Prospect of Particle Physics in China

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Outline

- Introduction
- BEPC and its results
- BEPCII
- Non-Accelerator Physics Experiments
- Light source and spallation neutron source
- Medium and long term plan of particle physics in China.

Particle Physics in China

- Chinese Nuclear physics and Particle physics researches have long tradition:
  - Zhongyao Zhao : discovery of Positron
  - Ganchang Wang: neutrino search
  - ……
- Institute of Modern Physics established at Chinese Academy of Sciences 1950.
- JINR Dubna:
  - Jointed 1956
  - Discovery of anti-Σ by the group led by Ganchang Wang
  - Withdraw 1965
- Chinese Government decided to use the money to build the Chinese HEP center

Particle Physics in China

- Independent Institute for High Energy Physics: Feb. 1973
- Open door after cultural revolution: sent physicists to Mark-J @ DESY since Jan. 1978
- Particle physicists worked at DESY,CERN and US
- China – US HEP agreement
- Beijing Electron Positron Collider (BEPC): milestone. constructed 1984-1988
- Provide big scientific platforms:
  - Synchrotron Radiation Light Sources:
    - Beijing synchrotron radiation facility (2.5GeV)
    - Hefei national synchrotron radiation light source (800MeV)
    - Shanghai Light source(3.5GeV, under construction)
  - Chinese Spallation Neutron Source

Institute of High Energy Physics

Comprehensive and largest fundamental research center in China

Major research fields :

- Particle physics: Charm physics @ BEPC, LHC exp., cosmic ray, particle astrophysics, ν physics …
- Accelerator technology and applications
- Synchrotron radiation technologies and applications

1030 employees, ~ 670 physicists and engineers,

400 PhD Students and postdoctors

Particle physics experiment group

- **Univ. of Science and Technology of China, Hefei**
- **Peking Univ.**
- **Tsinghua Univ.**
- **Shandong Univ.**
- **Huazhong Normal Univ.**
- **Chinese Inst. of Atomic Energy**
- **Nanjing Univ.**
- **……**

Dozens of PP and NP theory groups in institutes and universities.

Particle Physics Experiments in China

- **BEPC & BEPCII: BESII/BESIII**
- **Non-accelerator experiments**
  - **Yangbajing cosmic-ray observatory (Tibet)**
    - **China-Japan Air Shower Array**
    - **China-Italy Argo RPC carpet project**
  - **L3cosmic (finished)**
  - **AMS**
  - **Gamma Ray Burst Detector (flown 2001)**
  - **ChangEr Moon project: X ray spectrometer**
  - **Hard X-ray modulated telescope**
  - **Daya Bay reactor neutrino experiment**

Particle Physics Experiments in China

- **International collaborations:**
  - Mark-J (IHEP, USTC. finished)
  - LEP: L3, ALEPH (IHEP, USTC. finished)
  - Tristan: Amy (finished)
  - HERA: HERAb
  - Tevatron: D0 (USTC, IHEP)
  - LHC : ATLAS, CMS, LHCb, Alice
  - AMS (IHEP, IEE, Southeast Univ…)
  - KEKB: BELLE (IHEP,Peking, USTC)
  - Kamland (IHEP), SuperK(Tsinghua).
  - RHIC: Star, Phenoix
  - ILC R&D
  - …

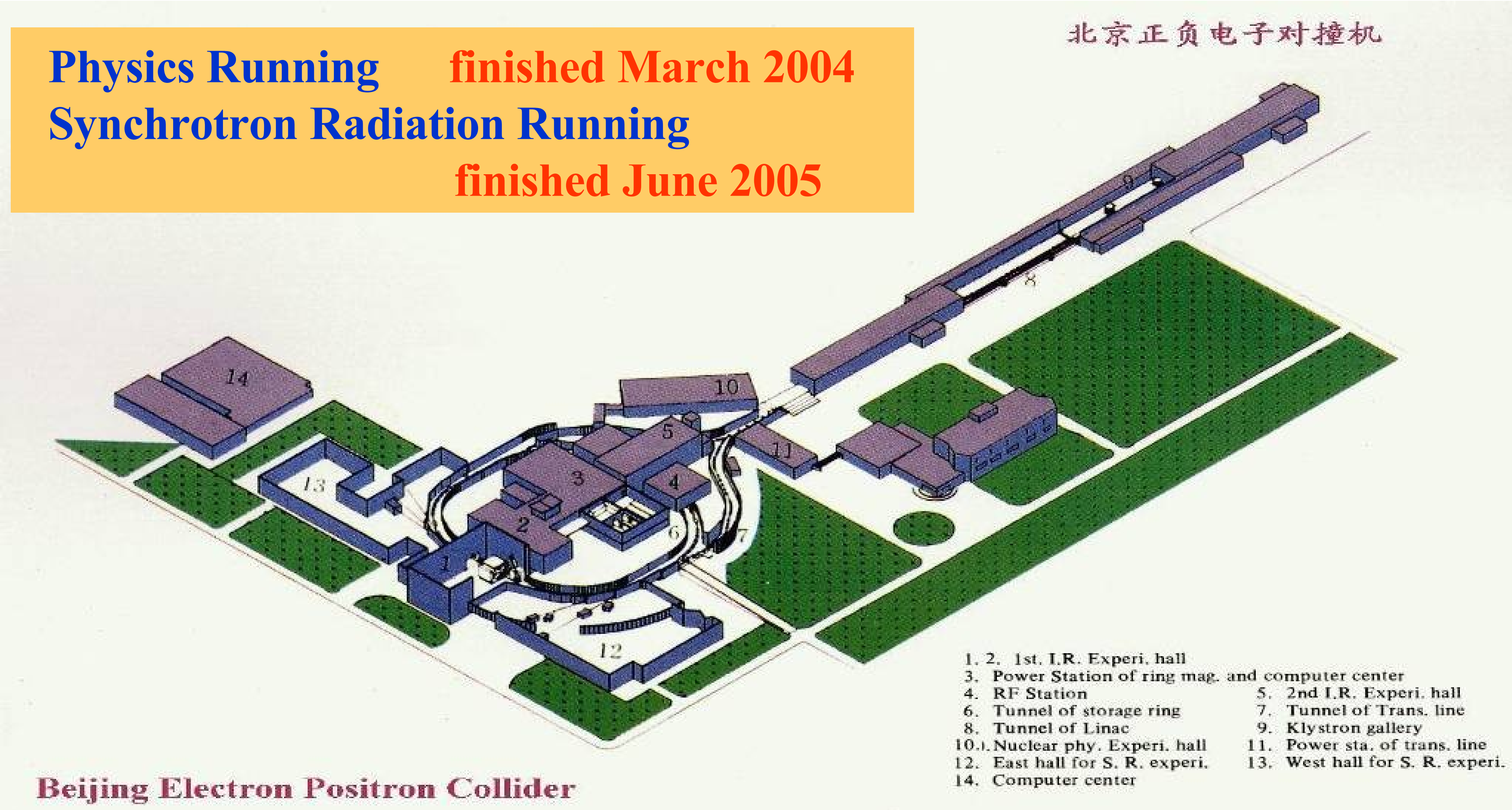
Bird's Eye View of BEPC

BEPC constructed in 1984 –1988 with beam energy: 1 – 2.8 GeV

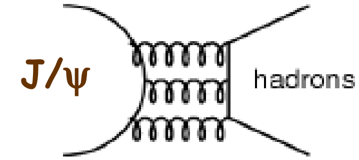
- Physics Run ： Luminosity $10^{31}cm^{-2}s^{-1}$ @ 1.89GeV, 5 month/year
- Synchrotron Radiation Run ： 140mA @ 2.2 GeV, 3 month/year

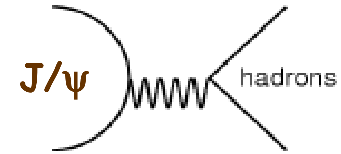
Physics Running finished March 2004

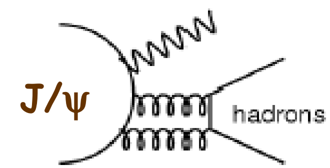
Synchrotron Radiation Running finished June 2005



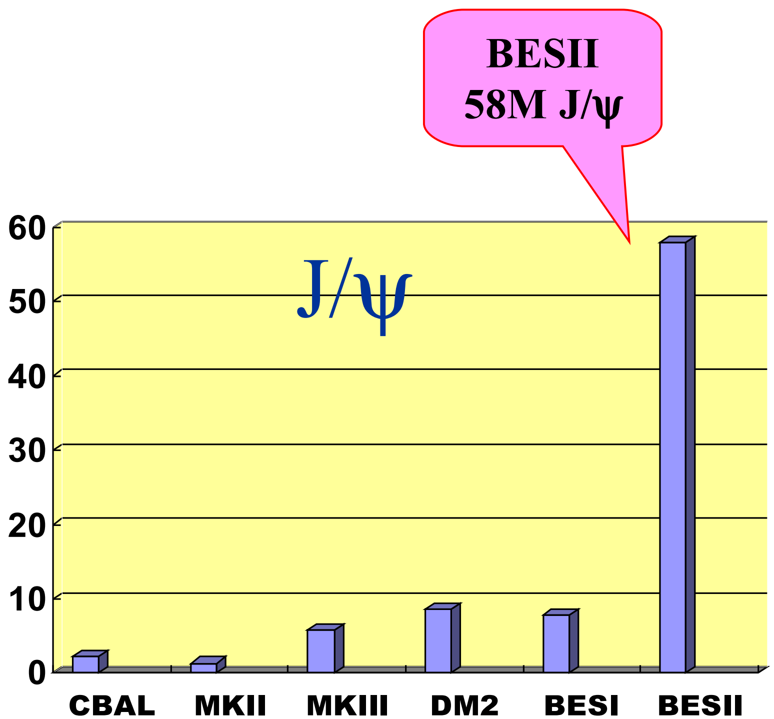
J/ψ decays: Light hadron spectroscopy search for new particles







World J/ψ Samples (×10⁶)



- **Gluon rich**
- **Very high production cross section**
- **Higher BR to hadrons than that of ψ' ("12% rule").**
- **Larger phase space to 1-3 GeV hadrons than that of Y**
- **Clean background environment compared with hadron collision experiments, e.g., "J^P, I" filter**

Main Physics Results from BES

- **Precision measurement of τ mass: world average value changed by 3σ, accuracy improved by factor of 10, and approved τ lepton universality.**
- **R Measurement at 2-5GeV: $\Delta R/R$ 15-20% →6.6%**
  - **Higgs mass prediction from SM**
  - **g-2 experiment**
  - **$\alpha(M_z^2)^{-1}$: 128.890±0.090 → 128.936 ± 0.046**
- **Systematic study of $\psi(2S)$ and J/ψ decays.**
- **Resonance X(1835) in $J/\psi \to \gamma\eta'\pi^+\pi^-$ with mass and width are consistent with that of the S-wave resonance X(1860) indicated by the pp mass threshold enhancement.**
- **> 400 results from BES quoted by PDG 2006.**

Impact of BES's New R Values on the SM Fit for α (M_z^2) and Higgs mass

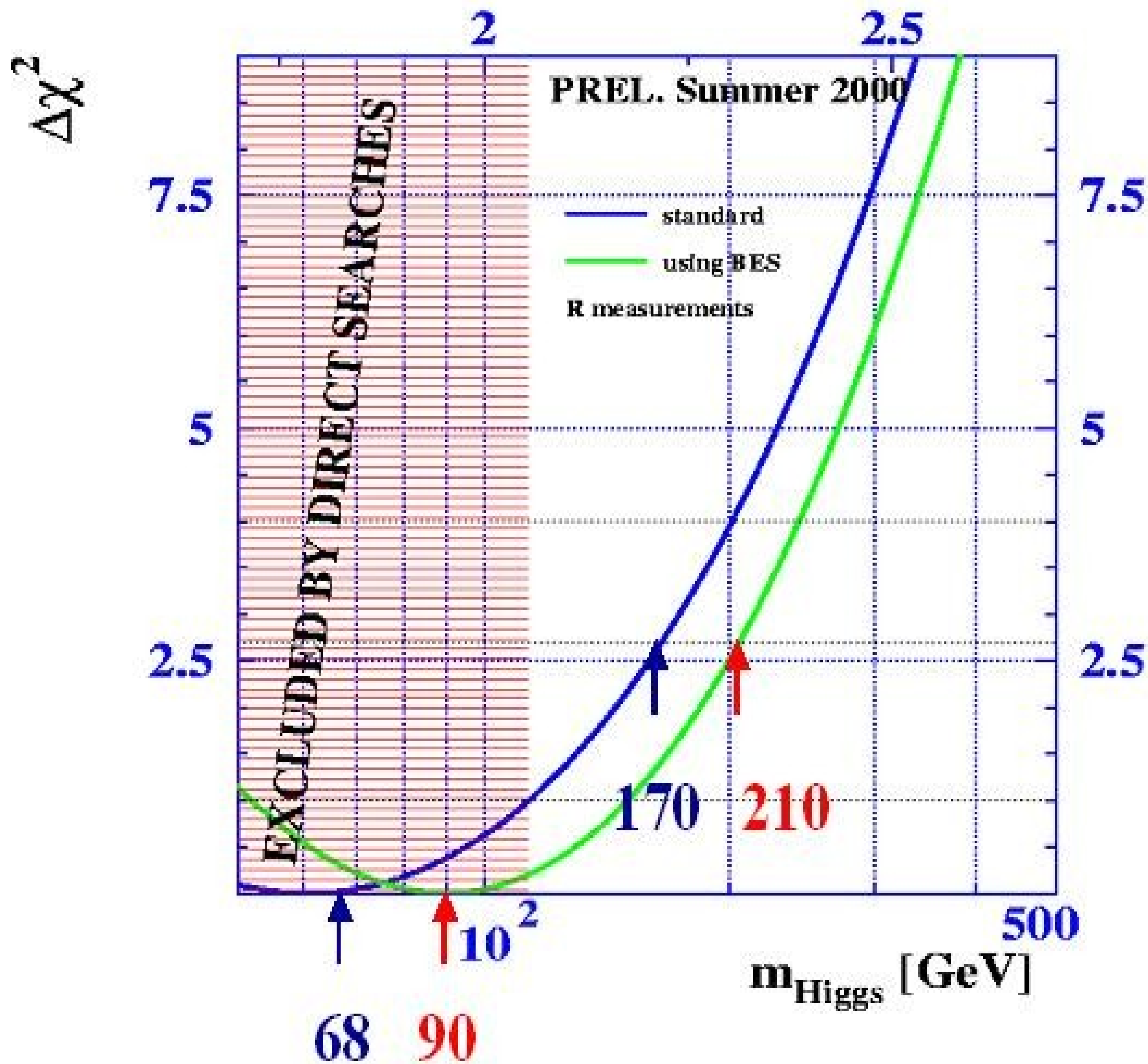
1995 before BES R data

$$\alpha(M_Z^2)^{-1} = 128.890 \pm 0.090$$

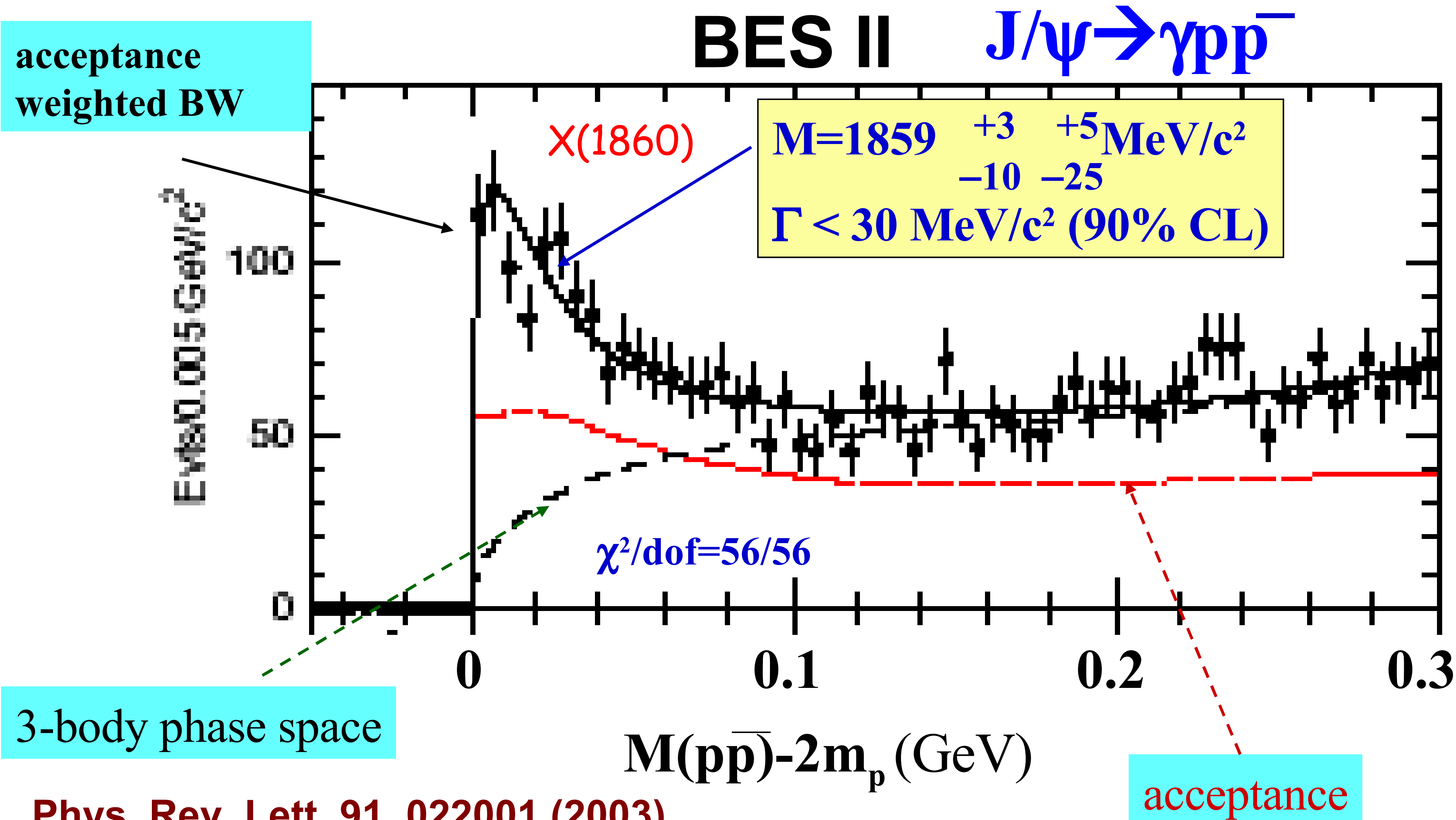
2001 with BES R data

$$\alpha(M_Z^2)^{-1} = 128.936 \pm 0.046$$

g — 2 experiment



Observation of an anomalous enhancement near the threshold of $p\bar{p}$ mass spectrum

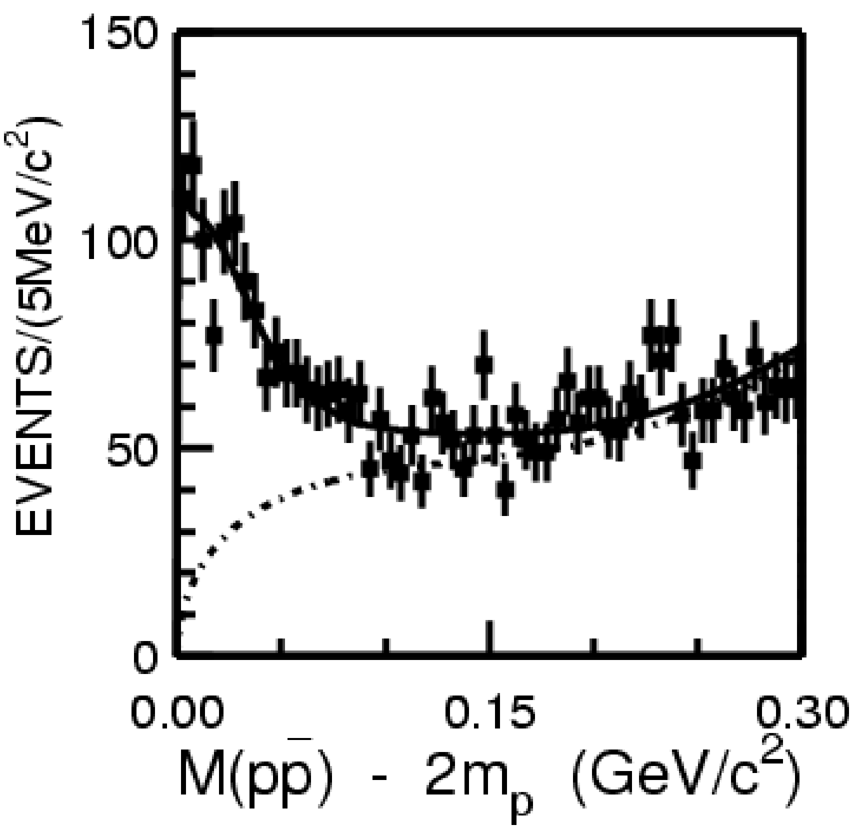


Phys. Rev. Lett. 91, 022001 (2003)

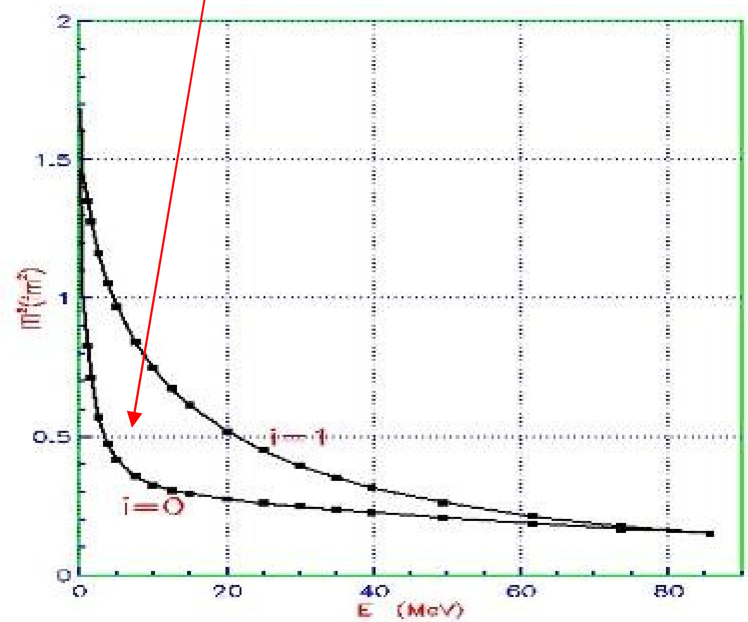
Fit to $J/\psi \rightarrow \gamma p\bar{p}$ including FSI

$M = 1830.6 \pm 6.7$ MeV

$\Gamma = 0 \pm 93$ MeV



Include FSI curve from A.Sirbirtsev et al.(hep-ph/ 0411386) in the fit (I=0)



X(1860) has large BR to $p\bar{p}$

- **BES measured:**

$$BR(J/\psi \to \gamma X(1860)) \bullet BR(X(1860) \to p\bar{p}) \sim 7\times10^{-5}$$

- **For a 0^{-+} meson:**

$$BR(J/\psi \to \gamma X(1860)) \sim 0.5-2\times10^{-3}$$

- **So we would have:**

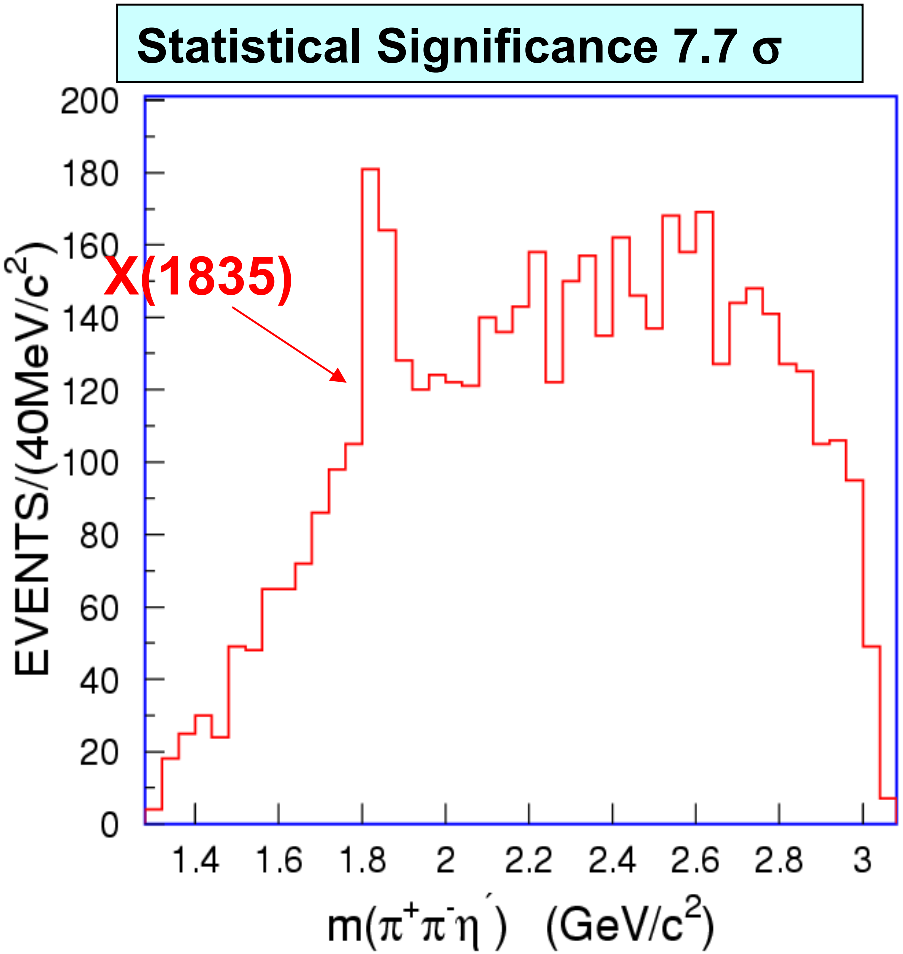
$$BR(X(1860) \to p\bar{p}) \sim 4-14\%$$

