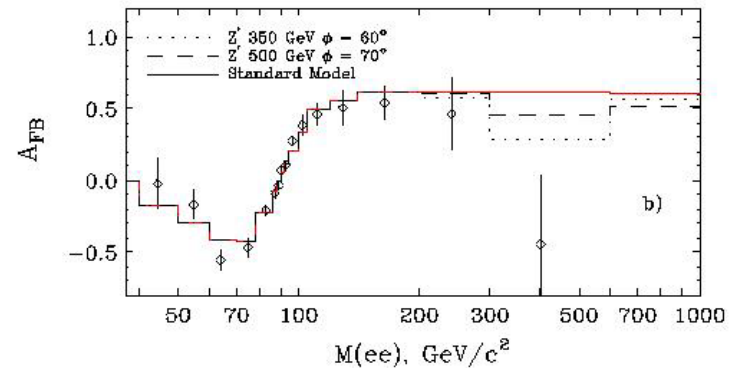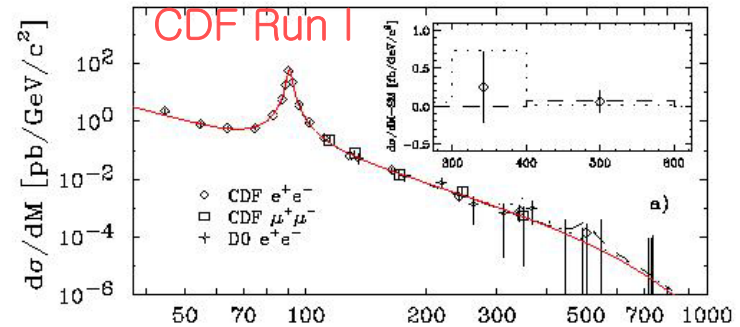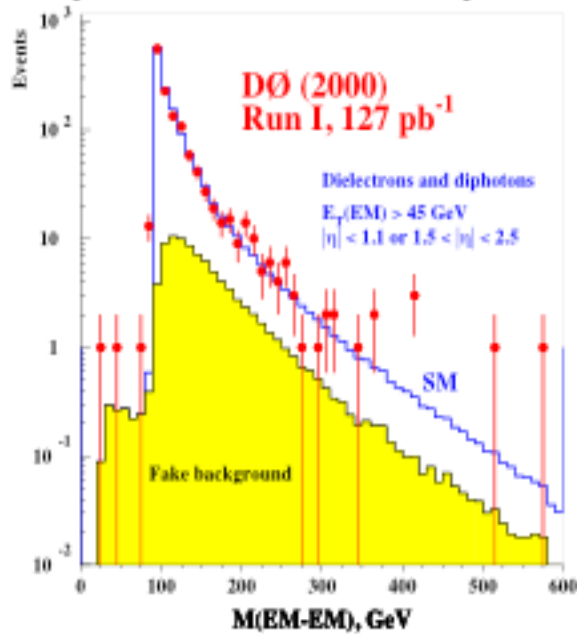# Tevatron–LHC connection

Extra Gauge Bosons

Yeon Sei Chung
University of Rochester

What can we have in our hands?

- ➢ Stand Model-Like Z´
- ➢ GUT (E6 ...)
- ➢ Extra Dimensions
  - – ADD (Arkani, Dimopoulos, Dvali) model
  - – RS (Randall-Sundrum) model
- ➢ Little Higgs
- ➢ SUSY
- ➢ Technicolor
- ➢ Topcolor

Tevatron Searches (Run I)

Comparison of the data with the SM predictions

DØ (2000)
Run I, 127 pb⁻¹

Dielectrons and diphotons
$E_T(EM) > 45$ GeV
$|\eta| < 1.1$ or $1.5 < |\eta| < 2.5$

