

# Process simulation in $e\gamma$ collisions with SHERPA

*Simulation for High Energy Reactions of Particles*

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# Introducing SHERPA

- General event generation framework for  $e^+e^-$ ,  $e\gamma$ ,  $\gamma\gamma$ ,  $ep$ , and  $pp$  collisions.
- Modular, written in C++
- First modules : AMEGIC++, APACIC++  
Matrix element generator and Parton shower  
(SHERPA provides unique interface of both)
- SHERPA provides also :
  - Event generation basics :  
Flavours, Particles, Event record, Analysis tools
  - Interface to HepEVT-common block
  - Interface to PDF's
  - Interface to Lund string fragmentation routines of Pythia.



# Example : $e\gamma \rightarrow \tilde{e}\chi_1^{(0)}$

Interesting process, if  $\tilde{e}$  cannot be pair-produced

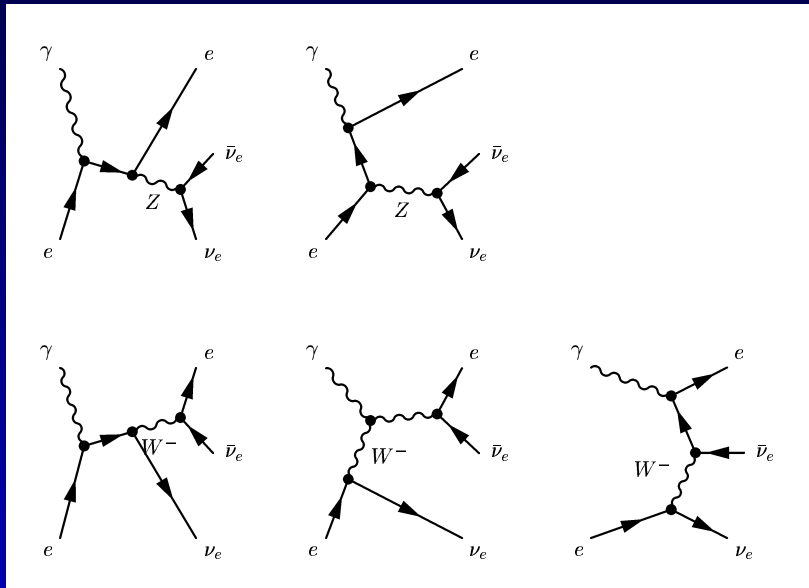
- Signals :  $e^-\gamma \rightarrow \tilde{e}_{L,R}\chi_1^{(0)} \rightarrow e^-\chi^{(0)}\chi^{(0)}$
- Signature : One electron, missing energy/ $p_\perp$
- Backgrounds :  $e^-\gamma \rightarrow eZ \rightarrow e^-\nu\bar{\nu}$ ,  
 $e^-\gamma \rightarrow \nu_e W^- \rightarrow e^-\nu_e\bar{\nu}_e$
- Ignored here : DIS on the photon, Final states with 4  $\nu/\chi^{(0)}$  :
  - $e^-\gamma \rightarrow \{eZ, \nu_e WZ\} \rightarrow e^-\nu\bar{\nu}\nu\bar{\nu}$
  - $e^-\gamma \rightarrow \tilde{\nu}_1 + \chi_1^- \rightarrow \nu_e\chi^{(0)} + e^-\chi^{(0)}\chi^{(0)}$ ,  
 $e^-\gamma \rightarrow \tilde{e}_{L,R} + \chi_2^{(0)} \rightarrow e^-\chi^{(0)}\chi^{(0)} + \nu\bar{\nu}$

(Will be covered in full analysis).

