A FEW COMMENTS ON THE TCF BASELINE DETECTOR

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SLAC TC WORKSHOP
8 MAR 99

- A TCF DETECTOR WAS DEVELOPED WITH THE INPUT OF MANY PEOPLE OVER THE COURSE OF SEVERAL WORKSHOPS AND DESIGN STUDIES (SLAC, SPAIN, CHINA)

Detector requirements

- **Detector-induced systematics must be kept small and accurately monitored:**
  - ◆ Error in geometrical acceptance
  - ◆ Error in efficiency
  - ◆ Error in resolutions
  - ◆ Non-gaussian tails
  - ◆ Mis-measurements (tracking, fake γ, overlaps, particle id)

=>

- ➤ Uniform & efficient detectors
- ➤ Highly granular
- ➤ Redundant measurements
- ➤ Frequent calibration & monitoring at J/ψ etc.

THIS IS A UNIQUE AND
VERY POWERFUL
TOOL TO CALIBRATE
AND MONITOR ALMOST
ANY ASPECT OF THE
τcF DETECTOR

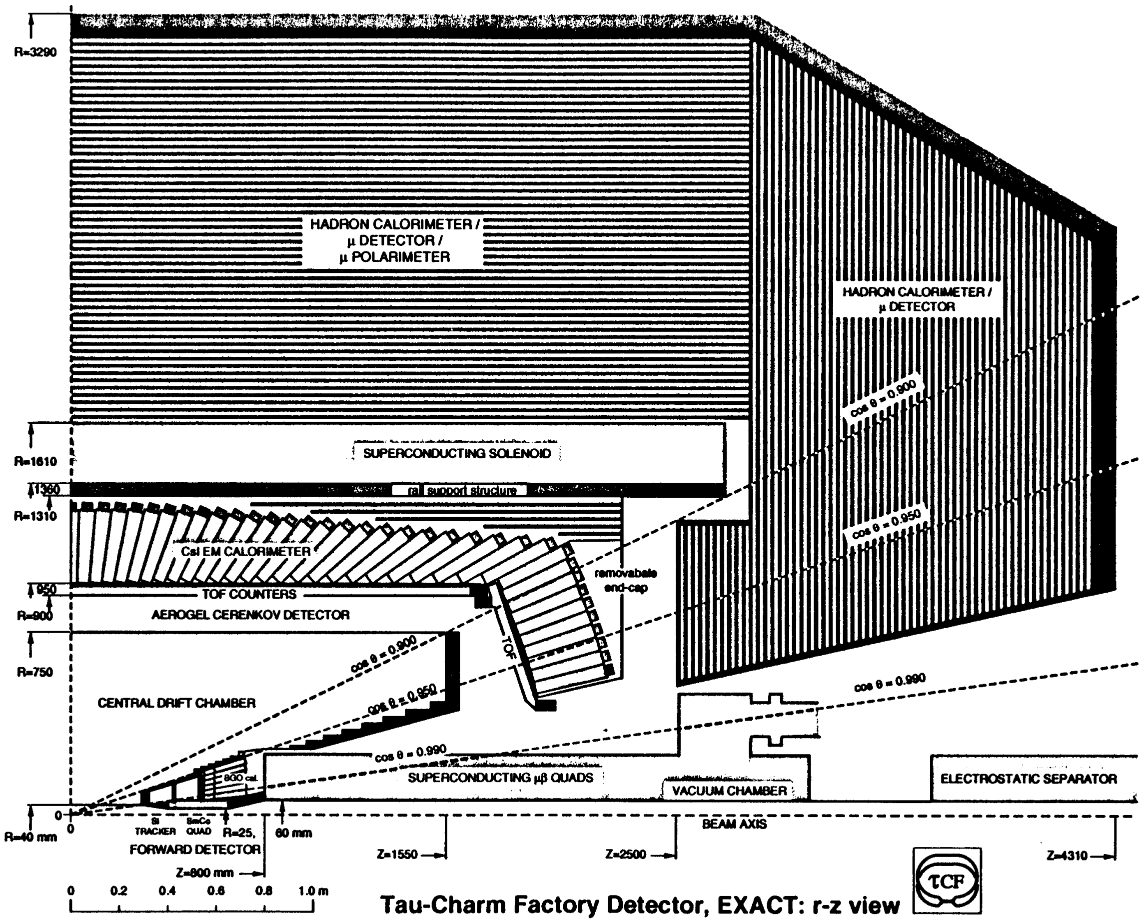
Detector calibration at TCF

- Example of some calibration channels at the J/ψ (1.3kHz total rate):

