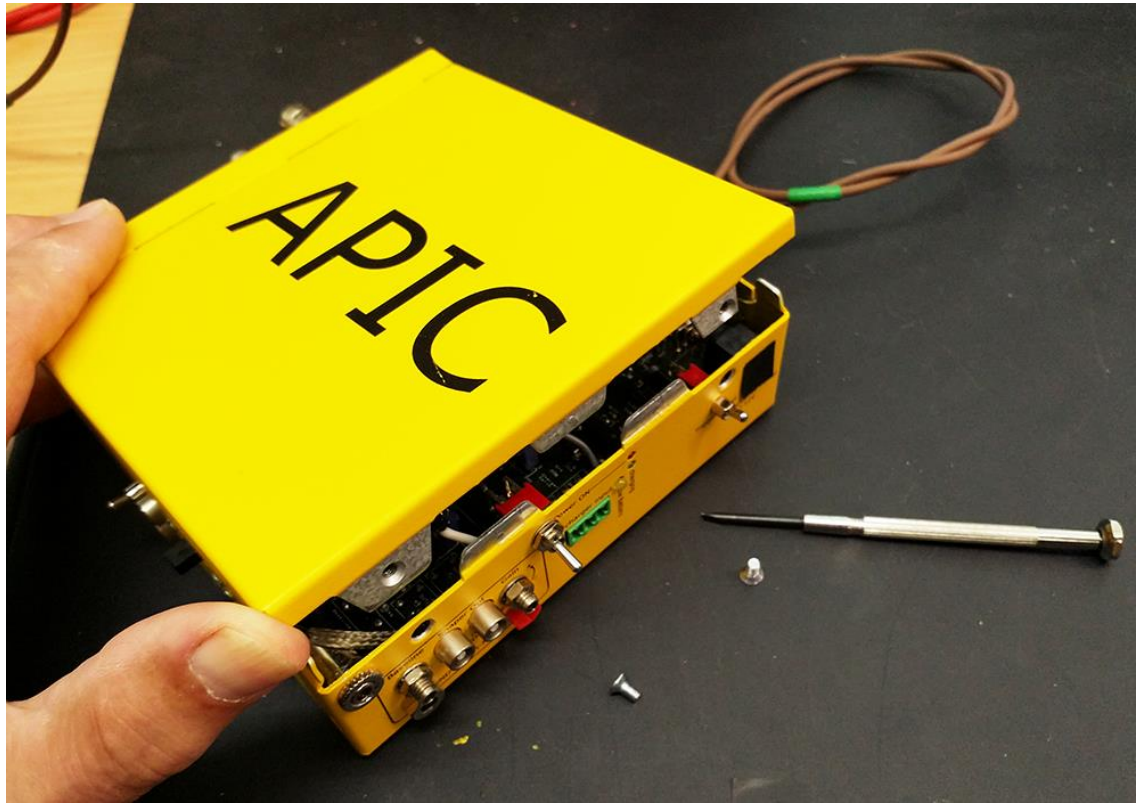
APIC getting started

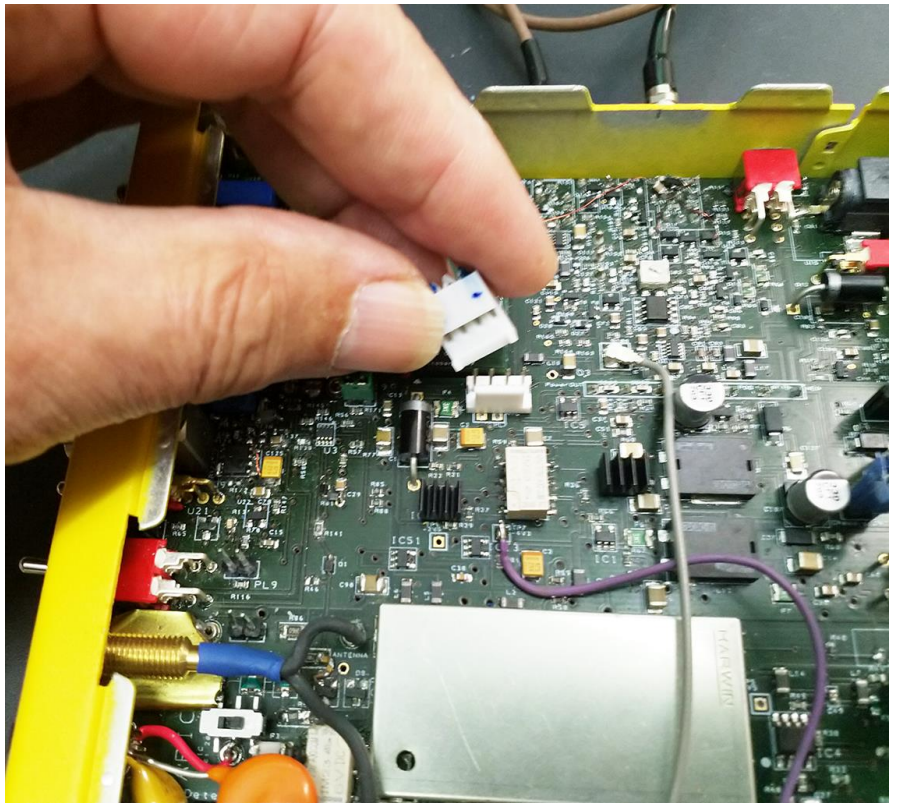
A practical Companion to

APIC User Manual

Unpacking /Battery connection



remove 2 screws, open cover



Plug 4-pin Battery connector
! Remove before shipment !

APIC Setup

Default APIC switch settings

- CSA selection: internal
- Baseline slide switch: Zero
- Shaper slide switch: fast
- Test pulse actuator: middle position
- Test pulse generator switch: intern
- HV bias :off
- CSA input slide switch: 360pF
- 50Ω NIM Trigger: off (bottom)
- Trigger sound: off (top)

APIC power

- APIC power switch on
  -> red LED
- Low power (medium – low discharge)
  ->orange LED blinking
  -> charger >= +15V ACDC charger to green connector
  -> green LED indicates charging
- No power (full discharge)
  -> immediate power
  -> +12V ACDC charger to round black DC connector
  -> green LED indicates charging + power OK
- Full power (batteries fully loaded)
  -> green LED off also with charger
- Autonomy: only preamp-shaper, no trigger, no bias HV
  -> up to 24h

Instruments and Accessories

Instruments:

- Digital Oscilloscope >= 500 MHz
- RMS Digital Voltmeter

Signal cables:

- 1 x 50Ω cable 3ns Lemo connector
- Copper-braid Grounding cable with 4mm Dia Banana Plug

Special Accessories

- ACDC charger 15V, 500mA with adapter to 3 pin (included)
- ACDC direct 12V, 500mA (optional)
- short LEMO 50 OHM cable (included)
- Screwdriver max. 3mm Dia (included)
- SHV cable to AC-coupled detector
- BNC cable to DC-couped detector
- Optional SHV to BNC adapter cable

Test signal rate setup

- Testpulse: **“external”** (for external use like LED pulsers, no charge pulse to CSA)
- Testpulse actuator: **“permanent”**

A.)

-> 50 Ohm cable from NIM 50 Ω to OSC with 50 Ω termination

-> trigger on negative NIM pulse 50ns, -1V

-> adjust **“Perm Rate”** trimmer to desired repetition rate R_{NIM}=1(2T)

B.)

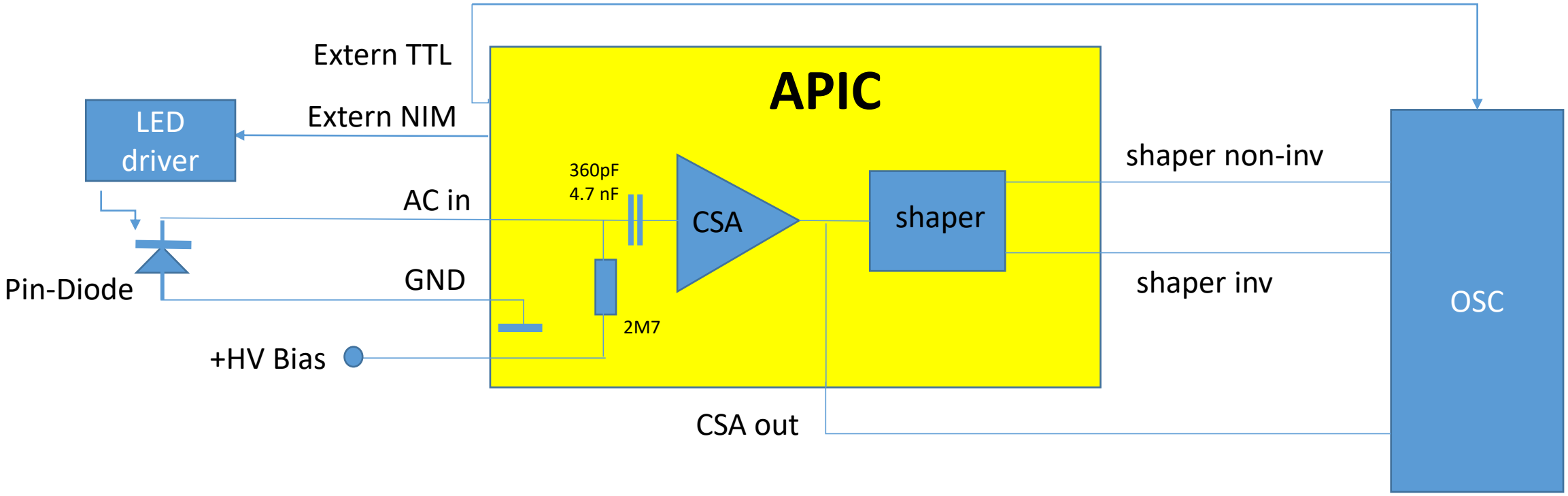
-> 50 Ohm cable from TTL 50 Ω to OSC with 50 Ω termination

