Perspective on the European Strategy from Asia

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CoEPP and University of Melbourne,
AUSTRALIA

Yes, from Asia!

… but with input from other Asians …

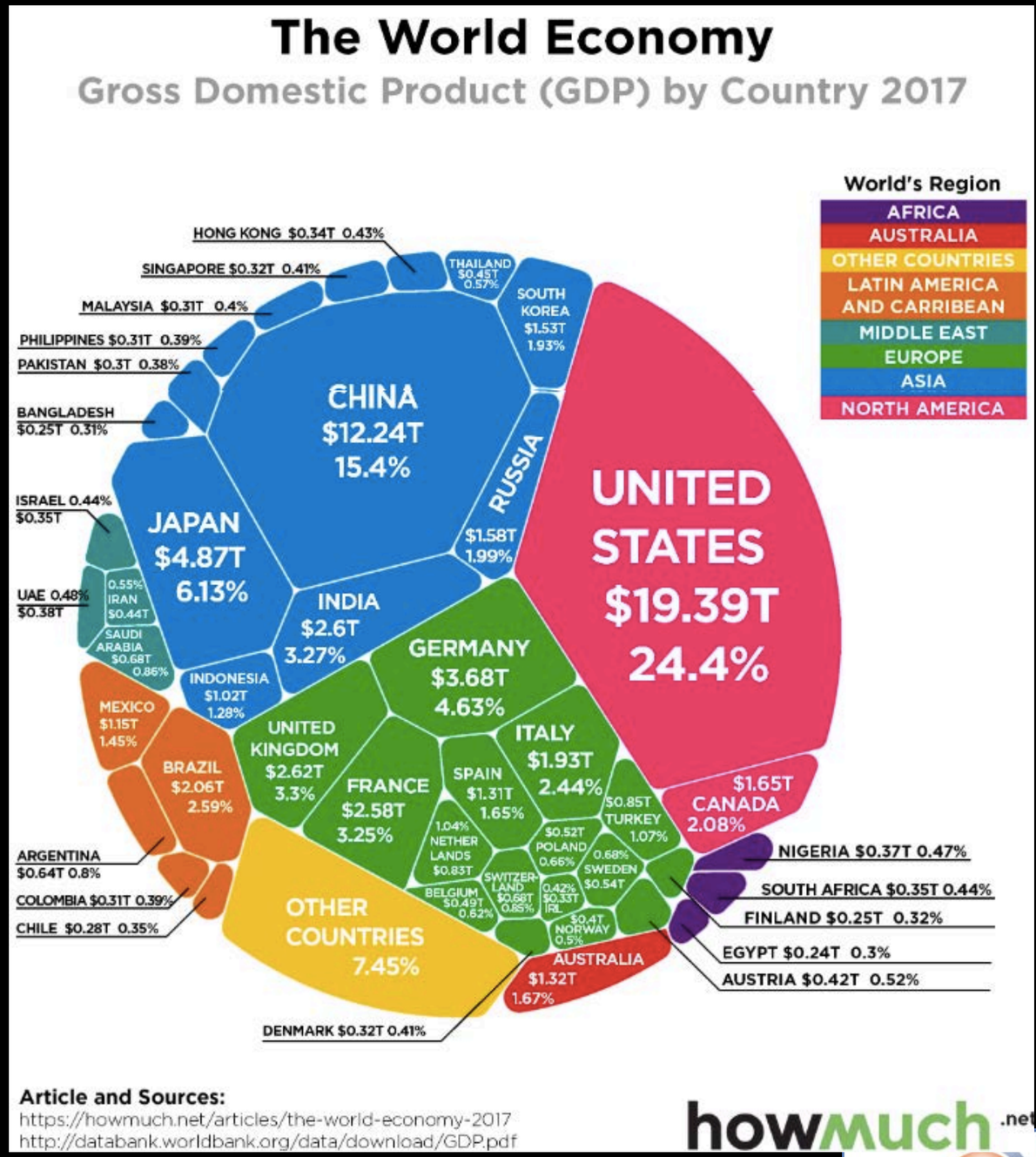
Usual Caveat :
Comments are my own, not an official position.
Any good ideas are probably those of others.
etc…

But first, some observations from this meeting…

- **If we are planning for decades into the future, we must get the opinions and involvement of the younger members of our community** (Peter Jenni)
- **Experts are telling us that high field magnets take decades to develop. "Are we going to spend the next 3 or 4 decades waiting for 16T magnets…"** anon.
  - ***100km tunnels may be the easy part of the next generation high energy frontier (with circular machines, at least)***
- **For new physics 14TeV μ+μ- ☞ 100TeV pp** (Vladimir SHILTSEV)
  - ***need to pursue muon collider vigorously***
- **When will plasma acceleration be central to planning?**

How can Asian projects/ facilities impact upon Europe's particle physics future?

Desire
Resources
People
Technology



Outline

- Existing Facilities
- Experience in Asian Collaboration
- Future Facilities of Key Impact to EPPSU2019
  - *In particular: ILC, CepC*
  - *Status*
- Benefits of Asia Hosting Major Facilities
- A Suggestion for Consideration

- Very little technical information will be presented.
- Much has been presented in this Symposium.
- Detailed documents have been submitted and referred to.
- Will concentrate on non-technical Asian perspective

Existing Facilities

- *Japan:*
  - *SuperKEKB/Belle II - high intensity B-factory*
  - *SuperKamiokande (T2K) (—> HyperK and Upgraded J-parc)*
  - *J-parc high intensity, low energy physics - COMET*
  - *Kamioka U/G Observatory - XMASS-I Direct Dark Matter Search*
  - *…*
- *China:*
  - *Daya Bay (—> JUNO) - Reactor Neutrino Physics*
  - *BEPC (Proposal: tau/charm factory)*
  - *LHAASO - Very high energy cosmic ray observatory*
  - *Jinpin - U/G laboratory - PANDA-X and CDEX Direct Dark Matter Searches*
  - *…*
- *Korea:*
  - *RENO - Reactor neutrino physics*
  - *…*

Participation in HEP

- Japan
- China
- India
- Korea
- Taiwan
- Hong Kong
- Australia
- Thailand, Vietnam, Indonesia …

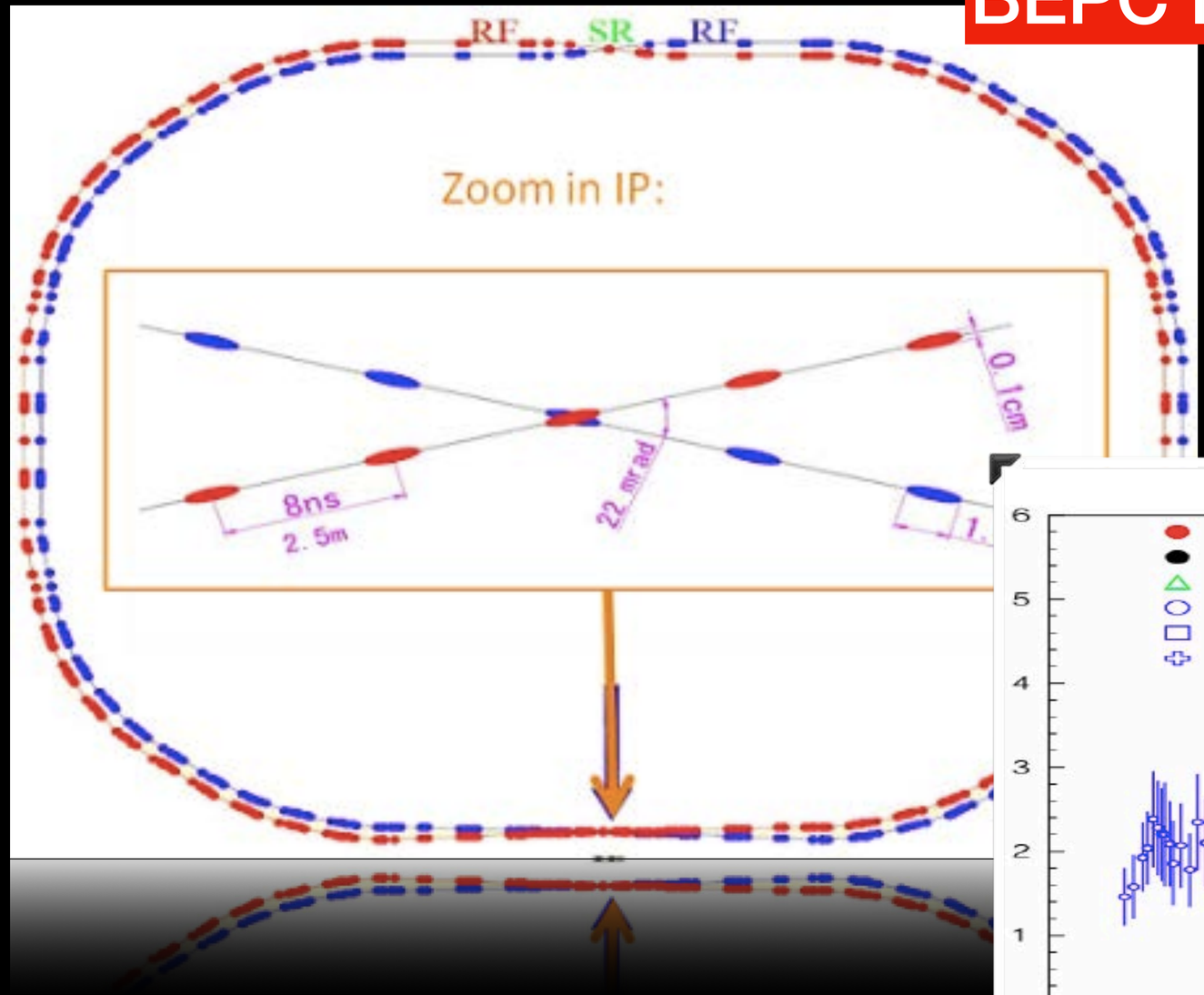
Considerable contributions to European and US programs