SM

Fake background

M(EM-EM), GeV

CDF Run I
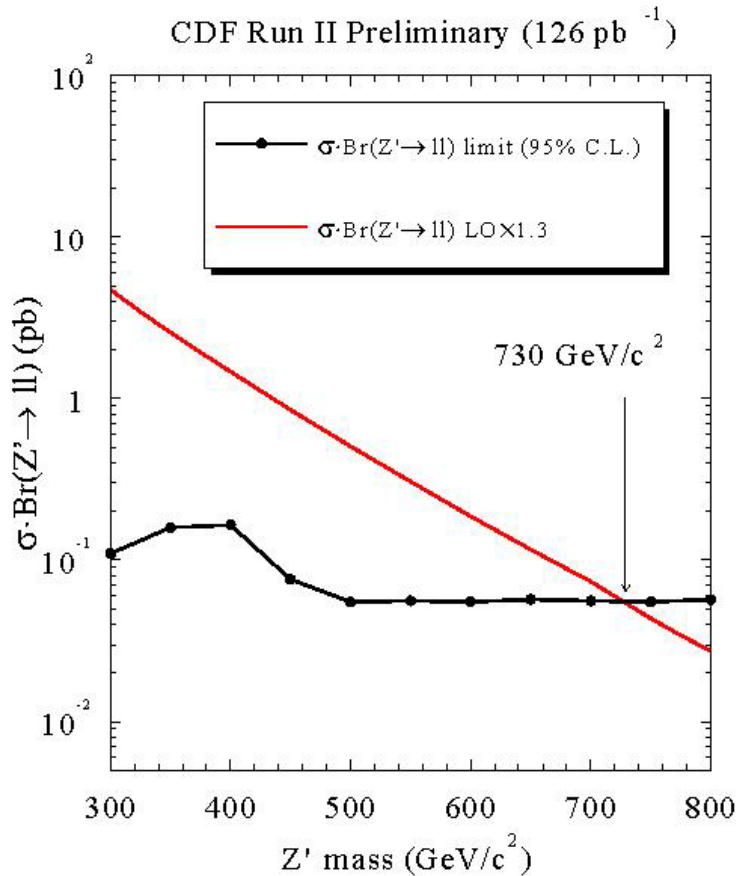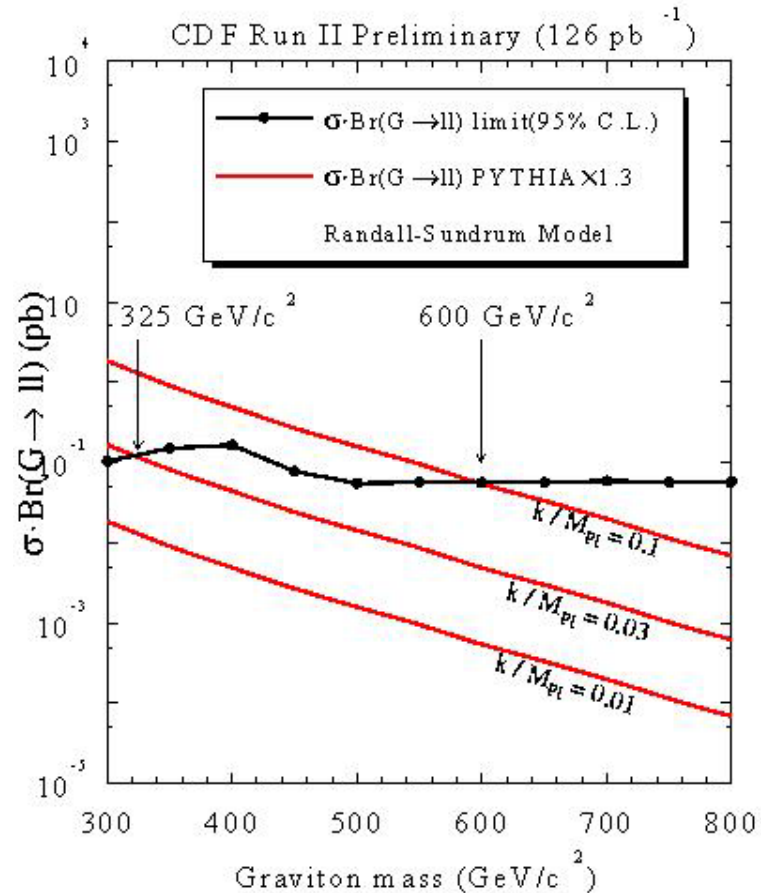
Searches performed by D0 and CDF

- CDF ee/$\gamma\gamma$: Ms > 939 (853) GeV for $\lambda=-1(+1)$ @ 95 % c.l.
- CDF ee/$\mu\mu$: M(Z´) > 690 GeV @ 95 % c.l.
- D0 ee/$\gamma\gamma$: Ms (GRW) > 1.2 TeV @ 95 % c.l.
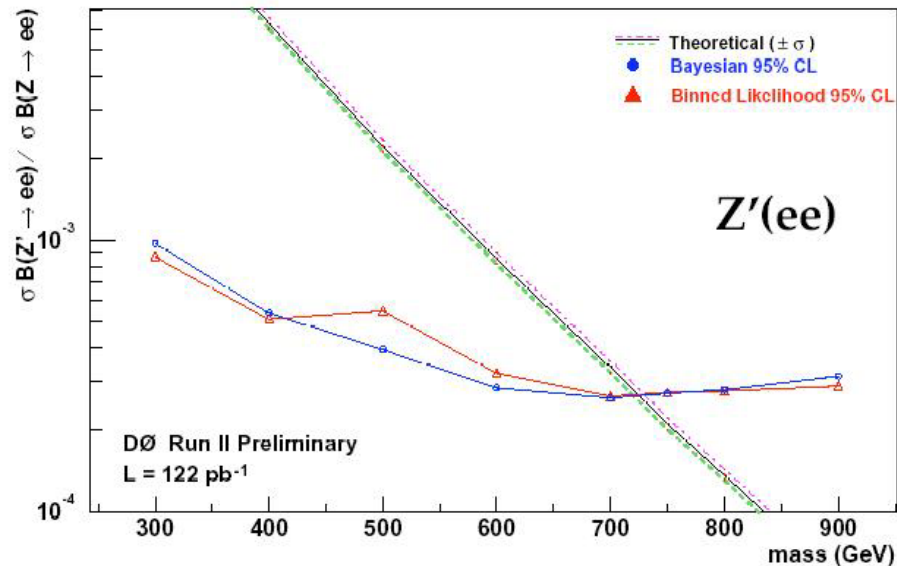
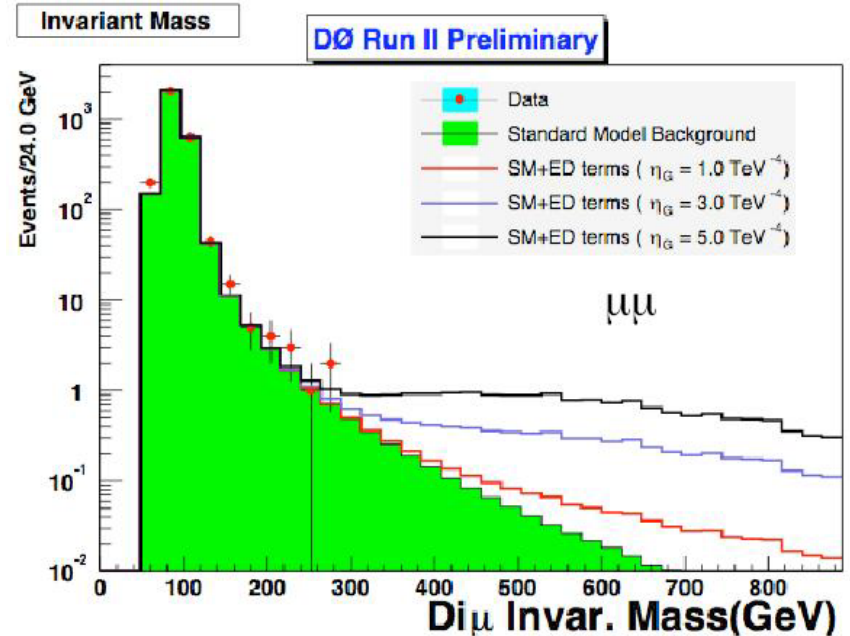# Tevatron Searches (CDF Run II)

