

Progress Update

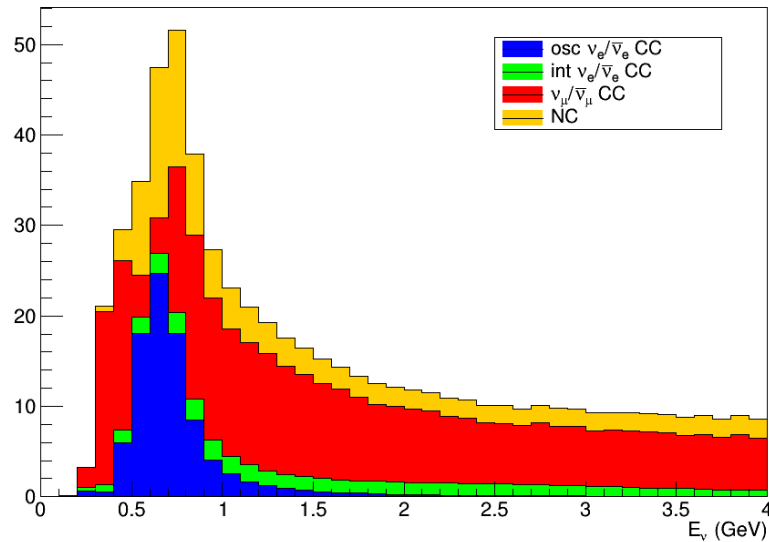
Trevor Towstego
UofT Neutrino/DM Meeting
April 6, 2018

Cut Flow E_ν Plots

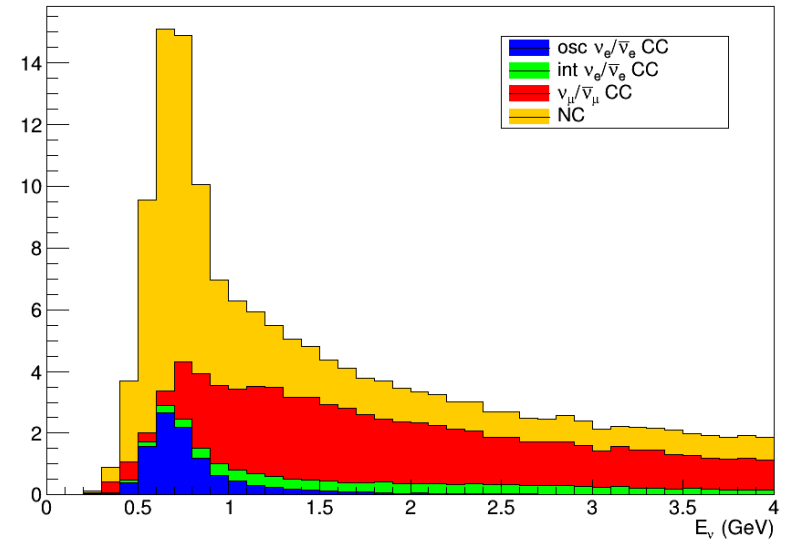
- Plots of E_ν at each step of cut flow
- Separated into three types of plots for each point in cut flow:
 - Signal type
 - CC breakdown by true interaction mode
 - Should probably change to breakdown by visible particles
 - NC breakdown by visible pions

2Re π baseline

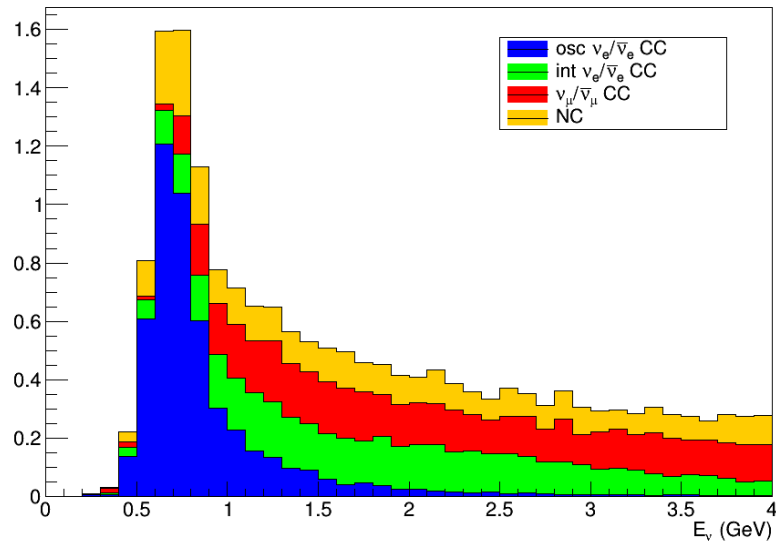
2Repi: FCFV



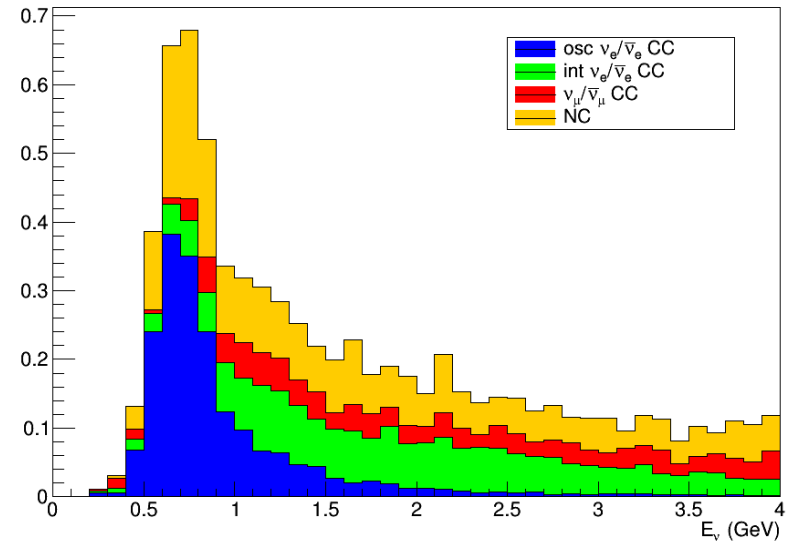
2Repi: 2 rings



2Repi: $e\pi$ -like

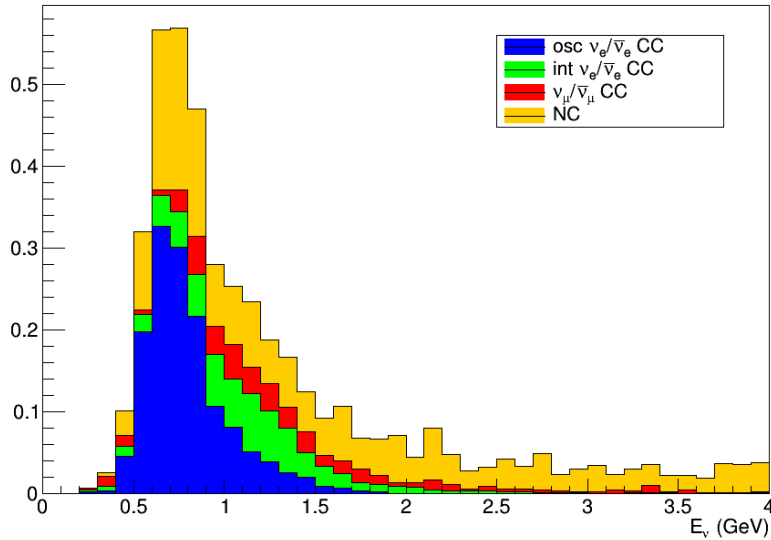


2Repi: 0 decay e

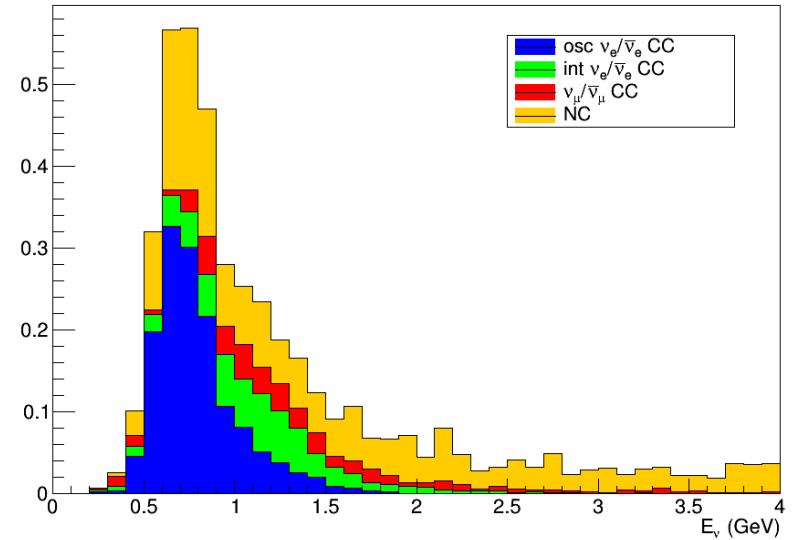


2Re π grid search

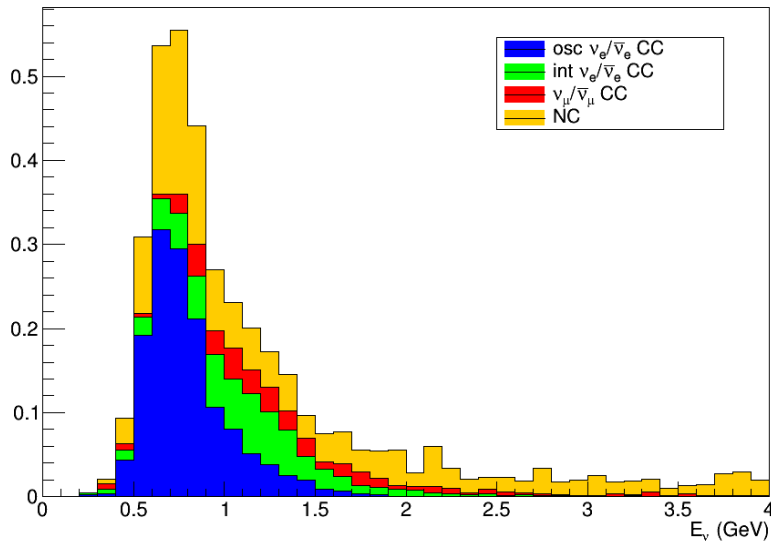
2Repi: $E_{\text{rec}} < 1.5 \text{ GeV}$



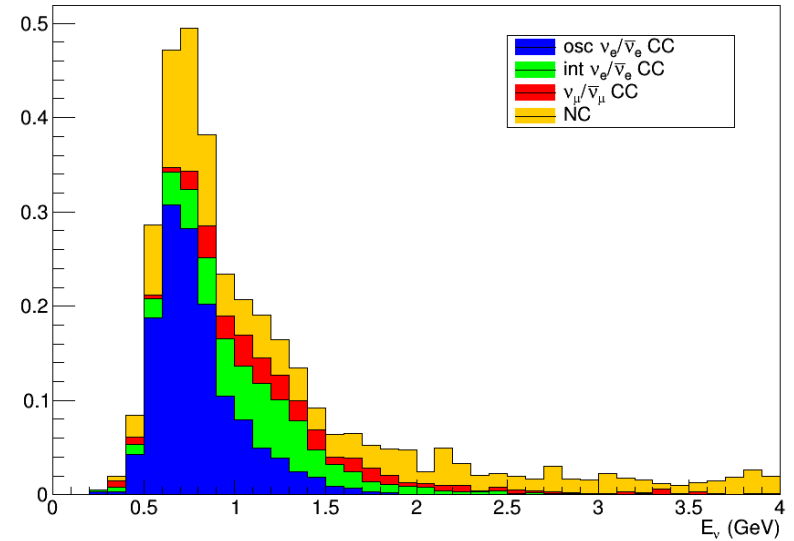
2Repi: $p_{\text{e-p}} \pi < 700 \text{ MeV}$



2Repi: $p_{\text{low}} > 50 \text{ MeV}$

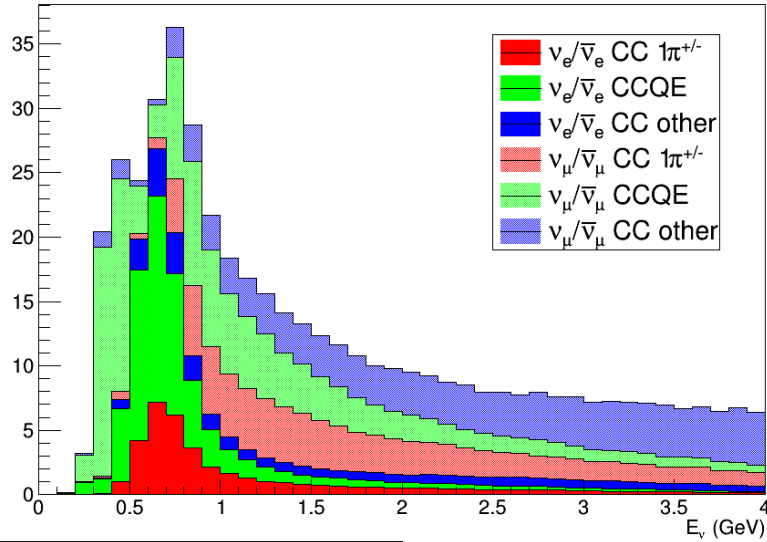


2Repi: $m_{\text{ex}} < 260 \text{ MeV} > 360 \text{ MeV} \parallel n_{\text{ll}} - n_{\text{ll}2\text{Re}} < -65$

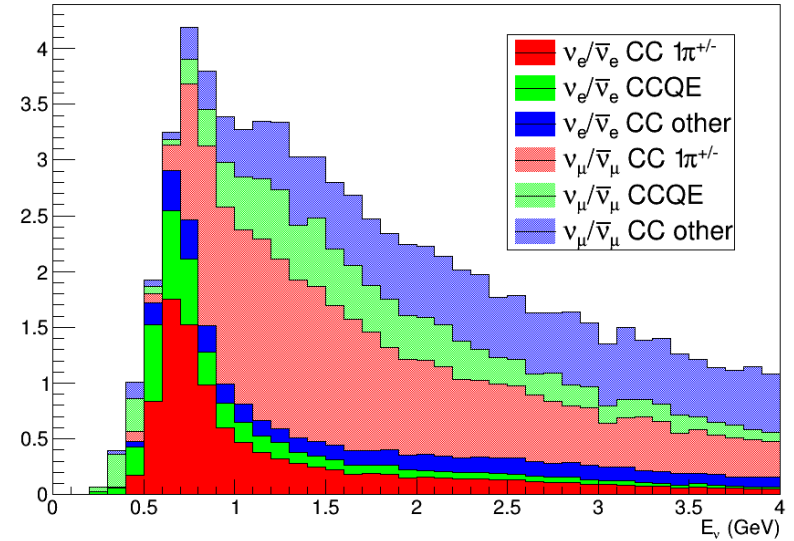


2Re π baseline: CC

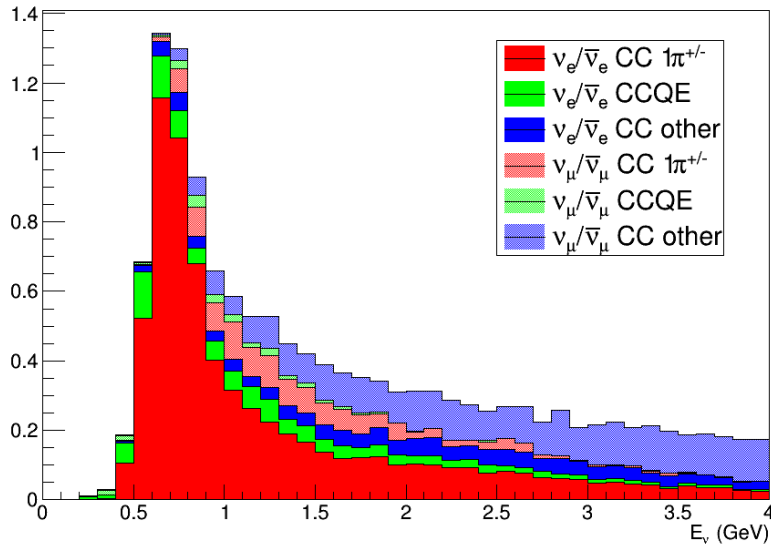
2Repi CC: FCFV



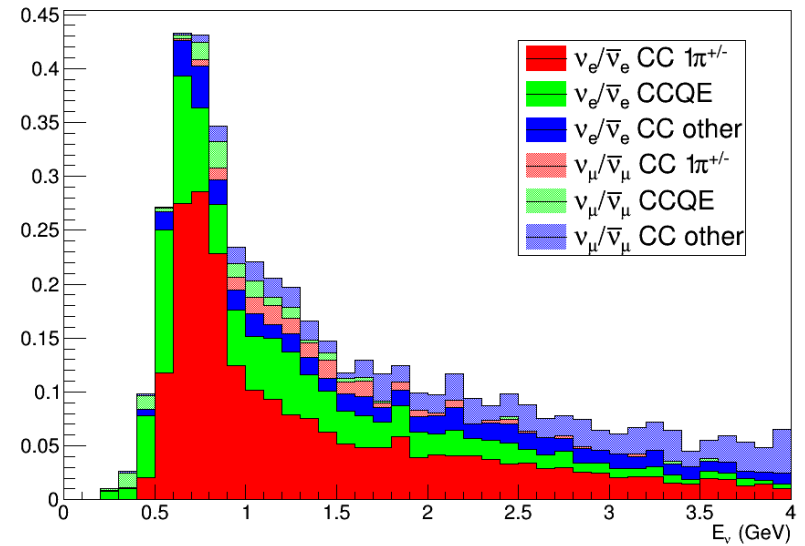
2Repi CC: 2 rings



2Repi CC: e π -like

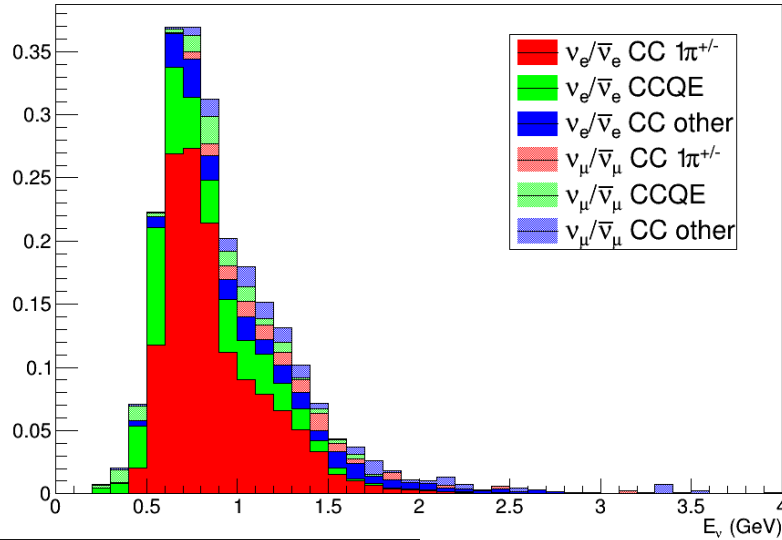


2Repi CC: 0 decay e

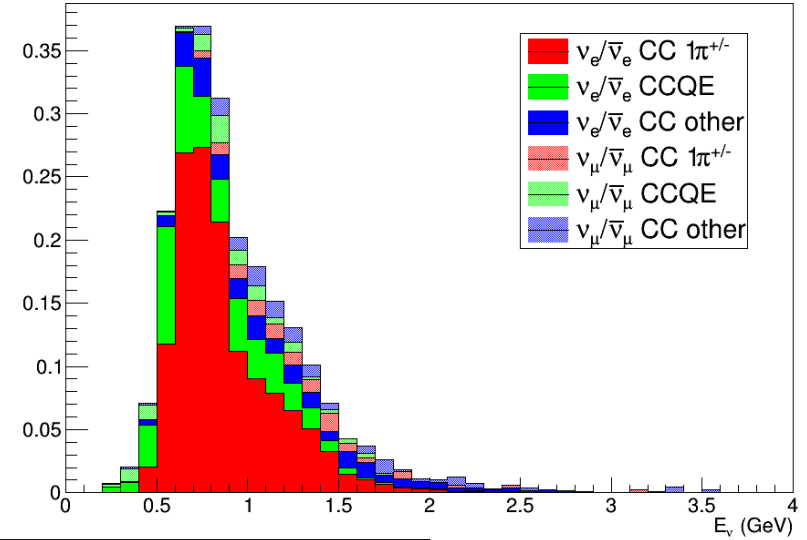


2Re π grid search CC

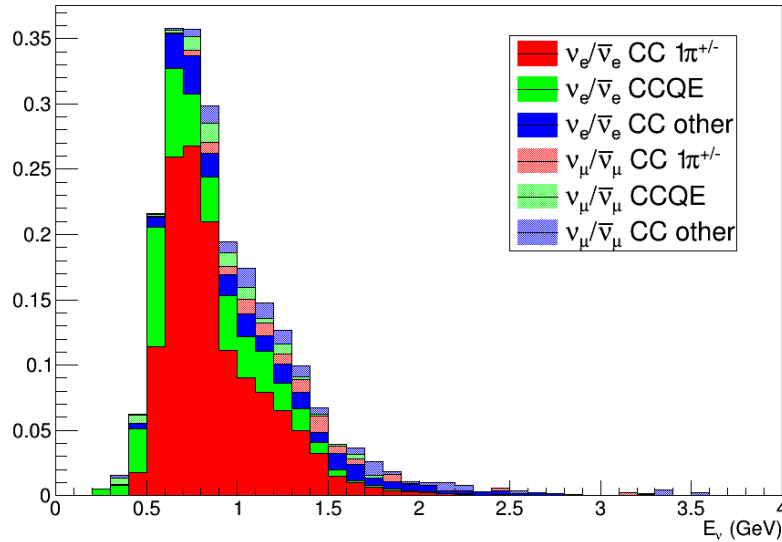
2Re π CC: $E_{rec} < 1.5 \text{ GeV}$



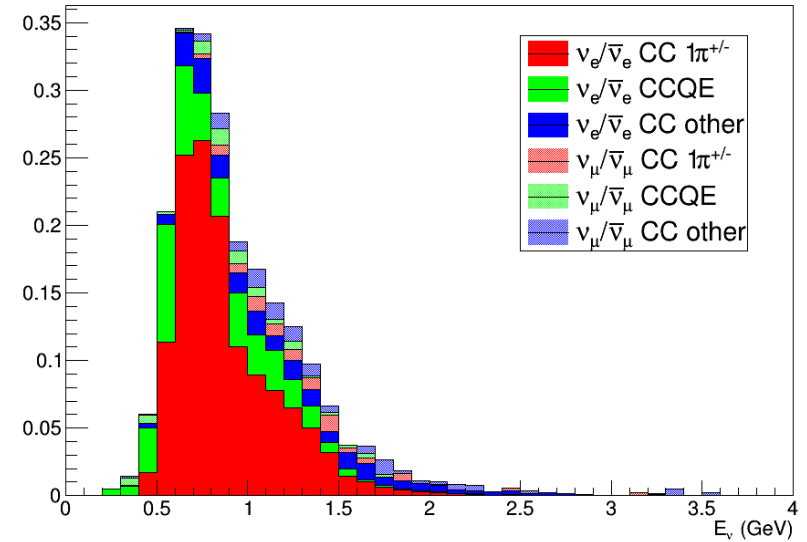
2Re π CC: $p_{e-p} \pi < 700 \text{ MeV}$



2Re π CC: $p_{low} > 50 \text{ MeV}$

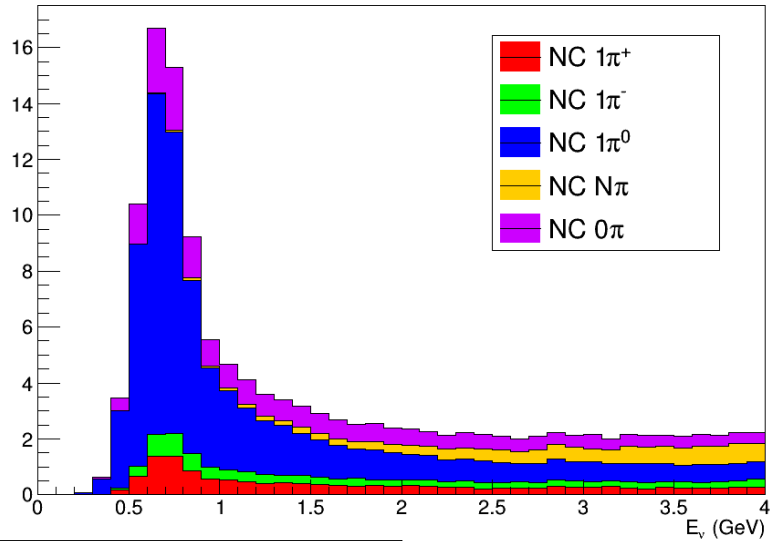


2Re π CC: $m_{e\pi} < 260 \text{ MeV} > 360 \text{ MeV} \parallel nll_{2Re\pi} < -65$

