Région Autonome
Vallée d'Aoste
Regione Autonoma
Valle d'Aosta
Assessorat de l'Éducation et de la Culture
Assessorato Istruzione e Cultura

LES RENCONTRES DE PHYSIQUE
DE LA VALLEE D'AOSTE
Results and Perspectives in Particle Physics

INFN
Istituto Nazionale
di Fisica Nucleare

Supermodels:

» New Physics with earliest LHC data «

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hep-ph: 0909.5213

Earliest Data:

2009: 1-2 TeV $10\ \mu b^{-1}$

2010: 7 TeV $10\text{-}100\ pb^{-1}$

2011: 7 TeV $100\text{-}1000\ pb^{-1}$

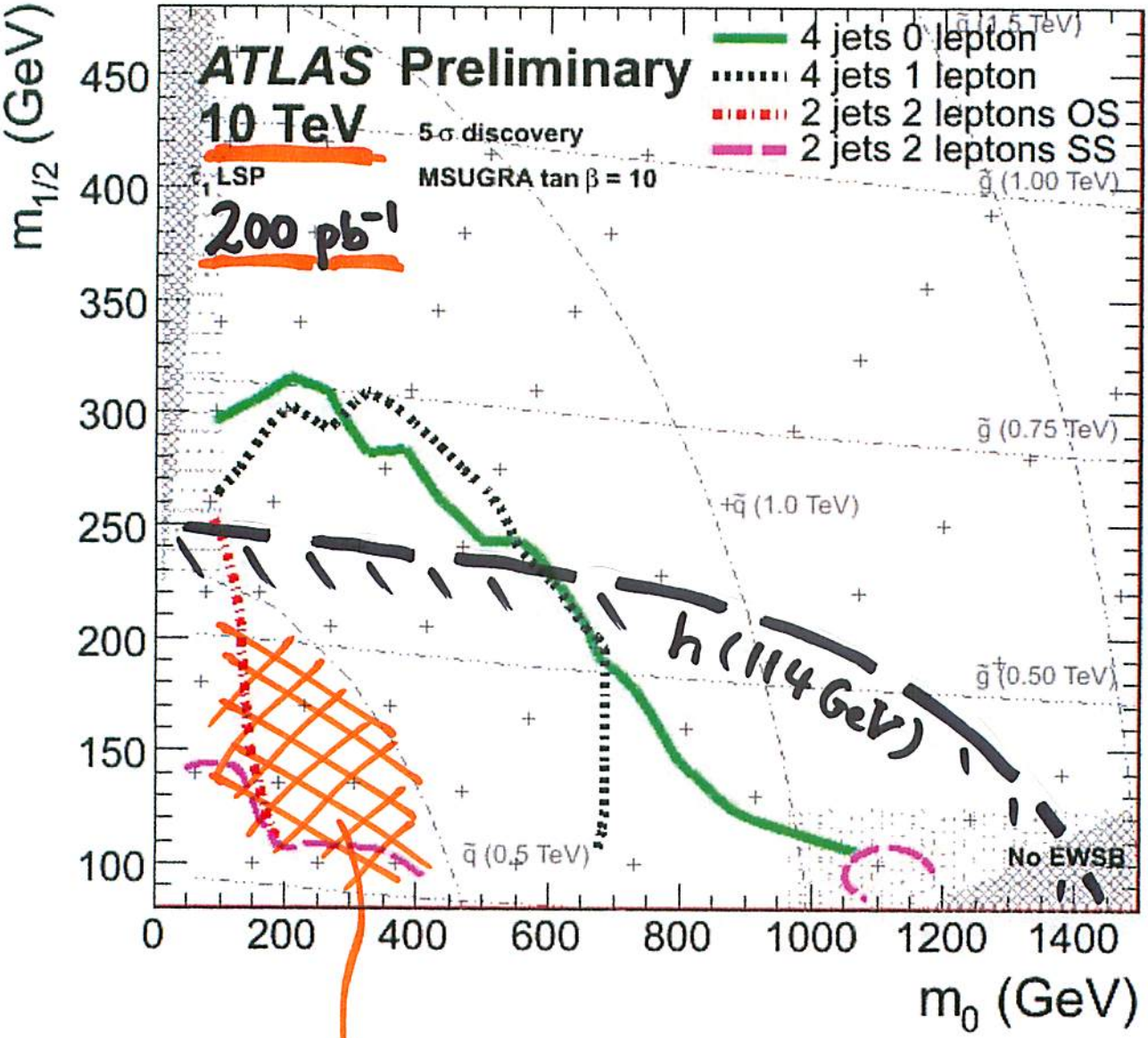
What can we do with a few 10's pb^{-1} ?

R. Tenchini (661 conference):

"First step [2010] is not relevant for anything * "

* fine print: response to question by audience about the new physics reach of a run with less than 50 pb^{-1}.