-> trigger on positive signal rectangular rate, amplitude 2.4V

-> adjust **“Perm Rate”** trimmer to desired repetition rate R_{TTL}=1/T

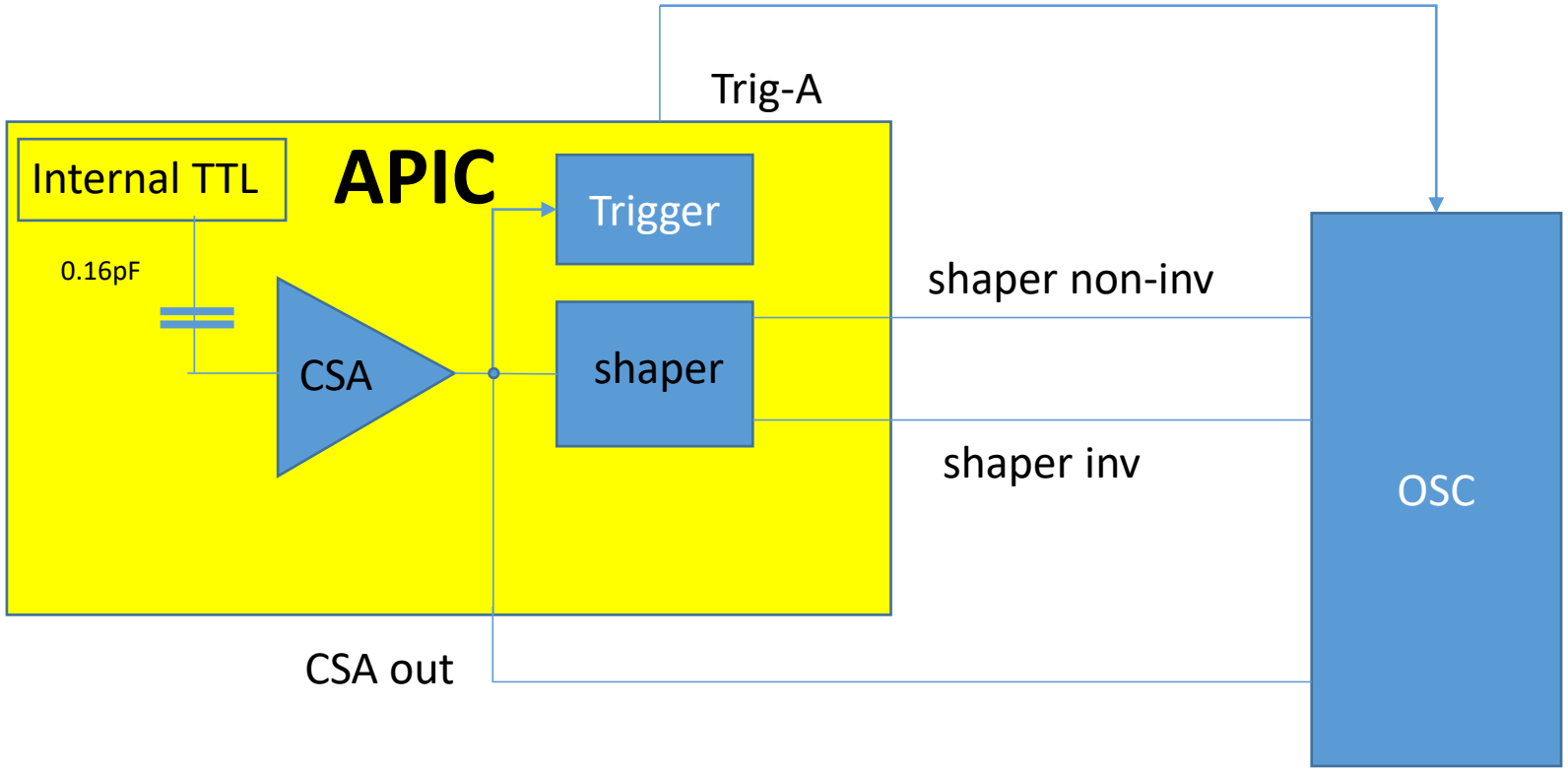
Test signal: external selection

Typical external test application

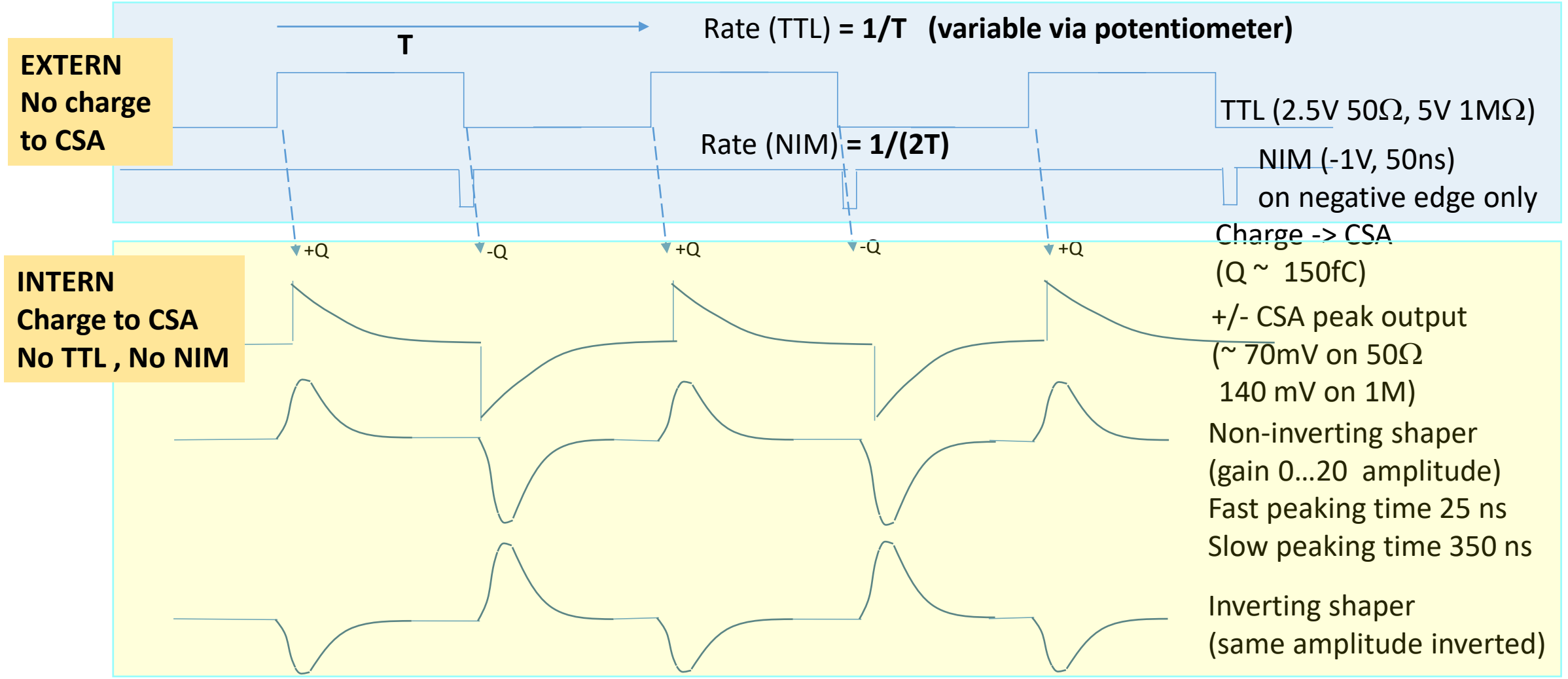


Test signal: internal selection

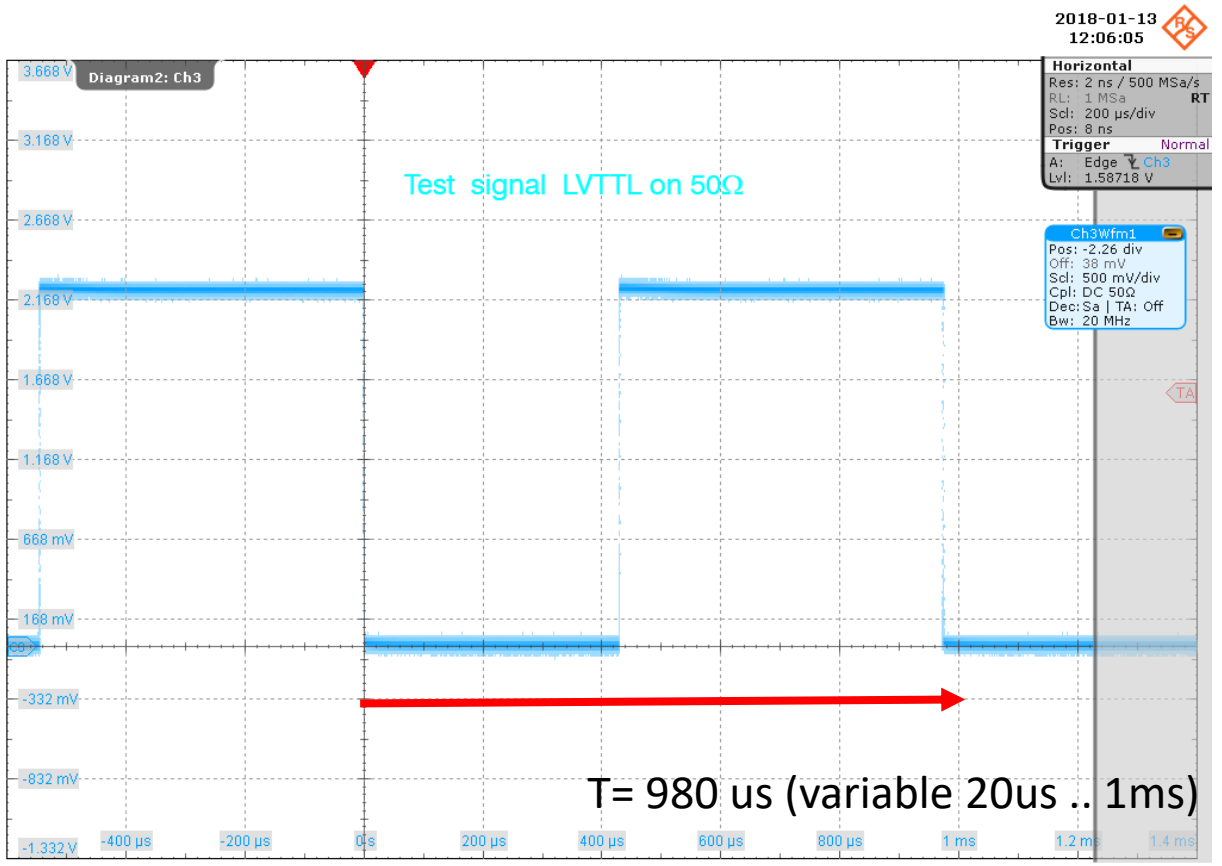
Typical internal test application



Understanding APIC test signal



TTL test pulse

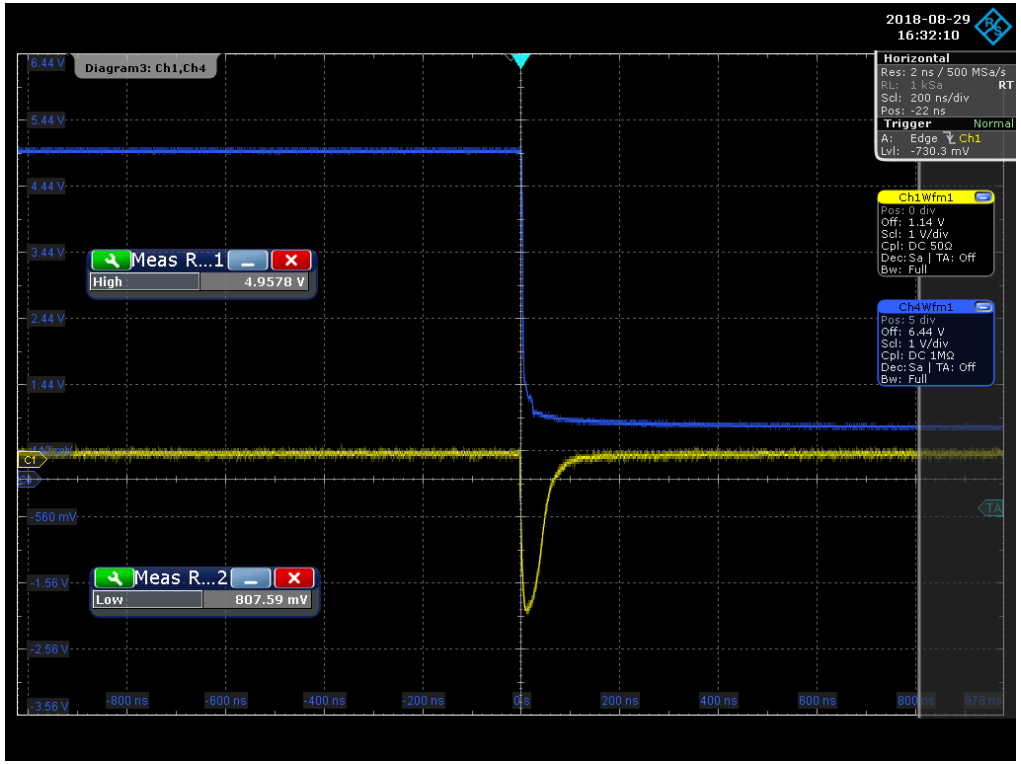


Terminated 50Ω
2.2V LVTTL

External Test signals (NIM, TTL, LVTTL) for external detector pulsing, no charge to CSA

TTL
1M
~ 5V

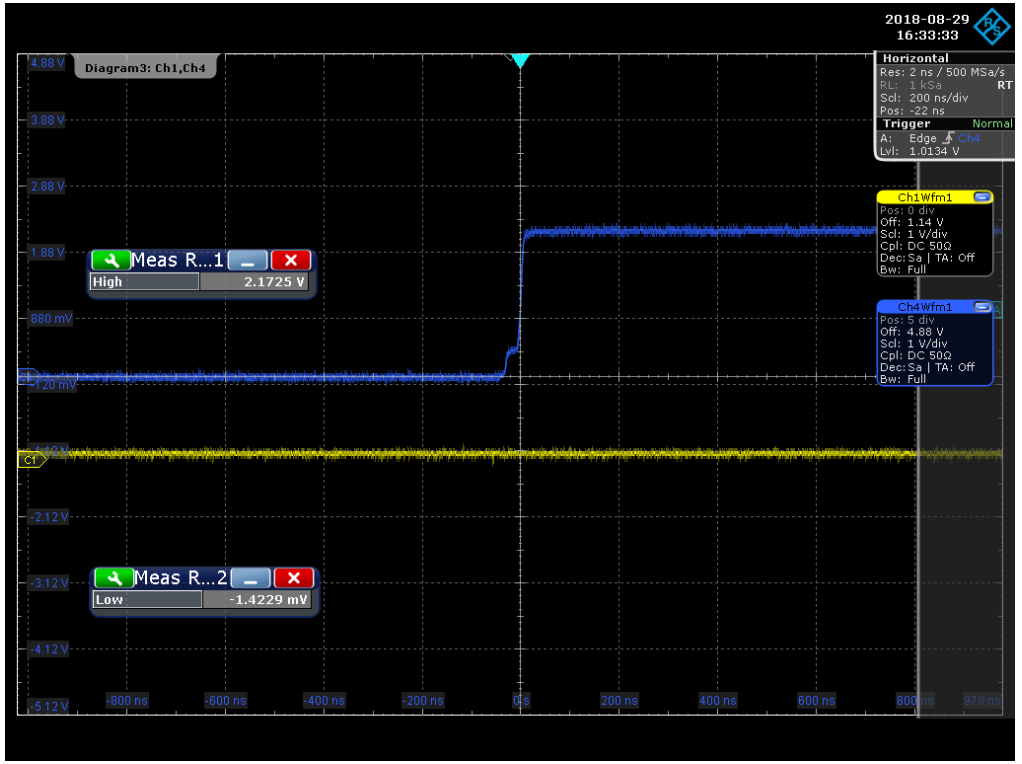
NIM
-800mV



NIM 50ns on falling edge

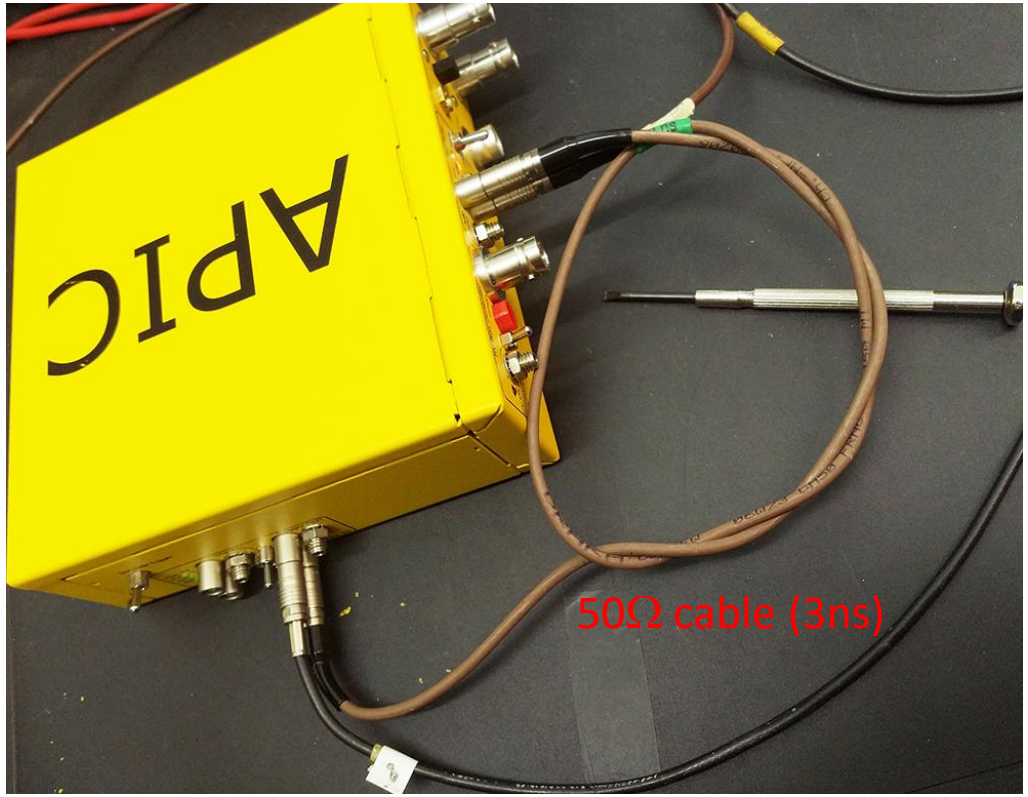
TTL
50Ω
~ 2.2V

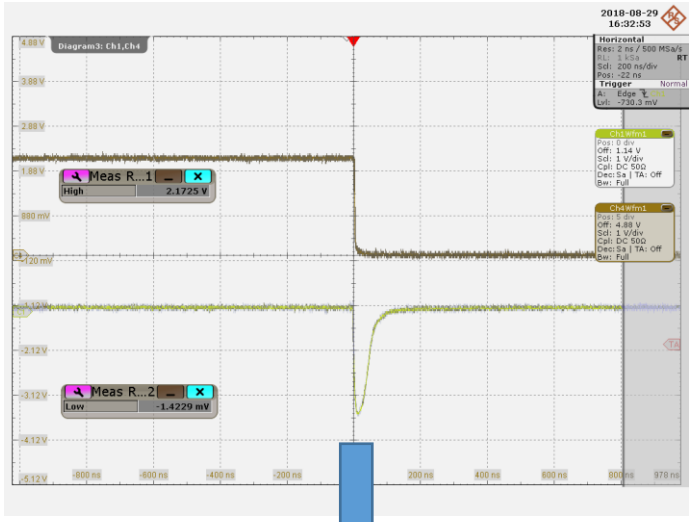
NIM
No signal



no NIM on rising edge !

