

Update π^0 BG study with timing information

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Introduction



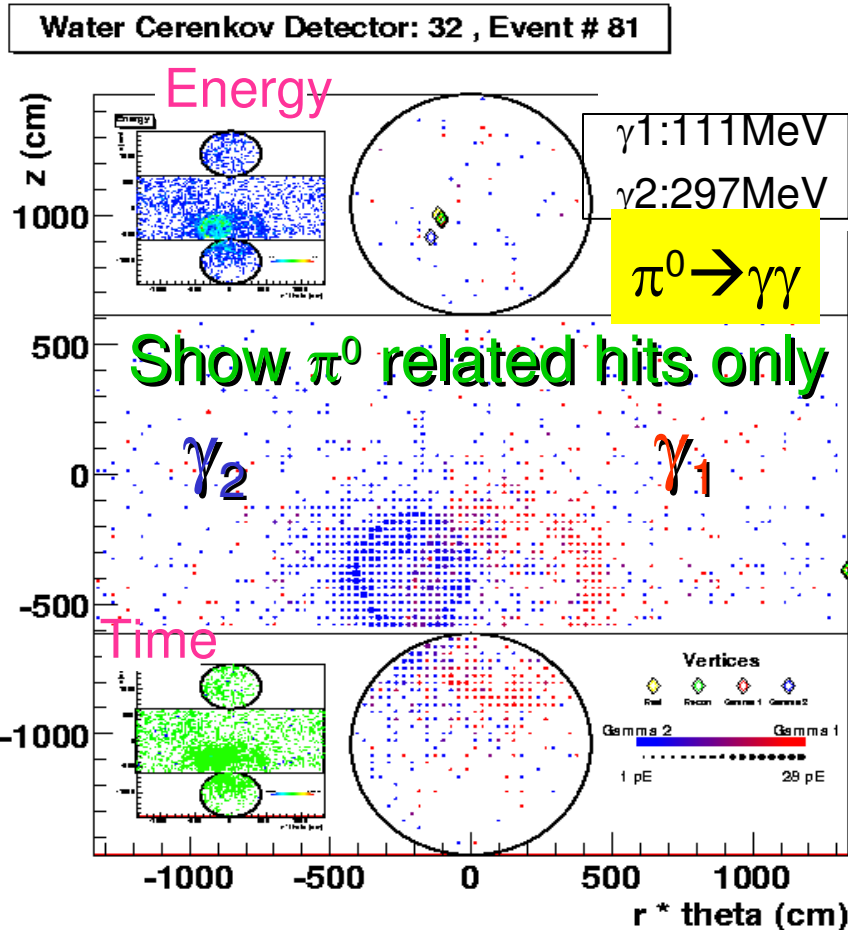
- Goal : new cut/likelihood parameter development for e/π^0 separation

Reminder : Eventdisplay & Category of π^0



- Root-based event display
- True π^0 / reconstructed information

- Read all 2km ν_μ MC vectors, apply 1 ring e-like cuts
- I categorized these 87 events by eye.

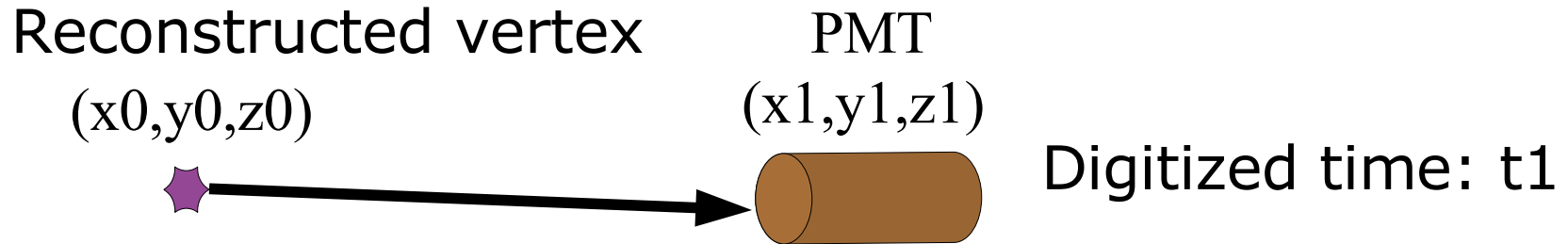


1) One of $E(\gamma)$ is too small	54
2) 2 rings overlap	17
3) Reconstructed vertex is far from real vertex	6
4) One of the conversion point of γ is considerably further away from the vertex than the other conversion point	12
5) Hard to decide between 3) or 4)	2

Tried to quantify above  categories

- Conversion point
- Ringer

New variable : Time @ rec vertex created



Time Of Flight = distance/velocity

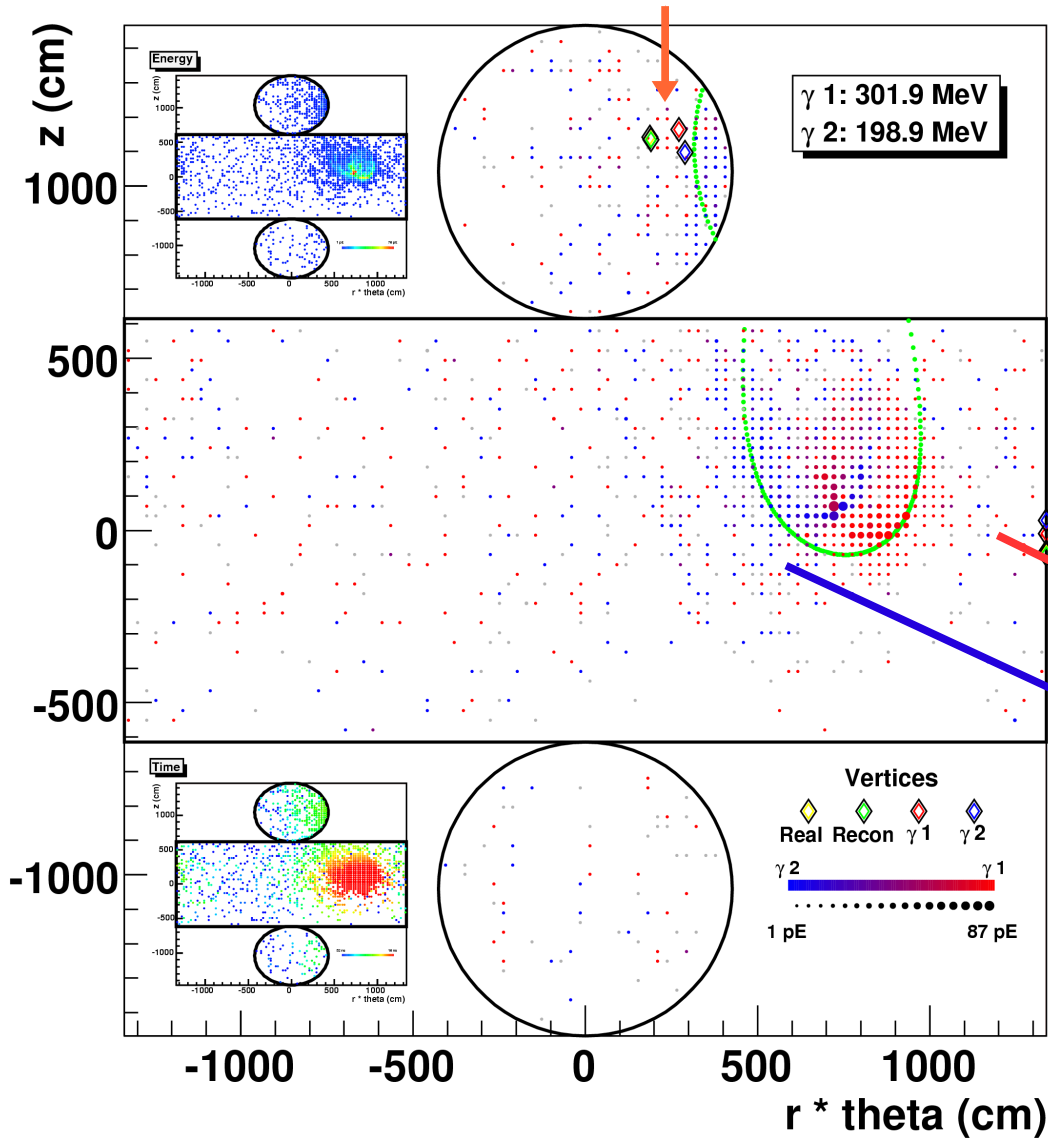
$$\text{velocity} = 30\text{cm}/1.333\text{ns}$$

