Overview of the future CEPC-SppC project in China

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for the accelerator team
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Acknowledgement

- FNAL: W. Chou
- SLAC: Y.H. Cai
- KEK: K. Ohmi, Y. Funakoshi, K. Oide, etc.
- Cornell U.: R. Talman
- CERN: F. Zimmermann, etc.
- Jlab: Y.H. Zhang
- ...... a lot of people are missed here!
Outlines

- Introduction
- Main considerations of AP
- Technical systems
- Organization & time schedule
- Summary
1. Introduction

- Motivations
  - Higgs Boson was discovered two years ago, with a lower energy than expected.
  - Circular collider seems more mature and promising.
  - More high energy physics hide in a possible pp collider converted by electron machine.
## Forthcoming Discoveries in Particle Physics

<table>
<thead>
<tr>
<th>Topic</th>
<th>Crucial measurement</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WIMP</strong></td>
<td>Existence</td>
<td>Dark Mater</td>
</tr>
<tr>
<td><strong>Higgs boson</strong></td>
<td>$M \sim 125$ GeV</td>
<td>Confirm spontaneous symmetry breaking in gauge theory</td>
</tr>
<tr>
<td>Super-symmetric particles</td>
<td>Existence, $M &gt; 1$ TeV</td>
<td>Hope of understanding gravity</td>
</tr>
<tr>
<td>Technicolour particles</td>
<td>Existence, $M &gt;$ TeV?</td>
<td>Dynamic symmetry breaking, Composite Higgs</td>
</tr>
<tr>
<td>Gravitational waves (Gravitons)</td>
<td>Existence</td>
<td>Support general relativity</td>
</tr>
<tr>
<td>Magnetic monopole</td>
<td>Existence, mass, electric charge</td>
<td>Electric and magnetic charge symmetry predicted by Dirac. Structure of gauge field configuration</td>
</tr>
<tr>
<td>Free quarks</td>
<td>Existence, fractional charge</td>
<td>Would confuse all current prejudice</td>
</tr>
<tr>
<td>Neutrino mass and oscillation</td>
<td>$M &lt; 1$ eV</td>
<td>Structure of GUTs. Eventual fate of the universe</td>
</tr>
<tr>
<td><strong>Exotic hadron Glueball</strong></td>
<td>$M_g = 1-2$ GeV, $M_{exotic, c} \sim 4$ GeV</td>
<td>Understand QCD</td>
</tr>
</tbody>
</table>

- **WIMP**: Weakly Interacting Massive Particle
- **Higgs boson**: The particle responsible for giving other particles masses
- **Super-symmetric particles**: Particles that are predicted to have a mass greater than 1 TeV
- **Technicolour particles**: Particles that are predicted to have a mass greater than a TeV
- **Gravitational waves (Gravitons)**: Predicted waves that could support general relativity
- **Magnetic monopole**: Particles that carry a magnetic charge
- **Free quarks**: Particles that are predicted to have fractional charges
- **Neutrino mass and oscillation**: Particles with masses less than 1 eV
- **Exotic hadron Glueball**: Particles with masses between 1 and 2 GeV and other exotic properties
Facilities: Possible Higgs Factories

• Linear Collider
  - ILC
  - CLIC
  - SLC-type
  - Advanced concepts

\[ L \mu \frac{P_{RF}}{E_{CM}} \sqrt{\frac{BS}{y}} \]
• γ-γ collider

◆ SAPPHIRE – ERL based, γ-γ based on LHeC, …
◆ CLICHÉ – CLIC Higgs Experiment

Need powerful laser…
• Muon collider

 ◆ Driven by high power p accelerator
 ◆ MW level target, collect pion to muon
 ◆ Cooling of Muon
 ◆ Acceleration, collision ring, detector…
Circular e-e+ collider

• In the existing tunnel:
  – LEP3, together w/LHC (27 km)

• Using lab field:
  – Fermilab Site Filler (16 km)

• Others:
  – DLEP (53 km), TLEP/FCC (80 km)
  – Super-Tristan (40, 60 km)
  – IHEP: CEPC+SppC (50, 70 km)
  – Very Large Lepton Collider (233 km)
A CEPC (phase I) + SppC (phase II) was proposed in IHEP, Sept. 2012

