WEBVTT

1
00:00:02.550 --> 00:00:15.599
Chad Orzel: Okay, so we're recording now, so our first speaker for the physics senior senior thesis session will be Jasper Berg who's working with Colin gleason so take it away Jasper.

2
00:00:16.710 --> 00:00:26.430
Jasper Bergh: So for my research I look at the pi zero pie 116 hundred hybrid may Sunday so first of all, what is mason it's.

3
00:00:27.000 --> 00:00:37.680
Jasper Bergh: composed of quirks and cork so from the standard model there's six of them and they're held together by glue ons which are the carriers have the strong force, just like photons are the carriers of the electromagnetic force.

4
00:00:38.490 --> 00:00:43.710
Jasper Bergh: So this research looked at only the interactions of the strong force.

5
00:00:46.050 --> 00:00:49.170
Jasper Bergh: So what nissan's are kind of hadron.

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00:00:50.250 --> 00:00:57.660
Jasper Bergh: These are two or more corks held together by the strong force which is again glue ons so for of one kind of hadron is a berry on.

7
00:00:57.750 --> 00:00:59.910
Jasper Bergh: Which is an odd number corks typically three.

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00:01:00.300 --> 00:01:10.530
Jasper Bergh: So examples of protons neutrons the picture on the left is a proton with to up corks in a down Cork, on the other hand, there's masons, which are an even number of corks.

9
00:01:11.460 --> 00:01:18.690
Jasper Bergh: This is typically a Cork in antiparticle Cork pair held together by one glue held held together by gluons again.

10
00:01:19.590 --> 00:01:29.070
Jasper Bergh: An example of the pie on Ada mega these all typically decay really fast see they're not commonplace, you know, make up matter, but you can still study them to study the strong force.

11
00:01:31.650 --> 00:01:36.810

Jasper Bergh: Also there's exotic hadron So these are things that aren't just the typical if there's three.

12
00:01:37.380 --> 00:01:46.290
Jasper Bergh: aren't typical three corks or a court candy Cork pair some of them are Tetra corks, which is a to court and the Court pairs authentic work which is for quirks and one anti quark.

13
00:01:46.770 --> 00:01:52.800
Jasper Bergh: A glue ball which isn't doesn't have any forks at all it's just glue ons held together into a ball that's why it's called a blue ball.

14
00:01:53.820 --> 00:02:01.050
Jasper Bergh: And finally, this hybrid masons which I was looking at this is a Cork anti quark pair with an excited go on a field, so you can think of this as.

15
00:02:01.380 --> 00:02:18.630
Jasper Bergh: A Cork and the corporate pair held together with glue ons but there's an additional massive glue on in the particle in the particle that contributes a lot of properties to it so pi 116 hundred is an exotic means on, with an estimated massive about 1600 1600 mega like MTV.

16
00:02:19.770 --> 00:02:21.120
Jasper Bergh: And the picture on the right is.

17
00:02:22.920 --> 00:02:32.550
Jasper Bergh: crappy diagram of the exotic means on the glue on is a light green because of the color charge, even though that's the color charges and actually color.

18
00:02:34.140 --> 00:02:40.110
Jasper Bergh: So how do we look for these hybrid Maisons well as with most things, a particle physics you just smashing particles together.

19
00:02:41.550 --> 00:02:54.660
Jasper Bergh: These high energy product with collisions produce a bunch of particles and then the, but these intermediate particles decay really quickly, so you can't measure them instead, you have to measure the particles which are are dictated into.

20
00:02:56.130 --> 00:03:05.400
Jasper Bergh: So we measure the decayed particles and then we can reconstruct the intermediate protocols by adding the four vectors of all of the.

21
00:03:06.060 --> 00:03:09.930

Jasper Bergh: particles together to, and we do keep on doing that to get their original Article.

22
00:03:10.860 --> 00:03:19.500
Jasper Bergh: And then we can create a master's degree of all the events and see a spike where the mass would be so on the right, this is a history i'm of pi zero.

23
00:03:20.040 --> 00:03:35.880
Jasper Bergh: Which is a very common raised on it's not an exotic means on so in this, we have two photons we combined together to get the masculine pi zero or pion and spike around this is about 1.3 gv, which is the measured massive a pie on.

24
00:03:37.980 --> 00:03:44.760
Jasper Bergh: So where do we can wear it was all of these experiments conducted these were all conducted at the Jefferson lab in Virginia.

25
00:03:45.210 --> 00:03:58.830
Jasper Bergh: On the left is an aerial photo and the right is a schematic diagram of it, this is a big particle electron particle accelerator that spin that a accelerates the electron around to about I think it's 12 gv.

26
00:04:00.030 --> 00:04:01.440
Jasper Bergh: there's four experiments attached to it.

27
00:04:02.520 --> 00:04:08.130
Jasper Bergh: we're like the experiment that I looked at was in hobby or the experiment where my data was wrong was in hall D.

28
00:04:10.260 --> 00:04:16.680
Jasper Bergh: And here's a photo of that experiment, this is the glue X experiment and ALDI on the left is the collider.

29
00:04:17.970 --> 00:04:23.970
Jasper Bergh: And the right is all the people who have worked on it or research Summit I think columns and I photo on the left.

30
00:04:25.650 --> 00:04:38.970
Jasper Bergh: it's a massive machine that takes it the electron beam from the Johnson lab turns it into a photon beam and then smashes that photon beam into a proton target and then measures, the scattering as a result of that.

31
00:04:41.310 --> 00:04:52.380
Jasper Bergh: So just a little bit of information about the glow blue X experiment it's a 12 gv electron beam that comes in, is to convert it into a nine G photon beam which is then.

32
00:04:52.860 --> 00:05:10.560
Jasper Bergh: which then hits with the proton target and then that collision creates a bunch of intermediate particles which are then measured by the collar perimeters of the front and around the target and there's also a magnet the Benz charged particles towards the gallery matters.

33
00:05:13.680 --> 00:05:13.920
Jasper Bergh: yeah.

34
00:05:15.180 --> 00:05:23.550
Jasper Bergh: And so, for this specific rate the key chain when I looked at was the Taiwan 1600 this specific the gateway and hadn't been looked at before.

35
00:05:25.110 --> 00:05:34.620
Jasper Bergh: So X in this the kitchen is the 512 300 so we have the incoming photon and proton that collide together produced two particles supposedly.

36
00:05:35.010 --> 00:05:53.160
Jasper Bergh: And then, this unknown particle we want it to decay into an Ada and a pi zero this Ada I mean Ada prime and a pi zero is eight a prime will then could decay into an Ada plus and minus particle the Ada will then came to three zeros as shown here and then all those zeros decay into photons.

37
00:05:54.330 --> 00:05:57.270
Jasper Bergh: The pipeline and by minus or just directly measured by the.

38
00:05:58.320 --> 00:06:01.500
Jasper Bergh: detector because they are decay, time is long enough that we can detect some.

39
00:06:03.900 --> 00:06:13.260
Jasper Bergh: Other reactions indications have been studied, but this is the only one that uses Ada two three zeros, this is the second most common decay path of eight up.

40
00:06:13.920 --> 00:06:24.000
Jasper Bergh: The other most common one is Ada into just two photons do hierarchy photons, so this is movie looking at, if this is a possible to K path for studying pie 116 hundred.

41
00:06:25.800 --> 00:06:35.130
Jasper Bergh: Okay, so a galactic produces a bunch of data and the first step is to filter it down to just contain the 11 particles that we care about.

42

00:06:36.240 --> 00:06:39.060
Jasper Bergh: All of a sudden, it was done with root produced by CERN.

