Monte Carlo Study of Tau-Charm Factory

Xiaoling Fan

August 16, 1994

Monte Carlo study of Tau-Charm Factory has been seriously done by τcF team working at CERN and Spain. In order to prepare a specific proposal for a Tau-Charm Factory construction in Beijing, a Monte Carlo group in IHEP was set up in May 1994 to study the physics goals of Tau-Charm Factory.

In our Monte Carlo simulation, a simple MC frame was constructed. We did not consider the detailed structure of detector, events are generated by MC generators, then the track parameters are smeared according to the detector performances which are completely based on the talk presented at the Third Workshop on the Tau-Charm Factory by Professor Jasper Kirkby[*].

[*] Jasper Kirkby, presented at the Third Workshop on the Tau-Charm Factory, Marbella, Spain, 1–6 June, 1993.

Following espects are covered in this talk:

1. m_τ measurement at τcF.

2. m_{ν_τ} measurement at τcF.

3. Measurement of Michel Parameter at τcF

4. D purely leptonic decay at τcF.

5. $D\bar{D}$ mixing at τcF.

6. D_s purely leptonic decay at τcF.

1. τ Mass Measurement at τ-Charm Factory

BES

- Scanning near the thresthold of $\tau^+\tau^-$ pair production, data-driven maximum likelihood searching strategy.

- 12 energy points.

- $\int Ldt \sim 5000nb^{-1}$.

Based on the $e\mu$ channel:

$$m_\tau = 1776.9 \pm^{0.4}_{0.5} \pm 0.2 \text{ MeV}$$

Synthesizing all 6 decay modes ($e\mu, e\pi, ee, \mu\pi, \mu\mu, \pi\pi$) to decrease the statistical error, m_τ has been got:

$$m_\tau = 1776.87 \pm^{0.23}_{0.24} \pm^{0.20}_{0.17} \text{ MeV}$$

τ-Charm Factory

- Same method as BES.

- 20 energy points.

- $\int Ldt \sim 20 \times 1000nb^{-1} = 20pb^{-1}$.

  $L_{\tau c} \sim 100 L_{BEPC}$, ~ 2 days.

- $\varepsilon_{e\mu} = 45\%$ (conservative).

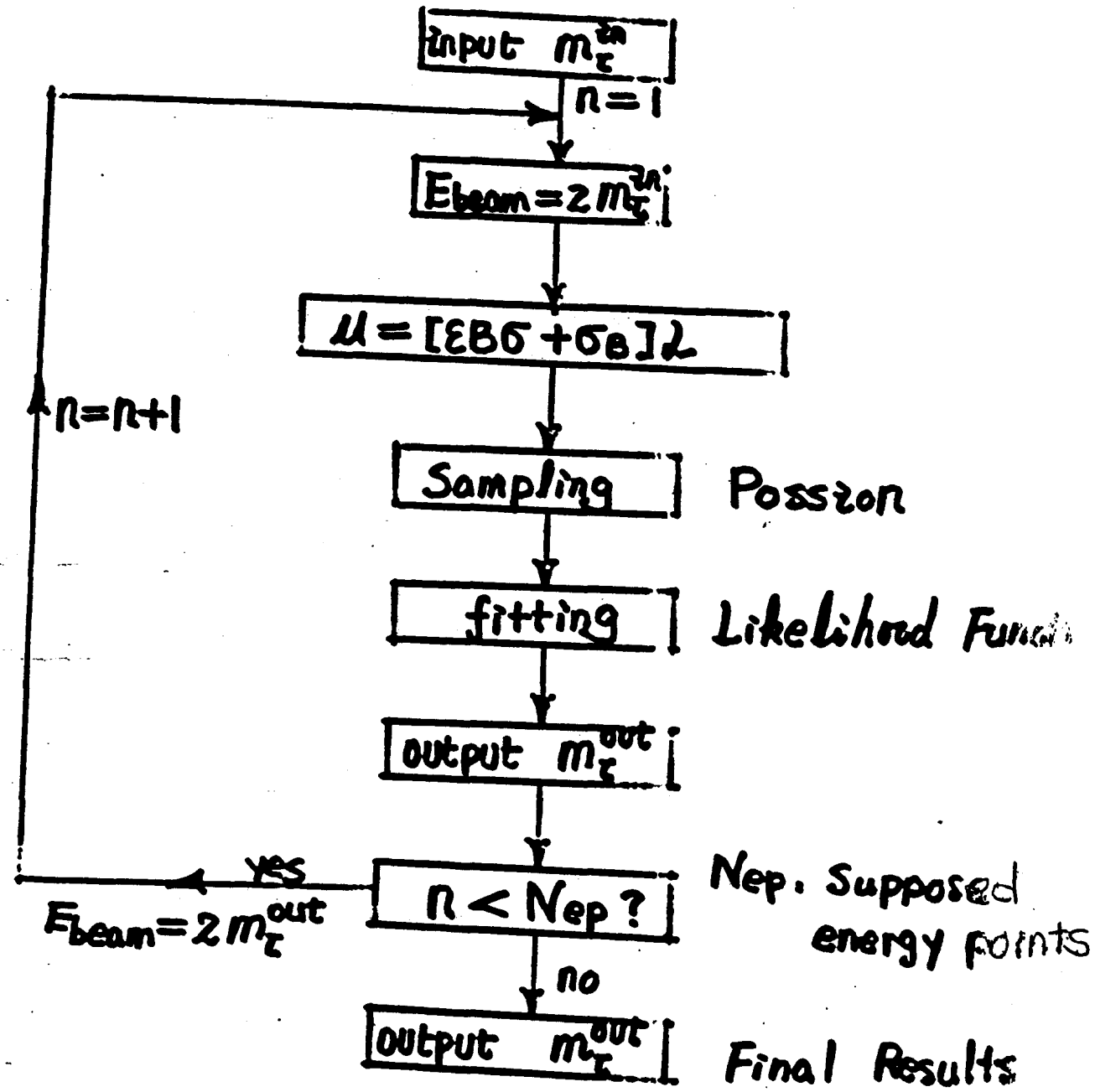
- $\Delta = 0.5$ MeV, 1.0 MeV.

  BES: 1.4 MeV.

  τcF: 1.0 MeV (standard mode).
  τcF: 0.1 MeV (monochromator mode).

- $m_\tau^{input} = 1777.00$ MeV.

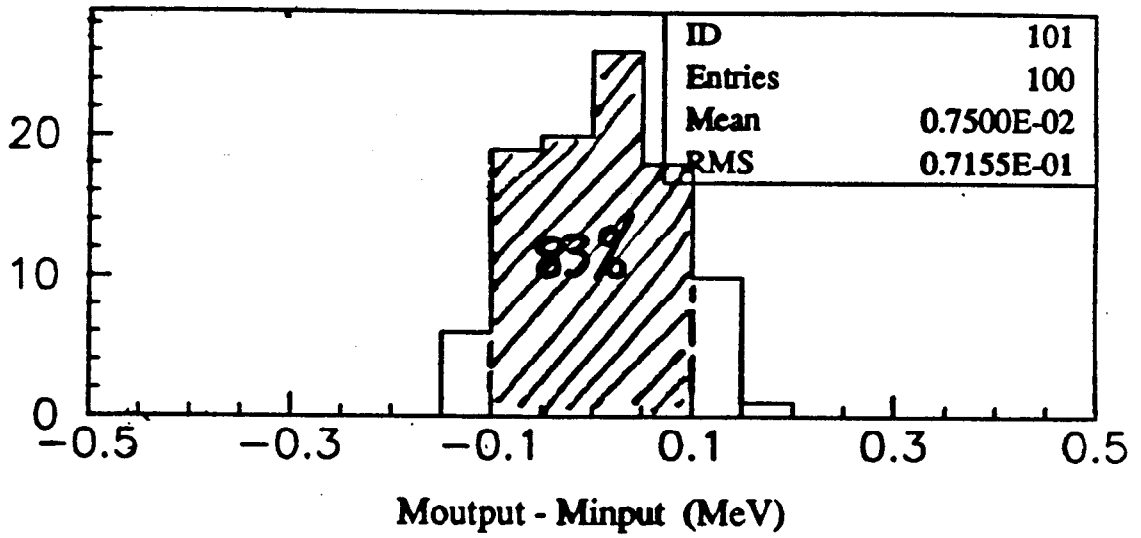
- $\sigma_B \sim 1\% \sigma$.

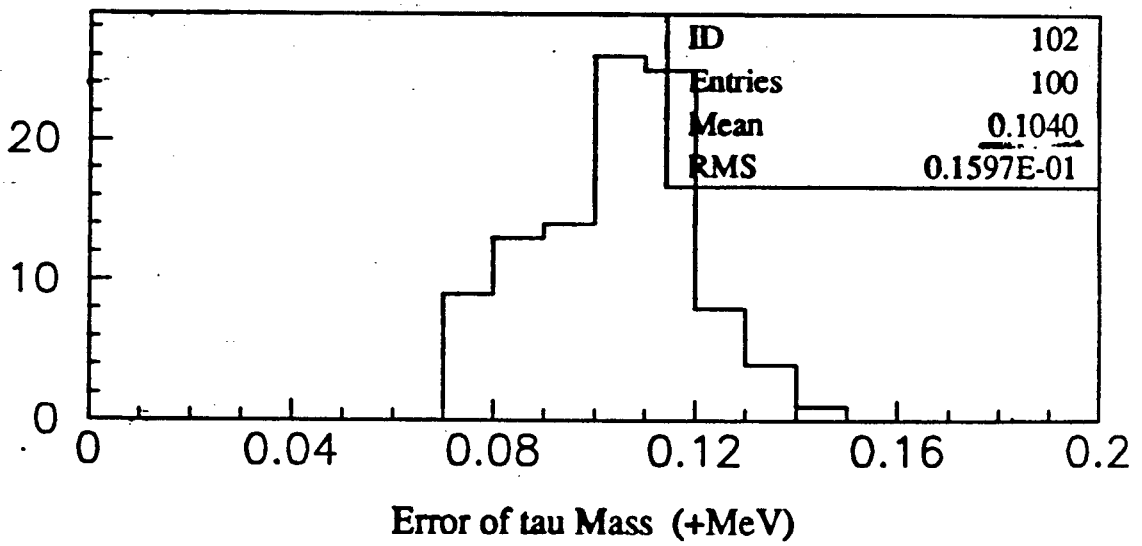


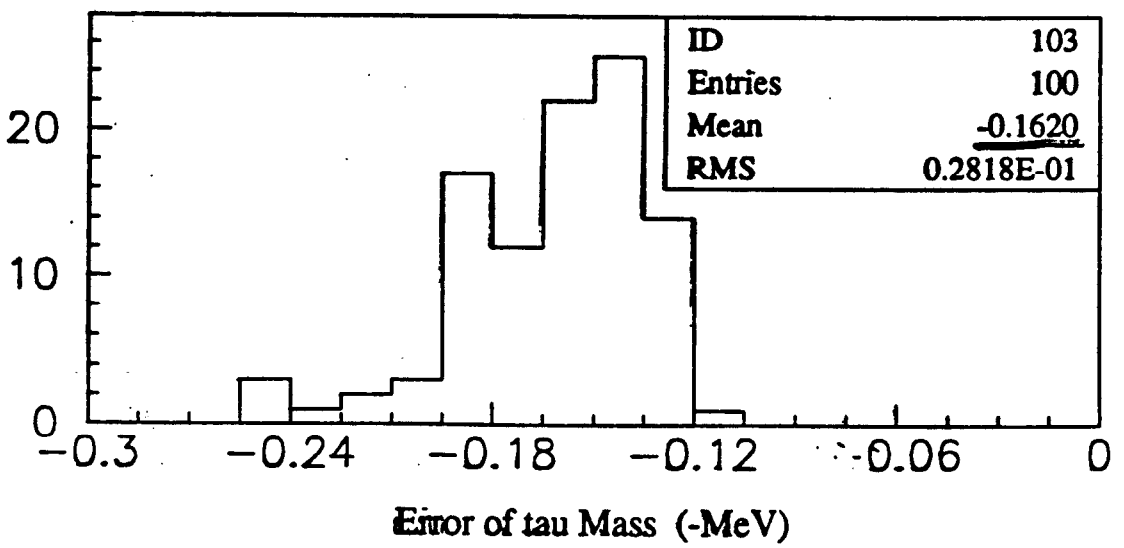
Flow Chart of one time Monte Carlo Simulation for tau Mass

