

Particle Physics from the Asian Perspective

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Contents

- HEP program in Asia
 - Asian participation to outside
- Future programs
 - Neutrino
 - Colliders

Thanks to:

Yifang Wang (IHEP)

T. Nakaya, M. Yokoyama (Hyper-K)

Y. Ushiroda (Belle II)

K. Shigaki (PHENIX and Alice)

T. Mori and A. Ishikawa (for ILC)
for slides and discussion

For more authentic and comprehensive review, see talks in

ICFA seminar (Oct 2014): <http://indico.ihep.ac.cn/event/3867/>

(e.g. talk by A. Suzuki “Asia-Pacific regional report”)

ACFA seminar (Jan 2015): <http://indico.ihep.ac.cn/event/4648/>

(e.g. talk by Y. Wang “Activities in IHEP”)

Asia LC workshop (21-24 Apr 2015): <https://agenda.linearcollider.org/event/6557/>

(e.g. talk by T. Mori “Closing Remarks” and many others)

HEP programs in Asia so far

- **Collider Physics**

Japan: TRISTAN → KEKB (Belle)

China: BES (I, II, III)

- **Neutrino**

Japan: Kamiokande → SK, KamLAND
T2K

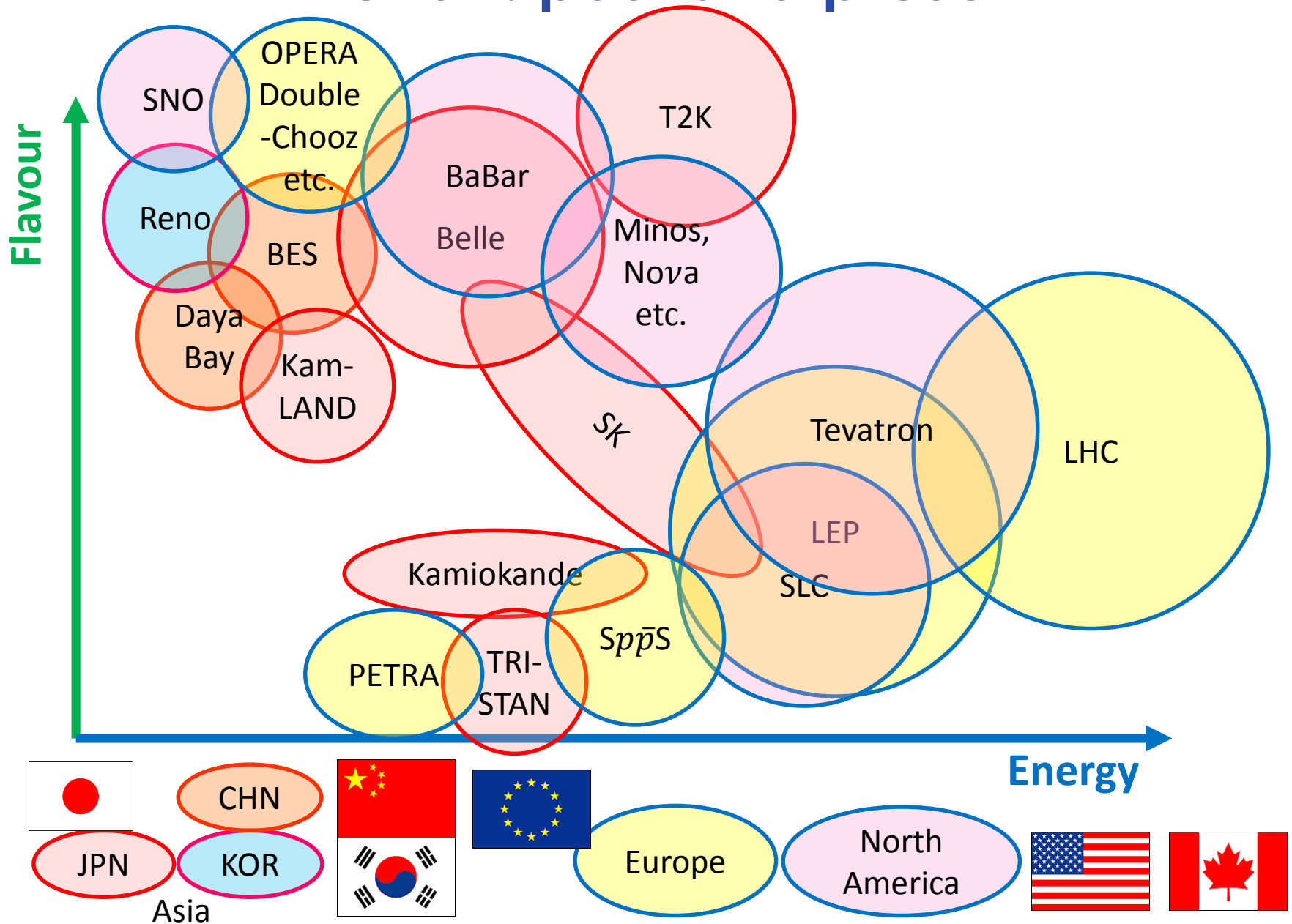
China: Daya Bay

Korea: RENO

(*) I have ~~deliberately~~ desperately dropped smaller experiments, underground activities (dark matter, neutrino-less $\beta\beta$, gravitational waves etc.) and cosmic-frontier experiments (Icecube, Telescope Array, CTA, LiteBIRD ...)

