A CLIC Run Plan

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New Physics likely to bring rich spectroscopy at the TeV scale: which are the requirements on the CLIC energies and beams in a run plan which optimises the spectroscopic measurements within a resonable time span ?

Interesting consider a run plan exercise similar to that carried out for a 500 GeV collider at Snowmass 2001

Consider here two scenarios:

- a high mass SUSY benchmark
- a UED benchmark

Run Scenarios for the Linear Collider

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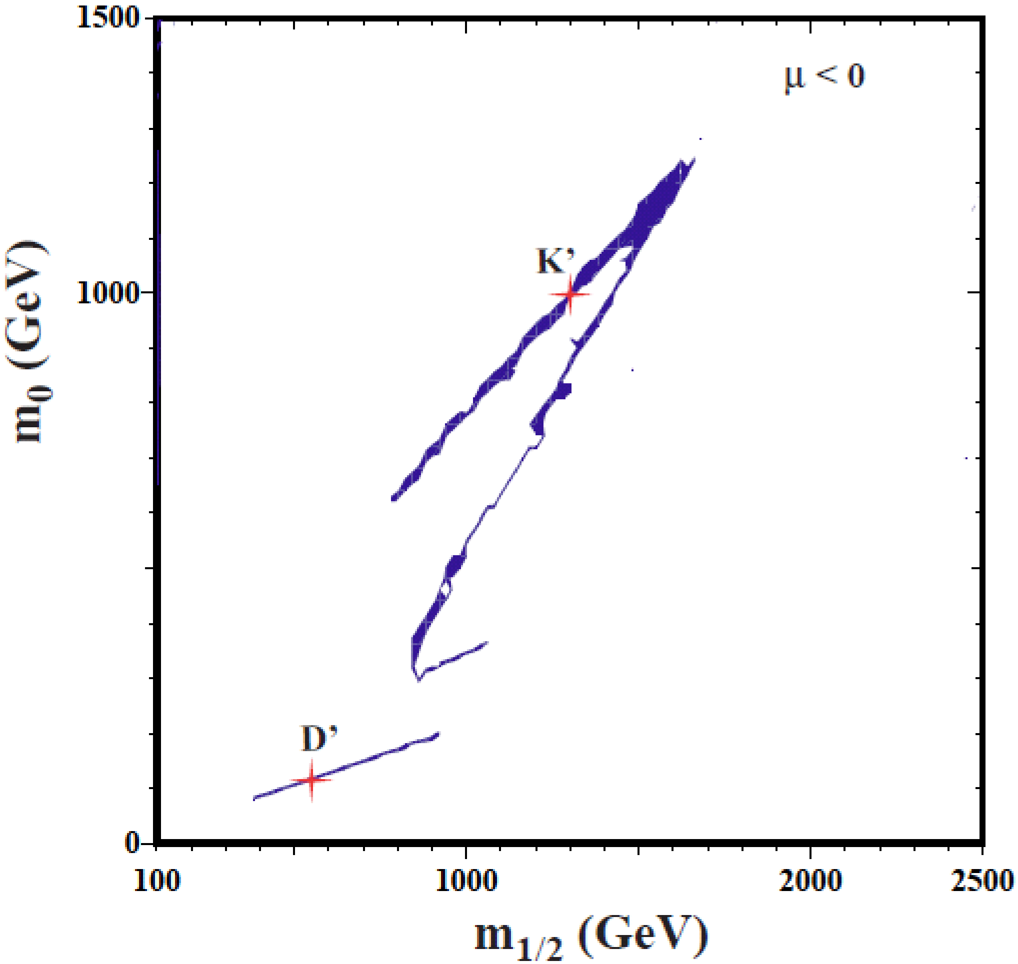
Scenarios are developed for runs at a Linear Collider, in the case that there is a rich program of new physics.

