A logical interface between a clinical accelerator and your physics research experiment

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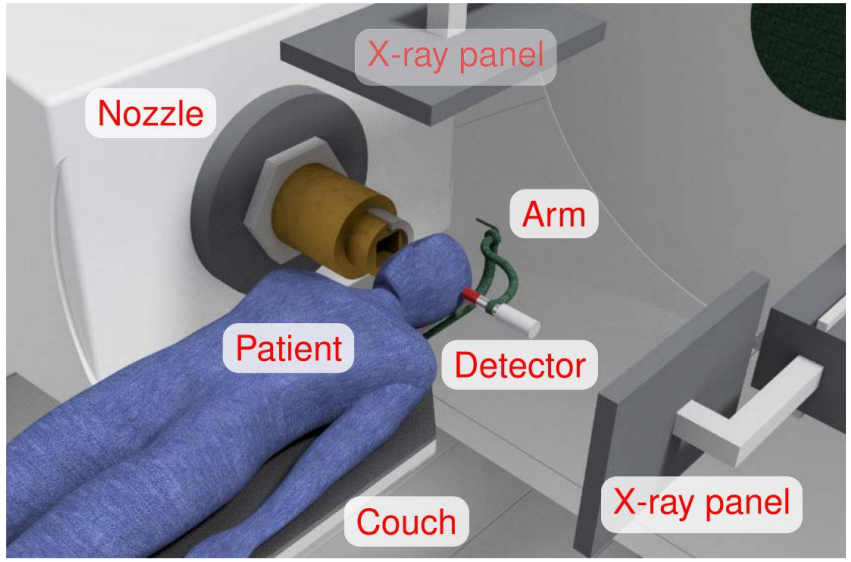
https://ohwr.org/project/sis1160-pci-io/-/wikis/home

Proton therapy use is growing exponentially but nowadays ***no standard way*** for real-time proton range verification

Our proposal is to develop a system to reduce the proton range uncertainty from 10 to 1mm
Counting prompt γ-ray and positron emitters with an uncollimated, coaxial-oriented scintillator and fast-DAQ
Target: brain, head&neck and paediatric tumours



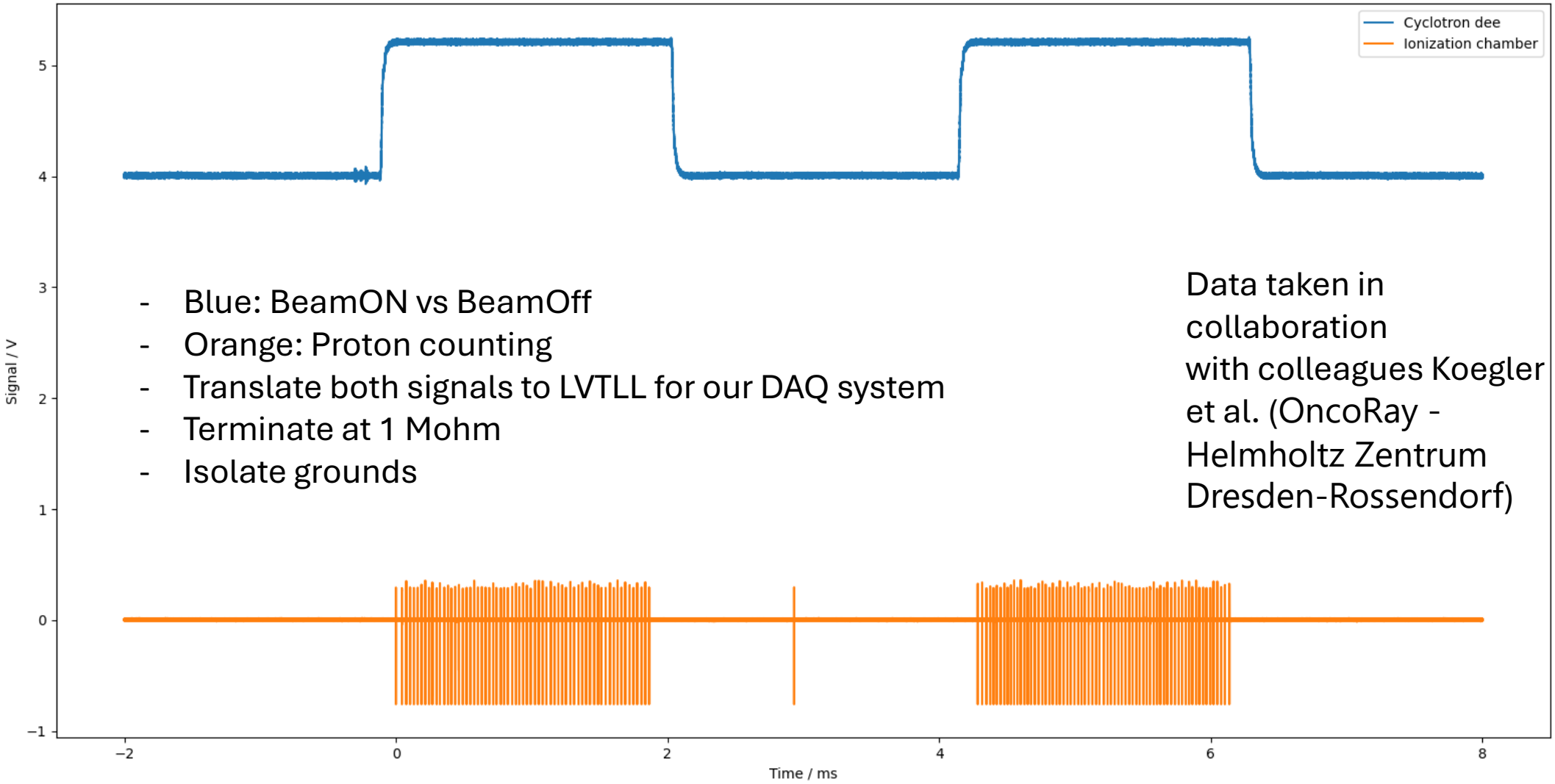
	State-of-the-art	Proposal
Scintillators [#]	8	1
Weight [Kg]	200	10
Cost [k€]	250	50
Data rate [kHz]	60	10,000
Pulse pile-up [%]	0	80
Integration	Unsolved	Easy

