

L1CalPulser for L1Cal2b upgrade.

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Abstract:

The approaching upgrade for L1Cal requires one to develop a new tool for diagnostics and debugging of new system. A special attention should be paid to the shutdown period, when there will be no beam in machine and actual upgrade will take place. During that time such a tool should allow one to trace the changes in the L1Cal system and prevent errors in installing and handling its various. Since this tool should be used in the absence of beam, it should use existing pulser.

This review presents this tool, which is now in the final stages of development.

Introduction

For the coming upgrade to the L1Cal system, one should develop a new tool, which allows one to diagnose and debug the system, especially during shutdowns, when different parts of the system are moved and plugged in. Since this tool is intended to operate in the absence of beam, a pulser should be used.

The tool should diagnose the system and provide the information for the user, which allows him to trace the changes in the system and find the problems.

The list of classes of such problems includes:

1. Dead towers: identifying towers, which **should be fired** by pulser and **showed the pedestal energy**.
2. Noisy towers: identifying towers, which **should not be fired** by pulser and characterised as being noisy.
3. Hot towers: identifying towers, which **should not be fired** by pulser and **showed too high energy**.
4. Low towers: identifying towers, which **should not be fired** by pulser and **showed too low energy**.

Once above basic problems are identified, the case of uncalibrated towers should be considered.

5. Uncalibrated towers: identifying towers, which **should be fired** by pulser and **showed non-zero, but incorrect energy**.

Although, one wants to analyze Electromagnetic and Hadronic parts separately.

The general sequence of steps to run L1CalPulser is the following:

First the pulser should be started (no beam required). Then the L1Cal Pulser package reads events, unpacks them and writes its output into text files. Finally, the L1PulserTool reads these text files and performs diagnostics of the system. Thus, the L1CalPulser package consists of L1Cal Pulser system, which reads and unpacks events and L1PulserTool, which allows user to carry out the actual diagnostics.

A special pulser run has been set to be run with the L1CalPulser. Pulser drives 32 RunI not overlapping patterns which allow one to analyze the L1Cal2a-2b systems quickly and

efficiently.

L1Cal examine and L1CalPulser comparison.

Since the L1CalPulser is intended to run offline (where is no beam), the comparison between these two tools is in place. There are three major issues here, namely:

1. Reference issue:

L1CalPulser gets the information on which trigger tower, which precision tower and which depths should be fired. The actual diagnostics is carried out by comparing the expectations and the pulser data. The tower is graded as normal if the expectation and the data agree. Otherwise, the problem is reported.

L1CalExamine doesn't have any information on expectation. It can just identify problems by comparing the plots to reference ones (which were taken for a specific run and assumed to be correct)

2. Timing issue:

L1CalExamine - should wait for hours to get enough events.

L1CalPulser – the actual run takes minutes, which is considerably faster.

3. Place issue:

L1CalExamine – depends on beam. During beam, the occupancy of all towers is roughly the same.

L1CalPulser – can go to a specific location by selecting an appropriate pulser configuration and study it thoroughly.

Of course, one should not conclude that L1CalPulser is better, than L1CalExamine. Each tool has its own area of usage and each tool complements the other.

The code description.

After L1CalPulser reads events from the pulser it dumps the output into the text files. To run the system, one should start L1Cal Pulser. The instructions are given below:

1. ssh to d0o145.fnal.gov
2. go to L1PulserTool dir.
3. Setup environment by writing: 'setup D0RunII p16.03.01' and 'd0setwa'
4. setup d0online
5. cd l1cal_examine/bin
6. start the L1CalPulser by typing './Runme.sh'
7. type 'init' and 'start'
8. start Pulser run (see respective section)
9. when Run finishes, type stop quit.

Having produced the output files, one can perform the actual diagnostics.

10. start the L1PulserTool by typing './L1PulserTool.py'

The basic outlook of the L1PulserTool is shown on the Figure 1.



Figure 1. The basic outlook of the PulserTool.

