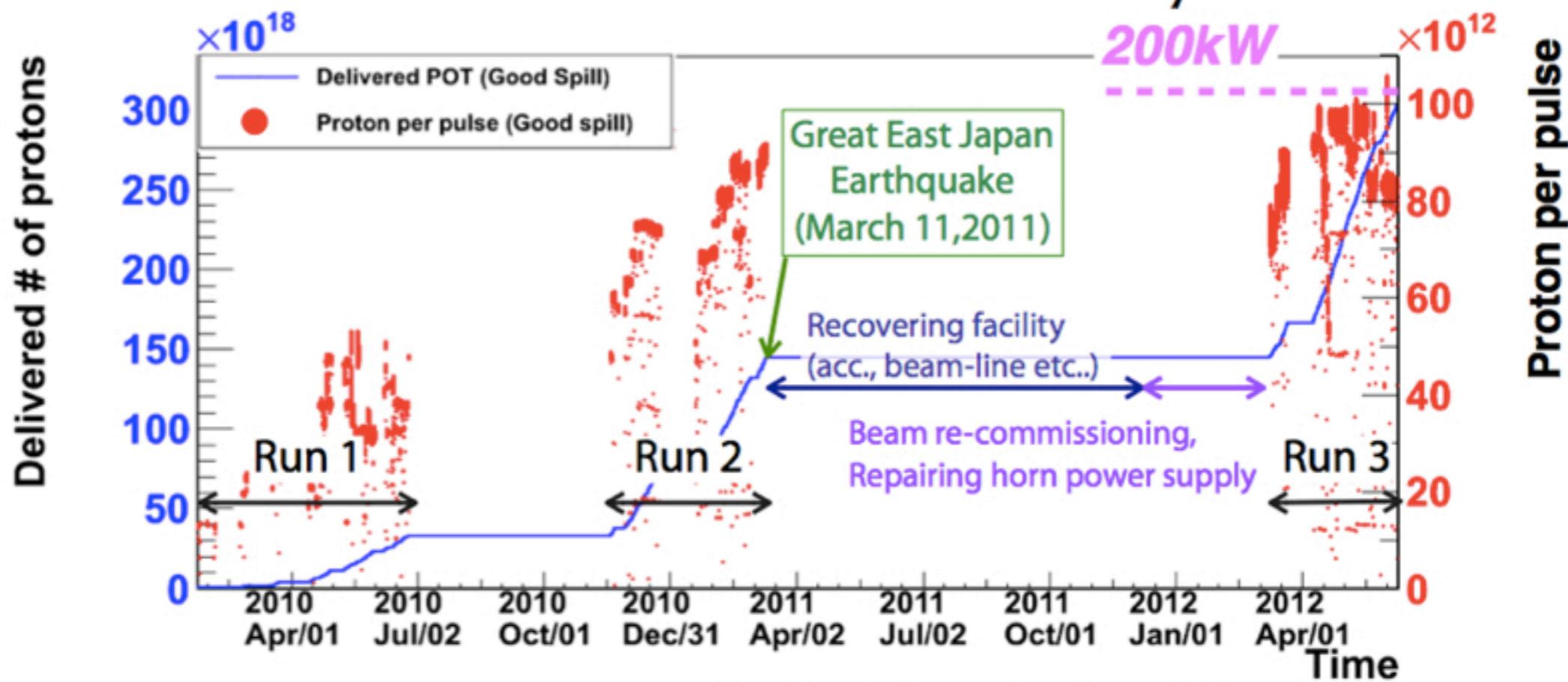


T2K Events in KamLAND

@ Collaboration Meeting in Hawaii
2012/10/9
H. Ikeda

Data collected and analyzed



Run1 + 2 (2010-2011)

1.43×10^{20} p.o.t.

* ND280 Run1+2 data is used for oscillation analysis

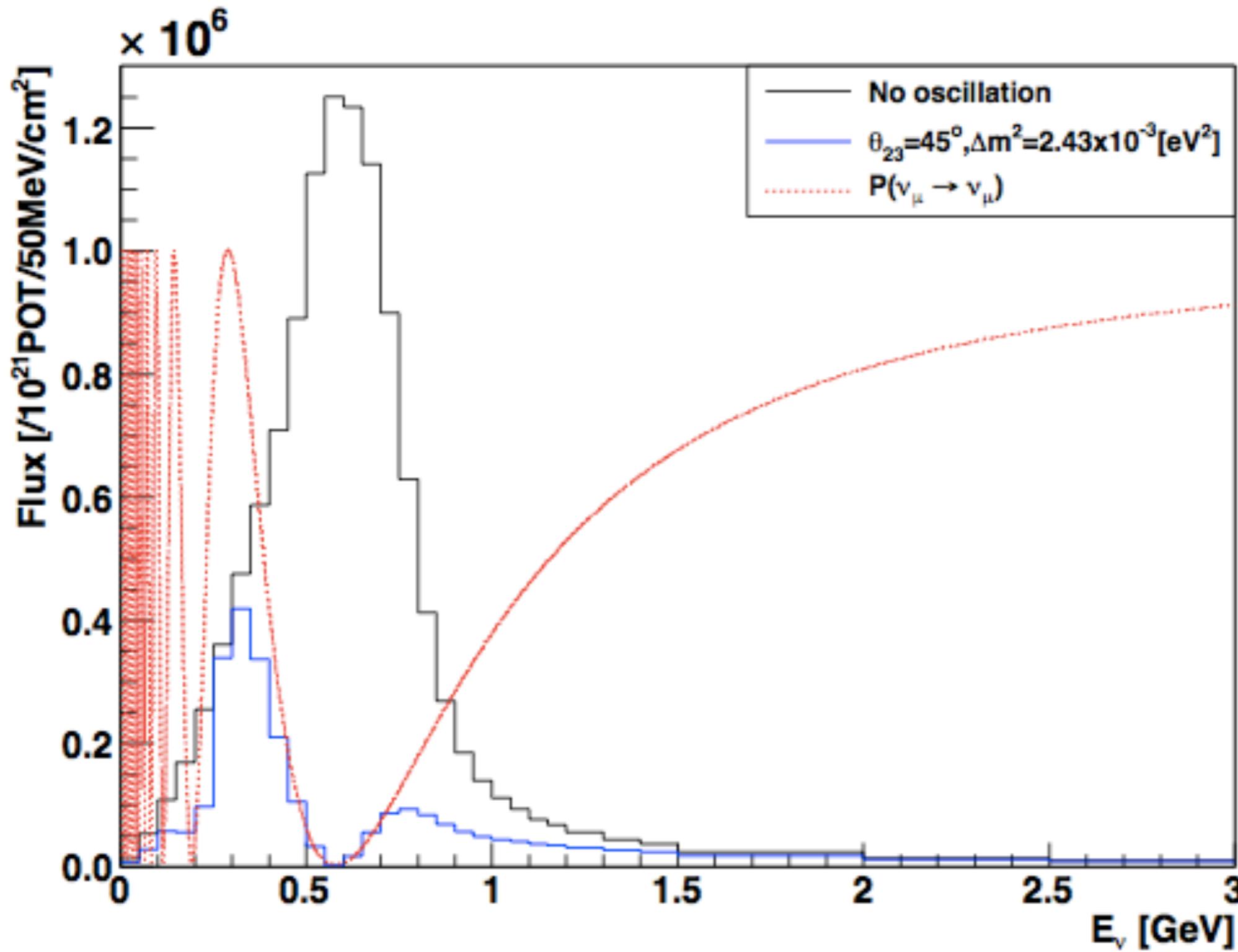
Run3 (2012) : 1.58×10^{20} p.o.t

* including 0.21×10^{20} p.o.t. with 200kA horn operation (13% flux reduction at peak)
(250kA horn current for nominal operation)

* ND280 Run3 data is checked and consistent with Run1+2

**Data for today's talk (full data set up to now) = 3.01×10^{20} p.o.t.
(18% of increase from Neutrino2012)**

Neutrino Spectrum from T2K

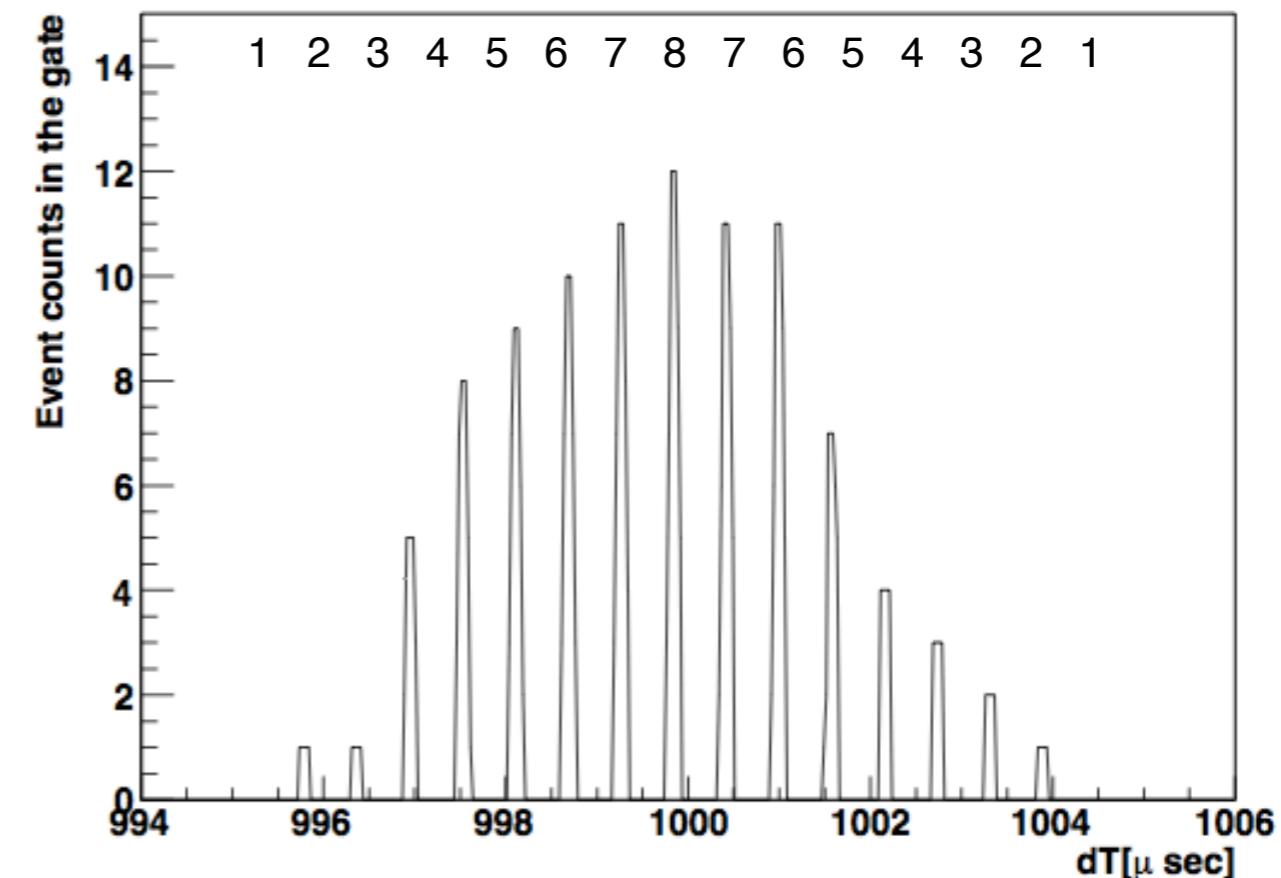
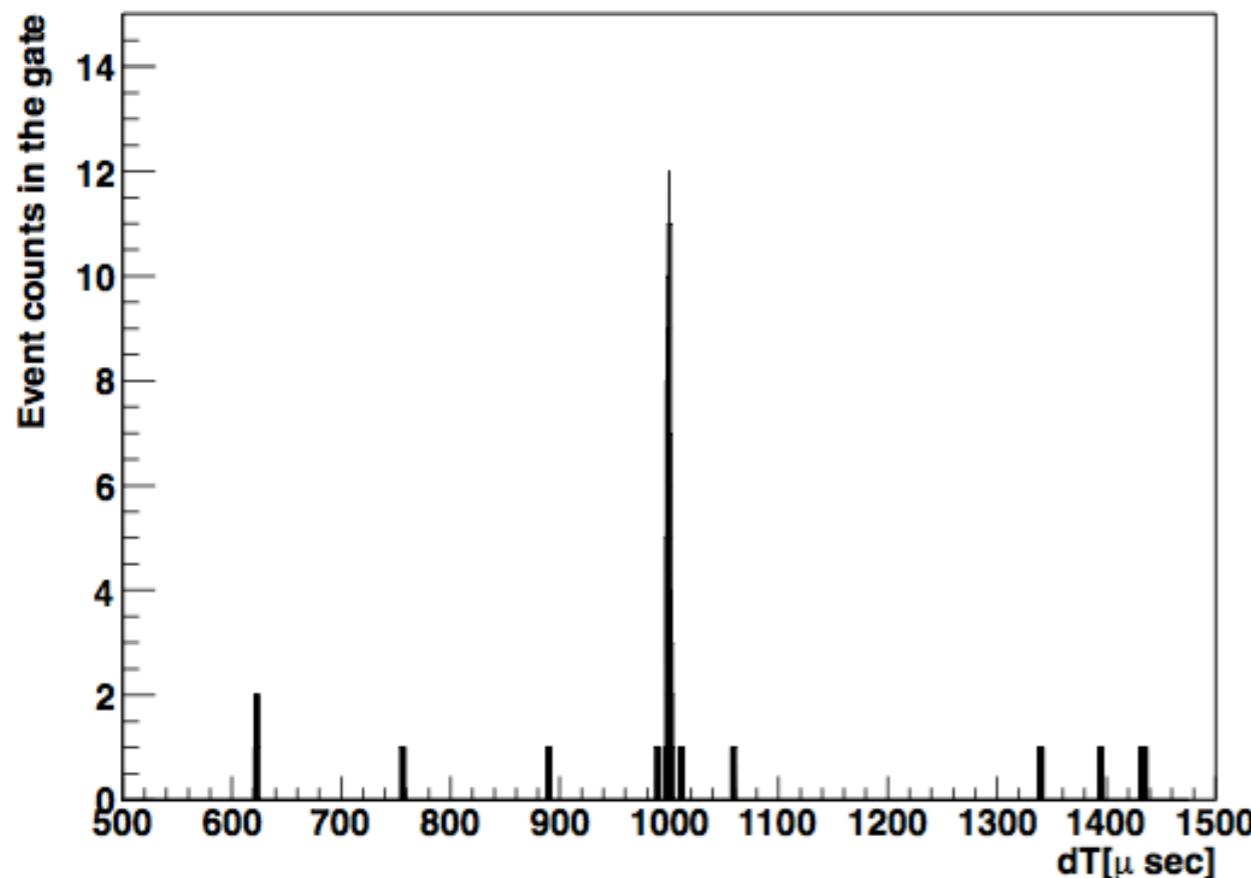
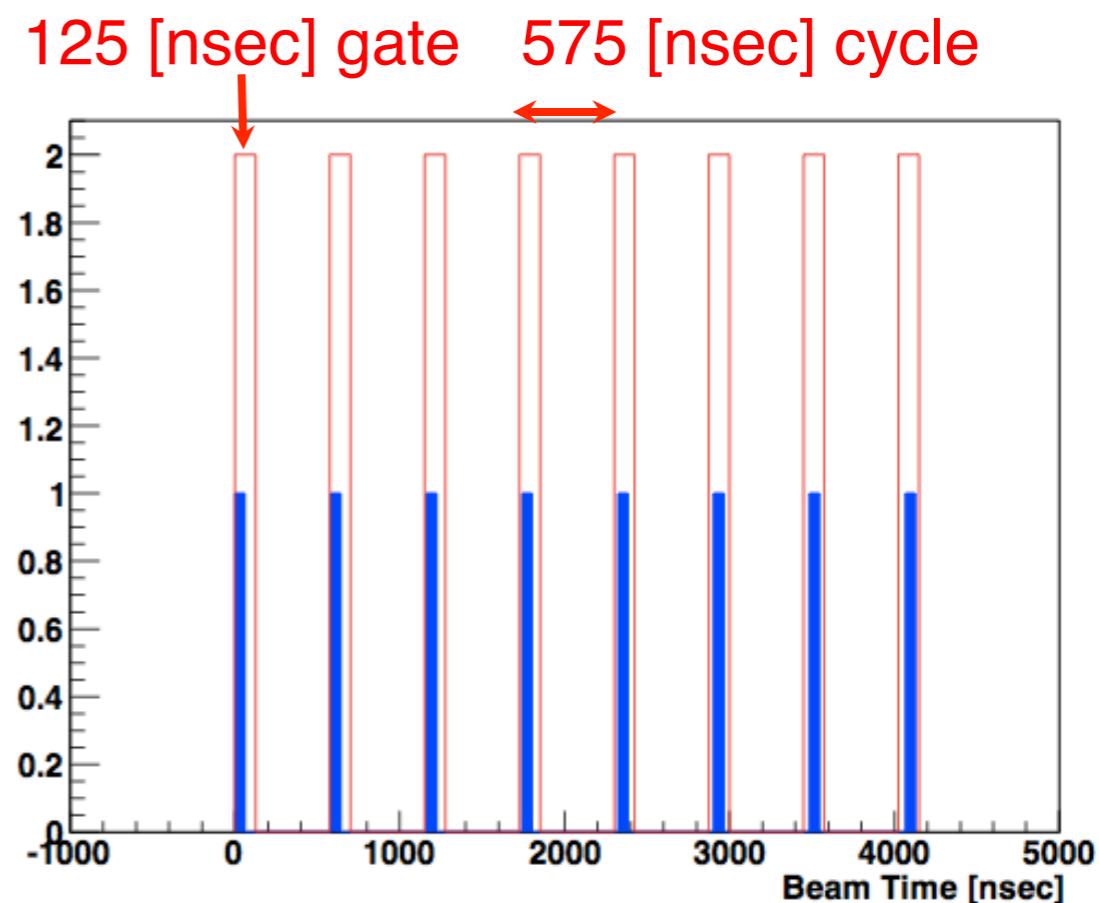


Beam Bunch

Count # of event for every
timestamps (25[nsec])

Selection:

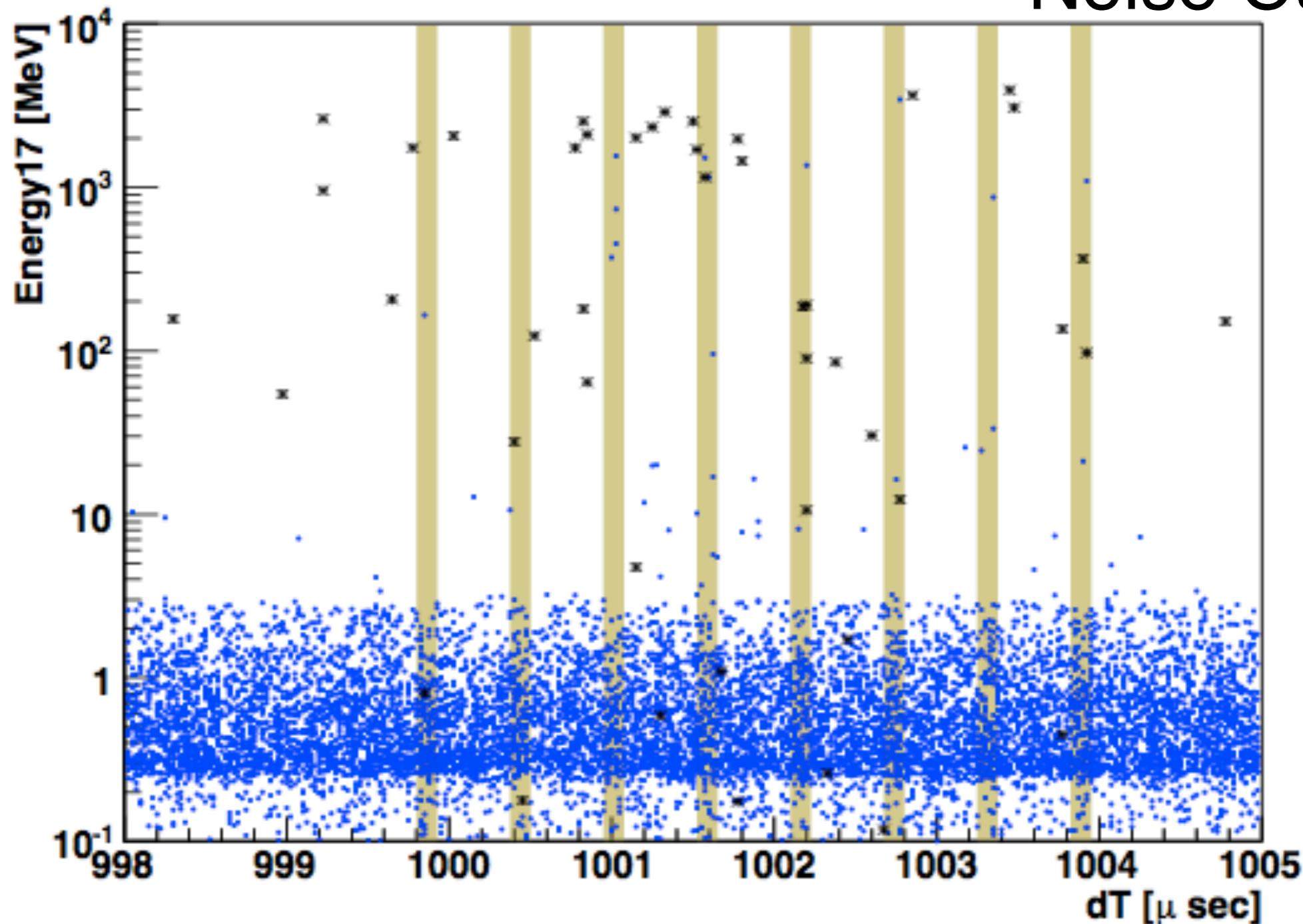
Energy > 50[MeV] ,
 $n_{200OD} < 5$



999.8 μsec has maximum # of events

Beam Timing @ KamLAND

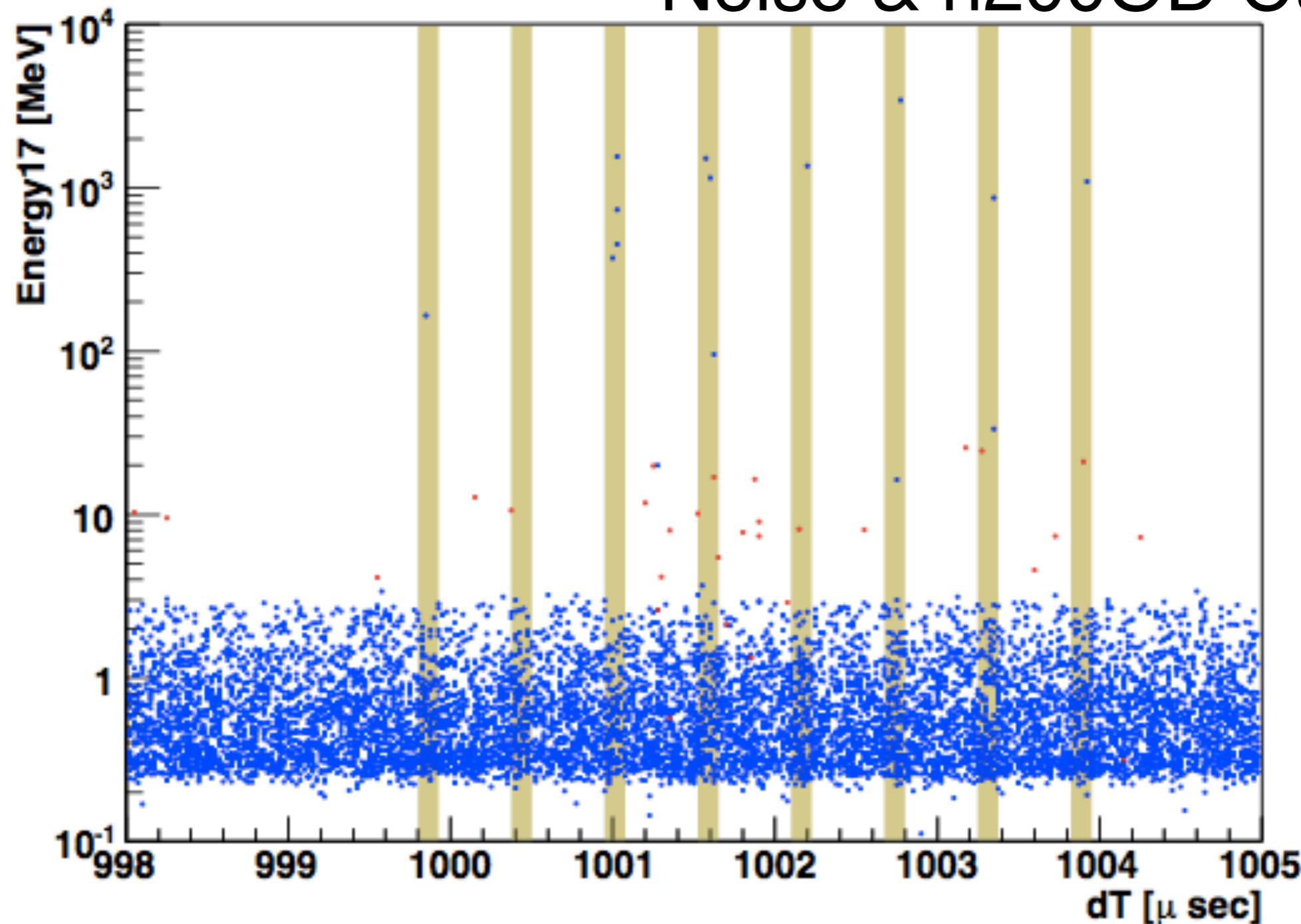
Noise Cut



* n200OD ≥ 5

Beam Timing @ KamLAND

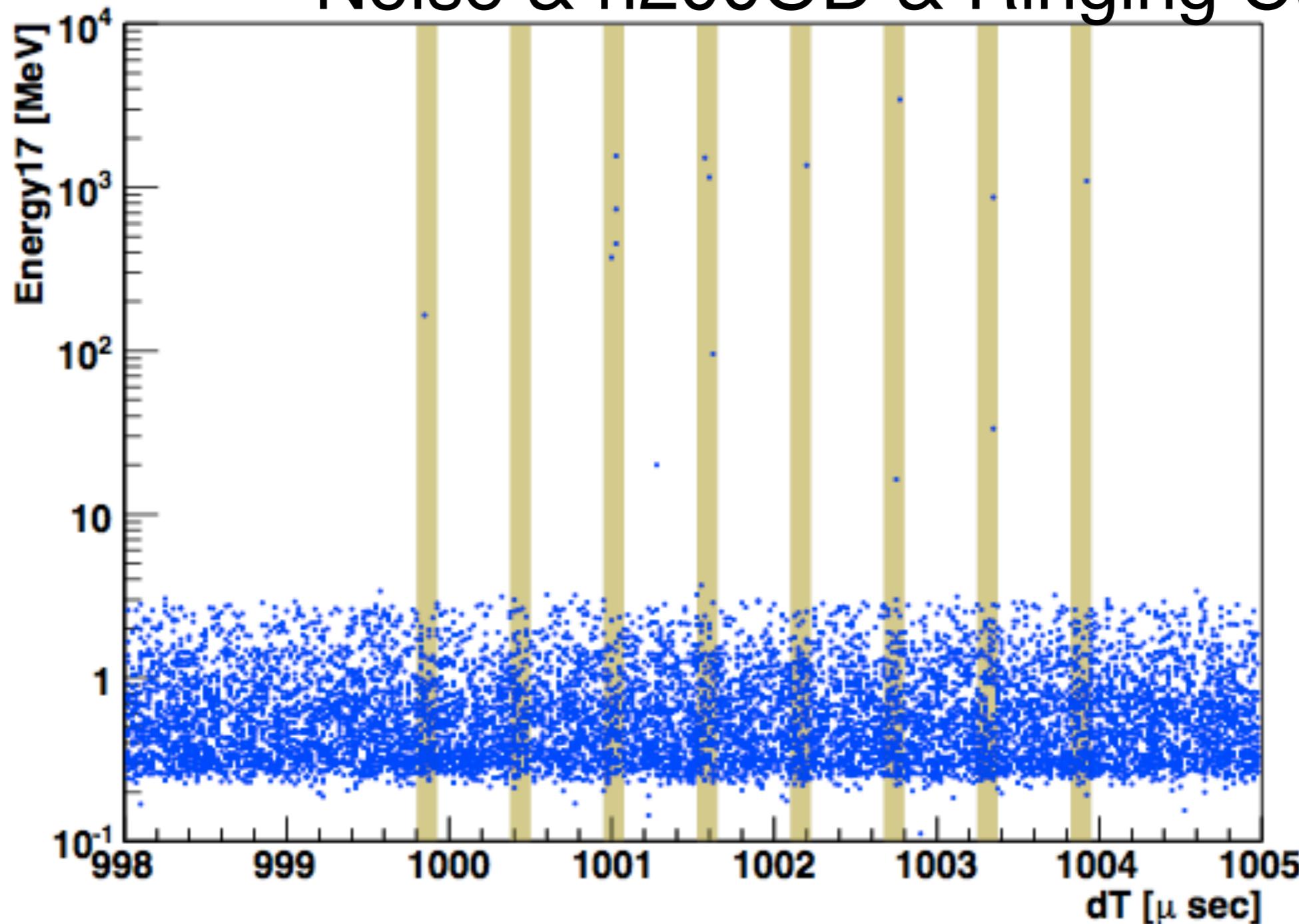
Noise & n200OD Cut



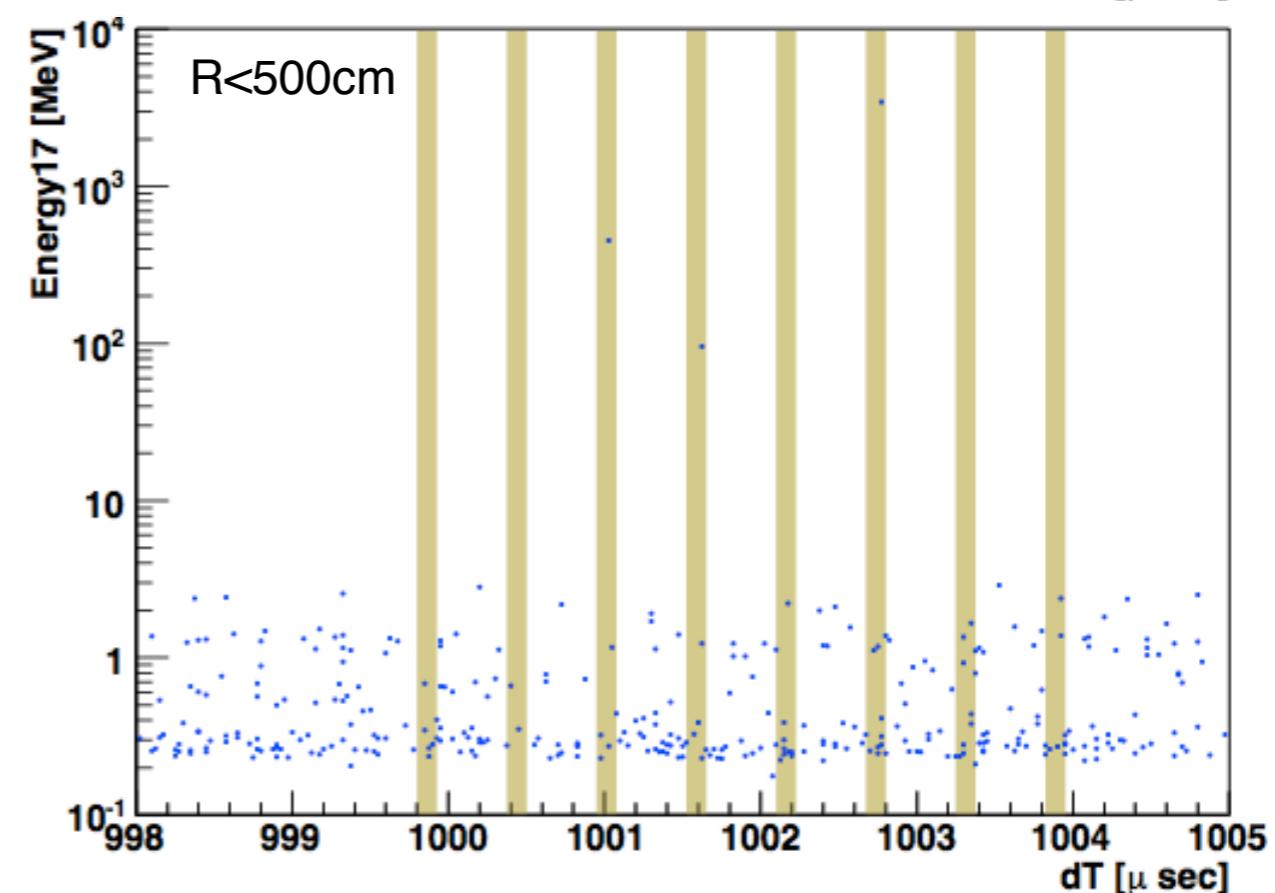
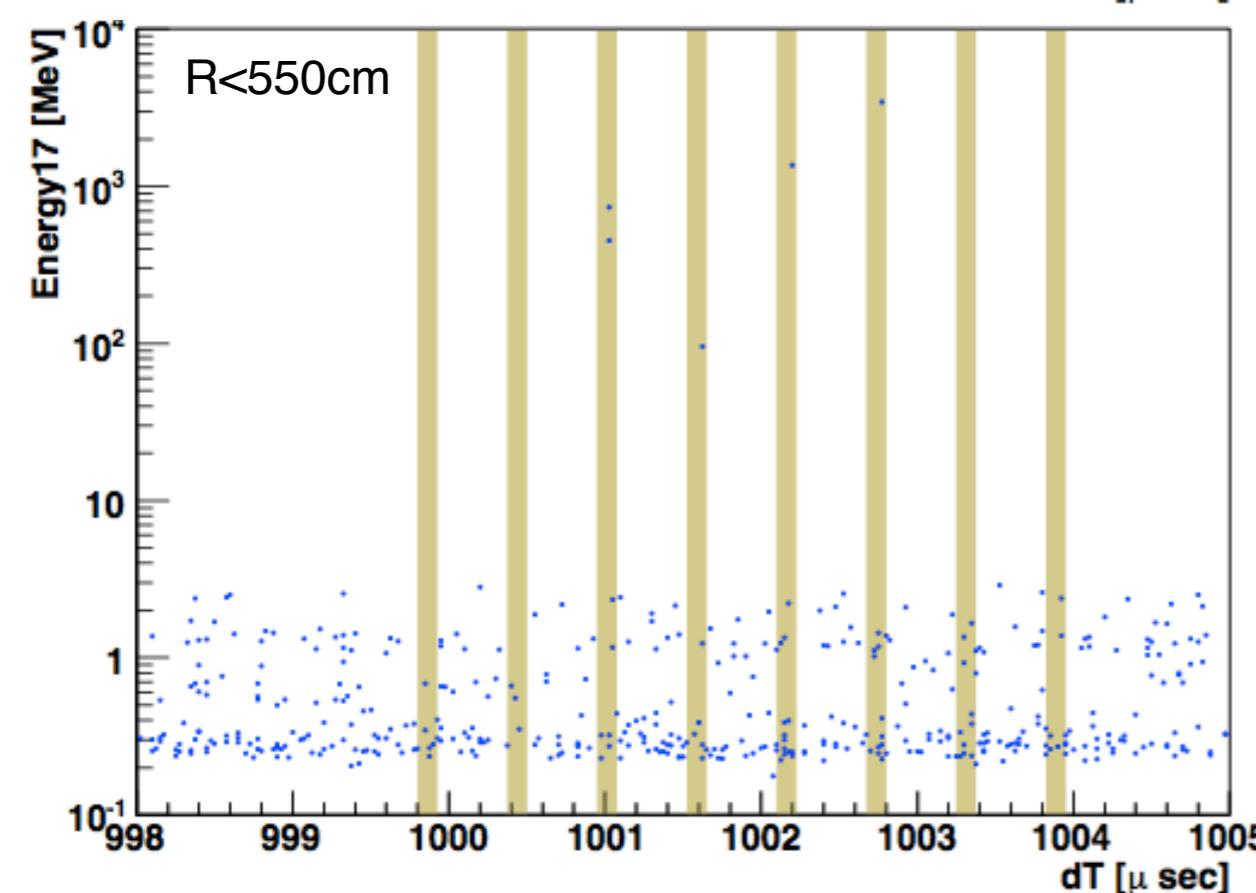
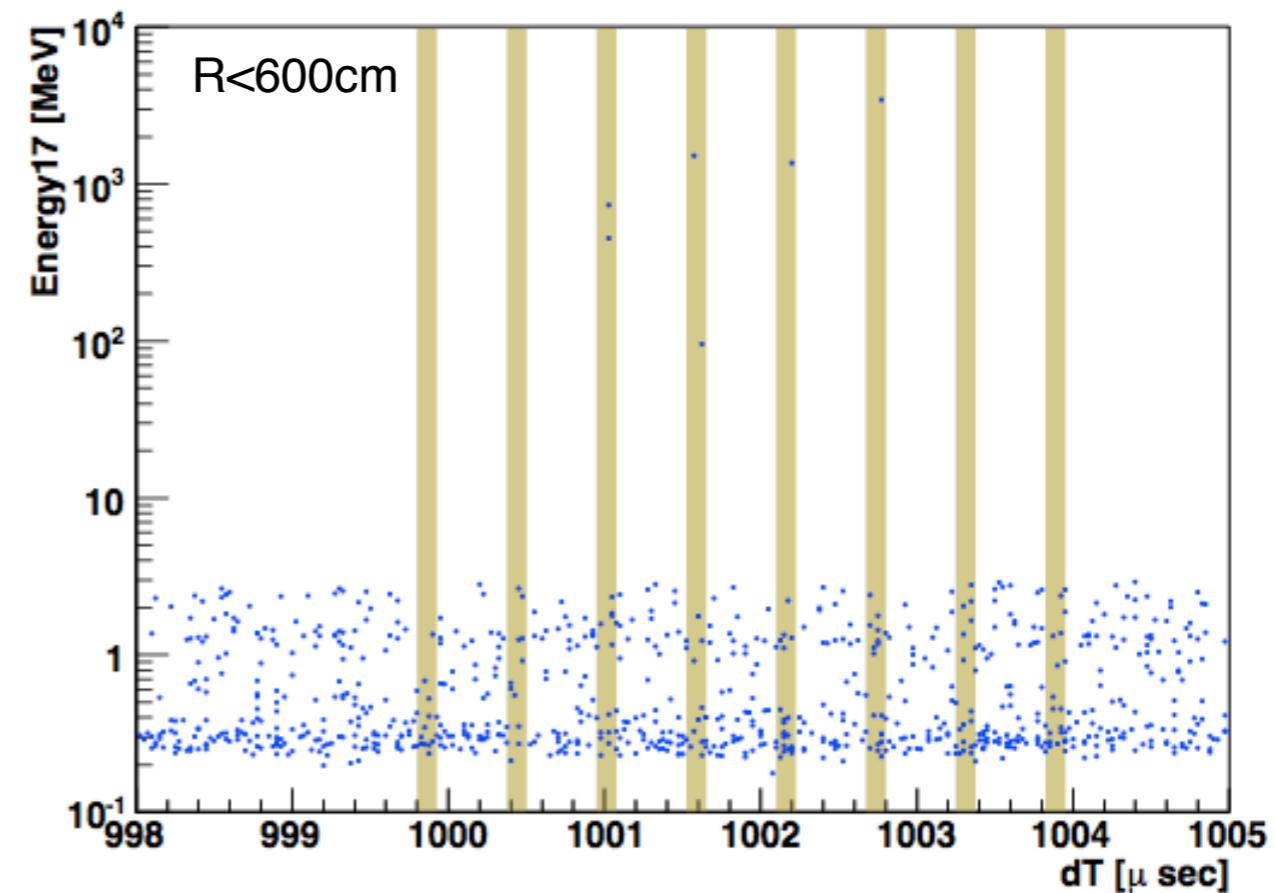
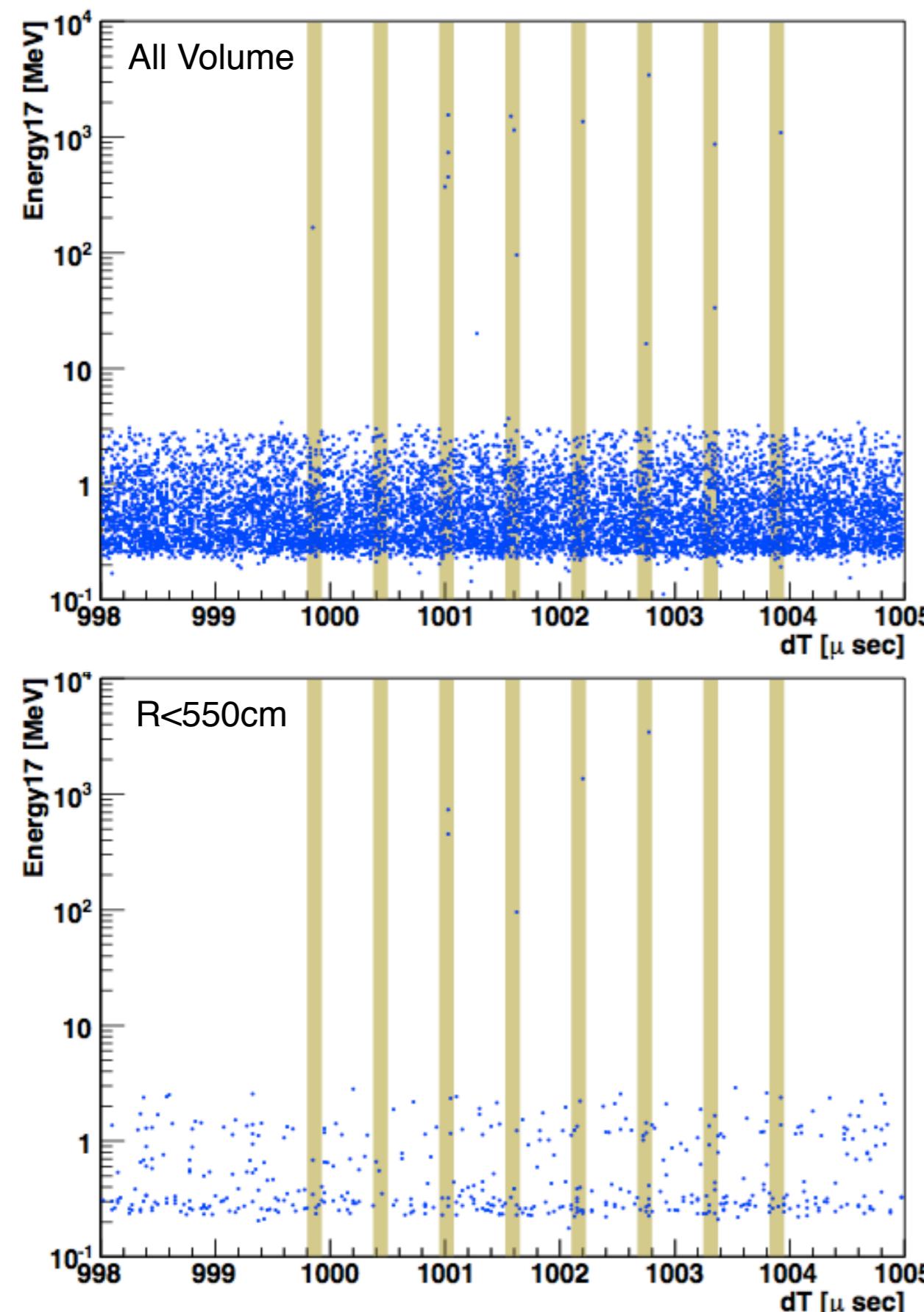
Red: Ringing Events

