Study of the beam polarization at the ILC using W^+W^- production

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Motivations

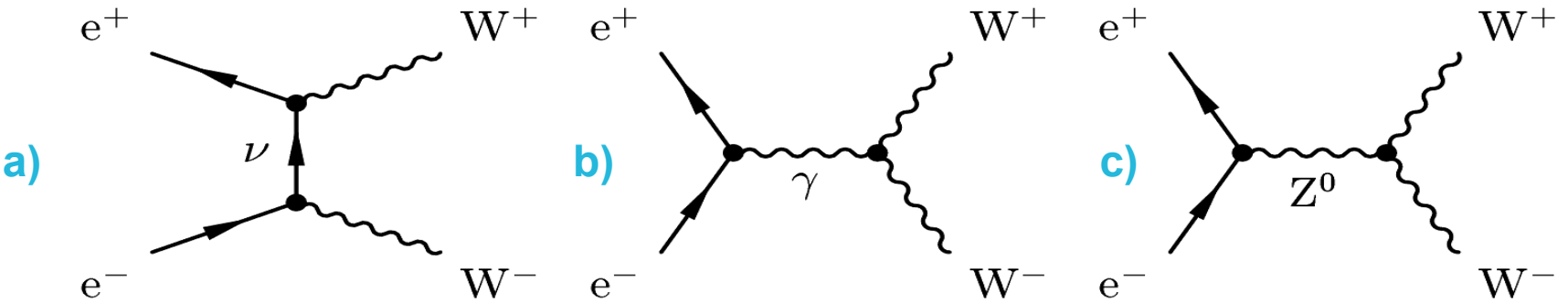
- Beam polarization is important for many physics measurements, with an aimed precision of 0.2%.

- External polarimeter can measure it on a short timescale but the polarization might change between polarimeter and I.P.. Calibration by means of a physics process is needed.

- W^+W^- production is sensitive to polarization and has an high cross section: fits in this purpose.

- Further importance for detector optimization:
  - PFA;
  - Lepton-ID;
  - Invariant mass resolution.

