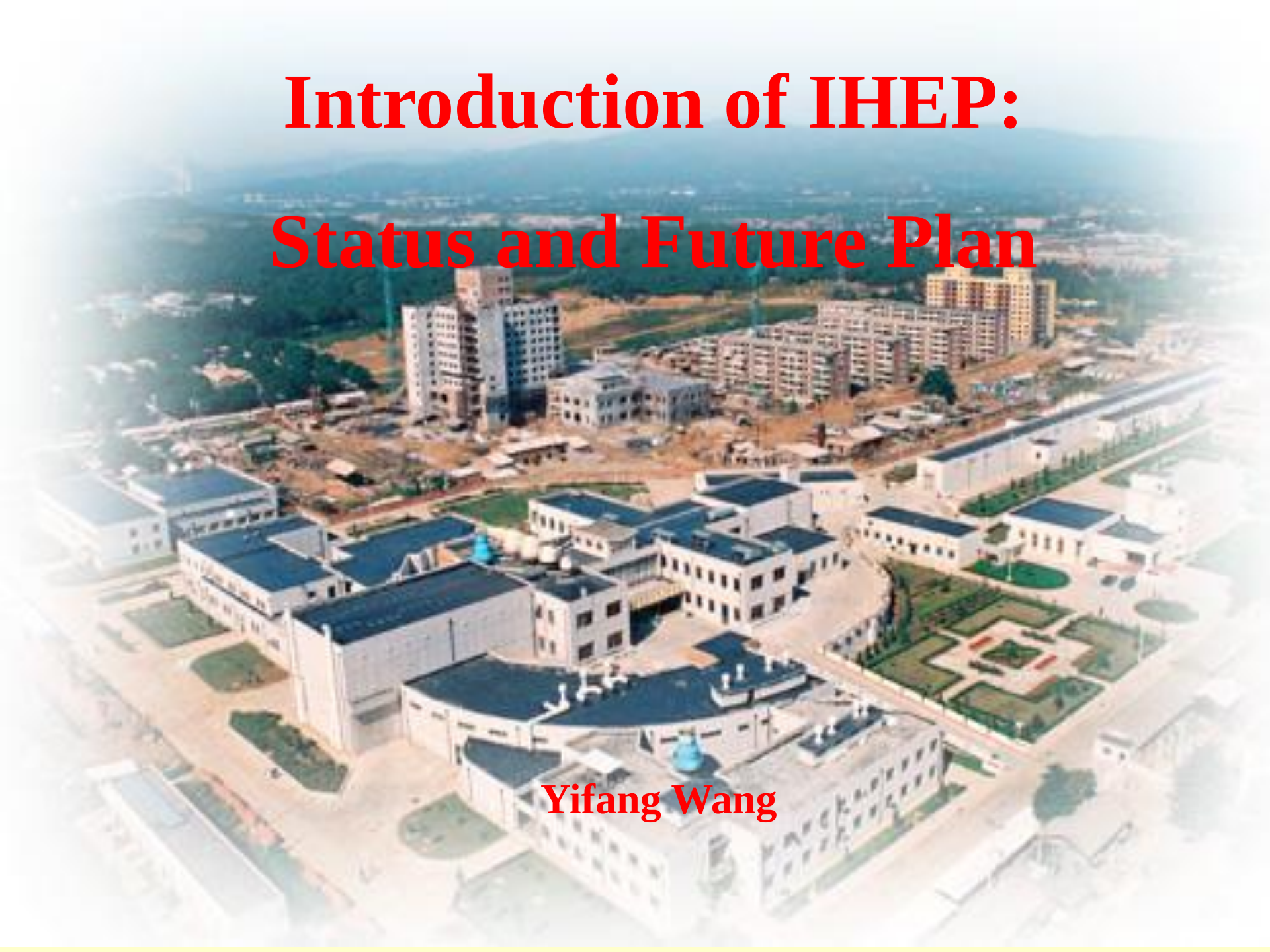
# Introduction of IHEP:

