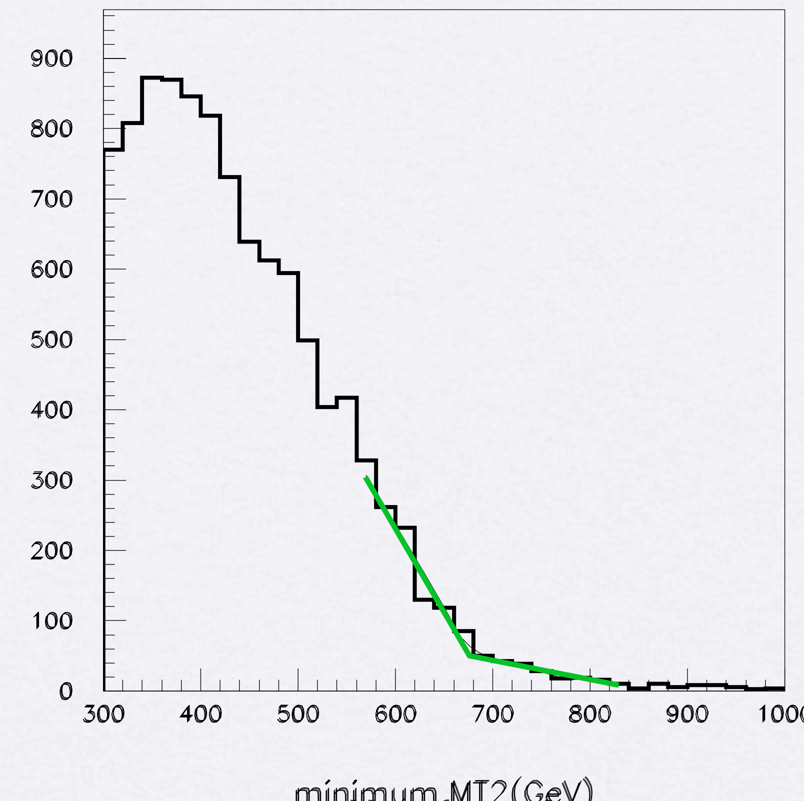
Events with hard ISR

$pp \to \tilde{g}\tilde{g}$

$\tilde{g} \to \tilde{q}^* q \to q\bar{q}\tilde{\chi}_1^0$







- ISR could be a problem of the event reconstruction (especially for three body decay

675.4 +/- 6.4 (imin. ge.3)

672.7+/- 3.5 (for all)

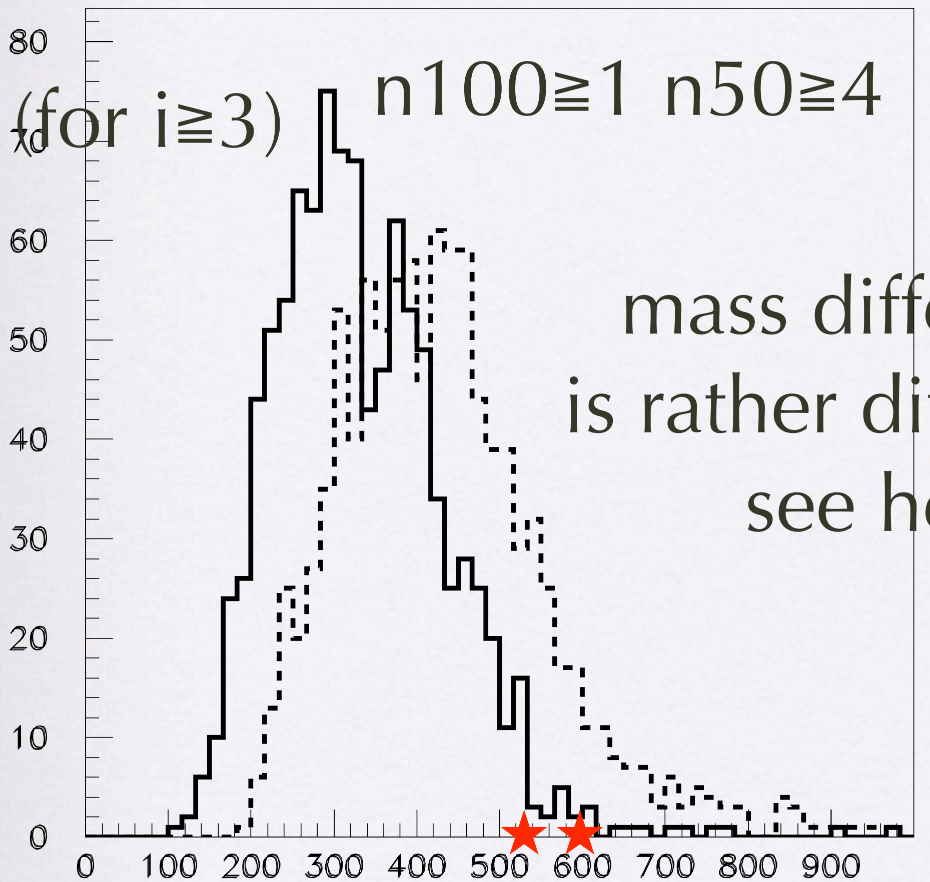
- remove one of the jet and calculate kinematical variable greatly improve

at 7TeV and 1fb^{-1}

mul=520GeV mgl=610GeV

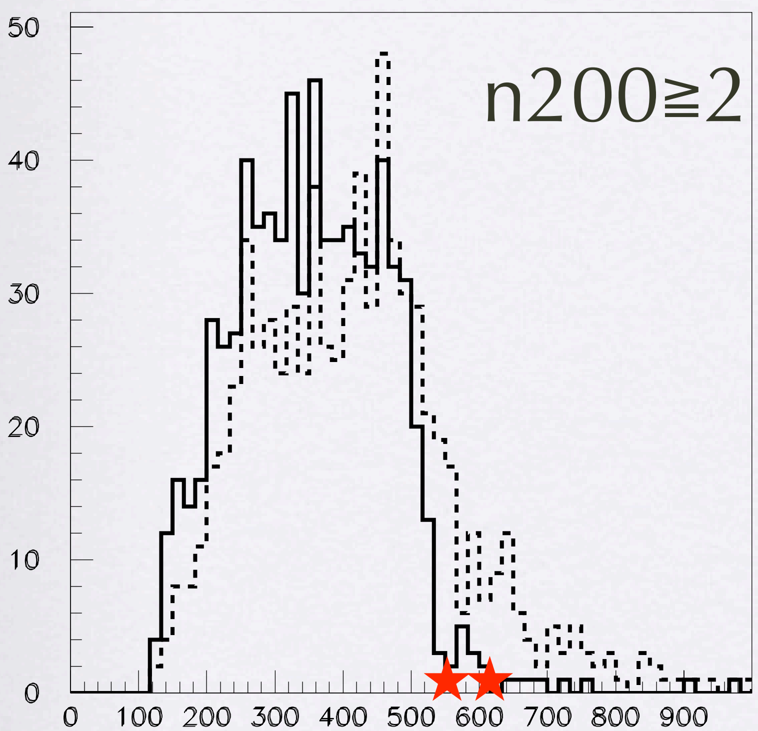
M_{T2}min (for i≧3)