- Time(γ (s) hit a PMT and digitized) – TOF
= $t(\text{rec vtx})$: Time at reconstructed vertex created

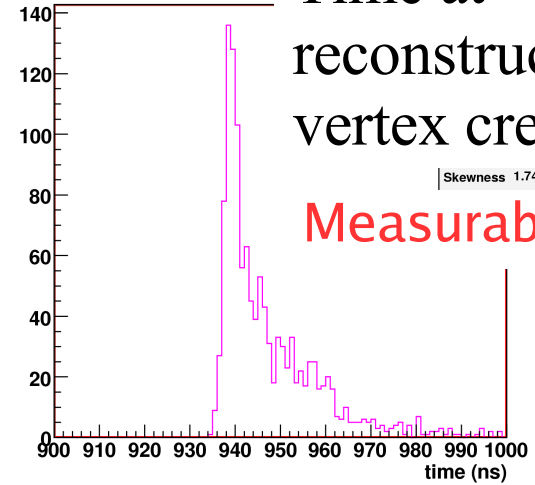
Ex) Conversion point is further away



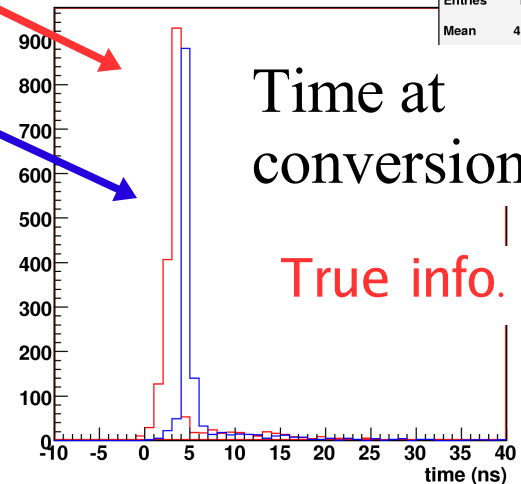
Water Cerenkov Detector: 59 , Event # 421



t(RecVtx): digitized time



t(conv): true

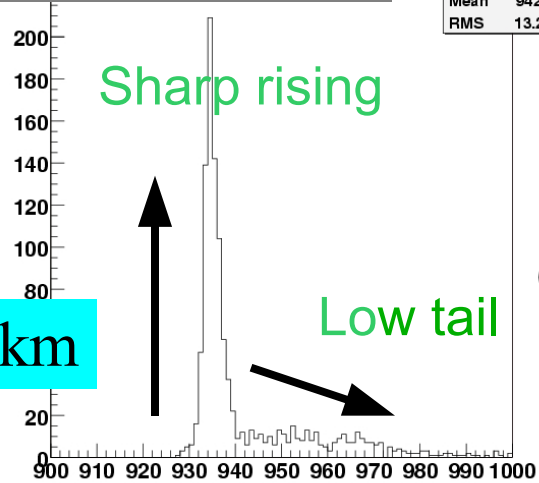


Time at reconstructed vtx created



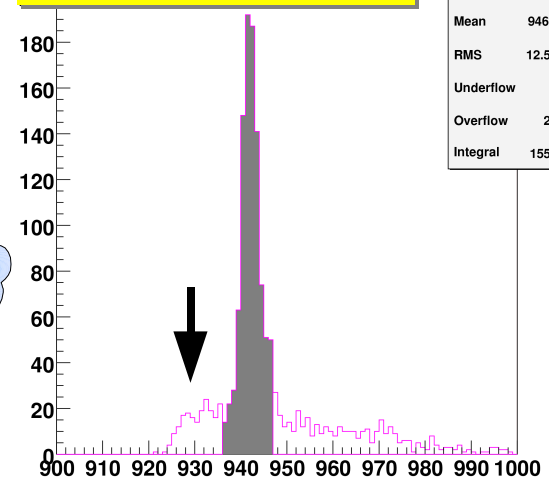
Signal (nu-e)

h1	
Entries	1127
Mean	942.1
RMS	13.25



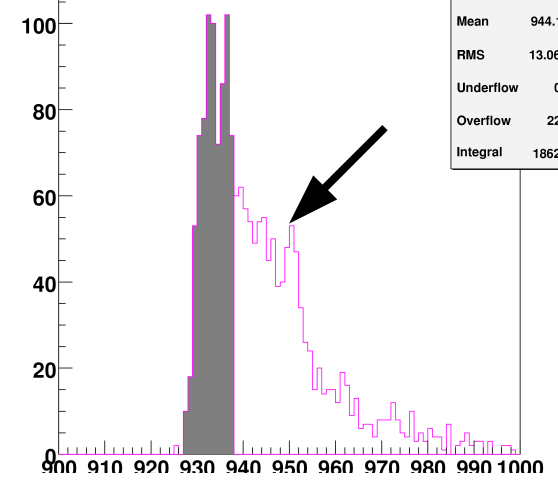
π^0 BG (nu- μ)

