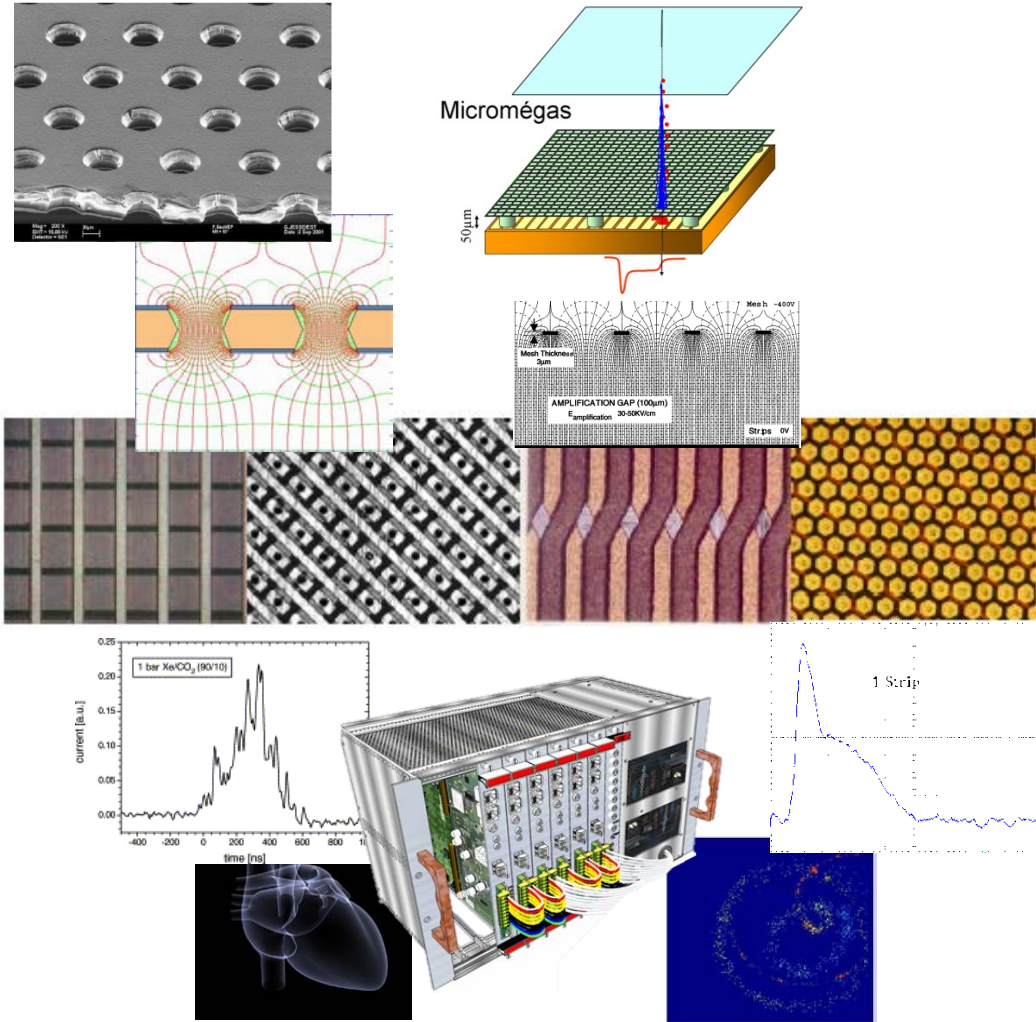
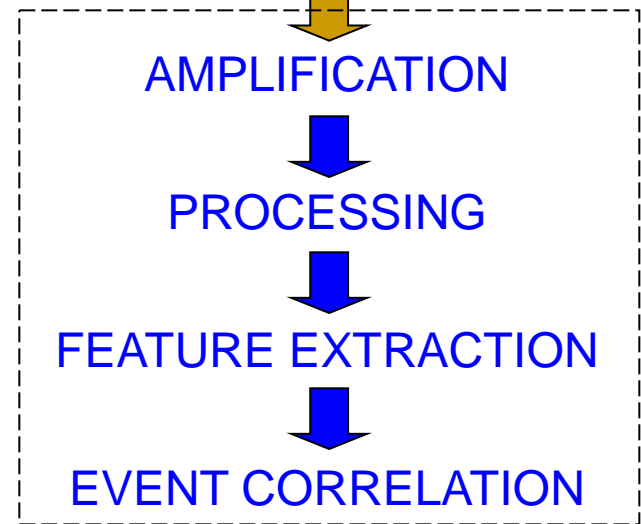

Electronics for Gas Detectors

Sorin Martoiu, CERN

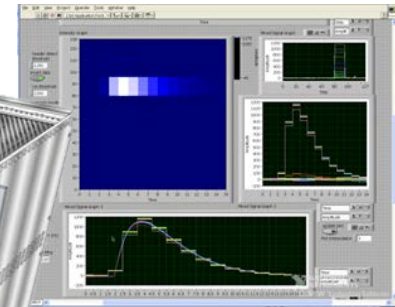
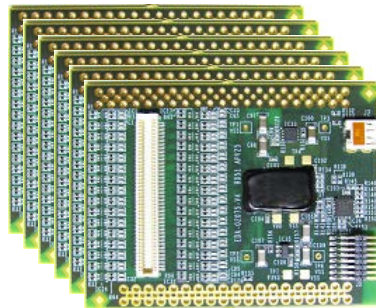
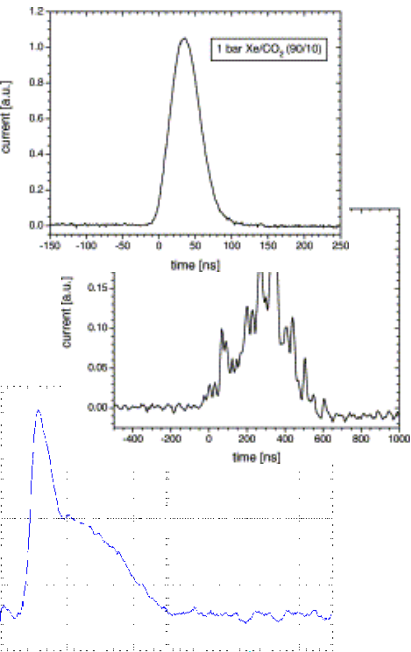
Electronics for Gas Detectors



IONIZATION
↓
DRIFT
↓
MULTIPLICATION
↓
READOUT



Electronics for Gas Detectors

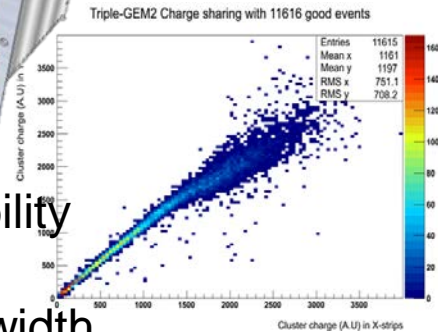


- Low noise ($0.1 \sim 1$ ke)
- High channel count (*up to millions of ch*)
- Discharge protection
- Radiation hardness

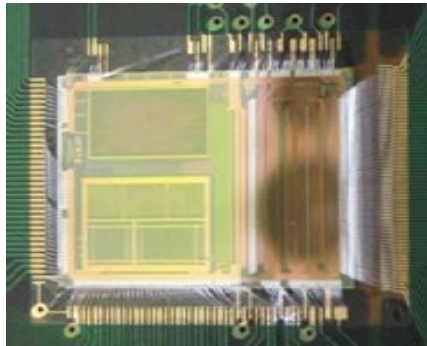
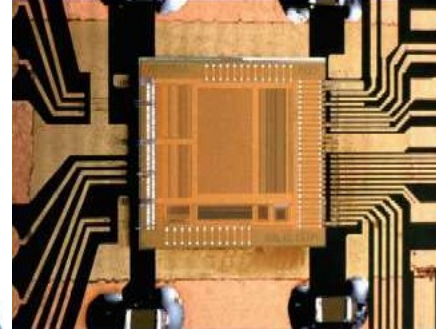
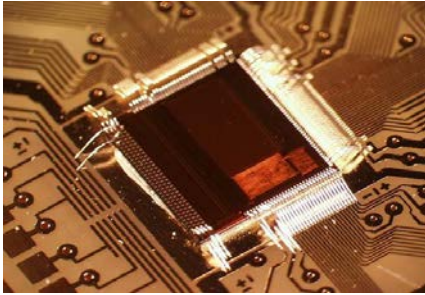
- signal range = 10 .. 1000 ke-
- signal width = 5 .. 200ns
- negative or positive polarity
- ...

