Fermilab TRAC Program 2013

Michelle Morris

Mentors: Sarah Lockwitz, Hans Jostlein, and Stephen Pordes

Prezi

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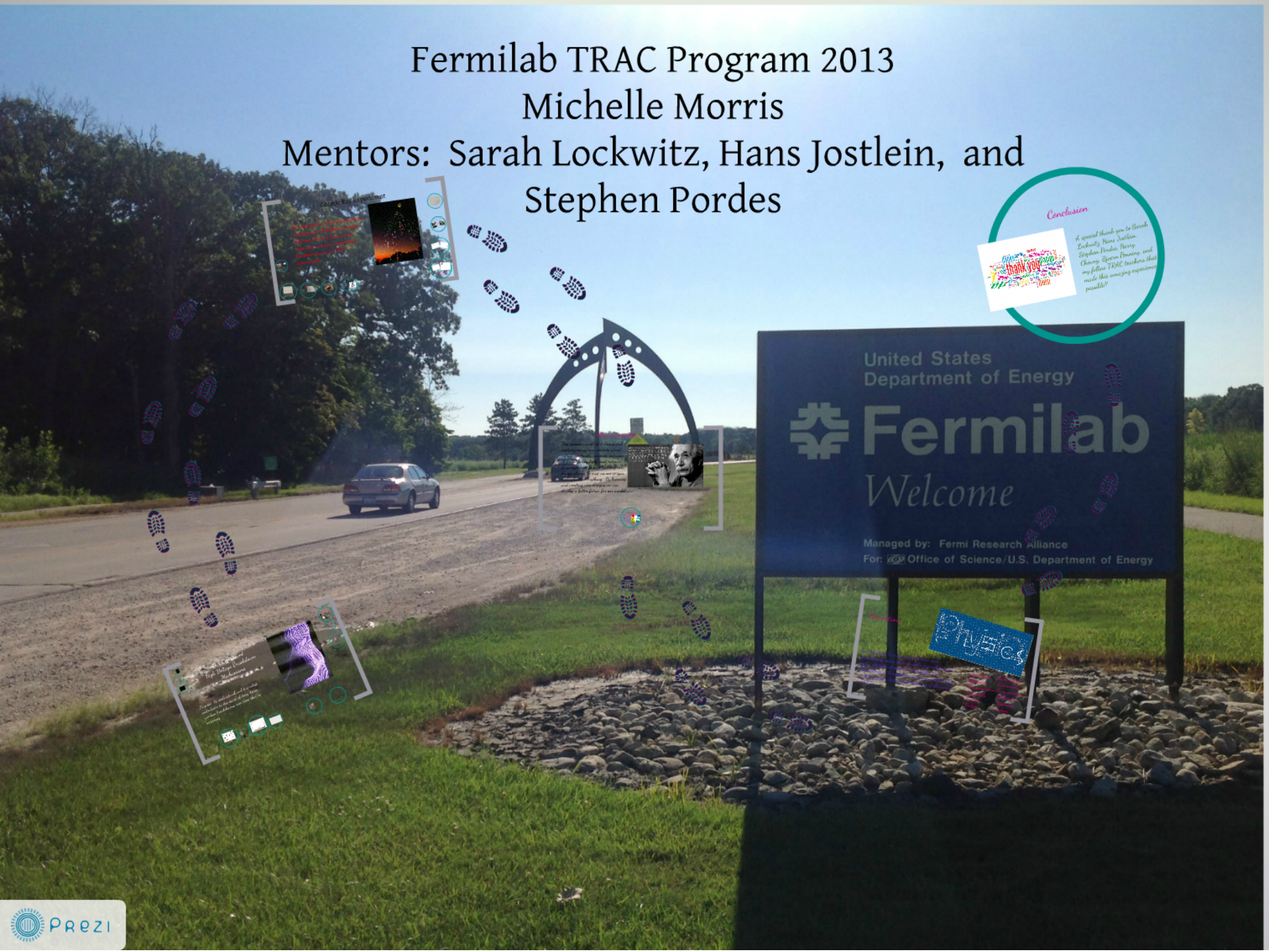

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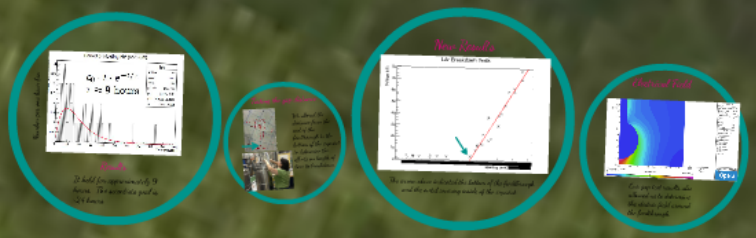
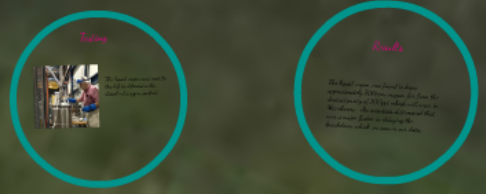
Our Experiment
High Voltage Breakdown Mechanisms

Purpose: to understand and test what contributes to the cause of long-term random breakdowns over time that is occurring





