Introduction of CEPC-SppC

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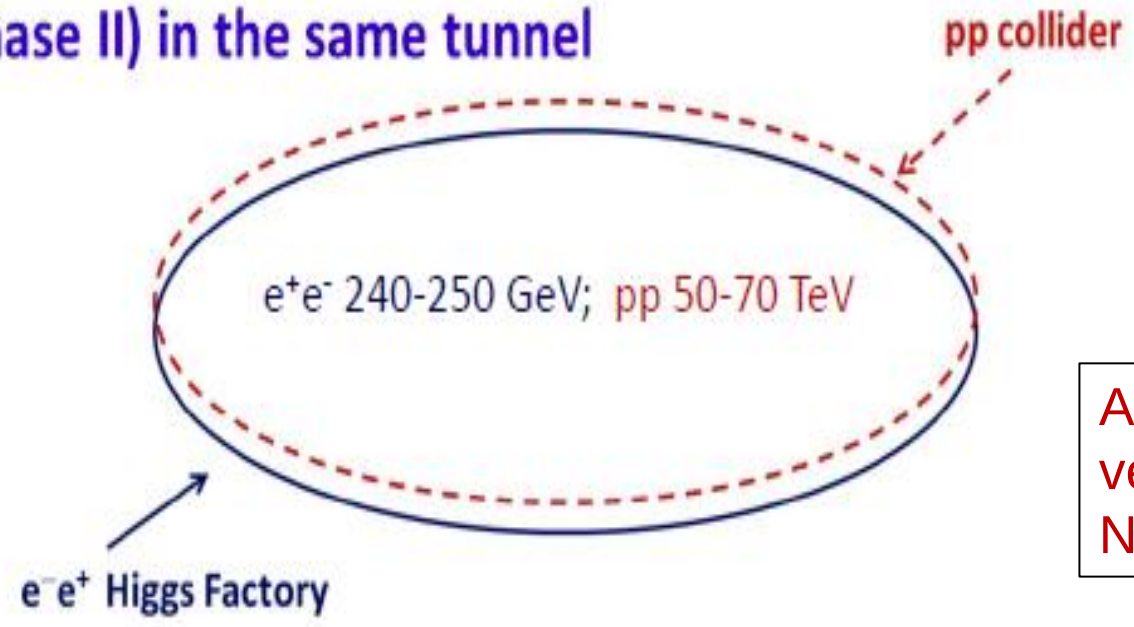
Feb. 13, 2014， Geneve

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

- **Circular Higgs factory (phase I) + super pp collider (phase II) in the same tunnel**



A 50-70 km tunnel is very affordable in China NOW

A Good Start

FERMILAB-CONF-13-037-APC
IHEP-AC-2013-001
SLAC-PUB-15370
CERN-ATS-2013-032
arXiv:1302.3318 [physics.acc-ph]

- Many workshops, seminars in China and in the world
  - Sep. 2013, Dec. 2013…
- Community support in China
  - June 2013, Xiangshan forum
- Start to organize ourselves
- Start to Lobby the government

Report of the ICFA Beam Dynamics Workshop

"Accelerators for a Higgs Factory: Linear vs. Circular"

(HF2012)

Alain Blondel[1], Alex Chao[2], Weiren Chou[3], Jie Gao[4], Daniel Schulte[5] and Kaoru Yokoya[6]

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[5] CERN, Geneva, Switzerland
[6] KEK, Tsukuba, Japan

February 15, 2013

A lot more will come !

In Practice

- A circular Higgs factory fits our strategic needs in terms of
  - Science (great & definite physics)
  - Timing (after BEPCII)
  - Technological feasibility (experience at BEPC/BEPCII and other machines in the world),
  - Manpower reality (our hands are free after ~2020)
  - Economical scale (although slightly too high)
- The risk of no-new-physics is complement by a pp collider in the same tunnel
  - A definite path to the future
- A unique position for China to contribute at this moment:
  - Economical growth ➔ new funding to the community
  - Large & young population ➔ new blood to the community
  - Affordable tunnel & infrastructure
  - If no new project, no new resources ➔ It is a pity if we miss it

Issues

- Realistic ?
  - Funding, man power, political issues, technical feasibility, ….
  - We hope to collaborate with whoever willing to host this machine. Even if the machine is not built in China, the process will help the HEP community
- ILC ➔ Complementary
  - No need to have the Push-pull option
  - Low energy(up to 250 GeV)@CEPC vs high energy(up to 1 TeV)@ILC
- LHC ➔ Complementary
  - We need to know the Higgs coupling to a great precision
  - Background, systematics, discovery potential, precision…
- Practical issues: too costly ?
  - BEPC cost/4 y/GDP of China in 1984 ≈ 0.0001
  - SSC cost/10y/GDP of US in 1992 ≈ 0.0001
  - LEP cost/8y/GDP of EU in 1984 ≈ 0.0002
  - LHC cost/10y/GDP of EU in 2004 ≈ 0.0003
  - ILC cost/8y/GDP of Japan in 2018 ≈ 0.0002
  - CEPC cost/6y/GDP of China in 2020 ≈ 0.00005
  - SPPC cost/6y/GDP of China in 2036 ≈ 0.0001