Asia and the European Strategy

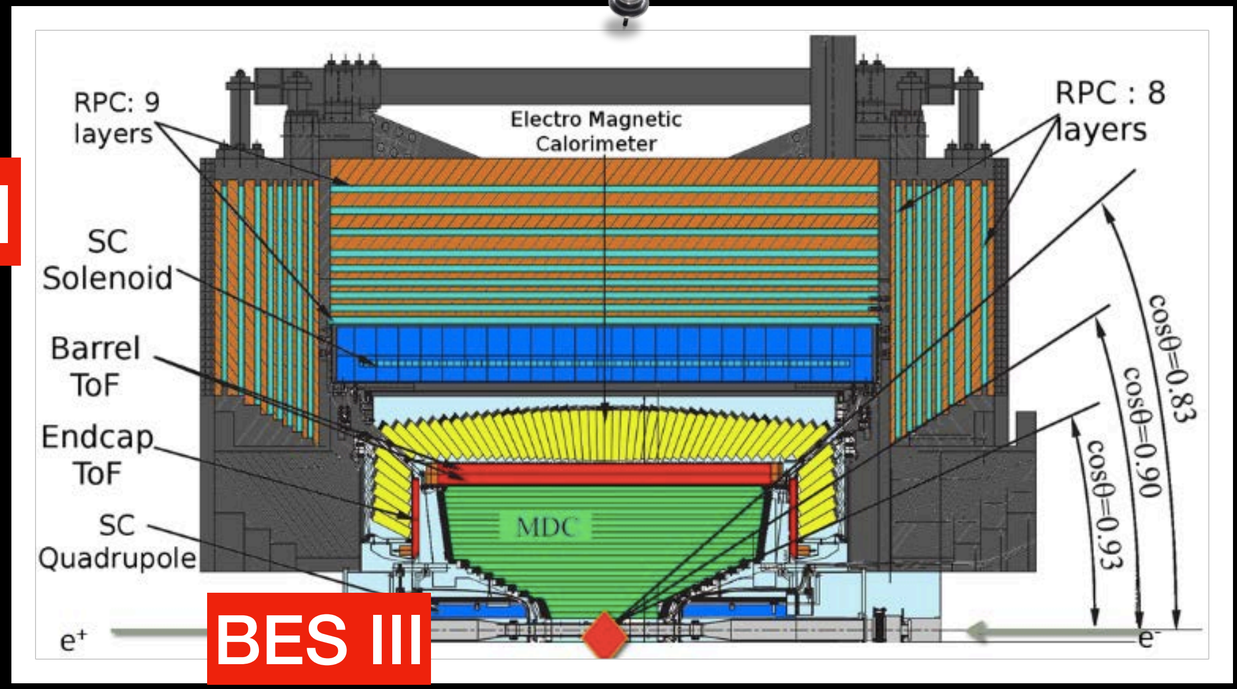
- **Strategy concentrates on Future Facilities**
  - ***Present Future Asian Facilities and their impact on Euopean Planning for Future Facilities:***
    - **HyperK (Japan), JUNO (China) are future facilities, briefly shown here.**
    - **Underground facilities especially Jinpin and Kamioka Underground Observatory, are of a scale that does not impact strongly on European planning.**
- **Will concentrate on:**
  - ***ILC (Japan)***
  - ***CEPC (China)***

  (And leave SppC for a future Strategy Planning meeting!)

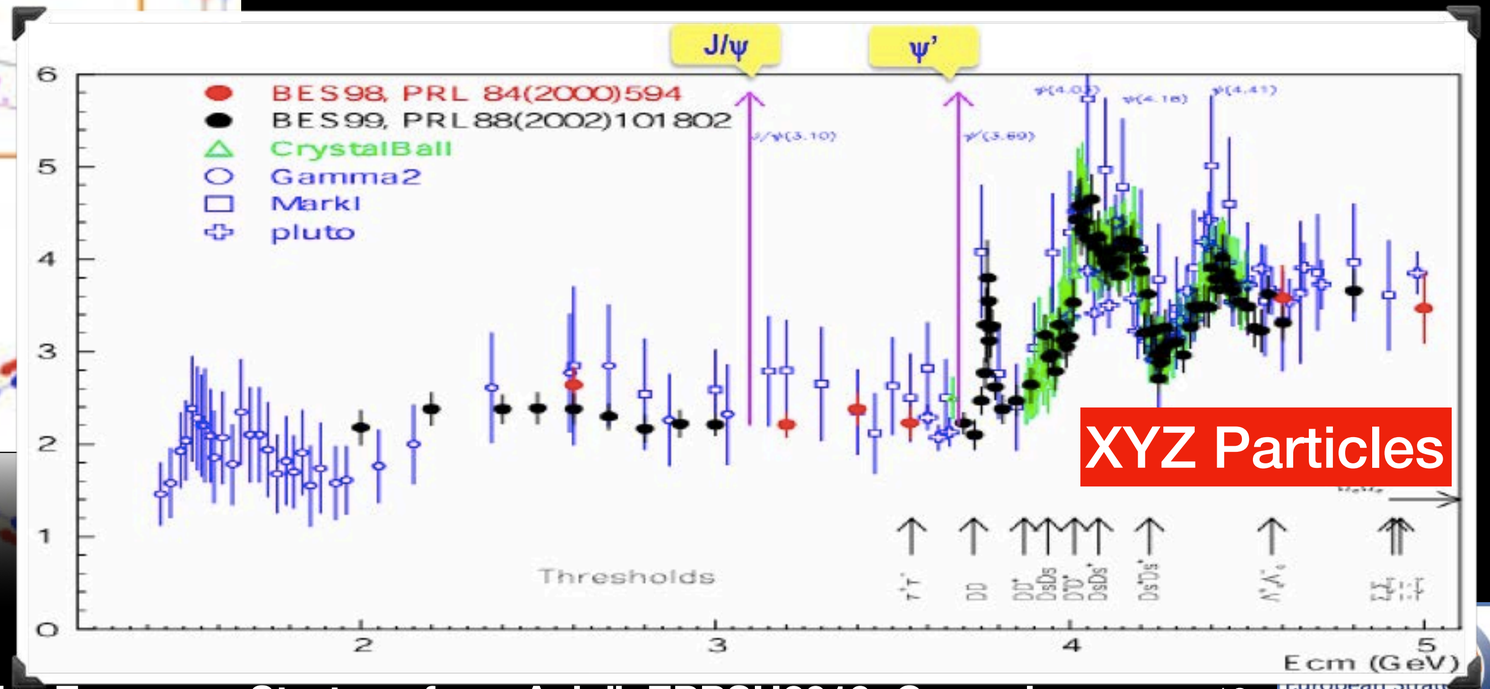
Postcards from China



BEPC II



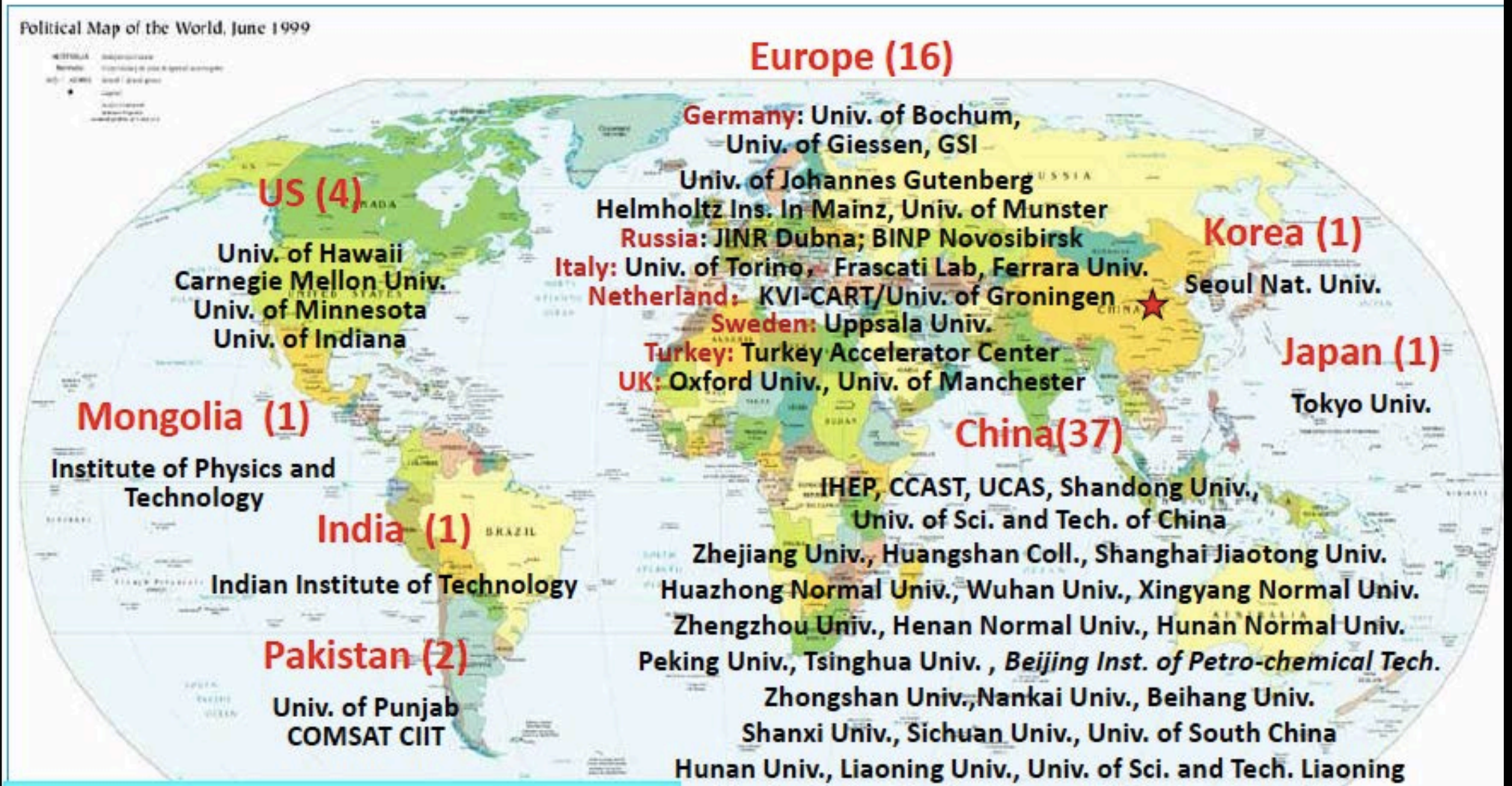
BES III



XYZ Particles

China HEP Hosting Experience

BESIII Collaboration



Europe (16)

Germany: Univ. of Bochum, Univ. of Giessen, GSI
Univ. of Johannes Gutenberg
Helmholtz Ins. In Mainz, Univ. of Munster
Russia: JINR Dubna; BINP Novosibirsk
Italy: Univ. of Torino, Frascati Lab, Ferrara Univ.
Netherland: KVI-CART/Univ. of Groningen
Sweden: Uppsala Univ.
Turkey: Turkey Accelerator Center
UK: Oxford Univ., Univ. of Manchester

US (4)

Univ. of Hawaii
Carnegie Mellon Univ.
Univ. of Minnesota
Univ. of Indiana

Korea (1)

Seoul Nat. Univ.

Japan (1)

Tokyo Univ.