n100≧1 n50≧4



mass difference
is rather difficult to
see here

n200≧2

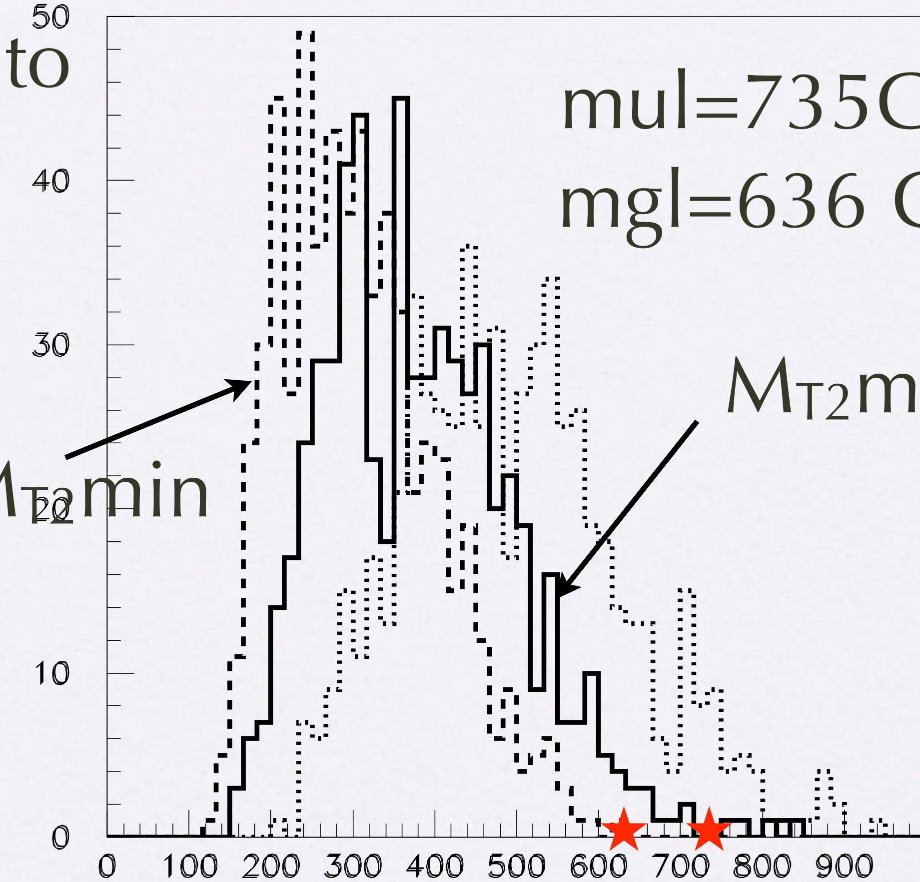


point 3

mul=735GeV
mgl=636 Gev

M_{T2}min (for i≧3)

