DIRECT SIGNATURE OF EXTRA DIMENSIONS

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$e^+e^- \to \gamma G$ (ie $\gamma \not{E}_T$)

See also
Besançon, Komamiya,
Landsberg, Cheung.

New features

1. REALISTIC DETECTOR ACCEPTANCE
2. $e^+e^- \to \nu\bar{\nu}\gamma$ BACKGROUND USING NUNUGPV-LC WITH BEAM POLARISATION AND BEAMSTRAHLUNG.

DETECTOR ACCEPTANCE

present ECFA/DESY design (much improved !)

$$\rightarrow \quad \theta_{min}^{Veto} = 23.5 \text{ mrad}$$

$$\theta_{min}^{Ecal} \gtrsim 83 \text{ mrad}$$

$\Rightarrow$ KINEMATIC CUTS OF

① $\frac{p_T^\gamma}{E_b} > 0.05$ (REJECT $(ee)\gamma$ ETC)

② $\sin\theta_\gamma > 0.1$

ACCELERATOR

$$\sigma_{\gamma G} \sim \frac{1}{s}\left(\frac{\sqrt{s}}{M_D}\right)^{2+\delta}$$

$\Rightarrow$ highest $\sqrt{s}$ is BEST

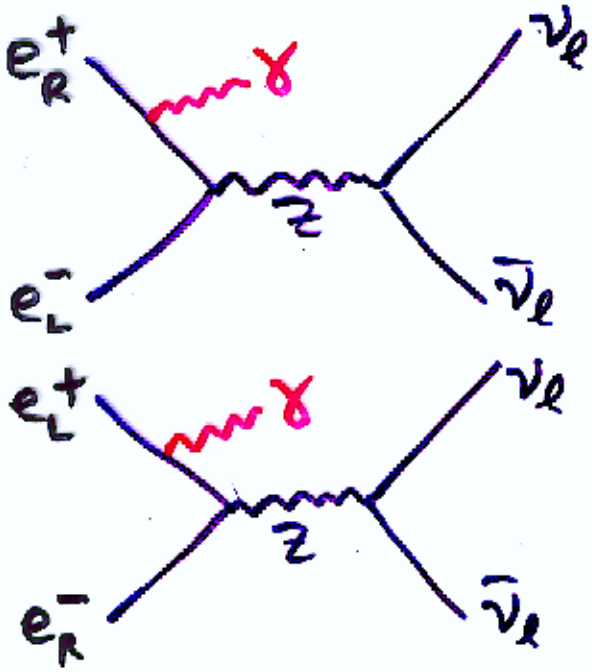
Assume $\sqrt{s} = 800$ GeV, $\mathcal{L} = 1000\ fb^{-1}$

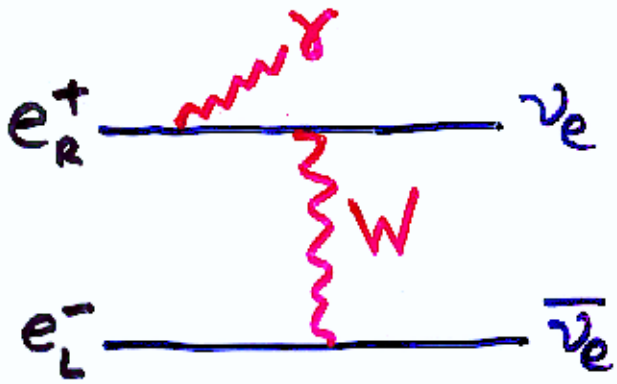
SEPARATING SIGNAL / BACKGROUND

(@ $\sqrt{s} = 800$ GeV)

SIGNAL : $e^+e^- \to \gamma G$

BACKGROUND : $e^+e^- \to \nu\bar{\nu}\gamma$





Use NUNUGPV Born level with IP and beamsstrahlung (TESLA 800, circe v7)
See G. Montagna et al @ Obernai.

Impose $E_\gamma < 250$ GeV to remove $Z\gamma$ (incl. beamsstrahlung!)

