A Large Ion Collider Experiment

CLASSIFYING EVENTS CONTAINING JETS WITH THE HELP OF A NEURAL NETWORK

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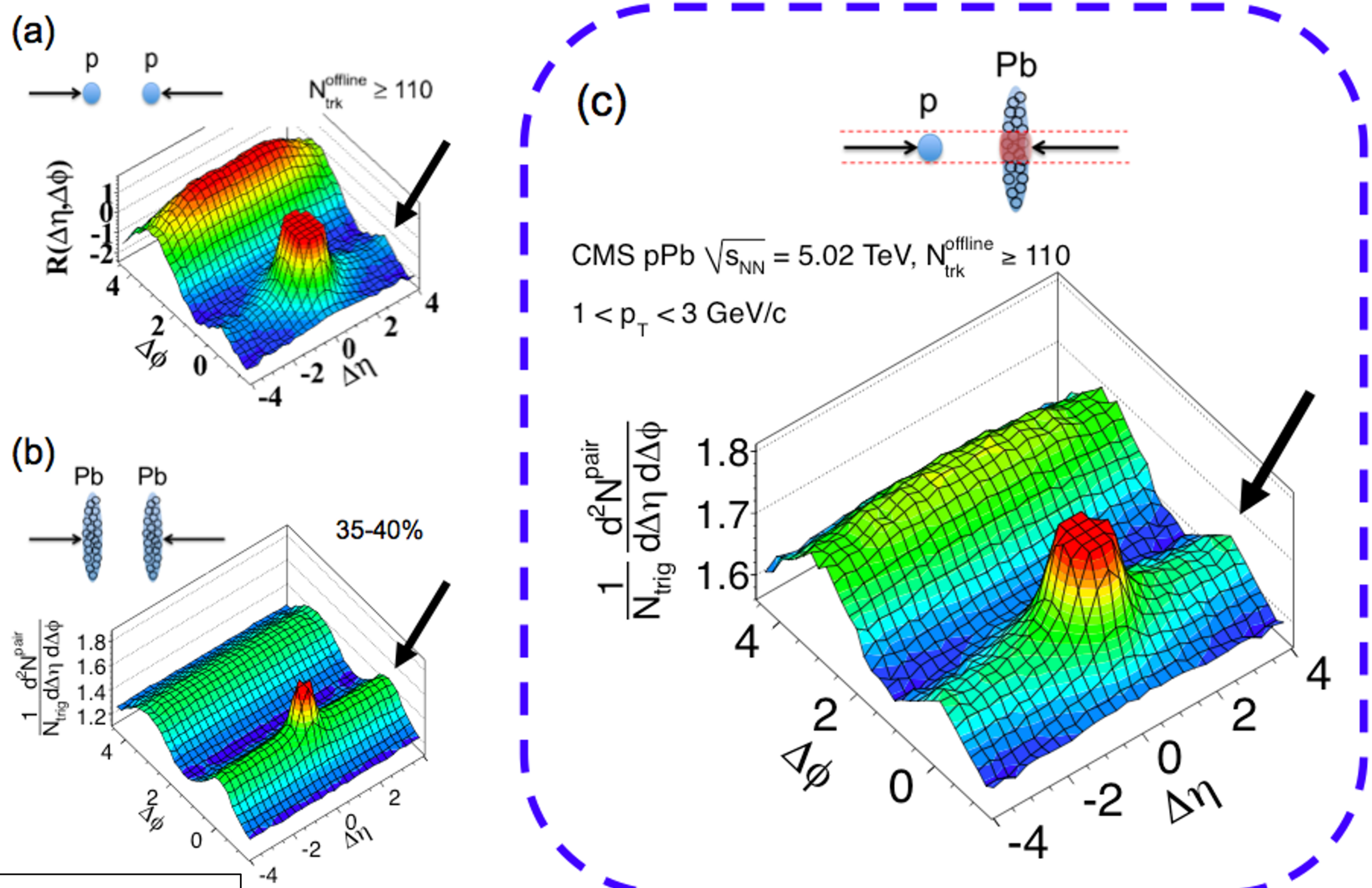
MOTIVATION AND THE AIM OF THE RESEARCH

