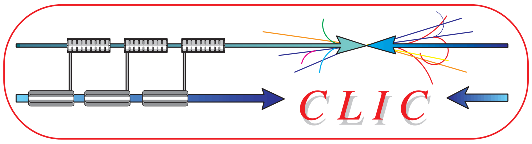
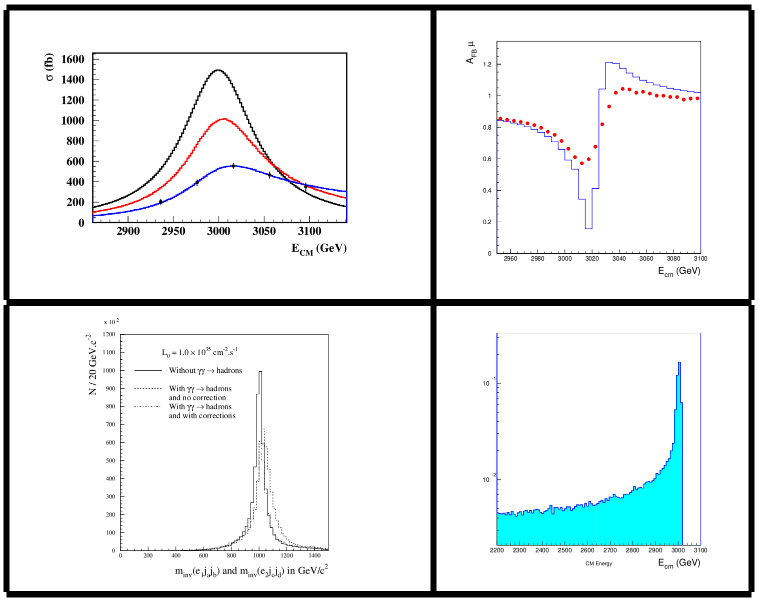
Linear Collider Workshop 2000 - LCWS 2000
Fermilab – October 24 - 28, 2000

Study of S-Channel Resonances at the CLIC Multi-TeV Collider



Marco Battaglia

CERN - Geneva



Contributions from
S. De Curtis, D. Dominici, A. Ferrari, J. Heikkinen, D. Schulte

Resonances in the Multi-TeV Mass Region

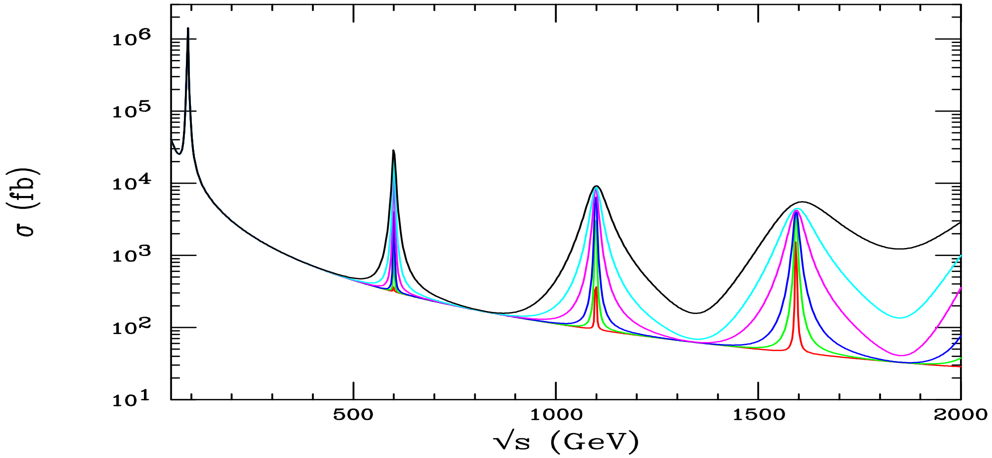
❖ Resonances in the multi-TeV mass range are predicted by models with:

Extra Gauge Bosons:

Sequential SM Gauge bosons, Left-Right Symmetric Models and GUT-inspired E_6 scenarios

Extra Dimensions:

Kaluza-Klein Resonances $\Gamma_{KK} = f(c) M^3_{KK}$ $\sigma(e^+e^- \to \mu^+\mu^-)$