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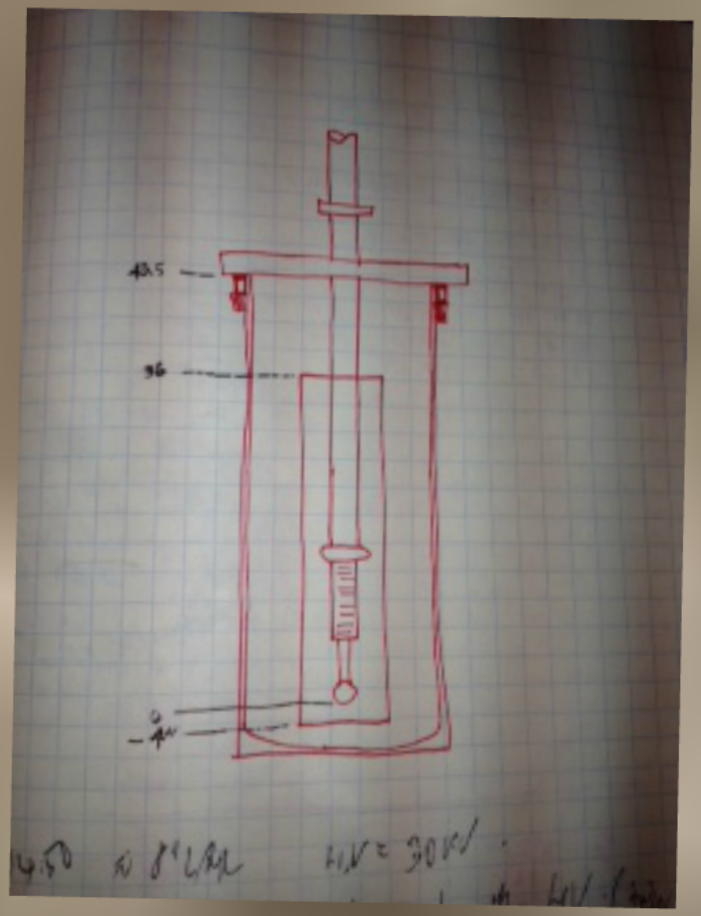

The Design

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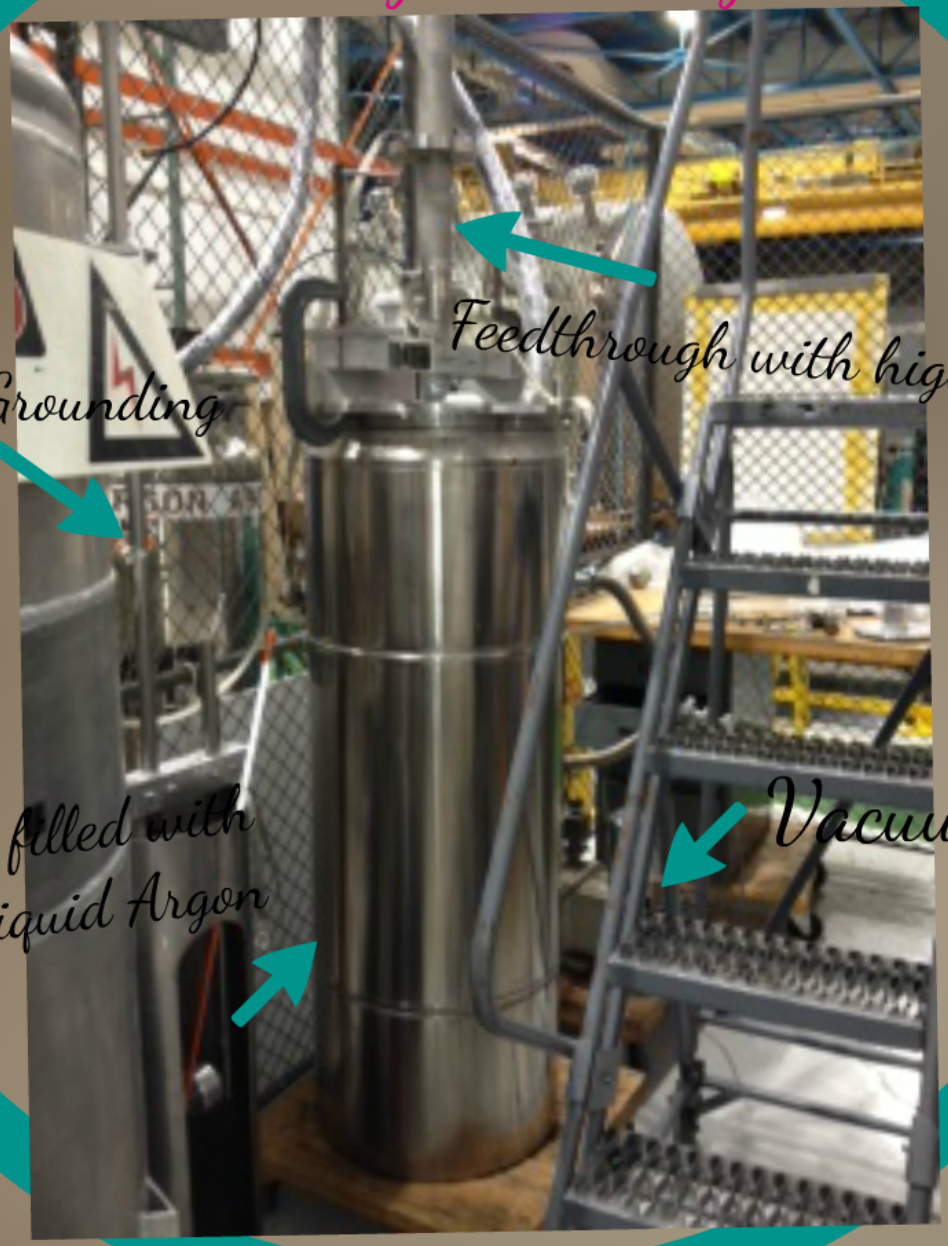
Building our design