There are two main windows in the L1PulserTool: the menu and the diagnostics screen. The information during diagnostics is reflected on this screen. Having Run L1CalPulser and L1PulserTool, one should save the run, by selecting File/Save and specifying the run number. After that, user should start diagnostics by selecting File/Run. The analysis will be carried out. In the end of the analysis the information on run will be shown in the diagnostics screen.

There are three basic coordinate systems, which are implemented in the code:

1. Physical coordinates. These coordinates are used for physical analyses. There are two major coordinates there: η and ϕ , which identify a trigger towers uniquely.
2. BLS coordinates. There are three major coordinates there: crate, ADC crate and BLS.
3. Preamp coordinates. There are two major coordinates there: box and board.

BLS and preamp coordinates are electronics coordinates. Identifying problems in these coordinates allows one to easily locate problematic electronics boards and fix or replace them.

There are 10 windows with information on all types of different problems per system of coordinates. To highlight any of the problems, user should select one of three menu buttons (Phys, Bls, Preamp) and then choose one of the corresponding windows. The list of windows generally resembles the list, given in the Introduction.

1. Dead towers. The tower is reported to have this sort of problem if the specific tower is supposed to be fired, but showed energy below some threshold (by default 1 GeV above pedestal and not η dependent)

2. Noisy towers. The tower is reported to have this sort of problem if the specific tower is not supposed to be fired, and its RMS exceeds a certain threshold. (by default some function of η – see settings for details)
3. Hot towers. The tower is reported to have this sort of problem if the specific tower is not supposed to be fired, and showed energy, exceeding some threshold. (by default 1 GeV above pedestal and not η dependent)
4. Low towers. The tower is reported to have this sort of problem if this specific tower is not supposed to be fired, and showed energy, less than some threshold. (by default 0.5 GeV below pedestal and not η dependent).

A separate attention is paid to the next category:

5. Uncalibrated towers. The tower is reported to have this sort of problem if this specific tower is supposed to be fired, was not reported as being dead, but the energy it showed didn't agree with expectations (by default the real energy is 20% above or below the expected energy).
Since, the pulser signals differ from the actual data signals, the expected energy for each tower was calculated from symmetry considerations, namely for each tower and for each pulser pattern, one selects just towers, with the same or opposite sign η and the same cells being fired in the tower. Then one reads the energies for these towers and finds their median, which is called: "The reference energy".

There are 3 system of coordinates, 5 classes of problems for electromagnetic and hadronic part. So, totally, there are $3 \times 5 \times 2 = 30$ diagnostics windows.

For each type of problem, the button appears. Left clicking on such a button, a user can diagnose a problem, gets different coordinates for a problematic tower, get information on patterns, for which this tower reported problem and towers with no problems. Moreover, a user can right click anywhere in any window and get the complete information on selected tower: coordinates, patterns, which fire this towers, specific cells, which should be fired in this tower by the pattern, measured energy for such a tower, reference energy and rms

The problematic towers are subdivided into three categories: less than one pulser pattern failed - blue, at least 6 pulser patterns failed; pink, all patterns failed – red. The red towers represent really problematic towers since just those towers should fail for all the pulser patterns. Looking at these towers, one can figure out all sorts of various problems, perform a diagnostics and maintenance.

The schematic view of the output is given below (Figure 2-6):

