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ESD Protection for Mu2e Tracker

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UW-LA CROSSE

Outline

- Mu2e experiment
- ESD Protection
- Testing
- Moving forward

Brief Intro to Mu2e

- Goal of experiment
  - Observe Charged Lepton Flavor Violation
  - Neutrinoless muon-to-electron conversion

- New record for single event sensitivity (2.87×10^{-17})

$$R\downarrow \mu e = \mu- + A(Z,N) \rightarrow e- + A(Z,N) / \mu- + A(Z,N) \rightarrow \nu\,\mu + A(Z-1,N)$$

- Need 3.6×10^{20} protons on target
  - Runtime of 3 years

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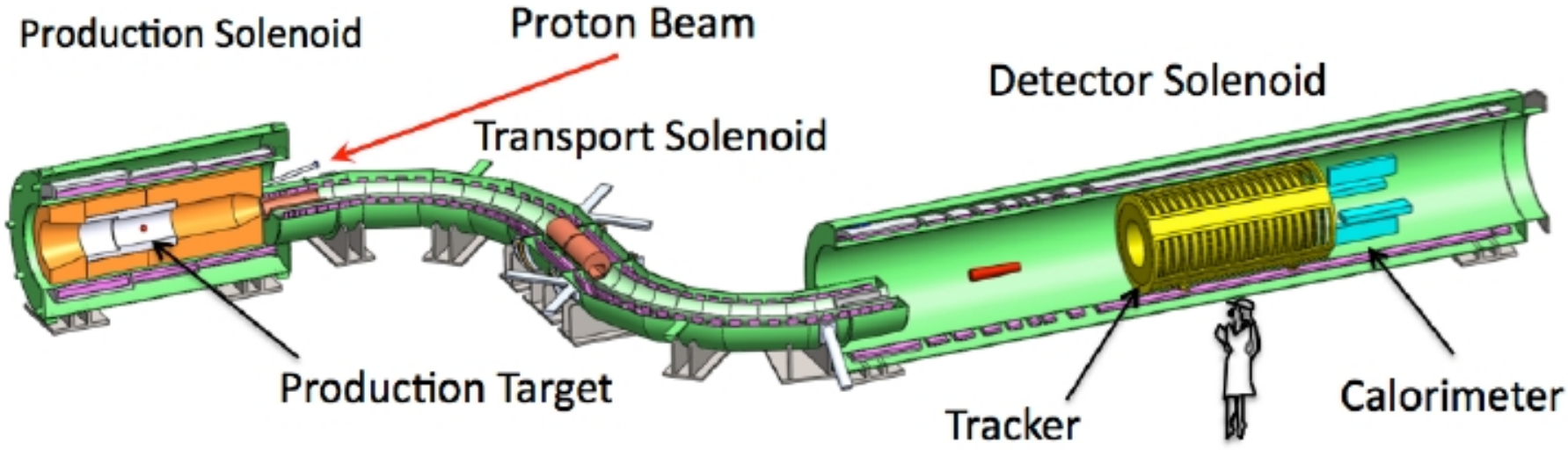
Implications of discovery

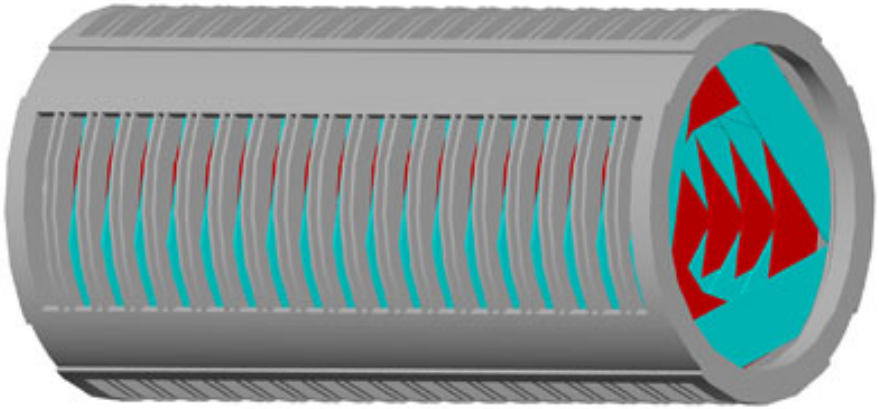
- Indicate new physics beyond scope of LHC
- Can help better understand LHC discoveries
- Improve the Standard Model