Beam Timing @ KamLAND

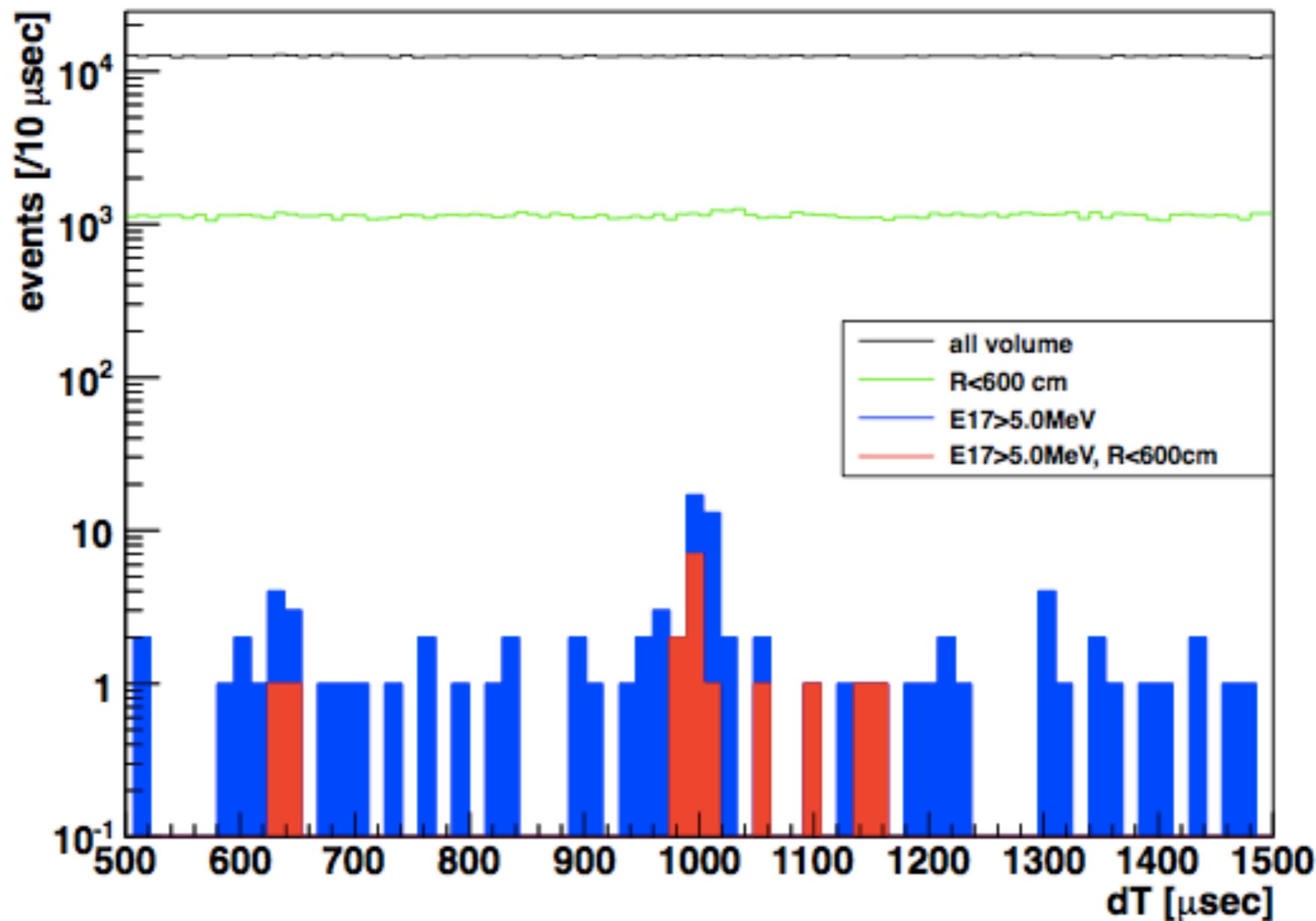
Noise & n2000OD & Ringing Cut



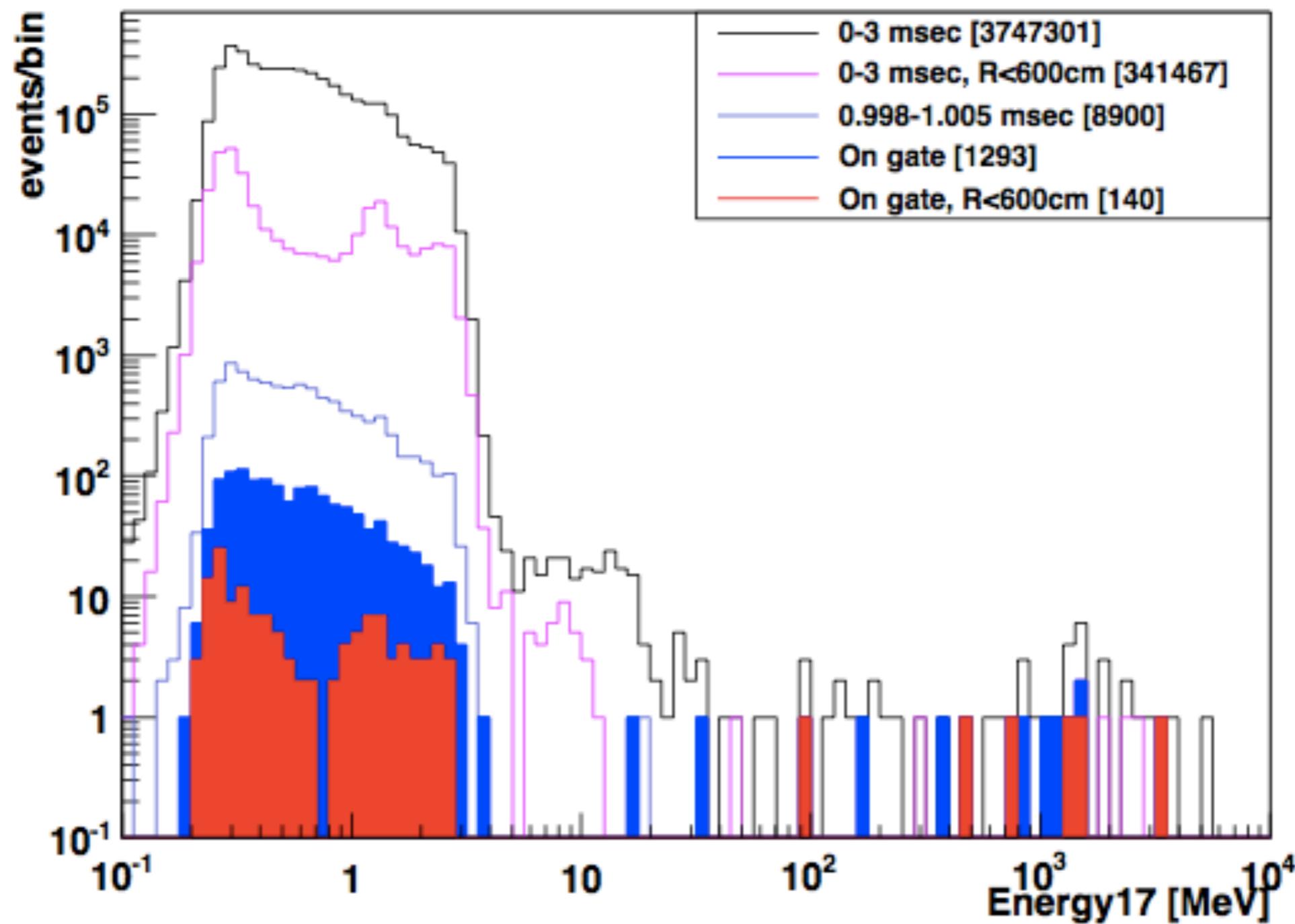
R dependence



dT distribution



Energy distribution



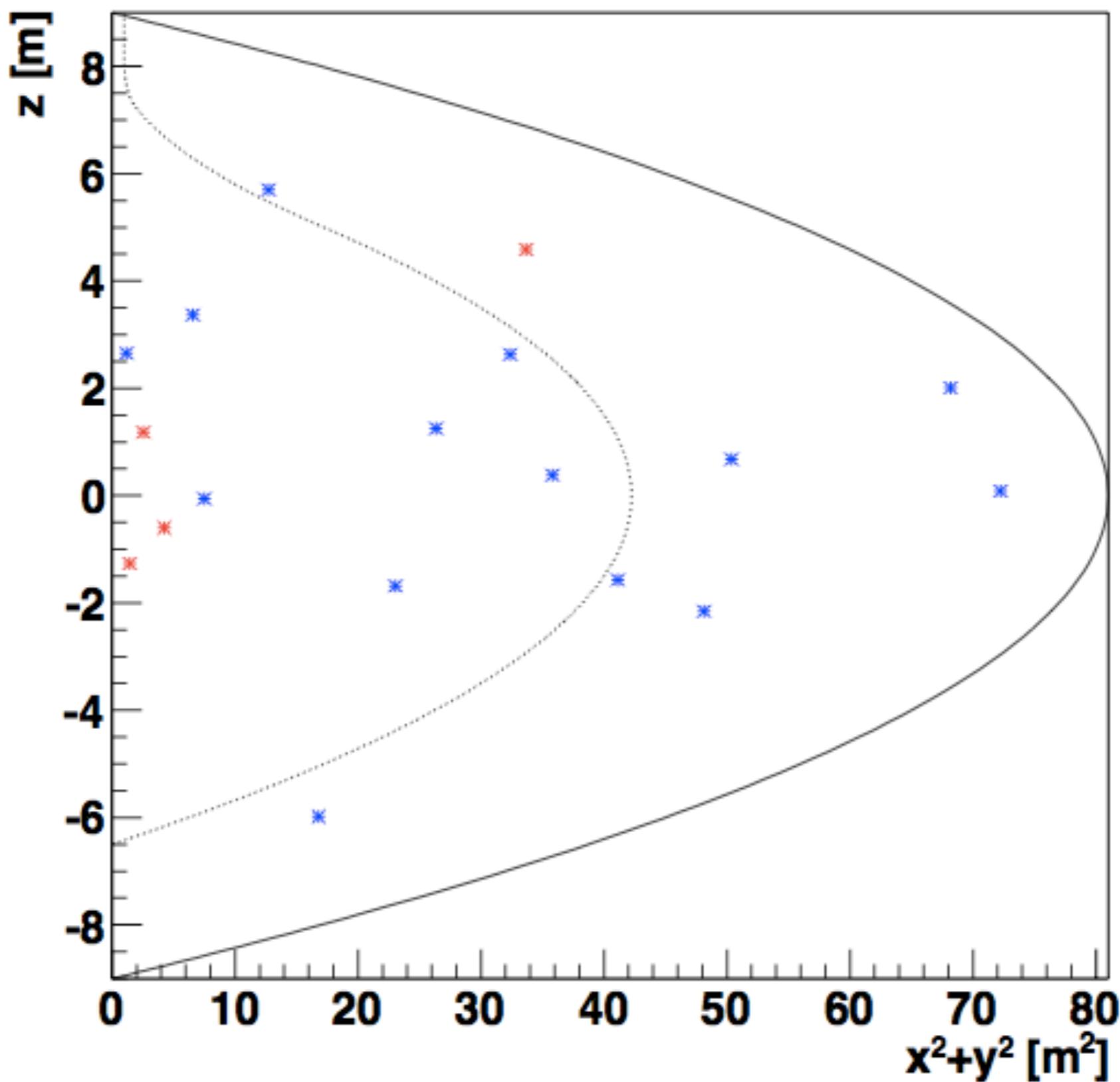
Candidates

Energy17 > 10MeV, n200OD<5

18 events remains,(including 4 fake mu events.)