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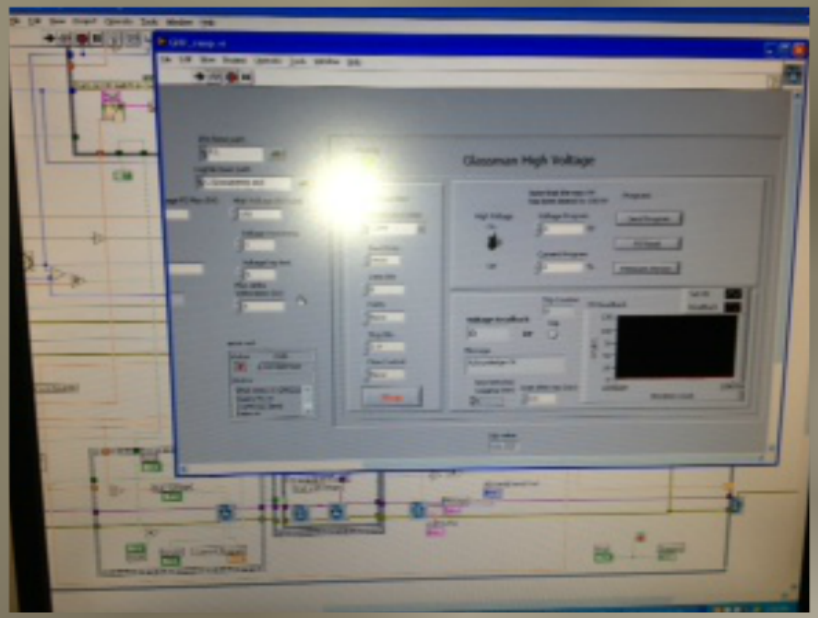
Collecting the data



We used a program in Labview to control our voltage and time intervals and record our results.

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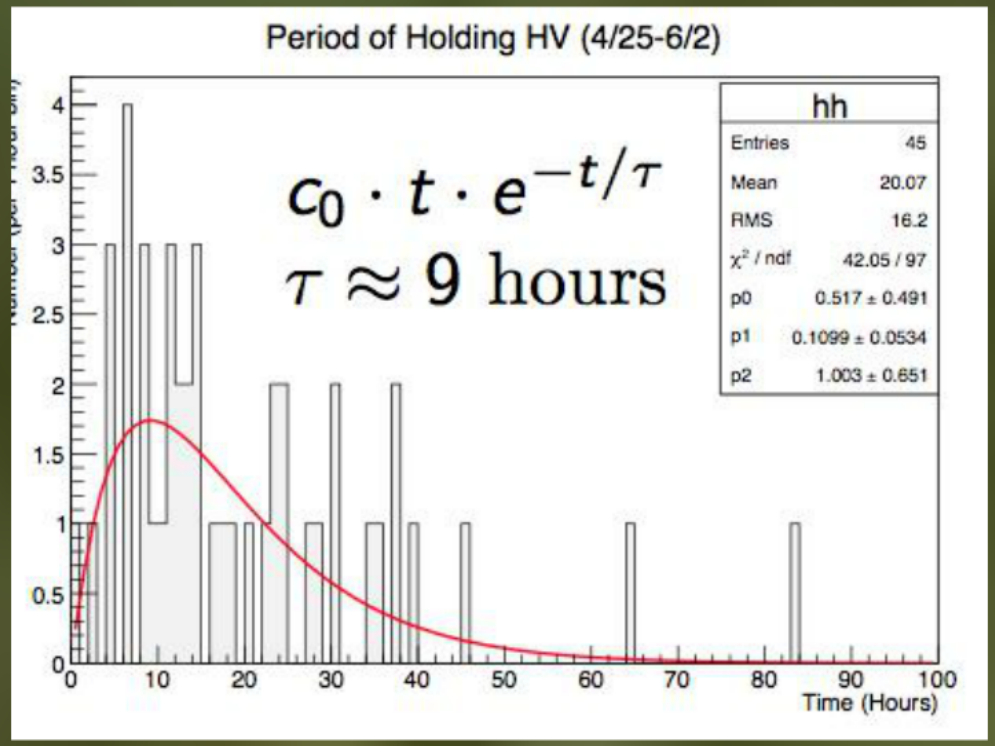
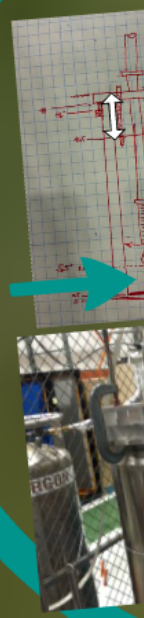
Number per one hour bin



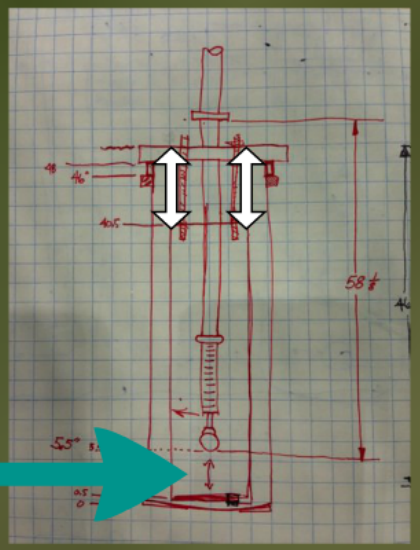
Results

It held for approximately 9 hours. The scientists goal is >24 hours.

Test



Testing the gap distance



We altered the distance from the end of the feedthrough to the bottom of the cryostat to determine the effects on length of time to breakdown.

