Non Susy BSM in 1st session

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Introdution

- Non Susy:
  - Bug eyed research: (analysis by topology)
    - E. Busato, D. Chodury, S. Ferrag, R. Godbole and (G. Polesello, J. Lykken, G. Azuelos)
  - Universal Extra-dimensions
    - D. Goudjami, H. Przysiezniak
  - Higgsless and $Z \rightarrow \tau\tau$
    - G. Azuelos
  - BSM Tools
    - See Peter's talk

Analysis by topologies

- Motivation:
  - Understand the SM predictions and establish their uncertainty band
  - Every prediction outside this band is a signature of new physics
- 1st year of LHC:
  - Simple topologies and robust analyses:
    - Di-leptons, di-photons, dijets…

First topologies

- Dileptons:
  - SM: $M_{\ell\ell}$, boost, $\Delta\eta$, θ^*, $\Delta\phi$

    .PDF,μ_{fact},μ_{ren}

    .WW, tt, tt, ECal linearity, charge mis-id, W+jet
  - S-channel resonances

    Z',G*,Z_H,Z_{KK}
  - Leptoquarks and Leptogluons
  - Heavy scalars

    Graviscalar, radion, heavy higgs
- Diphotons:
  - SM: using DiPhox

    .PDF,μ_{fact},μ_{ren},μ_{frag}, isolation

    .2-jets, γ+jet, ECal linearity,
  - S-channel resonances

    .G*
  - Virtual Excited quarks
  - Heavy scalars
  - Non commutative geometry:

    .Triphoton coupling

Dileptons: Standard Model at high energy

- Observables:

  $M_{\ell\ell}$, Pt, boost, $\Delta\eta$
- MC@NLO:

  σ computed by 100 GeV bin

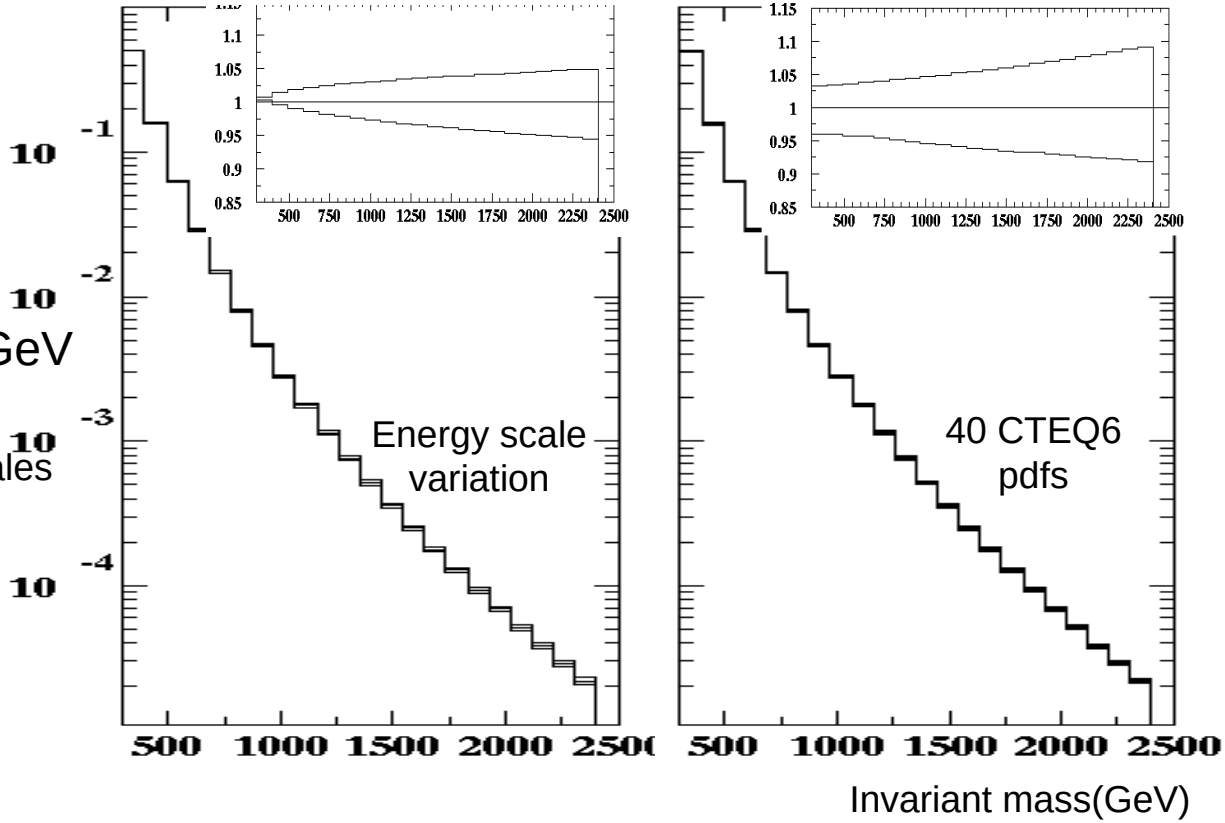
  200 GeV < invMass< 2500 GeV
- Sources of uncertainties:

  -Factorisation and Renormalisation scales

  $1/\pi * m_t < \mu < \pi * m_t$

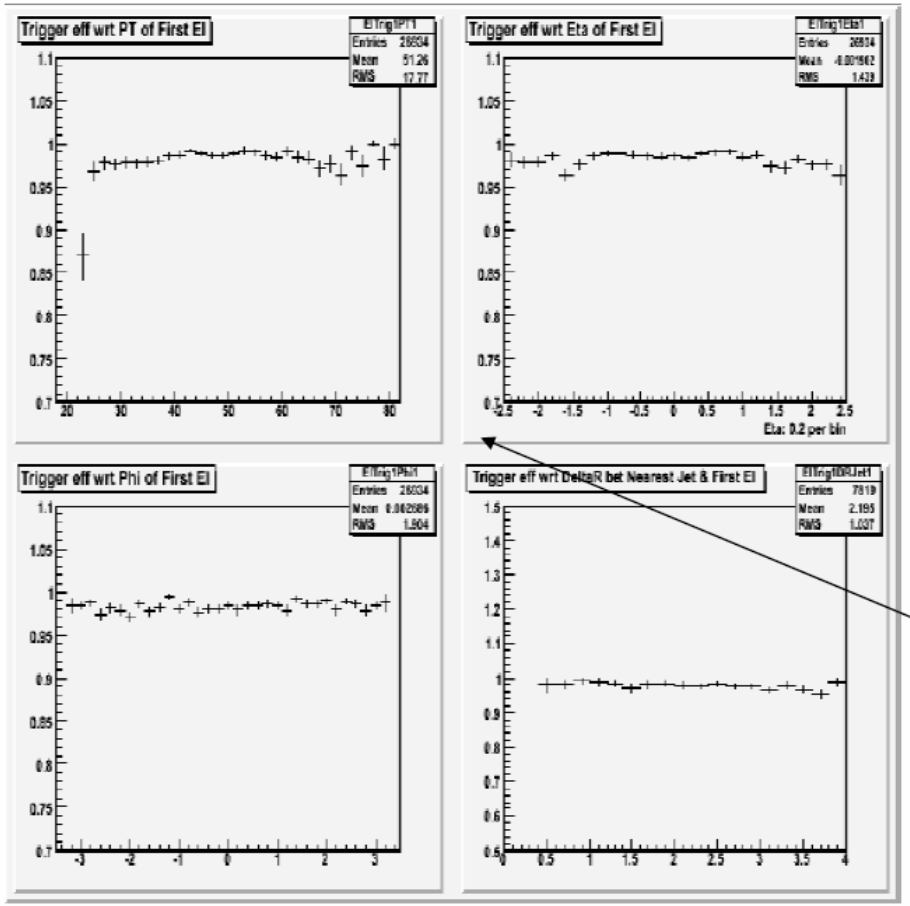
  -PDFs

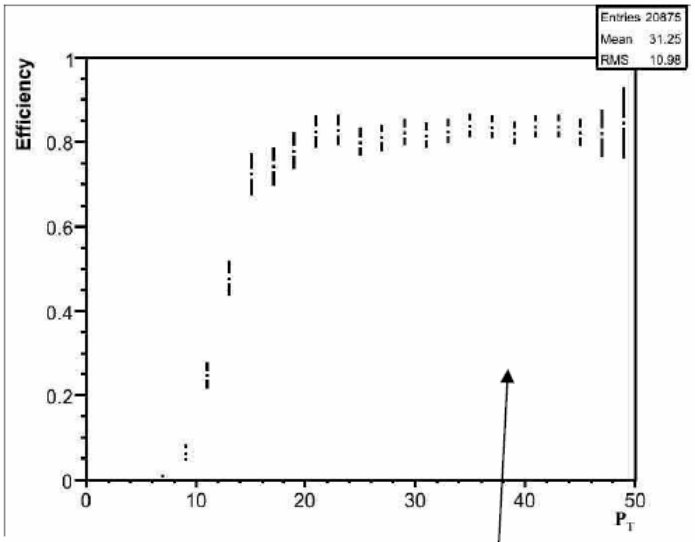
  CTEQ6 40+1 pdf1



Trigger studies

Electrons: V. Bansal
Muons: K. Black





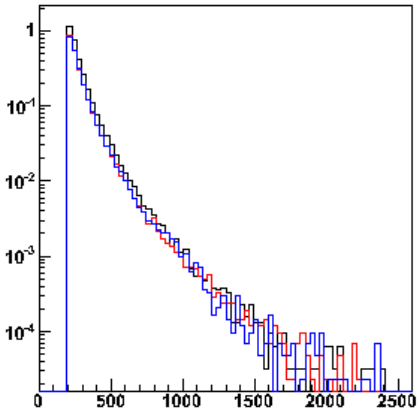
Tag and Probe

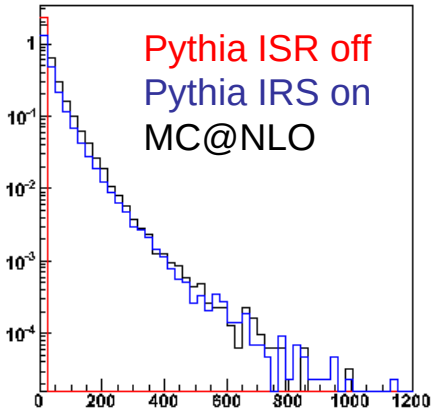
Electrons

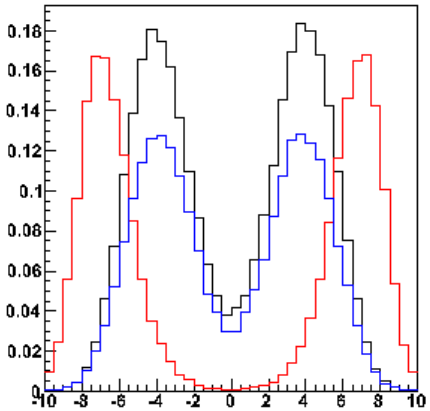
Muons

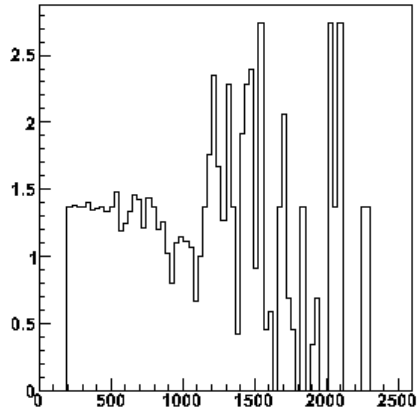
