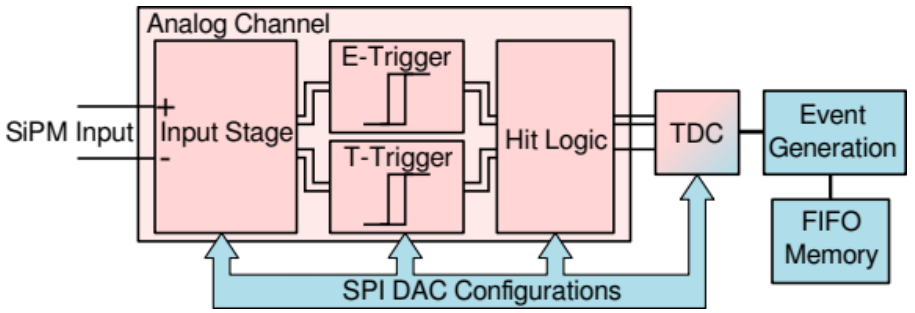
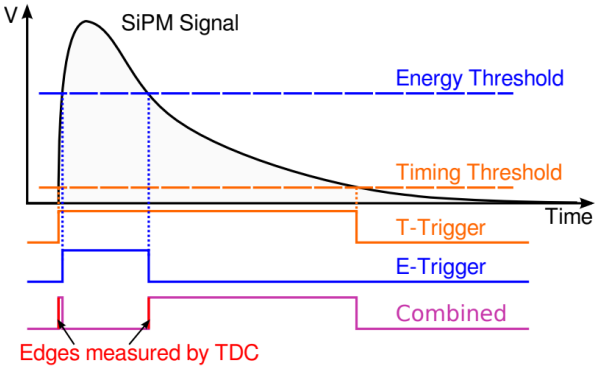
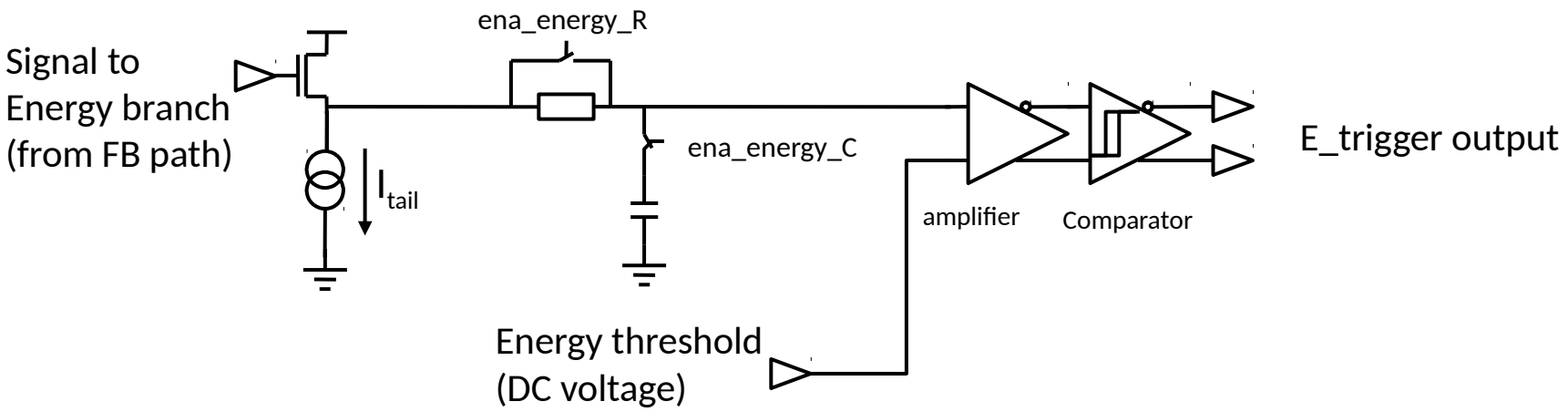
MuTRiG Energy Branch Modification (for Mu3e Fibre Detector)