# Feynman diagrams

Standard Model:

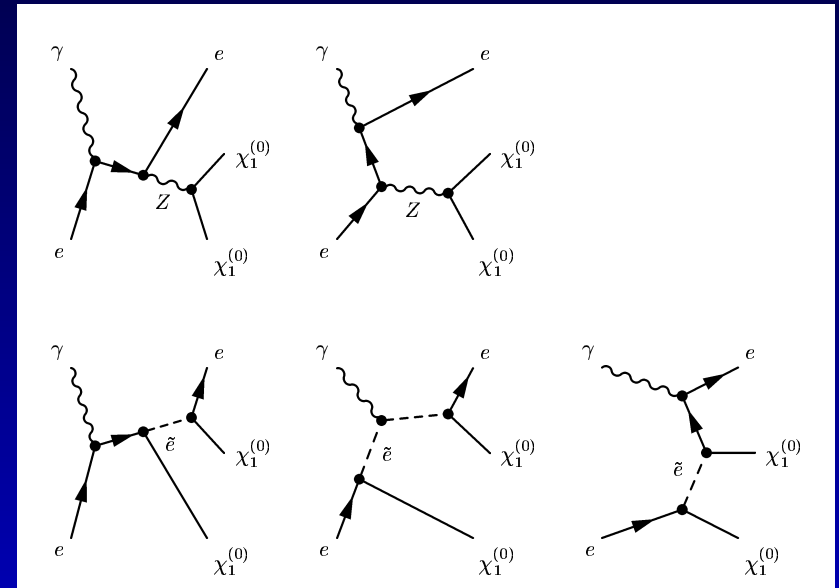
$$e^- \gamma \rightarrow e^- \nu \bar{\nu}$$



5 diagrams

MSSM:

$$e^- \gamma \rightarrow e^- \chi^{(0)} \chi^{(0)}$$