W^+W^- production and polarization - 1

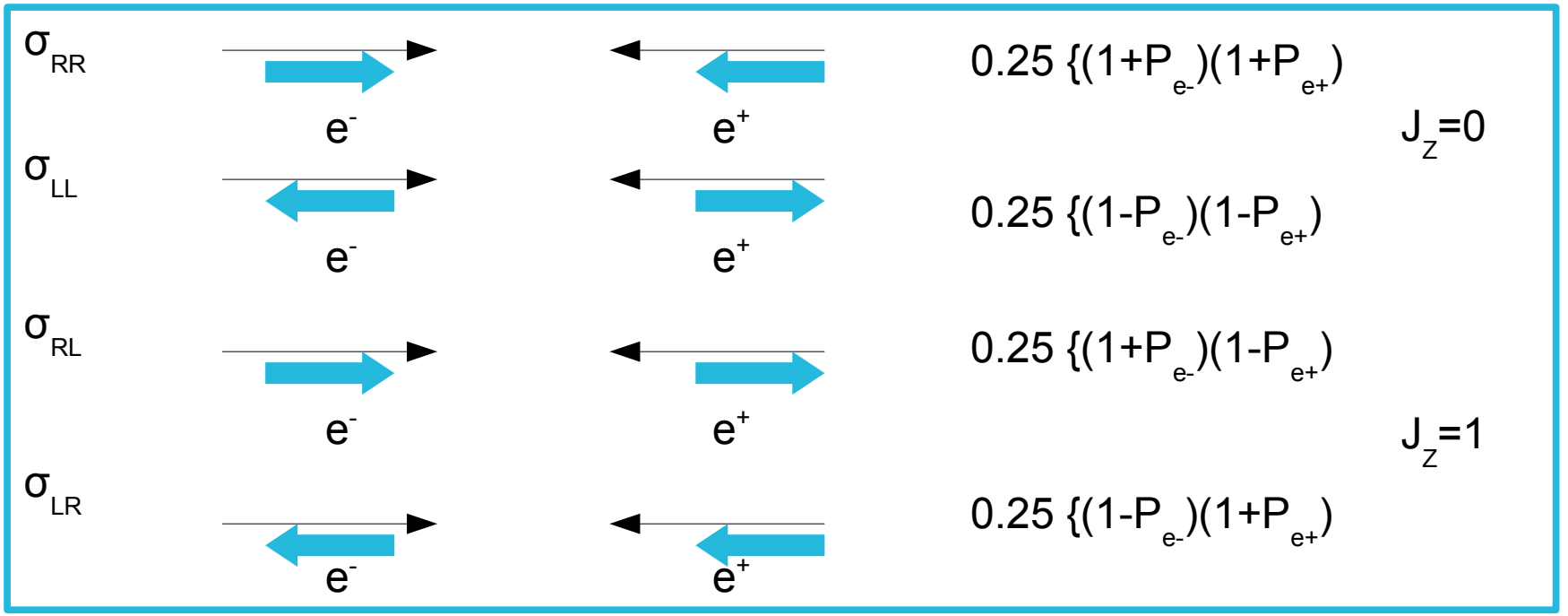


b) c) s-channel: e+ and e- must have opposite polarizations, to give the vector boson.

J_z=1 allows vector mediator

a) t**-channel**: same polarizations for e+ and e- are allowed.

W^+W^- production and polarization - 2



- The total cross section is therefore influenced by the beam polarizations:

$$\sigma(P_{e^-},P_{e^+}) = 0.25\,\{(1+P_{e^-})(1+P_{e^+})\sigma_{RR}+(1-P_{e^-})(1-P_{e^+})\sigma_{LL} + (1+P_{e^-})(1-P_{e^+})\sigma_{RL} + (1-P_{e^-})(1+P_{e^+})\sigma_{LR}\}.$$

- From the measured cross section it is possible to deduct, vice versa, the polarization.

Importance of beam polarization

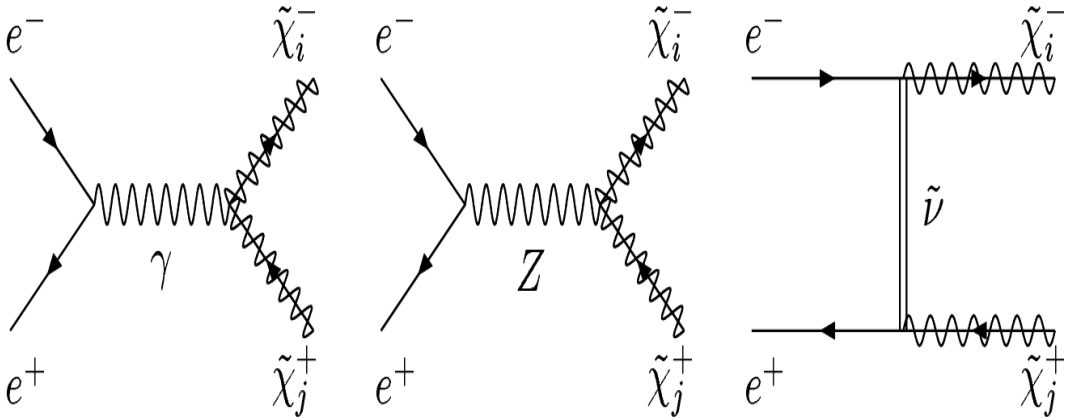
- It enables to enhance desired signal rates and suppress unwanted background: essential in searches for new physics were small rates are predicted.

- Allows to study properties of new particles, such as mixings and couplings.

Example: chargino mixing

- Charginos are a mixing of Winos and Higgsinos, according to the matrix element:

$$\begin{pmatrix} \tilde{\chi}_1^{\pm} \\ \tilde{\chi}_2^{\pm} \end{pmatrix} = \begin{pmatrix} M_2 & \sqrt{2}\, m_W \cos(\beta) \\ \sqrt{2}\, m_W \sin(\beta) & \mu \end{pmatrix} \begin{pmatrix} \tilde{W}^{\pm} \\ \tilde{H}^{\pm} \end{pmatrix}$$



s-channel: only $e_R^+ e_R^-$ or $e_L^+ e_L^-$ **t-channel: also $e_L^+ e_R^-$ or $e_R^+ e_L^-$**

- Winos can couple only to e_R^+ and to e_L^-, while higgsinos can couple to the Z-boson in the s-channel.
- Using beams polarization it is therefore possible to show the different contributions and study the chargino mixing.

