Data-driven methods for misreconstructed objects estimation in lepton final states with ATLAS at $\sqrt{s} = 13$ TeV

Searches for new physics in lepton final states provide powerful signature towards discoveries: challenging understanding of detector-related backgrounds.

**1) Charge misidentification probability**

- jets from initial/final state radiation can be misidentified as prompt leptons.
- Trident event: $e^- \rightarrow \gamma \rightarrow e^- e^- e^-$
  Electromagnetic cluster can be matched to wrong electron track in ID.

**2) Fake lepton background**

- Tight: pass more stringent identification and isolation criteria.
- Loose: pass required to fail tight isolation requirement. Fake leptons usually less isolated.

**3) Systematic uncertainties**

- Charge-flip: vary the choice of $Z$ peak range; negligible compared to statistical uncertainty in data and simulated events.
- Fake factors:
  - alter missing $E_T$ requirement to vary $W$ jets composition
  - change recoin jet requirements to study fake composition
  - $d_0$ varied up/down by 1 unit
  - normalization of simulated samples varied up/down by 10% to 20% across $p_T$ and $|\eta|$ bins

**4) Methods used in new physics searches**

- Doubly-charged boson Higgs production: 2,3,4 leptons final states, $N_{\text{jets}} = 0$
  Search for heavy leptons in type III See-Saw models (see Tadej Novak’s poster for more details): 2 leptons, 2 jets and missing $E_T$.

**Fig. 1**: Example of $t\bar{t}$ event with possible multiple misreconstructed objects.

**Tab.1**: "fake-enriched" control regions used for

- Special treatment for low statistics:
  - $P(0, |\eta|) = 32\% \rightarrow \lambda = 1.14$, 68% CL
  - $N_{\text{fake}} = 2 \times 0.38 \times (0.38 - 0.38 \times 0.25)$
  - $N_{\text{fake}} = 0.085$
  - $N_{\text{fake}} = 0.09$

- Prevents from 0% fake estimate (Fig. 6(b)).

Methods validated across different kinematic regimes and event topologies efficiently applied to more than one new physics search.