- Rate capability
- Efficiency
- Data Bandwidth

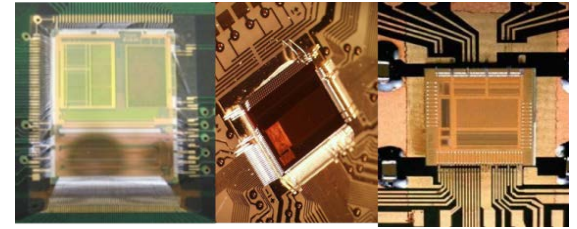
- Spatial resolution
- Temporal resolution
- Energy resolution



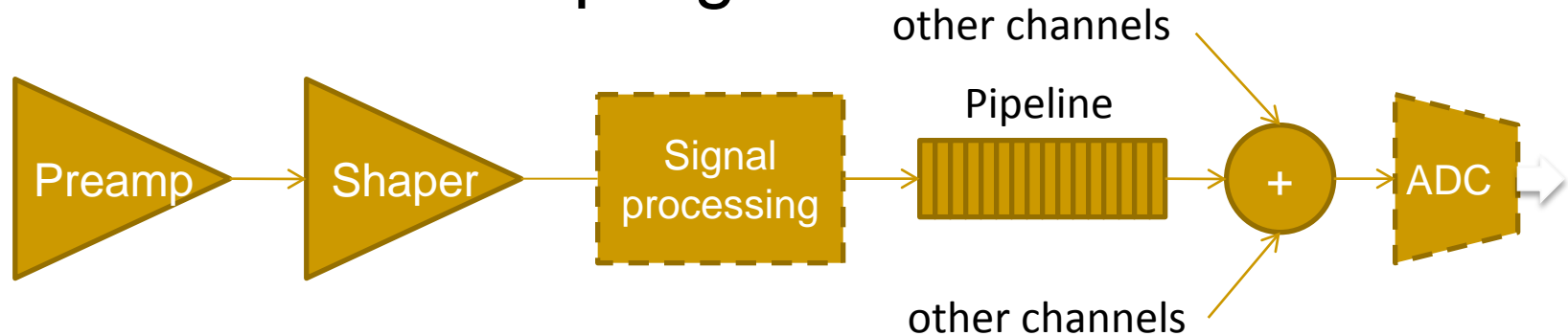
What front-end do I choose?