My apologies for other possible omission

HEP chart: past and present

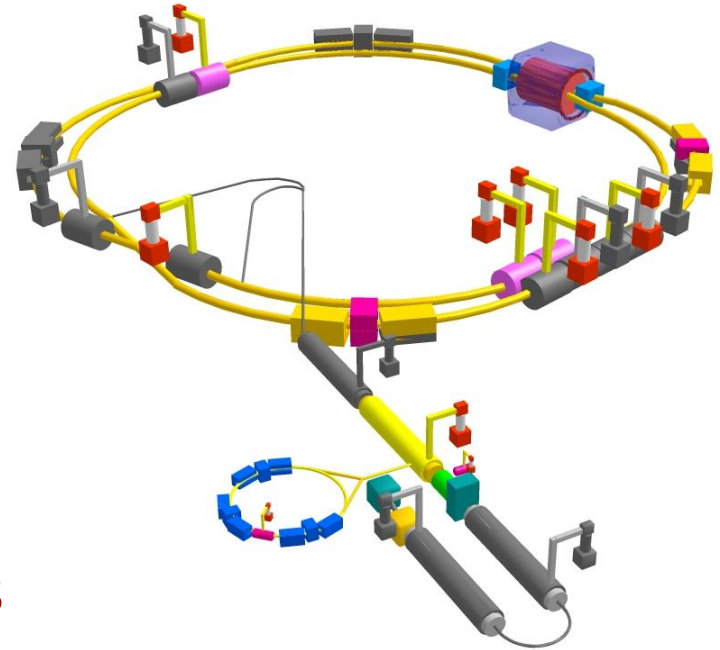


Future experiments in Asia

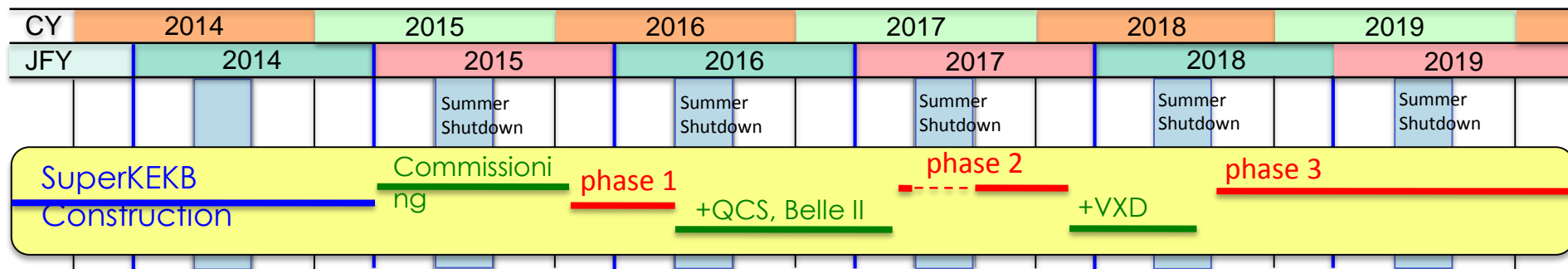
- **Flavour sector for charged particles (quarks and charged leptons)**
 - SuperKEKB / Belle II
 - J-Parc experiments (KOTO, COMET)
- **Flavour sector for neutral (neutrino)**
 - Hyper-Kamiokande
 - JUNO
- **Energy Frontier**
 - CEPC and SppS
 - ILC

The quark sector: Super KEKB / Belle II

- BSM, through anomaly in heavy quark decay **and** τ -lepton flavour violation
- x 40 in luminosity
- Several steps in commissioning: pilot run in 2017, full operation in 2018



SuperKEKB schedule



Phase 1: without final focusing magnets (QCS), without Belle II
 Phase 2: with QCS, with Belle II but VXD
 Phase 3: with QCS, with full Belle II including VXD



Europe	248
Austria	14
Czech	8
Germany	89
Italy	62
Poland	11
Russia	40
Slovenia	17
Spain	3
Ukraine	4

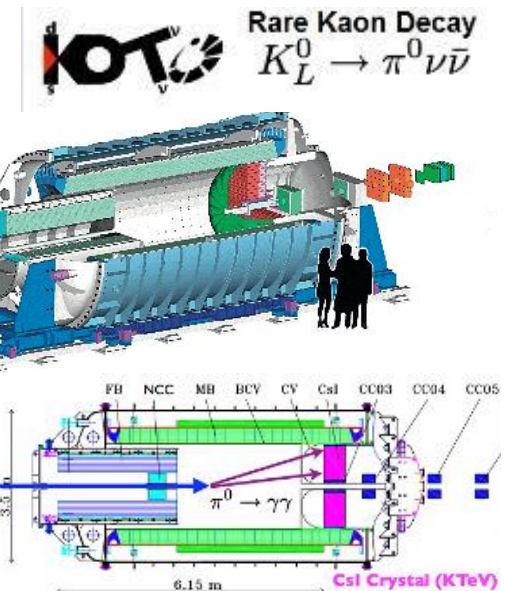
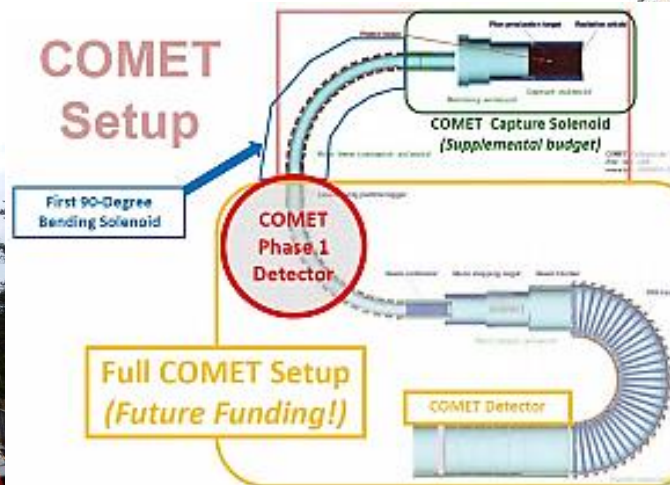
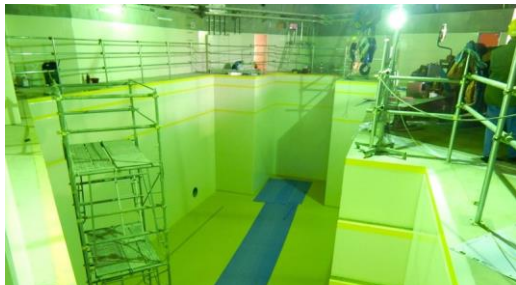
Asia	280		
Saudi Arabia	4	Korea	37
Australia	22	Malaysia	5
China	18	Viet Nam	1
India	25	Taiwan	25
Japan	139	Thailand	1
		Turkey	3

