Progress of BEPCII

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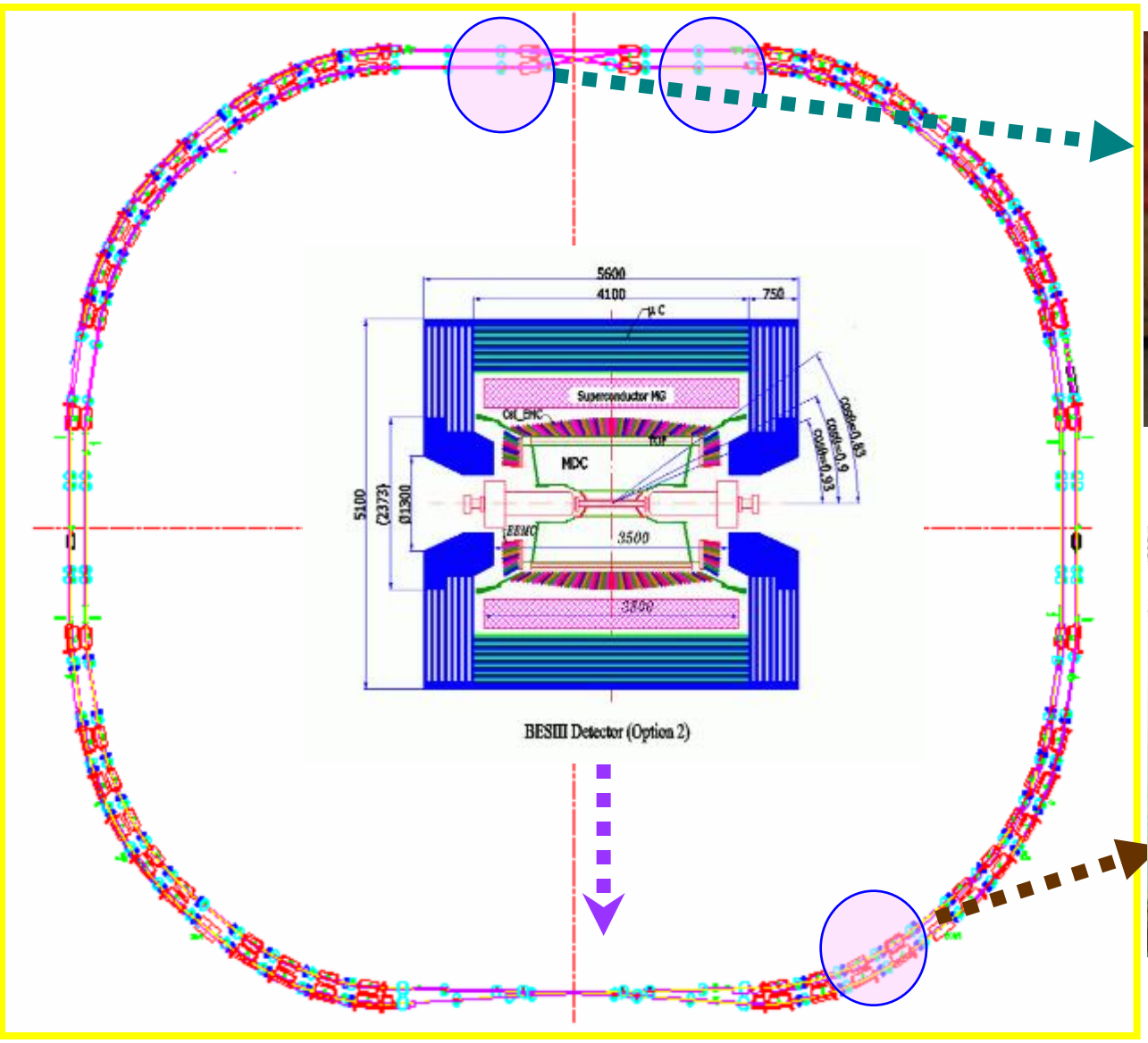
BEPCII: a high luminosity double-ring collider



SC RF

Beam magnets

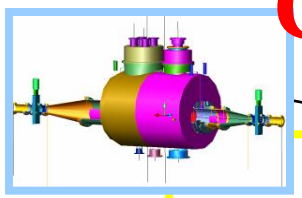
BEPC II Double ring Design

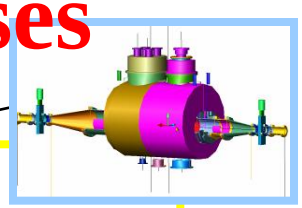
- In the existing BEPC tunnel, add another ring, cross over at south and north points, two equal rings for electrons and positrons. double-ring collision technology.
- 93 bunches，total current > 0.9A in each ring.
- Collision spacing：8 ns.
- Collision with large horizontal cross-angle（±11 mr）.
- Luminosity： $10^{33}\ cm^{-2}\ s^{-1}$ @ 3.78GeV of C.M. energy.
- Linac upgrade: e^+ 50mA/min. , Full energy injection of positron up to 1.89GeV
- SR run performance upgrade：250mA @ 2.5 GeV. Hard X-ray flux increased by one order of magnitude.
- Major detector upgrade：BES III.

Linac Performance reached the design goal

Parameters		Design	measurement	BEPC
Energy （GeV）		1.89	1.89	1.30-1.55
Current （mA）	e^+	37	66	~5
	e^-	500	550	300
Emittance （1σ，mm-mrad）	e+	0.40	0.35 ~ 0.27	----
	e^-	0.10	0.097~0.079	----
Energy spread (1σ, %)	e^+	0.50	0.371	~0.80
	e^-	0.50	0.295	~0.80
Energy stability （%）		0.15	0.05	----
Orbit stability （mm）		0.30	0.119 ~0.058	----
Repetition rate		50	50	12.5
e^+ injection rate （mA / min.）		50	61.5	1 ~ 3

Commissioning in 3 Phases





SR

e+

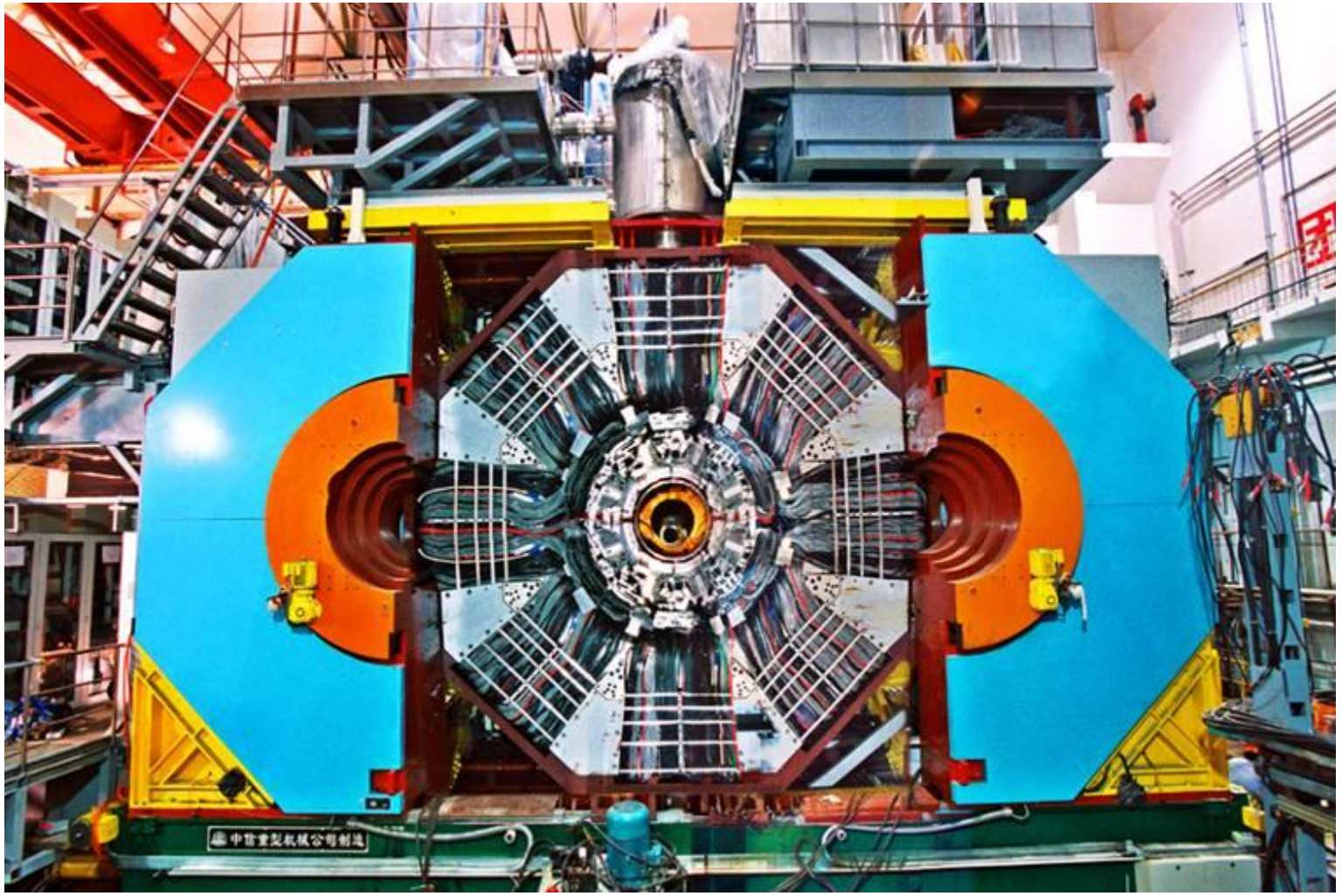
e

Collision: e^- ring (BER) + e^+ ring (BPR)
SR Operation: Outer ring (BSR)
Phase 1: IR with Conventional magnets
(Nov. 06 – July 07)

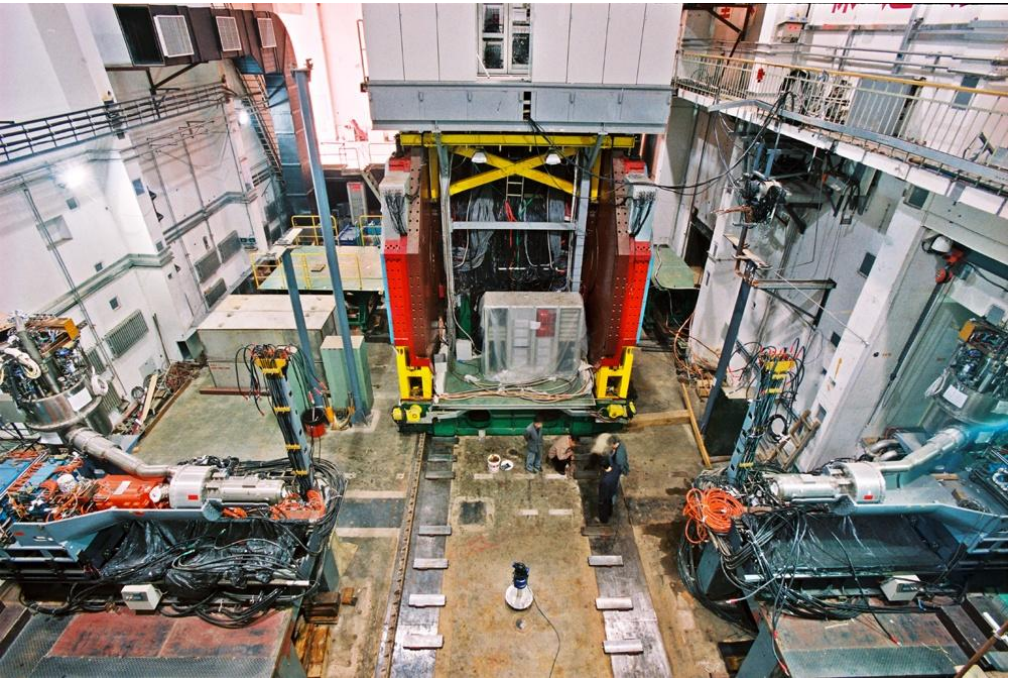
Phase 2: IR With SCQ (Oct. 07-Mar. 08)

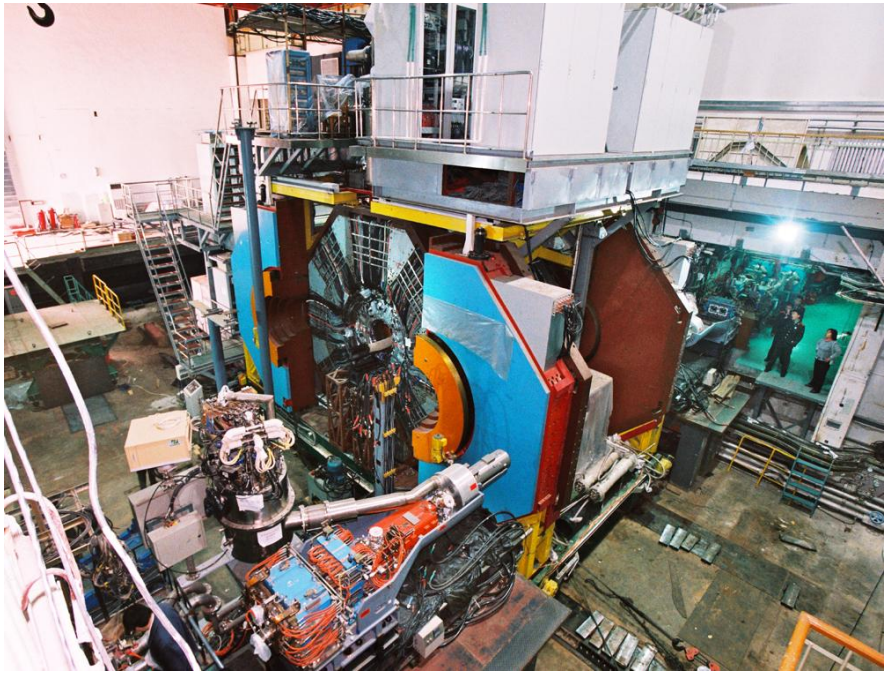
Phsse 3: BEPCII + BESIII (June 08 -

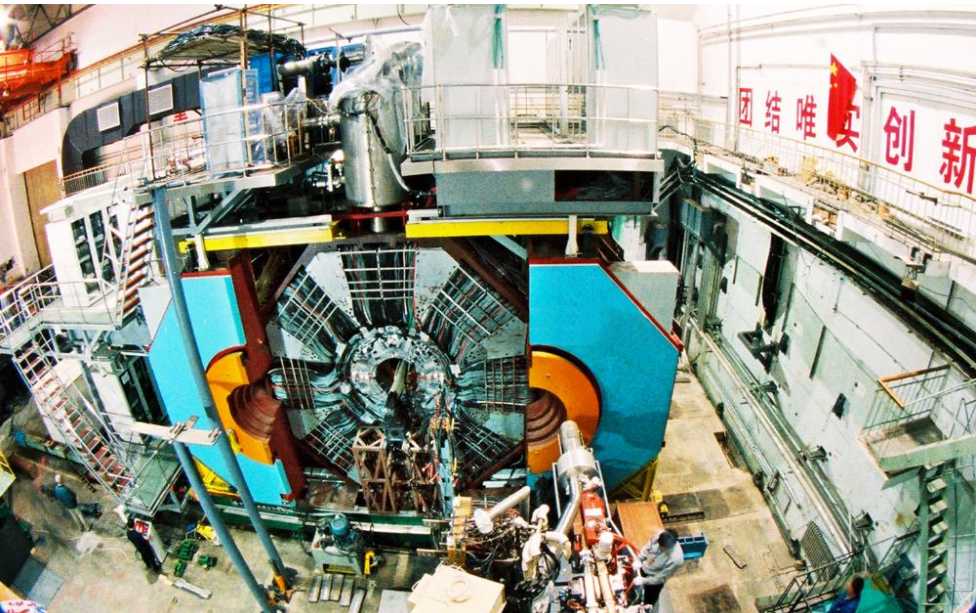
Detector installation and tuning completed April, and moved to IR May

