CURRENT STATUS OF BES AND THE PROSPECT

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March 6, 1999

PERL workshop at SLAC

1. Review of BEPC/BES
2. The Current Status of BEPC/BES
3. Data Taking Plan for the Near Future
4. The Physics Topics and the Main Goals
5. Possible Long Term Plan

1 REVIEW OF BEPC/BES

- Only e^+e^- colliding machine running at τ and charm energy region for nearly 10 years.
- Dual machine for HEP and SR.
- Data taken so far.

energy	data sample
J/ψ	9 M
ψ'	3.7 M
4.03 GeV	22.3 pb^{-1} (D_S, D, τ)
τ threshold scan	5.0 pb^{-1}
R measurement (6 points)	$>$ 1000 hadron events

- Main Results
  - Precise measurement of τ mass, correcting the mass by 7 MeV.
  - J/ψ physics
    - * confirmation of $\xi(2230)$ and its new decay modes.
    - * study of $f_0(980), f_2(1270), i/\eta(1440), f_0(1500)$ and $f_j(1710)$.

- D_S physics
  - * leptonic Br and f_{D_S}.
  - * $Br(D_S \to \phi\pi)$.
  - * $Br(D_S \to eX)$.
- ψ' physics
  - * VP suppression.
  - * VT suppression $\omega f_2, \rho a_2, K^{*0}\bar{K}_2^{*0}, \phi f_2'$.
  - * χ_c physics.
- D physics
  - * leptonic decay and f_D.
  - * other decay modes.

• Publication

- English papers, more than 20.
- Chinese papers, more than 20.
- Talks on international confereces and workshops, about 40.
- BES related work, 70 papers.
- More physics publication in last year.

• Training young people
about 25 postdoc, 32 Ph. D, 85 Master students, plus more than 10 Ph. D students from U. S. .

Table 2: BES results on decay branching fractions of the $\chi_{c0,1,2}$ charmonium states

	BES ($\times 10^{-3}$)	PDG ($\times 10^{-3}$)
$B(\chi_{c0} \to \pi^+\pi^-)$	$4.68 \pm 0.26 \pm 0.65$	7.5 ± 2.1
$B(\chi_{c2} \to \pi^+\pi^-)$	$1.49 \pm 0.14 \pm 0.22$	1.9 ± 1.0
$B(\chi_{c0} \to K^+K^-)$	$5.68 \pm 0.35 \pm 0.85$	7.1 ± 2.4
$B(\chi_{c2} \to K^+K^-)$	$0.79 \pm 0.14 \pm 0.13$	1.5 ± 1.1
$B(\chi_{c0} \to p\bar{p})$	$0.159 \pm 0.043 \pm 0.053$	< 0.9
$B(\chi_{c1} \to p\bar{p})$	$0.042 \pm 0.022 \pm 0.028$	0.086 ± 0.012
$B(\chi_{c2} \to p\bar{p})$	$0.058 \pm 0.031 \pm 0.032$	0.10 ± 0.01
$B(\chi_{c0} \to \pi^+\pi^-\pi^+\pi^-)$	$15.4 \pm 0.5 \pm 3.7$	37 ± 7
$B(\chi_{c1} \to \pi^+\pi^-\pi^+\pi^-)$	$4.9 \pm 0.4 \pm 1.2$	16 ± 5
$B(\chi_{c2} \to \pi^+\pi^-\pi^+\pi^-)$	$9.6 \pm 0.5 \pm 2.4$	22 ± 5
$B(\chi_{c0} \to K^0_s K^0_s)$	$1.96 \pm 0.28 \pm 0.52$	-
$B(\chi_{c2} \to K^0_s K^0_s)$	$0.61 \pm 0.17 \pm 0.16$	-
$B(\chi_{c0} \to \pi^+\pi^- K^+K^-)$	$14.7 \pm 0.7 \pm 3.8$	30 ± 7
$B(\chi_{c1} \to \pi^+\pi^- K^+K^-)$	$4.5 \pm 0.4 \pm 1.1$	9 ± 4
$B(\chi_{c2} \to \pi^+\pi^- K^+K^-)$	$7.9 \pm 0.6 \pm 2.1$	19 ± 5
$B(\chi_{c0} \to \pi^+\pi^- p\bar{p})$	$1.57 \pm 0.21 \pm 0.54$	5.0 ± 2.0
$B(\chi_{c1} \to \pi^+\pi^- p\bar{p})$	$0.49 \pm 0.13 \pm 0.17$	1.4 ± 0.9
$B(\chi_{c2} \to \pi^+\pi^- p\bar{p})$	$1.23 \pm 0.20 \pm 0.35$	–
$B(\chi_{c0} \to \Lambda\bar{\Lambda})$	0.22 ± 0.15	–
$B(\chi_{c1} \to \Lambda\bar{\Lambda})$	0.12 ± 0.10	–
$B(\chi_{c2} \to \Lambda\bar{\Lambda})$	0.27 ± 0.13	–
$B(\chi_{c0} \to K^+K^-K^+K^-)$	$2.14 \pm 0.26 \pm 0.40$	–
$B(\chi_{c1} \to K^+K^-K^+K^-)$	$0.42 \pm 0.15 \pm 0.12$	–
$B(\chi_{c2} \to K^+K^-K^+K^-)$	$1.48 \pm 0.26 \pm 0.32$	–
$B(\chi_{c0} \to \phi\phi)$	$0.92 \pm 0.34 \pm -.38$	–
$B(\chi_{c2} \to \phi\phi)$	$2.00 \pm 0.55 \pm 0.61$	–
$B(\chi_{c0} \to K^0_s K^+\pi^- + c.c.)$	< 0.71	–
$B(\chi_{c1} \to K^0_s K^+\pi^- + c.c.)$	$2.46 \pm 0.44 \pm 0.65$	–
$B(\chi_{c2} \to K^0_s K^+\pi^- + c.c.)$	< 1.06	–
$B(\chi_{c0} \to 3(\pi^+\pi^-))$	$11.7 \pm 1.0 \pm 2.3$	15 ± 5
$B(\chi_{c1} \to 3(\pi^+\pi^-))$	$5.8 \pm 0.7 \pm 1.2$	22 ± 8
$B(\chi_{c2} \to 3(\pi^+\pi^-))$	$9.0 \pm 1.0 \pm 2.0$	12 ± 8

