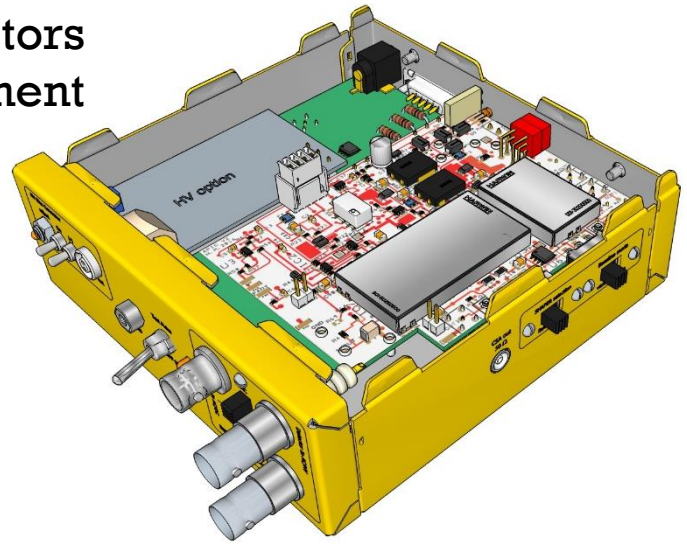
APIC 2017 PREAMP-SHAPER-TRIGGER-HV-BIAS

"NIM in a box", 0.8kg, 24h autonomy, solar panel charger

<u>APIC internal Modules</u>

- CSA + Shaper slow/fast
- NIM Trigger
- Bias Voltage for Si detectors
- Lithium Power management



Commercial APIC versions in prep. for sales for 2017*

3 versions:

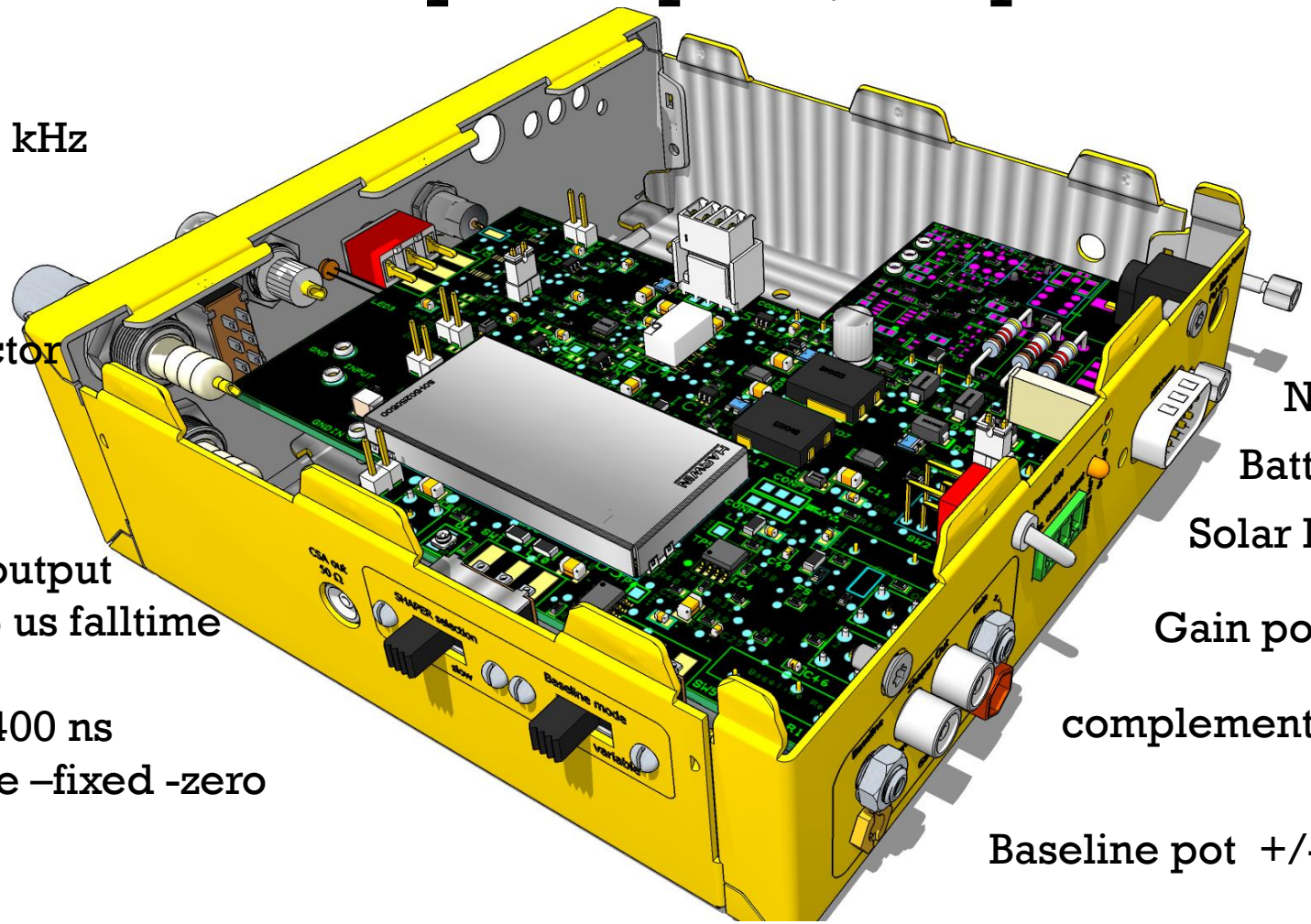
APIC-MPGD fast MPGD's (25ns/400ns) for high rate up 1 MHz
APIC-MPGD-H fast MPGD's (25ns/400ns) for high rate up 3MHz
APIC-MPCC high capacitance/charge MPPCs 1us/10us up 50 kHz (prelim)

* SRStechnology.ch

APIC basic version*: CSA preamplier, Shaper fast/slow

Test signal 1 kHz

DC input to CSA (BNC)
AC input to CSA (SHV)
390 pF / 4.7 nF coupling selector
HV to AC input filtered (SHV)



NIM cable power
Battery status display
Solar LiPo charger plug

CSA preamplifier 50 OHM output
0.5mV/fC 2ns risetime, 0.5 us falltime

Gain pot. 1..1000

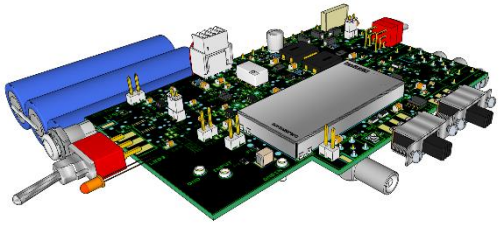
Shaper selections 25 ns – 400 ns
Baseline selections: variable –fixed -zero

complementary shaper outputs

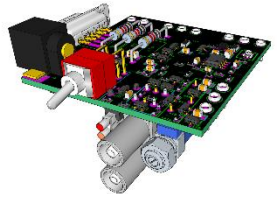
Baseline pot +/- 2V

APIC internal modules:

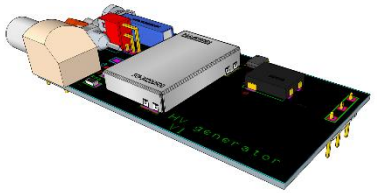
- **APIC (preamplifier- shaper) includes Battery and charger plugs**



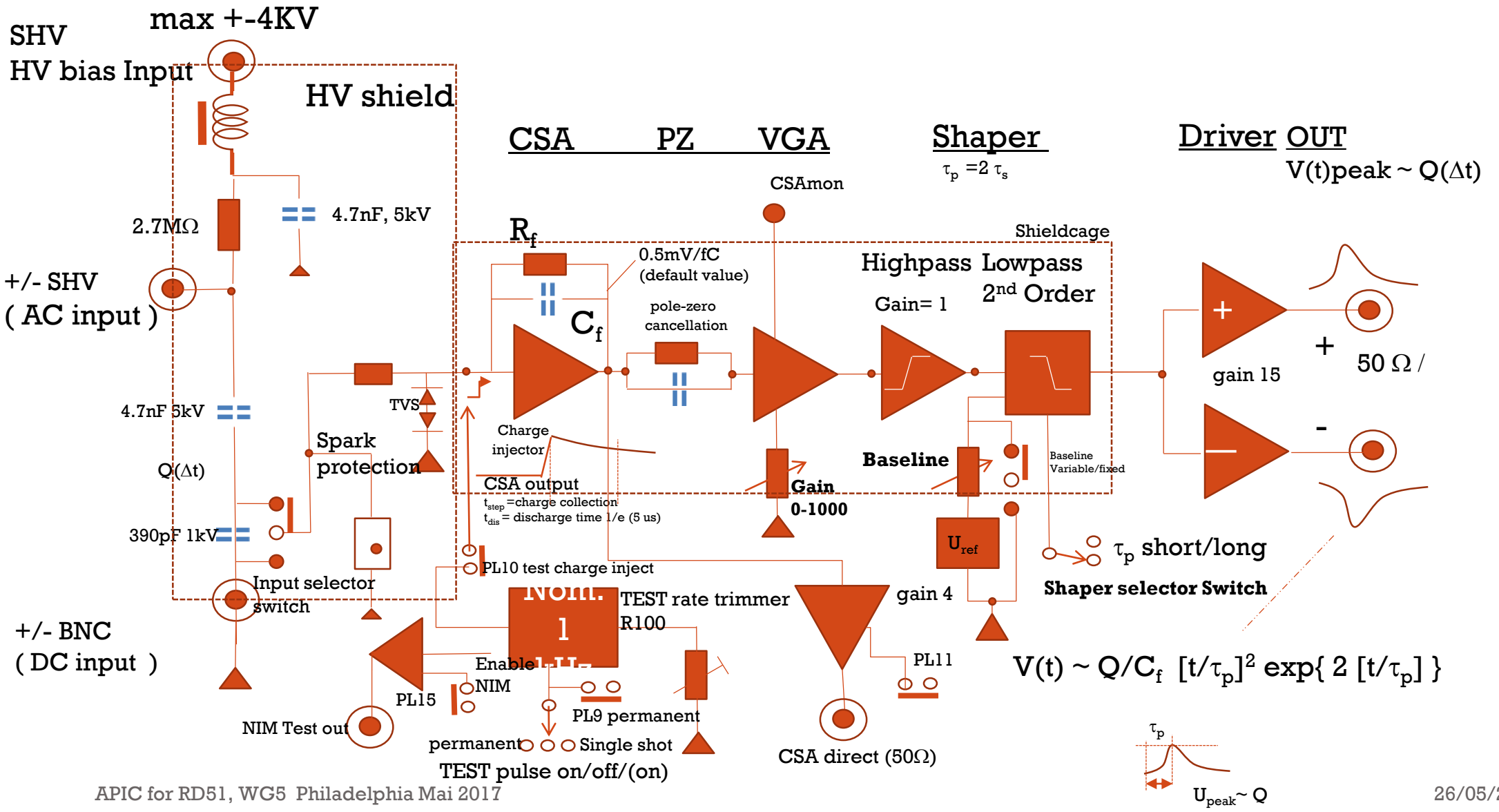
- **NIM Trigger and AUX power Unit**



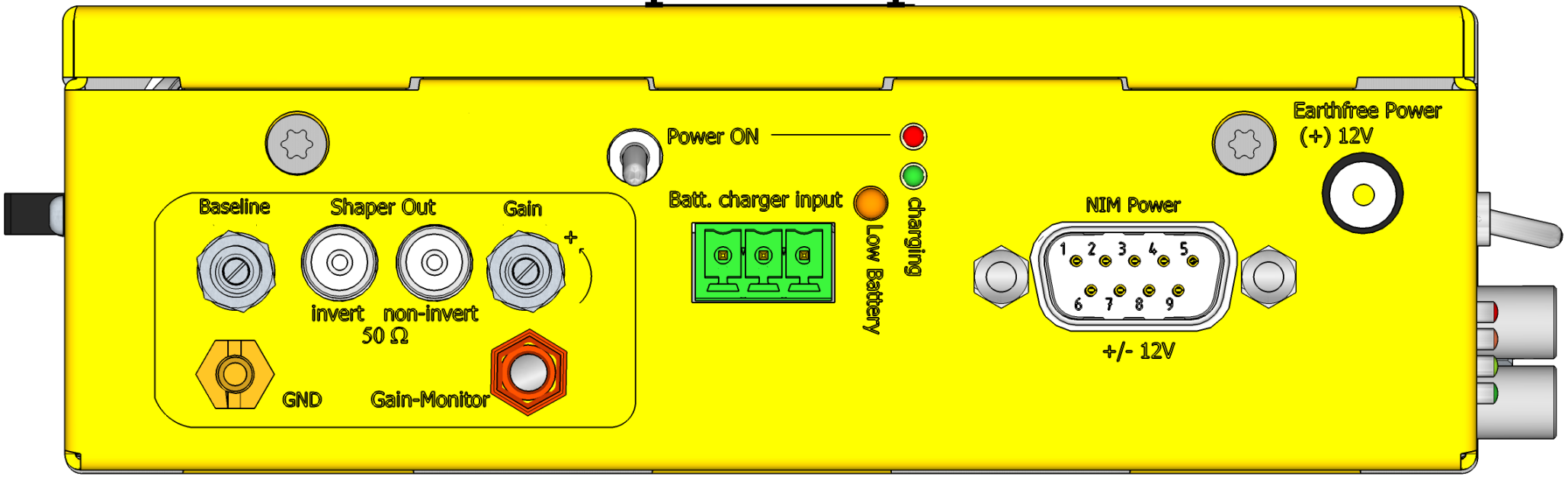
- **HV Bias Unit (10-110V Option so far)**