Introduction of MuTRiG analog part and energy branch







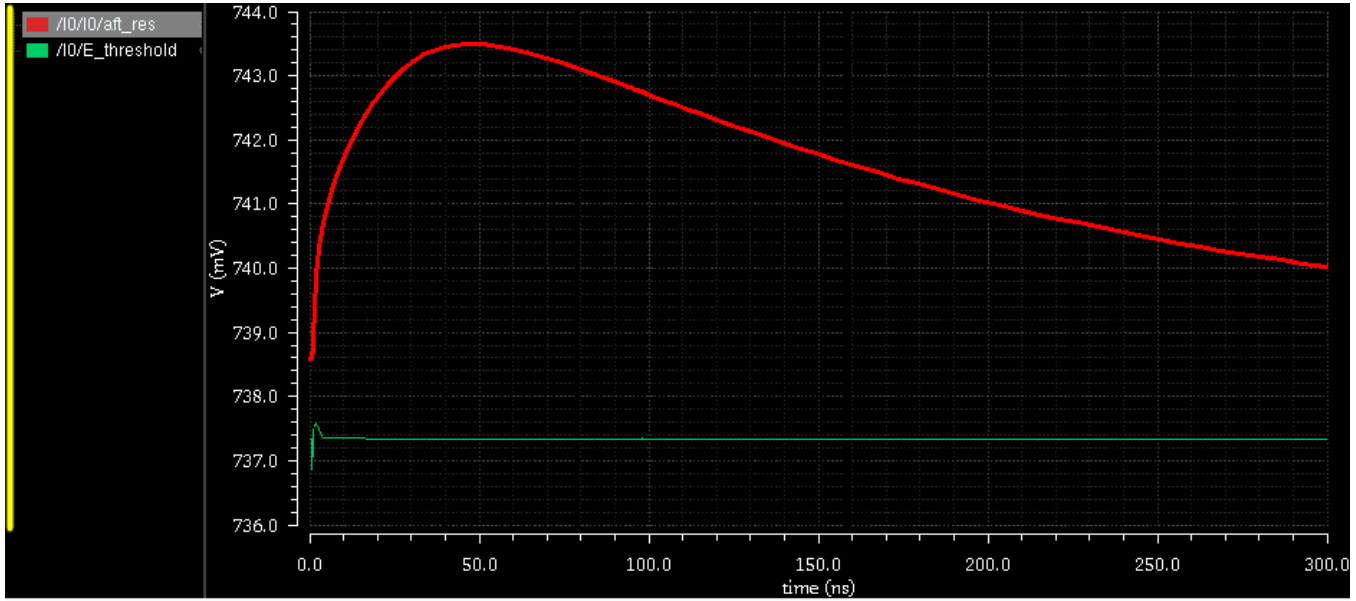
Problems and requirements

- With RC-filter, few-photon event signals have too small amplitude to trigger the energy branch.
- Without RC-filter, the energy trigger signals are too short such that the second edge of the combined signal falls into the dead time of TDC and is not registered by TDC.

Requirements:
1. To distinguish DCR event and physical event
2. To integrate the signals for the photons from the same event which might come with certain arrival time difference (5ns)

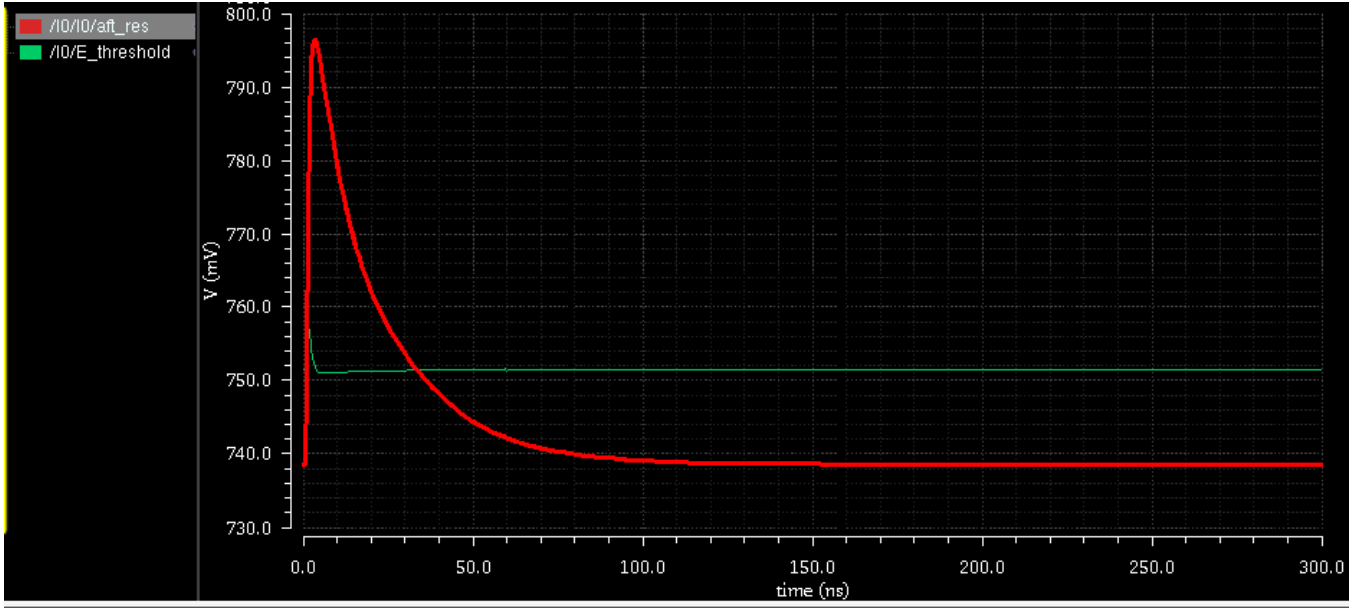
- The energy branch should be triggered by 1-photon event.
- The energy trigger signals should be longer than TDC dead time.
- The energy branch should have sufficient resolution to distinguish 1-photon event and 2-photon event.