✓ Published

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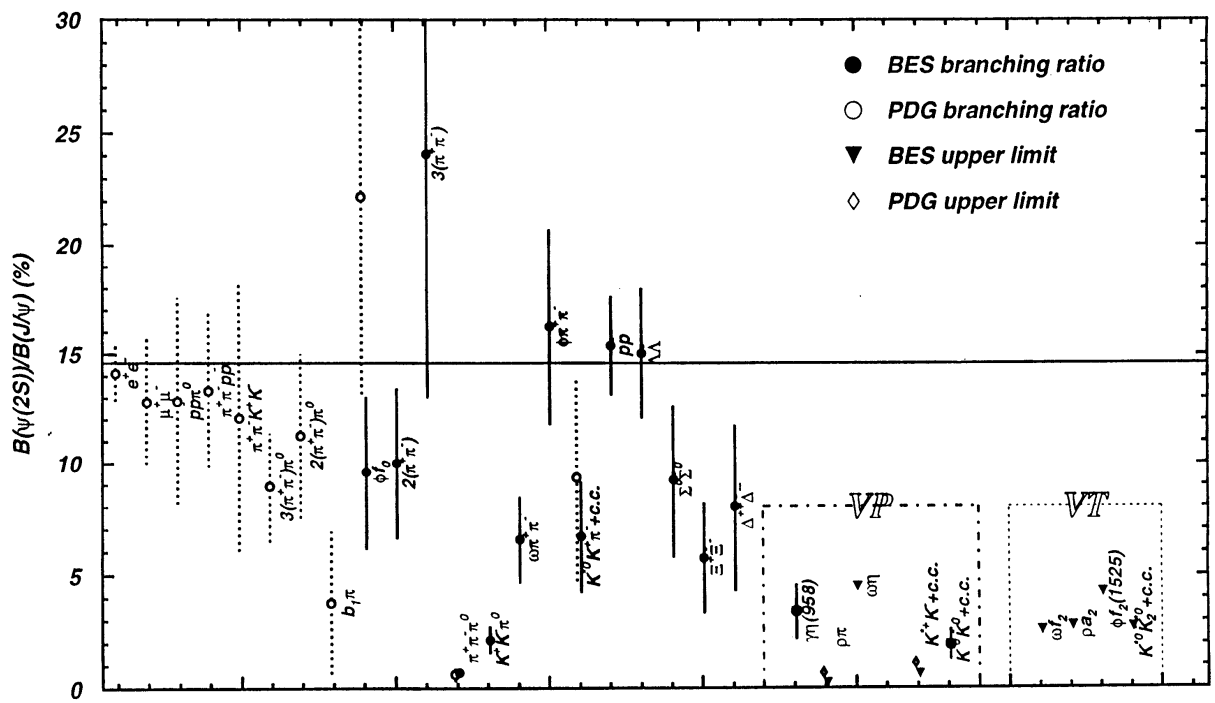
Table 2: ψ_{2S} Branching Ratios for Decays to Hadrons (Preliminary)

Channel	BES ($\times 10^{-4}$)	PDG ($\times 10^{-4}$)	
$\rho\pi$	< 0.28	< 0.83	
$K^+\overline{K}^*(892)^- + c.c.$	< 0.30	< 0.54	
$K^0\overline{K}^*(892)^0 + c.c.$	$0.81 \pm 0.24 \pm 0.16$	–	VP
$\omega\eta$	< 0.33	–	
– $\omega\pi^0$	$0.37 \pm 0.17 \pm 0.06$	–	
$\gamma\eta$	$0.53 \pm 0.31 \pm 0.08$	–	✓
$\gamma\eta'(958)$	$1.4 \pm 0.3 \pm 0.2$	–	✓
ωf_2	< 1.8	–	+
ρa_2	< 2.5	–	+ VT
$K^*(892)^0\overline{K}_2^*(1430)^0 + c.c.$	< 1.4	–	+
$\phi f_2'(1525)$	< 0.47	–	+
$K^*(892)^0\overline{K}^*(892)^0$	$0.45 \pm 0.25 \pm 0.07$	–	
$\phi\phi$	< 0.26	–	
$b_1\pi$	$6.2 \pm 0.9 \pm 0.9$	–	
$K_1(1270)\overline{K}$	$8.4 \pm 1.9 \pm 1.7$	–	AP
$K_1(1400)\overline{K}$	< 2.7	–	
$\pi^+\pi^-K^+K^-$	$6.9 \pm 0.3 \pm 1.2$	16 ± 4.0	
$K^+K^-K^+K^-$	$0.65 \pm 0.10 \pm 0.11$	–	
$\pi^+\pi^-\pi^0$	$1.03 \pm 0.13 \pm 0.16$	0.9 ± 0.5	
$K\overline{K}\pi$	$1.30 \pm 0.20 \pm 0.25$	–	
$K^*(892)^0K^-\pi^+$ c.c.	$4.8 \pm 0.5 \pm 0.7$	–	
ϕK^+K^-	$0.51 \pm 0.13 \pm 0.09$	–	
$\phi\pi^+\pi^-$	$1.3 \pm 0.2 + \pm 0.2$	–	
$\omega\pi^+\pi^-$	$4.7 \pm 0.7 \pm 1.0$	–	
$\rho^0\pi^+\pi^-$	$3.7 \pm 0.6 \pm 0.9$	4.2 ± 1.5	
$\Lambda\overline{\Lambda}$	$2.11 \pm 0.23 \pm 0.26$	< 4.0	
$\Sigma^0\overline{\Sigma}^0$	$0.94 \pm 0.30 \pm 0.38$	–	
$\Xi\overline{\Xi}$	$0.83 \pm 0.28 \pm 0.12$	< 2.0	
$\Delta^{++}\overline{\Delta}^{--}$	$0.89 \pm 0.10 \pm 0.24$	–	