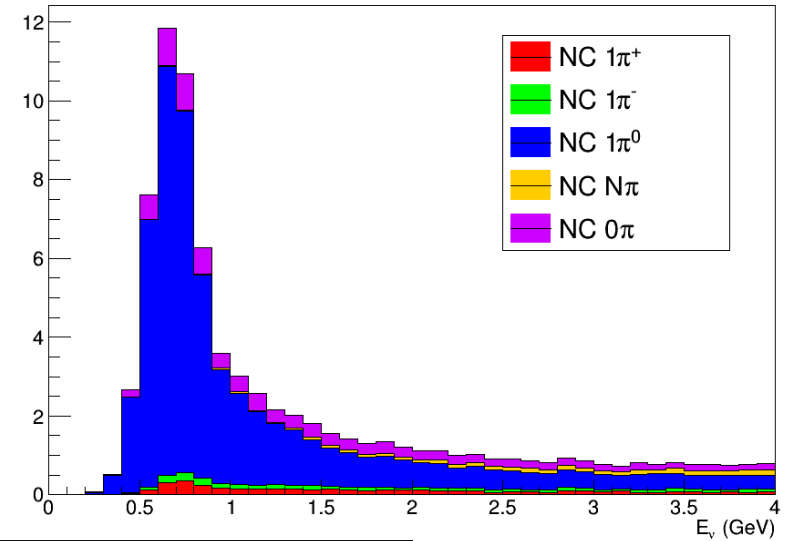


2Re π baseline: NC

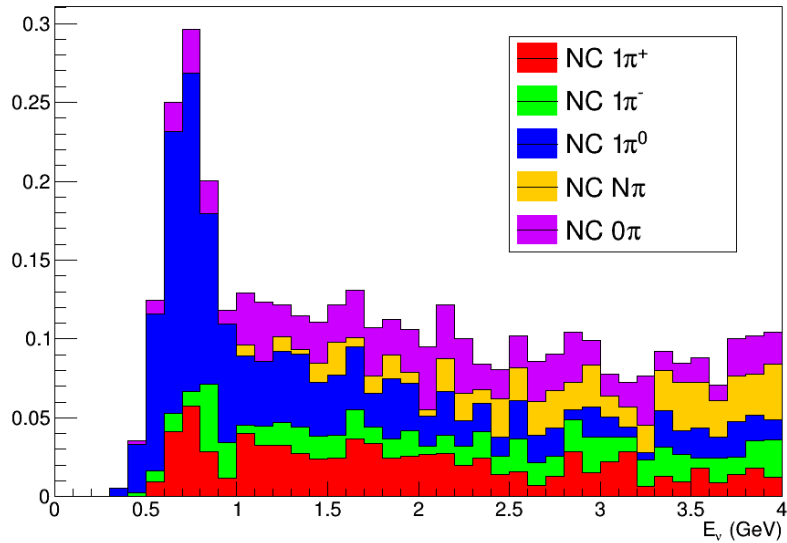
2Re π NC: FCFV



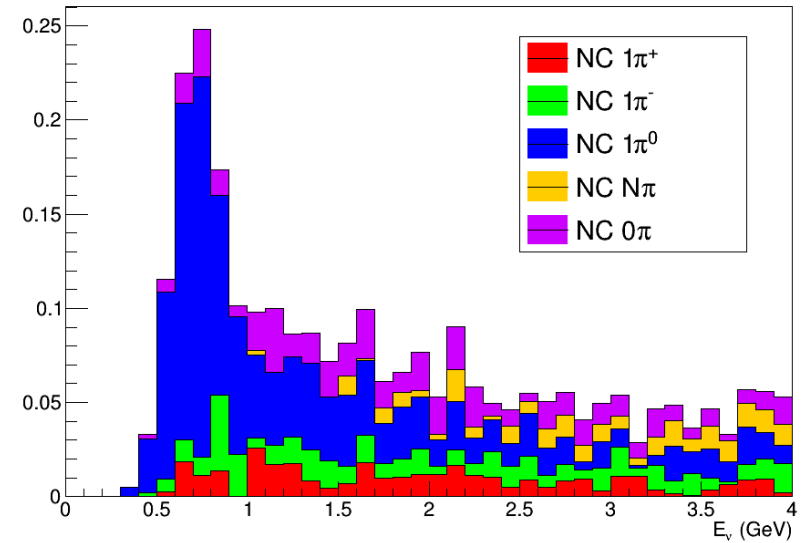
2Re π NC: 2 rings



2Re π NC: e π -like

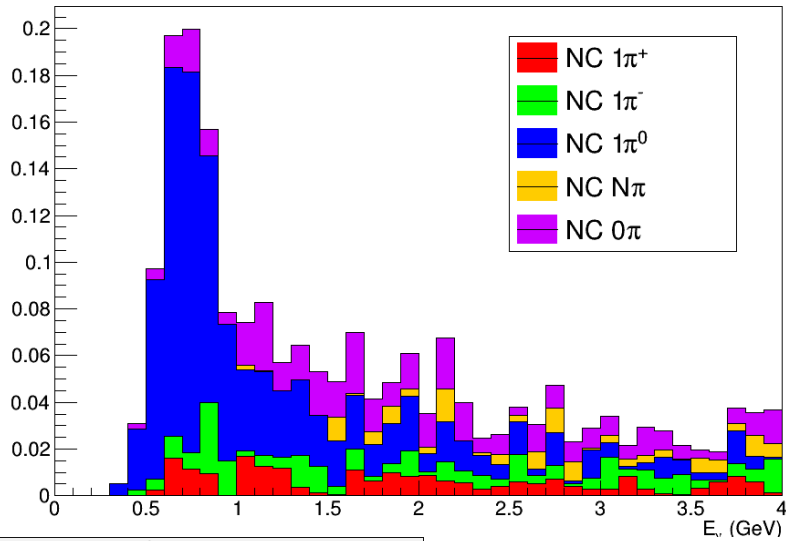


2Re π NC: 0 decay e

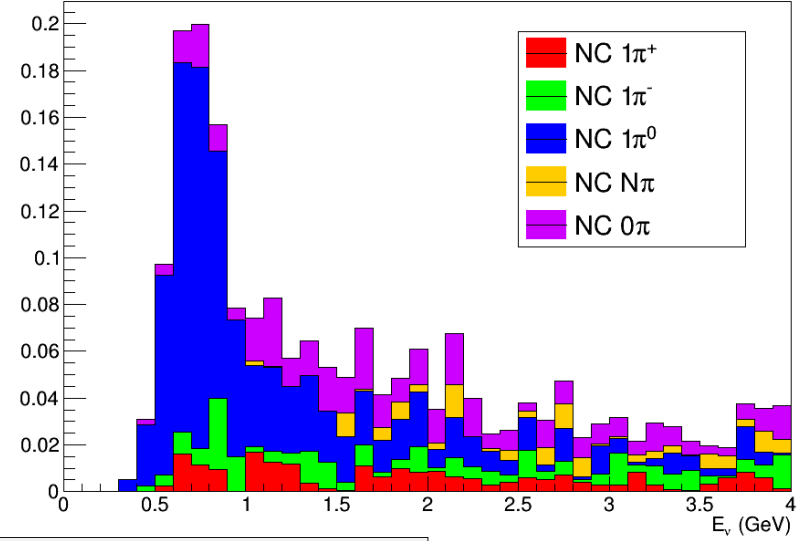


2Re π grid search: NC

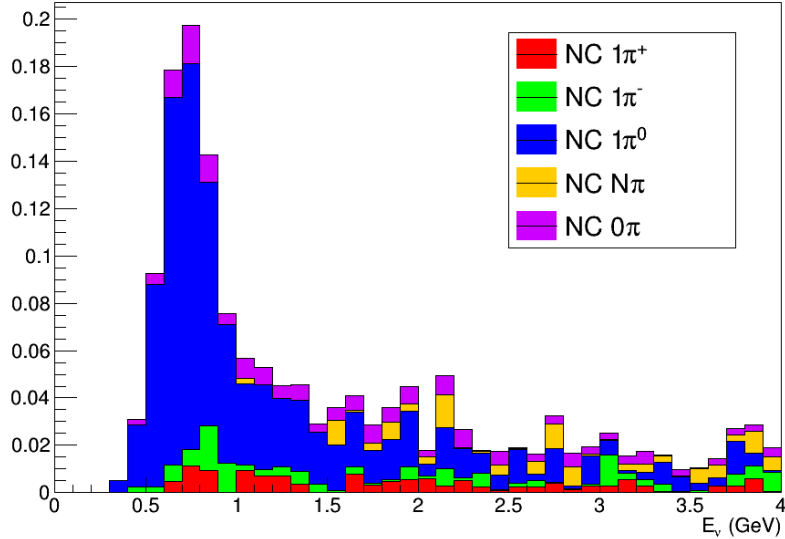
2Re π NC: $E_{\text{rec}} < 1.5 \text{ GeV}$



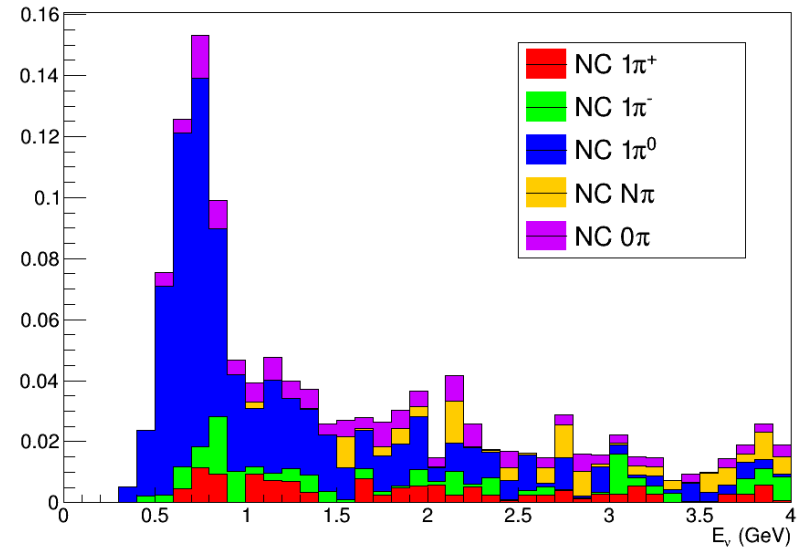
2Re π NC: $p_{e-p} \pi < 700 \text{ MeV}$



2Re π NC: $p_{\text{low}} > 50 \text{ MeV}$

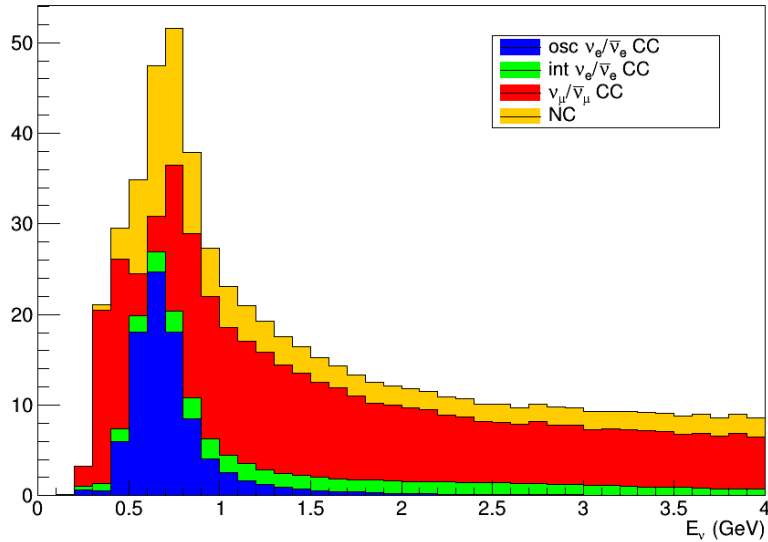


2Re π NC: $m_{\pi\pi} < 260 \text{ MeV} > 360 \text{ MeV} \parallel n_{\text{ll}} \text{ 2Re}\pi \text{ } -n_{\text{ll}} \text{ 2Re}\pi < -65$

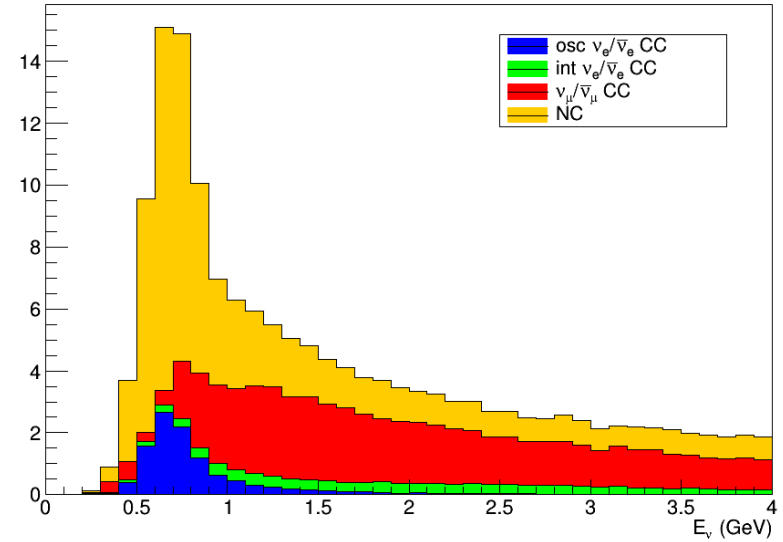


2Re π 1de baseline

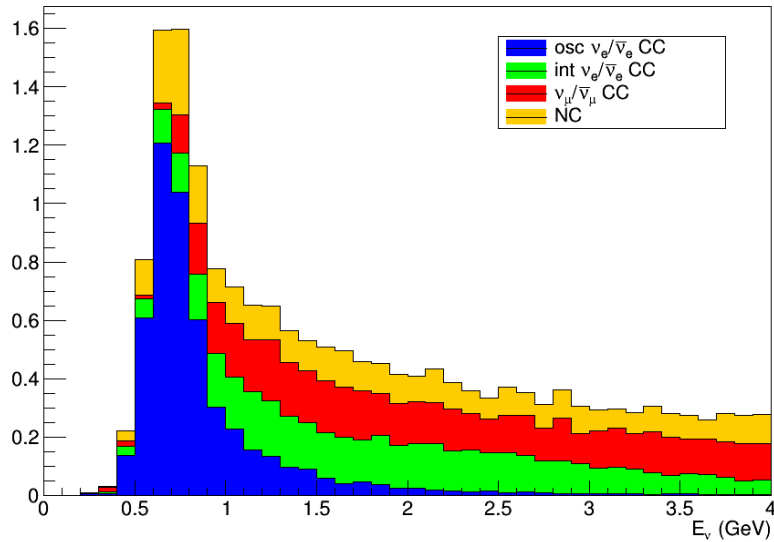
2Re π 1de: FCFV



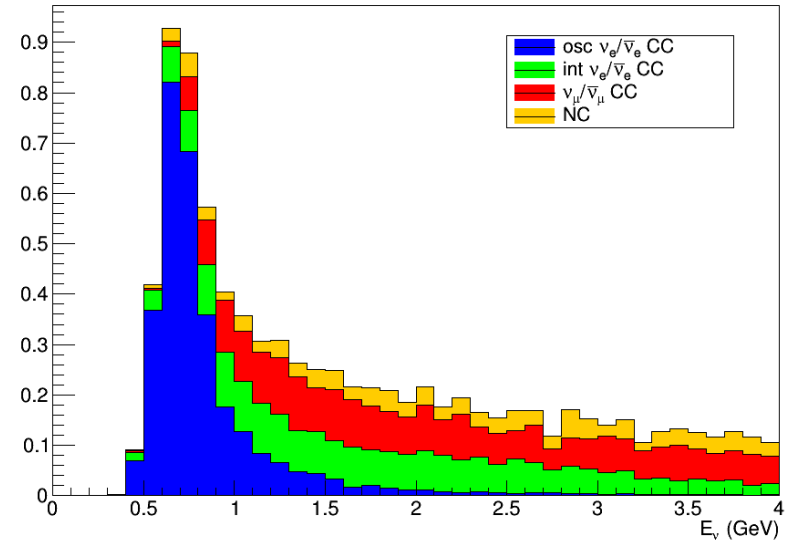
2Re π 1de: 2 rings



2Re π 1de: e π -like

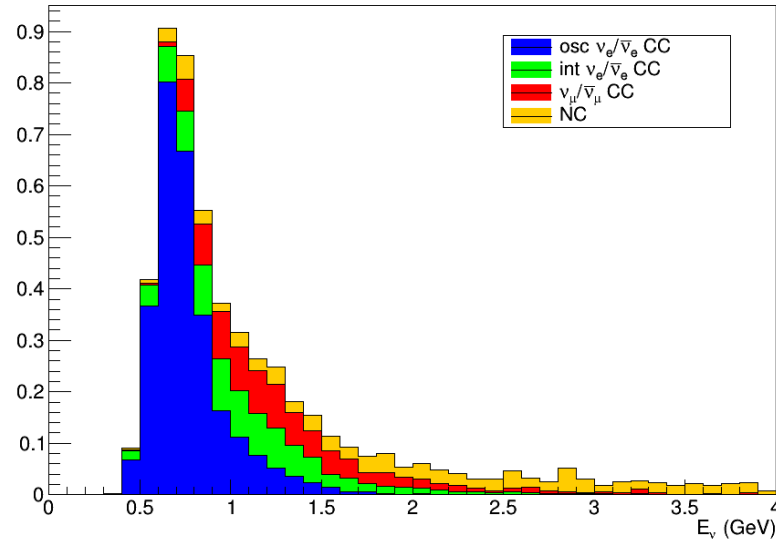


2Re π 1de: 1 decay e

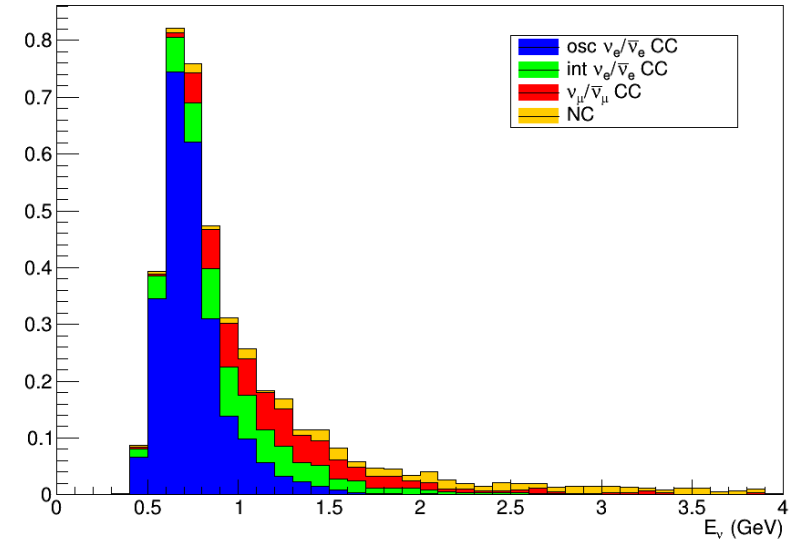


2Re π 1de grid search

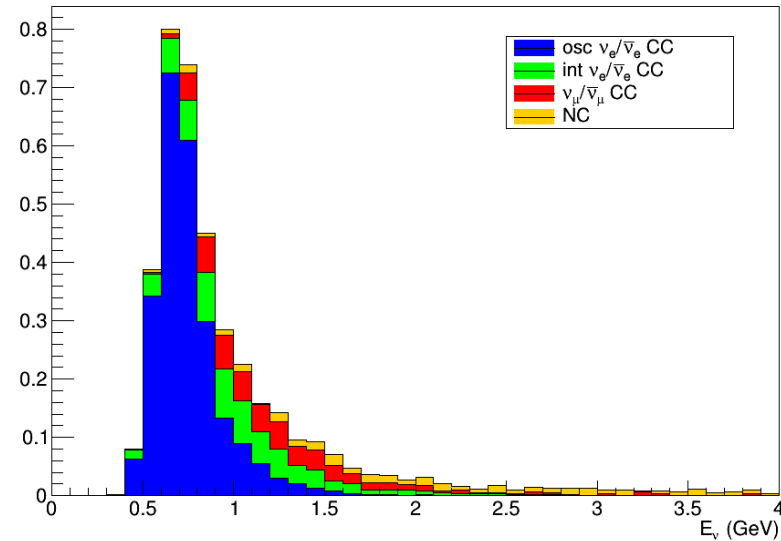
2Re π 1de: $E_{\text{rec}} < 1.5 \text{ GeV}$



