selectron production in electron photon collisions

“a first look at 1 TeV”

Linear Collider Workshop

Albert De Roeck, Alexander Oh, Thorsten Wengler

CERN

2.9.2004, Durham

V0.1

Motivation

- Assumption:
  - the neutralino and chargino have been discovered and mass parameters and couplings have been determined at the LHC or NLC.
- In the MSSM the gaugino masses provide a first insight into the nature of the SUSY Model.
- The sfermion masses provide additional information on the SUSY model as they involve additional soft SUSY breaking parameters. They are essential to fully understand the SUSY breaking mechanism.

Motivation

- The mass reach for the selectron is limited to about half $\sqrt{s_{ee}}$ in a LC.
- The accessible mass range in photon-electron collisions with back-scattered photons from an optimized laser beam is about 80% $\sqrt{s_{ee}}$
- Photon e- collisions become interesting if the selectron mass lies inbetween
  $0.5\ \sqrt{s_{ee}} < m < 0.8\ \sqrt{s_{ee}}$

Measurement of the selectron mass

- Endpoint measurements of the energy spectrum.
- The ratio of the cross sections for the two photon polarisations provides a direct measurement of the selectron mass (with the knowledge of the neutralino mass).

V.Barger, T.Han and J.Kelly
hep-ph/9709366

MC Sample Generation

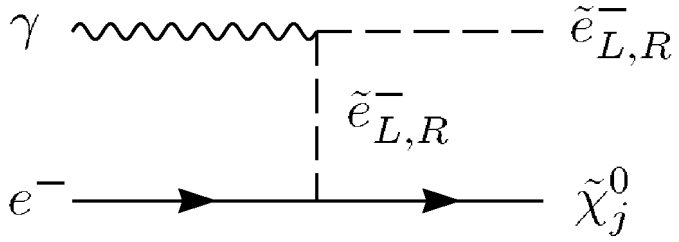
- Sherpa Version 1.04 with ISASUSY
  - mSUGRA
  - M_0 = 500. (700.) GeV
  - $M_{1/2}$ = 300. GeV
  - A_0 = 0.
  - tan(β) = 20
  - sign(μ) = +1

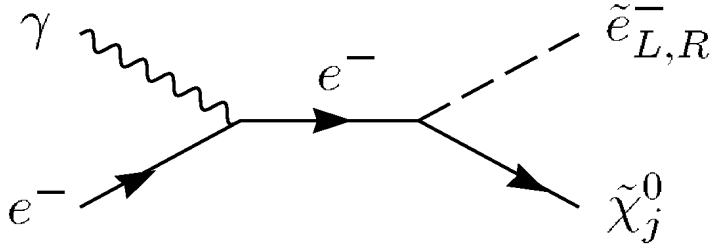
    => mass(selectron$_R$) = 513 (709) GeV

- Two sample sets with mass(selectron$_R$) = 513 GeV and 709 GeV for positive and negative photon polarisation.

Signal Production Process

- Photon produced by backscattered laser light
- s-, t-channel production
- selectron$_R$ -> e- + neutralino (100%)

