A Distributed Clustered Linux PCs System & Study of its Ability to Reconstruct BES-II Data [a]

(BES Annual Meeting 2000)

GANG RONG KANGLIN HE
SHAOQIANG ZHANG DAHUA ZHANG
JINZHI BAI SHENGTIAN XUE

1. Introduction
2. Feasibility Study & Comparison with HP/UNIX
3. Distributed PC/Linux Cluster & Application
4. Ability to Reconstruct the BES-II Data
5. Study of BES-II J/ψ Data Reconstruction
6. Summary

[a] Manny thanks to peolple from data production group of the First Department, Mrs J. Su and Dr. G.X Sun from computer center for their kindly help. We would like to thank to Dr. Liaoyuan Dong for his kindly help for installation of SCSI disk.

INTRODUCTION

- **Why need PCs?**
  - Data Offline Processing & Physics Analysis needs more CPU, larger DISK ...
  - PCs/Linux – PC is cheaper and Linux is free software. Easier to get more CPU and Larger Disk.
  - CERNLIBs – have been ported to Linux already. Make to use PC for physics analysis and data off-line processing possible.
- **PC/Linux Cluster–A Distributed PCs System**
  - A prototype: To try to set up a PCs Cluster based on Linux. To study
    - Stability ...
    - Feasibility ...
- **Is it possible to switch from HP/UNIX to PC/Linux?**

  If the result is OK, ⇒ maybe possible to switch the data off-line reconstruction and physics analysis from HP/UNIX to PC/Linux for BES/BES-II ⇒ Save a lot of Money & a lot of time !

Feasibility Study & Comparison

- **Why need do Feasibility Study ?**
  - Historically PCs never be used in the data offline processing & physics analysis. No software (CERNLIB ...) was avalaible to PCs in high energy physics world several years ago.

- The data offline processing & physics analysis have been mostly based on Large Machines such as IBM, VAX, HP... instead of Pcs.

- Hardware: Different CPU processors in PCs and HP Workstations.

- Software: Different operation system, different compiler, different CERNLIB and some other support software.

- Some people doubt that the PCs can be used in data offline processing and physics analysis in high energy physics experiments since they are so cheaper.

- are physics results the same from PCs and HP Machins?

- Are PCs stable in long time scal running?

• Comparison of Results from PC & HP

To answer these questions, one wants to know the consistent of the data reconstructed and results of physics analysis from different platforms, and so on ...

We studied the data off-line reconstruction and physics analysis on the HP and PCs platforms.

Software Environment

• BES/BES-II Code

  - V8.6 code of HP/UNIX version is available in the BES Lib.

  - V8.6 code was converted from HP/UNIX version to PC/Linux Version.

  - V101 and V102 code

• Complier

  - C, C++ and FORTRAN were optimized.

  - Others ...

• PC/Linux Platform

  - Red-hat 5.0, 6.0, 6.1 and 6.2 Linux were used as operation system for the PCs Cluster

  - CERNLIB in Linux Version was used

Comparison of Data Off-line Reconstruction on HP/UNIX and PC/Linux

• The comparison has been made with BES ψ' data reconstructed on the two platforms with the V8.6 code. (See BES99 for detail)

• The comparison has been made with BES-II ψ data reconstructed on the two platforms with the V101 and V102 code. (See the talk " Distributed Network Clustered Linux PCs System and Study of its Ability", BES Meeting in March 2000, for detail.)

• Conclusion

For more than 99%(96%) charged tracks, the reconstructed track kinematic variables are identical within 3(4) digits after points. These would give the same physics results in using the same data set but reconstructed on the two different platforms.

Comparison of D/Ds Physics Analysis on HP/UNIX and PC/Linux

• D/Ds single tags (4.03 GeV Data)

Data reconstructed on HP/UX. Analysis performed on the HP/UX and PC/Linux.

• D single tags

- *Ds* Analysis

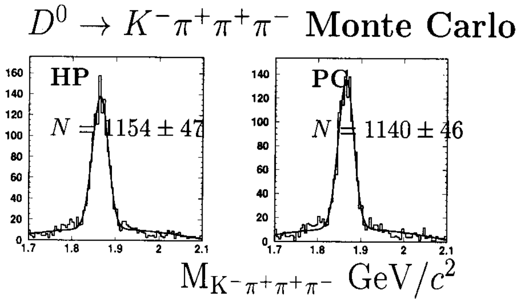
  Using Kinematic fitting method to search for the Ds decay candidates. Analysis results can be used to check the CERNLIB.

  The number of events observed on the two platforms are the same.

