

Deep Learning Powered Anomaly Detection for the Unknown

Benjamin Nachman

Lawrence Berkeley National Laboratory

cern.ch/bnachman



@bpnachman

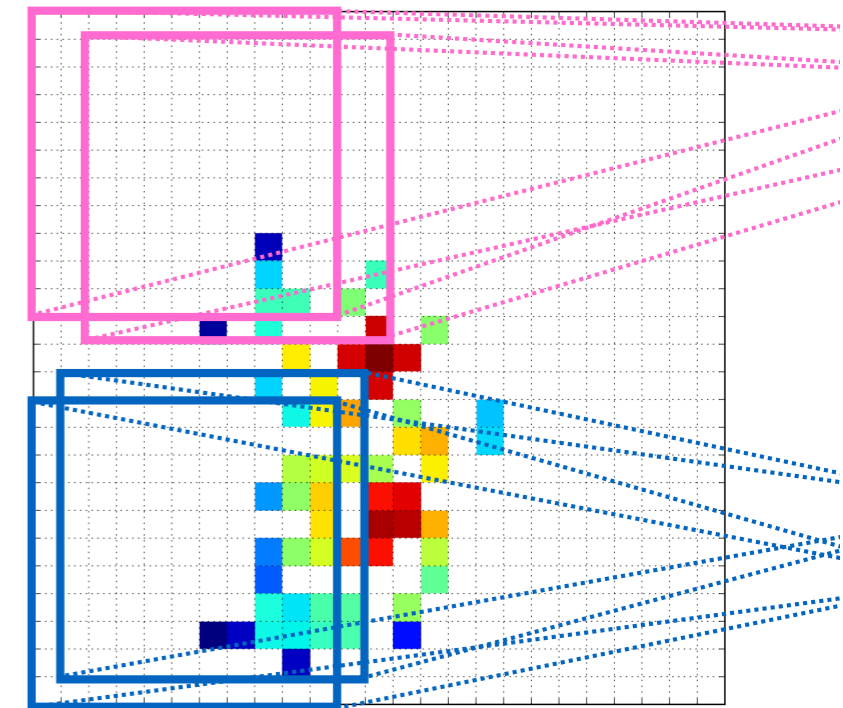


bnachman

bpnachman@lbl.gov



**BERKELEY
EXPERIMENTAL
PARTICLE
PHYSICS**



EF09 Snowmass Meeting
June 26, 2020

Questions in fundamental physics

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Theoretical and **experimental** questions motivate a deep exploration **of the fundamental structure of nature**

Dark matter

Hierarchy problem

Strong CP

Flavor puzzles

Baryogenesis

Dark energy

We have performed thousands of hypothesis tests & have no significant evidence for physics beyond the Standard Model

Three possibilities

- (1) There is nothing new at LHC energies
- (2) Patience! (new physics is rare)
- (3) We are not looking in the right place**

There is a lot left to explore!

