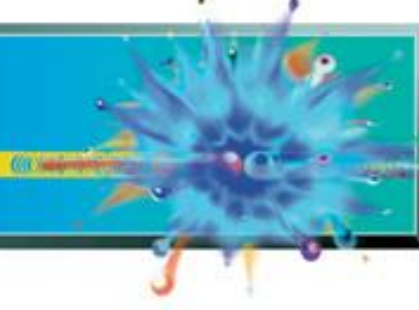


QuarkNet



# Using eLab Without a Detector

NATHAN UNTERMAN

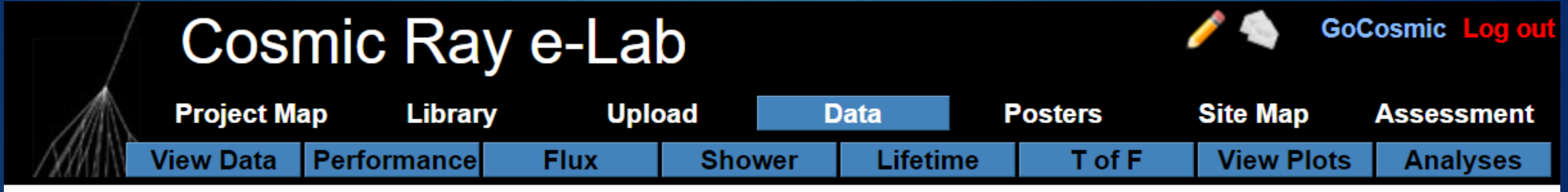
RICE UNIVERSITY JUNE 2021



# Golden Files

- ▶ How to find
  - ▶ Correct Tools
  - ▶ Geometry
  - ▶ Blessing Charts
- ▶ Classroom Strategies
- ▶ Differentiated learning

# Tools



Cosmic Ray e-Lab

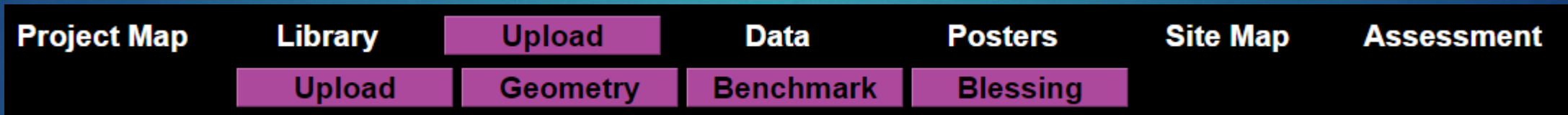
GoCosmic Log out

Project Map Library Upload **Data** Posters Site Map Assessment

View Data Performance Flux Shower Lifetime T of F View Plots Analyses

The screenshot shows the Cosmic Ray e-Lab navigation menu. The 'Data' menu item is highlighted in blue. Below it, a sub-menu is visible with items: View Data, Performance, Flux, Shower, Lifetime, T of F, View Plots, and Analyses. The 'Upload' menu item is also visible in the top row.

# Geometry



Project Map Library **Upload** Data Posters Site Map Assessment

Upload Geometry Benchmark Blessing

The screenshot shows the Cosmic Ray e-Lab navigation menu with the 'Upload' menu item highlighted in purple. Below it, a sub-menu is visible with items: Upload, Geometry, Benchmark, and Blessing.

Note: If you cannot directly get the geometry of a specific file, it can be seen from the Blessing Chart for that file.

## New Detector 6200 Entry:





Date:  /  /  @  :  [UTC](#) *Detector Geometry*

If you are using EQUIP for data acquisition, you still need to enter geometry data on this page for use in the Cosmic Ray e-lab.

GPS is @ (0,0,0).

Each point (x,y,z) represents the center of a counter.

Confused? Seeing errors? Please consult the [Geometry Tutorial](#).

