Fermilab

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G-2 tracker test beam T1042

Sergio Daniel Hernandez Charpak
Internship for Physics Majors - IPM Program
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Overview

I. Introduction – Motivation

II. The experiment G-2

III. The straw tracker

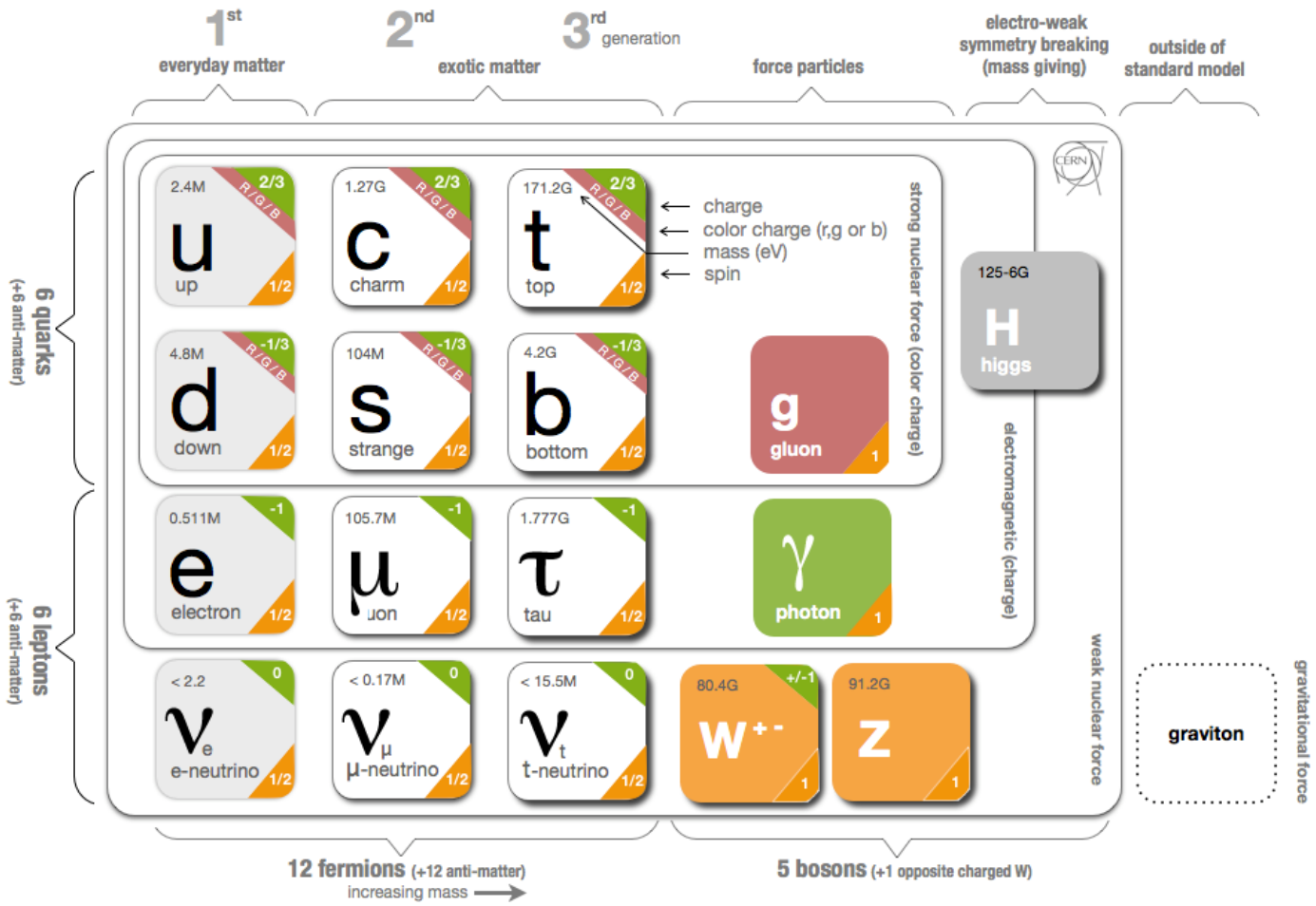
IV. The Test Beam

V. Analysis

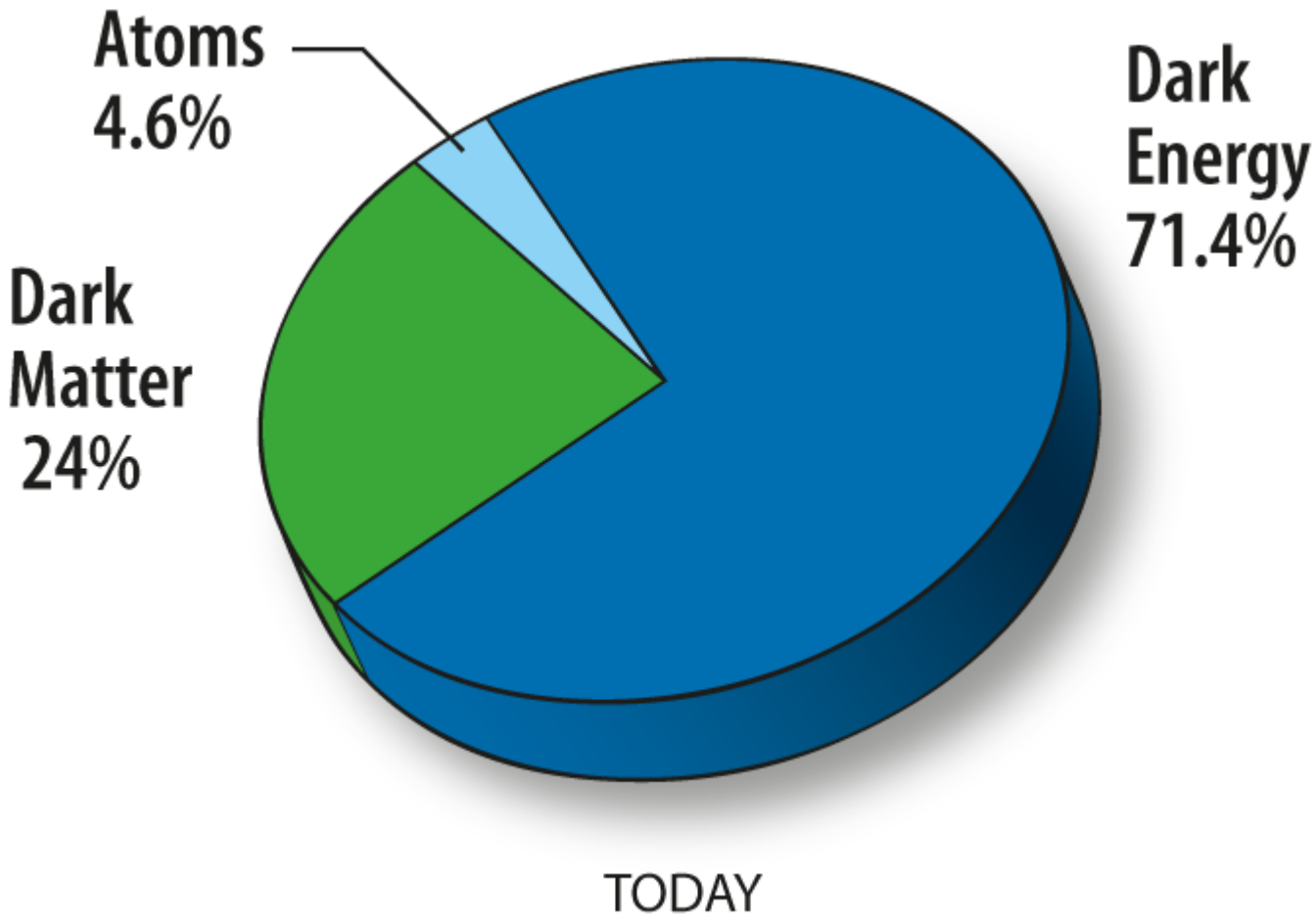
VI. Results

VII. Conclusions

The current Standard Model

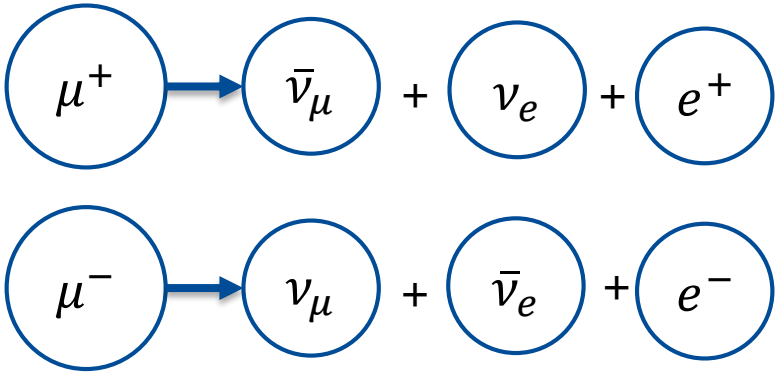


What about the rest?

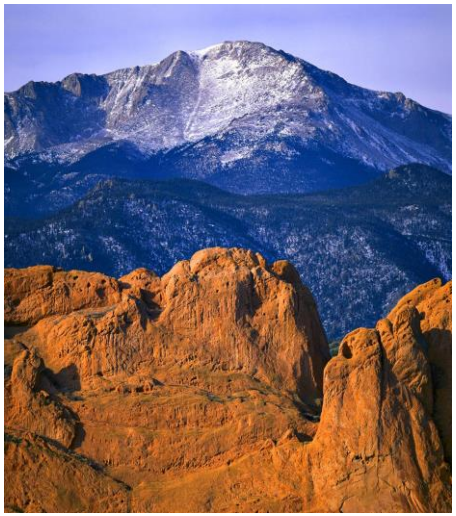


And Muons? → Our probes

- Discovered in Cosmic Rays in 1936



- Decay time 2.2 μs
  - Short to do fast experiments