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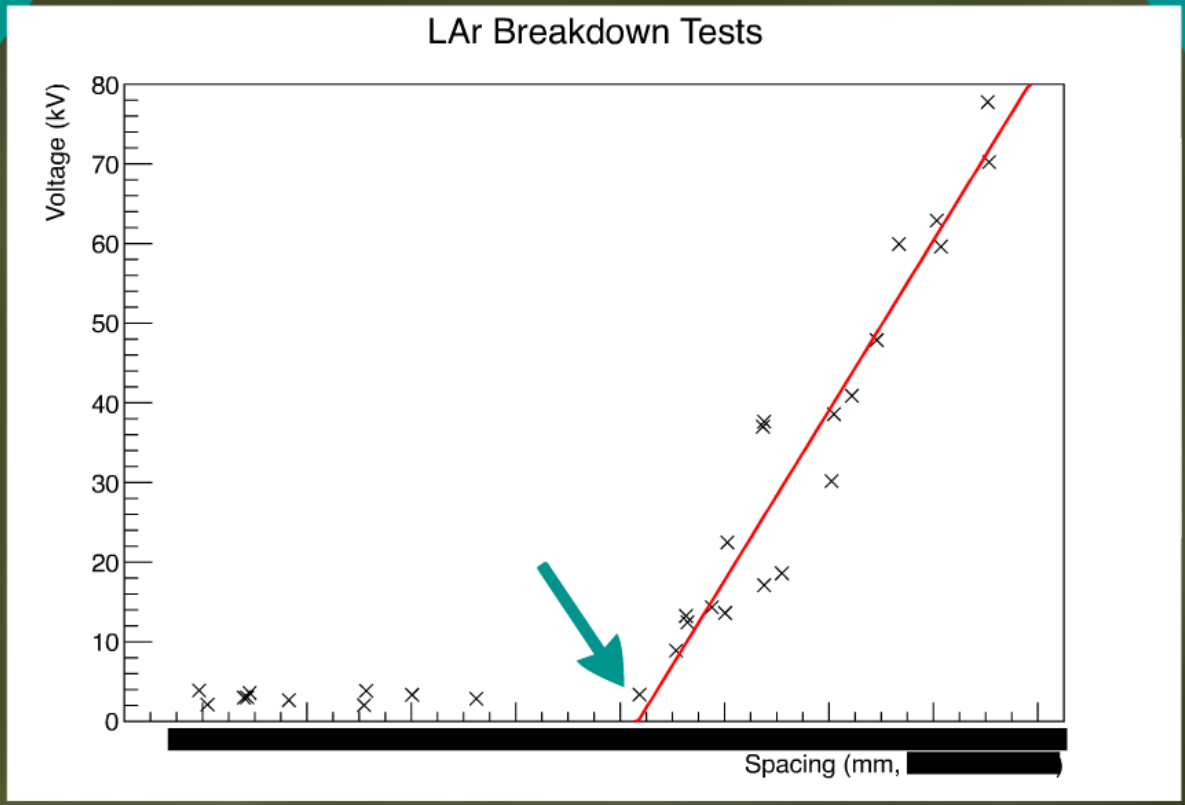
New Results



The arrow above indicated the bottom of the feedthrough and the metal covering inside of the cryostat.

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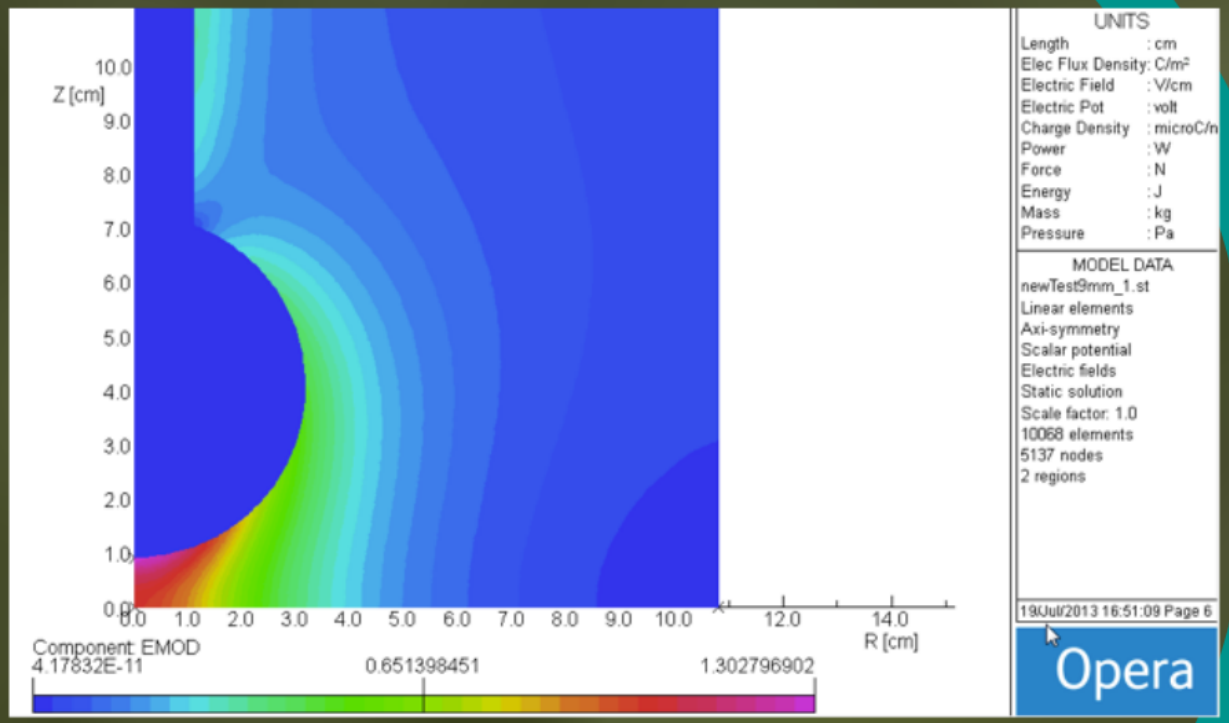
Electrical Field



Our gap test results also allowed us to determine the electric field around the feedthrough.

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Analyzing Results

The experiment was run many times over a period of 2 weeks. The results were varying each time with the breakdown getting less and less frequent. The scientists felt that this may be due to contamination of the liquid argon in the open cryostat.

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Testing

The liquid argon was sent to the lab to determine the dissolved oxygen content.

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Results

The liquid argon was found to have approximately 700ppm oxygen, far from the desired purity of 100ppt which will occur in Microboone. The scientists determined that was a major factor in delaying the breakdown which we saw in our data.

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Redesign of the feedthrough mechanism

We added more groves on the ultra high molecular weight polyethelene, removed the previous electron tracks, changed the grounding design, and placed the feedthrough in a sealed cryostat that had controlled purity monitors for the liquid Argon.

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Pending Results

The new feedthrough is currently sealed and running at PC4 and results will be determined soon.