t1	
Entries	1576
Mean	946.1
RMS	12.54
Underflow	0
Overflow	26
Integral	1550

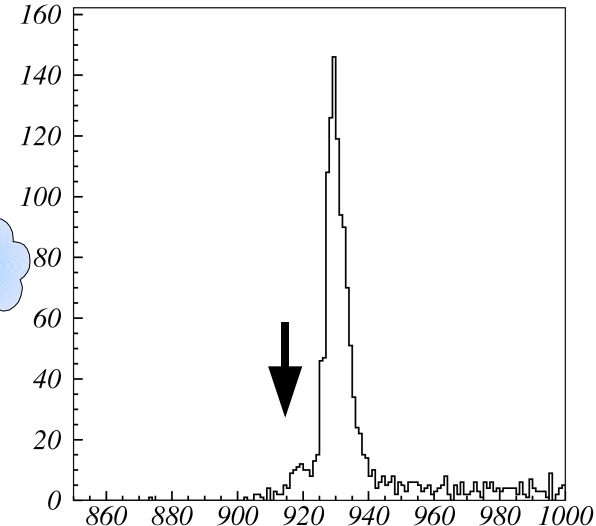
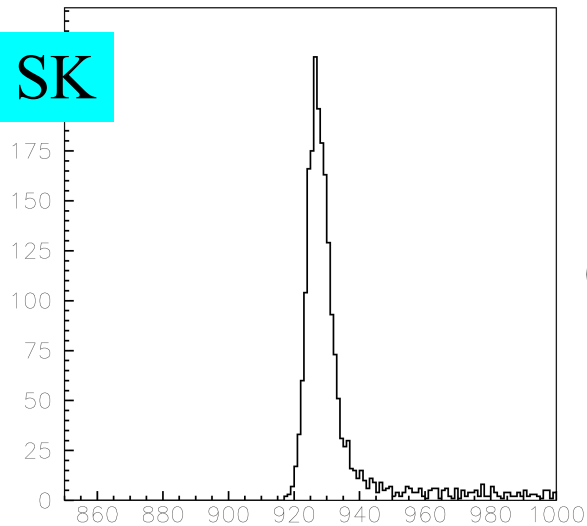


t(RecVtx): digitized time

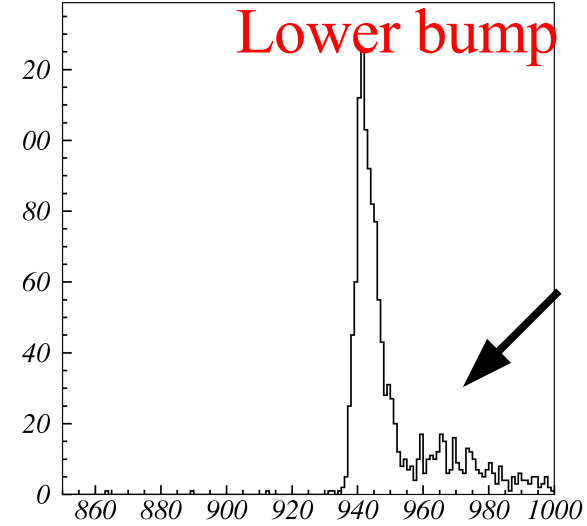
t1	
Entries	1884
Mean	944.1
RMS	13.06
Underflow	0
Overflow	22
Integral	1862



