

DÉCLENCHEMENT DU DÉTECTEUR EXTERNE

DE DELPHI

MESURE DES PARAMÈTRES DU MODÈLE STANDARD

DANS LE CANAL



I

L'EXPÉRIENCE

II

LE DÉCLENCHEMENT

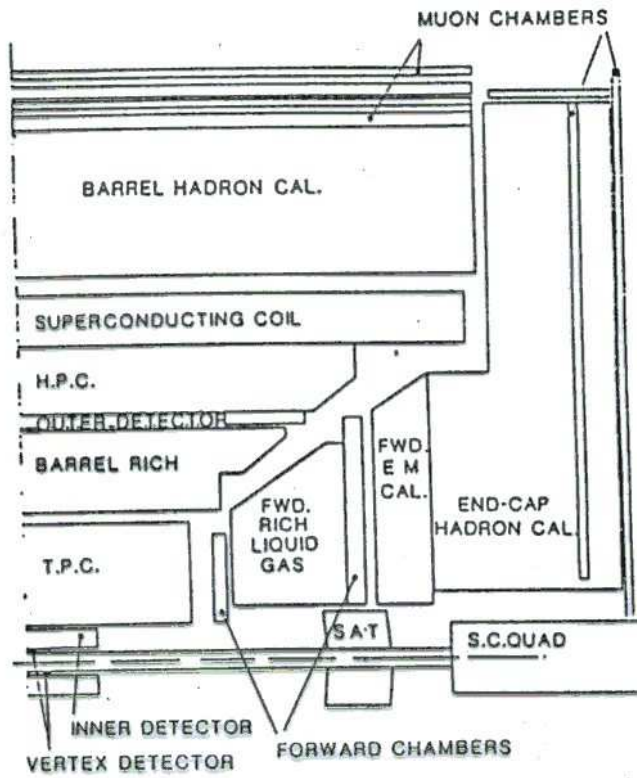
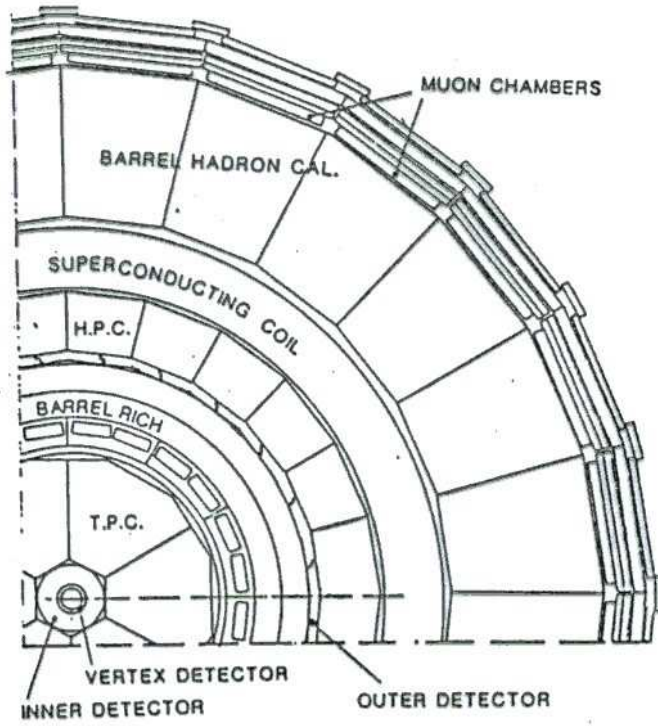
III

LE CANAL $e^+e^- \rightarrow \mu^+\mu^-$

IV

RÉSULTATS

CONCLUSION



θ ($^\circ$)

Résolution

 $R\phi$ (mm) z (mm)

DÉTECTEURS DE TRACE

VD	37-143	0.007	—
ID	17-163	0.11	< 2
• TPC	20-160	0.23	0.9
• OD	43-137	0.11	44
• MUB	52-138	1.5	10

DÉTECTEUR DE TEMPS DE VOL

TOF $41-139$ $\sigma_T = 1.2$ ns

DÉTECTEUR ČERENKOV

RICH $\sim 40-140$

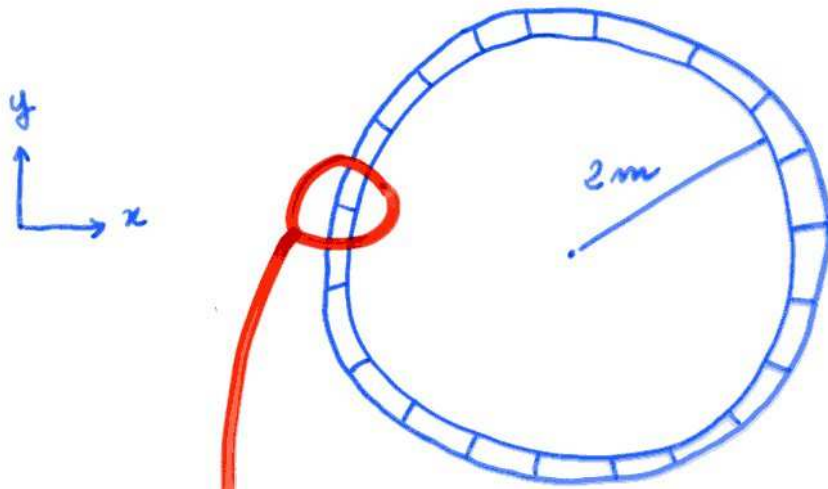
CALORIMÈTRES

		σ_e/E (%)
• HPC	43-137	$23/\sqrt{E} + 1.1$
• HAB	10-170	$120/\sqrt{E}$
SAT	2.5-7.7	$\sim 11.4/\sqrt{E} + 2.3$
VSAT	5-7 (mrad)	5% à 45.6 GeV

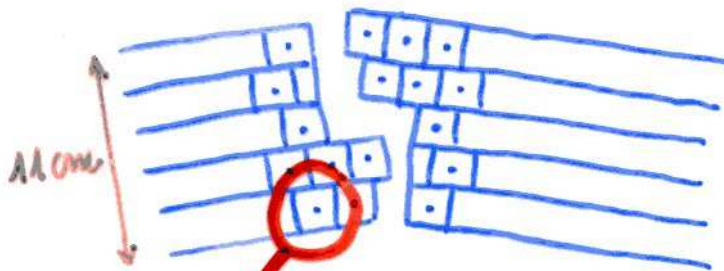
À L'AVANT :

FCA, RiF, FCB, EMF, HAF, HOF, HUF

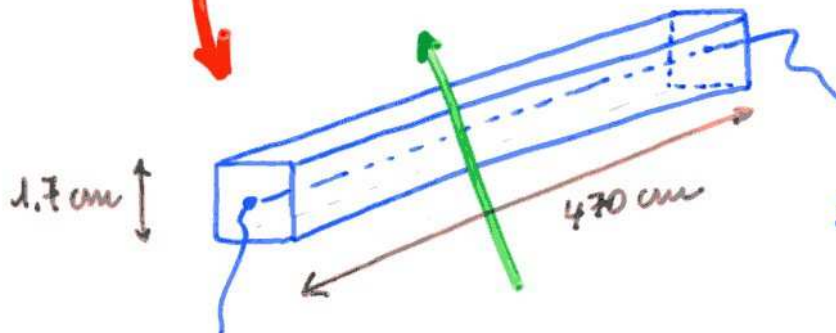
2) L'OD



24 PLANKS



5 COUCHES



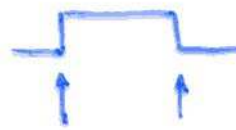
3480 tubes

LES DONNÉES DE L'OD

LES TDC's :



2 mots par tube



⇒ $R\phi$ ($\sigma \sim 150 \mu\text{m}$)

LES TFD's :

→ FTDC : un mot z par tube



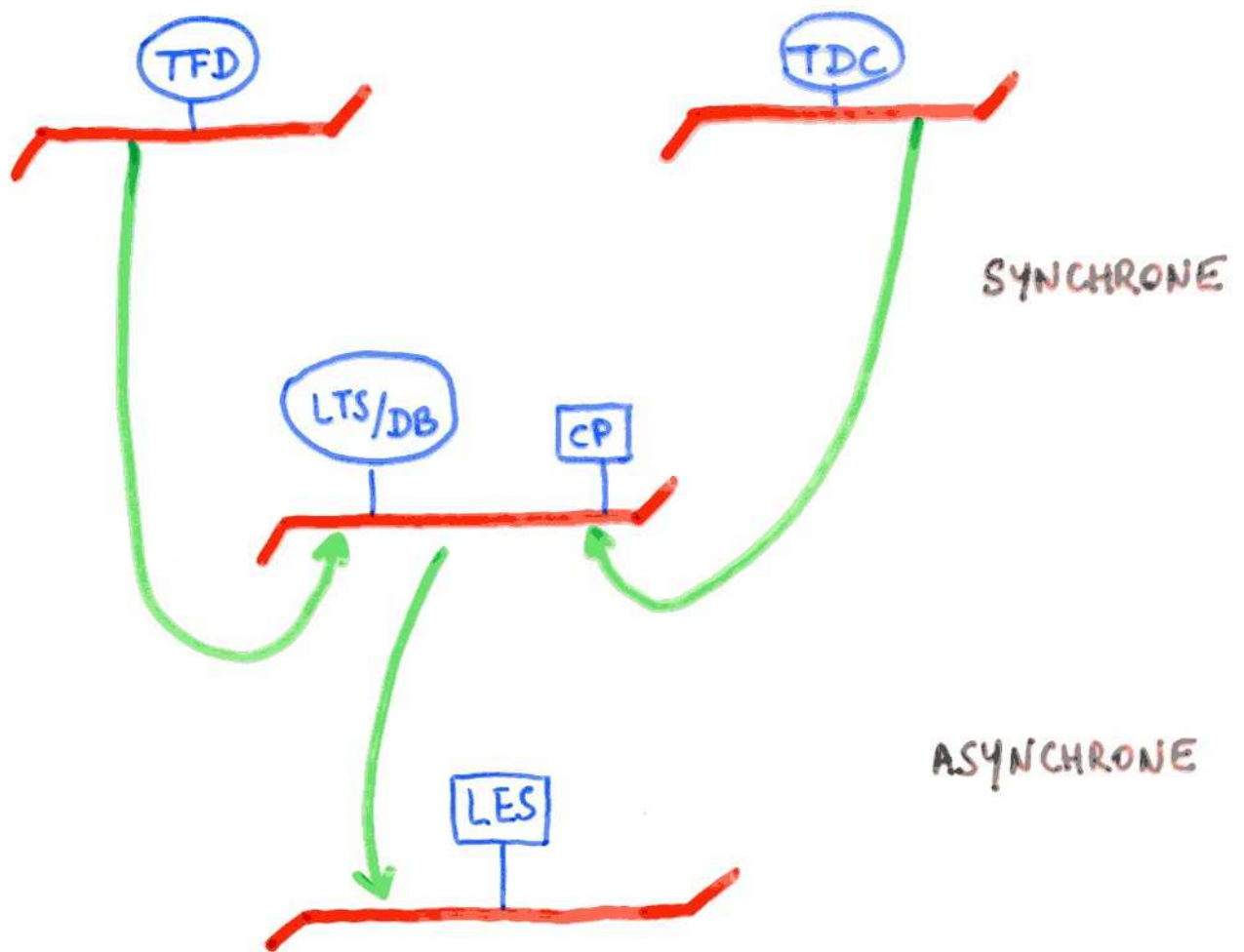
→ TF : reconnaissance de configurations (n traces)