Single-photon signal with RC filter On



- Amplitude: ~ 5mV.
- Less than LSB of energy threshold DAC (~7mV).

Single-photon signal with RC filter off

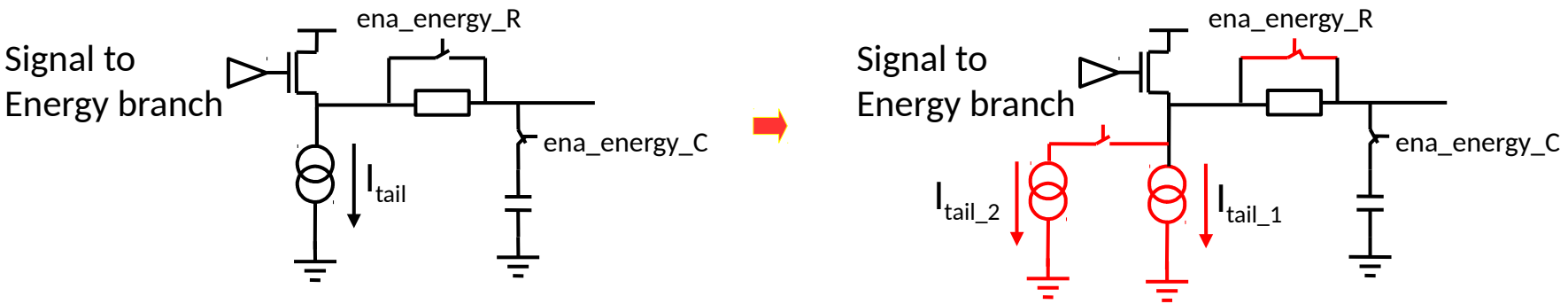


- Amplitude: ~ 60mV.
- Pulse is too short.

Solution

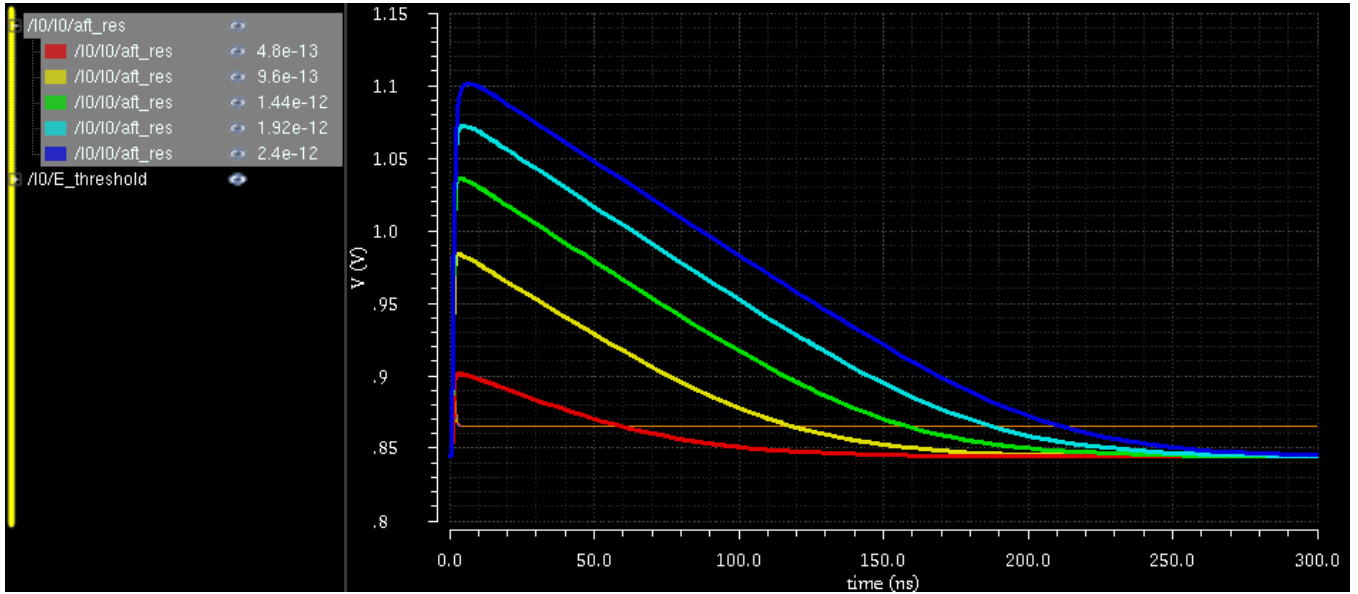
- Short the Resistor
- Reduce the bias current of previous source follower stage
- Add a switch to restore the original configuration