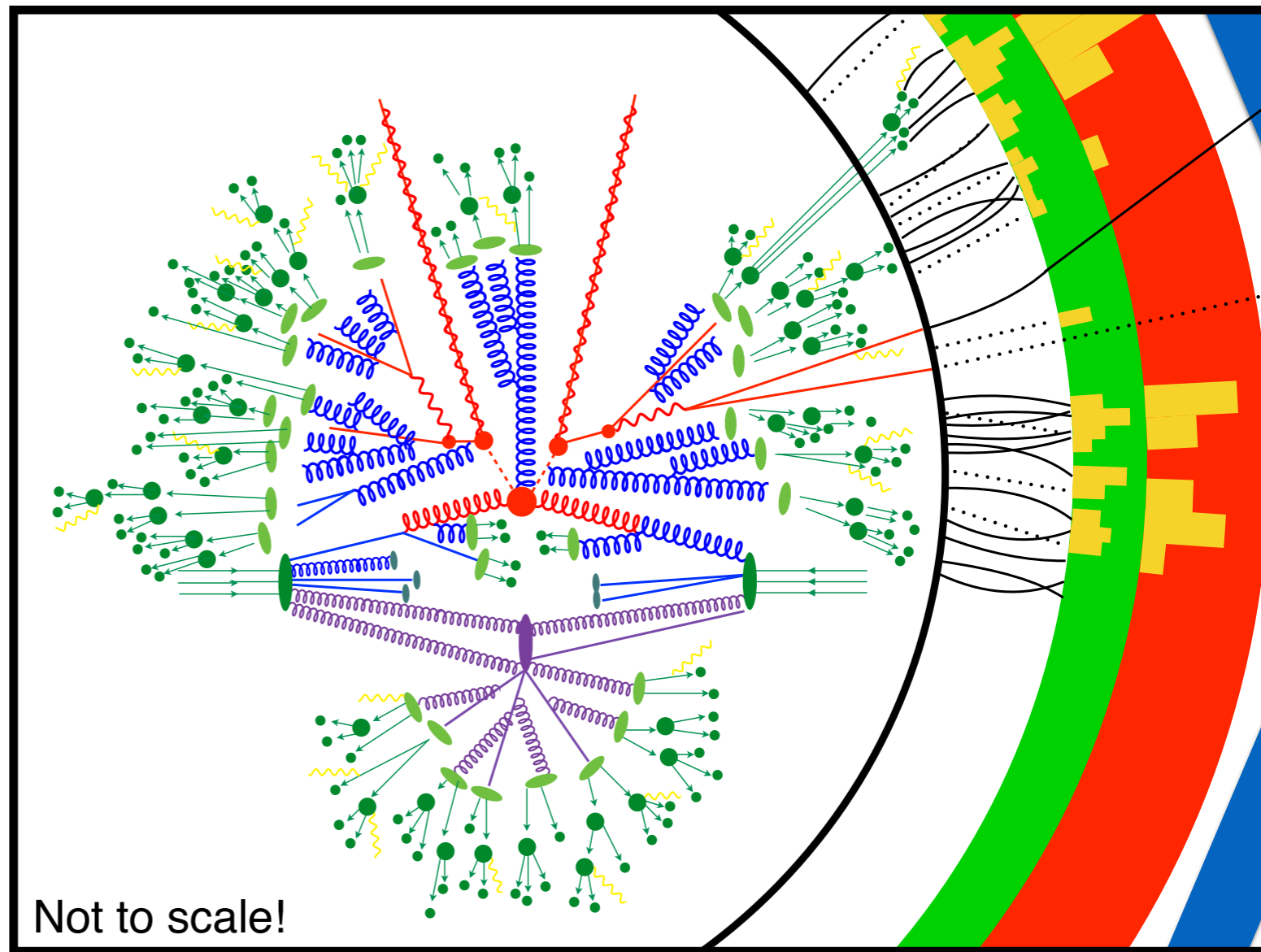
3

Key **challenge** and **opportunity**: *hypervariate phase space*
& *hyper spectral data*