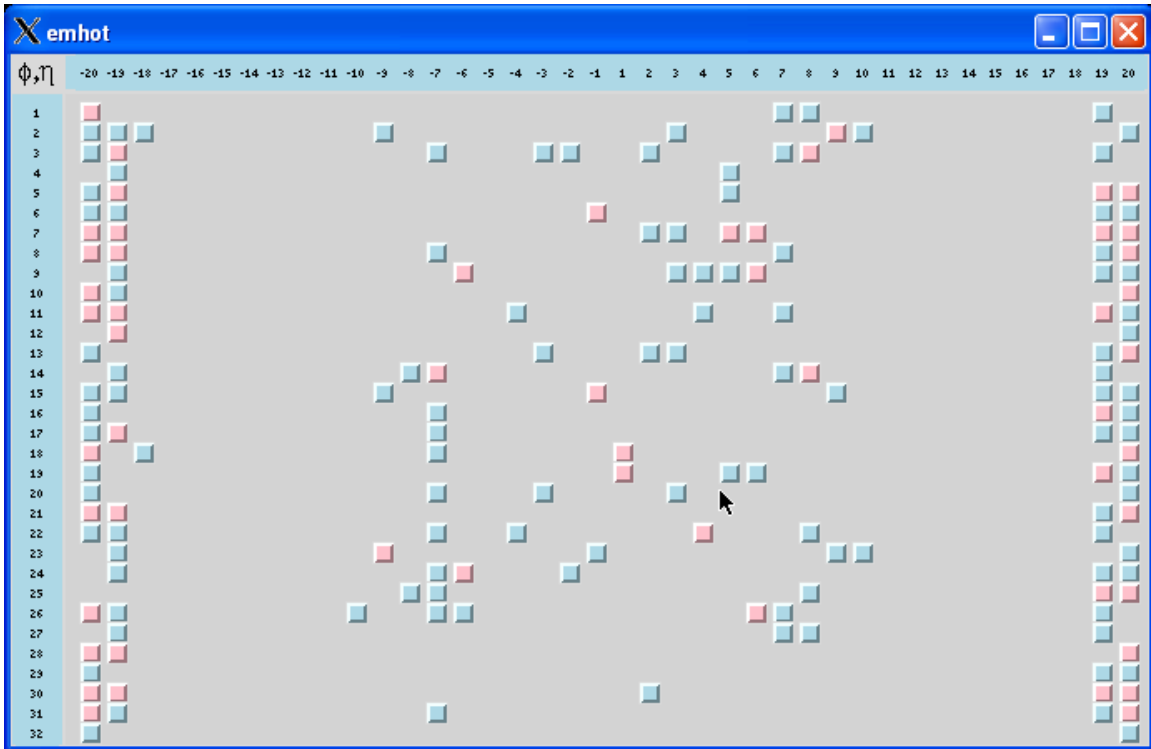


Figure 2. The output for em hot problems. Blue – less, than 6 patterns failed, Pink – at least 6, but not all, Red – all patterns failed.