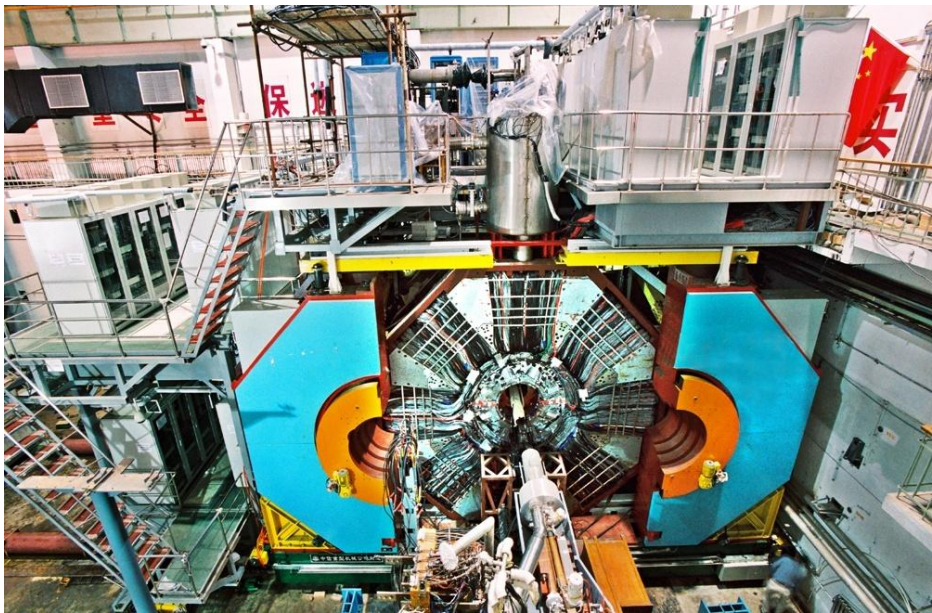


BESIII moved to IP: precision < 1 mm

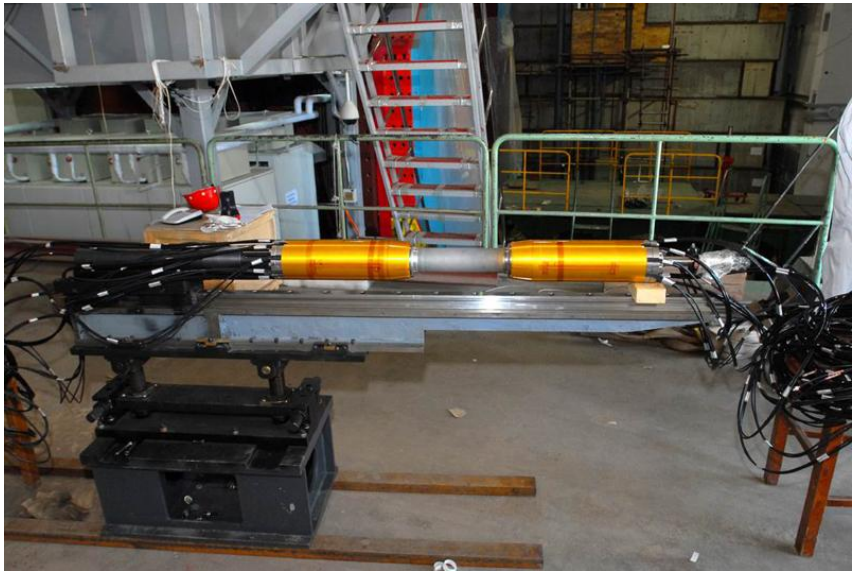


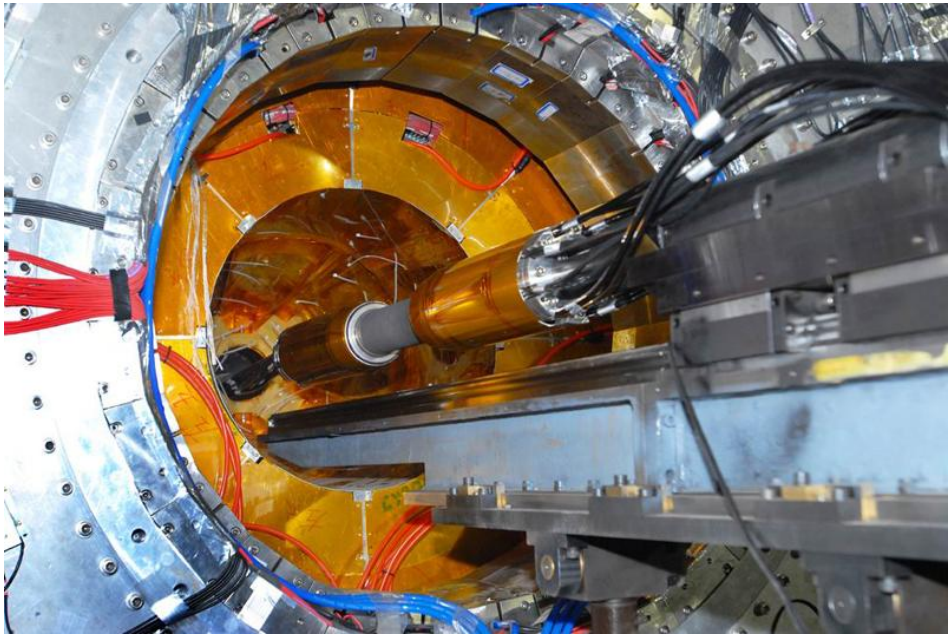


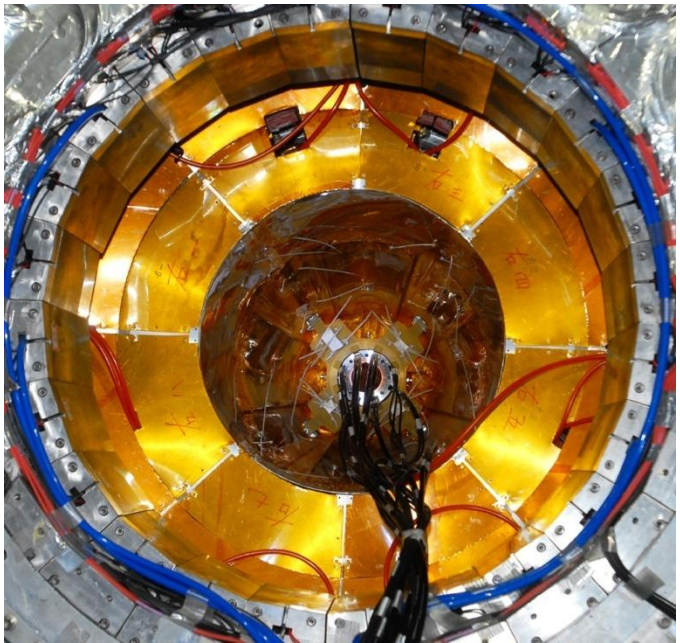




Be Beam-pipe installation



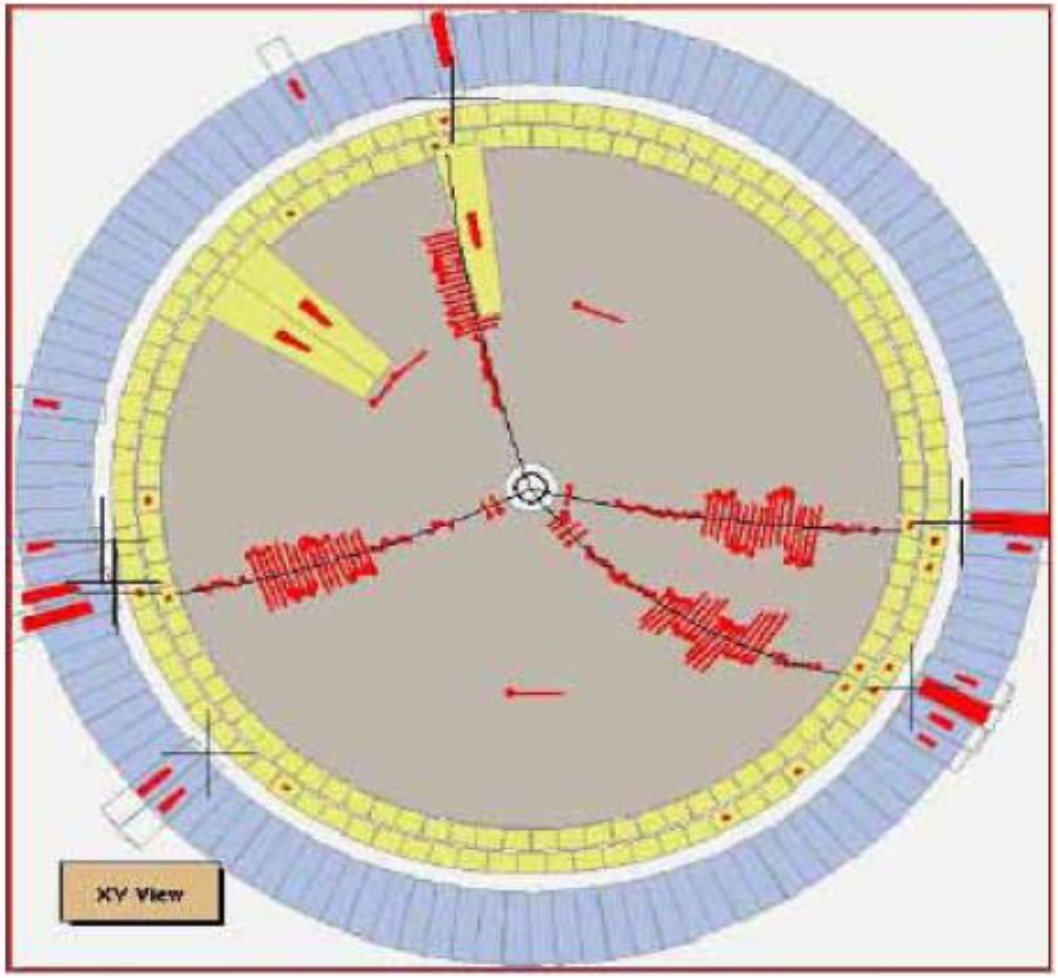


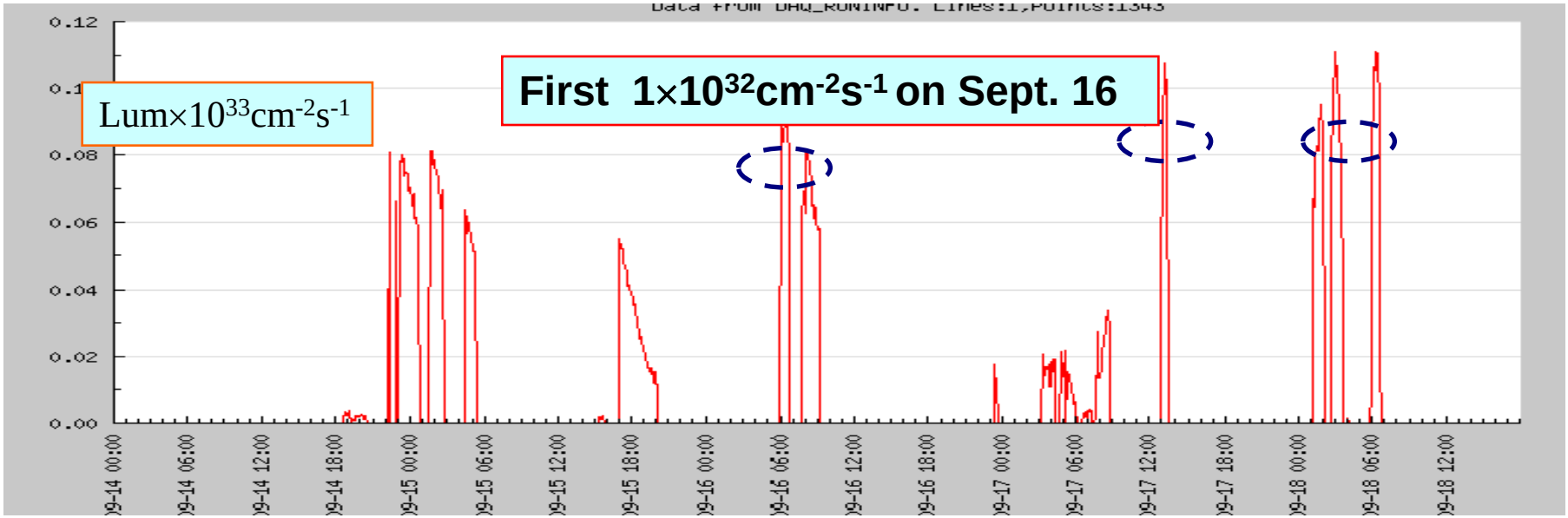


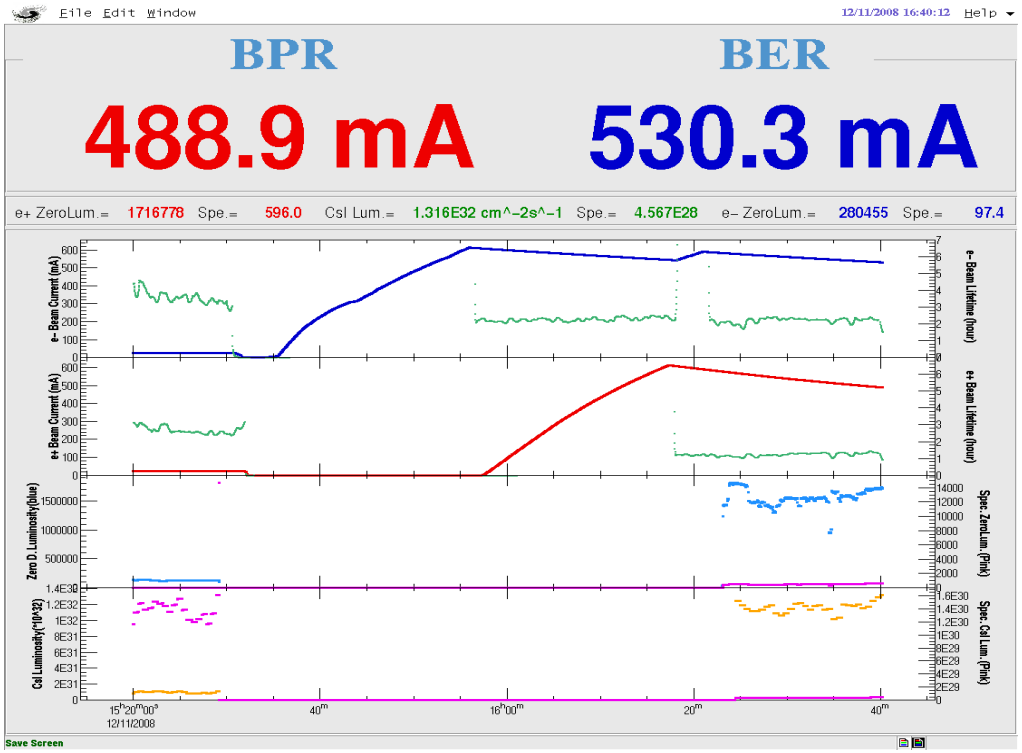
Joint Commissioning

- **Joint commissioning started 22 June.**

First hardron event observed on BESIII on July 19.







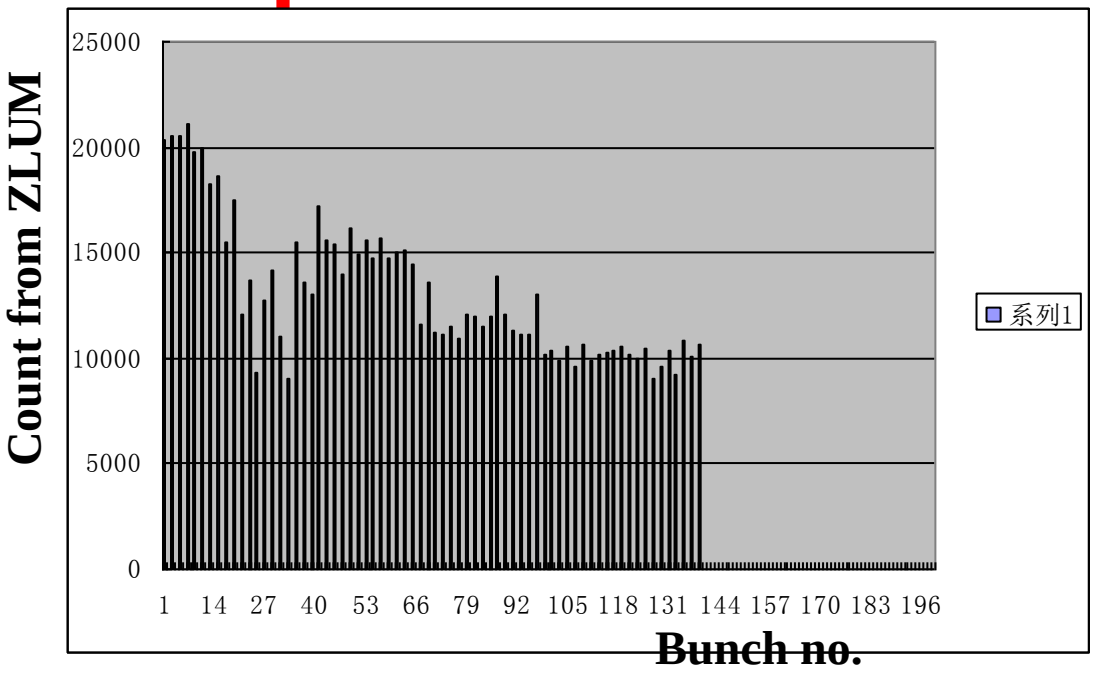
Lumi. record:
on Dec. 11,
1.3×1032cm^{-2}s^{-1} @
489mA*530mA
with 90 bunches

Main parameters achieved in collision mode

parameters	design	Achieved	
		BER	BPR
Energy (GeV)	1.89	1.89	1.89
Beam curr. (mA)	910	650	700
Bunch curr. (mA)	9.8	>10	>10
Bunch number	93	93	93
RF voltage	1.5	1.5	1.5
$*\nu_s$ @1.5MV	0.033	0.032	0.032
β_x^*/β_y^* (m)	1.0/0.015	~1.0/0.016	~1.0/0.016
Inj. Rate (mA/min)	200 e^-/ 50 e^+	>200	>50
Lum. ($\times 10^{33}cm^{-2}s^{-1}$)	1	0.185	

luminosity did not improve vs beam current as expected

Along bunch train, bunch luminosity in the tail is lower than the head, or luminosity does not increase propotional to the bunch number.



