Data Analysis-01

Introduction to the High Energy Experiment

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What is "physics"?

Physics

From Wikipedia, the free encyclopedia

This article is about the field of science. For other uses, see Physics (disambiguation).

Not to be confused with Physical science.

Physics (from Ancient Greek: φυσική (ἐπιστήμη), translit. *physikḗ (epistḗmē)*, lit. 'knowledge of nature', from φύσις *phýsis* "nature")[1][2][3] is the natural science that studies matter[4], its motion, and behavior through space and time, and that studies the related entities of energy and force.[5] Physics is one of the most fundamental scientific disciplines, and its main goal is to understand how the universe behaves.[a][6][7][8]

What is “particle physics”？

世界由什么组成?

世界如何组成?

世界如何演化?

产生 & 消失（衰变、湮灭）

How should we do?

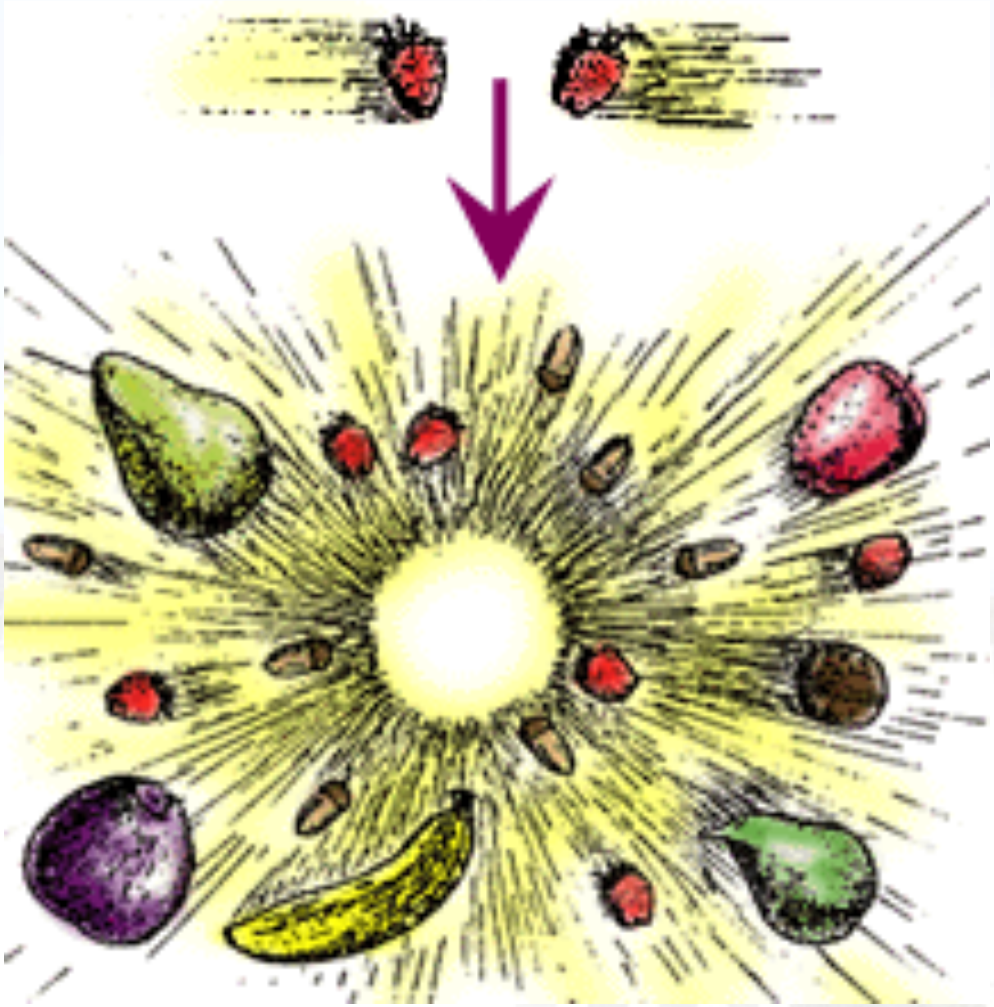
In 1964 Arno Penzias and Robert Wilson serendipitously discovered the cosmic background radiation, an omnidirectional signal in the microwave band.[70] Their discovery provided substantial confirmation of the big-bang predictions by Alpher, Herman and Gamow around 1950. Through the 1970s the radiation was found to be approximately consistent with a black body spectrum in all directions; this spectrum has been redshifted by the expansion of the universe, and today corresponds to approximately 2.725 K. This tipped the balance of evidence in favor of the Big Bang model, and Penzias and Wilson were awarded a Nobel Prize in 1978.

1978年	彼得·列昂尼多维奇·卡皮查	苏联	“低温物理领域的基本发明和发现”
	阿尔诺·艾伦·彭齐亚斯	美国	“发现宇宙微波背景辐射”
	罗伯特·伍德罗·威尔逊	美国	

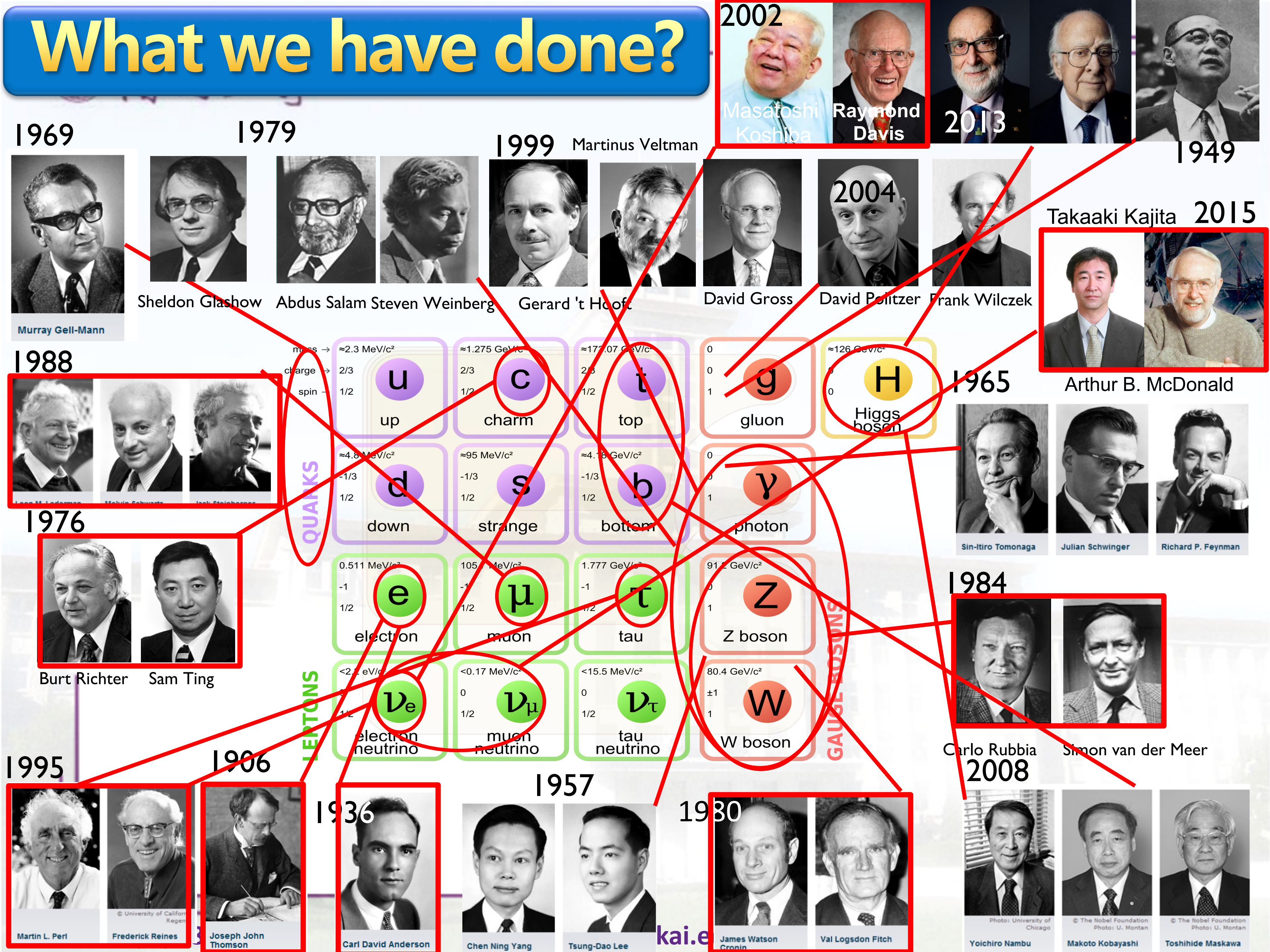
In 1989, NASA launched the Cosmic Background Explorer satellite (COBE), which made two major advances: in 1990, high-precision spectrum measurements showed that the CMB frequency spectrum is an almost perfect blackbody with no deviations at a level of 1 part in 10^4, and measured a residual temperature of 2.726 K (more recent measurements have revised this figure down slightly to 2.7255 K); then in 1992, further COBE measurements discovered tiny fluctuations (anisotropies) in the CMB temperature across the sky, at a level of about one part in 10^5.[77] John C. Mather and George Smoot were awarded the 2006 Nobel Prize in Physics for their leadership in these results.

2006年	约翰·马瑟	美国	“发现宇宙微波背景辐射的黑体形式和各向异性”
	乔治·斯穆特	美国	

How should we do?



What we have done?



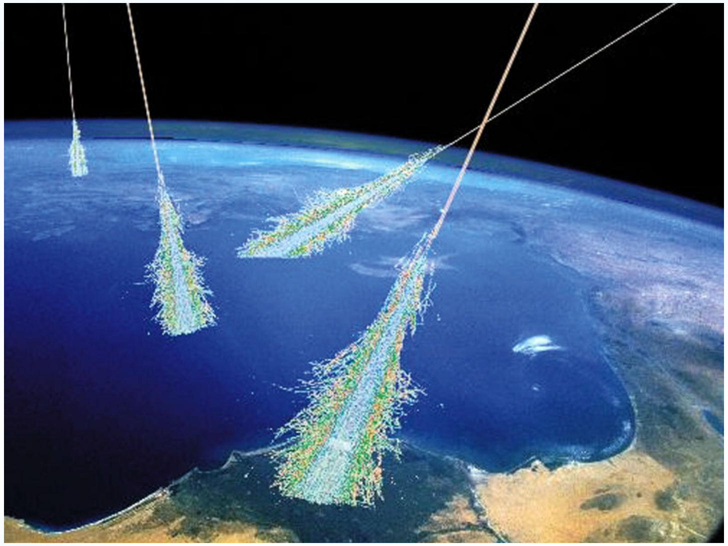
Far more important…

年代	贡献	荣誉	贡献者
1906	盖革计数管		H. Geiger, E. Rutherford
1911	威尔逊云室	1927	C. Wilson
1928	盖革米勒计数器		W. Muller
1929	符合方法	1954	W. Bothe
1925-1932	威尔逊云室的改进	1948	P. Blackett
1930'-1950'	核乳胶，核碎裂		M. Blau
1930	回旋加速器	1939	E. Lawrence
1930	高压倍加器	1951	J. Cockcroft, E. Walton
1940-1950	闪烁体，光电放大器		
1952	气泡室	1960	D. Glaser
1954-1962	氢气泡室及相关数据分析技术	1968	L. Alvarez
1959	火花室		福井崇时，宫本重德
1968	多丝正比室	1992	C. Charpak
1981	随机冷却方法，强反质子束	1984	V. D. Meers

HEP Experiment – 原理

HEP Experiment – 粒子源

- 放射源
- 宇宙线（反应堆）
  - 可获超高能量粒子
  - 统计量低
  - 随机性强
- 粒子加速器
  - 能量较宇宙线低
  - 能量可调节
  - 统计量高
  - 可控制与可重复性强
  - 直线加速器
  - 回旋加速器
  - 同步回旋加速器