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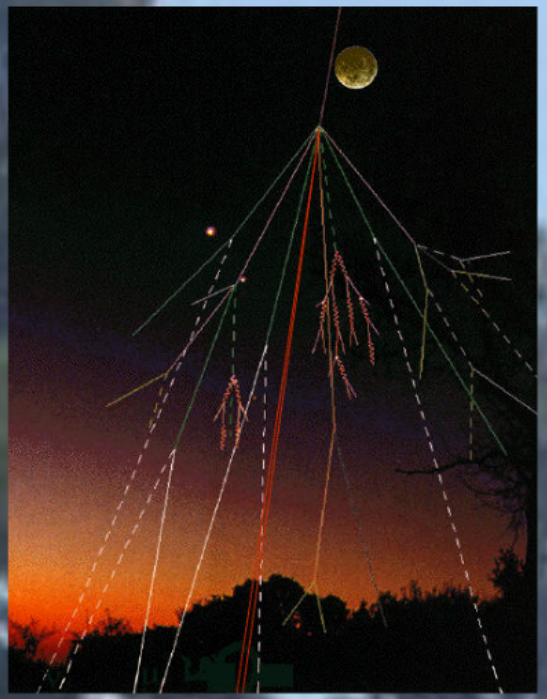
Cosmic Ray Experiment

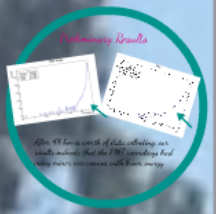
We designed a second experiment to determine if highly energetic electron showers from cosmic rays were causing immediate breakdowns in our HV experiment.



The Design

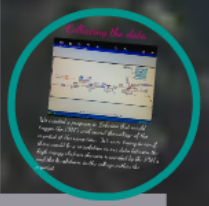
Setting up the scintillator

Building the stage for the scintillator



Preliminary Results

After 48 hours worth of data collecting our results indicated that the PMT coincidence had very rare occurrences with high energy.



Collecting the data

We created a program in Delphi that would trigger the CAEN and record the voltage of the scintillator at the same time. At each trigger the data would be in a variable in an array data structure, and the whole array would be written to the PMT's digital.

Problems encountered

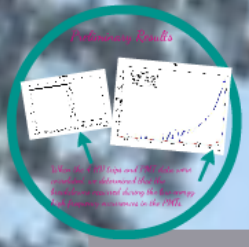
Everyone worked hard to keep their solar HV sufficient cause we experienced an issue with the wires, switches, pulses, etc. Lots of troubleshooting.

Weather Results Pending

We were unexpectedly really lucky at UC Davis and had sunny days.

Next Steps

A little hypothesis made by scientists is cosmic rays have enough energy to affect the breakdowns in our HV and sensors.



Preliminary Results

After the PMT tops and PMT data were compared, it determined that the coincidences recorded during the cosmic ray shower occurrence in the PMTs.

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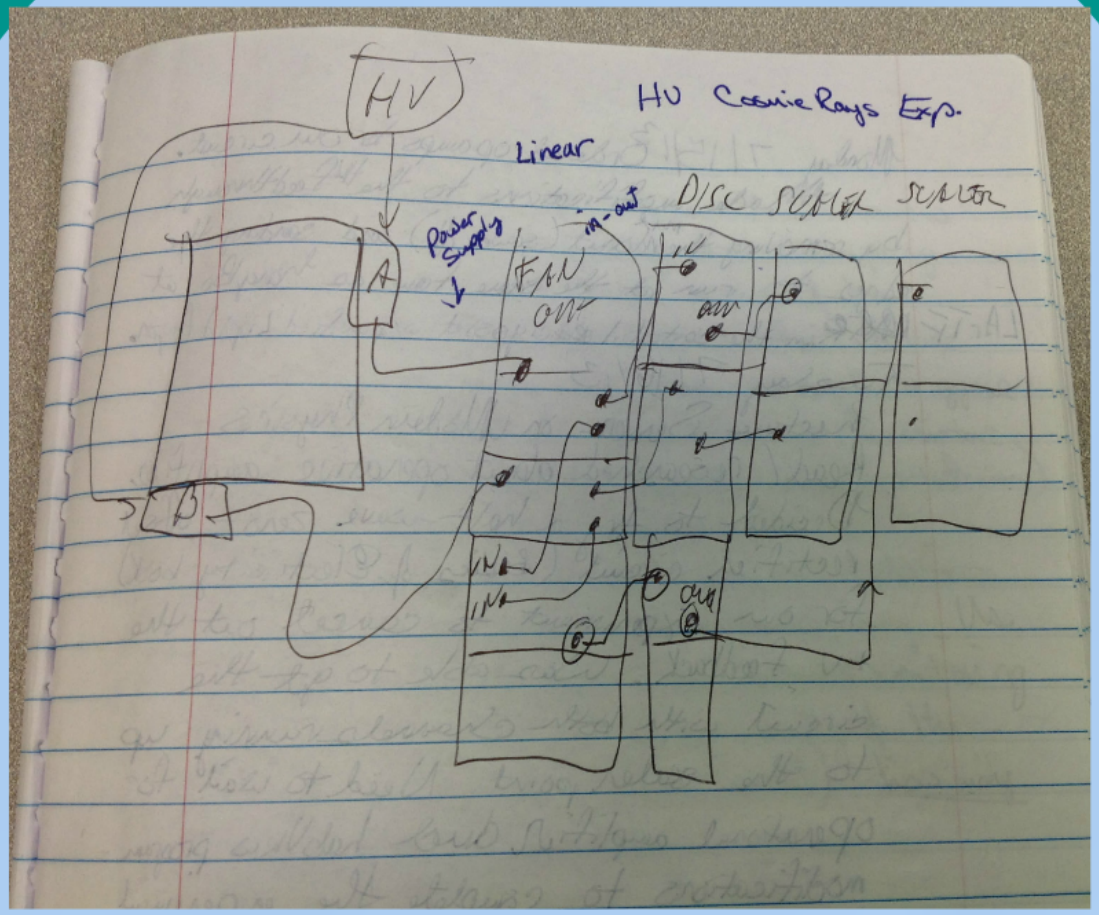

The Design

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Setting up the scintillator

We examined the scintillator for light leaks that may affect our experiment and the results. We covered all leaks with black electrical tape.