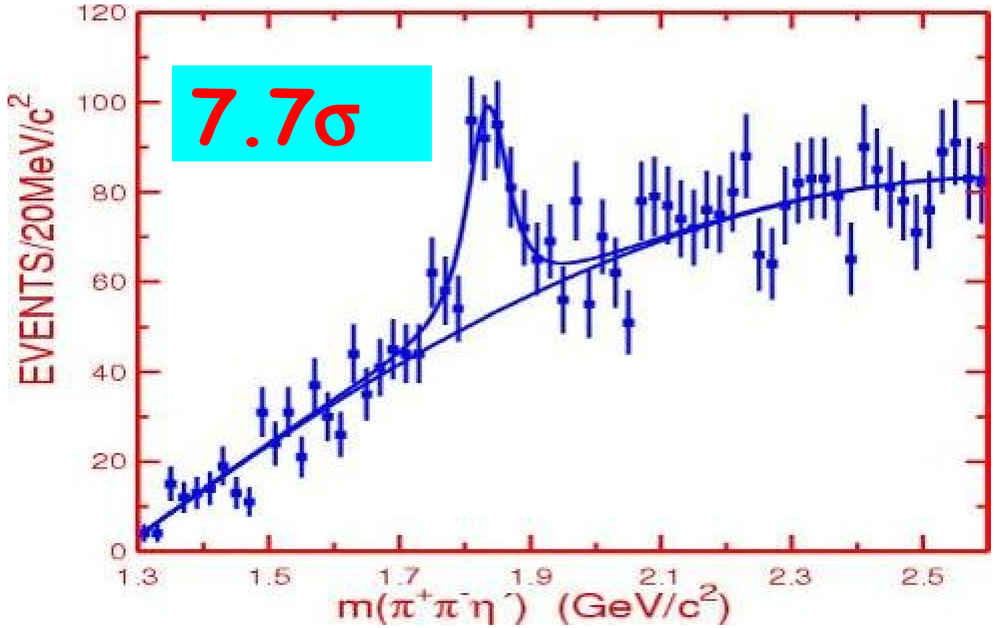
(This BR to $p\bar{p}$ might be the largest among all PDG particles)

Considering that decaying into $p\bar{p}$ is only from the tail of X(1860) and the phase space is very small, *such a BR indicates X(1860) has large coupling to $p\bar{p}$!*

BES: X(1835) in $J/\psi \to \gamma\eta'\pi^+\pi^-$

PRL 95 (2005) 262001





$N_{obs} = 264 \pm 54$

$M = 1833.7 \pm 6.1 \pm 2.7\ \mathrm{MeV/c^2}$

$\Gamma = 67.7 \pm 20.3 \pm 7.7\ \mathrm{MeV/c^2}$

$B(J/\psi \to \gamma X)B(X \to \pi^+\pi^-\eta') = (2.2 \pm 0.4 \pm 0.4)\times 10^{-4}$

X(1835) could be the same structure as ppbar mass threshold enhancement.

Observation of non-DDbar decays of ψ(3770)

- ψ(3770) is believed to be a mixture of 1D and 2S states of cc-bar systemIt is thought to decay almost entirely to pure DD-bar
- From a measurement of DD-bar cross section and R value, BESII found for the first time a significant fraction of non-DD-bar Br.

$$BF(\psi(3770) \to D^0\overline{D^0}) = (48.9 \pm 1.2 \pm 3.8)\%$$
$$BF(\psi(3770) \to D^+D^-) = (35.0 \pm 1.1 \pm 3.3)\%$$
$$BF(\psi(3770) \to D\overline{D}) = (83.9 \pm 1.6 \pm 5.7)\%$$
$$BF(\psi(3770) \to non-D\overline{D}) = (16.1 \pm 1.6 \pm 5.7)\%$$

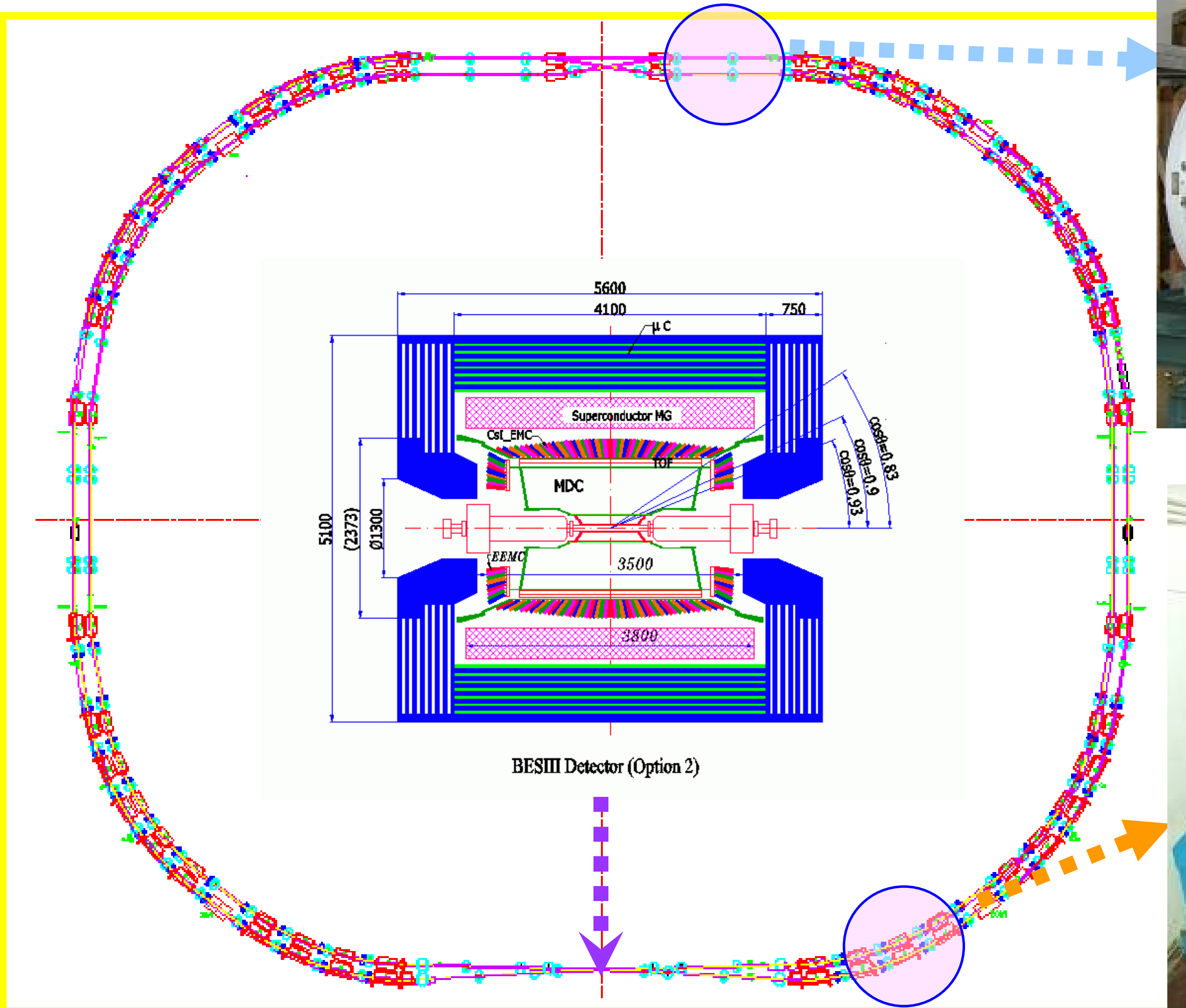
Hep-ex/0605105

- BESII also found for the first an exclusive channel of non-DDbar decays, which was confirmed later by CLEO-c:

$$B[\psi(3770) \to J/\psi\pi^+\pi^-) = (0.34 \pm 0.14 \pm 0.09)\%$$
$$\Gamma[\psi(3770) \to J/\psi\pi^+\pi^-) = (80 \pm 33 \pm 23)\ \text{keV}$$

PLB 605 (2005) 63

BEPCII

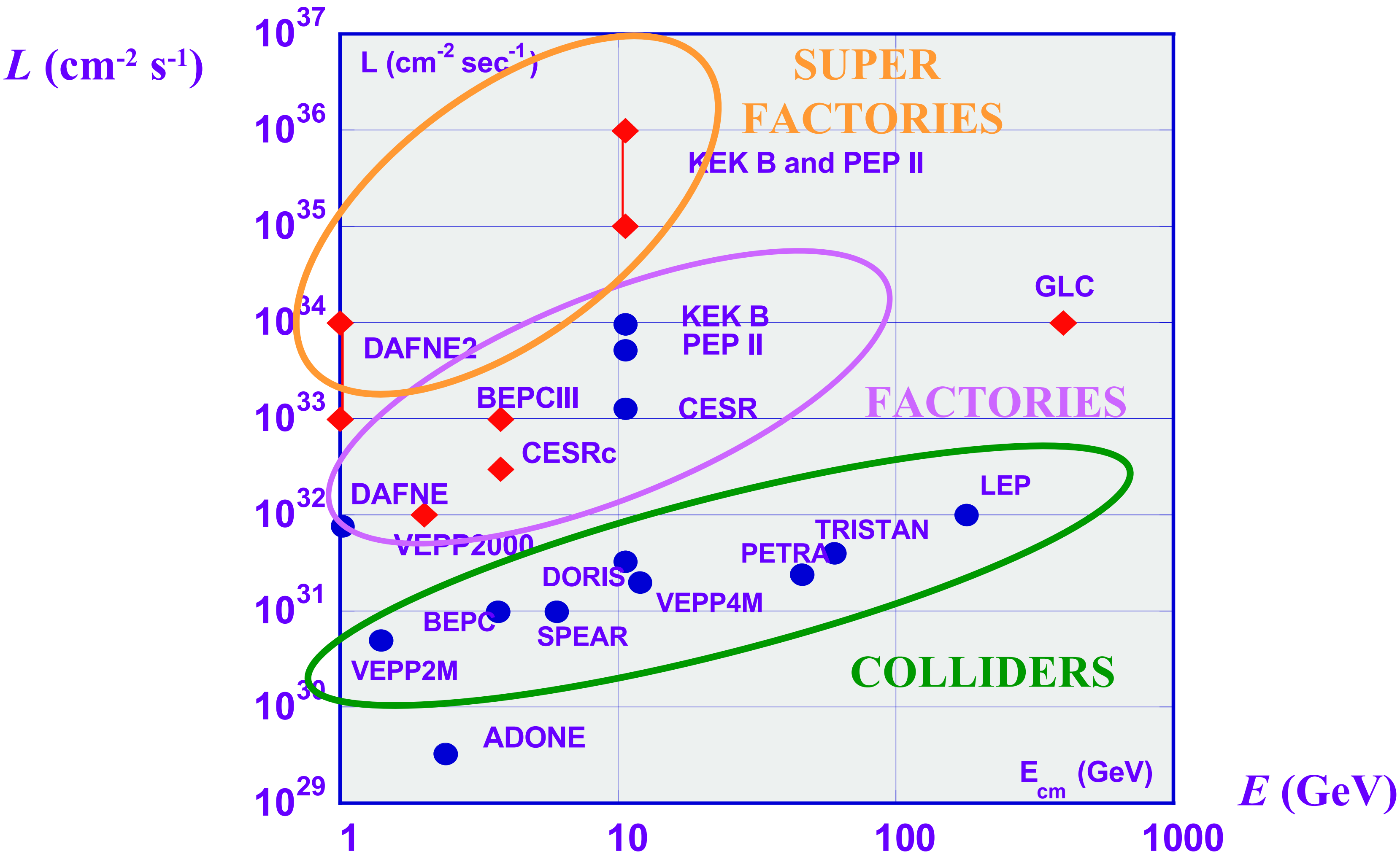


Build new ring inside existing ring . Two half new rings and two half old rings cross at two IR's, forming a double ring collider.

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 up to 1.89GeV
- SR run performance upgrade ： 250mA @ 2.5 GeV. Hard X-ray flux ti be increased by one order of magnitude.
- Major detector upgrade ： BES III.

e^+-e^- Colliders: Past, Present and Future



Physics at BEPCII/BESIII

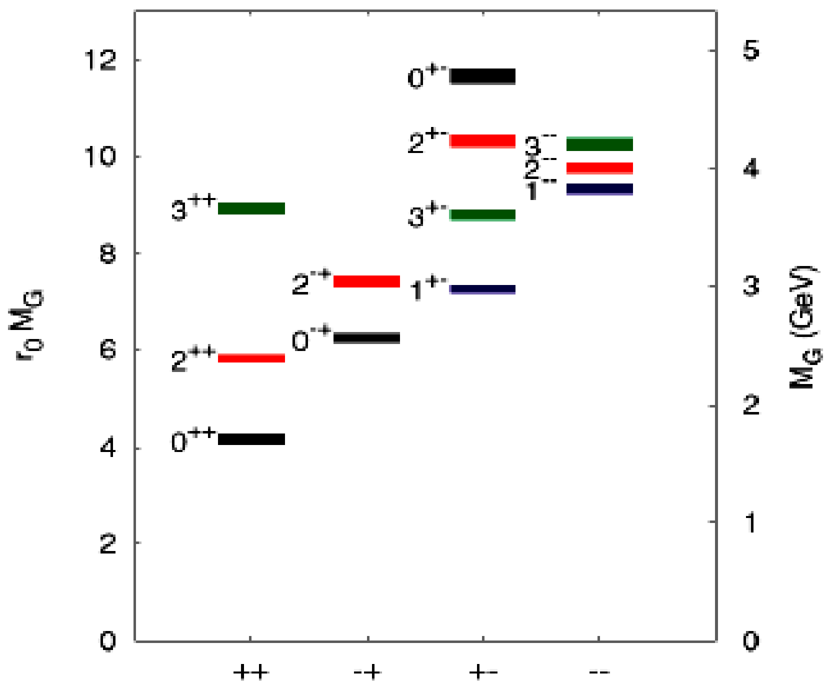
- Precision measurement of CKM matrix elements
- Precision test of Standard Model
- QCD and hadron production
- Light hadron spectroscopy
- Charmonium physics
- Search for new physics/new particles

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}

Light hadron spectroscopy

- Baryon spectroscopy
- Charmonium spectroscopy
- Glueball searches
- Search for non-qqbar states

10^{10} J/ψ events + LQCD are probably enough to pin down most of questions in of light hadron spectroscopy



Y. Chen *et al.*
PRD73:014516,2006
(updates Morningstar & Peardon, '99)

0^{++} : 1710 ± 50 ± 80

Also:
1611 ± 30 ± 160 Michael '98
1550 ± 50 ± ? Bali et al. '93

Spectrum of glueballs from LQCD

Precision measurement of CKM

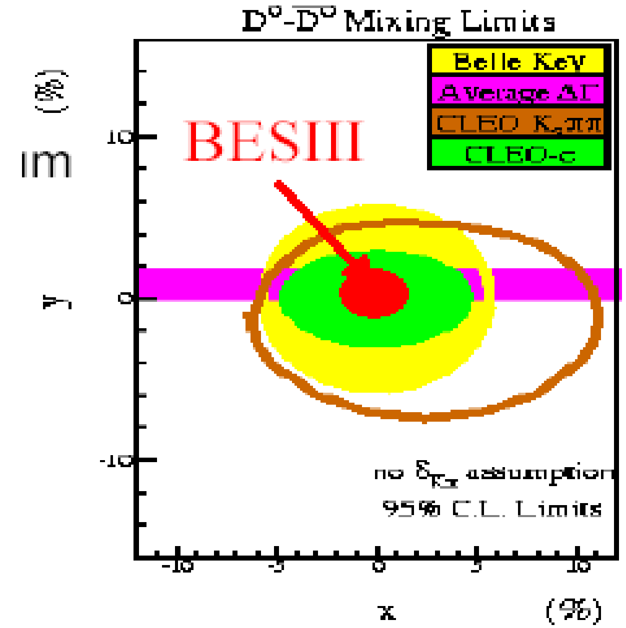
– Branching rations of charm mesons

- V_{cd} /$V_{cs:}$ Leptonic and semi-leptonic decays
- $V_{cb:}$ Hadronic decays
- V_{td}/$V_{ts:}$ f_D and f_{Ds} from Leptonic decays
- $V_{ub:}$ Form factors of semi-leptonic decays
- Unitarity Test of CKM matrix

	Current	BESIII
V_{ub}	25%	5%
V_{cd}	7%	1%
V_{cs}	16%	1%
V_{cb}	5%	3%
V_{td}	36%	5%
V_{ts}	39%	5%

Precision test of SM and Search for new Physics

- **DDbar mixing**
  - **DDbar mixing in SM ~ 10^{-3} - 10^{-10}**
  - **DDbar mixing sensitive to "new physics"**
  - **Our sensitivity : ~ 10^{-4}**
- **Lepton universality**
- **CP violation**
- **Rare decays : FCNC, Lepton no. violation, ...**



$D^0\overline{D}^0$ Mixing		
Reaction	Events Right Sign	Sensitivity of R_M
$\psi(3770) \to (K^-\pi^+)(K^-\pi^+)$	87195	1×10^{-4}
$\psi(3770) \to (K^-e^+\nu)(K^-e^+\nu)$	94351	3.7×10^{-4}
$\psi(3770) \to (K^-e^+\nu)(K^-\mu^+\nu)$	166808	
$\psi(3770) \to (K^-\mu^+\nu)(K^-\mu^+\nu)$	83404	
$D^{*+}D^- \to [\pi_s^+(K^+e^-\overline{\nu})(K^+\pi^-\pi^-)]$	76000	4.7×10^{-5}
$D^{*+}D^- \to [\pi_s^+(K^+\mu^-\overline{\nu})(K^+\pi^-\pi^-)]$	60000	
$D^{*+}D^- \to [\pi_s^+(K^+e^-\overline{\nu})(\text{other } D^- \text{ tag})]$	60000	
$D^{*+}D^- \to [\pi_s^+(K^+\mu^-\overline{\nu})(\text{other } D^- \text{ tag})]$	60000	

Progress of BEPCII

Stage #1: Linac upgrade reached designed goal

Linac Tunnel

RF Gallery

Linac performance reached design goals and stable

	Design	Measured	BEPC
Energy (e+ / e-) (GeV)	1.89	1.89	1.30-1.55
Current (e+) (mA)	37	61	~ 5
Current (e-) (mA)	500	> 500	~300
Emittance （ e+ ） (1 σ, mm-mrad ）	0.40 (37 mA)	0.39~0.41 (40~46 mA)	----
Emittance (e-) (1 σ, mm-mrad ）	0.10 (500 mA)	0.09~0.11 (600 mA)	----
Pulse Repe. Rate （ Hz ）	50	50	12.5
Energy Spread (e-) （ % ） **	± 0.50 (500 mA)	± 0.44 (600 mA)	± 0.80
Energy Spread (e+) （ % ） **	± 0.50 (37 mA)	± 0.50 (≥37 mA)	± 0.80

Stage #2: Storage Ring upgrade and phase 1 commissioning

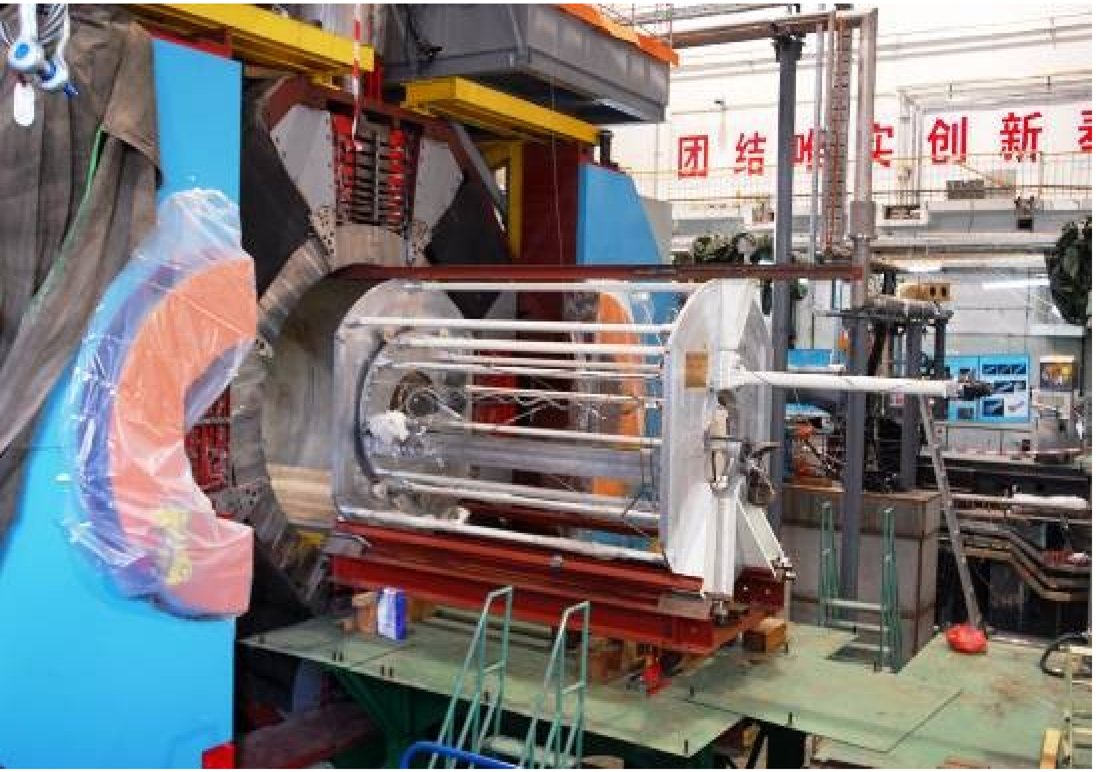
1. Jan.- June 2005 SR running √
2. Production of Double ring components Finished√
3. Remove old ring√, install Double ring√
4. BESIII construction √
5. Field mapping of SC quads & detector magnets √
6. Phase 1 commissioning √