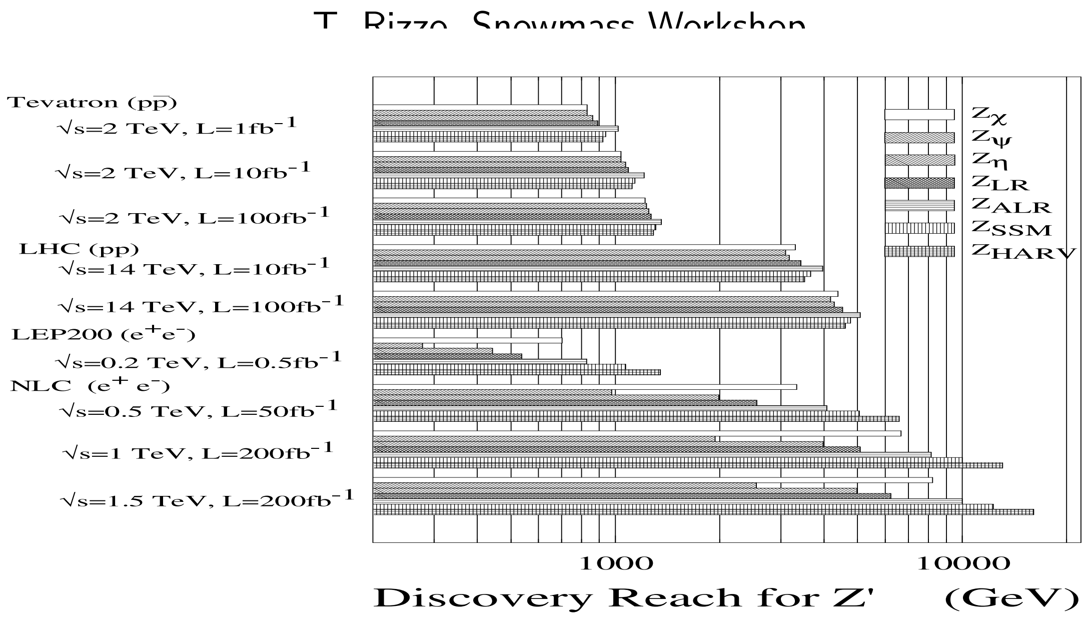


BESS Model:

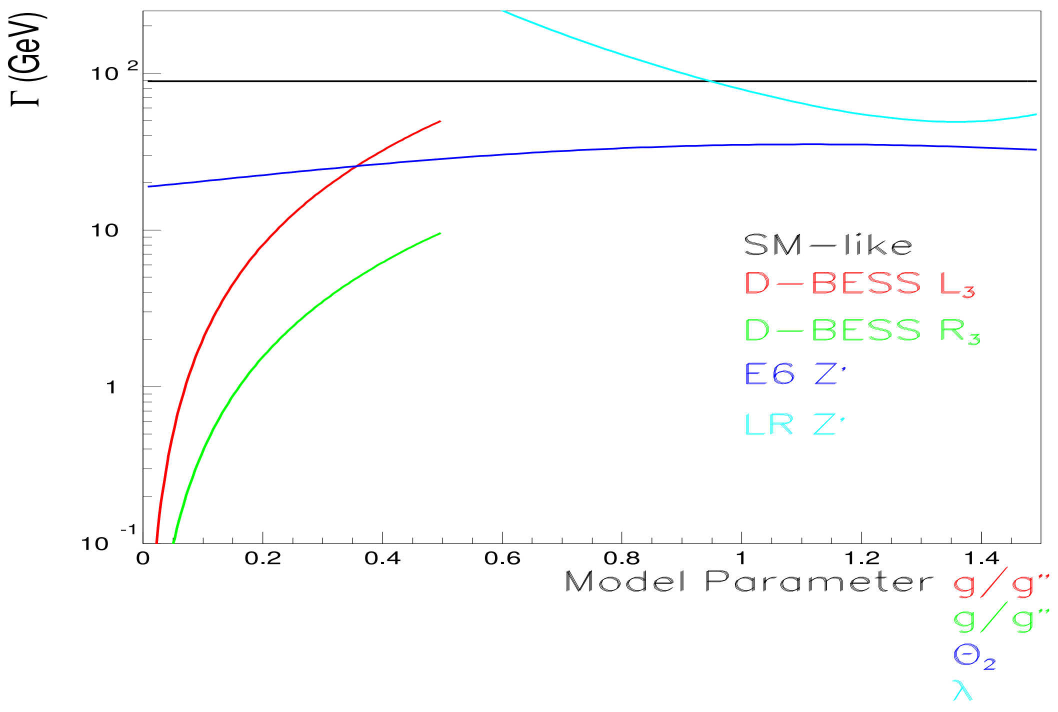
EW symmetry breaking driven by dynamics of TeV scale interacting fields.

