Jefferson Lab

HYDRA

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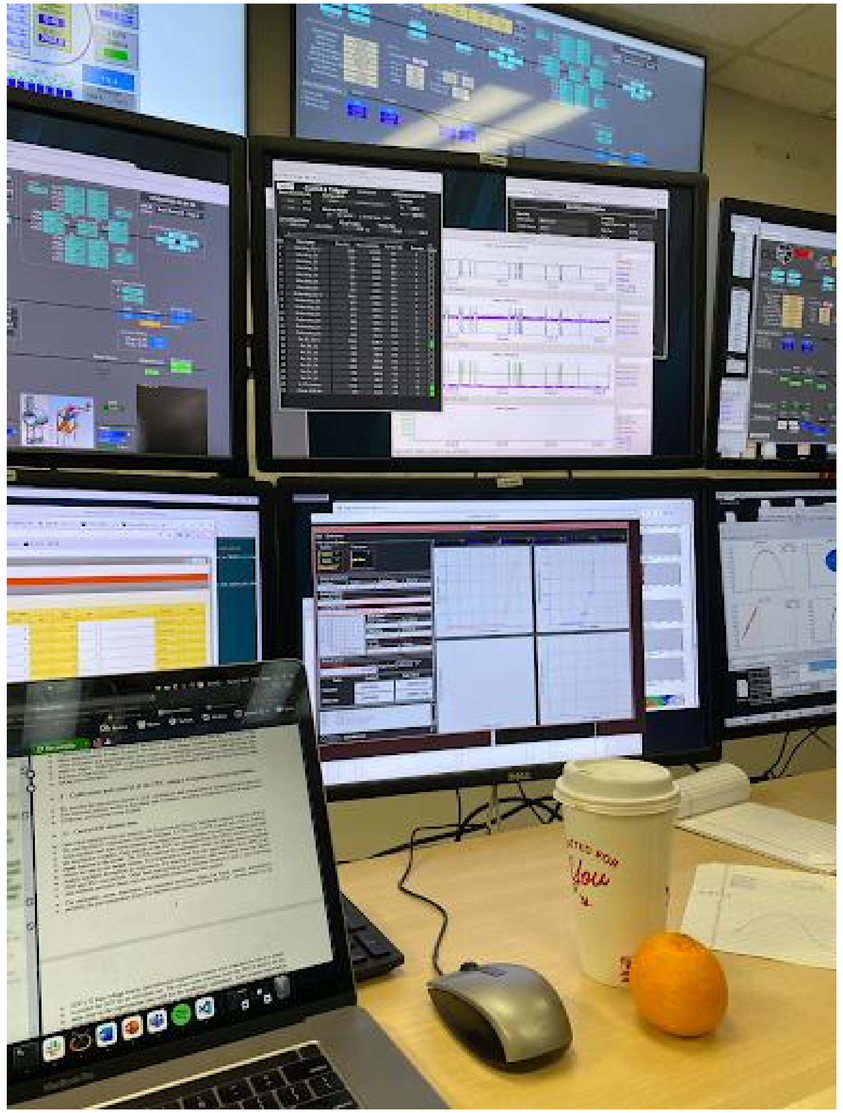


EPSCI

Developed and maintained by the Experimental Physics Software and Computing Infrastructure group

Outline

..deploy Hydra for autonomous validation of the simulation campaigns. This work will build on existing detector and physics benchmarks using Snakemake and will include plans to collaborate with the DSCs to develop a Q&A page for each subystem.