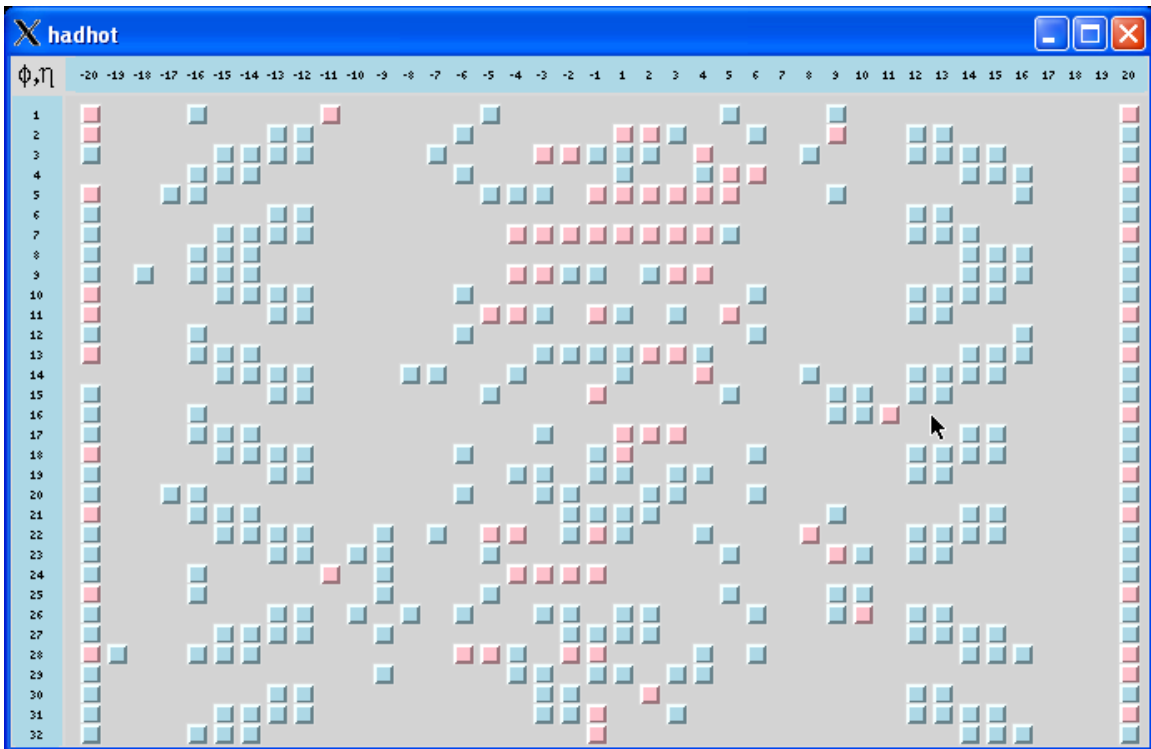


Figure 3. The output for had hot problems.

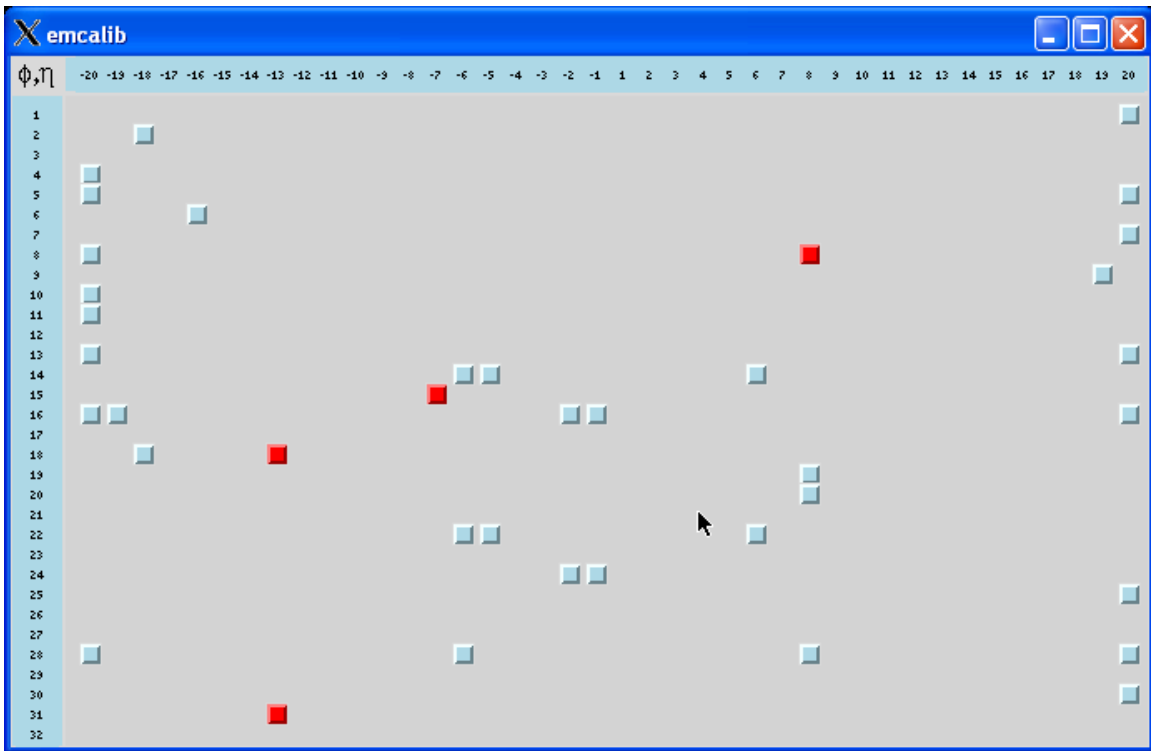


Figure 4. The output for em uncalibrated problems.

