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Pattern recognition in the PANDA experiment with neural networks

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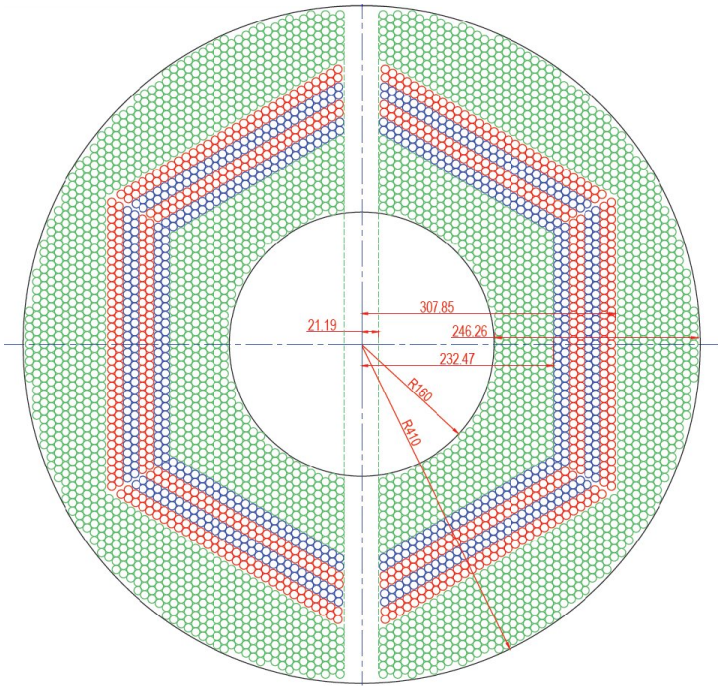
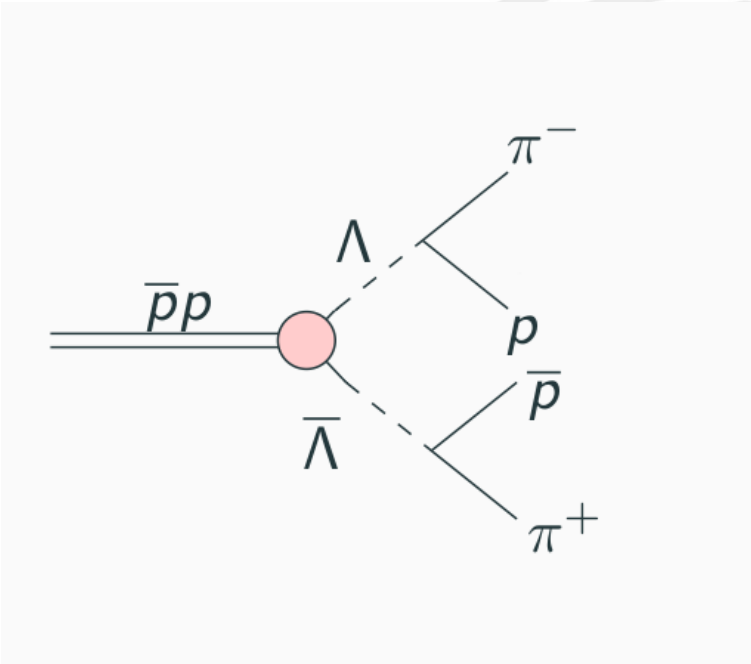
Introduction