- Previous work in our group at the University of Zagreb included analyses of two-particle correlations and the near-side “ridge” structure
- Large background coming from the jetty events - almost impossible to observe the “ridge”
- The idea is to find a classifier which will discriminate events based on jet presence
- As we got an NVIDIA grant for academic research we are interested in using a machine learning approach, in particular, neural networks

ALICE

TWO-PARTICLE CORRELATIONS



physletb.2012.11.025

ALICE

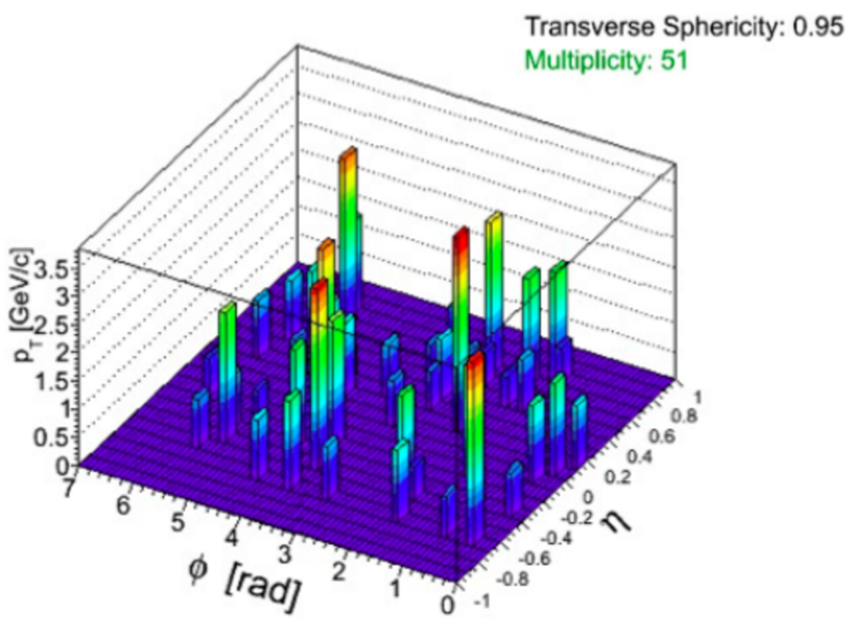
TWO-PARTICLE CORRELATIONS WITH THE SPHERICITY CUTS

