

学術創成  
「タウ・レプトン物理の新展開」  
5年間のまとめ

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**TAU LFV**

# $\tau$ LFV

- New Physics への架け橋

$\tau$ =最も重いレプトン { 感度が高い  
崩壊モードが豊富

→単に新しい物理の存在だけではなく、モデルについても言及

	SUSY+GUT (SUSY+Seesaw)	Higgs mediated	Little Higgs	non-universal Z' boson
$\left( \frac{\tau \rightarrow \mu\mu\mu}{\tau \rightarrow \mu\gamma} \right)$	$\sim 2 \times 10^{-3}$	0.06~0.1	0.4~2.3	$\sim 16$
$\left( \frac{\tau \rightarrow \mu ee}{\tau \rightarrow \mu\gamma} \right)$	$\sim 1 \times 10^{-2}$	$\sim 1 \times 10^{-2}$	0.3~1.6	$\sim 16$
Br( $\tau \rightarrow \mu\gamma$ ) @Max	$< 10^{-7}$	$< 10^{-10}$	$< 10^{-10}$	$< 10^{-9}$

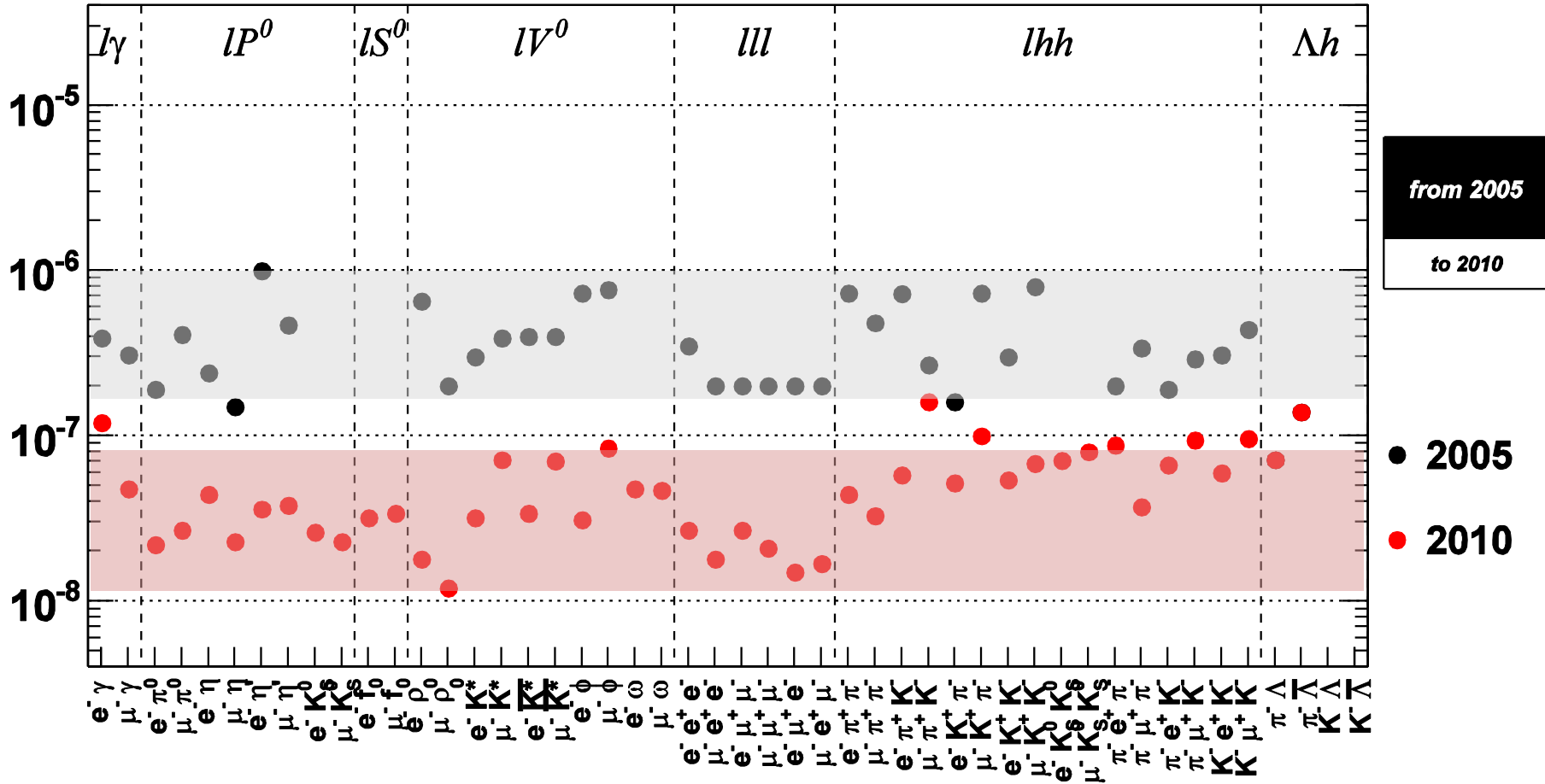
(JHEP 0705, 013(2007), PLB54 252 (2002))

他にも、Higgs mediate with large  $\tan\beta$ で (PRD74,035010(2006))

Br( $\tau \rightarrow \mu f_0$ ):Br( $\tau \rightarrow \mu\mu\mu$ ):Br( $\tau \rightarrow \mu\eta$ ) = 1.3 : 0.54 : 1