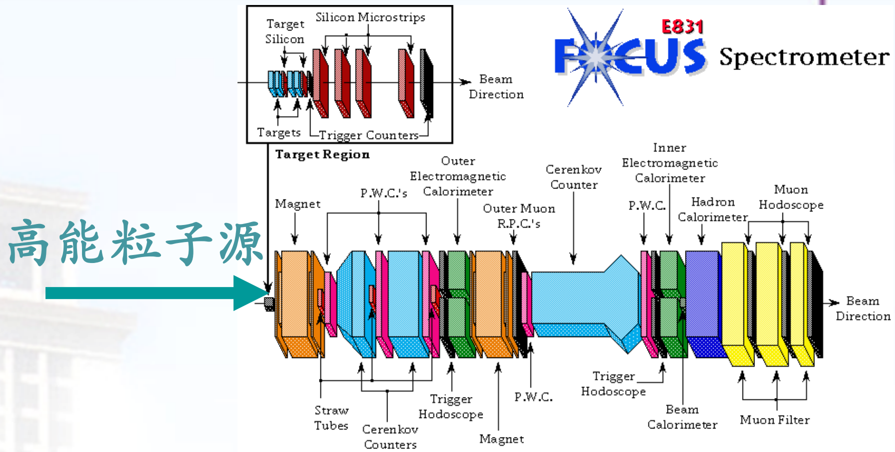
HEP Experiment – 反应方式

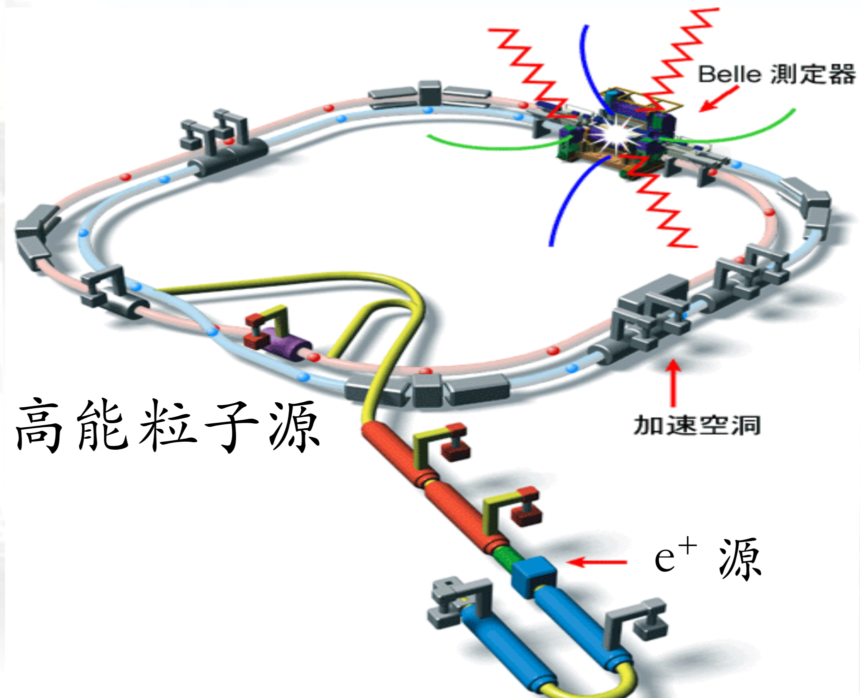
- 固定靶
  - 高能粒子束(m_1)轰击静止的粒子(m_2)靶

$$E_{cm}^2 \approx 2E_1 m_2$$

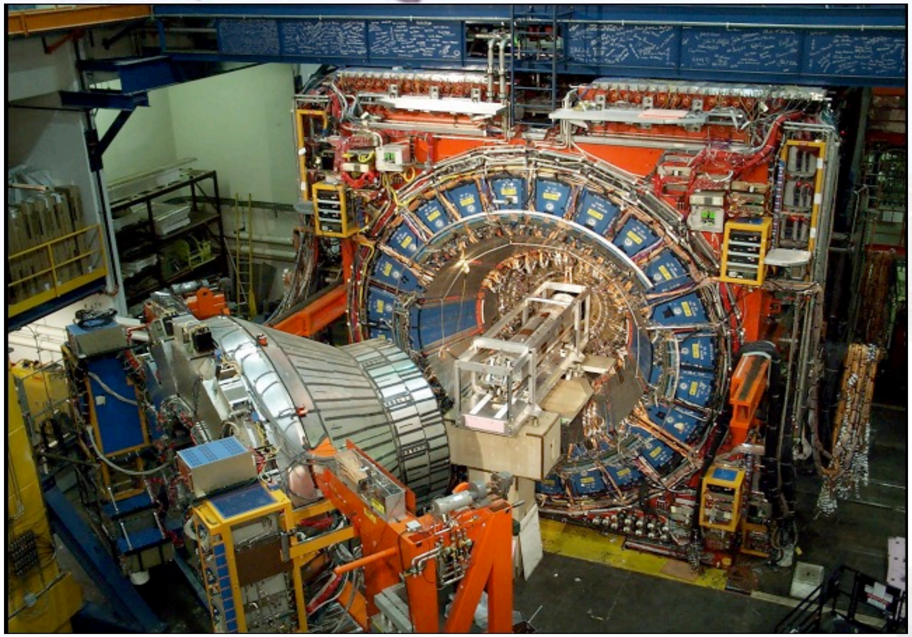
- 移动靶(对撞机)
  - 两束高能粒子对头碰撞

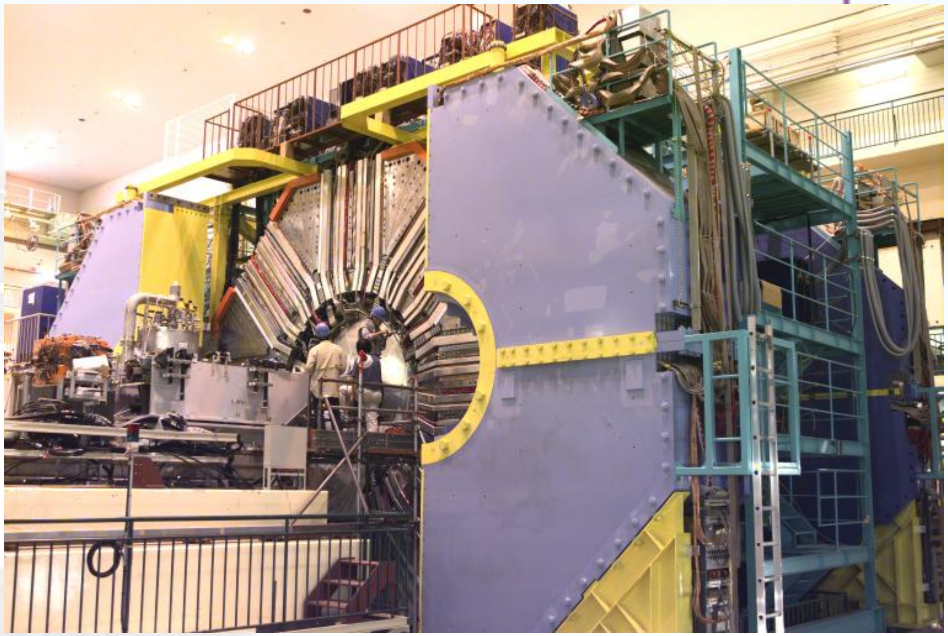
$$E_{cm}^2 = 4E_1 E_2$$

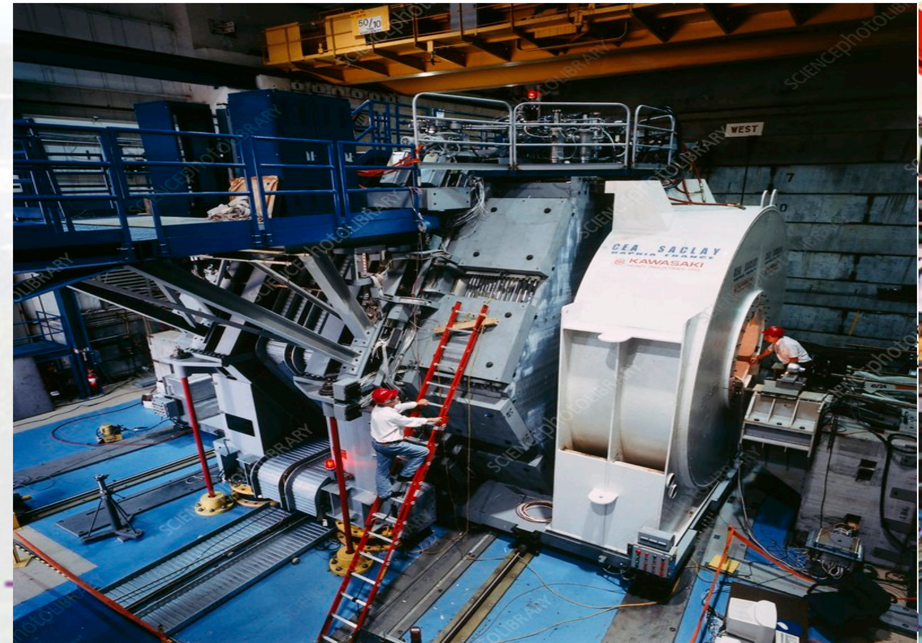


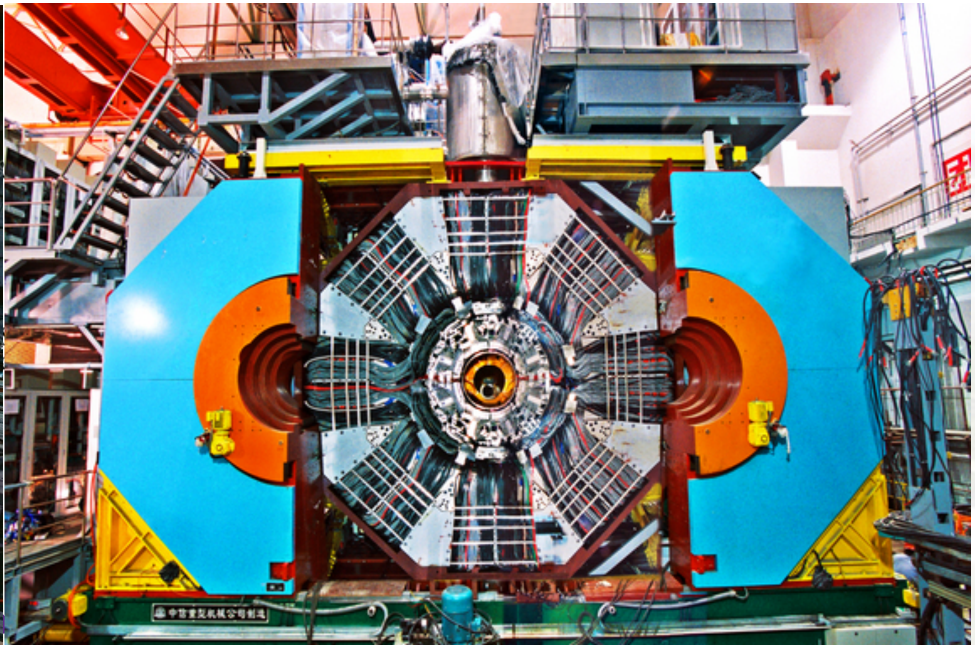


HEP Experiment – 探测器









From detector to data (D2D)

Details in Prof. 伍灵慧's talk

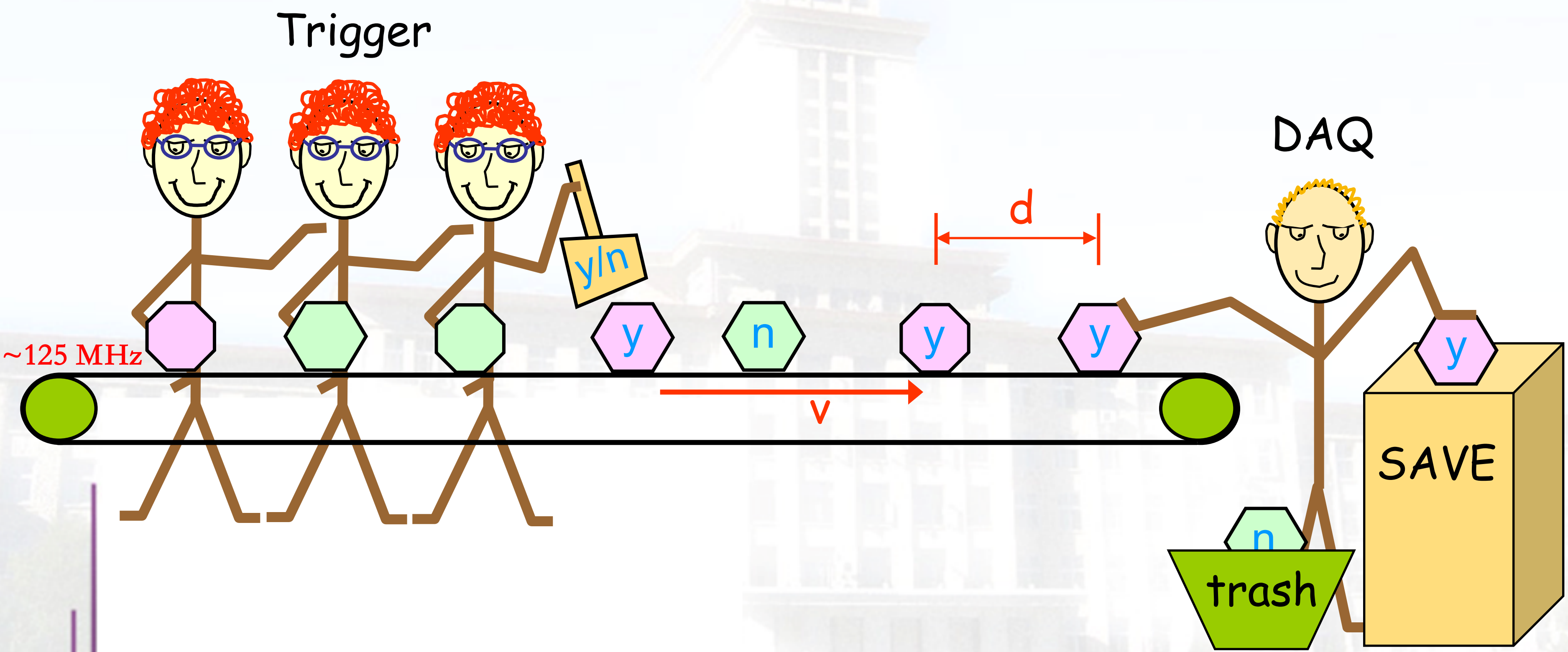
D2D: mechanism

- 探测原理：通过物质与粒子的相互作用
  1. 把中性粒子或射线转化为带电粒子；
  2. 将带电粒子通过电磁相互作用转化为电子、离子、可见光、声子；
  3. 利用宏观方法，将转化过来的上述粒子进行高效收集、放大、接收；
  4. 将接收的东西转化为“电信号”(电压信号或电流信号)；
  5. 电信号的处理：放大，成形，延迟以及数字化后输出到电脑；
  6. 数字化信息的加工，得到要测量的物理量；
- 可测量的主要粒子（以BESIII为例）
  1. Photon
  2. Electron
  3. Muon
  4. Pion
  5. Kaon
  6. Proton