MSUGRA



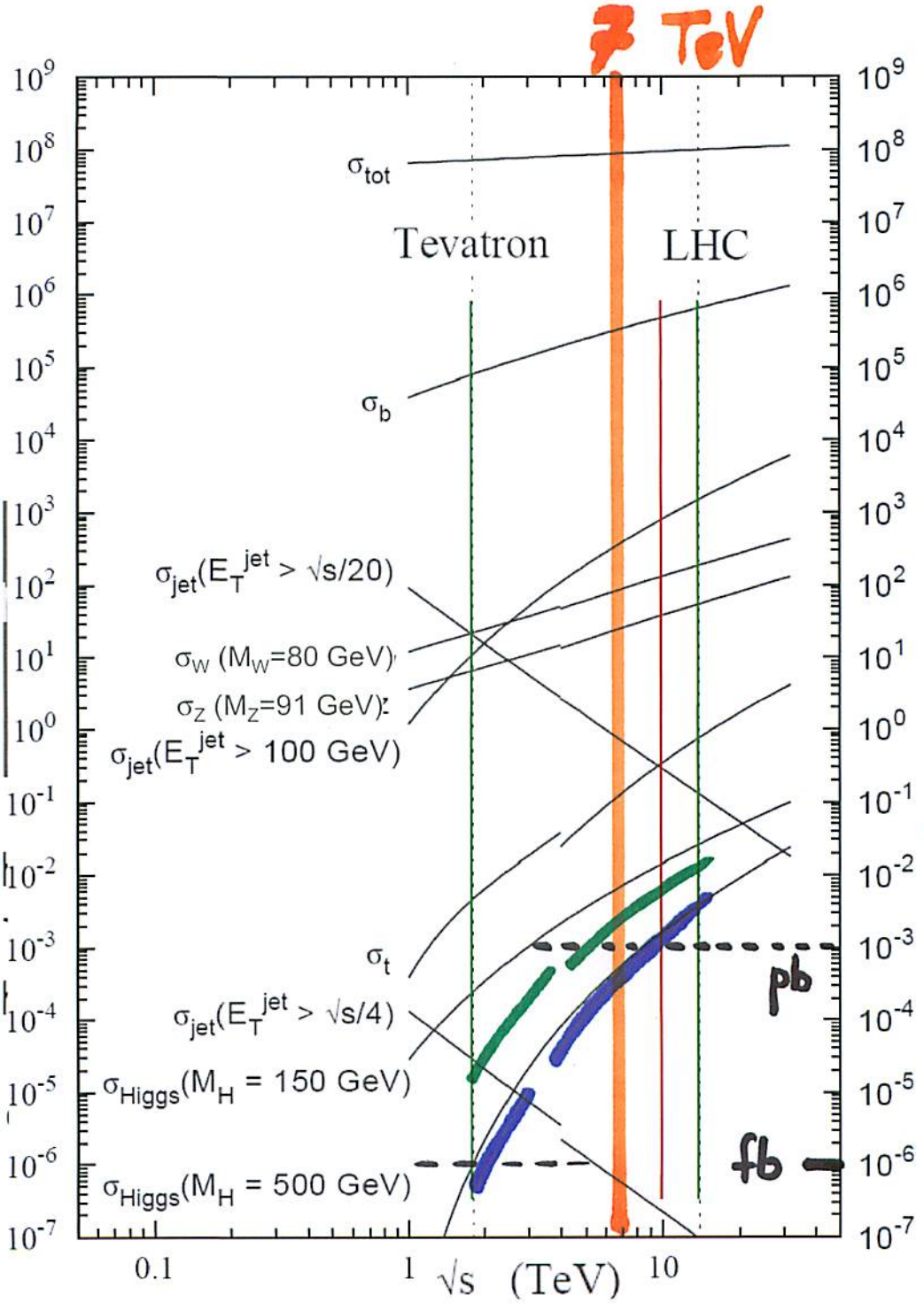
7 TeV, 10s pb⁻¹

Early discovery requires ...