ID	Q17	E17	R	dL	dQ	date	Comment
0	2905.5	6.7799	739.623	198.233	-634494	Tue Oct 12 12:28:53 2010	
1	5455.2	17.636	174.369	63.1451	-837040	Fri Dec 10 06:00:46 2010	
2	3864.8	13.477	198.409	168.978	-719622	Wed Oct 26 06:45:07 2011	
3	232460	1088.2	528.31	110.348	-413495	Tue Mar 13 21:26:30 2012	Outgoing, LS+BO
4	3908.9	13.06	712.997	1365.83	-46028.2	Wed Mar 21 10:16:27 2012	Outgoing, BO
5	6375.4	19.594	214.613	175.804	-812198	Sat Apr 7 17:59:20 2012	
6	15389	76.226	423.432	398.413	6775.85	Fri Apr 13 11:56:56 2012	FC, LS+BO
7	198140	873.76	660.177	36.8941	288296	Sat Apr 14 11:54:02 2012	Outgoing, LS+BO
8	264880	1210	599.559	44.285	31036	Fri Apr 20 03:43:57 2012	Outgoing, LS+BO
9	17490	131.26	849.998	64.6786	-817419	Fri Apr 27 18:47:05 2012	FC, LS+BO, 2sig
10	66042	298.06	725.233	123.365	-104397	Wed May 2 09:49:50 2012	Outgoing, LS+BO
11	126300	586.23	508.666	182.149	-6350.88	Thu May 3 07:06:32 2012	Outgoing, LS+BO
12	72515	363.02	274.043	421.956	70889.8	Thu May 3 21:49:49 2012	FC, LS+BO, 2sig
13	542590	2749.4	286.141	64.658	152763	Mon May 7 17:30:48 2012	Outgoing, LS+BO
14	259010	1246.8	672.817	41.3872	391564	Tue May 8 10:15:16 2012	Outgoing, LS+BO
15	122350	918.9	850.004	176.745	-76227.8	Wed May 16 01:48:10 2012	Outgoing, LS+BO
16	6482	26.651	726.453	801.535	-34332.8	Thu May 17 16:52:16 2012	Outgoing, BO
17	152470	692.37	627.126	21.0208	-148901	Thu Jun 7 15:48:08 2012	Outgoing, LS+BO

Vertex distribution



Neutrino Interactions

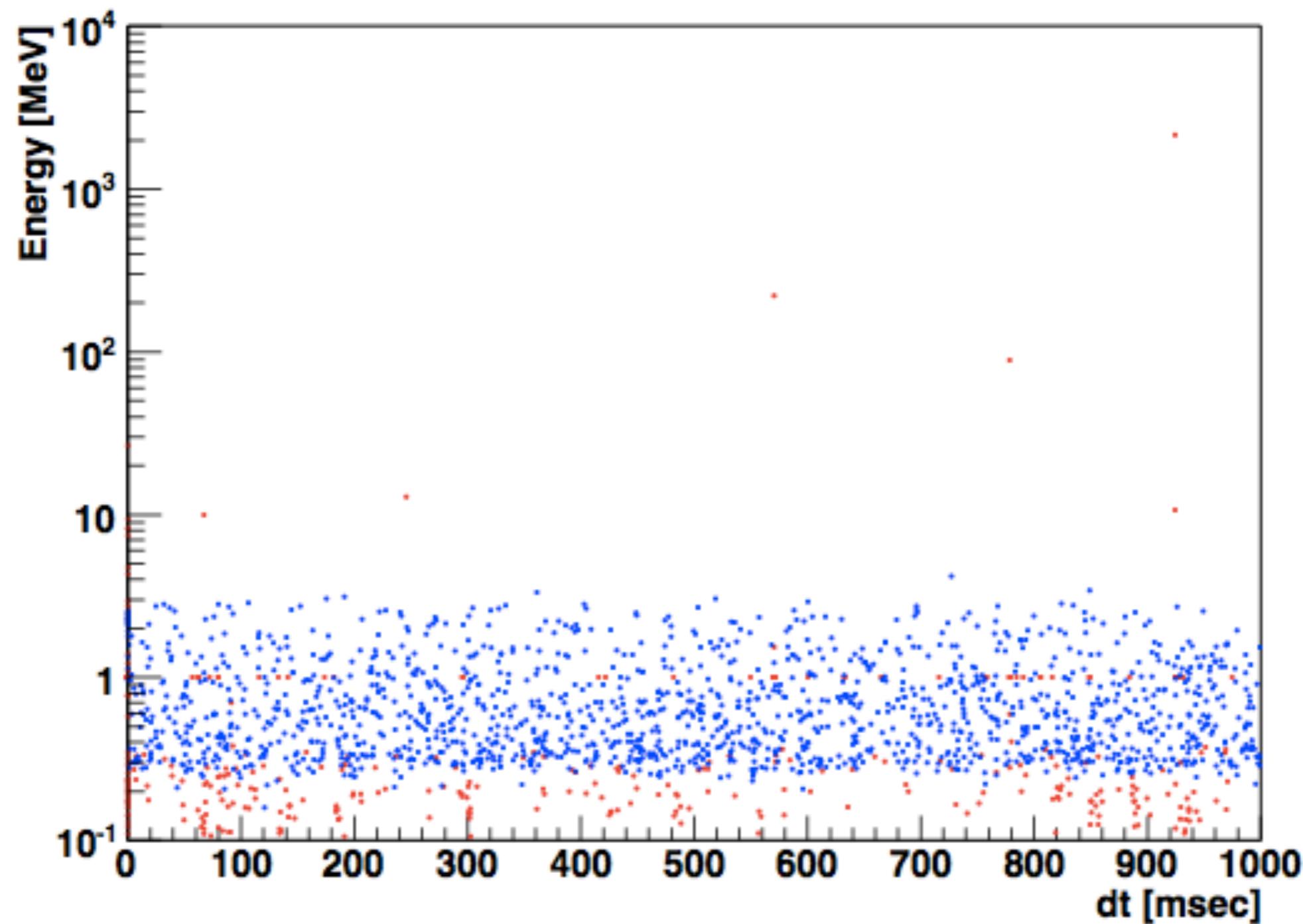
CCQE	$\nu_\mu + n \rightarrow \mu^- + p$
NCE	$\nu_\mu + p(n) \rightarrow \nu_\mu + p(n)$
CC1 π^+	$\nu_\mu + p(n) \rightarrow \mu^- + \pi^+ + p(n)$
CC1 π^0	$\nu_\mu + n \rightarrow \mu^- + \pi^0 + p$
NC1 π^\pm	$\nu_\mu + p(n) \rightarrow \nu_\mu + \pi^+(\pi^-) + n(p)$
NC1 π^0	$\nu_\mu + p(n) \rightarrow \nu_\mu + \pi^0 + p(n)$
Multi π	$\nu_\mu + p(n) \rightarrow \mu^- + N\pi^\pm + X$

CCQE	$\nu_\mu + {}^{12}\text{C} \rightarrow \mu^- + {}^{12}\text{N}$
NCE	$\nu_\mu + {}^{12}\text{C} \rightarrow \nu_\mu + {}^{12}\text{C}$
NCE	$\nu_\mu + p \rightarrow \nu_\mu + p$
CC1 π^+	$\nu_\mu + {}^{12}\text{C} \rightarrow \mu^- + \pi^+ + {}^{12}\text{C}$
CC1 π^+	$\nu_\mu + p \rightarrow \mu^- + \pi^+ + p$
CC1 π^0	$\nu_\mu + {}^{12}\text{C} \rightarrow \mu^- + \pi^0 + {}^{12}\text{N}$
NC1 π^\pm	$\nu_\mu + {}^{12}\text{C} \rightarrow \nu_\mu + \pi^\pm + {}^{12}\text{B}$
NC1 π^\pm	$\nu_\mu + {}^{12}\text{C} \rightarrow \nu_\mu + \pi^\mp + {}^{12}\text{N}$
NC1 π^\pm	$\nu_\mu + p \rightarrow \nu_\mu + \pi^\pm + n$
NC1 π^0	$\nu_\mu + {}^{12}\text{C} \rightarrow \nu_\mu + \pi^0 + {}^{12}\text{C}$
NC1 π^0	$\nu_\mu + p \rightarrow \nu_\mu + \pi^0 + p$
Multi π	$\nu_\mu + {}^{12}\text{C} \rightarrow \mu^- + N\pi^\pm + X$

${}^{12}\text{N}$: 10.0 msec 17.3 MeV ($\beta+$)

${}^{12}\text{B}$: 20.2 msec 13.3 MeV ($\beta-$)