Typical collision events
at the LHC produce
O(1000+) particles

We detect these
particles with
O(100 M)
readout channels

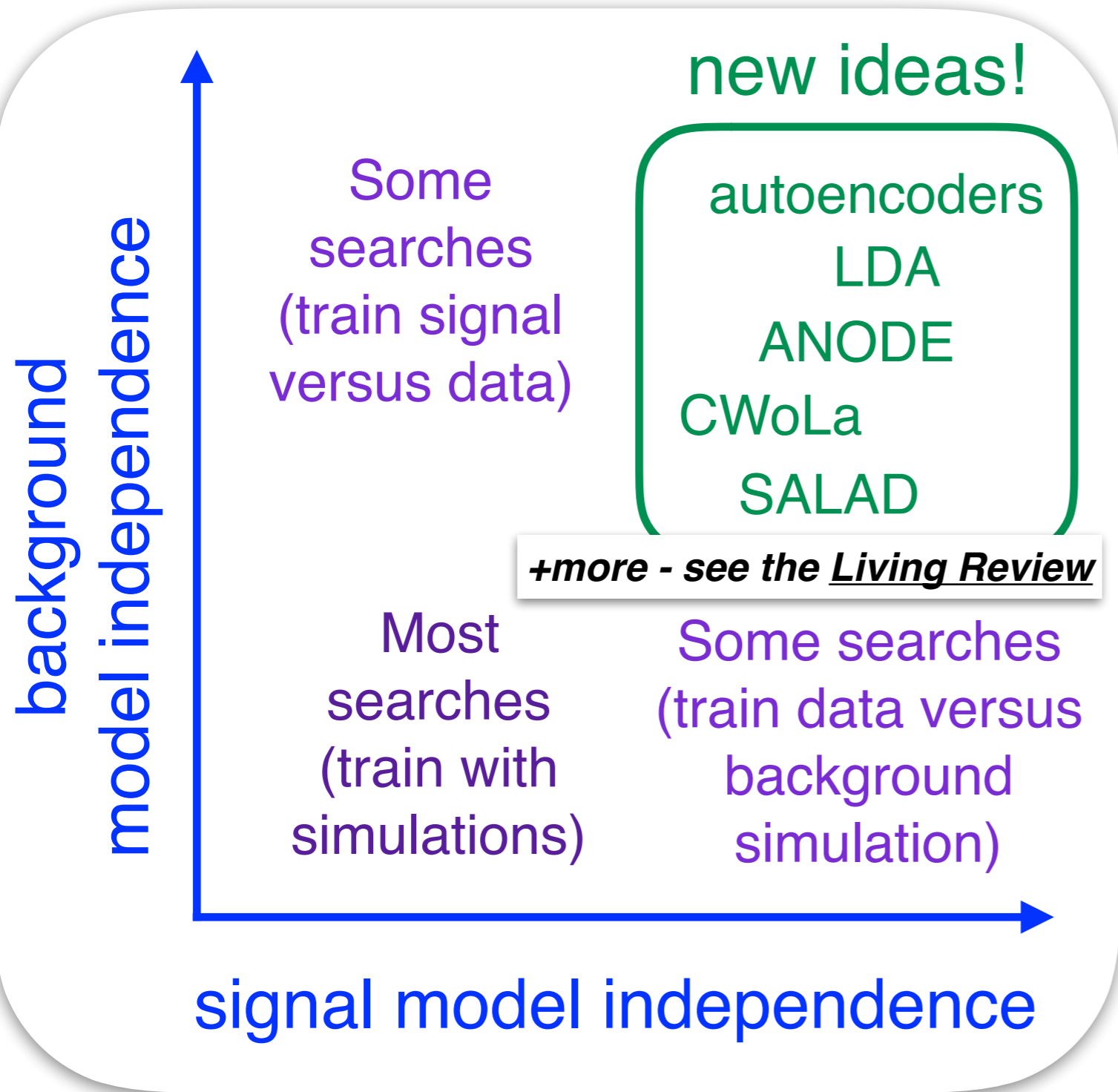
Image inspired by JHEP 02 (2009) 007



Not to scale!