	Active Channels:	1 <input checked="" type="checkbox"/>	2 <input checked="" type="checkbox"/>	3 <input checked="" type="checkbox"/>	4 <input checked="" type="checkbox"/>
	Cable Length (m)	Area(cm <sup>2</sup> )	x:E-W(m)	y:N-S(m)	z:Up-Dn(m)
 1	<input type="text" value="15.478"/>	<input type="text" value="744.2"/>	<input type="text" value="-0.40"/>	<input type="text" value="-4.680"/>	<input type="text" value="0.04"/>
 2	<input type="text" value="15.636"/>	<input type="text" value="744.2"/>	<input type="text" value="-0.40"/>	<input type="text" value="-4.680"/>	<input type="text" value="-0.870"/>
 3	<input type="text" value="15.662"/>	<input type="text" value="744.2"/>	<input type="text" value="-0.40"/>	<input type="text" value="-4.680"/>	<input type="text" value="-1.64"/>
 4	<input type="text" value="15.3"/>	<input type="text" value="744.2"/>	<input type="text" value="-0.40"/>	<input type="text" value="-4.680"/>	<input type="text" value="-1.67"/>



Stacked

Orientation



Unstacked



Visualize geometry

## GPS Coordinates

[GPS Coordinates Tutorial](#) 

[Find GPS Coordinates](#) 

Latitude:

Longitude:

e.g., 47:39.234736 N

e.g., 122:18.68 W

[Map GPS Coordinates](#) 

Altitude (m):

GPS Cable Length (m):

# Blessing Files

## Legend



View data  
Rollover for more info



Unstacked data



Stacked data



Blessed data  
Click to view blessing charts  
Rollover for more info



Unblessed data  
Click to view blessing charts  
Rollover for more info



Data has comments - Add more/View



Add comments

# File Search

Quick Searches (last 3 months): [GoCosmic](#), [Nate Unterman](#), [New Trier High School](#), [Northfield, IL](#)

City

▼ Advanced Search

Please enter dates in MM/dd/yyyy format (e.g. 06/11/2021).  
You may leave one or both date fields blank.

Start Date   to

Search:  All data  Refine results with extra parameters

Stacked:   Blessed:

The Drop Down menu has selections for DAQ and Date

# Available Files

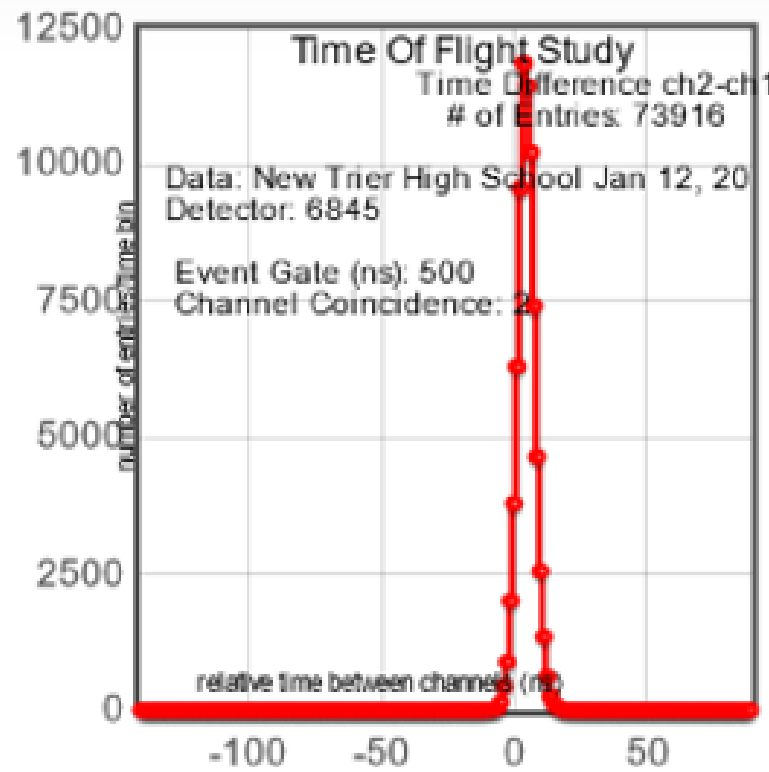
- ▶ Time of Flight
- ▶ Angle of Acceptance
- ▶ Shower Triangle Study
- ▶ Lifetime
- ▶ Shower Study 3.8 km Separation
- ▶ Speed of Muon
- ▶ Long Range Studies
  