Hydra

- What it is
- Use cases

Existing Benchmarks

- Physics and Detector benchmarks
- Evaluating simulation campaigns

Collaboration

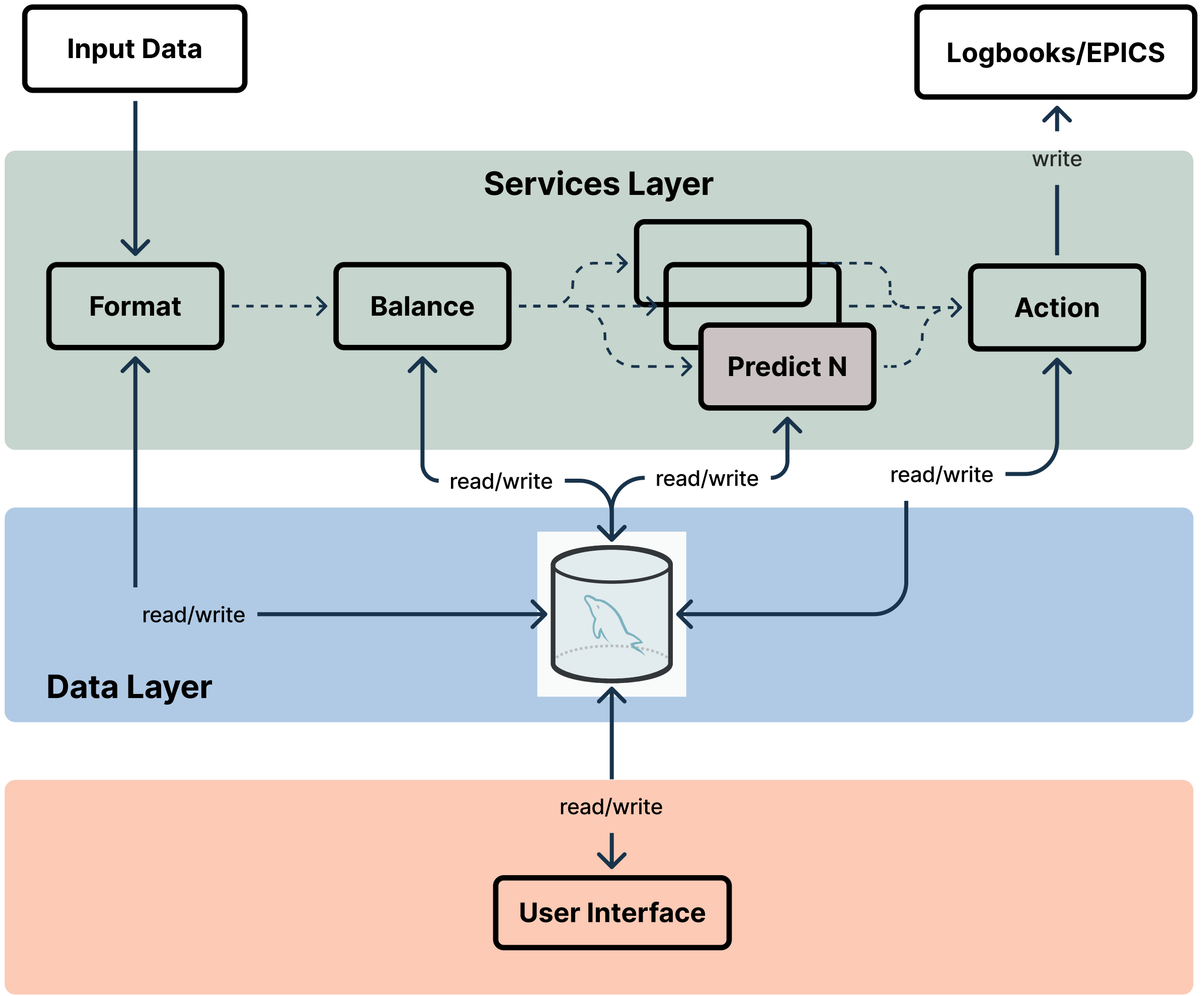
- Co-convener(s)
- Collaboration in general

HYDRA

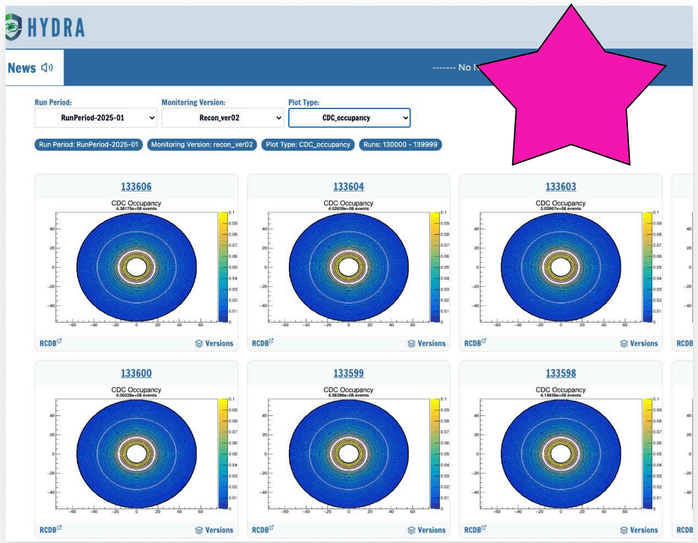
Services Layer (Python/Tensorflow): Convolutional networks (InceptionV3, VGG16, build your own), Siamese networks, Clustering Algorithms, Similarity Algorithms

Data Layer (MySQL): Comprehensive MySQL database, optional Run Conditions Database integration

User Interface (React/Flask): Web application for visualizing data, model classifications, labeling, performance metrics