SM–like Z´

RS graviton

Tevatron Searches (D0 Run II)

Z´, M(Z´)
μ+μ−(100 pb−1) : > 620 GeV @ 95 % c.l.
e+e−(122 pb−1) : > 719 GeV @ 95 % c.l.

Large Extra Dimensions, Ms(GRW))
μ+μ−(100 pb−1) : > 0.88 TeV @ 95 % c.l.
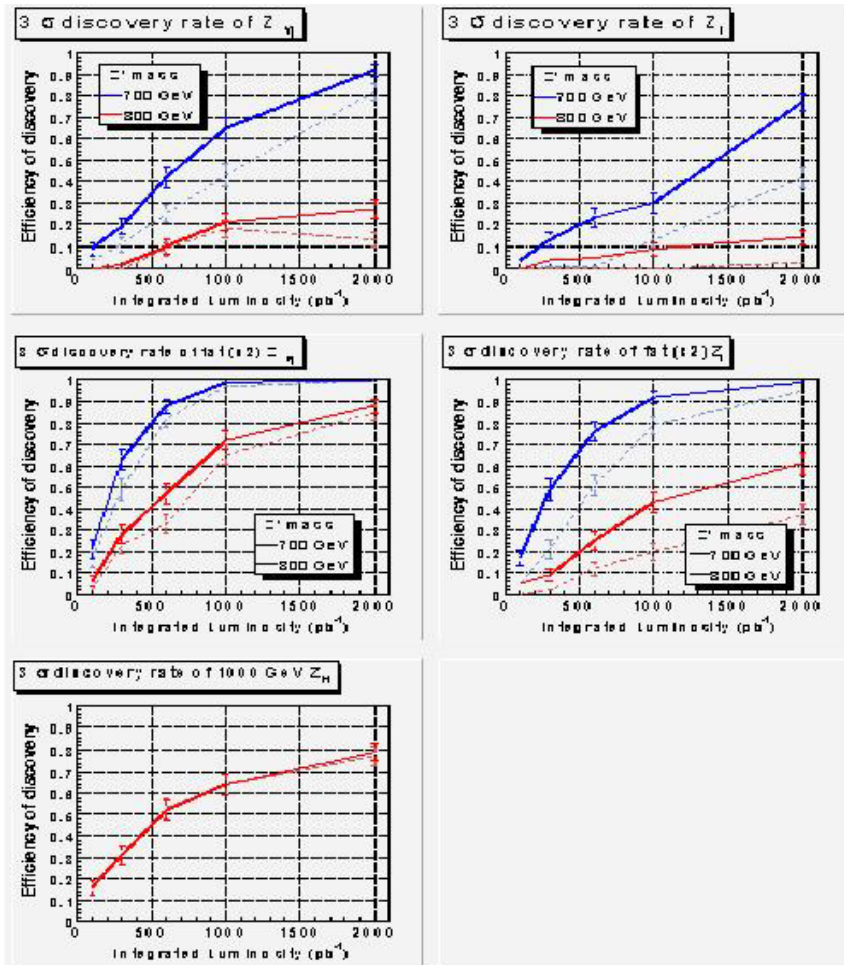ee/γγ (128 pb−1) : > 1.28 TeV @ 95 % c.l.