Particle	Final states	Rate (/day)
$\pi^{\pm},\pi^0$	$\rho\pi$	2M
$K^{\pm}$	K^*K	0.7M
p	pp, $pp\pi^0$, $pp\pi^{\pm}$	1.5M
γ	$\rho\pi$, $\gamma 4\pi^{\pm}$, γee	2M
K^0_L	$K^0_L K^0_S$	10k
n	$np\pi$	0.3M
e	ee, γee	8M
μ	$\mu\mu$, $\gamma\mu\mu$	8M

Design criteria

- Precision measurement of ch. particles
- Precision measurement of γ's
- Full solid angle acceptance
- Hermeticity ⇒ ν "DETECTION
- Excellent π, K, p id
- Excellent e, μ id
- MUON POLARIZATION
- Precision L measurement
- High-performance DAQ system



Tau-Charm Factory Detector, EXACT: r-z view

BASELINE TCF DETECTOR PERFORMANCE

Item	Performance
Charged particles:	
Momentum resolution: σ_p/p**(GeV/c)**	$0.2\% p \oplus 0.2\%/\beta$
Angular resolution: $\sigma_{\theta,\phi}$ **(mr)**	**2/p**β
p_t^{min}**(MeV/c) for efficient reconstruction**	**50**
Acceptance	**95%**
Photons:	
Energy resolution: σ_E/E**(GeV)**	$1\%/\sqrt{E} \oplus 2\%$
Angular resolution: $\sigma_{\theta,\phi}$ **(mr)**	$4/\sqrt{E} \oplus 2$
2γ **angular separation (mr)**	**50**
E_γ^{min}**(MeV) for efficient detection**	**10**
Acceptance	**95%**
Particle identification (inc. Če.):	
K/π **separation (below 1.5 GeV/c)**	$< 10^{-6}$
e/π **separation**	10^{-4}
μ/π **separation**	$2\%/p + 2\%$
Acceptance	**90%**
Additional particle identification:	
p_t^{min}(MeV/c) for efficient ν tagging by E_{miss}	100
K_L^0 acceptance × detection efficiency	80%
μ polarisation acceptance	20%

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-Trk$_{Eff}$	AS BES-I	95 %
Spatial-Res.σ_z	AS BES-I	5.5cm
DAQ	< 10ms	> 20ms

ABF detector differences

- **More similarities than differences:**
  - Similar design requirements
  - (Similar/same physicists!)

- **Asymmetric detector**

- **Silicon vertex detector:**
  - ABF ~4% X_0 (TCF ~0.2% X_0)
  - <Eloss> ~1 MeV + Landau fluct.
  - $\sigma(5\pi)$ = 2 MeV for TCF [$m(\nu_\tau)$]

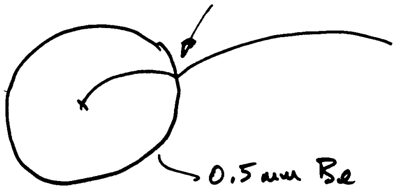
- **Particle (πK) id up to higher momenta:**
  - Boosted momenta in fwd direction
  - B physics: < ~4.5 GeV
  - τ physics: < ~8 GeV (TCF ~ 1GeV)

MASS RESOLUTION AT τ END-POINT

$\Rightarrow$ $M(\nu_\tau)$ MEASUREMENT

- $M(\nu_\tau)$ SENSITIVITY $\propto \dfrac{\sigma(M_{5\pi})}{\sqrt{N}}$

$\Rightarrow$ STRONG PREMIUM ON OPTIMIZING THE 5π (etc) MASS RESOLUTION.



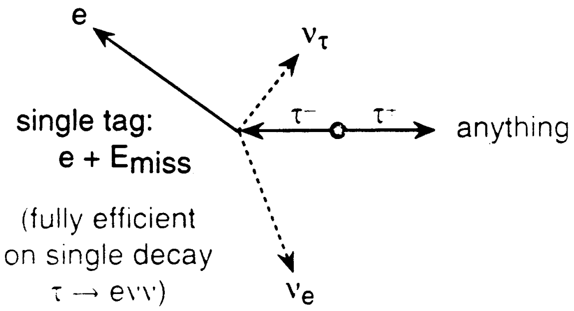
SINGLE SCATTER ALLOWS CORRECTION OF ANGLE

0.5 mm Be (0.2% X_0)

[MINIMIZES dE/dx LOSS, $\delta\theta$]