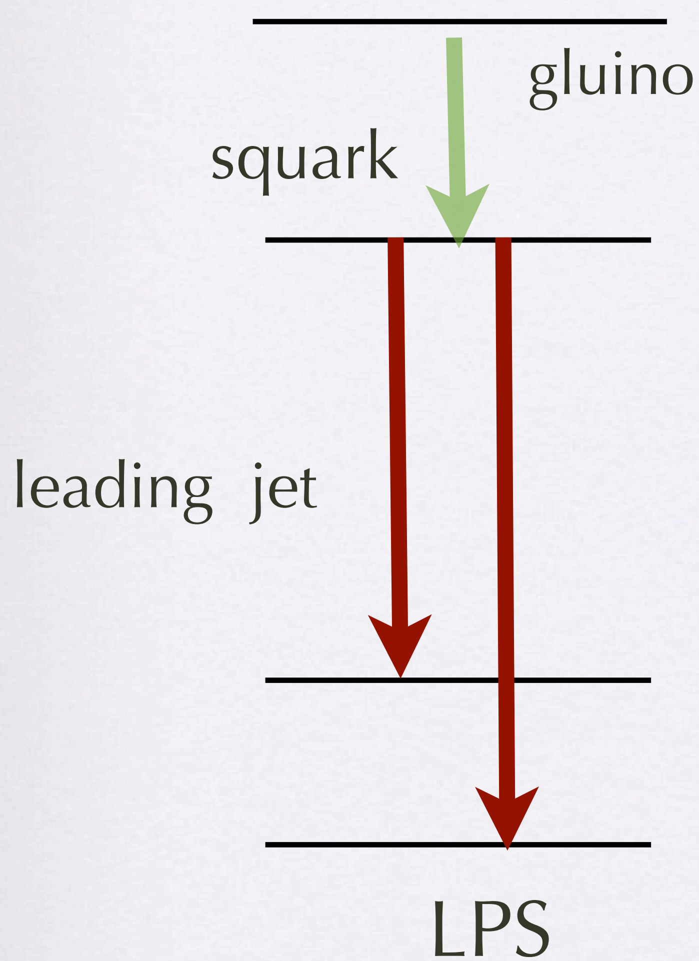
M_{T2}min

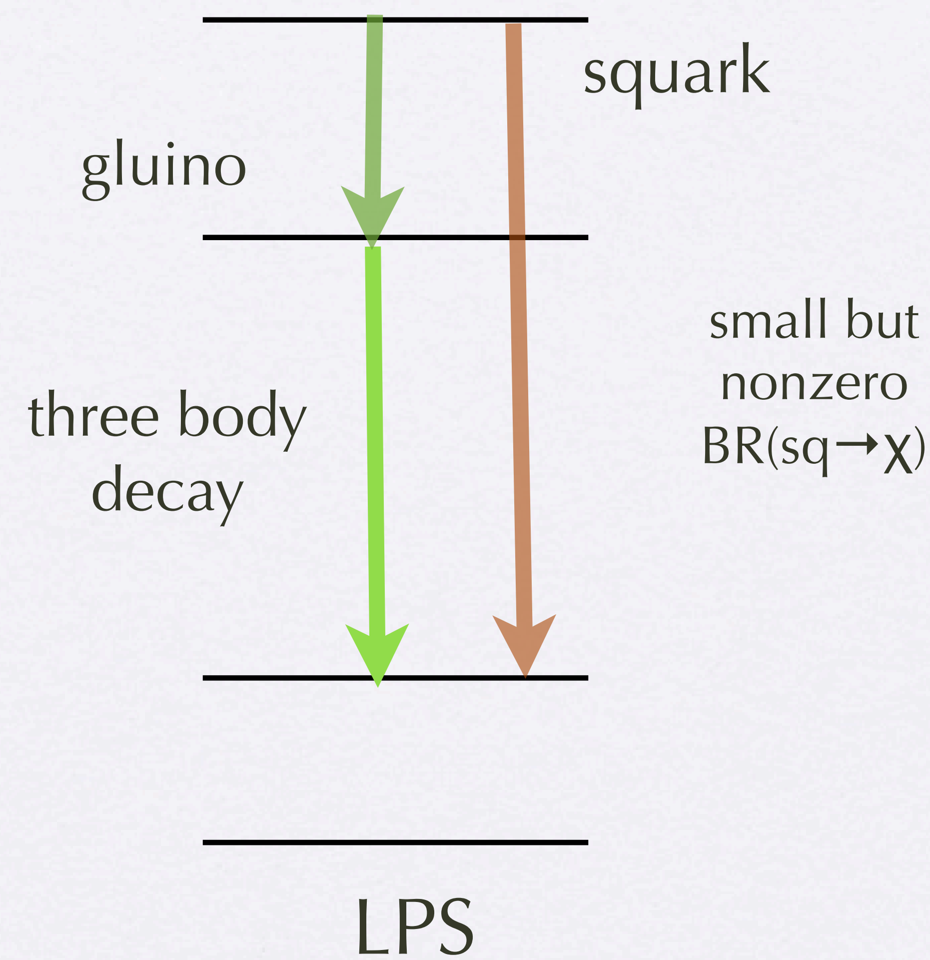


★ True squark/gluino mass

主な変更点* n200>2 のイベントの
比率が多いときは、
3rd jet からminimization をする。

- gluino-> squark 2 high pt jet soft things from the other cascade.
- squark-> gluino (with some squark-> EW ino leading very high pt jet)





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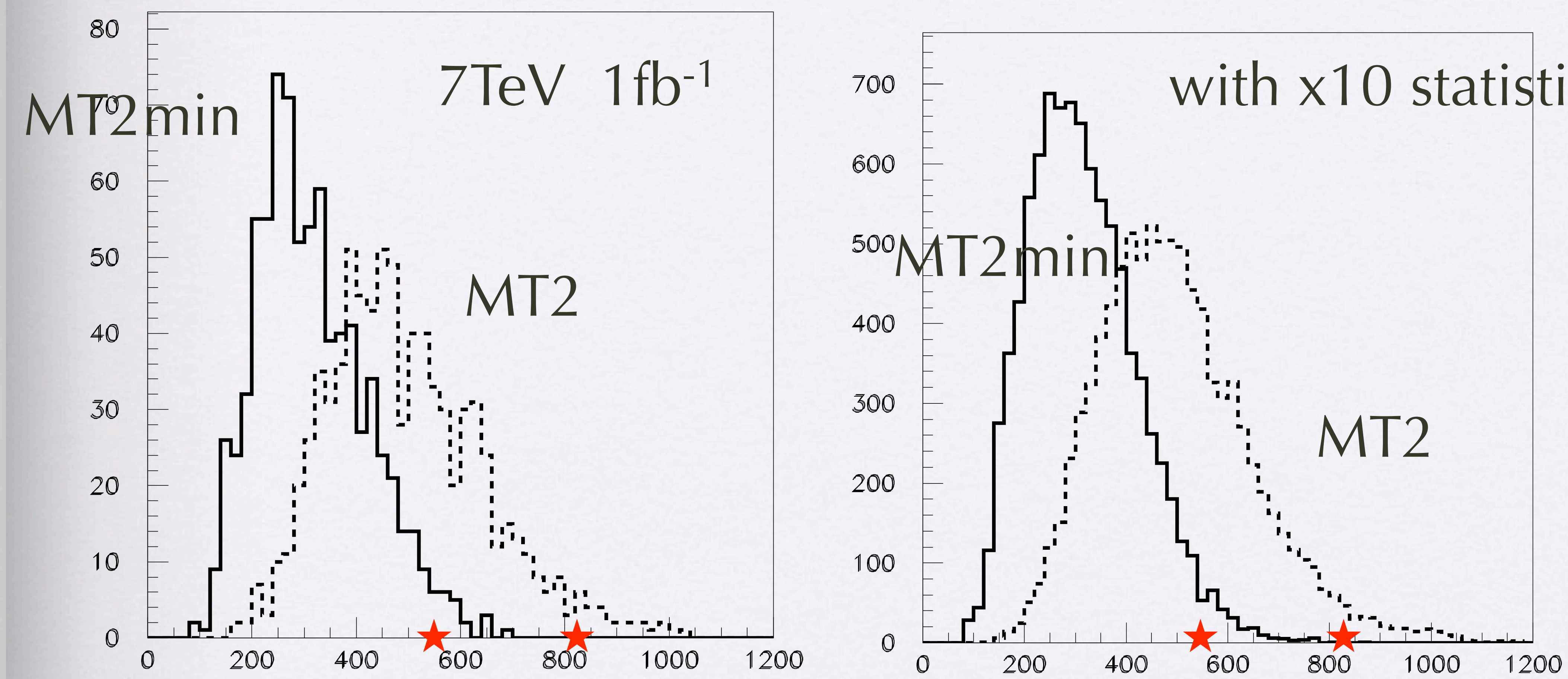
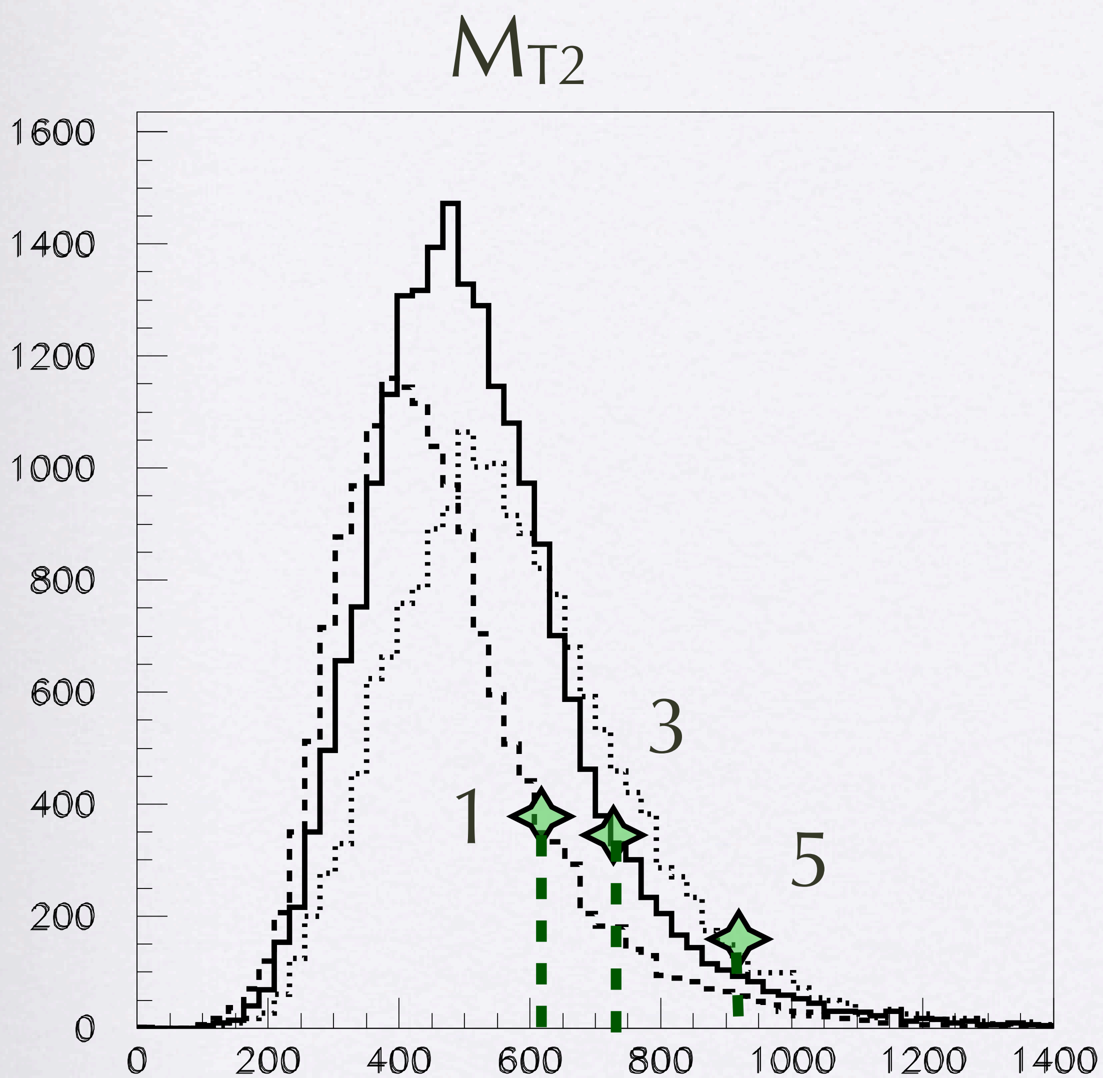
ISR effect is small for heavy squark mass because pT of the decay products are large.