Z´ LO Total Cross−sections and Forward backward Asymmetries at Tevatron

J. Lee et al.
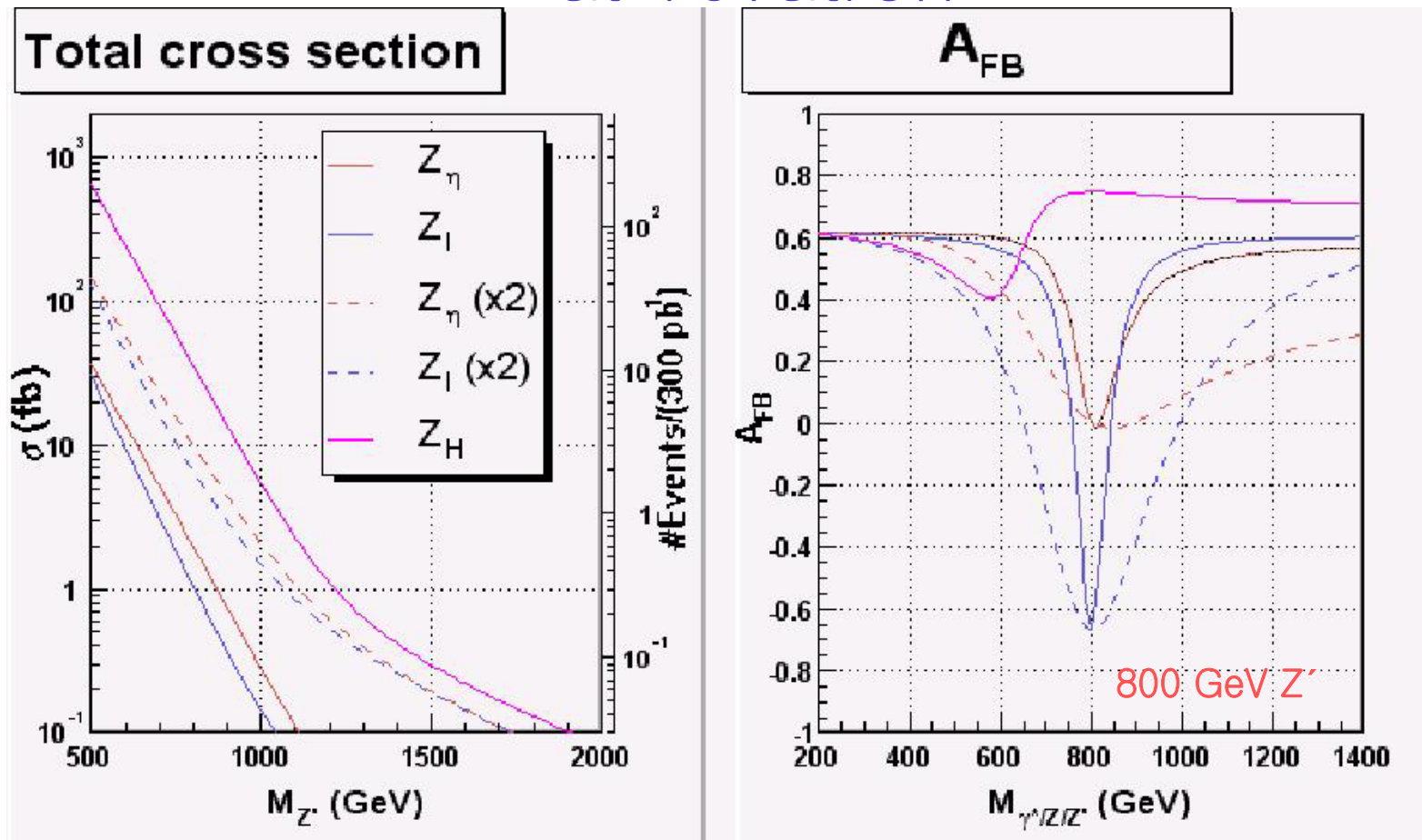
Prospects – Tevatron Run II

J. Lee et al.
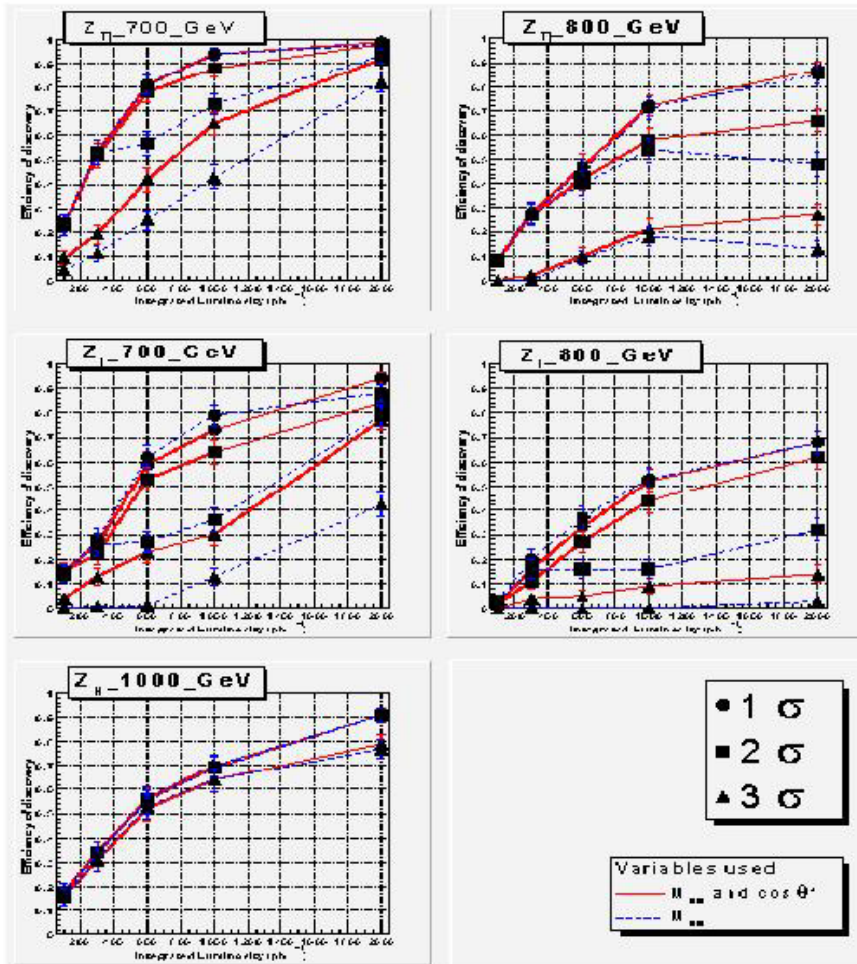
....	1D fit M(ee)
———	2D fit M(ee) vs cos(θ*)