2Re π 1de: $-300 < p_e - p_\pi < 350$

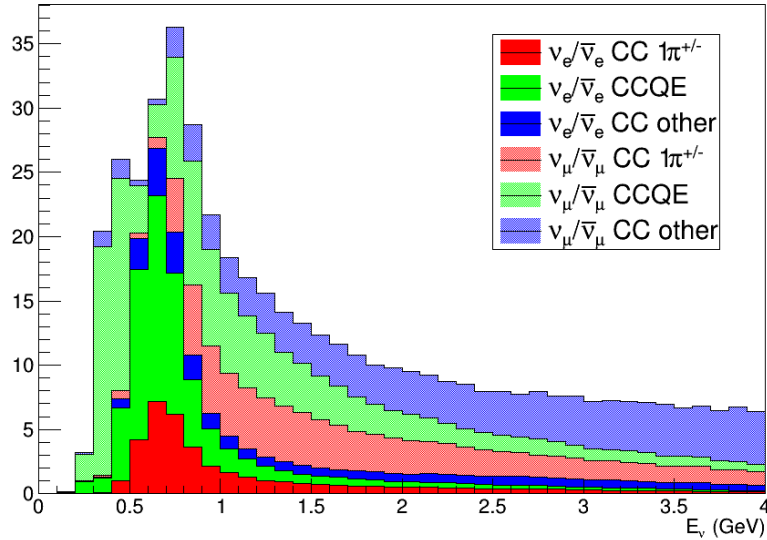


2Re π 1de: $d2se < 160$

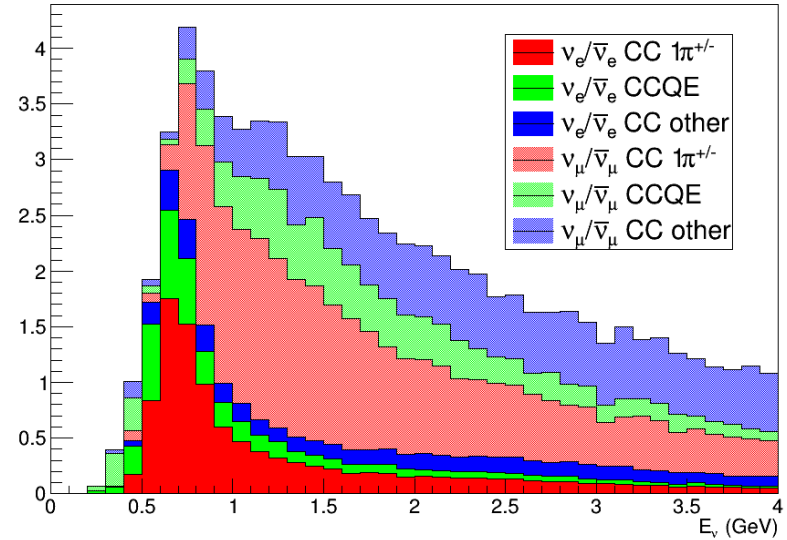


2Re π 1de baseline: CC

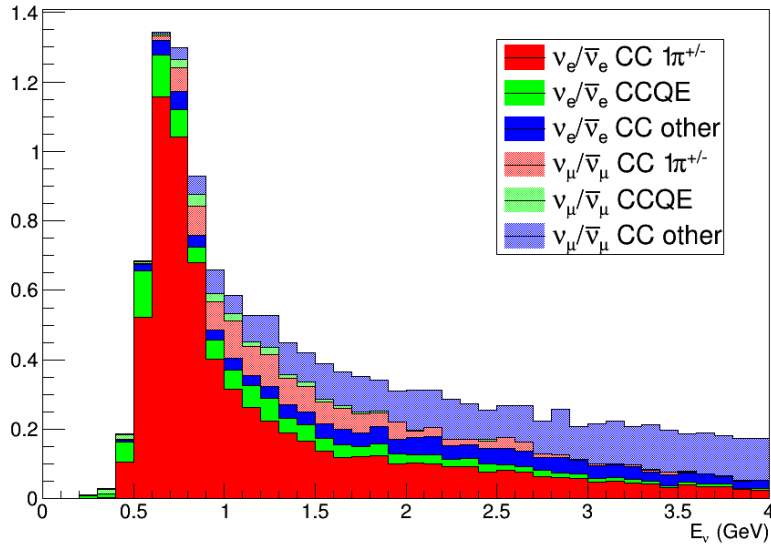
2Re π 1de CC: FCFV



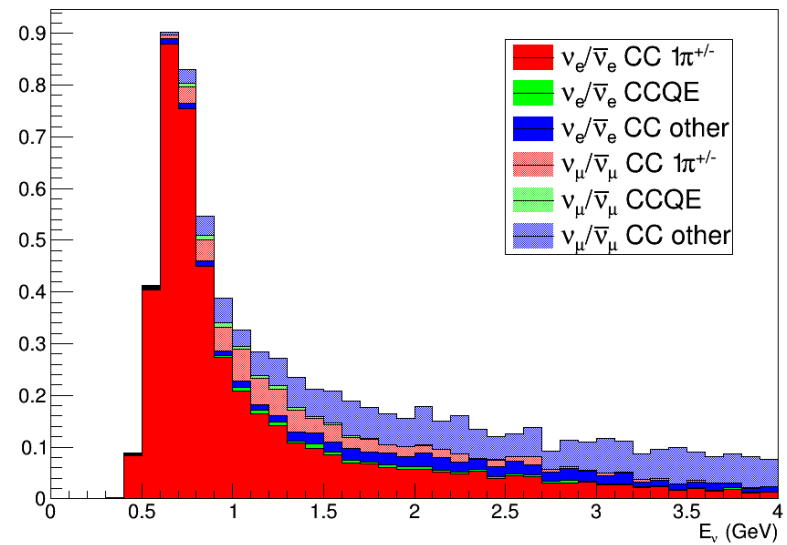
2Re π 1de CC: 2 rings



2Re π 1de CC: e π -like

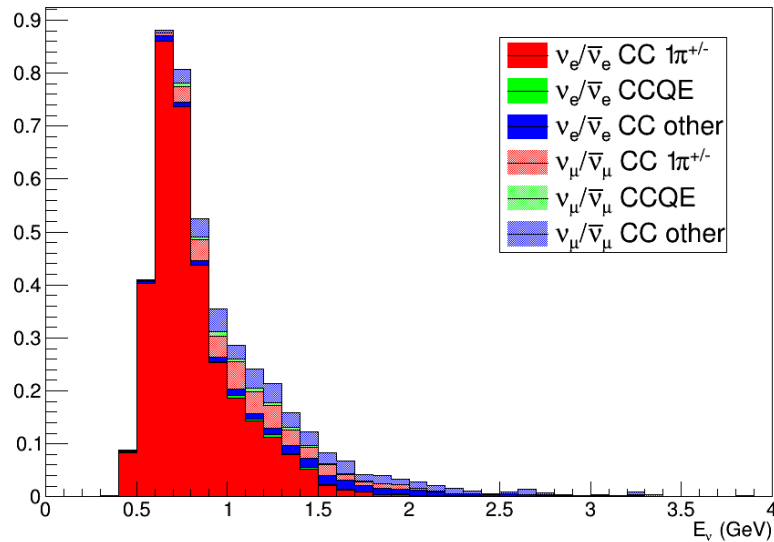


2Re π 1de CC: 1 decay e

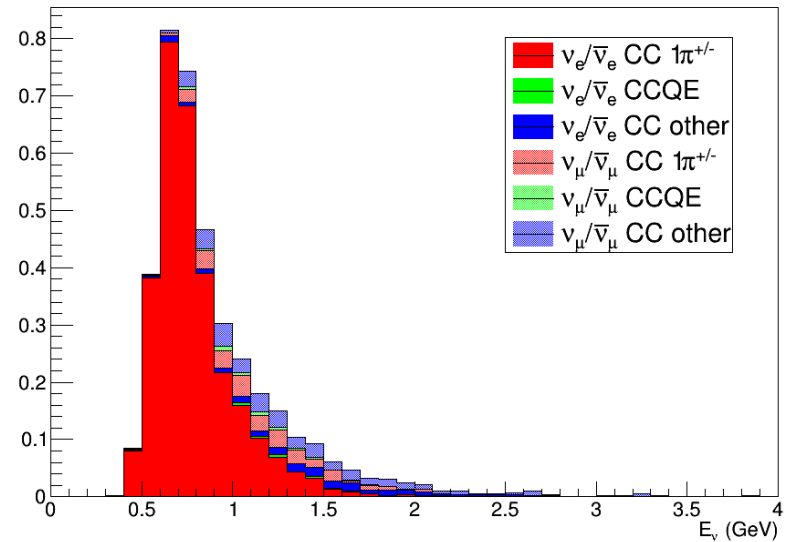


2Re π 1de grid search CC

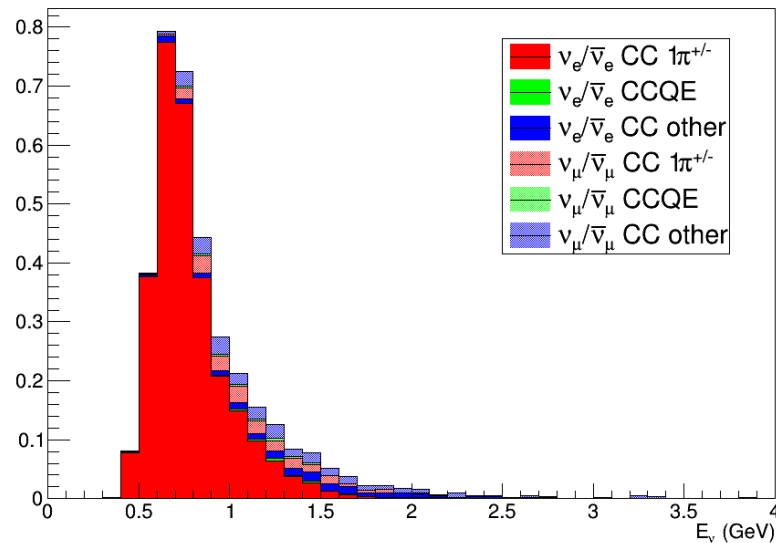
2Re π 1de CC: $E_{rec} < 1.5 \text{ GeV}$



2Re π 1de CC: $-300 < p_e - p_\pi < 350$

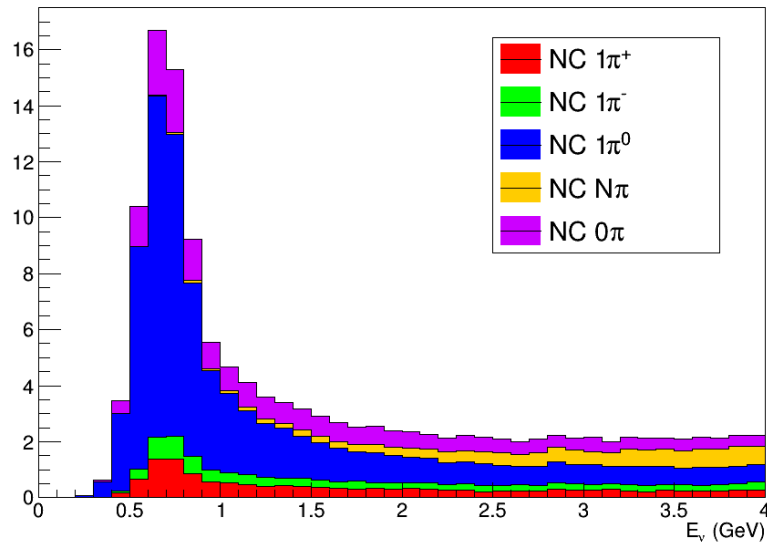


2Re π 1de CC: $d2se < 160$

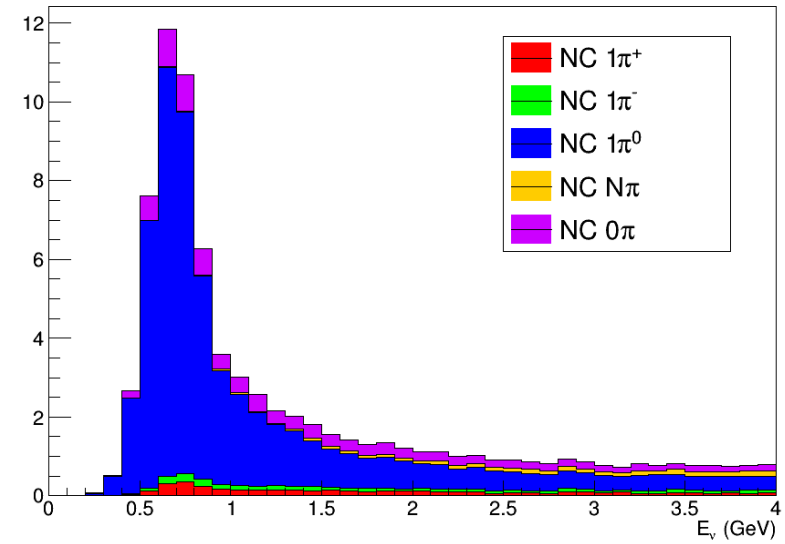


2Re π 1de baseline: NC

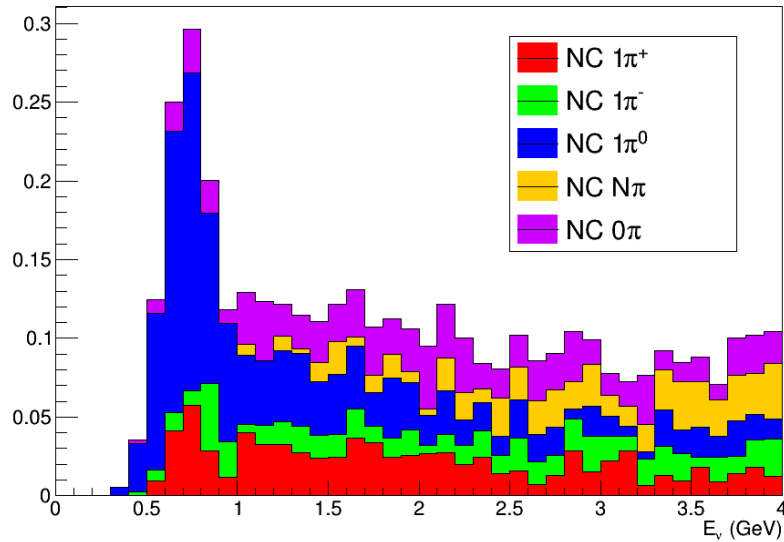
2Re π 1de NC: FCFV



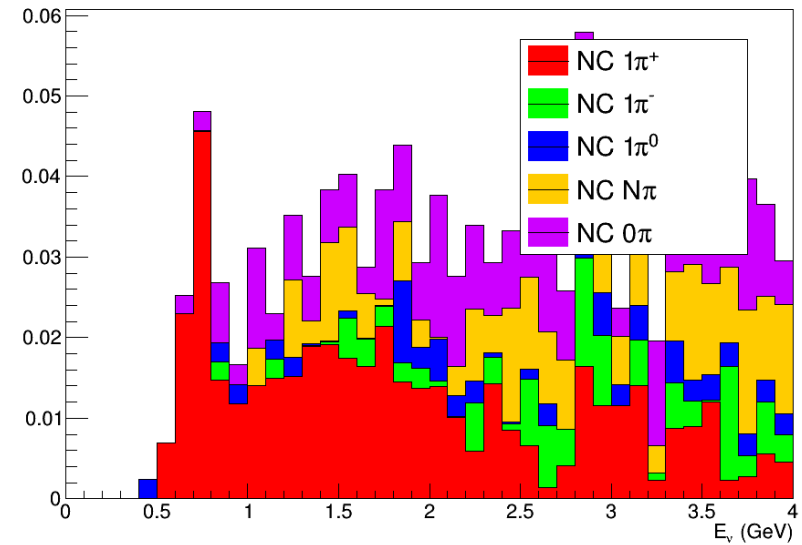
2Re π 1de NC: 2 rings



2Re π 1de NC: e π -like

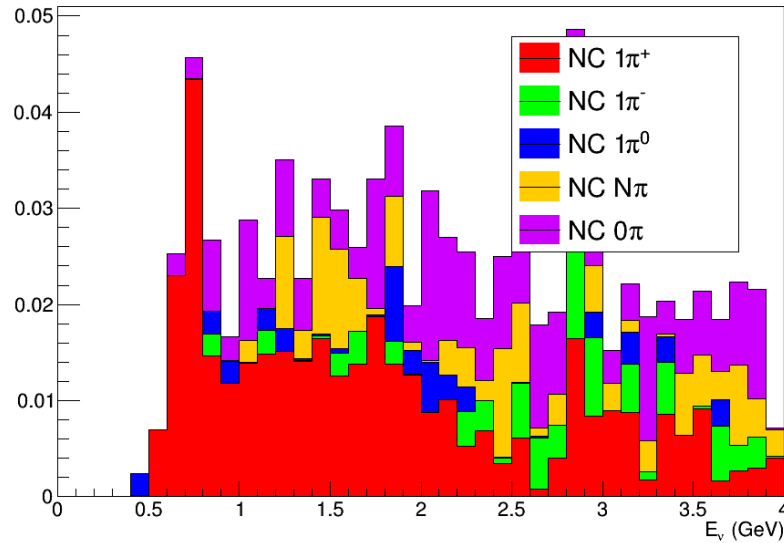


2Re π 1de NC: 1 decay e

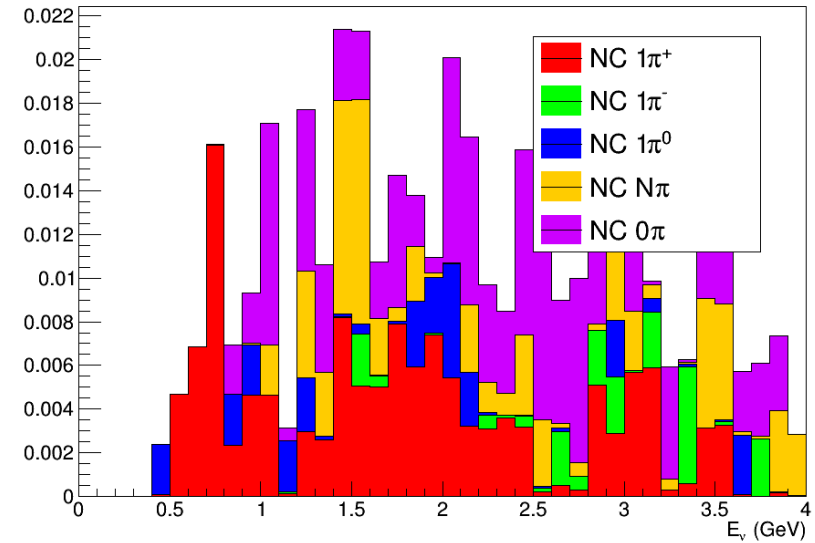


2Re π 1de grid search: NC

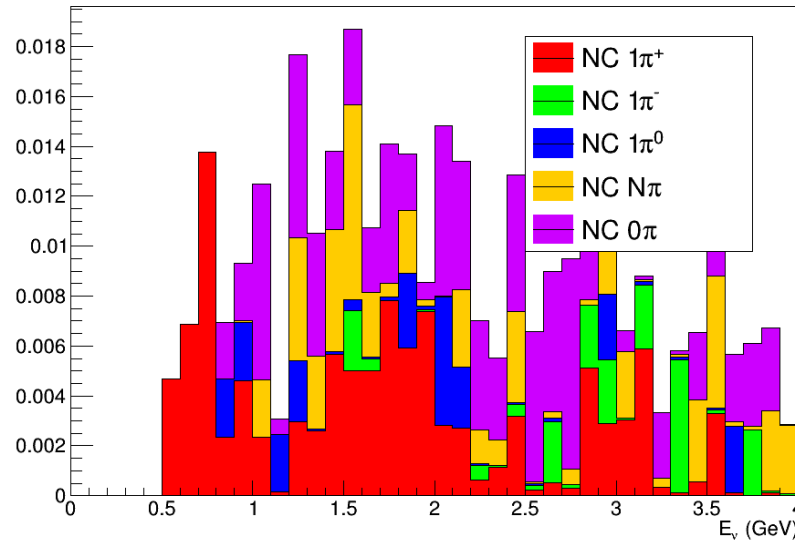
2Re π 1de NC: $E_{\text{rec}} < 1.5 \text{ GeV}$



