$K_{\pi 2}$ Branching Ratio.

Dmitri I. Patalakha

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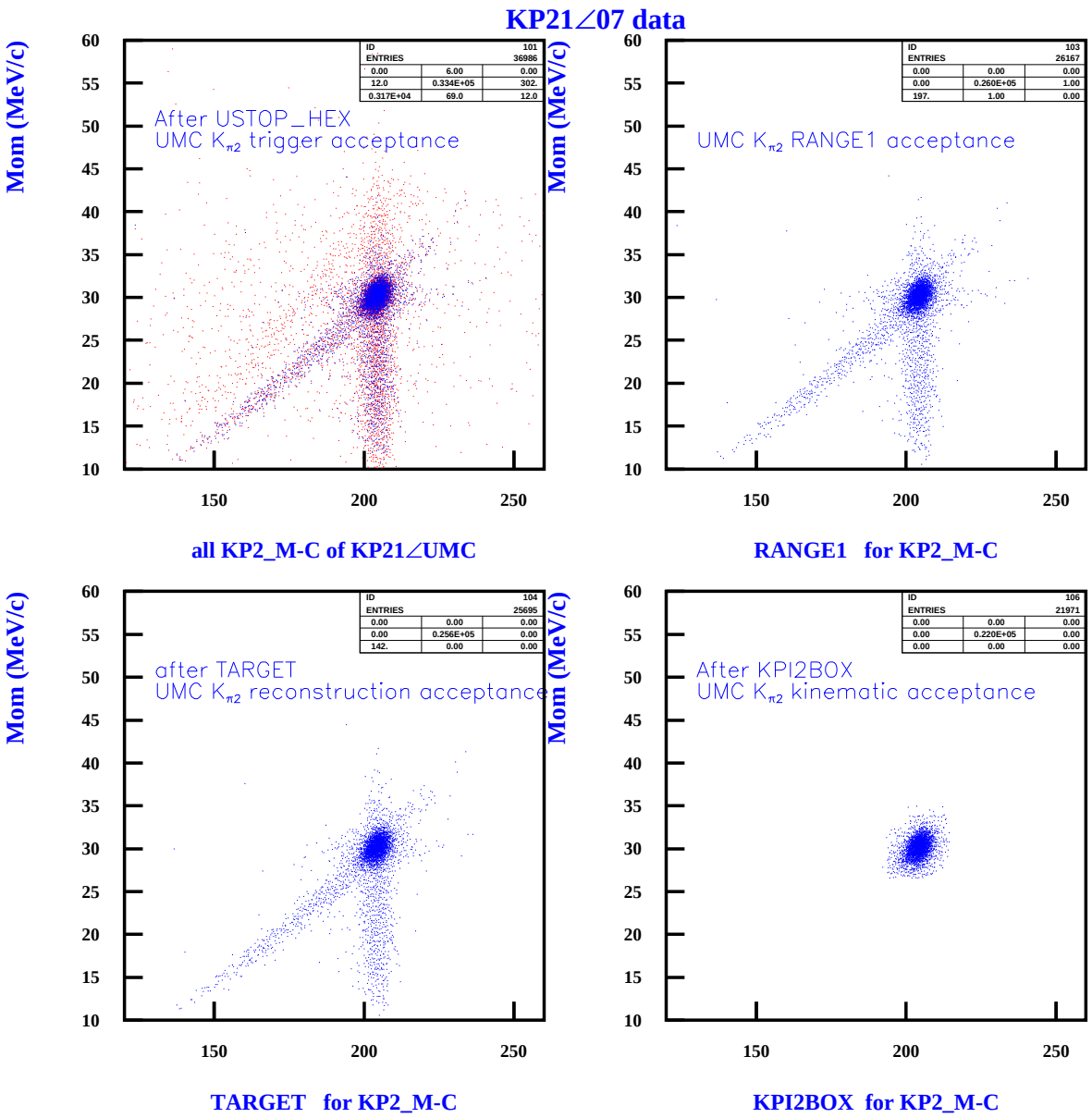

Figure 1: The $K_{\pi 2}$ events range vs momentum. UMC data.

The KP2 events after cuts are shown in blue colour.

