



UNIVERSITY OF
TORONTO

ν_e CCQE/CC1 π^+ Selection Studies

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 ν_e CCQE/CC1 π^+ Meeting
May 31, 2019

ν_e CC1 π^+ Hybrid Sample

- Step 1 (atm ν e-like extraction): – DONE
 - Generate list of 1-ring e-like events from atm data and from MC
 - Equalize MC to data
 - Extract e-like events from zbs files (data and MC)
- Step 2 (T2K $e\pi^+$ extraction): – DONE
 - Extract all $e\pi^+$ events from T2K MC and save kinematics to text file
- Step 3 (matching e's): – DONE
 - Match e from T2K MC $e\pi^+$ events with single ring e-like events from atm data/MC
 - Rotates T2K MC $e\pi^+$ events to line up the e with the e-like atm events
- Step 4 (merge e and π^+): – DONE
 - Generate MC π^+ ring with same kinematics as π^+ from matched T2K events
 - Merge atm e (data/MC) with MC π^+ to create hybrid events
- Step 5 (apfit, fiTQun):
 - Run apfit on hybrid .zbs files and run fillnt to get .hbk/.root files – DONE
 - Run fiTQun on hybrid .apfit.zbs files and run fillnt to get .hbk/.root files – DONE

ν_e CC1 π^+ sample construction is complete!

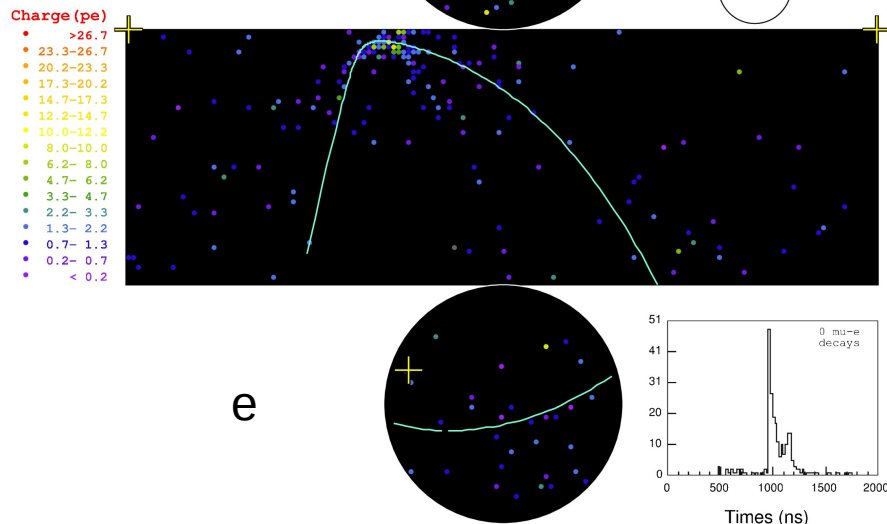
Validation: Event Displays

- Look at event displays of single e event, single π^+ event, and merged event
 - Do this for data and MC samples
 - Look at both charge and timing
 - Timing has yet to be studied
- Question: command line option to run superscan with timing instead of charge?

Data Sample

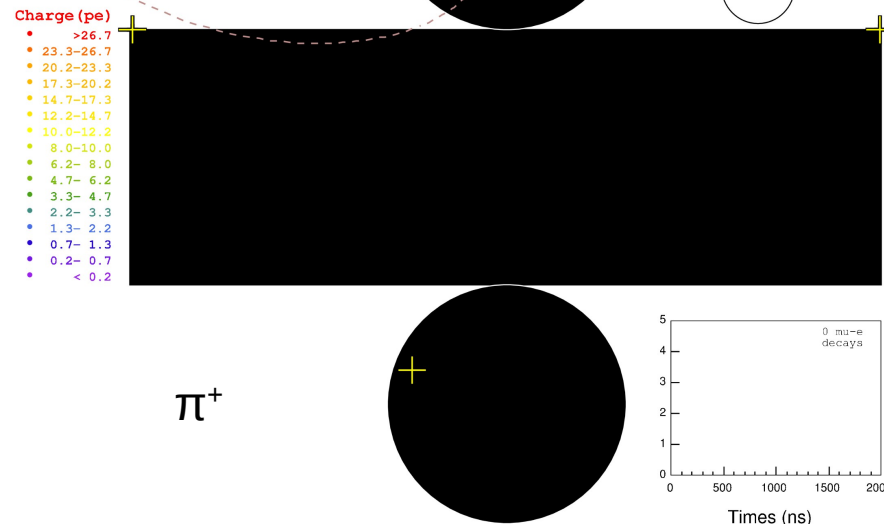
Super-Kamiokande IV

Run 61790 Sub 227 Event 49136464
08-10-20:22:24:32
Inner: 233 hits, 363 pe
Outer: 20 hits, 20 pe
Trigger: 0x1000000f
D_{wall}: 1.9 cm
Evis: 30.1 MeV
e-like, p = 30.1 MeV/c



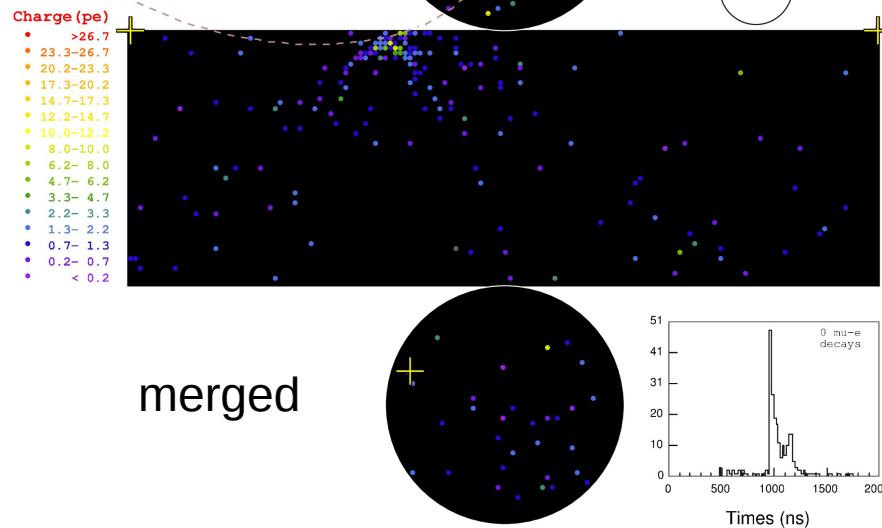
Super-Kamiokande IV

Rup 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 0 hits, 0 pe
Outer: 0 hits, 0 pe
Trigger: 0x00
D_{wall}: 1.9 cm
Evis: 0.0 MeV



Super-Kamiokande IV

Rup 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 233 hits, 363 pe
Outer: 0 hits, 0 pe
Trigger: 0x00
D_{wall}: 1.9 cm
Evis: 0.0 MeV



Not sure where π^+ is...
Too close to wall?
 $p_\pi = 362.1 \text{ MeV/c}$

Data Sample

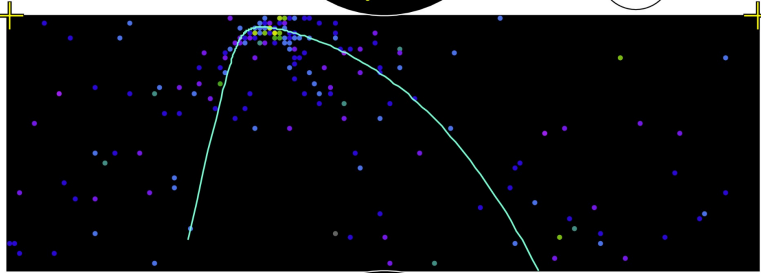
19-05-31

Super-Kamiokande IV

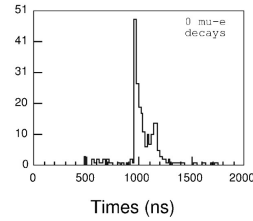
Run 61790 Sub 227 Event 49136464
08-10-20:22:24:32
Inner: 233 hits, 363 pe
Outer: 20 hits, 20 pe
Trigger: 0x1000000f
D_wall: 1.9 cm
Evis: 30.1 MeV
e-like, $p = 30.1$ MeV/c

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



e

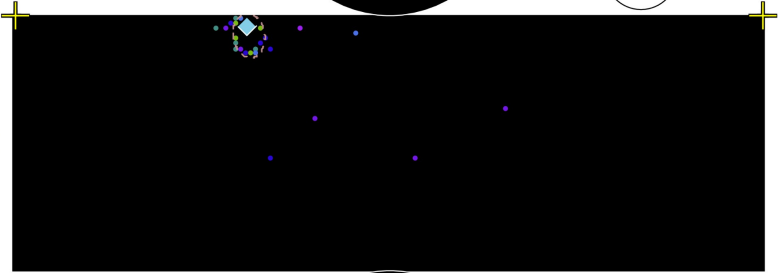


Super-Kamiokande IV

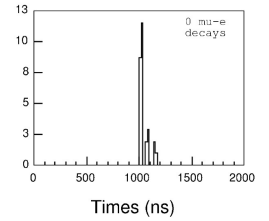
Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 29 hits, 95 pe
Outer: 0 hits, 0 pe
Trigger: 0x00
D_wall: 1.9 cm
Evis: 0.0 MeV

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



π^+

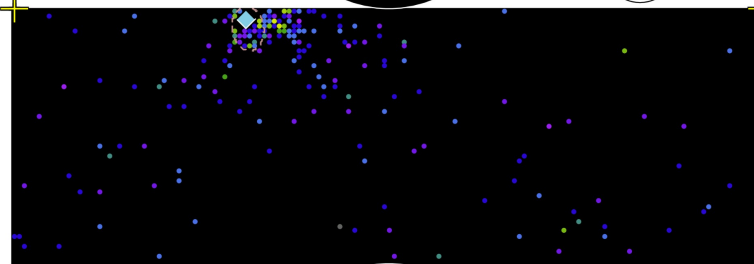


Super-Kamiokande IV

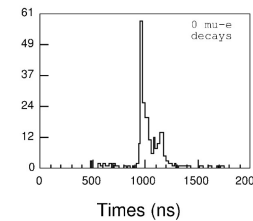
Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 258 hits, 459 pe
Outer: 0 hits, 0 pe
Trigger: 0x00
D_wall: 1.9 cm
Evis: 0.0 MeV