2Re π 1de NC: $-300 < p_e - p_\pi < 350$

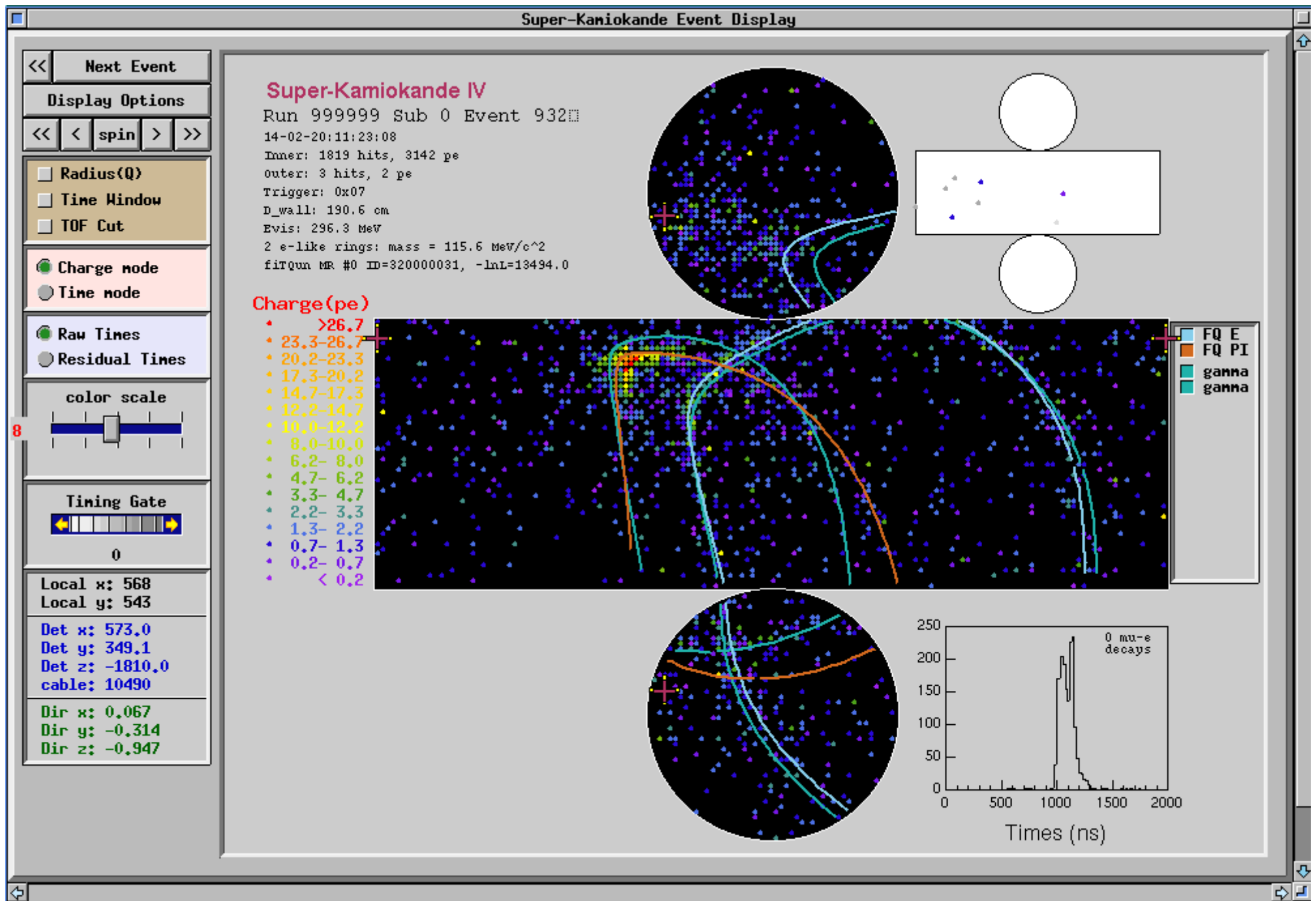


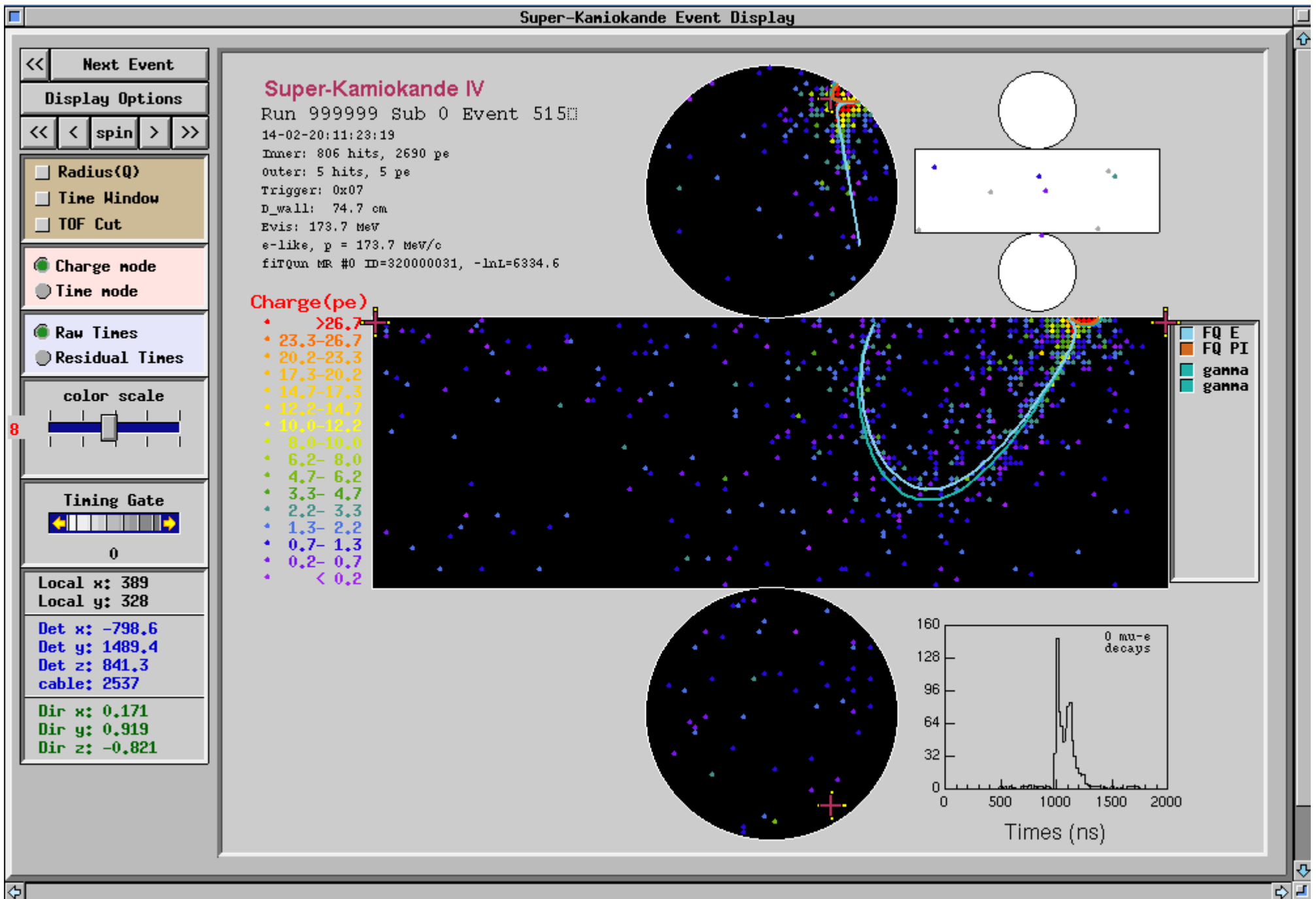
2Re π 1de NC: $d2se < 160$

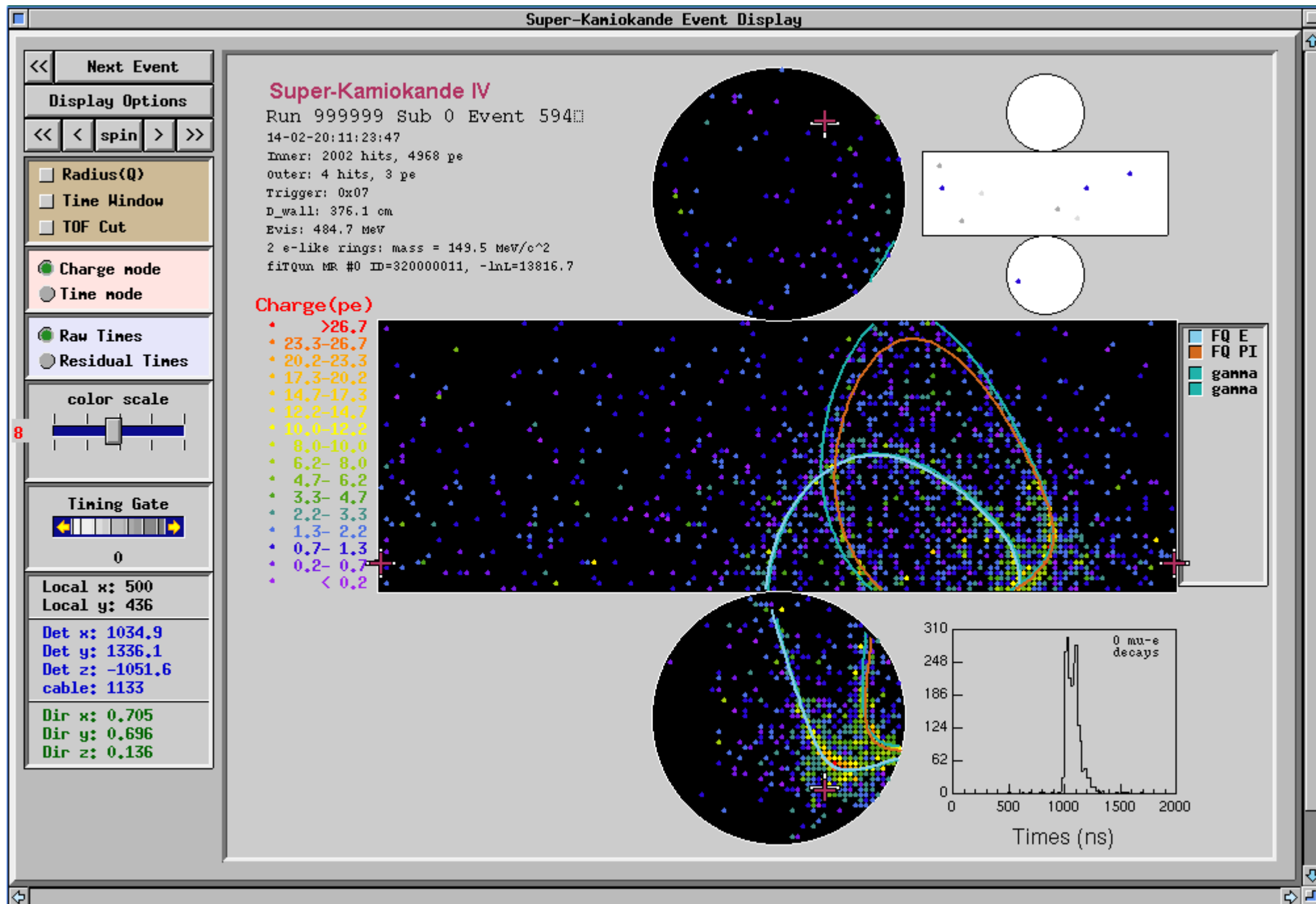


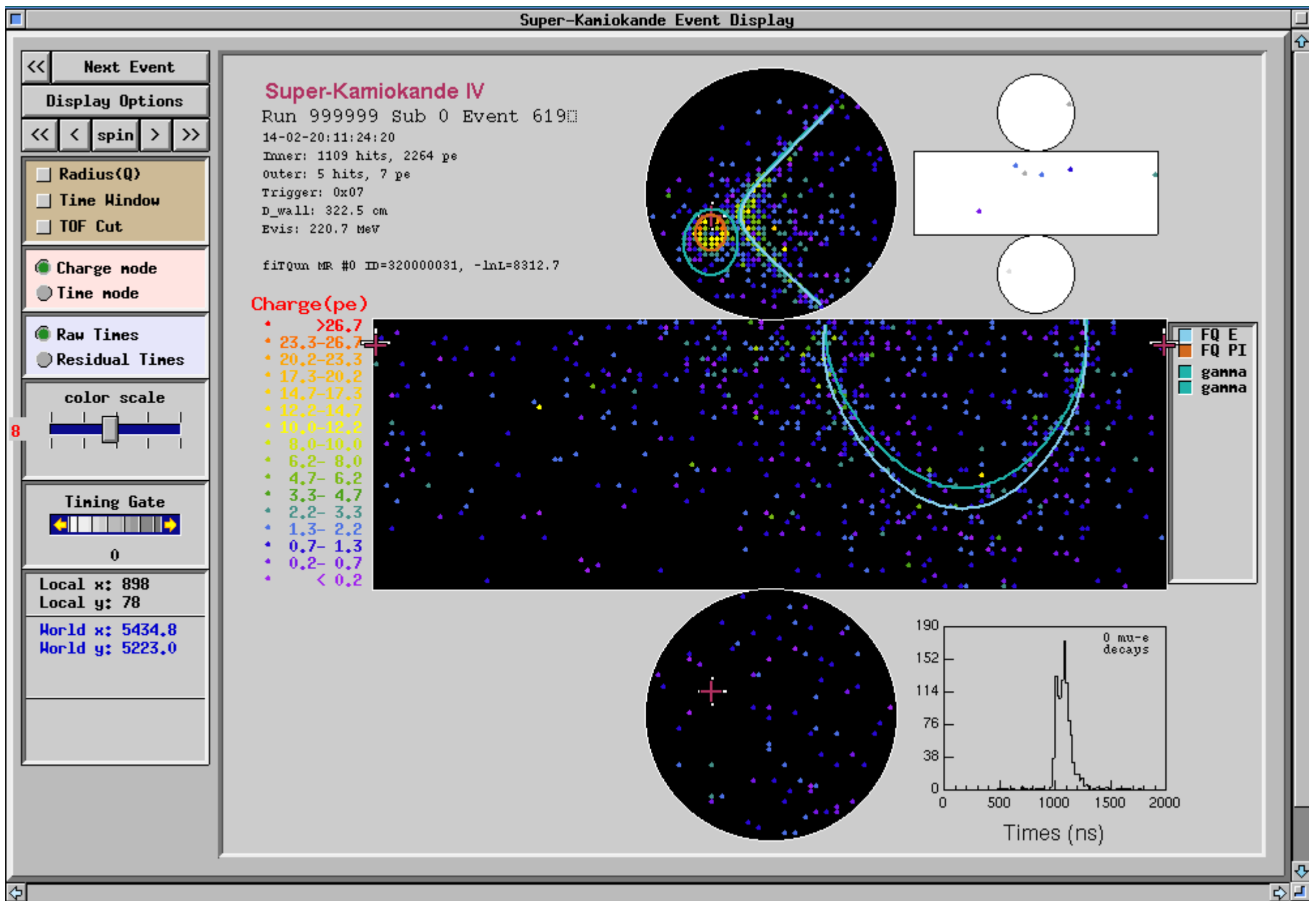
NC $1\pi^0$

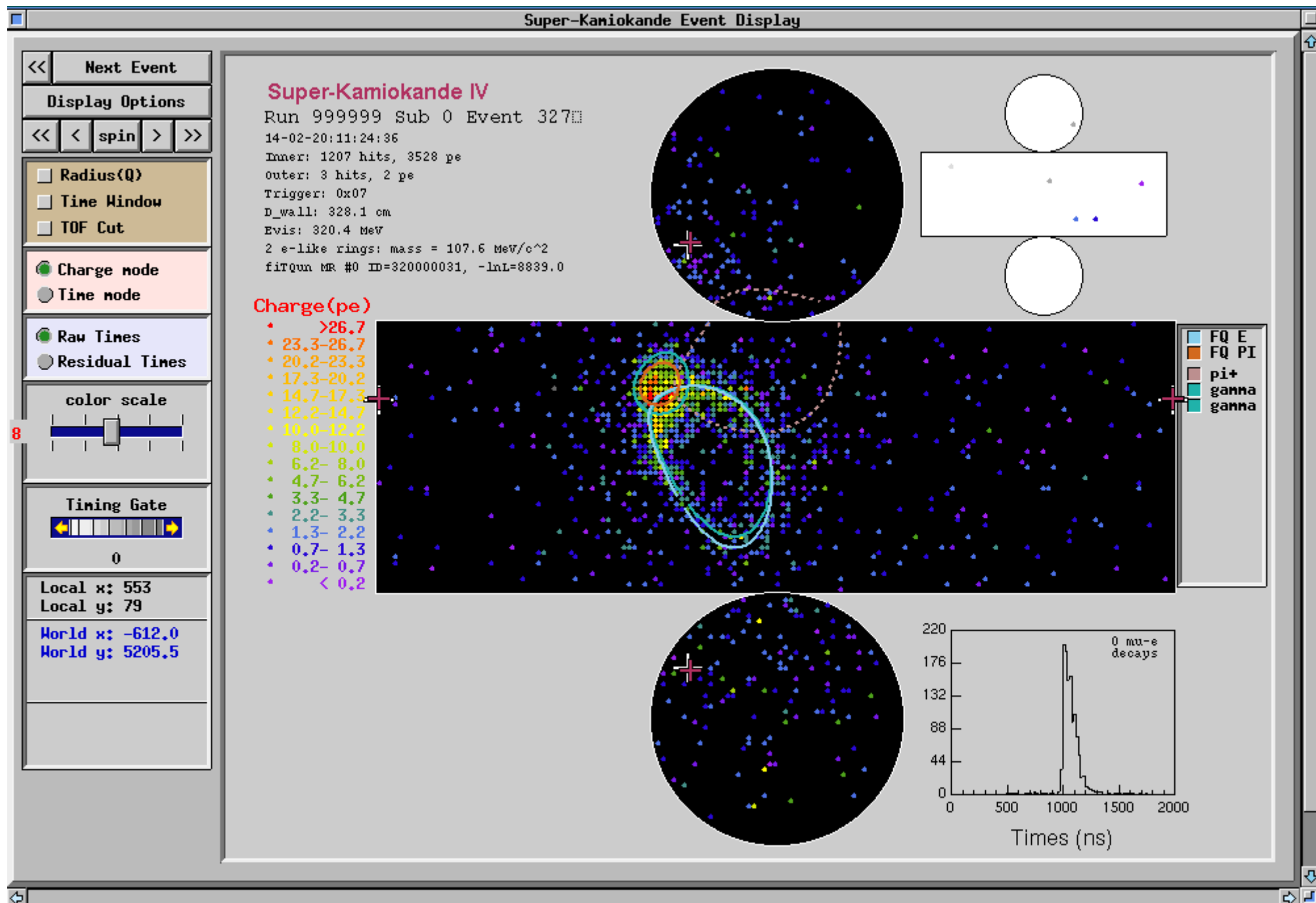
- Looked at NC events in superscan
 - All events have passed baseline $2\text{Re}\pi$ cut
- A bit of a tedious process
- Images of event display on following slides
 - fiTQun tracks and MC tracks shown