  For more detail please see BES99.

- D single tags (Monte Carlo)

  Data reconstructed and analysis performed on both HP/UX and PC/Linux.



  Monte Carlo efficiency would be the same within 0.6% on the two platforms.

- CONCLUSION:

  The difference of 0.6% in the Monte Carlo efficiencies calculated based on the two Monte Carlo data set generated and reconstructed on the Linux and UNIX platforms means that the physics results would be the same in using the BES data reconstructed on the two platforms. At present, the systematic uncertainty is much larger than 0.6% in the BES data. The 0.6% difference does not affect the physics result for BES physics, let along the random numbers of events generated are not the same in the two platforms.

CONFIGRATION OF THE CLUSTER AND ITS APPLICATION

- Hardware

  - The Kernel Clustered Linux PCs System

    A PIII-500 with 128M RAM and IDE/SCSI Disks has been set to be as a main server for the cluster.

    A desk printer, Tape drivers ...

    Two PII-400s with 128M RAM and IDE disks have been set to be the slaves.

    The 3 PCs are connected together though a Soho Basic HUB208b (10Mb/s).

    The three PCs connected each other together in the Kernel System form a small PC FARM.

  - The Shell Clustered Linux PCs System

    One PII-400 and one PIII-500 in Building 3 and one Celero-300 in Building No.5 have been set up to be 3 other slaves (128M RAM and IDE disks).

    The 6 PCs are connected through the IHEP Key Network (100MB/s) to form the Distributed Network Clustered Linux PCs System.

- Software

  - Operating System

    The Red-hat 6.1 Linux and Window 98.

    The main server only run Red-hat 6.1 Linux.

  - Data, File and Job Manergement

    * NIS (Network Information Service) – YP (Yellow Page)
      The NIS has been set for the PCs' communication each other within the Kernel Network Clustered PCs System.

    * NFS (Network File System)
      Data, Codes and Libaray are shared by the all PCs within the Distributed Network Clustered PCs System by using the NFS.

    * NQS (Network Queuing System)
      All Jobs (Drunk, Sober and others) can be manerged by the NQS.

- **Application in Physics Analysis**

  All D physics analysis have been performed within the Linux PCs cluster since November1998. Some Ds and J/ψ physics analysis are performed within the cluster as well.

  - $D^{0(+)} \to \phi X, K^{*0}X, \mu^+X...$

    The paper on the decay $D^{0(+)} \to \phi X$ will be published by PRD (Phys. Rev. D62 52001(2000)).

  - $D^0 \to \overline{K^0}\pi^+\pi^-, \overline{K^0}K^+K^-, ...$

    The paper will be submitted to PLB or PRD soon.

  - $D_S^+ \to K^{0*}X, ...$

    Talk given at Had'99, Beijing 24-28 August, 1999, published in Nuclear Physics, A675, 2000

  - $J/\psi \to D/\overline{D}X, D_S^+/D_S^-X...$ **(BES/BES-II Experiments)**
    Paper writing is in progress.

  - **Monte Carlo study of Charmed Meson Decays at $\sqrt{s} = 3.77$ GeV**

    Purpose

    * **To understand of background in measurement of f_D and to predict the precision of measurement of the absolute branching fractions.**
    * **to develop the physics analysis software for studies of the D physics.**

    Monte Carlo Data

    * **With the full simulation of BES-II detector, we generated 40 pb^{-1} $D\overline{D}$ data with a ratio of 0.42 : 0.58, which is the charged D to the neutral D mesons produced at 3.77 GeV. D mesons automatically decay to all possible final states according to the decay branching fractions quoted from PDG94.**
    * **The event generation, detector simulation and final states reconstruction are performed with "A Distributed Network Linux PCs System" (see Hardware Configuration Figure)**

    Analysis Results

    * **Absolute Branching Fractions**

      $$B(D^0 \to K^-\pi^+) = (3.62 \pm 0.15)\%,$$

      $$B(D^0 \to K^-\pi^-\pi^+\pi^+) = (8.19 \pm 0.35)\%,$$

      $$B(D^+ \to K^-\pi^+\pi^+) = (7.33 \pm 0.54)\%,$$

      where the errors are statistical only.

    * **Pure Leptonic Decay**
      We observed $5 \pm \sqrt{5}$ purly leptonic decay events for $D^+ \to \mu^+\nu$. The precision of the measured f_D is expected to be about 24% including systematic error.

