An automated VMM hybrid characterisation system

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May 20, 2021

Contents

Scalable Readout System

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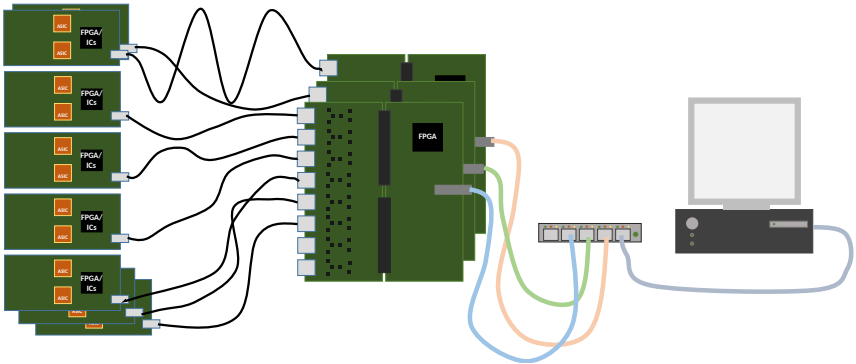
- Detector readout system by the RD51 collaboration @ CERN
- Small and large detectors possible with same hardware

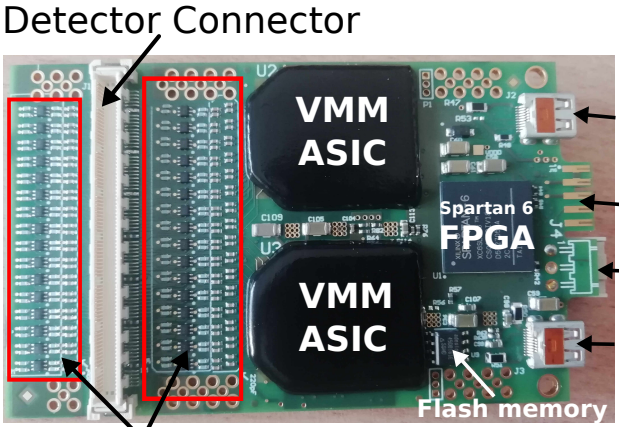


Hybrid ⇔ HDMI Cable ⇔ Adapter card+FEC ⇔ Ethernet ⇔ Switch ⇔ Ethernet ⇔ PC

[Implementation of the VMM ASIC in the Scalable Readout System,M.Lupberger]

SRS-VMM Project

- VMM detector readout ASIC developed for ATLAS NSW Upgrade
- VMM hybrid implementation of VMM into SRS
- Project now in mass production phase
- Automated testing needed (better test quality, time saving)



Test System Overview

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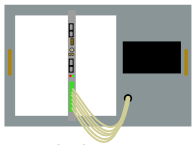
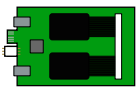
Minimal System

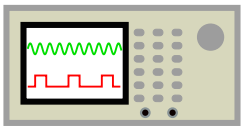

SRS Crate


VMM Hybrid

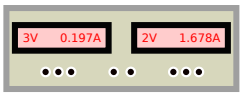

Computer
+
VMM Slow Control

- Read VMM monitoring Output
- Read VMM data
- Many tests possible

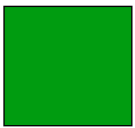
Optional extensions


Signal Generator

JTAG Programmer



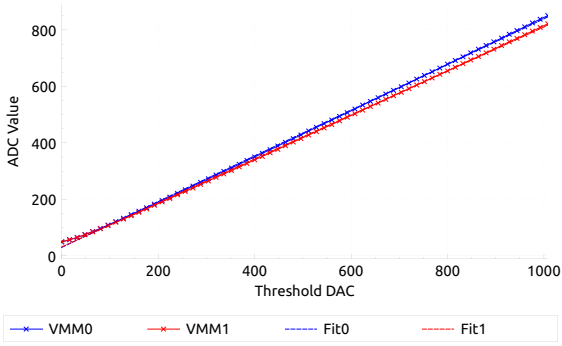
Power Supply


Multiplexer PCB

- Load Firmware
- Measure power consumption of hybrid
- Test connection detector plug $\leftrightarrow$ VMMs incl. protection circuit