Mongolia (1)

Institute of Physics and Technology

India (1)

Indian Institute of Technology

Pakistan (2)

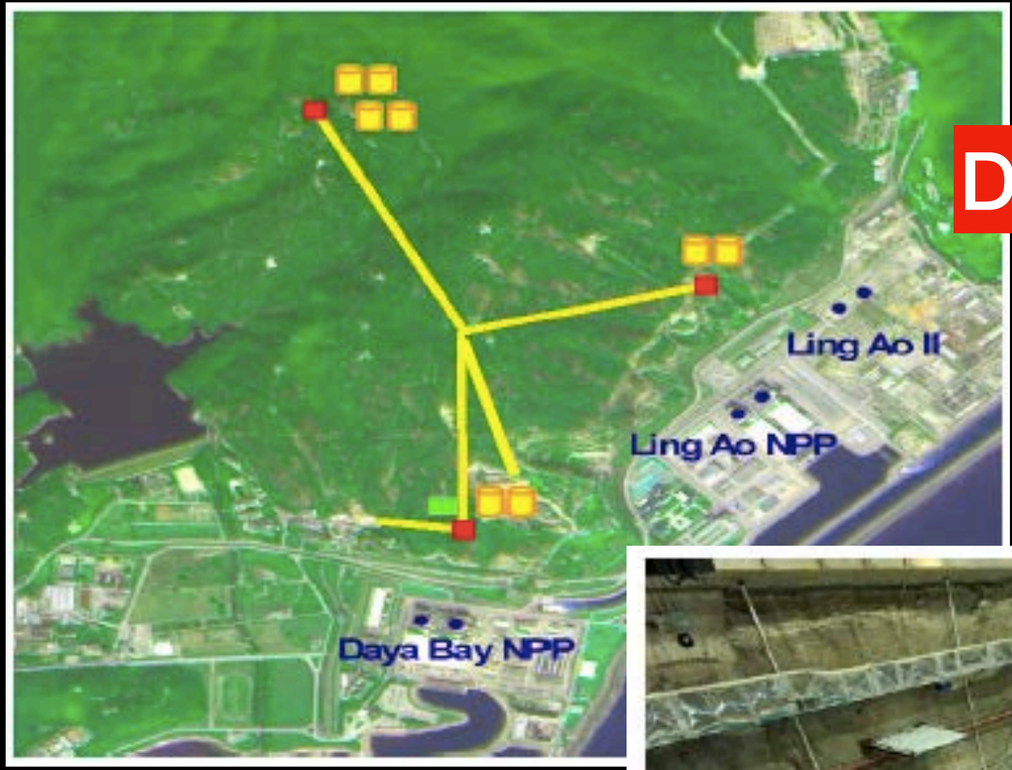
Univ. of Punjab
COMSAT CIIT

China(37)

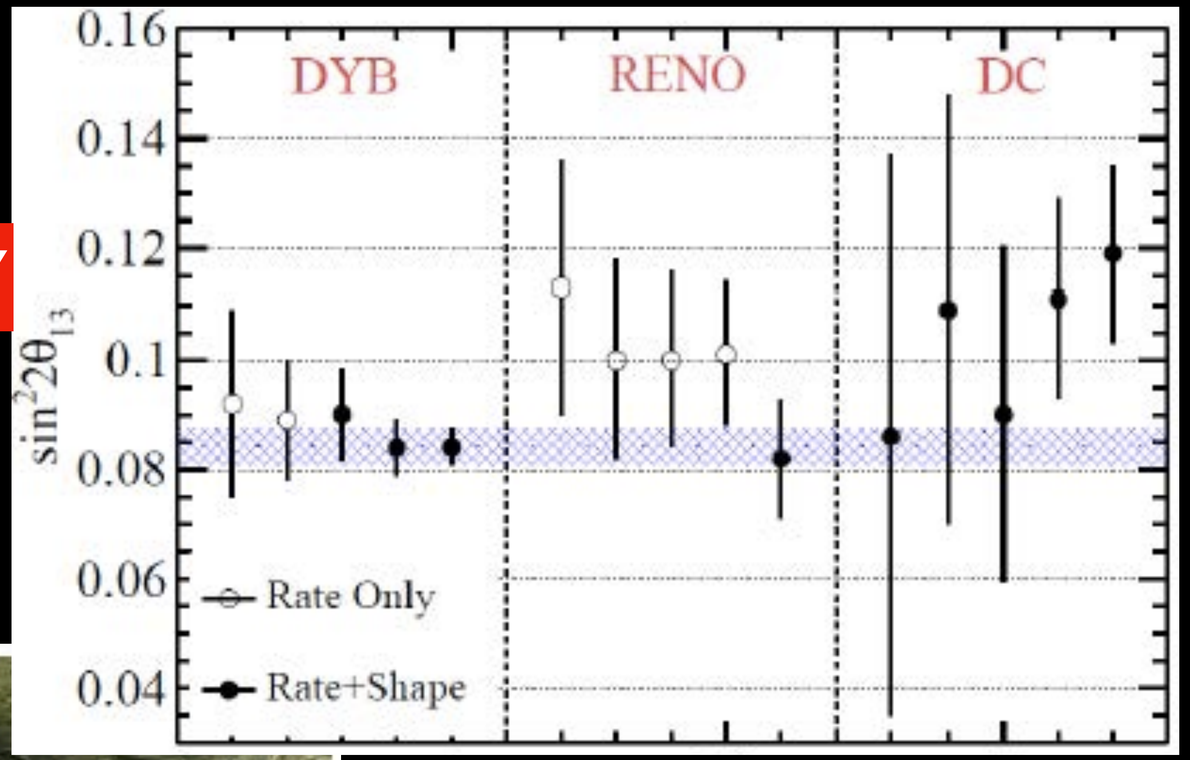
IHEP, CCAST, UCAS, Shandong Univ.,
Univ. of Sci. and Tech. of China
Zhejiang Univ., Huangshan Coll., Shanghai Jiaotong Univ.
Huazhong Normal Univ., Wuhan Univ., Xingyang Normal Univ.
Zhengzhou Univ., Henan Normal Univ., Hunan Normal Univ.
Peking Univ., Tsinghua Univ. , *Beijing Inst. of Petro-chemical Tech.*
Zhongshan Univ.,Nankai Univ., Beihang Univ.
Shanxi Univ., Sichuan Univ., Univ. of South China
Hunan Univ., Liaoning Univ., Univ. of Sci. and Tech. Liaoning
Nanjing Univ., Nanjing Normal Univ., Southeast Univ.
Guangxi Normal Univ., Guangxi Univ.
Suzhou Univ., Hangzhou Normal Univ.
Lanzhou Univ., Henan Sci. and Tech. Univ.
Jinan Univ., Fudan Univ.

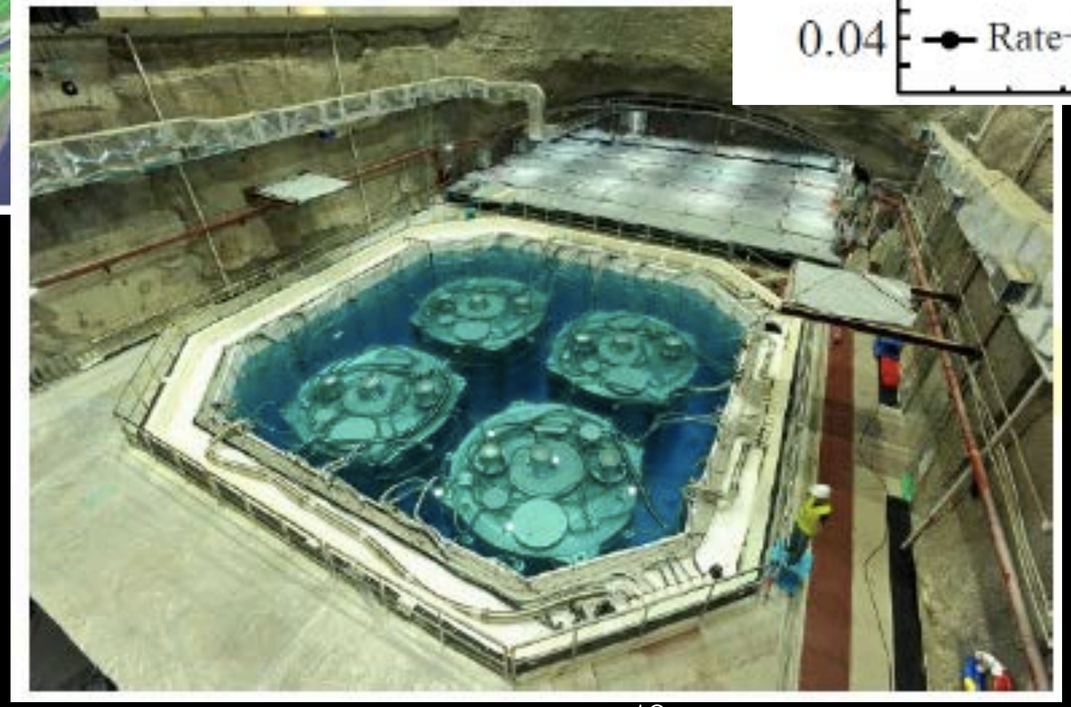
~ 450 members
from 64 institutions in 14 countries