APIC PREAMPLIFIER-SHAPER MAINBOARD



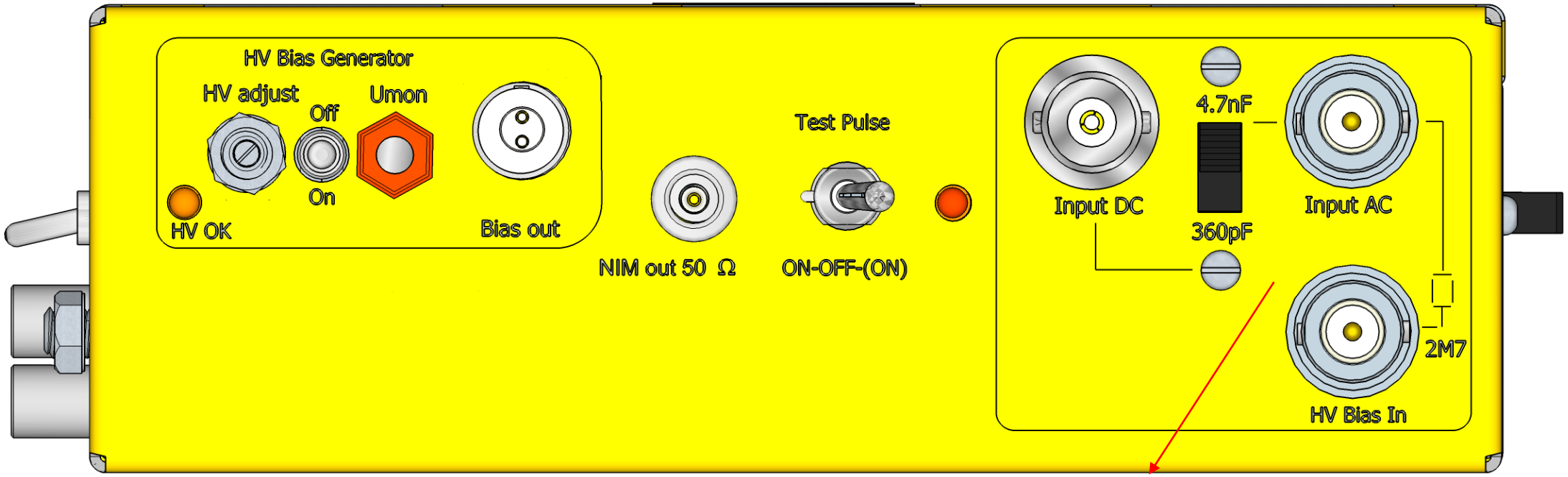
APIC output and power side



shaper output 50 OHM +/- 1.5 V linear invert and non-invert
20 turn potentiometer for gain 0 …1000
20 turn potentiometer for variable baseline mode
Gain voltage for gain determination
APIC GND plug 4mm Banana jack

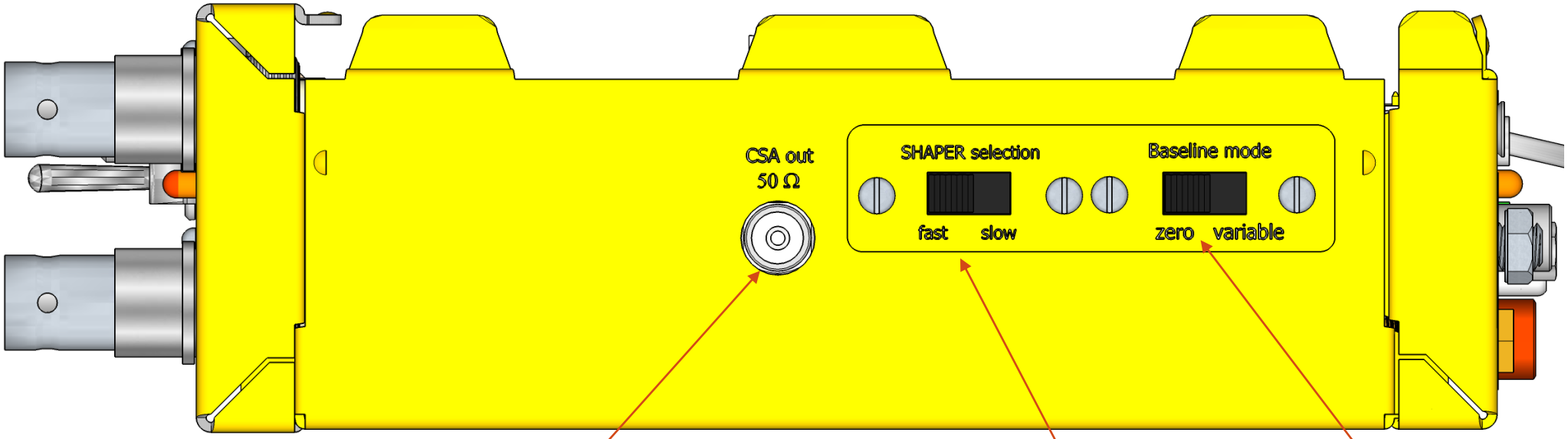
Power on , red LED
Battery charging mode, green LED
Low Battery, blinking LED
Battery charger +/- Volt from PS or solar panel up 65
Direct NIM standard preamp power (RS232 cable)
Direct round Jack DC power +12V 5.5mm Dia

Detector signal / HV input schemes



DC = direct input to CSA preamplifier, must be very small signal
AC = input to CSA via capacitor selection 360pF(DC enabled)/4.7nF(DC disabled)
AC = detector input (mesh etc.) with AC coupling as selected 4.7nF/360pF
HV bias= input via 2.7MOHM and LC filter to AC input for HV supply of detector mesh