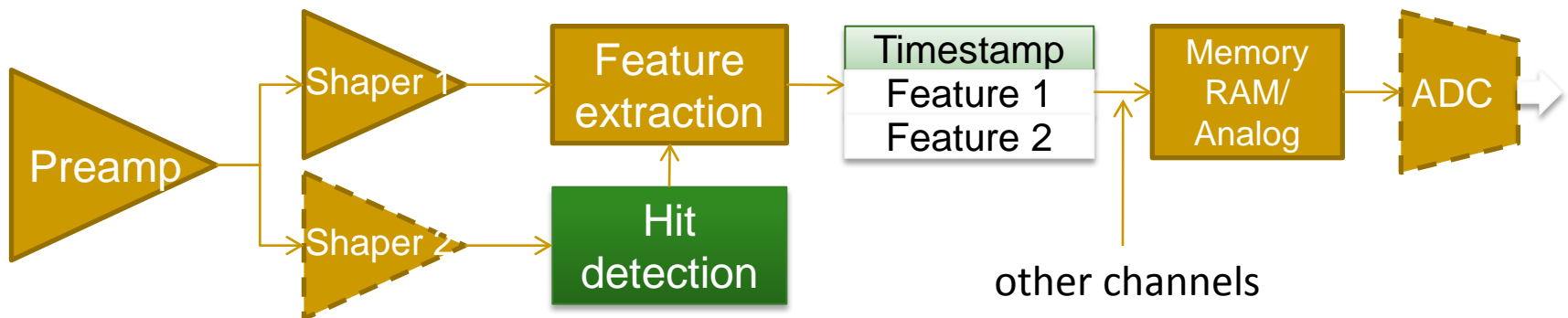
Front-End Architecture



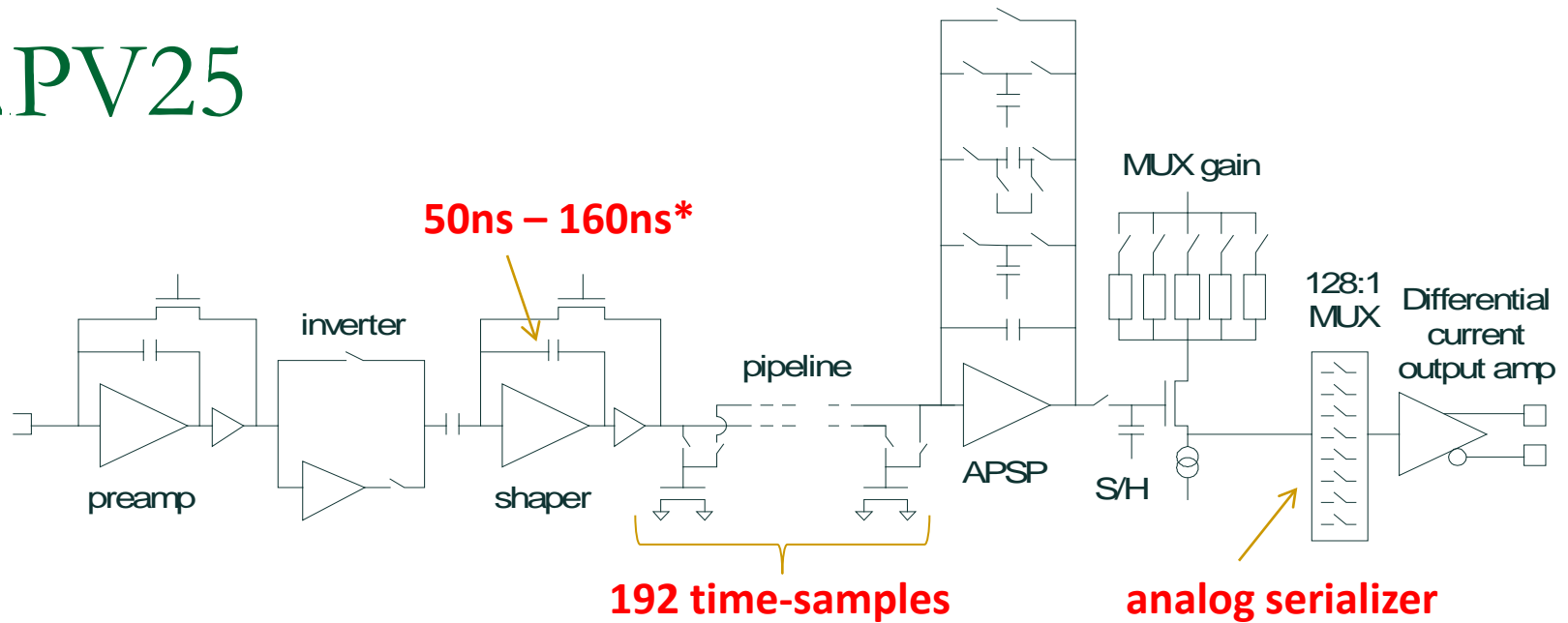
■ Waveform sampling



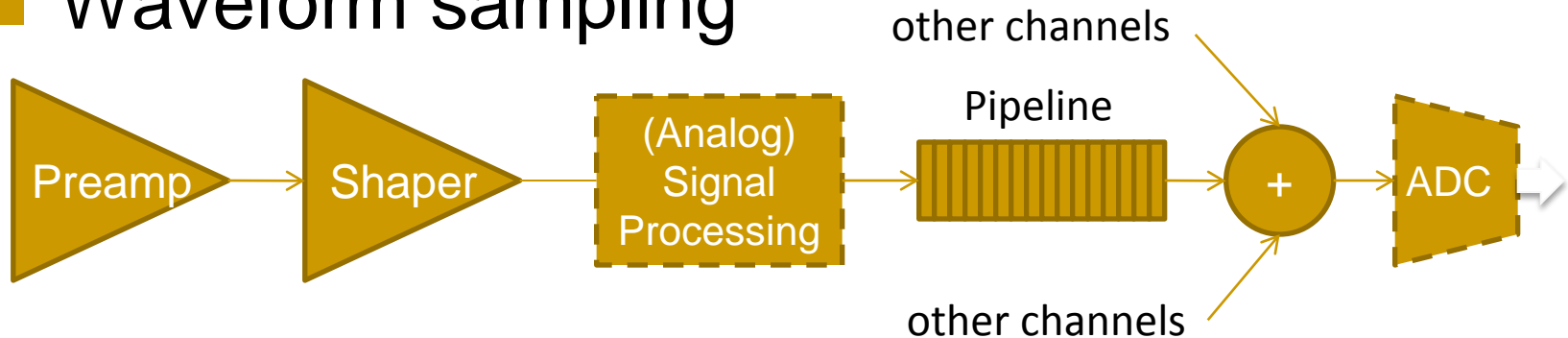
■ Self-triggered channel



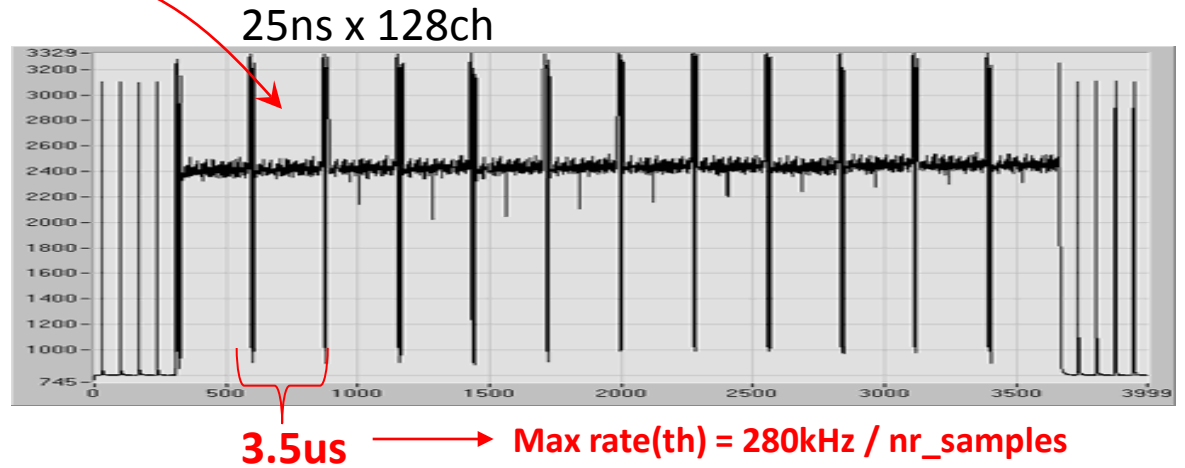
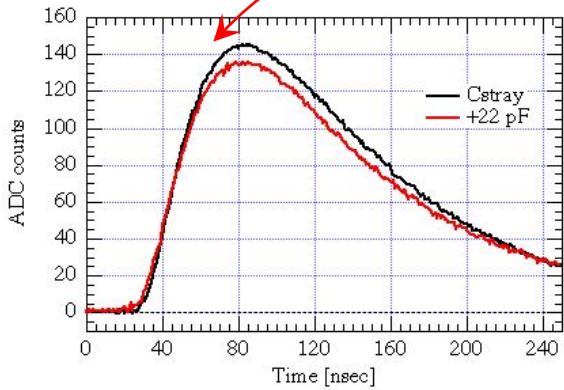
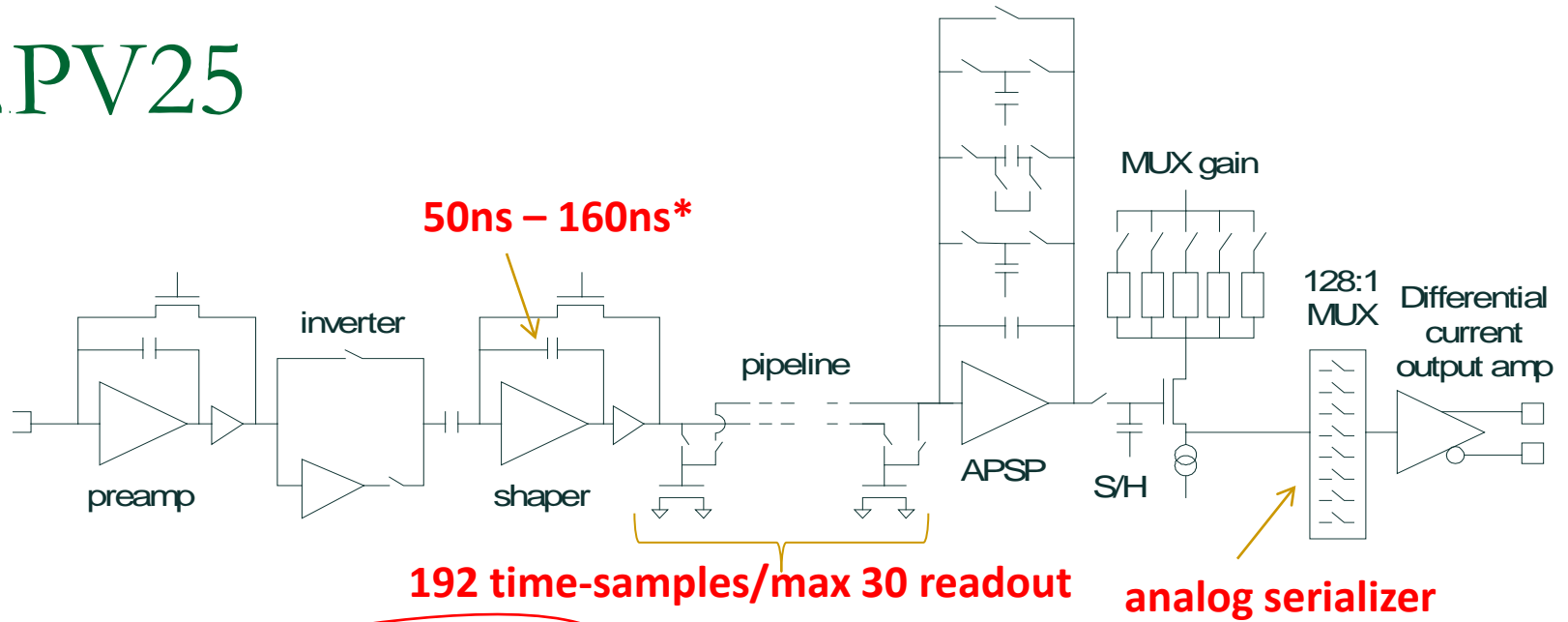
APV25



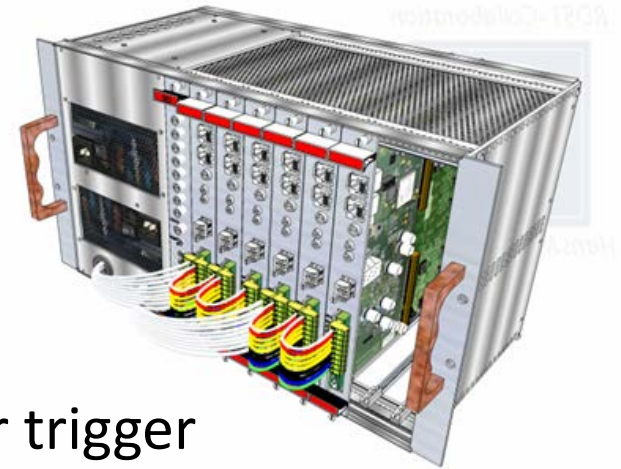
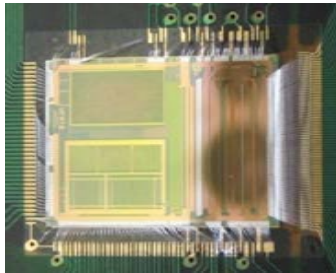
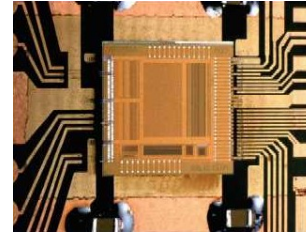
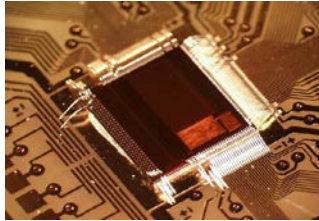
■ Waveform sampling



APV25

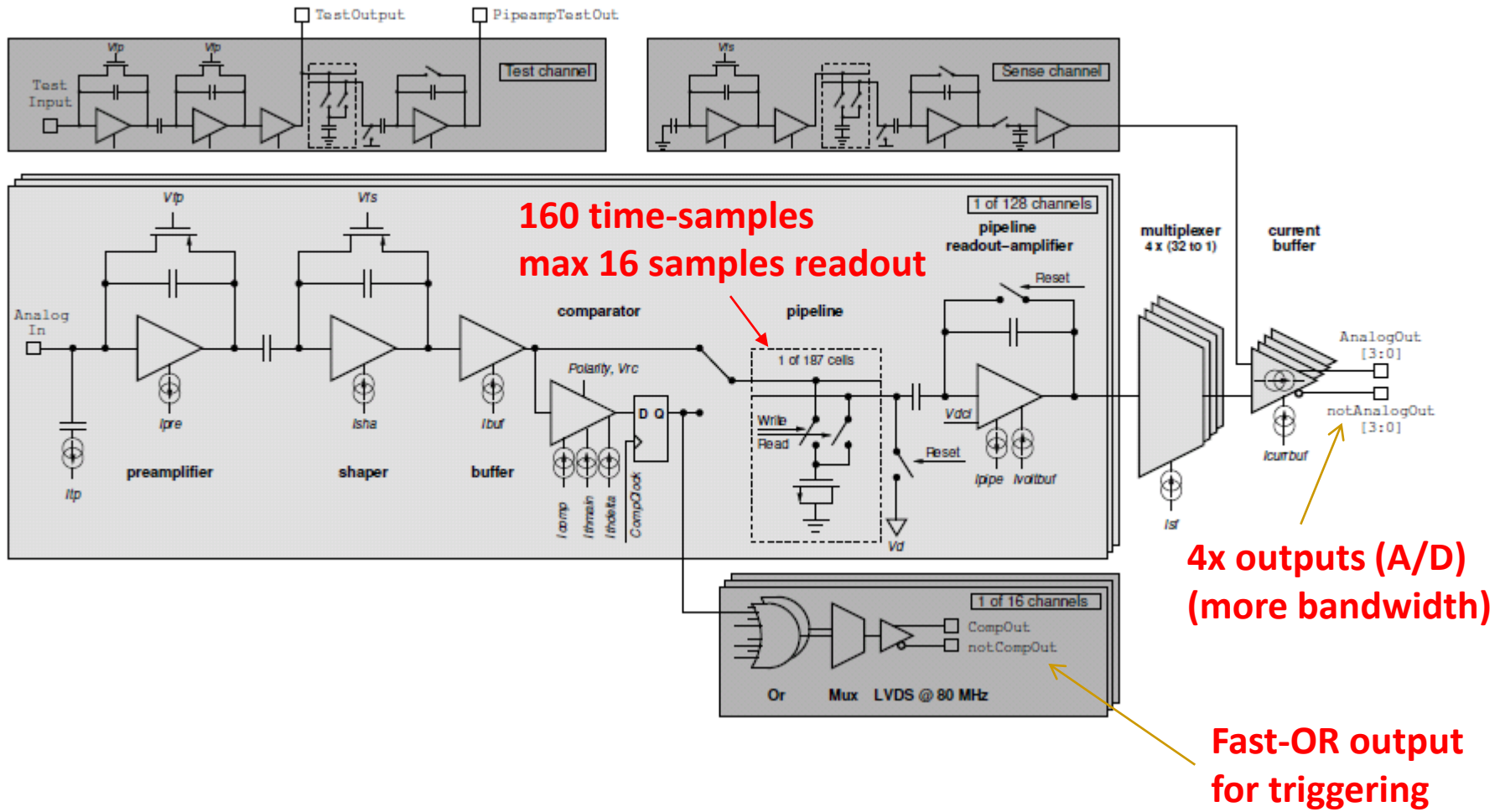


What front-end do I choose?

