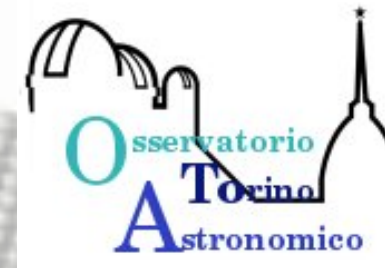




Catania-Torino laboratory network & FPGA controller for Intelligent Camera SiPM

Sergio Billotta, Massimiliano Belluso, Daniele Gardiol, Davide Loreggia



LABORATORIO DI MICROELETTRONICA APPLICATA

STAFF: Sergio Billotta, Massimiliano Belluso,
and TNT group: www.oato.inaf.it/gruppotnt

Attività:

- Progettazione su dispositivi a logica programmabile (FPGA)
- Studio e modellizzazione Sensori Silicio
- Progettazione elettronica di Front-end per rivelatori al silicio
- Collaborazione all'interno dell'ICT per applicazioni di FPGA in ambito astrofisico (HPC)
- Collaborazione tecnico scientifica con l'INAF – OA Torino: Laboratorio in rete, interferometria d'intensità
- Trasferimento tecnologico
- Progetto lauree Scientifiche



Intelligent Camera SiPM for Astrophysical Applications: Assessment Work

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(a) INAF- Astrophysical Observatory of Catania (IT)

(b) CNR- Institute for Photonics and Nanotechnologies of Padua (IT)

(c) INAF- Astronomical Observatory of Naples (IT)

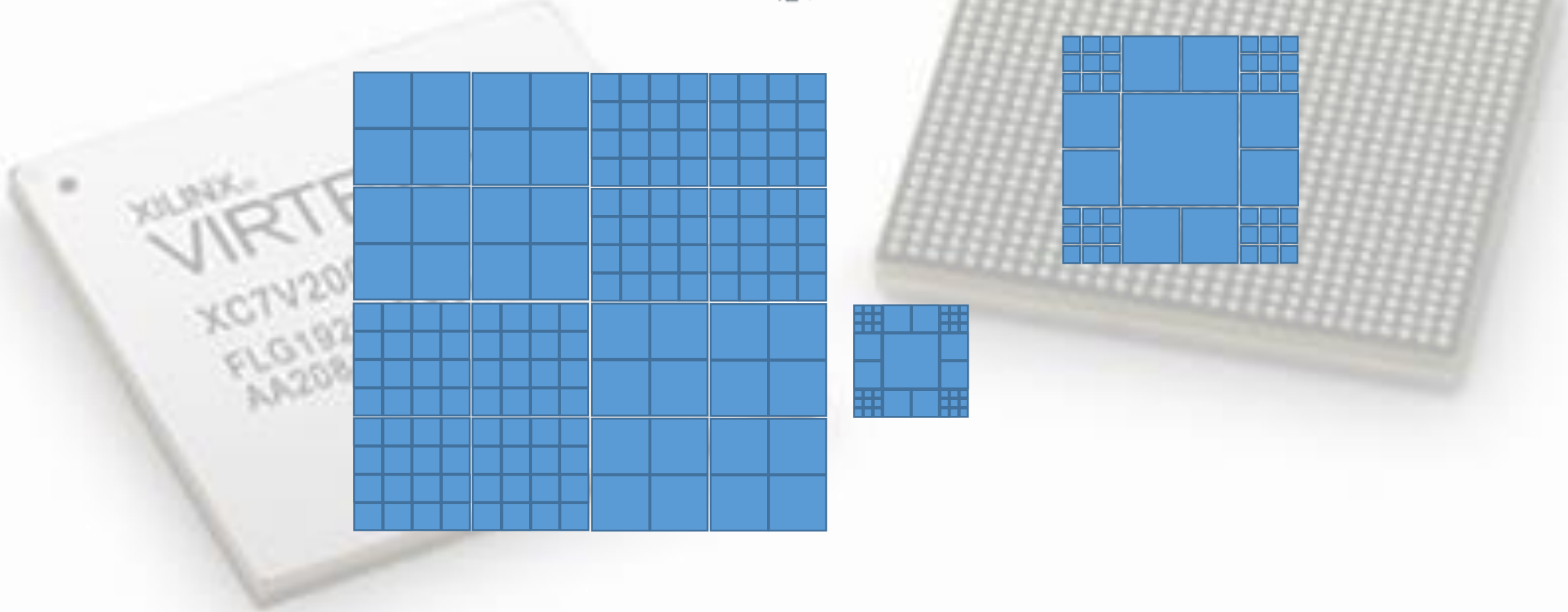
(d) INAF- Astrophysical Observatory of Turin (IT)