$\sigma(M_{5\pi}) = 2$ MeV cf. 15 MeV ALEPH/BABAR

Single-tagged τ samples at TCF



single tag:
e + E_{miss}

(fully efficient
on single decay
$\tau \rightarrow e\nu\nu$)

- Non-τ backgrounds 10^{-4} - 10^{-3}
  (below charm threshold)

- Typical backgrounds at CESR/LEP ~1%

- At 3.67 GeV:

	ε (qq)	ε(ττ)	#qq/ττ
No cuts	1	1	6
Emiss>0.8 GeV	.005	.95	.03
+Ee>0.4 GeV	10^{-5}	.24	$2\text{x}10^{-4}$

SINGLE-TAGGED τ SAMPLES AT τCF

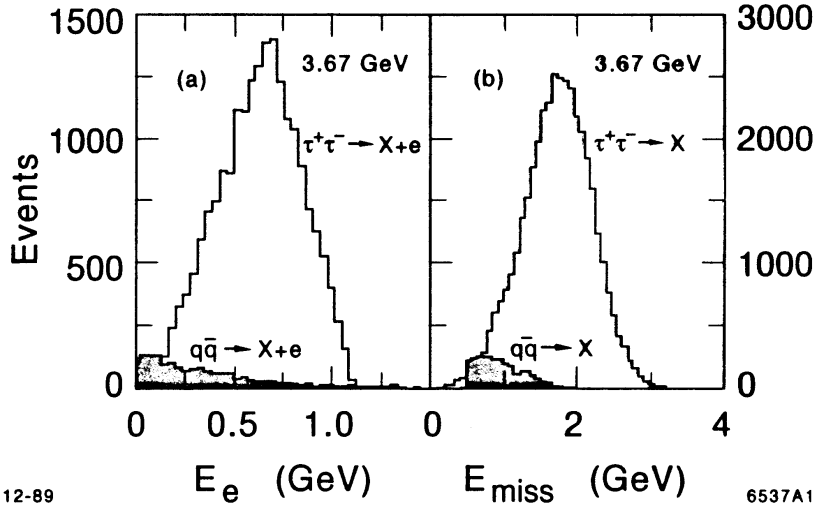
J. J. GOMEZ-CADENAS / JK

DETECTOR ASSUMPTIONS:

$P(\pi \to e) = 10^{-3}$

γ INEFF. $= 10^{-2}$ ← HERMITICITY

K^0_L INEFF $= 5\%$ ← "



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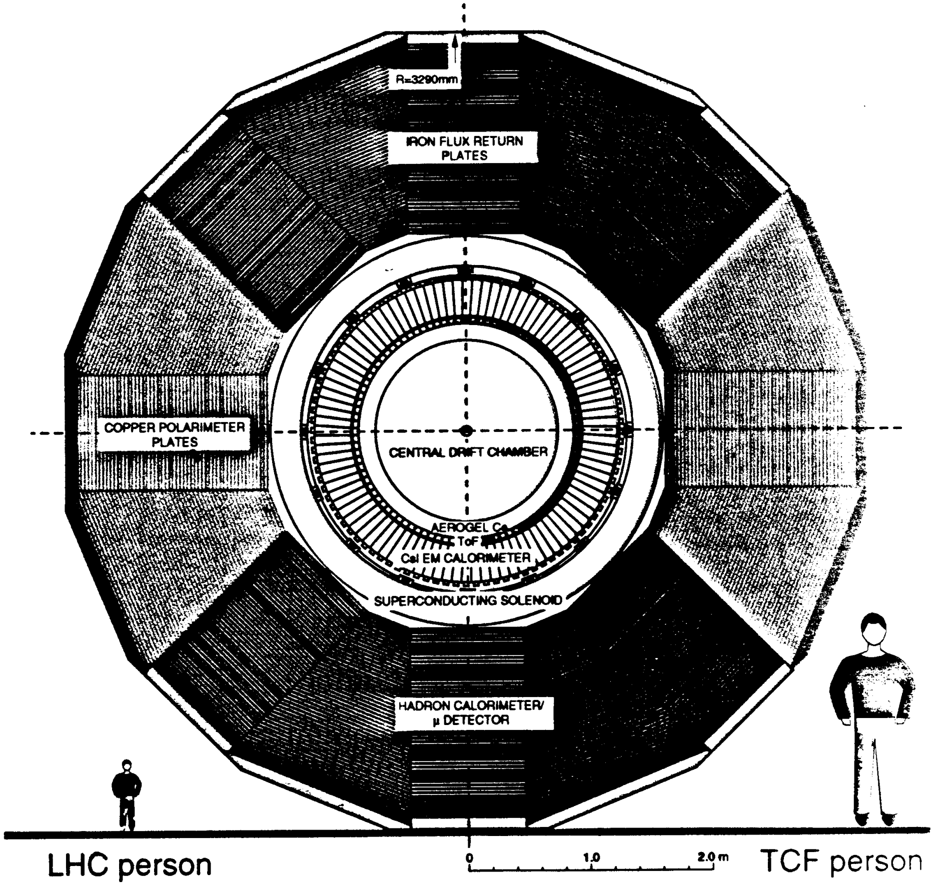
	$\epsilon(q\bar{q})$	$\epsilon(\tau^+\tau^-)$	$\#q\bar{q}/\tau^+\tau^-$
NO CUTS	1	1	6
$E_{miss} > 0.8$ GeV (+ $P^{\perp}_{miss} > 0.1$ GeV)	$5\ 10^{-3}$	0.95	0.03
+ $E_e > 0.4$ GeV	10^{-5}	0.24	$2\ 10^{-4}$