Vikas has also written
A tool to compute trigger efficiencies

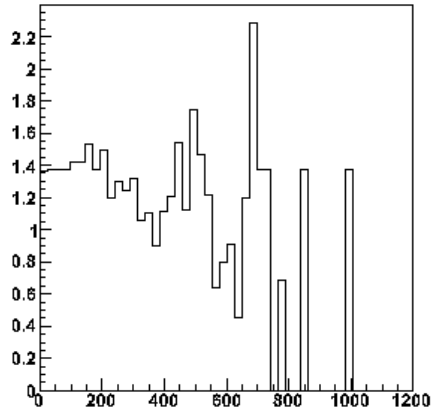
Dileptons: Standard Model

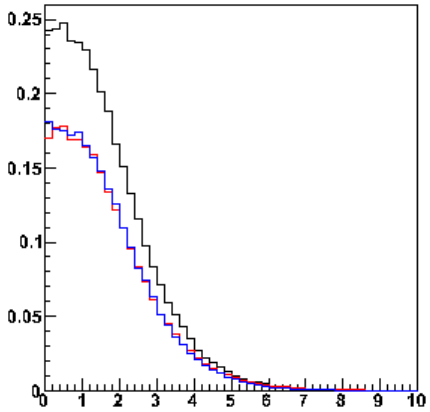












- energy scale pdf effects: in progress
- experimental study: WW, ττ, tt, ECal linearity, charge mis-id, W+jet. γ-conversion
- Large x ressumation and hard tails (Resbos, NNLO calculations)
- EW correction at high Pt spectrum

