Analysis of

$K^{\pm} \to \mu^{\pm} \pi^0 \pi^0 \nu$ ($K_{\mu 4}^{00}$) (Update)

Korotkova Anna, JINR

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Plan

New cuts

- Geometry cuts
- Time cuts
- Final cuts and signal

Trigger Efficiency

- Definitions of the control triggers
- Efficiency of the NUT and Charge trigger parts

Selection criteria $K_{\mu 4}^{(00)}$

Track:

- Exactly one reconstructed charged particle track;
- E over P (EoP) < 0.2;

LKR:

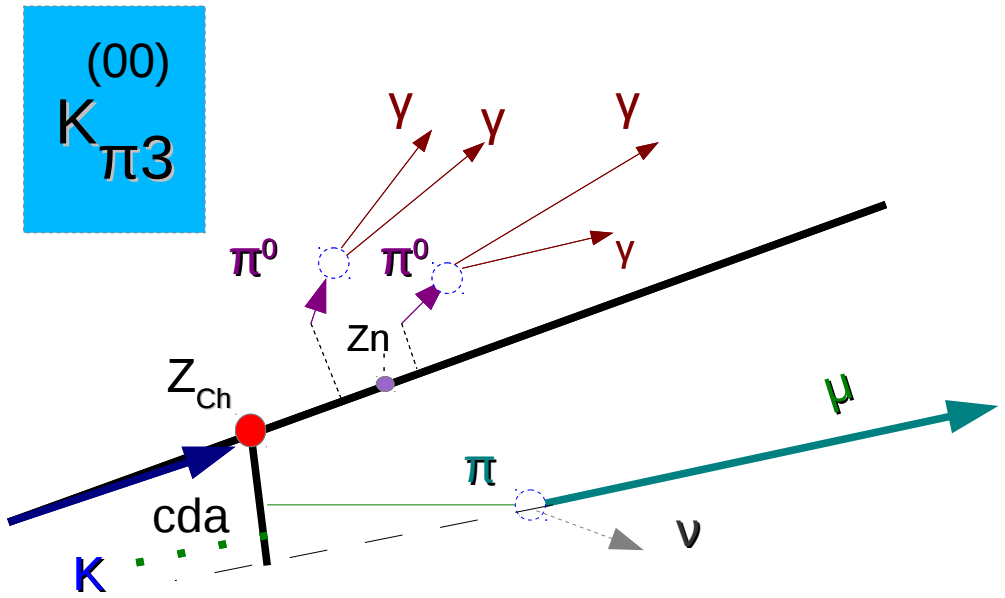
- The lower limit sums of all clusters LKR > 15 GeV; **for the trigger efficiency**

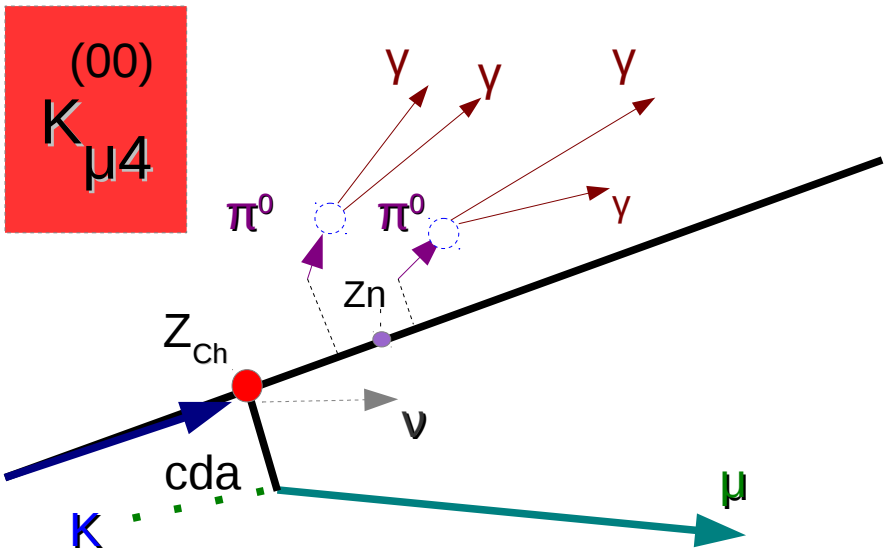
Cluster:

- Number of the clusters in the LKR > 3;
- Distance to the closest dead cell > 2 cm;
- Distance to the closest cluster > 10 cm;
- Maximum time from closest to other one > 5.0 ns;

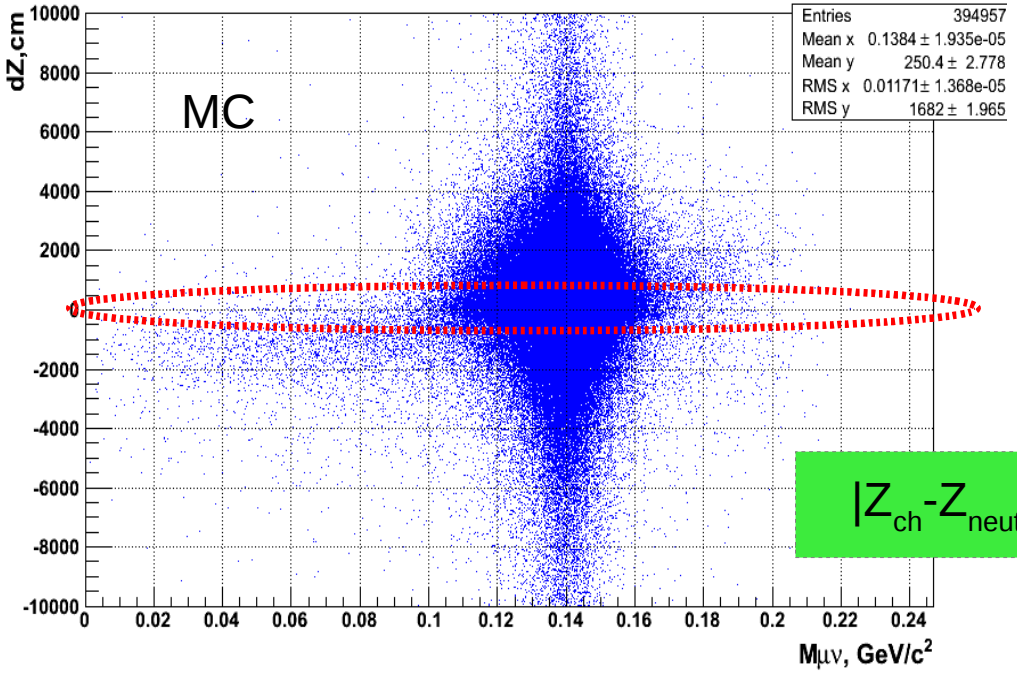
MUV:

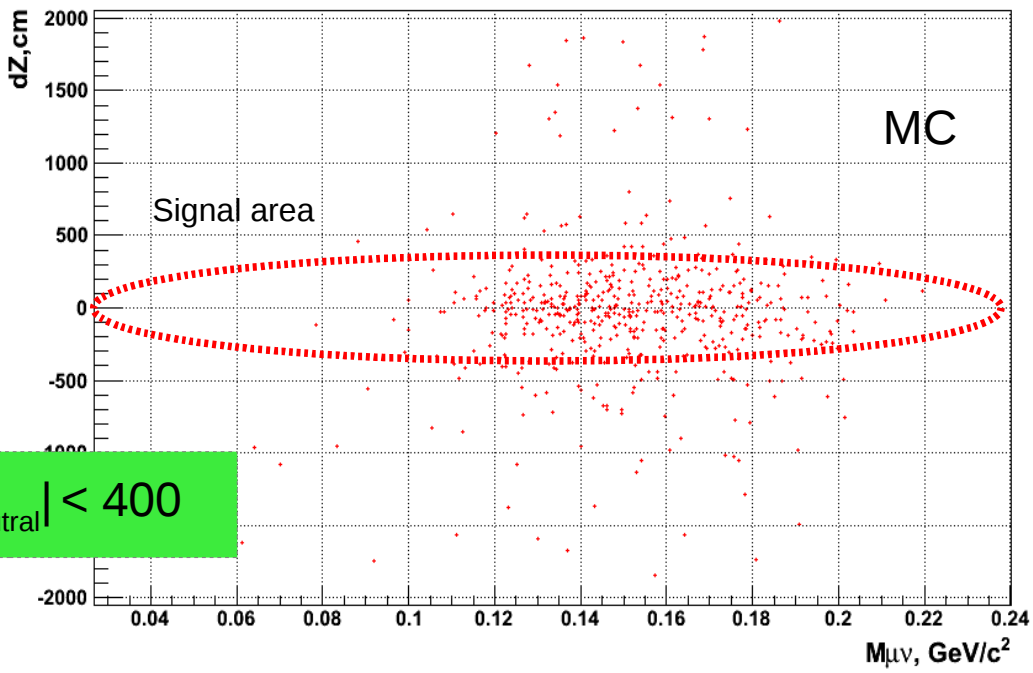
- No less than 6 row hits
- Track associated with in the MUV acceptance