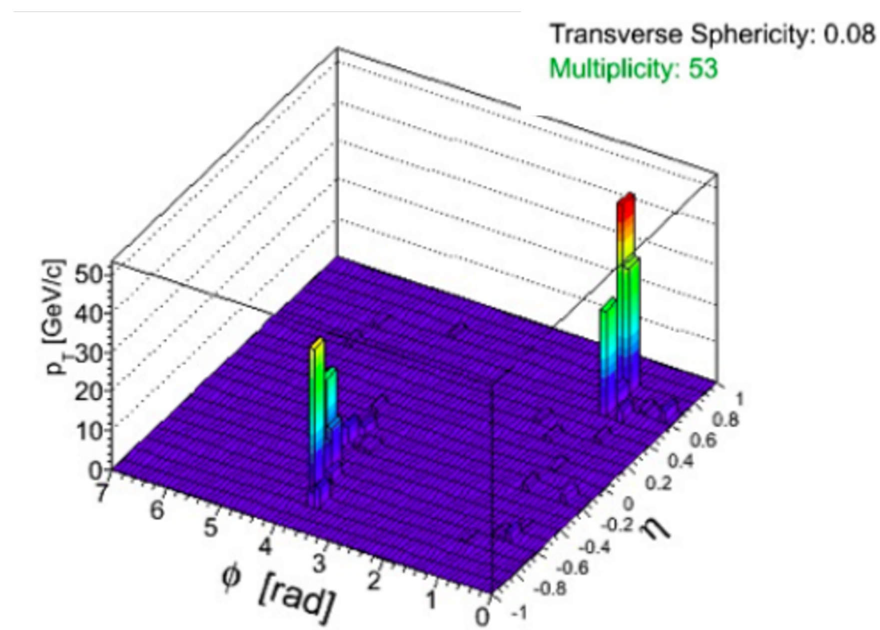
Transverse momentum matrix

$$\mathbf{S^{L}_{xy}} = \frac{1}{\sum_i p_{Ti}} \sum_i \frac{1}{p_{Ti}} \begin{pmatrix} p_{xi}^2 & p_{xi}p_{yi} \\ p_{yi}p_{xi} & p_{yi}^2 \end{pmatrix}$$

