OPTIMIZING PARTICLE DETECTION THROUGH CURRENT BUFFER DESIGN

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1. Motivation

Hybrid particle position detectors **push the limits** of high-precision measurements, but **signal reflections** distort data and reduce reliability. These interferences degrade signal integrity and detector performance.

This project implements **BJT-based current buffers** to **ensure precise current copying**. By stabilizing transmission and minimizing distortions, this approach enhances efficiency, unlocking more accurate experimental results.

2. Background

Hybrid particle detectors, which **integrate** segmented and time-of-flight (TOF) architectures, **enhance** spatial resolution and detection efficiency, being highly effective for precise measurements in experimental physics. However, signal **reflections** introduce distortions that degrade and compromise data integrity. These reflections result from impedance mismatches, causing unwanted signal distortion and inaccurate espacial resolution.

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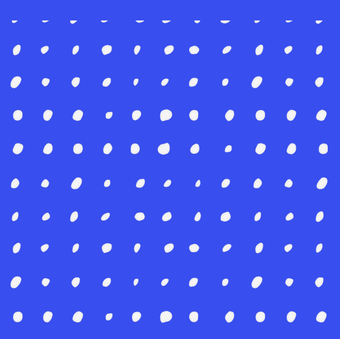
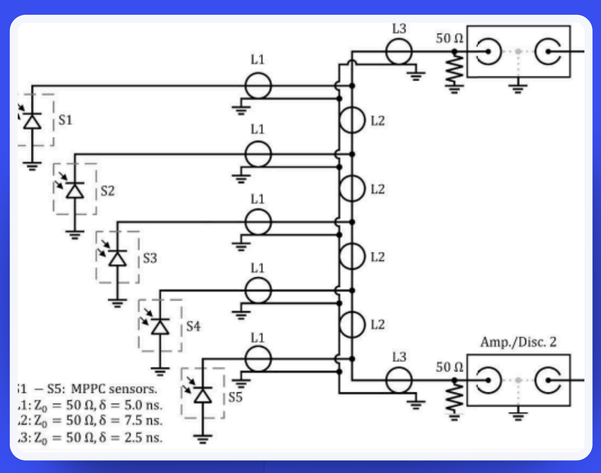


TIME-OF-FLIGHT

Mitigating reflection effects and achieving **precise current copying** are crucial to maintaining signal consistency and accuracy. Without effective mitigation, distortions can propagate through the system, resulting in **erroneous measurements** and reduced detector performance.

A promising approach involves leveraging **BJTs** and **current mirrors**. BJTs provide high current gain and low voltage drop, making them ideal for minimizing distortions, while current mirrors ensure uniform current distribution

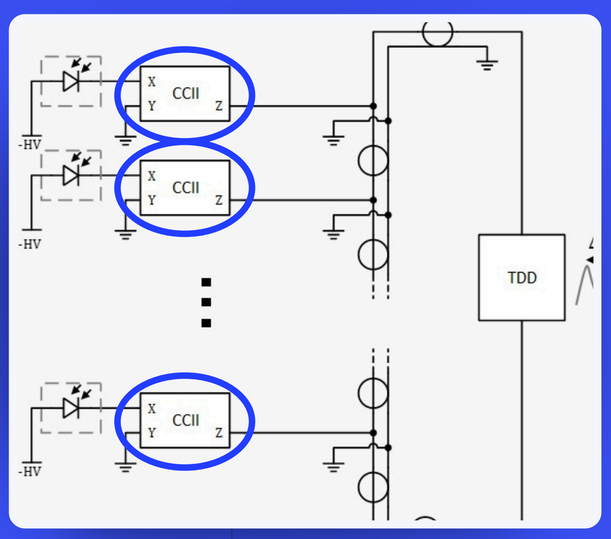
3. Problem and Methods



Before applying CCII.

To tackle the challenge of signal reflections in hybrid particle detectors, this project focuses on **implementing BJT-based current buffers to mitigate distortions**, ensure precise current copying, and enhance system stability and bandwidth.