$M_{\mu\nu}$ vs $Z_{Charged} - Z_{Neutral}$

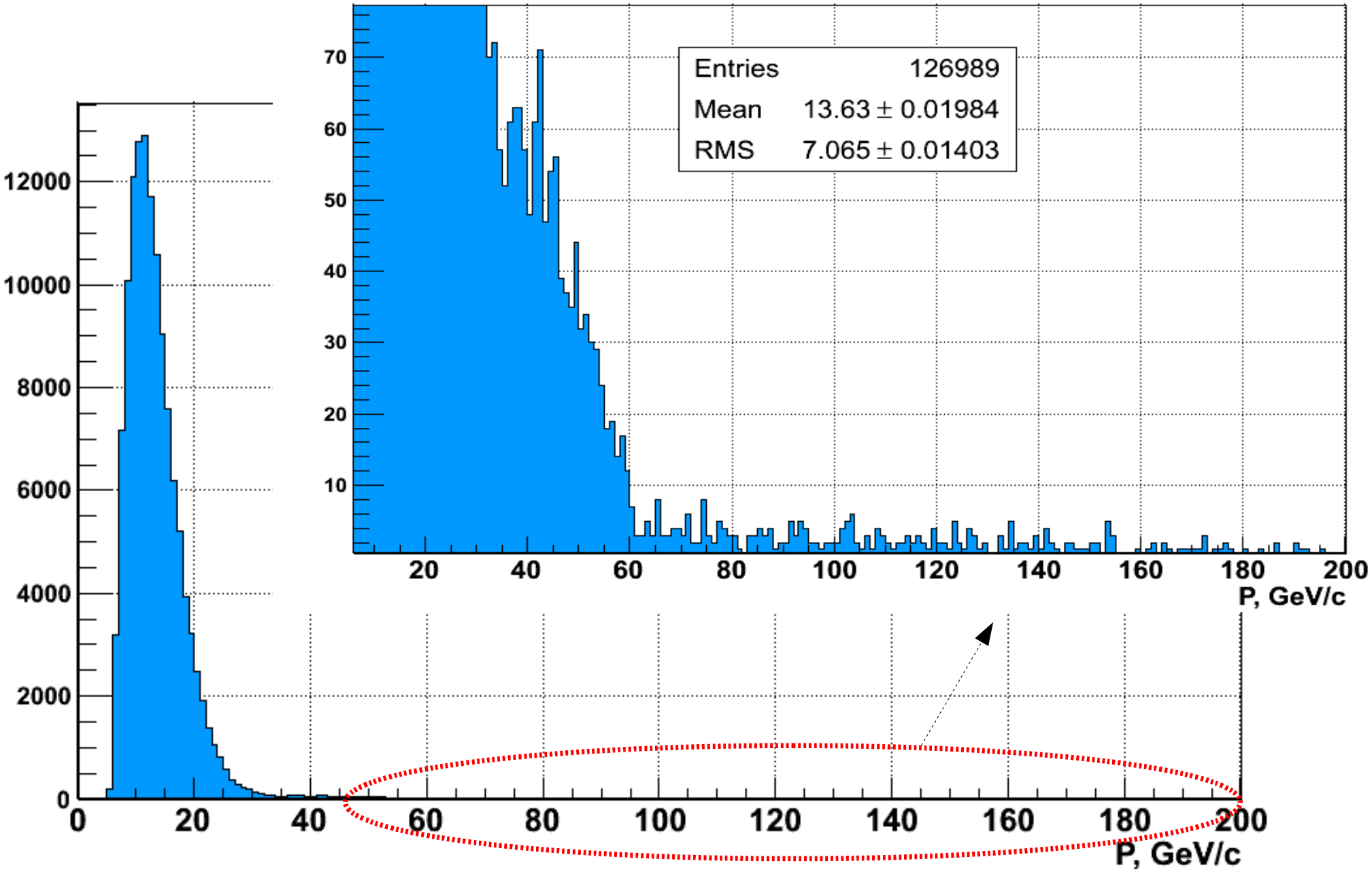


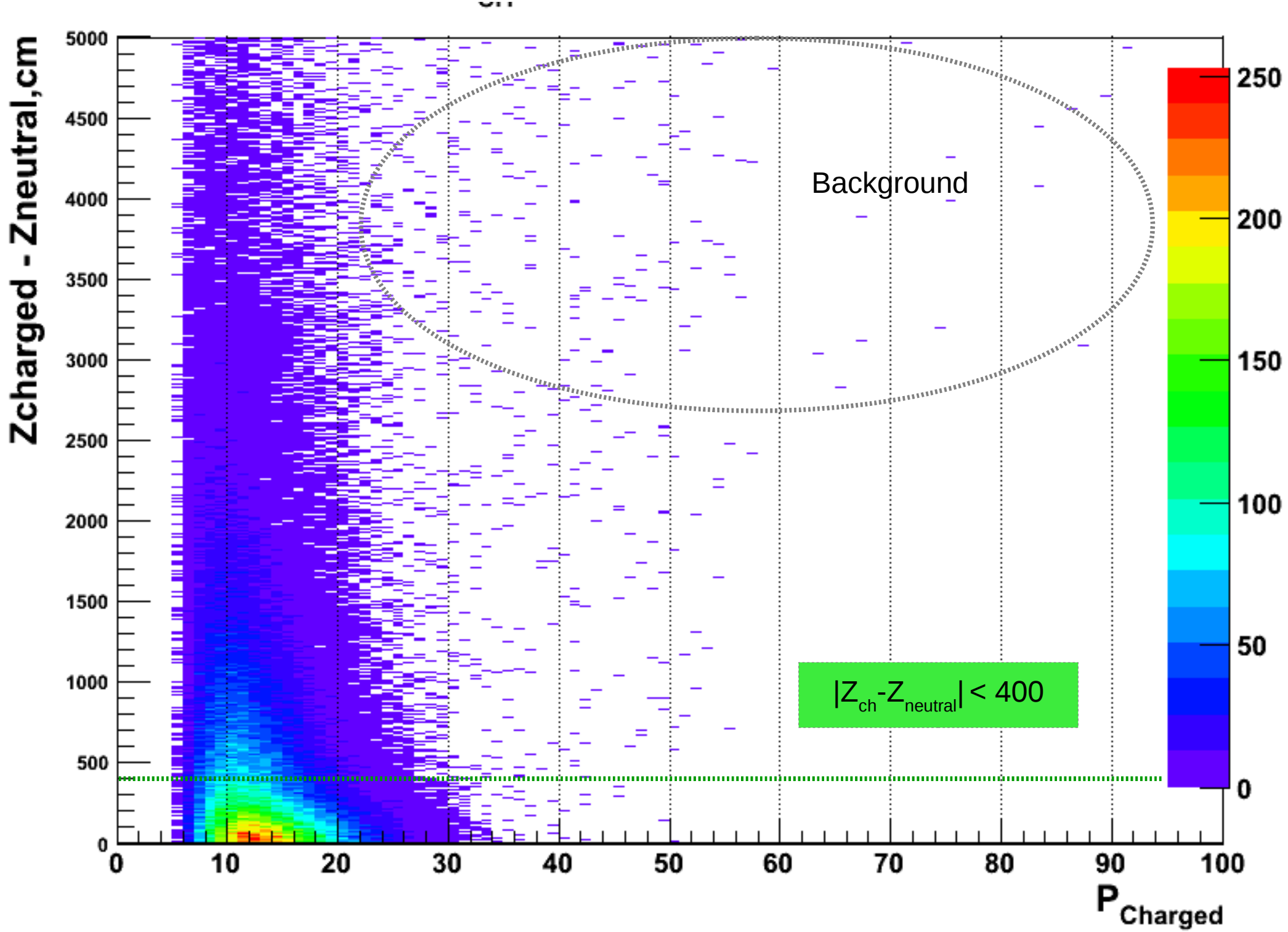


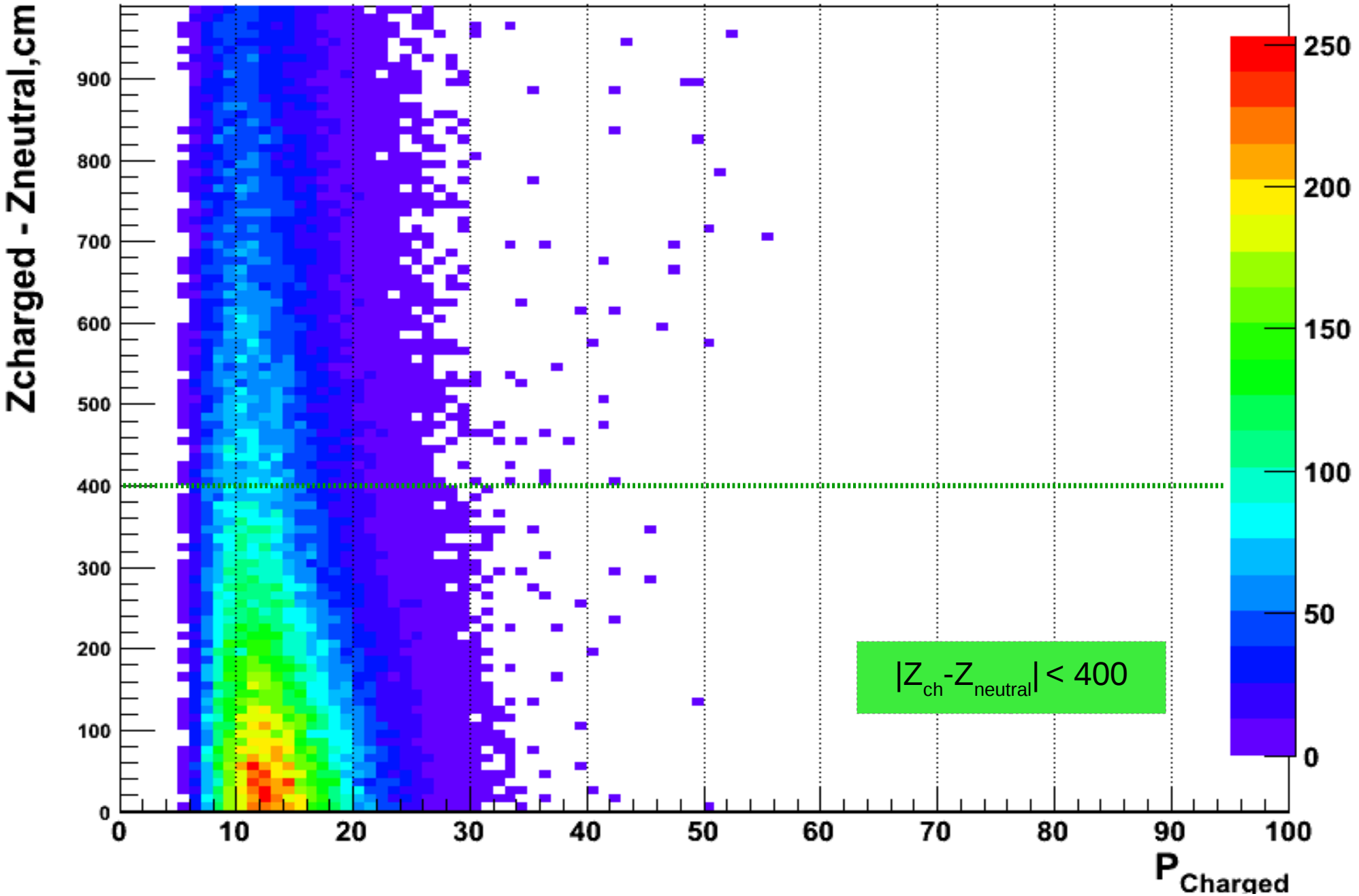
$|Z_{ch} - Z_{neutral}| < 400$

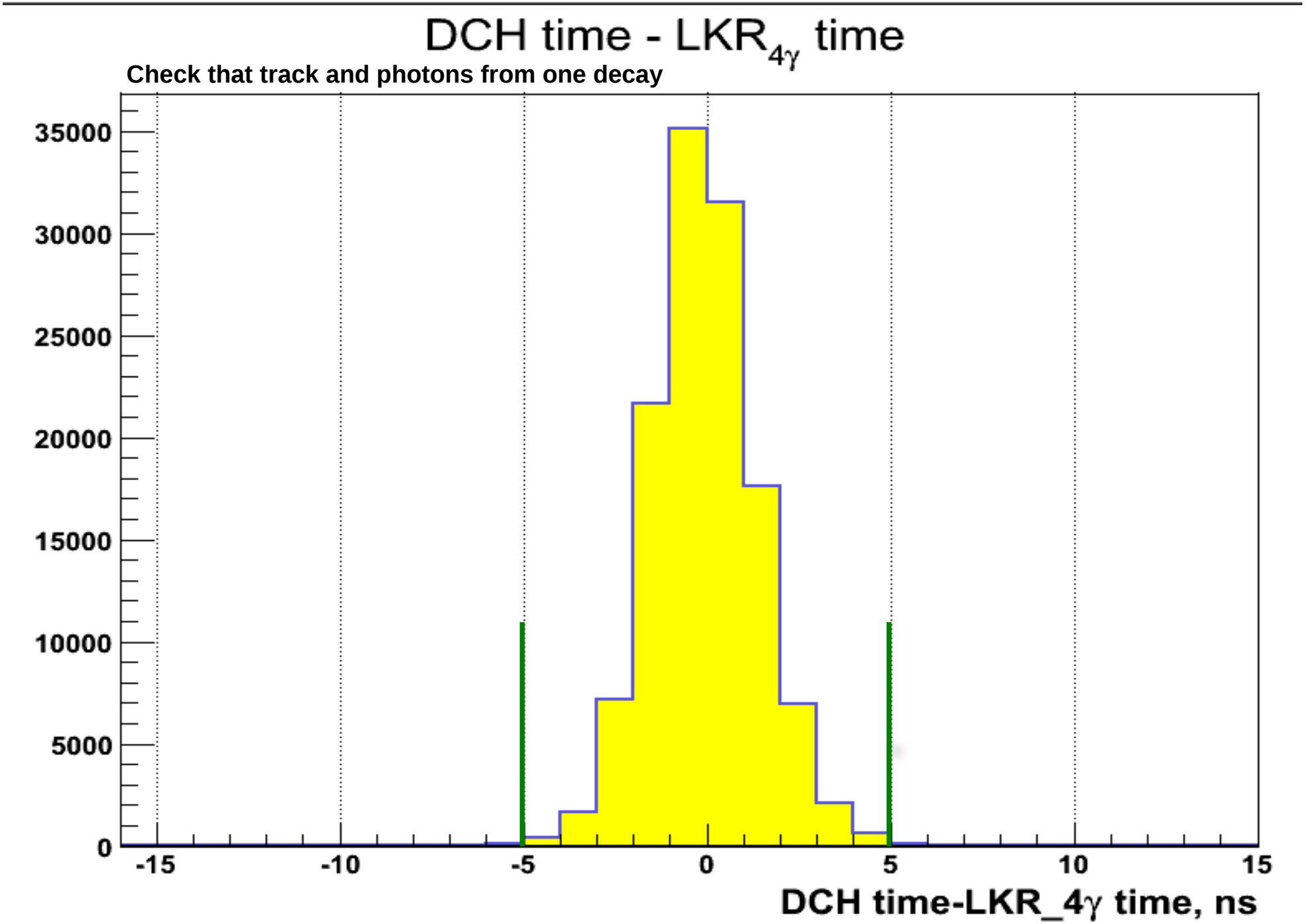
Tail of the momentum distribution

Small part of the data SS#1

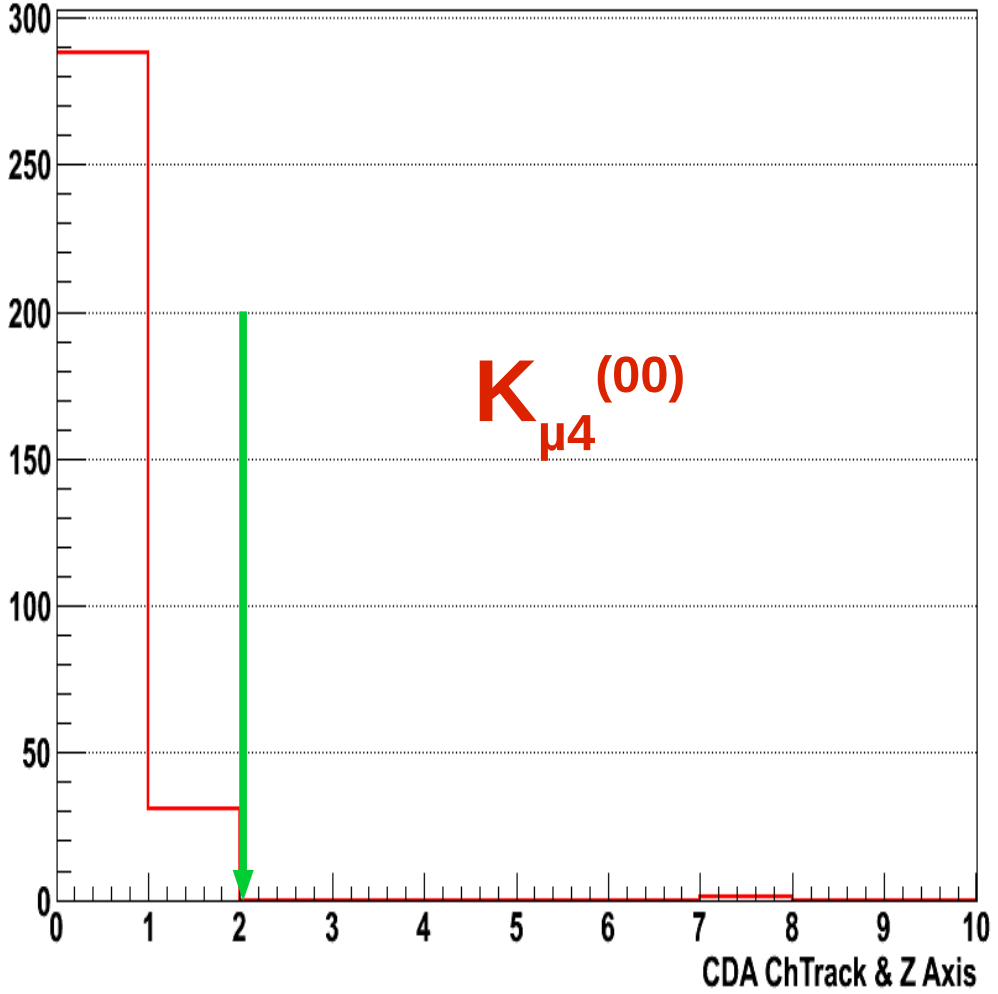


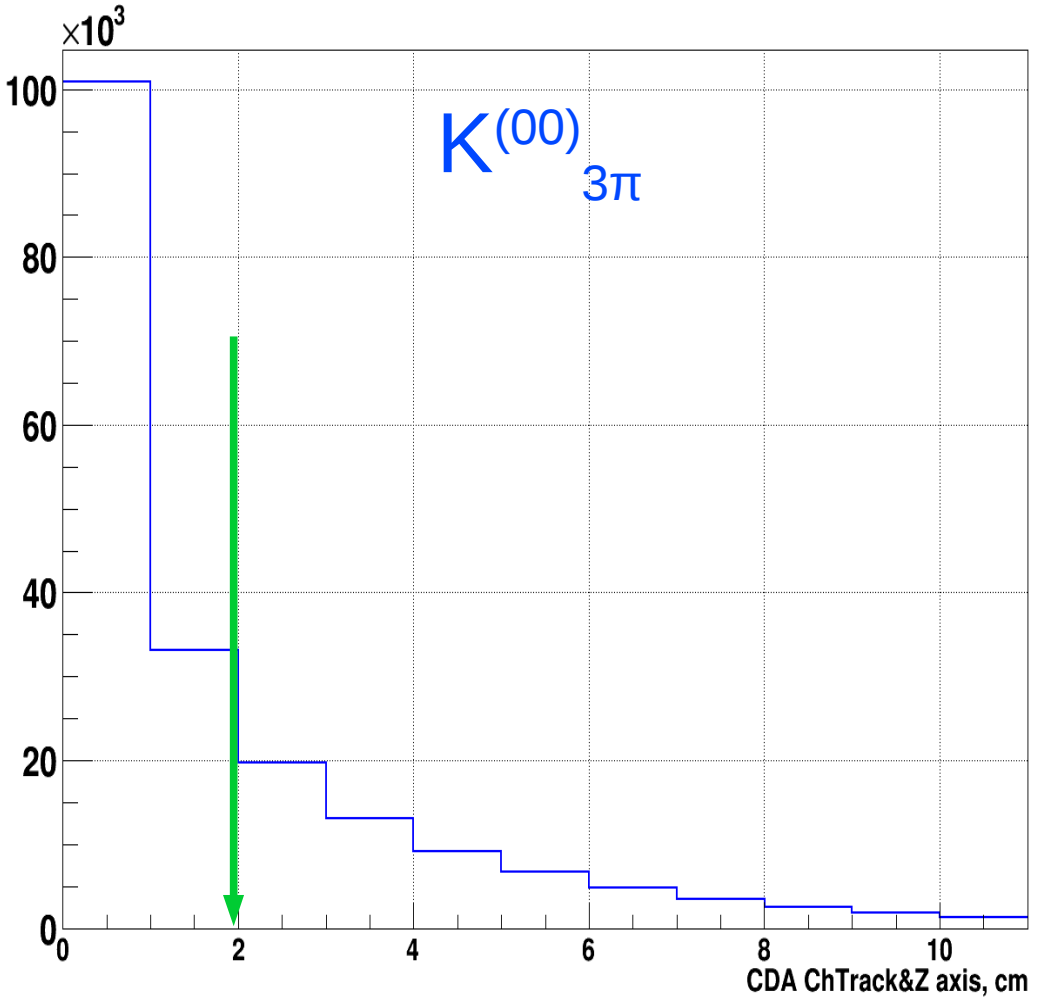

Zcharged - Zneutral,cm
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
P Charged
Background
|Z ch -Z neutral | < 400
250
200
150
100
50
0


Zcharged - Zneutral,cm
0
100
200
300
400
500
600
700
800
900
0
10