✓ published
\+ submitted


B(ψ(2S))/B(J/ψ) (%)
0
5
10
15
20
25
30
BES branching ratio
PDG branching ratio
BES upper limit
PDG upper limit
e+e-
μ+μ-
ppπ0
π+π-pp
π+π-K+K-
3(π+π-)π0
2(π+π-)π0
b1π
φf0
2(π+π-)
3(π+π-)
π+π-π0
K+K-π0
ωπ+π-
φπ+π-
K0K+π-+c.c.
pp
ΛΛ
Σ0Σ0
Ξ+Ξ-
Δ+Δ-
VP
γη(958)
ρπ
ωη
K*+K-+c.c.
K*0K0+c.c.
VT
ωf2
ρa2
φf2(1525)
K*0K2*0+c.c.

BES 英文文章

PRL 1, J.Z. Bai et al., BES Collab., Phys. Rev. Lett. 69 (1992) 3021-3024,
Measurement of the Mass of the τ Leton.

2, J.Z. Bai et al., BES Collab. High Ener. Phys. Nucl. Phys. 16(1992)385-393,
Experimental Study of $f_2(1270)$ in the J/ψ Hadronic Decay.

3, J.Z. Bai et al., BES Collab., Nucl. Instr. Meth. A334 (1994) 319-334,
The BES Detector.

4, Xiao-Ling Fan., BES Collab., Nuovo Cim. 107A(1994)1825-1828,
The Evidence of ξ (2.2).

5, Xiao-Ling Fan., BES Collab., Nuovo Cim. 107A(1994)1829-1839,
The Recent Status of BES at BEPC.

6, J.Z. Bai et al., BES Collab. High Ener. Phys. Nucl. Phys. 19(1995)125-131,
Experimental Study of $f_0(975)$ in J/ψ Decays.

PL 7, J.Z. Bai et al., BES Collab., Phys. Lett. B355 (1995) 374-380,
A Measurement of J/ψ Decay Widths.

PRD 8, J.Z. Bai et al., BES Collab., Phys. Rev. D52 (1995) 3781-3784,
Direct Measurement of the D_s Branching Fraction to $\phi\ \pi$.

PRL 9, J.Z. Bai et al., BES Collab., Phys. Rev. Lett. 74 (1995) 4599-4602,
Direct Measurement of the Pseudoscalar Decay Constant, f_{D_s}.

PRD 10, J.Z. Bai et al., BES Collab., Phys. Rev. D53 (1996) 20-34,
Measurement of the Mass of the τ Lepton.

PRL 11, J.Z. Bai et al., BES Collab., Phys. Rev. Lett. 76 (1996) 3502-3505,
Studies of ξ (2230) in J/ψ Radiative Decays.

PRD 12, J.Z. Bai et al., BES Collab., Phys. Rev. D54 (1996) 1221-1224,
Search for a Vector Gluball by a Scan of the J/ψ Resonance.

PRL 13, J.Z. Bai et al., BES Collab., Phys. Rev. Lett., 77 (1996) 3959-3962,
Structure Analysis of the $f_J(1710)$ in the Radiative Decay
$J/\psi \to \gamma K^+K^-$.

PRD 14, J.Z. Bai et al., BES Collab., Phys. Rev. D56 (1997)3779-3782,
A Measurement of the Branching Fraction of Ds Inclusive
Semileptonic Decay $D_s^+ \to e + X$.

PRD 15, J.Z. Bai et al., BES Collab., Phys. Rev. D57 (1998)28-32
Direct Measurement of Branching Ratio $D_s^+ \to \varphi X^+$.

PRD 16, J.Z. Bai et al., BES Collab., Phys. Rev. D57 (1998)3854-3859
Search for ψ (2S) Production in e^+e^- Annihilation at 4.03 GeV.

PL 17, J.Z. Bai et al., BES Collab., Phys. Lett. B424 (1998) 213-218
Decays of the J/ψ to $\Lambda\bar{\Lambda}$, $\Lambda\bar{\Lambda}\gamma$ and $\Lambda\bar{\Lambda}\pi^0$ Final States.

PRL 18, J.Z. Bai et al., BES Collab., Phys. Rev. Lett. 81 (1998) 1179-1182
Experimental Study of J/ψ Radiative Decay to $\pi^0\pi^0$.

PL 19, J.Z. Bai et al., BES Collab., Phys. Lett. B427 (1998) 188-194
Evidence of the Leptonic Decay $D^- \to \mu^-\nu_\mu$.

PRL 20, J.Z. Bai et al., BES Collab., Phys. Rev. Lett. 81 (1998) 3091,
Study of the P Wave Charmonium State χ_{cJ} in ψ (2S) Decays.

P.R.L. 6 P.R.D. 8 P.L. 3

PRD 21、J.Z. Bai et al., BES Collab., Phys. Rev. D58 (1998) 092006, Determinaion of J/ψ Leptonic Branching Fraction via ψ(2S) → $\pi^+\pi^-$ J/ψ.

PRD 22、J.Z. Bai et al., BES Collab., Phys. Rev. D58 (1998) 097101, Branching Fraction for ψ(2S) → γη' and γη.