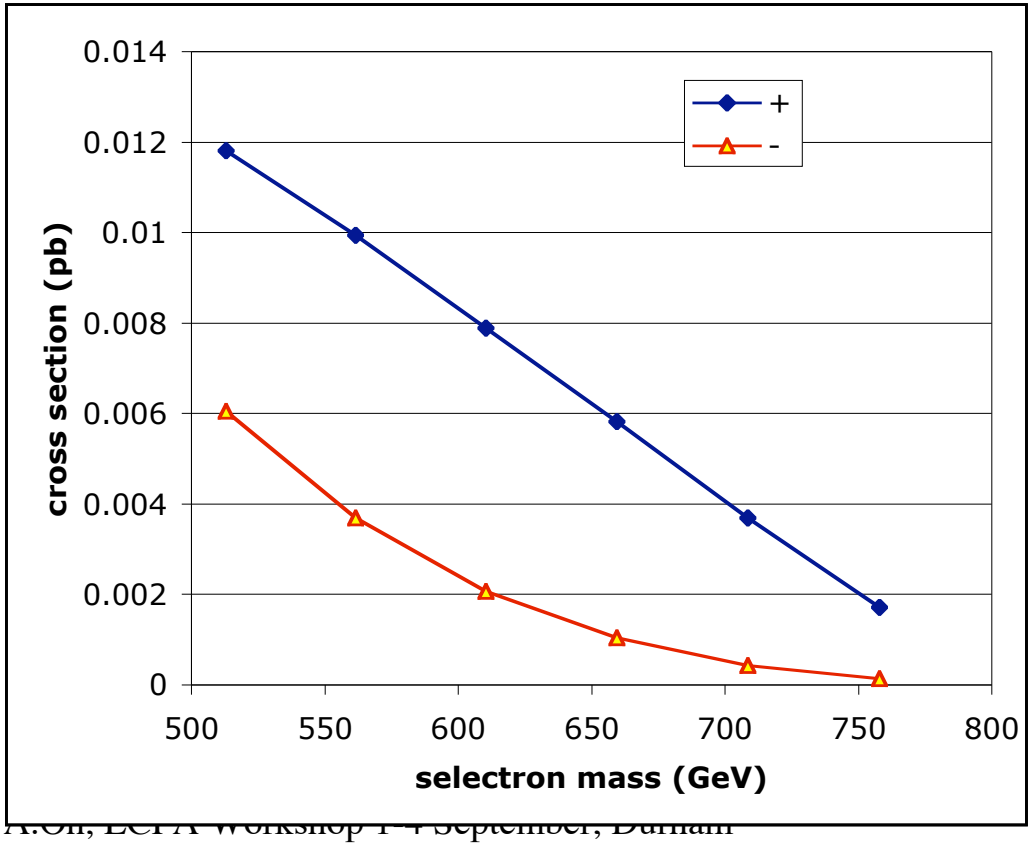




taken from
V.Barger, T.Han and J.Kelly
hep-ph/9709366

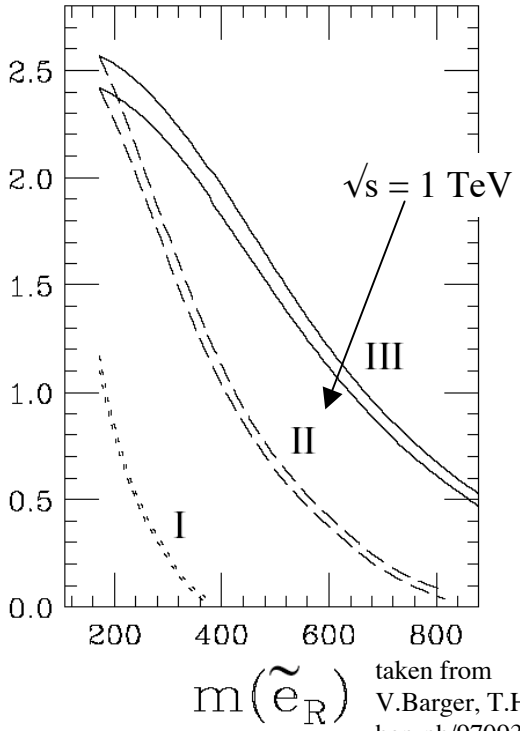
Signal Production Process

- Production Cross section
  - $|\cos(th)| < 0.9$
  - $E_t > 1$ GeV



Cross-section ratio

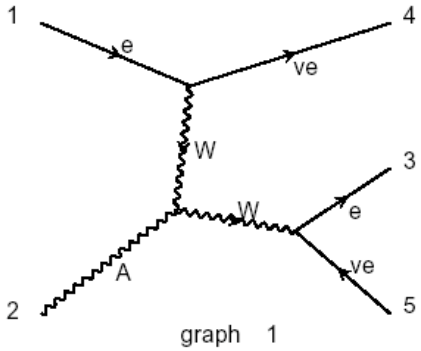
$$\frac{\sigma(e_+\gamma_- \to \tilde{e}_R\tilde{\chi}_1^0)}{\sigma(e_+\gamma_+ \to \tilde{e}_R\tilde{\chi}_1^0)}$$



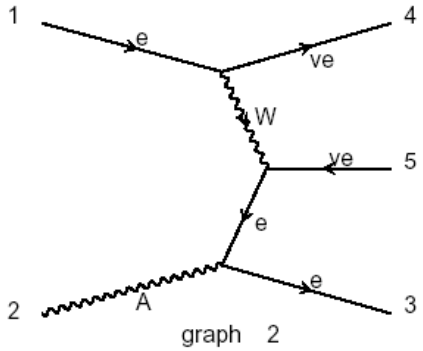
taken from
V.Barger, T.Han and J.Kelly
hep-ph/9709366

Background Processes

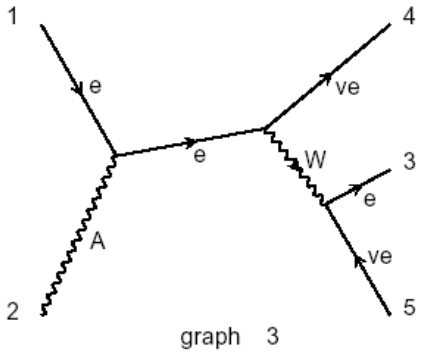
- Signature: e- + missing Energy



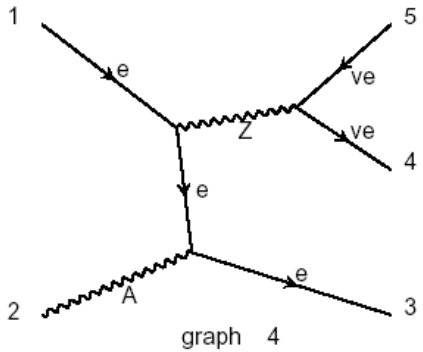
graph 1



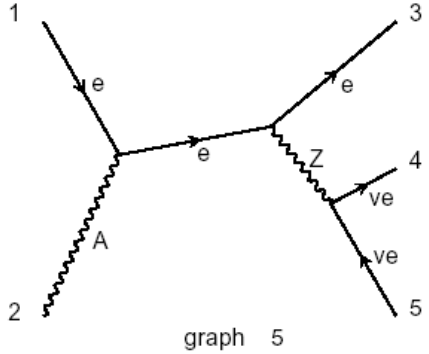
graph 2



graph 3



graph 4



graph 5

Background Processes

- Dominant contribution from single vector boson production.
- Suppression of W production for polarised electron beam.

$e\gamma \to X$	$\sqrt{s}_{e\gamma} = 0.5$	1.0
$X = W^-\nu_e$	$\sigma = 4.2 \times 10^4$ fb	$4.8{\times}10^4$
$e^-\nu\bar{\nu}$	$6.5{\times}10^3$	$6.3{\times}10^3$
$W^-Z\nu_e$	210	720
$Ze^-\nu\bar{\nu}$	23	79
$W^-W^+e^-\nu\bar{\nu}$	0.62	8.6
$ZZe^-\nu\bar{\nu}$	$3\ {\times}10^{-2}$	0.7

taken from V.Barger, T.Han and J.Kelly hep-ph/9709366

Machine

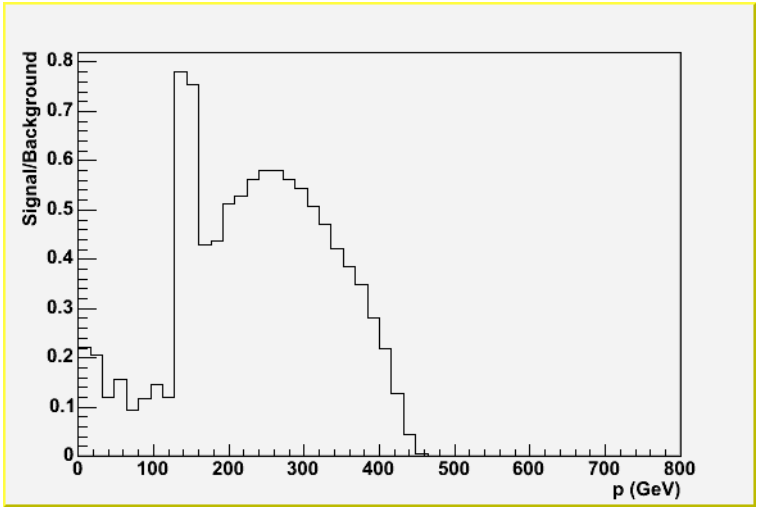
- $\sqrt{s_{ee}}$ = 1 TeV
- Photon produced by backscattered laser light.
- Polarisation of the photon P_γ= +1 , -1
- Electron beam polarisation set to P_e = +0.85

Detector Simulation

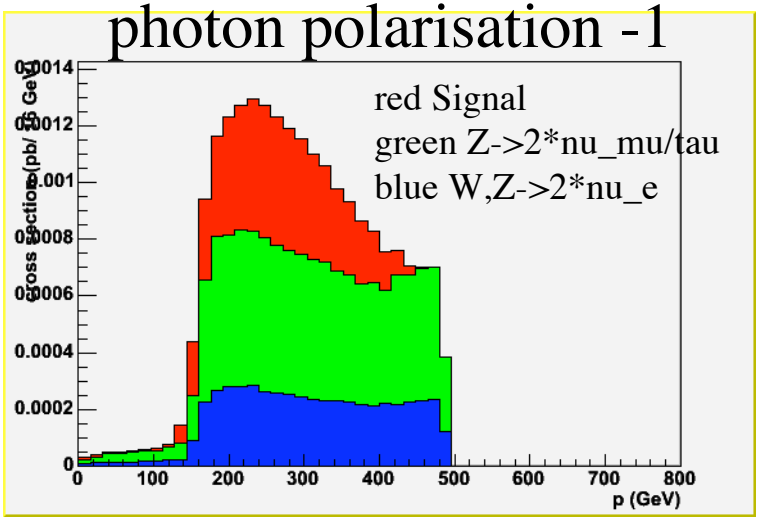
- Standard TESLA detector as implemented in SIMDET.
- SIMDET Version 4 with standard settings.
- “Selection criterium”:
  - one identified electron track