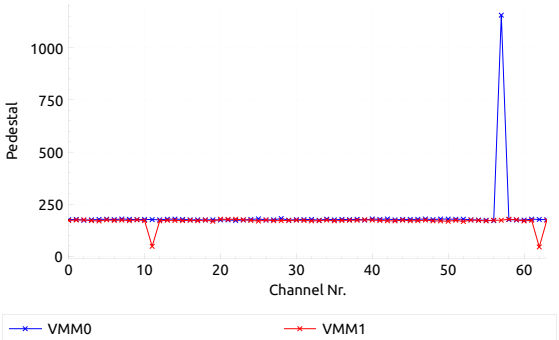
Important Tests

- Monitoring ADC Calibration



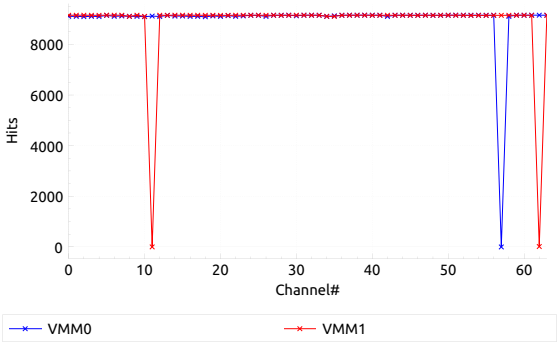
Important Tests

- Monitoring ADC Calibration
- Pedestal Tests



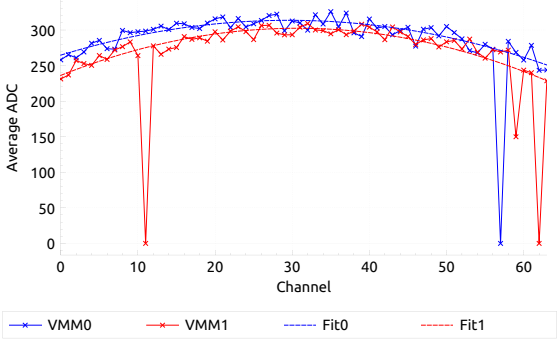
Important Tests

- Monitoring ADC Calibration
- Pedestal Tests
- Internal and External Test Pulses



Important Tests

- Monitoring ADC Calibration
- Pedestal Tests
- Internal and External Test Pulses
- Test Pulse Average ADC Curve



VMM Classification

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Class	Description
A	All channels working
B	One channel broken
C	2-3 channels broken
D	Many channels broken
E	VMM broken (e.g. when Hybrid has a short, or MonitoringADC is broken)

Table: Single VMM-ASIC classification

Hybrid Classification

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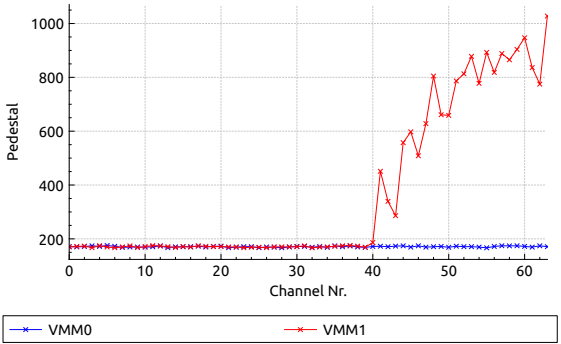
VMM class 1	VMM class 2	Hybrid class	Description
A	A	a	Two good VMMs
A	B	b	1-3 channels broken
A	C	b	on hybrid
B	B	b	
B	C	b	$\leq$ 3 broken channels total
B	C	c	$>$ 3 broken channels total
A/B/C/D	D	c	One ok VMM
A/B/C/D	E	c	
E	E	d	Hybrid broken