NIM signal stretcher

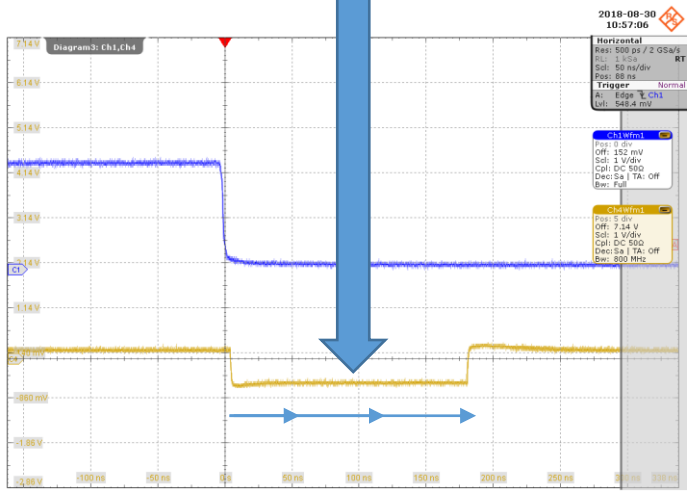




Ext TTL pulse

Ext. NIM test pulse

NIM 50Ω



Ext TTL pulse

Stretched NIM test pulse

Trigger OUT

Switch 50Ω NIM Trigger: on (top)

Connect **“NIM 50Ω”** output via short 50Ω cable to **“GATE-IN”**

-> adjust NIM signal length of **“Trigger OUT”** via **“Δt”** trimmer

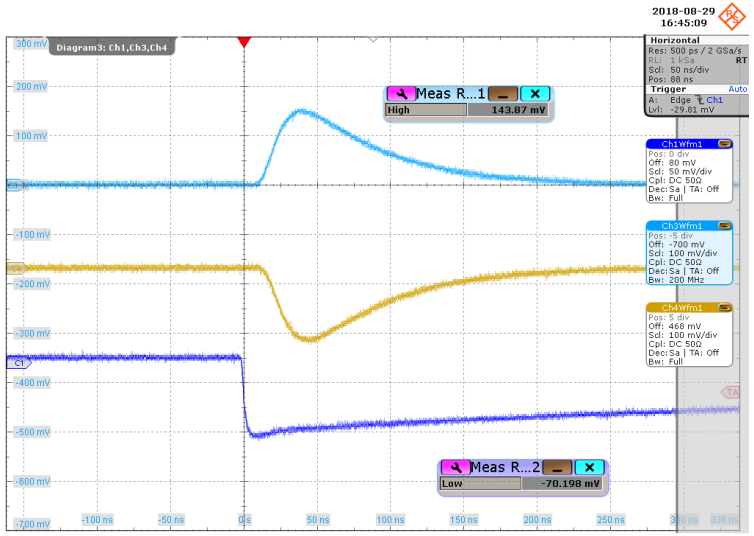
-> stretched NIM signal varies between 50 and 550ns

Test signal to CSA output

- Testpulse: **“internal”** (inject +/- charge to CSA)
- Testpulse actuator: **“permanent”**

  -> 50 Ohm cable from **“CSA-out”** to OSC with 50 Ω termination

  -> trigger on negative edge 70mV, slope ca 1 us



inverting shaper

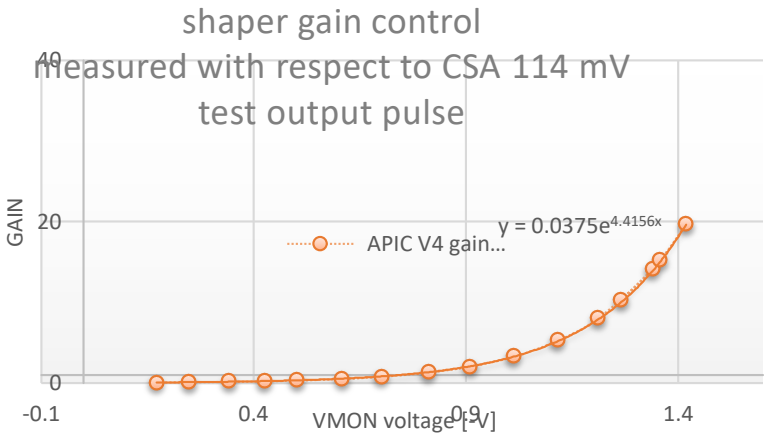
non inverting shaper

CSA

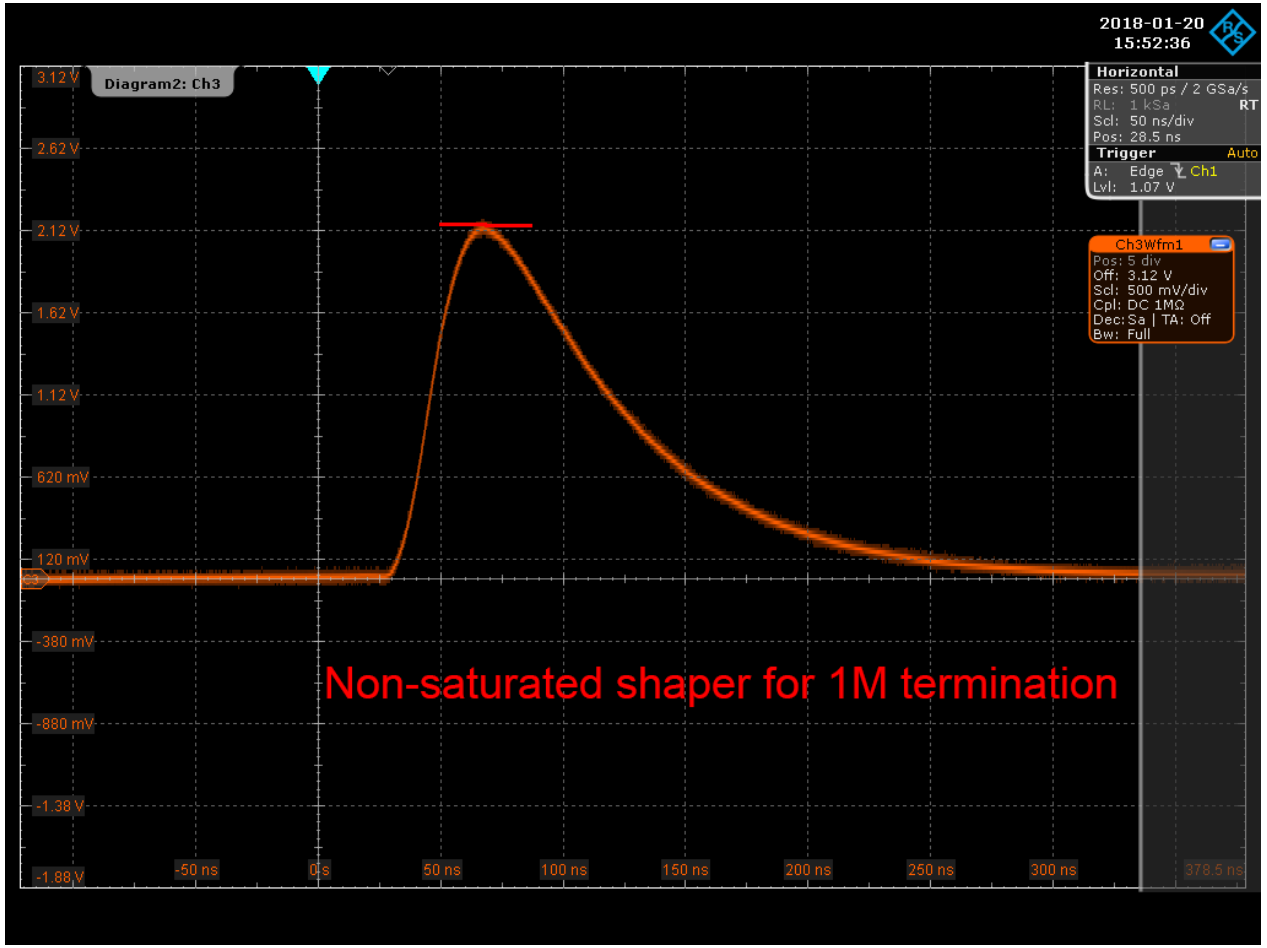
Shaper gain
test with internal test signal

- Set **“shaper selection”** to fast
- 50 Ω cable from **“shaper non-inverting” output** to OSC 50Ω

-> adjust **“Gain” trimmer**” to -1V measureable on **“Gain Monitor”**
-> trigger on negative going 25 ns semi-Gaussian peak ~350mV
-> adjust **“Gain” trimmer”** to -1.35V
-> trigger on negative going 25 ns semi-Gaussian peak ~1000mV
-> adjust **“Gain trimmer”** counterclockwise until signal disappears
-> Verify Zero-0 gain ~ -0.1V
-> adjust **“Gain trimmer”** back to -1V



Max 1.8V linear amplitude on 1M
Max 0.9V linear amplitude on 50Ω



Gain = 0.1 @ V_{mon} = -0.222V

Gain = 1 @ V_{mon} = - 0.744V

Gain =10 @ V_{mon} = - 1.265V

Gain = 20 @ V_{mon} = - 1.42V

Gain relative to CSA peak
(use 1M termination)

Peaking time selection

- 50 Ω cable from **“shaper non-inverting” output** to OSC 50Ω

- Select **“shaper selection”** to “slow”

  -> semi-Gaussian 350ns peaking time, falltime 1.5 us

- Select **“shaper selection”** to “fast”

  -> semi-Gaussian 25ns peaking time, falltime 150 ns

Fast and slow peaking time relative to CSA

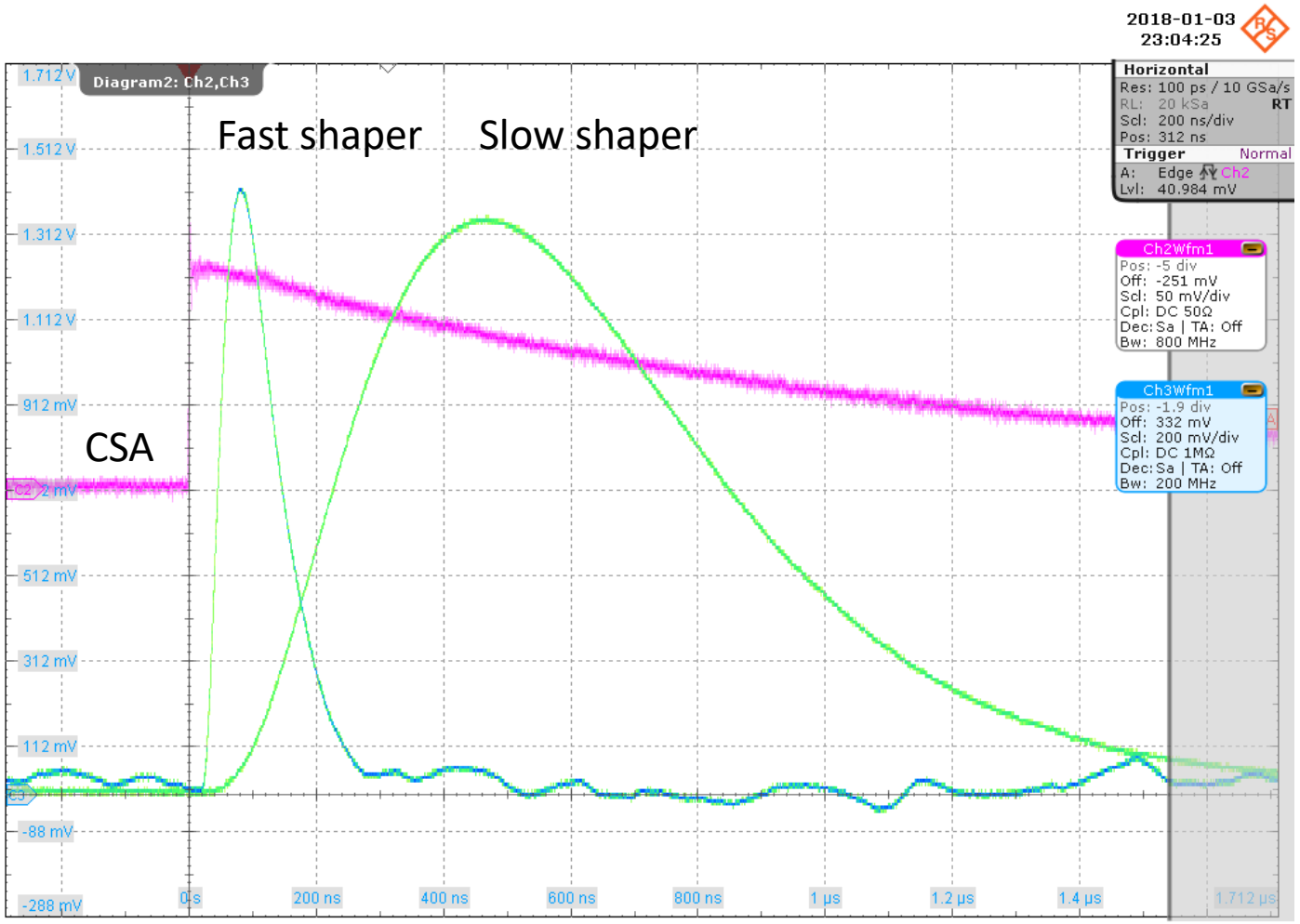
Fast: t_{peak} = 25 ns

for high rates with
detector capacitances < 100pF
increasing noise with
increasing detector capacitance*