3σ evidence Probabilities
Leading-Order calculation
No Background subtraction
Unbinned Likelihood method
2D fit improves the sensitivity

Prospects – Tevatron Run II (Cont')
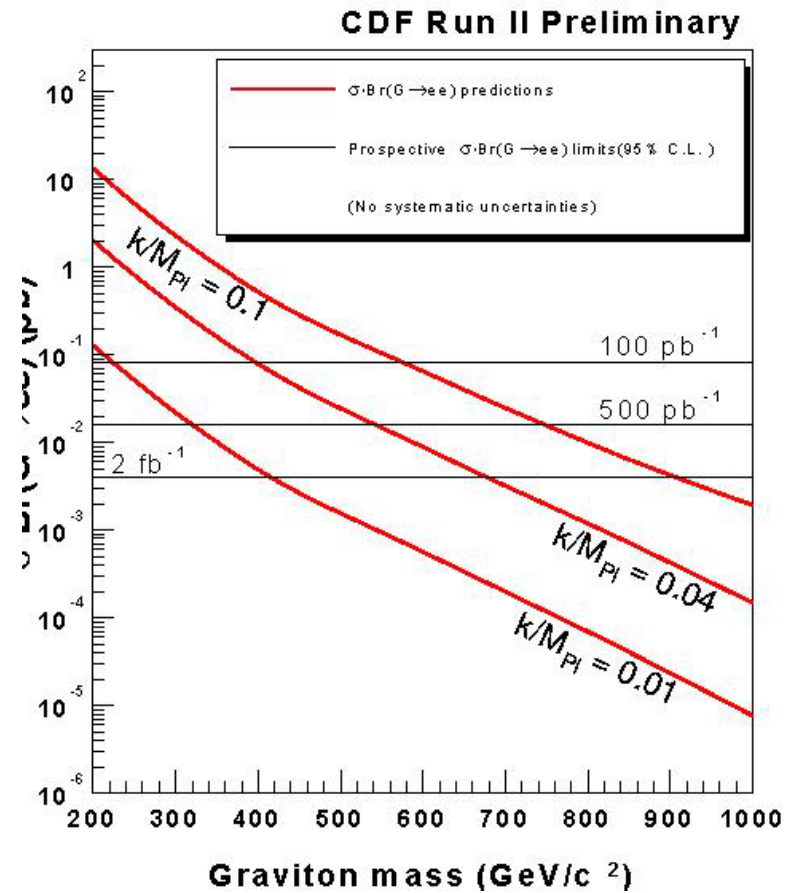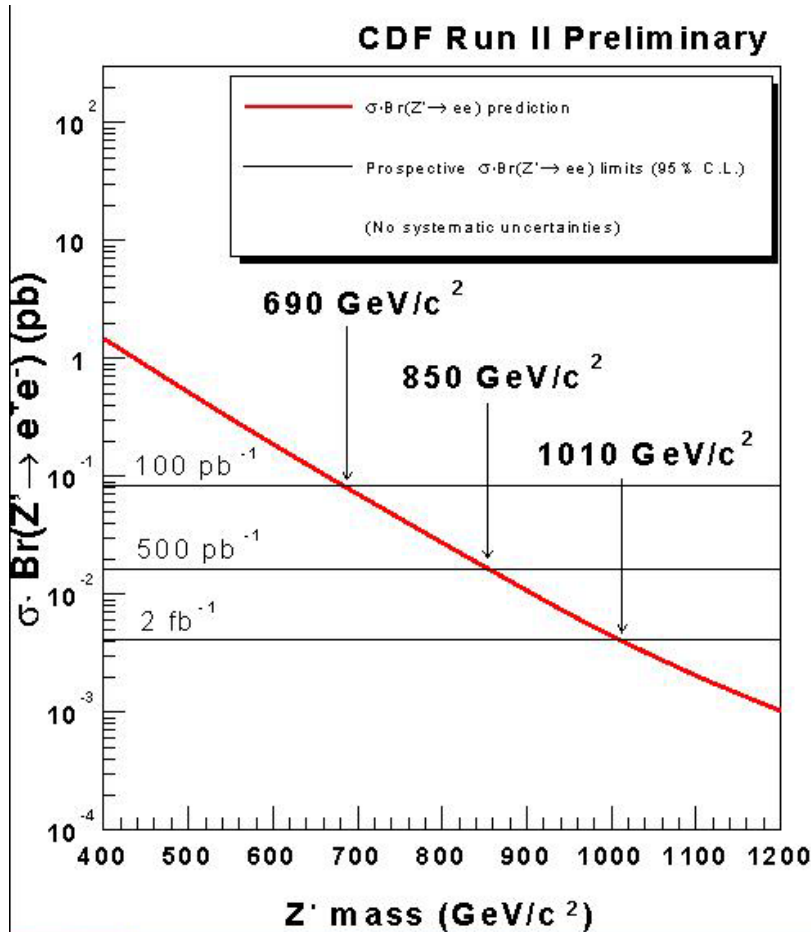