1、BES合作组，高能物理与核物理 16，769(1992) 北京谱仪.
2、BES合作组，同上 16，865(1992) 在北京正负电子对撞机(BEPC)上 τ 质量的实验测量.
3、BES合作组 同上 17， 97(1993) J／ψ强衰变中f_2(1270)性质的实验研究.
4、BES合作组 同上 19， 93(1995) ψ(2S)强衰变中的一个新的反常现象.
5、BES合作组 同上 19， 97(1995) τ轻子质量的精密测量.
6、BES合作组 同上 19，289(1995) J／ψ衰变中f_0(975)的实验研究.
7、BES合作组 同上 19，385(1995) $\sqrt{s}$=4.03GeV下 $\tau^\pm \Rightarrow \pi^+\pi^-\pi^\pm\nu_\tau$衰变的测量.
8、BES合作组 同上 19，577(1995) ψ(2S)的τ轻子对衰变研究.
9、BES合作组 同上 19，673(1995) J／ψ共振参数的测定.
10、BES合作组 同上 20， 97(1996) 由ψ(2S)⇒$\pi^+\pi^-$J／ψ道测量J／ψ轻子道衰变分支比.
11、BES合作组 同上 20，193(1996) Ds衰变常数的测量.
12、BES合作组 同上 20，481(1996) ψ(2S)⇒ρπ及ψ(2S)⇒$K\overline{K^*}$衰变的研究.
13、BES合作组 同上 20，961(1996) 关于ι/η(1440)的结构分析.
14、BES合作组 同上 20，1057(1996) 粲夸克偶素P波态χ_{c0}宽度测量.
15、BES合作组 同上 21， 89(1997) ψ(2s)强衰变中矢量－张量介子末态的反常压制.
16、BES合作组 同上 21， 97(1997) 大角度巴巴散射和双产生的研究与亮度测量.
17、BES合作组 同上 21，193(1997) $\tau^\pm \to \pi^\pm + n\pi^0 + \nu_\tau (n=0,1,2)$ 衰变分支比测量.
18、BES合作组 同上 21，385(1997) 北京谱仪上$J/\psi \to \gamma\pi^0, \gamma\eta, \gamma\eta' \to 3\gamma$衰变道的分支比测量.
19、BES合作组 同上 21，961(1997) J/ψ能区强子单举产生的实验研究.
20、BES合作组 同上 22， 97(1998) J/ψ衰变中的$\Lambda\overline{\Lambda}$，$\Lambda\overline{\Lambda}\gamma$和$\Lambda\overline{\Lambda}\pi^0$产生
21、BES合作组 同上 22，961(1998) 衰变中米歇尔(Michel)参数的测量.

2 CURRENT STATUS OF BEPC/BES

BEPC/BES have improved the performances after the upgrade since 1993.

BEPC

- The luminosity is roughly doubled, by improving the stability of the machine and reducing BES event readout time, the data collecting rate is more than doubled.

  At J/ψ, 200 k hadronic events can be collected per day.

- For SR run, at 2.2 GeV, 100 mA and τ = 20 - 30 hours.

BES

- BES performances have improved in general, especially in the TOF system and the DAQ system.

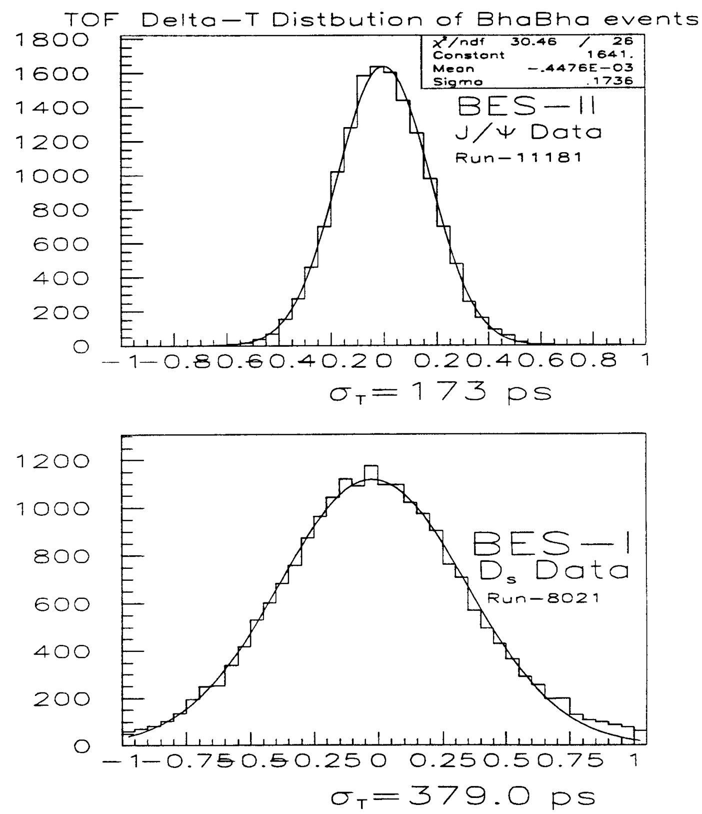
- By combining MDC and VC (MARK III straw tubes), the mom. resolution can be improved by about 20%.