- "easy" signature (leptons, ...)
- $N_{events} \gtrsim 10$

$$\Rightarrow \sigma \cdot Br \gtrsim 1 \text{ pb}$$

Cross Sections

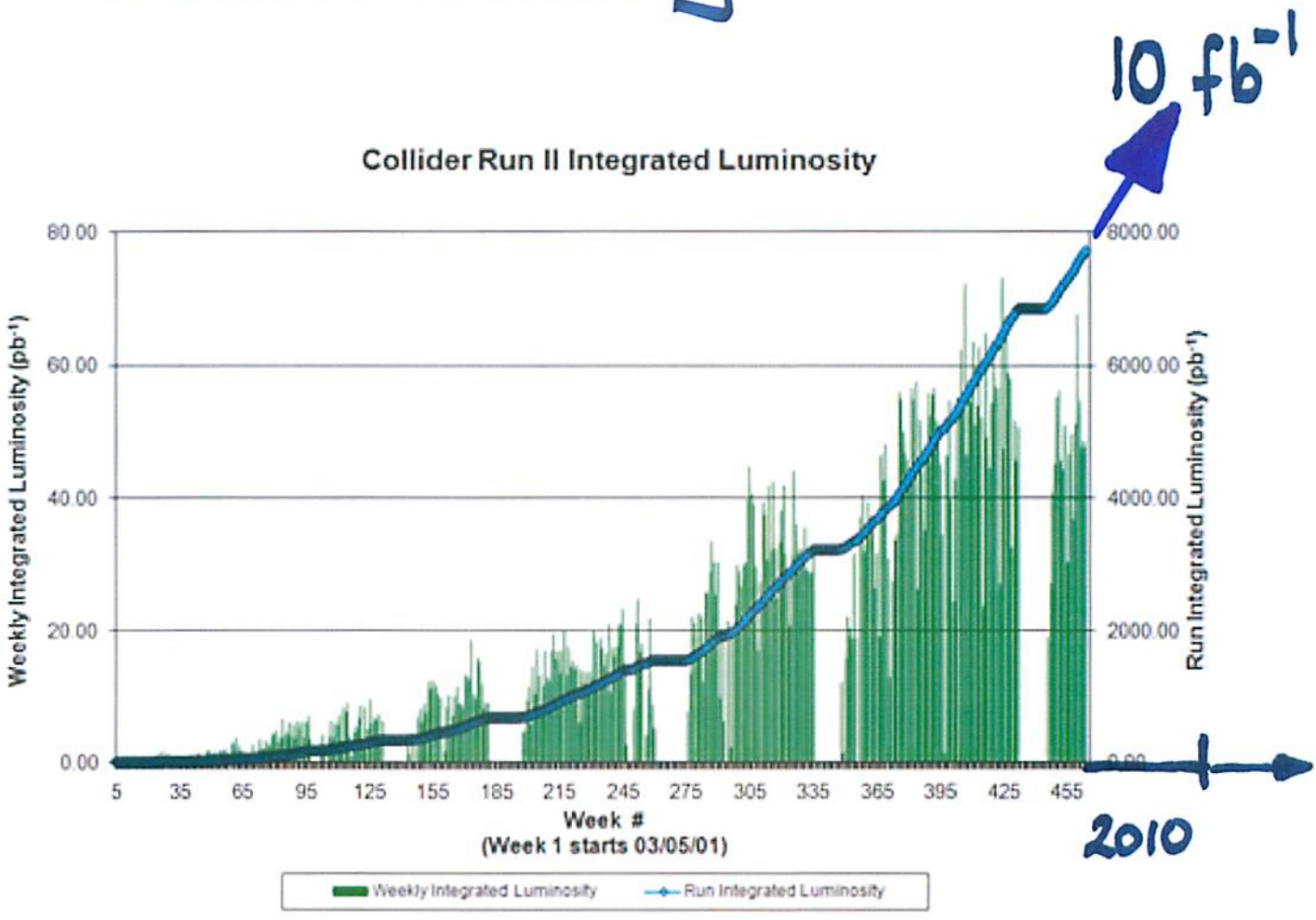


Z' 1.0 TeV

$\tilde{q}$ 0.5 TeV

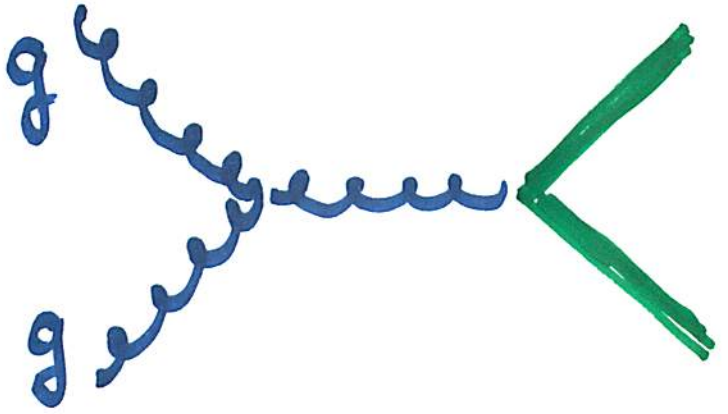
$$N_{events} = L \cdot \sigma \cdot Br$$

Tevatron Luminosity

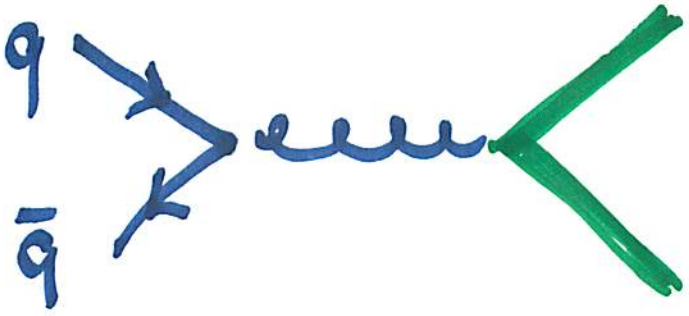


1st. example:

QCD-pair-production

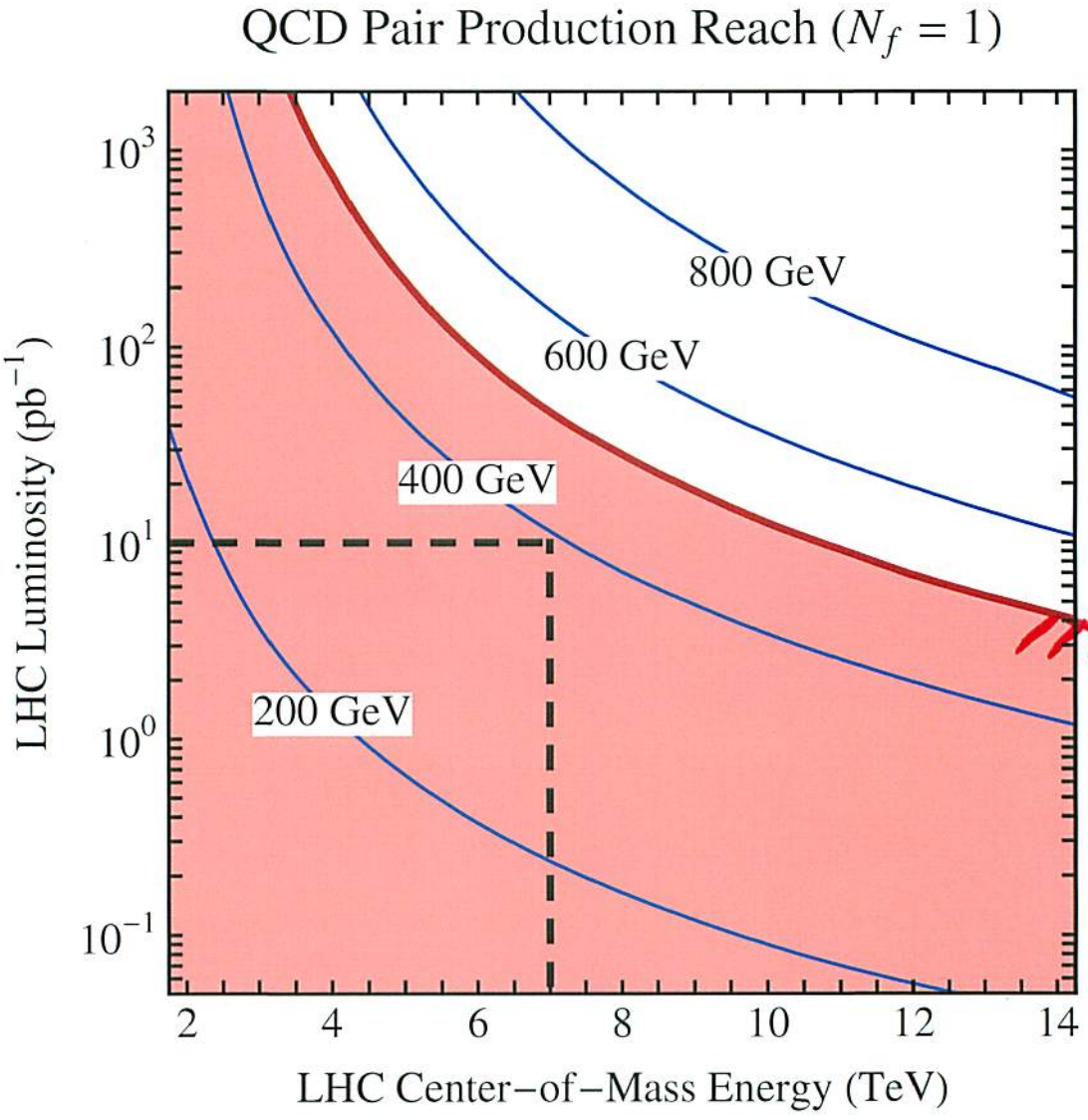


leptoquarks



"stable"

QCD pair production ...



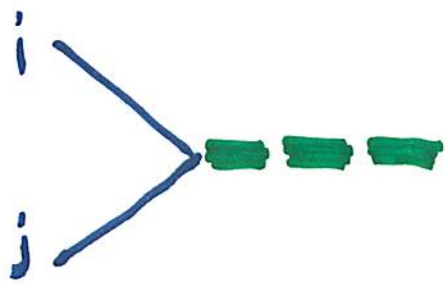
Teva-tron 500 GeV

... too small !!

we can do better !

n-final particle phase space

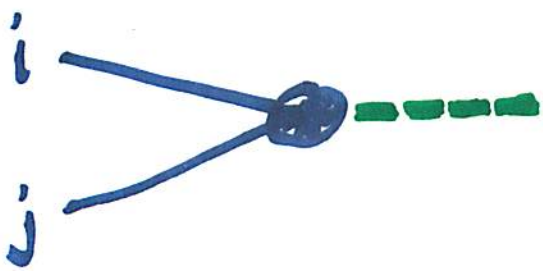
$$\prod_{i=1}^{n} \frac{d^3 p_i}{(2\pi)^3 2E_i} \Rightarrow \left(\frac{1}{16\pi^2}\right)^n$$

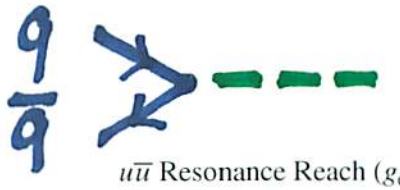


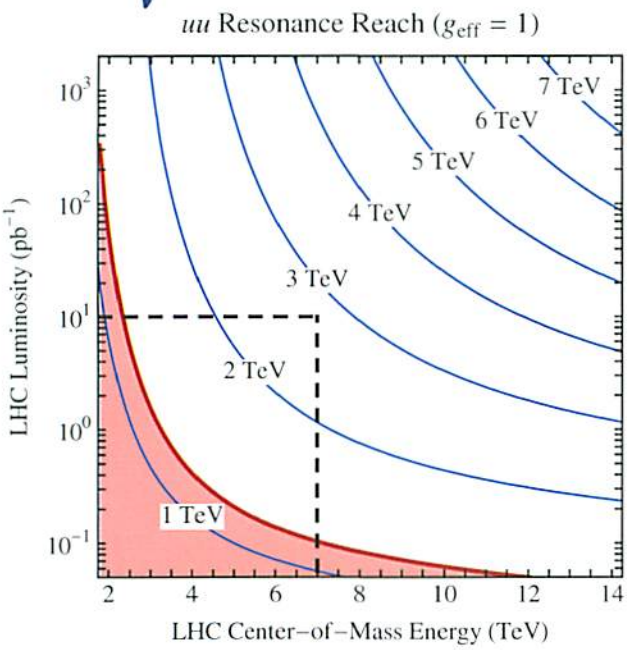
Resonances !