J. Lee et al.

······ 1D fit M(ee)
—— 2D fit M(ee) vs cos(θ*)

Evidence Probabilities
Leading-Order calculation
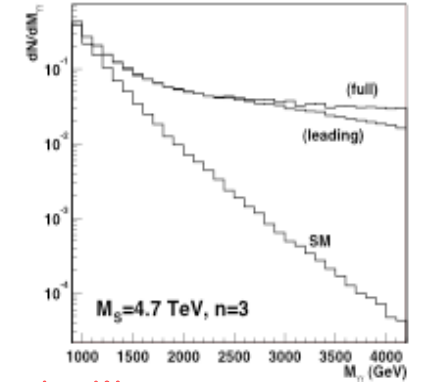No Background subtraction
Unbinned Likelihood method
2D fit improves the sensitivity

Prospects – Tevatron Run II (Cont')

CDF Run II Preliminary

σ·Br(Z'→ ee) prediction

Prospective σ·Br(Z'→ ee) limits (95% C.L.)

(No systematic uncertainties)

690 GeV/c²

850 GeV/c²

1010 GeV/c²

100 pb⁻¹

500 pb⁻¹

2 fb⁻¹

CDF Run II Preliminary

σ·Br(G→ee) predictions

Prospective σ·Br(G→ee) limits (95% C.L.)

(No systematic uncertainties)

k/M_Pl = 0.1

100 pb⁻¹

500 pb⁻¹

2 fb⁻¹

k/M_Pl = 0.04

k/M_Pl = 0.01

Graviton mass (GeV/c²)

Z´ and Extra Dimensions at LHC
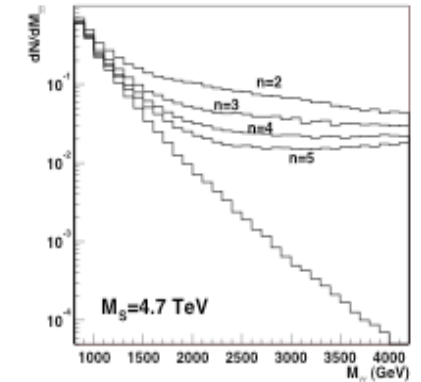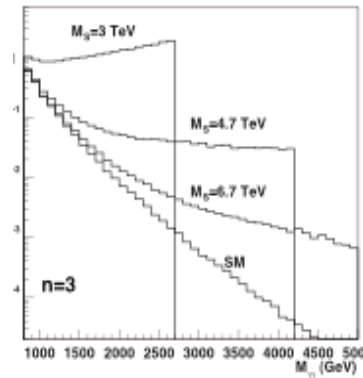
Various Z´