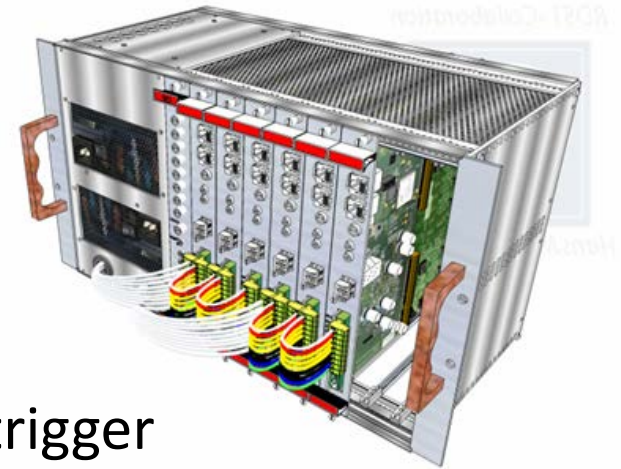
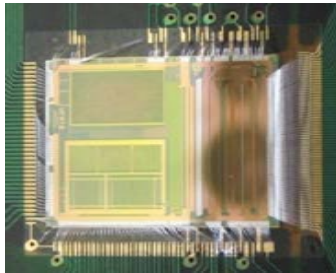
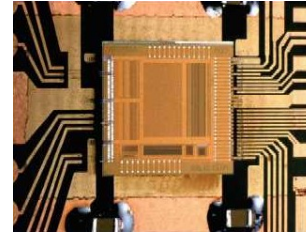
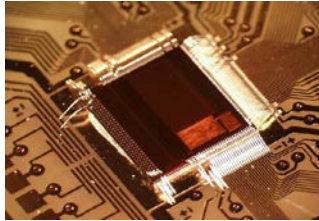


What if I need a little more bandwidth or trigger capability?

BEETLE

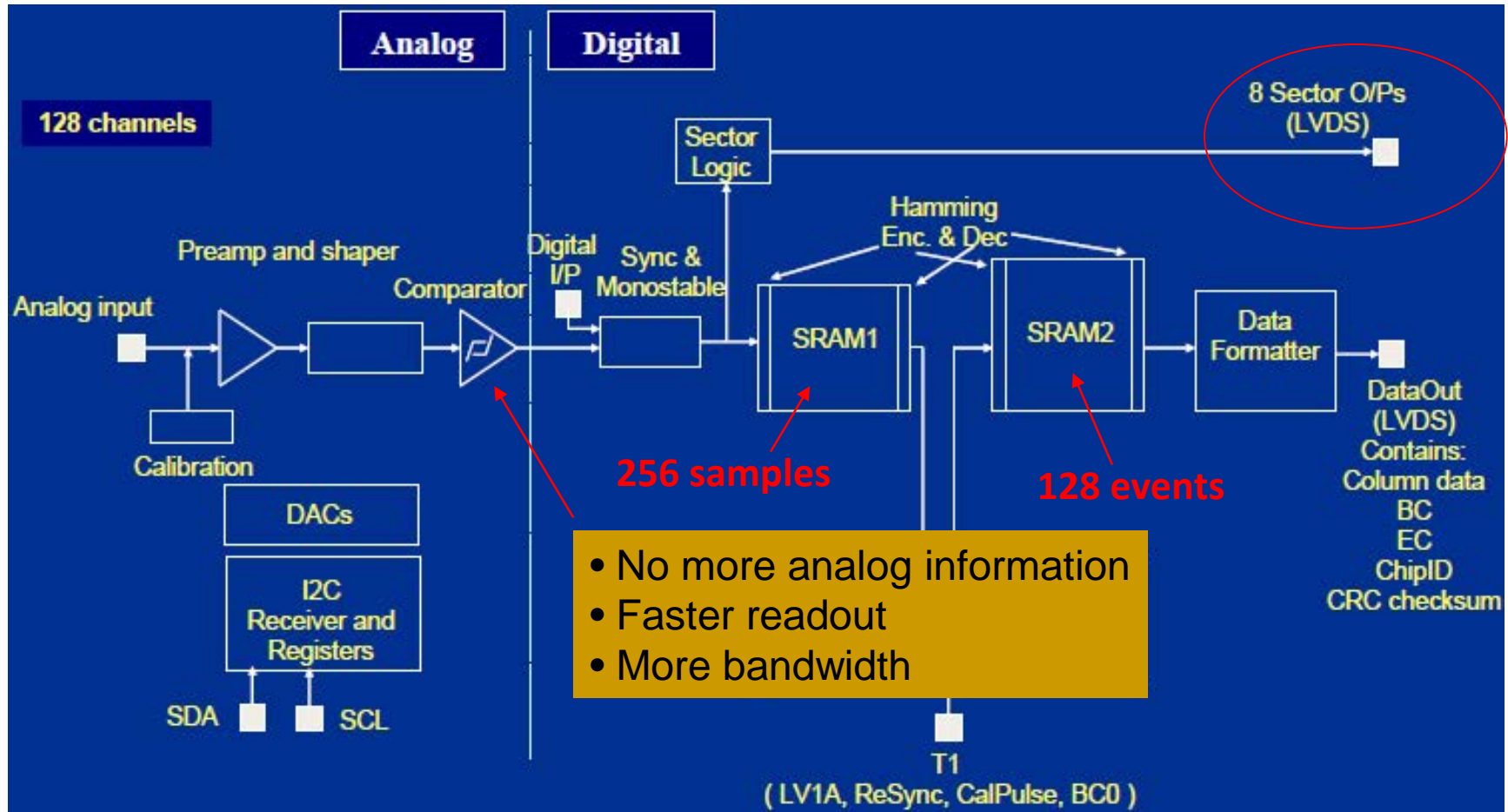


What front-end do I choose?

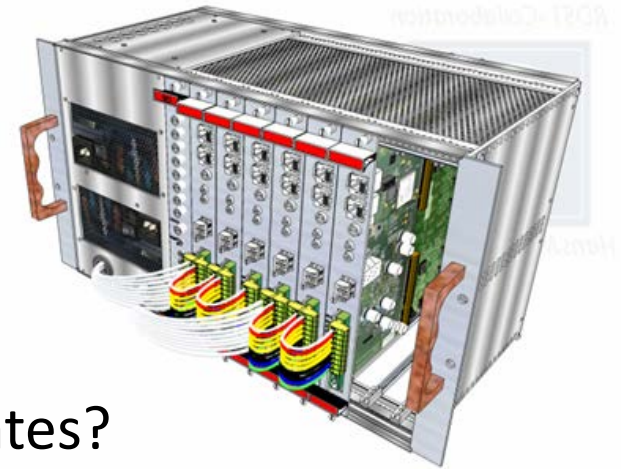
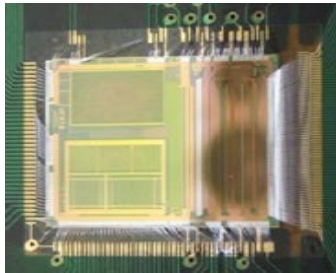
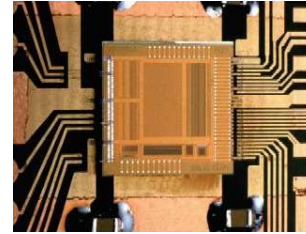
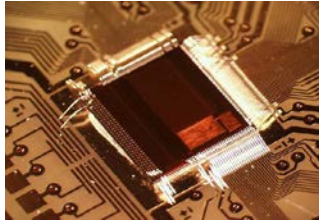


What if I need even faster readout with trigger capability?

VFAT – Binary readout

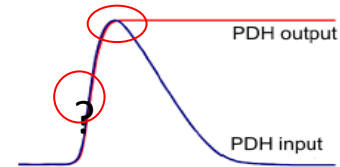
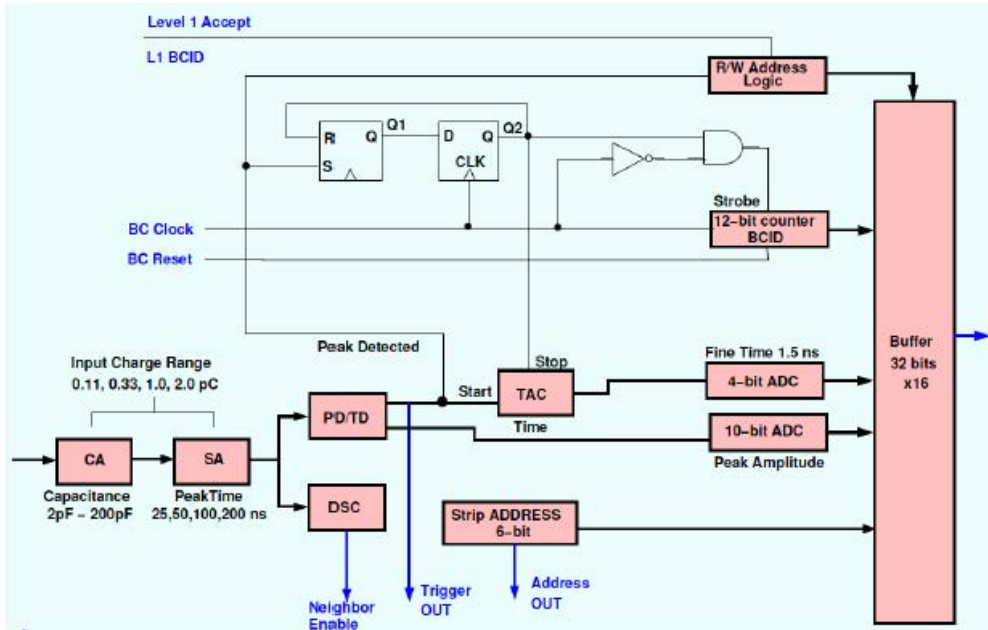


What front-end do I choose?