- CEPC: 240 – 250 GeV
- SppC: 50 – 100 TeV
- e⁻e⁺ Higgs Factory
- pp collider
Luminosity requirement

- **$e^-e^+$ collider**:
  - Higgs produced above the ZH threshold
  - Collide at $E_{cm} \sim 240$ GeV, $\sigma \sim 200$ fb
  - Need 20000 events/yr/IP, i.e., $100$ fb$^{-1}$/y $\rightarrow$ $L = 10^{34}$ cm$^{-2}$s$^{-1}$

- **Muon collider**
  - Higgs produced from s-channel
  - $\sigma \sim 40$ pb
  - 20000 Higgs/yr $\rightarrow$ $L = 5 \times 10^{31}$ cm$^{-2}$s$^{-1}$
3-ring in one tunnel

- Schematic layout
- Linac + booster as injectors

**CEPC:**
- \( E_b = 120 \text{GeV} \)
  - Limited by beamstrahlung & SR (~125GeV)
- Cross-section = 200 fb

\[ \text{Cross-section (fb)} \]

- Optimal energy
- Higgs mass = 125 GeV

Alain Blondal et al
• **Circumference**
  – Determined by SppC beam energy
  – Assume $E_{cm}=70\text{-}100\text{TeV}$ for new physics

<table>
<thead>
<tr>
<th>$E_{cm}$ (TeV)</th>
<th>B (T)</th>
<th>C (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>12</td>
<td>~80</td>
</tr>
<tr>
<td>70</td>
<td>20</td>
<td>~50</td>
</tr>
</tbody>
</table>

• **Beam power**
  – 50 MW/beam, synchrotron radiation (51.7MW w/ FFS)

• **Luminosity**
  – $\geq 1 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}/\text{IP}$
One RF station:
- 650 MHz five-cell SRF cavities;
- 4 cavities/module
- 12 modules, 8 m each
- RF length 120 m

D = 17.3 km
C = 54.752 km

(8 arcs, 5852.8 m each)
• 3 rings locate in one tunnel
  – CEPC & booster
  – SppC
• Crosstalk of CEPC straights & SppC’s detector
• Layout of CEPC determined by SppC layout
2. Main considerations on Accelerator Physics

• **Lattice Design**

In current design:

• Circumference: 54.7 km
• 8 arcs
• 8 straight sections
• 2 IRs
• Filling factor: ~0.7

➢ 8 RF sessions

Still in progress!
Lattice of arc sections

- Length of FODO cell: 47.2m
- Phase advance of FODO cells: 60/60 degrees
- Dispersion suppressor on each side of every arc
- Length: 92.4m

\[ \delta s / p \cdot c = 0. \]

Table name = TWISS
Dynamic aperture (w/o FFS)

- 2 sextupole families are applied to correct chromaticity
- dynamic aperture: $\sim 60 \int_x$ in hori. $\sim 60 \int_y$ in vert.
- $\pm 2\%$ momentum deviation

\[ \delta \beta / p_{\text{c}} = 0. \]

Table name = TWISS

$[10^{**}(3)]$
Pretzel scheme (1)

- No orbit in RF section to avoid beam instability and HOM in the cavity
- One pair of electrostatic separators for each arc
Pretzel scheme (2)

- IP2 and IP4 are parasitic crossing points, but have to avoid collision.
- Two more pairs of electrostatic separators for IP2 and IP4.

D = 17.4 km

C = 54.752 km
FFS in CEPC

• Functions of Interaction Region (IR) optics
  – Provide very small beta function to achieve very small beam size: \( \beta_y^* = 1.2\text{mm}, \sigma_y^* = 0.16\text{um} \), for CEPC
  – Correct large chromaticity due to small beta function: \( W \sim L^*/\beta_y^* \)

Based on Yunhai’s design

\[ L^* = 1.5\text{m} \]
\[ \beta_x^* = 0.8\text{m} \]
\[ \beta_y^* = 1.2\text{mm} \]
Beam-beam study

- Tune scan (studied with Yuan Zhang’s code)