    * **Semileptonic Decay**
      About 334 ± 20 $D^+ \to K^-e^+\nu$ events are observed. 37 ± 7 $D^+ \to \pi^-e^+\nu$ events are observed. $\Rightarrow$ give measurements of branching fraction with error about 6.2% and 20.0%, respectively.

    * **...**

ABILITY TO RECONSTRUCT THE BES-II DATA

- **CPU costs**

  It costs 23.6 and 28.7 minutes for PIII-500 and PII-400 to fully reconstruct one run BES-II data, respectively.

- **CPU idel**

  The average idel CPU of the PCs located in Building 3 is about 20%, while the average idel CPU of the slave PCs in the KNCPCS is about 5%. The main server has average idel CPU of about 0.3%.

- **Average load**

  In the case of running one BES-II data offline reconstruction job at each of the PCs, the average load is about 1.1 for the slave PCs, and 2.2 for the main server PC.

- MEM used
  MEM 128M, 125M used, 3M Free.

- Ability to deal with the BES-II data
  In the case of 24 hours CPU load, considering the system will read/write data from/onto tape.
  - The Kernel Network Clustered PCs System
    162 runs BES-II data can be fully reconstructed by Kernel Network Clustered PCs System per day.

  - The Shell Network Clustered PCs System
    110 runs BES-II data can be fully reconstructed by the Shell Network Clustered PCs System per day.

  A total of 272 runs data can be reconstructed per day.

- How manny days needed to reconstruct all data take within a year (about 3150 runs estimated) ?
  It takes about 12 days to fully reconstruct 3150 runs BES-II data with the "Distributed Network Clustered Linux PCs System, or about 20 days with the Kernel Network Clustered Linux PCs System if everything is fine !

- What percentage of the IHEP Key Network Ability is costed by the Distributed Cluster?

  One run raw data is about 60 Mb in size. The averaged real time to reconstruct one run data is about 30 minutes on the PCs in the Shell Network Cluster. These mean that one BES-II data offline reconstruction job running in the Shell Network Cluster PCs needs to transfer data from the Server at 0.033Mb per second. This costs only about 3/(10000*0.1) of the IHEP Key Network full ability (100Mb/s) or 3/(1000*0.1) of the Local Aera Network full ability (10Mb/s) for tranfering data.

  On the schedule of the Network Upgrade, the IHEP Key Network full ability to transfer data will be upgraded up to 1000Mb/s and the Local Aera Network full ability will be upgraded to 100Mb/s. So the percentage of the IHEP Key Network full Ability costed by one BES-II data reconstruction job running on the PC in the Distributed Cluster will be only tiny of the full Network ability.

- How about the data reconstruction with HP/UX Cluster?
  - HP/J5000 (hpws9)
    It costs about 36.3 minutes for one CPU to fully reconstruct one run BES-II data. Converting the CPU time into that for two CPUs working together, it costs 18.2 minute to fully reaconstruct one run BES-II data.

    79 runs BES-II data can be fully reconstructed for 24 hours.

  - HP/J2240(hpws8)
    It costs about 58.3 minutes for one CPU to fully reconstruct one run BES-II data. Converting the CPU time into that for two CPUs working together, it costs 29.2 minute to fully reaconstruct one run BES-II data.

    45 runs BES-II data can be fully reconstructed for 24 hours.

  - HP735/125 (hpws0 or hpws1)
    It costs about 101 minutes to fully reconstruct one run BES-II data.

    14 runs BES-II data can be fully reconstructed for 24 hours.

  A total of 138 runs data can be reconstructed per day.
  It takes about 23 days to fully reconstruct 3150 runs BES-II data with the HP/UX Cluster.

RECONSTRUCTION OF BES-II J/ψ DATA

Table 1: CPU time costed to fully reconstruct BES-II data.

CPU Type	30000 Events to be reconstructed [minute]	CPU costed per event [minute]	Note
HP/J5000 (hpws9)	$36.3/2 = 18.2$	0.0364	2 CPUs work together
HP/J2240 (hpws8)	$58.3/2 = 29.2$	0.0584	2 CPUs work together
HP735/125 (hpws0,1)	101	0.202	
PIII500	23.6	0.0472	
PII400	28.7	0.0570	
Celero-300	39.5	0.079	

- **Software**
  - **In March 2000, BES-II V102 code was converted from HP/UNIX into PC/Linux and run it there within the PCs Cluster.**
  - **BES-II J/ψ data were reconstructed with the PCs. Some comparison of the reconstructed data on HP/UNIX and PC/Linux was made. Results show that the physics results are the same with the data reconstructed on both HP/UNIX & PC/Linux platform (based on 400 run data).**
- **Data offline reconstruction**
  - **During time period from May 1-22,** All BES-II J/ψ Data **taken during 1999-2000 (**3545 RUN DATA **from run1361-16835) were reconstructed using 3 PCs of the Kernel PC Cluster.**