  - Long to manipulate the muons



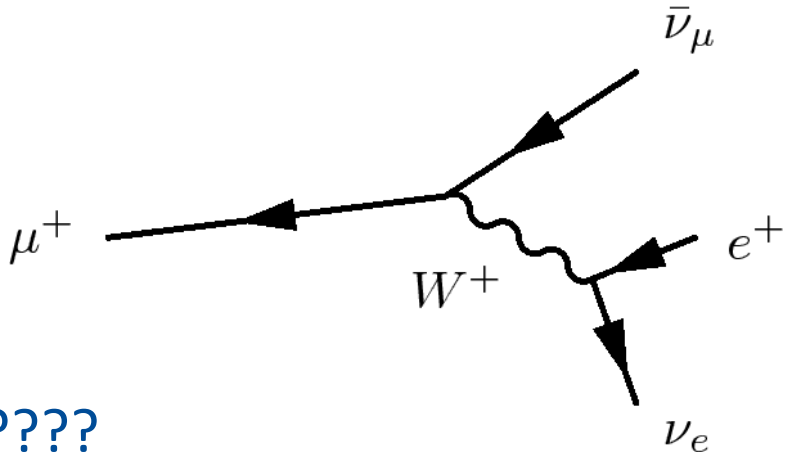
Pike's Peak, CO

- Same charge as the electron
- 207 times more massive

We know a lot and we know it precisely

"g-2" and a_μ

- Intrinsic magnetic moment, carries information about the spin
- Dirac predicted 2, but experiment differs
- Anomalous magnetic moment
- Standard Model prediction:



$a_\mu^{SM} = (g_\mu^{SM}-2)/2 = a_\mu^{QED} + a_\mu^{EW} + a_\mu^{QCD} + ????$

Uncertainty	*Goal [ppb]*
Experiment	**140**
Theory	**140**

Able to predict very precisely but also to measure very precisely.

We want to measure to a precision never seen before to get clues of the **Physics beyond the Standard Model.**