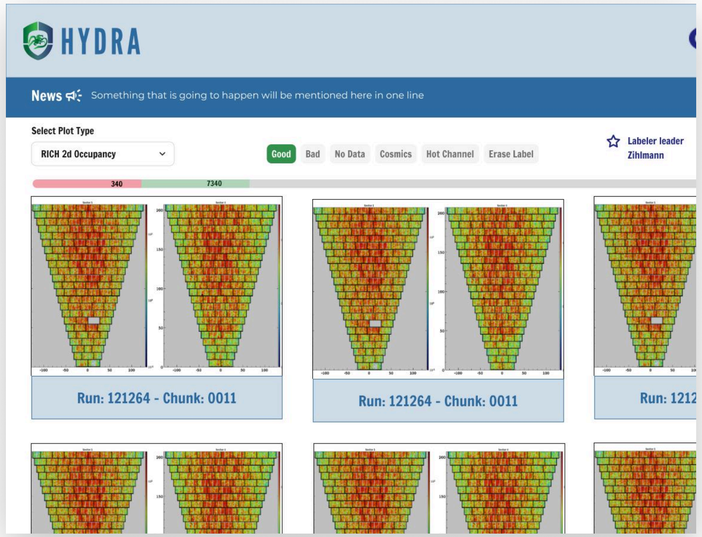


Primary Use Cases



Visualization

View, sort, and filter images.



Validation

Validate monitoring plots from simulation, calibration changes, etc.

Online Monitoring

Use neural networks, primarily InceptionV3, to classify monitoring images in near real time.

Eventual Autonomous Validation of Offline Images

Image Clustering

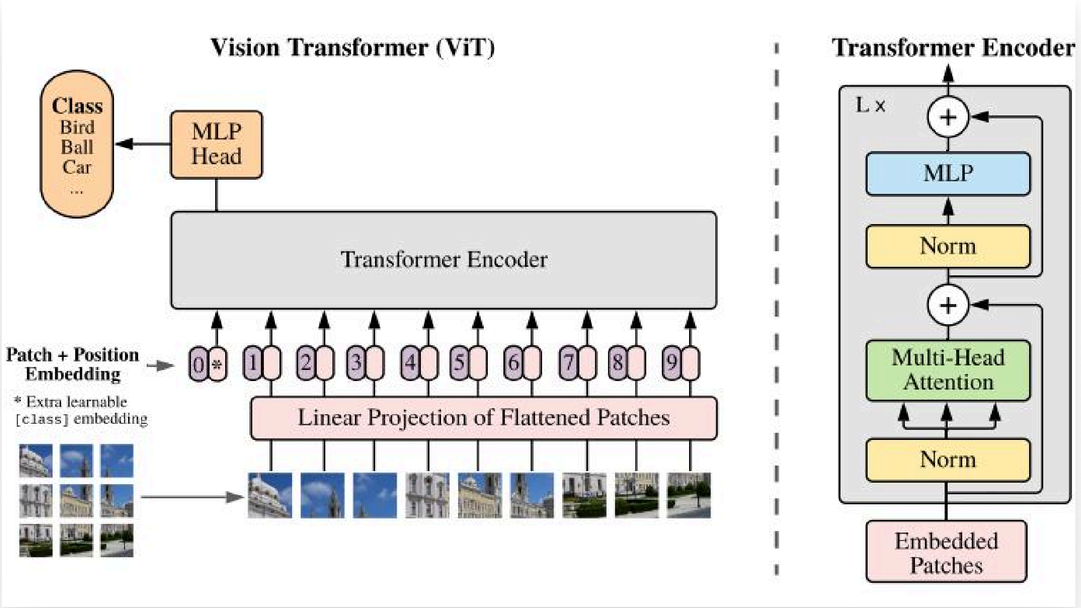
Clustering images does not require labels, and can be used to identify “different” images

Classification

Used Hydra’s “traditional” supervised learning approaches -- this will require enough data and labels

Autoencoders*

Recently approached by medical physicists to use autoencoders for medical image analysis