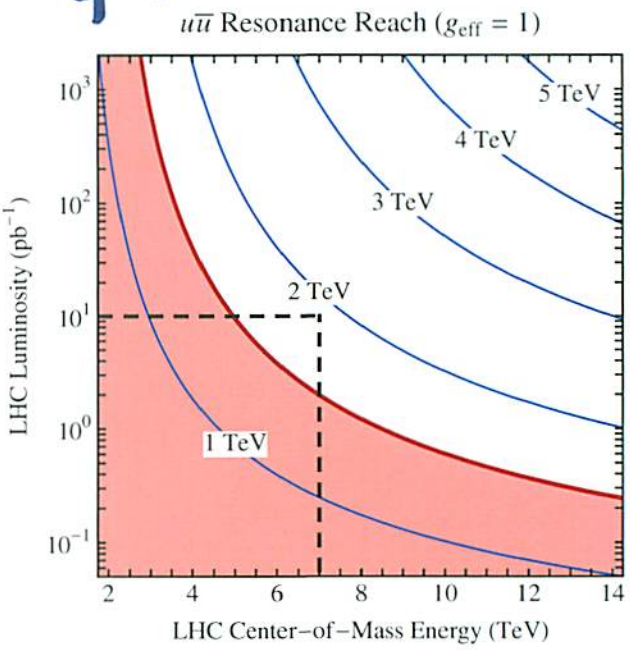
Classifying Resonances

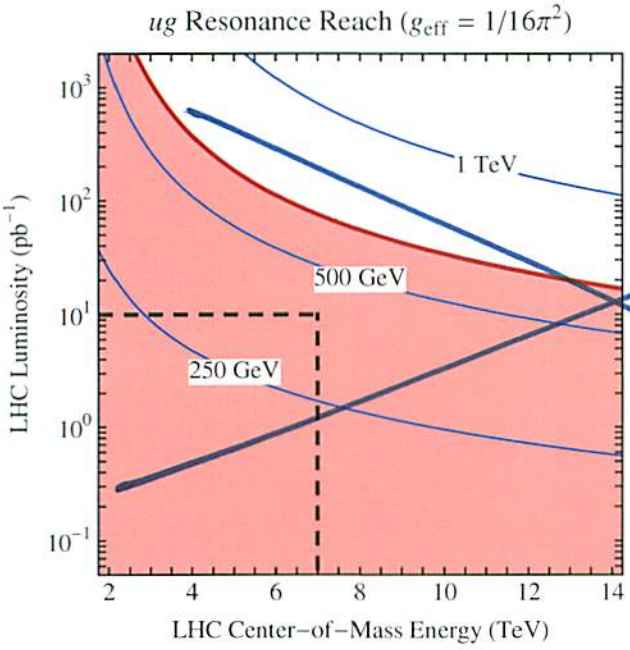
1. qq "diquark"
2. $q\bar{q}$ "Z', W', g', Gr', ..."
3. qg "excited quark"
4. gg "higgs"

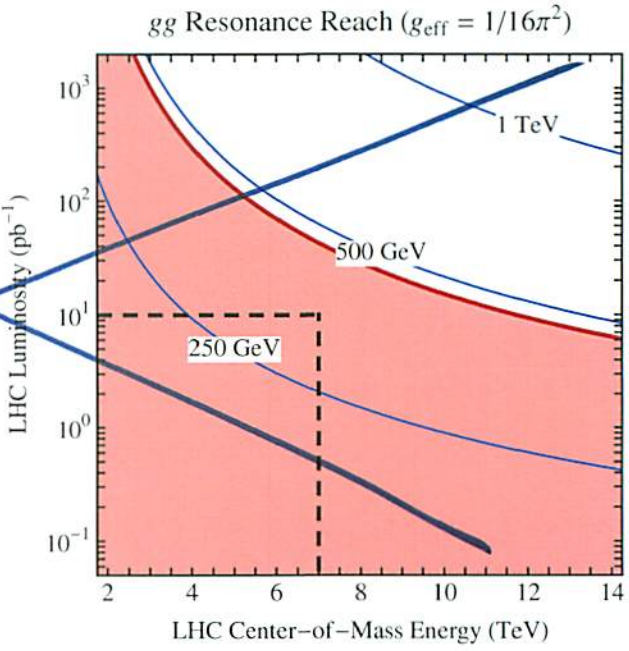


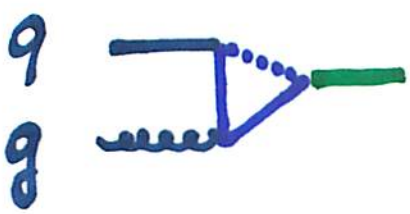


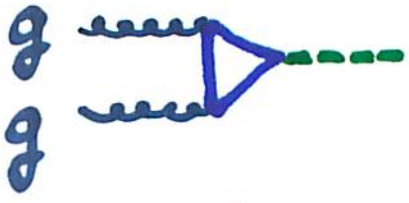












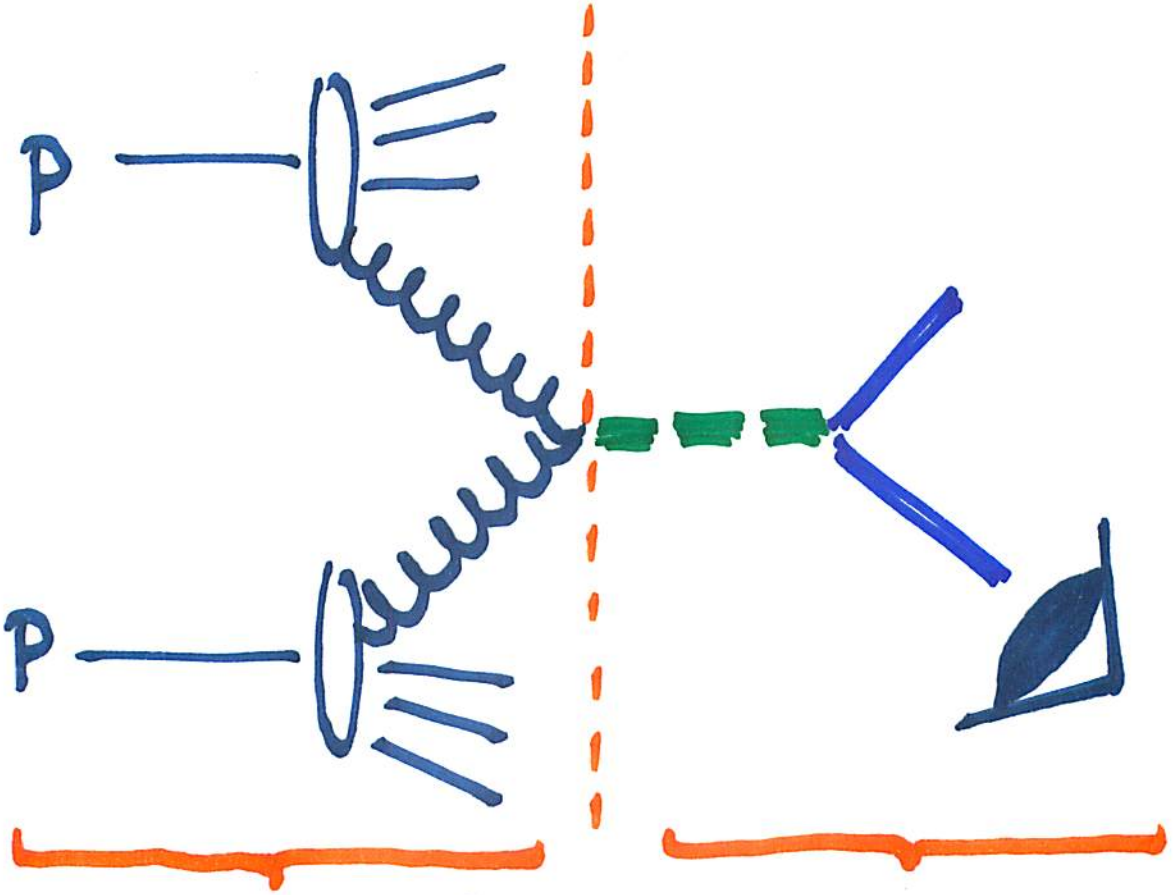
gauge invariance!