- ▶ Barometric Pressure Studies

# Time of Flight and Angle of Acceptance

Experiment	Experiment	DAQ	Date	Geometry	Position Channel 1 (m)	Position Channel 2 (m)	Position Channel 3 (m)	Position Channel 4 (m)	Coincidence	Gate (ns)	Pipeline (ns)	Comment
Time of Flight	Angle of Acceptance	6200	12.September.2019 -3	Stacked	0.04	-0.87	-1.64	-1.67	2	300	100	Barometer not reliable
Time of Flight	Angle of Acceptance	6200	13.September.2019	Stacked	0.04	-0.87	-1.64	-1.67	2	300	100	Barometer not reliable
Time of Flight	Angle of Acceptance	6200	14.September.2019	Stacked	0.04	-0.87	-1.64	-1.67	2	300	100	Barometer not reliable
Time of Flight	Angle of Acceptance	6200	15.September.2019	Stacked	0.04	-0.87	-1.64	-1.67	2	300	100	Barometer not reliable
Time of Flight	Angle of Acceptance	6200	16.September.2019 -0	Stacked	0.04	-0.87	-1.64	-1.67	2	300	100	Barometer not reliable
Time of Flight	Angle of Acceptance	6200	16.September.2019 -1	Stacked	0.04	-0.87	-1.64	-1.67	2	300	100	Barometer not reliable



### Time Difference ch2-ch1

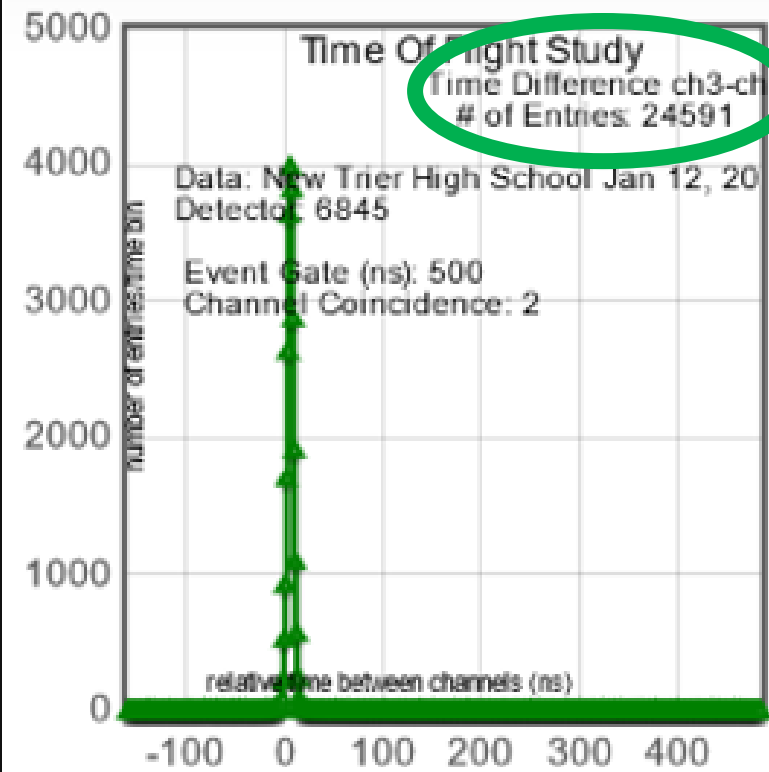
  

(View your saved names)

Save Chart

Advanced Controls

### Time Difference ch3-ch1

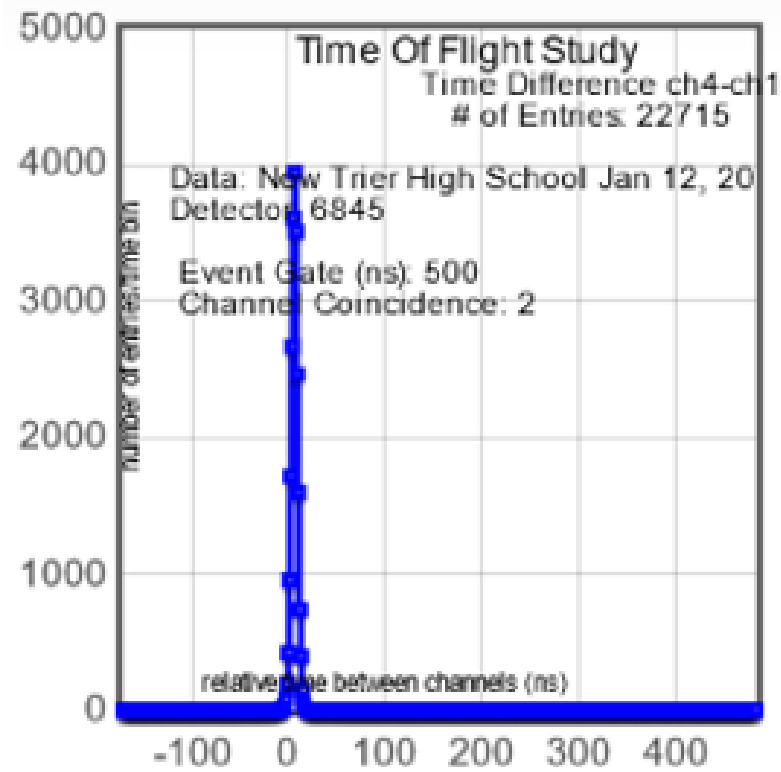
  

(View your saved names)