SK

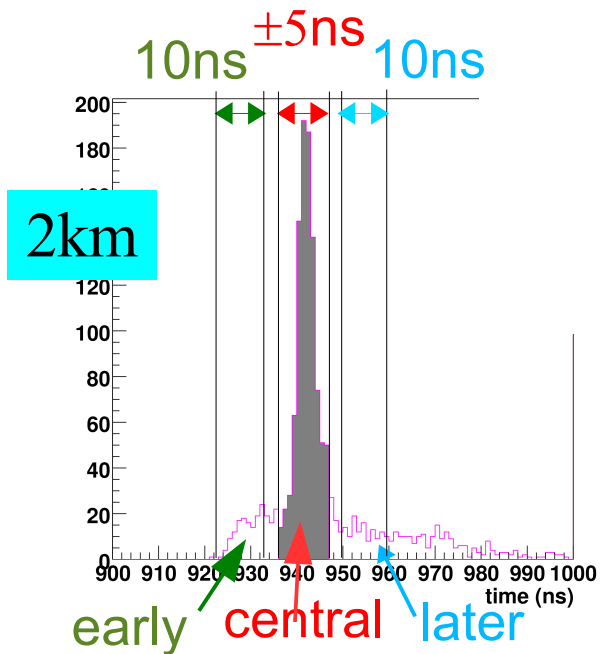


Lower bump

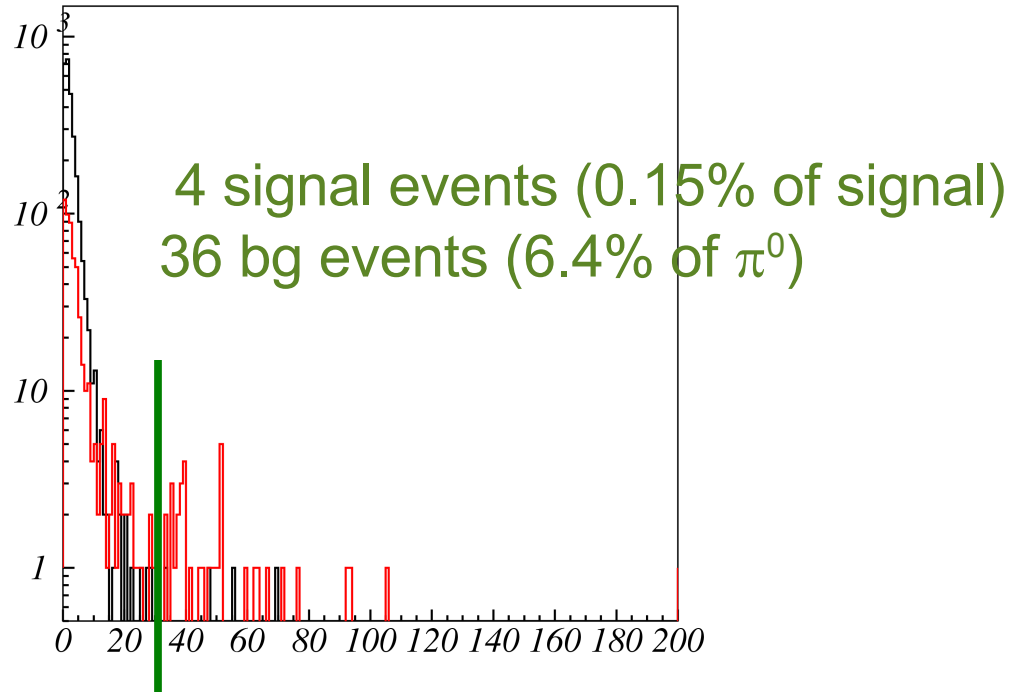
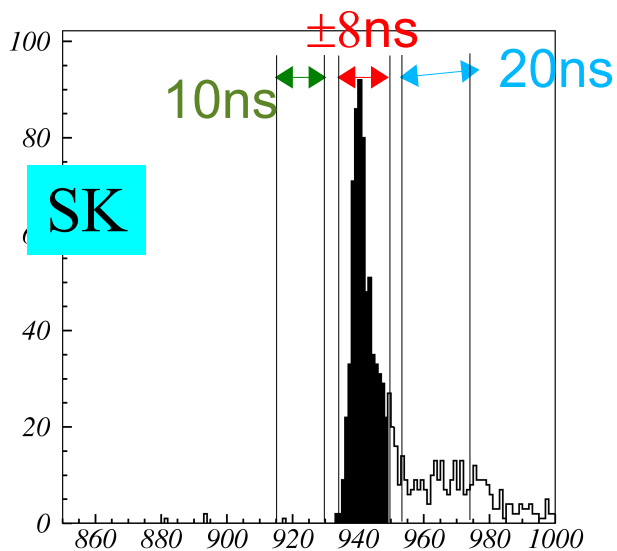
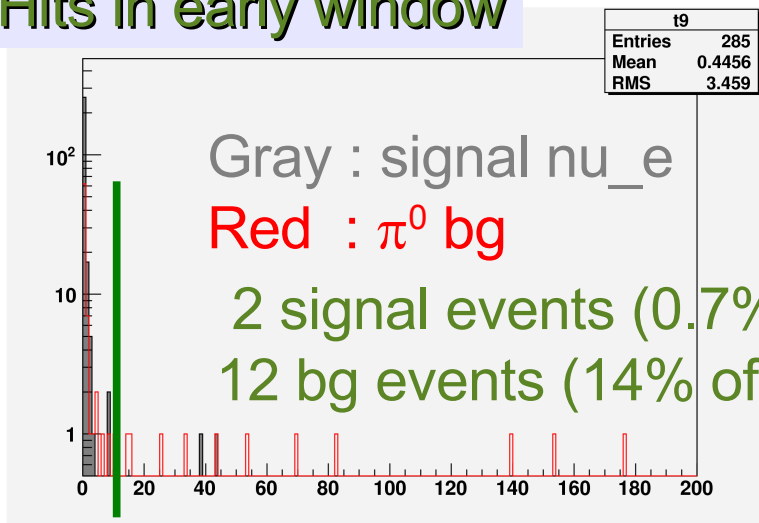


Find cuts to get rid of bumpy events

Time window : early peak

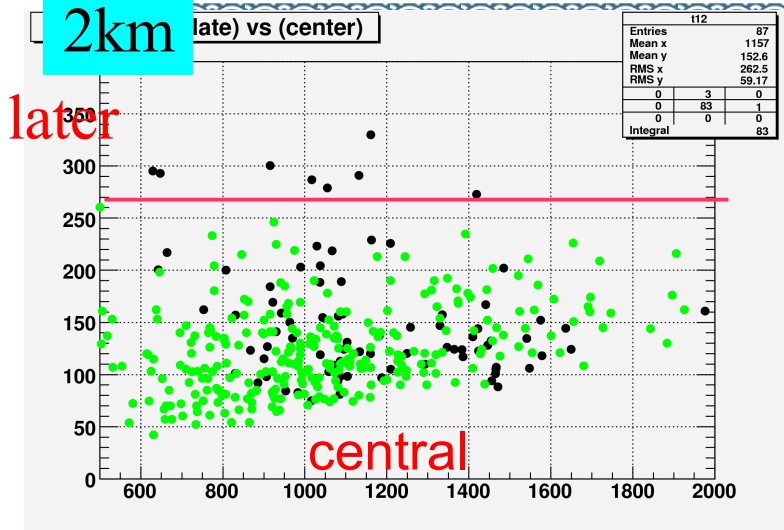


Hits in early window



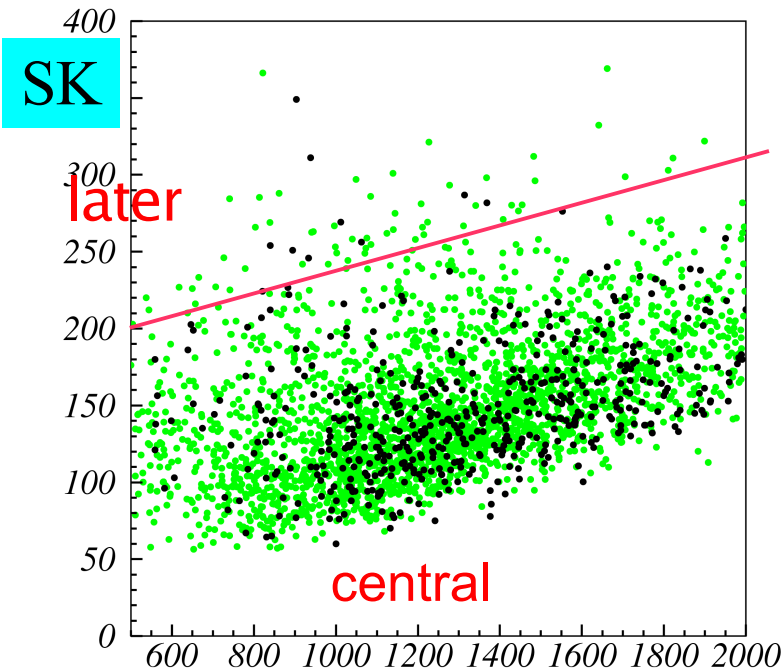


Time window : Later



black :BG
green : signal

Later>270 :
0 signal
11 pi0 (13% of pi0)



69 signal (2.6% of signal)
13 π^0 (2.3% of π^0)

Need to check.

Conclusion



- So far, this timing cut is effective for 2km (can get rid of 27% of p_0), but SK looks not. Need to investigate.
- I will try "ringer" for T2K-SK as well.