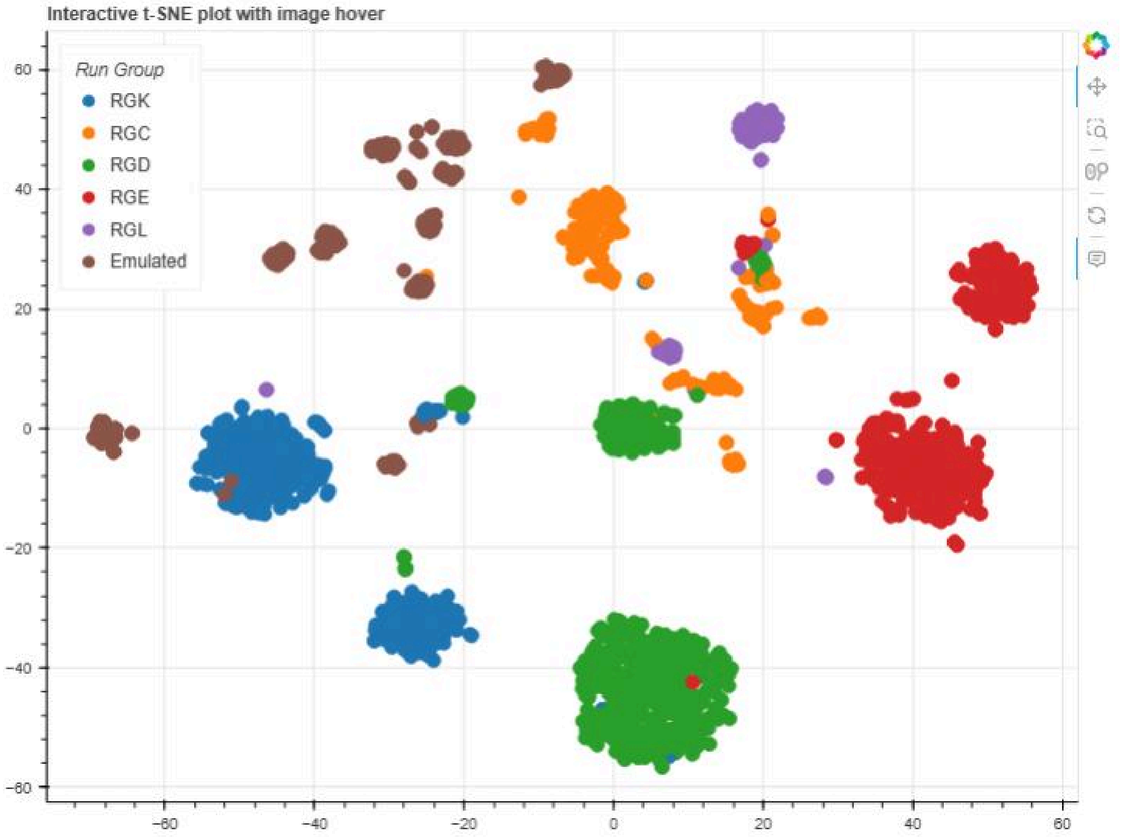
Vision Transformers*

Paper presented at ICLR: https://arxiv.org/pdf/2010.11929
Transformers for Image Recognition at Scale

*in development

Image Clustering

How similar are our images within a given run group and across run groups? Can we identify “Bad” or “dissimilar” images without using labels?



t-distributed stochastic neighborhood embedding: similar objects are modeled by nearby points and dissimilar are modeled by distant points. This link, https://distill.pub/2016/misread-tsne/, contains fun visualizations and explanations.