Muon polarimeter

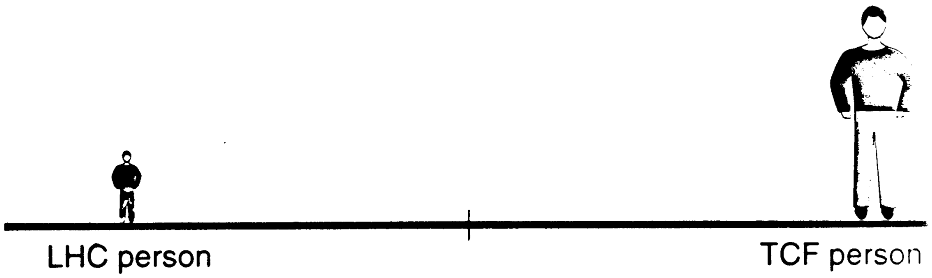
- **BTCF may be uniquely capable of measuring μ spin direction in $\tau \to \mu \nu \nu$ ($p_\mu < 1$ GeV !):**
  - ◆ CP violation observables in τ decays
  - ◆ ξ'_μ Michel parameter



LHC person

TCF person

- **Polarimeter:**
  - ◆ Cu plates (Fe flux return sufficient)
  - ◆ RPC readout (spin direction and μ decay time
  - ◆ Weak B field for precession


LHC person
TCF person

Muon polarimeter

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  - ◆ CP violation observables in τ decays
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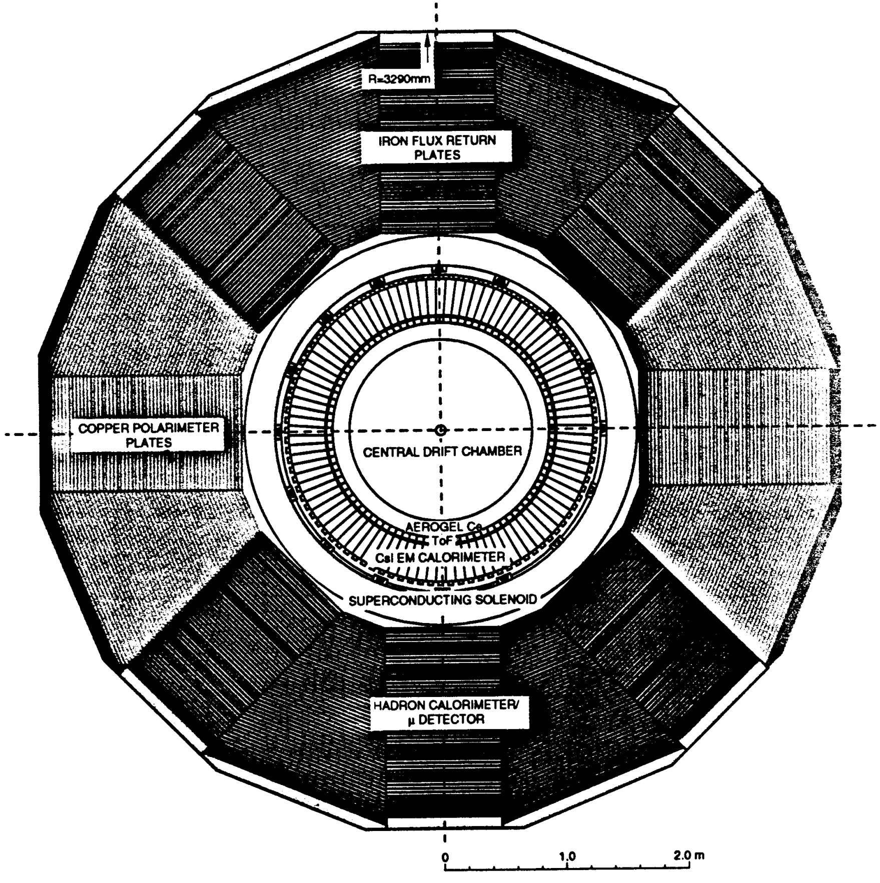