20
30
40
50
60
70
80
90
100
P Charged
250
200
150
100
50
0
|Z_ch -Z_neutral| < 400


DCH time - LKR$_{4\gamma}$ time
Check that track and photons from one decay
35000
30000
25000
20000
15000
10000
5000
0
-15
-10
-5
0
5
10
15
DCH time-LKR_4γ time, ns

CDA < 2


300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10
CDA ChTrack & Z Axis
K μ4 (00)


×10^3
100
80
60
40
20
0
0 2 4 6 8 10
CDA ChTrack&Z axis, cm
K (00) 3π

Final selection criteria $K_{\mu 4}^{(00)}$

Track:

- Exactly one reconstructed charged particle track;
- E over P (EoP) < 0.2;

LKR:

- The lower limit sums of all clusters LKR > 15 GeV; **for the trigger efficiency**

Cluster:

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MUV:

- No less than 6 row hits
- Track associated with in the MUV acceptance

Now	April
M_ν^2, $(GeV/c^2)^2$ > 0,16	M_ν^2, $(GeV/c^2)^2$ > 0,19
CDA < 2	No cuts
$E_{neutrino} > 0$	No cuts
$\lvert Z_{ch}-Z_{neutral}\rvert < 400$	No cuts

Analysis $K_{\mu 4}^{(00)}$ Update

$$\frac{X \cdot N_{K_{3\pi}}}{N_{K_{4\mu}}} = \frac{Br_{K_{3\pi}}}{Br_{K_{4\mu}}}$$

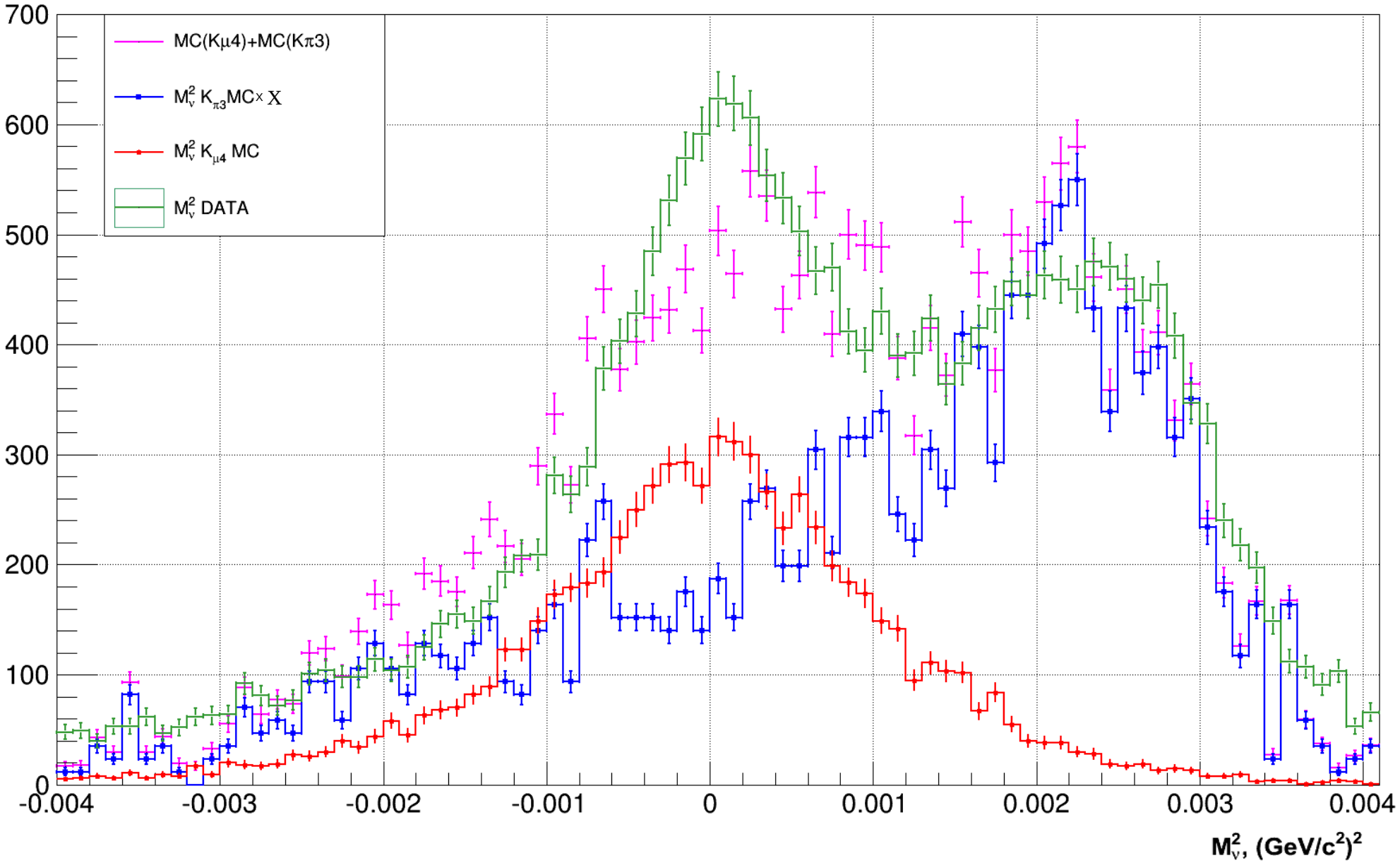
$Br(K_{3\pi}) = (1.761 \pm 0.022) \cdot 10^{-2}$

$Br(K_{\mu 4}) = 0.7 \cdot 10^{-5}$ (as expected to be)