Beamstrahlung OFF  \[ (0.54, 0.61) \]

Beamstrahlung ON
• Working points from beam-beam simulation (0.54, 0.61)
• Beam Lifetime vs dynamic aperture

Simulation & analysis not so consistent
Collective effects

- CEPC ring wake and impedance budget

|                     | R [kΩ] | L [nH] | $k_{\text{loss}}$ [V/pC] | $|Z_{\|}/n|_{\text{eff}}$ [Ω] |
|---------------------|--------|--------|--------------------------|-----------------------------|
| Resistive wall (Al) | 9.5    | 124.4  | 301.3                    | 0.0044                      |
| RF cavities (N=400) | 28.1   | --     | 893.9                    | ---                         |
| Total               | 37.6   | 124.4  | 1195.2                   | 0.0044                      |

- The longitudinal wake is fitted with the analytical model

$$W(s) = -Rc\lambda(s) - Lc^2\lambda'(s)$$

- The loss is dominated by the RF cavities.
- The imaginary part of the RF cavities is capacitive.

Longitudinal wake at nominal bunch length ($\sigma_z=2.66$mm)
• CSR, TMCI are not serious with very rough estimate
• Ion instability, ECI, will be less affected due to the other counter-rotating beam in the same vacuum chamber
• Due to pretzel scheme, when a beam cross a resonator (eg. RF cavity), the wake field excited by the beam will affect the other beam, i.e., the two beams will cross talk to each other.
• Some new phenomena: beam tilt effect
# Main parameters for CEPC

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam energy [E]</td>
<td>GeV</td>
<td>120</td>
<td>Circumference [C]</td>
<td>m</td>
<td>54752</td>
</tr>
<tr>
<td>Number of IP[N_{IP}]</td>
<td></td>
<td>2</td>
<td>SR loss/turn [U_0]</td>
<td>GeV</td>
<td>3.11</td>
</tr>
<tr>
<td>Bunch number/beam[n_b]</td>
<td></td>
<td>50</td>
<td>Bunch population [N_e]</td>
<td></td>
<td>3.79E+11</td>
</tr>
<tr>
<td>SR power/beam [P]</td>
<td>MW</td>
<td>51.7</td>
<td>Beam current [I]</td>
<td>mA</td>
<td>16.6</td>
</tr>
<tr>
<td>Bending radius [ρ]</td>
<td>m</td>
<td>6094</td>
<td>momentum compaction [ρ]</td>
<td></td>
<td>3.36E-05</td>
</tr>
<tr>
<td>Revolution period [T_0]</td>
<td>s</td>
<td>1.83E-04</td>
<td>Revolution frequency [f_0]</td>
<td>Hz</td>
<td>5475.46</td>
</tr>
<tr>
<td>Emittance (x/y)</td>
<td>nm</td>
<td>6.12/0.018</td>
<td>@_P(x/y)</td>
<td>mm</td>
<td>800/1.2</td>
</tr>
<tr>
<td>Transverse size (x/y)</td>
<td>μm</td>
<td>69.97/0.15</td>
<td>(x,y/IP)</td>
<td></td>
<td>0.118/0.083</td>
</tr>
<tr>
<td>Beam length SR [σ_{s,SR}]</td>
<td>mm</td>
<td>2.14</td>
<td>Beam length total [σ_{s,tot}]</td>
<td>mm</td>
<td>2.88</td>
</tr>
<tr>
<td>Lifetime due to Beamstrahlung</td>
<td>min</td>
<td>47</td>
<td>Lifetime rad. Bhabha [L]</td>
<td>min</td>
<td>52</td>
</tr>
<tr>
<td>RF voltage [V_{rf}]</td>
<td>GV</td>
<td>6.87</td>
<td>RF frequency [f_{rf}]</td>
<td>MHz</td>
<td>650</td>
</tr>
<tr>
<td>Harmonic number [h]</td>
<td></td>
<td>118800</td>
<td>Synchrotron oscillation tune [\ell_s]</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Energy acceptance RF [h]</td>
<td>%</td>
<td>5.99</td>
<td>Damping partition number [J_ε]</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Energy spread SR [σ_{s,SR}]</td>
<td>%</td>
<td>0.132</td>
<td>Energy spread BS [\ell_{s,BS}]</td>
<td>%</td>
<td>0.119</td>
</tr>
<tr>
<td>Energy spread total [σ_{s,tot}]</td>
<td>%</td>
<td>0.177</td>
<td>n_0</td>
<td></td>
<td>0.23</td>
</tr>
<tr>
<td>Transverse damping time</td>
<td>turns</td>
<td>78</td>
<td>Longitudinal damping time [τ_e]</td>
<td>turns</td>
<td>39</td>
</tr>
<tr>
<td>Hourglass factor</td>
<td>F_h</td>
<td>0.658</td>
<td>Luminosity/IP[L]</td>
<td>cm^{-2} s^{-1}</td>
<td>1.98E+34</td>
</tr>
</tbody>
</table>
Geometrical Arrangement

