

A Deep Learning Based Algorithm for PID Study with Cluster Counting

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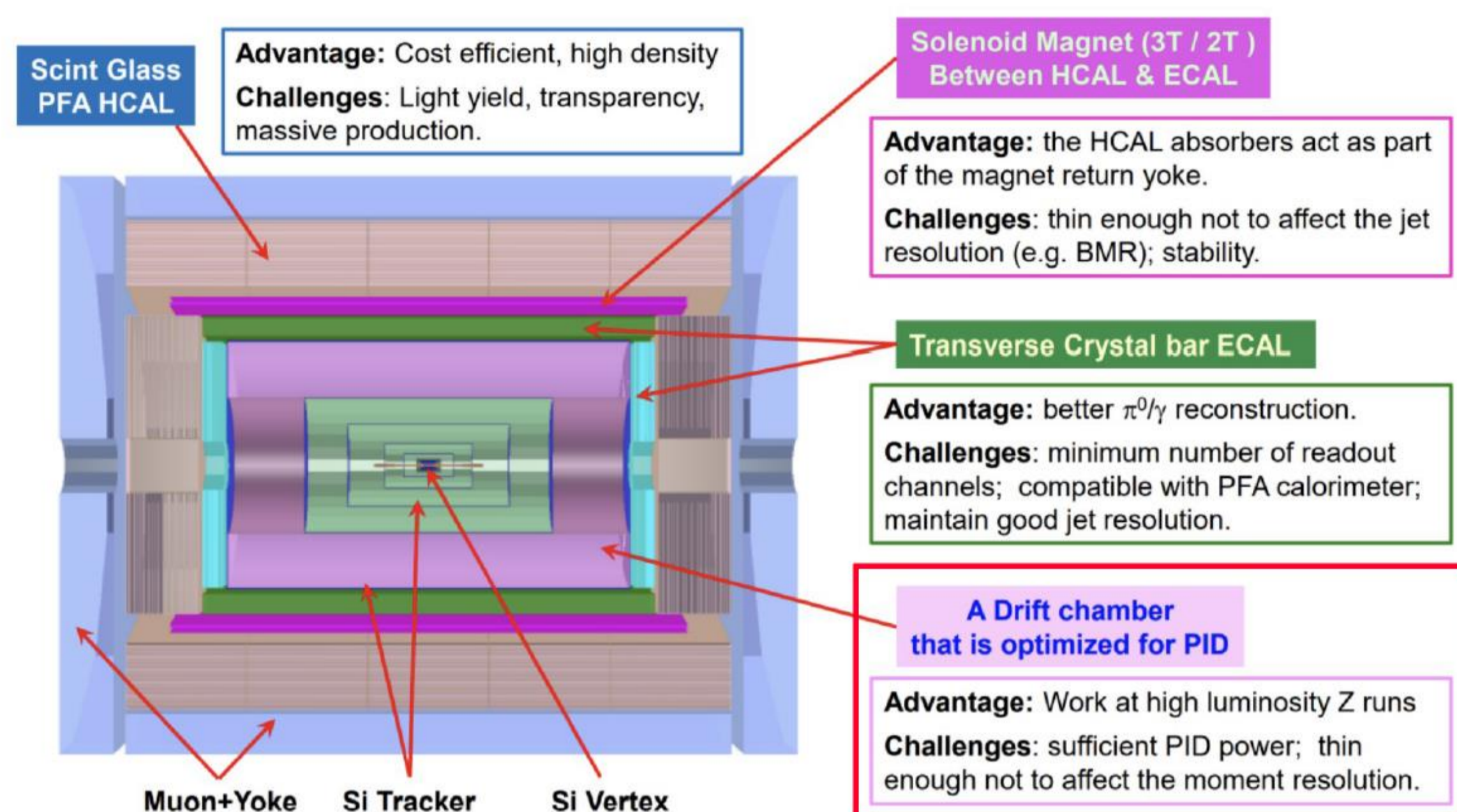
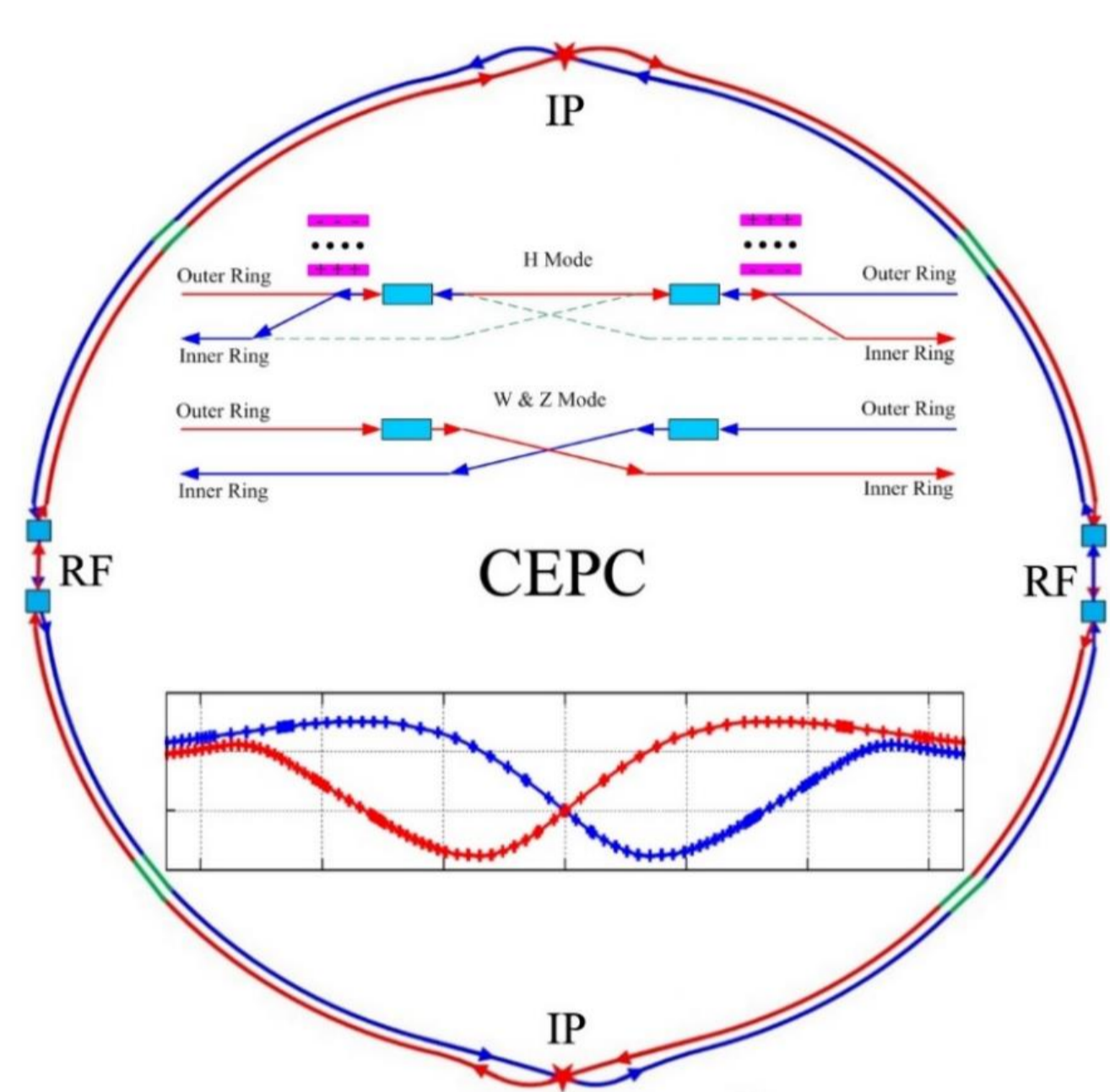
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1. Introduction