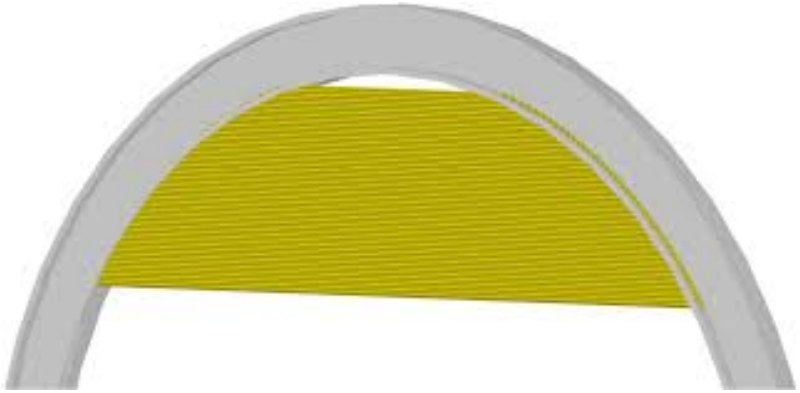
Mu2e Apparatus



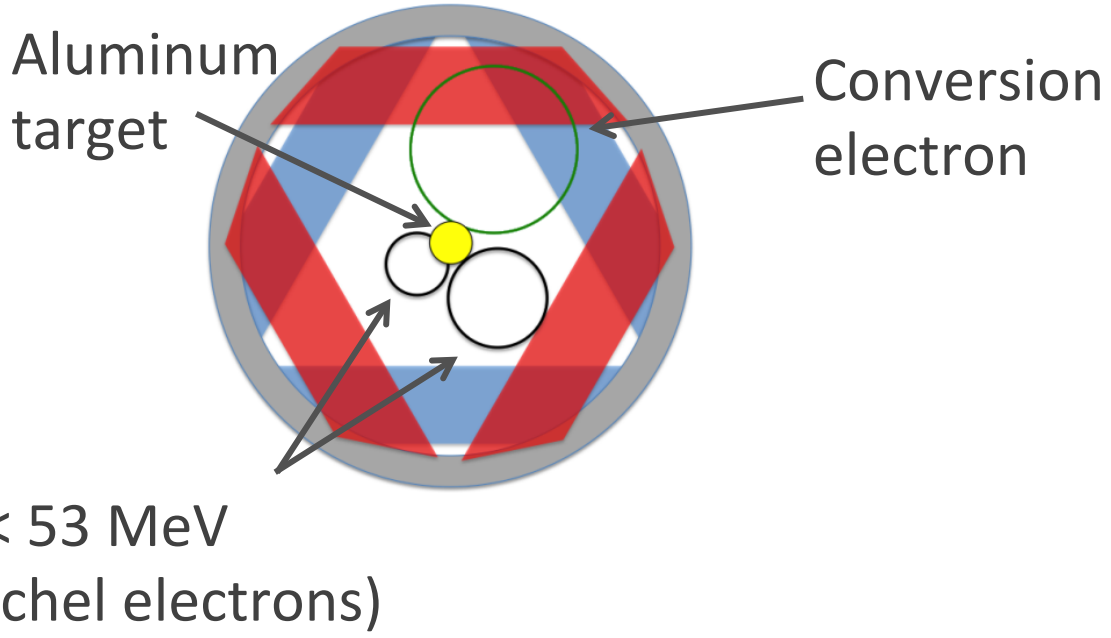
Tracker

- 3 meters long
- Straw drift chambers
- 18 measurement stations
  - 6 panels each
  - 96 straws per panel
    (~23,000 total straws)

