Checking HyCal ADC status

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This note describes the method of checking PMT anode and dynode signal status of HyCal channels. The final result downloaded to PrimEx caldb and is using in PrimEx-II data analysis and GEANT simulations.

The HyCal consists of 900 lead glass modules (ids: 1, 2...900) and 1156 $PbWO_4$ crystal modules (ids: 1001,1002...2156). Each module has the anode connected with ADC, and the last dynode connected with trigger TDC (many crystal channels also connected with individual TDCs).

Probe Functions

Probe function F1 and F2 described below, were used to test status of anode and dynode signals. Probe functions for different channels and different runs were compared. Channels which are physically located next to each other should have close values of F1 and F2 functions. These functions should also be stable with the time (vs Run Number).

We used pi0 production runs starting from run number 64704 (up to run 65112) to check the time stability of F1 and F2. We selected for analysis clusters with energy bigger than 1.5 GeV. Events with HyCal trigger were selected.

1.1 Definition of F1

The following function F1 was used to check anode (ADC) status of each HyCal channel:

$$\mathbf{F1(id) = N1(id) / [N1(1)+N1(2)+...+N1(2156)], \quad (1)}$$

where **N1(id)** is the number of clusters with the "central id" (cell with maximum energy deposition) "sitting" in **id** summed for the entire run. Channels with ADC problem have no or significantly reduced observed energy deposition in them for all or part of statistics. Thus function **N1** for them should be noticeably different from adjacent channels.

F1(id) = 0 means that the anode (ADC) of the HyCal channel for this **id** is dead.

1.2 Results for anode status

The color map presented in Fig. 1 shows F1 values for HyCal modules.

It is clearly seen that channels 875 and 877 have significantly reduced F1 value comparing with their neighbors. Channel 900 in bottom right corner is completely dead.

Fig. 2.1 and 2.2 show the stability of F1 function for ids 874, 875, 876 and 877 vs run number. F1 for ids 874 and 876 has normal value. F1 for id 875 for part of runs is abnormal, and F1 at id 877 is totally abnormal.

So, we can conclude, that channel 875 is dead from run 64950 to the end, and id 877 is dead for all runs.