For example:

Single bunch, 5.0mA×5.0mA， Lum_bunch=$2.5\times10^{30}cm^{-2}s^{-1}$

Multi-bunch, 93 bunches 450mA*450mA， Lum_total~$1.1\times10^{32}cm^{-2}s^{-1}$

Lum_total~93*lum_bunch/2

Understanding of “luminosity saturation” at high beam current

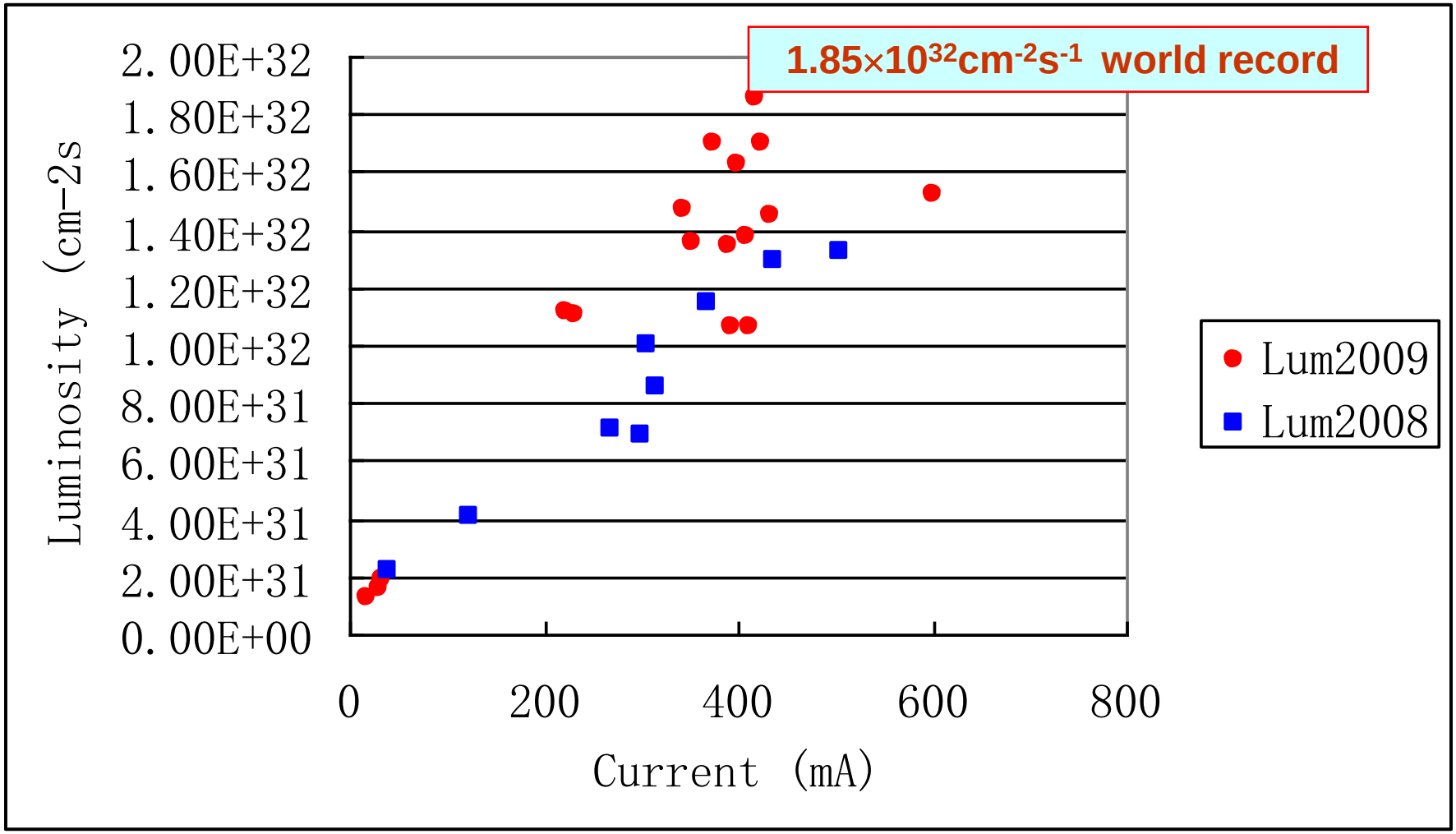
1) **Luminosity degradation mainly due to problem in BPR**
2) **ECI alone seems not the main cause to degrade the luminosity**

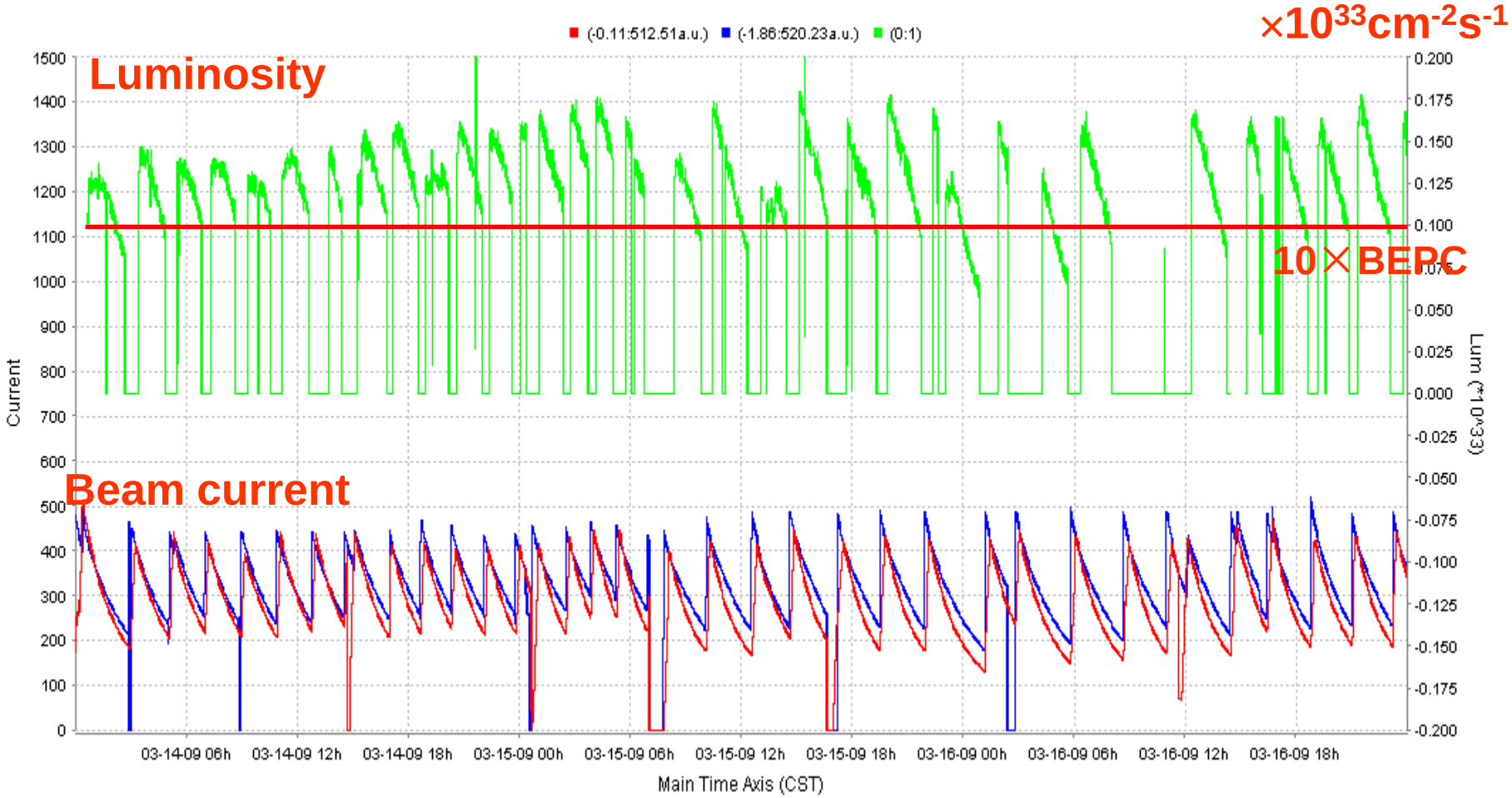
3) **The main cause is the longitudinal oscillation.**
4) **Vertical beam size is easily blow-up during beam-beam collision while the beam is oscillating longitudinally.**

To cure the longitudinal instability

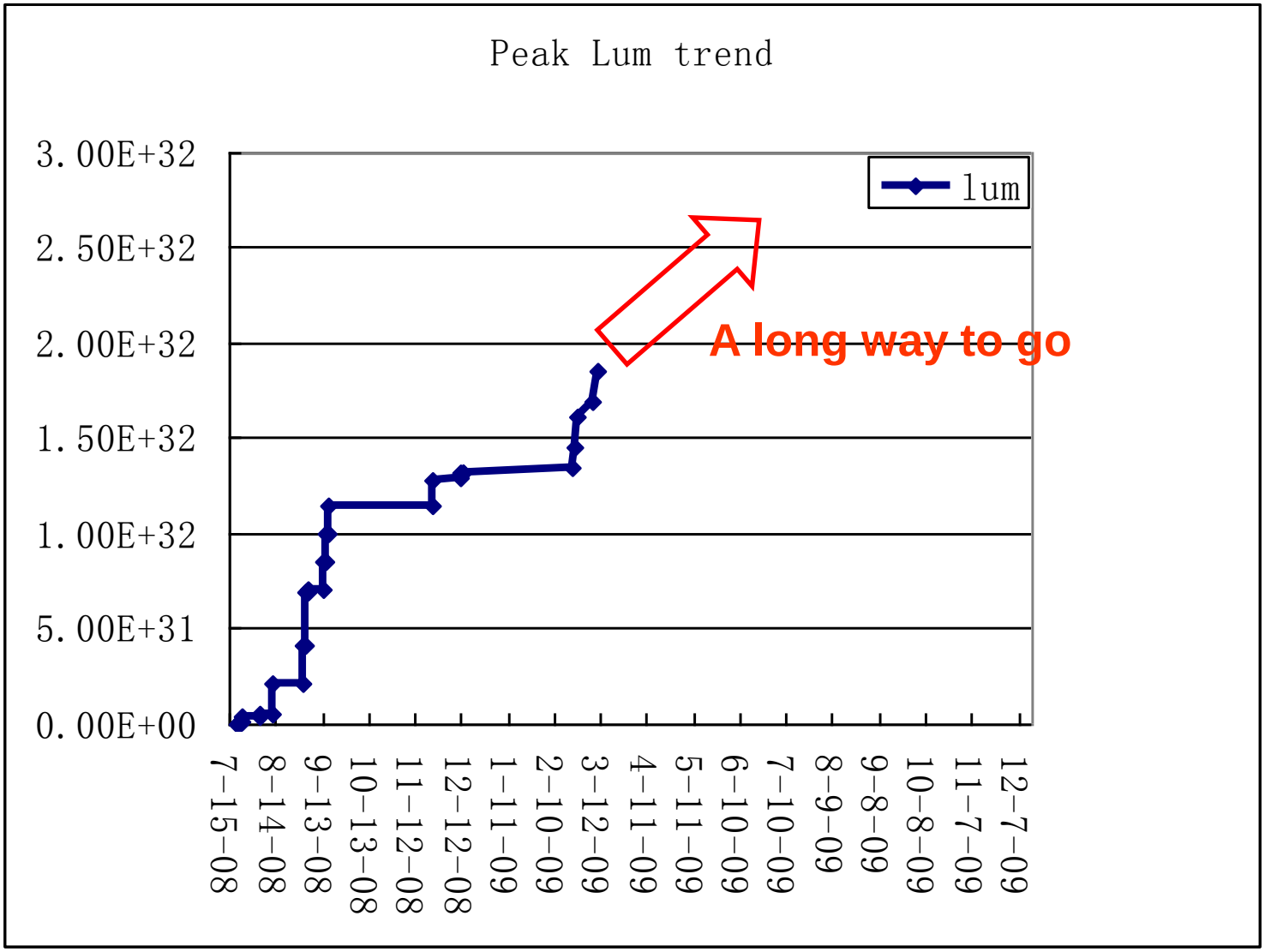
- **Longitudinal feedback system is being developed.**
- **Sources of longitudinal oscillation are still under investigation, particularly, to look for the difference between BER and BPR as the instabilities being stronger :**
  - **LLRF (seems OK)**
  - **HOM of movable mask, profile monitor, any damaged component…**
  - **The way to find the location of the source: BPM noise, temperature, vacuum, beam loss…**
  - **Jan. 2009 the screen monitors removed, the longitudinal oscillation in the positron ring became much weaken and the amplitude is same to that in electron ring.**

Compared to 2008, luminosity increases about 40% at the same beam current in collision





For HEP operation, machine is stable, with average ~3M events/day
From Mar. 6 to Mar. 19, about 30M ψ(2S) events collected.

