Flasher Identification at Daya Bay

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On behalf of the Daya Bay Collaboration

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0.Abstract

The Daya Bay Reactor Neutrino Experiment observed electron antineutrino disappearance by six functionally identical ADs(antineutrino detectors). All eight ADs have been running since October 2012. About 5% of triggered AD events are so-called flasher events, that are resulting from discharge within the base of PMTs. A variable, named FID, has been constructed to discriminate flasher events. In this presentation, we give a brief introduction on flasher phenomenon, flasher feature and flasher identification at Daya Bay experiment.

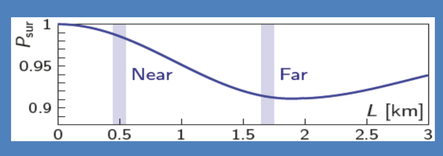
1.The Daya Bay Experiment

Daya Bay is a reactor neutrino experiment designed to measure $\sin^2 2\theta_{13}$ to 0.01 at 90% CL

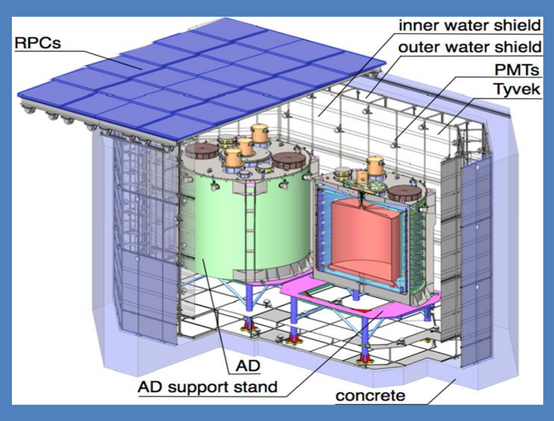
- 6 reactor cores, 17.4 GW_{th}
- Relative measurement
  - –2 near sites, 1 far site
- Multiple detector modules
- Good cosmic shielding

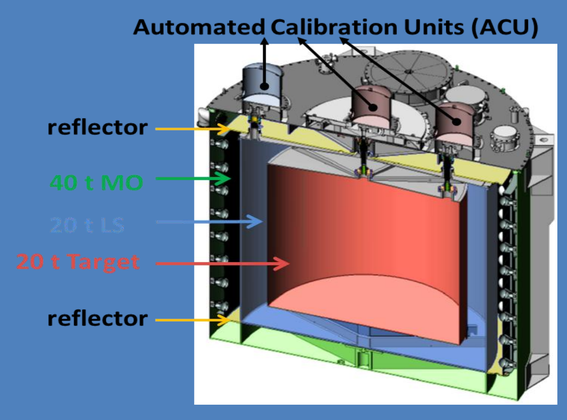
Table 1. Vertical overburden, muon rate R_μ, and average muon energy $<E_\mu>$ of the three EHs.

	overburden (m.w.e)	R_μ (Hz/m^2)	$<E_\mu>$/GeV
EH1	250	1.27	57
EH2	265	0.95	58
EH3	860	0.056	137



2.AD(Anti-neutrino Detector)