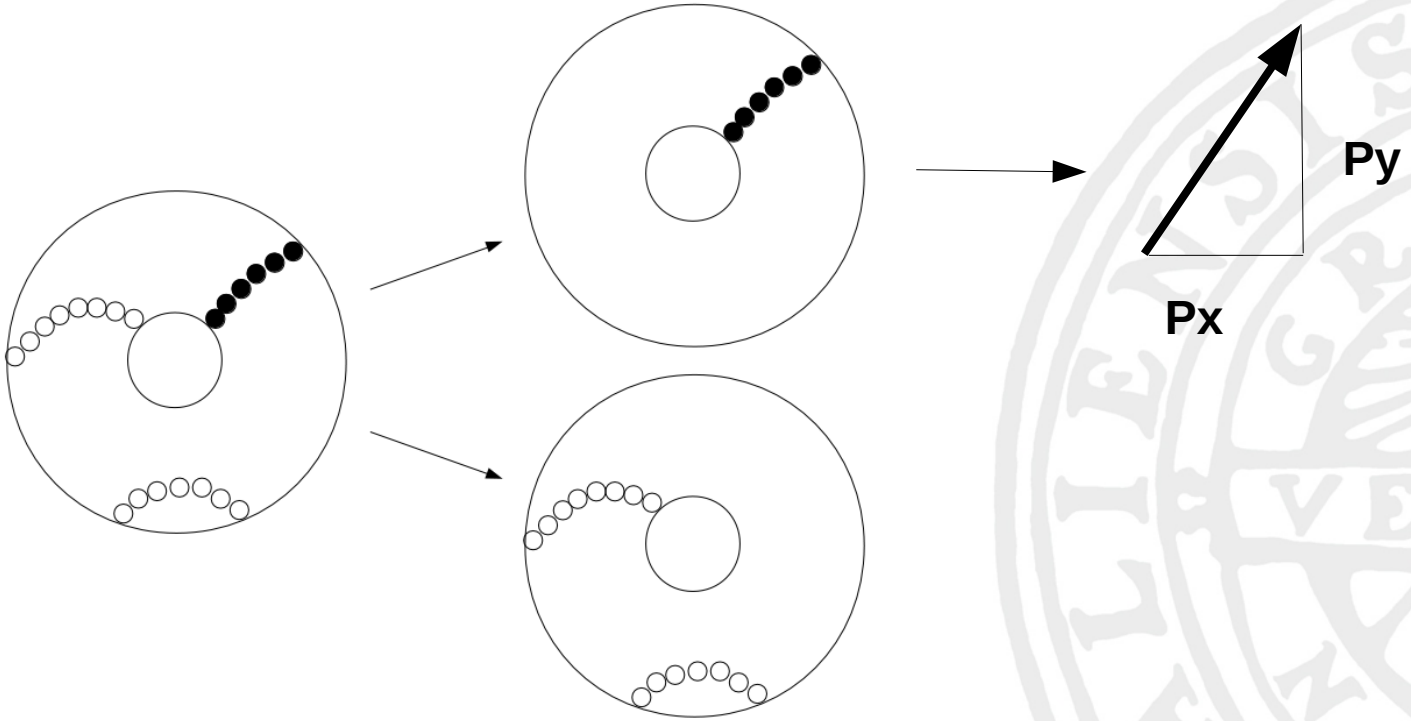
- Straw tube tracker (STT)
- Decay reaction





Problem description

- Identify specific particle tracks
- Extract physical observables
- Are neural networks a viable option?



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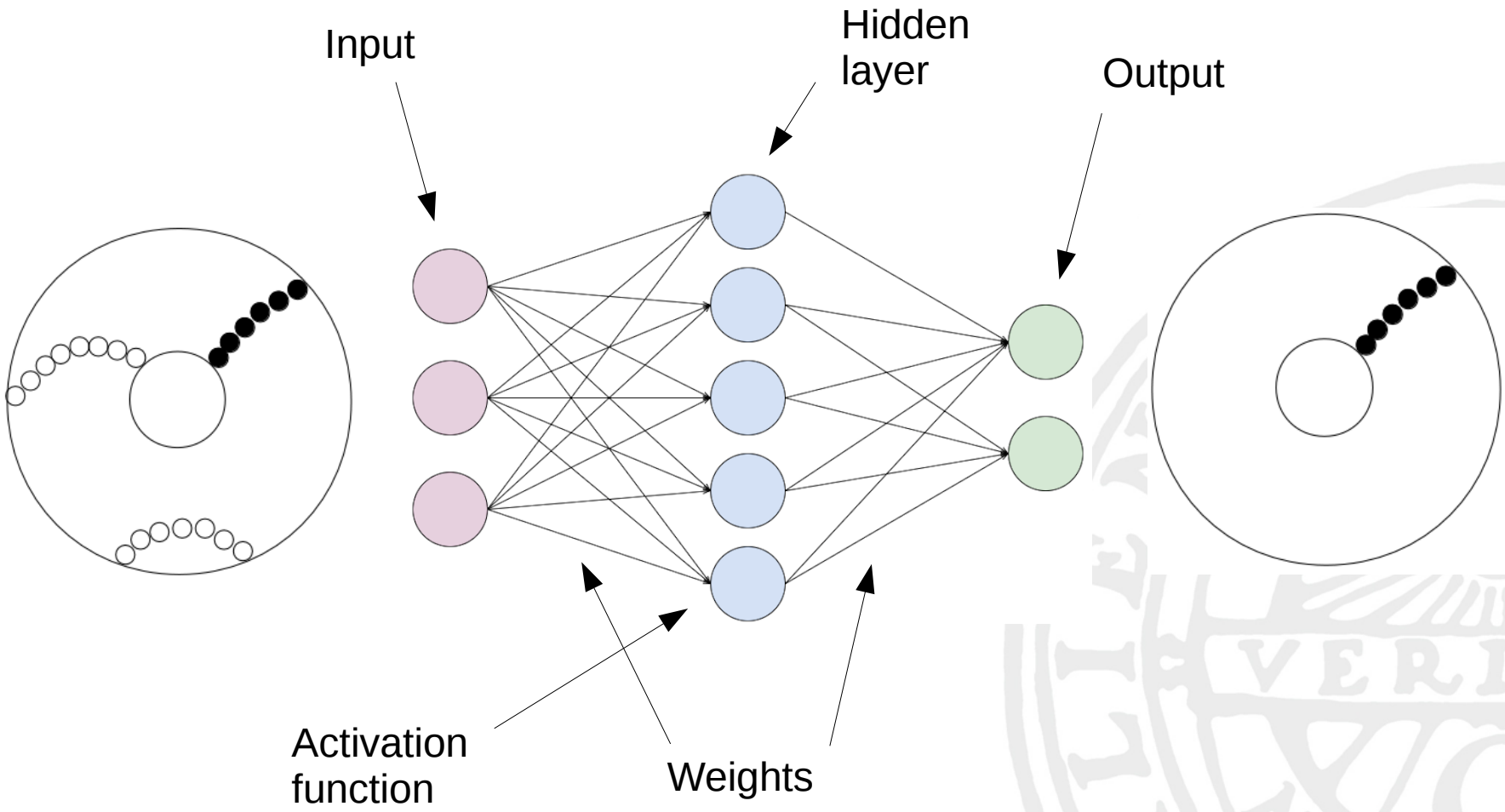
Neural networks