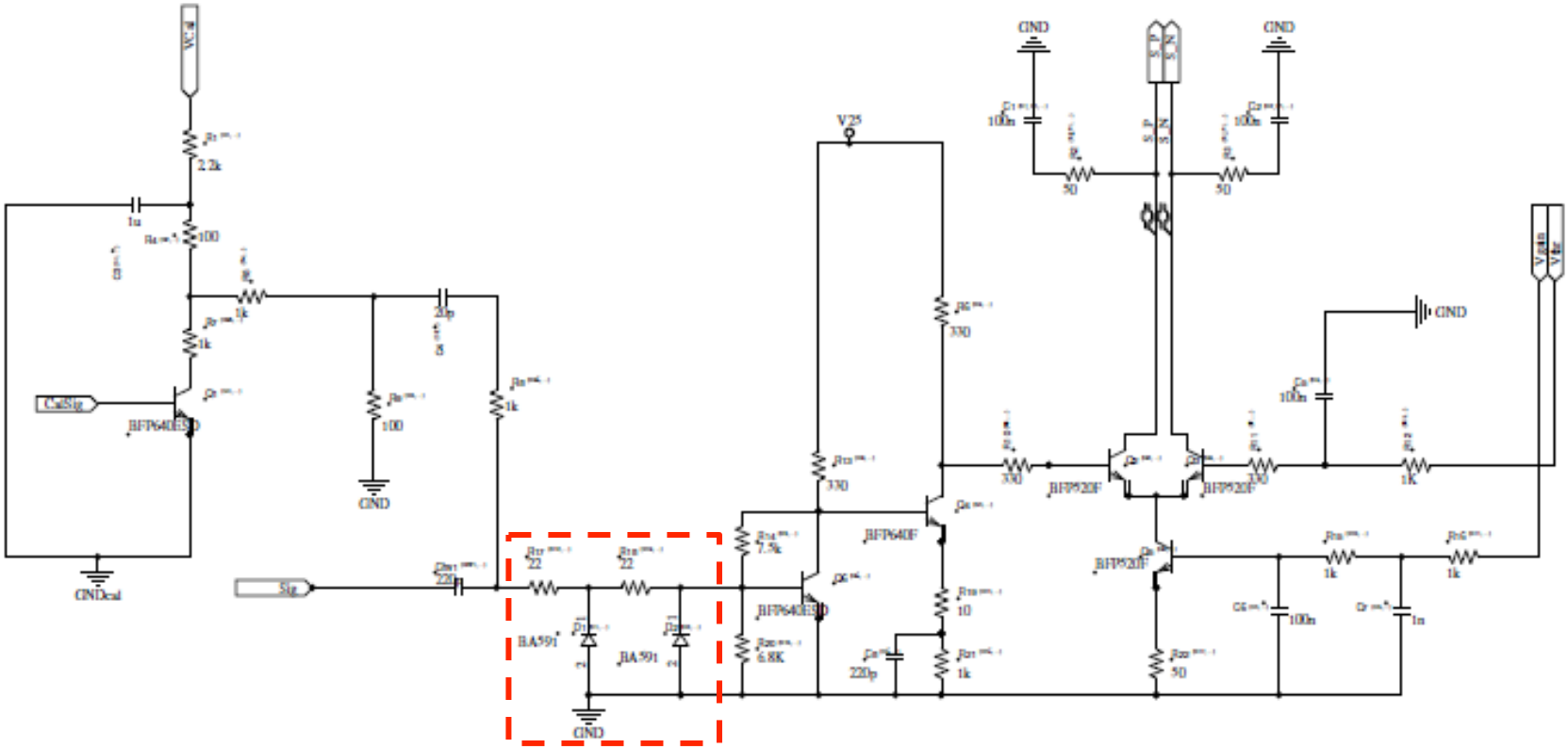




Tracker Cross Section



Preamps



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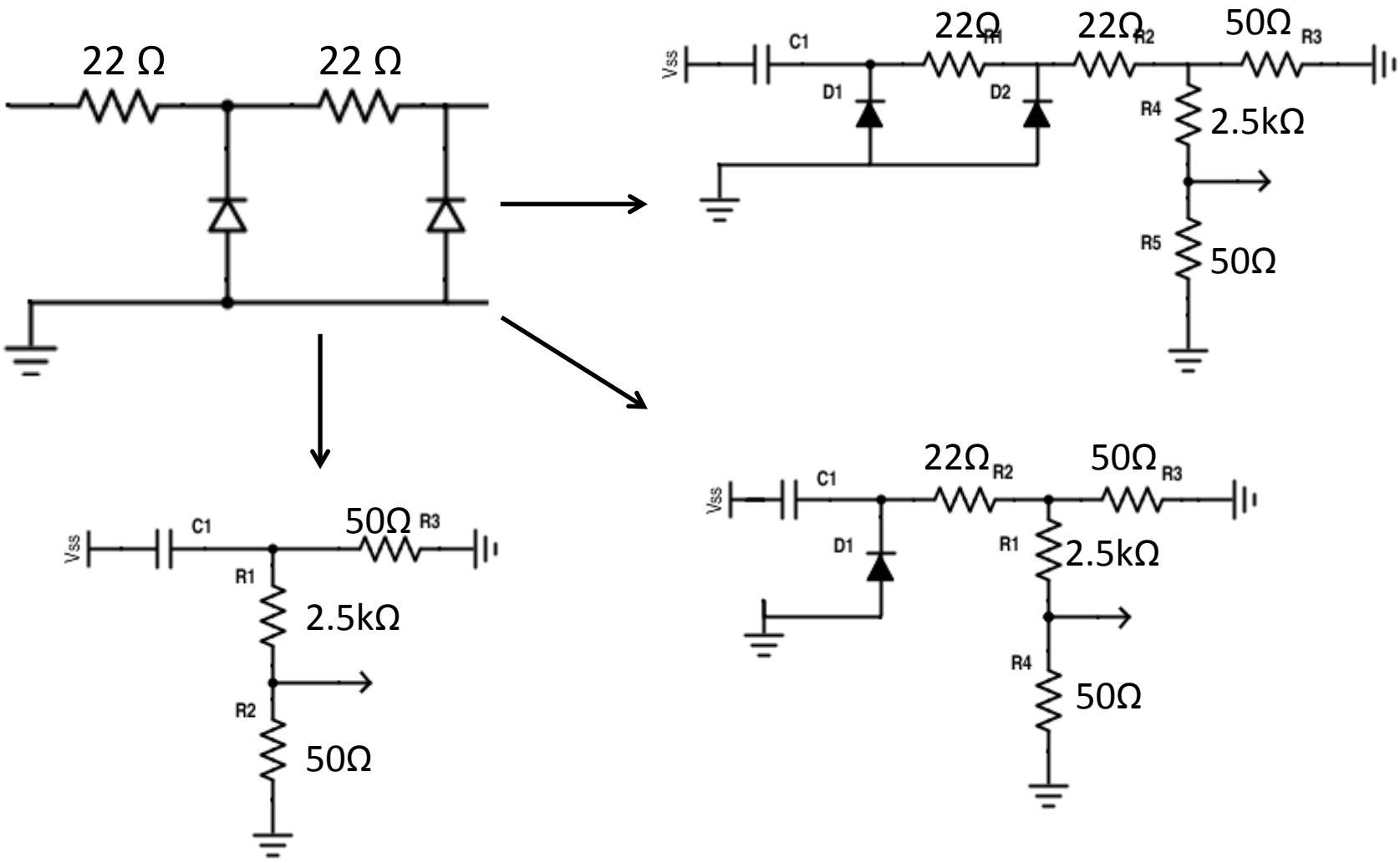
Preamps



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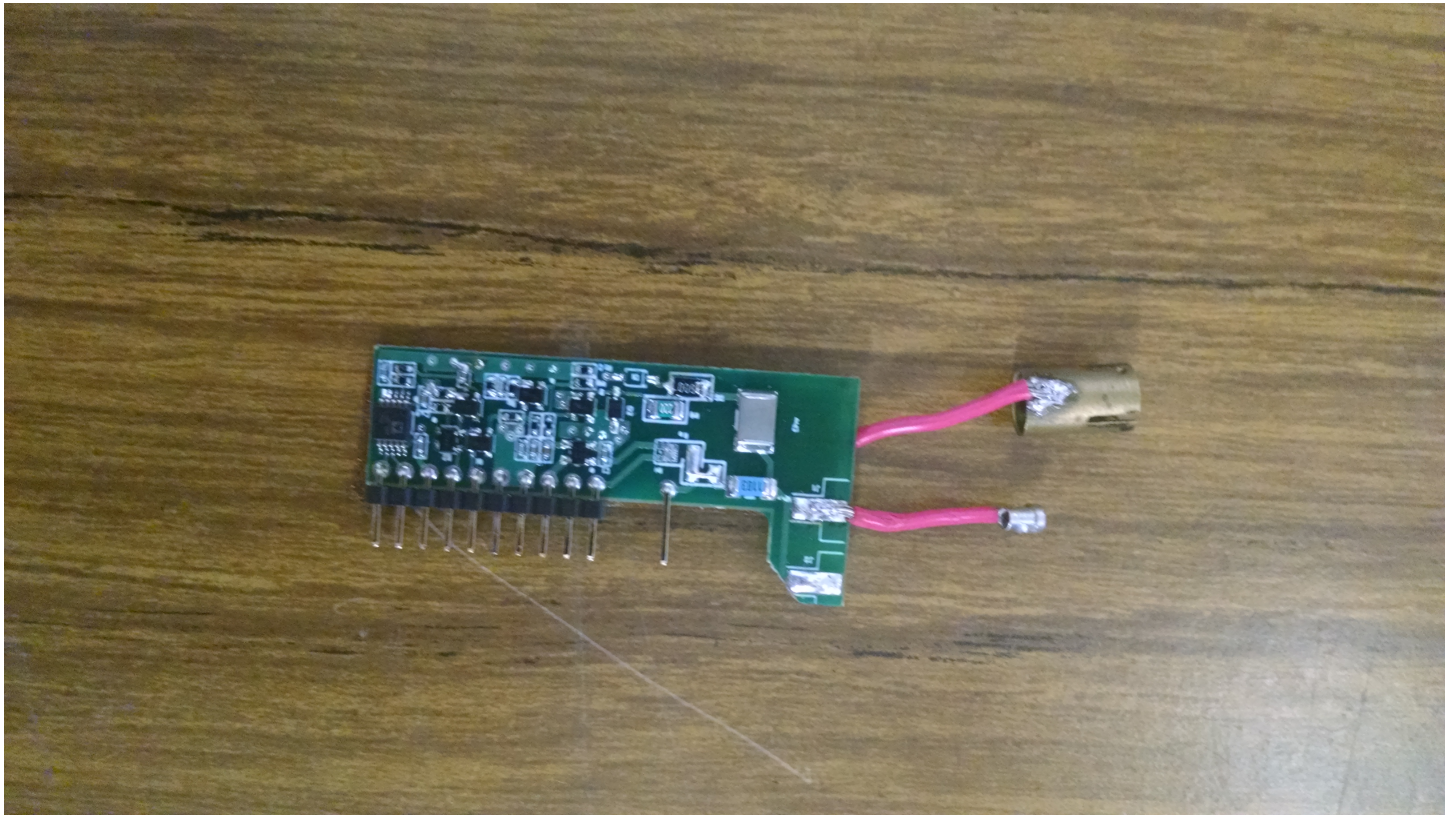
Experimental Setup



