New Physics with early LHC data ?

Supermodels !

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with

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D Walker

arXiv: 0909.5213

Early data

run 0. 0.9-7 TeV 0 pb^{-1}

Nov '09 → Feb '10

run 1.a. 7 TeV 10's of pb^{-1}

Feb - May '10

run 1.b. 9-10 TeV few 100 pb^{-1}

Jun - Oct '10

R. Tenchini :

GGI plenary 10/26/09

"First step is not relevant for anything."

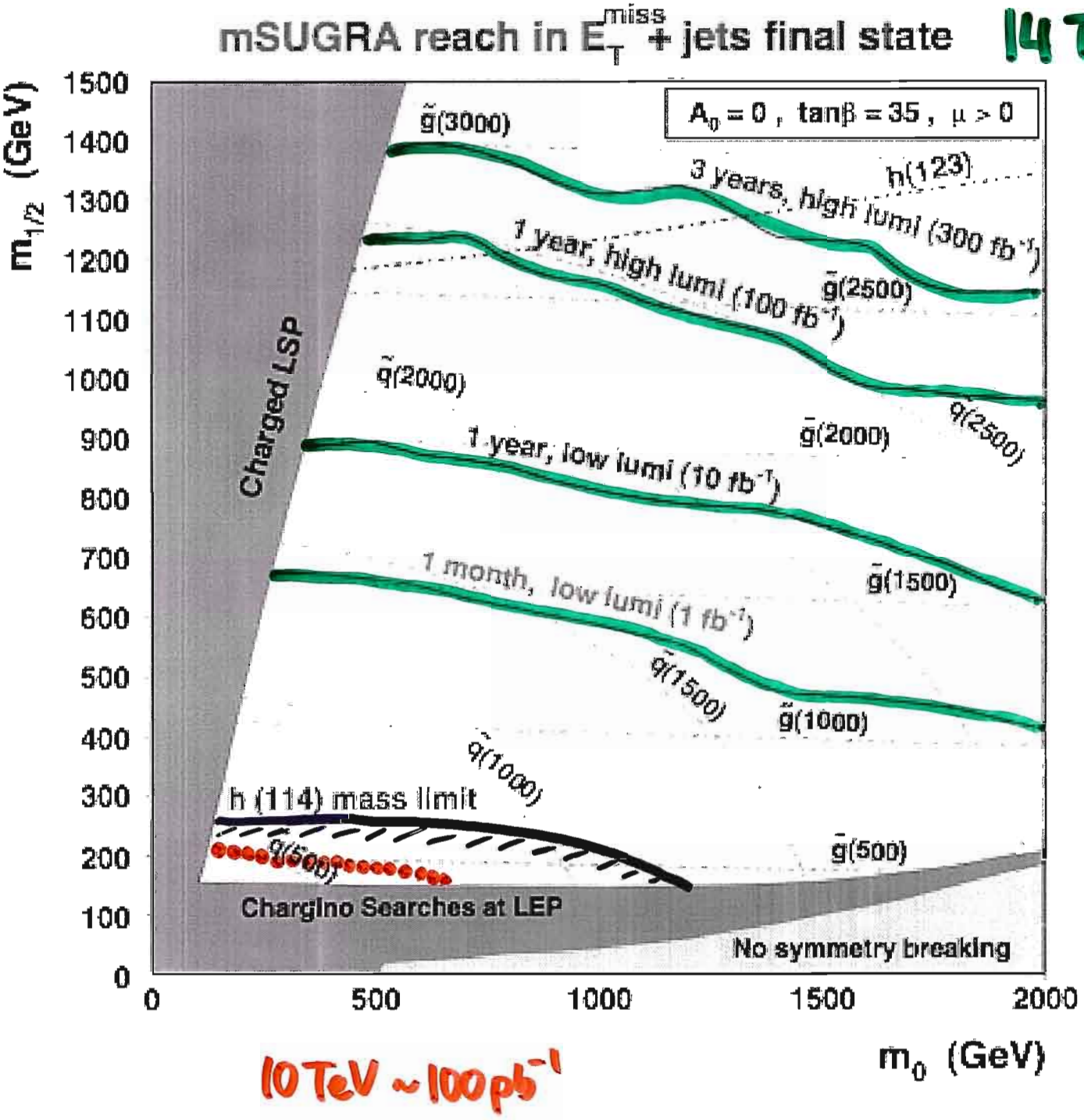
except supermodels

assume pessimistically...