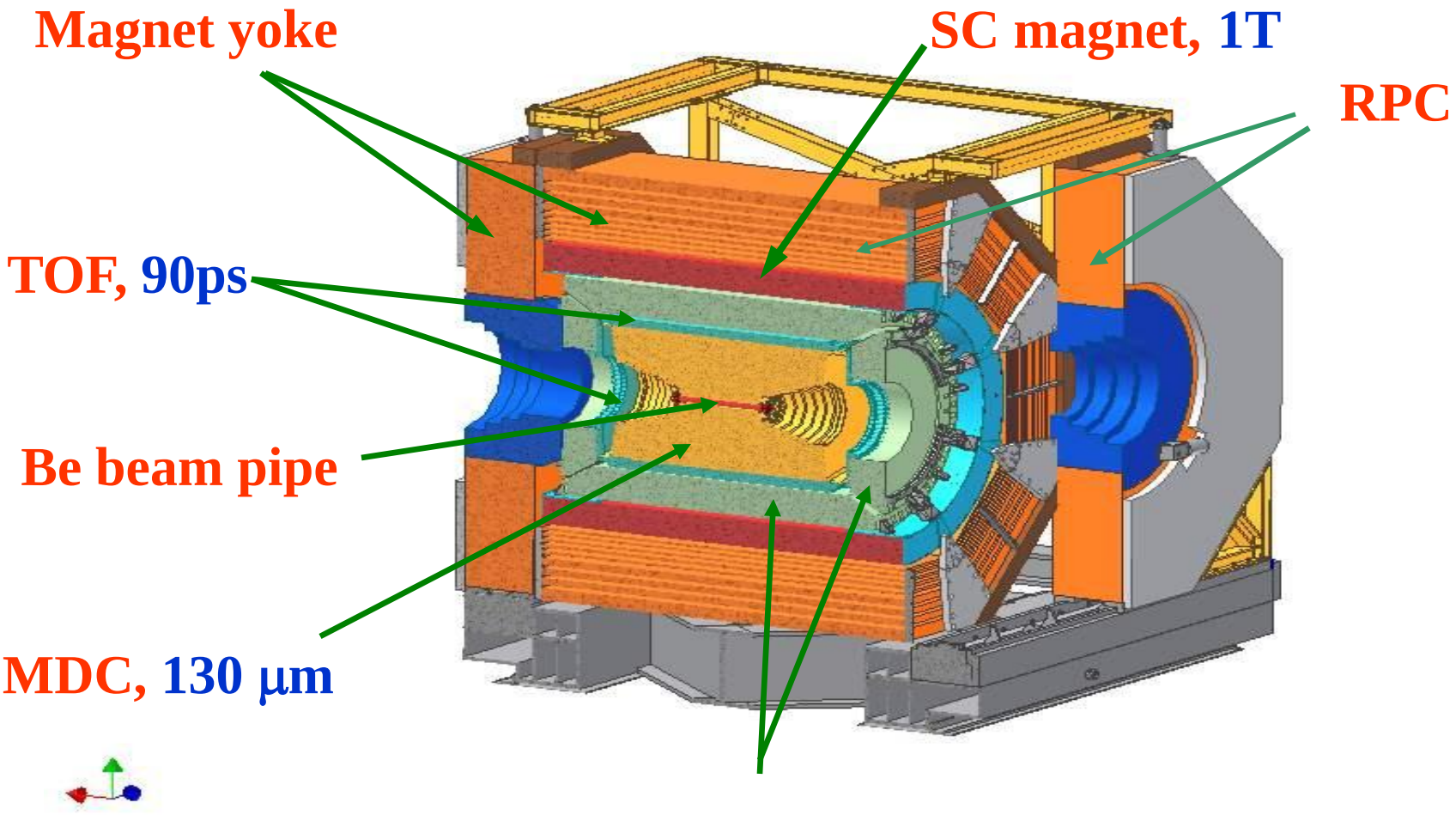

Peak Lum trend
3.00E+32
2.50E+32
2.00E+32
1.50E+32
1.00E+32
5.00E+31
0.00E+00
lum
A long way to go
7-15-08
8-14-08
9-13-08
10-13-08
11-12-08
12-12-08
1-11-09
2-10-09
3-12-09
4-11-09
5-11-09
6-10-09
7-10-09
8-9-09
9-8-09
10-8-09
11-7-09
12-7-09

BESIII Detector

— Adapt to high event rate : $10^{33}cm^{-2}\ s^{-1}$ and bunch spacing 8ns

— Reduce sys. errors for high statistics: photon measurement, PID…

— Increase acceptance， and give space for SC quads



BESIII collaboration

USA (7)

Univ. of Hawaii, Univ. of Washington
Univ. of Minisolta, Univ. of Florida
Univ. of Rochester
Carnegie Mellow Univ., RPI,

Europe (5)

GSI, Germany
University of Bochum, Germany
University of Giessen, Germany
JINR, BINP, Russia

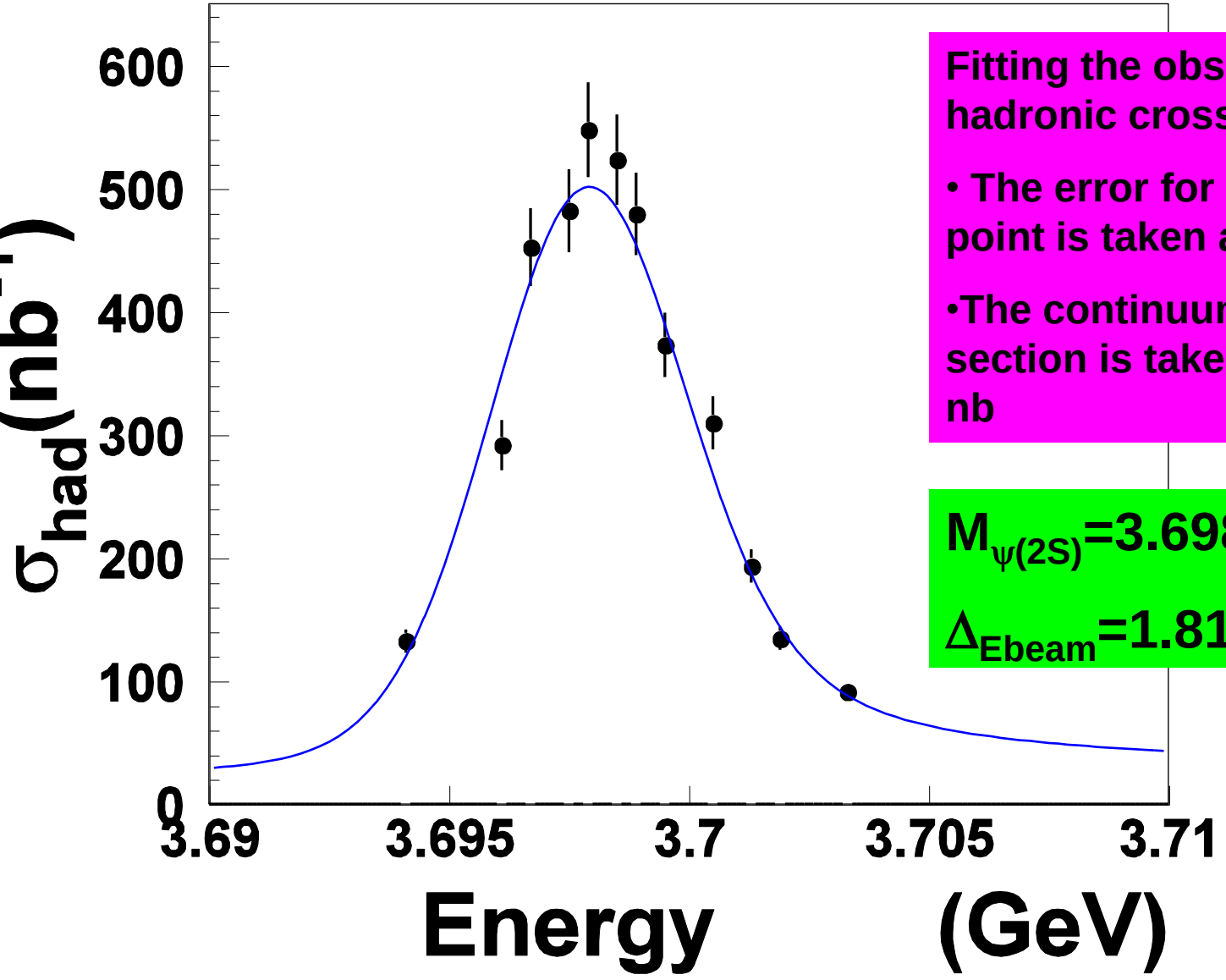
China (23)

IHEP, Peking Univ., Tsinghua Univ. ,
Univ. of Sci. and Tech. of China, CCAST,
Shandong Univ., Zhejiang Univ.
Huazhong Normal Univ., Wuhan Univ.
Zhengzhou Univ., Henan Normal Univ.
Zhongshan Univ.,Nankai Univ., Liaoning Univ.
Shanxi Univ., Sichuan Univ, Hunan Univ.,
Nanjing Univ., Nanjing Normal Univ.
Guangxi Normal Univ., Guangxi Univ.,
Hong Univ/, Chinese Univ. of Hong Kong

Japan (1)

Tokyo University

Beam Energy Calibration with psi(2S) scan



Fitting the observed hadronic cross-section

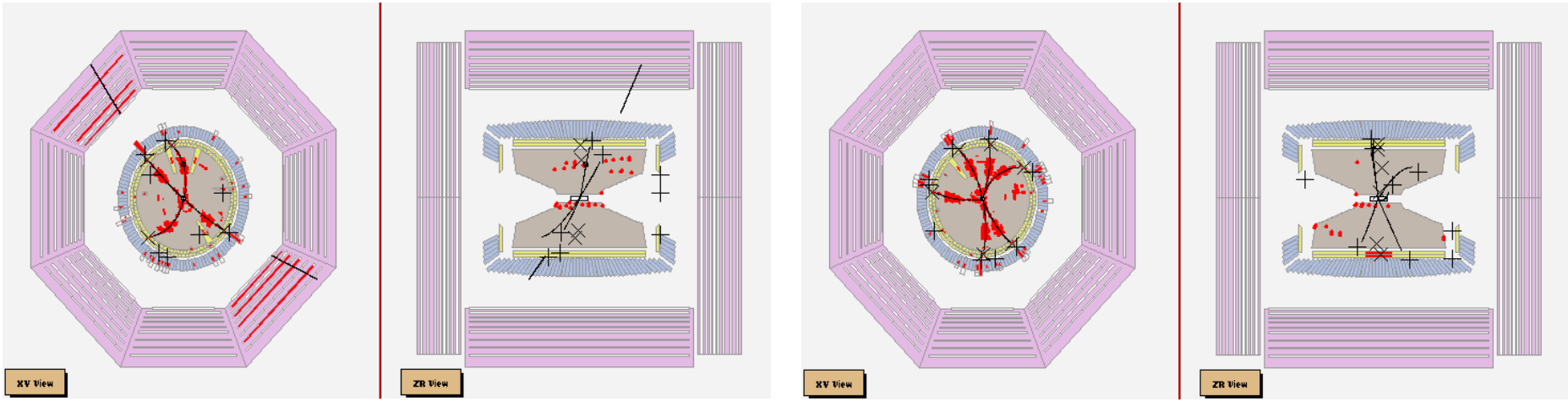
- **The error for each point is taken as 7%.**
- **The continuum cross section is taken as 20 nb**

$M_{\psi(2S)}$=3.698 GeV

Δ_{Ebeam}=1.81MeV

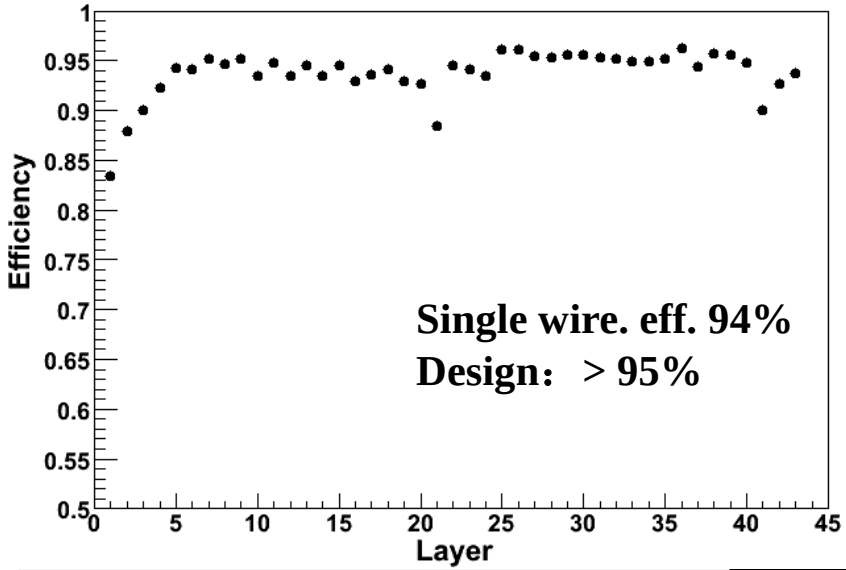
First data at psi(2S)

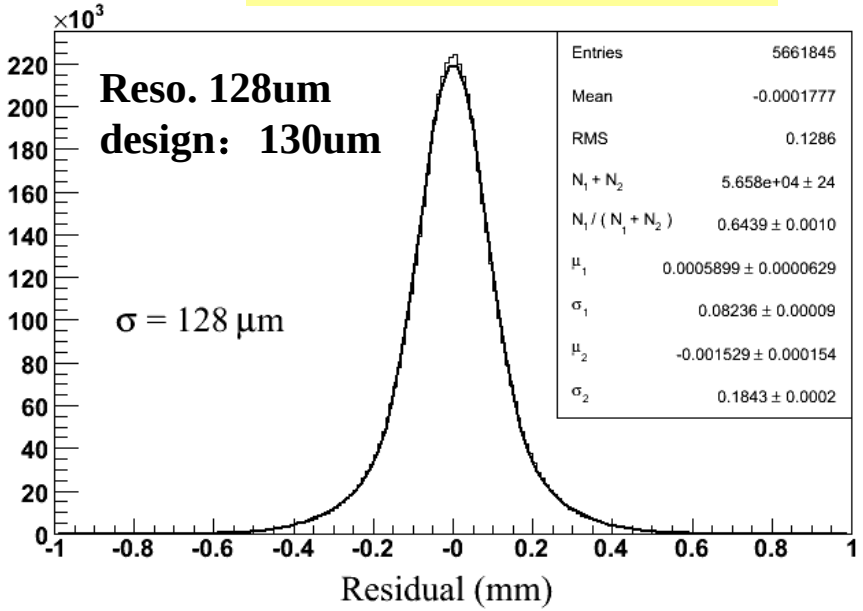
- Aug.: **1.3pb^{-1}**; Sep.: **2.3pb^{-1}**;
- Oct.: **14.4pb^{-1}**; Nov.: **4.8pb^{-1}**;
- Total integrated luminosity: **22.8pb^{-1}, 13M events**
- **Detector performance reached the design goal**
- **Physics results: see talk by Weiguo Li**

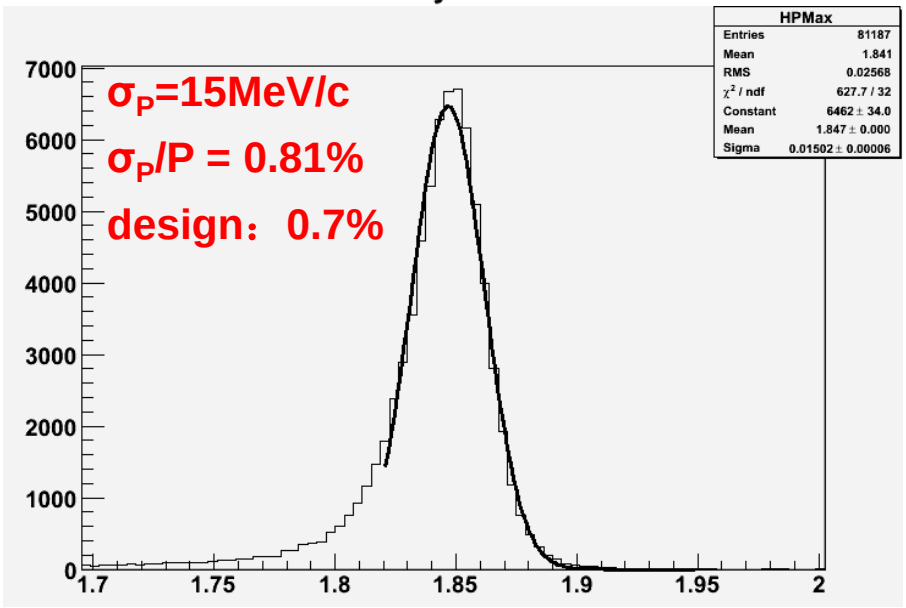


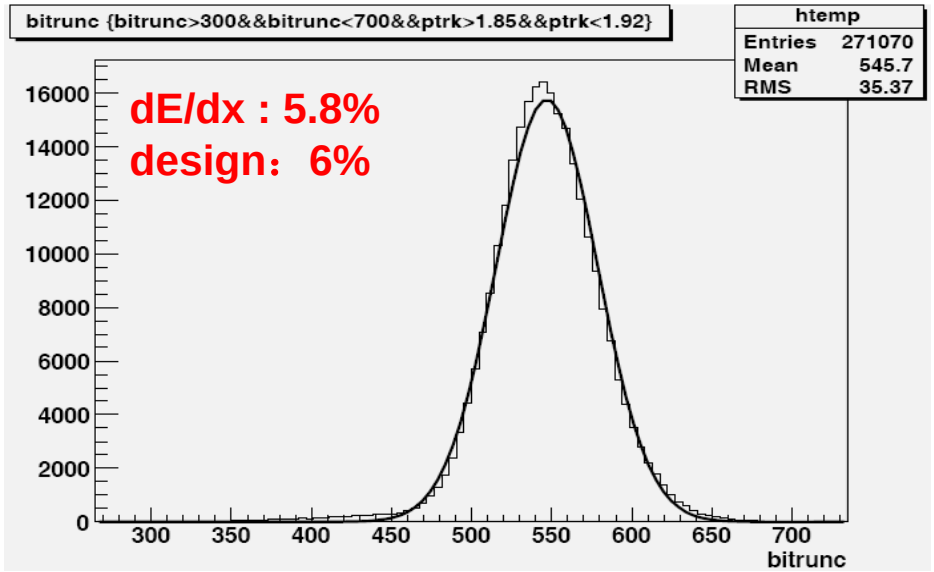
Draft chamber calibration

Babar: ~ 110 μm 6.2%
Belle: ~ 130 μm 5.7%
CLEO: ~ 110 μm 5.7%
BESIII: ~ 130 μm ~6%