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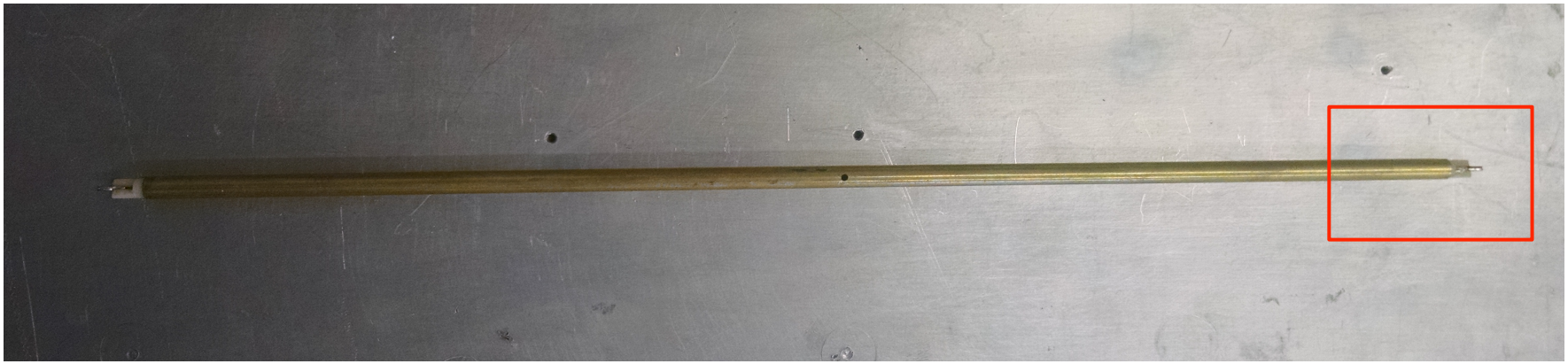
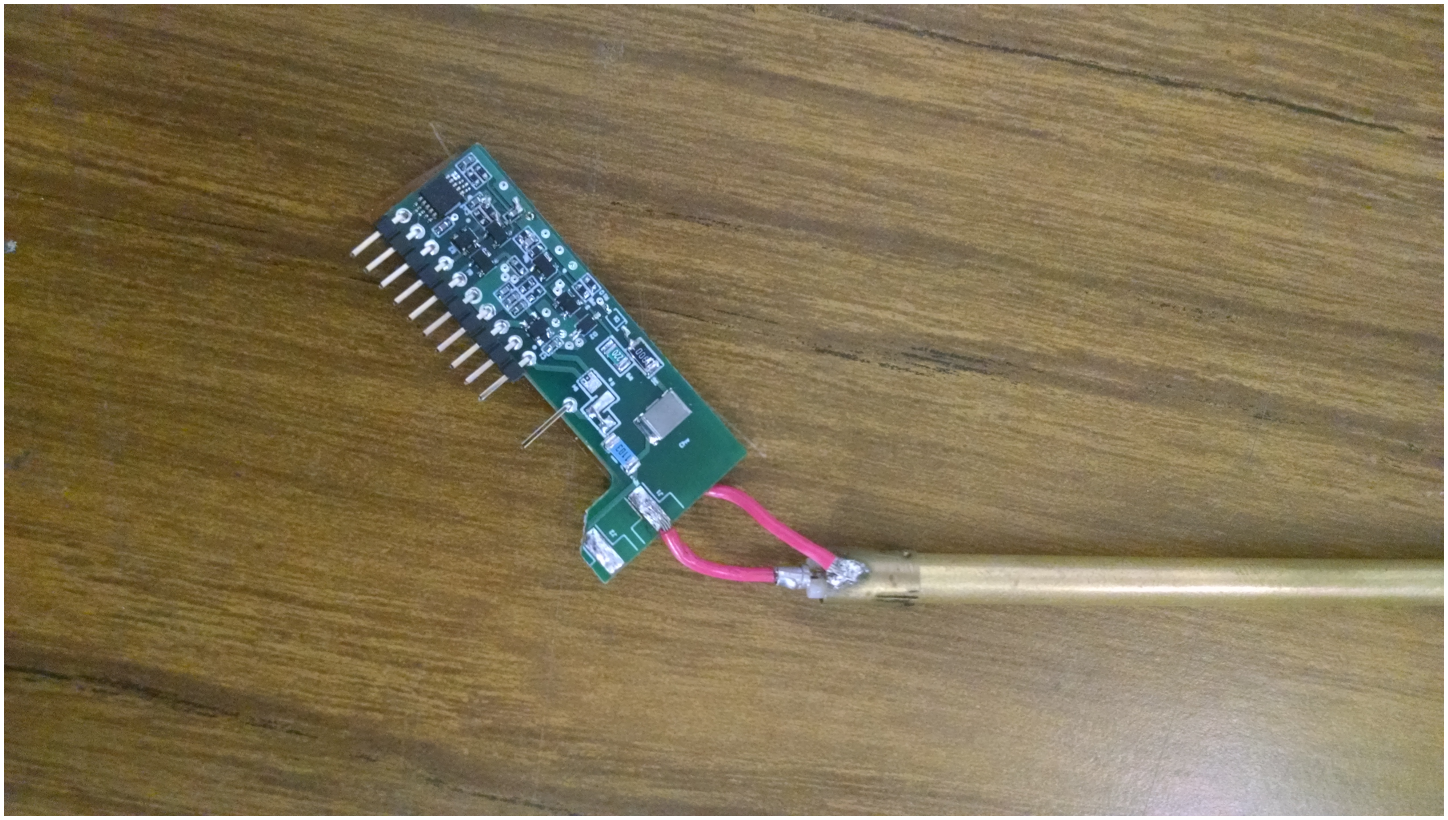
Experimental Setup