虽然粒子种类很多，但归根到底只有几种是稳定的；
虽然相互作用很复杂，但均可转化为电磁相互作用研究；
虽然粒子特性很多，但可通过测量几个基本量得到；

D2D: Trigger and DAQ

Have more than one person working in series (pipeline)



D2D: Trigger System

- 初始碰撞率： ~125 MHz (BEPCII/BESIII)
- DAQ记录率： ~3000 Hz (必须多级触发)
- L0 trigger： hardware trigger (sub-detectors individually)
- L1 trigger： hardware trigger (sub-detectors cooperatively)
  - ~125 MHz → ~4000 Hz
- L2 trigger： software trigger （快重建）
  - ~4000 Hz → ~3000 Hz
- L3 trigger： software trigger （全重建， absent@BESIII）

D2D: DAQ System

- BESIII海量数据，决定了需要巨大的数据存储系统；
- 若按照原始数据12Kbytes/事例估计，结合BESIII每年获取的数据量(如事例)，则一年内的总数据量： bytes，即120 TB；
- 假设这些数据每年重建三次，则有REC(约24Kbytes/事例)和DST(约2Kbytes/事例)的总量为720 T和60 TB；
- 目前IHEP计算中心约有4.74 PB的磁盘空间和5PB的磁带供BESIII的数据存储使用(截至2019年3月28)；
- Grid / Google Cloud

From data to "physics" (D2P)

D2P: offline data processing

- 离线数据校准（Alignment）
  - 初始定位值取探测器安装前的测量
  - 在磁场情况下,测量方式会发生变化(漂移距离测量要考虑洛仑兹力)
  - 利用对撞产生的带电径迹和宇宙线事例进一步实现精确定位(对DC非常重要)
  - 利用真实物理事例去发现偏差和检验结果
- 离线数据刻度（Calibration）
  - 探测器和电子学的响应,随时间环境(例如气压、温度等)变化
  - 探测器不同部位的响应是不均匀的
  - 入射粒子,入射角度不同,探测器的响应也会发生变化
  - 电子学的工作模式
  - 探测器建造和安装时的几何精度限制
- 离线数据重建（Reconstruction）
  - 电子学信息映射为物理信息（位置、能损、动量、能量、时间、电荷、等等）
  - 非常耗时，必要时要反复重做

D2P: offline data analysis

第一步 … 似

第三步 … ging

第五步 … 斤

第七步 … 㞐

$$B = (N^{obs} - N^{bkg}) / (N^{tot} \bullet \varepsilon \bullet B^{int})$$

第一步：物理动机

Forum: BAM-00042, Gang Li et al., Measurements of the branching fractions of psi'->J/psi pi pi and J/psi->ll

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BAM-00042, Gang Li et al., Measurements of the branching fractions of psi'->J/psi pi pi and J/psi->ll

The email gateway for this forum is: paper42@hnbes3.ihep.ac.cn

Inline Depth: 1 All Outline Depth: 1 2 All Add message:

28 Re: Acceptance DG11319 Ablikim *(Fah - 01 Aug, 2013)*
27 Fw: Acceptance DG11319 Ablikim *(LI Gang - 01 Aug, 2013)*

1 Re: Fw: Acceptance DG11319 Ablikim *(Yangheng Zheng - 01 Aug, 2013)*
2 Re: Fw: Acceptance DG11319 Ablikim *(Changzheng YUAN - 01 Aug, 2013)*
3 Re: Acceptance DG11319 Ablikim *(Hajime Muramatsu - 01 Aug, 2013)*
4 Re: Fw: Acceptance DG11319 Ablikim *(Huang, Guangshun - 01 Aug, 2013)*

下面，以BAM-00042为例，进行教学

第二步：蒙卡模拟-01

首先必须明确：

1. 信号道是啥？ ψ(3686) -> π+π-J/ψ, J/ψ -> l+l-
2. 本底道有啥？ ψ(3686) -> anything except signal
3. BOSS版本？ …
4. 真实化参数？ …
5. 质心系能量、能散、磁场、随机数
6. 产生子？ 到官方dec文件中找，无则暂用PHSP

```
Decay psi(2S)
0.00752    e+   e-                  PHOTOS VLL;
0.00750    mu+  mu-                  PHOTOS VLL;
0.003      tau+  tau-                PHOTOS VLL;
0.3260     J/psi   pi+ pi-                  JPIPI;
0.1684     J/psi   pi0 pi0                  JPIPI;
```

第二步：蒙卡模拟-02

文件名： test.dec

```
Decay psi(2S)
0.00752    e+    e-                PHOTOS VLL;
0.00750    mu+   mu-                PHOTOS VLL;
0.003      tau+  tau-               PHOTOS VLL;
0.3260     J/psi  pi+ pi-                  JPIPI;
0.1684     J/psi  pi0 pi0                  JPIPI;
0.0316     J/psi  eta              HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
0.00126    J/psi  pi0              HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
0.001      J/psi  gamma gamma PHSP;
0.00084    pi0 h_c PHSP;
#hadronic decays
0.0035      pi+ pi-   pi+ pi-   pi+ pi- pi0 PHSP;
0.0026      pi+ pi-   pi+ pi- pi0 PHSP;
0.0000867    rho+ a_2- PHSP;
0.0000867    rho0 a_20 PHSP;
0.0000867    rho- a_2+ PHSP;
0.000274     p+ anti-p- J2BB1;
0.000128     Delta++ anti-Delta-- J2BB2;
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;
0.000133     pi0 p+ anti-p- PHSP;
0.00006      eta p+ anti-p- 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;
0.00047      pi+ pi- pi0 pi+ pi- pi0 PHSP;
0.00095      eta pi+ pi- pi0 PHSP;
0.0012       eta pi+ pi- pi+ pi- PHSP;
0.00045      eta' pi+ pi- pi0 PHSP;
```

```
Decay psi(2S)
#0.00752    e+    e-                PHOTOS VLL;
#0.00750    mu+   mu-                PHOTOS VLL;
#0.003      tau+  tau-               PHOTOS VLL;
1.0     J/psi  pi+ pi-                  JPIPI;
#0.3260     J/psi  pi+ pi-                  JPIPI;
#0.1684     J/psi  pi0 pi0                  JPIPI;
#0.0316     J/psi  eta              HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
#0.00126    J/psi  pi0              HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
#0.001      J/psi  gamma gamma PHSP;
#0.00084    pi0 h_c PHSP;
Enddecay
##hadronic decays
#0.0035      pi+ pi-   pi+ pi-   pi+ pi- pi0 PHSP;
#0.0026      pi+ pi-   pi+ pi- pi0 PHSP;
#0.0000867    rho+ a_2- PHSP;
#0.0000867    rho0 a_20 PHSP;
#0.0000867    rho- a_2+ PHSP;
#0.000274     p+ anti-p- J2BB1;
#0.000128     Delta++ anti-Delta-- J2BB2;
#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;
#0.000133     pi0 p+ anti-p- PHSP;
#0.00006      eta p+ anti-p- 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;
#0.00047      pi+ pi- pi0 pi+ pi- pi0 PHSP;
#0.00095      eta pi+ pi- pi0 PHSP;
#0.0012       eta pi+ pi- pi+ pi- PHSP;
#0.00045      eta' pi+ pi- pi0 PHSP;
```

第二步：蒙卡模拟-03

文件名：jobOptions_sim_3686_test.txt

```
//DENG Zi-yan 2008-03-17
#include "$OFFLINEEVENTLOOPMGRROOT/share/OfflineEventLoopMgr_Option.txt"

//*************job options for generator (KKMC)***************
#include "$KKMCROOT/share/jobOptions_KKMC.txt"
KKMC.CMSEnergy = 3.686;
KKMC.BeamEnergySpread=0.0013;
KKMC.NumberOfEventPrinted=1;
KKMC.GenerateJPsi=true;
KKMC.ThresholdCut =  3.4; // a bit larger than threshold M_pi + M_pi + M_jpsi = 3.38

//*************job options for EvtGen***************
#include "$BESEVTGENROOT/share/BesEvtGen.txt"
EvtDecay.userDecayTableName="/scratchfs/bes/zhaomg/WinterSchool/test.dec";
EvtDecay.statDecays = true;

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

//**************job options for detector simulation******************
#include "$BESSIMROOT/share/G4Svc_BesSim.txt"
//configure for calibration constants
#include "$CALIBSVCROOT/share/calibConfig_sim.txt"
// Realization Parameters
//RealizationSvc.RunIdList = {9947,0,10111,27255,0,28236}; // jpsi data [2009 & 2012]
//RealizationSvc.RunIdList = {8093,0,9025,25338,0,27090}; // psip data [total]
RealizationSvc.RunIdList = {8093,0,9025}; // psip data [2009]
//RealizationSvc.RunIdList = {11414,0,13988,14395,0,14604,20448,0,23454}; // psipp data [total]

#include "$ROOTIOROOT/share/jobOptions_Digi2Root.txt"
RootCnvSvc.digiRootOutputFile = "Psi3686_pipiJpsi_Boss664_1w_18Jan2020_JOBNO.rtraw";

// Set output level threshold (2=DEBUG, 3=INFO, 4=WARNING, 5=ERROR, 6=FATAL )
MessageSvc.OutputLevel  = 6;
// Number of events to be processed (default is 10)
ApplicationMgr.EvtMax = 10000;
```

第二步：蒙卡模拟-04

文件名： genjob

```
-rwxr-xr-x 1 zhaomg physics   512 Jan 17 10:30 genjob
```

```
#!/bin/bash

# change these value for different usage
seedstart=40000
nobegin=1001
noend=1005

for i in `seq $nobegin $noend`
do
  jobno=`echo $i |cut -c 2-6`
  jobfile="sim_TEST_$jobno.txt"

  sed -e "s/JOBSEED/$(($seedstart+$i))/" jobOptions_sim_3686_test.txt > tmp_dir
  sed -e "s/JOBNO/$jobno/g" tmp_dir > $jobfile
  rm -f tmp_dir

  echo Create sim_TEST_"$jobno" successfully!
  mkdir "$jobno"
  mv sim_TEST_"$jobno".txt "$jobno"
  cd "$jobno"
  boss.condor sim_TEST_"$jobno".txt
  cd ../
#  sleep 0.1

done
```

第二步：蒙卡模拟-05

- 以BOSS664为例
- 登录服务器： ssh -Y zhaomg@lxslc7.ihep.ac.cn

```
[zhaomg@10:34 ~]$ ssh -Y zhaomg@lxslc7.ihep.ac.cn
zhaomg@lxslc7.ihep.ac.cn's password:
Last login: Fri Jan 17 10:35:35 2020 from 49.140.188.76
***********************************************************************
|  Time  |       Up Time      |Loing Users|        Load Average        |
 10:36:11 up 154 days, 14:57, 103 users,  load average: 3.06, 3.54, 3.97
***********************************************************************
TEL:5037(office);83050656
[zhaomg@lxslc701:10:36 ~]%
```

- 进入容器： hep_container shell SL5

```
[zhaomg@lxslc701:10:36 ~]%
[zhaomg@lxslc701:10:36 ~]% hep_container shell SL5
Singularity: Invoking an interactive shell within container...

[zhaomg@lxslc701:10:37 ~]%
```

- 编辑好文件（前面三页的文件）后，提交作业： ./genjob

```
[zhaomg@lxslc701:10:50 /scratchfs/bes/zhaomg/WinterSchool]% ll
total 68K
-rw-r--r-- 1 zhaomg physics  60K Jan 17 09:43 test.dec
-rw-r--r-- 1 zhaomg physics 1.6K Jan 17 10:27 jobOptions_sim_3686_test.txt
-rwxr-xr-x 1 zhaomg physics  512 Jan 17 10:40 genjob
[zhaomg@lxslc701:10:50 /scratchfs/bes/zhaomg/WinterSchool]% ./genjob
```