Current simulation

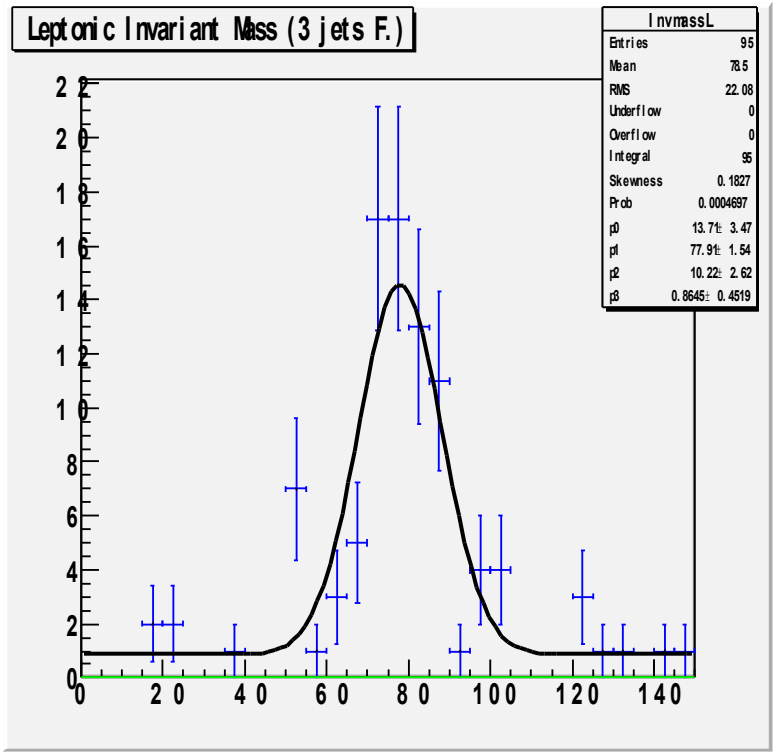
- **Simulation**: Old Mokka 5.4, LDC00Sc, B=4T files.
- **Tracking**: LEPTracking and TrackwiseClustering.
- **Particle flow**: Wolf.
- **Background**: at the moment using only qq.