Fermilab Muon G-2

- The Muon Campus

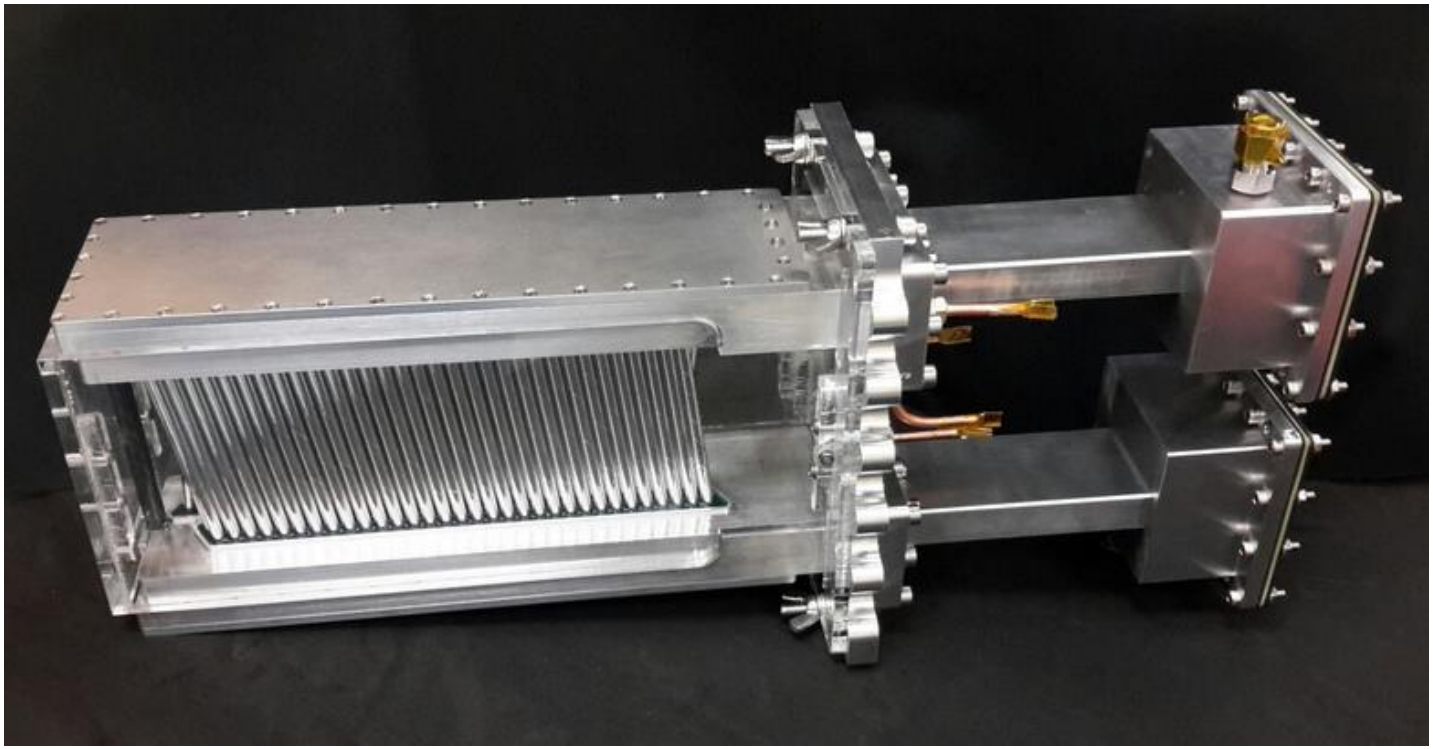
- The big move

- Current state

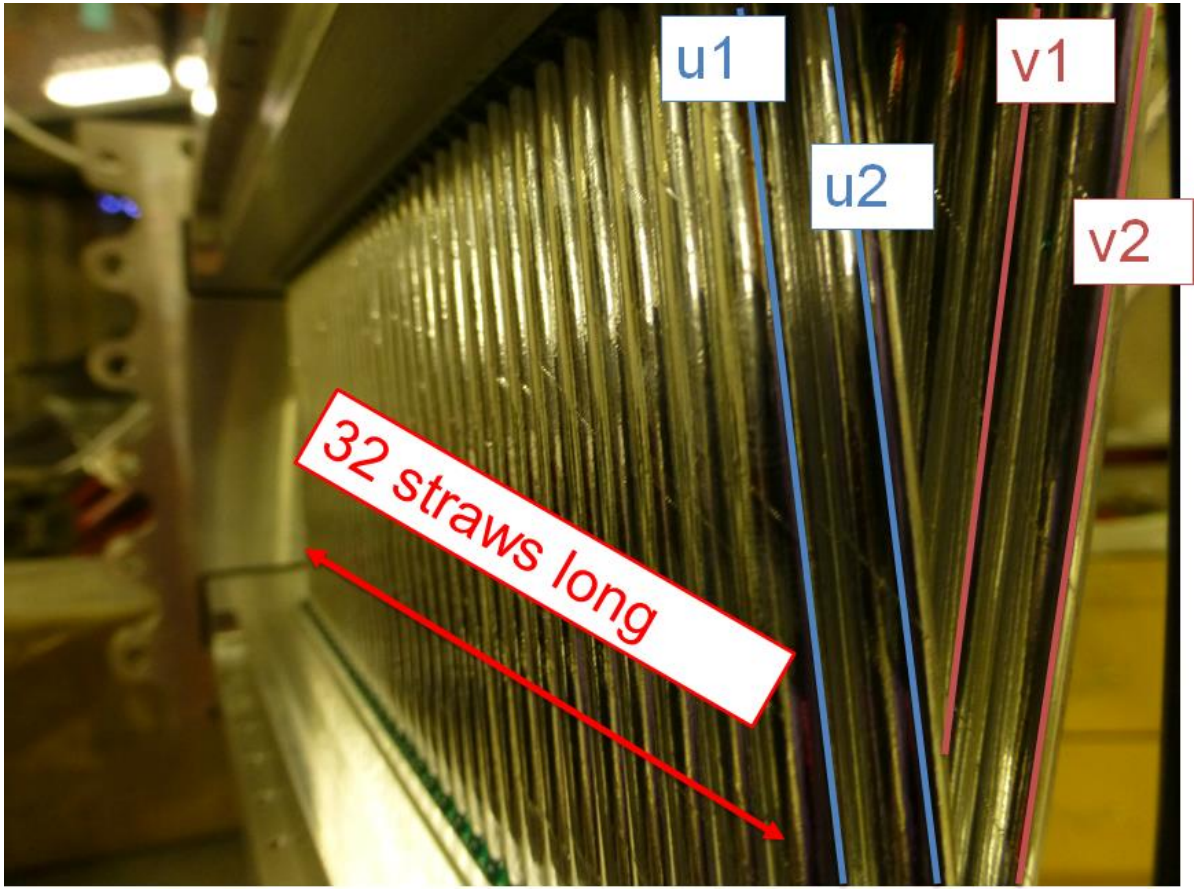
- Cooled and Powered on June 2015

The Straw Tracker

- Track the trajectory of the decayed positrons
- Get information of the Muon beam from this trajectory



The Straw Tracker



The 4 layers of the Straws.

