

LumiCal Sensor Alignment for TB2014

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Outline

Overview of 2014 TB system (telescope & LumiCal)

Telescope tracks

LumiCal signal processing & muon selection

Synchronization between LumiCal & telescope data

LumiCal planes alignment procedure

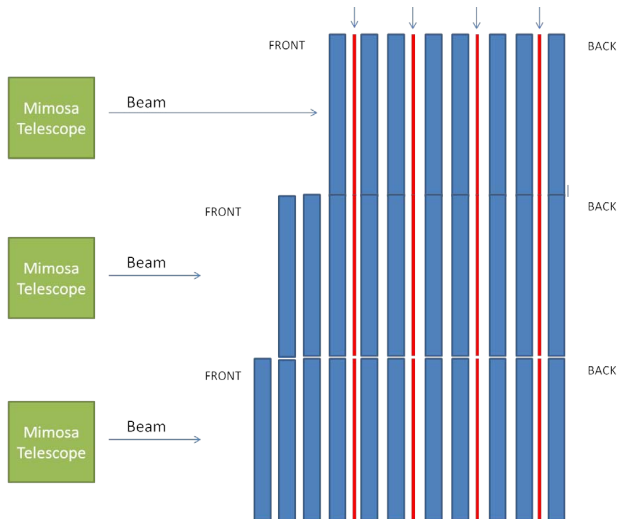
Conclusions and Outlook

Overview of the system



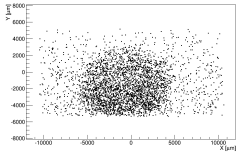
Overview of the system

Inside FCAL box (three different configurations):

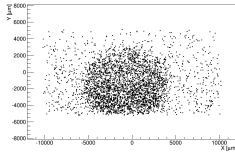


Telescope tracking results

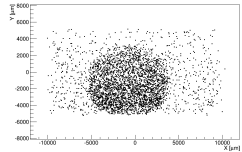
Hitmaps of all hits associated with tracks (e/μ runs):



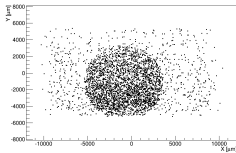
(a) Plane 1



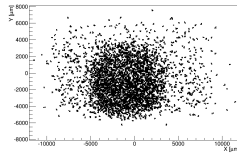
(b) Plane 2



(c) Plane 3



(d) Plane 4



(e) First LumiCal plane

LumiCal signal processing

Following the same procedure agreed upon in TAU and in the collaboration (for each channel):

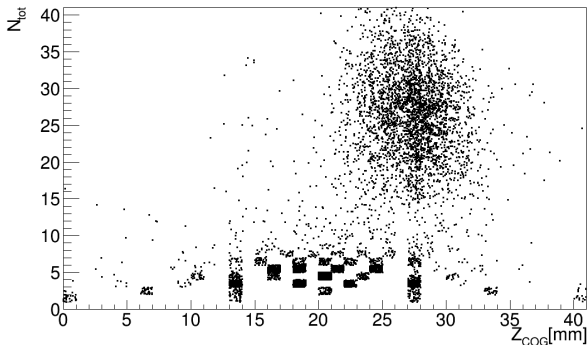
- Removal of base-line
- Calculation and subtraction of common mode noise
- Application of a deconvolution filter
- Determination if channel had a signal ($S_{17} \geq 3N$)