→ extend the tail of the signal

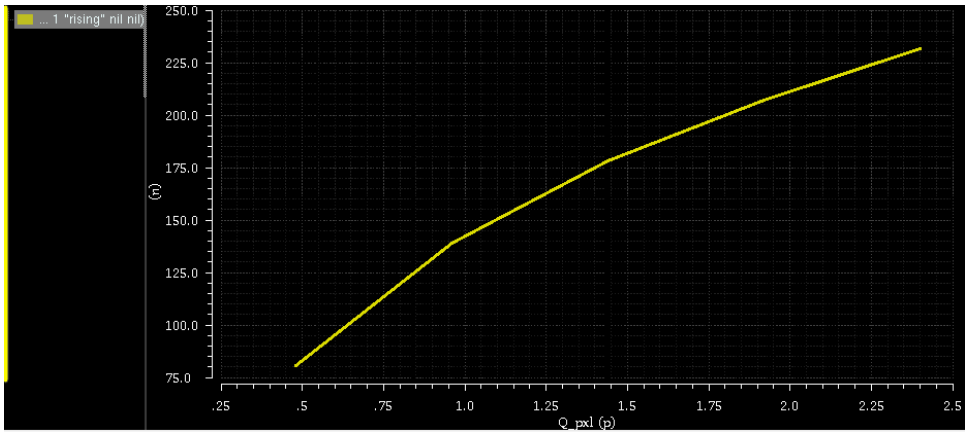


- Small I_{tail_1}
- $I_{tail\_1}+I_{tail\_2} = I_{tail}$

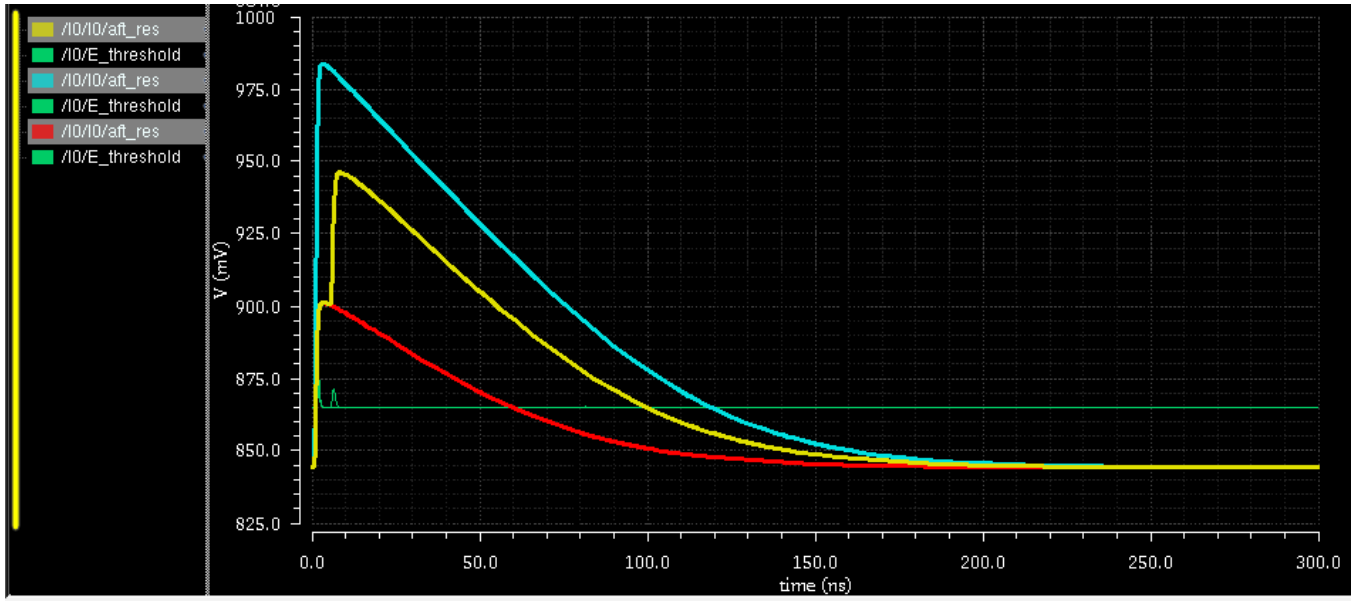
Signals for 1-5 photons events



- Amplitude: 50 – 250mV (covered by 7-30 E threshold DAC values)
- ToT pulse width: 80 – 230 ns