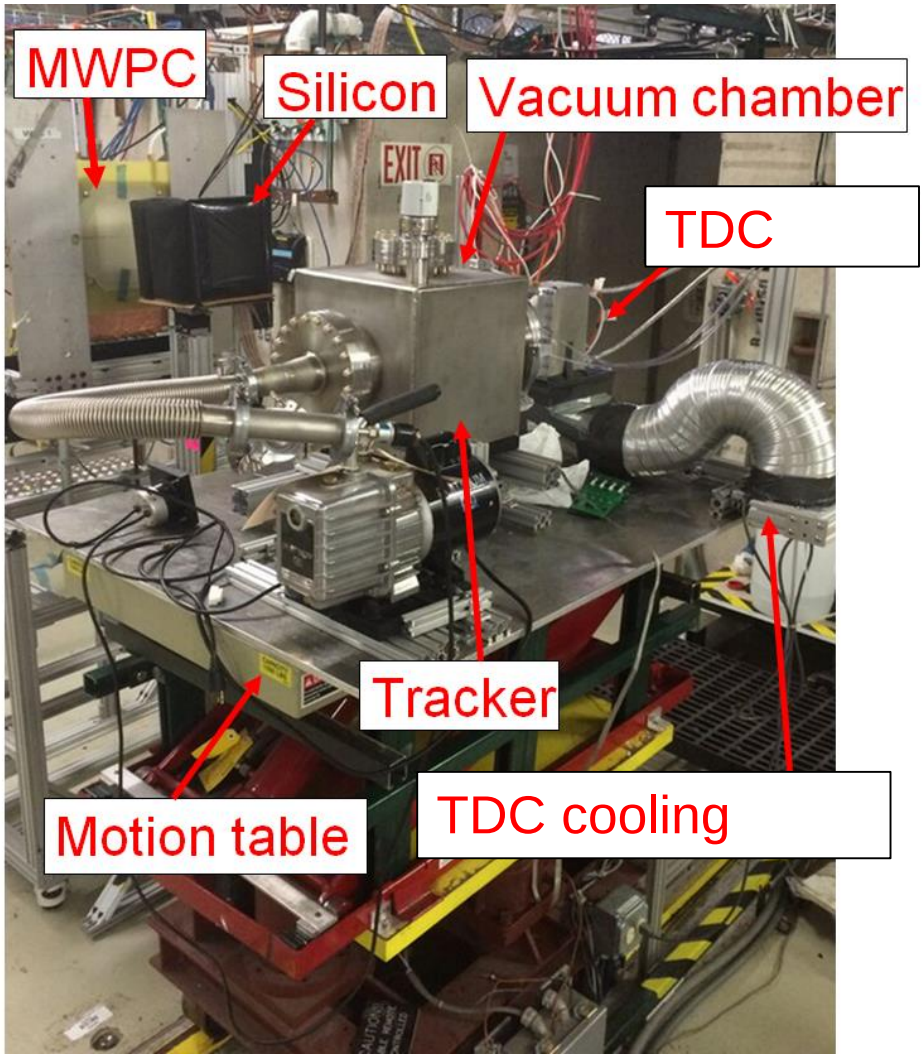
Straw parameters	
Wall Material	Aluminized Mylar
Wall thickness	15μm
Wire Material	Gold plated Tungsten
Wire diameter	25 μm
Straw length	10 cm
Stereo angle	±7,5° from vertical
Operating Voltage	1800 V

The Straws parameters

The Test Beam

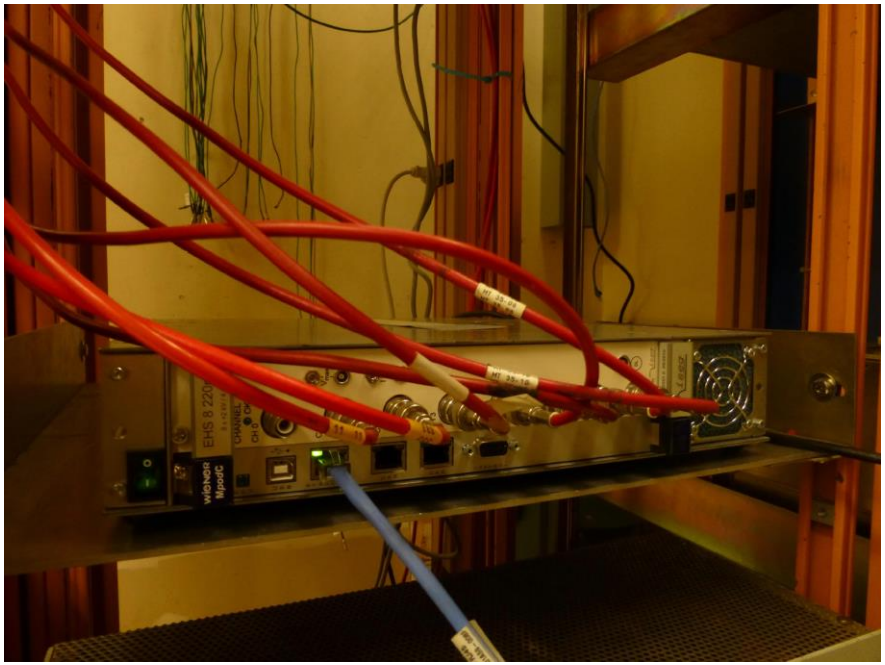
- MTest (FNAL)
- ~2 weeks
- 120 GeV protons
- Tracker module
- Ar-CO2 & Ar-Ethane

The Test Beam Team



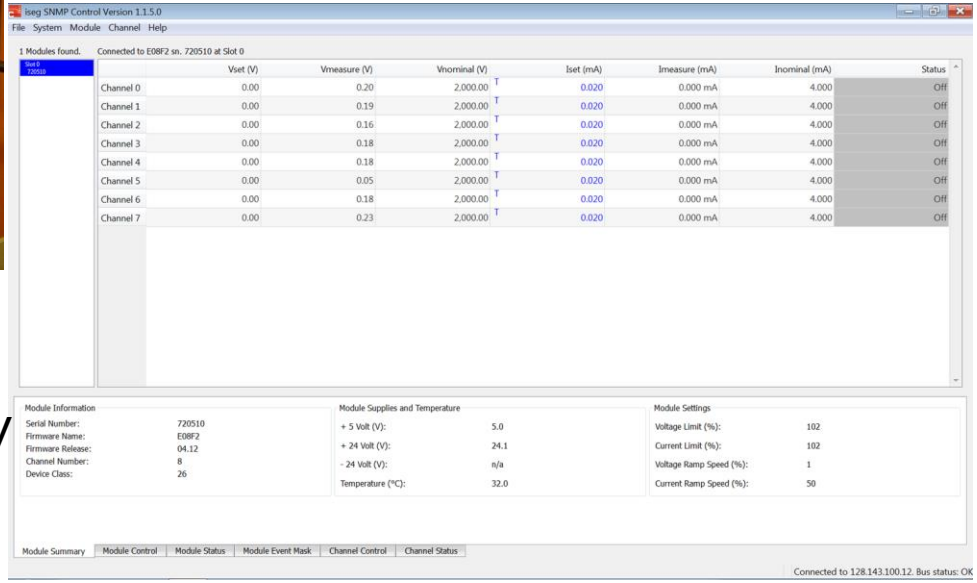
The Test Beam Layout

The HV Module



HV plugged in

- High Voltage
- Iseg EHS 8220p-F
- Switched Mode Power Supply (Supply)
- Low ripple and noise
- Resolution few pA
- Remotely controllable via SNMP