# Status and Future Plan



Yifang Wang

# History

**May 19, 1950 :**

Institute of Modern Physics, CAS

**Oct. 6, 1953:**

Institute of Physics, CAS

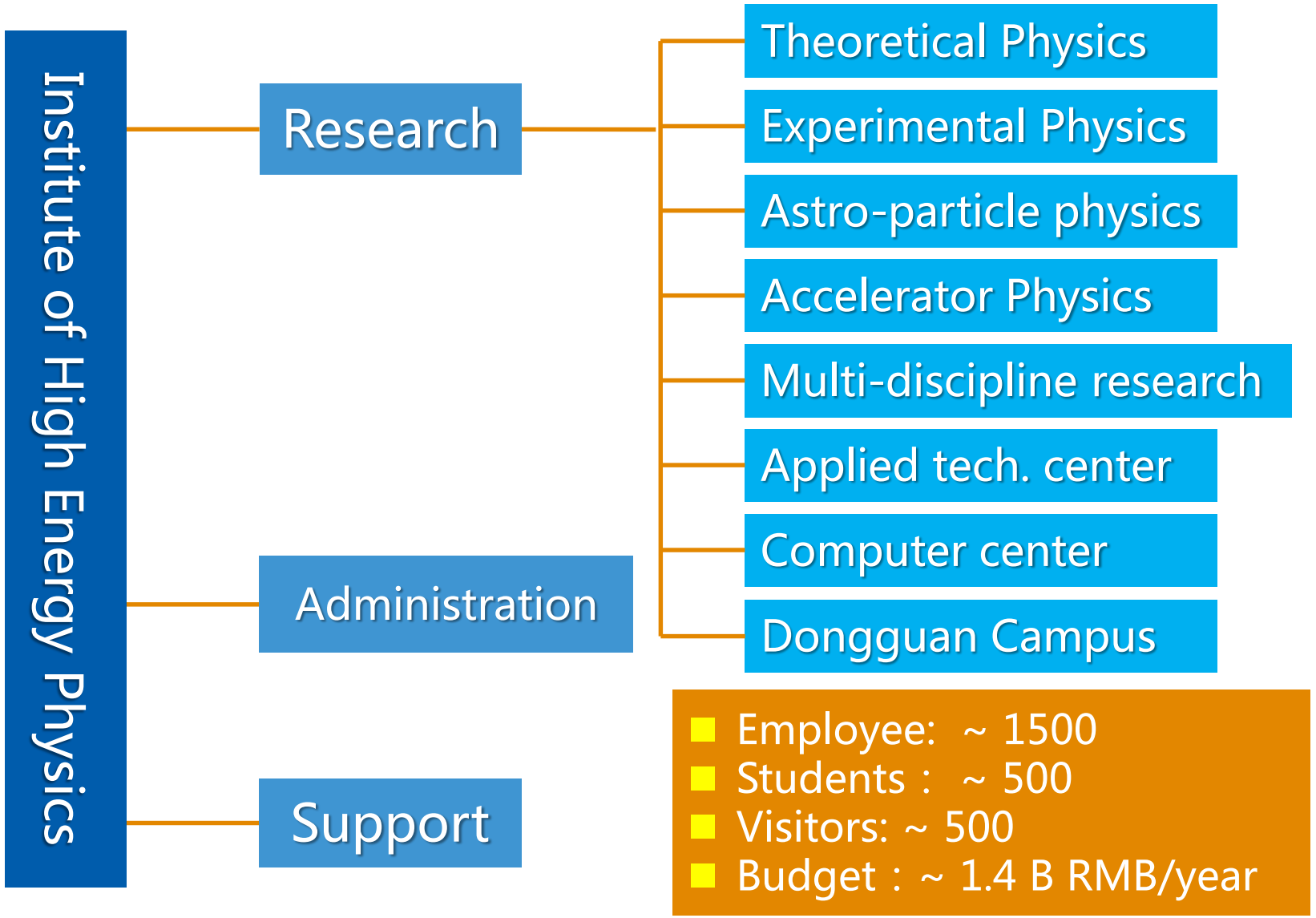
**July 1, 1958 :**

Institute of atomic energy

**Feb. 1, 1973:**

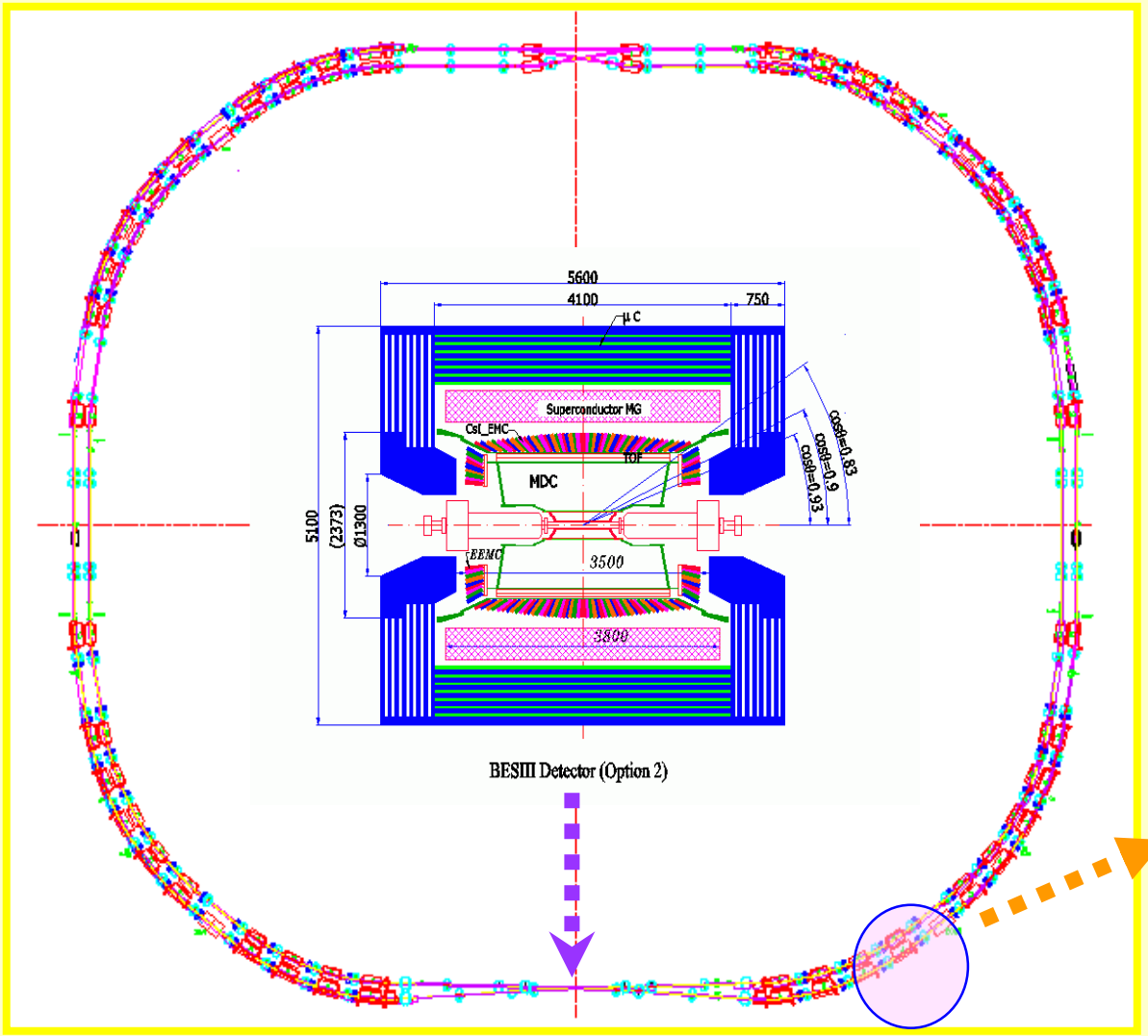
Institute of High Energy Physics, CAS

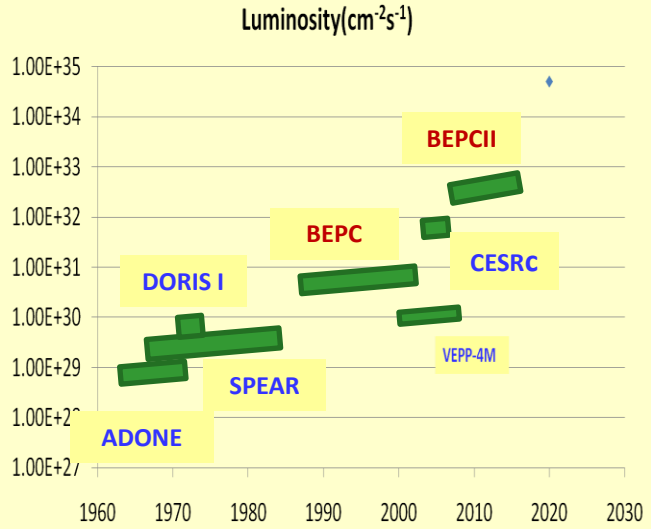
# IHEP Today


Institute of High Energy Physics
Research
Administration
Support
Theoretical Physics
Experimental Physics
Astro-particle physics
Accelerator Physics
Multi-discipline research
Applied tech. center
Computer center
Dongguan Campus
Employee: ~ 1500
Students : ~ 500
Visitors: ~ 500
Budget : ~ 1.4 B RMB/year

# Particle physics in China started from BEPC

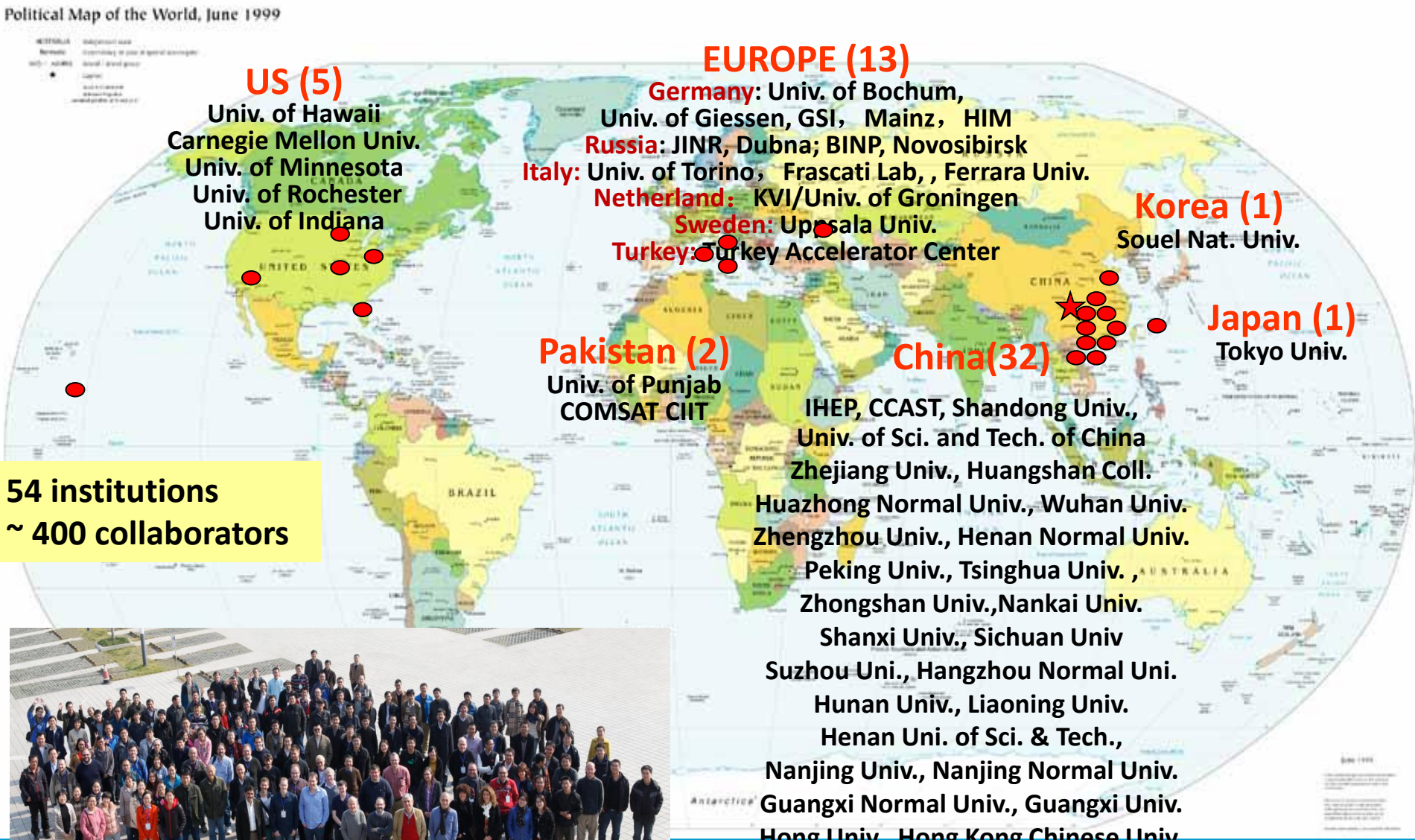
## BEPCII/BESIII: Operational since 2009