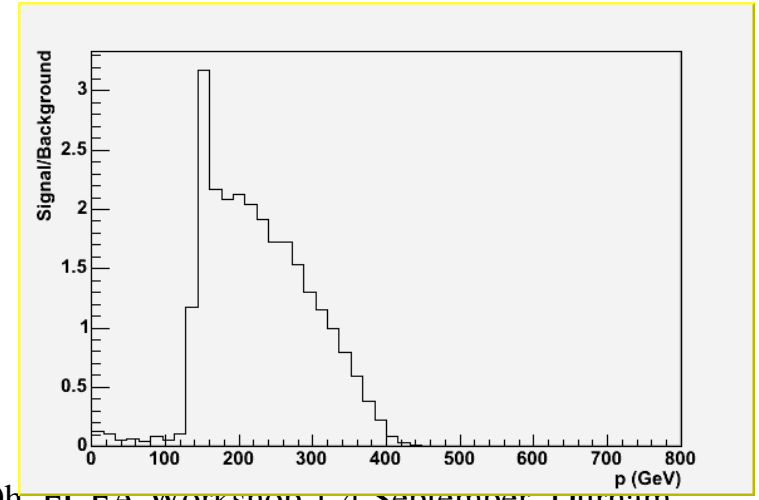
First Results

- Momentum, M_0 = 500 GeV

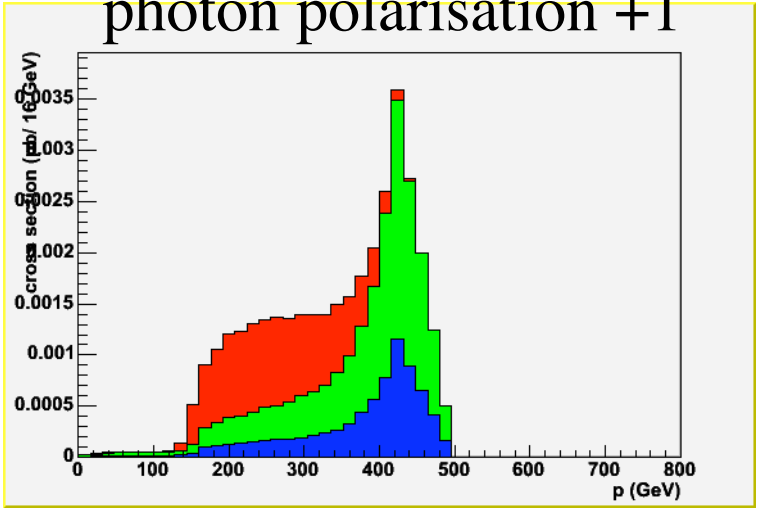


photon polarisation -1



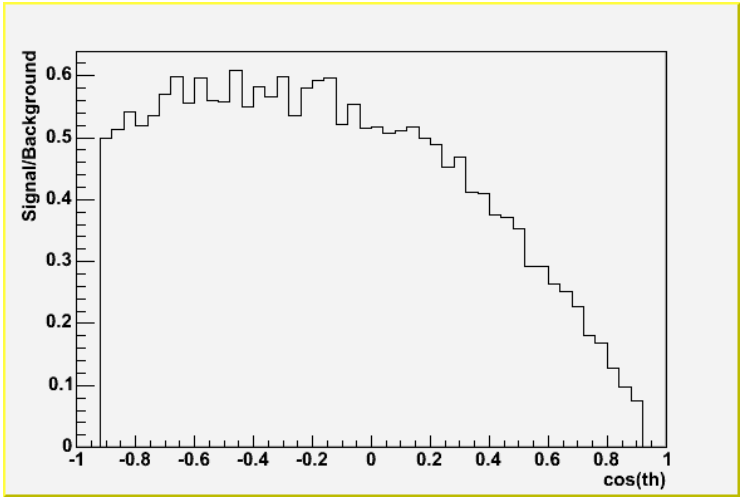


photon polarisation +1

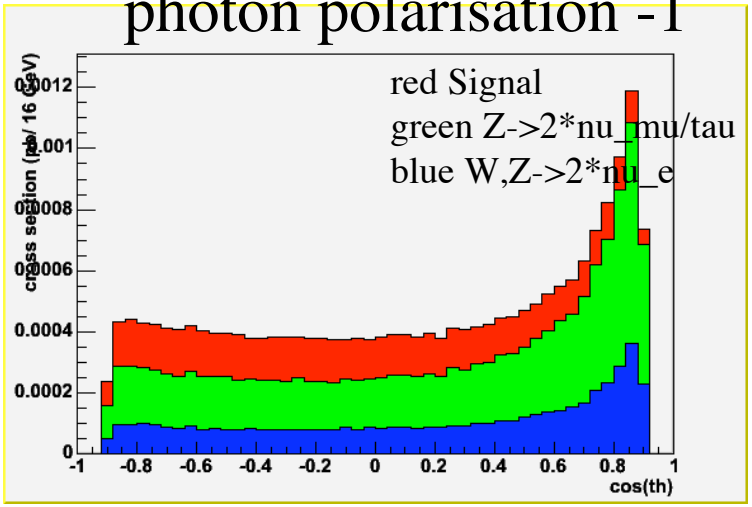


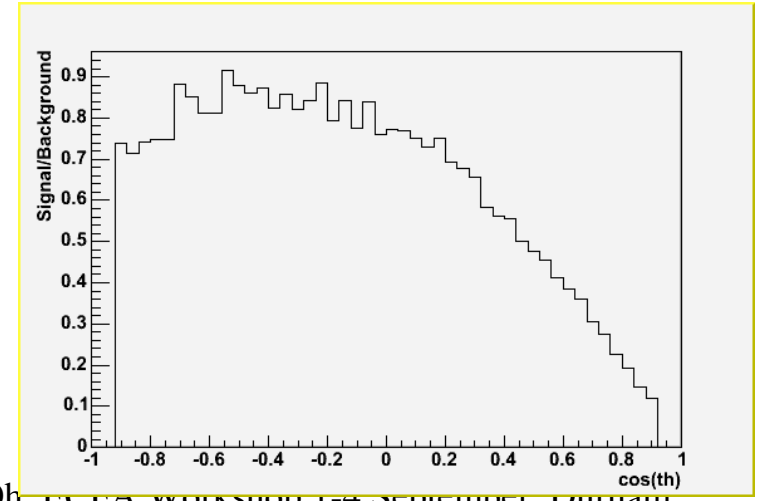
First Results

- cos(th), M_0 = 500 GeV

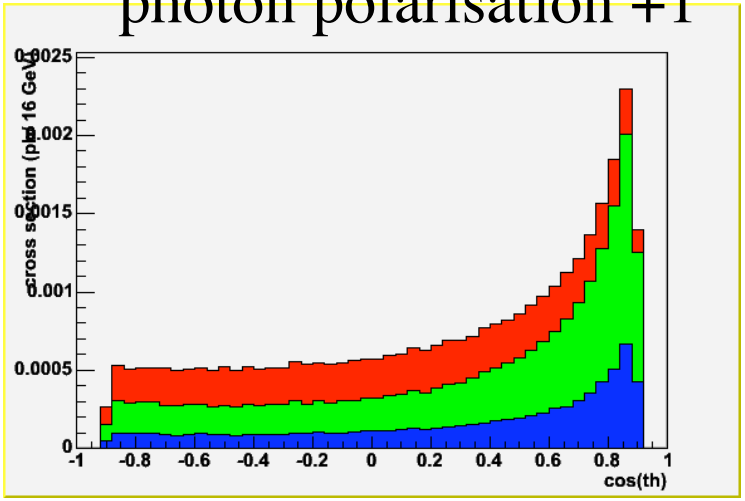


photon polarisation -1



