# AI/ML Mini-workshop at
# FCC Week 2024

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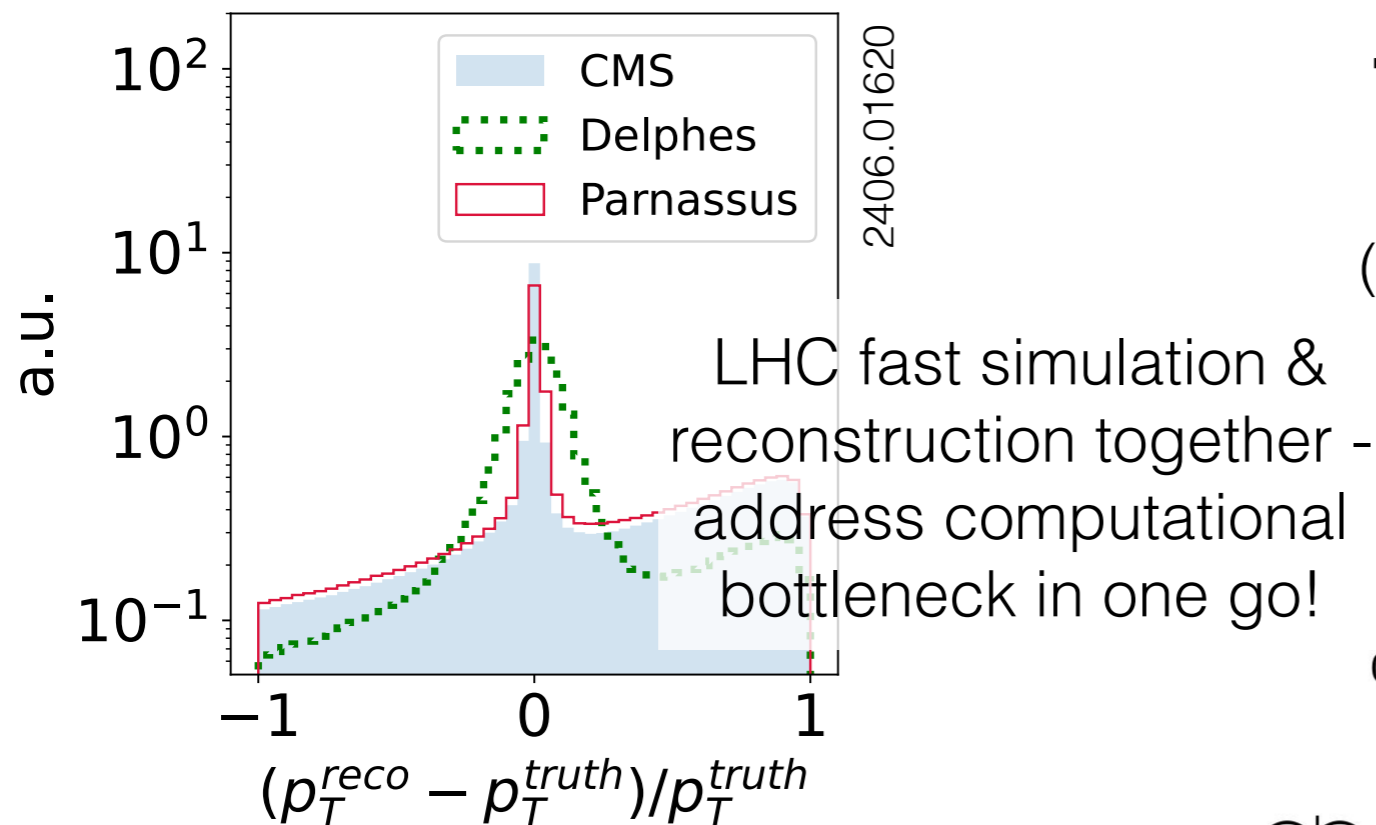bpnachman@lbl.gov

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AI/ML is already playing a critical role in nearly all aspects of collider physics. There is no doubt that it will play a central role for the design, operations, and data analysis of the FCC.