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



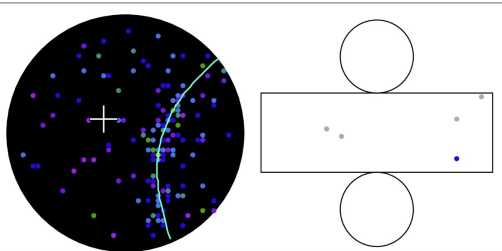
Data Sample

19-05-31

6

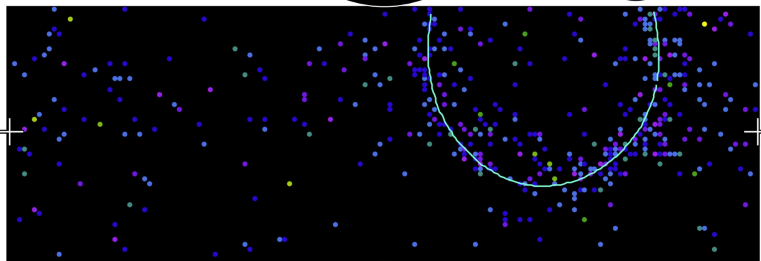
Super-Kamiokande IV

Run 62844 Sub 437 Event 87047571
09-01-03:06:07:15
Inner: 618 hits, 837 pe
Outer: 1 hits, 1 pe
Trigger: 0x1000007
D_wall: 1310.9 cm
Evis: 76.5 MeV
e-like, $p = 76.5$ MeV/c

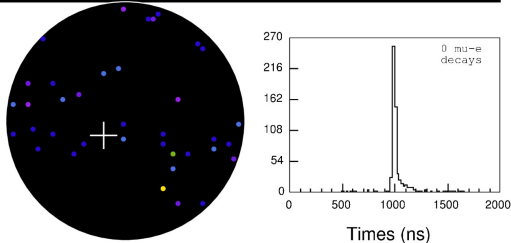


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

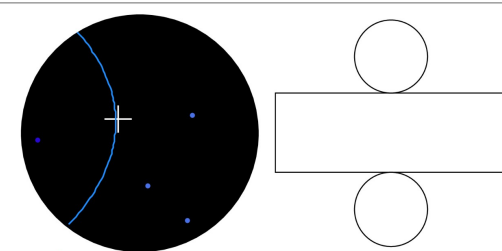


e



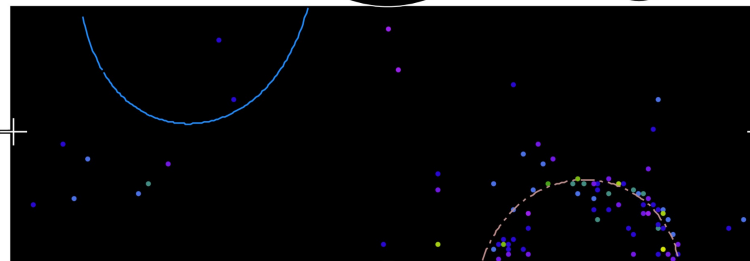
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 133 hits, 194 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 1310.9 cm
Evis: 0.0 MeV

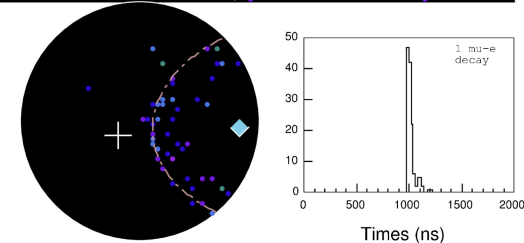


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



π^+

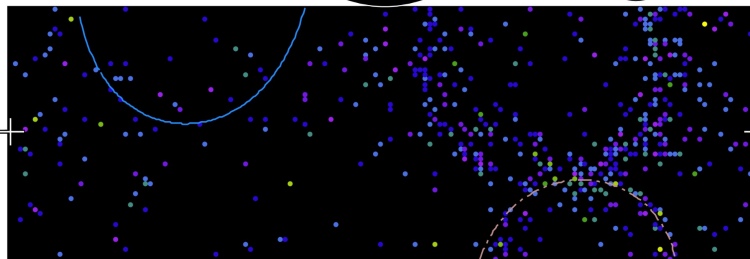


Super-Kamiokande IV

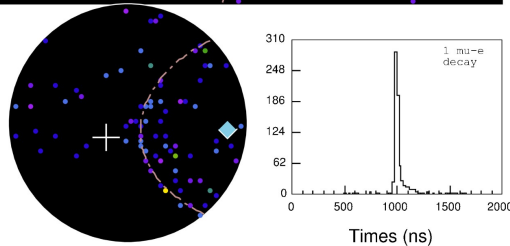
Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 741 hits, 1032 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 1310.9 cm
Evis: 0.0 MeV

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged

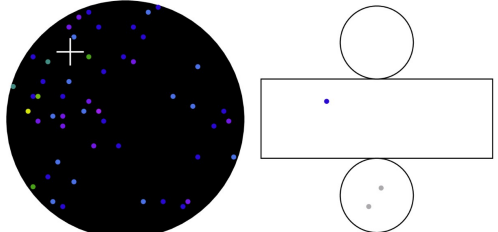


Data Sample

19-05-31

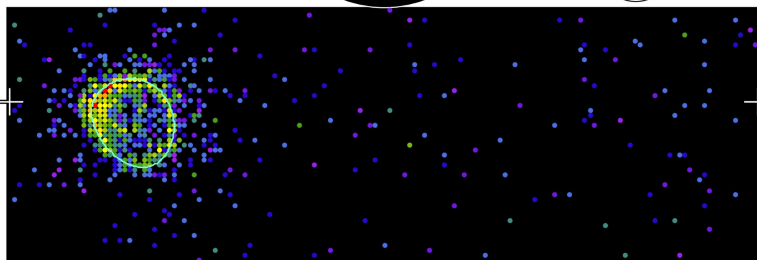
Super-Kamiokande IV

Run 65680 Sub 981 Event 183037056
09-10-15:13:29:56
Inner: 741 hits, 2062 pe
Outer: 1 hits, 0 pe
Trigger: 0x10000007
D_wall: 446.6 cm
Evis: 205.8 MeV
e-like, p = 205.8 MeV/c

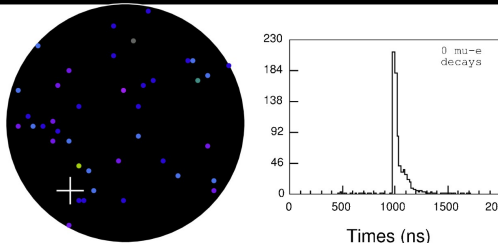


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

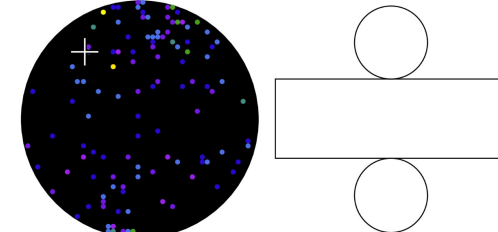


e



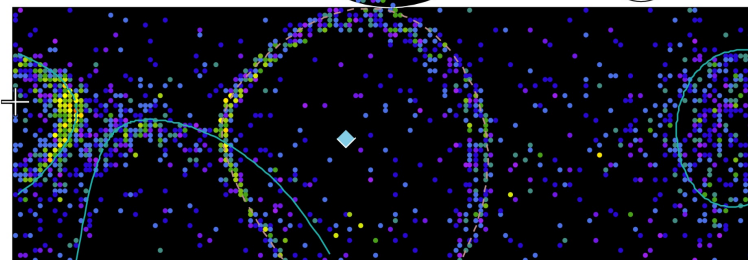
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 1777 hits, 3466 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 446.6 cm
Evis: 0.0 MeV

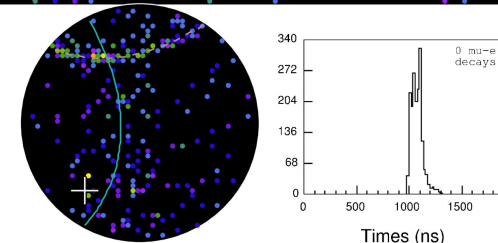


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



π^+

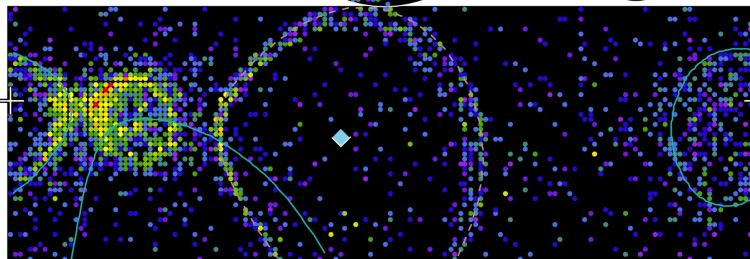


Super-Kamiokande IV

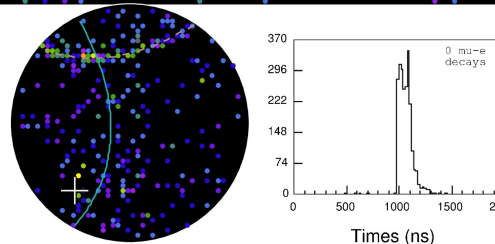
Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 2309 hits, 5502 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 446.6 cm
Evis: 0.0 MeV

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



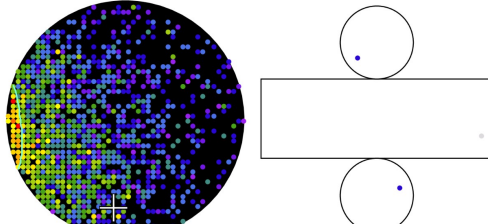
$$\pi^+ \rightarrow \pi^0 \rightarrow \gamma\gamma$$

Data Sample

19-05-31

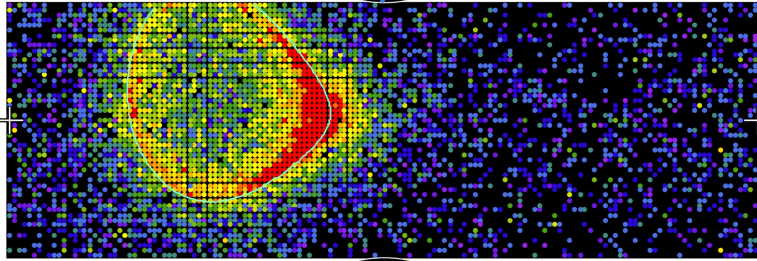
Super-Kamiokande IV

Run 66916 Sub 274 Event 65138042
10-06-07:17:39:52
Inner: 6045 hits, 32547 pe
Outer: 2 hits, 1 pe
Trigger: 0x1000007
D_wall: 422.8 cm
Evis: 3.4 GeV
e-like, p = 3418.5 MeV/c