High Mass SUYS Scenario:
Benchmark Point K’ (Eur. Phys. J. C33 (2004))



Unpolarised cross sections computed with ISASUGRA + PYTHIA 6.125;

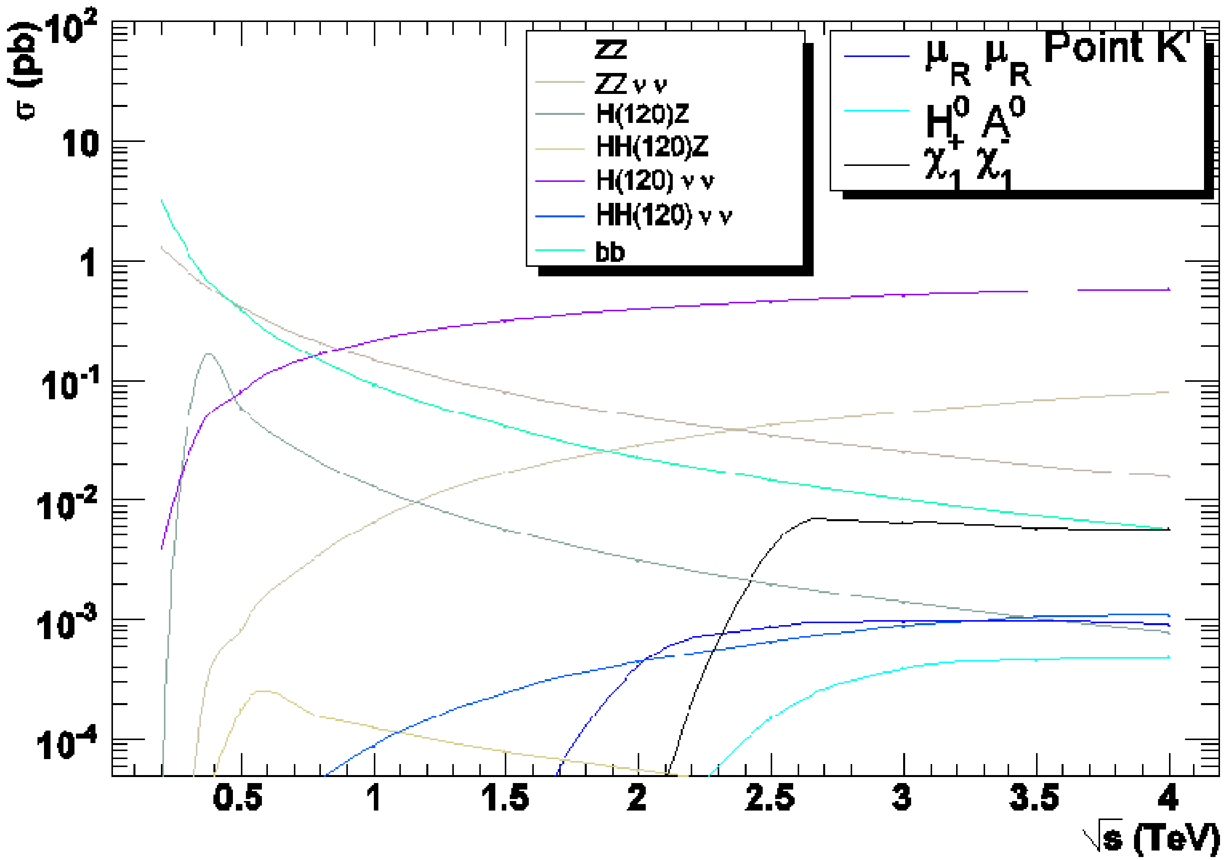
Polarised cross sections computed with SUSYGEN 3.00;

Beamstrahlung effect included using CALYPSO and files provided by D Schulte for CLIC 08 parameters;

Efficiency and S/B estimated from fully simulated and reconstructed events (MOKKA+MARLIN) for a CLIC-modified ILD detector.