# 2005年から2010年へ

90% C.L. Upper limits for LFV  $\tau$  decays

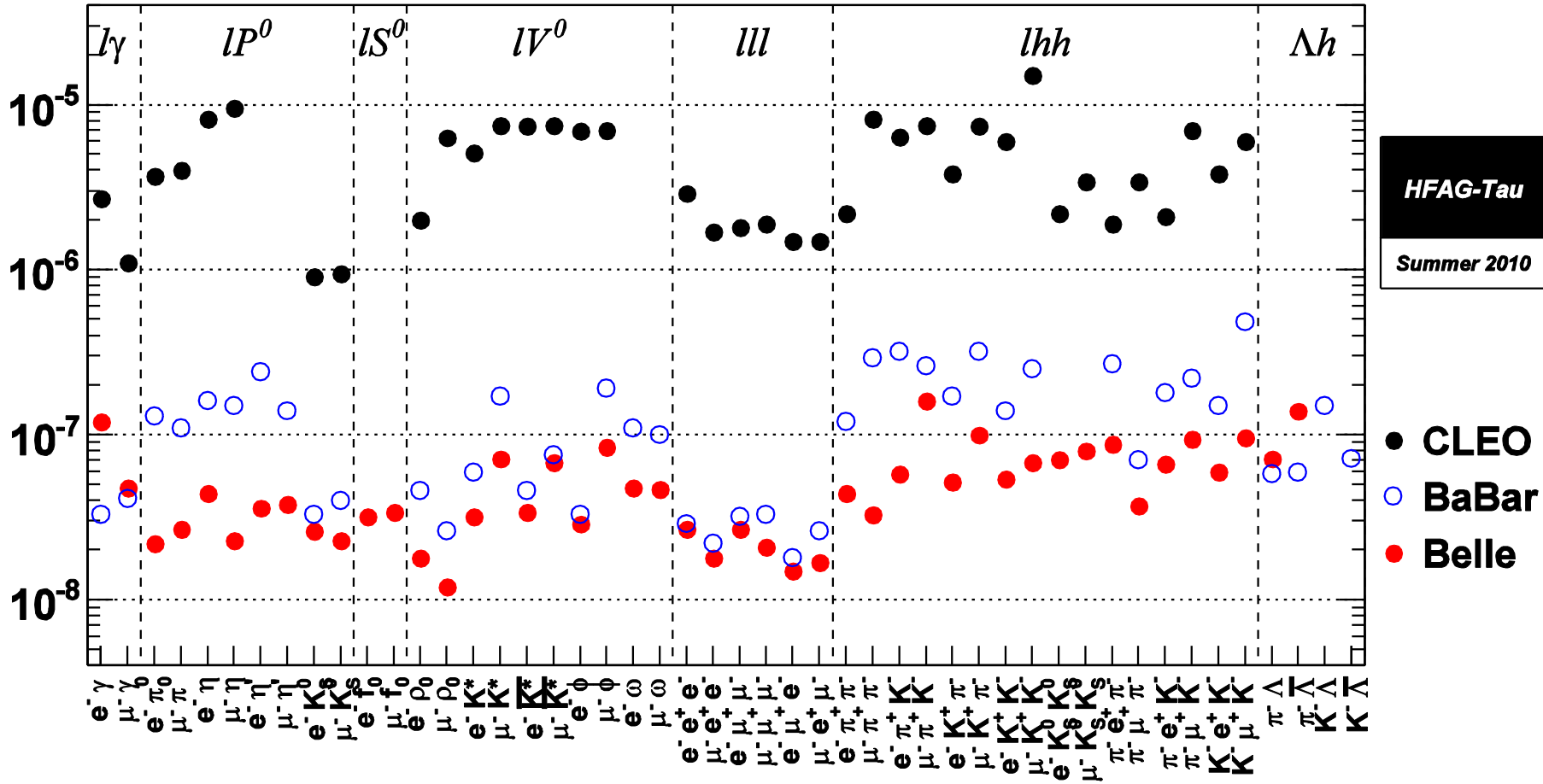


更新: 36モード  
新規: 6モード

Lum:  $O(10^2)$  から  $O(10^3)$  へ  
BF:  $O(10^{-7})$  から  $O(10^{-8})$  へ

# CLEO, BaBarとの比較

90% C.L. Upper limits for LFV  $\tau$  decays

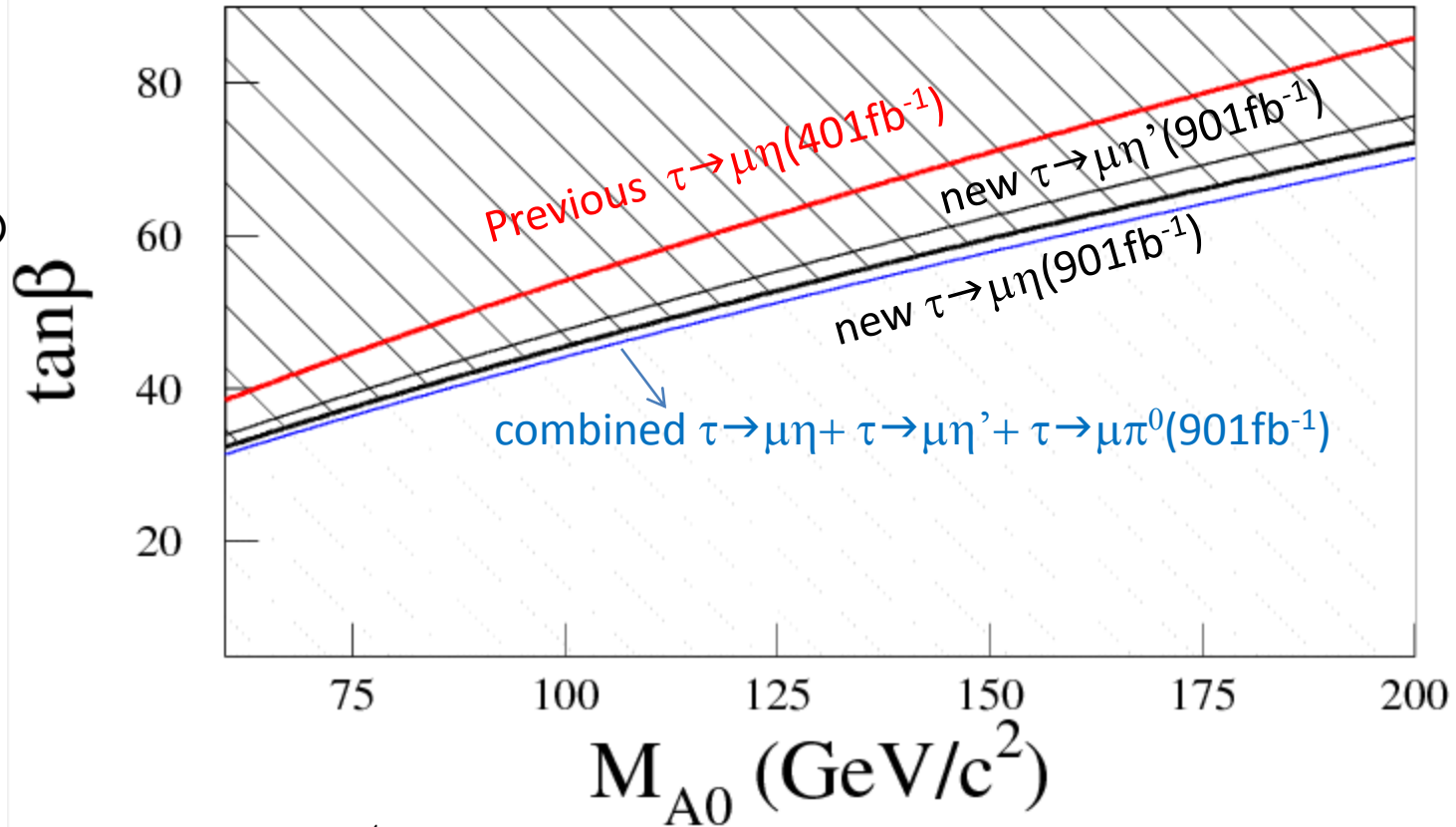


CLEOの100倍感度向上

# New Physics Parameters

Non-universal  
Higgs mass model

(M.J.Herrero et al,  
JHEP0806(2008)079)



$$Br(\tau \rightarrow \mu M) = C_M |\delta_{32}|^2 \left( \frac{100}{m_{A^0}(\text{GeV})} \right)^4 \left( \frac{\tan \beta}{60} \right)^6, |\delta_{32}|^2 = 1$$

$$C_\eta = 1.2 \times 10^{-7}, C_{\eta'} = 1.5 \times 10^{-7}, C_{\pi^0} = 3.6 \times 10^{-10}$$

# CPV IN TAU DECAYS

# $\tau$ 崩壊におけるCPV

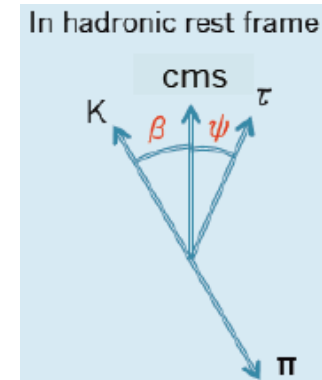
- これも新しい物理探索の一環

- 荷電ヒッグス粒子によって引き起こされるCPVを想定

- 干渉によってCPVを評価

- $\tau \rightarrow K_S \pi \nu$ ,  $\tau \rightarrow K \pi \pi \nu$  の2パターン

i)  $\tau \rightarrow K_S \pi \nu$



$$J_\mu = \langle K^0(q_1) \pi(q_2) | \bar{u} \gamma_\mu s | 0 \rangle$$

$$= (q_1 - q_2)^\nu \left( g_{\mu\nu} - \frac{Q_\mu Q_\nu}{Q^2} \right) F_V(Q^2) + Q_\mu F_S(Q^2)$$

ここにヒッグスを入れる

複素結合定数  
(虚部がCPV)

$$F_S \rightarrow \tilde{F}_S = F_S + \frac{\eta_S}{m_\tau} F_H$$

$$\frac{d\Gamma(\tau \rightarrow K \pi \nu)}{dQ^2 d \cos \theta d \cos \beta}$$

= (CP-conserving-term)

$$+ \underline{C(Q^2) \cos \psi \cos \beta \times \text{Re}(F_V \tilde{F}_S)}$$

測定量: 非対称性  $A_{\psi\beta}^{CP} = \langle \cos \psi \cos \beta \rangle_- - \langle \cos \psi \cos \beta \rangle_+$



# 結果 ( $\tau$ 崩壊におけるCPV)

699fb<sup>-1</sup> のデータを使用

Detector asym.

$\gamma$ -Z干涉

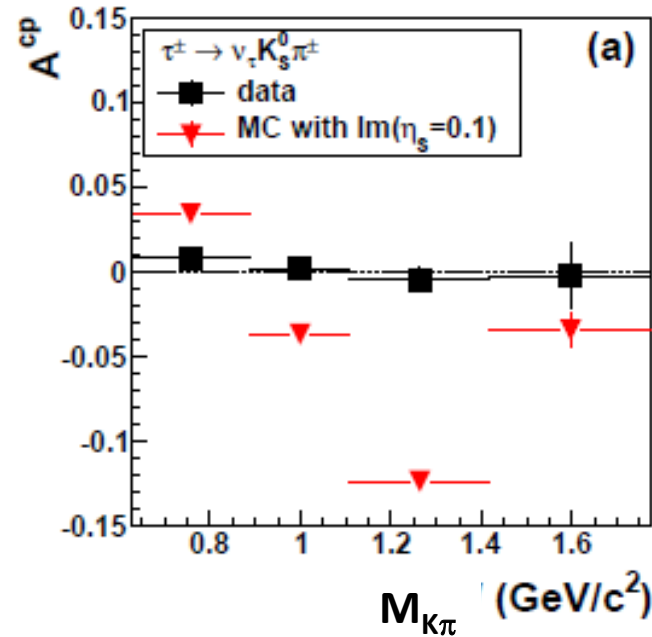
BG効果

補正済

• multi Higgs doublet model  
に対する制限

X,Z: complex coupling for Higgs

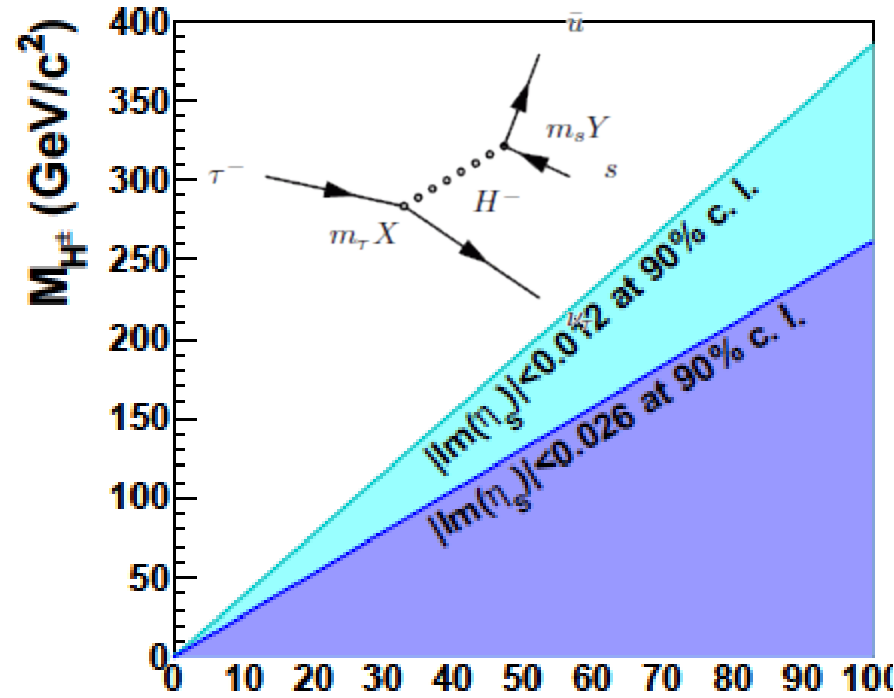
M<sub>H</sub>: lightest charged Higgs mass



90%CL upper limit:

$$\text{Im}(\eta_S) < (0.012 - 0.026)$$

(form factors (S,V)により変化)



(x10 <sup>-3</sup> )	M <sub>Kπ</sub> (GeV/c <sup>2</sup> )			
	0.625–0.890	0.890–1.110	1.110–1.420	1.420–1.775
A <sub>βψ</sub> <sup>CP</sup>	7.9 ± 3.9 ± 2.8	1.8 ± 2.1 ± 1.4	-4.6 ± 7.2 ± 1.7	-2.3 ± 19.1 ± 5.5

$\sqrt{|\text{Im}(XZ^*)|}$

# $\tau \rightarrow K\pi\pi\nu$ と CPV

$$\begin{aligned}
 J^\mu &\equiv \langle K^-(p_1)\pi^-(p_2)\pi^+(p_3) | \bar{s}\gamma^\mu(1-\gamma^5)u | 0 \rangle \\
 &= [F_1(s_1, s_2, Q^2)(p_1 - p_3)_\nu + F_2(s_1, s_2, Q^2)(p_2 - p_3)_\nu]T^{\mu\nu} \\
 &\quad + iF_3(s_1, s_2, Q^2)\epsilon^{\mu\nu\rho\sigma}p_{1\nu}p_{2\rho}p_{3\sigma} + \boxed{F_4}(s_1, s_2, Q^2)Q^\mu
 \end{aligned}$$

ここに新しい項  
(擬スカラー、

$F_1, F_2 : J^P = 1^-$  Vector  
 $F_3 : J^P = 1^+$  axial Vector  
 $F_4 : J^P = 0^+$  Psuedo Scalar

$$\begin{aligned}
 \frac{d\Gamma(\tau^-)}{dQ^2 ds_1 ds_2 d\gamma d\cos\beta d\cos\theta} &= \frac{G_F^2 \sin^2\theta_c (m_\tau^2 - Q^2)^2}{512(2\pi)^6 m_\tau^3 Q^2} \\
 &\times \left\{ \left[ \frac{2}{3}K_1 + K_2 + \frac{1}{3}\bar{K}_1(3\cos^2\beta - 1)/2 \right] (|B_1|^2 + |B_2|^2) \right. \\
 &+ \left[ \frac{2}{3}K_1 + K_2 - \frac{2}{3}\bar{K}_1(3\cos^2\beta - 1)/2 \right] |B_3|^2 + K_2|B_4|^2 \\
 &- \frac{1}{2}\bar{K}_1 \sin^2\beta \cos 2\gamma (|B_1|^2 - |B_2|^2) + \bar{K}_1 \sin^2\beta \sin 2\gamma \text{Re}(B_1 B_2^*) \\
 &+ 2\bar{K}_3 \sin\beta \sin\gamma \text{Re}(B_1 B_3^*) + \boxed{2\bar{K}_2 \sin\beta \cos\gamma \text{Re}(B_1 B_4^*)} \\
 &+ 2\bar{K}_3 \sin\beta \cos\gamma \text{Re}(B_2 B_3^*) - \boxed{2\bar{K}_2 \sin\beta \sin\gamma \text{Re}(B_2 B_4^*)} \\
 &+ 2\bar{K}_3 \cos\beta \text{Im}(B_1 B_2^*) + \bar{K}_1 \sin 2\beta \cos\gamma \text{Im}(B_1 B_3^*) \\
 &\left. - \bar{K}_1 \sin 2\beta \sin\gamma \text{Im}(B_2 B_3^*) + \boxed{2\bar{K}_2 \cos\beta \text{Im}(B_3 B_4^*)} \right\}
 \end{aligned}$$

