Particle Physics Programme in Asia

incl. Oceana

George W.S. Hou (侯維恕)
National Taiwan University

Particle Physics Programme in Asia HEP

Outline

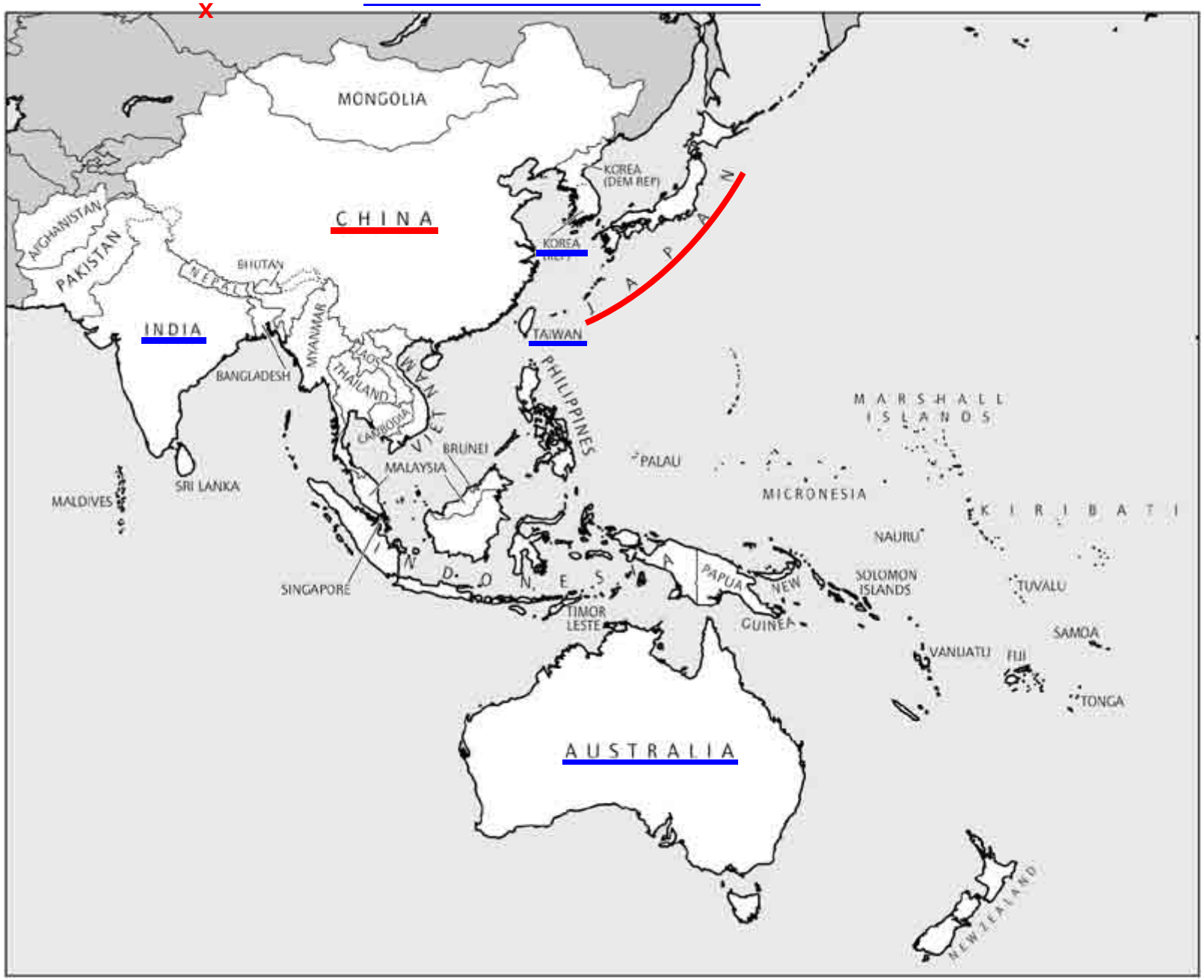
1. Asia-in-World →to→ Asia
2. Success to Successor
3. J-PARC and Non-Accelerator
4. The Hopefuls: ILC & CEPC(-SppC) → Yasuhiro Okada/ Yifang Wang (next talk)
5. Amalgamation of **ACFA**/AsiaHEP

ICFA Mission

- To promote international collaboration in all phases … of very high energy accelerators.
- To organize regularly world-inclusive meetings for the exchange of information on future plans for regional facilities and for the formulation of advice.
- To organize workshops for the study of problems related to super high-energy accelerator complexes and their international exploitation and to foster research and development of necessary technology.

Albrecht Wagner, ICFA Seminat at SLAC, Oct 2008 — Repeated by Joachim Mnich @ LP2017

AsiaHEP Member States



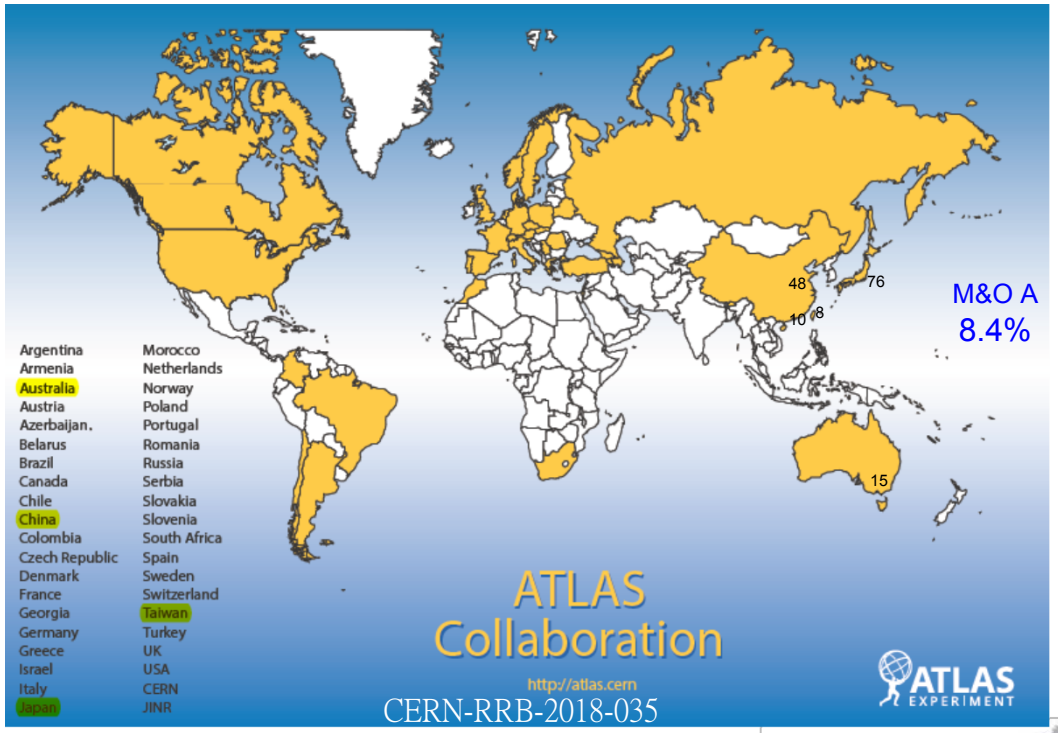
Feb. 2016

AsiaHEP/ACFA Statement on ILC + CEPC/SPPC

AsiaHEP and ACFA reassert their strong endorsement of the ILC, which is in a mature state of technical development. The aim of ILC is to explore physics beyond the Standard Model by unprecedented precision measurements of the Higgs boson and top quark, as well as searching for new particles which are difficult to discover at LHC. The Higgs studies at higher energies are especially important for measurement of WW fusion process, to fix the full Higgs decay width, and to measure the Higgs self-coupling. In continuation of decades of world-wide coordination, we encourage redoubled international efforts at this critical time to make the ILC a reality in Japan. The past few years have seen growing interest in a large radius circular collider, first focused as a "Higgs factory", and ultimately for proton-proton collisions at the high energy frontier. We encourage the effort lead by China in this direction, and look forward to the completion of the technical design in a timely manner.

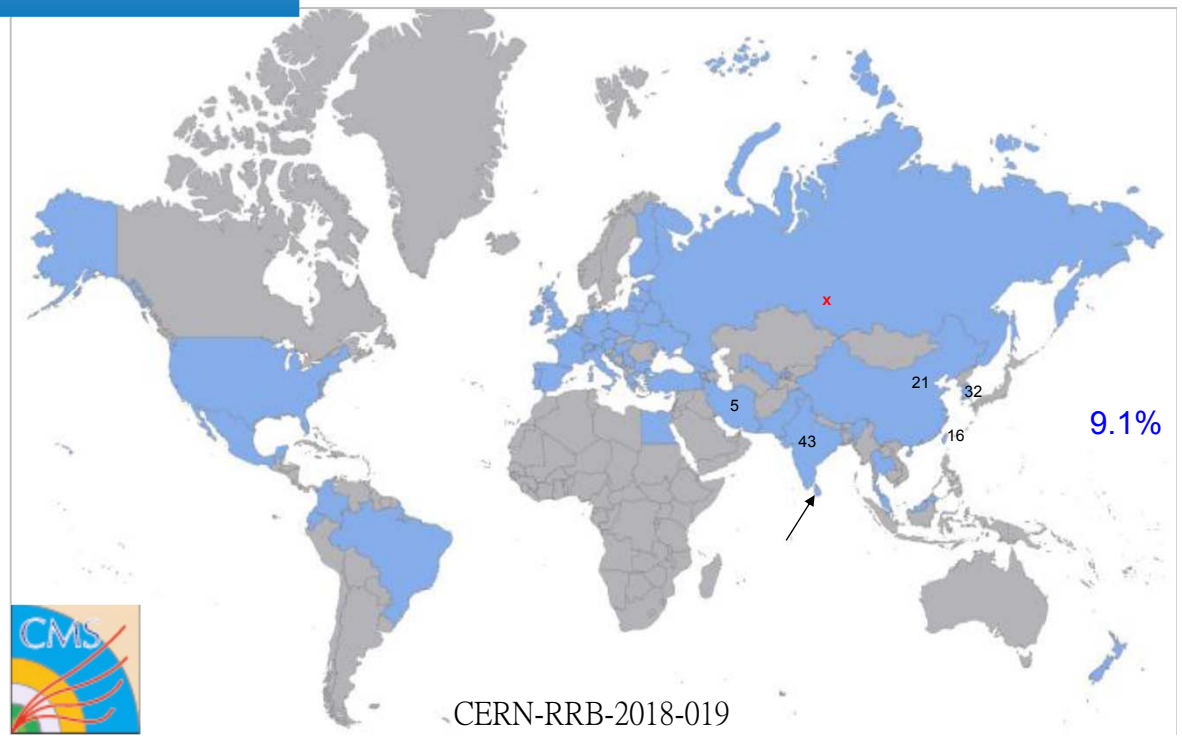
ILC

CEPC



M&O A
8.4%

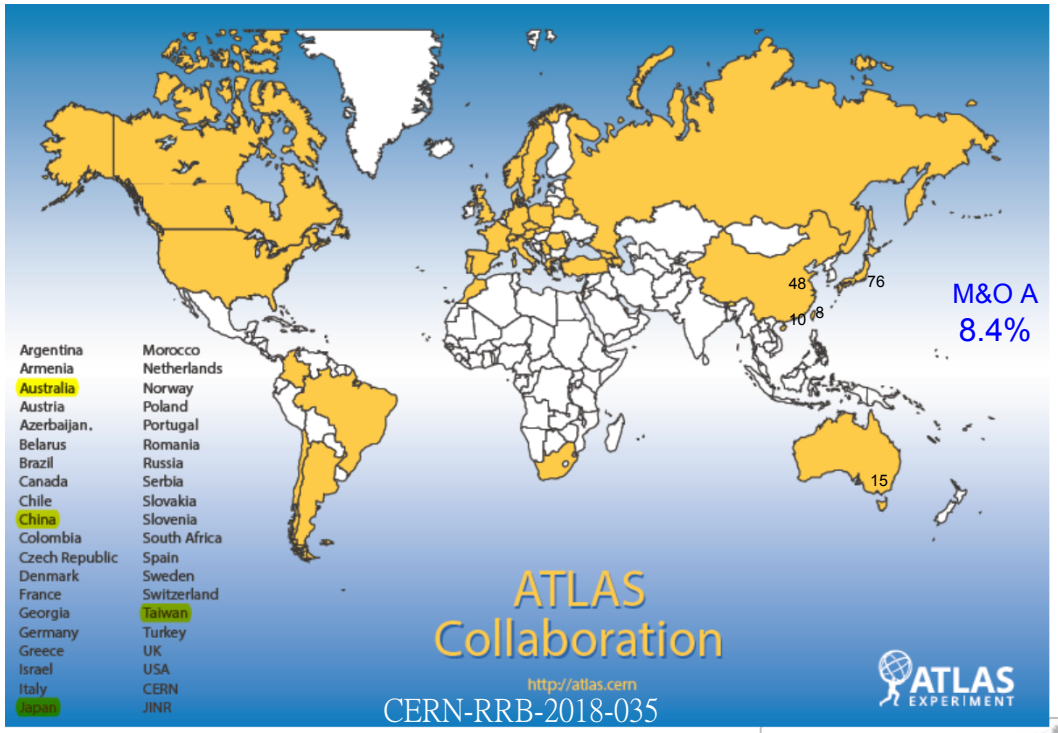
LHC is current World HEP Focus



9.1%

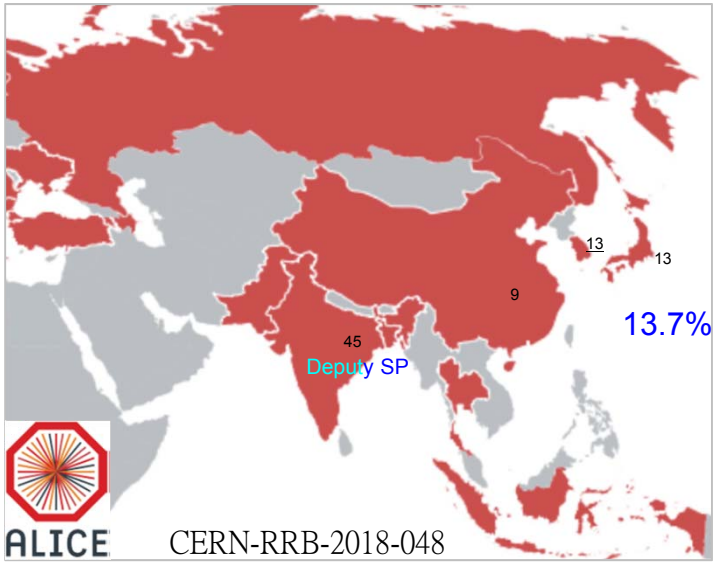
PPP Asia

LHC is current World HEP Focus



M&O A
8.4%

LHCb: 21 (China) 4.1%



13.7%

PPP Asia

Phase-2 > 21 MCHF

9.1%

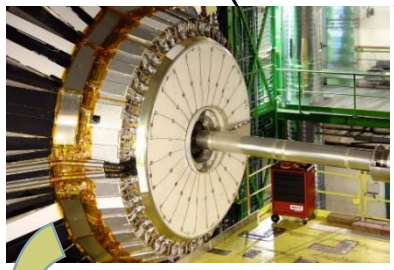
The High-Granularity Calorimeter HGCal for CMS Phase II Upgrade

Stathes Paganis
(5/28 para.)

Challenging !!

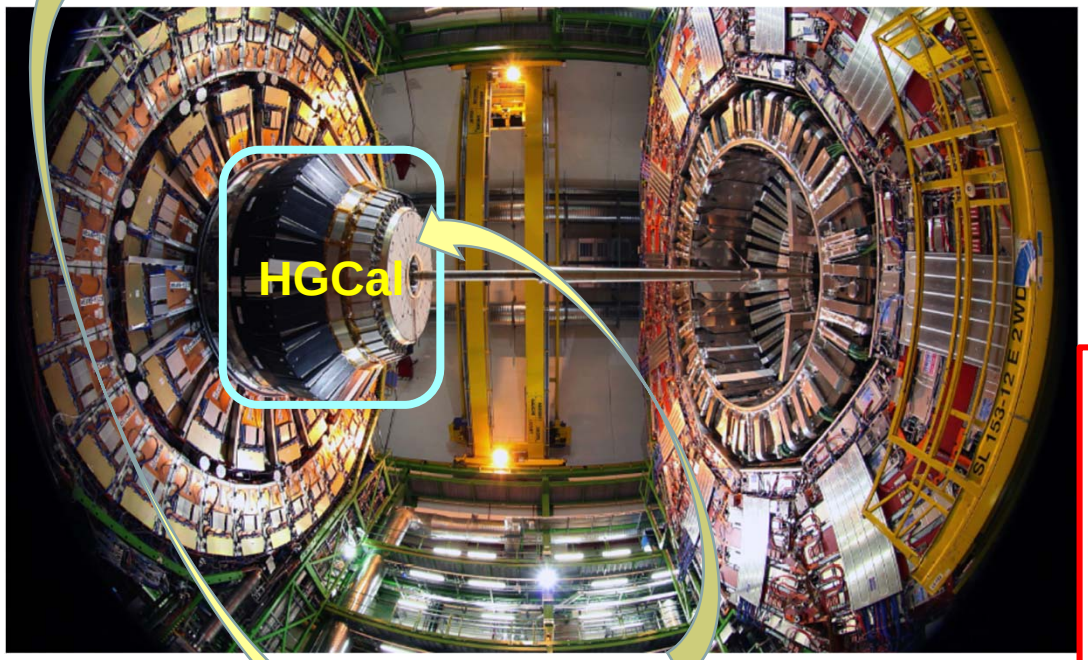
Taiwan: 2.87 MCHF

Preshower ('02–'08)

