

# Challenges in Particle Tracking: Detectors, Methods and AI

(MVSem)  
summer term 2024

# Organisation

Dates: Mondays at 4pm → schedule of presentations

Lecturers: Dr. Heiko Augustin, Dr. Sebastian Dittmeier, Prof. André Schöning

Requirements: Physics Bachelor & interest in topic

Deliverables: 30 min presentation + “proceedings” max. 6 pages

ECTS: 6 credit points

# Topics I

## Detectors

- Drift Chamber (Ref: W.Blum und L.Rolandi, Particle Detection with Drift Chambers, Springer)
- MWPC [[ref1](#), [ref2](#), [ref3](#) p127+]
- TPC Gas [[ref1](#), [ref2](#), [ref3](#) p154+]
- TPC Liquid [[ref1](#), [ref2](#)]
- Si-Strips [[ref1](#), [ref2](#) [ref3\(#1\)](#)]
- Hybridisation(Pixel) [[ref1](#), [ref2](#)]
- MAPS [[ref1](#), [ref2](#)]
- HV-MAPS [[ref1](#), [ref2](#)]
- SciFi [[ref1](#), [ref2](#), [ref3](#)]

# Topics II

## Methods

- Kalman Filter [[ref1](#), [ref2](#)]
- Cellular Automaton [[ref](#)]
- Hough-Transform [[ref1](#), [ref2](#) , [ref3](#)]
- Vertexing [[ref1](#), [ref2](#), [ref3](#)]
- SW Alignment of Tracking Detectors [[ref](#)]
- Track Trigger (FTK: <https://arxiv.org/pdf/2101.05078.pdf>)
- Uncertainties and Fitting (General)

# Topics III

## Artificial Intelligence

- Improving Tracking with Neural Networks [[ref1](#), [ref2](#), [ref3](#)]
- Track Seed Filtering and Jet Tracking with Convolutional Neural Networks [[ref1](#), [ref2](#)]
- Muon track reconstruction with Recurrent Neural Networks [[ref1](#), [ref2](#)]
- Charged Particle Tracking with Graph Neural Networks [[ref1](#), [ref2](#), [ref3](#)]
- One-shot Tracking with Object condensation [[ref1](#), [ref2](#)]

## Other

- Fast Tracking on GPUs

# Preliminary Schedule

15.4.: 1st preparation meeting (today)

22.4.: 2nd preparation meeting

13.5.: “Early Bird” presentations

03.6.: presentations

17.6.: presentations

01.7.: presentations

08.7.: presentations

15.7.: presentations

in total 11 presentations

# Writeup (“Proceedings”)

- Short summary of presentation
- Structure:
  - Title
  - Abstract
  - Introduction
  - Main part: theory, setup, method
  - Results
  - Conclusion
- Latex is recommended
- Maximum 6 pages

# Short Overview of Topics

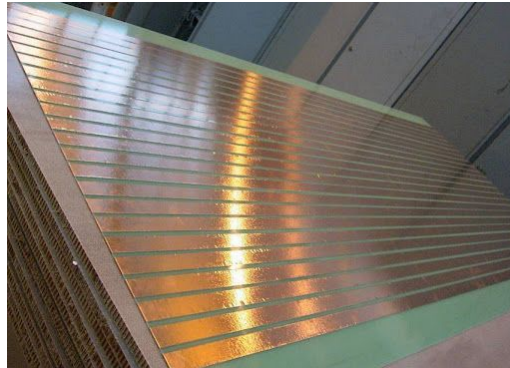
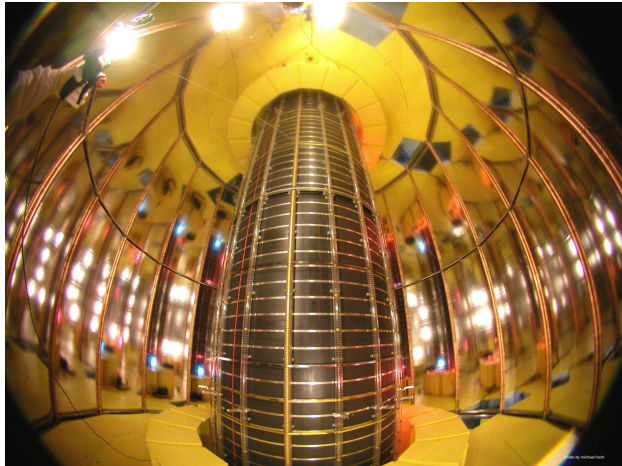
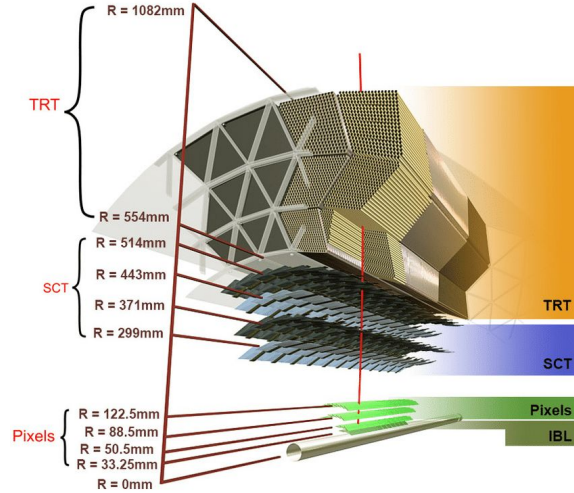
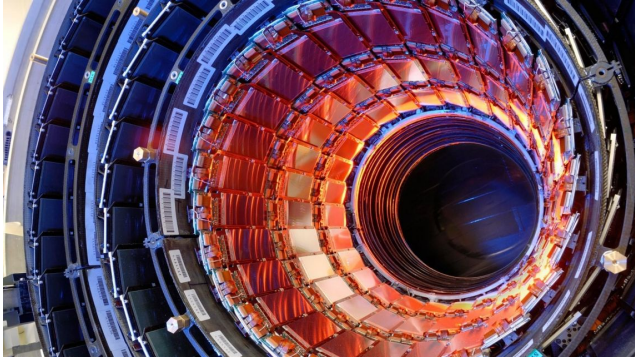
- Tracking Detectors
- Track Reconstruction Methods and Fitting of Track Parameters
- Tracking with Artificial Intelligence

