

Early Z' Searches at the LHC

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Outline

- Motivation
- Signal
- Search reach
- Model parametrization
- Exclusion
- Future

Why is a theorist giving this talk?

- A dilepton resonance is a clean signal, and a perfect place to look for new physics
 - Tail wags the dog— theorists try to come up with reasons to have a resonance
- It could be a lot of things (experiments need to know what to look for)
- We (theorists and experimenters) need to know what can be found, what's ruled out, and if we find something, what it is
- This isn't a talk about favorite models—I don't have one

Where to look

- Tevatron looked for resonances in electrons, muons, and jets (typical model hypotheses ruled out 500-1000 GeV)
- Z' is neutral, make with $q\bar{q}$
 - Penalty for antiquark at LHC; suppresses Z' , not QCD (no searching for dijets)
- That leaves dileptons (will discuss electrons, muons)

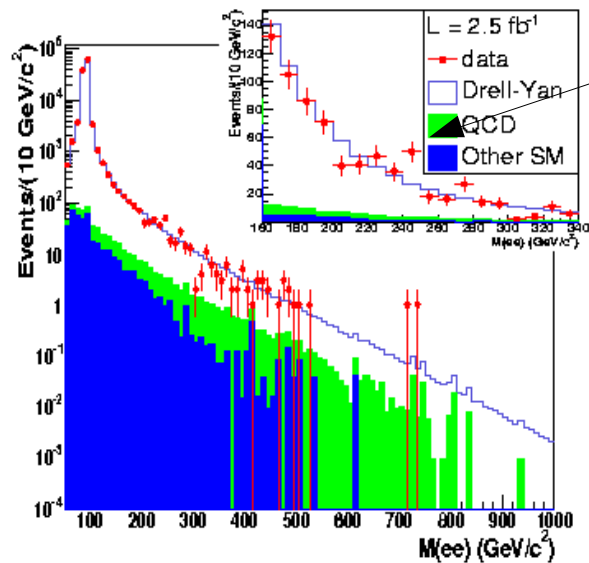
Mind your e's and μ 's

- Both great search channels (great resolution, clean)
- Look for generation-dependent models
- Most models still generation-independent; check sanity

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CDF Run II Preliminary

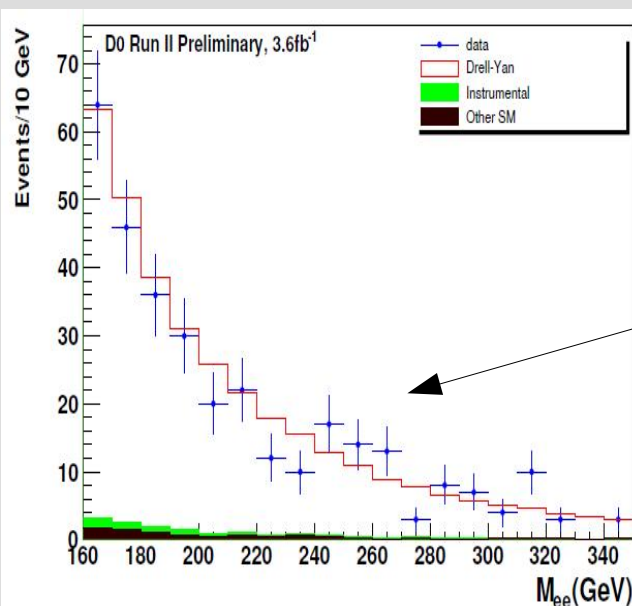
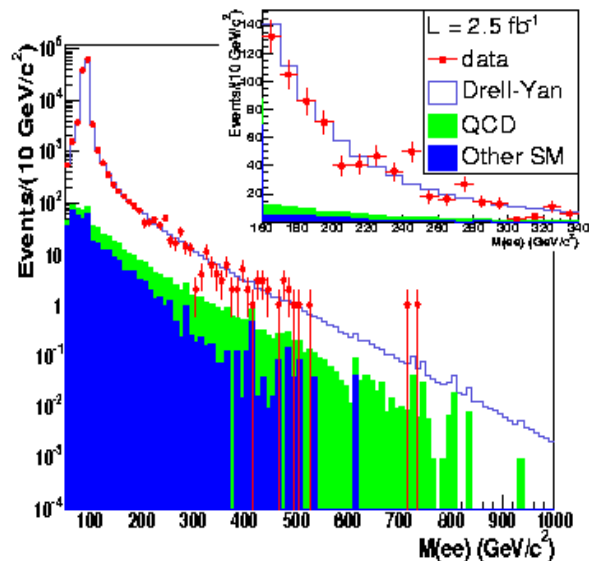


3.8 σ excess!

