Hadron Identification

- **Representing PID information**:
  - EDM4hep data model has an improved way of representing PID assumptions:
    - There are N PID assumptions (which carry their own weight) that link to a `ReconstructedParticle`.
    - This information should be used in physics analyses.   **This is interface between reconstruction and physics analysis.**
  - EDM4hep data model and EICrecon support algorithmic flow where we combine responses from various PID systems:
    - As a starting point, we should aim for a reconstruction for each PID system.

- We should ideally populate the PID information through the use of reconstruction algorithms.

- As an alternative, we can use in EICrecon parametrizations based on standalone reconstruction or estimates.

- One possible approach is the unfolding method, as utilized by HERMES: **However, there are other methods, for example, the use of ML.**
  - Parametrize the relationship between the identified hadron types to the true hadron types:

$$\mathcal{P} = \begin{pmatrix} P_\pi(\pi) & P_\pi(K) & P_\pi(p) \\ P_K(\pi) & P_K(K) & P_K(p) \\ P_p(\pi) & P_p(K) & P_p(p) \\ P_X(\pi) & P_X(K) & P_X(p) \end{pmatrix}$$

The $\mathcal{P}$-matrix depends on the momentum and the event topology of the hadron tracks.

The elements of the inverse $\mathcal{P}$-matrix can be interpreted as event weights which relate the identified hadron types to the true hadron types.

  - Pion weights, kaon weights and proton weights are assigned to each identified hadron track according to the inverse $\mathcal{P}$-matrix .
  - **Required steps**:
    - Use a parametrization for reconstruction of the identified hadron track. As an initial step, we can use use true hadron types.
    - Use a parametrization for the inverse $\mathcal{P}$-matrices. As an initial step, we can use use only 1 and 0 as event weights.
    - The parametrizations could be determined either in standalone reconstruction code or based on estimates.

    In a nutshell: Populate the PID information using parametrizations based on standalone reconstruction or estimates in EICrecon.