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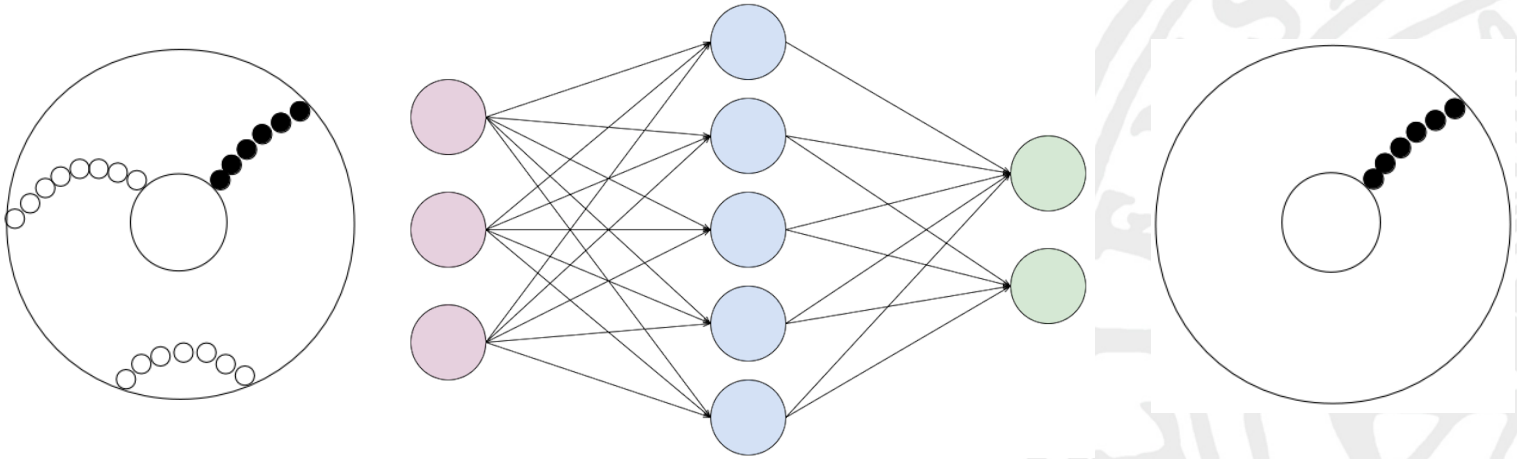
Method

- Two neural networks:
  - Pattern recognition
  - Momentum regression
- Trained on simulated data
- Implemented in Matlab