Save Chart

Advanced Controls

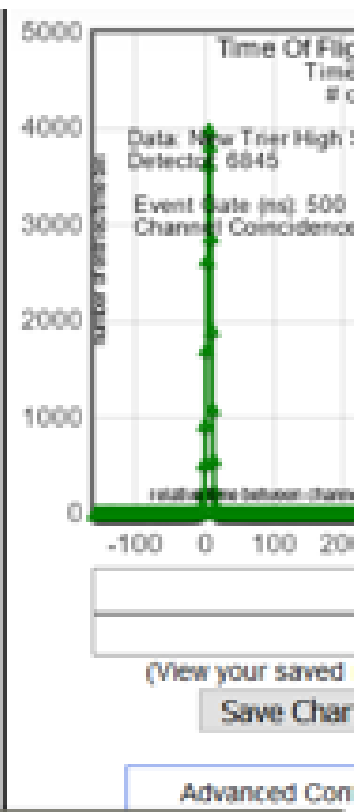
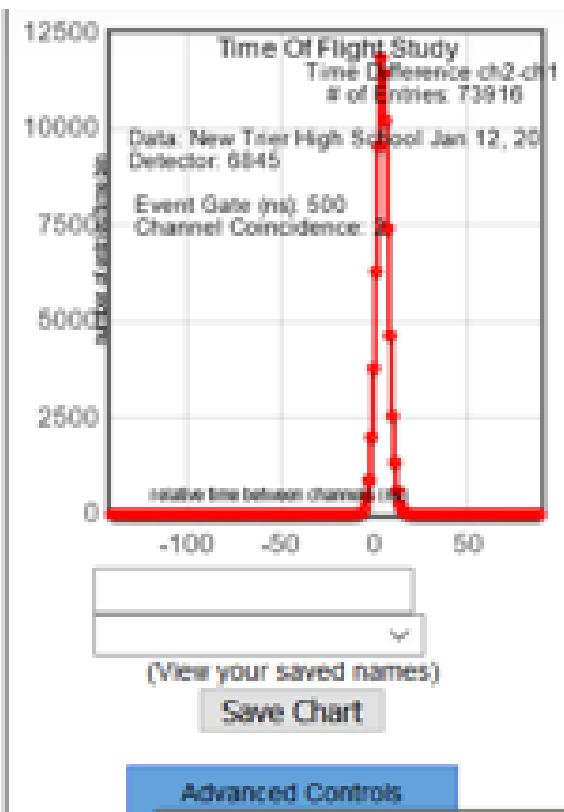
### Time Difference ch4-ch1

(View your saved names)