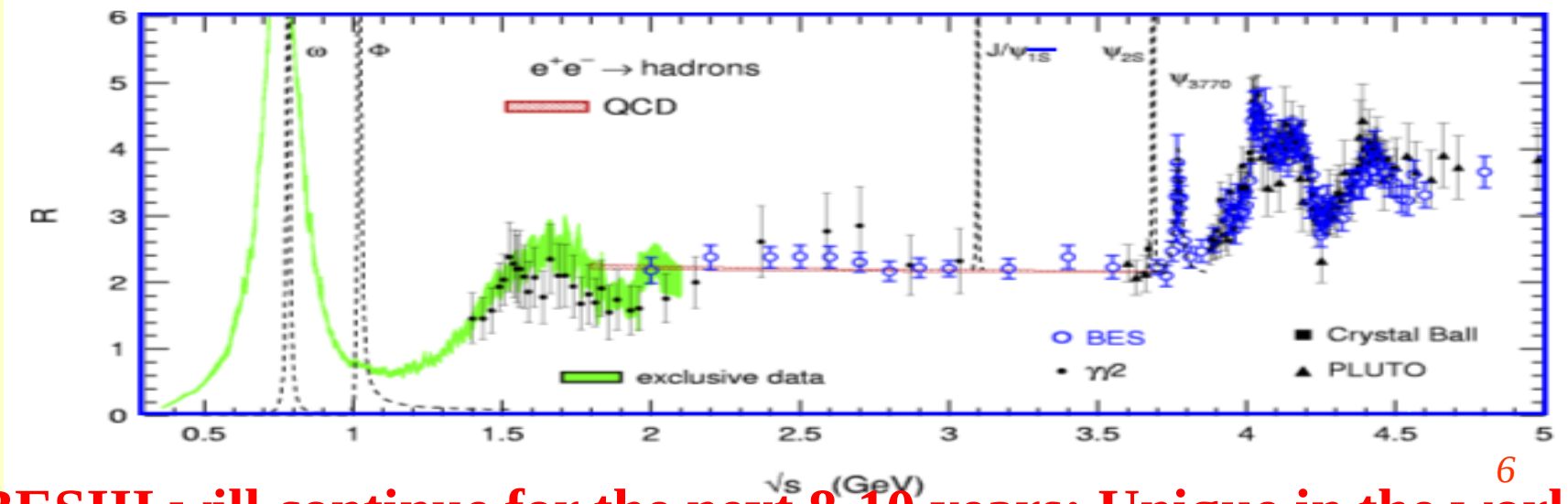

**$e^+e^-$ collider at tau-charm**

# BESIII: an international collaboration



# BESIII Data Taking Status & Plan

| | Previous Data set | BESIII now | Goal |
|---|---|---|---|
| J/psi | BESII: 58M | 1.2 B | 10B |
| Psi' | CLEO: 28 M | 0.5 B | 3B |
| Psi'' | CLEO: 0.8 /fb | 3.0/fb | 20 /fb |
| ψ(4040)/ψ(4160) /X(4260) etc. | CLEO: 0.6/fb @ ψ(4160) | 0.5/fb ψ(4040); 2.3/fb @~4260, 0.5/fb@ ~4360; 1/fb@~4420; 0.5/fb@~4600 | ~ 10 /fb |
| R scan & Tau | BESII @10K/pnts | 105 pnts@3.8-4.6 GeV | 100K/pnts |



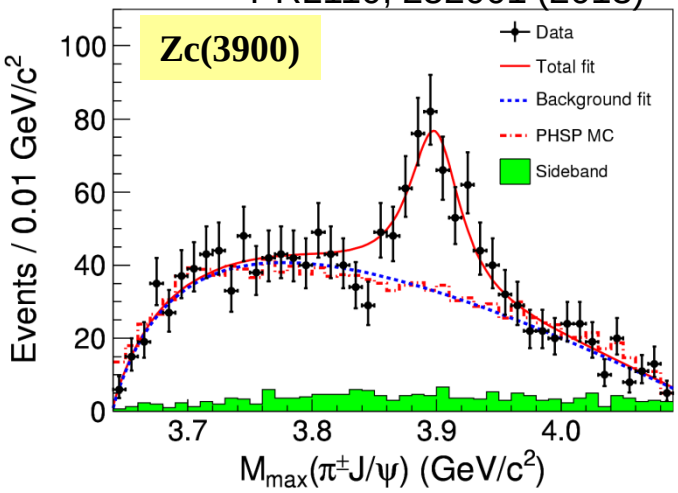



**BESIII will continue for the next 8-10 years: Unique in the world**

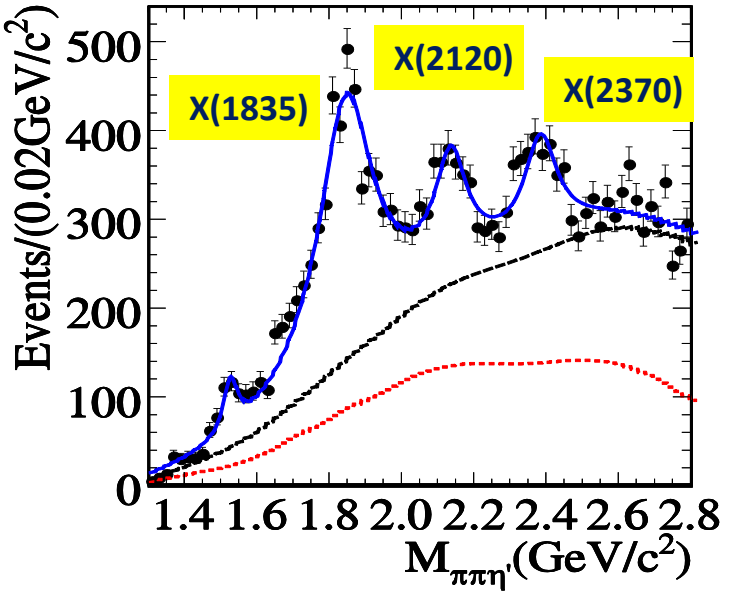
# Highlights from BEPCII/BESIII

- Main Highlights:
  - Discovery of $Zc^{\pm}(3900)$: a four-quark states
  - Discovery of neutral accompany states: $Zc^{0}(3900)$
  - Discovery of higher mass accompany states $Z_c(4025)/Z_c(4020)$, …
  - Exotic light hadrons: X(1835), X(1870), X(2120), …
  - Charm physics, QCD, etc.
- > 25 papers/year, > 150 papers in total so far
- BESIII will continue to operate for another ~8 years.

PRL110, 252001 (2013)

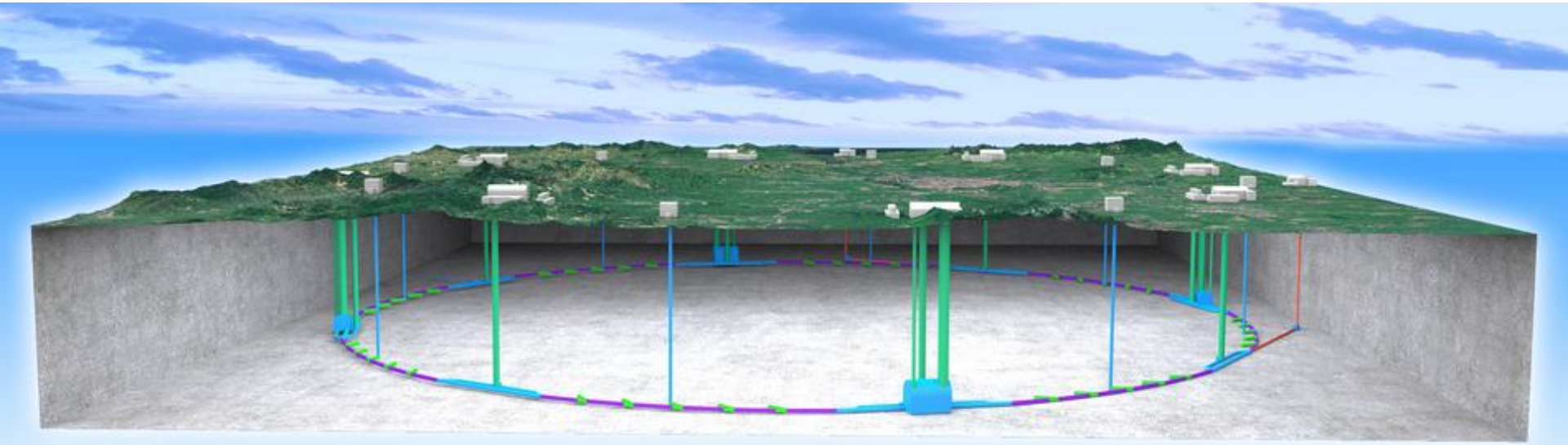



PRL 106 (2011) 072002



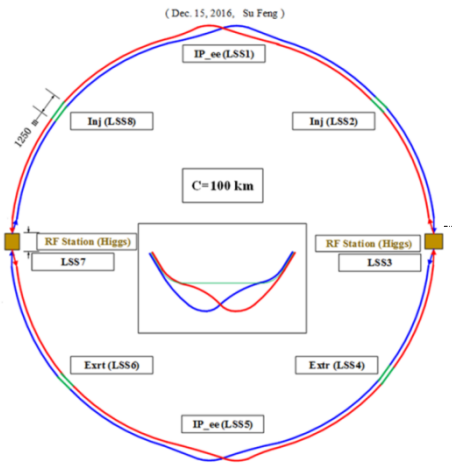
# The Future: CEPC+SppC

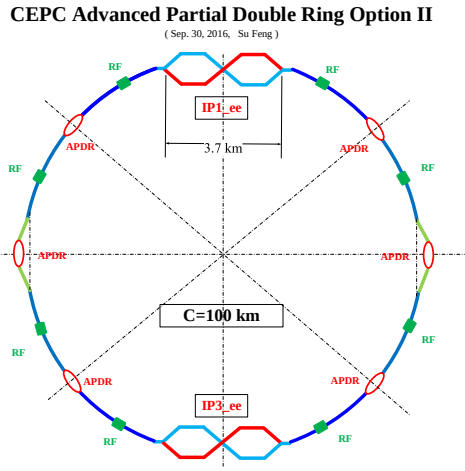
- An $e^+e^-$ collider for Higgs&Z factories ($L > 2\times10^{34}cm^{-2}s^{-1}$) in a 100 km tunnel with 30 MW SR power; upgradable to 50 MW
- At least 4 SR beamlines with $E_\gamma > 600$ keV
- Compatible to possible pp/ep/AA colliders in the future