43
00:06:40.230 --> 00:06:51.330
Jasper Bergh: So after we filter down just 11 articles, we end up with 14.3 million data points each of these data points has properties of the 11 particles, like the mass velocity and energy.

44
00:06:52.920 --> 00:07:01.290
Jasper Bergh: And then we perform some additional selection cut initial selection cuts, like the park identification timing window to make sure that the event occurred within a specific time.

45
00:07:02.370 --> 00:07:08.970
Jasper Bergh: We make sure that the event originated inside the proton target it wouldn't make sense for a collision to happen outside proton target.

46
00:07:10.320 --> 00:07:20.010
Jasper Bergh: We check that the energy fit with the energy of the beam and then we performed a kinematic fit to a better fit all of the variables in the equation.

47
00:07:23.520 --> 00:07:25.380
Jasper Bergh: So one of the first simple cuts, we did.

48
00:07:26.550 --> 00:07:32.280
Jasper Bergh: Was the T channel mental SAP variable, this is just a calculated quantity for particle collisions.

49
00:07:33.630 --> 00:07:48.600
Jasper Bergh: In short, it a larger T corresponds with a higher momentum, transfer or a smaller cheaper corresponds with a larger moment in France or and we want a large mind i'm transfer, so we ended up cutting out all data points that had a key of greater than one.

50
00:07:49.890 --> 00:08:03.960
Jasper Bergh: These particle these events might coincide with the production of an excited berry on so that would be window photon and the proton combined together to form one particle and then that particle the case, but we don't want that we just want one exotic means on to be produced.

51
00:08:05.430 --> 00:08:11.850
Jasper Bergh: Again we cut it when it was greater than one, so this only limited not too many data points from our.

52
00:08:13.110 --> 00:08:13.530
Jasper Bergh: Data set.

53
00:08:15.390 --> 00:08:25.080
Jasper Bergh: And next we tried to select for pi zeros this was a combination of just the two photons the kinematic fit said what the photons we're going to be so there's not one through eight.

54
00:08:28.050 --> 00:08:45.360
Jasper Bergh: So if we just add before vectors together we get plots that have a sharpie so getting built in the top left plot, was the first and second photon the top right is the third, fourth and so on, we see, we see a sharp peak where the mass of the pie on is, but we also have a very large background.

55
00:08:47.130 --> 00:08:50.010
Jasper Bergh: background behind it, we need to cut that out to you know.

56
00:08:51.840 --> 00:09:01.500
Jasper Bergh: We need to cut that out, so we can get better results later down the line, so how we did this is first we just define a maximum and minimum and cut out all events beside outside of that.

57
00:09:02.280 --> 00:09:10.860
Jasper Bergh: But what we also did is if, for example, photon zero and photon five combined to be a mask comparable that to apply on.

58
00:09:11.550 --> 00:09:26.970
Jasper Bergh: Then we cut that out because photon zero and vote on five shouldn't be a result of of 150 so we skipped any false pi zero combinations and after that the the plots lock looked a lot more clear, especially the first plot, which is the result of the first two photons.

59
00:09:29.280 --> 00:09:34.440
Jasper Bergh: Next we look, we tried to combine the last three pions into an Ada.

60
00:09:36.060 --> 00:09:42.240
Jasper Bergh: As a reminder, this is the second most common decay channel of an Ada the most common is to hire n G photons.

61
00:09:43.110 --> 00:09:51.510
Jasper Bergh: So this is simple enough, we just add the three four vectors of the pie zeros that we calculate before together and we find a nice shirt peak where the mass of the eight is supposed to be.

62
00:09:52.230 --> 00:09:57.600
Jasper Bergh: The we got almost exactly the same masses other experiments, a better, which is good.

63
00:09:58.050 --> 00:10:12.510
Jasper Bergh: And then we can fit this mass instagram with a relativistic breadwinner distribution, which is the probability distribution for the case of high energy particles, he also had a quadratic background function to account for the small amount of background in the in the collision.

64
00:10:15.300 --> 00:10:21.810
Jasper Bergh: Next, we did the pie, the Ada Brian particle, which is a combination of the Ada the pipeline in five minutes by mason's.

65
00:10:23.310 --> 00:10:30.810
Jasper Bergh: If we just combine them directly, we get a distribution that doesn't look so good, the Ada prime particle corresponds with this tiny peek over on the left.

66
00:10:31.410 --> 00:10:39.690
Jasper Bergh: With a giant background function of background noise, so we need to perform some additional cuts to reduce that background and get a clear signal of Ada Brian.

67
00:10:40.800 --> 00:10:45.930
Jasper Bergh: So, first we did the massive Ada versus the massive Ada prime you can see that the Ada prime particle here.

68
00:10:46.950 --> 00:10:48.180
Jasper Bergh: corresponds with this little.

69
00:10:50.280 --> 00:10:51.240
Jasper Bergh: Line down here.

70
00:10:52.440 --> 00:11:02.280
Jasper Bergh: And, but there's also a bunch of background directly above the age of eight up Brian particle so we can't directly cut the the massive Ada to get a clear signal.

71
00:11:03.690 --> 00:11:16.440
Jasper Bergh: What we could also do is look for intermediate particles that are produced, but are not the ones we won't want to look at so, for example, if the Omega particle which typically the case into a pipe last time is and by zero is produce.

72
00:11:17.670 --> 00:11:33.750
Jasper Bergh: Then we will measure those pipeline myosin pi zero but we don't want that, so we can cut out the massive those Omega Omega similar we can do the delta plus plus and the delta zero the delta plus plus the case do a proton plus typically in the delta zero decays into a proton pi minus.

73
00:11:35.010 --> 00:11:42.870
Jasper Bergh: So, if we add the four factors of pi zero minus five plus if there's a spike there, we would get the we see.

74
00:11:43.680 --> 00:11:53.820
Jasper Bergh: that there was an Omega particle produced and that's what we see there's a very large spike directly at the massively Omega particle and this corresponds with the production of the Omega particle.

75
00:11:54.480 --> 00:12:05.850
Jasper Bergh: So we can just cut out the mass from Point seven 2.8 cut out all events with that mass point 7.8, and so we were remove all of the Ada part, though, make a particle production from the background.

76
00:12:06.990 --> 00:12:16.440
Jasper Bergh: Similarly, we can do the same thing with delta plus plus delta zero, but the peak, which is about at 1.25 on these two plots isn't that noticeable, especially when compared to the background.

77
00:12:16.800 --> 00:12:24.090
Jasper Bergh: So we chose not to cut it because it would be removing more background that it will be removing delta zero and delta plus plus.

78
00:12:25.650 --> 00:12:36.000
Jasper Bergh: So that we put all those together and then add the four factors of particles that combined data prime we get a very clear signal for the Ada prime article, which occurs directly at the right massive about.

79
00:12:37.140 --> 00:12:49.170
Jasper Bergh: Point 958 GB and then we can fit that again with a Brett Ratner distribution, plus a linear background to get a very clear six to one signal the background radiation ratio.

80
00:12:51.150 --> 00:13:01.890
Jasper Bergh: Finally, we can combine that Ada prime with the last pi zero to create the pie, once the supposedly pie 116 hundred The problem here is that we don't have enough data to.

81
00:13:02.970 --> 00:13:08.760
Jasper Bergh: Properly make any statistical arguments about if we see a pie pie 116 hundred but we.

82
00:13:10.440 --> 00:13:13.260
Jasper Bergh: Like there is two peaks there, but we don't really know which ones which.

83
00:13:14.580 --> 00:13:18.000
Jasper Bergh: So there's not enough data confirm that this shows by 116 hundred.

