BESIII Software Framework

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Outline

Course Arrangement

- Course characteristics:
  - simple course.
  - need to be familiar with its framework and use it flexibly.
  - need a lot of practice.

- Course arrangement:

Course	Duration (Min)
BESIII Offline Software System	20 - 30
Monte Carlo Simulation	20 - 30
HTCondor System	10 - 20
Practice	100 - 130

BESIII Offline Software System (BOSS)

Introduction

- The BESIII Offline Software System (BOSS):
  - developed on the operating system of Scientific Linux CERN (SLC), using C++ language.
- The main purpose:
  - Access to BESIII software packages.
  - Reconstruction data (J/psi, $\psi(3686)$, $\psi(3770)$ and XYZ)
  - Simulation and reconstruction of Monte Carlo sample.
  - Create algorithm for your analysis.
  - Calculate data/Monte Carlo sample using your algorithm.

Lxslc account

- Lxslc account application
  - Fill the form (http://afsapply.ihep.ac.cn/ccapply/userapplyaction.action).
  - Send an email (Included your information) to Shuopin Wen.
- The disk spaces for users on lxslc:

Disk	Spaces
/afs/ihep.ac.cn/users/	500 M
/workfs	5 G
/besfs/users	50 G
/scratchfs/	500 G

- Note that: the expiry date of the password is 250 days. Please use 'kpasswd username' to change your password.

Set Boss Environment

- Prerequisites:
  - Have your own CVS account, or you can use the public CVS account: bes3/bes3charm.
  - Have an account on IHEP Farm (Lxslc account).
  - Create two directories, which hold your environment settings and your workarea.
- Shell type
  - .bashrc: source '.sh' files to setup your BOSS environment.
  - .tcshrc: source '.csh' files to setup your BOSS environment.
- BOSS version:
  - 703 and above: Set the BOSS environment directly.
  - 6.6.4: Enter the container, and then set the BOSS environment.
  - Command: /cvmfs/container.ihep.ac.cn/bin/hep_container shell SL5.

How to Set Boss Environment

- Copy a template:
  - Make a directory for environment setting: mkdir cmthome.
  - Make a directory as your work area: mkdir workarea.
  - Copy the template files to your directory which will hold your environment settings: cp /cvmfs/bes3.ihep.ac.cn/bes3sw/cmthome/cmthome-7.0.5-Slc6Centos7Compat cmthome.
- Set up your CVS account:
  - Firstly, modify the file:setupCVS.sh: vim setupCVS.sh.
  - Then use your own/public cvs account to replace the username: maqm.
  - Lastly, setup your own CVS environment. source setupCVS.sh/cvs login.
  - Then input your CVS account password.

How to Set Boss Environment

- Connect with CMT: source setupCMT.sh
- Modify the requirements file:
  - Set your own work area: macro WorkArea "/ihepbatch/bes/maqm/workarea"
  - Release path_remove CMTPATH "$WorkArea" path_prepend CMTPATH "$WorkArea"

```
#Add your worarea to CMTPATH
#macro WorkArea "/ihepbatch/bes/maqm/cvmfs/703p02"
# Add dev area to the front of your CMTPATH (but first remove any previously defined devarea which is under your home directory)
#path_remove CMTPATH  "${WorkArea}"
#path_prepend CMTPATH "${WorkArea}"
```

- Config your environment settings:
  - cmt config
  - source setup.sh

How to run a simple example

- Check out/copy TestRelease from BOSS environment
  - cd <yourworkarea>
  - cp -r /cvmfs/bes3.ihep.ac.cn/bes3sw/Boss/7.0.3/TestRelease .
  - cd TestRelease/*/cmt
  - cmt broadcast cmt config
  - source setup.sh
- Run the example
  - cd ../run
  - boss.exe jobOptions_sim.txt
- Set environment variable

```
source /workfs/bes/qusq/cmthome-7.0.3-Slc6Centos7Compat/setupCMT.csh
source /workfs/bes/qusq/cmthome-7.0.3-Slc6Centos7Compat/setup.csh
source /workfs/bes/qusq/cmthome-7.0.3-Slc6Centos7Compat/setupCVS.csh
source /workfs/bes/qusq/7.0.3-CentOS/TestRelease/TestRelease-00-00-86/cmt/setup.csh
```

Monte Carlo Simulation

Introduction

What is the Monte Carlo simulation ?