第二步：蒙卡模拟-06

- 提交作业：./genjob

```
[zhaomg@lxslc701:11:12 /scratchfs/bes/zhaomg/WinterSchool]% ./genjob
Create sim_TEST_001 successfully!
1 job(s) submitted to cluster 61277853.
Create sim_TEST_002 successfully!
1 job(s) submitted to cluster 61277856.
Create sim_TEST_003 successfully!
1 job(s) submitted to cluster 61277859.
Create sim_TEST_004 successfully!
1 job(s) submitted to cluster 61277860.
Create sim_TEST_005 successfully!
1 job(s) submitted to cluster 61277863.
[zhaomg@lxslc701:11:12 /scratchfs/bes/zhaomg/WinterSchool]%
```

- 查看状态：hep_q -u zhaomg

```
[zhaomg@lxslc701:11:09 /scratchfs/bes/zhaomg/WinterSchool]% hep_q -u zhaomg

JOBID           OWNER           SUBMITTED       RUN_TIME        ST PRI SIZE CMD
61276962.0      zhaomg          01/17 11:08     0+00:01:12      R  0   0.0  xboss sim_TEST_001.txt
61276965.0      zhaomg          01/17 11:08     0+00:01:12      R  0   0.0  xboss sim_TEST_002.txt
61276968.0      zhaomg          01/17 11:08     0+00:01:12      R  0   0.0  xboss sim_TEST_003.txt
61276971.0      zhaomg          01/17 11:08     0+00:01:12      R  0   0.0  xboss sim_TEST_004.txt
61276974.0      zhaomg          01/17 11:08     0+00:01:12      R  0   0.0  xboss sim_TEST_005.txt

5 jobs; 0 completed, 0 removed, 0 idle, 5 running, 0 held, 0 suspended
[zhaomg@lxslc701:11:09 /scratchfs/bes/zhaomg/WinterSchool]%
```

第二步：蒙卡模拟-07

- 目录内状态

```
[zhaomg@lxslc701:11:17 /scratchfs/bes/zhaomg/WinterSchool]% ls
001  002  003  004  005  genjob  jobOptions_sim_3686_test.txt  test.dec
[zhaomg@lxslc701:11:17 /scratchfs/bes/zhaomg/WinterSchool]%
```

- 小目录内状态

```
[zhaomg@lxslc701:11:19 /scratchfs/bes/zhaomg/WinterSchool]% cd 001
[zhaomg@lxslc701:11:19 /scratchfs/bes/zhaomg/WinterSchool/001]% ll
total 1.4M
-rw-r--r-- 1 zhaomg physics 1.6K Jan 17 11:12 sim_TEST_001.txt
-rw-r--r-- 1 zhaomg physics  180 Jan 17 11:13 sim_TEST_001.txt.bosserr
-rw-r--r-- 1 zhaomg physics 1.1M Jan 17 11:17 Psi3686_pipiJpsi_Boss664_1w_18Jan2020_001.rtraw
-rw-r--r-- 1 zhaomg physics 339K Jan 17 11:19 sim_TEST_001.txt.bosslog
[zhaomg@lxslc701:11:19 /scratchfs/bes/zhaomg/WinterSchool/001]%
```

- 等待行结束，然后进行“重建”

第二步：蒙卡模拟-08

文件名：jobOptions_rec_3686_test.txt

```
//input ROOT MC data
#include "$ROOTIOROOT/share/jobOptions_ReadRoot.txt"
#include "$OFFLINEEVENTLOOPMGRROOT/share/OfflineEventLoopMgr_Option.txt"
// background mixing
#include "$BESEVENTMIXERROOT/share/jobOptions_EventMixer_rec.txt"
#include "$CALIBSVCROOT/share/job-CalibData.txt"
#include "$MAGNETICFIELDROOT/share/MagneticField.txt"
#include "$ESTIMEALGROOT/share/job_EsTimeAlg.txt"
// PAT+TSF method for MDC reconstruction
#include "$MDCXRECOROOT/share/jobOptions_MdcPatTsfRec.txt"
#include "$KALFITALGROOT/share/job_kalfit_numf_data.txt"
#include "$MDCDEDXALGROOT/share/job_dedx_all.txt"
#include "$TRKEXTALGROOT/share/TrkExtAlgOption.txt"
#include "$TOFRECROOT/share/jobOptions_TofRec.txt"
#include "$TOFENERGYRECROOT/share/TofEnergyRecOptions_MC.txt"
#include "$EMCRECROOT/share/EmcRecOptions.txt"
#include "$MUCRECALGROOT/share/jobOptions_MucRec.txt"
#include "$EVENTASSEMBLYROOT/share/EventAssembly.txt"
#include "$PRIMARYVERTEXALGROOT/share/jobOptions_kalman.txt"
#include "$VEEVERTEXALGROOT/share/jobOptions_veeVertex.txt"
#include "$HLTMAKERALGROOT/share/jobOptions_HltMakerAlg.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 = JOBSEED;
//Set output level threshold (2=DEBUG, 3=INFO, 4=WARNING, 5=ERROR, 6=FATAL )
MessageSvc.OutputLevel = 6;

//ROOT input data file
EventCnvSvc.digiRootInputFile={"/scratchfs/bes/zhaomg/WinterSchool/root/Psi3686_pipiJpsi_Boss664_1w_18Jan2020_JOBNO.rtraw"};
//ROOT output data file
EventCnvSvc.digiRootOutputFile="/scratchfs/bes/zhaomg/WinterSchool/root/Psi3686_pipiJpsi_Boss664_1w_18Jan2020_JOBNO.dst";

//Number of events to be processed (default is 10)
ApplicationMgr.EvtMax = 10000;
```

第二步：蒙卡模拟-09

文件名： recjob

```
-rwxr-xr-x 1 zhaomg physics  413 Jan 17 14:06 recjob
```

```
#!/bin/bash

# change these value for different usage
seedstart=40000
nobegin=1001
noend=1005

for i in `seq $nobegin $noend`
do
  jobno=`echo $i |cut -c 2-6`

  jobfile="rec_test_$jobno.txt"

  sed -e "s/JOBSEED/$(($seedstart+$i))/" jobOptions_rec.txt > tmp_dir
  sed -e "s/JOBNO/$jobno/g" tmp_dir > $jobfile
  rm -f tmp_dir

  echo Create rec_test_"$jobno" successfully!
  boss.condor rec_test_"$jobno".txt

done
```

第二步：蒙卡模拟-10

- 提交作业： ./recjob

```
[zhaomg@lxslc701:14:08 /scratchfs/bes/zhaomg/WinterSchool/rec]% ./recjob
Create rec_test_001 successfully!
Create rec_test_002 successfully!
Create rec_test_003 successfully!
Create rec_test_004 successfully!
Create rec_test_005 successfully!
[zhaomg@lxslc701:14:08 /scratchfs/bes/zhaomg/WinterSchool/rec]%
```

- 查看状态： hep_q -u zhaomg

```
[zhaomg@lxslc701:14:10 /scratchfs/bes/zhaomg/WinterSchool/rec]% hep_q -u zhaomg

JOBID           OWNER           SUBMITTED       RUN_TIME        ST PRI SIZE CMD
61296776.0      zhaomg          01/17 14:09     0+00:00:00      I  0   0.0  xboss rec_test_001.txt
61296778.0      zhaomg          01/17 14:09     0+00:00:00      I  0   0.0  xboss rec_test_002.txt
61296780.0      zhaomg          01/17 14:09     0+00:00:00      I  0   0.0  xboss rec_test_003.txt
61296782.0      zhaomg          01/17 14:09     0+00:00:00      I  0   0.0  xboss rec_test_004.txt
61296783.0      zhaomg          01/17 14:09     0+00:00:00      I  0   0.0  xboss rec_test_005.txt

5 jobs; 0 completed, 0 removed, 5 idle, 0 running, 0 held, 0 suspended
[zhaomg@lxslc701:14:10 /scratchfs/bes/zhaomg/WinterSchool/rec]%
```

第三步： Coding-01

南開大學

报告里常见的选择条件

那么，这些条件是如何翻译到code里面的呢？

A. $\psi' \to \pi^+\pi^- J/\psi$, $J/\psi \to$ **anything**

The large branching fraction and the easy tagging are two advantages for $\pi^+\pi^- J/\psi$ final state. In this work, the first thing need to do is acquiring the pure number of $\pi^+\pi^- J/\psi$ channel.

Our goal is that after $\pi^+\pi^-$ selection, we can tag inclusive J/ψ in the $\pi^+\pi^-$ recoil mass spectrum. So we require at least one pair of oppositely charged candidate pions.

- Track level cuts for soft pion candidates
  - $|V_z| < 10$cm
  - $|V_r| < 1$cm
  - $|\cos\theta| < 0.80$
  - $|\vec{p}| < 0.45$GeV$/c$
  - all charged tracks satisfy above selection criteria are assumed to be pion.
- nGood+ ≥ 1 && nGood$- \geq 1$
- $\cos\theta_{\pi^+\pi^-} < 0.95$
- $3.05\text{GeV}/c^2 \leq M^{rec.}_{\pi^+\pi^-} \leq 3.15\text{GeV}/c^2$
  assuming all charge tracks are pions, $M^{rec.}_{\pi^+\pi^-}$ is defined as:

$$M^{rec.}_{\pi^+\pi^-} = \sqrt{(p_{ecm} - p_{\pi^+} - p_{\pi^-})^2} \ ,$$

where p is 4 momentum of pion.

B. For $\psi' \to \pi^+\pi^- J/\psi, J/\psi \to l^+l^-$ **process**

- Track level cuts
  - $|V_z| < 10$cm
  - $|V_r| < 1$cm
  - $|\cos\theta| < 0.80$
  - $|\vec{p}| < 2.0$GeV$/c$
- nGood $>= 4$
- The charged tracks with $|\vec{p}| < 0.45$ GeV/c are assumed to be pion, select the $\pi^+\pi^-$ pair candidates by minimizing $|M^{rec.}_{\pi^+\pi^-} - M_{J/\psi}|$
- $\cos\theta_{\pi^+\pi^-} < 0.95$
- $3.05\text{GeV}/c^2 \leq M^{rec.}_{\pi^+\pi^-} \leq 3.15\text{GeV}/c^2$
- Take the two fastest positive and negative tracks as lepton candidates, identify the e/μ pair
  - $\mu^+\mu^-$:$[E/p]^+ < 0.26$ and $[E/p]^- < 0.26$
  - e^+e^-:$[E/p]^+ > 0.80$ or $[E/p]^- > 0.80$ or $\sqrt{([E/p]^+ - 1)^2 + ([E/p]^- - 1)^2} < 0.4$
- $\cos\theta_{l^+l^-} < -0.95$ in lab frame.
- $2.7\text{GeV}/c^2 < m_{l^+l^-} < 3.2\text{GeV}/c^2$ for $\pi^+\pi^-e^+e^-$ channel and $3.0\text{GeV}/c^2 < m_{l^+l^-} < 3.2\text{GeV}/c^2$ for $\pi^+\pi^-\mu^+\mu^-$ channel

第三步： Coding-02

```
//psi'--> J/psi pion pion, J/psi --> di-leptons
//Kai Zhu (zhuk@ihep.ac.cn)
#include "GaudiKernel/MsgStream.h"
#include "GaudiKernel/AlgFactory.h"
#include "GaudiKernel/ISvcLocator.h"
#include "GaudiKernel/Sm
#include "GaudiKernel/ID
#include "GaudiKernel/Pr

#include "EventModel/Ever
#include "EventModel/Ever
#include "EventModel/Ever
#include "TrigEvent/TrigE
#include "TrigEvent/TrigD
#include "McTruth/McParti

#include "EvtRecEvent/Evt
#include "EvtRecEvent/Evt
#include "DstEvent/TofHit

#include "TMath.h"
#include "GaudiKernel/INT
#include "GaudiKernel/NTu
#include "GaudiKernel/Boo
#include "GaudiKernel/IHi
#include "CLHEP/Vector/Th
#include "CLHEP/Vector/L
#include "
using CLHE
using CLHE
using CLHE
#include "
#ifndef EN
   typedef
#endif
#include "
#include "
#include "
#include "
#include "
#include "

#include "
#include <
//const do

const doub
const doub
const doub
const doub
const doub
const doub
const doub
const doub
typedef std::vector<int> Vint;
typedef std::vector<HepLorentzVector
```

```
pipiJpsi::pipiJpsi(const std::string& name, ISvcLocator* pSvcLocator) :
  Algorithm(name, pSvcLocator) {
  //Declare the properties
.93);
);
e);
```

```
StatusCode pipiJpsi::initialize(){
  MsgStream log(msgSvc(), name());

  log << MSG::INFO << "in initialize()" << endmsg;

  StatusCode status;

  NTuplePtr nt1(ntupleSvc(), "FILE1/vxyz");
  if ( nt1 ) m_tuple1 = nt1;
  else {
    m_tuple1 = ntupleSvc()->book ("FILE1/vxyz", CLID_ColumnWiseTuple, "ks N-Tuple example");
```

```
StatusCode pipiJpsi::execute() {

  MsgStream log(msgSvc(), name());
::SUCCESS; }
::SUCCESS; }
ESS; }
 || evtRecTrkCol->size()>99) return StatusCode::SUCCESS;
  m_cout_charge ++;

   return StatusCode::SUCCESS;
}
```

```
StatusCode pipiJpsi::finalize() {

  MsgStream log(msgSvc(), name());
  log << MSG::INFO << "in finalize()" << endmsg;
  if(m_eventrate) cout << "all event: "
    << m_cout_all << endl
      << "only channel " << m_chan_det << ": " << m_cout_everat << endl;
  cout << "all event: " << m_cout_all << endl
    << "all collection point is OK: " << m_cout_col << endl
    << "charged tracks >=3: " << m_cout_charge << endl
    << "good charged tracks [3,4]: " << m_cout_nGood << endl
    << "after momentum assign: " << m_cout_mom << endl
    << "after recoild mass cut: " << m_cout_recoil << endl;

  return StatusCode::SUCCESS;
}
```

