Status of the Silicon Detectors (SID)

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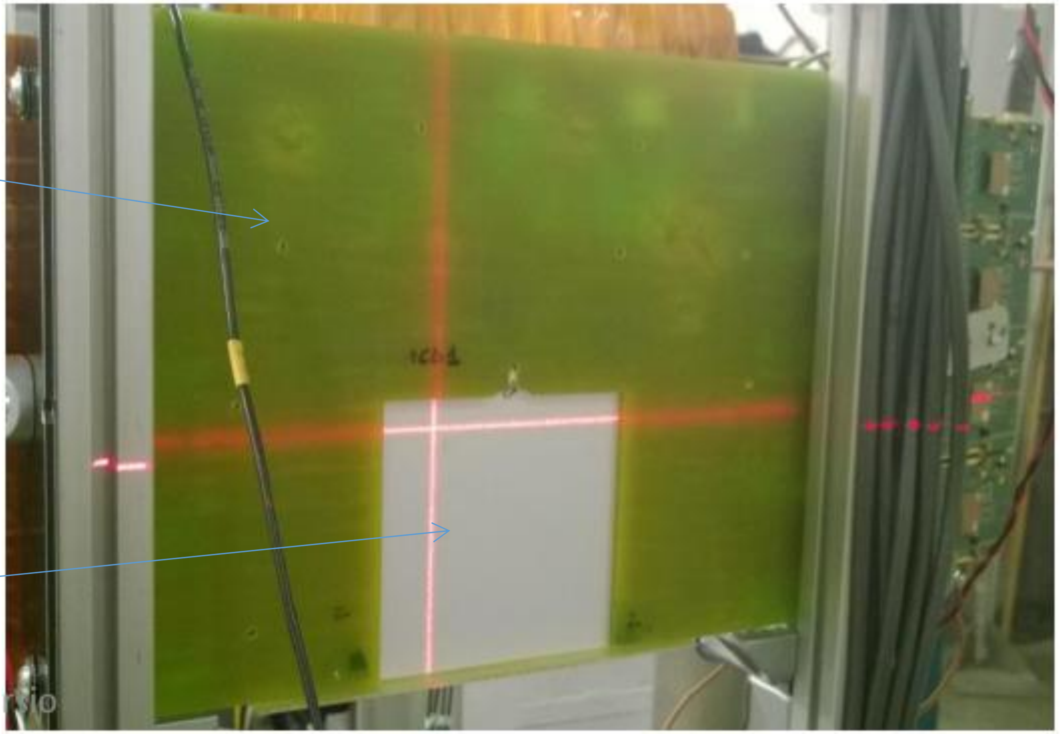
Summary

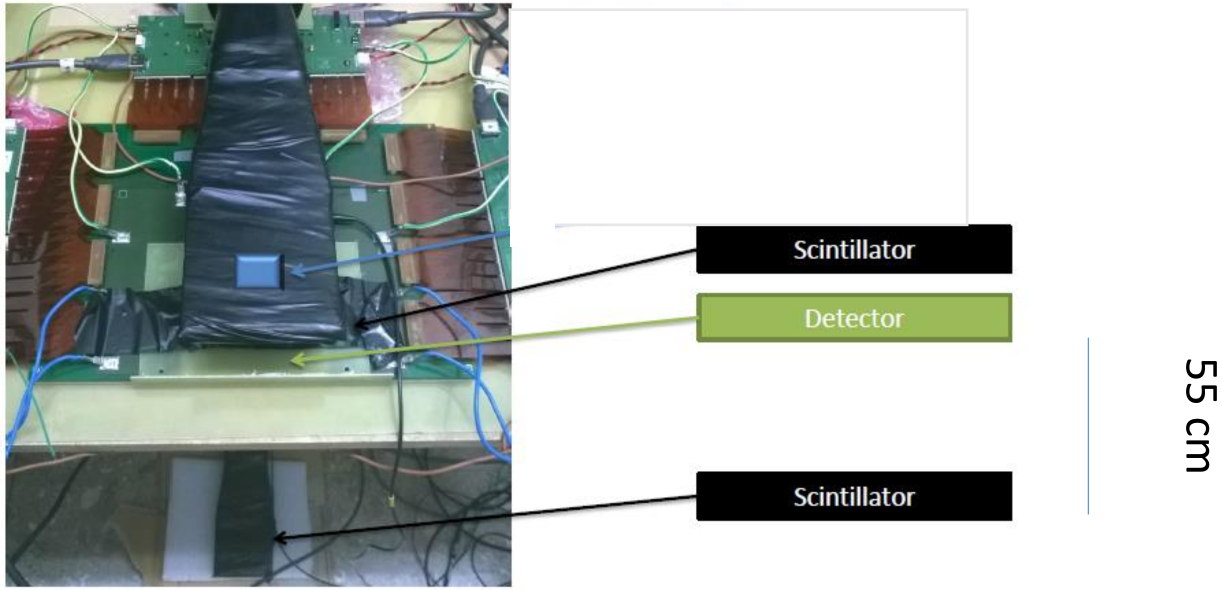
- Last studies on the prototype with cosmic rays.
- Solving the wirebondings breakup issue.
- Future activities at the Rome laboratory (Laser test station).
- Production at the INFN Bari bonding facility.
- Silicon microstrip production schedule.