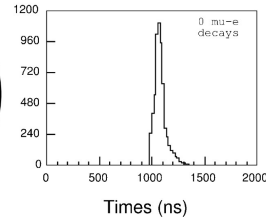
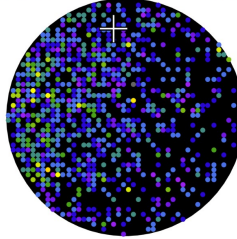


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

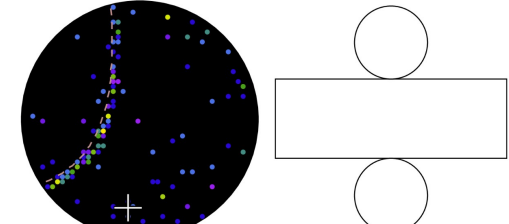


e



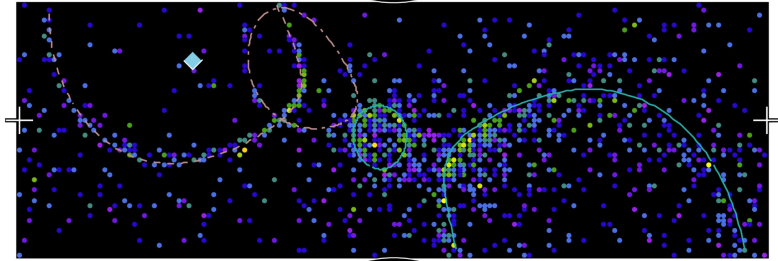
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 1570 hits, 2611 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 422.8 cm
Evis: 0.0 MeV

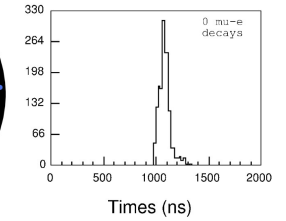
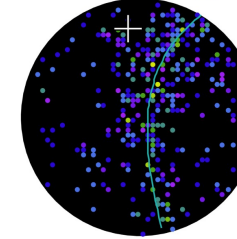


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

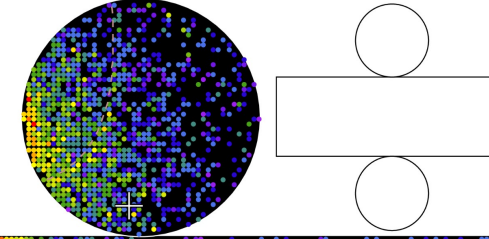


π^+



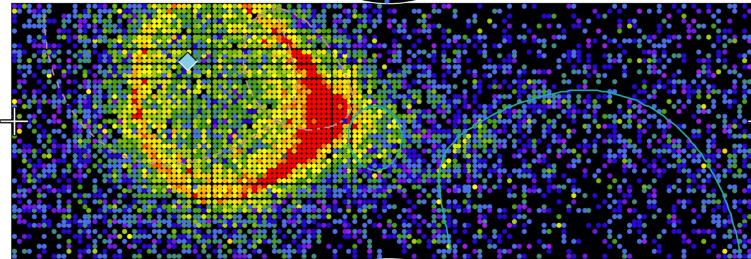
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:39:34
Inner: 6785 hits, 35153 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 422.8 cm
Evis: 0.0 MeV

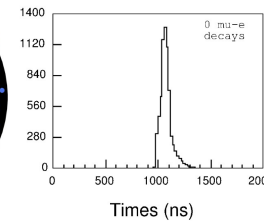
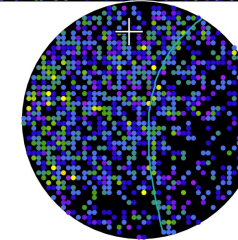


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



$$\pi^+ \rightarrow \pi^+ \quad \pi^0 \rightarrow \gamma\gamma$$

Data Sample

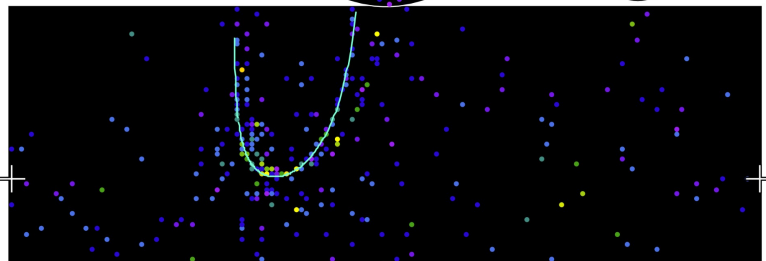
19-05-31

Super-Kamiokande IV

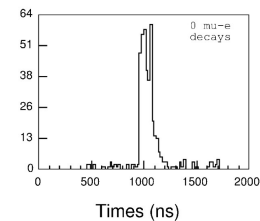
Run 68039 Sub 187 Event 44511673
11-01-13:16:02:58
Inner: 422 hits, 712 pe
Outer: 4 hits, 4 pe
Trigger: 0x1000007
D_wall: 390.9 cm
Evis: 47.9 MeV
e-like, p = 47.9 MeV/c

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



e

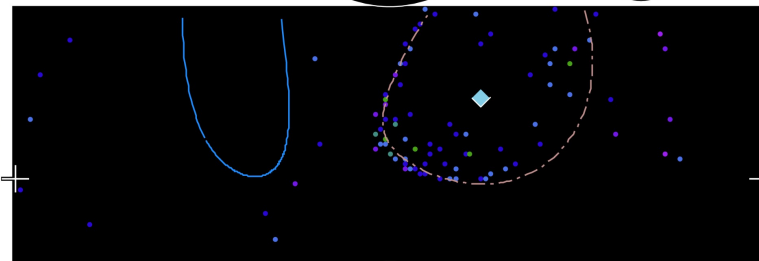


Super-Kamiokande IV

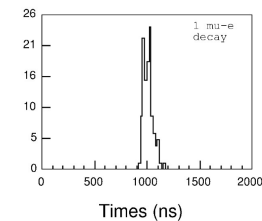
Run 999999 Sub 0 Event 1
19-05-16:03:39:35
Inner: 115 hits, 158 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 390.9 cm
Evis: 0.0 MeV

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



π^+

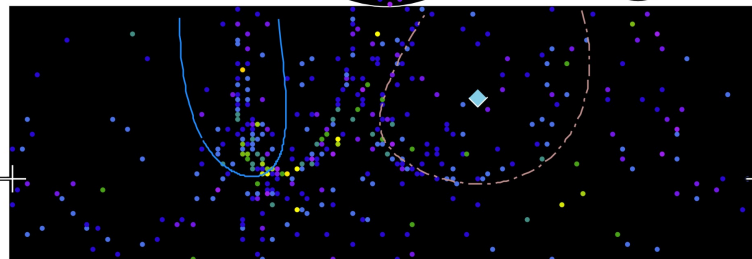


Super-Kamiokande IV

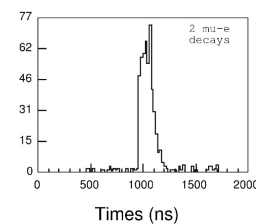
Run 999999 Sub 0 Event 1
19-05-16:03:39:35
Inner: 533 hits, 871 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 390.9 cm
Evis: 0.0 MeV

Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



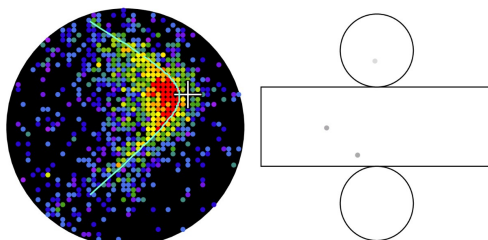
Data Sample

19-05-31

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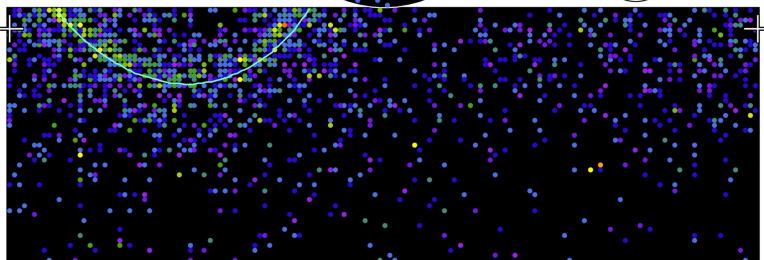
Super-Kamiokande IV

Run 74217 Sub 430 Event 446216633
15-12-12:16:18:03
Inner: 2282 hits, 6883 pe
Outer: 0 hits, 0 pe
Trigger: 0x10000007
D_{wall}: 296.3 cm
Evis: 652.1 MeV
e-like, p = 652.1 MeV/c

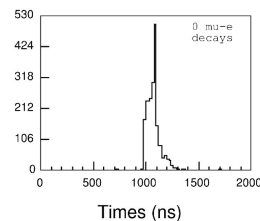
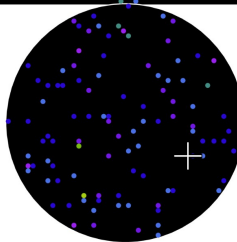


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

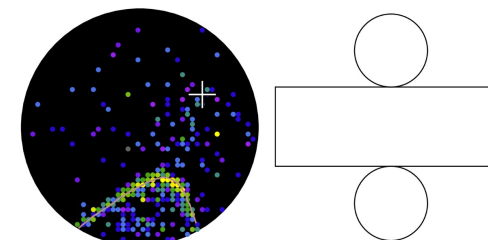


e



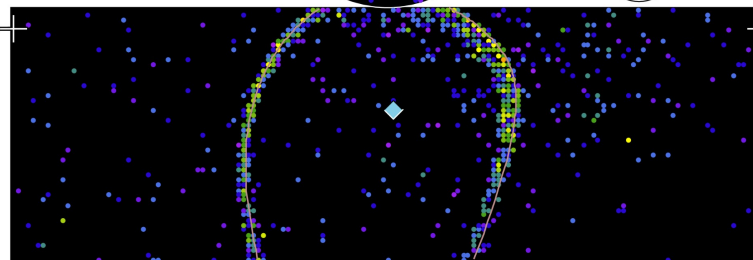
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:39:36
Inner: 1063 hits, 2365 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_{wall}: 296.3 cm
Evis: 0.0 MeV