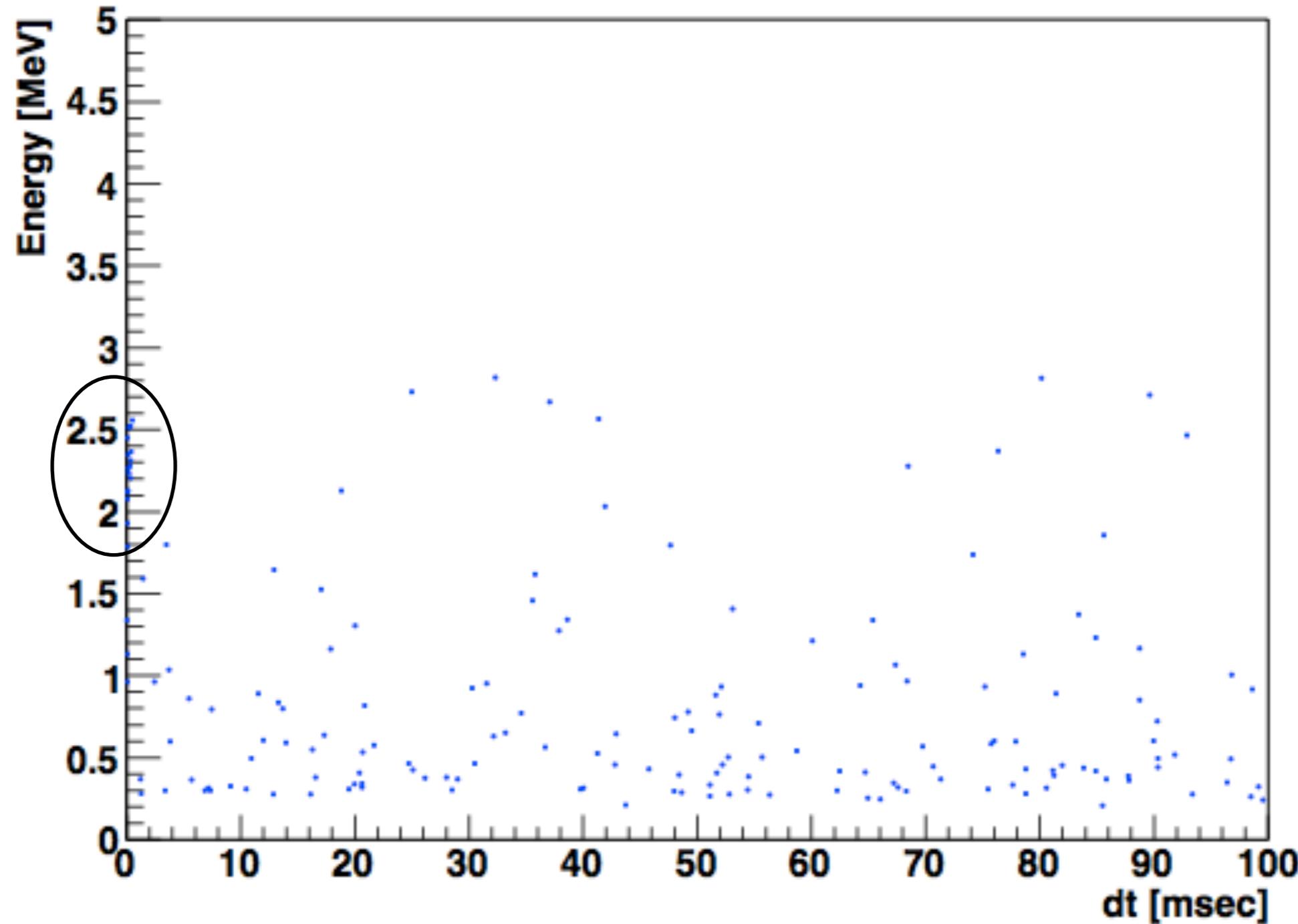
Events after 1 sec



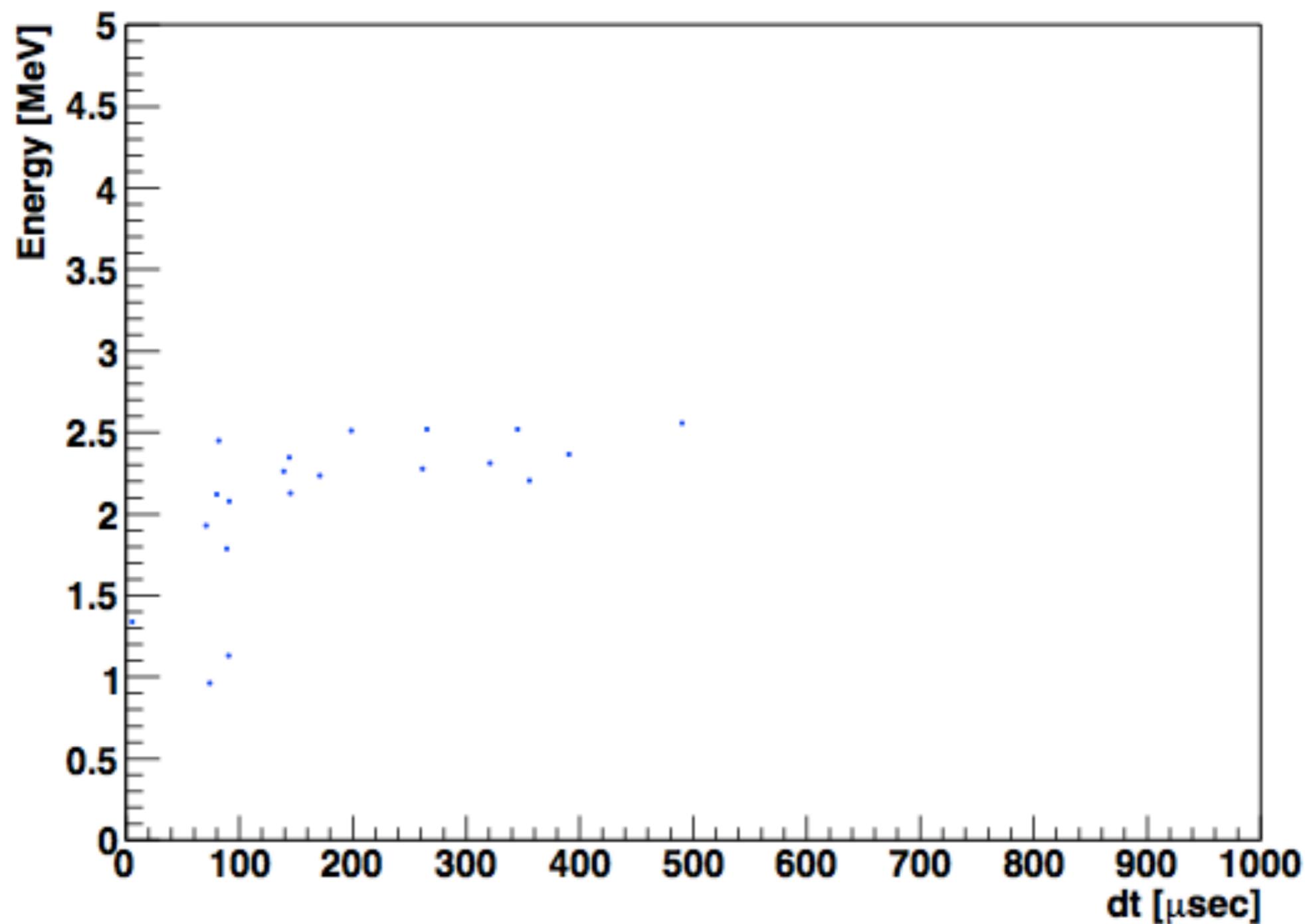
Red: Ringing, Noise, Flasher Events

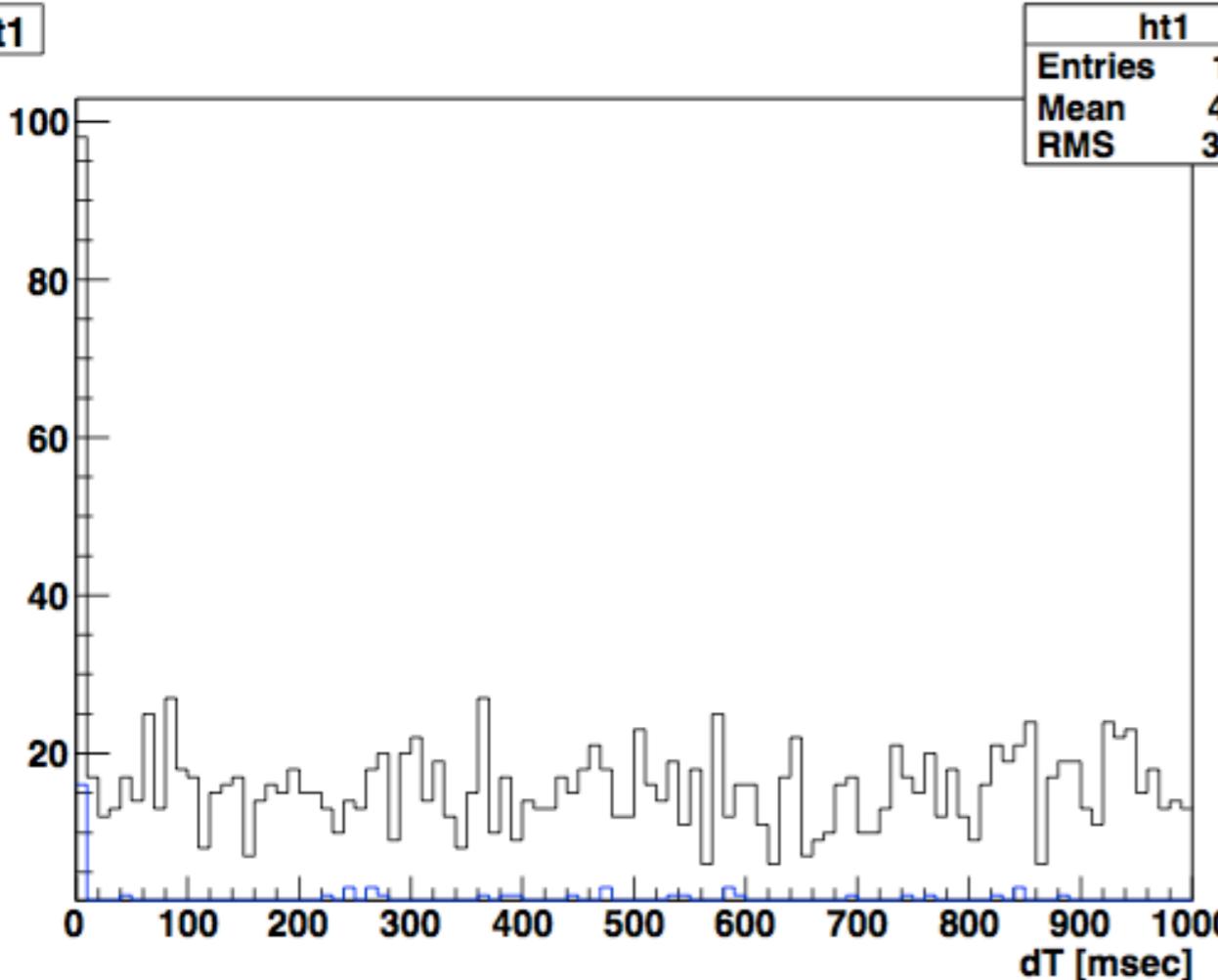
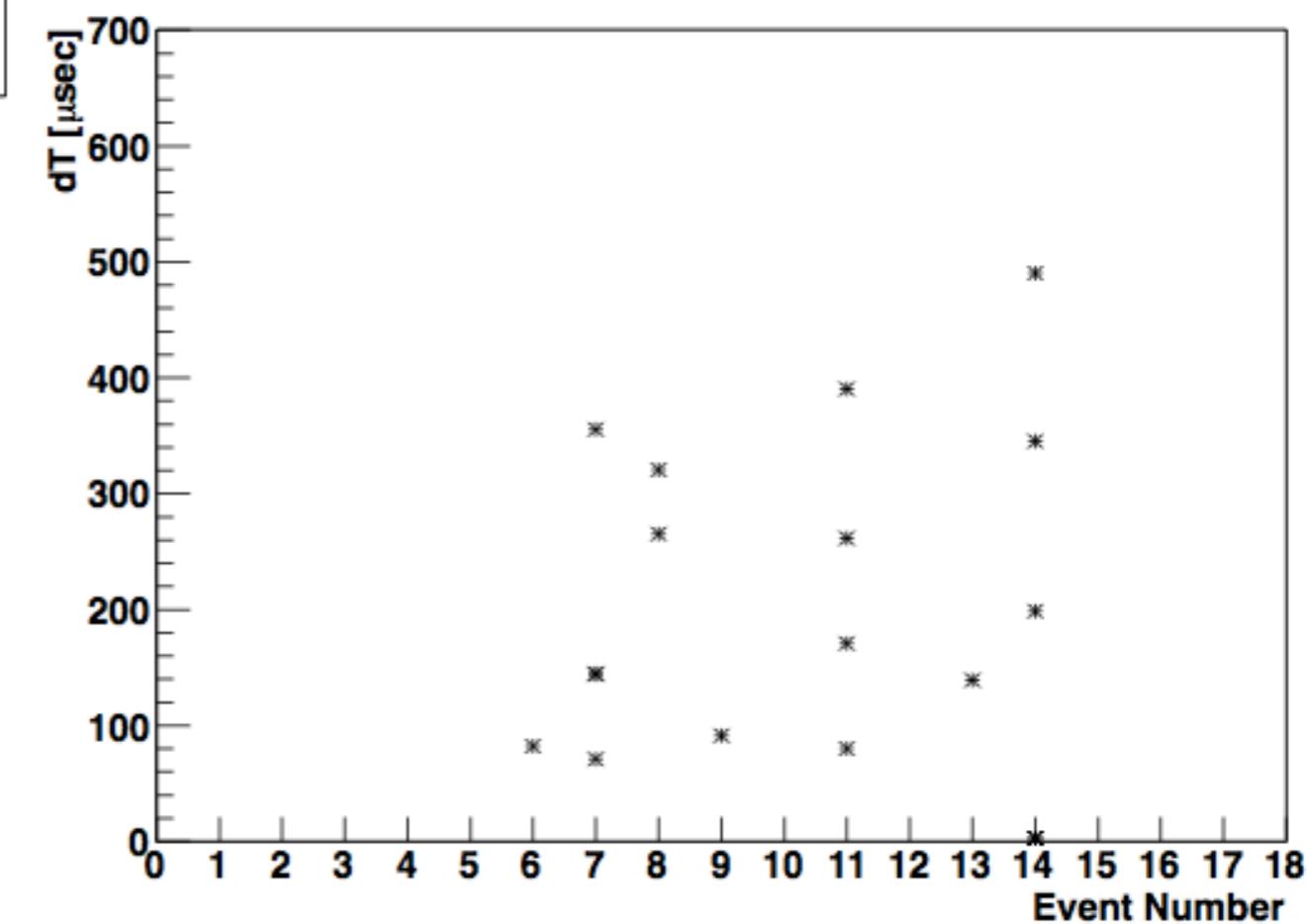
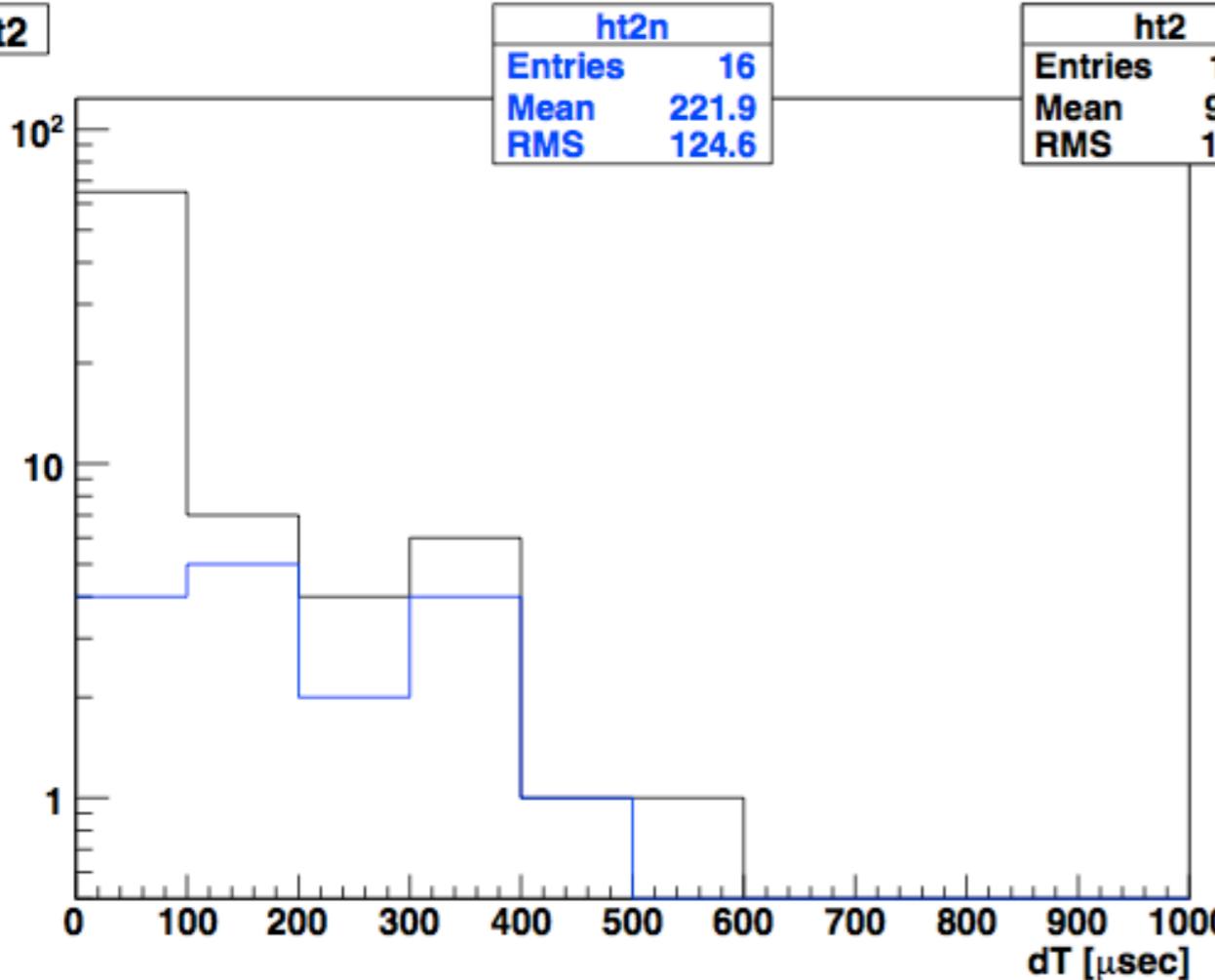
Events after 100 msec

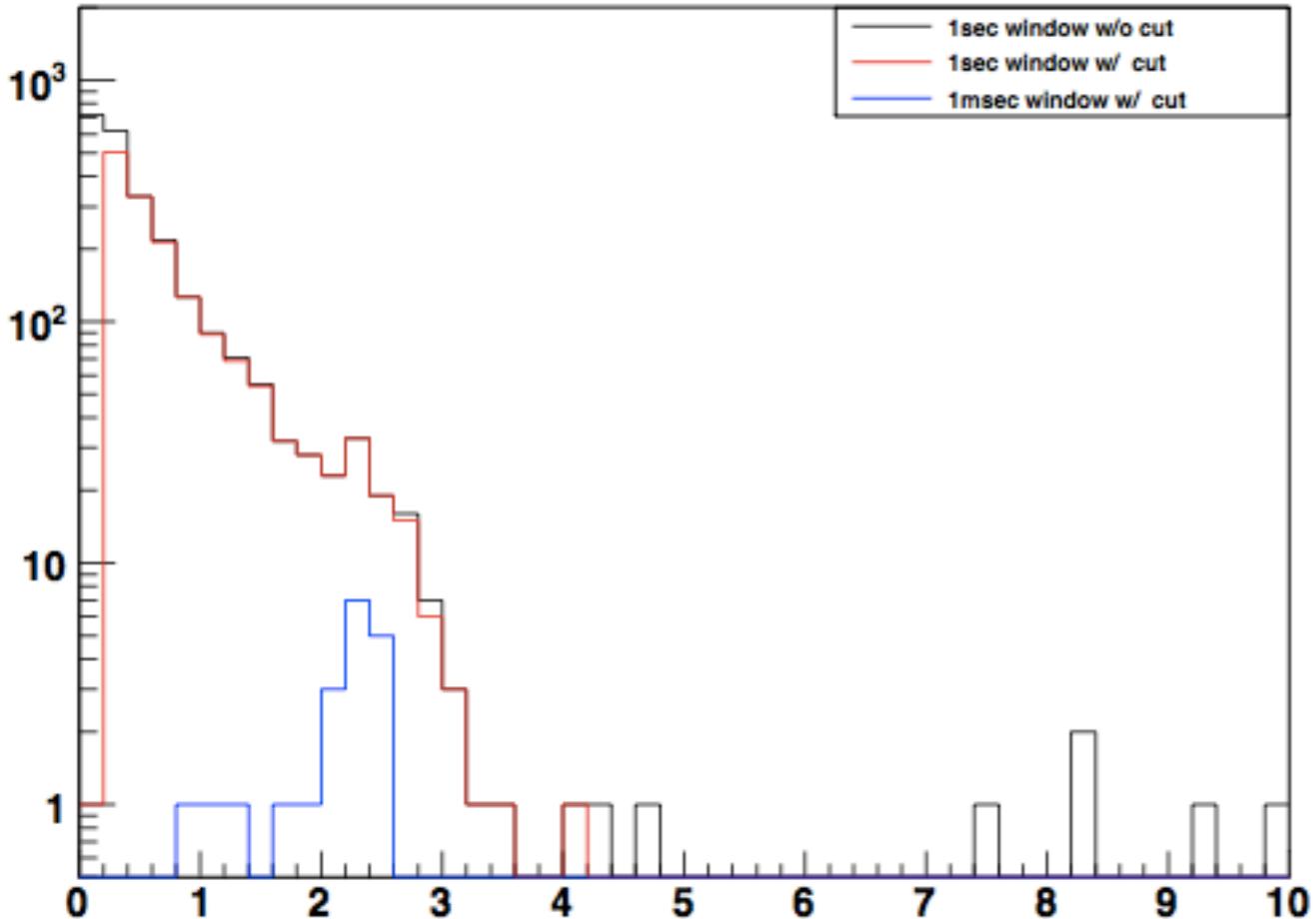
$^{12}\text{N}/^{12}\text{B}$ window



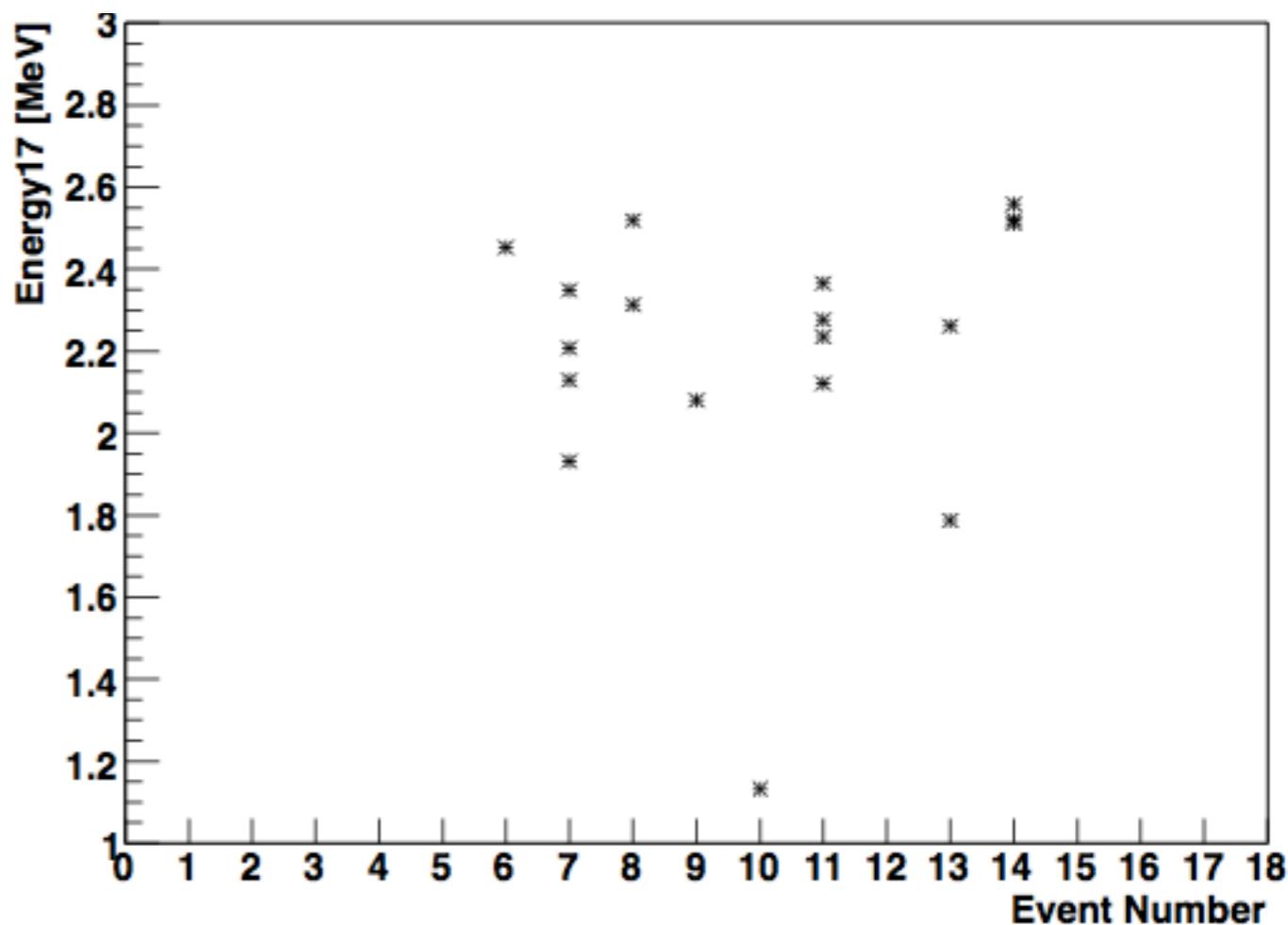
Neutrons



ht1**ht2**



Many neutron observed.
 $^{12}\text{N}/^{12}\text{B}$ tagging is hard
because of spallation
interaction from target
Carbon.



Summary

- 14 T2K-induced event observed.
- Neutrino type, energy and interaction has not determined yet.

To Do for data

- Check $n \geq 2000$ OD events
- Discrimination going through / stopping event
- Single / Double pulse
- Delayed event (n capture, decay electron) search
- MoGURA data

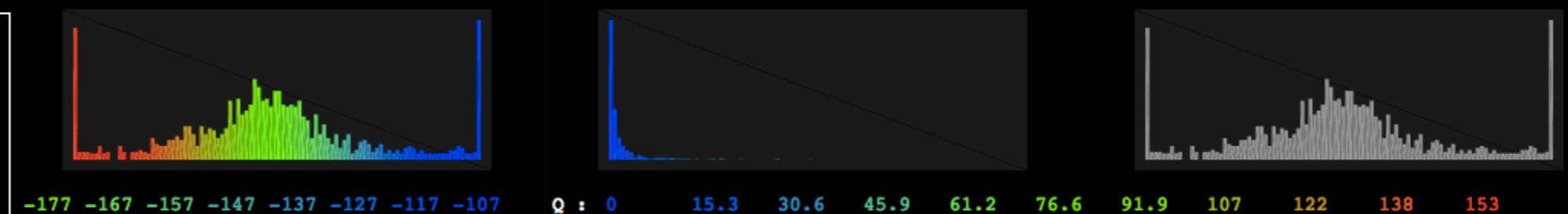
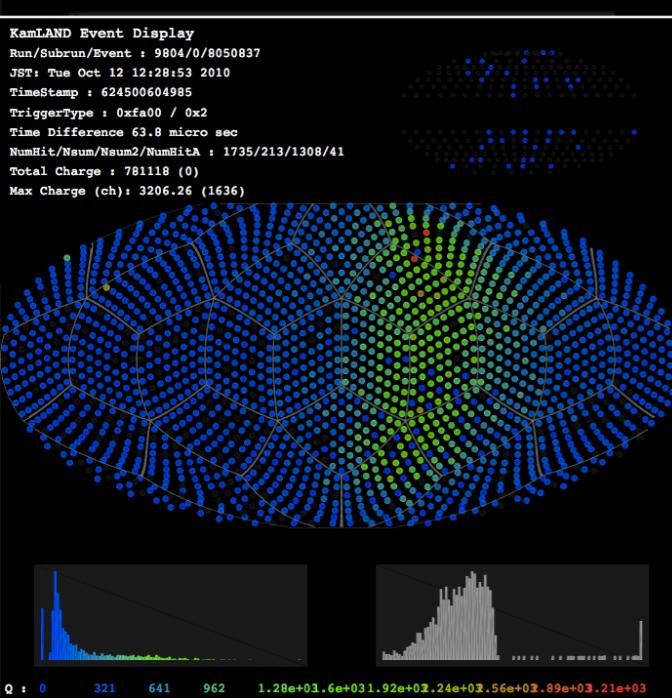
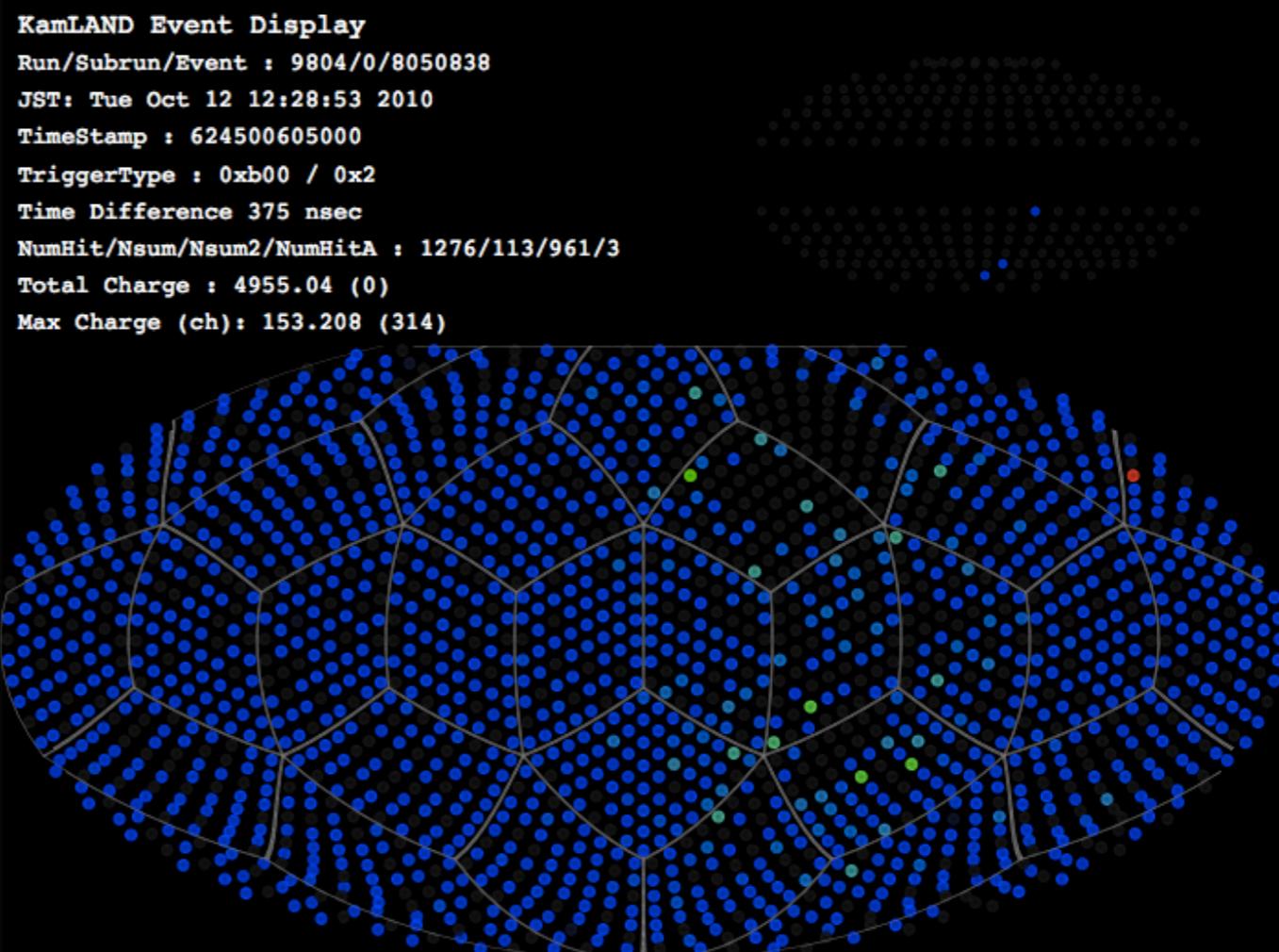
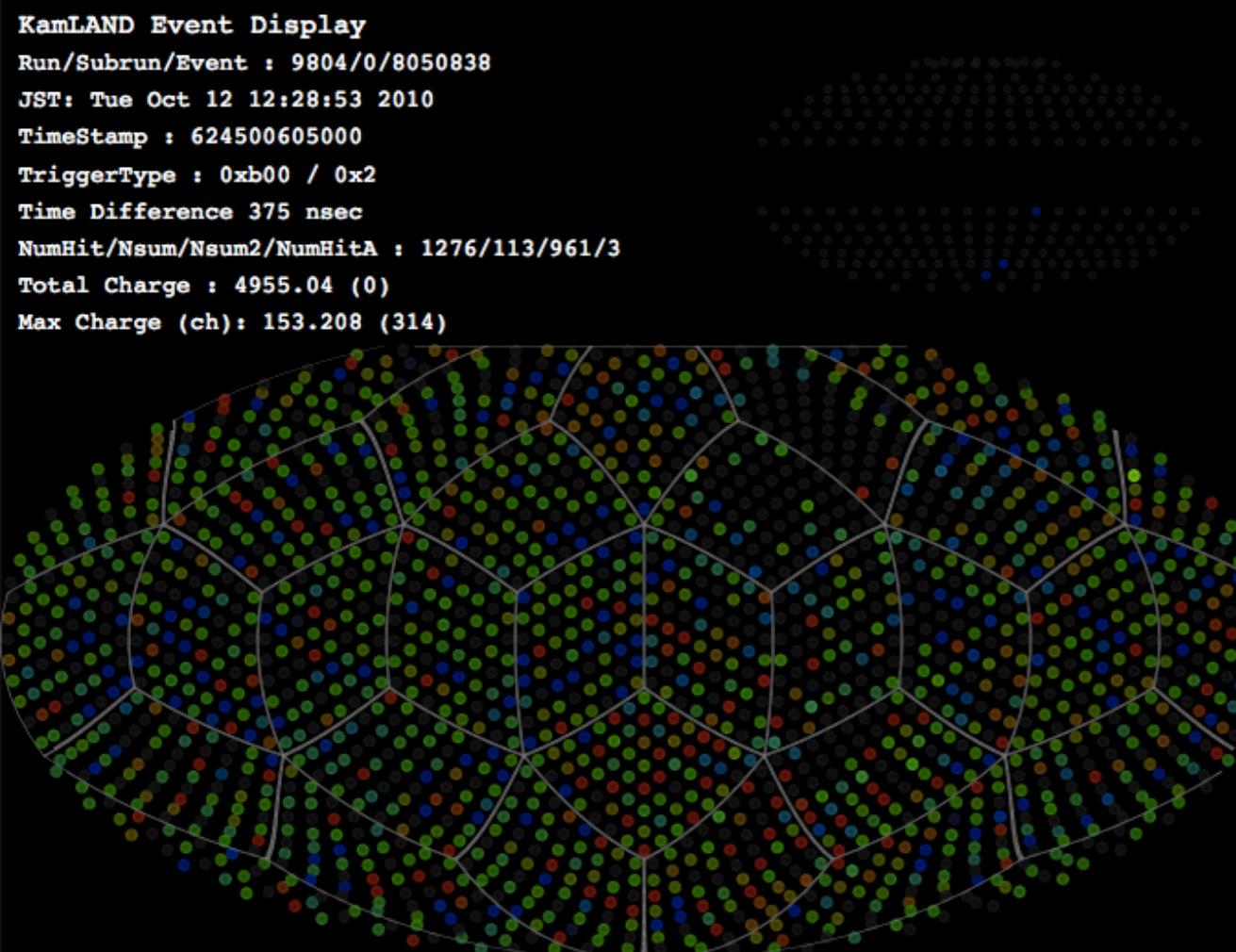
To Do for simulation