Last studies on the Prototype



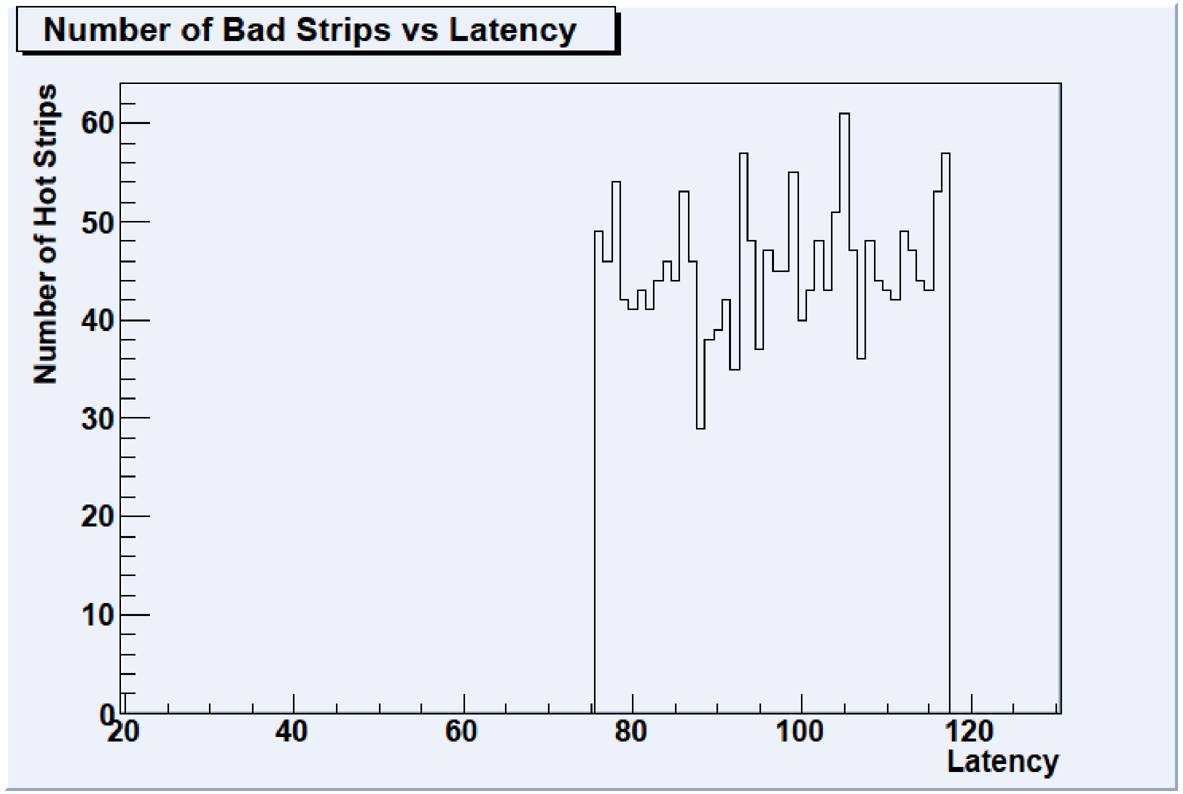
We tested the prototype with cosmic rays:

Cosmic Ray Test



We expect 1 MIP/trigger on average.

Analysis first step: «Hot» strips detection.



A strip is defined as «hot» if its ADC value is smaller (bigger in absolute value) than a certain threshold more than 5 times each 1000 events.

This becasuse the probability of a strip to be fired by a cosmic ray in 1000 events is 1000/2070 and hence the probability to be fired 6 times is, according to the Poisson distribution, 0.00001.

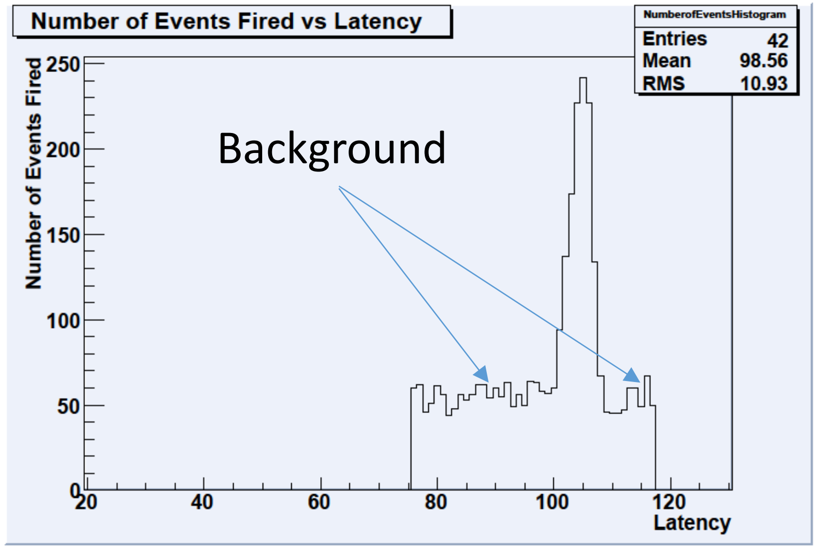
The threshold is set tipically to 5σ times the ADC strip pedestal

Hot strips are not considered in the analysis.

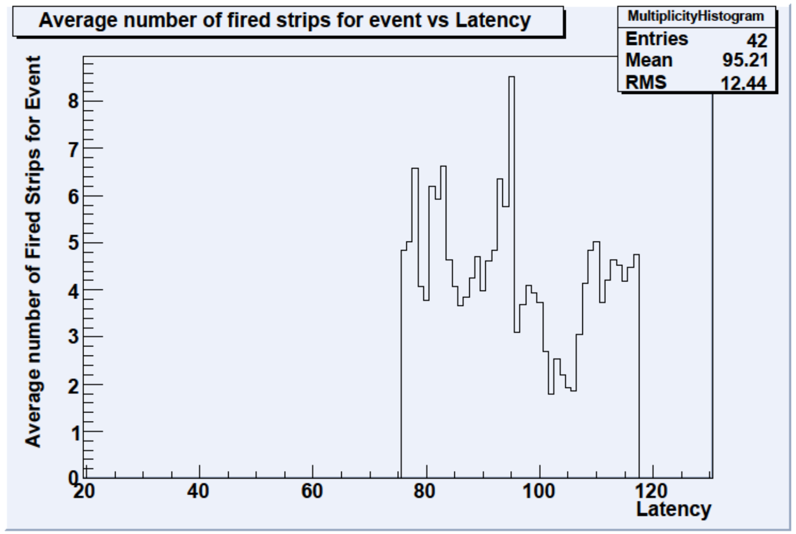
Analysis second step: «Noisy» events detection.

