

Connections to the Beginning: Circuit Boards for CERN

Dillon Acker-James, Electrical Computing Engineering Major

Mentor: Aditya Dalakoti

Faculty Advisor: Professor Forrest Brewer, Electrical
Computer Engineering

Funding: High Granularity Calorimeter Studies (HGCal)



One of the Hottest Places in the Known Universe

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15 Million Kelvin

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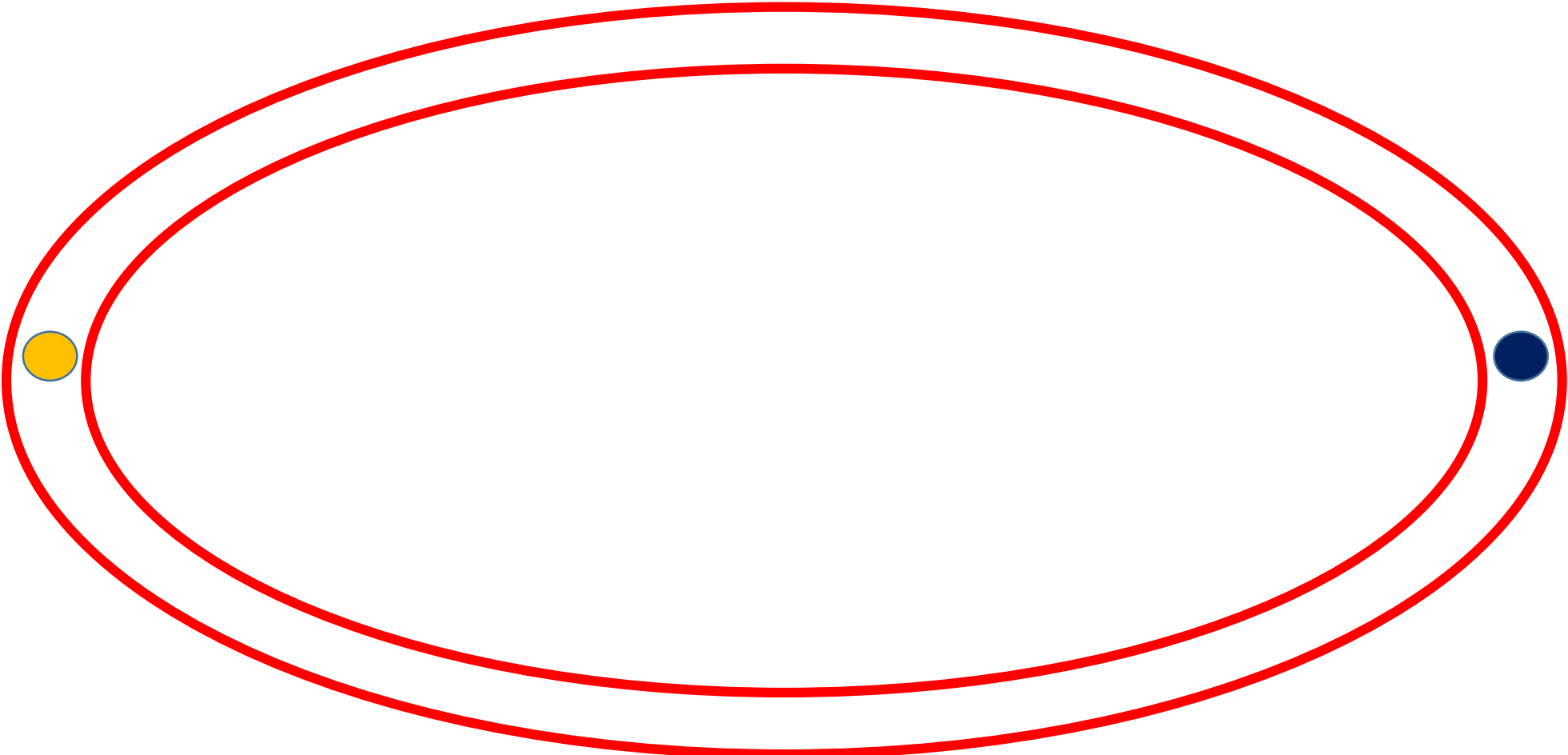