- When we analyze a decay process, we mainly need these steps
  - Determine the decay process that we want to study
  - Write algorithms with C++ and study selection criteria
  - Check on signal events you get
  - Run data and see what happened to data
  - Background analysis
  - Re-determine selection criteria
  - Obtain results
  - Study systematic uncertainties

An MC simulation is a way of simulating possible real decays in data using known physics process.

The classification of the Monte Carlo Simulation

- Exclusive Monte Carlo simulation (Signal MC)
  - You generate decay process, which involves only your signal channel.
  - For example, if we want to study $J\psi \to \rho^0\pi^0$, we need to generate the signal Monte Carlo:

```
#
#   jpsi->Rhopi
#
Decay J/psi
1.0000  rho0   pi0     HELAMP 1.0 0.0 0.0 0.0 1.0 0.0;
Enddecay


Decay rho0
1.000   pi+  pi-       VSS;
Enddecay


Decay pi0
1.000   gamma  gamma   PHSP;
Enddecay

End
```

The classification of the Monte Carlo Simulation

- Inclusive Monte Carlo simulation
  - An MC simulation that included all known physical processes
  - For example, if we want to study J/ψ, $\psi(3686)$ or $\psi(3770)$ decay processes, we need to use:

```
Decay D0
#
#================Semileptonic decays=======================
#
0.0217   K*-  e+  nu_e          PHOTOS   SLPOLE_DtoKstarlnu;
#Gamma20
0.0355   K-   e+  nu_e          PHOTOS   SLBKPOLE_DtoKlnu;
#Gamma18
0.00076   K_1-  e+  nu_e         PHOTOS   ISGW2;
#Gamma25
0.0004   K-  pi0 e+ nu_e     PHSP;
#Gamma22
0.0007    anti-K0 pi- e+ nu_e    PHSP;
#Gamma23
0.00289  pi-  e+  nu_e          PHOTOS   SLBKPOLE_Dtopilnu;
#Gamma28
0.0019   rho- e+  nu_e          PHOTOS   SLPOLE_Dtorholnu;
#Gamma30
0.0198   K*-  mu+ nu_mu         PHOTOS  SLPOLE_DtoKstarlnu;
#   0.0230   K*-  mu+ nu_mu         PHOTOS  SLPOLE_DtoKstarlnu;
#Gamm21
0.0331   K-   mu+ nu_mu         PHOTOS  SLBKPOLE_DtoKlnu;
#   0.03863  K-   mu+ nu_mu         PHOTOS  SLBKPOLE_DtoKlnu;
#Gamma19
0.00076  K_1-  mu+ nu_mu         PHOTOS  ISGW2;
#Similar as Gamma25
0.0004   K-  pi0 mu+ nu_mu   PHSP;
#Similar as Gamma22
0.0007   anti-K0 pi- mu+ nu_mu   PHSP;
#Similar as Gamma23
0.00237  pi-  mu+ nu_mu         PHOTOS  SLBKPOLE_Dtopilnu;
#Similar as Gamma28
0.0019   rho- mu+ nu_mu         PHOTOS  SLPOLE_Dtorholnu;
#Similar as Gamma30

0.0389   K-  pi+                     PHSP;
#Gamma31
0.0122   K_S0   pi0                   PHSP;
#Gamma32
0.0100   K_L0   pi0                   PHSP;
```