84
00:13:19.800 --> 00:13:37.170
Jasper Bergh: So in conclusion we turned from 14.3 million events originally with the 11 particles down to 707,000 600 events with a for a pie one and the purpose was to look for pie 116 hundred decaying into the.

85
00:13:38.220 --> 00:13:43.740
Jasper Bergh: Aid of prime pi zero, but with the Ada decaying and three zeros, which is the inside the kitchen.

86
00:13:44.340 --> 00:13:52.020
Jasper Bergh: And we successfully reconstructed the Ada and data prime for the a pathway, and this and showing a nearly six to one signal the background in Ada.

87
00:13:52.890 --> 00:14:02.040
Jasper Bergh: This is a viable channel to look for other exotic exotic means on but with more data so some additional work that could be done is to run with more data.

88
00:14:02.370 --> 00:14:16.380
Jasper Bergh: collection is still running and there's more data be fun, we can do more efficient cuts at each job so, for example, when we cut on the Ada prime we didn't exactly tune it to produce the most signal background ready ratio.

89
00:14:17.460 --> 00:14:30.090
Jasper Bergh: We can also study the descent detector acceptance, the public sector isn't perfect and there's some areas of the texture that check more particles and others, and you need to study that to make any further claims about if you detect a particle or not.

90
00:14:31.380 --> 00:14:33.510
Jasper Bergh: that's it any questions.

91
00:14:38.130 --> 00:14:46.620
Chad Orzel: All right, thank you so um so we got some time for questions for Jasper anybody.

92
00:14:48.030 --> 00:14:48.750
Chad Orzel: Have a question.

93
00:14:50.430 --> 00:14:51.150

Chad Orzel: Francis.

94
00:14:52.410 --> 00:14:53.940
Chad Orzel: Or are you just you're plotting.

95
00:14:54.390 --> 00:15:01.440
Francis Wilkin: Oh, I did not have a question I was only applauding Those are my reaction buttons, but I could ask a question, I have a couple questions handy.

96
00:15:03.600 --> 00:15:05.430
Francis Wilkin: thing is, it is it okay.

97
00:15:05.760 --> 00:15:06.030
Chad Orzel: yeah.

98
00:15:06.420 --> 00:15:12.870
Francis Wilkin: Okay, one thing is, I find that the the the fineman diagrams a little bit mind boggling because.

99
00:15:13.560 --> 00:15:22.290
Francis Wilkin: I was told from fundamental physics, that you know, a single particle can't decay into two particles, but of course all the medicines are really made of to.

100
00:15:22.590 --> 00:15:31.830
Francis Wilkin: quark so they're not really single particles it just to my I it seems funky to have a single particle turn into two photons but I know that it's allowed.

101
00:15:33.840 --> 00:15:44.220
Francis Wilkin: And another related just basic, fundamental thinking concept is usually aren't aren't all the quarks electrically charged I don't think that any of them are truly.

102
00:15:44.730 --> 00:15:53.940
Francis Wilkin: Without electric charge, so you say you're only studying the strong interaction, but the electromagnetic must be in there, I guess at a lower level in terms of energies.

103
00:15:54.690 --> 00:16:07.500
Jasper Bergh: yeah well these aren't true fireman diagrams cuz they don't show the you know the core composition is just a general overview of the key chain and also, I mean there is the electrical force within the face on so i'm not sure how strong, it is, though.

104

00:16:09.990 --> 00:16:10.380
Francis Wilkin: Thank you.

105
00:16:13.980 --> 00:16:14.730
Chad Orzel: questions.

106
00:16:18.420 --> 00:16:18.840
Anybody.

107
00:16:23.070 --> 00:16:32.430
Chad Orzel: Okay, so if we don't have further questions, so thank you again Jasper, and you can stop sharing your screen and we'll switch over.

108
00:16:33.570 --> 00:16:35.460
Chad Orzel: To Helen shares.

109
00:16:36.270 --> 00:16:38.100
Helen Black (she/her): go ahead and do that.

110
00:16:40.980 --> 00:16:43.200
Helen Black (she/her): Okay, if everybody see this.

111
00:16:44.430 --> 00:16:55.200
Chad Orzel: yep you're good Okay, so our next speaker is Ellen black who's working down accelerator with the scala break so take it away.

112
00:16:56.100 --> 00:17:03.240
Helen Black (she/her): Thank you yeah my name is Helen and my product is titled pixie analysis of heavy metals and soils from the George Washington bridge.

113
00:17:05.910 --> 00:17:16.560
Helen Black (she/her): We go so first a little bit of background about my experiment on the inspiration here was really from a similar experiment that was done a few years ago where soils were collected.

114
00:17:16.560 --> 00:17:26.130
Helen Black (she/her): From around the hell gate bridge in New York City and through analysis they determined that in the soil samples, there were heavy metals such as.

115
00:17:26.760 --> 00:17:38.370
Helen Black (she/her): lead and other similar metals as well, and so the idea here was that I could use the same method of pixie and apply it to a different bridge in New York City and kind of the.

116
00:17:41.070 --> 00:17:49.860
Helen Black (she/her): main idea is that many of these bridges have parks underneath them that are open to the public, and if there is loving the soil that can be a potential health concern.

117
00:17:51.780 --> 00:17:58.410
Helen Black (she/her): So I specifically chose the George Washington bridge which spans Hudson river between northern Manhattan and northern New Jersey.

118
00:17:58.740 --> 00:18:07.950
Helen Black (she/her): And in my research no specific studies had been found, like really studying the soil, specifically under the the George Washington bridge, but in.

119
00:18:08.370 --> 00:18:15.780
Helen Black (she/her): One study that I read on the area around the George George Washington bridge and Manhattan was noted a lead hotspot.

120
00:18:16.500 --> 00:18:32.760
Helen Black (she/her): In a study that kind of looked at the average lead cosmic concentrations in New York City and the kind of noted that this could be due to the bridge but also could be due to a hospital that is nearby that was undergoing construction at the time, so the real source wasn't totally known.

121
00:18:34.500 --> 00:18:40.740
Helen Black (she/her): And the samples I collected last summer from the New York and New Jersey side of the George Washington bridge.

122
00:18:41.490 --> 00:18:51.360
Helen Black (she/her): at varying distances, starting from the Center and on the New York side I moved in the southern direction and collected samples, and on the New Jersey side, I was able to collect them from the north and south side.

123
00:18:51.810 --> 00:19:02.130
Helen Black (she/her): and using Google maps, I was able to find the coordinates of each exact location and I was able to calculate the distance from the Center and moving onward.

124
00:19:04.440 --> 00:19:12.960
Helen Black (she/her): So these are two maps of the New York and New Jersey sides of the bridge, where I was able to pinpoint my exact locations of the samples.

125
00:19:13.770 --> 00:19:25.170

Helen Black (she/her): As you can see here they span the north and south side and on the New York side they just spanned the south side, as I said, and here you can see the distances and exact coordinates that I marked down.

126
00:19:27.450 --> 00:19:36.300
Helen Black (she/her): From there after I collected the dirt samples i'm in the lab here at Union I was able to try the samples and remove any excess liquid.

127
00:19:36.660 --> 00:19:44.130
Helen Black (she/her): And from there, I used for tier sifter and sifted the dirt samples to remove any rocks or larger clumps of dirt.

128
00:19:44.730 --> 00:19:54.300
Helen Black (she/her): And from there, I started the sifted soil and test tubes and spend them using a mechanical spinner for about 12 hours to ensure that they are uniformly mixed.

129
00:19:54.930 --> 00:20:06.630
Helen Black (she/her): And after that I was able to weigh one gram for each different location and make two pellets that I press using hydraulic press and.