7-10 TeV

- 10 pb^{-1} "low"
- 100 pb^{-1} "high"

of usable luminosity



10 TeV ~ 100 pb^{-1}

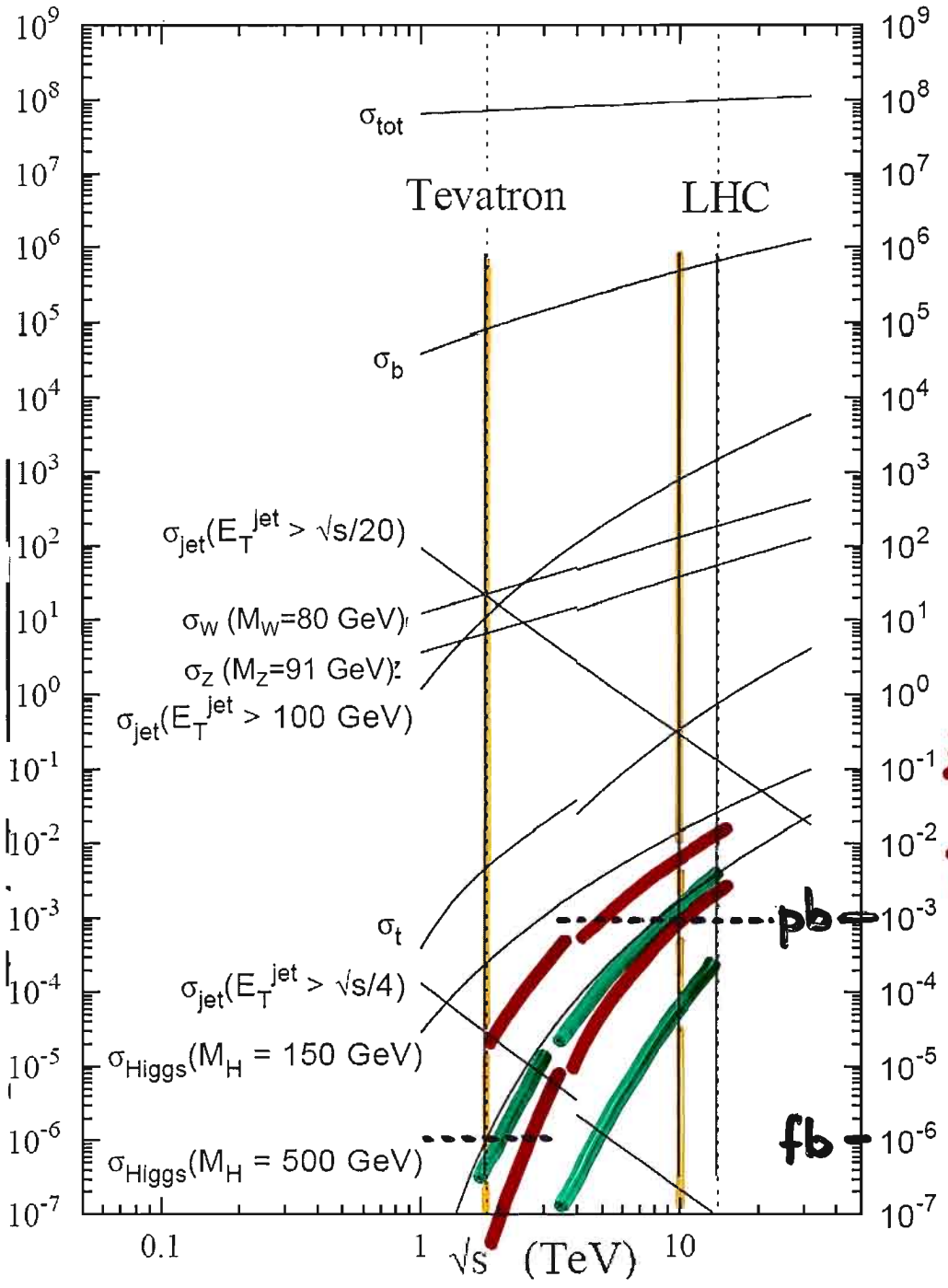
Early discovery needs ...

"easy" signature (leptons, ...)

A. $N_{events}^{LHC} \gtrsim 10$

$$\Rightarrow \sigma \cdot Br. \gtrsim \begin{cases} 1\ pb & \text{"low"} \\ 0.1\ pb & \text{"high"} \end{cases}$$