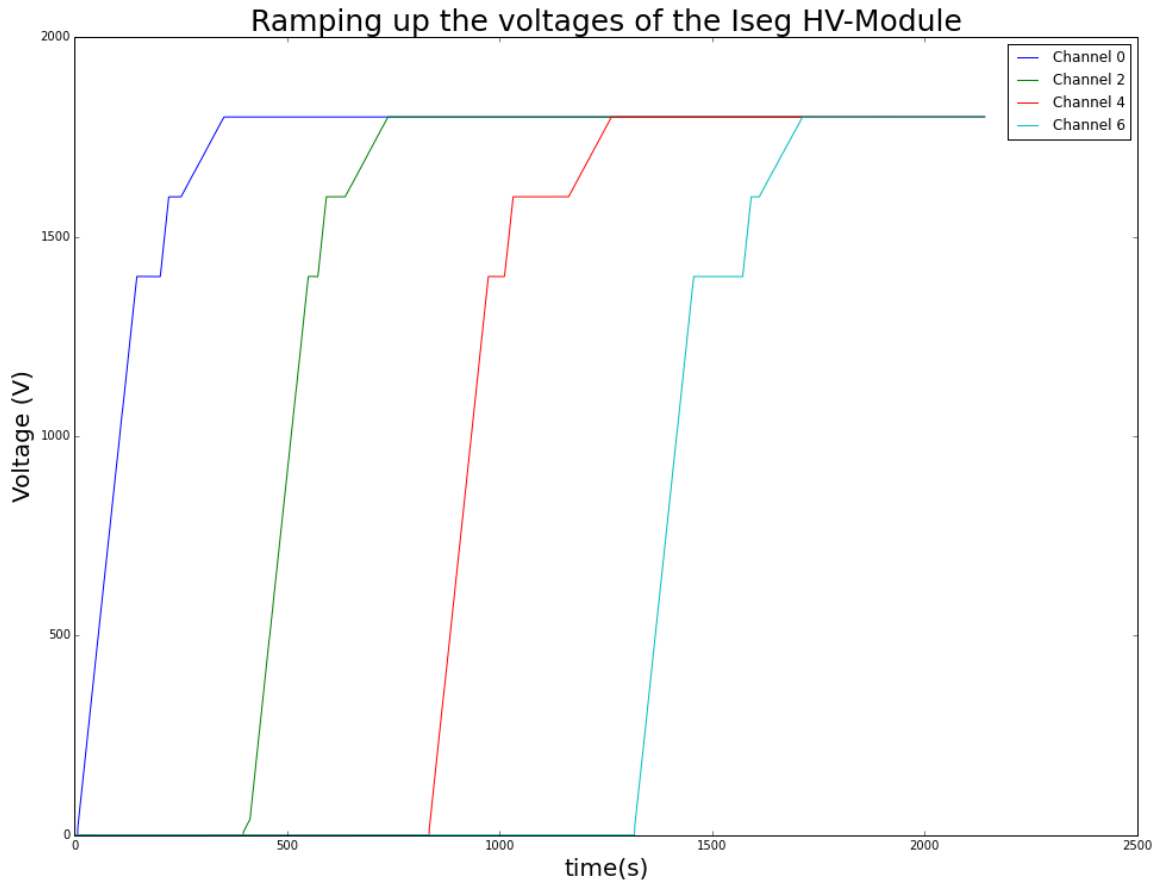
Iseg SNMP GUI

Operated at 1400-1500-1600-1700-1800V

Ramp speed of 1%

Current trip of 20 μA

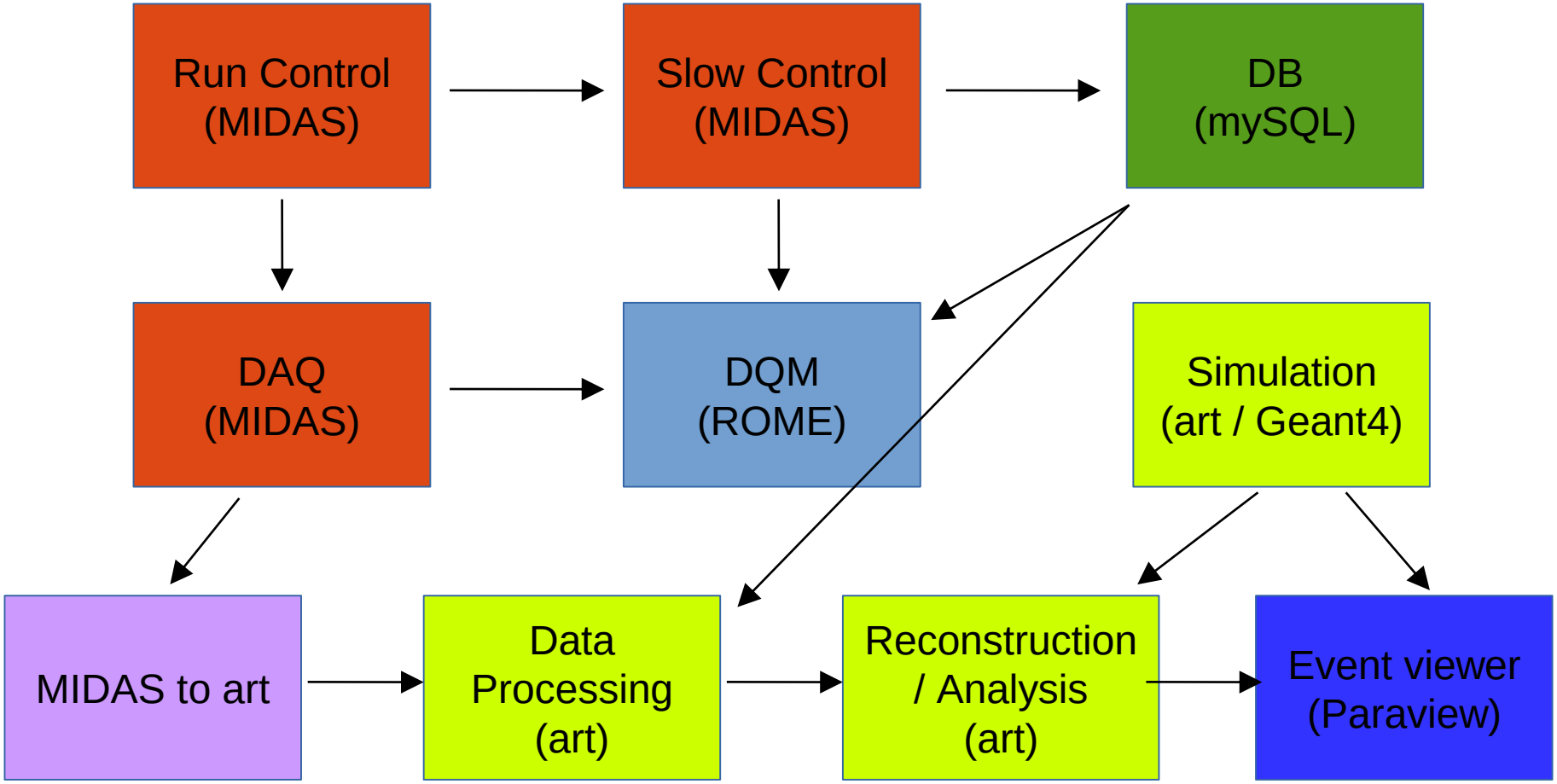
The HV Module



Worked fine!

Analysis - Collaboration Software

g-2 software chain - Simulation and Analysis - Written in collaboration



Analysis - Time Differences - Contribution

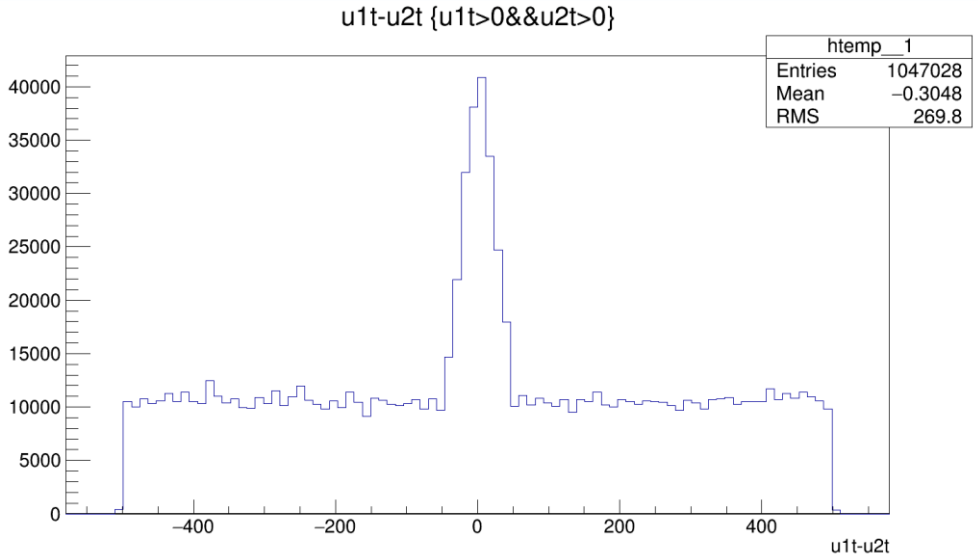