CLIC

Mass Spectrum and
e^+e^- Pair-Production Cross Sections



Model	K'
$m_{1/2}$	1300
m_0	1001
$\tan\beta$	46
sign(μ)	−
m_t	175
Masses	
$\|\mu(m_Z)\|$	1420
h	123
H	1161
A	1153
$H^\pm$	1164
χ	554
χ_2	1064
χ_3	1430
χ_4	1437
$\chi_1^\pm$	1064
$\chi_2^\pm$	1435
$\tilde{g}$	2820
e_L, μ_L	1324
e_R, μ_R	1109
ν_e, ν_μ	1315
τ_1	896
τ_2	1251
ν_τ	1239
u_L, c_L	2722
u_R, c_R	2627
d_L, s_L	2723
d_R, s_R	2615
t_1	2095
t_2	2366
b_1	2297
b_2	2349

Kinematic Endpoints at 3 TeV

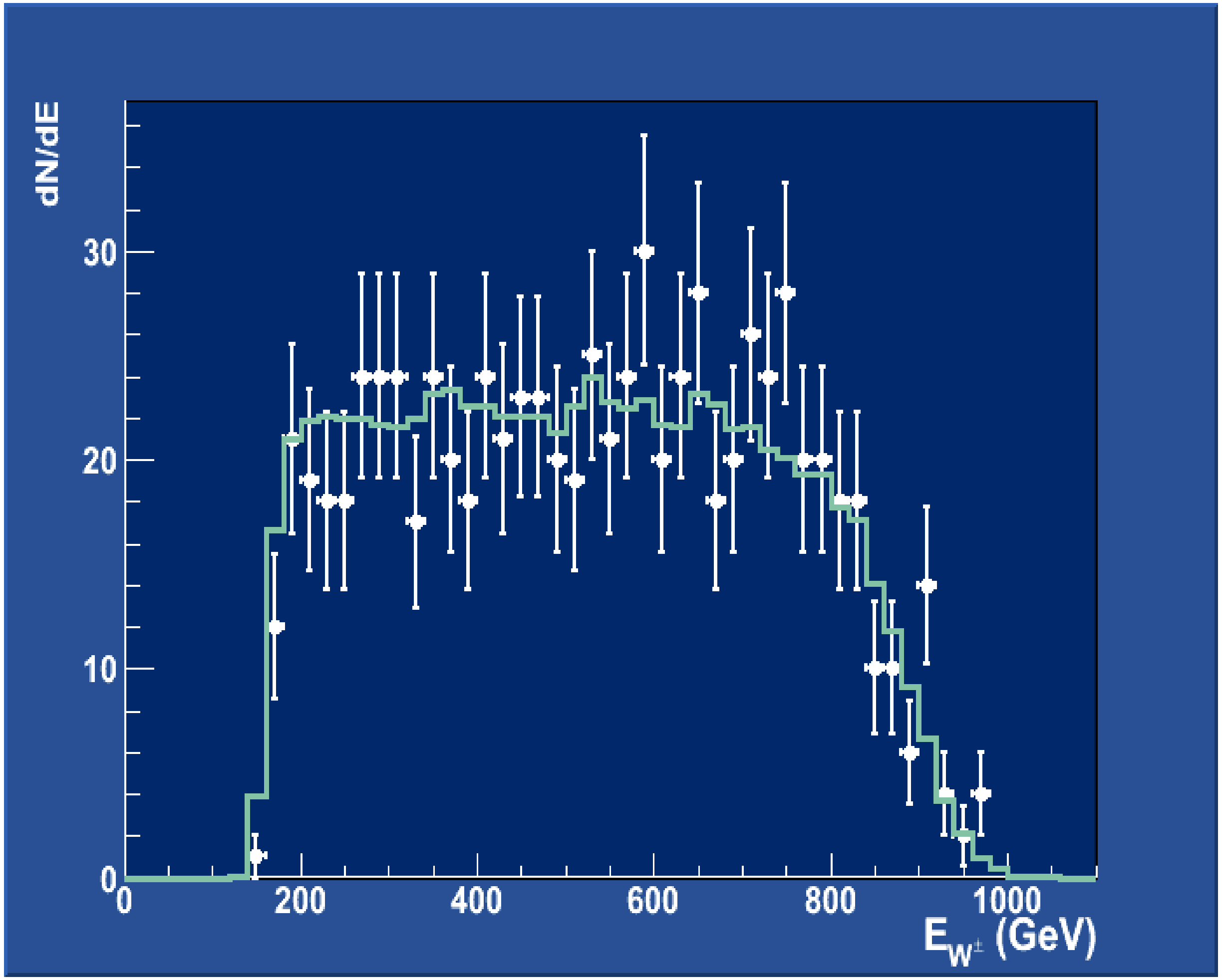
Operate at highest energy to determine masses using kinematic endpoints: 2 ab^{-1} at 3 TeV