Experimental Setup



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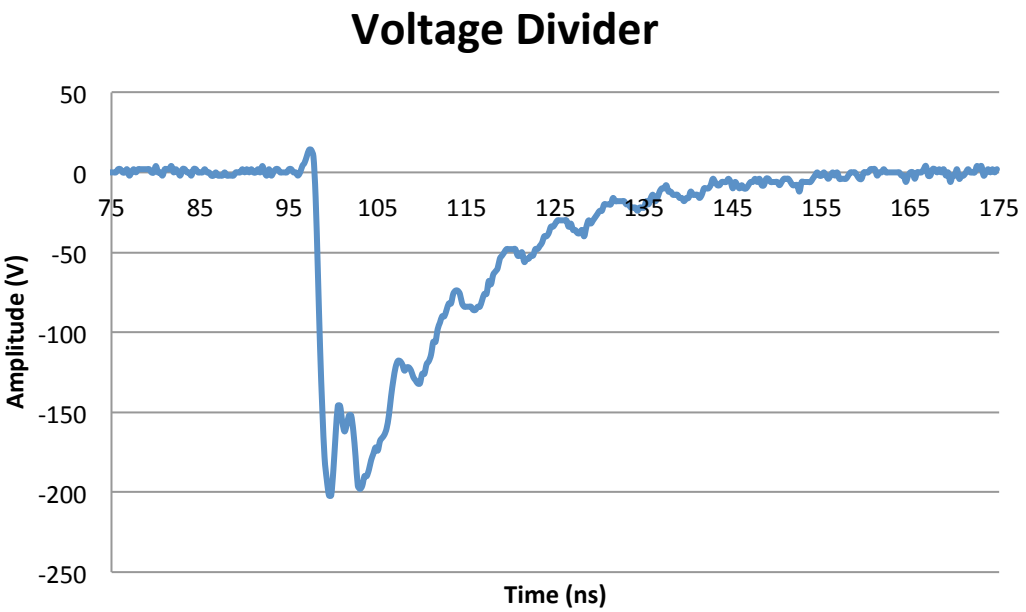
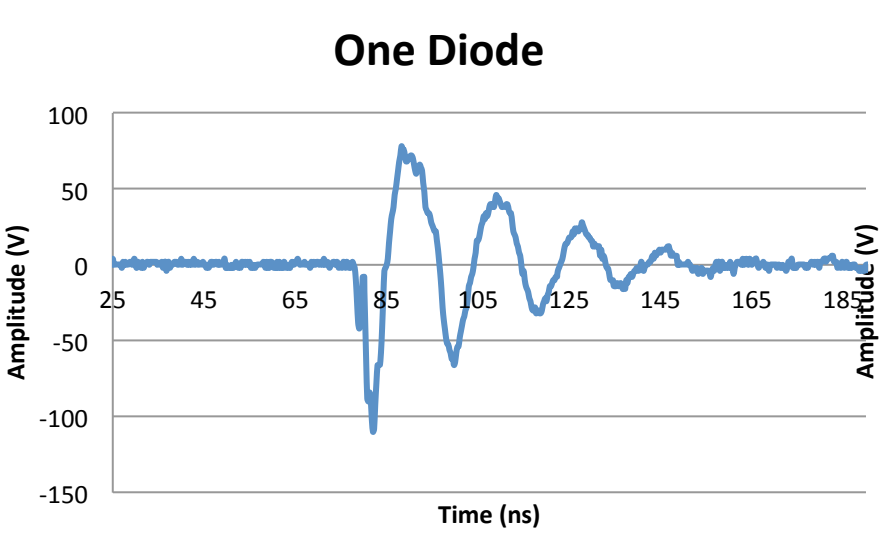
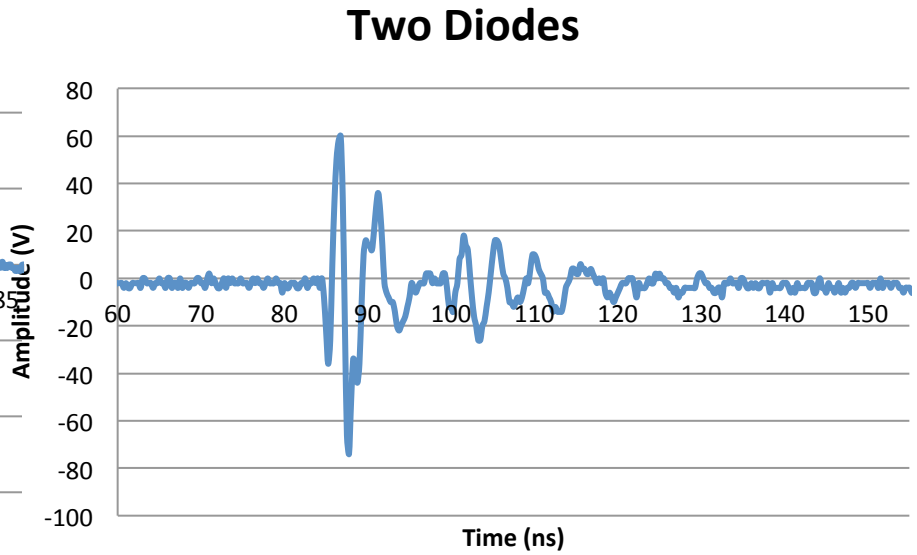
Results