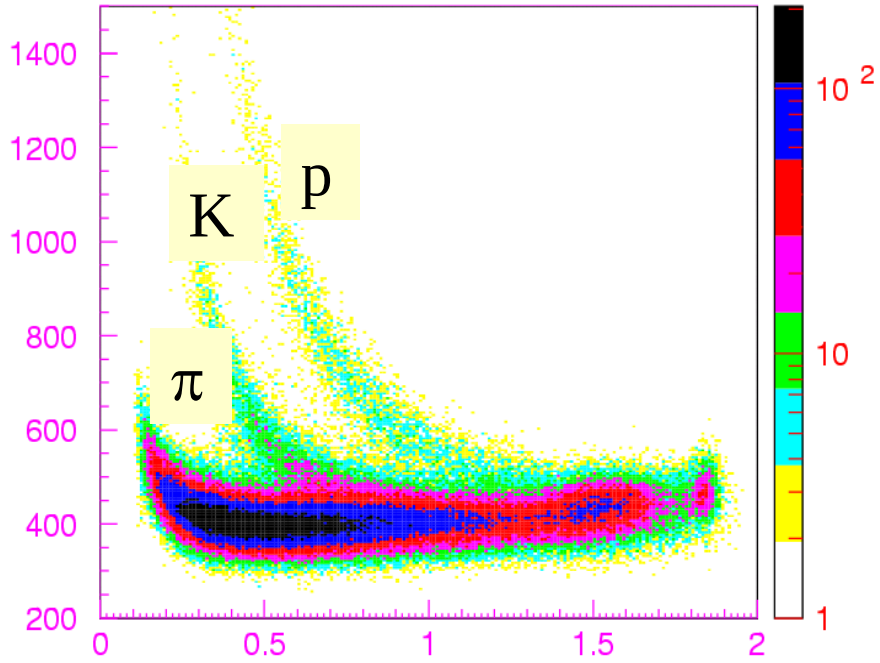






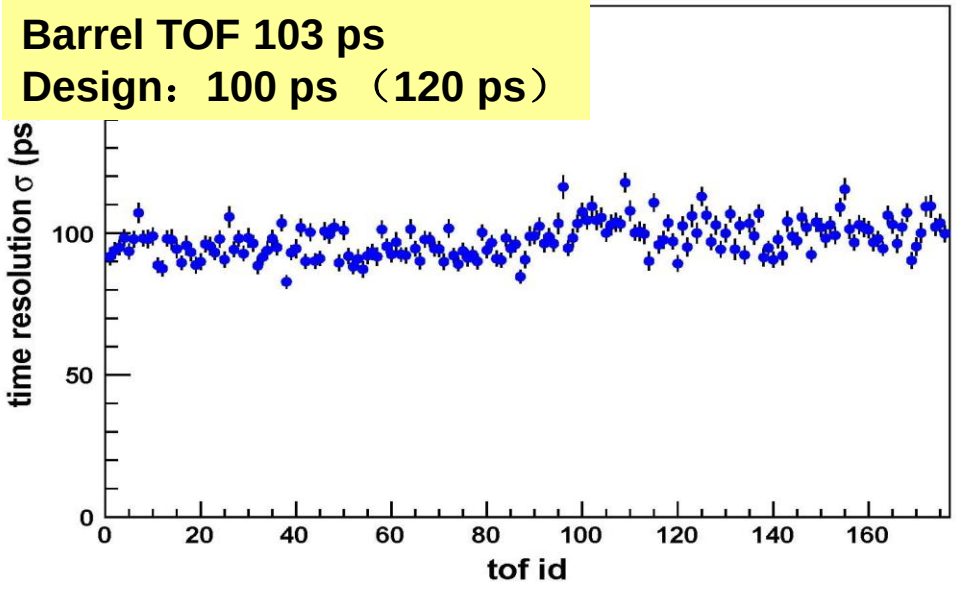


TOF: reconstruction and callibration

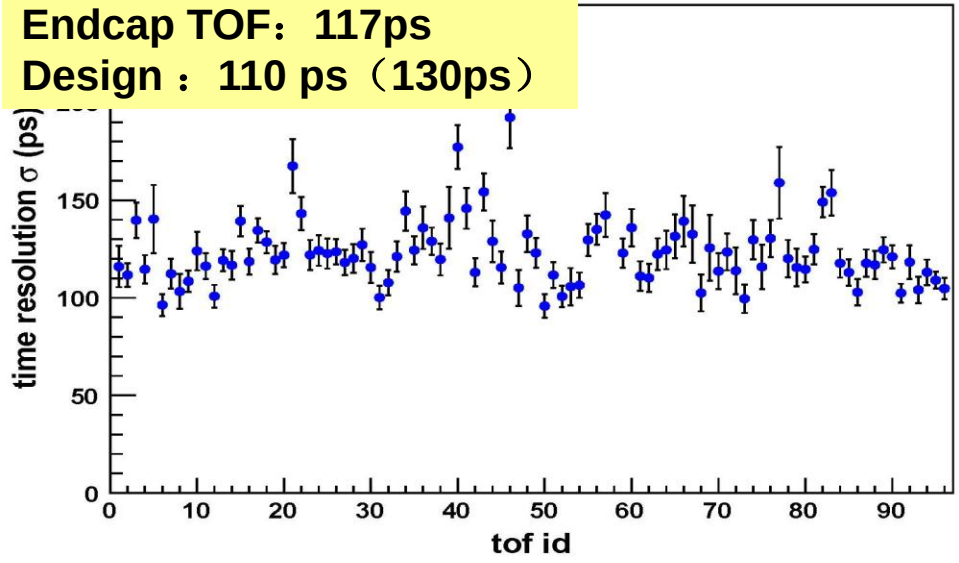


detector	L(cm)	intrinsic
BESIII	**240**	**90 ps**
CLEOII	280	139 ps
OBELIX	300	170 ps
BELLE	255	90~100 ps
CDFII	279	100 ps
HARP	180-250	160 ps

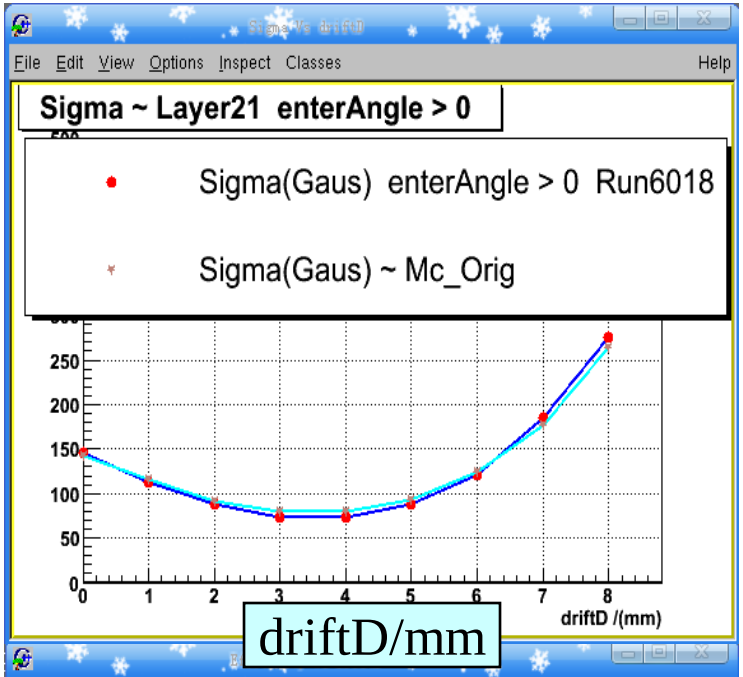
Barrel TOF 103 ps
Design：100 ps （120 ps）



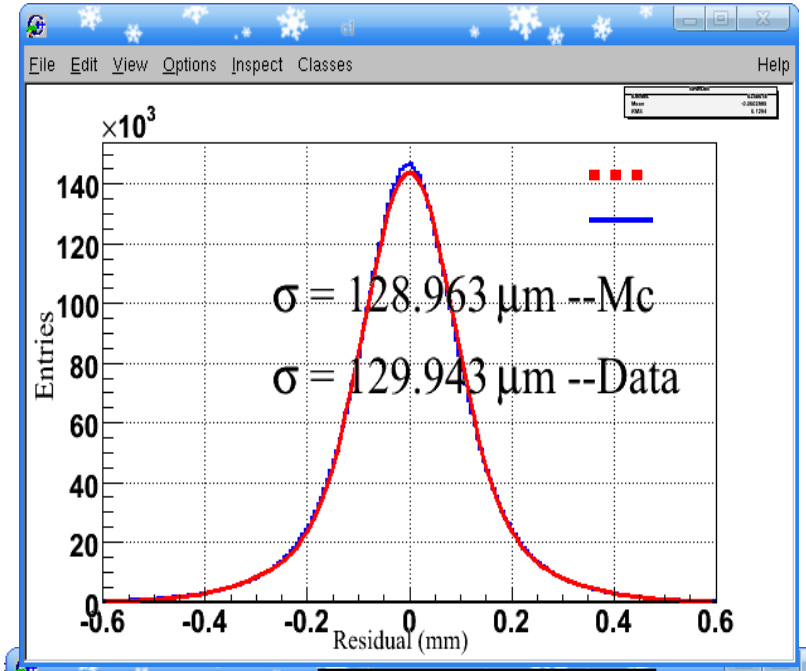
Endcap TOF：117ps
Design ： 110 ps（130ps）



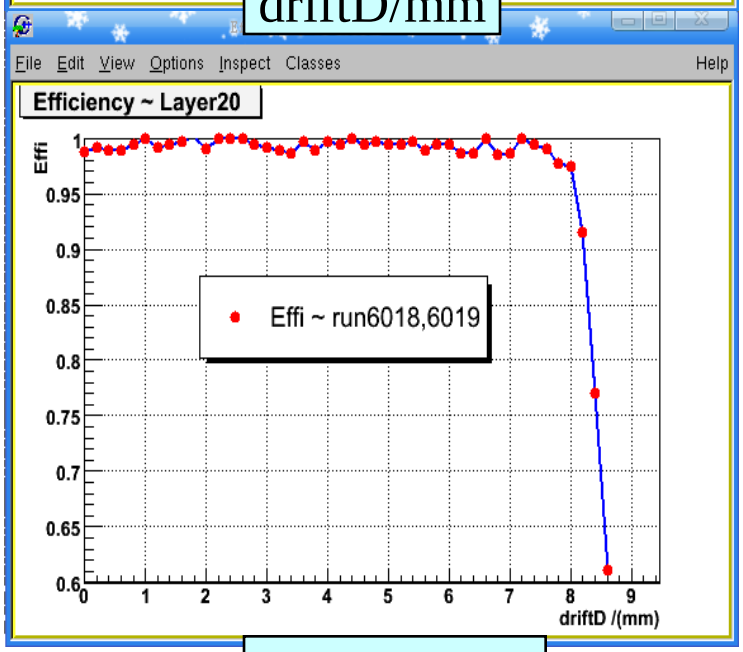
Draft Chamber MC Tuning： comparison between data and MC



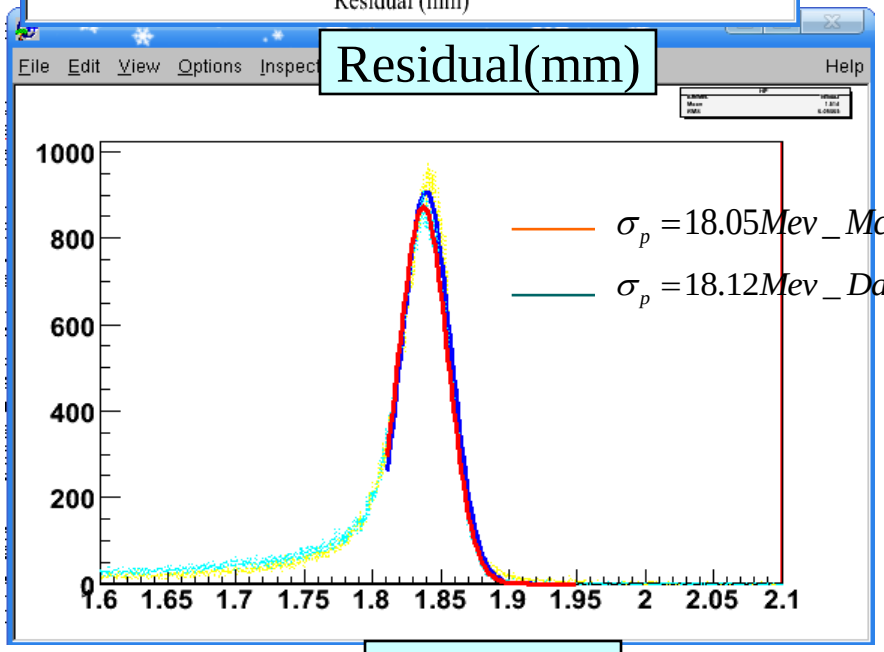
driftD/mm



Residual(mm)



driftD/mm



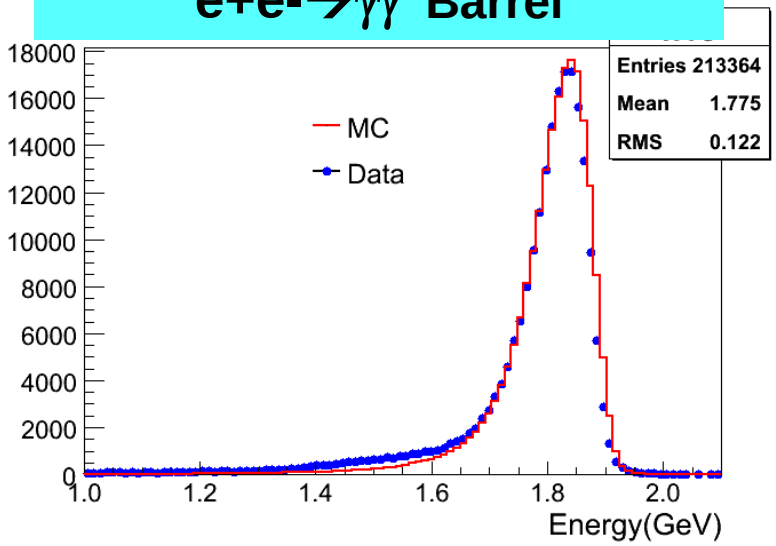
driftD/mm

Energy and position resolution of photon in EMC

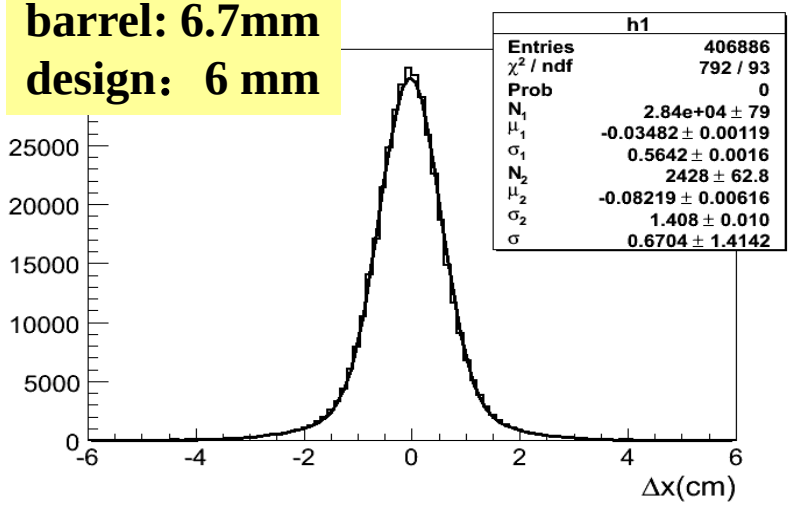
- **Channel：**
  - e+e-→γγ
  - π^0→γγ
  - e+e-→ e+e-γ
  - ψ'→γ$\chi_{c\,1,2}$