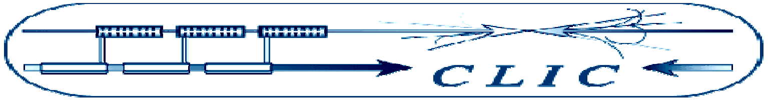
Endpoints in two-body processes sensitive to ratio of masses to LSP mass;

Resolution dominated by luminosity spectrum for μ (e ?) final states, parton energy for W/Z/q(?)

Extract (correlated) mass values with typical $\delta M/M \sim 2 - 3\%$

$\delta\Omega_\chi h^2 / \Omega_\chi h^2 \sim 0.15 - 0.20$ for $\delta M_{LSP}/M_{LSP} \sim 3\%$





Threshold Scans at 2 to 3 TeV

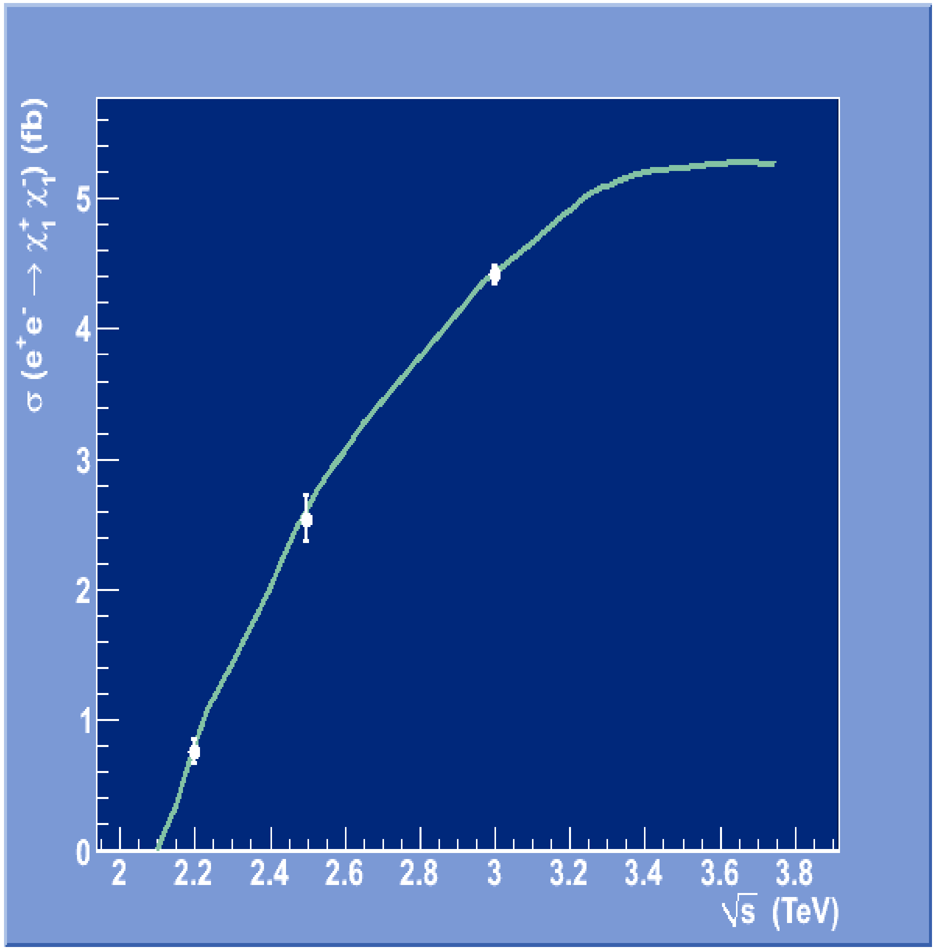
Scan Optimisation

Multi point scan not most effective approach when luminosity is limited:

Example: $\chi_1^{\pm}$ threshold scan with 1 ab^{-1} below maximum energy (2.2, 2.5, 2.7 TeV)

Luminosity sharing	Mass Error
0.33/0.33/0.33	± 8.3 GeV
0.5/0.5/0.0	± 7.0 GeV
0.7/0.3/0.0	± 6.3 GeV

(see also G Blair, Snowmass 2001)



The Role of Beam Polarisation

Polarisation useful to enhance signal cross sections (L/R for charginos and L sfermions and R/L for R sfermions) or to enhance S/B by switching off SM processes (such as W^+W^-)

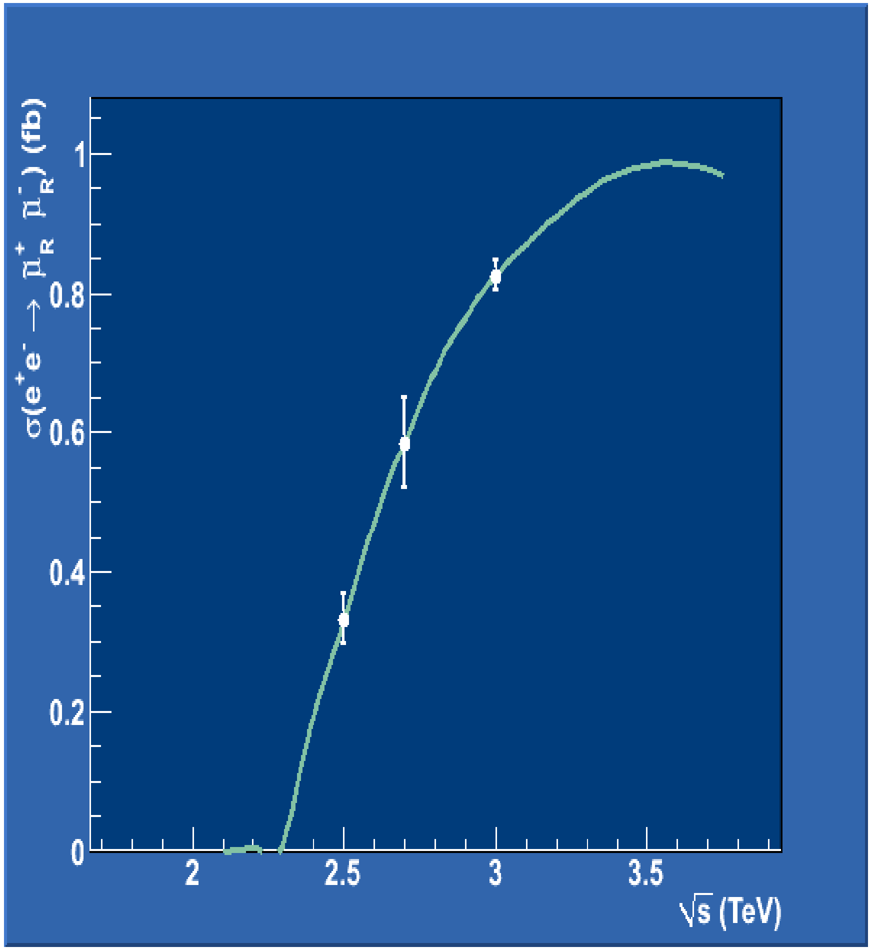
e+e- $\rightarrow \chi^+_1 \chi^-_1$ Production Cross Sections

√s (TeV)	no-pol (fb)	-0.8/0.0 (fb)	-0.8/+0.6 (fb)
3.0	4.6	8.5	13.6
2.2	1.0	1.8	2.9