    $\Rightarrow$ 173 RUNs/Day (PIII-500 + 2×PII-400)

    Compaire to

    $\Rightarrow$ 152 RUNs/Day (HP/J5000 + HP/J2240 + 2×HP735/125)

    $\Rightarrow$ 72 RUNs/Day (PIII-500)

    $\Rightarrow$ 80 RUNs/Day (HP/J5000)

  - **The reconstructed data were used for study of Momentum Correction and so on ....**
  - **The all reconstructed data are available for physics analysis.**
  - **We use this reconstructed data to study the decays $J/\psi \to D/\overline{D}$ X and $J/\psi \to D_S^{\pm}$ X**

    since we have to estimate the detection efficencies with Monte Carlo data for calculation of the branching fractions.

SUMMARY

PC/Linux can be used in data offline processing & physics analysis very well.

A Distributed Network Clustered PCs System has been set up.

A parallel jobs processing environment NQS was set up for the BES-II data offline processing and physics analysis.

Within the Distributed Network Clustered PCs System, 272 runs BES-II data taken at 3.097 GeV can be reconstructed per day for 24 hours loaded CPUs.

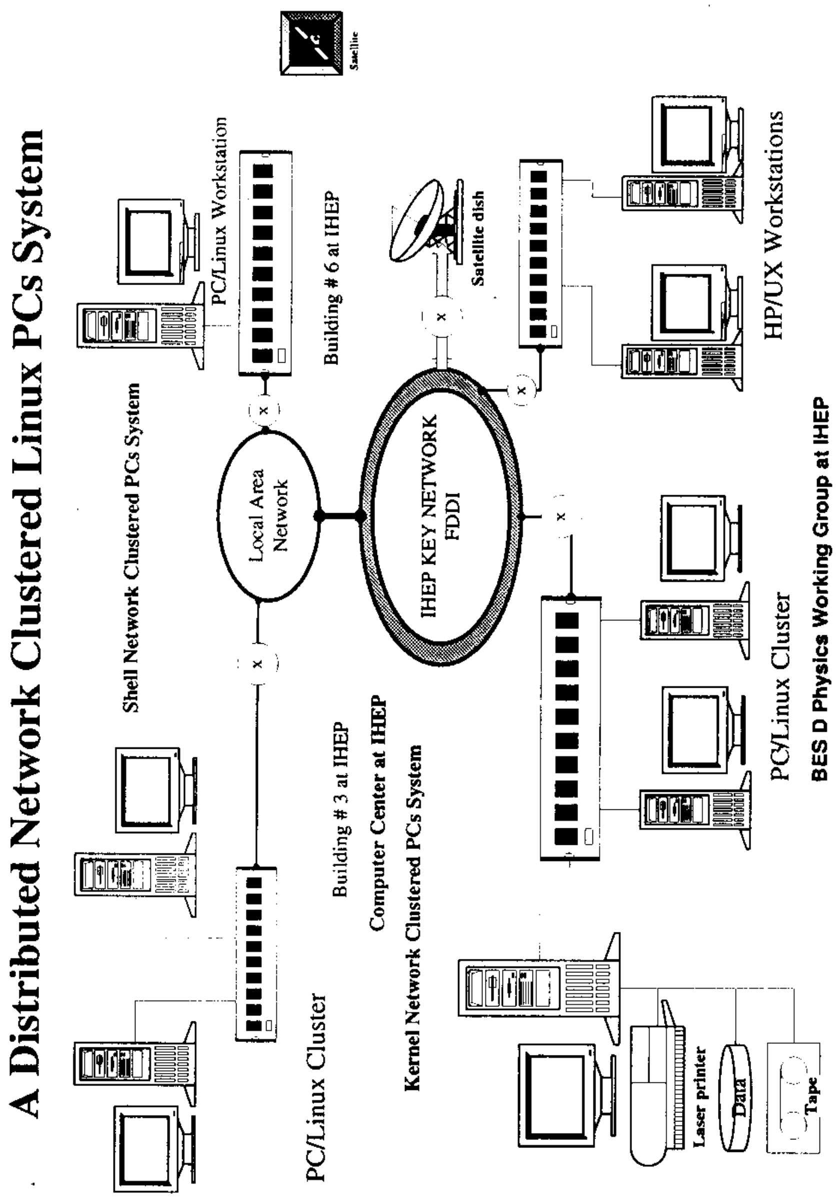
If we want to finish reconstructing 3150 runs BES-II data (taken per year) within a weekend (2.5 days), we need to have a cluster which consists of

- **6 dual CPU PIII800. It costs about 100000 RMB.**

  or

- **10 dual CPU HP9000/J5000. It cost about 7500000 RMB.**

If we connect the 6 PCs together to form the Kernel System, It takes only 2.3 days to finish reconstructing 3150 BES-II data.