Tau Charm Factory Monte Carlo Simulation

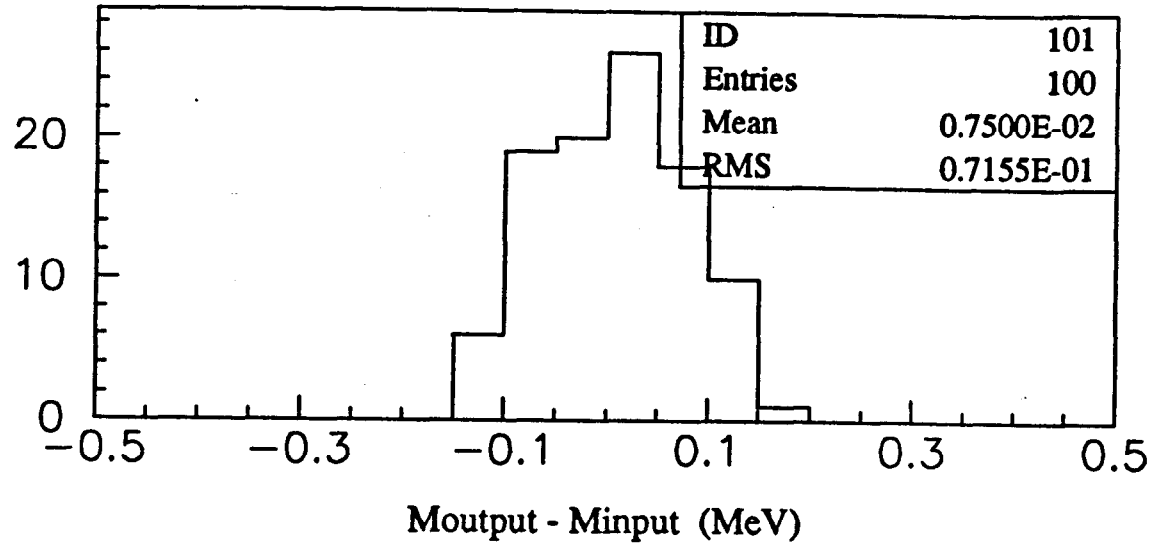
(Δ=0.5 MeV)

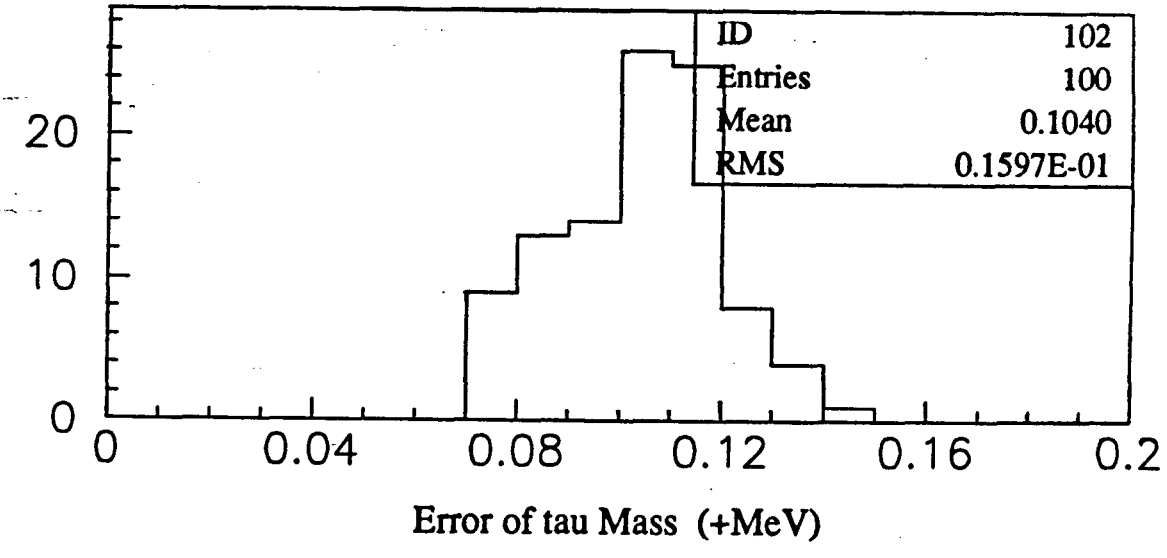


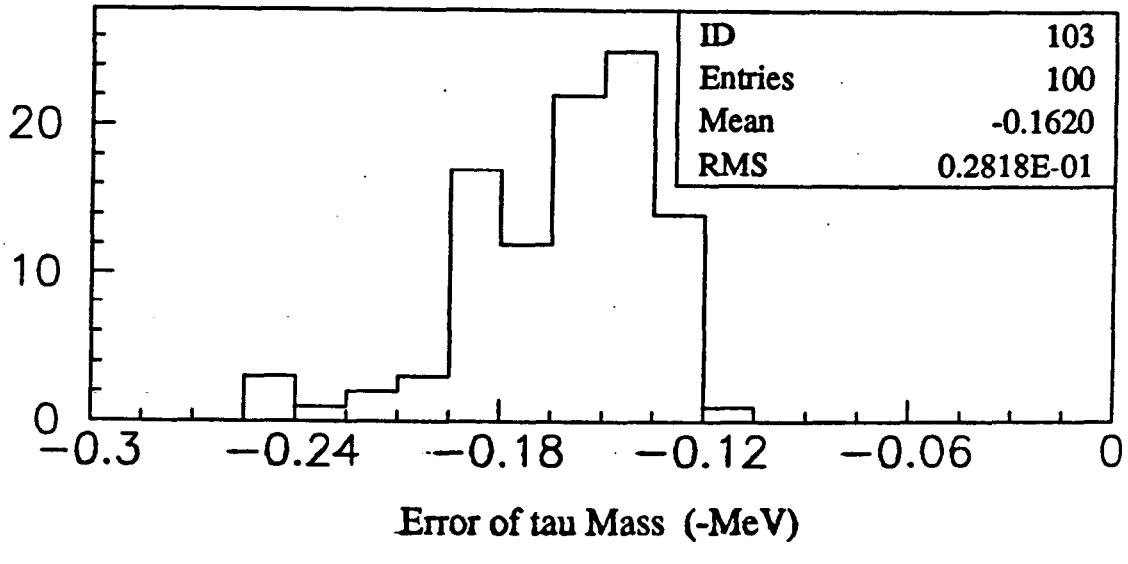




Tau Charm Factory Monte Carlo Simulation







τ Mass

Based on $e\mu$ channel, m_τ is expected to be obtained as (only statistical error):

$$m_\tau \pm^{0.10}_{0.16} \qquad (\Delta = 0.5 \text{ MeV})$$
$$m_\tau \pm^{0.17}_{0.24} \qquad (\Delta = 1.0 \text{ MeV})$$

Synthesizing all 6 decay modes ($e\mu, e\pi, ee, \mu\pi, \mu\mu, \pi\pi$) to decrease the statistical error, m_τ is expected to be obtained as (only statistical error):

$$m_\tau \pm^{0.05}_{0.08} \qquad (\Delta = 0.5 \text{ MeV})$$
$$m_\tau \pm^{0.09}_{0.12} \qquad (\Delta = 1.0 \text{ MeV})$$

The statistical error on τ mass is expected to be 0.1 MeV/c^2 or less at τcF. It is important to precise test of lepton unversality!

Systematic Error

- Unstability of beam energy.
- Uncertainty of beam energy spread.
- Uncertainty in detector acceptance.
- Errors in luminosity measurement.
- Background events for each decay channel.
- Bias deduced from the energy step during the scanning.

BES: ~ 0.20 MeV/c^2.

τcF: < 0.10 MeV/c^2 is expected !

2. τ Neutrino Mass Measurement at τCF

1. Operating Energy Points

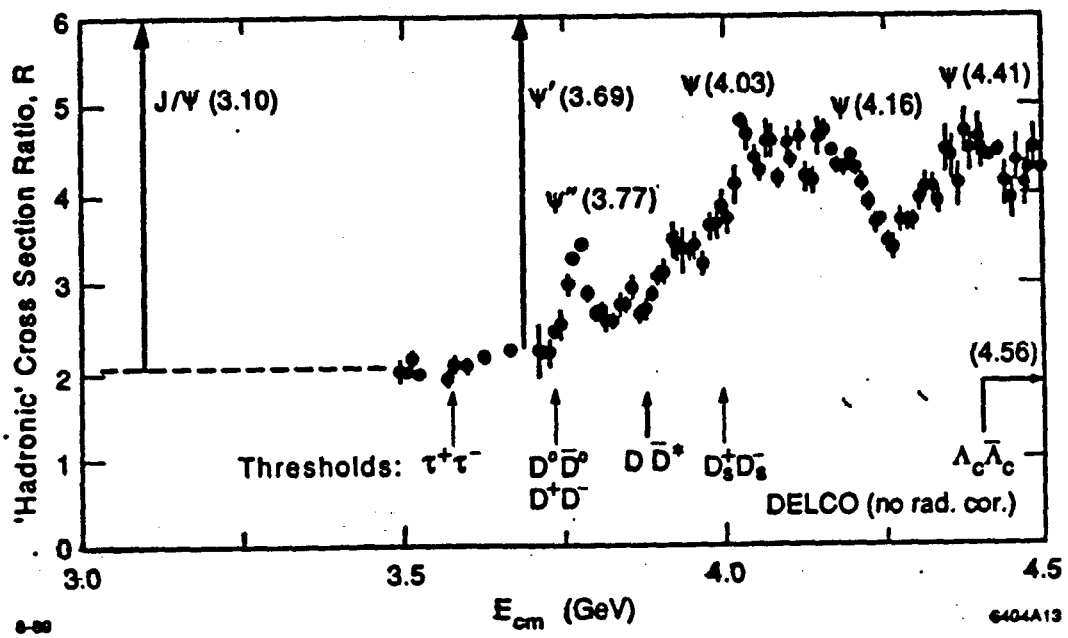
$\sqrt{S}$ (GeV)	$\sigma_{\tau\tau}$ (nb)	$N_{\tau\tau}$/Year
3.555 [1)]	0.22	3.4×10^6
4.25 [2)]	3.56	5.5×10^7
10 [3)]	0.86	4.0×10^7

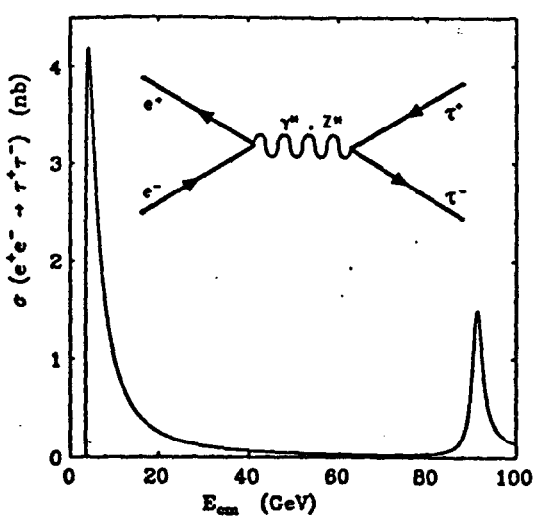
- τ-C: $L \sim 10^{33} cm^{-2} s^{-1}$
- B: $L \sim 3 \times 10^{33} cm^{-2} s^{-1}$

1) τ is produced almost at rest.

