Status of BES-III

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(JINR)

on behalf of the BES-III Collaboration
The BES-III Collaboration

**P.R.China:** CCAST, Guangxi Normal University, Guangxi University, GUCAS, Henan Normal University, Huazhong Normal University, Hunan University, IHEP, Liaoning University, Nanjing Normal University, Nanjing University, Nankai University, Peking University, Shanxi University, Sichuan University, Shandong University, The Chinese University of Hong Kong, The University of Hongkong, Tsinghua University, USTC, Wuhan University, Zhejiang University, Zhengzhou University

**Germany:** Bochum University, GSI Darmstadt, Universitaet Giessen

**Japan:** Tokyo University

**Joint Institute for Nuclear Research (JINR)**

**Russia:** Budker Institute of Nuclear Physics

**USA:** Carnegie Mellon University, Rensselaer Polytechnic Institute, University of Florida, University of Hawaii, University of Rochester, University of Minnesota, University of Washington

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The BEPCII/BESIII Project

- **Luminosity**
  - $10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ @ 1.89GeV
  - $0.6 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ @ 1.55GeV
  - $0.6 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ @ 2.1GeV

The project timeline

- Linac installation  2004
- Ring installation   2005
- The detector installation  2006
- BEPCII/BESIII commissioning  autumn 2007
- Start of data taking (cosmics)  january 2008
- Start of data taking  july 2008

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### BEPCII in collision mode

<table>
<thead>
<tr>
<th>Machine parameters</th>
<th>design</th>
<th>Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BER</td>
<td>BPR</td>
</tr>
<tr>
<td>Energy (GeV)</td>
<td>1.89</td>
<td>1.89</td>
</tr>
<tr>
<td>Beam curr. (mA)</td>
<td>910</td>
<td>550</td>
</tr>
<tr>
<td>Bunch curr. (mA)</td>
<td>9.8</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Bunch number</td>
<td>93</td>
<td>93</td>
</tr>
<tr>
<td>RF voltage</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Tunes ($\beta_x/\gamma_y$)</td>
<td>6.54/5.59</td>
<td>6.540/5.599</td>
</tr>
<tr>
<td>Inj. Rate (mA/min)</td>
<td>200 e⁻/ 50 e⁺</td>
<td>&gt;200</td>
</tr>
<tr>
<td>Lum. ($\times 10^{33}$cm⁻²s⁻¹)</td>
<td>1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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## Event statistics

<table>
<thead>
<tr>
<th></th>
<th>Center-of-Mass Energy (GeV)</th>
<th>Peak luminosity (10^{33}\text{cm}^{-2}\text{c}^{-1})</th>
<th>Physics cross-section (nb)</th>
<th>Expected number of events per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>(J/\psi)</td>
<td>3.097</td>
<td>0.6</td>
<td>~3400</td>
<td>(1.0 \times 10^{10})</td>
</tr>
<tr>
<td>(\tau^+\tau^-)</td>
<td>3.67</td>
<td>1.0</td>
<td>~2.4</td>
<td>(1.2 \times 10^{7})</td>
</tr>
<tr>
<td>(\psi(2S))</td>
<td>3.686</td>
<td>1.0</td>
<td>~640</td>
<td>(3.0 \times 10^{9})</td>
</tr>
<tr>
<td>DD</td>
<td>3.770</td>
<td>1.0</td>
<td>~5</td>
<td>(2.5 \times 10^{7})</td>
</tr>
<tr>
<td>(D_sD_s)</td>
<td>4.030</td>
<td>0.6</td>
<td>~0.32</td>
<td>(1.0 \times 10^{6})</td>
</tr>
<tr>
<td></td>
<td>4.140</td>
<td>0.6</td>
<td>~0.67</td>
<td>(2.0 \times 10^{6})</td>
</tr>
</tbody>
</table>
The BES-III detector

- Muon ID
- TOF
- Be beam pipe
- Drift Chamber
- CsI(Tl) calorimeter
- SC magnet
The BES-III detector

Installation precision is better than 1 mm
## Design detector properties

<table>
<thead>
<tr>
<th>Subdetector</th>
<th>BESIII</th>
<th>BESII</th>
<th>CLEOc</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MDC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_{xy} = 130$ um</td>
<td></td>
<td>250 um</td>
<td>90 um</td>
</tr>
<tr>
<td>$\Delta P/P = 0.5% @ 1\text{GeV}$</td>
<td>2.4%@1GeV</td>
<td>0.5% @ 1GeV</td>
<td></td>
</tr>
<tr>
<td>dE/dx resolution 6-7%</td>
<td>8.5%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td><strong>EMC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta E/E = 2.5% @ 1\text{GeV}$</td>
<td>20%@1GeV</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>$\Delta \theta \sim 5\text{mrad} @ 1\text{GeV}$</td>
<td>25mrad @1GeV</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOF</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_T$: barrel:100 ps end-cap:110 ps</td>
<td>180 ps barrel 350 ps endcap</td>
<td>RICH</td>
<td></td>
</tr>
<tr>
<td><strong>Muon Identifier</strong></td>
<td>9 layers</td>
<td>3 layers</td>
<td>----</td>
</tr>
<tr>
<td><strong>Magnet</strong></td>
<td>1.0 Tl</td>
<td>0.4 Tl</td>
<td>1.0 Tl</td>
</tr>
</tbody>
</table>
Calibration using cosmic rays

MDC single wire resolution < design spec. ×110%

EMC energy resolution < design spec. ×140%

TOF time resolution < design spec. ×130%

MUC efficiency ~ design spec. ×100%

To be improved by further calibration using Bhabha and dimuon events

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\( \tau \) physics program

- \( \tau \) mass measurement
- Branching ratio measurement
- Study of Lorentz structure of the weak charged current
Tau mass measurement