CSA preamp output and Shaper selector side

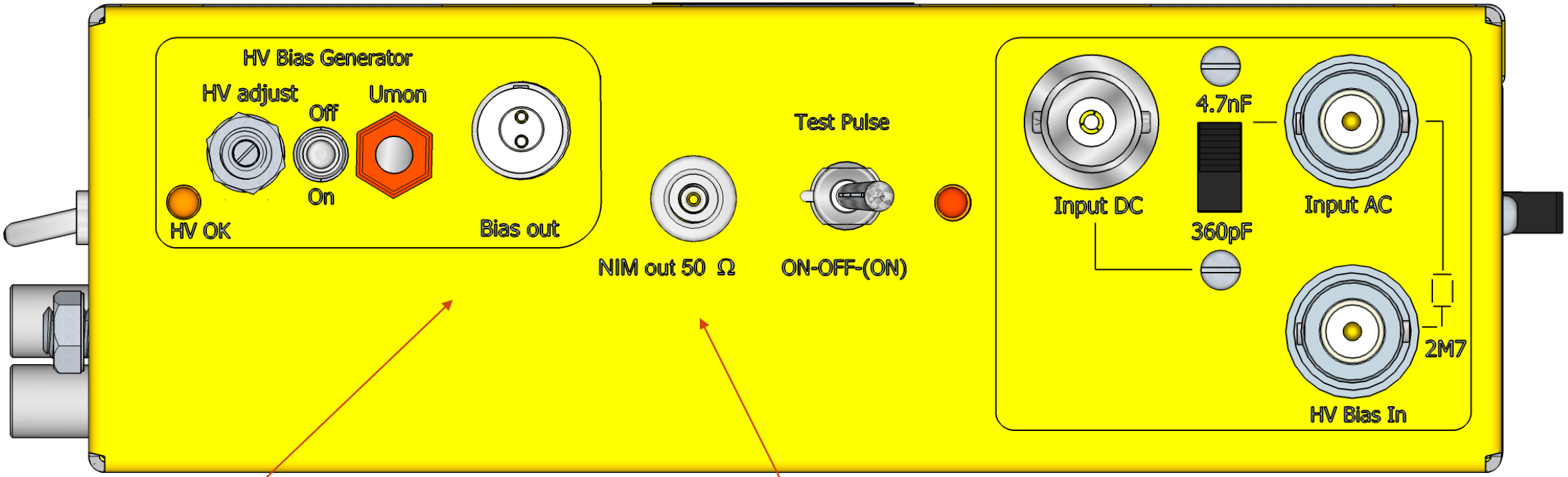


CSA preamplifier output, 50 OHM
Gain V/V=4, both polarities, tr = 2ns

shaper selection, peaking time
MPGD fast =25 ns, slow = 400ns
MPPC fast = 1us, slow = 10us

Temp. compensated
var. baseline +/- 1.5V
zero/fixed baseline 0V

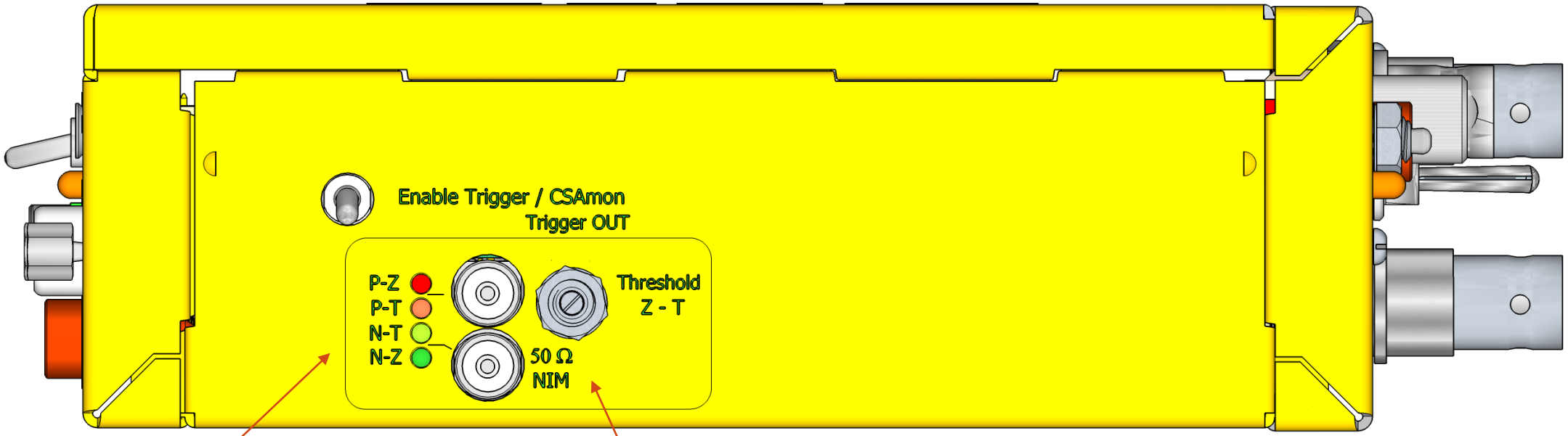
HV bias and Test pulse



HV bias option 10V…110V filtered for solid-state detectors (APD , Si PM, photodiodes, CVdiamond, etc)
UMON= direct HV unfiltered for DVM

Test pulse NIM output square wave , rate fixed via trimmer
pos. signals on rising edge, neg. signals on falling edge
single or permanent trigger via actuator switch
Use of clip cable -> short edge pulse to trigger UV LED

NIM Trigger Option side



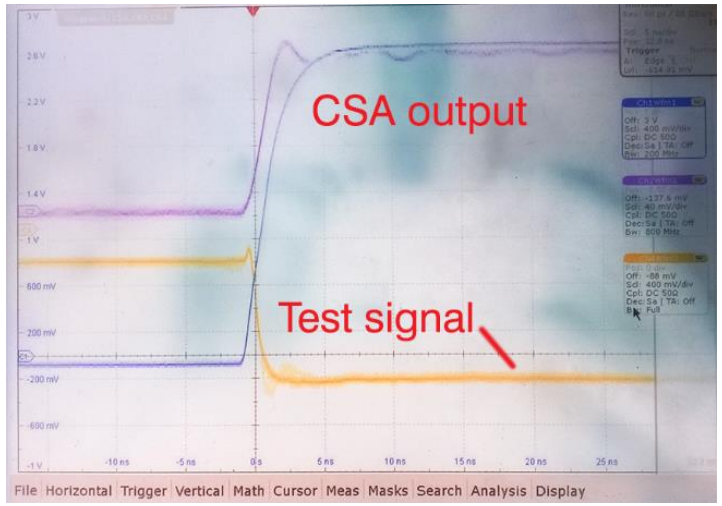
P-Z positive signal threshold
P-T **positive input triggered**
N-T **negative input triggered**
N-Z negative input threshold

discriminator trimmer for positive and negative APIC input
LED indicator for discriminator settings
Complementary NIM output 50 OHM, 30-50ns pulse width depending on threshold