2 resonances survived $qq, q\bar{q}$

a closer look:

parton-luminosities

beating the Tevatron: $N^{LHC} \gtrsim N^{Tev.}$



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

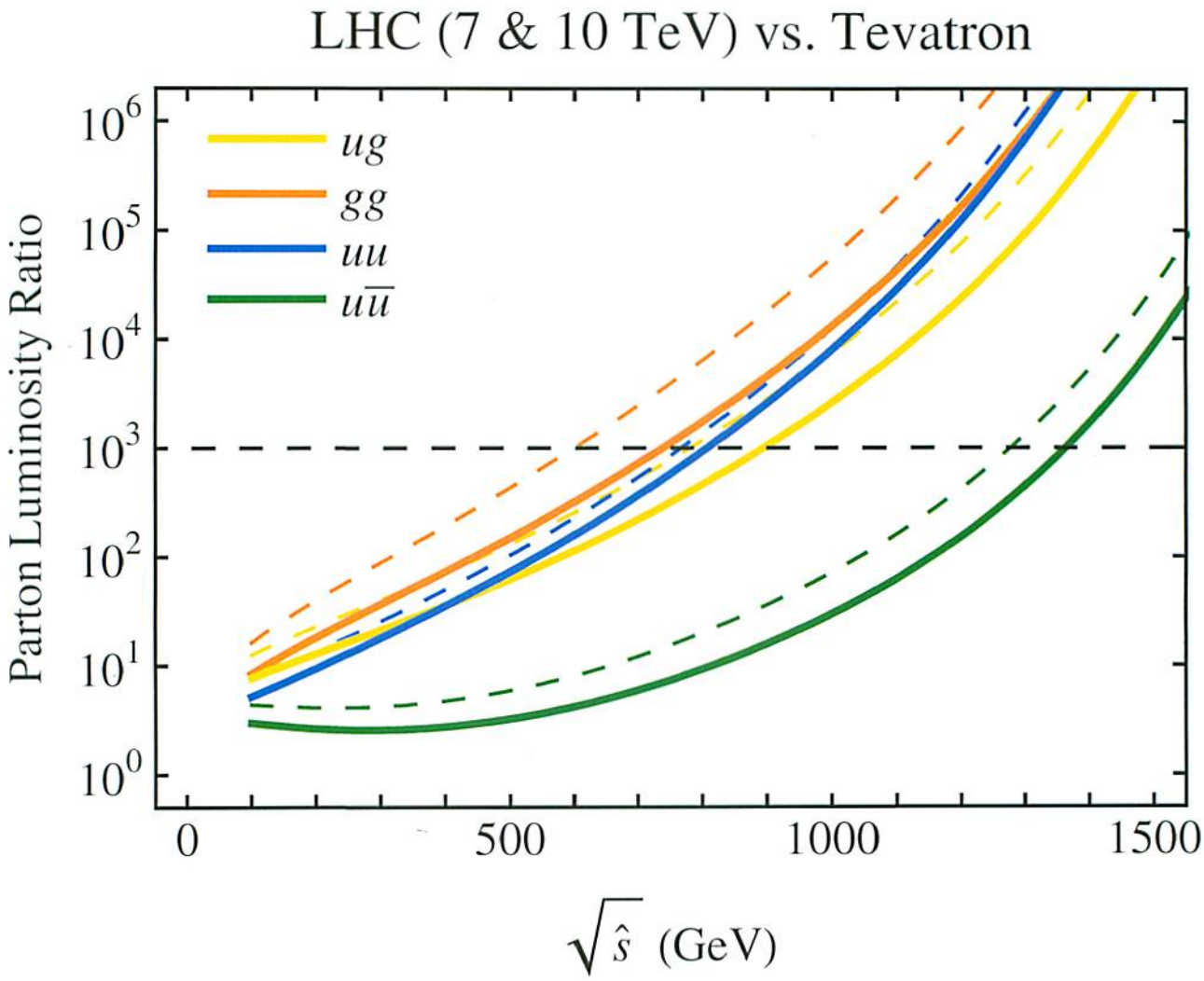
universal $\hat{\sigma}(\hat{s}) \cdot Br \cdot Eff$

need: $\Omega^{LHC} L^{LHC} \gtrsim \Omega^{Tev} L^{Tev}$

need to win by 10^3

lose by 10^{-3}

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



LHC wins with
- large mass
- ~~qq~~, ~~qg~~, gg

Supermodels require :