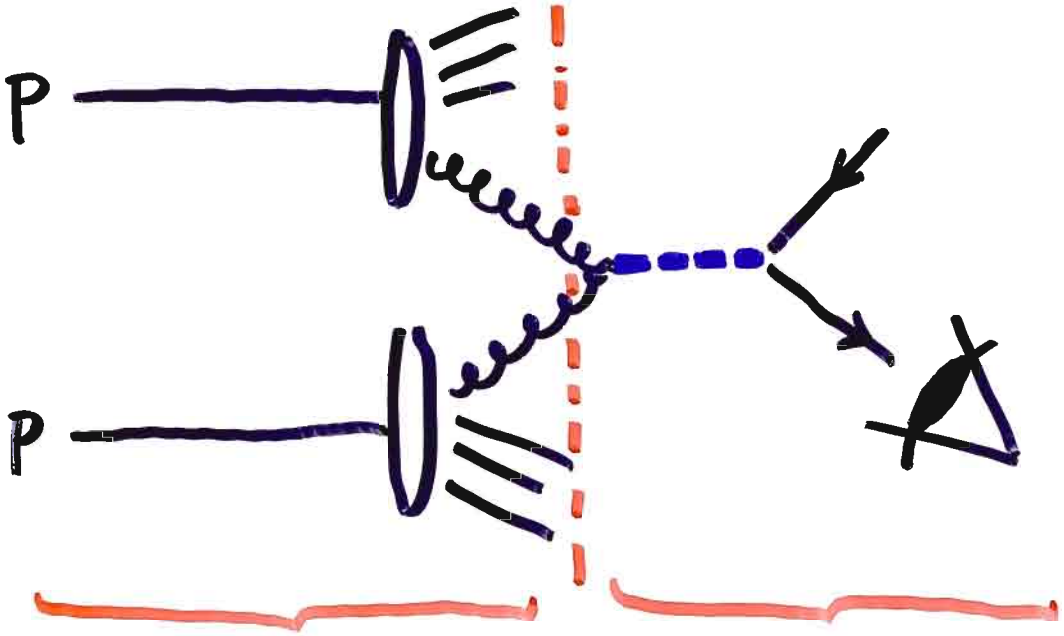
Cross Sections



$$N_{events} = L \cdot \sigma \cdot Br$$

beat the Tevatron

i.e. $N^{LHC} \gtrsim N^{Tevatron}$



"parton luminosity" $\Omega(s, \hat{s})$

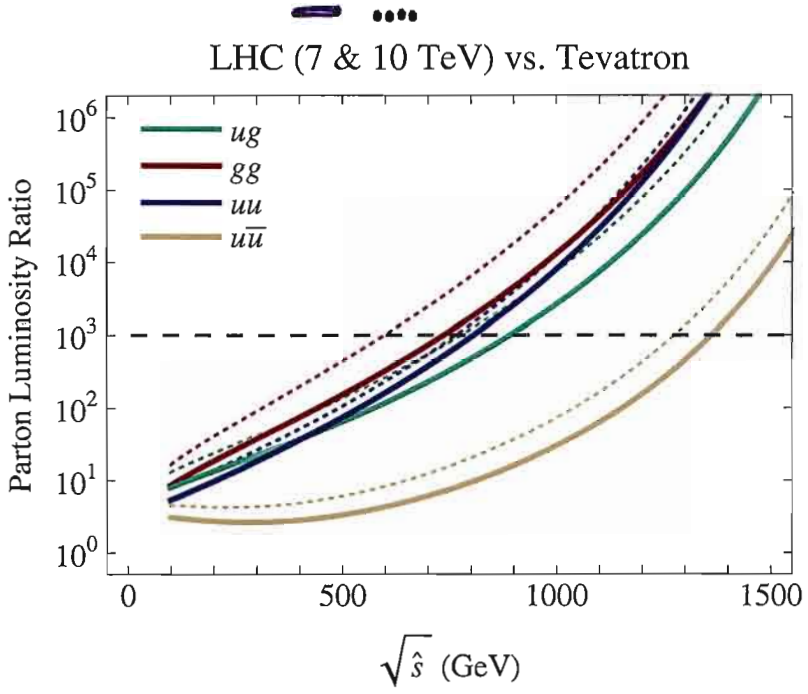
universal $\hat{\sigma}(\hat{s}) \cdot Br \cdot Eff$

want: $\Omega^{LHC} L^{LHC} \gtrsim \Omega^{Tev.} L^{Tev}$

win by ?