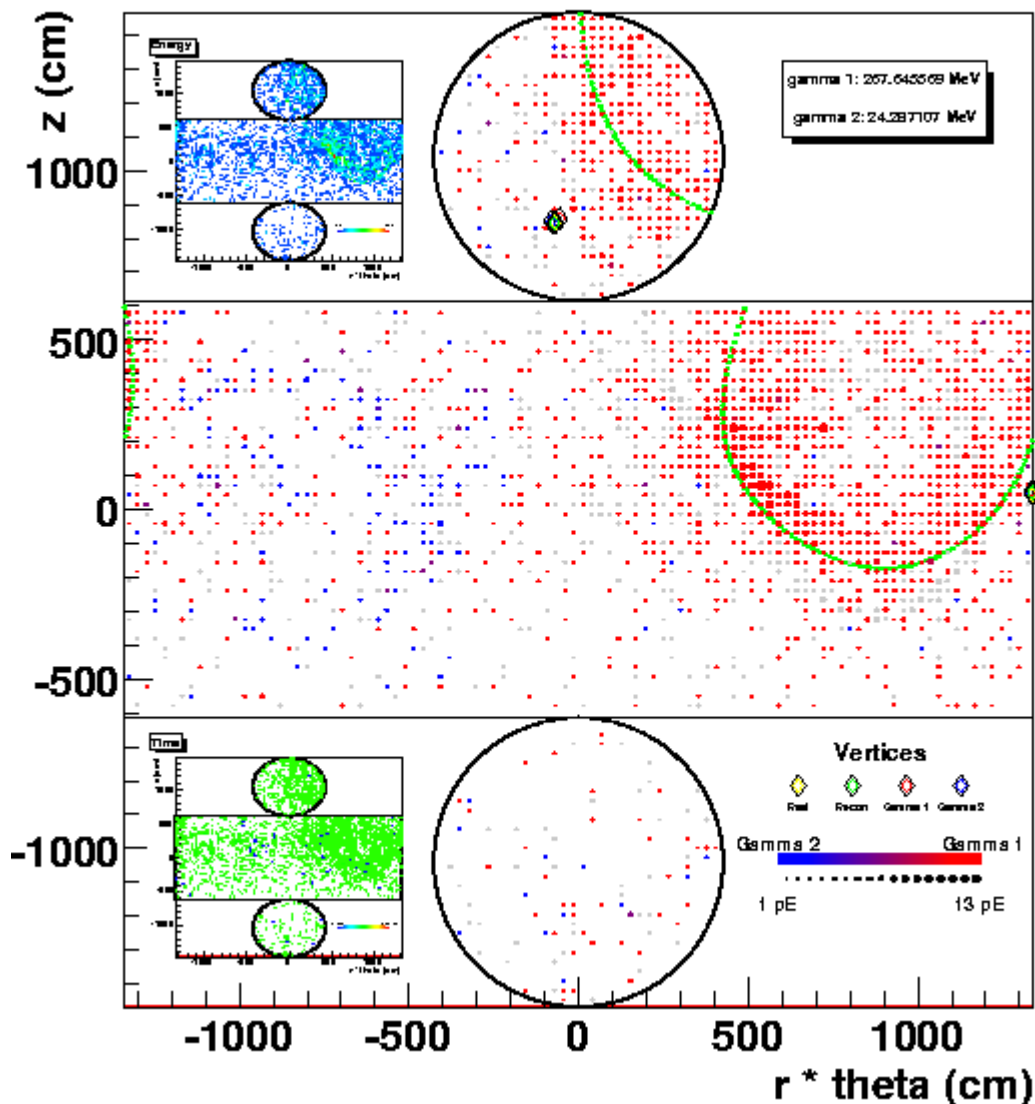


Back up

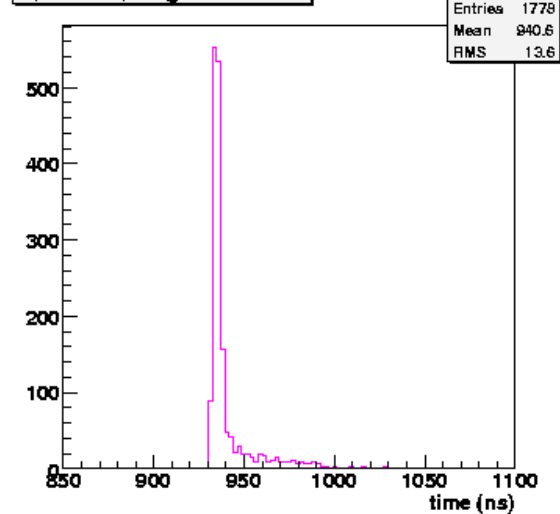
1) One of $E(\gamma)$ is too small



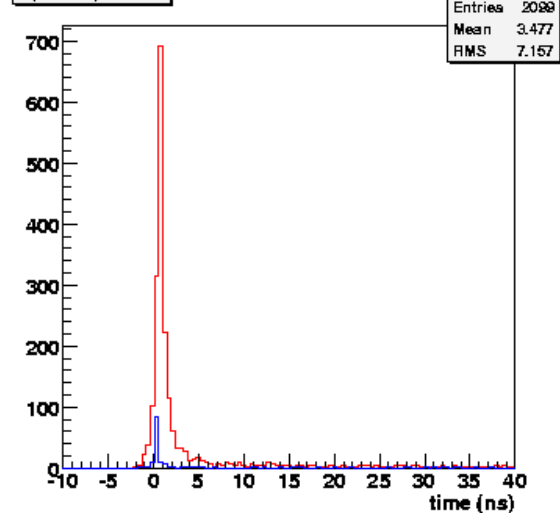
Water Cerenkov Detector: 47 , Event # 292