15 Million Kelvin

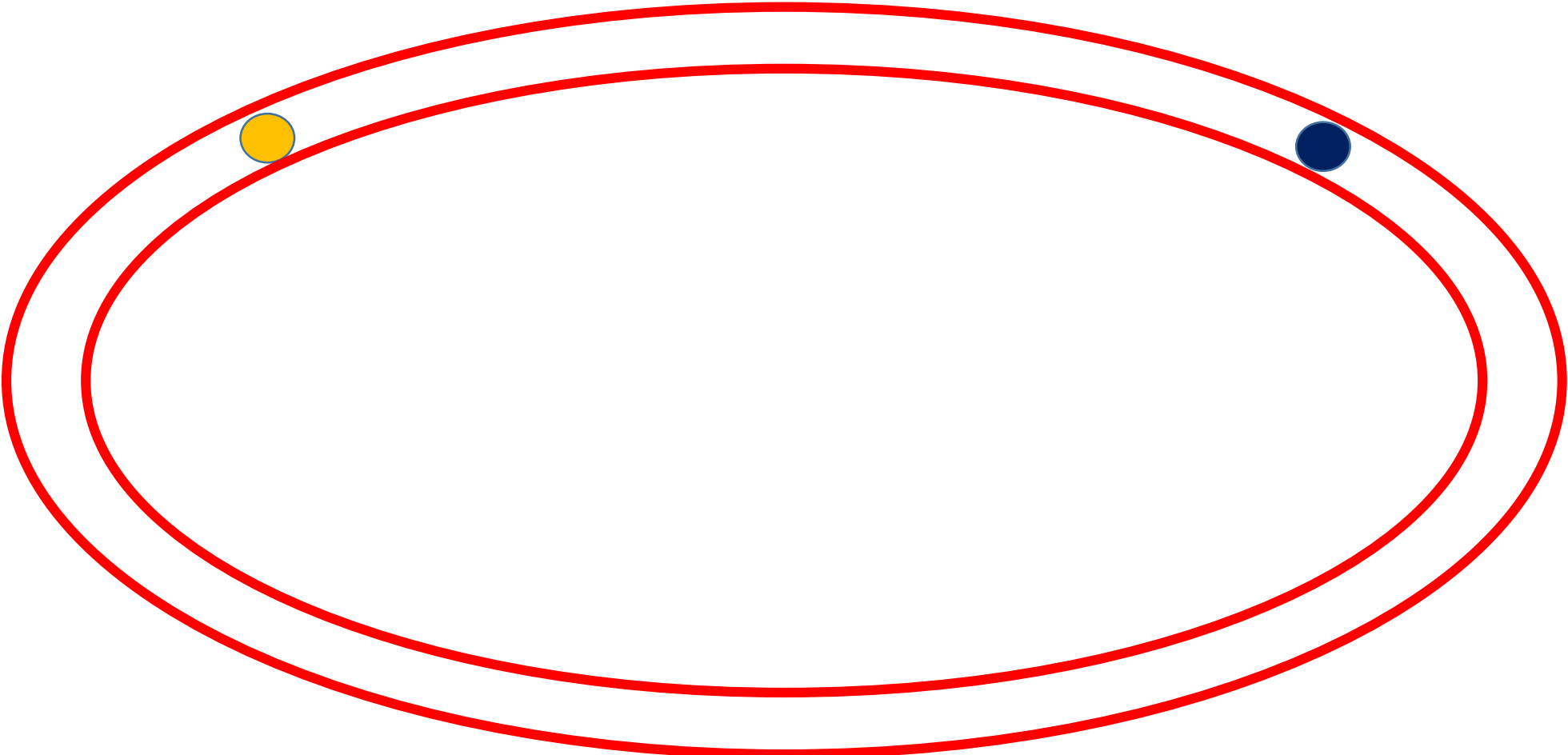


5.5 Trillion Kelvin

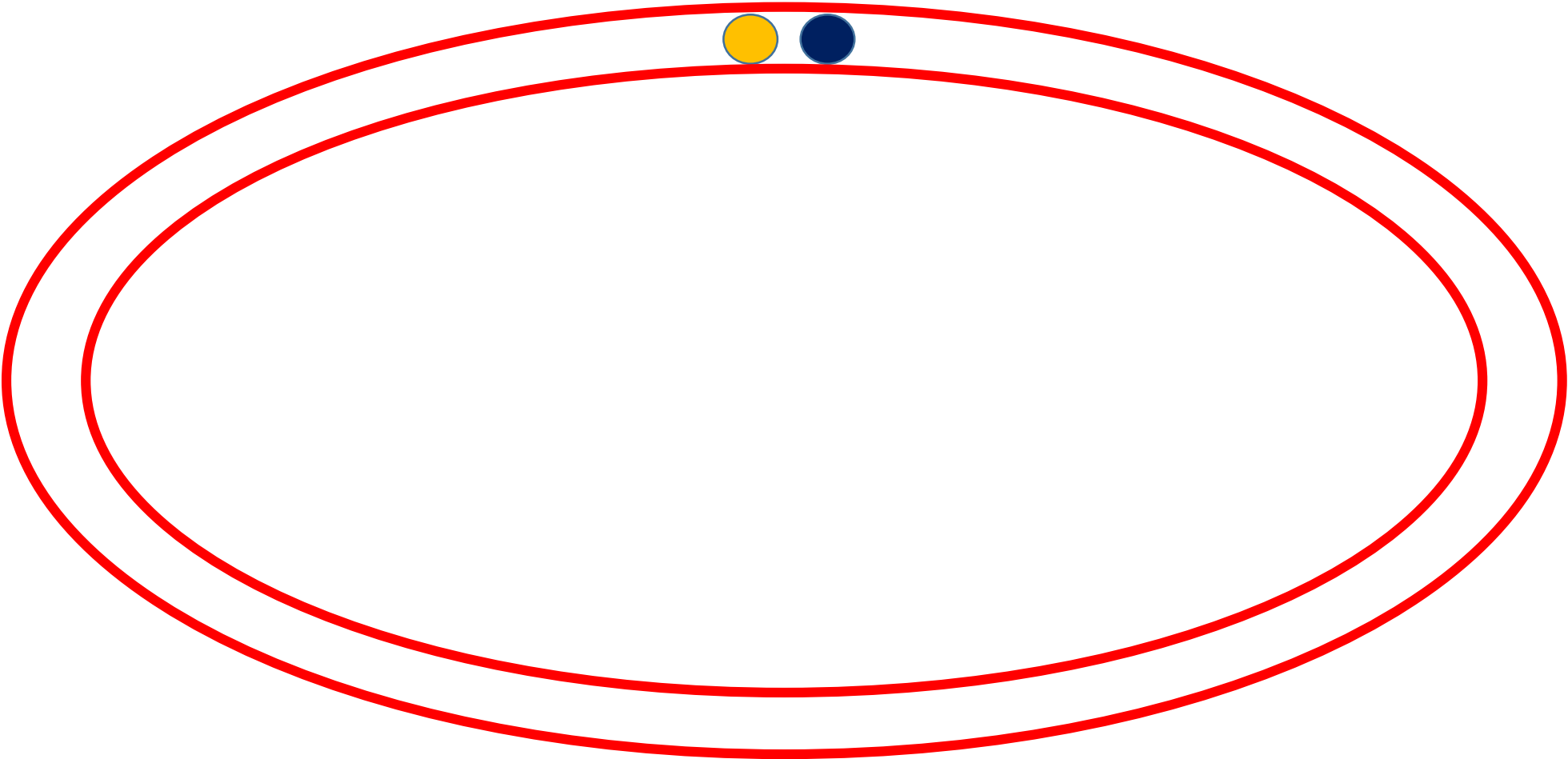
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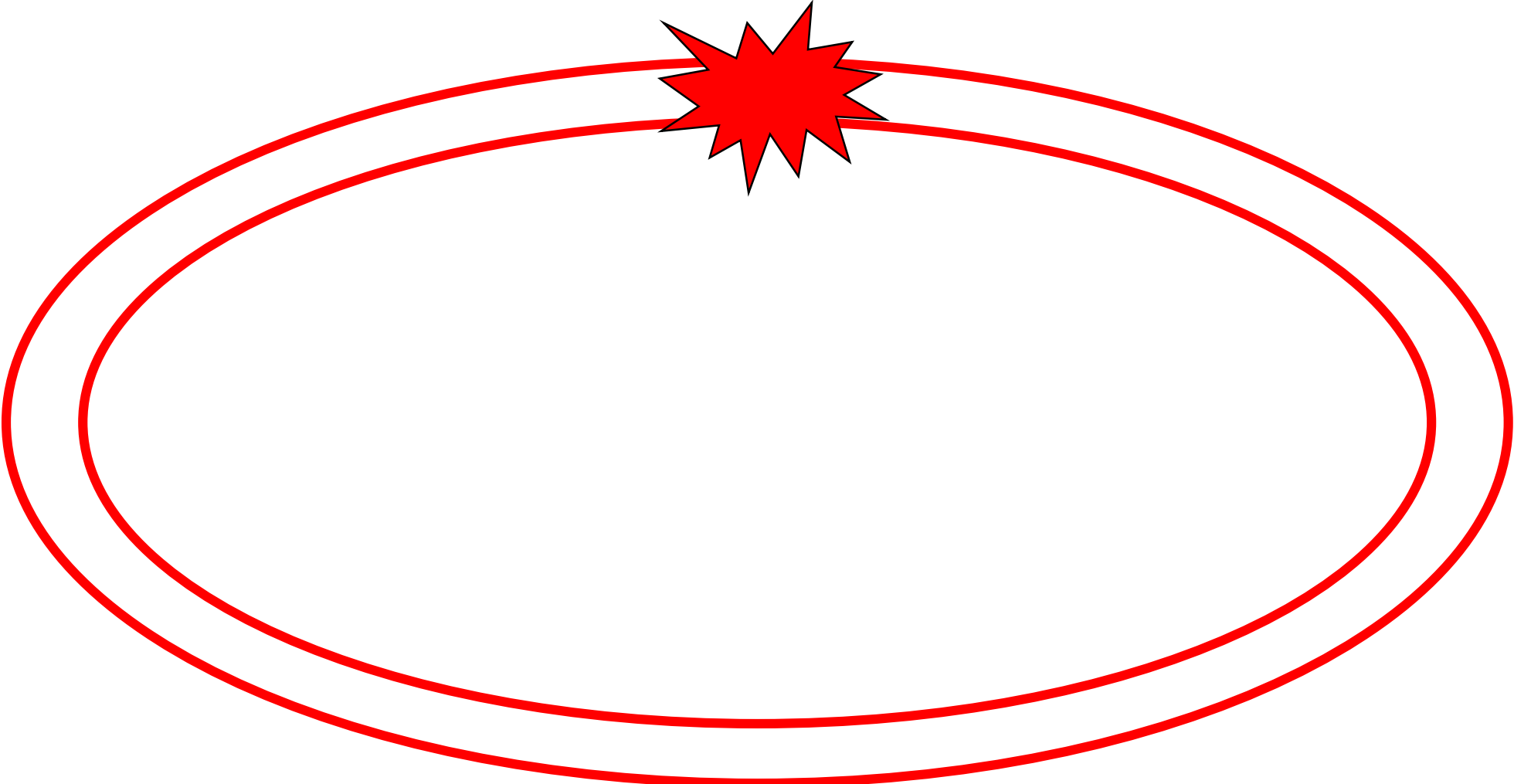
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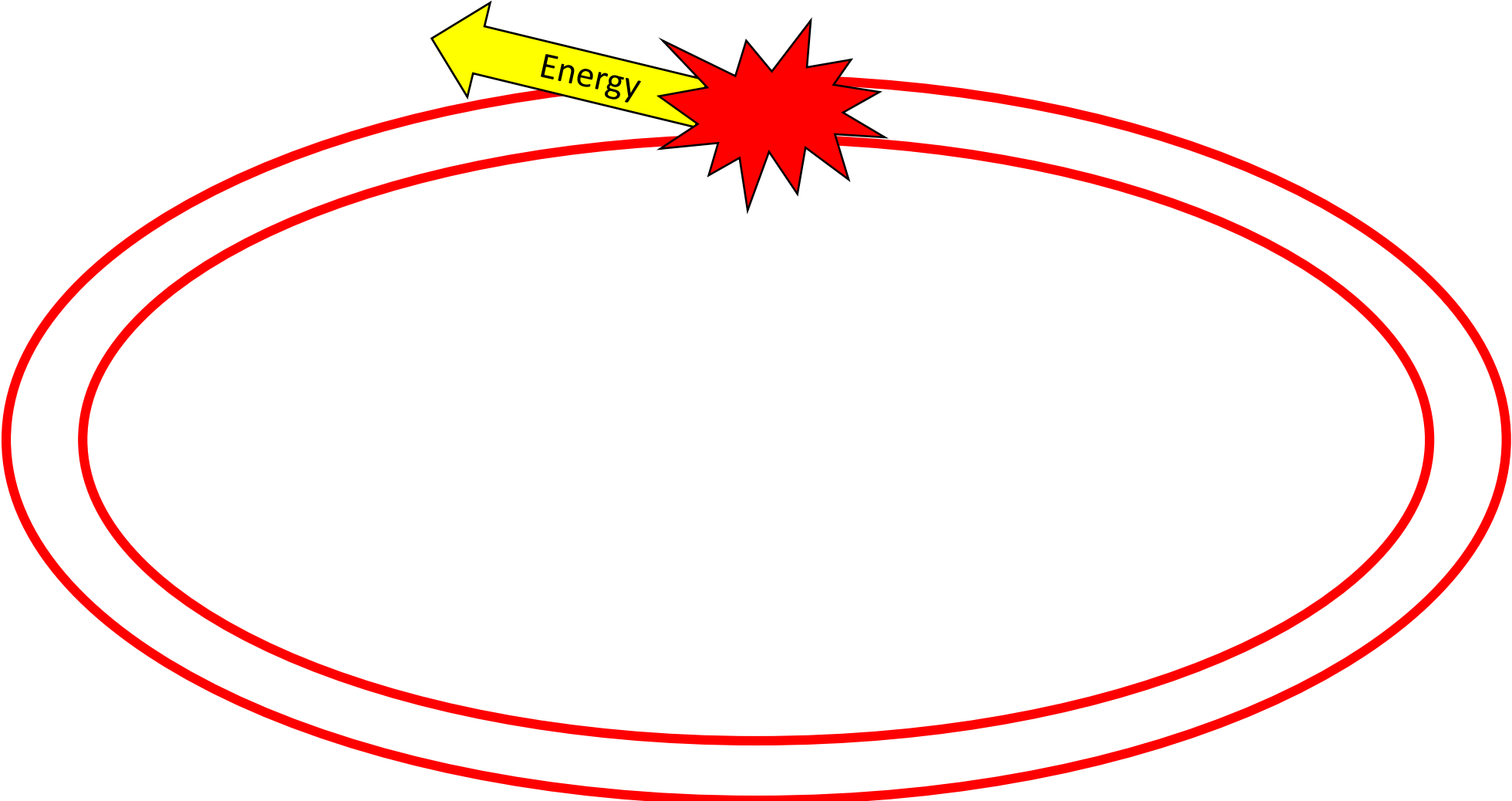
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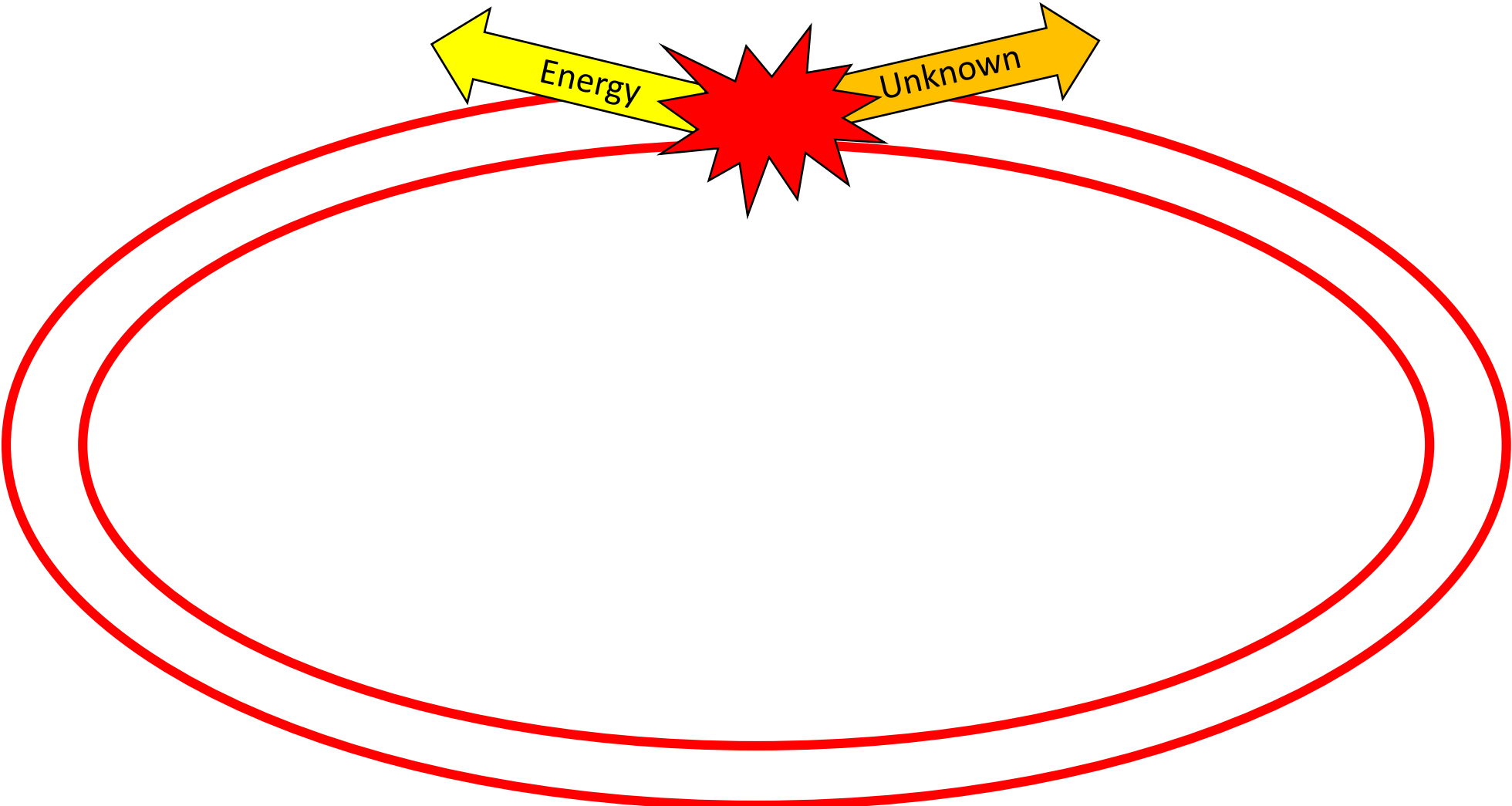
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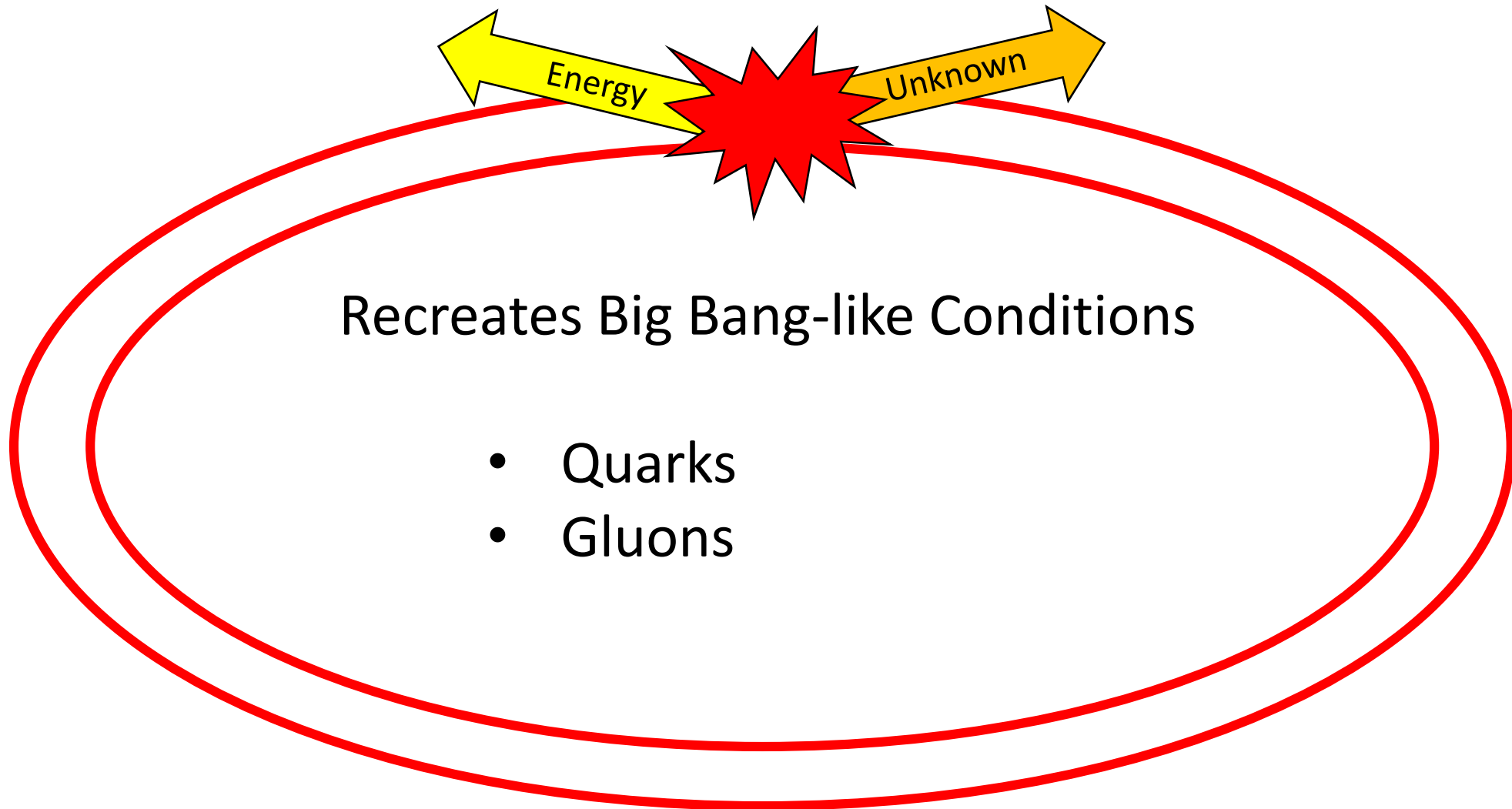
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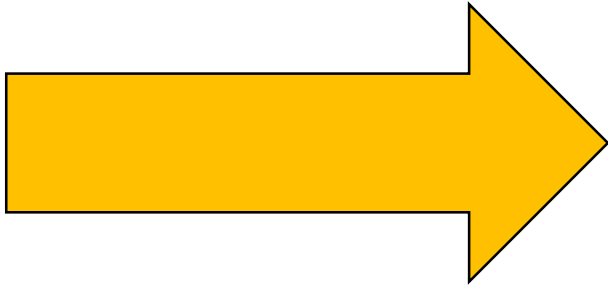
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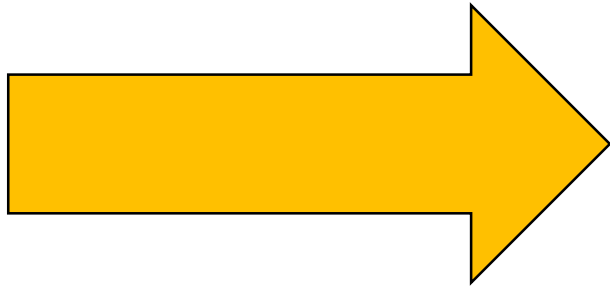


Connections Must Withstand Radiation and Have High Data Rates

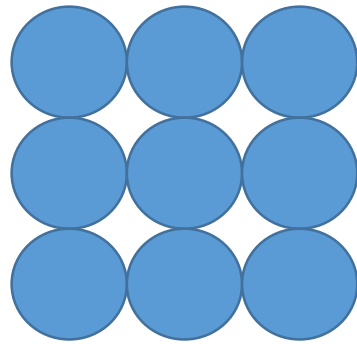


Unknown

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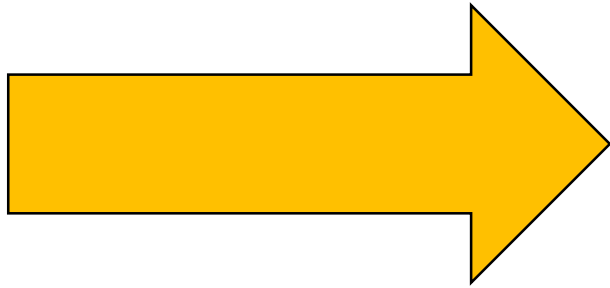