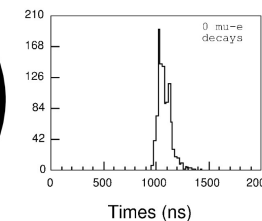
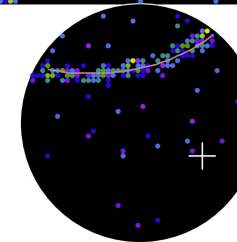


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

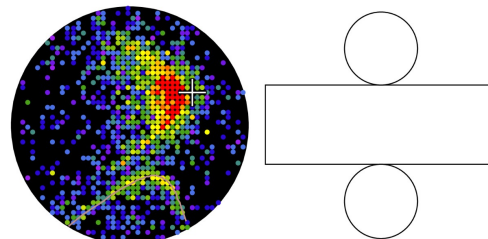


π^+



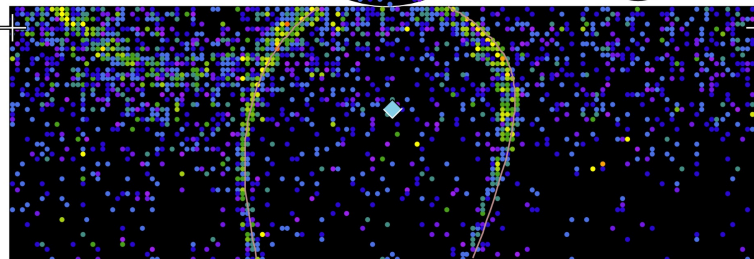
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:39:36
Inner: 3080 hits, 9238 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_{wall}: 296.3 cm
Evis: 0.0 MeV

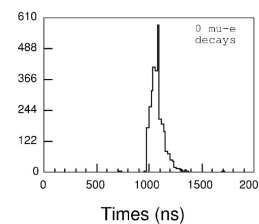
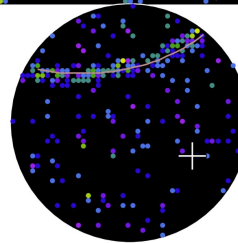


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



Data Sample

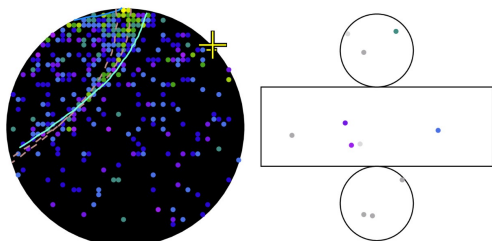
19-05-31

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MC Sample

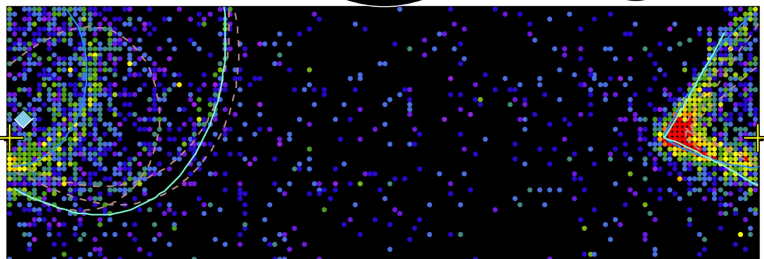
Super-Kamiokande IV

Run 999999 Sub 201 Event 8
16-03-10:19:06:31
Inner: 2329 hits, 9204 pe
Outer: 4 hits, 4 pe
Trigger: 0x07
D_{wall}: 0.3 cm
Evis: 589.8 MeV
e-like, p = 589.8 MeV/c

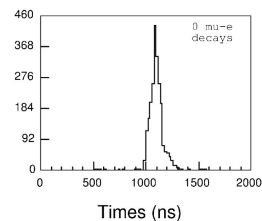
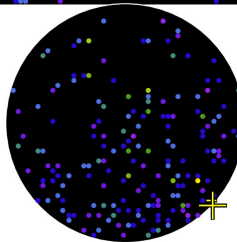


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

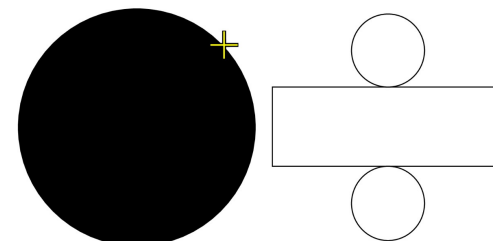


e



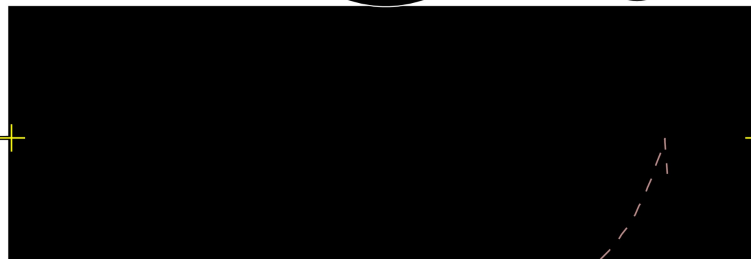
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 0 hits, 0 pe
Outer: 0 hits, 0 pe
Trigger: 0x00
D_{wall}: 0.3 cm
Evis: 0.0 MeV

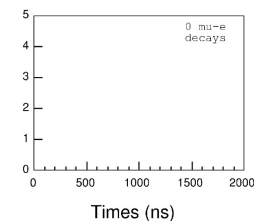
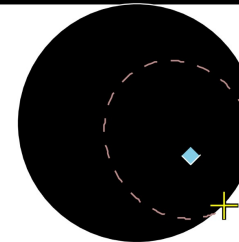


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

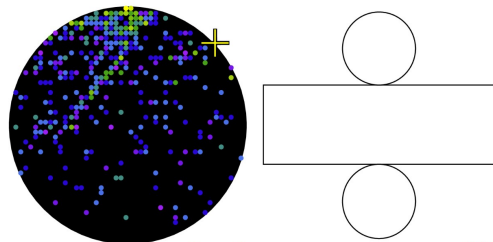


π^+



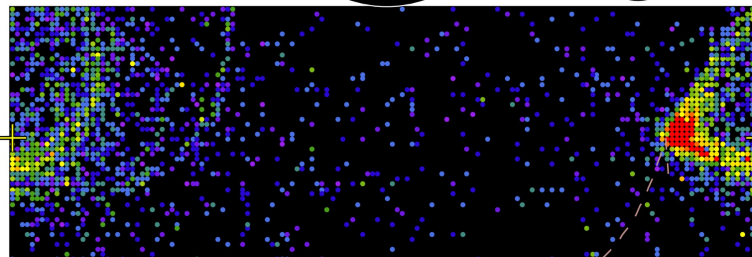
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 2329 hits, 9204 pe
Outer: 0 hits, 0 pe
Trigger: 0x00
D_{wall}: 0.3 cm
Evis: 0.0 MeV

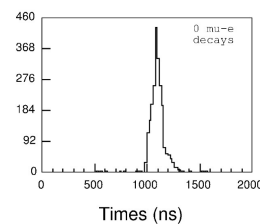
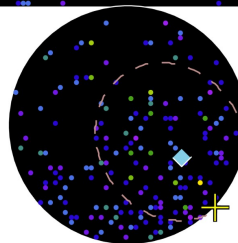


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



MC Sample

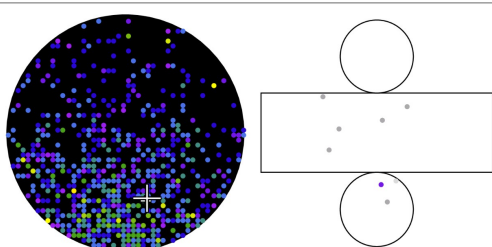
19-05-31

Not sure where π^+ is...
Too close to wall?
 $p_\pi = 217.7 \text{ MeV/c}$

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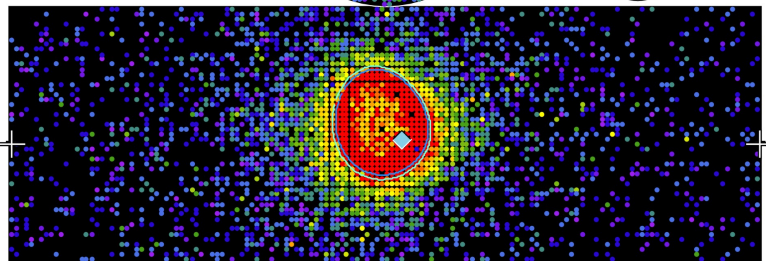
Super-Kamiokande IV

Run 999999 Sub 201 Event 6409
16-03-10:19:07:18
Inner: 4030 hits, 26421 pe
Outer: 1 hits, 0 pe
Trigger: 0x07
D_wall: 715.5 cm
Evis: 2.7 GeV
e-like, $p = 2708.1$ MeV/c

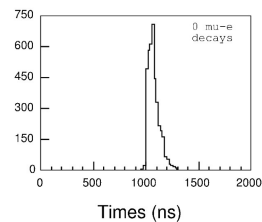
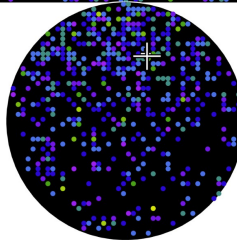


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

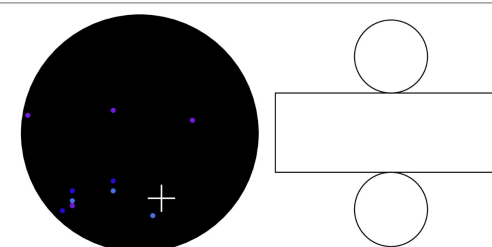


e



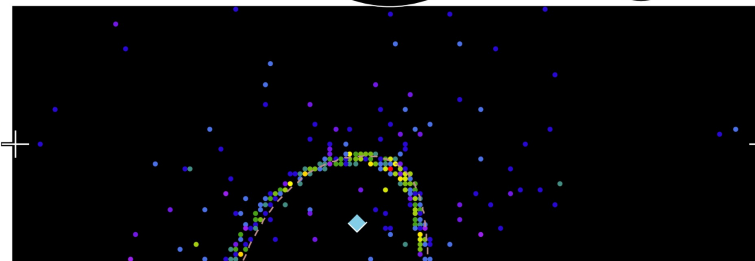
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 338 hits, 890 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 715.5 cm
Evis: 0.0 MeV