- A strip is defined «fired» when its ADC value is smaller than a certain threshold
- The threshold is set tipically to 5σ times the ADC strip pedestal
- An event is defined «noisy» when the number of strips fired in it is 6 or bigger
- This because we expect, on average, 1 MIP for trigger and hence the probability to have 5 strips fired in one event is, according to the Poisson distribution, 0.0005.
- Noisy events are not considered in the analysis

Analysis third step: Right Latency search.



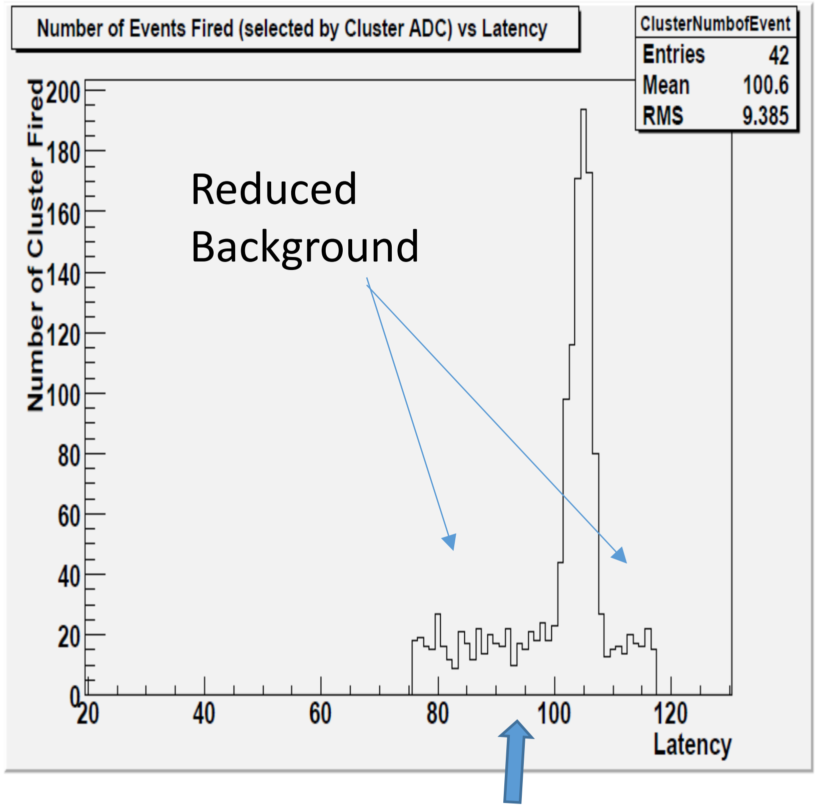
Number of events out of 1000 with at least one strip «fired» as function of the latency.



Average number of strips fired in one event as function of the latency.

Right Latency = 106!

Analysis fourth step: «Cluster» Analysis.



Single Strip Threshold = Cluster Threshold = - 150

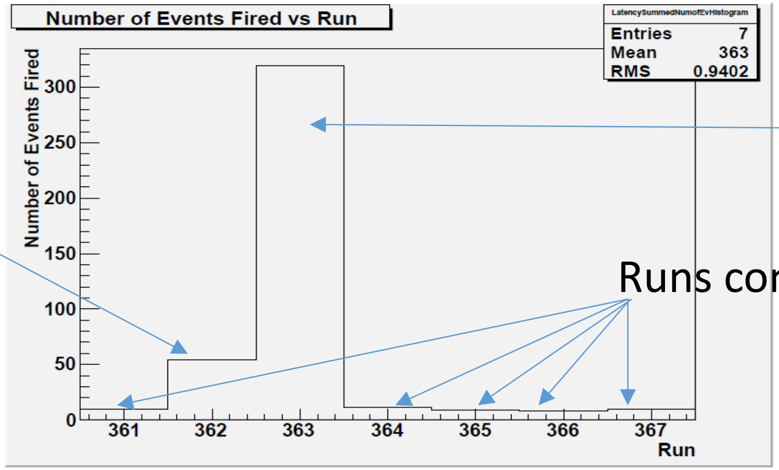
The Cluster analysis allows to reduce the background:

A «Cluster» is defined as three contigous strips. If the probability of a strip to generate a signal from noise (for example a signal 5σ times bigger than the pedestal) and hence a «false» MIP is P, the probability that three contigous strips to generate simultaneously three noisy (big) signals OF THE SAME SIGN is smaller than P. We can define, as in the case of the single strips, a threshold for clusters. If a group of three contigous strips produces three ADC values whose sum is smaller (bigger in absolute value) than the threshold set for the clusters, a MIP is supposed to have fired the cluster. Often (but not always) the cluster threshold is set equal to the single strip threshold.

Analysis fifth step: «Summing up all the latency in a run».

For zeroing the background one has to maximize the ratio signal to noise. This is achieved collecting as much as possible of the signal . A signal lasts 8-9 latencies. In one event MPDs register the ADC values produced in 6 contigous latencies. We hence sum up for each strip all the 6 ADC values registered by the MPDs in the single events. An event is considered detecting a MIP when the sum of the 6 ADC values is smaller (bigger in absolute value) than a certain threshold.

Run containing latencies 97-103 (part of the signal)

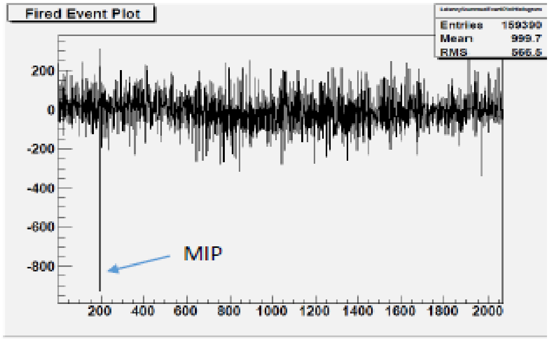


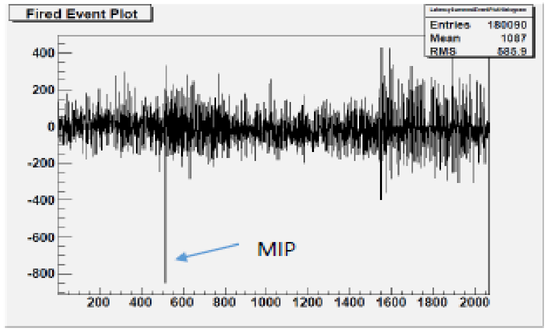
Run containing latencies 103-108 (most of the signal)

