Experimental Methods

Co-conveners: Mario Cromaz and Michelle Kuchera

Overview

31 attendees

15 lightning talks

15 unique institutions

Format:

- Lightning talks: 3-4 slides with Q&A
- Discussions: 4-5 groups
  - Tangible results (near-term goals): Wednesday
  - Big Goals (infinite $$, resources, time, dream Big): Thursday
  - Emergent themes – collective opinion

Dream Big: Long Term Goals

Holistic approach to experimentation

Standardized data formats

Experiment design not limited by computation

Dream Big: Long Term Goals

Holistic approach to experimentation:

- Integrate disparate data sources: accelerator, experiment controls, detector data
- Realtime analysis and feedback for quick diagnostics and optimization
- Unique challenge in NP – accelerator-based, quick-turnaround experiments
- Global optimization of experiment design

Dream Big: Long Term Goals

Standardized data formats:

- Common formats for NP AI
  - allows resource sharing across subfields
  - streamlines workflow for collaboration and AI innovation
- Publicly available datasets for AI development and benchmarking
- Reanalysis of experiments for new observables with new tooling

Dream Big: Long Term Goals

Experiment design not limited by computation:

- High luminosity, statistics to observe rare processes
- Ability to extract all necessary information (not necessarily high data rates!)
  - Make fast, good decisions with confidence
- Implementation: data compactification, triggers (FPGA, software), fast online analysis, etc.

Near Term Goals

Educate and build a broader community

Improving analysis

Uncertainty quantification

Near Term Goals

Educate and build a broader community:

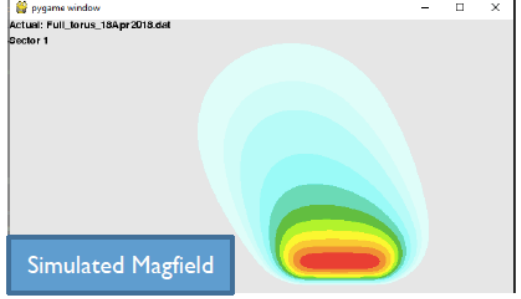
- NP-supported and maintained educational resources and tutorials
  - Central portal for NP community
- Training of NP scientists
  - Identifying AI opportunities
  - Using AI models
  - Training models
  - Developing architectures
- Build an infrastructure for AI / ML scientists in the NP community
  - lab positions
  - University collaborations or joint positions

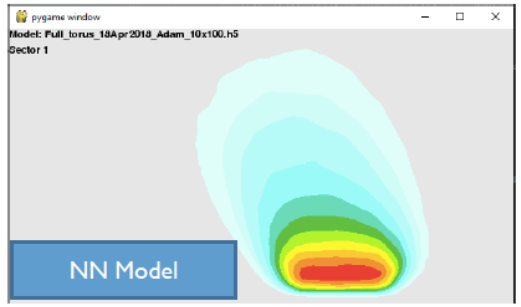
Near Term Goals

Improving analysis:

- Improved sensitivity, tracking
- Faster analysis → faster scientific output

Near Term Goals





William Phelps
and Andru Quiroga

Improving analysis:

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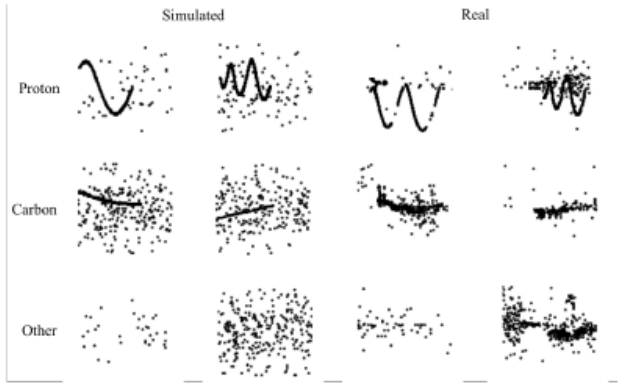