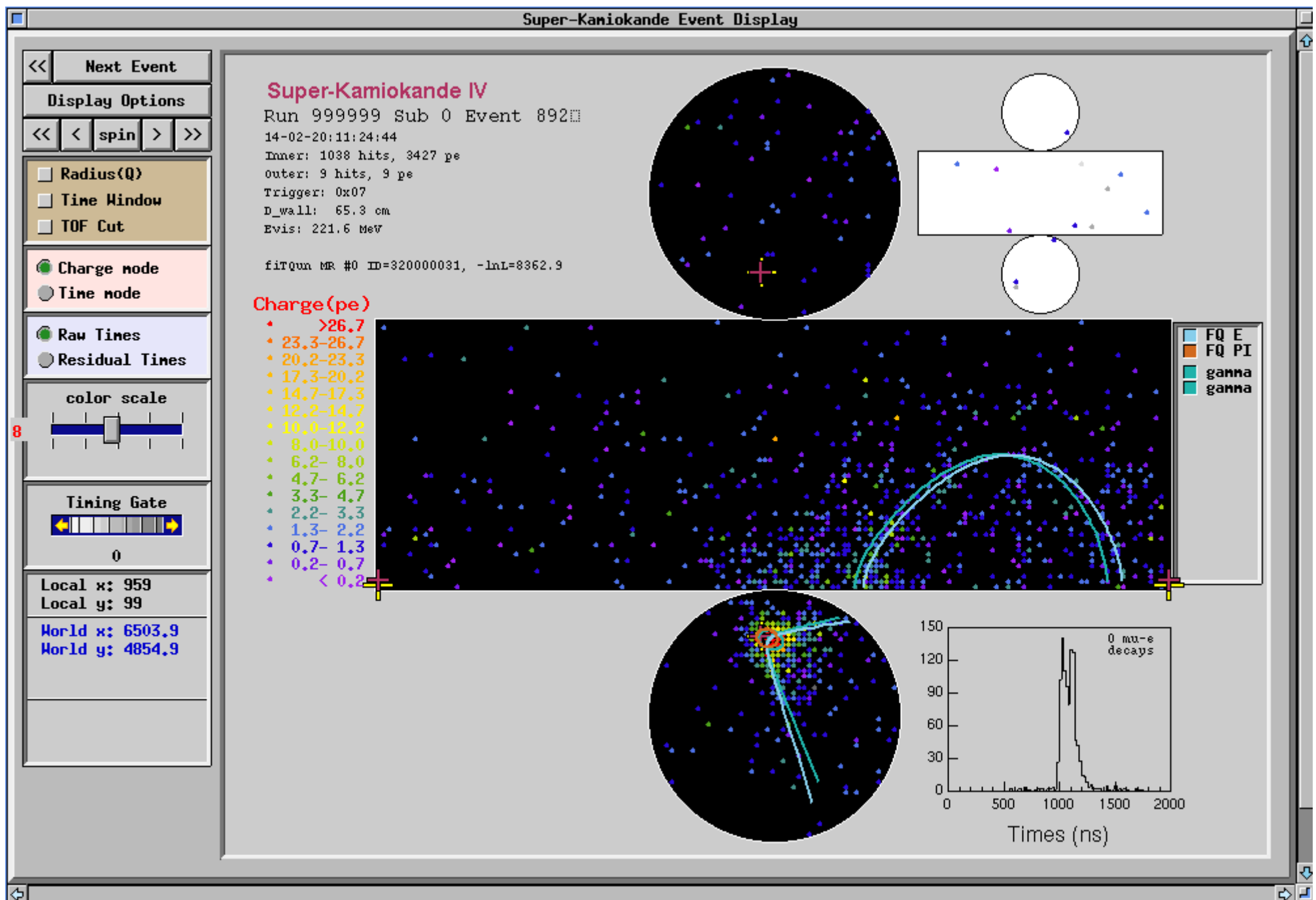


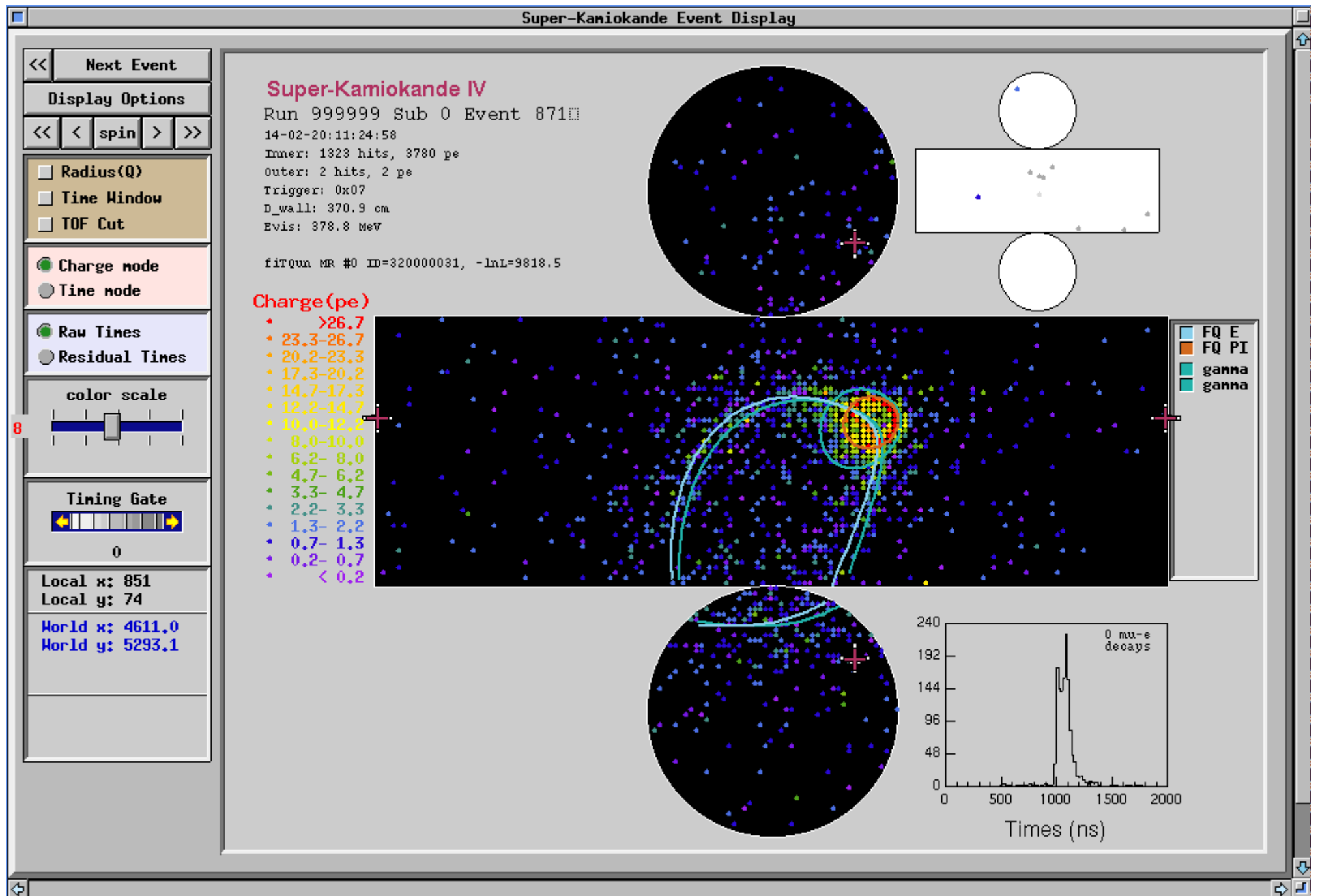


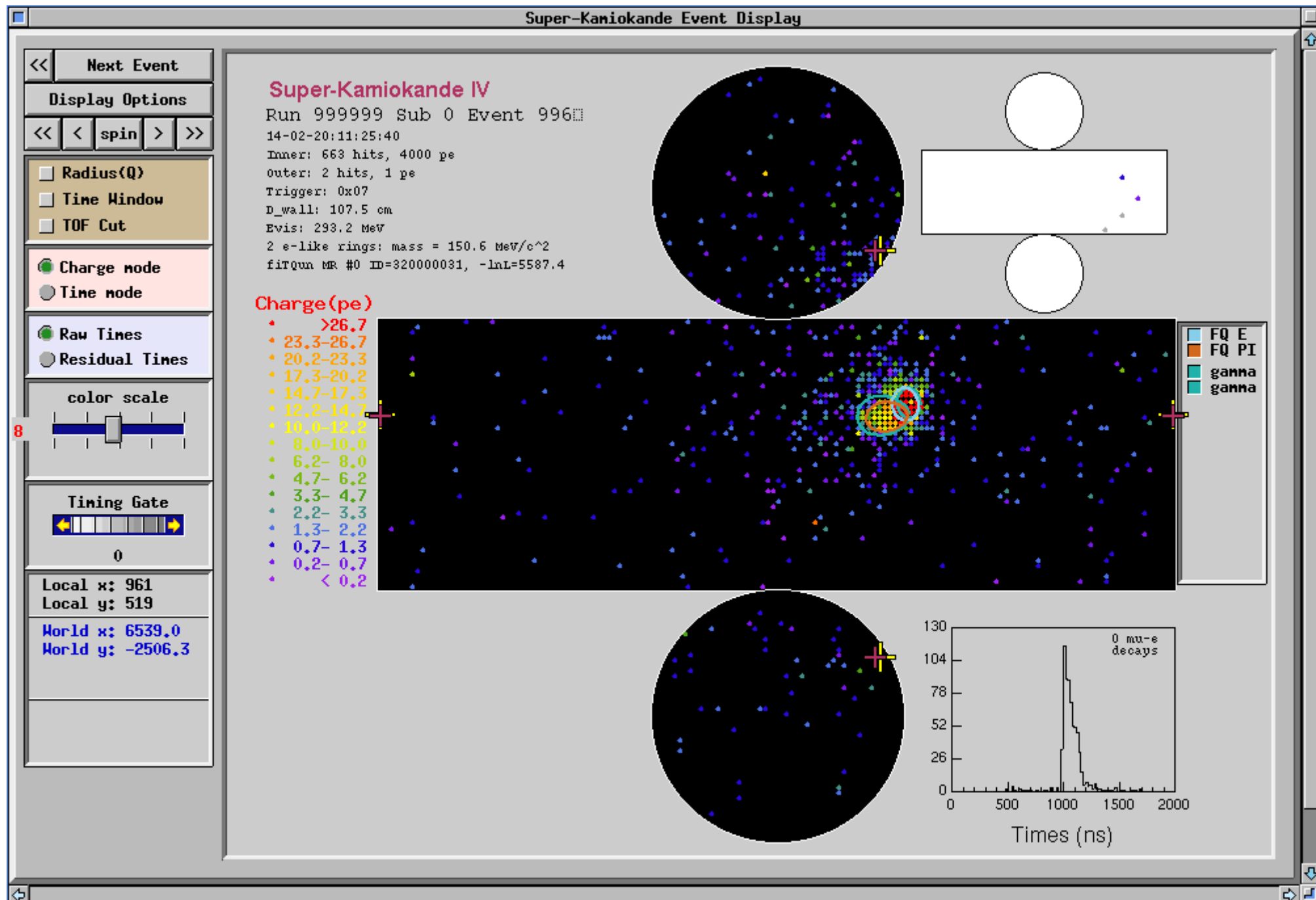


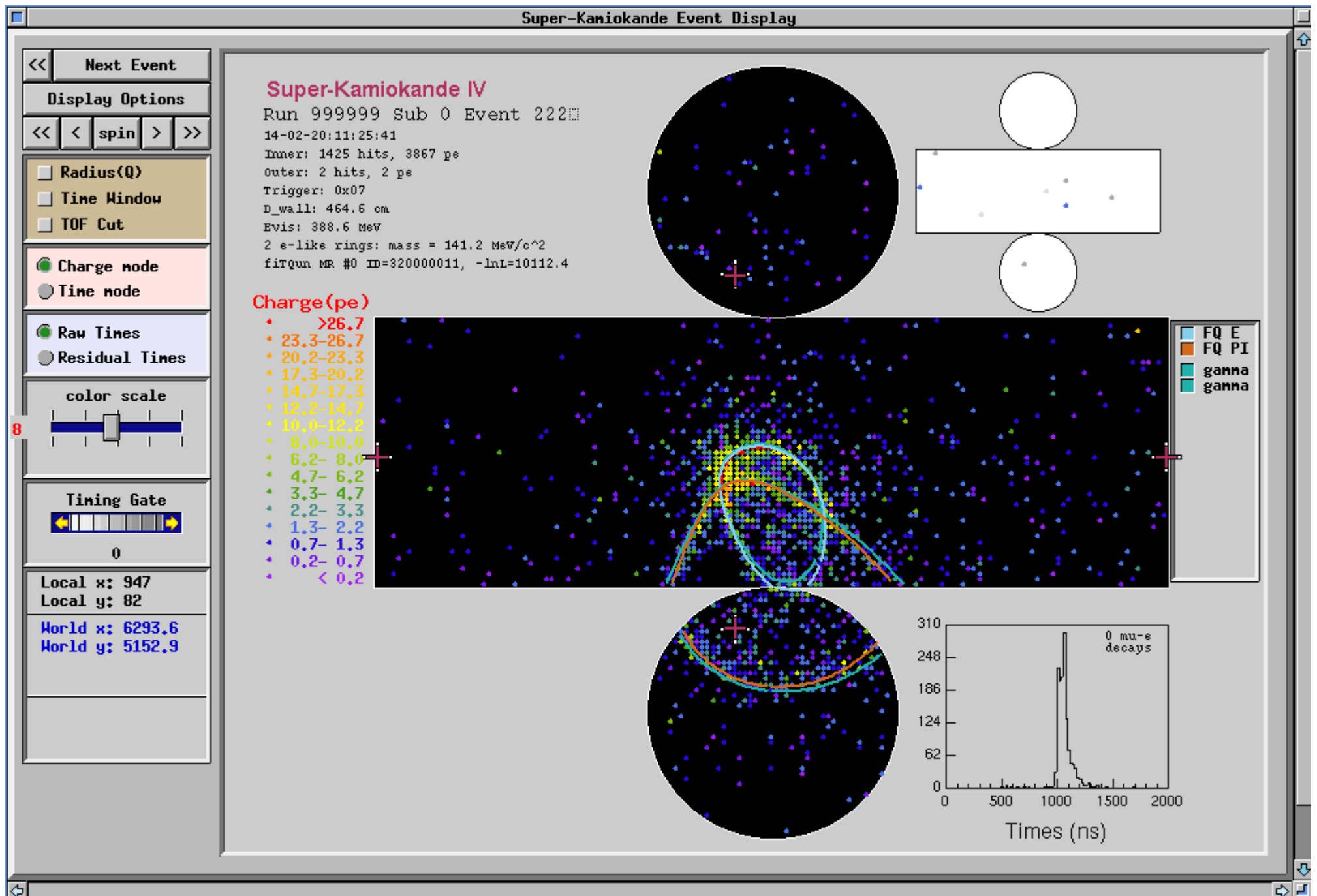


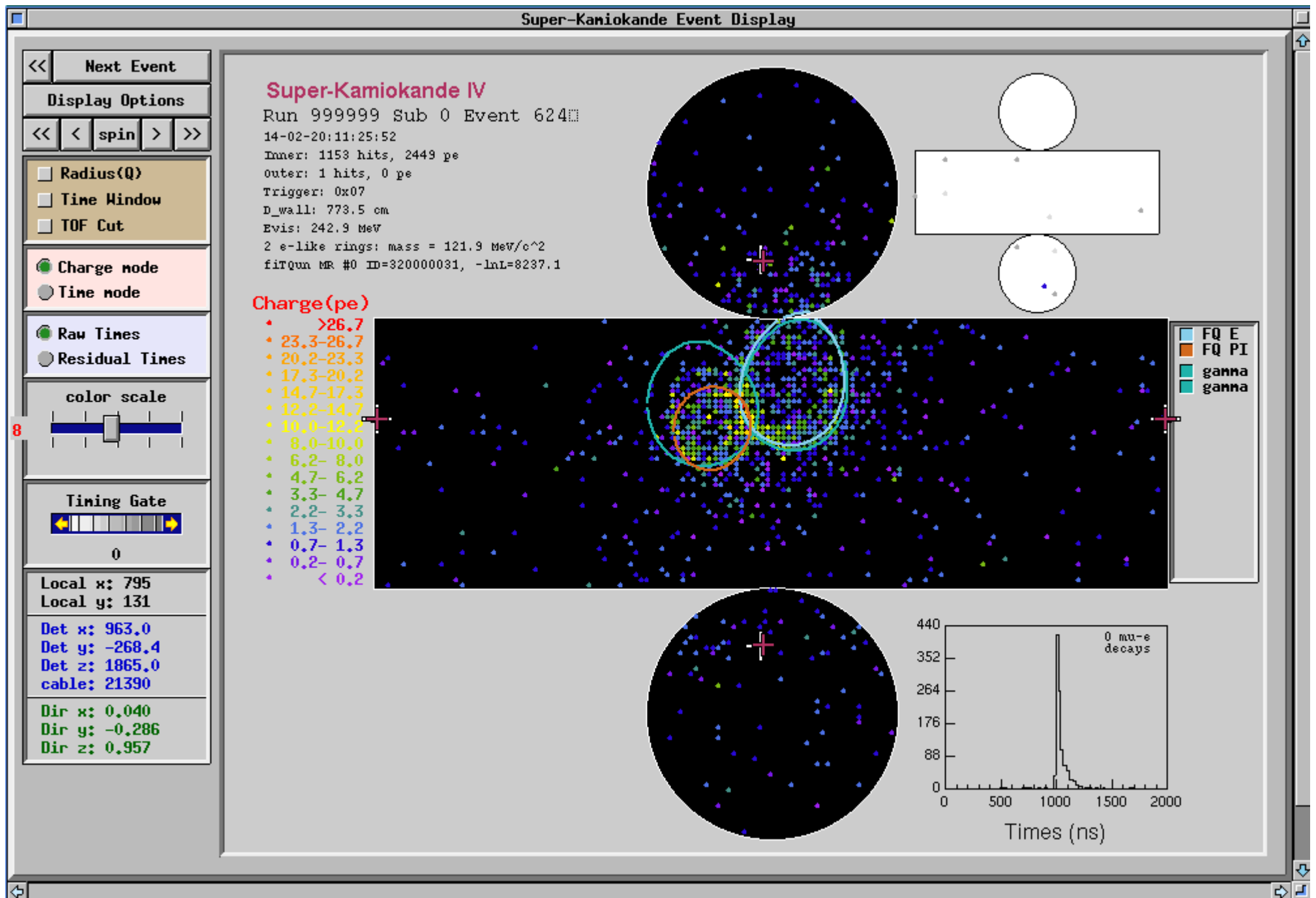


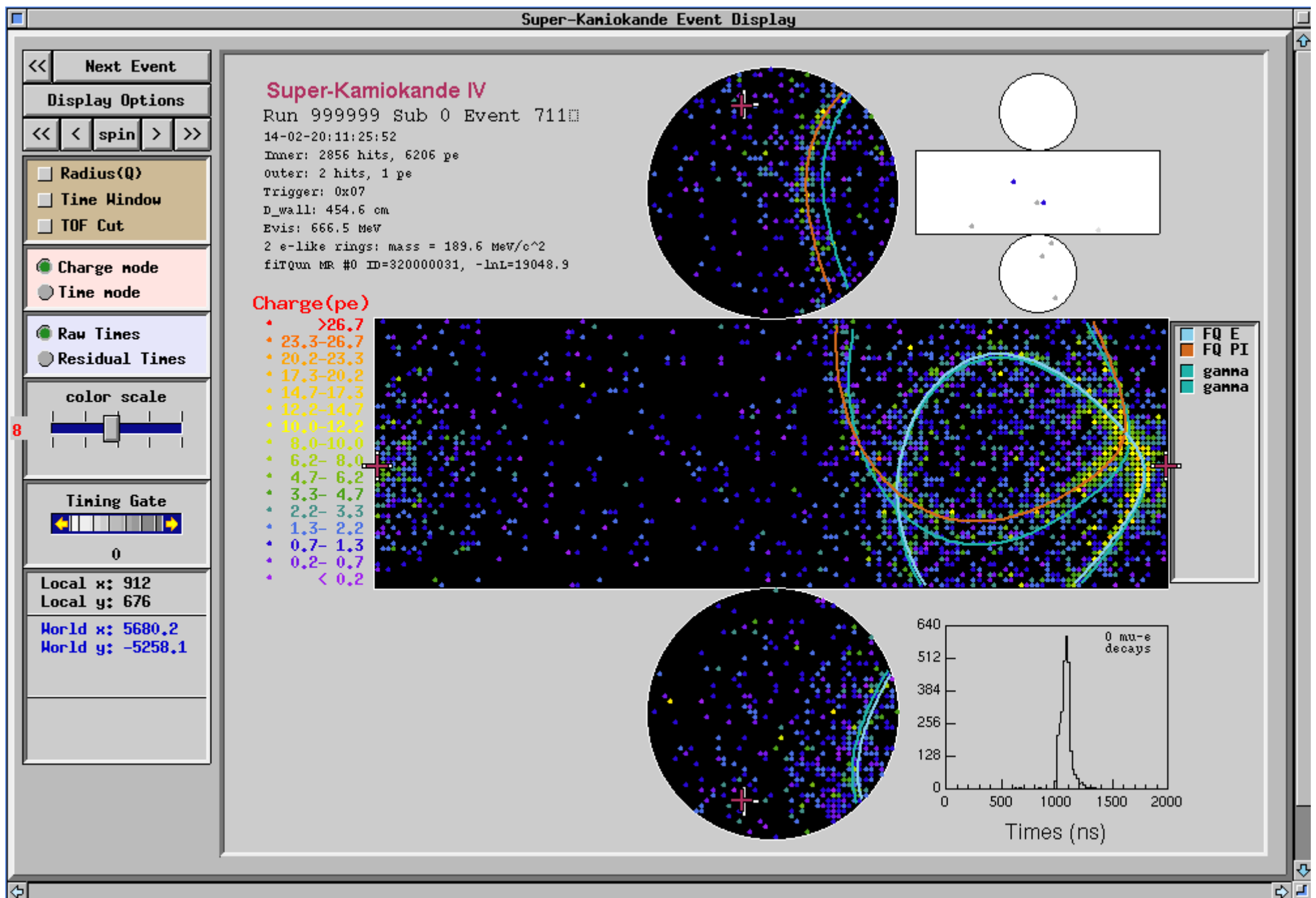


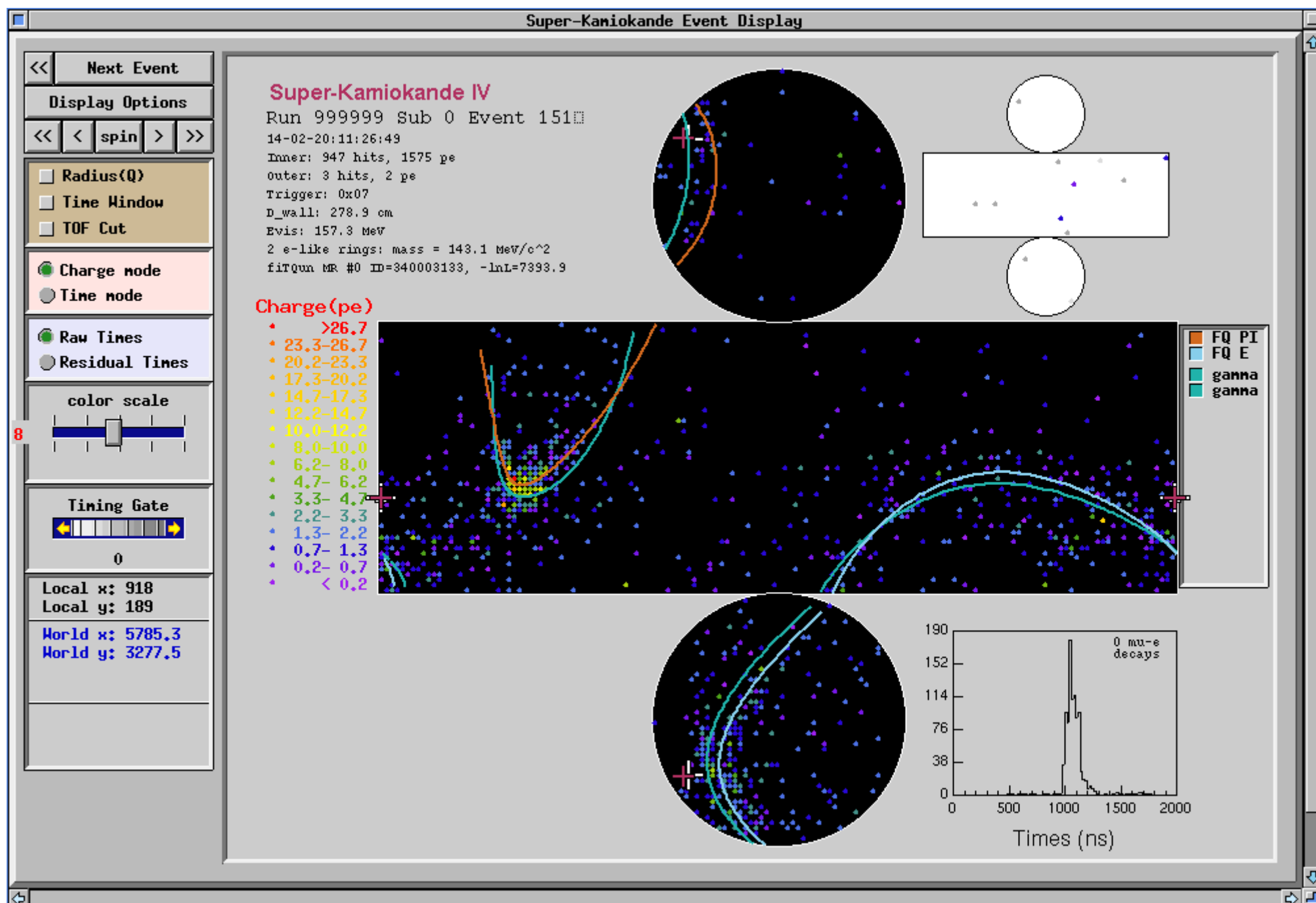


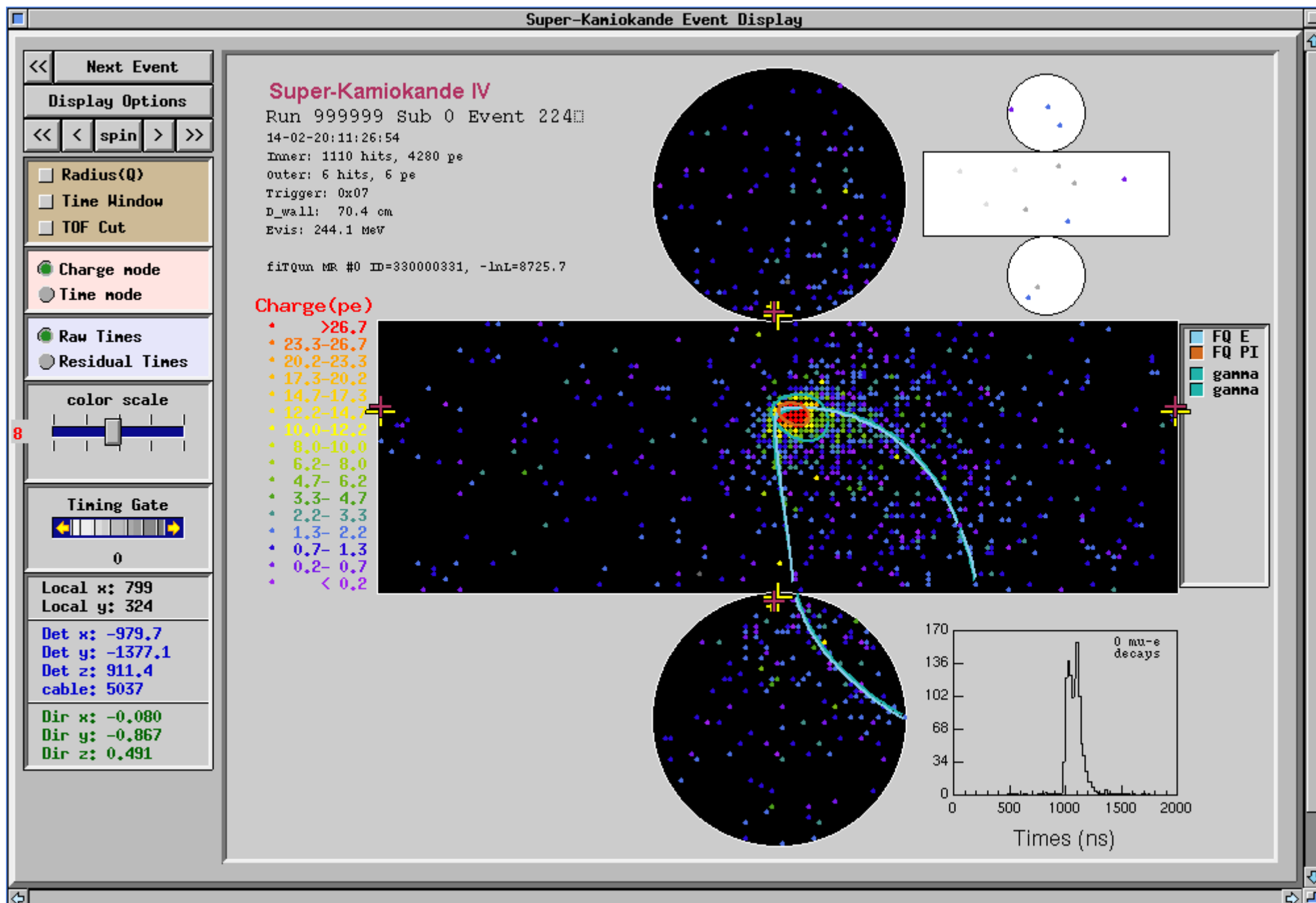


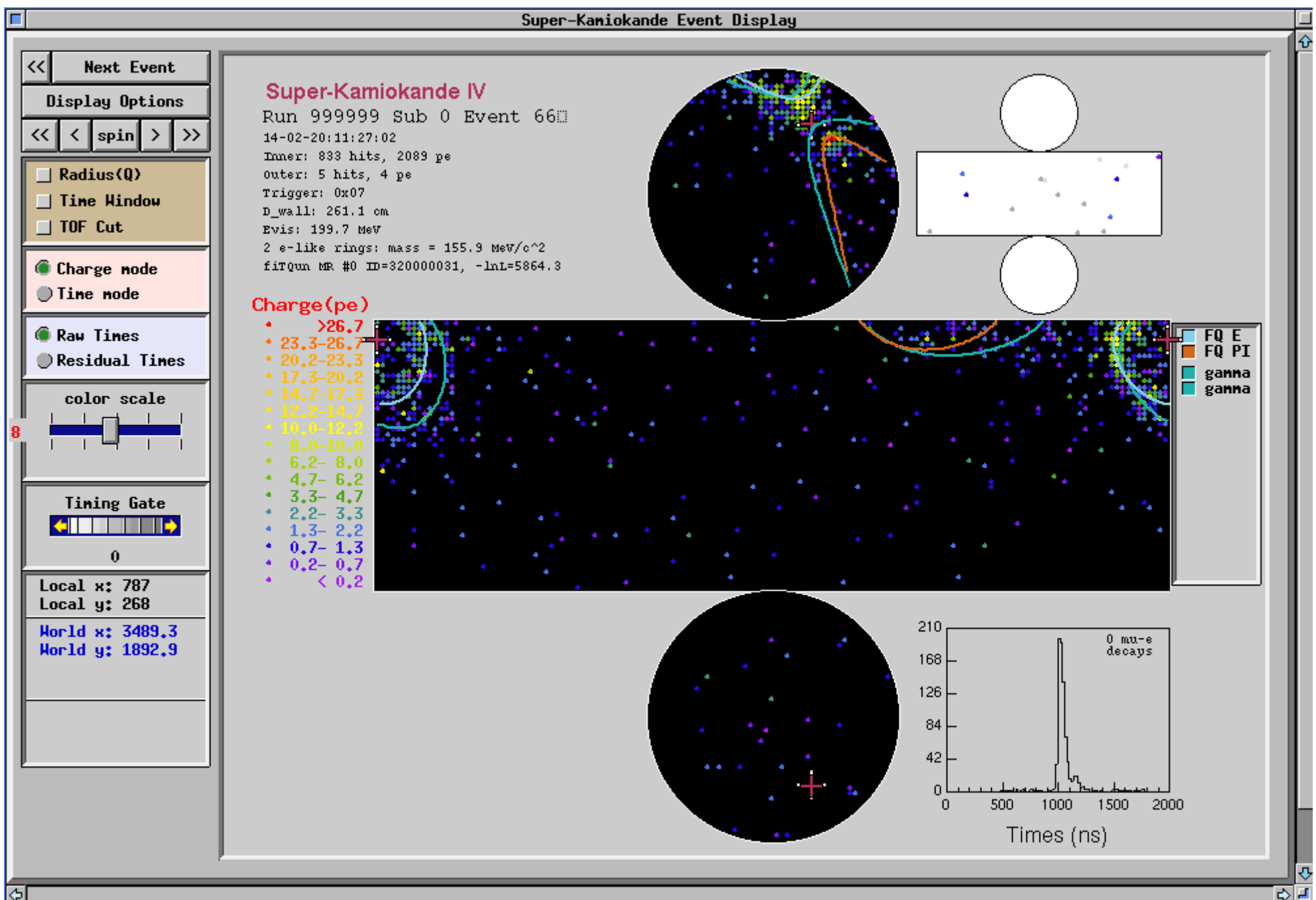


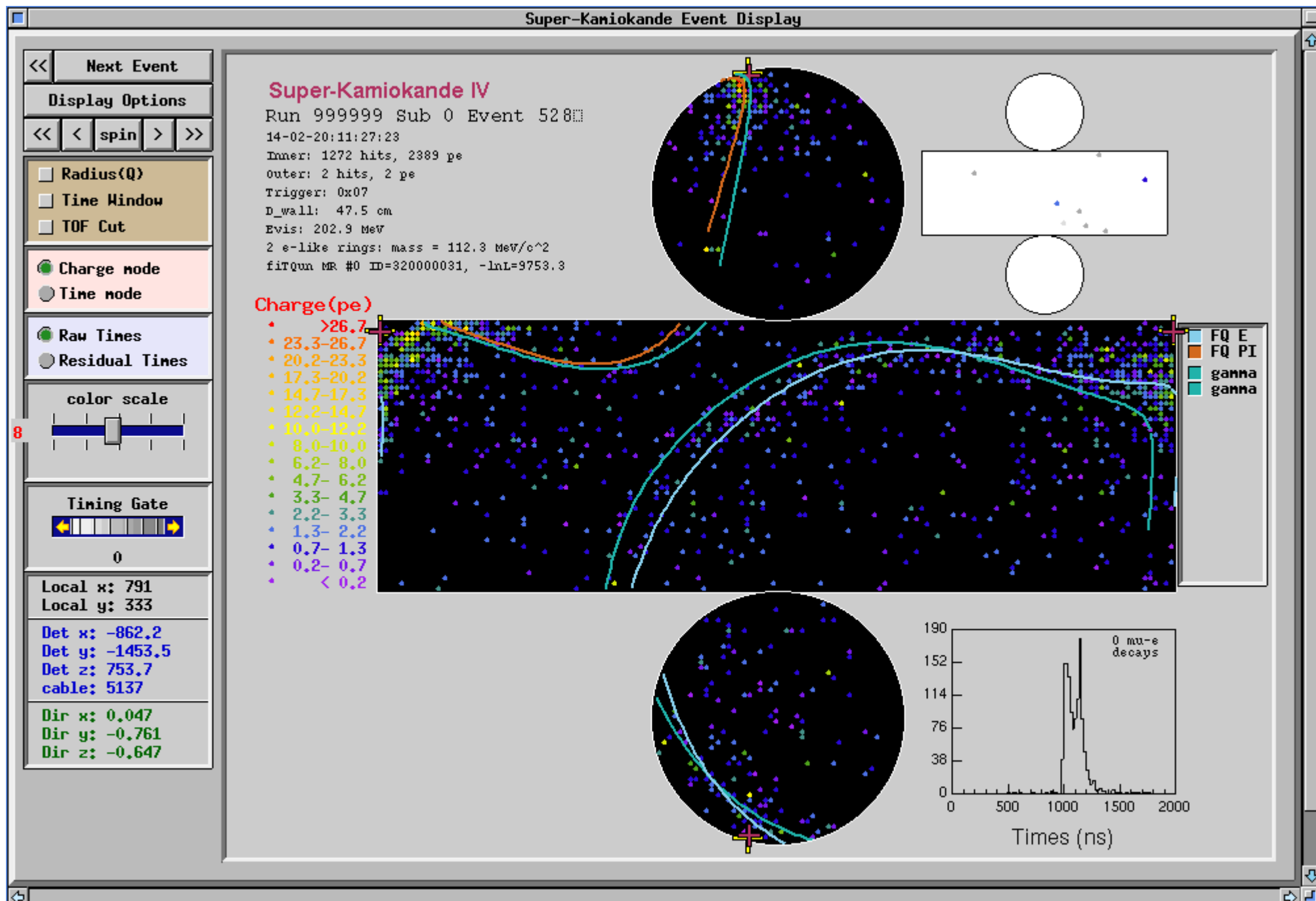


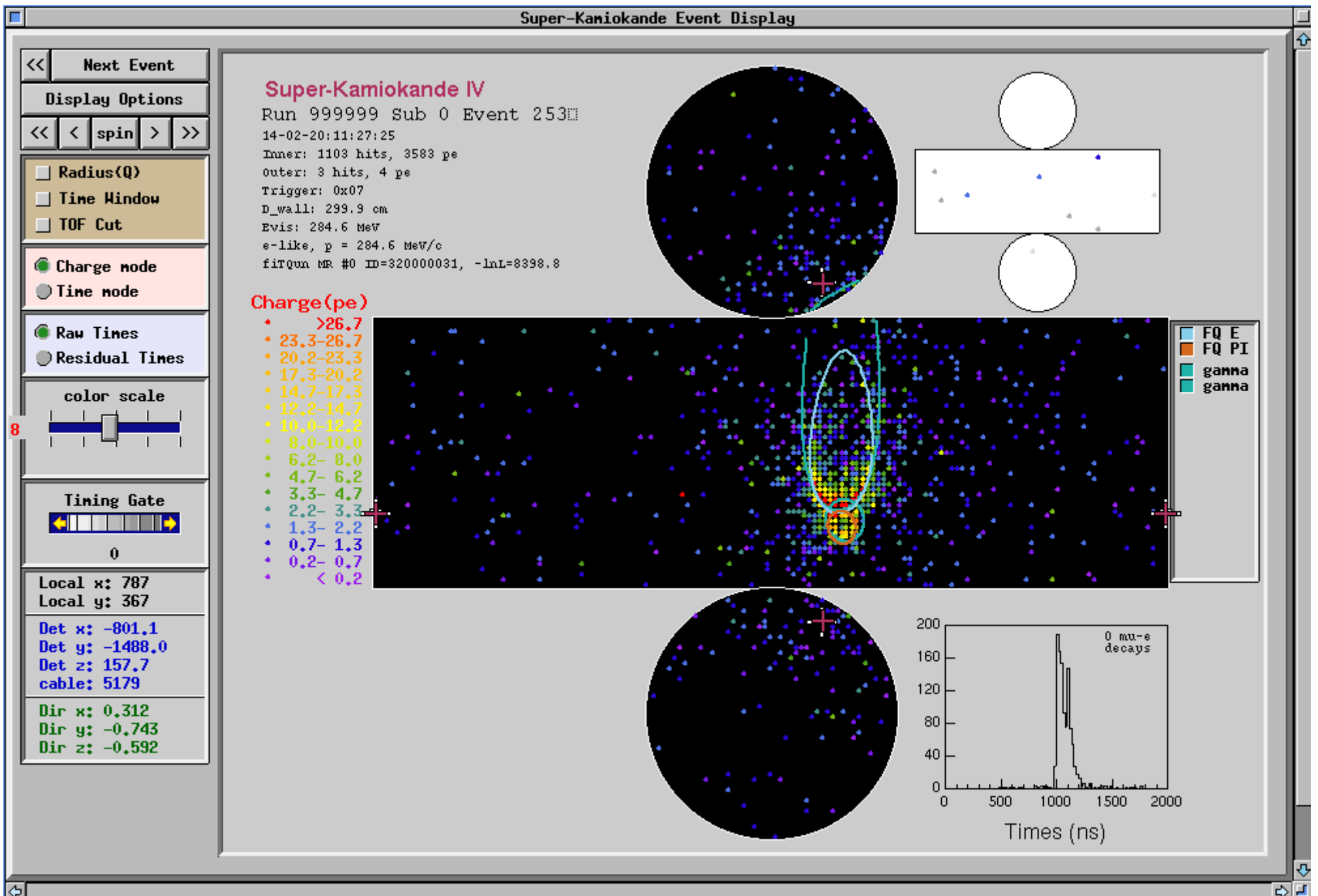


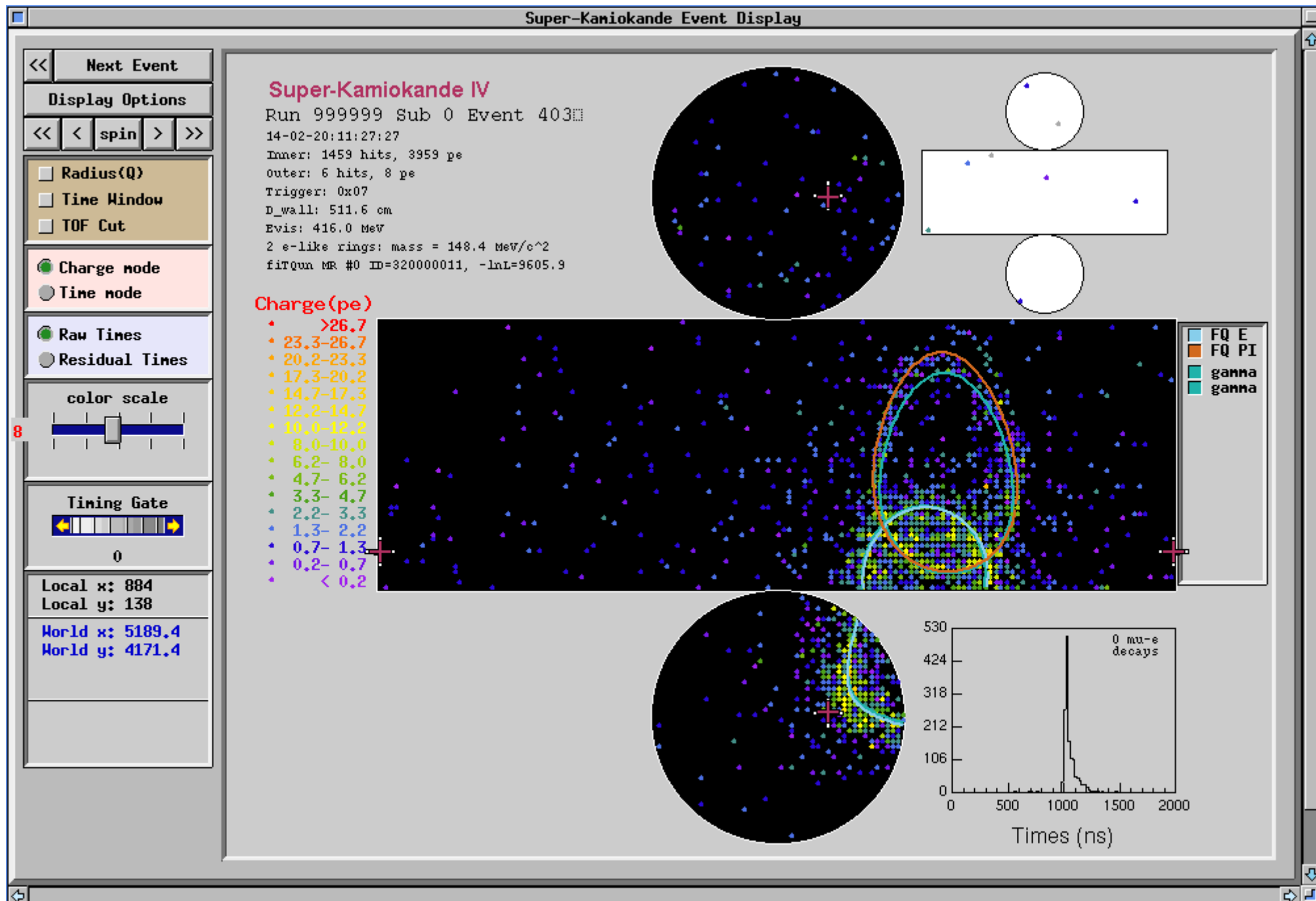


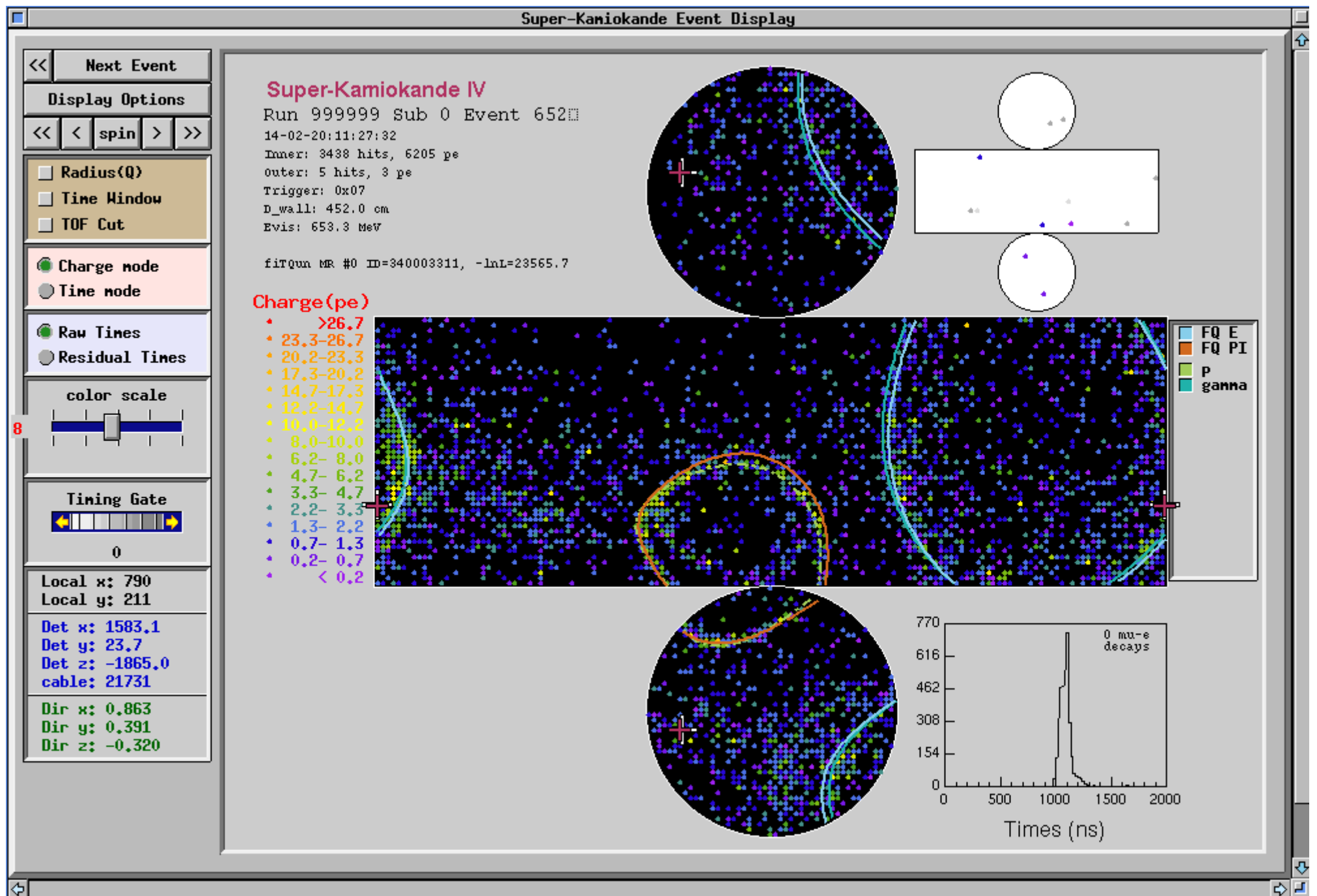


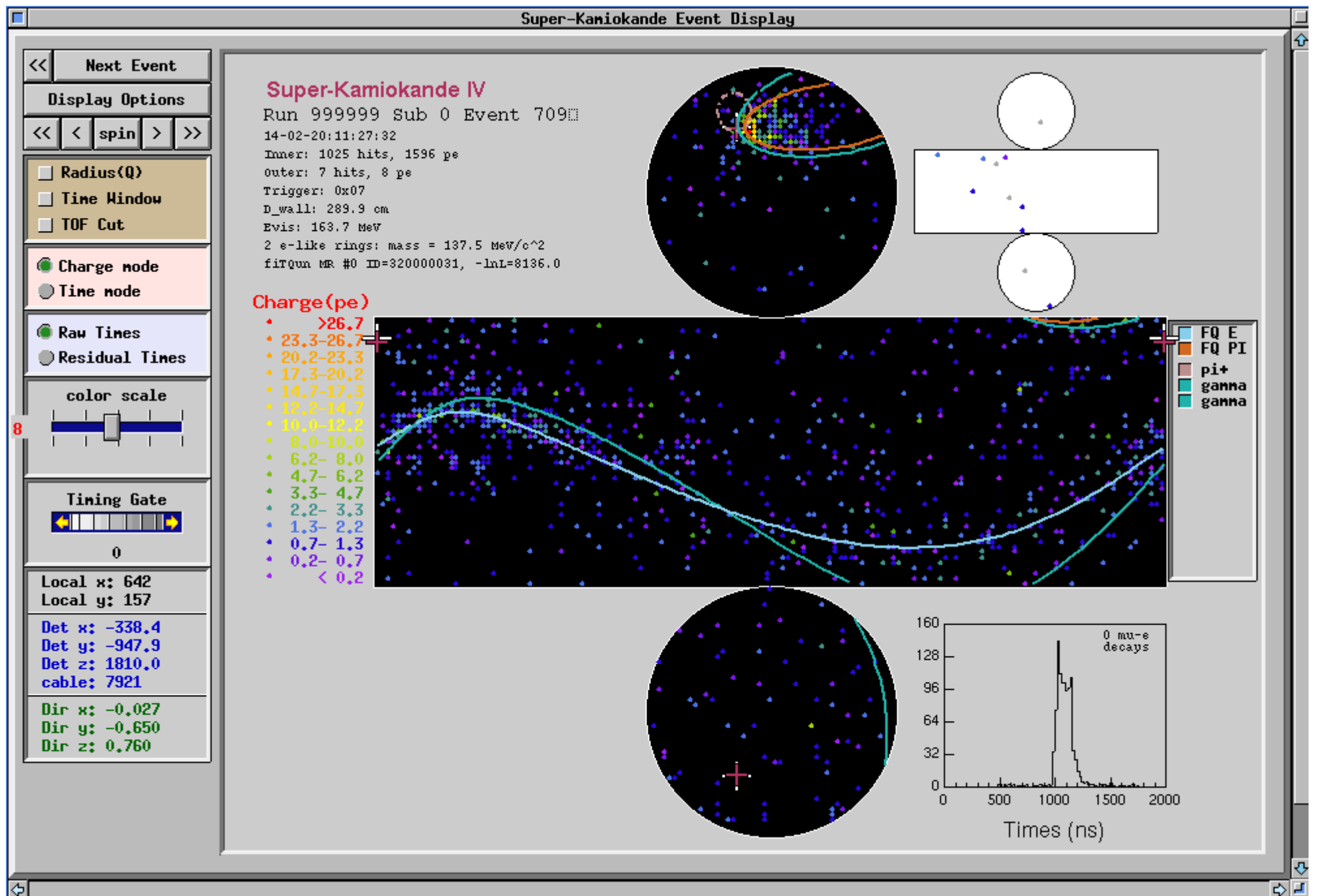


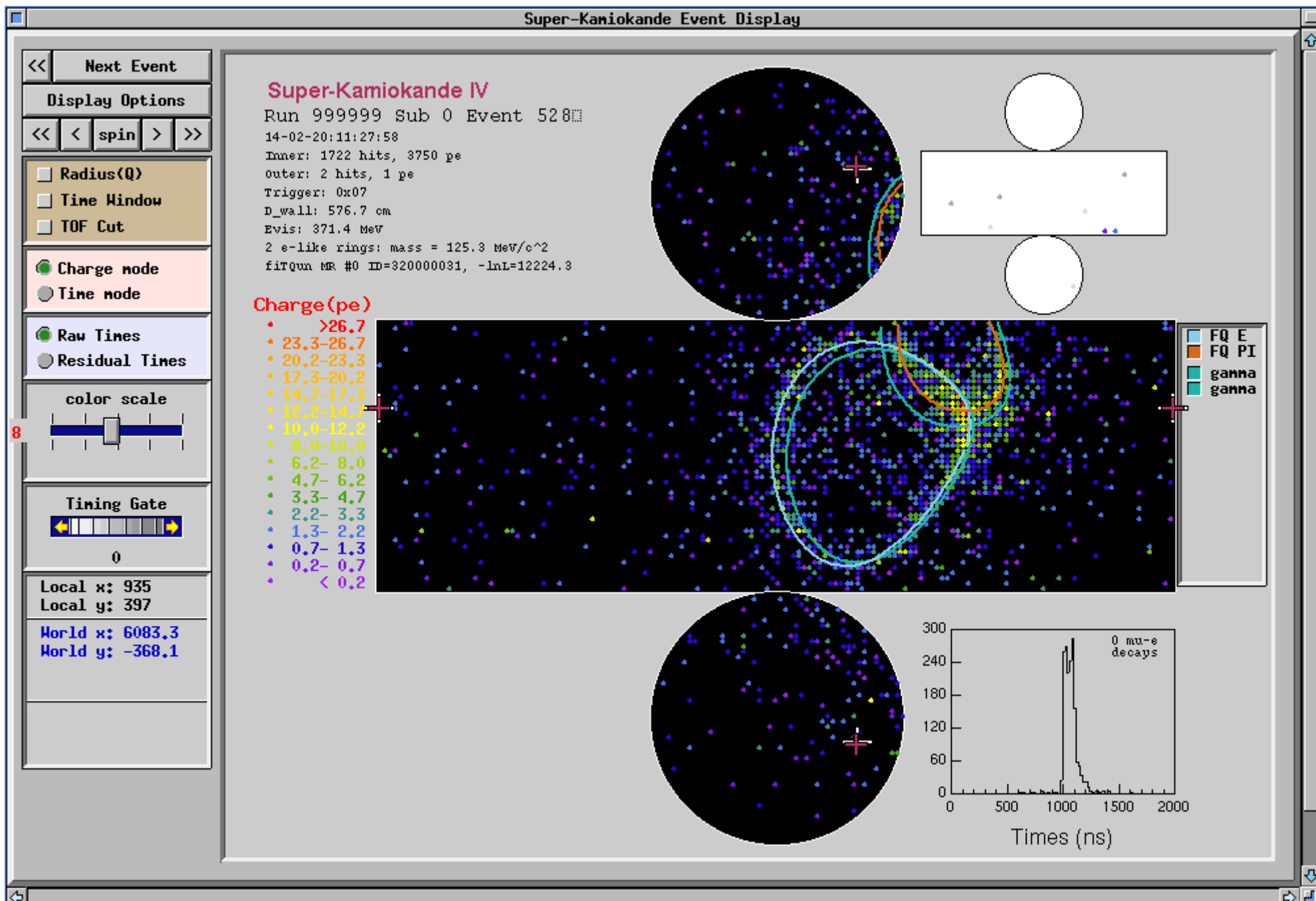


