Introduction to Hall-D Software

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Online Documentation

- Wiki : http://www.jlab.org/Hall-D/software/wiki
  (click on “Offline Software” on Right-hand menu)

- DocDB : http://portal.gluex.org
  (click on “Documents” in upper right corner)

- JLab mailing lists :
  halld-offline@jlab.org
  halld-mc@jlab.org

- doxygen:
  http://www.jlab.org/Hall-D/software/HDSoftware_Documentation

- JANA : http://www.jlab.org/JANA

Using pre-compiled binaries on the JLab CUE

- Pre-built binaries exist on the Hall-D group disk for every tagged release in ***/group/halld/Software/builds***

- Builds for both Fedora 8 and RHEL5 exist in the same directory structure. The environment can be set up to use a build by sourcing the *setenv.csh* file in the appropriate release directory e.g.

source /group/halld/Software/builds/release-2009-02-24/setenv.csh

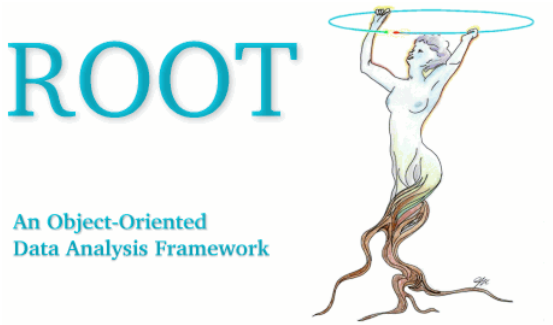
Creating a private build of Hall-D Offline Software

The next few slides will give info on how to create a private build on you own computer including:

- Required 3rd party packages
- Accessing the Hall-D subversion repository
- Organization of source code
- Environment
- Creating a build using BMS

Required 3rd Party Packages

- JANA (**J**lab **ANA**lysis framework)
  - Event processing and calibration DB access
- CERNLIB
  - GEANT3 Monte Carlo
- ROOT
  - Reconstruction
  - Event Viewer
  - Tree/histogram creation
- XERCES (XML parser for C/C++)
  - Read in XML geometry for both simulation and reconstruction
  - HDDM (Hall-D Data Model) tools



The Hall-D Subversion Repository

- Anonymously accessible via WWW
  - https://halldsvn.jlab.org/repos
- subversion has command syntax that mirrors CVS (for the most part)

Check out release:

svn co https://halldsvn.jlab.org/repos/tags/release-2009-02-24

Update changes from repository:

svn update

Commit changes:

svn commit

List repository contents:

svn ls https://halldsvn.jlab.org/repos/tags

Calibration and Conditions Database

- Few calib./cond. parameters exist now (e.g. B-field map), but they are necessary for running both simulation and reconstruction code

- Get them from the repository like this:

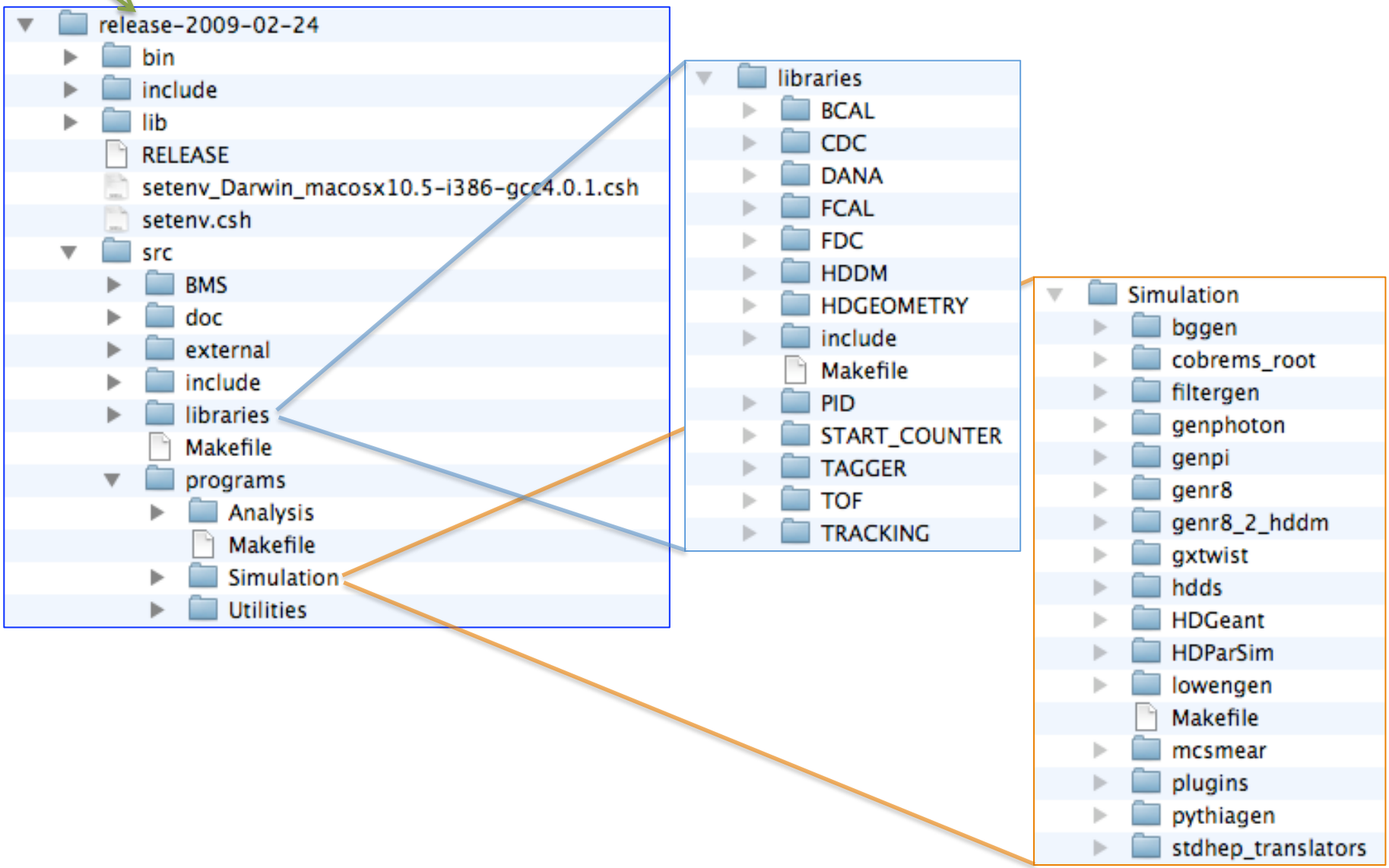
svn co https://halldsvn.jlab.org/repos/trunk/calib

- Set environment to use them like this:

setenv JANA_CALIB_URL file:///path/to/calib

Organization of Source Code

$HALLD_HOME



Environment

```
# HALLD
setenv HALLD_HOME /Users/davidl/HallD/builds/release-2009-02-24
setenv BMS_OSNAME Darwin_macosx10.5-i386-gcc4.0.1
setenv PATH ${HALLD_HOME}/bin/${BMS_OSNAME}:$PATH

# JANA
setenv JANA_HOME /Users/davidl/12GeV/builds/jana_0.4.9/Darwin_macosx10.5-i386-gcc4.0.1
setenv JANA_CALIB_URL file:///Users/davidl/HallD/calib
setenv JANA_GEOMETRY_URL xmlfile://${HALLD_HOME}/src/programs/Simulation/hdds/main_HDDS.xml
setenv JANA_PLUGIN_PATH /Users/davidl/12GeV/builds/jana_0.4.9/Darwin_macosx10.5-i386-gcc4.0.1/lib
setenv PATH ${JANA_HOME}/bin:$PATH

# ROOT
setenv ROOTSYS /usr/local/root/PRO
setenv DYLD_LIBRARY_PATH ${ROOTSYS}/lib:$DYLD_LIBRARY_PATH
setenv PATH ${ROOTSYS}/bin:$PATH

# CERNLIB
setenv CERN /usr/local/cern
setenv CERN_LEVEL PRO
setenv DYLD_LIBRARY_PATH ${CERN}/${CERN_LEVEL}/lib:$DYLD_LIBRARY_PATH
setenv PATH ${CERN}/${CERN_LEVEL}/bin:$PATH

# Java
setenv JAVAROOT /usr

# Xerces
setenv XERCESCROOT /usr/local/xerces/PRO
setenv DYLD_LIBRARY_PATH ${XERCESCROOT}/lib:$DYLD_LIBRARY_PATH
```

Creating a Build Using BMS

- **B**uild **M**anagement **S**ystem is simply a set of standard "makefile"s used to build the Hall-D code. To do a "standard" build, just invoke "make" from $HALLD_HOME/src
- BMS compiles all files with .cc, .c, or .F suffixes in a directory

Makefile for hd_root

```
PACKAGES = ROOT:DANA

include $(HALLD_HOME)/src/BMS/Makefile.bin
```

About 80% of the Makefiles in programs directory have 2 or 3 lines!