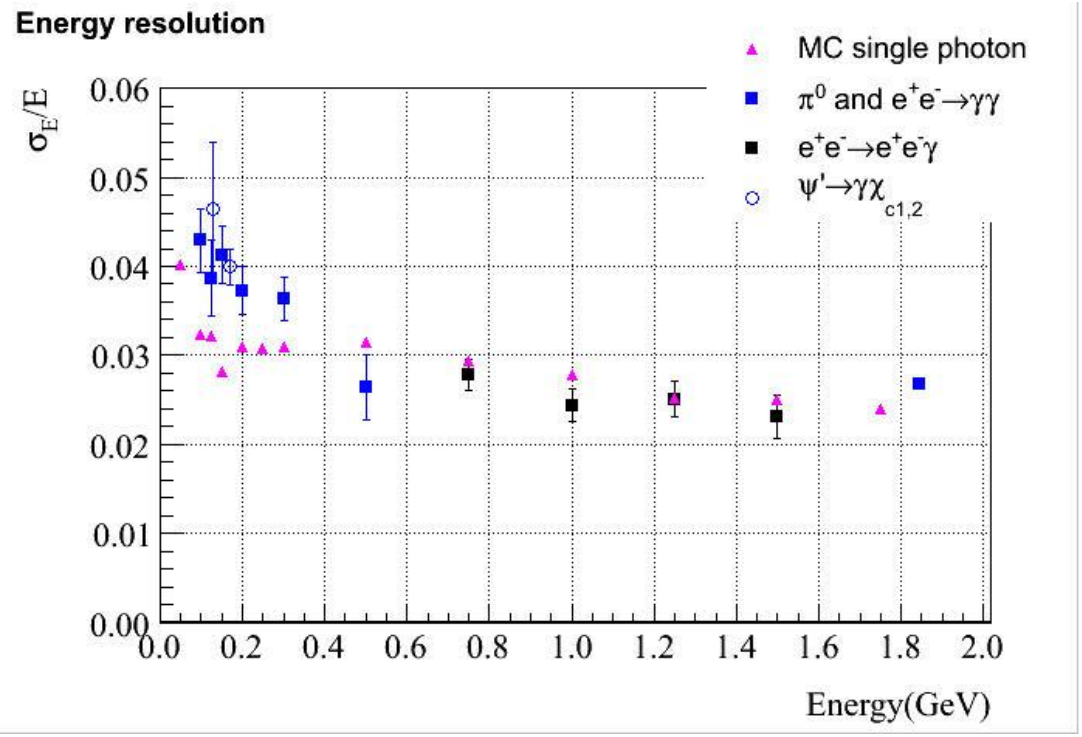
Babar:
2.67%@1GeV
Belle: 2.2% @1GeV
Cleo: 2.2% @1GeV
BESIII: 2.5%@1GeV

e+e-→γγ Barrel



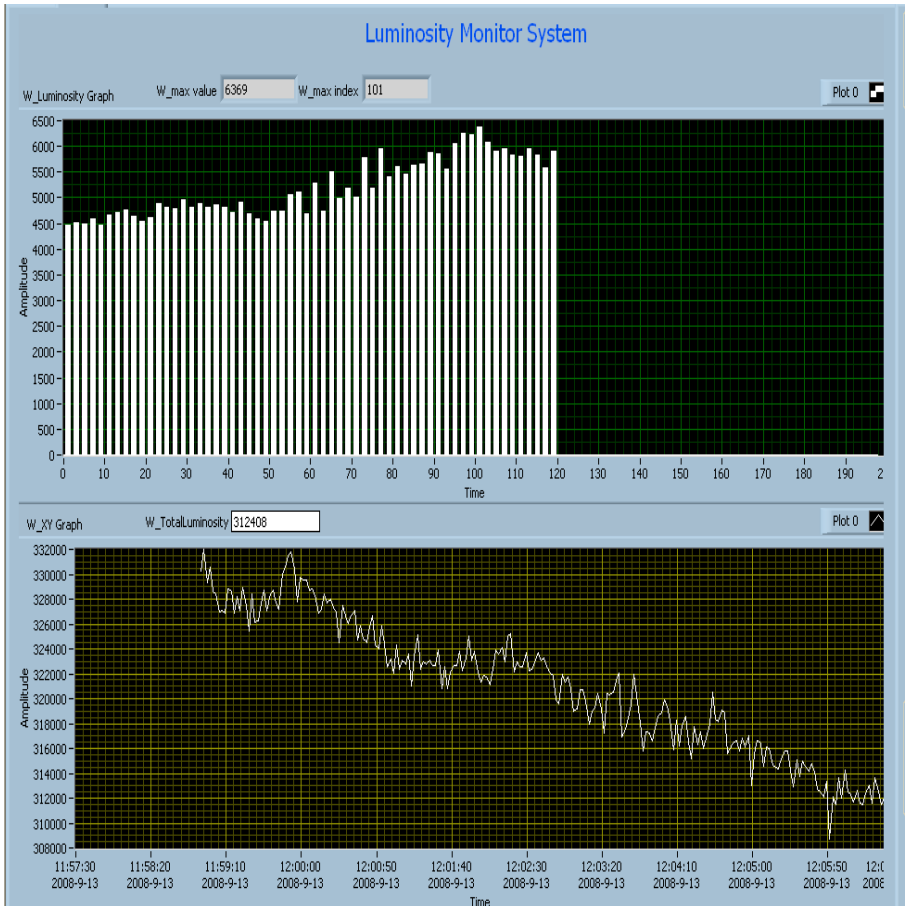
barrel: 6.7mm
design： 6 mm

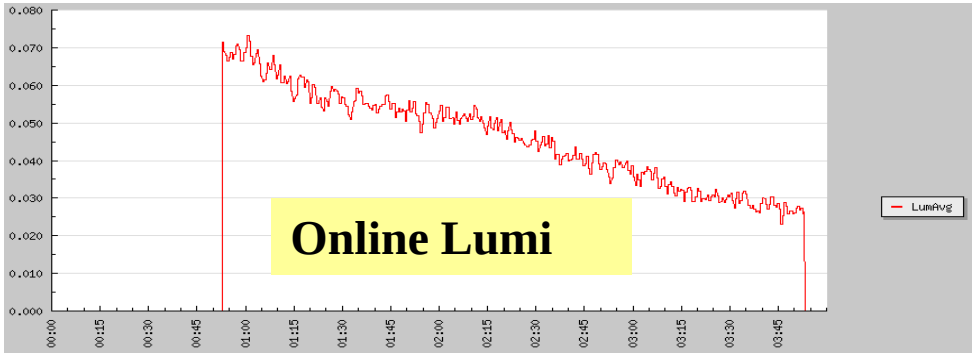


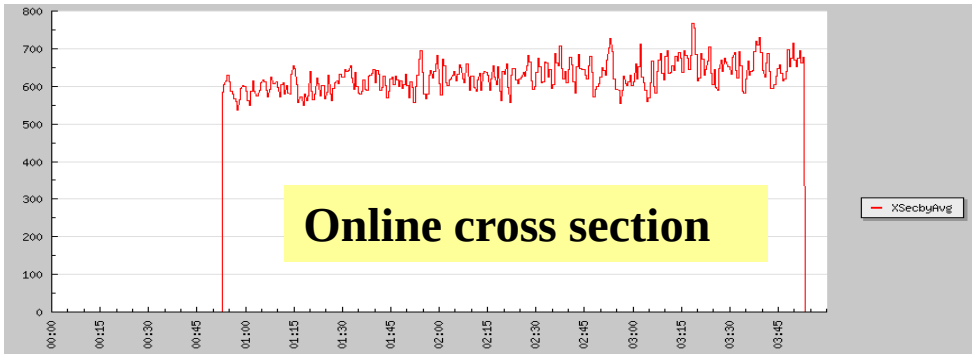


Luminosity monitor

- **Small angle：real-time bunch-by-bunch lumi. for storage ring tuning**
- **End cap EMC：absolute measurement of Lumi.**



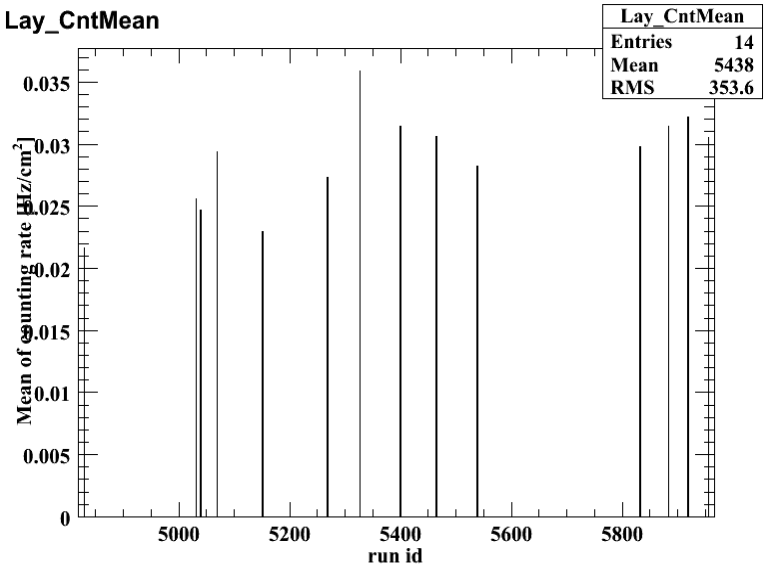




Consistent within 10%

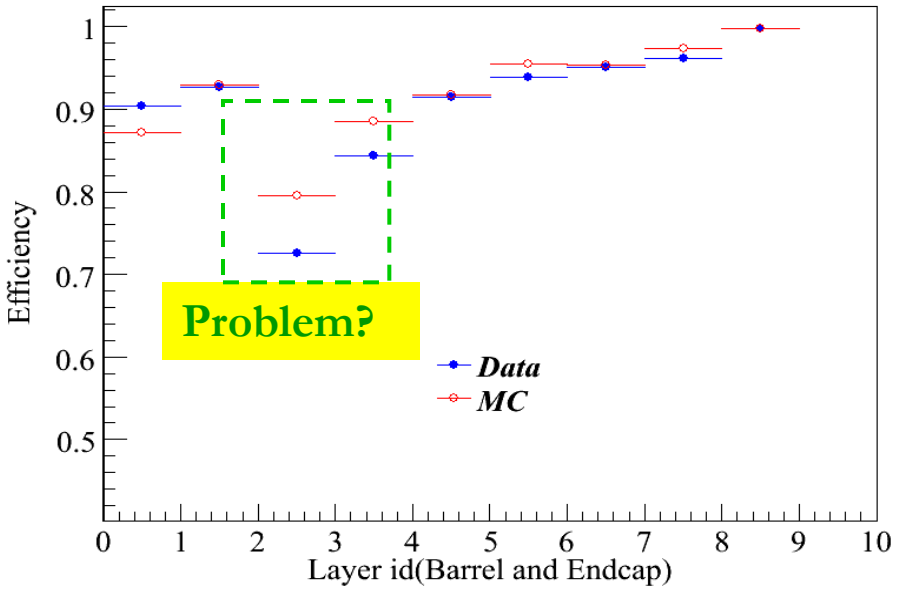
RPC Muon Chamber

- **Ave. eff. 92% close to design**
- **Spatial reso. 21.3mm > design**
- **noise~ 0.04Hz/cm2 > design**

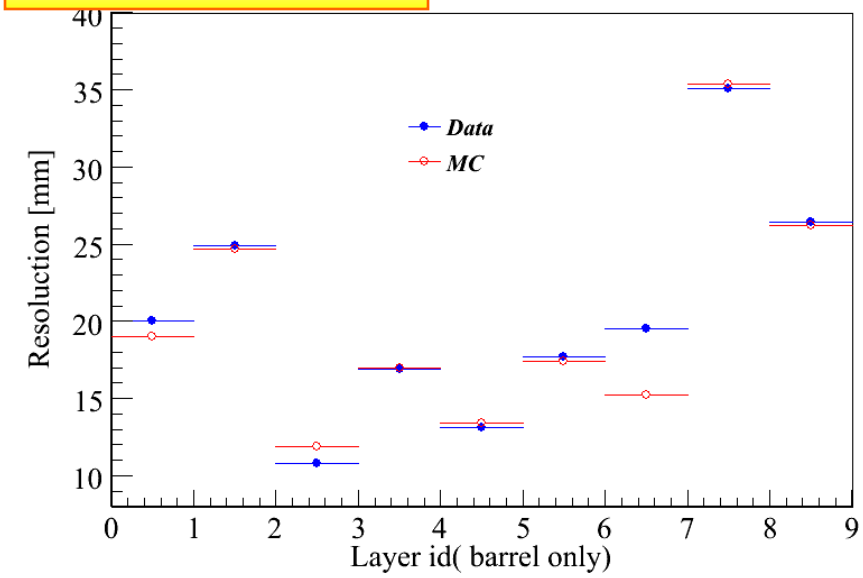


Counting rate: < 0.04Hz/cm^2
Design: 0.1Hz/cm^2

Efficiency

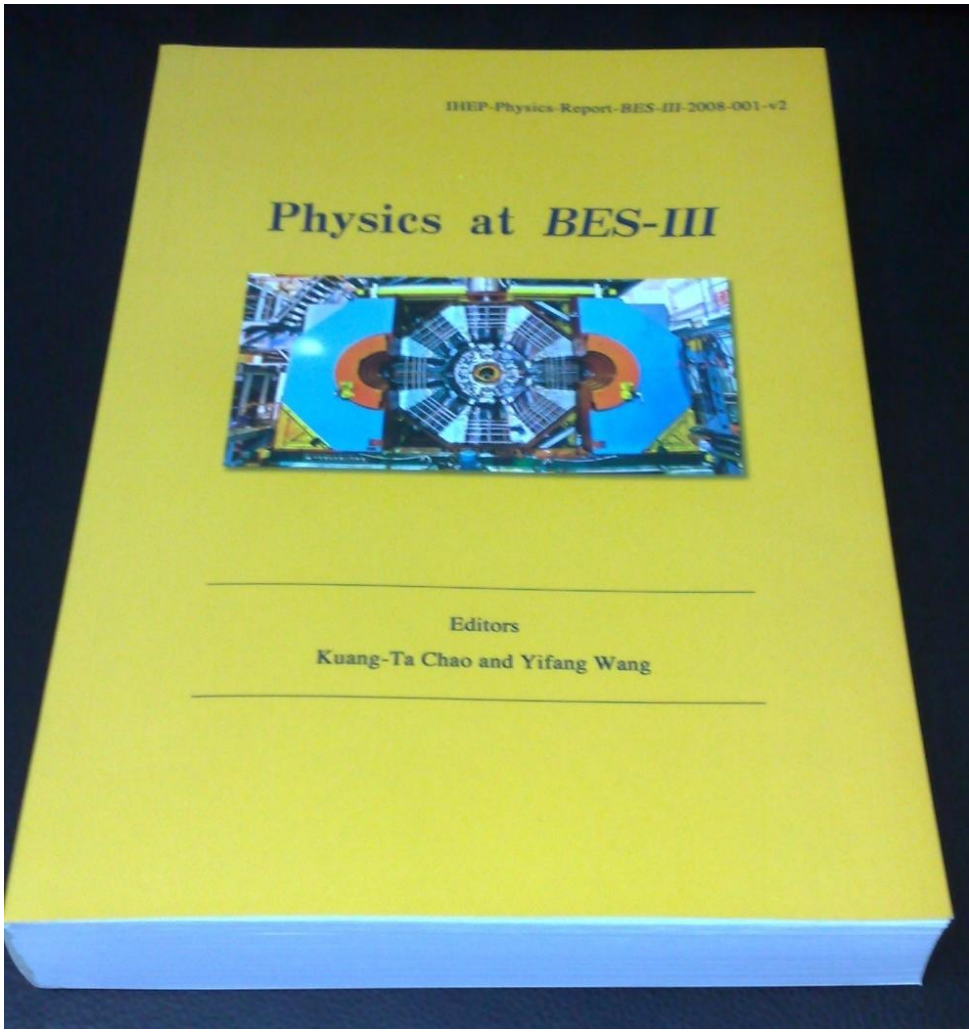


Spatial resolution



BESIII: physics and MC

- **BESIII physics yellow book：major physic topics, method and expected results by international team (theorists and experimentalists)**
- **Data taking plan and preparation of analysis for every topics**