America	106
Canada	20
Mexico	8
U.S.A	78

23 countries/regions
99 institutions
>600 researchers

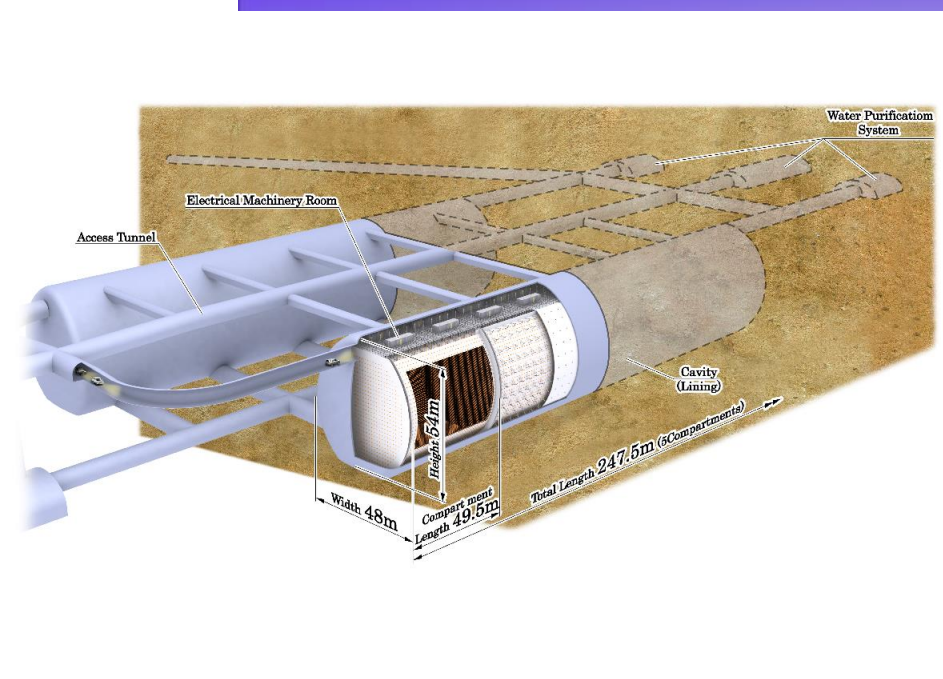
J-Parc experiments

- Koto: $K^0 \rightarrow \pi^0 \nu \bar{\nu}$
 - Five countries including Korea, Taiwan
- Comet: $\mu - e$ conversion
 - 160 researchers from 13 countries including China, Korea, India, Saudi Arabia, Malaysia and Vietnam



Hyper-Kamiokande

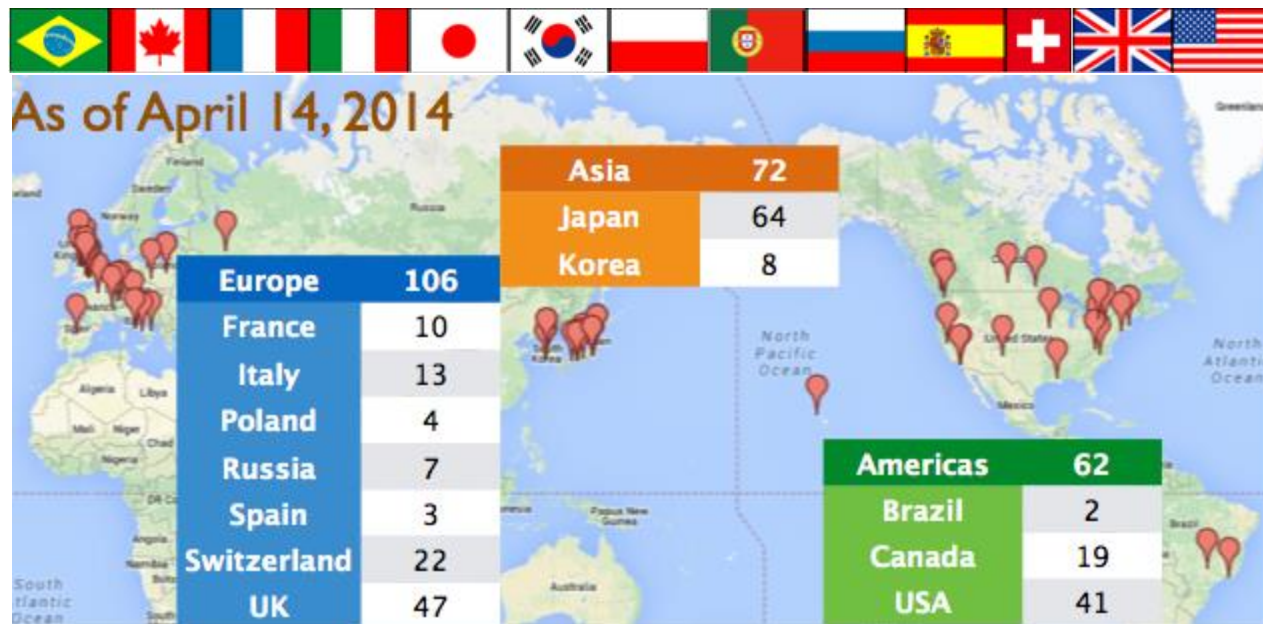
- x25 volume to Super-K
- Oscillation and CP in neutrino: Events from J-Parc x50 wrt T2K