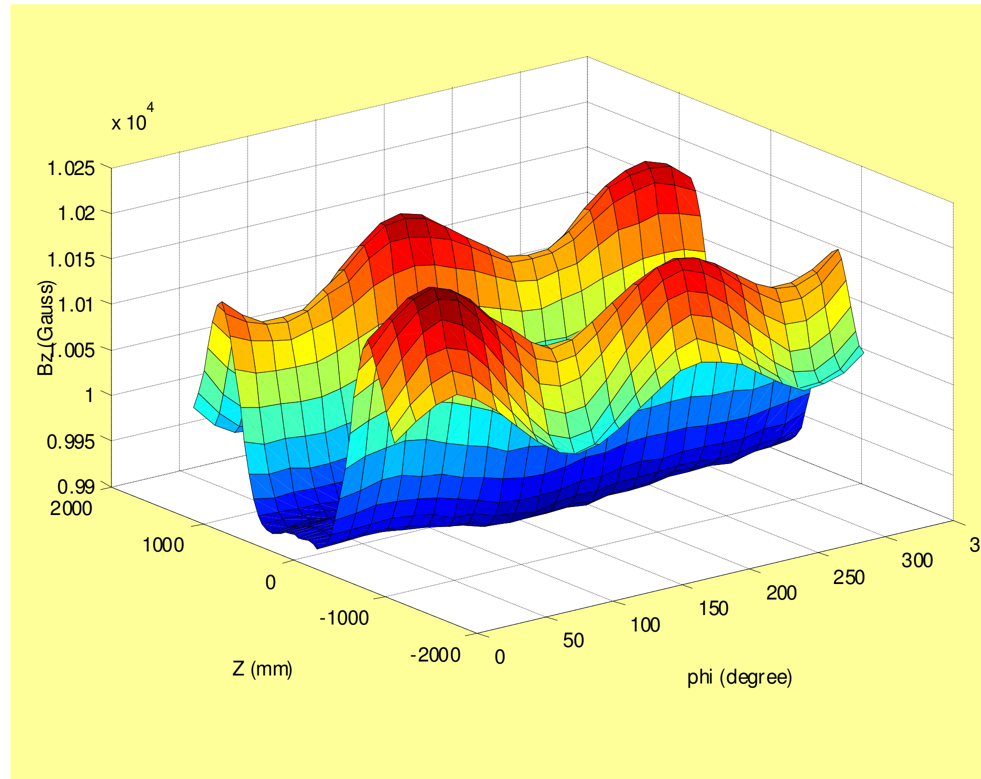
Storage Ring installation finished

Phase 1 commissioning of Storage Ring (conventional magnets @ IR) reached goal

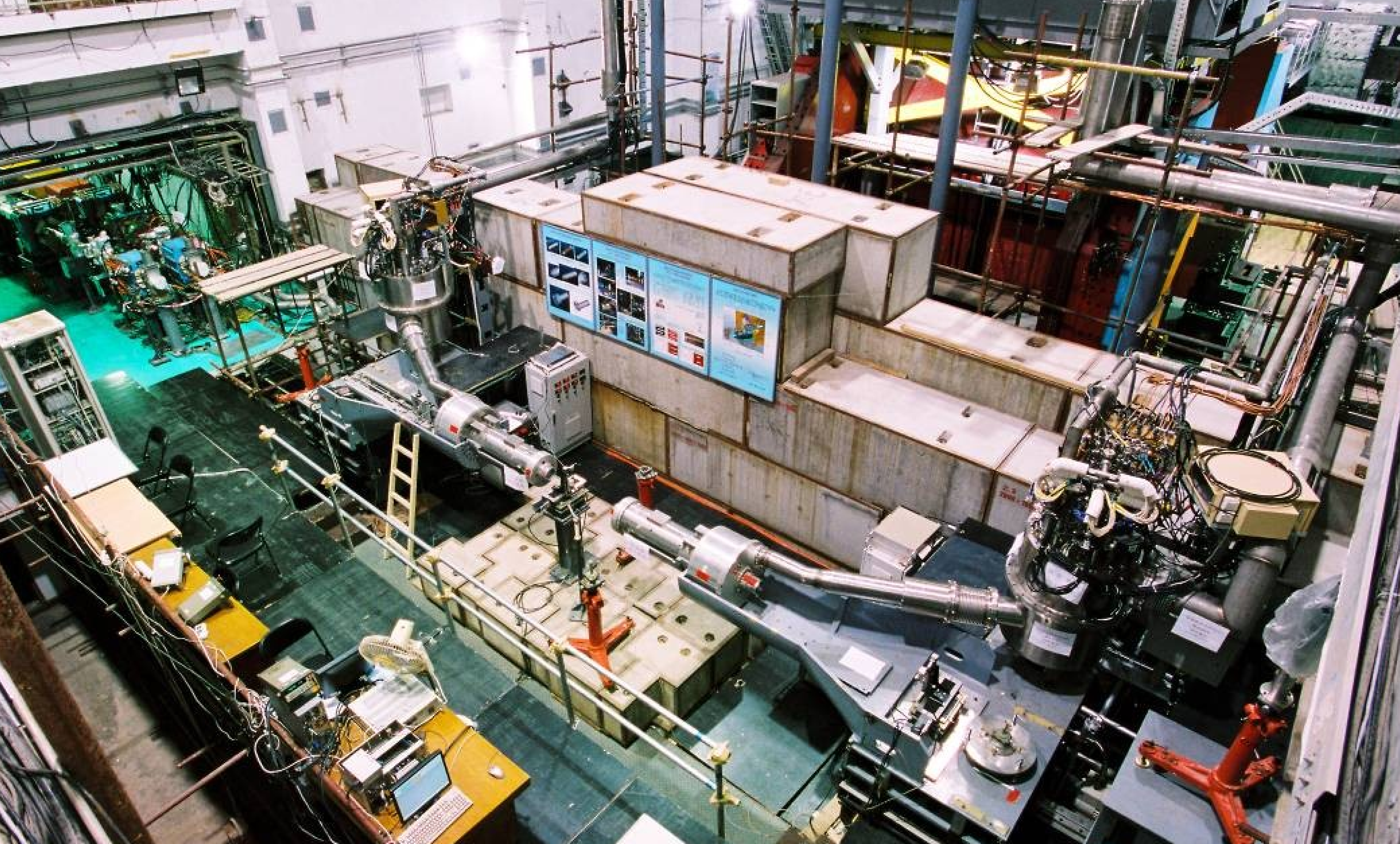
- **First beam stored in storage ring 18 Nov.2006**
- **Synchrotron radiation run started Dec. 2006. Twice in total 3 month.**
- **First collision: 25 March 2007.**
- **Now 50 by 50 bunches collision works.**
- **Electron beam current reaches 500 mA, positron beam current reaches 200mA**
- **The measurement of the storage ring parameters are in agreement with prediction. The luminosity is quite good.**

SC magnets runs stable, Field mapping with SC quads completed with good uniformity



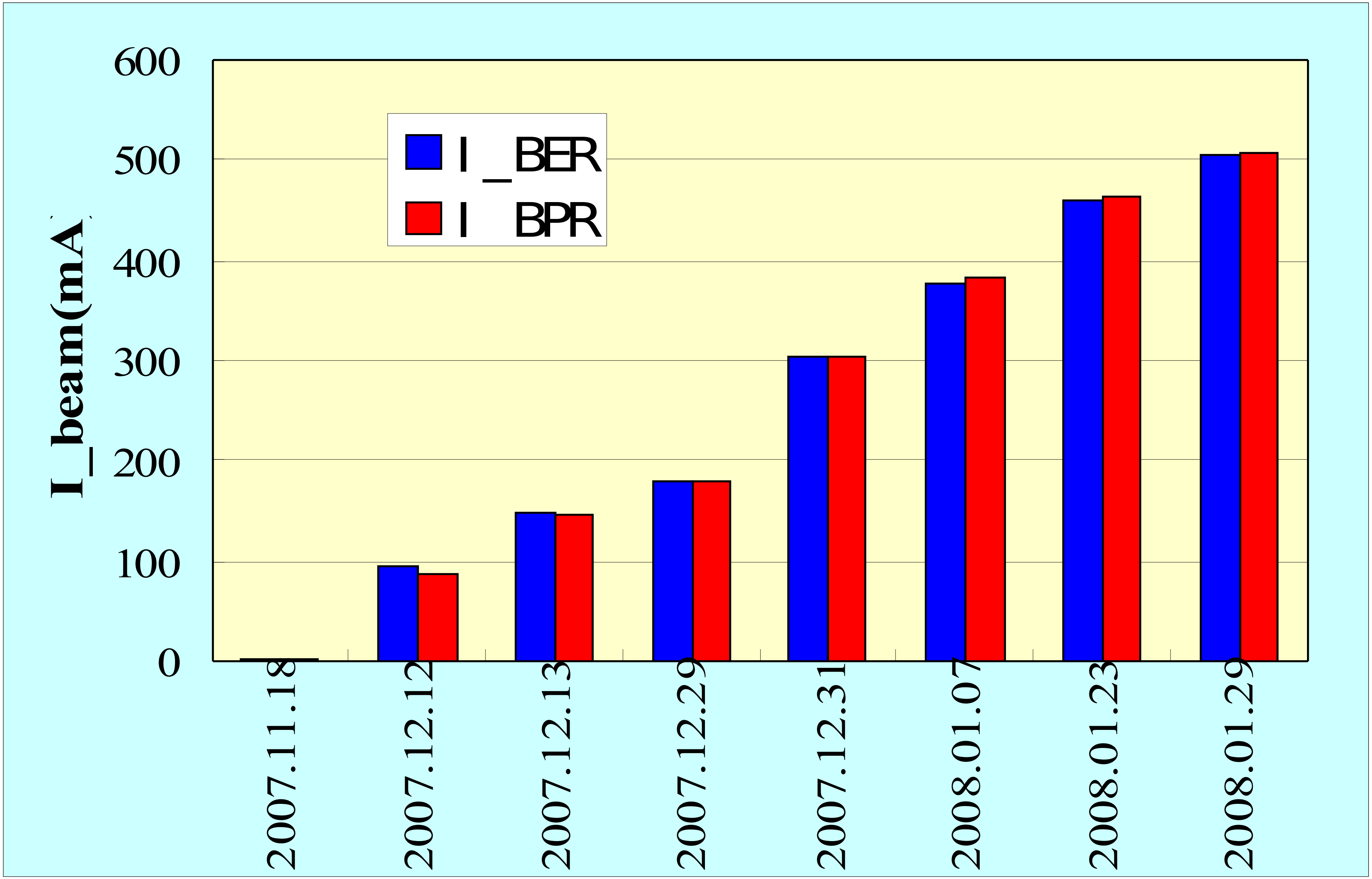


Special thanks to DESY for help to Cryogenics commissioning and fieldmapping



SC quads installed at IR.
Phase II commissioning started 24 Oct.

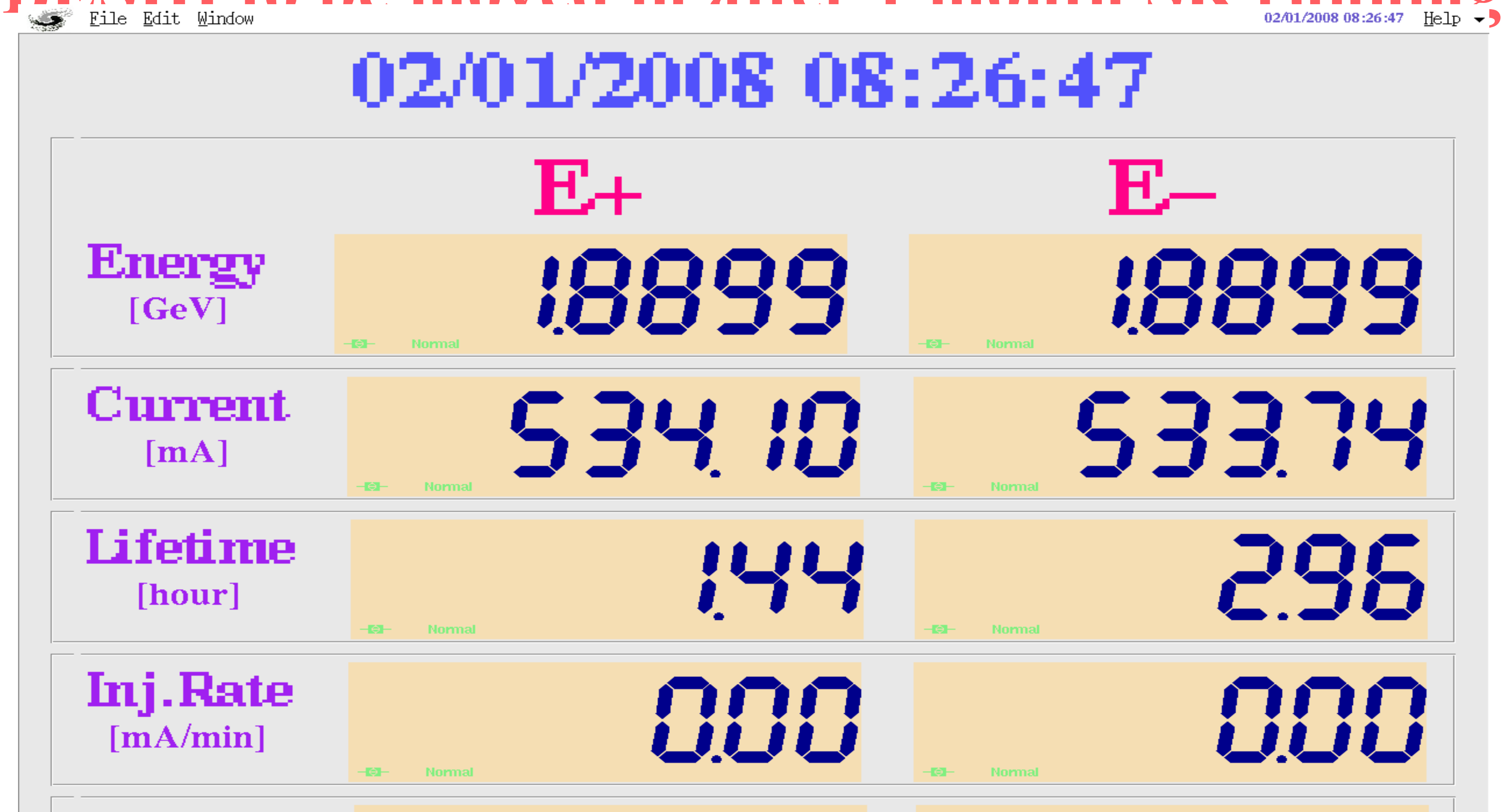
Collision beam current



Phase II commissioning reached the goals:

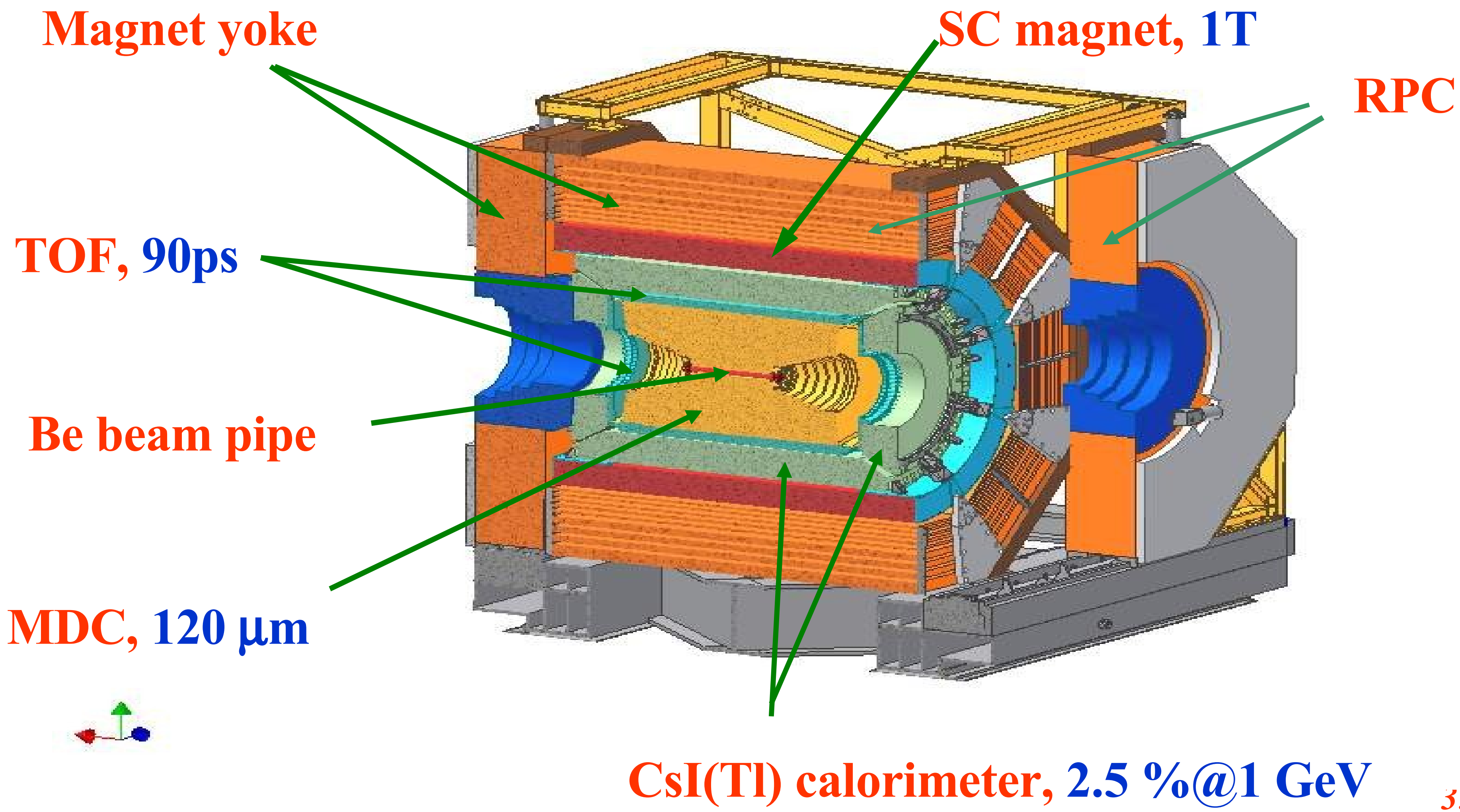
Lumi. > $10^{32}cm^{-2}s^{-1}$, background acceptable.

BESIII to be moved in after 1 month SR running

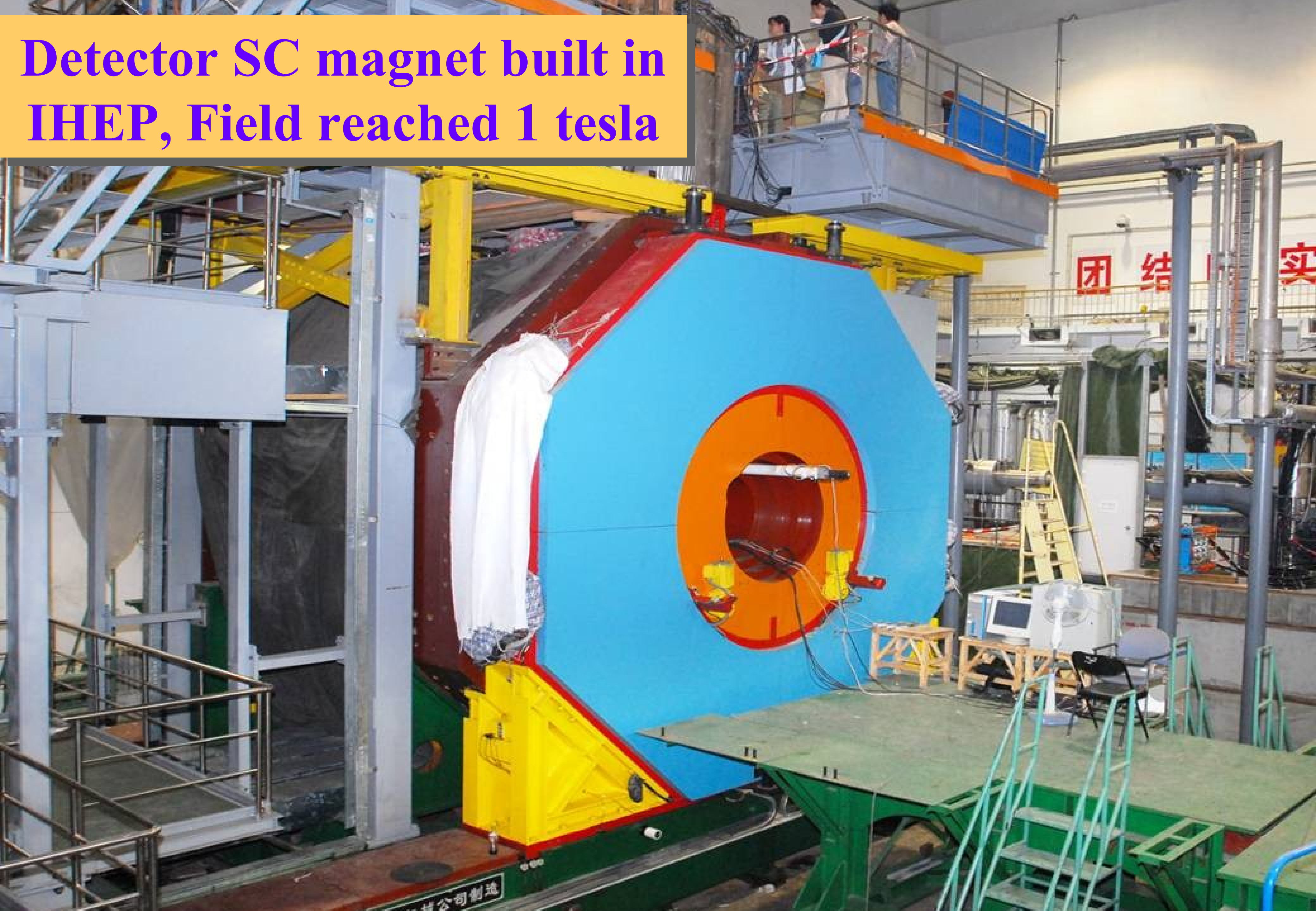


BESIII Detector

— 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

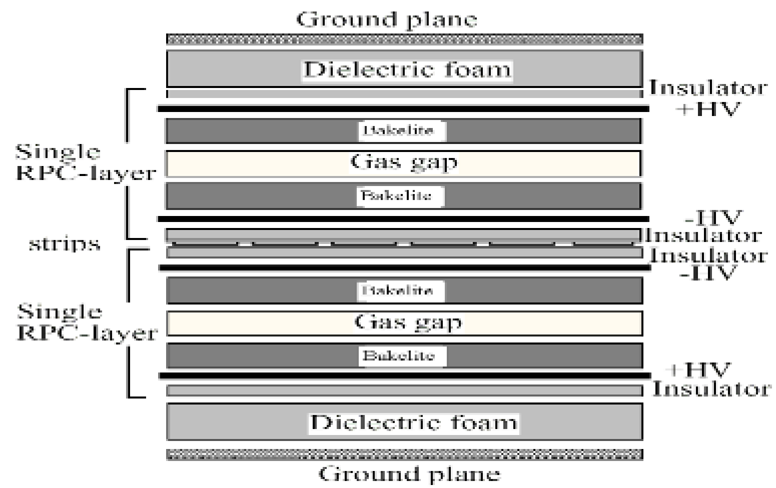


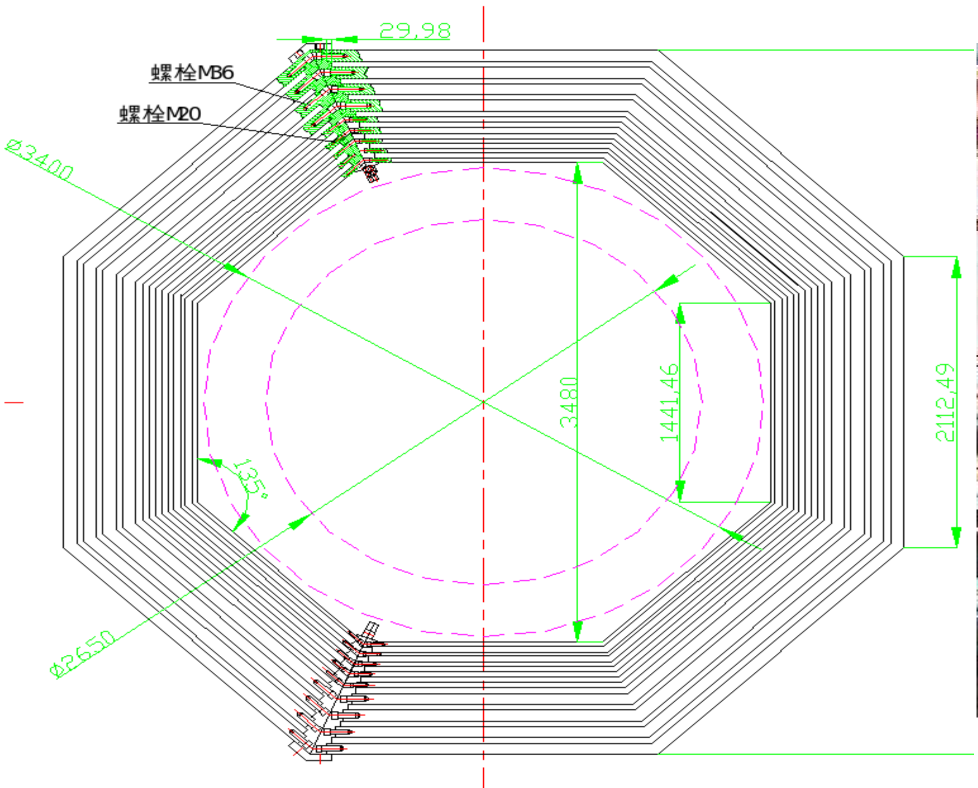
Detector SC magnet built in IHEP, Field reached 1 tesla



μ system : RPC

- 9 layer, 2000 m²
- Special bakelite plate w/o linseed oil
- 4cm strips, 10000 channels
- Noise less than 0.1 Hz/cm²
- Good candidate for ILC HCAL
  and muon chamber