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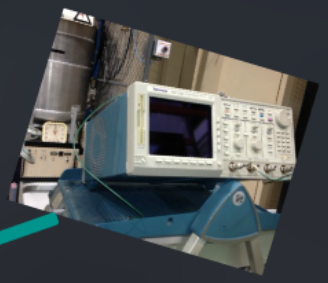
Building the design from the scintillator



We used a linear fan in-out, discriminator, amplifier, scaler, power supply, resistors, capacitors, and a NIM bin. Our design had a lot of noise so we used an oscilloscope to determine necessary corrections that needed to be made.

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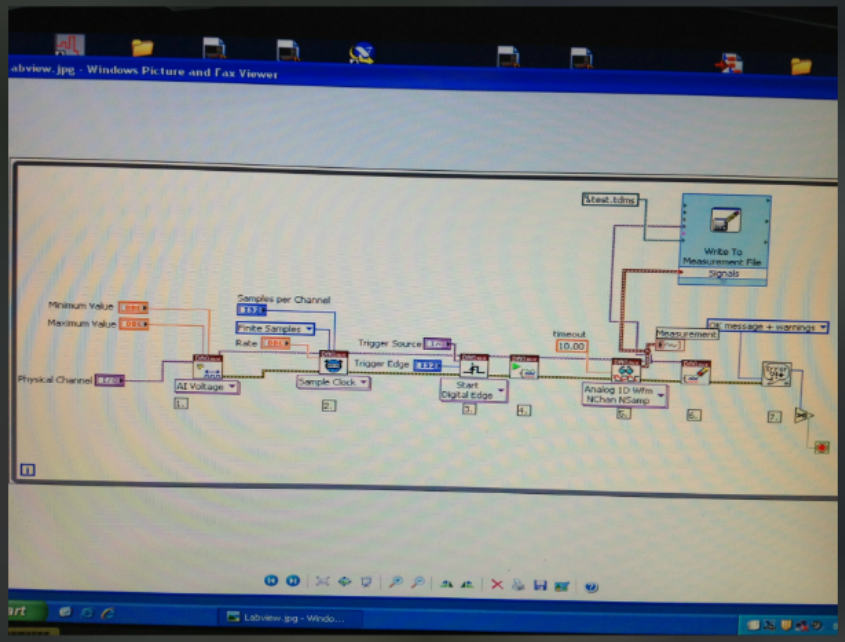
Collecting the data



We created a program in Labview that would trigger the PMT's and record the voltage of the cryostat at the same time. We were trying to see if there would be a correlation in our data between the high energy electron showers recovrded by the PMT's and the breakdown in the voltage within the cryostat.

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Problems encountered

Everyone worked hard to try and solve the software issues we encountered as well as the noise issues within our electronics.

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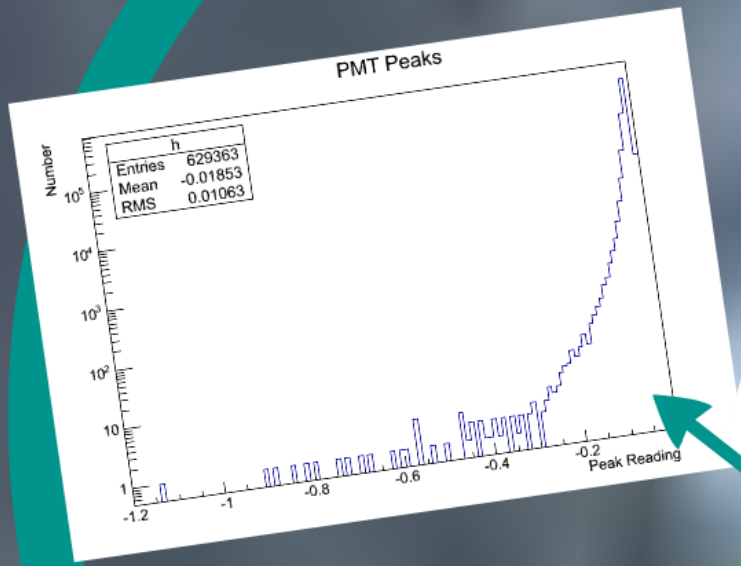
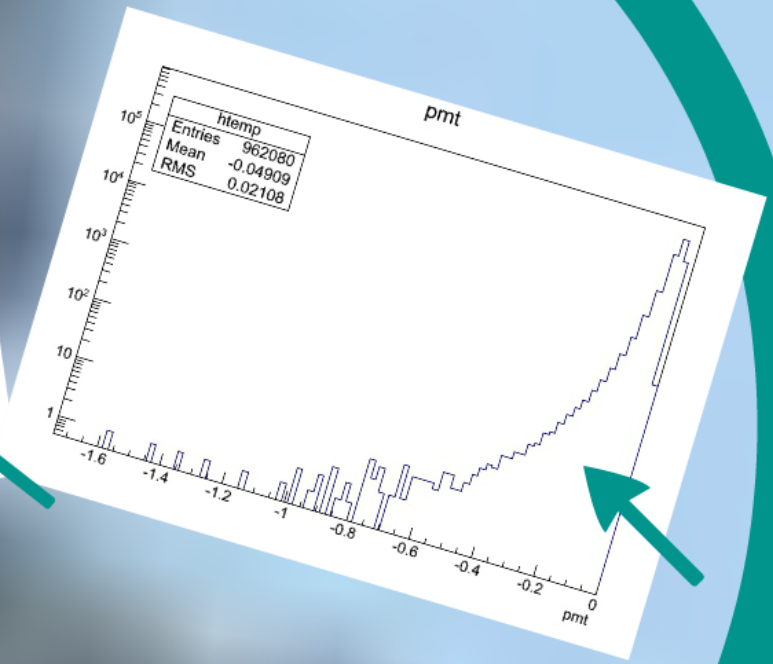
Preliminary Results





After 48 hours worth of data collecting, our results indicate that the PMT recordings had many minor occurrences with lower energy.

