Karlsruhe Institute of Technology

Update on my thesis

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Recap: Aim of the Thesis

- Identification of tau decays by a ML algorithm
- Full simulation data of the CLD detector concept for FCC-ee
- Only low level detector data as inputs
- No variables from particle flow reconstruction as inputs

Recap: Full Simulation Data

- Use of full simulation data of the CLD detector concept
- Workflow:
  - MC simulation in Pythia8 for $Z \rightarrow \tau\tau$ signal and $Z \rightarrow qq$ and bhabha background
  - CLD detector simulation using Geant4
  - Reconstruction with Pandora

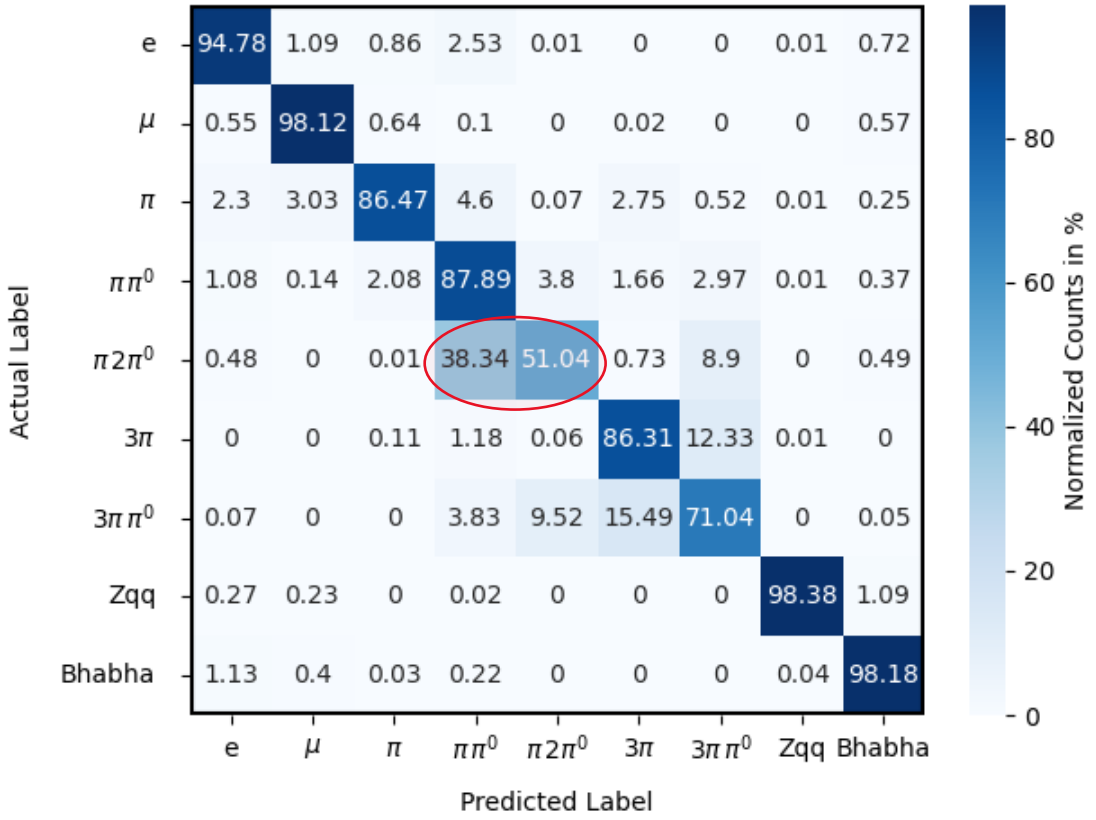
- For the training:
  - Only the information of the detector hits (x,y,z coordinates, hit type, energy and momentum) as inputs
  - No inputs from reconstruction

Recap: Model Training

- Training of a Geometric Algebra Transformer (GATr) model
- For the latest model:
  - 50,000 signal events
  - 20,000 Zqq and 10,000 Bhabha events
  - 50 epochs