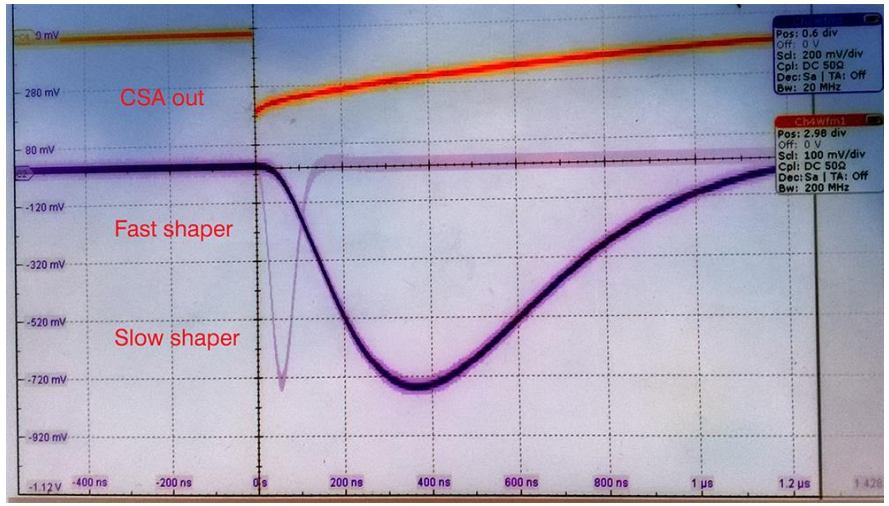
APIC RESPONSE TO TEST SIGNAL

Measurements with unconnected APIC

Time domain 10 ns
Test signal -> CSA internal response (probe)
-> CSA extrenal response 50 OHM



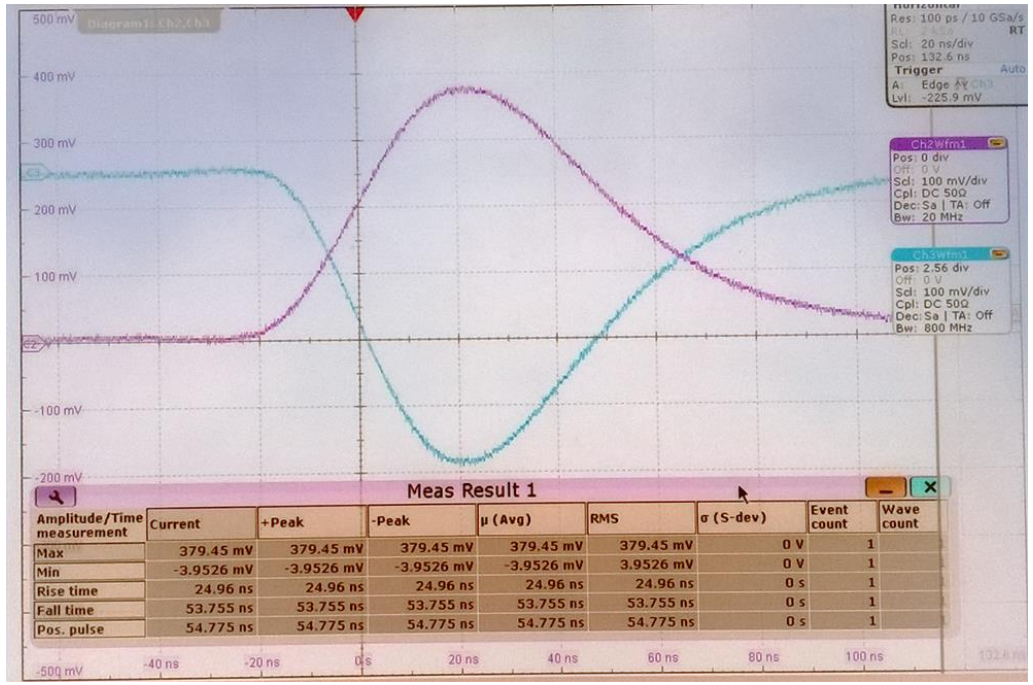
Time domain 500 ns
Test signal -> CSA step+ longterm decay shape
-> Fast shaper signal
-> Slow shaper



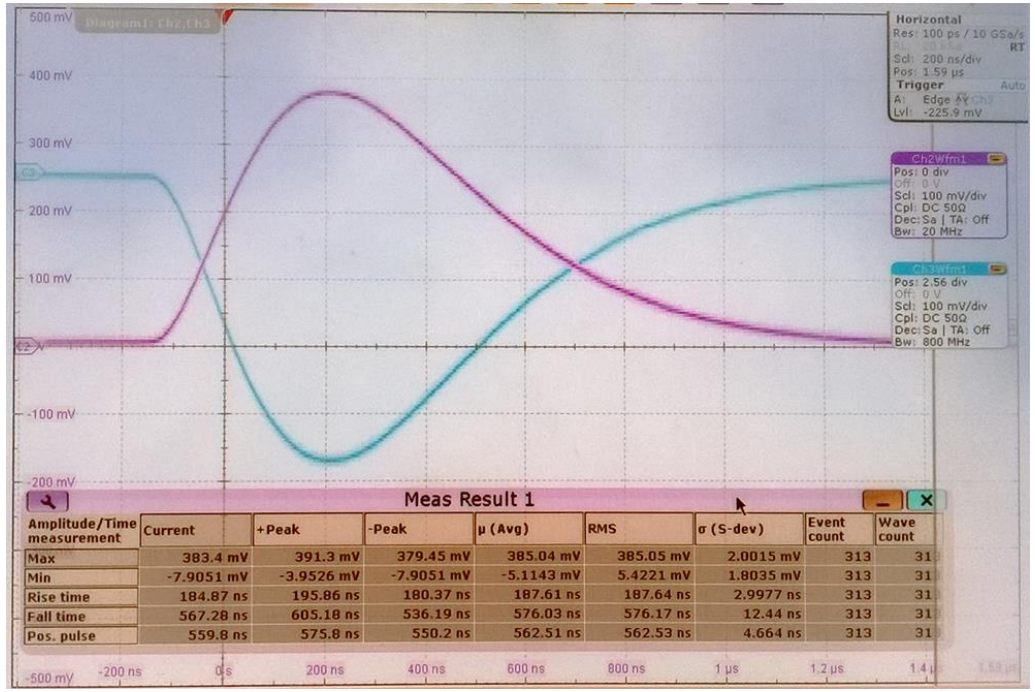
PULSE TIME AS FUNCTION OF DETECTOR CAPACITY