Dileptons: LeptoGluon virtual exchange

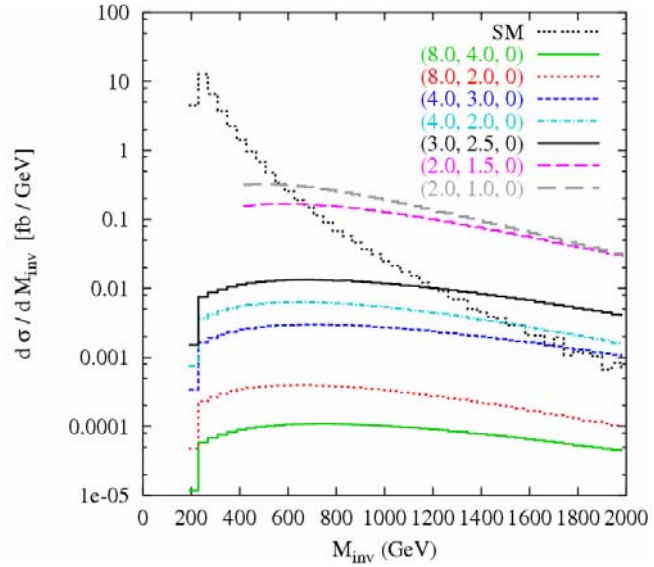
g + g → $\ell^+ \ell^-$

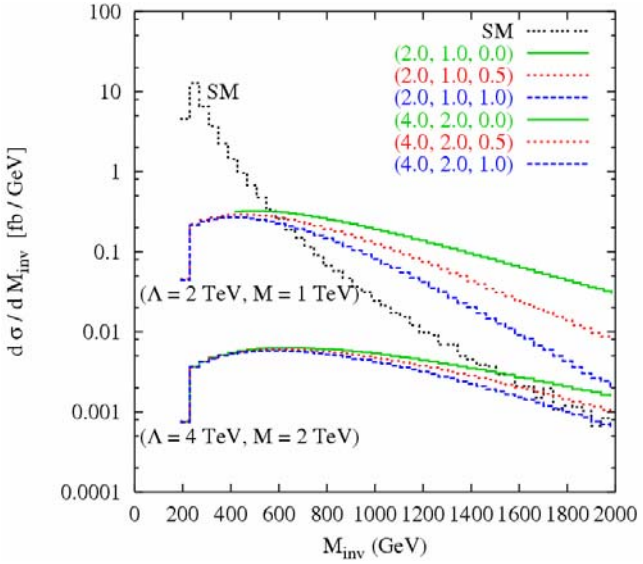
- Spin 1/2 or 3/2 particles in composite models
- 2 scales (parameters) involved:
  Λ and M_{LG}
- HERA limit: (resonance production)

$\Lambda > 700$ GeV for $M_{LG} \sim 150$GeV

- Production cross section:

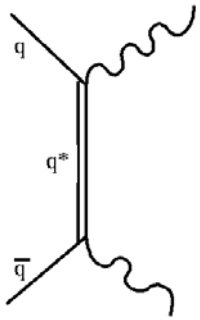
$$\frac{d\hat{\sigma}}{d\hat{t}}(g\,g \to \ell^+\,\ell^-) = \frac{\pi\,\alpha^2}{4\,\Lambda^4}\left\{\frac{\hat{t}\,\hat{u}}{\hat{s}^2}\left[\frac{\hat{t}^2}{(\hat{t}-M^2)^2}+\frac{\hat{u}^2}{(\hat{u}-M^2)^2}\right]+\frac{M^2}{\hat{s}}\left[\frac{\hat{t}}{(\hat{t}-M^2)}+\frac{\hat{u}}{(\hat{u}-M^2)}\right]^2\right\}$$