Slow: t_{peak} = 350 ns

for detector capacitances < 1nF

* including signal cable capacitance



Complementary shaper signals

- 50 Ω cable from **“shaper non-invert” output** to OSC 50Ω – Ch1
- 50 Ω cable from **“shaper invert” output** to OSC 50Ω – CH2

  -> adjust **“Gain” trimmer”** to -1.35V

  -> trigger on negative going 25ns semi-Gaussian

  -> complementary analogue signals peak ~1000mV

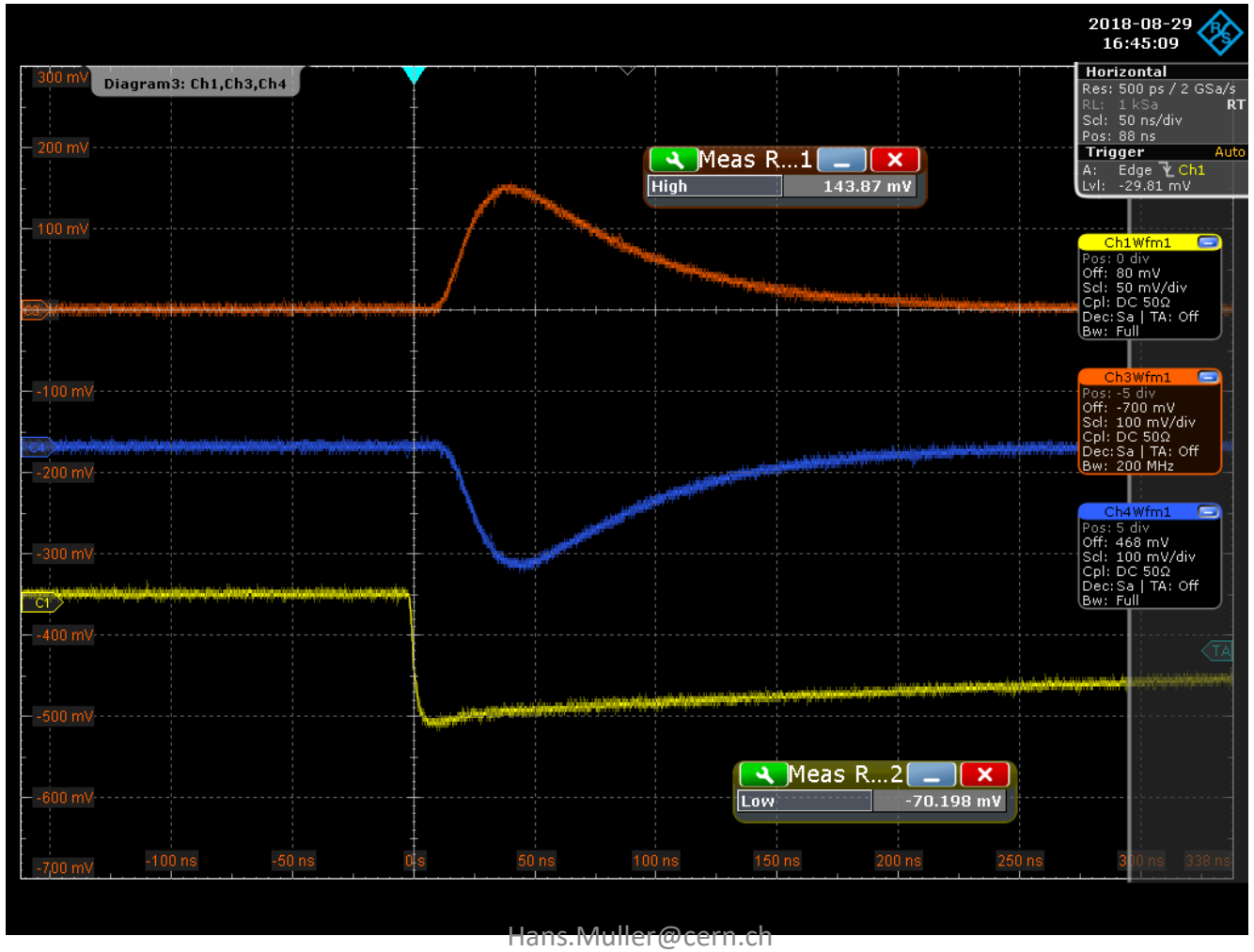
  -> change CH1 and CH2 to 1M

  -> shaper signal amplitudes double

  -> Use complementary “add” to subtract Ch2-Ch1

  -> differential shaper signal doubles

Complementary shaper output relative to CSA signal



Baseline setting

- Slide **“Baseline mode”** to variable

  -> turn **“Baseline”** trimmer + observe baseline change on OSC

  -> +/- 200mV DC change of baseline variation

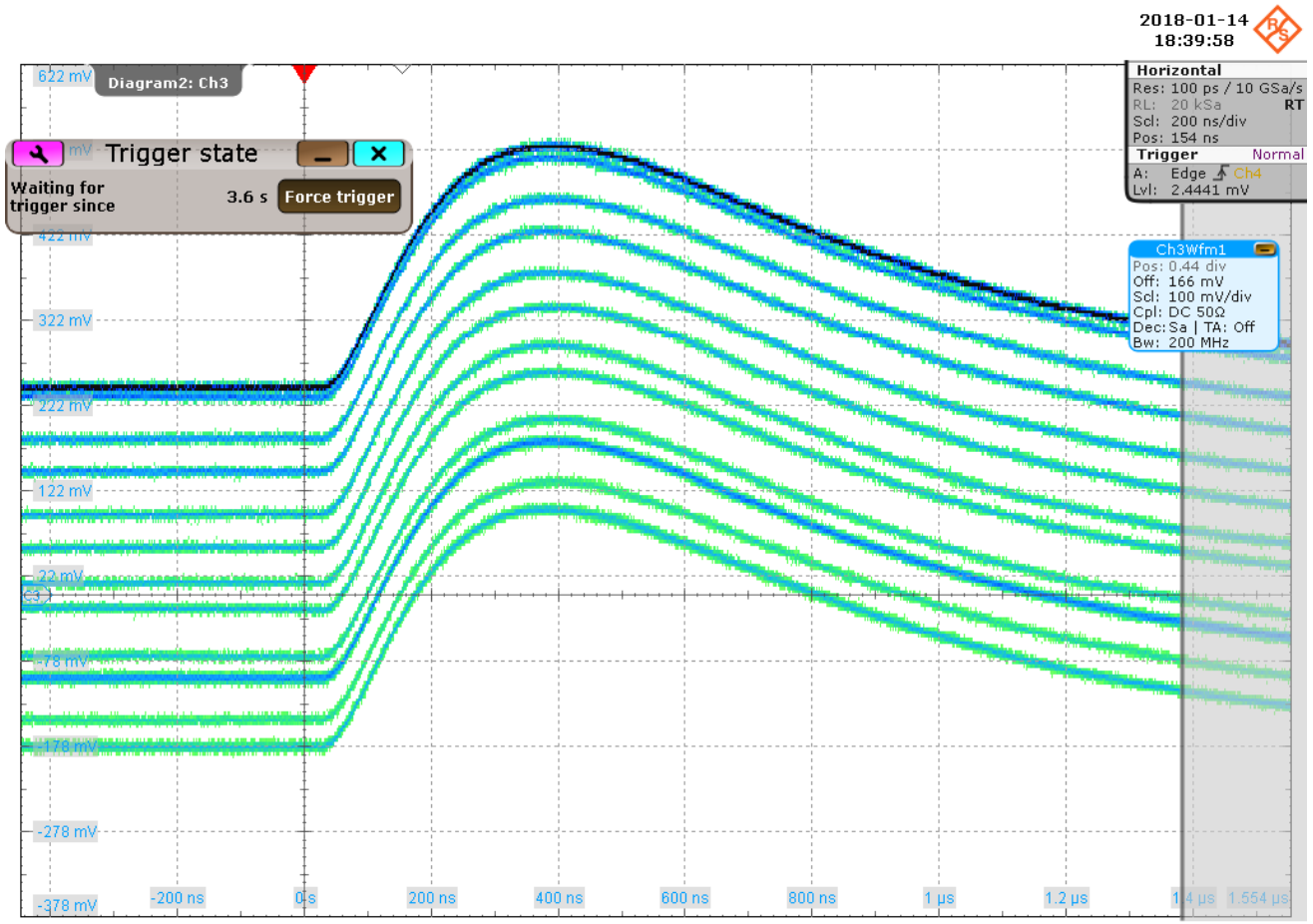
- Slide **“Baseline mode”** to zero

  -> baseline goes back to 0V

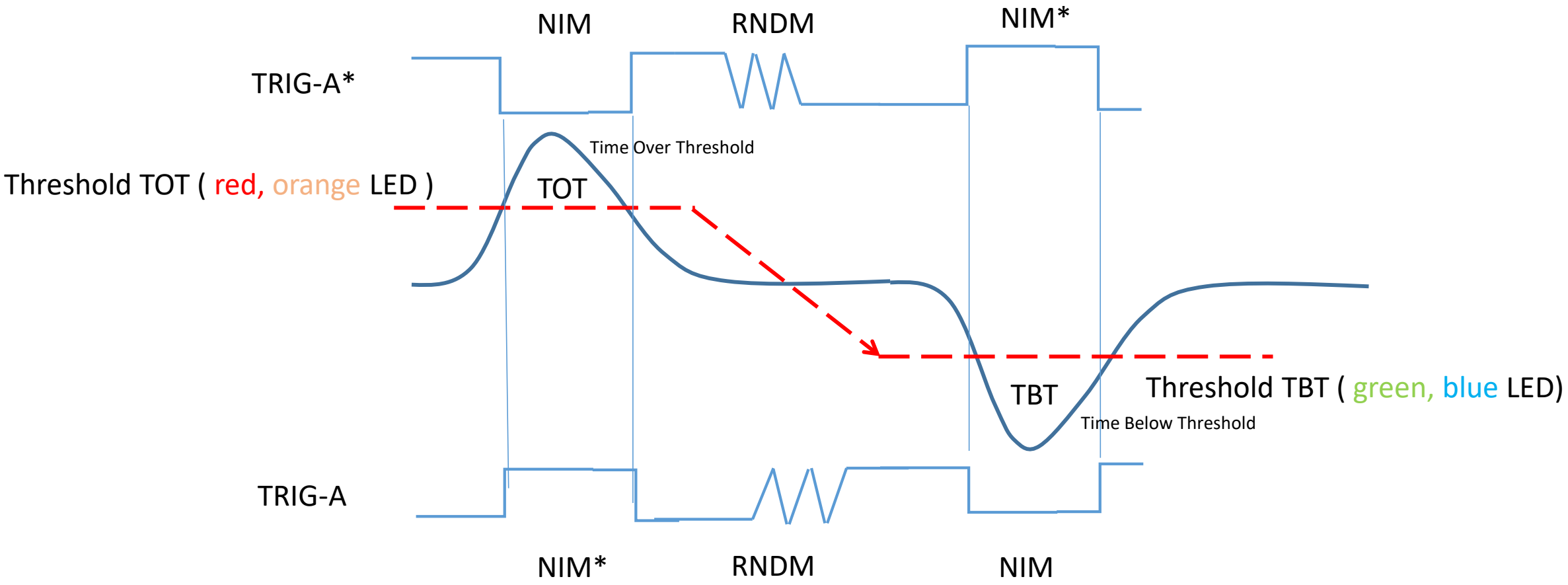
- Slide **“Baseline mode”** to variable and zero

  -> baseline changes between variable and zero DC offset

Shaper baseline variator



TOT and TBT trigger selection



Trigger A and A* (complementary NIM)