Extra-Gauge Bosons: Z'

EXPECTED REACH FROM TEVATRON/LHC/LC



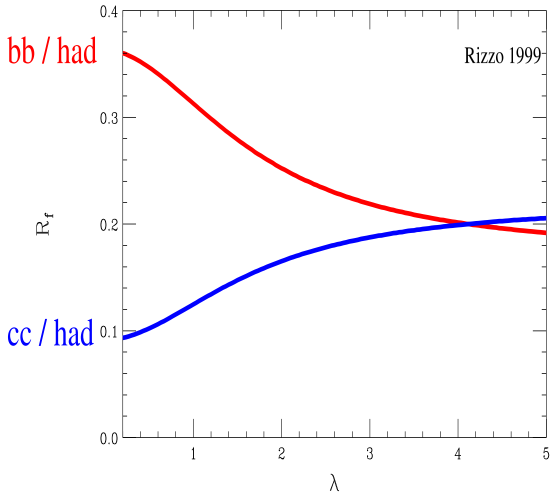
❖ Lineshape analysis may allow to distinguish resonance nature and measure model parameters:

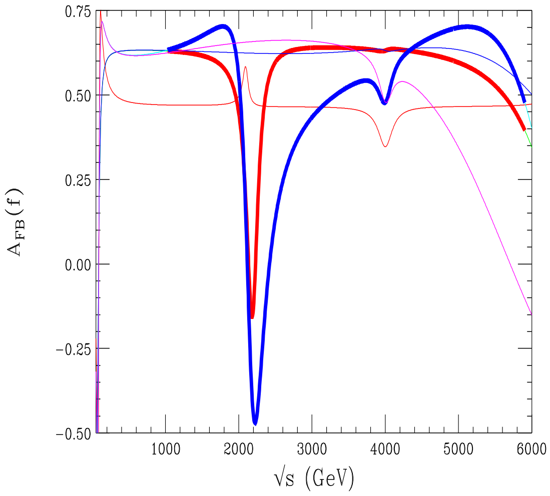


❖ Probe flavour dependent A_{FB} and partial widths to bf disentangle degenerate resonances from extended Gauge Boson Z' signature.

Characterizing a $Z^{(1)}/\gamma^{(1)}$ KK Excitation

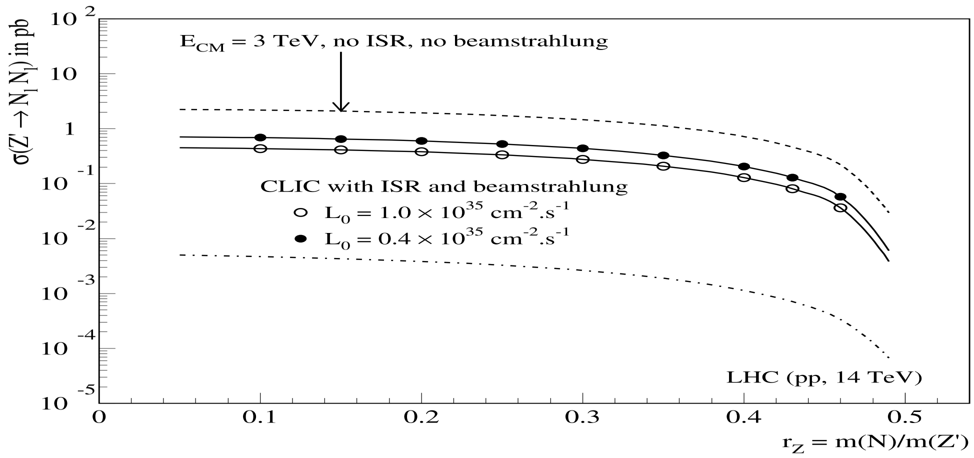
, T. Rizzo, Phys.Rev. D61 (2000)





❖ Study **exotic decay modes in Left Right Symmetric Model**:

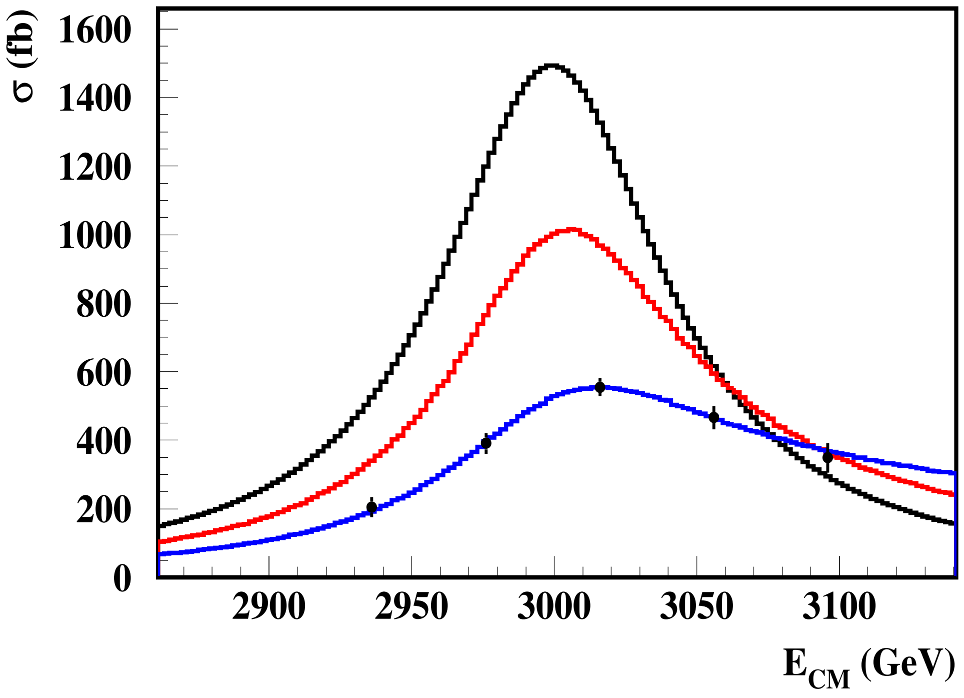
$\sigma(e^+e^- \to Z' \to N_eN_e$ for $m_{Z'} = 3$ TeV and diff. values of $m_N/m_{Z'}$ (manifest left-right symmetry) :



Z' Study at CLIC

❖ $\sqrt{s}$ Scan (Z^0-like Lineshape Scan)

$$e^+e^- \to Z' \to f\bar{f}$$

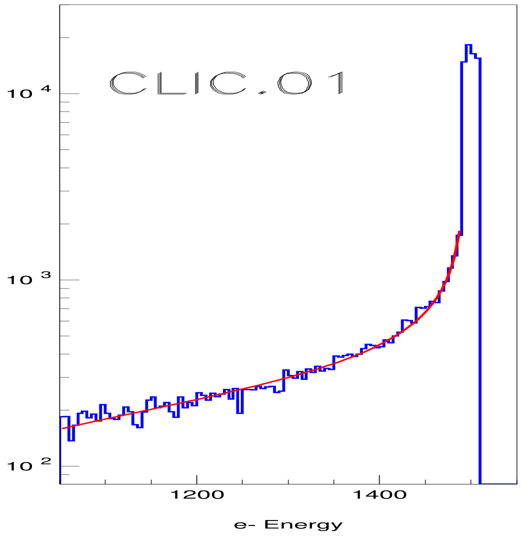


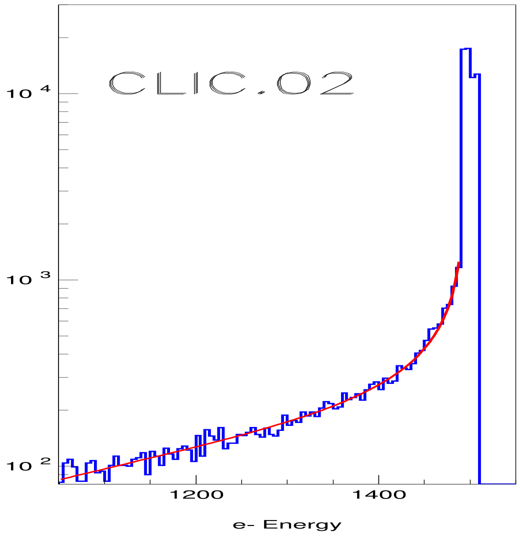
❖ **Study effect on Peak Energy Scan from**

- ISR;
- Beam energy spread;
- Beamstrahlung spectrum;
- Accelerator induced backgrounds (Pairs, $\gamma\gamma$).

