AI/ML optimized polarization

Naomi Jarvis, Workshop on Polarized Target Studies with Real Photons in Hall D, 21 February 2024

2y DOE grant, EPSCI-led, waiting for funds to arrive

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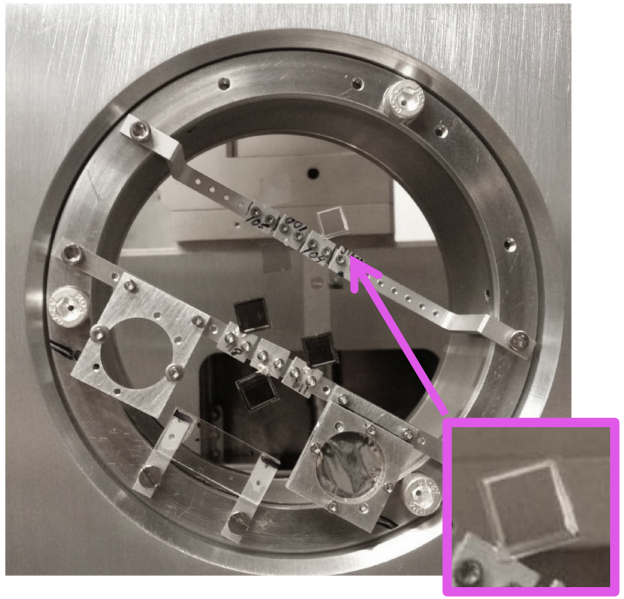
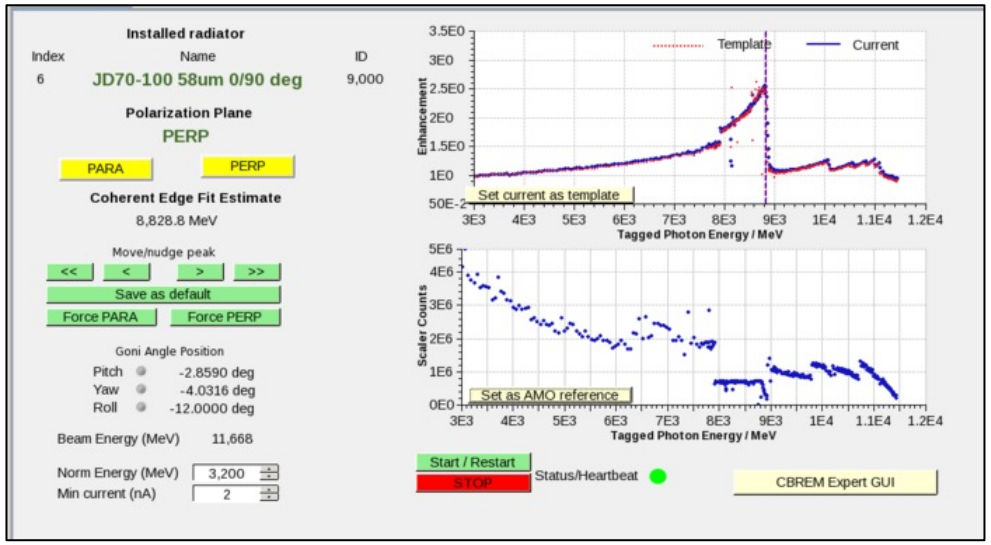
AI/ML optimized polarization at Jefferson Lab



Hall D

Develop AI/ML model and control software to continuously monitor and adjust the position and orientation of the diamond crystal in the electron beam for improved photon beam polarization.
Used for GlueX collaboration experiments, exotic mesons (gluonic excitations), $c\bar{c}$ etc