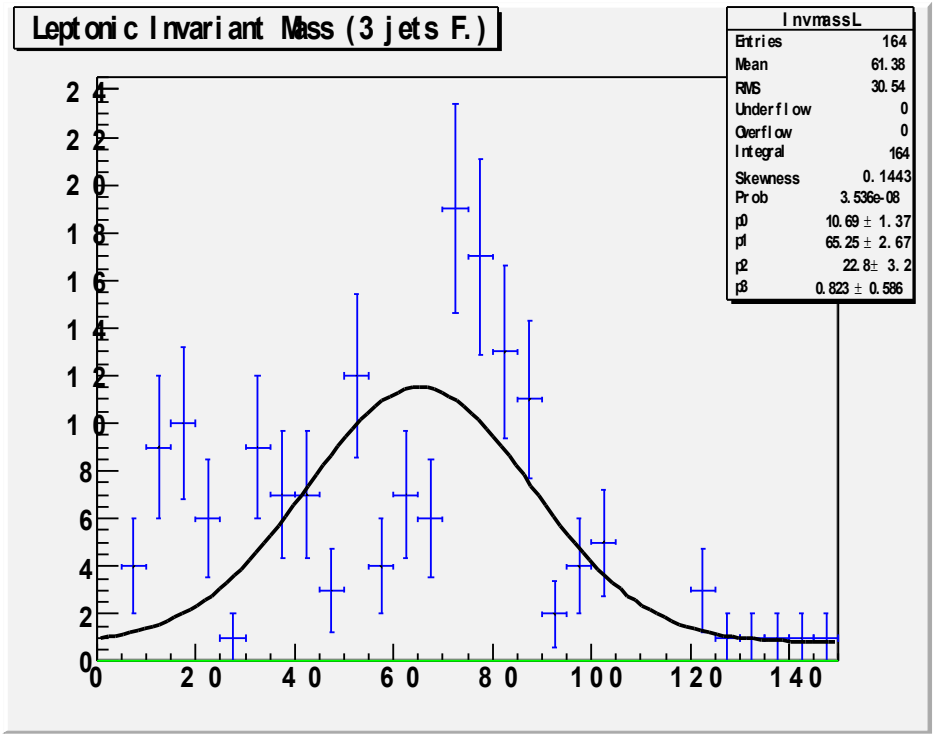
Current selection

- Only semileptonic channel: forcing 3 jets (Duhram). One jet is the lepton:
  - Isolated (5 degrees theta-phi).
  - Charged.
  - One and only one track with p_T > 10 GeV.
  - If more than one track:
    - Three tracks: electron radiating photon converting to pair.
      Two tracks must have invariant mass → 0.
      The third track must be an electron: E/p → 1.
    - In case of muon: E/p → 0; only one track allowed.

- Preselection cuts:
  - Ntracks ≥ 5.
  - Neutrino: P_T>5 GeV, ∑E < 450 GeV.
  - Isr: M_{vis}>100 GeV.

