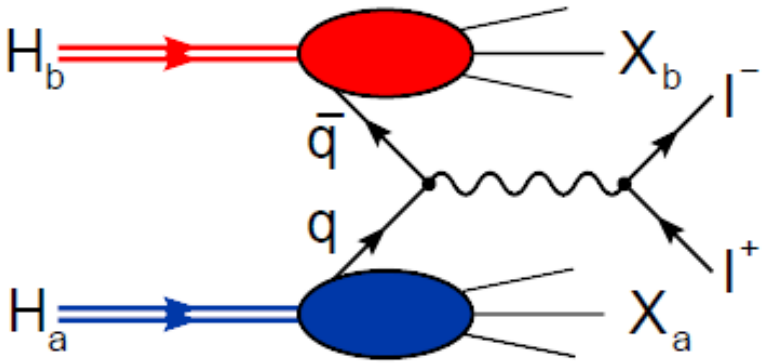
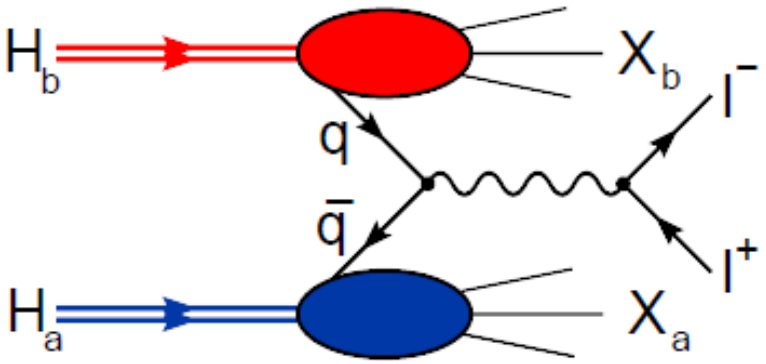
Study of Drell-Yan process with pair production of polarized tau-leptons

Drell-Yan process





- **Cross section factorizes into hadronic and leptonic parts**
- **Very simple structure**
- **Cleanest hard hadron-hadron scattering process**

Very convenient process for probing parton distribution functions

Partons distribution functions (PDF)

Collinear PDFs

Density: $f_1(x,Q^2)$

Helicity: $g_1(x,Q^2)$

Transversity: $h_1(x,Q^2)$

Transverse moment dependent PDFs

Sivers: $f_{1T}^{\perp}(x,k_T,Q^2)$

Worm-gear-T: $g_{1T}^{\perp}(x,k_T,Q^2)$

Boer-Mulders: $h_1^{\perp}(x,k_T,Q^2)$

Worm-gear-L: $h_{1L}^{\perp}(x,k_T,Q^2)$

Pretzelosity: $h_{1T}^{\perp}(x,k_T,Q^2)$

Tau to single pion and neutrino decay mode

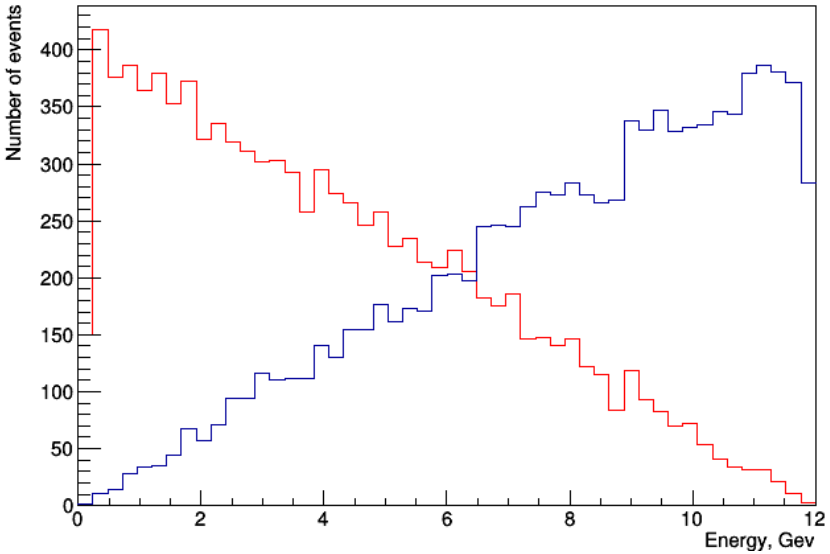
- Tau decays mostly in hadronic channels
- Hadronic decay to single pi-meson and neutrino

is of special interest

$$\tau^- \longrightarrow \pi^- \nu_\tau$$
$$\tau^+ \longrightarrow \pi^+ \bar{\nu}_\tau$$