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- The diagram illustrates the organizational structure and timeline of the SCJ-MEXT project. At the top, a red box labeled 'SCJ-MEXT project' is connected by a double-headed blue arrow to a red box labeled 'MEXT(*)'. Above this, text indicates the 'Master plan for large-scale projects: Sep 2013'. Below the SCJ-MEXT project box, a large blue box contains the text 'Social science Medical Science Technology ...'. To the left, a vertical stack of boxes represents the project's components: 'KEK' (top), 'ICRR', 'JAXA..', and 'JAHEP' (bottom). Arrows point from these boxes towards the SCJ-MEXT project box. A red arrow points from 'JAHEP' to 'KEK'. Text on the left side of the diagram includes 'Community', 'er-K (2014)', 'CJ)', 'riority', 'er Plan', and '14'. On the right side, text indicates 'Requesting a report in 2013' with an arrow pointing to the SCJ-MEXT project box.

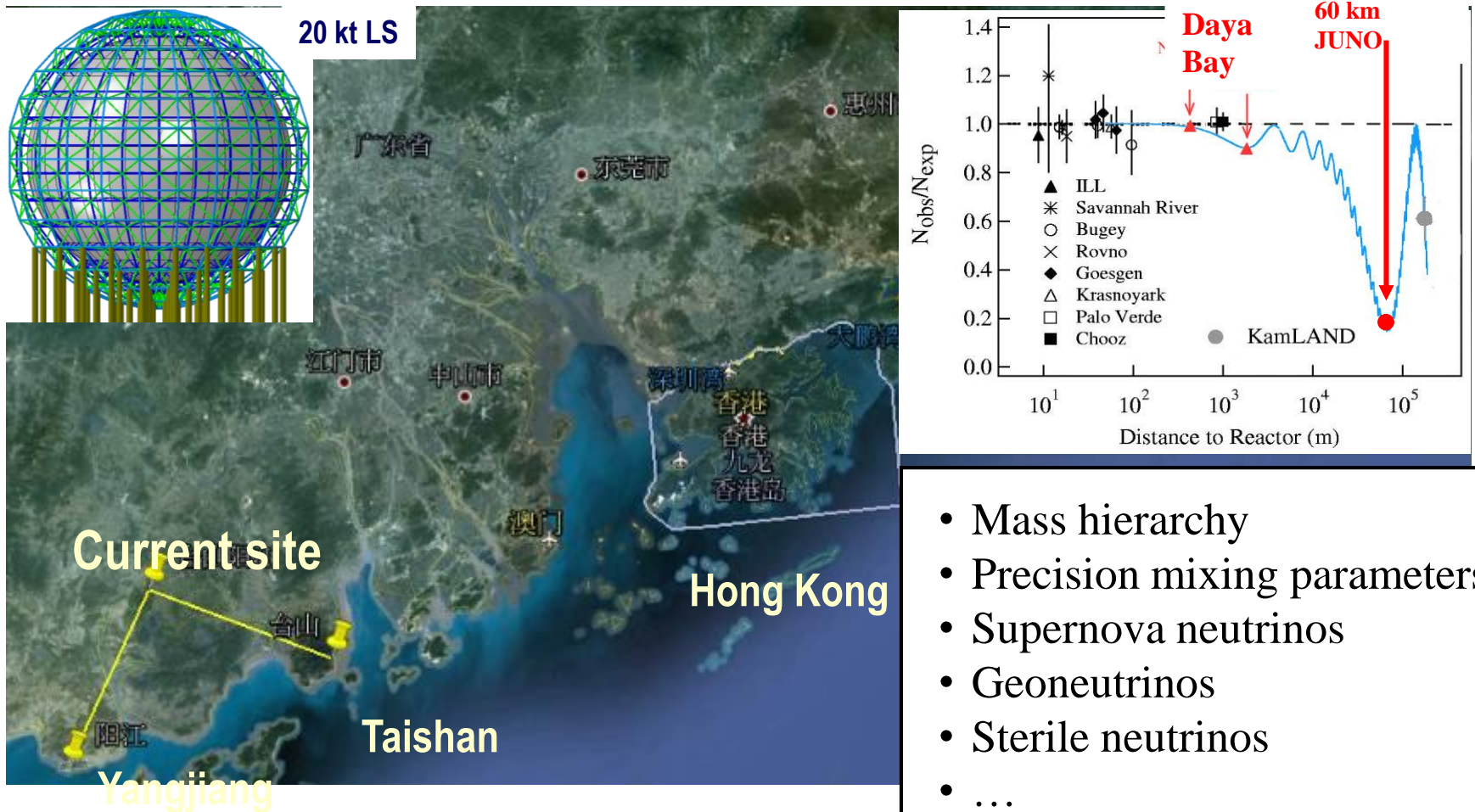
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Hyper-K collaboration, schedule