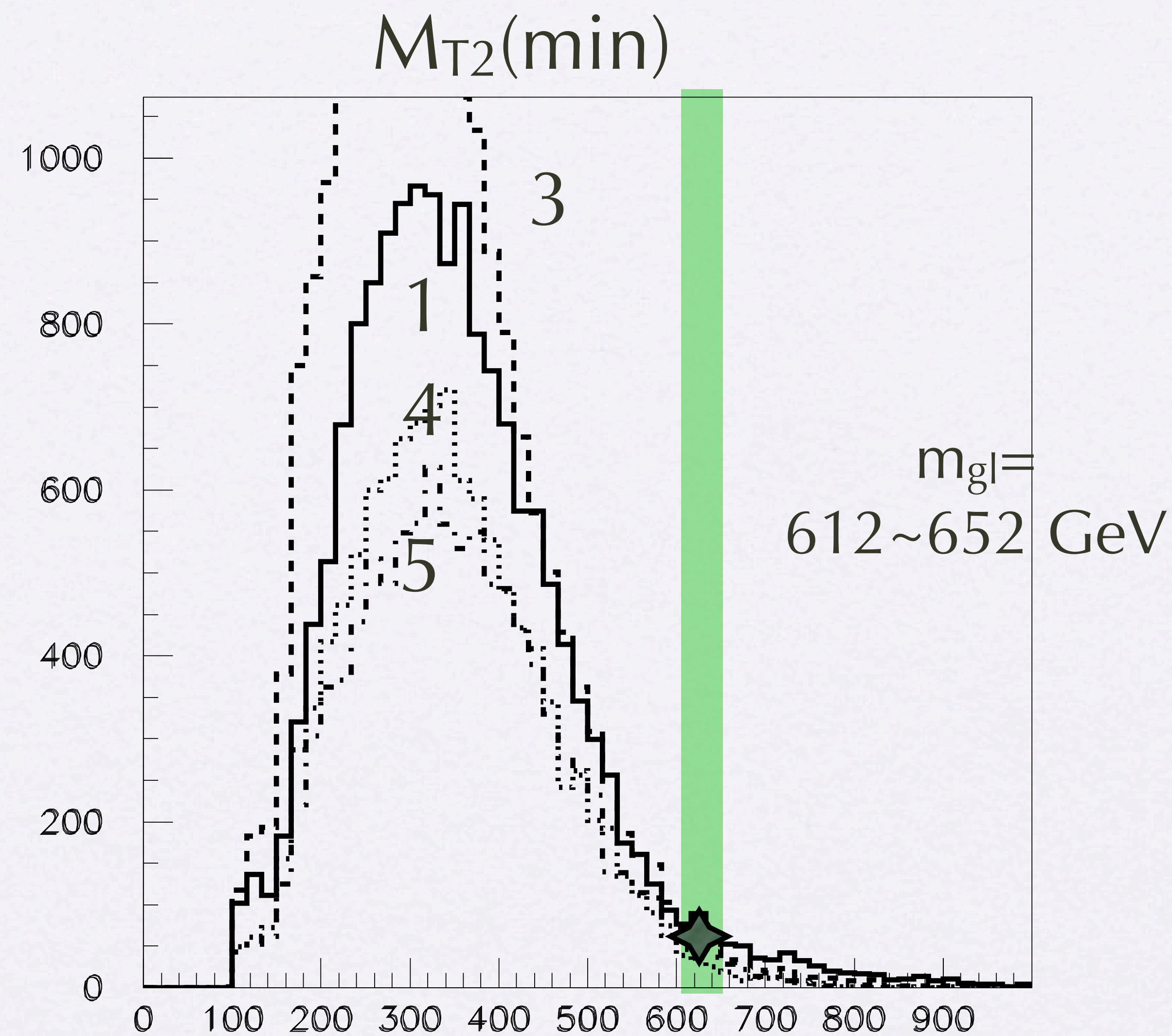
mgl=558GeV mul=825 GeV



using global shape probably more useful.

M_{T2}(min) for mixed case (14TeV, 60000 events)





MT2 is more affected by ISR
gluino mass ~ M_{T2}(min) end point.
Total SUSY cross section ⇄squark mass scale.