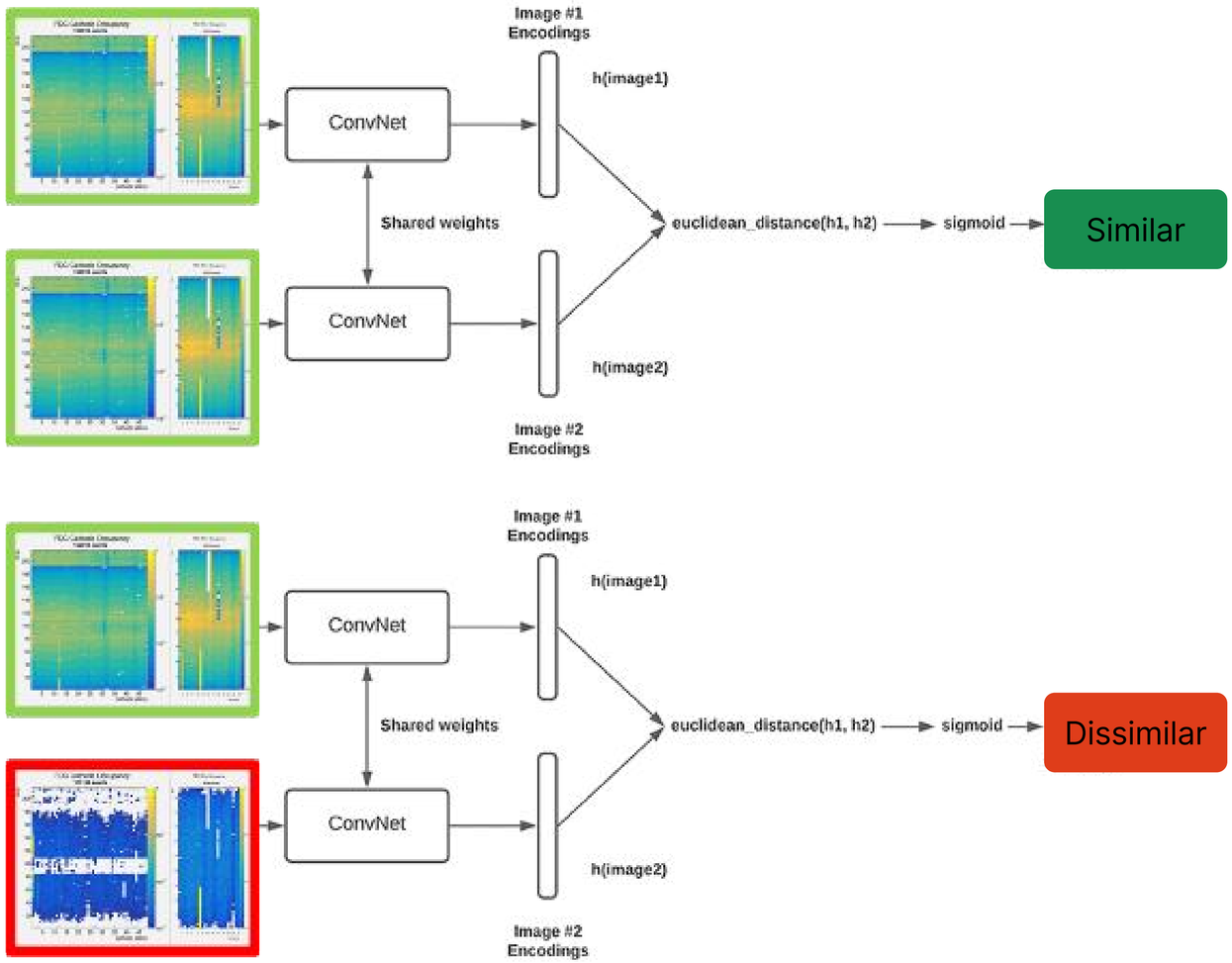
Siamese Models

Siamese models learn to compare two inputs (in our case images) and determine how *similar* they are.

Think of this as Hydra's equivalent to humans comparing images to their reference.

