**Analysis of Quasi-Elastic e-n & e-p $Q^2$ Documentation**
**Alexander Balsamo**

# 1 Setup

## 1.1 Installation

Download **COATJAVA**:
https://github.com/JeffersonLab/clas12-offline-software/releases

Unzip the tar file:
tar xzvf coatjava-5a.3.3.tar.gz

Download **Groovy**:
http://groovy-lang.org/install.html#SDKMAN

Open a terminal and enter:
$ curl -s get.sdkman.io | bash
Follow the instructions on-screen to complete installation.
Open a new terminal or type the command:
$ source "$HOME/.sdkman/bin/sdkman-init.sh"
Then install the latest stable Groovy:
$ sdk install groovy
After installation is complete and you've made it your default version, test it with:
$ groovy -version

## 1.2 Environment Variables

For **COATJAVA**
setenv JLAB_ROOT /opt/app/jlab_software/
setenv JLAB_VERSION devel
setenv $JLAB_ROOT/$JLAB_VERSION/ce/jlab.csh

For **Java**
setenv JAVA_HOME /usr/lib/jvm/java-1.8.0-openjdk-1.8.0.161-0.b14.el7_4.x86_64/jre/
setenv PATH ${PATH}:${JAVA_HOME}/bin

For **Groovy**
setenv SDKMAN_DIR /home/$< user >$/.sdkman
/home/$< user >$/.sdkman/bin/sdkman-int.sh

# 2 Run Codes

## 2.1 Analysis

**epenQ2v6.groovy** was written using COATJAVA Version 5a.3.3, with the goal to extract a quasi-elastic e-n/e-p $Q^2$ Ratio, $R$. This java code reads reconstructed hipo files. In the analysis, we first match the solid angle for *e-n* and *e-p* events. The electron information is used to predict the path of both a neutron and proton through CLAS12. If both particles interact in CLAS12 the *e-n* and *e-p* events have the same solid angle. We select QE events by searching for nuclei near the predicted position. An angular cut between the predicted 3-momentum of the nucleon and the measured value, $\theta_{pq}$, separates QE and inelastic events.

How to Run:
$ /run-groovy epenQ2v6.groovy yourReconstructedFile.hipo

Output:
**histEpenQ2.hipo**
This output can be viewed using the histogram viewer script, *epenQ2HistViewer.groovy.*

## 2.2   Histogram Viewer

**epenQ2HistViewer.groovy** is a java-script written to view the output file *histEpenQ2.hipo* from the java analysis code *epenQ2v6.groovy.*

How to Run:
$ run-groovy epenQ2HistViewer.groovy histEpenQ2.hipo

This will display $Q^2$ histograms for reconstructed data along each analysis cut, as well as ratio plots for reconstructed and generated events. Calculated reconstructed and generated ratios should appear within the terminal window.