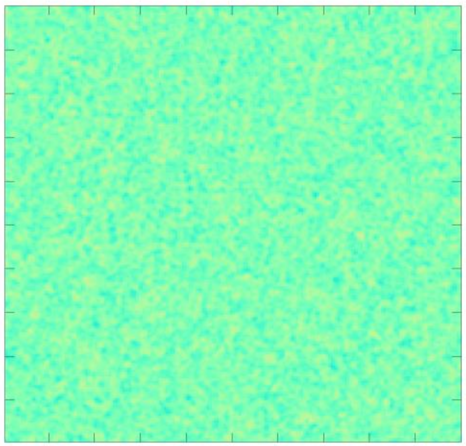
Current projects

Identifying Spinodal clumps using deep learning

- An important goal of HIC is the search for the QCD phase transition
- Spinodal decomposition is a unique feature of dynamical phase transitions
- But: How to design observables and what to expect event-by-event wise.



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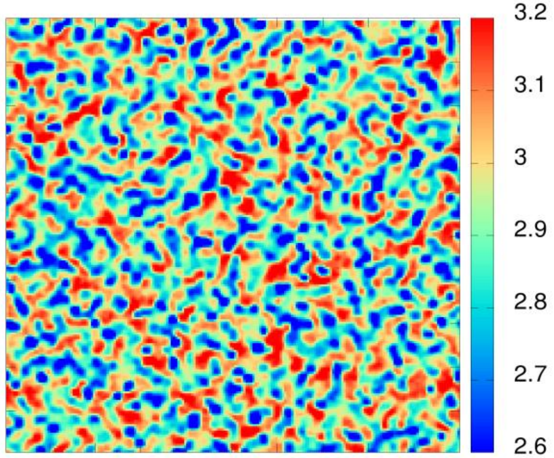

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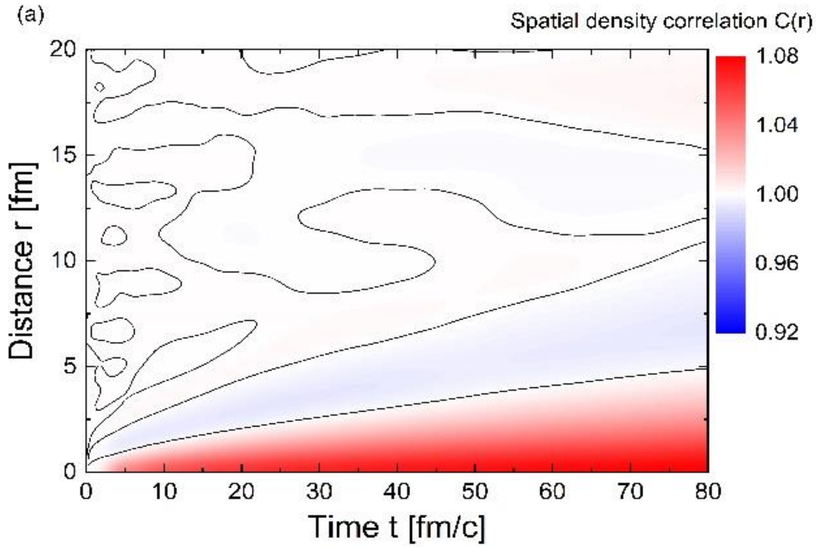
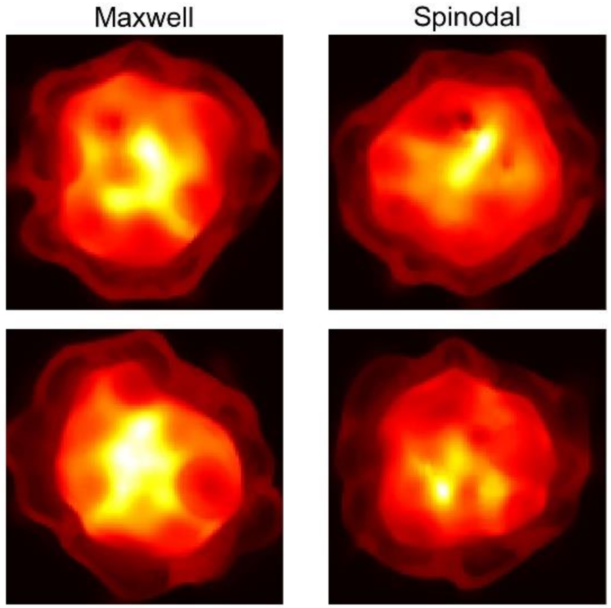
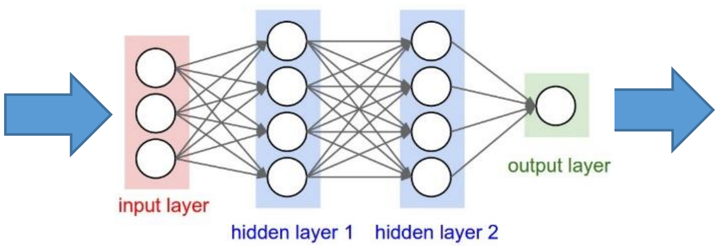