2) With maximum $\sigma_{\tau\tau}$.

3) With back-to-back topology.


'Hadronic' Cross Section Ratio, R
J/Ψ (3.10)
Ψ' (3.69)
Ψ(4.03)
Ψ(4.16)
Ψ(4.41)
Ψ'' (3.77)
(4.56)
Thresholds: τ+τ−
D°D̄°
D+D−
D D̄*
D+sD−s
ΛcΛ̄c
DELCO (no rad. cor.)
E_cm (GeV)
6404A13


σ (e+e− → τ+τ−) (nb)
e+
e−
γ*, Z*
τ+
τ−
E_cm (GeV)

2. Channel Selection

Mode	$\tau \to KK\pi\nu_\tau$	$\tau \to 5\pi\nu_\tau$
Br	$(2.2\pm^{1.7}_{1.1}) \times 10^{-3}$	$(5.6 \pm 1.6) \times 10^{-4}$
Q=$m_\tau - m_h$	$\sim$ 0.65 GeV	$\sim$ 1.08 GeV
$\bar{p}(\sqrt{S} = 10GeV)$	$\sim$ 1.25 GeV	$\sim$ 0.83 GeV
$\bar{p}(\sqrt{S} = 4GeV)$	$\sim$ 0.5 GeV	$\sim$ 0.33 GeV
$\sigma_m(\sqrt{S} = 10GeV)$	6.0 MeV	—
$\sigma_m(\sqrt{S} = 4GeV)$	3.5 MeV	—

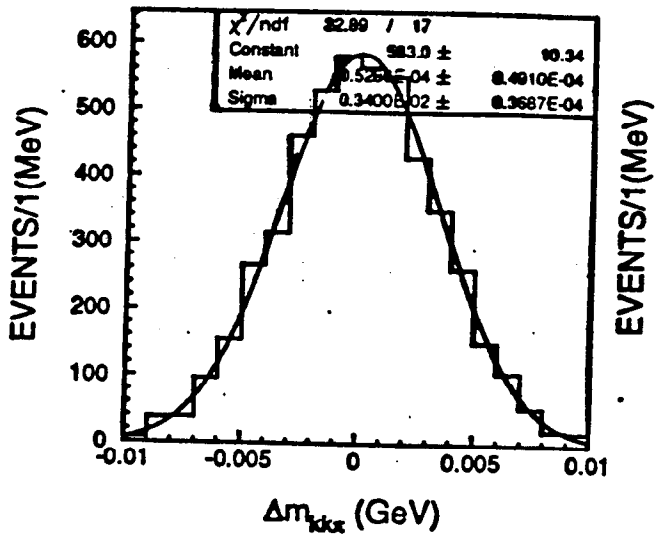
- τcF: TOF + dE/dX.

Only $\tau \to KK\pi\nu_\tau$ process has been analysed so far due to the time limitation. The analyses of $\tau \to 5\pi\nu_\tau$ is in progress.

2) For same upper limit of m_{ν_τ}, $\sigma_{m_{\nu_\tau}} \propto \sigma_m/\sqrt{N}$,

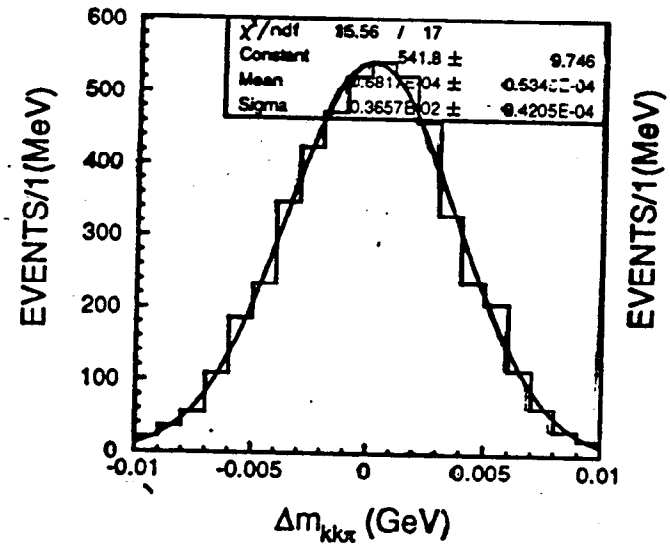
$$\sigma_m(BF) \sim 1.6 \times \sigma_m \ (\tau\text{cF})$$

$$N_{KK\pi}(BF) \sim 2N_{KK\pi} \ (\tau\text{cF})$$



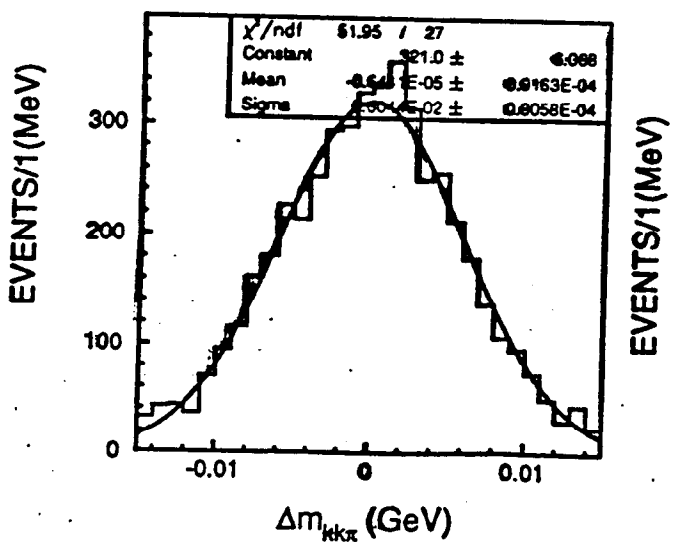
$\sqrt{s} = 3.55$ GeV

$\sigma_m = 3.4$ MeV



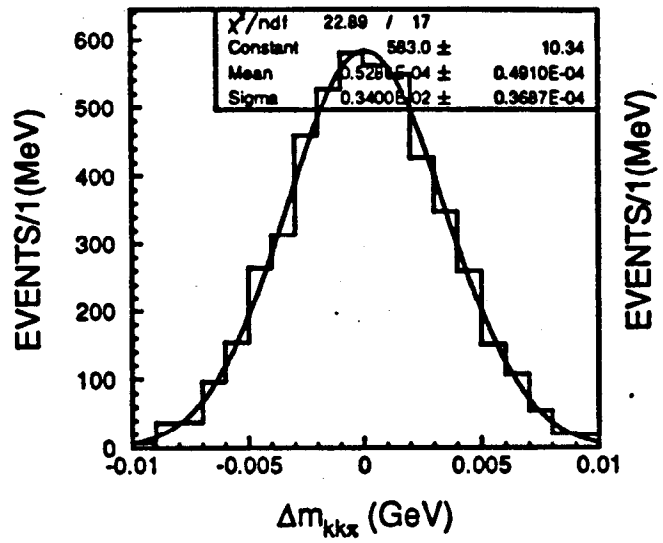
$\sqrt{s} = 4.25$ GeV

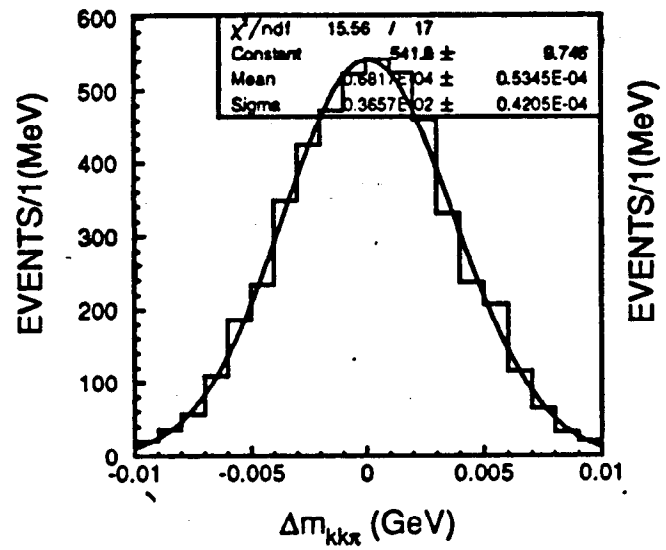
$\sigma_m = 3.6$ MeV

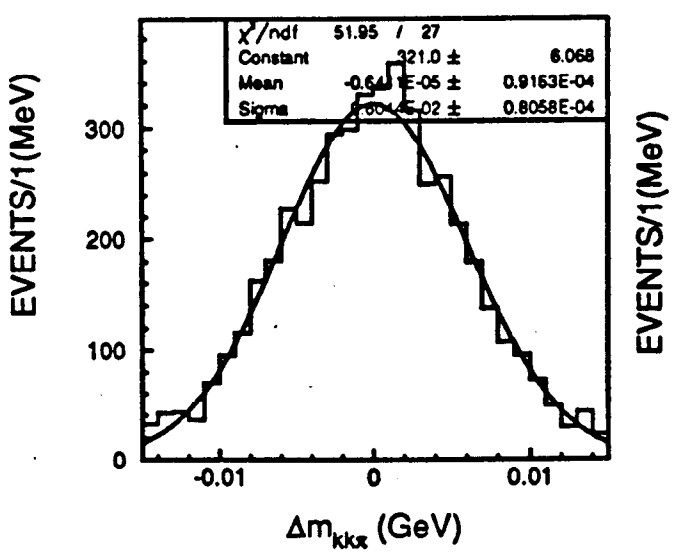


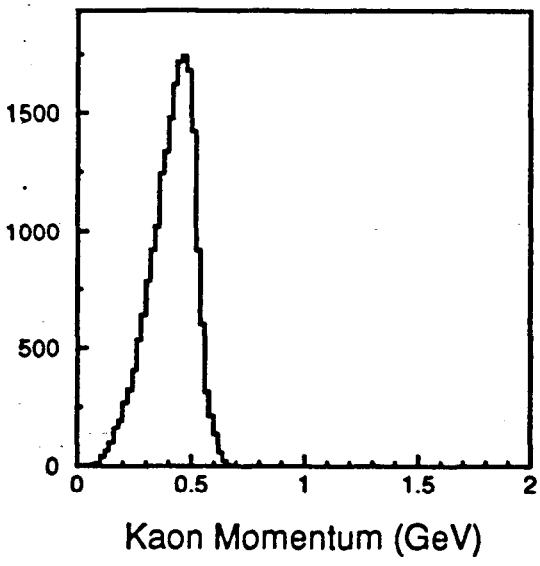
$\sqrt{s} = 10$ GeV

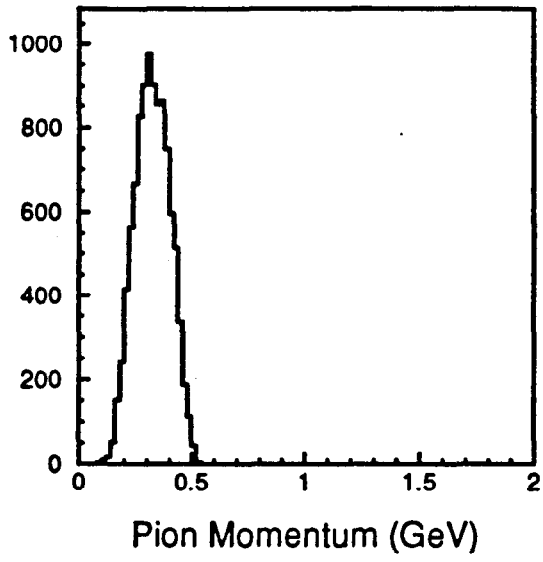
$\sigma_m = 6.0$ MeV


χ²/ndf 22.89 / 17
Constant 583.0 ± 10.34
Mean 0.5281E-04 ± 0.4910E-04
Sigma 0.3400E-02 ± 0.3687E-04
EVENTS/1(MeV)
Δm_kkπ (GeV)