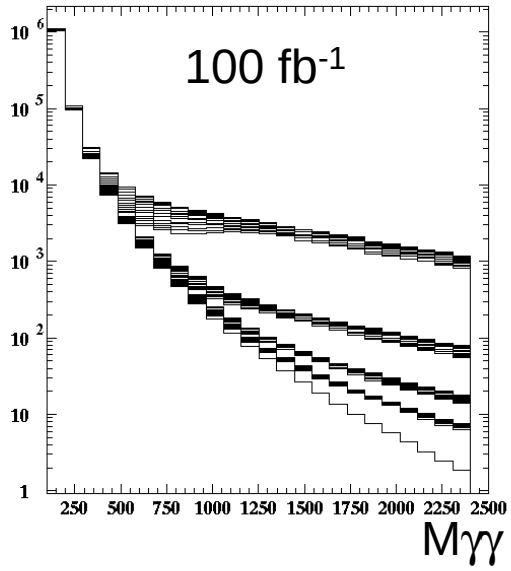




DiPhotons: Virtual exchange of excited quark

$q + q \rightarrow \gamma + \gamma$

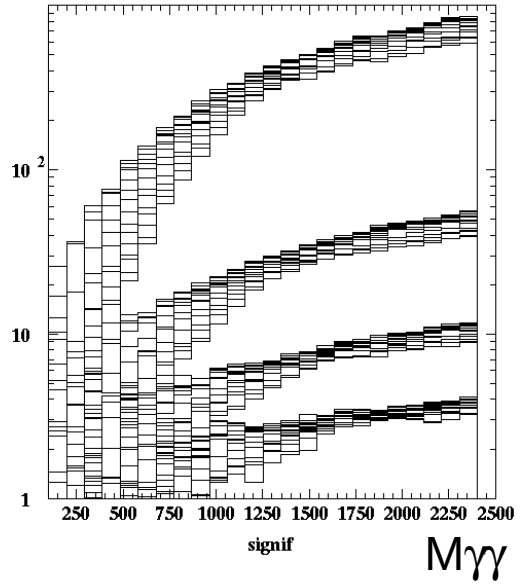




- Spin ½ particles in composite models
- 2 scales (parameters) involved:
  Λ and M_{EQ}
- Production cross section:

$$\frac{3\,\hat{s}^2}{2\,\pi\,\alpha^2}\,\frac{d\,\hat{\sigma}}{d\,\hat{t}} = e_q^4\left[\frac{\hat{u}}{\hat{t}}+\frac{\hat{t}}{\hat{u}}\right] - \frac{e_q^2}{\Lambda^2}\left[\frac{\hat{t}^2}{\hat{t}-M^2}+\frac{\hat{u}^2}{\hat{u}-M^2}\right] + \frac{1}{\Lambda^4}\left\{\hat{t}\hat{u}\left[\frac{\hat{t}^2}{(\hat{t}-M^2)^2}+\frac{\hat{u}^2}{(\hat{u}-M^2)^2}\right]+M^2\,\hat{s}\left[\frac{\hat{t}}{(\hat{t}-M^2)}+\frac{\hat{u}}{(\hat{u}-M^2)}\right]^2\right\}$$

- Implemented in Pythia



UED scenario and Gravity Mediated decays of the LKP

Driss Goujdami, Université Cadi Ayyad Marrakech
Helenka Przysiezniak, LAPP, Annecy

- 1 TeV^{-1} Extra-dimension + N large extra-dimensions eV^{-1}
- SM particles allowed only in TeV^{-1} and gravitation propagates everywhere

- KK number is conserved (Momentum conservation along XD)

→ Pair production only and stable Lightest KK Particle (LKP==γ^*)

- At tree level, the KK masses:

$m_n^2 = n^2/R^2 + m_{SM}^2$ R (~TeV^{-1})

- Heavier KK decay cascade → LKP + soft SM particles.
- LKP: missing energy or gravity mediated decay (KK number violation)

(hep-ph/0201300 Macesanu, McMullen, Nandi;
Phys.Rev.D64, 095010 (2001), T.G.Rizzo;
Phys.Lett.B482 195(2000), A.DeRujula,A.Donini,M.B.Gavela and S.Rigolin).

- Studied exemple: $\gamma^* \rightarrow \gamma$ + massive Graviton (which is massive).

TOOLS

Generation: CompHEP

Two 5D fermionic fields denoted q• and q° are associated to each SM fermion

Processes	σ fb	Processes	σ fb	Processes	σ fb
$gg \to g^*g^*$	212	$q\bar{q} \to g^*g^*$	14	$qg \to q^\bullet g^*$	605
$qq \to q^\bullet q^\bullet$	175	$q\bar{q} \to q^\bullet \bar{q}^\bullet$	25	$gg \to q^\bullet \bar{q}^\bullet$	11
$q\bar{q} \to q'^\bullet \bar{q}'^\bullet$	22	$qq' \to q^\bullet q'^\bullet$	121	$q\bar{q}' \to q^\bullet \bar{q}'^\bullet$	26
$qq \to q^\bullet q^\circ$	222	$q\bar{q} \to q^\bullet \bar{q}^\circ$	16	$qq' \to q^\bullet q'^\circ$	84
$q\bar{q}' \to q^\bullet \bar{q}'^\circ$	38				