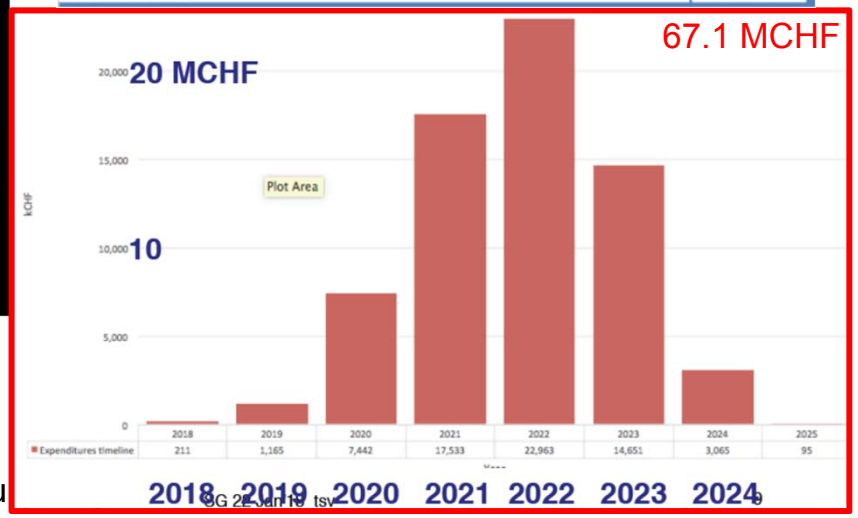


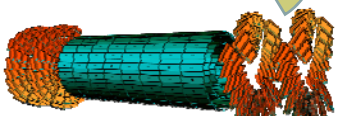
Lead: UCSB
Also: IHEP (China)
BARC (India)
CMU
TexasTech

Module Assembly Center (MAC)
in new Si-Lab @ NTU



Sum of Cost kCHF CBS	Total
1.1 - Mechanical Systems	11'441
1.10 - Installation and Commissioning	226
1.2 - Cassettes	3'027
1.3-1.4 Sensors and Modules	25'992
1.5 - Scintillator/SiPM Modules	2'945
1.6 - Electronics and Electrical Systems	15'762
1.7 - Backend System (Trigger and DAQ)	6'226
1.8 - Slow control	598
1.9 - Detector Assembly (on surface)	910
Grand Total	**67'127**

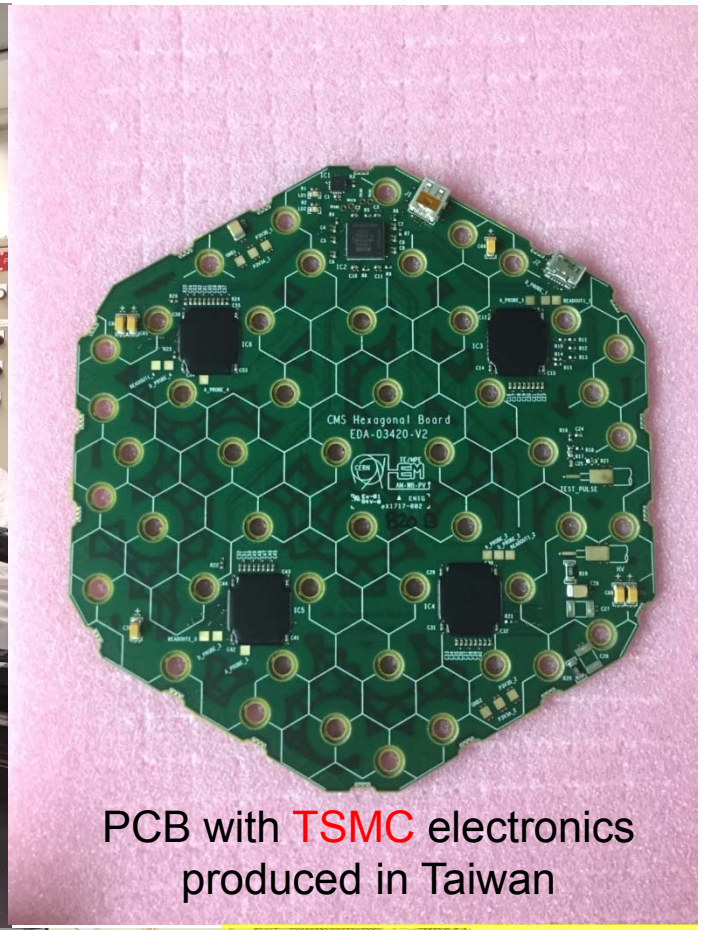




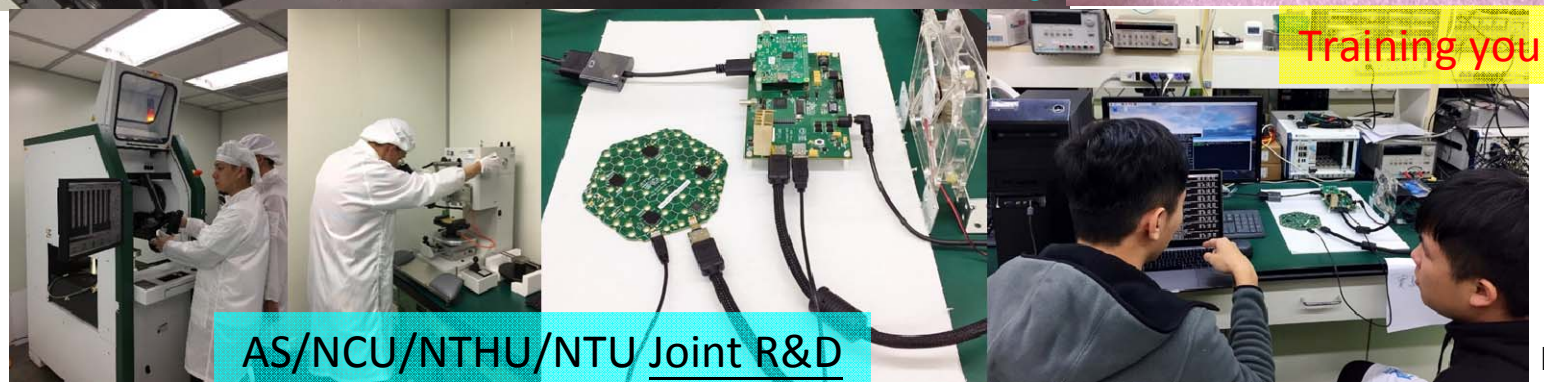
Pixel 1 ('10–'16)

CMS HGCal MAC in Taiwan

NTU AstroMath Building



PCB with TSMC electronics produced in Taiwan



Training young talents

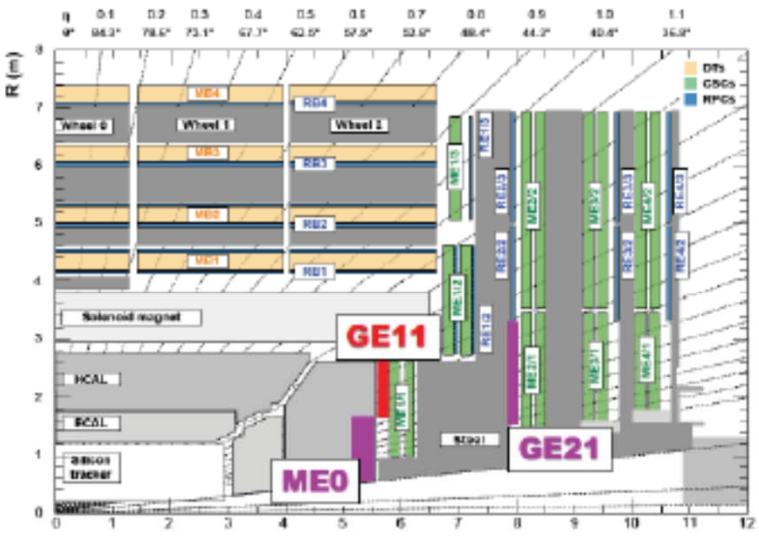
AS/NCU/NTHU/NTU Joint R&D

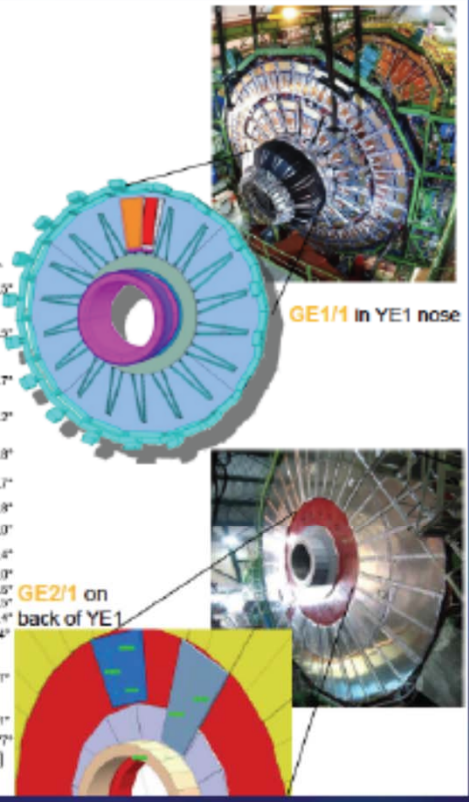
Courtesy: Youngjoon Kwon

CMS Phase II Upgrade

- Total cost for Phase II (LS2+LS3) : 265MCHF
  - 2.25% share by KCMS: 6MCHF (~70억)

- LS2: GE11 (1.6 < |eta| < 2.2) : LS2
- LS3: GE21 (1.6 < |eta| < 2.45) : LS3
- LS3: ME0 (2.0 < |eta| < 3.5): LS3





- LS2 : Muon-GEM (GE11)
  - KCMS share: 650kCHF
- LS3 (2023~2024)
  - GEM & RPC: ~2.5MCHF
  - Common fund: ~0.5MCHF
  - Tier 1 (option)
  - Backup project: L1 Trigger & calorimeter

11

CMS →to→ Asia

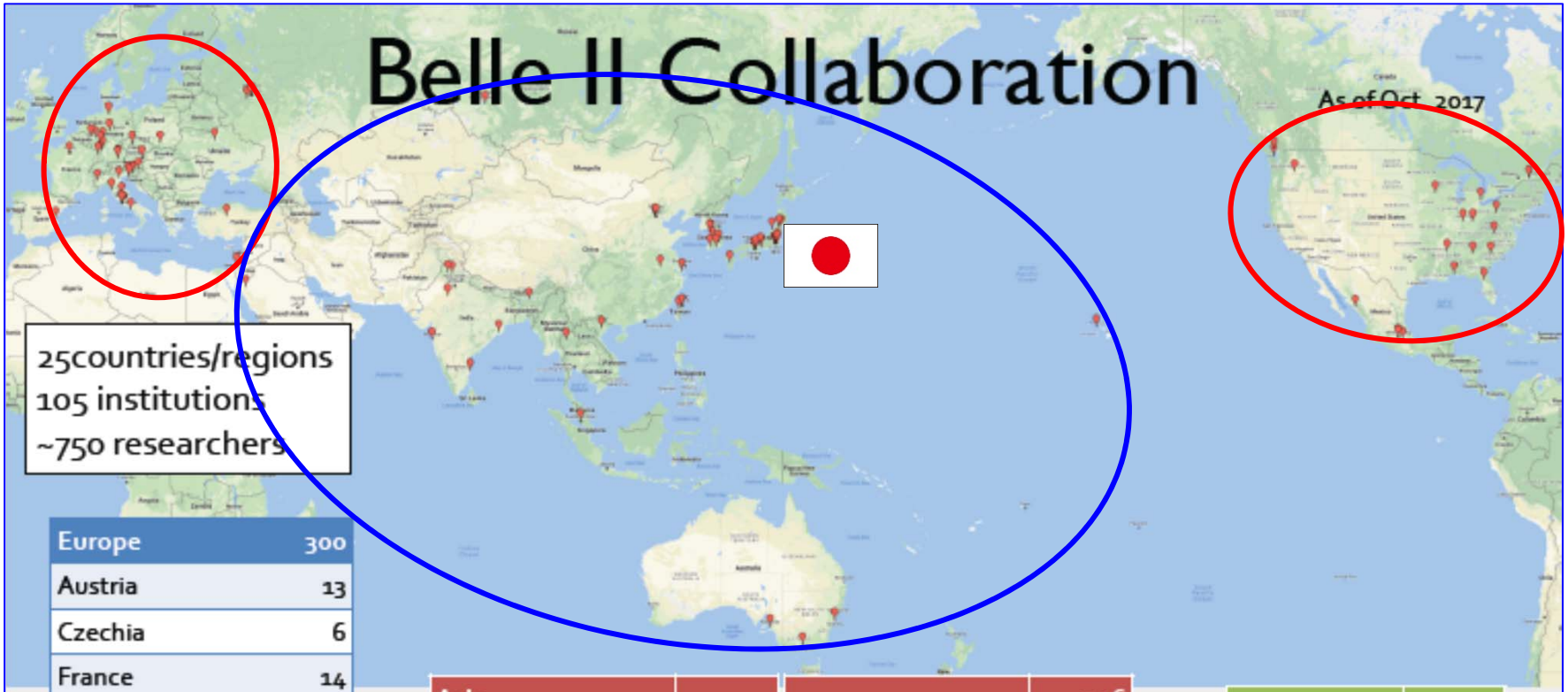

2000


Kajari Mazumdar
CMS Wk Mumbai '16


CMS
CMS WEEK
tifr
BARC
14 – 18 November, 2016
Tata Institute of Fundamental Research
Mumbai, India

Growing Attraction of Asia

Toru Iijima @ ICFA Seminar 2017



Europe	300
Austria	13
Czechia	6
France	14
Germany	110
Israel	3
Italy	76
Poland	13
Russia	42
Slovenia	16
Spain	4
Ukraine	3

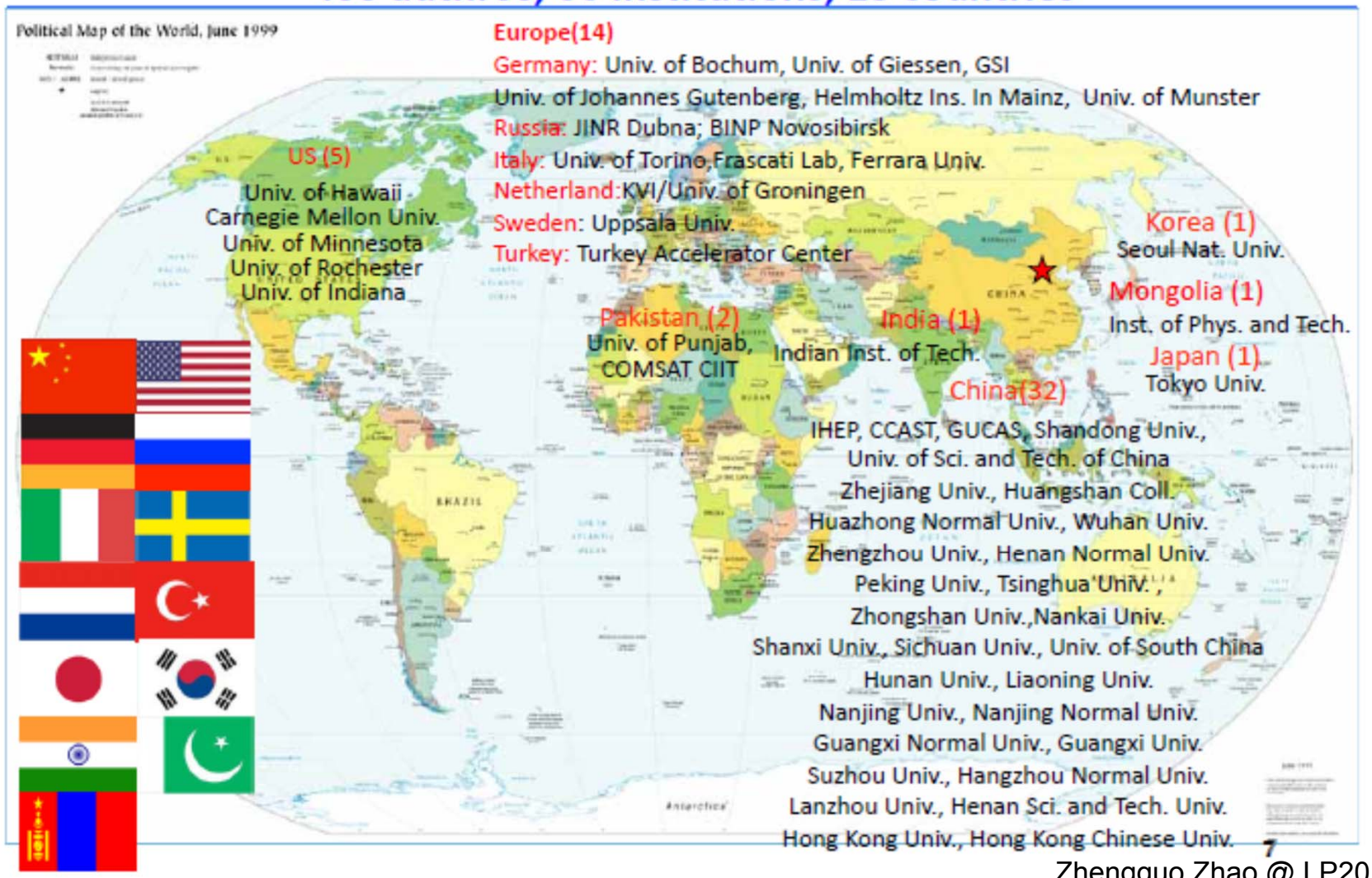
Asia			346
Saudi Arabia	1	Korea	43
Australia	33	Malaysia	6
China	33	Vietnam	3
India	44	Taiwan	28
Japan	150	Thailand	2
		Turkey	3

America	129
Canada	28
Mexico	12
USA	89

Growing Attraction of Asia

BESIII Collaboration

~400 authros, 60 institutions, 13 countries



Zhengguo Zhao @ LP2017

Growing Attraction of Asia

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.
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
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

Yifang Wang, Pub. Lect. @ LP2017

Growing Attraction of Asia

MEG-II @ PSI

COMET

160 researchers from 32 Institutes in 13 countries + 1 International Institute

Major contributions from Asian countries

Japan – (host) Facility, Detector & Analysis,
China – Tracker Electronics & Physics analysis
India – Beam monitor, Vietnam – Analysis,
Malaysia - Analysis

... and of course many from other countries !