- Because the feedthrough problems, MDCII is modified to run in splitting HV mode. Cautions are made to keep the endpaltes at low

Table 3. The BES-II Detector Performance (Run11001-11970) Comparison with That of BES-I(The D_s data in 1994)

Detector	Performance BES-II	BES-I
MDC:		
$Wire_{Eff}$	$\simeq$ 96.2 %.	96 % (L8)
Spatial-Res.σ_{xy}	$\simeq$ 190-220 μm	$\simeq$ 200 to 250 μm
Mom-Reso.	$\delta p/p \simeq 1.78\%\sqrt{(1+p^2)}$	$\delta p/p = 1.76\%\sqrt{(1+p^2)}$
Z Vert. Posit.	$\simeq$ 0.62 cm	$\simeq$ 0.6 cm
Z-Beam Spread	$\simeq$ 3.18 cm	4-5cm
dE/dx: σ_{tru}	$\simeq$ 8.4 %.	$\simeq$ 7.9 %
BTOF:		
Time-Rec.σ_T	$\simeq$ 172 ps.	$\simeq$ 375 ps.
Atten. Leng.	3.5-5.5 m	1-1.2 m
BSC:		
ERG-Res.	$\delta E/\sqrt{E} \simeq 20.3\%$.	$\delta E/\sqrt{E} = 23.8\%$.
Err-Z-Posit.	$\simeq$ 2.3 cm	4.5 cm
ESC:		
ERG-Res.	$\delta E/\sqrt{E} \simeq 22.1\%$.	$\delta E/\sqrt{E} = 24.4\%$.
Vert. Chamber:		
Spatial-Res. σ_{xy}	$\simeq$ 99.4μm	not worke
Trk_{Eff}	$\simeq$ 97 %	not worke
Muon Counter		
$Mu\text{-}Trk_{Eff}$	AS BES-I	95 %
Spatial-Res.σ_z	AS BES-I	5.5cm
DAQ	$<$ 10ms	$>$ 20ms

The Comparison of TOF Time Resolution of the BES-I and BES-II



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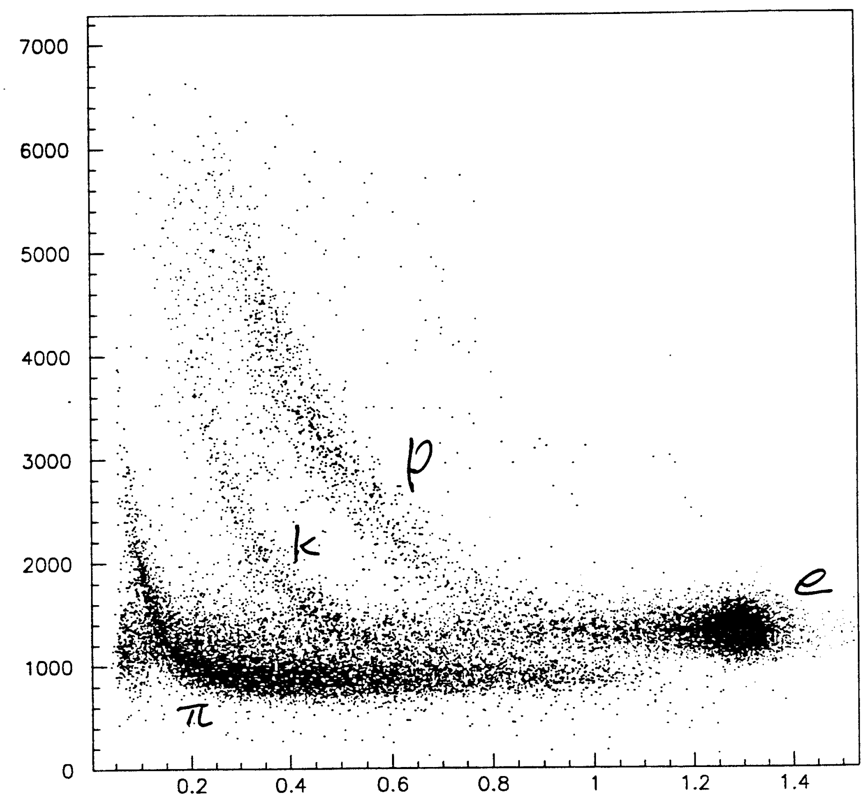
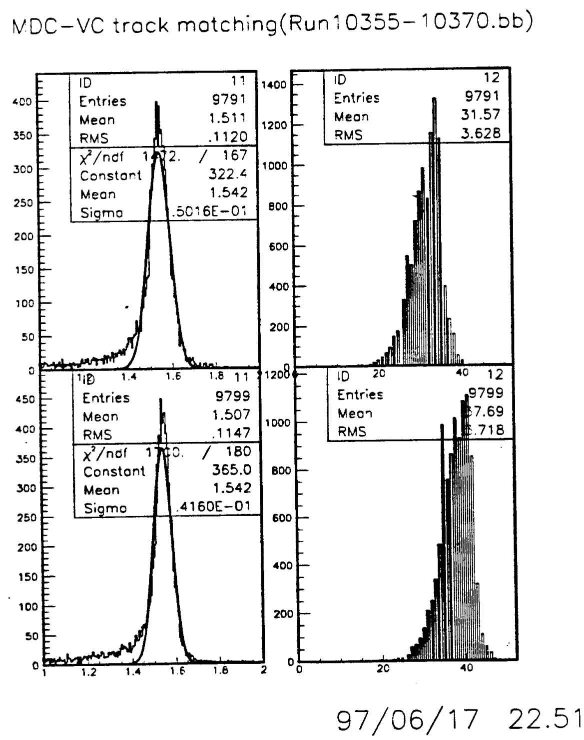


PHMP11 VS P

Table 4. The Comparison of MDC Tracking Before and After MDC-VC Track Matching

Parameters	MDC Only	MDC and VC
$\Delta P(e^+e^-)$	$\simeq$ 51 MeV	$\simeq$ 41 MeV
Vert. Z Erro	$\simeq$6.6 mm	$\simeq$ 4.2 mm



room temperature. Noise level is similiar to MDCI.

- MDCIII is under construction.

