The BESIII experiment at BEPCII

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Institute of High Energy Physics
Representing BESIII Collaboration
Hadron07
Oct. 8-13, 2007, Frascati
Beam energy: 1.0-2.1 (2.3) GeV
Magnet, RF power
Luminosity: $1 \times 10^{33}$ cm$^{-2}$s$^{-1}$
Optimum energy: 1.89 GeV
Energy spread: $5.16 \times 10^{-4}$
No. of bunches: 93
Bunch length: 1.5 cm
Total current: 0.91 A
SR mode: 0.25 A @ 2.5 GeV
Physics at BEPCII/BESIII

- Precision measurement of CKM matrix elements
- Precision test of Standard Model
- QCD and hadron production
- Light hadron spectroscopy
- Charmonium physics
- Search for new physics/new particles

A review book on tau-charm physics at BESIII ~ 800 pages, to be completed this year

<table>
<thead>
<tr>
<th>Physics Channel</th>
<th>Energy (GeV)</th>
<th>Luminosity $(10^{33} \text{ cm}^{-2}\text{s}^{-1})$</th>
<th>Events/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>J/ψ</td>
<td>3.097</td>
<td>0.6</td>
<td>$1.0 \times 10^{10}$</td>
</tr>
<tr>
<td>τ</td>
<td>3.67</td>
<td>1.0</td>
<td>$1.2 \times 10^7$</td>
</tr>
<tr>
<td>ψ’</td>
<td>3.686</td>
<td>1.0</td>
<td>$3.0 \times 10^9$</td>
</tr>
<tr>
<td>D*</td>
<td>3.77</td>
<td>1.0</td>
<td>$2.5 \times 10^7$</td>
</tr>
<tr>
<td>Ds</td>
<td>4.03</td>
<td>0.6</td>
<td>$1.0 \times 10^6$</td>
</tr>
<tr>
<td>Ds</td>
<td>4.14</td>
<td>0.6</td>
<td>$2.0 \times 10^6$</td>
</tr>
</tbody>
</table>
Light hadron spectroscopy

- Baryon spectroscopy
- Charmonium spectroscopy
- Glueball searches
- Search for non-qqbar states

$10^{10} J/\psi$ events is probably enough to pin down most of problems of light hadron spectroscopy

Spectrum of glueballs from LQCD

Y. Chen et al.
PRD73:014516,2006
(updates Morningstar & Peardon, ‘99)

$0^{++}: 1710 \pm 50 \pm 80$

Also:
$1611 \pm 30 \pm 160$ Michael ’98
$1550 \pm 50 \pm ?$ Bali et al. ’93
Example 1

$X(1835)$ at BESIII via $J/\psi \rightarrow \gamma \eta' \pi^+ \pi^-, \eta' \rightarrow \eta \pi^+ \pi^-$

58M $J/\psi$ data at BESIII

at BESIII

2.5 days' data taking

$M(\eta' \pi \pi)$ GeV/c$^2$

>10$\sigma$

at BESII

2 years' data taking

$M(\eta' \pi \pi)$ GeV/c$^2$

5.0$\sigma$
Example 2

Search for $1^{-+}$ via $J/\psi \to \rho^0 X$, $X \to \eta \pi^0$

$M(\eta\pi^0)$ GeV/$c^2$

Entries 18900

theta1-data

phita1-data

theta2-data

phita2-data
Charmonium physics

• Understand charmonium spectroscopy and charmonium decay dynamics
  – Hadronic transition
  – Radiative transition
  – Study of spin-singlets (h_c, η_c, η'_c)
  – Hadronic decays and pQCD rule
  – Radiative decays and non-qqbar states
  – ...

• Search for rare decays and new phenomena
$\psi(2S) \rightarrow \gamma \eta_c(1S)$

Example 3

- $\psi(2S) \rightarrow \gamma \eta_c(2S)$
- $\psi(2S) \rightarrow \pi^0 h_c, h_c \rightarrow \gamma \eta_c(1S)$
Precision measurement of CKM

---- Branching fractions of charm mesons

Precise measurements of Charm decays will provide inputs directly or indirectly to improve the accuracy of CKM elements determinations

- $V_{cd}/V_{cs}$: Leptonic and semi-leptonic decays
- $V_{cb}$: Hadronic decays
- $V_{td}/V_{ts}$: $f_D$ and $f_{Ds}$ from Leptonic decays
- $V_{ub}$: Form factors of semi-leptonic decays
- Unitarity Test of CKM matrix
Some simulation results
relative errors(%) on the measurements

