

Experiment 949-PNN2  
Technical Note No. xxx Single Cut Failure Benji Lewis

Abstract

## 1 Introduction

## 2 implementation

- Protect against observing inside of box.

Do test run(s) on a sample with an inverted cut (do not include the inverted cut in the cut list).

- Study will never include cuts that may be removed, such as *ev5*, *chi5max*.

Need to obtain this list.

- Initial study not consider cuts that have a high chance of being changed soon or later, such as *ccd pul*.

Need to obtain this list.

- Only consider the loosest cuts. i.e. Big & Small boxes.

TDNN

PNN2-Box

Photon-Veto

DELCO

CHI567

UTCqual

- Grouping highly correlated hits. i.e. an event fails only 3 highly correlated cuts then consider this as a 1 cut failure.

- Setup cuts

Bad\_Run

SKIM(5) or SKIM(6) or SKIM(7) for 1/3 and SKIM(1) or SKIM(2) or SKIM(3) for 2/3 sample.

## 2.1 Cut List & Grouping of Cuts

Grouping cuts such that if any combination of a group will only count as a one cut failure will yield a larger set of one-cut failure events than a basic one-cut failure study, as was done in E787-PNN2. We have decided to group the cuts into 13 groups. 6 of these groups are single cuts (not grouped), 3 groups are groups of two or three cuts, the other groups are TD cuts, Kinematic cuts, Beam cuts, and Other cuts. The list of all cuts used are shown in the following tables.

| Cut Groups            |                           |
|-----------------------|---------------------------|
| Cut name              | additional info           |
| $PNN2Box_{loose}$     | Loose version (E949 box)  |
| PV(no AD, no TG)      | Loose version             |
| PV(AD)                |                           |
| DELCO-3               | Loose Version. delc+DELO3 |
| B4EKZ                 |                           |
| TGZfool               |                           |
| Extra Target Energy   | see Table 2               |
| Energy in Kaon fibers | see Table 2               |
| Target/IC             | see Table 2               |
| TD cuts               | see Table 3               |
| Kinematics            | see Table 4               |
| Beam                  | see Table 5               |
| Other                 | TG cuts, see Table 6      |

Table 1: Cut Groups used in 1 and 2 cut failure studies.

| Small Groups              |  |
|---------------------------|--|
| Cut name                  | additional info                            |
| $TGPV_{loose}$<br>OPSveto | Extra energy in TG due to other particles  |
| CCDPUL<br>EPIONK<br>TIMKF | Energy under the Kaon related.             |
| TGCEO<br>KIC              | Pathological beam events entering thru IC. |

Table 2: Cut Groups used in 1 and 2 cut failure studies.

| TD cuts              |                 |
|----------------------|-----------------|
| Cut name             | additional info |
| IPIflg               |                 |
| ELveto               |                 |
| TDFool               |                 |
| $TDVar_{nn_{loose}}$ |                 |
| RSHEX                |                 |
| RSHEX2               |                 |

Table 3: Note that *ev5* is not included in the loose version of TD cuts.

| Kinematic Cuts |  |
|----------------|--|
| Cut name       | additional info  |
| cos3d          |  |
| zfrf           |  |
| zutout         |  |
| UTCqual        |  |
| TIC            |  |
| EIC            |  |
| layv4          | $5 \geq layv4 \geq 19$   |
| icodel14       | Found RSSC hit.  |
| LAYER14        | layv4.eq.14.and.dzutsc14 <sub>i</sub> -99. (lay 14 stop and used z info in UTC). |
| RngMom         |  |
| prrf           | prrf1,prrfz  |
| RSdEdX         | rsdedxcl,rsdedxmax,rslike  |

Table 4: Cut Groups used in 1 and 2 cut failure studies.

| Beam Cuts |                 |
|-----------|-----------------|
| Cut name  | additional info |
| BWtrs     |                 |
| CKtrs     |                 |
| CKtail    |                 |
| CPItrs    |                 |
| CPItail   |                 |
| B4dEdX    |                 |
| B4trs     |                 |
| B4ccd     |                 |
| timcon    |                 |

Table 5: Cut Groups used in 1 and 2 cut failure studies.

| <b>Other TG cuts</b> |   |
|----------------------|---|
| Cut name             | additional info                                     |
| TGqualt              |   |
| npitg                |   |
| epitg                |   |
| epimax               |   |
| TGer                 |   |
| targf                |   |
| dtgttp               |   |
| rtdif                |   |
| drp                  |   |
| TGKtim               |   |
| TGedge               |   |
| TGdEdX               | rtghi,etghi,tgdedx1,tgdedx2                         |
| TGenr                |   |
| pigap                |   |
| TGlike               | tglike1,tglike2                                     |
| TGB4                 | tgdb4,tgdb4tip,tgdvxtip,tgdvxpi                     |
| PhiVtx               |   |
| chi567               | Zhe's loose version                                 |
| chi5max              |   |
| verrng               |   |
| angli                |   |
| TGfitallK            |   |
| tpics                | PNN2, st.dev of energy weighted TG-fiber pion times |
| TGtcon               | cut on Kaon timing (energy dependent)               |
| B4etcon              | ADC/CCD Energy and Time consistency.                |

Table 6: eic,tic not belong here?

| <b>Other pathological cuts?</b> |                 |
|---------------------------------|-----------------|
| Cut name                        | additional info |
| upvtrs                          |                 |
| rvtrs                           |                 |

| <b>PASS1 &amp; Pass 2 Cuts</b> |                 |
|--------------------------------|-----------------|
| Cut name                       | additional info |
| BADRUN                         |                 |
| TRIGGER                        |                 |
| Lev1.1                         |                 |
| Lev1.2                         |                 |
| RD_TRK                         |                 |
| TRKTIM                         |                 |
| TARGET                         |                 |
| PSCUT                          |                 |
| TGCUT                          |                 |
| STLAY                          |                 |
| UTC                            |                 |
| RDUTM                          |                 |
| BAD_STC                        |                 |
| FITPI                          |                 |
| PDC                            |                 |
| TDCUT                          |                 |
| PVCUT                          |                 |

Table 7: Cut applied to all events as setup cuts

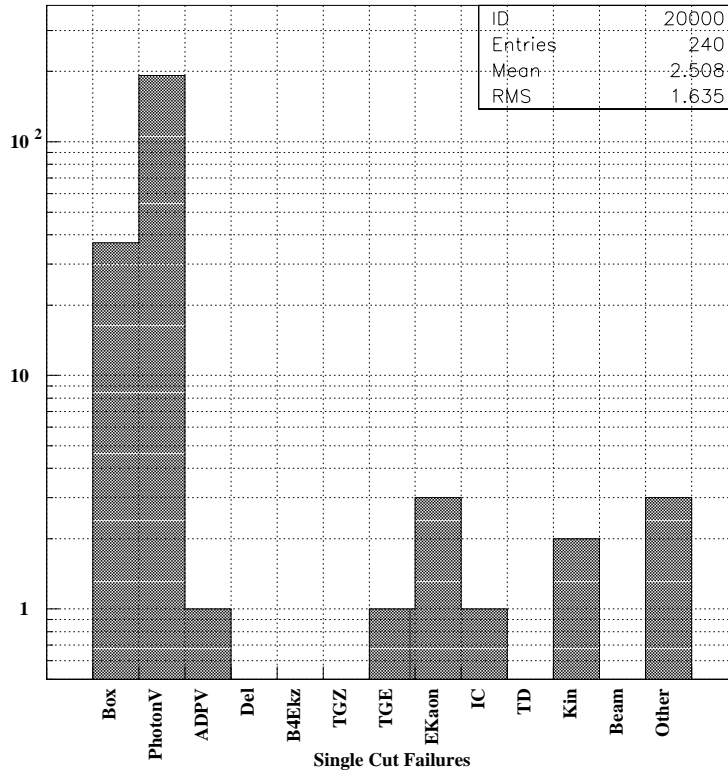


Figure 1: Distribution of single cut failures.

### 3 Results

There were 240 single cut failures observed in the 1/3 data (processed from skimmed data on disk), see Fig. 1. There are 11 events which fail groups other than Box and Photon-Veto.

### 4 ADPV event

Event 19149 from Run 49905 fails only the ADPV. It was determined that CCDPUL should have failed this event as there is a large second pulse in a kaon fiber, as shown in Fig. 2. The energy of the second pulse is at least half of the total energy in the fiber. Making the pion have an energy of  $\approx 8$  MeV which is much larger than the CCPUL threshold. Therefore, this event is in fact a two cut failure.

Joss Ives analyzed why this event was not removed by CCPUL and ???



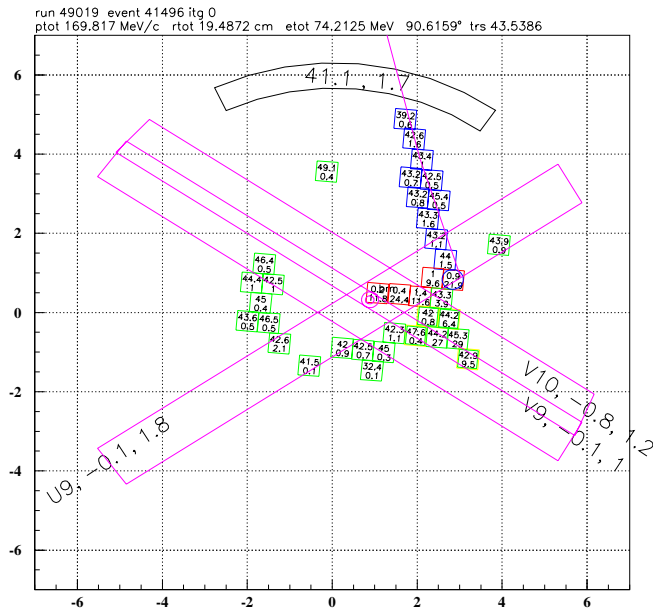


Figure 3: Reconstruction of the extra target energy event.

## 5 Extra Target Energy Event

Event 41496 from Run 49019 fails OPSVETO and TGPV from the extra target energy group. This is believed to be a  $K_{e4}$  event. There is  $16.9 \text{ MeV}$  of energy in fibers flagged as opposite side pions. From view of the Target, Fig. 3, there appears to be a negative charged track with  $\approx 76 \text{ MeV}$  energy and a positive charged track with  $\approx 10 \text{ MeV}$ . Both extra tracks stop within the target radius. There does not appear to be any significant second pulses in the kaon target fibers.



## 6 Energy in Kaon Fiber Events

## 7 IC Event

## 8 Kinematic Events

## 9 Other Events

## 10 Kinematic Box Events

There are 37 Events which fail the Kinematic Box cut group.

## 11 Photon-Veto Events

There are 192 Events which fail the Photon-Veto cut group. Fig. ?? shows the kinematic distribution for the Photon-Veto single cut failures. They are evenly distributed throughout the signal box region and seems to have a similar

## 11.1 EC outer only events

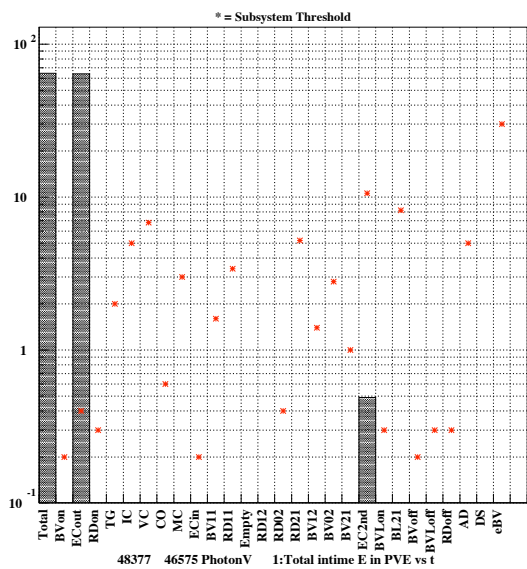
There are 16 events which only failed the EC outer-ring PV subsystem.

### 11.1.1 Run 48377 Event 46575

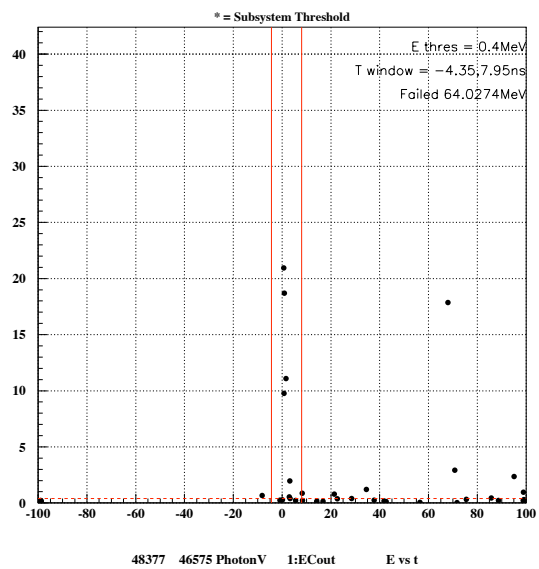
This event failed with 64 MeV (threshold 0.4 MeV). This event is located in the upper-right corner of the PNN2 kinematic box.

As seen in Fig. 4, there is a RD11 hit close to the energy threshold that is at decay time, but because of the time window not being center about the decay time the hit is not considered in time. There is also an RD12 hit that is above the energy threshold with the same issue with respect to the time window.

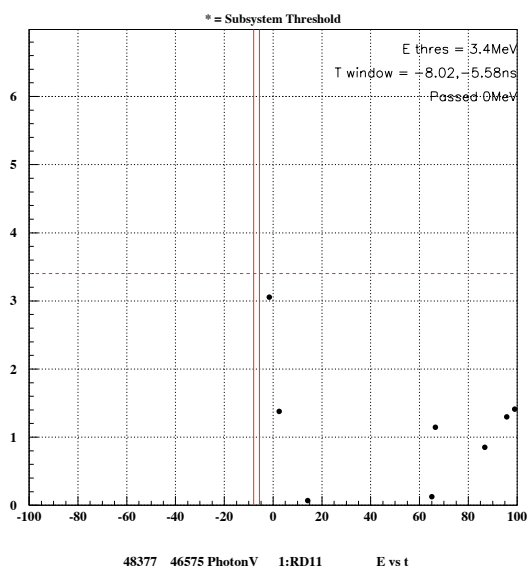
2007/06/21 01.30



2007/06/21 01.30



2007/06/21 01.30



2007/06/21 01.30

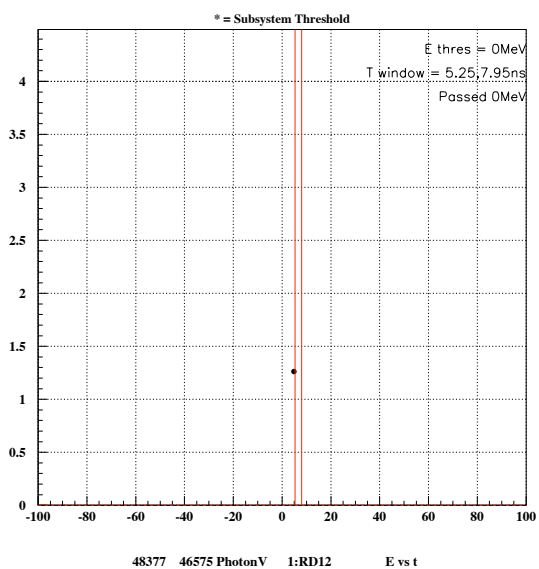


Figure 4: Energy vs Time plots of various PV detectors for EC 1-cut failure.