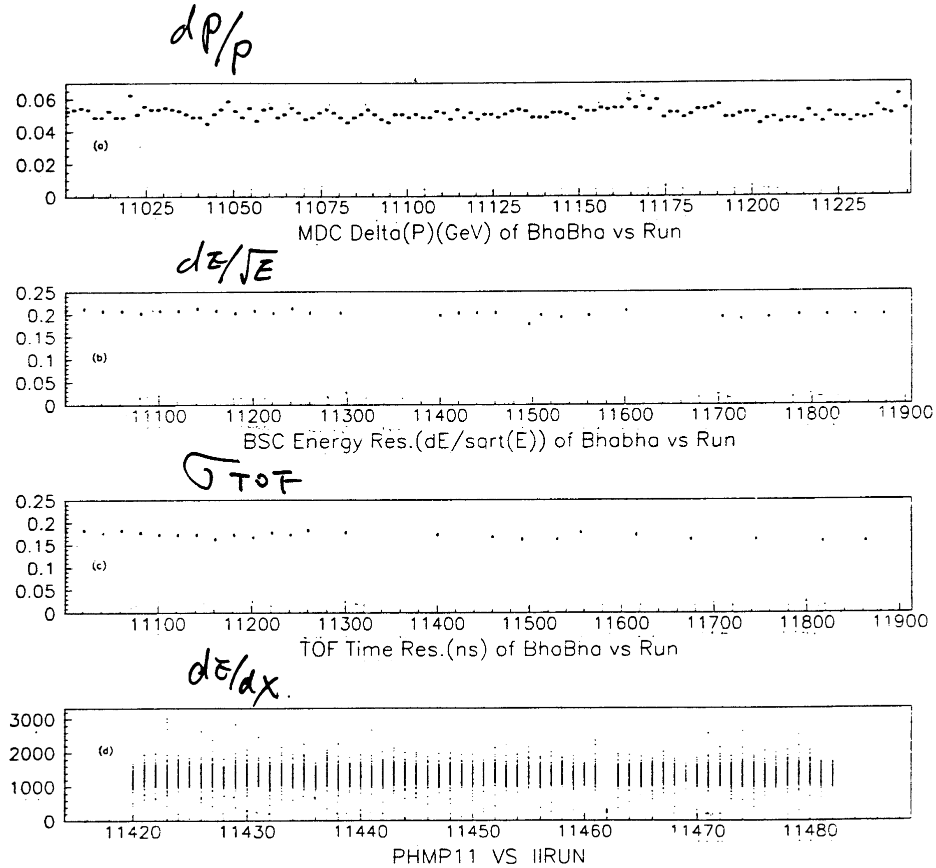
From the recent data taken at J/ψ and for the R measurement, The data quality is quite good and stable.

New MDC

As MDCII, it is a collaboration between IHEP and U. Hawaii and Colorado S. U..

Endplates and outer cylinder	Hawaii
Pre-amplifier boards	Hawaii
Feedthroughs and tubes	Colorado State
Inner cylinder	IHEP
Mechanical Assembling	IHEP
Wire string	IHEP
HV system	IHEP

It is planned to install MDCIII in the summer of 2000.


dP/p
0.06
0.04
0.02
0
(a)
11025 11050 11075 11100 11125 11150 11175 11200 11225
MDC Delta(P)(GeV) of BhaBha vs Run
dE/√E
0.25
0.2
0.15
0.1
0.05
0
(b)
11100 11200 11300 11400 11500 11600 11700 11800 11900
BSC Energy Res.(dE/sqrt(E)) of Bhabha vs Run
σ TOF
0.25
0.2
0.15
0.1
0.05
0
(c)
11100 11200 11300 11400 11500 11600 11700 11800 11900
TOF Time Res.(ns) of BhaBha vs Run
dE/dx
3000
2000
1000
0
(d)
11420 11430 11440 11450 11460 11470 11480
PHMP11 VS IIRUN

3 DATA TAKING PLAN FOR THE NEAR FUTURE

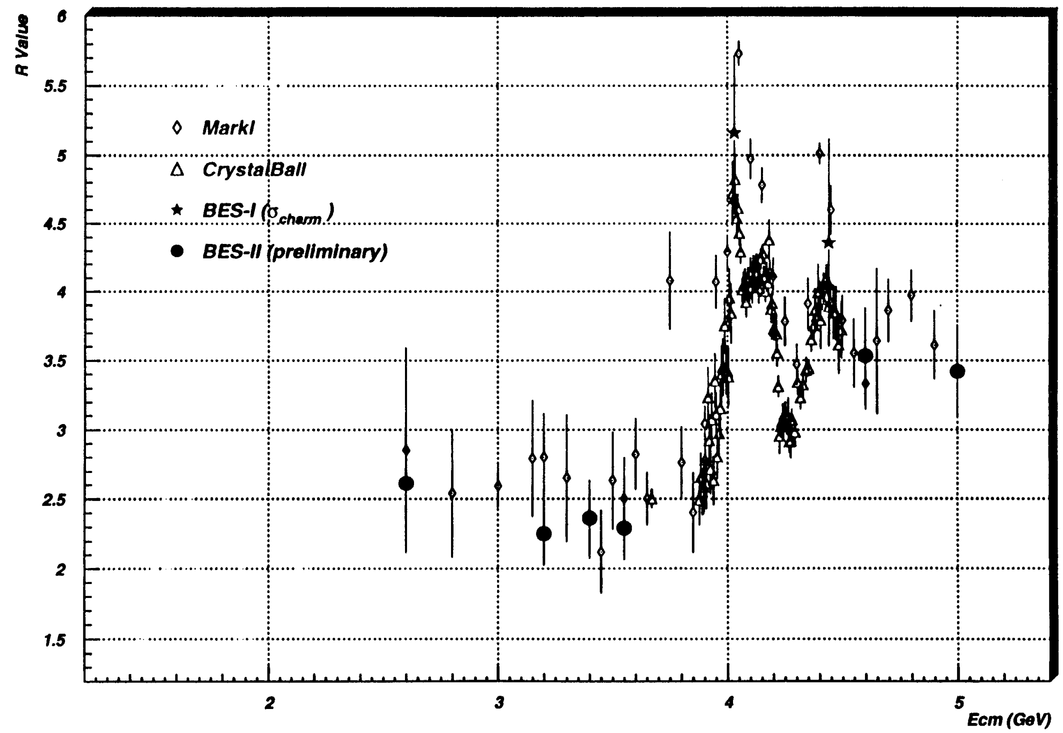
- Continue to take R measurement, complete data taking before the summer.
- Take a large J/ψ data sample.
- Select more energy points to take data, ψ', ψ'', or 4.03 GeV for D_S.