$N_{K\mu 4}$ = 500 000

$N_{K\pi 3}$ = 107429931

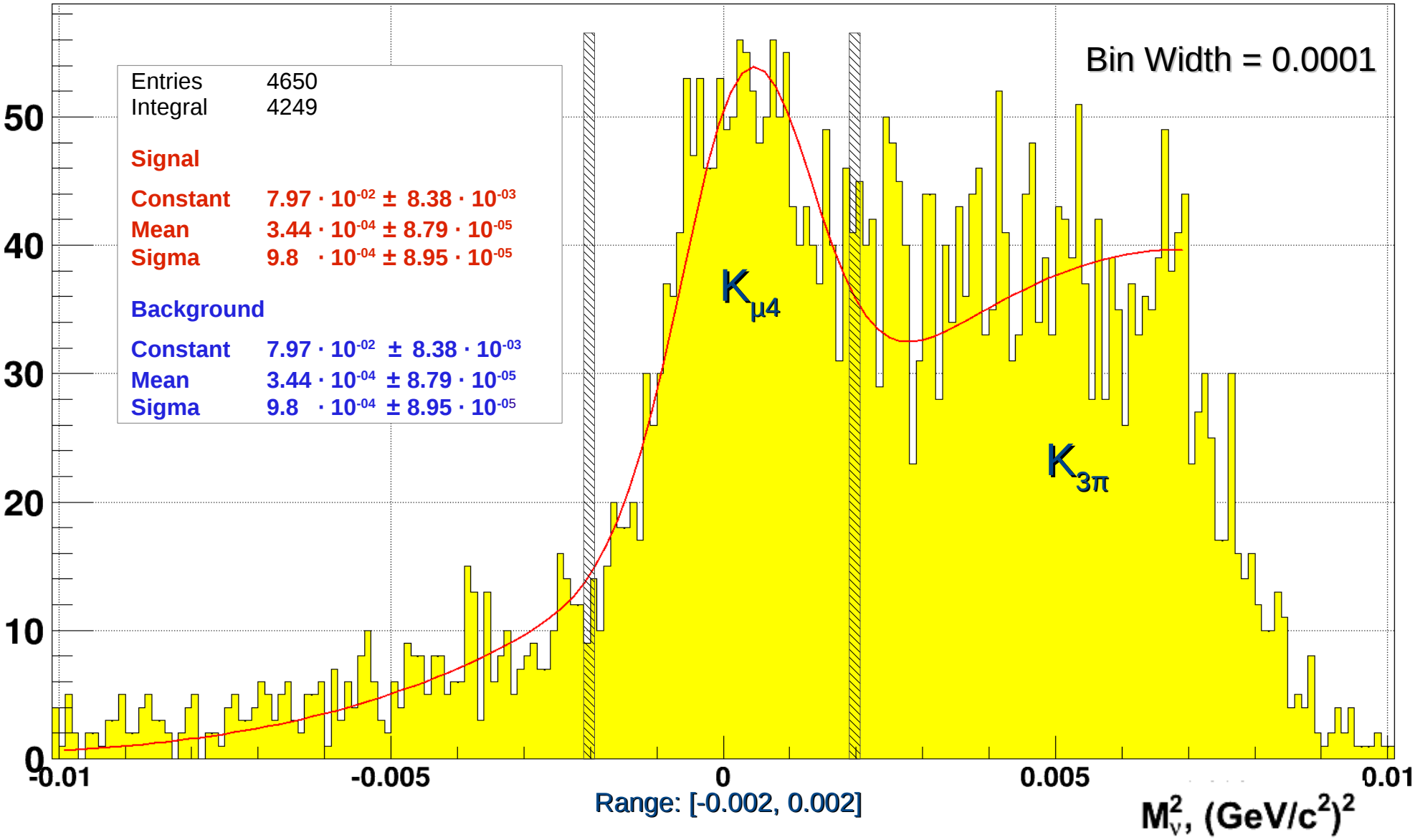
$$M_{\mu^{\pm}\nu}{}^2 = (E_k - E_{\pi_1^0} - E_{\pi_2^0})^2 - (\vec{P}_k - \vec{P}_{\pi_1^0} - \vec{P}_{\pi_2^0})^2$$



$K_{\mu 4}$ 754.7 ± 94.5 Events

$$f(x)=\frac{N_{events}}{\sigma_S\sqrt{2\pi}}e^{\frac{-(x_S-\mu_S)^2}{2\sigma_S^2}}+\frac{N_{events}}{\sigma_{Bg}\sqrt{2\pi}}e^{\frac{-(x_{Bg}-\mu_{Bg})^2}{2\sigma_{Bg}^2}}$$