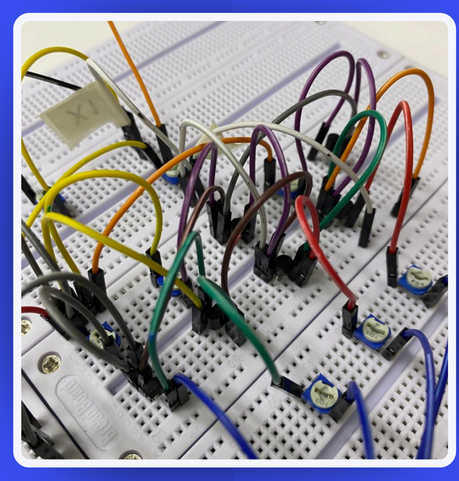
*" From **BJT's** to **Current Mirrors** to **Current Conveyor** "*

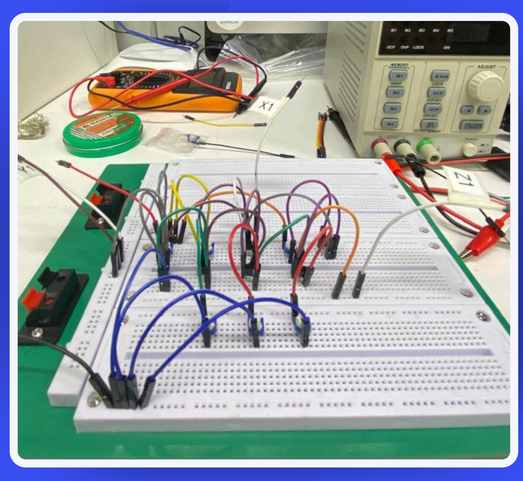


After applying CCII.

Development began with BJT-based current mirrors, incorporating Wilson topology to improve accuracy. **Simulations** and **experimental validations** confirmed the previus properties of current copying and strengthening signal consistency.

To further optimize performance, current conveyors were explored, leading to the selection of the **Matsuura topology** due to its simple and reliable replication. A low frecuencie prototype built on a protoboard **successfully** validated the design and simulations.

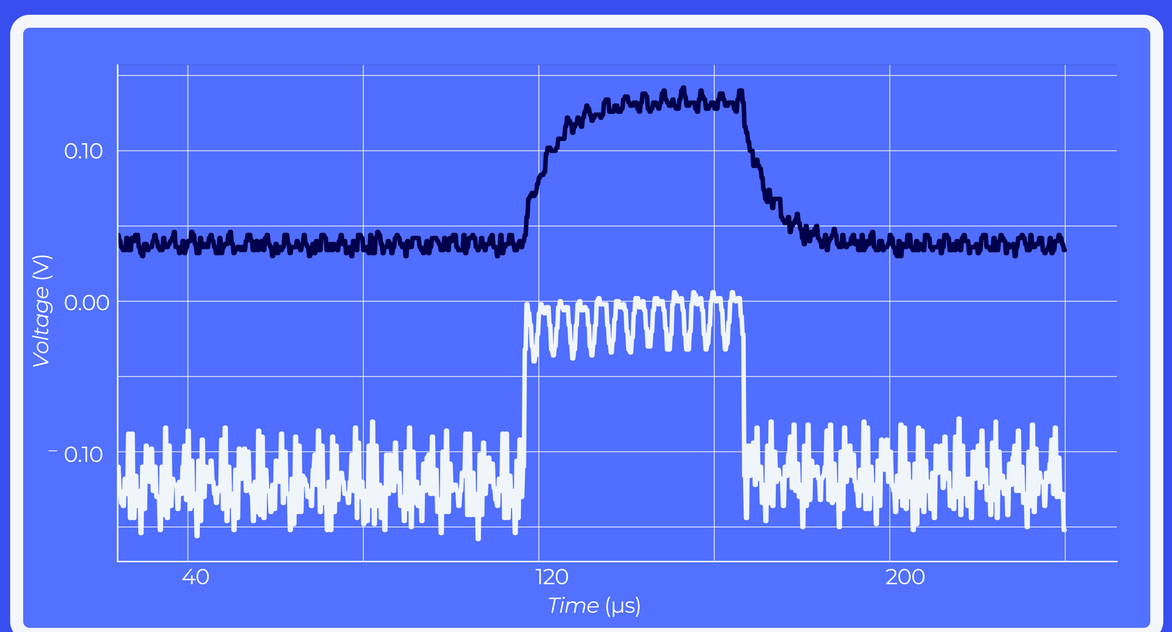




Protoboard current buffer.

4. Results

Experimental validation confirmed the effectiveness of the proposed solution, achieving precise **current copying** across circuits. The system ensured consistent, stable performance, reinforcing its potential for real-world applications.



Current copying comparison, between input and output.

5. Conclusions

BJT-based current buffers ensure **precise current copying**, minimizing distortions and enhancing reliability in hybrid particle detectors.

Next steps include implementing noise reduction techniques, such as filtering methods. An additional validation of the **reflects mitigation** must be done. The ultimate goal is to develop a **finalized prototype** for testing in a real particle detector environment, ensuring practical reliability and performance.

6. Acknowledgments

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