lose by 1000

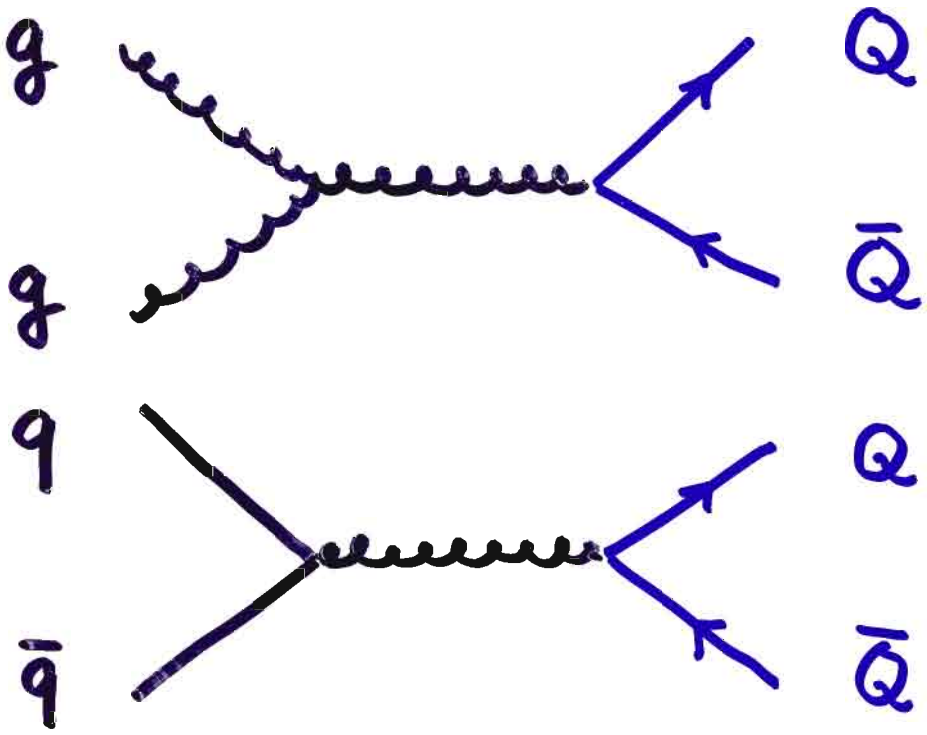
$\frac{\Omega^{LHC}}{\Omega^{TeV}}$



LHC wins for

- large mass
- gg, gq, qq

Example: QCD pair production



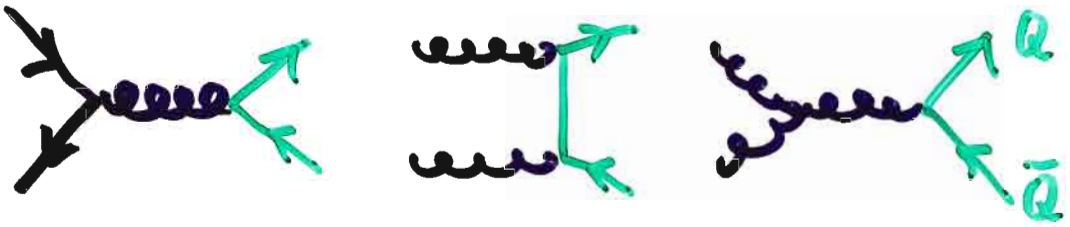
Signature ?

Q stable ⟶ "heavy muon"

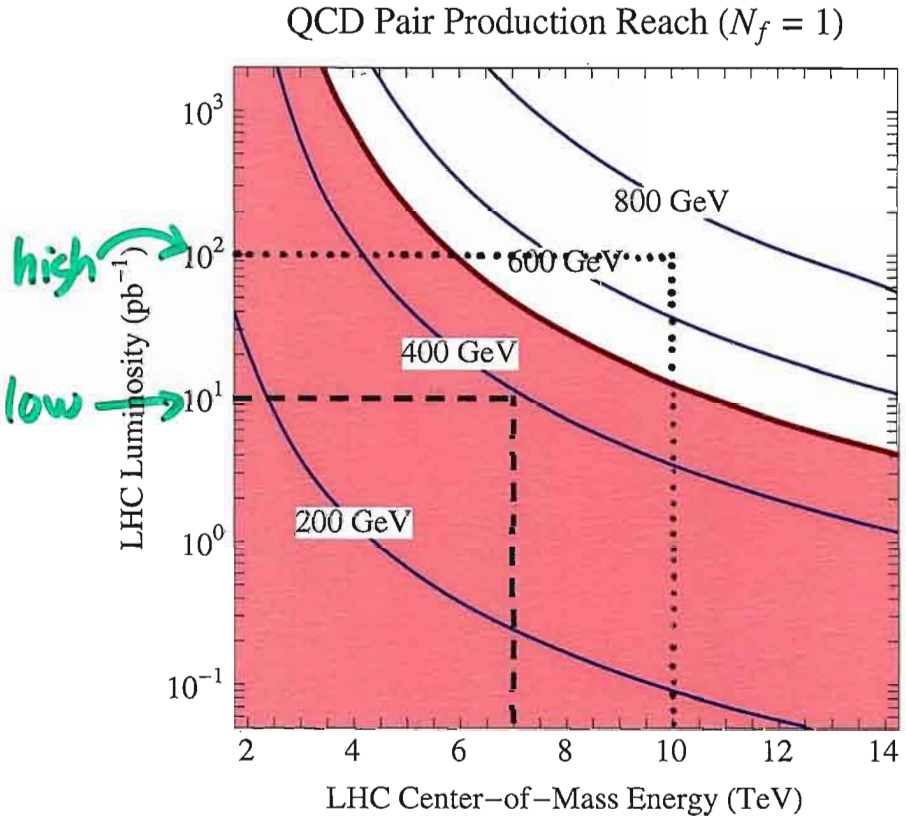
Q leptoquark ⟶ $\ell^+\ell^- jj$

⋮

New quarks



QCD



high →

low →

← Tevatron reach: 500 GeV

We can do better !

phase space for final particles

$$\prod_{i=1}^{n} \frac{d^3 p_i}{(2\pi)^3 2E_i} \Longrightarrow \left(1/16\pi^2\right)^n$$

$\Longrightarrow$ single resonance production

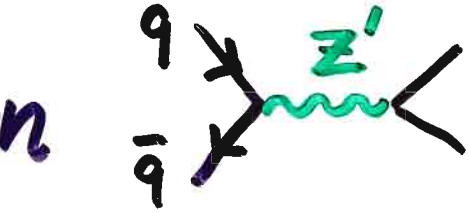
(like Z @ LEP)