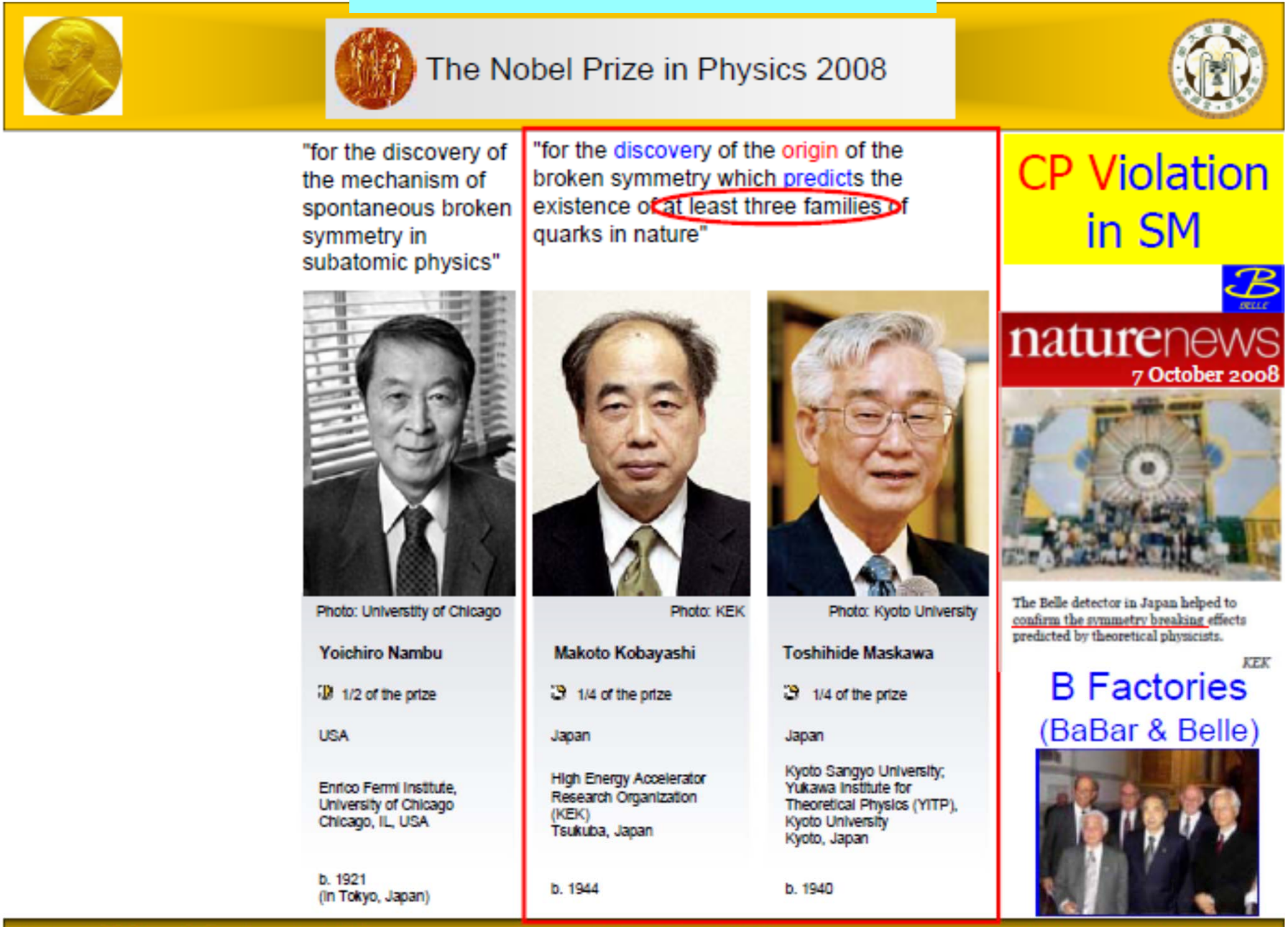
J-PARC

g–2 @ KEK

98 members from 21 Institutes in 8 countries

Hyper-K

2. Success to Successor



SuperKEKB Accelerator

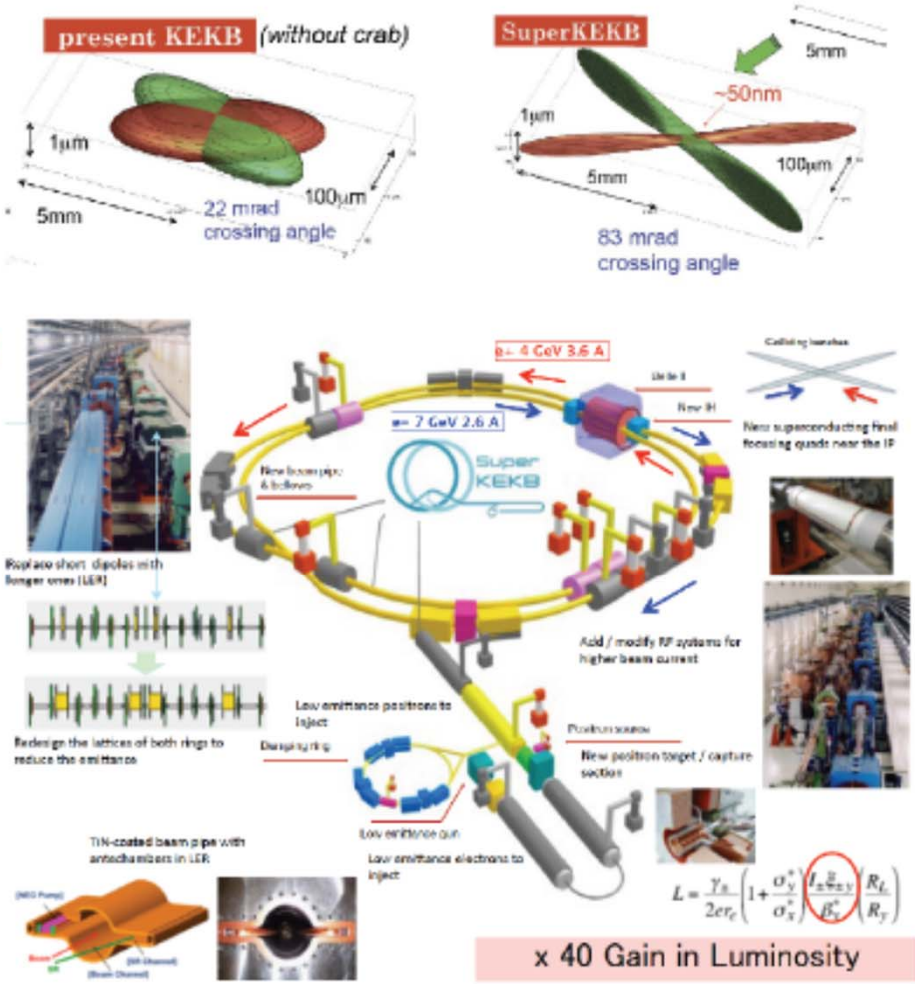
- Low emittance ("nano-beam") scheme employed (originally proposed by P. Raimondi)

Machine parameters

	SuperKEKB LER/HER	KEKB LER/HER
E(GeV)	4.0/7.0	3.5/8.0
ε_x (nm)	3.2/4.6	18/24
βy at IP(mm)	0.27/0.30	5.9/5.9
βx at IP(mm)	32/25	120/120
Half crossing angle(mrad)	41.5	11
I(A)	3.6/2.6	1.6/1.2
Lifetime	~10min	130min/200min
L($cm^{-2}s^{-1}$)	80×10^{34}	2.1×10^{34}

x20

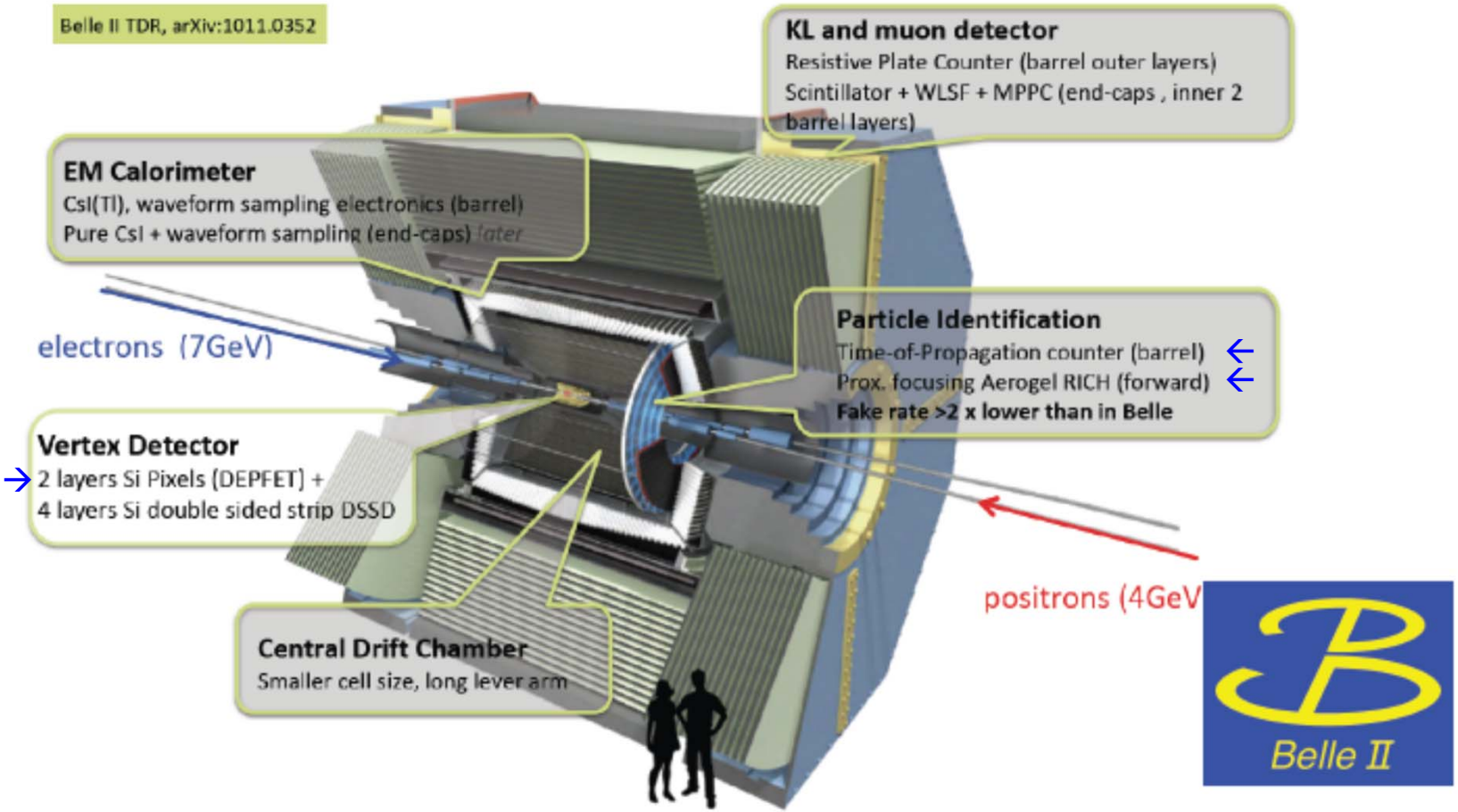
x2



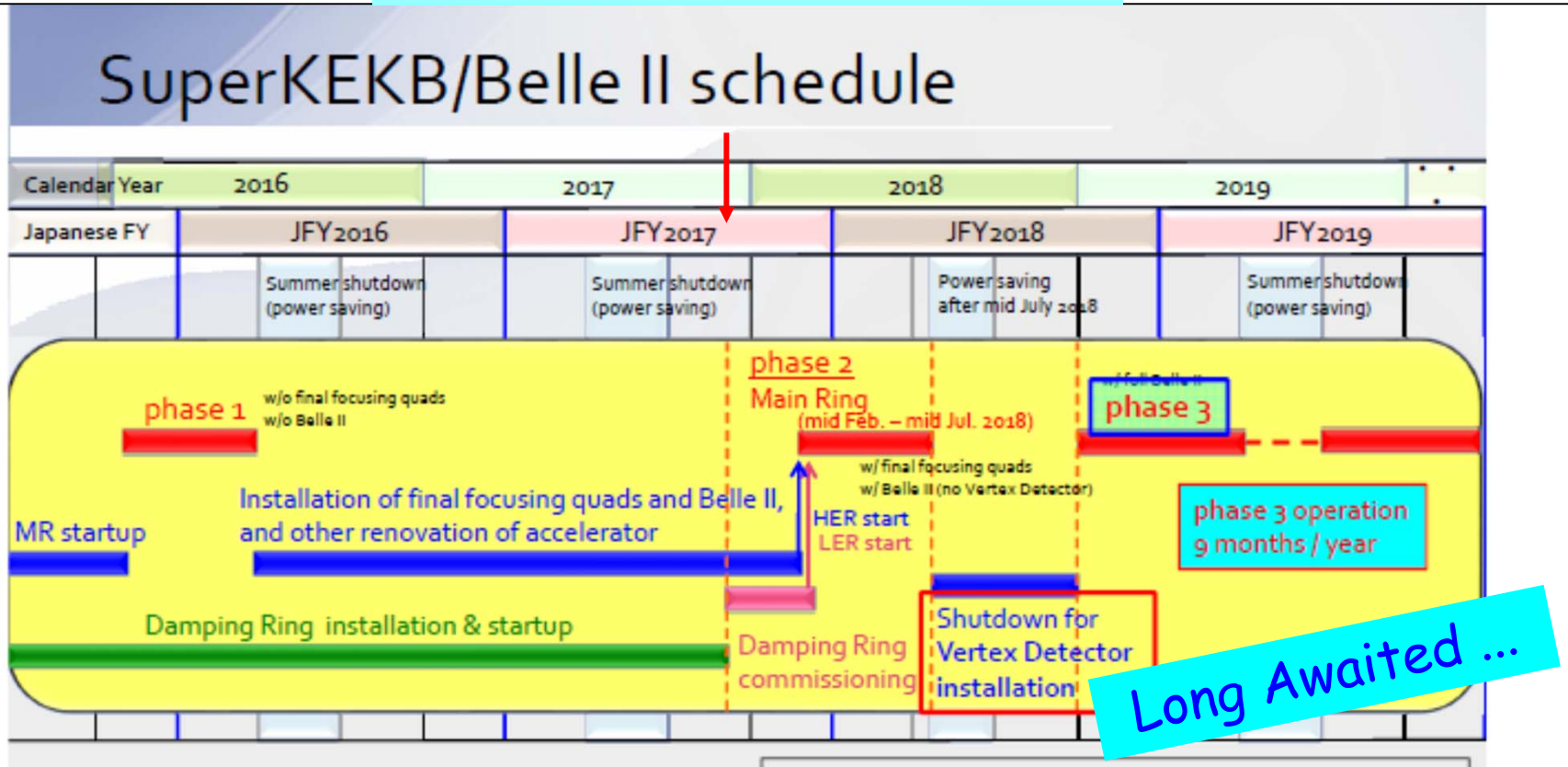
Toru Iijima @ ICFA Seminar 2017

Belle II Detector

- Deal with higher background (10-20×), radiation damage, higher occupancy, higher event rates (L1 trigg. 0.5→30 kHz) ←
- Improved performance and hermeticity



2. Success to Successor

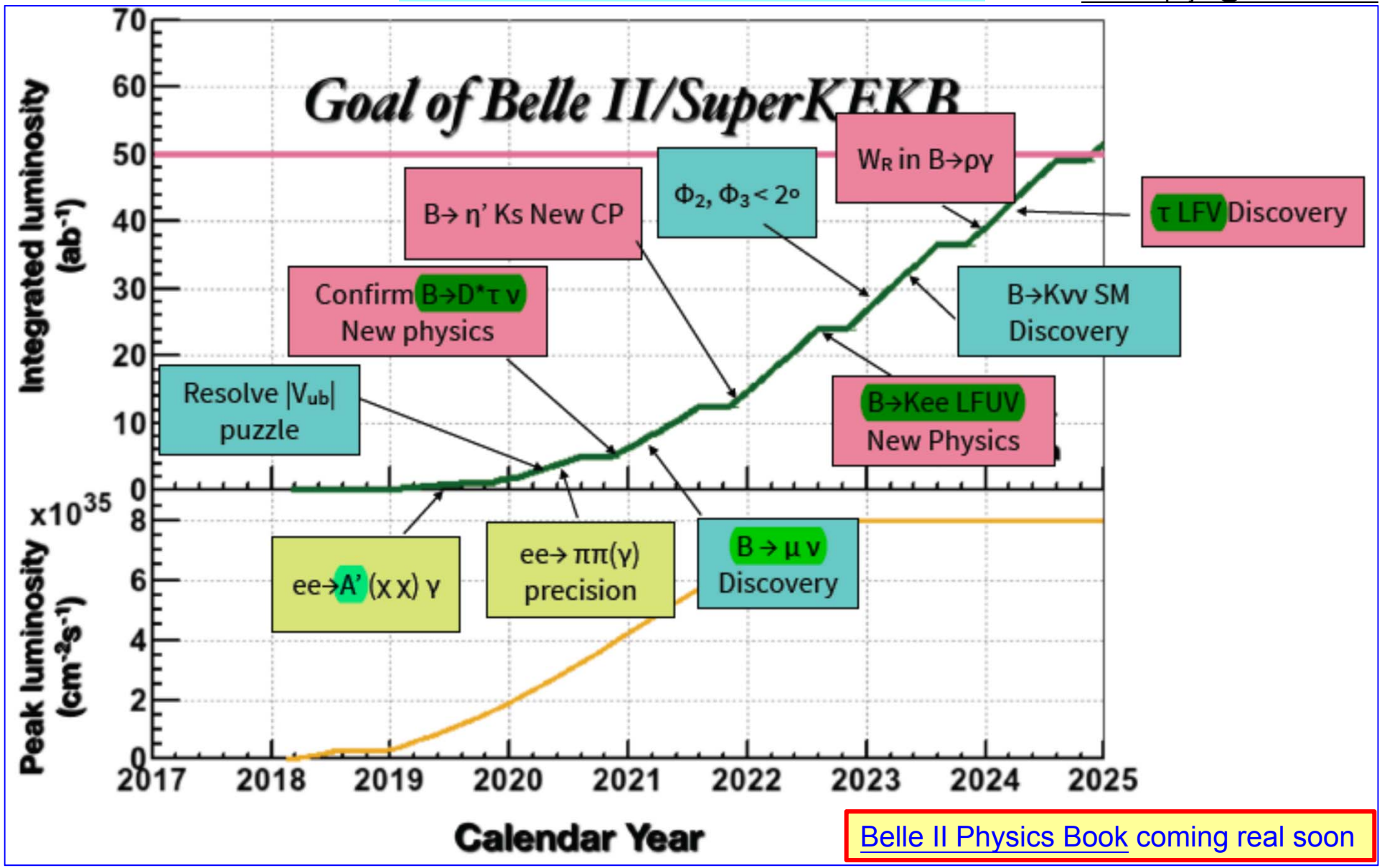


Phase 1 (w/o final focusing Q, w/o Belle II):
- Accelerator system test and basic tuning,
- **Vacuum scrubbing**,
- **Low emittance tuning**, and
- **Beam background studies**

Phase 2 (w/ final focusing Q, w/Belle II but background monitors instead of vertex detectors)
- **Verification of nano-beam scheme**
  target: $L>10^{34}\ cm^{-2}s^{-1}$
- Understand **beam background** especially in **vertex detector** volume