Identifying Spinodal clumps using deep learning



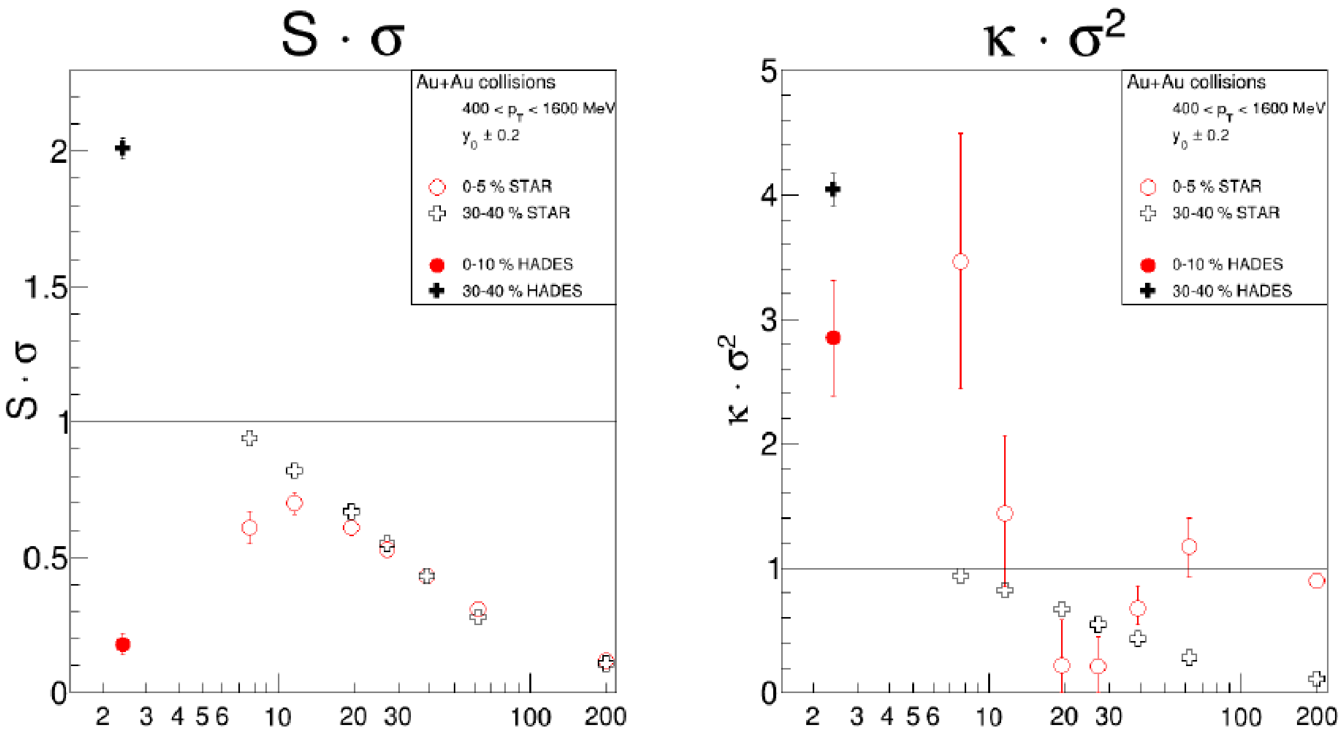


Results (almost TBP)**:**

- A CNN works well to identify the clumps in coordinate space event-by-event
- Momentum space it is much worse: correlations are more hidden
- Will lead to "outlier" events.