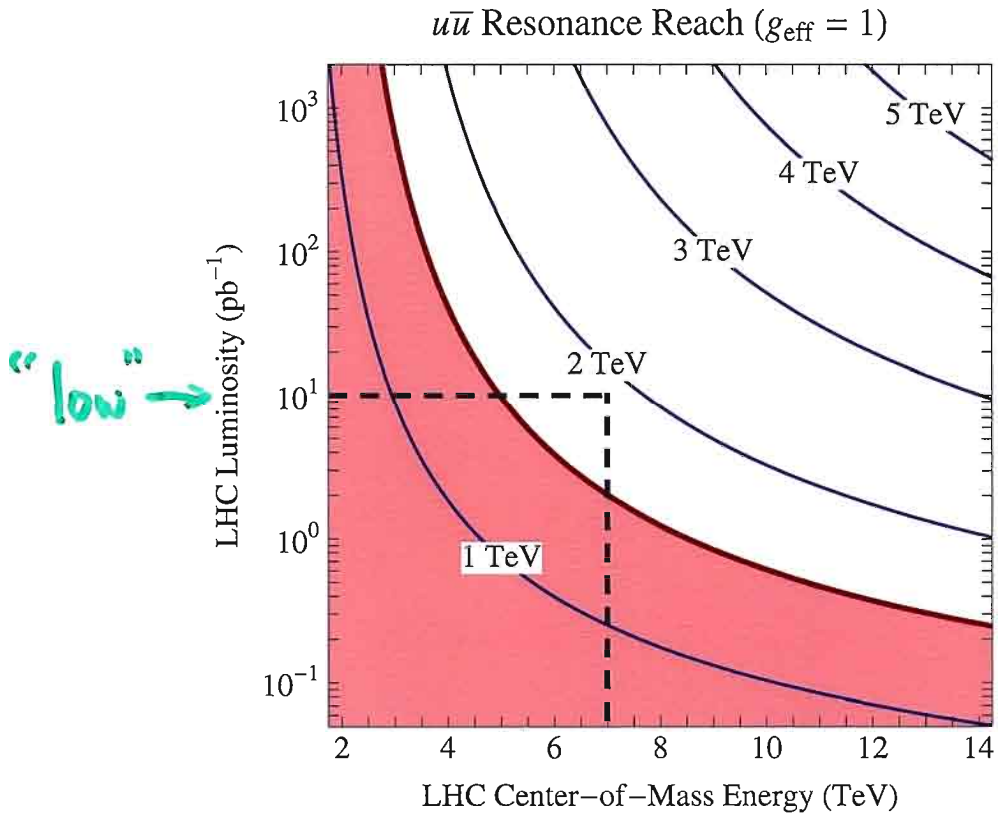
Classifying Resonances

1.	$q\bar{q}$	Z' $(W'; g'; G_R'; \ldots)$	1
2.	gg	"higgs"	$1/16\pi^2$
3.	qg	excited quark	$1/16\pi^2$
4.	qq	diquark	1

$g_{eff} =$

1. Z' production



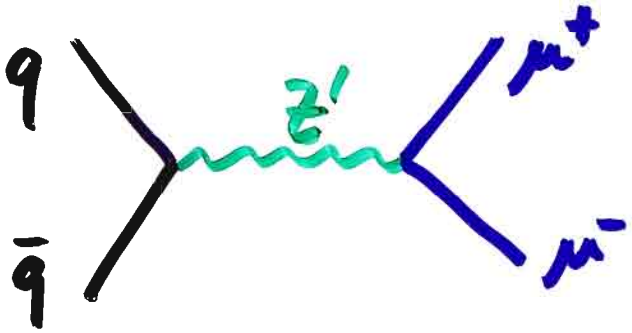


"low" →

Tevatron 1.5 TeV

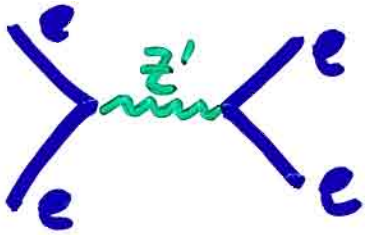
Decays: Z'

a.)