Save Chart

Advanced Controls



Refit X Values: Min X:  Max X:  Refit X

Mean: 4.04  
Std Dev: 3.57

X-axis scale: Min X:  Set Max X:  Set

Y-axis scale: Min Y:  Set Max Y:  Set

Bin Width 1.25

Reset All

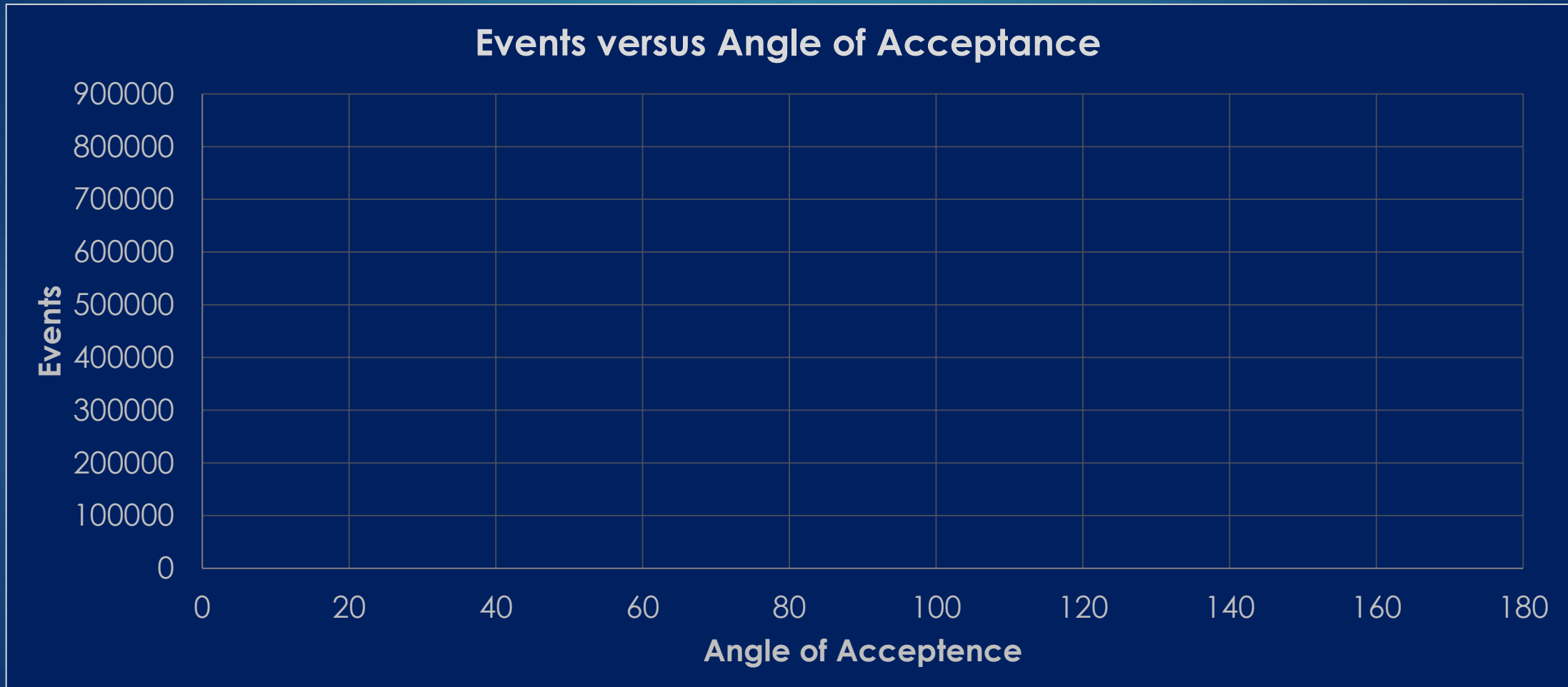


# Angle of Acceptance Analysis

24-hour files only		angle acceptance = $\tan^{-1}((\text{side}/2)/(\text{channel separation}/2))^2$						
NOT corrected for pressure		angle acceptance = $\tan^{-1}((0.26/2)/(\text{channel separation}/2))^2$						
	Channel pair	1-2	1-3	1-4	2-3	2-4	3-4	1-2-3-4
	Separation (meters)	0.824	1.68	1.71	0.856	0.859	0.03	1.71