Due to the weak nature of this decay and the fact that neutrinos are always left-handed, the energy spectra of pi-meson is strictly correlated with the polarization state of decaying tau lepton

Correlation between the energy spectra of produced pi-meson and the polarization of decayed tau



Energy spectra of the pi-meson produced from decays of taus which are: mostly left-handed (red), mostly right-handed (blue)

- In decays of mostly left-handed taus significant part of the momentum is transferred to neutrinos
- Conversely, in decays of mostly right-handed taus most of the momentum is transferred to the pi-meson

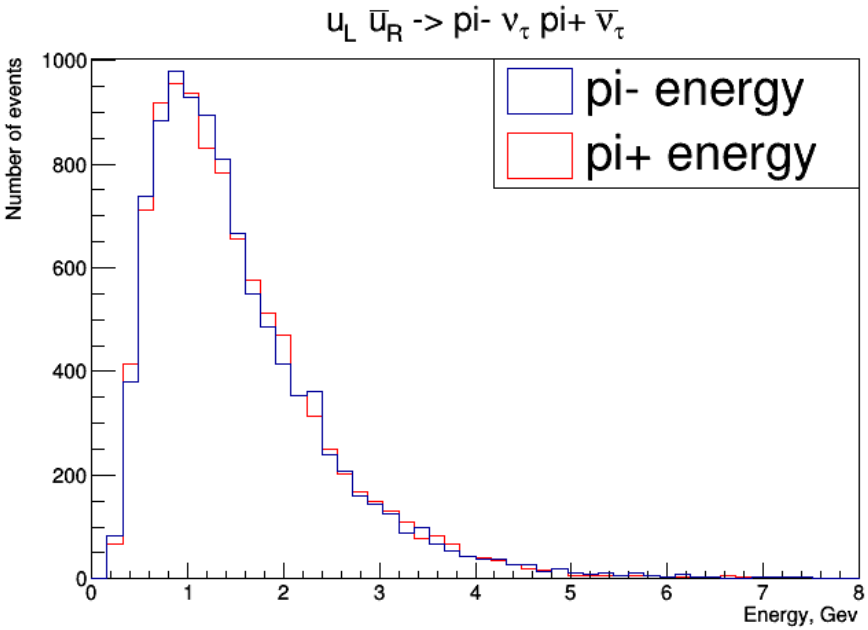
Simulation chain

CompHEP (events generation)

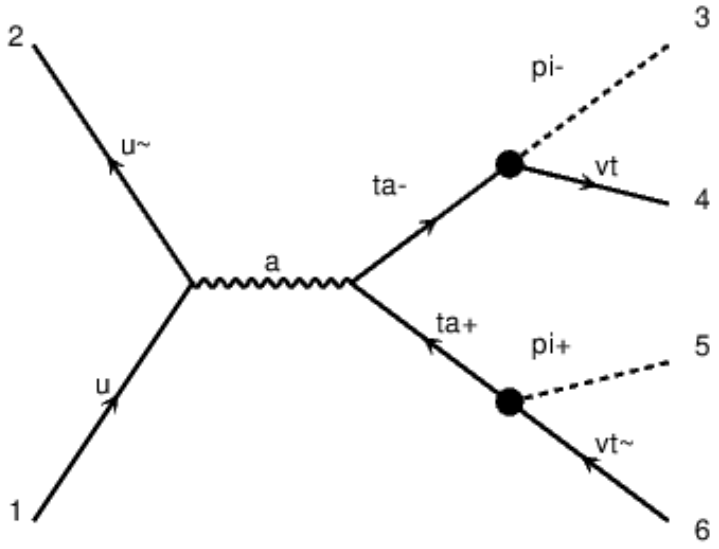
Pythia 8 (parton showers, hadronization)