Lepton mode

- model with m1,m2<<m3 ex. first two generation as NG boson. (arXiv1004.4164[hep-ph], Mandal,Nojiri, Sudano, Yanagida)
- the large third generation scalar mass⇄less constraint from B decay, higgs mass,...
- DM constraint ⇄Higgs mass at GUT scale.
- Three DM consistent solution

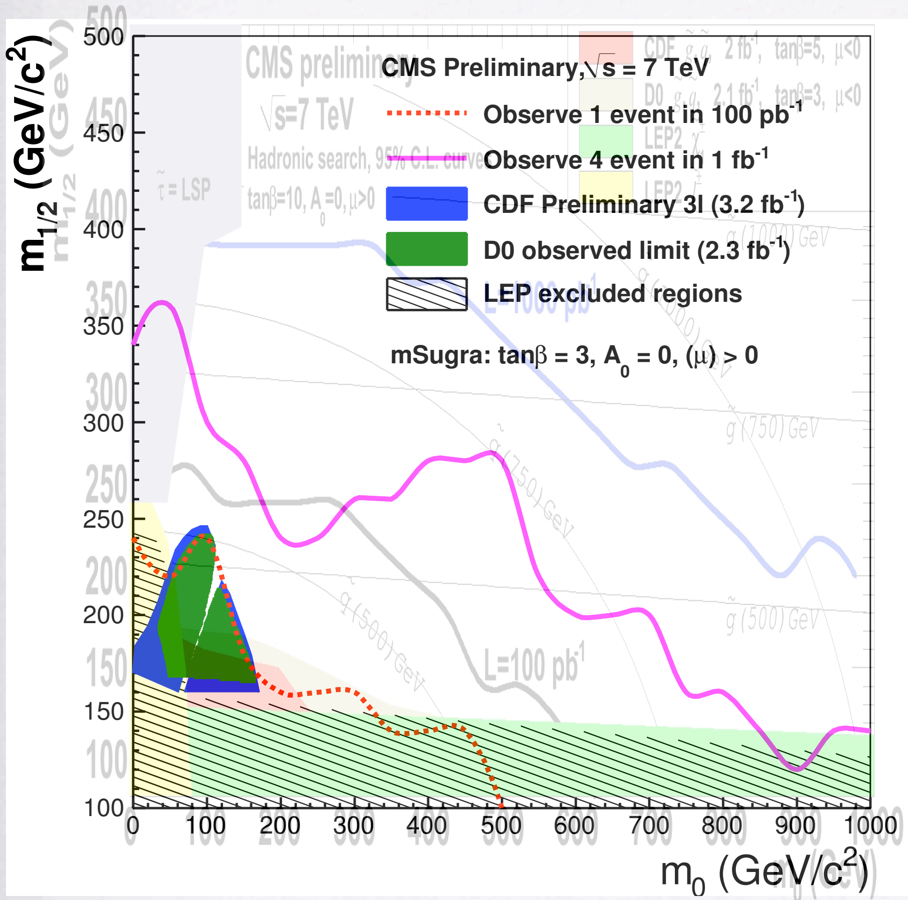
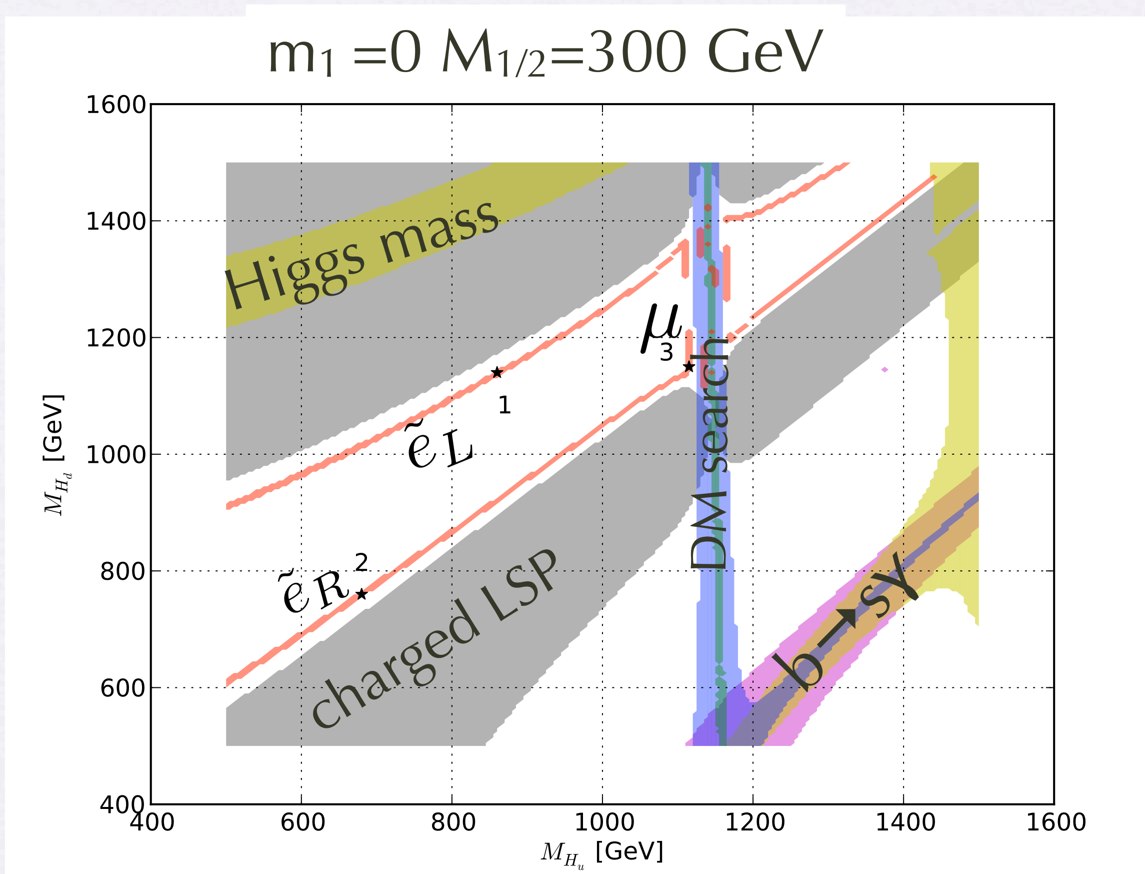
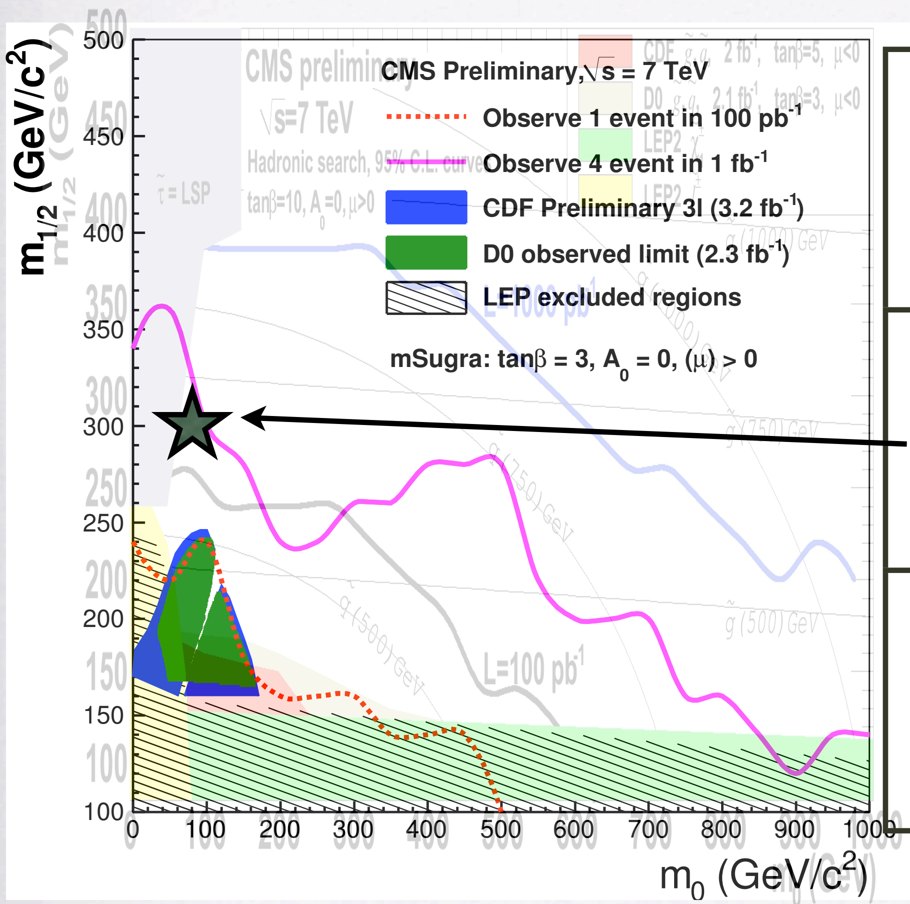