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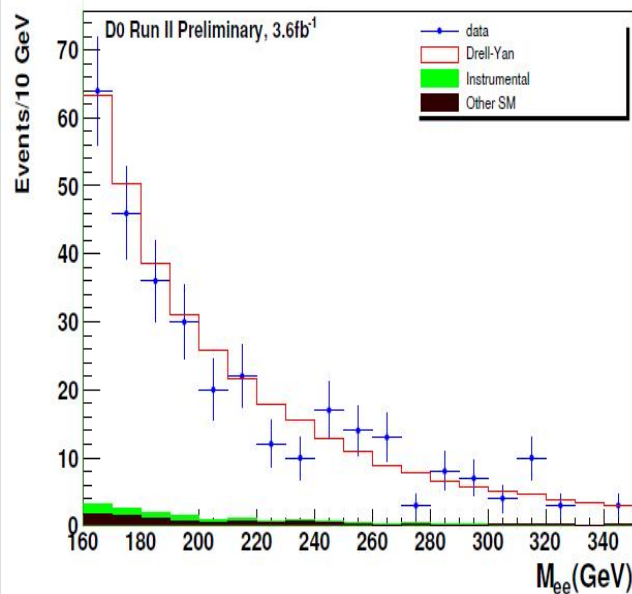
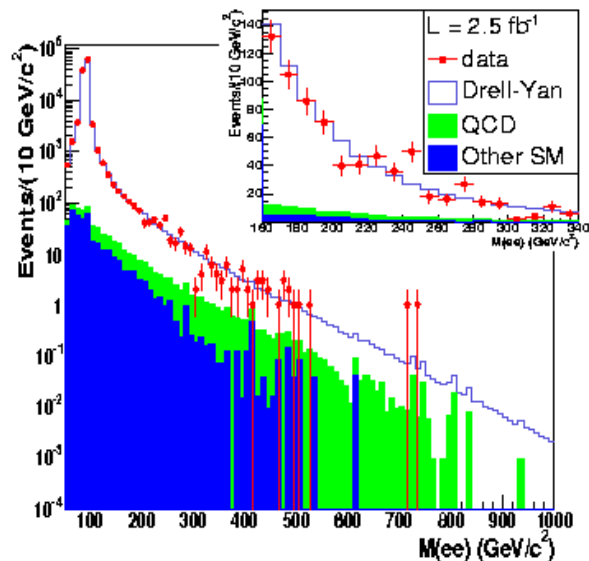
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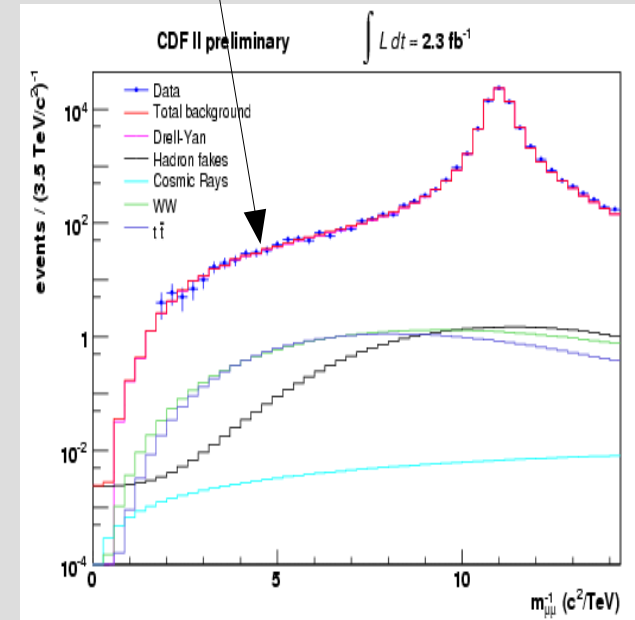