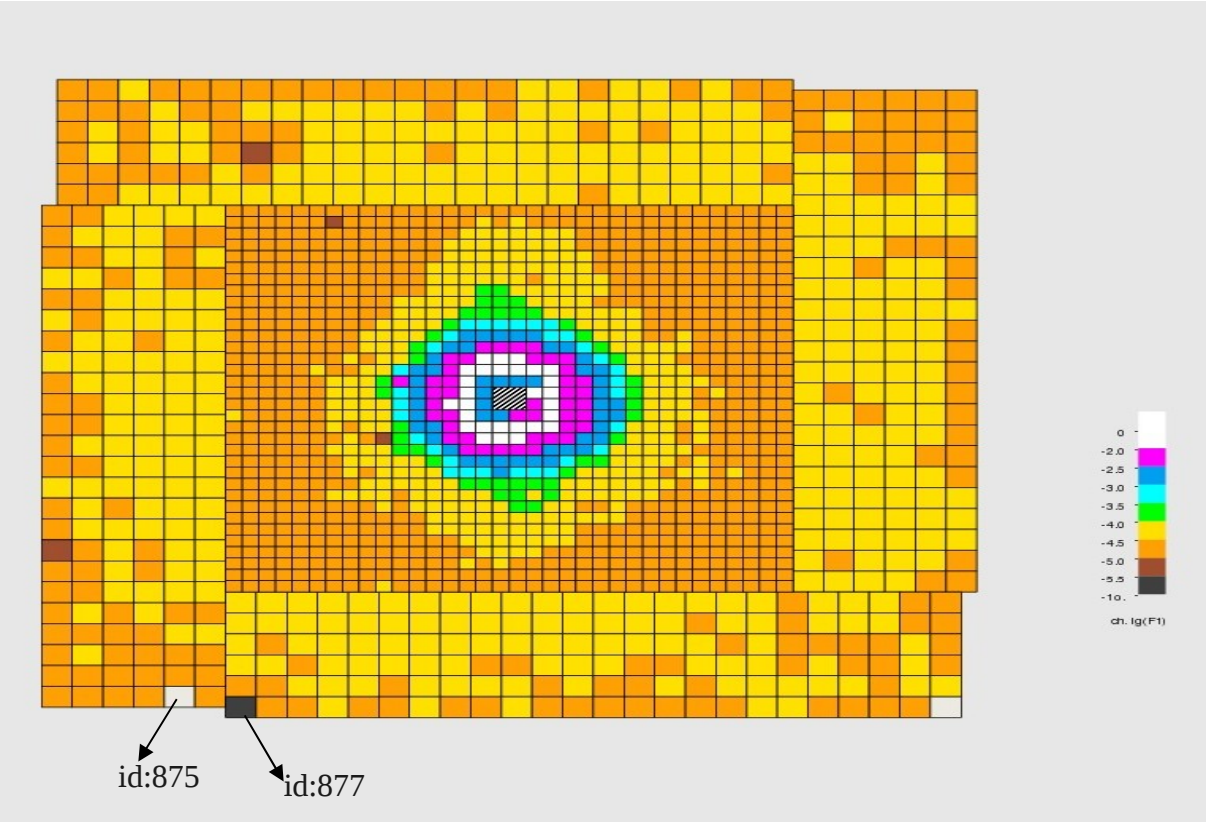
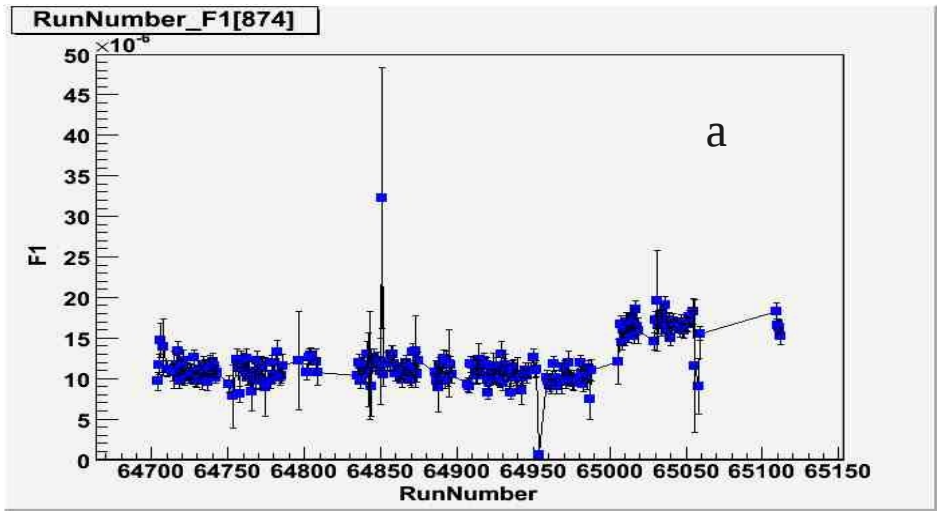


Fig 1. Color map representing F1 values for run 65052 , anode at id 875, 877 and 900 are abnormal.