→ MEAN z : n_z

⇒ $\sim 500 \text{ ms}$

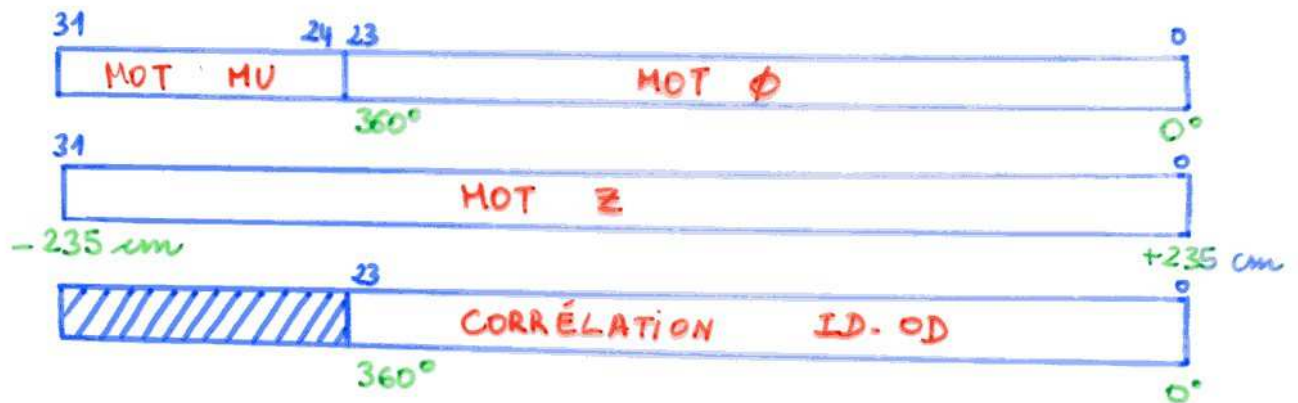
SYSTÈME D'ACQUISITION DE L'OD



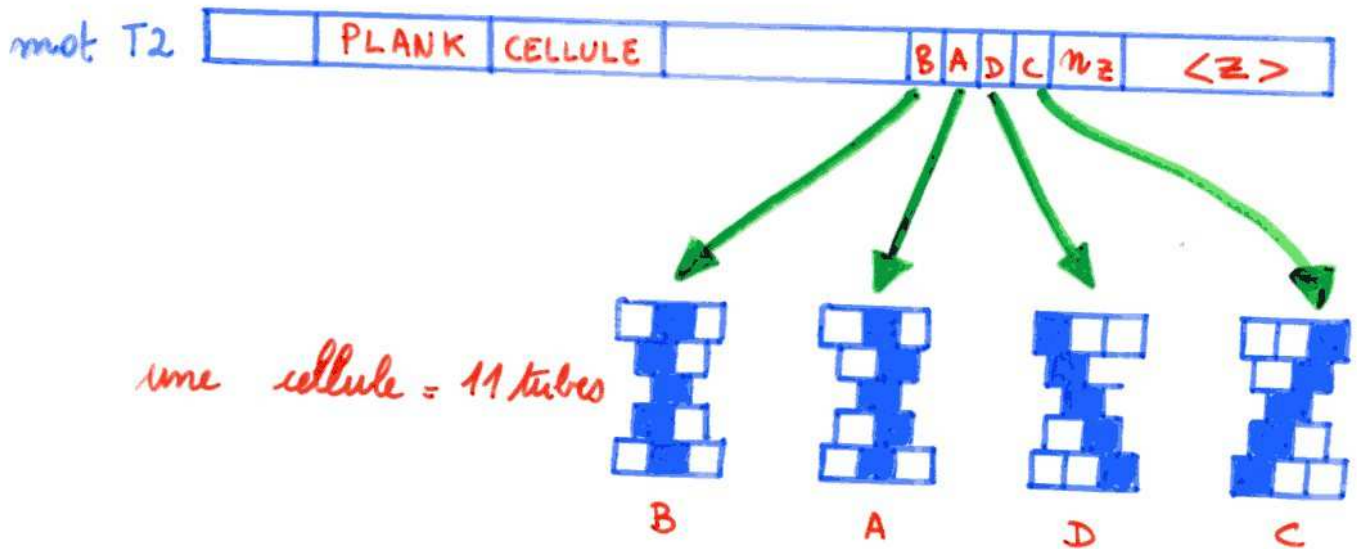
II LE DÉCLENCHEMENT

1°) LE DÉCLENCHEMENT DE L'OD

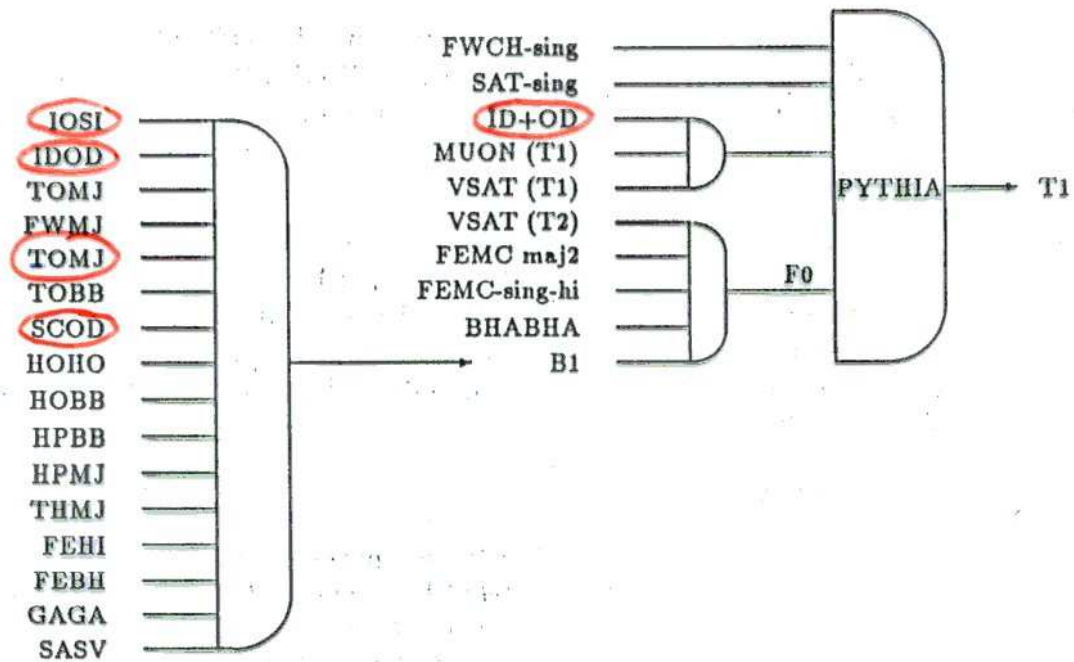
PREMIER NIVEAU (≈ 99 μs)