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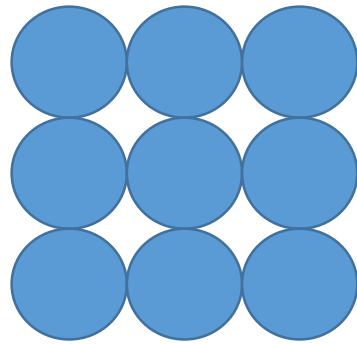


Silicon Detectors

Connections Must Withstand Radiation and Have High Data Rates



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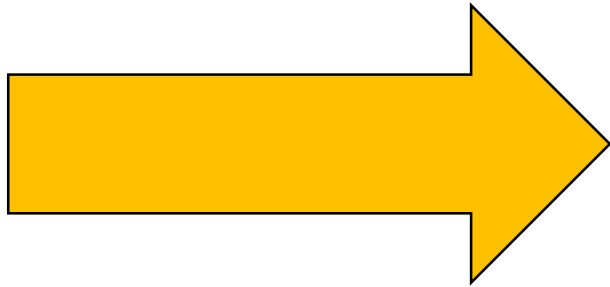


Silicon Detectors

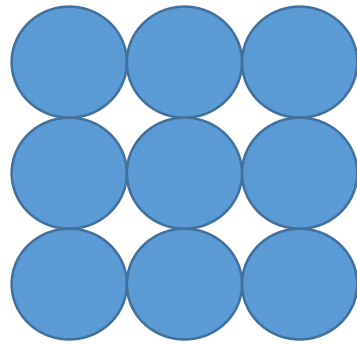


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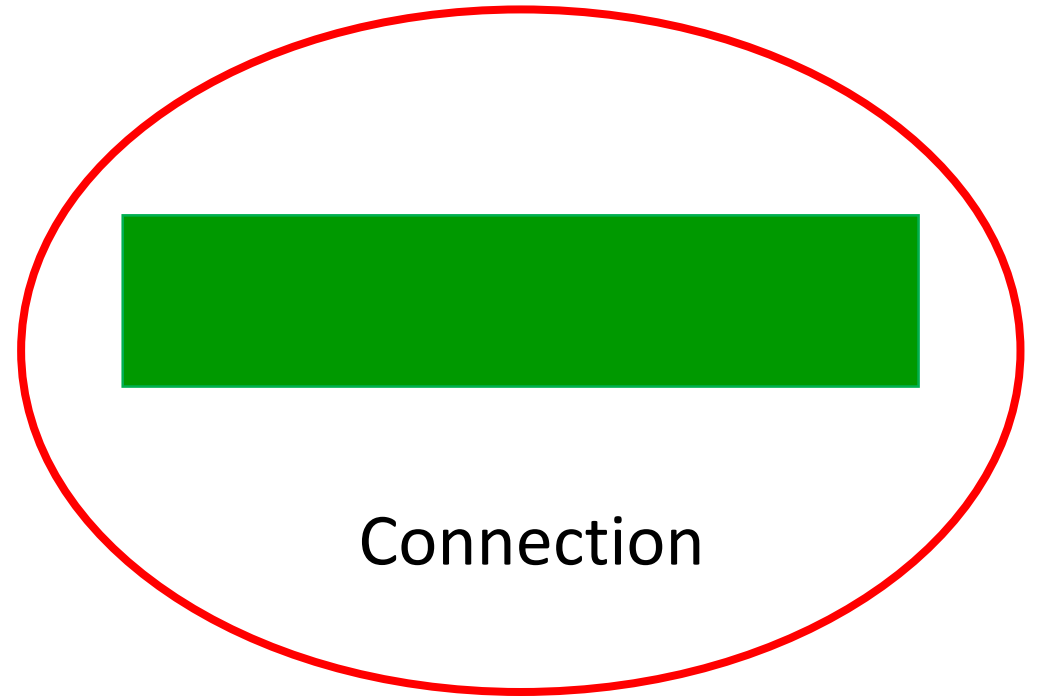
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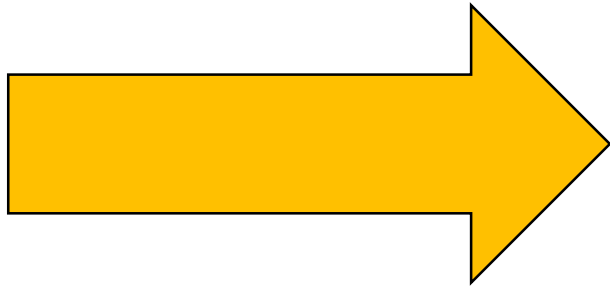


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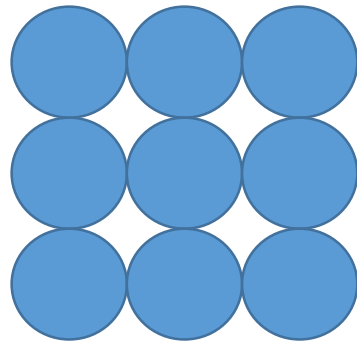


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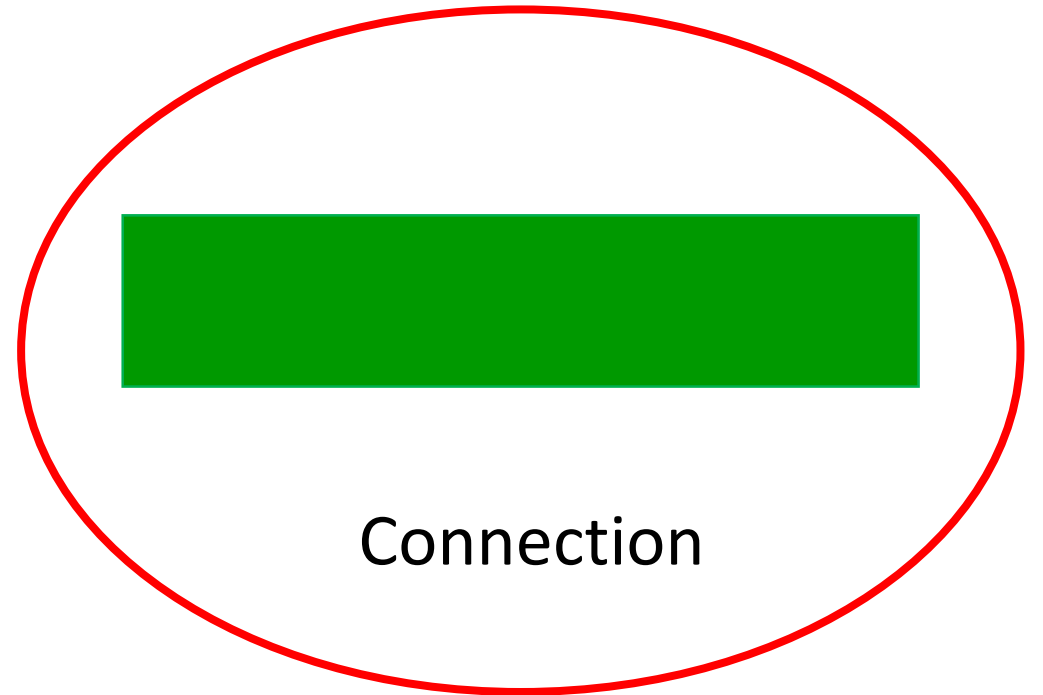
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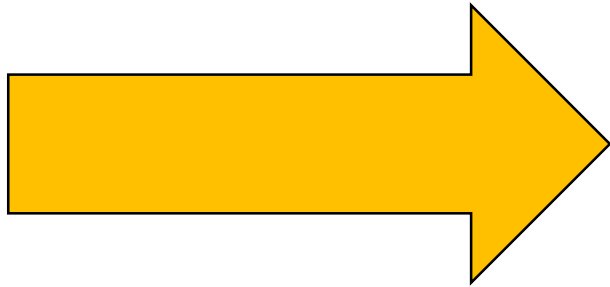
Silicon Detectors



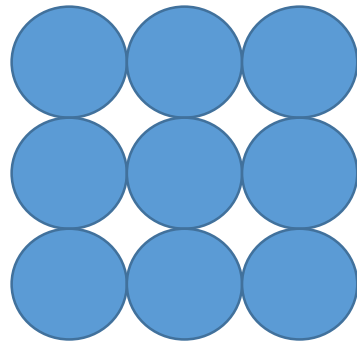
Connection

Withstand
Radiation

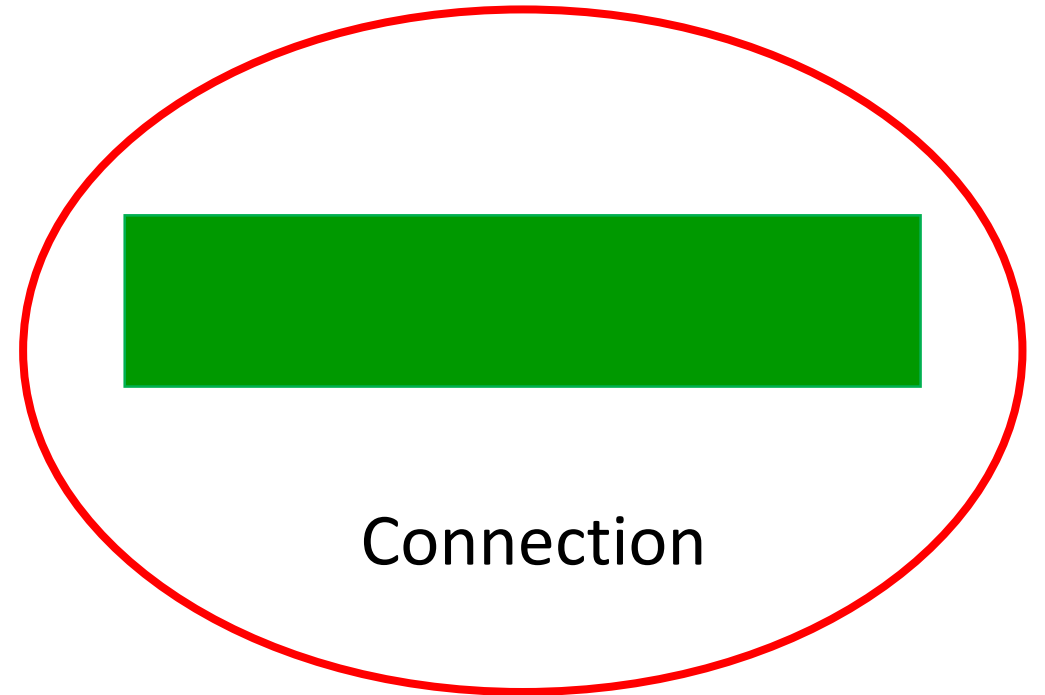
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Unknown



Silicon Detectors

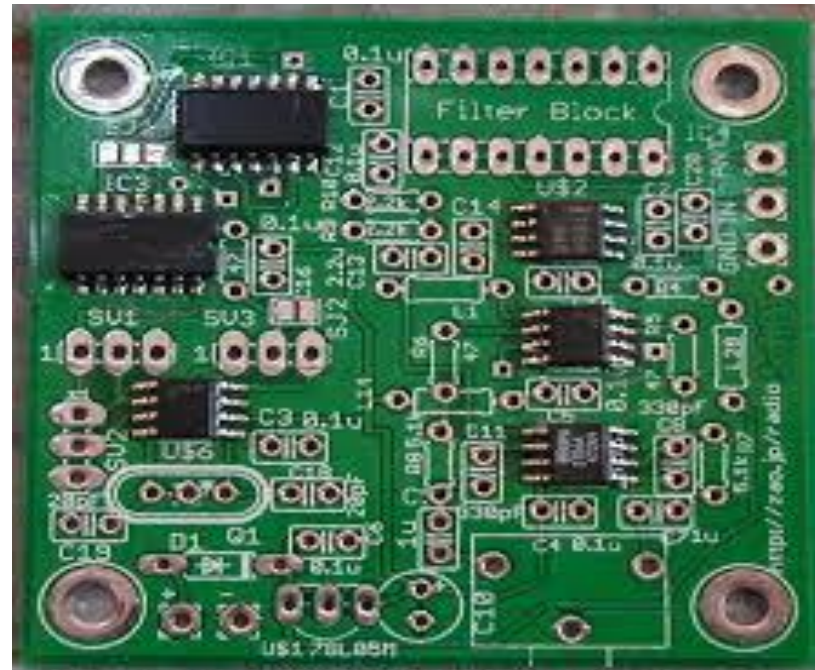


Connection

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Radiation

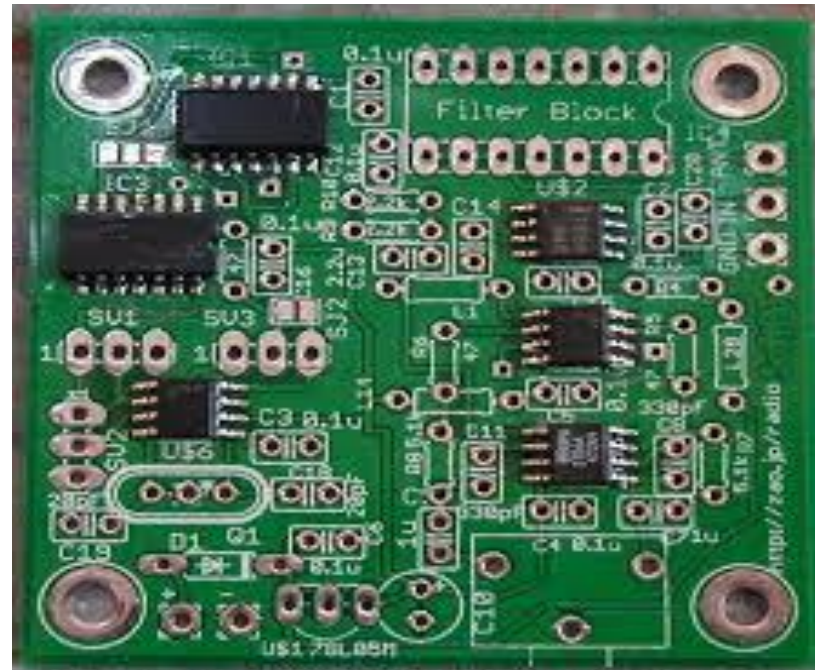
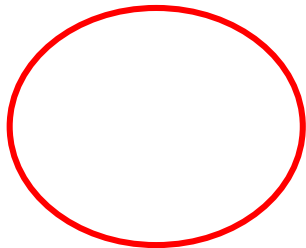
High Data
Rates