1/R=MKK=1.3 TeV

Cascade decay: Pythia

Existing excited quark and boson decay channels are used

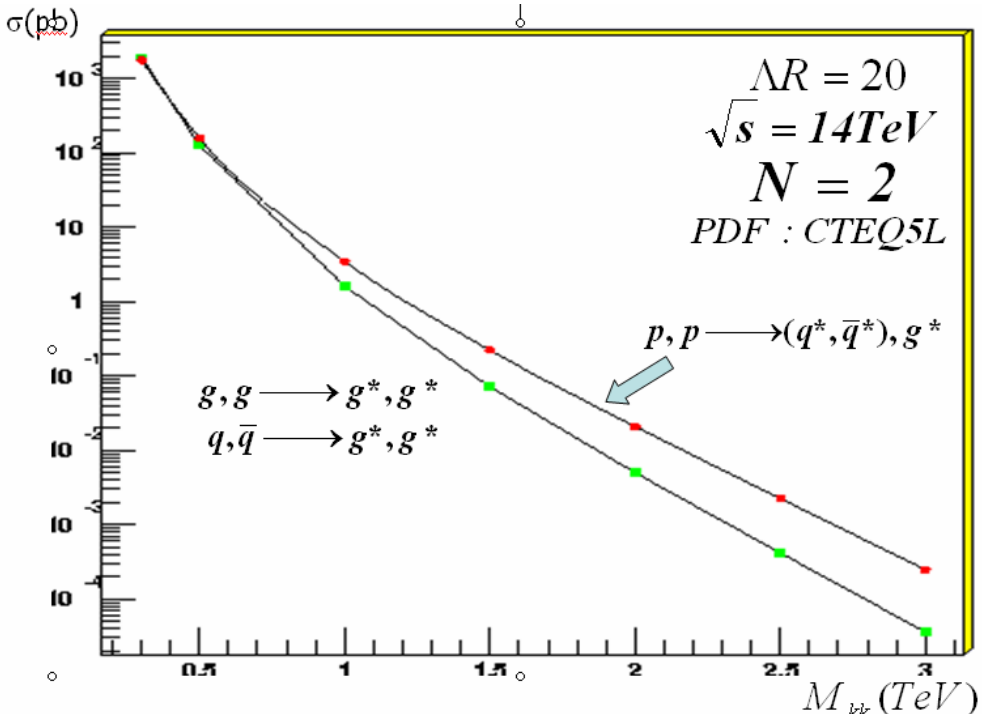
$$q_1^\bullet \to q\, Z_1^* \to q\, l\, l_1^\bullet \to q\, l\, l\, \gamma_1^*, \quad \text{Br.} \sim 33\%$$
$$q_1^\bullet \to q\, W_1^* \to q\, l'\, l_1^\bullet \to q\, l'\, l\, \gamma_1^*, \quad \text{Br.} \sim 65\%$$

LKP decay $\gamma^* \to \gamma + G$: GMSB decay of LSP → gravitino+photon is used.

Our ultimate plans are to decay the KK photon outside of Pythia using proper integration over all graviton KK states and taking into account spin effects.