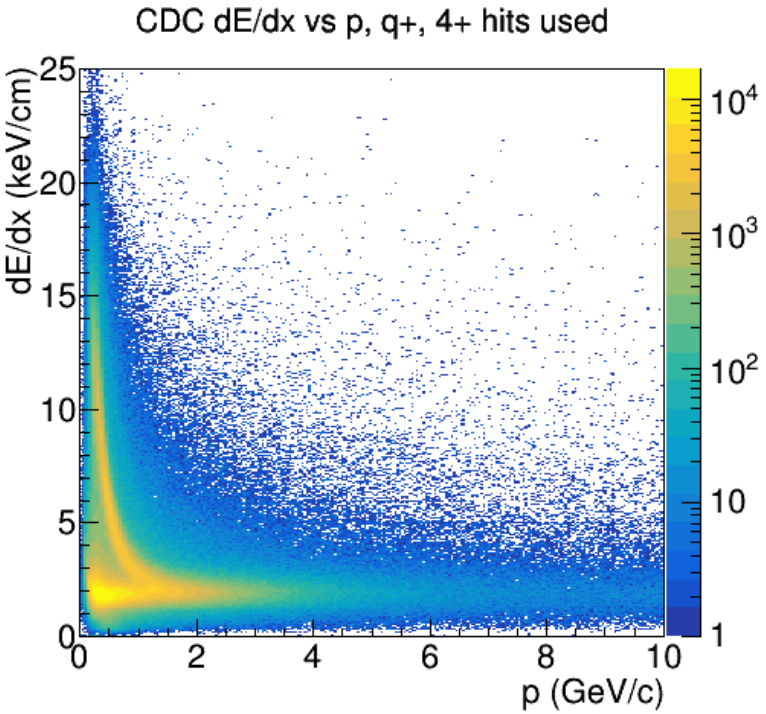
Hall B

Develop AI/ML model and control software to continuously monitor and adjust the frequency of the microwave source used for polarizing the cryo-target protons via hyperfine interaction. Use NMR to measure polarization.
Used for CLAS-12 collaboration experiments, quark spin studies, etc.

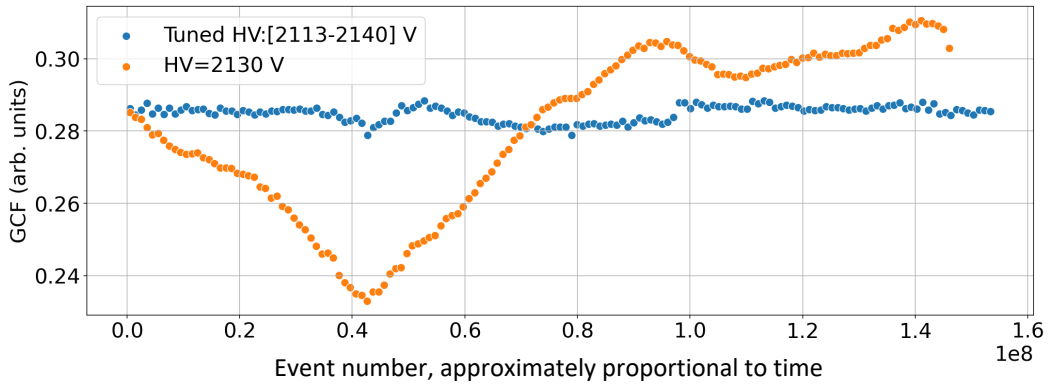
Our earlier work: RoboCDC – automatic gain stabilization for GlueX CDC

The polarized target projects would follow a development strategy broadly similar to that for RoboCDC, different in detail.

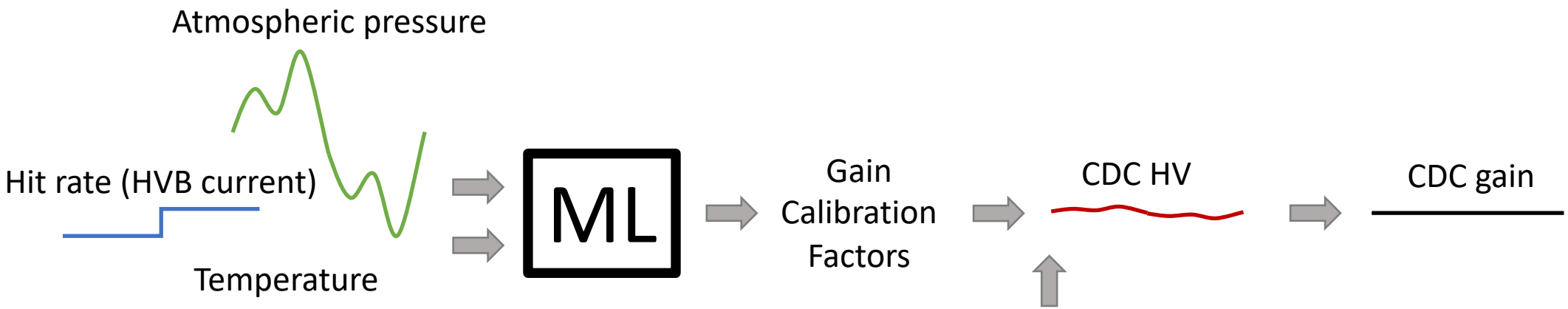
CDC: central drift chamber, straw tube gas filled tracking detector surrounding GlueX target
Signal time used to locate charged particle tracks
Energy deposition used for charged particle identification
Pulse height varies +/- 15% with atmospheric pressure, data acquisition stops & restarts whenever ΔP > limit
Calibrations afterwards correct for gain changes. RoboCDC reduces gain changes, improves monitoring, speeds calibrations.



Gain correction factor vs time, ML-tuned and constant HV



RoboCDC – how it works



AI/ML model: Gaussian Process Regression

Trained using environmental data + conventional GCFs
Main dataset has 984 runs, divided 80:20 for train/test

The model uses environmental data to predict GCF in a few seconds

ACAT-2021 paper