Voltage Divider
50
0
-50
-100
-150
-200
-250
75
85
95
105
115
125
135
145
155
165
175
Amplitude (V)
Time (ns)

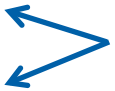
Results

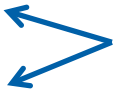

One Diode
100
50
0
-50
-100
-150
Amplitude (V)
25
45
65
85
105
125
145
165
185
Time (ns)

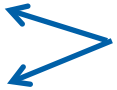

Two Diodes
80
60
40
20
0
-20
-40
-60
-80
-100
Amplitude (V)
60
70
80
90
100
110
120
130
140
150
Time (ns)

Results

Material	Stages of ESD Protection	Average Amplitude of spark (V)
Leads	zero	408.18
	one	132.18
	two	97.87
Brass Straw	zero	353.33
	one	170.60
	two	122.40
Mylar Straw	zero	305.00
	one	95.33
	two	79.67







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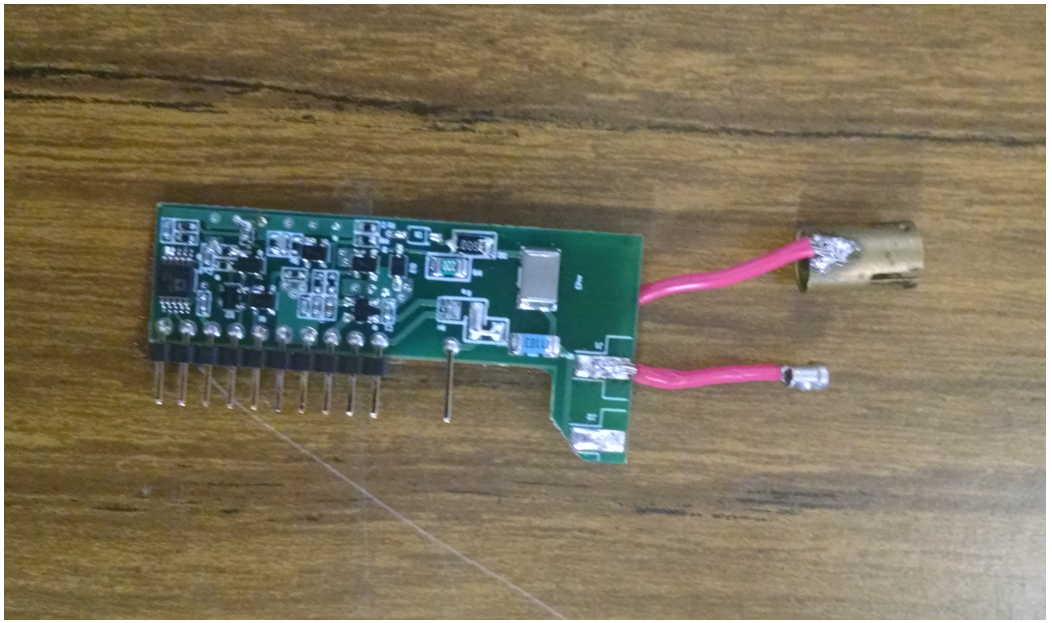
Durability Testing

- Sparked at 1500 V
- Position of resistor relative to diode important
- Need to devise a more efficient method of testing