130
00:20:07.260 --> 00:20:16.890
Helen Black (she/her): us also polyvinyl alcohol is a binding agent to hold everything together, and you can see right here on my samples were stored in small plastic containers with their appropriate label.

131
00:20:19.110 --> 00:20:29.520
Helen Black (she/her): So the method we use here to determine the concentration and composition of the soils was pixie which stands for proton and do some X Ray Mr emission spectroscopy.

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00:20:30.120 --> 00:20:35.070
Helen Black (she/her): And the key idea here is that when an incident high energy proton beam interacts with the sample.

133
00:20:35.580 --> 00:20:43.500
Helen Black (she/her): protons and the beam can eject electrons from the atom typically from the inner Shell and that will create a vacancy in the inner Shell orbital.

134
00:20:44.430 --> 00:20:48.930
Helen Black (she/her): From there electrons in the higher Shell orbitals have a probability that they can.

135
00:20:49.500 --> 00:21:00.450

Helen Black (she/her): descend into the vacancy in the inner child item and the interstellar orbital and when this happens, an x Ray is produced that's characteristic to a specific nucleus of charges see.

136
00:21:00.900 --> 00:21:15.360
Helen Black (she/her): And so, here we can really fingerprint these elements and determine the composition, by looking at these X Ray energies which we can measure and, like I said, these are related to specific nucleus of charged seed.

137
00:21:17.070 --> 00:21:34.320
Helen Black (she/her): And to produce these high energy proton beams we use the accelerator here at Union and the iron beam analysis lab and we produced a to point to me the proton beam and the produce X rays were collected on mtech silicon detector with Resolution of about 150 electron volts.

138
00:21:36.630 --> 00:21:59.070
Helen Black (she/her): So this the energy after energies that were produced on produced a spectrum, as you can see here, this is just for one of the samples that I collected, but before we can do any real analysis of this sample we first had to do some calibrations of the data to kind of.

139
00:22:00.750 --> 00:22:20.310
Helen Black (she/her): To well first to calibrate the X axis from channel to energy using a set of thin micro matter standards and really what we want to do here is to identify what these peaks mean and what I mean by that is what elements these peaks are related to by looking at their specific energies.

140
00:22:22.170 --> 00:22:38.220
Helen Black (she/her): So due to determine the concentration of elements we calculated these concentration concentration is using groups, which is an online software they used to do all my analysis and on the concentration, we followed this equation here to.

141
00:22:40.170 --> 00:22:48.900
Helen Black (she/her): To make these calculations and, as you can see, the concentration is related to a number of constants that i'll go through quickly, but the way the process works.

142
00:22:49.410 --> 00:23:03.540
Helen Black (she/her): Was that we pointed a we pointed the proton beam at each of these samples here that we attach to a target ladder for 10 minutes, and after that we pointed on the proton beam through the hole here.

143
00:23:04.260 --> 00:23:15.690
Helen Black (she/her): For another 10 minutes and the purpose of that was to determine the charge Q additionally some of the other parameters are T, which is the transmission coefficient.

144
00:23:16.440 --> 00:23:35.640
Helen Black (she/her): There any absorbers in the detector H, which is the solid angle of the detector which we wish I calculated using a set of standards which i'll talk about in a moment y Z is the intensity of the principal X Ray line y sub T is the theoretical intensity and epsilon is the detector efficiency.

145
00:23:38.490 --> 00:23:50.160
Helen Black (she/her): So the we use a set of fin standards to determine this value H, which once again is the solid angle of the detector and what we did here was we ran these standards.

146
00:23:50.850 --> 00:24:01.860
Helen Black (she/her): Through Group X and compared they're measured concentrations through Group X to their actual reported concentrations and this ratio allowed us to calculate h.

147
00:24:02.490 --> 00:24:11.880
Helen Black (she/her): And we also analyze a sample from nest of the New York New Jersey waterway just kind of get an idea of how are good analysis of how how good our analysis.

148
00:24:12.900 --> 00:24:22.500
Helen Black (she/her): And really be as kind of the same idea i'm comparing the reported concentrations from nist with the calculated concentrations from Group X to.

149
00:24:23.010 --> 00:24:37.290
Helen Black (she/her): kind of see how accurate our readings could be, and this graph here is a spectra of an iron standard specifically and these peaks are like related to the associated associated energies of iron.

150
00:24:39.540 --> 00:24:46.620
Helen Black (she/her): So these two graphs kind of show the differences of the measured versus the reported on concentrations.

151
00:24:47.370 --> 00:24:52.020
Helen Black (she/her): On the left here is of the different standards that we use of different elements.

152
00:24:52.590 --> 00:25:01.230
Helen Black (she/her): The blue marks represent the measured concentrations from good PICs and the orange represents the reported and also from here, we did it.

153
00:25:01.860 --> 00:25:17.190

Helen Black (she/her): We use the same process with the nist standard and kind of identified the different elements that were contained in that sample and so yeah by doing this, we can kind of see how close we can expect our values from the samples I collected to be.

154
00:25:19.920 --> 00:25:30.900
Helen Black (she/her): So, finally, after all this calibration we were able to identify some of the peaks and kind of understand the composition of the samples that I collected.

155
00:25:31.380 --> 00:25:43.860
Helen Black (she/her): And here the solid line is the fit that who picks generated after all the calibrations and the dashed line here represents the original spectra of.

156
00:25:44.400 --> 00:25:52.740
Helen Black (she/her): That I previously showed you so as you can see here, I was able to identify a lot of different elements that are contained in this sample.

157
00:25:53.370 --> 00:26:05.880
Helen Black (she/her): There are several different metals such as iron zinc copper and also lead, which is interesting and this specific spectra is from directly under the bridge in the New York side and.

158
00:26:06.630 --> 00:26:21.510
Helen Black (she/her): Additionally, the bottom portion here represents the accuracy of the fit from good PICs and kind of like the more noise, we can see in this bottom part the worst of it is so after a lot of trial and error, this was the best fit that we could generate.

159
00:26:24.090 --> 00:26:33.750
Helen Black (she/her): and hear this kind of a little bit of a mess of data kind of represents the raw output of data that is associated with the spectra that I just showed you.

160
00:26:34.260 --> 00:26:46.440
Helen Black (she/her): And on the left here are all the different elements that I put into PICs and asked it to look for when i'm analyzing the spectra and over here, you can see.

161
00:26:46.920 --> 00:27:01.110
Helen Black (she/her): who picks tells you whether these elements were detected, yes or no, sometimes a little bit uncertain and in this box here, you can see the measured concentrations that are associated with each of these elements.

162
00:27:03.750 --> 00:27:12.090

Helen Black (she/her): So after repeating that process for all my different samples, I was able to plot, the concentration of lead as a function of distance from the bridge.

163
00:27:13.020 --> 00:27:23.010
Helen Black (she/her): So this graph specifically shows the concentration of lead vs distance on the New York side of the bridge and the positive values here indicate on moving south of the bridge.

164
00:27:23.580 --> 00:27:39.270
Helen Black (she/her): And as you can see there's kind of a downward trend, as we move away from the bridge which is really interesting and kind of indicates that you know the source of lead could be from the bridge i'm like I said before, I wasn't able to.

165
00:27:40.350 --> 00:27:49.560
Helen Black (she/her): collect samples from the north side of the bridge, but I by doing so maybe in the future that will could also help us understand if this trend tends to.

166
00:27:50.430 --> 00:28:01.470
Helen Black (she/her): Also do if the continent, if the concentration of lead also decreases on the Northern side that could also help us, you know point and determine whether this lead is from the bridge.

167
00:28:03.450 --> 00:28:15.300
Helen Black (she/her): I also repeated this process on the New Jersey side and these results are a lot more ambiguous there's not as nice of a trend, as we saw on the New York side.