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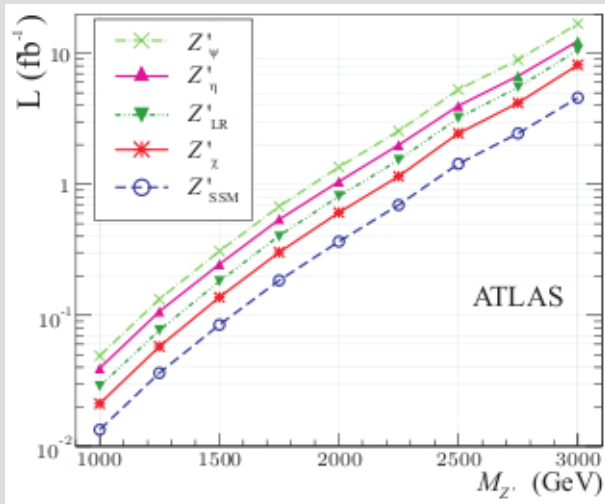
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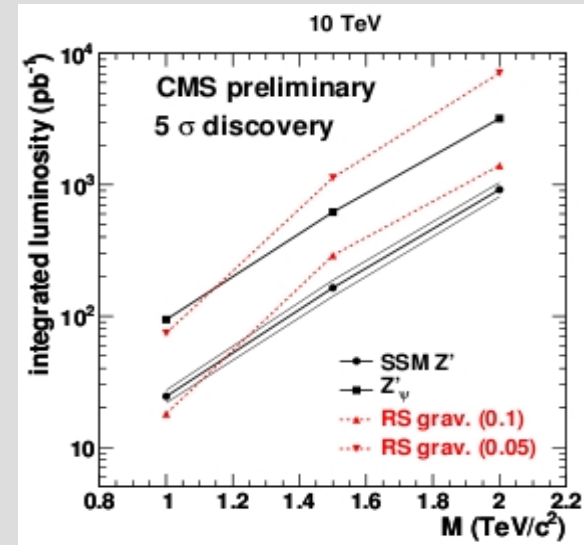
Nada...