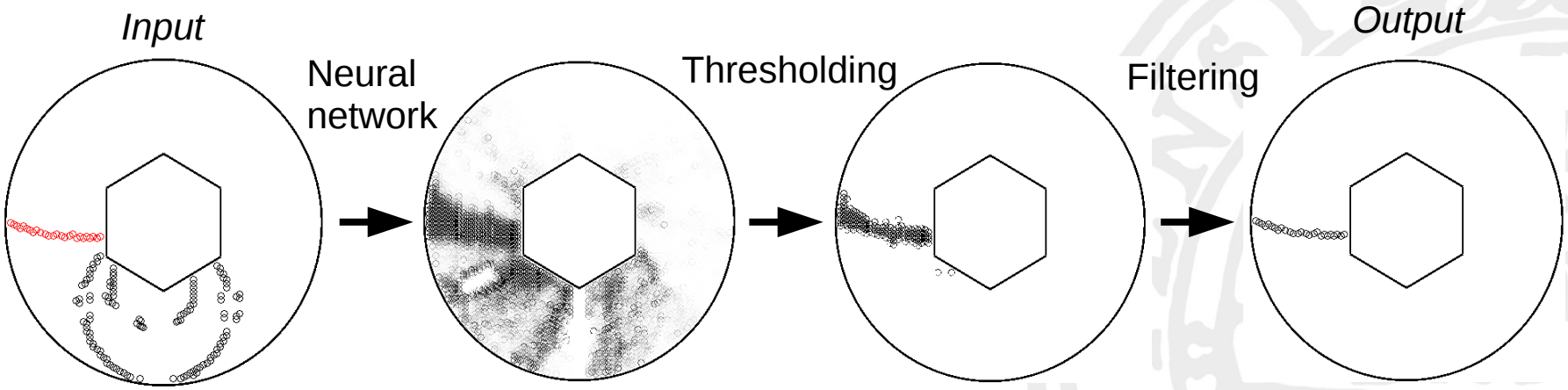
Method – Pattern recognition

- Identify the track of a specified particle
- Input: Raw STT signals (tube hits)
- Output: Specific particle track
- Four hidden layers



Method – Post processing

- Thresholding
- Filtering



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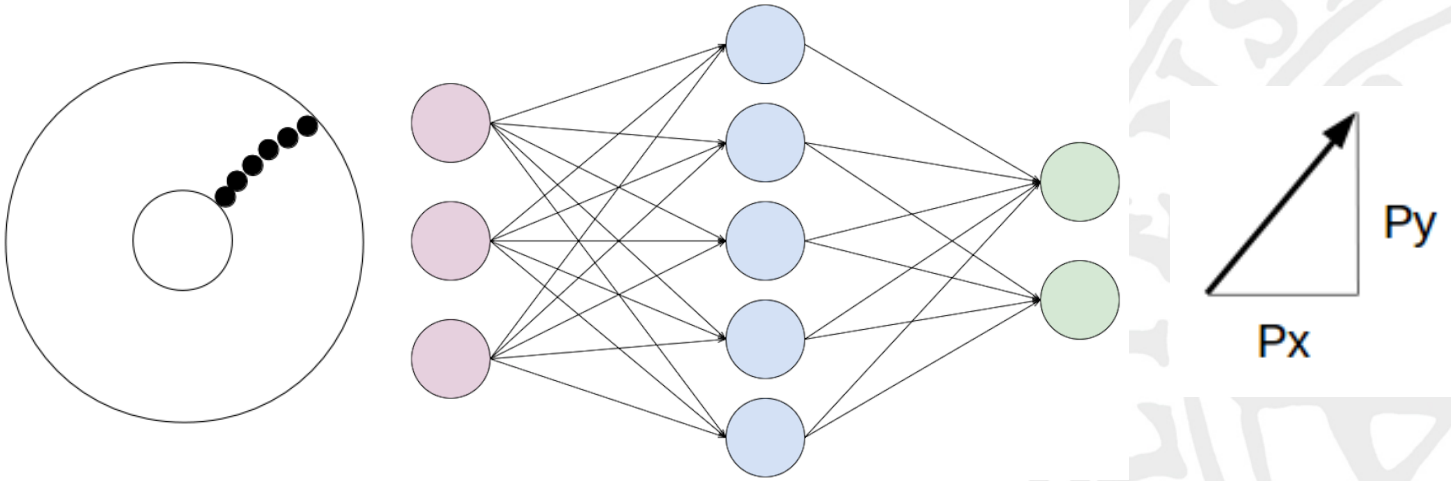
Method – Momentum regression

- Extract the momentum of a specified particle
- Input: Specific particle track
- Output: 2D momentum vector
- Six hidden layers