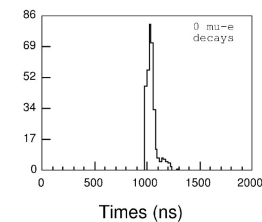
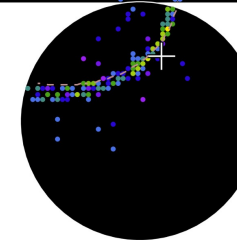


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

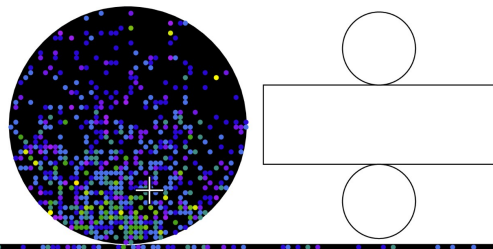


π^+



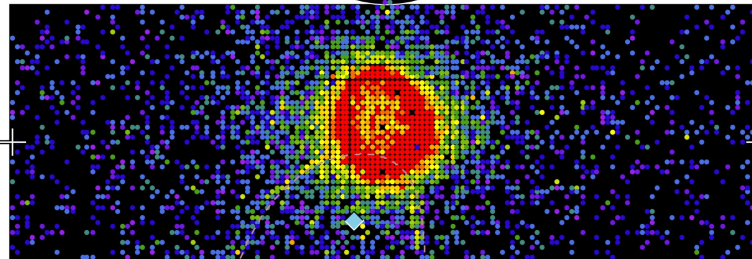
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 4157 hits, 27312 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 715.5 cm
Evis: 0.0 MeV

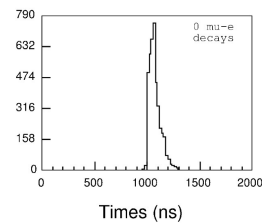
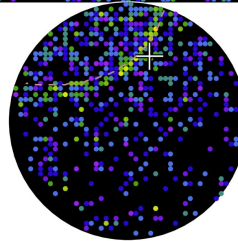


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



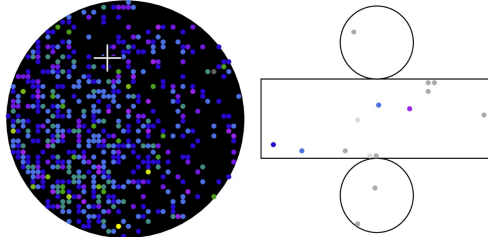
MC Sample

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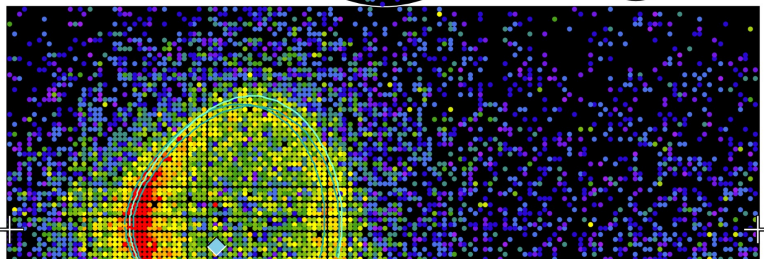
Super-Kamiokande IV

Run 999999 Sub 201 Event 10569
16-03-10:19:07:48
Inner: 5672 hits, 31509 pe
Outer: 4 hits, 4 pe
Trigger: 0x07
D_wall: 452.1 cm
Evis: 3.3 GeV
e-like, $p = 3304.6$ MeV/c

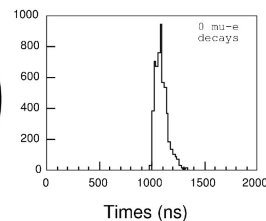
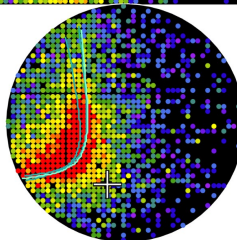


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

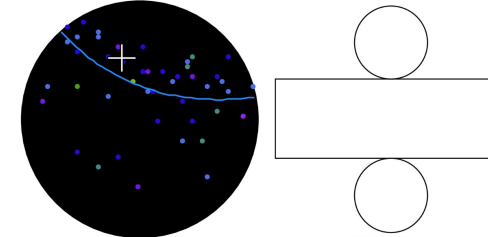


e



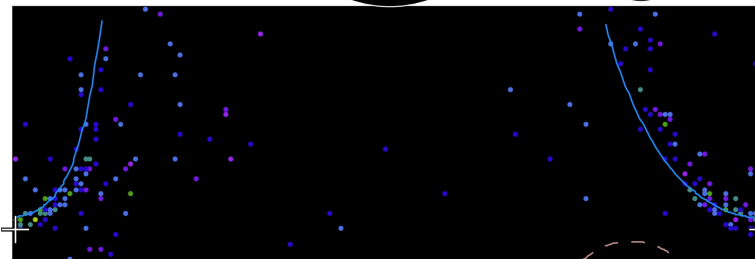
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 247 hits, 352 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 452.1 cm
Evis: 0.0 MeV

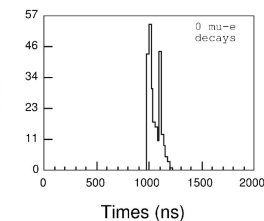
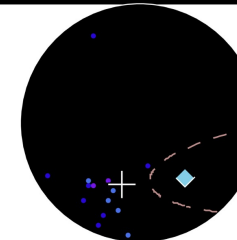


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

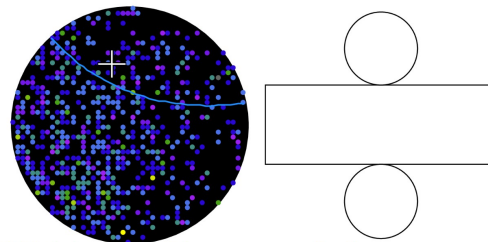


π^+



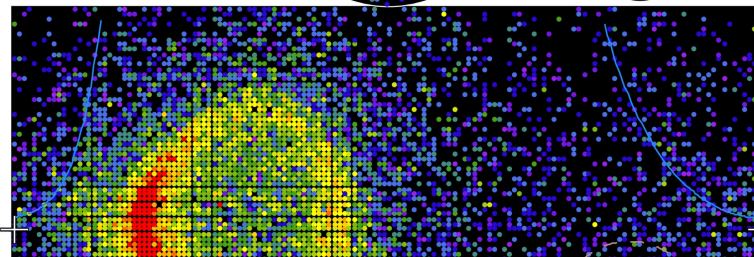
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 5781 hits, 31645 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 452.1 cm
Evis: 0.0 MeV

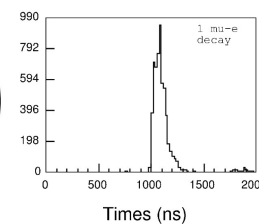
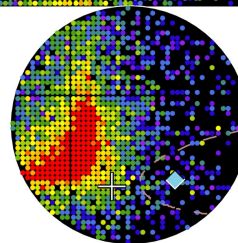


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



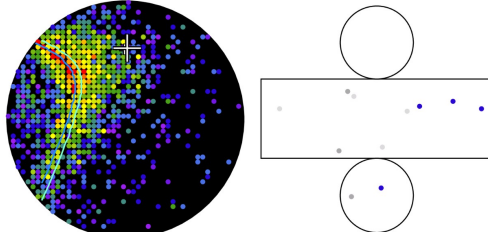
MC Sample

19-05-31

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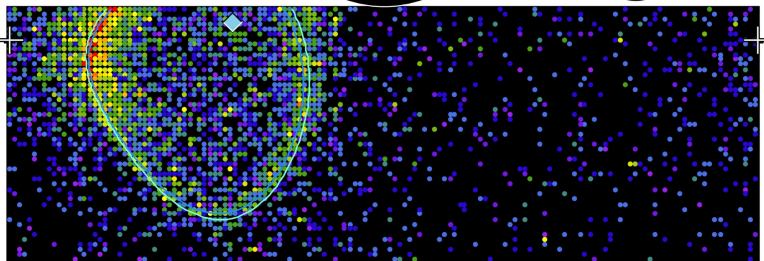
Super-Kamiokande IV

Run 999999 Sub 202 Event 5540
16-03-10:19:07:10
Inner: 3676 hits, 11610 pe
Outer: 4 hits, 3 pe
Trigger: 0x07
D_wall: 480.7 cm
Evis: 1.2 GeV
e-like, p = 1232.1 MeV/c

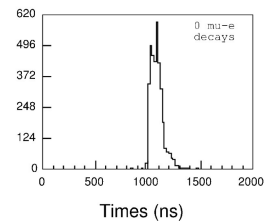
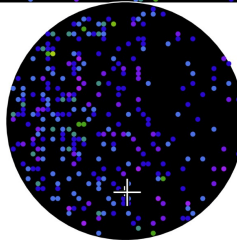


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

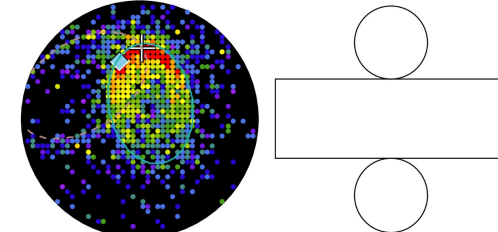


e



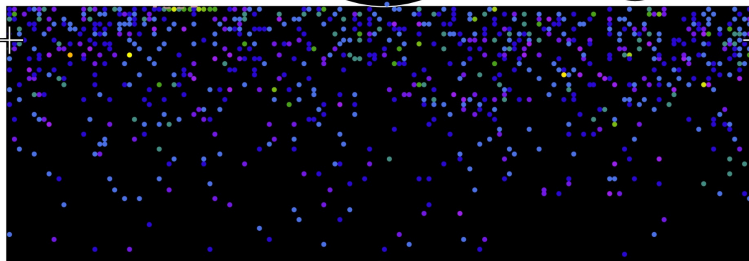
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 1628 hits, 5842 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 480.7 cm
Evis: 0.0 MeV

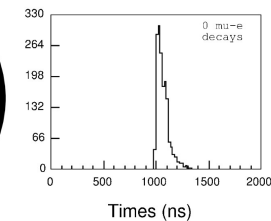
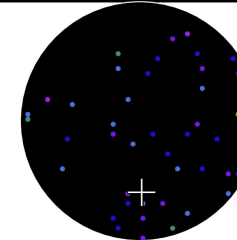