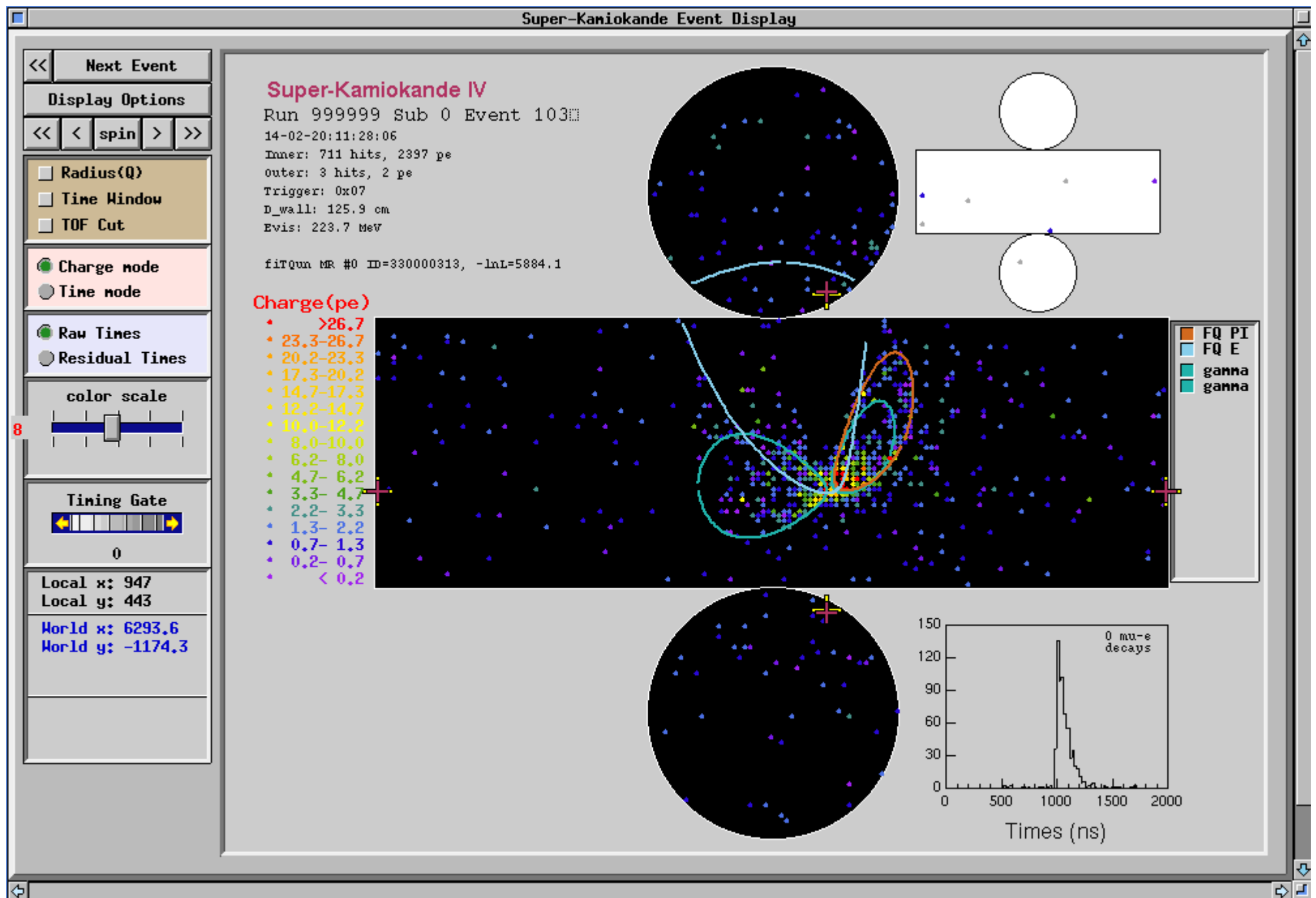


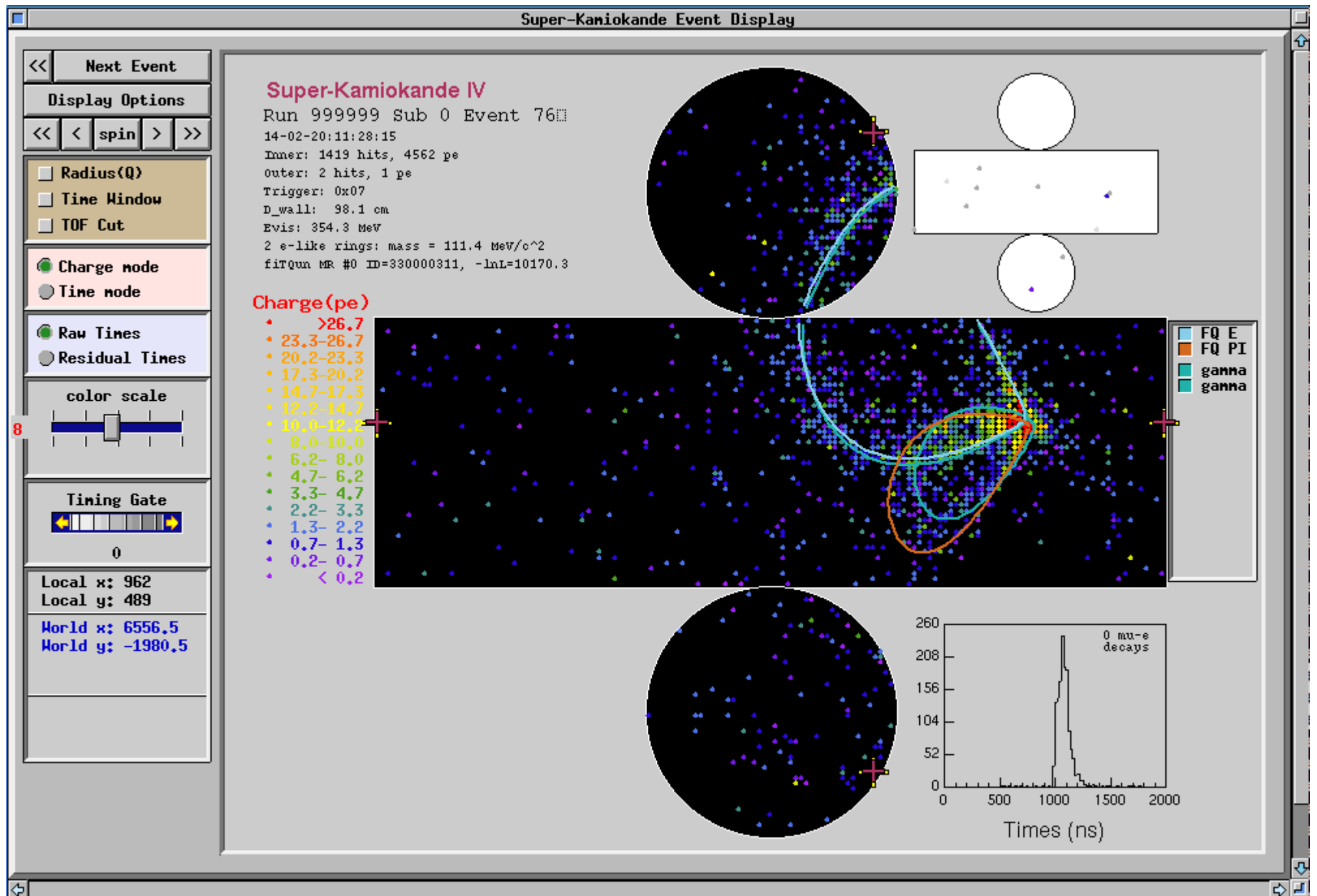


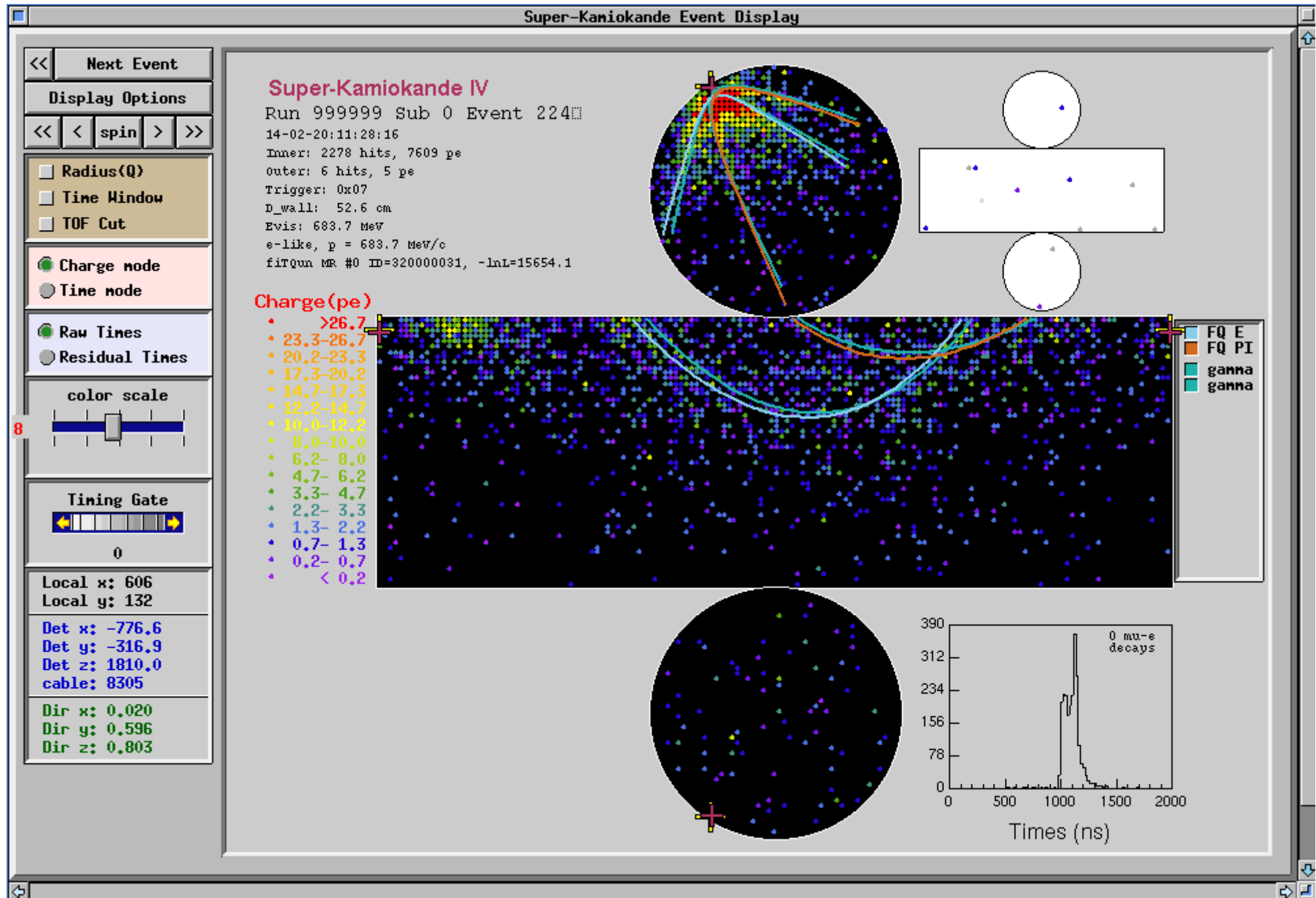


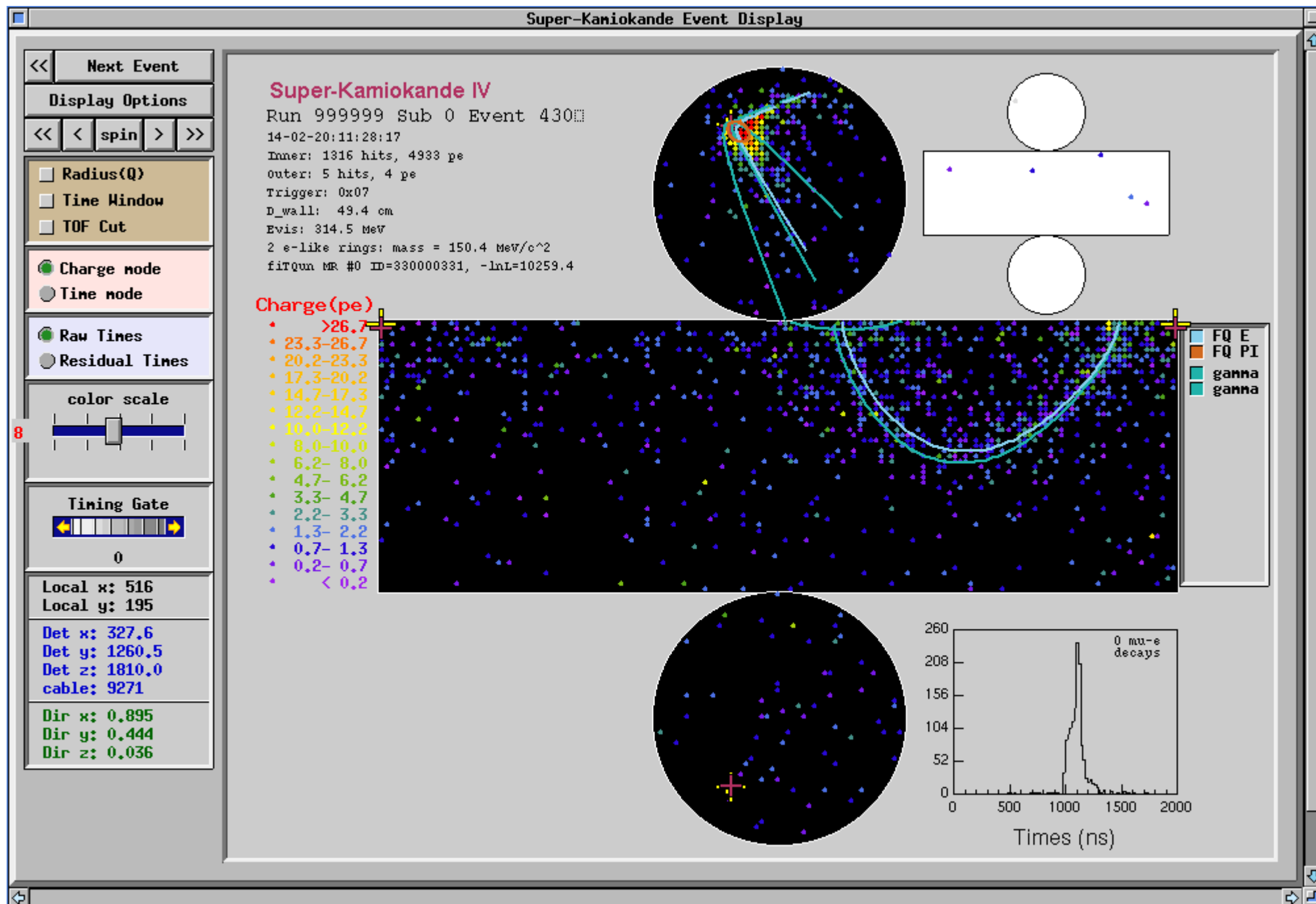


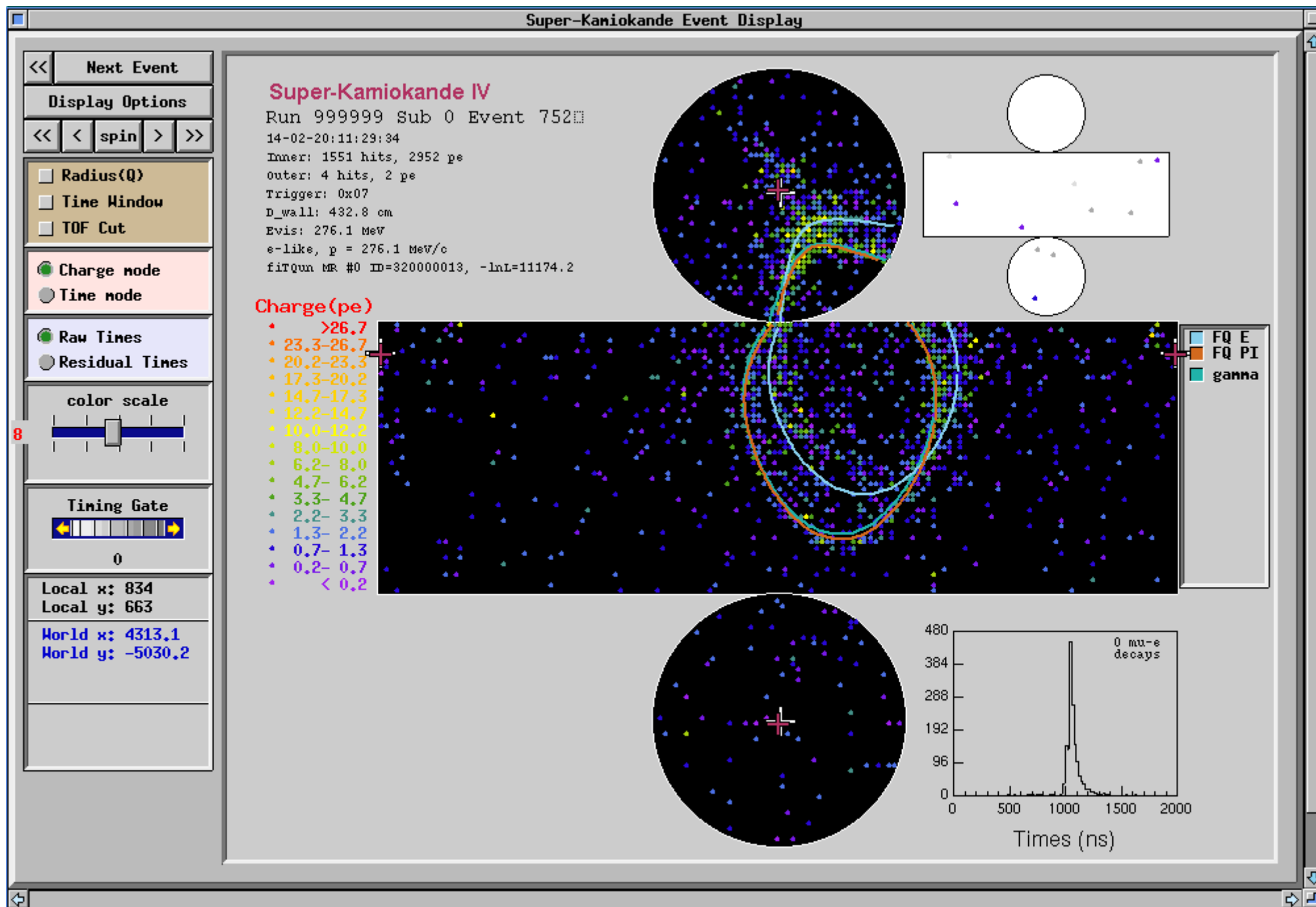


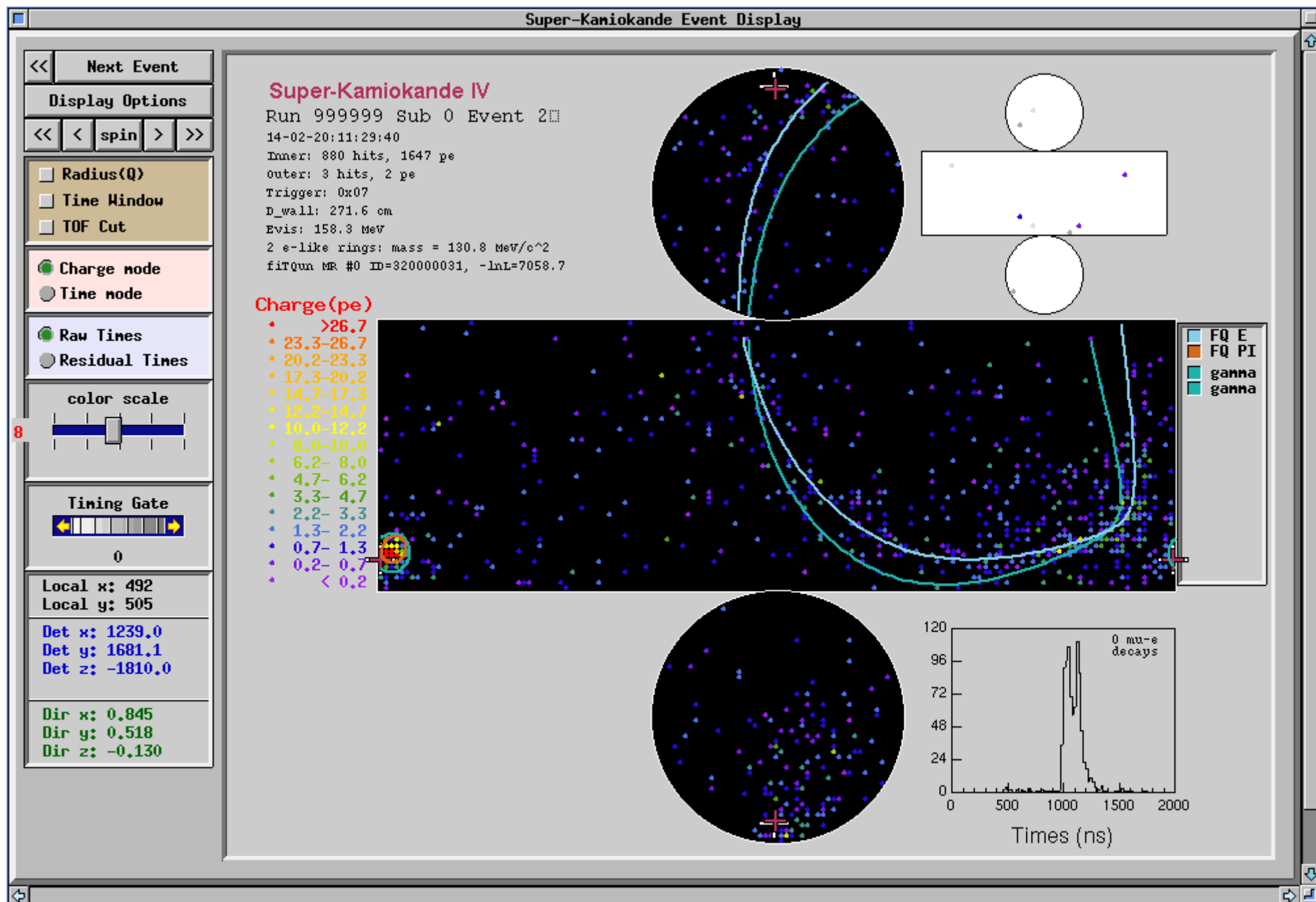












Thoughts

- Way to determine size of ring from ntuples?
- Look at fqpi0 information

TMVA vs fiTQun

2Repi	MLP		BDT	
Cuts	Notes	FOM	Notes	FOM
nll2repi nll2rpie nll2ree	HiddenLayers= N+5,N+5,N+5	0.719	MaxDepth=5	0.765
nll2repi nll2rpie nll2ree mrmom1 mrmom2	HiddenLayers= N+5,N+5,N+5	0.859	MaxDepth=5	0.854

baseline: 0.626

2Repi1de	MLP		BDT	