CPを破る項

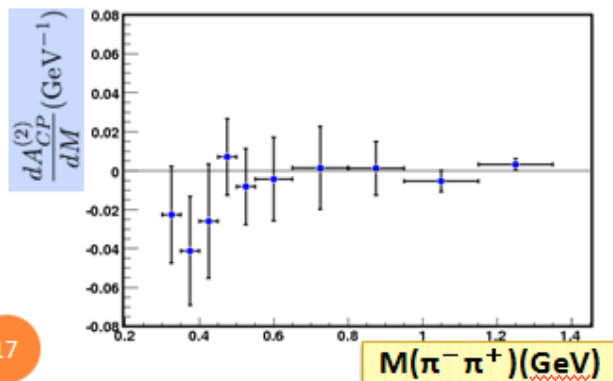
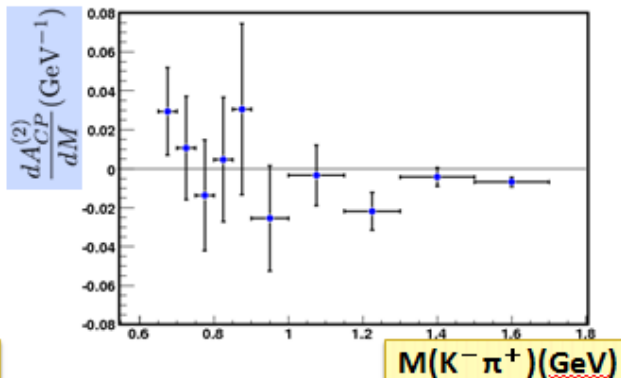
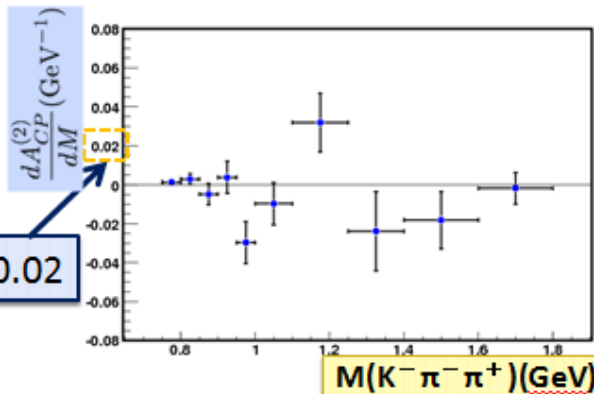
$$\begin{aligned}
 Q^2 &= M(K^-\pi^-\pi^+)^2 \\
 s_1 &= M(\pi^-\pi^+)^2 \\
 s_2 &= M(K^-\pi^+)^2
 \end{aligned}$$

# 途中経過

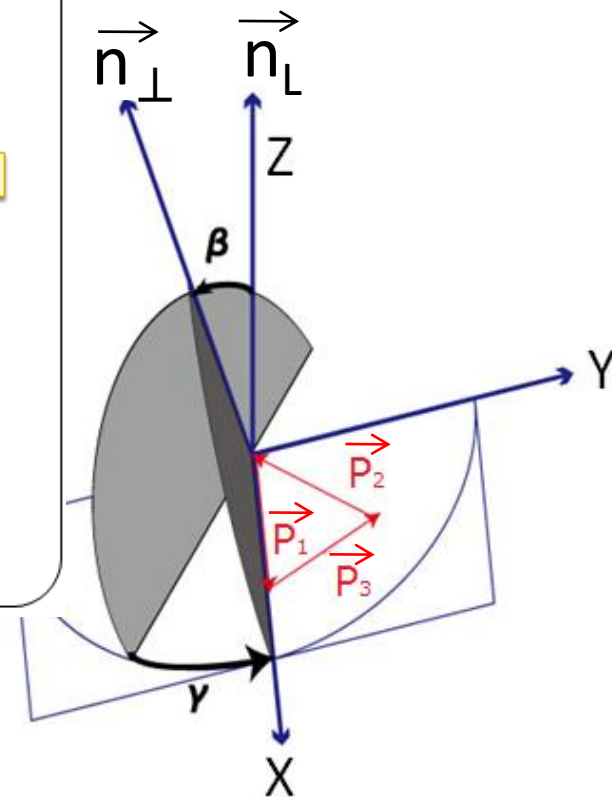
$$\tau^- \rightarrow K^- \pi^- \pi^+ \nu_\tau$$

72fb<sup>-1</sup> だけ  
補正はまだ

CP asymmetry  $A_{CP}^{(2)}$ :  $\sin\beta\cos\gamma$



Consistent with zero within 1  $\sigma$

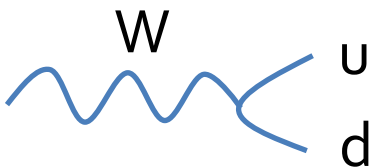


**2<sup>ND</sup> CLASS CURRENT**

# 2<sup>nd</sup> class current search

- 標準模型の精密検証
- 新物理ではないのにもかかわらず未発見

- Weak current:



$PG(-1)^J$  で2種類に分類される

1<sup>st</sup> class current

$$PG(-1)^J = +1 \quad J^{PG} = 0^{--}(\pi), 1^{+-}(\rho), 1^{++}(a_1), \dots$$

2<sup>nd</sup> class current

$$PG(-1)^J = -1 \quad J^{PG} = 0^{+-}(a_0), 1^{++}(b_1), \dots$$



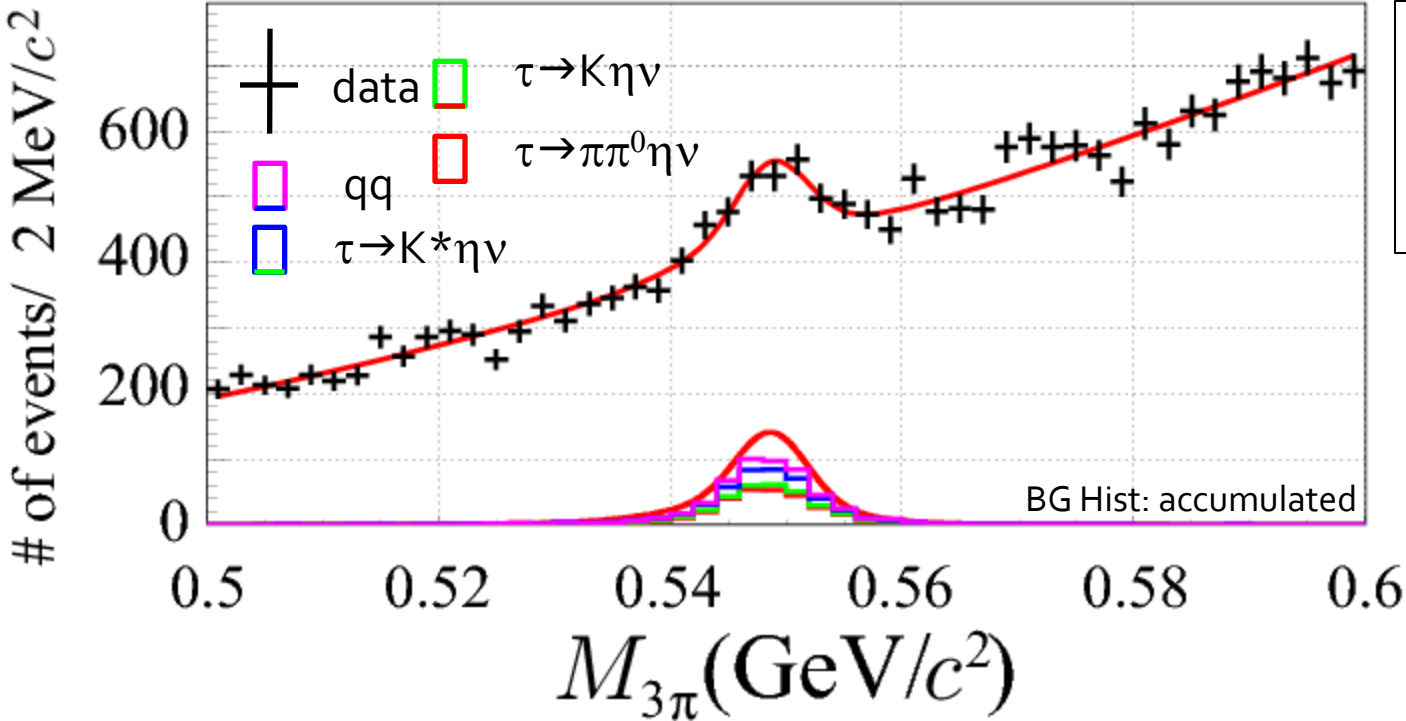
Suppressed by  
isospin symmetry

$$\begin{aligned} \tau &\rightarrow \pi \eta \nu \\ \tau &\rightarrow \pi \eta' \nu \\ \tau &\rightarrow \pi \omega \nu \end{aligned}$$

が2nd class  
Currentに  
よって引き  
起こされる

# $\tau \rightarrow \eta \pi \nu$ の $\eta$ 分布

650 fb<sup>-1</sup> のデータを利用。  $\eta$  は  $\pi^+ \pi^- \pi^0$  から再構成 (  $\gamma\gamma$  はBGが多いため )



Fit result

$$N_{\eta}^{\text{fit}} = 749.2 \pm 67.3$$

$$M_{\eta}^{\text{fit}} = 548.9 \pm 0.5 \text{ (MeV)}$$

$$\chi^2/N_{\text{dof}} = 62.6/48$$

BG curve fixed  
(2<sup>nd</sup> polynomial)  
with sideband data  
Signal shape  
(triple gaussian)  
decided by MC dist.

自身の測定結果を利用 (後述)

mode	BF(PLB672,209(2009))
$\tau \rightarrow \pi \pi^0 \eta \nu$	$(1.35 \pm 0.03 \pm 0.07) \times 10^{-3}$
$\tau \rightarrow K \eta \nu$	$(1.58 \pm 0.05 \pm 0.09) \times 10^{-4}$
$\tau \rightarrow K^* \eta \nu$	$(1.34 \pm 0.12 \pm 0.09) \times 10^{-4}$