<table>
<thead>
<tr>
<th>Mode</th>
<th>δB/B(4fb⁻¹)</th>
<th>δB/B(20fb⁻¹)</th>
<th>δB/B(PDG06)</th>
<th>CLEOc(281pb⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D^0 \rightarrow K^-\pi^+$</td>
<td>0.5</td>
<td>0.2</td>
<td>1.8</td>
<td>2.0 (3.891±0.035 ±0.059 ± 0.035)</td>
</tr>
<tr>
<td>$D^+ \rightarrow K^-\pi^+\pi^+$</td>
<td>0.5</td>
<td>0.2</td>
<td>3.6</td>
<td>2.2 (9.15±0.10 ±0.16 ± 0.007)</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-e^+\nu$</td>
<td>0.7</td>
<td>0.3</td>
<td>3.1</td>
<td>~3</td>
</tr>
<tr>
<td>$D^0 \rightarrow \pi^-e^+\nu$</td>
<td>1.8</td>
<td>0.8</td>
<td>6.8</td>
<td>~5</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\mu^+\nu$</td>
<td>0.9</td>
<td>0.4</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>$D^0 \rightarrow \pi^-\mu^+\nu$</td>
<td>2.1</td>
<td>1.0</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>$D^+ \rightarrow \mu^+\nu$</td>
<td>4.0</td>
<td>2.0</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>$f_{D^+}$</td>
<td>2.0</td>
<td>0.9</td>
<td>7.7</td>
<td>7.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mode</th>
<th>δB/B(4fb⁻¹)</th>
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<th>δB/B (PDG06)</th>
<th>CLEOc(281pb⁻¹)</th>
</tr>
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<tr>
<td>$D_{S}^+ \rightarrow \phi\pi^+$</td>
<td>4.0</td>
<td>1.8</td>
<td>14</td>
<td>7.5</td>
</tr>
<tr>
<td>$D_{S}^+ \rightarrow \phi e^+\nu$</td>
<td>5.0</td>
<td>2.2</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>$D_{S}^+ \rightarrow \mu^+\nu$</td>
<td>5.7</td>
<td>2.5</td>
<td>31</td>
<td>8.1</td>
</tr>
<tr>
<td>$f_{DS^+}$</td>
<td>2.8</td>
<td>1.3</td>
<td>9</td>
<td>5</td>
</tr>
</tbody>
</table>

Systematic errors will be dominant, Dalitz plot analyses
Precision test of SM and Search for new Physics

- **DDbar mixing**
  
  \[ \text{DDbar mixing in SM } \sim 10^{-3} - 10^{-10} \]
  
  DDbar mixing sensitive to “new physics”
  
  Our sensitivity : \( \sim 10^{-4} \)

- **Lepton universality**

- **CP violation**

- **Rare decays**
  
  FCNC, Lepton no. violation, ...

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Events Right Sign</th>
<th>Sensitivity of ( R_M )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \psi(3770) \rightarrow (K^-\pi^+)(K^-\pi^+) )</td>
<td>87195</td>
<td>( 1 \times 10^{-4} )</td>
</tr>
<tr>
<td>( \psi(3770) \rightarrow (K^-e^+\nu)(K^-e^+\nu) )</td>
<td>94351</td>
<td>( 3.7 \times 10^{-4} )</td>
</tr>
<tr>
<td>( \psi(3770) \rightarrow (K^-e^+\nu)(K^-\mu^+\nu) )</td>
<td>166808</td>
<td></td>
</tr>
<tr>
<td>( \psi(3770) \rightarrow (K^-\mu^+\nu)(K^-\mu^+\nu) )</td>
<td>83404</td>
<td></td>
</tr>
<tr>
<td>( D^{*+}D^- \rightarrow [\pi^+_s(K^+e^-\bar{\nu})(K^+\mu^-\pi^-)] )</td>
<td>76000</td>
<td></td>
</tr>
<tr>
<td>( D^{*+}D^- \rightarrow [\pi^+_s(K^+\mu^-\bar{\nu})(K^+\pi^-\pi^-)] )</td>
<td>60000</td>
<td></td>
</tr>
<tr>
<td>( D^{*+}D^- \rightarrow [\pi^+_s(K^+e^-\bar{\nu})(\text{other } D^- \text{ tag})] )</td>
<td>60000</td>
<td></td>
</tr>
<tr>
<td>( D^{*+}D^- \rightarrow [\pi^+_s(K^+\mu^-\bar{\nu})(\text{other } D^- \text{ tag})] )</td>
<td>60000</td>
<td>( 4.7 \times 10^{-5} )</td>
</tr>
</tbody>
</table>
Example 5