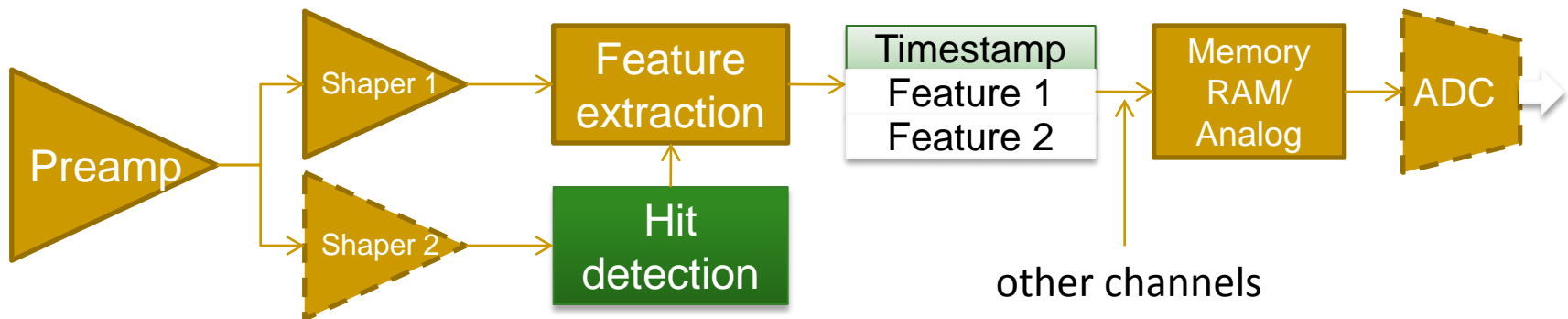
What do I do if I have very high events rates?

MAMMA BNL Chip (VMM1)



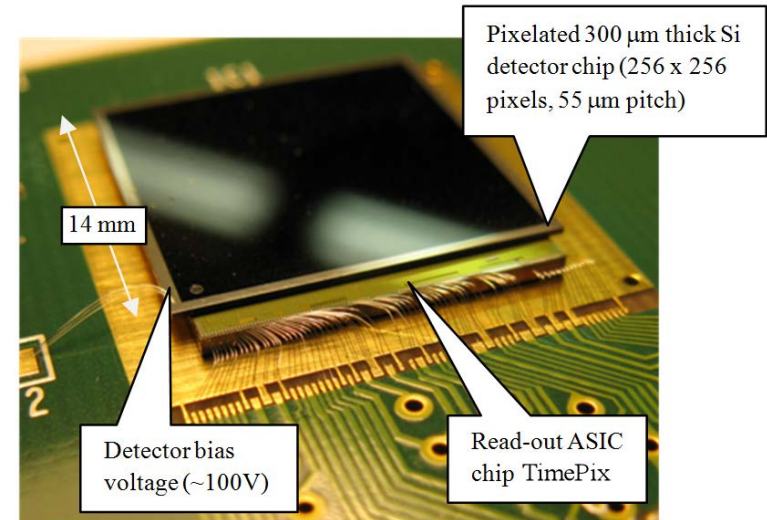
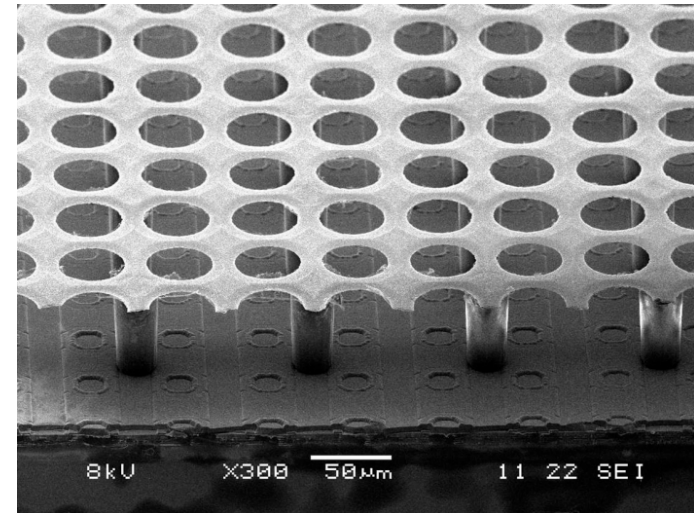
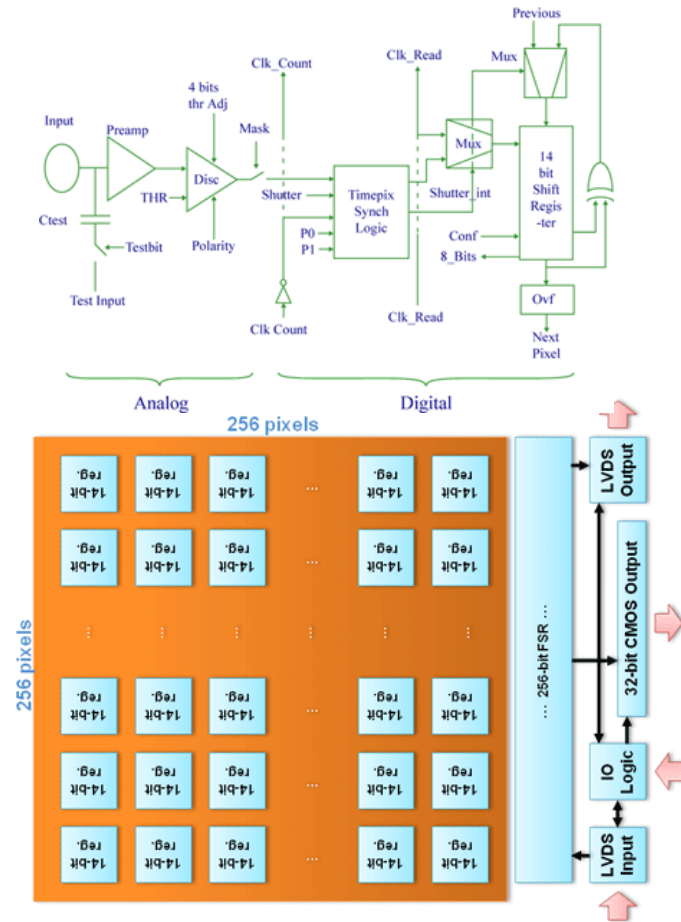
- Data driven system
- No sampling clock
- Self triggered
- Natural zero-suppression
- Feature extraction

To SRS

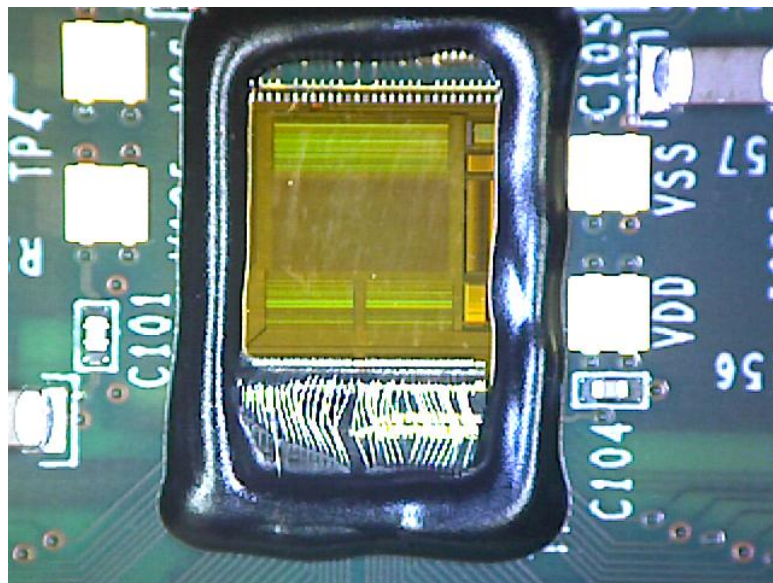
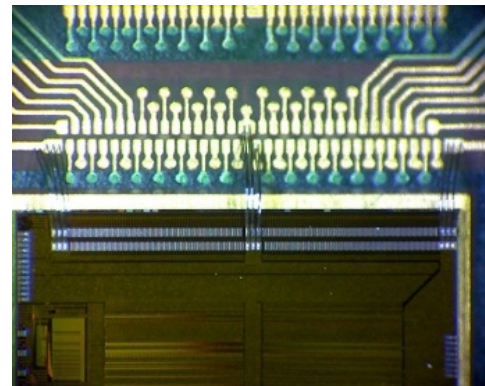
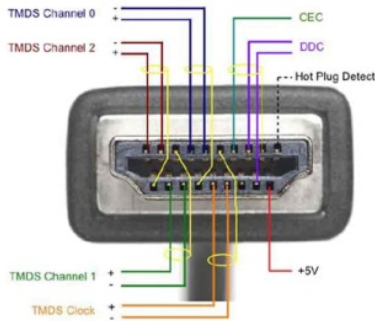
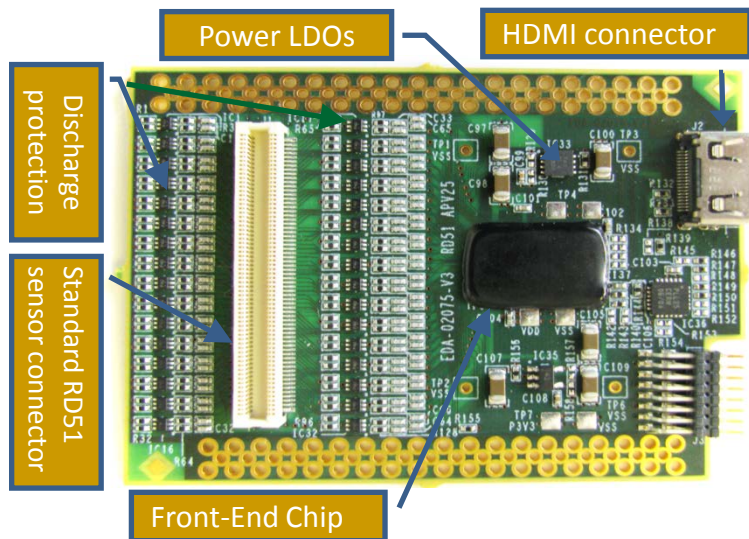