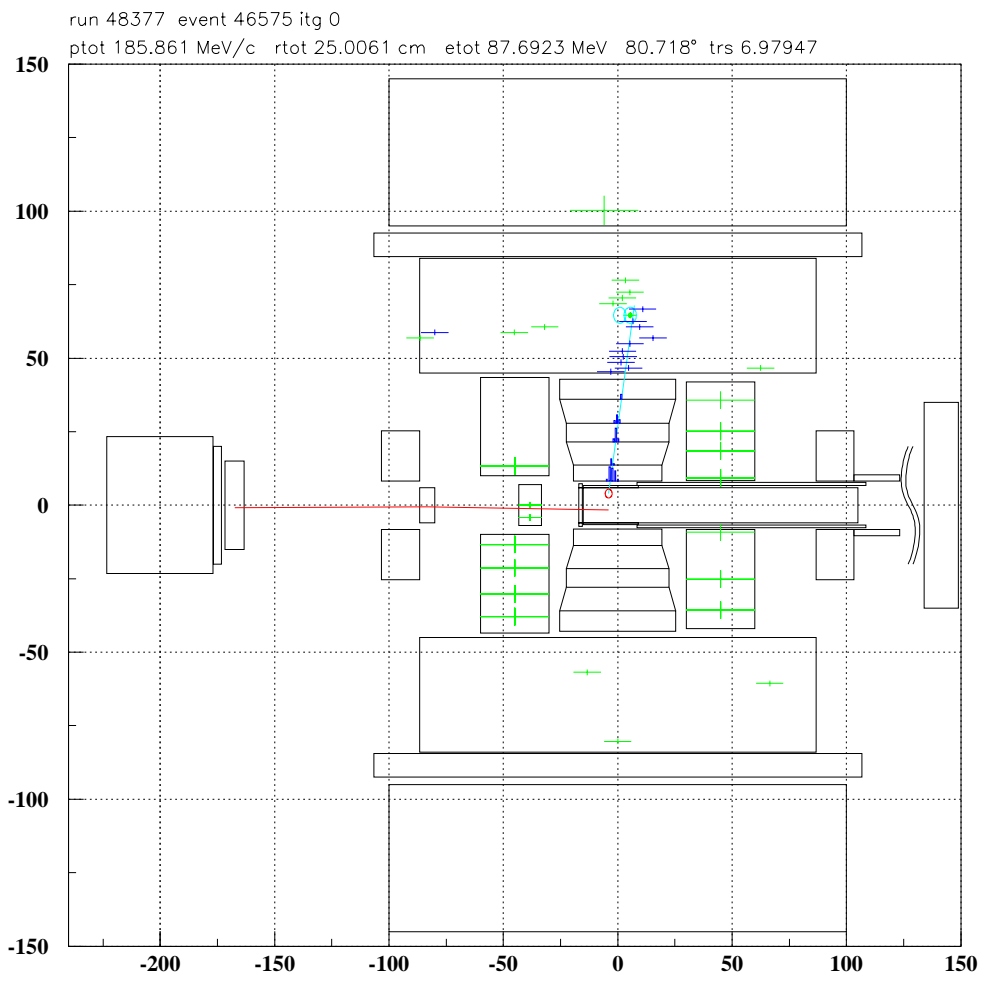
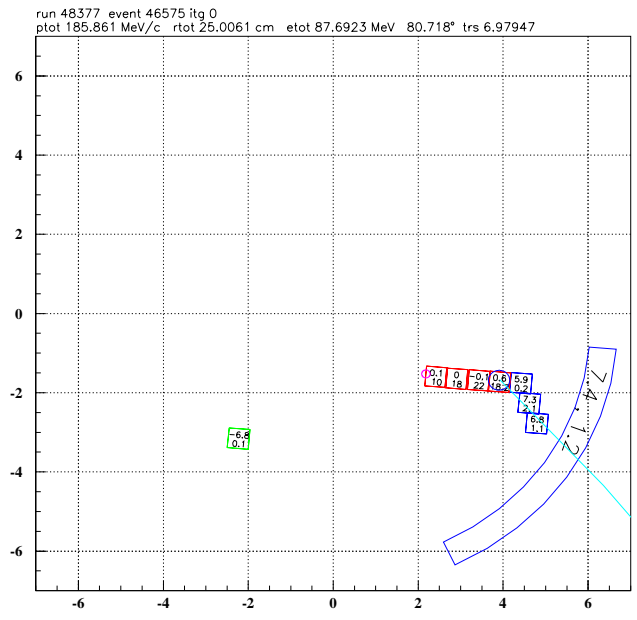
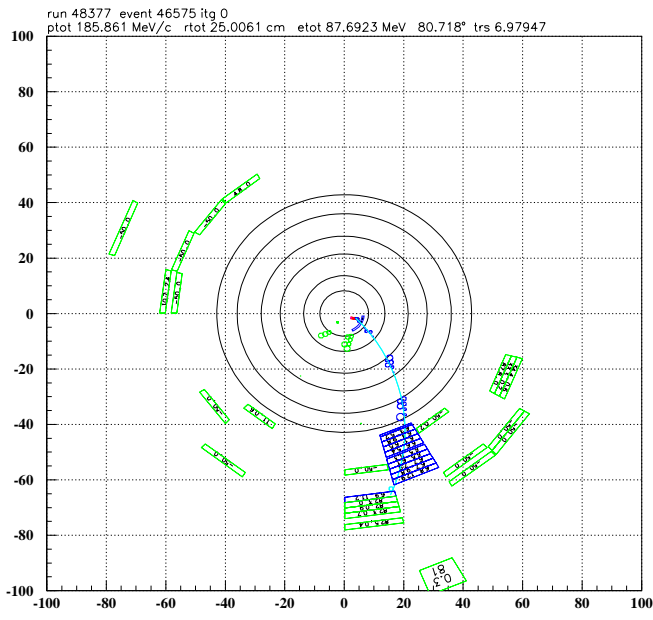


Figure 5: Reconstruction plots of various PV detectors for EC 1-cut failure.

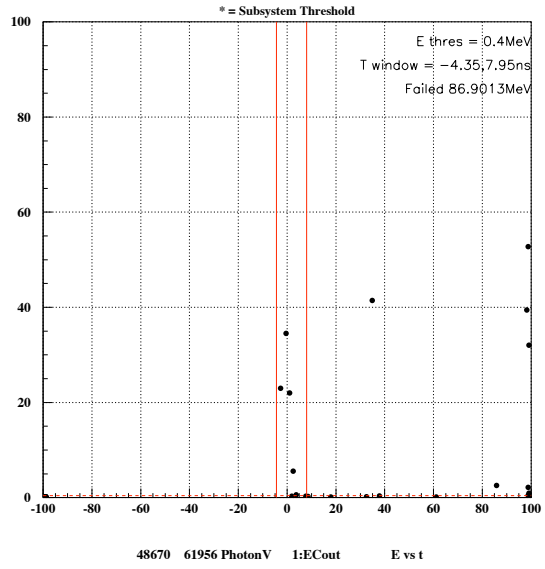
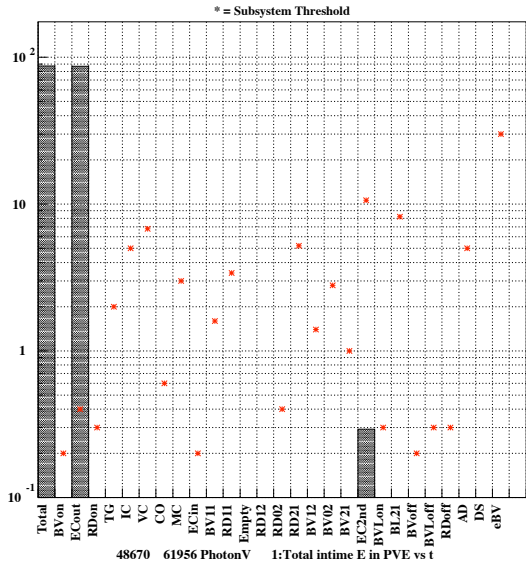


Figure 6: Energy vs Time plots of various PV detectors for EC 1-cut failure.

### 11.1.2 Run 48670 Event 61956

This event failed with 87 MeV (threshold 0.4 MeV). This event is located in the center of the PNN2 kinematic box and comes close to failing DELCO with  $t_{pi} - t_k \approx 4.$ .

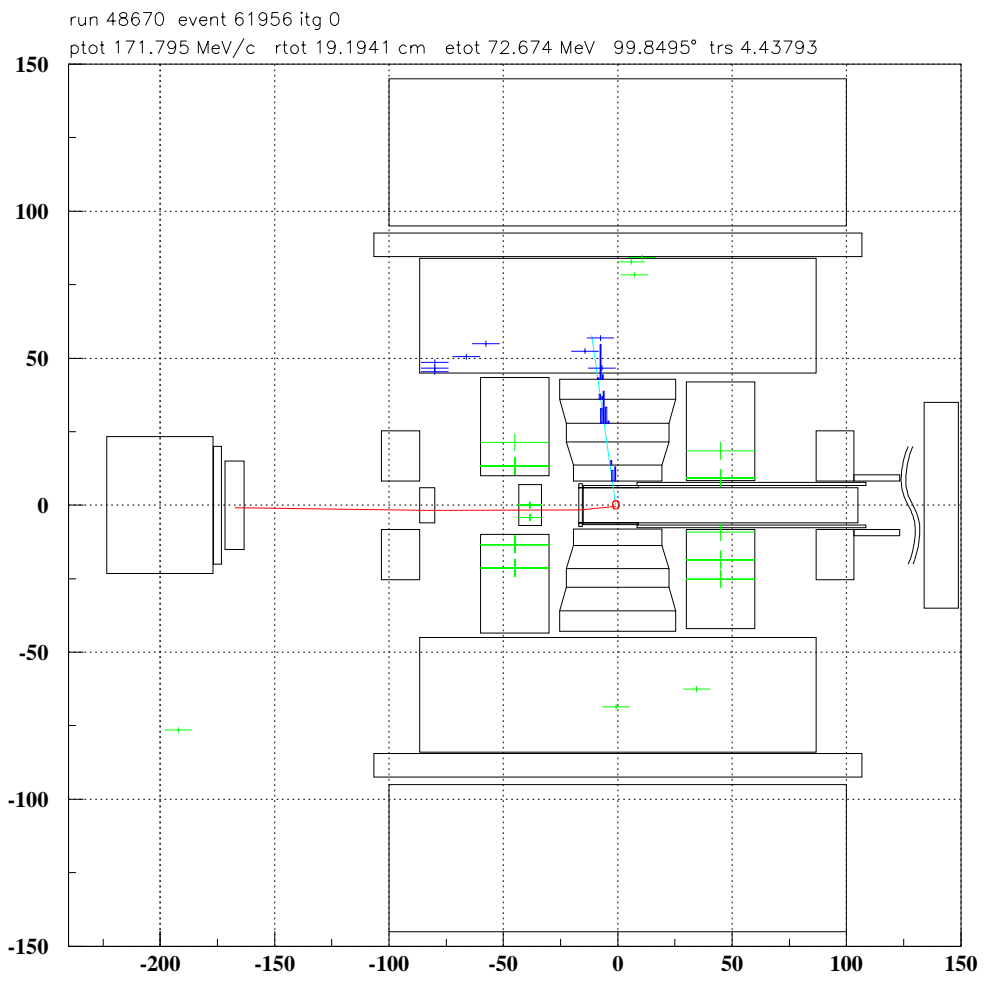
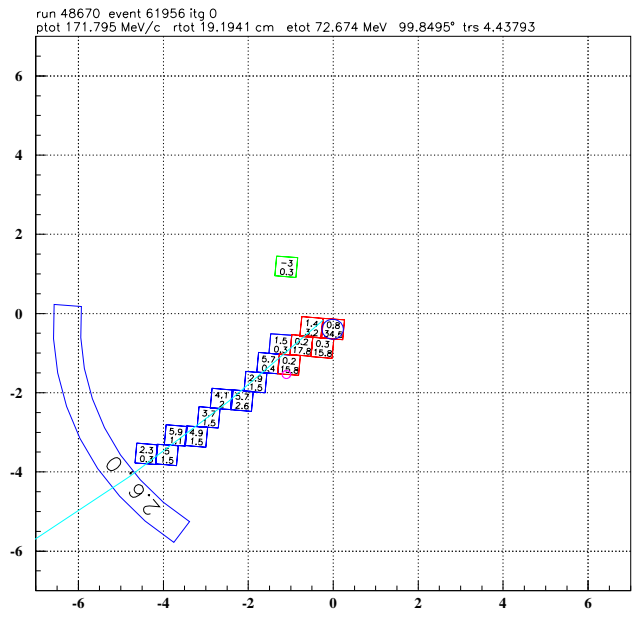
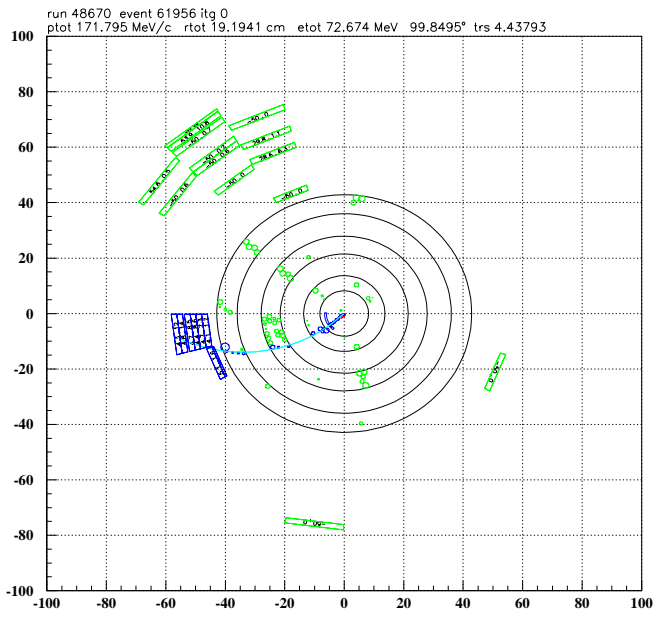


Figure 7: Reconstruction plots of various PV detectors for EC 1-cut failure.

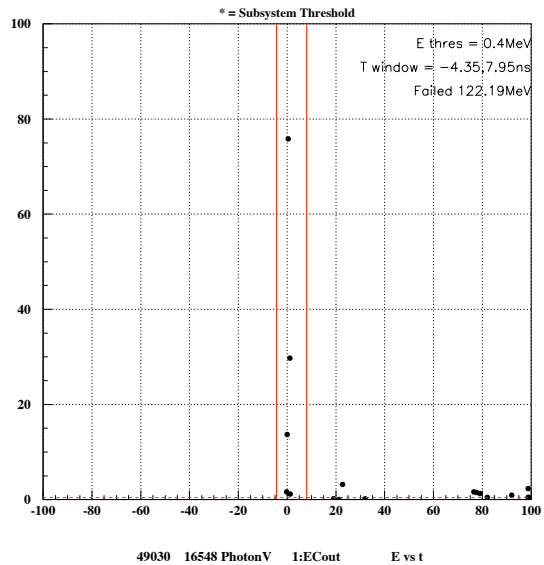
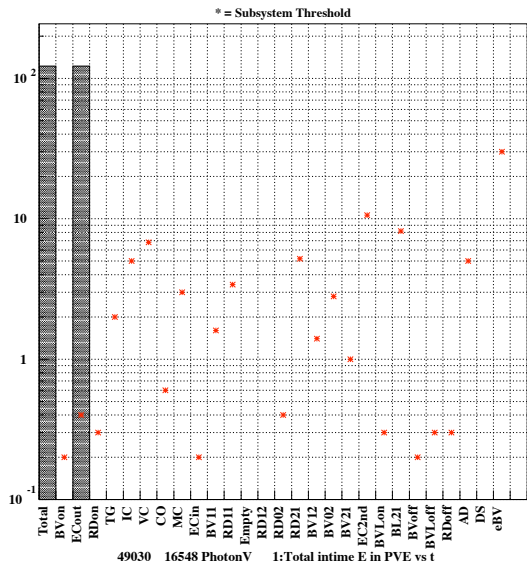


Figure 8: Energy vs Time plots of various PV detectors for EC 1-cut failure.

### 11.1.3 Run 49030 Event 16548

This event failed with 122. MeV (threshold 0.4 MeV) where the photon went upstream. This event is located in the center of the PNN2 kinematic box.