ML Powered Anomaly Detection

4



Rapidly developing area - see e.g. the LHC Olympics 2020



*G. Kasieczka. BPN, D. Shih
<https://lhco2020.github.io/homepage/>*

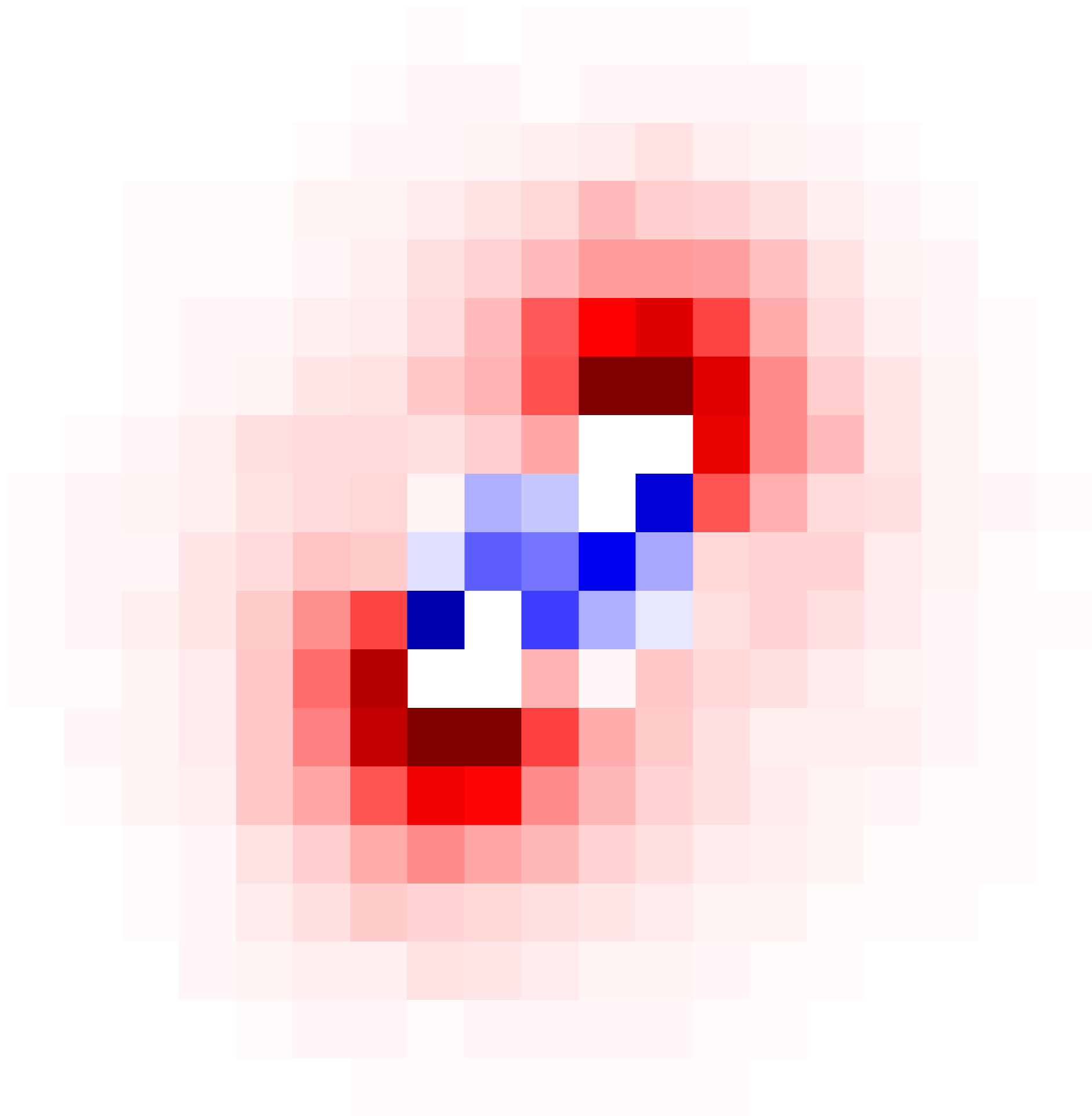
We need your great ideas!



This is an active area of R&D and I don't think it would be all that useful to repeat studies for different collider configurations.

Ultimately, my goal is to ensure that anomaly detection is part of the main physics program strategy and not just an after thought.

To this end, it seems like a useful Snowmass contribution could be to provide a survey of existing and future methods and discuss their potential for discovery at future colliders.



Fin.