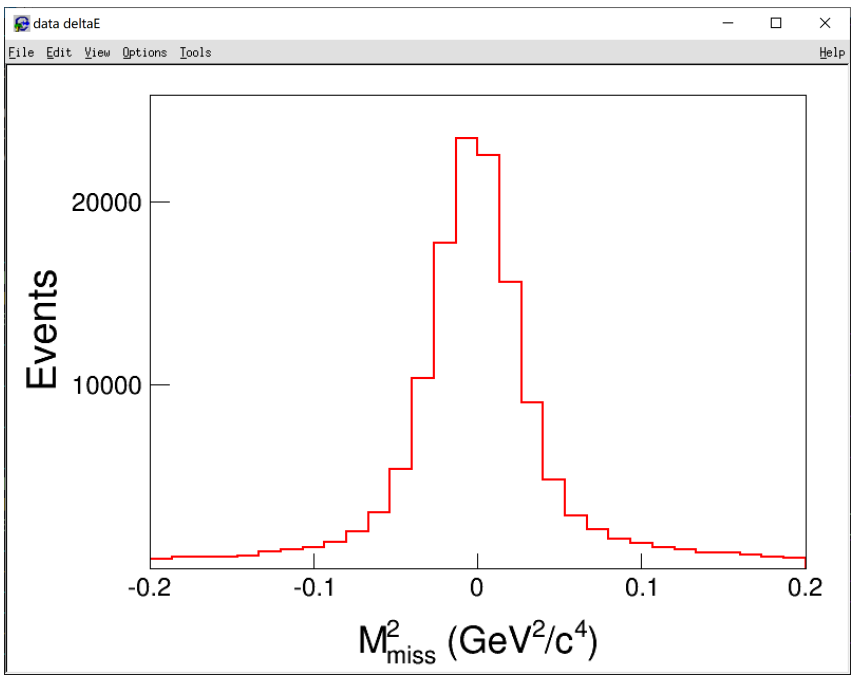
```
Decay psi(2S)
0.00772   e+   e-               PHOTOS VLL;
0.00770   mu+  mu-               PHOTOS VLL;
0.003     tau+  tau-             PHOTOS VLL;
0.3504    J/psi  pi+ pi-                JPIPI;
0.1769    J/psi  pi0 pi0                JPIPI;
0.0328    J/psi  eta             HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
0.0013    J/psi  pi0             HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
0.00031   J/psi  gamma gamma PHSP;
0.00086   h_c pi0 PHSP;
#hadronic decays
0.0035     pi+ pi-  pi+ pi-  pi+ pi- pi0 PHSP;
0.00272    pi+ pi-  pi+ pi- pi0 PHSP;
0.0000867   rho+ a_2- PHSP;
0.0000867   rho0 a_20 PHSP;
0.0000867   rho- a_2+ PHSP;
0.000276    p+ anti-p- J2BB1;
0.000128    Delta++ anti-Delta-- J2BB2;
0.0001      Lambda0 anti-p- K+ PHSP;
0.00018     Lambda0 anti-p- K+ pi+ pi- PHSP;
0.00028     Lambda0 anti-Lambda0 pi+ pi- PHSP;
0.00028     Lambda0 anti-Lambda0 J2BB1;
0.00026     Sigma+ anti-Sigma- J2BB1;
0.00022     Sigma0 anti-Sigma0 J2BB1;
0.00011     Sigma*+ anti-Sigma*- J2BB2;
0.00018     Xi- anti-Xi+ J2BB1;
0.00028     Xi0 anti-Xi0 J2BB1;
0.000079    Omega- anti-Omega+ PHSP;
0.00011     pi0 p+ anti-p- PHSP;
0.000011    pi0 f_0(2100) PHSP;
0.00005     eta p+ anti-p- PHSP;
0.000007    eta f_0(2100) PHSP;
0.000069    omega p+ anti-p- PHSP;
0.0006      pi+ pi- p+ anti-p- PHSP;
0.000248    p+ anti-n0 pi- PHSP;
0.000248    n0 anti-p- pi+ PHSP;
0.00032     p+ anti-n0 pi- pi0 PHSP;
0.00048     pi+ pi- pi0 pi+ pi- pi0 PHSP;
```

How to use the Monte Carlo simulation ?