Creating Printed Circuit Boards (PCBs)



Creating Printed Circuit Boards (PCBs)

Space

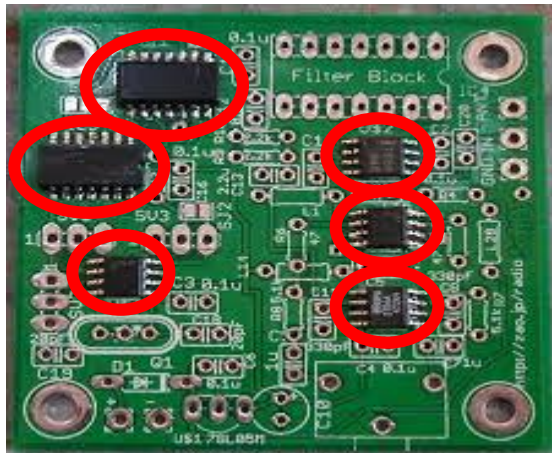


Power



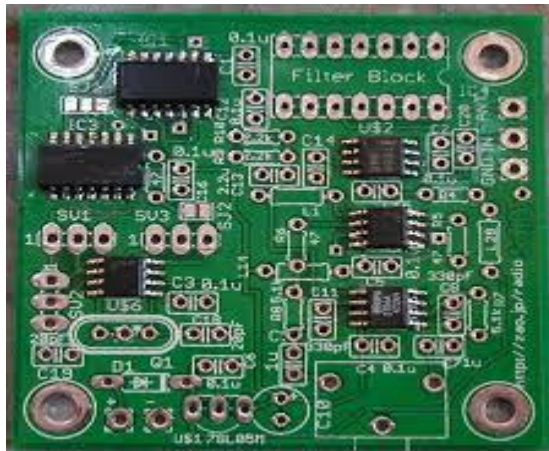
Creating Printed Circuit Boards (PCBs)

Test Integrated Circuits



Creating Printed Circuit Boards (PCBs)

Test Integrated Circuits

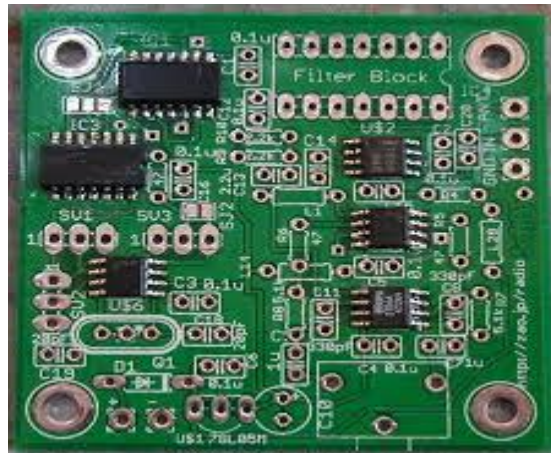


Make a Long PCB

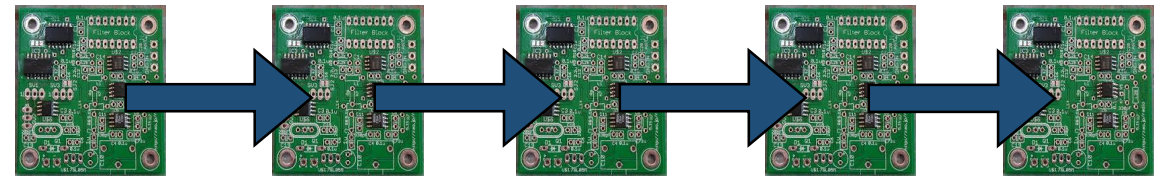


Creating Printed Circuit Boards (PCBs)

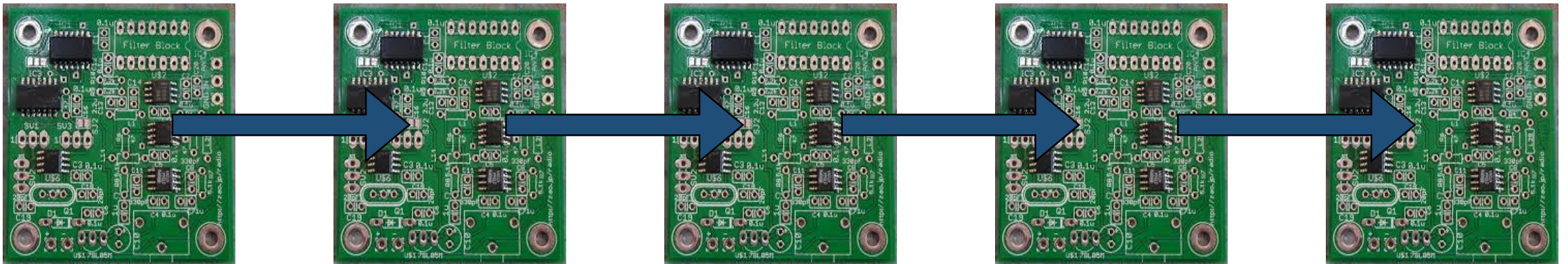
Test Integrated Circuits



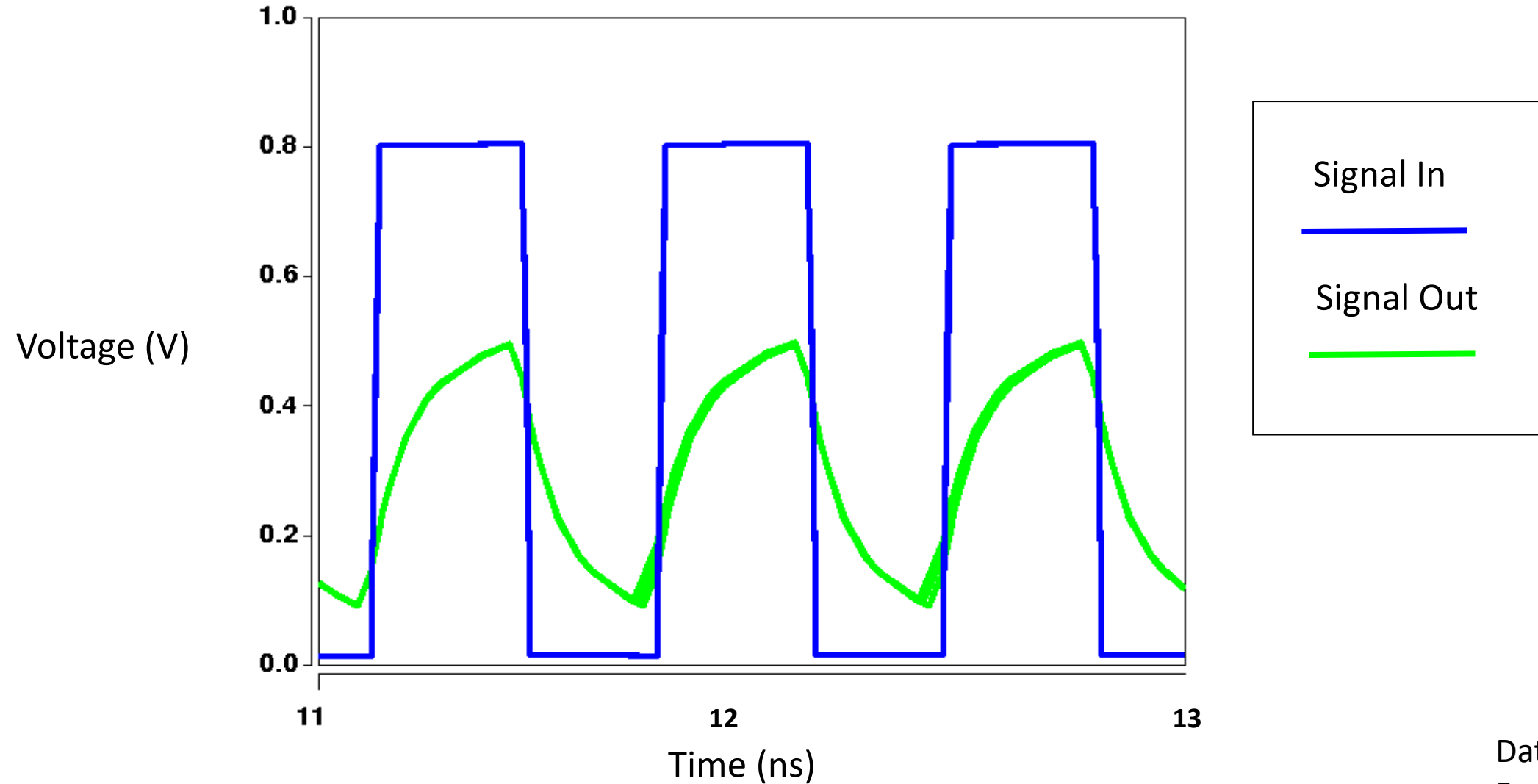
Make a Long PCB



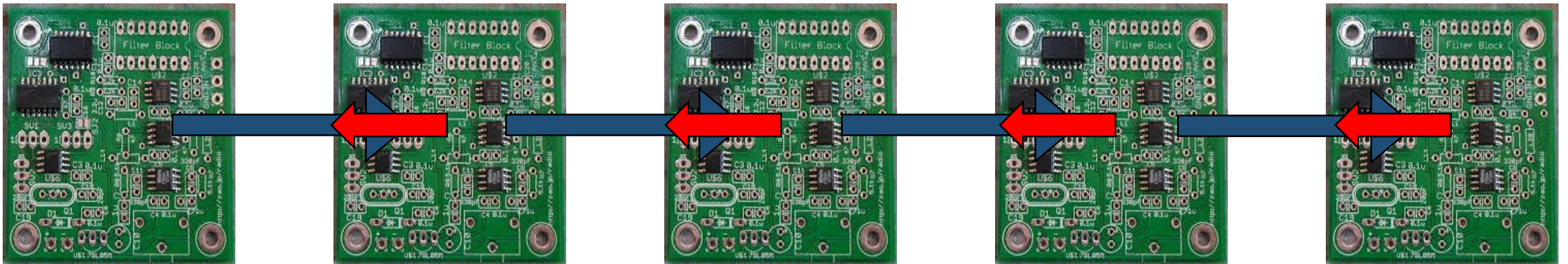
Transmission Causes Loss of Data and Imperfections Cause Reflection



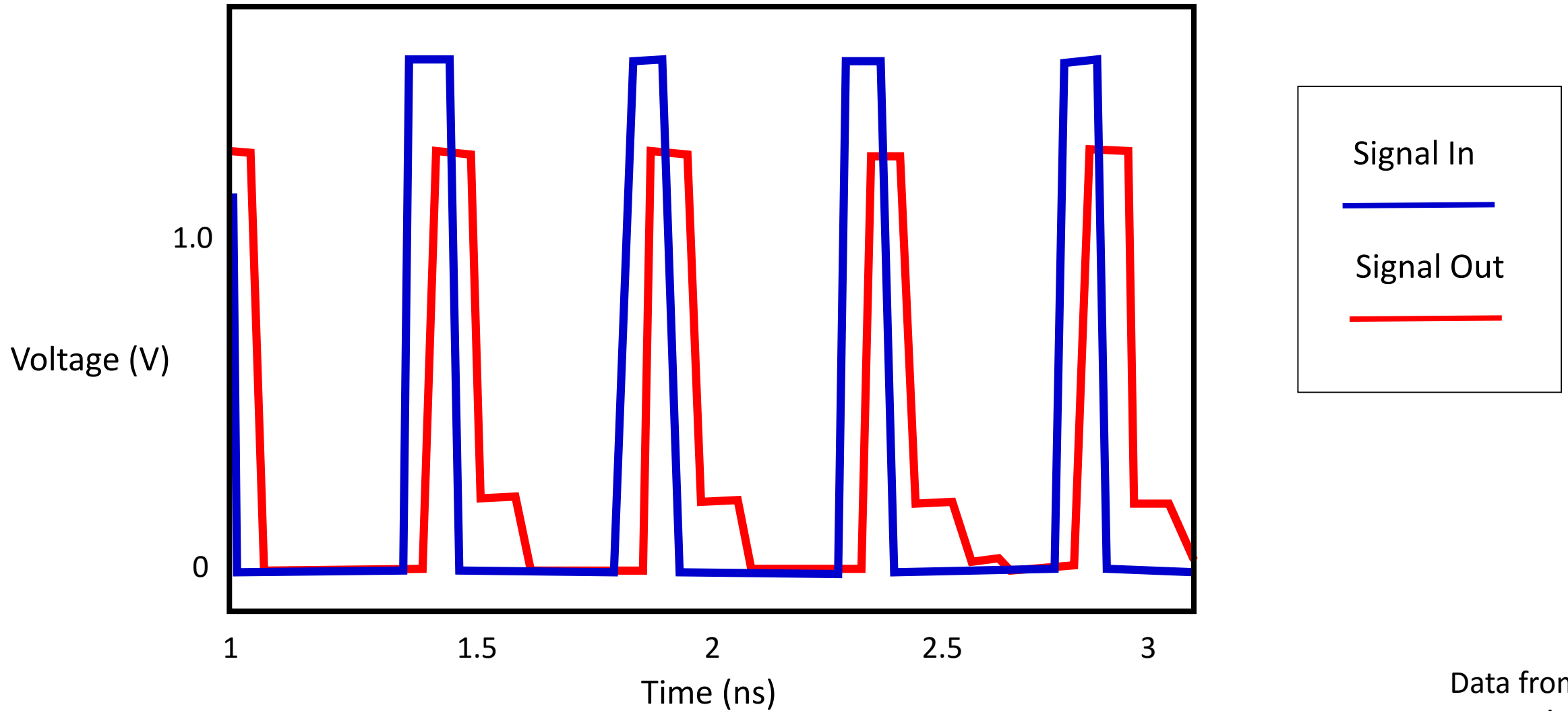
Transmission Causes Loss of Data




Transmission Causes Loss of Data and Imperfections Cause Reflection



Imperfections Cause Reflection



Design for PCB's in Ladder

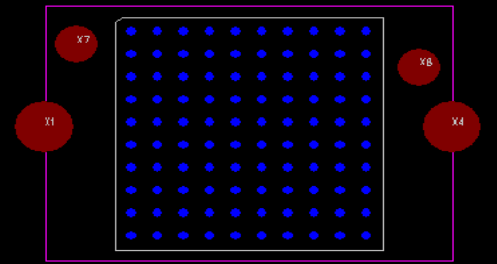
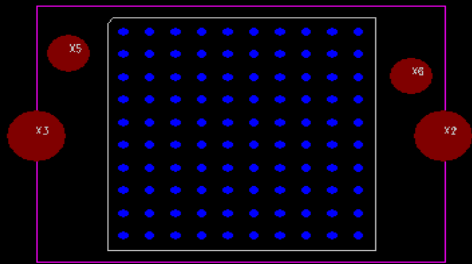
Component Layer 