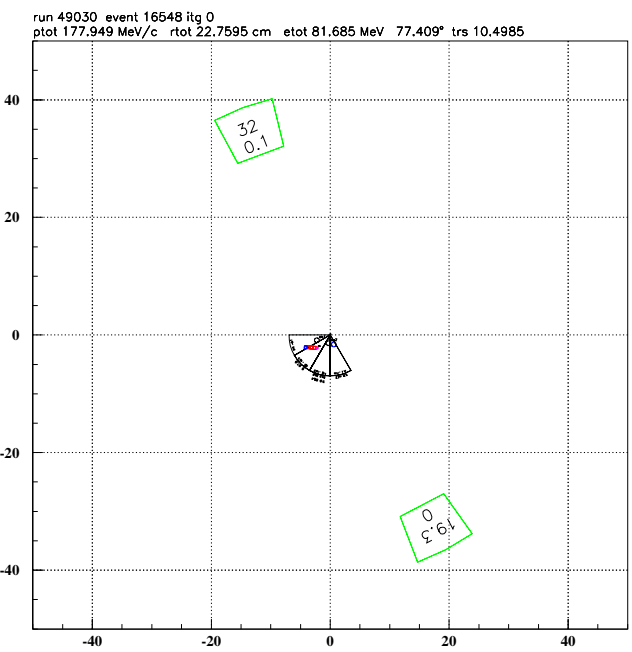
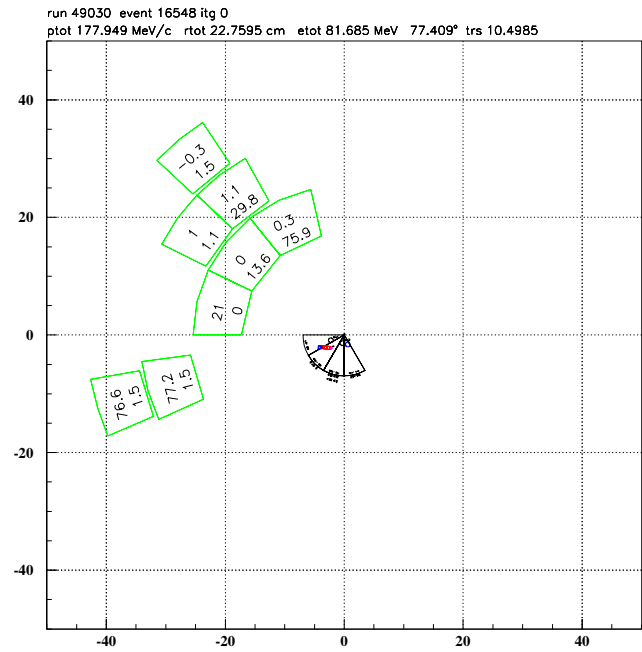
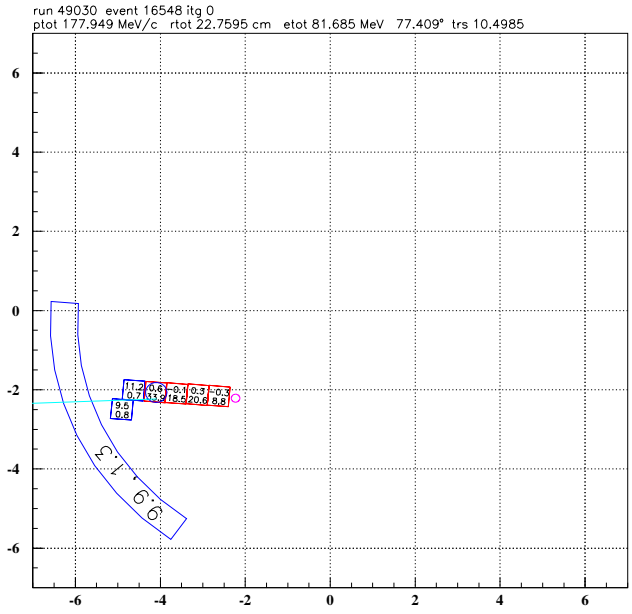
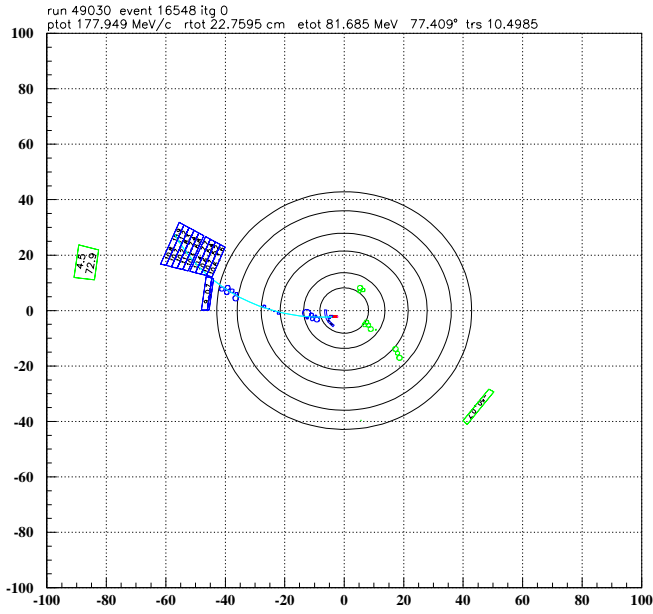


Figure 9: Reconstruction plots of various PV detectors for EC 1-cut failure.

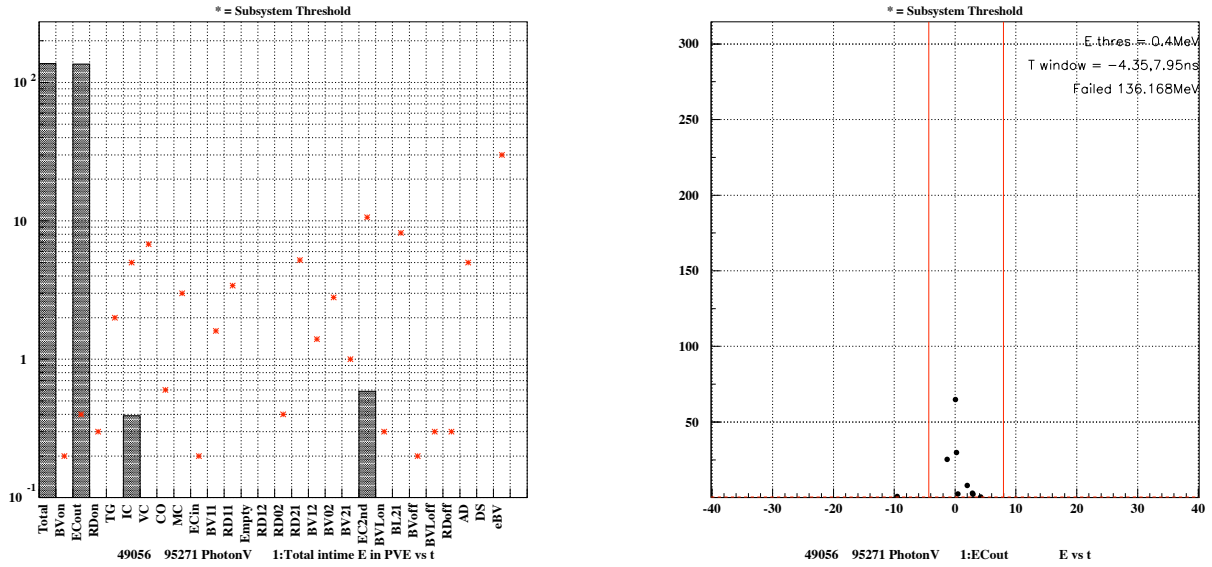


Figure 10: Energy vs Time plots of various PV detectors for EC 1-cut failure.

#### 11.1.4 Run 49056 Event 95271

This event failed with 136. MeV (threshold 0.4 MeV) and is located in the center of the PNN2 kinematic box. As seen in Fig. 11, it appears that this event should have been cut by CCPUL with a second pulse energy of 1.585 MeV in the decay vertex fiber. For some reason the cut did not do it's job.

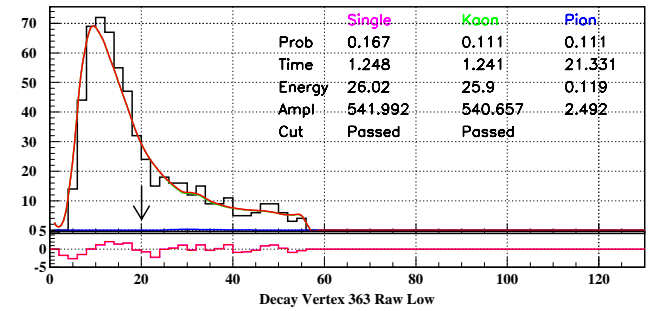
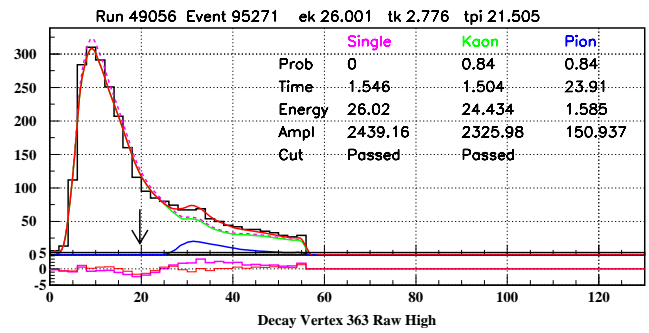
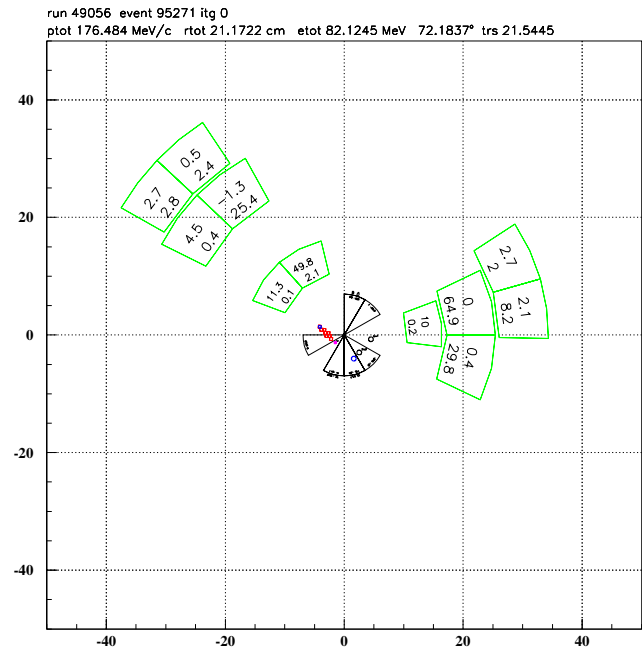
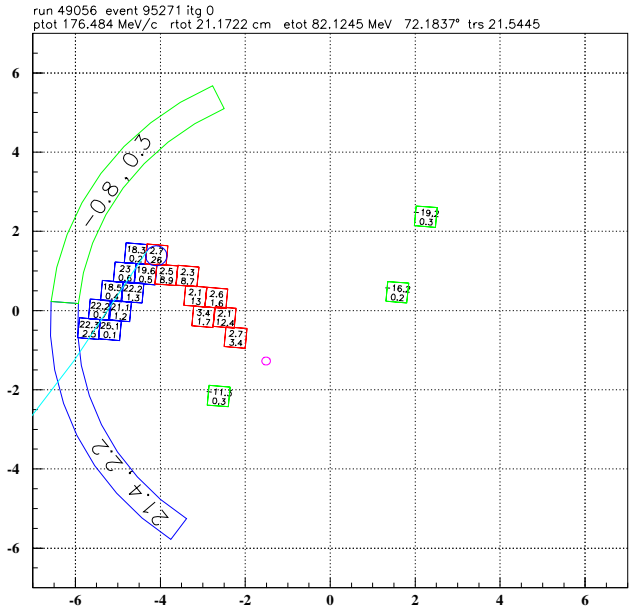
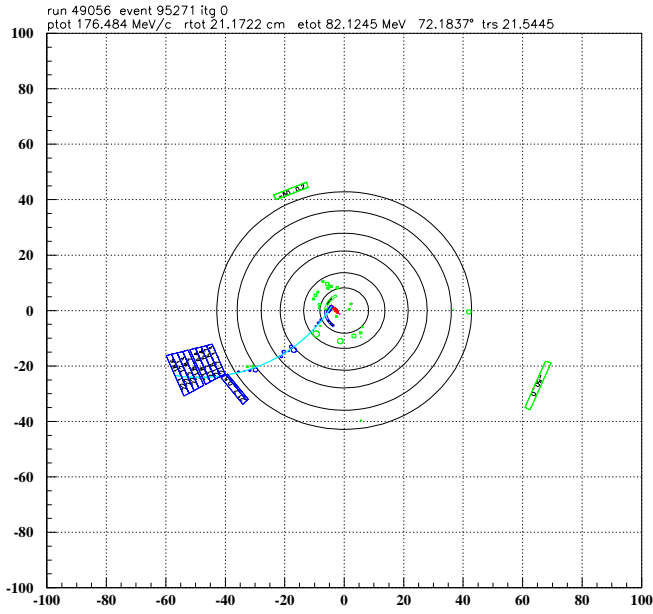


Figure 11: Reconstruction plots of various PV detectors for EC 1-cut failure.

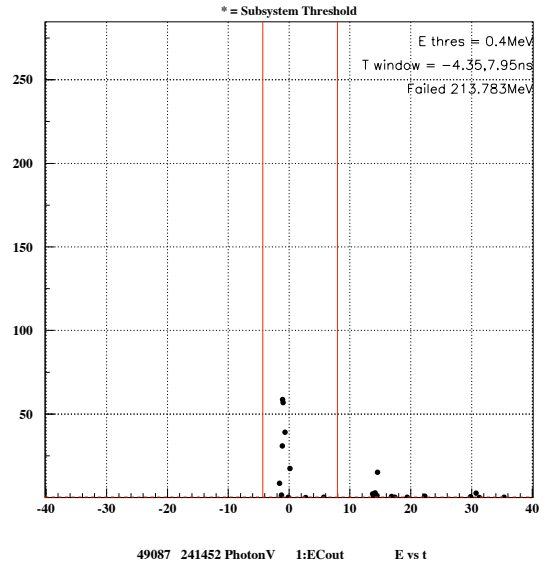
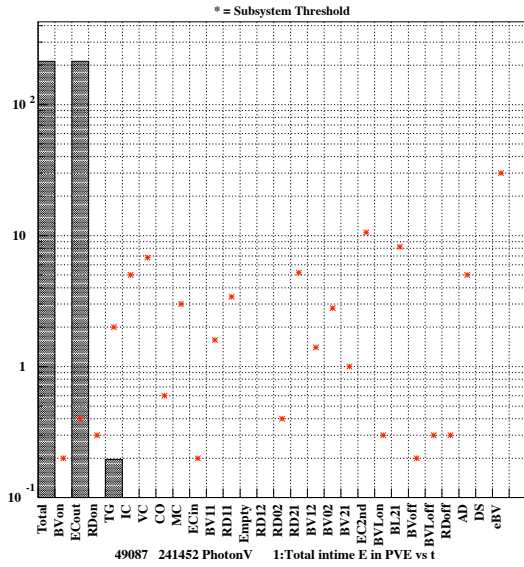


Figure 12: Energy vs Time plots of various PV detectors for EC 1-cut failure.

### 11.1.5 Run 49087 Event 241452

This event failed with MeV (threshold 0.4 MeV) in the EC-outer PV and is located in the bottom-left corner of the PNN2 kinematic box. As seen in Fig. 13, it appears that this event should have been cut by CCPUL with a second pulse energy of 1.415 MeV in the decay vertex fiber. For some reason the cut did not do its job.