Figure 13: Estimated 95% C.L. exclusion limits for the all-hadronic SUSY search, expressed in mSUGRA param-

- Experimental reach based on leptons are not impressive compared with jets.
- We may focus on the models with large lepton branching ratio (looking for a key under the...)



Heavy third generation



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	with b	with tau	2lepton
universal	30%	16%	4%
heavy third generation	3%	2%	15~30%

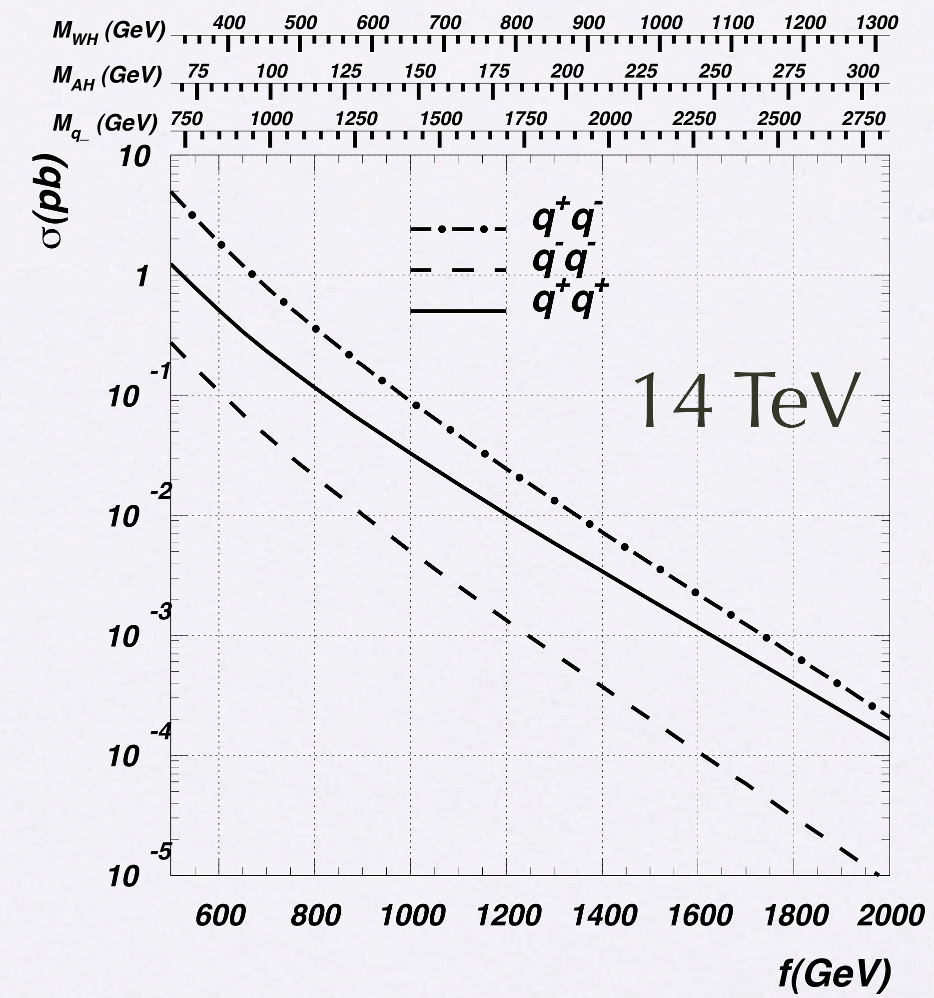
- Experimental reach based on leptons are not impressive compared with jets.
- We may have to focus on the models with large lepton branching ratio (looking for a key under the...)

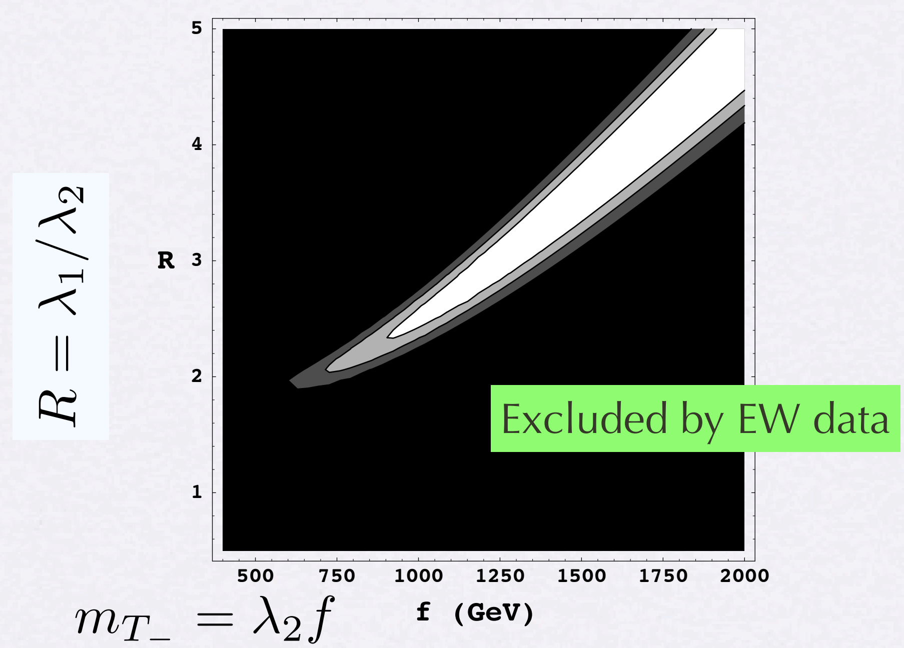
Little Higgs model, UED, more toy models.