Ground Layer 

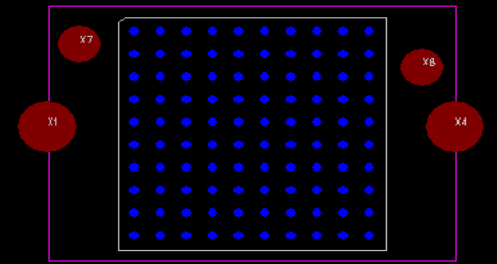
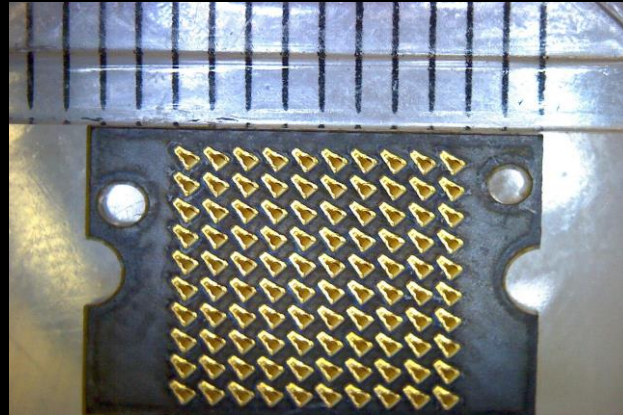
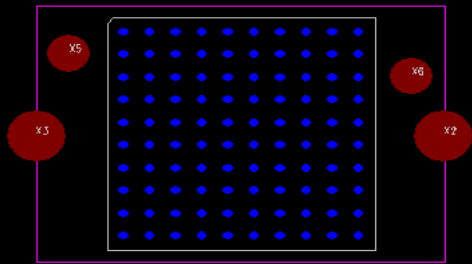
Signal Layer 