Booster

Collision ring

2 m
Twiss Parameters of the injection region

Septum
Kicker

Injection part of the CEPC Lattice
Win32 version 8.51/15
28/05/14 16.28.09
## Injection time structure

<table>
<thead>
<tr>
<th>$T_{\text{life}}$ (s)</th>
<th>Lum Drop</th>
<th>dN</th>
<th>$f_{\text{injection}}$ (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>10%</td>
<td>9E11</td>
<td>90s</td>
</tr>
</tbody>
</table>

**Injection time structure**

- **Injection period**: ~10s.

**Graphical Representation**

- **Injection period** indicated by a diagram showing the time structure with a peak at 1800 seconds, a lum drop of 10%, and decay to 9E11 dN in 90 seconds.
Injection Options

Bump height

Bumped
Stored beam

Septum
Injected beam

Acceptance

\[ B = 10\sigma_{xi} + S \]

\[ 5\int_{xc} + 5\int_{xi} + S \]
Booster & linac

- Preliminary design for booster and transport lines
- Maybe a smaller booster with lower beam energy is necessary
Lattice functions: booster vs. collider

FODO cell

ARC
Unpolarized linac

Totally 10GeV Linac

Gun
3.2nC for E-
10nC for E+

4GeV
10nC on Target

0.2 GeV

e+
Converter

6 GeV
3.2nC E+

5GeV
10nC on Target

0.2 GeV

e+
Converter

E+

Totally 6GeV Linac

Gun
3.2nC for E-
10nC for E+

0.2 GeV

6 GeV
3.2nC E-

6 GeV
3.2nC E+
Polarized linac

- Polarized Electron Source (R&D)

10GeV Linac

- Polarized electron gun for e-
- Polarized electron beam collide with unpolarized positron
3. Technical Systems

- All technical systems have been looked at
  - SRF, Cryo., power, magnet, vacuum, mechanics, instrumentation,…
- Conceptual designs of all systems have been done
- Each system has a request of R&D items
### Magnets

<table>
<thead>
<tr>
<th><strong>Dipole magnet</strong></th>
<th>type A</th>
<th>type B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>1984</td>
<td></td>
</tr>
<tr>
<td>Beam energy (GeV)</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Bending angle (rad)</td>
<td>3.17E-03</td>
<td></td>
</tr>
<tr>
<td>Bending radius (m)</td>
<td>5683.74</td>
<td></td>
</tr>
<tr>
<td>Magnetic gap (mm)</td>
<td>100 (as LEP)</td>
<td></td>
</tr>
<tr>
<td>Magnetic Length (m)</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Maximum field strength (T)</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Good field region, GFR (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field uniformity across GFR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integral field deviation (magnet to magnet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Quadrupole magnet</strong></th>
<th>type A</th>
<th>type B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>2304</td>
<td></td>
</tr>
<tr>
<td>Beam energy (GeV)</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Aperture diameter (mm)</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Magnetic Length (m)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Maximum field gradient (T/m)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Good field region, GFR radius (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmonic field errors across GFR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integral field deviation (magnet to magnet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Sextupole magnet</strong></th>
<th>type A(SF)</th>
<th>type B(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>992</td>
<td>992</td>
</tr>
<tr>
<td>Beam energy (GeV)</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Aperture diameter (mm)</td>
<td>150 (as LEP)</td>
<td>150</td>
</tr>
<tr>
<td>Magnetic Length (m)</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Strength of sextupole field (T/m^2)</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Good field region, GFR radius (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmonic field errors across GFR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Superconducting RF System

- Accelerate e+ & e- beams, compensate synchrotron radiation losses, provide enough RF voltage for energy acceptance of the CEPC booster and main ring; dominates CEPC cost & efficiency.