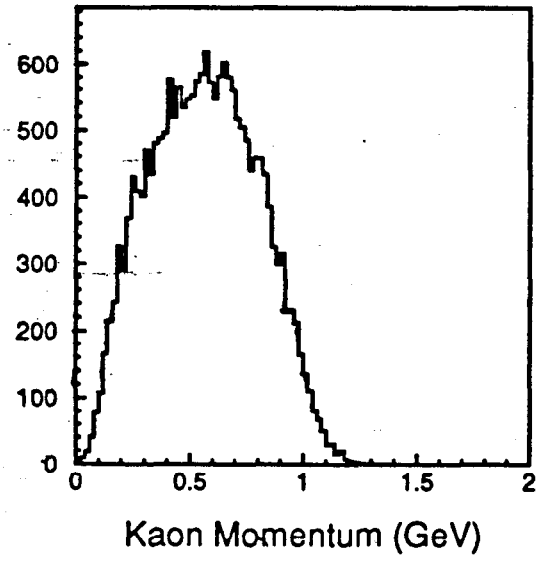

χ²/ndf 15.56 / 17
Constant 541.8 ± 9.746
Mean 0.5681E-04 ± 0.5345E-04
Sigma 0.3657E-02 ± 0.4205E-04
EVENTS/1(MeV)
Δm_kkπ (GeV)

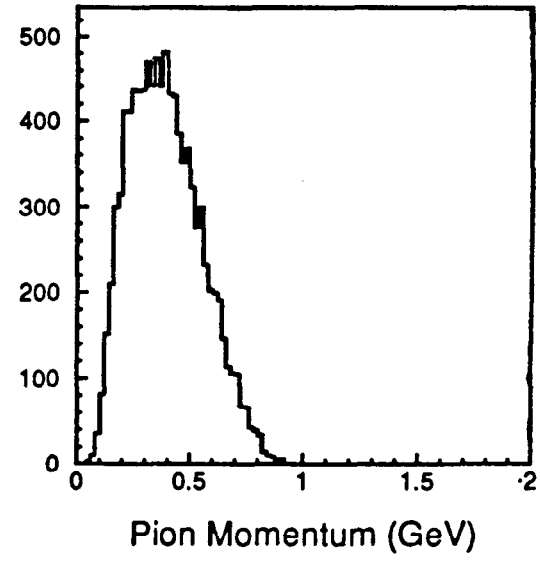

χ²/ndf 51.95 / 27
Constant 321.0 ± 6.068
Mean -0.6411E-05 ± 0.9163E-04
Sigma 0.8604E-02 ± 0.8058E-04
EVENTS/1(MeV)
Δm_kkπ (GeV)



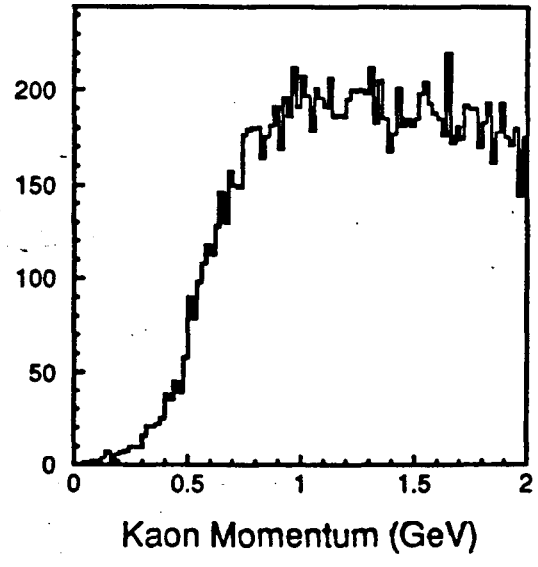


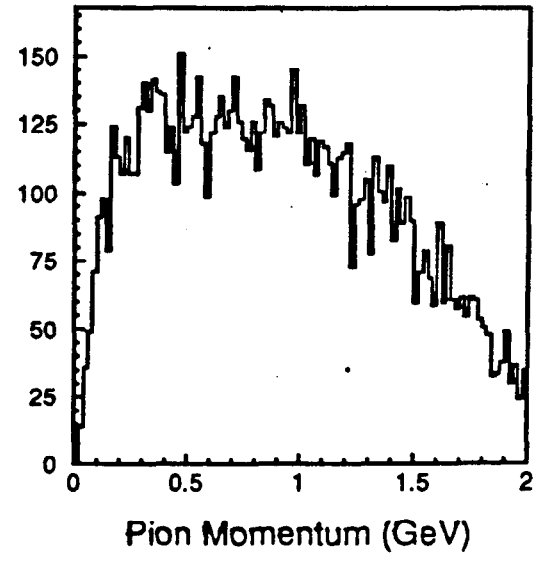
$\sqrt{s} =$ 3.555 GeV





$\sqrt{s} =$ 4.25 GeV





$\sqrt{s} =$ 10 GeV

Particle Decay to All Known Channels

Mode / Cut	DATA	$\tau^+\tau^-$	$q\bar{q}$	DD^*	D^*D^*	$D_s^+D_s^-$
4 Prong, N_γ=0	3.4 %	5.9 %	4.5 %	1.4 %	0.5 %	0.9 %
$P_{miss} > 200MeV$	2.7 %	5.8 %	3.1 %	1.4 %	0.5 %	0.9 %
e/μ tag	0.3 %	1.7 %	0.2 %	0.4 %	0.2 %	0.3 %

- $\tau^+\tau^-$: KORALB
- $q\bar{q}$: LUND 6.2

3. The Upper Limit of m_{ν_τ}

1) $\tau \to \rho''(1750)\nu_\tau \to KK\pi\nu_\tau$

Tag: $\tau \to e\nu_e\nu_\tau, \mu\nu_\mu\nu_\tau$.

2) Global selection efficiency.

τ-C: $\varepsilon_{lKK\pi}(\sqrt{S} \sim 4GeV) \sim 15\%$
B: $\varepsilon_{lKK\pi}(\sqrt{S} \sim 10GeV) \sim 25\%$
BES: $\varepsilon_{lKK\pi} \sim 10\%$
ARGUS: $\varepsilon_{l3\pi} \sim 25\%$

3) The fraction of event with $m_{KK\pi} > 1.75GeV$,

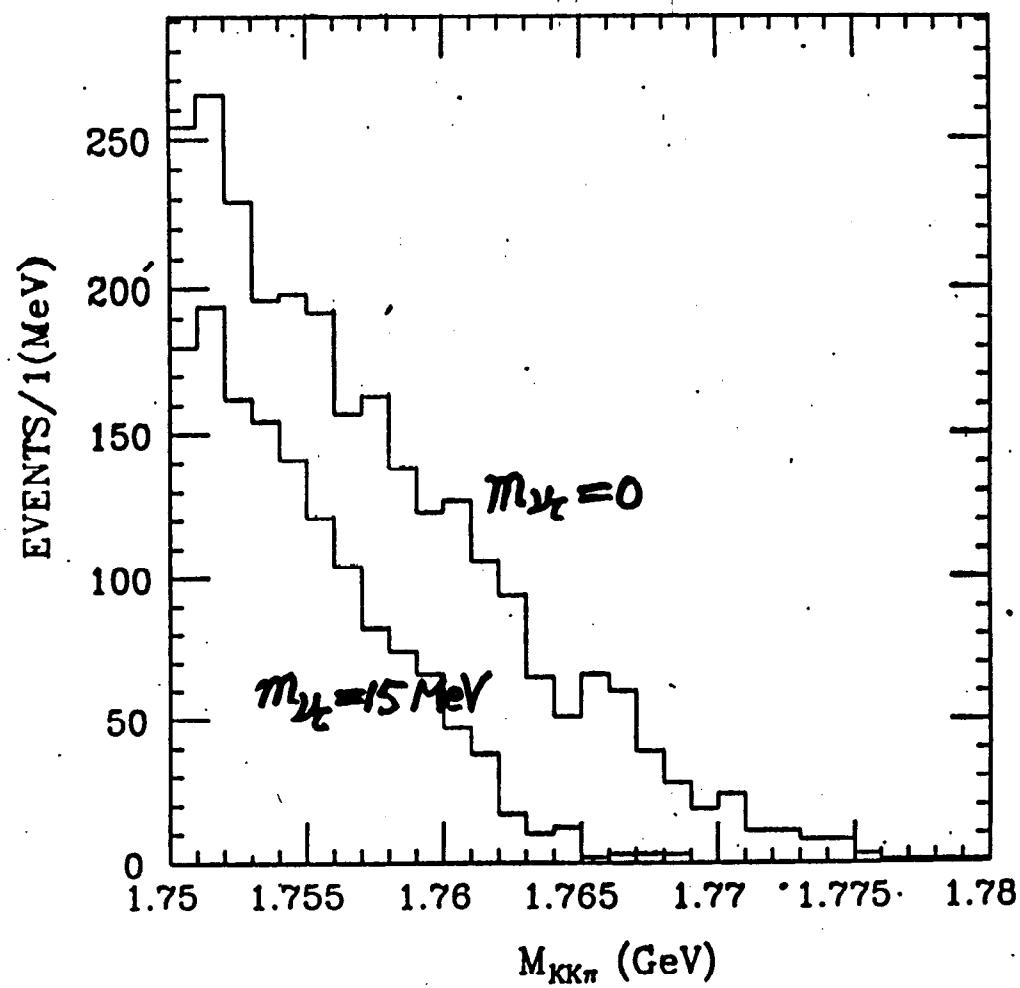
$$f_{end} \sim 1.5\%$$

4) Tagged Events

$$N_{tagged} \sim 2N_{\tau\tau} \times (B_e + B_\mu) \times Br(KK\pi) \times f_{end} \times \varepsilon_{lKK\pi}$$

~ 8 events/year $\sqrt{S} = 3.555$ GeV
~ 130 events/year $\sqrt{S} = 4.25$ GeV
~ 150 events/year $\sqrt{S} = 10$ GeV

$\tau \to KK\pi\nu_\tau$



($\sqrt{s}$ = [illegible] GeV)

5) Estimation of m_{ν_τ} limit.