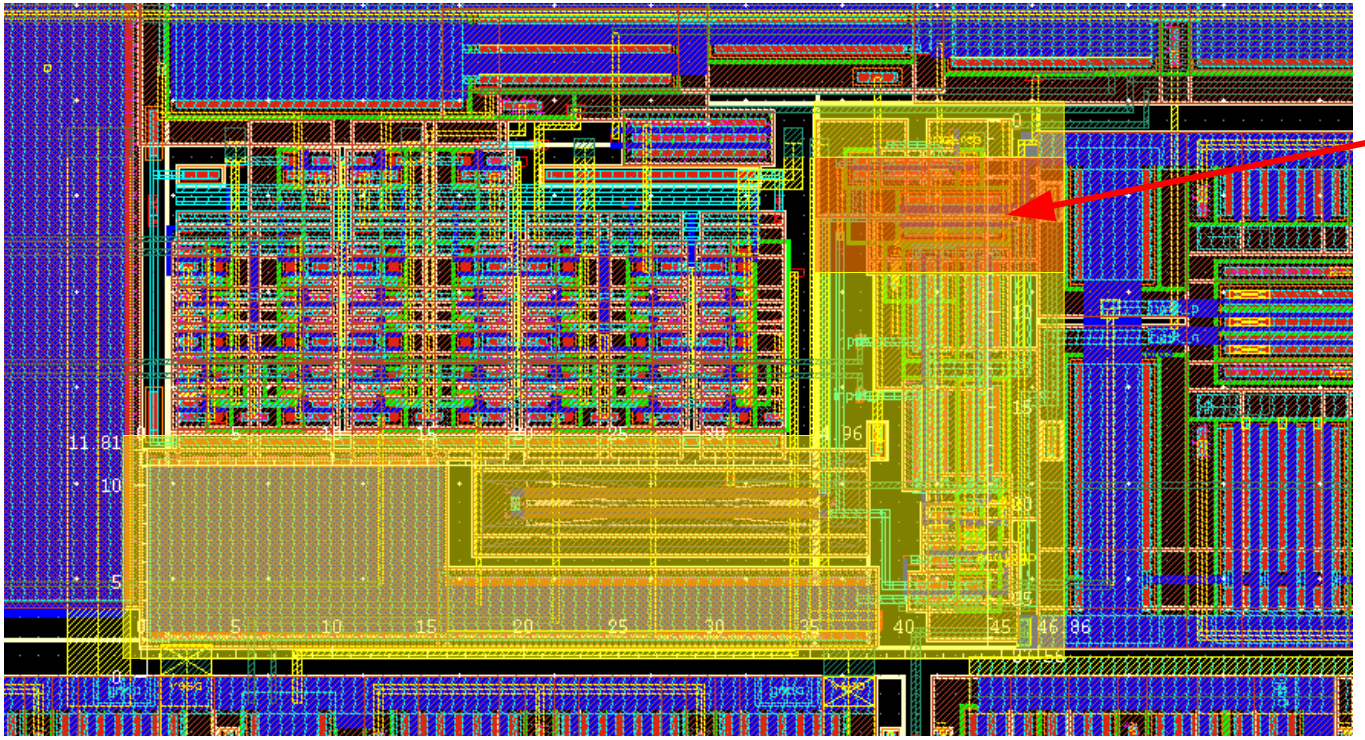


Signal with 2 photons separated by 5 ns



Case	ToT (ns)
1-photon	80
2-photon (5n separation)	120
2-photon (at the same time)	139

Layout Plan



- Add a switch here (one more SPI bit).
- Add a small transistor here.

Further Modifications

- De-couple the energy threshold and timing threshold?