14 diagrams :  $\tilde{e}_L \leftrightarrow \tilde{e}_R$ ,

$$\chi^{(0)} \leftrightarrow \chi^{(0)}.$$

# Parameters and cuts

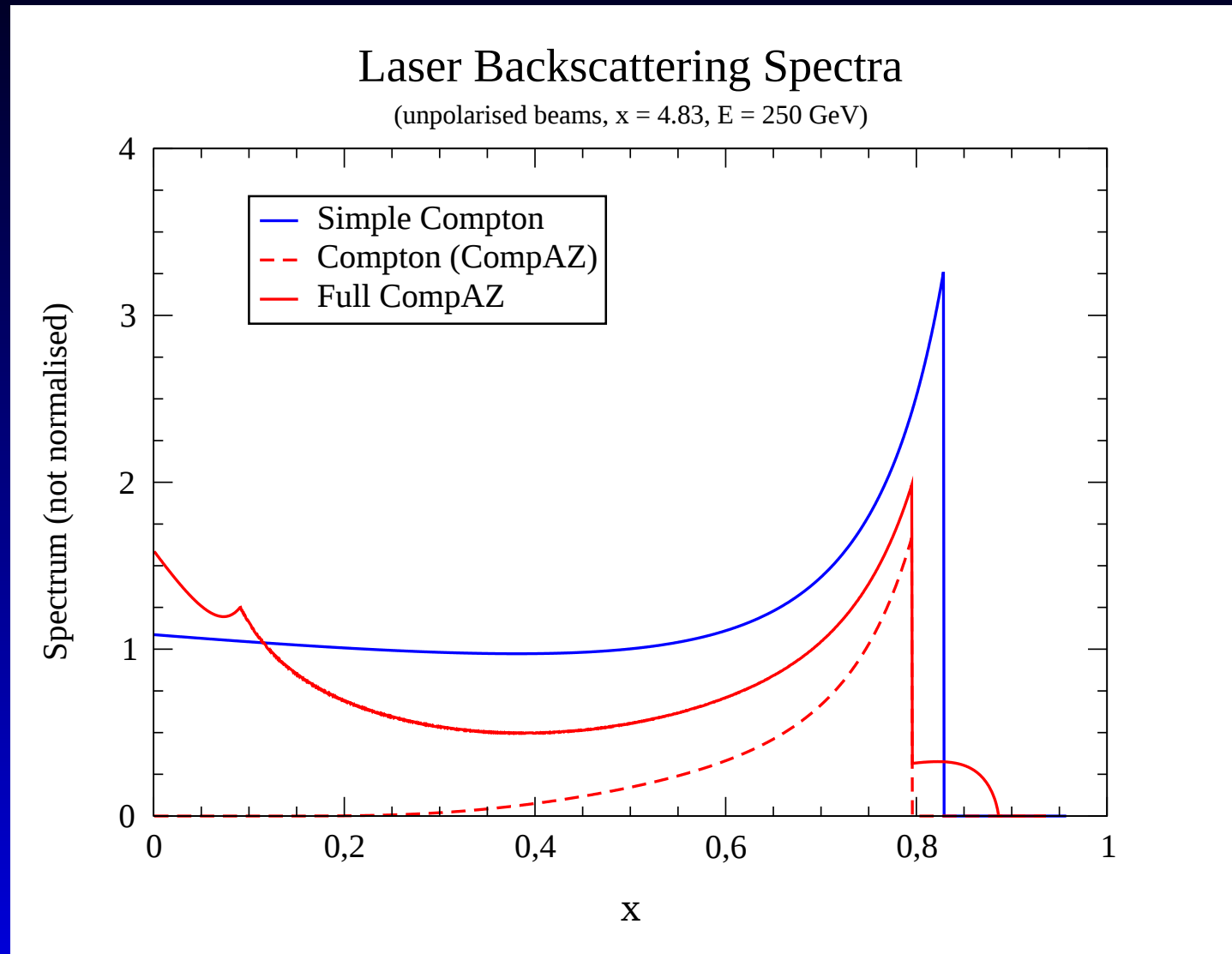
## Parameters:

- Unpolarized beams, Backscattering parameter :  $x = 4.83$ ,  $\sqrt{s} = 0.5$  TeV,  $1/\alpha = 128$ .
- $M_W = 80.22$  GeV,  $M_Z = 91.1888$  GeV,  $\Gamma_W = 2.12$  GeV,  $\Gamma_Z = 2.49$  GeV
- SPS1a with Isajet, v.7.46:  
$$\begin{array}{llll} M_0 & = & 100 \text{ GeV}, & M_{1/2} = 250 \text{ GeV}, & A_0 & = & -100 \text{ GeV}, \\ \tan \beta & = & 10, & \text{sign}[\mu] & = & 1, & M_t & = & 175 \text{ GeV} \end{array}$$
- $$\begin{array}{llll} M_{\chi_1} & = & 96.12 \text{ GeV}, & M_{\tilde{e}_L} = 202.14 \text{ GeV}, & M_{\tilde{e}_R} & = & 143.01 \text{ GeV}, \\ & & & \Gamma_{\tilde{e}_L} & = & 0.114 \text{ GeV}, & \Gamma_{\tilde{e}_R} & = & 0.202 \text{ GeV} \end{array}$$

## Cuts:

- $p_\perp > 5$  GeV for  $e^-$ ,  $W^-$ ,  $\tilde{e}$

# Beam spectrum



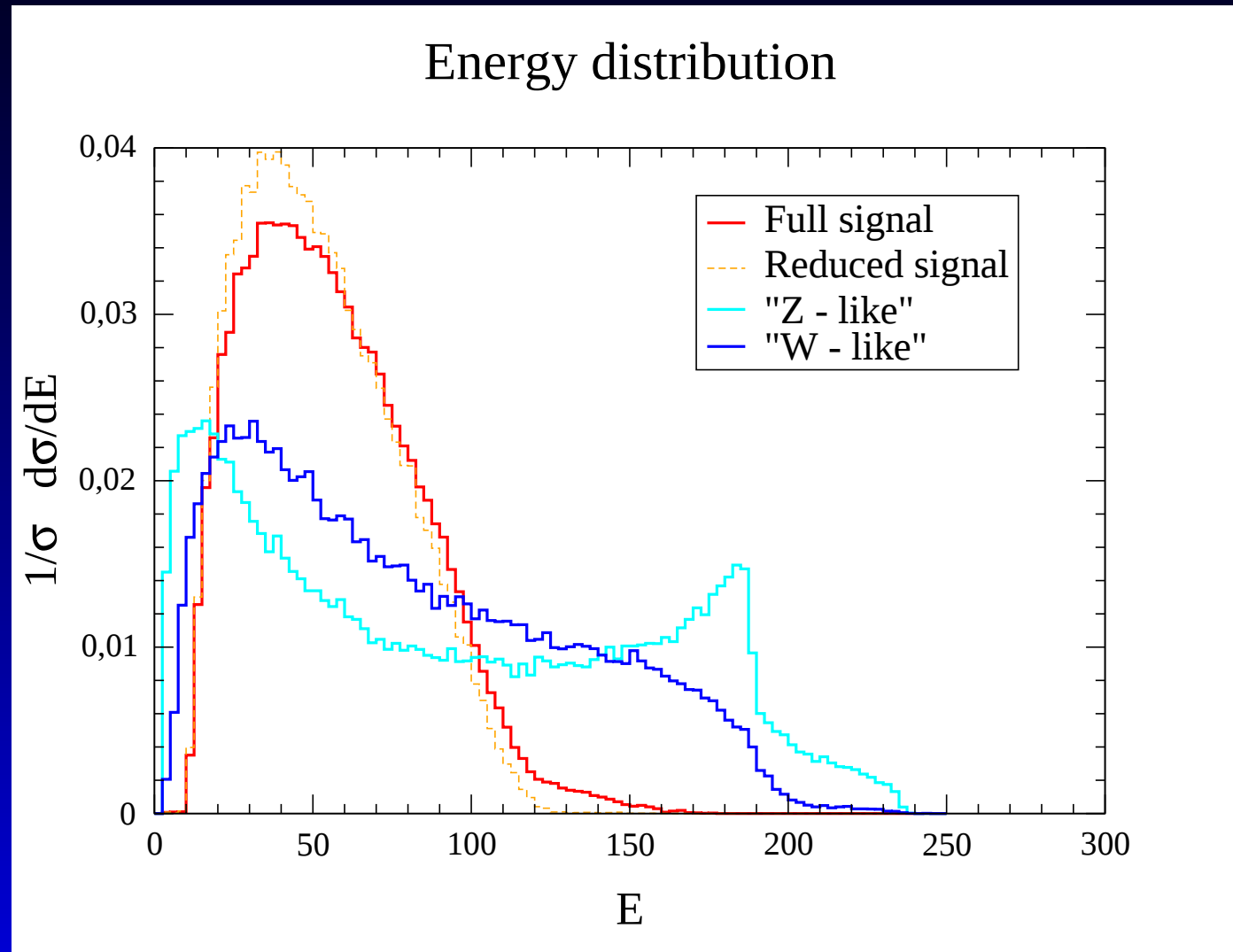
# Cross sections ( $2 \rightarrow 2$ processes)

| F.S.                       | Compton  | + ISR    | CompAZ  | + ISR   |
|----------------------------|----------|----------|---------|---------|
| $eZ$                       | 4.26 pb  | 4.34 pb  | 3.07 pb | 3.11 pb |
| $\nu_e W$                  | 11.56 pb | 11.31 pb | 6.71 pb | 6.66 pb |
| $\tilde{e}_R \chi_1^{(0)}$ | 155.3 fb | 151.4 fb | 90.5 fb | 88.6 fb |
| $\tilde{e}_L \chi_1^{(0)}$ | 15.38 fb | 14.71 fb | 9.08 fb | 8.70 fb |