Once I have the 4 layers of Digits from the run.

Quick look

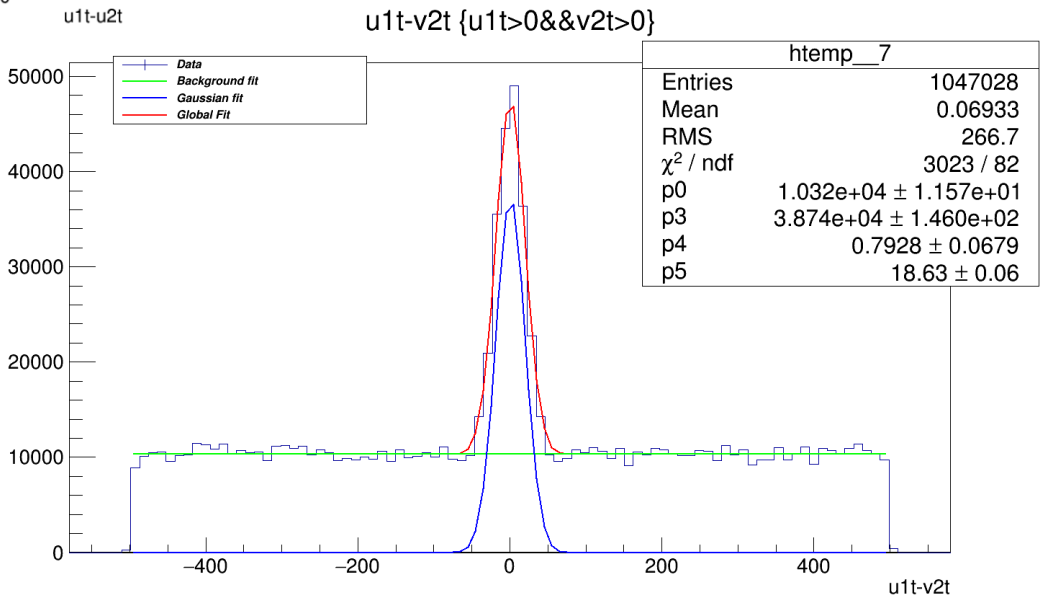
loop over digit1
if{View;Layer;Wire}
1st match
loop over digit2
if{View;Layer;Wire}
if{+-500ns}
2nd match
loop over digit3
if{View;Layer;Wire}
if{+-500ns}
3rd match
loop over digit4
if{View;Layer;Wire}
if{+-500ns}
4th match

Analysis - Time Differences

Argon:Ethane (50:50)