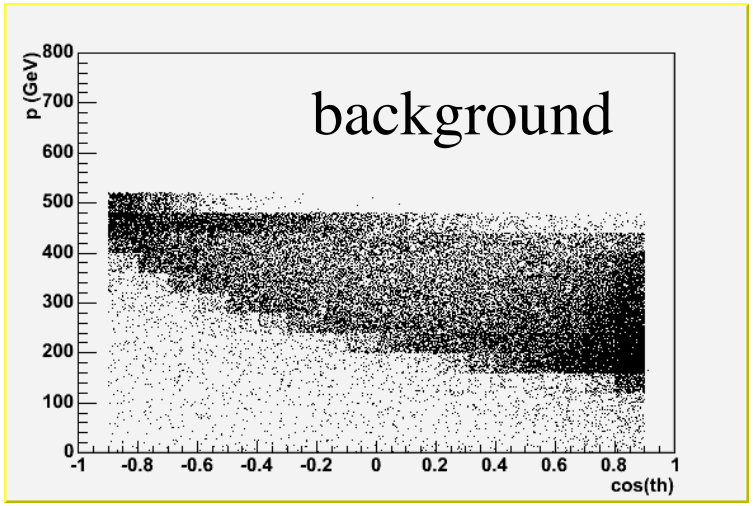


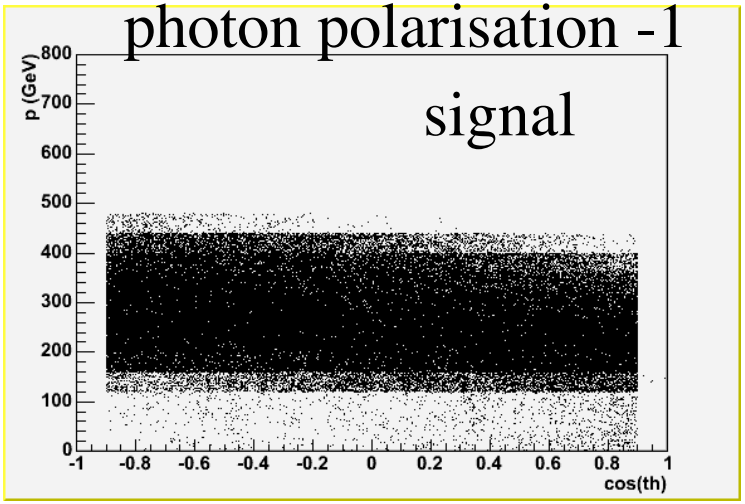
photon polarisation +1

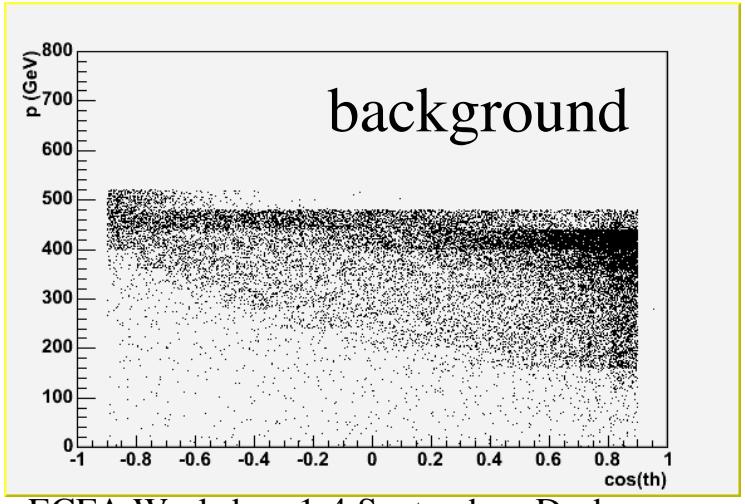


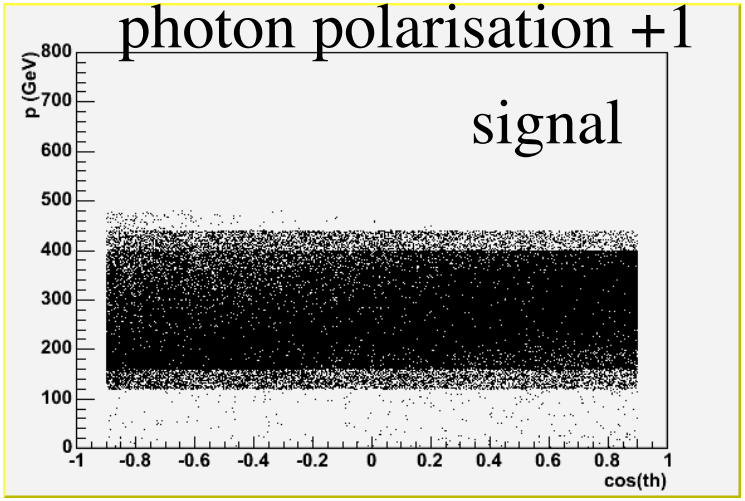
First Results

- p vs cos(th), M_0 = 500 GeV





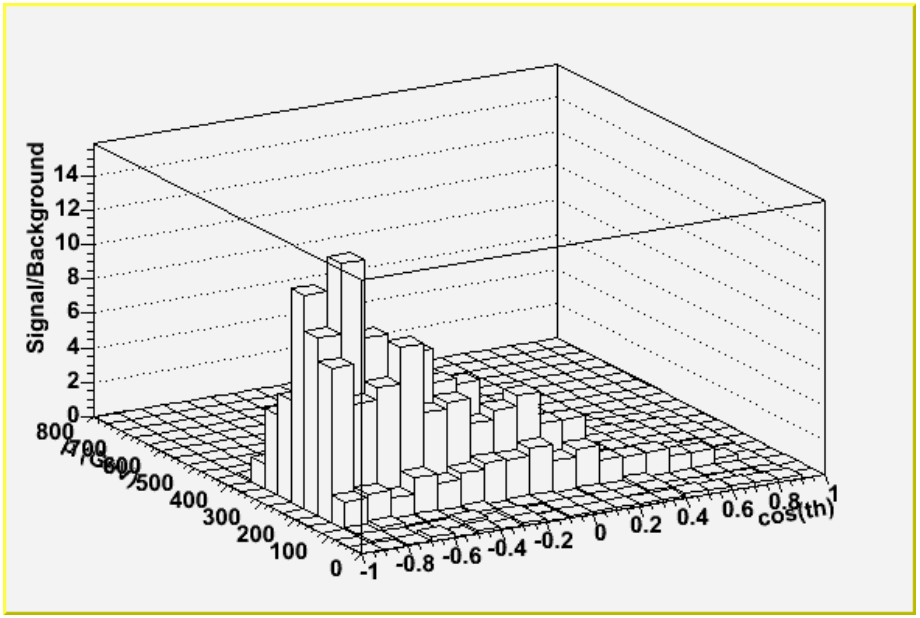




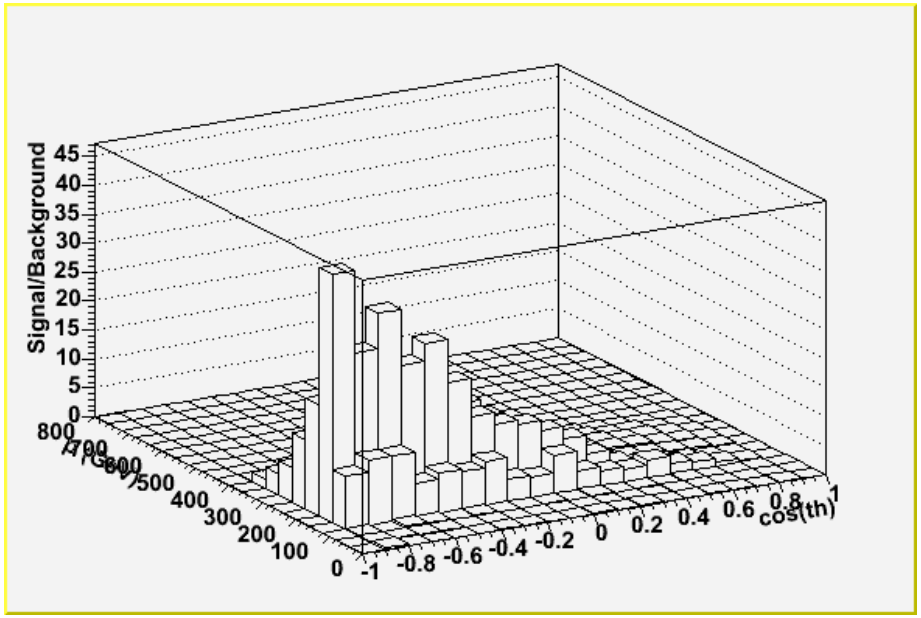
First Results

- p vs cos(th), M_0 = 500 GeV

photon polarisation -1

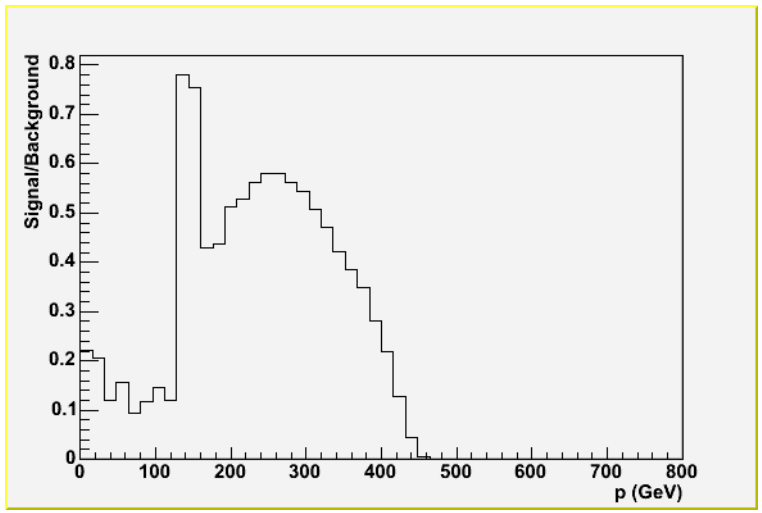