*The goal of this session is to capture a snapshot of the state of the art.*

1. Facility    *accelerator design, operations; magnet training, …*

2. Detectors    *detector design, construction (e.g. QA/QC), operations, data acquisition, …*

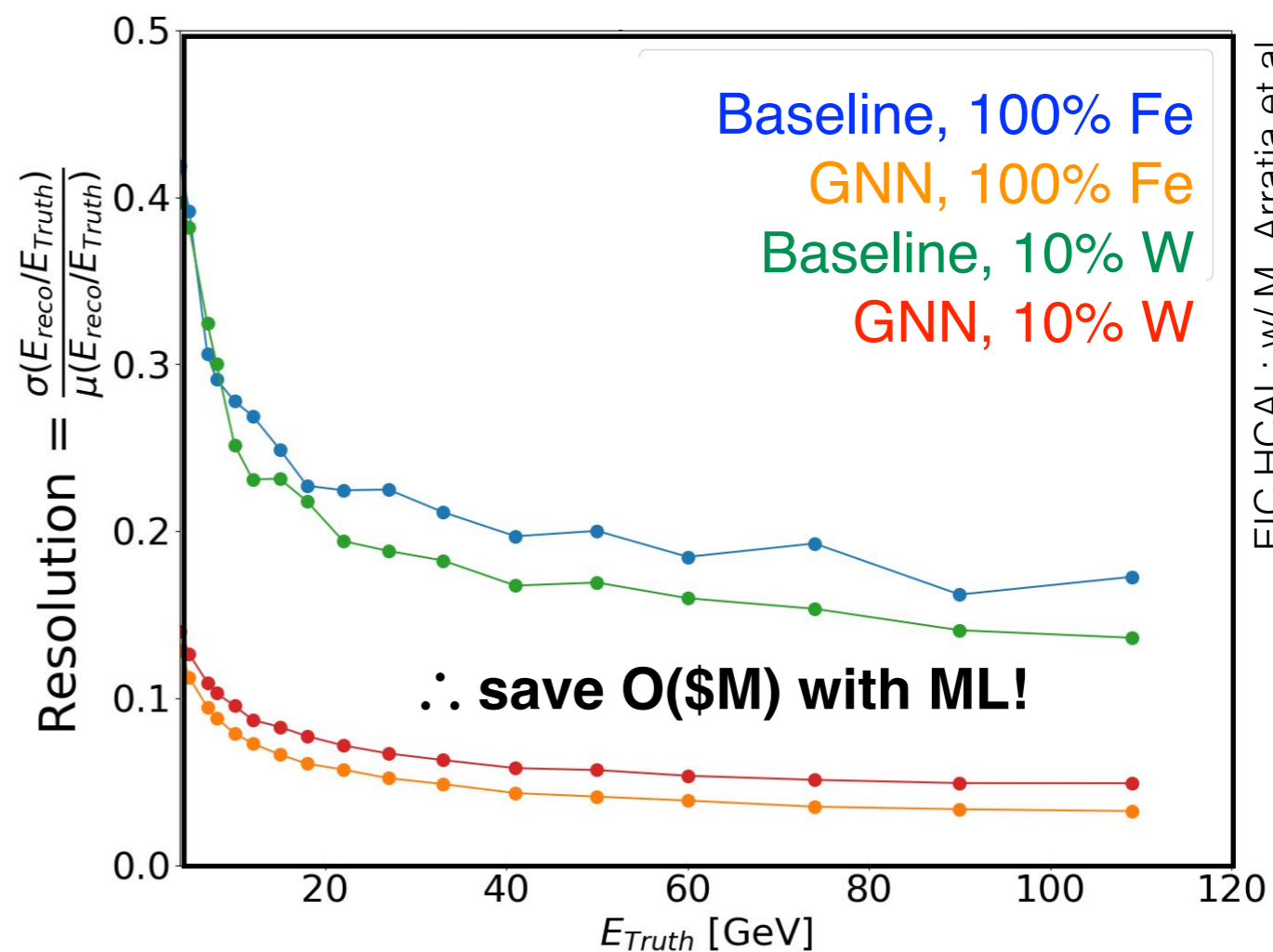3. Data analysis    *reconstruction, simulation, statistical analysis, …*

2406.01620

CMS
Delphes
Parnassus

$(p_T^{reco} - p_T^{truth})/p_T^{truth}$

a.u.

LHC fast simulation & reconstruction together - address computational bottleneck in one go!

**These are just examples - we will hear more in today's session!**

(+ there is even more - just the tip of the iceberg)

Codesign of EIC calorimeter
*definitive answer: do we need W?*

2404.16091

| | AUC | Acc | $1/\epsilon_B$ | |
| --- | --- | --- | --- | --- |
| | | | $\epsilon_S = 0.5$ | $\epsilon_S = 0.8$ |
| ResNet 50 | 0.885 | 0.803 | 21.4 | 5.13 |
| EFN | 0.901 | 0.819 | 26.6 | 6.12 |
| hlDNN | 0.938 | 0.863 | 51.5 | 10.5 |
| DNN | 0.942 | 0.868 | 67.7 | 12.0 |
| PFN | 0.954 | 0.882 | 108.0 | 15.9 |
| ParticleNet | 0.961 | 0.894 | 153.7 | 20.4 |
| PET classifier (4M) | 0.959 | 0.890 | 146.5 | 19.4 |
| OMNILEARN (4M) | 0.961 | 0.894 | 172.1 | 20.8 |
| PET classifier (40M) | 0.964 | 0.898 | 201.4 | 23.6 |
| OMNILEARN (40M) | **0.965** | **0.899** | **207.30** | **24.10** |

LHC top tagging:
avoid expensive simulations - fine tune a foundation model!

Baseline, 100% Fe
GNN, 100% Fe
Baseline, 10% W
GNN, 10% W

$Resolution = \frac{\sigma(E_{reco}/E_{Truth})}{\mu(E_{reco}/E_{Truth})}$

$E_{Truth}$ [GeV]

EIC HCAL; w/ M. Arratia et al.