Cuts	Notes	FOM	Notes	FOM
nll2repi nll2rpie nll2ree	HiddenLayers= N+5,N+5,N+5	0.923	MaxDepth=5	0.924
nll2repi nll2rpie nll2ree mrmom1 mrmom2	HiddenLayers= N+5,N+5,N+5	1.183	MaxDepth=5	1.170

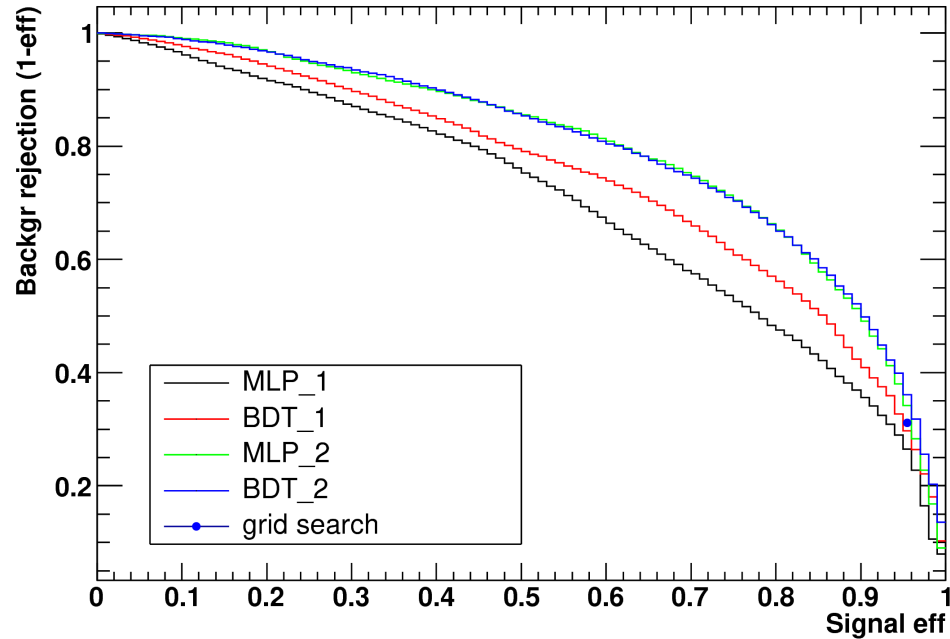
baseline: 0.916

Highest FOM values so far

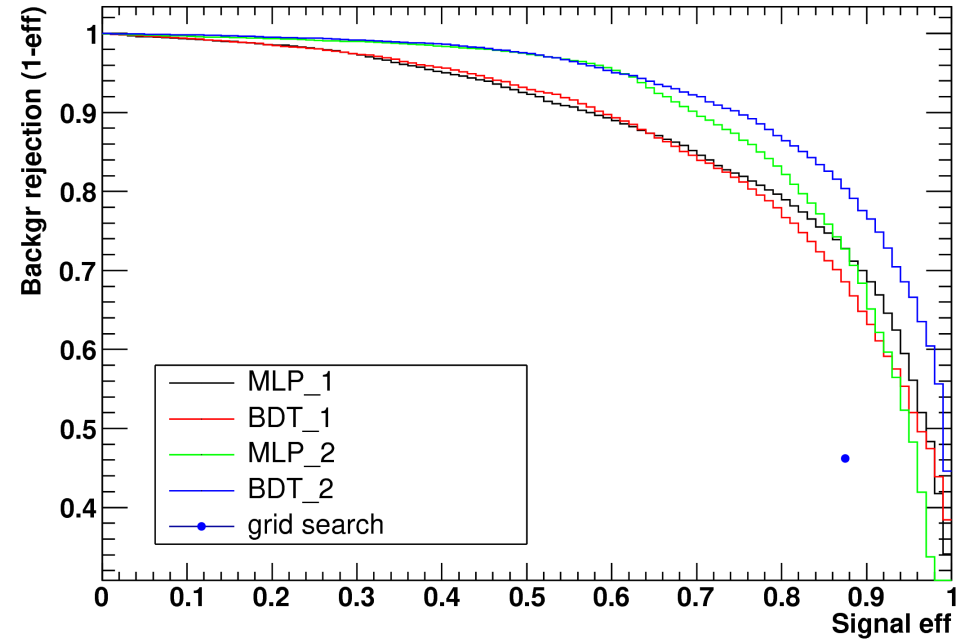
- Also running TMVA with a number of inputs:
 - nll2repi, nll2rpie, nll2ree
 - mrmom1, mrmom2
 - mrdir1 (x,y,z), mrdir2 (x,y,z)
 - mrpid1, mrpid2
- Having some issues with memory usage (~150 GB needed)
 - Submitted job on neut cluster
 - Wanted to include ring position vectors as well, but removed due to memory concerns