- Simulate neutrino interaction.
- FBE/MoGURA DAQ

Event displays

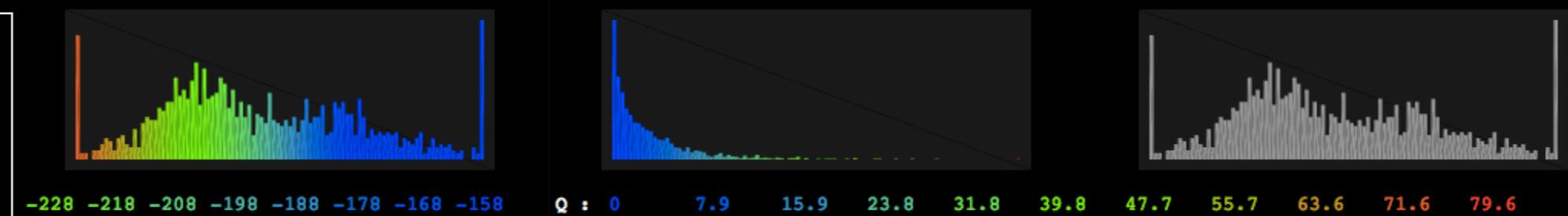
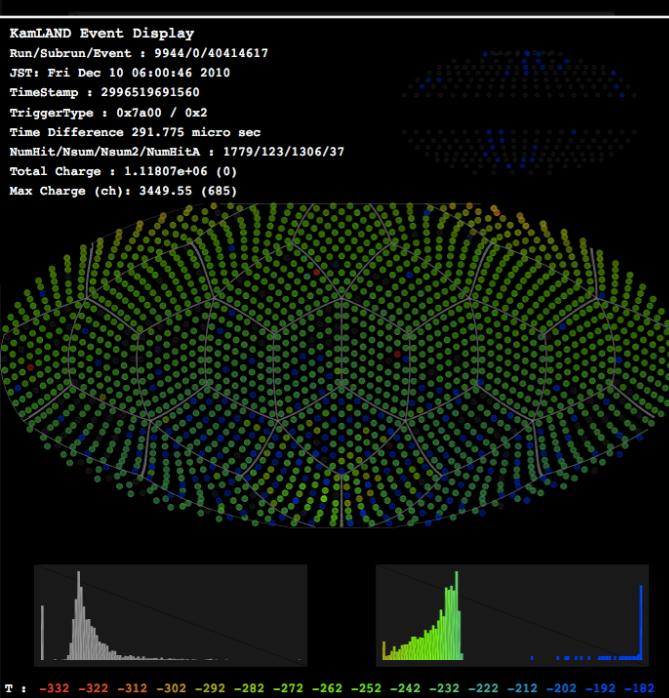
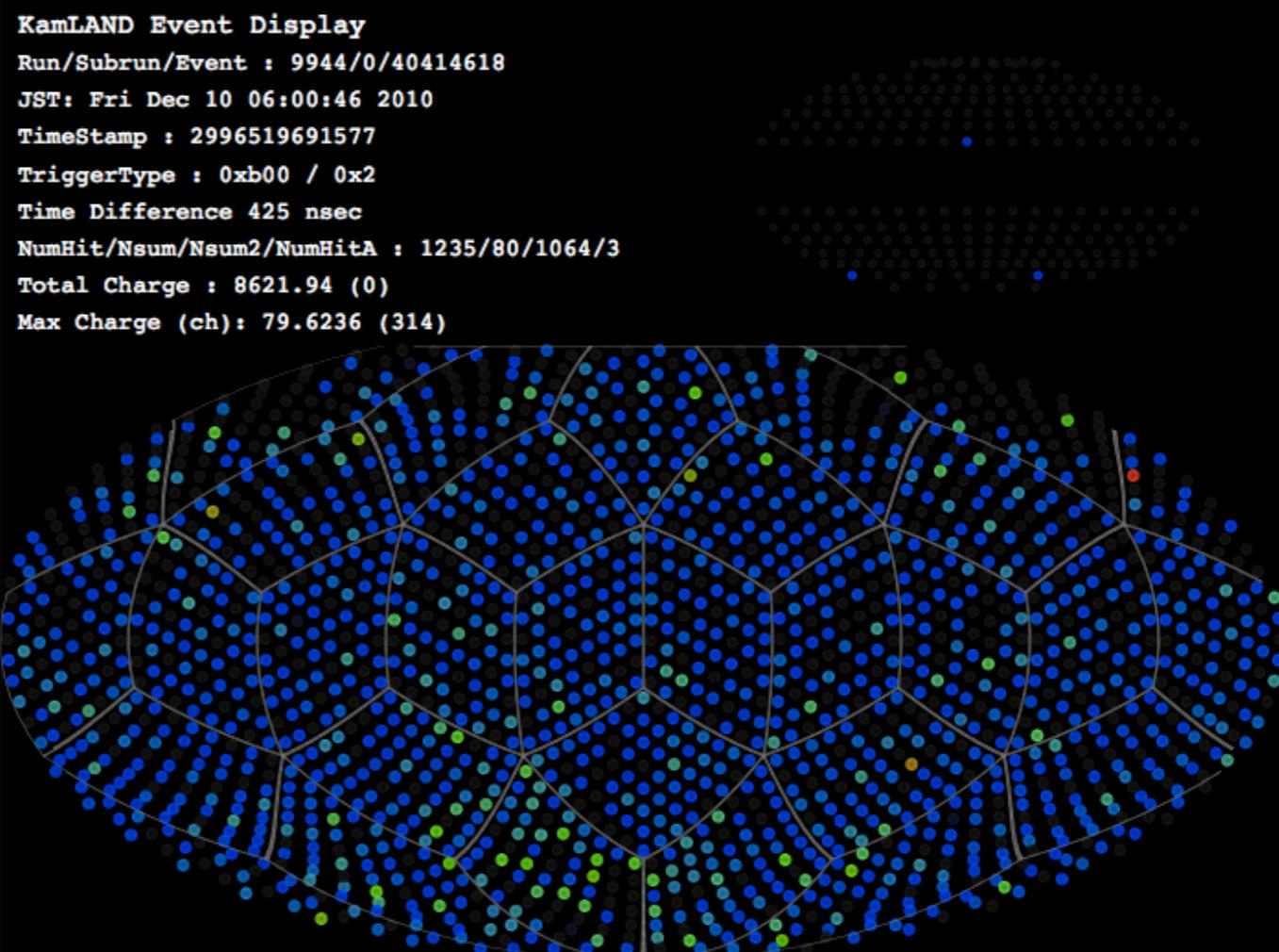
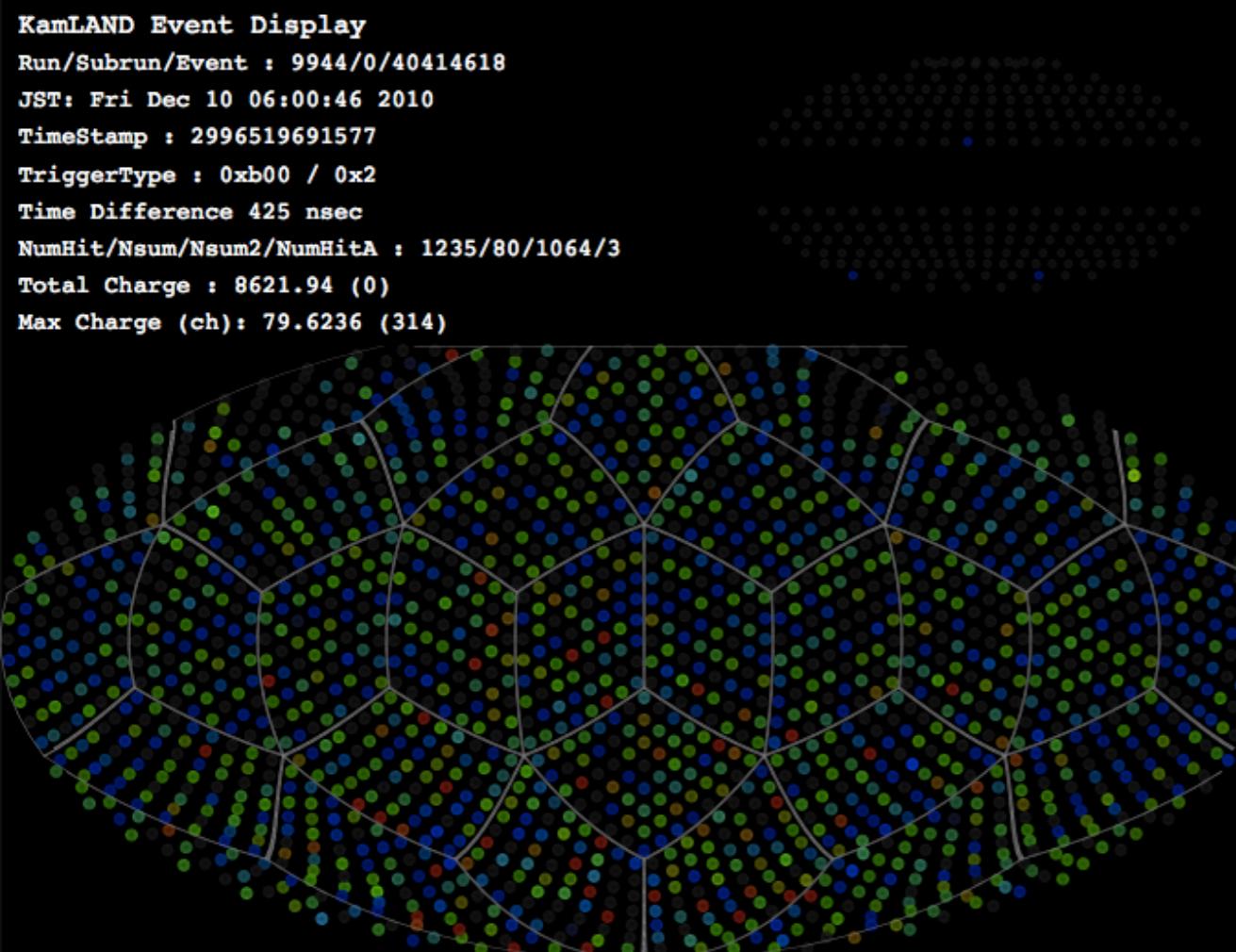
0