Find $\sigma_{e_L^-}^{\nu\bar{\nu}\gamma} = 2.63$ pb

$\sigma_{e_R^-}^{\nu\bar{\nu}\gamma} = 5.32$ fb

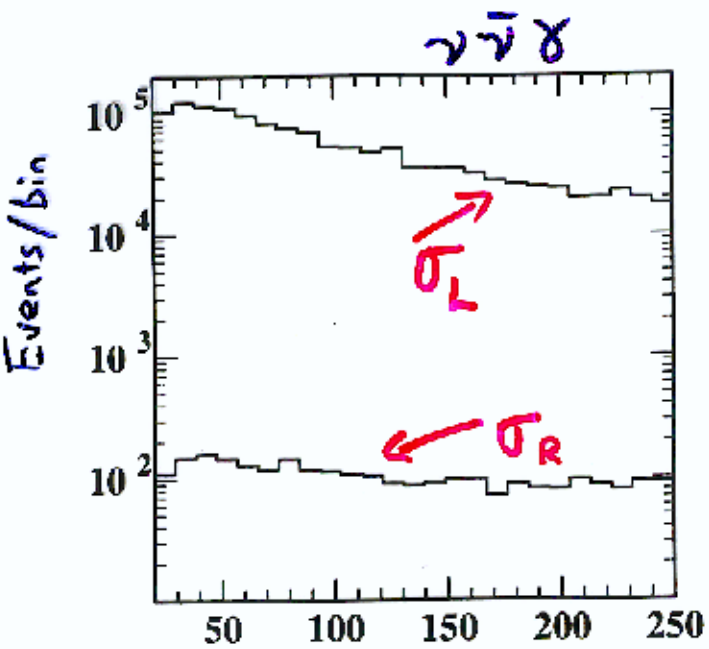
while

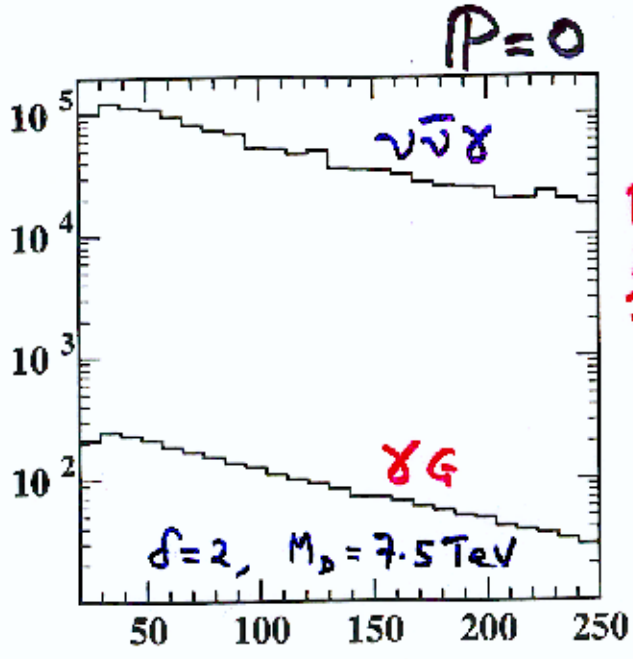
e.g. for $f = 2$, $M_D = 7.5$ TeV

$\sigma_{unpol}^{\gamma G} = 2.7$ fb

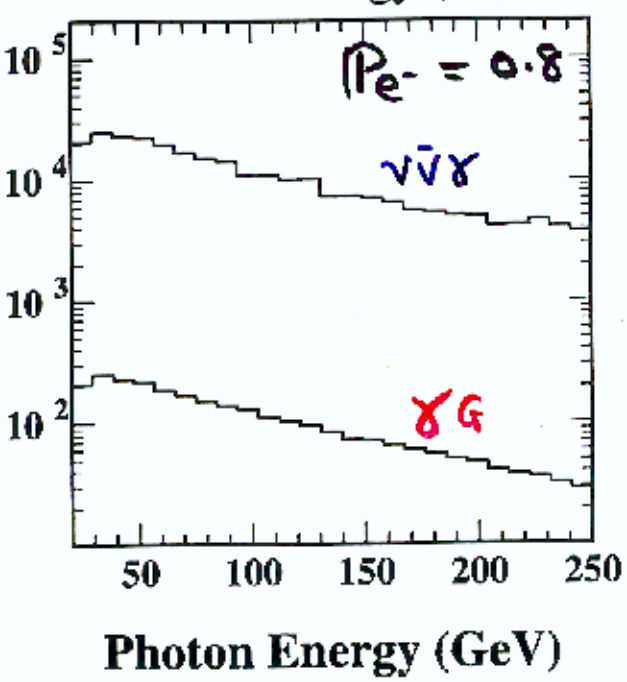
POLARISATION is THE KEY!