t(RecVtx): digitized time



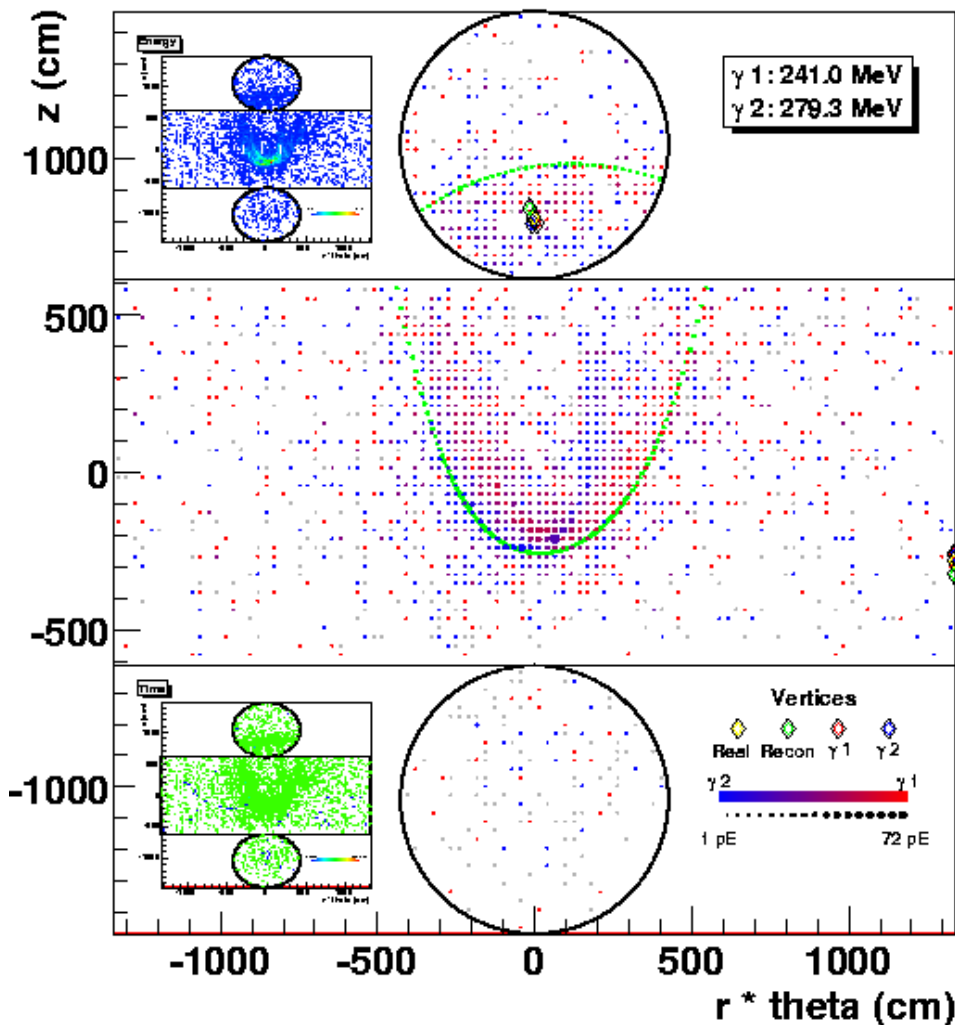
t(conv): true



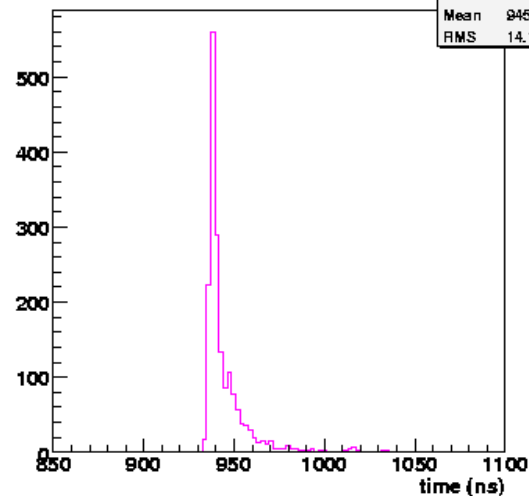
2) Two rings overlap : case 1



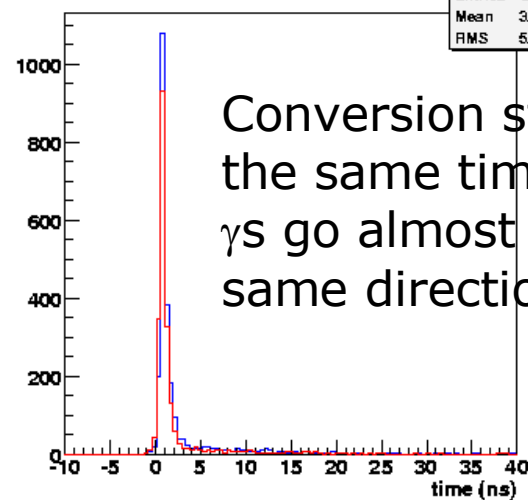
Water Cerenkov Detector: 104, Event # 407



