Test of Si Photmultipliers for scintillator detectors, neutron and x-ray

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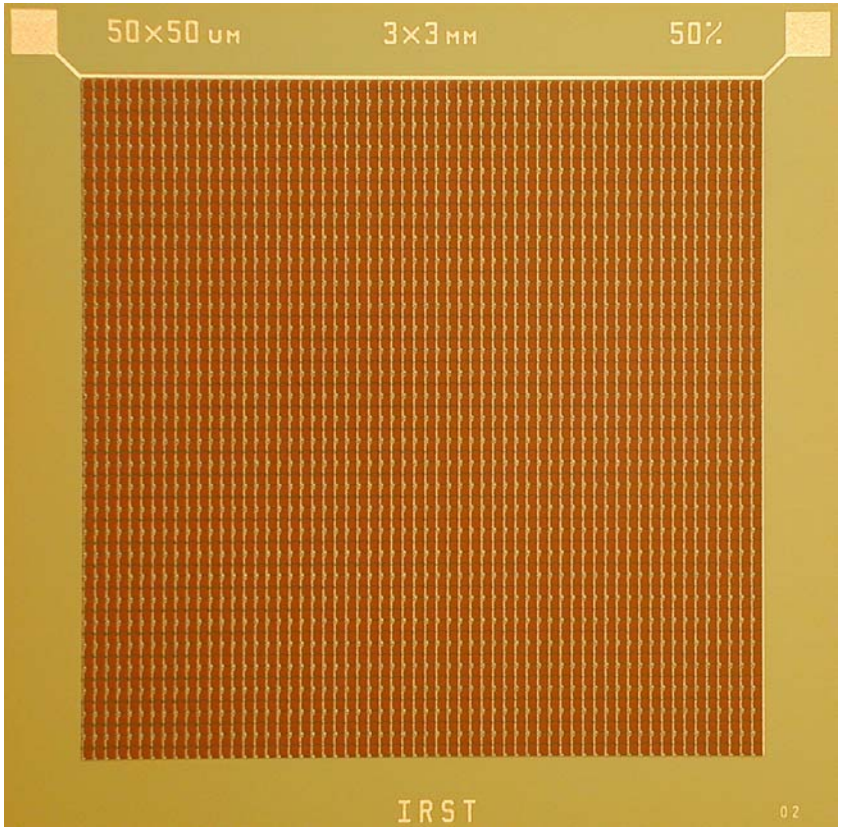
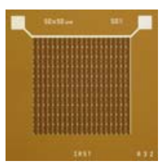
Neutron tests performed on a 3x3 mm^2 chip composed of 3600 cells 50x50 μm^2. This device has been produced by IRST

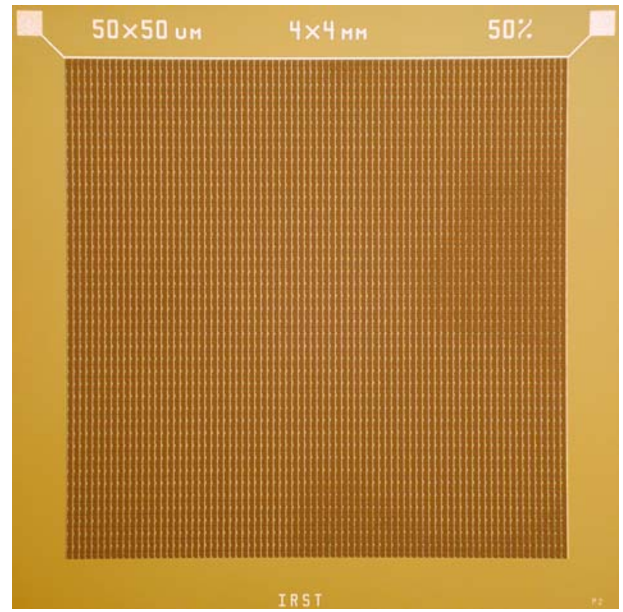


Width of the dead region around each micro cell, 50 μm.