$SU(2)^2 \times U(1)^2 \rightarrow SU(2) \times U(1)$

with T partity.
fermion partners, and heavy EW gauge boson partners

- The cross section is about factor 1/4 small for same squark grluino mass.
- factor 1/10 at 7 TeV
- ~ 600 GeV may be accessible,but not acceptable with EW precision measurements. no gluion partner





UED model and “partner spins”
(for SUSY 600 GeV, sq sq 21% sq gl 40% gl gl 12%)
toy UED model with large mass splitting

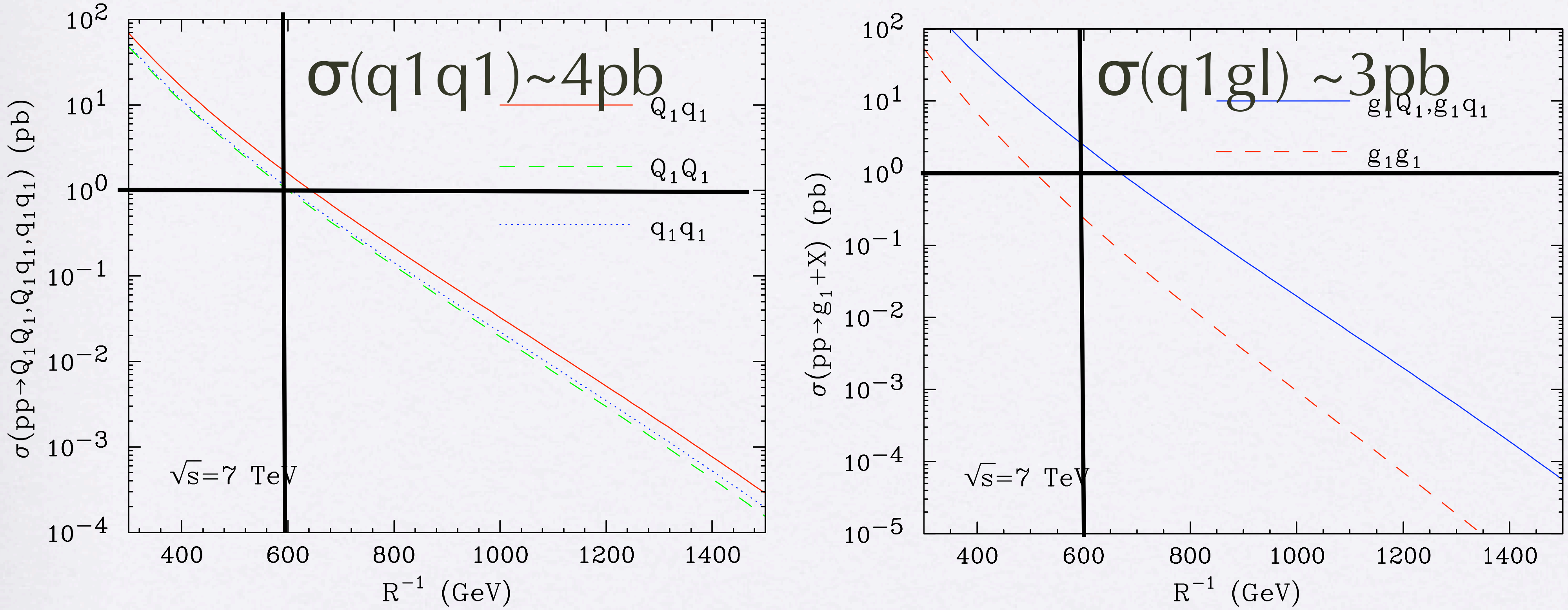


Figure 4. Strong production of $n = 1$ KK particles at the LHC for $\sqrt{s} = 7$ TeV: (a) KK-quark pair production; (b) KK-quark/KK-gluon associated production and KK-gluon pair production. The cross sections have been summed over all quark flavors and also include charge-conjugated contributions such as $Q_1\bar{q}_1$, $\bar{Q}_1 q_1$, $g_1\bar{Q}_1$, etc. We use CTEQ6L parton distributions [91] and choose the scale of the strong coupling constant α_s to be equal to the parton level center of mass energy.

tools

Durh, in LHCPP

Implemented models

	CalcHep	Herwig	MadGraph	Sherpa	Whizard
SM	✓	✓	✓	✓	✓
cMSSM	✓	✓	✓	✓	✓
MSSM	✓	✓	✓	✓	✓
NMSSM	✓	✓	✓	✓	✓
2HDM	✓	✓	✓	✓	✓
UED	✓	✓	✓	✓	✓
ADD				✓	
Technicolor					