photon polarisation +1

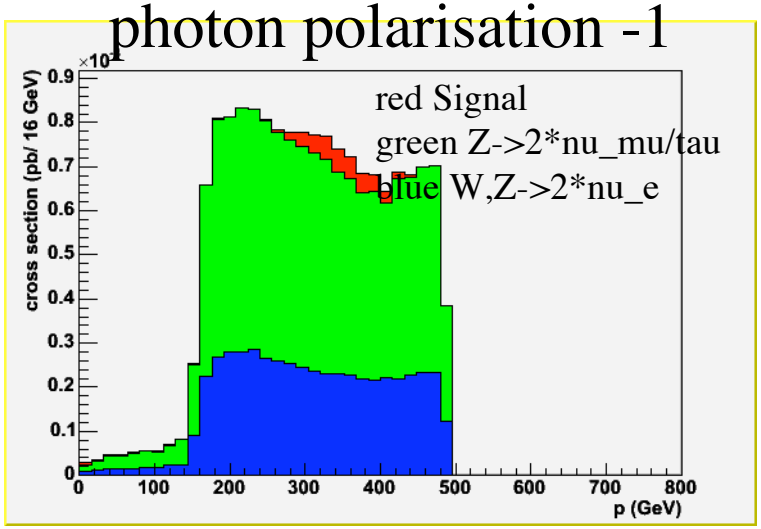


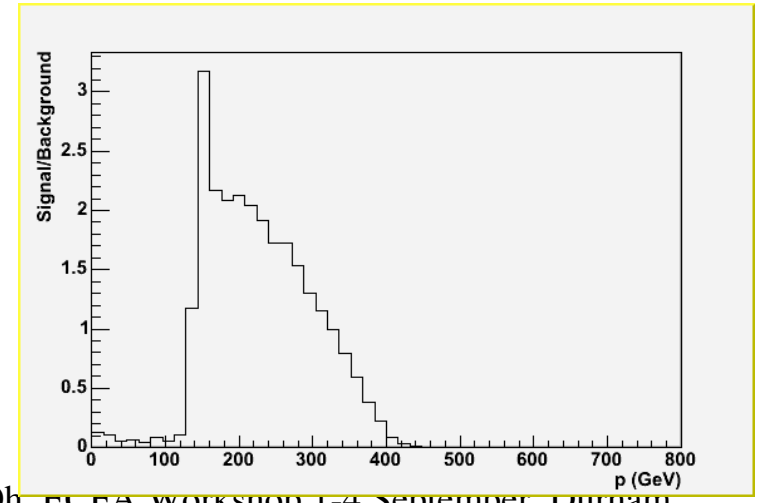
First Results

- Momentum, M_0 = 700 GeV

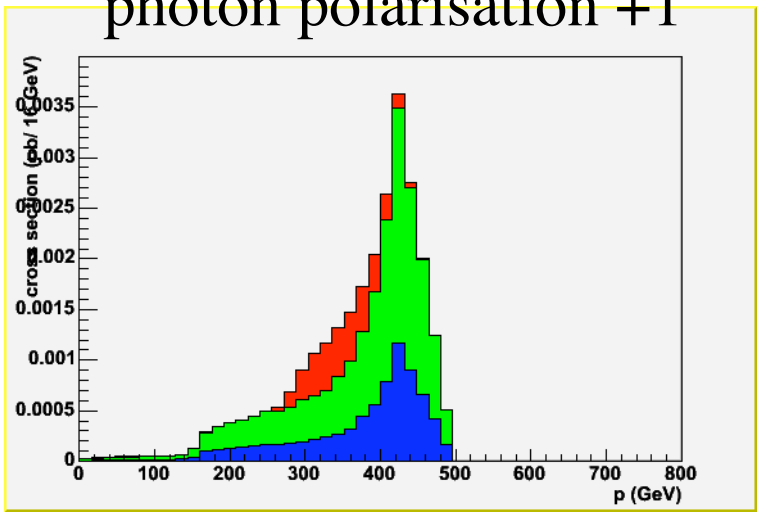


photon polarisation -1



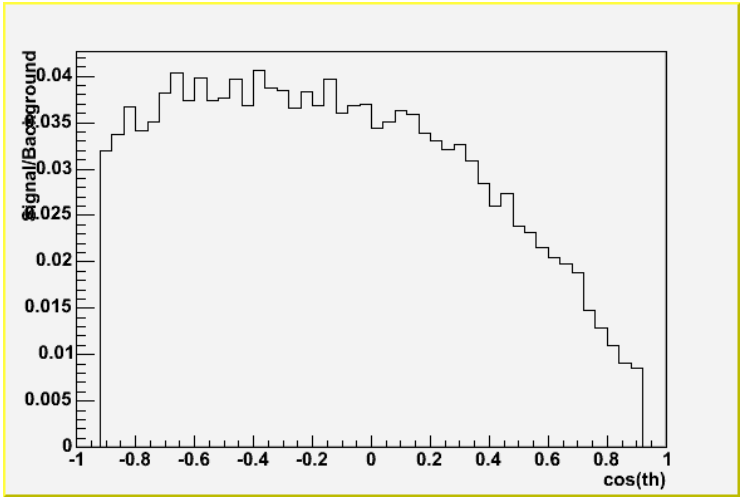


photon polarisation +1

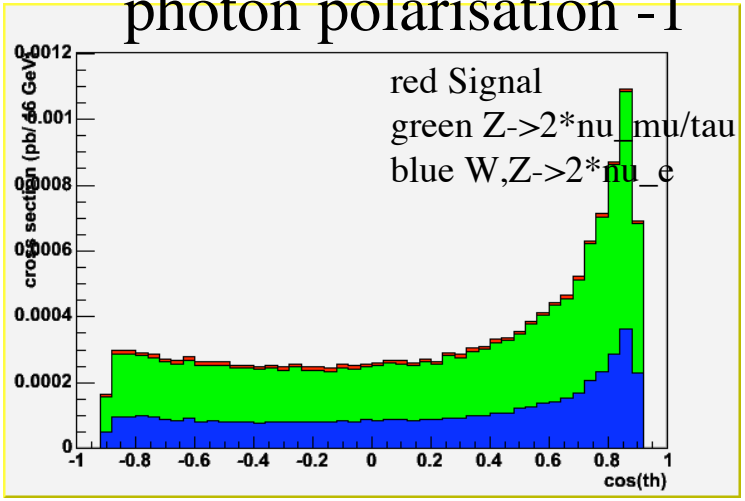


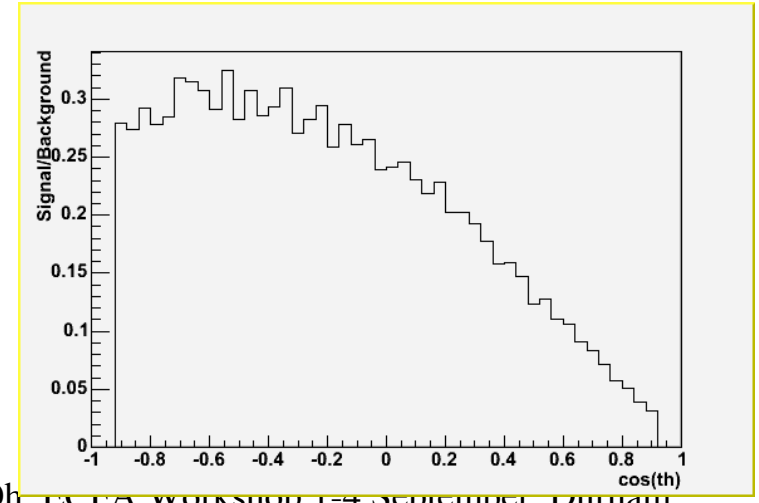
First Results

- cos(th), M_0 = 700 GeV