168
00:28:15.750 --> 00:28:23.700
Helen Black (she/her): And I mean you can kind of see on the North side of the bridge that does debt, but then it goes up again on the South side it's a little bit all over the place.

169
00:28:24.720 --> 00:28:25.710
Helen Black (she/her): So these.

170
00:28:27.390 --> 00:28:31.890
Helen Black (she/her): However, there is there was lead detected so that still is an interesting find.

171
00:28:32.910 --> 00:28:38.460
Helen Black (she/her): But like I said more analysis could definitely be needed to understand what these trends really mean.

172
00:28:41.580 --> 00:28:53.640

Helen Black (she/her): And finally, a quick summary like I said lead was detected at the base of the George Washington bridge that generally on the New York side at least decreased with increasing distance from the bridge.

173
00:28:54.180 --> 00:29:01.440
Helen Black (she/her): And on the New Jersey side, it was a little bit more ambiguous, but it does seem, at least for the New York side that this lead was from the bridge itself.

174
00:29:02.040 --> 00:29:11.280
Helen Black (she/her): And this is the second bridge that we've studied to at Union from the New York City area that contain lead in a park underneath it was just an interesting find.

175
00:29:12.270 --> 00:29:24.090
Helen Black (she/her): In the future, and analysis of core samples from the riverbed of the Hudson could also help us determine like really, what was the cause of this detected lead, and if it was impact from the bridge.

176
00:29:25.020 --> 00:29:35.670
Helen Black (she/her): But there also are many more business to study that could have similar findings, a lot of these bridges on that we're constructing the early you know 20th century as the George Washington in hell gate bridge is.

177
00:29:36.000 --> 00:29:52.200
Helen Black (she/her): Where were originally quoted in a lead based paint so that could indicate that bridges that were constructed doing a similar time could possibly have led in their surroundings as well um so thank you all so much for your time and I believe I have some time for questions now.

178
00:29:59.760 --> 00:30:08.310
Chad Orzel: So thank you and questions for Helen I see john you're the first one, the top on my list there.

179
00:30:08.760 --> 00:30:17.250
Jonathan Marr: yeah so there's anything you have to New York City bridges you've tested any thoughts, by doing a local bridges look at the ones going over the mohawk.

180
00:30:18.300 --> 00:30:27.930
Helen Black (she/her): um yeah I mean I think um yeah that wasn't really what I was focusing on but I definitely think we could do some more analysis of purchase here as well.

181
00:30:29.550 --> 00:30:30.690
Jonathan Marr: Much easier to get the data.

182
00:30:33.630 --> 00:30:33.990
Helen Black (she/her): So.

183
00:30:34.530 --> 00:30:36.480
Chad Orzel: Ah, so heather your.

184
00:30:38.400 --> 00:30:56.010
Heather Watson (She/Her): yeah hi thanks that was great um, I guess, I just have a question that like maybe the highest concentration that you measured was something around 2000 ppm near near the bridge on the New York side, and I was wondering if you had any idea like how that compares to some like EPA.

185
00:30:57.600 --> 00:30:58.200
Heather Watson (She/Her): sort of.

186
00:30:59.550 --> 00:31:08.820
Heather Watson (She/Her): Guidelines on what is inappropriate i'm planning to have you know, do you have any sense of what you know how dangerous is that or not dangerous.

187
00:31:08.850 --> 00:31:25.230
Helen Black (she/her): yeah um I don't really know honestly off the top of my head, but that's something I am like exploring in my as i'm writing my thesis but yeah it's definitely elevated and compared to the surrounding area.

188
00:31:25.830 --> 00:31:26.880
Heather Watson (She/Her): yeah absolutely.

189
00:31:27.120 --> 00:31:28.740
Helen Black (she/her): that's good question so.

190
00:31:29.580 --> 00:31:35.190
Chad Orzel: distinguish between you, you suggested the possibility that.

191
00:31:36.540 --> 00:31:50.460
Chad Orzel: This is due to paint on the bridges, but, of course, like in that same era, a lot of cars were burning leaded gasoline so, can you distinguish between you know and that's like the main point of the gw bridge right is that.

192
00:31:50.490 --> 00:31:54.750
Chad Orzel: Millions of cars, so do you distinguish between those at all or.

193
00:31:55.440 --> 00:32:09.120

Helen Black (she/her): um I don't believe so, through my method of analysis um but yeah but there have been recent projects on the George Washington bridge that like have specifically you've been like removing lead based paint.

194
00:32:09.330 --> 00:32:13.770
Helen Black (she/her): Like over you know the past recent years so i'm could be to that, I mean I.

195
00:32:13.770 --> 00:32:16.770
Helen Black (she/her): Just scraping every day together yeah exactly.

196
00:32:19.170 --> 00:32:30.630
Scott LaBrake: Just to follow up on the question heather asked the EPA has about a 400 parts per million limit on player is that involved children, which is probably just about 400 parts per million too high.

197
00:32:33.270 --> 00:32:33.510
Heather Watson (She/Her): Right.

198
00:32:34.260 --> 00:32:36.060
Scott LaBrake: Then it goes up higher for different types of.

199
00:32:36.060 --> 00:32:36.630
Scott LaBrake: Soil but.

200
00:32:38.070 --> 00:32:38.880
Heather Watson (She/Her): yeah okay.

201
00:32:41.550 --> 00:32:42.930
Chad Orzel: Any other questions.

202
00:32:48.180 --> 00:32:57.720
Chad Orzel: Okay, so thank you again, and you can stop sharing and then we'll switch over to jake is the next.

203
00:32:58.530 --> 00:32:59.160
Helen Black (she/her): on the list.

204
00:33:02.430 --> 00:33:03.360
Feinstein Jake: sure everyone.

205
00:33:05.310 --> 00:33:06.840
Feinstein Jake: me share my screen here.

206
00:33:12.660 --> 00:33:13.320
Chad Orzel: alright.

207
00:33:14.220 --> 00:33:17.340
Feinstein Jake: This slideshow button and everyone's saying yep.

208
00:33:17.400 --> 00:33:25.770
Chad Orzel: We got you so right so here's jake Feinstein a script and it's working with other Watson and he's going to tell us about that take it away.

209
00:33:25.800 --> 00:33:36.600
Feinstein Jake: It just says Chad said, my name is Jacob financing under the supervision of Dr heather Watson i've been conducting research to putting old chum positron annihilation lifetime spectroscopy or emails.

210
00:33:37.290 --> 00:33:49.170
Feinstein Jake: To Union college, so this presentation will cover the work of this project in general i'll begin with some important information that serves as motivation and ground level introduction to the theory of this project.

211
00:33:49.980 --> 00:33:58.050
Feinstein Jake: also discuss the methods using this experiment, including the SAP and the current work with completed for the establishment of really what we had for a.

212
00:33:59.100 --> 00:34:08.880
Feinstein Jake: While finally we'll we'll conclude by presenting some preliminary results of the data analysis methods that were beginning to undertake and the future of this project on the long scale.

213
00:34:10.170 --> 00:34:19.080
Feinstein Jake: So, beginning with this, the question is well why do we need a new analysis technique in general let's start talking about radiation.

214
00:34:19.410 --> 00:34:25.590
Feinstein Jake: So radiation damage in general is extremely harmful to organic material and that's a major health threat.

215
00:34:26.430 --> 00:34:38.130
Feinstein Jake: using nuclear energy, which we unfortunately use a lot of we produce a lot of nuclear waste, which is radioactive and has to be properly contained, for the reason that radiation is harmful.