Table: Hybrid classification

Pedestal Problem



- Problem occurs at high gains with fast pedestal measurements (Baseline jumps and has no time to settle)
- In operation could lead to problems with high charges
- Hybrids however usable
- "-" behind VMM class indicates this problem

Tested Hybrids

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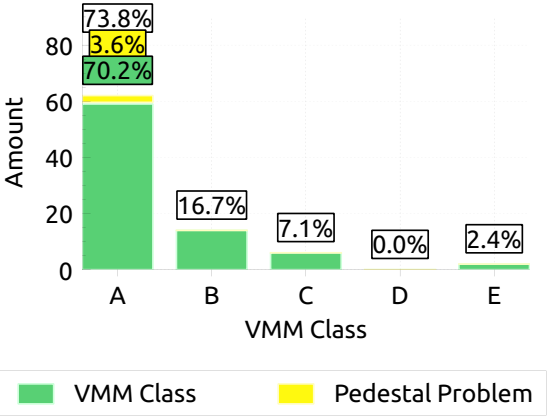
- Batch Spring 2020
  - 10 Hybrids in Bonn
  - 6 Hybrids from Mainz
  - 26 from LSBB
- Batch Autumn 2020
  - 120 Hybrids in Bonn (Physikalisches Institut)
  - 14 Hybrids in Bonn (Helmholtz Institut für Strahlen- und Kernphysik)