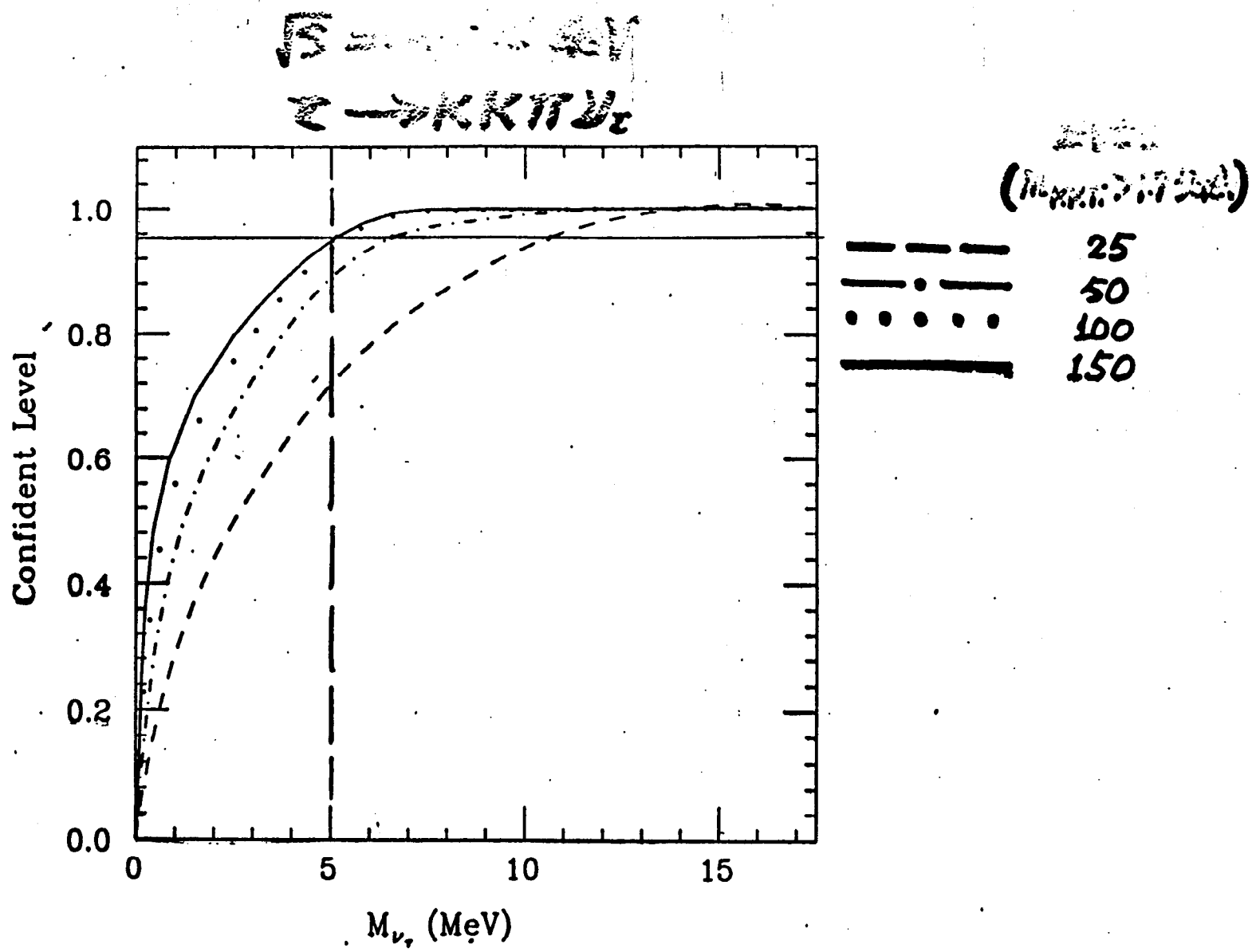
$$L_i(m_{\nu_\tau}) = \int_{2m_K+m_\pi}^{m_\tau} \frac{d\Gamma(m, m_{\nu_\tau})/dm}{\Gamma_{tot}} R(m, m')dm$$

$$L(m_{\nu_\tau}) = \prod_{i=1}^{N} L_i(m_{\nu_\tau})$$

$$C.L. = \int_0^{m_{\nu_\tau}} L_(m_{\nu_\tau})dm_{\nu_\tau}$$

The statistical upper limit (95% C.L.) on the ν_τ mass is $\sim$ 5 MeV/c^2 from $\tau^\pm \rightarrow K^-K^+\pi^\pm\nu_\tau$ events, it is almost the same as that given by Jasper Kirkby (4.7 MeV/c^2). He also showed that the statistical upper limit (95% C.L.) on the ν_τ mass is 3.5 MeV/c^2 from $\tau^\pm \rightarrow 5\pi^\pm\nu_\tau$ events. Combining both decays gives an upper limit (95% C.L.) of 2.9 MeV/c^2.

In order to realize this accuracy, very careful control of backgrounds and systematic errors will be required.


Confident Level
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
M_{ν_τ} (MeV)
25
50
100
150

3. Michel Parameter Measurement at τcF

For tau leptonic decay,

$$\tau \rightarrow e^- + \bar{\nu}_e + \nu_\tau$$

In tau rest frame,

$$\frac{dN}{dx} \sim x^2[12(1-x) - \frac{8}{3}\rho(3-4x) + r(x)]$$

x = E_e/E_{max}.
$\rho = \frac{3}{4}\frac{(g_V-g_A)^2}{(g_V-g_A)^2+(g_V-g_A)^2}$.
r(x) : radiative corrections.

- Possible ρ value

V-A type:	$\rho = \frac{3}{4}$
Pure V type:	$\rho = \frac{3}{8}$
Pure A type:	$\rho = \frac{3}{8}$
V+A type:	$\rho = 0$

- In standard model $\rho = \frac{3}{4}$.
- Present experimental result: $\rho_\tau = 0.727 \pm 0.033$ ($\sqrt{s} \sim$ 10 GeV).

If Tau-Charm Factroy operates at tau rest frame, tag channels,

$$\tau \rightarrow \pi\nu_\tau,\ K\nu_\tau$$

Monochromatic Pion and Kaon momentum can ensure clean data sample!

In our Monte Carlo simulation,

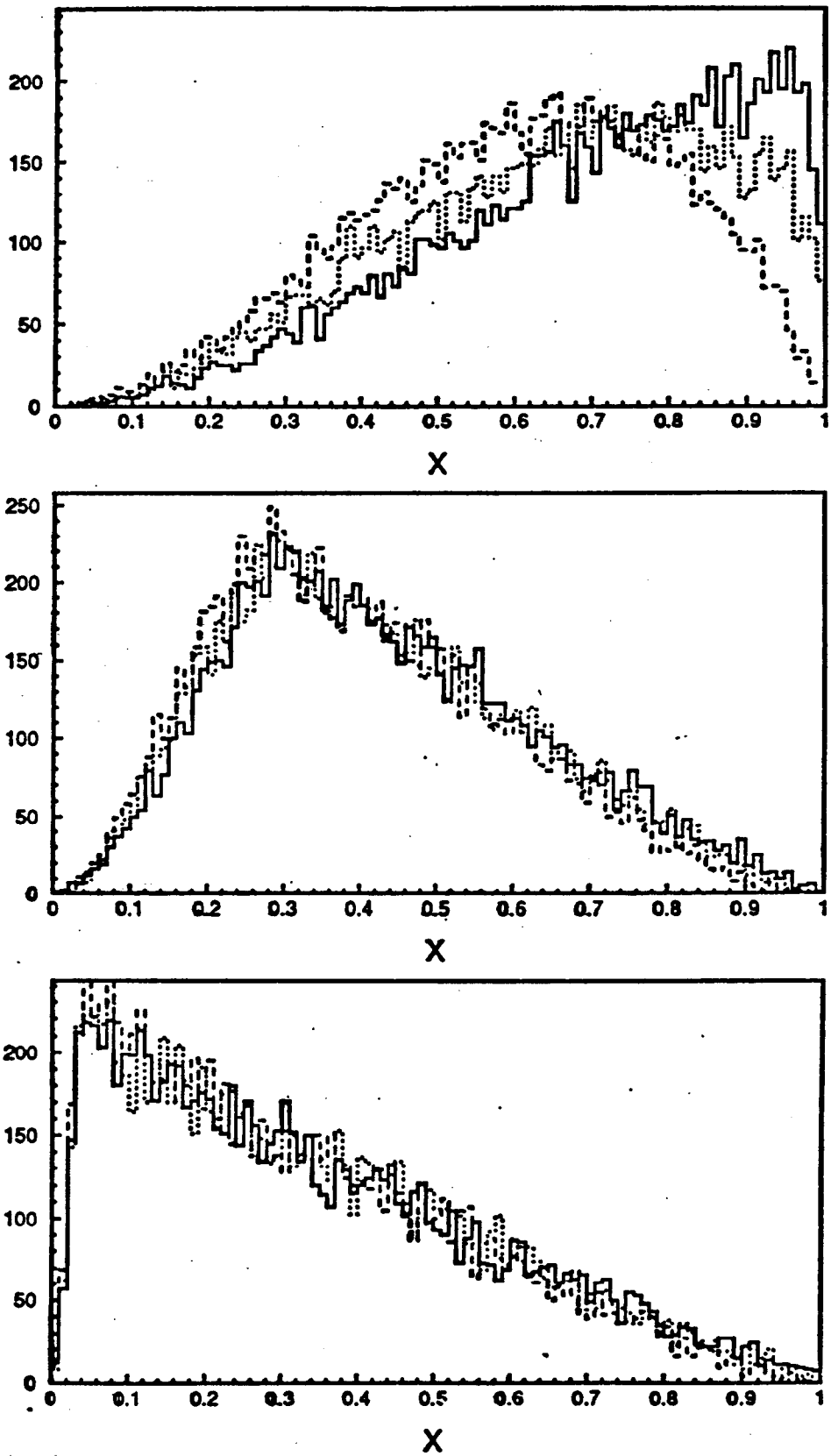
- $\sqrt{s}$=3.555 GeV, ρ is sensitive in whole x region.
- $\sqrt{s}$=4.25 GeV, ρ is not sensitive in whole x region.
- $\sqrt{s}$=10 GeV, ρ is fairly not sensitive in whole x region.

We expect ρ accuracy to be 0.5 % at τcF.

$\rho = \frac{3}{4}$

$\rho = \frac{3}{8}$

$\rho = 0$



$\sqrt{s} =$ [illegible] GeV

$\sqrt{s} =$ [illegible] GeV

$\sqrt{s} =$ [illegible] GeV

04/08/94 23.42

4. Pure Leptonic Decay of D at τcF

1) Importance

- Foundamental decay constant (upper limit $f_D < 290$MeV).
- f_B can be extrapolated reliably by f_D.
- Test to theoretical models (Lattice QCD, Potential, Bag, ...).

2) Advantages over B-Factory

- Large data sample (for one year running).

Particle	MKIII ($9.3pb^{-1}$)	B-F ($2fb^{-1}$)	τcF ($10fb^{-1}$)
D^0 (single)	$5.4 \times 10^4(\psi'')$	1.5×10^7 (10GeV)	$5.8 \times 10^7(\psi'')$
D^+ (single)	$3.9 \times 10^4(\psi'')$	0.7×10^7 (10GeV)	$4.2 \times 10^7(\psi'')$

- Pure $D\bar{D}$ final states near threshold.
- Backgrounds can be directly measured above or below threshold.
- Tagging technique can be used to tag D signal.
- Particle seperation is easier than that at high energy region ($\sqrt{S} \sim 10$ GeV).