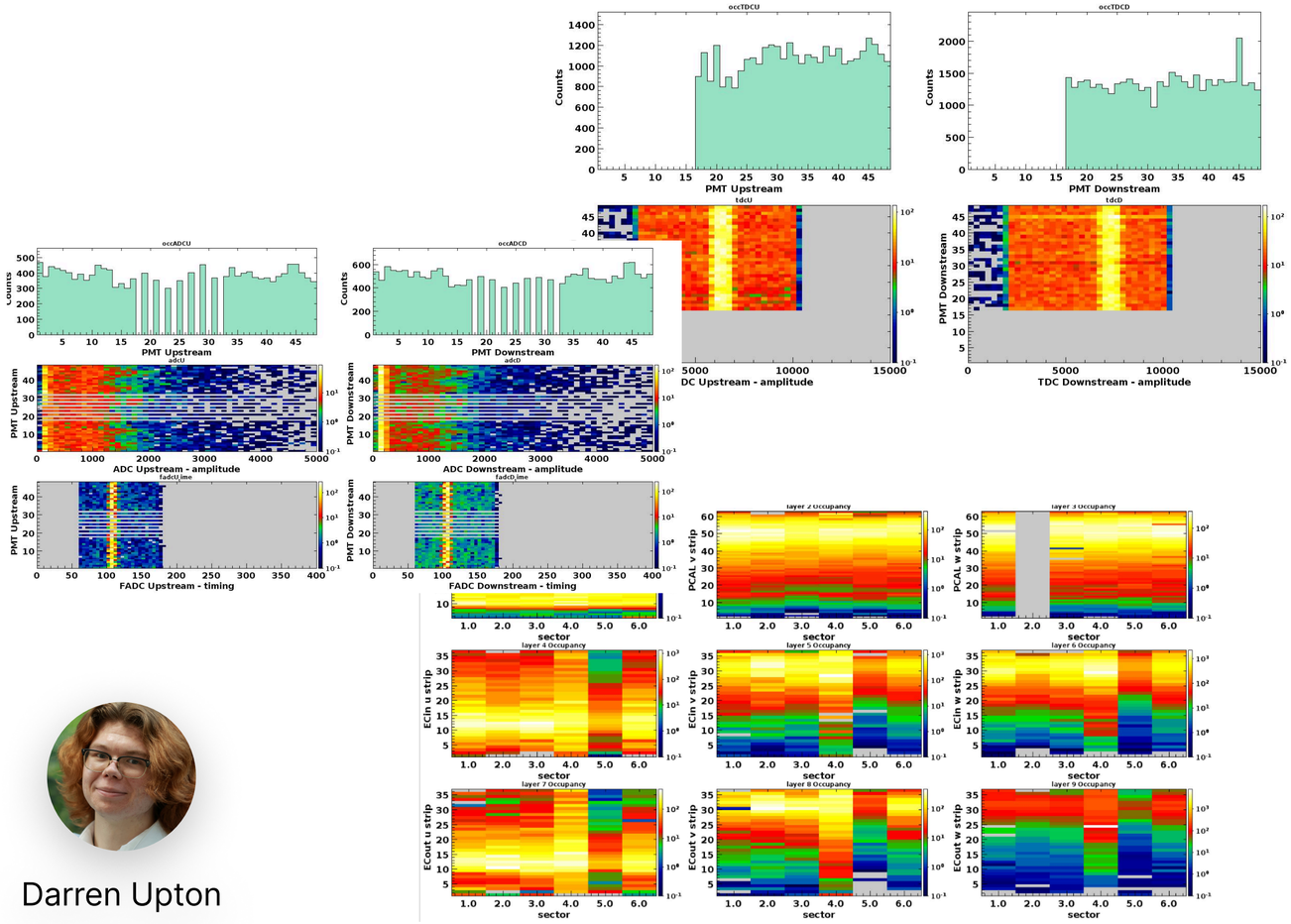
Jordan O'Kronley

UT Physics Graduate Student
Image clustering and siamese models



What if we don’t have any “Bad” images?

Our graduate students have developed to software to emulate various failure modes in real data by modifying databases and regenerating the images.



Darren Upton

We can simulate bad plots to use in training.

Plot Types and Plots in Hydra

Plot Type

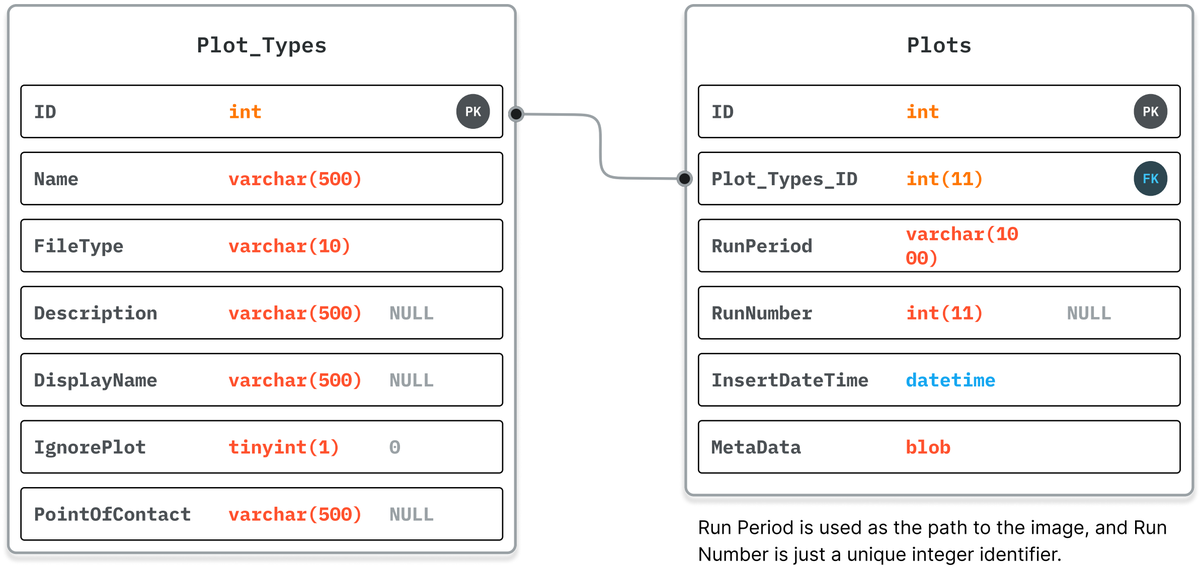
An example *type* of plot that should be monitored.

Example: Detector 1 Occupancy

Plots

References to each of the kinds of *plot types* an experiment or collaboration generates