- One of the world largest SRF installations
  - 12 GeV RF voltage, 640 cavities, total cryomodule length 1.4 km
  - 104.5 MW beam power, 2 MW HOM power, 124 MW installed RF power
  - 126 kW (4.2 K equiv.) installed cryogenic power (similar to LHC)

- Three main design and technical challenges
  - Cavity with very high $Q_0$ at 15-20 MV/m (use state-of-the-art technology)
  - Huge HOM power extraction and low heat load (key issue)
  - Very high power CW coupler (robust, clean assembly and low heat load)

- SRF R&D and pre-production planned for extensive development of key technology, personnel, infrastructure and industrialization
384 cavities in 8 sections

CEPC SRF System location

90 cavities
180 m

One Ring / Two Beam

Harmonic number: 116245
Circumference: 53.6 km
frf: 650 MHz
f0: 5.6 kHz
Ib: 16.6 mA
Pb: 50 MW/beam
SCC: 400
HOMs: ~6.5 kW/cav
Q0: 1E+10
# SRF System Parameters Update

<table>
<thead>
<tr>
<th>Parameters</th>
<th>CEPC-Collider</th>
<th>CEPC-Booster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavity Type</td>
<td>650 MHz 5-cell Nitrogen-doped Nb</td>
<td>1.3 GHz 9-cell Nitrogen-doped Nb</td>
</tr>
<tr>
<td>Cavity number</td>
<td>384</td>
<td>256</td>
</tr>
<tr>
<td>$V_{\text{cav}} / V_{\text{RF}}$</td>
<td>17.9 MV / 6.87 GeV</td>
<td>20 MV / 5.12 GeV</td>
</tr>
<tr>
<td>$E_{\text{acc}}$ (MV/m)</td>
<td>15.5</td>
<td>19.3</td>
</tr>
<tr>
<td>$Q_0$</td>
<td>$4\times10^10$ @ 2K</td>
<td>$2\times10^10$ @ 2K</td>
</tr>
<tr>
<td>Cryo AC power (MW)</td>
<td>~15</td>
<td>~2.3 (21% DF)</td>
</tr>
<tr>
<td><strong>Qualified test</strong></td>
<td><strong>20 MV/m @ 4E10</strong></td>
<td><strong>23 MV/m @ 2E10</strong></td>
</tr>
<tr>
<td>Cryomodule number</td>
<td>96 (4 cav. / module)</td>
<td>32 (8 cav. / module)</td>
</tr>
<tr>
<td><strong>RF power / cav. (kW)</strong></td>
<td><strong>280</strong> (cf 260)</td>
<td>20</td>
</tr>
<tr>
<td>RF source number</td>
<td>384 (330 kW)</td>
<td>256 (25 kW)</td>
</tr>
<tr>
<td>HOM damper (W)</td>
<td>10k ferrite +1k hook</td>
<td>50 (hook+ceramic)</td>
</tr>
</tbody>
</table>
IHEP SRF Key Technology Experience

1.3 GHz 9-cell cavity
vertical test 20 MV/m, $Q_0=1.4\times10^9$

1.3 GHz test cryomodule
horizontal test soon

12 m 1.3 GHz cryomodule
for Euro-XFEL

650 MHz $\beta=0.82$ 5-cell cavity
vertical test soon

500 MHz coupler
420 kW CW TW

HOM absorber
ferrite 6kW

500 MHz cavity module
horizontal tested
Civil infrastructure

- Initial geological investigation and conceptual design of the tunnel has been started
  - Underground tunnel
  - Surface facility
  - Utilities
  - Cost estimate and optimization
Conventional facilities design

- The normal tunnel cross-section is divided into three parts:

  - The outer side of the main ring:
    - where the CEPC machine components and services will be installed. The booster machine components will be installed on the top of CEPC machine ring.
  