- $N_{events} \gtrsim 10$

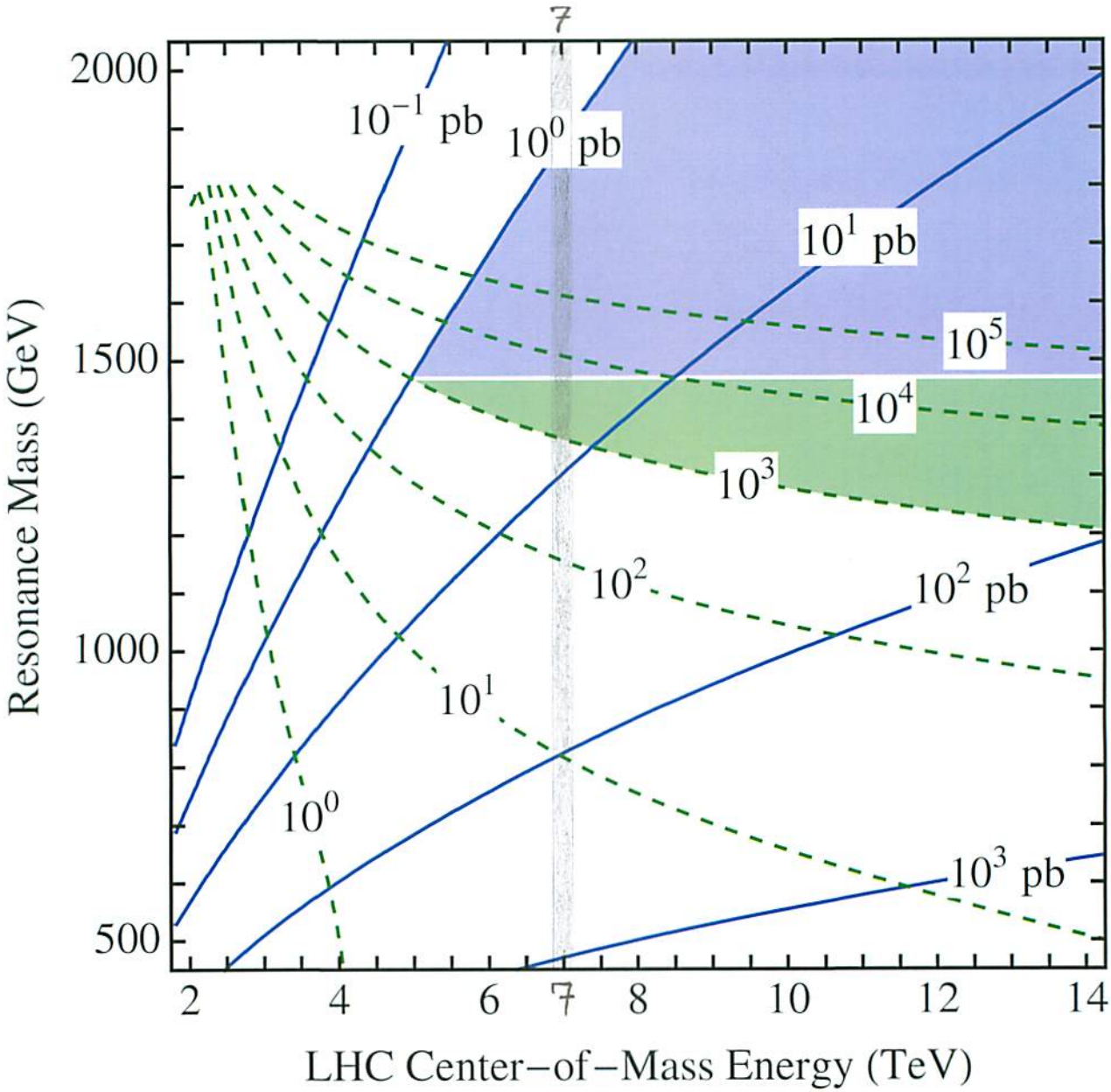
$\Rightarrow$ $\boxed{\sigma \cdot Br \gtrsim 10^{0}\ pb}$

- $N_{ev.}^{LHC} \gtrsim N_{ev.}^{TeV}$

$\rightarrow$ $\boxed{\Omega^{LHC} / \Omega^{TeV} \gtrsim 10^{3}}$

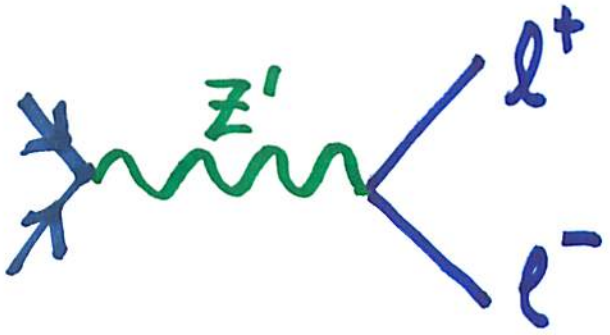
"Z'"

$u\bar{u}$ Resonance Reach



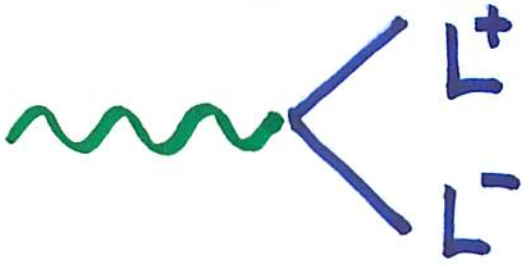
Z' final states

- leptons?