fake mu



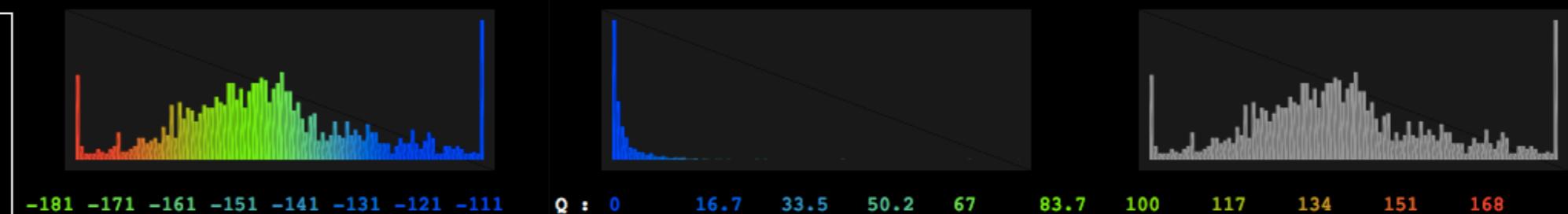
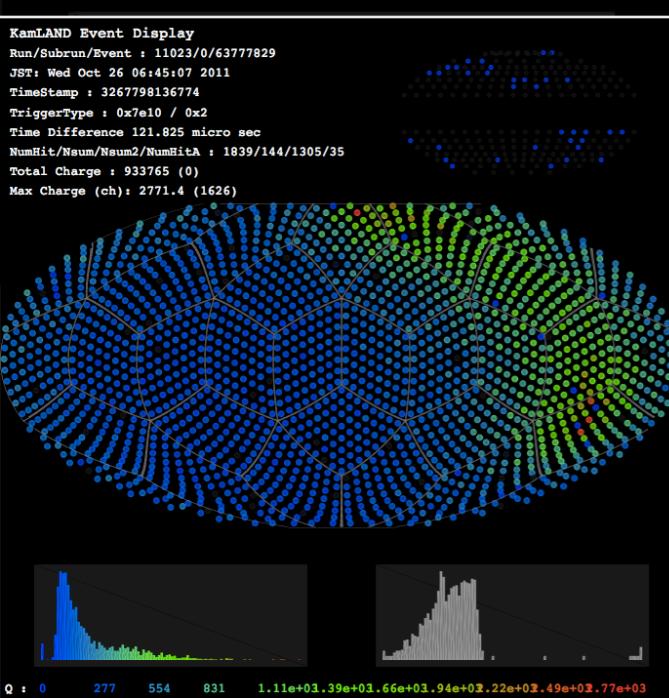
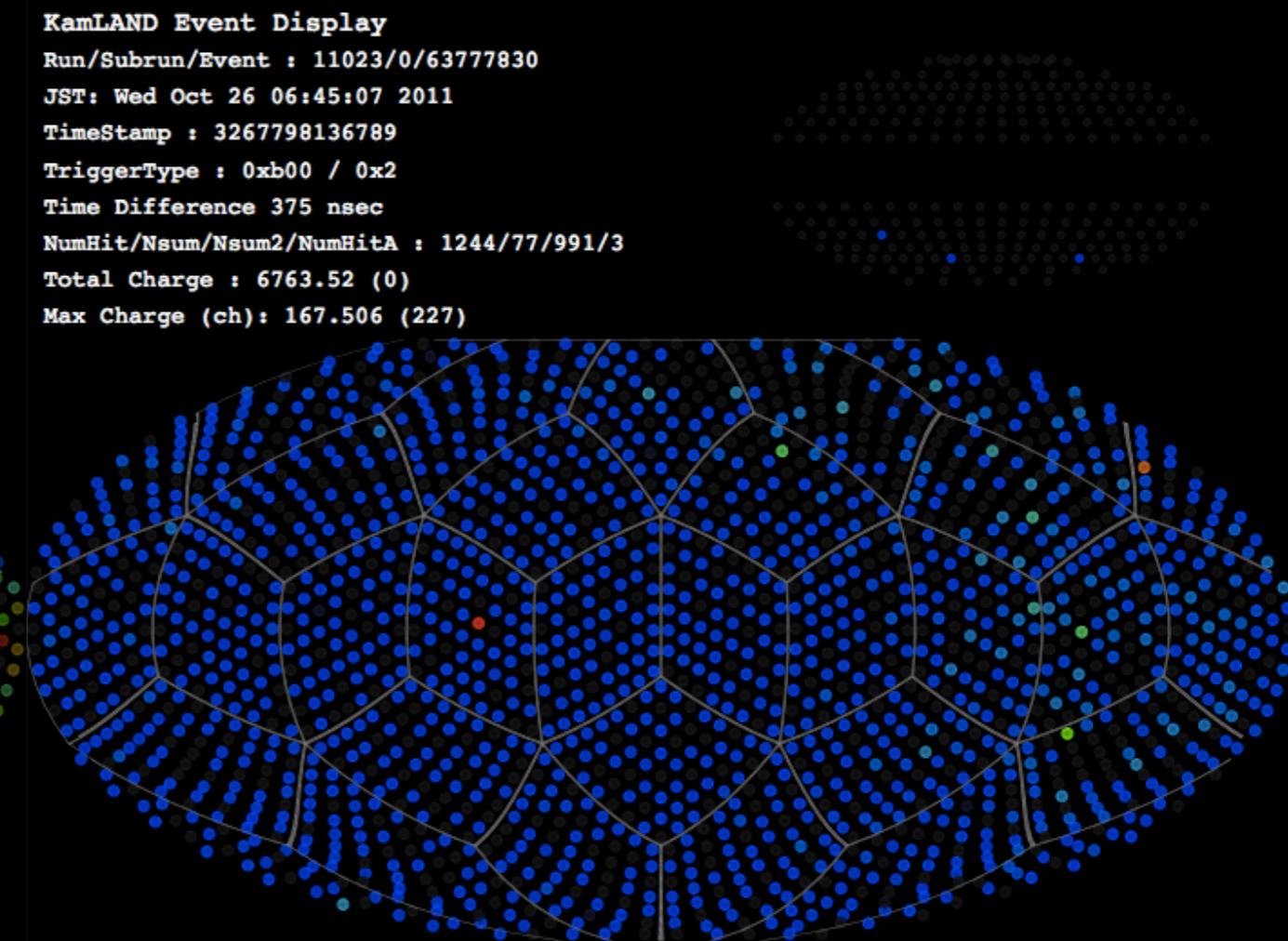
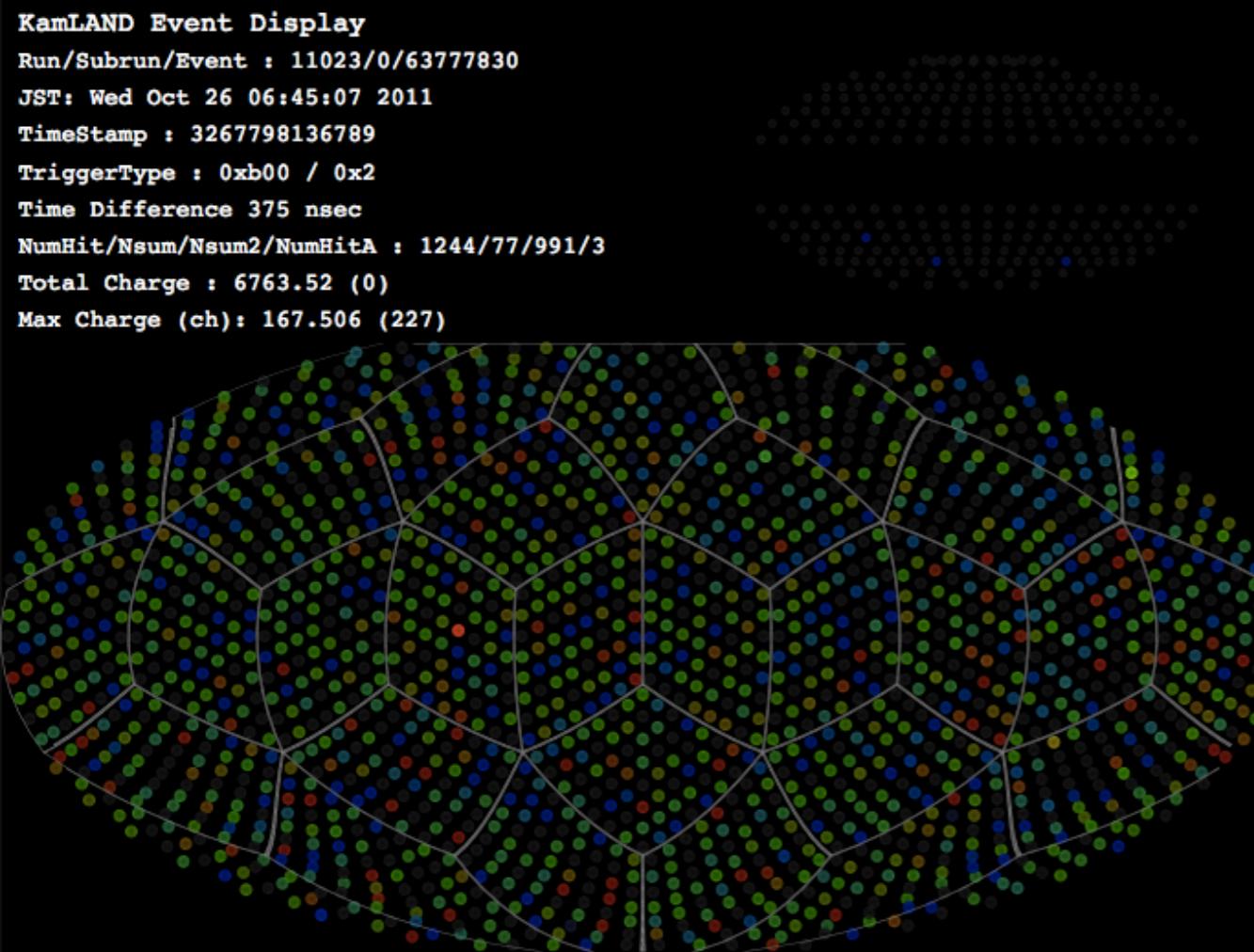
1

fake mu



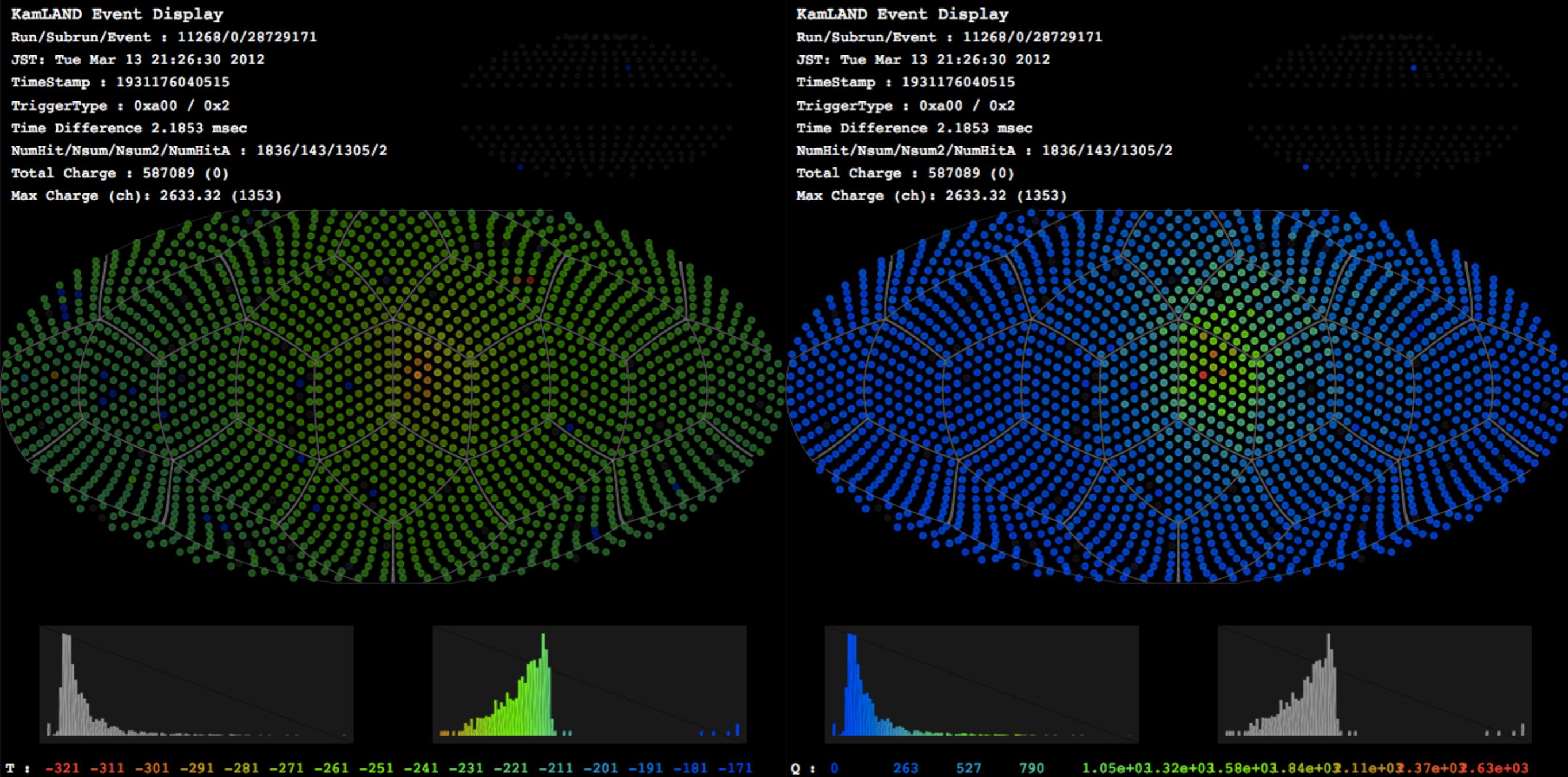
2

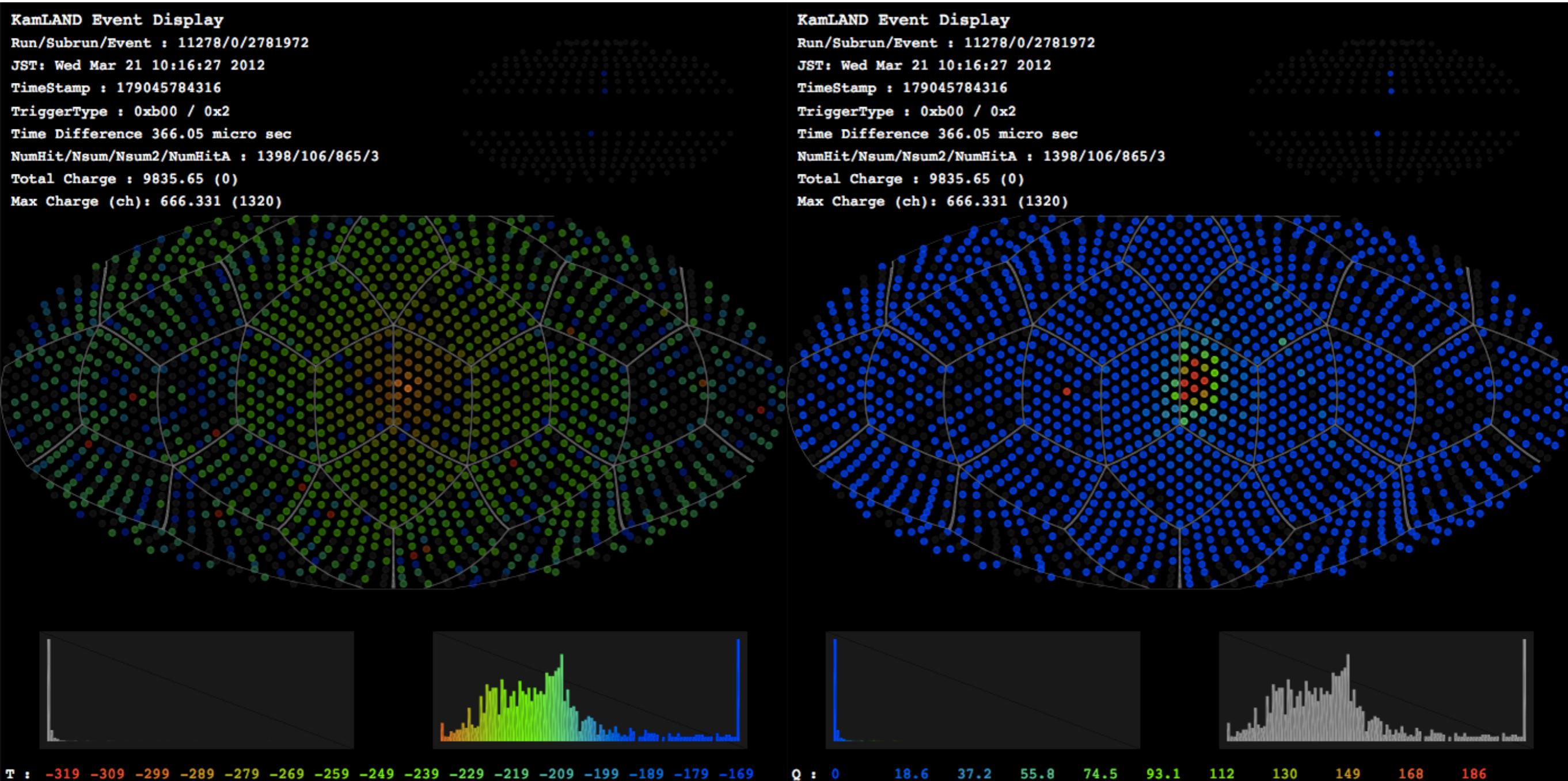
fake mu



3

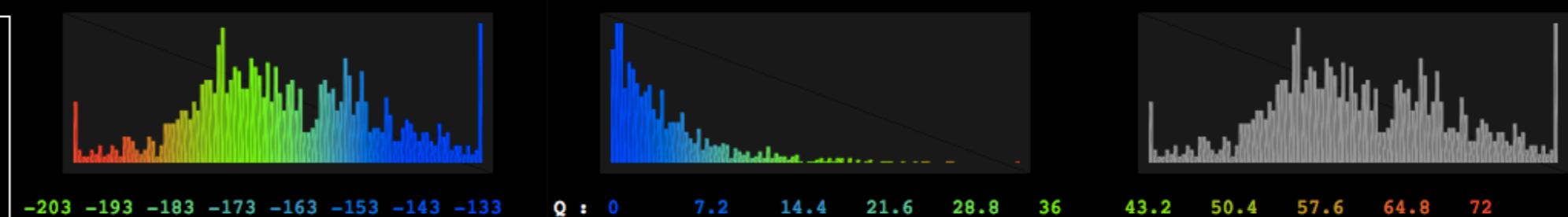
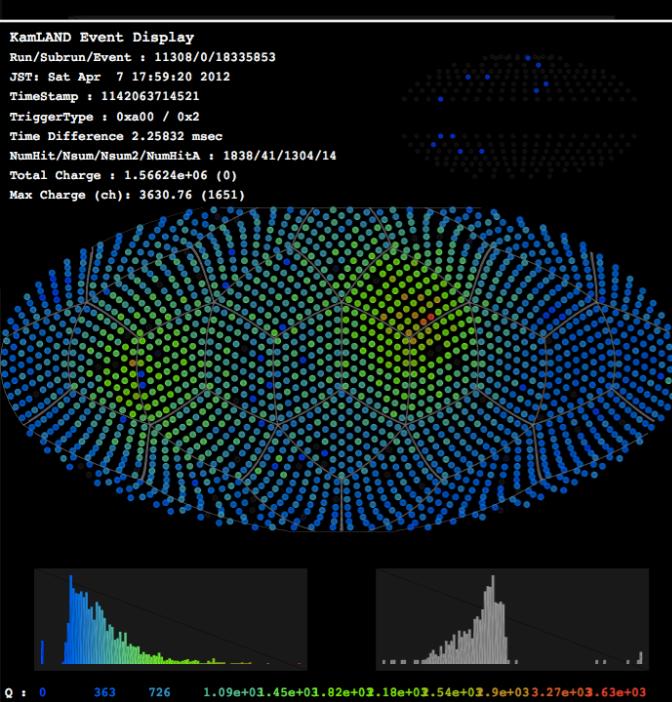
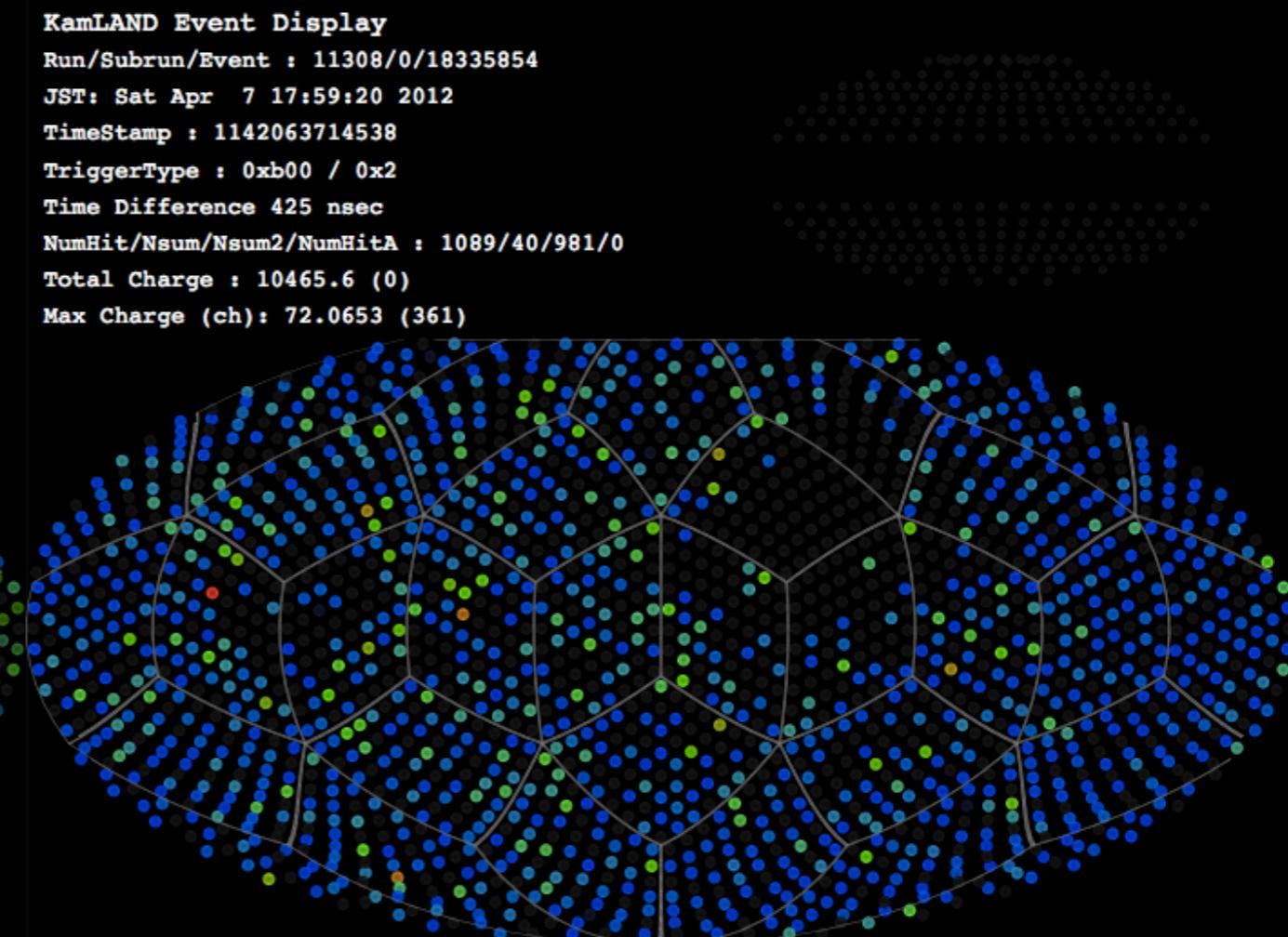
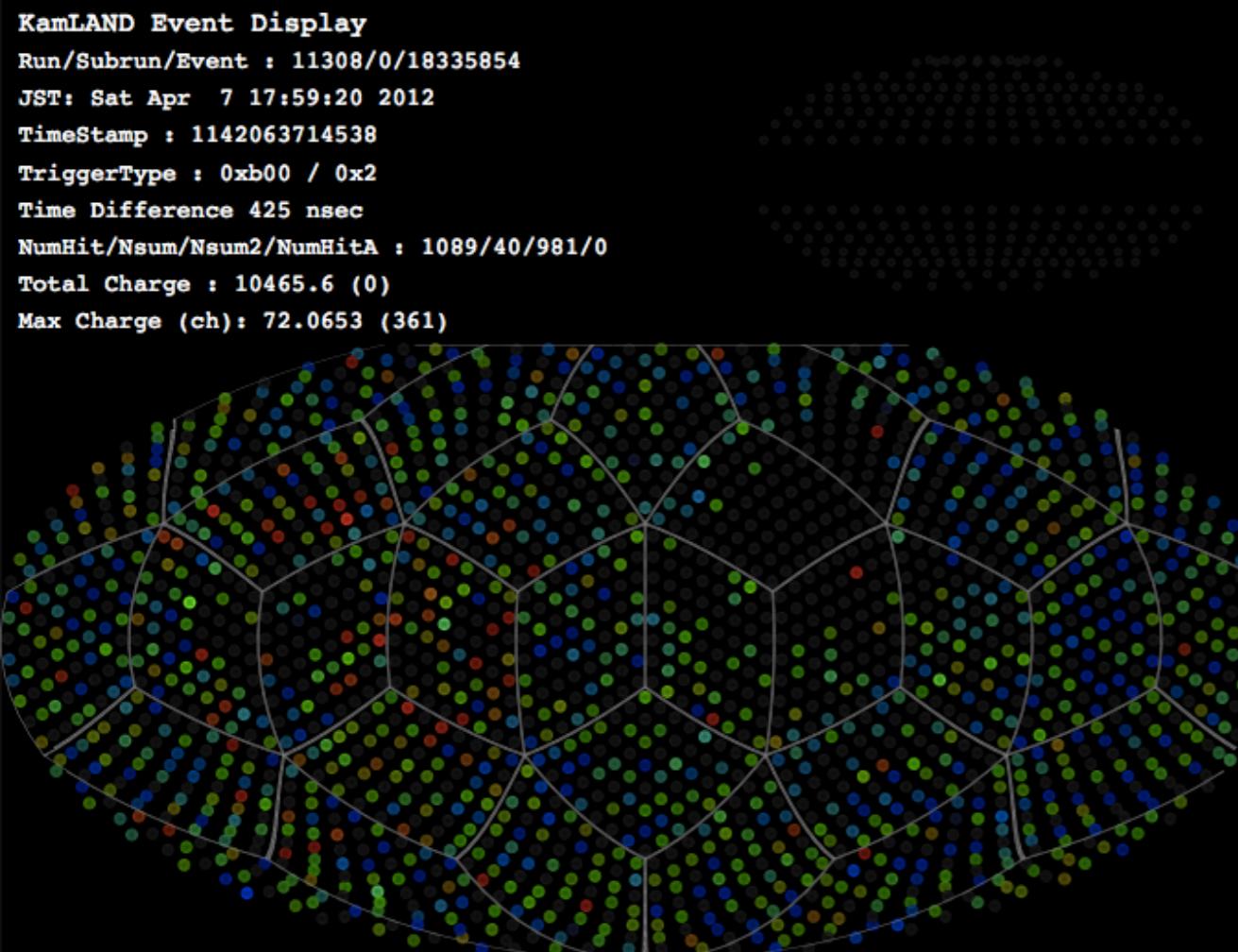
outgoing,LS+BO