第三步： Coding-03

First event

initialize()

execute()

分析程序主体
continue; // 跳出本Loop
return StatusCode::SUCCESS; // 跳出本event
return StatusCode::FAILURE; // 直接停止程序

ALL events

Last event

finalize()

第三步： Coding-04

RecTofTrack

RecEmcShower	use EmcRecEventModel EmcRecEventModel-* Emc #include “EmcRecEventModel/RecEmcShower.h”	
the following items are available for both DST and REC data		

RecMucTrack	use MucRecEvent MucRecEvent-* Muc #include “MucRecEvent/RecMucTrack.h”	
the following items are available for both DST and REC data		
int	trackId()	id of ext track
int	id()	id of this muc track
int	status()	status of the track. 1: 3D line.
int	type()	seed mode. 0: ext, 1: emc, 2: muc
int	startPart()	start position of track locates in which part
int	endPart()	end position of track locates in which part
int	brLastLayer()	last layer with hits in barrel
int	ecLastLayer()	last layer with hits in end cap
int	numHits()	total hits on the track
int	numLayers()	number of layers with hits
int	maxHitsInLayer()	max number of hits in layers
double	depth()	depth of the track transport in iron
double	chi2()	$\chi 2$ of track fitting
int	dof()	degree of freedom for the fit
double	rms()	track fit quality status flag(undefined)
double	xPos(),yPos(),zPos()	position on the start of track in muc (mm)
double	xPosSigma(),yPosSigma(),zPosSigma()	error of position on the start of track in muc (mm)
double	px(),py(),pz()	momentum on the start of track in muc
double	distance()	distance between ext track and fired strip in 1^{st} layer of MUC
double	deltaPhi()	delta phi between mdc momentum and direction of MUC track
the following items are only available for REC data		
vector<int>	getVecHits()	hit list of attached strip in this track
vector<int>	getExpHits()	hit list of expected strip in this track
vector<float>	getDistHits()	distance between hit and the track

RecEmcFractionMap	getFractionMap3x3()	Map of 3x3 RecEmcFraction in the shower.
RecEmcFractionMap	getFractionMap5x5()	Map of 5x5 RecEmcFraction in the shower.
double	getTime()	Time of central crystal in the shower.
double	getEAll()	Energy sum of all crystals in the shower.

double

第三步： Coding-05

如何在程序里添加一个变量：“三步走”

1. 在.h文件中定义

```
// with the method of momentum sel
NTuple::Tuple* m_tuple8;
```

```
NTuplePtr nt8(ntupleSvc(), "FILE1/infmom");
 if ( nt8 ) m_tuple8 = nt8;
 else {
   m_tuple8 = ntupleSvc()->book ("FILE1/infmom",
   if ( m_tuple8 )    {
     status = m_tuple8->addItem ("momlepp", m_mo
     status = m_tuple8->addItem ("momlepmm", m_r
     status = m_tuple8->addItem ("mompionm", m_r
     status = m_tuple8->addItem ("mompionp", m_r
     status = m_tuple8->addItem ("pipidang", m_p
     status = m_tuple8->addItem ("cmslepp", m_cr
     status = m_tuple8->addItem ("cmslepm", m_cr
     status = m_tuple8->addItem ("invtwopi", m_r
     status = m_tuple8->addItem ("invjpsi", m_mo
     status = m_tuple8->addItem ("recoil", m_mas
     status = m_tuple8->addItem ("invmass", m_in
     status = m_tuple8->addItem ("totene", m_tot
     status = m_tuple8->addItem ("totpx", m_tot_
     status = m_tuple8->addItem ("totpy", m_tot_
     status = m_tuple8->addItem ("totpz", m_tot_
     status = m_tuple8->addItem ("epratio", m_ep
```

```
// With momentum method calculate the invariant mass of Jpsi
// actually we use the recoil mass
HepLorentzVector m_lv_recoil, m_lv_jpsi;
m_lv_recoil = m_lv_lab - m_lv_pionp - m_lv_pionm;
m_lv_jpsi = m_lv_lepp + m_lv_lepm;

m_mass_twopi = (m_lv_pionp + m_lv_pionm).m();
m_mass_recoil = m_lv_recoil.m();
m_mass_jpsi = m_lv_jpsi.m();

// Jpsi mass cut
if( m_mass_recoil < 3.05 || m_mass_recoil > 3.15 ) return sc;
if( m_mass_jpsi < 3.0 || m_mass_jpsi > 3.2 ) return sc;
m_cout_recoil ++;

HepLorentzVector m_ttm(m_lv_jpsi + m_lv_pionp + m_lv_pionm);
if(m_ttm.m()>4 || m_ttm.m()<3) return sc;

// dangle between pions, suppress gamma convertion
m_pipi_dang = m_lv_pionp.vect().cosTheta(m_lv_pionm.vect());

m_mom_pionp = m_lv_pionp.vect().mag();
m_mom_pionm = m_lv_pionm.vect().mag();
m_mom_lepp = m_lv_lepp.vect().mag();
m_mom_lepm = m_lv_lepm.vect().mag();
m_trans_ratio_lepp = m_lv_lepp.vect().perp()/m_lv_lepp.vect().mag();
m_trans_ratio_lepm = m_lv_lepm.vect().perp()/m_lv_lepm.vect().mag();
m_trans_ratio_pionp = m_lv_pionp.vect().perp()/m_lv_pionp.vect().mag();
m_trans_ratio_pionm = m_lv_pionm.vect().perp()/m_lv_pionm.vect().mag();

Hep3Vector m_boost_jpsi(m_lv_recoil.boostVector());
HepLorentzVector m_lv_cms_lepp(boostOf(m_lv_lepp,-m_boost_jpsi));
HepLorentzVector m_lv_cms_lepm(boostOf(m_lv_lepm,-m_boost_jpsi));
m_cms_lepm = m_lv_cms_lepm.vect().mag();
m_cms_lepp = m_lv_cms_lepp.vect().mag();
log << MSG::DEBUG << "jpsi four momentum in cms " << m_lv_cms_lepp + m_lv_cms_lepm <<endreq;

m_inv_mass = m_ttm.m();
m_tot_e = m_ttm.e();
m_tot_px = m_ttm.px();
```

第三步：Coding-06

糟蹋一个算法的通常步骤：

1. 在TestRelease中cmt目录的requirement文件里添加算法
2. 进入工作目录，例如：cd /ihepbatch/bes/zhaomg/6.6.4.p02
3. Checkout算法包，cmt co Analysis/Physics/PsiPrime/PipiJpsiAlg

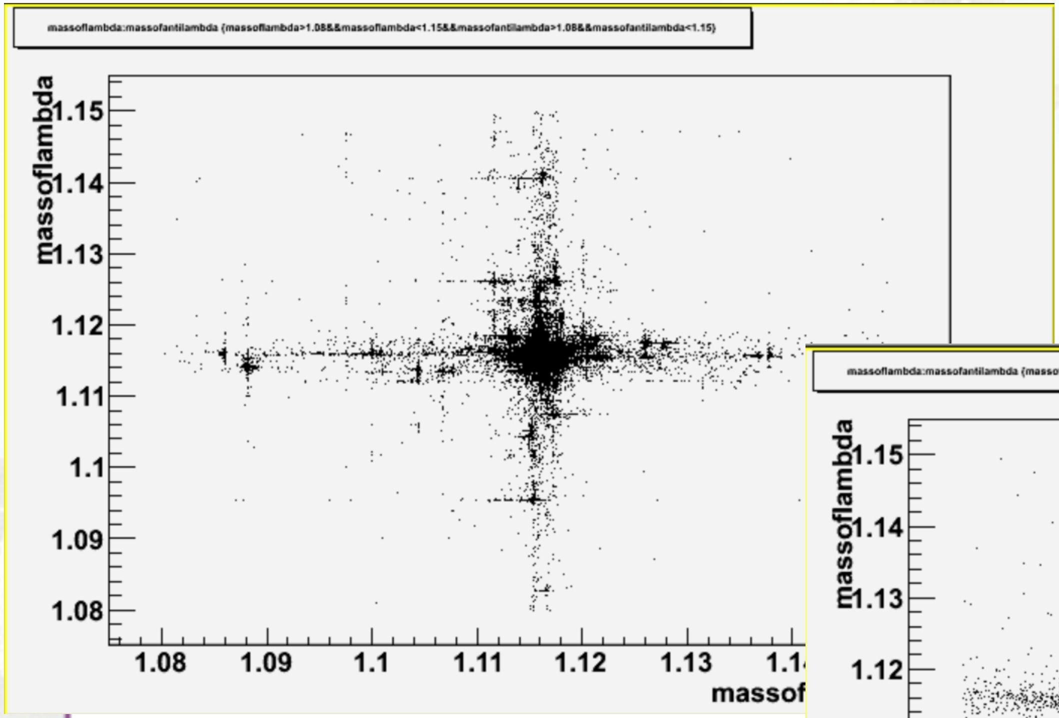
   或cp算法包，cp -r ~whoami/xxx PipiJpsiAlg
3. 改写
4. 进入PipiJpsiAlg算法的cmt目录，进行编译
5. cmt br config