Competition and multiple machines are healthy ingredients of our community

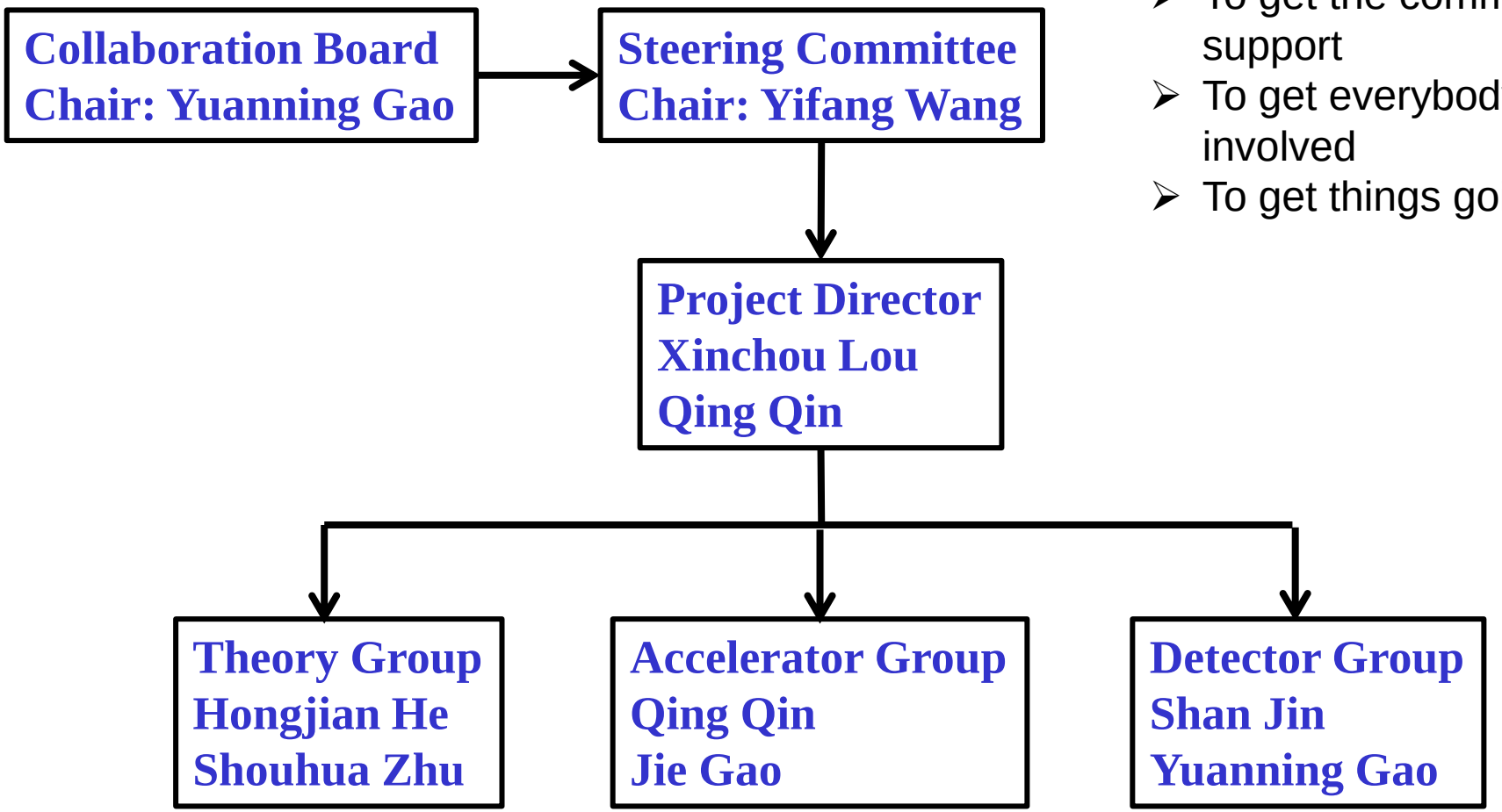
Internationalization

- This is a machine for the world and by the world: not a Chinese one
- As a first step, "Center for Future High Energy Physics (CFHEP)" is established
  - Prof. Nima Arkani-Hamed is now the director
  - Many theorists(coordinated by Nima and Tao Han) and accelerator physicists(coordinated by Weiren Chou) from all the world have signed to work here from weeks to months.
  - More are welcome ➔ need support from the related management
  - Current work:
    - Workshops, seminars, public lectures, working sessions, …
    - Pre-CDR
  - Future works (with the expansion of CFHEP)
    - CDR & TDR
    - Engineer design and construction
  - A seed for an international lab ➔ Organized and managed by the community
- We hope to closely collaborate with FCC@CERN