$C_D = 0$ pF

Fast shaper



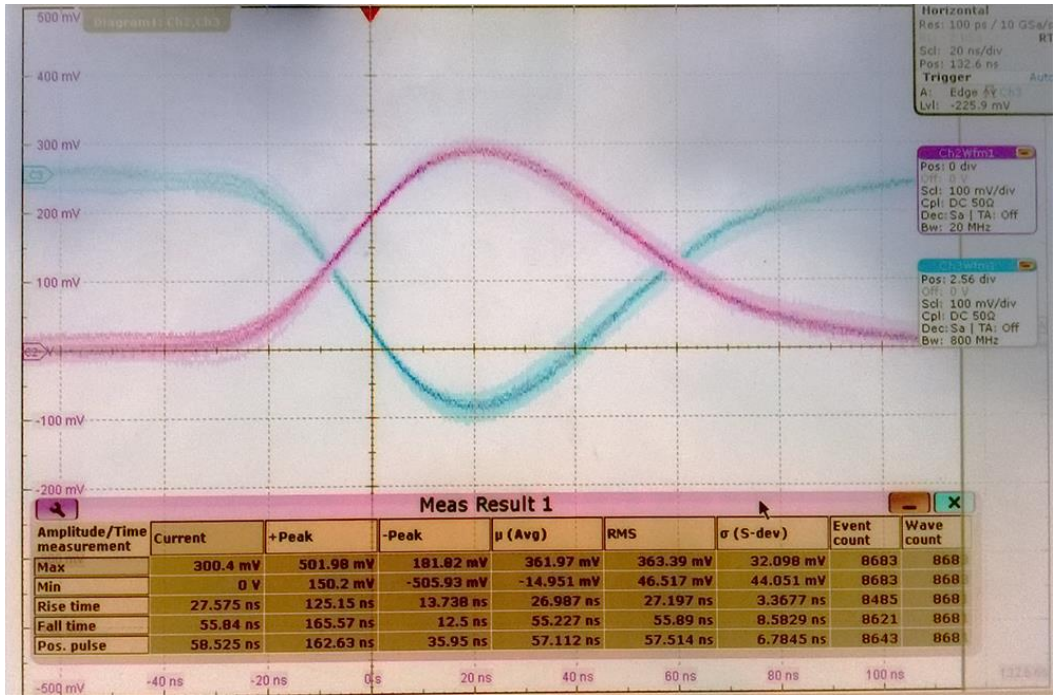
Slow shaper



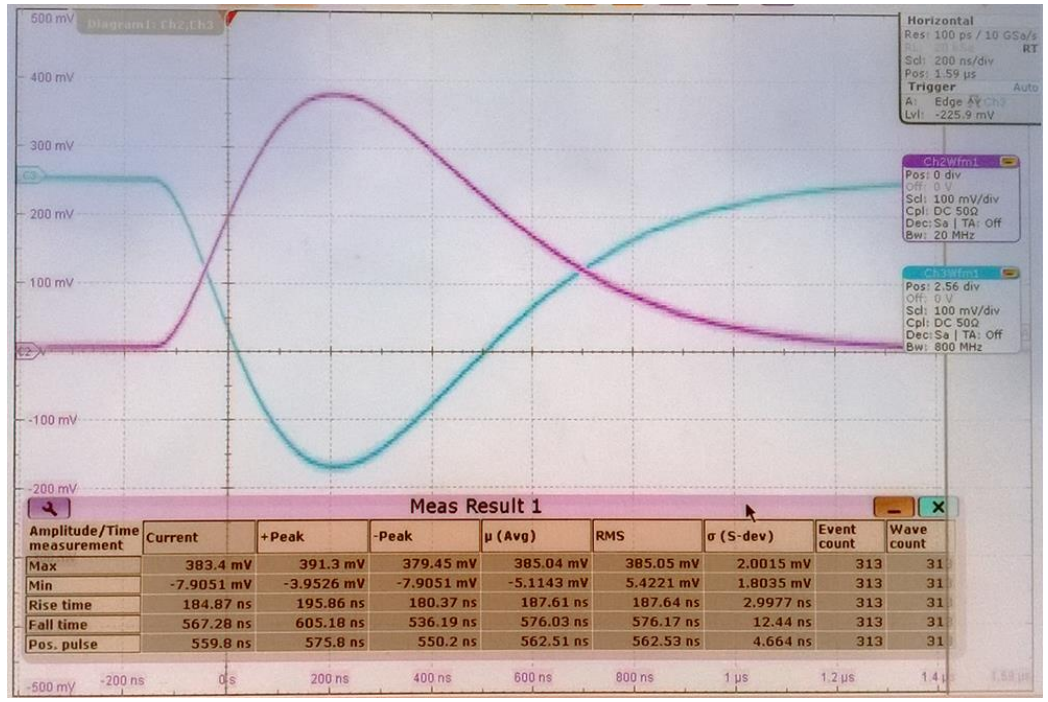
PULSE TIME AS FUNCTION OF DETECTOR CAPACITY