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

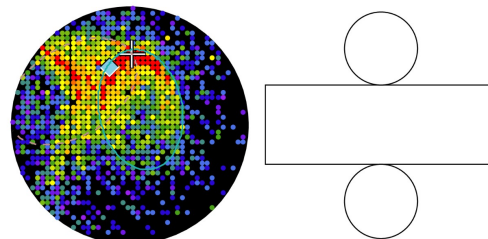


π^+



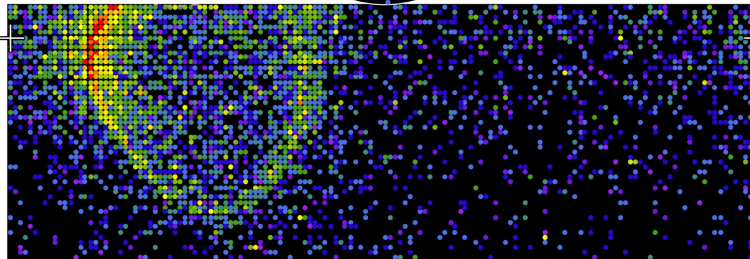
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 4542 hits, 17446 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 480.7 cm
Evis: 0.0 MeV

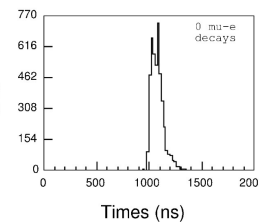
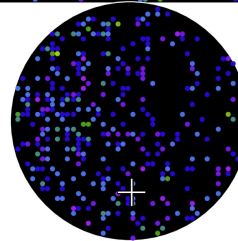


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



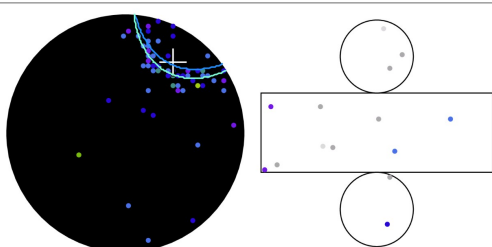
MC Sample

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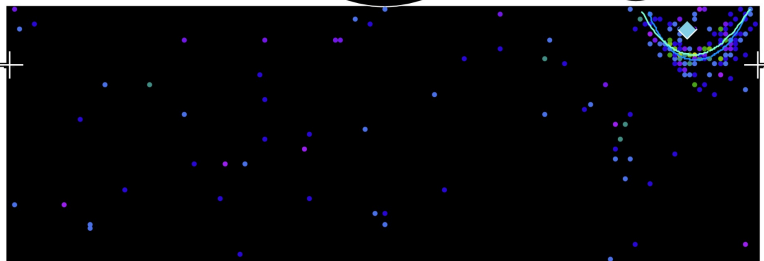
Super-Kamiokande IV

Run 999999 Sub 202 Event 10693
16-03-10:19:07:49
Inner: 241 hits, 352 pe
Outer: 5 hits, 5 pe
Trigger: 0x07
D_wall: 489.0 cm
Evis: 30.2 MeV
e-like, $p = 30.2$ MeV/c

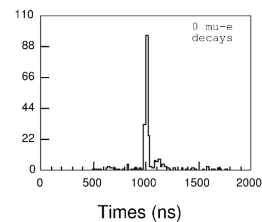


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

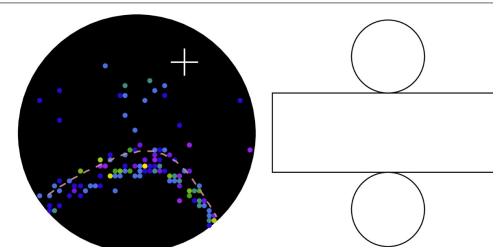


e



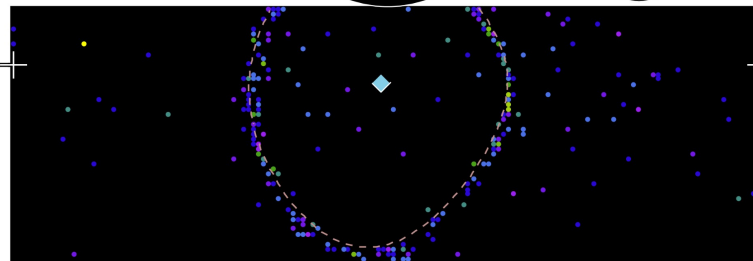
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 340 hits, 555 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 489.0 cm
Evis: 0.0 MeV

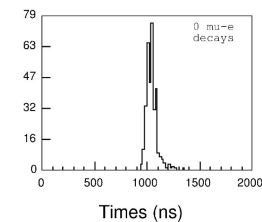


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

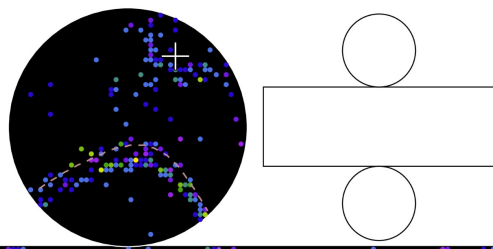


π^+



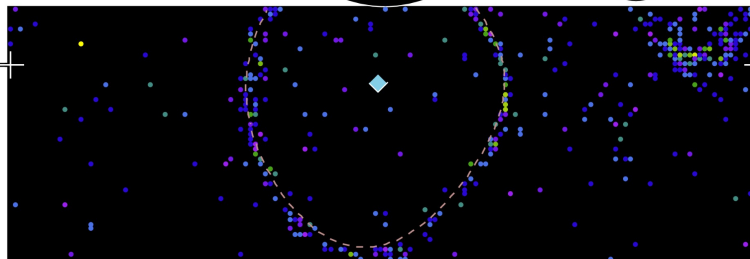
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:19
Inner: 580 hits, 906 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 489.0 cm
Evis: 0.0 MeV

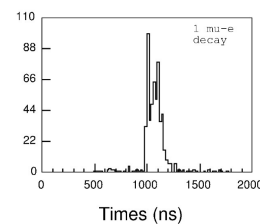


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



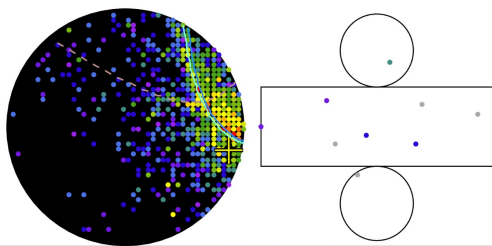
MC
Sample

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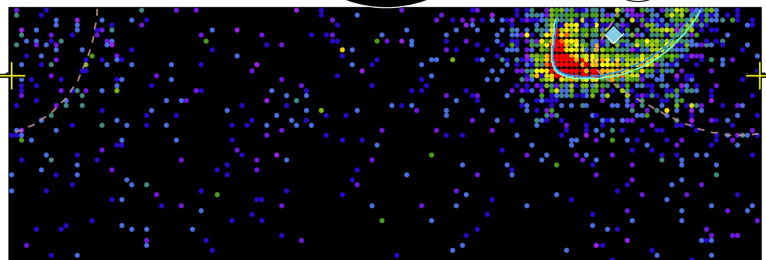
Super-Kamiokande IV

Run 999999 Sub 205 Event 2135
16-03-10:19:06:50
Inner: 1740 hits, 9140 pe
Outer: 5 hits, 5 pe
Trigger: 0x07
D_wall: 197.3 cm
Evis: 834.2 MeV
e-like, $p = 834.2$ MeV/c

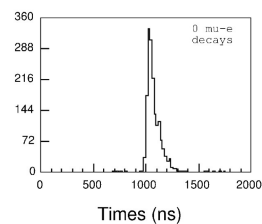
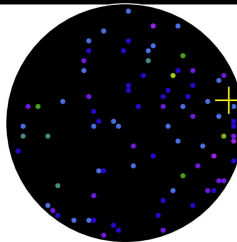


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

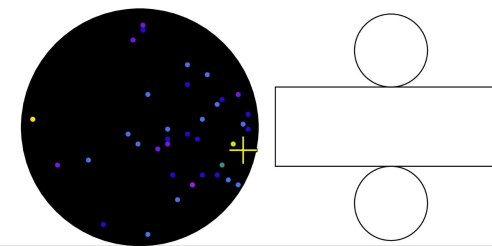


e



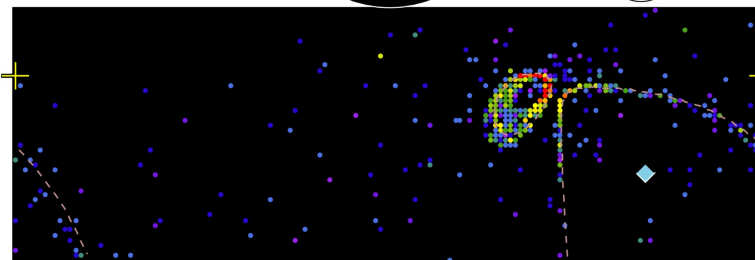
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:20
Inner: 467 hits, 1758 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 197.3 cm
Evis: 0.0 MeV

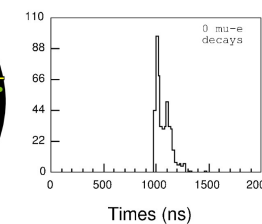
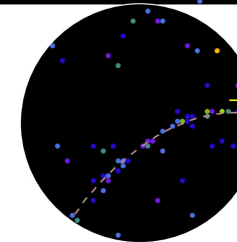


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

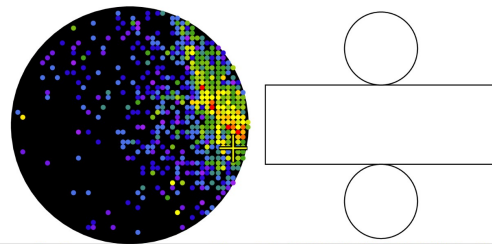


π^+



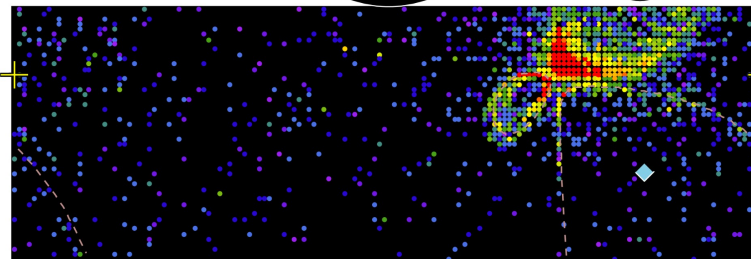
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:20
Inner: 2081 hits, 10925 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 197.3 cm
Evis: 0.0 MeV