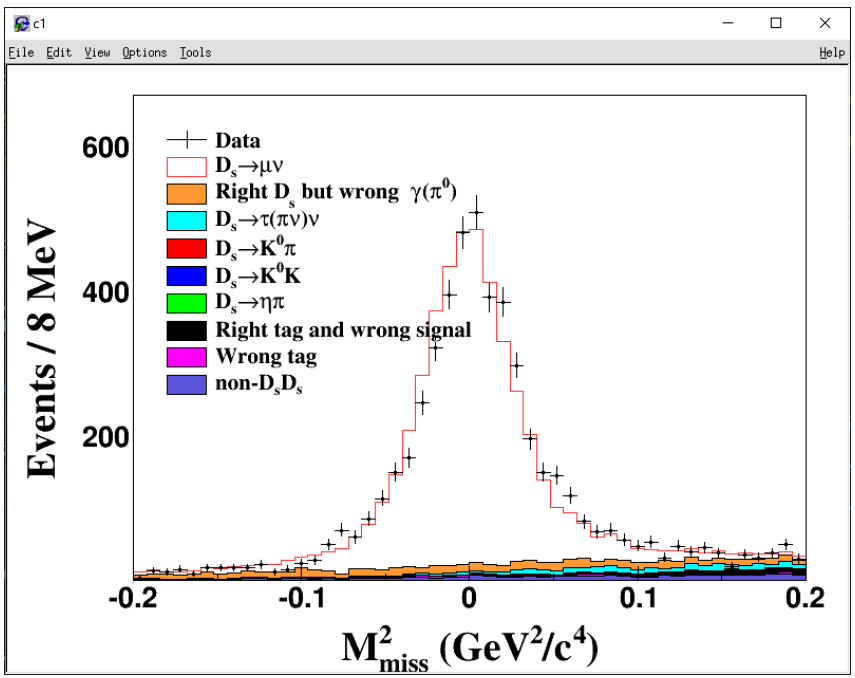
How to use the Monte Carlo simulation ?

Decay channel: $D_s^+ \to \mu^+ \nu_\mu$

Left: Signal MC



Right: Inclusive MC



How to simulate MC event

Signal MC: Simulation → Reconstruction → Analysis

boss.exe jobOptions_sim.txt

```
#include "$OFFLINEEVENTLOOPMGRROOT/share/OfflineEventLoopMgr_Option.txt"

//**************job options for generator (KKMC)***************
#include "$KKMCROOT/share/jobOptions_KKMC.txt"
KKMC.CMSEnergy = 3.097;
KKMC.BeamEnergySpread=0.0008;
KKMC.NumberOfEventPrinted=1;
KKMC.GenerateJPsi=true;

//**************job options for EvtGen***************
#include "$BESEVTGENROOT/share/BesEvtGen.txt"
EvtDecay.userDecayTableName = "rhopi.dec";

//***************job options for random number************************
BesRndmGenSvc.RndmSeed = 100;

//***************job options for detector simulation******************
#include "$BESSIMROOT/share/G4Svc_BesSim.txt"

//configure for calibration constants
#include "$CALIBSVCROOT/share/calibConfig_sim.txt"

// run ID
RealizationSvc.RunIdList = {-9989};

#include "$ROOTIOROOT/share/jobOptions_Digi2Root.txt"
RootCnvSvc.digiRootOutputFile = "rhopi.rtraw";


// OUTPUT PRINTOUT LEVEL
// Set output level threshold (2=DEBUG, 3=INFO, 4=WARNING, 5=ERROR, 6=FATAL )
MessageSvc.OutputLevel  = 2;

// Number of events to be processed (default is 10)
ApplicationMgr.EvtMax = 50;
```

How to simulate MC event

rhopi.dec: $J\psi \to \rho\pi^0$, $\rho \to \pi^+\pi^-$, $\pi^0 \to \gamma\gamma$

```
#
#   jpsi->Rhopi
#
Decay J/psi
1.0000  rho0   pi0      HELAMP 1.0 0.0 0.0 0.0 1.0 0.0;
Enddecay


Decay rho0
1.000   pi+  pi-        VSS;
Enddecay


Decay pi0
1.000   gamma  gamma    PHSP;
Enddecay

End
```