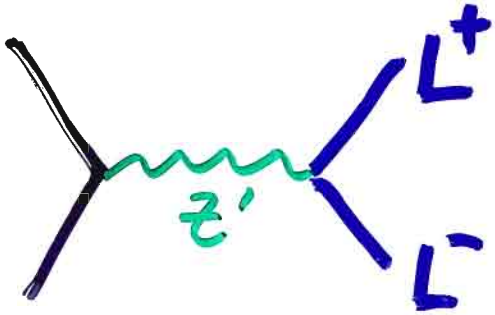


LEP II bounds

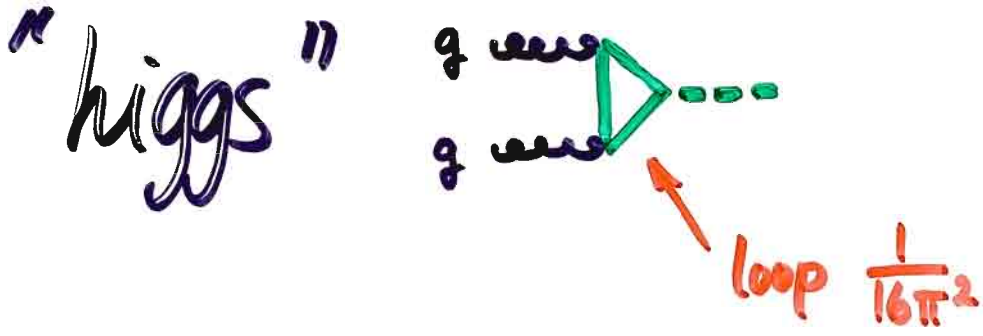
$m_{Z'} > 5\,TeV$

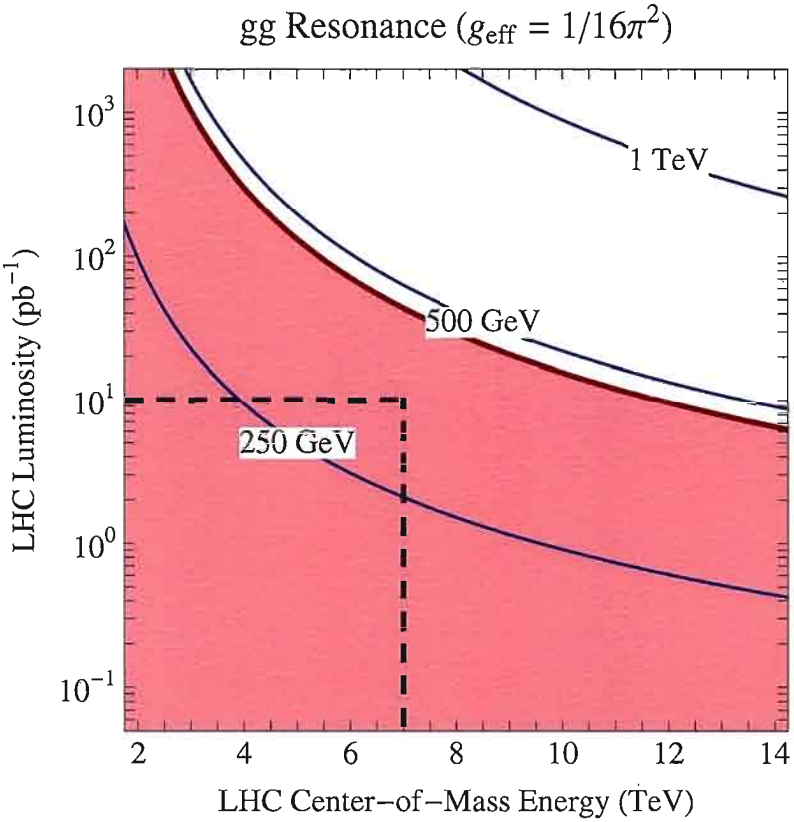


b.)