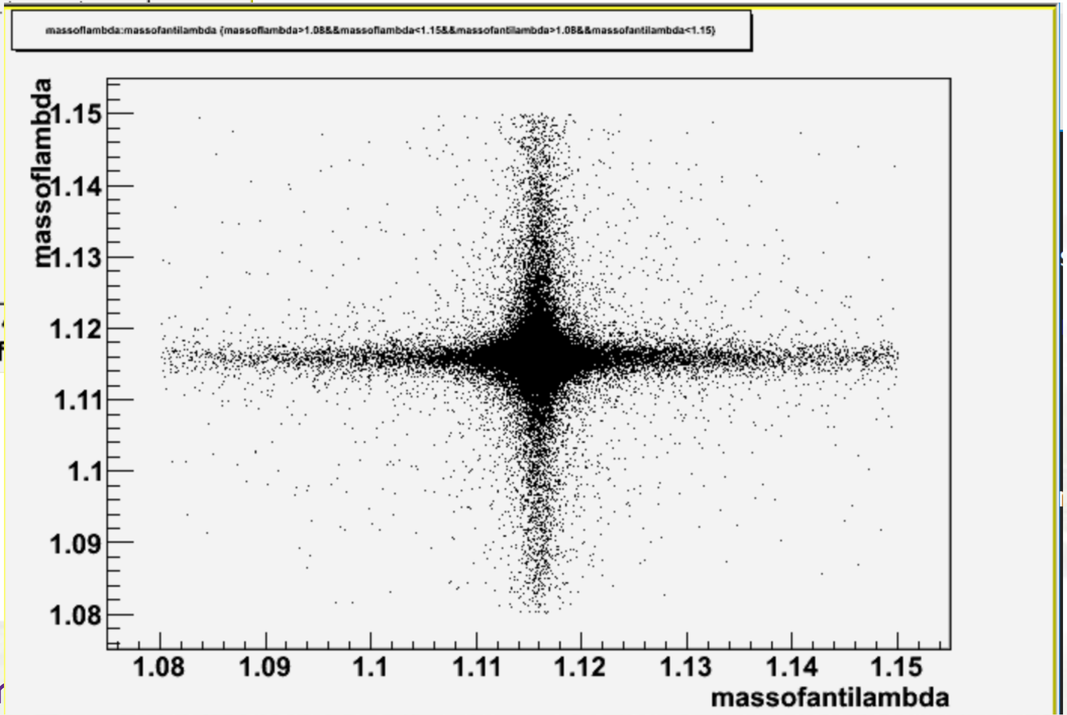
   cmt br gmake

   source setup.csh

第四步： Debugging-01

通过check典型的data/mc分布，判断代码是否存在有明显错误 （谁都无法保证没有bug，但在初步分析时必须没有“明显”bug）





第四步： Debugging-02

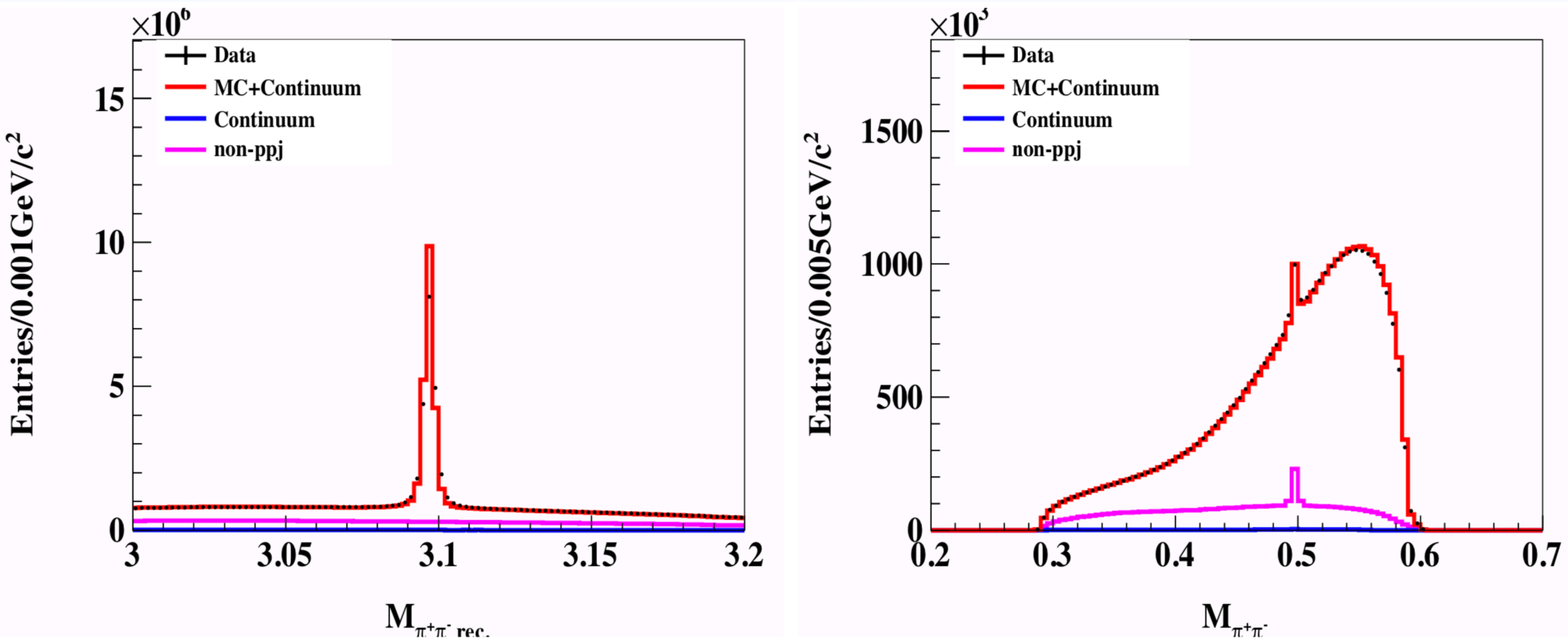


FIG. 1. The recoiling mass and invariant mass of the two charge pions for $\pi^+\pi^- J/\psi, J/\psi \to$ anything.

第四步： Debugging-03

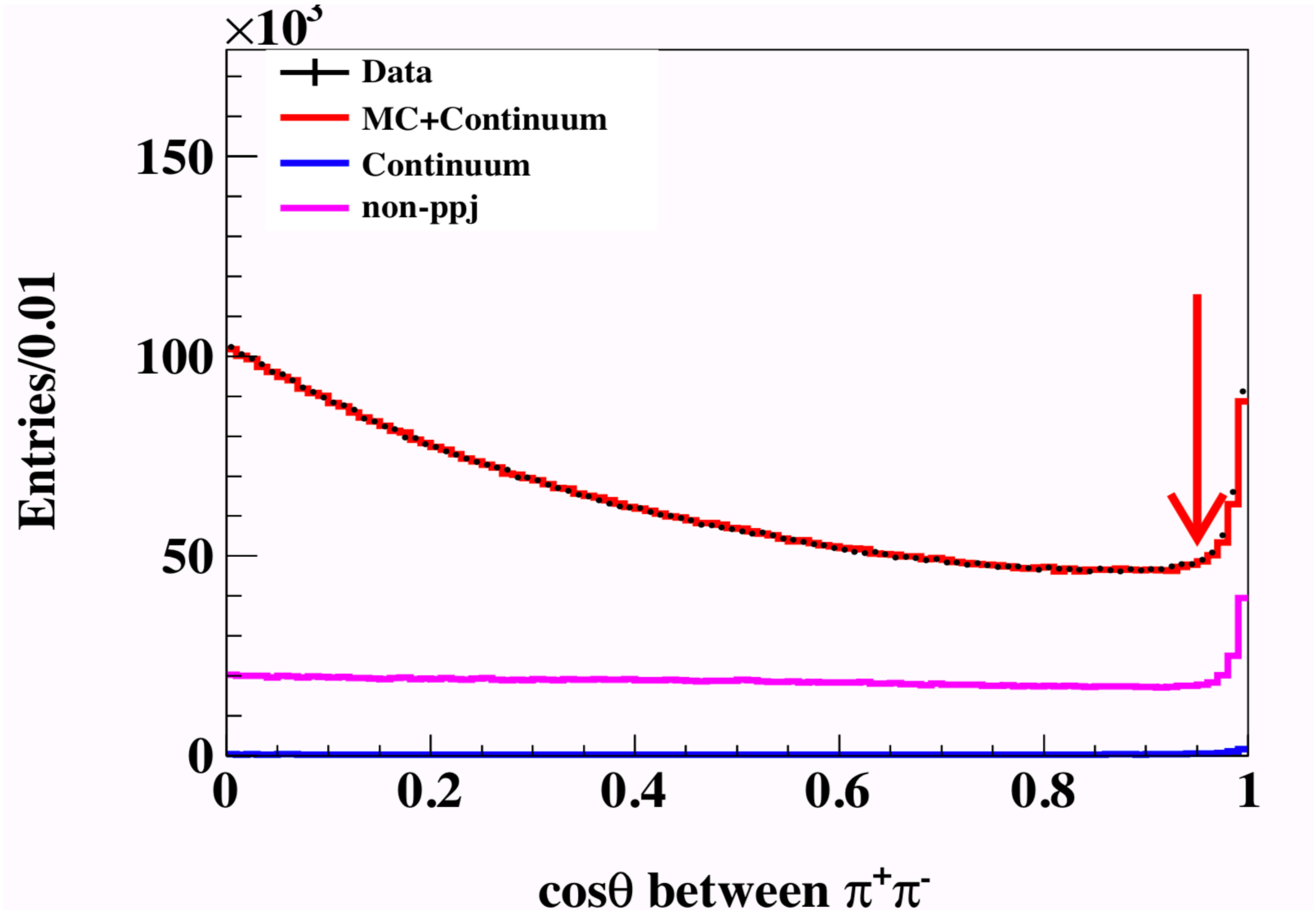


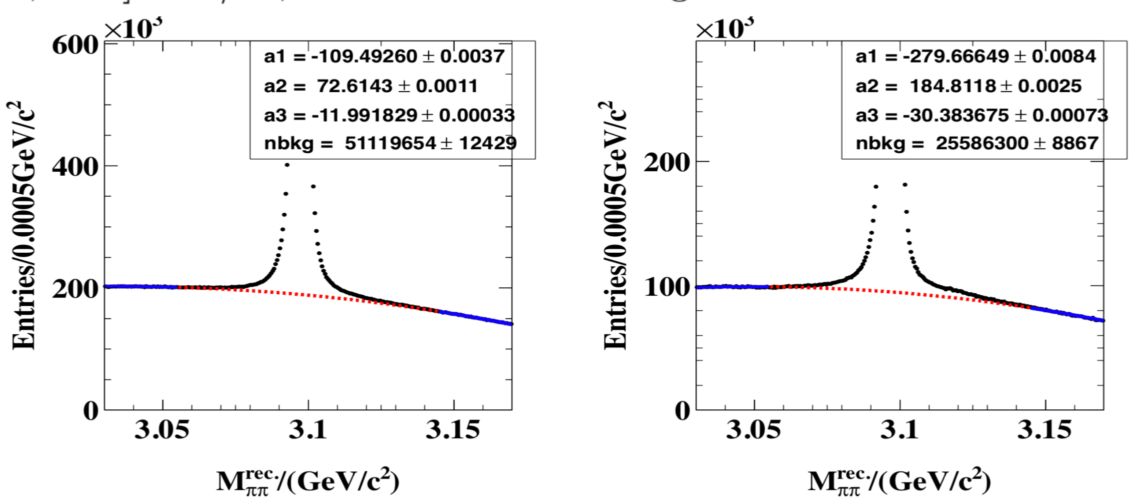
FIG. 4. Cosine distributions of the angle between two pions in $\pi^+\pi^- J/\psi$

$B = (N^{obs} - N^{bkg})/(N^{D} \cdot \varepsilon \cdot B_{int})$

第五步：初步分析-01

a. Number of $\psi' \to \pi^+\pi^- J/\psi$ events

The first method is the side-band method. Here the strategy is that the background shape is determined by the events in the side-bands far enough from the signal region, and then subtract the background contribution in signal region, the shape interpolated from the side-band, to obtain the number of signals. Here we must choose side-band region far enough to ensure the tails of signal can be neglected. The resolution of $\pi^+\pi^-$ recoil mass is less than 3MeV/c^2(width of J/ψ is negligible), so we take the side-band as $[3.03, 3.055] \bigcup [3.145, 3.17]$GeV/c^2, which is safe enough. The fitted results are shown in Fig 28.



Details in Prof. 李刚's talk

b. Number of $\psi' \to \pi^+\pi^- J/\psi$, $J/\psi \to l^+l^-$ events For these two exclusive decays, the background level is rather low, so here we count the number of the signals directly. The signal region is defined as $[m^{rec.}_{\pi^+\pi^-} - 0.015, m^{rec.}_{\pi^+\pi^-} + 0.015]\mathrm{GeV}/c^2$.

$B = (N^{obs} - N^{bkg})/(N^{D} \cdot \varepsilon \cdot B_{int})$

第五步：初步分析-02

III. BACKGROUND STUDY

peaking and non-peaking

A. $\psi' \to \pi^+\pi^- J/\psi$, $J/\psi \to$ anything

For the inclusive process $\psi' \to \pi^+\pi^- J/\psi$, $J/\psi \to$ anything, the backgrounds have three parts, one is the non-$\psi' \to \pi^+\pi^- J/\psi$ processes, such as $\psi' \to$ light hadron decays, or $\psi' \to \eta J/\psi$, and so on. The second comes from $\psi' \to \pi^+\pi^- J/\psi$ decays, but one or both the two soft charge tracks are taken the wrong ones. The last part is the continuum background and non-physical backgrounds, such as beam-related background.

B. $\psi' \to \pi^+\pi^- J/\psi$, $J/\psi \to e^+e^-$ and $J/\psi \to \mu^+\mu^-$

For these two exclusive decays, the backgrounds have two main sources, one is backgrounds from ψ' decays, and the other from continuum processes.

In conclusion, the background of inclusive process is smooth and have no peak on the recoil mass spectrum of $\pi^+\pi^-$, and the ones of two exclusive processes are very low, just at per mille level, which can be treated easily.