Cut	2002 (acc.)	2007 (acc.)
KT	49997	99993
T•A	22697(0.45397)	44891(0.44894)
Reach Layer B	19090(0.84108)	37605(0.83769)
19ct-bar	18797(0.98465)	36986(0.98354)
UFATE	15910(0.84641)	31222(0.84416)
USTMED	15568(0.97850)	30518(0.97745)
USTOPHEX	13909(0.89344)	27426(0.89868)
$A^{UMC}_{K_{\pi 2},trig}$	0.27820 ± 0.00200	0.27428 ± 0.00141
UTC	13909(1.00000)	27426(1.00000)
RDUTM	13909(1.00000)	27426(1.00000)
UTCQUAL	13489(0.96980)	26910(0.98119)
TARGET	13348(0.98955)	26910(1.00000)
$A^{UMC}_{K_{\pi 2},recon}$	0.95967 ± 0.00167	0.98119 ± 0.00082
KPI2STOP	12831(0.96127)	26842(0.99747)
COS3D	12305(0.95901)	25716(0.95805)
KPI2BOX	11225(0.91223)	22927(0.89155)
$A^{UMC}_{K_{\pi 2},kin}$	0.84095 ± 0.00317	0.85199 ± 0.00216
$A^{UMC}_{K_{\pi 2}}$	0.22451 ± 0.00187	0.22929 ± 0.00133

Table 1: UMC $K_{\pi 2}$ acceptance of cuts applied in the$K_{\pi 2}$ branching ratio analysis. NIDIF is on. In E949, the ($\overline{19_{ct} + 20_{ct} + 21_{ct}}$) trigger condition has been changed to $\overline{19_{ct}}$.

$$(ONLINE\ \ TRIGGER)_{K_{\pi 2}} = KB \times T \cdot 2 \times (6_{ct} + 7_{ct}) \times \overline{19_{ct}} \tag{1}$$

UMC cut definitions

- **T•A ≡ T•2** *Requirement is ext(8) ≡ TRUE ?. Really one is applyed in UMC codes.*
- **Reach layer B** *The inner nine layers of 19 mm thick counters were ganged together into 3 superlayers reffered as the A, B and C having 4,3 and 2 layers of scintillator, respectevely. [1] Requirement is layv4 ≥ 6. Really by Zhe Wang this requirement is* $(6_{ct} + 7_{ct})$. *I believe it ≡ lct(6).and.lct(7)=.true. in ntuple.*
- $\overline{19_{ct}}$ *μ-veto (see for detail in [2] p.207).*
- **UFATE** [a] *requires that the pion stopped without decaying or interacting, this is why it has no acceptance loss for the NIDIF-off case.*
- **USTMED** *requires that the pion stopped in the RS scintillator.*
- **USTOP_HEX** *The offline reconstructed stopping counter agrees with the real one.*
- **RANGE1** *is PASS1 or PASS2 cut.*
- **UTCQUAL** *The UTCQUAL cuts require a track with a minimum of four z position measurements in UTC. A second requirement is a minimum value of* 10^{-5} *for the likelihood function constructed from the number of used xy hits, the number of UTC layers and the number of unused xy hits in each super layer (see for detail in [2] p.71).*
- **TARGET** *is SWATH CCD reconstruction cut.*
  TARGET ≡ ITGQUAL ≥ 2 in PNN1 and ITGQUAL ≥ 9 in PNN2.
- **KP2STOP** *requires the stopping layer to be between layers 8 and 15 inclusive.*
- **COS3D** *Cut any event with a dip angle outside the effective detection region* $-0.5 < cos3d < 0.5$.
- **KPI2BOX** *is a 3σ cut on the* $K_{\pi 2}$ *range, energy and momentum.*

$$199.53 < \quad ptot \quad < 211.67 \tag{2}$$

$$28.2 < \quad rtot \quad < 33.42 \tag{3}$$

$$100.45 < \quad etot \quad < 115.75 \tag{4}$$

[a] UFATE, USTMED and USTOP_HEX [3] are cuts based on UMC truth variables.

