DNN reconstruction of neutrino p_z

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Neutriono longitudinal component

- No way to measure it directly

  > Problematic for boson polarisation measurements, very sensitive to boson decay caracteristics

- Usual evaluation methods :

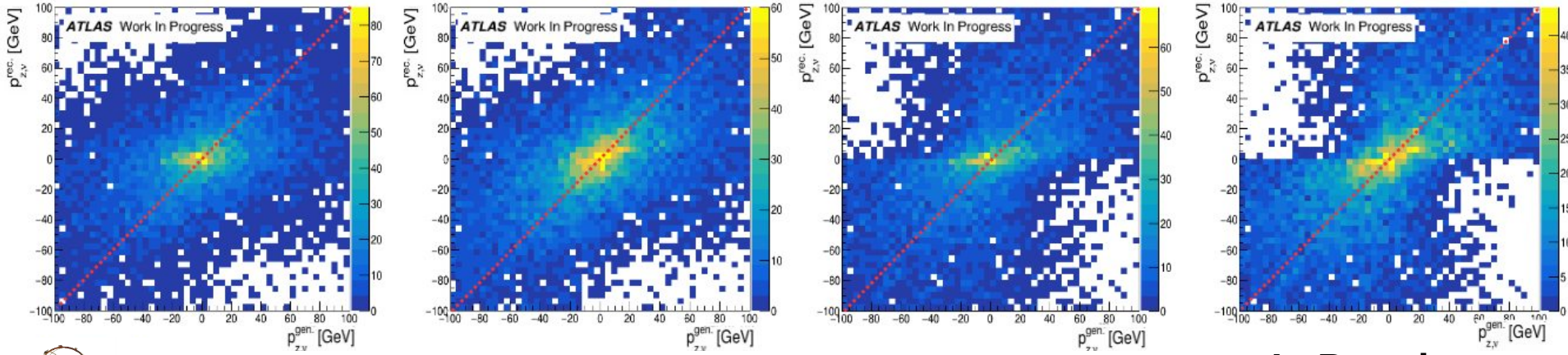
  > Assuming $M_W = M_{pole}$: $A\,p_{z,\nu}^2 + B\,p_{z,\nu} + C = 0$

  $$A = p_{T,lep}^2$$
  $$B = -2\,p_{z,lep}\left(p_{x,lep}\,p_{x,\nu} + p_{y,lep}\,p_{y,\nu} + \frac{M_W}{2}\right)$$
  $$C = -\left(p_{x,lep}\,p_{x,\nu} + p_{y,lep}\,p_{y,\nu} + \frac{M_W}{2}\right)^2 + E_{lep}^2\,p_{T,\nu}^2$$

  > Second order equation → 2 solutions in most cases (& can be complex)

- Several methods tested to deal with the ambiguity

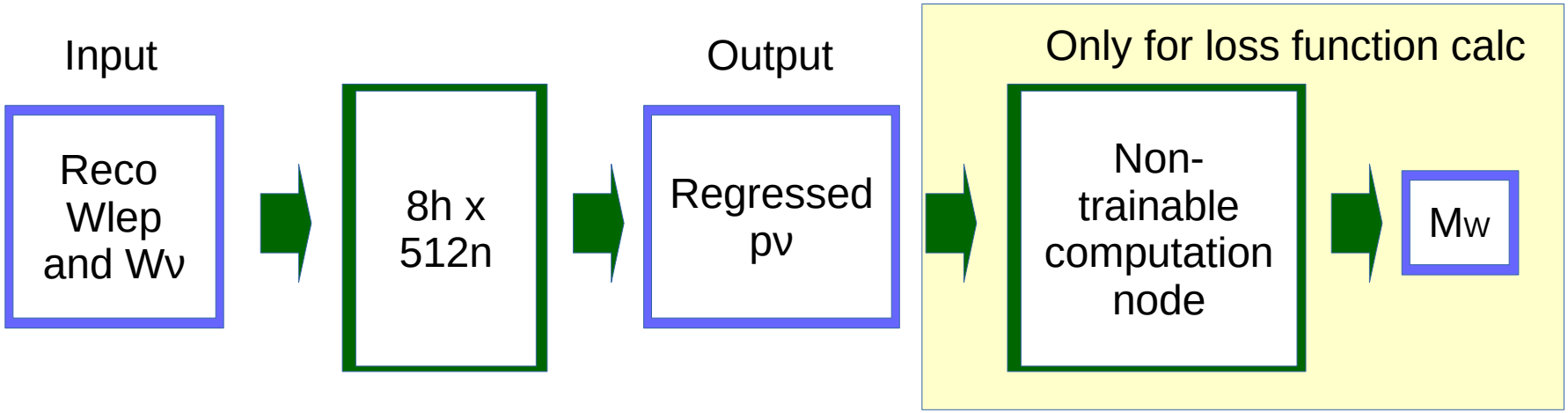
  > No clear winner :