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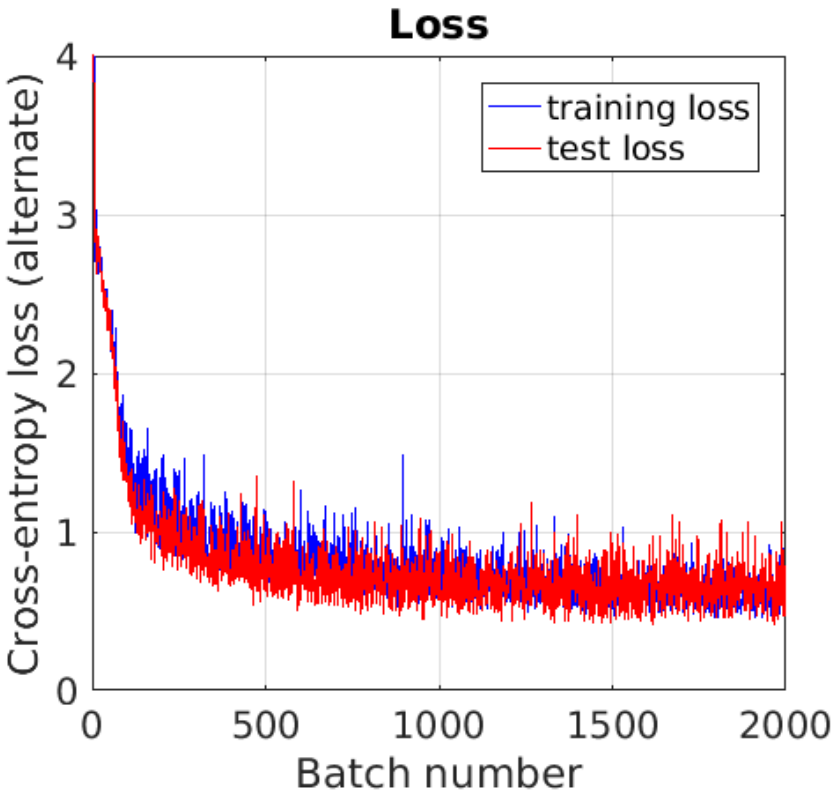
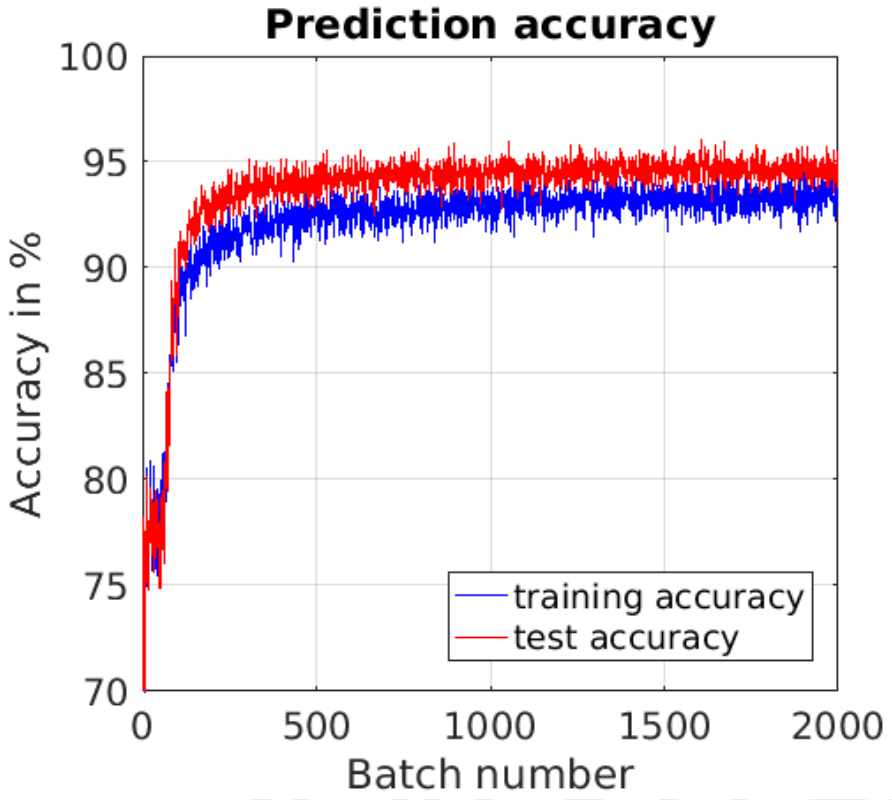
Results – Pattern recognition