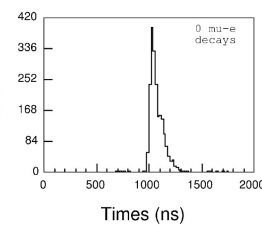
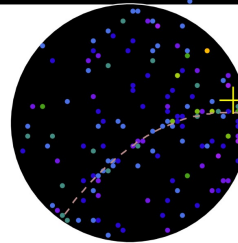


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



$\pi^+ \rightarrow \pi^+ p$

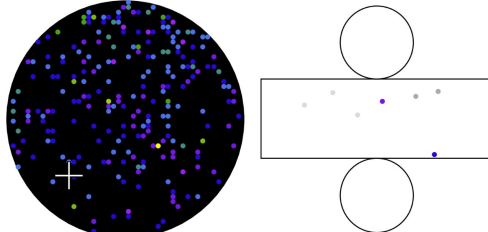
MC
Sample

19-05-31

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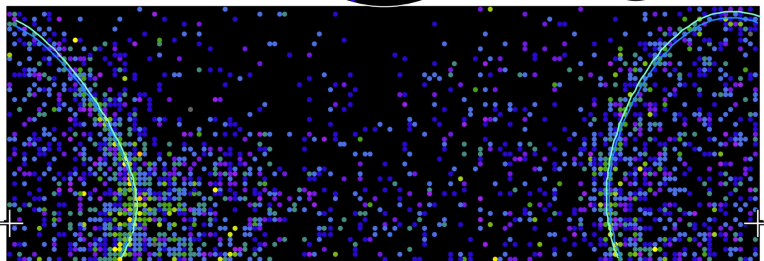
Super-Kamiokande IV

Run 999999 Sub 208 Event 4145
16-03-10:19:07:37
Inner: 3117 hits, 6475 pe
Outer: 2 hits, 1 pe
Trigger: 0x07
D_wall: 555.4 cm
Evis: 654.9 MeV
e-like, p = 654.9 MeV/c

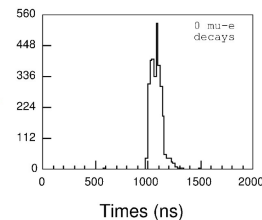
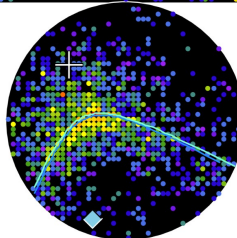


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

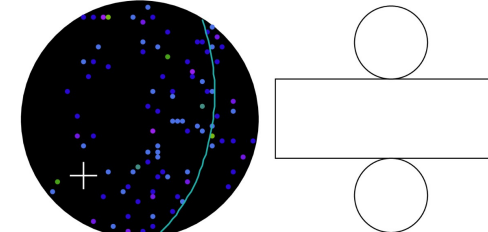


e



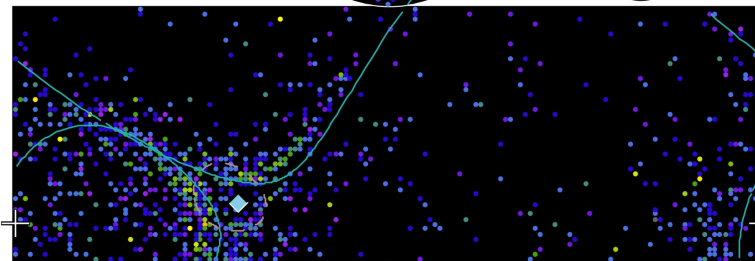
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:21
Inner: 1334 hits, 2356 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 555.4 cm
Evis: 0.0 MeV

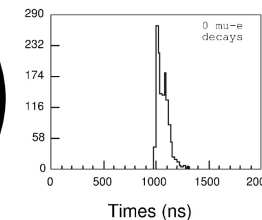
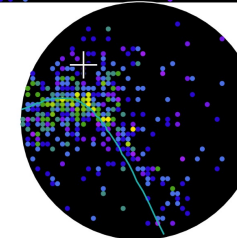


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2

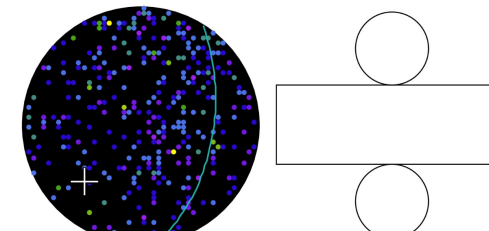


π^+



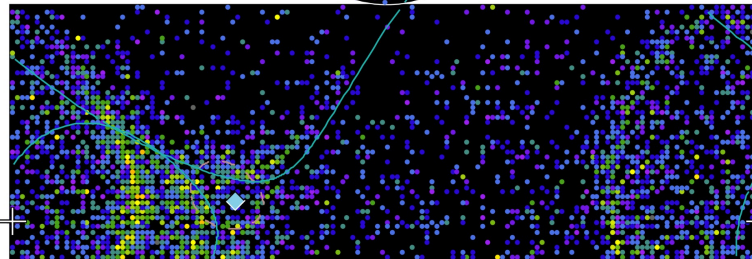
Super-Kamiokande IV

Run 999999 Sub 0 Event 1
19-05-16:03:41:21
Inner: 3830 hits, 8854 pe
Outer: 0 hits, 0 pe
Trigger: 0x07
D_wall: 555.4 cm
Evis: 0.0 MeV

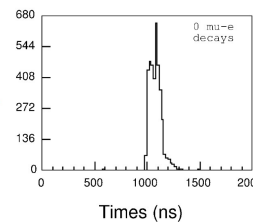
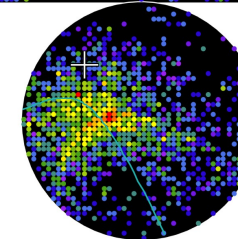


Charge (pe)

- >26.7
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2- 8.0
- 4.7- 6.2
- 3.3- 4.7
- 2.2- 3.3
- 1.3- 2.2
- 0.7- 1.3
- 0.2- 0.7
- < 0.2



merged



$$\pi^+ \rightarrow \pi^0 \rightarrow \gamma\gamma$$

MC Sample

19-05-31

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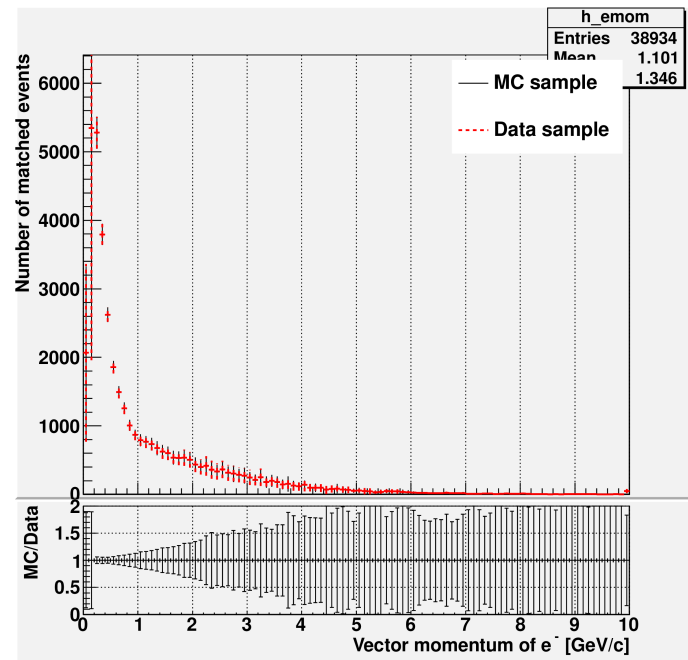
Future Work