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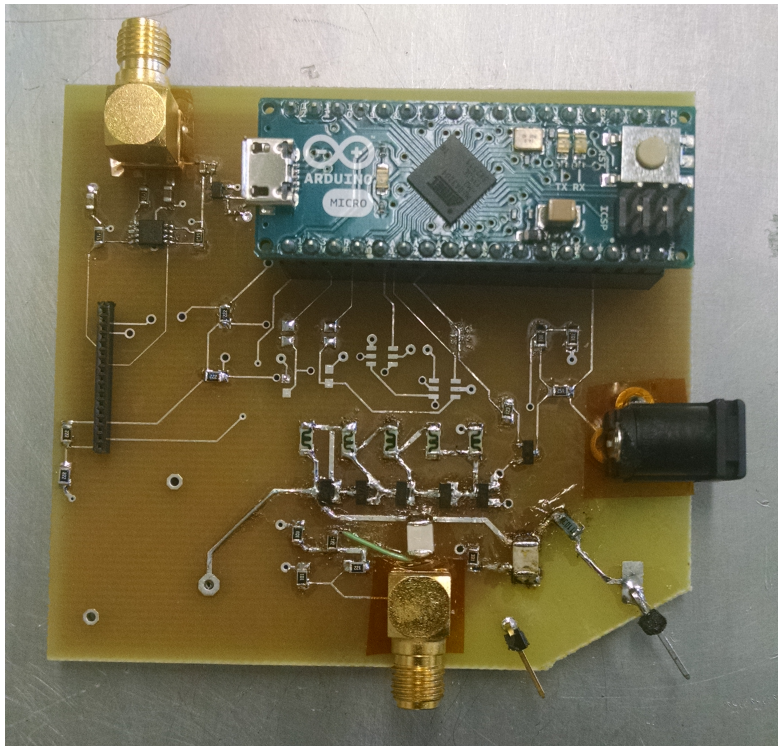
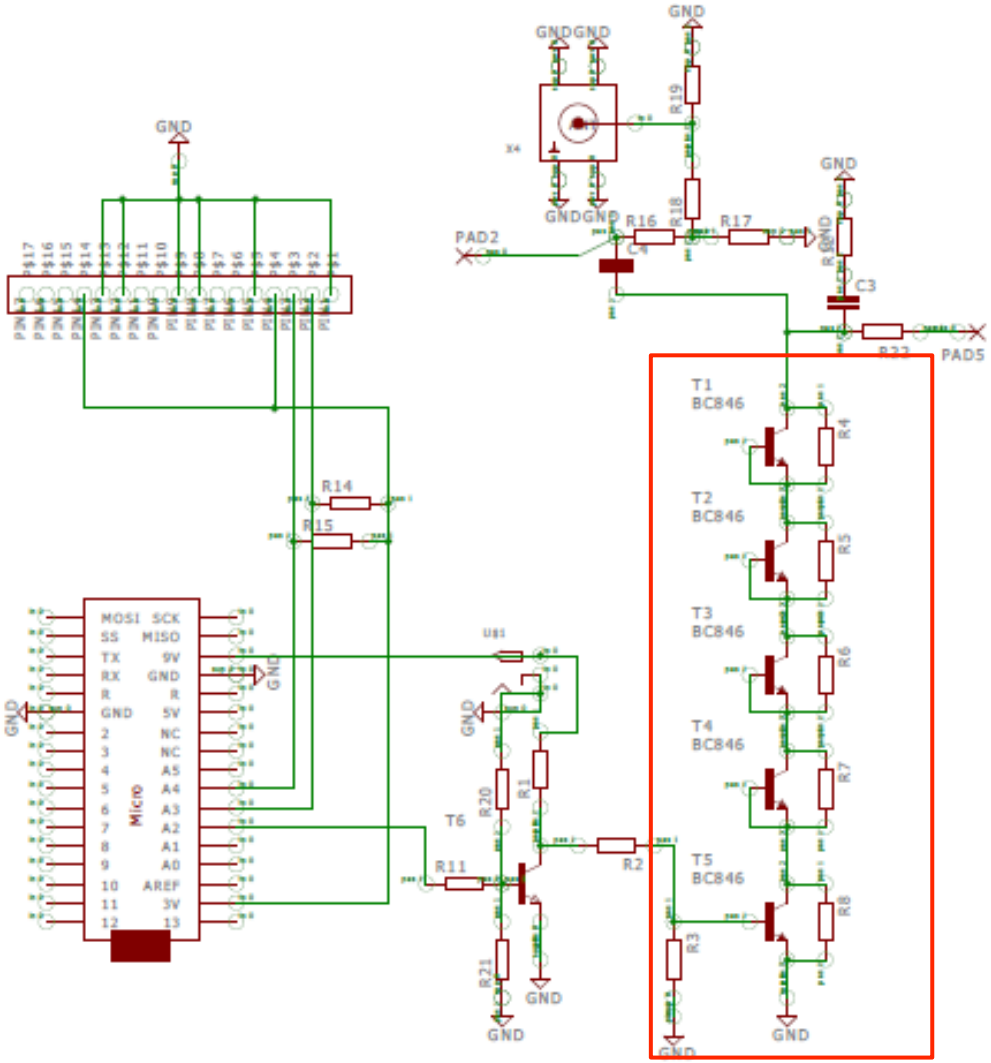
Moving Forward

- Assemble test circuit to automatically send spark to preamp
  - Control via an Arduino Micro
  - Write code to control quantity/speed of sparks



Test Circuit



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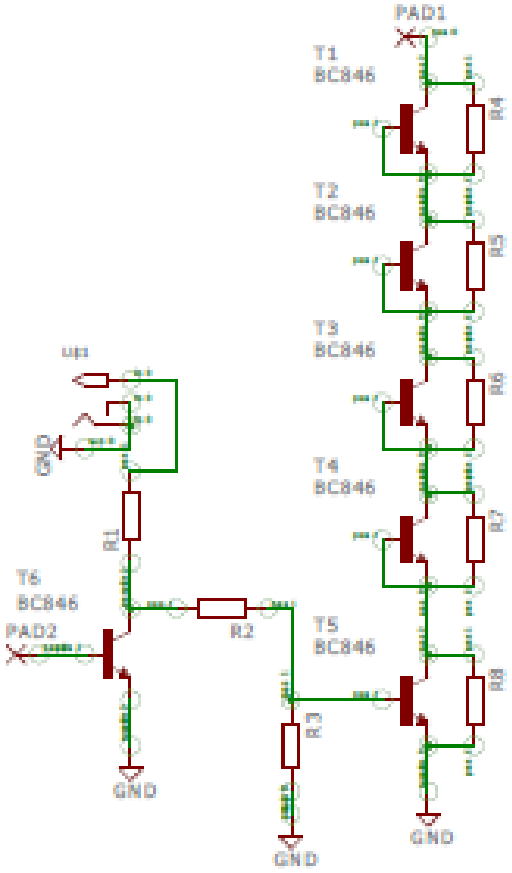
Avalanche Transistors



- Basically high speed switches
  - < 1ns reaction time
- Rely on breakdown characteristics
  - Won't avalanche until a certain voltage is reached