- Connect 50Ω cable **“ A* ”** to OSC with 50Ω term. and 500mV/Div

-> automatic trigger on OSC , NIM signal -0.8V

-> turn trimmer **“+/- level “ over full range**

-> signal level between GND and -1V

-> NIM signal flips from positive to negative NIM

-> intermediate level generates random signals

-> **red LED :** positive charge on APIC input

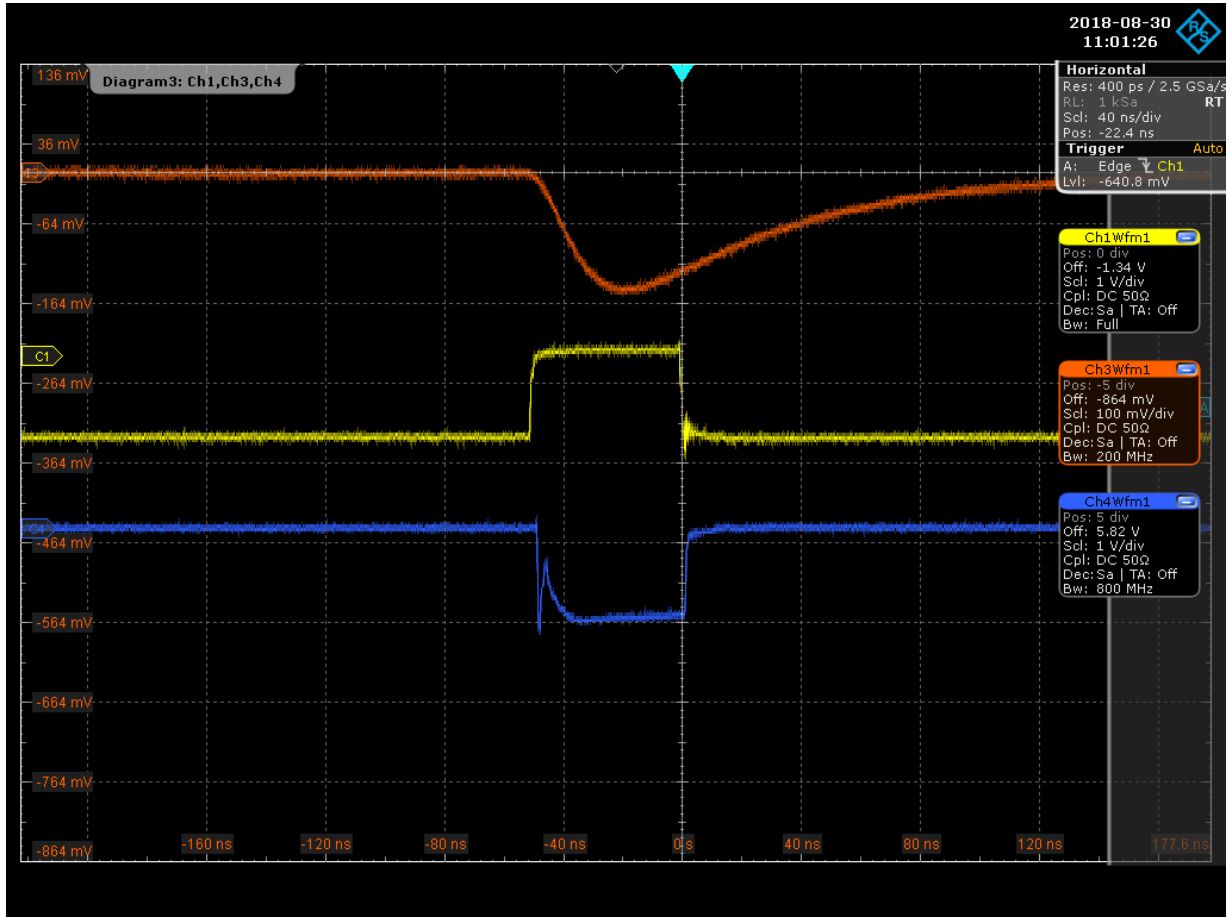
-> **orange LED :** positive charge signal triggered (TOT)

->**blue LED :** negative charge signal on APIC input

-> **green LED :** negative charge signal triggered (TBT)

-> fine-tune level until NIM signal on OSC until stable (0.8V, 50 ns)

Complementary A and A* triggers



non inverted shaper signal

A* trigger

A trigger

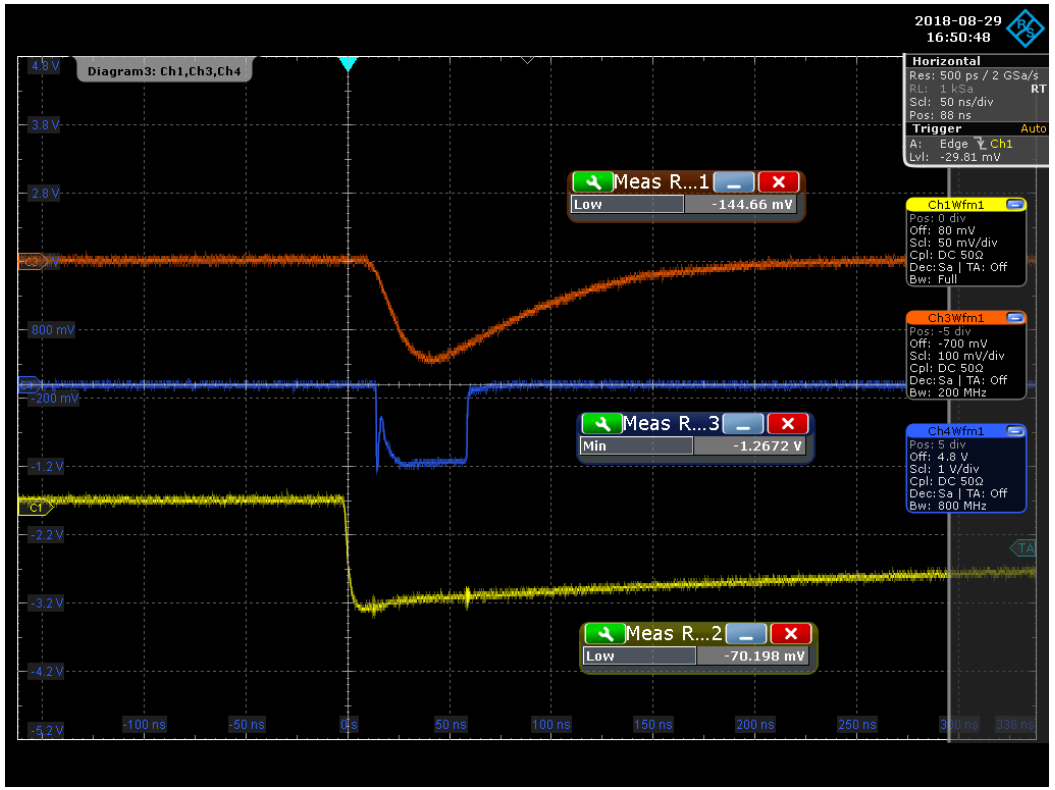
A or A* triggers are always complementary NIM signals

In the shown TBT case both A and A* belong to a triggered negative charge signal

TBT for neg. charge -> neg. NIM on TRIG-A

- Switch 50Ω NIM on
  -> LEDs light up in random state
- Connect 50Ω cable **“A”** to OSC with 50Ω termination and 500mV/Div
  -> trigger on negative NIM signal -0.8V
  -> if no or random trigger turn trimmer **“+/- level “**
  -> **blue LED** means negative charge on input
  -> **green LED** means negative charge signal triggered
  -> fine-tune NIM signal on OSC until stable (-1V, 50 ns)

Trig A trigger: neg. NIM signal on negative input charge*



Non inverting shaper

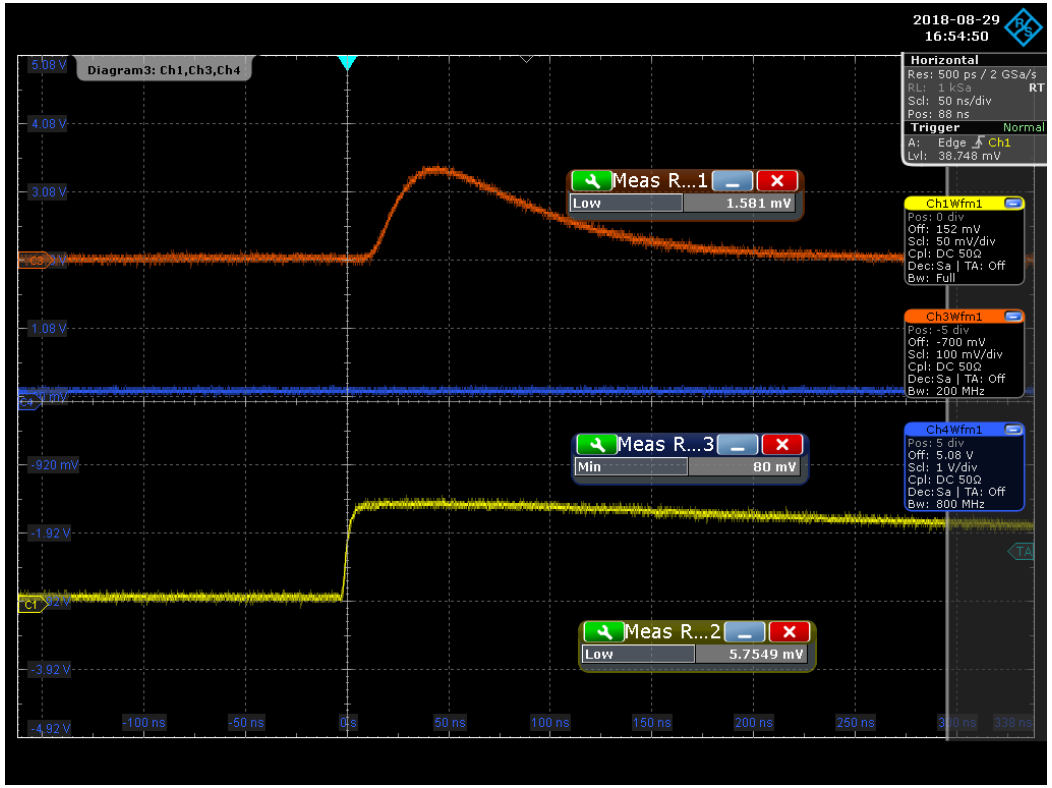
TRIG-A

CSA

* imperfections like spike in NIM signal and crosstalk on CSA observed on APIC prototypes will be removed on final versions

TBT level on positive charge input
TOT level on negative charge input

No trigger on TRIG-A and TRIGA A*



pos. shaper

TRIG-A for TBT

pos. CSA

NIM Pulse stretcher test

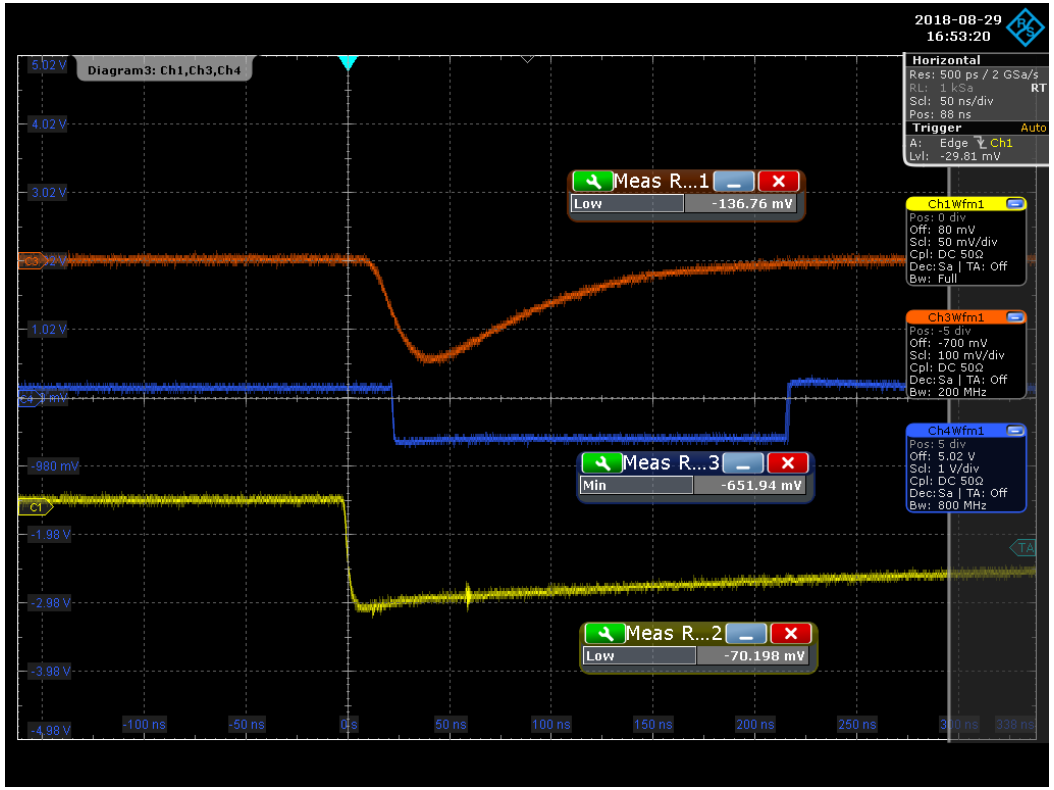
- Select TBT trigger
- Connect **“TRIG A”** output via short 50Ω cable to **“GATE-IN”**
- Connect **“Trigger OUT”** to OSC 50Ω , -0.8 V