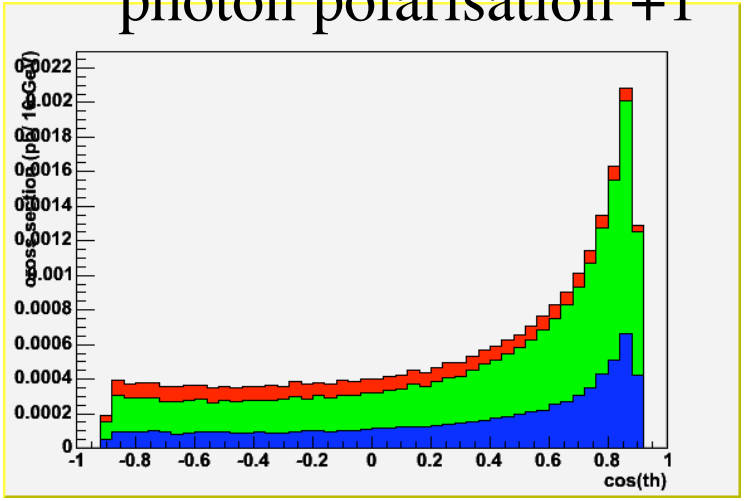


photon polarisation -1



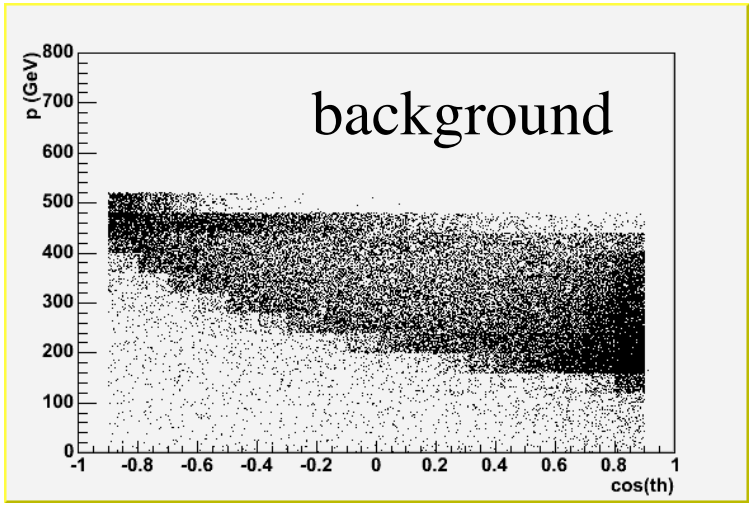


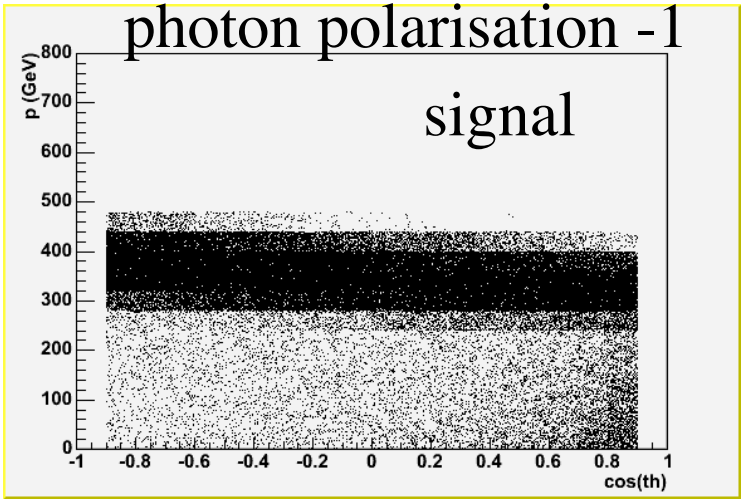
photon polarisation +1

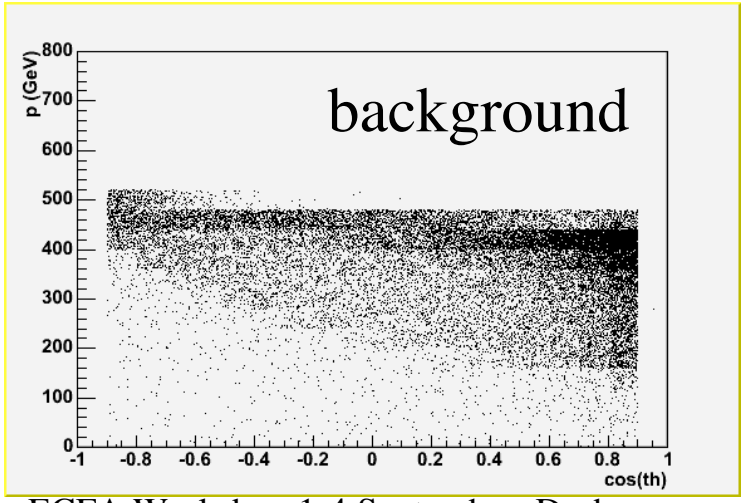


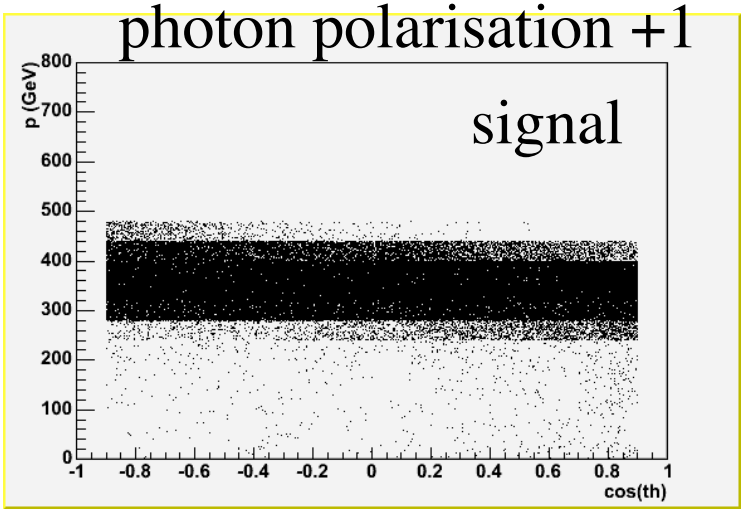
First Results

- p vs cos(th), M_0 = 700 GeV





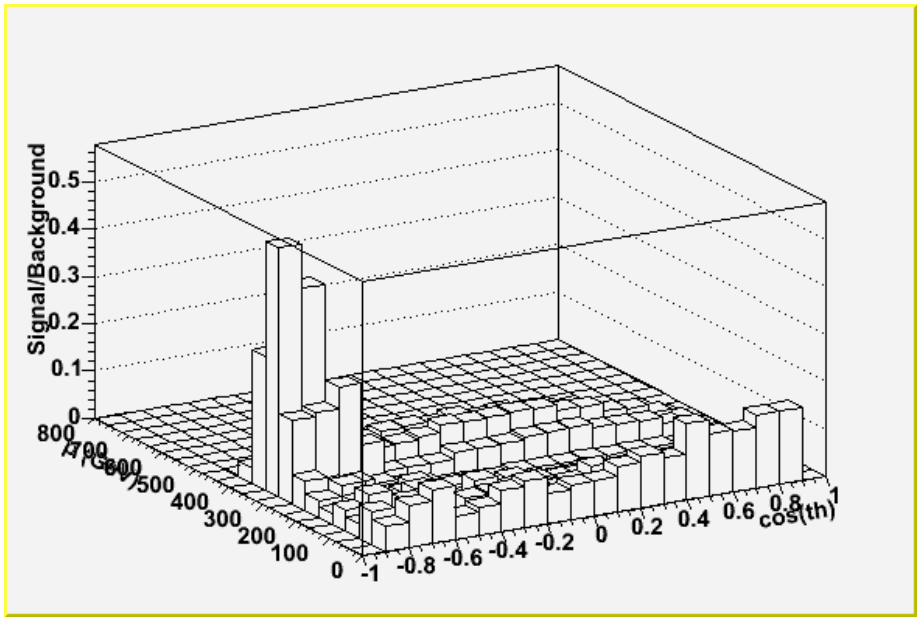




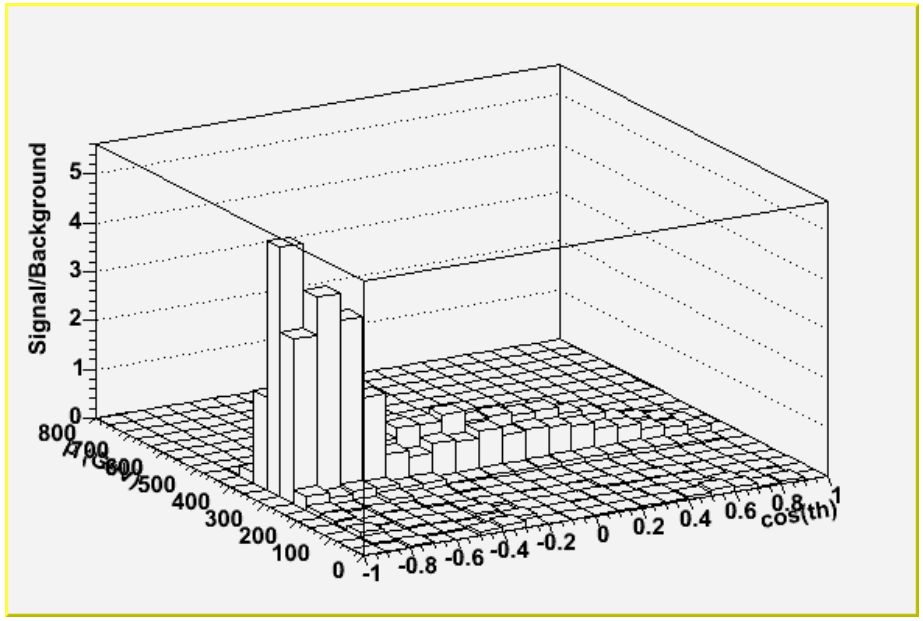
First Results

- p vs cos(th), M_0 = 700 GeV