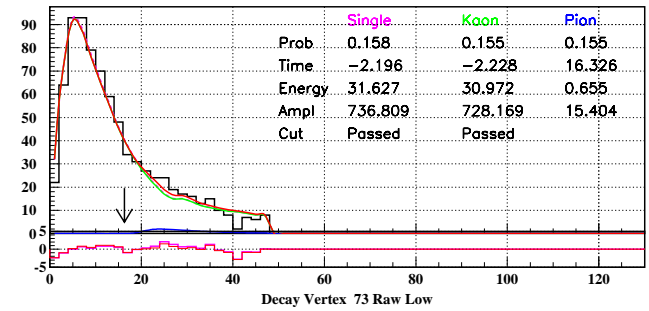
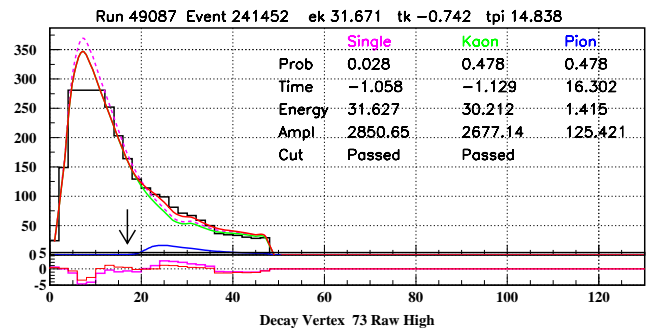
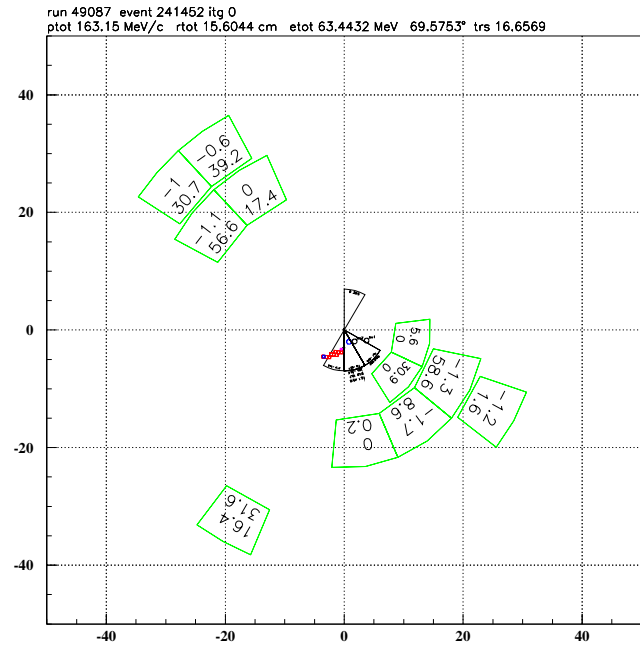
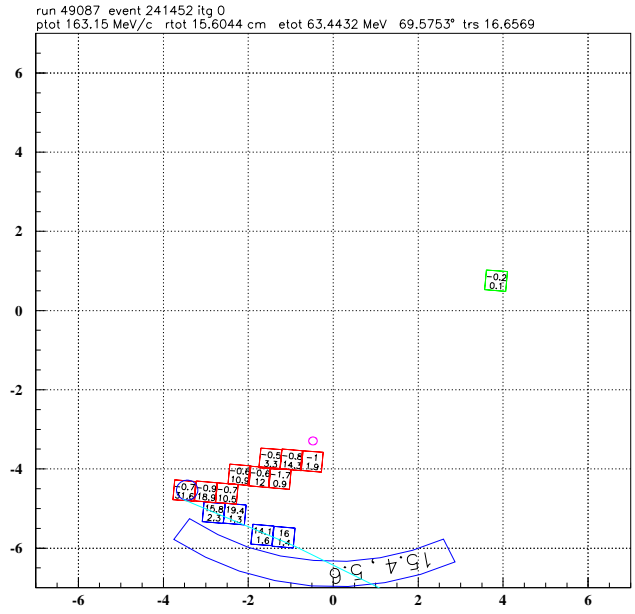
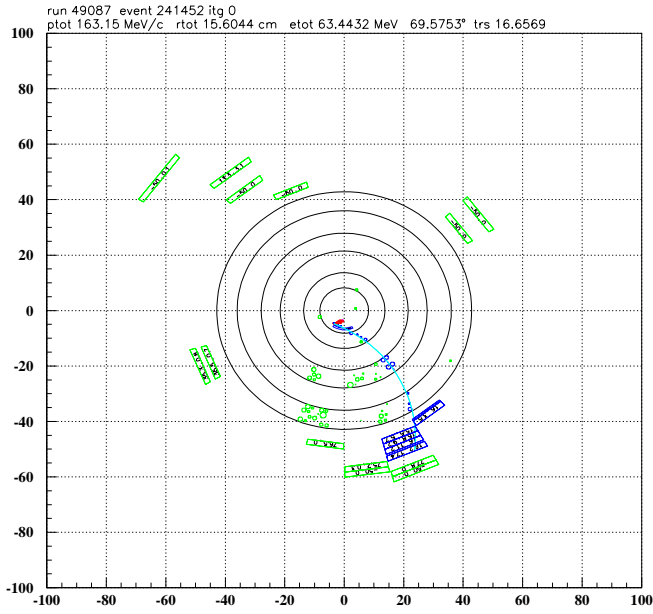


Figure 13: Reconstruction plots of various PV detectors for EC 1-cut failure.

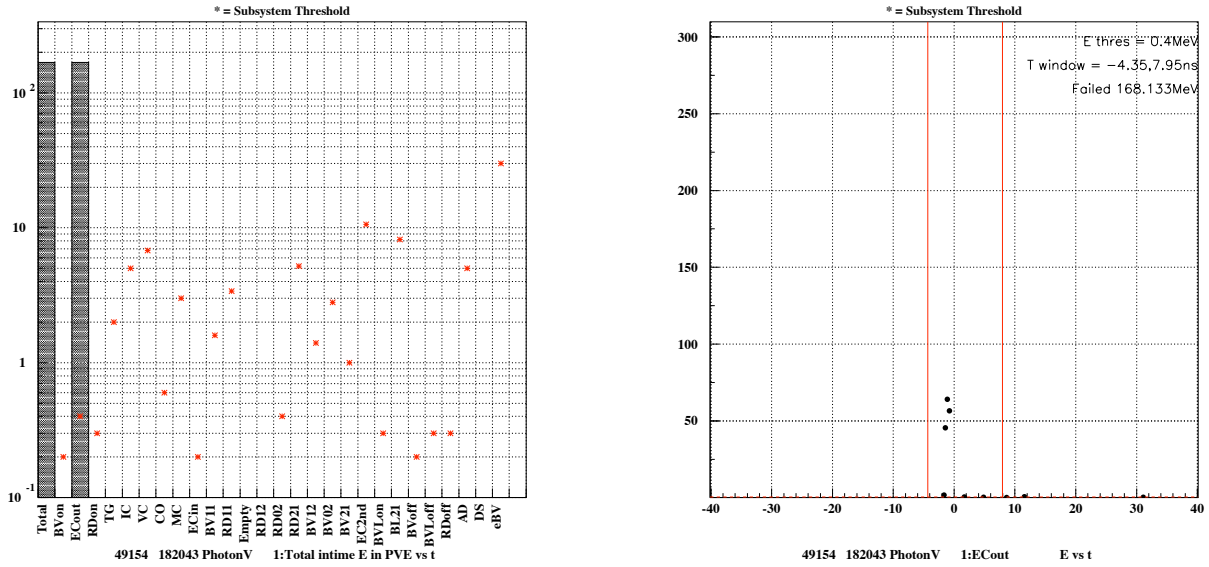


Figure 14: Energy vs Time plots of various PV detectors for EC 1-cut failure.

### 11.1.6 Run 49154 Event 182043

This event is very clean in the beam system and target. The only PV hits are located in the downstream EC. This event failed with 168. MeV (threshold 0.4 MeV) in the EC-outer PV and is located in the lower-left corner of the PNN2 kinematic box.

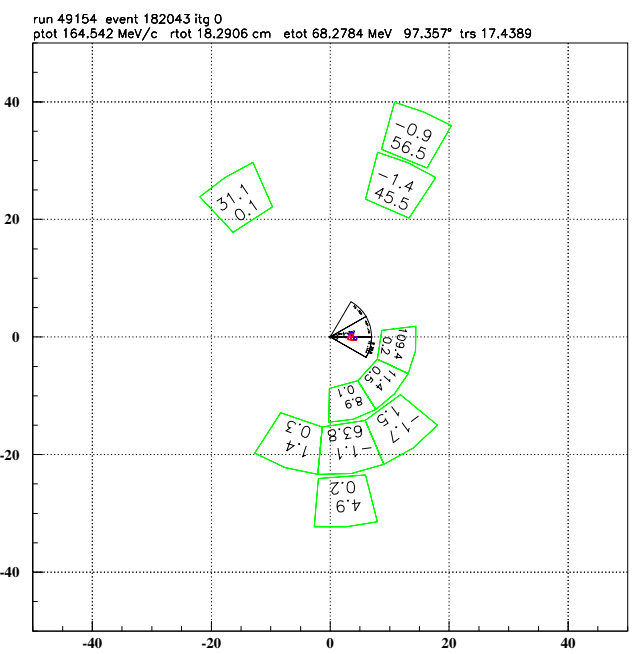
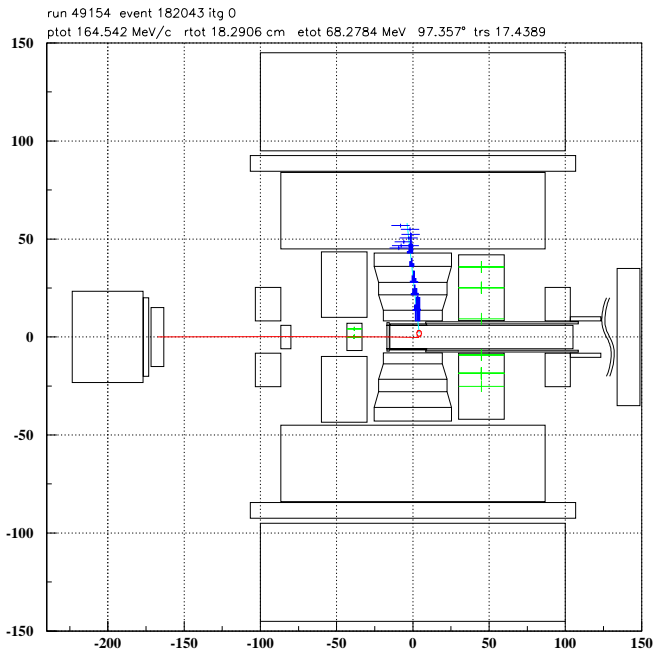
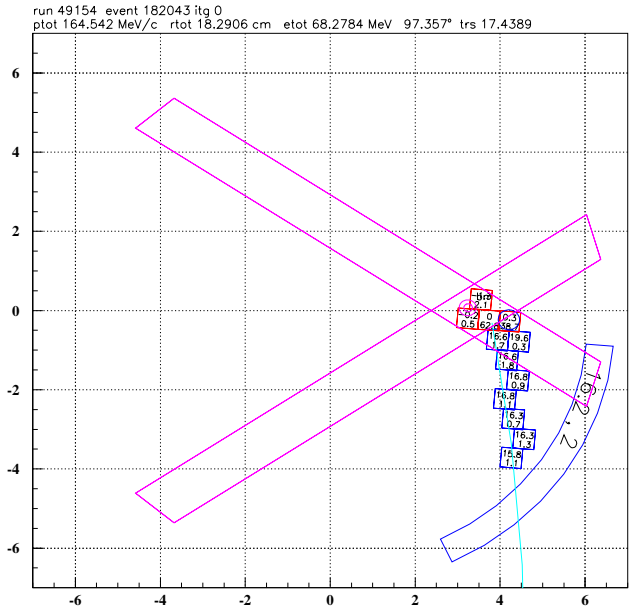
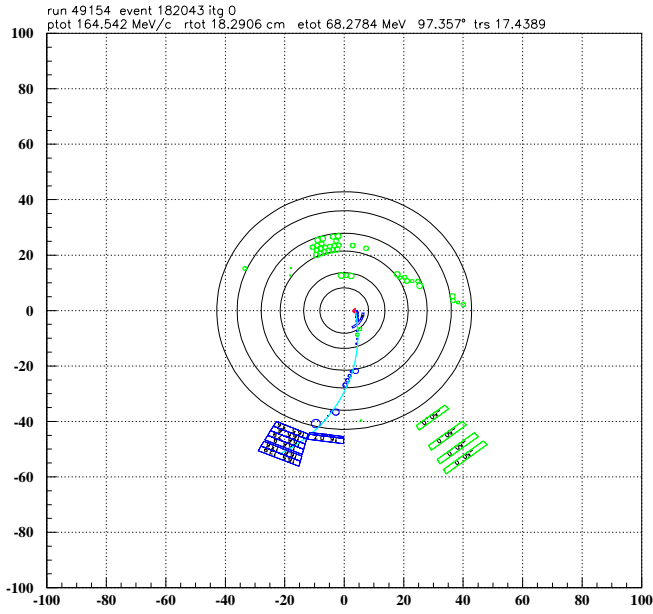


Figure 15: Reconstruction plots of various PV detectors for EC 1-cut failure.

### 11.1.7 Run 49336 Event 122151

This event failed with  $\text{MeV}$  (threshold  $0.4 \text{ MeV}$ ) in the EC-outer PV and is located in the upper-right corner of the PNN2 kinematic box.

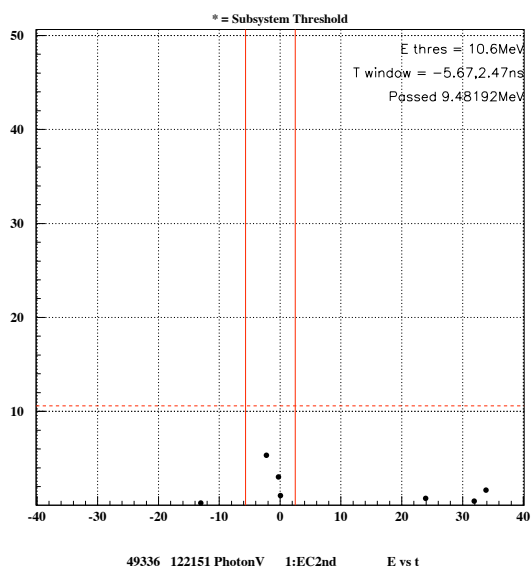
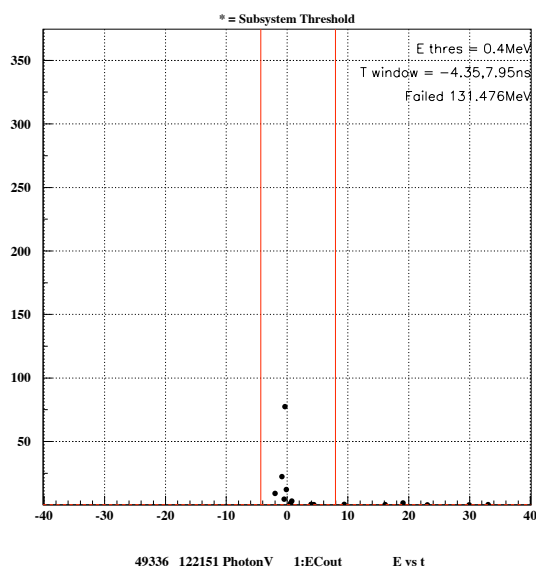
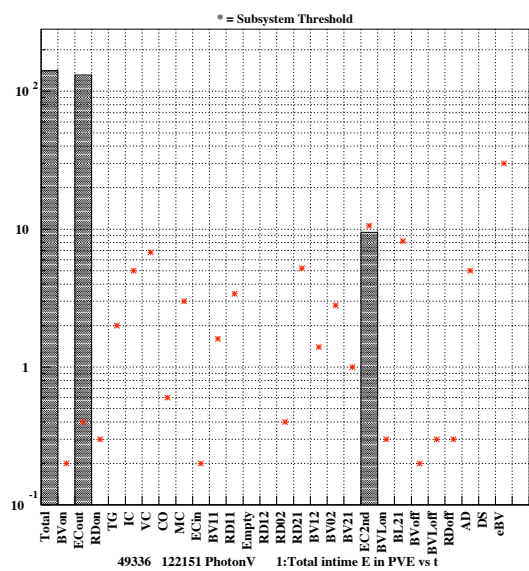


Figure 16: Energy vs Time plots of various PV detectors for EC 1-cut failure.