Postcards from China



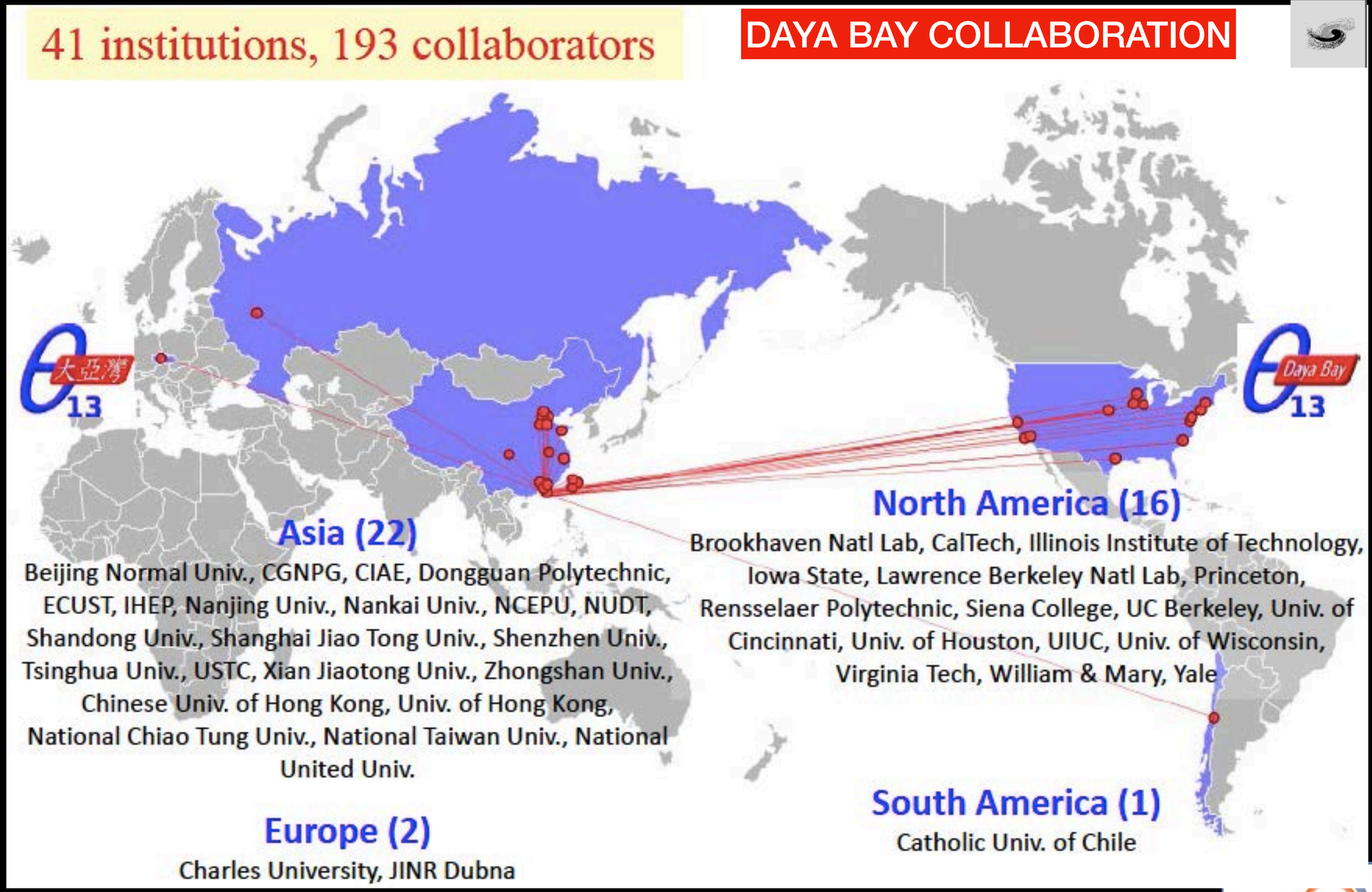
DAYA BAY





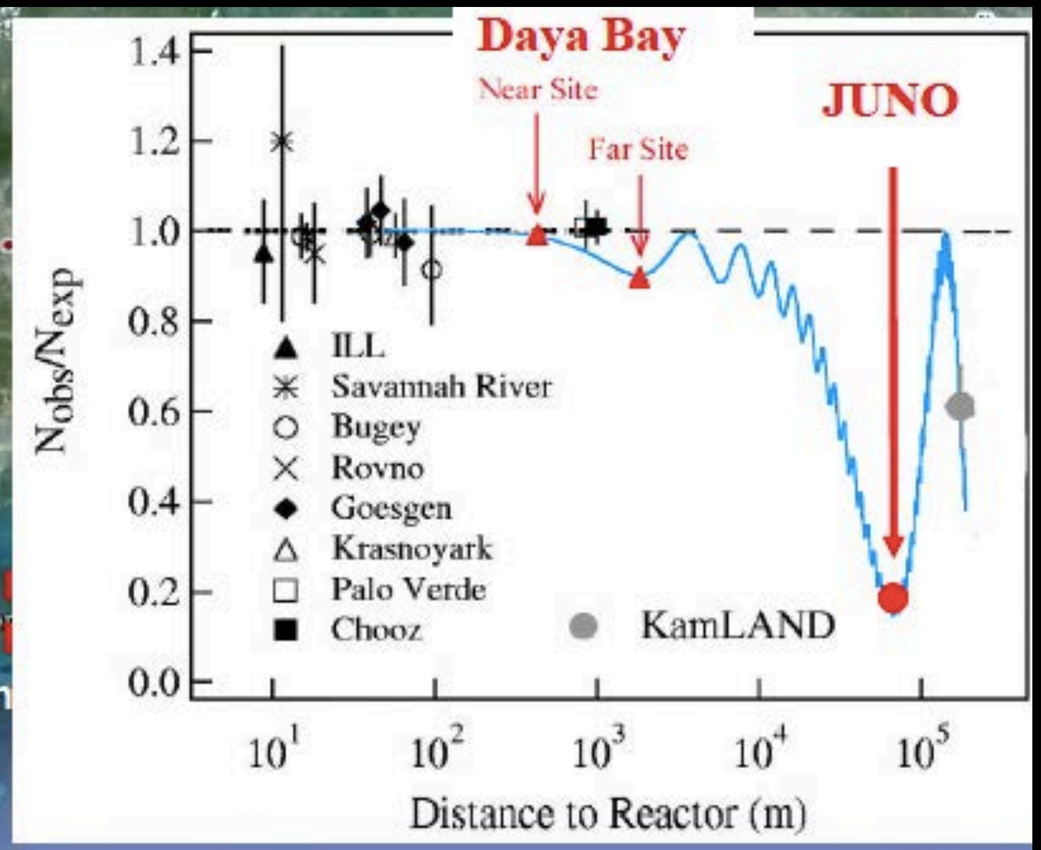
Yifang Wang
IAS-HKUST, Jan. 24, 2019

China HEP Hosting Experience



Postcards from China

JUNO



eg. J. Phys. G 43: 030401 (2016) (arXiv:1507.05613)

by 2020: 26.6 GW

Yifang Wang
IAS-HKUST, Jan. 24, 2019

China HEP Hosting Experience

17 Countres & regions, 77 institution， 580 members

Europe (28)

Belgium(1)
- ULB

Czech(1)
- Charles U

Latvia(1)
- IECS

Finland(1)
- U.Oulu

France(5)
- APC Paris
- CPPM Marseille
- IPHC Strasbourg
- Subatech Nantes
- CENBG-IN2P3

Italy(8)
- INFN-Catania
- INFN-Frascati
- INFN-Ferrara
- INFN-Milano
- INFN-Mi-Bicocca
- INFN-Padova
- INFN-Perugia
- INFN-Roma 3

Germany(7)
- FZ Jülich
- RWTH Aachen
- TUM
- U.Hamburg
- IKP FZI Jülich
- U.Mainz
- U.Tuebingen

Russia(3)
- INR Moscow
- JINR
- MSU

Slovakia (1)
- FMPICU

America(6)

US(2)
- UMD
- UMD-Geo

Chile(2)
- PCUC
- UTFSM

Brazil（2）
- PUC-Rio
- UEL

Asia (38)

China（33）
- BJ Nor. U.
- CAGS
- Chongqing U.
- Shanghai JT U.
- DGUT
- ECUST
- Guangxi U.
- HIT
- IHEP
- U. Of South China
- Ninan U.
- Nanjing U.
- Natl. Chiao-Tung U.
- Natl. Taiwan U.
- Natl. United U.
- Nankai U.
- NCEPU
- Pekin U.
- SDU
- Sichuan U.
- CIAE
- SYSU
- Tsinghua U.
- UCAS
- USTC
- Jilin U.
- Wuhan U.
- Wuyi U.
- Xi'an JT U.
- Xiamen U.
- NUU.

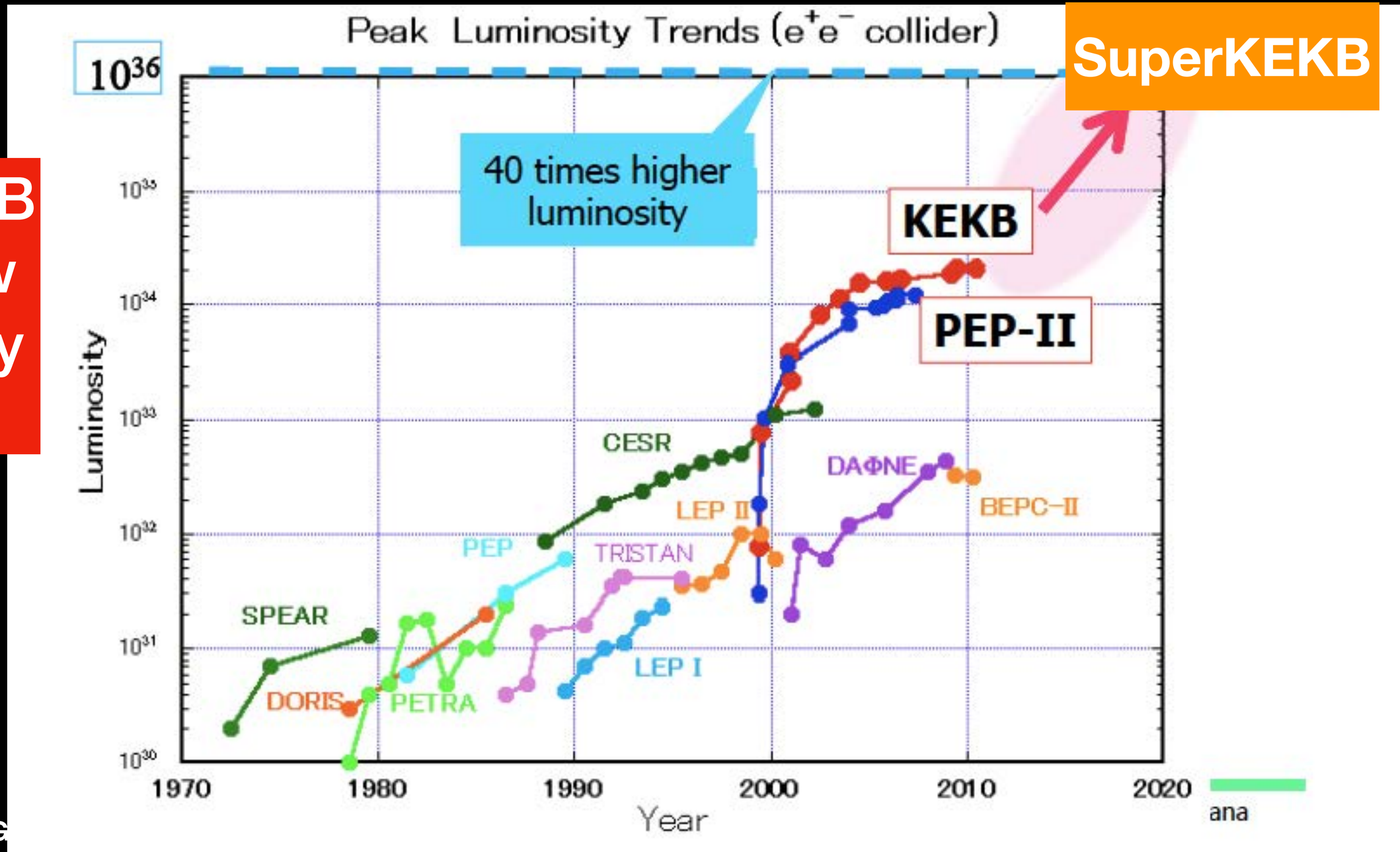
Armenia(1)
- Yerevan Phys. Inst.