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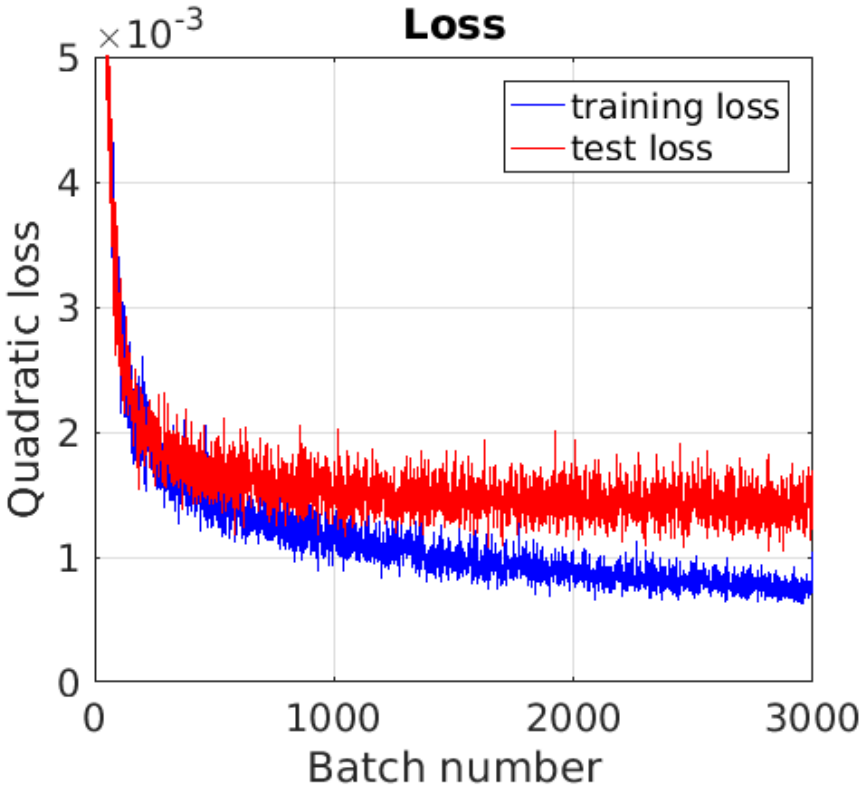
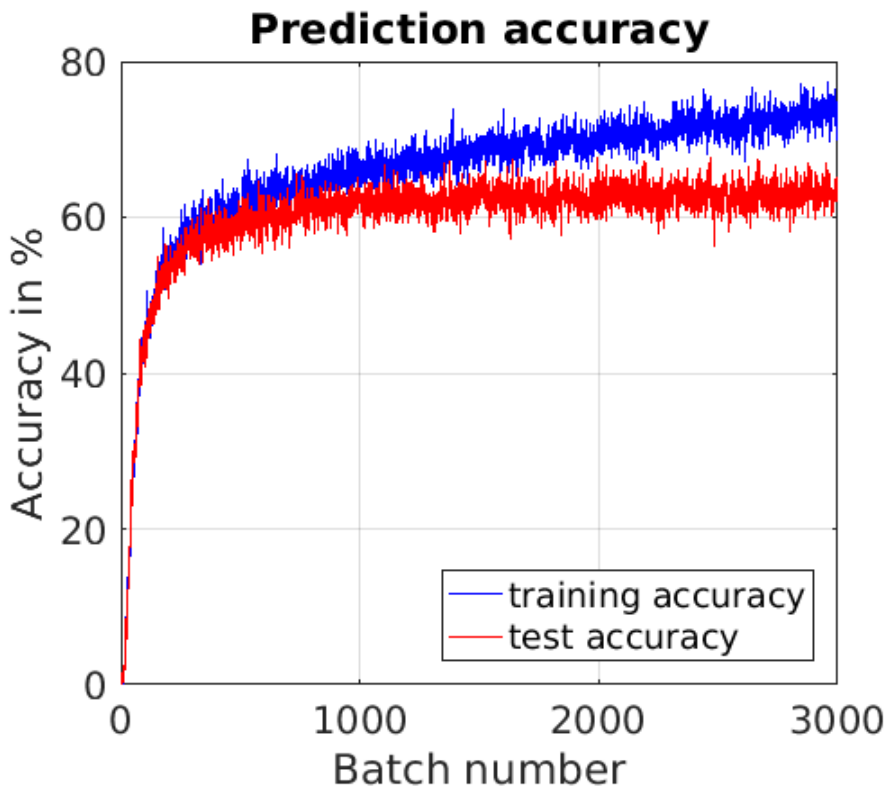
Results – Momentum regression