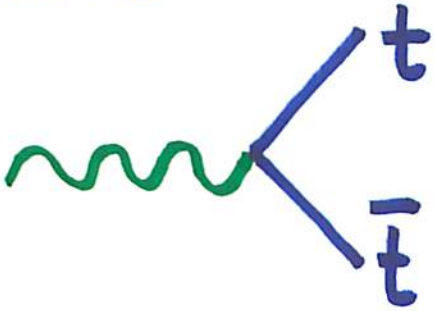


LEP II: $m_{Z'} \gtrsim 5$ TeV

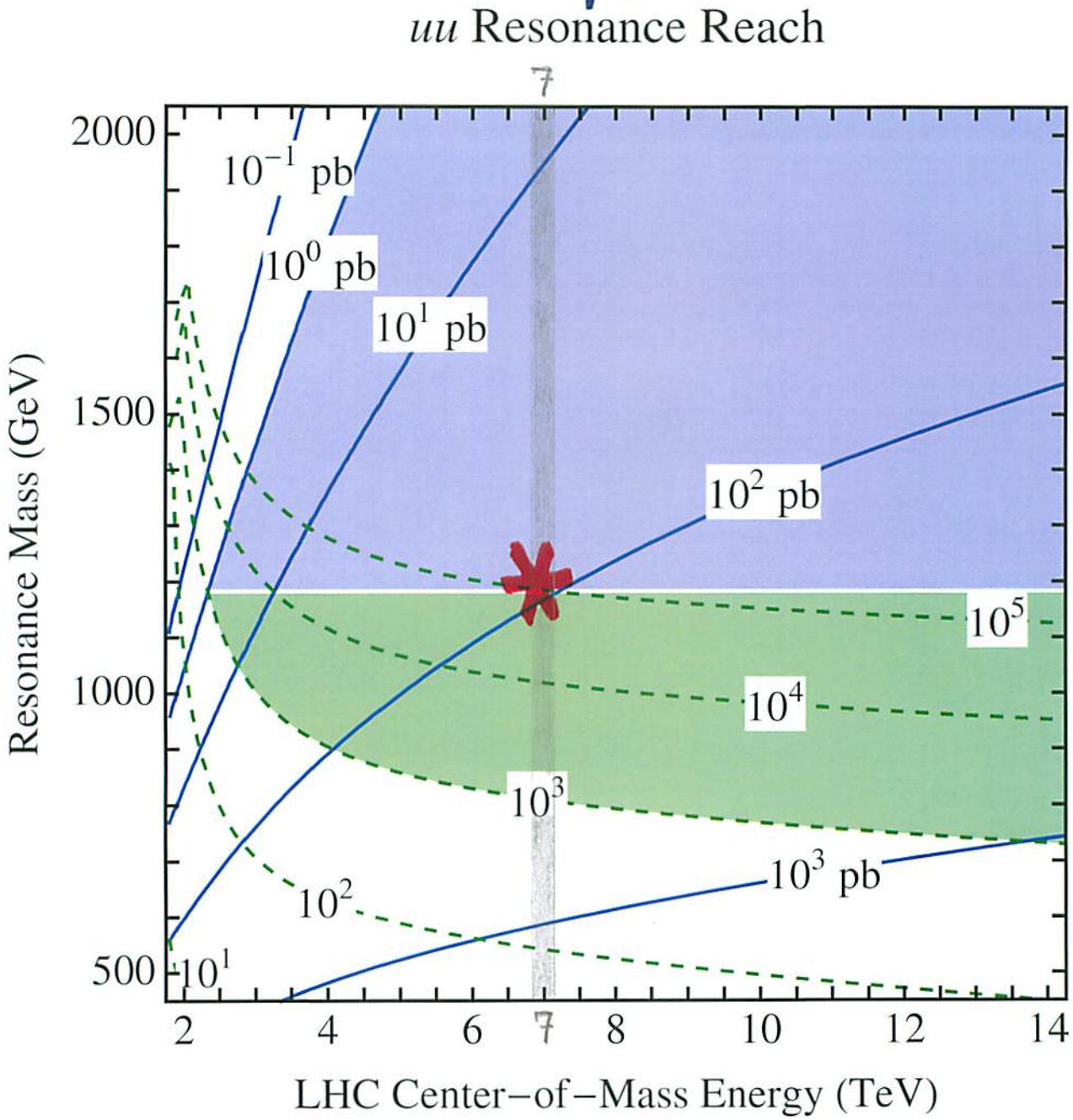
- new "stable" charged particle



- top quarks



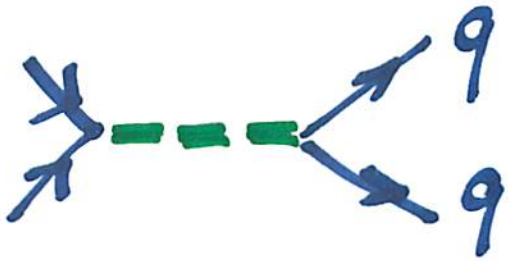
"diquark"



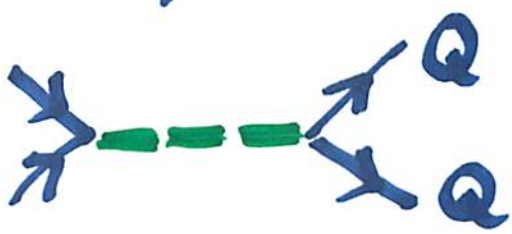
* 1000 events

diquark final states

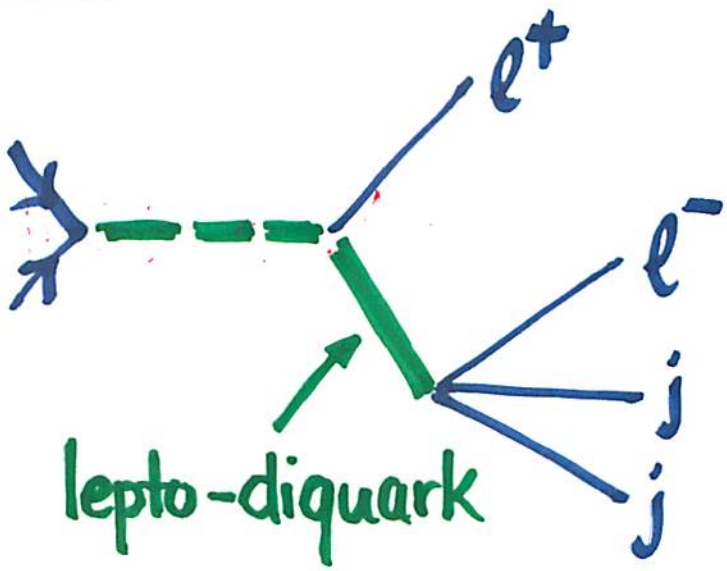
- dijets



- stable new quarks



- cascades



- ⋮

Conclusions

required

- $\gtrsim$ 10 events
- $N^{LHC} \gtrsim N^{Tev.}$

10 pb^{-1}	diquark	SUPER-MODELS !
	$Z' \to L^+L^-$	
100 pb^{-1}	leptoquarks	ORDINARY MODELS
1 fb^{-1}	SUSY, XD	
	Little Higgs	
	Higgs	