3) Expected Pure Leptonic Events

$$B_r(D^+ \to \mu^+\nu) = \frac{G_F^2}{8\pi} f_D^2 \tau_D m_D m_\mu^2 |V_{cd}|^2 (1 - \frac{m_\mu^2}{m_D^2})^2$$

$$f_D = 175 \text{ MeV} \quad \Rightarrow \quad B_r = 2.7 \times 10^{-4}$$
$$f_D = 250 \text{ MeV} \quad \Rightarrow \quad B_r = 5.5 \times 10^{-4}$$

$$N_{tag} = 2N_{D\bar{D}} Br(D \to K\pi\pi) Br(D \to \mu\nu) \varepsilon_{K\pi\pi} \varepsilon_{\mu\nu}$$

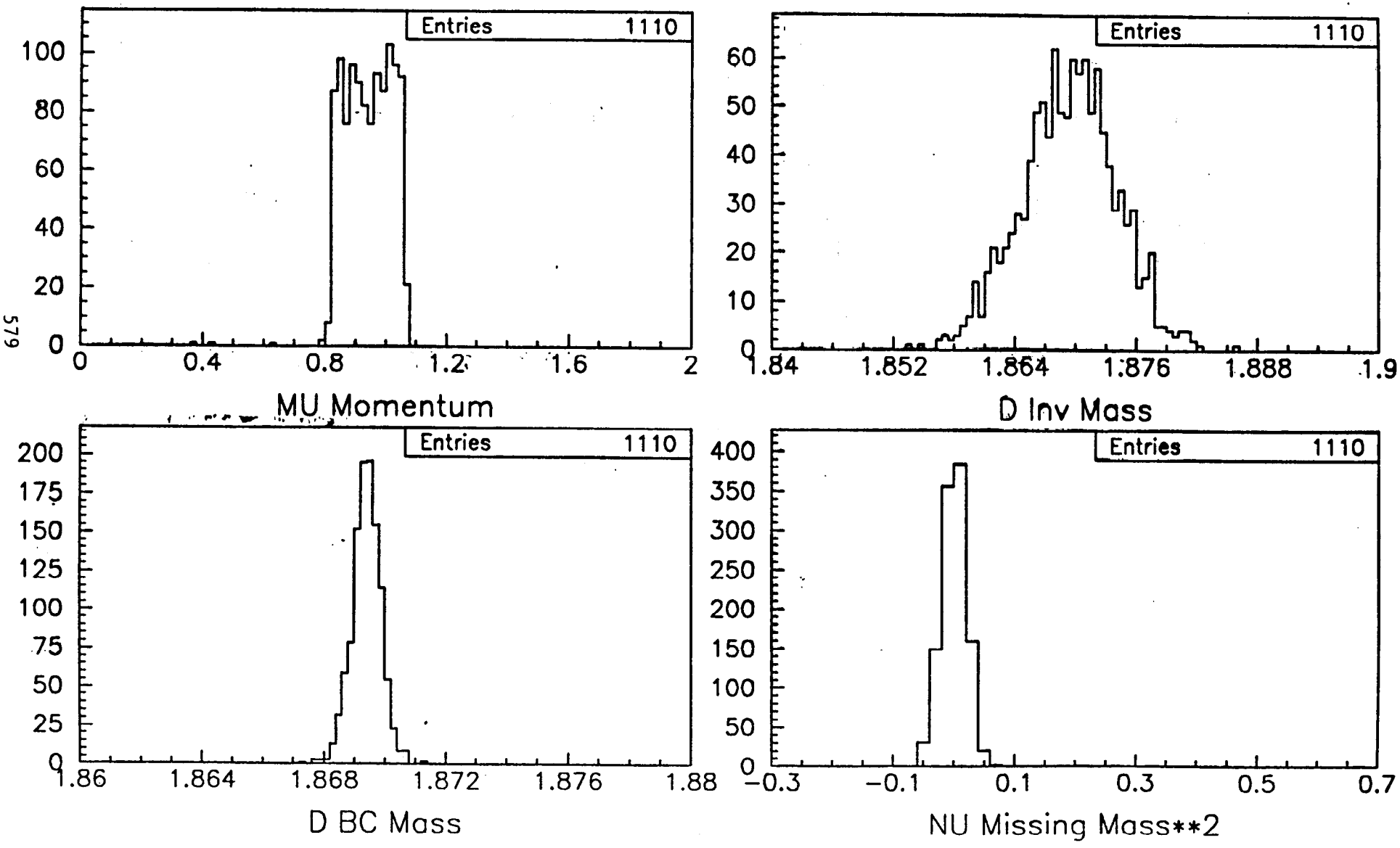
- In our Monte Carlo, $N_{D\bar{D}} = 2.1 \times 10^7$.
- Only $D \to K\pi\pi$ is used as the tagged channel.

$$Br(D \to K\pi\pi) = 8\% \qquad \varepsilon(D \to K\pi\pi) \sim 60\%$$
$$Br(D \to \mu\nu) = 2.7 \times 10^{-4} \quad \varepsilon(D \to \mu\nu) \sim 80\%$$

- From MKIII's experinence, a factor of 1.5 should be introduced to N_{tag}. In τcF, more channels available for tagging, at least a factor of 2 should be applied to N_{tag}.
- Conservative estimation on N_{tag}.

$$N_{tag}(D \to \mu\nu) \approx 1100$$

Psi(3770) --- DDbar Pure Leptonic Decay (Single Tagged)



4) Backgrounds

$$D^+ \rightarrow \bar{K}^0\pi^+, \bar{K}^0\mu^+\nu, \pi^0\pi^+, \ldots$$

ν square missing masses from the backgrounds lie in high mass band, well seperated from signal.

5) Statistical Error

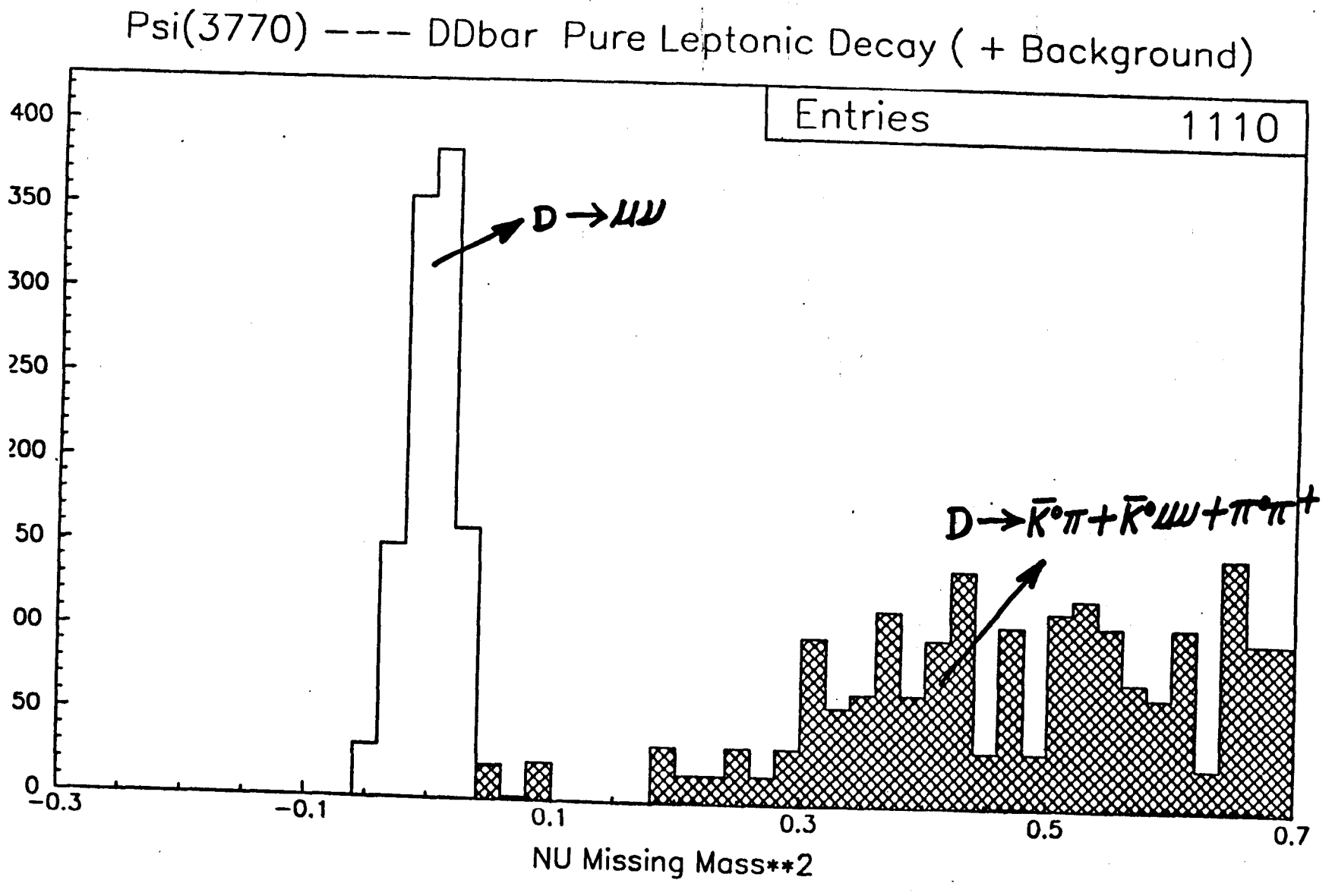
From 1100 detected events, 3% statistical error for Br($D \rightarrow \mu\nu$) is expected, since $Br \propto f_D^2$, 1 $\sim$ 2% statistical error for f_D is expected.

6) Systematic Error

Systematic errors arise from:

- uncertainties in detector efficiency.
- contribution from background events.
- uncertainties in particle identification, fake photons, mis-tracked particles etc..

It is expected that the systematic error for f_D will be the same level as its statistical error.


Psi(3770) --- DDbar Pure Leptonic Decay (+ Background)
Entries 1110
D→μν
D→K̄°π+K̄°μν+π°π+
400
350
300
250
200
50
00
50
0
−0.3
−0.1
0.1
0.3
0.5
0.7
NU Missing Mass**2

5. $D^0\bar{D}^0$ Mixing at τcF

1) Current Status

- Standard Model predicts,

$$r_D \equiv \frac{Br(\bar{D}^0 \to D^0 \to f)}{Br(D^0 \to f)} \leq 10^{-5} - 10^{-4}$$

- Present upper limit: $r_D < 10^{-3}$ at 90% C.L.

2) Signature of Mixing

$$\psi'' \to D^0\bar{D}^0(\rightsquigarrow D^0) \to (K^-\pi^+)(K^-\pi^+)\,.$$
$$\psi'' \to D^0\bar{D}^0(\rightsquigarrow D^0) \to (K^-e^+\nu)(K^-e^+\nu)\,.$$

Double Cabbibo Suppressed Decay (DCSD), same final state as $D^0\bar{D}^0$ mixing,

I.I. *Bigi*[*] proved: DCSD is impossible in the above processes due to the quantum statistics violation!

[*] Proc. Tau-Charm Factory Workshop, SLAC, California, USA, 23-27 May 1989, ed. L.V. Beers, SLAC-Report-343(1989).

3) Backgrounds Simulation

$$\psi'' \to D^0\bar{D}^0 \to (K^-\pi^+)(K^+\pi^-). \qquad \text{dominant}$$
$$\psi'' \to D^0\bar{D}^0 \to (K^-\pi^+)(K^+K^-)\,.$$
$$\psi'' \to D^0\bar{D}^0 \to (K^-\pi^+)(\pi^+\pi^-)\,.$$

Strong ability of particle identification at τCF is essential for background rejection.