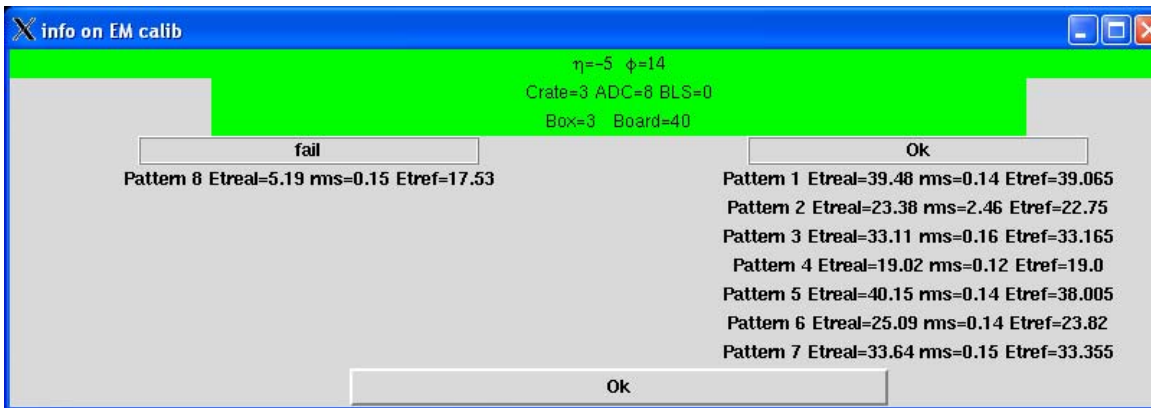


Figure 5. The info when left clicking mouse for em calib $\eta=-5, \phi=14$. Left column says, that pattern 8 failed for this tower. Right column lists all pattern, which are Ok again for this tower.

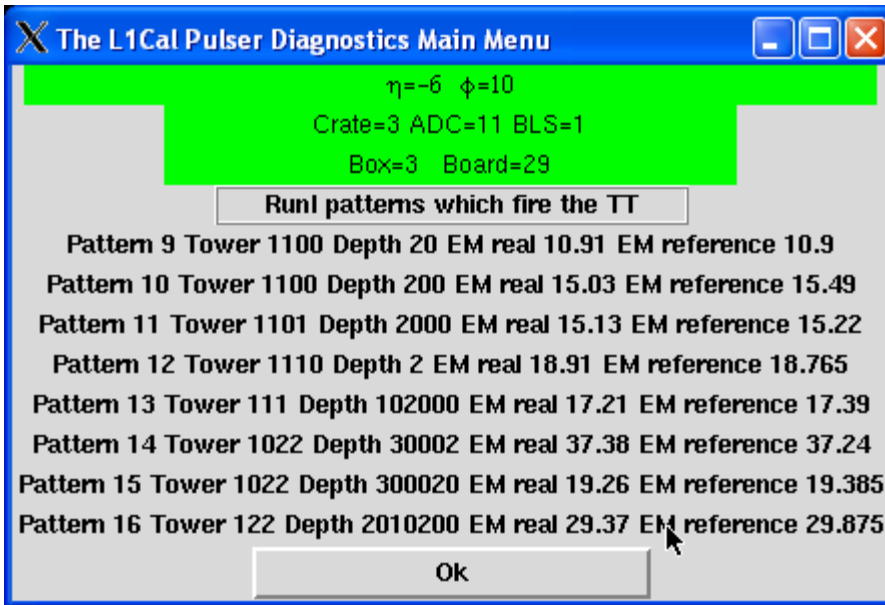


Figure 6. The info when right clicking mouse for em calib $\eta=-6, \phi=10$. The detailed info on all patterns which are supposed to fire this tower is provided.

There is also one item in the L1PulserTool menu, called Pulser, which allows one to see the towers, which should be fired by specific patterns (pattern_templates), which can be selected by user. Also, this item allows user to select which pattern to examine (pattern_real). The trigger towers which should be fired by a specific pattern are drawn as green buttons on output windows. See Figure 8.