C_D = 200 pF

Fast shaper Increased noise and risetime

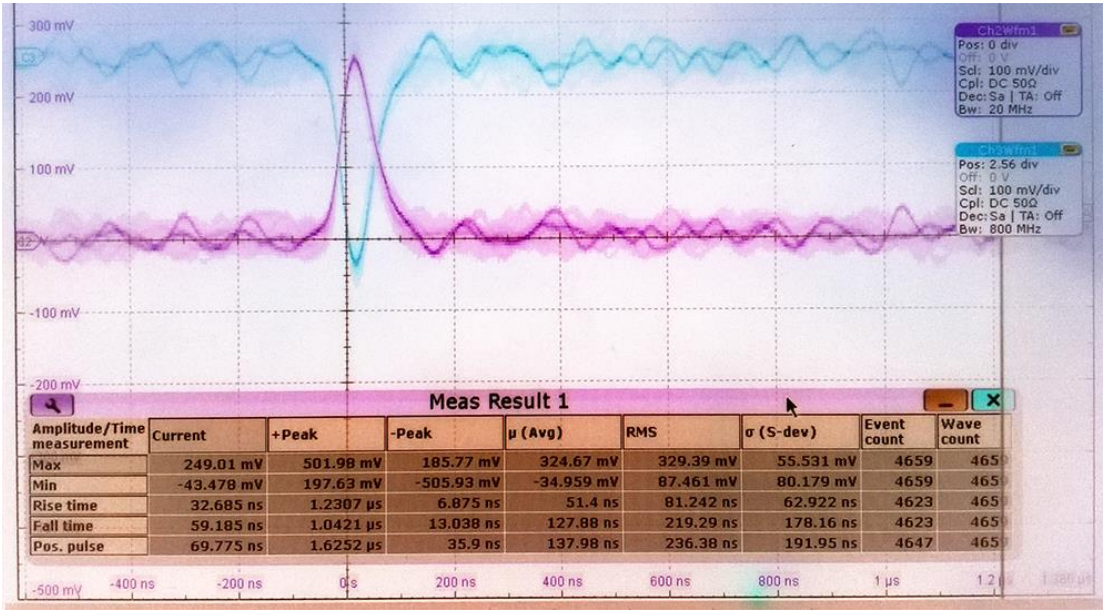


Slow shaper low noise and normal risetime



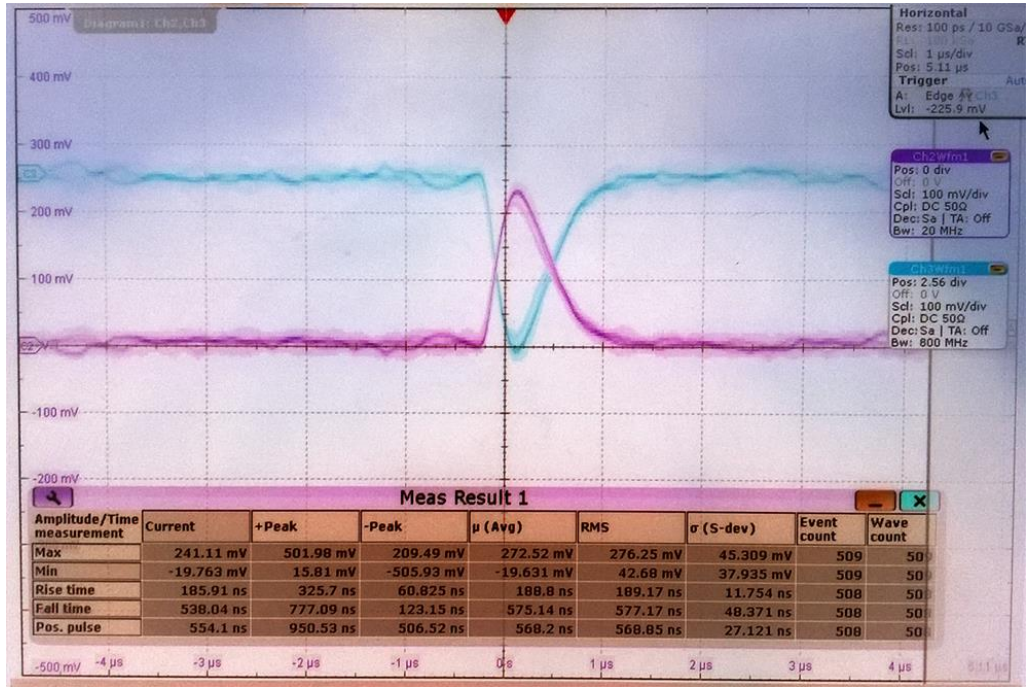
Noise short/long shaper for C_D =390pF

Short shaper, C_D =390pF
important noise and increased peaking time



Amplitude/Time measurement	Current	+Peak	-Peak	µ (Avg)	RMS	σ (S-dev)	Event count	Wave count
Max	249.01 mV	501.98 mV	185.77 mV	324.67 mV	329.39 mV	55.531 mV	4659	465
Min	-43.478 mV	197.63 mV	-505.93 mV	-34.959 mV	87.461 mV	80.179 mV	4659	465
Rise time	32.685 ns	1.2307 µs	6.875 ns	51.4 ns	81.242 ns	62.922 ns	4623	465
Fall time	59.185 ns	1.0421 µs	13.038 ns	127.88 ns	219.29 ns	178.16 ns	4623	465
Pos. pulse	69.775 ns	1.6252 µs	35.9 ns	137.98 ns	236.38 ns	191.95 ns	4647	465

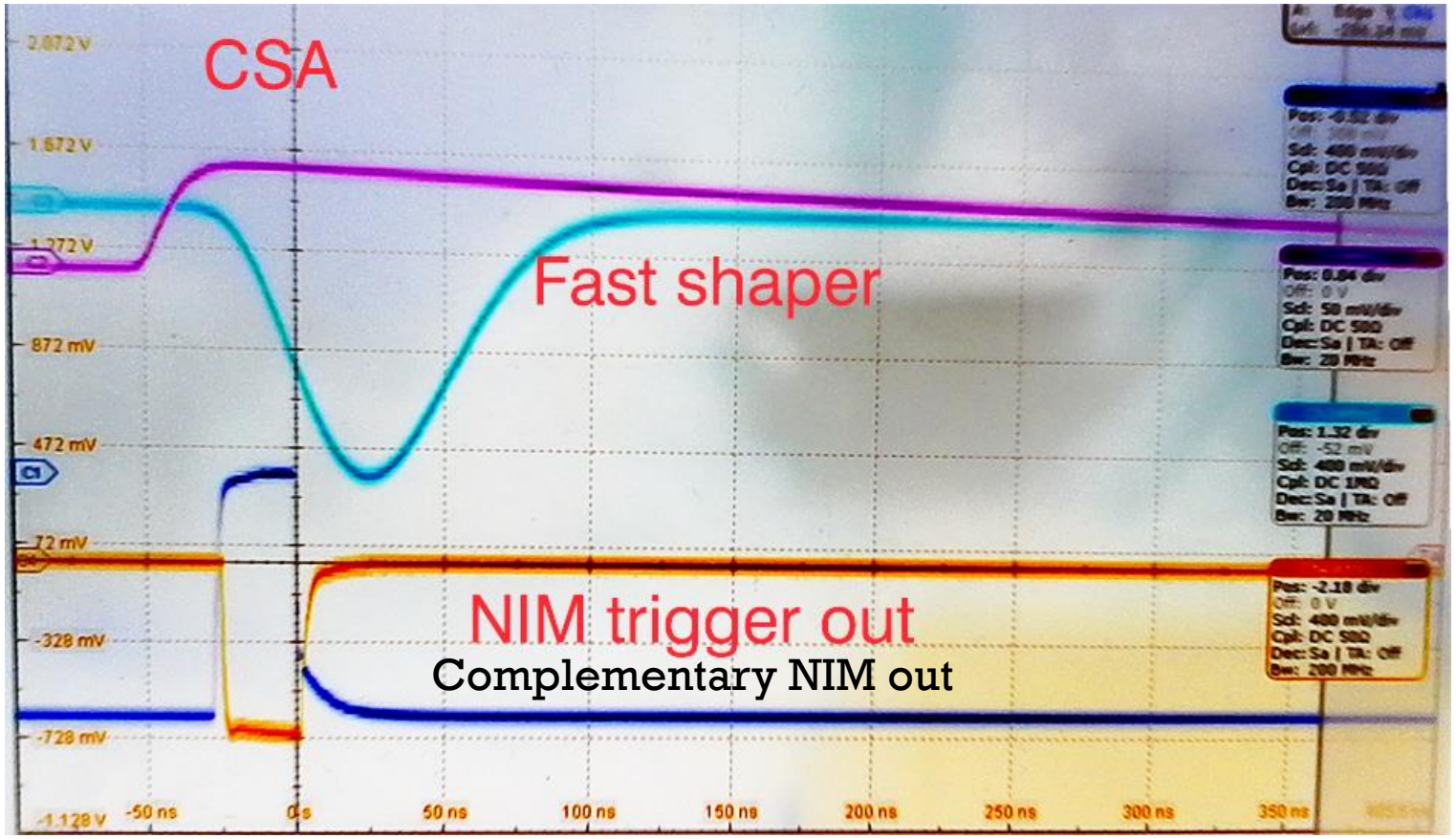
Long shaper, C_D =390pF
tolarable noise normal peaking time