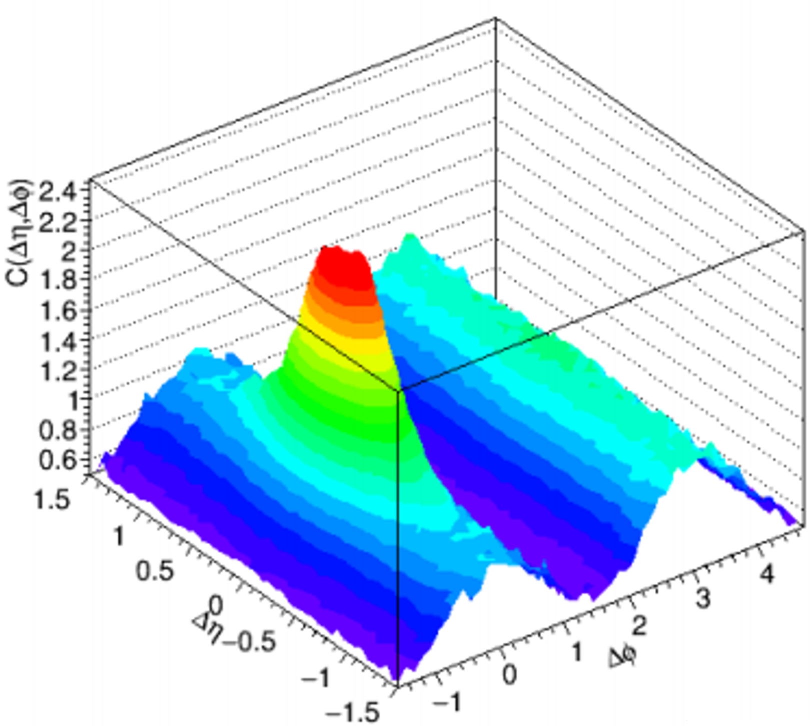
Transverse sphericity

$$S_T \equiv \frac{2\lambda_2}{\lambda_2 + \lambda_1}$$

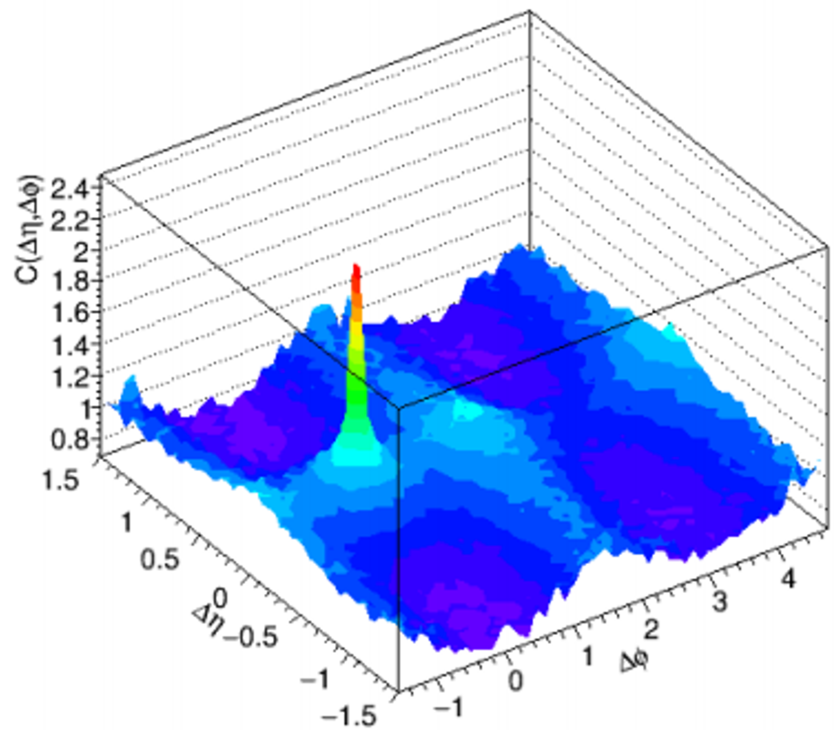




TWO-PARTICLE CORRELATIONS WITH THE SPHERICITY CUTS

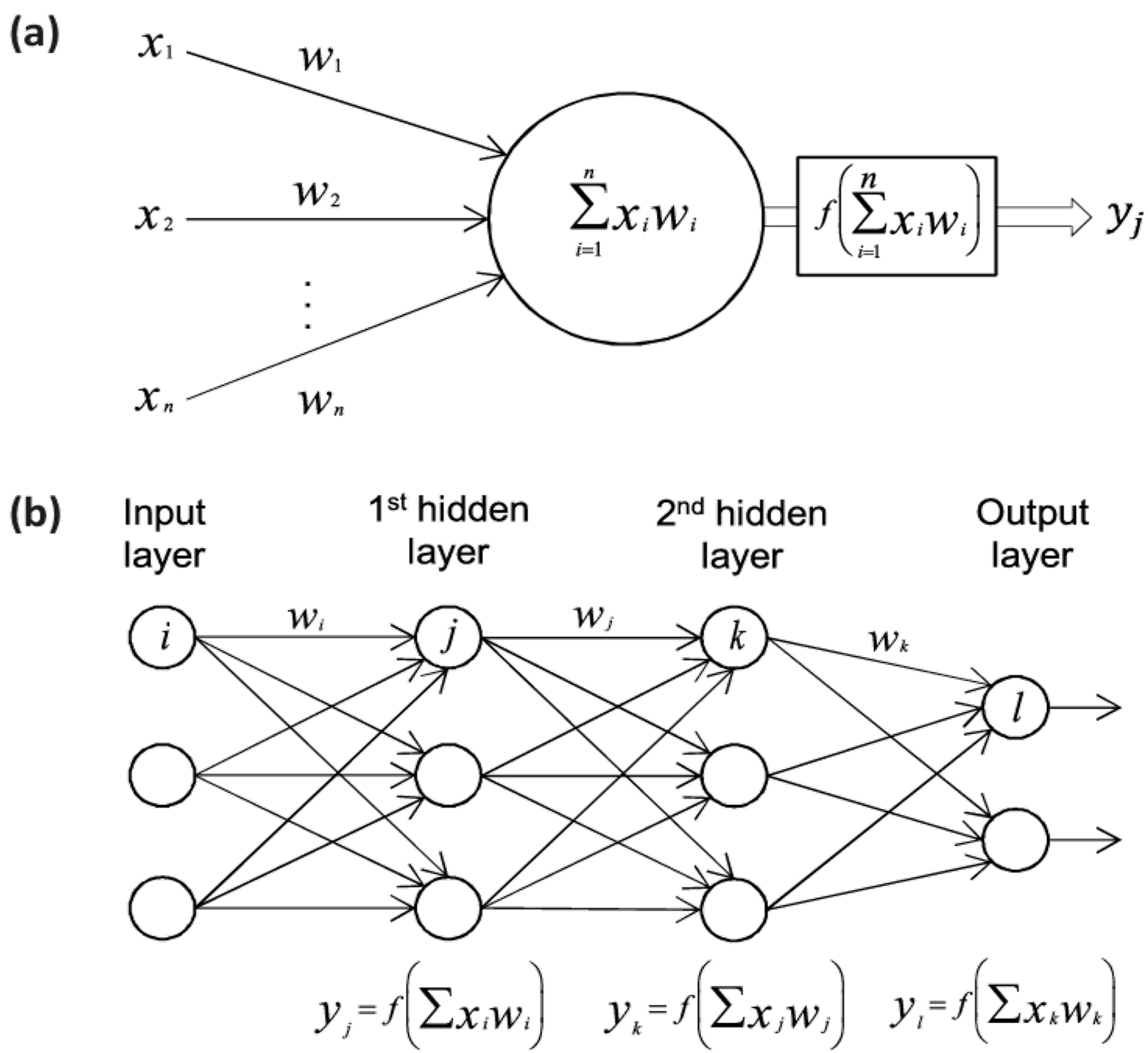


$S_T < 0.5$



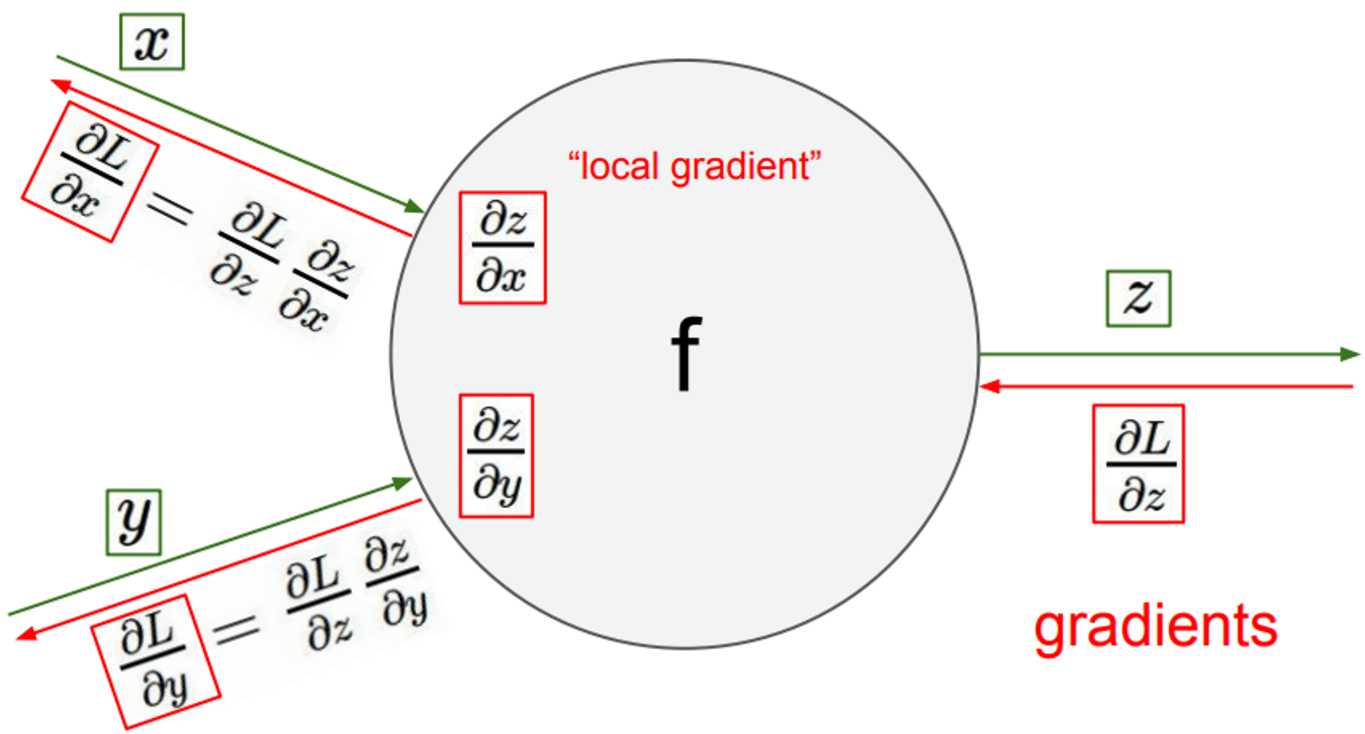
$S_T > 0.9$