$$N_{\eta}^{\text{fit}} = 749.2 \pm 67.3$$

$$N_{\pi \pi \eta \nu} = 313.2 \pm 7.2$$

$$N_{K \eta \nu} = 42.4 \pm 2.3$$

$$N_{K^* \eta \nu} = 127.0 \pm 3.6$$

$$N_{qq} = 75.7 \pm 11.7$$

$$N_{\eta}^{\text{sig}} = 190.9 \pm 68.6$$

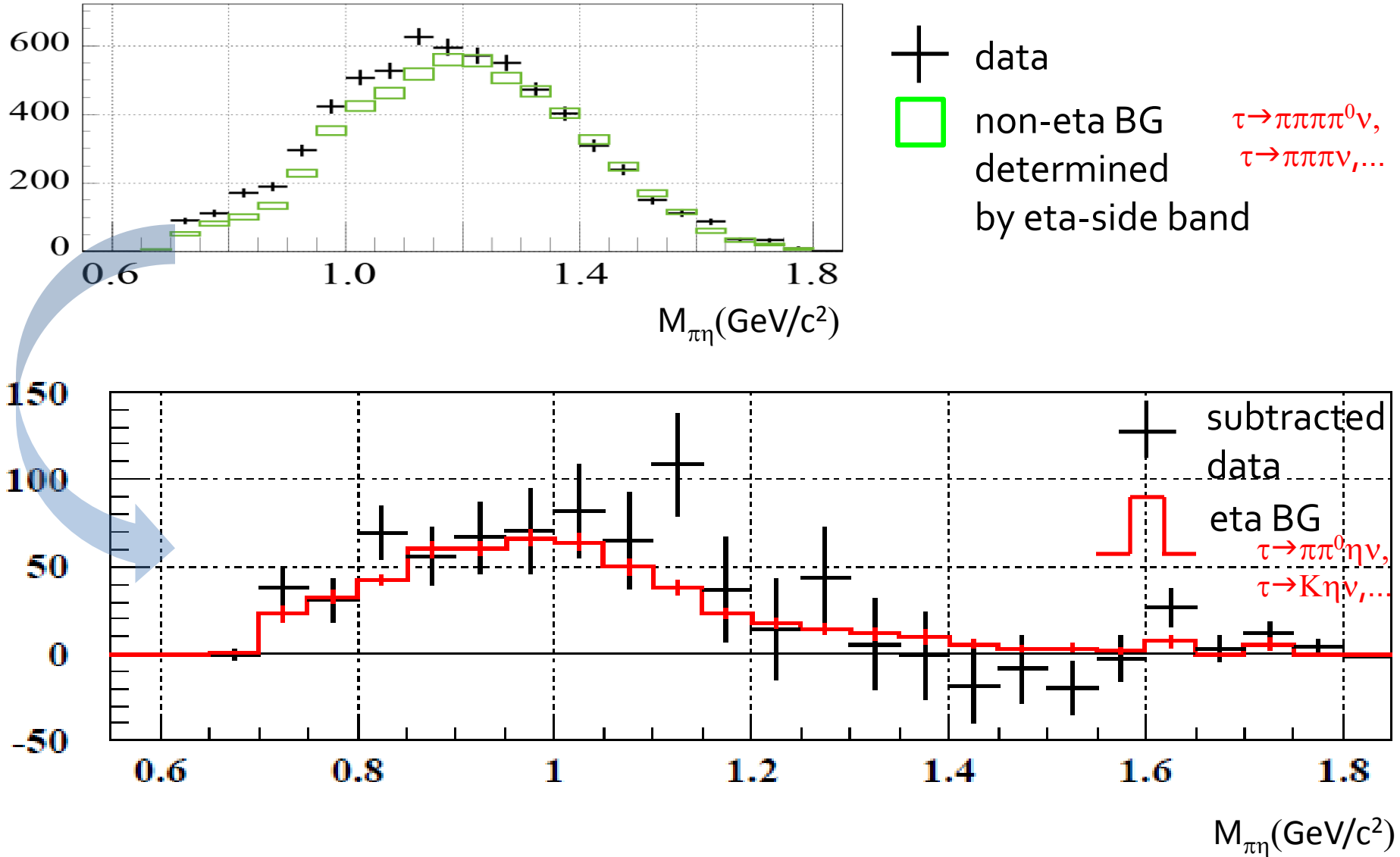
(2.8 $\sigma$  w/o systematics)

$$\mathcal{B}(\tau \rightarrow \pi \eta \nu) =$$

$$(4.4 \pm 1.6 \pm 0.8) \times 10^{-5}$$

(2.4 $\sigma$ )

# 信号領域の $M_{\pi\eta} (= M_{4\pi})$ 分布 ( $542 < M_{3\pi} < 556 \text{ MeV}$ )



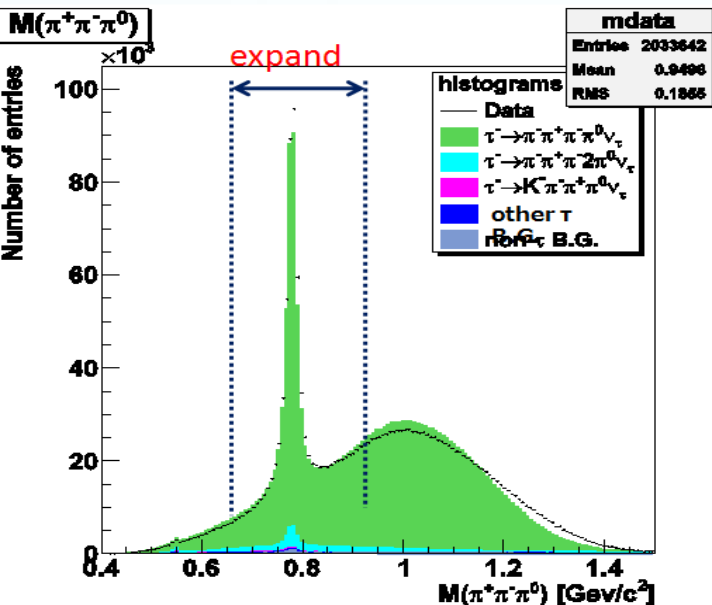
この時同時に

$$\mathcal{B}(\tau \rightarrow \pi\eta'\nu) < 6.1 \times 10^{-6} @ 90\% \text{ CL}$$

$$\text{BaBar: } \mathcal{B} < 7.2 \times 10^{-6}$$

# もう一つの2nd class current( $\tau \rightarrow \pi \omega \nu$ )

$M(\pi^+ \pi^- \pi^0)$  in  $\tau^- \rightarrow \pi^- \pi^+ \pi^- \pi^0 \nu_\tau$



- 595/fb data
- $2.0 \times 10^6$   $3\pi\pi^0\nu$
- 2 entry/events are plotted
- Background
 

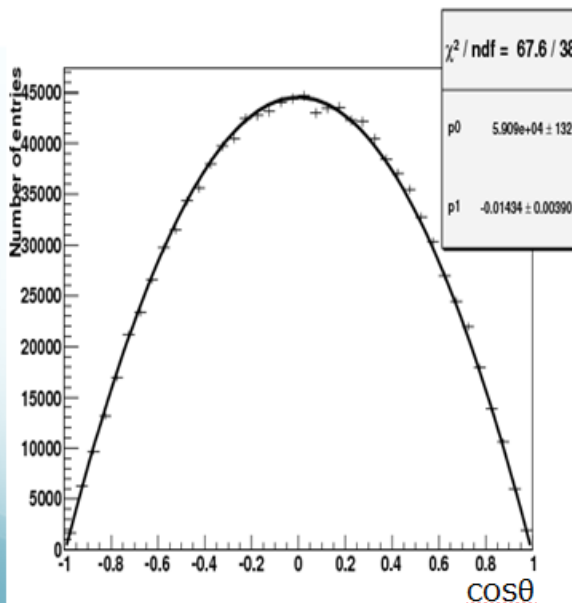
$3\pi$	$2\pi^0\nu$	3.6%
(largest one)		
$K2\pi$	$\pi^0\nu$	0.37%
qq-conti.		3.5%
-----		
total		8.1%

$\rho \rightarrow \pi\omega$  以外に  
 $b_1 \rightarrow \pi\omega$  の存在を期待

## cos $\theta$ distribution

- BG is subtracted
- Acceptance is corrected

CLEOの約10倍の感度で  
SCC fraction を測定



【fit function】

$$F(\cos\theta) = N[\epsilon \cdot F^{\text{SCC}}(\cos\theta) + (1 - \epsilon)F^{\text{FCC}}(\cos\theta)]$$

•  $F^{\text{SCC}}(\cos\theta) = 1$  case

$$Y = \frac{3Y_{\text{max}}}{4} \left\{ (1 - \epsilon)(1 - \cos^2\theta) + \frac{2}{3}\epsilon \right\}$$

$Y_{\text{max}}$  : Normalization  
 $\epsilon$  : SCC contribution

【Fit results】

$$\epsilon = -0.0143 \pm 0.0039$$

$$(\chi^2 = 67.48, \text{NDF} = 38)$$

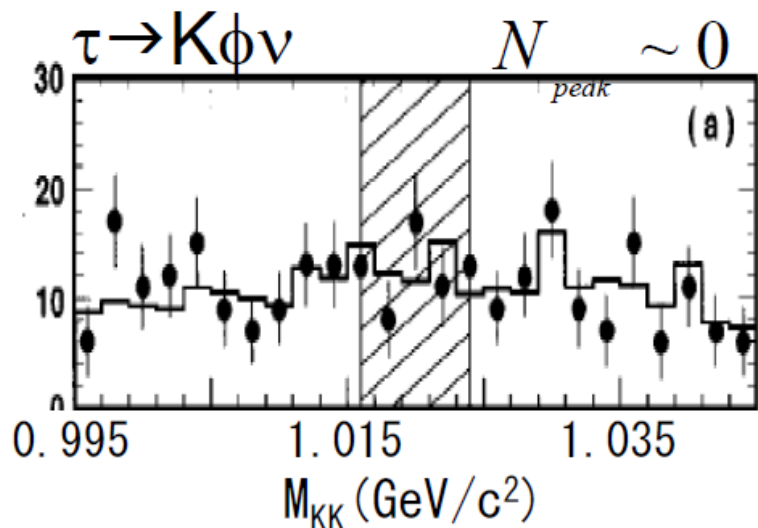
UL of SCC at 90% C.L. is

$$\epsilon < 0.0050$$

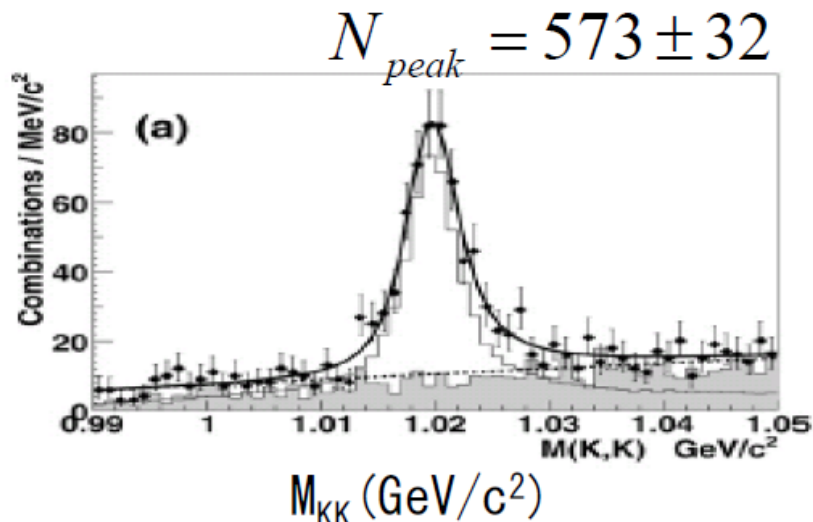


**MEASUREMENT OF BRANCHING  
FRACTIONS FOR TAU HADRONIC DECAYS**

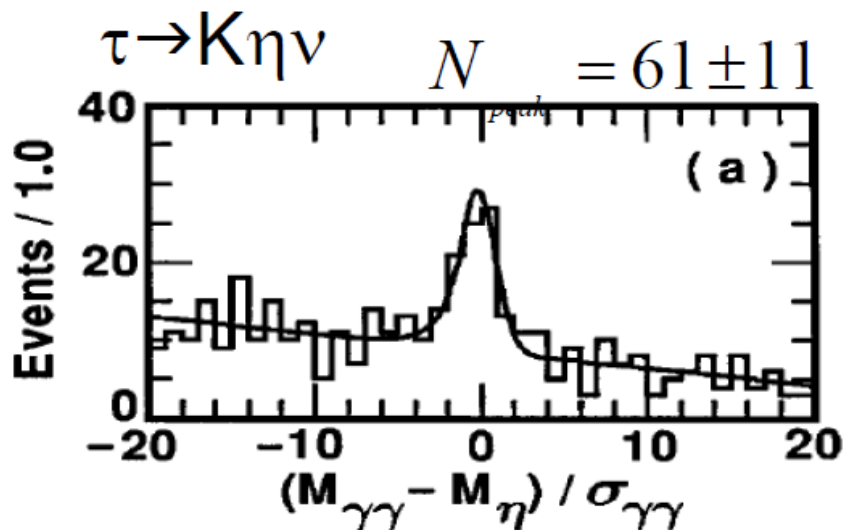
# Belle 高統計データ vs 過去の実験



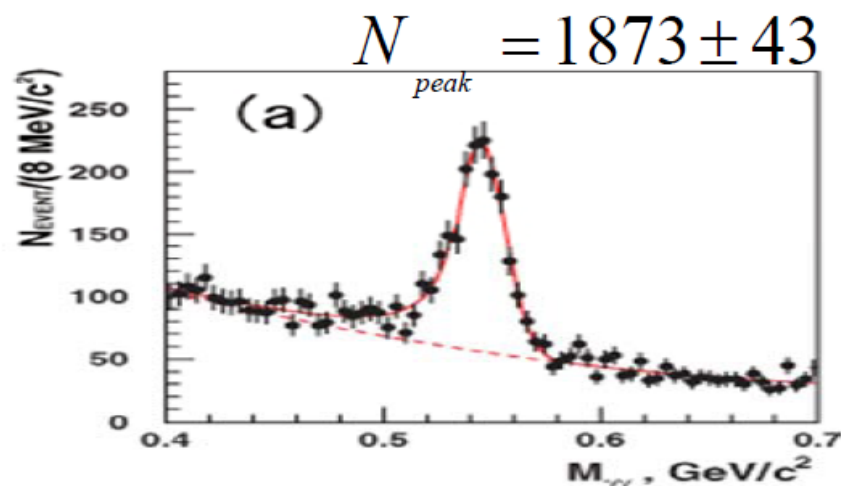
CLEO  $3.1\text{fb}^{-1}$  (1997)