216
00:34:38.610 --> 00:34:54.600

Feinstein Jake: Now a nuclear waste, unfortunately remains a health risk for thousands and thousands of years, so as a society, we need to look for the best long term way to contain safely contain nuclear waste, as it will persist is in danger, long afterwards.

217
00:34:55.710 --> 00:35:04.200
Feinstein Jake: So currently in use for containment of nuclear waste we use a lot of high frank metallic alloys as well as concrete and plastics to contain.

218
00:35:05.520 --> 00:35:18.210
Feinstein Jake: This radioactive that piece of the all of the materials using containment or exactly to contain the waste health threat presented by radioactive waste is that, as the radiation, the waste admits.

219
00:35:19.500 --> 00:35:33.780
Feinstein Jake: it's admitted into the container and the material of the container which may damage the container itself, just as radiation is a damn harmful and threatening to organic material it's also harmful and threatening to inorganic material so.

220
00:35:35.520 --> 00:35:43.770
Feinstein Jake: The idea is that when radiation is a bit into this container material, it creates defects which may allow for the waist to escape.

221
00:35:44.220 --> 00:35:59.160
Feinstein Jake: The goal that we have to achieve is reducing the amount of radioactive leaks, as much as possible in our containment of this waste, the project we have undertaken AIDS is method for evaluating these defects very directly.

222
00:36:00.390 --> 00:36:03.930
Feinstein Jake: and seeing how these defects may arise in containment materials.

223
00:36:04.290 --> 00:36:11.880
Feinstein Jake: But before we get into that we also have to discuss a little bit more of the basics of these metallic compounds that typically make up these containment materials.

224
00:36:12.150 --> 00:36:20.580
Feinstein Jake: In this case, metallic compounds we refer to generally as crystals but crystalline materials are the focal point of this industry.

225
00:36:21.600 --> 00:36:21.810
Feinstein Jake: Is.

226

00:36:23.280 --> 00:36:36.090
Feinstein Jake: Generally, a crystal is kind of any material atomic structure as a periodically symmetrical structure as a very nice repeating back so in this diet and in this photograph to the right.

227
00:36:37.050 --> 00:36:52.350
Feinstein Jake: You can see this very uniform iron less than each white spot here, as was written represents a column of atoms and these rows are very nicely aligned exactly kind of us as you'd expect in a symmetrical structure.

228
00:36:53.400 --> 00:37:02.310
Feinstein Jake: Now, the idea of a crystal structures that yes, it's perfect, but there are still effects so to observe what a defect looks like in a crystal structure.

229
00:37:03.210 --> 00:37:13.650
Feinstein Jake: We can look at the most kind of prevalent defect we're talking about as a patient effect, but here we have a model layer of molybdenum it's Melinda dumb guy sulfide.

230
00:37:14.280 --> 00:37:28.650
Feinstein Jake: And you can see the regular almost hexagonal pattern in this model layer, but the what is nicely highlighted between circles, here we can see what's in fact missing or vacancy difference in.

231
00:37:29.310 --> 00:37:38.820
Feinstein Jake: The relation between vacancy defects and if you city or permeability of these materials is really like simple more empty space you give a container the.

232
00:37:39.660 --> 00:37:52.620
Feinstein Jake: The worst it's going to be at containing things right, if there are more holes more stuff gets through so an undertaking this project we are making an effort to make the measurements of the concentration of defects within crystal truck.

233
00:37:53.790 --> 00:37:57.240
Feinstein Jake: getting a little bit more into the analysis method itself we're going to talk.

234
00:37:58.140 --> 00:38:10.860
Feinstein Jake: about some of the fundamentals of this theory, so we can begin with the fundamental building blocks of the universe electrons and positrons to jump into electrons and protons, which are two of the fundamental building blocks.

235
00:38:12.900 --> 00:38:15.930
Feinstein Jake: to play on we.

236
00:38:18.630 --> 00:38:29.850
Feinstein Jake: We look at these electrons and pastor wants to simply for the the idea that they are they're anti matter and matter counterpart electrocuting the matter to me.

237
00:38:31.020 --> 00:38:45.360
Feinstein Jake: As a this when an electron positron me they annihilate and admit anti parallel 511 ke VI gamma rays know anti parallel just refers to the fact that the these gamma rays will be separated by 180 degrees is shown in this picture to the right.

238
00:38:46.530 --> 00:38:59.040
Feinstein Jake: And that annihilation is presents a measurable amount of light which is important for this experiment of the annihilation and subsequent a mission of this a.

239
00:38:59.550 --> 00:39:11.130
Feinstein Jake: gamma Ray photon lastly serve as one of the signals that we need in this important thing to know is that in crystals electrons are found everywhere except for the fact that.

240
00:39:11.730 --> 00:39:20.820
Feinstein Jake: If if, in your crystal structure, there was a defect, it is less likely that you find an electron there is no Adam for the crystal for the electron the circle.

241
00:39:21.870 --> 00:39:28.650
Feinstein Jake: For to orbit around faintly now that brings us specifically topology transfer capacity and generally.

242
00:39:34.320 --> 00:39:39.780
Feinstein Jake: Oh you're in this experiment, we needed to start with a source of.

243
00:39:41.400 --> 00:39:42.840
Feinstein Jake: What we're talking about positrons.

244
00:39:43.980 --> 00:39:44.760
Feinstein Jake: We.

245
00:39:47.970 --> 00:40:06.540
Feinstein Jake: won't work, so we began with a source of positrons now the source that we use in this experiment is a and micro primary source of sodium 22 highly radioactive and it miss a large number of positrons, and this is used in a sodium fluoride compound.

246
00:40:08.160 --> 00:40:16.710
Feinstein Jake: Now this tiny emitter is going to be the source that we use for positrons and how produces it is so 22 is a radioactive substance as an art goes to K.

247
00:40:17.220 --> 00:40:34.110
Feinstein Jake: At mit's positron but it decays into neon 22 excited state of the 22 for the most part, and as it begins in the excited state of neon point to that, then D excites into the ground state of the 22,000,012 74 K gv gamma Ray now.

248
00:40:35.250 --> 00:40:46.860
Feinstein Jake: This 1274 ke VI gamma Ray is going to be the marker that we use for the mission of this positron now, as I turned into this diagram here, it will become a little bit more clear what.

249
00:40:49.260 --> 00:41:01.380
Feinstein Jake: School we began on the left hand side with this E plus source, which is our positron sorts of sodium 22 and as an apartment is emitted from the source, we see the correlated.

250
00:41:02.610 --> 00:41:09.690
Feinstein Jake: Be camera ready, we can record that has the positron entered for security purposes of it but nice lattice structure.

251
00:41:10.410 --> 00:41:26.190
Feinstein Jake: It will eventually pulled out in public slide with an electron and annihilate producing to anti parallel a 511 K EB gamma rays again, which we can measure, now the timing resolution measurements that we make super high resolution measurements that we.

252
00:41:27.720 --> 00:41:30.120
Feinstein Jake: Make during this.

253
00:41:33.180 --> 00:41:41.970
Feinstein Jake: Will denote The lifetime positive so we're simply subtracting the start time for the positron emission with its subsequent annihilation.

254
00:41:43.980 --> 00:42:00.750
Feinstein Jake: it's about do, how does the lifetime of this positron with an unstable related defects in the sample, the answer is very simple, if there are more defects and less electrons takes longer to him, so that is how we are making these direct measurements of.

255
00:42:03.120 --> 00:42:08.760
Feinstein Jake: moving into our current work, this is laboratory setup you can see, on the right.

256
00:42:10.410 --> 00:42:21.120
Feinstein Jake: In both the top and bottom picture, one is zoomed in so that you can see, more specifically, the detectors quite a lot going on, but most of the current work that.