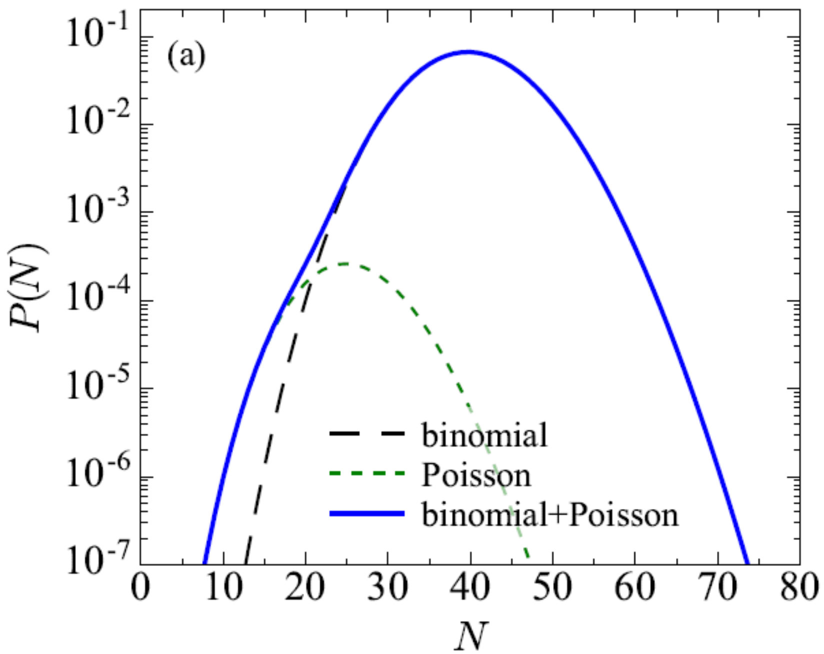
Unsupervised learning for event classification

- Experiments measured „non-random“ multiplicity distributions
- Defined by the cumulants of the multiplicity distribution.
- C.B.M. maybe at sweet-spot for non-statistical outliers



Work in progress

- Measurement's can be explained by two event-classes!
- We cannot assume the idea of random outliers anymore!



➢ In order to understand the physics we need to be able to identify the systematic outliers

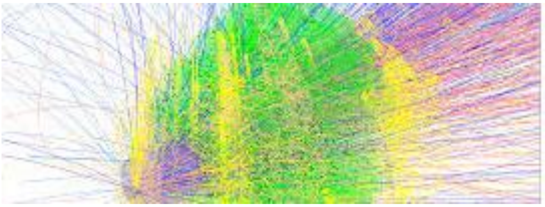
➢ Unsupervised learning

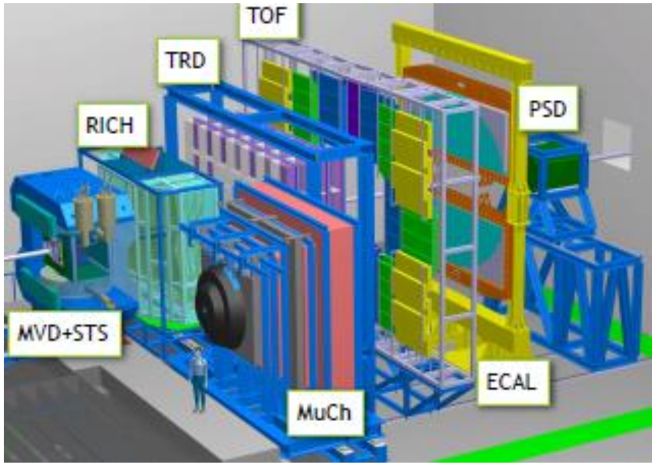
➢ Simulate with model and try to find unbiased way to separate event classes for further study