# CEPC accelerator

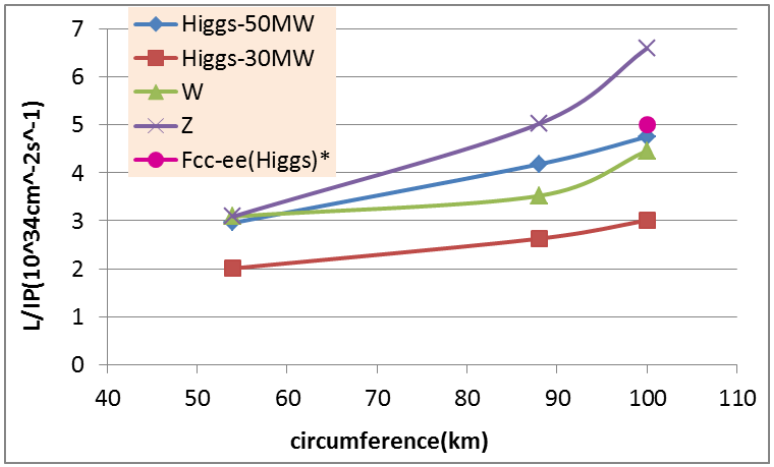
- **Design: partial and full double ring, 100 km, 30 MW**
- **Accelerator Physics: lattice, bem-beam interactions, optimization, dynamic aperture, …**
- **MDI, RF system, injector, …**



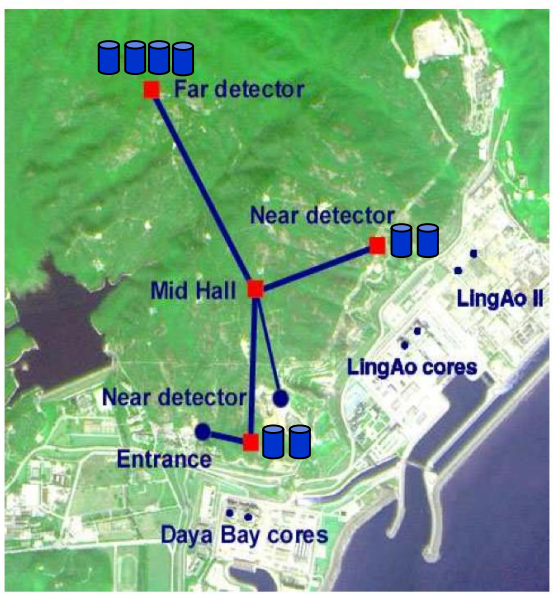



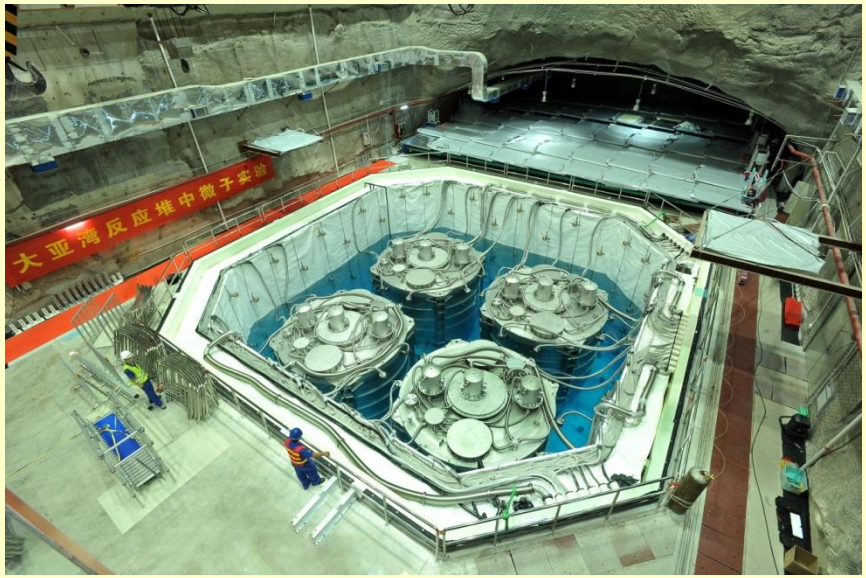

| 参数 | Design Goal for Z | Design Goal for Higgs |
|---|---|---|
| Particles | e+, e- | e+, e- |
| Center of mass energy | 2*45.5 GeV | 2*120 GeV |
| peak luminosity | >1*$10^{34}$/$cm^2$s | 2*$10^{34}$/$cm^2$s |
| No. of IPs | 2 | 2 |
| Polarization | Possible | |