photon polarisation -1

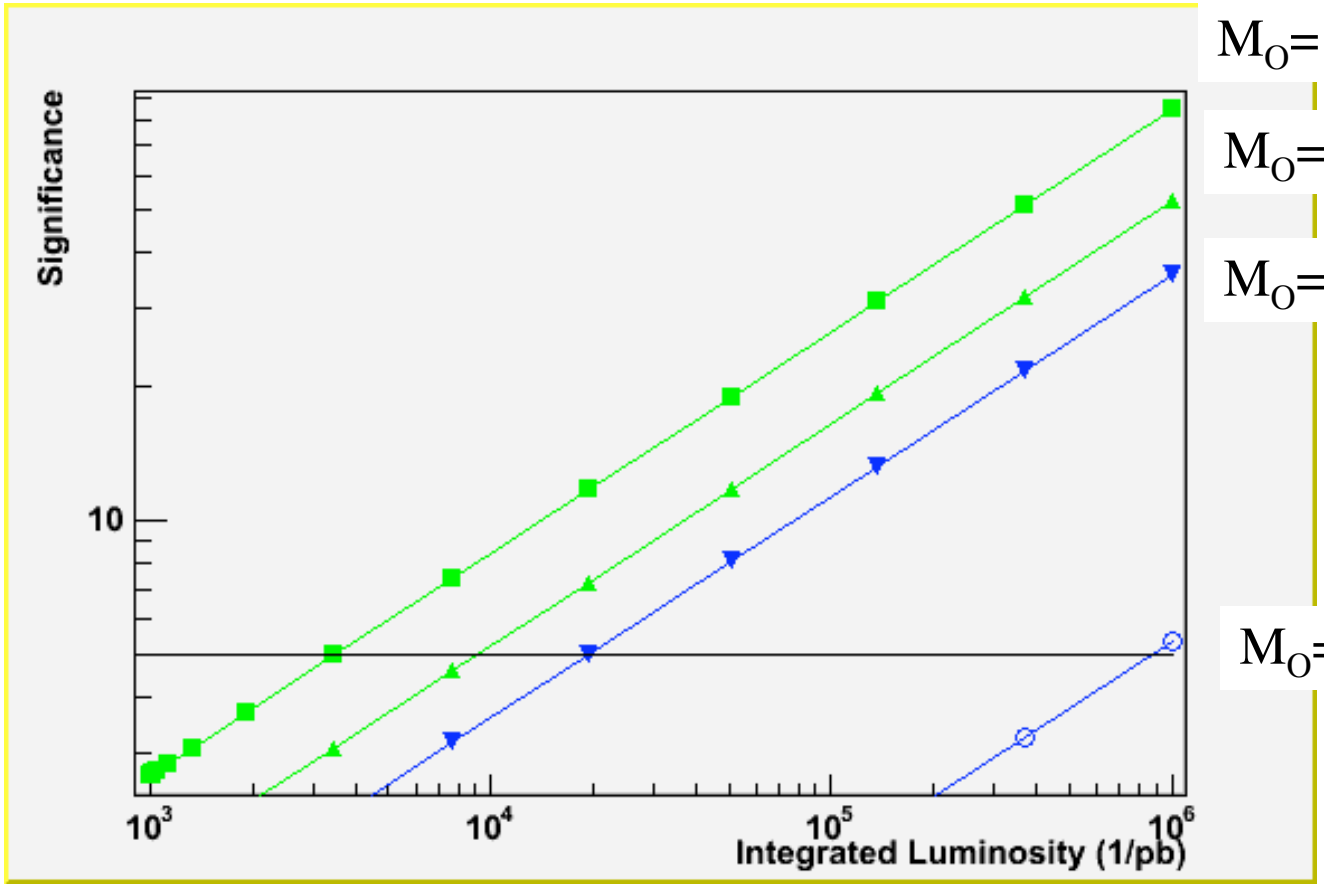


photon polarisation +1



First Results

- Optimistic "back-of-the-envelope" estimate for the significance of the cross section measurement as a funtion of integrated luminosity, ignoring systematic uncertainties:



Summary & Outlook

- With an LC operating in the e- γ collision mode the selectron mass is accessible beyond the kinematic pair production limit.
- A first look at $\sqrt{s_{ee}}$ =1 TeV shows promising signals for selectron masses up to M_0=700 GeV.
- Next steps:
  - Try a log-likelihood fit to extract cross section.
  - Estimate precision of mass measurement.
  - Have a closer look at additional (non-resonant and SUSY) background sources.

Acknowledgements

- SHERPA TEAM
  - Tanju Gleisberg, Stefan Hoeche, Frank Krauss, Andreas Schaelicke, Steffen Schumann, Jan Winter