Extra Dimensions
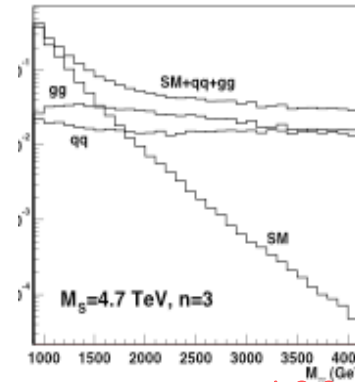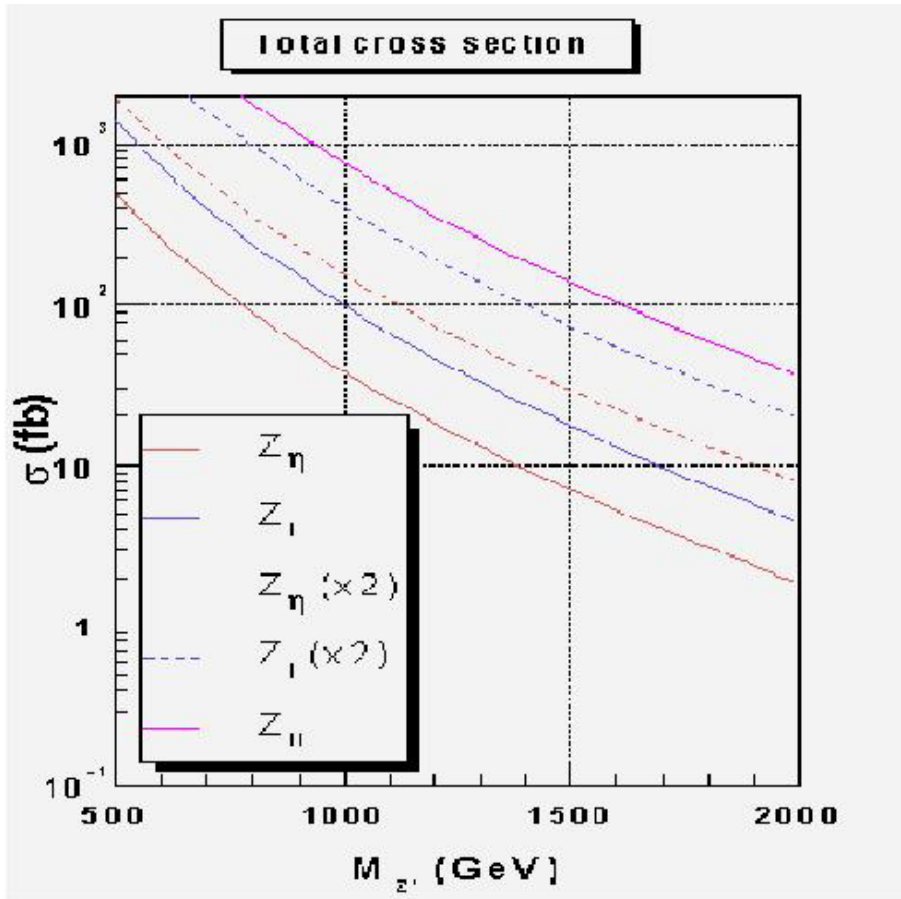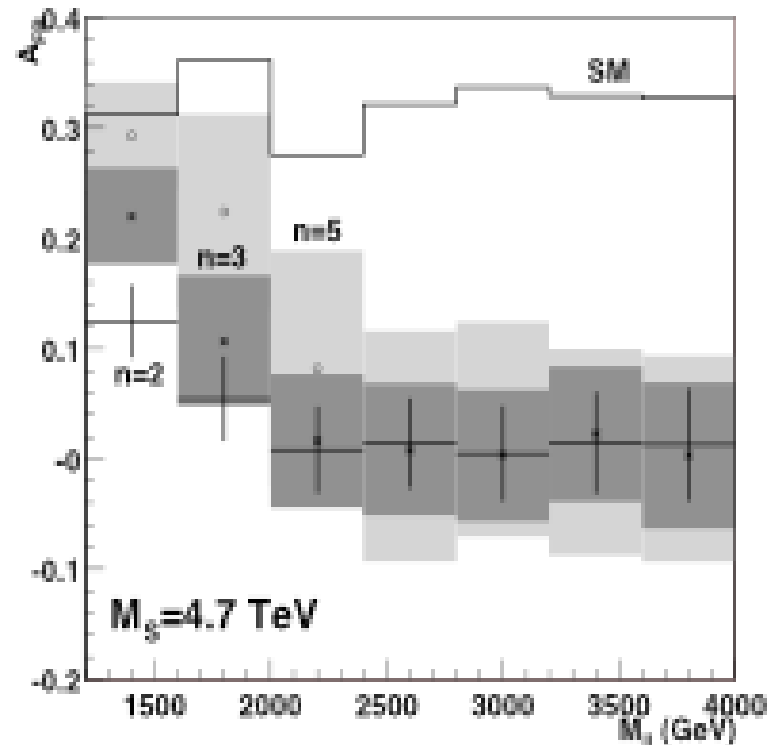