Current status

- Organization
- Site
- Initial design effort
- Timeline

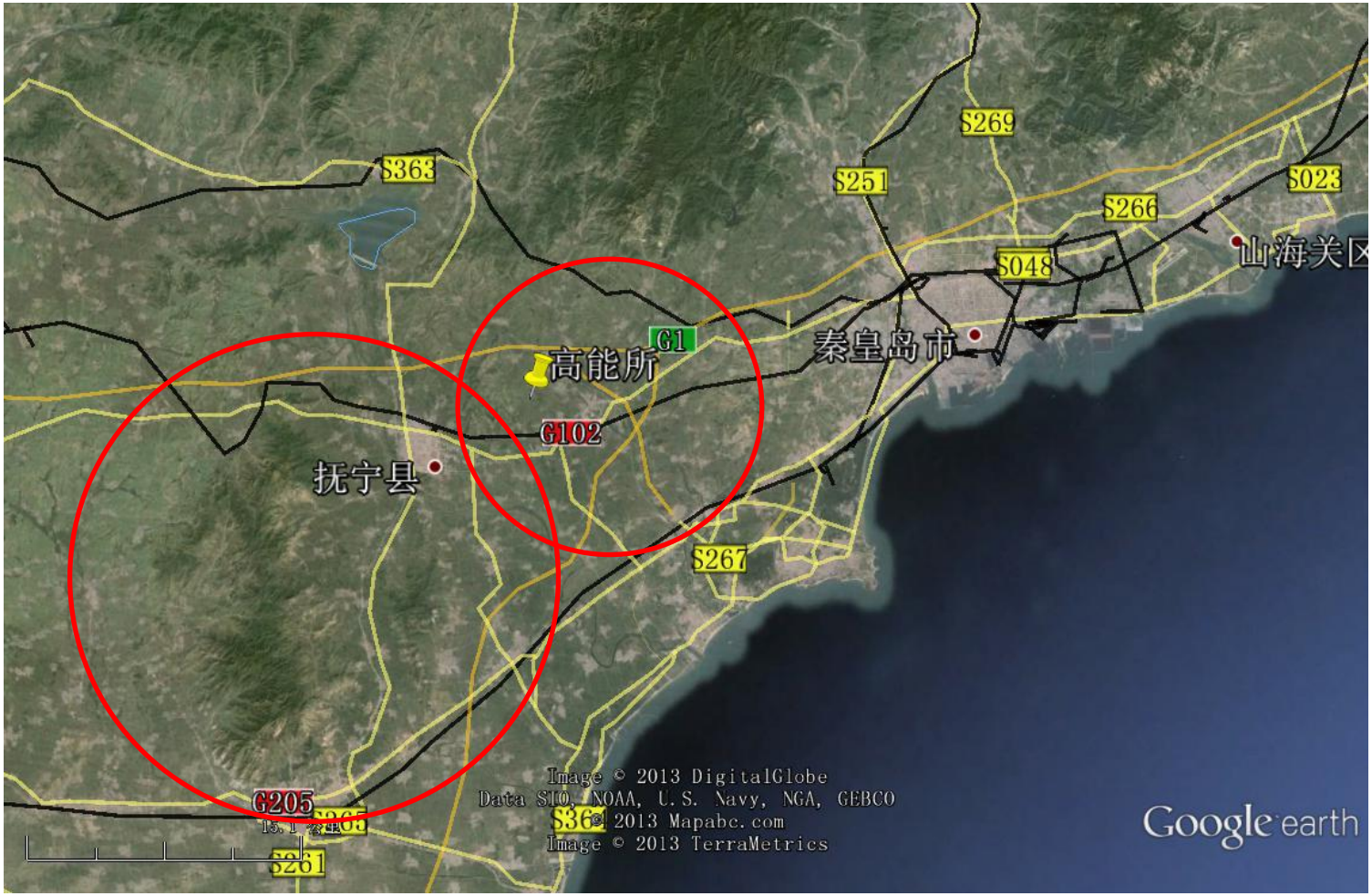
Current organization for pre-study



- To get the community support
- To get everybody involved
- To get things going

Site

- Preliminary selected: Qinhuangdao (秦皇岛）
- Strong support by the local government



Easy Access

- 300 km from Beijing
- 3 h by car
- 1 h by train

Beautiful Place for a Science Center

Best beach & cleanest air
Summer capital of China

Starting point of the Great Wall

Wine yard

Good geological condition

- Base rock type: granite
- Base rock depth: 0.5 - 2 m
- Seismic intensity: no more than the level 7 (some damage to houses), 0.10g
- Earth vibration(RMS, nm):

	Zhangjiakou	Huailai	Qinhuangdao	Tianjing	Huairou
1~100hz	~12	~40	~1.9	~470	~60
4~100hz	~7	~14	~0.8	~24	

Building the tunnel in granite will have the lowest cost

Current design

CEPC basic parameters:

- Beam energy ~120 GeV.
- Synchrotron radiation power ~50 MW.
- 50/70 km in circumference.