CONCLUSION:

The software enviroment based on Linux PCs (PC Farm, PC Cluster,...) would be a nice choice for BES/BES-II experiments. This can give us the best ratio of the performance over the price (75 Factor)!

Study of D Physics with BES-II at BEPC

— D Physics Opportunities at the $\psi''(3770)$

RONG GANG HE KANGLIN
ZHENG ZHIPENG ZHANG DAHUA

A Proposal for $\psi''(3770)$ D Physics with BES-II at BEPC

BES Annual Meeting 2000, Dalian, Liaoni, June 6–8, 2000

OUTLINE

1. Introduction
2. e^+e^- Exp. at ~ 10.0 and 3.77 GeV
3. Physics Topics
   - Measurement of Absolute Branching Fractions
   - Measurement of Pseudoscalar Coupling Constant, f_D
   - Study of D Semileptonic Decays
   - Search for Rare Decays
   - Study of Decays $\psi'' \to$ non $D\overline{D}$
   - Measurement of Resonant Parameter of $\psi''(3770)$
4. Monte Carlo Studies of D Decays at the $\psi''(3770)$
5. Summary and Conclusion

INTRODUCTION

Why $\psi''(3770)$ D physics with BES-II?

- **14 years ago at BES workshope (87), BES was planing to take**
  - J/ψ **data at 3.097 GeV for about 2 years**
  - ψ'' **data at 3.770 GeV for about 2 years**
  - **data at 4.14 (4.03) GeV for study of F and F***
  - **data at ~ 3.56 GeV for study of τ decay**
  - ψ' **data 3.686 GeV**
  - **...**

  The last foure items are not in order.

- **After about 10 years successfully running BES/BES-II have collected data sample:**
  - 9.6×10^6 J/ψ **data at 3.097 GeV (BES)**
  - **About 5 pb^{-1} of data at ~ 3.56 GeV for measurement of mass of τ and study of τ decays**
  - **22.3 pb^{-1} of data at 4.03 GeV for study of D_S^+ (F) decay properties.**
  - 3.79×10^6 ψ' **data at 3.686 GeV**
  - **R scan data in the region of 2 to 5 GeV (BES-II).**
  - $\sim 2.5 \times 10^7$ J/ψ **data at 3.097 GeV (BES-II), and will collect another $\sim 2.5 \times 10^7$ J/ψ data at 3.097 GeV (BES-II) in the following year.**

- **BES/BES-II have not yet taken data at 3.77 for study of D^0, D^+ decays.**

- **There are still some interesting & important opened physics topics which may be only well studied with the $\psi''(3770)$ data.**

- **When will BES-II collect data at 3.77 GeV?**

  We belive that It is a right time to collect data at 3.77 GeV for study of D^0 and D^+

physics right away after finishing collecting J/ψ data, because there are still some interesting & important opened physics topics which can be studied better with the data taken at 3.77 GeV.

e^+e^- EXPERIMENTS AT $\sim$ 10 GeV AND 3.77 GeV

- **Experiments at ~ 10 GeV**
  - **Measured values of relative branching ratios could be to approach to a precision of $\sim 1\%$.**
  - **Absolute branching fractions can not be measured well. Results may suffer from a systematic shift due to not easily understood systematic uncertainty.**
- **Experiments at 3.77 GeV**
  - **D^+D^- and $D^0\overline{D^0}$ mesons are produced directly in resonance $\psi''(3770)$. $e^+e^- \rightarrow \psi''(3770), \psi''(3770) \rightarrow D\overline{D}$.**
    $\Rightarrow$ Particle production kinematics is simple and predictable. Results would be with small & understood backgroud or without background.
  - **Kinematic fitting or beam energy constraint can be used in the event analysis to improve the mass resolution with a $\sigma_{m_D} \sim 1.8$ MeV. Can enrich the selected D sample, get very good ratio of signal to noise in the mass plots.**
  - **"Double Tag Method" could be applied to get very good ratio of signal to noise in D meson sample selected. Systematic error can be reduced and understood well. No uncertainties in normalization. Gives the absolute measurements of f_D, $B(D^0 \rightarrow K^-\pi^+)$, $B(D^+ \rightarrow K^-\pi^+\pi^+)$, $B(D^0 \rightarrow K^-e^+\nu)$, $B(D^0 \rightarrow \pi^-e^+\nu)$, $B(D^+ \rightarrow \overline{K^0}e^+\nu)$, and so on...**
  - **$B(D^0 \rightarrow K^-\pi^+)$ and $B(D^+ \rightarrow K^-\pi^+\pi^+)$ will be used for all normalization in D, B Z^0 and T physics.**
  - **Some rare decays may be found due to small background.**