Thailand(3)
- SUT
- PPRLCU
- NARIT

Parkistan(1)
- PINSTECH

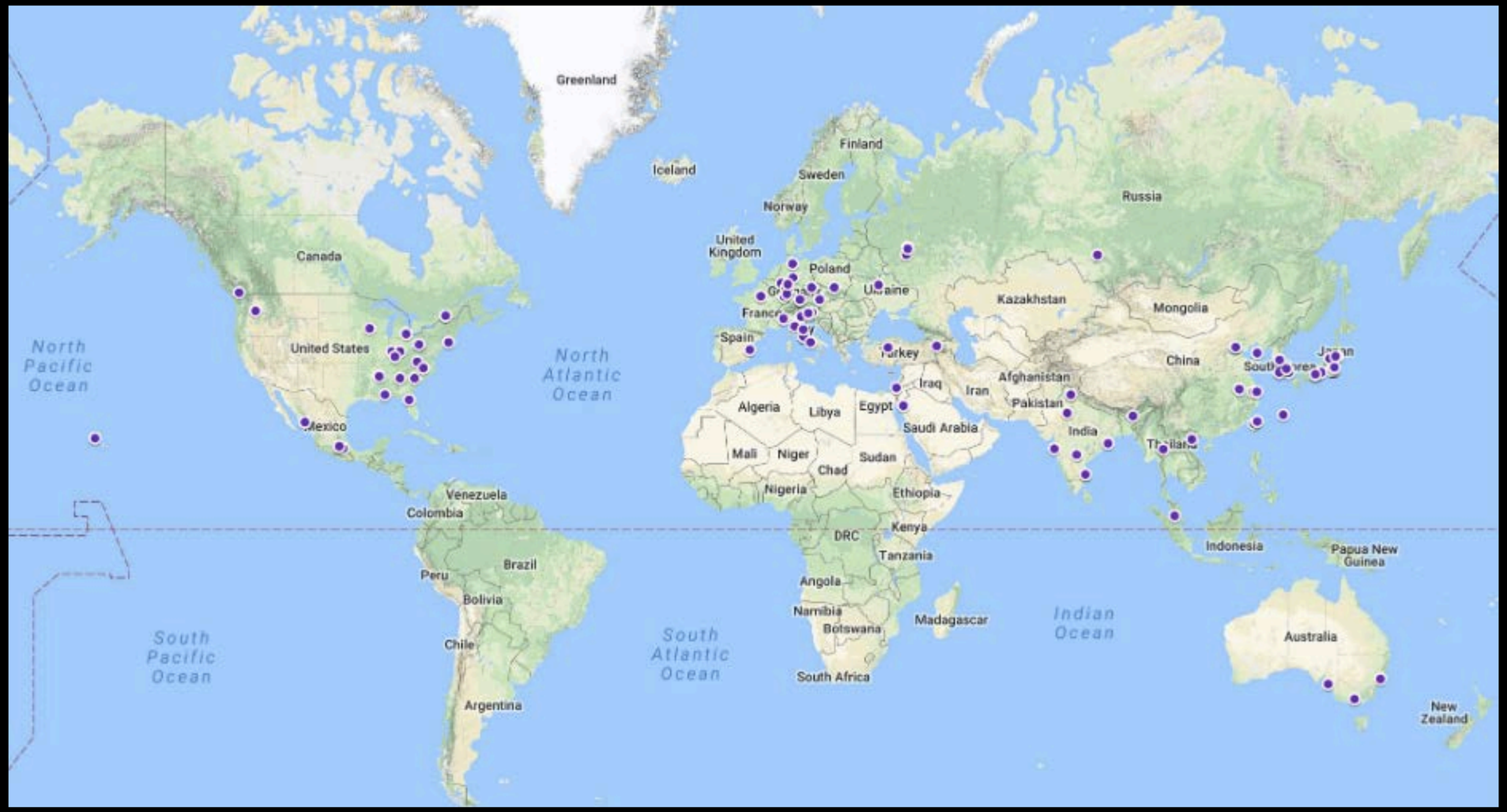
Postcards from Japan

SuperKEKB to set new Luminosity Record



Belle II Collaboration

- Over 800 International Collaborators
- Commencing operation
- Expected to run through 2026+



Belle II - LHCb Comparison

P.Urquijo, U. Melbourne

Belle II
Higher sensitivity to decays with photons and neutrinos (e.g. $B \to K\nu\nu$, $\mu\nu$), inclusive decays, time dependent CPV in B_d, τ physics.

LHCb
Higher production rates for ultra rare B, D, & K decays, access to all b-hadron flavours (e.g. Λ_b), high boost for fast B_s oscillations.

Overlap in various key areas to verify discoveries.

Upgrades
Most key channels will be stats. limited (not theory or syst.).
LHCb scheduled major upgrades during LS3 and LS4.
Belle II formulating a 250 ab^{-1} upgrade program post 2028.

Observable	Current Belle/ Babar	Current LHCb	Belle II (50 ab^{-1})	LHCb (23 fb^{-1})	Belle II Upgrade (250 ab^{-1})	LHCb upgrade II (300 fb^{-1})
CKM precision, new physics in CP Violation						
$\sin 2\beta/\varphi_1$ ($B \to J/\psi K_S$)	0.03	0.04	0.005	0.011	0.002	0.003
γ/φ_3	13°	5.4°	1.5°	1.5°	0.4°	0.4°
α/φ_2	4°	–	0.6°	–	0.3°	–
$\lvert V_{ub}\rvert$ (Belle) or $\lvert V_{ub}\rvert/\lvert V_{cb}\rvert$ (LHCb)	4.5%	6%	1%	3%	<1%	1%
φ_s	–	49 mrad	–	14 mrad	–	4 mrad
S_{CP}($B \to \eta' K_S$, gluonic penguin)	0.08	○	0.015	○	0.007	○
A_{CP}($B \to K_S\pi^0$)	0.15	–	0.04	–	0.02	–
New physics in radiative & EW Penguins, LFUV						
S_{CP}($B_d \to K^* \gamma$)	0.32	○	0.035	○	0.015	○
R($B \to K^* l^+ l^-$) ($1<q^2<6$ GeV$^2/c^2$)	0.24	0.1	0.03	0.03	0.01	0.01
R($B \to D^* \tau\nu$)	6.4%	10%	1.5%	3%	<1%	1%
Br($B \to \tau\nu$), Br($B \to K^* \nu\nu$)	24%, –	–	4%, 9%	–	1.7%, 4%	–
Br($B_d \to \mu\mu$)	–	90%	–	34%	–	10%
Charm and τ						
ΔA_{CP}($KK-\pi\pi$)	–	8.5×10^{-4}	5.4×10^{-4}	1.7×10^{-4}	2×10^{-4}	0.3×10^{-4}
A_{CP}($D \to \pi^+\pi^0$)	1.2%	–	0.2%	–	0.1%	–
Br($\tau \to e\gamma$)	$<120\times10^{-9}$	–	$<12\times10^{-9}$	–	$<5\times10^{-9}$	–
Br($\tau \to \mu\mu\mu$)	$<21\times10^{-9}$	$<46\times10^{-9}$	$<3\times10^{-9}$	$<16\times10^{-9}$	$<0.3\times10^{-9}$	$<5\times10^{-9}$

arXiv: 1808.08865 (Physics case for LHCb upgrade II), 1808.10567 (Belle II Physics Book)

○ *Possible in similar channels, lower precision*
– *Not competitive.*

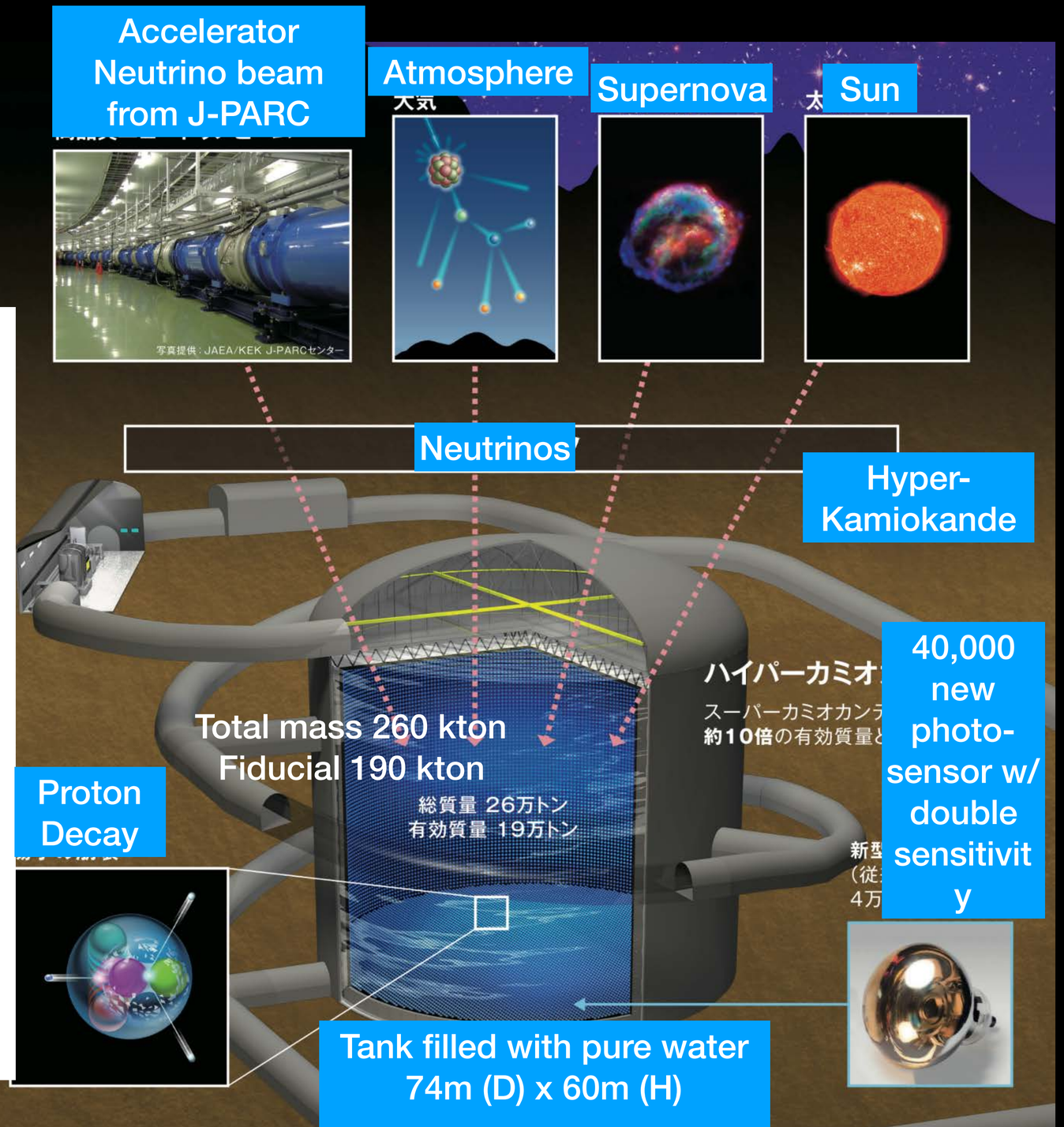
Postcards from Japan - Hyper-Kamiokande

New water Cherenkov detector, Hyper-Kamiokande with 190 kiloton fiducial mass and double-sensitivity PMTs

J-PARC neutrino beam upgrade to 1.3MW with new and upgraded near detectors

Broad science program

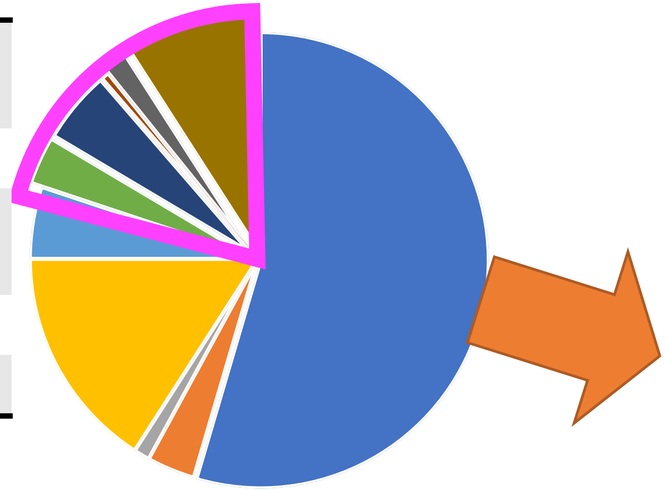
- Precise measurements of neutrino oscillations and CP asymmetry in lepton sector
  δCP accuracy 22°(δ=±90°)
- Proton decay reach to 1035 years ($p \rightarrow e + \pi^0$)
- Rich neutrino astronomy objects: Sun, nearby supernova, diffuse SN neutrinos, GW coincidence ν, etc



European participation in Japan-based neutrino program

Super-Kamiokande (as of Jan.2019)