How to reconstruct MC event

boss.exe jobOptions_rec.txt

```
//output ROOT REC data
#include "$ROOTIOROOT/share/jobOptions_Dst2Root.txt"

//configure of calibration constants for MC
#include "$CALIBSVCROOT/share/calibConfig_rec_mc.txt"


//***************job options for random number************************
BesRndmGenSvc.RndmSeed = 100;

//Set output level threshold (2=DEBUG, 3=INFO, 4=WARNING, 5=ERROR, 6=FATAL )
MessageSvc.OutputLevel = 2;

//ROOT input data file
EventCnvSvc.digiRootInputFile = {"rhopi.rtraw"};

//ROOT output data file
EventCnvSvc.digiRootOutputFile ="rhopi.dst";

//Number of events to be processed (default is 10)
ApplicationMgr.EvtMax = 50;
```

How to analysis MC event

boss.exe jobOptions_ana_rhopi.txt

```
#include "$ROOTIOROOT/share/jobOptions_ReadRec.txt"
#include "$VERTEXFITROOT/share/jobOptions_VertexDbSvc.txt"
#include "$MAGNETICFIELDROOT/share/MagneticField.txt"
#include "$ABSCORROOT/share/jobOptions_AbsCor.txt"

#include "$RHOPIALGROOT/share/jobOptions_Rhopi.txt"

// Input REC or DST file name
EventCnvSvc.digiRootInputFile = {"rhopi.dst"};

// Set output level threshold (2=DEBUG, 3=INFO, 4=WARNING, 5=ERROR, 6=FATAL )
MessageSvc.OutputLevel = 5;

// Number of events to be processed (default is 10)
ApplicationMgr.EvtMax = 50;

ApplicationMgr.HistogramPersistency = "ROOT";
NTupleSvc.Output = { "FILE1 DATAFILE='rhopi_ana.root' OPT='NEW' TYP='ROOT'"};
```

HTCondor System

Introduction

- HTCondor is a popular job management system in HEP field. It's flexible and powerful for high throughput computing in very large clusters
- Preparations

  The HepJob is installed in the following directory. It's recommended to set the directory in your PATH environment variable:

  - for bash

```
$ export PATH=/afs/ihep.ac.cn/soft/common/sysgroup/hep_job/bin:$PATH
```

  - for tcsh

```
$ setenv PATH /afs/ihep.ac.cn/soft/common/sysgroup/hep_job/bin:$PATH
```

Preparations

- Preparations

  The application file of the job should be executable. We can check and change the file permission as following:

  - Show the job permission

```
$ /bin/ls -l job.sh
-rw-r--r-- 1 jiangxw u07 85 Aug 29 18:23 job.sh
```

The file job.sh is not executable. It can be set by the command `chmod`

```
$ /bin/chmod +x job.sh
```

Then, the additional ' `x` ' in the first column indicates the executable permission

```
$ /bin/ls -l job.sh
-rwxr-xr-x 1 jiangxw u07 85 Aug 29 18:23 job.sh
```

How to submit jobs

Command:

```
hep_sub [-h] [-g {physics,juno,dybrun,dyw,u07,offlinerun,pku,longq}]
          [-p {virtual,local,ali}] [-u {vanilla,grid,docker}] [-o OUT]
          [-e ERROR] [-n NUMBER] [-os OPERATINGSYSTEM]
          [-t {atlasbm,hxmtbm,wljMC}] [-prio PRIORITY]
          [-np NUMBERPROCESS] [-argu ARGUMENTS [ARGUMENTS ...]]
          [-dir DIRECTORY] [-mem MEMORY] [-quiet] [-part PARTITION]
          [-name NAME] [-slurm] [-site SITENAME] [-jf JOBFILE]
          [-tf TRANSFERFILE] [-wn WORKNODE] [-wt WALLTIME]
          jobscript
```

How to submit jobs

- `jobscript` : job application name, both absolute path and relative path are supported. For example

```
$ hep_sub job.sh
```