Delphes (detector simulation, event reconstruction)

Energy spectra of pi-meson in unpolarized *pp* collisions at $\sqrt{S} = 25.2$ Gev

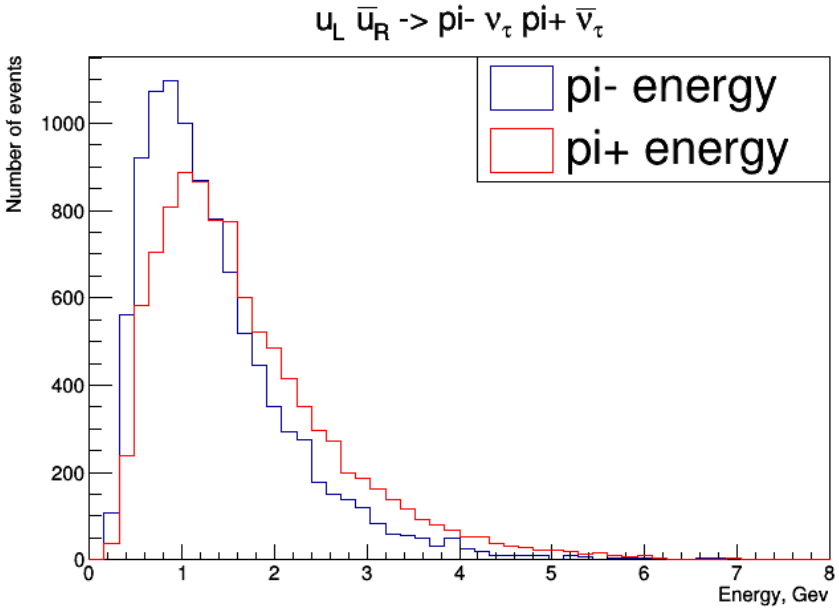


Energy spectra of pi-mesons, unpolarized case

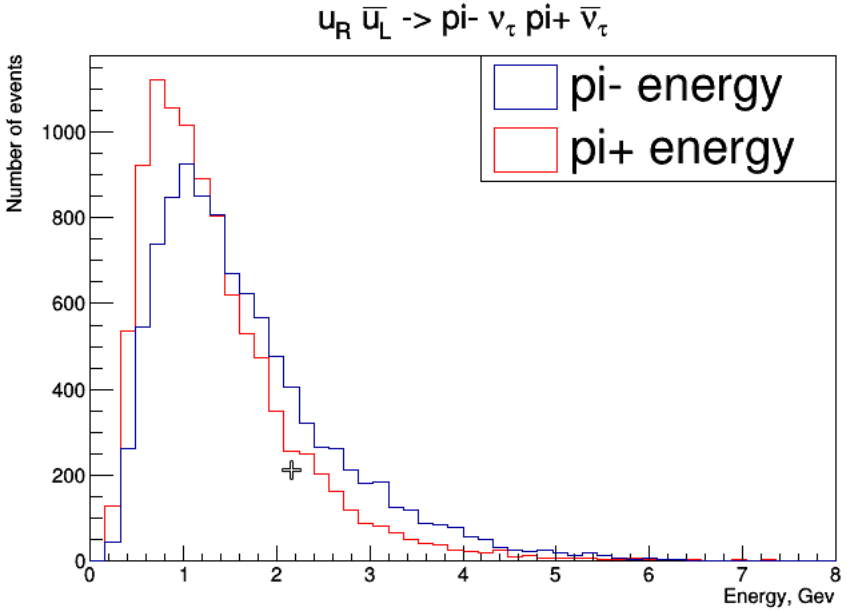


The process diagram

Energy spectra of pi-meson in polarized *pp* collisions



Case of left-handed up and right-handed anti-up collision



Case of right-handed up and left-handed anti-up collision

Summary

• The energy spectra of the pi-meson is convenient, easily measurable, characteristic of the polarization state of the parent tau

• Feasibility of the utilisation of the proposed parameterization in studying polarized parton distribution functions have been demonstrated

• Basic model of the proposed process have been created

• A new approach will be developed for the extraction of TMD PDFs from the upcoming data from polarized Drell-Yan experiments

Thank you for your attention!