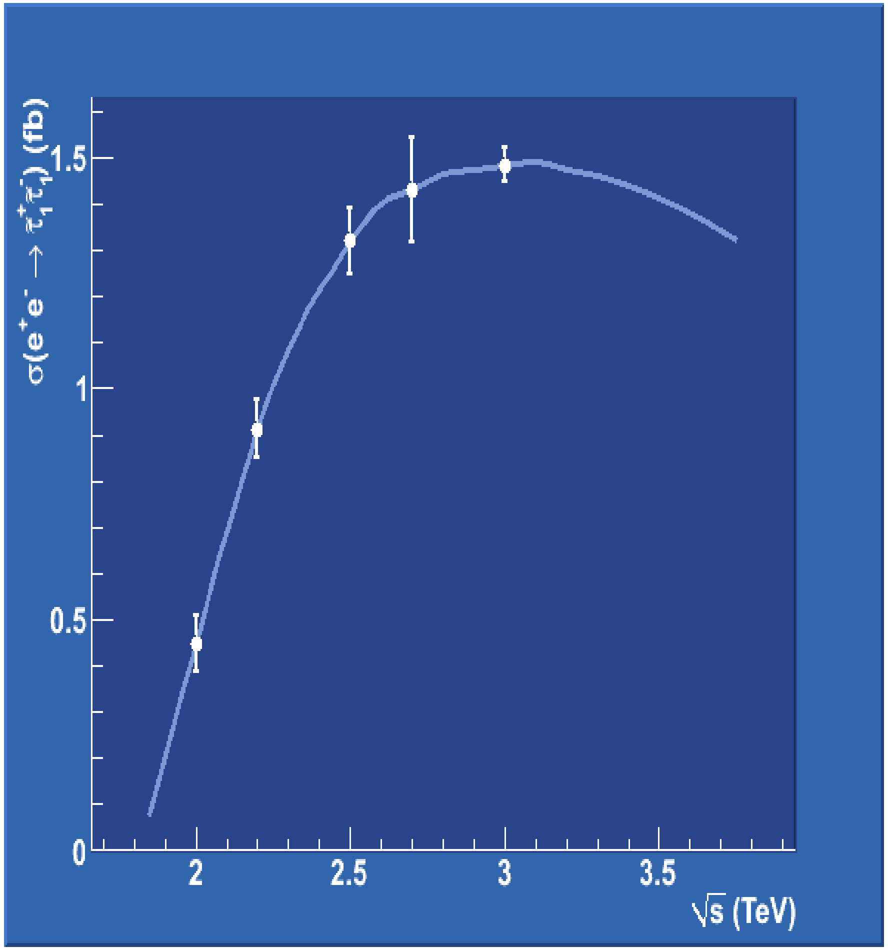
Accuracy on χ^+_1 Mass from Scan

No Polarisation	-0.8/0.0	-0.8/0.6
(1061±6.3) GeV	(1061±4.3) GeV	(1061±3.3) GeV

$e^+e^- \rightarrow \mu^+_R \mu^-_R$



$e^+e^- \rightarrow \tau^+_1 \tau^-_1$



Energy	L (ab^{-1})	P	Comments
3.0	2.0	-	Determine kin. Endpoints + Higgs
2.7	0.3	+0.8	Scan μ_R and e_R
2.5	0.3	-0.8	Scan χ^+ and τ_1
2.5	0.4	+0.8	Scan μ_R and e_R
2.2	0.7	-0.8	Scan χ^+ , τ_1, μ_R and e_R
2.0	0.5	-0.8	Scan τ_1
3.0	1.0	-0.8/+0.8	Study SUSY processes with pol.