Details in Prof. 李刚's talk

$$B = (N^{obs} - N^{bkg})/(N^{D} \cdot \varepsilon \cdot B_{int})$$

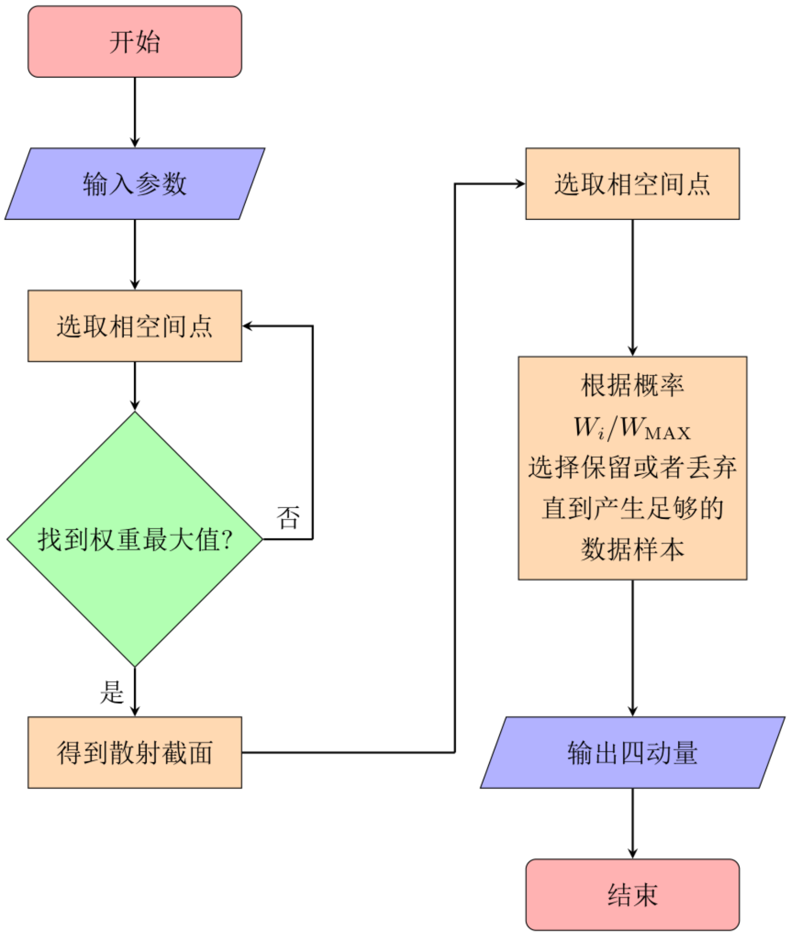
第五步：初步分析-03

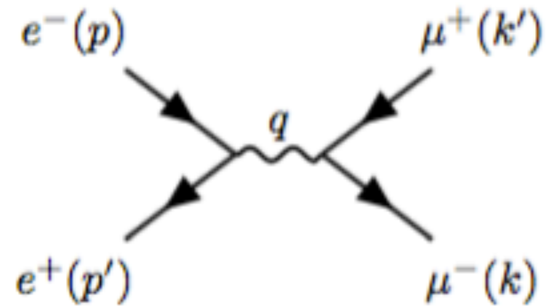
- 探测效率（Efficiency）反映了“观测到的”事例数和“真实物理过程产生的”事例数之间的关系；通过mc模拟确定;
- 在mc事例的模拟中，必须尽可能地重现真实物理过程，包括物理事例的生成、探测器物质的构建、物理事例与探测器物质的相互作用、环境的影响等，这是确保探测效率无偏的根本;
- 通过与数据完全一致的分析方法，得到mc事例的信号产额，除以mc事例的总数，即得探测效率;

$$B = (N^{obs} - N^{bkg}) / (N^{D} \cdot \varepsilon \cdot B_{int})$$

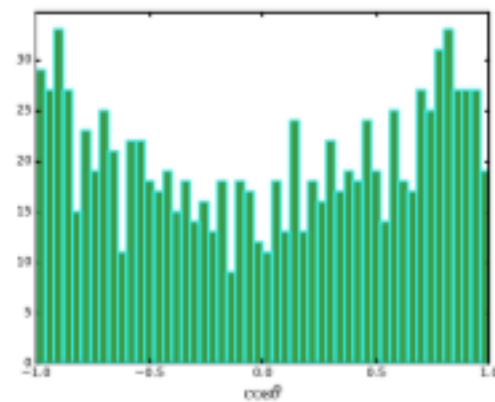
第五步：初步分析-04

MC 事例是依据的是已知的物理过程产生的.





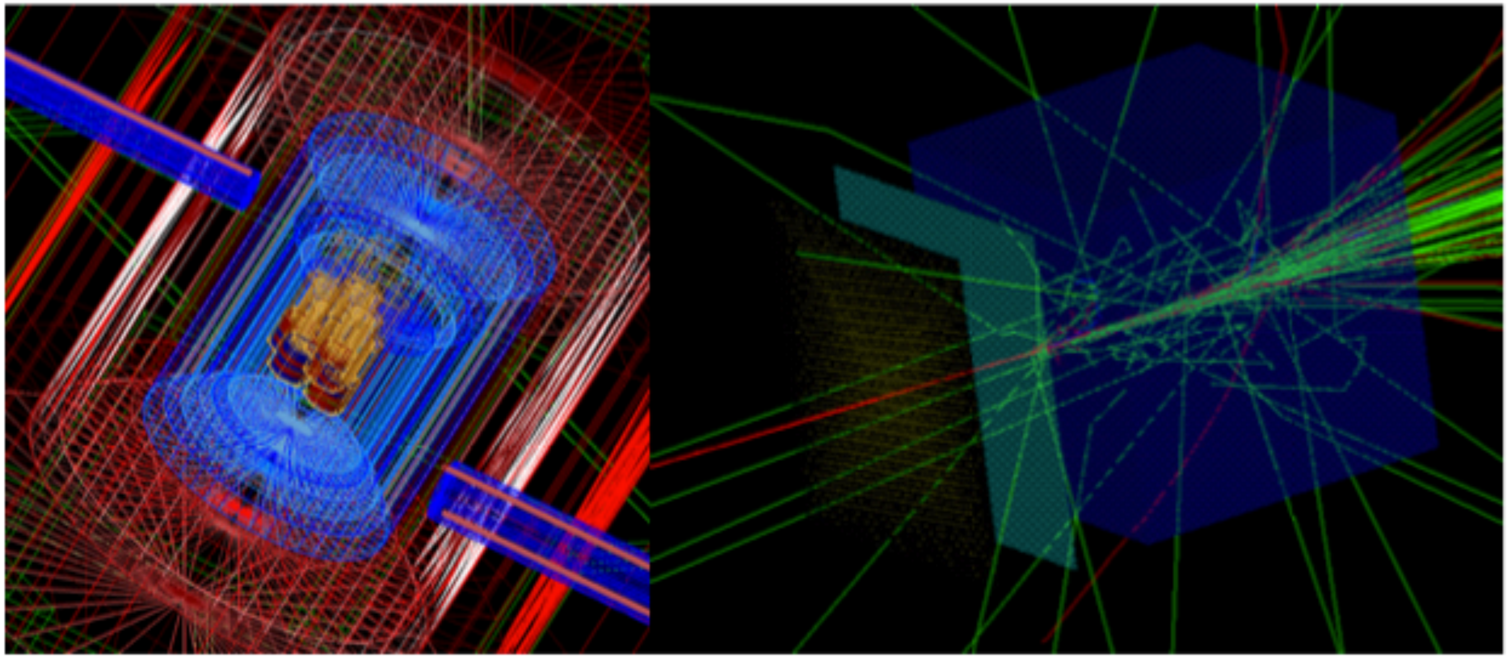
$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4\hat{s}}(1+\cos^2\theta)$$



$$B = (N^{obs} - N^{bkg}) / (N^{D} \cdot \varepsilon \cdot B_{int})$$

第五步：初步分析-05

使用相关软件包（基于 Geant 4），模拟探测器的材质几何信息等，进而模拟粒子与探测器的相互作用.



$$B = (N^{obs} - N^{bkg})/(N^{D} \cdot \varepsilon \cdot B_{int})$$

第五步：初步分析-06

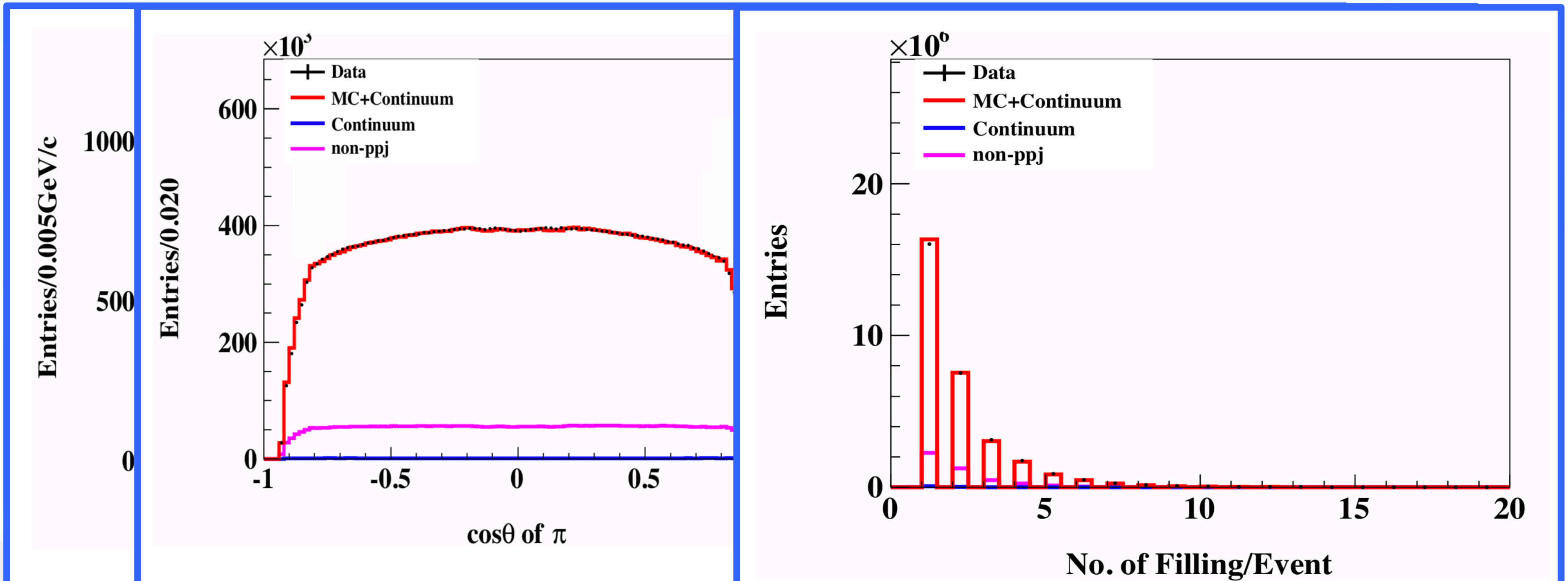


FIG. 3. The cosine of polar an

FIG. 5. The number of filling time of each event

通过对末态粒子动量和角分布等信息的比较，可以看出数据和mc之间的符合程度，上图展示了对比的结果，可见数据与mc之间符合得很好，所以，mc模拟是可靠的，基于此得到的探测效率是无偏的。

$B = (N^{obs} - N^{bkg}) / (N^{D} \cdot \varepsilon \cdot B_{int})$

第五步：初步分析-07

These two decay processes are generated in the inclusive Monte Carlo sample with $JPIPI$, $PHOTOS$ and VLL modules in BesEvtGen generator and BOOST simulation package.

TABLE XI. Summary of results of three process

process	$N_{sig.}$ of data	N_{sig} of MC	$\epsilon(\%)$	$\mathcal{B}(\%)$
$\psi' \to \pi^+\pi^- J/\psi$(side-band)	19534198 ± 11738	18813520 ± 4882	52.62 ± 0.03	34.91 ± 0.03
$J/\psi \to e^+e^-$	718829 ± 848	660840 ± 813	32.20 ± 0.04	5.996 ± 0.008
$J/\psi \to \mu^+\mu^-$	771135 ± 878	707697 ± 841	34.54 ± 0.04	5.988 ± 0.007

The $\psi' \to \pi^+\pi^- J/\psi, J/\psi \to$ anything process is generated by BesEvtGen with same assumptions for $\psi' \to \pi^+\pi^- J/\psi$ in the exclusive decay of $\psi' \to \pi^+\pi^- J/\psi, J/\psi \to l^+l^-$. For J/ψ decay, all the known decay branching ratios are generated by proper models in BesEvtGen according to the PDG [4], the unknown part generated by LUNDCHARM model.

The acceptance is determined to be $\epsilon = (52.62 \pm 0.03)\%$ with BesEvtGen method.