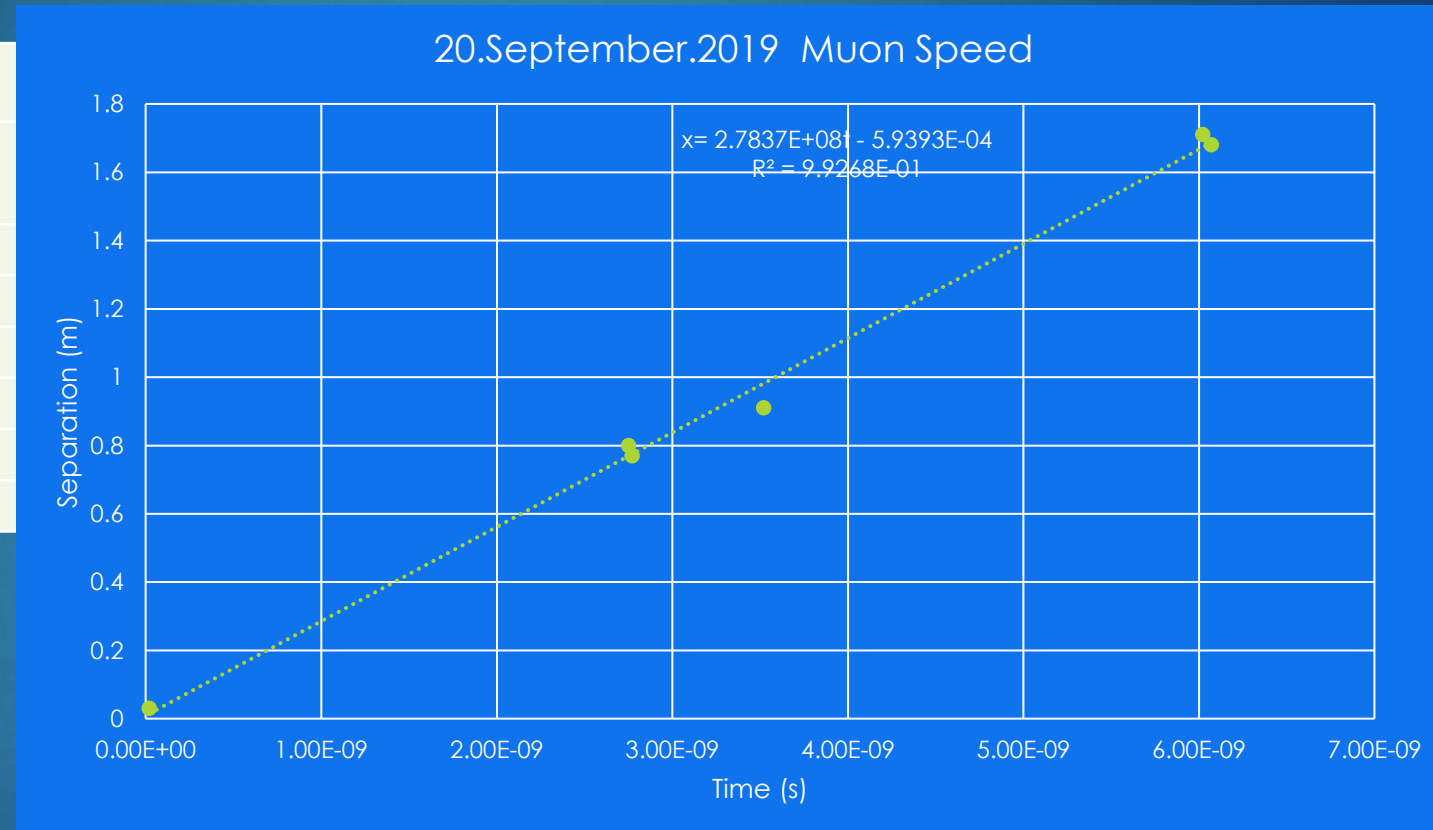
Date	DAQ	Number of Events for (Counter Pair) Angle of Acceptance						17.3°	Column E - I
		(1-2) 35.0°	(1-3) 17.6°	(1-4) 17.3°	(2-3) 33.8°	(2-4) 33.7°	(3-4) 166.8°		
13.Sept.2019	6200	58231	19049	17552	80896	71747	835224	15189	2363
14.Sept.2019	6200	57692	19070	17526	80208	71162	834085	15246	2280
15.Sept.2020	6200	58237	19271	17744	81205	71745	837186	15451	2293
17.Sept.2019	6200	57898	19144	17575	80434	71168	834965	15298	2277
18.Sept.2019	6200	57688	19077	17561	81210	71542	834466	15201	2360
20.Sept.2019	6200	55889	18888	17360	80395	71322	835586	15123	2237
21.Sept.2019	6200	55655	18701	17276	80445	71582	835501	15059	2217