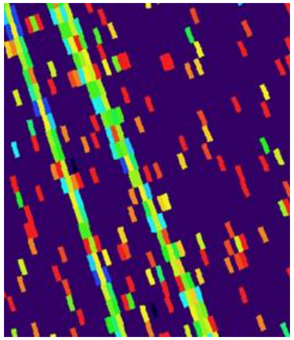
AI for future Detectors (O. Linnyk)

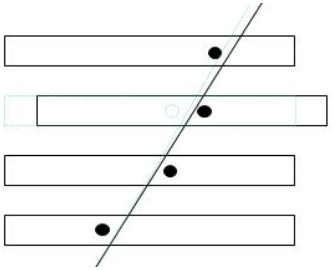
Challenges:

- 10^5-10^7 collisions per second, high data flux
- High radiation load, aging
- Many particles/tracks per collision









Solutions:

- AI allows online decoding of underlying physics for the event selection, with controlled accuracy
- AI-algorithms for frequent recalibration and quality control of detector sub-systems
- Great speed-up of tracking and realignment algorithms by AI-optimisation

Courtesy O.Linnyk, I.Kisel, CBM Collaboration

AI for future Detectors (Real example)

Consider a TPC or a solid-state-based detector sub-system, which records hits on individual pads or pixels. During operation, a fraction of the activated pads/pixels is defect or registers noise. Identifying these will improve the accuracy and significance of the measurement.

Solution:

- An AI-algorithm was trained to distinguish “good” pads from “bad” ones based on the patterns of the ADC signal from single pads.
- The filter maps for entire TPCs were created within seconds, accuracy 95%.
- Algorithm performance generalizes to different conditions (drift velocity,…)

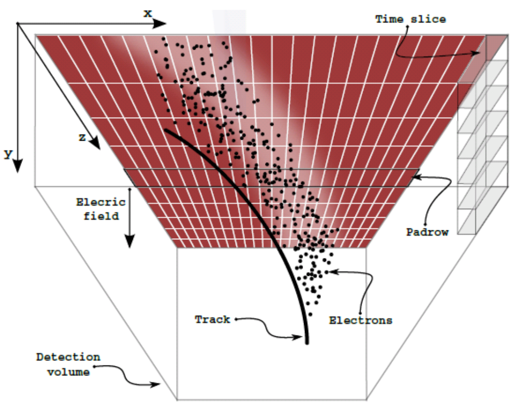
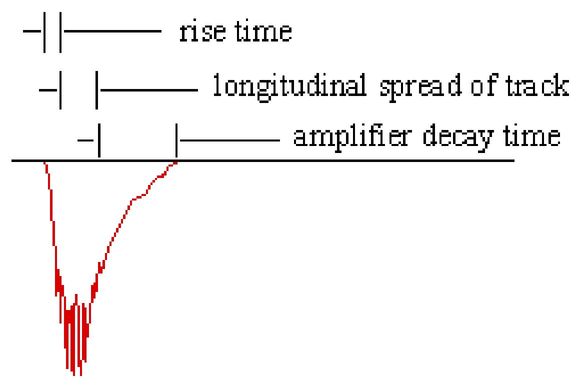
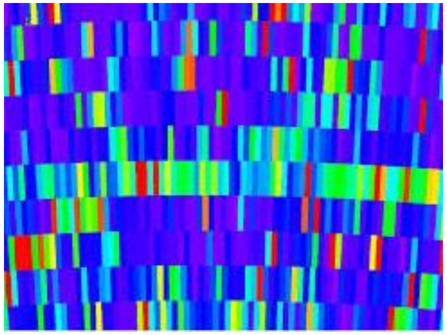


Figure 2. Simplified illustration of TPC working principle.





Courtesy O.Linnyk, NA61/SHINE and CLEO Collaborations

See Manuel Lorenz talk

- The HADES experiment used a neural network to improve Lambda detection efficiency.
- Used an old package of root.
- Can we find new state-of-the-art methods to improve?
- Use for other particles
- Use less information.

What/who are are looking for?

Many more possible projects in theoretical physics, experimental physics.
Even other fields of science (seismology, industrial applications, medicine etc.)

- Trying to apply ML methods to physical sciences.
- We are looking for (stipend based) enthusiastic PhD students and young postdocs for AI, DL and ML applications to physical sciences and especially C.B.M. physics.
- Broad field of interest.
- Interdisciplinary environment.