Tau selection



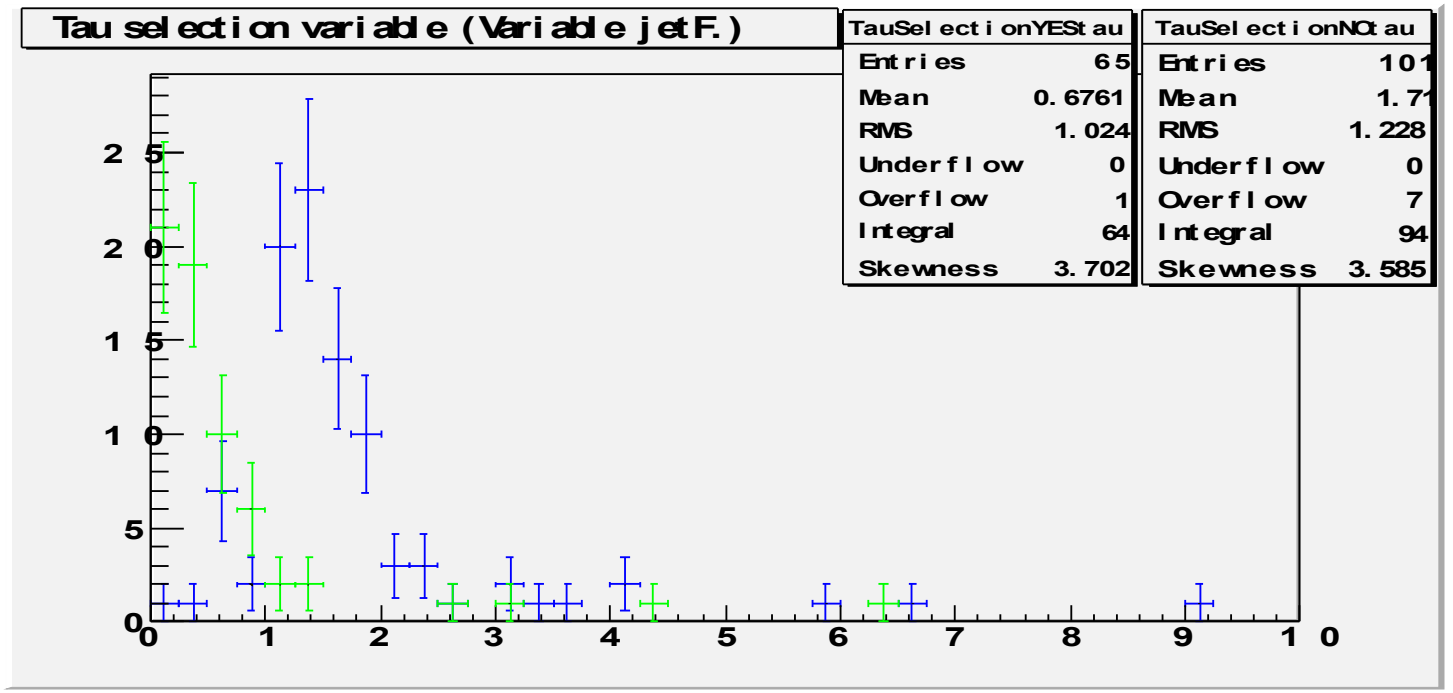


- Tau can decay, and more neutrinos are present in the final state.
- This disturbs the reconstruction of the W “leptonic” invariant mass from the lepton+missing momentum.
- Eliminate the tau contribution?

Tau selection

- At the moment using a cut-oriented tau selection:

$$\left(\frac{E_{VIS}}{E_{CM}}\right)^2 + \left(\frac{E_{lepton}}{E_{beam}}\right)^2 < 1$$