t(RecVtx): digitized time



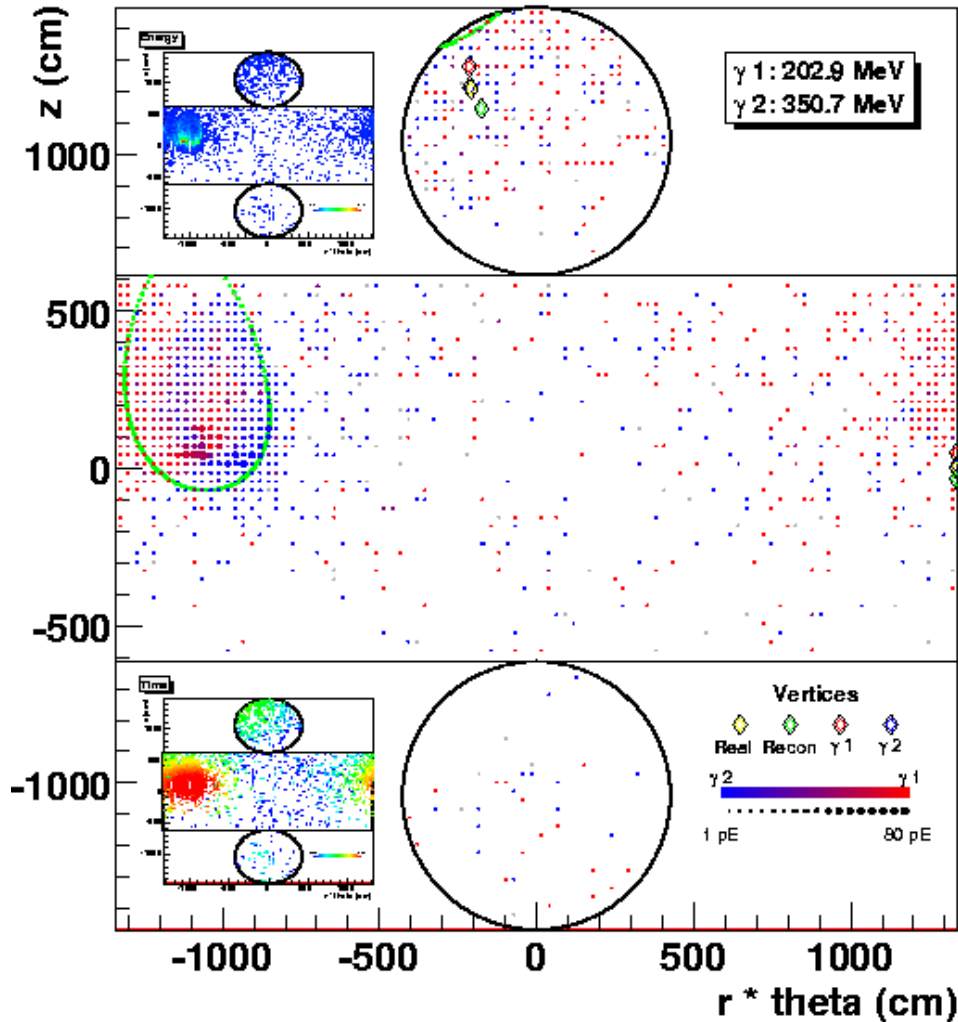
t(conv): true



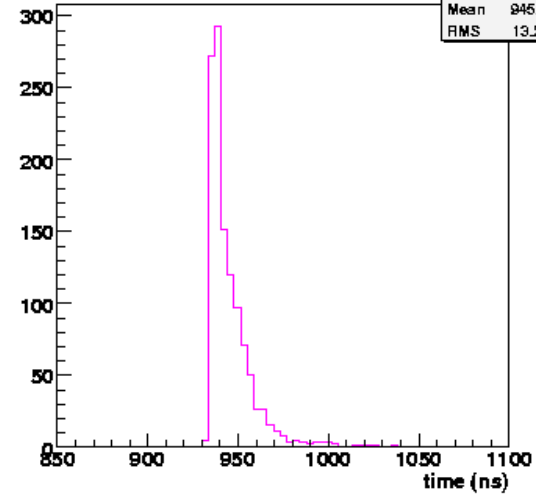
3) two rings overlap : case 2



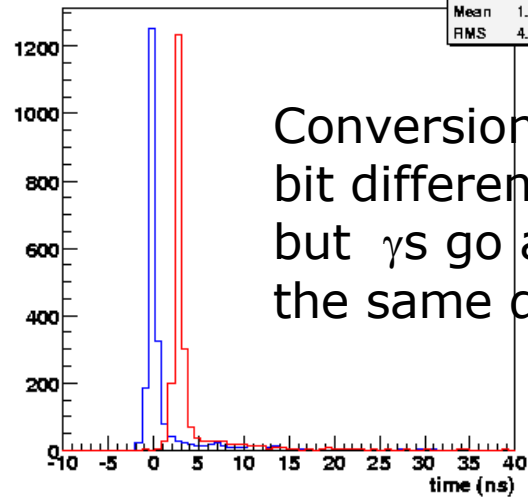
Water Cerenkov Detector: 42 , Event # 20



t(RecVtx): digitized time



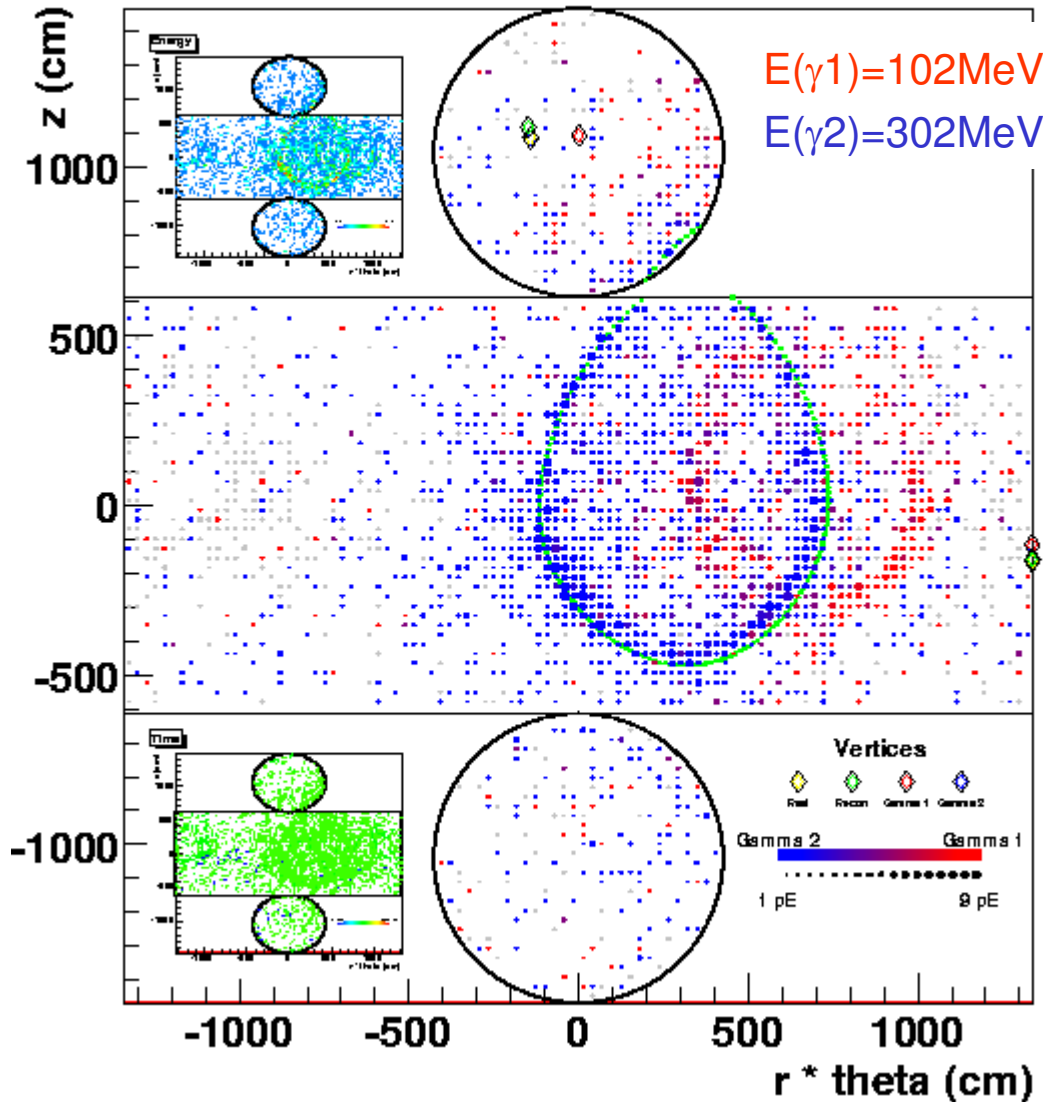
t(conv): true



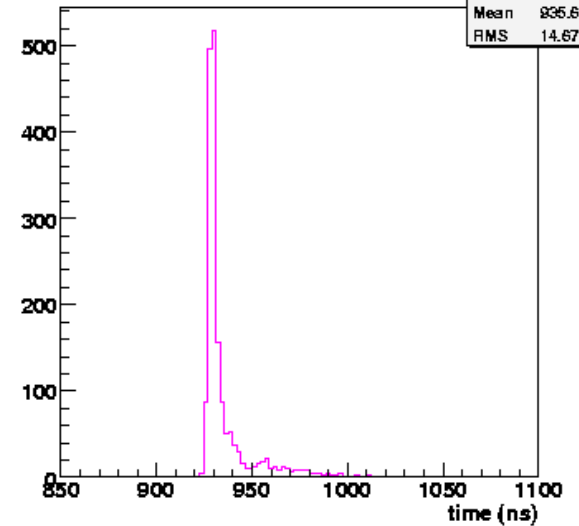
Conversions start a bit different time but γ s go almost the same direction

