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TIMING OF THE SCI-FI DETECTOR

For the analysis of experimental data is necessary to know the characteristic time of the signals. In this paper we consider the timing of the signal coming from the SCI-FI detector.

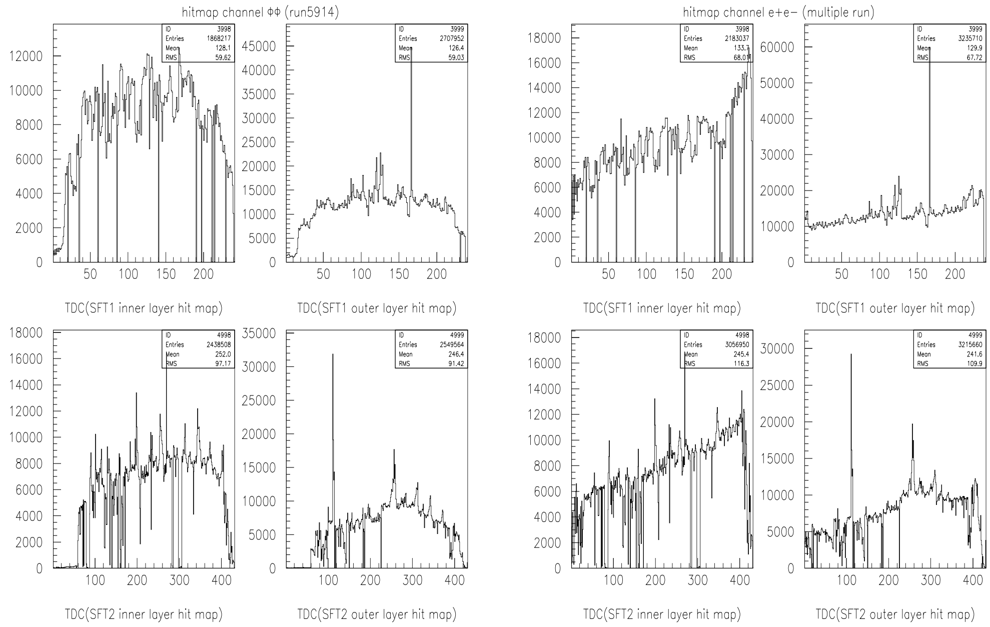
With the TDCs of the SCI-FI detector we can study the interval of time between the passage of the particle through the fibers and the common stop. The signal of start is the signal from fibers, while signal of stop it is the common stop and is the same for each trigger. Here we won't describe in detail the common stop.

Studing some time spectra we can say that for each fiber the time spectrum generally follows a gaussian distribution, like one could expect, we call these *normal channels*. There are basically two types of bad channels, whose time distribution is not gaussian shaped, rougly called *dead* and *latch channels*. The firsts are either, not active or damaged, that is, sometime they give a very small number of signals, as we'll see later. The second type instead gives a lot of signals with random time. Normally latch's spectrum is bad, very far from gaussian shape and with very high number of entries.
During the observation of some spectra we have found another type of signal that we call *reflection channels*. Normally the mean time is between 50 and 100 ns, but in the case of *reflection channels* there are two peaks, one between 0 and 50 ns and the other one between 50 and 100 ns. We suppose that the higher-time peak corresponds to the signal and the lowest-time peak is due to some reflections.

We have developed a routine (a .kumac file, for PAW) that provides the mean time and the standard deviation for each *normal* and *reflection channel* and recognizes the *dead* and *latch channel*. We'll explain later the methods used in the routine to do this.