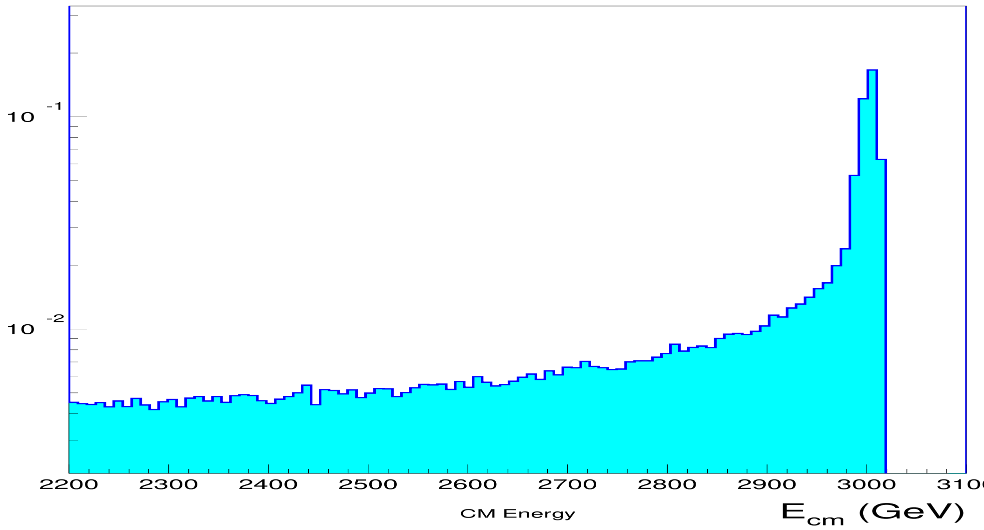
CLIC Beam Parameters

CLIC e^- Energy Spectrum - E_{beam} = 1.5 TeV
Yokoya - Chen Parametrization Fit
to CLIC Beam Simulation





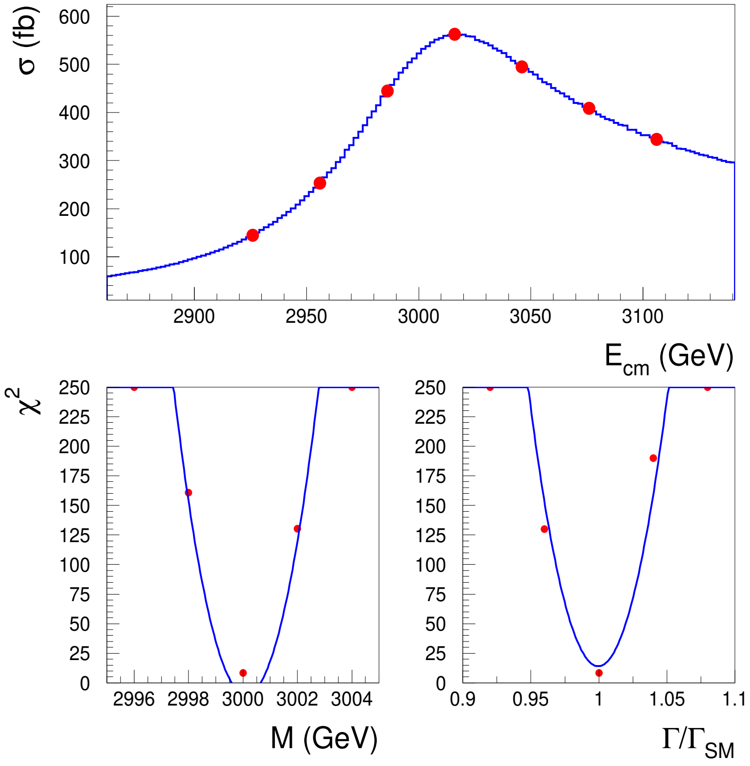
	L (cm^{-2} s^{-1}) at $\sqrt{s}$ = 3 TeV	N_γ Guinea Pig	N_γ Fit
CLIC.01	1.05 $\times 10^{35}$	2.2	2.35 $\pm$ 0.15
CLIC.02	0.40 $\times 10^{35}$	1.2	1.57 $\pm$ 0.22