2. Success to Successor

Phil Urquijo @ LIO 4/2018

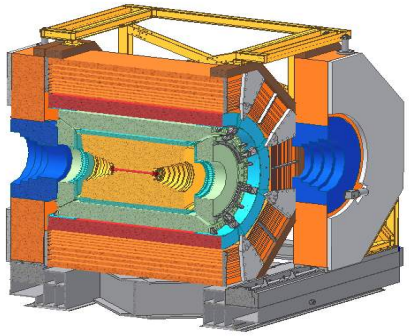


Belle II Physics Book coming real soon

→ Masako Iwasaki

2. Success to Successor

BESIII upgrade



2012
Initial proposal

2013
R&D and CDR preparation

2014
CDR approval
R&D and detector design

2015
Detector design
Begin construcition
Start RISE project.

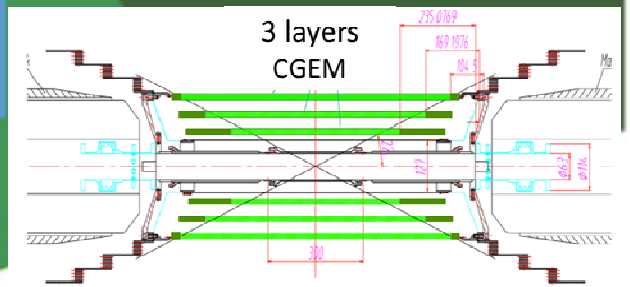
2016
Complete detector design
Coninue detector construction
Electronics development

2017
Continue detector and electronics production
Full CGEM-IT test

2018
Installation and commissioning (summer 2018)

8+ yrs?
- XYZ's
- statistics
- E scans

European input



Xiaoyan Shen @ China-Japan-2017

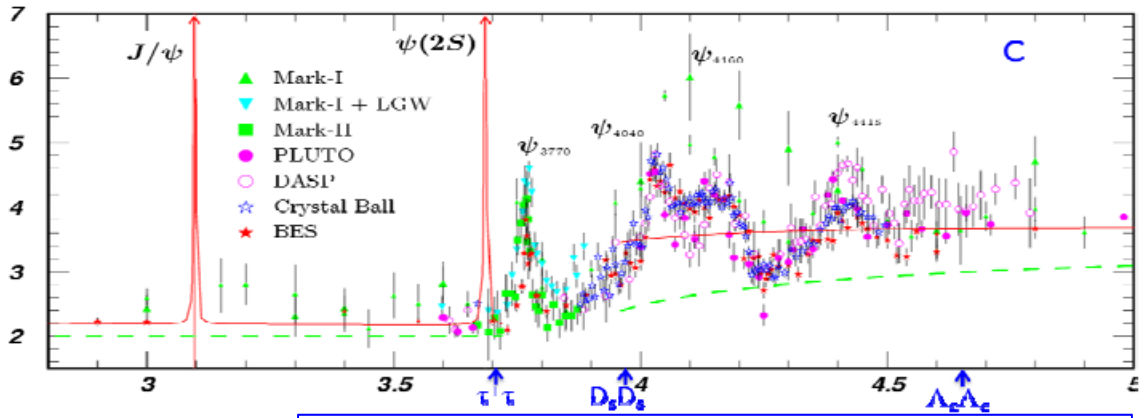
2. Success to Successor

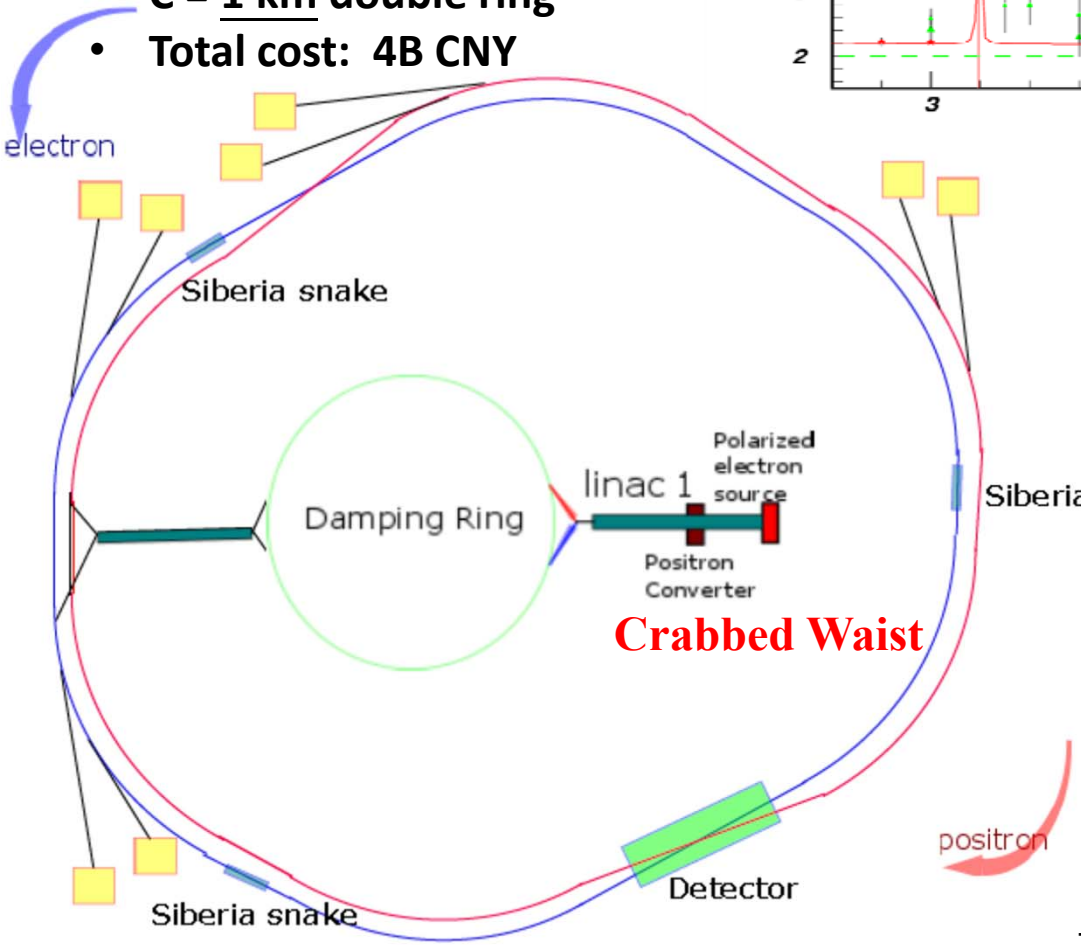
in planning

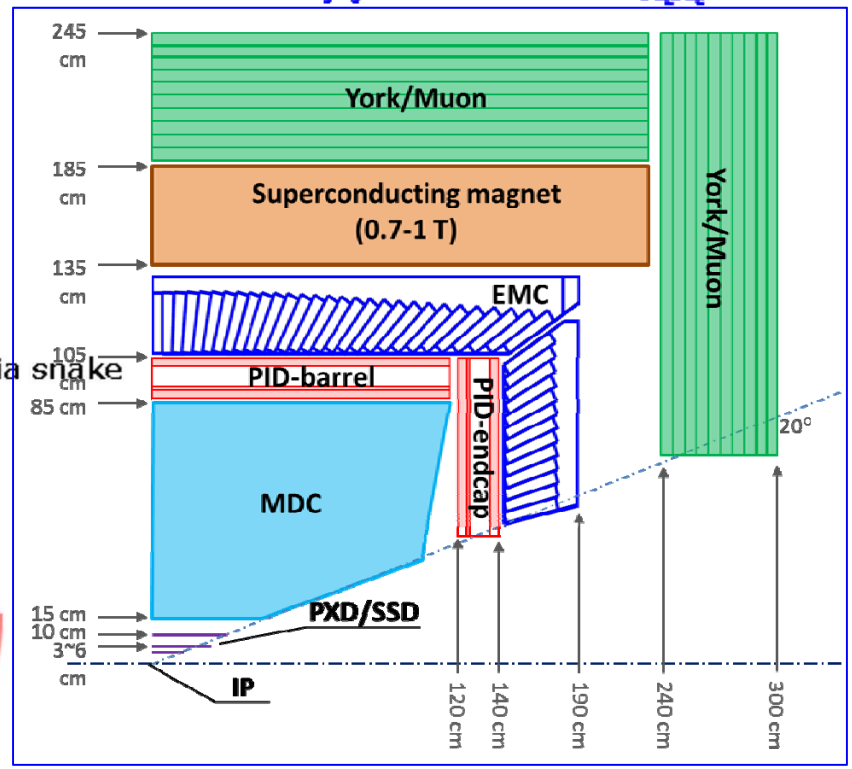
also: BINP@Novosibirsk

Super Tau-Charm Facility (STCF)

- E_{cm}=2-7 GeV
  L = 1×10^{35} cm^{-2} s^{-1} at 4 GeV
- C = 1 km double ring
- Total cost: 4B CNY

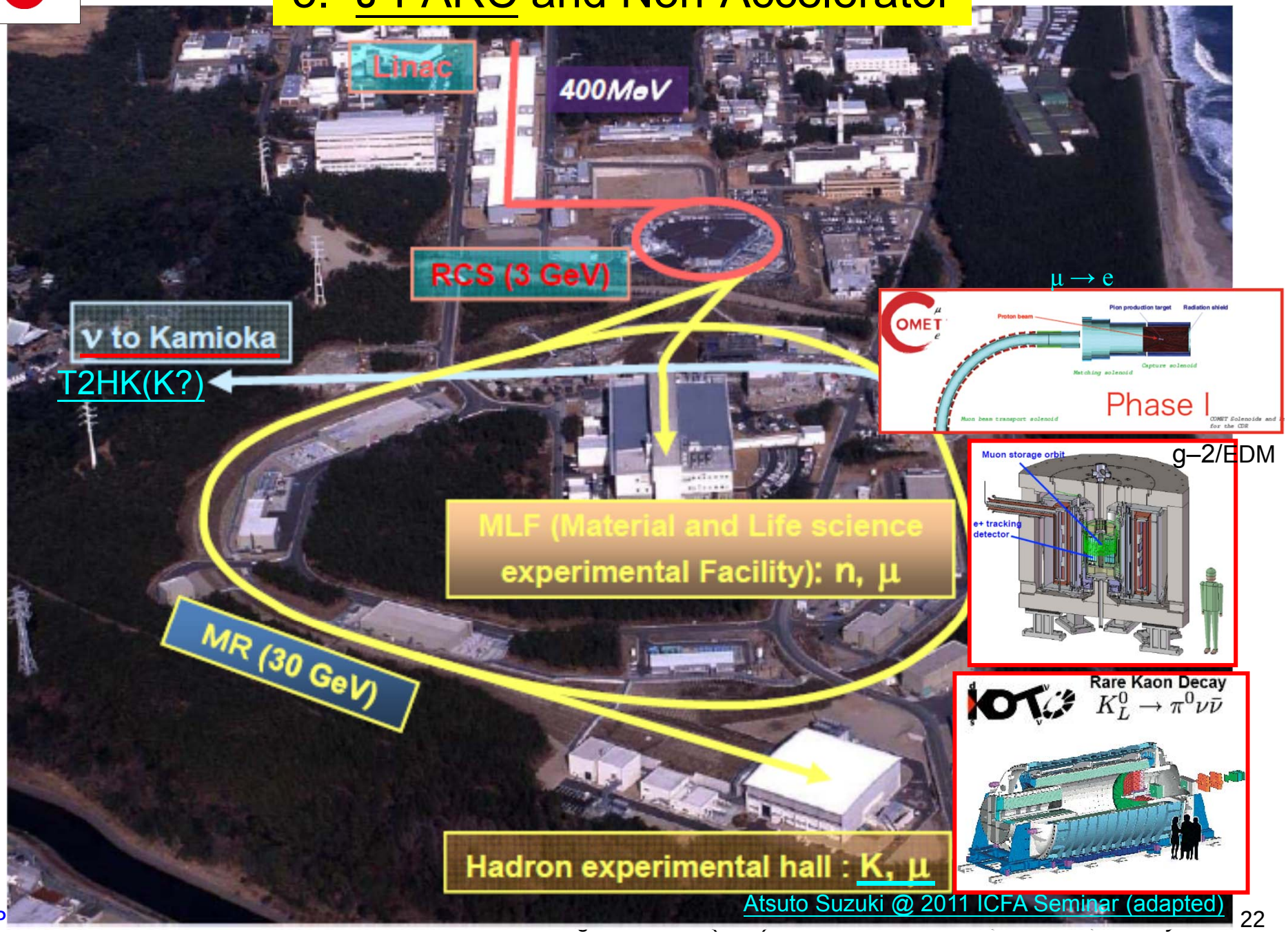






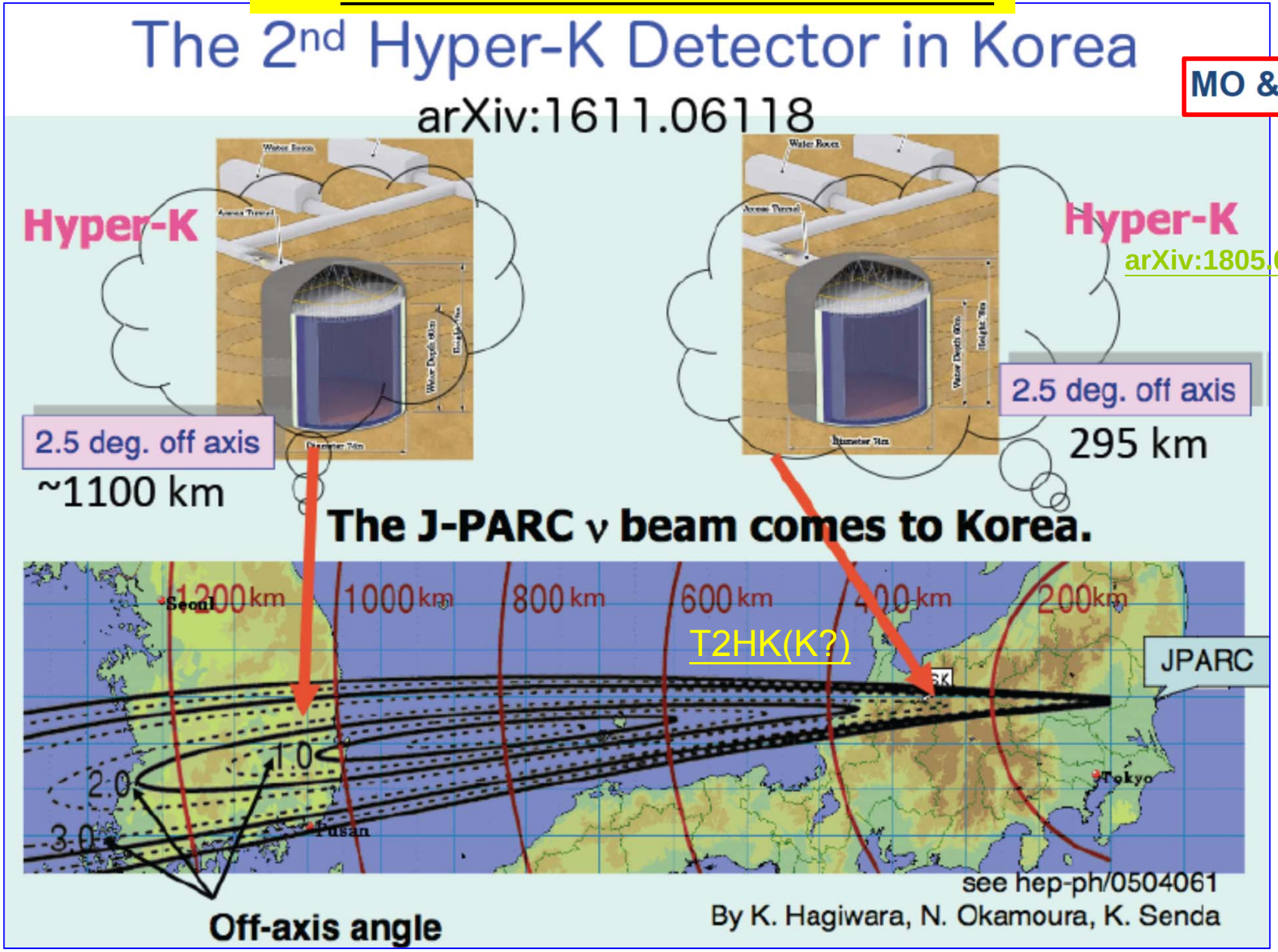
Zhengguo Zhao @ HIEPA2018 (target: USTC, Hefei)

3. J-PARC and Non-Accelerator



Atsuto Suzuki @ 2011 ICFA Seminar (adapted)

3. J-PARC and Non-Accelerator



Tsuyoshi Nakaya @ LP2017

3. J-PARC and Non-Accelerator

Neutrino Mixing Angles

Atmospheric Neutrino Oscillation — θ_{23}

~45° (1998)
Super-K; K2K

↓

Solar Neutrino Oscillation — θ_{12}

34° (2001)
SNO, Super-K;
KamLAND

↓

Reactor Neutrino Oscillation — θ_{13}

9° (2012)
Yifang Wang
Daya Bay, RENO
Soo-Bong Kim
Double Chooz
+ T2K (2011)
Koichiro Nishikawa