**CEPC baseline** **CEPC option**



# Daya Bay reactor neutrino experiment



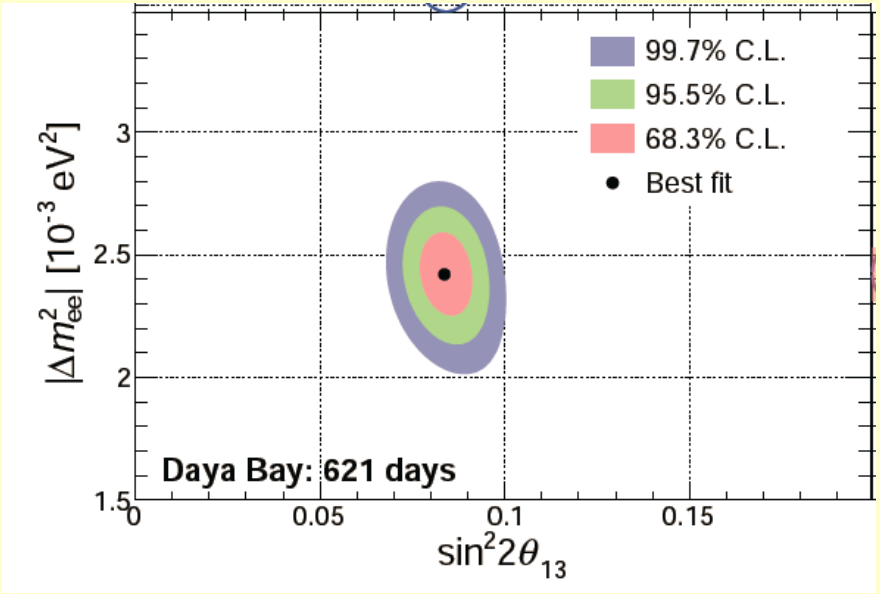



**First measurement reported in 2012:**

$\mathbf{Sin^2 2\theta_{13} = 0.092 \pm 0.016(stat) \pm 0.005(syst)}$

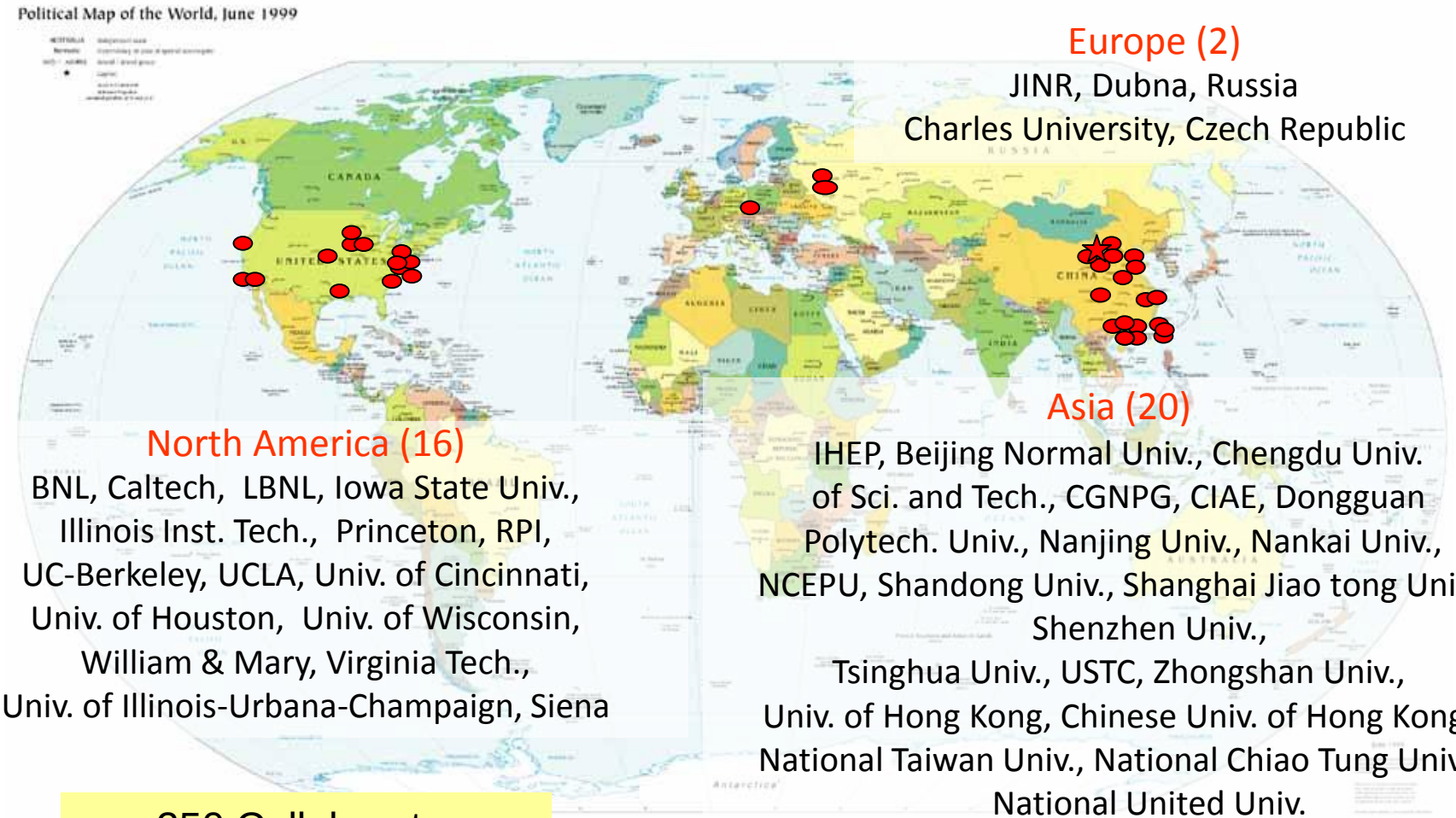
**Probability of non-zero $\theta_{13}$ 5.3 $\sigma$**

F.P. An et al., Phys. Rev. Lett. 108, (2012) 171803




**Current precision: ~ 4 %**
**Will continue until 2020, goal: 3%**

# Daya Bay Collaboration




Europe (2)

JINR, Dubna, Russia

Charles University, Czech Republic

North America (16)

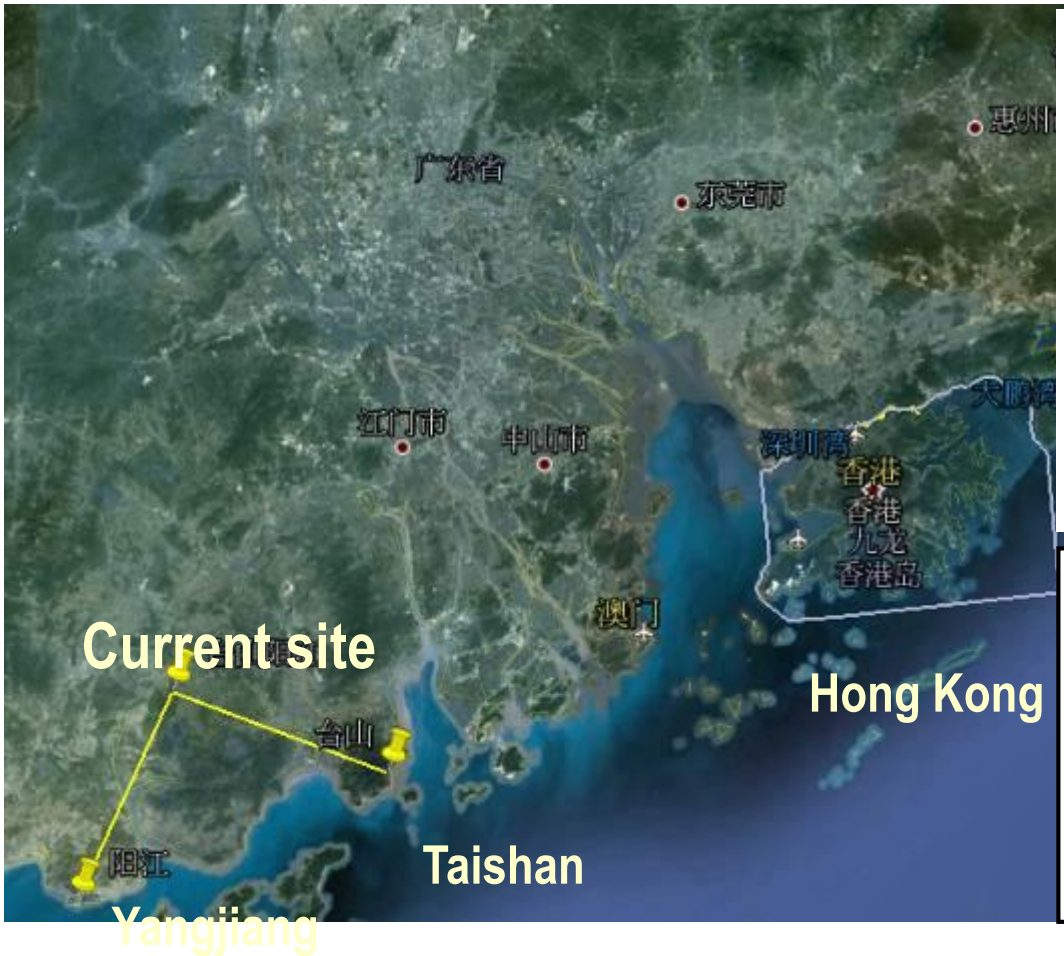
BNL, Caltech, LBNL, Iowa State Univ., Illinois Inst. Tech., Princeton, RPI, UC-Berkeley, UCLA, Univ. of Cincinnati, Univ. of Houston, Univ. of Wisconsin, William & Mary, Virginia Tech., Univ. of Illinois-Urbana-Champaign, Siena

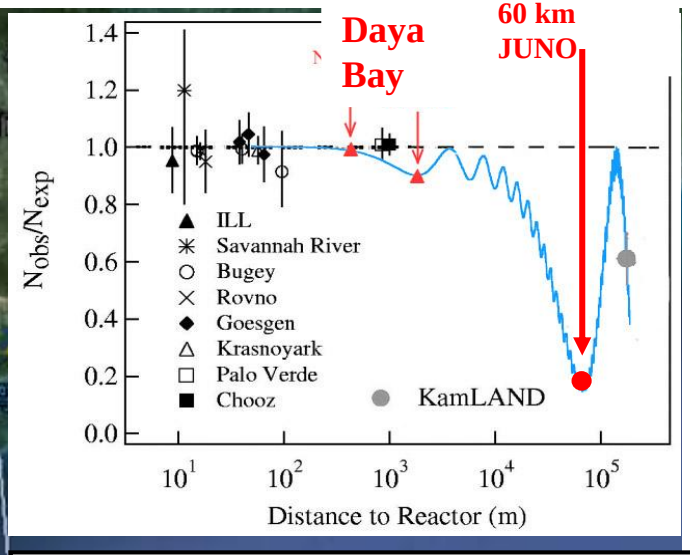
Asia (20)