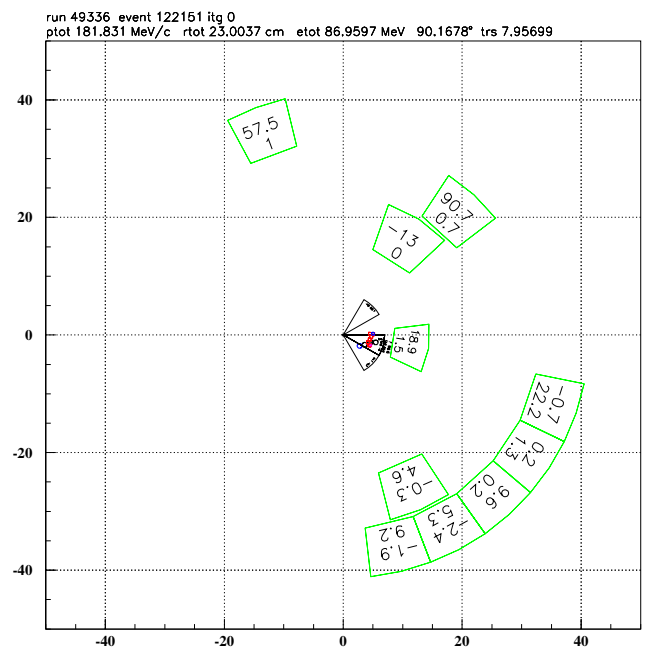
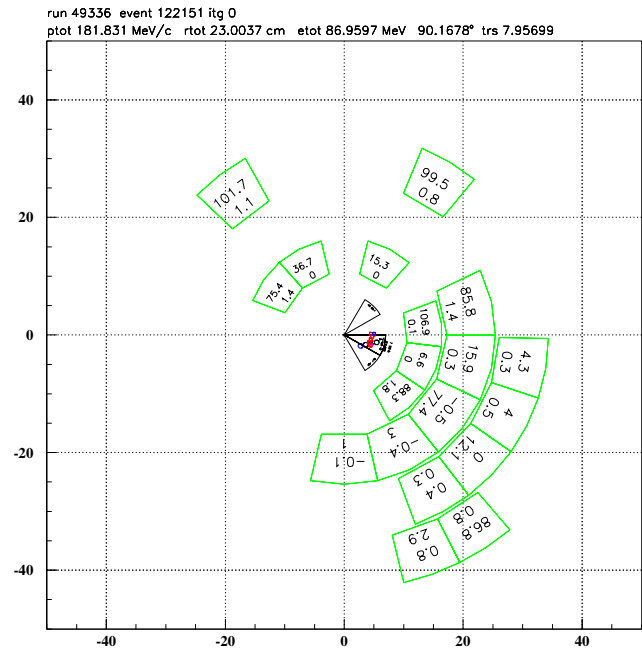
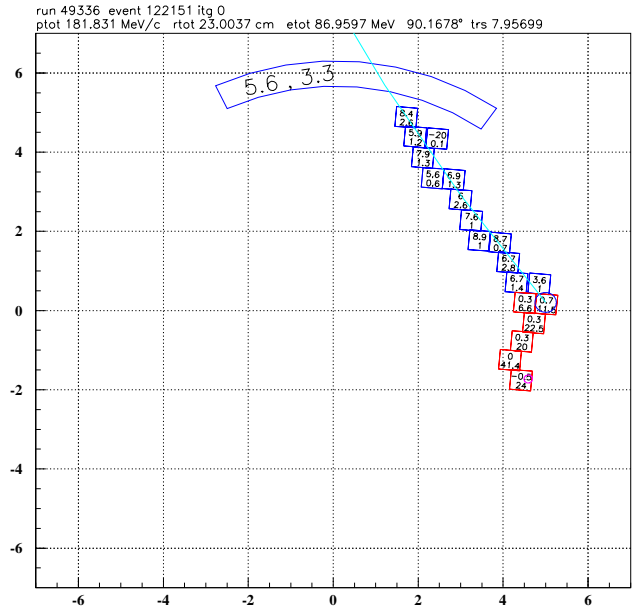
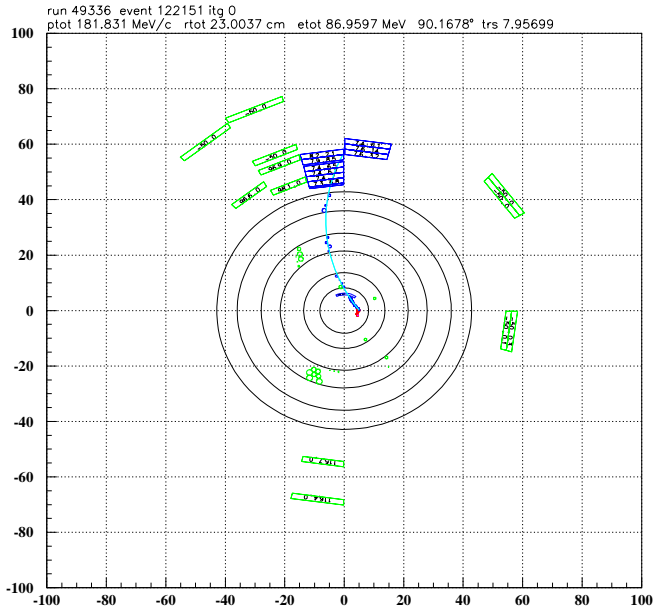


Figure 17: Reconstruction plots of various PV detectors for EC 1-cut failure.

### 11.1.8 Run 49347 Event 144903

This event failed with 116. MeV (threshold 0.4 MeV) in the EC-outer PV and is located in the upper-right corner of the PNN2 kinematic box. As seen in Fig. ??, it appears that CCPUL should have cut this event using the low-gain channel, due to the high-gain being saturated.

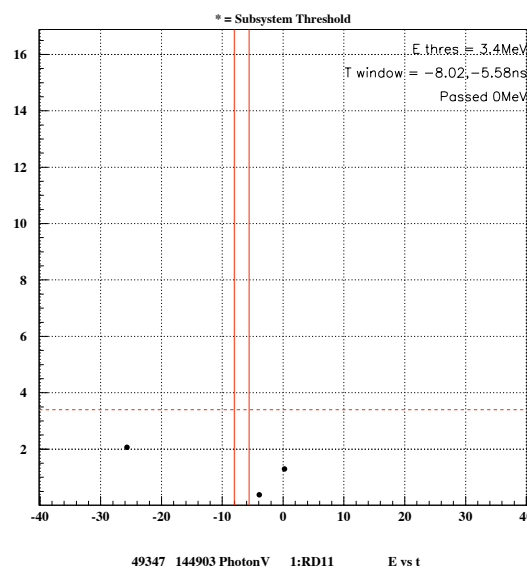
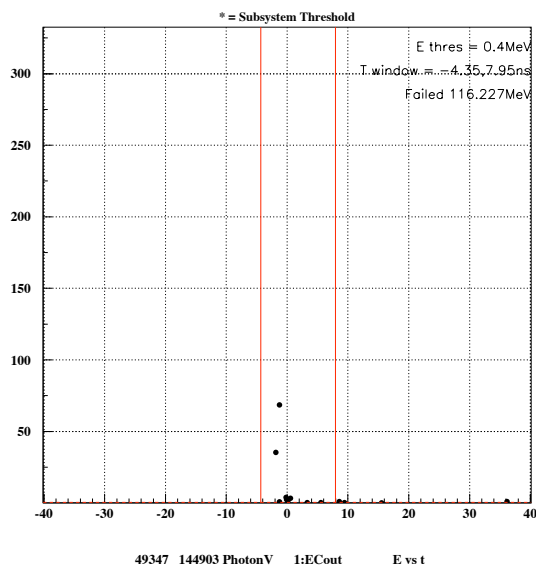
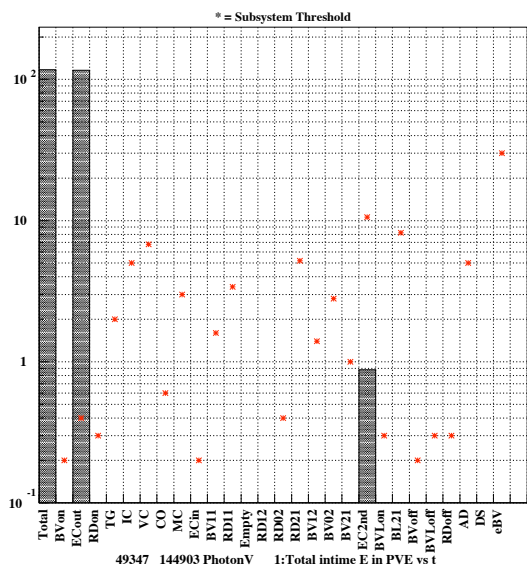


Figure 18: Energy vs Time plots of various PV detectors for EC 1-cut failure.



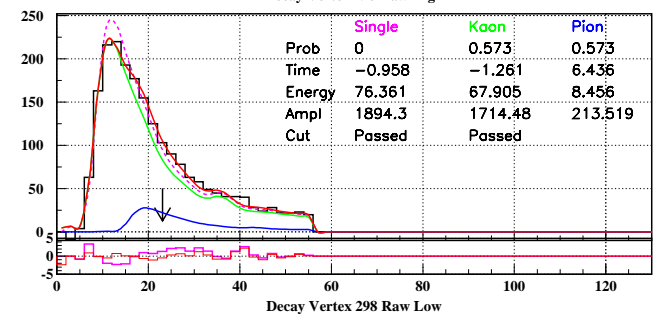
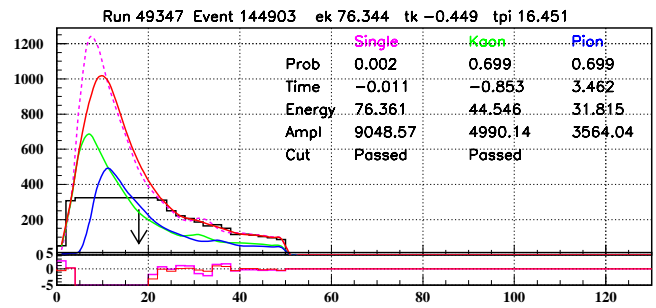
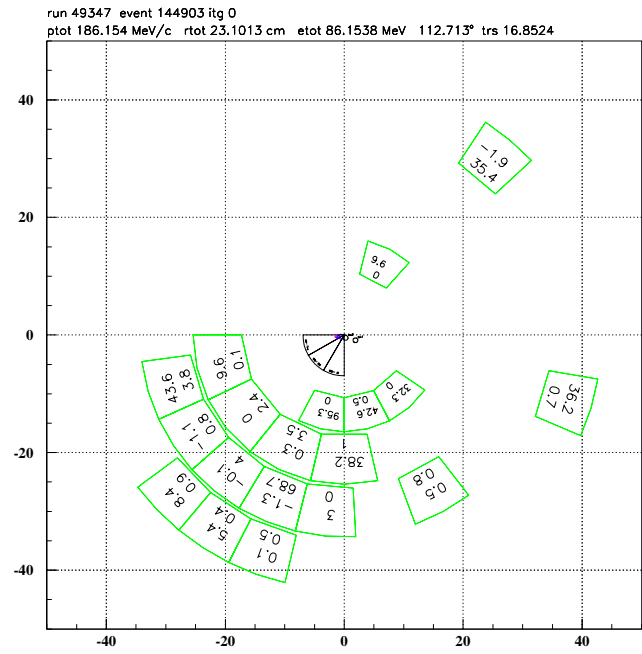
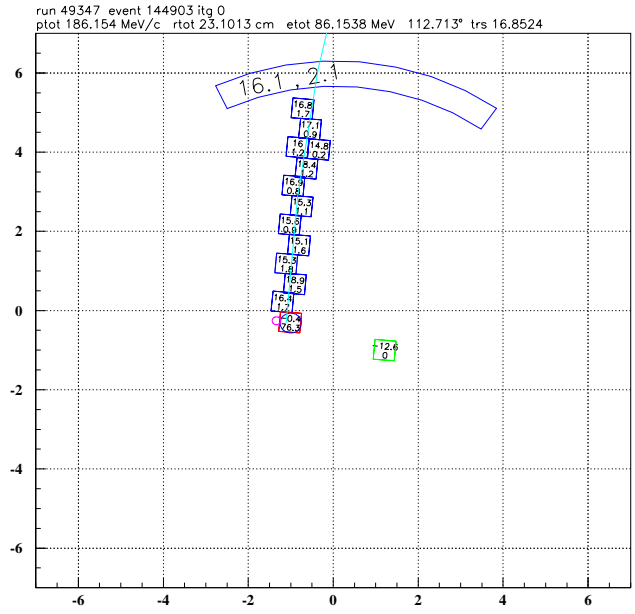
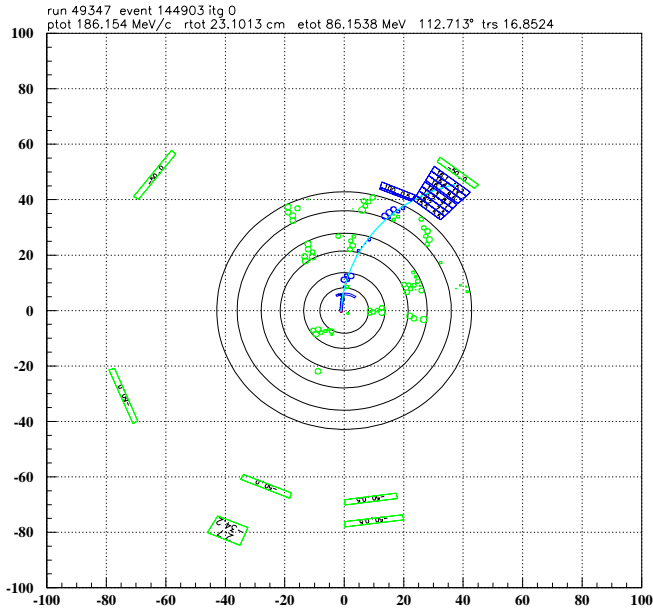


Figure 19: Reconstruction plots of various PV detectors for EC 1-cut failure.

### 11.1.9 Run 49364 Event 199161

This is a late kaon event where  $t_k = 36$  ns. This event failed with 113. MeV (threshold 0.4 MeV) in the EC-outer PV and is located in the lower-left corner of the PNN2 kinematic box. The decay-vertex fiber appears to have a single pulse fit poor fit, but a worse double pulse fit.