Search Reaches



14 TeV



- Usual benchmarks can be discovered in first 100 pb^{-1} through more than 1 TeV (past Tevatron)
- Searches shape dependent—narrow width models show up early, large width degenerates into counting experiment

Assumptions, assumptions

- There are more models on heaven and earth...
- Even usual benchmarks (E_6 GUTs) have free parameters, like overall coupling (or mixing between multiple $U(1)$)
- There are lots of other models, some even motivated to be at LHC scale (Little Higgs, RS)
- Generic model will require new exotic fermions—invisible decays, affects leptonic branching fraction

Parametrize models

- Z' peak cross section goes like (spin 1 case)

$$\frac{d\sigma}{dY} = \sum_{q=u,d} a_1^q c_q$$

$$c_q = \frac{M_{Z'}}{24\pi\Gamma_{Z'}} (q_R^2 + q_L^2)(e_R^2 + e_L^2) = (q_R^2 + q_L^2) Br(Z' \rightarrow ll)$$

Carena, Daleo, Dobrescu, Tait

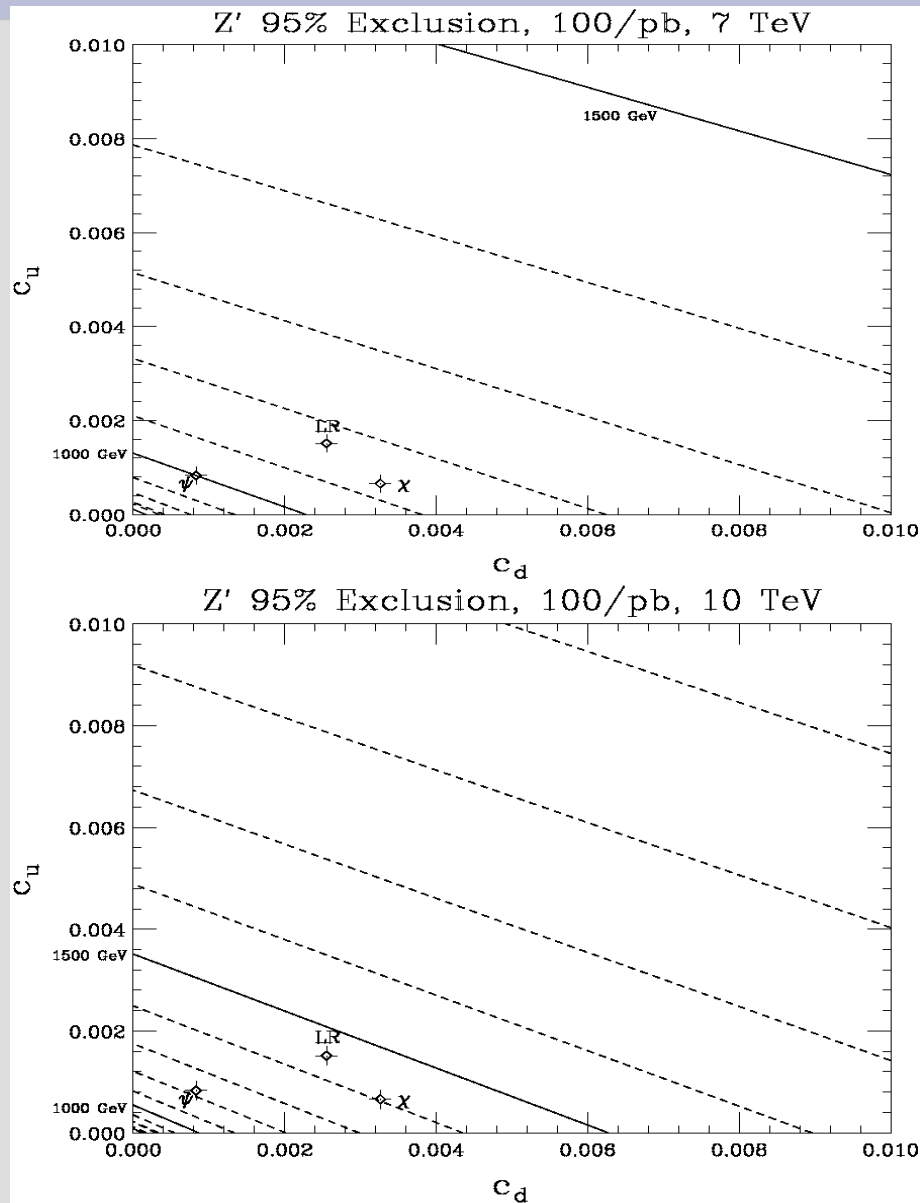
Even interference terms negligible for early searches

- Coefficients only depend on mass, PDFs, cuts
- Invert data to bound coupling combination
 - Works for almost every model