Preview of dead and latch channels with the hit map

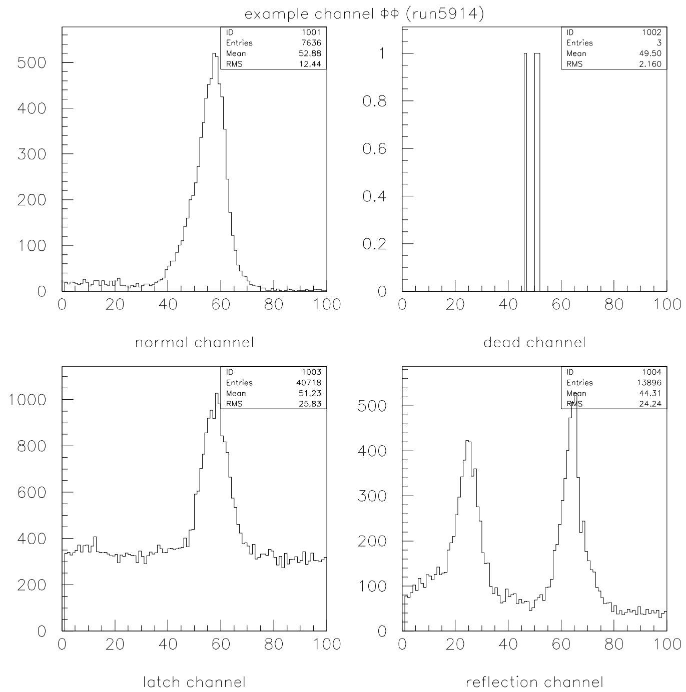
We can have an idea about the possible *dead* and *latch channels* from the *hit map*. In the *hit map* we can see the number of signals issued by each fiber. For each analisys there are four *hit maps*, one for each layer of the SCI-FI datector.
Below we show two examples of *hit map* for two different type of data: one for the channel $\phi\phi$ and the other for the channel e^+e^-.



The firsts 58 fibers of the layers 3 and 4 in the $\phi\phi$ data are in veto so they aren't *dead channels*, infact in the e^+e^- data those are active. The other holes in the *hit map* correspond to the *dead channels*, as you can see the number of signals for these fibers is about zero. Also we can suspect the presence of the *latch channels* in corrispondence of the peaks with a great number of signals, e.g. the *channel* 166 of the 'SFT1 outer layer'. Unfortunately we cannot use this criteria to recognize the *latch channels*, because for example the channel 114 of 'SFT2 outer layer' isn't latch, but it's a *reflection channel*, the only *reflection channel* that we have.

All the type of channels

Below we show some examples of *normal*, *dead*, *latch* and *reflection channels*.



Description of the histograms

Normal channel

As you can see, the histogram of a *normal channel* follows a gaussian shape, in first aproximation. Sometime there is a little tail in the low side of the distribution or some effects of reflection, but in general these are not important.

Dead channel

It's easy to recognize the *dead channels*, because the number of entries is very small, not enough to obtain a reasonable fit.

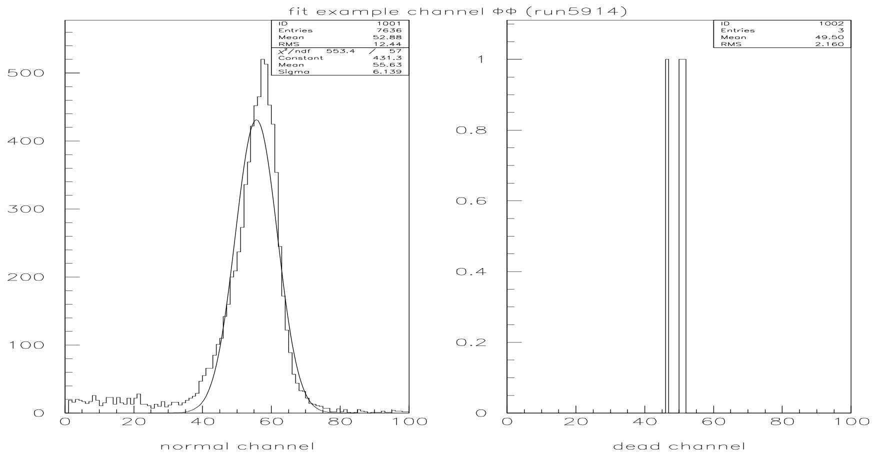
Latch channel

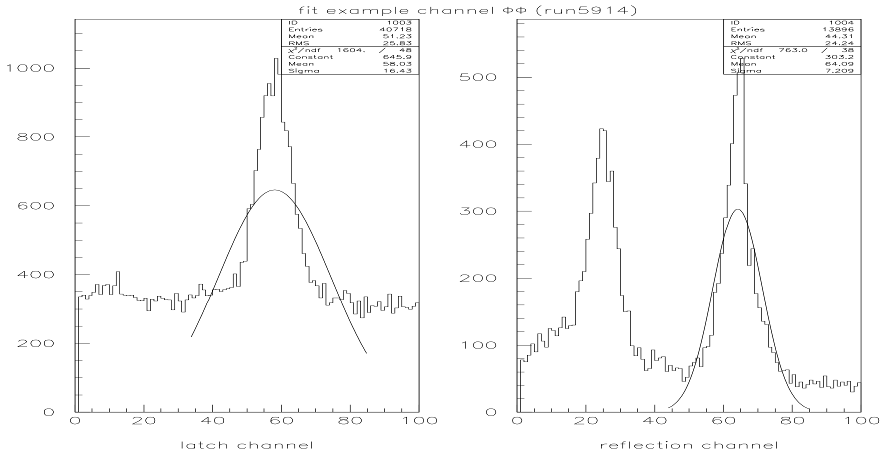
In this plot the *latch channel* has a peak corrisponding to a reasonable mean time, but there is a lot of background. Generally the peak is random and background is high. If we fit these histograms, we can see that $\sigma < \frac{t_0}{5}$; where t_0 is the mean time and σ the standard deviation. A fit with these parameters is bad.