Muon selection

Selected only muon events using a topological cut. Defined

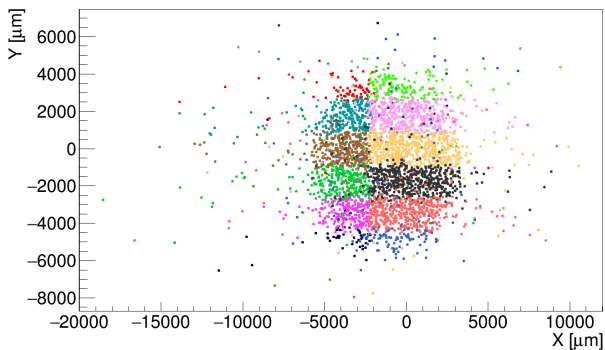
$$N_{tot} = \sum_{i=1}^4 N_i, \quad Z_{COG} = \frac{\sum_{i=1}^4 N_i Z_i}{N_{tot}},$$

where N_i is the number of hits on the i 'th plane. One expects $N_{tot} \leq 16$ and $Z_{COG} \approx Z_{geo}$ for muons.



LumiCal - telescope synchronization

Color coded hitmaps: hit position is acquired from the telescope, while the color is determined according to the channel in LumiCal that showed a signal for the same event.

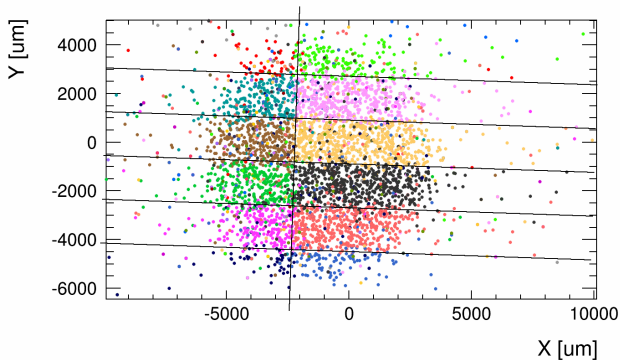


Sensor pad structure is clearly visible!

Note: values on axes are given in the telescope reference frame.

LumiCal planes alignment

Define borders between pads:



LumiCal planes alignment

Assuming a rigid sensor structure (i.e. a constant 1.8mm pad pitch), the borders can be parametrized using three parameters: (x, y) location and a rotation angle, α .

Determining these parameters enables us to transform any point in the sensor reference frame to the telescope reference frame, and to determine which pad in the sensor was hit according to the hit position in the telescope frame.

LumiCal planes alignment

In order to find the alignment parameters, defined an error function:

$$\Delta = \sum_{i=1}^{N_{hits}} \sigma_i(x, y, \alpha), \quad (1)$$

where

$$\sigma_i(x, y, \alpha) = \begin{cases} 0 & \text{if the location of point } i \text{ is inside the pad that} \\ & \text{showed a signal in the corresponding event,} \\ 1 & \text{otherwise,} \end{cases}$$

and minimized Δ w.r.t the parameters (placing the borders in such a manner that as many hits as possible are correctly placed).

LumiCal planes alignment

Dealing with muon events only, the straight line tracks can be propagated to the next LumiCal planes to form similar hitmaps (muons do not interact with the absorber plates). This way, the procedure can be repeated for each plane independently

Alignment results

The numbers are in the telescope reference frame. Relative alignment among the different planes can be calculated by subtraction...

Configuration/Plane	$X_{center}(\mu m)$	$Y_{center}(\mu m)$	$\alpha_{rotation}(deg)$
1/1	-2230	-820	2
1/2	-2180	-1030	1.5
1/3	-1930	-710	1.1
1/4	-2230	-550	1
2/1	-2230	-900	1.2
2/2	-2180	-1070	1.4
2/3	-2030	-760	1.1
2/4	-2280	-550	1
3/1	-2230	-900	1.2
3/2	-2180	-1070	1.4
3/3	-2030	-760	1.1

The differences among the planes are small but noticeable, whereas the differences among the three configurations for each plane are negligible and are probably a result of statistical fluctuation.

Conclusion

- An alignment of LumiCal planes for TB 2014 has been carried out, using muon events and information from the telescope.
- Any point on any plane can be transformed to the telescope reference frame.
- Pad locations can be defined in the telescope reference frame.
- Relative alignment of the planes can also be inferred.