DEUXIÈME NIVEAU



3) L'OD dans le déclenchement global de DELPHI



$ID + OD = \text{correlation } ID \cdot OD$

$IOSI = ID + OD \text{ prescaled}$

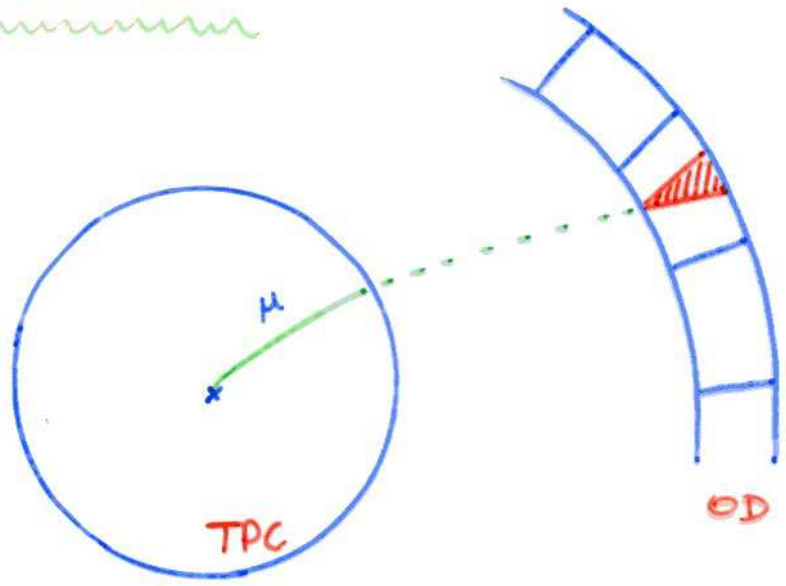
$IDOD = (ID * OD) \text{ bb}$

$IOMJ = ID * (OD \text{ maj } 2)$

$SCOD = TOF * (OD \text{ maj } 1)$

EFFICACITÉS DE DÉCLENCHEMENT

au premier niveau

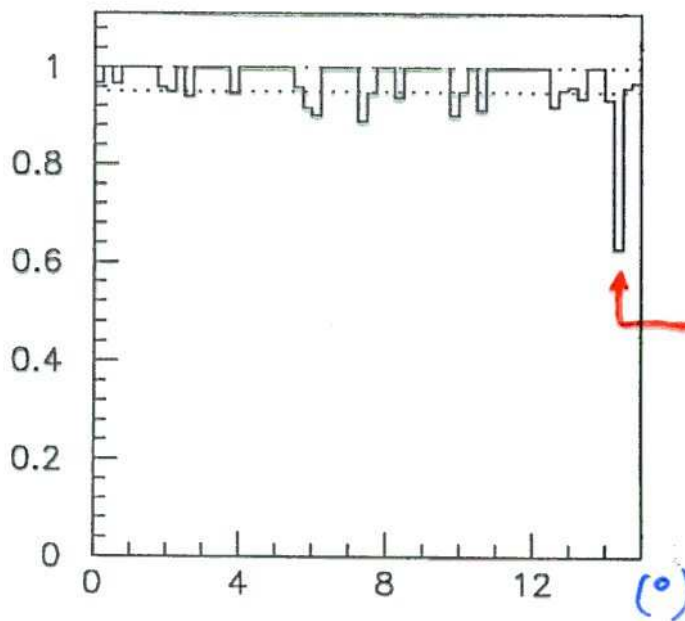


MOT $\phi \Rightarrow \epsilon_{\phi} = \frac{\text{[diagram of one tube]} + \text{[diagram of two tubes]}}{\text{[diagram of two tubes]}} = (97.0 \pm 0.5) \%$



- pb d'alimentation
- inefficacité des tubes

EFFICACITÉ EN ϕ



$$\epsilon_{\phi} = (97.0 \pm 0.5)\%$$

CELLULE 29

ϕ MODULO UN PLANK

FINALEMENT

$$\begin{aligned} \epsilon_{T1} &= \epsilon \cdot \epsilon_{LTS/DB} \\ &= (98.4 \pm 0.4)\% \quad \text{PAR TRACE} \end{aligned}$$

Efficacité de second niveau

$$\varepsilon = \frac{\sum \text{traces } T_2}{\sum \text{traces } T_1} = 99.7\%$$

En fait, on demande $n_3 \gg 2$

$$\Rightarrow \varepsilon = (97.5 \pm 0.4)\%$$

et $\varepsilon_{T_2} = \varepsilon \cdot \varepsilon_{T_1}$

$$\varepsilon_{T_2} = (95.9 \pm 0.4)\%$$

LE TROISIÈME NIVEAU

Niveau de déclenchement	Taux de déclenchement (Hz)
collisions	$45 \cdot 10^3$
T1	500
T2	2
T3	2
T4	2

Augmentation de Luminosité

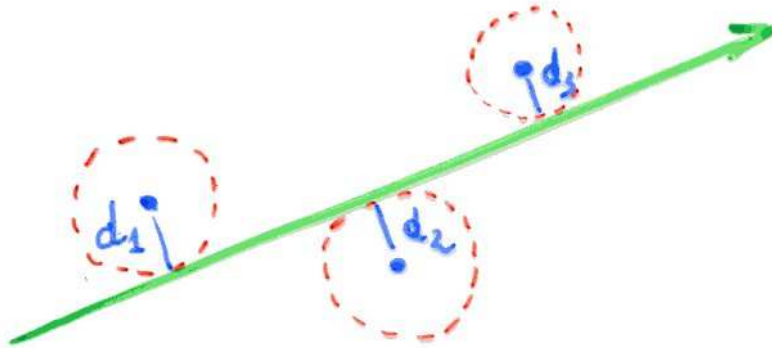
Rejection d'événements

Acquisition d'événements rares

Préparation du T4

T3

2°) le t_0



équation de contrainte :

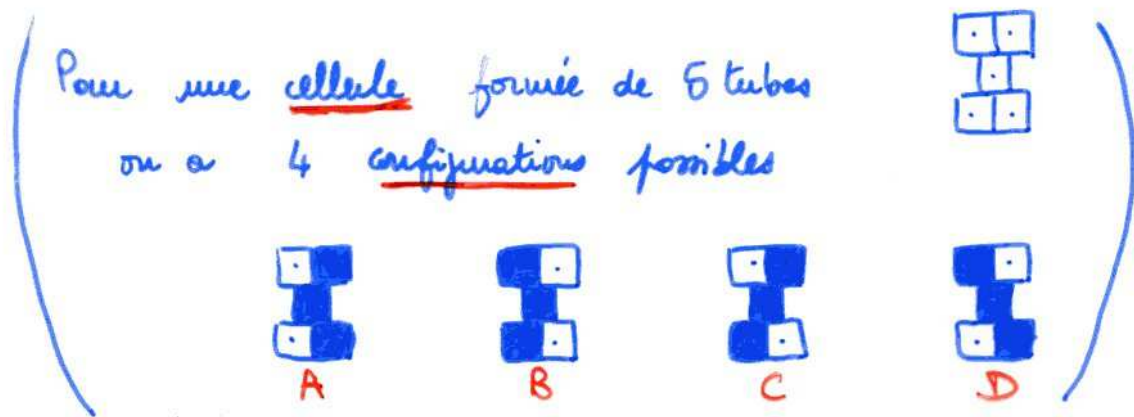
$$d_1 - 2d_2 + d_3 = a \quad (\text{algébrique!})$$

Principe :

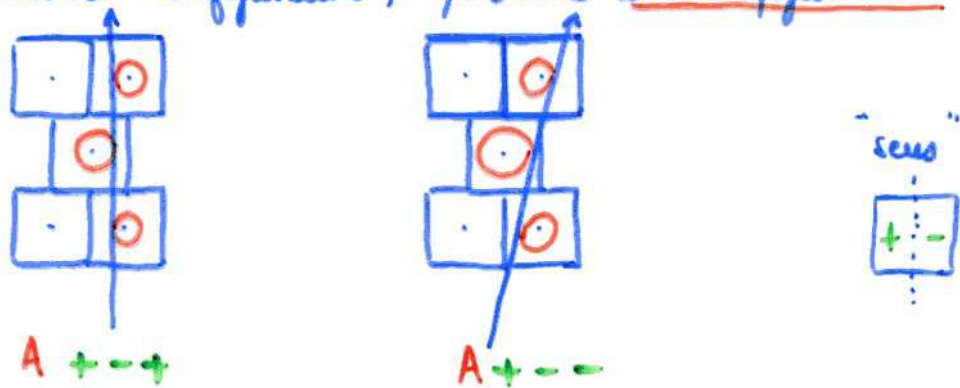
pour une trace en temps : $a = \text{constante}$

pour une trace hors temps : a est aléatoire

En réalité, relation arithmétique !



Pour une même configuration, plusieurs sous-configurations (2 ou 3)



Equations de contraintes

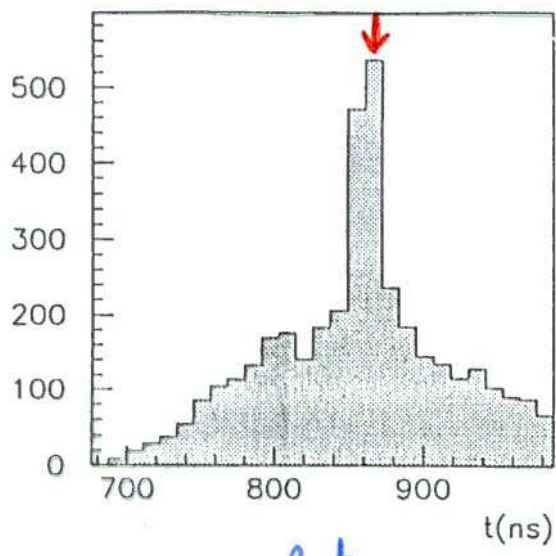
$$\begin{aligned}
 + d_1 + 2d_2 + d_3 &= ct_0 = a \\
 + (D_1 + t_0) + 2(D_2 + t_0) + (D_3 + t_0) &= a \\
 D_1 + 2D_2 + D_3 &= a + 4t_0
 \end{aligned}$$

$$\begin{aligned}
 + d_1 + 2d_2 - d_3 &= a \\
 + (D_1 + t_0) + 2(D_2 + t_0) - (D_3 + t_0) &= a \\
 D_1 + 2D_2 - D_3 &= a + 2t_0
 \end{aligned}$$