  - The inner side of the main ring (reserved for SppC)
  
  - Middle area of the main ring:
    - which is set aside for handling and transporting equipments

Courtesy G. Lin

Portal-shaped cross section
SppC Accelerator Design (preliminary)

- Proton-proton collider luminosity

\[ L_0 = \frac{N_p^2 N_b f_{rep} \gamma}{4\pi \epsilon_0 \beta_{ip}} F \]

\[ F = \sqrt{1 + \left( \frac{\theta_c \sigma_z}{2\sigma_{x,ip}} \right)^2} \]

\[ = \frac{N_p r_p}{4} 0.004 \]

- Main constraint: high-field superconducting dipole magnets

  - 50 km: \( B_{\text{max}} = 12 \text{ T}, E = 50 \text{ TeV} \)
  - 50 km: \( B_{\text{max}} = 20 \text{ T}, E = 70 \text{ TeV} \)
  - 70 km: \( B_{\text{max}} = 20 \text{ T}, E = 90 \text{ TeV} \)
# SppC Main Parameters (preliminary)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference</td>
<td>52</td>
<td>km</td>
</tr>
<tr>
<td>Beam energy</td>
<td>35</td>
<td>TeV</td>
</tr>
<tr>
<td>Dipole field</td>
<td>20</td>
<td>T</td>
</tr>
<tr>
<td>Injection energy</td>
<td>2.1</td>
<td>TeV</td>
</tr>
<tr>
<td>Number of IPs</td>
<td>2 (4)</td>
<td></td>
</tr>
<tr>
<td>Peak luminosity per IP</td>
<td>1.2E+35</td>
<td>cm⁻²s⁻¹</td>
</tr>
<tr>
<td>Beta function at collision</td>
<td>0.75</td>
<td>m</td>
</tr>
<tr>
<td>Circulating beam current</td>
<td>1.0</td>
<td>A</td>
</tr>
<tr>
<td>Max beam-beam tune shift per IP</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Bunch separation</td>
<td>25</td>
<td>ns</td>
</tr>
<tr>
<td>Bunch population</td>
<td>2.0E+11</td>
<td></td>
</tr>
<tr>
<td>SR heat load @arc dipole (per aperture)</td>
<td>56</td>
<td>W/m</td>
</tr>
</tbody>
</table>
4. Organization & time schedule

Institutional Board
Y.N. Gao (TU)
J. Gao (IHEP)

Steering Committee
Y.F. Wang (IHEP), Y.N. Gao (TU), J. Gao (IHEP),
X.C. Lou (IHEP), Q. Qin (IHEP), H.J. Yang (SJTU),
L. Han (USTC), S. Jin (IHEP), H.J. He (TU),
S.H. Zhu (PKU), Y.J. Mao (PKU)

Project Directors
X.C. Lou (IHEP)
Q. Qin (IHEP)

Theroy
H.J. He (TU)
S.H. Zhu (PKU)

Accelerator
Q. Qin (IHEP)
J. Gao (IHEP)

Detector
S. Jin (IHEP)
Y.N. Gao (TU)
About 110 participants and 20 institutions registered.
## Pre-CDR for accelerator design

<table>
<thead>
<tr>
<th>Section</th>
<th>Topic</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Main parameters</td>
<td>Guo Yuanyuan, Geng Huiping, Wang Dou, Xiao Ming, Gao Jie</td>
</tr>
<tr>
<td>4.2</td>
<td>Lattice</td>
<td>Geng Huiping, Wang Dou, Guo Yuanyuan, Wang Na,</td>
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<tr>
<td></td>
<td></td>
<td>Wang Yiwei, Xiao Ming, Peng Yuemei, Bai Sha, Su Feng,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Xu Gang, Duan Zhe, Gao Jie</td>
</tr>
<tr>
<td>4.3</td>
<td>IR and MDI</td>
<td>Wang Dou, Geng Huiping, Wang Yiwei, Bai Sha, Gao Jie</td>
</tr>
<tr>
<td>4.4</td>
<td>Beam instability</td>
<td>Wang Na, Wang Yiwei</td>
</tr>
<tr>
<td>4.5</td>
<td>Beam-beam effects</td>
<td>Zhang Yuan, Guo Yuanyuan, Wang Dou, Xiao Ming, Gao Jie</td>
</tr>
<tr>
<td>4.6</td>
<td>Synchrotron radiation</td>
<td>Ma Zhongjian, Geng Huiping</td>
</tr>
<tr>
<td>4.7</td>
<td>Injection and beam dump</td>
<td>Cui Xiaohao, Su Feng, Xu Gang</td>
</tr>
<tr>
<td>4.8</td>
<td>Background</td>
<td>Yue Teng</td>
</tr>
<tr>
<td>4.9</td>
<td>Polarization</td>
<td>Duan Zhe</td>
</tr>
</tbody>
</table>