NEURAL NETWORKS



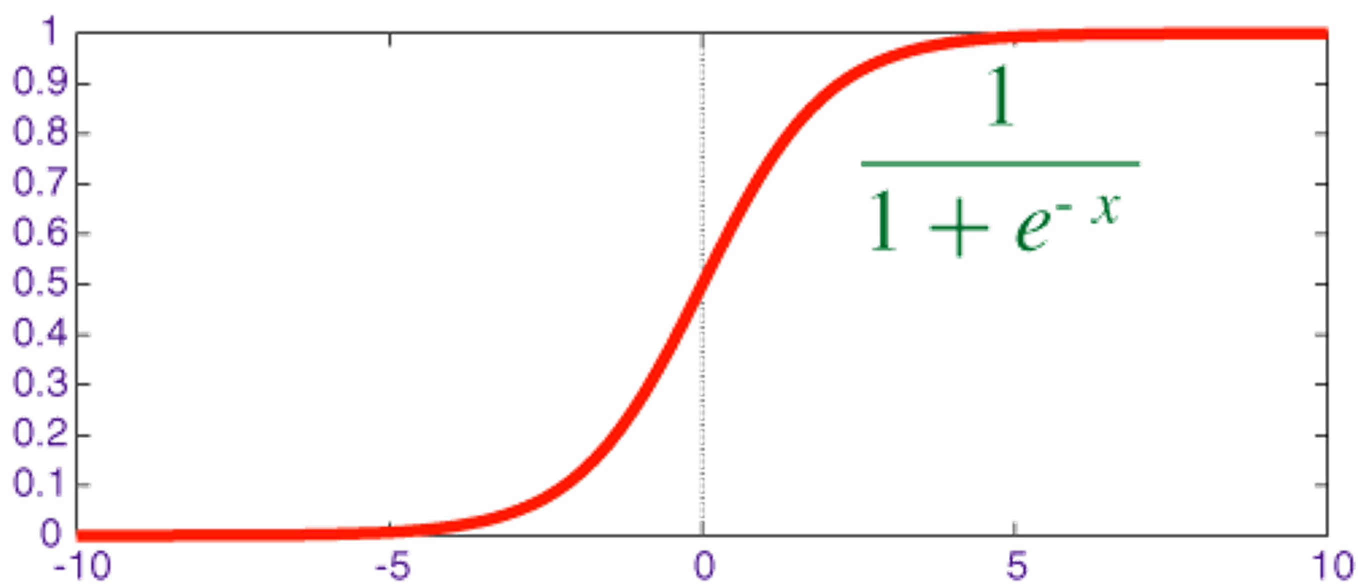
NEURAL NETWORKS

- Sequential matrix multiplication with non-linear activation functions between layers
- Fitting on a given dataset using a backpropagation algorithm
- Minimizing the error function L (distance between the predicted and target values)



NEURAL NETWORKS

- A sigmoid activation function at the output of the neural network is used for classification problems
- The signal target values are set to 1, and the background target values are set to 0.
- If the neural network is successfully fitted its output should be the probability that the input data point represents a signal