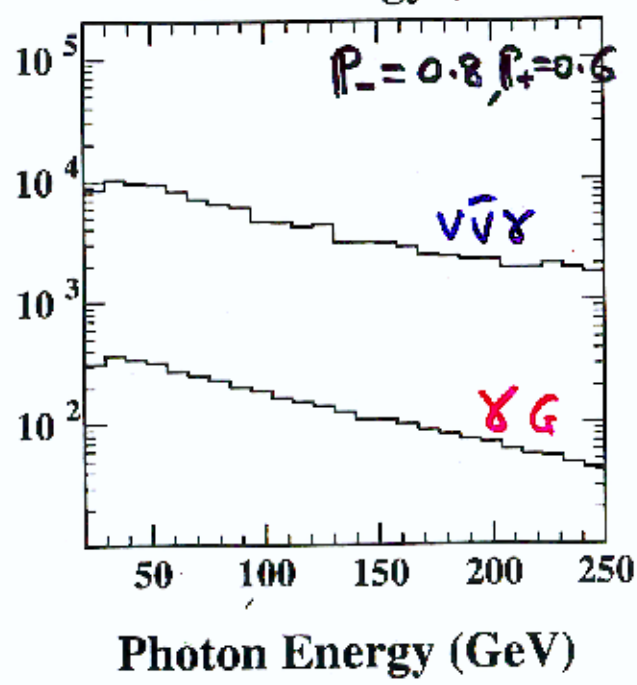
$\sqrt{s} = 800$ GeV
$\mathcal{L} = 1\,ab^{-1}$





νν̄γ BKGD. LOOKS JUST LIKE THE SIGNAL





The $\frac{S}{\sqrt{B}}$ Significance improves by 2.2 and by 5.0
equivalent* to lumi upgrades of × 5 and × 25
with P_{e^-} or P_{e^-} AND P_{e^+}

* actually BETTER.

ULTIMATE REACH

$\sqrt{s} = 800$ GeV $\mathcal{L} = 1\,ab^{-1}$

Example : $\delta = 2$, M_D sensitivity.

	No P	$P_{e^-} = 0.8$	$(P_-, P_+) = (0.8, 0.6)$
5σ (statistical)	6.2 TeV	7.6 TeV	9.3 TeV
S/B $\|_{5\sigma}$	0.4%	1.0%	1.5%
σ_S (fb)	5.7	2.6	1.7
σ_b (fb)	1320	270	113
95% CL limit	7.8 TeV	9.5 TeV	11.7 TeV

Systematics : $\mathcal{O}(1\%)$ experimental → limit "less polarised" potential.

Theory errors for $\frac{\Delta\mathcal{L}}{\mathcal{L}}$ and $\sigma_{\nu\bar{\nu}\gamma}$ a major concern.

CONCLUDING REMARKS

- ESPECIALLY WITH $\mathbb{P}$ OLN. THE LC REACH LOOKS VERY PROMISING.
- SYSTEMATICS IMPORTANT — theory for SM process
  — lumi ...
- HIGHER $\sqrt{s}$ HELPS
- BETTER $\mathbb{P}$ HELPS TOO
- NEED TO ELIMINATE BEAM μ. + COSMIC μ BACKGROUNDS BY DESIGN.
- LHC SENSITIVITY TO REAL GRAVITON EMISSION IS HARD TO PREDICT → BUT MAY BE NON-PERTURBATIVE IF OBSERVED.

  → LC / LHC ARE COMPLEMENTARY WITH LC OFFERING POTENTIAL TO DIAGNOSE THE NEW PHYSICS.