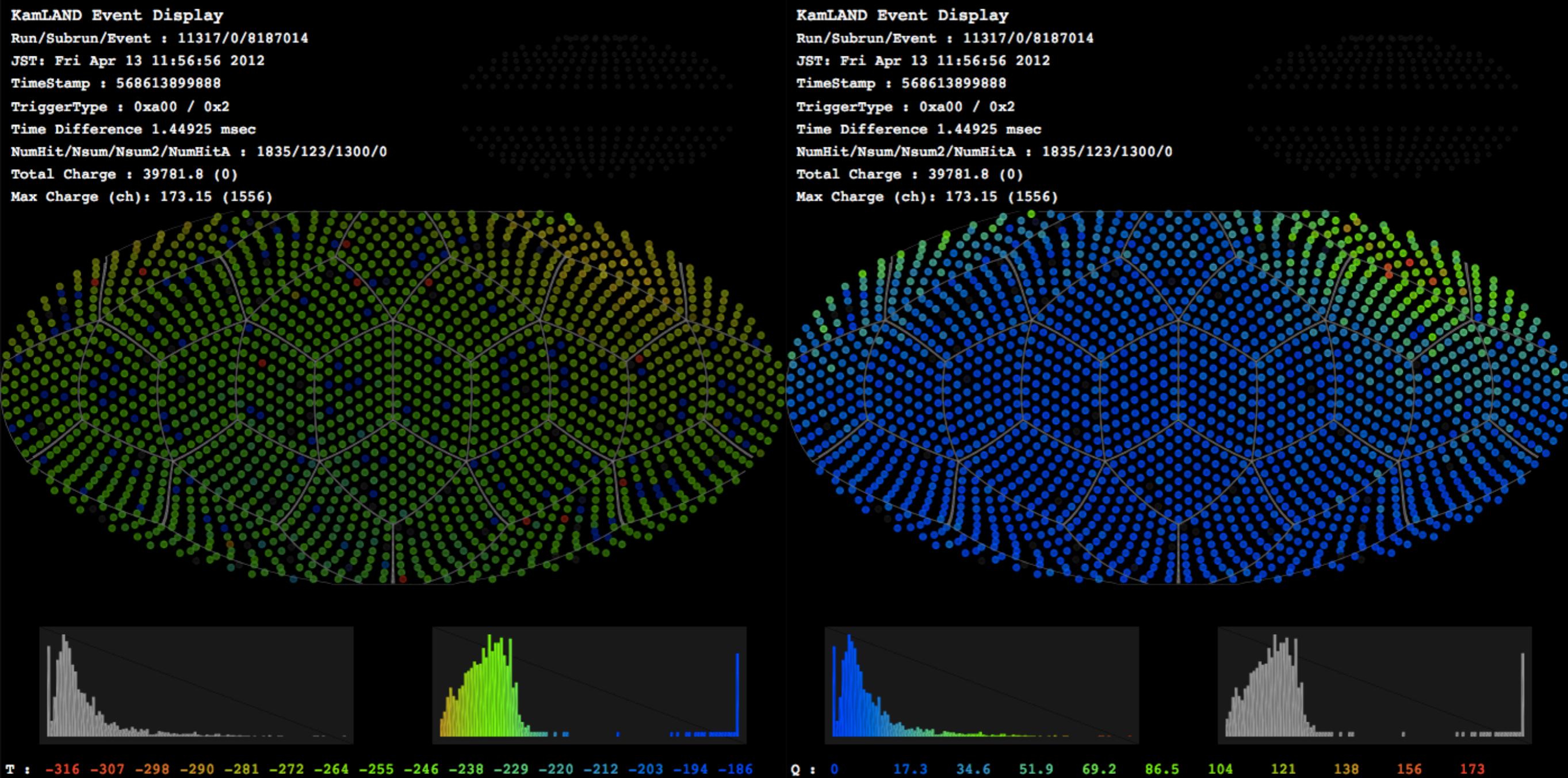


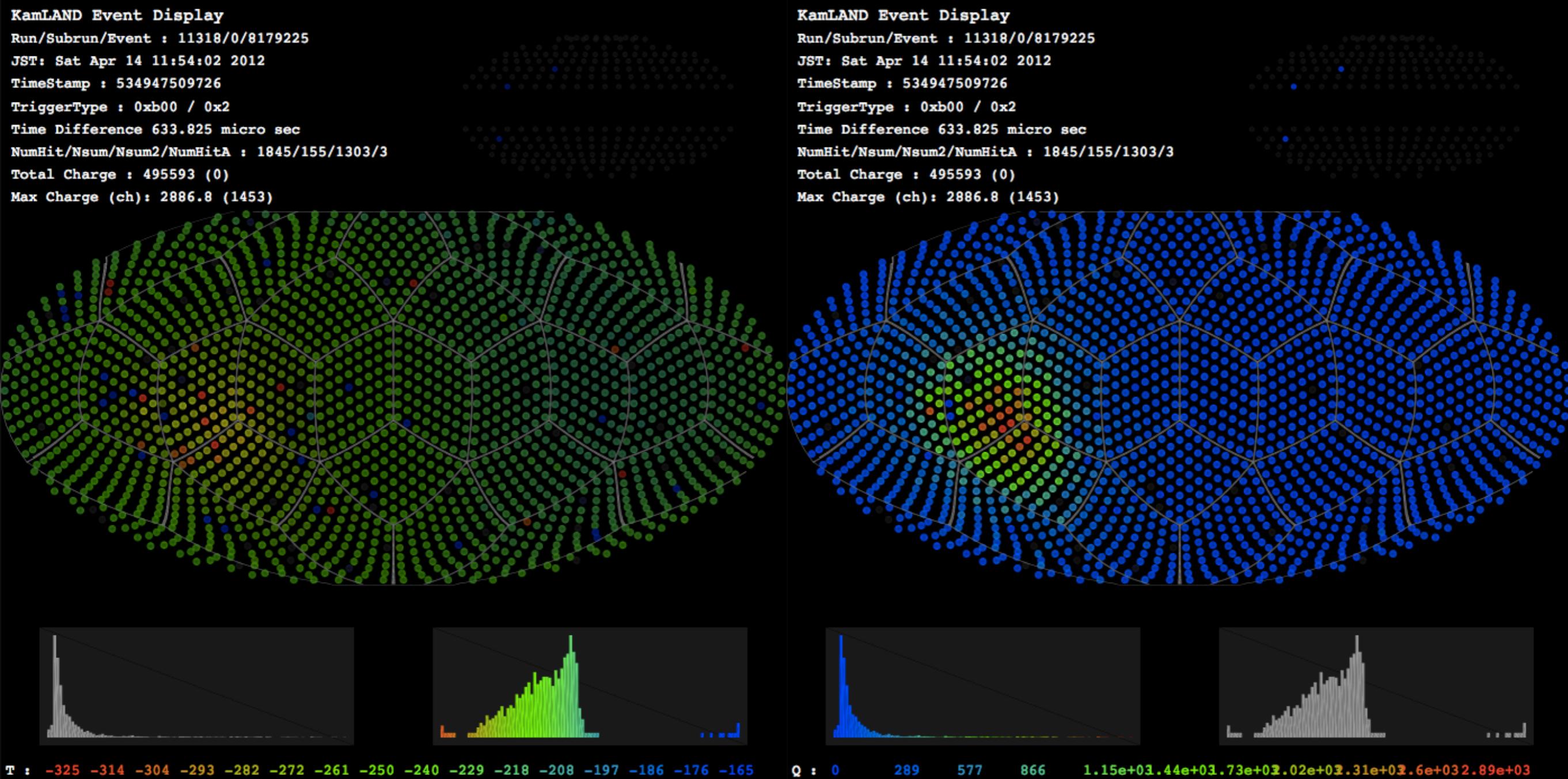


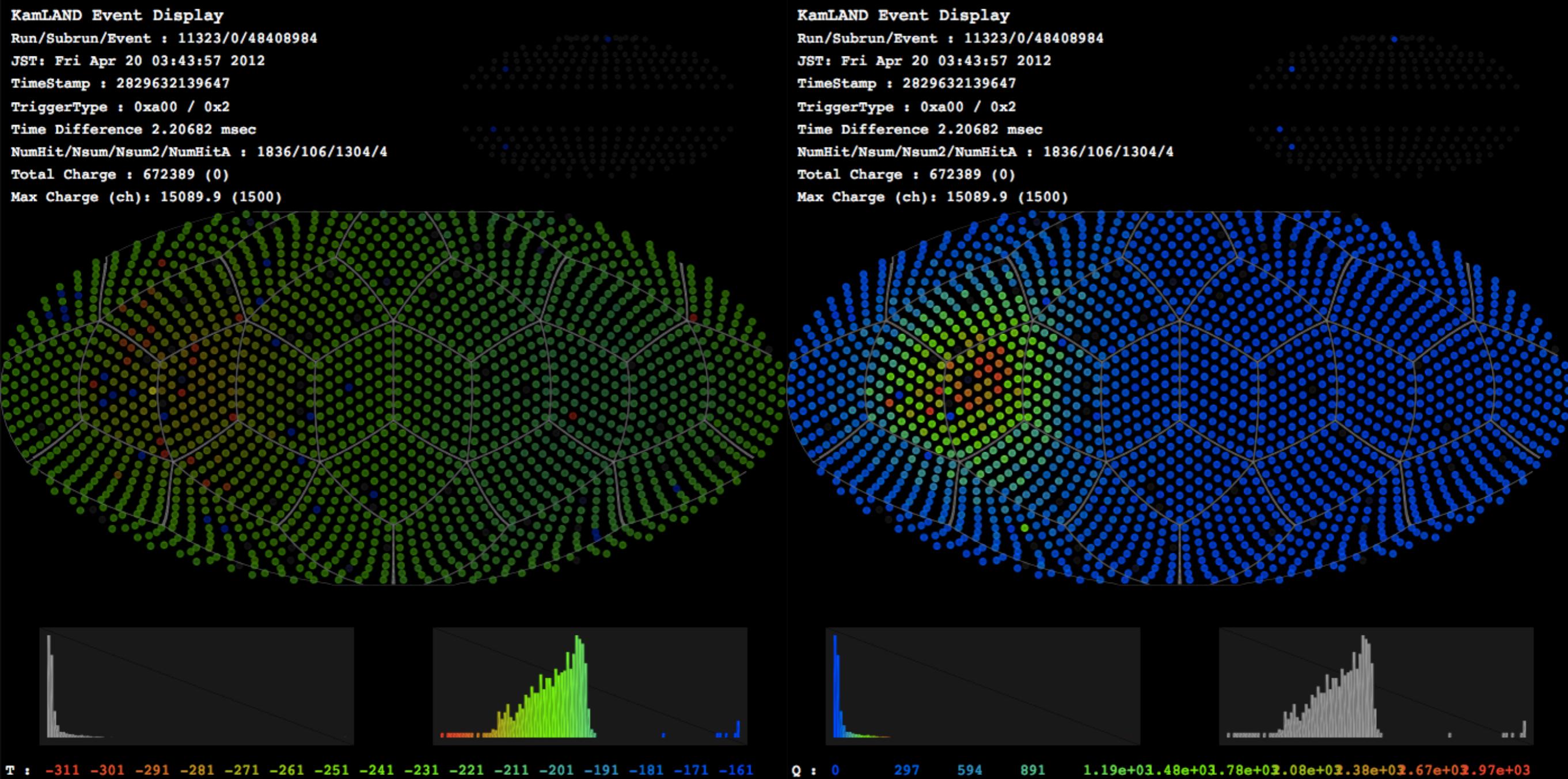
5

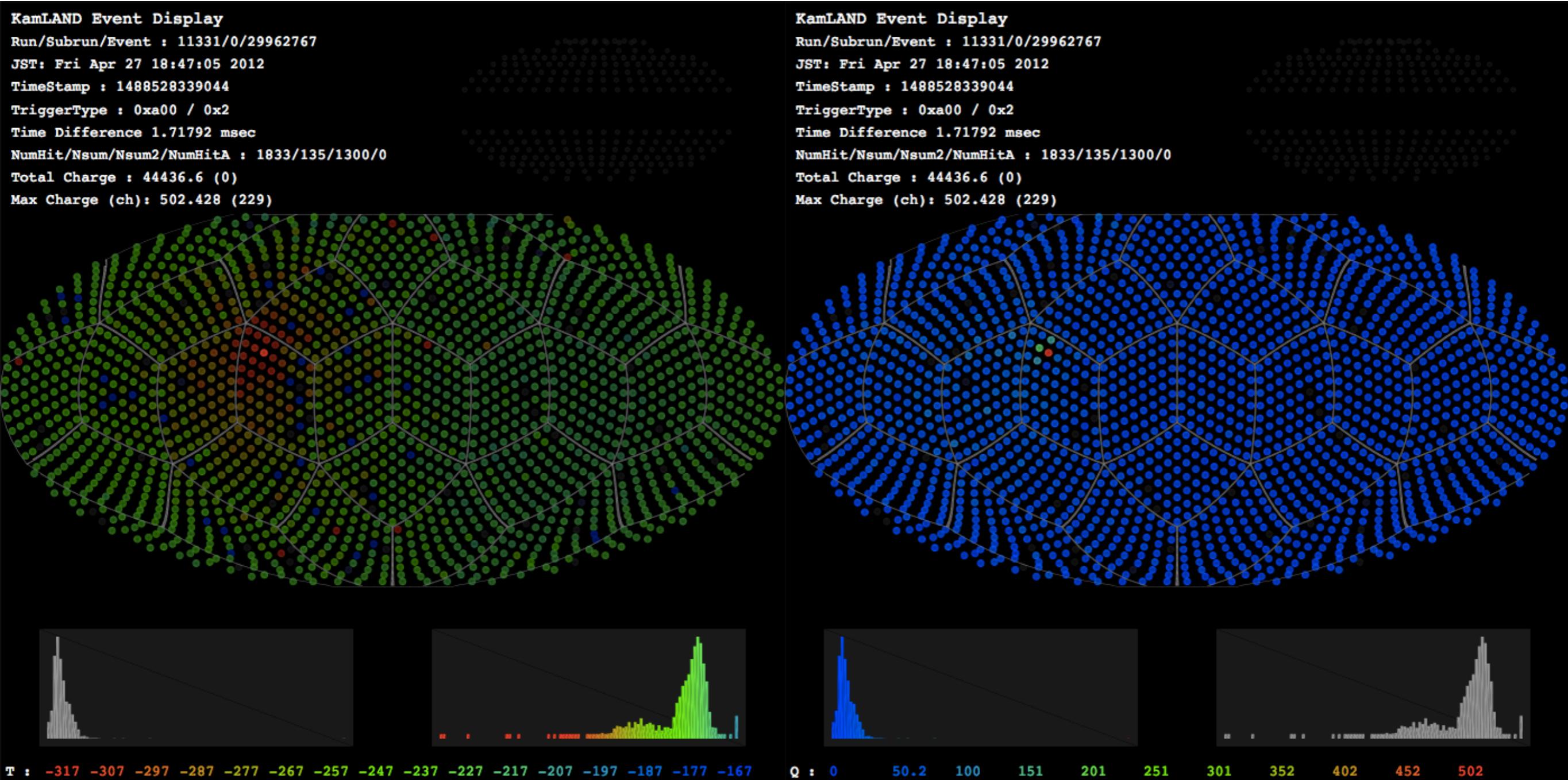
fake mu











10

outgoing,LS+BO