D PHYSICS TOPICS AT $\psi''(3770)$

Absolute branching fractions for $D^0 \rightarrow K^-\pi^+$ and $D^+ \rightarrow K^-\pi^+\pi^+$

- The absolute branching fractions for $D^0 \rightarrow K^-\pi^+$ and $D^+ \rightarrow K^-\pi^+\pi^+$ are very important normalization constents for both D and B physics.
- The two absolute decay branching fractions enter into Cabibbo-Kobayshi-Maskawa matrix element determinations. So more precisely measuring the $B(D^0 \rightarrow K^-\pi^+)$ and the $B(D^+ \rightarrow K^-\pi^+\pi^+)$ can directly improve the CKM matrix element measurements
  $|V_{cs}|$: determine from $B(D^0 \rightarrow K^-e^+\nu)$
  $|V_{cd}|$: determine from $B(D^0 \rightarrow \pi^-e^+\nu)$
  $|V_{cb}|$: determine from $B(\bar{B}^0 \rightarrow D^+l^-\bar{\nu})$ and $B(B^- \rightarrow D^0l^-\bar{\nu})$, where the $D^+ \rightarrow K^-\pi^+\pi^+$ and $D^0 \rightarrow K^-\pi^+$.
- The debt of the number of Charm in B semileptonic decay ...

Measurement of the Pseudoscalar Coupling Constant, f_D^+

- f_D^+ is a fundamental constant in particle physics. It describes the overlapping of the quark wave functions. In theory lattice gauge (Potential models, Bag model, Sum rules ...) calculations predict the values of f_D.
- The f_D^+ measurement will allow comparison with the theoretical calculation to improve the theory.
- Using the measured value of f_D^+ as inputs, one can more precisely estimate the value of f_B, which is very difficult to be measured due to $|V_{bu}| \sim 0.002$.

f_B is an important constant, which play a fundamental role in experiments, such as $B^0\overline{B^0}$ mixing experiment and measurement of CP violation.

- f_D^+ relates to D^+ leptonic decay branching fraction by

$$B(D^+ \to l^+\nu) = \frac{G_F^2 f_{D^+}^2}{8\pi} \mid V_{cd} \mid^2 m_l^2 m_{D^+} \tau_{D^+} \left(1 - \frac{m_l^2}{m_{D^+}^2}\right)^2.$$

With a measured $B(D^+ \to l^+\nu)$, the f_D^+ can be extracted out directly.

Previous Measurements of f_D

- MARK-III – No candidate event of $D^+ \to \mu^+\nu$ was observed. They set an upper limit $f_D <$ 290 MeV at 90% C.L.
- SPEC – No event $D^+ \to \mu^+\nu$ was observed.
- BES observed 1 event of $D^+ \to \mu^+\nu$. Made a measurement of $f_D = (300^{+180+80}_{-150-40})$ MeV.

BES-II can make an improved measurement of f_D.

An Example of Measurements of $f_{D_S^+}$ (f_{D^+})

CLEO 94 & 98 (2.13 & 4.79 pb^{-1} data at $\sim$ 10 GeV)

- Method
  - $D_S^{*+} \to \gamma D_S^+$, where $D_S^+ \to \phi\pi^+, l^+\nu$
  - The γ and l^+ can be directly measured
  - The neutrino momentum is estimated from the missing energy and momemtum in hemisphere of leptons

    $\Rightarrow$ to determine the candidate D_S^+ and D_S^{*+} and $\Delta M = m(l\nu_l\gamma) - m(l\nu_l)$

    Signal events should peak at $m_{(D_S^{*+})} - m_{(D_S^+)} \simeq 141$MeV
- Result

$$f_{D_S^+} = \begin{cases} 344 \pm 37 \pm 52 \pm 34 & \text{Year 94} \\ (282 \pm 30 \pm 43 \pm 34 & \text{Year 94 correction)} \\ 280 \pm 19 \pm 28 \pm 34 & \text{Year 98} \end{cases}$$

Using the same method replacing the γ by π^+ for the decay chain $D^{*+} \to \pi^0 D^+$, where $D^+ \to K^-\pi^+\pi^+, l^+\nu$ the f_{D^+} may be measured.