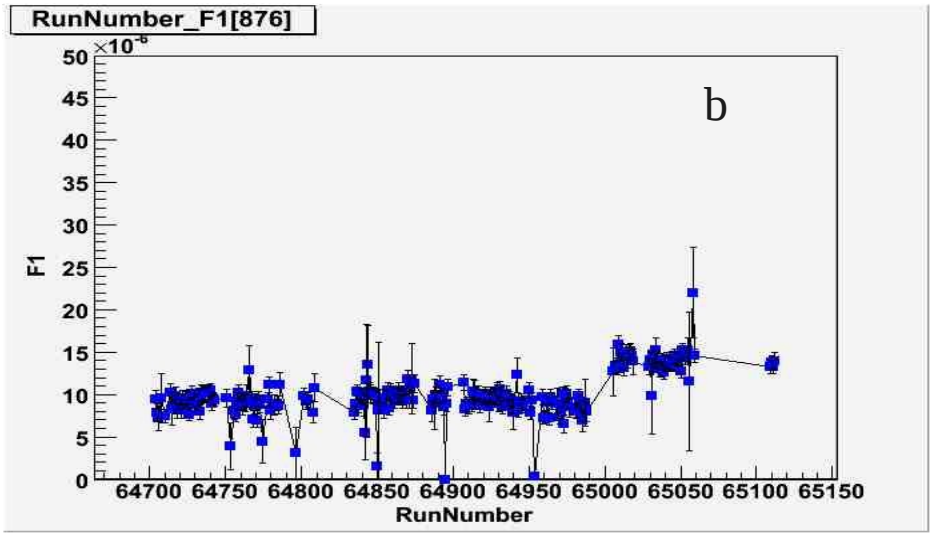
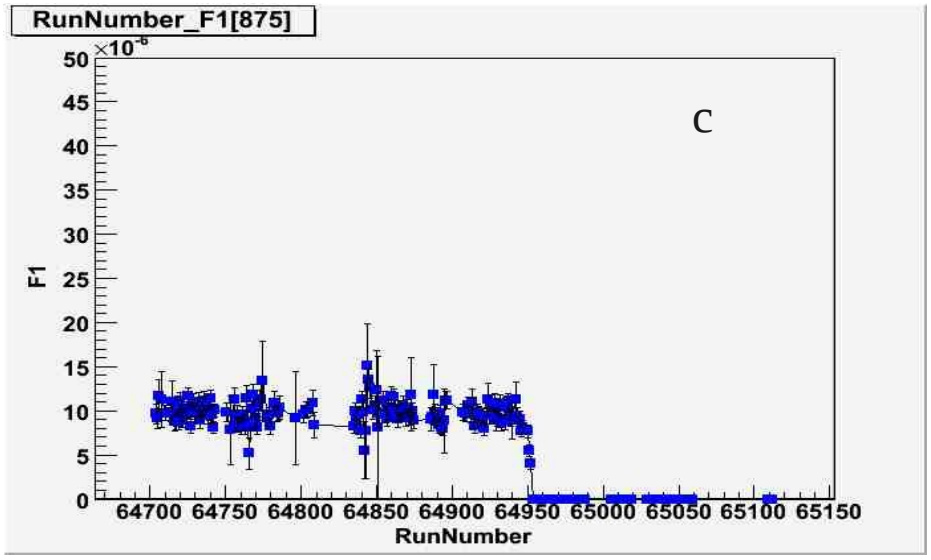


Fig 2.1. F1 vs run number for: (a) channel id 874; (b) channel id 876. id 874 and id 876 are normal.