Scan of $\psi(3770)$ peak

$\Gamma_{\psi(3770)}^{\text{tot}} = 26.8 \pm 0.5 \text{ MeV} \quad 26.9 \text{ MeV}$

$\Gamma_{\psi(3770)}^{ee} = 256 \pm 9 \text{ eV} \quad 251 \text{ eV}$

$B[\psi(3770) \to D \bar{D}]$

$(88.2 \pm 2.4 \pm 2.0) \% \quad \text{Measured value}$

$89 \% \quad \text{Input value}$
QCD and hadron production

- R-value measurement
- Measurement of $\alpha_s$ at low energies
- Hadron production at J/$\psi$, $\psi'$, and continuum
- Multiplicity and other topology of hadron events
- BEC, correlations, form factors, resonance, etc.

<table>
<thead>
<tr>
<th>Error on R</th>
<th>$\Delta \alpha^{(5)}_{\text{had}} (M_Z^2)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>0.02761 ± 0.00036</td>
</tr>
<tr>
<td>3%</td>
<td>0.02761 ± 0.00030</td>
</tr>
<tr>
<td>2%</td>
<td>0.02761 ± 0.00029</td>
</tr>
</tbody>
</table>

Errors on R will be reduced to 2% from currently 6%
Tau mass measurement

Data taking strategy (~2 weeks)

Event Selection & Eff. determination

BG. study

Optimal Point to determine \( m_\tau \)

Using Compton scattering technique to measure the beam energy

Current:

\[
m_\tau = 1776.96 \pm 0.18 \pm 0.25 \pm 0.21 \pm 0.17 \text{ MeV}
\]

BESIII expected:

\[
\Delta m_\tau = \pm 0.05 \pm 0.09 \text{ MeV}
\]
Current status of BEPCII/BESIII construction
Installation of linac is complete
# Summary of the Linac commissioning

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Goal</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beam energy (GeV)</strong></td>
<td>1.89</td>
<td>1.89 (e-); 1.89 (e+)</td>
</tr>
<tr>
<td><strong>Beam current (mA)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e^+$</td>
<td>40</td>
<td>40 - 63</td>
</tr>
<tr>
<td>$e^-$</td>
<td>500</td>
<td>&gt; 500</td>
</tr>
<tr>
<td><strong>Repetition rate (Hz)</strong></td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>Emittance (1σ) (mm⋅mrad)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e^+$</td>
<td>0.53</td>
<td>0.32 ~ 0.20</td>
</tr>
<tr>
<td>$e^-$</td>
<td>0.067</td>
<td>0.080 ~ 0.096</td>
</tr>
<tr>
<td><strong>Energy spread (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e^+$</td>
<td>± 0.50</td>
<td>±<a href="mailto:0.73@1.30GeV">0.73@1.30GeV</a></td>
</tr>
<tr>
<td>$e^-$</td>
<td>± 0.50</td>
<td>&lt; ±<a href="mailto:0.80@1.30GeV">0.80@1.30GeV</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(&lt; ±<a href="mailto:0.55@1.89GeV">0.55@1.89GeV</a>)</td>
</tr>
</tbody>
</table>
The BEPCII storage ring installation was completed in the beginning of Nov. 2006
Conventional magnets were installed in IR to start ring commissioning and SR operation
Milestone of BEPCII storage ring commissioning

Nov. 2006  Beam commissioning start
Nov. 2006  Beam was stored in the storage ring
Dec. 2006  Accumulated beam $\sim 6$ A $\cdot$ hrs.,
           beam life time $\sim 1.5$ hrs @ 60mA.
Dec. 2006  Start to provide SR beams for users
Mar. 2007  First $e^+e^-$ collision, Lumi $\sim 10^{30}$ cm$^{-2}$ s$^{-1}$ (normal Q)
           collision of 100 mA + 100 mA, lumi $\sim 10^{31}$ cm$^{-2}$ s$^{-1}$
June 2007  Provide SR beams for users at 2.5GeV,
           200 mA with a lifetime of 5.5 hr
Aug. 2007  Beam current reached 500 mA
           SCQ magnet mapped and now at the interaction region
           (was a serious problem)
Future plan