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

~250 Collaborators

# Next Step: JUNO for Mass Hierarchy



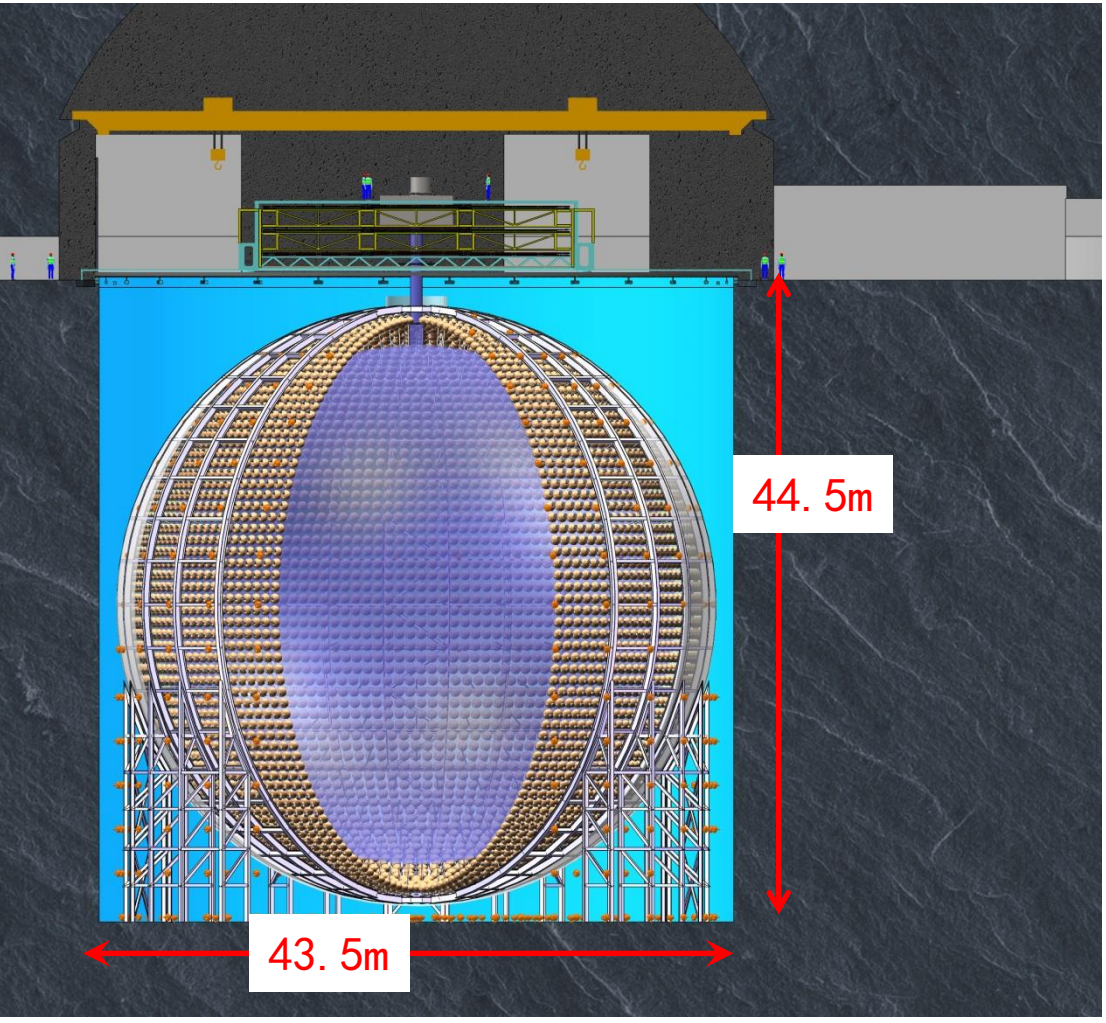




- Mass hierarchy
- Precision mixing parameters
- Supernova neutrinos
- Geoneutrinos
- Sterile neutrinos

- **Construction started on 2015**
- **Planned data taking on 2020**

# JUNO Detector and Challenges

- Largest LS detector ➔ × 20 KamLAND， × 40 Borexino
- Highest light yield ➔ × 2 Borexino， × 5 KamLAND




- Hugh cavern:
  - ~ 48m× 70m,
  - Under construction
- Largest Acrylic tank:
  - Φ 35.4米( 13m@SNO)
  - Contract signed
- 20 kt LS
  - Best attenuation length: 25m (15m @ Daya Bay)
  - Lab test OK
- 20000 20” PMT
  - Highest photon detection efficiency : 30%*100% = 30% （25%*60%=15% @ SuperK）
  - Prototypes OK, contract signed:
    - 15000 NNVT, 5000 HAMAMATSU

# JUNO Collaboration

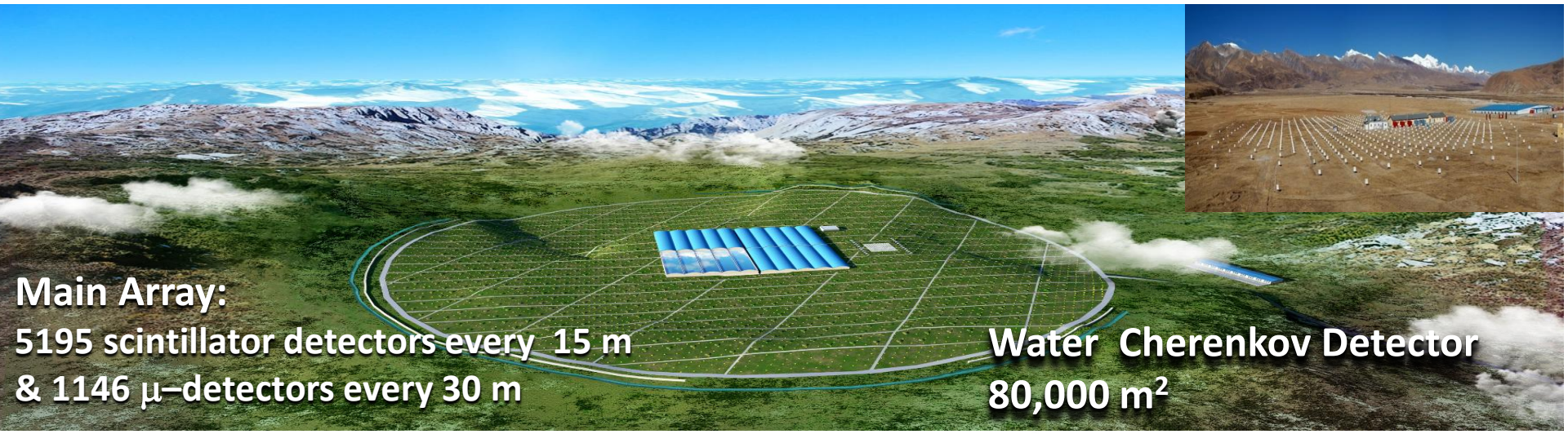
| Country | Institute |
|---|---|
| Armenia | Yerevan Physics Institute |
| Belgium | Universite libre de Bruxelles |
| Brazil | PUC |
| Brazil | UEL |
| Chile | PCUC |
| Chile | UTFSM |
| China | BISEE |
| China | Beijing Normal U. |
| China | CAGS |
| China | ChongQing University |
| China | CIAE |
| China | DGUT |
| China | ECUST |
| China | Guangxi U. |
| China | Harbin Institute of Technology |
| China | IHEP |
| China | Jilin U. |
| China | Jinan U. |
| China | Nanjing U. |
| China | Nankai U. |
| China | NCEPU |
| China | Pekin U. |
| China | Shandong U. |
| China | Shanghai JT U. |

| Country | Institute |
|---|---|
| China | IMP-CAS |
| China | SYSU |
| China | Tsinghua U. |
| China | UCAS |
| China | USTC |
| China | U. of South China |
| China | Wu Yi U. |
| China | Wuhan U. |
| China | Xi'an JT U. |
| China | Xiamen University |
| China | NUDT |
| Czech Rep. | Charles U. |
| Finland | University of Oulu |
| France | APC Paris |
| France | CENBG |
| France | CPPM Marseille |
| France | IPHC Strasbourg |
| France | Subatech Nantes |
| Germany | Forschungszentrum Julich ZEA2 |
| Germany | RWTH Aachen U. |
| Germany | TUM |
| Germany | U. Hamburg |
| Germany | IKP FZJ |

| Country | Institute |
|---|---|
| Germany | U. Mainz |
| Germany | U. Tuebingen |
| Italy | INFN Catania |
| Italy | INFN di Frascati |
| Italy | INFN-Ferrara |
| Italy | INFN-Milano |
| Italy | INFN-Milano Bicocca |
| Italy | INFN-Padova |
| Italy | INFN-Perugia |
| Italy | INFN-Roma 3 |
| Latvia | IECS |
| Pakistan | PINSTECH (PAEC) |
| Russia | INR Moscow |
| Russia | JINR |
| Russia | MSU |
| Slovakia | FMPICU |
| Taiwan | National Chiao-Tung U. |
| Taiwan | National Taiwan U. |
| Taiwan | National United U. |
| Thailand | NARIT |
| Thailand | PPRLCU |
| Thailand | SUT |
| USA | UMD1 |
| USA | UMD2 |