Methods

- A scintillator with high count-rate capabilities (10 Mcps)
- A fast PMT supplied 10x the max recommended rating
- A dead-time-free data acquisition system at 2.5 Gsps/14-bit (Struck SIS1160-SFMC01 PCIe Gen3x8), using ROOT.
- Embed the accelerator status in the 15th bit of the waveform

https://doi.org/10.1109/TRPMS.2019.2930362
https://doi.org/10.1016/j.nima.2022.166701

Motivation: track accelerator logical status without jeopardizing clinical safety

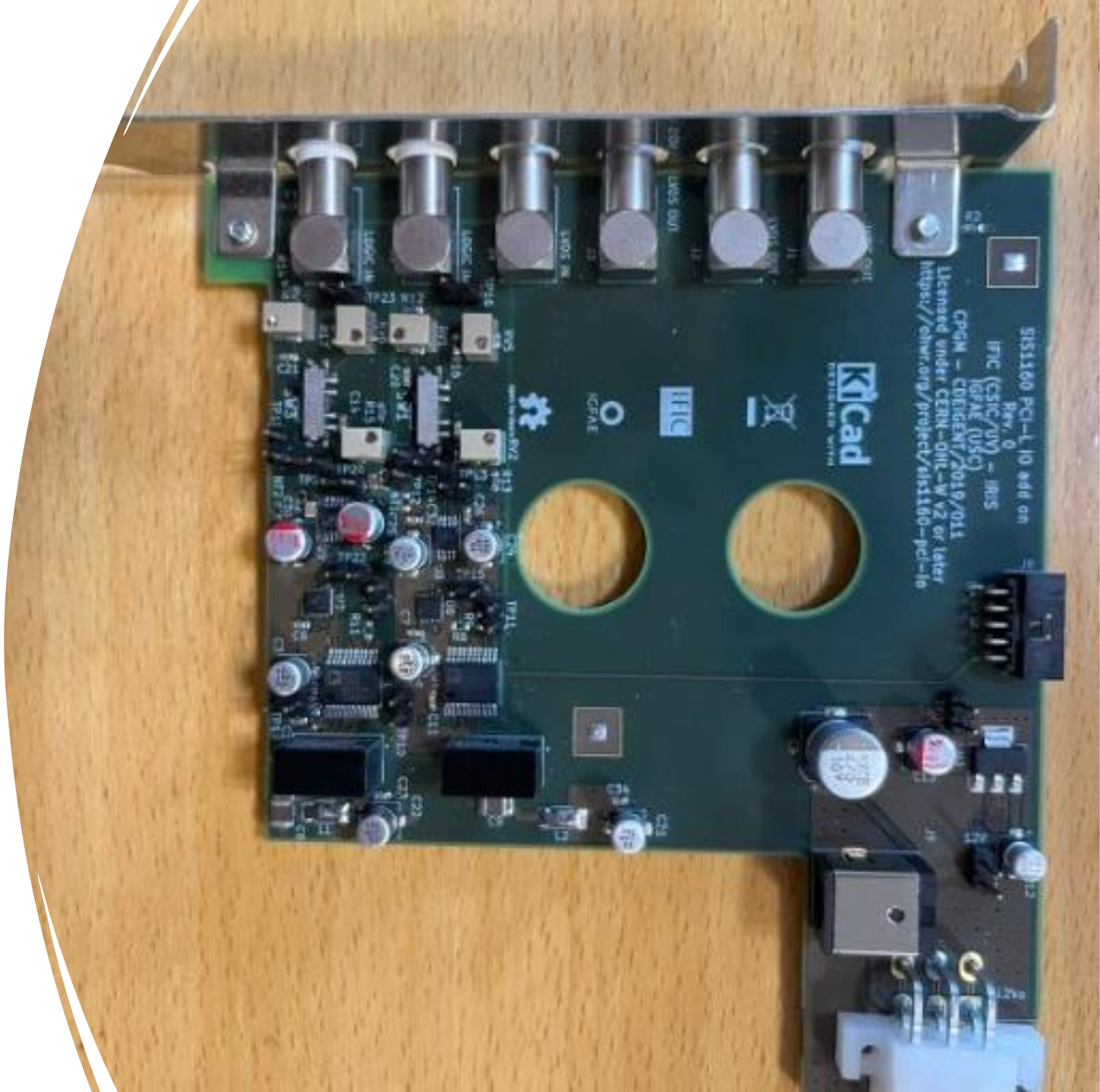


- Blue: BeamON vs BeamOff
- Orange: Proton counting
- Translate both signals to LVTLL for our DAQ system
- Terminate at 1 Mohm
- Isolate grounds

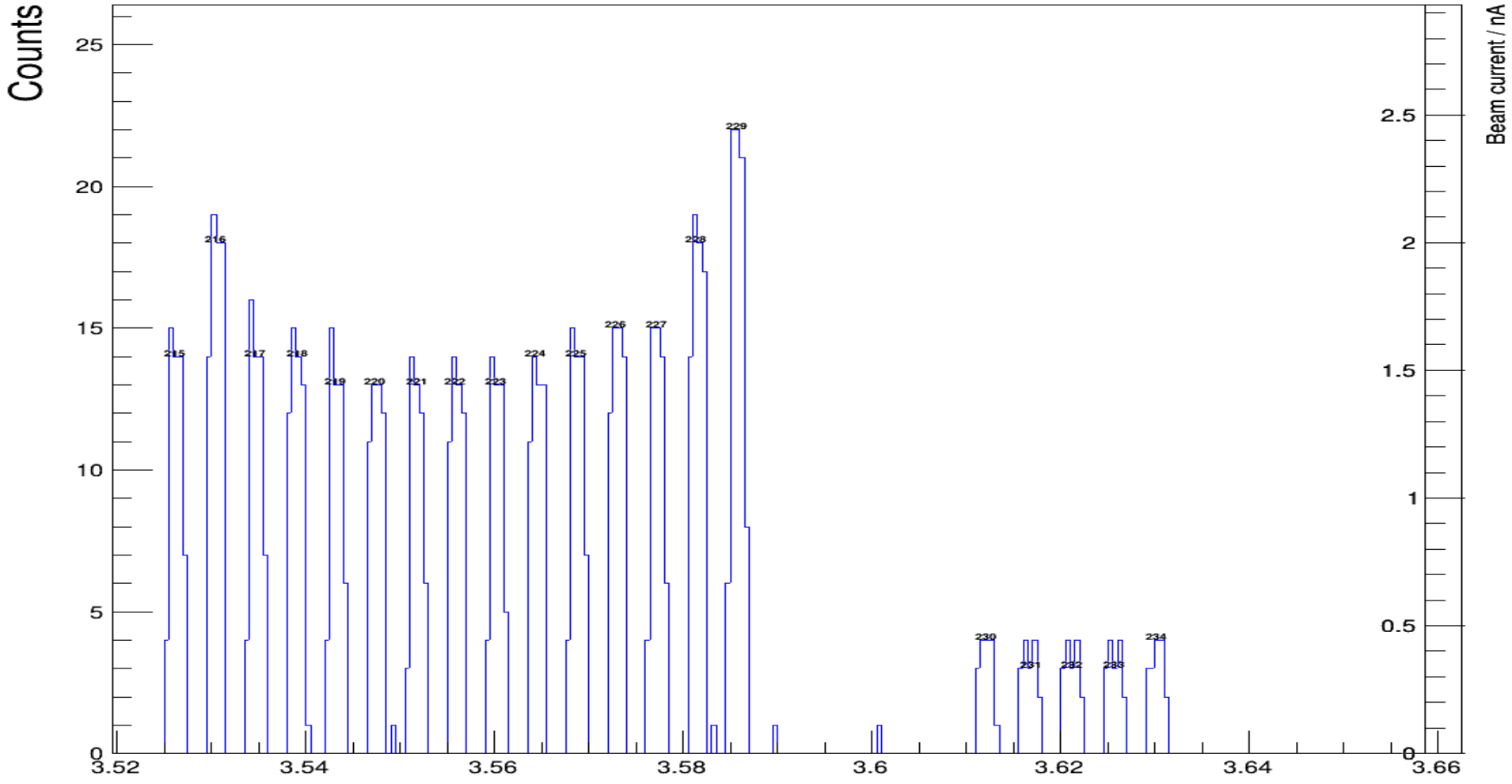
Data taken in collaboration with colleagues Koegler et al. (OncoRay - Helmholtz Zentrum Dresden-Rossendorf)