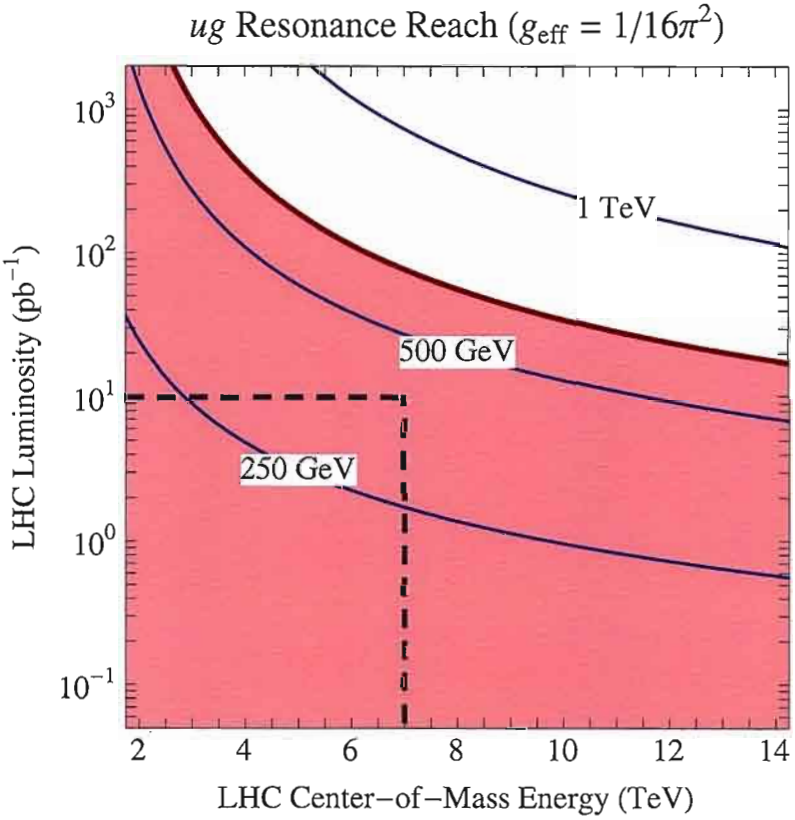


new "stable" lepton

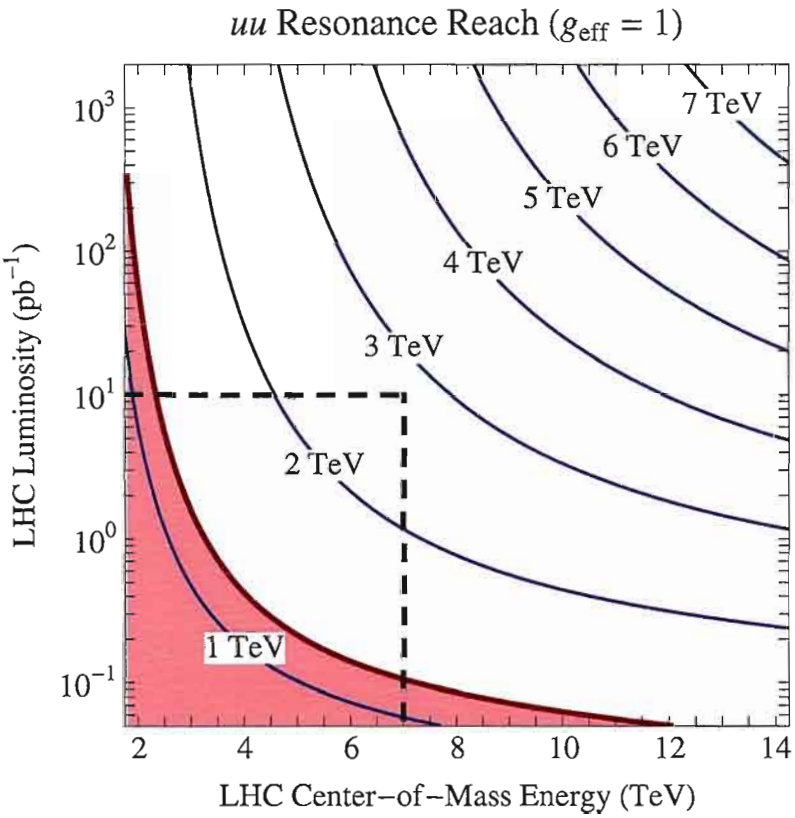

"higgs"
g
g
loop $\frac{1}{16\pi^2}$


gg Resonance ($g_{\text{eff}} = 1/16\pi^2$)
LHC Luminosity (pb^{-1})
10^3
10^2
10^1
10^0
10^{-1}
1 TeV
500 GeV
250 GeV
2
4
6
8
10
12
14
LHC Center−of−Mass Energy (TeV)

"excited quark"