- **Visitors from other labs in the world participate the Pre-CDR joint works**
## Accelerator activities

<table>
<thead>
<tr>
<th>Visitors</th>
<th>Period</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dick Talman</td>
<td>April 13th – May 15th</td>
<td>Parameters and other topics</td>
</tr>
<tr>
<td>Armen Apyan</td>
<td>April 1st – April 30th</td>
<td>GuineaPig and CAIN</td>
</tr>
<tr>
<td>Yoshihiro Funakoshi</td>
<td>April 1st-April 15th</td>
<td>Parameter, injection and others</td>
</tr>
<tr>
<td>Dmitry Shatilov</td>
<td>April 1st- April 16th</td>
<td>Beam-beam simulation</td>
</tr>
<tr>
<td>Kazuhito Ohmi</td>
<td>April 16th-April 30th</td>
<td>Beam-beam simulation</td>
</tr>
<tr>
<td>Yunhai Cai</td>
<td>April 16th – April 30th</td>
<td>Lattice and FFS</td>
</tr>
<tr>
<td>Yuhong Zhang</td>
<td>April 16th-April 30th</td>
<td>Electron proton collider</td>
</tr>
</tbody>
</table>
HF2014 is focused on a circular e+e- collider design for a Higgs factory.
Both accelerator physics and technical systems were reviewed.
• Possible site: Qinhuangdao, Hebei province
CFHEP was founded

Center for Future High Energy Physics was founded on Dec 17, 2013

**Director:** Nima Arkani-Hamed (IAS, USA)
**Deputy Director:** Cai-Dian Lu (IHEP, China)

**Academic Committee:**
Sally Dawson (BNL, USA), Tao Han (U. Pittsburgh/Tsinghua U.), et. al.

**Advisory Board:**
Chao-Hsi Chang (ITP), Kuang-Ta Chao (Peking U.), et. al.

**Administration secretary:**
CHEN Li, DANG Lei
CFHEP workshops

- **Workshop on Future High Energy Circular Colliders** --- December 16-17, 2013, Beijing, China
- **1st CFHEP Symposium on circular collider physics** --- February 23-25, 2014, Beijing, China
- **2nd CFHEP Symposium on circular collider physics** --- August 11-15, 2014, Beijing, China
- **Flavor and top physics @ 100 TeV workshop** --- March 4-7, 2015, Beijing, China
Time schedule

• CPEC
  – Pre-CDR study, R&D and preparation work
    • Pre-study: 2013-15 ➔ Pre-CDR by the end of 2014
    • R&D: 2016-2020
    • Engineering Design: 2015-2020
  – Construction: 2021-2027
  – Data taking: 2030-2036

• SPPC
  – Pre-study, R&D and preparation work
    • Pre-study: 2013-2020
    • R&D: 2020-2030
    • Engineering Design: 2030-2035
  – Construction: 2036-2042
  – Data taking: 2042 -
Summary

• CEPC-SppC is the most important HEP project in the near future in China.
• “All” aspects of the CEPC machine design have been touched.
• Accelerator physics of CEPC ring, are being studied. Technical issues are also being considered, and some key technologies are proposed for R&D.
• The first stable version is ready by the end of 2014, together with the pre-CDR report finished.
• Still a long way to the SppC. Key tech R&D needed.
Thanks for your attention!