Run 405 – Threshold* 400mV – HV 1800 V – Beam Rate 100k

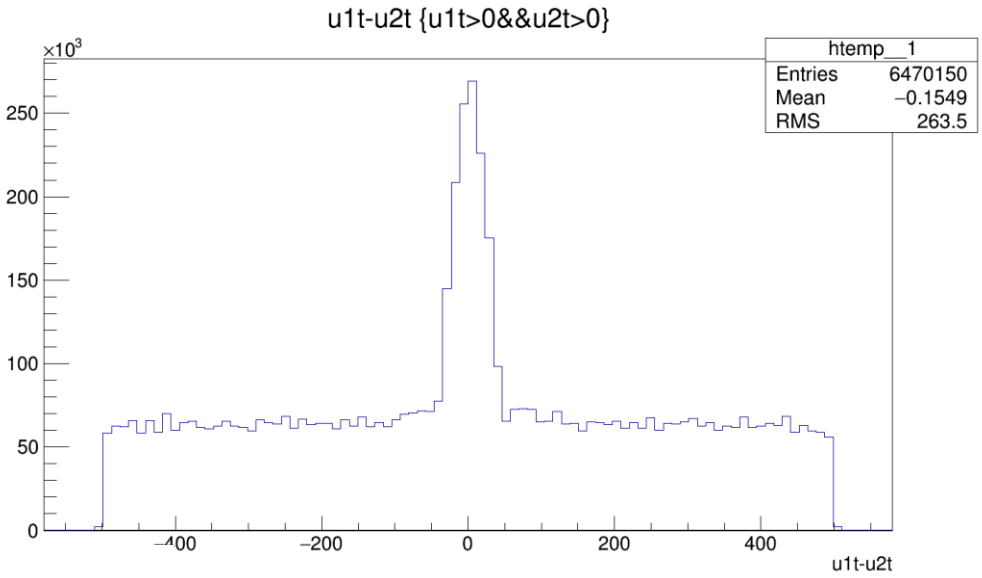


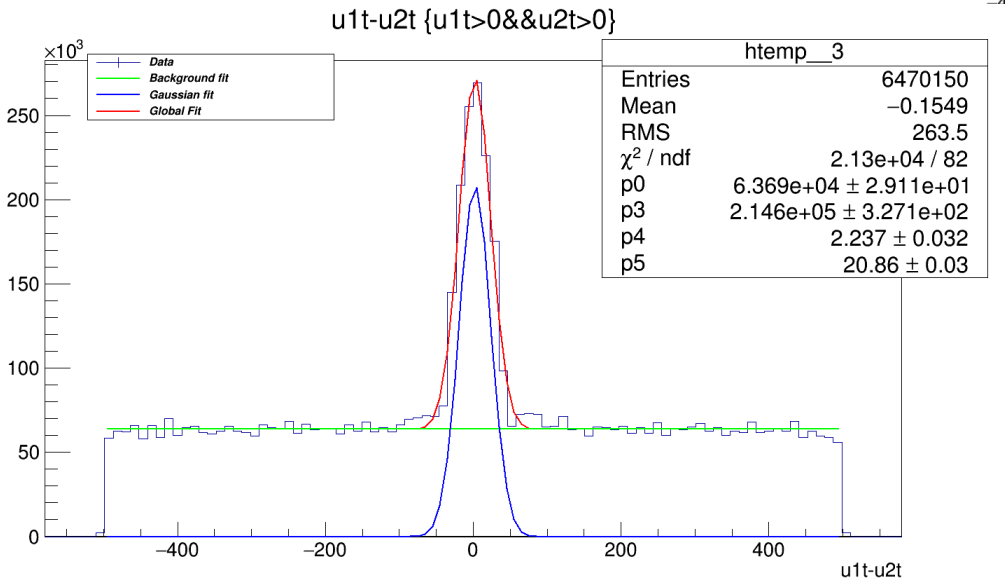
*Readout Electronics Threshold

Analysis - Time Differences

Argon:Co2 (80:20)