Reflection channel

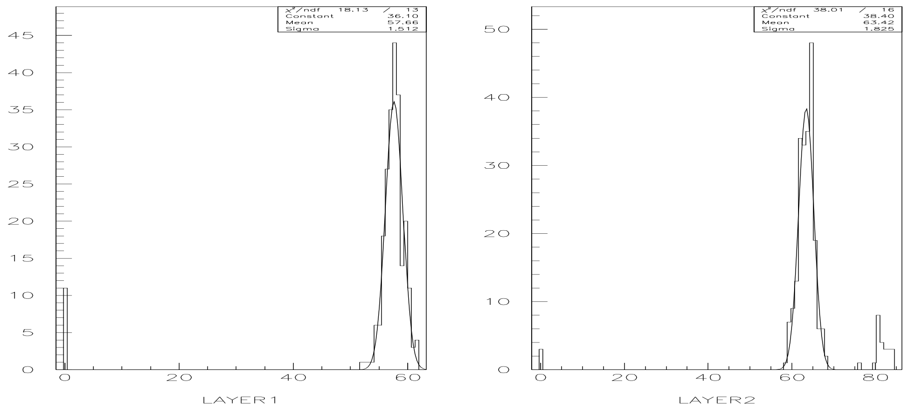
The peak between 0 and 50 ns is due to some reflections of the signals, while the other one corrisponds to the mean time. We can say that because generally the mean time is between 50 and 100 ns. To fit correctlythis histogram we don't have to take into account the part that contains the reflection. Also, *normal channel* have some reflections but they are usually negligible, in *reflection channel* it's not.

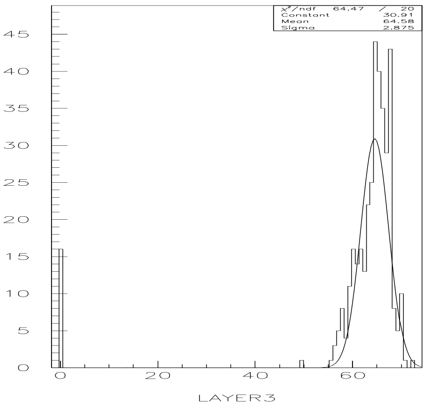
In the routine we use these criterias to obtain the mean time (t_0) and standard deviation (σ) of *normal* and *reflection channels* and to recognized the *dead* and *latch channels.* Below we show the fit obtained using this criteria.

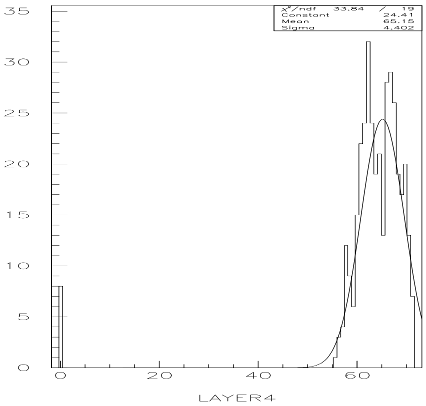




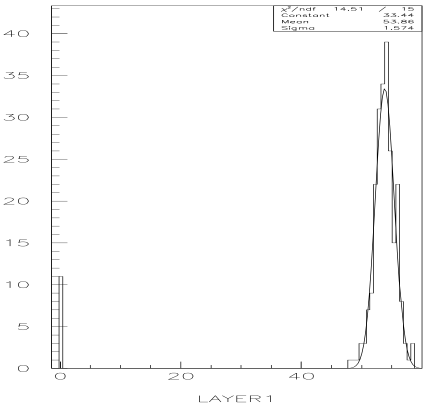
We have analized the run with the highest luminosity for each stack, from the results of the routine we can plot the distributions of the mean times for each layer. For example below we show the distributions of the mean times of the *run5781*, *stack25*, looking at the $\phi\phi$ data.