Cut	$K_{\mu 2}$	$K_{\pi 2}$
ALL	1012463	81214
BAD_RUN	1012463	81214
BAD_STC	1012312	80802
TRIGGER	1012312	80802
RD_TRK	1012312	80802
TRKTIM	1012131	80802
UTC/RANGE	1012131	80802
UTC/RANGE	——-	——
UTCQUAL	871794	70119
TARGET	858032	67908
COS3D	822638	64911
B4DEDX	805954	63298
CPITRS	796131	62406
CPITAIL	795417	62352
ICBIT	795125	62328
TIC	790785	61766
TIMCON	786883	61285
TGCCD	786883	61285
DCBIT	678125	52030
DELCO	581780	44934
CKTRS	562201	43547
CKTAIL	544527	42268
BWTRS	513378	39879
U/RPVTRS	506246	39114
TARGF	481968	37126
DTGTTP	481881	37116
RTDIF	476187	36697
TGQUALT	476187	36697
PIGAP	470855	36298
TGB4	442814	34123
KIC	436050	33611
TGGEO	424754	27745
B4EKZ	406721	26719
TGZFOOL	406721	26719
PV(noBV)	371206	——
FITPI	——	19321
KP2BOX	——	17037
KP2STOP	——	16972
RTOT40	367233	——
$N_{K_{\mu 2}}$ or $N_{K_{\pi 2}}$	367233	16972

$K_{\pi 2}$ 2002	$K_{\pi 2}$ 2007	Cut name
81214(1.00000)	80433(1.00000)	ALL
81214(1.00000)	78497(0.97593)	BAD_RUN
80802(0.99493)	77955(0.99309)	BAD_STC
80802(1.00000)	77955(1.00000)	TRIGGER
80802(1.00000)	77955(1.00000)	RD_TRK
80802(1.00000)	77938(0.99978)	TRKTIM
80802(1.00000)	71833(0.92167)	UTC
80802(1.00000)	70603(0.98288)	RDUTM
70119(0.86779)	61284(0.86801)	UTCQUAL
67908(0.96847)	61284(1.00000)	TARGET
64911(0.95587)	55660(0.90823)	COS3D
63298(0.97515)	54225(0.97422)	B4DEDX
62406(0.98591)	53391(0.98462)	CPITRS
62352(0.99913)	53353(0.99929)	CPITAIL
62328(0.99962)	53343(0.99981)	ICBIT
61766(0.99098)	52972(0.99304)	TIC
61285(0.99221)	52454(0.99022)	TIMCON
52030(0.84898)	43788(0.83479)	DCBIT
44934(0.86362)	37249(0.85067)	DELCO
43547(0.96913)	35892(0.96357)	CKTRS
42268(0.97063)	34731(0.96765)	CKTAIL
39879(0.94348)	32640(0.93979)	BWTRS
39114(0.98082)	31900(0.97733)	RVUPV
37126(0.94917)	29940(0.93856)	TARGF
37116(0.99973)	29940(1.00000)	DTGTTP
36697(0.98871)	29568(0.98757)	RTDIF
36697(1.00000)	29568(1.00000)	TGQUALT
36298(0.98913)	28920(0.97808)	PIGAP
34123(0.94008)	26528(0.91729)	TGB4
33611(0.98500)	25905(0.97652)	KIC
27745(0.82547)	22320(0.86161)	TGGEO
26719(0.96302)	20289(0.90900)	B4EKZ
26719(1.00000)	20031(0.98728)	TGZFOOL
26719(1.00000)	20031(1.00000)	PV_noBV
19321(0.72312)	8667(0.43268)	IPIFLG
17037(0.88179)	6780(0.78228)	KPI2BOX
16972(0.99618)	6778(0.99970)	KP2STOP
16972(1.00000)	6778(1.00000)	RTOT40
16972	6778	$N_{K_{\pi 2}}$ 2002 or 2007

Table 2: For the $K_{\mu 2}$, cuts applied in the f_s analysis. RTOT40 requires range > 40 cm to remove some $K_{\pi 2}$ and radiative $K_{\mu 2}$ not removed by PV(noBV). For the $K_{\pi 2}$, cuts applied in the $K_{\pi 2}$ BR analysis. KP2BOX is a 3σ cut on the KPI2 range, energy and momentum. KP2STOP requires the stopping layer to be between layers 8 and 15 inclusive.