- Machine study will start Oct. 17, 2007
- Another SR run is planed at the end of 2007
- By march 2008, lumi shall reach \( \sim 10^{32} \text{ cm}^{-2} \text{ s}^{-1} \) and backgrounds acceptable
- The BESIII detector will be moved to the interaction region by March 2008
- The goal is that BEPCII should reach a lumi. around \( 3 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1} \) by the end of 2008
The BESIII Detector

Magnet yoke

SC magnet, 1T

TOF, 100ps

Be beam pipe

MDC, 120 μm

CsI(Tl) calorimeter, 2.5 %@1 GeV

RPC
• Drift chamber and its electronics (IHEP, Sichuan, Tsinghua)
• CsI(Tl) calorimeter and its electronics (IHEP, Tsinghua)
• TOF\[ IHEP, USTC\[ Tokyo\[ Hawaii\[ \]
• TOF electronics \[ USTC\[ \]
• RPC\[ IHEP, Uni. of Washington\[ \]
• RPC electronics \[ USTC\[ \]
• Trigger\[ IHEP, USTC\[ \]
• DAQ & online software (IHEP, Tsinghua)
• Offline software \[ IHEP, Peking\[ Shangdong\[ Nanjing\[ \]
• Superconducting magnet \[ IHEP\[ Wang NMR\[ \]
• Mechanics (IHEP)
• Technical support (IHEP, Tsinghua)
Drift chamber

- To measure the momentum of charged particles

**Design spec.:**

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Single wire reso.</th>
<th>dE/dx reso.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEO</td>
<td>~110µm,</td>
<td>5.7%</td>
</tr>
<tr>
<td>Babar</td>
<td>~110µm,</td>
<td>6.2%</td>
</tr>
<tr>
<td>Belle</td>
<td>~130µm,</td>
<td>5.7%</td>
</tr>
<tr>
<td>BESIII</td>
<td>~120µm</td>
<td>6%</td>
</tr>
</tbody>
</table>

- Rin = 63mm; Rout = 810mm; length = 2400 mm
- 7000 Signal wires: 25(3% Rhenium) µm gold-plated tungsten
- 22000 Field wires: 110 µm Al
- Gas: He + C₃H₈ (60/40)
- Momentum resolution@1GeV:
  - $\frac{\sigma_{P_t}}{P_t} = 0.32\% \oplus 0.37\%$
All preamplifiers are mounted and tested
Cosmic-ray tests completed

- Mean: $-2.772 \times 10^{-5}$
- RMS: 0.123
- $\chi^2$/ndf: 2234/154
- Prob: 0
- $p_0 = 24.2 \pm 5551$
- $p_1 = 1.416 \times 10^{-4} \pm 9.471 \times 10^{-5}$
- $p_2 = 0.00022 \pm 0.07865$
- $p_3 = 23.5 \pm 2245$
- $p_4 = 0.000456 \pm 0.000392$
- $p_5 = 0.0008 \pm 0.1854$

- $\sigma = 120 \mu m$
- $V_T^L = 60$, $V_T^H = 80$
BESIII CsI(Tl) crystal calorimeter

- To measure the energy of electromagnetic particles
- Barrel: 5280 crystals, Endcap: 960 crystals
- Crystal: (5.2x 5.2 – 6.4 x 6.4) x 28cm³
- Readout: ~13000 Photodiodes, 1cm×2cm,
- Energy range: 20MeV – 2 GeV
- Position resolution: 6 mm@1GeV
- Tiled angle: theta ~ 1-3°, phi ~ 1.5°

Babar: 2.67% @1GeV
BELLE: 2.2% @1GeV
CLEO: 2.2% @1GeV
BESIII: 2.5% @1GeV
CsI Calorimeter

Testing:
- Size
- Source tests ($^{137}$ Cs)
- LED tests
- PD tests
- Preamp tests
- Cosmic ray tests
- Beam tests (6 x 6 array):

Energy resolution (1GeV)
\[ \sigma_E = 2.62\% \]

Position resolution (1GeV)
\[ \sigma_{x-y} = 6\ mm \]
Crystal production and tests completed

<table>
<thead>
<tr>
<th></th>
<th>France Sanit-Gobain</th>
<th>Shanghai Institute of Ceramics</th>
<th>Beijing Hamamatsu</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordered</td>
<td>2040(960)</td>
<td>1920</td>
<td>1320</td>
<td>5280(960)</td>
</tr>
<tr>
<td>Replaced</td>
<td>87(4)</td>
<td>316</td>
<td>79</td>
<td>482(4)</td>
</tr>
</tbody>
</table>

![Graphs showing crystal sample size and decrease of light output](image)
Crystal assembly completed
Barrel assembly completed
PID: Time-Of-Flight counters