257
00:42:22.650 --> 00:42:23.550
Feinstein Jake: He did alongside.

258
00:42:24.570 --> 00:42:34.920
Feinstein Jake: Watson and my vineyard has been building this entire setup given the specified for to make this experiment work.

259
00:42:35.940 --> 00:42:51.090
Feinstein Jake: After building the next step of the process is to calibrate all the electronics, so that they're actually of use for this experiment and now wow this has taken up the bulk of my time we have been able to make some initial data collection, which will present on as well.

260
00:42:52.950 --> 00:43:00.450
Feinstein Jake: Oh, the physical setup is where we'll we'll can, there are a few key components of the physical so that way to get into, and this.

261
00:43:00.840 --> 00:43:13.170
Feinstein Jake: Electronic schematic that we see at the top here is kind of going to be our guide and well currently apparent where what all of these products are it doesn't need to be because we're going to get into it with.

262
00:43:15.660 --> 00:43:22.770
Feinstein Jake: What started that attackers, these are the first part of our experiments, something you could see a little bit in the back on one of the photos are.

263
00:43:23.730 --> 00:43:33.780
Feinstein Jake: These two detectors are fast classic simulator detectors which means they have a very good resolution scale and they so these fast passes into it is will amplify and.

264
00:43:34.830 --> 00:43:41.520
Feinstein Jake: Other departments actually convert a photo signals or gamma rays and pick up these.

265
00:43:42.000 --> 00:43:57.600
Feinstein Jake: 511 caveat and 1274 K ED gamma rays and turn them into an electrical signal that could be continued on throughout the circuit now these signals are all well and good, but they must be discriminated so that we know the parish to the signals that we want and not just any.

266
00:43:58.860 --> 00:43:59.100
Feinstein Jake: of us.

267
00:44:00.750 --> 00:44:18.690
Feinstein Jake: Oh, the constant fraction of scrimmage are here for this purpose, and we see them in the CRATE in the picture to be operating in the plan now these distributors, they discriminate signals outside of the accepted range and we refer to the accepted range as the accepted.

268
00:44:20.820 --> 00:44:28.290
Feinstein Jake: The range here right, so these this discrimination will take only the correct amplitude.

269
00:44:28.740 --> 00:44:39.060
Feinstein Jake: For a designated number of time and if that employee if the amplitude of the input signals is the correct amplitude it's allowed to pass, and this is part of the calibration to take the.

270
00:44:39.630 --> 00:44:43.950
Feinstein Jake: matter what the corrected amplitude is and then to put that underneath the square meters.

271
00:44:44.790 --> 00:44:51.840
Feinstein Jake: So, moving on along the circuit, we have the delay box, which is an equally important part of the circuit and the delay box.

272
00:44:52.560 --> 00:45:12.240
Feinstein Jake: Basically, ensures that we have a baseline for one that's festival arrives first obstacle that no delay between the start and stop signal if there's 07 we could very well be getting these as registers, at the same time, they put an artificial delay of about 20 seconds been.

273
00:45:16.440 --> 00:45:20.730
Feinstein Jake: been a bad signal in our top signal which ensures that there is kind of a base.

274
00:45:22.050 --> 00:45:29.850
Feinstein Jake: Of when the signal should be coming in and as if we have a higher degree of separation between the signals a longer positron lifetime.

275
00:45:30.150 --> 00:45:40.950
Feinstein Jake: Then we can adopt that, based on the delay there and we can measure that based on laughter right there, so the next part is the since box now this fast Vincent block is the.

276

00:45:42.780 --> 00:45:46.530
Feinstein Jake: incidence the part that guarantees that we have a positron.

277
00:45:48.210 --> 00:45:49.620
Feinstein Jake: And all of these.

278
00:45:51.990 --> 00:46:01.170
Feinstein Jake: Well, the past coincidence block sense of gay through it's only coincidental start and stop soon as fast as we have is 100 nanoseconds long.

279
00:46:02.250 --> 00:46:14.130
Feinstein Jake: admins you can say, and as long as it receives as long as the the cf discriminated which are connected to it give it a two signals to start signal and a stop say know.

280
00:46:14.580 --> 00:46:23.220
Feinstein Jake: Within 100 nanoseconds those signals will be allowed to continue to pass through into the next part of the time, the amplitude converter, if not, they are thrown out.

281
00:46:23.910 --> 00:46:32.580
Feinstein Jake: So that brings us to the next part which is the kind of convert it takes the time difference between the signals that are given.

282
00:46:34.140 --> 00:46:38.220
Feinstein Jake: into outputs it as a wave who's pulsate or.

283
00:46:41.610 --> 00:46:54.330
Feinstein Jake: Not is then connected to a multi channel analyzer in this case we use micro excuse me, oh first actually that's a good book First, we want to talk a little bit about the calculation for.

284
00:46:55.710 --> 00:47:04.800
Feinstein Jake: calibration of the tack, we have we have this program maestro which you can see it's a little bit of a sneak peek we have.

285
00:47:06.720 --> 00:47:21.060
Feinstein Jake: What in an artificially or nanoseconds using a pulsar so we have increase the delay between the time signals in our system with kerfuffle also before I believe in signals we've created.

286
00:47:22.560 --> 00:47:38.160
Feinstein Jake: A difference for all its own lifetime of starting at 32 nanoseconds with a pain to for nanoseconds increase an incremental increase all the way up to 112 which gave us the approximate.

287
00:47:39.420 --> 00:47:51.120
Feinstein Jake: change that we would need for to get turn this energy spectrum into a time spectrum, which actually brings us directly into the ncaa and multiple planets it's just.

288
00:47:52.650 --> 00:48:07.170
Feinstein Jake: A energy spin for all purposes as an energy spectrum program takes energy on the X axis to cancel the y axis and, in our case, it will graph and he puts us back to the 1024.

289
00:48:08.970 --> 00:48:19.350
Feinstein Jake: Energy definitely know what we have been using this because we converted this X axis energy into time, which will give us information about the lifetime of the positron.

290
00:48:21.210 --> 00:48:24.480
Feinstein Jake: Now preliminary sector data we can talk about.

291
00:48:25.830 --> 00:48:26.280
Feinstein Jake: it's what.

292
00:48:27.450 --> 00:48:28.740
Feinstein Jake: In creating.

293
00:48:30.000 --> 00:48:39.060
Feinstein Jake: This experiment, we finally been able to run some data, and we have second data of iron on the left and medium off side on the right.

294
00:48:39.510 --> 00:48:53.820
Feinstein Jake: hand up for those of you with a very keen eye for detail, you will notice that there isn't much change between the iron and magnesium oxide spectra, and the reason for that is that we have chosen to very high purity and very.

295
00:48:55.440 --> 00:49:03.990
Feinstein Jake: Well grown bristol's of iron and magnesium oxide and we are actually expecting a lot of variation in the lifetime so positrons within the same.

296
00:49:05.250 --> 00:49:11.670
Feinstein Jake: So what is this the reason for their christine's back there doesn't seem to be a lot of interesting information.

297
00:49:12.720 --> 00:49:18.120
Feinstein Jake: So the analytical methods were using pals three, which is a program I studied.

298
00:49:19.950 --> 00:49:39.900
Feinstein Jake: I believe, and so this program was developed by people perform and emotional customer has to be in Europe, and this openness is available for purchase online i'm not this fits this program will fit the spectrum that we have with.

299
00:49:41.220 --> 00:49:56.400
Feinstein Jake: The Times effectively the data analysis performed by this program gives us the lifetimes of the positron that we expect to see in the sample or the very variety of positron lifetimes that we see in the sample corresponding to different numbers and intensities defect.