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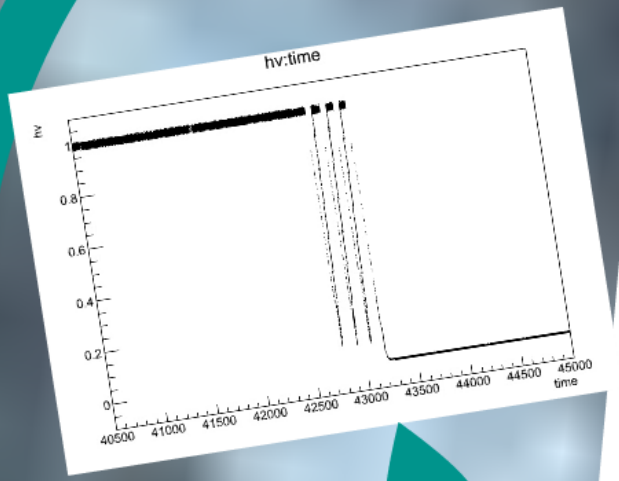
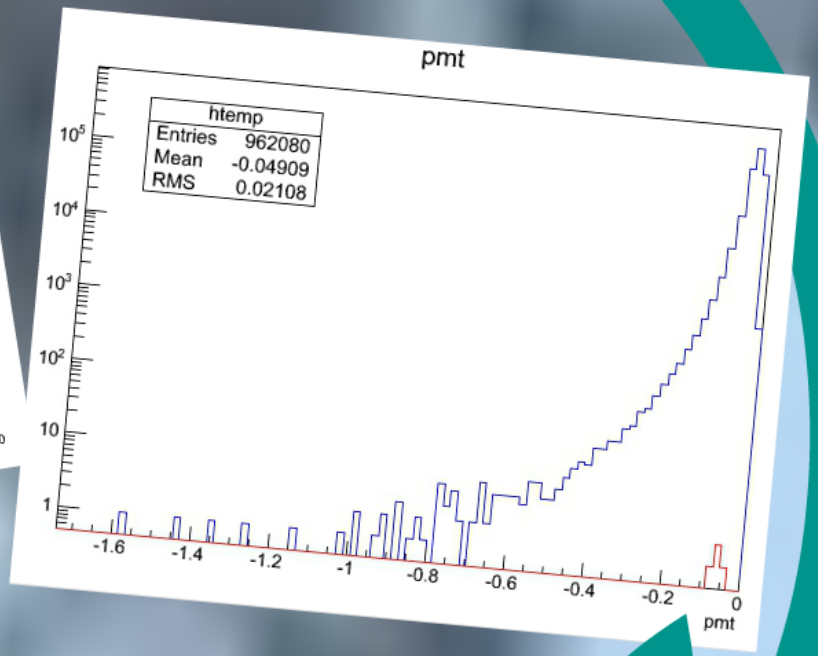
Preliminary Results





When the 4 HV trips and PMT data were correlated, we determined that the breakdowns occurred during the low energy high frequency occurrences in the PMTs.

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Further Results Pending

The cosmic ray experiment is currently running at PC4 and we are still analyzing data.

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Next Steps

A new hypothesis that the scientists are currently discussing is how humidity may be effecting the breakdown in the high voltage.

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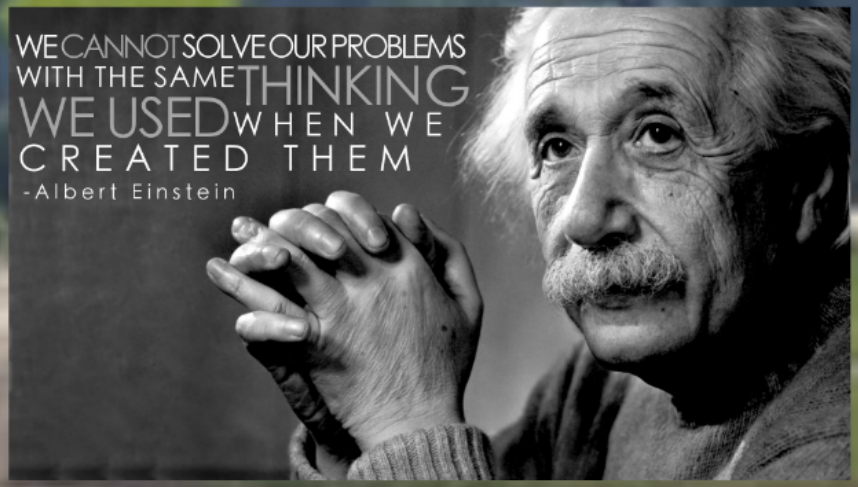
Physics Knowledge

This summer involved learning and applying many new concepts about energy, electricity, currents, software, electrical fields, light, and patience. It is important to keep learning new things always because no one person understands everything. By learning and creating new designs we can develop a better future for our world!



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Problem Solving Process

It is important as a scientist to be able to ask questions, obtain solutions, qualitatively and quantitatively analyze data, conduct experimental investigations, and communicate everything with your peers. Science is a constant ongoing process that involves lots of communication, observations, and reasoning skills.