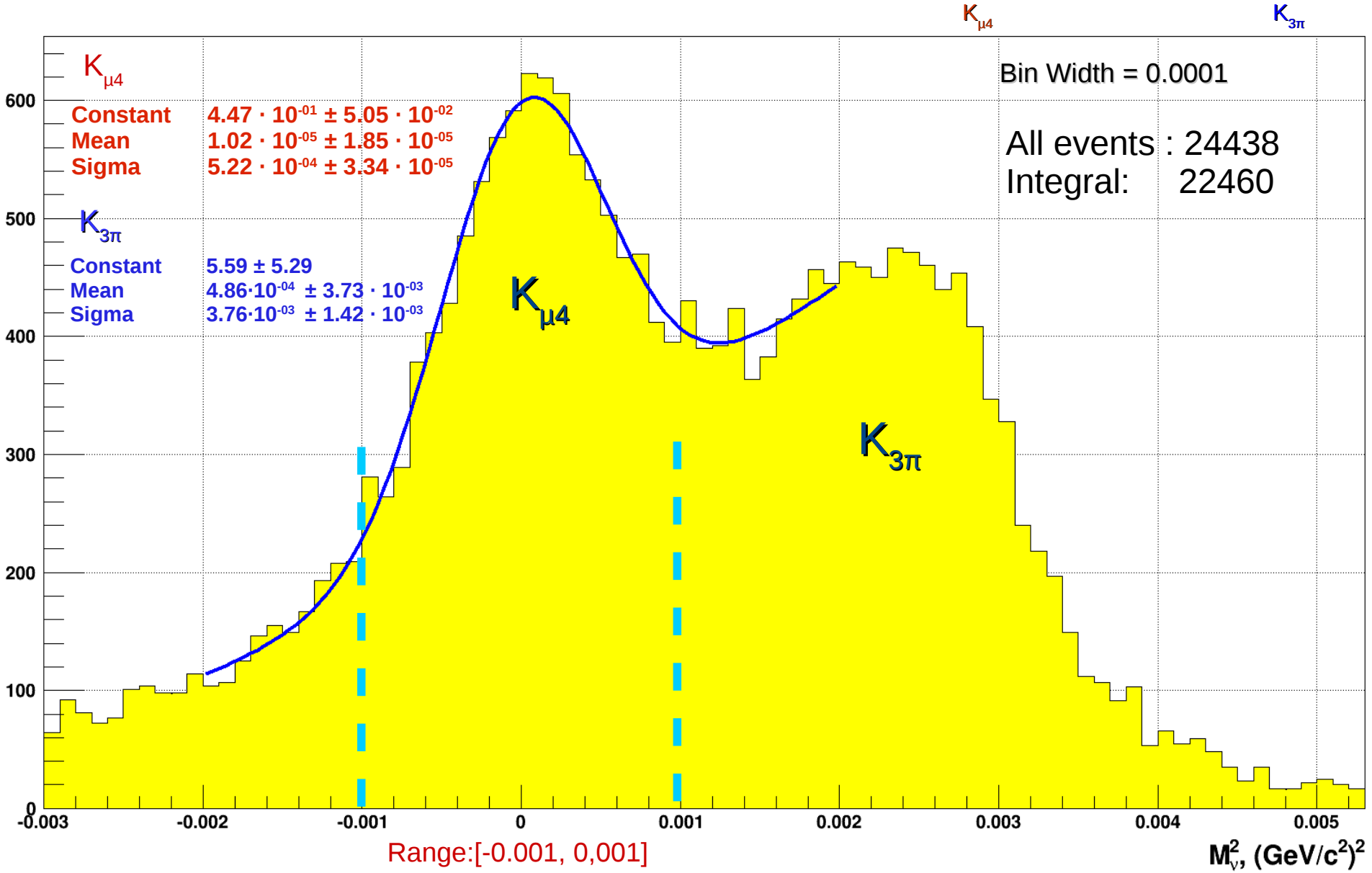
Statistic's significance: 8σ



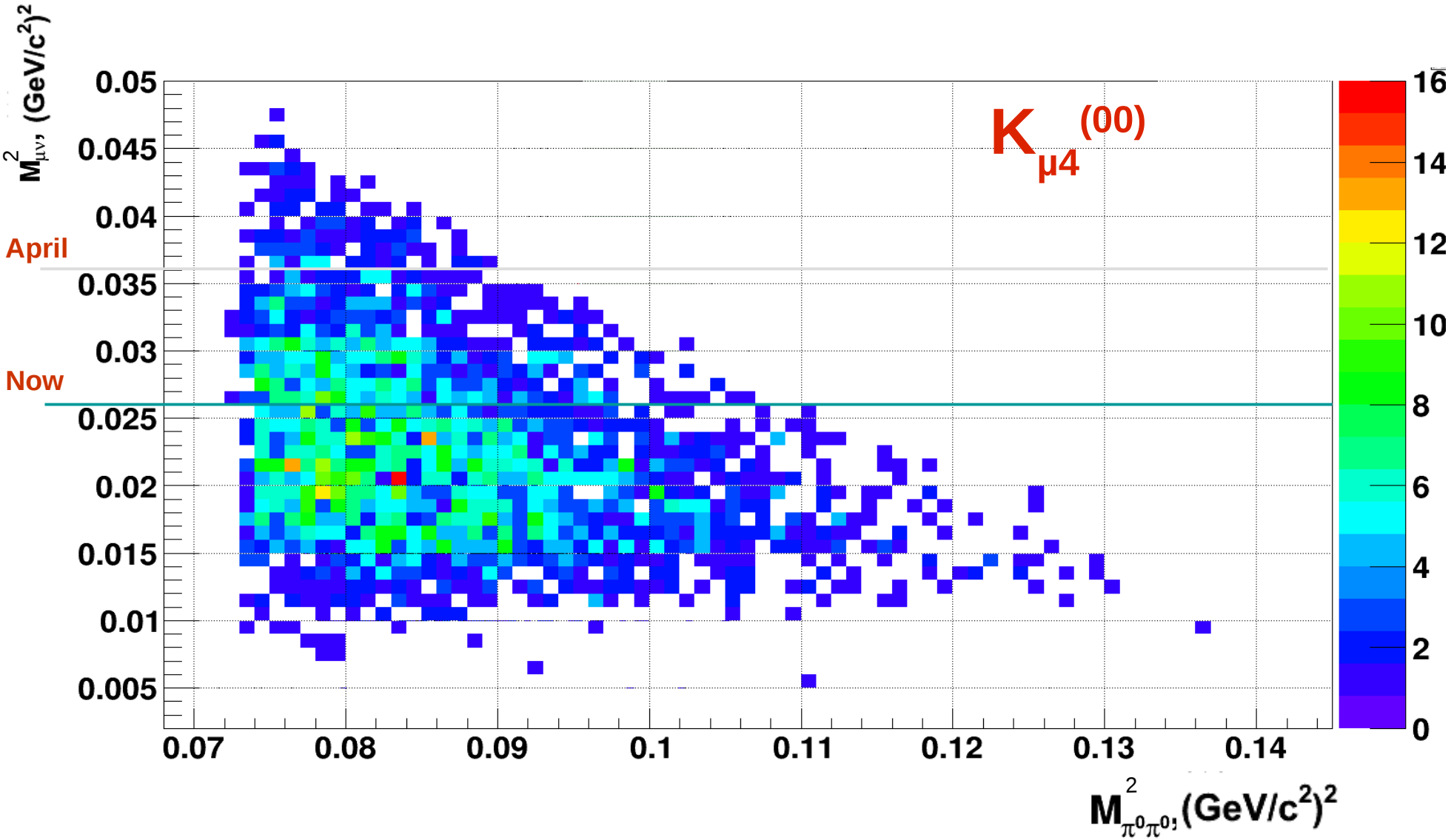
Events: 4221.48 +/- 526.196

Statistic's significance: 8σ

$$f(x)=\frac{N_{events}}{\sigma_S\sqrt{2\pi}}e^{\frac{-(x_S-\mu_S)^2}{2\sigma_S^2}}+\frac{N_{events}}{\sigma_{Bg}\sqrt{2\pi}}e^{\frac{-(x_{Bg}-\mu_{Bg})^2}{2\sigma_{Bg}^2}}$$



Dalitz plot


$K_{\mu 4}^{(00)}$
April
Now
$M^2_{\mu\nu}$, $(GeV/c^2)^2$
$M^2_{\pi^0\pi^0}$, $(GeV/c^2)^2$
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
16
14
12
10
8
6
4
2
0

Trigger Efficiency

Main (no shortcuts indicated) trigger paths

Mode	Pretrigger			Trigger		
	Name	D	ϵ	Name	D	ϵ
$\pi^{\pm}\pi^{+}\pi^{-}$	C-PRE	1		MB-2VTX	1	$\sim 94\%$
$(+K_{e4}, \pi ll, l\nu ll, \ldots)$				MB-1VTX	1	$\sim 99\%$
$\pi^{\pm}\pi^{+}\pi^{-} - 1\pi$	C-PRE	1		MB-1VTX	1	
$\pi^{\pm}\pi^{0}\pi^{0}$	$Q1\cdot$ NT-PEAK	1	$\sim 99\%$	MB-1TRK-P	1	$\sim 95\%$
	$Q1 \cdot NT - NOPEAK$	1	$\sim 90\%$	NO MB	80	1
$\pi^{\pm}\pi^{0}\gamma$	$Q1\cdot$ NT-PEAK	1	$\sim 85\%$	MB-1TRK-P	1	
				MB-1TRK-X	20	
				NO MB	50	1
	$Q1\cdot$ NT-NOPEAK	1		NO MB	80	1
$\pi^{\pm}\pi^{0}, \pi^{\pm}\gamma\gamma, \ldots$	$Q1\cdot$ NT-PEAK	1		MB-1TRK-2/3	20	
	$Q1\cdot$ NT-PEAK	1		NO MB	50	
	$Q1\cdot$ NT-NOPEAK	1		NO MB	80	
K_{e3}	$Q1\cdot$ NT-NOPEAK	1		NO MB	80	
	$Q1\cdot$ NT-PEAK	1		MB-1TRK-P	1	
	$Q1\cdot$ NT-PEAK	1		NO MB	50	
$K_{\mu 3}$	KMU3-PRE	100		MB-1TRK-P	1	
	KMU3-PRE	100		NO MB	50	
K_{e2}	KE2-PRE	100		MB-1TRK-2	20	
	KE2-PRE	100		NO MB	50	
$K_{\mu 2}$	KMU2-PRE	100		NO MB	50	

Default trigger word (after June 25th, 2003)			
Code	Name	Trigger	D
0x0001	MB-2VTX	2-vertex	1
0x0002	MB-1VTX	1-vertex with mass cut	1
0x0004	MB-WDOG	MB(NOT IN TIME) $\cdot L1 \cdot L1_{on}$	1
0x0008	C-PRE	$Q2 \cdot \overline{AKL} + Q1/100$	100
0x0010	MB-1TRK-P	anti-$\pi^+\pi^0$ cut	1
0x0020	MB-1TRK-3	anti-K_{l2} cut	20
0x0040	MB-1TRK-2	K_{l2} cut	20
0x0080	MB-ZFAKE	Downscaled for debugging	200
0x0100	NT-NOPEAK	$NUT(COG < 30cm \cdot Z < 9500cm \cdot ELKR > 15GeV)$	80
0x0200	N-MBIAS	$T0N$	200
0x0400	NT-PEAK	$NUT(NX > 2ORNY > 2)$	50
0x0800	KMU3-PRE	$Q1 \cdot \overline{Q2} \cdot 1\mu \cdot \overline{AKL} \cdot NUT(ELKR > 15GeV)$	50
0x1000	LKR-CAL-NZS	Not zero supp.	1
0x2000	LKR-CAL-ZS	Zero supp.	1
0x3000	PULSE	HAC/PMB pulser	1
0x4000	2BODY-PRE	KE2-PRE/D + KMU2-PRE/D	50
0x8000	RND	K_L monitor OR $K^{\pm}$ monitor random	5
KE2-PRE	$Q1 \cdot \overline{Q2} \cdot \overline{1\mu} \cdot \overline{AKL} \cdot NUT(ELKR > 15GeV \cdot EHAC < 10GeV \cdot M2 = M1 * *2)$		
KMU2-PRE	$Q1 \cdot \overline{Q2} \cdot 1\mu \cdot \overline{AKL} \cdot NUT(ELKR < 10GeV)$		
KMU3-PRE	$Q1 \cdot \overline{Q2} \cdot 1\mu \cdot \overline{AKL} \cdot NUT(ELKR > 15GeV)$???		