Other devices mounted in the same way are also available from IRST. Custom design is possible.

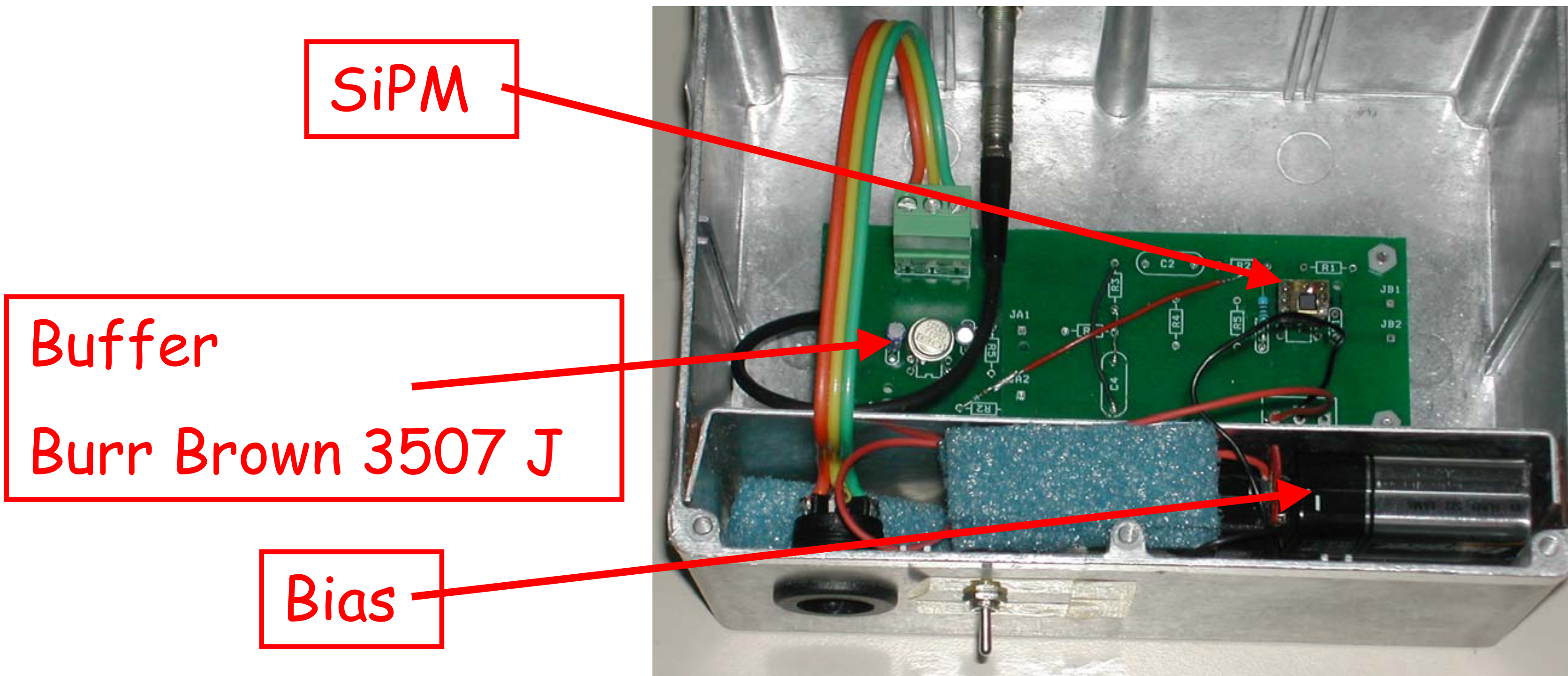


1x1 mm^2

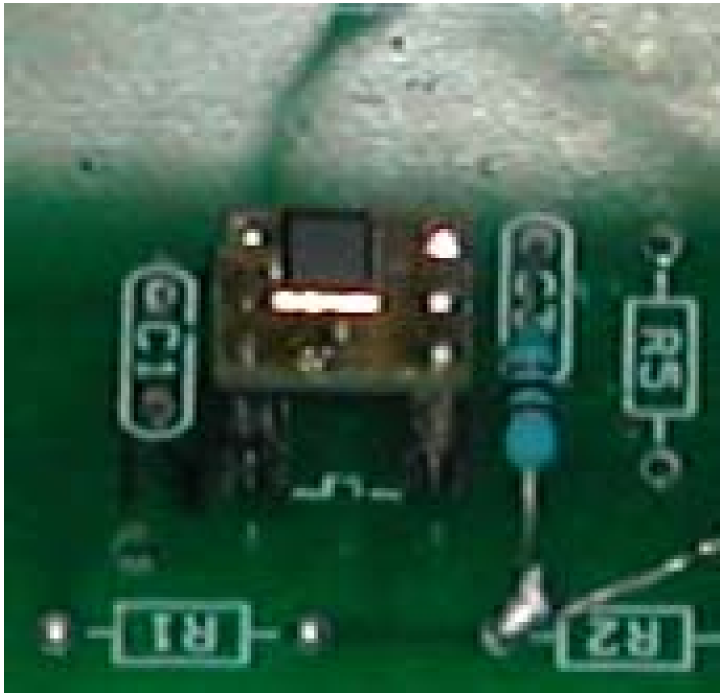


4x4 mm^2

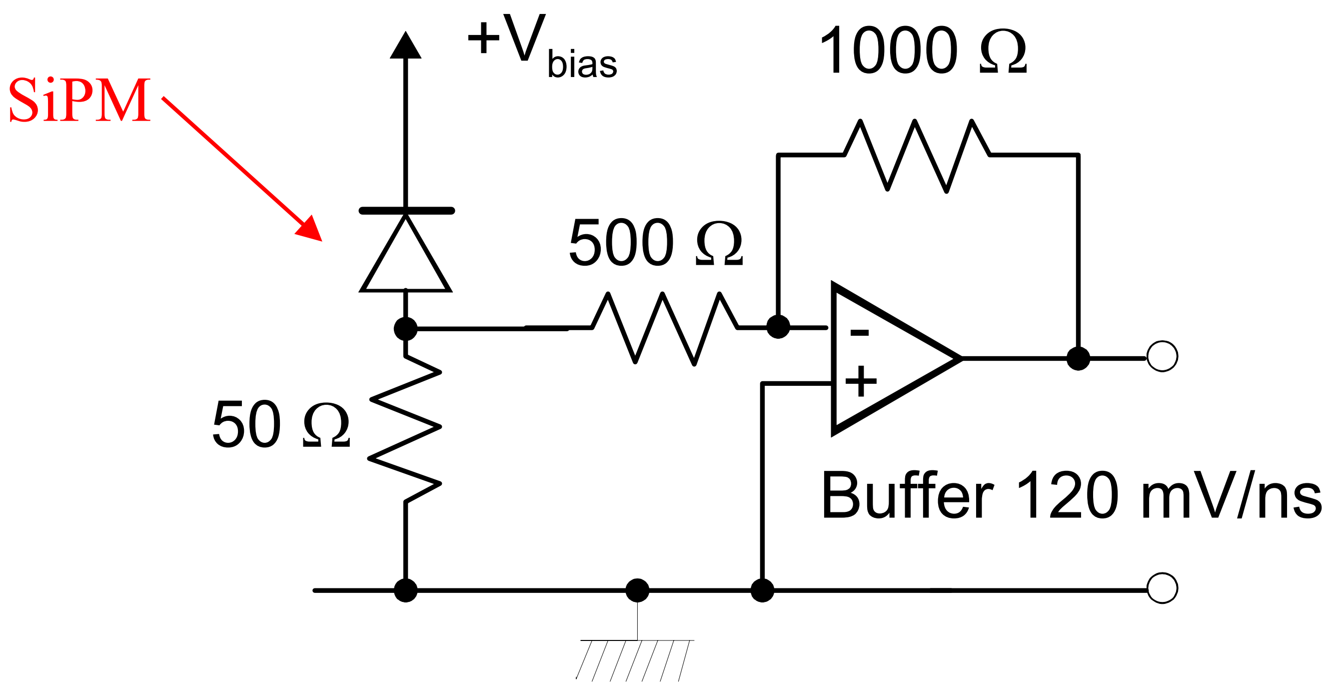
The first test device is in the picture. The scintillator (litium glass and ZnS with ^{6}Li) is inserted in front of the SiPM at a minimum distance. In the second test it is coupled directly to the SiPM to collect an increased light pulse.