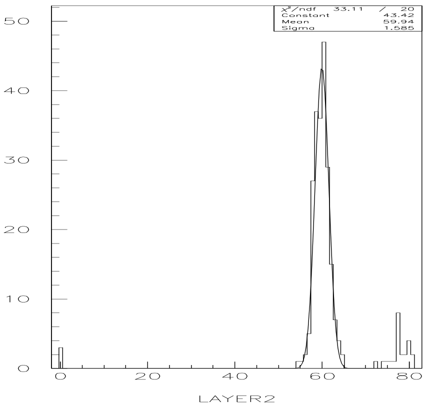


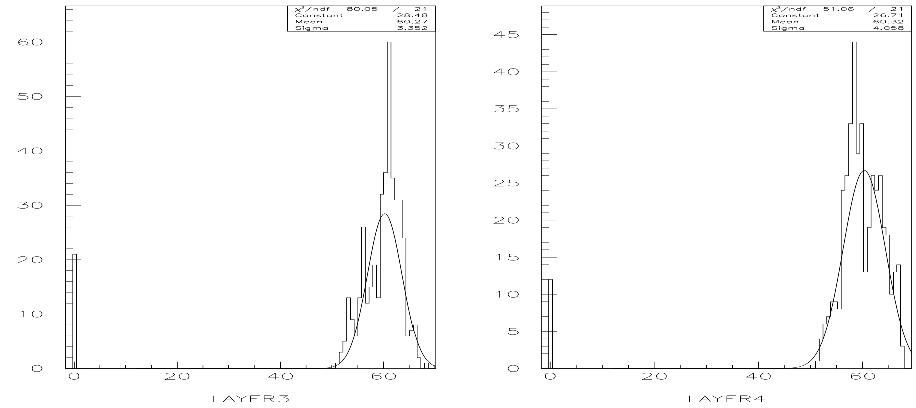




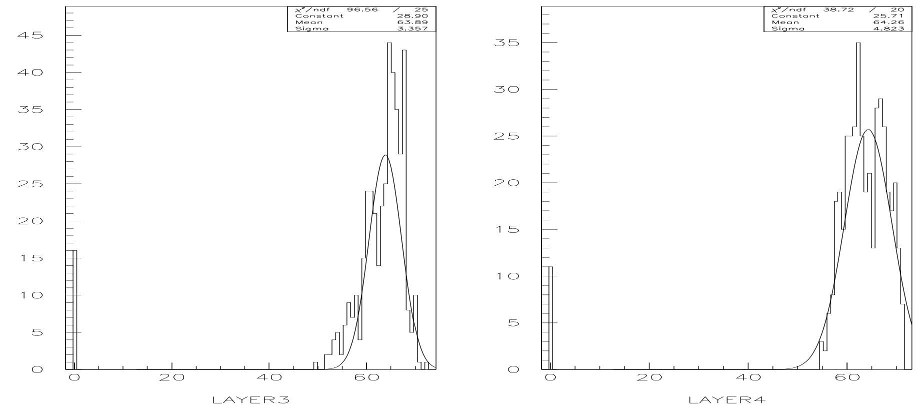
As you can see the mean times distibutions are very narrow ($\frac{\sigma_t}{\langle t_0 \rangle} < 6\%$ or less). For each layer there are the mean ($\langle t_0 \rangle$) and standard deviation (σ_t) of the mean times of each fiber. The bin corrispondent to zero ns is due to the *dead channels*. We have neglected the *latch channels* because there are only a few of them and we don't have to take them into account to study the distribution of the mean times. It could seem strange the secondary peak around 80 ns of layer 2, but analizing some other stack you can see the same thing. Therefore we can think that this effect is due to a different hardware delay of this channels.
Below we also show the distributions of the mean time for the e^+e^- data (from different stacks), obtained with the same method.