# Cross sections ( $2 \rightarrow 3$ processes)

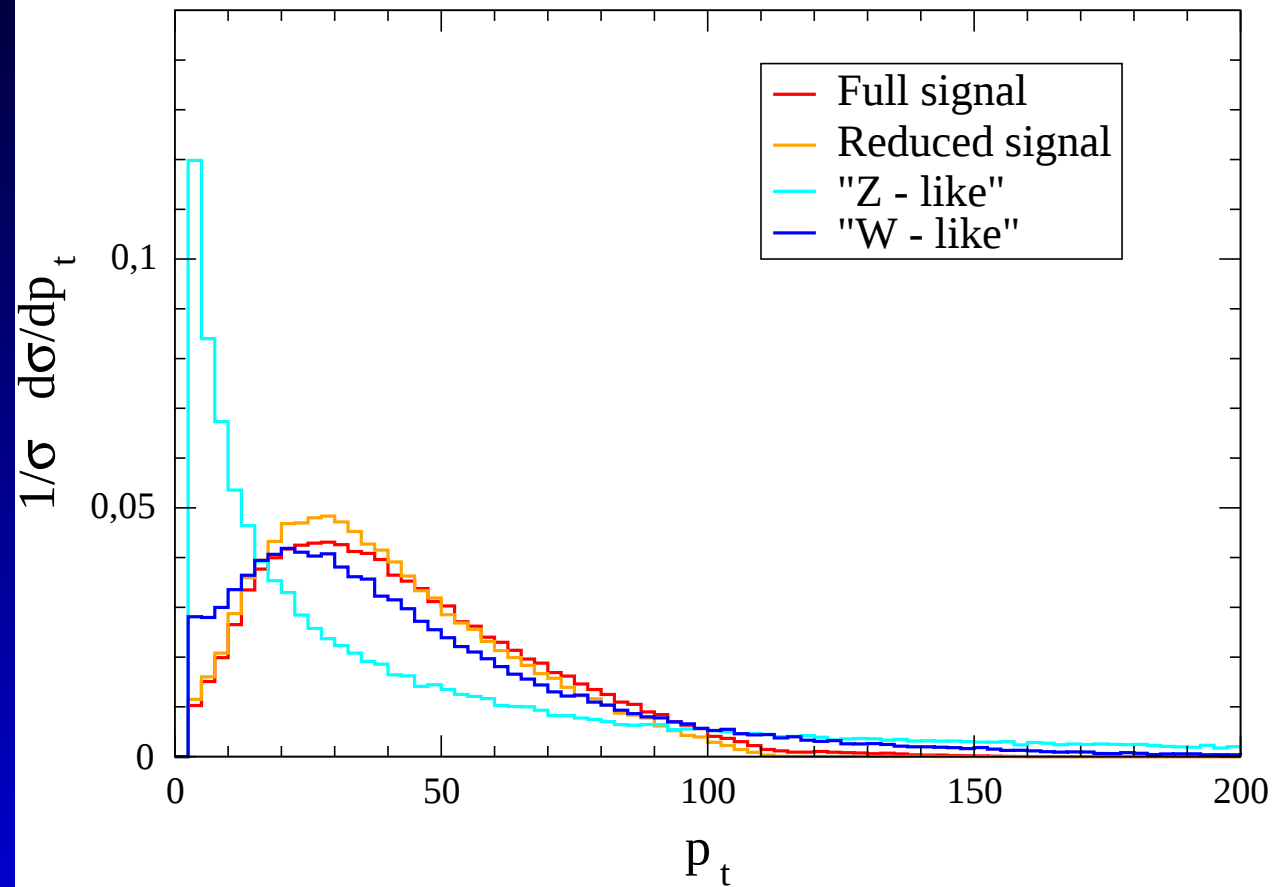
| F.S.                                              |                              | CompAZ + ISR |
|---------------------------------------------------|------------------------------|--------------|
| $e\nu_\mu\bar{\nu}_\mu + e\nu_\tau\bar{\nu}_\tau$ |                              | 0.426 pb     |
| $e\nu_e\bar{\nu}_e$                               | full                         | 2.505 pb     |
| $e\nu_e\bar{\nu}_e$                               | ( $W$ only)                  | 2.285 pb     |
| $e\chi_1^{(0)}\bar{\chi}_1^{(0)}$                 | full                         | 0.103 pb     |
| $e\chi_1^{(0)}\bar{\chi}_1^{(0)}$                 | (no $Z$ )                    | 0.103 pb     |
| $e\chi_1^{(0)}\bar{\chi}_1^{(0)}$                 | (no $Z$ , no $\tilde{e}_L$ ) | 0.093 pb     |