Belle  $401\text{fb}^{-1}$  (2006)



CLEO  $3.5\text{fb}^{-1}$  (1996)



Belle  $485\text{fb}^{-1}$  (preliminary)

# 測定された分岐比

Mode	Branching fraction $\mathcal{B}$ ( $\times 10^{-4}$ )		
	This work	Previous exp.	Ref.
$\tau^- \rightarrow K^- \eta \nu_\tau$	$1.58 \pm 0.05 \pm 0.09$	$2.6 \pm 0.5 \pm 0.5$ $2.9 \pm 1.3 \pm 0.7$	CLEO [7] ALEPH [9]
$\tau^- \rightarrow \pi^- \pi^0 \eta \nu_\tau$	$13.5 \pm 0.3 \pm 0.7$	$17 \pm 2 \pm 2$ $18 \pm 4 \pm 2$	CLEO [6] ALEPH [9]
$\tau^- \rightarrow K^- \pi^0 \eta \nu_\tau$	$0.46 \pm 0.11 \pm 0.04$	$1.77 \pm 0.56 \pm 0.71$	CLEO [8]
$\tau^- \rightarrow \pi^- K_S^0 \eta \nu_\tau$	$0.44 \pm 0.07 \pm 0.02$	$1.10 \pm 0.35 \pm 0.11$	CLEO [8]
$\tau^- \rightarrow K^{*-} \eta \nu_\tau$	$1.34 \pm 0.12 \pm 0.09$	$2.90 \pm 0.80 \pm 0.42$	CLEO [8]
$\tau^- \rightarrow K^- K_S^0 \eta \nu_\tau$	$< 4.5 \times 10^{-6}$		
$\tau^- \rightarrow \pi^- K_S^0 \pi^0 \eta \nu_\tau$	$< 2.5 \times 10^{-5}$		
$\tau^- \rightarrow K^- \eta \eta \nu_\tau$	$< 3.0 \times 10^{-6}$		
$\tau^- \rightarrow \pi^- \eta \eta \nu_\tau$	$< 7.4 \times 10^{-6}$		

490fb<sup>-1</sup>

$$\text{Br}(\tau \rightarrow K^{*0} K \nu) = (1.78 \pm 0.01 \pm 0.10) \times 10^{-3}$$

$$\text{Br}(\tau \rightarrow K^{*0} K \pi^0 \nu) = (2.39 \pm 0.46 \pm 0.26) \times 10^{-5}$$

$$\text{Br}(\tau \rightarrow h \pi^0 \nu) = (25.67 \pm 0.01 \pm 0.39)\%$$

$$(\text{Br}(\tau \rightarrow \pi \pi^0 \nu) = (25.24 \pm 0.01 \pm 0.39)\%)$$

$$\text{Br}(\tau \rightarrow K_S^0 K_S^0 \pi \nu) = (2.34 \pm 0.04 \pm 0.18) \times 10^{-4} \quad (\text{PDG } (2.4 \pm 0.5) \times 10^{-4})$$

$$\text{Br}(\tau \rightarrow K_S^0 K_S^0 \pi \pi^0 \nu) = (1.9 \pm 0.4 \pm 0.2) \times 10^{-5} \quad (\text{PDG } < 2.0 \times 10^{-4})$$

previous result(ARGUS)

$$\text{Br}(\tau \rightarrow K^{*0} K \nu) = (2.0 \pm 0.5 \pm 0.4) \times 10^{-3}$$

550fb<sup>-1</sup>

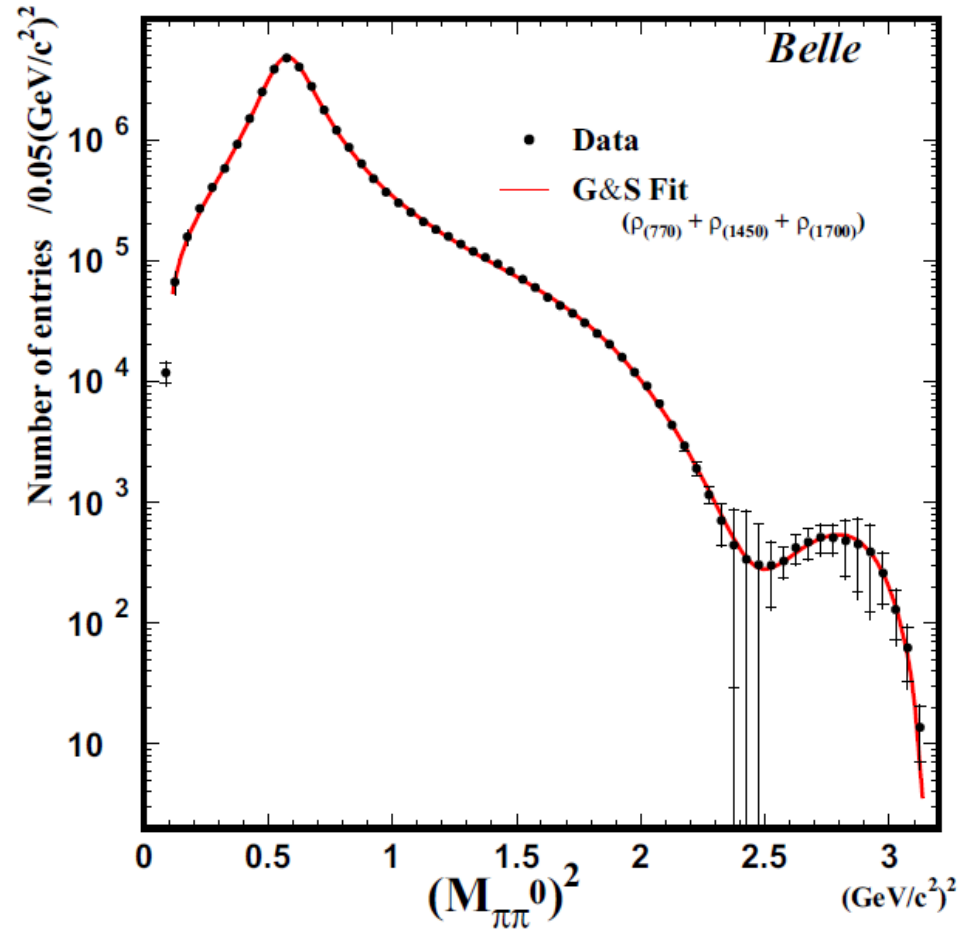
previous result(CLEO)

$$\text{Br}(\tau \rightarrow h \pi^0 \nu) = (25.87 \pm 0.12 \pm 0.42)\%$$

72.2fb<sup>-1</sup>

680fb<sup>-1</sup>

# 評価された分布 ( $\tau \rightarrow \pi\pi^0\nu$ )

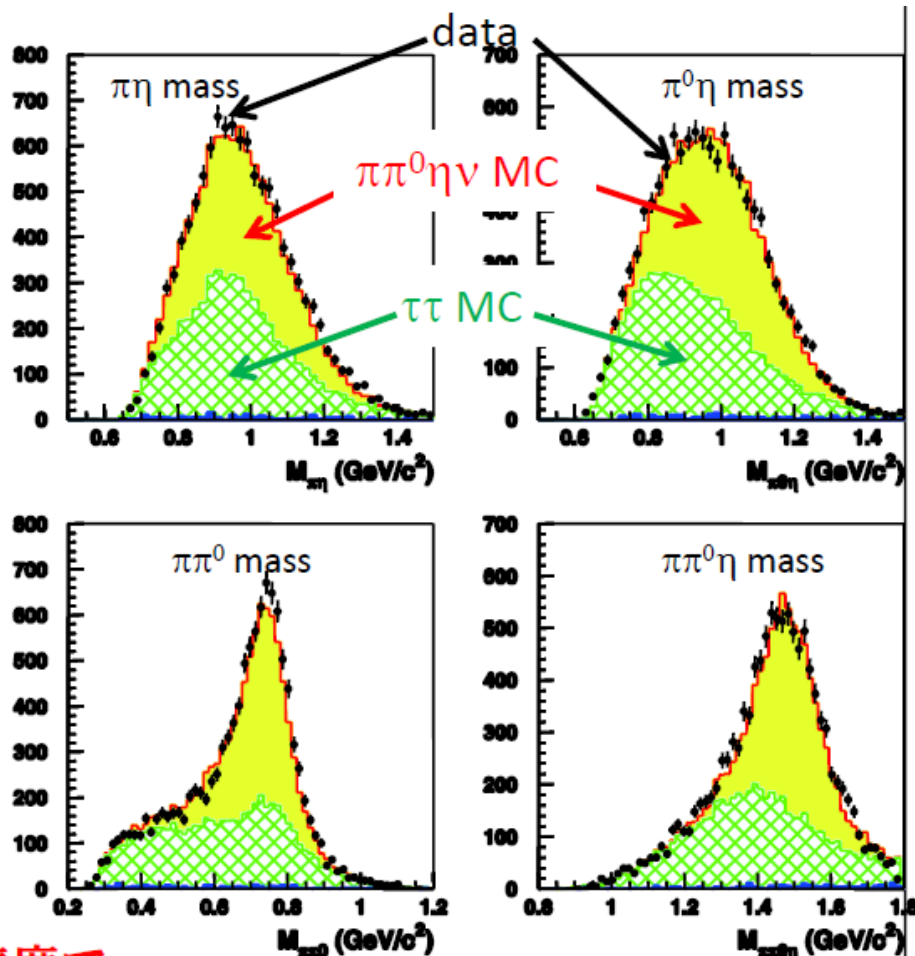


Parameter	Fit result (fixed $ F(0) ^2$ )	Fit result (all free)
$M_\rho$ , MeV/ $c^2$	$774.6 \pm 0.2 \pm 0.5$	$774.9 \pm 0.3 \pm 0.5$
$\Gamma_\rho$ , MeV	$148.1 \pm 0.4 \pm 1.7$	$148.6 \pm 0.5 \pm 1.7$
$M_{\rho'}$ , MeV/ $c^2$	$1446 \pm 7 \pm 28$	$1428 \pm 15 \pm 26$
$\Gamma_{\rho'}$ , MeV	$434 \pm 16 \pm 60$	$413 \pm 12 \pm 57$
$ \beta $	$0.15 \pm 0.05^{+0.15}_{-0.04}$	$0.13 \pm 0.01^{+0.16}_{-0.04}$
$\phi_\beta$ , degree	$202 \pm 4^{+41}_{-8}$	$197 \pm 9^{+50}_{-5}$
$M_{\rho''}$ , MeV/ $c^2$	$1728 \pm 17 \pm 89$	$1694 \pm 41 \pm 89$
$\Gamma_{\rho''}$ , MeV	$164 \pm 21^{+89}_{-26}$	$135 \pm 36^{+50}_{-26}$
$ \gamma $	$0.037 \pm 0.006^{+0.065}_{-0.009}$	$0.028 \pm 0.020^{+0.059}_{-0.009}$
$\phi_\gamma$ , degree	$24 \pm 9^{+118}_{-28}$	$-3 \pm 13^{+136}_{-29}$
$ F(0) ^2$	[1.0]	$1.02 \pm 0.01 \pm 0.04$
$\chi^2/\text{NDF}$	80/52	65/51
$\rho''(1700)$ signif., $\sigma$	6.5	7.0