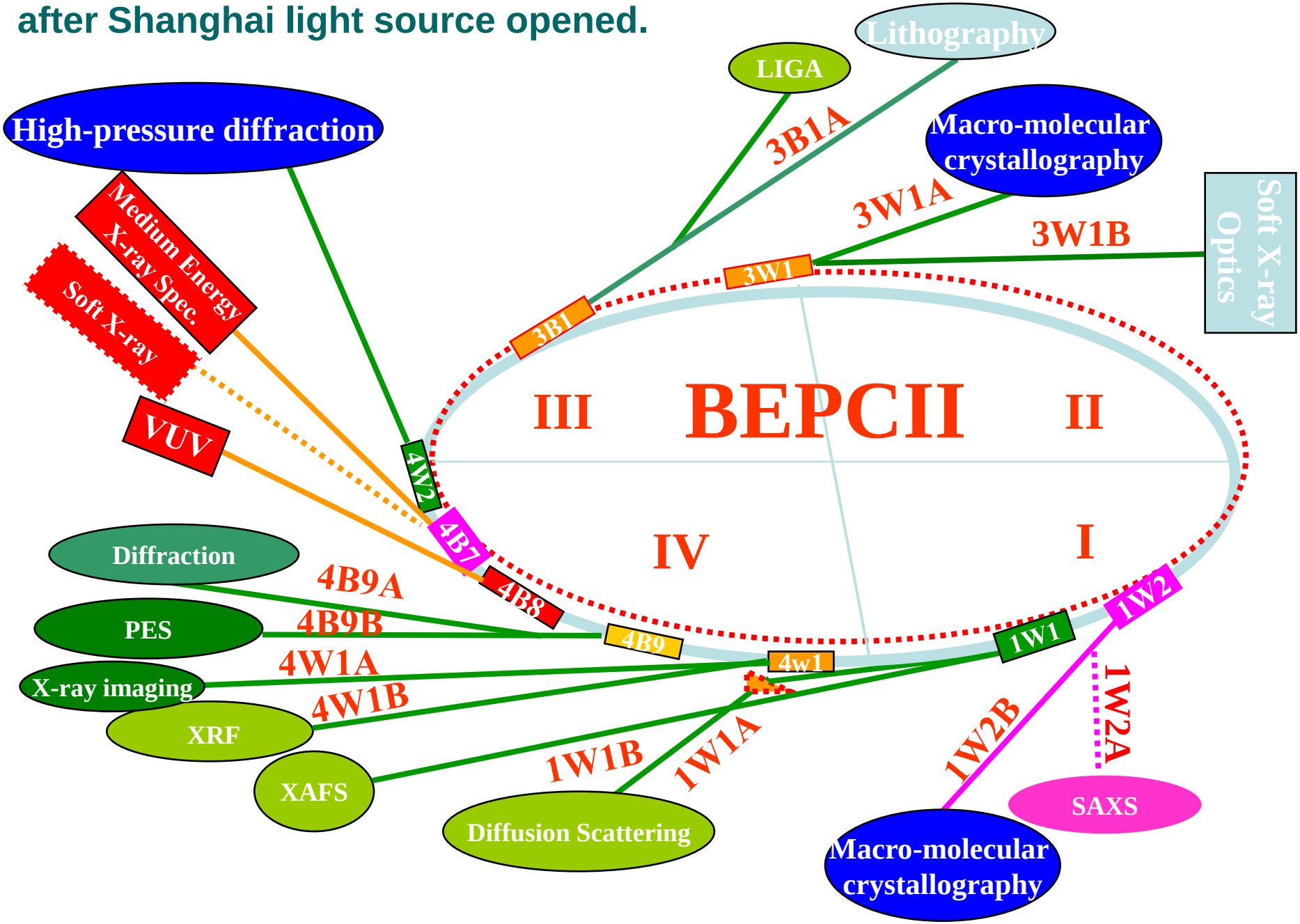
hep-ex/0809.1869，
Published by World Scientific soon

Physics at BEPCII/BESIII

- Precision measurement of CKM matrix elements
- Precision test of Standard Model
- QCD and hadron production
- Light hadron spectroscopy
- Charmonium physics
- Search for new physics/new particles

Physics Channel	Energy (GeV)	Luminosity (10^{33} cm^{-2}s^{-1})	Events/year
J/ψ	3.097	0.6	1.0×10^{10}
τ	3.67	1.0	1.2×10^{7}
ψ'	3.686	1.0	3.0×10^{9}
D*	3.77	1.0	2.5×10^{7}
Ds	4.03	0.6	1.0×10^{6}
Ds	4.14	0.6	2.0×10^{6}

BSRF: major SR center in north China after Shanghai light source opened.



Beijing Synchrotron Radiation Facility

- **Upgrading of BSRF finished**
  - **To adapt the high flux of BEPCII SR**
  - **Front areas and beamlines: cooling and protection under higher heat load**
  - **Parasitic mode: for more bending magnet beam lines + some wigglers.**
  - **New experiment hall and new beamlines.**
  - **More shielding: higher beam energy and current mean higher radiation dose;**
- **SR performance reached the design goals: maximum current and life time.**
- **Dedicated SR commissioning with E=2.5GeV, I=250mA and top-off injection (eff.>95%)during**
  - **Feb. 25 2008 – March 28 2008**
  - **Dec. 25 2008 – Jan. 20 2009**

BEPCII: Running plan of 2009

- **Jan.: SR running until 20 Jan.**

  Shutdown: remove profile monitors at e+ ring, install movable mask at e- ring
- **Feb. machine studies at 1.84GeV, compared with the performance of 2008,**
- **From March: data taking at 1.84GeV 90-100M?**
- **Middle of April - June data taking at 1.55GeV**
- **July- August shutdown: install longitudinal feedback kicker**
- **Sept. - high current, tuning longitudinal feedback at 1.84GeV;**

  Goal: high current high luminosity
- **SR running:**
  - **dedicated running: Dec. 2009**
  - **more parasitic running**

Status of Daya Bay reactor neutrino experiment

Layout

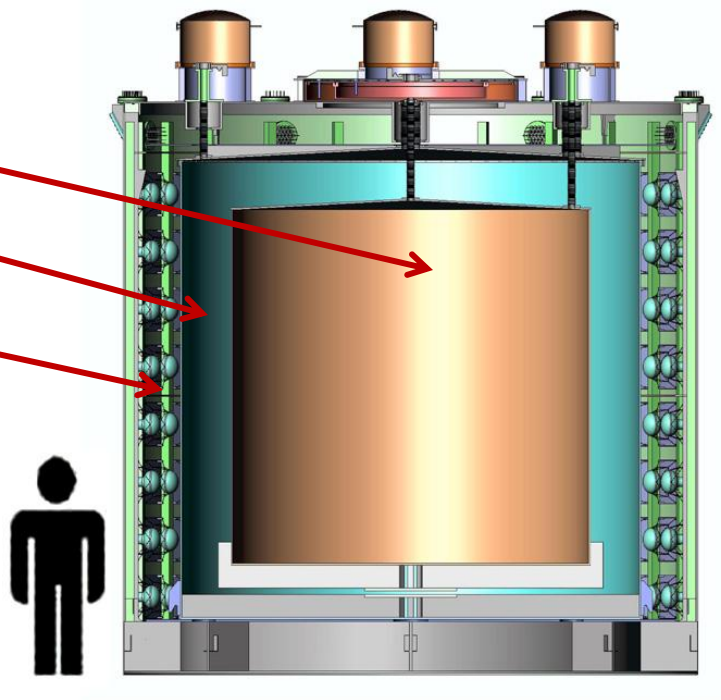
- Near-far cancellation
- Two near sites and one far sites connected by ~3000 tunnel
- Event rate：
  ~1200/day near
  ~350/day far
- backgrounds：
  B/S ~0.4%

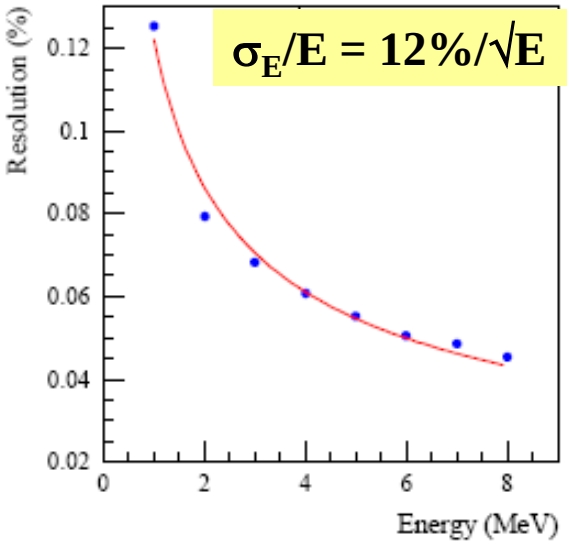
Central Detector modules

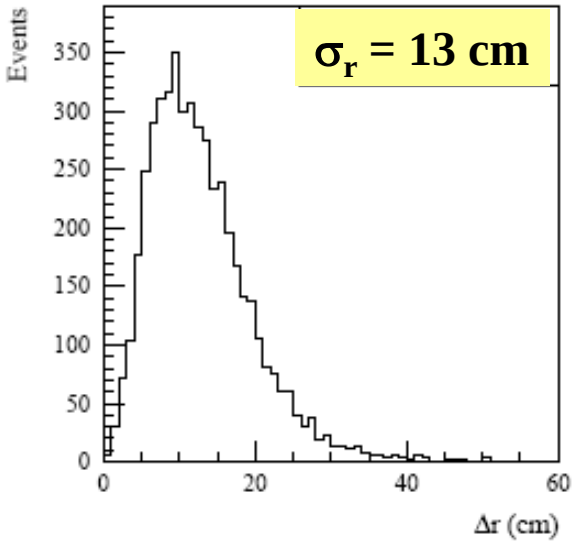
- Three zones modular structure:
  - I. target: Gd-loaded scintillator
  - II. γ-catcher: normal scintillator
  - III. Buffer shielding: oil
- 192 8”PMT/module
- Reflector at top and bottom to ease engineering difficulties and save cost:

  Photocathode coverage

  5.6 % ➔ 12%(with reflector)





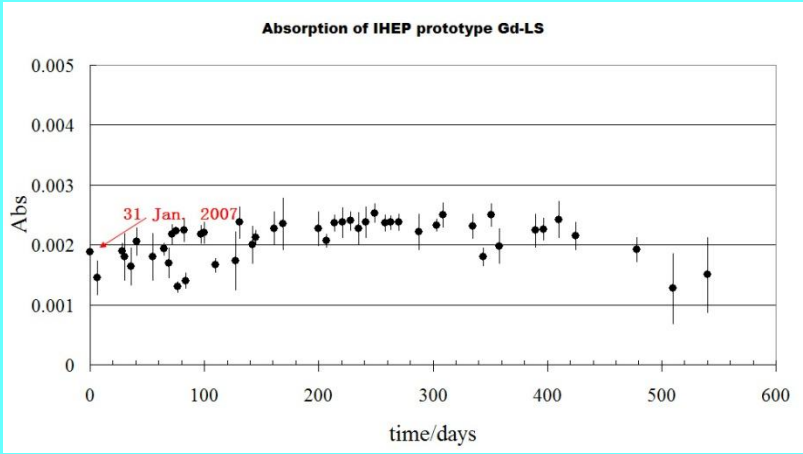


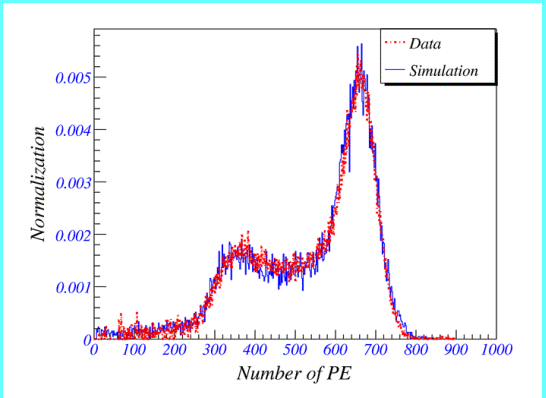
Target: 20 t, 1.6m
γ-catcher: 20t, 45cm
Buffer: 40t, 45cm

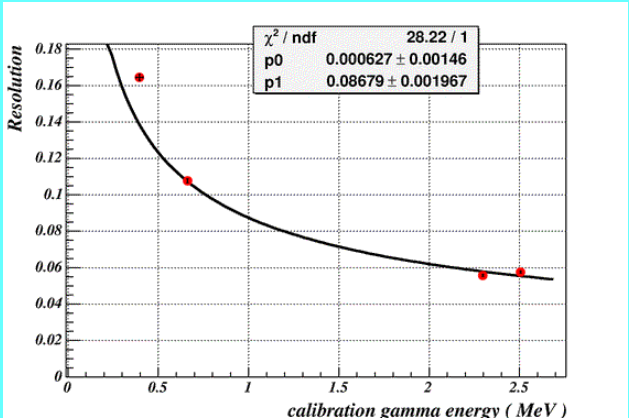
Total weight: ~100 t

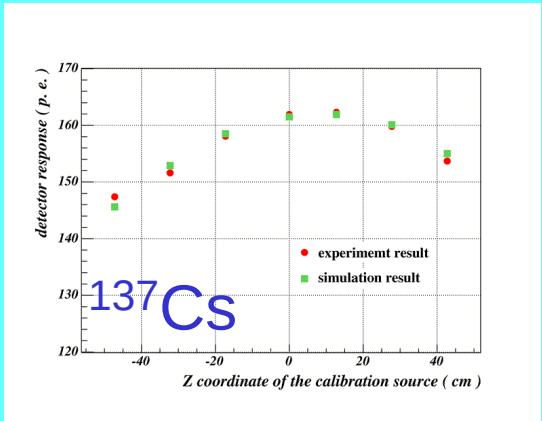
Prototype

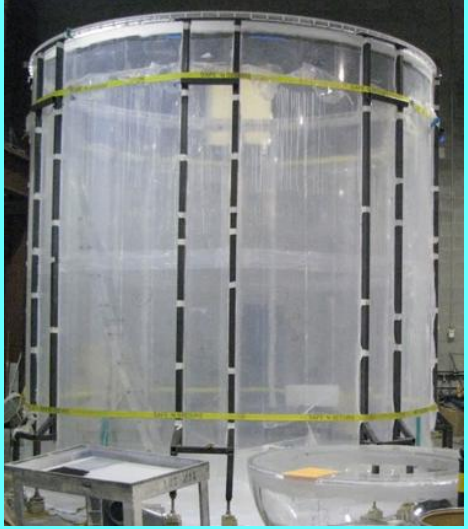
- **Motivation**
  - Validate the design principle
  - Test technical details of tanks
  - Test Gd-LS
  - Test calibration and Pu-C source
- **Achievements**
  - Energy response & MC Comparison
  - Reconstruction algorithm
  - Neutron response & Pu-C source
  - Effects of reflectors
  - Gd-LS