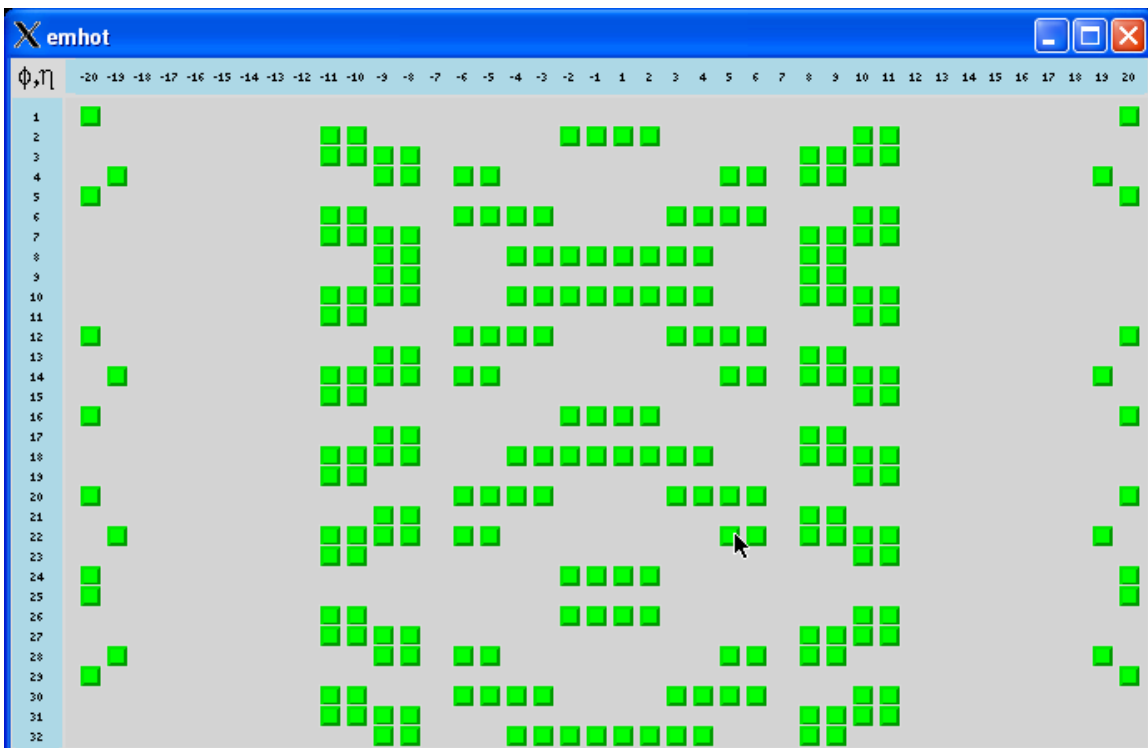


Figure 8. Trigger Towers, which are supposed to be fired by RunI Pattern6.

Moreover, one can see these patterns in different system of coordinates. See Figure 9.

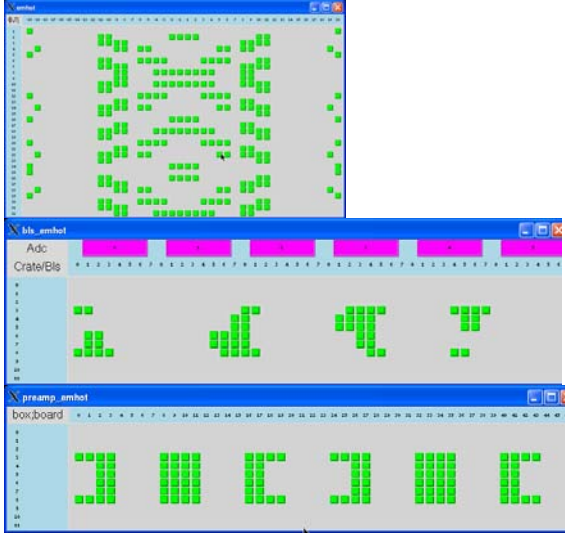


Figure 9. RunI Pattern 6 in different system of coordinates. Upper plot – physical, middle plot – BLS coordinates, the down plot – preamp coordinates.