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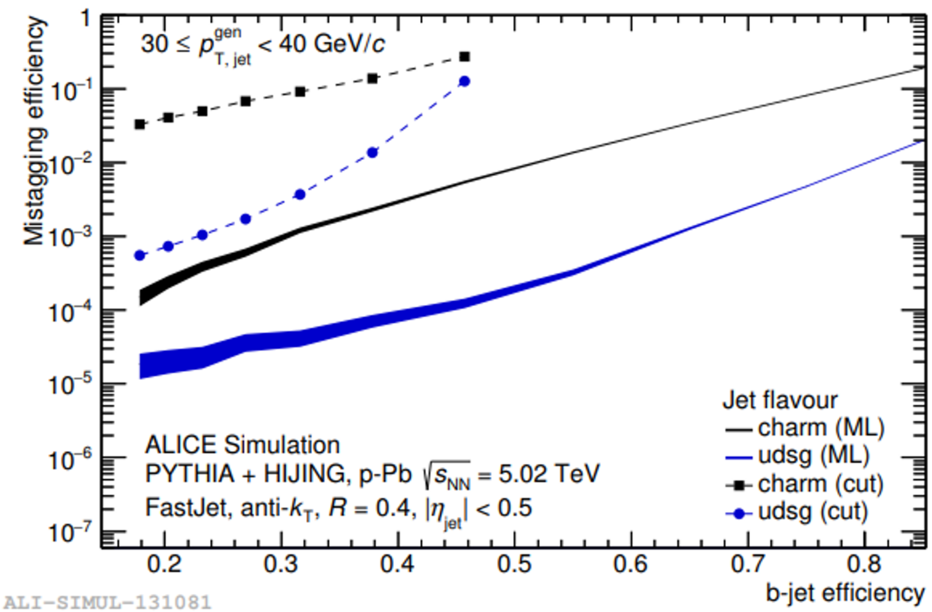
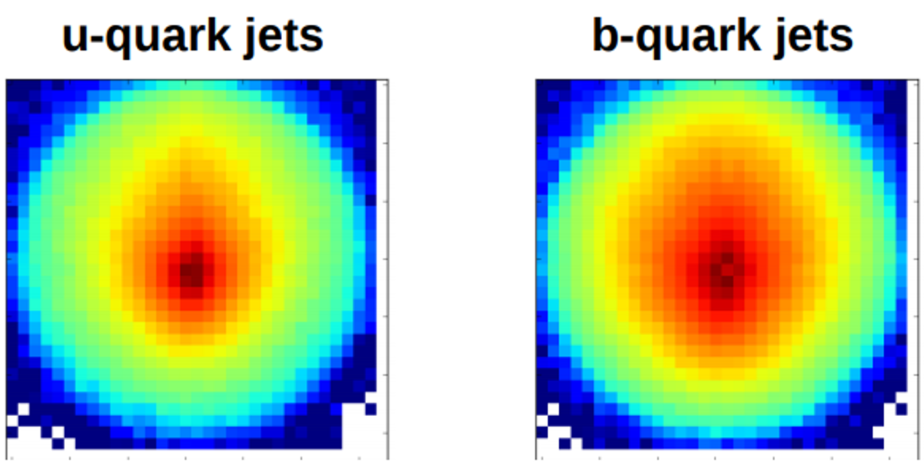
NEURAL NETWORKS IN PARTICLE PHYSICS





- Jet tagging methods using neural networks have been developed recently

- Jet images are used as input data
- Outputs (in this case) are jet flavors

ANALYSIS PROPOSITION

- The idea is to take low-level parameters such as transverse momenta, pseudorapidities and azimuthal angles of particles as input data

- Afterwards, create a training dataset consisting of known events and **find a way to assign labels to them according to jet presence**

- Train the neural network on the created dataset

- Use the trained neural network to discriminate real events and use it as a cut in the analysis of two-particle correlation functions

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QUESTIONS & DISCUSSION

- The biggest problem is how to assign labels to events in the training data
- Using existing jet algorithms on the simulated data?
- Make a data driven classifier in an unsupervised manner? (https://indico.cern.ch/event/765224/contributions/3301728/)
- What is the way to evaluate the performance of the jet algorithm?
- What are the basic properties a jet classifying algorithm should have?