Particle	Mass Accuracy (GeV)
$\chi^{\pm}_1$	± 4.3
$\mu^{\pm}_R$	± 6.2
$\tau^{\pm}_1$	± 6.7
χ^0_1	± 4.0

Minimal Universal Extra Dimensions (MUED) Benchmark Point

KK Level = 1

generations 1

e : 1276.07 1259.44

ν_e: 1276.07

u : 1420.41 1400.64

d : 1420.41 1397.5

generations 2

μ : 1276.07 1259.44

ν_μ: 1276.07

c : 1420.41 1400.64

s : 1420.41 1397.5

generations 3

τ : 1276.07 1259.44

ν_τ: 1276.07

t : 1361.86 1406.58

b : 1395.48 1397.5

γ : 1249.19

Z : 1303.64

$W^\pm$: 1303.6

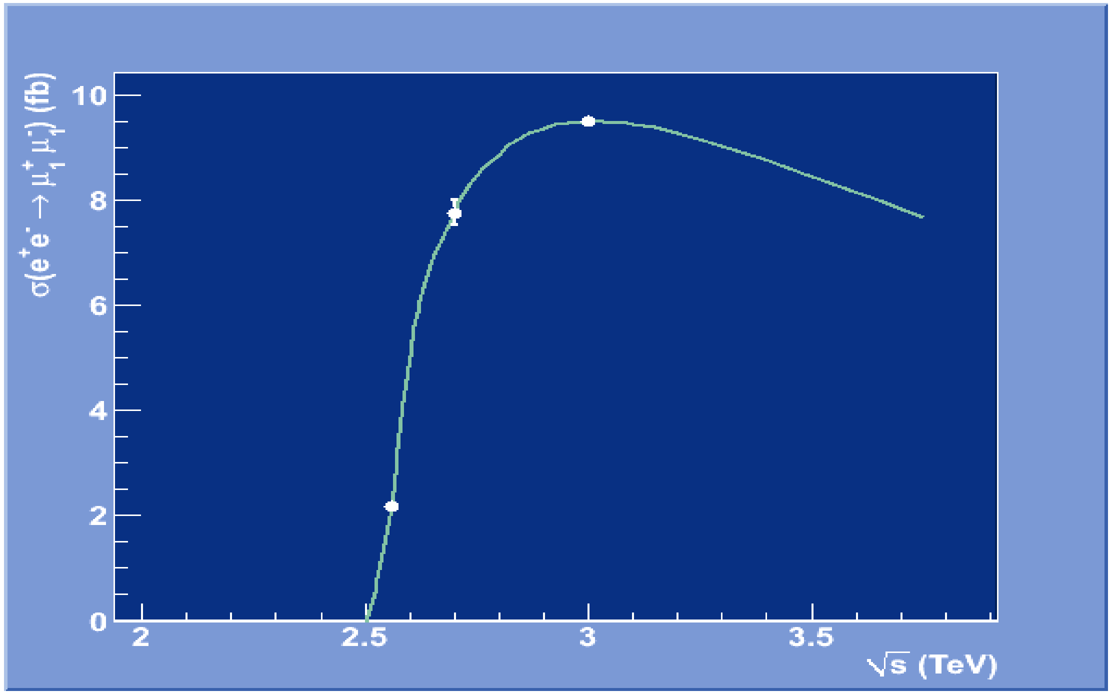
g : 1503.84

Cross sections computed with CalcHep based on model provided by KC Kong

Events generated with CompHep 4.4.0+PYTHIA 6.125

Efficiency and S/B based on analysis of fully generated and reconstructed events (MOKKA+MARLIN) with CLIC-adapted ILD detector

Energy	L (ab^{-1})	P	Comments
3.0	0.5	-	Determine kinematical endpoints
2.7	0.3	-	Scan μ_1 and other KK excitations
2.56	0.7	-	Scan μ_1 and other KK excitations



Global Fit to 1/R =
(1249.9 ± 0.51) GeV

Threshold scans are specific feature of operation of e+e- collider and provide with essential mass, width and quantum number information in study of new spectroscopy;

Percent to permil mass accuracy can be obtained at CLIC by taking ~1/3 of the total luminosity off the maximum energy in a realistic scenario (but need to quantify effects of uncertainties on luminosity spectrum and beam energy);

Use polarisation to enhance signal / suppress backgrounds (scans) and as analyser (3 TeV) (but need to accurately determine effective polarisation in collisions and to estimate/control depolarisation effects at IP).