最終的にg-2への $\pi\pi$ の寄与

$$a_\mu^{\pi\pi}[2m_\pi, 1.8 \text{ GeV}/c^2] = (523.5 \pm 1.5(\text{exp.}) \pm 2.6(\text{Br.}) \pm 2.5(\text{isospin})) \times 10^{-10},$$

# 評価された分布 ( $\tau \rightarrow \pi\pi^0\nu$ )

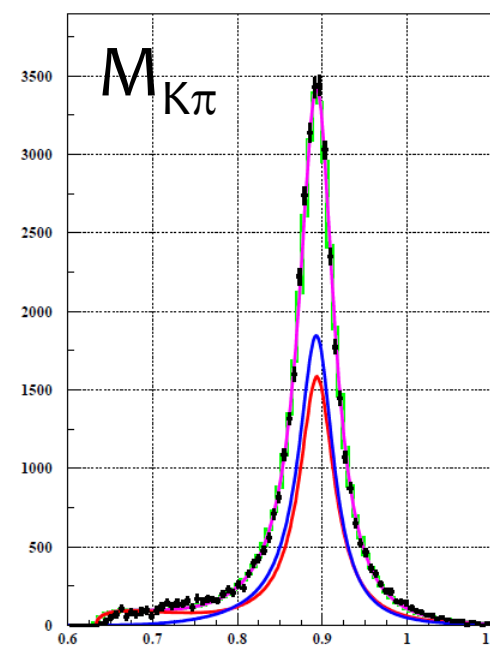
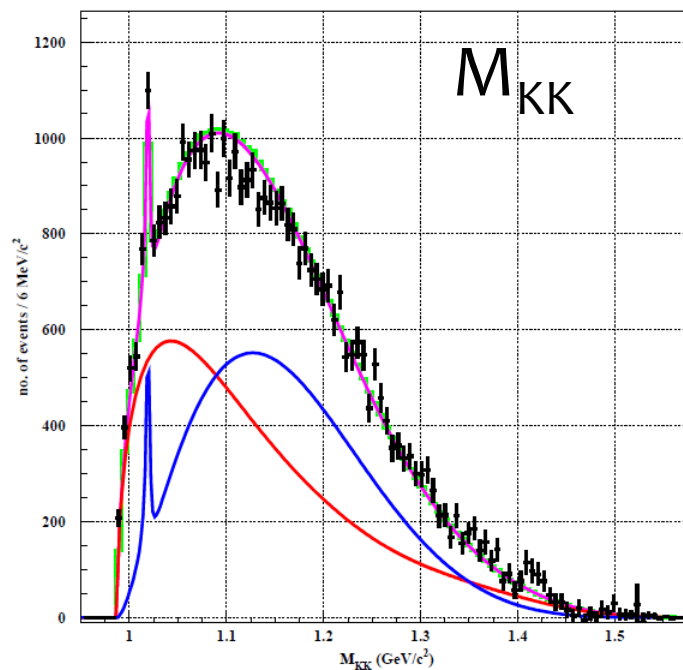
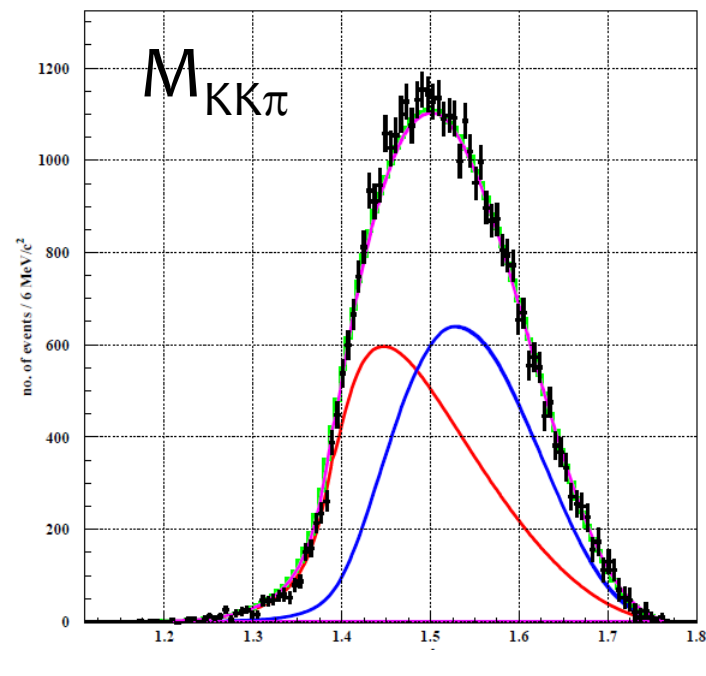


黄色の分布は  $ee \rightarrow \pi\pi\eta$  過程を CVCを利用して  $\tau \rightarrow \pi\pi^0\nu$  に焼きなおした分布。CVCがよく機能していることが確認できる。

4)  $\text{Im} \langle \pi^+ | \text{to} \langle \pi^+ | \pi^+ | \pi^0 | \nu \rangle_{\text{tau}} \rangle$  and  $\text{Re} \langle \pi^+ | \text{to} \langle \pi^+ | \pi^+ | \pi^+ | \pi^+ \rangle$  at low energies. Pablo Roig, (Orsay, LPT). LPT-ORSAY-10-70, Oct 2010. 4pp. To appear in the proceedings of 15th International QCD Conference: QCD 10 (25th anniversary), Published in Nucl.Phys.Proc.Suppl.207-208:145-147,2010. e-Print: arXiv:1010.0224 [hep-ph]

6) Quest for precision in hadronic cross sections at low energy: Monte Carlo tools vs. experimental data. By Working Group on Radiative Corrections and Monte Carlo Generators for Low Energies (S. Actis et al.). BIHEP-HEPTOOLS-09-018, IEKP-KA-2009-33, LNF-09-14-P, LPSC-09-157, LPT-ORSAY-09-95, LTH-851, MZ-TH-09-38, Published in Eur.Phys.J.C66:585-686,2010. e-Print: arXiv:0912.0749 [hep-ph]

# 評価された分布( $\tau \rightarrow \text{KK}\pi\nu$ )

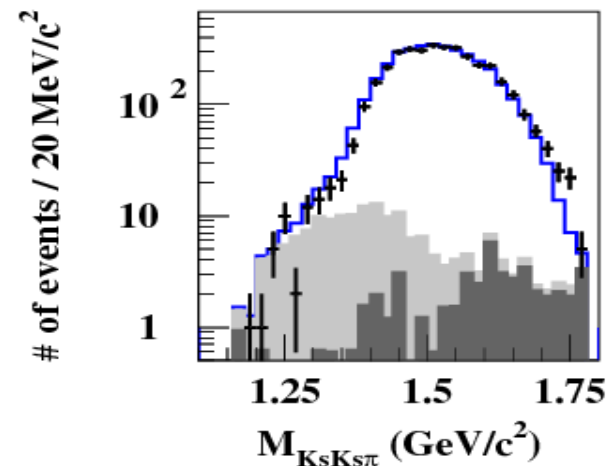
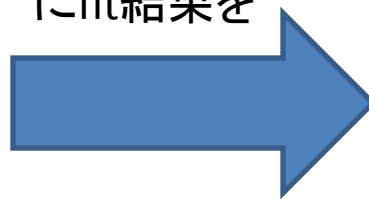


Vector:  $\tau \rightarrow \rho\nu$  /  $\rho \rightarrow K^*K$  /  $K^* \rightarrow \pi K$   
 /  $\rho \rightarrow \omega\pi + \phi\pi$  /  $\omega(\text{or } \phi) \rightarrow \text{KK}$   
 Axial :  $\tau \rightarrow a_1\nu$  /  $a_1 \rightarrow K^*K$  /  $K^* \rightarrow \pi K$   
 /  $a_1 \rightarrow \rho\pi$  /  $\rho \rightarrow \text{KK}$

を考慮して、3つの質量分布に対し  
Fitを行う。

この結果から、 $\Gamma_V/\Gamma_A = 1.13 \pm 0.07$

さらに  
 $\tau \rightarrow \text{KOKO}\pi\nu$   
にfit結果を



# まとめ

- 世界最高統計タウデータ ( $500 \sim 1000 \text{fb}^{-1}$ ) を利用して6モード (LFV: 42, CPV: 2, SCC: 3, Br: 14) を解析
- LFV
  - 新たに6モードの探索 + CLEOの100倍の感度達成
    - 統計の伸びだけではなくBGの理解のためもの
- CPV
  - CLEOの10倍の感度達成
- SCC
  - $\tau \rightarrow \eta \nu$ で兆候を観測・その他でCLEOの10倍の感度達成
- SM hadronic decay
  - 14のモードを測定。精度を4~8倍向上
  - $a_{\mu}^{\pi\pi}$  評価、 $\Gamma_V/\Gamma_A$  評価

where  $\psi$  denotes the angle between the direction of the CM frame and the direction of the  $\tau$  as seen from the hadronic rest frame and can be calculated as

$$\cos \psi = \frac{x(m_\tau^2 + Q^2) - 2Q^2}{(m_\tau^2 - Q^2)\sqrt{x^2 - 4Q^2/s}}. \quad (5)$$

(see [3]). The angle  $\beta$  is defined by  $\cos \beta = \vec{n}_L \cdot \hat{q}_1$  where  $\hat{q}_1 = \vec{q}_1/|\vec{q}_1|$  is the direction of the  $K_S^0$  and  $\vec{n}_L$  is the direction of the  $e^+e^-$  center of mass (CM) system, both observed in the hadronic rest frame. The azimuthal angle  $\alpha$  is not observable in this experiment and has to be averaged out. The variable  $\theta$  is the angle between the direction opposite to the direction of the CM system and the direction of the hadronic system in the  $\tau$  rest frame. In this experiment, the direction of the  $\tau$  is not known but  $\theta$  can be calculated from the hadronic energy  $E_h$  measured in the CM system:

$$\cos \theta = \frac{2xm_\tau^2 - m_\tau^2 - Q^2}{(m_\tau^2 - Q^2)\sqrt{1 - 4m_\tau^2/s}}, \quad x = 2\frac{E_h}{\sqrt{s}}, \quad (2)$$

where  $s = 4E_{\text{beam}}^2$  denotes the squared CM energy.