**550 collaborators from 71 institutions in 17 countries and regions**

# From ASγ/ARGO to LHAASO

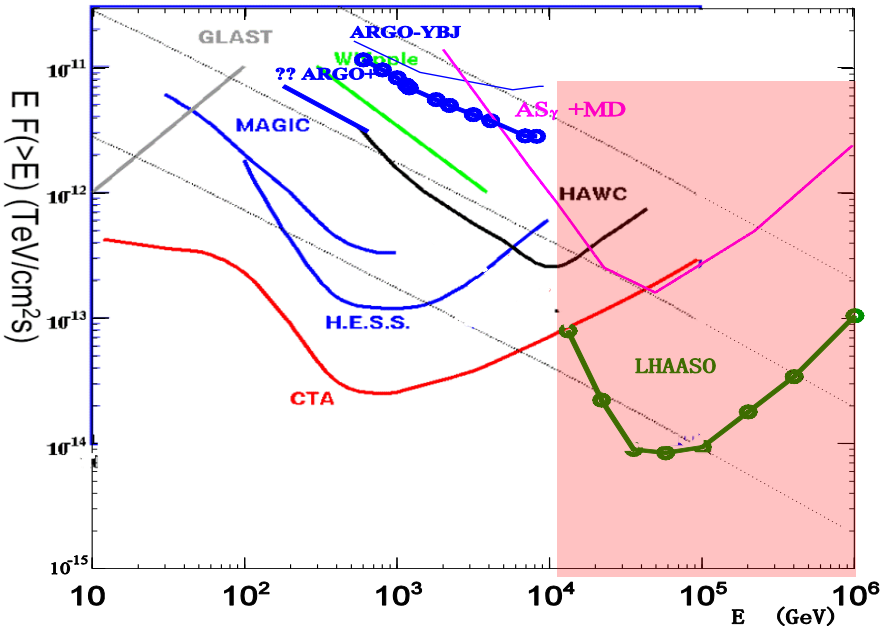




**Funded for 2017-2020**
**Construction started**

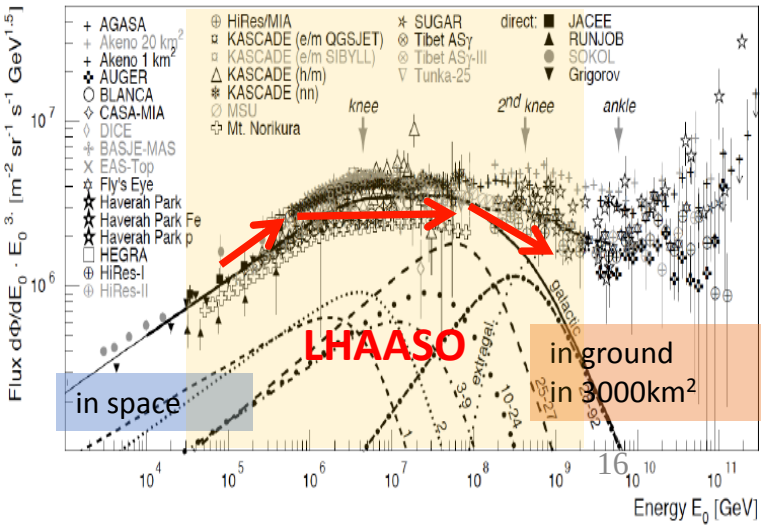
# Science at LHAASO

- Unique for 10 TeV γ astronomy with the highest sensitivity in the world
- Window for discovering the hadronic origins of cosmic rays
- Crucial CR data covering a very wide energy region of knees
- Exploring for new physics, such as DM or quantum gravity



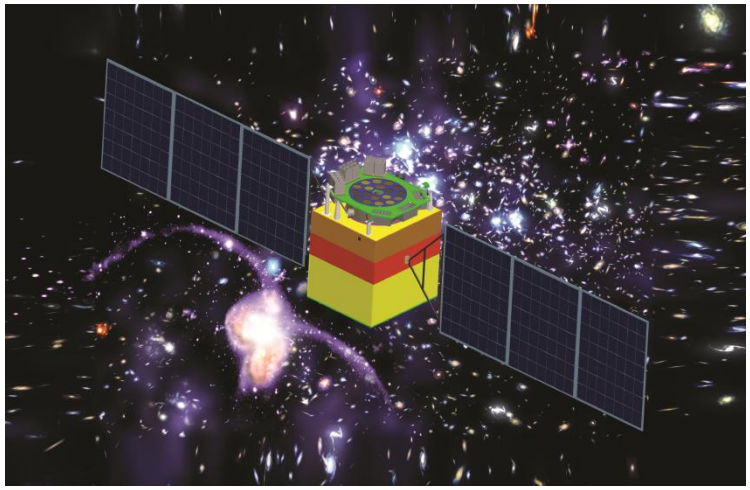

**Complementary to CTA:**

- All the time
- All the sky
- Time-variant sources
- Extended sources
- Fast indication for CTA

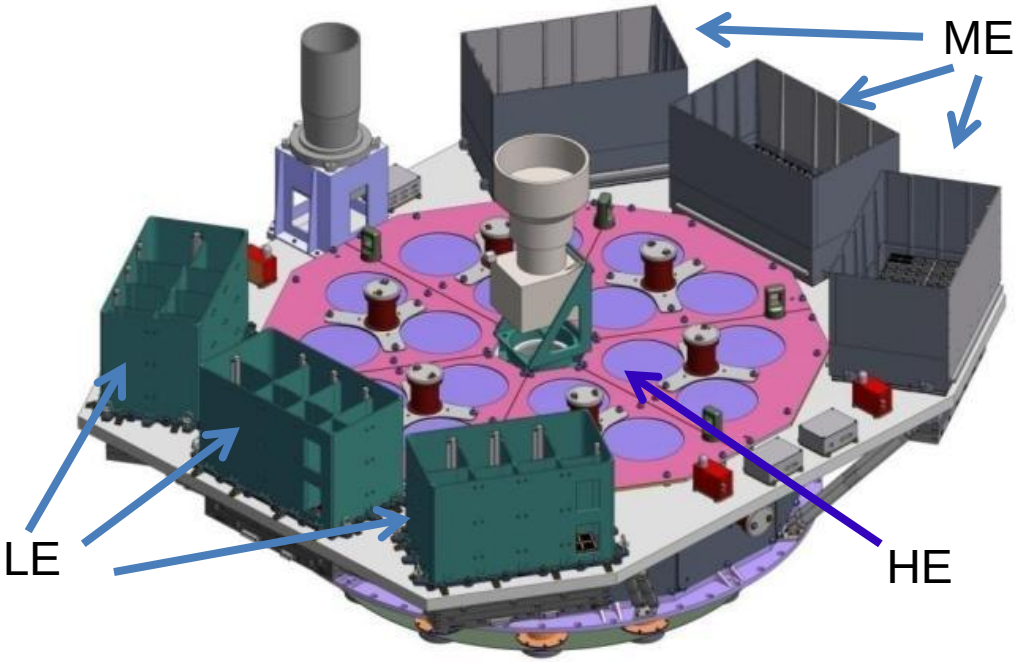


# Hard X-ray modulated telescope ( HXMT )

- **Full sky survey with good angular resolution and sensitivity**
- **Lunched in June, 2017**

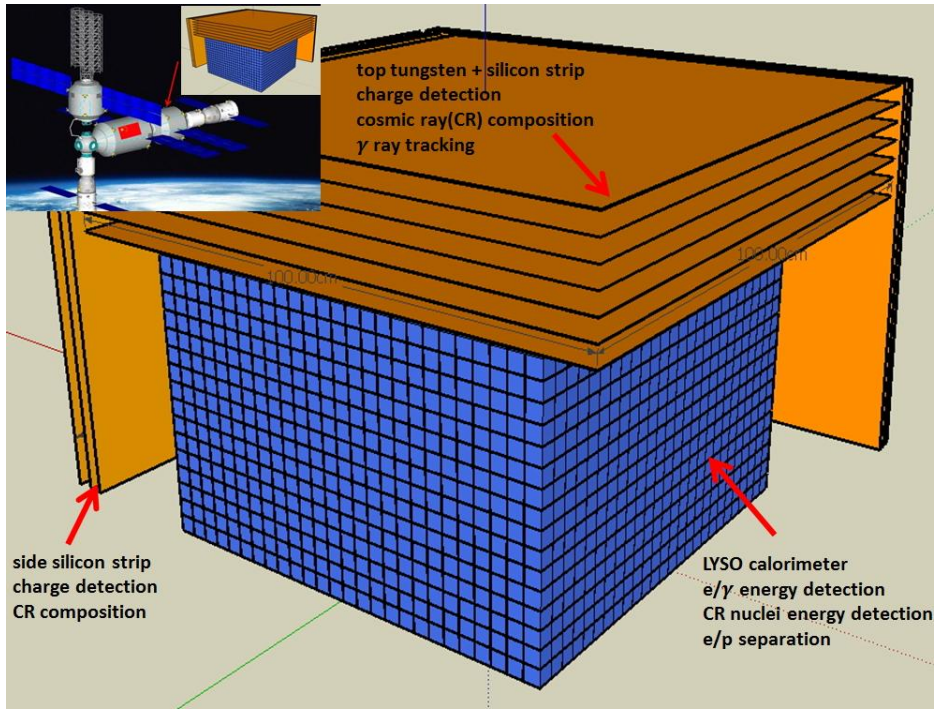


**Total mass： 1021kg**
**signal： 1881 Ch.**
**Power： 350W**



# HERD @ the China's Space Station

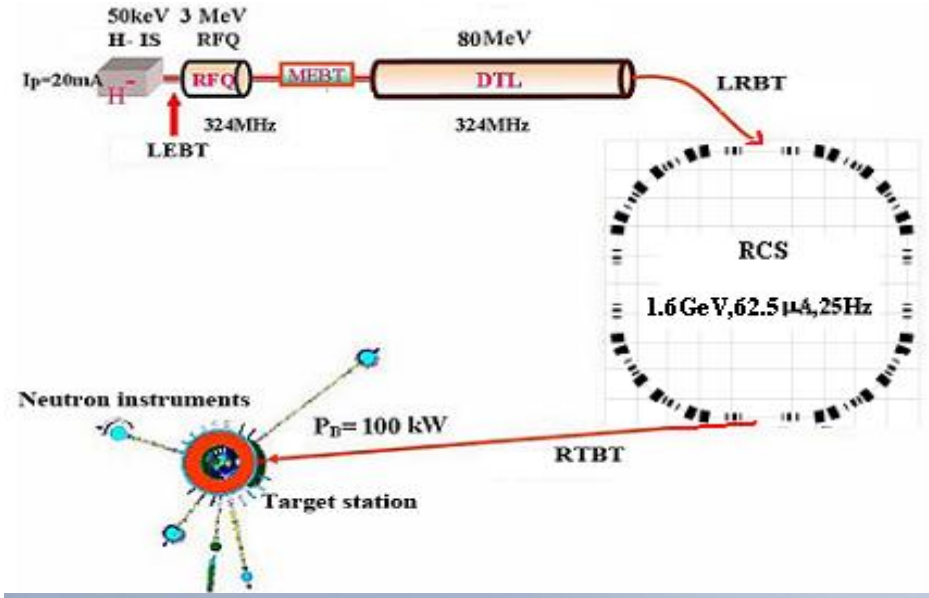
- **Science**
  - **Dark matter search: γ from 0.1 – 10,000 GeV**
  - **Spectral and composition measurements of CRs between 300 GeV to PeV**
  - **Complementary to LHAASO: directly measured composition & spectrum in space**
  - **Next generation cosmic-ray exp. after AMS & Fermi**
- **Status**
  - **Groups from China, Italy, Switzerland, Sweden,…**
  - **Launch in ~2023**