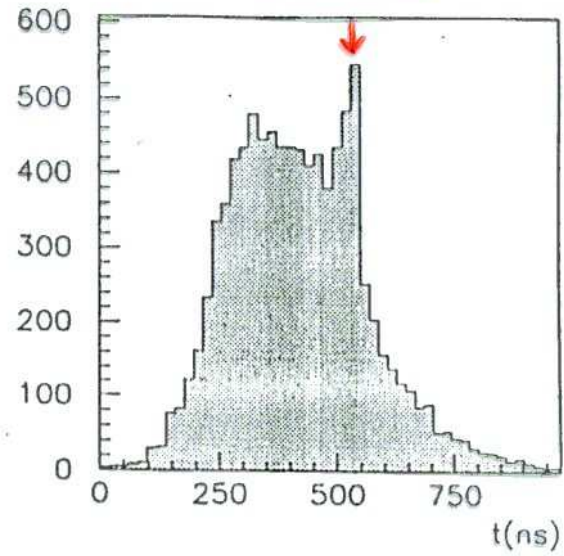
1 sous-configuration \Rightarrow 1 équation de contrainte

mot T2 \Rightarrow configuration
mot TDC \Rightarrow D_i } \Rightarrow t_0

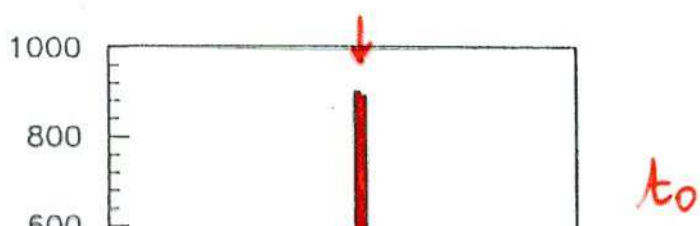
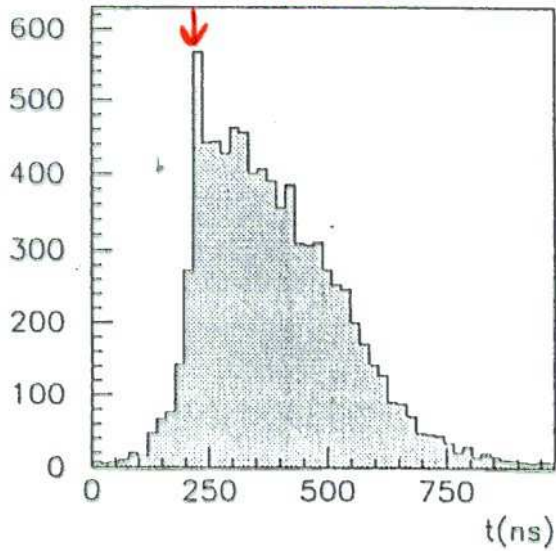
$a + 4t_0$



$a + 2t_0$



$2t_0$



$t_0 = (117 \pm 2) \text{ ns}$

LES "LOCAL TRIGGER 3 RESULTS"

DANS LE CP
(3ms)

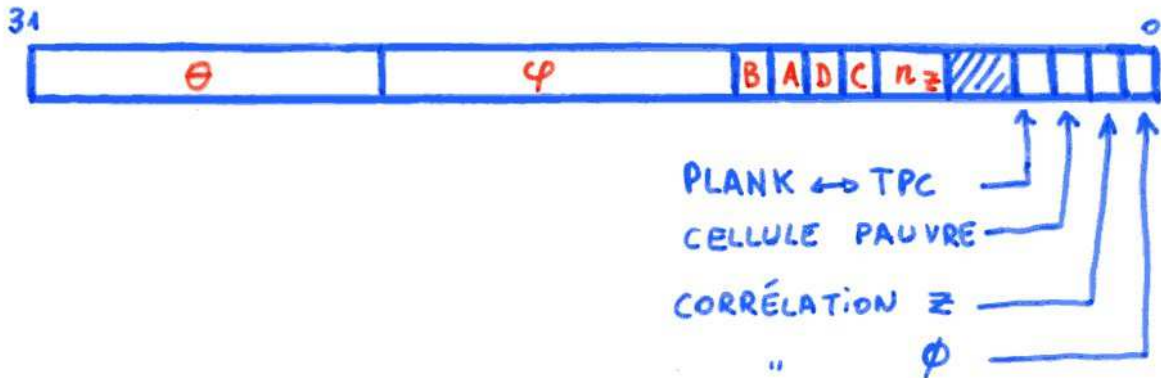
MOT T2



CONVERSION $\left\{ \begin{array}{l} PL, COL \rightarrow \varphi \\ z \rightarrow \theta \end{array} \right.$



MOT LT3R



BLOCKLET



PARTITION DE DÉCLENCHEMENT

LES "LOCAL TRIGGER 3 DATA"

DANS LE LES
(30 ms)

MOTS TFD et MOTS TDC



DÉMULTIPLÉXAGE
CLASSEMENT
CONVERSION



MOT LT3D



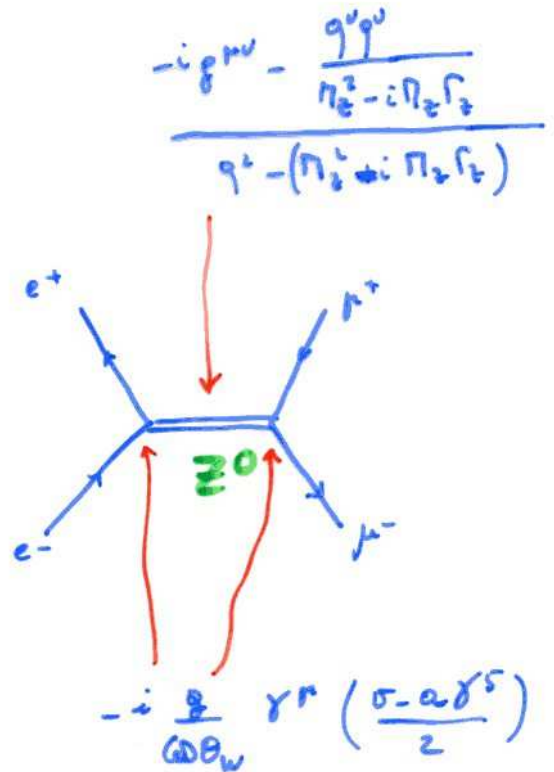
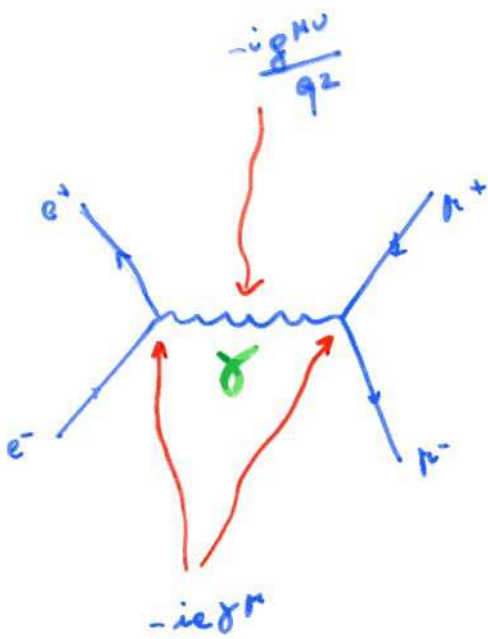
BLOCKLET



FLOT DE DONNÉES

III LE CANAL $e^+e^- \rightarrow \mu^+\mu^-$

1) RAPPELS



$$\frac{d\sigma}{d\Omega} = a(1 + \cos^2\theta) + \underbrace{b}_{\uparrow} \cos\theta$$

$$\sigma_{\mu\mu}(s = \Lambda_Z^2) = \frac{12\pi}{(\Lambda_Z\Gamma_Z)^2} \Gamma_e\Gamma_\mu \Rightarrow \Gamma_\mu$$

Asymétrie about-arrivé :

$$A_{FB} = \frac{\int_{\cos\theta > 0} d\sigma - \int_{\cos\theta < 0} d\sigma}{\int_{\cos\theta > 0} d\sigma + \int_{\cos\theta < 0} d\sigma} = \frac{3b}{8a}$$

$$A_{FB}(A=H_2^2) = 3 \left(\frac{v_e^2 a_e}{v_e^2 + a_e^2} \right) \cdot \left(\frac{v_\mu a_\mu}{v_\mu^2 + a_\mu^2} \right) \left. \vphantom{A_{FB}(A=H_2^2)} \right\} \Rightarrow a_\mu, v_\mu$$
$$\Gamma_\mu = \frac{G_F M_Z^3}{6\sqrt{2}\pi} (v_e^2 + a_e^2) (v_\mu^2 + a_\mu^2)$$

RECONNAISSANCE DES $e^+e^- \rightarrow \mu^+\mu^-$

- BASE : ÉVÉNEMENTS "LEPTONIQUES" :
- distances au vertex
 - < 10 traces
 - $p > 5 \text{ GeV}$

BRUITS DE FOND :

- COSMIQUES
- $e^+e^- \rightarrow \tau^+\tau^-$

"OUTILS"

- HPC
- HAB
- MUB

2) LES DÉTECTEURS

HPC

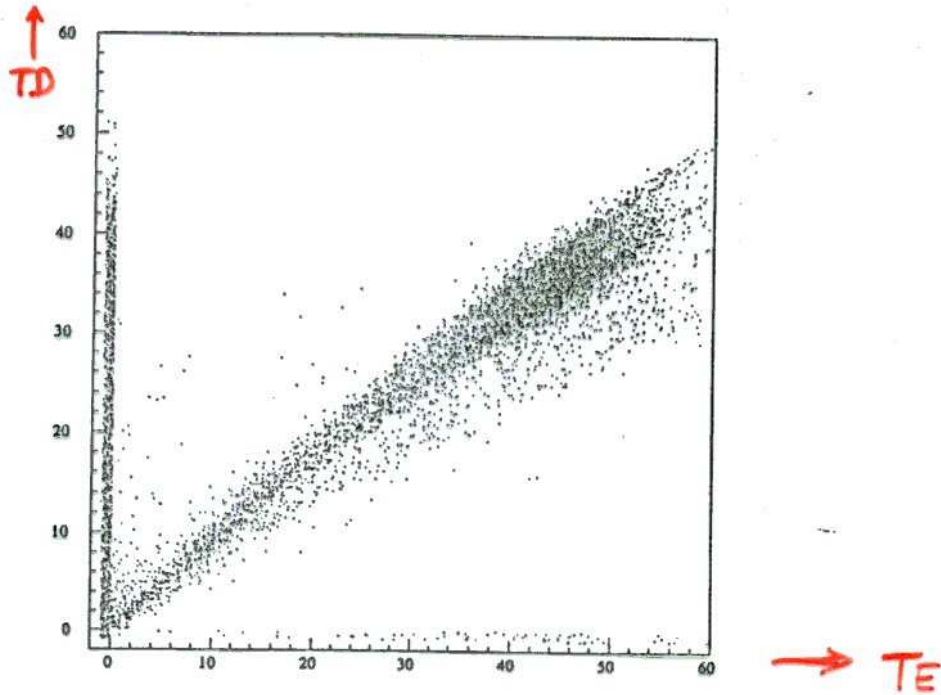


Figure 3.6: E_{HPC}^{TD} en fonction de E_{HPC}^{TE} (GeV)