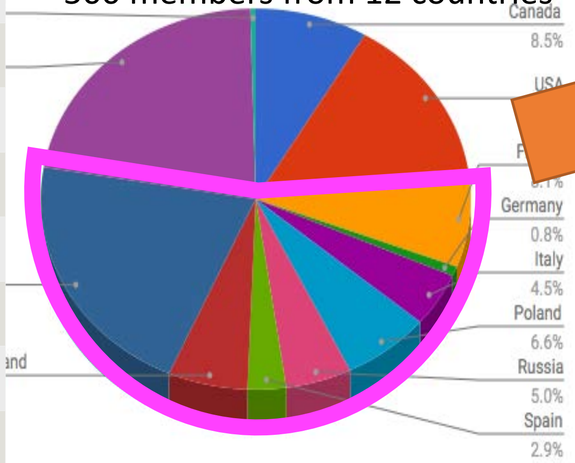
France
Italy
Poland
Spain
UK



T2K (as of Jan 2019)

Europe	266
France	39
Germany	4
Italy	22
Poland	32
Russia	24
Spain	14
Switzerland	29
UK	102

~500 members from 12 countries



CERN joined T2K in March 2019

Hyper-Kamiokande (as of Dec. 2018)

~300 members from 17 countries

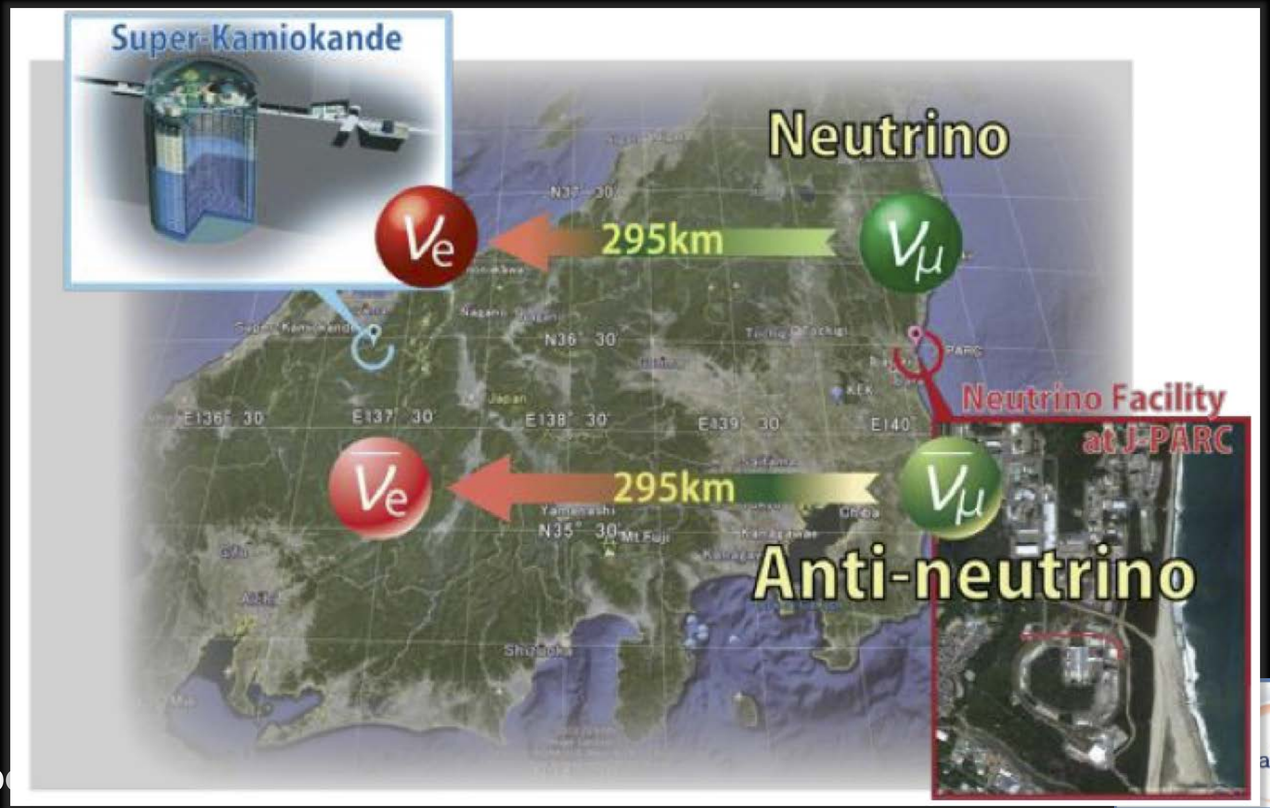
Europe (130 people)	Asia (105 people)	Americas (62 people)
Armenia	Korea	Brazil
France	India	Canada
Germany	Japan	USA
Italy		
Poland		
Russia		
Spain		
Sweden		
Switzerland		

25-50% of collaborators are from Europe!

Complementarity of DUNE/LBNF and T2HK

- *Different ν-energy*
- *Different Baseline (1300 vs. 295km)*

→ *Complementary sensitivity to Lepton-CP Violation and ν Mass Hierarchy*



Hyper-K project status

- Priority project of host labs, ICRR/UTokyo and KEK
  - *International review committee under directors*
- Listed among seven priority projects in the MEXT Roadmap 2017
  - *Its importance and urgency are recognized by the Japanese government*
- Seed funding for FY2019 has been allocated by MEXT
- Preparing for start of construction in 2020
- Expect to begin operation in ~2027

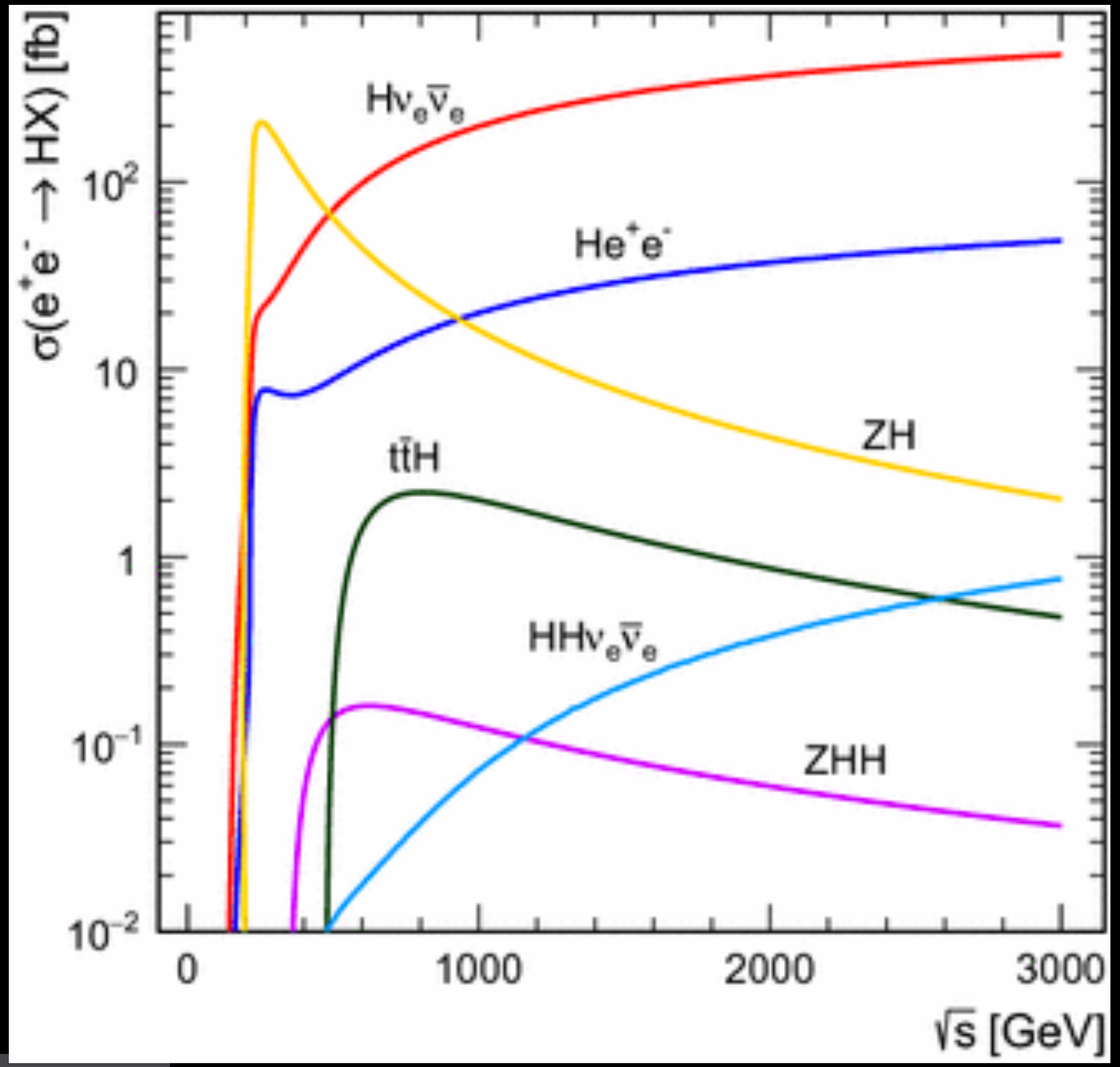
Direct Impact on CERN Planning

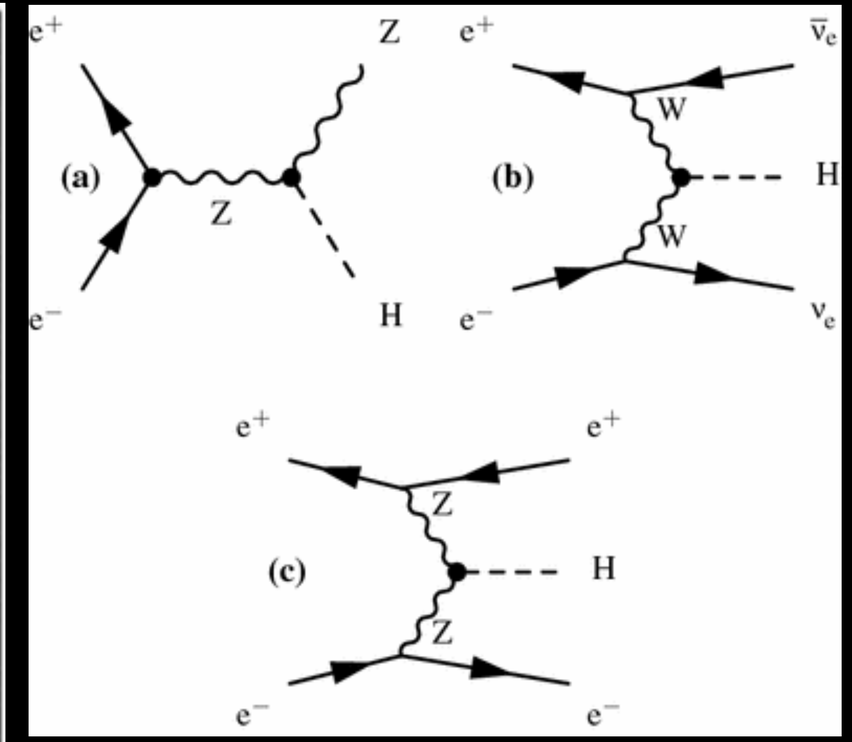
- ILC <—> CLIC
- CEPC <—> FCC(ee)
- Nature of Impact of these parallels on planning

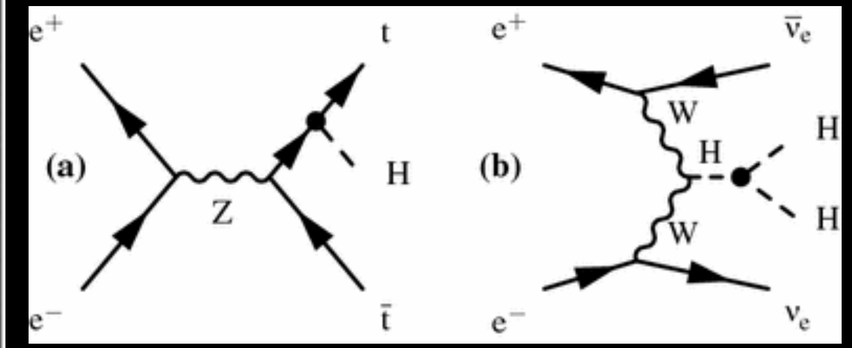
(And potentially impact of SppC on FCC(hh), but will not be considered further here.)