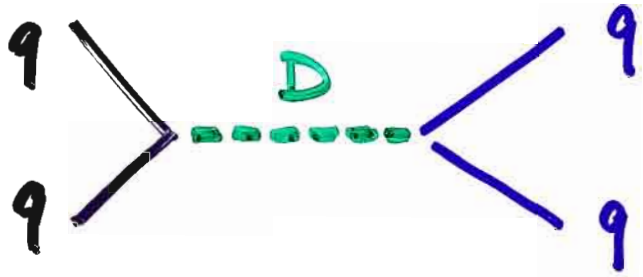


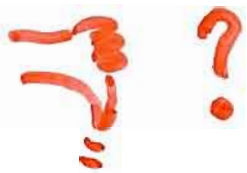
4. diquark production



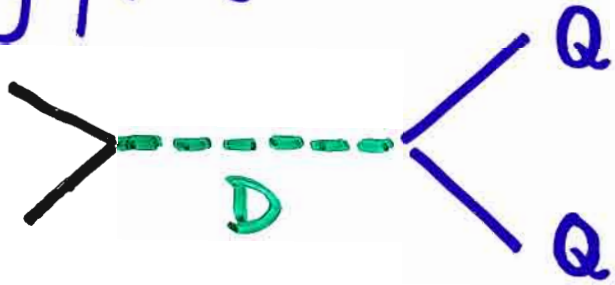
diquark final states

- dijets

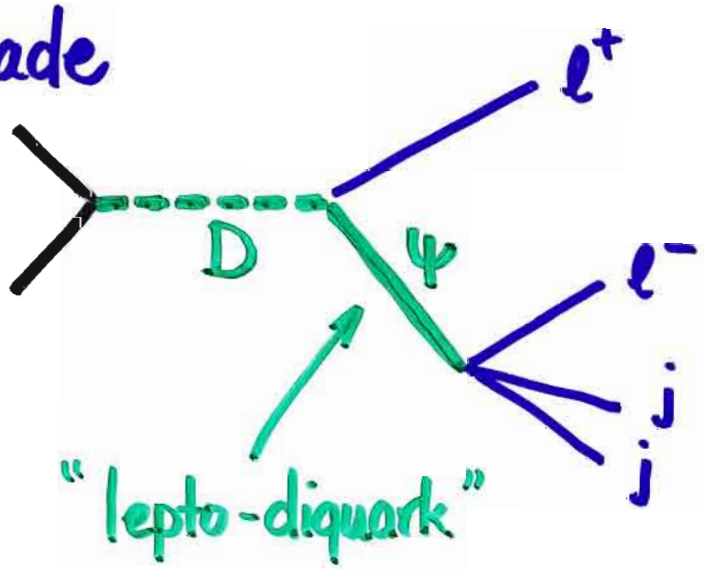




- stable heavy quarks



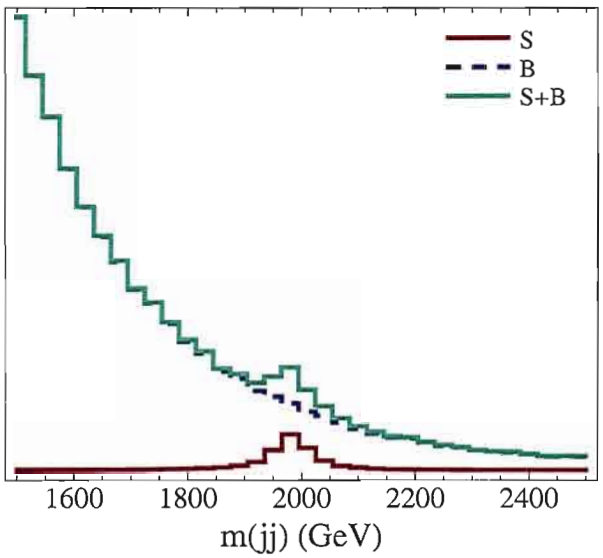
- cascade



- ...

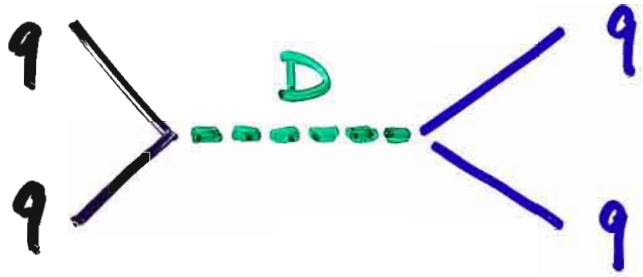
diquarks

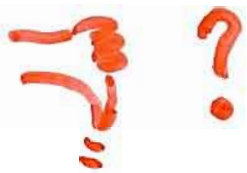
∞ - luminosity di-jets



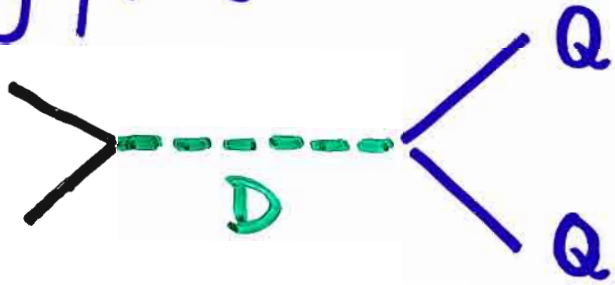
diquark final states

- dijets





- stable heavy quarks



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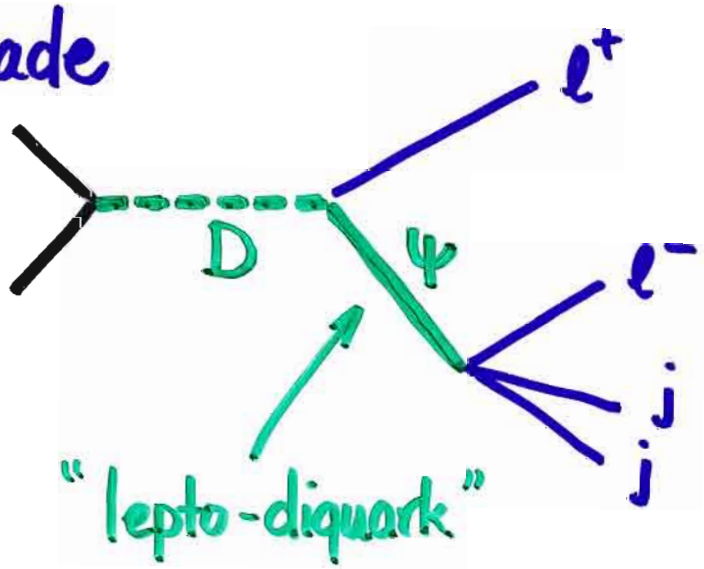

- ...

Conclusions

- no reach for MSUGRA, gM, higgs, Little Higgs even with 100 pb^{-1}
- big difference between 100 & 10 pb^{-1}

$100\,pb^{-1}$

Z'

stable quark
leptoquark

$10\,pb^{-1}$

diquark

truly super