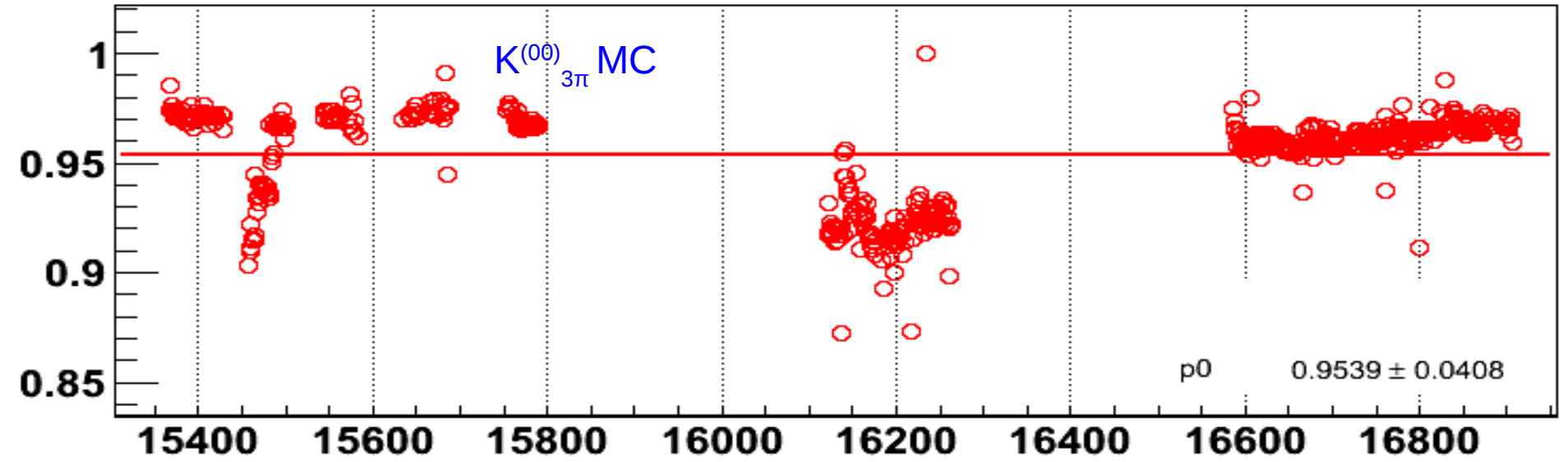
Efficiency, QMBX %

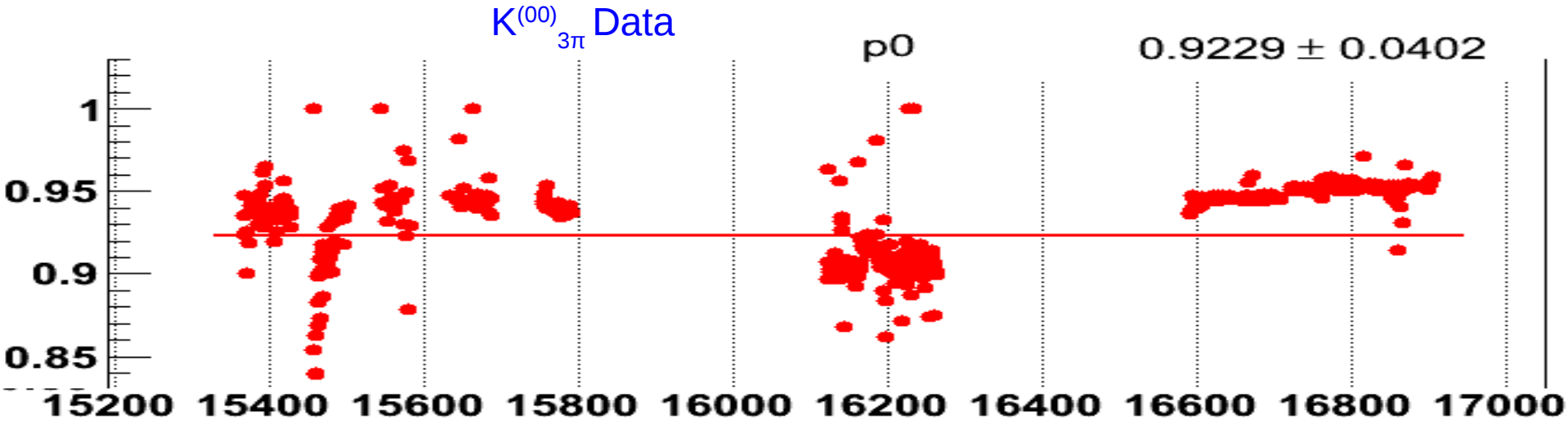
NTpeak —(sevt->trigWord>>10)
NoPeak —(sevt->trigWord>>8)
NTPK3 — (sevt->trigWord>>14)

$$Eff._{MBOX} = \frac{N((NTpeak+NOPEAK+NTPEAK)*MB-1TRK-P)}{N(NTpeak+NOPEAK+NTPEAK)}$$ for #Run <= 16540

$$Eff._{MBOX} = \frac{N((NTpeak+NOPEAK+NTPEAK+NTPK3)*MB-1TRK-P)}{N(NTpeak+NOPEAK+NTPEAK+NTPK3)}$$ for #Run > 16540

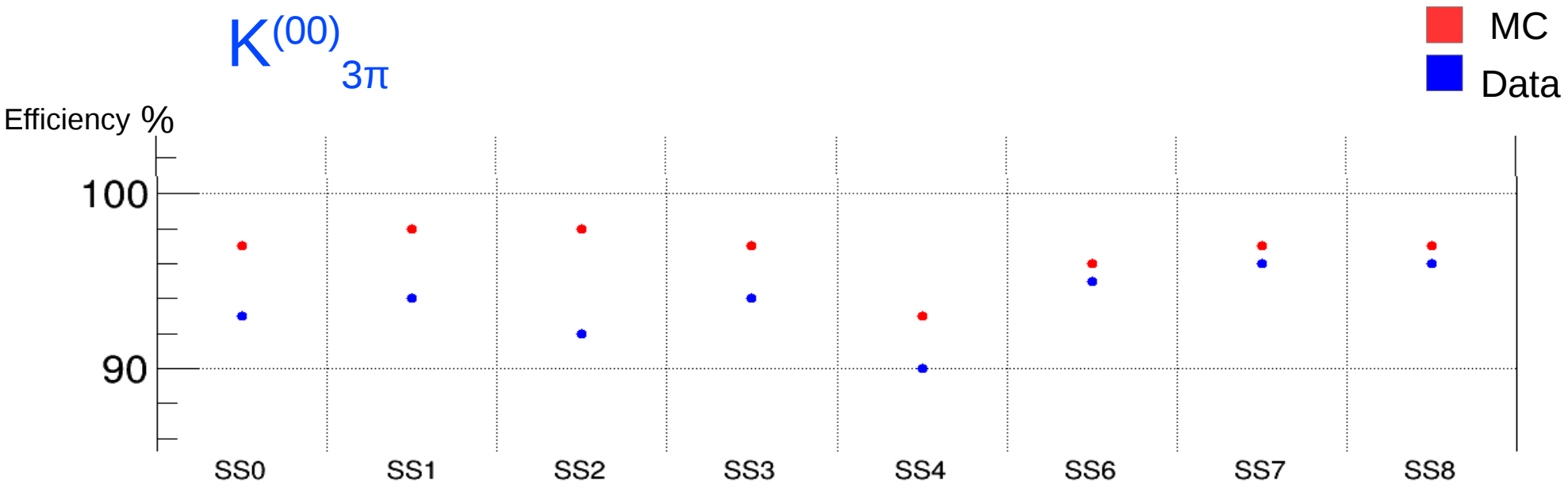
MB−1TRK−P Bit: 14 Ch.:6 PU 1 (any time slice 4,5,6)





Efficiency, QMBX %

$K^{(00)}_{3\pi}$

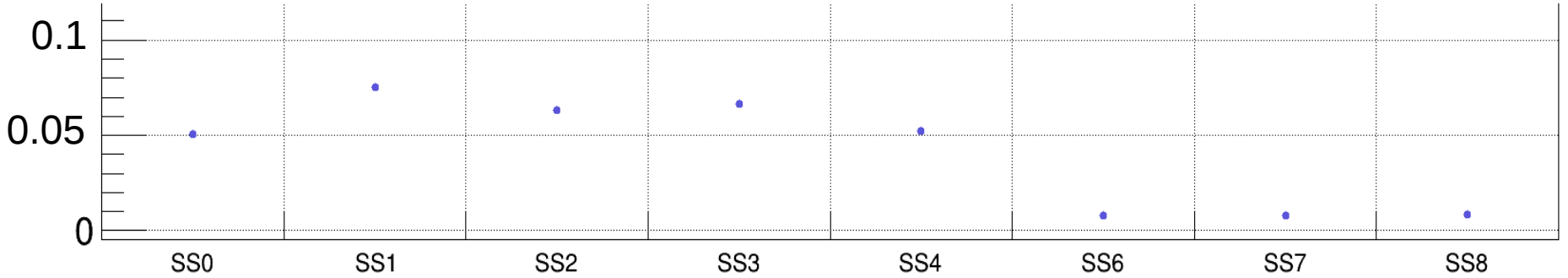


$K^{(00)}_{3\pi}$

QMBX Efficiency DATA

SS0	SS1	SS2	SS3	SS4	SS6	SS7	SS8
0.92	0.93	0.92	0.94	0.9	0.95	0.95	0.95

$$\delta = \sqrt{\varepsilon \cdot (1-\varepsilon)/N} \quad \text{X } 100$$



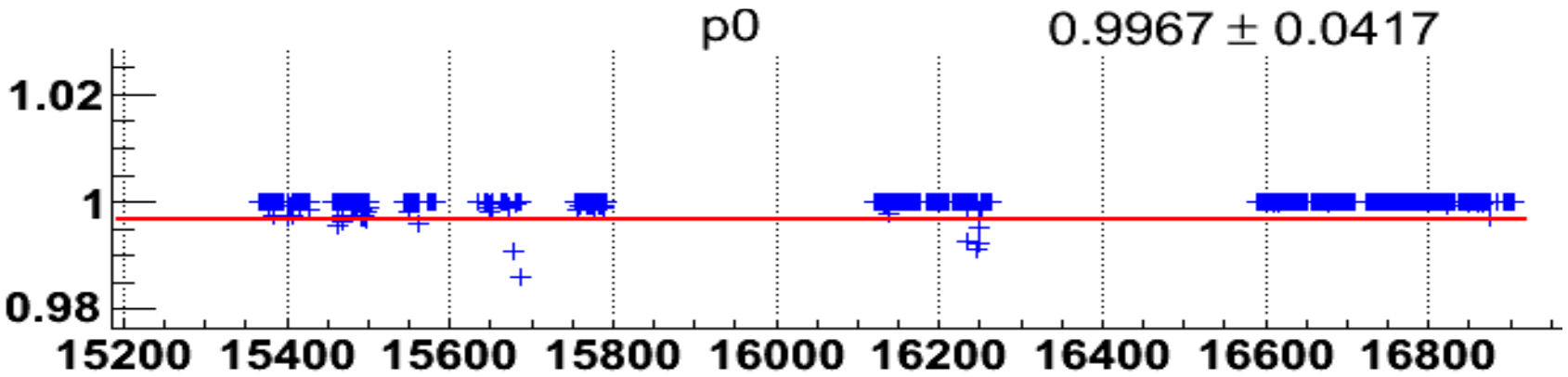
Efficiency, NUT %

$$\text{Eff.NTpeak} = \frac{N\,(\text{TRKP} * \text{NTpeak})}{N\,(\text{TRKP})}$$