Use of the *HALLD_MY* environment variable

The *HALLD_MY* environment variable can be used to develop or modify a small piece of the code in a private area while using headers and libraries from a common build that is in a public area.

```
setenv HALLD_HOME /group/halld/Software/builds/release-2009-02-24
setenv HALLD_MY  ~/HallD

cp -r $HALLD_HOME/src/programs/Analysis/hd_ana ./
cd hd_ana
make

<…. builds private hd_ana executable ….>

<… run program from private directory …>
$HALLD_MY/bin/$BMS_OSNAME/hd_ana hdgeant.hddm
```

Looking at an HDDM data file

Files used for generated events and simulated data are in HDDM format. This is unique to Hall-D, but several tools exist to inspect and manipulate them.

- hd_dump
  - Dump single event information to screen one event at a time
- hdview2
  - Draw single event graphically with GUI
- hd_ana , hd_root
  - Batch processing of large numbers of events usually to produce ROOT files with trees/histograms

The *hd_dump* program

```
hd_dump hdgeant_1photon.hddm -DDMCThrown -DDPhoton
```

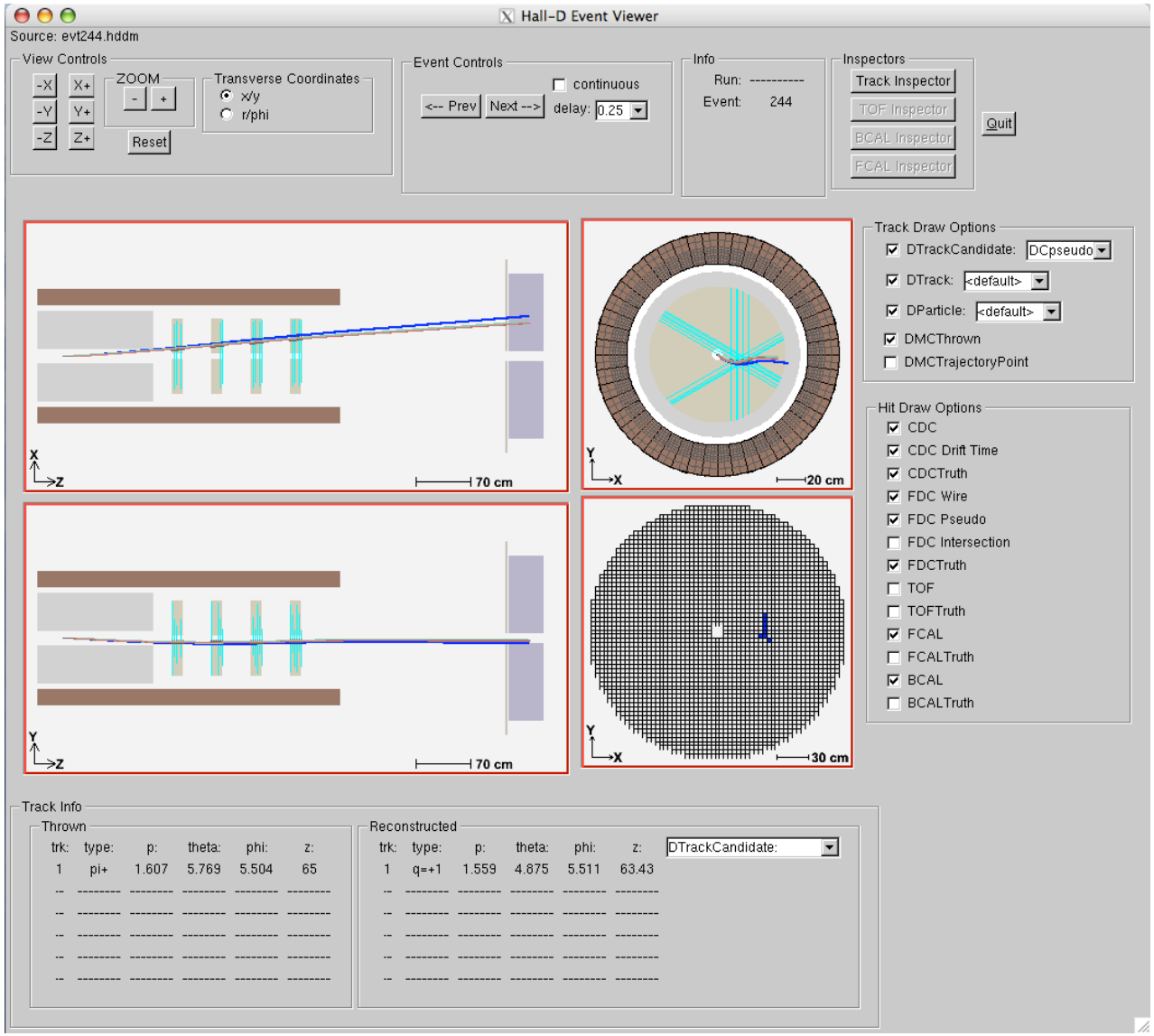
```
============================================================
Event: 33

Registered factories: (56 total)

Name:             nrows:  tag:
---------------- ------- --------------
DBCALGeometry         1
DFCALHit             11
DFCALCluster          1
DFCALPhoton           1
DFCALGeometry         1
DFCALTruthShower      1
DFCALMCResponse      11
DMCFCALHit           19
DTOFGeometry          1
DMCTrackHit           1
DMCThrown             1
DMCTrajectoryPoint    2
DTrackFitter          1
DTrackFitter          1    "ALT1"
DTrackHitSelector     1
DTrackHitSelector     1    "ALT1"
DPhoton               1

DMCThrown:
  q: x(cm): y(cm): z(cm): E(GeV):    t(ns): p(GeV/c): theta(deg): phi(deg): type: pdgtype: myid: parentid: mech:
-------------------------------------------------------------------------------------------------------------------
 +0    0.0    0.0   65.0   3.000 -999.000      3.000       4.000     7.132     1        0     1          0     0

DPhoton:
 E(GeV): Px(GeV/c): Px(GeV/c): Px(GeV/c):   X(cm):   Y(cm):   Z(cm):   Tag:
-------------------------------------------------------------------------
   3.06       0.21       0.02       3.05     0.00     0.00    65.00      1
```