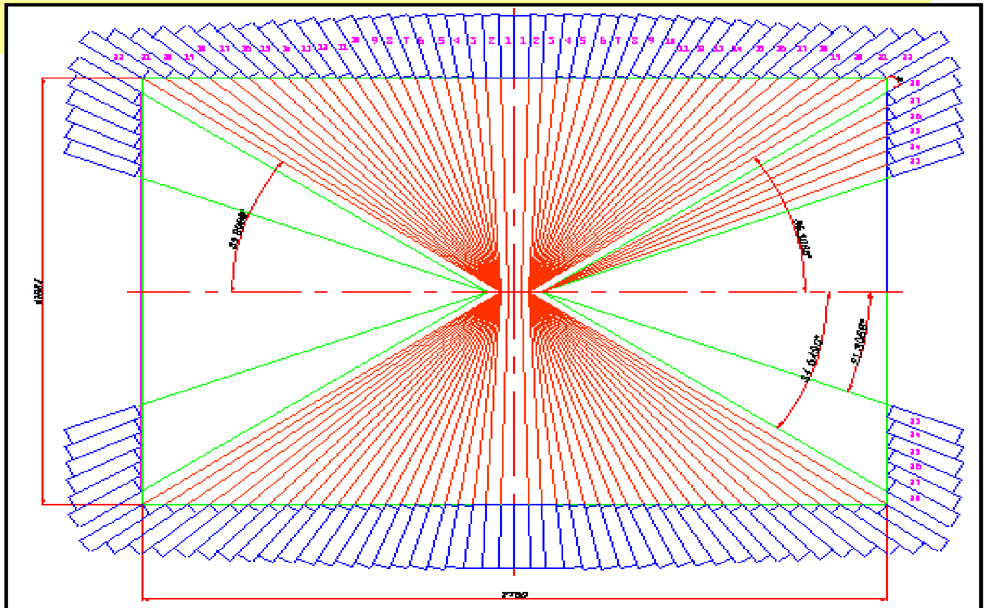


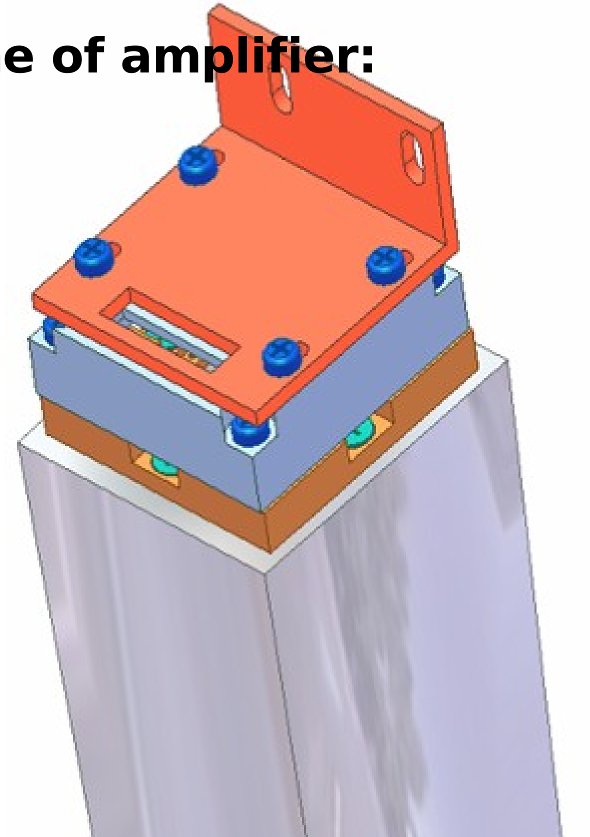


CsI(Tl) crystal calorimeter

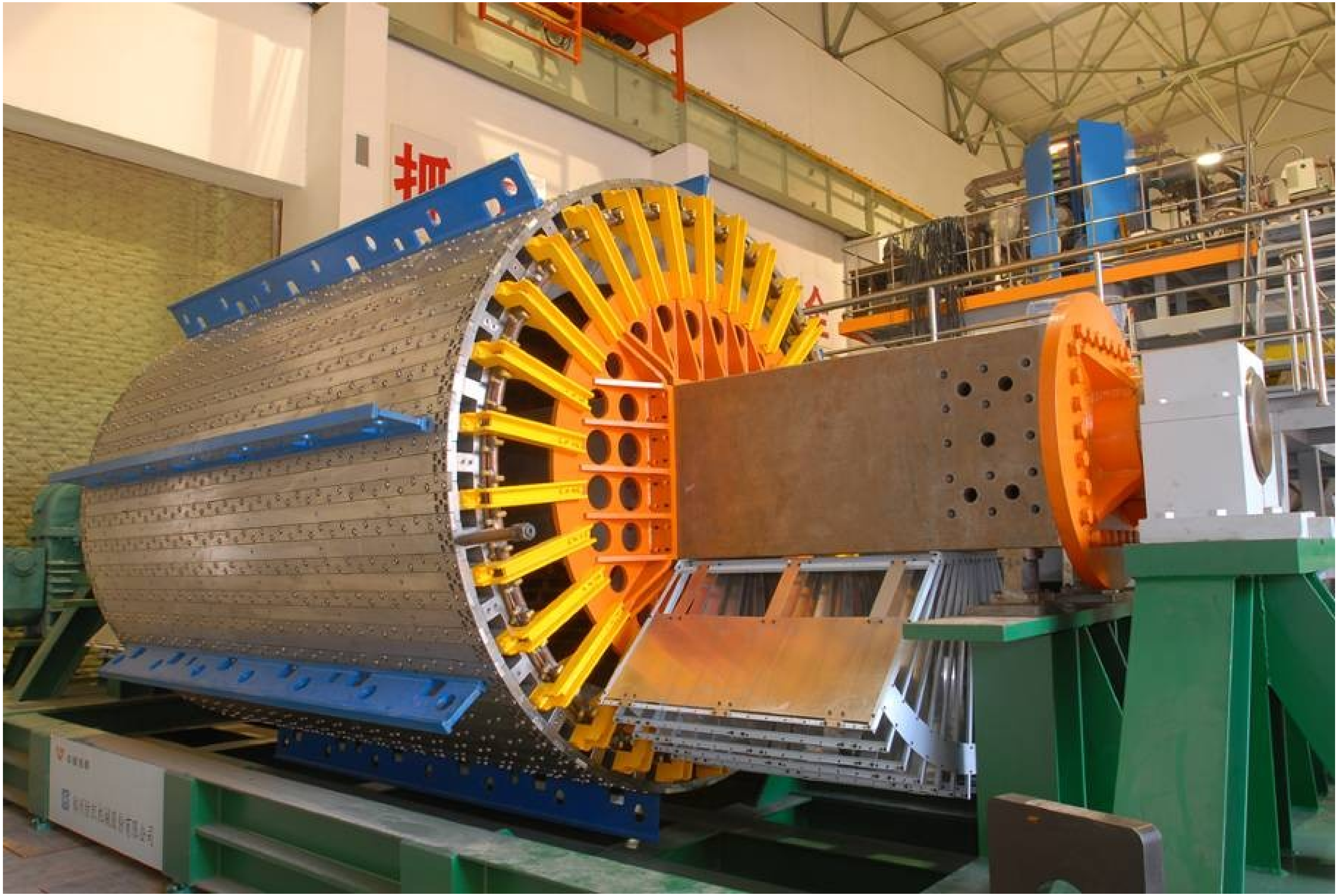
- Design goals:
  - Energy: 2.5% @ 1GeV
  - Spatial: 0.6cm @ 1GeV
- Crystals:
  - Barrel: 5280 w: 21564 kg
  - Endcaps: 960 w: 4051 kg
  - Total: 6240 w: 25.6 T

- 2 Photodiode+2 Preamp+ (1 Amplifier)
- Photodiode(PD): Hamamatsu S2744-08 (1cm x 2cm)
- Preamplifier noise: <1100 e (~220kev)
- Shaping time of amplifier: 1μs

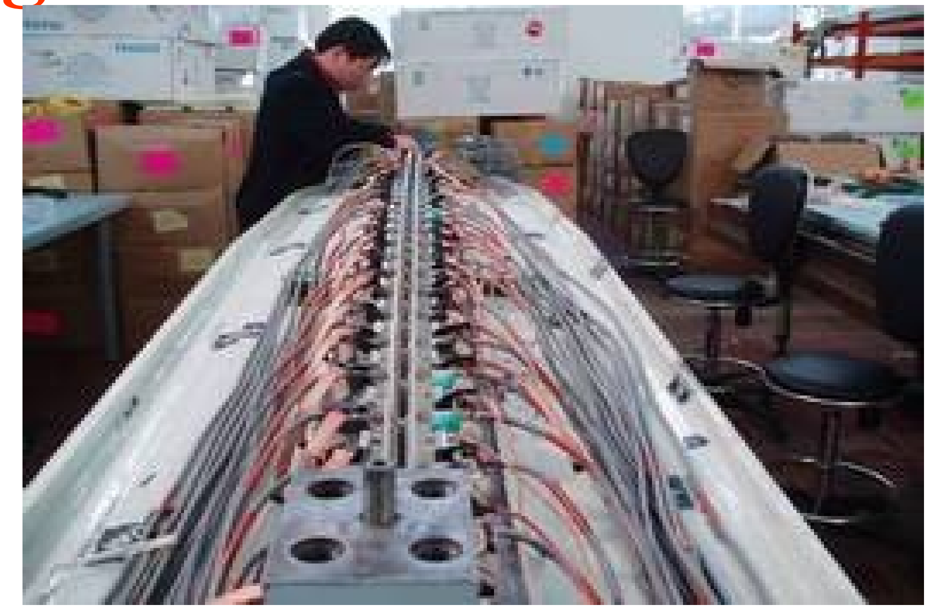




Support Structure of EMC Barrel



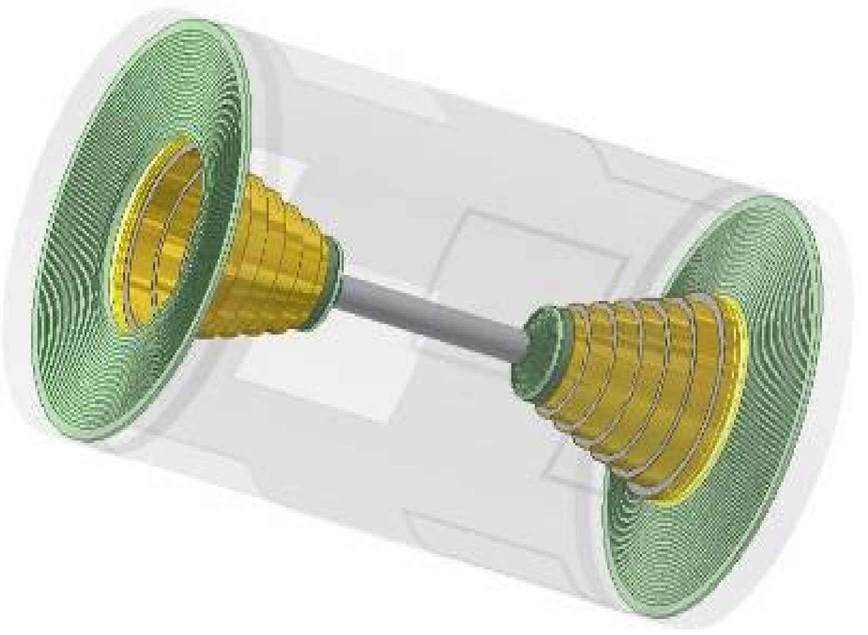
Assembling of EMC barrel

Barrel EMC installation

Main Drift Chamber

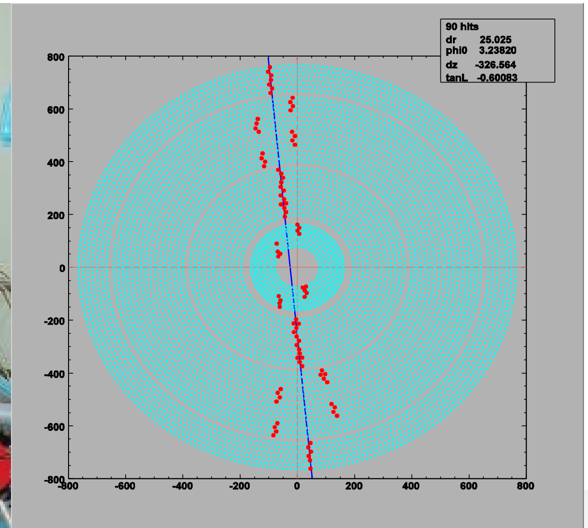
- **Small cell**
- **7000 Signal wires: 25μm gold-plated tungsten**
- **22000 Field wires: 110 μm gold-plated Aluminum**
- **Gas: He + C_3H_8 (60/40)**
- **Momentum resolution@1GeV:** $$\frac{\sigma_{P_t}}{P_t} = 0.32\% \oplus 0.37\%$$
- **dE/dX resolution: ~ 6%.**

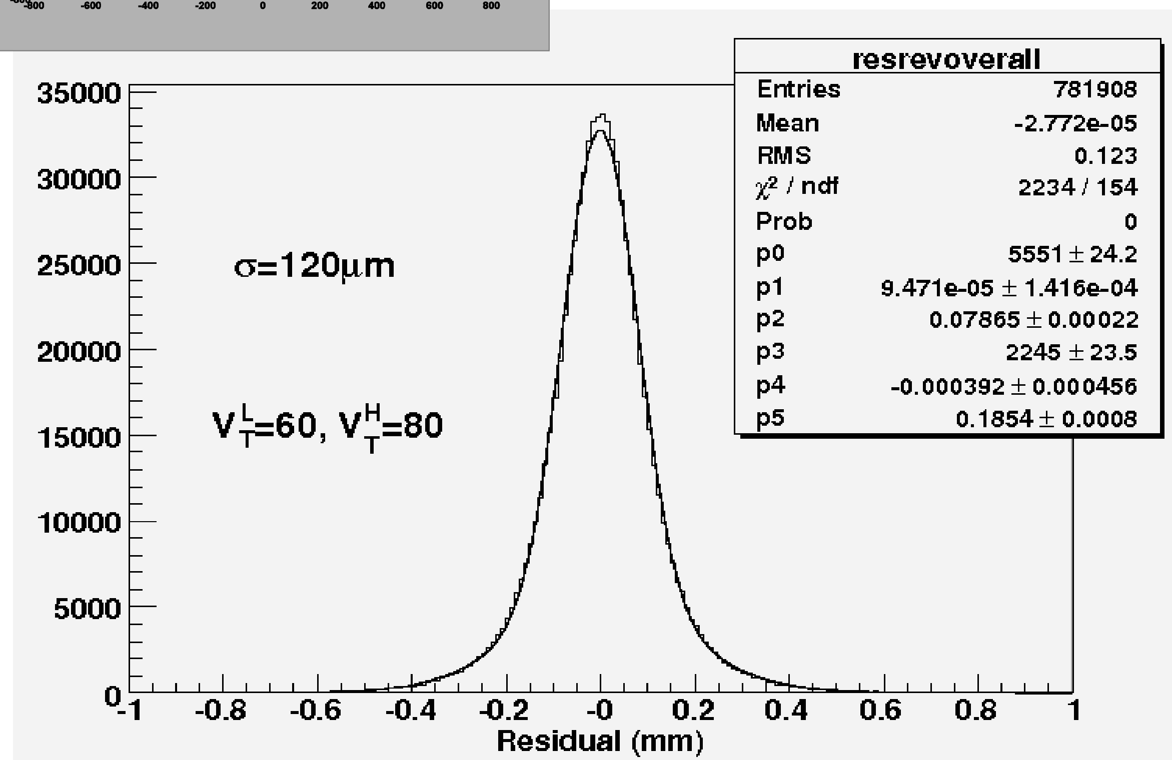


MDC construction finished

- **Wiring completed with good quality**
- **Inner chamber and outer chamber assembled**
- **Gas leakage test finished**
- **Cosmic-ray test started**

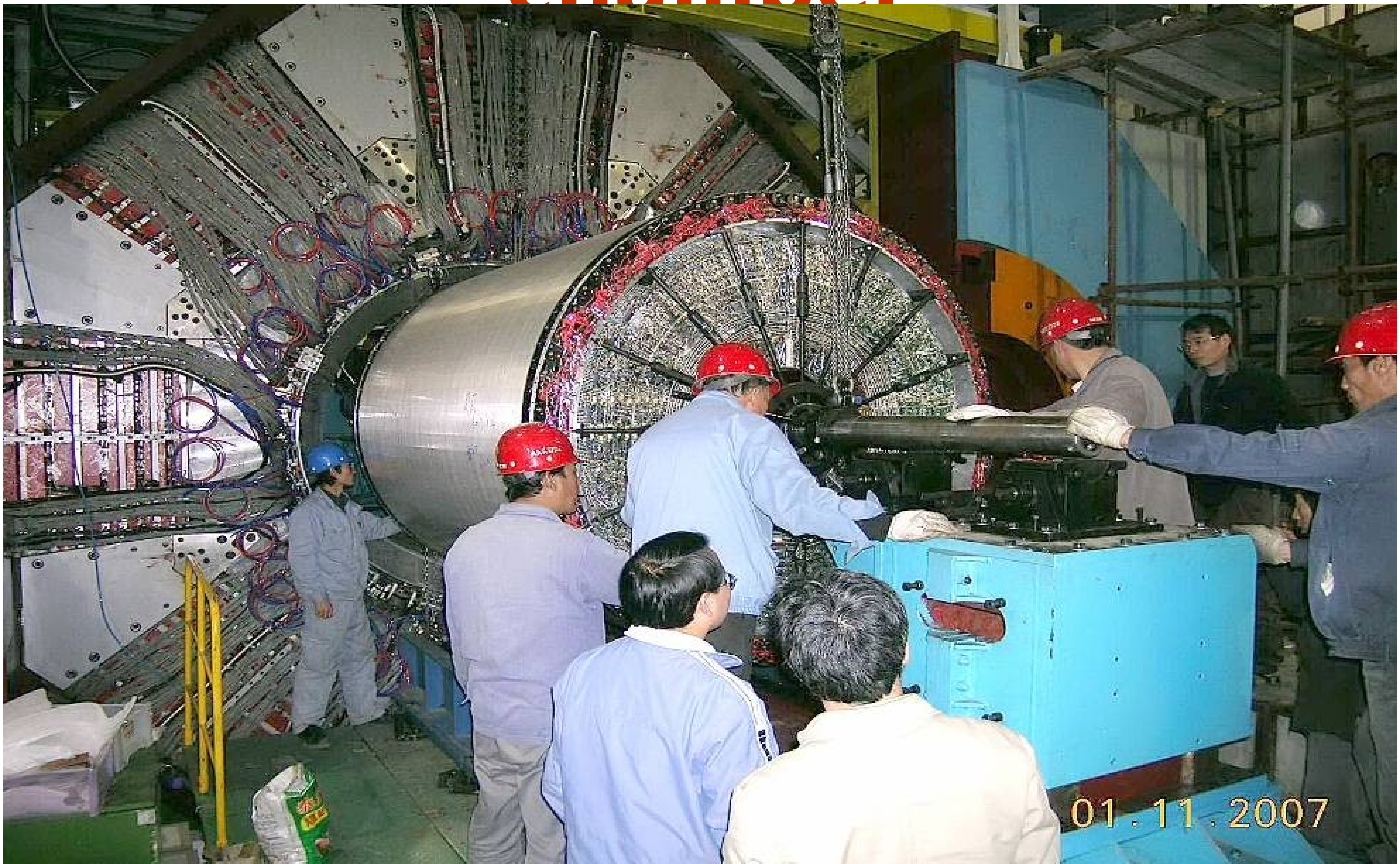
Cosmic ray test: single wire resolution 120μm

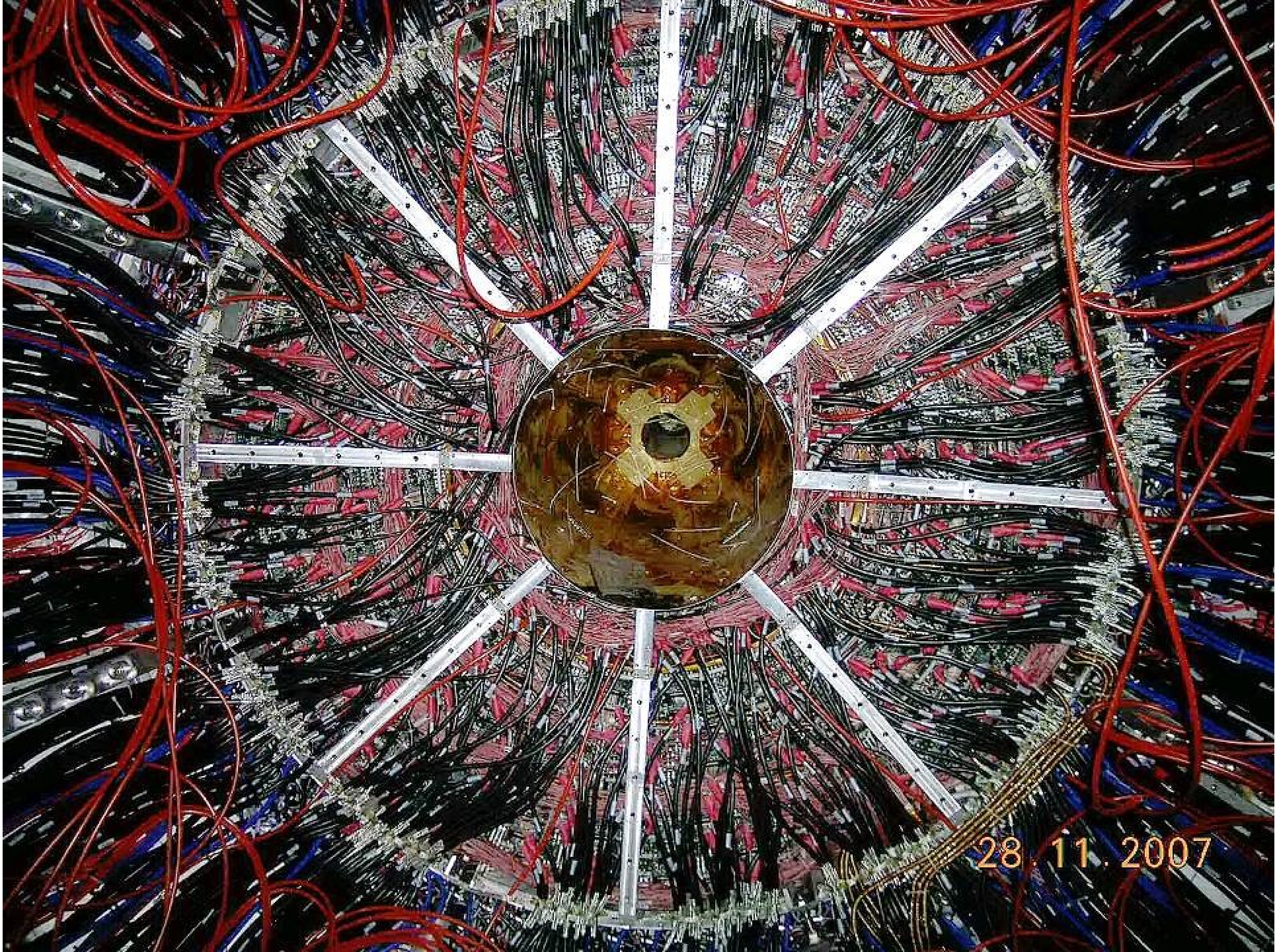




Assembling of TOF

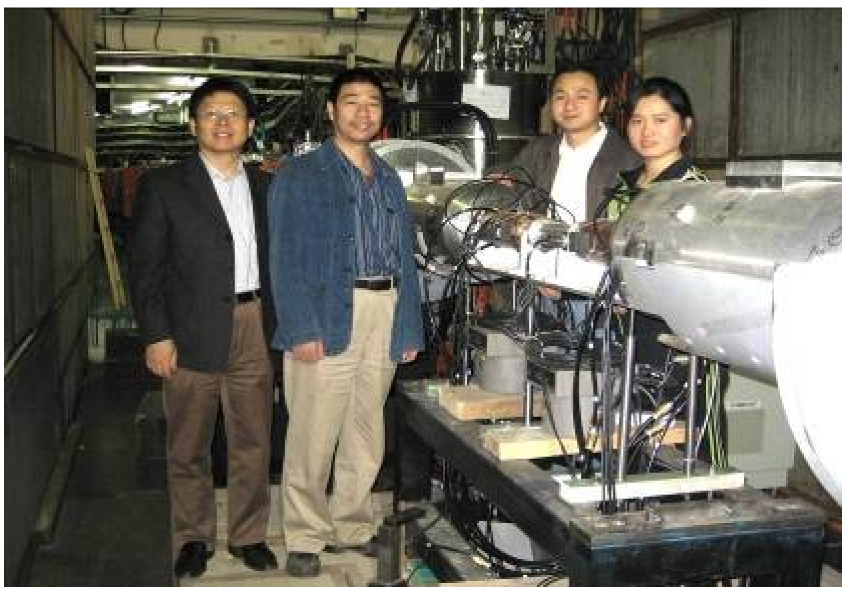
Installation of draft chamber




28 . 11 . 2007

East Endcap of EMC and TOF are ready

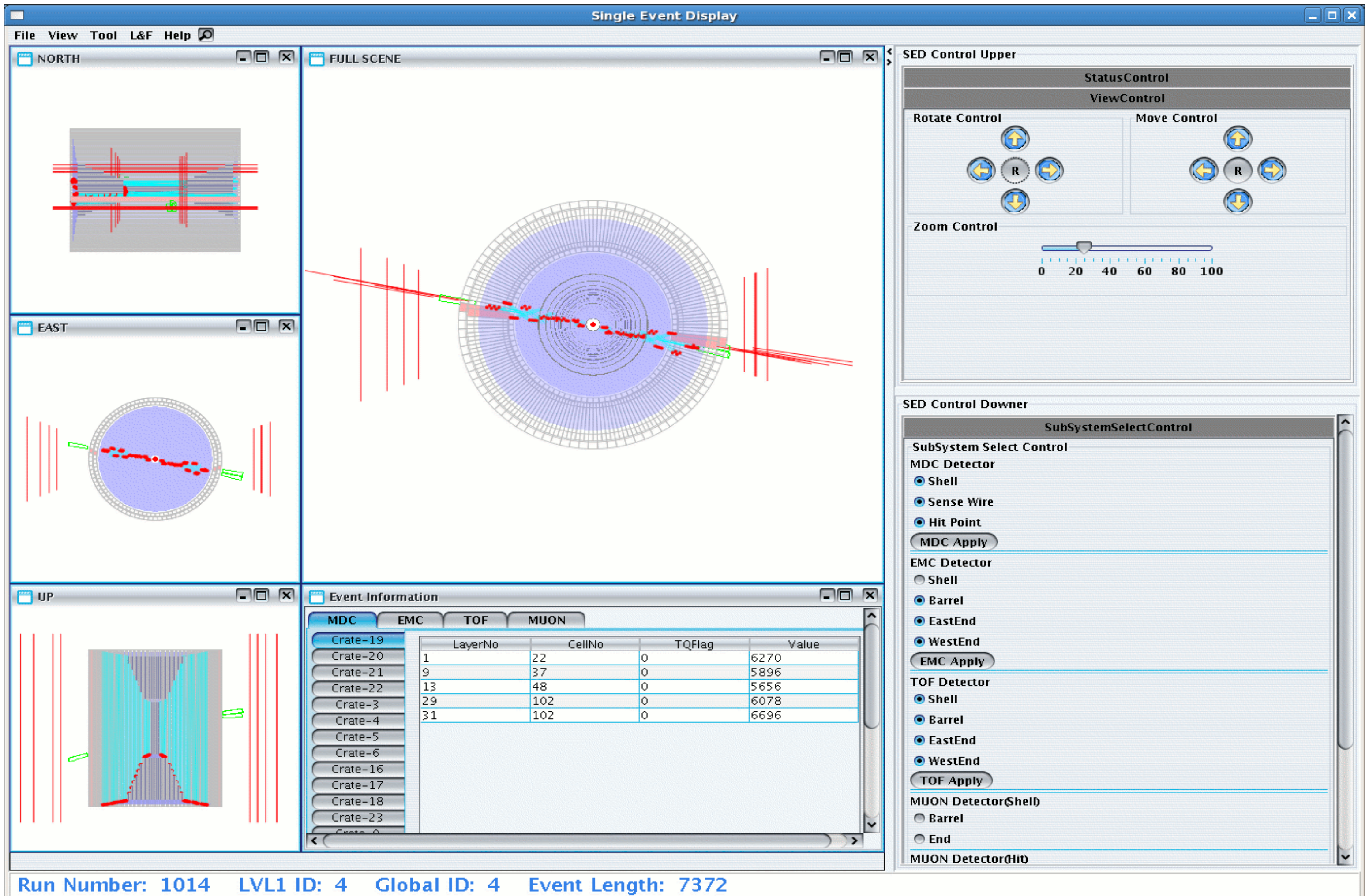
Beryllium beam pipe



Cosmic ray event in BESIII

- ✓ Trigger+DAQ with MDC + EMC + TOF+MUON

Read to be moved into the interaction point.