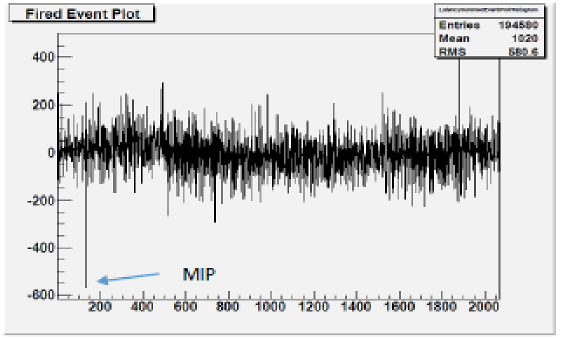
Runs containing only background

Three examples of MIPS

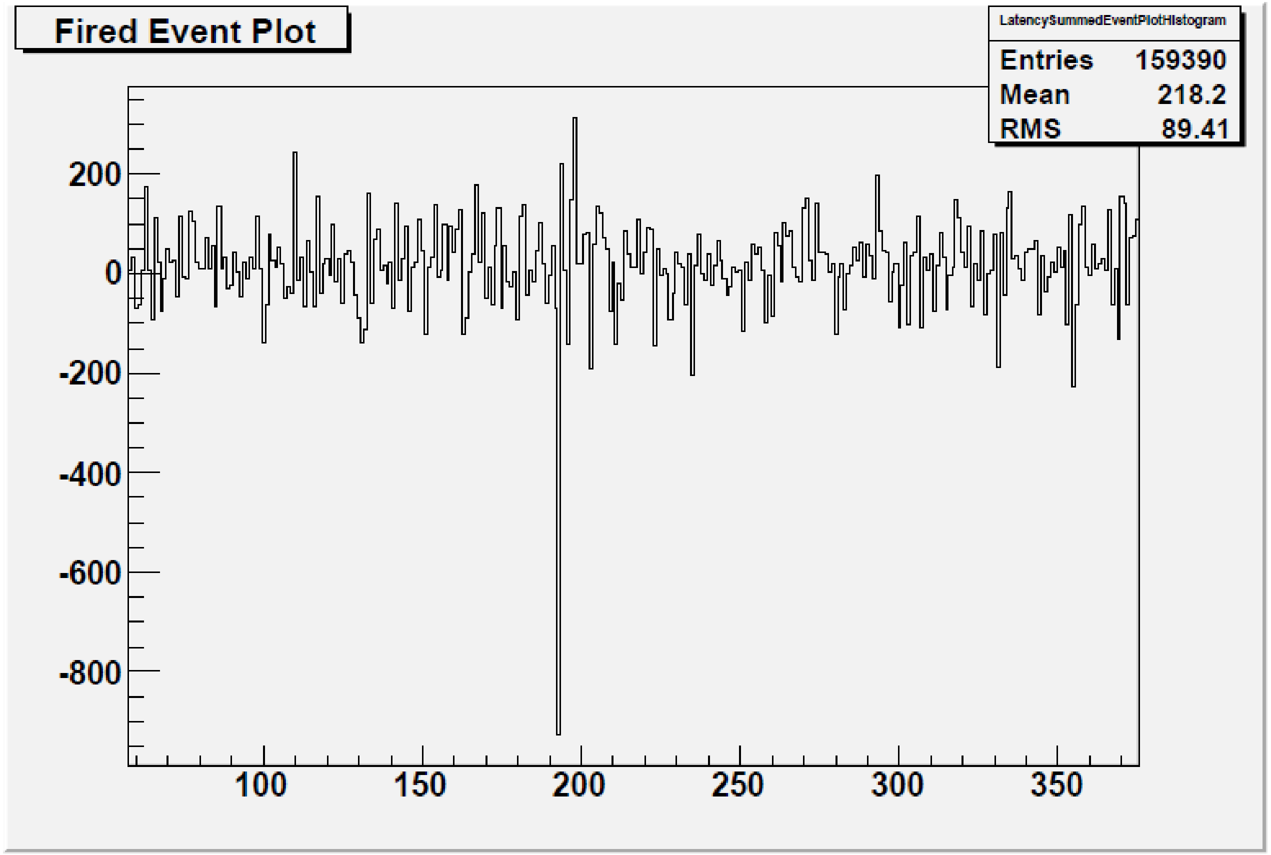
Performing the sum over the six latencies in one event MIPS are identified without any doubt.