Other

Pixel readout - TIMEPIX



SRS Hybrids

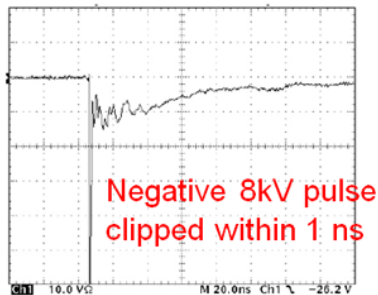


- standard RD51 connector
- discharge protection
- micro-HDMI
 - clk & trg
 - data links
 - dcs (I2C)
- industry-ready design
- purchase through CERN store

SRS Hybrids – Discharge Protection

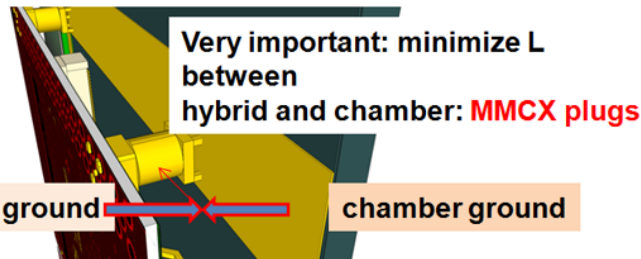
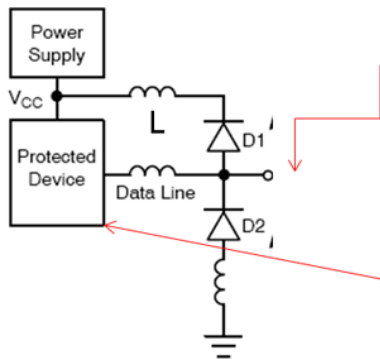
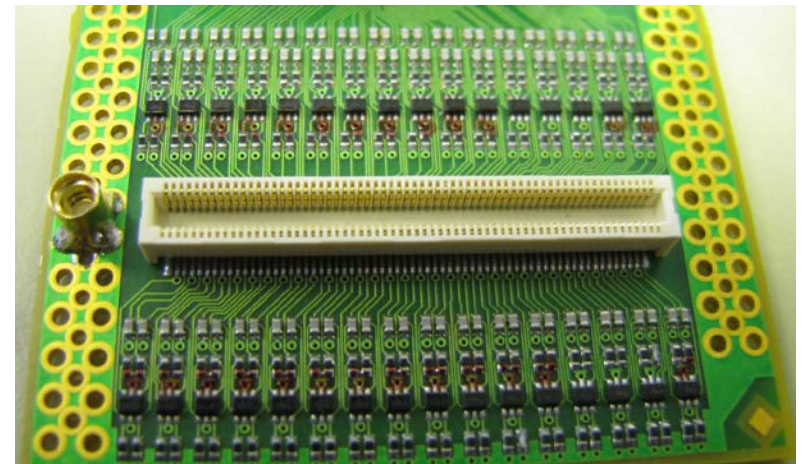
Sparc protection on hybrid

NUP4114UPXV6 quad ESD diodes: < 1 pF

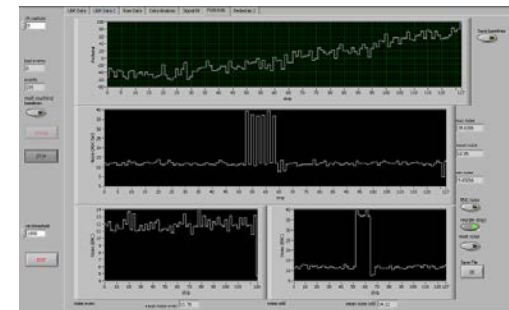


IEC 61000-4-2 Spec.

Level	Test Voltage (kV)	First Peak Current (A)	Current at 30 ns (A)	Current at 60 ns (A)
1	2	7.5	4	2
2	4	15	8	4
3	6	22.5	12	6
4	8	30	16	8



Negative clipped: $V_n = -V_f - L \times \frac{di_{esd}}{dt}$
 Positive clipped: $V_p = V_{cc} + V_f + L \times \frac{di_{esd}}{dt}$



SRS Hybrids – Discharge Protection

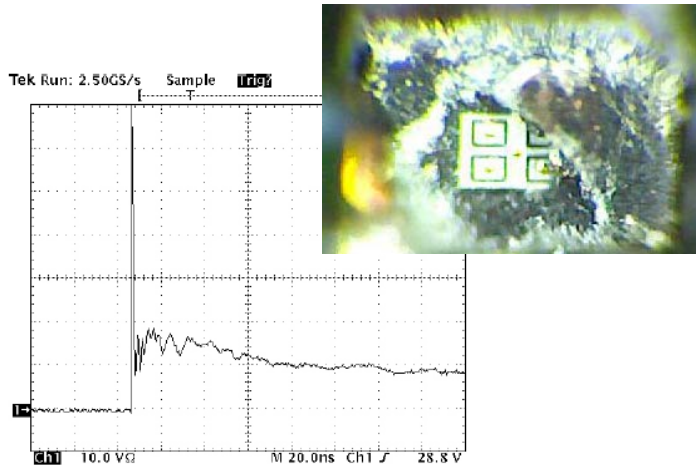
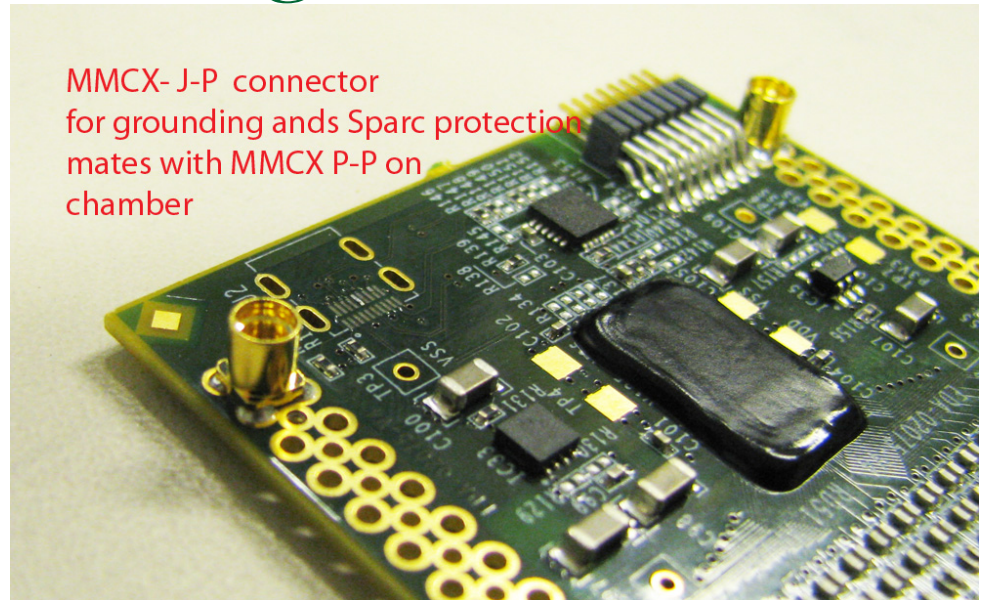
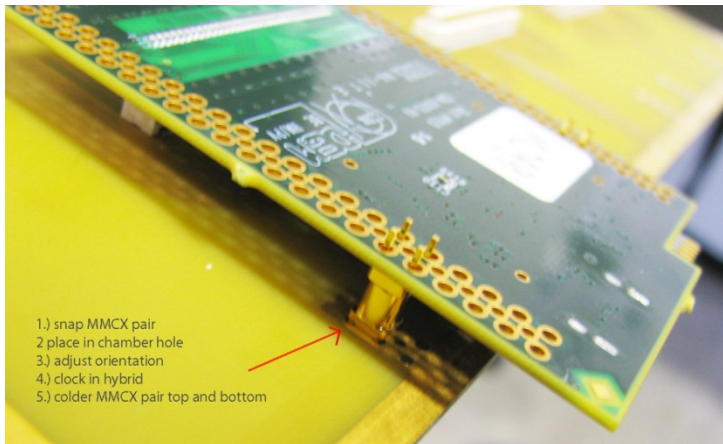