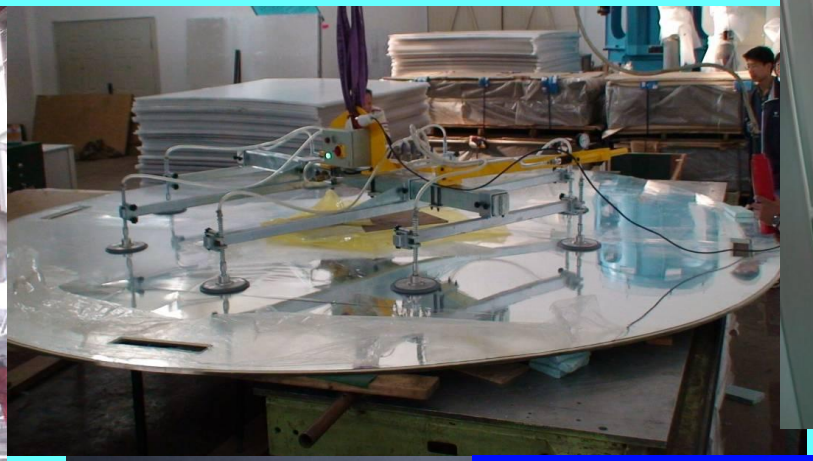


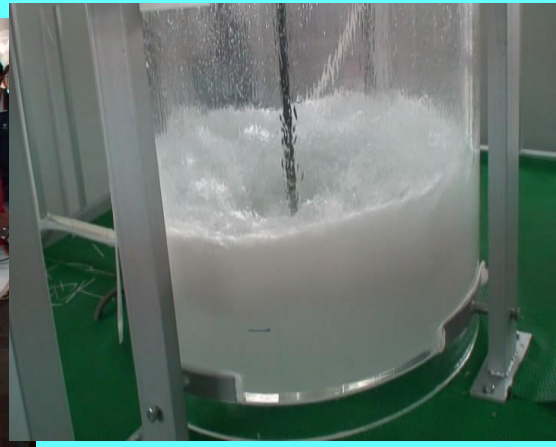


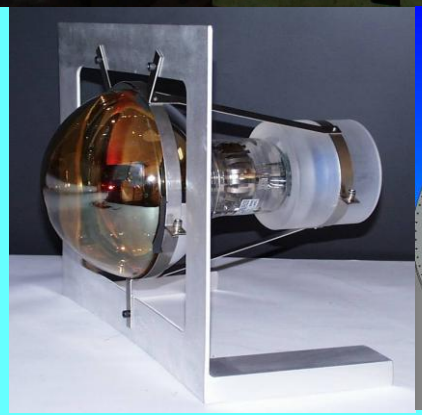


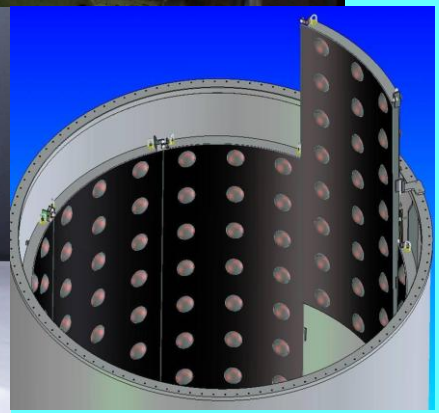


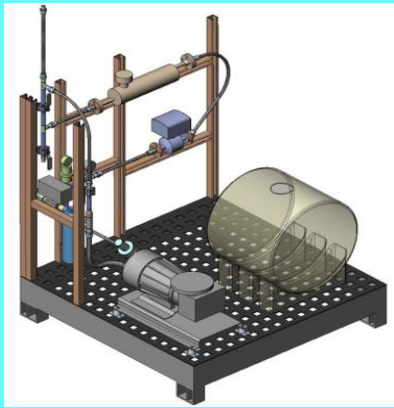






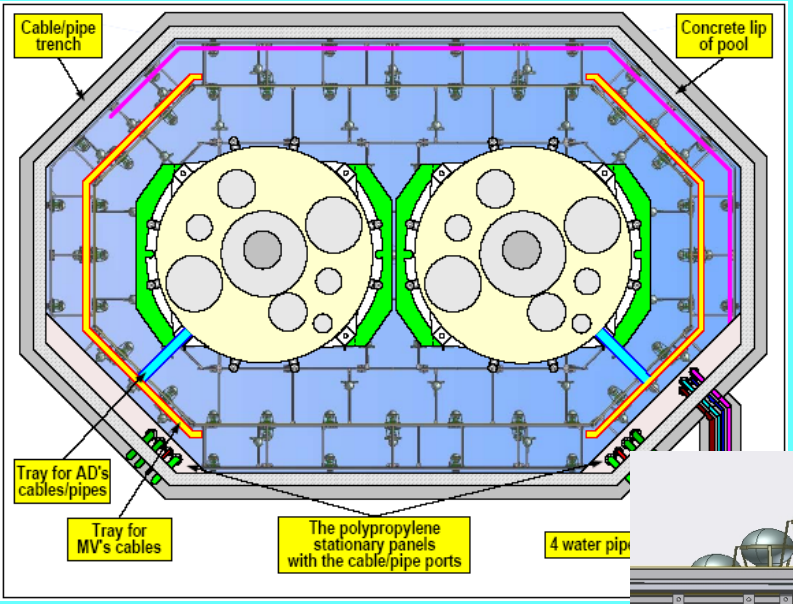


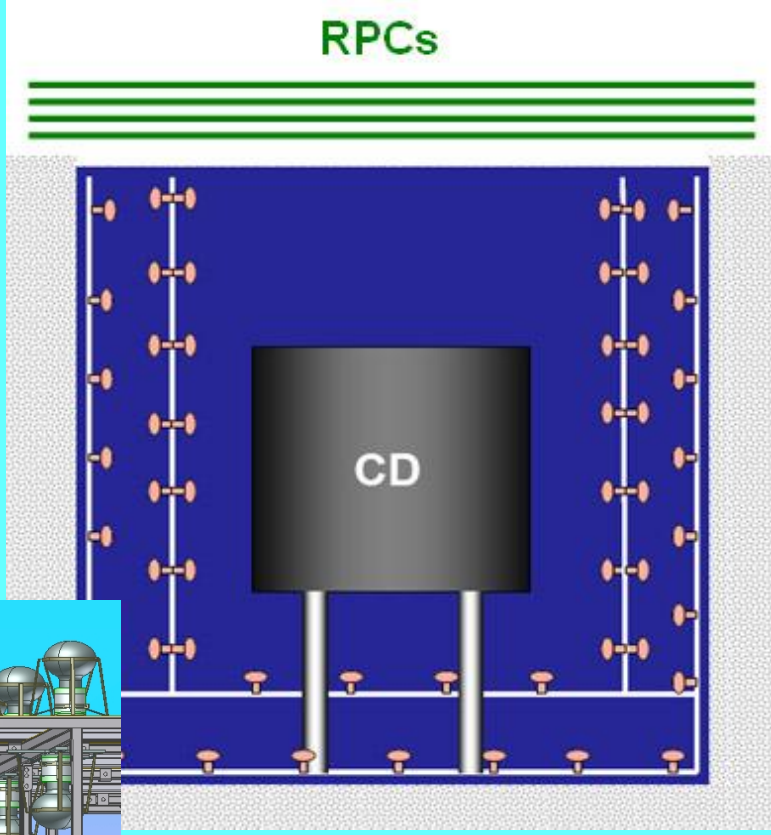


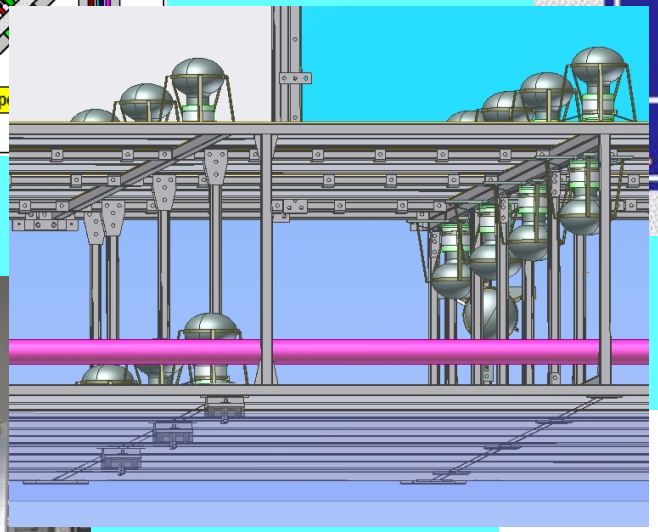


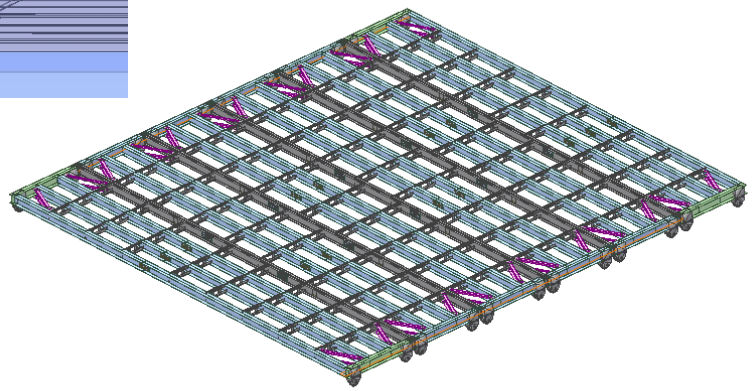
First stainless steel vessel finished

Veto detector

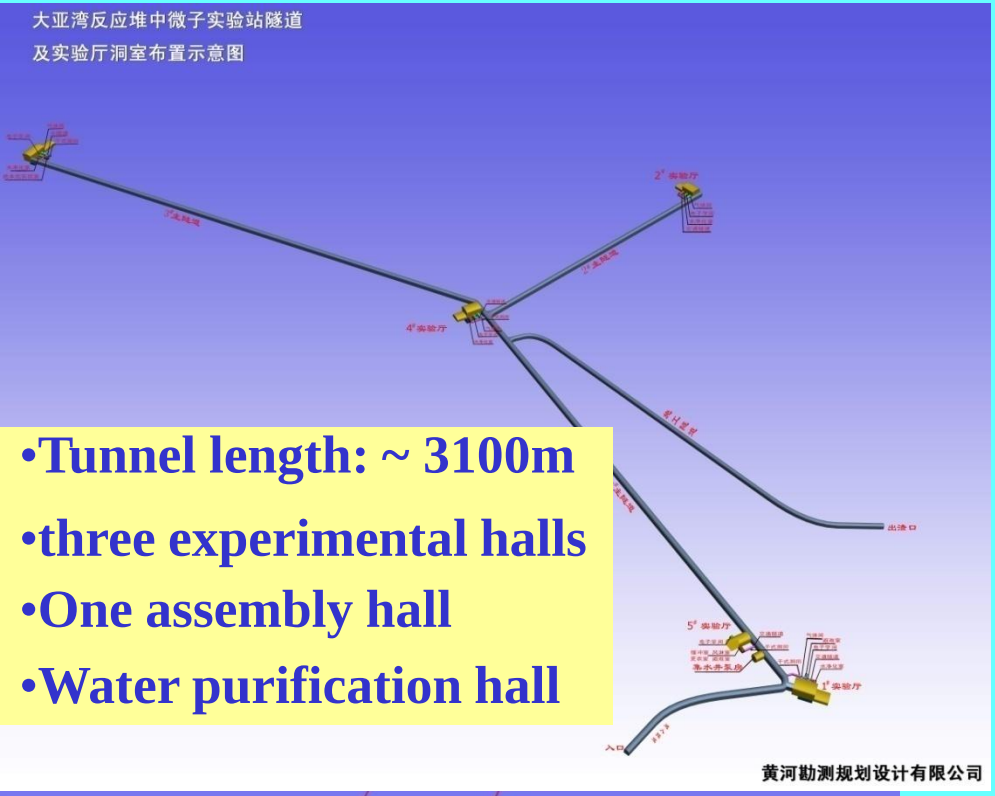




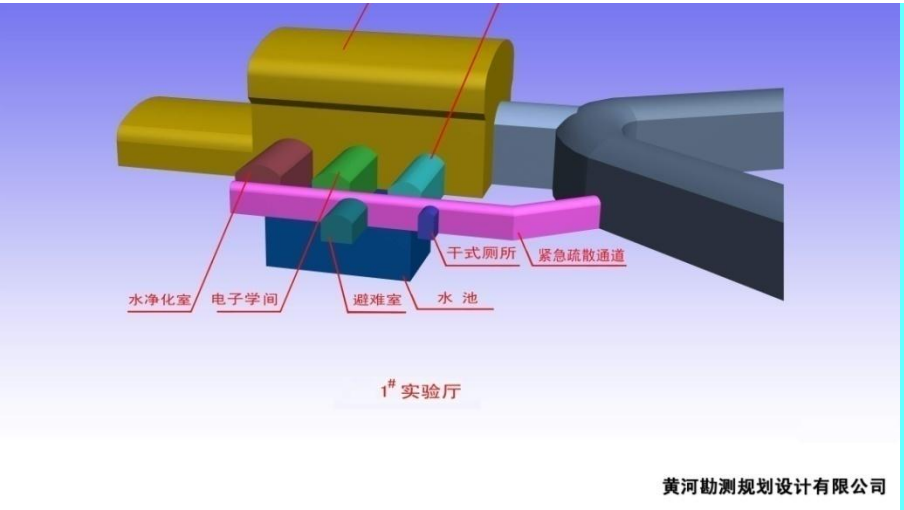




Civil construction



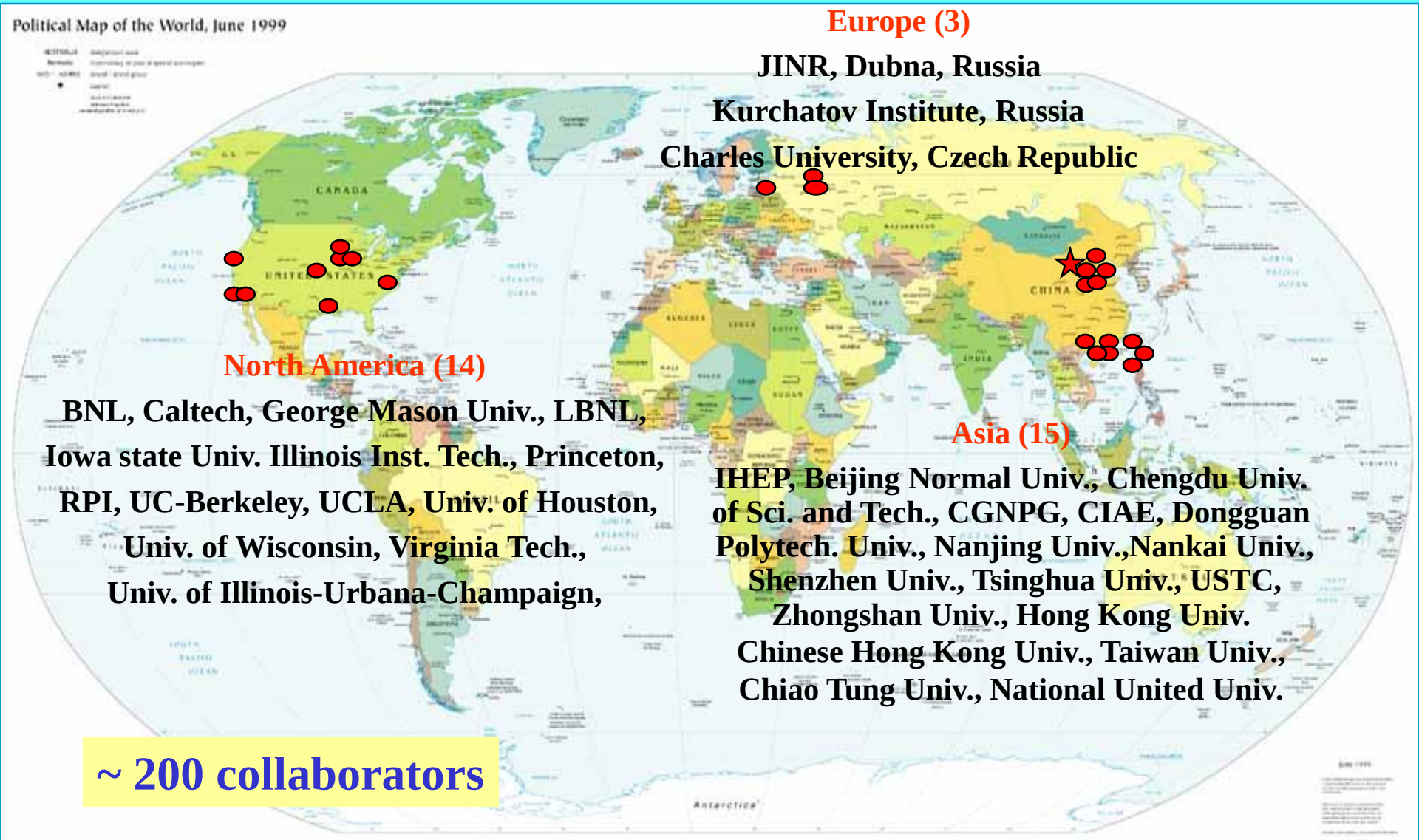
- Tunnel length: ~ 3100m
- three experimental halls
- One assembly hall
- Water purification hall



Civil construction

Tunnel finished 1/3
First experimental hall to be finished this July
All civil to be finished by next spring

Daya Bay collaboration



Europe (3)

JINR, Dubna, Russia

Kurchatov Institute, Russia

Charles University, Czech Republic

North America (14)

BNL, Caltech, George Mason Univ., LBNL, Iowa state Univ. Illinois Inst. Tech., Princeton, RPI, UC-Berkeley, UCLA, Univ. of Houston, Univ. of Wisconsin, Virginia Tech., Univ. of Illinois-Urbana-Champaign,

Asia (15)

IHEP, Beijing Normal Univ., Chengdu Univ. of Sci. and Tech., CGNPG, CIAE, Dongguan Polytech. Univ., Nanjing Univ.,Nankai Univ., Shenzhen Univ., Tsinghua Univ., USTC, Zhongshan Univ., Hong Kong Univ. Chinese Hong Kong Univ., Taiwan Univ., Chiao Tung Univ., National United Univ.

~ 200 collaborators

Summary

- **The construction of BEPCII was finished June 2008, on schedule and within budget.**
- **The first hadron events: 19 July 2008.**
- **The commissioning of BEPCII goes smoothly, the luminosity reached 1.85 $\times 10^{32} cm^{-2} s^{-1}$**
- **BESIII performances reached the design specifications, and consist with the MC simulation: good understanding**
- **High statistical and high resolution data samples at BESIII will come soon, Interesting physics results expected.**
- **The construction of Daya Bay exp. is going well, data taking will start at the end of 2010, and reach sensitivity of 0.01 (90%c.l.) within 3 years**