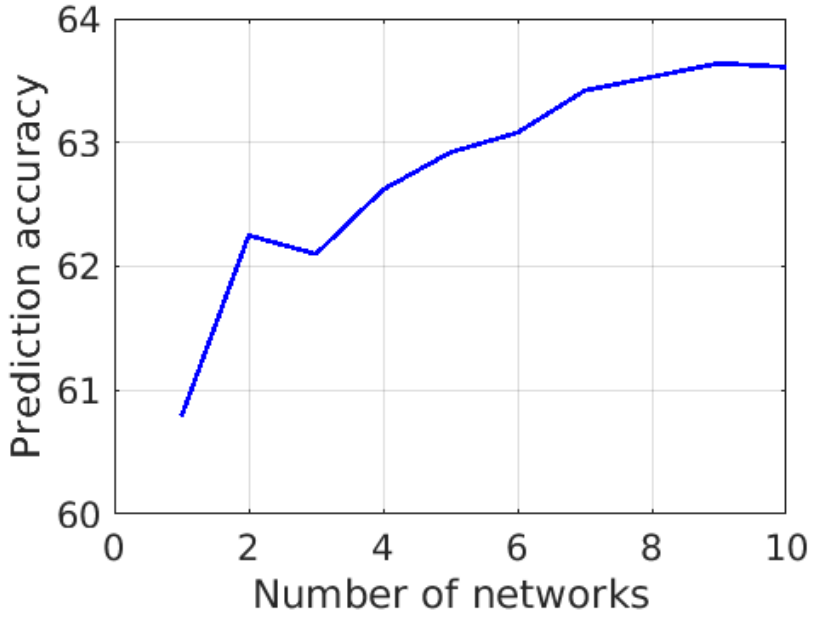


Results – Multiple networks

- 10 networks combined
- Slight accuracy increase, longer computational time

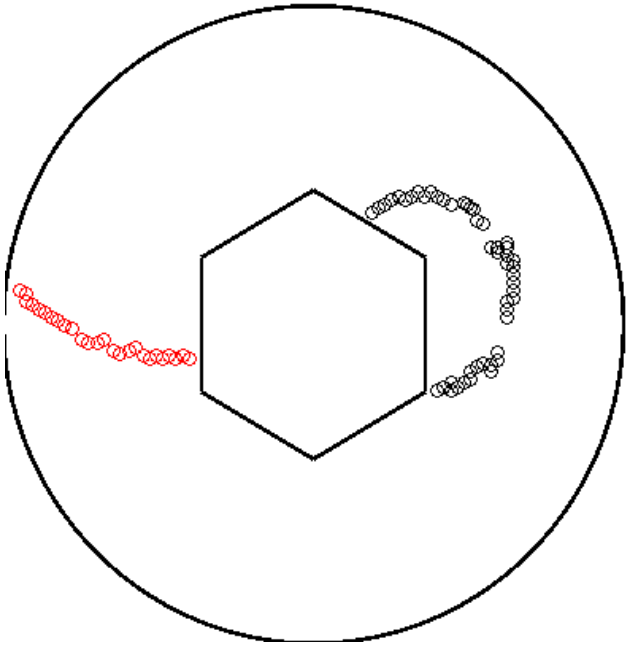
Pattern recognition

Momentum regression

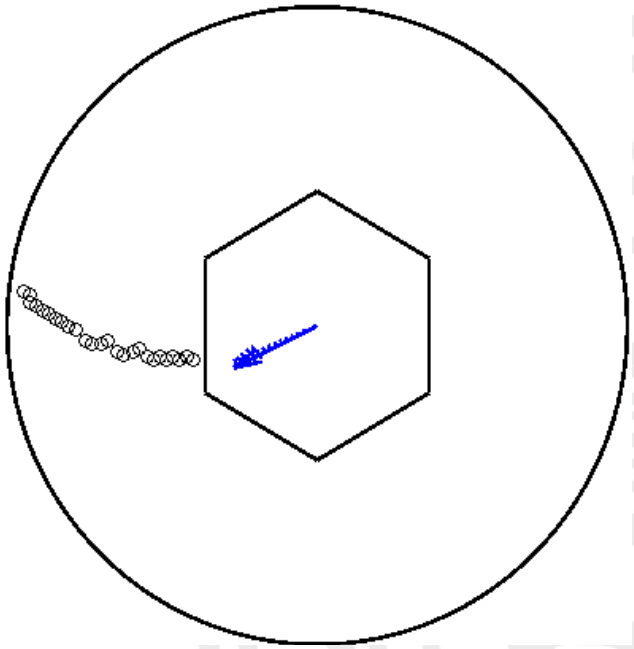


Visualization – Easy case

Input:



Output:



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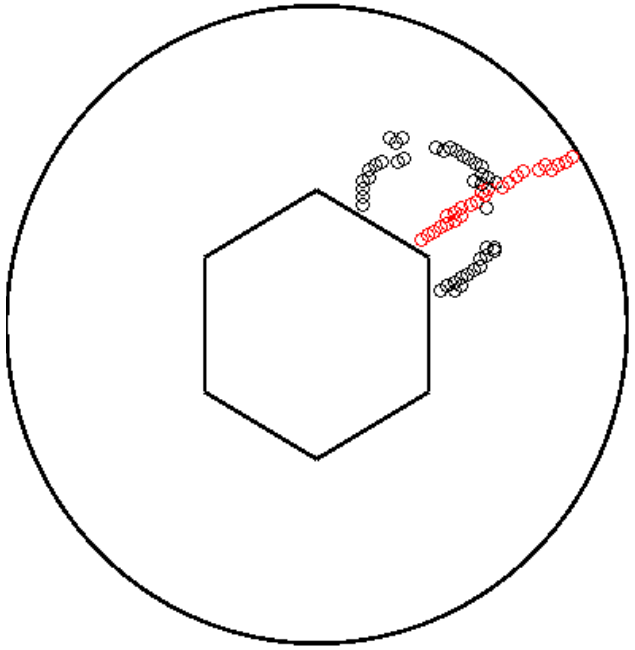
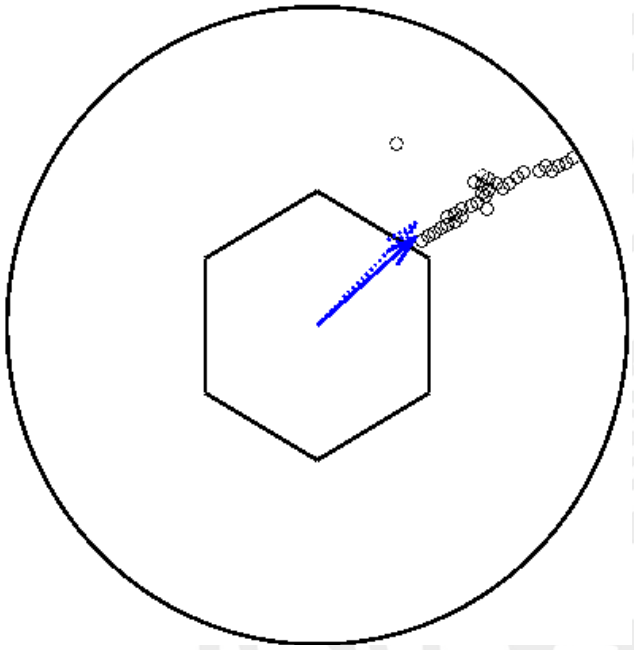
Visualization – Hard case

Input:



Output:



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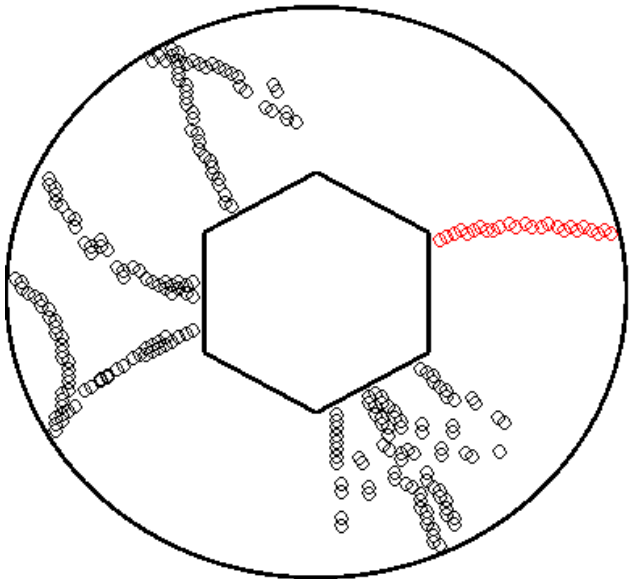
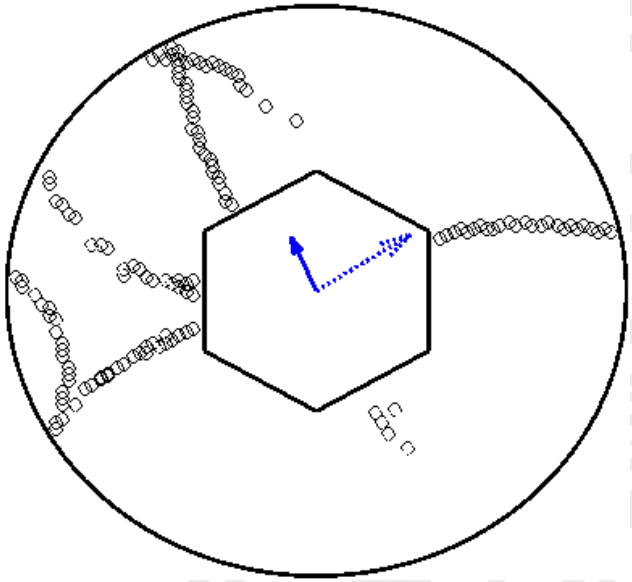
Visualization – Failure case

Input:



Output:



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Discussion and conclusions

- Finding good parameters can be difficult
- Large networks require large data sets
- One network for each particle
- Requires sufficient hardware
- Is machine learning a viable option?

Future improvements

- Include other detectors
- Include different decay reactions
- Study different network structures
- Optimize hyperparameters with different optimization methods

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Thank you
for listening!