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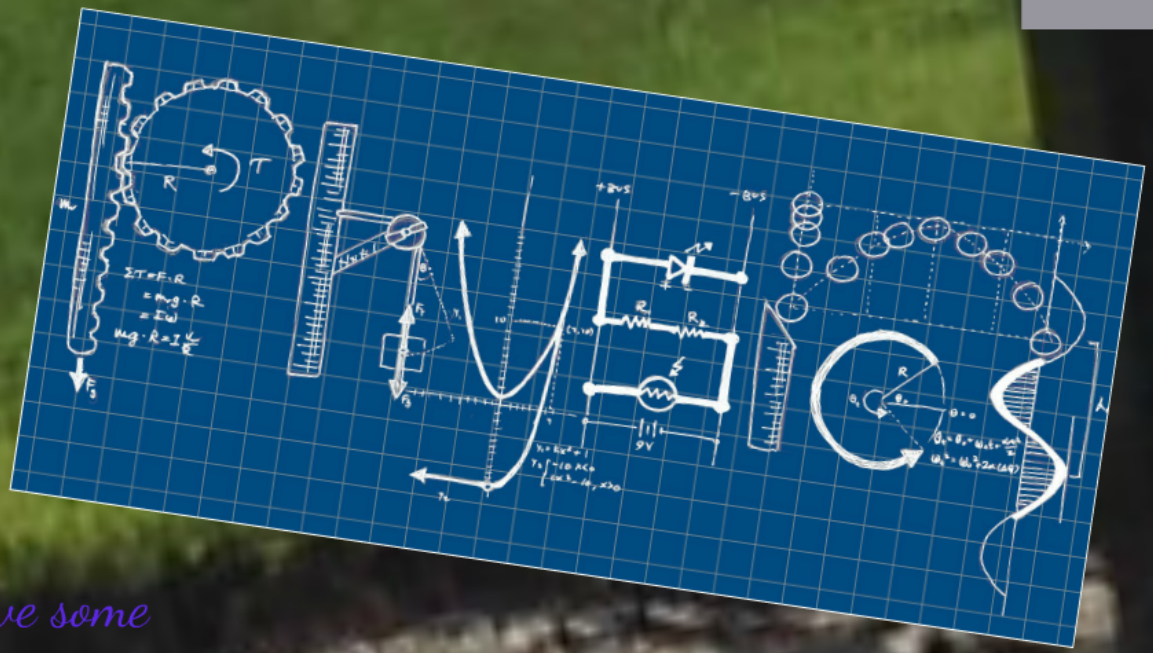
Connections



As a physicist, it is important to have some knowledge of many other disciplines to achieve your goals. All types of people work together and communicate at Fermilab to create new solutions for our future and a better understanding of the world we live in.

Engineering	Mathematics
Chemistry	Government
Communication	Programming
Technology	Mechanics
Geology	Statistics
Biology	Ecology

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Conclusion

A special thank you to Sarah Lockwitz, Hans Jostlein, Stephen Pordes, Harry Cheung, Bjoern Penning, and my fellow TRAC teachers that made this amazing experience possible!!

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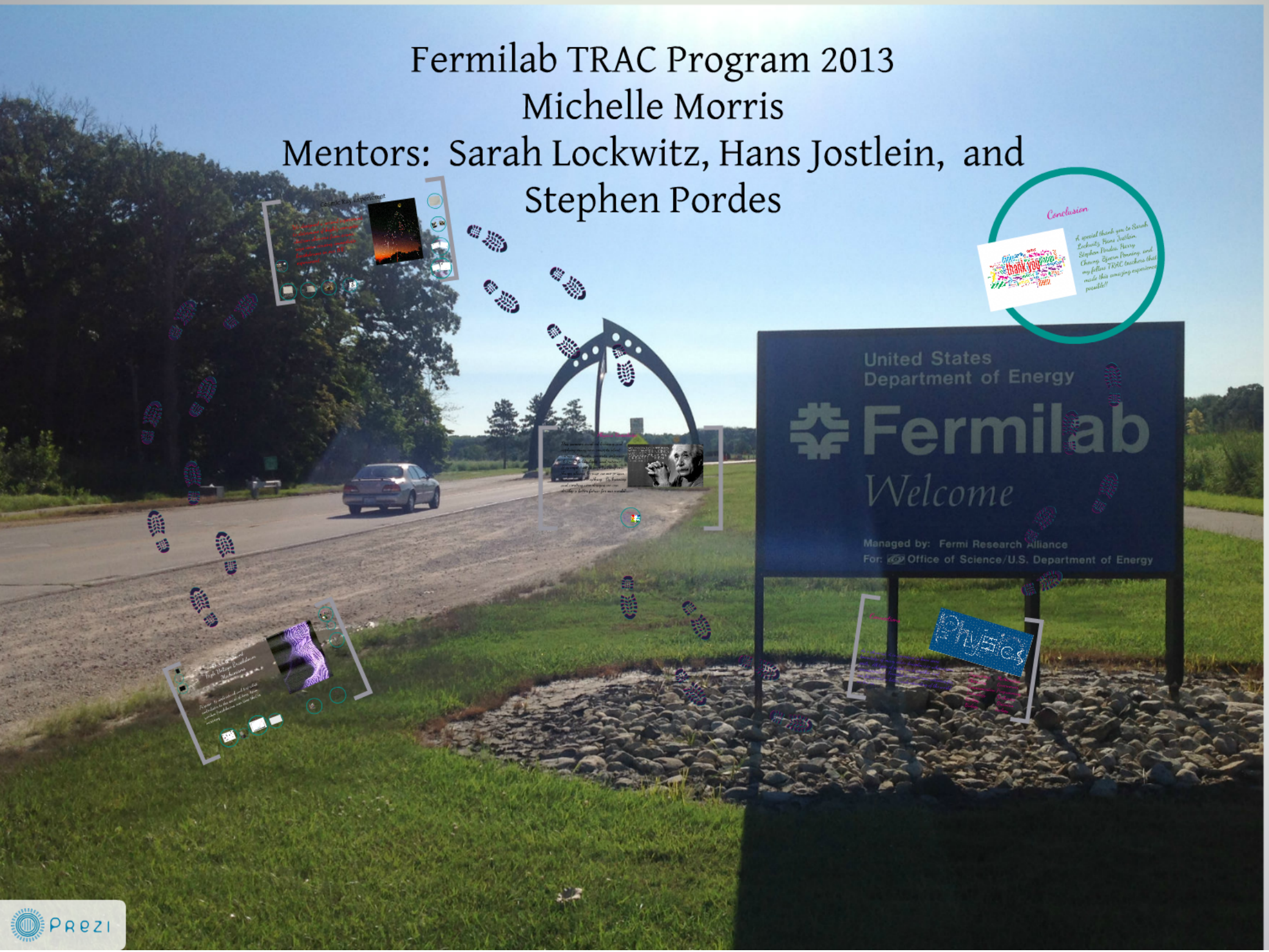

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