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

Japan (1)

Tokyo University

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

Schedule

- Aug. 07 – March 08: Phase II commissioning
  - Installation of SC quads at Interaction region√
  - Tuning of storage ring: > $1.5\times10^{32}cm^{-2}s^{-1}$ background ok √
  - SR running: 25.Feb – 26 Mar.
  - Assembling of BESIII: √
- April. 08: BESIII detector moved into beam line
- May. 08 : Starting machine-detector tuning.
- Physics run by Summer 08
- Goal: $3\times10^{32}cm^{-2}s^{-1}$ by the end of 2008

LHC Experiments

1. CMS
   - 1/3 of CSC at muon end caps (IHEP)
   - HV boards for RPC (IHEP)
   - RPC of barrel muon (Beijing Univ.)
   - Physics and MC
2. Atlas
   - Drift Monitor chambers (IHEP)
   - Physics and MC
3. LCG: Tier 2
4. LHCb: Tsinghua Univ.
5. Alice: CIAE…

Yangbajing Cosmic Ray Observatory （ Tibet a.s.l. 4300m ）

IHEP-INFN Argo RPC   China-Japan Air Shower Array

New anisotropy component and corotation of GCR

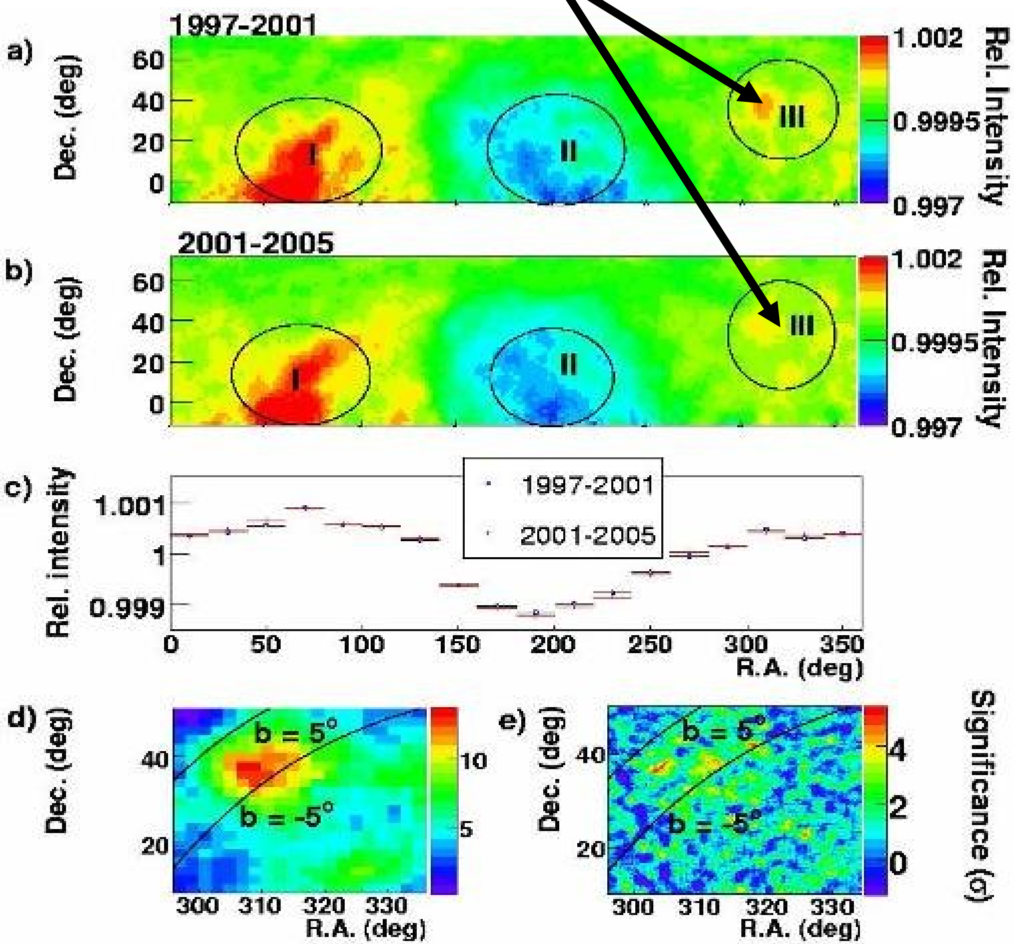
(Science 314(2006) 439-443)

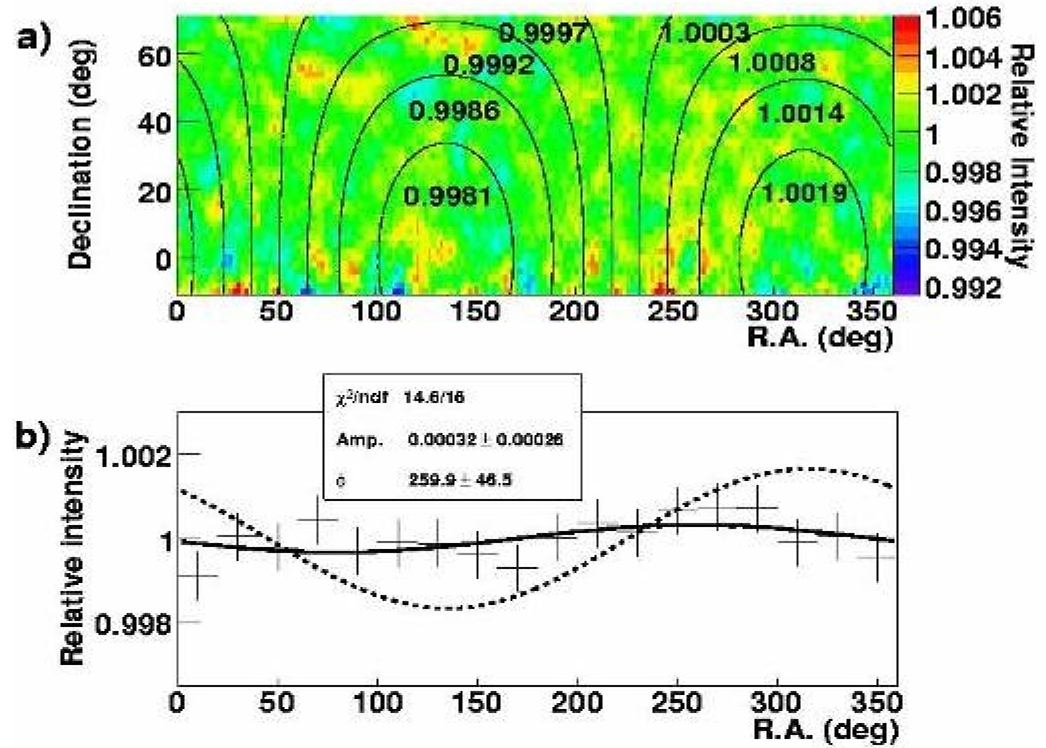
Celestial Intensity map (E~3TeV)

Intensity @ E~300TeV

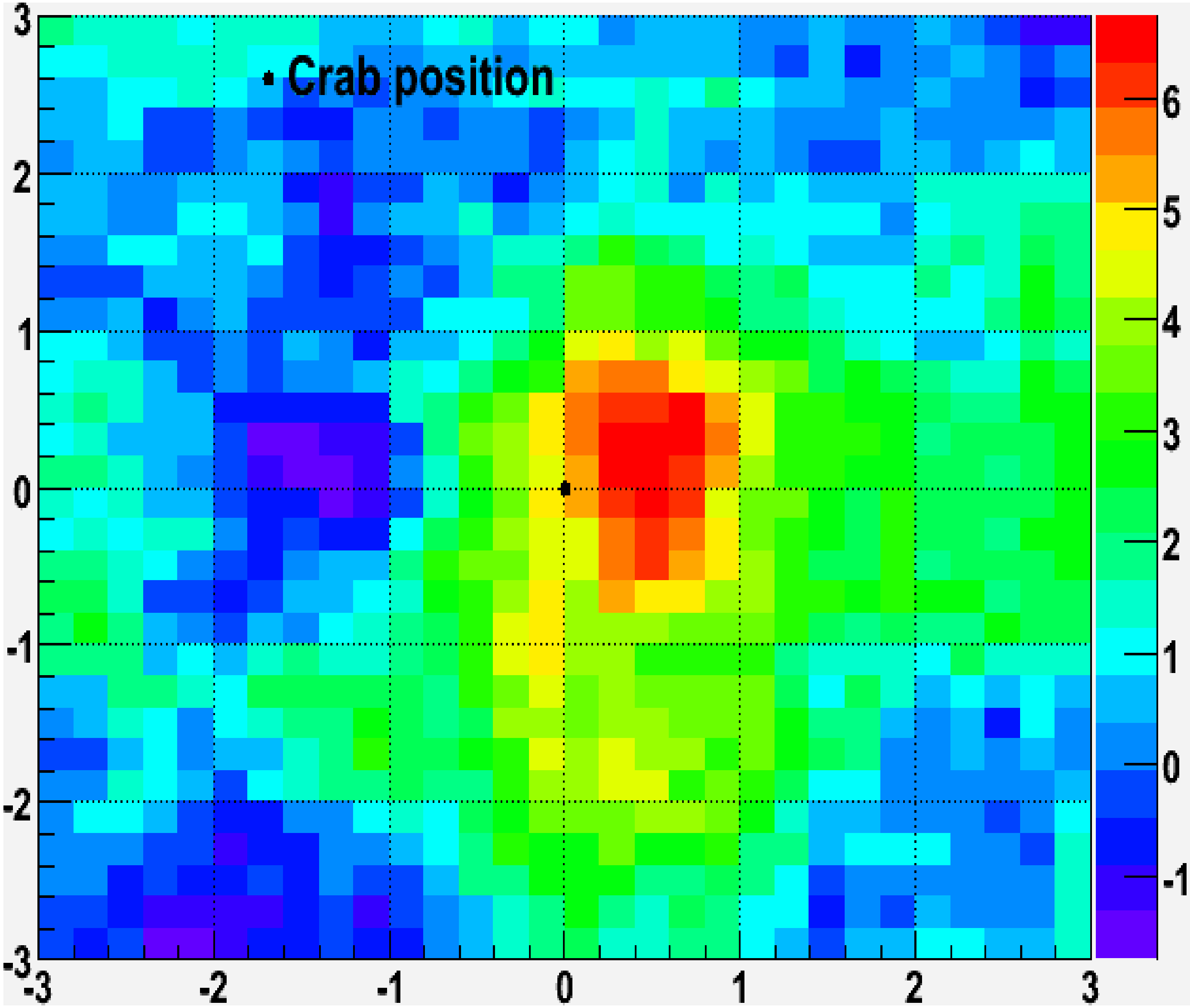
New anisotropy component

Amp=0.16% w/o corotation;
Observation: 0.03%±0.03%.





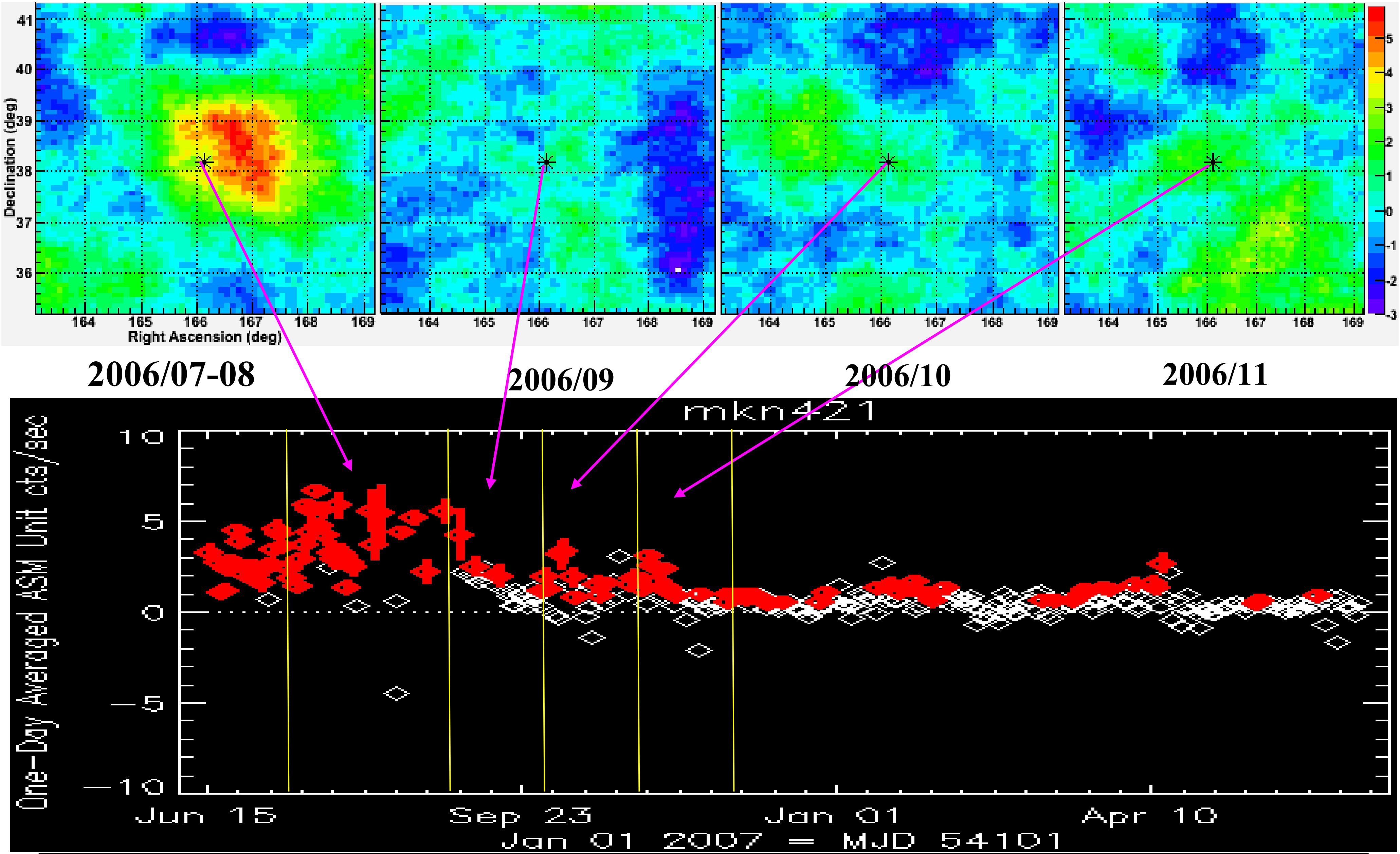
YBJ-ARGO Measurement of Crab 6.7σ



data: 07/06-04/07

cuts:

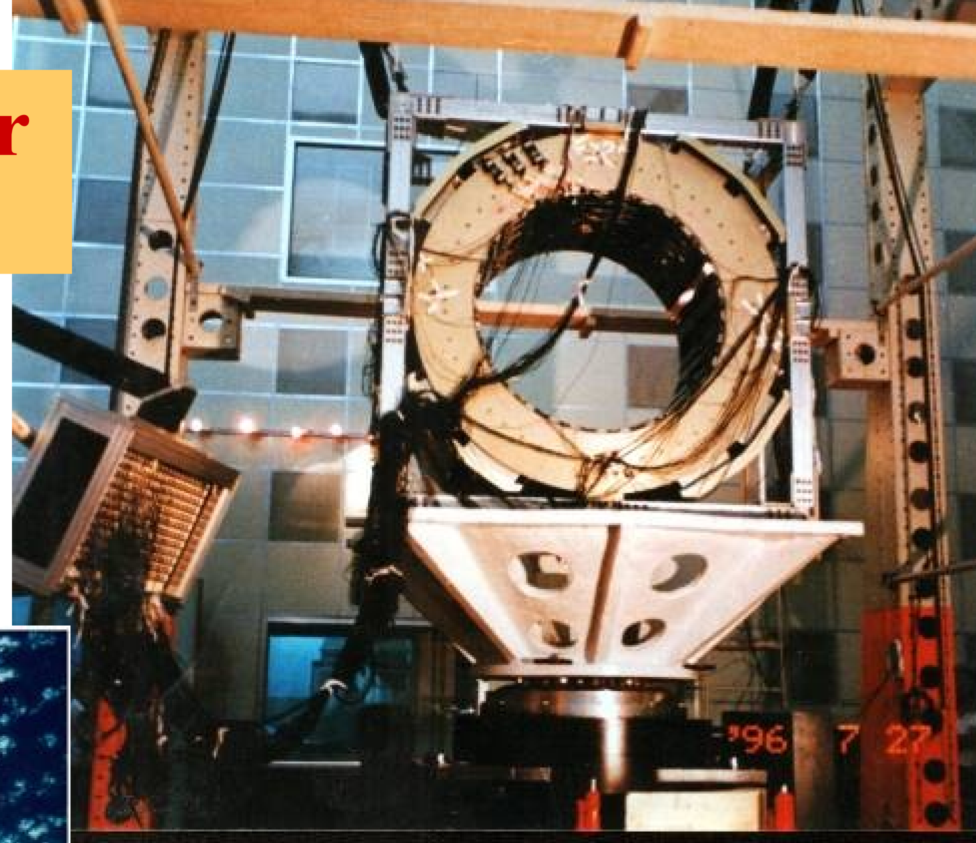
- Smooth angle 1.0°
- nhit>60.
- Core_x<60m,
- Core_y<60m
- zenith<40degree

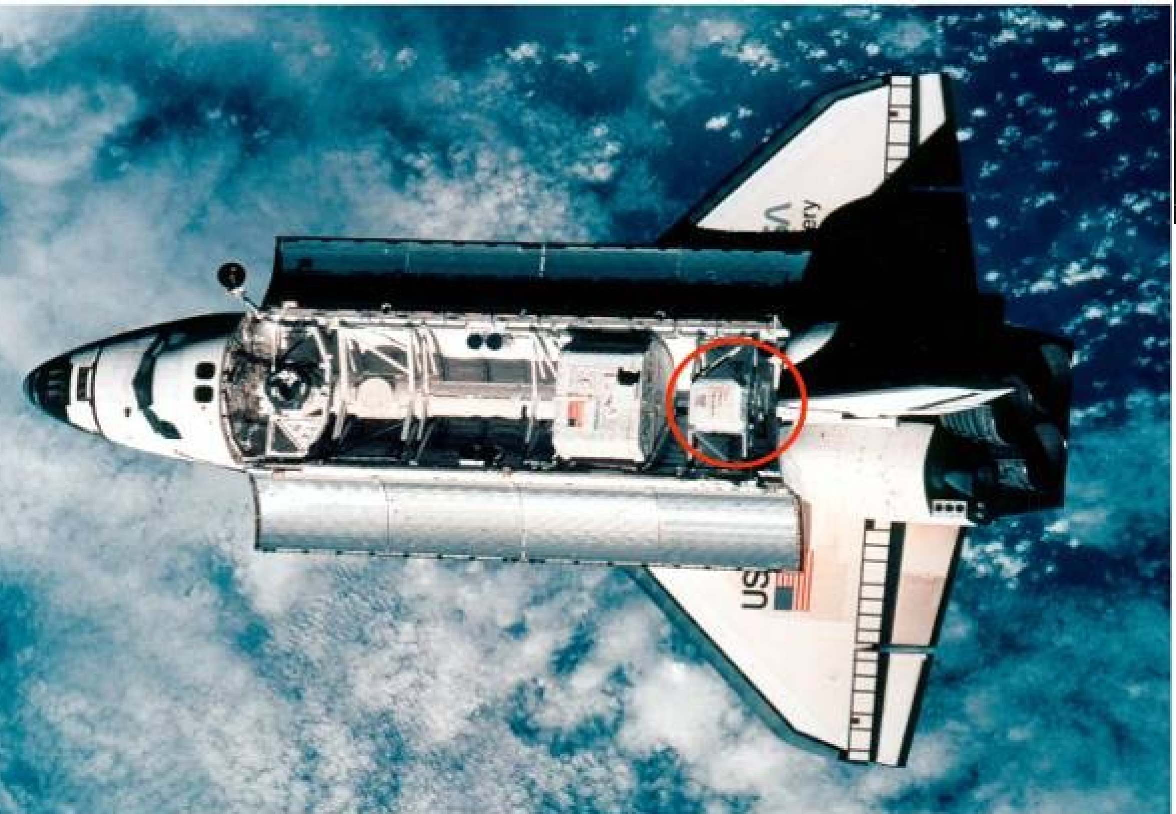


Lightcurves of Mrk 421 from the ASM of RXTE

Alpha Magnetic Spectrometer

- Search for antimatter and dark matter
- precision measurement of isotopes



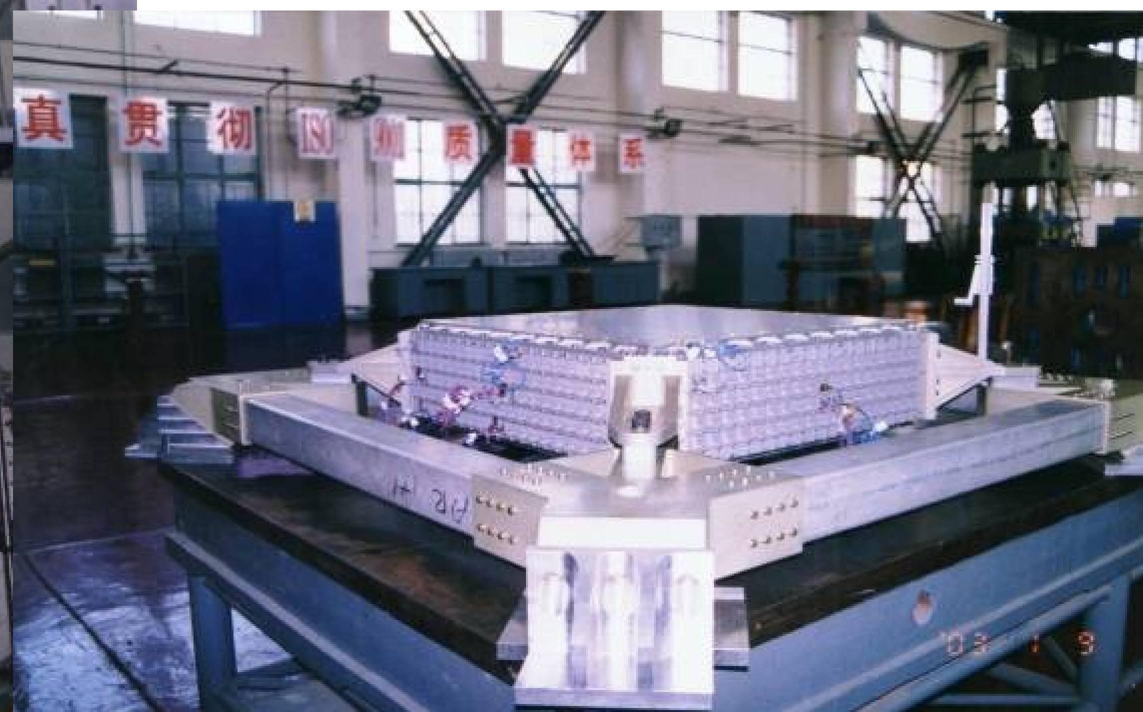


AMS01 permanent magnet and structure were built at Beijing, and became the first big magnet in space as payload of Discovery June 1998.