- `-g` : to indicate the job group. The user's primary group is used by default if it is not set. For example, if you want to use the computing resources of juno

```
$ hep_sub -g juno job.sh
```

- `-p` : to indicate the resource pool. Currently their are 2 types of resource pools, the local physical resource pool and the virtual machine resource pool. The local physical resource pool is used by default if it is not set. For example, if we want to use the virtual machine resource pool

```
$ hep_sub -p virtual job.sh
```

How to submit jobs

- `-o` : to write the standard output of the job to a file. When it is not set, the standard output is wrote to a file named "jobname+.out".
- `-e` : to write the standard error of the job to a file. When it is not set, the standard error is wrote to a file named "jobname+.err".
- `-l` : to write the job log to a file. The job log file is not generated by default if it is not set. The job log file is meaningless in most cases. We can ignore it if you are uncertain.
- `-os` : to indicate the operation system version for the job. It is SL6 by default if it is not set. For example, we can set the job running on a SL7 node as following

```
$ hep_sub -os SL7 job.sh
```

How to query jobs

Command:

```
hep_q [-h] [-u [USER]] [-i ID] [-run] [-p {virtual,local,ali}]
      [-t {atlasbm,hxmtbm,wljMC}] [-st STARTTIME]
      [-stat {run,idle,other} [{run,idle,other} ...]] [-slurm]
```

Options:

- `-u` : to query the jobs of the specified user. It is the current user by default. For example

  ```
  $ hep_q -u <username>
  ```

  The current user's jobs are queried if we use " `hep_q -u` " without a username.

- `-i` : to query a job with JobID or the clusterid. There is no default value to it. A JobID consists of a clusterid and a processid, in the form of clusterid.processid (a JobID 3745232.1 contains a clusterid 3745232 and a processid 1). Take the JobID 3745232.1 as example

  ```
  $ hep_q -i 3745232.1
  ```

  The processid is ignored when we query all the jobs belonging to a same clusterid

  ```
  $ hep_q -i 3745232
  ```

How to remove jobs

Command:

```
hep_rm [-h] [-a] [-t {atlasbm,hxmtbm,wljMC}] [-p {virtual,local,ali}]
       [-name NAME] [-slurm]
       [jobs [jobs ...]]
```

Options:

- `jobs` : to indicate the JobIDs for removing. One or more JobIDs are supported in each invoking

  ```
  $ hep_rm 3745232 3745233.0
  ```

  all jobs with clusterid 3745232, and the job with JobID 3745233.0 will be removed at the same time.

- `-a` : to remove all the jobs belonging to the current user. For example

  ```
  $ hep_rm -a
  ```

- `-t` : to indicate a job template. For example, it is necessary to cpecmpi users

  ```
  $ hep_rm –i 3745232 –t cepcmpi
  ```

- `-forcex` : force to delete the job stucked in stat "X". Please note that this parameter only take effects on "X" job. Stat "X" generally indicates there would be a problem between job server and worker node, and the job is in a deleting status. If remove job 3745232.0 which is stucked in stat "X", please run the following command:

  ```
  $ hep_rm 3745232 –forcex
  ```

HTCondor for BESIII

1) BESIII Users

For the standard boss jobs, we can use the simplified command `boss.condor` :

```
$ boss.condor joboptions.txt
```

For other BESIII jobs, please set your group as `physics` :

```
$ hep_sub -g physics job.sh
```

Job querying and removing are the same as previous descriptions.

Summary

- In this report, we learn that
  - BESIII Offline software system
  - Monte Carlo Simulation
  - HTCondor system
- References:
  - https://docbes3.ihep.ac.cn/ offlinesoftware/index.php/Main_Page
  - /cvmfs/bes3.ihep.ac.cn/bes3sw/Boss/7.0.3/TestRelease/TestRelease-00-00-86/run
  - http://afsapply.ihep.ac.cn/cchelp/en/local-cluster/jobs/HTCondor/#2
  - http://afsapply.ihep.ac.cn/cchelp/zh/local-cluster/jobs/HTCondor/#2

Thank you