L. Portales

DNN regression

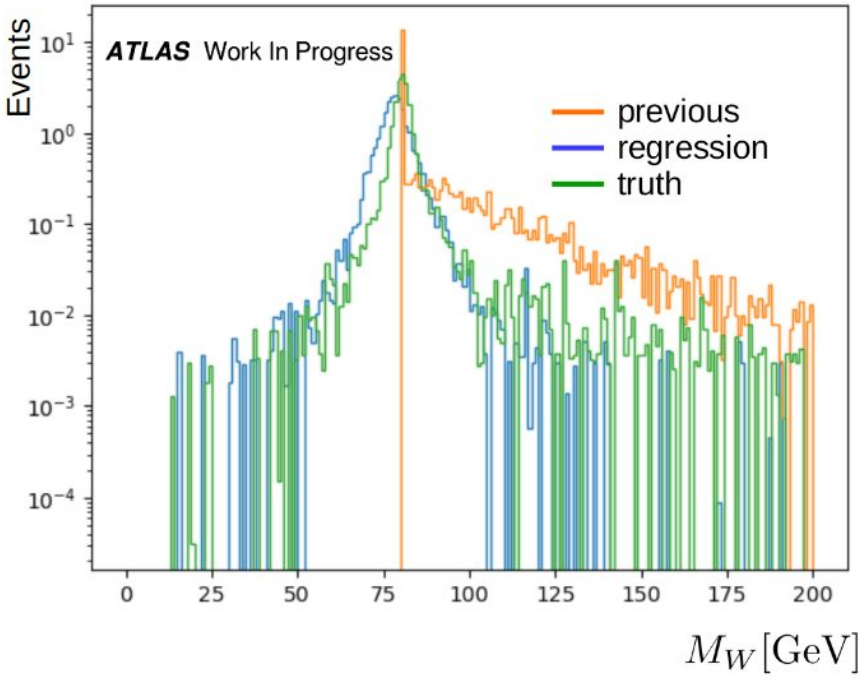
- Use a feedforward NN with 8h x 512nodes to predict pz.
- Sample: inclusive WZ simulated with Powheg+Pythia
- Inputs: 4-momentum of charged lepton from W.
  MET.
  neutrino pz as reconstructed from previous analysis.
- Output: 4-momentum of the neutrino and W mass
- Challenge: W mass is not fixed to PDG value, use regression to estimate truth W mass event by event.

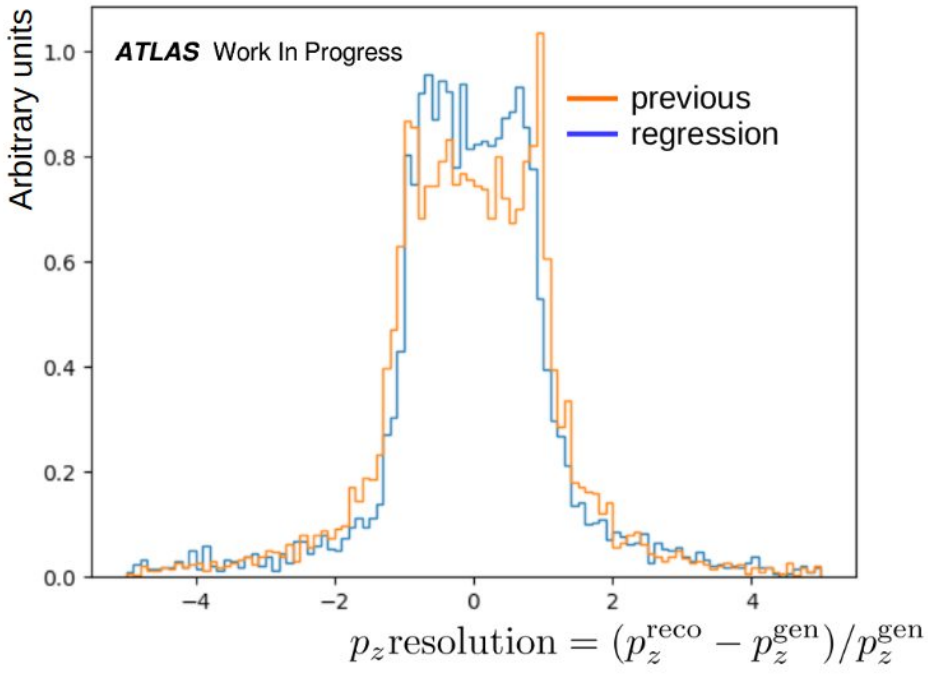


- Training = minimization of Mean Squared Error (MSE) of P4ν
  + MSE of M_W.

Pz ν reconstruction performance

- Slight improvement w.r.t. previous reconstruction.
- M_W has a small bias: fix it with fine tuning of loss function.





E. Sauvan

- Sensitivity increase: If the DNN for polarization is trained on variables calculated with DNN pz ν reconstruction the expected significance of LL modes increases from **6.5σ** to **7.2σ**.