∴ **save O($M) with ML!**

# Agenda

**13:30** → 15:00    **AIML mini workshop**

**Convener**: Ben Nachman (Lawrence Berkeley National Lab. (US))

**13:30**    **Introduction**

**Speaker**: Ben Nachman (Lawrence Berkeley National Lab. (US))

**13:45**    **Accelerator Design/Control**

**Speaker**: Auralee Edelen

**14:10**    **Accelerator Design/Control**

**Speaker**: Remi Lehe (Lawrence Berkeley National Laboratory)

   📄 FCC_AIML.pdf    📄 FCC_AIML.pptx

**14:35**    **Detector design**

**Speaker**: Dr Karthik Suresh (College of William and Mary)

   📄 AID2E FCC Week 20...

**15:30** → 18:00    **AIML mini workshop**

**Convener**: Ben Nachman (Lawrence Berkeley National Lab. (US))

**16:00**    **Fast inference**

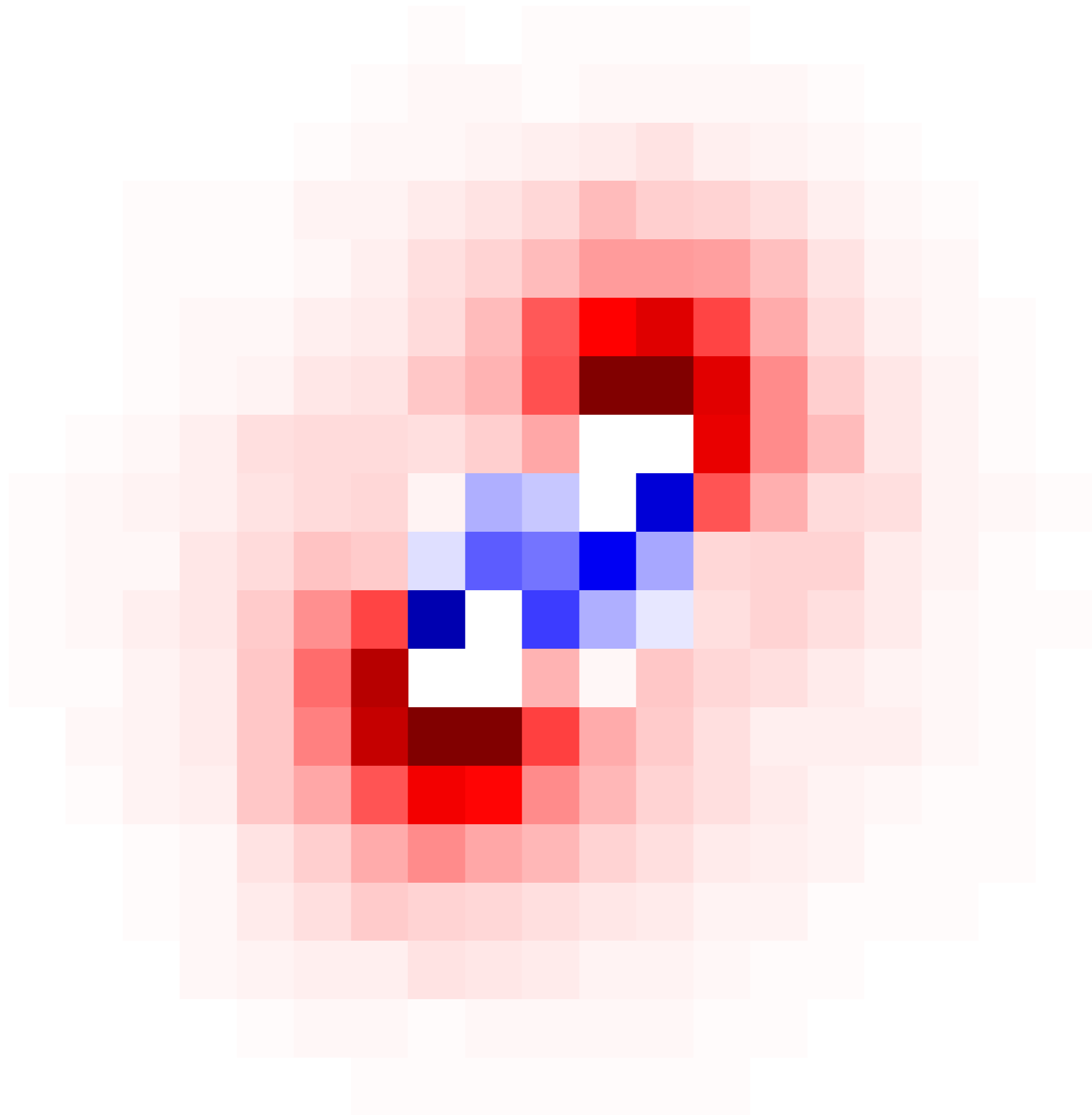**Speaker**: Elham E Khoda (University of Washington (US))

**16:30**    **Data Analysis**

**Speaker**: Dennis Noll (Lawrence Berkeley National Lab (US))

**17:00**    **Google GenAI demo**

**Speaker**: Dustin Sell (Google)

*See also a number of other talks embedded in other sessions!*

Fin.