Run 314 – Threshold* 300mV –
HV 1500 V – Beam Rate 10k

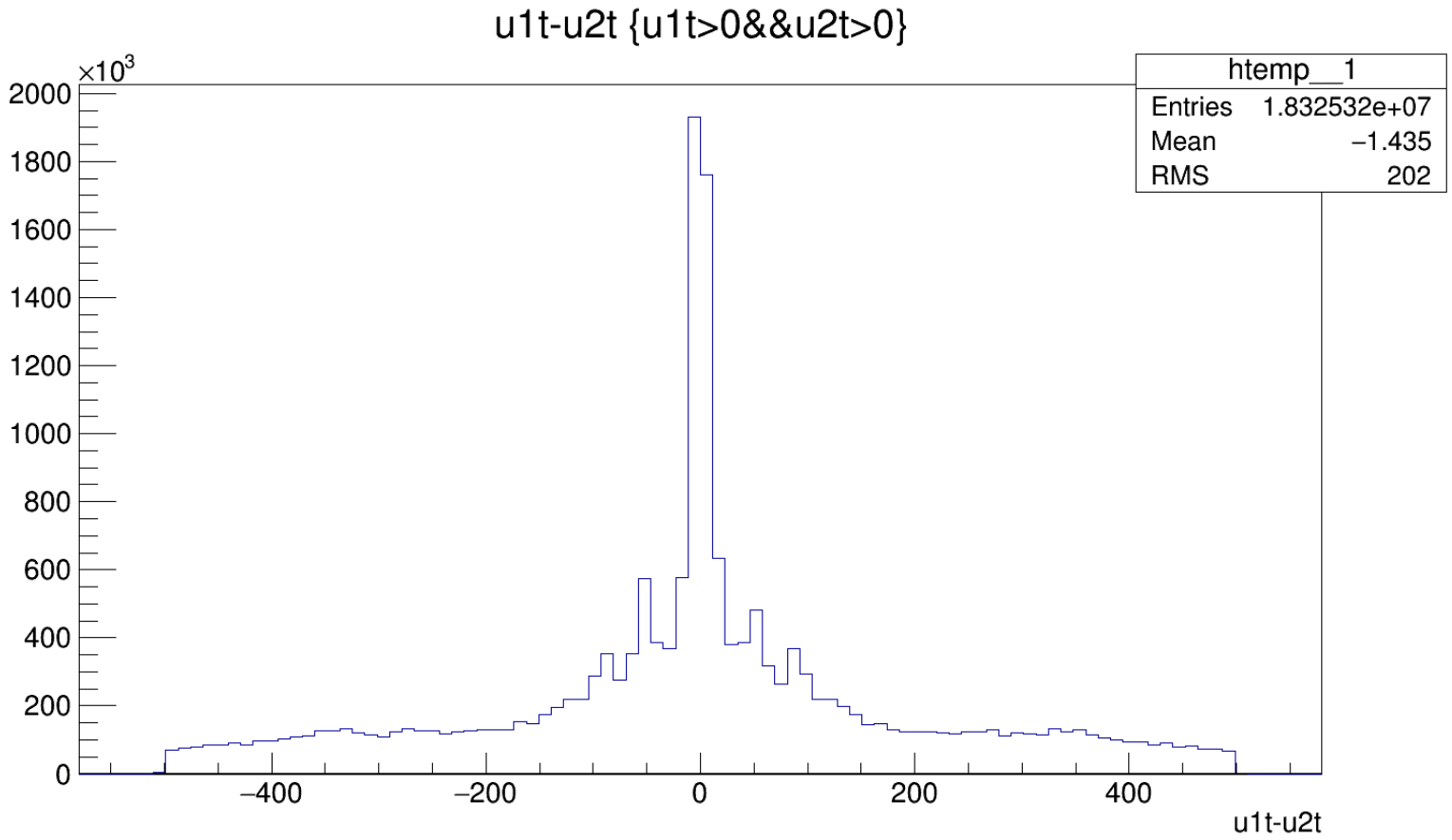




*Readout Electronics Threshold

Fermilab

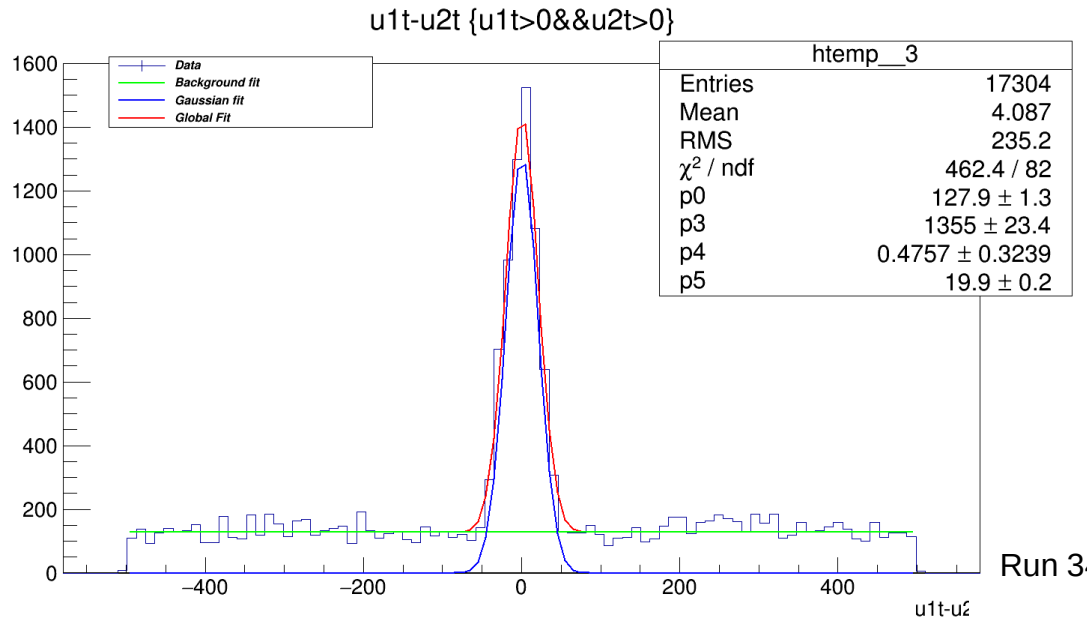
Analysis - Time Differences **Argon:Co2** (80:20)



Run 340 – Threshold* 1200mV – HV 1600 V – Beam Rate 10k

*Readout Electronics Threshold

Analysis - Results

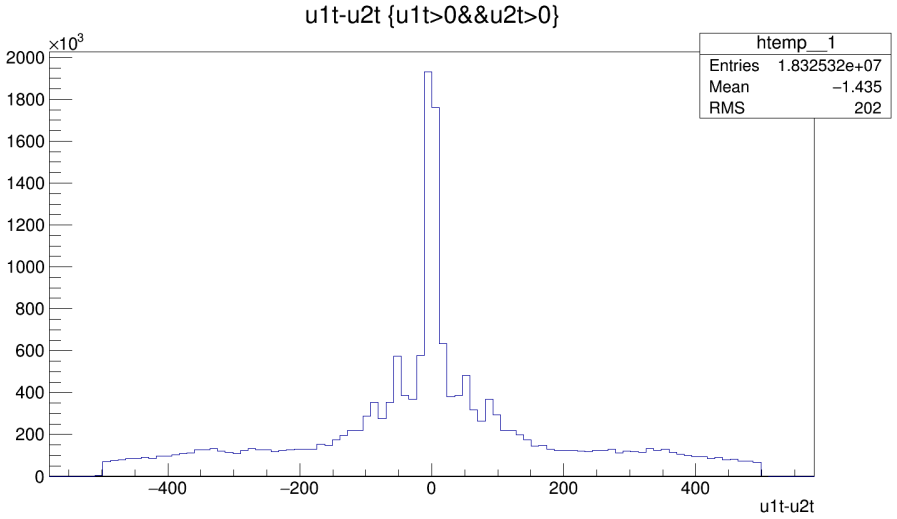


Run 413–Threshold 1000mV–HV 1800 V–Beam Rate 100k

- Higher Threshold – Less noise
- Some signs of breakdown in Argon:Co2

- Δt centered in 0 - Hits are correct.
- Gaussian and flat noise fit
- Most are beneath the Gaussian.

Run 340 – Threshold 1200mV – HV 1600 V – Beam Rate 10k



Conclusions

- Experiment in the frontier of the Standard Model
- Test beam was an opportunity to see collaboration happen
- Operated the HV module and gained knowledge about it.
- The time differences between straw layers are near 0. The hits registered by the straws represent the reality.
- The higher threshold, the less noise
- Argon:Co2 vs Argon:Ethane
- There is still analysis to be done

Acknowledgments

- Brendan C Casey – Fermi National Laboratory
- Thomas Stuttard – University College of London
- Tammy Walton – Fermi National Laboratory
- Brendan Kiburg - Fermi National Laboratory

Thank you!

Any questions?

- "Muon G – 2 Technical Design Report." Fermi National Accelerator Laboratory, 15 June 2015. Web. 26 June 2015.
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