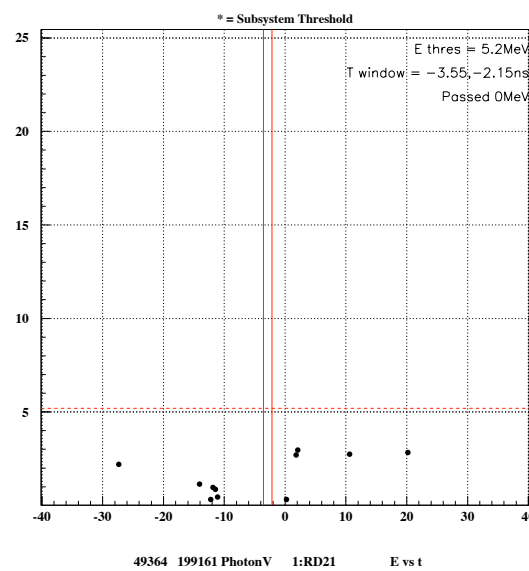
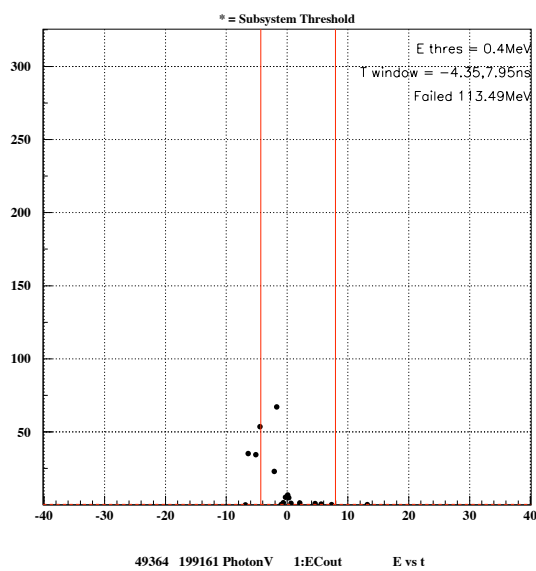
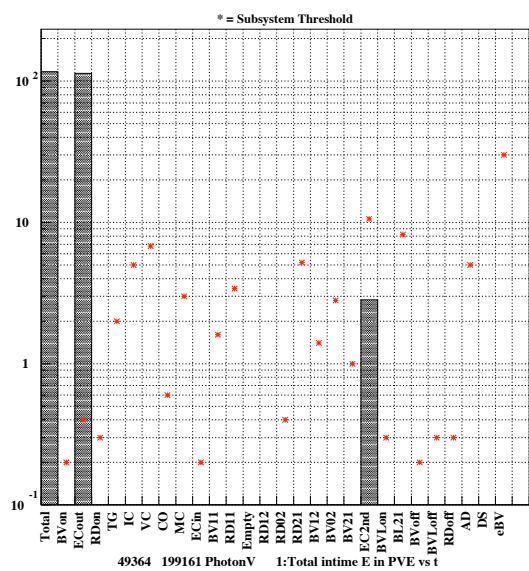


Figure 20: Energy vs Time plots of various PV detectors for EC 1-cut failure.

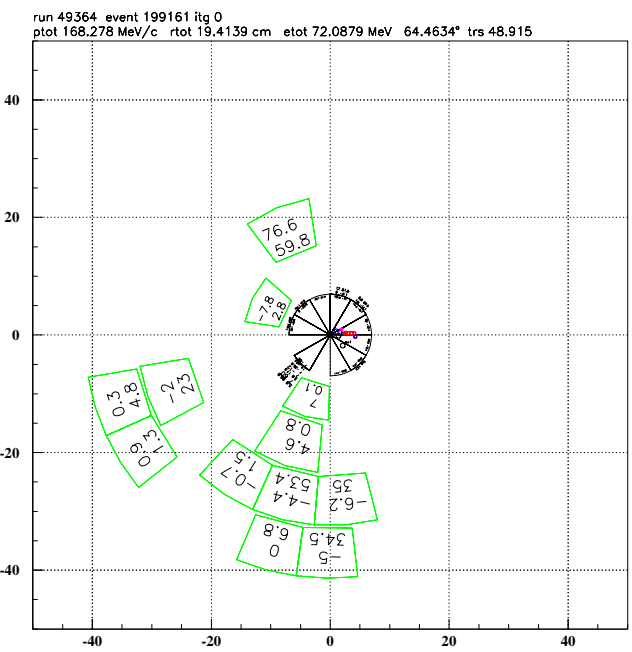
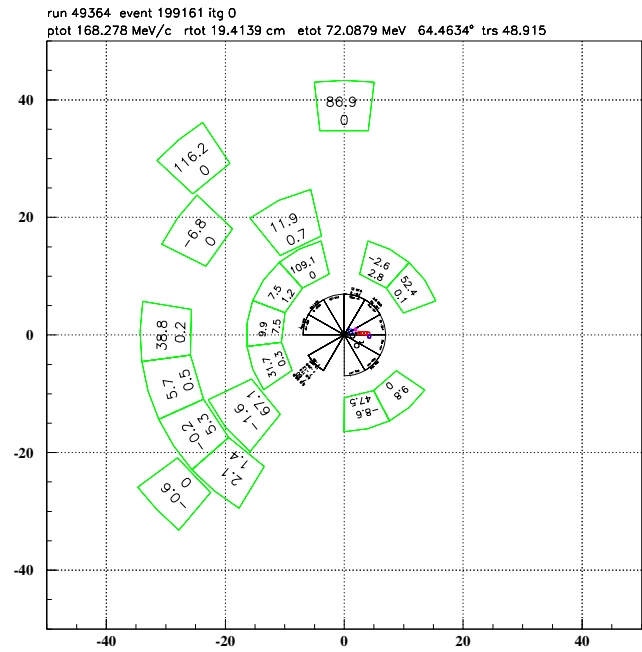
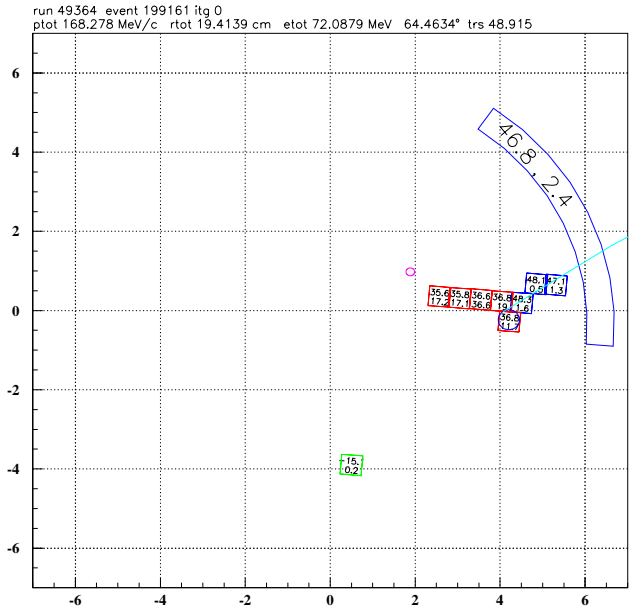
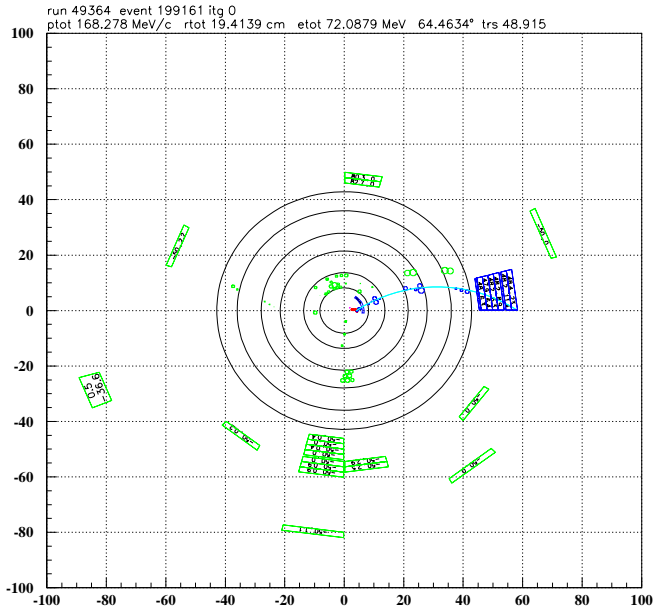
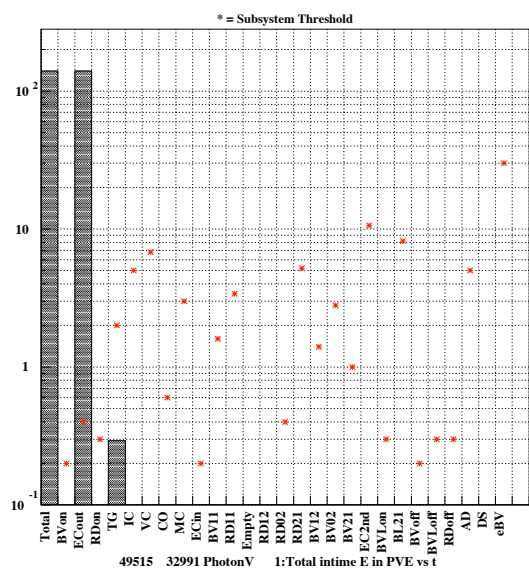


Figure 21: Reconstruction plots of various PV detectors for EC 1-cut failure.

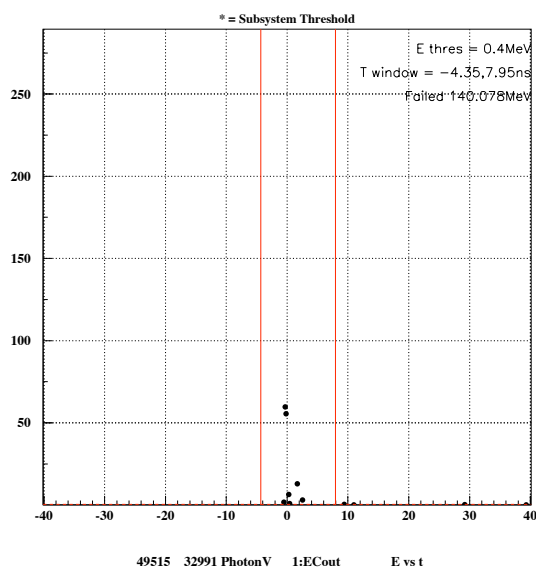
### **11.1.10 Run 49515 Event 32991**

This event failed with 140. MeV (threshold 0.4 MeV) in the EC-outer PV and is located in the upper-right corner of the PNN2 kinematic box.

2007/07/06 01.30



2007/07/06 01.30



2007/07/06 01.31

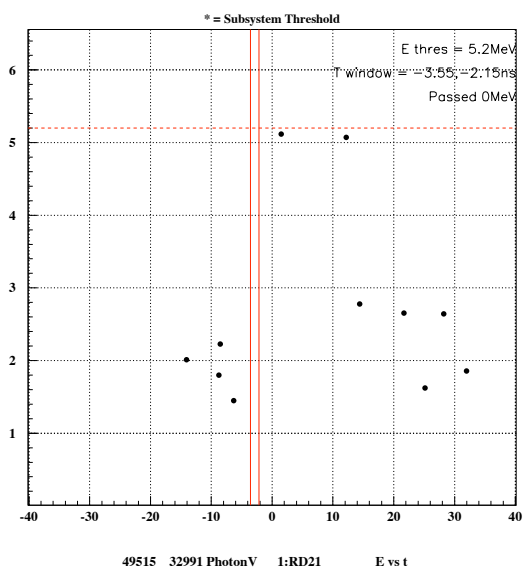


Figure 22: Energy vs Time plots of various PV detectors for EC 1-cut failure.

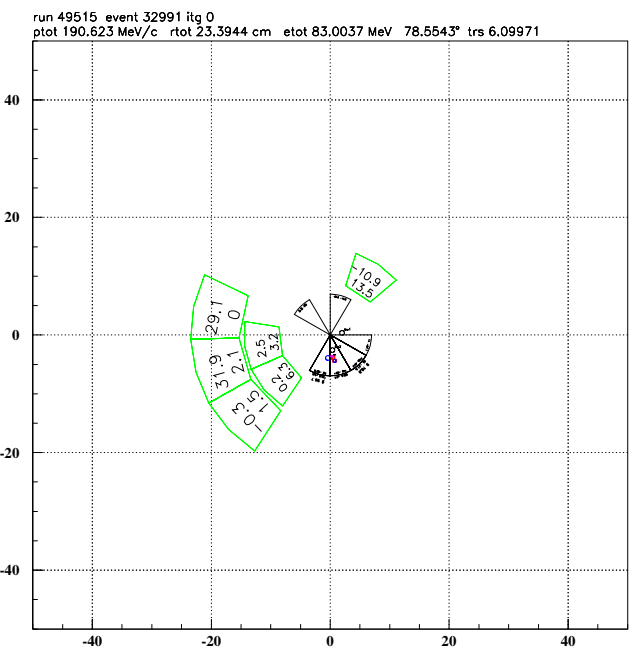
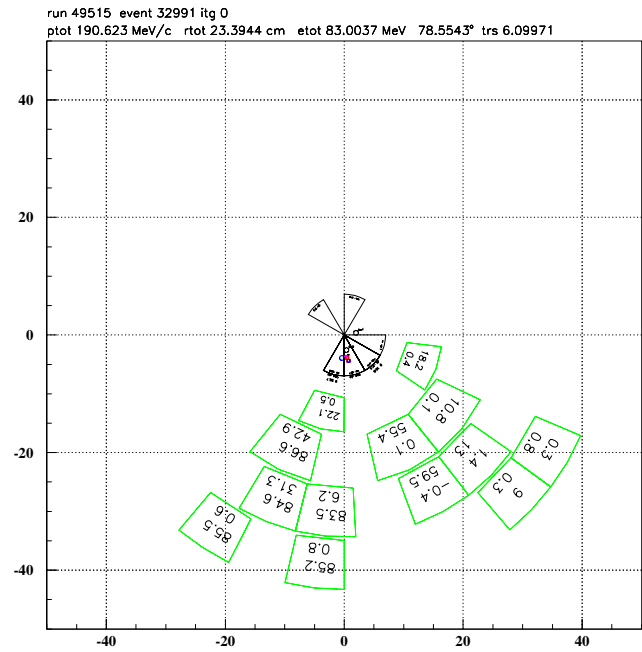
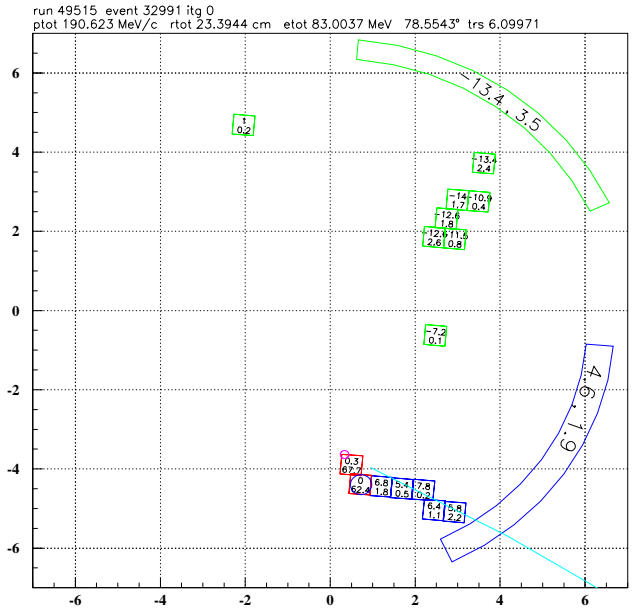
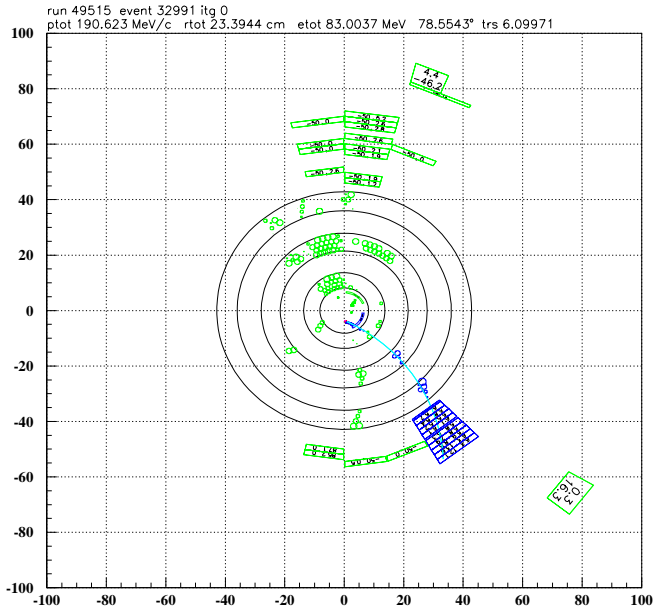


Figure 23: Reconstruction plots of various PV detectors for EC 1-cut failure.