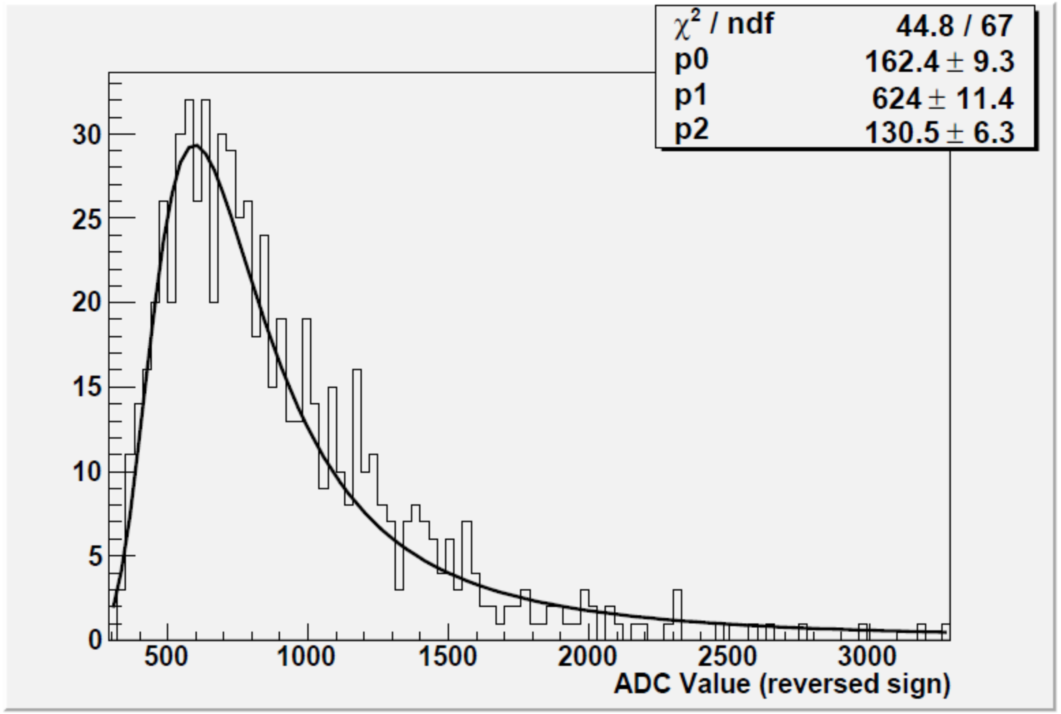


An example of a MIP (zoomed)



Landau Distribution

Performing, for all the MIPs, the sum over the six latencies registered by the MPDs, the ADC sums (proportional to the energies deposited by the MIPS in the silicon microstrip detector) follows the Landau distribution:

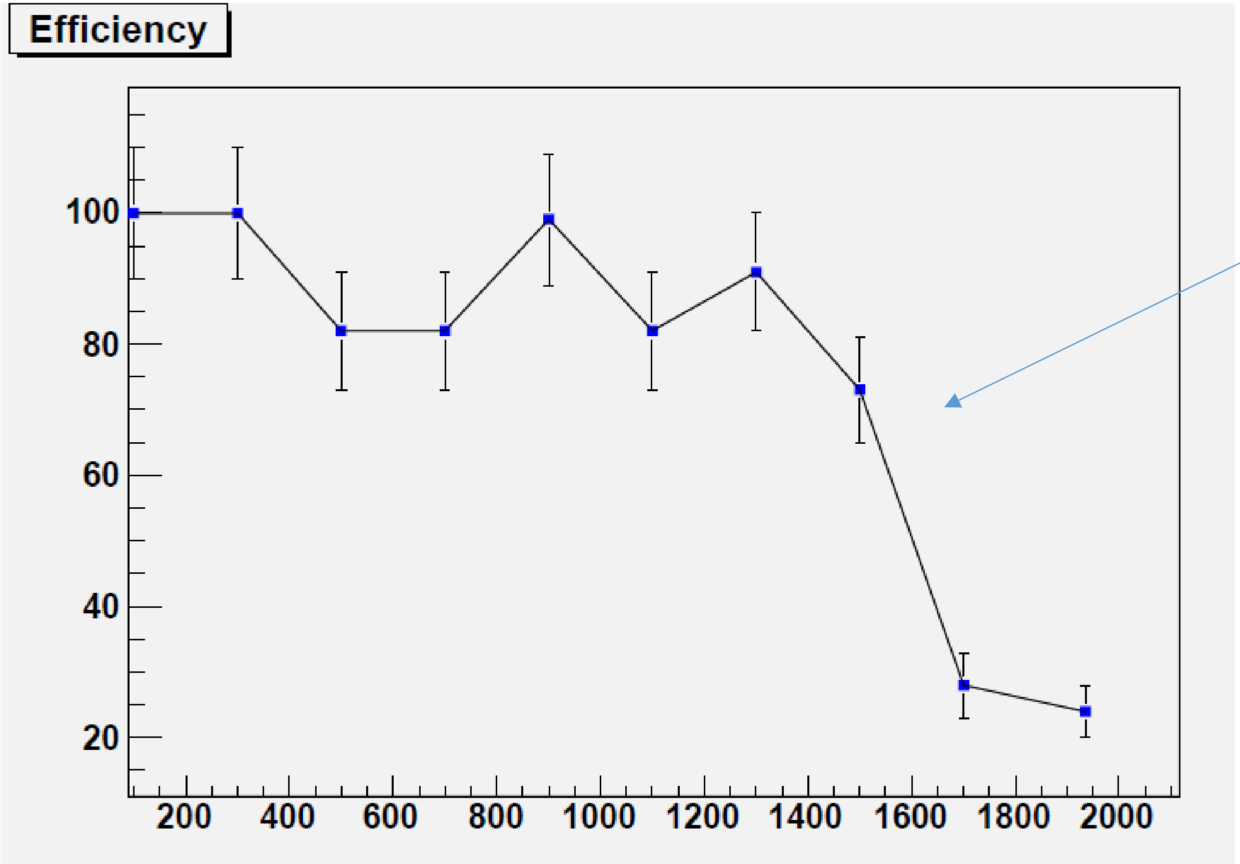


Efficiency (1)

- To get a good efficiency, because the pedestals drift during the long time needed to collect 1000 cosmic ray events, it is better to calculate for each strip the average of the ADC values over the 1000 events and check then for each event if one strip produced an ADC sum over the six latencies smaller (bigger in absolute value) than a certain threshold. At the moment APV25 cards seem apparently have different behavior from each other. Different appropiate thresholds were then chosen for each silicon region. The thresholds were chosen in order that in the runs that do not contains the latencies interested by the MIP signals, the background was on average less than 1%.