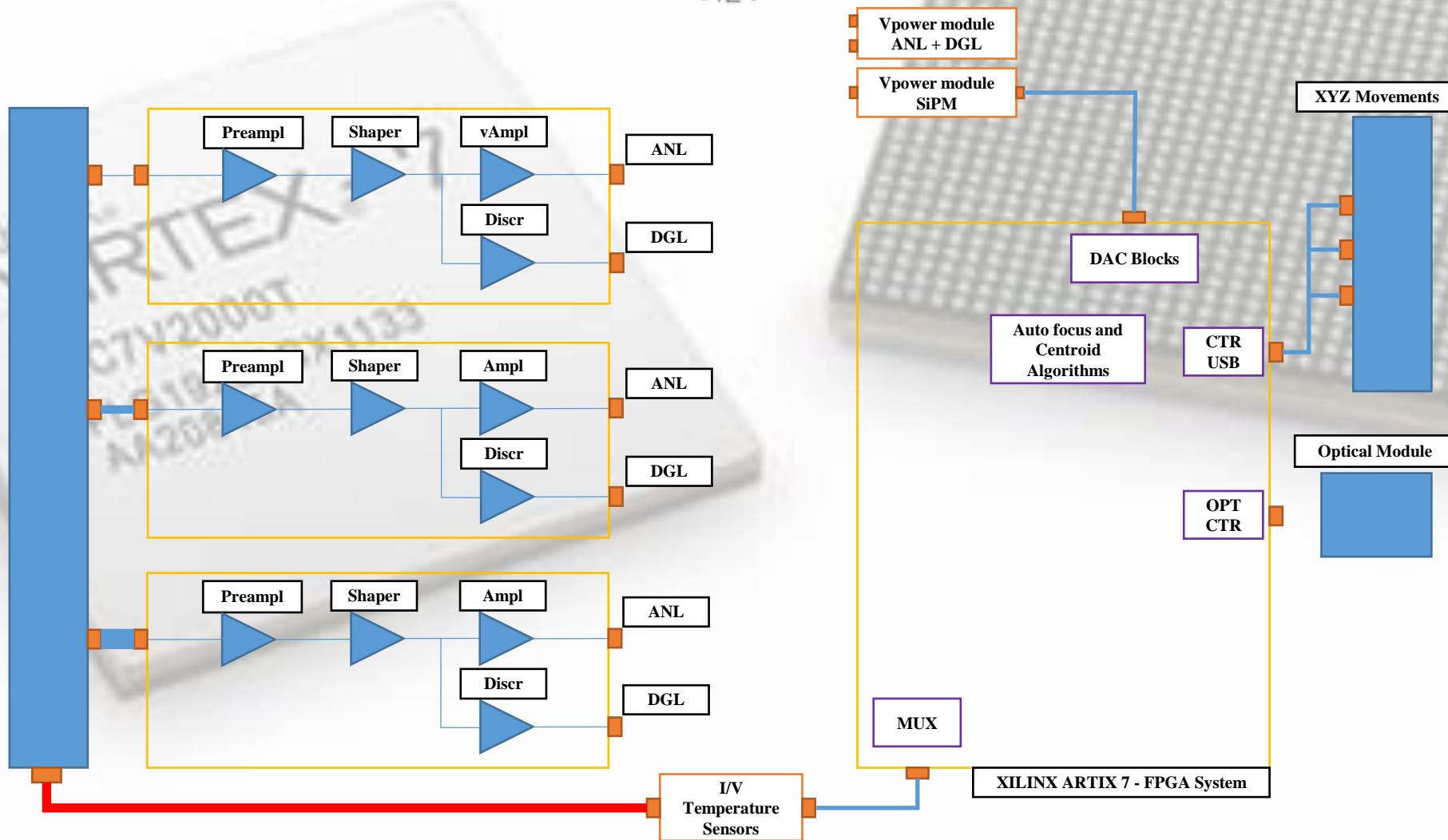
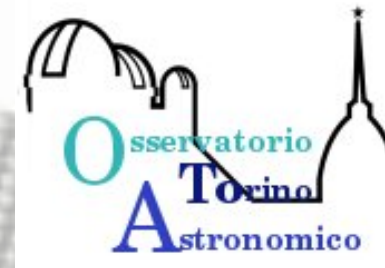
(e) INAF- Astronomical Observatory of Padua (IT)