- To measure the flight time of particles in order to identify them: \( m = \frac{P}{L/t} \)

High quality plastic scintillator: 2.4 m long, 5cm thick
Test beam at IHEP: for various types of scintillators, thickness, wrapping materials, ...
Test beam at IHEP: for various types of scintillators, thickness, wrapping materials, …

- **Pions**: $104 \pm 11$ ps
- **Protons**: $70 \pm 2$ ps
- **Electrons**: $94 \pm 3$ ps
Scintillator tests completed

- PMT test completed at Tokyo University
- Preparation for installation completed
- Monitor system by Hawaii University completed
μ system: RPC

- 9 layer, 2000 m²
- Special bakelite plate w/o linseed oil
- 4 cm strips, 10000 channels
- Noise less than 0.1 Hz/cm²
Mass production ---- Bare chamber test

Training time: 1 - 3 days; endcap 320RPCs, barrel 590RPCs

**Efficiency**
- **Endcap 7.5kV**
  - Min. 83.5%
  - Max. 98.5%
  - Aver. 93.46%
- **Barrel 7.5kV**
  - Min. 85.6%
  - Max. 99.02%
  - Aver. 95.39%

**Counting Rate**
- **Endcap 7.5kV**
  - Min. 0.038
  - Max. 0.598
  - Aver. 0.210
- **Barrel 7.5kV**
  - Min. 0.016
  - Max. 0.599
  - Aver. 0.095

**Dark Current**
- **Endcap 7.5kV**
  - Aver. 3.47
- **Barrel 7.5kV**
  - Aver. 1.605
Test results after installation

Module size: 3800mm * 1640mm
Strip length: 3800mm
Strip width: 33mm
Average strip efficiency: 0.99
Spatial resolution: 14.2mm
Muon chamber installation completed
Super-conducting magnet: 1T@3400 A
The magnet reached super-conducting status and 1T magnetic field at 3364A. Field mapping with SCQ completed Aug., 07
Electronics

- Drift chamber: 6500ch, $s_t \sim 500\text{ps}$, $s_q \sim 5 \text{ fc}$, 10bit ADC
- Calorimeter: 6300ch, $s_q \sim 0.5\text{fc}$, 3×10bit ADC, noise < 1000ENC
- TOF: 500ch, $s_t \sim 20\text{ps}$, 10bit ADC
- RPC: 10000ch, bit map
- Prototype and beam test all meet the design spec.
- Mass production completed
- Some tested with full trigger/DAQ system
Trigger system hardware structure

Trigger condition processor
Trigger table
Main trigger controller
Fan out
RD
TCL
BUS

Scaler

6UVME

TDC

8UVME

MDC

logic

MDC

EMC

TOF

NIM crate

Total
4× 9UVME
1×6UVME
1×NIM

From front electronics
Key technical issues solved (speed, network, CPU, etc.)

specification: $\sim 50 \text{Mb/s}, \ 4000 \text{ Hz, } 10 \times \text{B-factory}, \ 1000 \times \text{BESII}$
Offline software system

FACS

Gaudi
- Simulation
- Calibration
- Reconstruction
- Physics Analysis
- Event Display

Calibrator
- Register, write
- Search
- Read

Metadata (persistent)
- MySQL rdbms

Calibration & Database

Cal-MDC
Cal-TOF
Fast-track
Event-T0

Pre-tracking
- Cal-MDC
- Cal-TOF
- Fast-track
- Event-T0

Post-tracking
- MDC-track
- EMC(B/E)
- TOF(B/E)
- MUID

Detector-Geo
- Exp. data
- MC data

Cal-Data
- Control-Data

REC Data

DST Data

Generator

Simulation

Digitization

Transient Event Store

Reconstruction

V0FIND

Phy-tracking

EVERTEX

DST Made
Monte Carlo simulation

- GEANT4 based simulation framework completed
- Geometry, material and detector response completed
- Real detector response including 3D magnetic field, noise, trigger, bunch size etc completed
- All tested by reconstructed physics events
- Many generators, some are new for tau-chram physics
- Stable operation, large data sample generated
Event reconstruction and calibration

- Gaudi based framework completed
- Sub-detector reconstruction and calibration almost completed:
  - Kalman-filter based track fitting
  - Basic calibration algorithm established
  - No-bias Event reconstruction
  - Resolution in agreement with specification
  - Timing zero can be reconstructed
  - Secondary vertex can be reconstructed
  - Online event filter
  - Stable operation for physics studies

\[ \chi_{c0}: 126 \text{ MeV} \]
\[ \chi_{c1}: 170 \text{ MeV} \]
\[ \chi_{c2}: 259 \text{ MeV} \]