- 240 members from 13 countries
 - EU meeting this week; also efforts to invite more from other regions
- Earliest scenario: construction from 2018, operation 2025

Next Step: JUNO for Mass Hierarchy



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

- The only one based on reactor: independent of CP phase
- Construction started from 2015, operation from 2020
- Also planned: RENO-50 (Korea)

“QCD Physics”: DIS and HI in Asia

Heavy Ion (RHIC, LHC)



BNL(STAR
or PHENIX)
and CERN
(Alice)

Alice

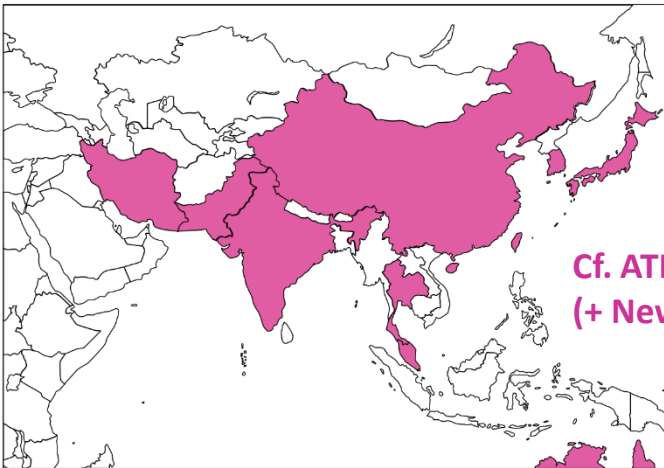
ep collider (HERA)



HERA
and
LHeC

HERA

LHC multi-purpose detectors



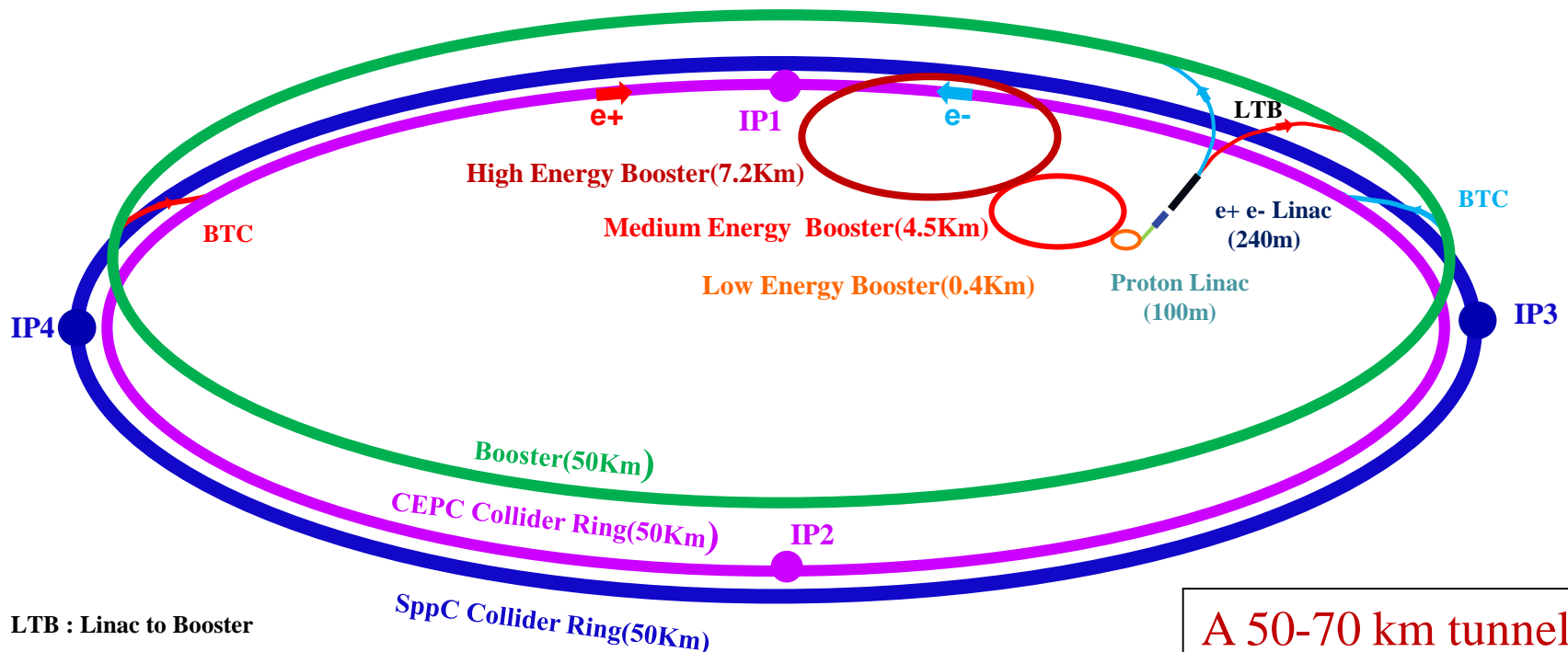
Cf. ATLAS and CMS
(+ New Zealand)

- No dedicated machine but strong interest !!