Ground Layer 

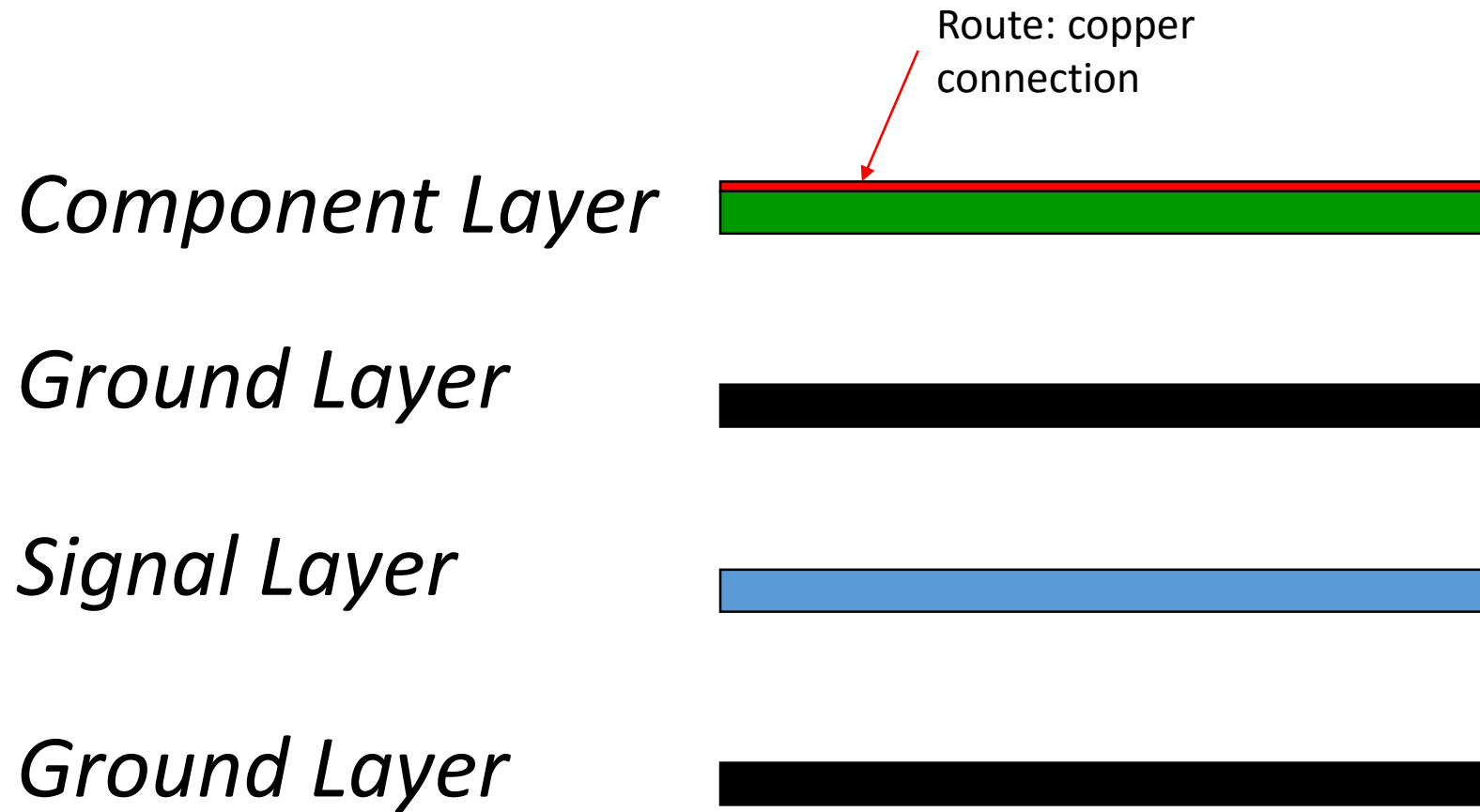
Component Layer



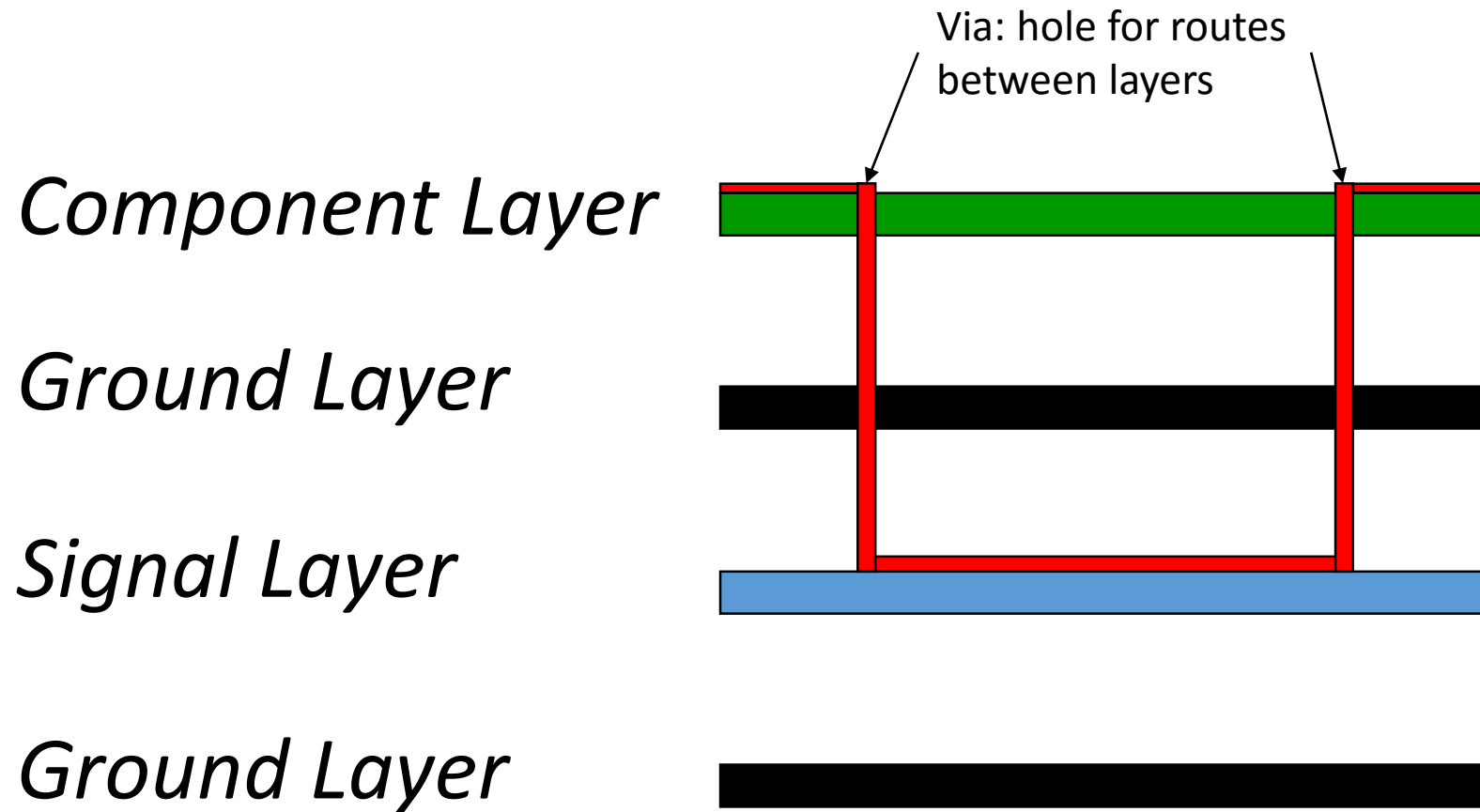
Component Layer



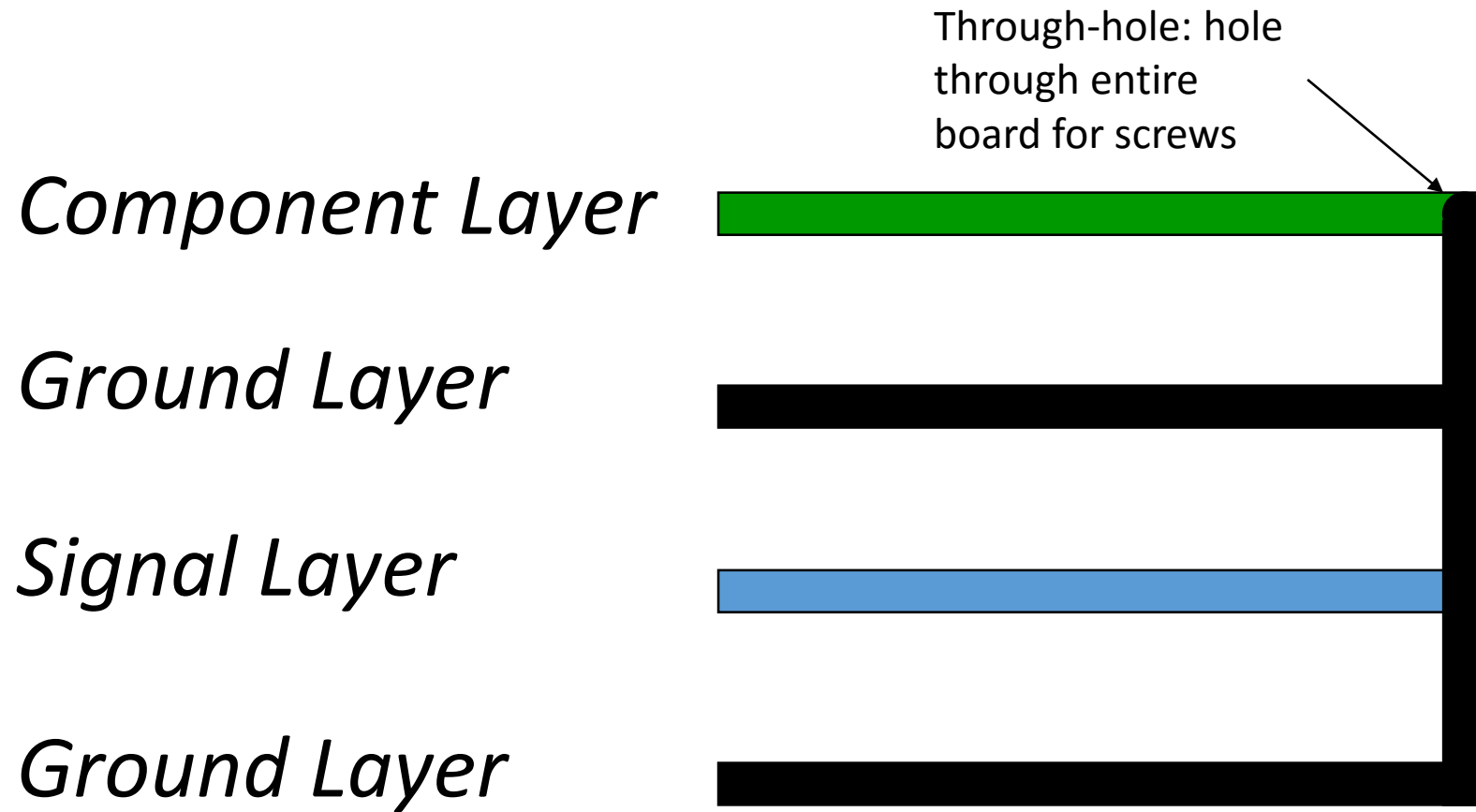
Design for PCB's in Ladder



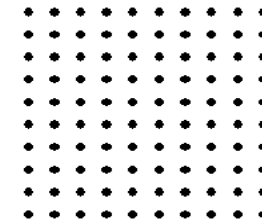
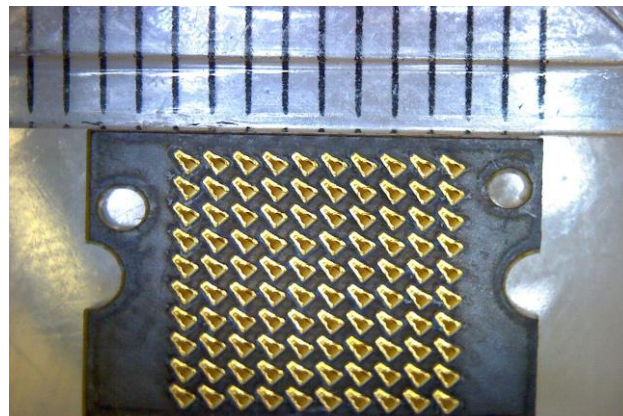
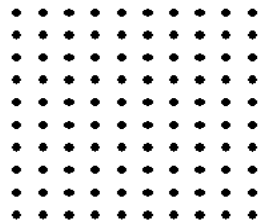
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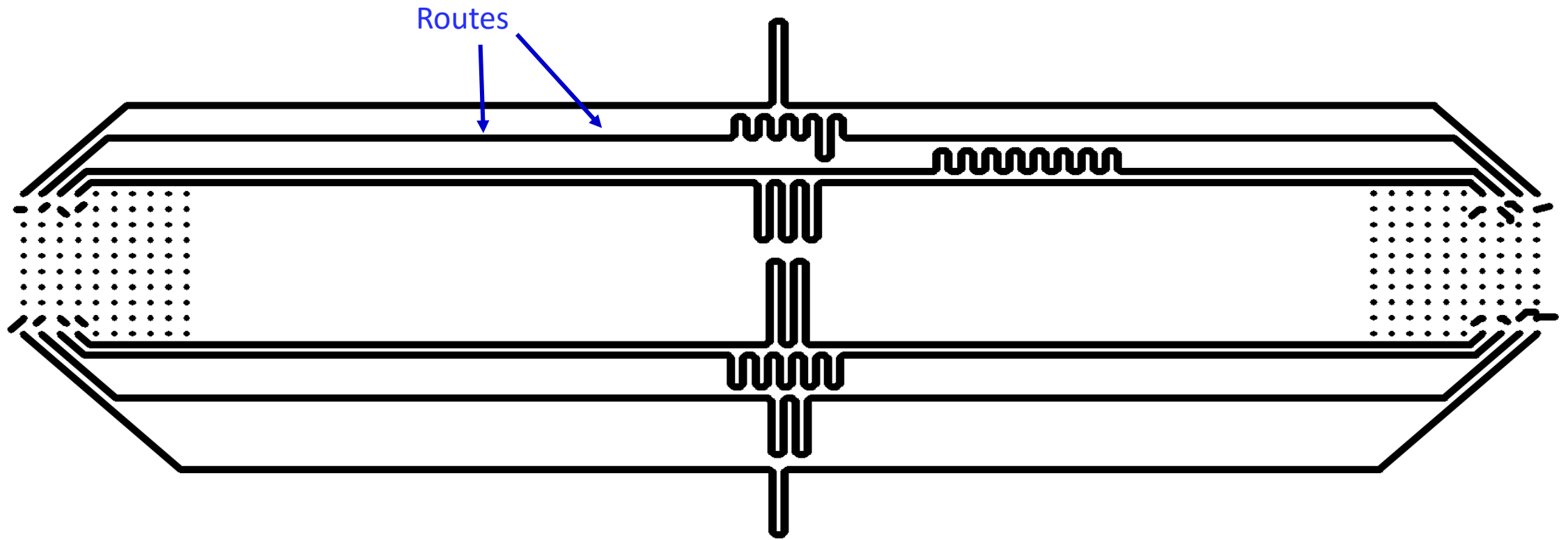
Design for PCB's in Ladder