Our solution

- Designed with KiCad between IGFAE and IFIC
- Available at OHWR
- Sustains 20 MHz signals
- Input: LEMO, any voltage/polarity
- Output: flat cable, LVTTL
- Optimizations ongoing



Example of our GPIO measurements after trigger + isolation for proton counting and pencil-beam spot identification



Conclusions

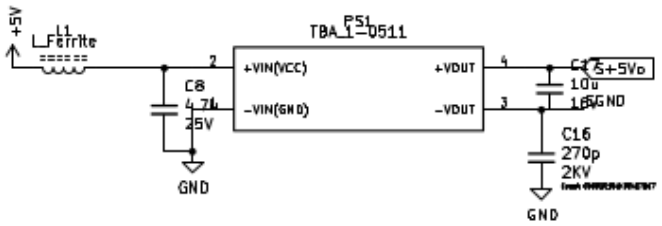
- Different open software could we use for applications outside CERN in the medical application community.
  - Kicad.
  - Root.
  - OHWR.

THANKS

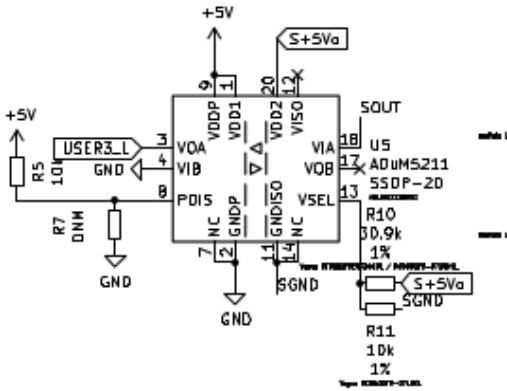
Backup

Isolation branch

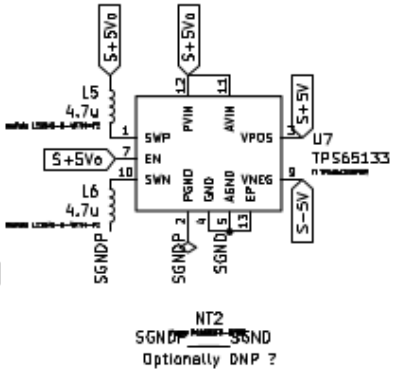
Isolated power



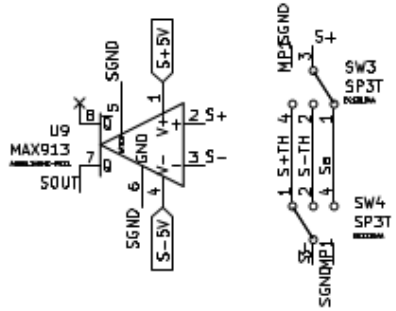
Isolation



Bipolar Supply



Triggering



Input