Total Relative Error on the Measured $f_{D_S^+}$

$$\delta = \sqrt{\delta_{stat}^2 + \delta_{sys}^2 + \delta_{norm}^2}$$

At $\sim$ 10 GeV

$$\begin{array}{lll} \delta_{stat} & \simeq 10\% & \\ & < 10\% & \text{(B Factories)} \\ \delta_{sys} & \simeq \text{(12-15)}\% & \text{(CLEO \& B Factories)} \\ \delta_{norm} & \simeq (12-15)\% & \text{(CLEO \& B Factories)} \end{array}$$

The total error is dominated by the systematic instead of statistic

At 3.77 GeV

$$\begin{array}{lll} \delta_{stat} & \simeq 22\% & \text{for 40 bp}^{-1} \\ \delta_{sys} & \simeq 5\% & \text{BES} - \text{II} \\ \delta_{norm} & = 0\% & \text{BES} - \text{II} \end{array}$$

The total error (BES-II 40 bp^{-1} data) would be at the same level as that from B-Factories if the B-Factories can measure the f_{D^+} using the method.

Conclusion BES-II can not compete in statistic with B-Factories, but can competite in systematic with them. BES-II can give a no bias absolute value on the f_{D^+}.

Comment In fact, due to Cabibbo-Suppressed decay $D^+ \to \mu^+\nu$ It is more difficut for B-Factories to measure the f_{D^+} than the $f_{D_S^+}$. Even if they can measure the f_{D^+}, the systematic error may not be smaller than that of $f_{D_S^+}$. The best place to measure f_{D^+} is at BEPC with BES-II.

Study of D Semileptonic Decays

Focused on understanding of the weak decay mechanism and measuring CKM matrix elements.

- Exclusive Semileptonic Decay $D^0 \to K^- l^+ \nu$, $\pi^- l^+ \nu$
  - The transition rates for $D^0 \to K^- e^+ \nu_e$ and $D^0 \to \pi^- e^+ \nu_e$ are related the Form Factors $f_+^K(0)$ and $f_+^\pi(0)$ by

    $$\Gamma(D^0 \to K^- e^+ \nu_e) = 1.54 |V_{cs}|^2 |f_+^K(0)|^2 \times 10^{11} s^{-1}$$

    $$\Gamma(D^0 \to \pi^- e^+ \nu_e) = C |V_{cd}|^2 |f_+^\pi(0)|^2 \times 10^{11} s^{-1}$$

    where the C is a constant.
  - The ratio $\left|\frac{V_{cd}}{V_{cs}} \frac{f_+^\pi(0)}{f_+^K(0)}\right|^2$ is related the ratio $\frac{B(D^0 \to \pi^- e^+ \nu_e)}{B(D^0 \to K^- e^+ \nu_e)}$ by

    $$\left|\frac{V_{cd}}{V_{cs}} \frac{f_+^\pi(0)}{f_+^K(0)}\right|^2 = 0.508 \frac{B(D^0 \to \pi^- e^+ \nu_e)}{B(D^0 \to K^- e^+ \nu_e)}$$

    The form factors $f_+^\pi(0)$ and $f_+^K(0)$ can be extracted out or $|V_{cd}/V_{cs}|$ can be measured.

Data	$\frac{\delta B(D^0 \to K^- e^+ \nu_e)}{B(D^0 \to K^- e^+ \nu_e)}$	$\frac{\delta B(D^0 \to \pi^- e^+ \nu_e)}{B(D^0 \to \pi^- e^+ \nu_e)}$	EXP.
9.6 pb^{-1}	$\sim$ 15%	$\sim$ 44%	MARK-III
40 pb^{-1}	$\sim$ 6.2%	$\sim$ 20%	Estimation for BES-II/BEPC

- $D^0 \to K^{*-} e^+ \nu$, $D^0 \to \rho^- e^+ \nu$ $D^+ \to \overline{K^0} e^+ \nu$, $D^+ \to \pi^- e^+ \nu$, $D^+ \to K^{*0} e^+ \nu$, $D^+ \to \rho^0 e^+ \nu$ $\Rightarrow$ to measure V_{cd}/V_{cs}
- Measurement of $\frac{B(D^+ \to \overline{K^0} e^+ \nu_e)}{B(D^0 \to K^- e^+ \nu_e)}$