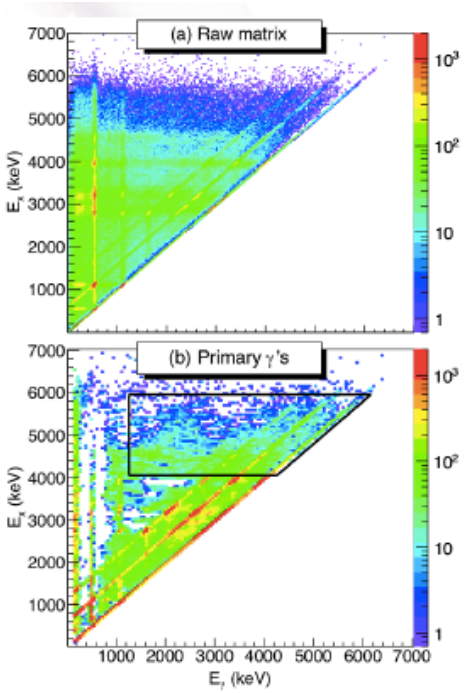
Class	F1 Score		
	LR	NN	CNN
Proton	0.55	0.69	0.77
Carbon	0.87	0.97	0.78
Other	0.71	0.75	0.93

Simulated data

Class	F1 Score		
	LR	NN	CNN
Proton	0.61	0.65	0.64
Carbon	0.41	0.46	0.38
Other	0.83	0.78	0.86

Real data

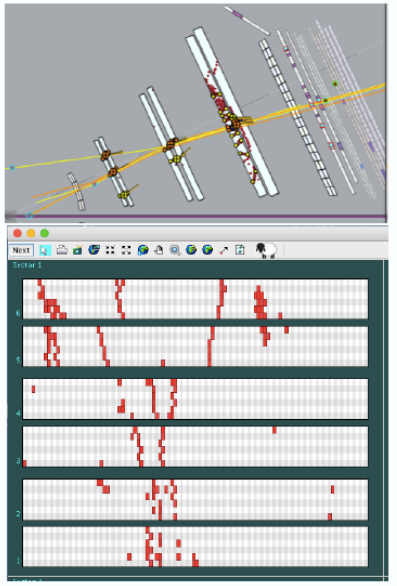
FRIB AT-TPC: Daniel Bazin



MSU: Cade Dembski

Model Type	*A1* Metric	*Ac* Metric	*Ah* Metric	*Af* Metric	Training Accuracy	Time to Train	Time to Predict / sample
MLP	96.5%	20.2%	92.1%	3.4%	94.7%	252 *sec*	4 *μs*
ERT	93.3%	19.9%	91.9%	6.6%	99.9%	1.7 *sec*	5 *μs*
CNN	96.4%	30.1%	89.4%	3.5%	93.4%	457 *sec*	1.2 *ms*