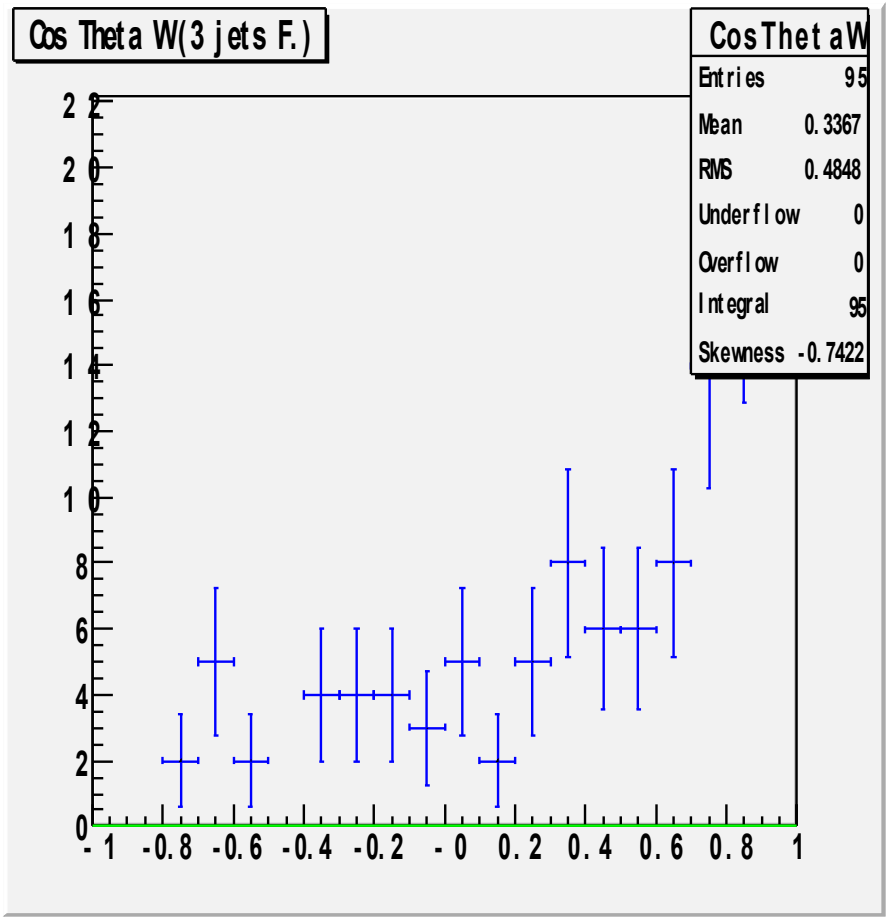


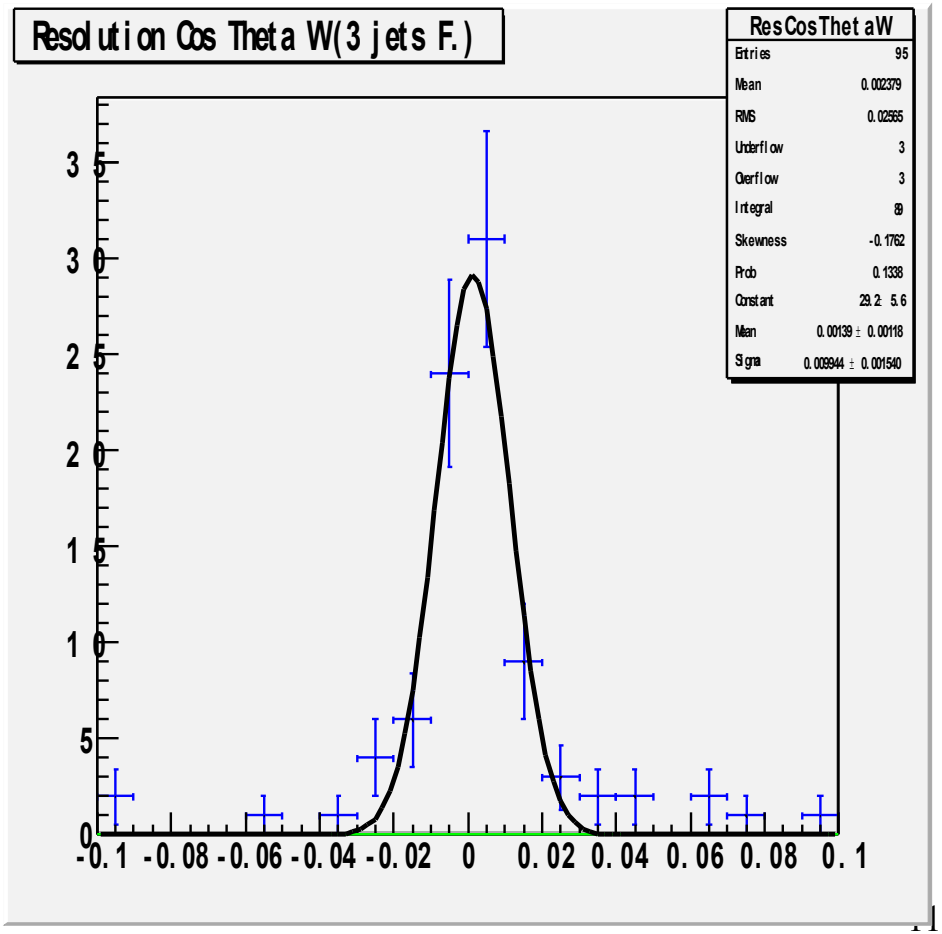
Tau

Electron
Muon

Cos θ_w

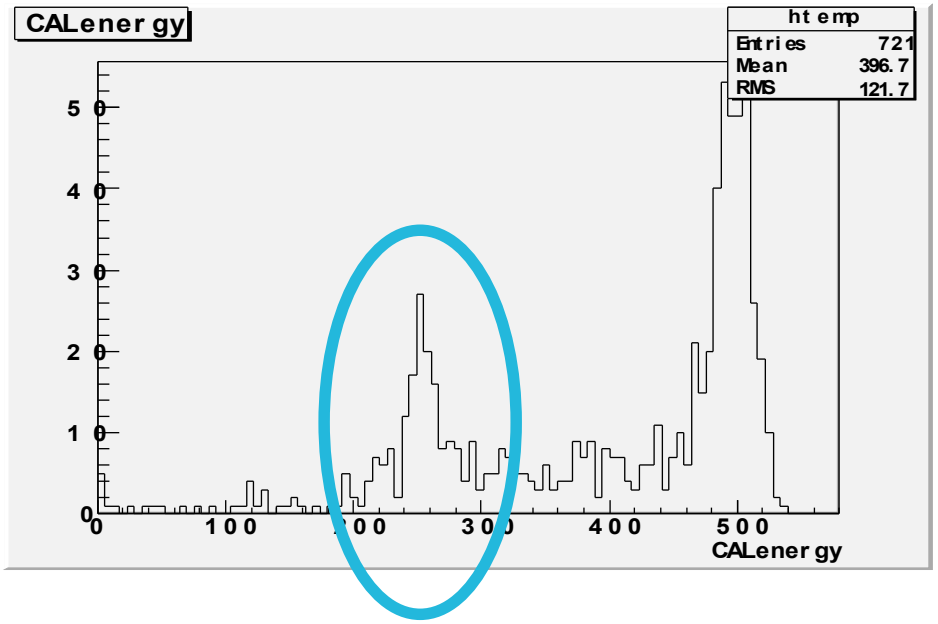
Results for **Cos θ_w** with the resolution obtained from true MC information.