All reconstruction algorithms are automatically activated and list of all objects produced is shown first

Objects specified for printing are printed next

The *hdview2* Event Viewer

```
hdview2 hdgeant.hddm
```



- Somewhat primitive, but still useful for certain single event diagnostics
- Drawing of both charged and neutral tracks
- Easily turn on/off drawing of tracks at various stages of reconstruction (helical fit, wire-based fit, time-based fit)
- ROOT based

Filling ROOT trees and histograms from HDDM data

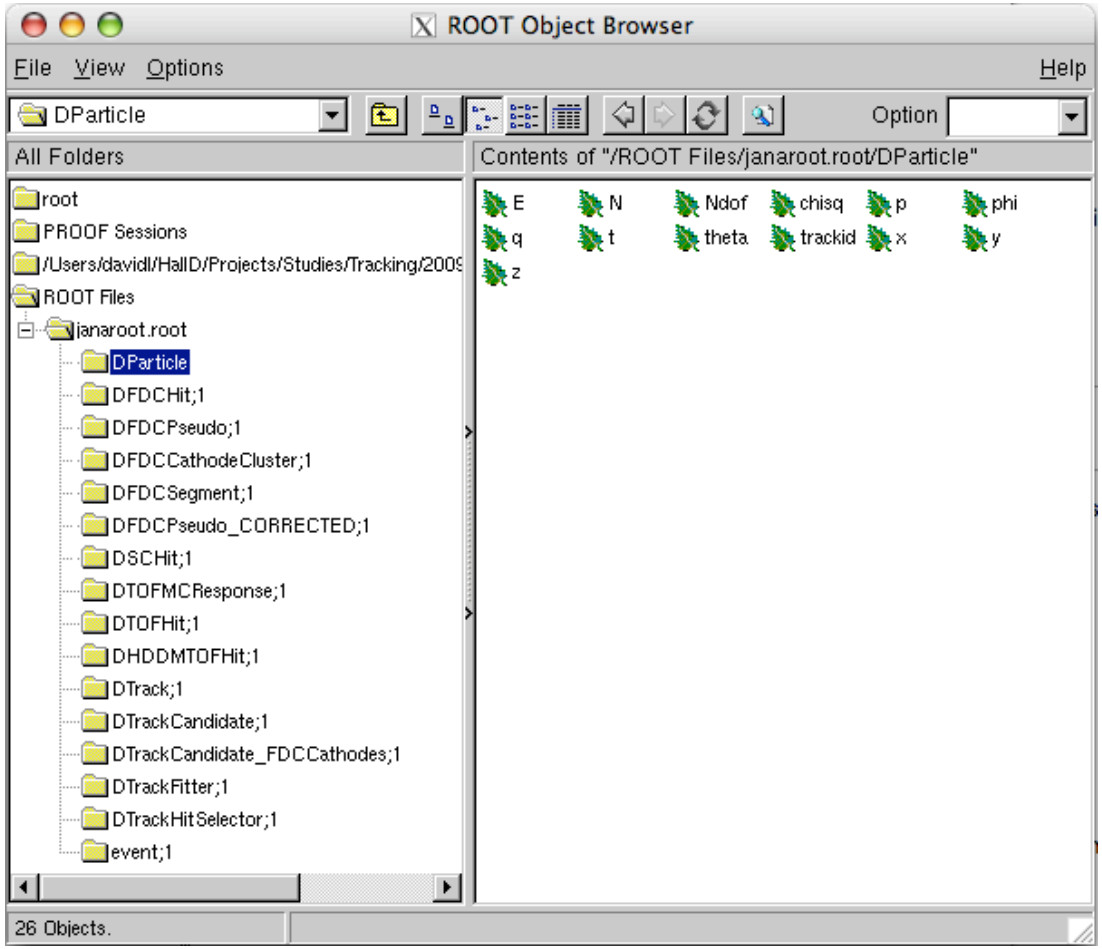
There are multiple ways to generate ROOT TTree and histogram objects from data in HDDM files

- janaroot plugin
- existing Hall-D plugins
- Customizing your own executable or plugin

I'll briefly describe the first 2 options here and will leave the last one for later when you need more advanced control over the reconstruction

The *janaroot* plugin

```
hd_ana --plugin=janaroot --auto_activate=DParticle hdgeant.hddm
root janaroot.root
```



janaroot will generically make TTree objects from the data objects produced in JANA

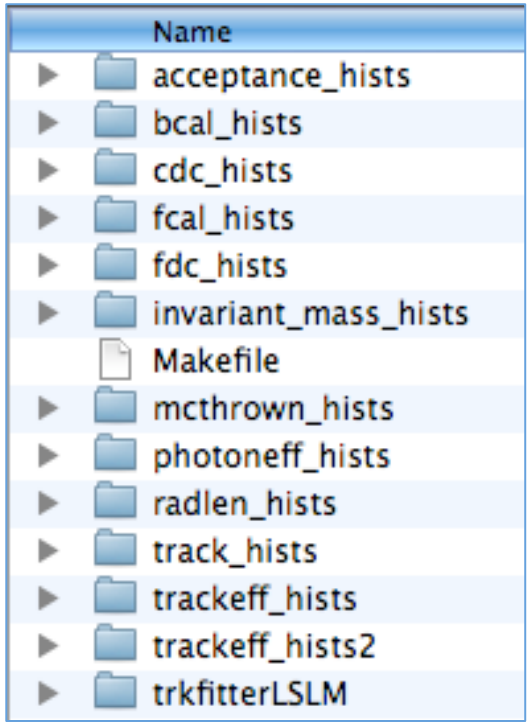
Same mechanisms used to print data to screen in *hd_dump* are used to create trees so anything you see there, will show up here.

The *event* TTree includes all other TTrees allowing leaves of one tree to be plotted against leaves of another

Useful for getting started without having to learn a lot about *JANA*

Other DANA plugins

Several plugins already exist that make various ROOT trees and histograms. Any number of these can be added to the command line (via the --plugin=XXX argument) to have all of the trees/histograms show up in the same ROOT file



If one of these doesn't give you exactly what you need then one of them should at least provide a reasonably close example that can be tweaked.

In particular, you may want to look at *invariant_mass_hists* for a examples on making ρ and π^o invariant mass histograms.

Summary

- The first stop when looking for information on Hall-D software should be the GlueX Wiki (http://wiki.gluex.org)
- All of the software is available for anonymous checkout from the Hall-D subversion repository
- Questions can be sent to one of the halld mailing lists : halld-mc@jlab.org and halld-offline@jlab.org