The SiPM is mounted on a small test board which can be removed to compare different devices.



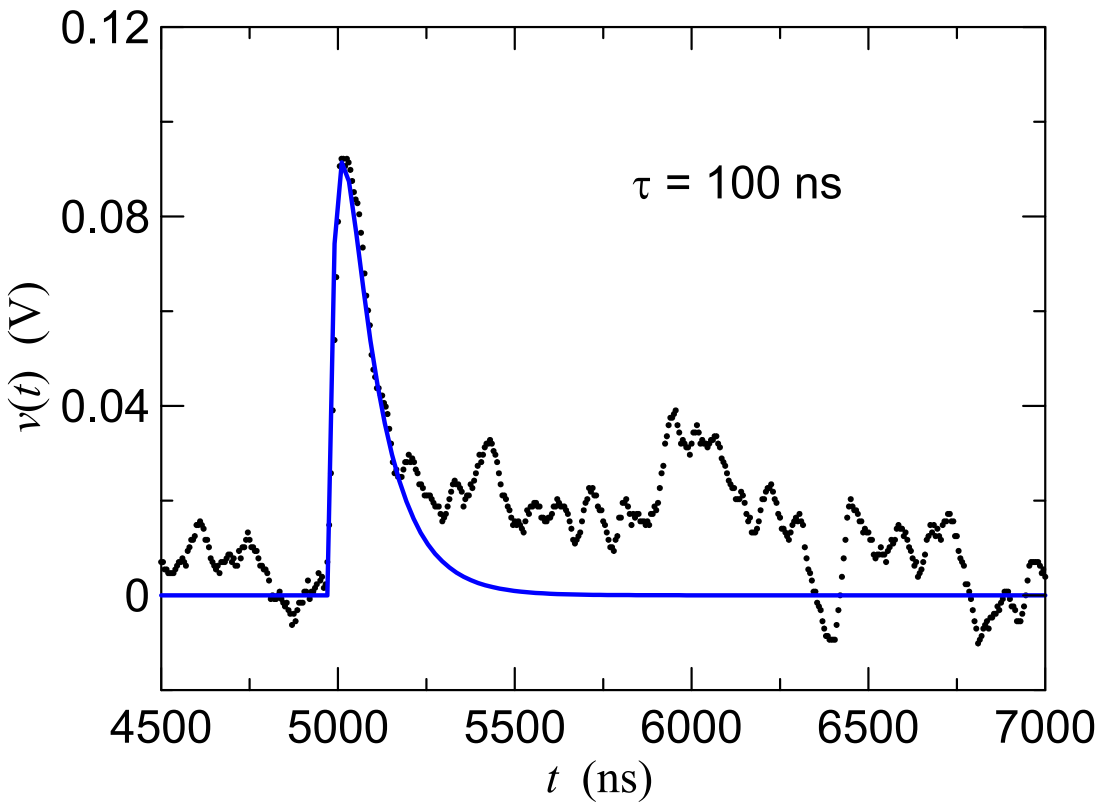
A simple scheme has been employed. The output signal has been acquired using a fast scope.