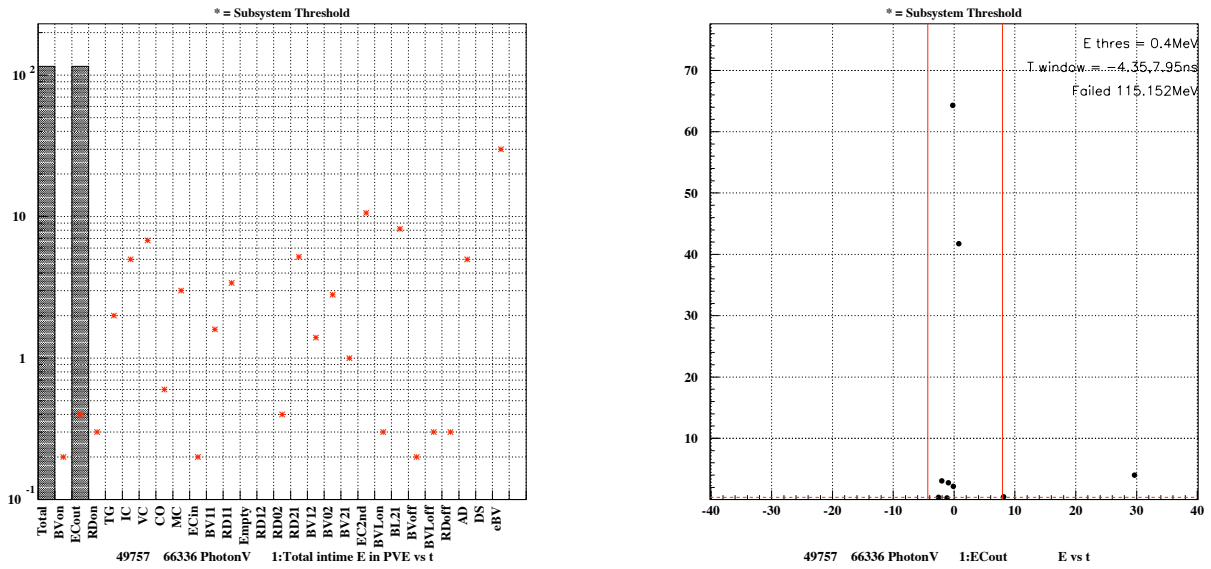


Figure 24: Energy vs Time plots of various PV detectors for EC 1-cut failure.

### 11.1.11 Run 49757 Event 66336

This event failed with 115. MeV (threshold 0.4 MeV) in the EC-outer PV and is located in the upper-right corner of the PNN2 kinematic box.



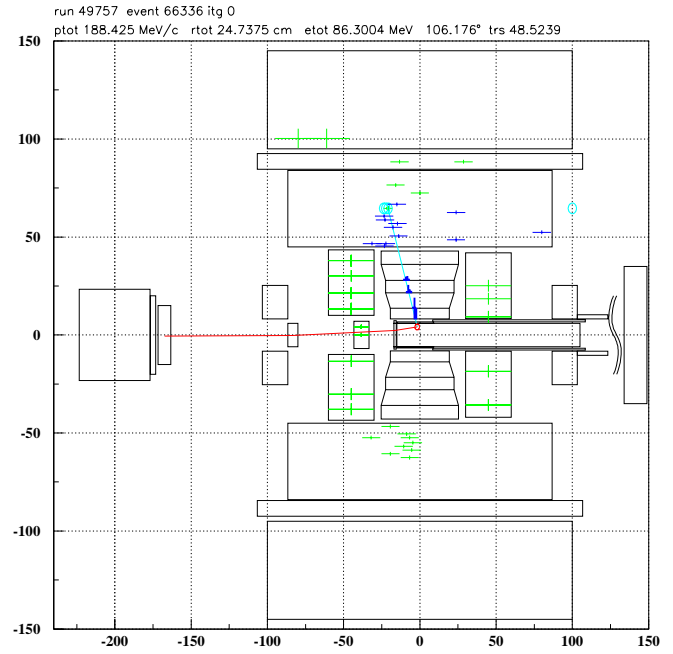
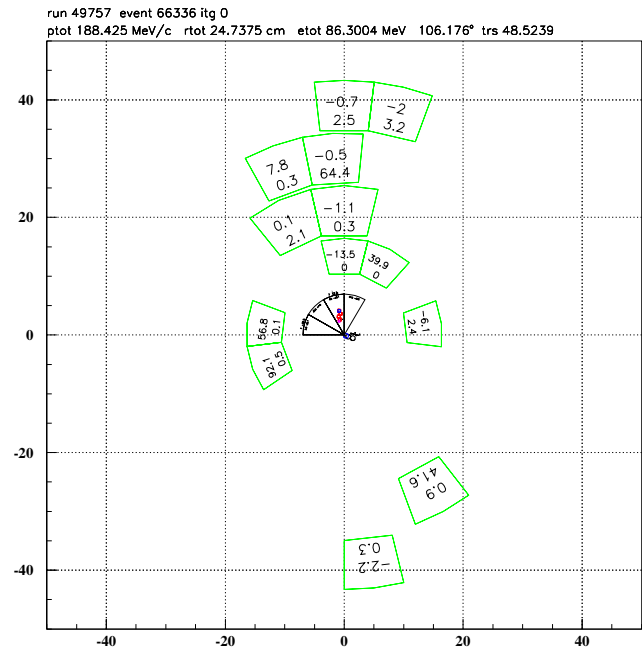
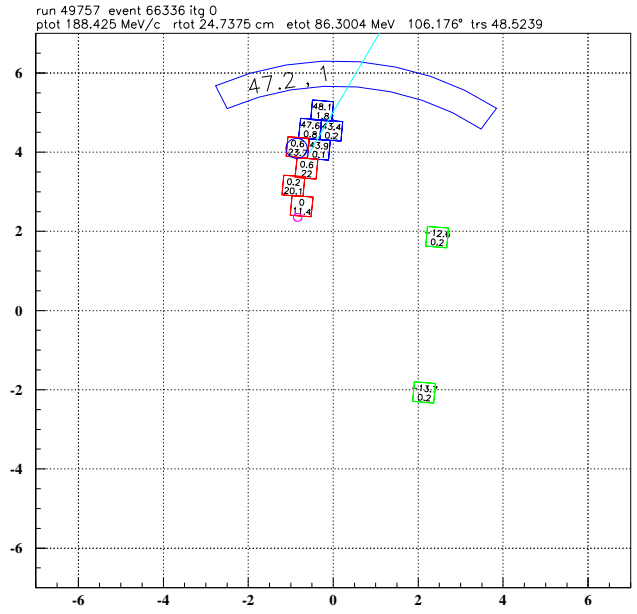
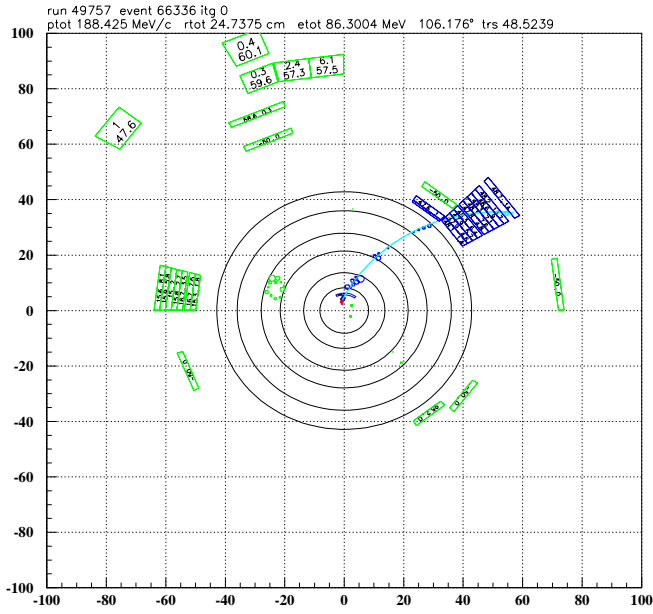


Figure 25: Reconstruction plots of various PV detectors for EC 1-cut failure.

11.1.12 Run 49787 Event 126030

### 11.1.13 Run 50021 Event 22458

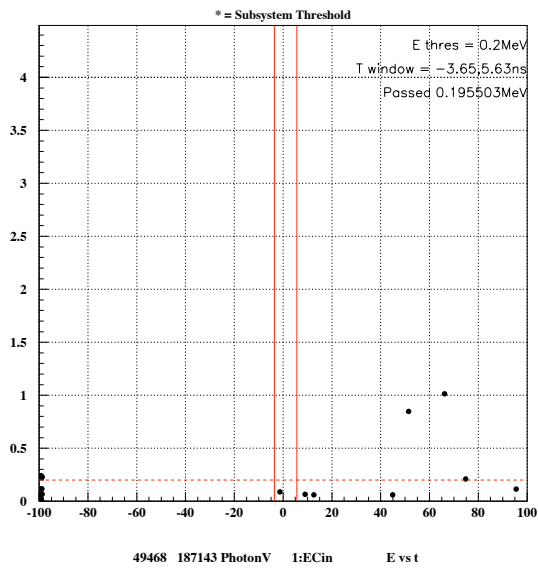
#### 11.1.14 Run 50058 Event 191811

11.1.15 Run 50130 Event 156915

11.1.16 Run 50209 Event 133590



2007/06/21 01.39



2007/06/21 01.39

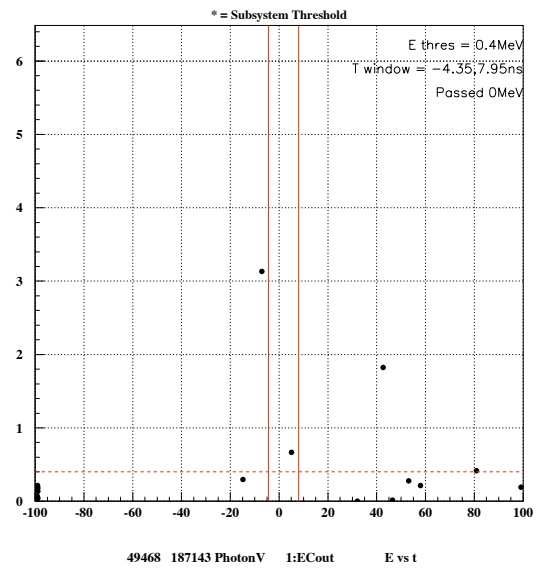


Figure 27: The EC inner-ring (outer-ring) hits are shown in the left (right) plot.



## 11.3 RS Only Events

There are 2 events which only failed the RS PV subsystem.

### 11.3.1 Run 48239 Event 24495

This is a late Kaon event,  $t_k = 23ns$ . The initial kaon,  $t \approx 0ns$ , must have scattered in the cerenkov counter because there are no observed hits at  $t \approx 0ns$ . This event occurs in the middle of PNN2 kinematic box.

The plot of RD11 (single ADC, single TDC) in Fig. 16 shows two hits with large energy that is at decay. However, the cut window is not centered around the decay time. Since RD11 is correlated with RD21 (which cut this event) and other RD PV cuts, it is possible that the PV optimization artificially pushed the time window away from decay time.

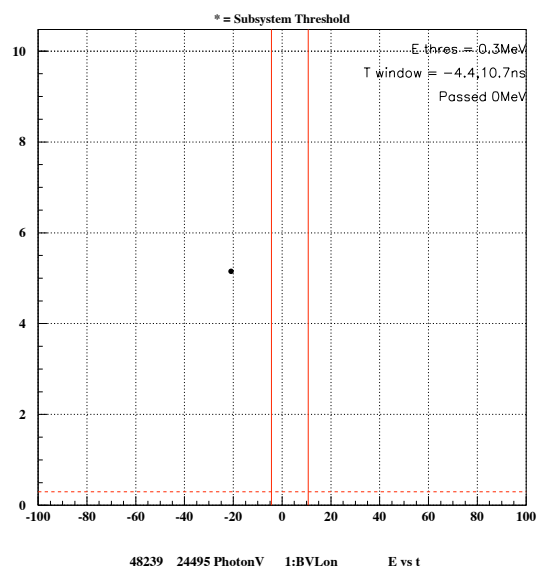
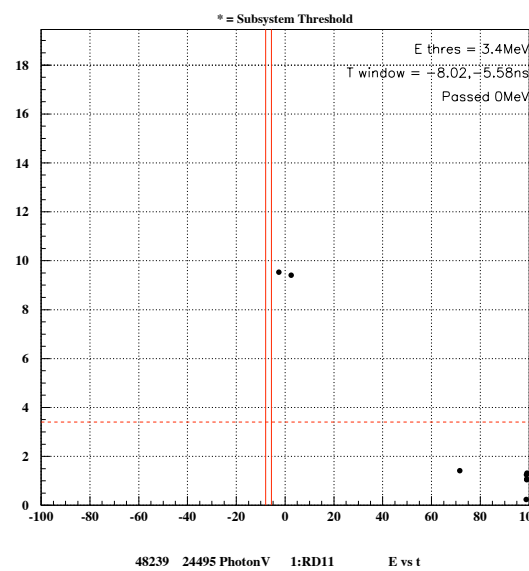
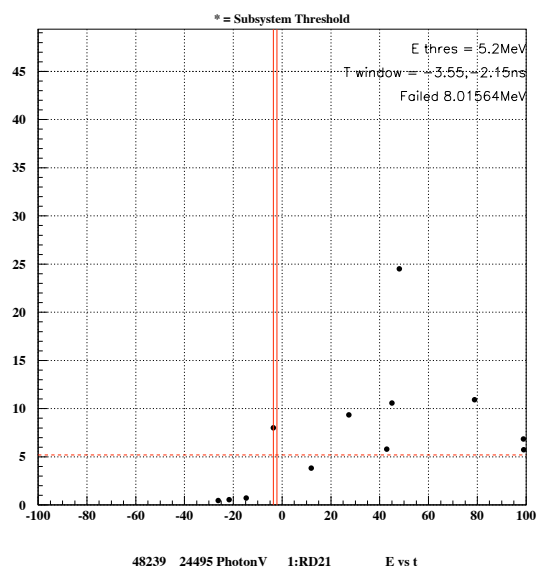
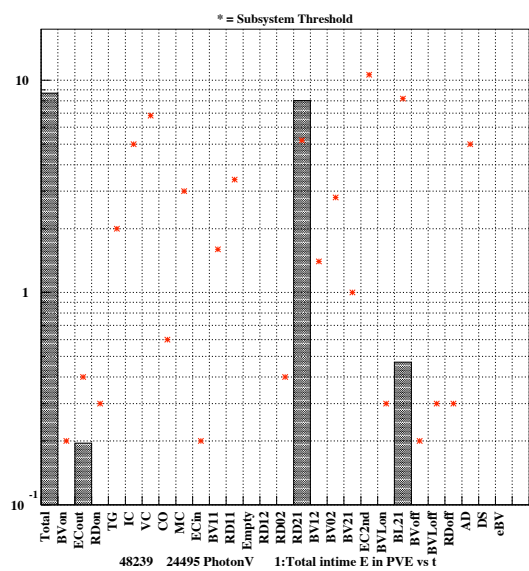


Figure 28: Energy vs Time plots of various PV detectors for RD 1-cut failure.