	Energy (GeV)	Data now	Planned	time
J/ψ	3.1	9 M	35 M	10 Mon.
ψ'	3.69	3.7 M	15 M	8 Mon.
ψ''	3.77		40 pb^{-1}	10 Mon.
D_S	4.03	22.3 pb^{-1}	45 pb^{-1}	8 Mon.

According to the above estimation, the total time needed is 36 months, right now each year 5 months are allocated for BES data taking. So more than 7 years are needed to take all the above data. The time needed for each data sample may be shorten. After J/ψ data run, the plan will be adjusted.

4 THE PHYSICS TOPICS AND THE MAIN GOALS

- Besides taking new data, various physics topics are under study using available data sample.
- R measurement
- Main Physics Goals
  1. <u>J/ψ physics</u>
     With at least 35 M events.
     - Measure the spin-parity of $\xi(2230)$.
     - Make detailed study of $non - q\bar{q}$ states, $f_0(980), f_2(1270), i/\eta(1440), f_0(1500)$ and $f_j(1710)$.
     - Systematic study of J/ψ decays.
  2. <u>ψ' physics</u>
     - Already improved the results of quite a number of decay modes and find new modes, and improved the VP suppression, find VT suppression. A factor of 4 more data can much improve the results.
     - Search for η_c', $^1P_1$.
     - study of χ states
     - Search for $nob - q\bar{q}$ states.


R Value
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
MarkI
CrystalBall
BES-I (σ_{charm})
BES-II (preliminary)
2
3
4
5
Ecm (GeV)

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♦ R values and Systematical Errors

$$R \equiv \frac{\sigma^0_{hadron}}{\sigma^0_{\mu^+\mu^-}} = \frac{1}{\sigma^0_{\mu^+\mu^-} \cdot \bar{\varepsilon}_{had} \cdot \varepsilon_{trg} \cdot (1+\delta)} \cdot \frac{N^{obs}_{had} - N^{total}_{bg}}{L}$$

Estimation of the uncertainty to the value of R measured at 2.6 GeV **(preliminary!)**

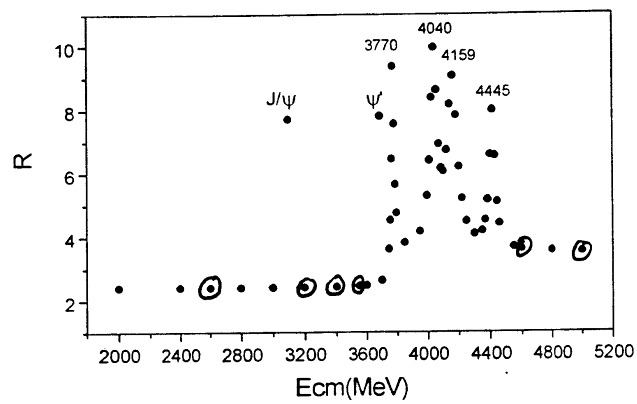
Source	Errors to R(%)
Hadronic event selection	4.0 ↘
Background subtraction	2.5
Hadron efficiency	5.5 ↘
Luminosity	4.0 2.7
Radiative correction	3.5 1.5
Trigger efficiency	0.5
Systematic quadrature sum	9.0 7.0

Estimated uncertainty of α for R values below 5 GeV with different precision. The last column are the reduced uncertainties in percentage as compared to the present uncertainty of α listed in the first row(659 ppm)

E_{cm} (GeV)	ΔR/R (%)	E_{cm} (GeV)	ΔR/R (%)	1/α	Uncer. (ppm)	%
1.0 - 2.5	15	2.5 - 5.0	15	128.89±0.085	659	
	15		10	128.89±0.073	566	14
1.0 - 3.0	15	3.0 - 5.0	10	128.89±0.079	613	7.0
1.0 - 3.0	15	3.0 - 5.0	5	128.89±0.074	574	13
1.0 - 2.0	15	2.0 - 5.0	10	128.89±0.071	551	16
	15		5	128.89±0.056	434	34
	10		5	128.89±0.051	396	40

Future Plan

- 1st continuum 2.0, 2.4, 2.8, 3.0, 4.6, 4.8, 5.0
- 2nd resonance 3.7 - 4.5



Energy points have been and to be scanned. R values at the resonances are arbitrary.

BES Analysis Topics

Note: Analyses using J/ψ data sample not included.

1. ***Ds* Physics**

- $B(Ds \to \mu\upsilon, \tau\upsilon)$ using additional tag channels [4]
- $B(Ds \to K^{\pm}X)$ [5]

2. ***D* Physics**

- Inclusive Charm Cross Section at 4.03GeV [3]
- $B(D \to \phi X)$ [3]
- D^{*+} Branching Fractions [5]
- $B(D \to \mu X)$ (semileptonic) [4]
- $B(D \to eX)$ and electron momentum spectrum [4]
- $B(D \to Ke\upsilon)$ and $B(D \to \pi e\upsilon)$ [5]
- $B(D \to K^{*0}X)$ [3]
- $B(D^0 \to K^0\pi^+\pi^-, K^0K^+K^-, K^0\phi)$ [5]
- $B(D^0 \to \pi^+\pi^-, K^+K^-)$, $B(D^+ \to \phi\pi^+)$ [5]