In our Monte Carlo, a small sample of background $(K^-\pi^+)(K^+\pi^-)$ events (5000) was produced, no contamination $(K^-\pi^+)(K^-\pi^+)$ found. ENCOURAGING! More background events need to be produced to carefully study the misidentification of particles (MKIII had 3 like-sign kaon events, unable to see if they came from backgrounds at $\sigma_{TOF} = 200$ ps).

AIM: To keep the background to the level of one event or less!

4) Optimistic estimation on mixing events

Suppose: $r_D = 10^{-4}$, $\varepsilon_1 = \varepsilon_2 = 80\%$,

$$\begin{aligned} N_m &= 2N_{D^0\bar{D}^0}Br(D^0 \to K^-\pi^+)Br(\bar{D}^0 \to K^-\pi^+)\varepsilon_1\varepsilon_2 \\ &= 2 \times 2.9 \times 10^7 \times (3.65 \times 10^{-2})^2 \times 10^{-4} \times (0.80)^2 \\ &\sim 5 \end{aligned}$$

A few mixing events expected under $r_D = 10^{-4}$.

6. Pure Leptonic Decay of D_s at τcF

The width of pure leptonic decays of D_s is,

$$\Gamma(D_s \to l\nu) = \frac{G_F^2}{8\pi} f_{D_s}^2 m_{D_s} m_l^2 |V_{cs}|^2 (1 - \frac{m_l}{m_{D_s}})^2$$

which can be determined from the branching ratio and lifetime,

$$Br(D_s \to l\nu) = \frac{\Gamma(D_s \to l\nu)}{\Gamma_{total}} = \tau_{D_s} \cdot \Gamma(D_s \to l\nu)$$

so the weak decay constant f_{D_s} can be experimentally determined.

1) τ-Charm Factory

- $\sqrt{S} = 4.03$ GeV, $\sigma \sim 400$pb.
- $\int Ldt \sim 10fb^{-1}$ in one year.
- $N_{D_s^+ D_s^-} \sim 400pb \times 10fb^{-1} \sim 4 \times 10^6$.

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \eta' \rho^+$, $D_S^- \to \nu\nu$
  $\rho^+ \to \pi^+\pi^0$, $\eta' \to \gamma\rho^0$
  $\rho^0 \to \pi^+\pi^-$, $\pi^0 \to \gamma\gamma$ $9.5\% \times 30.0\% \times 98.798\% = 2.82\%$

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \eta' \rho^+$, $D_S^- \to \nu\nu$
  $\rho^+ \to \pi^+\pi^0$, $\eta' \to \pi^+\pi^-\eta$
  $\pi^0 \to \gamma\gamma$, $\eta \to \gamma\gamma$ $9.5\% \times 44.1\% \times 98.798\% \times 38.9\% = 1.61\%$

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \eta \rho^+$, $D_S^- \to \nu\nu$
  $\rho^+ \to \pi^+\pi^0$, $\eta \to \gamma\gamma$
  $\pi^0 \to \gamma\gamma$ $7.9\% \times 38.9\% \times 98.798\% = 3.04\%$

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \eta \rho^+$, $D_S^- \to \nu\nu$
  $\rho^+ \to \pi^+\pi^0$, $\eta \to \pi^+\pi^-\pi^0$
  $\pi^0 \to \gamma\gamma$, $\pi^0 \to \gamma\gamma$ $7.9\% \times 23.6\% \times 98.798\% \times 98.798\% = 1.82\%$

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to K^{*0} K^+$, $D_S^- \to \nu\nu$
  $K^{*0} \to K^\pm \pi^\mp$ 2.6%

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to K^{*0} K^{*+}$, $D_S^- \to \nu\nu$
  $K^{*0} \to K^\pm \pi^\mp$, $K^{*+} \to K^+\pi^0$
  $\pi^0 \to \gamma\gamma$ 5.0%

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \phi \pi^+$, $D_S^- \to \nu\nu$
  $\phi \to K^+K^-$ $2.8\% \times 49.1\% = 1.37\%$

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \phi \rho^+$, $D_S^- \to \nu\nu$
  $\rho^+ \to \pi^0\pi^+$, $\phi \to K^+K^-$
  $\pi^0 \to \gamma\gamma$ $5.2\% \times 49.1\% \times 98.798\% = 2.52\%$

- $e^+e^- \to D_S^+ D_S^-$, $D_S^+ \to \eta' \pi^+$, $D_S^- \to \nu\nu$
  $\eta' \to \gamma\rho^0$
  $\rho^0 \to \pi^+\pi^-$ $3.7\% \times 30.0\% = 1.11\%$

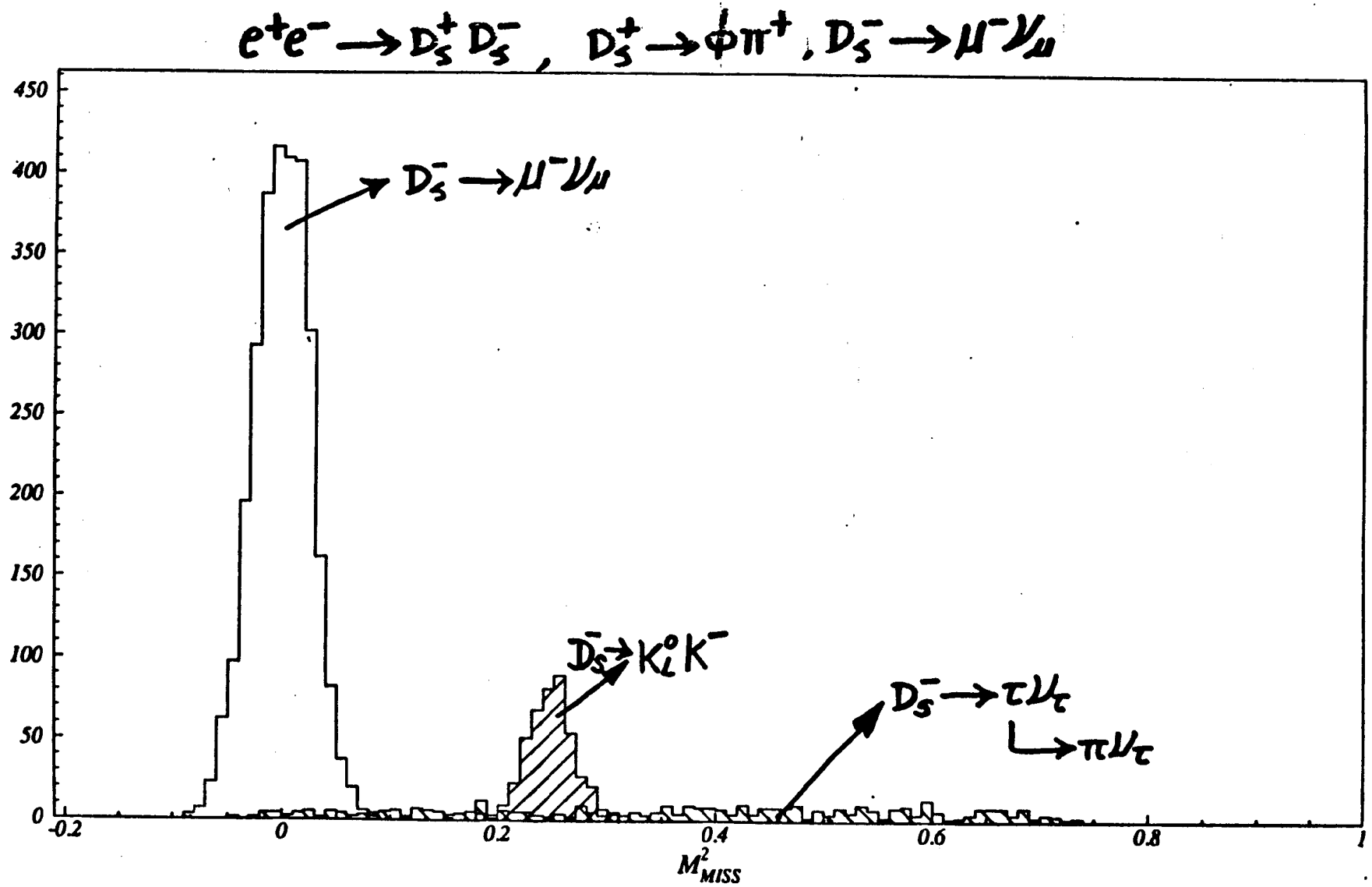
2) Advantages Over B-Factory

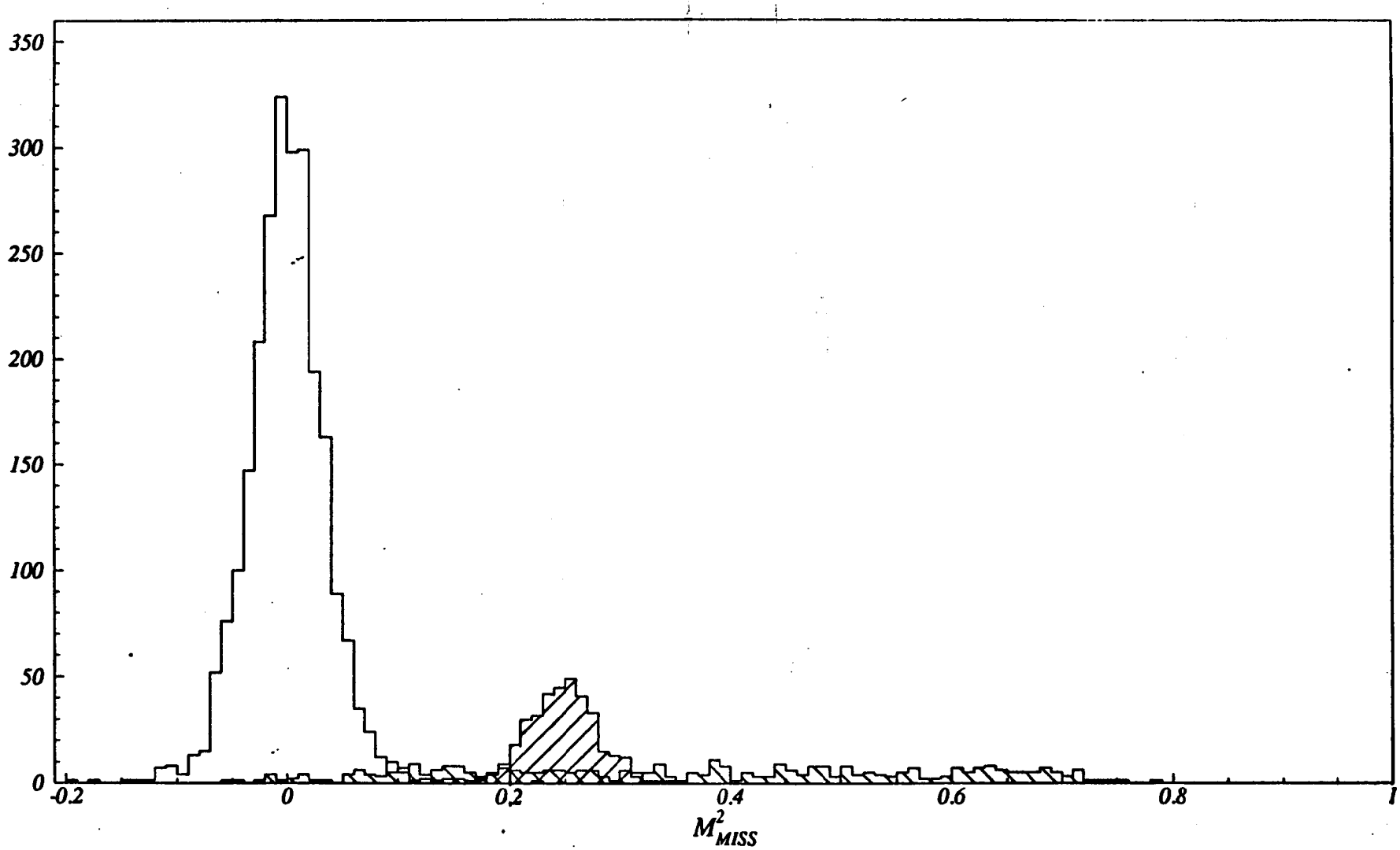
- Measuring backgrounds experimentally by lowering the beam energy below the threshold.
- Lower backgrounds.
- Operating near threshold, single-tagging technique can be used.
- Particle identification is easier than that at high energy region ($\sqrt{S} \sim 10$ GeV).