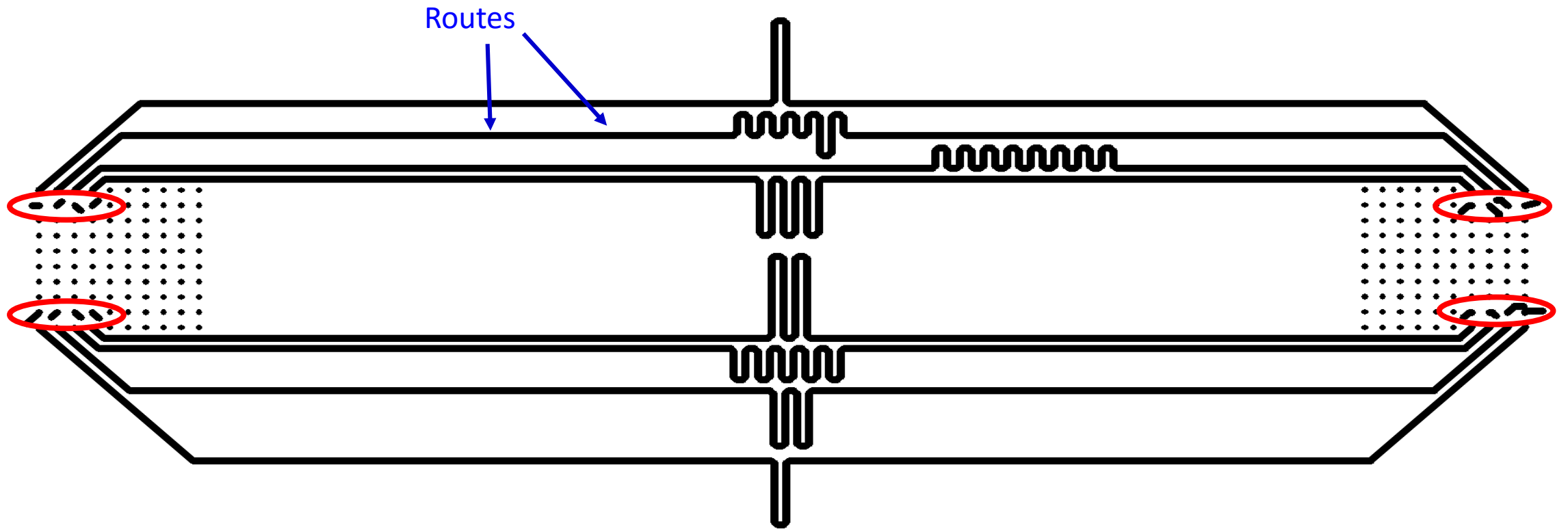
Unrouted Board



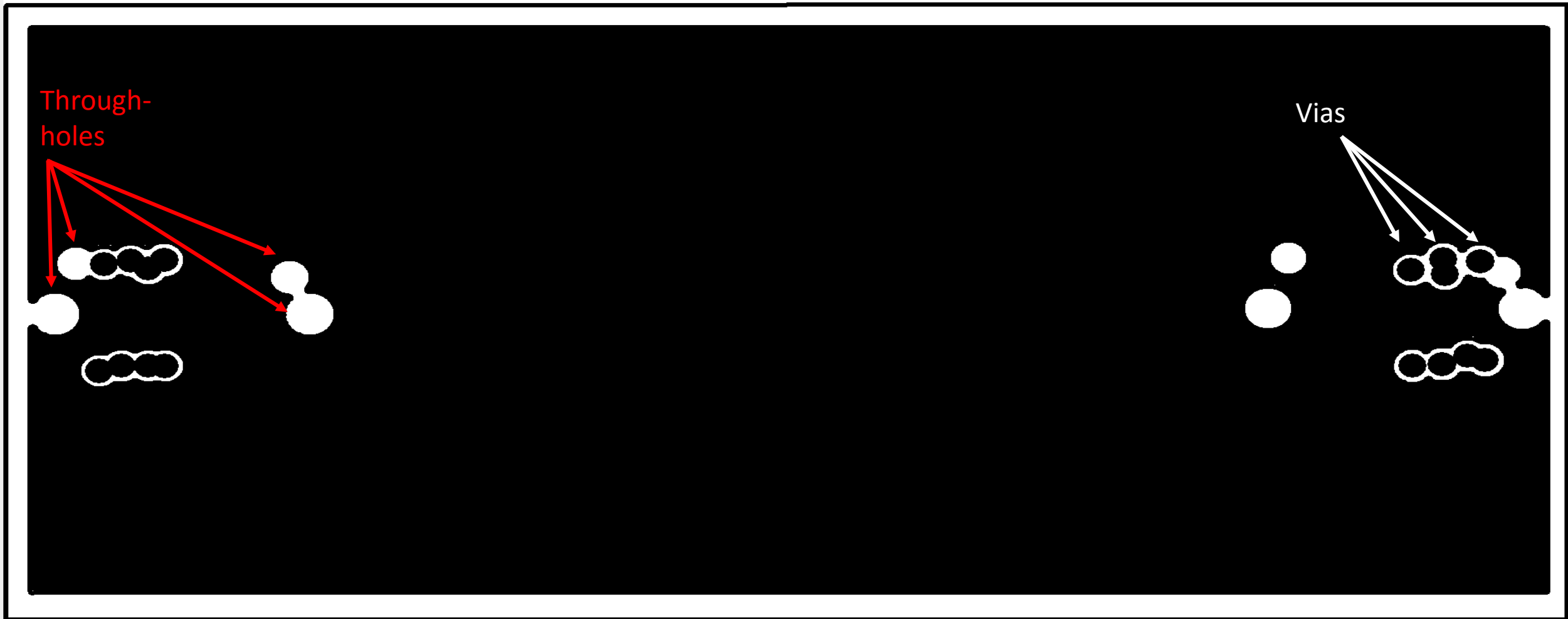
First: Component Layer



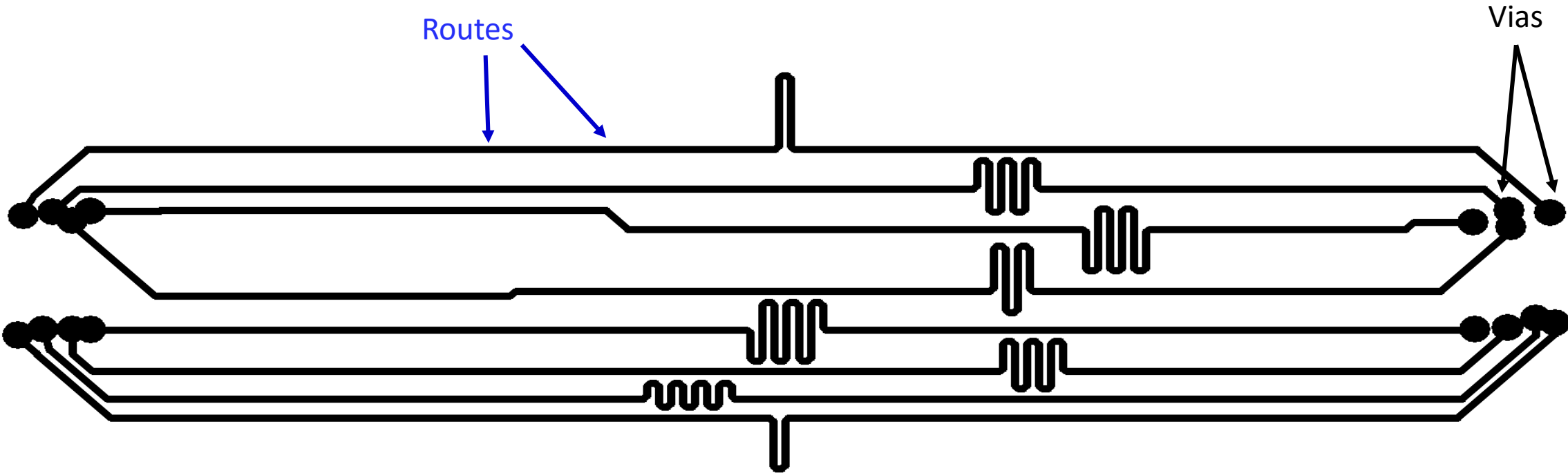
First: Component Layer



Second: Ground Layer



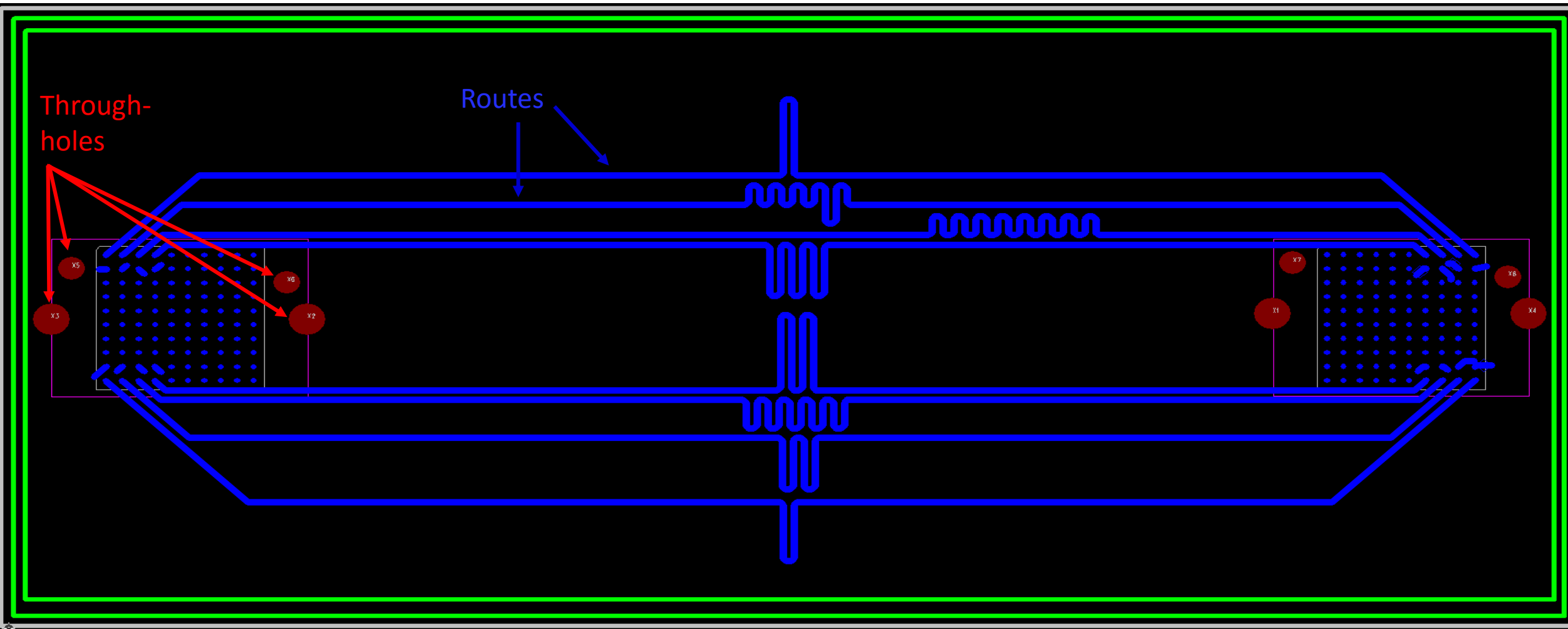
Third: Signal Layer



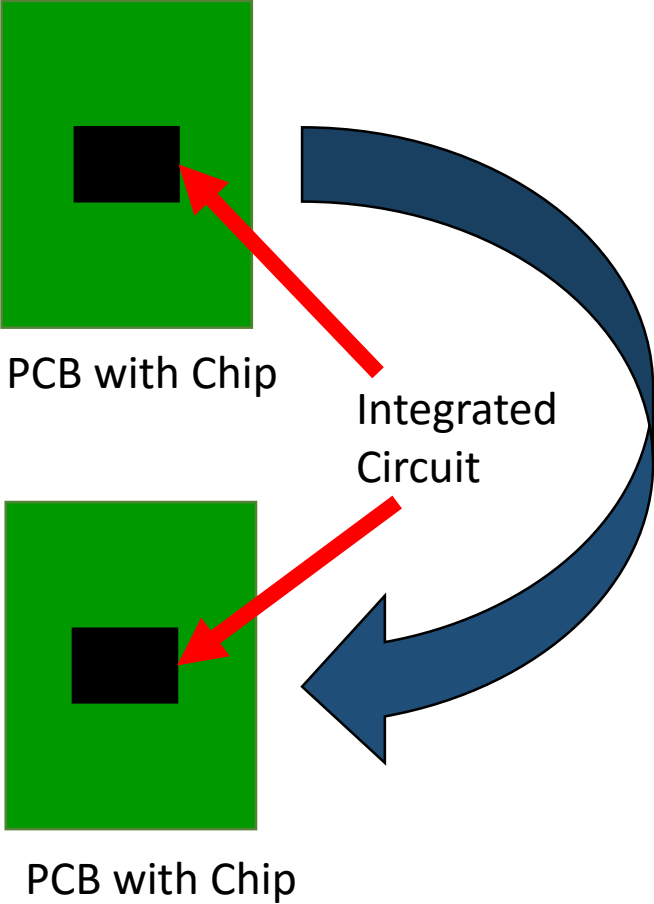
Fourth: Bottom Layer



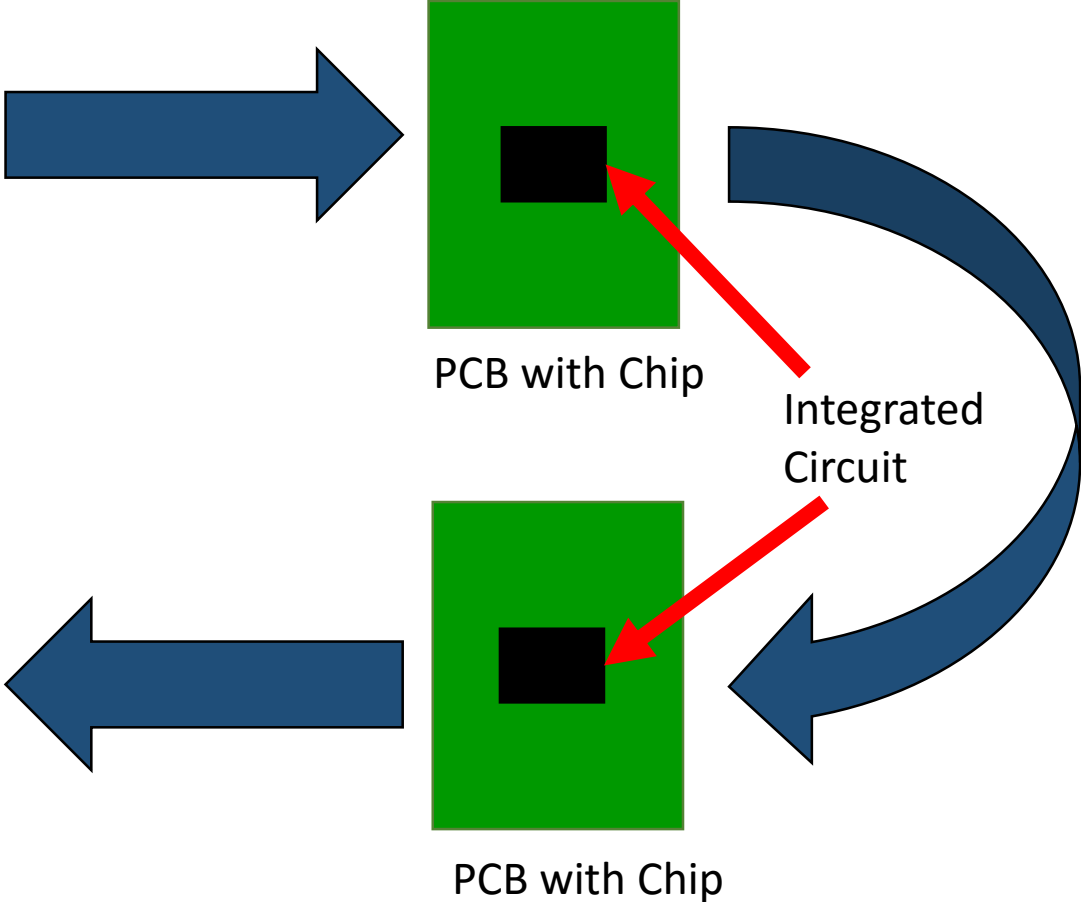
Finished Board



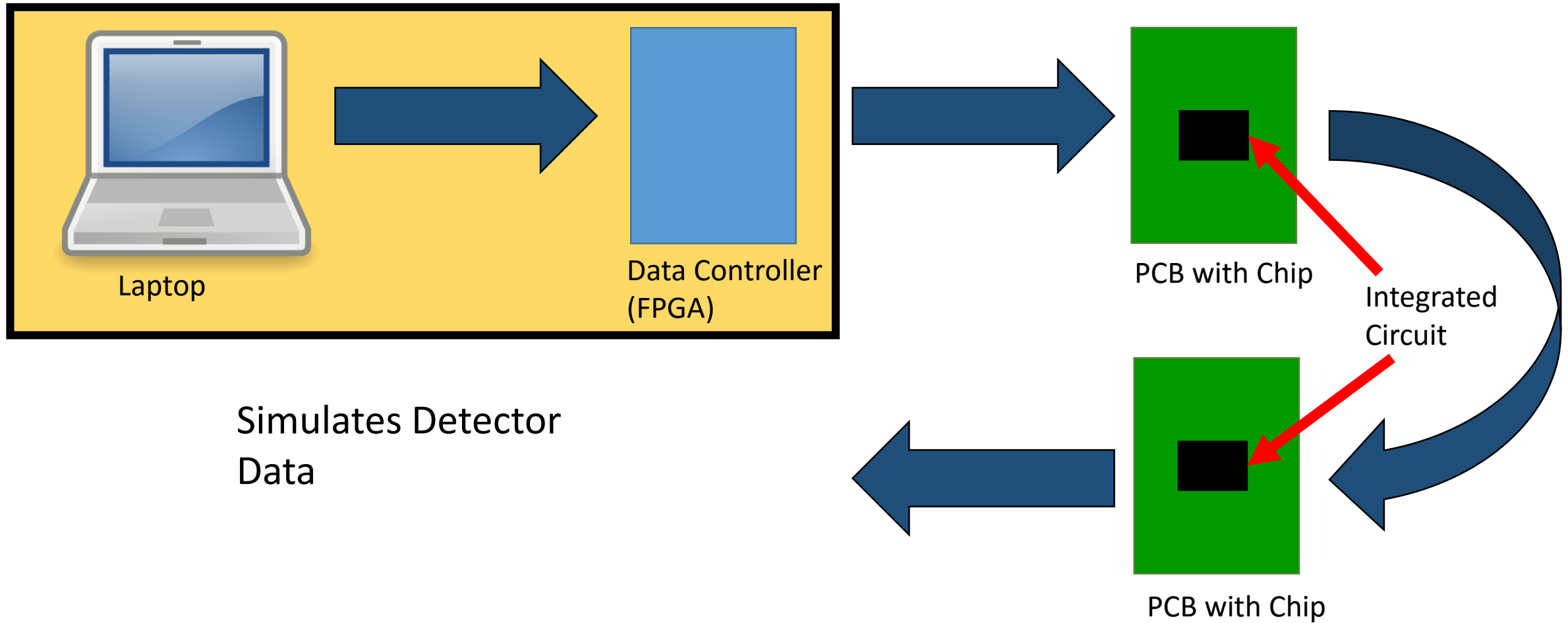
Testing Integrated Circuits



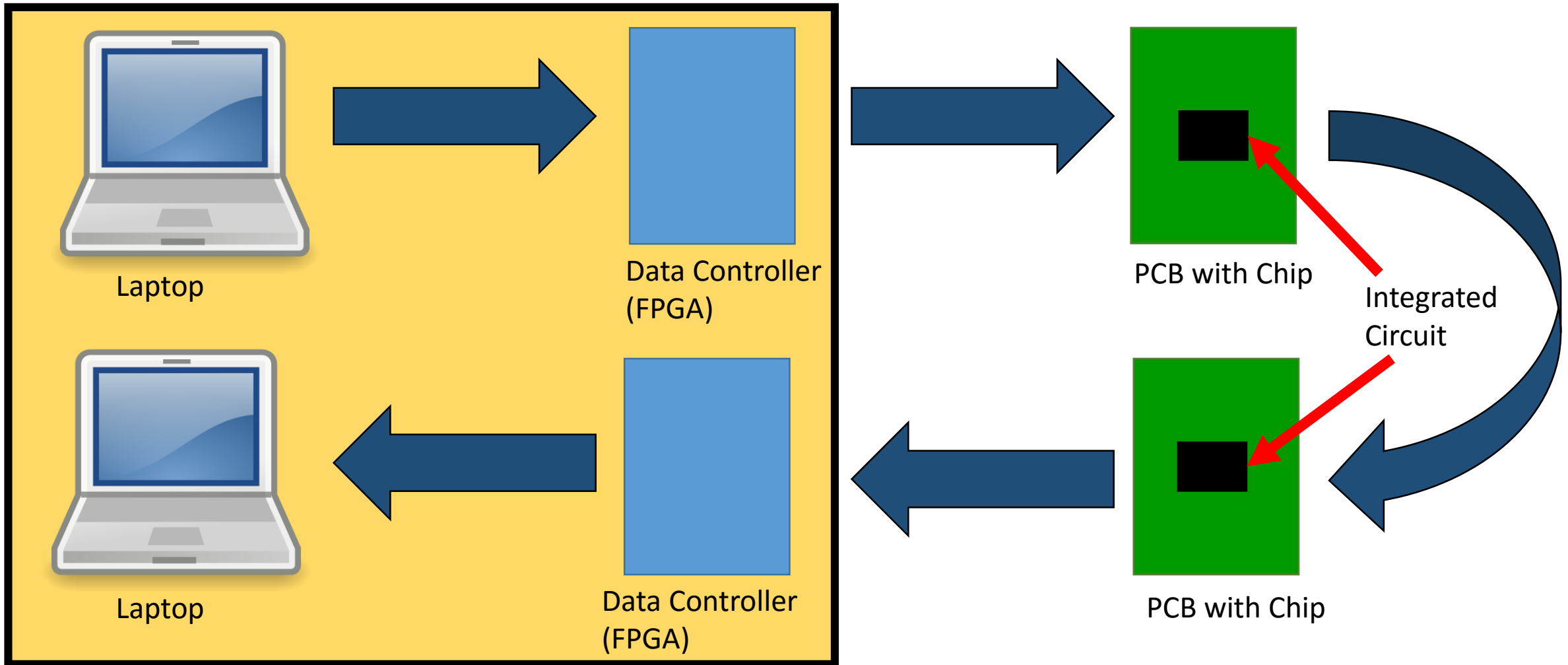
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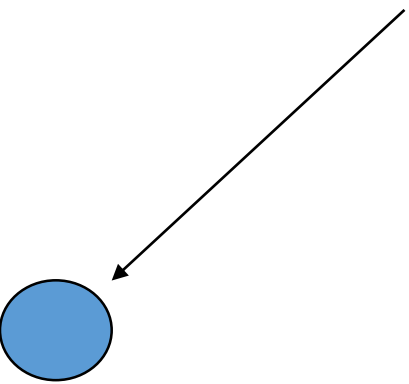