Z' Lineshape Fit

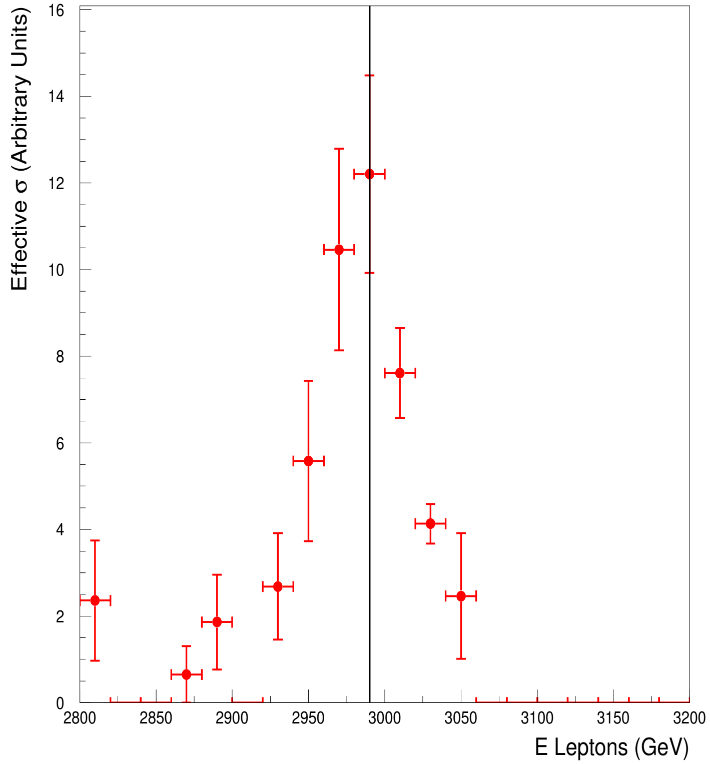
Peak Energy Scan

$$Z' \to q\bar{q},\ \ell^+\ell^-$$

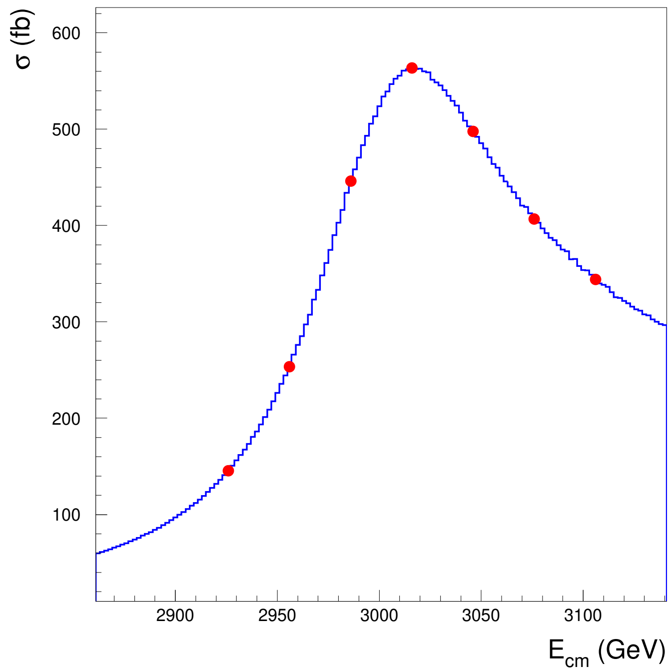


Autoscan with Beamstrahlung Spectrum

$$Z' \to \ell^+\ell^-$$



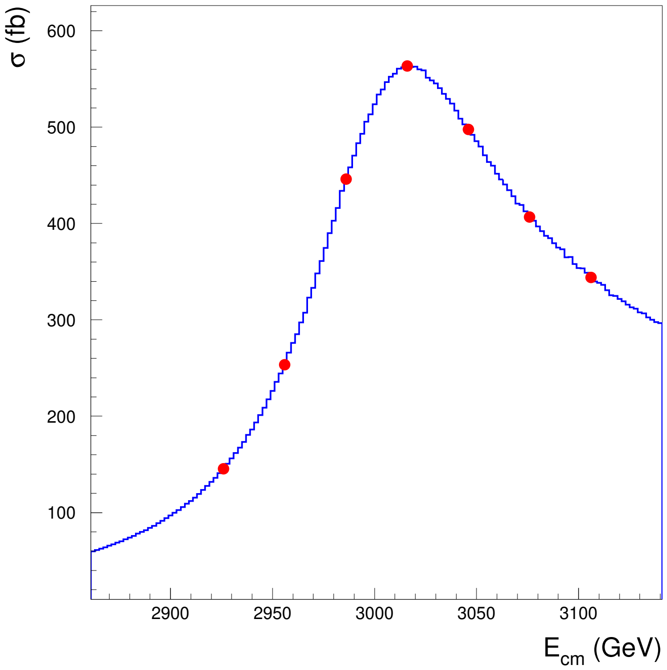
- Assume $M_{Z'} = 3.0$ TeV and $\Gamma(Z')/M_{Z'} \simeq \Gamma(Z^0)/M_{Z^0}$ (Γ_{SM});
- Compute $\sigma(e^+e^- \to Z')$ vs. $\sqrt{s}$ including ISR and beamstrahlung for a range of mass and $\Gamma(Z')/\Gamma_{SM}$ values;
- Assume $\int L = 1000$ fb^{-1} (CLIC.01) or 400 fb^{-1} (CLIC.02) shared in 3-7 points scan and extract $M_{Z'}$, $\Gamma(Z')/\Gamma_{SM}$ and σ_{peak} from χ^2 fit:



Fit Accuracy

Observable	Breit Wigner	CLIC.01	CLIC.02
$M_{Z'}$ (GeV)	3000 $\pm$ .12	$\pm$ .15	$\pm$ .21
$\Gamma(Z')/\Gamma_{SM}$	1. $\pm$ .001	$\pm$ .003	$\pm$ .004
σ^{eff}_{peak} (fb)	1493 $\pm$ 2.0	564 $\pm$ 1.7	669 $\pm$ 2.9

A First Estimate of Systematics from Luminosity Spectrum

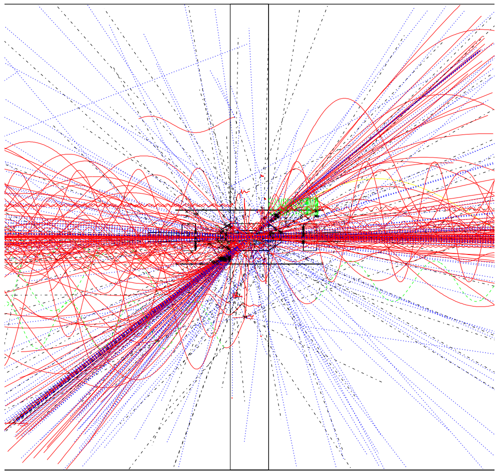


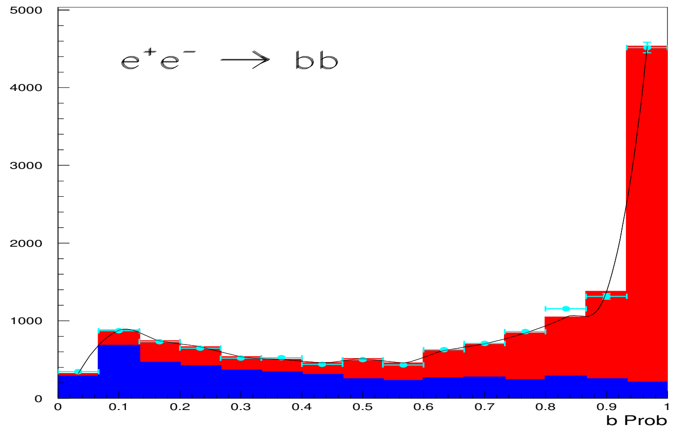
Uncertainties for 1% Syst.

Observable	σ_p	N_γ	F
$M_{Z'}$ (GeV)	$\pm$ 0.01	$\pm$ 0.03	$\pm$ .10
$\Gamma(Z')/\Gamma_{SM}$	$\pm$ 0.01	$\pm$ .001	$\pm$ .004

