

# Pre-Training

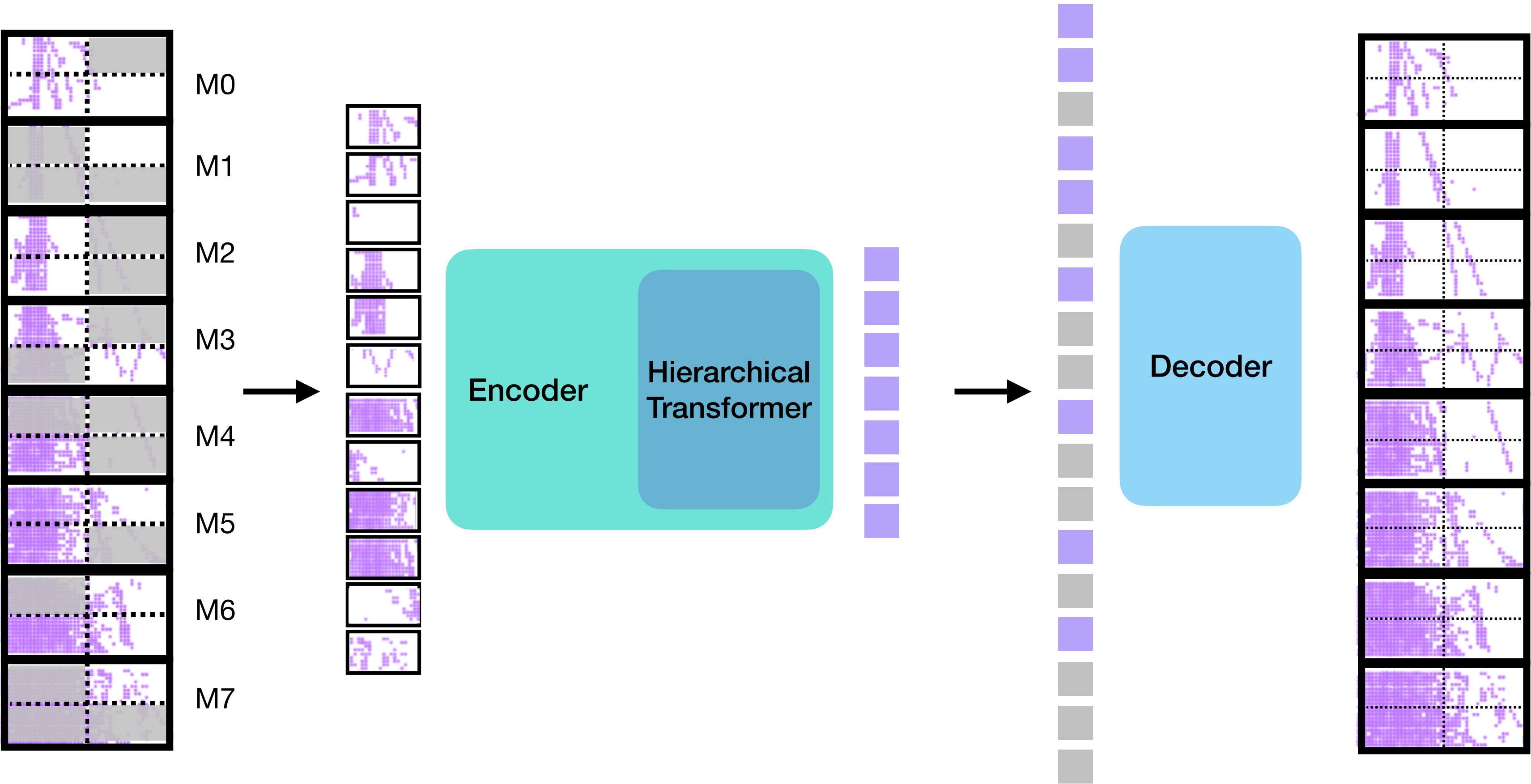
## The Model

Patched input

Masked input

Non-Masked embedding

Masked embedding



# Our Training Strategy

## A Two-Stage Approach

- Stage 1: Self-Supervised Pre-Training

- *Goal*: Force the model to learn a rich, physical representation of events.
- **How**: A dual-objective Masked Autoencoder (MAE).
  - ▶ *Reconstruction Task*: Reconstruct masked (hidden) parts of the event.
  - ▶ *Contrastive Task*: Machine learning framework for grouping hits that share the same voxel ID.

- Stage 2: Supervised Fine-Tuning

- *Goal*: Adapt the "smart" pre-trained encoder to specific physics tasks.
- **How**: Transfer Learning - Use the pre-trained weights as a starting point and fine-tune for classification and regression.
  - **Classification Task**:
    - ▶ *NuE CC, NuMu CC, NuTau CC, NC*
  - **Regression Task**:
    - ▶ *Visible Momentum ( $E_{vis}$ ,  $Pt_{miss}$ ), Jet Momentum, Lepton Momentum*