1.1 CEPC and the 4th conceptual detector

- CEPC is designed as the double ring accelerator with length ~ 100 km
- CEPC runs as
 - Higgs factory: ~ 4 M Higgs
 - Z & W factory: ~ 4 Tera Z, 100M W

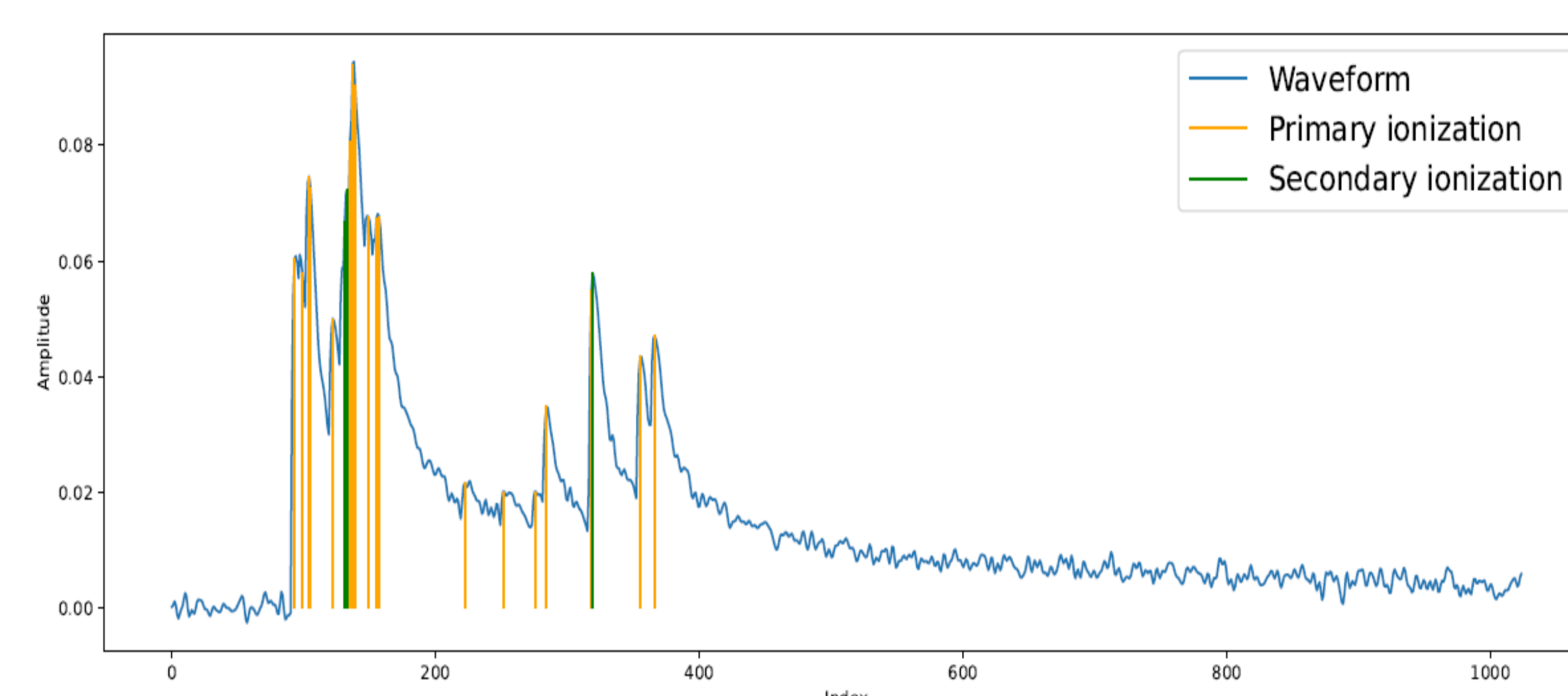


1.2 PID with the drift chamber

- Require $> 2\sigma K/\pi$ separation for $p < 20$ GeV/c
- Ionization measurement: dE/dx vs. dN/dx
 - dE/dx : total energy loss, large fluctuation
 - dN/dx : # of primary ionizations (N_p), small fluctuation (theoretical relative resolution $1/\sqrt{N_p}$)

