In recent works we presented the results of the characterization and the study of performance of several Silicon Photomultipliers delivered from MEPHI and we proposed an electrical model of the SiPM to be used in analog simulations for the VLSI design of the pilot chip with 0.35 μm technology produced. The results of the simulations was also presented. In this work we present the results of several tests performed on the SiPM connected to the pilot chip. We also describe the prototype board with a microcontroller designed to adjust the parameters of the chip and to provide an adjustable and temperature controlled power supply to the SiPM. The results of the tests obtained allow us to refine the circuits design for the next chip. This chip has been developed inside the ALTREISS and KLOE collaboration.

### Abstract

The chip is made of 8 channels for 8 SiPM. Each channel consists basically of one amplifier and one discriminator. The discriminators thresholds are adjustable for each channel. The main goals of this pilot prototype chip are the fast response of the discriminators, reduced jitter and adjustable threshold providing a large dynamical range. In order to obtain these performances we have chosen a current amplifier design.

The figure on the left shows the simplified schematic of one of the two parts of the fully balanced input stage. Another identical side is implemented to obtain a fully differential functionality with a feedback. This improves the bandwidth and the input impedance of a factor of two. On the right side the simplified schematic of the fast current amplifier is shown.

We investigated the dynamical range and linearity of the chip. We made a simulation by mean of a model of the 3x3 mm² SiPM from MEPHI (Moscow Engineering and Physics Institute) developed in a previous work. We compared the results of the simulations (on the left side) with the real measurement performed on the chip (on the right side).

### Measurement vs. Simulation

We performed several measurement in order to check the timing capability of the device. We made use of the same injection circuit to connect the pulse generator to the input channels of the chip. We measured the distribution of the arrival times of many pulses of fixed amplitude and RMS ( jitter). Then we repeated the measure for various values of the pulse amplitude. All the timing measures were obtained with a V775 VME module by CAEN (35 ps per channel) in common stop mode.

The figure above on the left shows the time distribution obtained with a fixed pulse amplitude corresponding to about 27 equivalent hit pixels. The figure above on the right shows the pulse spectrum obtained from the sum of the whole set of time measurements made with all the different amplitudes. A cosmic ray test has also been performed using a 1x1mm Hamamatsu SiPM coupled with a small BC418 plastic scintillator.

We used a telescope made of two scintillators of the same type coupled with two PM. The signal coming from the PMs has been discriminated with a CFD in order to avoid the time-walk.

### Timing

We made use of the same ACQ system. The resulting spectrum is shown on the bottom right plot.

### Conclusions

We have designed, produced and tested the pilot chip of a CMOS front-end for SiPM devices. Thanks to the encouraging results of the performed tests the developing of the second version of the chip is already in progress. We plan to make several improvements: get a better time resolution refining both the amplifying and discriminating sections; make a chip that fits the input characteristics of a wide range of SiPM devices; provide the new version with a high performance analog output.