# Energy of the electron

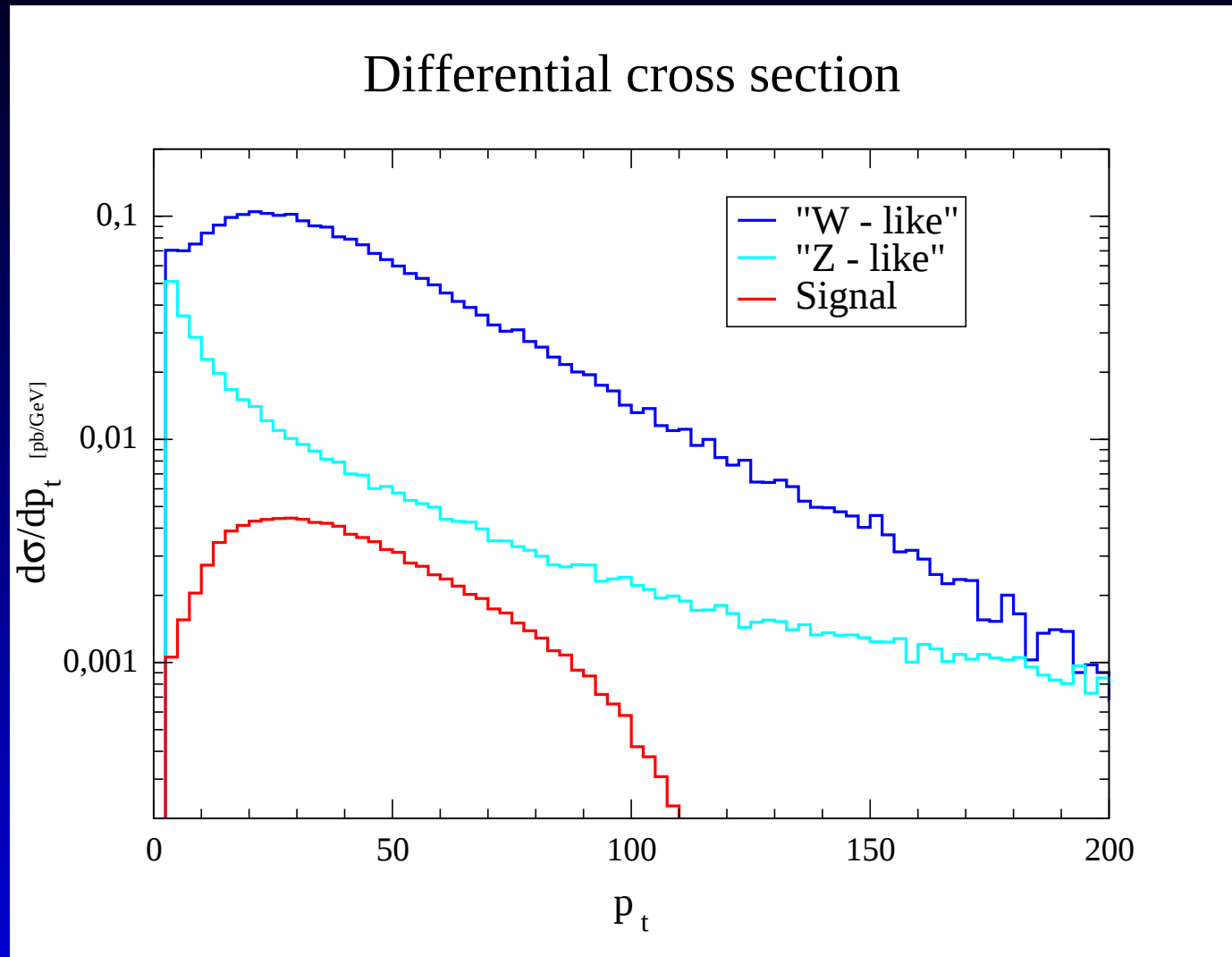


# $p_{\perp}$ of the electron

Transverse momentum distribution



# $p_{\perp}$ of the electron



# Conclusion

- First results for  $e\gamma \rightarrow \tilde{e}\chi^{(0)}$  by SHERPA  
 $\implies$  nice (but trivial) check of the framework.
- Realistic beam spectra (CompAZ) change the result for the total cross section significantly.  
Only mild dependence on ISR.
- Combination of total cross section and kinematical distribution look quite tough for the SUSY point chosen.

# The way ahead for $e\gamma \rightarrow \tilde{e}\chi^{(0)}$

- Cross check results (once more)
- Include the same for polarised beams
- Interface to detector simulation
- Add backgrounds neglected so far (5-bodies & QCD)
- More SUSY scenarios

# The way ahead for SHERPA

- Construction of the framework proceeds.
- Matrix elements up & running (AMEGIC++), very well tested and competitive (s. talk by S. Schumann)
- Interface to parton shower tested for  $e^+e^-$  collisions, expect QCD tuning with LEP-I data.
- Some special cases for parton shower await implementation.
- Interface to hadronization working.
- But still major work ahead . . . .