- Run 778 → Number of Events Fired 2 (does not contain latencies of interest)
- Run 779 → Number of Events Fired 0 (does not contain latencies of interest)
- Run 780 →Number of Events Fired 103 (does contain most of the signal)
- Run 781 → Number of Events Fired 14 (it contains some signal residual)
- Run 782 → Number of Events Fired 1 (does not contain latencies of interest)

Efficiency (2)

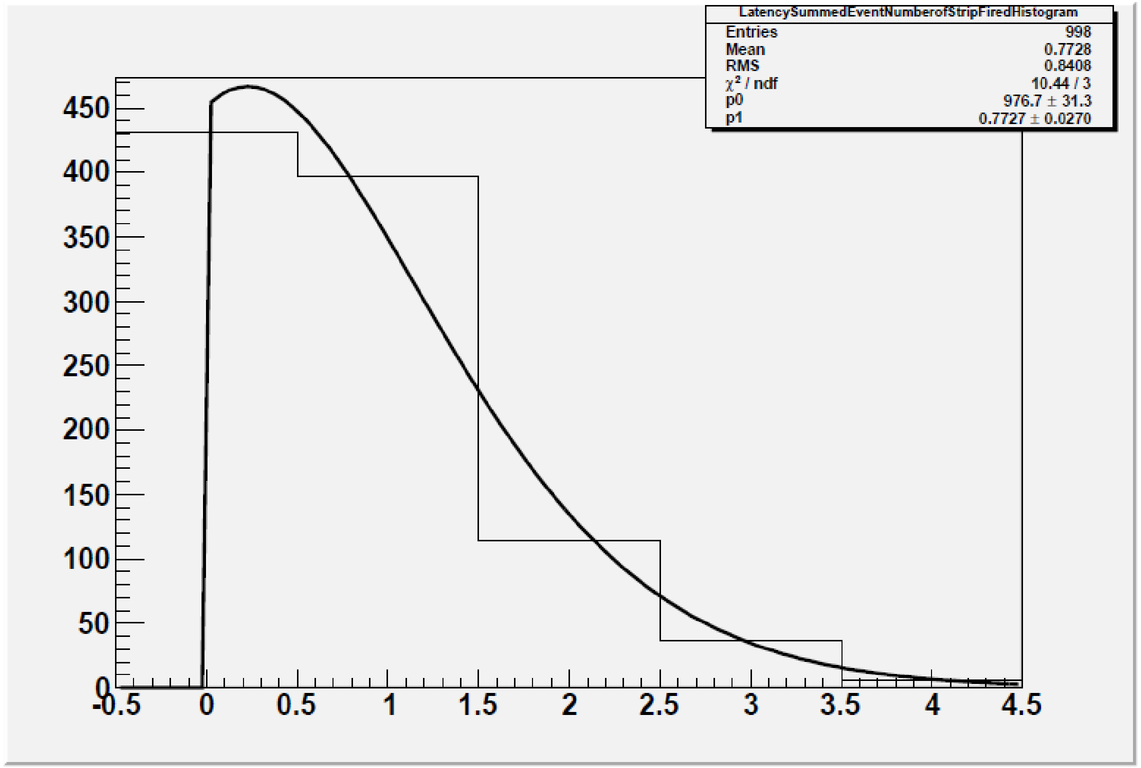


Zone plagued by wirebondings breakups

Efficiency vs Number of Strip

MIP molteplicity

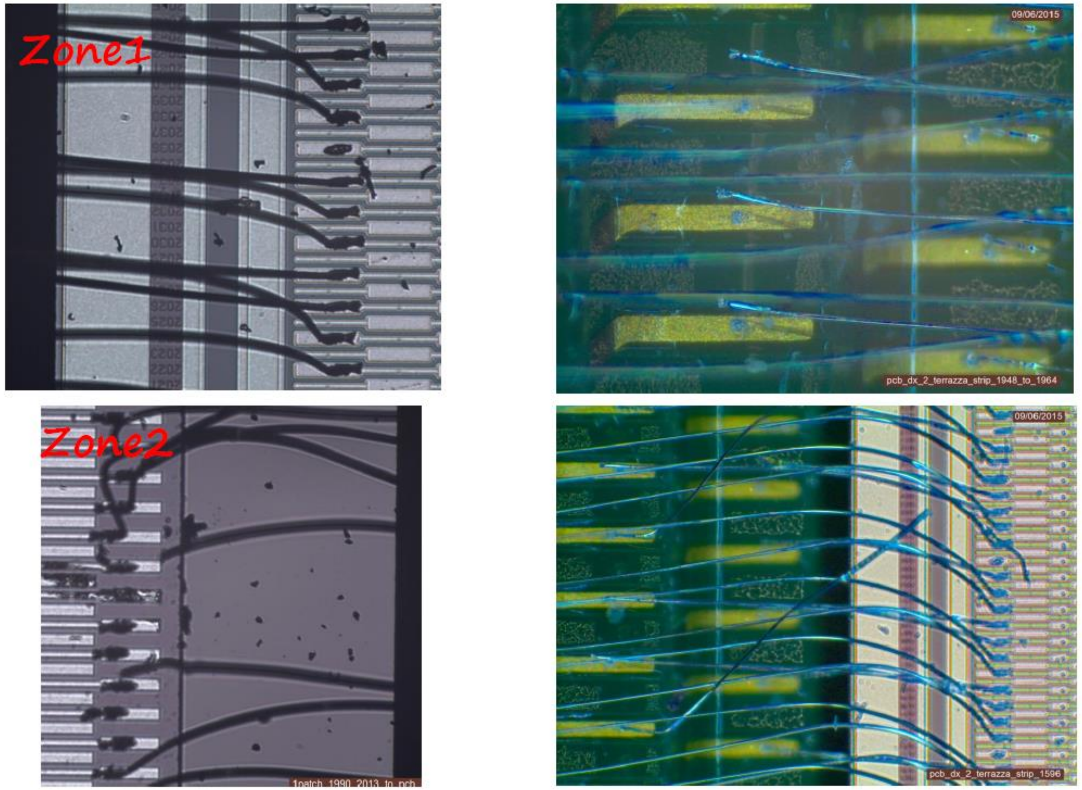
- The MIP molteplicity (distribution of the number of MIPS for event) follows nearly the expected Poisson distribution. Small deviations from this distribution are (likely) due to the presence of small amount of background (to be proved quantitatively)