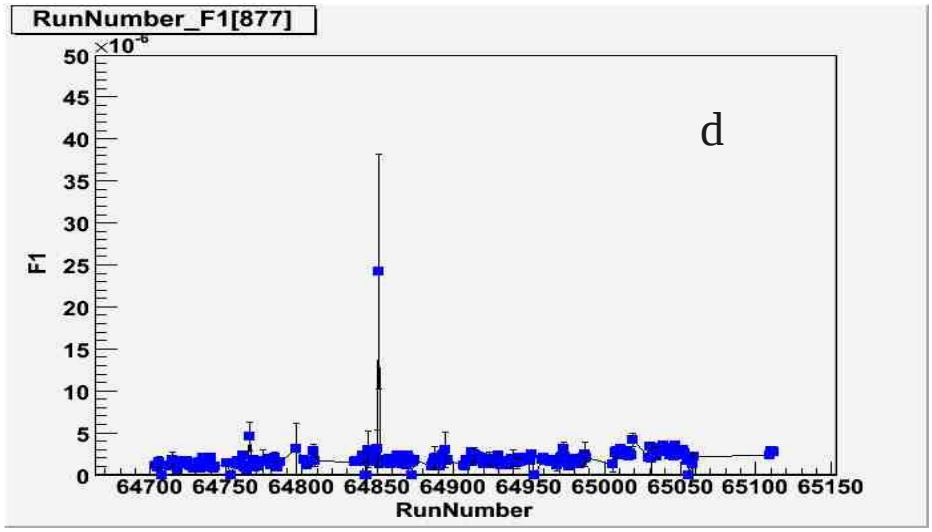


Fig 2.2. F1 vs run number for: (c) channel id 875; (d) channel id 877. Anode signal for ids 875 and 877 is abnormal

2.1 Definition of F2

The following probe function F2 is used to check the dynode(Trigger) status of each HyCal detector module:

$$\mathbf{F2(id) = N2(id)/N1(id)} \qquad (2)$$

where N2 is same as N1, defined in previous paragraph but it's selected from one cluster events (as already noted we are using event with HyCal trigger on). Channels with trigger signal (TDC) problem may not produce HyCal trigger. Since here we selected only one cluster events, it is unlikely to get trigger signal from other channels. Thus **N2** function will be significantly reduced in case of such a problem.

If **F1(id)** is normal but **F2(id)** is too low, that means that the dynode (trigger) signal of that HyCal module is dead.

2.2 Results for dynode status

In the color map presented in Fig 3, F2 values are shown. For a few channels (dark squares) F2 value is obviously distinguished from their adjacent channels. F2 values for these ids are abnormal.

Comparing the distribution of F2 vs run number for all channels, the abnormal dynodes can be figured out. In the Fig 4.1 dynodes for channels id 1689 and id 1072 are normal, In the Fig 4.2 dynodes of channels 1690 and id 1073 are abnormal. Channels with bad F1 are automatically excluded from dynode (F2) analysis.