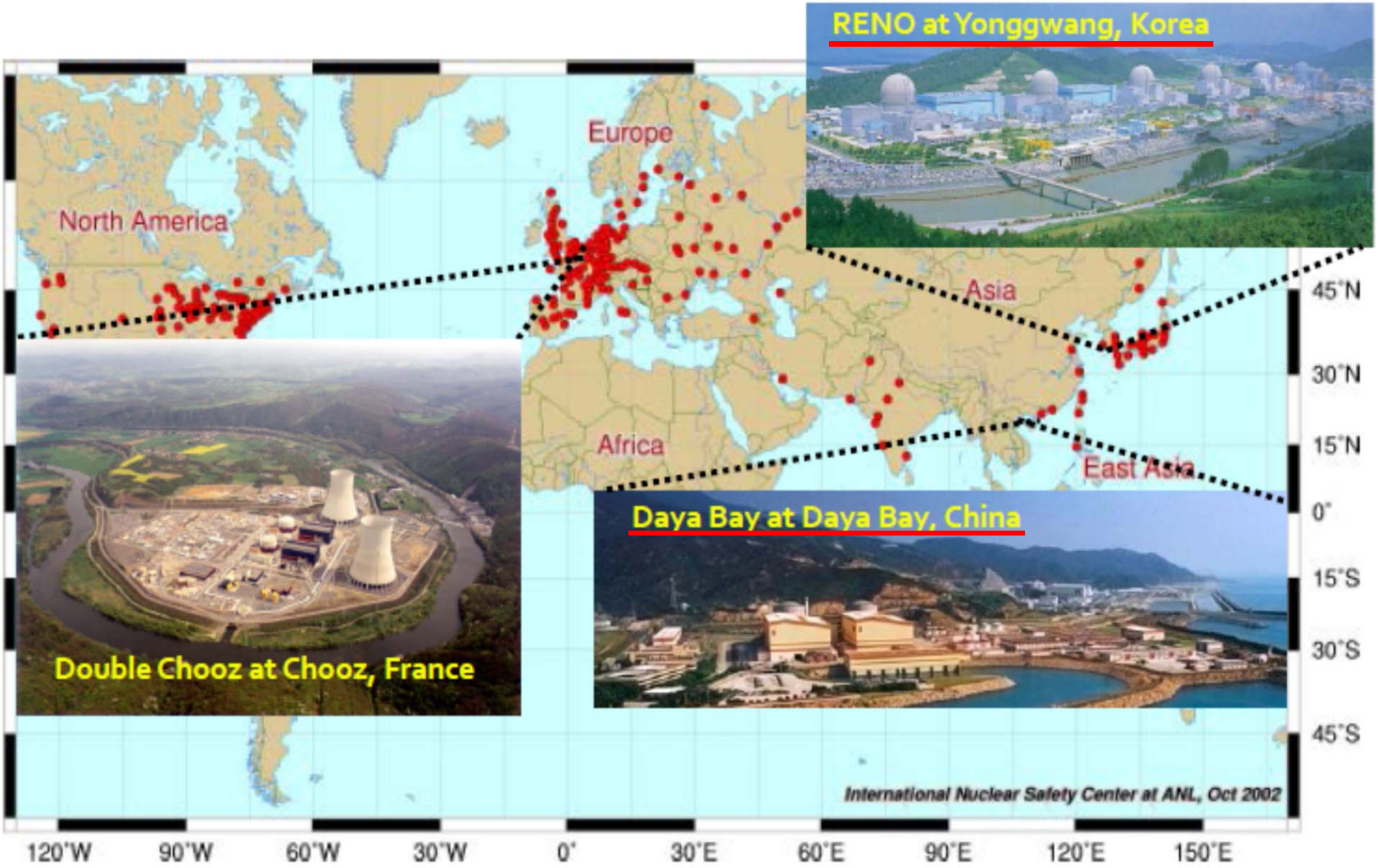
2015 Nobel Prize

2017 Pontecorvo Prize

"Neutrino has mass"
"Established three-flavor mixing framework"

3. J-PARC and Non-Accelerator

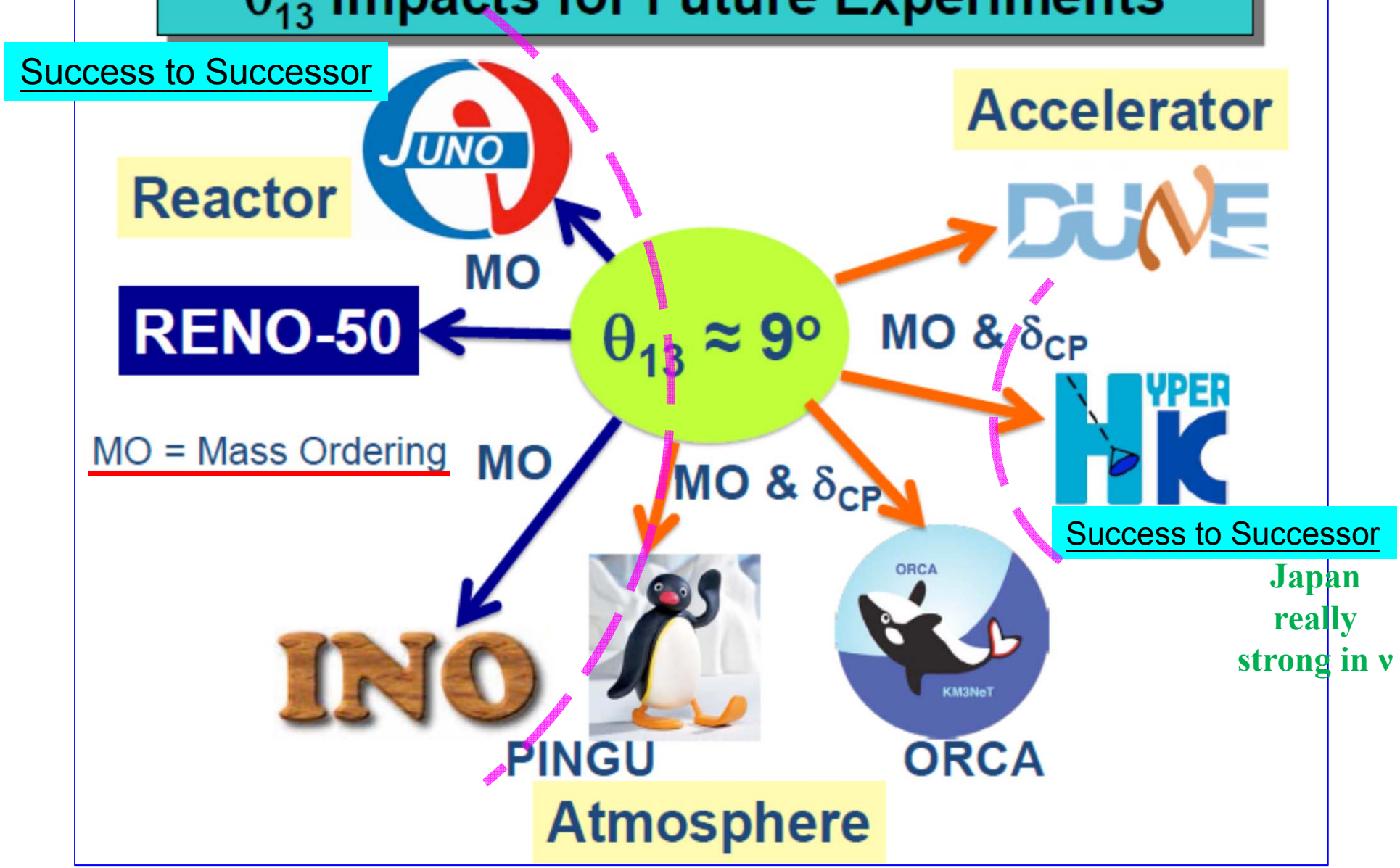
Reactor θ_{13} Experiments



Soo-Bong Kim, TCHOU Inaugural, 3/2018

3. J-PARC and Non-Accelerator

θ_{13} Impacts for Future Experiments



Japan really strong in ν

Soo-Bong Kim, TCHOU Inaugural, 3/2018

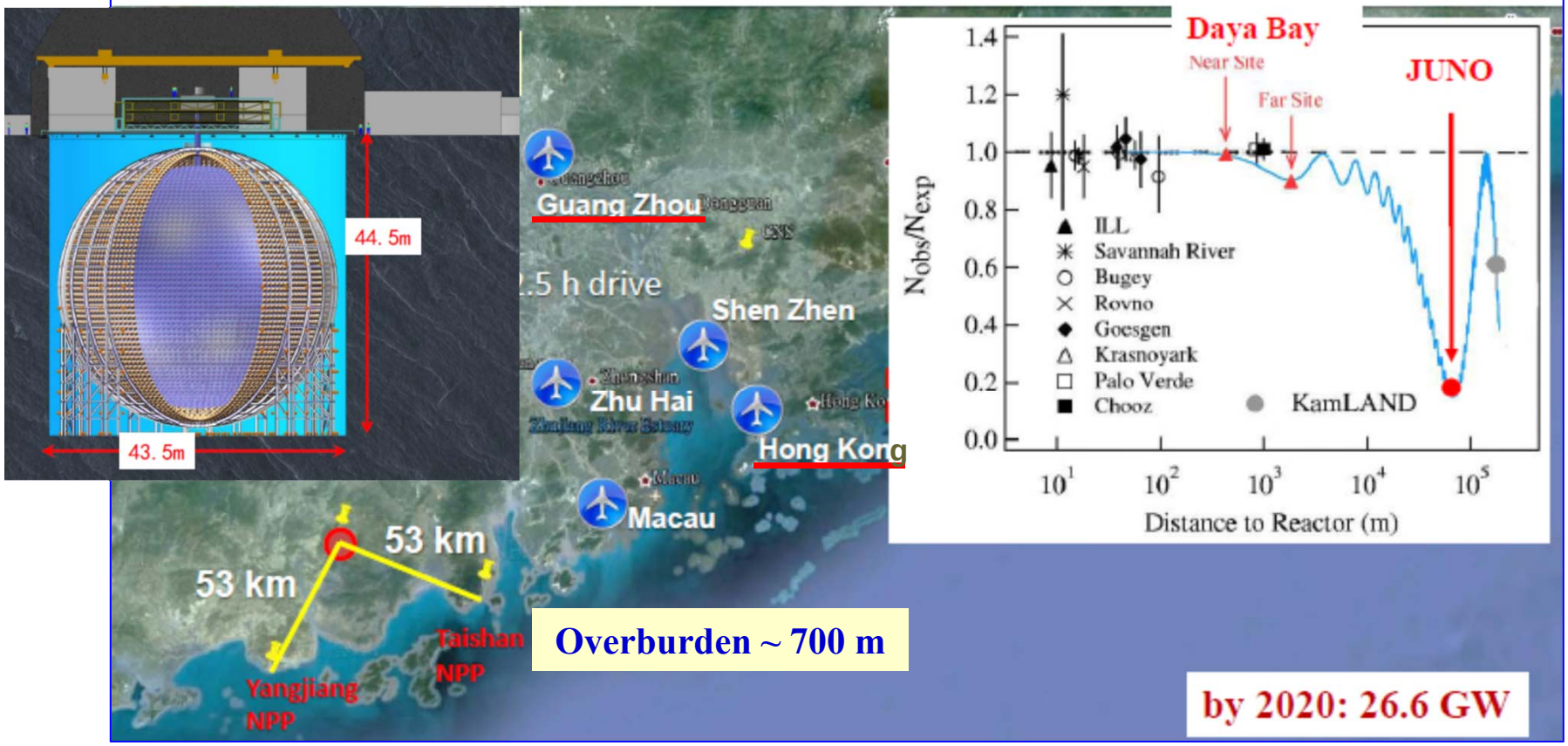
3. J-PARC and Non-Accelerator

Mass Ordering

Success to Successor

The JUNO Experiment

NPP	Daya Bay	Huizhou	Lufeng	Yangjiang	Taishan
Status	Operational	Planned	Planned	Under construction	Under construction
Power	17.4 GW	17.4 GW	17.4 GW	17.4 GW	18.4 GW



Yifang Wang, Pub. Lect. @ LP2017

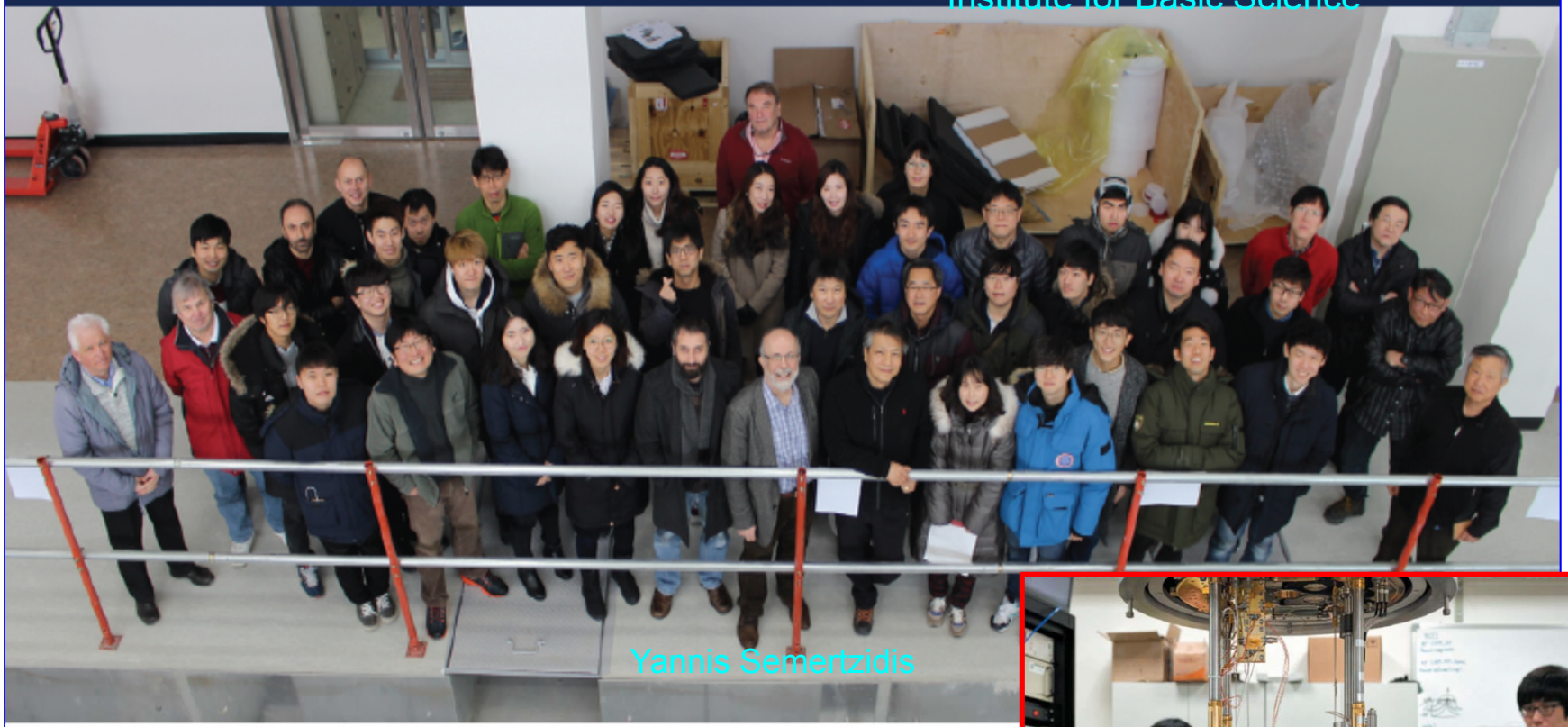
Courtesy: Youngjoon Kwon

3. J-PARC and Non-Accelerator

Center for Axions and Precision Physics (IBS)

Korea

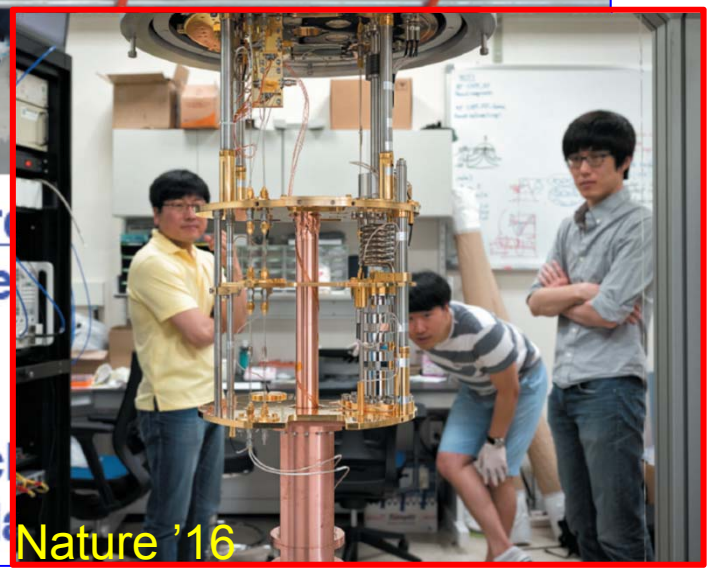
Institute for Basic Science



Yannis Semertzidis

Physics
- Axion Search
- Proton EDM — Proposal
- Muon g-2 experiment — Fermilab
- mu2e experiment — COMET
- Precision Physics

Human Resour
- 25 research fe
- 20 students
- 5 staffs
- Engineers/tec
- Visiting schola

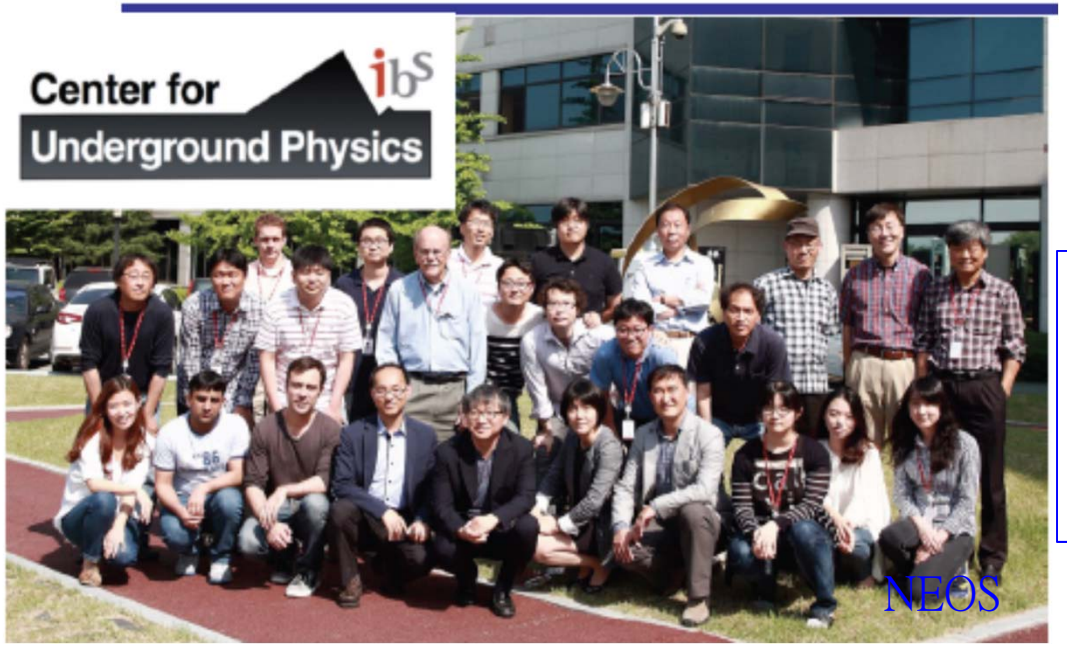


Nature '16

Courtesy: Youngjoon Kwon

3. J-PARC and Non-Accelerator

Korea

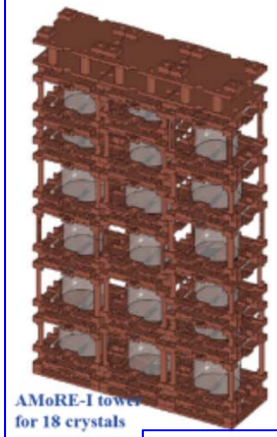


COSINE-100
COSINE-200
(NaI / DAMA)