- Event displays of timing
- Run BDT-based event selection on hybrid sample

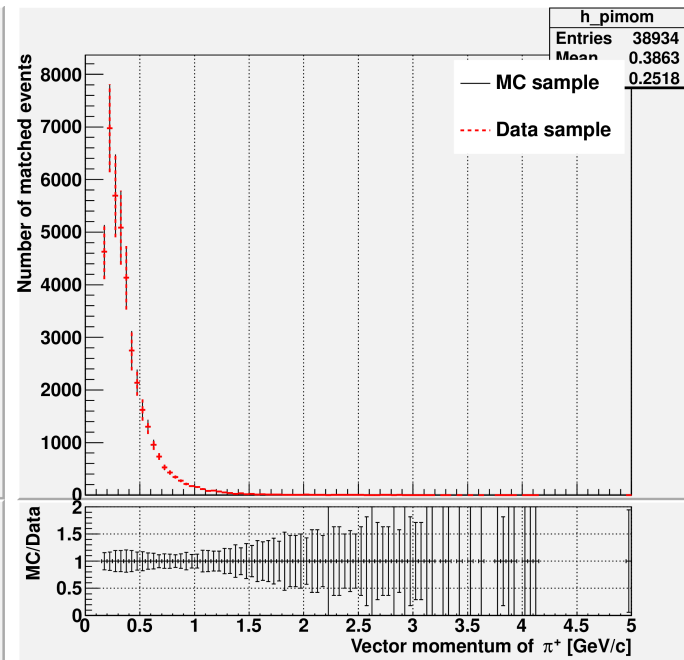
Backup

Kinematics of matched events

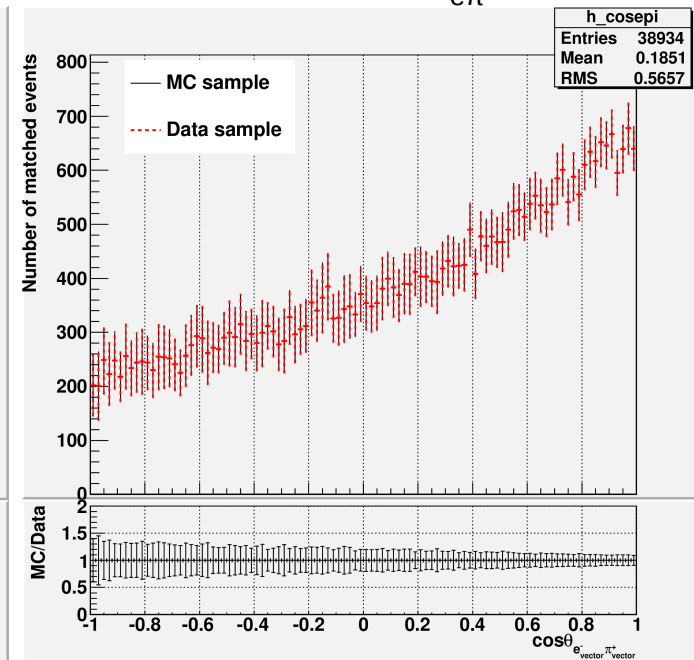
True e^- momentum



True π^+ momentum

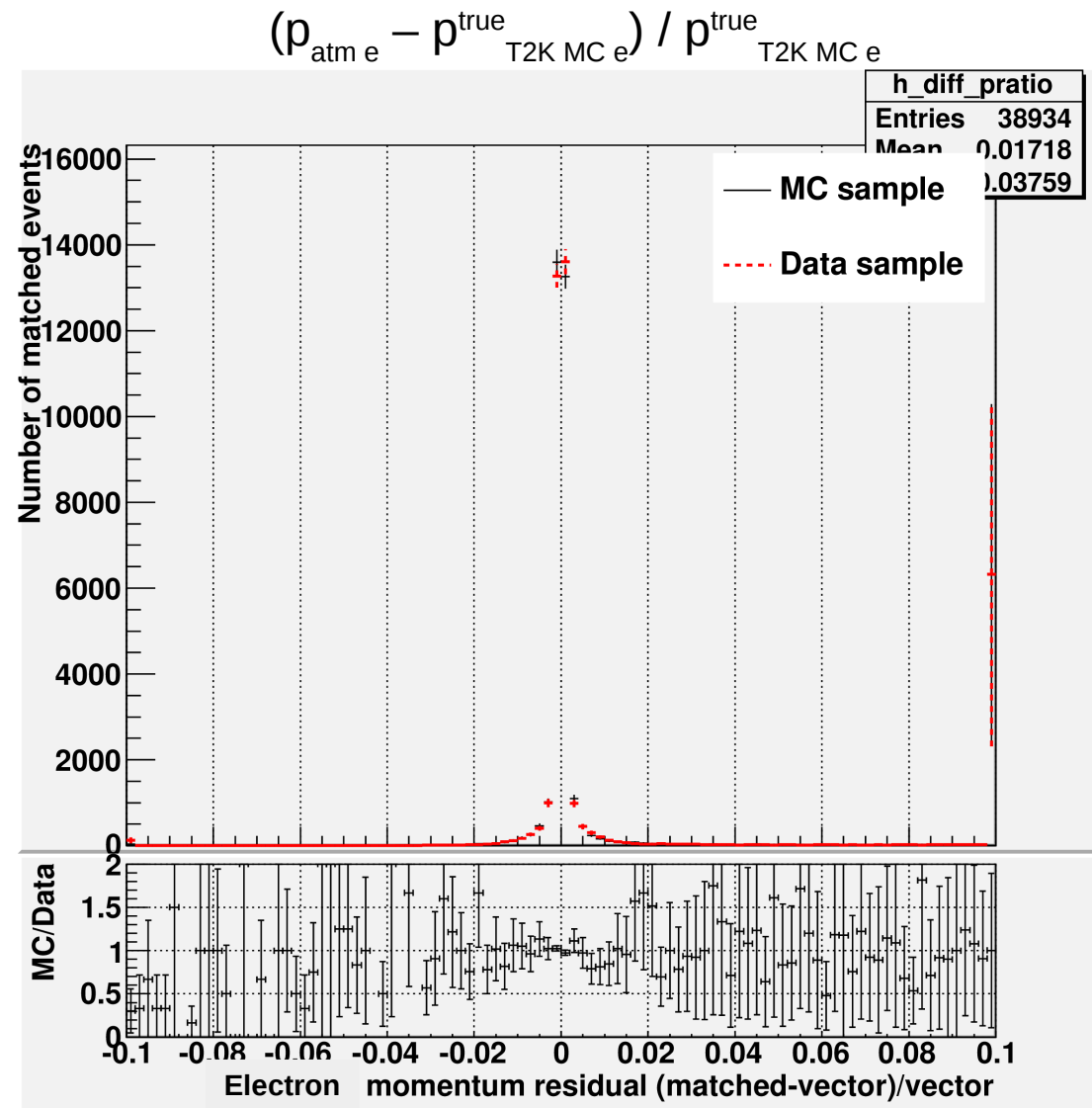


True $\cos(\theta_{e\pi})$



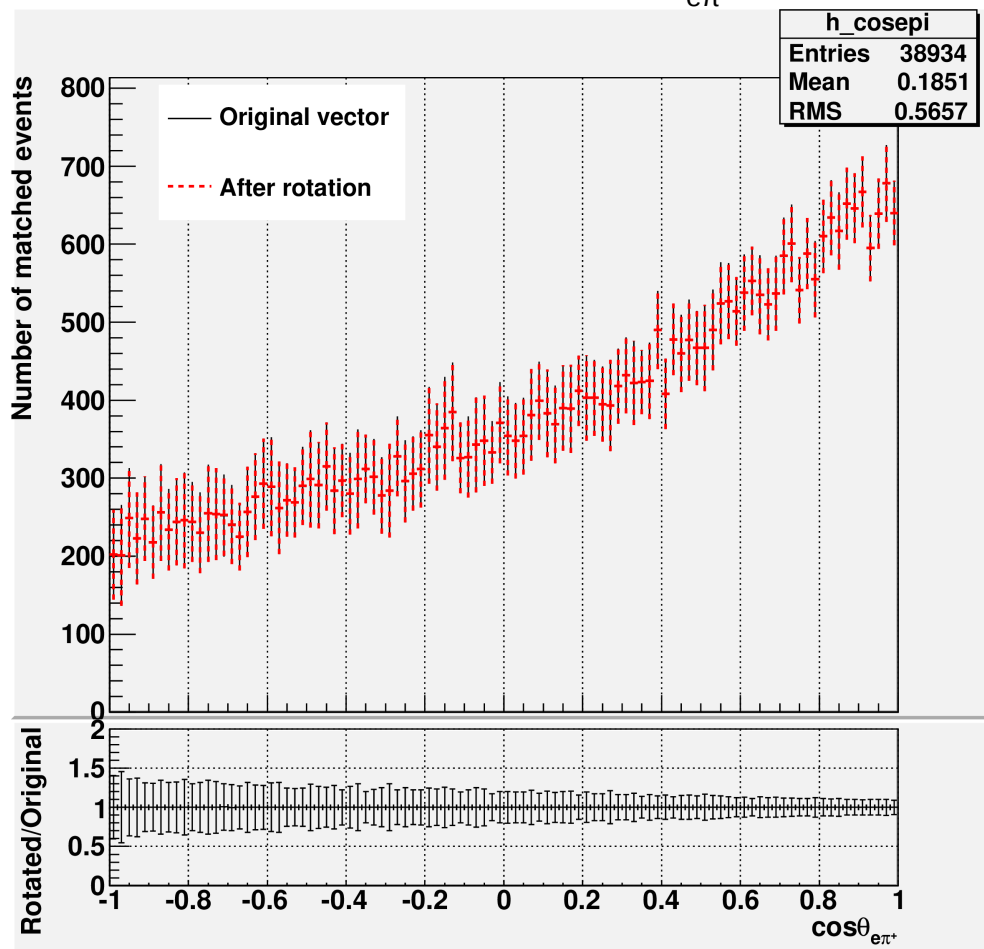
MC/data should be perfectly matched (by construction)

Matched e Momentum Difference

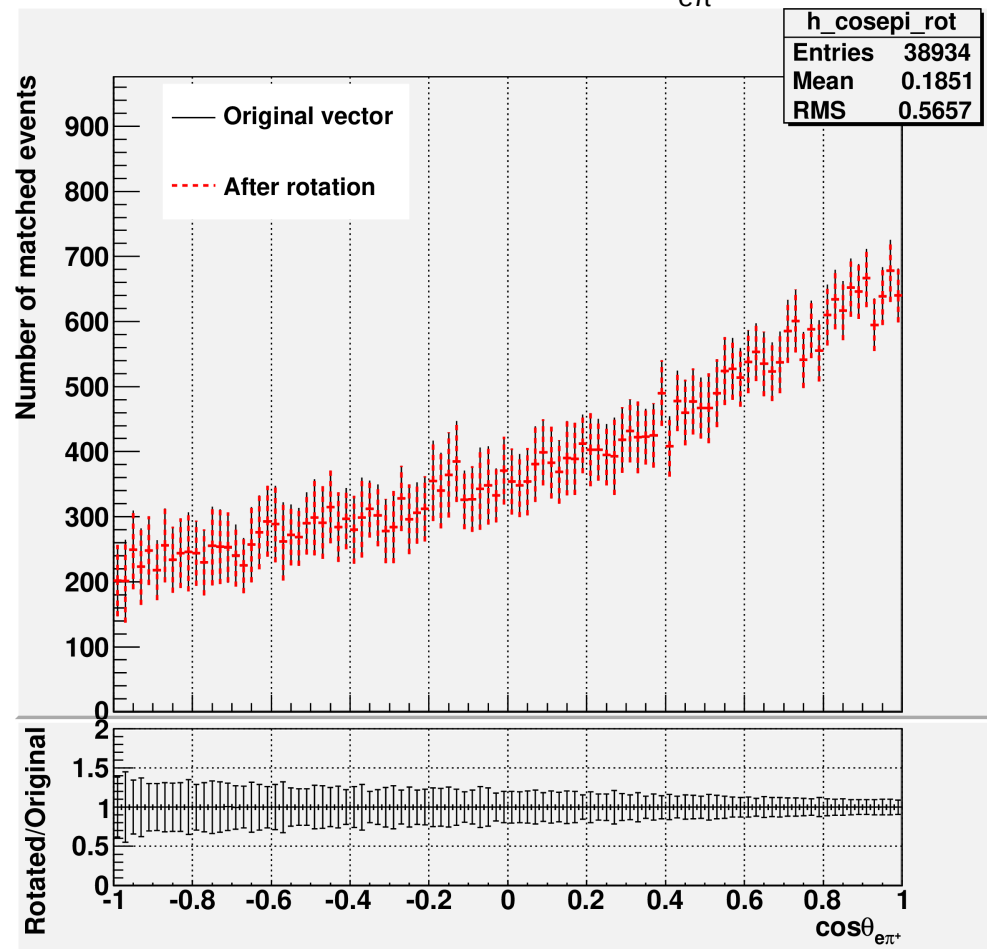


Rotation

Data Sample: $\cos(\theta_{e\pi^-})$



MC Sample: $\cos(\theta_{e\pi^-})$



Rotated/original should be perfectly matched (by construction)
Data sample and MC sample should have same distribution (by construction)