# Angle of Acceptance



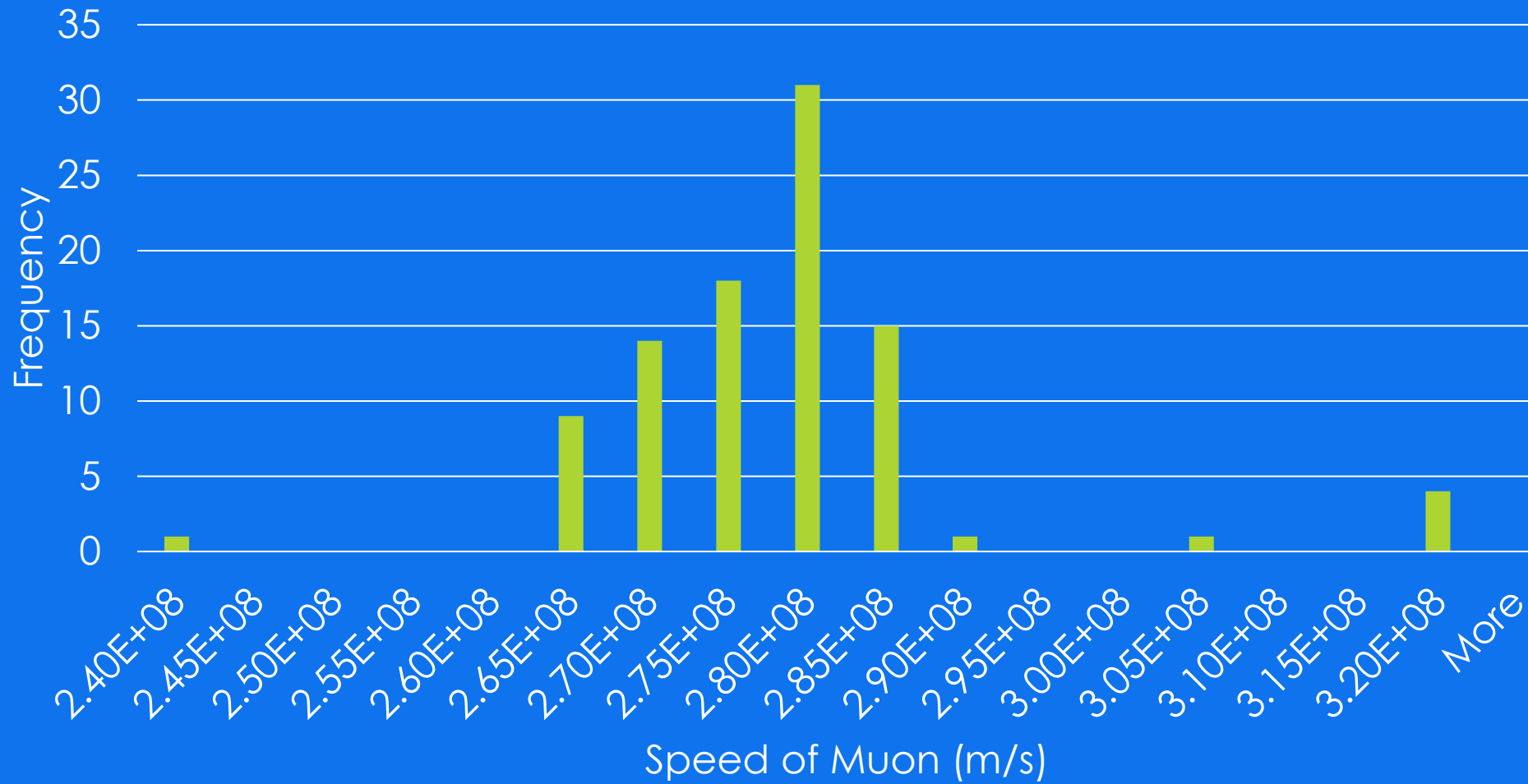
# Speed of Muon

20.Sept.2019		DAQ 6200
Counter Pair	Time (s)	Spacing (m)
1 - 2	3.52E-09	0.91
1 - 3	6.07E-09	1.68
1 - 4	6.02E-09	1.71
2 - 3	2.77E-09	0.77
2 - 4	2.75E-09	0.8
3 - 4	2.00E-11	0.03