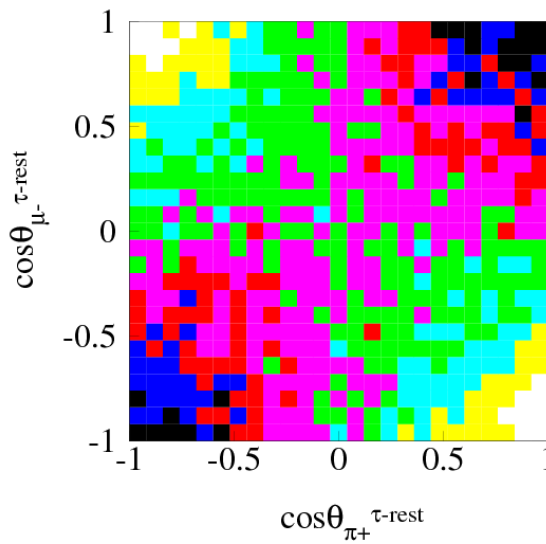
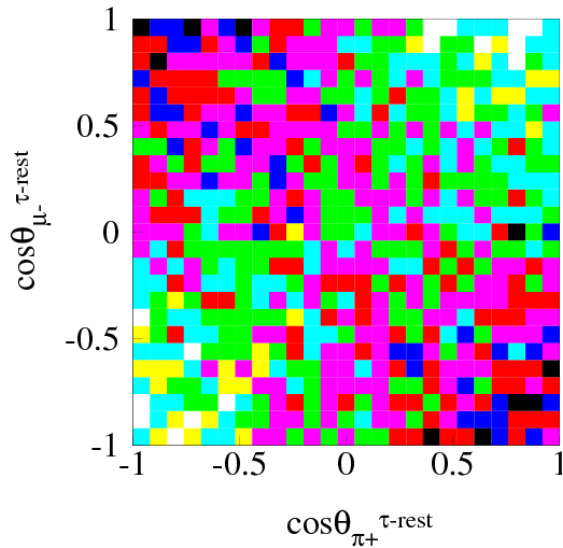
# 発見と探索感度向上

$\tau \rightarrow \mu\gamma$  で相関を考える

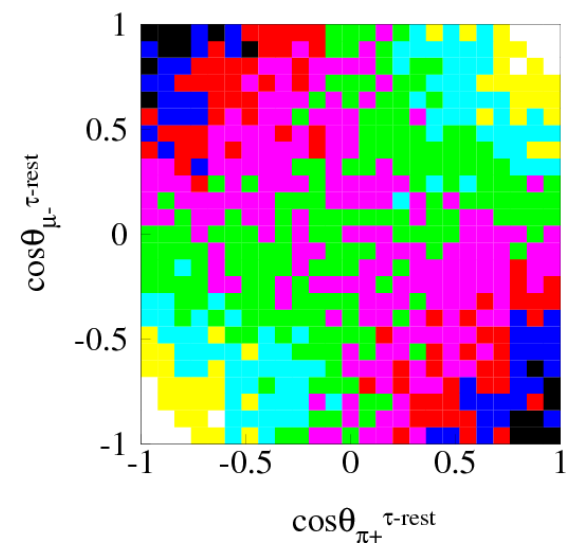
# generator level での話

$$\tau^- \rightarrow \mu^- \nu \nu / \tau^+ \rightarrow \pi^+ \nu$$

$$\tau^- \rightarrow \mu^- \gamma(L/R) / \tau^+ \rightarrow \pi^+ \nu$$



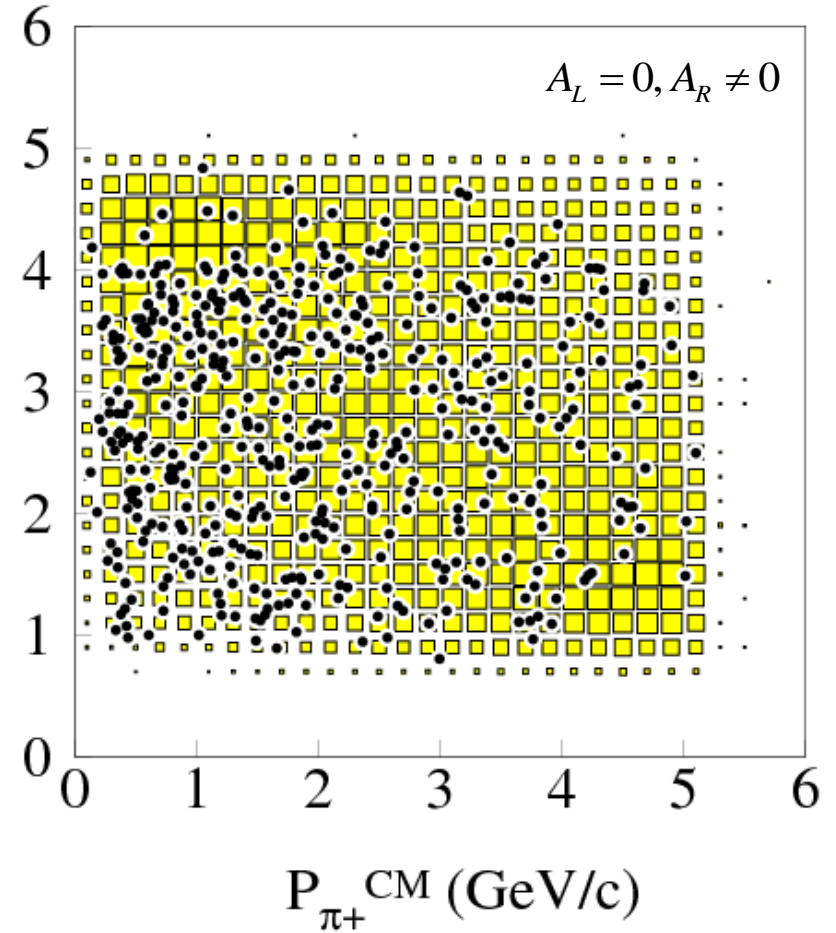
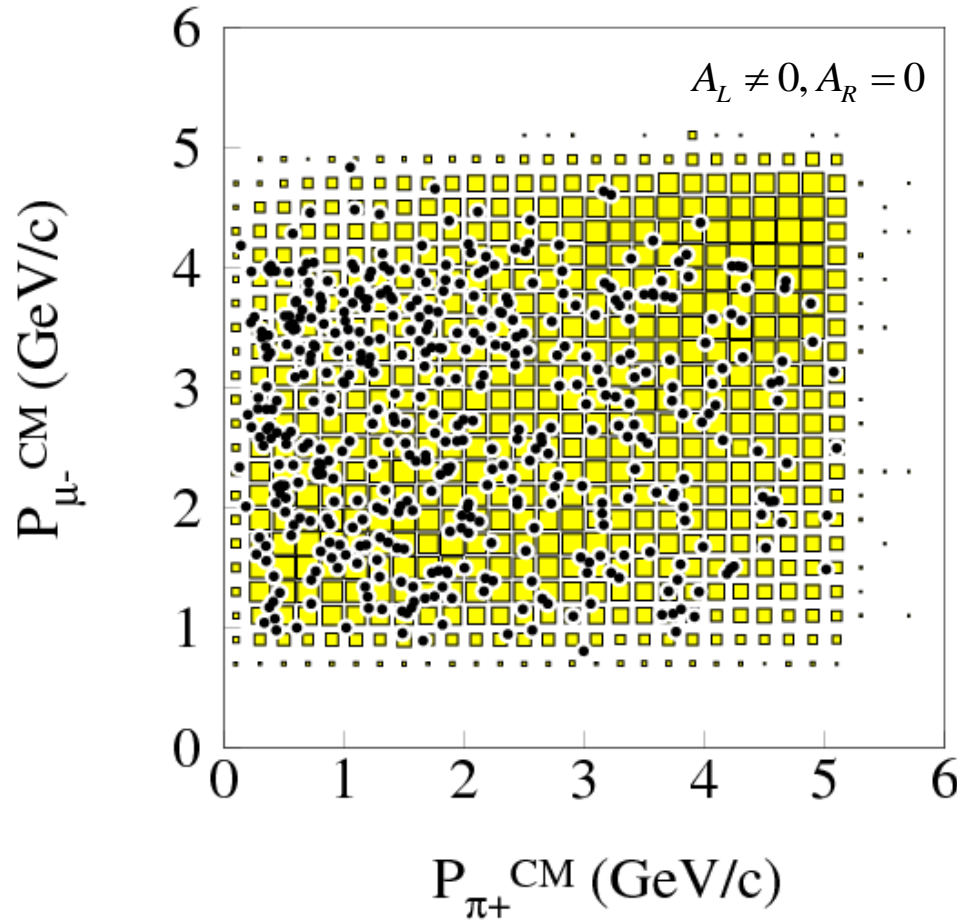
$$A_L \neq 0, A_R = 0$$



$$A_L = 0, A_R \neq 0$$

Left handed なタイプと  $\tau^- \rightarrow \mu^- \nu \nu / \tau^+ \rightarrow \pi^+ \nu$  はよくセパレート可能に見える  
 → 実際に測定されたデータではどうか？

# 運動量の相関

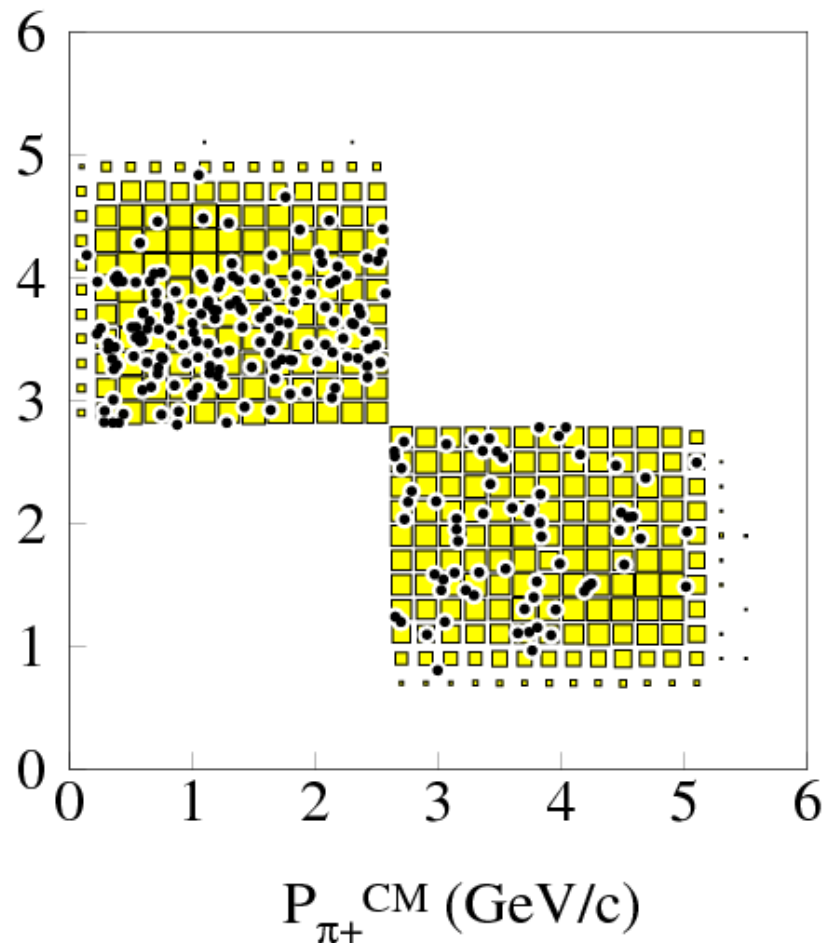
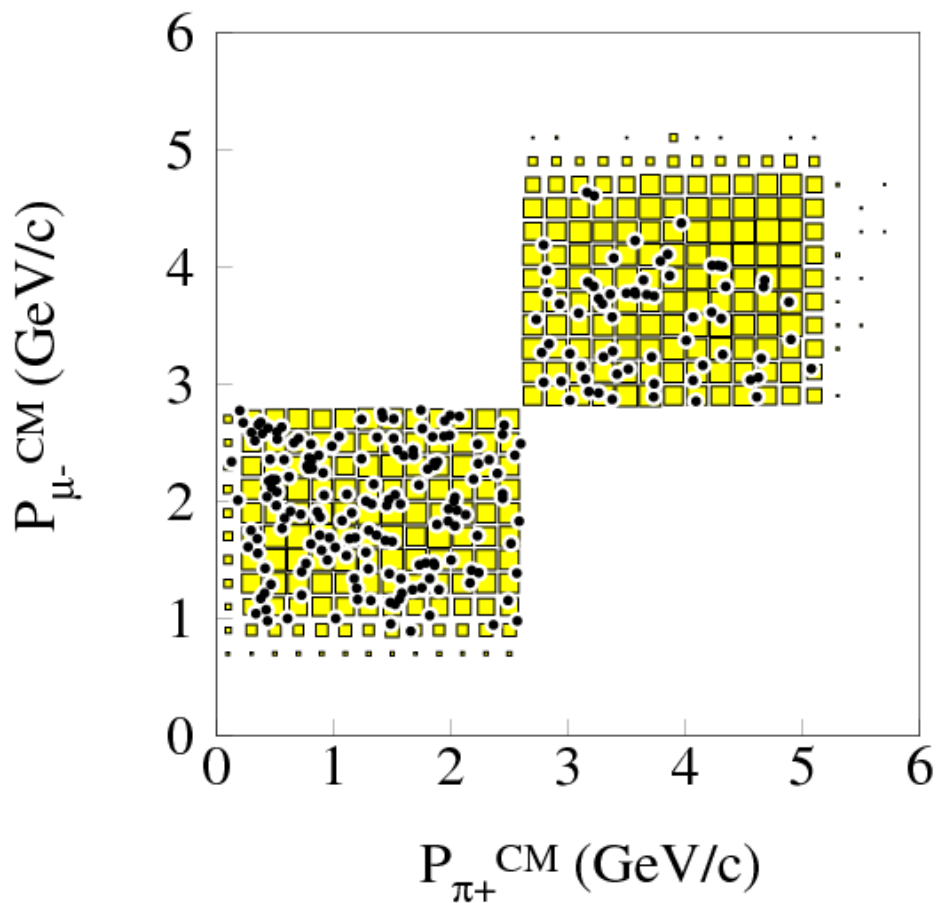