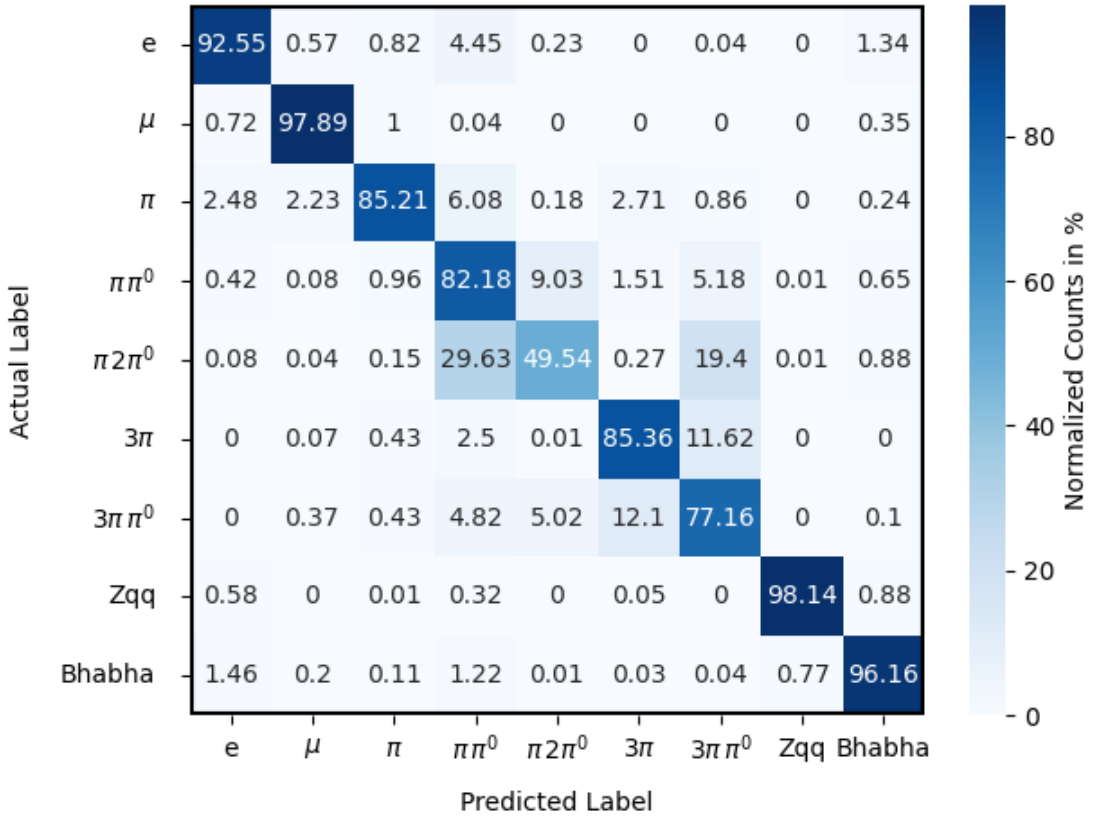
Tau ID with Backgrounds

- Model that includes Zqq and bhabha backgrounds
- Tested with 50,000 signal, 20,000 Zqq and 10,000 Bhabha events
- Good performance for leptonic decays and backgrounds
- Bad efficiency for $\pi\ 2\pi^0$ class, a lot are misclassified as $\pi\pi^0$
- Room for improvement for the $3\pi\ \pi^0$ class



Improving the Performance

- Doubling the weight on the loss calculation for the $\pi\ 2\pi^0$ class
- Makes no real difference



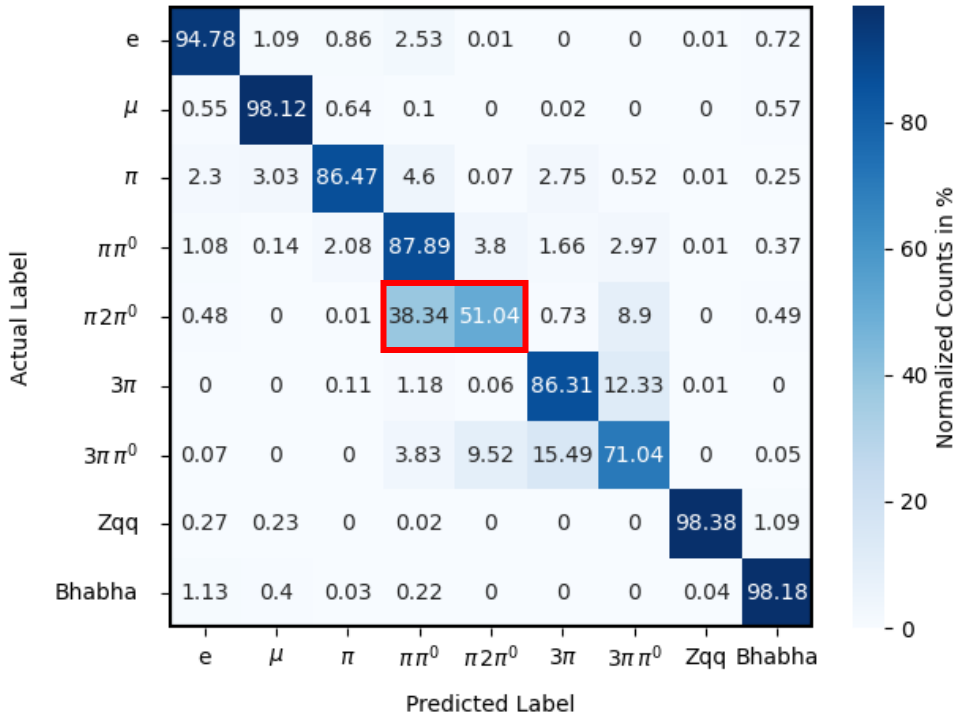
Comparison to Explicit Reconstruction

Explicit by Maria Cepeda

	Reconstructed Tau ID						
	h	h+γ	h+2γ	h+3γ	h+4γ	3h	n
$\pi^{\pm}$	0.81	0.03	0.00	0.01	0.01	0.00	0.13
ρ $(\pi^{\pm}\pi^{0})$	0.03	0.21	0.59	0.07	0.01	0.00	0.09
a_1 $(\pi^{\pm}2\pi^{0})$	0.00	0.02	0.09	0.31	0.39	0.00	0.10
a_1 $(\pi^{\pm}\pi^{\mp}\pi^{\pm})$	0.02	0.00	0.00	0.00	0.00	0.74	0.16

- Assumption: $h + \gamma$ and $h + 2\gamma$ are ρ
- $h + 3\gamma$ and $h + 4\gamma$ are $a1$ $(\pi\ 2\pi^{0})$
- Efficiency of the ML better in all classes except $\pi\ 2\pi^{0}$

Machine Learning



Outlook

- Improve the efficiency for the $\pi\, 2\pi^0$
- Maybe changes in the model configuration can improve the efficiency for $\pi\, 2\pi^0$
- Meeting with Jan on Friday for his expertise

- Thesis writing is close to being done, missing only the discussion of the latest results
- Thesis deadline on March 3rd

Backup

Green: weights doubled