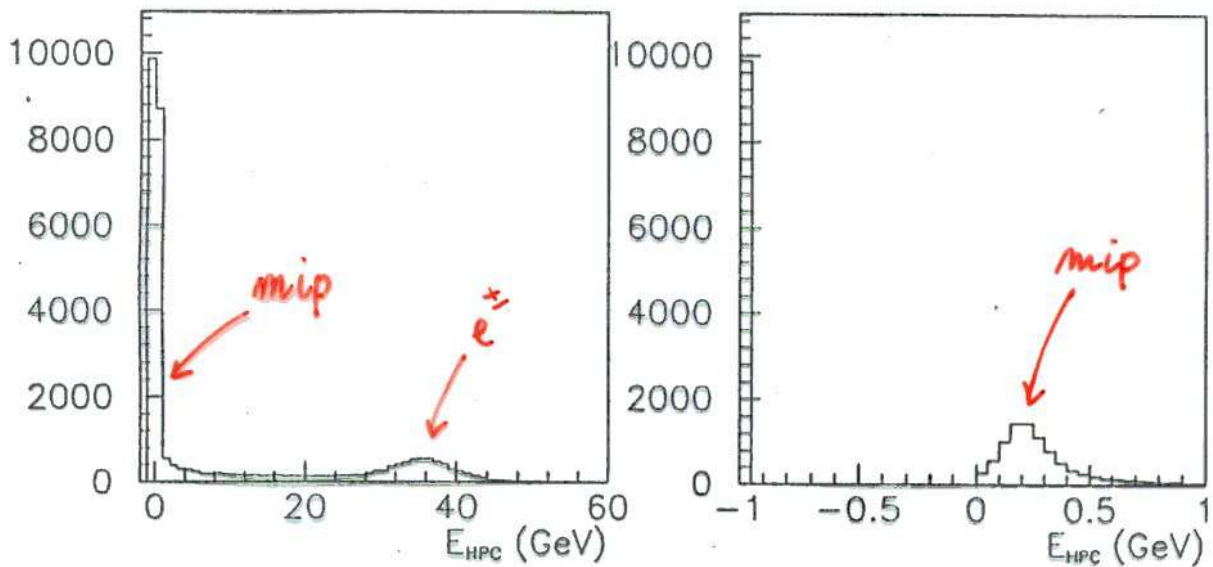
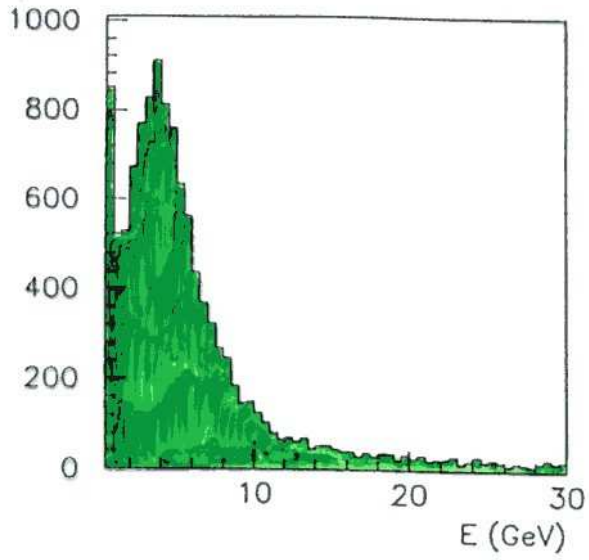


Figure 3.7: énergie déposée dans la HPC

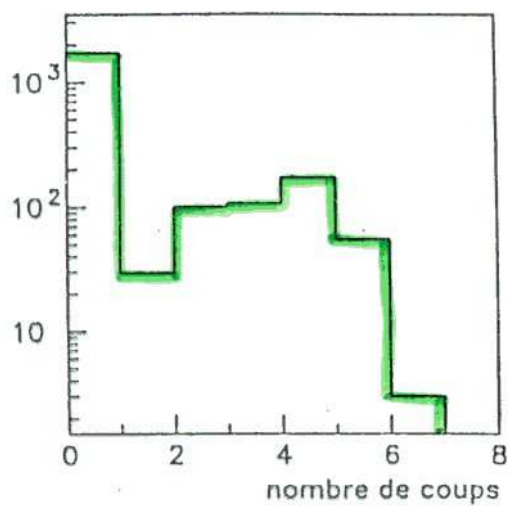
$\Rightarrow 0 < E_{HPC} \leq 1 \text{ GeV}$

HAB



$$0 < E_{\text{HAB}} * \sin^2(\theta) \leq 10 \text{ GeV}$$

MUB

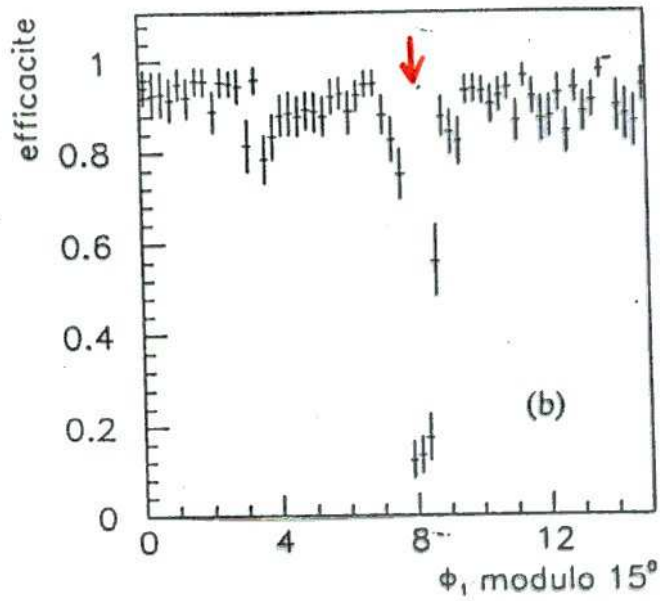
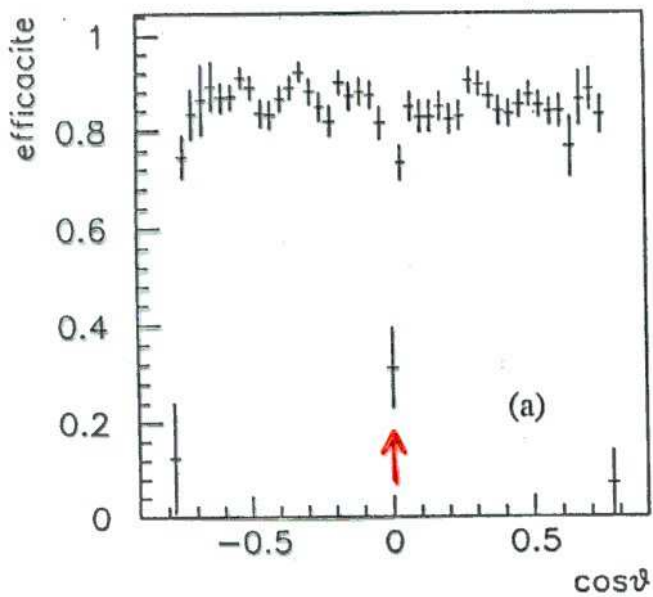


$$N_{\text{MUB}} \geq 1$$

EFFICACITÉ D'IDENTIFICATION

HPC

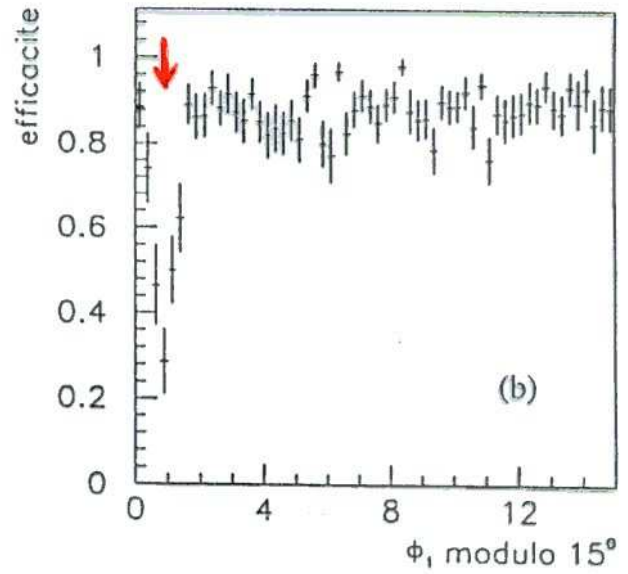
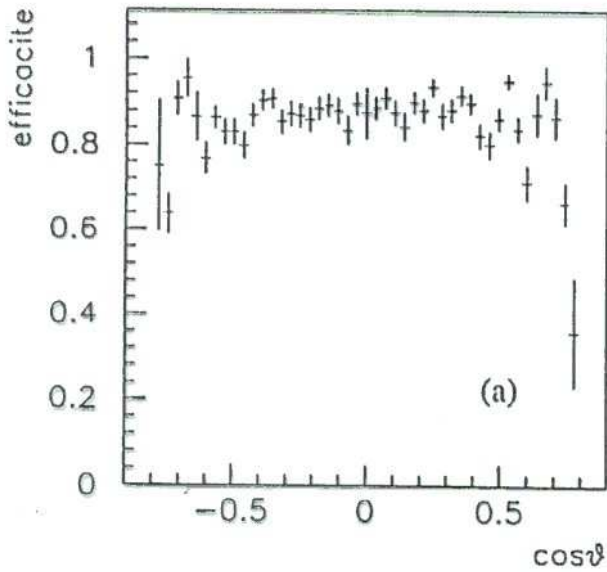
$$\epsilon_{\text{HPC}} = \frac{N_{\text{HPC}} \geq 1 \otimes 0 < \epsilon_{\text{HPC}} \leq 1}{N_{\text{HPC}} \geq 1}$$



how true : $\epsilon_{\text{HPC}} = (91.9 \pm 0.4)\%$

HAB

$$\epsilon_{HAB} = \frac{N_{HAB} > 1 \text{ \& } 0 < E_{HAB} \leq 10}{N_{HAB} > 1}$$