NEOS (SBL)

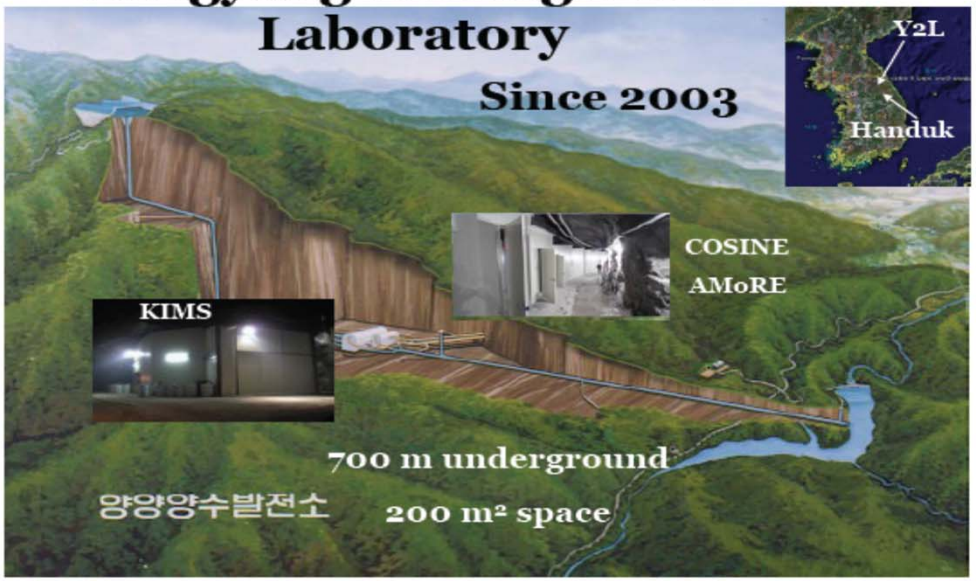
AMoRE-II @ Handuk mine
~200 kg X-MoO_4 crystals

AMoRE-I @ Y2L

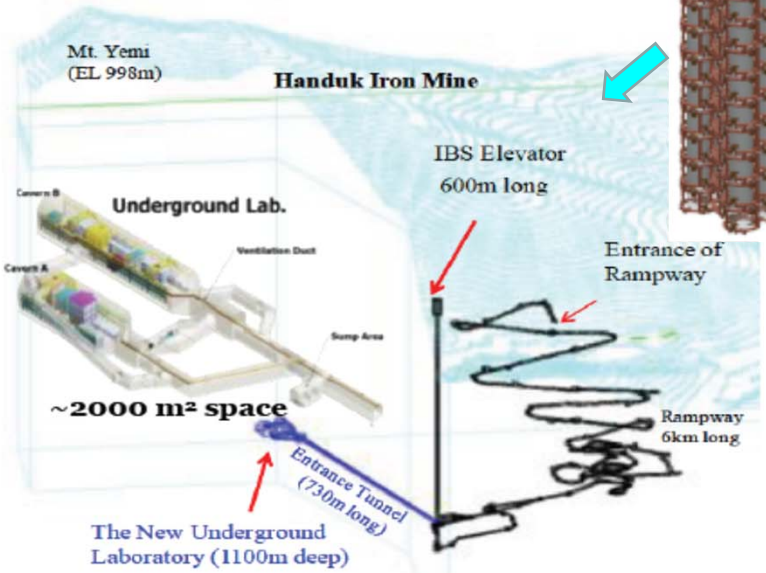


~5kg $CaMoO_4$

Yangyang Underground Laboratory

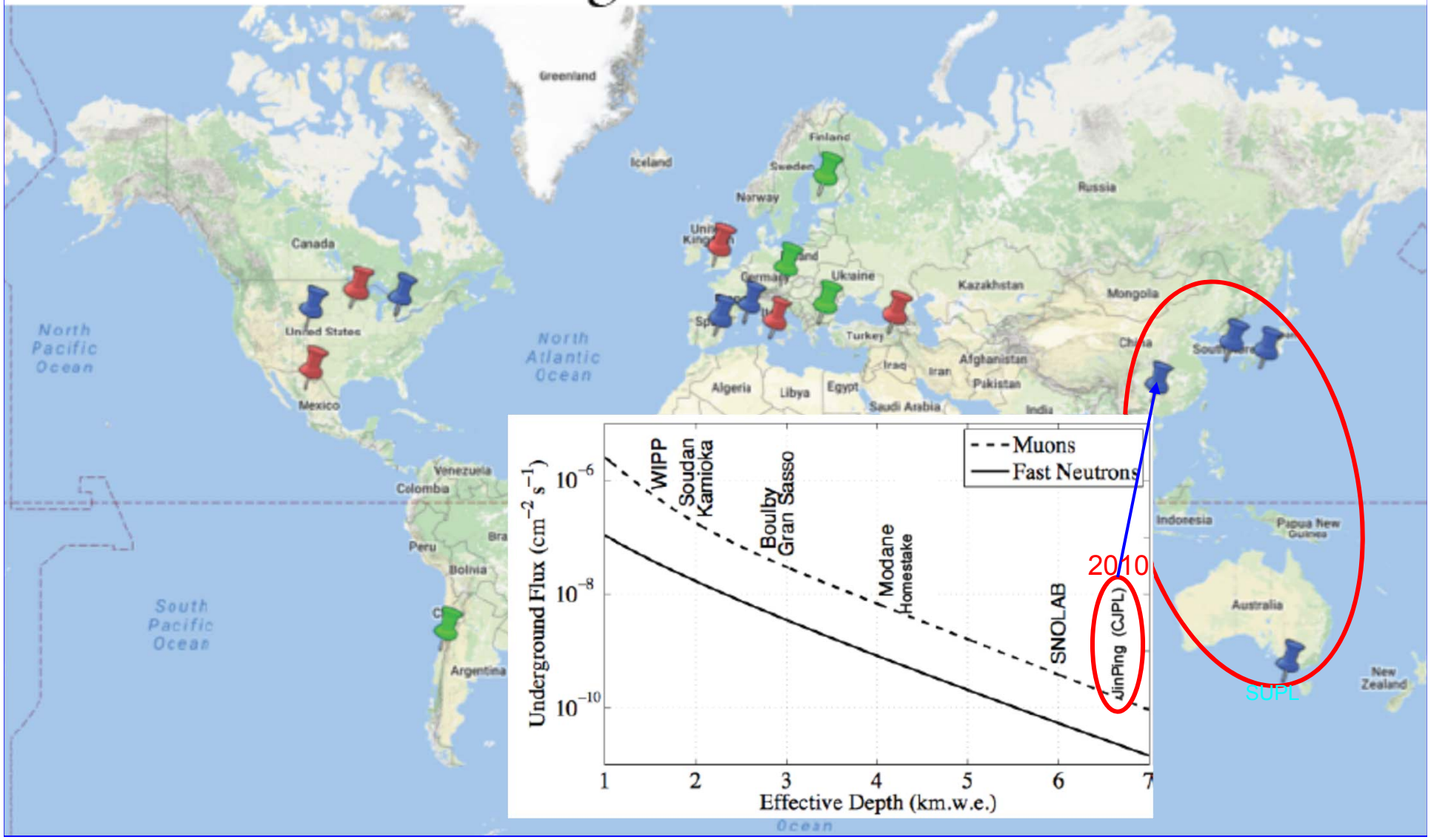


Handuk Iron mine



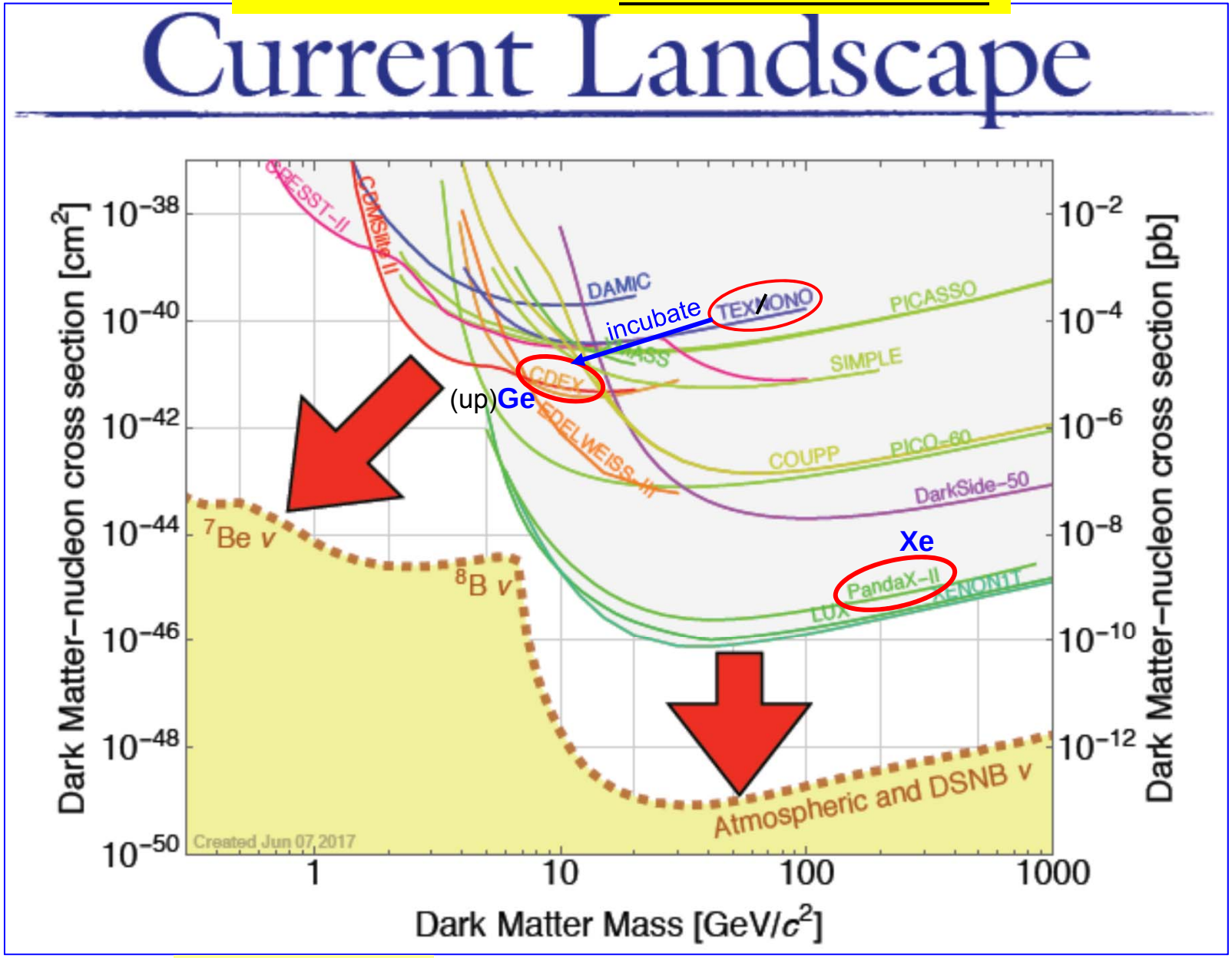
3. J-PARC and Non-Accelerator

World Underground Facilities



Jodi Cooley @ ICFA Seminar 2017

3. J-PARC and Non-Accelerator

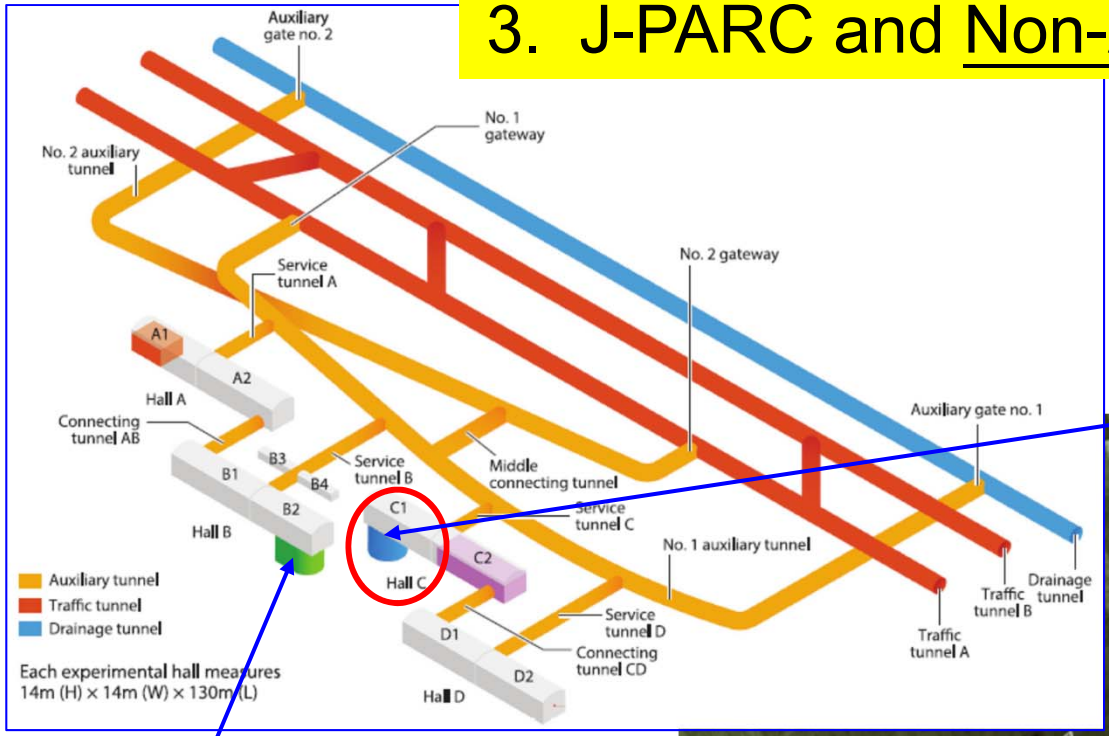


CJPL-I

Also: 0νDBD

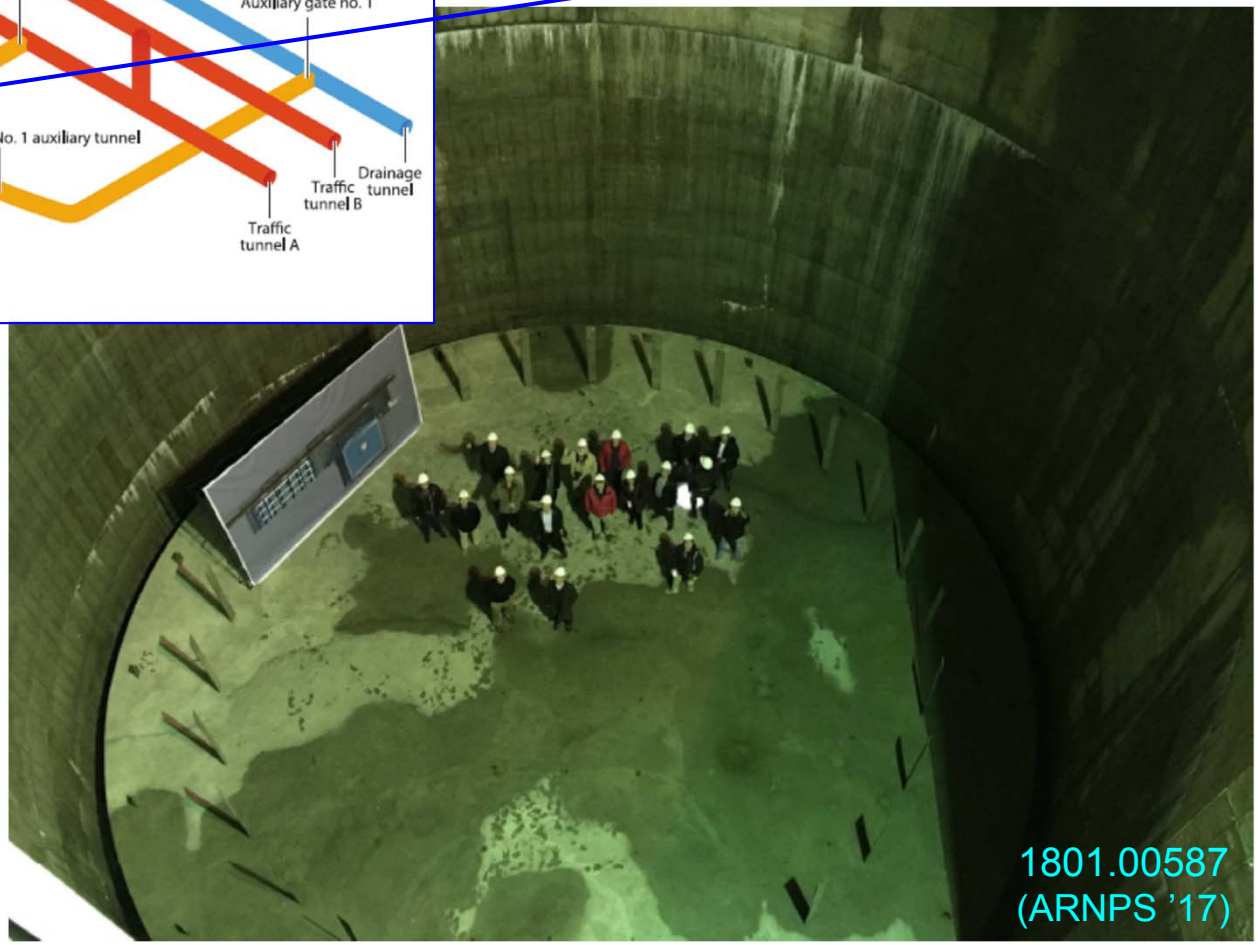
Jodi Cooley @ ICFA Seminar 2017

3. J-PARC and Non-Accelerator



PandaX

CDEX Hall @ CJPL-II

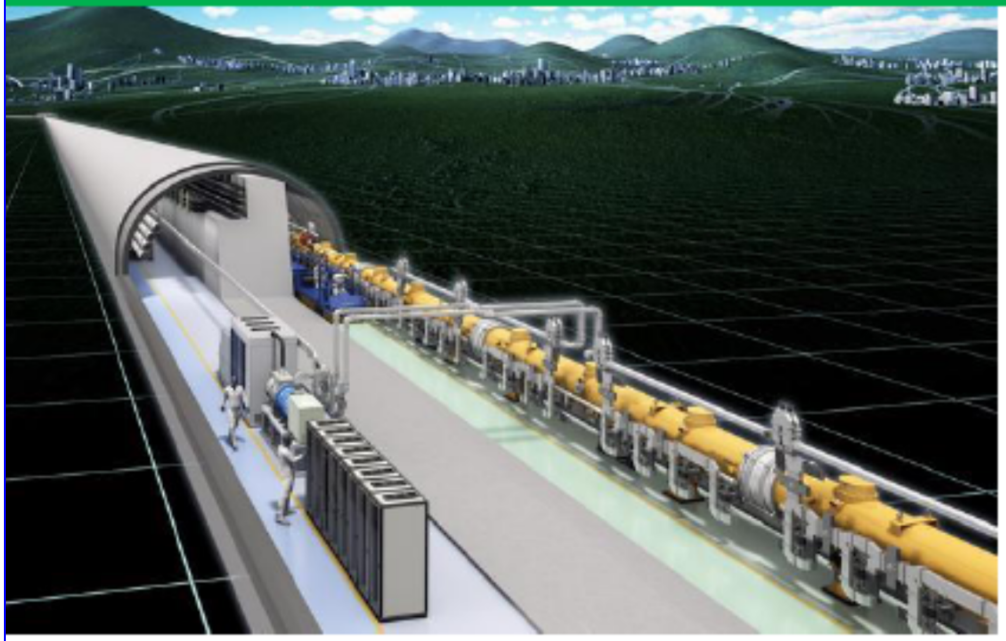


1801.00587
(ARNPS '17)

N.B. Leave out Particle
Astro and Space ...