Abstract:

World scale projects dedicated to ground based astronomy require new technology developments in many fields and also for realization of compact focal plane cameras. Usually these cameras are dedicated to specific astrophysical applications and optimized for a particular telescope configuration. However in many cases single telescopes (as well as arrays) can be well suited for scientific studies that were not driving the requirements in the project-planning phase. The objective of this work is an assessment towards the development of an Intelligent Camera SiPM (IC-SiPM) for astrophysical applications, based on silicon multiplier (SiPM) and programmable electronics (FPGA). IC-SiPM should be easily adaptable to different plate scale of currently existing or under construction telescopes for big science projects. The flexibility will be guaranteed by multi-size SiPM arrays, multi-function channels conditioning electronics, auto-focus and centring electro-mechanical system based on FPGA.







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TSV MPPC array

S13361-3050NE-08, S13361-3050NS-08

Low Cross Talk type

S13361-3050AE-08, S13361-3050AS-08

■ Overview

The S13361 series are the MPPCs for the precision measurements. The strongest point of these MPPCs is drastically reduced cross talk, compared to our previous products. The S13361 series use the TSV (Through Silicon Via) technology. There is no wire bonding, so the package outline is very close to the MPPC array. The outer gap from active area edge to package edge is only 0.2mm. The pitch between ch is 3.2mm. This package realizes the 4-side buttable arrangement.

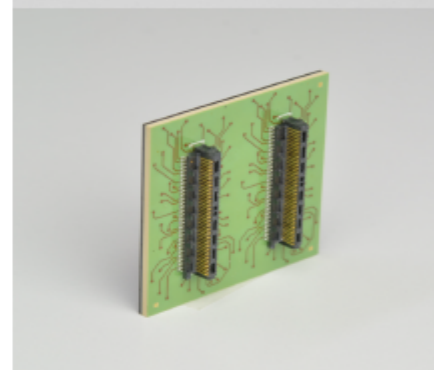
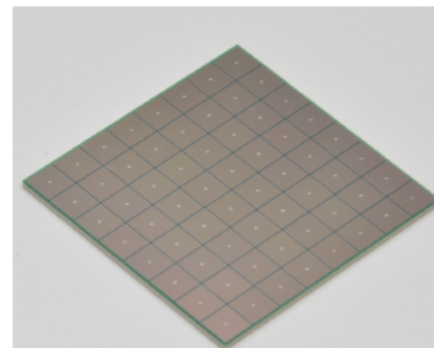
These MPPCs are designed for the applications in the photon counting region, including medical, non-destructive inspection, environmental chemical analysis, high energy physics experiments, and many other fields.