Future high-energy colliders

The Future: CEPC+SppC

- For about 8 years, we have been talking about “What can be done after BEPCII in China”
- Thanks to the discovery of the low mass Higgs boson, and stimulated by ideas of Circular Higgs Factories in the world, CEPC+SppC configuration was proposed in Sep. 2012



LTB : Linac to Booster

BTC : Booster to Collider Ring

A 50-70 km tunnel is
relatively easier NOW
in China

Scientific Goals

- **CEPC (e^+e^- : 90-250 GeV)**
 - Higgs Factory: Precision study of Higgs(m_H , J^{PC} , couplings)
 - Z & W factory: precision test of SM
 - Flavor factory: b, c, τ and QCD studies
- **SppC (pp: 50-100 TeV)**
 - Directly search for new physics beyond SM
 - Precision test of SM
 - e.g., h^3 & h^4 couplings

Three pillars: EW phase transition, naturalness, dark matter
CEPC-SppC complementary with each other

Timeline (dream)

- **CPEC**

- Pre-study, R&D and preparation work
 - Pre-study: 2013-15
 - **Pre-CDR for R&D funding request**
 - R&D: 2016-2020
 - Engineering Design: 2015-2020
- Construction: 2021-2027
- Data taking: 2028-2035

- **SppC**

- Pre-study, R&D and preparation work
 - Pre-study: 2013-2020
 - R&D: 2020-2030
 - Engineering Design: 2030-2035
- Construction: 2035-2042
- Data taking: 2042 -

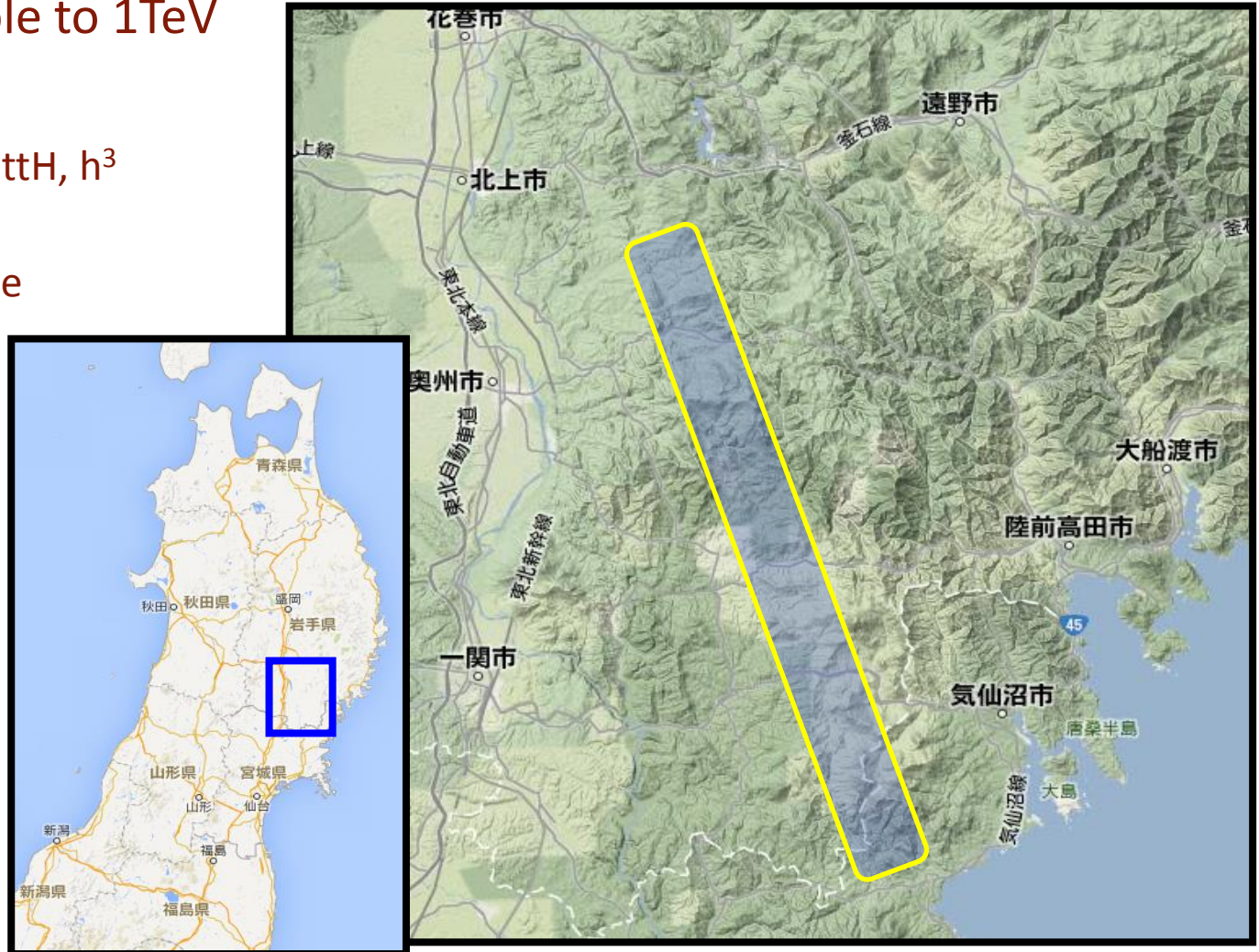
Complementary with ILC

Yifang Wang (IHEP)
Underlines by YY

- **Energy :**
 - CEPC for Z and Higgs(250 GeV)
 - ILC can go to 500 GeV for all couplings(Htt etc)
- **Detector :**
 - One detector each for ILC and CEPC . ILC can give up Push-Pull.
 - ILC & CEPC: cross check
- **Technology:**
 - ILC can go to higher energy → FEL
 - CEPC can go to higher Luminosity → Synchrotron
- **Timeline:**
 - ILC starts from 2020 ?
 - CEPC starts from 2022 ?
- **Why two ? One is enough ?**
 - Two very different technology. Very different possibility for future.
 - Cross check : 2 accelerator + 2 detector is better than 1 (ILC) + 2 detector