- Inclusive Semileptonic Decays
  - $B(D^{0(+)} \to l^+ X)$ — to understand the lifetime difference of the charmed mesons.
  - The ratio of lifetimes of D^+ over D^0 is measured at the precision of $\sim 2\%$.
  - BES-II/BEPC can measure the inclusive semileptonic branching fractions for $D^+ \to \mu^+$X and $D^0 \to \mu^+$X.
  - To measure lepton momentum spectra from D decay

Data	$\frac{\delta B(D^+ \to e^+ X)}{B(D^+ \to e^+ X)}$	$\frac{\delta B(D^0 \to e^+ X)}{B(D^0 \to e^+ X)}$	$\frac{B(D^+ \to e^+ X)}{B(D^0 \to e^+ X)}$	Experiment
9.6 $^{-1}$	$\sim$ 11%	$\sim$ 15%	$\sim$ 19.6%	MARK-III
40 pb^{-1}	$\sim$ 3.7%	$\sim$ 5.0%	$\sim$ 6.6%	Estimation f BES-II/BEPC

Search for D rare decays

- Search for D Exotic decays such as $D^0 \to \mu^+ \mu^-$, $e^+ e^-$, $e^+ \mu^-$... to test the Standard Model.

- Double Cabibbo-Suppressed decays by using double tag method

- Search for $D \to \gamma K^*$ ...

Study of Decays for $\psi'' \to$ non $D\overline{D}$

- About 20% $\psi''(3770)$ decays into non-$D\overline{D}$. It is interesting to know what are the non-$D\overline{D}$ decays.

- Measure the resonant parameters of $\psi''(3770)$ to understand ψ family better.

Monte Carlo Studies at 3.77 GeV

Purpose

- To understand of background in measurement of f_D and to predict the precision of measurement of the absolute branching fractions.
- to develop the physics analysis software for studies of the D physics.

Monte Carlo Data

- With the full simulation of BES-II detector, we generated 40 pb^{-1} $D\overline{D}$ data with a ratio of 0.42 : 0.58, which is the charged D to the neutral D mesons produced at 3.77 GeV. D mesons automatically decay to all possible final states according to the decay branching fractions quoted from PDG94.
- The event generation, detector simulation and final states reconstruction are performed with **"A Distributed Network Linux PCs System"** (see Hardware Configuration Figure)

Analysis Results

- Absolute Branching Fractions

$$B(D^0 \to K^- \pi^+) = (3.62 \pm 0.15)\%,$$

$$B(D^0 \to K^- \pi^- \pi^+ \pi^+) = (8.19 \pm 0.35)\%,$$

$$B(D^+ \to K^- \pi^+ \pi^+) = (7.33 \pm 0.54)\%,$$

where the errors are statistical only.

- Pure Leptonic Decay
  We observed $5 \pm \sqrt{5}$ purly leptonic decay events for $D^+ \to \mu^+\nu$. The precision of the measured f_D is expected to be about 24% including systematic error.

- Semileptonic Decay
  About 334 ± 20 $D^+ \to K^-e^+\nu$ events are observed. 37 ± 7 $D^+ \to \pi^-e^+\nu$ events are observed. $\Rightarrow$ give measurements of branching fraction with error about 6.2% and 20.0%, respectively.

- ...

SUMMARY AND CONCLUSION

- We have great physics opportunities at $\psi''(3770)$ with BES-II at BEPC.
- If we take about 40 pb^{-1} data at 3.77 GeV, some very nice phyics results can be obtained:
  - Absolute branching fractions for $D^0 \to K^-\pi^+$, $D^+ \to K^-\pi^+\pi^+$.
  - Measurement of f_D.
  - $|V_{cd}|$, $|V_{cs}|$, $f_+^{\pi}(0)$ and $f_+^K(0)$ from measurements of $B(D^0 \to \pi^-e^+\nu)$ and $B(D^0 \to K^-e^+\nu)$. ...
  - Measurements of inclusive semileptonic decays.
  - Search for some rare decays
  - $\psi''(3770) \to \mathrm{non}D\overline{D}$ decays.
  - Measure the resonant parameters of $\psi''(3770)$.
- Using the data we will not only improve many measurements on the decay branching fractions of D^0 and D^+ mesons, but also study τ decay properties.
- BES-II can not compete in statistic with B-Factories, but can compete in systematic with them, and the results are no bias and complementary to that from B-Factories with a total comparable error with that from B-Factorie and other Higher Energy Experiments.
- It is worth collecting data at 3.77 GeV for about one year after J/ψ data taking next year.