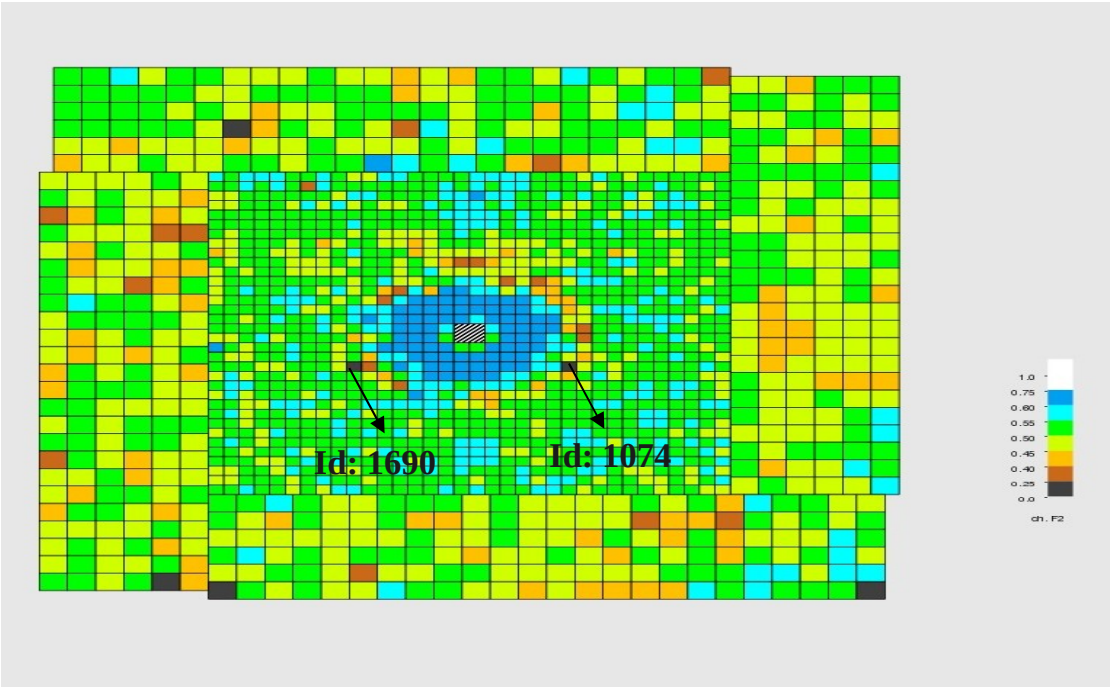
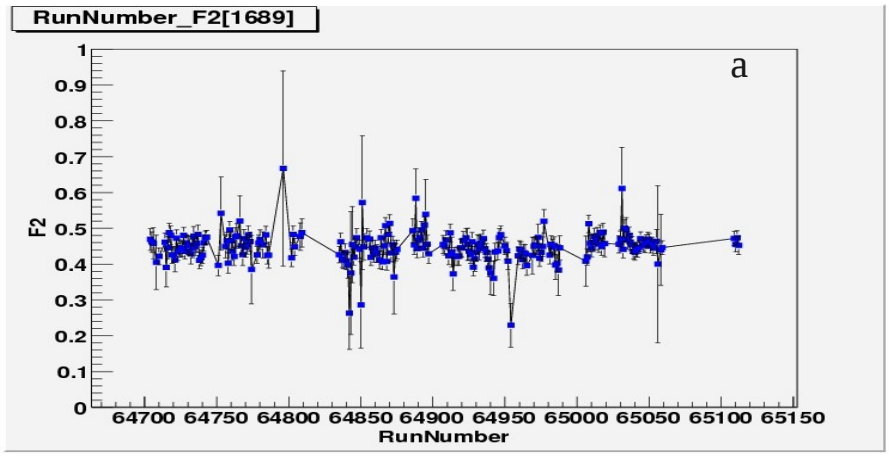


Fig 3. Color map representing F2 values for run 65052, dynodes for ids 1690 and 1074 are abnormal



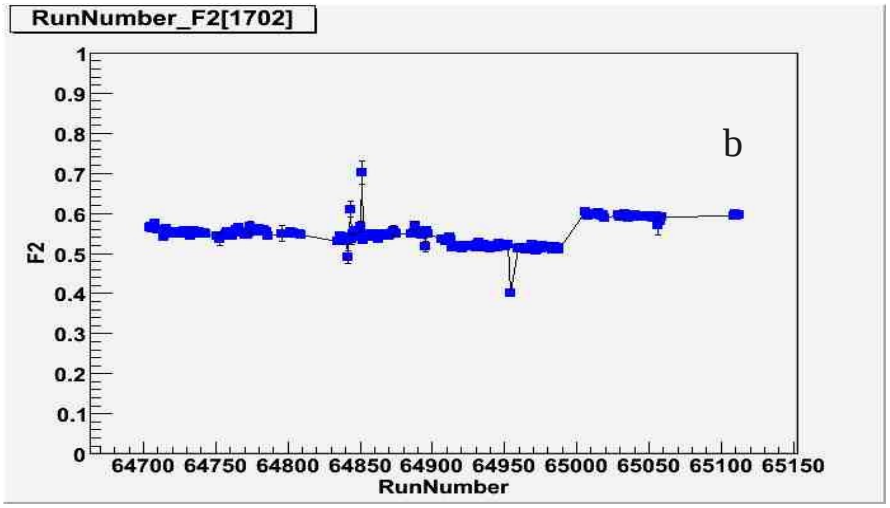
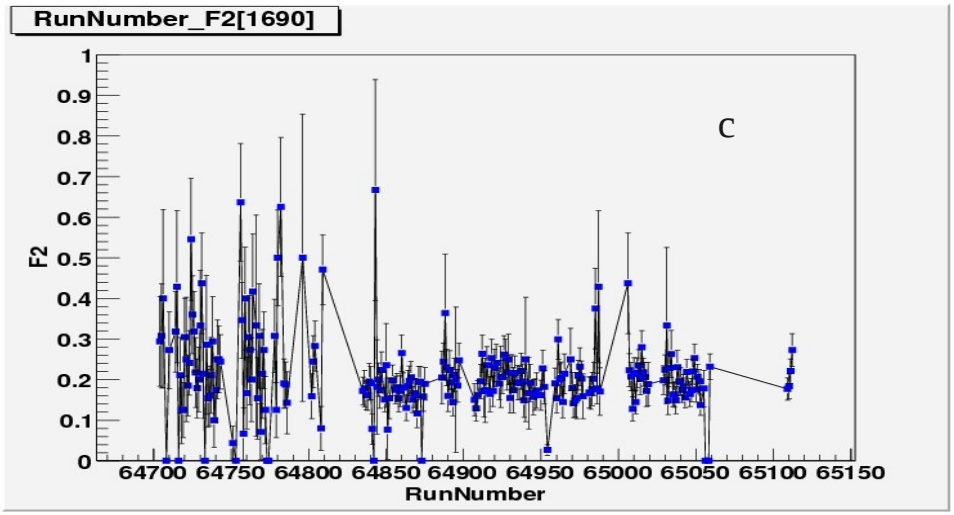