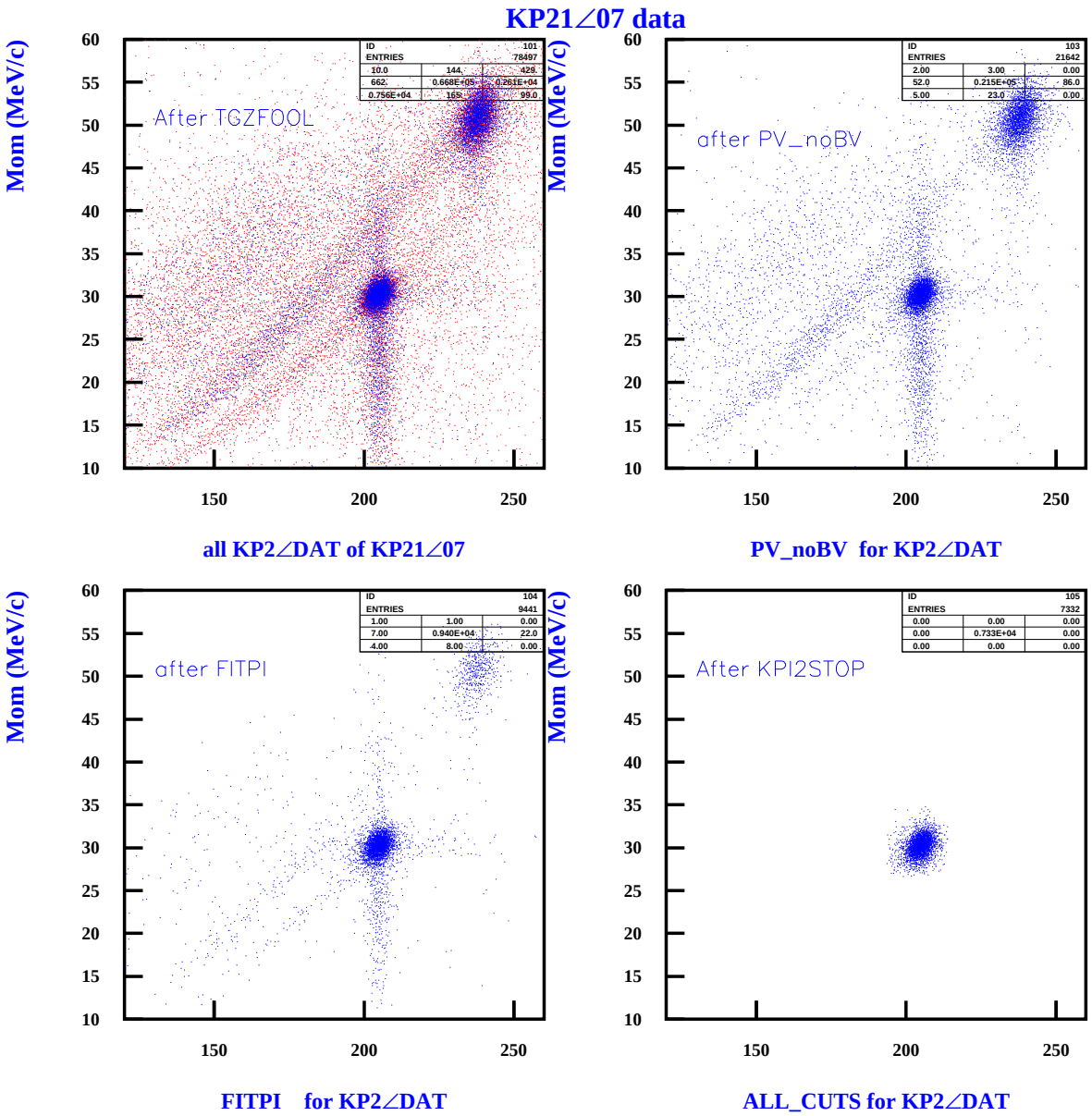

Figure 2: The $K_{\pi 2}$ events range vs momentum. $K_{\pi 2}(1)$ Monitoring data

The KP2 events after cuts are shown in blue colour.