-> place **“Trig A –Trig A*”** selector in middle position

-> adjust NIM signal length of **“Trigger OUT”** via **“Δt”** trimmer

-> stretched NIM signal varies between 50 and 550ns

Trig A NIM length stretcher
Gate-IN-> Trig Out



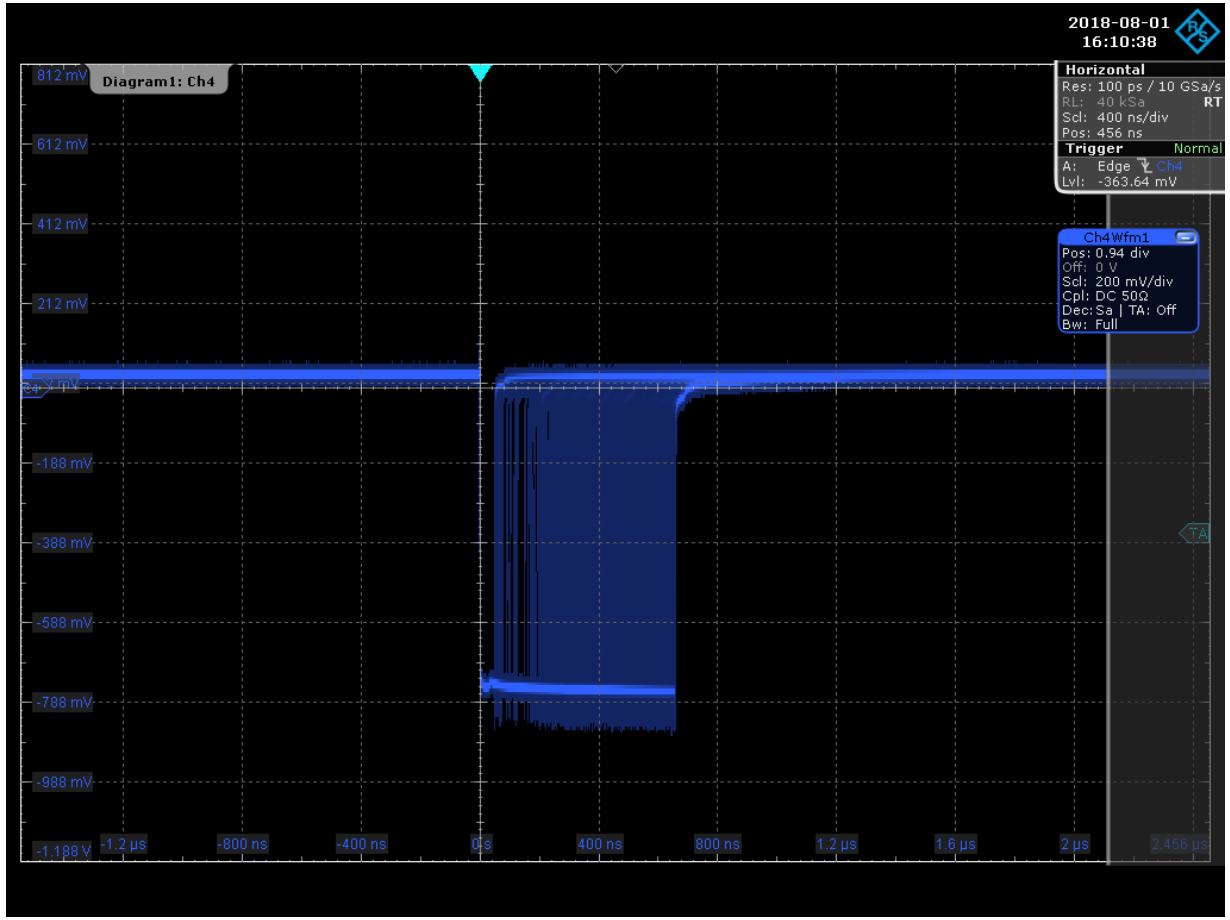
Non inverted shaper

Trig –out with input from TRIG A

CSA

Pulse stretcher range

Trig-out NIM signal



Signal length for different turns of Δt trimmer
50 -550 ns

Buzzer test

- NIM signal on **“Trigger OUT “** must be active
- Switch **“Trigger Sound“** Buzzer on
- High /Low pitch noise depending in charge input rate (test signal rate setup)

  -> adjust **“Perm Rate”** trimmer: buzzer noise changes

External Trigger gate/Coincidence

- Set up Trigger A (neg. charge -> NIM) with Test or other charge signal
- Connect external NIM signal to **“Gate-IN”**
- Connect 50Ω cable from **“Trigger-OUT”** to OSC 50Ω CH1
- Place **“Trig-A –Trig A*”** selector in middle position
- Activate external NIM signal

  -> trigger CH1 on NIM -0.7V

  -> stretched NIM signal generated from external NIM

  > adjust NIM signal length of **“Trigger OUT”** via **“Δt”** trimmer
- Place “Trig-A –Trig A*” selector in Trig A position[1]

  -> “Trigger OUT” signal only if time coincident with external “Gate-in”

1 on APIC prototypes switch is inverted

AC coupled detector input (with HV bias)

- Connect AC coupled CSA Input “Input AC” to detector via SHV cable connector as short as possible (RG58/U adds 82pF/m to C_{det} !!)
- Connect extra thick GND cable from detector to GND (4mm Banana)
- Place Test pulse switches to “Extern” and center position between Single and Perm (red test LED MUST BE off)
- Select coupling capacitor to CSA input 360pF or 4.7nF (depending detector capacitance, look at S/N what is better)
- Do not connect anything to Input DC (if needed can be disabled via internal slide switch)
- Optionally connect external HV bias voltage for detector to SHV “HV Bias In” (max 4kV)
- Optionally for Si diodes up 100V connect APIC Bias output to HV Bias input
-

DC coupled detector input[1]

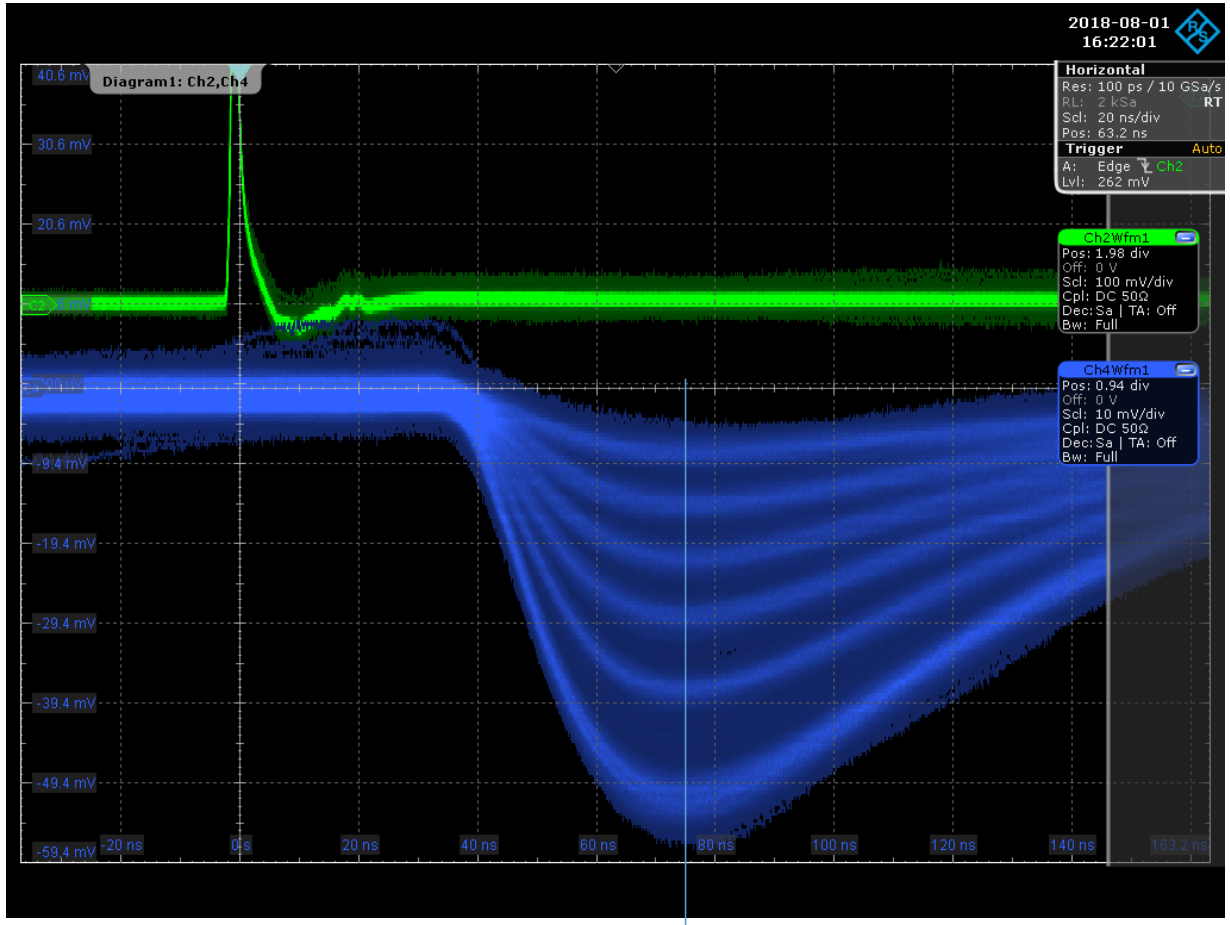
ONLY for DC bias – free detector signals !

- Connect DC coupled CSA Input “Input DC” to detector via BNC cable connector as short as possible
- Connect extra GND cable from detector to GND (4mm Banana)
- Place Test pulse switches to Extern and center position between Single and Perm (red test LED = off)
- Place capacitor selector to AC to 360 pF (minimum coupling)
- Do not connect anything to SHV connectors Input AC and HV Bias

1 this input can be disabled via an internal slide switch

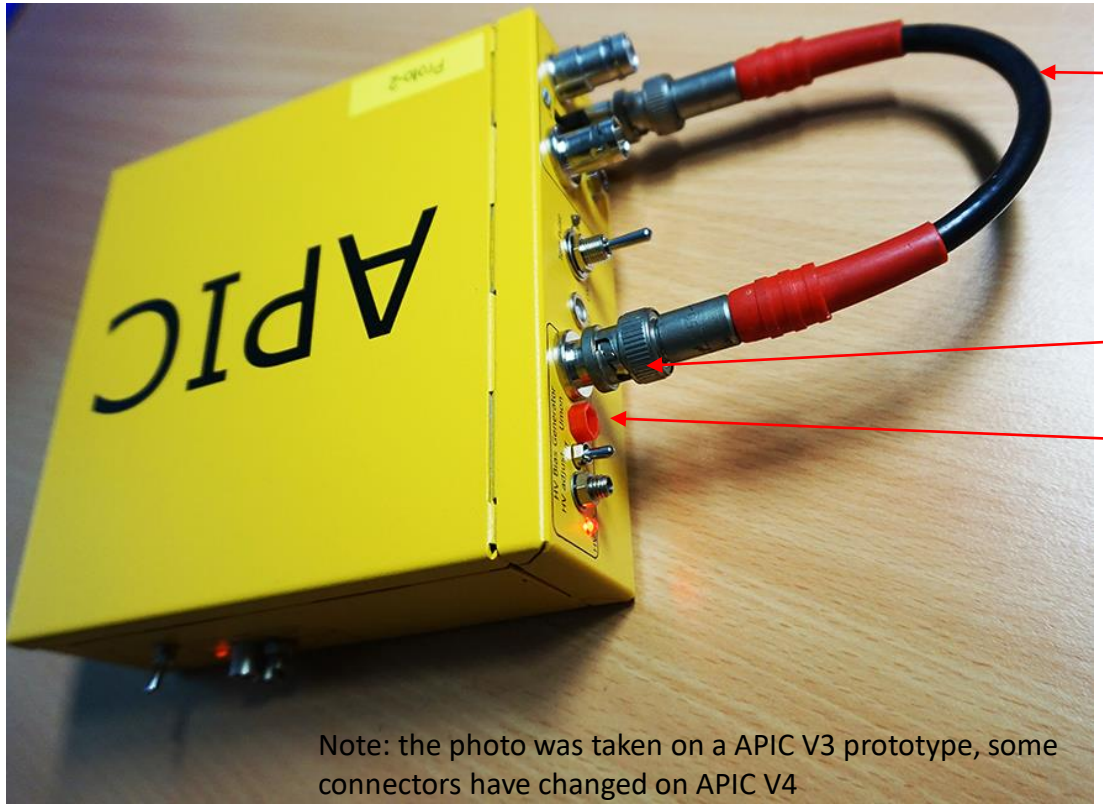
Shaper peak response to variable charge signal

External LED pulser
to photodiode ->APIC



peak time amplitude invariant

HV Bias connectivity



Note: the photo was taken on a APIC V3 prototype, some connectors have changed on APIC V4

Special **BNC to SHV cable** connects Bias voltage to a detector (connected on the HV AC input)

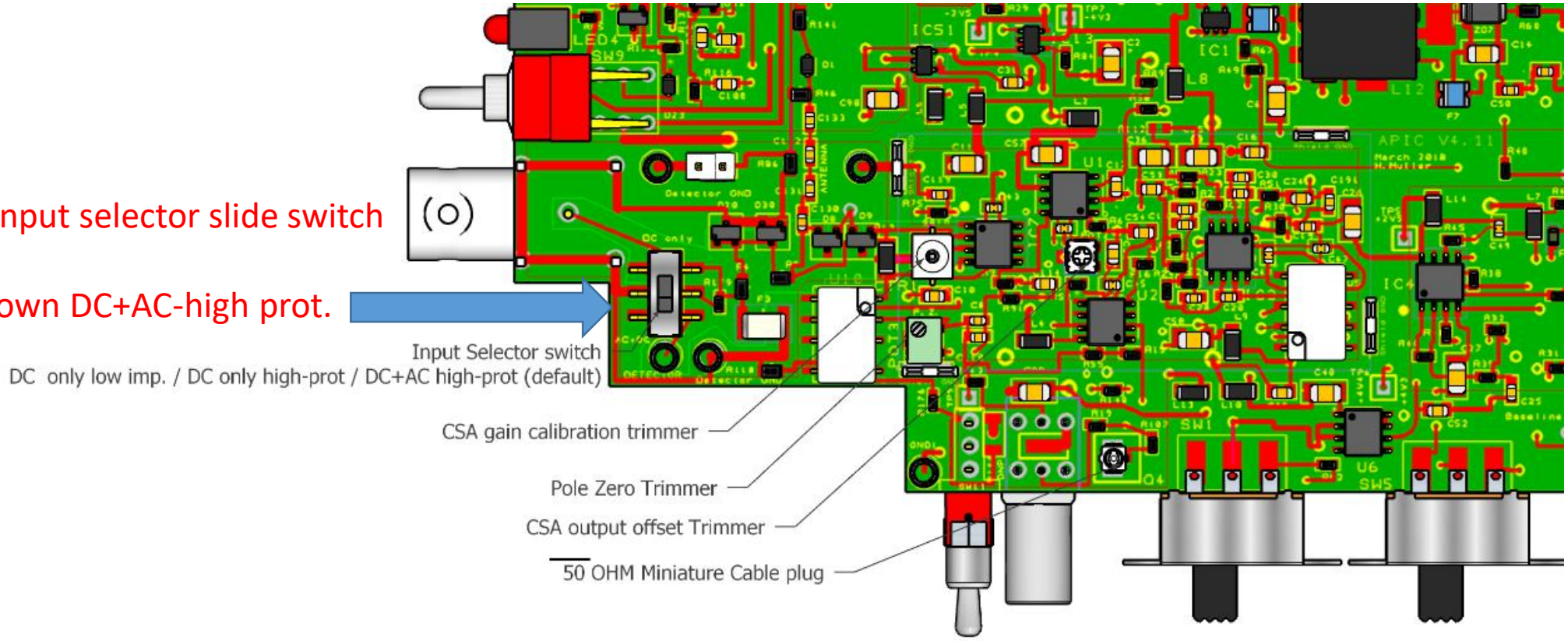
\+ HV Bias for Si Diodes on BNC connector

V_{mon} monitoring voltage to measure HV Bias

Following slides: Features APIC V4.1

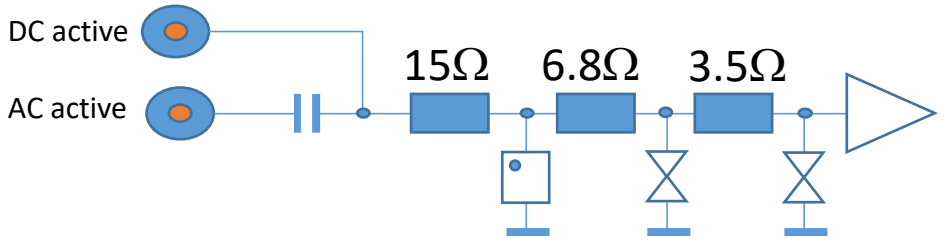
Internal Input selector

Internal PL8 input selector slide switch
3 positions,
Default as shown DC+AC-high prot.