Example: Detector 1 Occupancy from Campaign 1, Campaign 2, ..., Campaign N



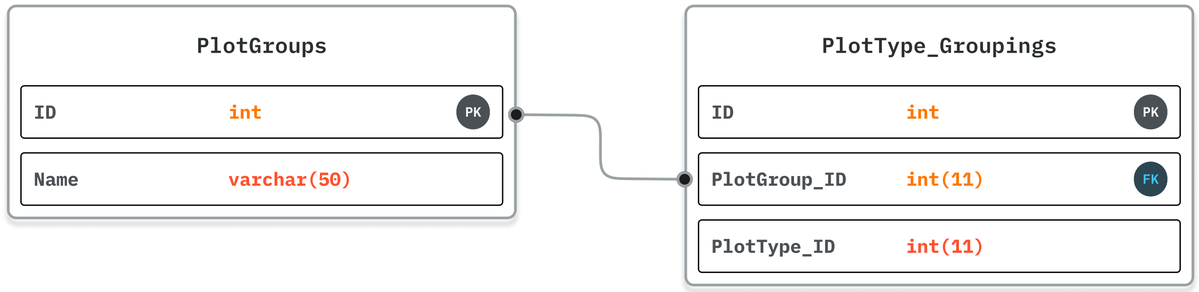
Run Period is used as the path to the image, and Run Number is just a unique integer identifier.

How are plots organized?