The acceptances of $\psi' \to \pi^+\pi^- J/\psi, J/\psi \to e^+e^-$ and $\psi' \to \pi^+\pi^- J/\psi, J/\psi \to \mu^+\mu^-$ processes are determined to be $32.20 \pm 0.04\%$ and $34.54 \pm 0.04\%$ as listed in TableXI

$B = (N^{obs} - N^{bkg})/(N^{D} \cdot \varepsilon \cdot B_{int})$

第五步：初步分析-08

1. $\mathcal{B}(\psi' \to \pi^+\pi^- J/\psi)$

If we take the total number of ψ' from inclusive hadron method, 106.5±1M, the branching ratio of $\psi' \to \pi^+\pi^- J/\psi$

$$\mathcal{B}(\psi' \to \pi^+\pi^- J/\psi) = \frac{N^{obs.}_{\psi' \to \pi^+\pi^- J/\psi}}{\epsilon_{mc} N_{tot}} = 35.05\% \pm 0.03\ . \quad (1)$$

2. $\mathcal{B}(J/\psi \to l^+ l^-)$

The branching ratios of $\mathcal{B}(J/\psi \to e^+e^-)$ and $\mathcal{B}(J/\psi \to \mu^+\mu^-)$ are calculated with the formula

TABLE XI. Summary of results of three process

process	$N_{sig.}$ of data	N_{sig} of MC	$\epsilon(\%)$	$\mathcal{B}(\%)$
$\psi' \to \pi^+\pi^- J/\psi$(side-band)	19534198 ± 11738	18813520 ± 4882	52.62 ± 0.03	34.91 ± 0.03
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第六步：深入分析

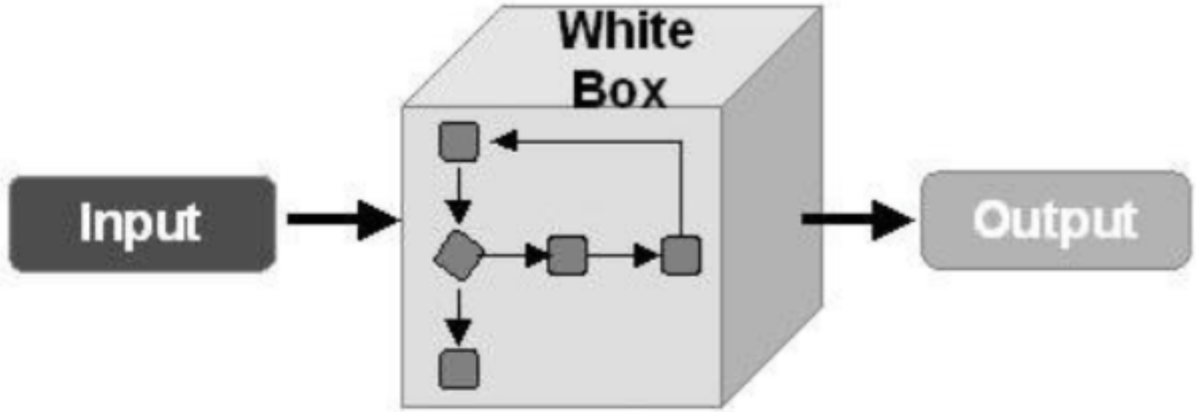
提高统计显著性

1. 提高探测效率（validation & improvement）
2. 提高信号产额
3. 压低本底污染

Details in Prof. 李刚's talk

第七步：输入输出检查-01

- 得到了初步结果之后，你会发现，这个结果有可能与历史上的其它结果相符，也有可能矛盾。如何让别人相信「我们的结果」是正确的呢?
- 尽管我们无法对「真实的物理」进行检验，但我们可以利用「已知的物理」来做 check。
- 即，通过 mc 模拟的方法，做输入/输出检查（I/O Check）。



第七步：输入输出检查-02

- 完全相同的分析过程之后…

TABLE I. Summary of MC input/output check results of the three processes ($\mathcal{B}$ is in percent).

Modes	$\mathcal{B}_{\rm in}$	$N_{\rm obs}(10^3)$	$\mathcal{B}$
$\pi^+\pi^- J/\psi$	32.6	18783.4 ± 5.1	32.64 ± 0.03
$\pi^+\pi^- e^+e^-$	5.93	660.6 ± 0.8	5.912 ± 0.024
$\pi^+\pi^- \mu^+\mu^-$	5.94	707.5 ± 0.8	5.930 ± 0.024

第八步：系统误差

- 粒子物理实验中遇到的所有误差，都可以归为统计误差和系统误差两个大类。
- 统计误差由实验数据的多少决定，只要实验数据无限多，此项误差是可以无限减小的；
- 系统误差是不可避免的、由实验方法（包括设备、人员等）导致的误差。
- 对系统误差的准确估计,是结果可靠性的重要保证。

第八步：系统误差

- 粒 … 和系统误
- 统 … ，此项误
- 系 … 等）导致
- 对

TABLE IV. Summary of the systematic uncertainties (%) in the branching fractions.

Sources	$\pi^+\pi^- J/\psi$	e^+e^-	$\mu^+\mu^-$
Tracking	0.80	0.20	0.20
Multiplicity of J/ψ	0.20	0.20	0.20
$M_{\pi^+\pi^-}$ distribution	0.35	0.01	0.01
Background shape	0.03	0.03	0.04
Fit/Count range	0.06	0.14	0.14
Bin size	0.06	0.06	0.06
E/p	$\cdots$	0.18	0.09
$\cos\theta_{\pi^+\pi^-}$	0.13	0.07	0.07
$\cos\theta_{l^+l^-}$	$\cdots$	0.04	0.05
FS			
Fit			
Trigger	0.10	0.30	0.30
Number of $\psi(3686)$	0.81	$\cdots$	$\cdots$
Sum in quadrature	1.28	0.62	0.63

Details in Prof. 郑波's talk

From physics to paper (P2P)

P2P: BESIII文章发表流程

1. 选题。
2. 足够成熟后（视主要作者能力，一般在1-4个月左右），开始进入 Group Meeting Report 阶段。
3. Group 内没意见后（视工作的复杂程度和主要作者的勤快程度，一般在1-6个月左右），开始申请 Physics & Software Meeting Report。
4. 回答完 P&S Meeting 会议的意见（一般在2周-2个月左右），进入「合作组内部审稿阶段」即 memo 阶段。
5. 回答完 memo referee committee 的问题后（一般在6个月-24个月左右），进入 draft 阶段。
6. 完善 draft 后（一般在1-4个月），进入 Collaboration Wide Review 阶段，经受整个合作组的审查（实际是3-6个 Reading Group）。
7. CWR 结束后（一般在2-6个月），进入PubCom（一般几周），然后是 Waiting Spokesperson Approval 阶段。
8. 发言人都同意后（通常1-几周），Submit to Journal。

一般来说，一个分析，完成所有流程至少需要8-14个月，经历若干个环节、侧重点不同的审查……集团作战，可靠性很有保障！

P2P: 最后结果

PHYSICAL REVIEW D **88,** 032007 (2013)

Precision measurements of $\mathcal{B}[\psi(3686) \to \pi^+\pi^- J/\psi]$ and $\mathcal{B}[J/\psi \to l^+l^-]$

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A. Zhemchugov,[20,†] B. Zheng,[42] J. P. Zheng,[1] Y. H. Zheng,[37] B. Zhong,[24] L. Zhou,[1] X. Zhou,[45] X. K. Zhou,[37] X. R. Zhou,[41]
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(BESIII Collaboration)

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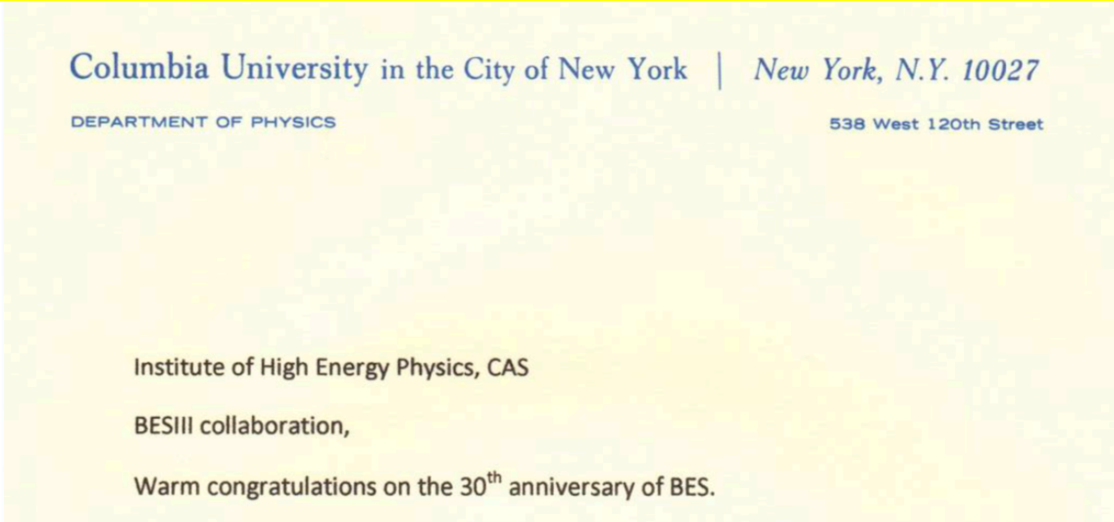
Based on $(106.41 \pm 0.86) \times 10^6$ $\psi(3686)$ events collected with the BESIII detector at the BEPCII collider, the branching fractions of $\psi(3686) \to \pi^+\pi^- J/\psi$, $J/\psi \to e^+e^-$, and $J/\psi \to \mu^+\mu^-$ are measured. We obtain $\mathcal{B}[\psi(3686) \to \pi^+\pi^- J/\psi] = (34.98 \pm 0.02 \pm 0.45)\%$, $\mathcal{B}[J/\psi \to e^+e^-] = (5.983 \pm 0.007 \pm 0.037)\%$, and $\mathcal{B}[J/\psi \to \mu^+\mu^-] = (5.973 \pm 0.007 \pm 0.038)\%$. The measurement of $\mathcal{B}[\psi(3686) \to \pi^+\pi^- J/\psi]$ confirms the CLEO-c measurement, and is apparently larger than the others. The measured J/ψ leptonic decay branching fractions agree with previous experiments within one standard deviation. These results lead to $\mathcal{B}[J/\psi \to l^+l^-] = (5.978 \pm 0.005 \pm 0.040)\%$ by averaging

Symposium on 30 Years of BES Physics



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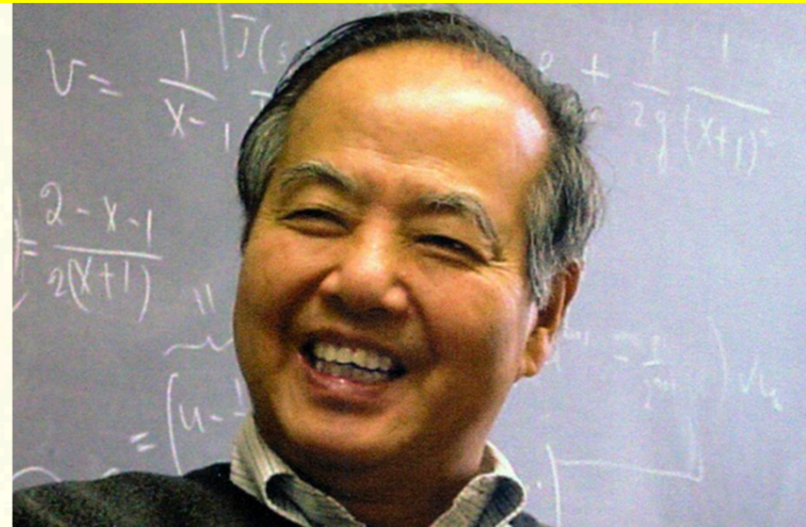
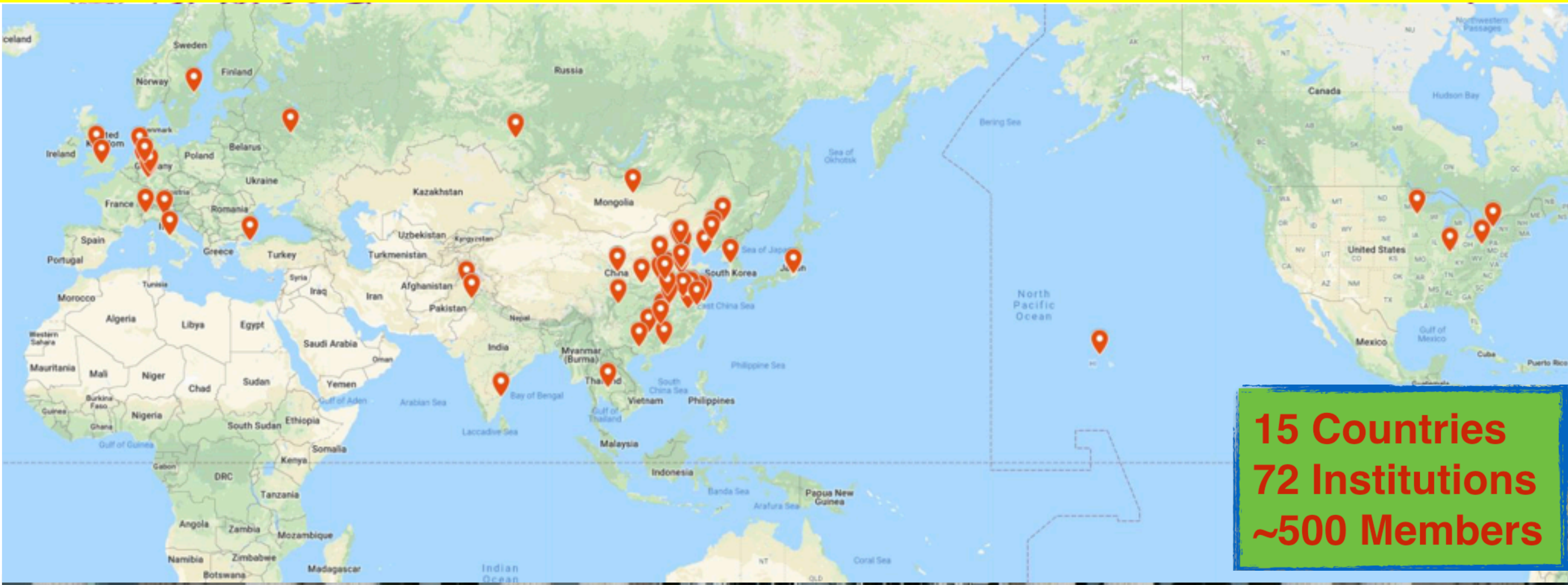
BESIII collaboration,

Warm congratulations on the 30th anniversary of BES.



BESIII Collaboration



15 Countries
72 Institutions
~500 Members

Thank You