信号 MC



$\tau^- \rightarrow \mu^- \nu \nu / \tau^+ \rightarrow \pi^+ \nu$  MC

# Cutしてみる

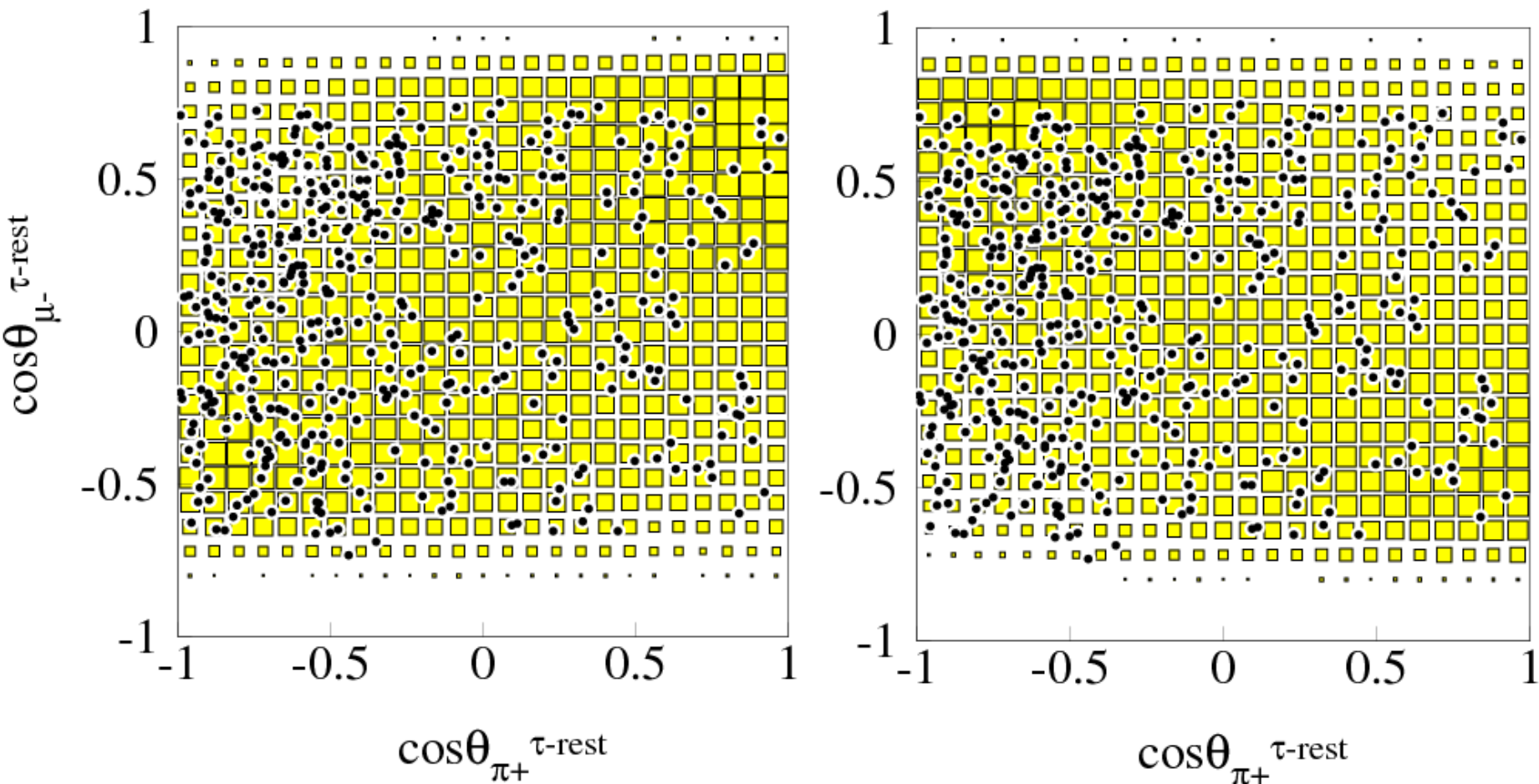


$$\frac{\mathcal{E}_{\text{after}}}{\sqrt{N_{\text{after}}^{\text{BG}}}} / \frac{\mathcal{E}_{\text{before}}}{\sqrt{N_{\text{before}}^{\text{BG}}}} = 0.82$$

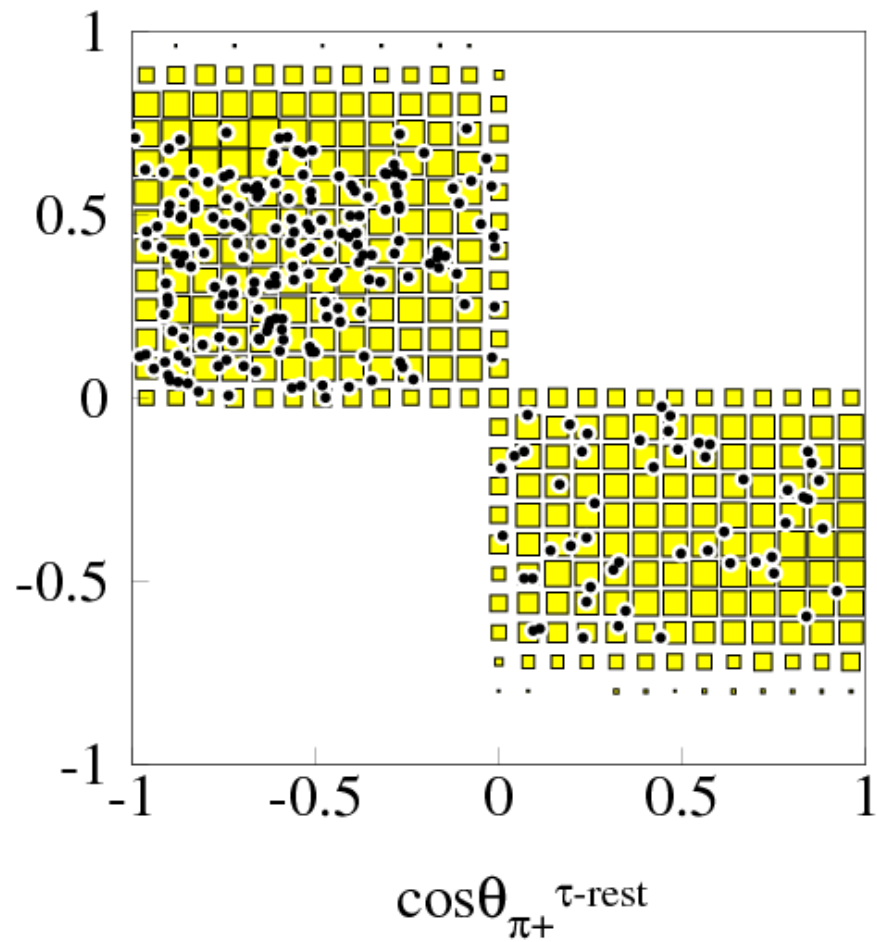
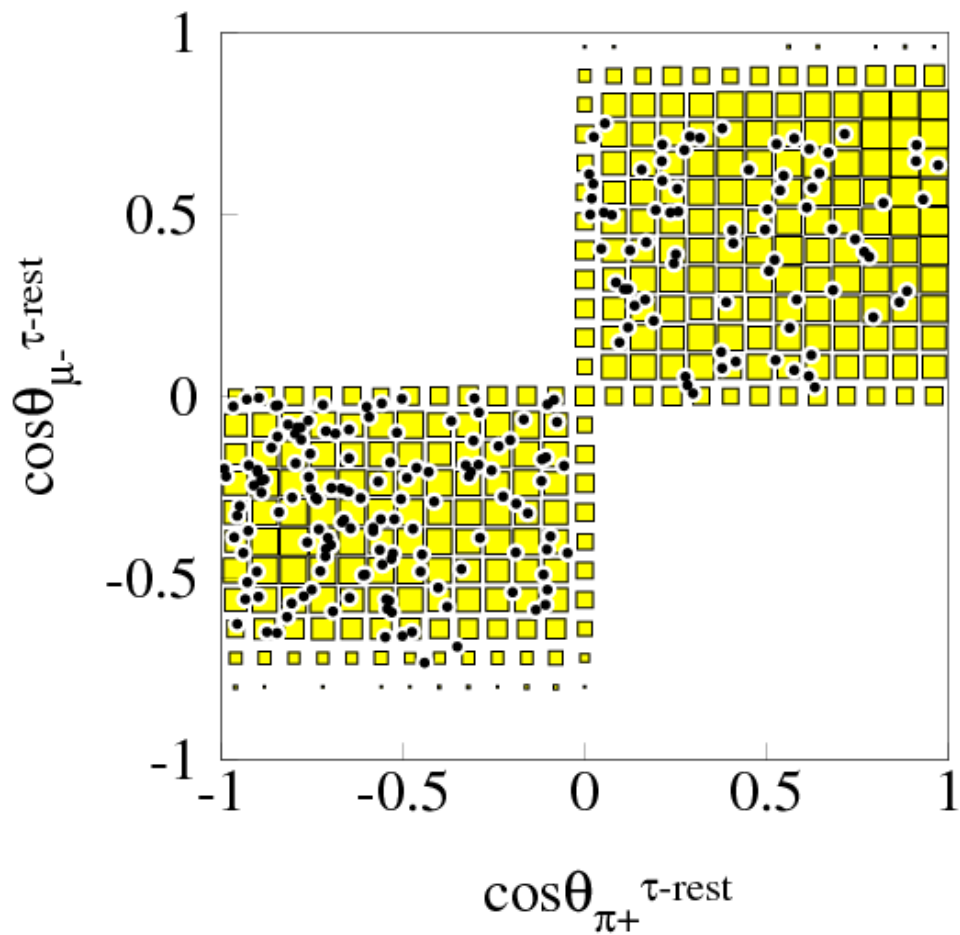
0.84

Figure of Meritはむしろ悪くなっている

# タウ制止系での角度



今、信号側のタウは再構成されているので、反対側のタウもCM系では再構成可能  
但し、BG事象では明後日の方向をむいている。



$$\frac{\mathcal{E}_{after}}{\sqrt{N_{after}^{BG}}} / \frac{\mathcal{E}_{before}}{\sqrt{N_{before}^{BG}}} = 0.84$$

0.83