ROC Curves

2Re π ROC curves

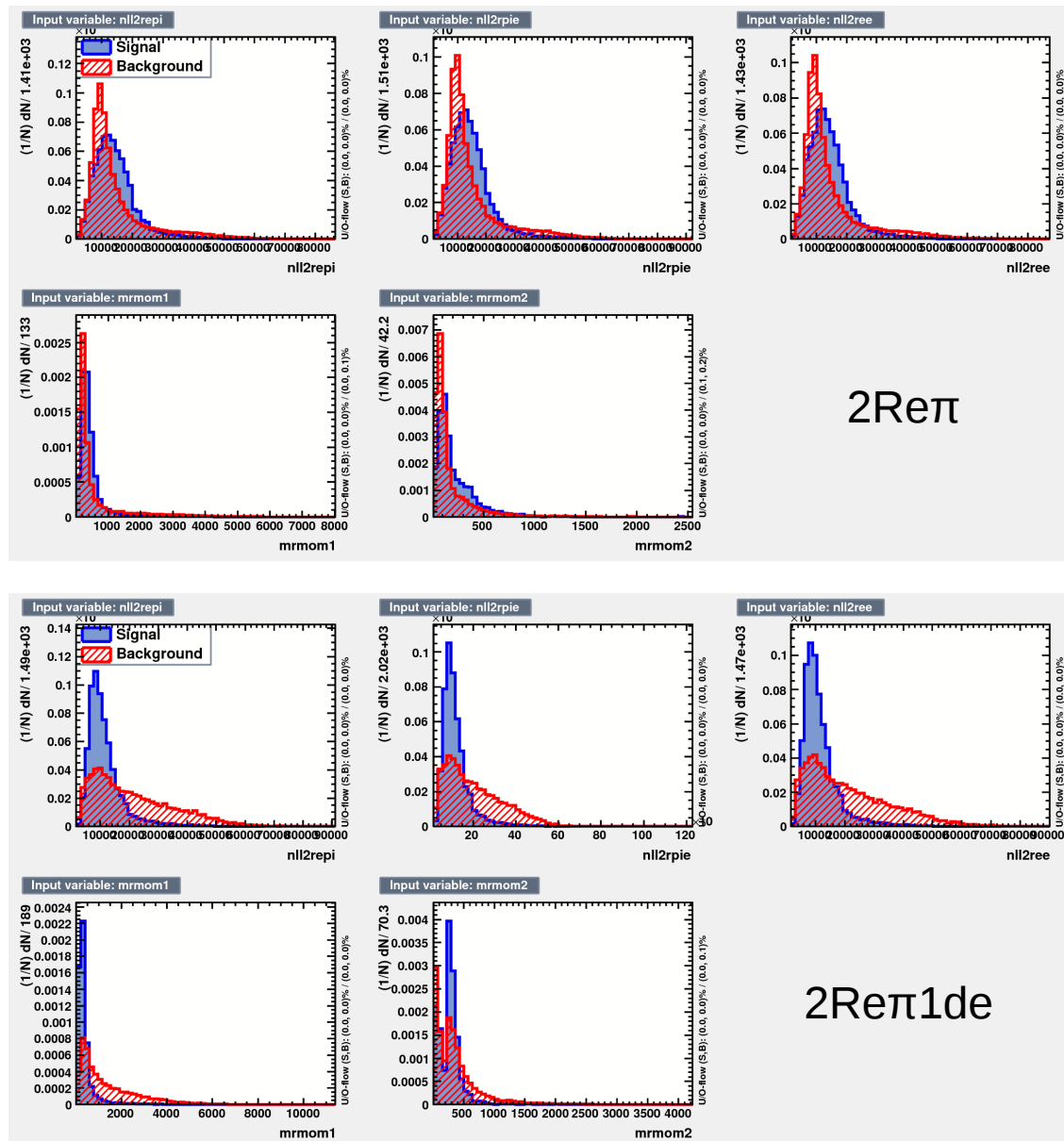


2Re π 1de ROC curves

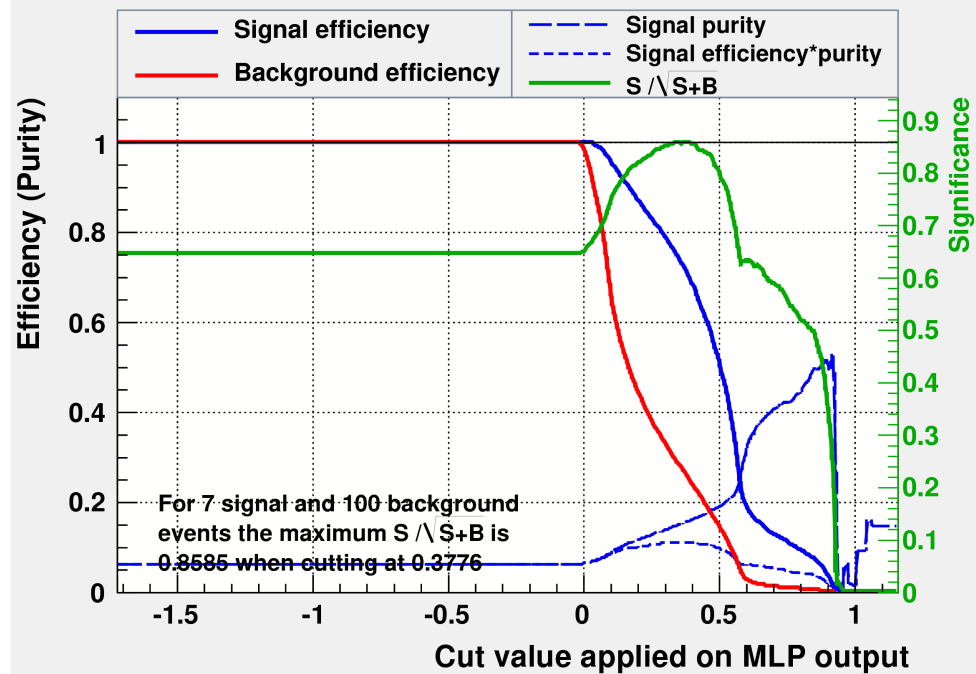


Suffixes of 1 and 2 correspond to first and second rows in table on previous slide, respectively

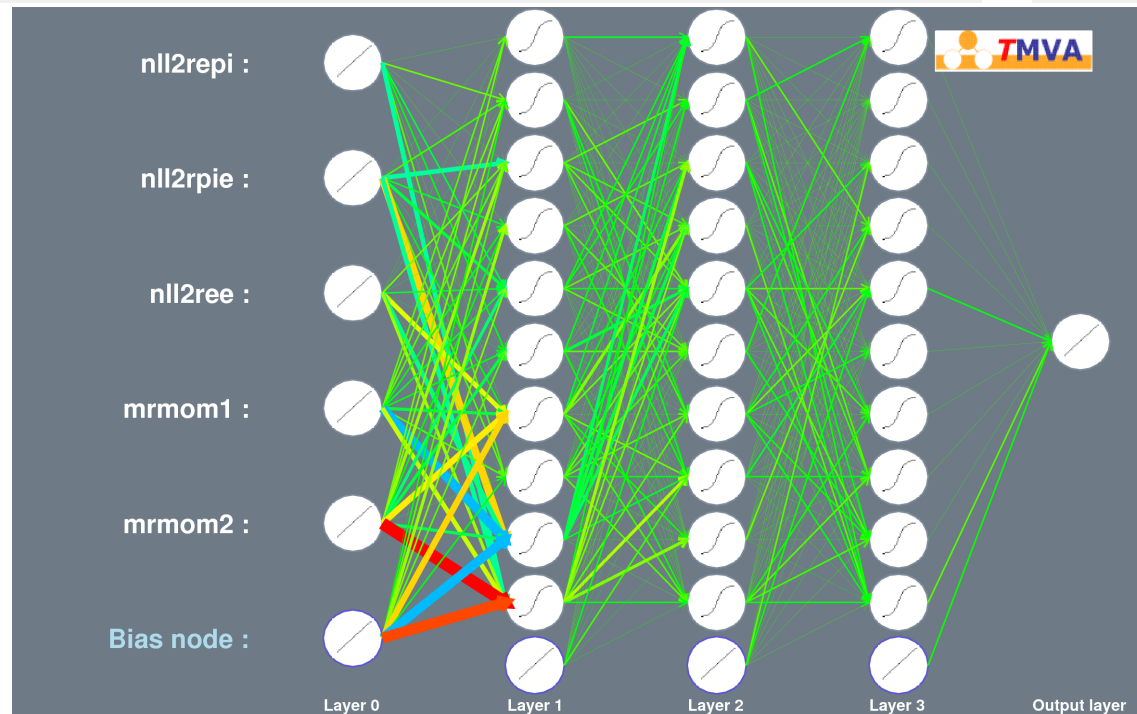
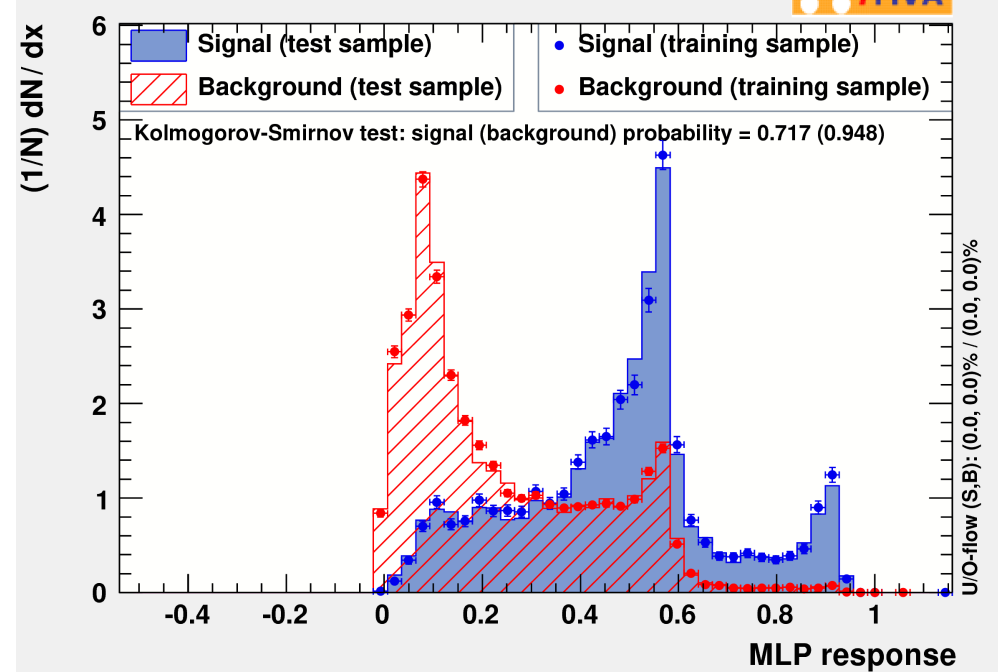
Input Variables



Cut efficiencies and optimal cut value

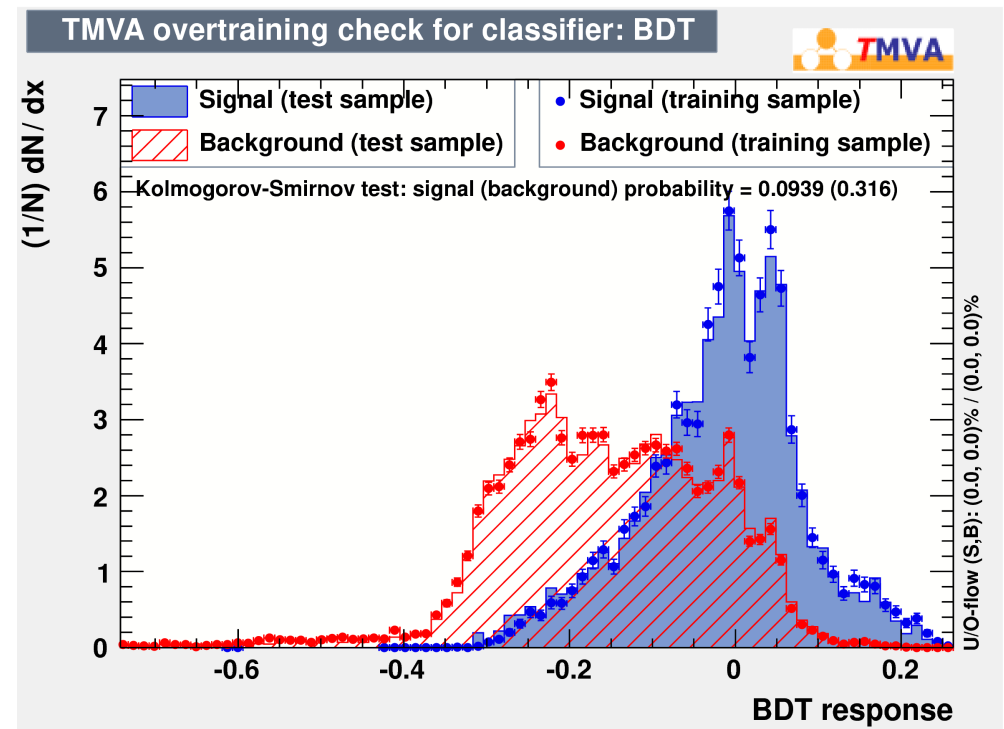
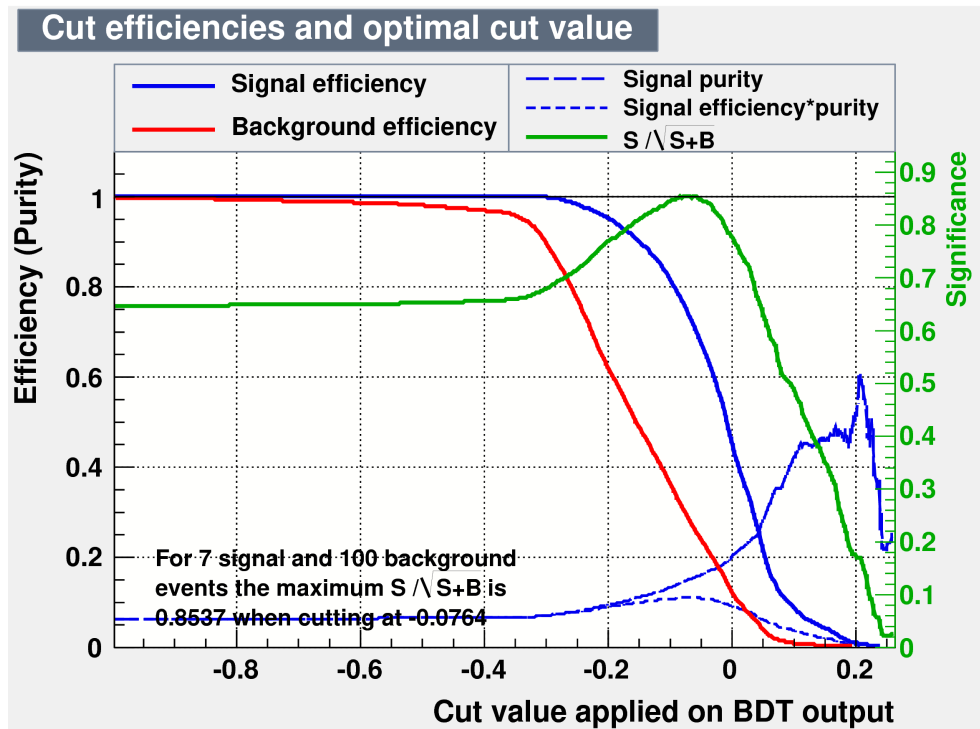


TMVA overtraining check for classifier: MLP

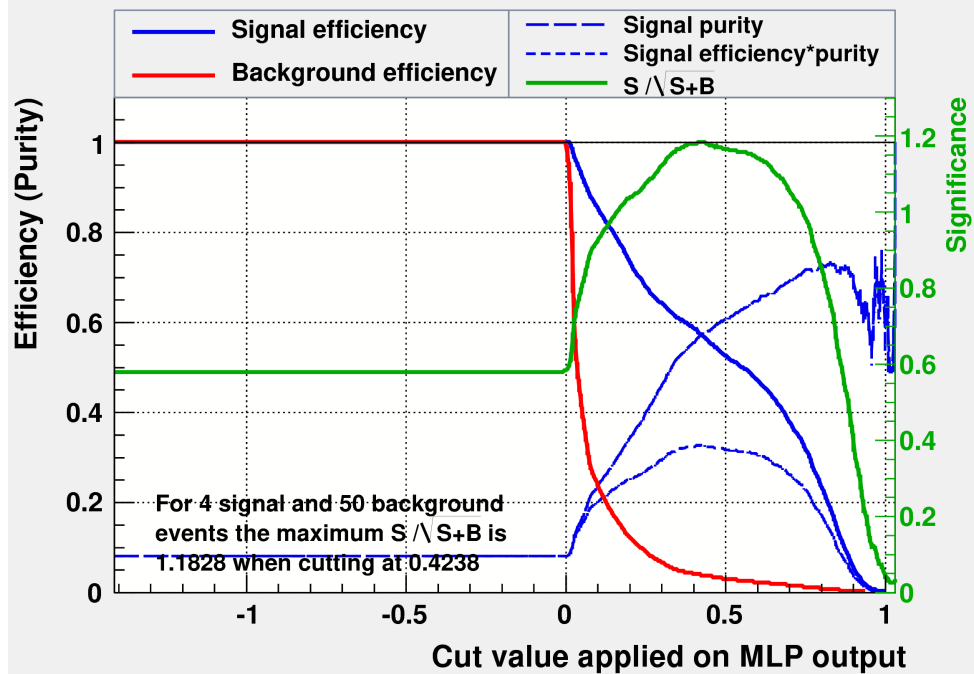


2Re π : MLP

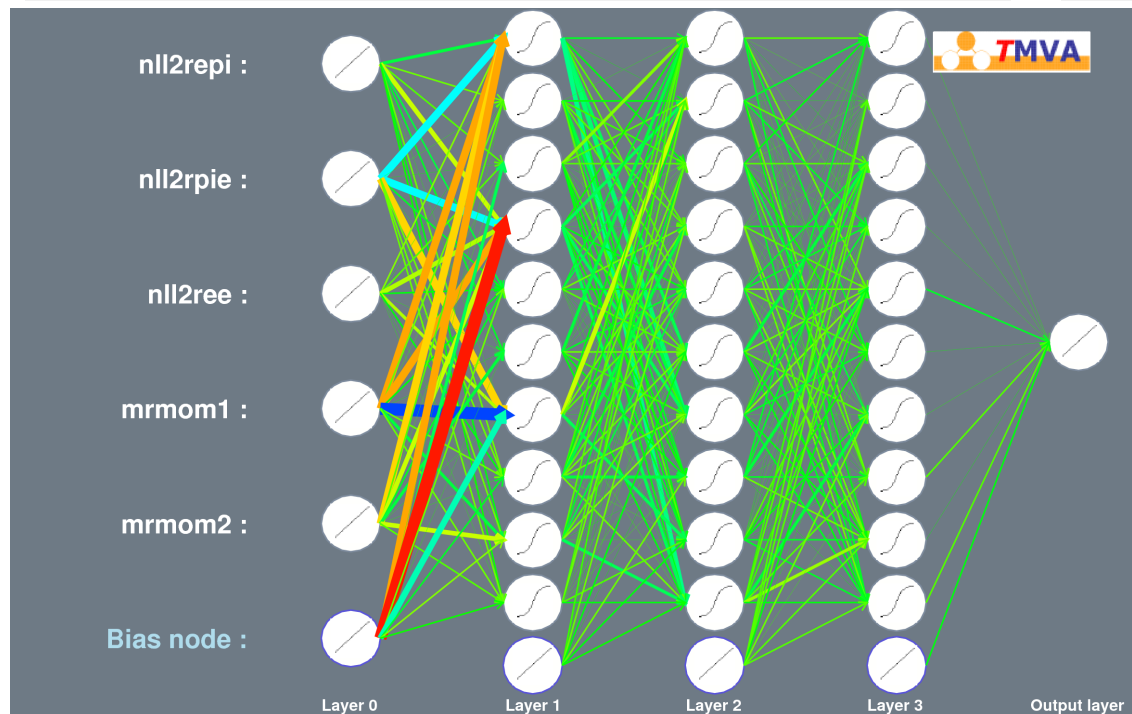
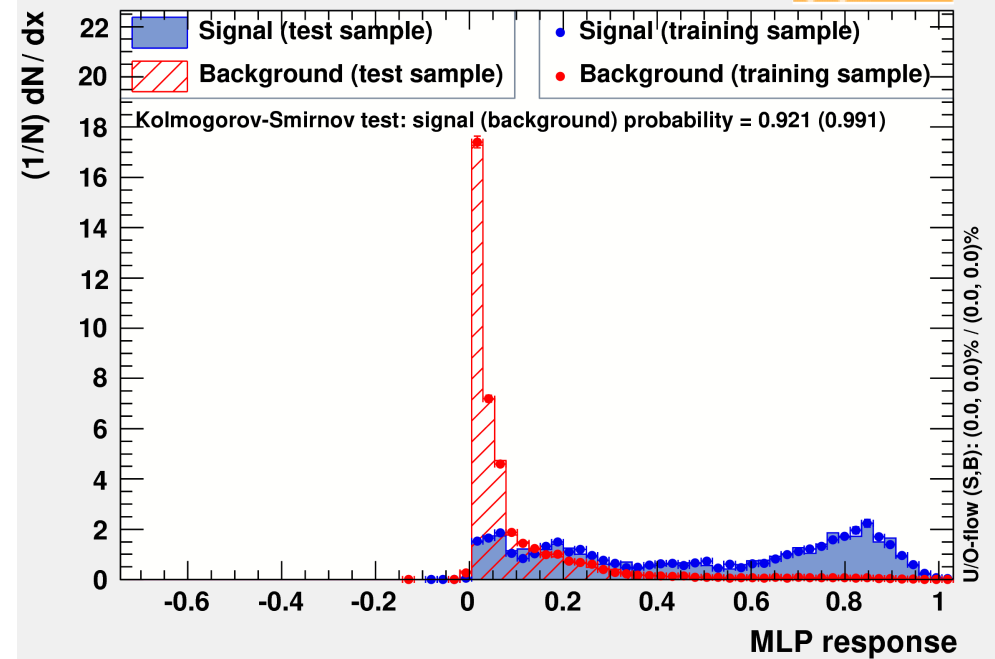
2Re π : BDT



Cut efficiencies and optimal cut value



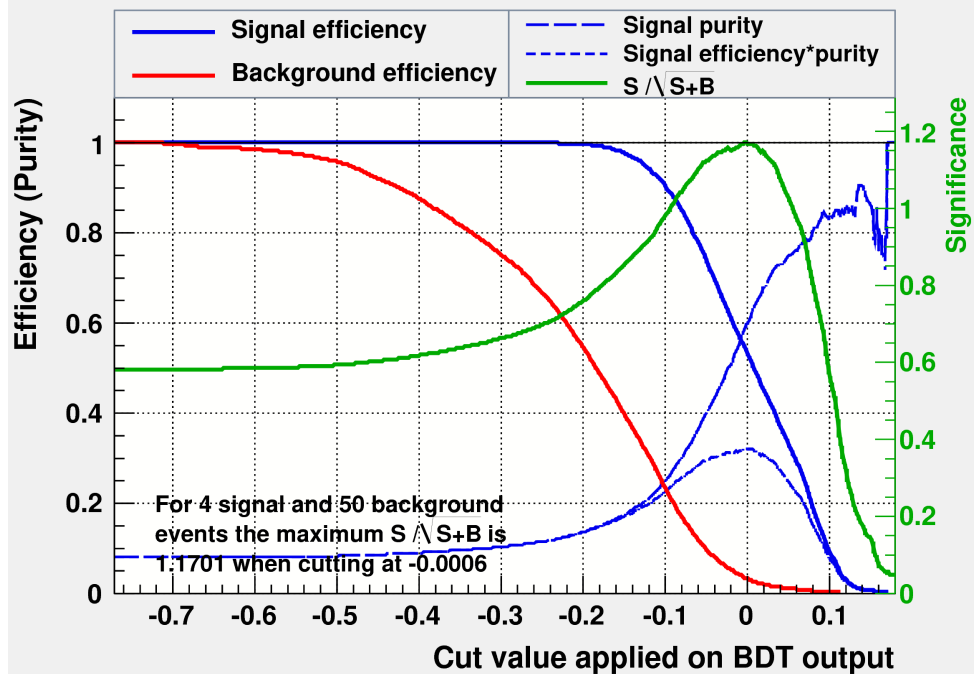
TMVA overtraining check for classifier: MLP



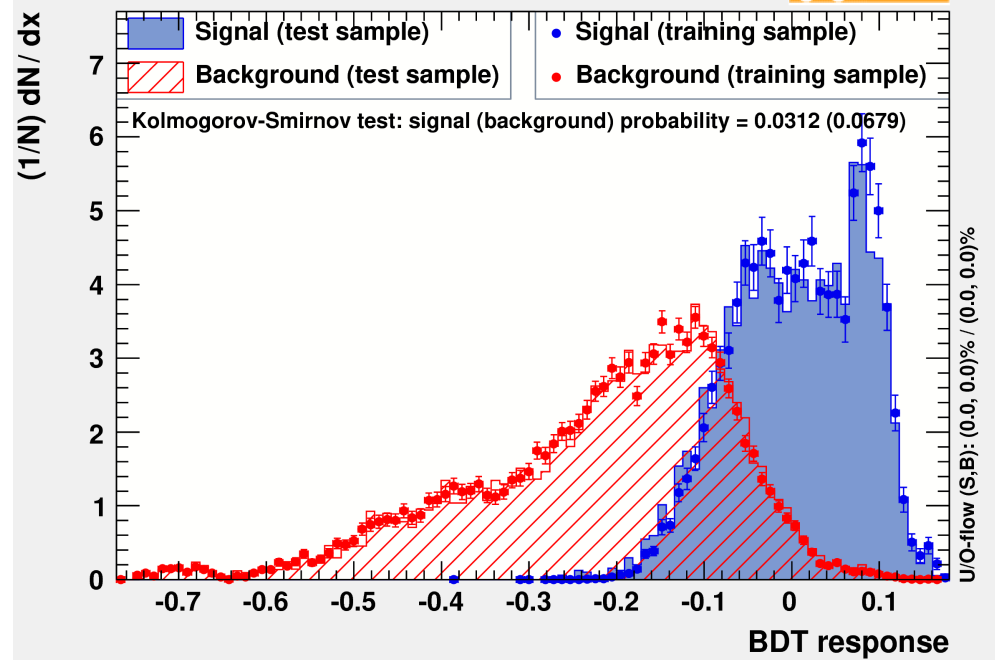
2Reπ1de: MLP

2Re π 1de: BDT

Cut efficiencies and optimal cut value



TMVA overtraining check for classifier: BDT



Thoughts

- If job on neut doesn't run, might try running on neutsrv2 sometime during the weekend
 - neutsrv2 has over 250 GB of memory
- Want to start looking into CNNs for ring ID next week