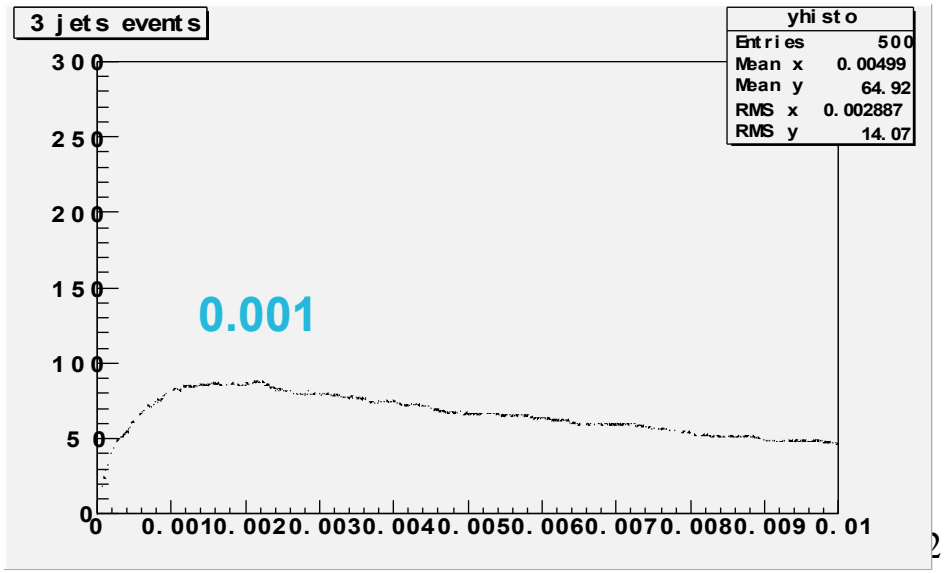




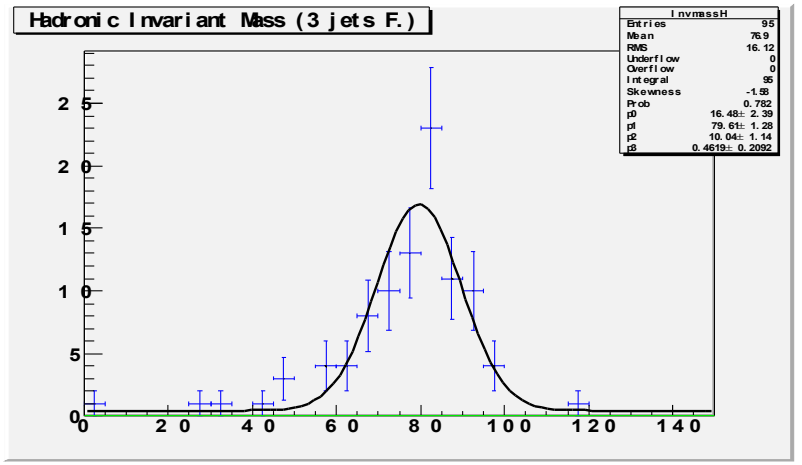
Variable jets finder: Y cut

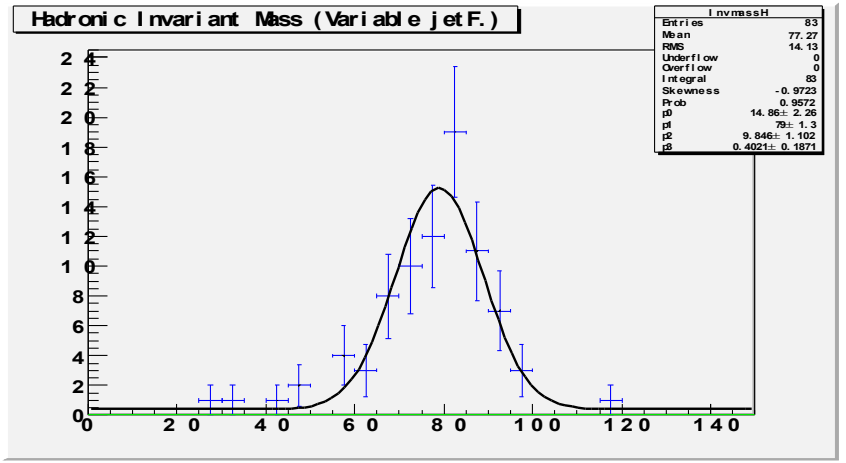
- The same analysis has been repeated with the variable jet finder, asking for and not imposing three jets.
- Y cut choice:
  - W^+W^- events with $200 < E_{CAL} < 300$ GeV is expected to be a very pure semileptonic sample: μ penetrates all the calorimeter without leaving an energetic deposit.
  - Choosen the Y cut that gives the maximum number of 3 jets.