ILC or CLIC

- **Status well documented**
  - https://clic.cern/european-strategy
  - https://ilchome.web.cern.ch/content/ilc-european-strategy-document
- **See S. Steinar Stapnes talk (Monday)**
- **See D. Schulte talk (Monday)**
  - ***No feasibility issue is known for any of the proposed higgs factories CLIC, ILC, FCC-ee and CEPC***


σ(e⁺e⁻ → HX) [fb]
Hν_eν̄_e
He⁺e⁻
ZH
tt̄H
HHν_eν̄_e
ZHH
10²
10
1
10⁻¹
10⁻²
0
1000
2000
3000
√s [GeV]


(a)
(b)
(c)
e⁺
e⁻
Z
W
H
ν_e
ν̄_e


(a)
(b)
e⁺
e⁻
t
t̄
Z
H
W
ν_e
ν̄_e

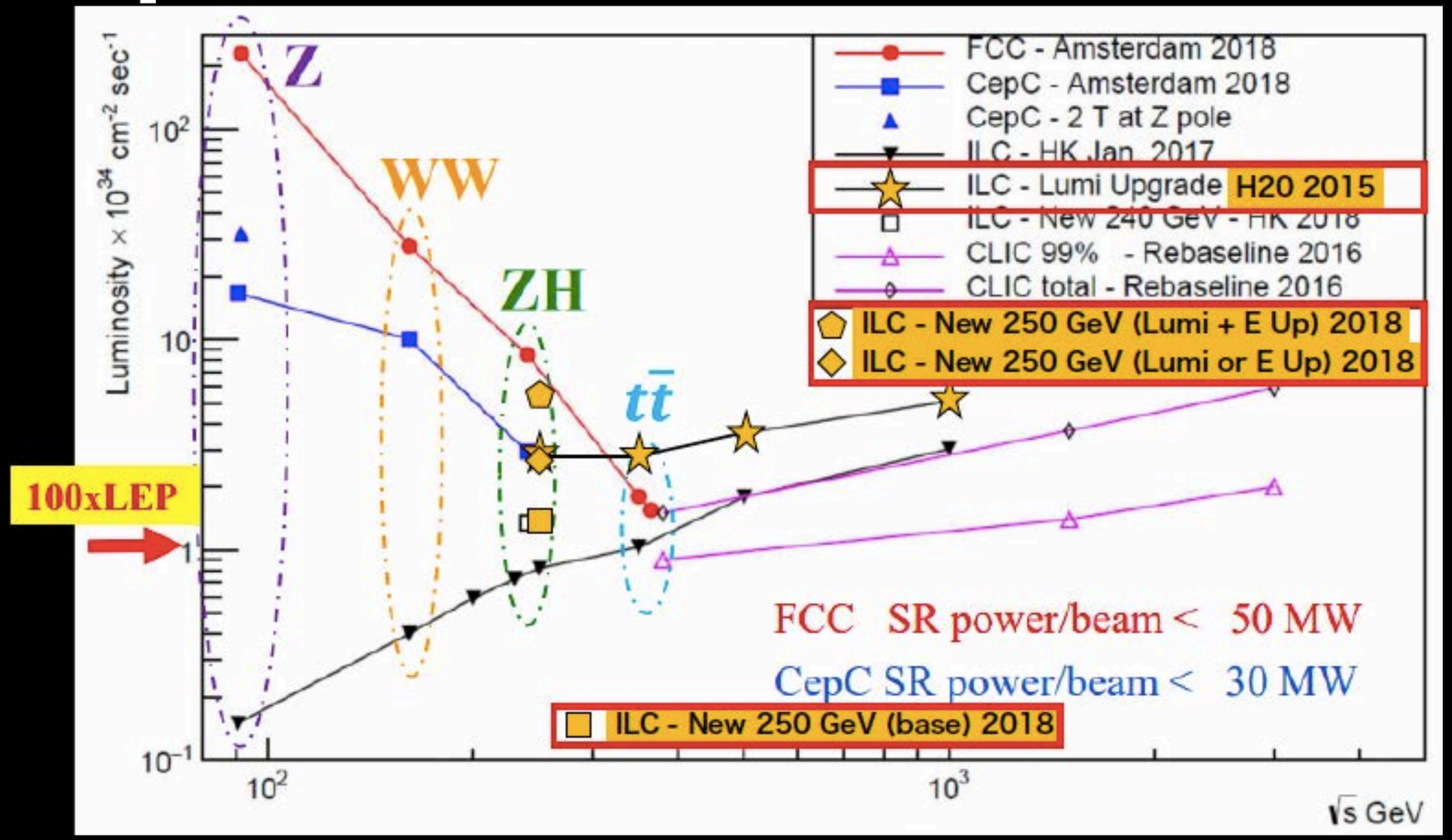
ILC or CLIC?

See S. Stapnes talk this Symposium

- **"We need a linear collider!"**
- **Both are capable of providing the essential "Higgs Factory":**
  - ***240-250GeV e+e- Collider***
  - ***Extending to high energy:***
    - CLIC initial capability already at 380GeV - top quark threshold
      - ILC up to ~800 -1000GeV - Future upgrade, more $
      - CLIC to multi-TeV - Future upgrade, more CHF
    - both at significant additional cost

e+e- Lumi Comparison

- Apparently significant difference at the overlap region (~250GeV) quite a range of luminosities
- See D Schulte's talk: differences should not be taken too seriously at this stage!



- Original Plot, F. Bedeschi , CEPC Workshop, Rome, May 2018
- Updates Private communication, Keisuke Fujii, IPNS, KEK

ILC Update

“Why is it taking so long to get a decision from Japan?”

<u>ILC IS STILL VIABLE</u>

We are hopeful of a positive response from the Japan

Recent Developments of ILC in Japan

- **KEK & Japanese HEP: Post-2012 Higgs ->**
  - ***ILC 250GeV Higgs factory in Japan, upgradable in energy.***
- **November 2017:**
  - ***LCB strong support***
  - ***Timely decision sought from Japanese Government***
- **July 2018:**
  - ***ILC Advisory panel of MEXT recommended the ILC proposal be reviewed by the SCJ.***
- **December 2018:**
  - ***SCJ released its report - some issues need addressing***
- **March 2019:**
  - ***MEXT presented its view to the LCB meeting in Tokyo***
  - ***ILC Federation of Diet Members message of support***
    - MEXT and KEK released their action plans.
  - ***ICFA made clear that other options being considered at EPPSU2019***

MEXT= Ministry of Education, Culture, Sports, Science & Technology in Japan

Science Council of Japan (SCJ), Master Plan

- SCJ represents all sciences but
  - *Not policy making nor budgetary authority*
- Large-scale project proposals sought every three years.
  - *recommends "priority programs" to MEXT*
  - *2017 round: 20 selected from 200 proposals*
- MEXT Minister: ILC be evaluated in this process to provide evidence of support by the broader academic community in Japan
  - *ILC proposal submitted with recommendation letter from Barry Barish*
  - *Results of this evaluation will be publicist February 2020 (informally late 2019?)*
- Active political work continues

International WG initiated by KEK, MEXT

- Members: 2 (Europe), 2 (North America), 2 (Asia incl. Japan)
- Update ILC-PIP to describe:
  - *International share of the remaining technical development*
  - *Organization and governance of the ILC Laboratory*
  - *Model of international cost-sharing for construction and operation*
- Will report to MEXT and other government agencies as a recommendation from the international ILC community ~ September 2019
- Draft report will be presented at the LCB meeting in August 2019

But can CERN/Europe Rely on Asia?

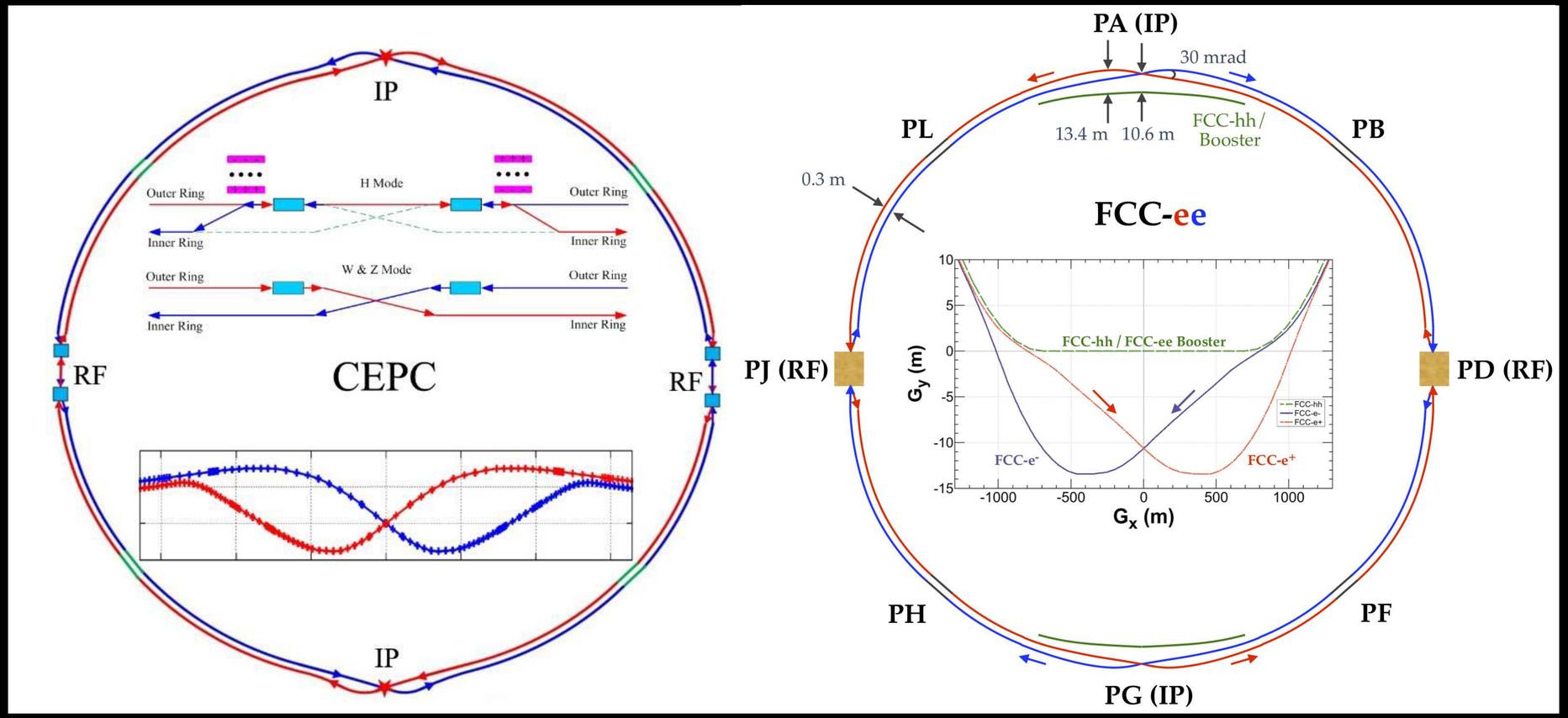
ILC:

- *It has taken a long time to get this far*
  - *(SLC), NLC, GLC, JLC ….*
- *But finally ILC - International Linear Collider*
  - ILC250 as first phase
  - Japan as Host, with strong participation by all regions
- *So why so hard?*
  - 4.8-5.3BILCU pricetag with about half from Japan
    - Very big additional national investment in HEP
  - "Zero Sum Gamers" (non-HEP scientists) in Japan (… but remember the SSC)
  - Process, cultural differences: perhaps our expectation of the process unrealistic
- *Are we there yet?*
  - No! but Very Positive Signals
  - Still hoping for international negotiations to start soon, construction from 2023-24

CepC or FCC(ee)

See M. Benedikt talk this Symposium

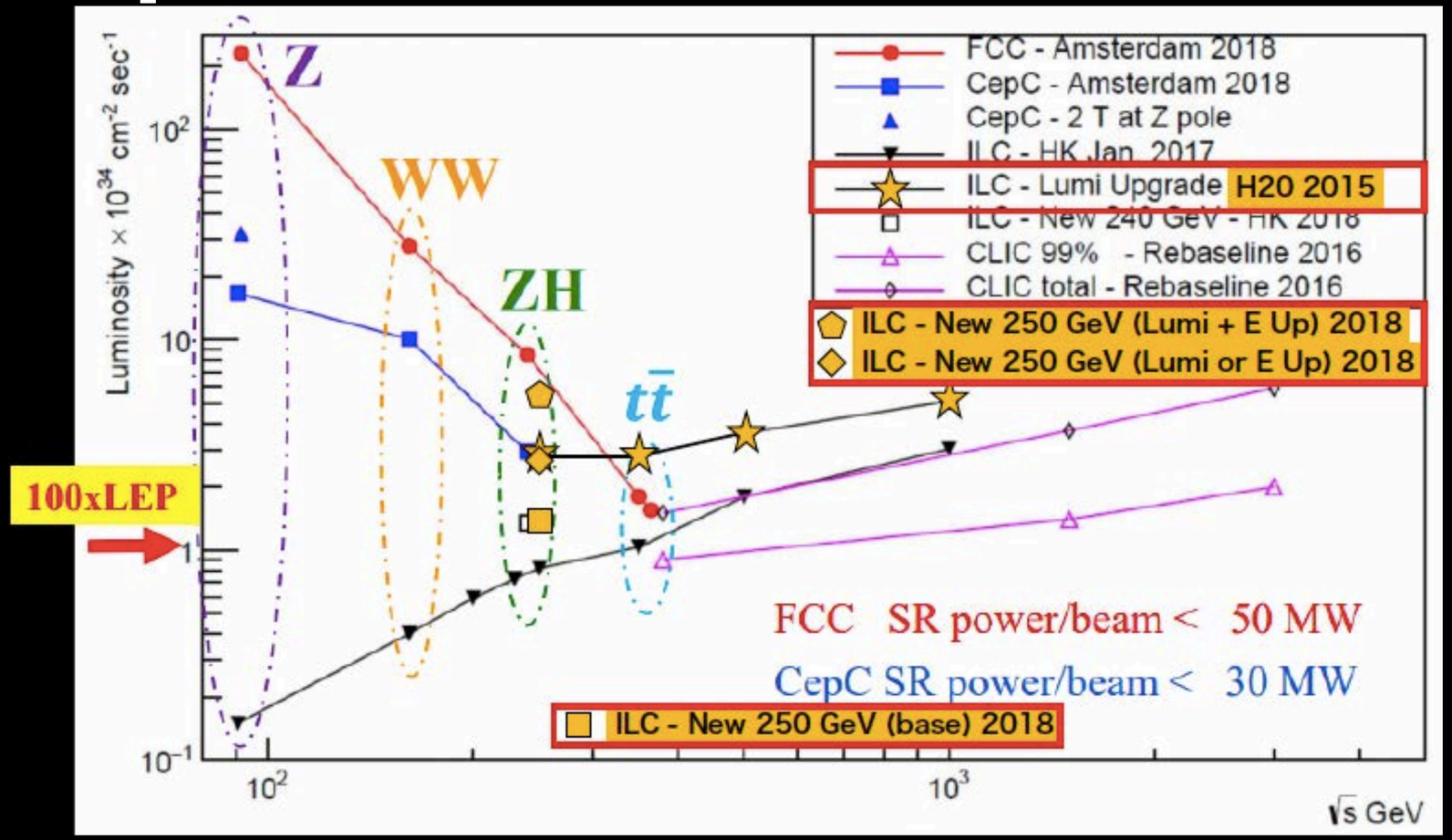
- Similar and becoming more so!
- Still have different constraints applied in design details



Also, CEPC Conceptual Design Report Volume 1 - Accelerator IHEP-CEPC-DR-2018-01

e+e- Lumi Comparison

- **Complementary nature:**
  - ***Circular colliders have very high luminosity at low energy***
  - ***Linear colliders have high energy development path***



- Original Plot, F. Bedeschi , CEPC Workshop, Rome, May 2018
- Updates Private communication, Keisuke Fujii, IPNS, KEK

CepC Path to Funding

- **"Chinese Initiated International Large Scientific Plan and Large Scientific Project" :**
  - ***By 2020 3-5 Projects will be selected for further development with some funding***
  - ***Following a small number of years (?), 1~2 projects selected for construction***
  - ***Should be complementary to other large national or multinational scientific projects.***
  - ***Be seen to be important to international scientific organizations' and laboratory scientific projects and activities.***
  - ***Process has commenced***

Yifang Wang, Jie Gao

Asian Perspective

- CepC represents additional resources to our field.
  - *~$6B additional resource is very significant.*
- Possible to have CepC operational by early to mid-2030?
  - *Considerably ahead of FCC(ee)*
- China wishes to achieve international status with large scientific projects
  - *We should try very hard to gain from this strategy.*
- Circular and Linear Solution to (initial) higgs factory have different development strengths
  - *Complementary solutions*

But can CERN/Europe Rely on Asia?

- **CepC**
  - ***Approval process will be internal but needs International (moral) support***
    - ICFA support for potential international facility
- **But clear advantages**
  - ***Considerable hosting cost moved to China***
  - ***Additional staff and students for the field***
- **China will depend upon international involvement**
  - ***IAC for CepC/SppC has been operating for several years***

Western attitude to China?

- This and other cultural differences need to be overcome
  - *Both Real and Imagined.*
- China would be well advised to pursue a CERN-like approach to operation
  - *Can our Chinese colleagues achieve this?*
  - *We need to give support / encouragement for real internationalisation of this major initiative*
- Can CERN provide the example and leadership in this goal?
  - *Highly regarded at scientific and government level*
  - *We hope so!!*

ILC/CepC Advantage for Europe

- **Allows concentration on proton, high energy future**
  - ***CERN essential for the energy frontier.***
  - ***Proton and high-field magnet expertise***
  - ***The ONLY laboratory capable of attempting very difficult projects, thus should be setting a "high bar"***
- **CERN infrastructure in protons beams outlays the fear of a second 100km tunnel.**
  - ***Possible to see a new proton collider at CERN by mid-2040s (not mid 2060s, but also not 100TeV)***

- European Particle Physics Planning is CERN Planning
- CERN Planning is Planning for the whole field.
- Asian capacity, needs and contributions are important.

Achieving an optimum?

- CERN is unique to our field and must be maintained at the leading edge.
- Whilst acknowledging the benefits and power of competition our field is renowned for cooperation
- Cooperation across regions requires a strong base (CERN) and strong leadership
- Consider how best to satisfy our field (in fact how best to keep it viable) with all potential resources

The Needs of Particle Physics

- A e+e- collider higgs factory ASAP
  - *and, yes, in time, t-tbar, ttH, HH, ..*
- A new energy frontier facility following HL-LHC
  - *even without a specific physics driver, as yet*
  - *pp, ion-ion and ep all possible*
- An active field, with multiple activities in parallel:
  - *particle physics data taking and analysis*
  - *accelerator physics, including μμ colliders and plasma acc'n*
  - *detector development*
  - *advanced computing techniques*

Asian (and personal) View

- Diversity is Critical to thrive in all environments, including HEP.
  - *Big and small facilities/experiments, at various stages of development and operation*
- Push for e+e- colliders, both Linear and Circular, as soon as possible.
  - *Linear Collider: ILC*
    - 1 Collision point
  - *Circular Collider: CepC*
    - 2 Collision points
- Push for FCC tunnel to be ready at completion of HL-LHC
  - *Stage the energy frontier with best option magnets available for early 2040's*
  - *?? Default: ~8T LHC magnets optimised for price*
    - Minimum energy: >50TeV
    - Magnet upgrade foreseen.
  - *ep and ion-ion options available*
  - *4 collision points*
  - *Upgrade path to higher energy after 20 years operation?*

See A. Yamamoto, L. Rossi, V. Shiltzev talks this symposium

Some comments to this suggestion

- The key point is to embrace Asian resources/desires/ competencies in Europe planning.
- Construction and operation time/geography/national spread
- Avoid a serial program going out to end of century
  - *We already have an issue of timelines with potential students*

Asian (and personal) View

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Happy planning!

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ICFA Statment, Tokyo March, 2019

- ***ICFA** confirms the international consensus that the **highest priority for the next global machine is a "Higgs Factory"** capable of precision studies of the Higgs boson. At this ICFA meeting **options for a Higgs Factory were discussed -- the ILC, as well as other collider technologies***
- ***ICFA** reaffirms the **scientific significance of the ILC** and that the ILC is in a **sufficient state of technical readiness for approval for construction***
- ***… A clear statement of Japan's position towards hosting the ILC** would have had **significant impact in the ongoing discussions on the formulation of the European Strategy for Particle Physics Update**.*
- ***… All options will be considered in the European Strategy for Particle Physics Update and by ICFA***

SCJ concerns, Dec. 2018

- The ILC project is far more expensive than the large number of big research facilities … examined by SCJ … the committee considers it is necessary to have broad support … (Requires) More extensive discussion including not only the elementary particle physics field
- More dialogue with the general public and residents … is needed to communicate … potential merits …of regional development …
- … not feasible unless it is based on unprecedentedly strong international cooperation. … no clear prospect for appropriate international cost-sharing …