3) Monte Carlo Simulation

- C_sI(Tl) calorimeter enables us to tag some neutral decay channels with large branching ratios.
- at least $\sim 25\%$ branching fraction of total D_s decay modes can be used to tag D_s signal.
- single-tagging efficiency $\varepsilon_s \sim 60\%$
- resolution of D_s invariant mass $\sigma_m^{inv} \sim 10$ MeV.
- resolution of D_s beam constrained mass $\sigma_m^{bc} \sim 1.2$ MeV.

A more detailed Monte Carlo study shows that the backgrounds from $D\bar{D}, DD^*, D^*D^*$ contribute less in the D_s signal region, the signal can be clearly distinguished.


$e^+e^- \to D_s^+ D_s^-$, $D_s^+ \to \phi\pi^+$, $D_s^- \to \mu^-\nu_\mu$
$D_s^- \to \mu^-\nu_\mu$
$D_s^- \to K_L^0 K^-$
$D_s^- \to \tau\nu_\tau$
$\hookrightarrow \pi\nu_\tau$
450
400
350
300
250
200
150
100
50
0
-0.2
0
0.2
0.4
0.6
0.8
1
M^2_{MISS}



Square mass of missing

4) Estimation of f_{D_s}

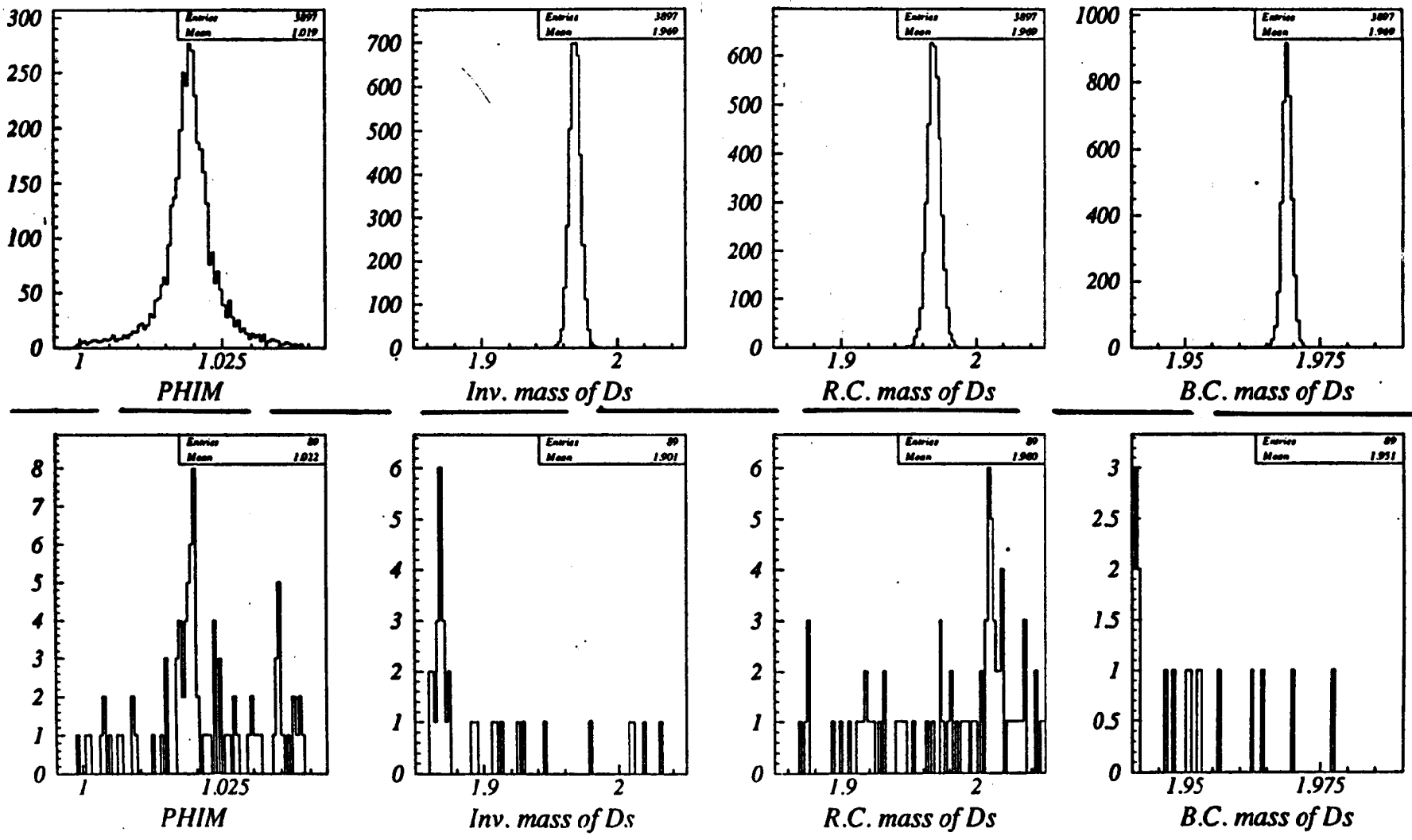
Assuming the branching ratio of $D_s \rightarrow \mu\nu$ is 5×10^{-3}. According to our Monte Carlo simulation, the detector acceptance for this process is $\sim$ 75%, 4000 - 5000 $D_s \rightarrow \mu\nu$ events will be expected in one year's running. The statistical error for f_{D_s} can be reached $1 \sim 2\%$.

Systematic errors arise from:

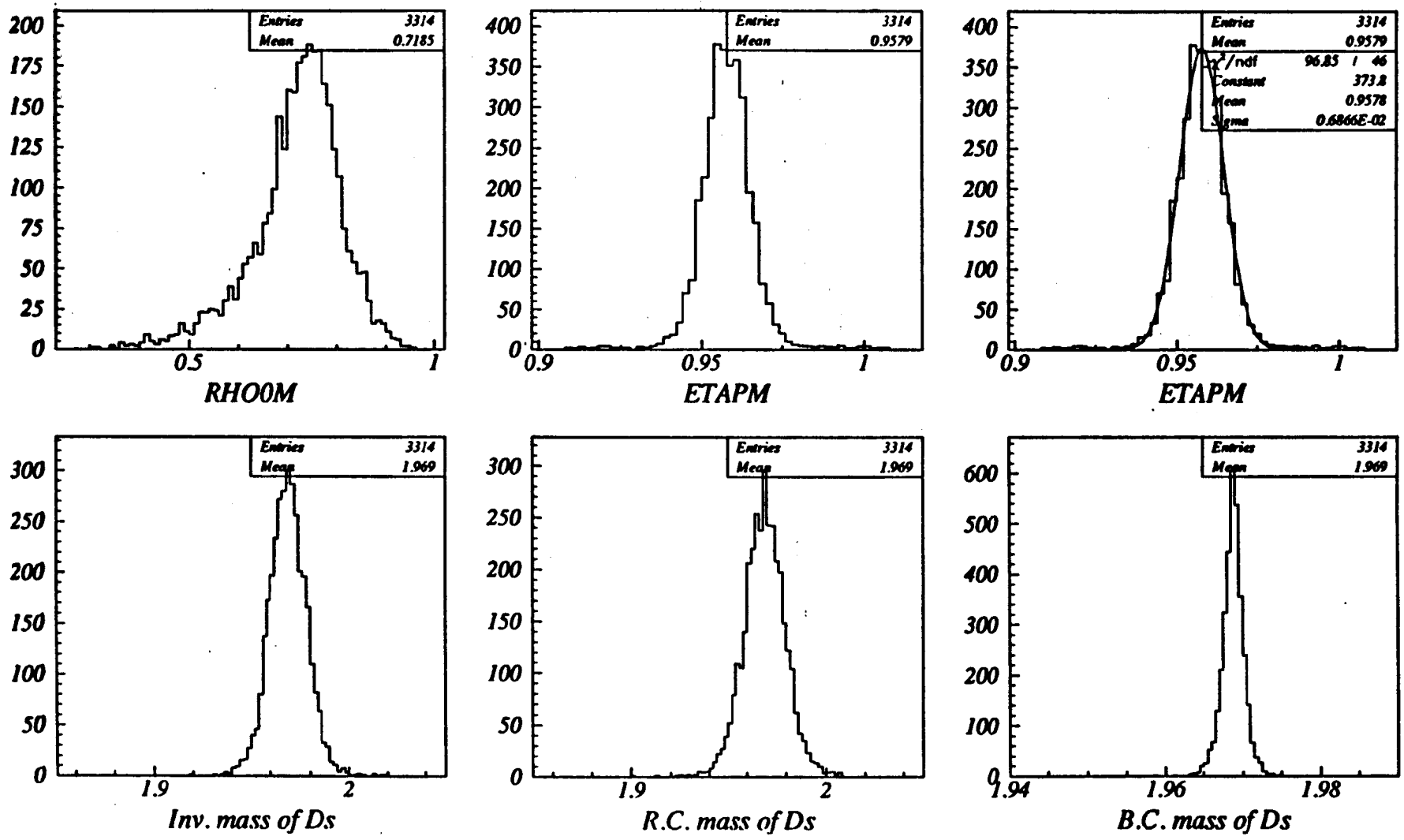
- uncertainties in detector efficiency.
- contribution from background events.
- uncertainties in particle identification, fake photons, mis-tracked particles etc..

It is expected that the systematic error for f_{D_s} will be the same level as its statistical error.

$e^+e^- \to D_s^+ D_s^-$, $D_s^+ \to \phi\pi^+$, $D_s^- \to \nu\nu$, $\phi \to K^+K^-$



DI


Entries 3314
Mean 0.7185
RHO0M
Entries 3314
Mean 0.9579
ETAPM
Entries 3314
Mean 0.9579
χ²/ndf 96.85 / 46
Constant 373.8
Mean 0.9578
Sigma 0.6866E-02
ETAPM
Entries 3314
Mean 1.969
Inv. mass of Ds
Entries 3314
Mean 1.969
R.C. mass of Ds
Entries 3314
Mean 1.969
B.C. mass of Ds

Summary

At Tau-Charm Factory:

σ_{m_τ} (MeV)	< 0.1 MeV
Upper Limit of m_{ν_τ} (MeV)	~ 3 MeV
σ_ρ (%)	$O(0.5\%)$
$D - \bar{D}$ Mixing	$r_D \sim 10^{-4}$
σ_{f_D} (%)	$O(2\%)$
$\sigma_{f_{D_s}}$ (%)	$O(2\%)$

Based on full advantages of the large increase in statistics expected at Tau-Charm Factory, and a high-resolution detector, τcF will provide a super experimental tool to fundamental measurement with unprecedented precision in a wide range involving τ, charm and charmonium decays. The threshold region can offer the best control of systematic errors.

τcF and B-factory are complementary rather than replaceable each other.