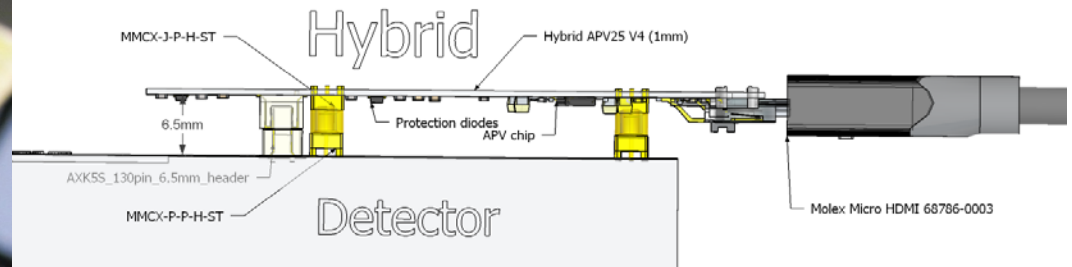
Figure 1. ESD Clamping Voltage Screenshot
Positive 8 kV Contact per IEC61000-4-2



MMCX-J-P connector
for grounding and Sparc protection
mates with MMCX P-P on
chamber



- 1.) snap MMCX pair
- 2.) place in chamber hole
- 3.) adjust orientation
- 4.) clock in hybrid
- 5.) colder MMCX pair top and bottom

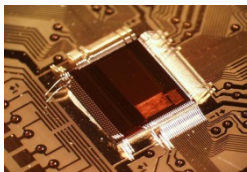
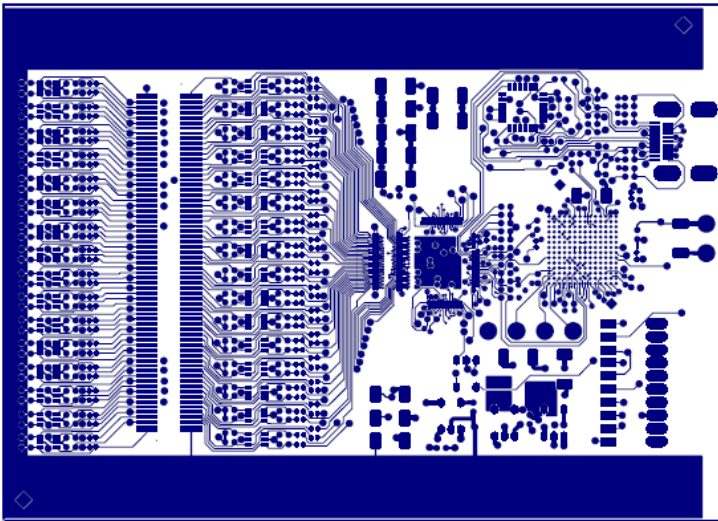


Samtec MMCX
coax connector

GND connection (< 2mohm)
middle pin can be used for power
mechanical connection

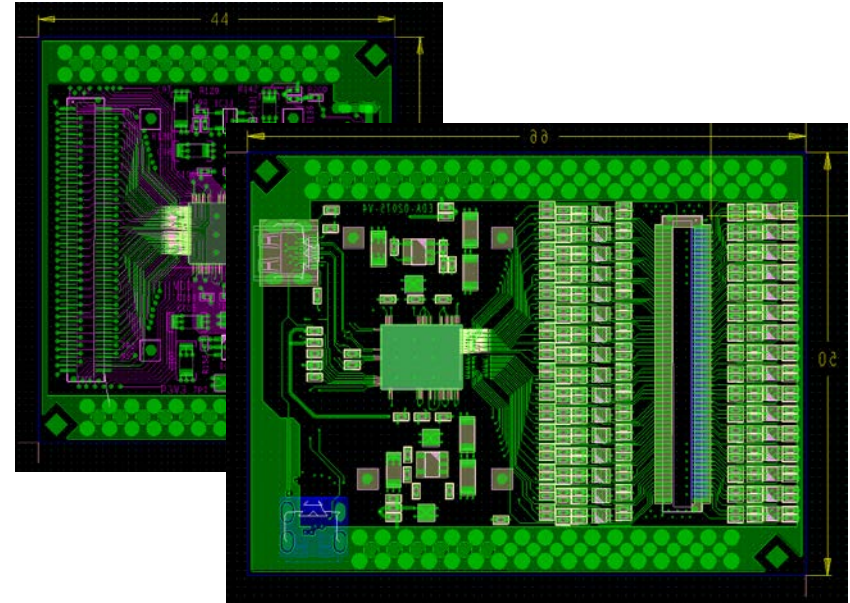
New Hybrids

■ BEETLE Hybrid



- Rad-tol CPLD
 - Comparator OR/MUX
 - Clk & Trg decode
- Work in progress

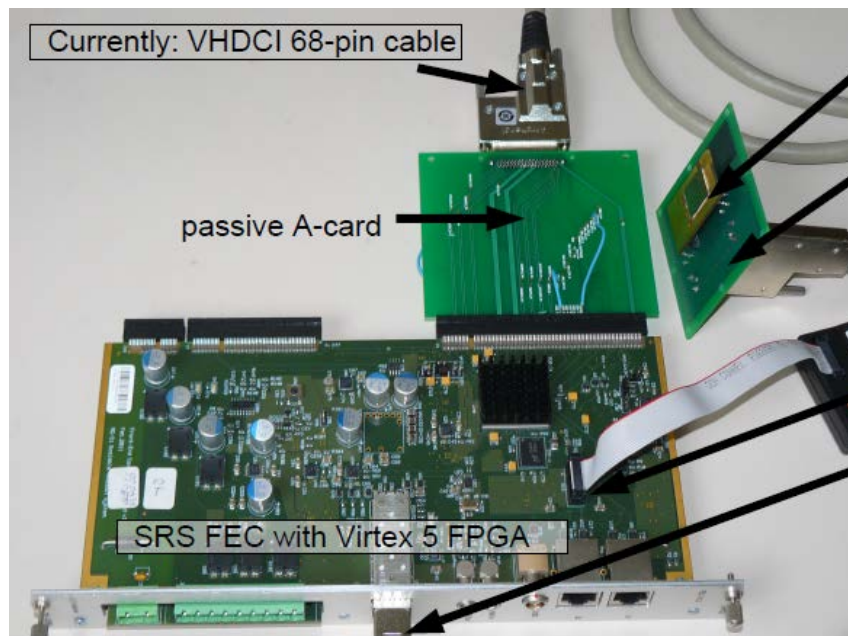
■ VFAT2 Hybrid



- Optional stacking conn. for *cable-less* connection
- Power option via MMCX connectors
- First prototypes foreseen for Aug-Sep 2012

Other

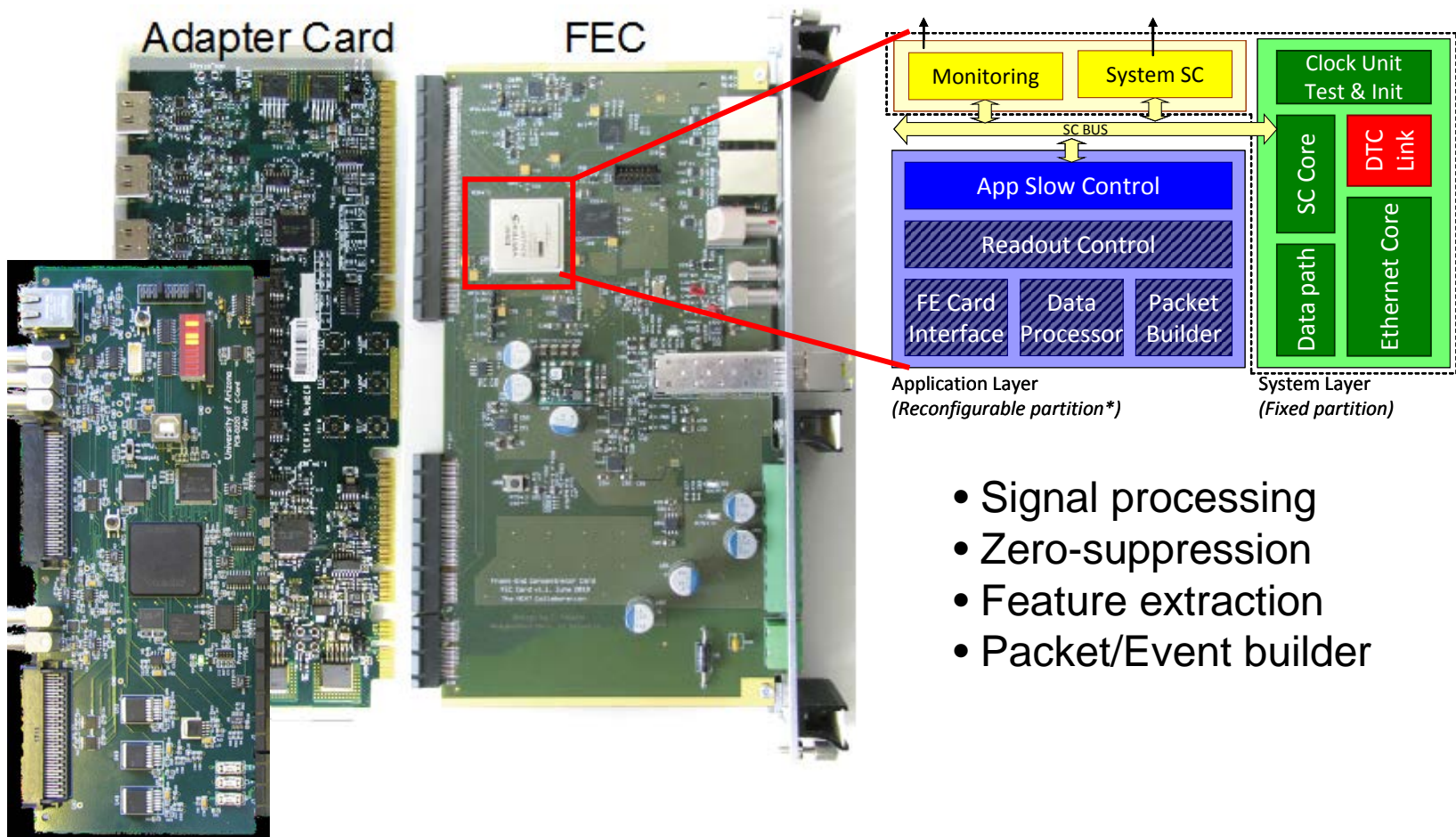
TIMEPIX (CERN/Bonn)