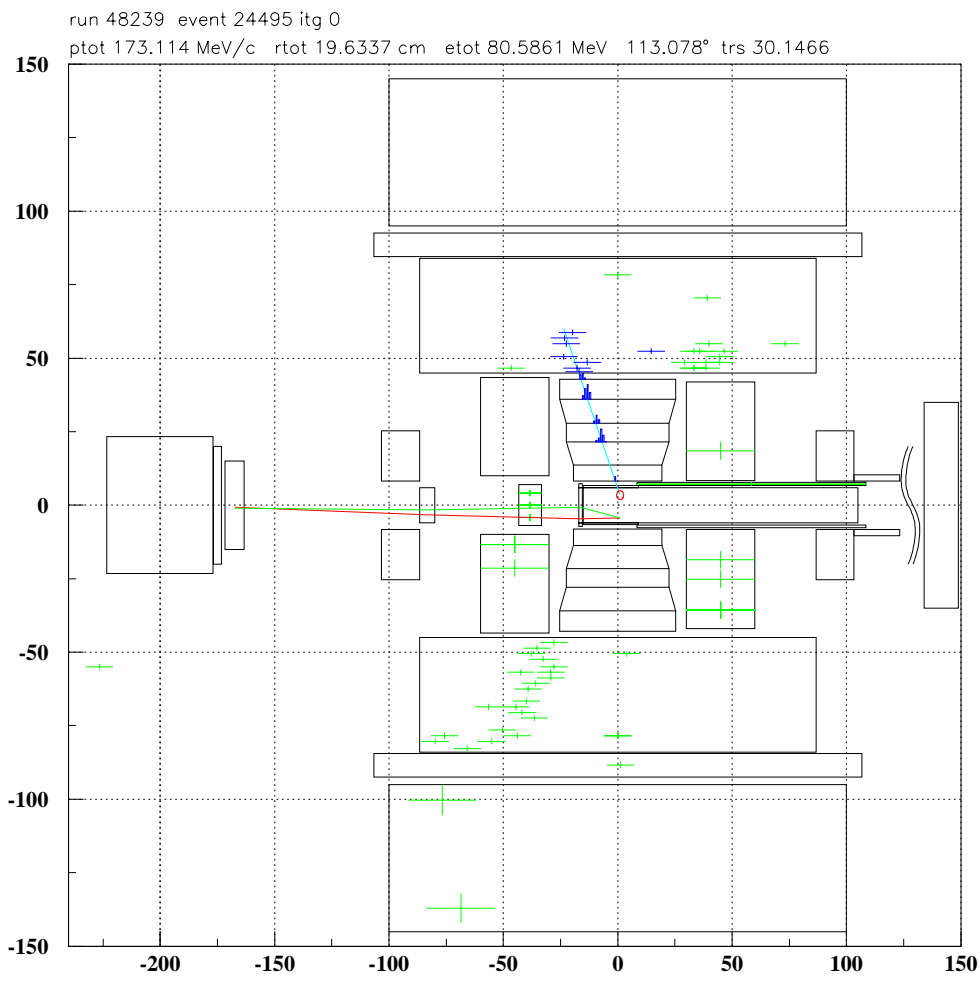
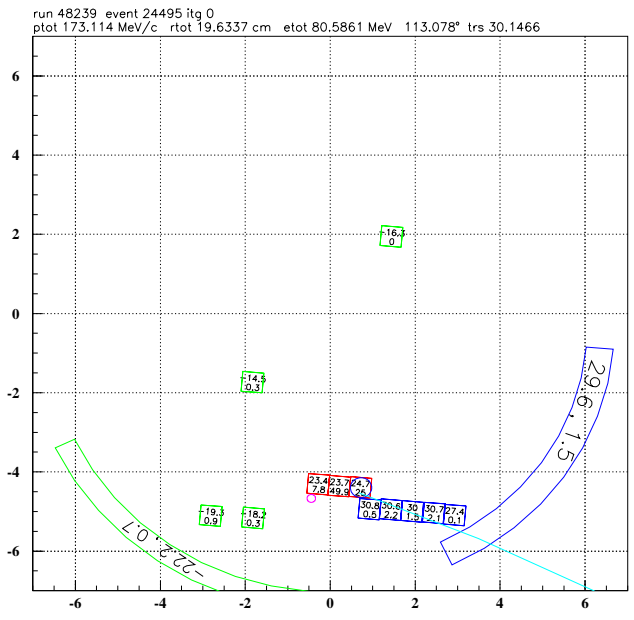
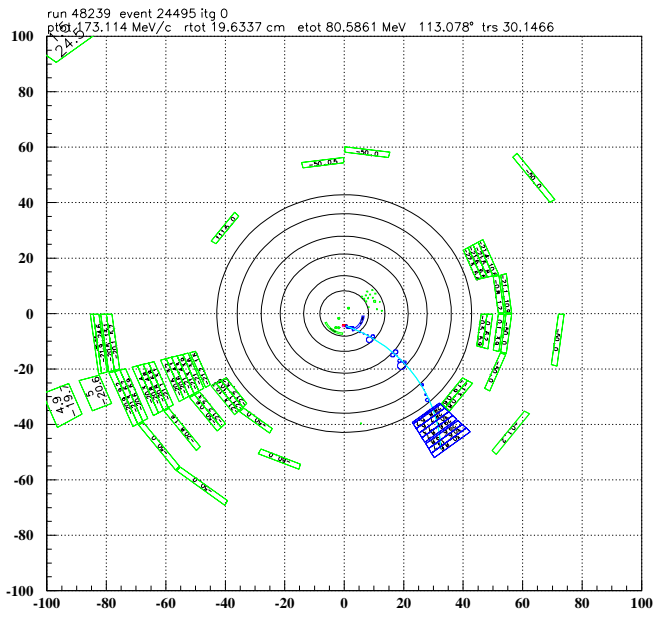


Figure 29: Reconstruction plots of various PV detectors for RD 1-cut failure.

### 11.3.2 Run 50184 Event 86934

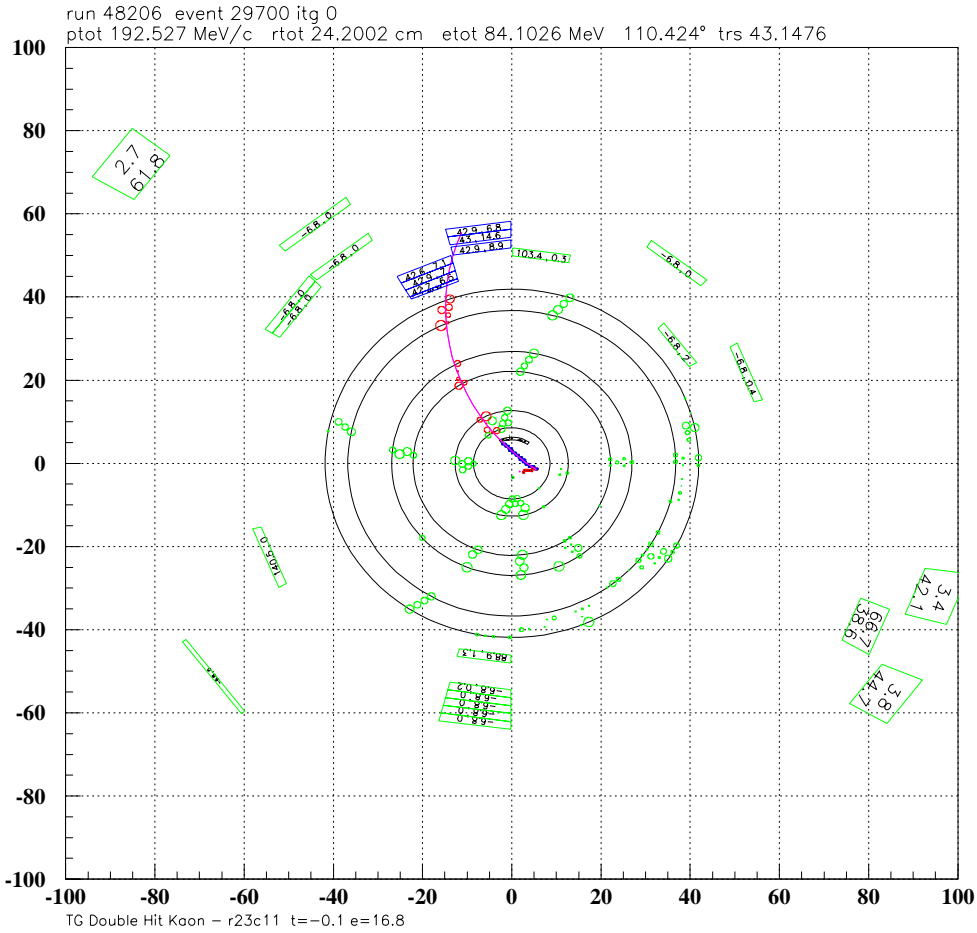


Figure 30: Event reconstruction of BV 1-cut failure. The hits which forced the event to fail are on the far right side toward the bottom

## 11.4 BV Only Events

There are 2 events which only failed the BV PV subsystem.

### 11.4.1 Run 48206 Event 29700

This event fails on the BV PV requirement. However, there is an hit with large energy (67 MeV) in the BVL detector, see Fig. 18 and Fig. 20, that is within 1 ns of the time window. The BVL hit is located back-to-back with the  $\pi^+$ -track. There is also a hit within the Collar which has 9 MeV, well above threshold, but is fractionally outside the time window, see last plot in Fig. 20.

In Fig. 19, we observe a CCDPUL fit with a second pulse energy of 1.09 MeV in the low gain counter. ??? I'm not sure if this would fail if the second pulse energy with these probabilities exceeded the threshold of 1.25.

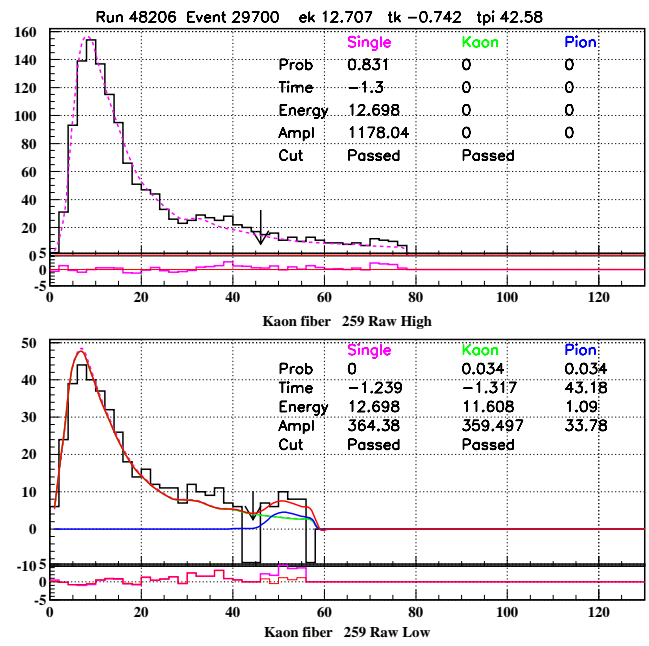
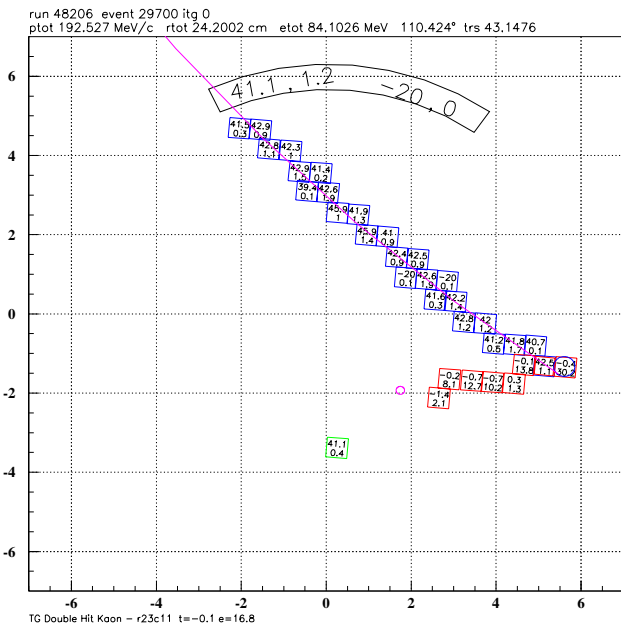
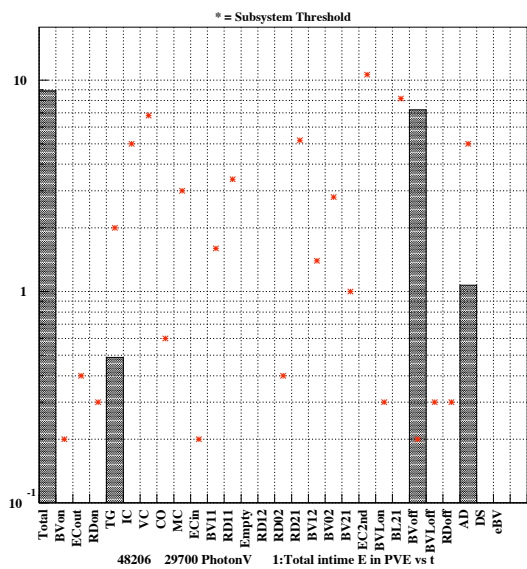
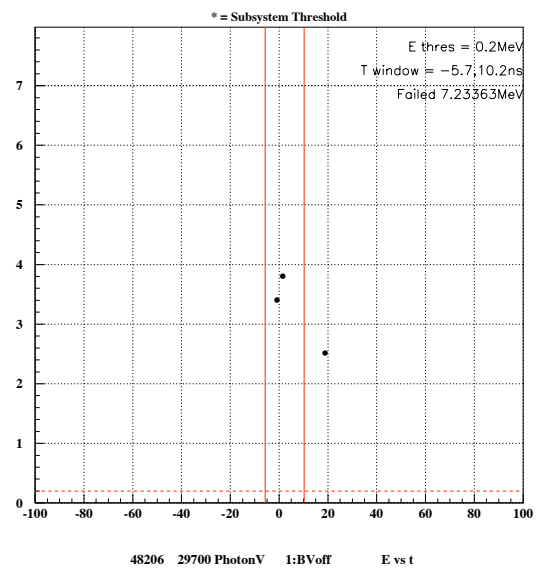


Figure 31: Left: TG reconstruction of BV 1-cut failure. Right: CCDPUL fit.

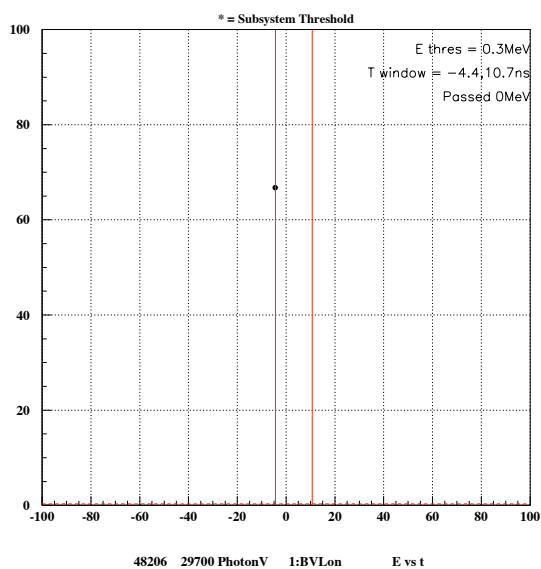
2007/06/21 01.45



2007/06/21 01.46



2007/06/21 01.46



2007/06/21 01.45

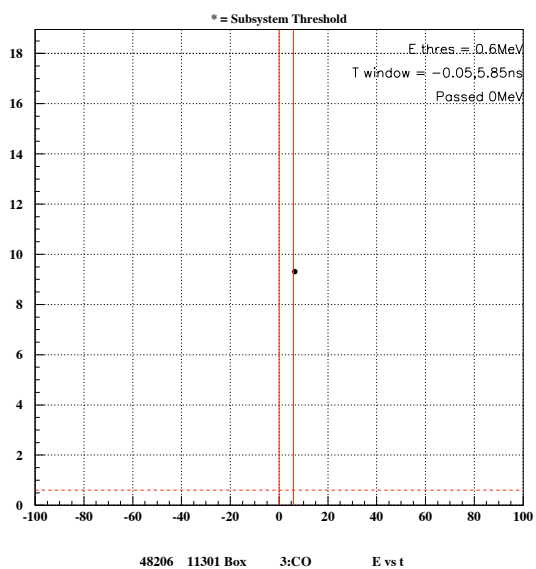


Figure 32: Energy vs Time plots of various PV detectors for BV 1-cut failure.

## 11.4.2 Run 49950 Event 9972



## 11.5 Other PV Events

## 12 Conclusions

## References

[1]