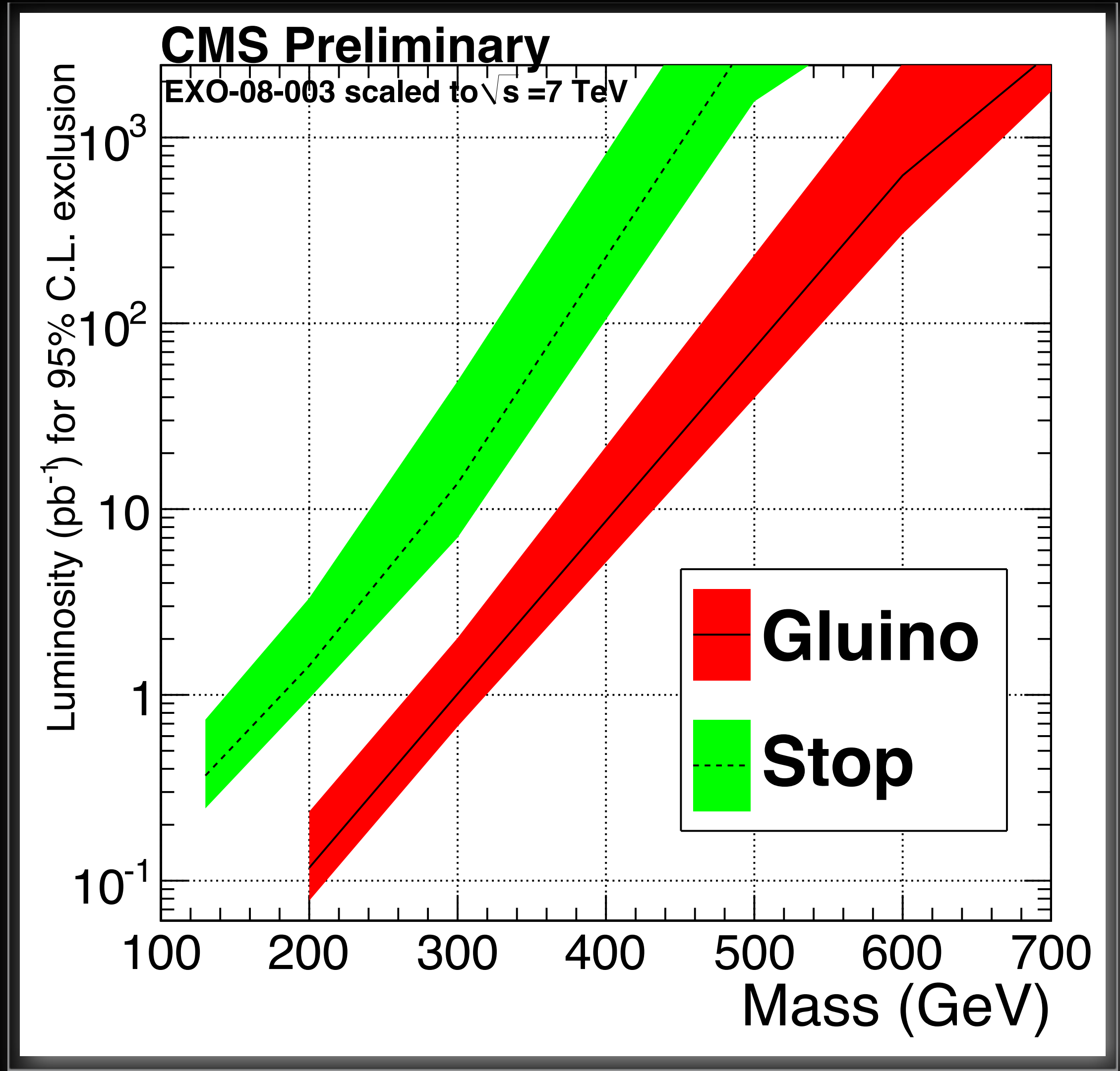
- Still many model missing/private... how to make them public..?

Exisotic

Heavy Stable Charged Particles

CMS NOTE-2010/008

- Exploit distinct signature
  - **low velocity, high momentum**
  - **use muon timing and tracker dE/dx to identify candidates**
  - **10 TeV result scaled to 7 TeV**
  - **Probing 0.5 TeV with 100 pb^{-1}**
- Side-note
  - **dE/dx commissioned!**
    - Kaons, protons and deuterons
      - the latter is not present in MC...



95% C.L. exclusion limit for HSCP searches at 7TeV

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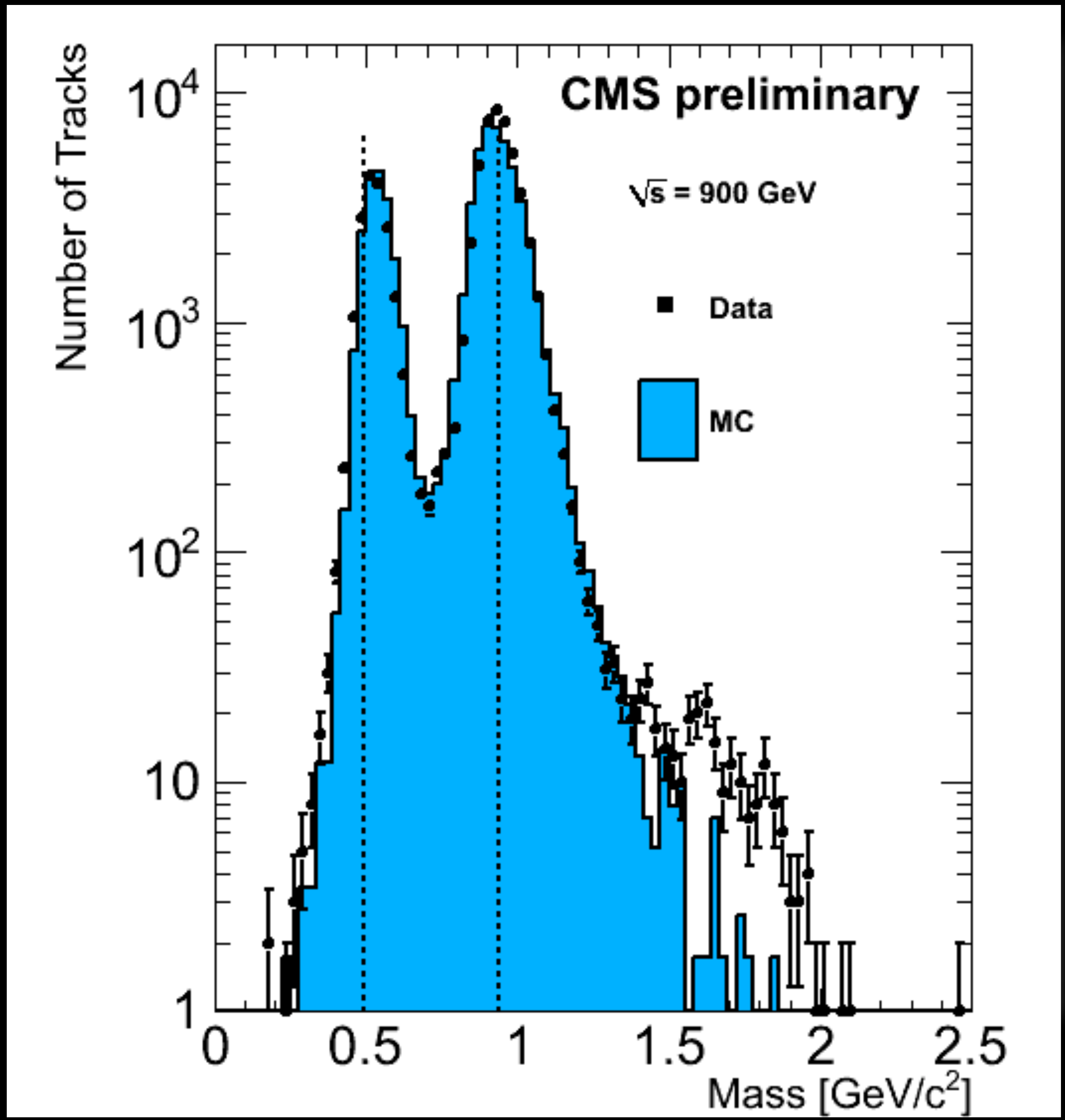

at 7TeV

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