VMM1 (BNL/Arizona)

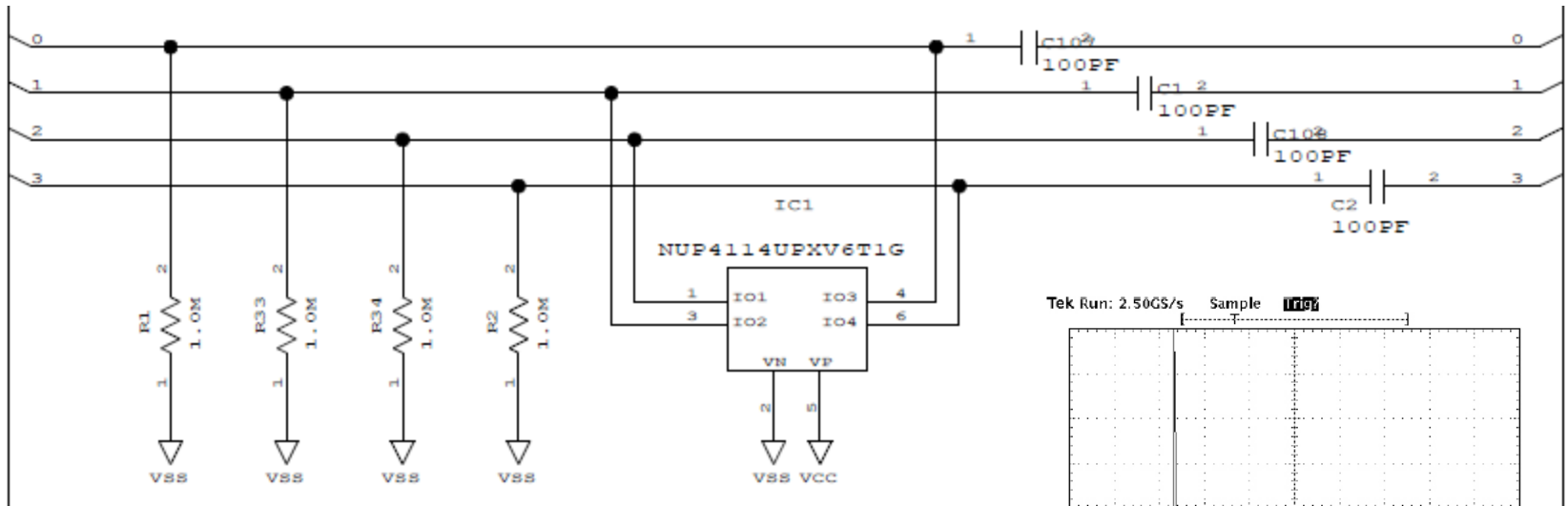


SRS – Digital Processing



Thank you!

Discharge Protection



OnSemiconductor NUP4114 datasheet: transient voltage suppressor designed to protect high speed data lines from ESD. Ultra-Low capacitance and high level of ESD protection makes this device well suited for use in USB 2.0 applications.

Features: Low Capacitance (0.7 pF Typical Between I/O Lines)

- ESD Rating of Class 3B (exceeding 8kV) per Human Body Model, and Class C (exceeding 400V) per Machine Model
- Stand Off Voltage: 5 V

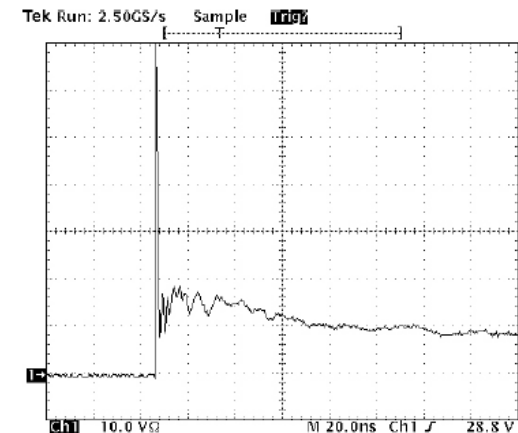
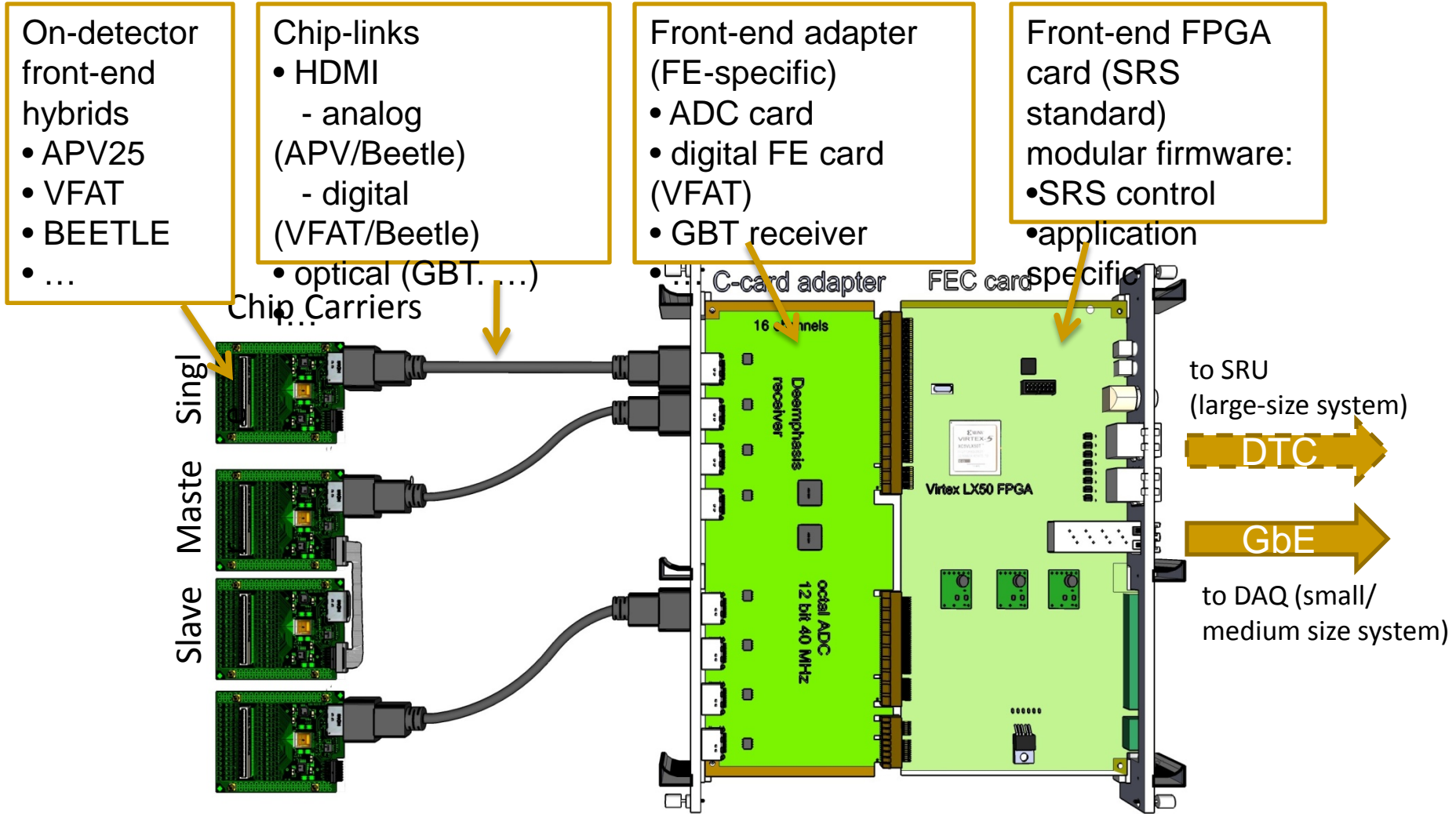


Figure 1. ESD Clamping Voltage Screenshot Positive 8 kV Contact per IEC61000-4-2

SRS Overview



I need a bigger system

- Network switch
 - Medium-size system
 - Synchronization
- SRU
 - Medium and large systems
 - Builtin synchronization
 - Firmware under development