- Polarimeter:
  - ◆ Cu plates (Fe flux return sufficient)
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K^0_L DETECTION IN XSTAL EM CALORIMETER

$\bar{p}p \to K_L K_S$

$\uparrow$

795 MeV/c

SUFFERT/MARE [illegible] 13

$\epsilon = 57 \pm 3$ % / 30cm CsI(Tl) XSTALS

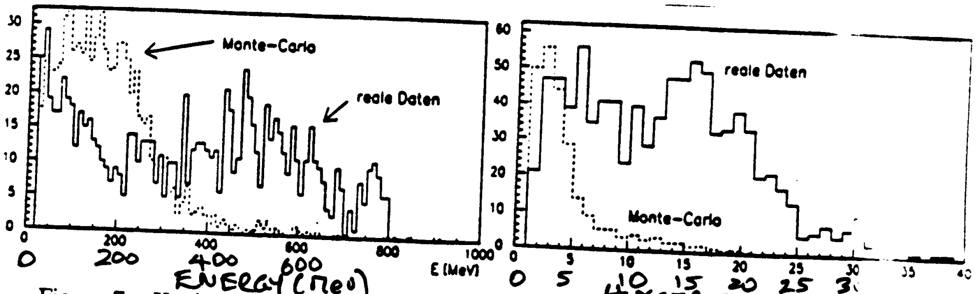

Figure 7: K_L interaction in the CB e.m. calorimeter, $p(K_L)$ = 795 MeV/c; full line: experimental data, dotted line: Monte Carlo data [7], (a) energy distributions, (b) distribution of the number of crystal per K_L cluster.

DETECTOR / MACHINE BACKGROUNDS

D. STOKER / SLAC
P. ROUDEAU / ORSAY

1. SYNCHROTRON RADIATION

- $E_c = 0.35$ keV (cf. m.f.p. 1 keV γ = 0.1 μm Cu)
- HEAT LOAD ± 8m OF IP = 2W/m FROM SYNCH. RADN.

2. SCATTERED BEAM PARTICLES + BREMSSTRAHLUNG

- 6 kHz e RATE ($p_\perp > 0.1$ GeV) HIT B-PIPE ± 0.8m OF I.P. [@ $2\ 10^{-9}$ mbar]
- COMPARABLE RATE OF HARD γ's

COMPUTING

1. ON-LINE

- PHYSICS RATE : ~ 2 kHz ON-RESONANCE
  ~ 100 Hz OFF-RES. (SCALE e^+e^-)

- TRIGGER INVOLVES STANDARD LHC ARCHITECTURE: DEADTIMELESS LEVEL 1 (38 ns Δt), LEVEL 2 AND FULL EVENT RECONSTRUCTION IN LEVEL 3 PROCESSOR

- I/O BANDWIDTHS OK : 20 k byte EVENT SIZE
  40 Mbyte/s @ 2 kHz

- LEVEL 3 PROCESSOR OF 2×10^4 MIPS REQUIRED [~100 × LEP DETECTOR]

- DATA STORAGE REQUIREMENTS ARE SUBSTANTIAL:
  - ~ 60 Tbytes/y [ASSUMING 10% ON-RES + 90% OFF-RES]
  - 2 kHz RATE FILLS 10 Gbyte CASSETTE IN 4 min!
    (⇒ WRITE 100% DST + 5% RAW DATA?)

2. OFF-LINE

1) M/C GENERATION : - USE ON-LINE CPU IF 10% ON-RES.
⇒ OTHERWISE 2×10^4 MIP OFF-LINE

2) RE-PROCESSING : - 2 × PER YEAR; COMPLETE IN 1 MO
⇒ 1×10^4 MIP PROCESSOR

3) PHYSICS ANALYSIS : - READ ALL DST'S 2 × PER WEEK
⇒ 3×10^4 MIP PROCESSOR