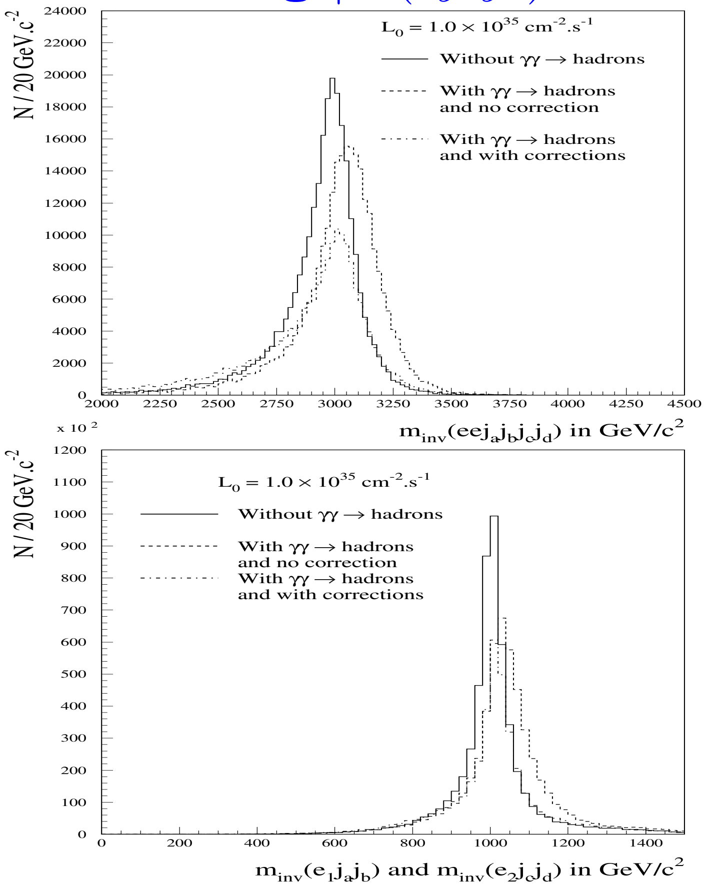
Z' Decays

$Z' \to b\bar{b}$ **from multiplicity b Tagging**





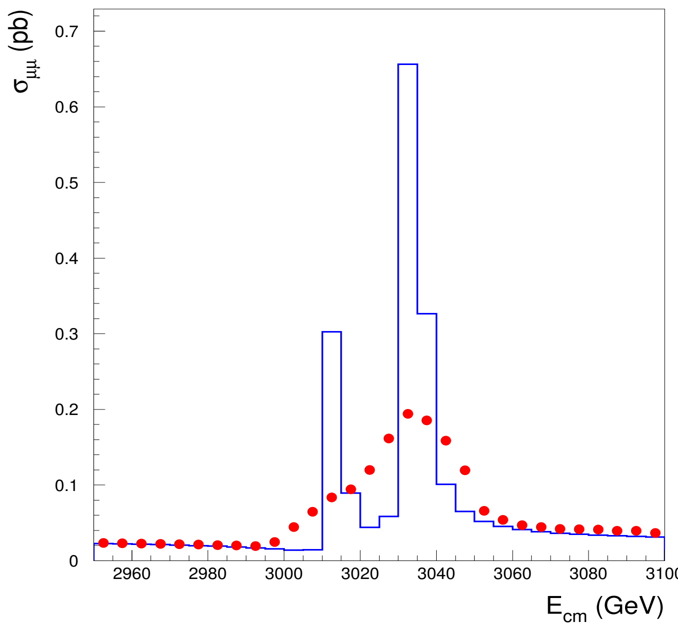
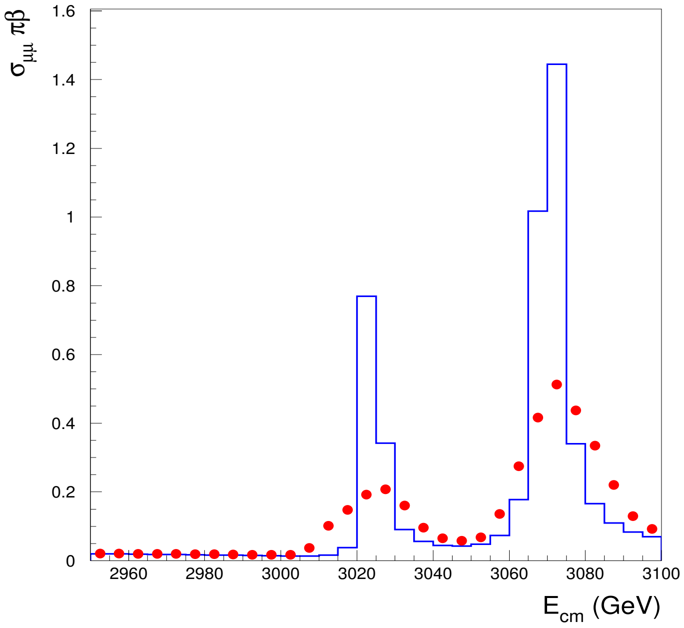
$Z' \to N_e N_e$ **Reconstruct N_e by $(e_1 j_a j_b\,,\, e_2 j_c j_d)$ combination minimizing $|m(ej_1j_2) - M_N|$**



D-BESS Model Study at CLIC

- Resolving Narrow and Nearly Degenerate D-BESS Resonances a challenge for multi-TeV large Υ collider design.
- Splitting of L_3 and R_3 Resonances defined by $g/g^{“}$ coupling ratio;

Energy Scan of Narrow Resonances

$g/g^{“} = 0.10$	$g/g^{“} = 0.15$
	

Study A_{FB} to Resolve Degenerate Resonances

$A_{FB}^{\mu\mu}$ g/g“ $= 0.10$	A_{FB}^{bb} g/g“ $= 0.10$