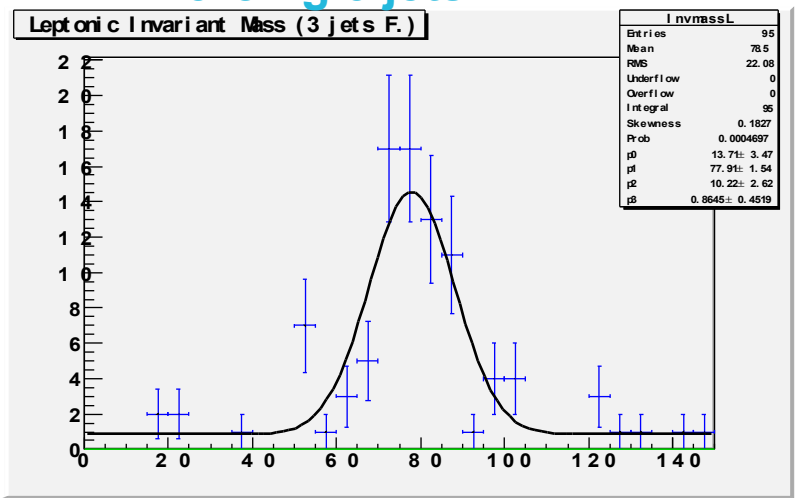


Variable jets finder vs 3 jets finder

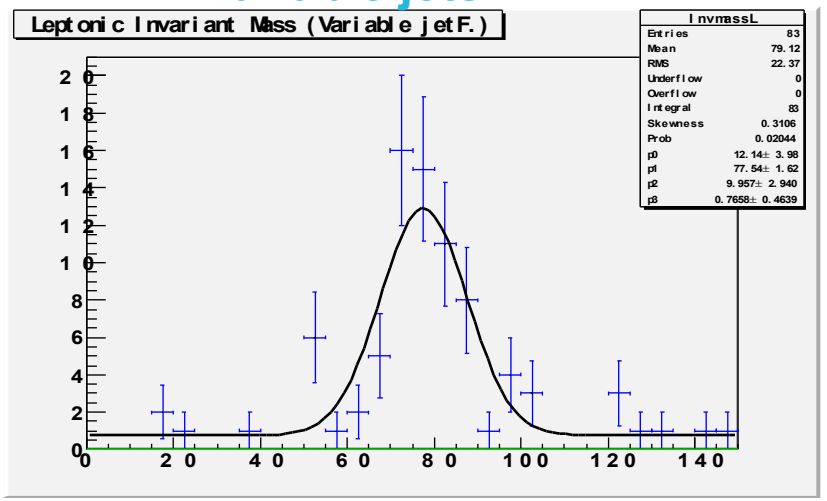




Forcing 3 jets



Variable jets



Tot. events selected: 83 for variable jet finder and 95 forcing 3 jets.

Upgrades

- **Simulation**:
  - New Slac samples, LDC01_05Sc model.
  - Background: more statistic needed, and qqqq background.

- **Reconstruction**:
  - Pandora;
  - Lepton-ID.

- **Analysis**:
  - Kinematic fitting;
  - More sophisticated tau selection;
  - Setting up a selection also for hadronic, 4 jets, decays.