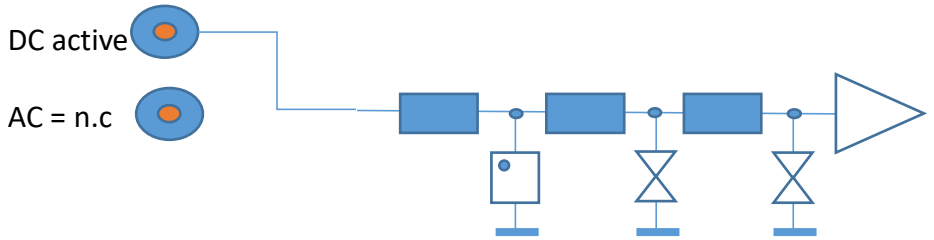


3-position input microswitch

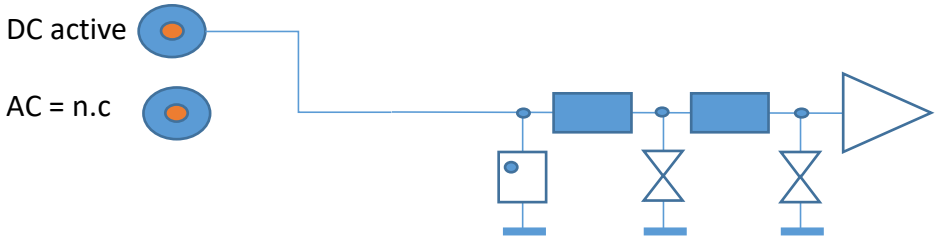
Down = standard position
AC and DC high protection



Middle
DC only high protection



Up
DC only high protection

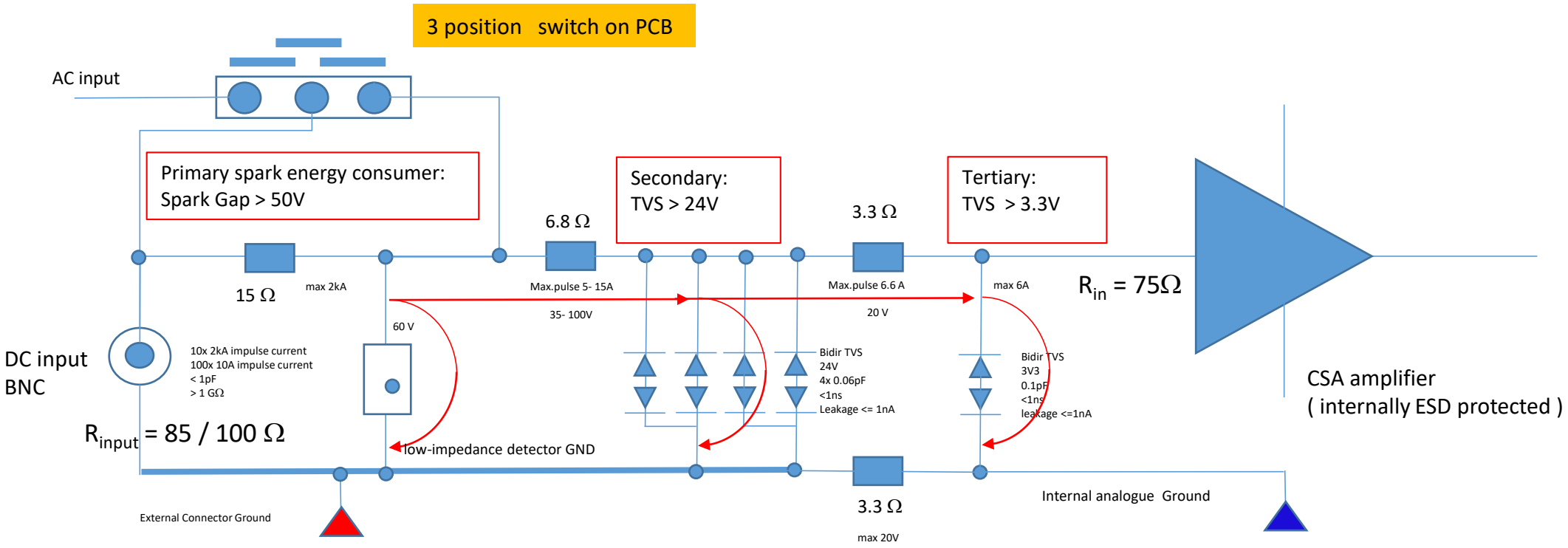


Spark protection

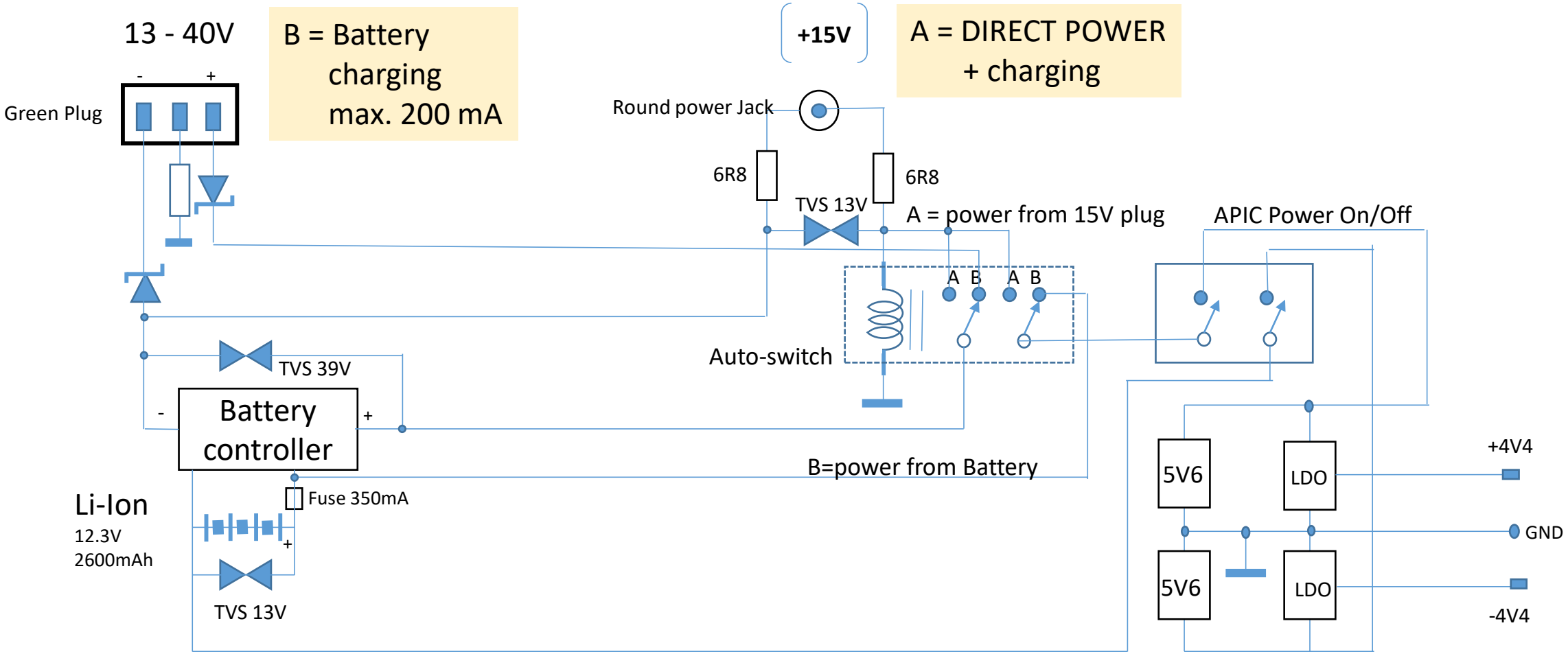
APIC triple spark protection scheme:

ΔU_{in} >> 50V : 1 ns -> $\Delta U_{out\ max}$ = 3V

$C_{parallel}$ = 1pF, R_{series} = 25Ω, I_{leak} <= 1nA



APIC V4.1 Power & Charging scheme

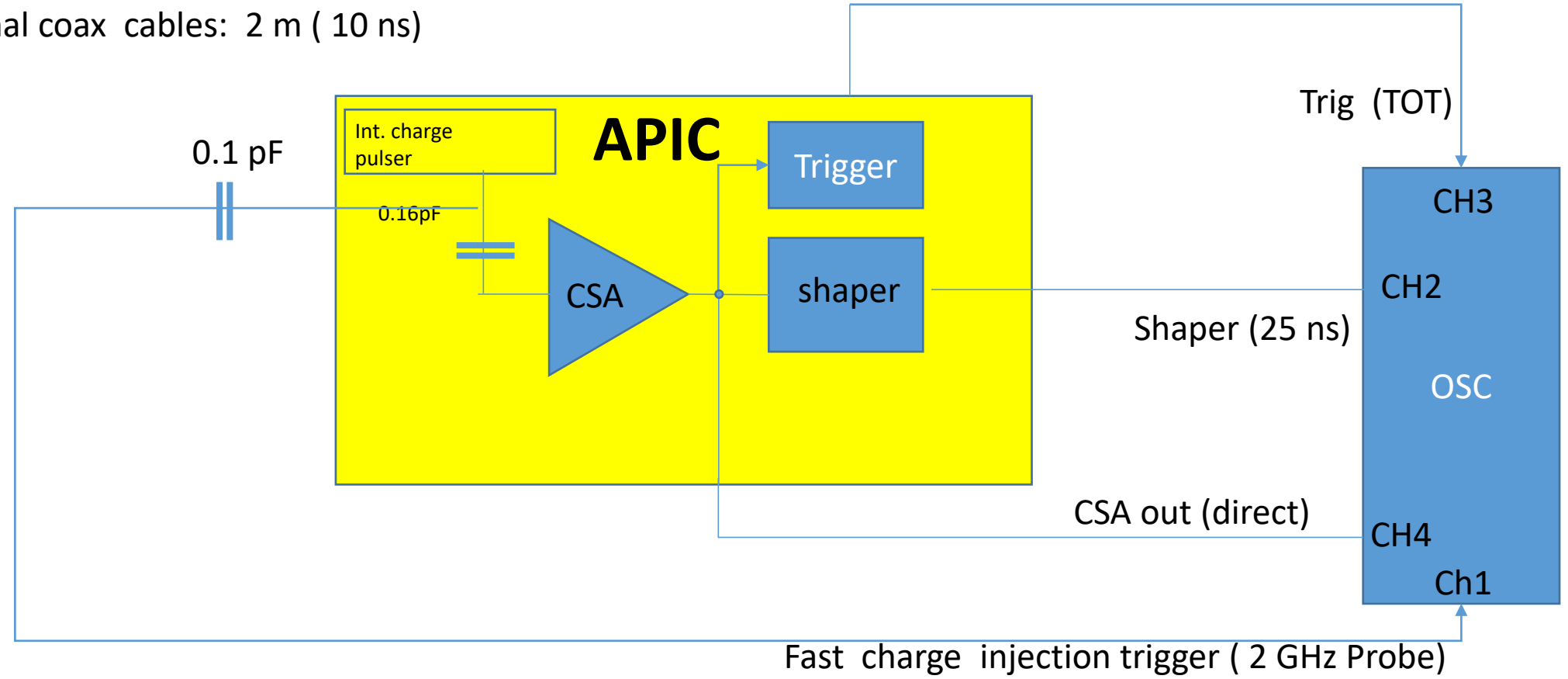


APIC Timing measurements

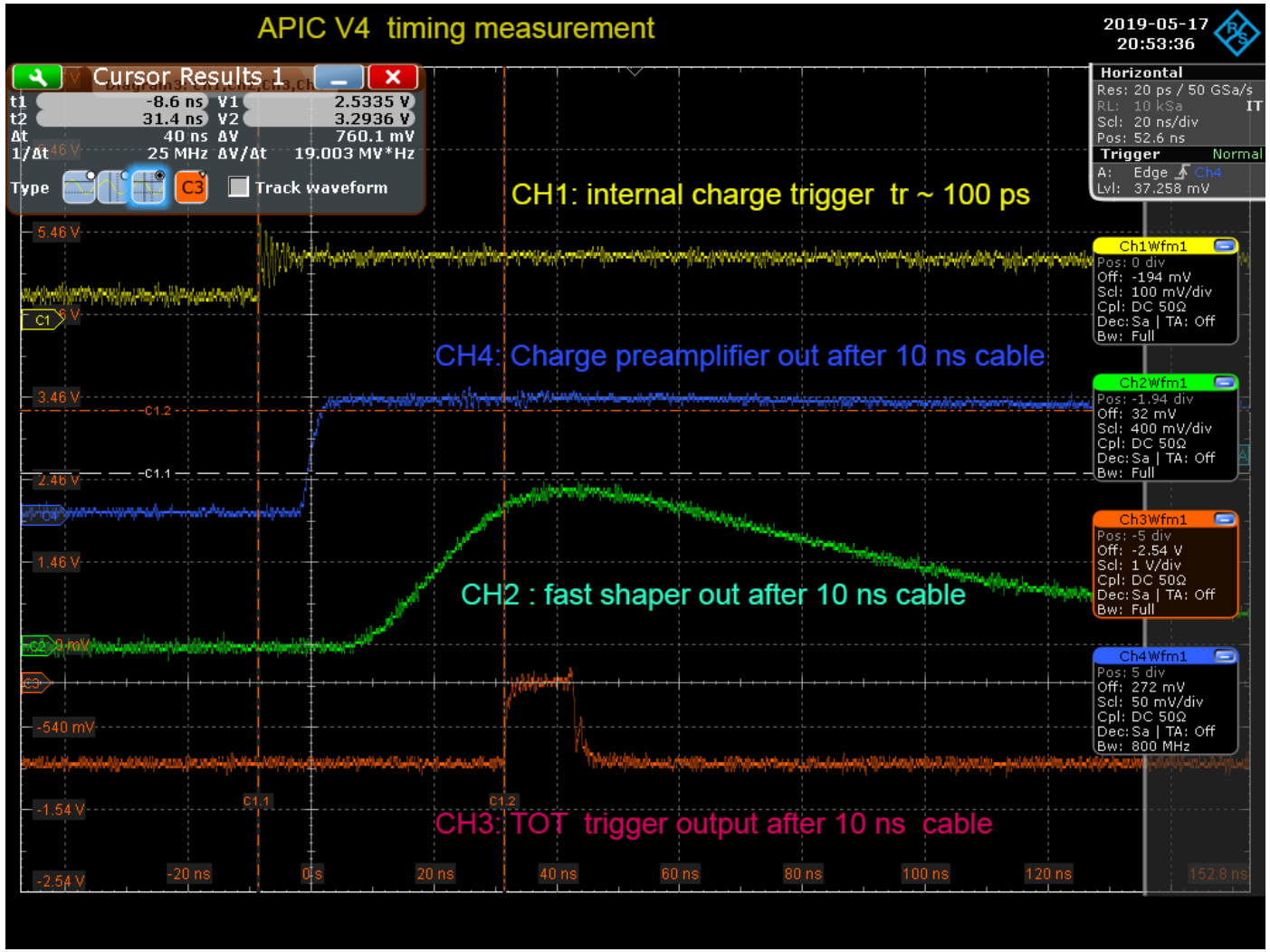
(following measurements)

Test setup for timing

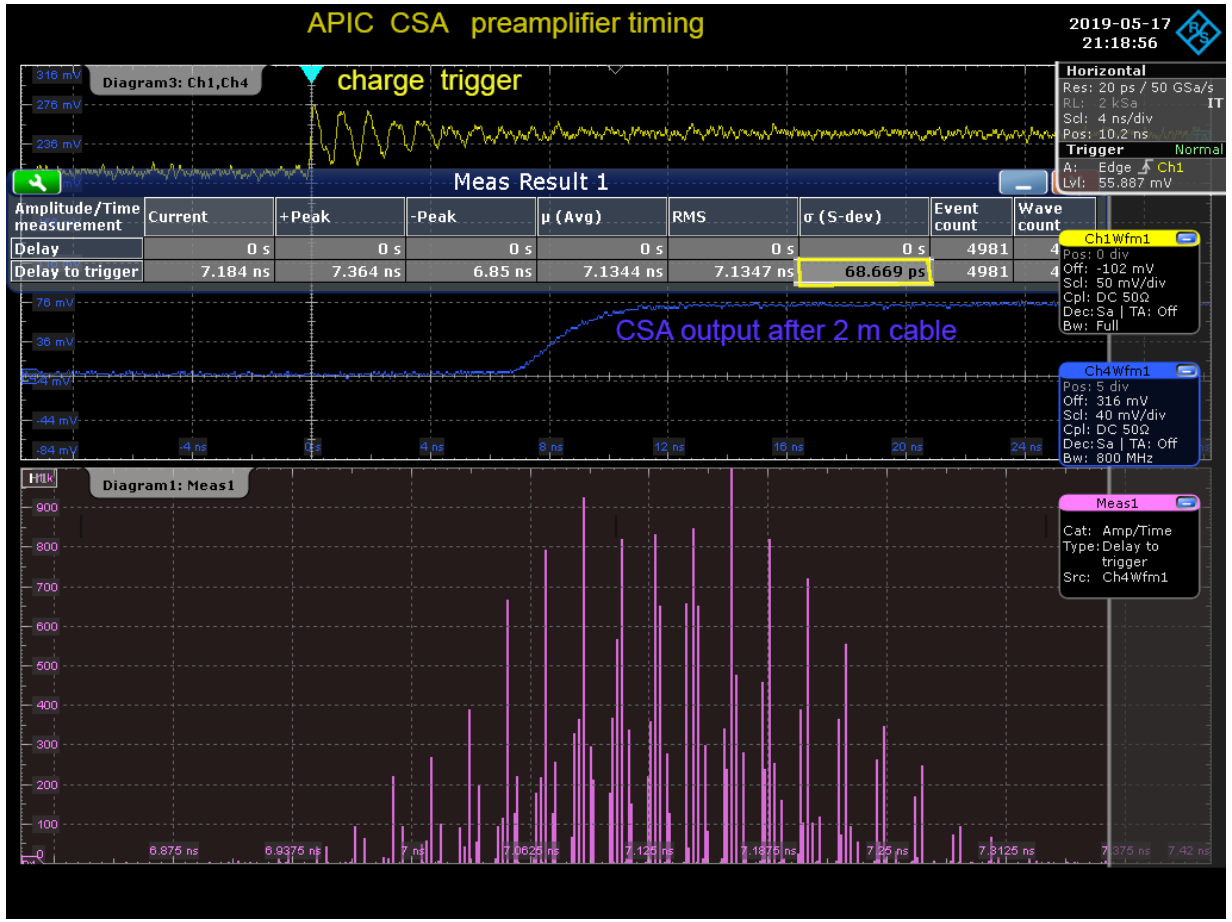
All external coax cables: 2 m (10 ns)



Timing overview with fast internal trigger

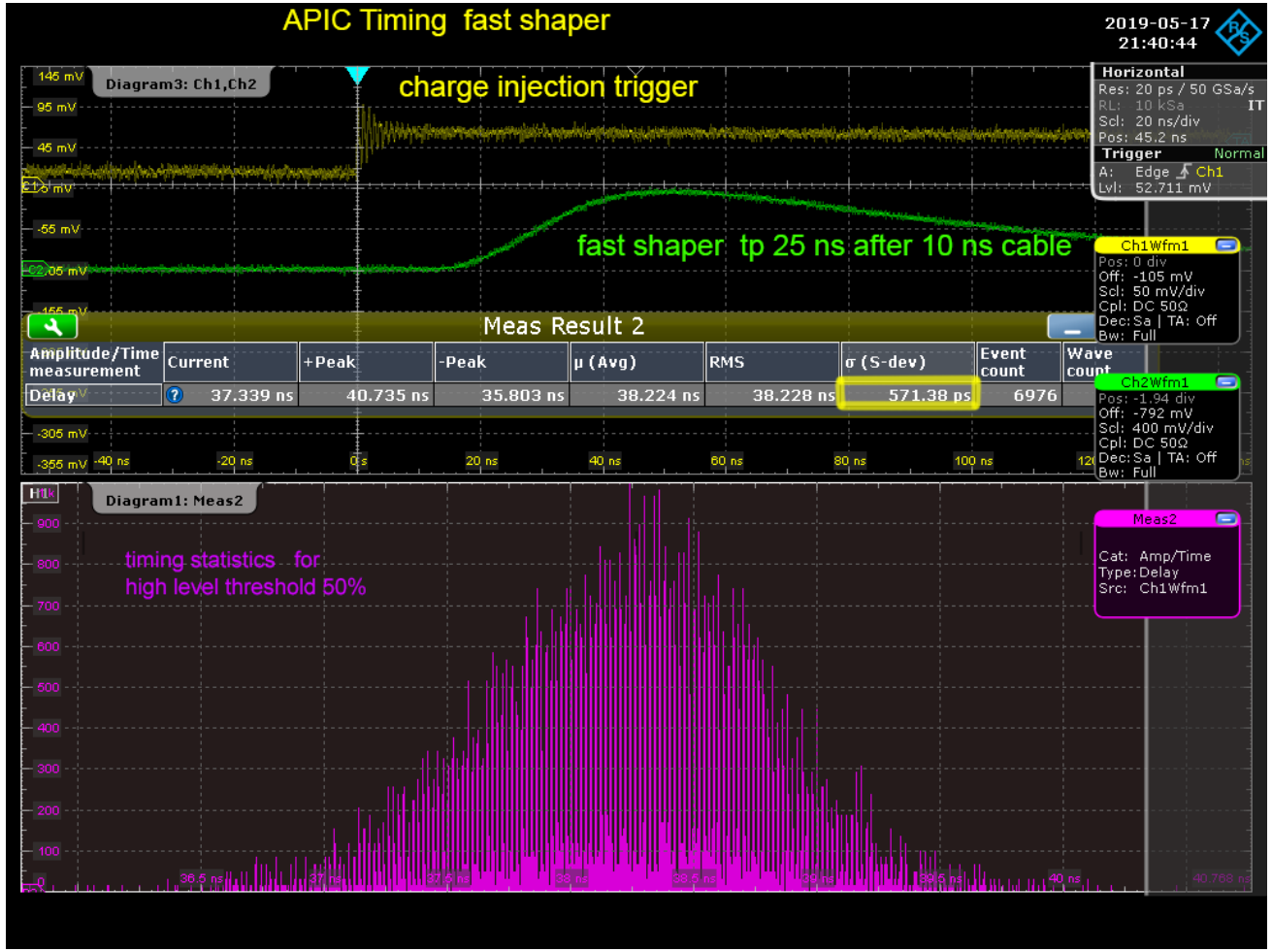


Timing CSA preamplifier



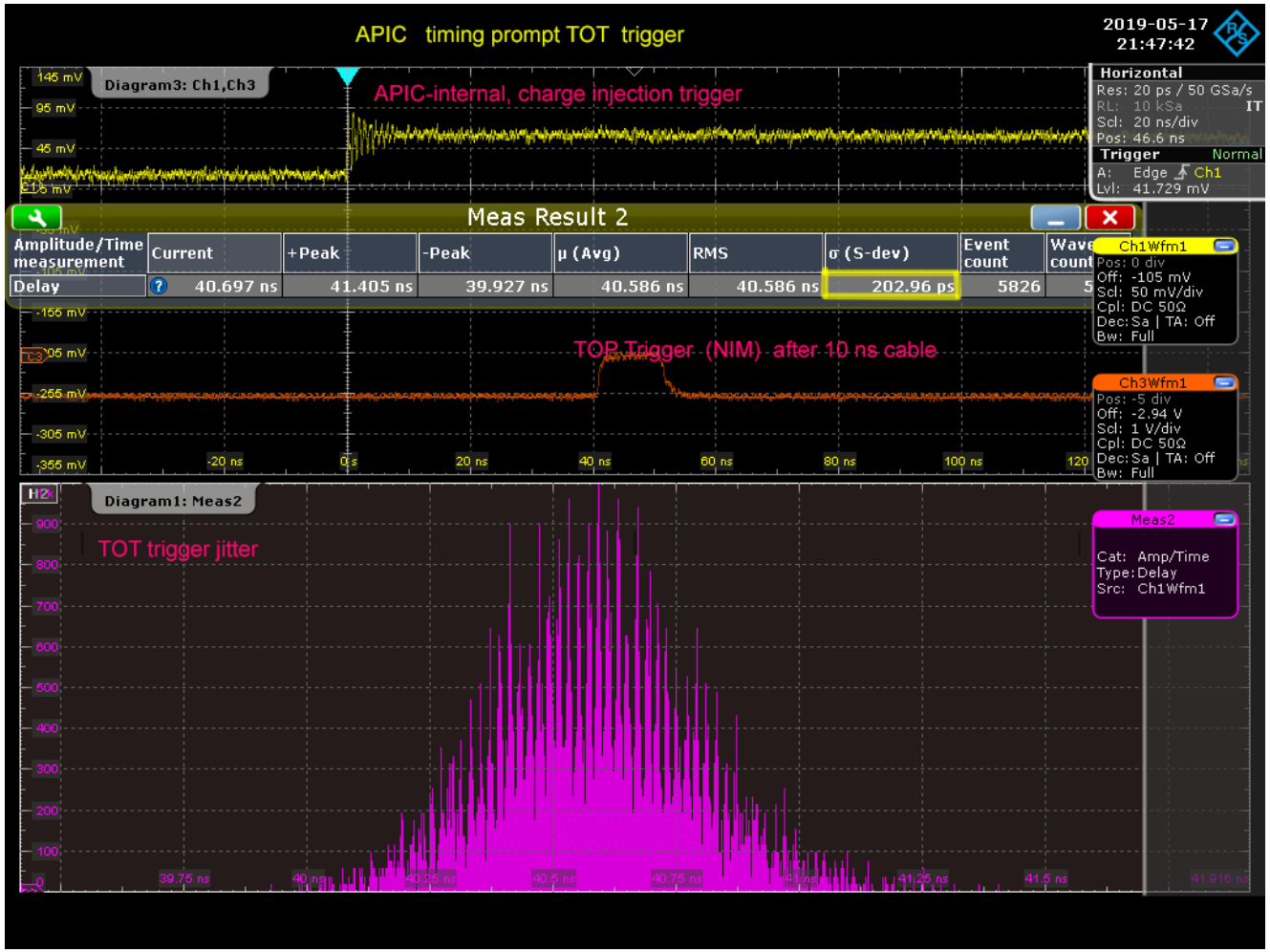
Based on the APIC-internal charge trigger with tr ~ 100 ns, the external CSA preamplifier signal jitter (after 2 m coax and 50% signal Threshold applied to the center CSA signal) is 68 ps.

Timing fast shaper



Based on the APIC-internal charge trigger with tr ~ 100 ns, an external threshold to the fast shaper selection (after 2 m coax and 50% signal threshold at high signal level) is 0,57 ns .

Timing TOT trigger



Based on the APIC-internal charge trigger the TOT trigger risetime (after 2 m coax and 50% of the NIM signal)
is 0,2ns .