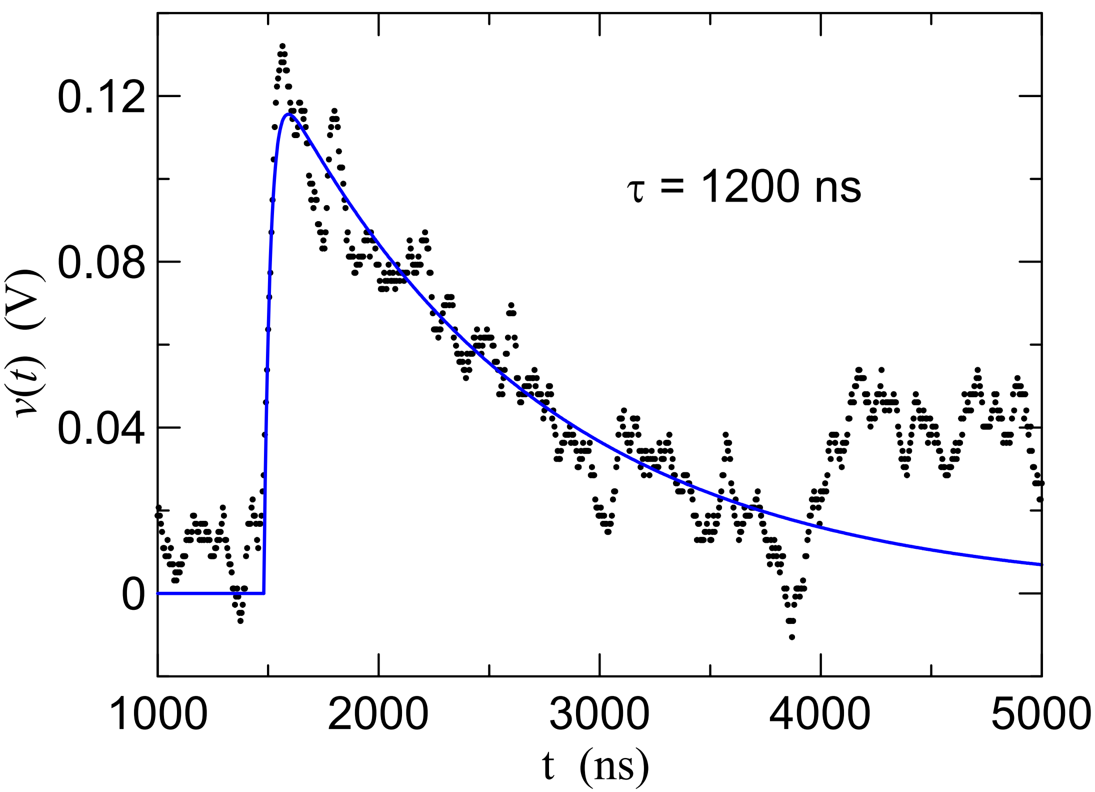
The test has been performed at FRMII using a rather long wavelength beam. The first analysis has been performed using a ^{6}Li glass and no integration of the signal apart from that intrinsically present in the circuit (~2 ns).

Several fast acquisitions have been analysed. A trigger level of 40 mV and a time step of 0.25 ns were used. The length of each acquisition was 20 μs. The actual neutron efficiency was not measured.

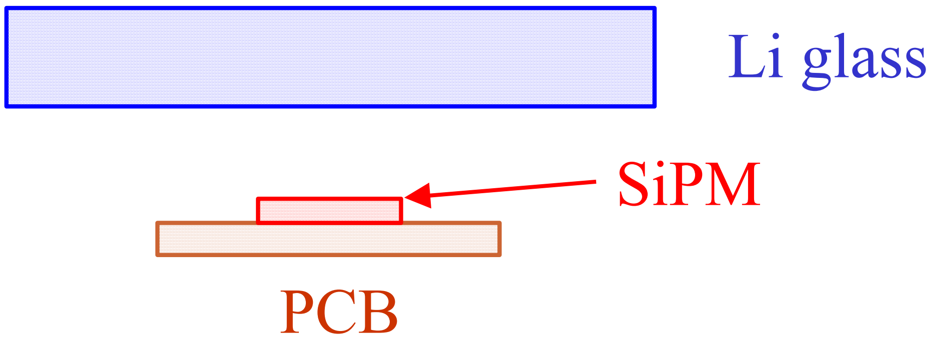
A typical neutron pulse is reported in the plot, where the neutron pulse is fitted to a simple form which includes a rise time of 30 ns (collection time) and a decay time of 100 ns. A statistical analysis of the data will be performed in order to define the resolution of the neutron pulses.