1.3 Cluster counting algorithm

- Determine the N_p from the induced current waveform



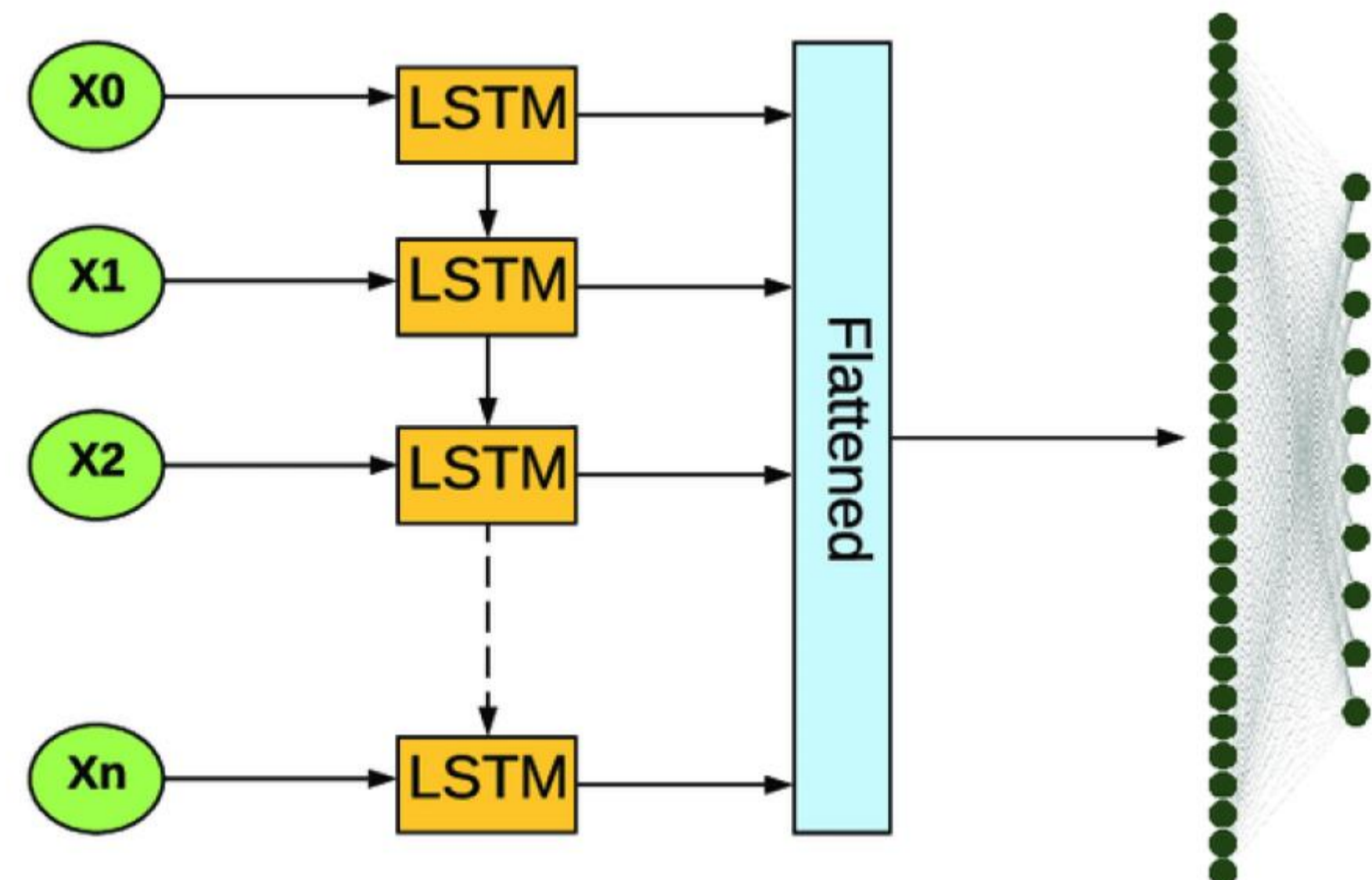
2. Peak Finding Algorithm with RNN

2.1 Peak finding problem

- Find all ionization peaks
- A classification problem on slicing window samples
- Time-sequence data structure