Testing Integrated Circuits

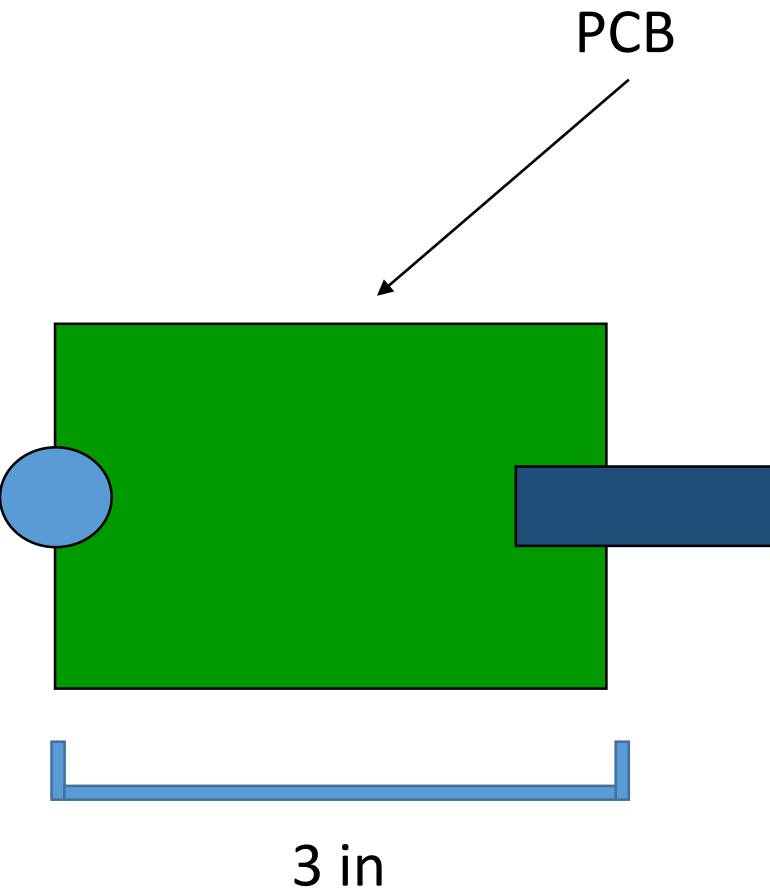


Making a Long PCB

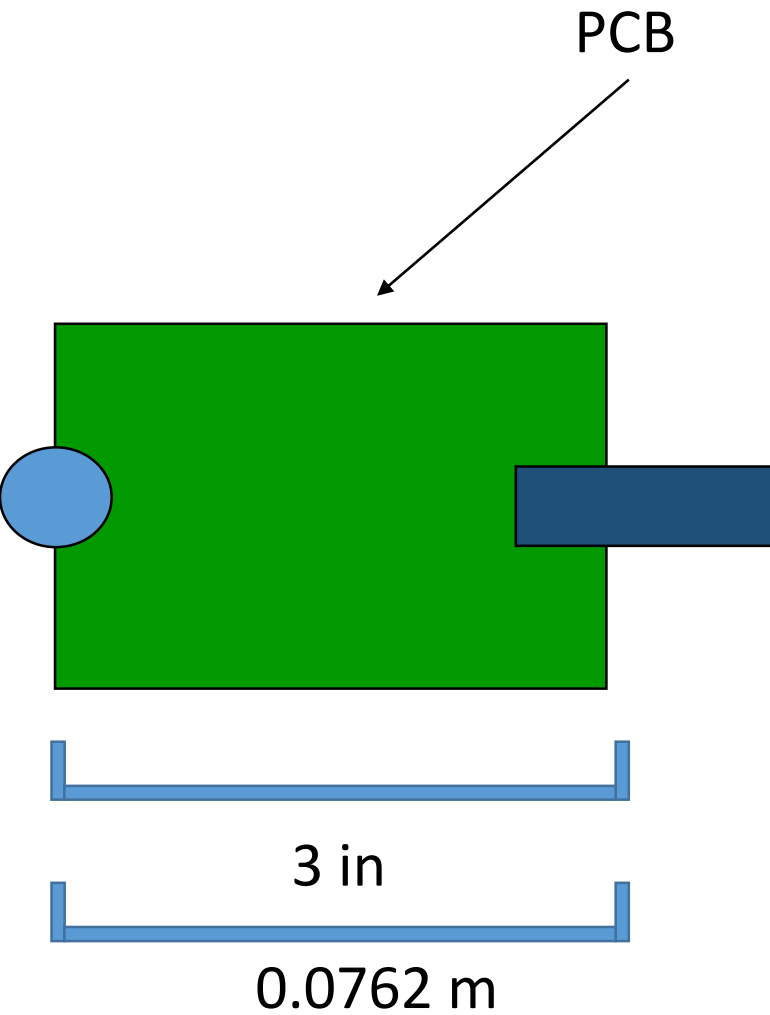
Signal



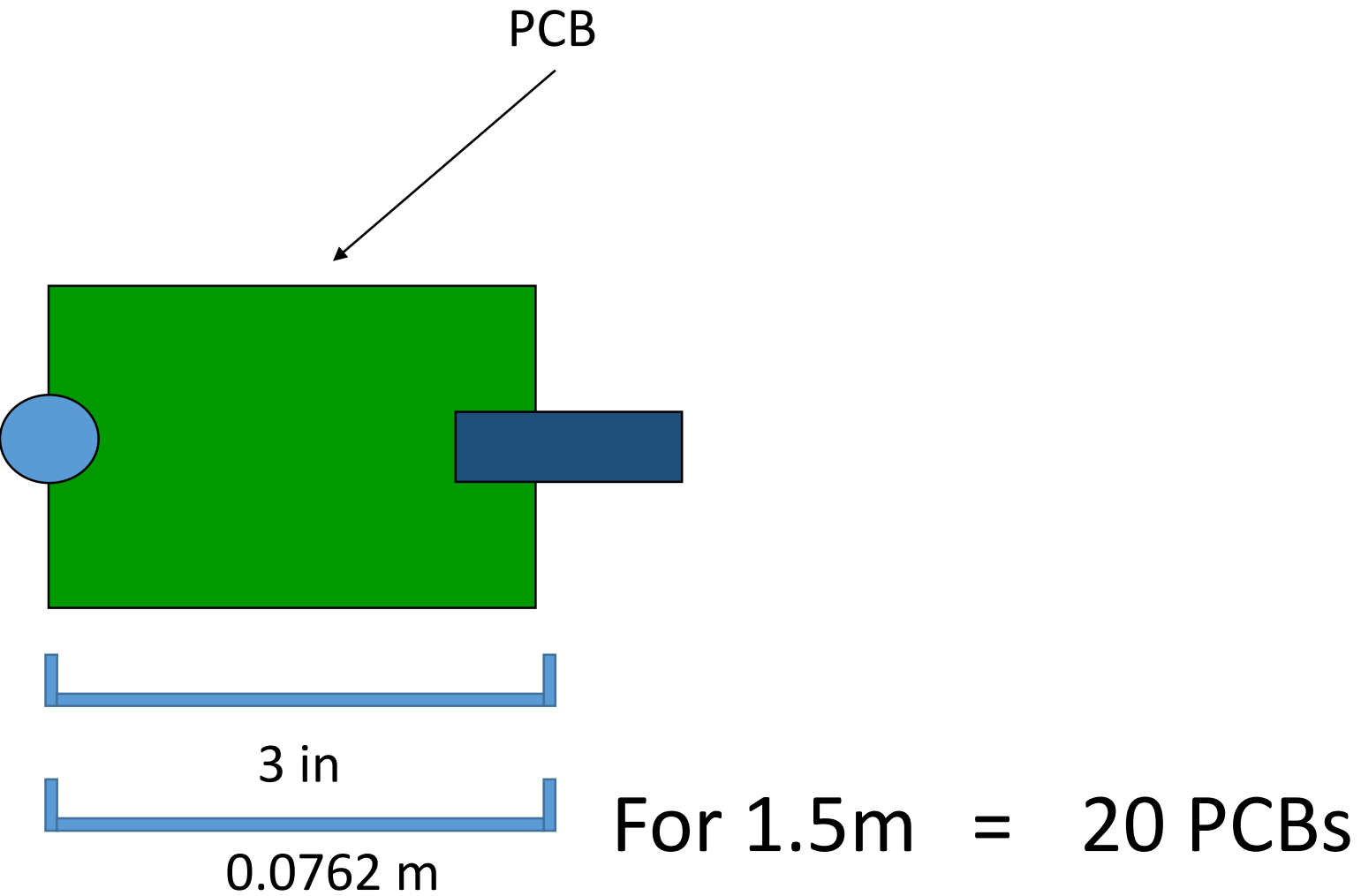
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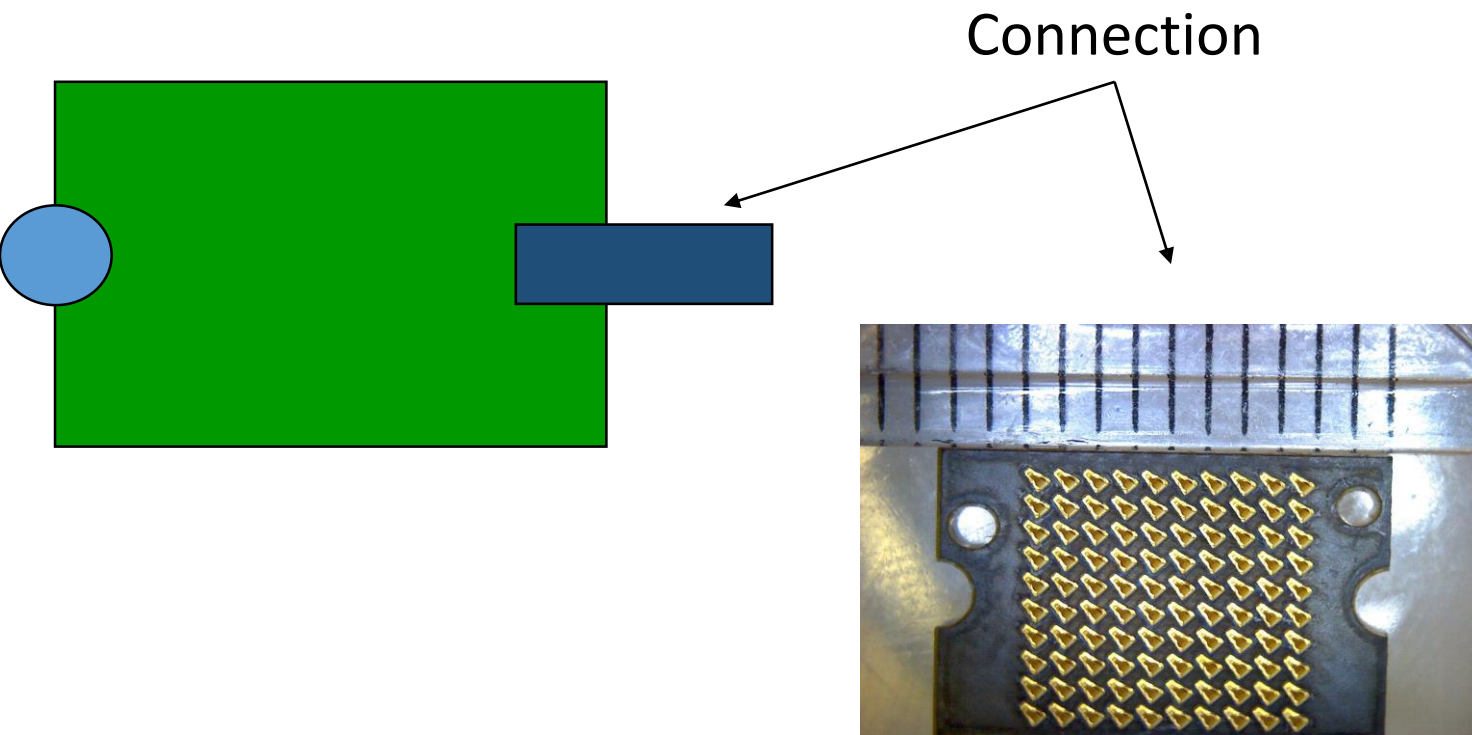
Making a Long PCB



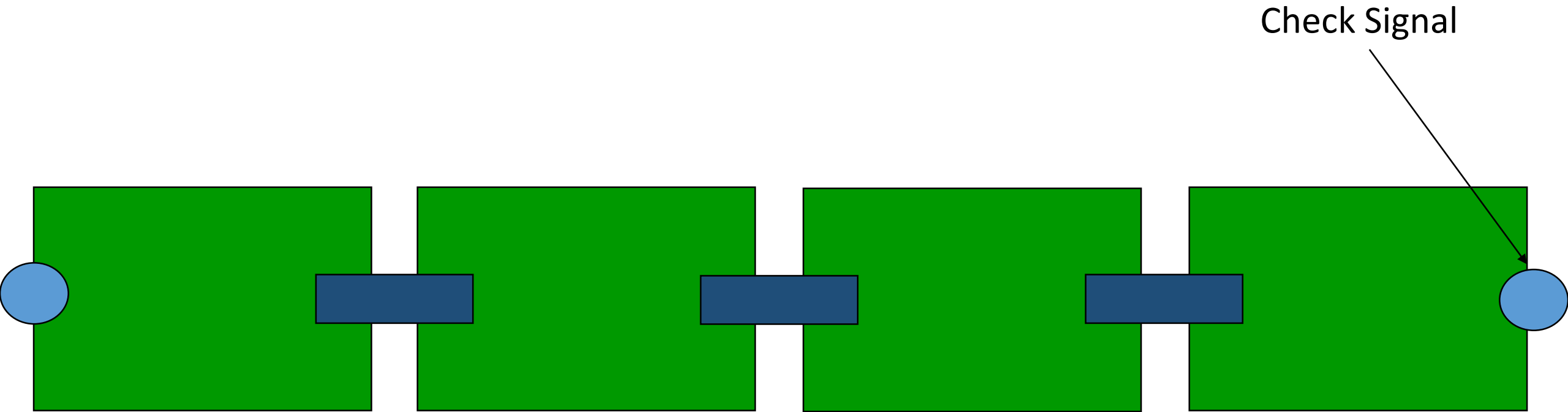
Making a Long PCB



Making a Long PCB



Making a Long PCB



Acknowledgements

Professor Forrest Brewer

The Brewer Lab

EUREKA and CSEP

Aditya Dalakoti

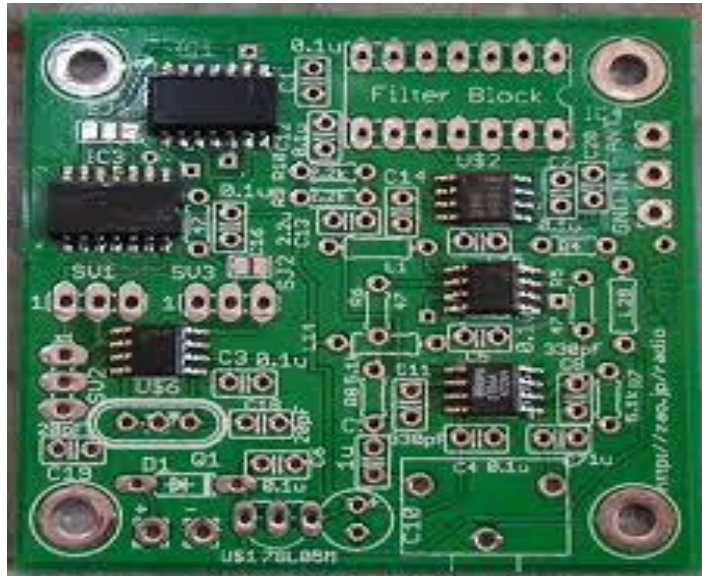


UC SANTA BARBARA
engineering

UCSB

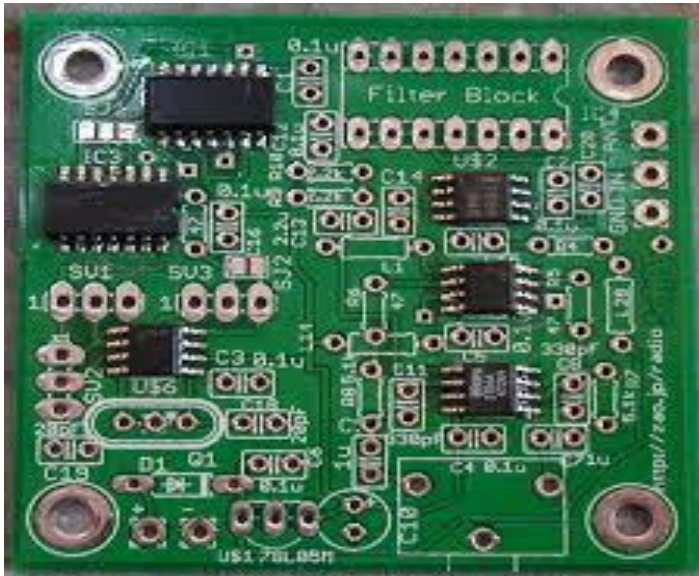


PCBs Vs. Wires



1,000 PCBs

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1,000 PCBS



100,000 Wires