3. **ψ' Physics**

- $B(\psi' \to$ Axialvector Pseudoscalar) [4]
- $B(\psi' \to$ Baryons) [4]
- $\psi' \to \gamma\pi^+\pi^-, \gamma KK)$ [4]
- $B(\psi' \to 5\gamma's)$ [5]
- $B(\psi' \to$ Vector Pseudoscalar) [4]
- $\psi' \to \pi^+\pi^-\psi$ [5]

- $B(\psi' \to \tau^+\tau^-)$ [4]
- $B(\psi' \to \pi\pi J/\psi)$ [5]
- $\psi' \to \gamma\gamma J/\psi$, branching fractions and helicity amplitudes [5]
- ψ' resonance parameters [5]

4. Charmonium $\chi_{co}, \chi_{c1}, \chi_{c2}$ Physics

- Study of Hadronic Decays of χ_{cJ} States [4]

5. J/ψ Physics with ψ' Sample

- $\psi' \to \pi^+\pi^-\rho\pi$ [5]
- $B(J/\psi \to 3\gamma)$ [5]

6. τ Physics

- CP Violation in τ Decays [5]
- Mass Limit of τ Neutrino [5]

7. R Measurement

- R Measurement [3]
- Determination of the proton form factors [5]
- Multihadron final states with R data [5]

References

[1] Accepted by international journal.
[2] Submitted to international journal.
[3] Submitted to ICHEP 98.
[4] Analysis finished with BES internal referees.
[5] Analyzing or planned to Analyze.

J/ψ Physics in Process

- J^{PC} analysis of $\xi(2230)$ in $J/\psi \to \gamma\pi^+\pi^-$, $\gamma K\overline{K}$, ...in process;
- Search for other decay modes, e.g. $\xi(2230) \to \eta\eta'$, $\eta'\eta'$ and VV
- J^{PC} study of $f_J(1710)$ in $J/\psi \to \omega K\overline{K}$, $\phi K\overline{K}$, in process;
- J^{PC} analysis of $f_0(1500)$ in $J/\psi \to \gamma 4\pi$, $\gamma\pi\pi$, $\gamma K\overline{K}$, in process;
- Study of 0^{-+} glueball candidate in $J/\psi \to \gamma\eta\pi\pi$, $\gamma K\overline{K}\pi$ and $\gamma\gamma V$.
- PWA Analysis of BES Date on $J/\psi \to \gamma K^+K^-\pi^+\pi^-$;
- Study meson-nucleon interactions in $J/\psi \to p\bar{p}\pi^0$, $p\bar{p}\eta$..., in process
- Study N Resonance(I=$\frac{1}{2}$) in in J/ψ baryonic decays
  $N^*(1440)$, $N^*(1520)$, $N^*(1535)$....

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3. D_S Physics

With 45 pb^{-1} more data and the improved detector performances, the expected results are:

$D_S \rightarrow l\nu\bar{\nu}$	30 %
f_{D_S}	15 %
$D_S \rightarrow \phi\pi$	22 %
$D_S \rightarrow eX$	10-20 %

4. D Physics

With 40 pb^{-1} data sample and $\sigma_{D^0} = 5.8nb, \sigma_{D^+} = 4.2nb$.

– Absolute decay Br

	BES Expected	MARK III
$D^0 \rightarrow K^-\pi^+$	4.5%	9.5%
$D^+ \rightarrow K^-\pi^+\pi^+$	7.0%	14.3%

– Semileptonic decays

	BES Expected	MARK III
$D^+ \rightarrow e^+X$	5.0%	11%
$D^0 \rightarrow e^+X$	6.4%	14%

– Purely leptonic decay, expect 5-7 events

– Study the mechanism of D decays

5. τ lepton and charm baryons Physics
   – M_{ν_τ} measurement
   – Michel parameters
   – Study of charm baryons

Now BES Colloaboration

IHEP
Chinese Universities
U. S. Groups
Korea Group

For some special topics, there are collaborating partner from England and CERN.

5 POSSIBLE LONG TERM PLAN

BES will continue to take data for a few years. But considering that two B-Factories will have data soon and CESR has increased the luminosity much. BEPC and BES have to do something, in order to be competitive in a long run.

Possible long term direction can be as follows, (to certain extent, it is my personal opinion).

- $\tau - cahrm$ factory.

  It is quite nature for IHEP to build a world-class facility such as τcF. The feasibility study for BTCF was concluded in Nov. , 1996. But after that, application to the Chinese Government for building BTCF was not successful, the main concerns are,

  - The physics achievable at τcF may not be the first class in the world. Some of the important physics topics mentioned in the study may not be realized.
  - The cost of BTCF is quite significant, considering China is still a developing country. Also the foreign participation in the project is an important factor financially.

– There are some technical uncertainties in building such a machine. The team in China, both in the field of accelerator and detector, may not be able to meet the requirements needed to build such a facility.

But the key is still the first question, can τcF produce world-class results? If the answer is yes, then the indication is that the Chinese Government may support the project, and the question about the technical uncertainties may be already answered or will be answered soon, after B-Factories and ϕ-Factory get into operation. The question about the team quality now in China can be solved, by training the youth people at BEPC/BES, sending some of them abroad, by recruiting experts with Chinese origin in the other countries, by collaborating with other countries in designing and constructing the machine and the detector.

- Continue to upgrade the BEPC/BES to further increase the luminosity by an order of magnitude, meanwhile to upgrade BES detector accordingly, the main physics will be to concentrate on J/ψ and ψ' to study the hadron spectroscopy, including the search of glueball and other $non - q\bar{q}$ states.

- China may concentrate its efforts on some non-accelerator facility for HEP related researches.

- To Focus on international collaboration

  As HEP facilities become larger and more expensive, international collaboration is a way to go. If this is the case, then we have to advise our government to invest sunstantially in such international collobaration, so China can not only send physicists to participate such collaboration, but also contribute in building the detectors even in the construction of the machine, to the level matched to Chinese economy.