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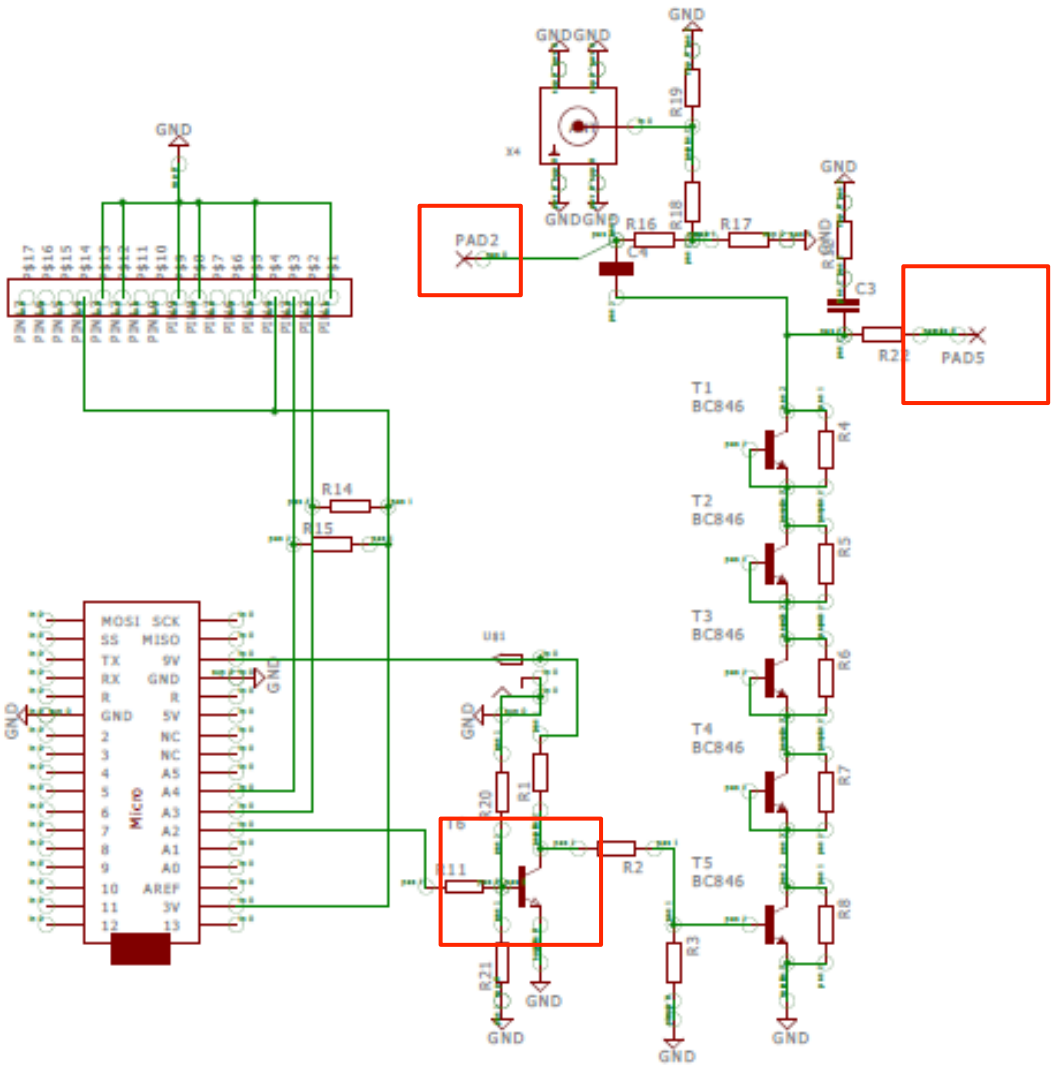
Test Circuit



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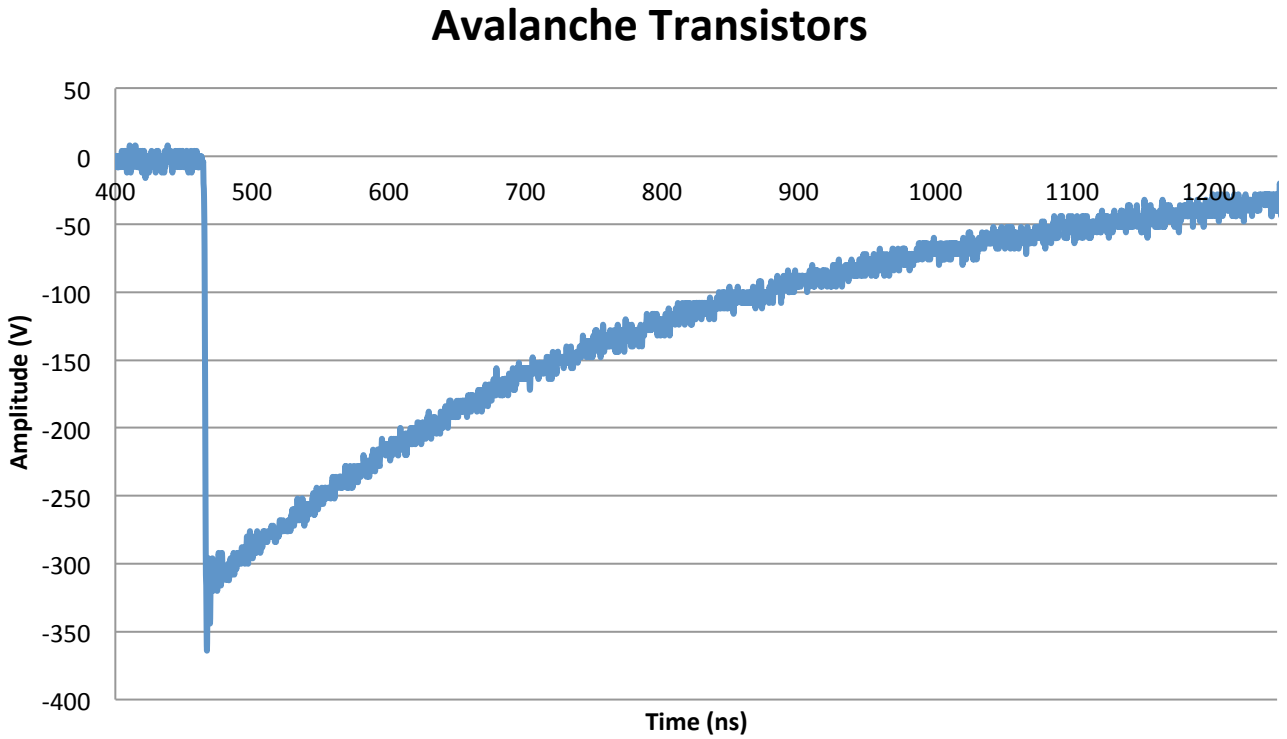
Signal



1.437 ns fall time

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Conclusions

- One stage of protection plausible so far
- More testing necessary
- Exciting to see what Mu2e finds!

Acknowledgments

- Vadim Rusu and Aseet Mukherjee
- SIST committee
- Fellow interns
- Fermilab