

# Deep Learning Model: Flavour

## Classification Results

- Overall Accuracy : 77% (BDT) → **81%**.
- The most significant improvement:  $\nu_e$  CC:
  - Precision: 0.76% → 0.89%, Recall: 0.60% → 0.84%.
  - **Why?** *Pre-Train* learns generalizable representation of what a physically EM shower.
- **First Identification of Tau Neutrinos:**
  - Promising first step: **11 true  $\nu_\tau$  CC events correctly identified** (*BDT had 0% Precision*).
  - **Why?** *Pre-Train* created a feature space where rare events could become *separable* from other classes.

| Class         | Precision   | Recall      |
|---------------|-------------|-------------|
| $\nu_e$ CC    | 0.89        | 0.84        |
| $\nu_\mu$ CC  | 0.82        | 0.94        |
| $\nu_\tau$ CC | <b>0.79</b> | <b>0.00</b> |
| NC            | 0.73        | 0.58        |

| Pred.      | True<br>$\nu_e$ | True<br>$\nu_\mu$ | True<br>$\nu_\tau$ | True<br>NC    |
|------------|-----------------|-------------------|--------------------|---------------|
| $\nu_e$    | <b>13,395</b>   | 789               | 103                | 726           |
| $\nu_\mu$  | 1,864           | <b>72,208</b>     | 1,705              | 12,748        |
| $\nu_\tau$ | 0               | 0                 | <b>11</b>          | <b>3</b>      |
| NC         | 603             | 3,537             | 2,596              | <b>18,403</b> |

# Deep Learning Model: Visible Energy

## Regression Results

- **$E_{\text{vis}}$** : magnitude of visible\_momentum
  - For CC it corresponds to Incoming Neutrino Energy.
  - For NC it corresponds to Hadrons Energy.
- Remarkable improvement in energy reconstruction:
  - Eliminated bias for  $\nu_e$  CC.
  - The resolution is almost *halved* for all classes.