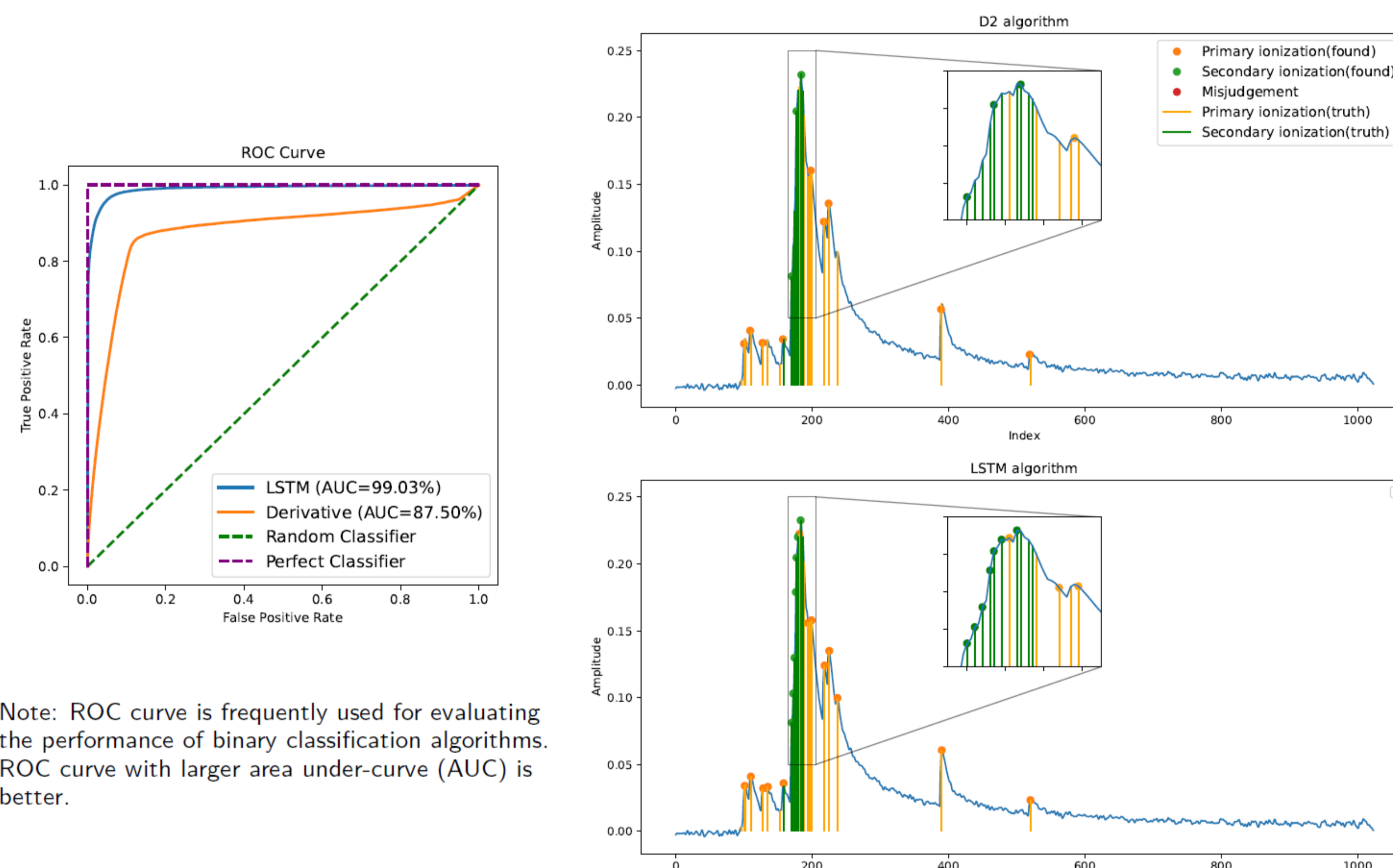
2.2 Network structure

- Main blocks: Recurrent Neural Network (RNN)



2.3 Results

- RNN-based classifier is much better than the one with traditional derivative method, especially for pile-up situations