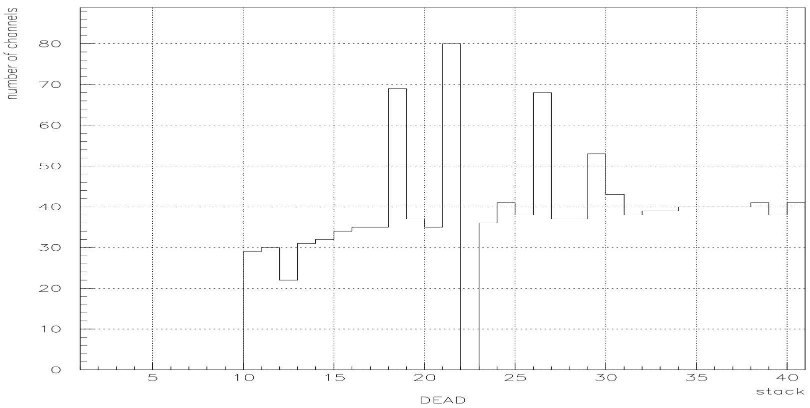


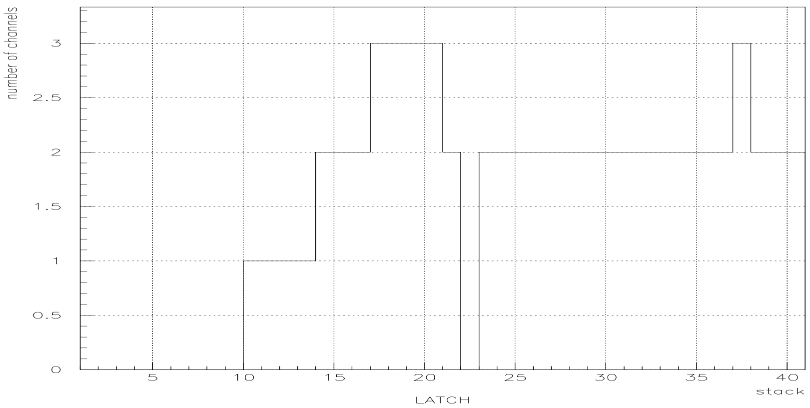
Since we have to use some data, different from $\phi\phi$, to calculate t_0 and σ of the firsts 58 fibers of the layers 3 and 4, you can see that the e^+e^- is right to do this substitution. In fact looking the distributions of the mean time of the layers 3 and 4 for the two types of data, you can see that the means are not so different, generally within a σ.
Below we show the plots of layers 3 and 4 obtained replacing the firsts 58 fibers in veto in the $\phi\phi$ data with the values of t_0 and σ of the e^+e^- data. The layers 1 and 2 are not showed because they have not been modified.



Also these distributions are very narrow, like the other histograms $\frac{\sigma_t}{\langle t_0 \rangle} <$ 6% or less.

In the following plot we show the number of *dead* and *latch channels* versus the stack number for the $\phi\phi$ data.





The firsts 10 stacks haven't been analized, because they require a special treatment. The VBIAS voltages and discriminator threoholds were not adjusted yet, so the signals were very noisy.
In the top plot you can see a few peaks that differe from the normal level of about 30 channels. This is due to the breakdown of a QPA02 that inhibits 32 channels.
In the bottom plot you can see that normally there are 2 dead channels. The number rises to 3 when the only reflection channel becomes very bad, this is, it has a lot of background.

Description of the routine timing.kumac

In the first step we define all vectors and we fill the ones that remain costant in the routine. The following part is composed of four identical parts, one for each layer. Below we describe the part for the layer 1.

layer 1
It begins a loop on all fibers of the layer 1.

determination of the bin corrispondent to the peak
This step provides the bin that corresponds to the peak of the histogram.

classification of the dead channels
Here there are the selection: if the number of entries is smaller than 100, then the channel is ceirtantly dead. There is also another selection that is used to consider dead the first 58 channels of the layer 3 and 4 in the case of $\phi\phi$ analisys.

change of the peak for reflection channels
In the case of a reflection channel it is possible to have the max filled bin in corrispondence of the peak of the reflection and not for the peak near the mean time. With these instructions we search the second peak near the mean time.

selection of range for the fit
Once determined the real peak near the mean time we choose a range of 50 ns around the peak to fit the histogram.

classification of the latch channels
Looking the parameter of fit (t_0 and σ) we recognize a latch, because for this kind of channel σ is greater than the 20% of t_0. Also we require that the number of entries for a latch channel has to be greater than 1000.

write on output file
Once all the channels have been classified we write the parameters of the fit for each fiber in a file, with the following structure:

layer	*fiber*	t_0	σ