- Discussed in detail at Tau'06 by Mo X.H

- Expected accuracy $5 \times 10^{-5}$ or 0.09 MeV

- Few days of data taking are enough to get necessary statistics (one week of data taking gives statistical uncertainty $\sim 0.017$ MeV)

- Absolute energy scale calibration system would allow to eliminate most significant contribution to the systematics

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Branching ratio measurement

- $e\mu$ final state
- hadronic final states
- spectral functions
**Study of e\(\mu\) and hadronic final states near \(\tau\) threshold at BESIII**

<table>
<thead>
<tr>
<th>(\tau^- \rightarrow e^- \nu \nu), (\tau^+ \rightarrow \mu^+ \nu \nu) @3.6GeV</th>
<th>Statistic error</th>
<th>(L) (pb(^{-1}))</th>
<th>(t) (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^{-2})</td>
<td>196</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>(10^{-3}) (PDG: 0.3% )</td>
<td>(1.96 \times 10^4)</td>
<td>227.3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\tau^+ \tau^- \rightarrow \pi^+ \pi^- \nu \nu) @3.554GeV</th>
<th>Statistic error</th>
<th>(L) (pb(^{-1}))</th>
<th>(t) (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^{-1})</td>
<td>(1.96 \times 10^2)</td>
<td>2.27</td>
<td></td>
</tr>
<tr>
<td>(10^{-2}) (PDG: 0.6% )</td>
<td>(1.96 \times 10^4)</td>
<td>227.3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\tau^+ \tau^- \rightarrow K^+ K^- \nu \nu) @3.554GeV</th>
<th>Statistic error</th>
<th>(L) (pb(^{-1}))</th>
<th>(t) (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^{-1})</td>
<td>(4.8 \times 10^4)</td>
<td>551.8</td>
<td></td>
</tr>
<tr>
<td>(10^{-2}) (PDG: 3.3% )</td>
<td>(4.8 \times 10^6)</td>
<td>55176</td>
<td></td>
</tr>
</tbody>
</table>

(More detailed studies, including \(K\pi\), are in progress)
Hadronic $\tau$ decays & spectral functions

ALEPH

Statistics

- No tagging;
- Tau decay selected: $\sim 327000$
- $\tau \rightarrow \pi\pi^0$ selected: $\sim 81000$

ALEPH measurement
$\text{Br}(\tau \rightarrow \nu\pi\pi^0)$:
$25.924 \pm 0.097 \pm 0.085$

BES-III

Statistics (3 month of dedicated run at energy slightly below $\psi(2S)$):

- Total statistic expected: $3 \times 10^6$
- Single (lepton) tag: ($\tau^+ \rightarrow l^+\nu$, $\tau^- \rightarrow$ hadrons)
  - $\sim 2 \times 10^6$ tagged tau decay (0.35x2x3e6)
  - $\sim 1.4 \times 10^6$ tagged hadronic tau decay
  - $\sim 0.5 \times 10^6$ tagged $\tau \rightarrow \pi\pi^0$ decays

- Assuming
  - geometrical efficiency: 80% (4x0.95)
  - lepton selection efficiency 80%
  - $\pi^0$ registration efficiency within acceptance $\sim 90%$ (all gamma registered in EMC)

Finally we expect $\tau \rightarrow \pi\pi^0$ statistic: $290,000$

**Systematics:**

External background
Mass reconstruction accuracy
Decay mode misidentification (Ex. $\pi\pi^0\pi^0$ as $\pi\pi^0$)

One more BES3 advantage: good kaon identification allows to measure strange spectral function (in ALEPH only statistical K/$\pi$ separation was possible (by dE/dx, $\sim 3.5\sigma$)

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Study of Lorentz structure of the weak charged current (1)

- In general case, the tau decay can be caused by different types of interaction: scalar, vector, tensor, left-handed, right-handed

- These possibilities are parameterized in terms of Michel parameters ($\rho, \eta, \xi, \tilde{\xi}\delta$), which were extensively studied at LEP and CLEO

- An extension of the Michel parametrization - an anomalous tensor interaction which requires derivatives in the Lagrangian, can be looked for. Such possibility was never considered before.

- The anomalous tensor interaction was measured in DELPHI (together with the “standard” Michel parameters), but with a large statistical error and only under the assumption that the “standard” Michel parameters take exactly the Standard Model values
Both the Michel parameters and the constant of the anomalous tensor interaction can be measured from the energy spectrum of the tau decay:

\[ \frac{d\Gamma}{dx} \sim x^2(3(1-x) + \rho(8x/3-2) + \kappa x) \]

Here \( x = \frac{E}{E_{\text{max}}} \) is the normalized energy of the tau decay product.

The non-SM values of the Michel parameters and of the tensor interaction result in different distortions of the spectrum, which allows a simultaneous measurement of both (provided the statistics is sufficient).
Study of Lorentz structure of the weak charged current (3)

- Preliminary Monte-Carlo studies show that the BESIII statistics and the detector performance are sufficient to improve the precision of the current results by a significant factor:
  - $\rho$: by factor of 2
  - $\eta$: by factor of 5
  - $\kappa$: by factor of 10
- The large statistics also makes it possible to measure all parameters simultaneously, without assumption that all other parameters take the SM values
Summary

- Construction and installation of BEPCII and BESIII completed successfully. Commissioning is ongoing.
- Current machine luminosity is 10% of design value. It is expected to reach 30% by the end of the year.
- Detector properties after preliminary calibration using cosmic rays are close to design ones. No major hardware problems found.
- $\tau$ physics program is prepared.
- Data taking plan is not fixed for the forthcoming years yet. However dedicated run for tau physics is unlikely until 2010.

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