UED: some results

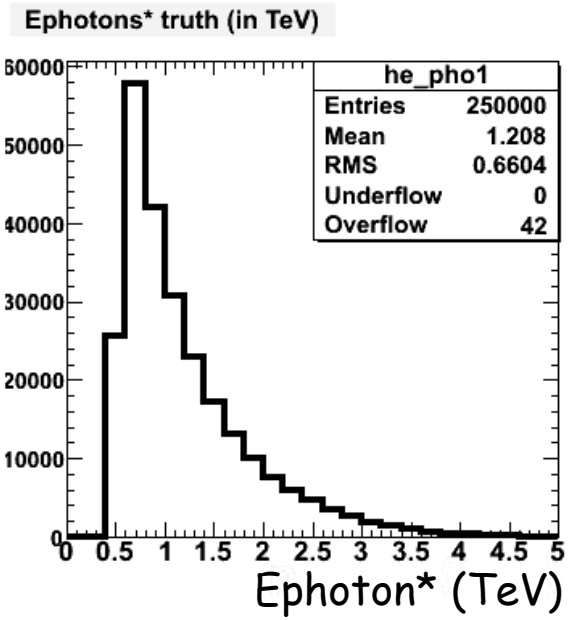
Production Cross Sections from CompHEP

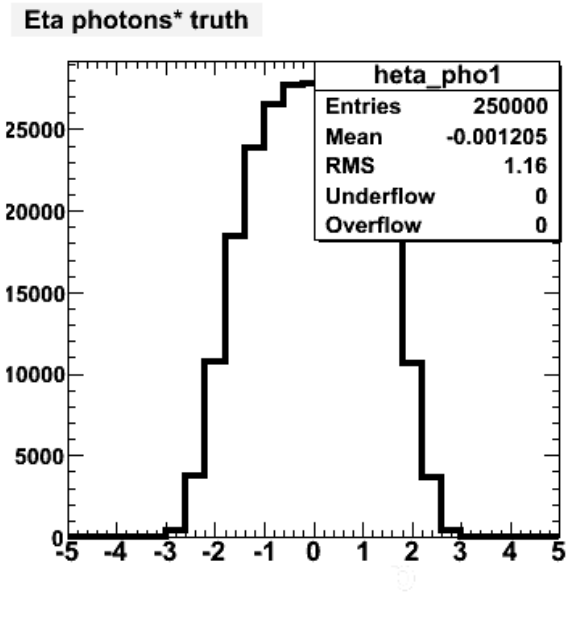


Cascade decay from Pythia

1/R=500GeV, ΛR=10

$$q_1^{\bullet} \to q\, Z_1^* \to q\, l\, l_1^{\bullet} \to q\, l\, l\, \gamma_1^*,$$
$$q_1^{\bullet} \to q\, W_1^* \to q\, l'\, l_1^{\bullet} \to q\, l'\, l\, \gamma_1^*,$$





Higgless models

G. Azuelos

Warped space, with boundary conditions that break the symmetry on the TeV brane and on the Planck brane:

C. Csáki et al., hep-ph/0310355,
C. Csáki, hep-ph/0412339

The model explains:

- **γ : massless photon (flat wavefunction in bulk)**
- **W, Z : lowest KK states of massive gauge bosons**
- **correct ratio of W/Z mass**

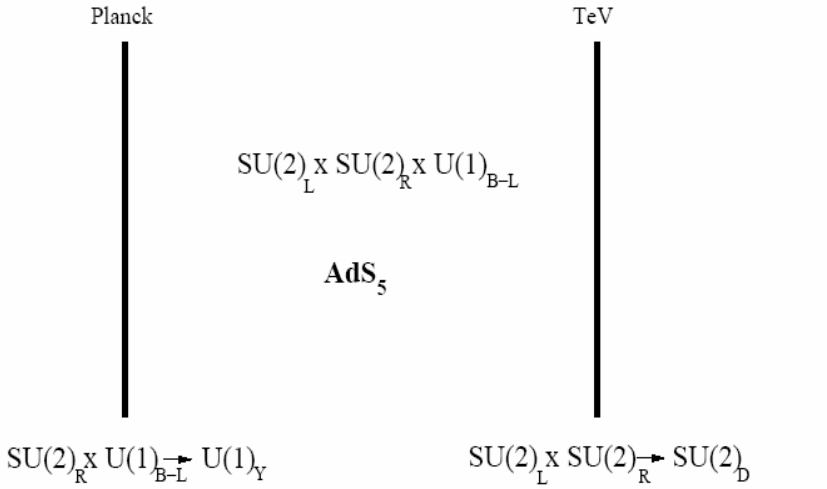


Figure 3: The symmetry breaking structure of the warped higgsless model.

Important constraints:

- **S parameter from LEP:**
  → **weak coupling of Z' to fermions (and possibly light Z')**
- **unitarity in VB scattering**
  → **resonances in WZ scattering distinguishable from QCD-like chiral Lagrangian model resonances.**
- **problems with the top**

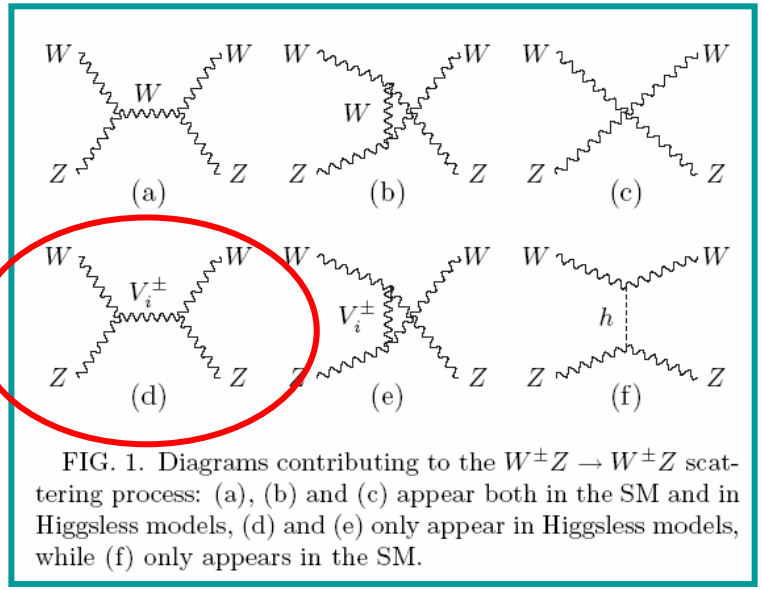


FIG. 1. Diagrams contributing to the $W^{\pm}Z \to W^{\pm}Z$ scattering process: (a), (b) and (c) appear both in the SM and in Higgsless models, (d) and (e) only appear in Higgsless models, while (f) only appears in the SM.