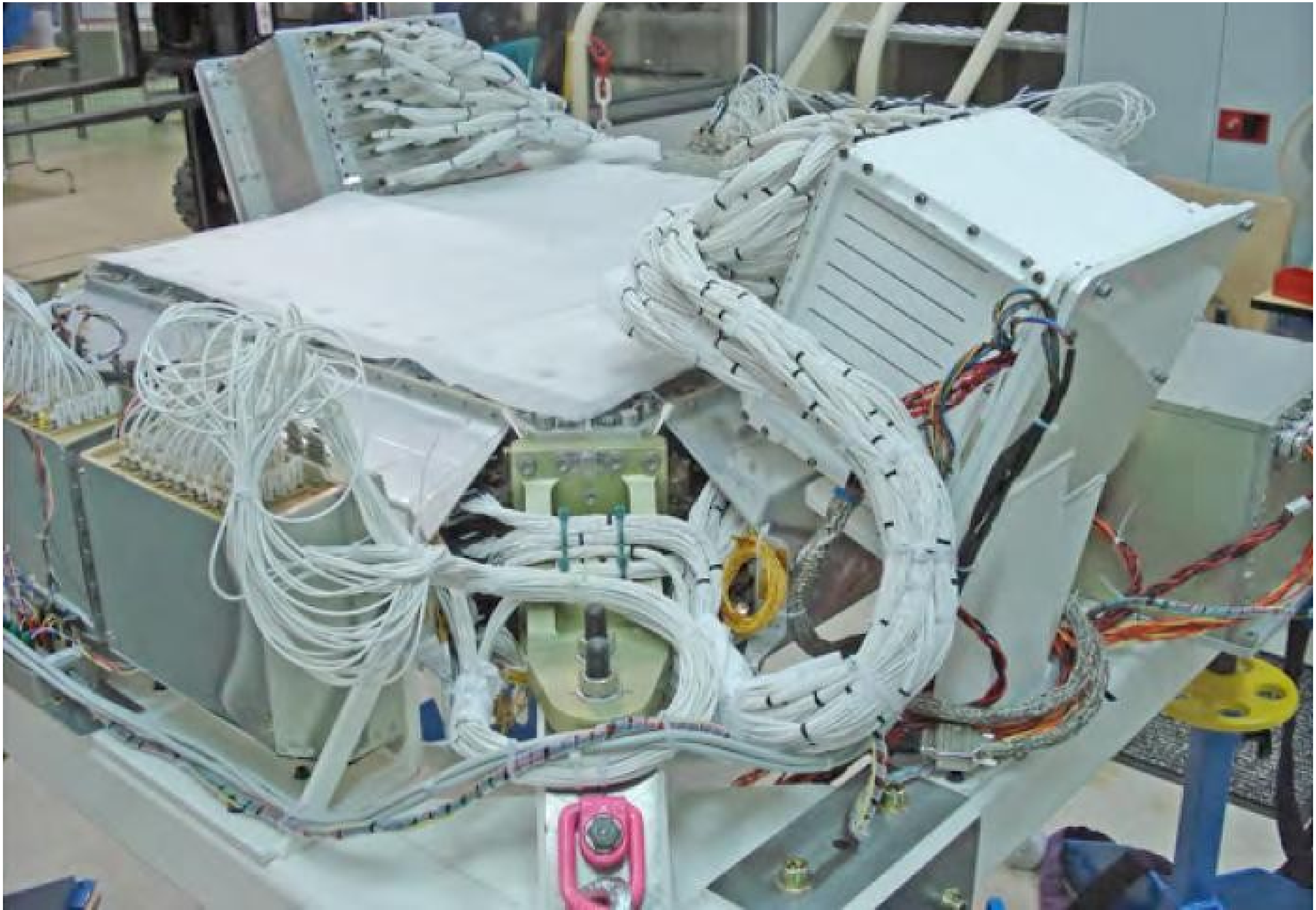
AMS02 ECAL: 700Kg
IHEP LAPP and PISA

Space qualification at Beijing

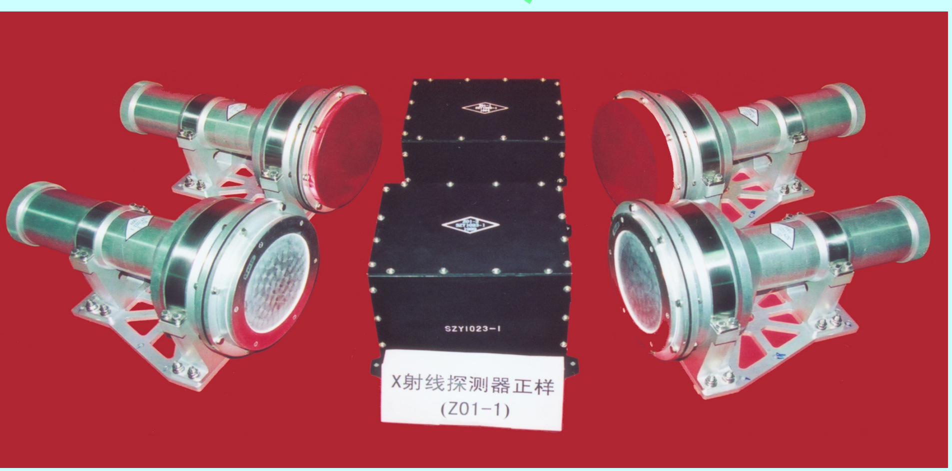
ECAL assembling at IHEP



AMS ECAL beam test



γ Burst Detector

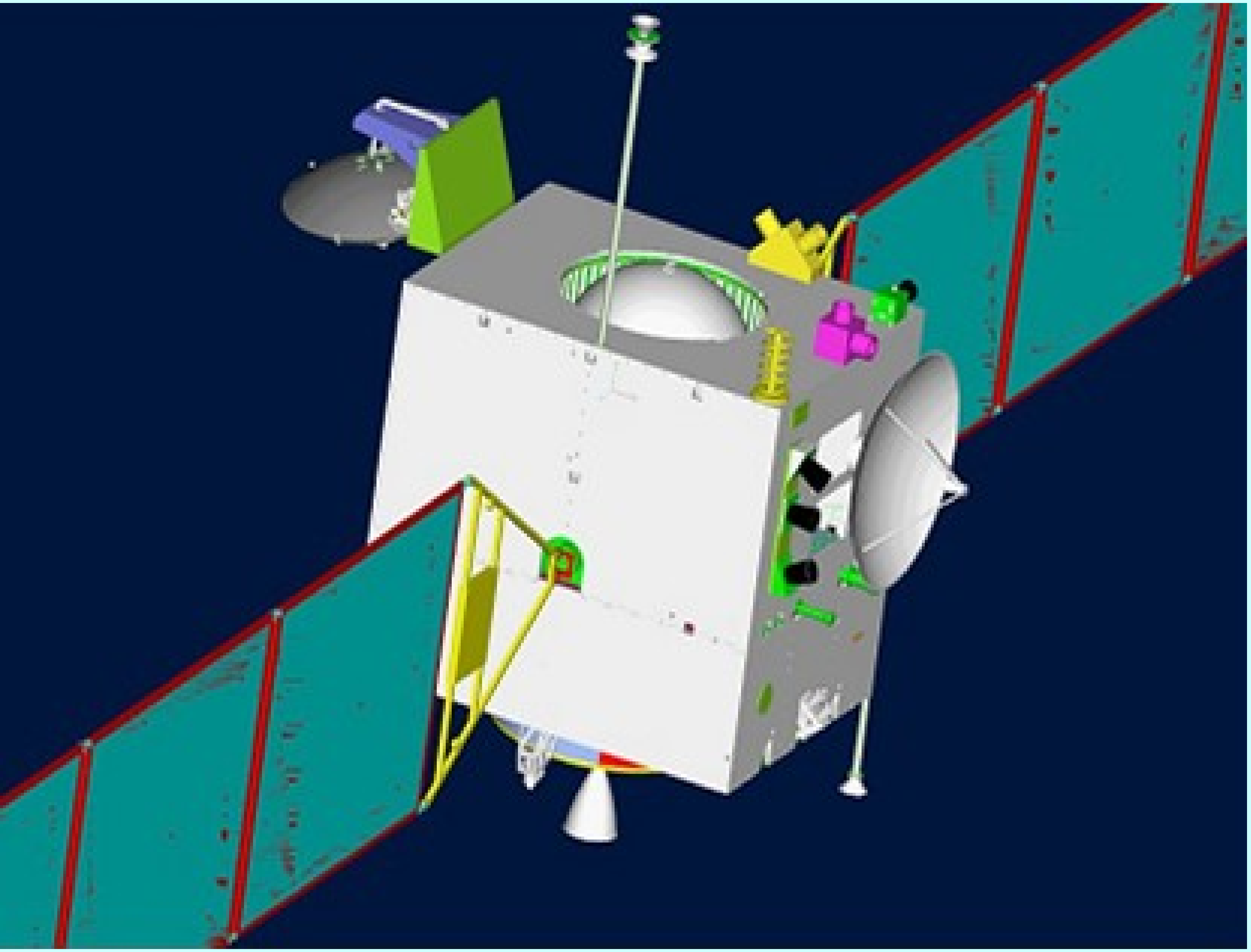


Shenzhou-2 Spacecraft

Flown 2001, First Astronomy detector of

ChangEr-1 (Chinese Moon Project)

Launched 24 Oct. 2007, Switch on 28 Nov.



Payload:

Optical System

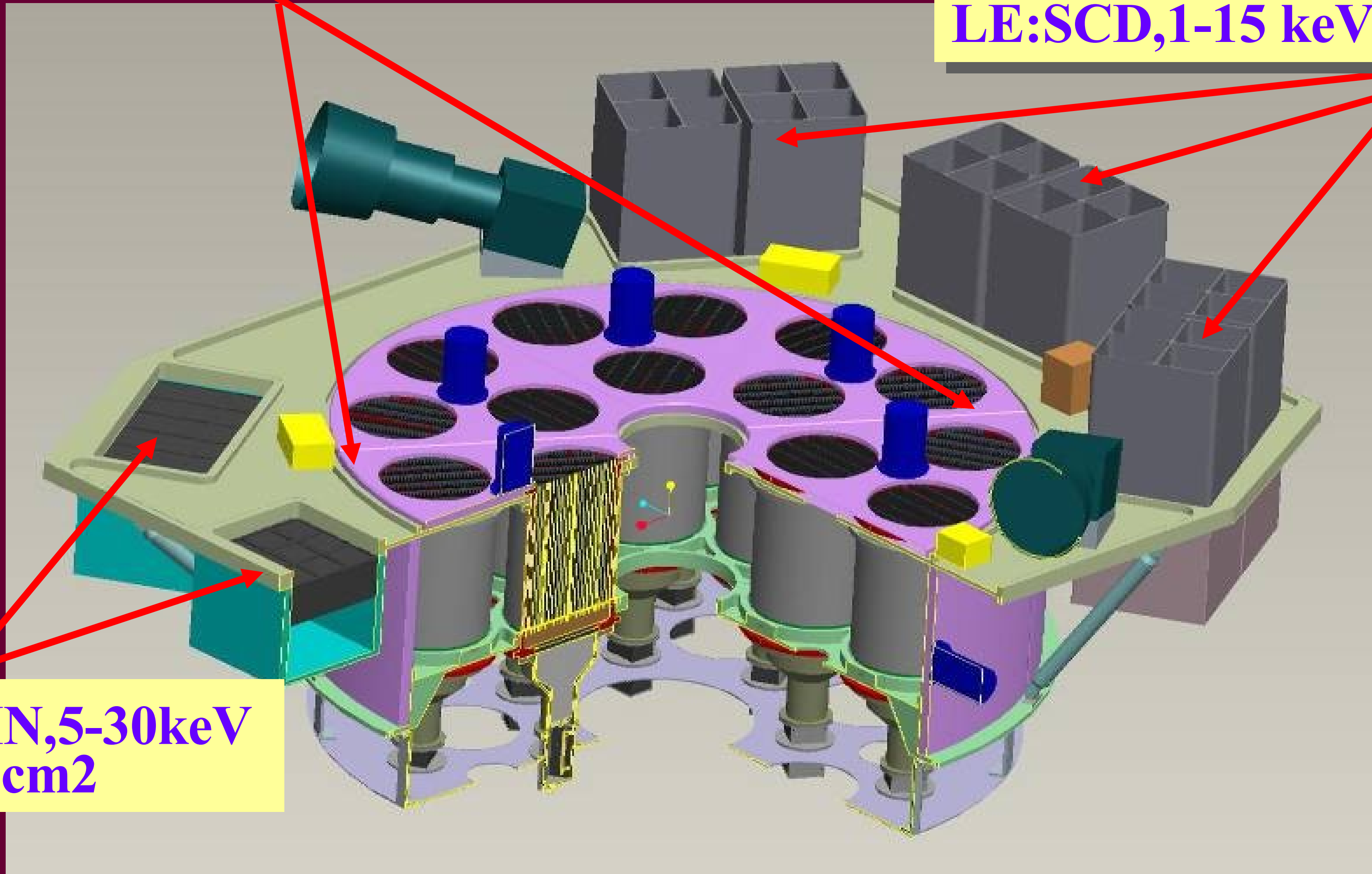
X ray spectrometer

γ ray Spectrometer

Laser altimeter

Solar wind detector

Made by Chinese Academy of Sciences

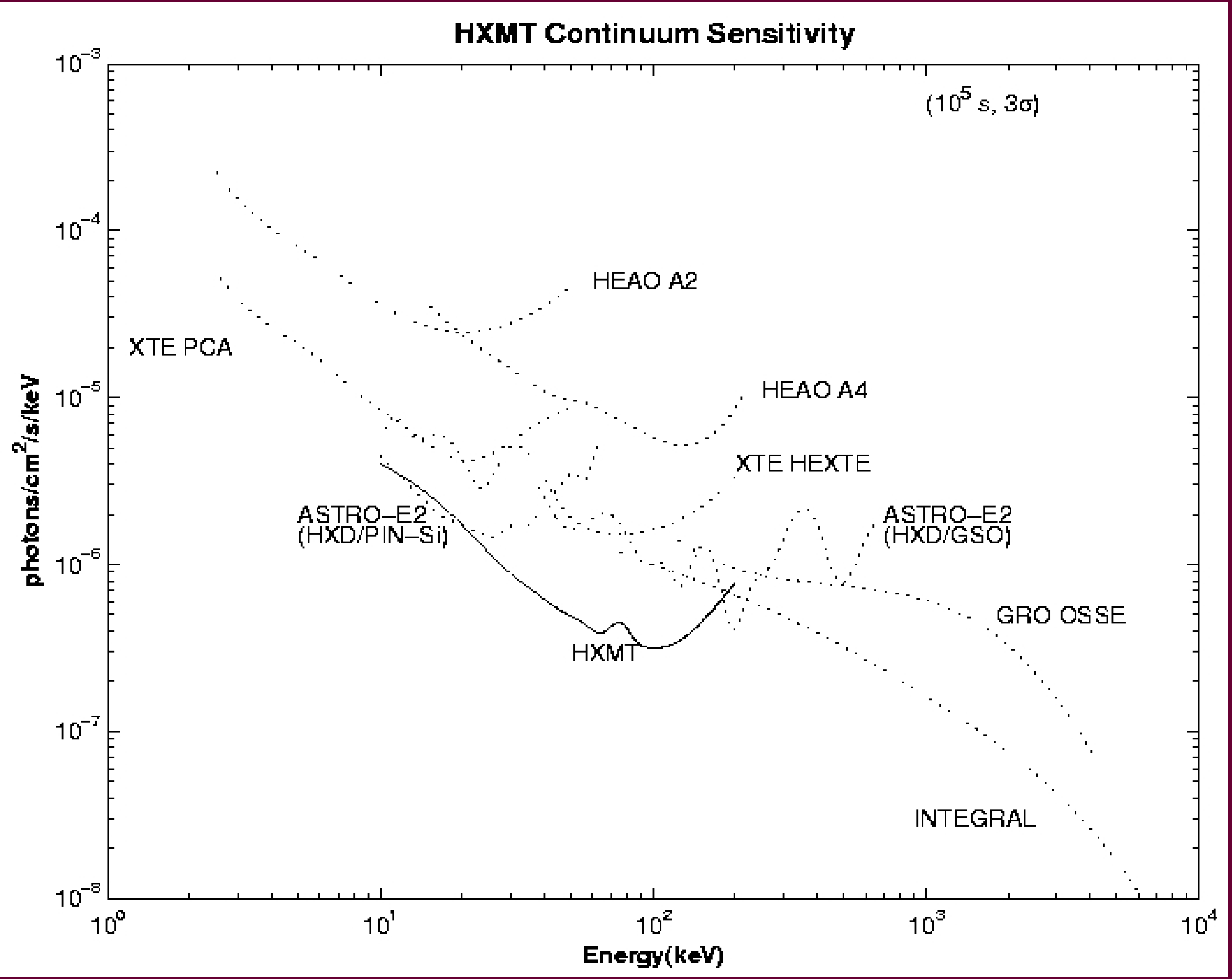


Hard X-ray Modulation Telescope (HXMT)

Size ： 1900×1600×1000 mm   1100 kg

Satellite 2700 kg

Sensitivity



Main advantages and key science of HXMT

Hard X-ray sky survey with highest sensitivity

- **High precision hard X-ray full sky map:**
- **Discover highly obscured supermassive BHs:**
- **Discover new types of high energy objects:**

High precision pointed observations of HE objects

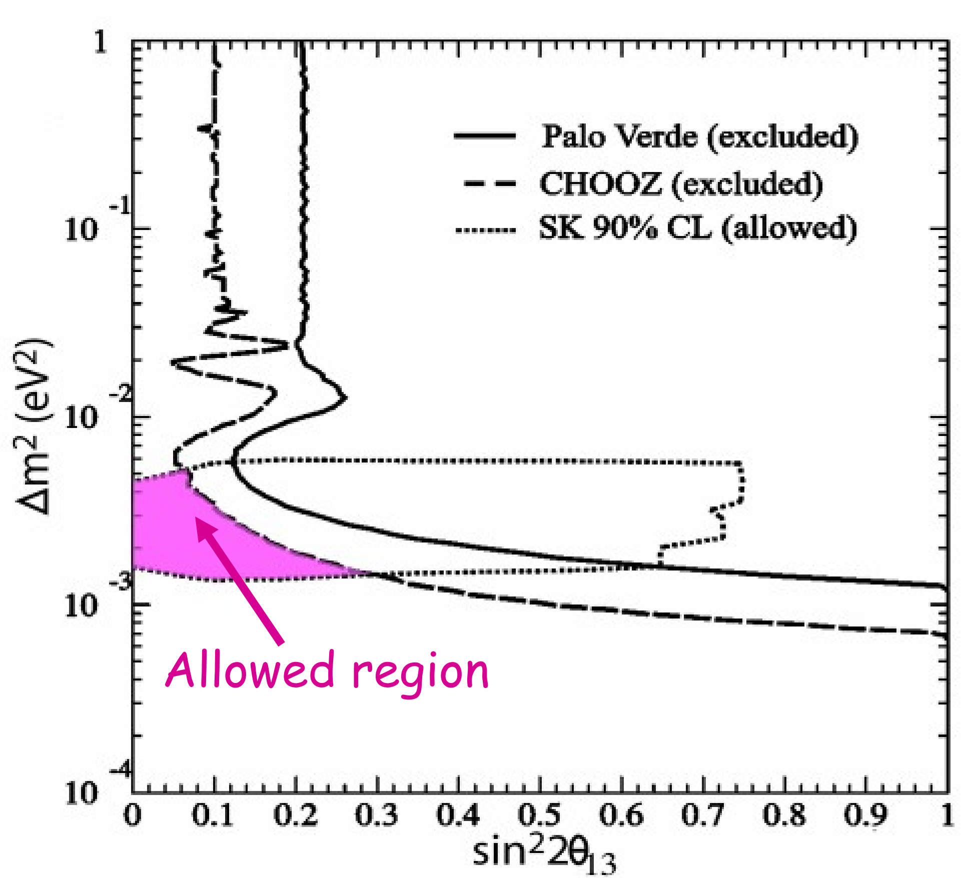
- **Space-time in strong gravitational field: dynamics and radiation near stellar mass and supermassive BHs**
- **Equation of state in strong magnetic field: neutron star and its surface properties**
- **High energy particle acceleration: AGN,**

Comparison of HXMT and other two telescopes in the same energy band.

	Integral/IBIS	HXMT/HE	wift/BAT
			
Angular Resolution	12’	< 5’	14’
Source Location (20σ)	1’	< 1’	1’
Pointed Sensitivity (mCrab@100 keV)	3.8	0.5	9
Half Year Survey Sensitivity (mCrab)	2	0.5	1
Observation Capability			
All sky survey	ok	good	yes
Selected sky deep survey	good	good	bad
Narrow field pointing observation	bad	good	no

Precision measurement of neutrino mixing parameter θ_{13}

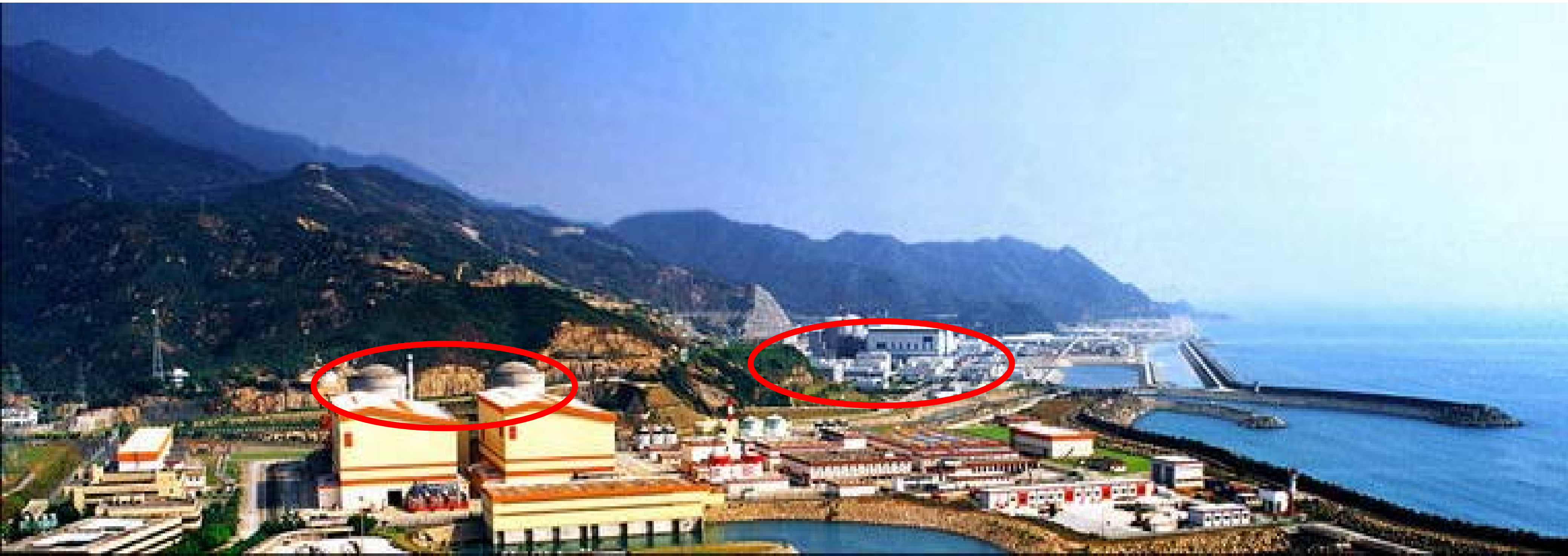
Current Knowledge PRD62,072002



- **Provides direction to future of neutrino physics**
- **No good reason (symmetry) for $\sin^2 2\theta_{13} = 0$**
- **Even if $\sin^2 2\theta_{13} = 0$ at tree level, $\sin^2 2\theta_{13}$ will not vanish at low energies with radiative corrections**
- **Theoretical models predict $\sin^2 2\theta_{13} \sim 0.001$-$0.1$, typical precision: 3-6%**
- **Measurement of $\sin^2 2\theta_{13}$ with precision < 0.01 is desired, i.e. improvement of an order of magnitude**