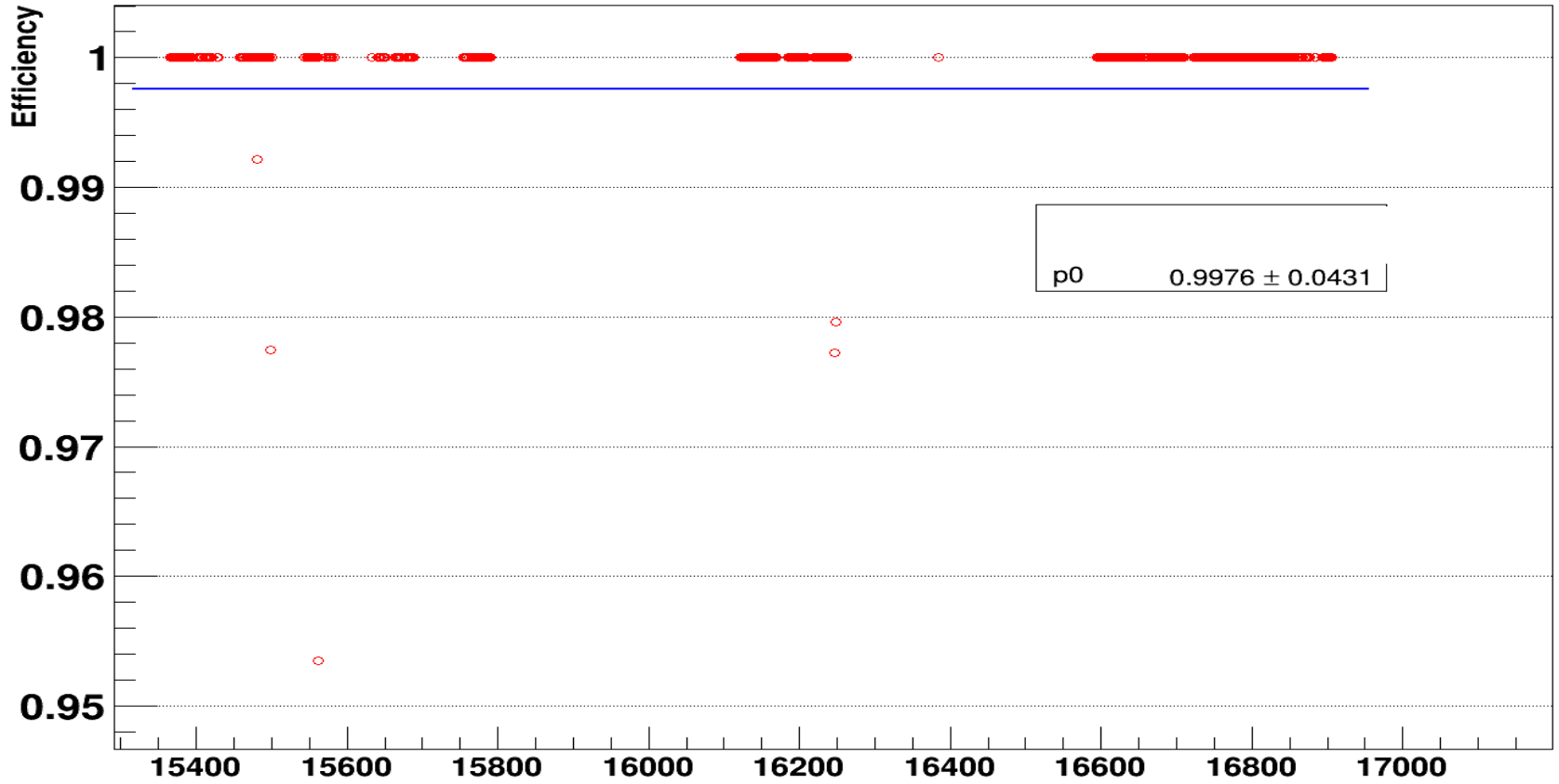
TRKP — sevt->trigWord>>4

NTPEAK Bit: 3 Ch.:14 PU 2 (any time slice 4,5,6)

$K^{(00)}_{3\pi}$ Data

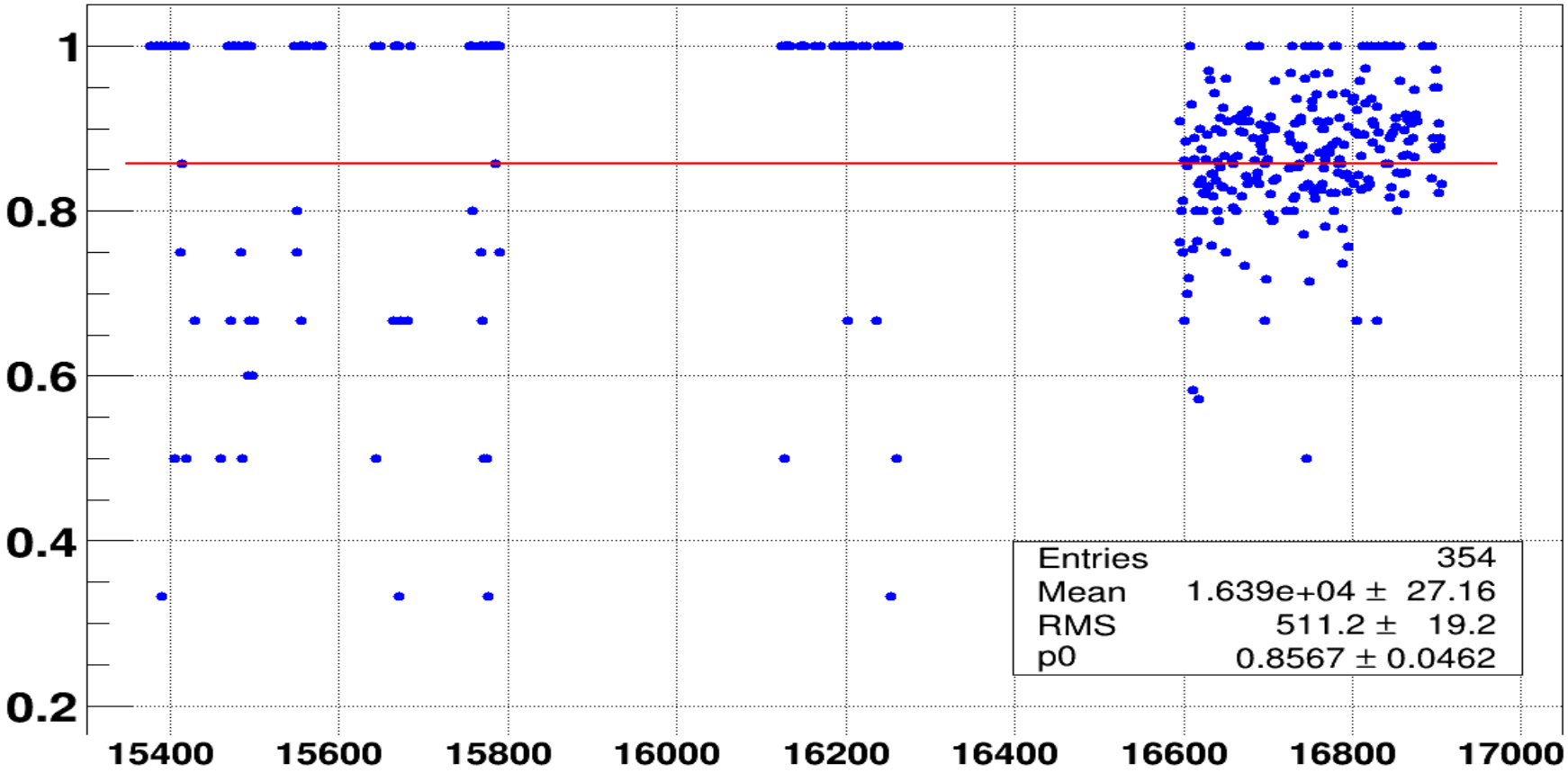


$K_{\mu 4}^{(00)}$ Data



Efficiency, QMBX %

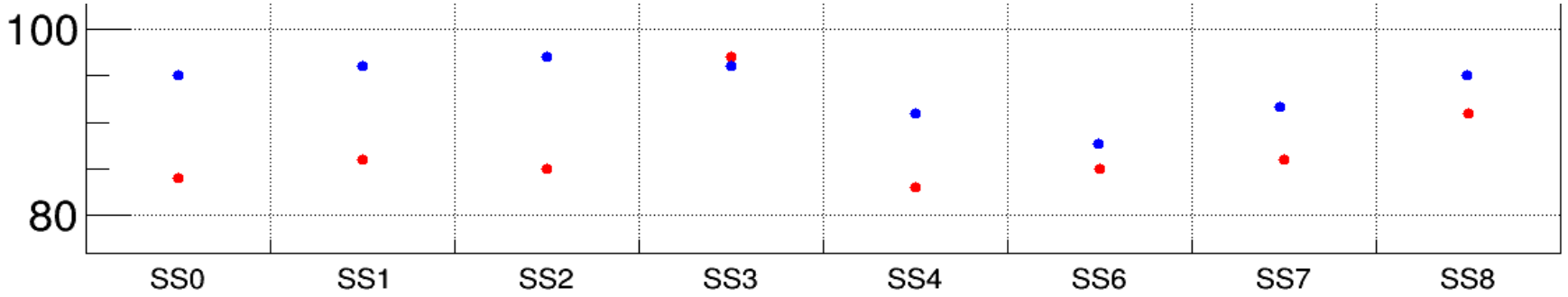
$K_{\mu 4}$DATA



DATA

MC

$K_{\mu 4}$ MC



Trigger Efficiency

	$K^{(00)}_{3\pi}$ QMBX	$K^{(00)}_{3\pi}$ NUT	$K_{\mu 4}^{(00)}$ QMBX	$K_{\mu 4}^{(00)}$ NUT
MC	0,95		0,88	
Data	0,92	0,99	0,85	0,99

TO DO:

- Add statistics from the other Trigger's conditions
- Optimisation Trigger Efficiency
- Final cuts optimisation
- Branching estimation