Broad topics touching various aspects relevant in Nuclear and Particle Physics

- detector instrumentation & particle interaction with matter
- electronics
- statistical methods
- minimisation problems, machine learning
- fast & complex algorithms (e.g. for trigger)
- computing & software
- hardware processors & heterogeneous computing

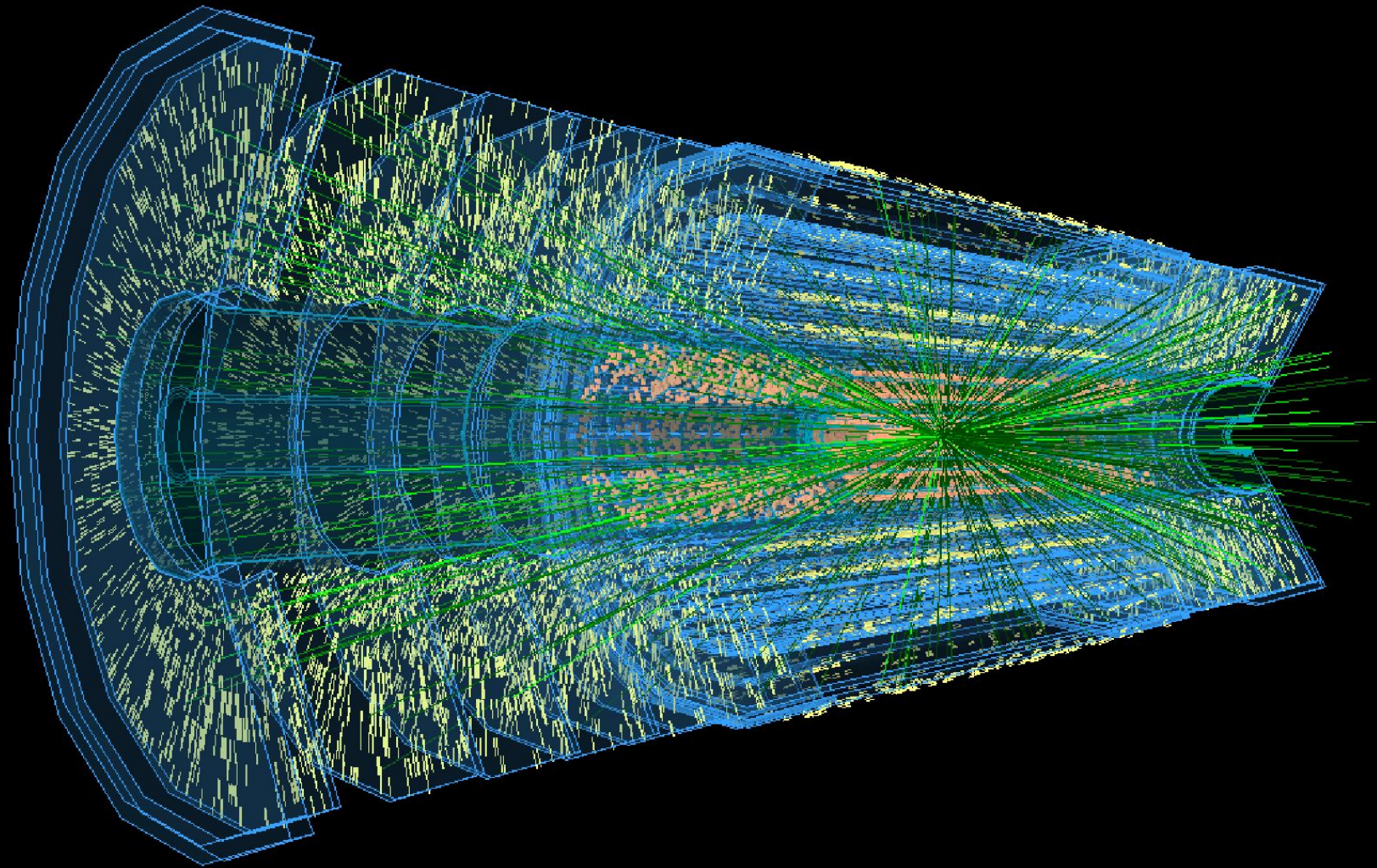


# Tracking Detectors

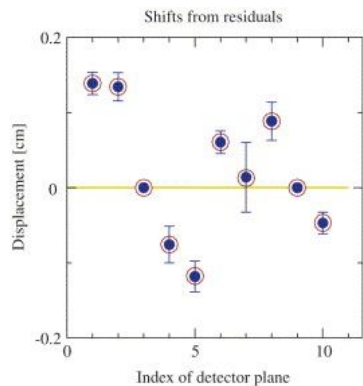
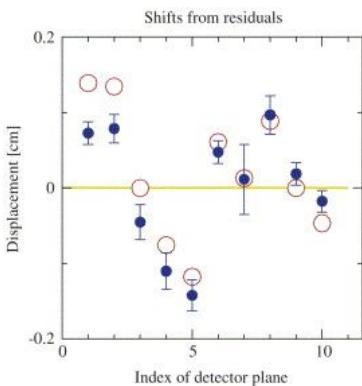
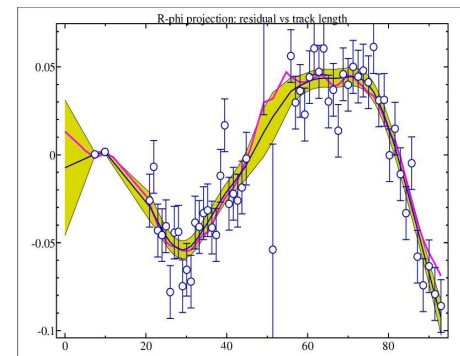
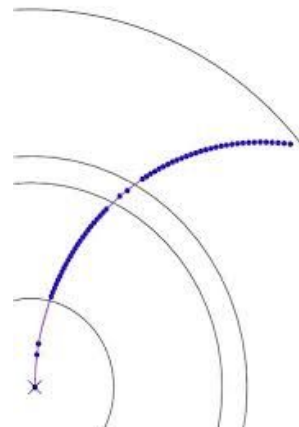
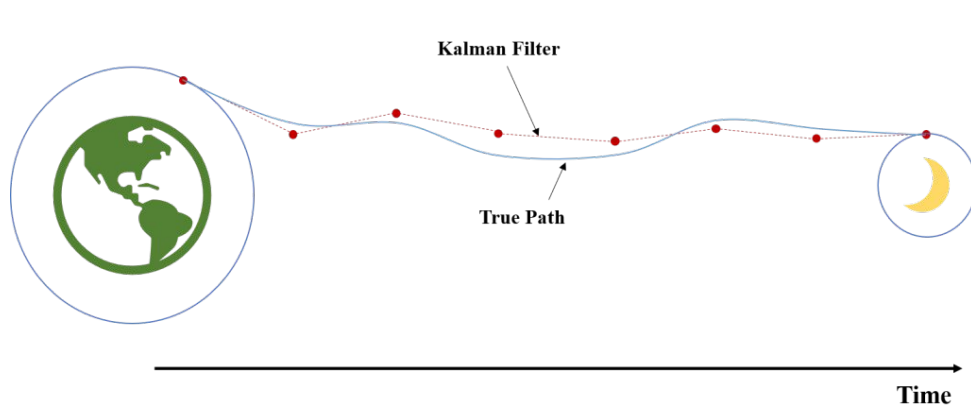