Cut	$K_{\mu 2}$	$K_{\pi 2}$	$K_{\pi 2}$ 2002	$K_{\pi 2}$ 2007	Cut name
ALL	1012463	81214	81214(1.00000)	80433(1.00000)	ALL
BAD_RUN	1012463	81214	81214(1.00000)	78497(0.97593)	BAD_RUN
BAD_STC	1012312	80802	80802(0.99493)	77955(0.99309)	BAD_STC
TRIGGER	1012312	80802	80802(1.00000)	77955(1.00000)	TRIGGER
RD_TRK	1012312	80802	80802(1.00000)	77955(1.00000)	RD_TRK
TRKTIM	1012131	80802	80802(1.00000)	77938(0.99978)	TRKTIM
UTC/RANGE	1012131	80802	80802(1.00000)	70532(0.90498)	RANGE1
UTCQUAL	871794	70119	70119(0.86779)	61227(0.86807)	UTCQUAL
TARGET	858032	67908	67908(0.96847)	61227(1.00000)	TARGET
COS3D	822638	64911	64911(0.95587)	55660(0.90908)	COS3D
B4DEDX	805954	63298	63298(0.97515)	54225(0.97422)	B4DEDX
CPITRS	796131	62406	62406(0.98591)	53391(0.98462)	CPITRS
CPITAIL	795417	62352	62352(0.99913)	53353(0.99929)	CPITAIL
ICBIT	795125	62328	62328(0.99962)	53343(0.99981)	ICBIT
TIC	790785	61766	61766(0.99098)	52972(0.99304)	TIC
TIMCON	786883	61285	61285(0.99221)	52454(0.99022)	TIMCON
TGCCD	786883	61285	61285(1.00000)	52454(1.00000)	TGCCD
DCBIT	678125	52030	52030(0.84898)	43788(0.83479)	DCBIT
DELCO	581780	44934	44934(0.86362)	42700(0.97515)	DELCO
CKTRS	562201	43547	43547(0.96913)	39984(0.93639)	CKTRS
CKTAIL	544527	42268	42268(0.97063)	37884(0.94748)	CKTAIL
BWTRS	513378	39879	39879(0.94348)	35623(0.94032)	BWTRS
U/RPVTRS	506246	39114	39114(0.98082)	34780(0.97634)	RVUPV
TARGF	481968	37126	37126(0.94917)	32636(0.93836)	TARGF
DTGTTP	481881	37116	37116(0.99973)	32636(1.00000)	DTGTTP
RTDIF	476187	36697	36697(0.98871)	32216(0.98713)	RTDIF
TGQUALT	476187	36697	36697(1.00000)	32216(1.00000)	TGQUALT
PIGAP	470855	36298	36298(0.98913)	31480(0.97715)	PIGAP
TGB4	442814	34123	34123(0.94008)	28801(0.91490)	TGB4
KIC	436050	33611	33611(0.98500)	28080(0.97497)	KIC
TGGEO	424754	27745	27745(0.82547)	24183(0.86122)	TGGEO
B4EKZ	406721	26719	26719(0.96302)	21926(0.90667)	B4EKZ
TGZFOOL	406721	26719	26719(1.00000)	21642(0.98705)	TGZFOOL
PV(noBV)	371206	——	26719(1.00000)	21642(1.00000)	PV_noBV
FITPI	——	19321	19321(0.72312)	9335(0.43134)	IPIFLG
KP2BOX	——	17037	17037(0.88179)	7287(0.78061)	KPI2BOX
KP2STOP	——	16972	16972(0.99618)	7285(0.99973)	KP2STOP
RTOT40	367233	——	16972(1.00000)	7285(1.00000)	RTOT40
$N_{K_{\mu 2}}$ or $N_{K_{\pi 2}}$	367233	16972	16972	7285	$N_{K_{\pi 2}}$ 2002 or 2007

Table 3: For the $K_{\mu 2}$, cuts applied in the f_s analysis. RTOT40 requires range > 40 cm to remove some $K_{\pi 2}$ and radiative $K_{\mu 2}$ not removed by PV(noBV). For the $K_{\pi 2}$, cuts applied in the $K_{\pi 2}$ BR analysis. KP2BOX is a 3σ cut on the KPI2 range, energy and momentum. KP2STOP requires the stopping layer to be between layers 8 and 15 inclusive.