A. Birkedal et al., hep-ph/0412278

resonance in WZ scattering

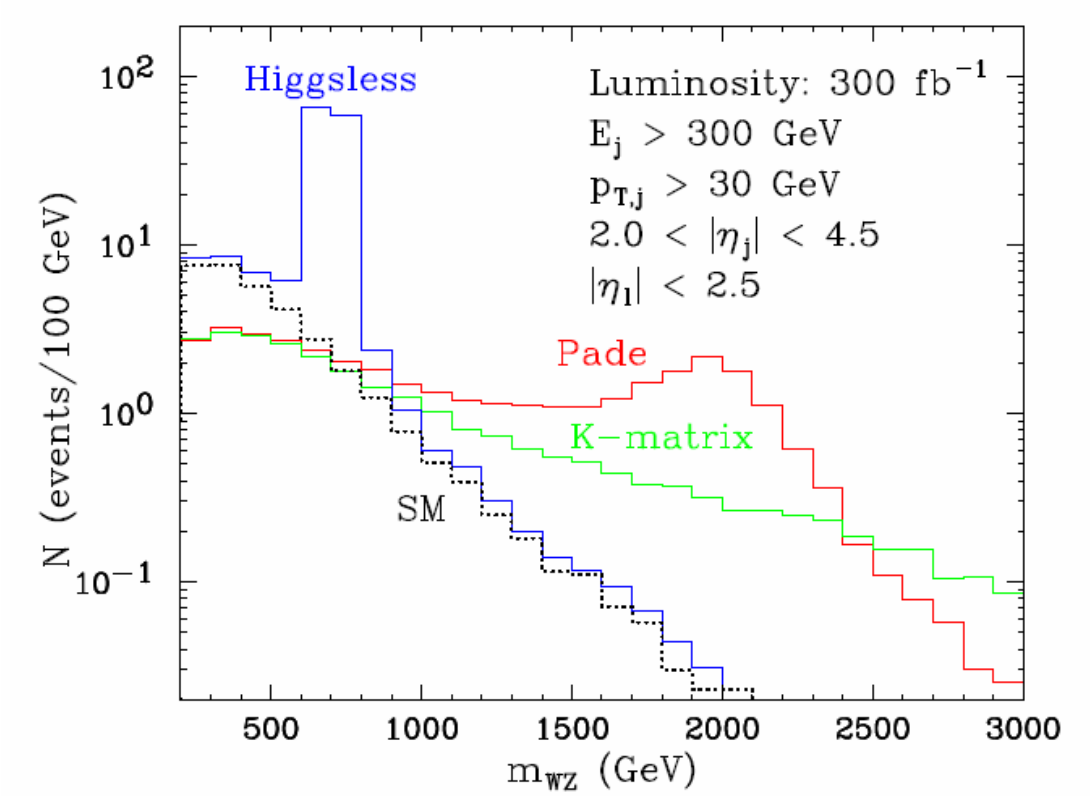


FIG. 4. The number of events per 100 GeV bin in the $2j + 3\ell + \nu$ channel at the LHC with an integrated luminosity of 300 fb^{-1} and cuts as indicated in the figure. The model assumptions and parameter choices are the same as in Fig. 2.

A. Birkedal et al., hep-ph/0412278

BSM Tools – Session 1

Contact: Peter Skands
(skands@fnal.gov)

Discussions so far concentrated on:

- Extending the SUSY Les Houches Accord
- Tools for Extra Dimensions
- Tools for NMSSM and CPV-SUSY
- + some bug-eyed BSM ...

Projects - 1

- Extending the SLHA [Allanach, Porod, Moortgat, Penaranda, Desch, Wienemann, Skands, Schumacher, Lykken, Godbole, Kraml, Choudhury, Guchait, Boudjema, ...]
  - CPV, RPV, Flavour Violation, NMSSM
  - Framework for Theory Errors, Cross sections
  - Validating Tools
- Tools for Extra Dimensions
  [Ferrag, Kraml, de Roeck, Azuelos, Skands, Miakov?]
  - Collecting a repository, review available tools
  - Validating, esp private and semi-public tools
  - Towards standardization & benchmarks?

Projects - 2

- K-factors / Universality
  Huston, Mrenna, more?
  - To what extent are higher-order corrections universal?

- Event Generators for NMSSM
  Hugonie, Skands, Moretti, Kraml, Zerwas
  - Very important to investigate more & soon, need tools. NMHDecay + event generators ...

- Event Generators for CPV-SUSY
  Mrenna, Kraml, Schumacher, Richardson?