JLab CLAS 12: Gagik Gavalian



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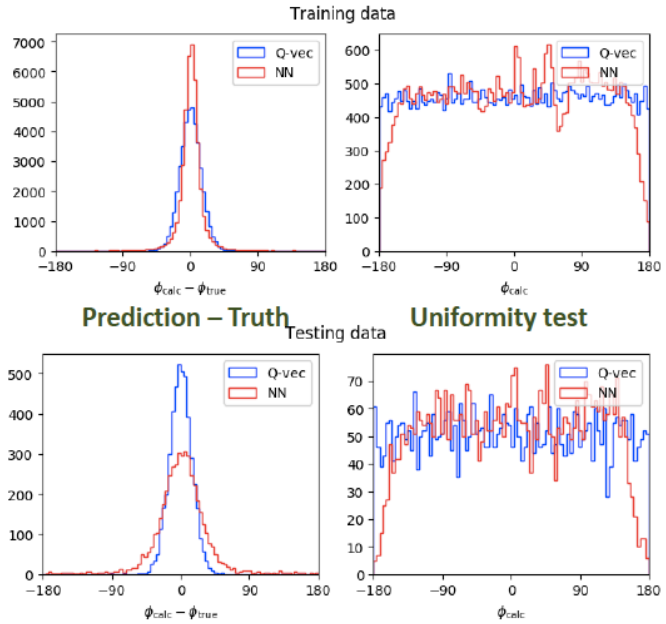
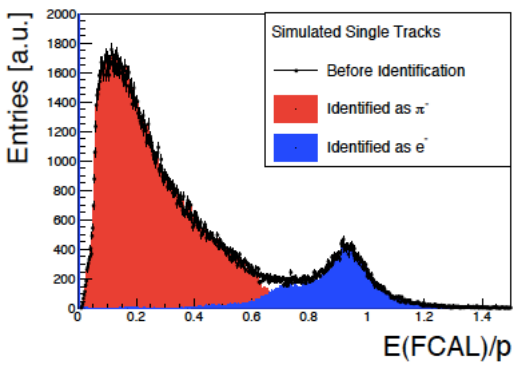
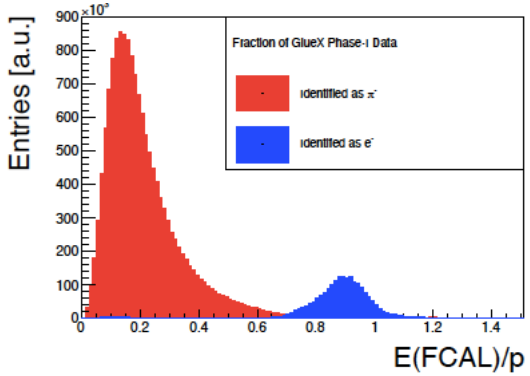
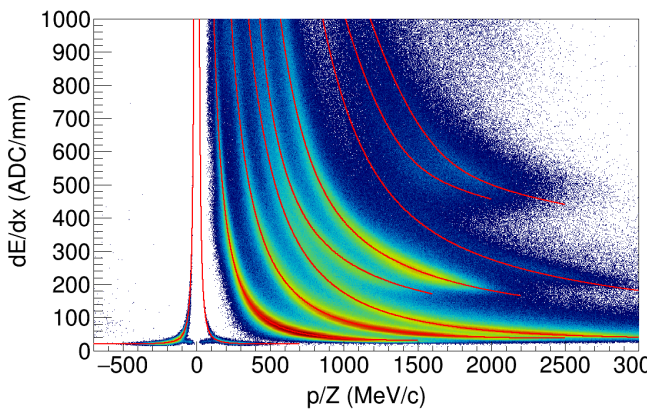