Plot Groups

Plots can be categorized into meaningful groups

Example: Campaign, Working Group, Calorimeters, Drift Chambers, etc



Plot Type Groupings

Which *plot types* are associated with a given group

Example: Backwards EMCal belongs with Calorimeters

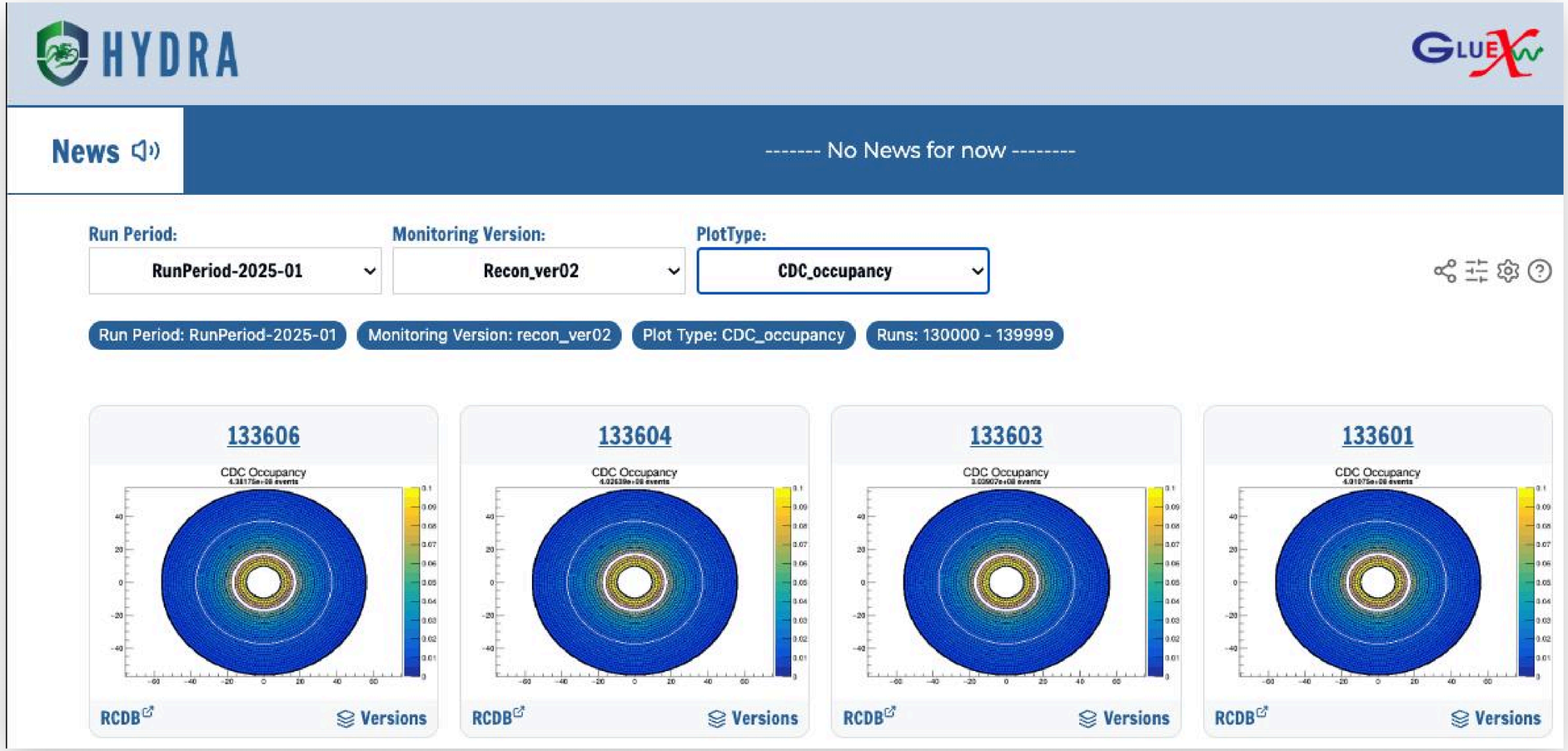
Super Groups

A group can be long to different groups

Example: Physics Working Group includes Jets and Heavy Flavor

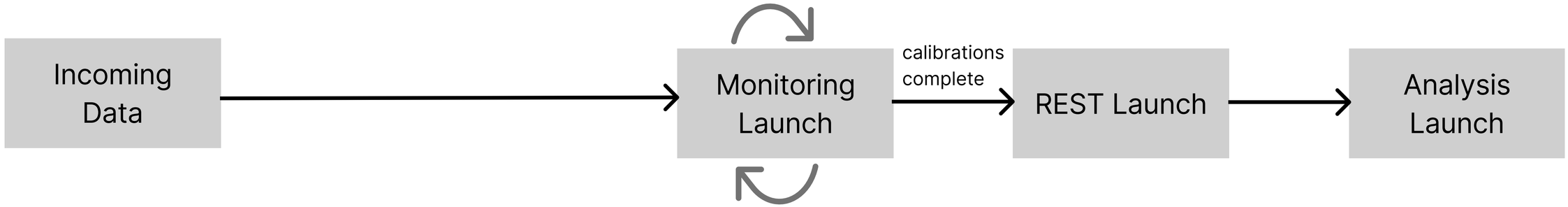
Plot Browser for Visualization

View, filter, and sort plots based on run numbers, monitoring versions, detectors, simulation campaigns, etc
This is the most used consistently used interface across all of our deployments.



GlueX Monitoring: Data Acquisition to Analysis

GlueX generates image-based data throughout data taking, calibration, and analysis.



Minutes/Hours	Daily	Weeks	Months	Months/Years
shift crew detector experts	online monitoring coordinator	detector experts offline monitoring coordinator analysis coordinator	*offline* monitoring coordinator	analysis coordinator

Thomas Britton was responsible for producing a daily brief

Monitoring Launch Overview

Input Data

GlueX: Experimental data in the form of ROOT files

ePIC: Simulated data in the form of ROOT files

Plugins

GlueX: Plugins developed by detector experts using halld_recon, make meaningful QA plots for each major detector subsystem

ePIC: Benchmarks developed by detector experts using eic_recon

Visualization with Hydra

Plot Browser updates automatically with newly generated data

Existing Benchmarks

Detector Benchmarks

Meant to provide a maintained set of performance plots for individual detector subsystems

Physics Benchmarks

Meant to evaluate ePIC detector as a whole with respect to a given physical process

identify good candidate(s) to produce for March campaign

Status and Action Items

Hydra Deployment

- Hydra for ePIC has been deployed on a new web server
- Database with CI image artifacts has been backed up
- Will remove default LDAP authentication to provide open access to image data
- Hydra developers can implement new features on request from ePIC collaborators based on need

https://code.jlab.org/epsci/hydra/

hydrateam@jlab.org

Monitoring Launch Software

- GlueX collaboration kindly provided software for their monitoring launches (python-based) to use for inspiration
- Develop launch software for ePIC

Collaboration

- Identify co-convener(s) to interface with PWGs/DWGs
- Will host future tutorials in collaboration with User Learning

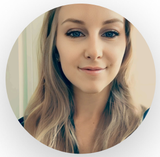
Hydra team

David Lawrence

EPSCI
Physics, CS, AI/ML

Thomas Britton

EPSCI
Physics, CS, AI/ML



Torri Jeske

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Physics, Operations, Full Stack Development

Nataliia Matsiuk

Information + Records
Containerization, QA

Raiqa Rasool

EPSCI
CS, Full Stack Development

Darren Upton

ODU Physics Graduate Student
MLOps, Data Augmentation

Jordan O'Kronley

UT-Knoxville Physics Graduate Student
Siamese Models

Sachin Gupta
Tobias Stockmanns

CBM experiment at GSI

Nathan Baltzell
Casey Morean
Naomi Jarvis
Christine Ploen

Jefferson Lab

Summary Statistics

	Hall D	Hall B	Hall A	Hall C	FAIR/GSI	Total
Year deployed	2019	2022	2024	2024	2026	
Labeled Images / Total Images	637,885 / 12,243,320	352,804 / 747,554	5440 / 83,376	7800 / 465,853	2002 / 2002	1,005,949 / 13,542,105
Active Models	19	61	-	6	-	86
Batch / frequency	16 / min	81 / 3-5min	42 / run	92 / run	-	-
Runs with 1 bad image	1,822	1,081	-	33	-	-
Total classified	2,834,043*	2,324,870	-	2475	-	5,161,388

*since record keeping began