has trou : $\epsilon_{HAB} = (83.5 \pm 0.4)\%$

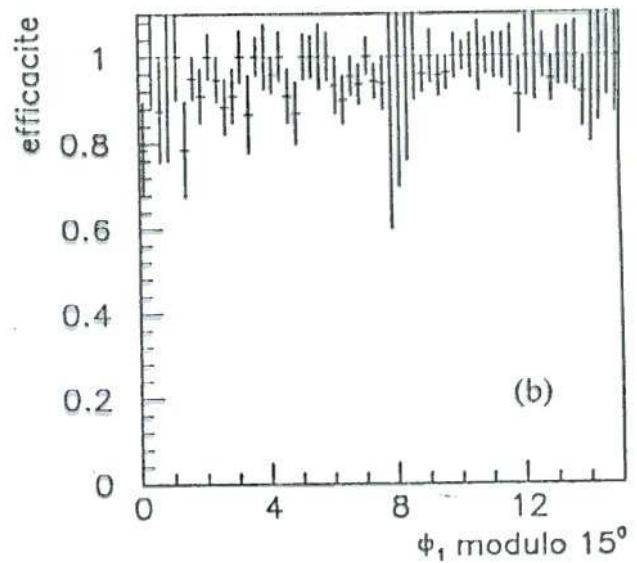
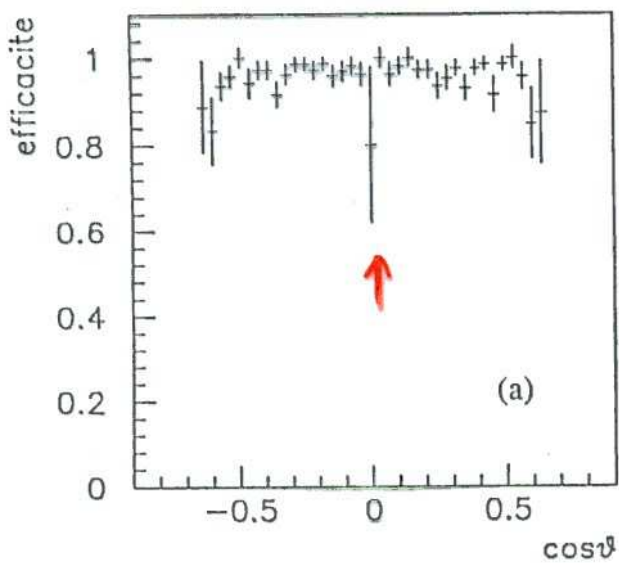
MUB

1 acolinearité $< 1^\circ$

2 trace 1 : $\begin{cases} 0 < E_{HPC} \leq 0.4 \text{ GeV} \\ 0 < E_{HAB} \leq 6.0 \text{ GeV} \end{cases}$

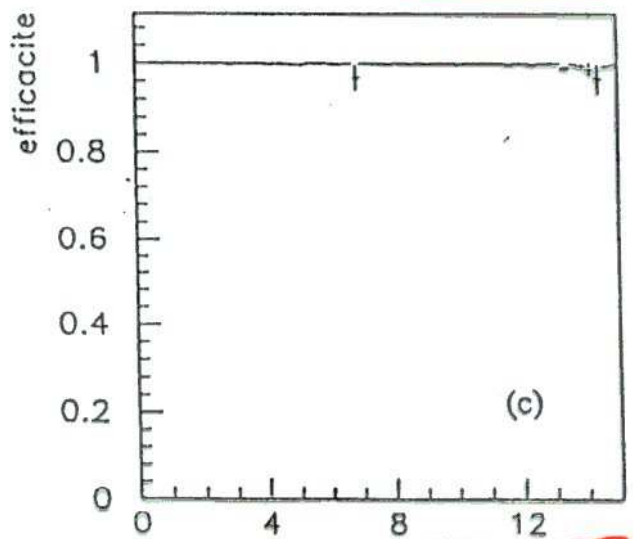
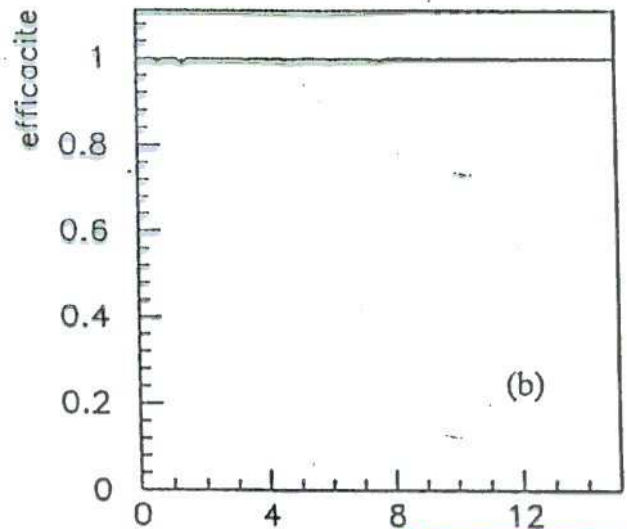
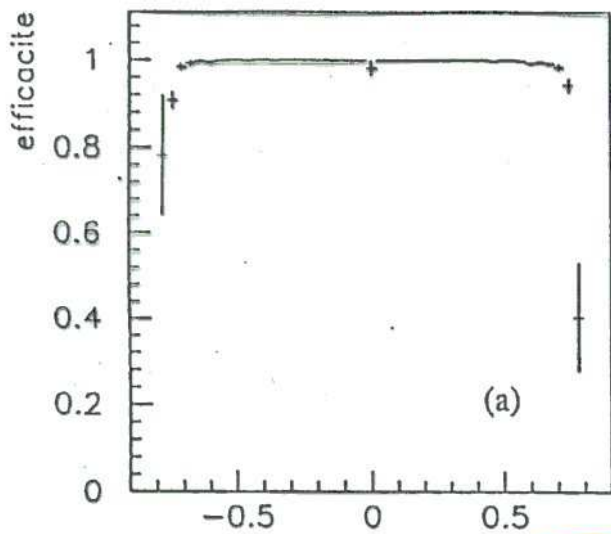
3 trace 2 : $N_{MUB} > 1$

$$\epsilon_{MUB} = \frac{\boxed{1} \otimes \boxed{2} \otimes \boxed{3} \otimes N_{MUB} \geq 1}{\boxed{1} \otimes \boxed{2} \otimes \boxed{3}}$$



$$\epsilon_{MUB} = (96.8 \pm 0.5) \%$$

Efficacité d'identification



↙
 $43^\circ < \theta < 137^\circ$

pour une trace: $\epsilon = \epsilon_{HPE} \otimes \epsilon_{HAB} \otimes \epsilon_{PUB}$

pour $\mu^+ \mu^-$:

$$\epsilon_{\text{identification}} = \epsilon^2$$

⇒

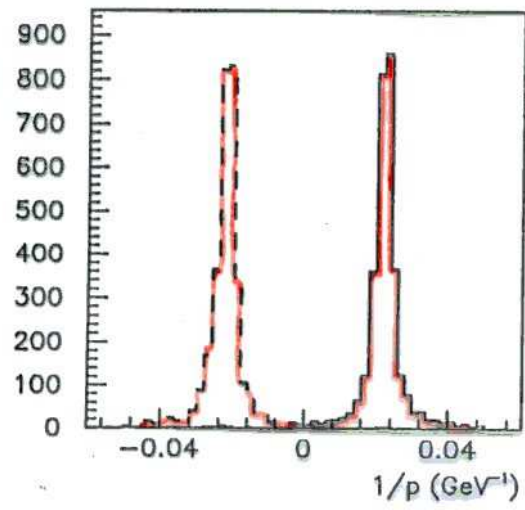
$$\epsilon_{\text{identification}} = (99.94 \pm 0.06)\%$$

3) Sélection des événements

Coupe :

élimine

- $43^\circ < \theta < 137^\circ$ bouchons
- $p > 20 \text{ GeV}$ $\tau^+ \tau^-$
- $0 < E_{HPC} \leq 1 \text{ GeV}$
ou
 $0 < E_{HAB} \leq 10 \text{ GeV}$
ou
 $N_{HVB} > 0$
- $\begin{cases} |\theta_1 + \theta_2 - 180^\circ| < 10^\circ \\ |\varphi_1 + \varphi_2 - 180^\circ| < 10^\circ \end{cases}$ $\tau^+ \tau^-$, $\mu^+ \mu^- (\delta)$
- $\begin{cases} E_{HPC}^1 < 5 \text{ GeV} \\ E_{HPC}^2 < 5 \text{ GeV} \end{cases}$ $e^+ e^-$
- $\begin{cases} E_{HAB}^1 < 20 \text{ GeV} \\ E_{HAB} < 20 \text{ GeV} \end{cases}$ $\tau \rightarrow \pi$



Energie (GeV)	Nombre d'événements	Luminosité (nb) ⁻¹
88,22	31	219,55 ± 2,76
89,22	83	341,50 ± 3,47
90,22	205	320,33 ± 3,40
91,22	1820	2022,30 ± 8,67
92,22	205	289,93 ± 3,33
93,22	93	272,47 ± 3,27
94,22	91	364,07 ± 3,81
total	2528	3830,15 ± 11,95

IV RÉSULTATS

1°) MÉTHODES

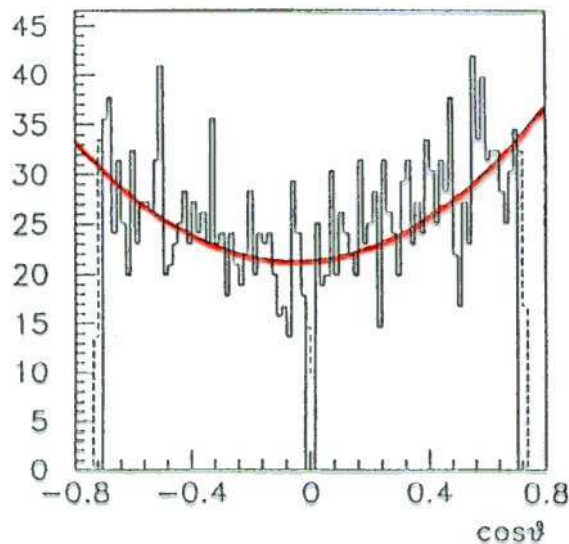
ⓐ Ajustement global

$$\frac{d\sigma}{d\cos\theta} = a(1 + \cos^2\theta) + b\cos\theta$$

$$A_{FB} = \frac{3b}{8a}$$

⇒

$$\frac{d\sigma}{d\cos\theta} = \frac{3\sigma}{8} \left[(1 + \cos^2\theta) + \frac{8}{3} A_{FB} \cos\theta \right]$$