The ILC

- TDR completed in 2013
- Site selected in Japan: Tohoku-Kitakami area (north) in 2013
- \sqrt{s} upgradable to 1TeV
- Physics:
 - Higgs including ttH , h^3
 - SUSY in wider parameter space
 - Top precision



ILC status in Japan

- JAHEP recommendation: next priority projects are Hyper-K and **ILC**
- KEK submitted a proposal to SCJ in 2013
 - but ILC was not part of the Master Plan

- The SCJ instead gave a special report for ILC, requesting to study

1. **Physics research strategy** of ILC in the view of LHC upgrade path
2. A funding scheme **not affecting other activity** in science/national projects
3. Domestic organisation to implement the project (KEK + Japanese universities)
4. **Human resources** for construction, operation and, in particular, the leadership positions



ILC status in Japan (2) WG under MEXT

Q1: Physics research strategy

➤ Physics WG

Q2: Validity of cost estimate

➤ TDR WG

Q3: Domestic organisation

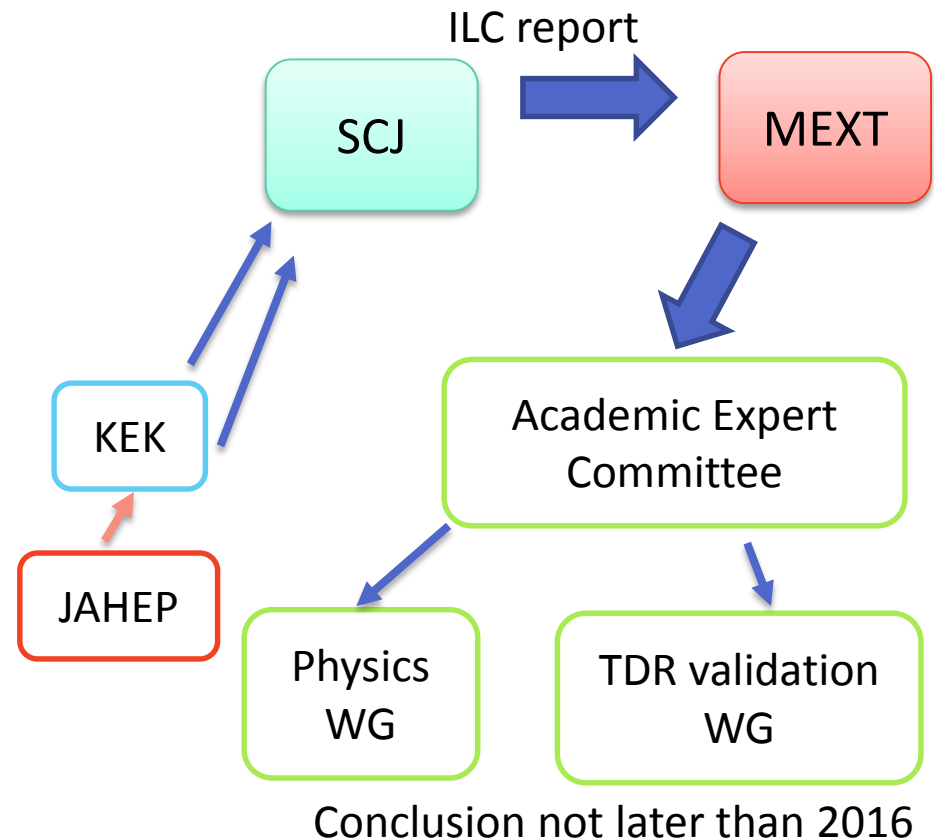
➤ ILC planning office in KEK

Q4: Human resources

- MEXT new WG
- International Cooperation absolutely important

The question: international cost shearing

Beyond MEXT (see next slide)