Fig 4.1. F2 vs run number for: (a) channel id 1689; (b) channel id 1702. Dynodes for this ids are normal.



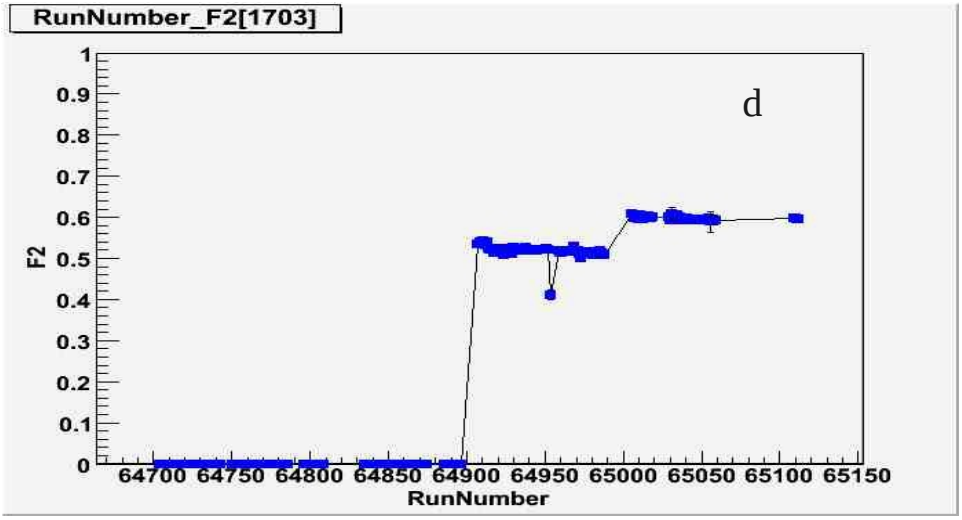


Fig 4.2. F2 vs run number for: (c) channel id 1690; (d) channel id 1073. Dynodes for these ids are abnormal. .

Conclusion

1. ADC status for HyCal channels has been monitored for all pi0 production runs from run number 64704 until the end.
2. Tables for ADC status have been loaded to PrimEx caldb: *system=crystal* and *glass*, *attribute=status*. Values legend: 0 - ok, 1 - dead dynode, 2 – dead ADC, -1 - non existent channel (hole). This table is used by prim_ana and GEANT.
3. About 5 dead channels (either ADC or just TDC) were found.