$E = 91.2 \text{ GeV}$

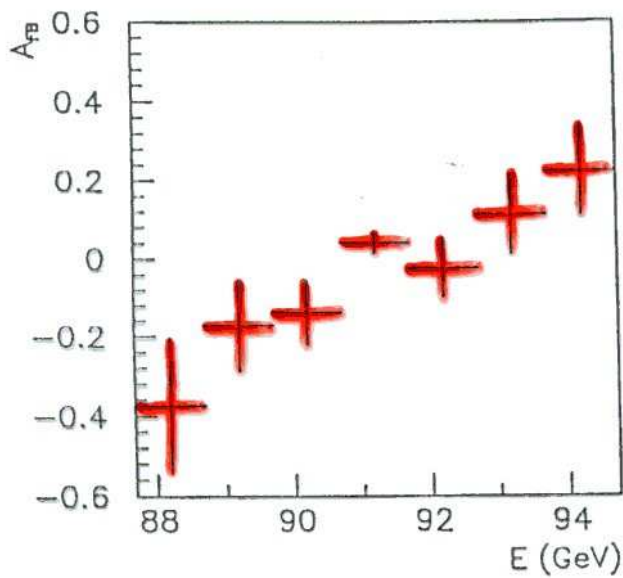
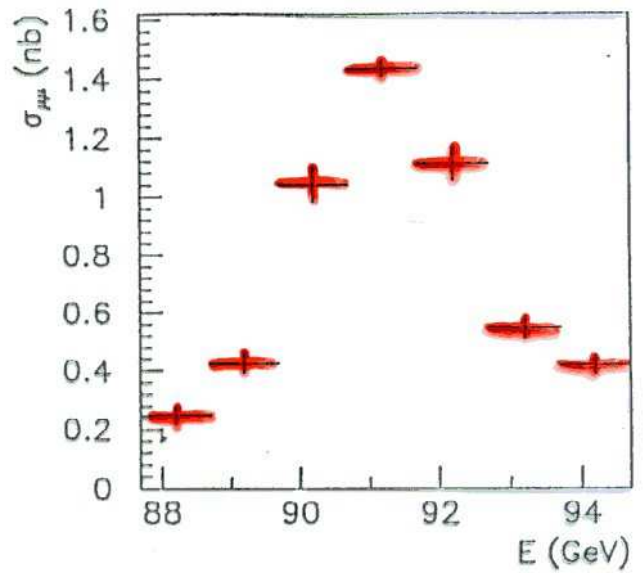
⇒

σ et A_{FB}

mais } 2 paramètres
ajustement hors pic

⑥ COMPTAGE

$$\sigma = \frac{2}{s}$$



$$A_{FB} = \frac{N_{\cos\theta > 0} - N_{\cos\theta < 0}}{N_{\cos\theta > 0} + N_{\cos\theta < 0}}$$

② Maximum de vraisemblance

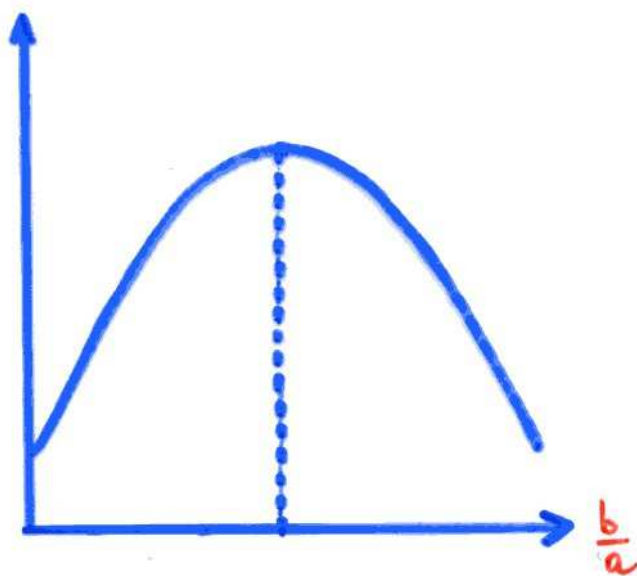
$$\frac{dP}{d\omega\theta} = \frac{(1+\omega^2\theta) + \frac{b}{a}\omega\theta}{\int (1+\omega^2\theta) + \frac{b}{a}\omega\theta d\omega\theta}$$

$$\mathcal{L} = \frac{\pi}{N} \left(\frac{dP}{d\omega\theta} \right)$$

Estimateur

$$\frac{\partial \mathcal{L}}{\partial \frac{b}{a}} = 0$$

$$\mathcal{L} \propto (1+\omega^2\theta) + \frac{b}{a}\omega\theta$$



⇒

A50

FACTEURS DE CORRECTION

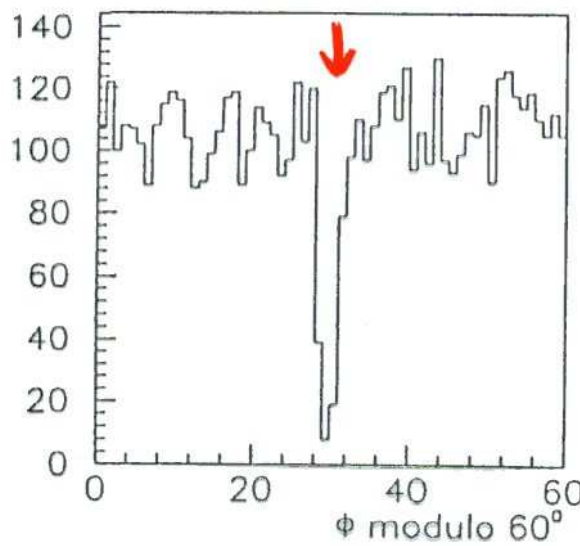
(pour la section efficace)

● STABILITÉ DES DONNÉES

● EFFICACITÉ DE DÉCLENCHEMENT

1.017 ± 0.003

● EFFICACITÉ DE DÉTECTION



1.047 ± 0.002

● PERTES DUES AUX COUPURES
CORRECTION D'ACCEPTANCE

1.019 ± 0.002

● CONTAMINATION COSMIQUE

$1 - 2\% \frac{\text{LUM (RUN)}}{\text{LUM. TOTALE}}$

● CONTAMINATION $\tau^+\tau^-$

0.984 ± 0.002

2) Les résultats

DONNÉES : $\left\{ \begin{array}{l} \sigma(s) \\ A_{FB}(s) \end{array} \right.$

PARAMÈTRES : $\left\{ \begin{array}{l} M_Z, \Gamma_Z \\ m_{top}, m_H \end{array} \right.$