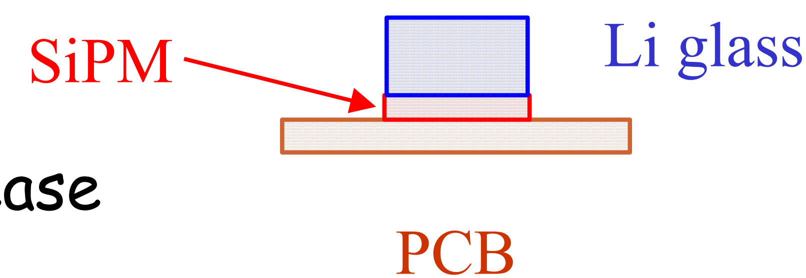
Similar results, but with longer decay time were obtained using a ZnS scintillator in a similar configuration. The time step was 5 ns, while the rest of the sistem is identical.



We are progressing along two directions: define a good front end electronics and collecting the light in the best way to reduce the noise to signal ratio.



First test, coupling in air



Second test, coupling with grease

The second test was perfomed in similar conditions but the scintillator was small (3x3 mm^2) and coupled directly on the SiPM.

The signal to noise ratio was better. The second test demonstrated:

a direct coupling is simple

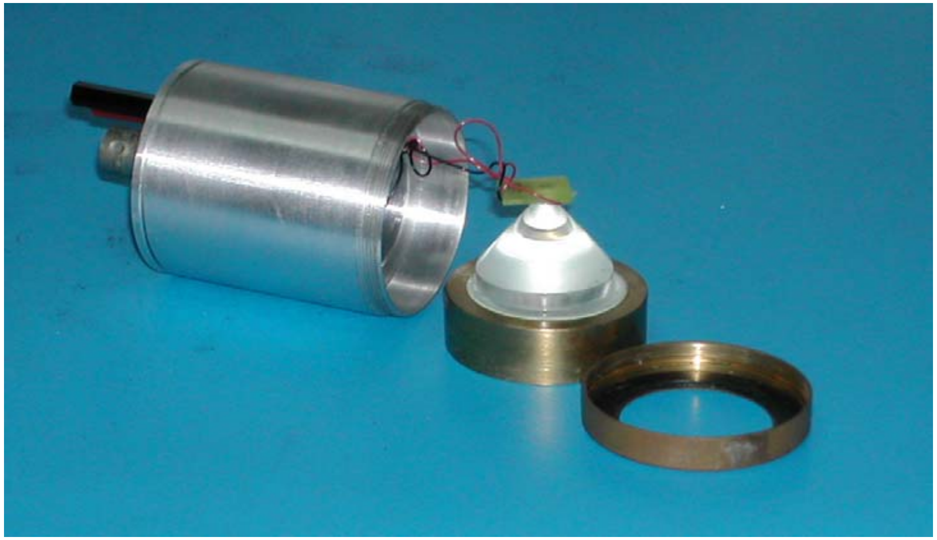
a light reflector on the scintillator back is necessary

A reduced noise level is necessary (e.g. smaller size)

The SiPM offer quite some advatage, bias current (battery) 0.1 μA, bias voltage 35 V, simple front end electronics, no charge preaplifier, no magnetic field effect.

The direct coupling improves the light collection. Further improvements will be obtained by using a reflector to collect almost all the photons from the scintillator.

New tests are being made using light guides to reduce the size of the SiPM with respect to scintillator. First application: 1x1 mm^2 SiPM coupled to 1" NaI:Tl x-ray scintillator.



Tests to be made soon. Front end electronics beind defined.

Assembled system