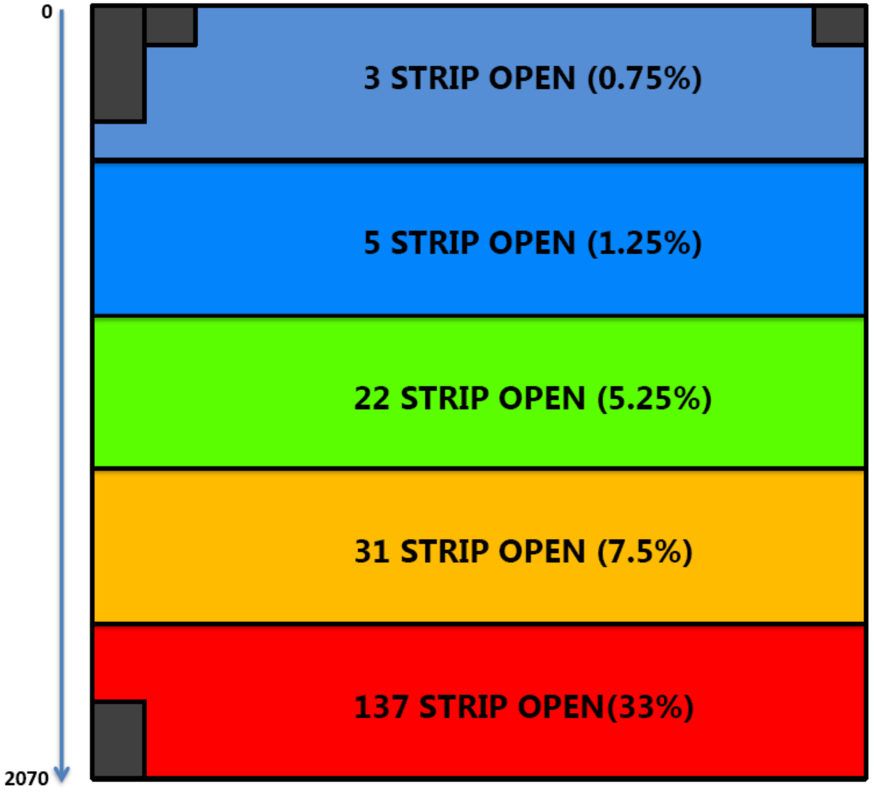
Wirebonding breakup issue

- The prototype experienced wirebonding breakups

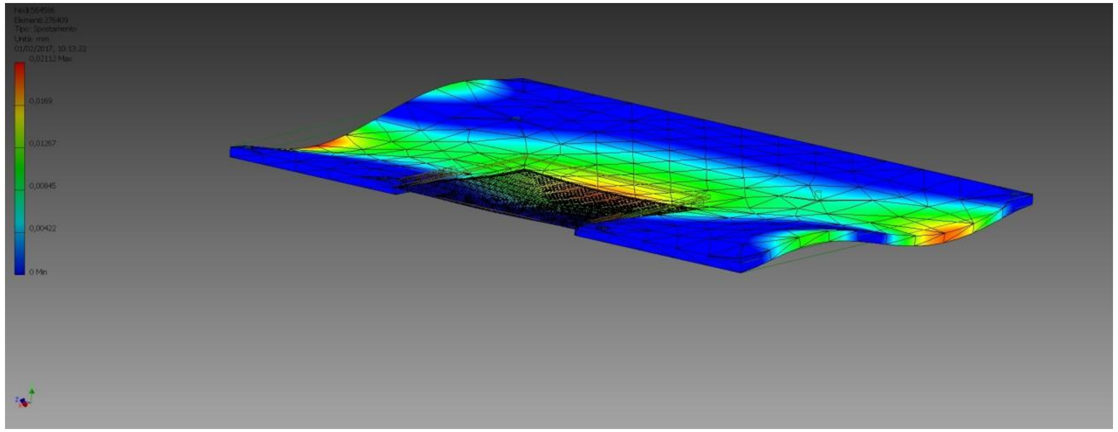
Broken Wires on SiD side and PCB side

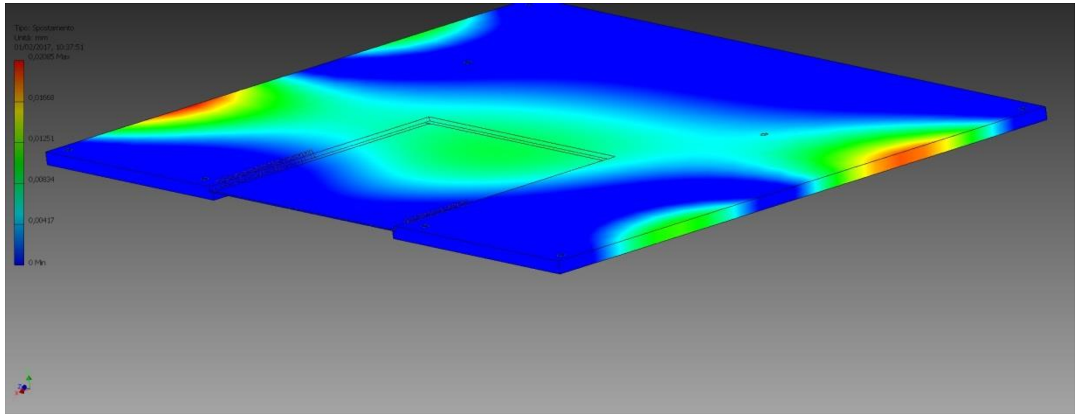


Broken Bonding Map SID & PCB



Wirebonding breakup issue solution





Simulations performed by F. Noto, LNS engineer, shows that even an uincorrect handling cannot breakup or remove wirebondings. The problem was caused hence only by Silicon detector transportation. F. Noto is performing numerical simulations to design a safe transport system for silicon detector delivery to Jlab.

Pulse Laser test station at the Rome Laboratory (1)

A dedicated test System will generate some pseudo-mip inside the SiD using a pulse laser and one optical fiber located over the SiD.