VMM Yield - Batch Spring 2020

Class	N	N-
A	59	3
B	14	0
C	6	0
D	0	0
E	2	0
Total	81	3

Table: VMM Yields Spring 2020

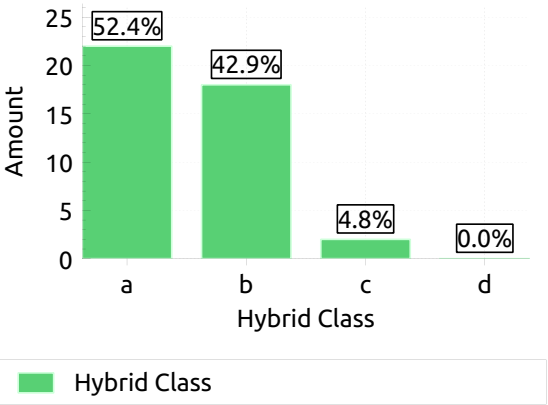


With Class A,B,C acceptable: Total VMM Yield 97.6 %

Hybrid Yield - Batch Spring 2020

Class	N
a	22
b	18
c	2
d	0
Total	42

Table: Hybrid Yields Spring 2020

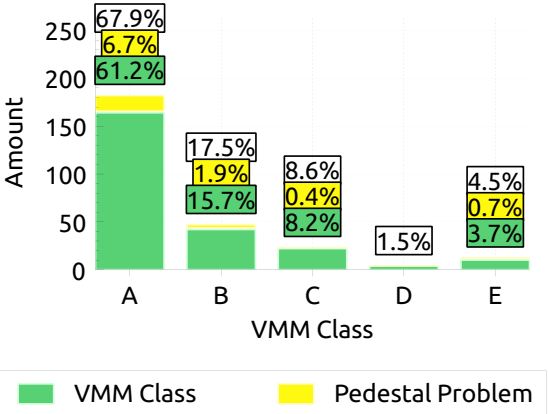


With Class a,b acceptable: Total Hybrid Yield 95.3 %

VMM Yield - Batch Autumn 2020

Class	N	N-
A	164	18
B	42	5
C	22	1
D	4	0
E	10	2
Total	242	26

Table: VMM Yields Autumn 2020

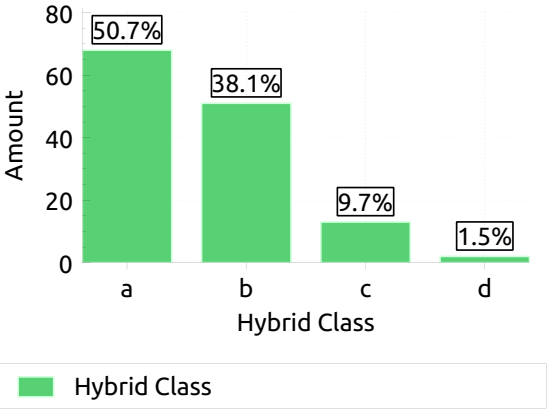


With Class A,B,C acceptable: Total VMM Yield 94 %

Hybrid Yield - Batch Autumn 2020

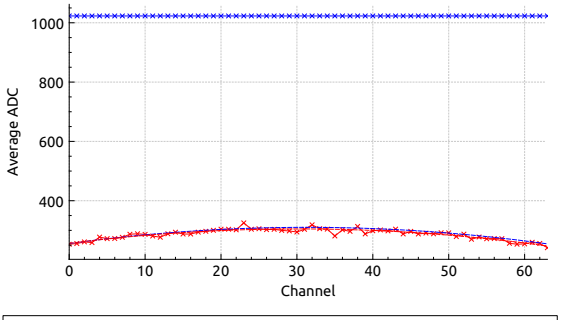
Class	N
a	68
b	51
c	13
d	2
Total	134

Table: Hybrid Yields Autumn 2020



With Class a,b acceptable: Total Hybrid Yield 88.8 %

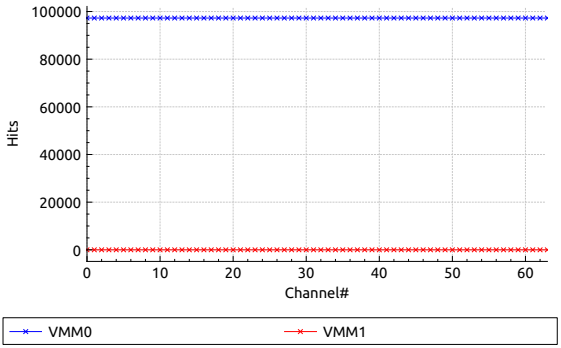
Broken internal ADCs




```
Hit:   5, offset: 25, vmmID:  2, ch:  0, bcid:  200, tdc:   58, adc: 1023, over thr: 1
Hit:   6, offset: 25, vmmID:  3, ch: 29, bcid:  200, tdc:   24, adc:  367, over thr: 1
Hit:   7, offset: 26, vmmID:  2, ch:  0, bcid:  200, tdc:   52, adc: 1023, over thr: 1
Hit:   8, offset: 26, vmmID:  3, ch: 29, bcid:  200, tdc:   22, adc:  366, over thr: 1
Hit:   9, offset: 27, vmmID:  2, ch:  0, bcid:  200, tdc:   64, adc: 1023, over thr: 1
```

- All hits on all channels have ADC 1023
- Pulses visible on analog monitoring output, amplitude can be varied by changing test pulse height in slow control
- Internal channel ADCs seem to be broken

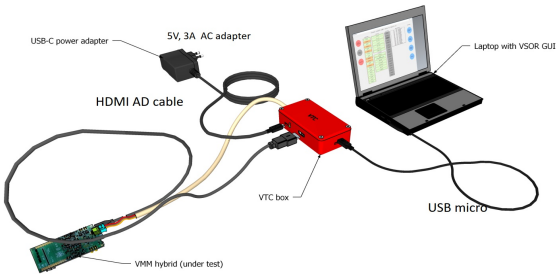
No Test pulses



- No pulses given out by the VMM
- Pulses visible on analog monitoring output
- Reason still unknown, maybe broken data line on HDMI

Side Note: VMM Tester Card (VTC)

- Tests HDMI pins and electronic connections
- Useful to test electronic functionality and find very bad hybrids in production
- VTC cannot find the problems with Channel ADCs
- VTC measures pedestal, but cannot find the problem as measurement is slower



[VTC User Guide, M. Hracek et al.]

Thank you for your Attention

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Do you have questions?