4) Electron conversion point is far away from vtx

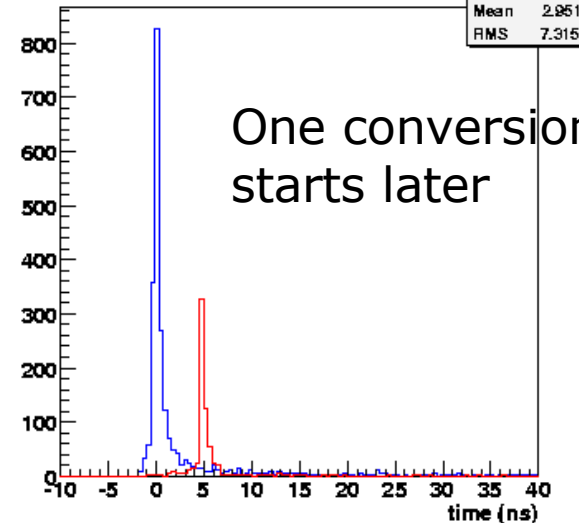
Water Cerenkov Detector: 35 , Event # 426



t(RecVtx): digitized time



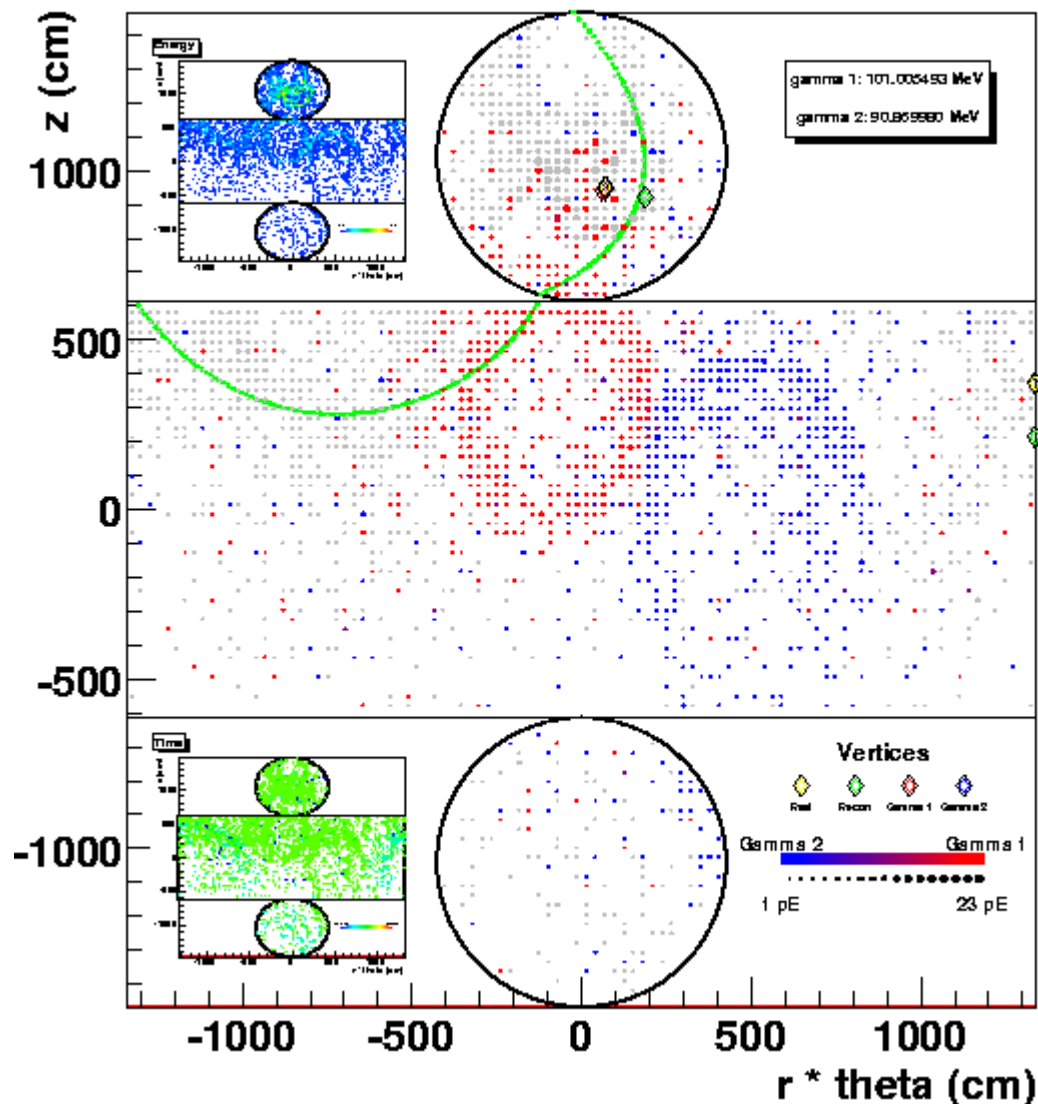
t(conv): true



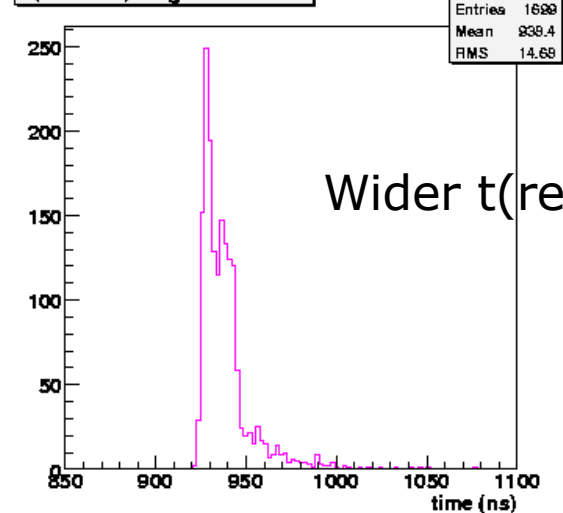
5) Reconstructed vertex is far away from real vtx



Water Cerenkov Detector: 69 , Event # 432



t(RecVtx): digitized time



Wider t(rec vtx)

t(conv): true