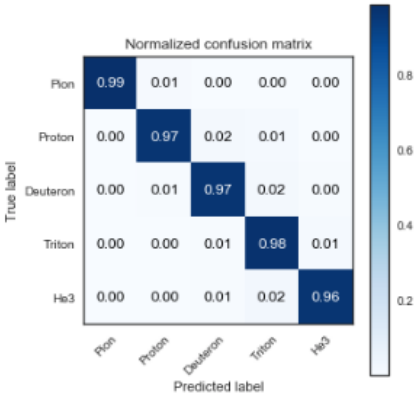
NSCL: Fanurs C.E. Teh





GlueX: Daniel Lersch





FRIB: Chun Yuan Tsang

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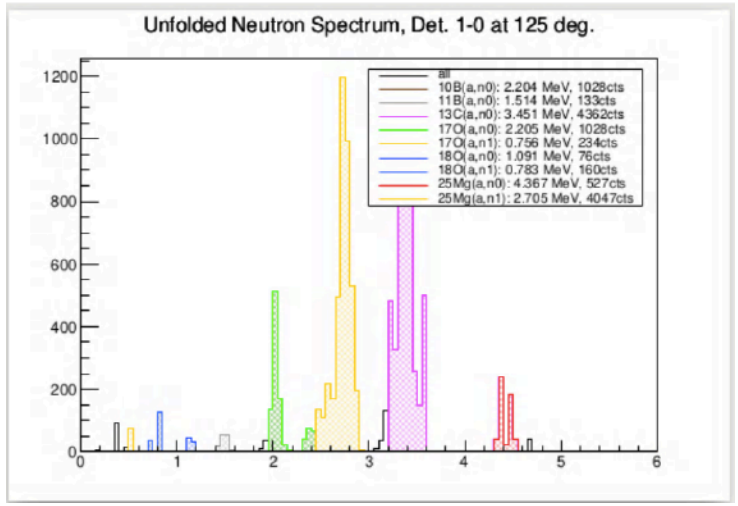
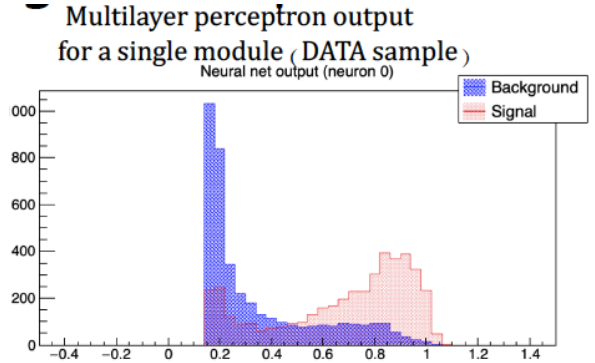
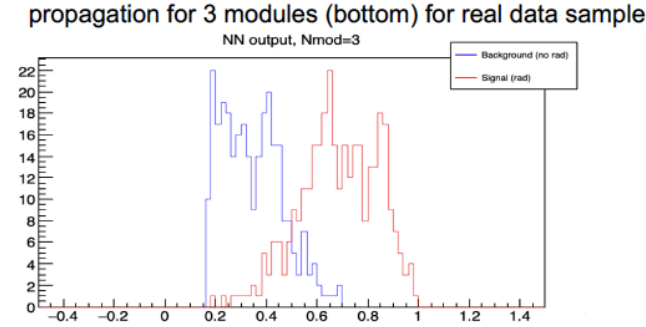