3 Events

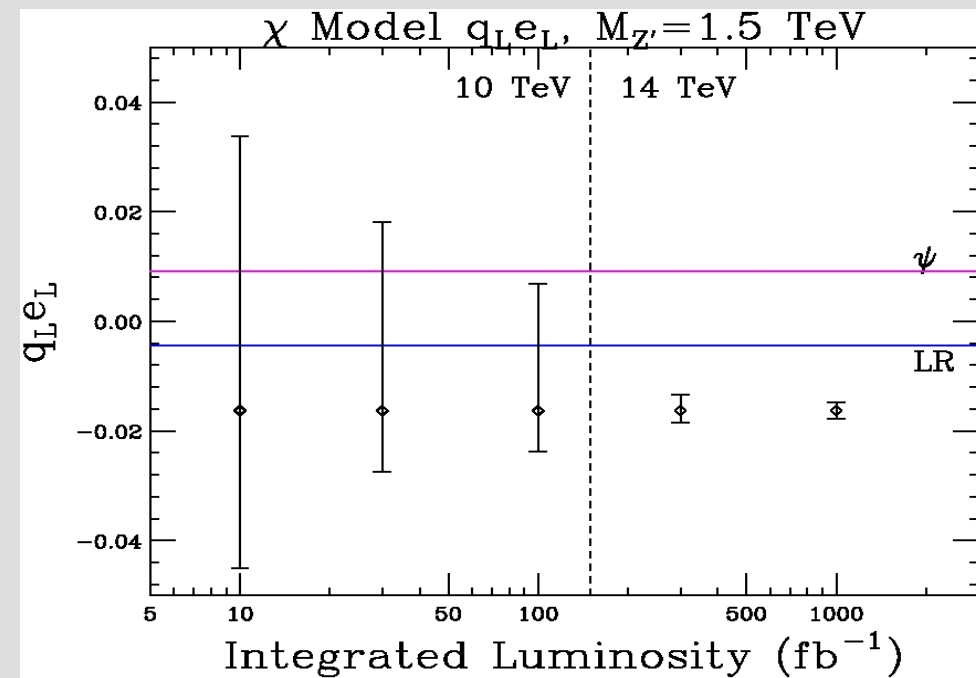
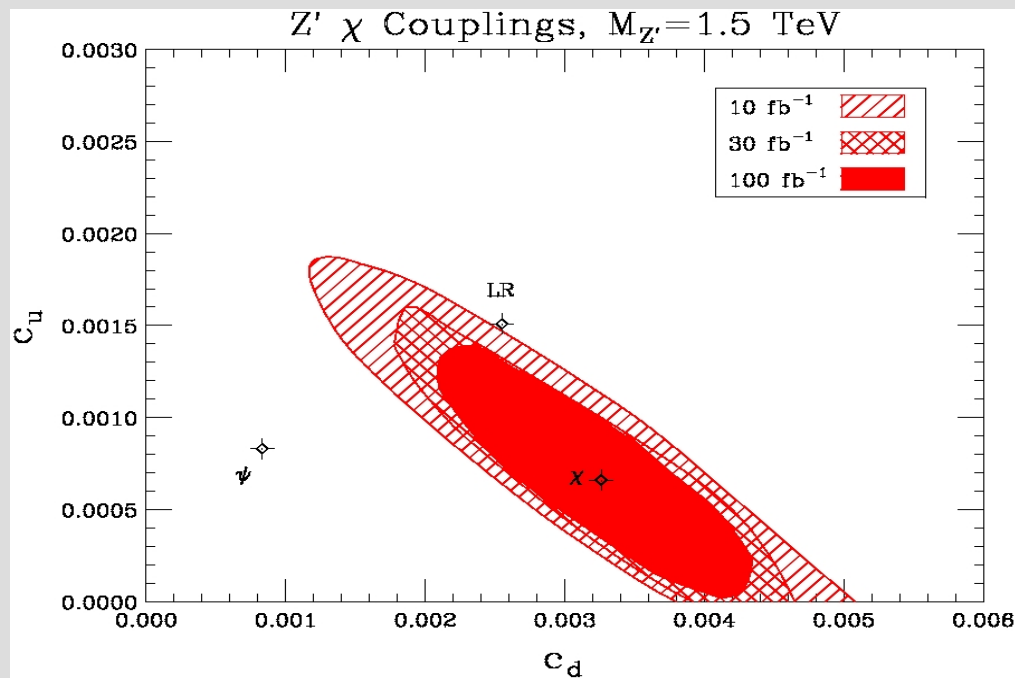
- Basically zero DY background if you go far enough in invariant mass
- If 3 events expected, fluctuates to zero 5% of the time
 - 95% exclusion if your model predicts 3 or more events in a bin
 - Robust against bin size (and thus model assumptions), just pick large enough bins to contain anything you would call a Z'
 - I picked 10% of mass as a demonstration

Start excluding parameter space



- Typical models somewhat improved over Tevatron at 7 TeV, large improvement at 10
- Large masses with reasonable couplings completely inaccessible by Tevatron
- Plot these bounds, satisfy all theorists with one fell swoop

The future



Li, Petriello, SQ

- Measure couplings! Let's figure out what that resonance is! (Need lots more data)

Summary

- A Z' is more than a signal if it exists
- Consider doing model-independent bounds
- We will need more time to figure out what it is, but it will happen
- Good luck and good hunting!