v 2.78E+08

# Speed of Muon Histogram 12.September-30.November.2019



# Shower Triangle Study

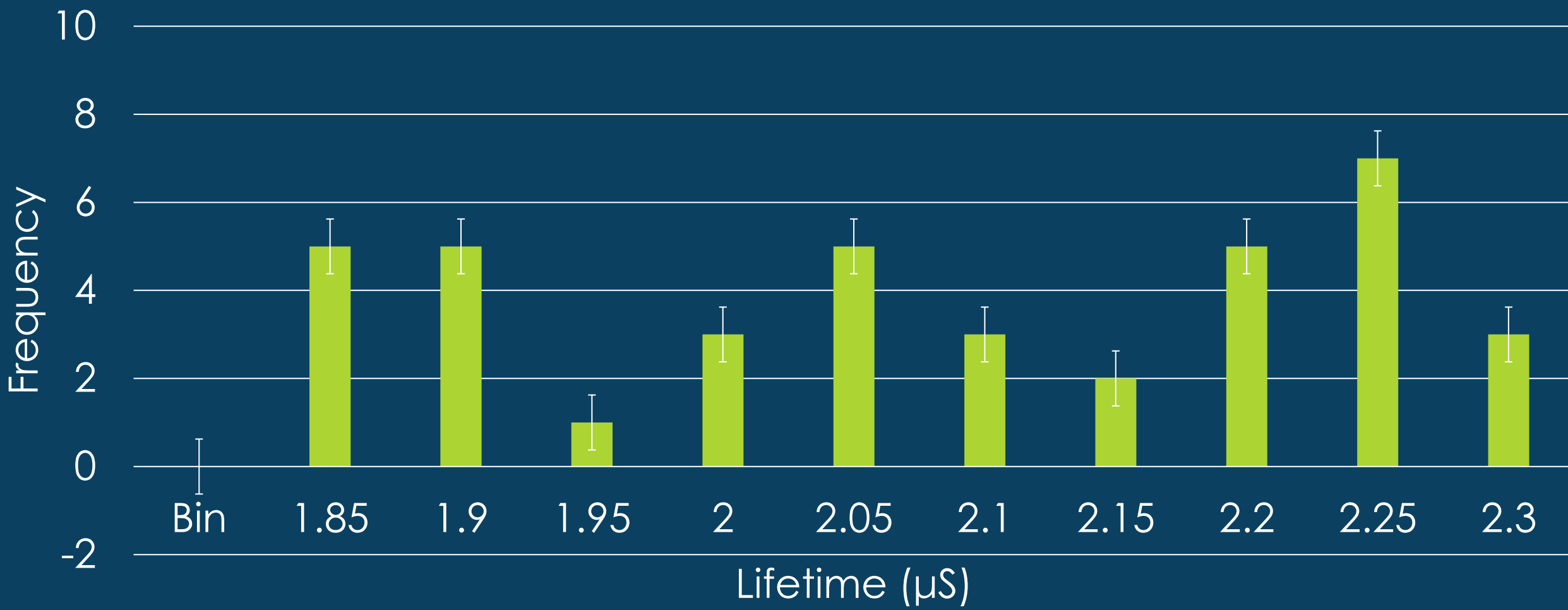
Indoor Study								All need to normalize by duration
Experiment	DAQ	Date	Time Duration	Geometry	Side Length (m)	Events	Coincidence	Comment
Shower Triangle	6690	06.September.2015	14:34	Stack	0.00	38988	3	
Shower Triangle	6690	04.November.2015	0:56	Array	0.50	442	3	
Shower Triangle	6690	04.November.2015	12:58	Array	1.00	108	3	
Shower Triangle	6690	04.November.2015	17:00	Array	1.50	99	3	
Shower Triangle	6690	04.November.2015 - 05.November.2015	22:29	Array	2.00	37+ 274	3	Crosses midnight UTC

# Muon Lifetime

DAQ	Date	Configuration	Position Channel 1 (m)	Position Channel 2 (m)	Position Channel 3 (m)	Position Channel 4 (m)	Coincidence	Gate Width (seconds)	Bins	Lifetime ( $\mu$ S)	Comments
6234	21.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	2.1	Run under OLD program
6234	22.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	2.25	Run under OLD program
6234	23.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	2.24	Run under OLD program
6234	24.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	1.99	Run under OLD program
6234	25.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	2.36	Run under OLD program
6234	26.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	2.06	Run under OLD program
6234	27.December.2017	Stacked	0.12	0.1	x	0	1	1.00E-05	40	2.29	Run under OLD program



# Frequency versus Lifetime



# Shower Study 3.8 km Separation



DAQ	Date	Configuration	DAQ	Date	Configuration
6200	07.February.2020	Stacked	6845	07.February.2020	Stacked
6200	08.February.2020	Stacked	6845	08.February.2020	Stacked
6200	09.February.2020	Stacked	6845	09.February.2020	Stacked
6200	10.February.2020 -0	Stacked	6845	10.February.2020 -0	Stacked
6200	10.February.2020 -1	Stacked	6845	10.February.2020 -1	Stacked
6200	11.February.2020	Stacked	6845	11.February.2020	Stacked

# Barometric Studies

- ▶ Any stacked file lends itself to barometric studies
- ▶ Days may be concatenated together under Flux study. Barometer tool will show concatenated Blessing Charts.

# Classroom Strategies

- ▶ In most studies, enough files for individualized assignment
- ▶ Simple studies, such as speed of muons, taking averages
  - ▶ More complex with histograms
  - ▶ Outlier error analysis
  - ▶ Differentiated Instruction possibilities
- ▶ Multiple sections of course can build analysis cooperatively
- ▶ Poster writing
- ▶ Reflection and metacognition of process
- ▶ More difficult problems, such as shower study at 3.8 km available for enrichment
- ▶ What else can be asked of the data set?

# Other Studies

- ▶ Might Lunar Shadow be buried within the data set?
- ▶ Severe weather
- ▶ . . . Only limited by imagination

# Questions?



# Contact

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- ▶ 773 758-0464