100 fb−1 dilepton

Signal will be clear and can be optimized with mass cuts

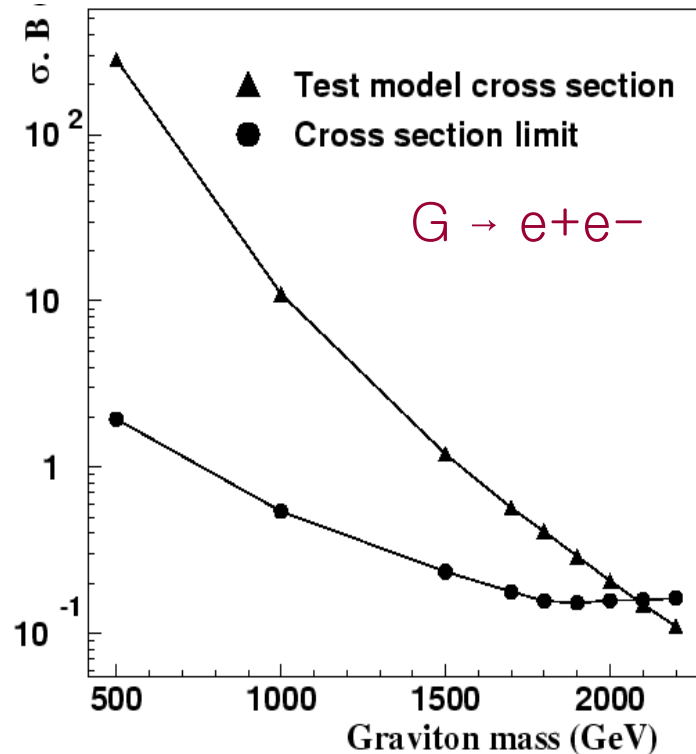# Extra Dimensions (M vs. A_FB) at LHC

100 fb−1 dilepton
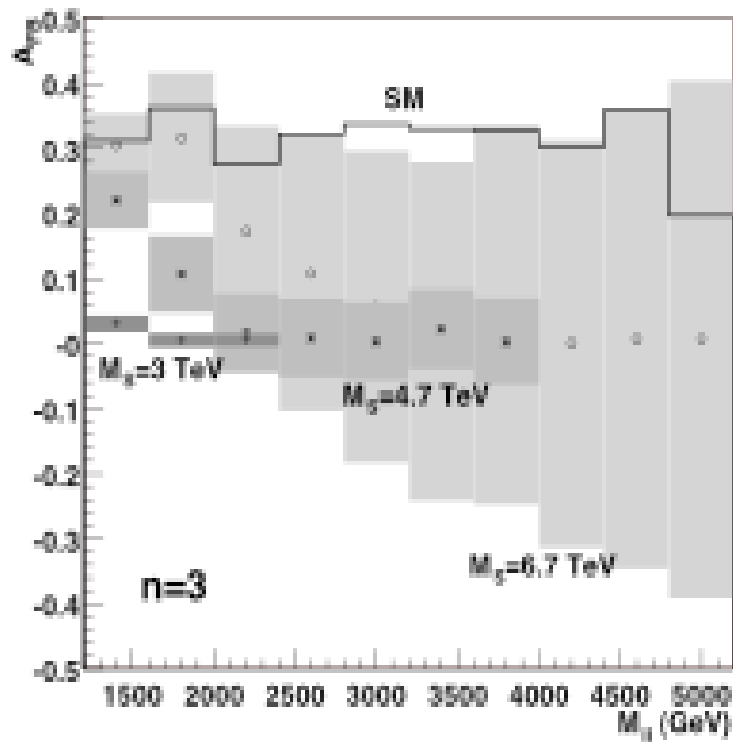
Interference between graviton and SM
➔Modifies Asymmetry
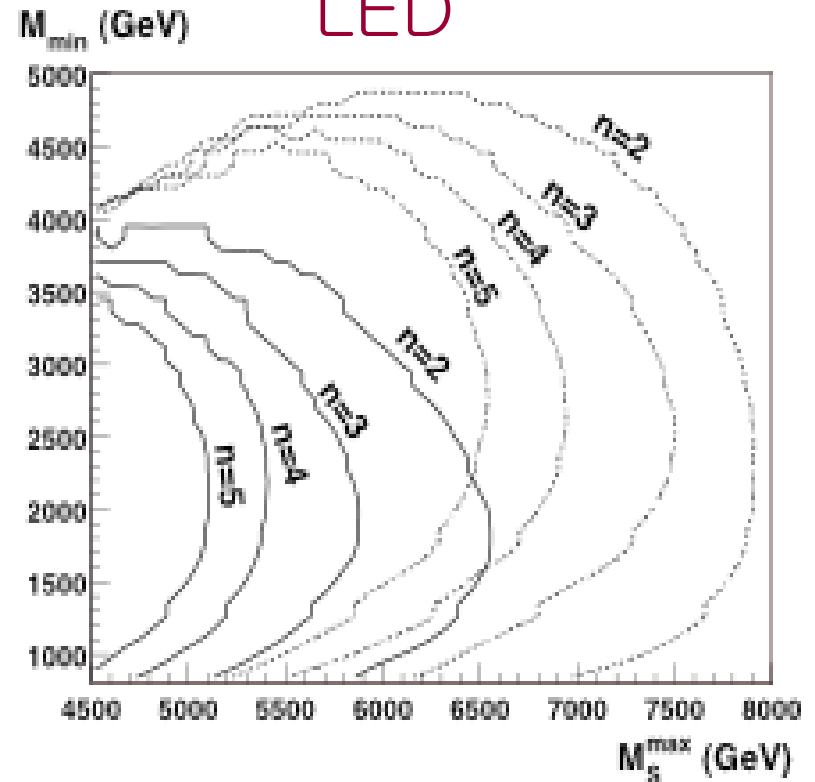➔Use both M and asymmetry improve sensitivity

Graviton Search at LHC

RS

LED

$G \rightarrow e+e-$

10 events for 100 fb−1 at M_G = 2.2 TeV
Search limit is 2080 GeV (5 σ)

5 σ reach for $\gamma\gamma$ signal
for 10 fb−1 and 100 fb−1

Challenges

For the case of boson mass is larger than 1 TeV,

Monte Carlo

    High order Calculations

    Simulation

Backgrounds

    for setting limits

        assumed zero background to be conservative

    for evidence/discovery

        important to understand background amount & shape

        irreducible background – SM Z/gamma, EWK processes (well known)

        QCD

        – opposite charge requirement to reduce it

        – Charge mis-identification – not negligible

        – solution: sideband in mass dist. & asymmetry ??

Particle Identification efficiency

Summary

➢ Search for various Extra Gauge Bosons
   at Tevatron Run II is underway and
   will be fully explored at LHC

➢ Use both cross-section and asymmetry
   improve the sensitivity

➢ Challenges
   ✓ Monte Carlo
   ✓ Backgrounds
   ✓ Particle ID Efficiency

- $\delta Pt / Pt^2 = \delta(1/Pt) = \delta C = 0.001$
  (COT+BC or COT+SI)
- Curvature $C = 1/Pt$

ex. Pt = 500 GeV muon
- $C = 1/500 = 0.002 +- 0.001$

ex. Pt = 50 GeV
$C = 1/50 = 0.02 +- 0.001$