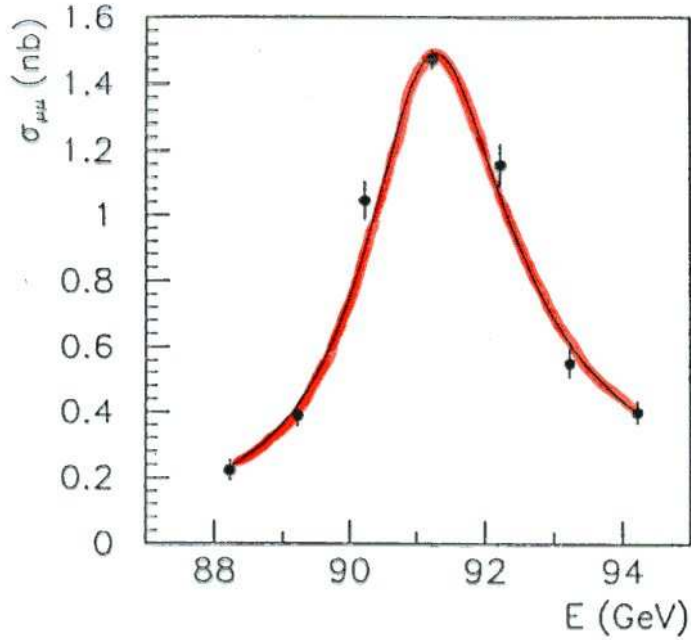


ZFITTER

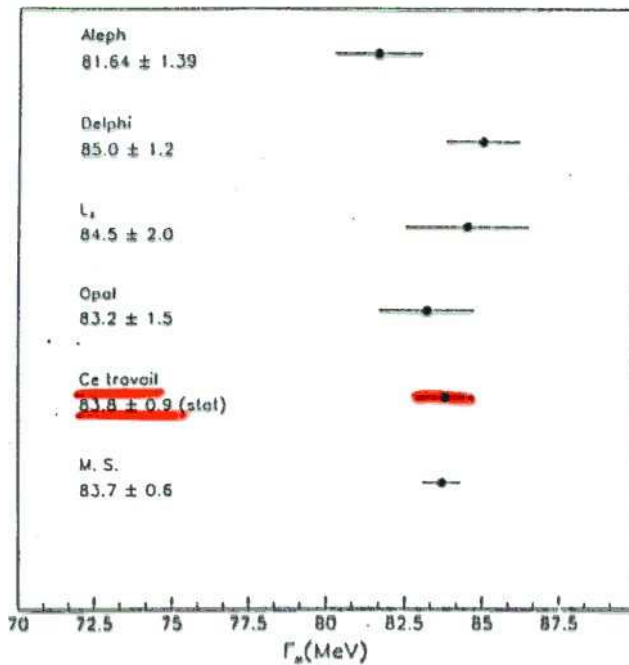


Γ_μ
 α_μ, σ_μ

POUR LA LARGEUR



$\Rightarrow (\Gamma_e \Gamma_\mu)^{1/2} = (82.7 \pm 0.9) \text{ MeV}$

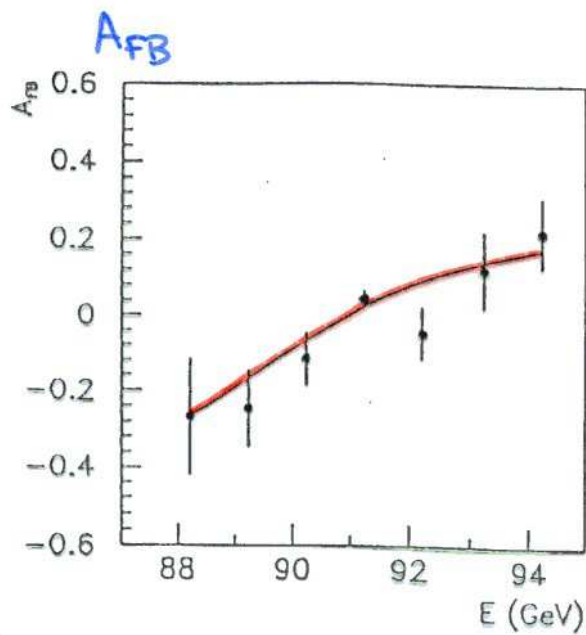


Γ_μ

POUR LES CONSTANTES DE COUPLAGES

AJUSTEMENT : σ et A_{FB}

pour l'asymétrie



\Rightarrow $\left\{ \begin{array}{l} a_e a_\mu = 0.246 \pm 0.003 \\ v_e v_\mu = 0.0026 \pm 0.017 \end{array} \right.$

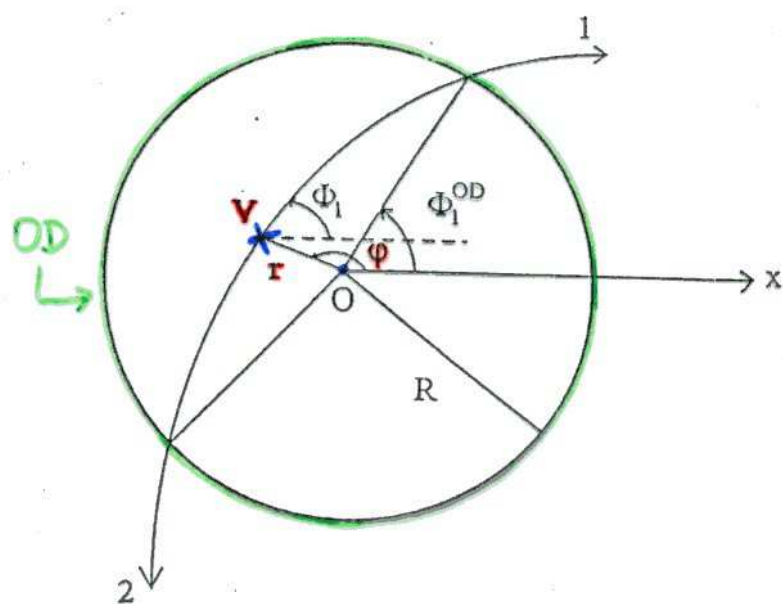
$$\Gamma_{\mu} = \frac{\alpha(M_Z^2) M_Z}{48 \bar{s}^2 c^2} [1 + (1 - 4\bar{s}^2)^2]$$

$\frac{1}{128}$ $91.175 \pm 0.010 \text{ GeV}$

$\bar{s}^2 \approx \sin^2 \theta_W + \cos^2 \theta_W \frac{3G_F M_Z^2}{8\pi^2 \sqrt{2}}$

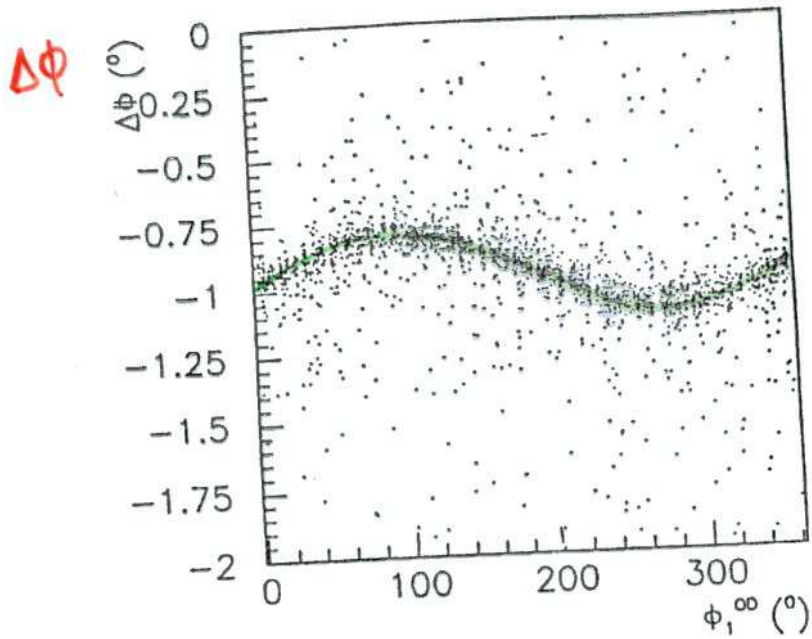
$$\Rightarrow \bar{s}^2 = \sin^2 \theta_W = 0.234 \pm 0.03$$

L'ACOLINÉARITÉ



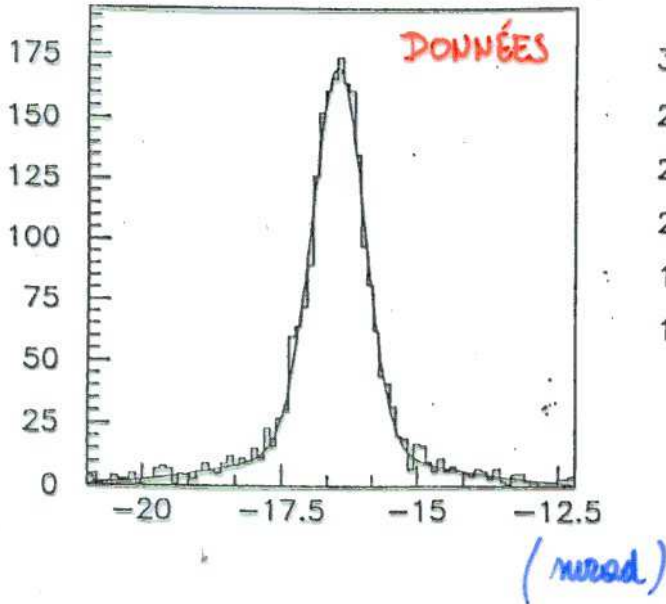
$$\begin{cases} \phi_1 = \phi_1^{OD} + \frac{\pi}{R} \sin(\phi_1^{OD} - \psi) \\ \phi_2 = \phi_2^{OD} + \frac{\pi}{R} \sin(\phi_2^{OD} - \psi) \end{cases}$$

$$\Rightarrow \Delta\phi \approx (\phi_1^{OD} - \phi_2^{OD}) - \frac{2\pi}{R} \sin(\psi - \phi_1^{OD})$$

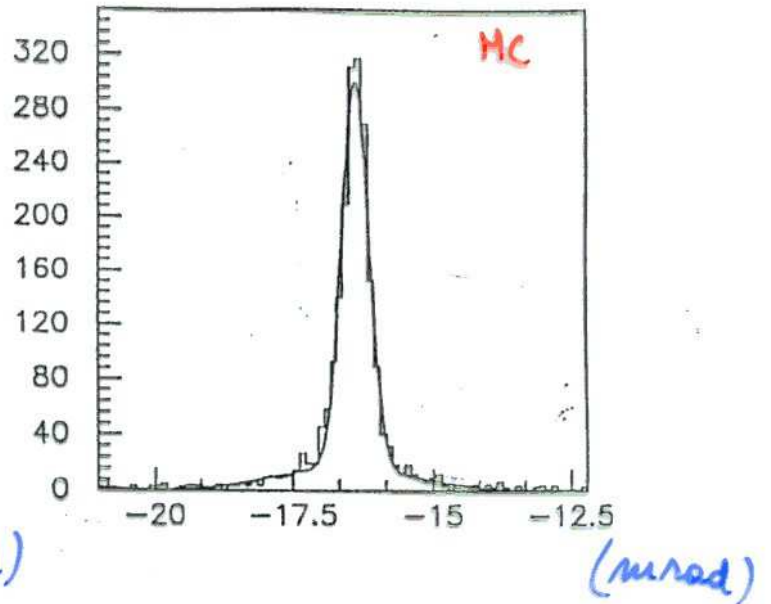


$$\Rightarrow \begin{cases} r = (2.83 \pm 0.07) \text{ mm} \\ \psi = (187.5 \pm 1.6)^\circ \end{cases}$$

$\Delta\phi$



$$\sigma = (0.48 \pm 0.02) \text{ mrad}$$



$$\sigma = (0.24 \pm 0.01) \text{ mrad}$$

⇒ Pb de simulation

- DÉTECTEUR (OD) MAL SIMULÉ ?
- EFFETS IMPORTANTS NON INCLUS ?

CONCLUSION

L'OD

- FONCTIONNEMENT D'UN DÉTECTEUR
 - PARTICIPATION : T3
 - TRAVAIL SUR LE DÉCLENCHEMENT
- DÉTECTEUR " UTILE "
 - REJET DES COSMIQUES
 - PB DE SIMULATION

LE CANAL $e^+e^- \rightarrow \mu^+\mu^-$

- EXPÉRIMENTAL
 - EFFETS DE DÉTECTEURS (SEGMENTATIONS)
RÉPONSES
- THÉORIQUE : $\sigma_{\mu\mu}$, AFB, Γ_{μ} , a_{μ} , v_{μ} , \bar{S}^2 , ...

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