■ Features

- Significantly reduced Cross talk
- Low after pulse
- Very compact package with small dead space
- Superior photon counting capability
- Low voltage ($V_{op}=53V$ Typ.) operation
- High gain: 10^5 to 10^6

■ Application

- Astro physical application
- High energy physics experiment
- Nuclear medicine
- PET
- Environmental analysis





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Datasheet Citiroc 1

Citiroc is a 32-channel front-end ASIC designed to readout silicon photo-multipliers (SiPM).

Citiroc allows triggering down to 1/3 pe and provides the charge measurement with a good noise rejection. Moreover, Citiroc outputs the 32-channel triggers with a high accuracy (100 ps).

An adjustment of the SiPM high-voltage is possible using a channel-by-channel DAC connected to the ASIC inputs. That allows a fine SiPM gain and dark noise adjustment at the system level to correct for the non-uniformity of SiPMs.

Timing measurement down to 100 ps RMS jitter is possible along with 1% linearity energy measurement up to 2500 p.e. The power consumption is about 2mW/channel, excluding ASIC output buffer.

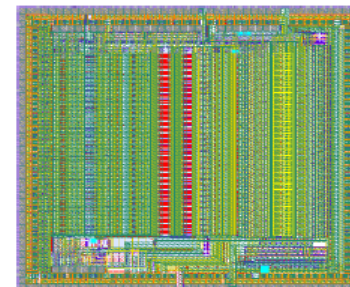


Figure 1 - ASIC layout

Parameter	Value
Detector Read-Out	SiPM, SiPM array
Number of Channels	32
Signal Polarity	Positive
Sensitivity	Trigger on 1/3 of photo-electron
Timing Resolution	100 ps RMS on single photo-electron
Dynamic Range	0-400 pC i.e. 2500 photo-electrons @ 10 ⁹ SiPM gain
Packaging & Dimension	Naked die - 4.1 x 4.1mm - 16.5mm ² / TQFP 160
Power Consumption	60mW Analogue Core (excluding output buffer) 95mW Asic Outing (all outputs on)
Inputs	32 voltage inputs with independent SiPM HV adjustments
Outputs	32 trigger outputs 1 multiplexed charge output 1 ASIC trigger output (Trigger OR)
Internal Programmable Features	32 HV adjustment for SiPM (16x8bits), Trigger Threshold Adjustment (10bits), channel by channel gain tuning, 32 Trigger Masks, Channel by Channel Output Enable, Trigger Latch

Table 1 - ASIC main parameters



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Power supply for MPPC®



C11204-01

Bias power supply with built-in high precision temperature compensation for MPPCs

The C11204-01 is a high voltage power supply that is optimized for MPPCs (multi-pixel photon counters). It can output up to 90 V. It contains a temperature compensation function that constantly optimizes the MPPC operation even in environments with varying temperatures. It also has built-in output voltage monitor and output current monitor. All functions can be controlled from a PC via its serial interface (UART).

Features

- Wide output voltage range: 50 V to 90 V
- Low ripple noise^{*1}: 0.1 mVp-p typ.
- Superb temperature stability: ± 10 ppm/ $^{\circ}$ C typ.
- Finely adjustable resolution (in 1.8 mV steps)
- Serial interface

*1: No load, using the recommended circuit

Applications

- Power supply for MPPCs

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Supply voltage	Vs		6	V
Operating temperature	Topr	No condensation	0 to +50	$^{\circ}$ C
Storage temperature	Tstg	No condensation	-20 to +70	$^{\circ}$ C

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Recommended operating conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage	Vs		4.75	5	5.25	V
High level input voltage (RXD)	VIH	$4.75 \leq Vs \leq 5.25$	$0.65V_{cc}$	-	Vcc	V
Low level input voltage (RXD)	UIL	$4.75 \leq Vs \leq 5.25$	0	-	$0.4V_{cc}$	V
High level input voltage (TXD)	VOH	Vs = 5 V	$V_{cc} - 2.0$	-	Vcc	V
Low level input voltage (TXD)	Vol	Vs = 5 V	-	-	2.0	V