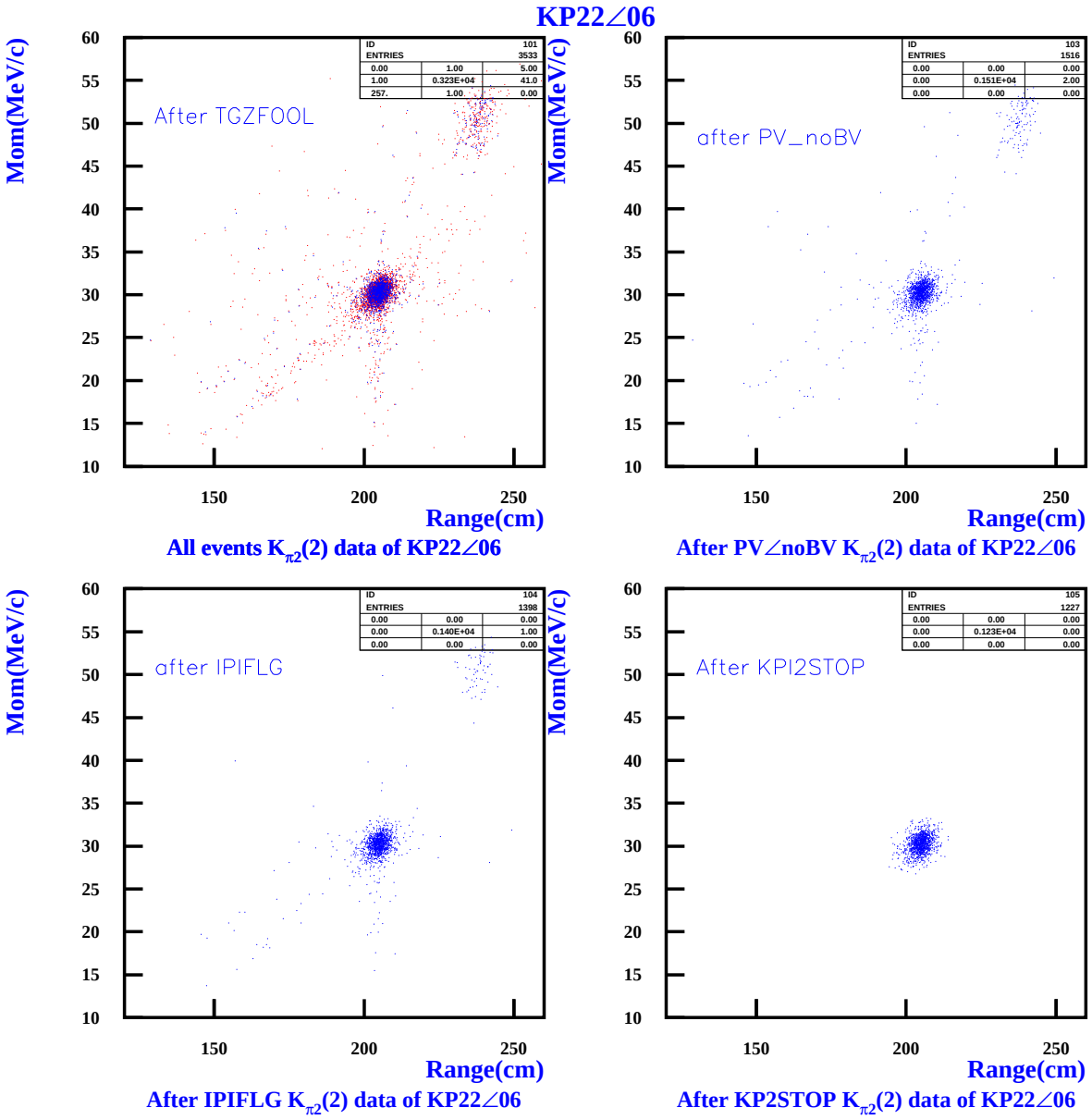

Figure 3: The $K_{\pi 2}$ events range vs momentum. $K_{\pi 2}(2)$ Monitoring data

The KP22 events after cuts are shown in blue colour.

References

[1] André Spence Turcot, "Search for the decay $K+ \to \pi^+\nu\bar{\nu}$" The University of Victoria, Ph.D. Thesis (1994).

[2] S. Chen, J. Hu, A. Konaka, J. Mildenberger, K. Mizouchi, T. Sekiguchi, D. Vavilov, **2002 $\pi^+\nu\bar{\nu}$ data analyses**, E949 K-034.

[3] Ilektra-Athanasia Christidi, "Search for the rare decay $K+ \to \pi^+\nu\bar{\nu}$ with $p_{\pi^+} < 199 MeV/c$", The Stony Brook University, Ph.D. Thesis (2006).