Daya Bay nuclear power plant

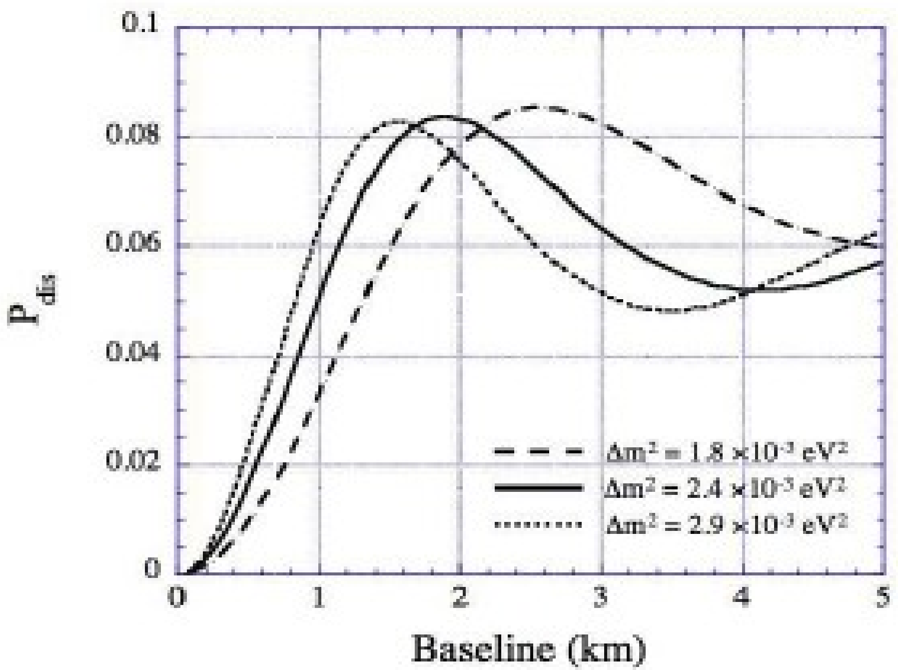
- 4 reactor cores, 11.6 GW
- 2 more cores in 2011 for a total of 17.4 GW
- Mountains near by, easy to construct a lab with enough overburden to shield cosmic-ray backgrounds

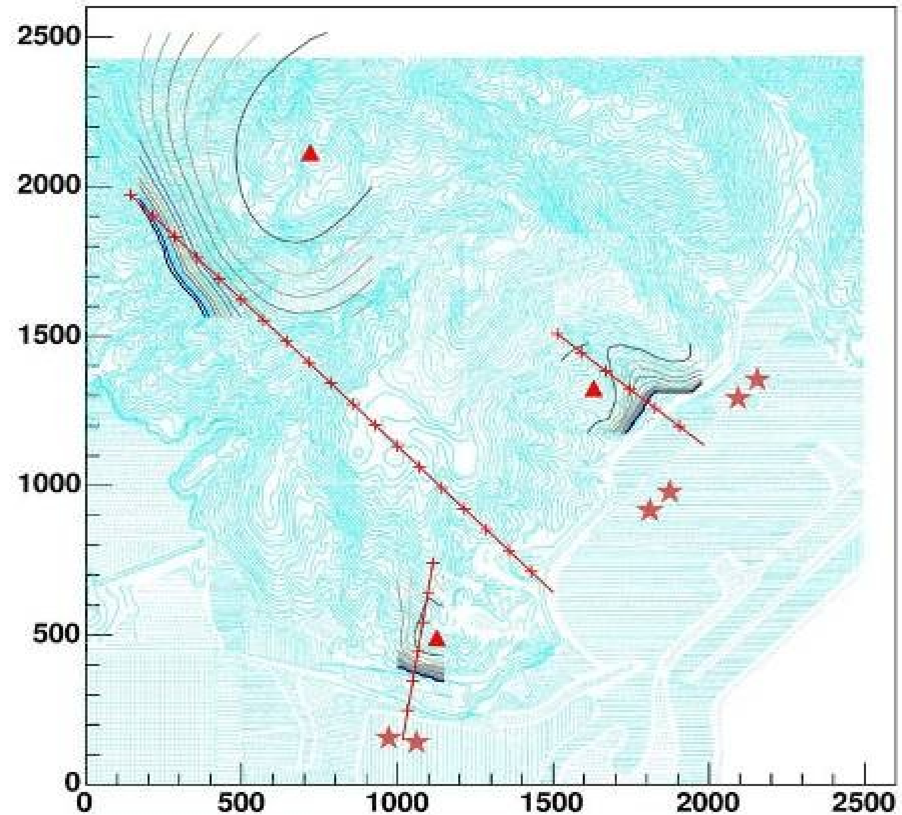


Design considerations: 1% precision

- ***Identical near and far detectors*** **to cancel reactor-related errors**
- ***Multiple modules*** **for reducing detector-related errors and cross checks**
- ***Three-zone detector modules*** **to reduce detector-related errors**
- ***Overburden and shielding*** **to reduce backgrounds**
- ***Multiple muon detectors*** **for reducing backgrounds and cross checks**
- ***Movable detectors*** **for swapping**

Baseline optimization and site selection





- **Neutrino flux and spectrum**
- **Detector systematical error**
- **Backgrounds from environment**
- **Cosmic-ray induced backgrounds (rate and shape) taking into mountain shape: fast neutrons, 9Li, …**

Experimental layout

- **Identical detector at near and far site to perform relative measurement in order to cancel reactor related systematic error**
- **Experimental halls are connected by 3000m tunnel**

- **Signal rate ：**
  ~1200/day Near
  ~350/day Far
- **Backgrounds ：**
  B/S ~0.4% Near
  B/S ~0.2% Far

Background related errors

- **Uncorrelated backgrounds:**

  U/Th/K/Rn/neutron

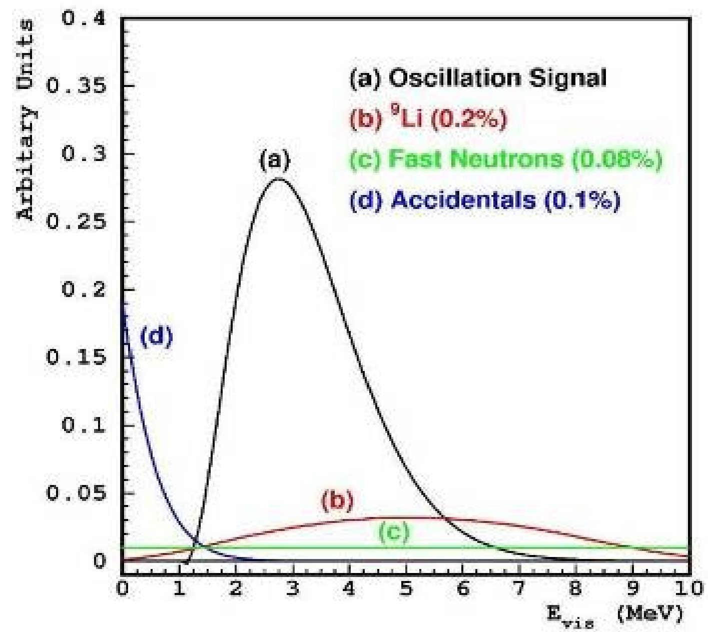
  Single gamma rate @ 0.9MeV < 50Hz

  Single neutron rate < 1000/day

- **Correlated backgrounds:** $n \propto E_\mu^{0.75}$

  Fast Neutrons: double coincidence

  $^8He/^9Li$: neutron emitting decays



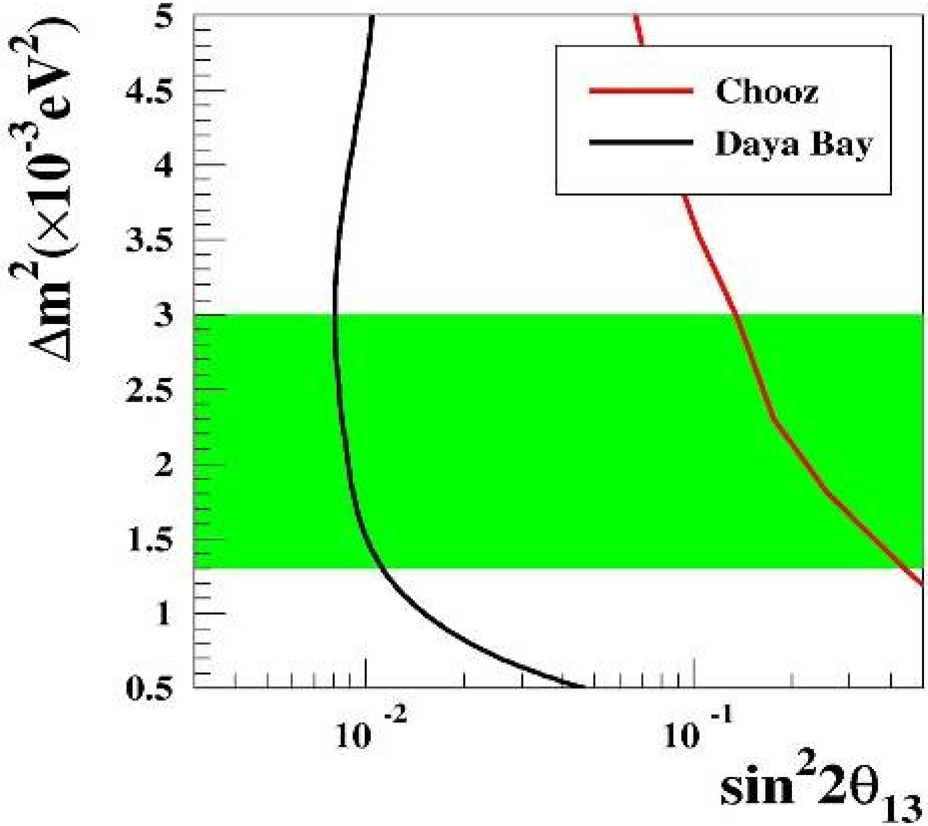
	Daya Bay Near	Ling Ao Near	Far Hall
Baseline (m)	363	481 from Ling Ao 526 from Ling Ao II	1985 from Daya Bay 1615 from Ling Ao's
Overburden (m)	98	112	350
Radioactivity (Hz)	<50	<50	<50
Muon rate (Hz)	36	22	1.2
Antineutrino Signal (events/day)	930	760	90
Accidental Background/Signal (%)	<0.2	<0.2	<0.1
Fast neutron Background/Signal (%)	0.1	0.1	0.1
$^8He+^9Li$ Background/Signal (%)	0.3	0.2	0.2

Schedule

- Ground Breaking of civil construction Oct. 2007
- Bring up first pair of detectors Oct. 2009
- Begin data taking with the Near-Far configuration Dec. 2010

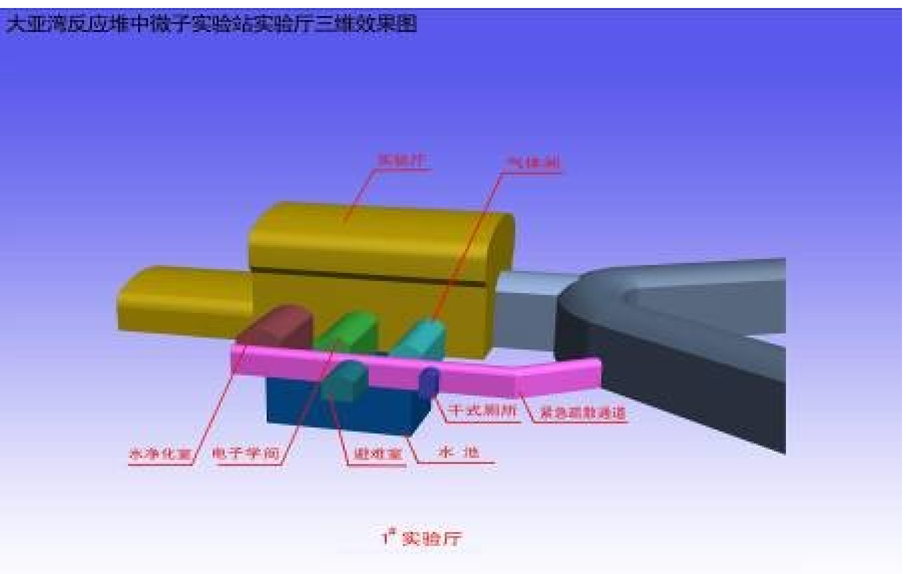
Expect to reach the sensitivity of 0.01 with 3 years of running.

Sensitivity to $\sin^2 2\theta_{13}$



sources	Uncertainty
Reactors	0.087% (4 cores) 0.13% (6 cores)
Detector (per module)	0.38% (baseline) 0.18% (goal)
Backgrounds	0.32% (Daya Bay near) 0.22% (Ling Ao near) 0.22% (far)
Signal statistics	0.2%

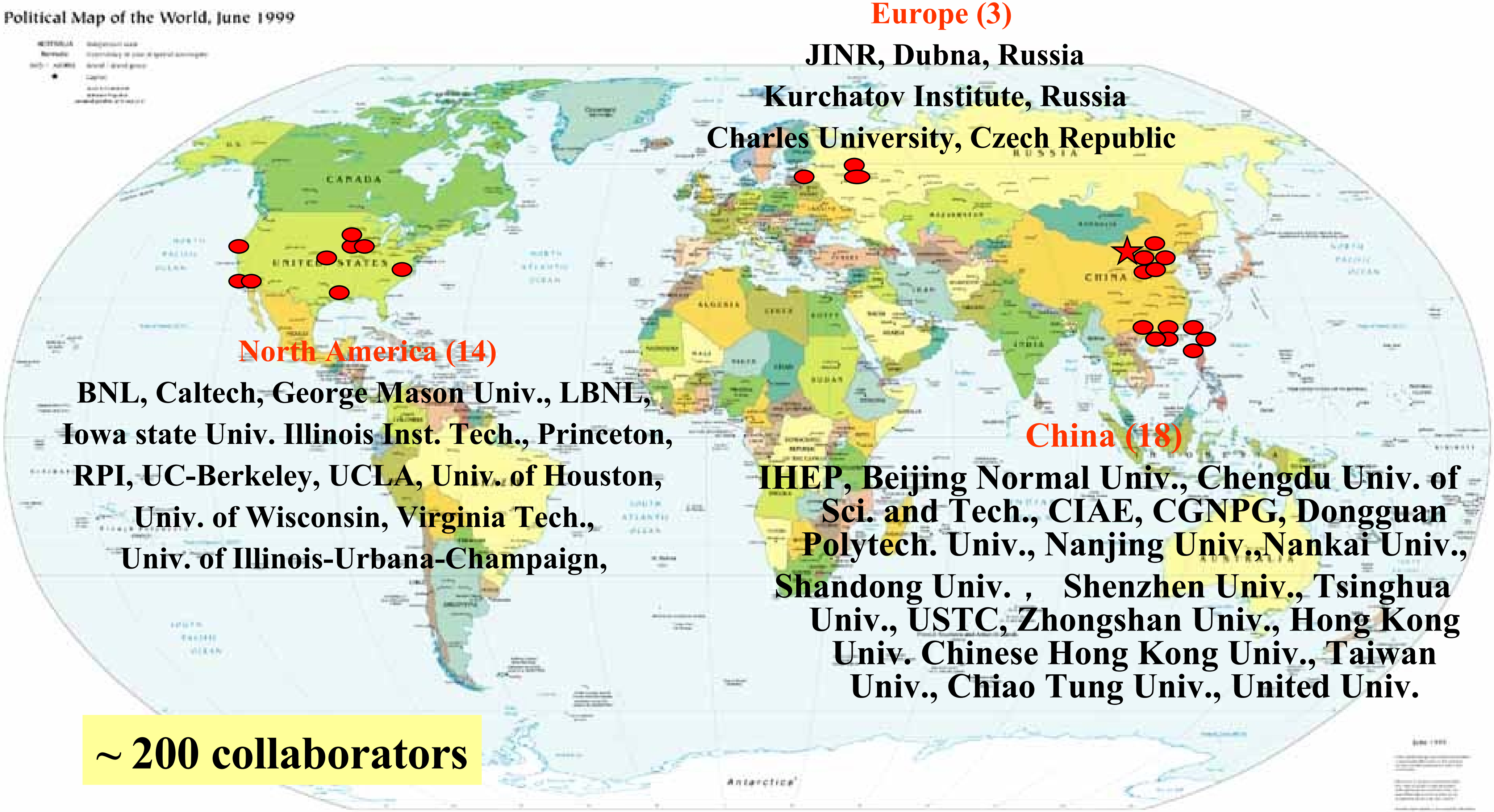
Tunnel and experimental halls



黄河勘测规划设计有限公司

- Three experimental halls
- Surface assembly building
- Utility and safety
- Construction time: 22 months

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,

China (18)

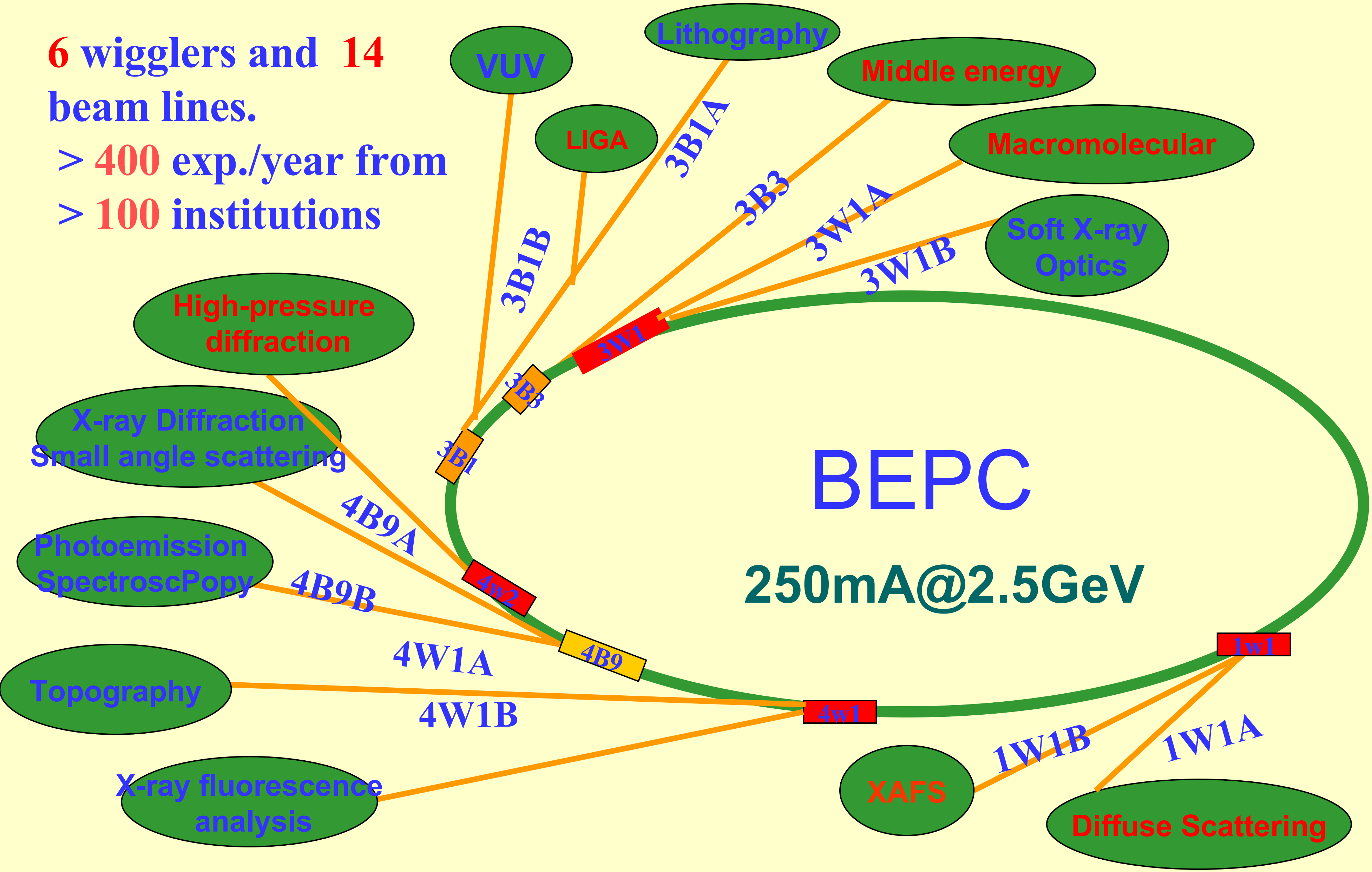
IHEP, Beijing Normal Univ., Chengdu Univ. of Sci. and Tech., CIAE, CGNPG, Dongguan Polytech. Univ., Nanjing Univ.,Nankai Univ., Shandong Univ. , Shenzhen Univ., Tsinghua Univ., USTC, Zhongshan Univ., Hong Kong Univ. Chinese Hong Kong Univ., Taiwan Univ., Chiao Tung Univ., United Univ.

~ 200 collaborators

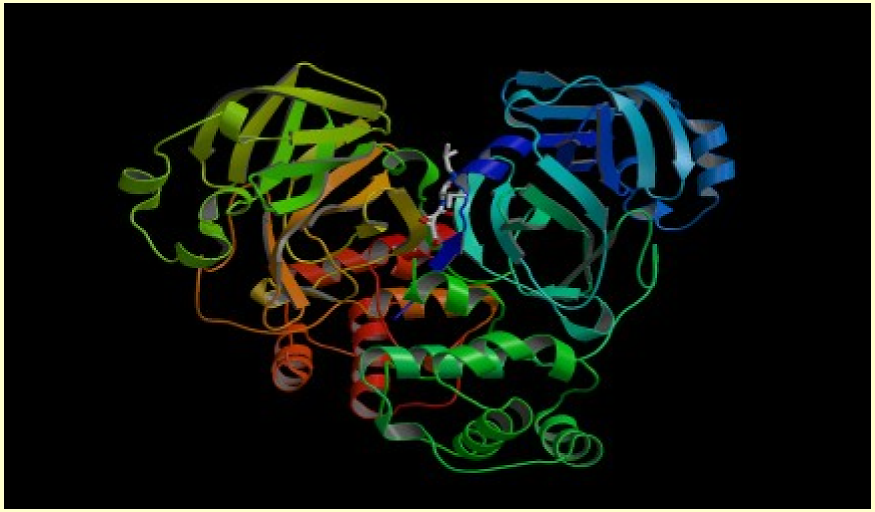
6 wigglers and 14 beam lines.