4.1. The Hopefuls: ILC

ILC (International Linear Collider)



Advantages of linear colliders

(1) No energy loss due to synchrotron radiation
(c.f. Circular Colliders
$-\Delta E/\text{turn} \propto (E/m)^4 R^{-1}$)

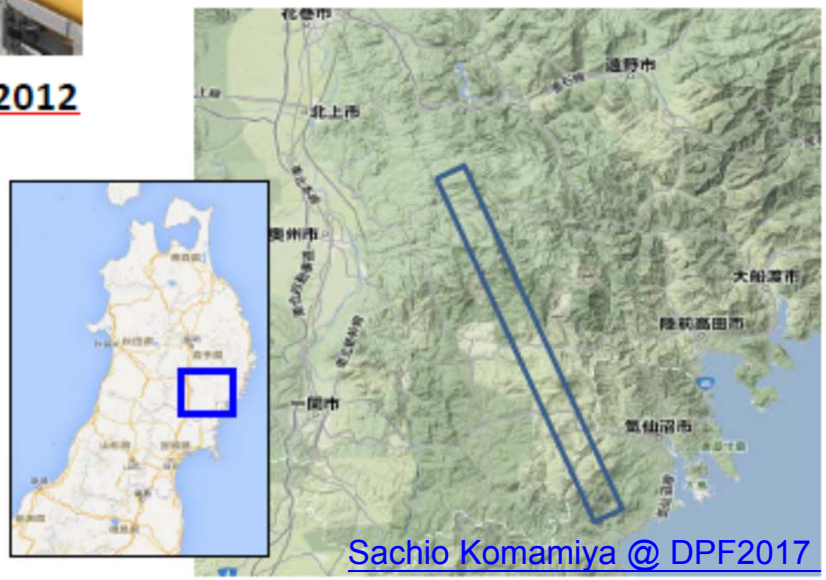
(2) Energy extendability:
length, (gradient) ⇒ energy

(3) Beam Polarization

Discovery of the 125 GeV Higgs Boson at LHC in 2012
⇒ obvious physics target (Higgs is a portal of physics beyond the Standard Model)
⇒ triggered early construction of the ILC

ILC Site Candidate Location in Japan:
Kitakami

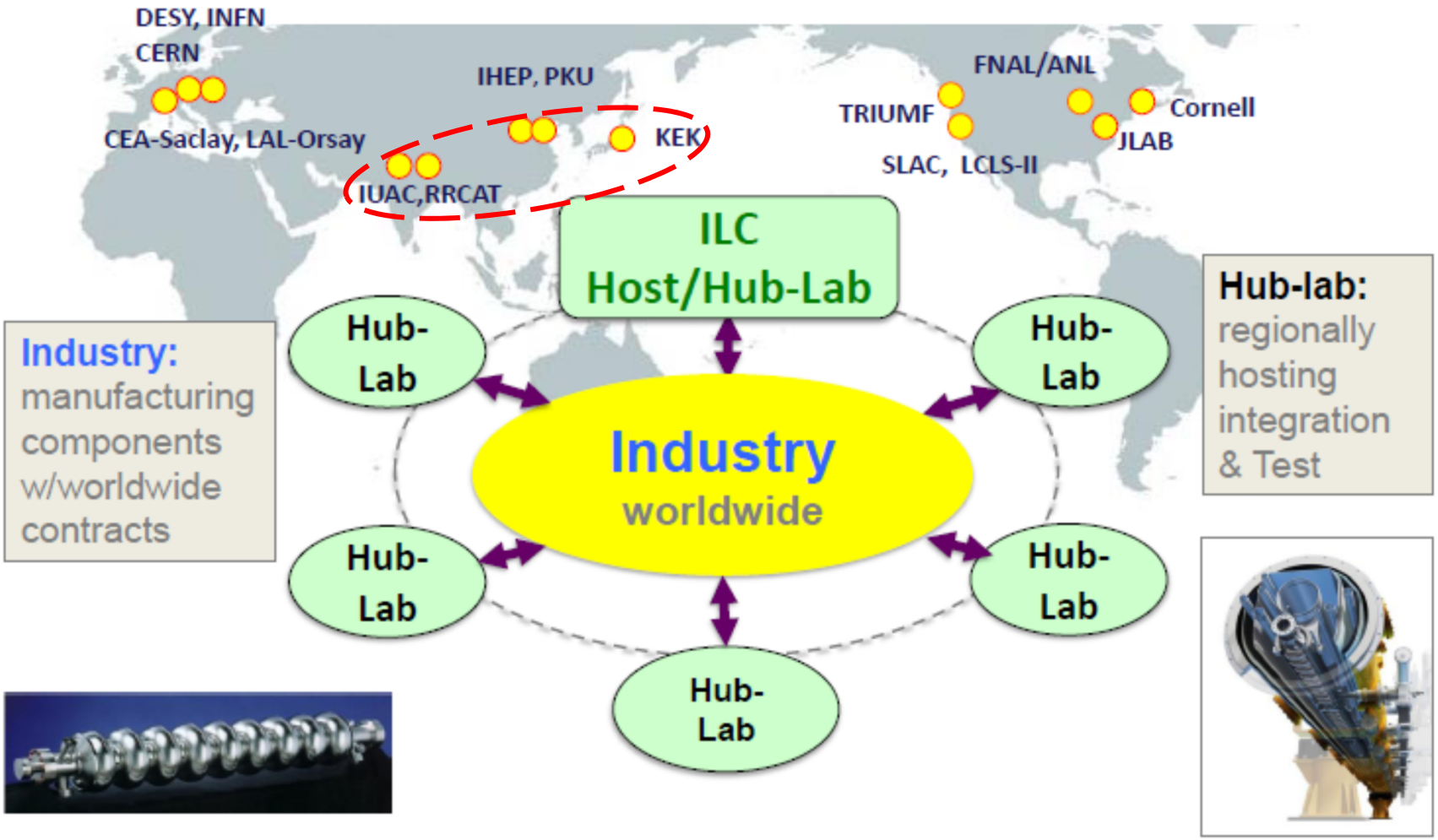
Earthquake-proof stable bedrock of granite.
No faults cross the line.



Sachio Komamiya @ DPF2017

➔ Yasuhiro Okada, next talk

ILC SRF Global Integration Model



2017 ICFA seminar (Nov. 8, 2017) 30

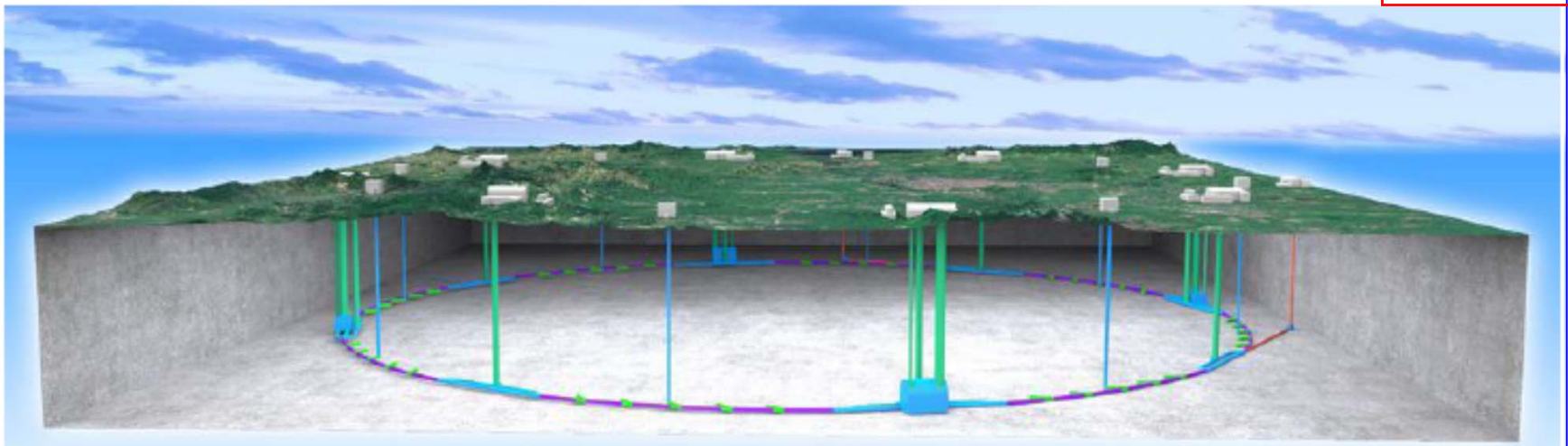
4.2. The Hopefuls: CEPC(-SppC)

CEPC: A Higgs Factory

→ Yifang Wang, Monday

- Since 2005, we were discussing the next machine after BEPC/BEPCII
- Thanks to the low mass Higgs, there is the possibility to build a Higgs Factory: Circular e+e- Collider(CEPC)
  - Looking for Hints (from Higgs) ➔ direct searches
  - The tunnel can allow us to build pp, AA, ep colliders in the far future: Super proton-proton Collider(SppC)

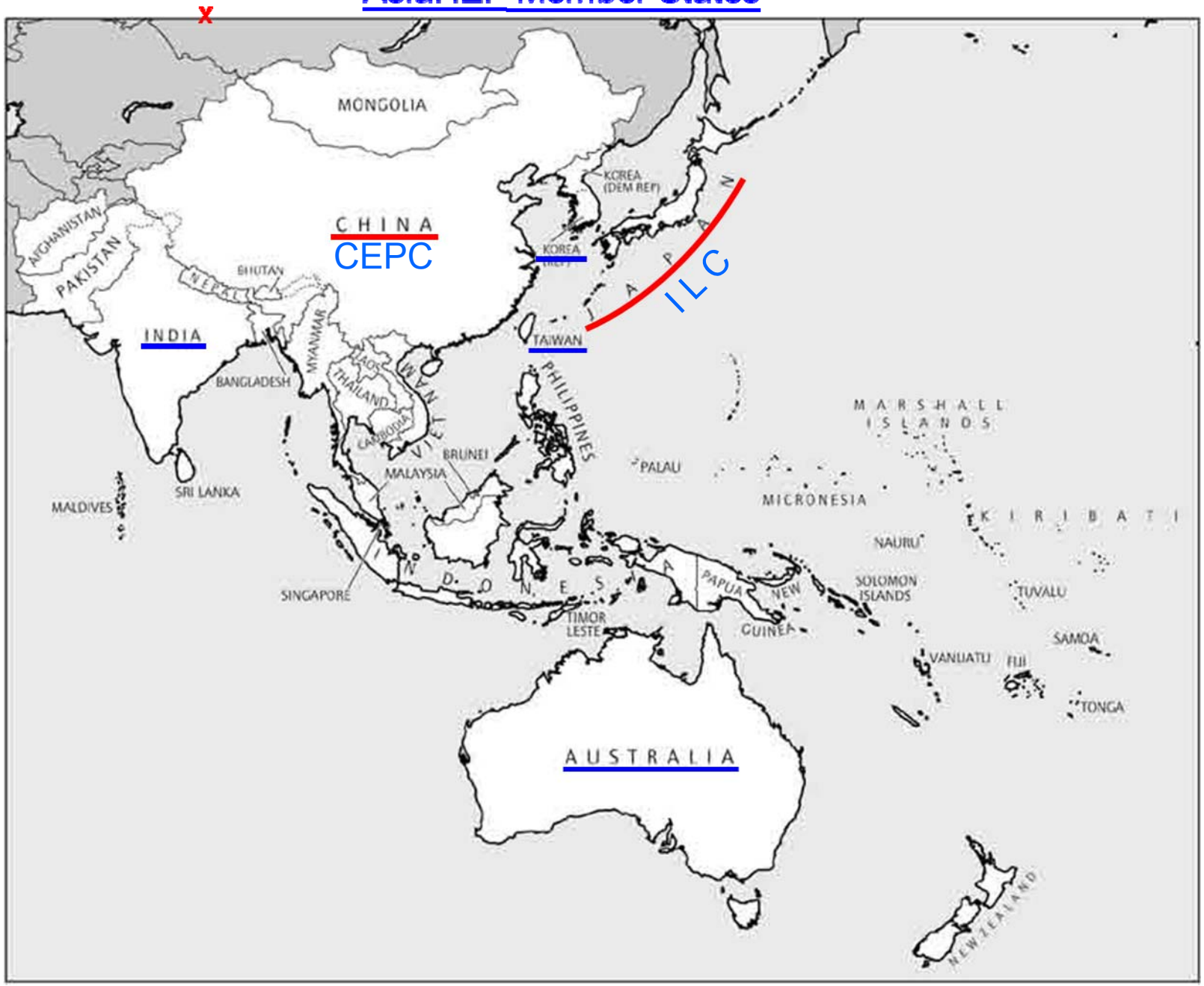
LEP100
↓ FCC
LHC100



We had B-factories, c-factories, ϕ-factories, Z-factories in the past. It is very natural to think about Higgs factories

Yifang Wang, Pub. Lect. @ LP2017

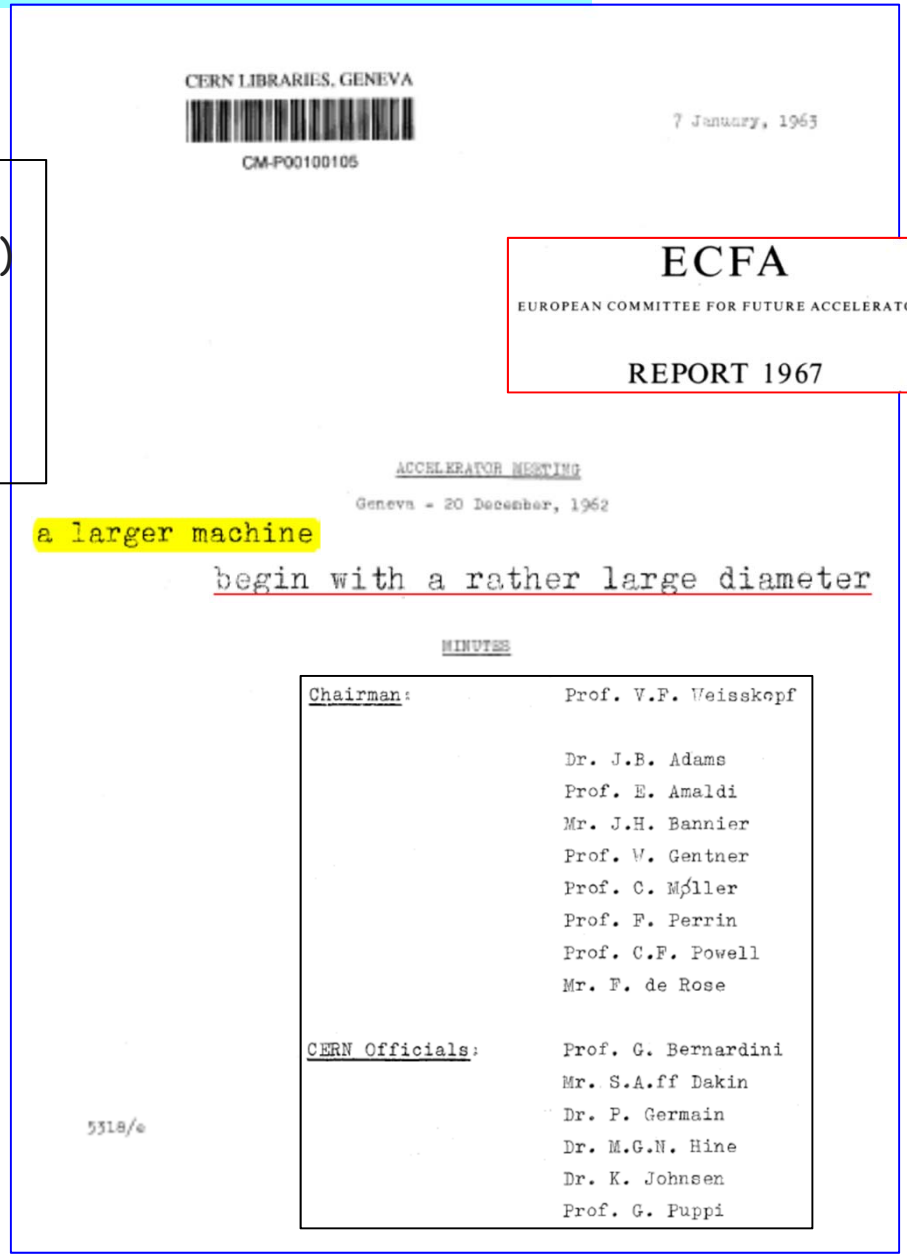
AsiaHEP Member States



5. Amalgamation of **ACFA**/AsiaHEP

Timeline of xCFA's:

- 1963 (or 67): ECFA (Weisskopf as CERN DG)
- 1976: ICFA
- 1996: **ACFA** (Sugawara + ZP Zheng, i.e. KEK + IHEP)
- 2012: - AsiaHEP (before h(125))



CERN LIBRARIES, GENEVA

CM-P00100106

7 January, 1963

ECFA

EUROPEAN COMMITTEE FOR FUTURE ACCELERATORS

REPORT 1967

ACCELERATOR MEETING

Geneva - 20 December, 1962

a larger machine

begin with a rather large diameter

MINUTES

Chairman:	Prof. V.F. Weisskopf
	Dr. J.B. Adams
	Prof. E. Amaldi
	Mr. J.H. Bannier
	Prof. W. Gentner
	Prof. C. Møller
	Prof. F. Perrin
	Prof. C.F. Powell
	Mr. F. de Rose
CERN Officials:	Prof. G. Bernardini
	Mr. S.A.ff Dakin
	Dr. P. Germain
	Dr. M.G.N. Hine
	Dr. K. Johnsen
	Prof. G. Puppi

5318/e

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- 2012: - AsiaHEP (before h(125))

put ACFA back in line w/ "xCFA" namesake

a step forward on 2/2018 (together w/ Geoff Taylor)

➔ AsiaAC?