Notre Dame: Yulia Furletova

Virginia Tech: Mai Dahshan and Nicholas Polys





JLab: Yulia Furletova

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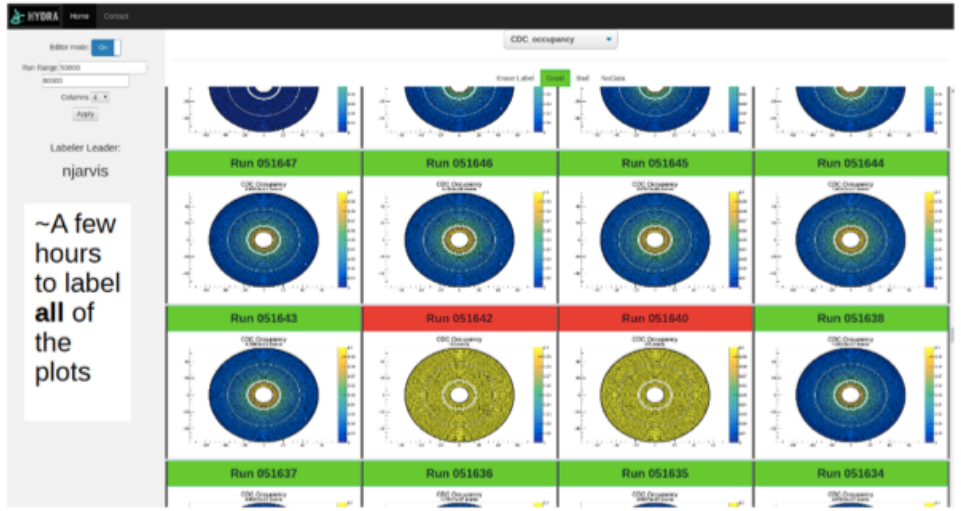
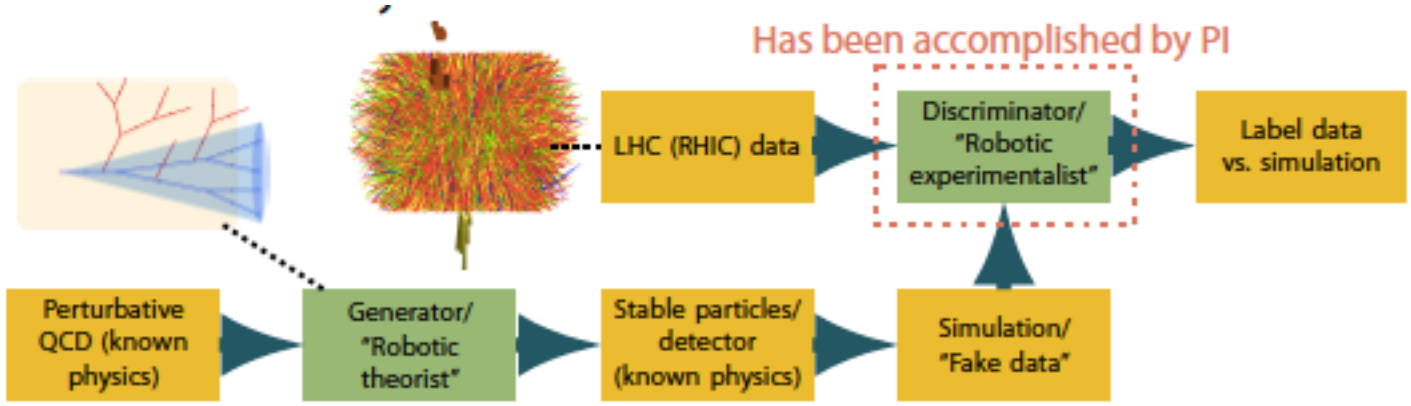
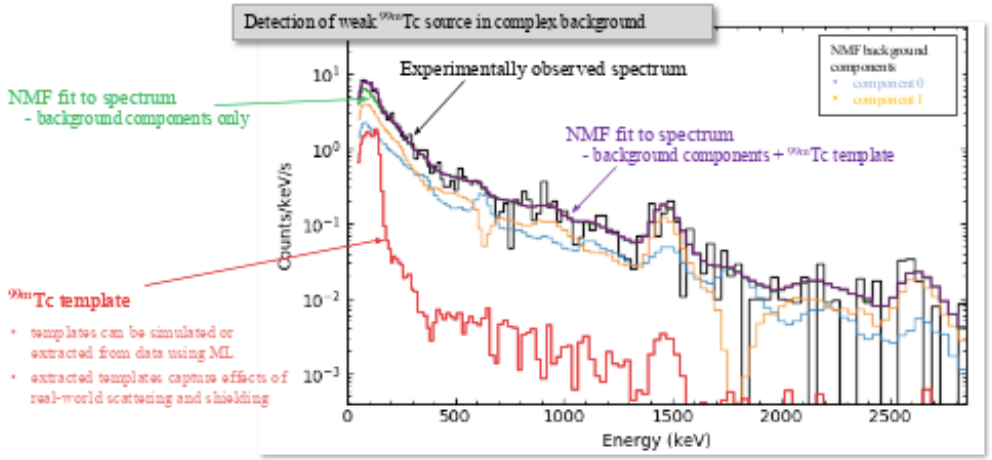


JLab: Thomas Britton



LBL: Yue Shi Lai



LBL: Ren Cooper

Near Term Goals

Uncertainty quantification:

- AI methods with well-defined systematic and statistic uncertainties
- Establish metrics for evaluation and comparison of algorithms

THANK YOU!

ALL of the contributors and participants in the Experimental Methods working group!