On Figure 10 RunI pattern with hot towers for this patterns are drawn.

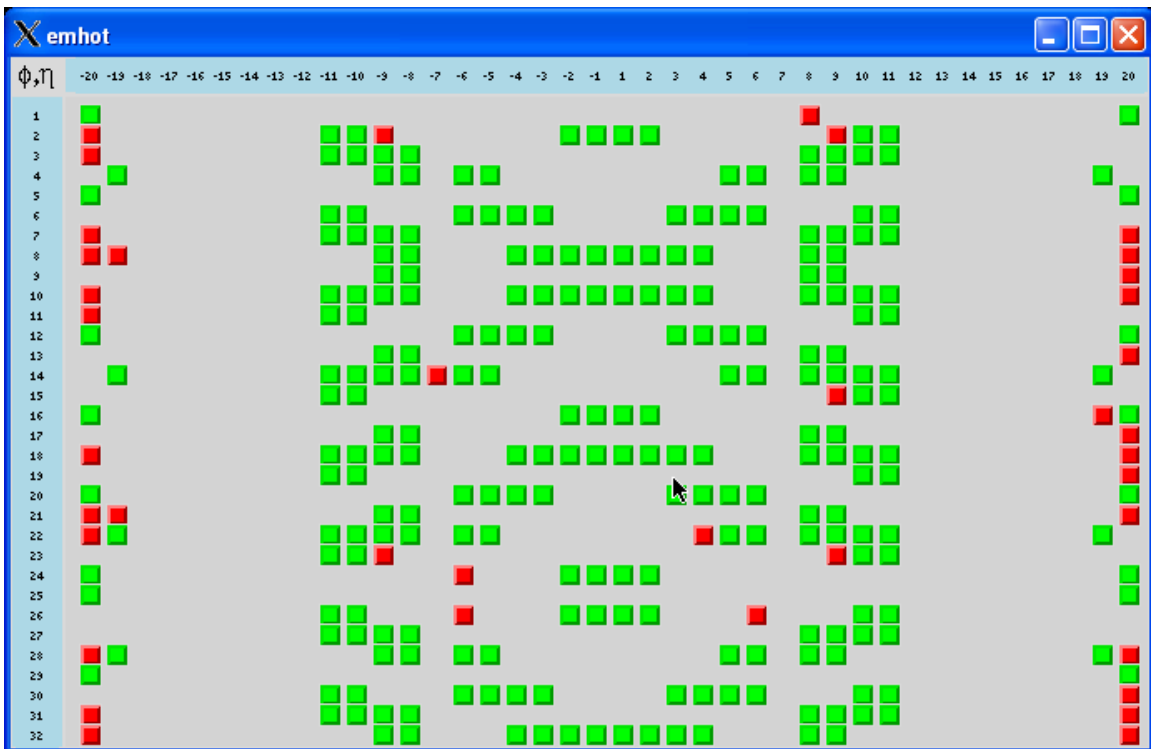


Figure 10. Patterns, which are supposed to be fired by Run I Pattern 6 and corresponding problems.

Crosstalk

The present study showed a significant crosstalk between different parts of electronics (BLS, Preamp) in the existing system, namely:

Pattern, firing a trigger tower may affect neighboring trigger towers, which are supposed to be at pedestal to:

1. Make them hot.
2. Make them low.

See, Figure 10.

This crosstalk should not create any problem, since the tower should be considered as problematic if it failed for all the patterns (see code description). Moreover, the plan for the next week is to get a list of crosstalks for each specific tower to make it possible to eliminate such a problem. Still, the crosstalk is quite an important issue, since many problems can be identified by studying it (An example is a cable switching. For a pulser pattern 6, a trigger tower which was supposed to be fired showed zero energy, while one, which was not supposed to be fired and situated near it, showed pretty high energy.). That's why the option: 'To eliminate problematic towers' will be incorporated in the L1PulserTool.

Conclusion

The L1CalPulser is a powerful tool for diagnosing L1Cal problems. It should be used together with L1Cal2b Examine to test the electronics and can not be overestimated especially during the upcoming shutdown.