Amplitude/Time measurement	Current	+Peak	-Peak	µ (Avg)	RMS	σ (S-dev)	Event count	Wave count
Max	241.11 mV	501.98 mV	209.49 mV	272.52 mV	276.25 mV	45.309 mV	509	50
Min	-19.763 mV	15.81 mV	-505.93 mV	-19.631 mV	42.68 mV	37.935 mV	509	50
Rise time	185.91 ns	325.7 ns	60.825 ns	188.8 ns	189.17 ns	11.754 ns	508	50
Fall time	538.04 ns	777.09 ns	123.15 ns	575.14 ns	577.17 ns	48.371 ns	508	50
Pos. pulse	554.1 ns	950.53 ns	506.52 ns	568.2 ns	568.85 ns	27.121 ns	508	50

for C_D > 400pF, long shaping time prefereable

APIC NIM TRIGGER



<u>Shown trigger selection:</u>
trigger on positive CSA = negative input

Not shown, other trigger selections:
trigger on negative CSA = positive input
-trigger on both neg. and pos.

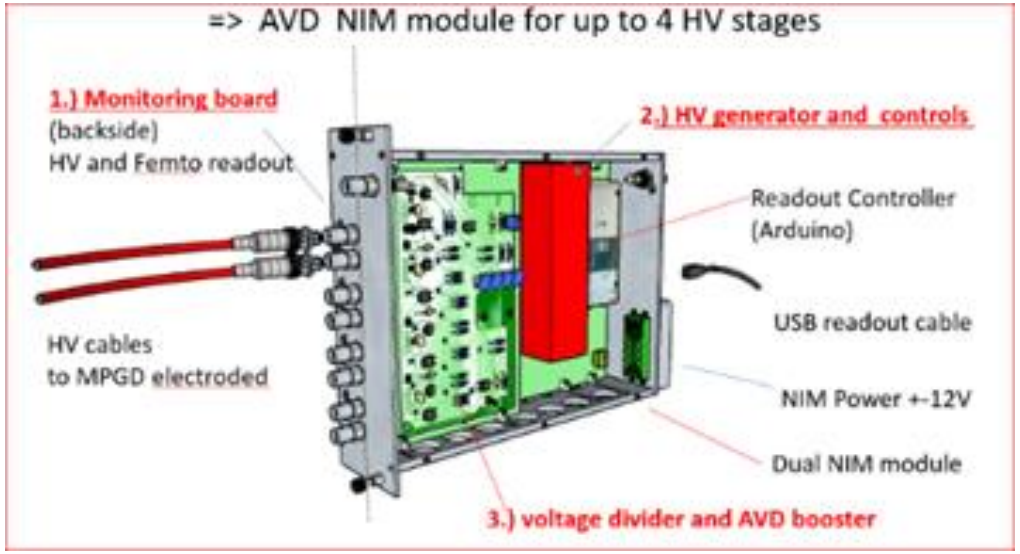
trigger delay ca. 25 ns after rising edge of CSA preamplifier
trigger pulse width 10-50ns tunable via internal trimmer

AVD NIM

Miniaturized power supply for MPGD's (ongoing)

Active voltage generator/ divider for MPGs up to 9 fields

1. HV module up 5kV
2. Active MPGD field generation with user-defined resistor configurator
3. Max. 9 fields (4 GEMS + Drift)
4. rate-independent active fields
5. Glitch-free, proportionally coupled MPGD fields
6. Short circuits on single GEM does not alter the other fields
7. Prompt e-Fuses for detector currents O(10uA) adjustable
8. Spark energy quenchers on all fields
9. Realtime Voltage and Pico-ampere measurement on up 4 GEM stages
10. Control, and monitoring with parameter display
11. Manual control panel



AVD NIM box with 3 functional units

-prototype NIM box with HV and monitoring board exists

-preparing for distributable prototypes

AVD STATUS

- 1st AVD prototype tested for ALICE TPC upgrade in 2014/15
- GDD upgrade with Arduino control, e-Fuses, HV and picoamp readout in 2015
- Upgrade from external HV supply to internal HV module -> complete & compact
- summer student 2016: 1st Arduino controlled AVD – NIM

<u>Planned 2017 Summer activity</u>

-merge all AVD modules in a NIM box dual width 4 modular PCB's

-test a new, alternative HV module

-new MPGD field configurator: plugin instead of individual resistors

BACKUPS /REMINDERS

WHERE TO BUY SRS

(this is the most difficult about SRS)

SRS procurement until 2016

INHOUSE production RD51 (basically all early systems)

CERN Store (from produces like Rentron, Prisma, NEOHM etc)
https://edh.cern.ch/Document/SupplyChain/MAG

AVP hybrids, FEC + ADC cards, Minicrates, HDMI cables, SRS accessories
However !!! Only via team account, delivery only to CERN, APV purchase restrictions

EicSys **http://www.eicsys.eu/**

Blades, RTM cards; ADC mezzanines
waiting for news and testbeam qualification

SRS procurement from 2017+

INHOUSE production RD51: stopped !

CERN Store: continued for team account owners only

NEW SRS production and purchase licencies* 2017

No team account ? ask CERN/KT for SRS purchase licence

Direct SRS sales starting in 2017:

SAMWAY Electronics: http://www.samwayelectronic.com

FEC and ADC cards, Eurocrates, SRS-ATCA mezzanines etc

SRS Technology: http://www.srstechnology.ch

APIC, hybrids, Powerbox, DVMcards, SRU, AVD etc

APV (ANALOGUE)

APV (250 nm CMOS)

- Pipeline depth: max. 192 clocks
- Trigger latency: max. 3 us
- Noise: < 500 e- intrinsic >750..1400 e- on detector
- dynamic range: 25 fC
- Detector capacity: 18… < 60pf
- ADC ext. 4096/1000 [counts/baseline]
- Gain: fixed CSA gain 100uA/mip, 5 output signal gains (in step of 20%)
- Timing jitter : ½ (1/fc) [+- 12ns]
- Shaping times: 50 ns adjustable to 80 ns
- max readout rate (few samples): 5kHz

VMM (DIGITAL)

SRS
Scalable Readout System

VMM (130nm CMOS)

- Pipeline depth: 64 digital frames (peak)
- Trigger latency: (self triggered) or L0 (12.8us)
- noise : < 400 e- on 10x10 detector reported
- dynamic range: expect >> 25 fC
- Detector capacity: 30pF .. .. < 1nF
- ADC: embedded, 10 bit
- Gains: 8 CSA gains [0.5..16mV/fC]
- Timing jitter: 20 bit t-stamp, 1ns resolution
- Shaping times: 4 [25… 200ns]
- max readout rates: estimated 1 MHz/ch

ADAPTERS PANASONIC-HRS