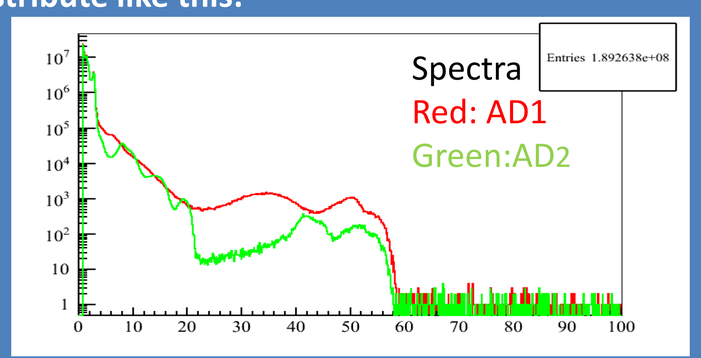


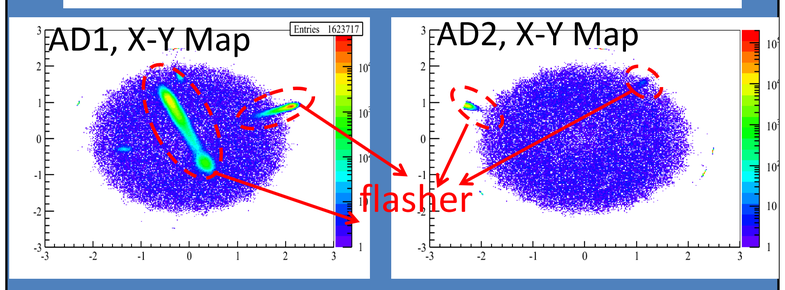


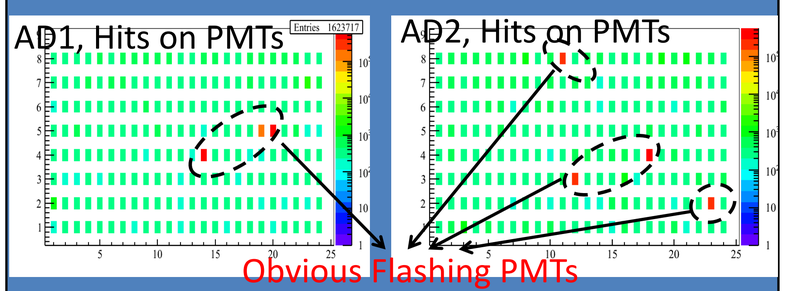
- Multiple Anti-neutrino Detector (AD) modules to reduce syst. err.
  - –Far: 4 modules， near: 2 modules
- Multiple muon detectors to reduce veto eff. uncertainties
  - –Water Cherenkov： 2 layers

3.Flasher phenomenon

ADs in the same experiment hall(EH) are identical, e.g. AD1 and AD2 of EH1. it is reasonable they have similar energy spectra. Vertex distribution and PMT hit rate are expected to have relative uniform distribution. However, triggered events distribute like this:





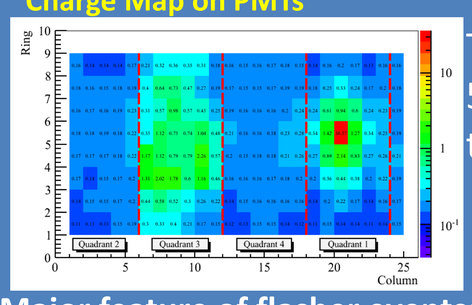


Phenomena of Spectra deviation between identical ADs, vertex clusters and abnormal hot PMTs are caused by flasher events.

Events in each figure are in energy region of (6, 12)MeV.

4.Flasher flasher features

Charge Map on PMTs



The PMT in Ring 5-Column 20 is the flashing PMT.

Major feature of flasher events:
1.The flasher PMT has the largest Charge mostly.
2.Two hot clusters in the charge map, one is around the flashing PMT and another one is always in the opposite side of the flashing PMT.

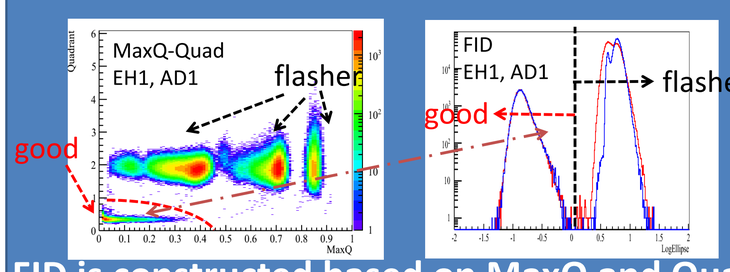
5.Definition of FID

Based on flasher features, two variable been defined:

MaxQ is the largest fraction of the total detected charge seen by a single PMT.

Quad = Q3/(Q2+Q4).

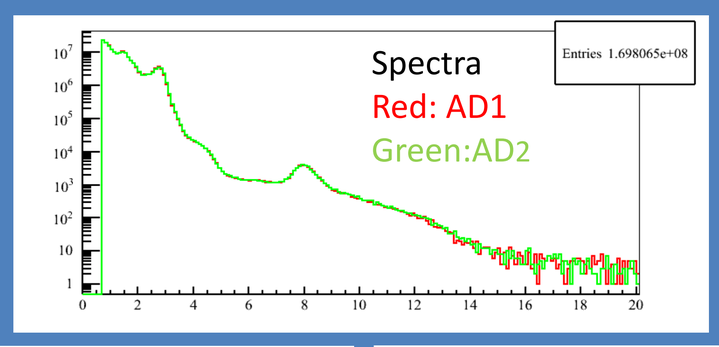
Qi is the charge sum of PMTs in the i-th quadrant.*[see the charge map on the previous page]*