> 400 exp./year from

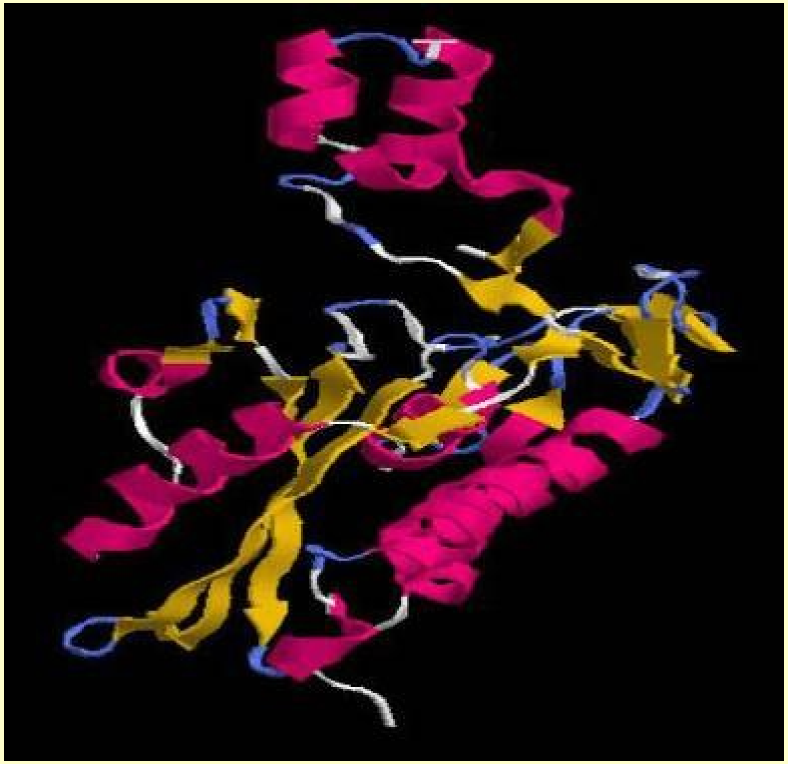
> 100 institutions



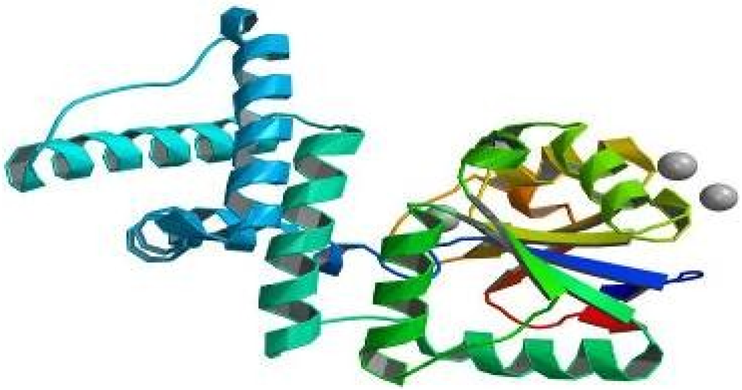
Beijing Synchrotron Radiation Facility



SARS protein CoV M^{pro}

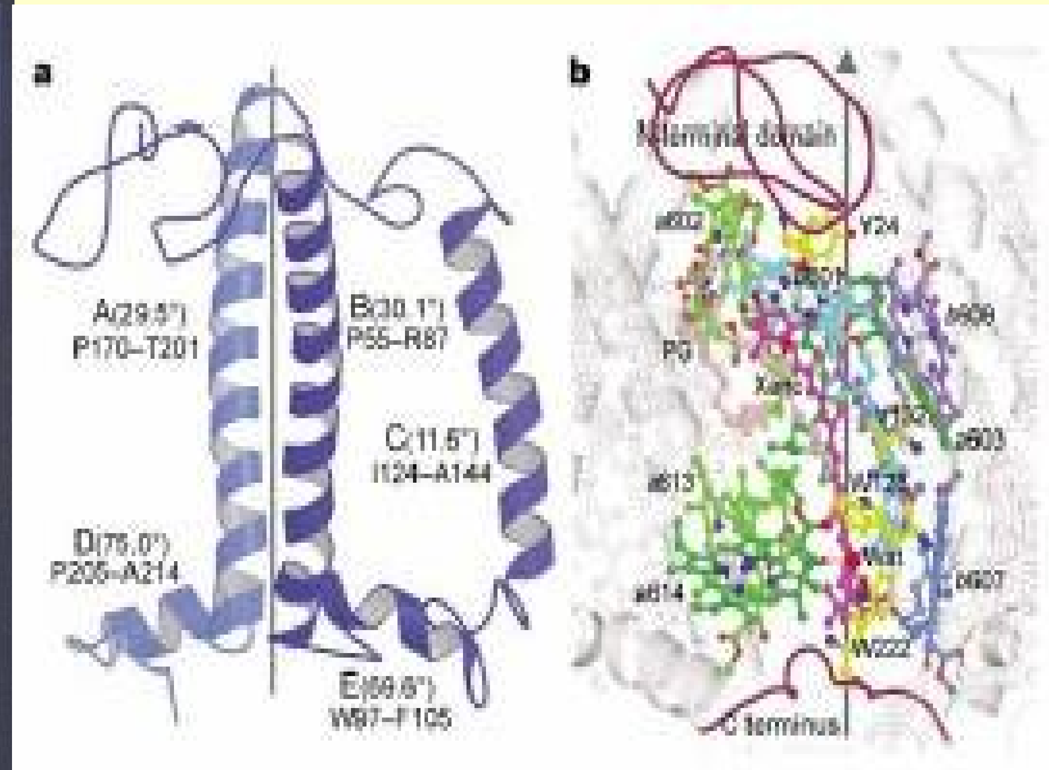


Structure of CRISP Protein



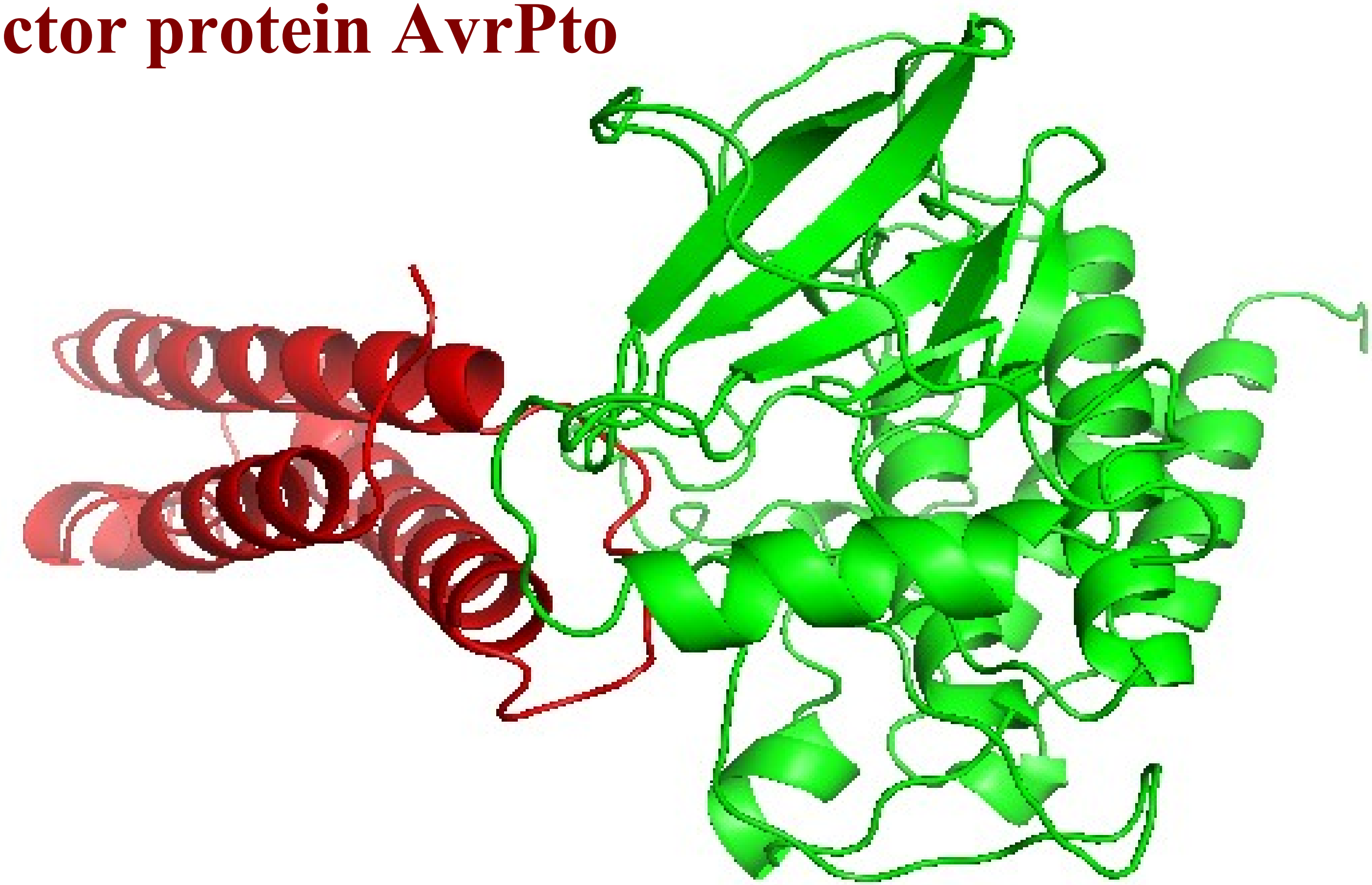
Structure of MASA from MAD

More than 60 Protein structures obtained from BSRF



Structure of third type of light–harvester protein. The structure diffraction data taken at BSRF.

The structural basis for activation of plant immunity by bacterial effector protein AvrPto



Jijie Chai group, NIBS, Nature, 449, 243 (12 Aug 2007)

Status of Chinese SNS

- Chinese government approved. Funding procedure is underway.
- RCS H^- beam; RFQ 3.5MeV; 81MeV(DTL) to 230 MeV (+SCL) Rapid-cycling synchrotron: 1.6 GeV 100KW
- IHEP is in charge of the project
- Site: Dongguan, Guangdong province. a branch of IHEP
- Budget: 1.4B RMB + the fund (0.5B) & the land from the local governments
- 5.5 year: first beam

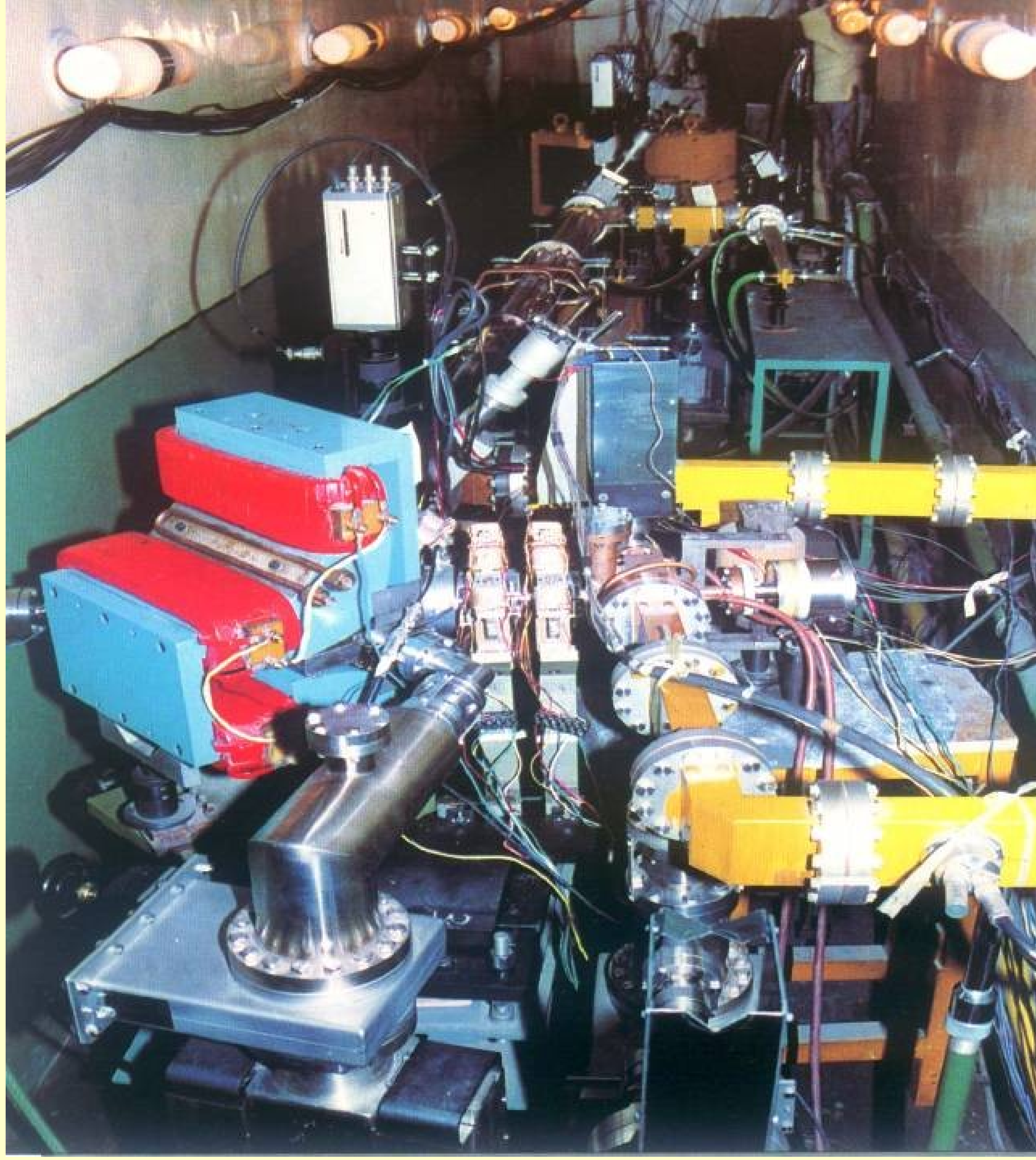
Chinese Spallation Neutron Source

CSNS Parameters

	Phase I	Phase II	Phase II’
Beam power on target [kW]	120	240	500
Proton energy on target [GeV]	1.6	1.6	1.6
Average beam current [μA]	76	151	315
Pulse repetition rate [Hz]	25	25	25
Protons per pulse [10^{13}]	1.9	3.8	7.8
Linac energy [MeV]	81	134	230
Linac type	DTL	DTL	DTL+SCL
Target number	1	1	1 or 2
Target material	Tungsten		
Moderators	H_2O (300K), CH_4(100K), H_2(20K)		
Number of spectrometers	7	18	>18

Beijing Free Electron Laser

- First in Asia
- Beam energy 30 MeV
- Infra-red FEL
- many applications



Chinese Particle Physics in 21st Century

- Particle Physics & particle astrophysics: great challenges and great opportunities in 21st century
- Chinese economy grows quickly and steadily
- Chinese government increases the supports to sciences and technology significantly and constantly .
- With construction of BEPCII/BESIII, Shanghai light source and CSNS, the new generation of Chinese accelerator and detector teams are shaping: young and growing fast. They could catch the future opportunity in particle physics
- Strong demands on
  - the large scientific facilities based on accelerators.
  - the application of accelerator and detector technology

Chinese Particle Physics Medium and Long Term Plan

- Charm physics @ BEPCII
- Intl. collaborations: LHC exp., EXFEL, ILC,…
- Particle Astrophysics exp. at Space
  - Modulated hard X-ray telescope satellite
  - SVOM
- Cosmic ray measurement
  - Yangbajing Cosmic ray Observatory
  - Cosmic ray neutrinos telescope (under discussion)
- Neutrino experiments:
  - Daya Bay Reactor neutrino to measure $\sin^2 2\theta_{13}$
  - Very LBL oscillation: J-Prac→Beijing (under discussion)
- National underground Lab. (under discussion)

Chinese Particle Physics Medium and Long Term Plan (cont.)

- High power proton Accelerator:
  - Chinese Spallation Neutron Source
  - Accelerator Driven Subcritical system
- Hard X-ray FEL
- Convert BEPC into dedicated SR source after BEPCII finished physics running

IHEP extents research fields, to protein structure, nano-science, material science…

→ Multiple discipline research center

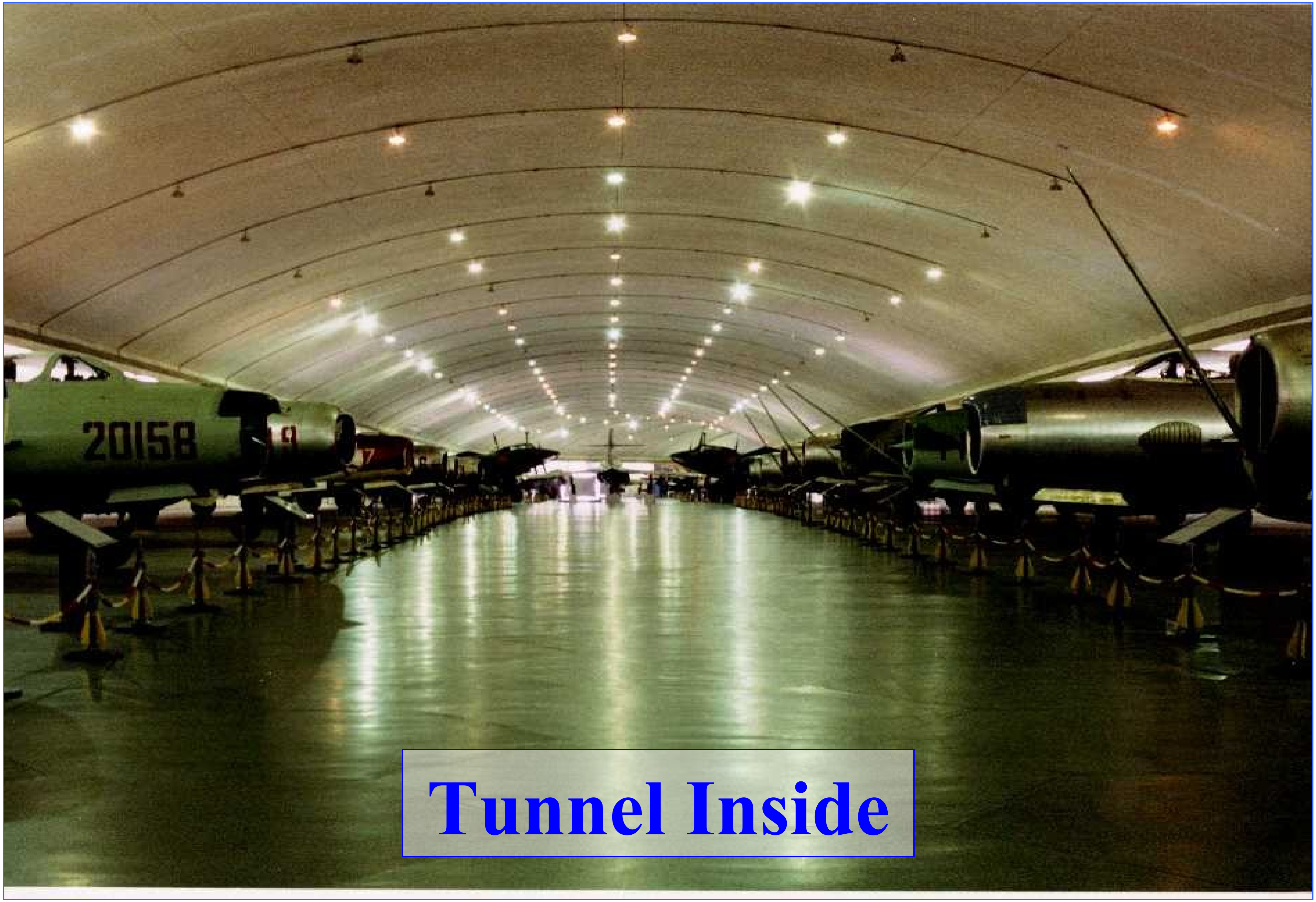
VLBL ν Experiment of J-Parc to Beijing

- VLBL ν exp. with 2000 - 4000 km is very interesting for many important physics, if $\sin^2 2\theta_{13}$ is not too small:
  - Sign of the difference of ν mass square
  - CP phase of ν
- VLBL ν experiment from J-parc to Beijing
  - Good tunnel: 20 km north of Beijing, near highway to Great Wall. 560 m long, 34 meter wide, 13 meter height , 150 m rock on top
  - Good infrastructure available
  - 2200 km to Beijing with 9.5^o dip angle
- Second ν beam line required.
  J-Parc phase 2? ν Factory ?
- Two reports issued and several papers published.

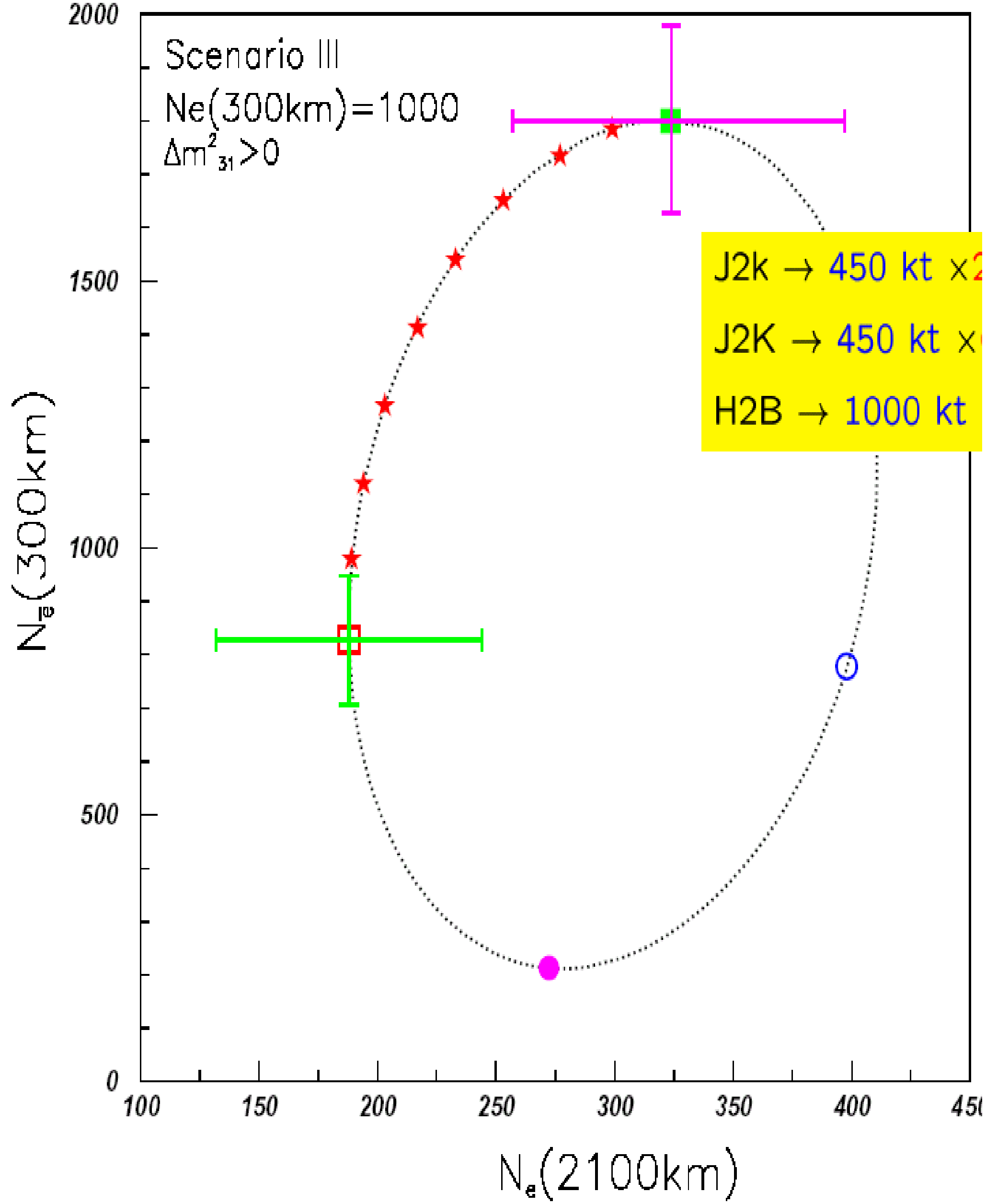
Tunnel Gate

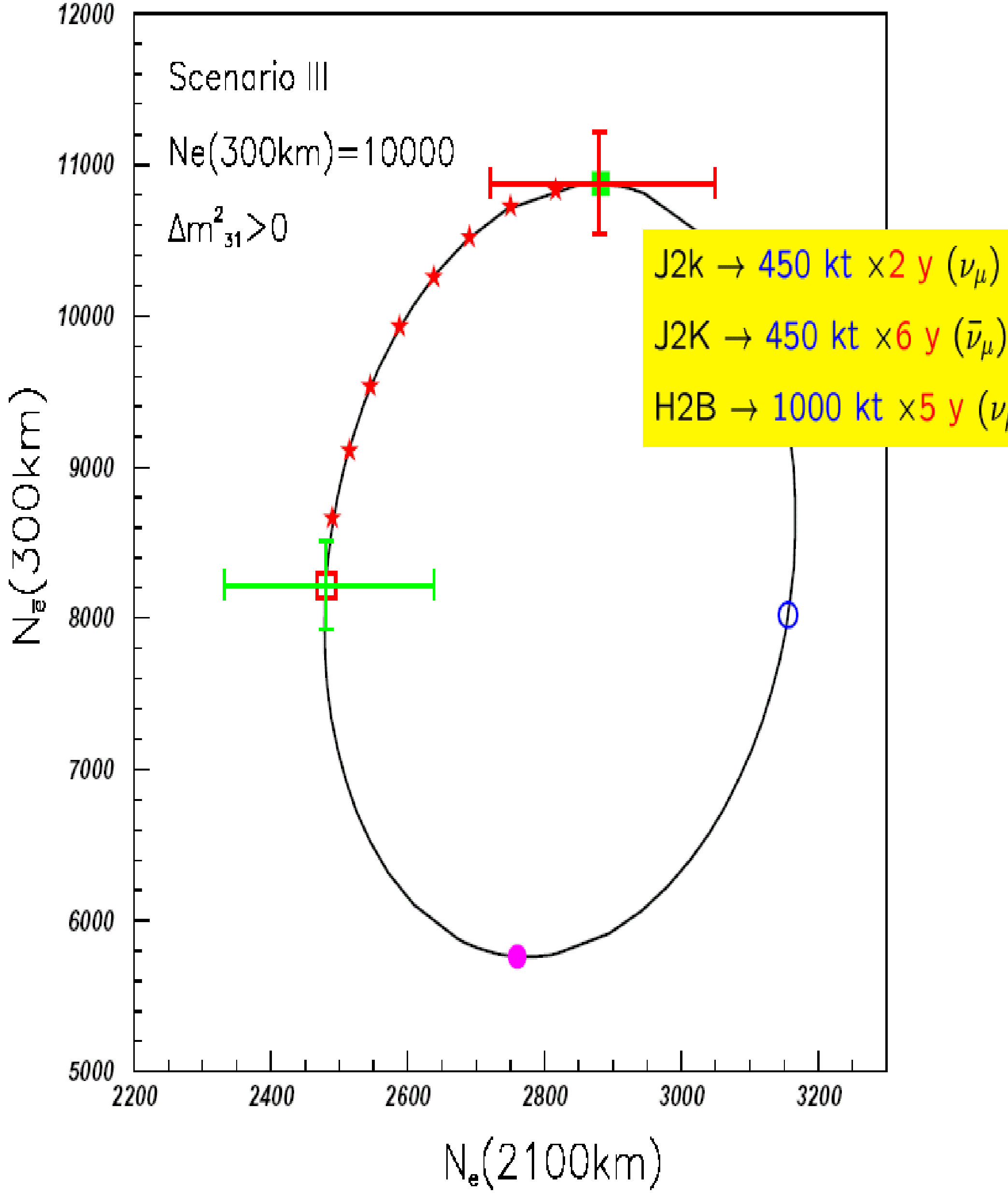
(Aviation Museum)

20Km north of Beijing, near highway to Great Wall



Tunnel Inside





$\sin^2(2\theta_{13}) \sim 0.007$

$\sin^2(2\theta_{13}) \sim$ 0.07

Look forward for more cooperation with German Physicists!

Thanks !