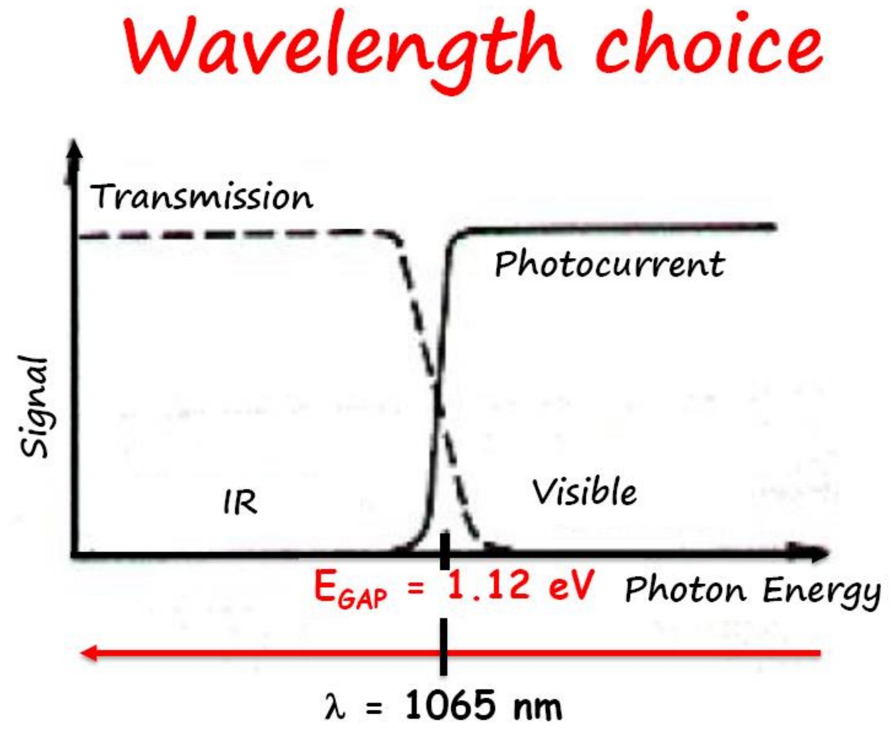
This system will:

- Test SiD efficiency (Good channels/Bad Channels)
- Test Read-Out electronics
- Measure SiD S/N Ratio
- Be always avaible (Test Beam is not always avaible!!!)

Hardware features:

- XYZ motorized 5 μm step stage for fiber positioning
- Θ manual adjustement
- SMJ 5-125 Optical Fiber
- Pulsed Laser ($\lambda \approx 1065$ μm, near-IR)
- Camera for SiD alignment with the system

Pulse Laser test station at the Rome Laboratory (2)

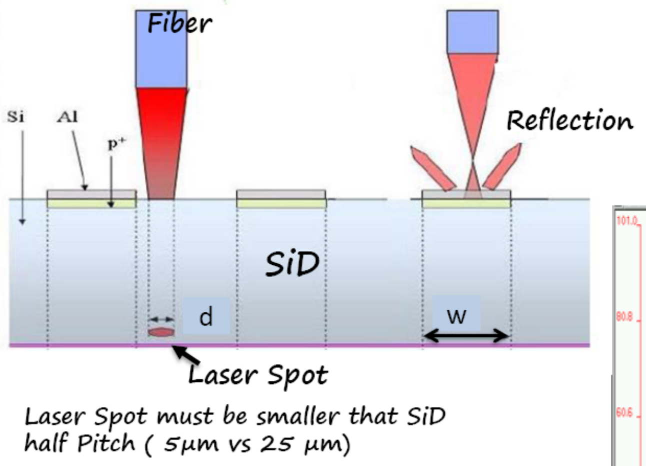


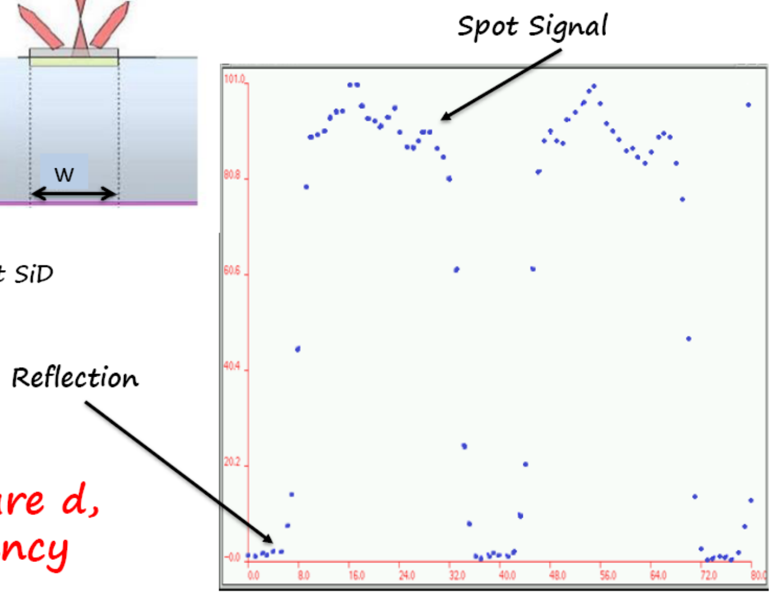
High number of photons goes through SiD without interaction!

BUT a small amount generate Signal !!!!!!!!!!!!!!!!!

Pulse Laser test station at the Rome Laboratory (3)

How it works





Is possible to measure d, w, pitch and efficiency

The test station is ready and will operate as soon as it will be validated by the Rome Physics Department Laser Safety Officer (LSO)

Future Activities:
Production at the INFN Bari clean room.

- The INFN-Bari will take over the automatic wirebonding of silicon microstrip detector.

- Tests on dummy detectors and spare PCBs already performed succesfully. Very last tests on glues and resins.

- The transportation of wirebonded PCB + detector systems will test the transportation system safety.

Schedule:

- **End of March 2017**: last tests on dummy detectors and spare PCBs automatic wirebonding operations.

- **End of April 2017:** production of a detector + PCB with reduced ground plane area (to test PCB noise production).

- **May to July 2017:** production of final silicon microstrip detectors. Their test at Rome (Laser + cosmic rays). Design and construction of the trasportation system to detctor delivery to Jlab

- **From september 2017 on:** Ready to install!!!