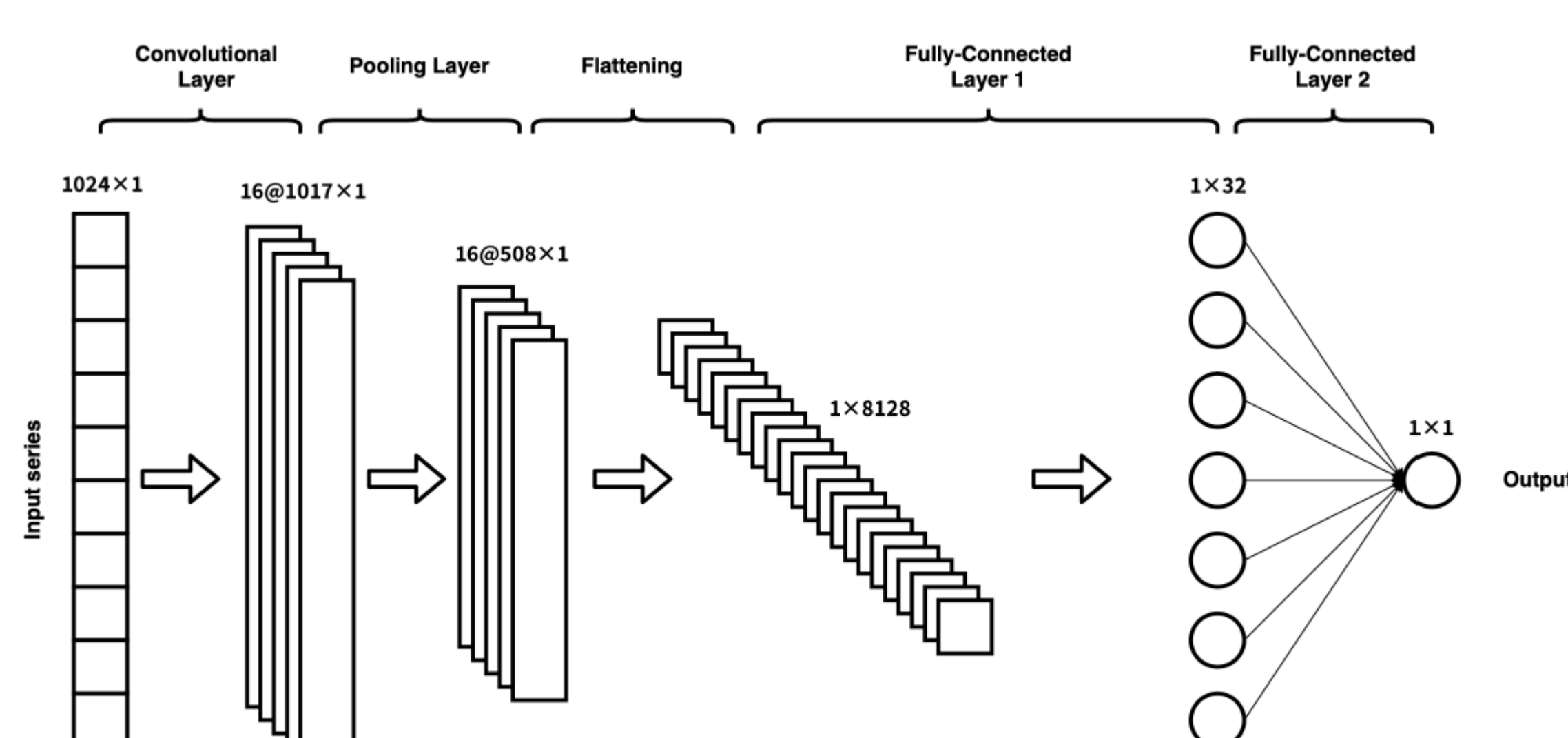
3. N_p Determination with CNN

3.1 N_p determination problem

- Determine N_p from detected times in peak finding
- A regression problem
- 1D pattern recognition

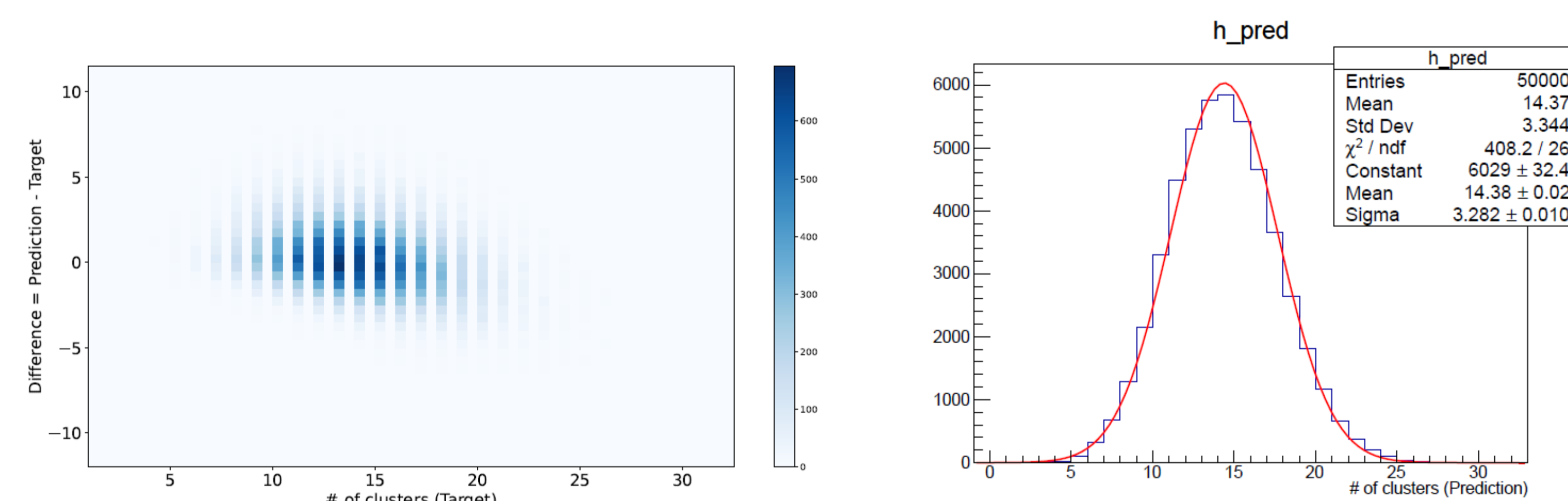
3.2 Network structure

- Main blocks: Convolutional Neural Network (CNN)



3.3 Results

- Single cell resolution $\sim 22.8\%$ (close to truth 22.3%)



4. Summary and Outlook

- A two-step cluster counting algorithm with ML is developed
- The algorithm is able to achieve a resolution close to the truth-level, which is better than the algorithm based on derivatives
- To make the full evaluation of the algorithm and to apply to the experimental data

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