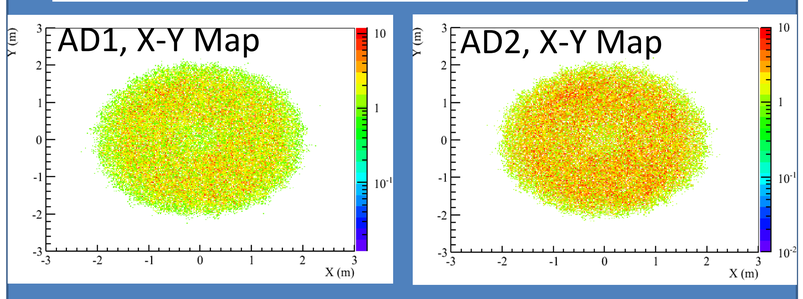


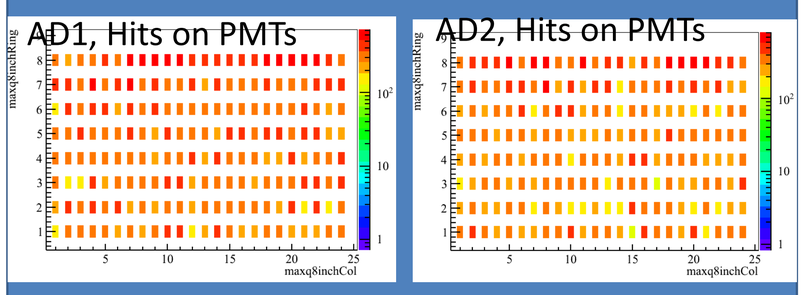
FID is constructed based on MaxQ and Quad:
FID = log10[(MaxQ/0.45)2 + Quad2].
If FID > 0(Ellipse>1), flasher event;
else if FID < 0(Ellipse<1), physical event.

6.FID performance

After flasher events rejected, spectra of AD1 and AD2 are similar with each other, clusters in vertex distribution vanished and hit counts on PMTs are in the same level.

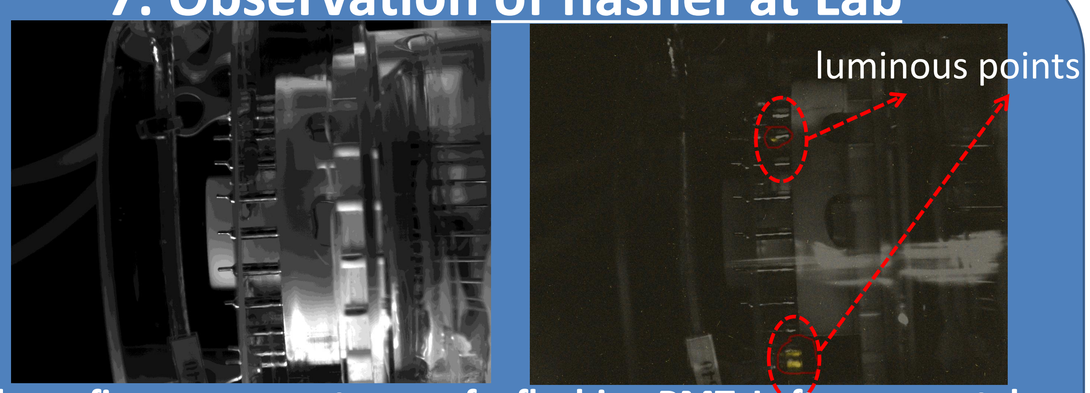






Several other algorithms based on charge or time features of flasher have also been studied. Combination of Quad and MaxQ is the most simple and powerful one.

7. Observation of flasher at Lab



Above figures are part map of a flashing PMT. Left one was taken at light environment. Right one was taken at dark environment, from which one can see obvious light points. This is so-called flasher phenomenon.

8.Summary

- Flasher events result from discharge within the base of PMTs.
- Based on charge features of flasher, a variable name FID has been constructed to identify flasher events.
- If FID>0, flasher event;
  Else if FID<0, physical event.
- FID works stable since the beginning of data taking at Daya Bay.
- Signal inefficiency is less than 0.02% and flasher contamination is controlled at a low level.

Thanks to every contributor to flasher study at Daya Bay!