| | X0(λ) | ΔE/E for e | e/p sep | e GF $m^2sr$@ 200GeV | p GF $m^2sr$@100TeV |
|---|---|---|---|---|---|
| HERD (2020) | 55(3) | 1% | $10^{-6}$ | 3.1 | 2.3 |
| Fermi (2008) | 10 | 12% | $10^{-3}$ | 0.9 | -- |
| AMS02 (2011) | 17 | 2% | $10^{-6}$ | 0.12 | -- |
| DAMPE (2015) | 31 | 1% | $10^{-4}$ | 0.3 | -- |
| CREAM (2015) | 20(1.5) | -- | -- | -- | 0.2 |

# Facilities for other Sciences

# China Spallation Neutron Source




**Phase I： 100 kW Phase II： 500 kW**

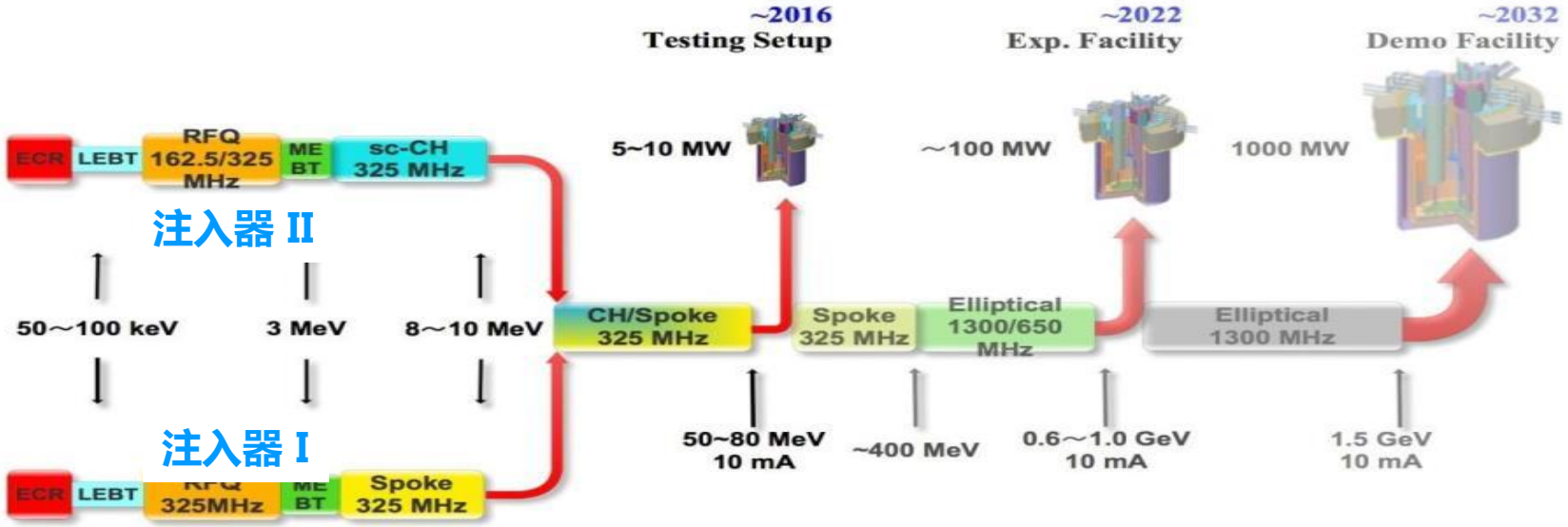
**Start time: 2011**

**Completion time: 2017**

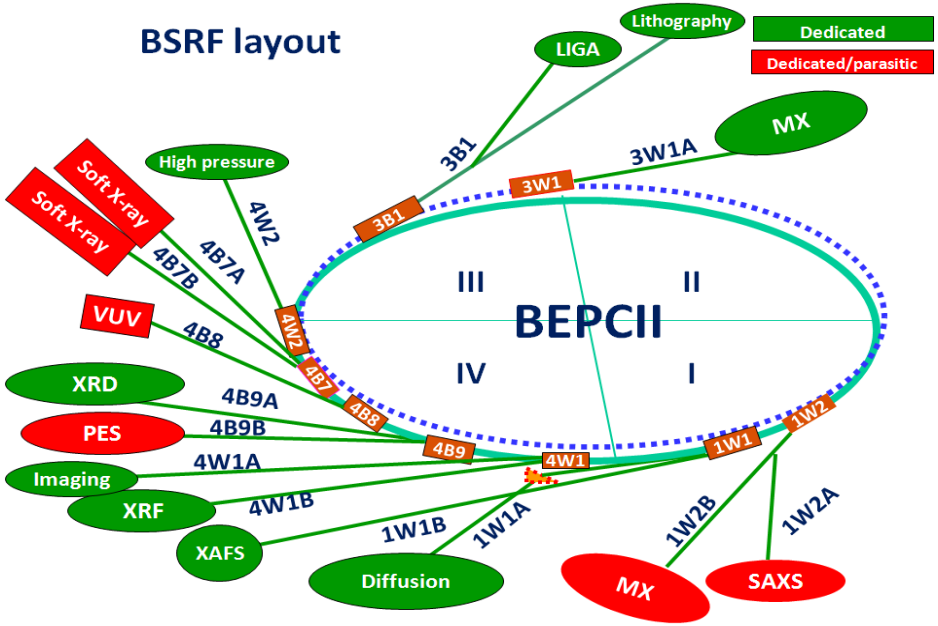
- Construction finished
- LINAC tested
- First neutron beam this week

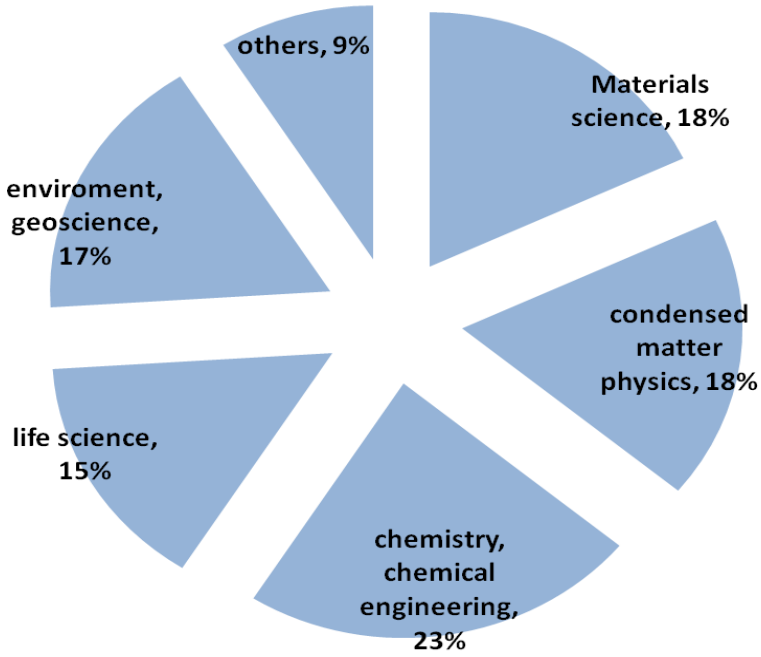
# ADS R&D

- Accelerator-driven reactors for spent fuel transmutation.
- ADS Injector I Proton Beam Reaches 14 low-β SC spoke cavities: 10.1MeV@10.5mA on June 17, 2016
- Future: 250MeV@10mA approved
- Goal: 1.5 GeV@10mA



# BSRF




**5** insertion devices , **14** beam lines , **15** experimental stations

**> 2000** dedicated hours /year

**> 500** exp./year , from **> 100** institutions

# High Energy Photon Source(HEPS)

6GeV SR facility
Low emmitance: 0.06nm·rad
~1300m storage ring

48-7BA lattice
Brilliance: >$10^{22}$phs/s/mm$^2$/mrad$^2$/0.1BW

# Future Plan of IHEP