Accelerator Consortium
[**L**ight**S**ource & **N**eutron**S**ource]
(for mutual benefit)

Timing & Vision

Timeframe: European Strategy Update

Merriam-Webster

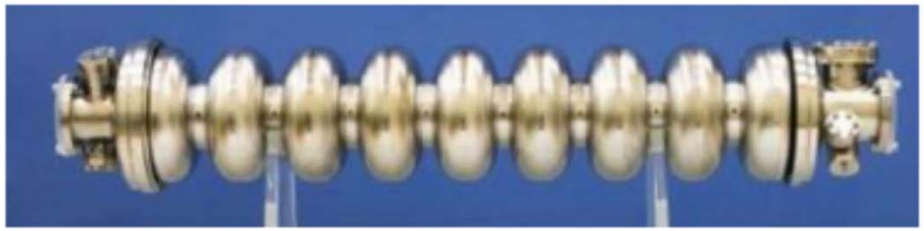
amalgamation: the action or process of uniting or merging two or more things

Summary

- Asia's Economic footprint looms large
- Asia HEP expanding rapidly
- Let's HELP realize ILC in Japan
- Let's HELP realize CEPC(-SppC) in China
- **ACFA** needs to restore to xCFA namesake,
  but maintain LS/NS base, for mutual benefit

US-Japan cost reduction

Shin Michizono @ LCWS2017



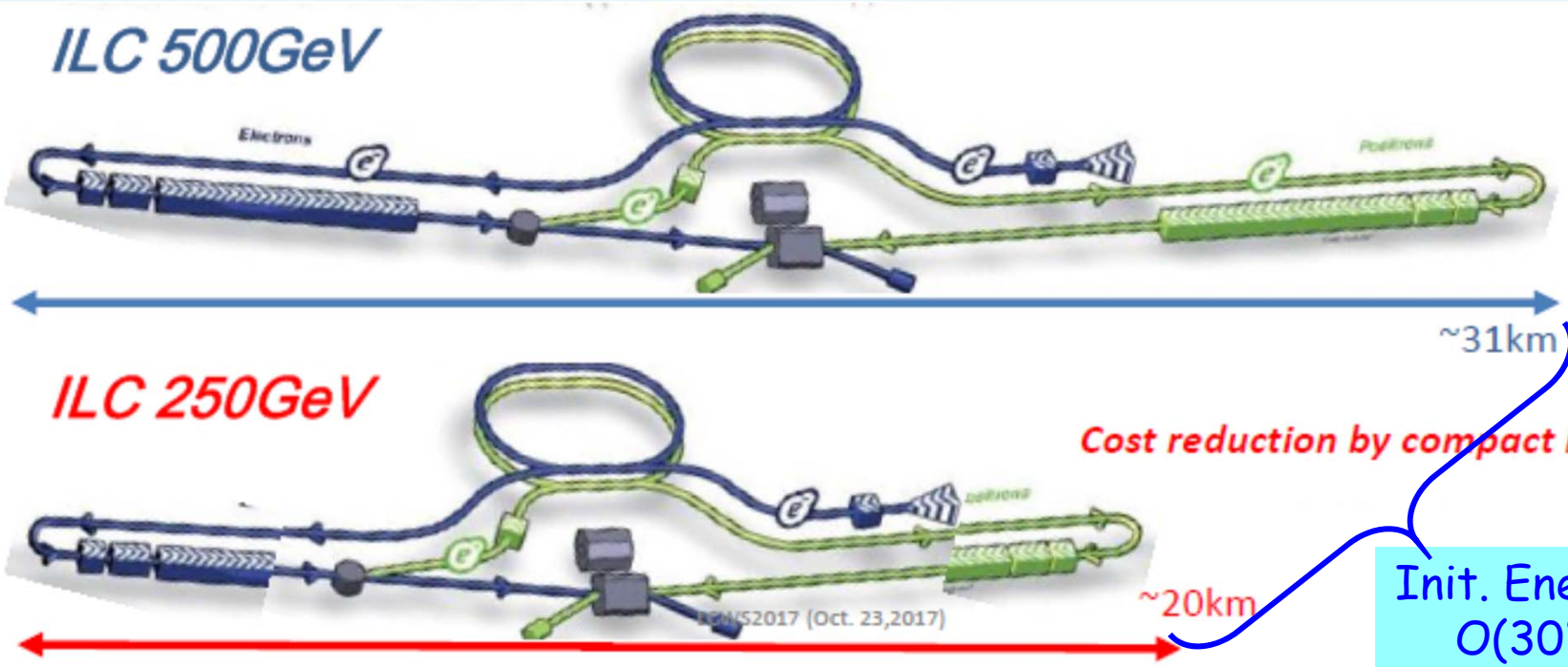
Cost reduction by technological innovation

SCRF improvements: O(10%)

Innovation of Nb (superconducting) material process: decrease in material cost

Innovative surface processing for high efficiency cavity by FNAL: decrease in number of cavities

Staging



Cost reduction by compact ILC

Init. Energy: O(30%)

Shin Michizono @ LCWS2017

World wide Labs for SRF system

LCWS2017 (Oct. 23,2017)

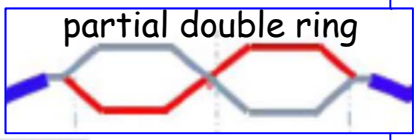
26

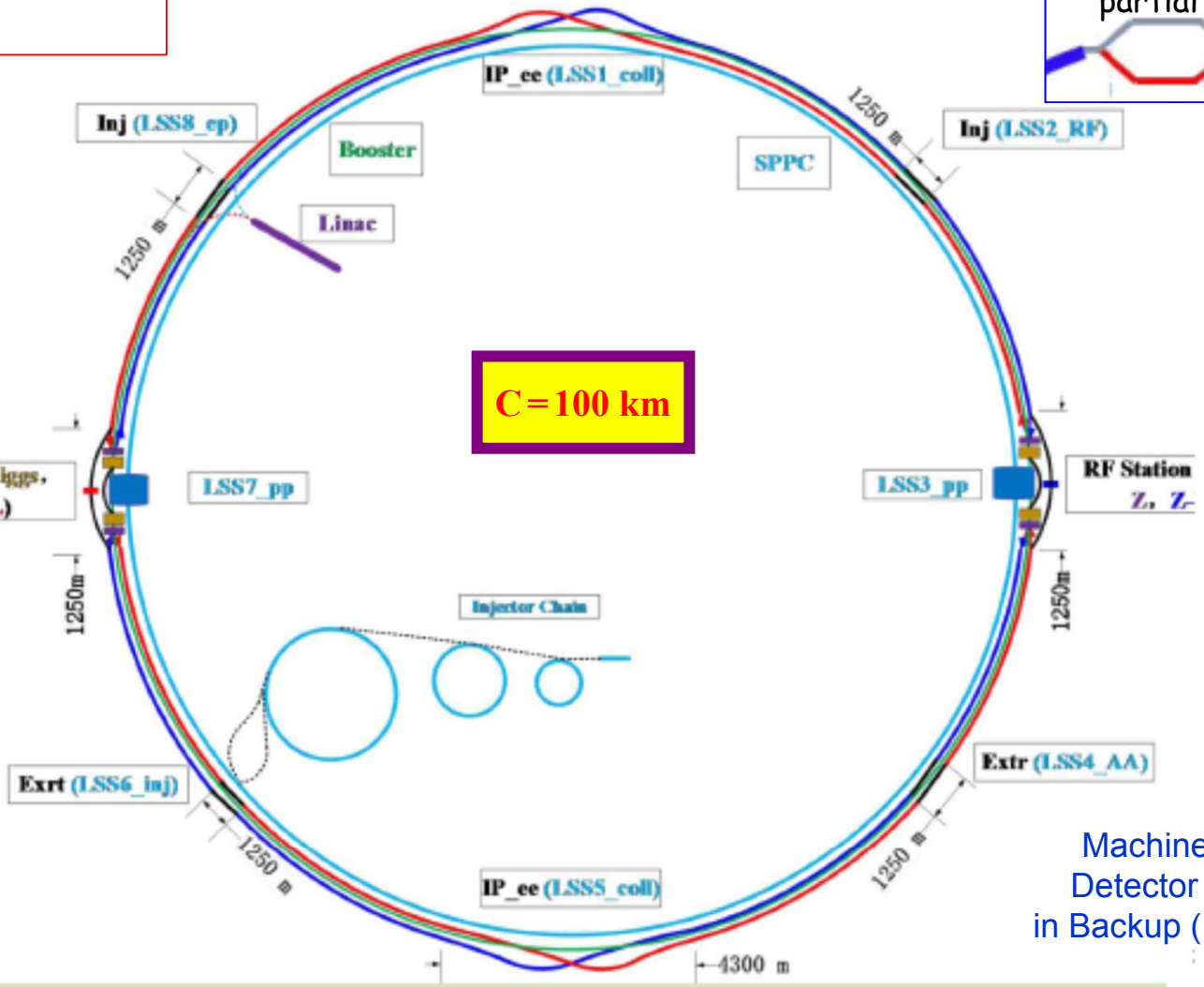
3 machines in one tunnel:

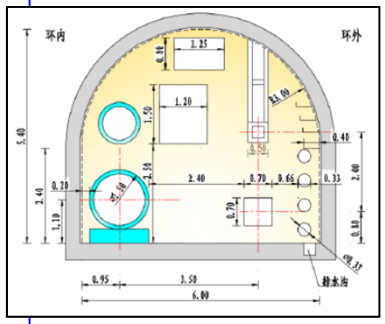
- CEPC & booster
- SppC

Layout of CEPC-SPPC

CDR 2017







Machine params.,
Detector & params.
in Backup (➔ Qing QIN)

Layout and hardware satisfying both the Z and the H programs

$L = 2\times10^{34} cm^{-2}s^{-1}$ (at E_{cm}=240 GeV)

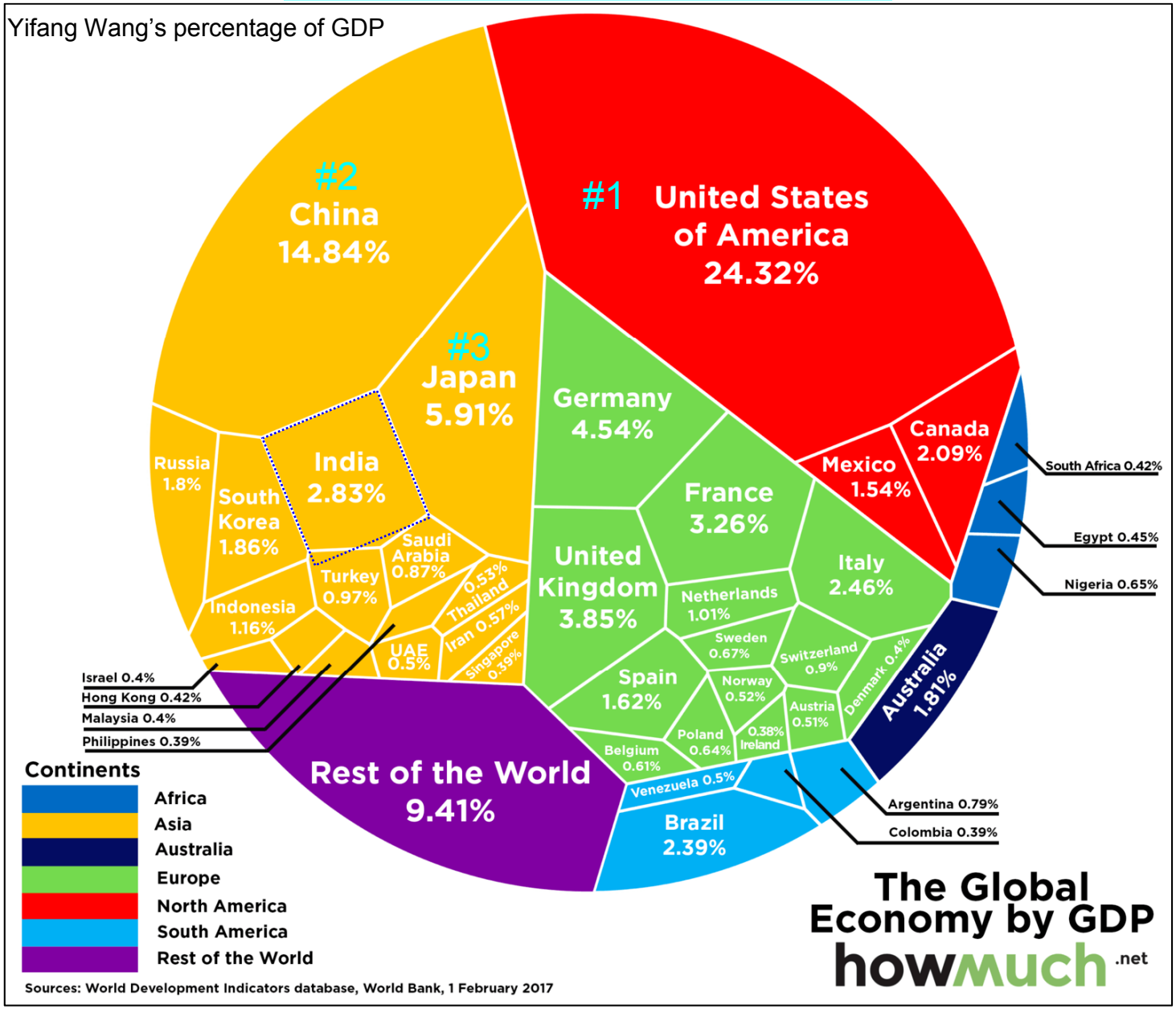
$L = 1\times10^{34} cm^{-2}s^{-1}$ (at E_{cm}=91 GeV)

Xinchou Lou @ LP2017

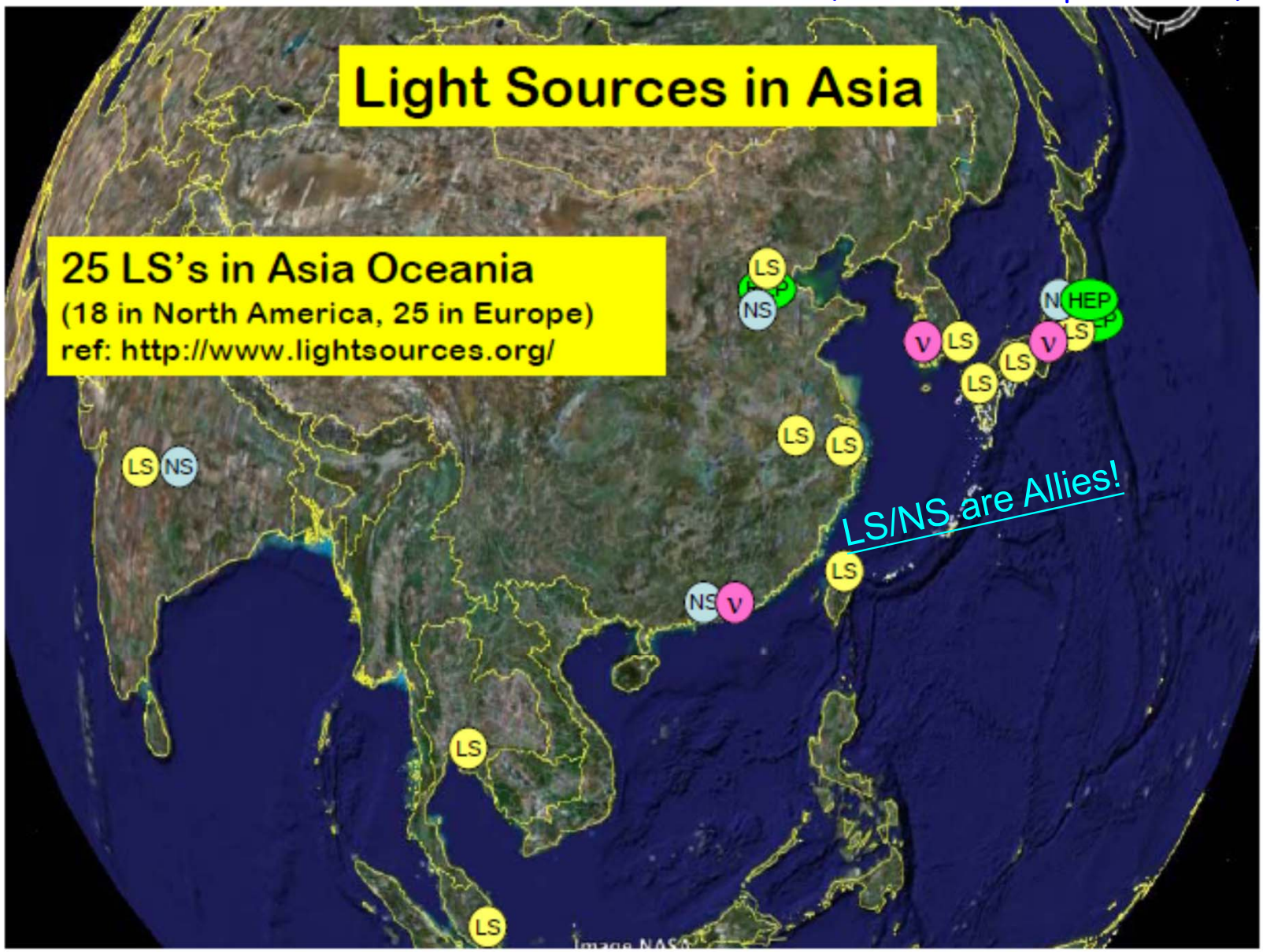
It's the Economy ...

+ Technology/Manpower

in backup: Yifang Wang's percentage of GDP



The "Asia Condition" (diff. from Europe in 1960's)



Mitsuaki Nozaki @ 2008 ICFA Seminar