# Methods: Track Reconstruction and Track Fits

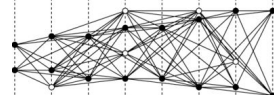




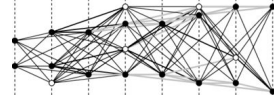
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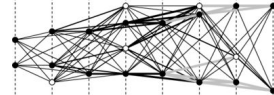
iteration 1



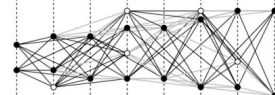
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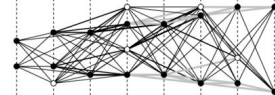
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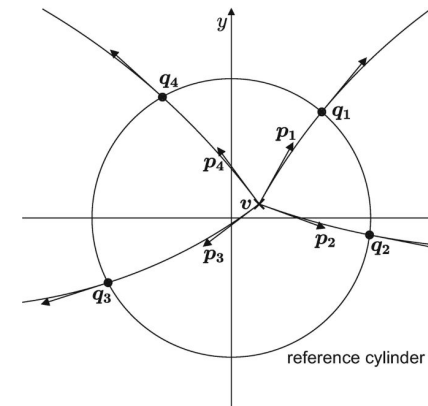
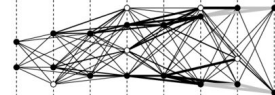
iteration 2



iteration 4



iteration 6



# Tracking with Artificial Intelligence