Inclusive \( \gamma \) spectrum in \( \psi(2S) \) decays
Schedule

• 2/2003: Official approval of the project
• 7/2004: BESII detector shutdown
• 5/2005: Magnet yoke & muon chamber installation
• 9/2006: Super-conducting magnet cool down
• 8/2007: Magnetic field mapping finished
• 10/2007: EMC installation done
• 10/2007: MDC/TOF installation starts
• 1/2008: Cosmic-ray tests
• 3/2008: BESIII detector in beam line
• Summer of 08: Start data taking (test run)
Barrel EMC installed in the yoke

Now mounting barrel TOF to MDC, assembling endcap EMC
Japan (1)
Tokyo University

USA (2)
University of Hawaii
University of Washington

Europe (4)
GSI, Germany
University of Bochum, Germany
University of Giessen, Germany
JINR, Dubna, Russia

China (22)
IHEP, CCAST, GUCAS
Univ. of Sci. and Tech. of China
Shandong Univ., Zhejiang Univ.
Huazhong Normal Univ., Wuhan Univ.
Zhengzhou Univ., Henan Normal Univ.
Peking Univ., Tsinghua Univ.
Zhongshan Univ., Nankai Univ.
Shanxi Univ., Sichuan Univ
Hunan Univ., Liaoning Univ.
Nanjing Univ., Nanjing Normal Univ.
Guangxi Normal Univ., Guangxi Univ.
Summary

• BEPCII/BESIII construction is close to the completion
• BESIII assembly and installation will be finished this year, physics run will start next summer
• Physics and software preparation underway
• We are excited about the great physics opportunities of BESIII and welcome new collaborators
Thanks
Precision measurement of CKM

---- Branching ratios of charm mesons

- $V_{cd}/V_{cs}$: Leptonic and semi-leptonic decays
- $V_{cb}$: Hadronic decays
- $V_{td}/V_{ts}$: $f_D$ and $f_{Ds}$ from Leptonic decays
- $V_{ub}$: Form factors of semi-leptonic decays
- Unitarity Test of CKM matrix

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>BESIII</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{ub}$</td>
<td>25%</td>
<td>5%</td>
</tr>
<tr>
<td>$V_{cd}$</td>
<td>7%</td>
<td>1%</td>
</tr>
<tr>
<td>$V_{cs}$</td>
<td>16%</td>
<td>1%</td>
</tr>
<tr>
<td>$V_{cb}$</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>$V_{td}$</td>
<td>36%</td>
<td>5%</td>
</tr>
<tr>
<td>$V_{ts}$</td>
<td>39%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Example 3

\( \psi(2S) \rightarrow \gamma \eta_c(1S) \)

- Eff. ~ 19%
- \( \bar{\sigma} = 12.16 \text{ MeV}/c^2 \)

- Eff. ~ 54%
- \( \bar{\sigma} = 11.69 \text{ MeV}/c^2 \)

- Eff. ~ 23%
- \( \bar{\sigma} = 10.10 \text{ MeV}/c^2 \)

\( \psi(2S) \rightarrow \gamma \eta_c(2S) \)

- Eff. ~ 15%
- \( \bar{\sigma} = 20.9 \text{ MeV}/c^2 \)

- Eff. ~ 50%
- \( \bar{\sigma} = 20.4 \text{ MeV}/c^2 \)

- Eff. ~ 18%
- \( \bar{\sigma} = 16.8 \text{ MeV}/c^2 \)

\( \psi(2S) \rightarrow \pi^0 h_c, h_c \rightarrow \gamma \eta_c(1S) \)

- Eff. ~ 6%

- Eff. ~ 8%

- Eff. ~ 4%
**Example 5**

Scan of $\psi(3770)$ peak

\[
\Gamma_{\psi(3770)}^{\text{tot}} = 26.8 \pm 0.5 \text{ MeV} \quad 26.9 \text{ MeV} \\
\Gamma_{\psi(3770)}^{\text{ee}} = 256 \pm 9 \text{ eV} \quad 251 \text{ eV}
\]

Measured value

Input value

\[
B[\psi(3770) \rightarrow D \bar{D}] = (88.2 \pm 2.4 \pm 2.0) \% \quad \text{Measured value} \\
89 \% \quad \text{Input value}
\]

\[1.64 \pm 7.3 \pm 4.3\]