Future steps

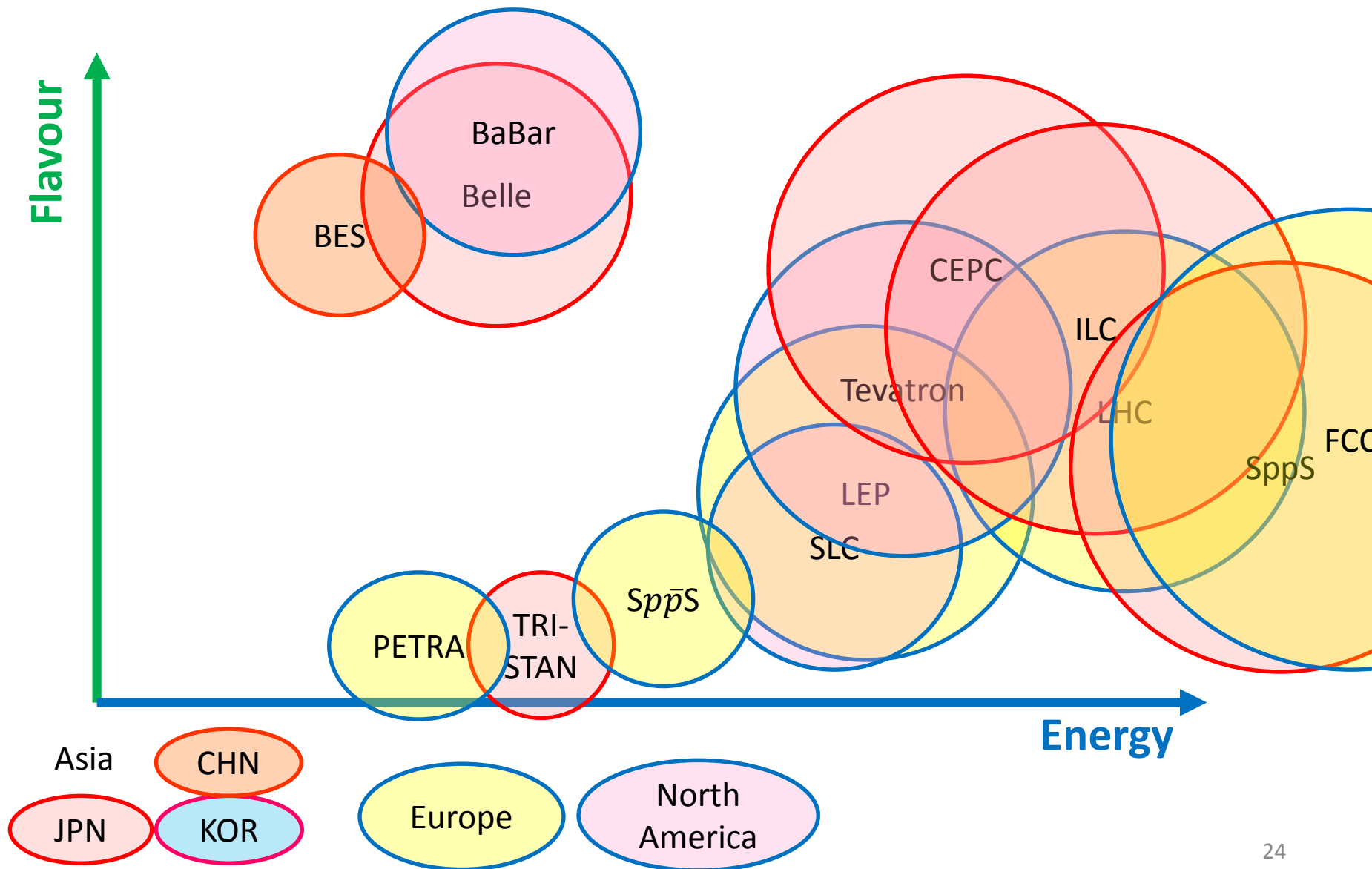
- MEXT official review by WGs (NOW)
- Government-to-government discussion on issues and preparation (NOW)
 - Discussion between Europe – US – Japan in 2014
- Support from policy-makers (diet members)
 - Resolution and Policy Report to prime minister Shinzo Abe
 - Visits to Washington (2014 and also now)
 - to Europe and Asia (winter 2015) foreseen

Why is MEXT and diet members talk to governments before deciding?

ILC in Japan: truly be GLOBAL !

- No way to do it as semi-domestic project
 - Cost, and
 - Human resource
- Driving force for us (and politicians):
“the first large international project in Asia”
- Government has to make sure the reactions of countries when taking decision
 - Keeping close contact with other countries

HEP chart (accelerators only)



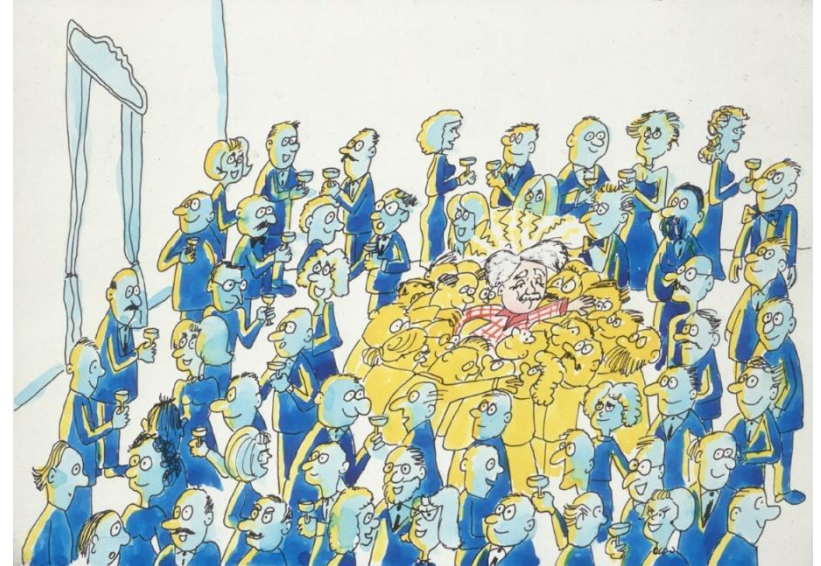
Summary

Asia has been and will be
playing major role in flavour physics,
but not as much for energy frontier

We strongly wish to contribute there
by having future collider(s) in Asia

Flavour and Higgs

- For charged fermions, only Higgs knows the flavour i.e. mass Eigenstate
 - Except for charged weak bosons, but with a different matrix
- Particles are “defined” by Higgs
 - No Higgs, you never know who you are
- Then, how Higgs does distinguish particles?
 - It does at it does ...



Flavour physics *is* Higgs physics

“QCD Physics”: DIS and HI in Asia

- Strong interest to heavy ion experiments:
 - To BNL: Korea, China, India, Japan (PHENIX), China, India, Korea (STAR)
 - To CERN (Alice):
Japan, China, Korea(big), Thailand, Indonesia*, India(big), Pakistan
- DIS
 - Strong spin community in Japan,
 - To DESY: HERA participation from Japan, Korea (ZEUS) and from Armenia, Mongolia (H1)
 - LHeC: also participation from Asia (Turkey, Japan)
- E.g.: to other LHC experiments
 - ATLAS: China, Hong Kong, Japan, Australia
 - CMS: China, Iran, Malaysia, Pakistan, Taiwan, Thailand, Turkey, Korea, India, New Zealand