SppC basic parameters:

- Beam energy ~50-90 TeV.
- 50/70 km in circumference.
- Needs B_{max} ~20T.

The circumference of CEPC will be determined later based on the cost estimate. A total budget cap is preliminarily set to be about 20B RMB.

Accelerator design: CEPC

- **Main ring:**
  - A FODO lattice in arcs with 60 degree phase advances
  - 16-folder symmetry
  - RF sections distribute around the ring
    - f_{rf} = 700MHz is chosen
  - Pretzel scheme is adopted for multi-bunch collision
  - Double ring option is under-investigation
  - ATF2 type and ILC type FFS designs are currently under study
- **Booster:**
  - In the same tunnel of the collider (6 – 120 GeV)
- **Linac:**
  - 6GeV–Linac will be adopted

Main parameters of CEPC at 50km

Parameter	Unit	Value	Parameter	Unit	Value
Bean Energy	GeV	120	Circumference	km	50
Number of IP		2	L_0 /IP (10^{34})	$cm^{-2}s^{-1}$	2.62
No. of Higgs/year/IP		1E+05	Power(wall)	MW	200
e+ polarization		0	e- polarization		0
Bending radius	km	6.2	N_e/bunch	1E10	35.2
N_b/beam		50	Beam current	mA	16.9
SR loss	(GeV/turn)	2.96	SR power/beam	MW	50
Critical energy of SR	MeV	0.6	ε_x,n	mm-mrad	1.57E+06
ε_y,n	mm-mrad	7.75E+03	β_{IP} (x/y)	mm	200/1
Trans. size (x/y)	μm	36.6/0.18	Bunch length	mm	3
Energy spread SR	%	0.13	Full crossing angle	mrad	0
Lifetime due to Bhabha	sec	930	Damping part. No. (x/y/z)		1/1/2
b-b tune shift x/y		0.1/0.1	Syn. Osci. tune		0.13
RF voltage V_{rf}	GV	4.2	Mom. compaction	1E-4	0.4
Long. Damping time	turns	40.5	Ave. No. of photons		0.59
dB beam-beam	%	0.014			

Main Parameters of SppC

Parameter	SppC-1	SppC-2
Beam energy (TeV)	25	45
Circumference (km)	49.78	69.88
Number of IPs	2	2
SR loss/turn (keV)	440	4090
N_p/bunch (10^{11})	1.3	0.98
Bunch number	3000	6000
Beam current (mA)	0.5	0.405
SR power /ring (MW)	0.22	1.66
B_0 (T)	12	19.24
Bending radius (km)	6.9	7.8
Momentum compaction (10^{-4})	3.5	2.5
β_{IP} x/y (m)	0.1/0.1	0.1/0.1
Norm. trans. emit. x/y (μm·rad)	4	3
ξ_y/IP	0.004	0.004
Geo. luminosity reduction factor F	0.8	0.9
Luminosity /IP ($10^{35}cm^{-2}s^{-1}$)	2.15	2.85

Detector: From ILD to CEPC

- Many new designs
  - Changed granularity (no power pulsing)
  - Changed L*
  - Changed VTX inner radius and TPC outer Radius
  - Changed Detector Half Z
  - Changed Yoke/Muon thickness
  - Changed Sub detector design
  - …
- All Changes need to be implemented into simulation, iterate with physics analysis and cost estimation

Timeline (dream)

- **CPEC**
  - Pre-study, R&D and preparation work
    - Pre-study: 2013-15
      - **Pre-CDR by the end of 2014 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 -

Action items(partially)

- Pre-CDR by the end of 2014
- Approaching the Chinese government in 2015 for R&D funding (next 5-year planning: 2016-2020)
- Get community support in China: ready for some kind of review
- Be active part of the global effort
  - Workshops, joint efforts, statement(?), …
- Develop documents to address scientific, economical and industrial benefits to China and to the world
- Education: public lectures, books, multi-media, …
- Media: news release, event coverage, interview, …
- ……

Summary

- **It is difficult**
- **But it is very exciting**
- **Even if it is not in China, it is still very beneficial to our field and to the Chinese HEP & Science community**
- **We fully support a global effort**

- **Let’s us work for our dream**