300
00:49:58.020 --> 00:49:58.470
Feinstein Jake: So.

301
00:49:59.550 --> 00:50:09.270
Feinstein Jake: Moving on, we will talk a little bit of a future work this project now the remainder of my time here will be making basic measurements know materials with confirmation.

302
00:50:10.320 --> 00:50:14.850
Feinstein Jake: or focused on metal oxide and metal oxide magnesium.

303
00:50:16.230 --> 00:50:20.580
Feinstein Jake: Giving honor to the summer we're going to begin performing details on an empty and plastic.

304
00:50:21.240 --> 00:50:33.360
Feinstein Jake: bottles in with radiation damage has already been in boost so we've looked at 16 samples will we're going to want to look at the irradiated samples of the damage samples to see if there are differences in Defense and how so.

305
00:50:34.560 --> 00:50:47.610
Feinstein Jake: But the goal after summer of 21 and to continue on into the future, some form larger scale studies on crystals and again to compare containment or geological material samples with other methods of experimental.

306
00:50:48.540 --> 00:50:55.920
Feinstein Jake: measurement, so there are different experiments which can indirectly measure defects and they should complement he pals very nicely and.

307
00:50:57.120 --> 00:51:08.850

Feinstein Jake: Is all I would like to extend a special thanks to the Faculty volunteers and make this possible includes Dr Michael vineyard and Dr Daniel maniac additionally this product was made possible by the International side.

308
00:51:10.950 --> 00:51:11.850
Feinstein Jake: very much.

309
00:51:12.960 --> 00:51:15.870
Feinstein Jake: Time and if you have any questions thinking that.

310
00:51:19.080 --> 00:51:23.220
Chad Orzel: So thank you so Questions see Mike.

311
00:51:24.780 --> 00:51:28.200
Michael?s iPad: yeah jake so that the tech spectrum.

312
00:51:29.250 --> 00:51:38.370
Michael?s iPad: it's interesting I see structure over there, higher times I would have expected the accidental coincidence background next one over.

313
00:51:40.800 --> 00:51:50.340
Michael?s iPad: yeah I would have expected that to be kind of a uniform, you know just a flat distribution now have any idea what this little structures are.

314
00:51:51.720 --> 00:52:04.710
Feinstein Jake: Oh at the higher level of what these structures are we don't really have a good idea what are these this residual structures, although it is entirely possible that there are.

315
00:52:06.360 --> 00:52:19.080
Feinstein Jake: Other coincident other an odd things going on with their at the last fast classic simulators can pick up a wide range of signals if any of these signals are.

316
00:52:19.800 --> 00:52:33.000
Feinstein Jake: Barely within the range, but just above or below the range of accepted signals and it's possible for some of them to still get in up besides that it could be an artifact of the detectors themselves or an artifact of something in the electronics, although it sounds.

317
00:52:33.030 --> 00:52:38.400
Michael?s iPad: Good yeah well, the fact that their peaks indicates that there's been you know.

318
00:52:38.430 --> 00:52:38.850

Feinstein Jake: Some.

319
00:52:38.880 --> 00:52:43.980
Michael?s iPad: Real high incidence of to back to events happening at the same time yeah.

320
00:52:44.550 --> 00:52:46.350
Feinstein Jake: And i'm not sure why are.

321
00:52:47.160 --> 00:52:53.910
Michael?s iPad: Also on the next on the next slide there are those that X axis is in time not energy.

322
00:52:57.120 --> 00:52:57.810
Michael?s iPad: it's time.

323
00:52:58.980 --> 00:53:06.510
Feinstein Jake: Yes, so the way this that there are program exports this because it's maestro it exports them as as energy and there is no way to.

324
00:53:06.840 --> 00:53:08.460
Michael?s iPad: Oh, you know these are for.

325
00:53:08.460 --> 00:53:21.060
Michael?s iPad: maestro okay yeah I know it'd be better to import it, you know, take the the Act, the ascii file and put it in applauding package yourself, we can label the axes appropriately.

326
00:53:22.560 --> 00:53:24.240
Feinstein Jake: yeah Thank you okay.

327
00:53:29.010 --> 00:53:29.970
Chad Orzel: Other questions.

328
00:53:34.800 --> 00:53:35.100
ready.

329
00:53:39.030 --> 00:53:41.880
Chad Orzel: Okay, then, thank you very much.

330
00:53:42.900 --> 00:53:47.640
Chad Orzel: switch off your screen and we'll move on to our last speaker.

331
00:53:50.040 --> 00:53:55.050

Chad Orzel: was going to be Dan resnick Dan you can share what you're using.

332
00:53:57.510 --> 00:53:57.810
A.

333
00:54:00.060 --> 00:54:02.040
Daniel Resnick: Full screen so.

334
00:54:02.790 --> 00:54:09.930
Chad Orzel: So our final speaker will be Dan resnick who's been working with Neil young man so take it away.

335
00:54:10.800 --> 00:54:20.760
Daniel Resnick: Alright, so as Chad said i'm Daniel resnick and my advisors nearly a man and today i'll be talking to you guys about dimensional reduction and scale or field theory so.

336
00:54:23.070 --> 00:54:36.180
Daniel Resnick: First, we need to talk about the three ingredients, so to speak, that we need to describe a dimensional reduction, so we need three things, how to describe physics on the atomic scales, which we get from quantum mechanics.

337
00:54:37.020 --> 00:54:46.500
Daniel Resnick: We need to account for special relativity and there are multiple ways that you can incorporate this into a physical model, the one that we're going to use is.

338
00:54:47.310 --> 00:54:57.450
Daniel Resnick: The client Gordon equation, whereas you're shooting your equation comes from a classical relationship between energy and momentum the client Gordon equation comes from a relativistic.

339
00:54:58.020 --> 00:55:06.240
Daniel Resnick: relationship between energy and momentum and it governs a different object called a claim Gordon and fields, which is a function of both space and time.

340
00:55:06.600 --> 00:55:12.450
Daniel Resnick: And then, finally, the third thing we need is the ability to incorporate the background curvature of space time.

341
00:55:13.200 --> 00:55:21.480
Daniel Resnick: That we came to know about from einstein's general theory of relativity so with these three things we can start talking about dimensional reduction.

342
00:55:22.200 --> 00:55:31.680
Daniel Resnick: And, in particular, what this means is we're going to start adding extra dimensions to our space time and asking what happens when we get rid of them so.

343
00:55:32.670 --> 00:55:47.370
Daniel Resnick: In particular, you want to consider something like this because string theories require more dimensions in order to to operate and Mathematically speaking it's pretty easy to write down a D dimensional.

344
00:55:48.450 --> 00:55:53.010
Daniel Resnick: equation so, for example, I can write down the claim Gordon equation and extra dimensions but.

345
00:55:53.340 --> 00:56:03.270
Daniel Resnick: actually coming up with a physical interpretation, for that is really hard, because the bottom line is that we observe the world in three spatial dimensions and one time dimension.

346
00:56:03.660 --> 00:56:15.210
Daniel Resnick: So, in order to consider a theory like this is places restrictions on the type of extra dimensions, we can consider, and in particular they need to be compact defied so i'll.

347
00:56:15.600 --> 00:56:24.780
Daniel Resnick: give an example of what a compact vacation might look like so imagine you're a particle that's constrained to move along a cylinder.

348
00:56:25.890 --> 00:56:38.940
Daniel Resnick: You have one dimension that's effectively like a line that propagates forever and you've got a finite compact defied dimension in a circle and you allow your particle to rotate around the cylinder, so to speak.

349
00:56:39.510 --> 00:56:46.530
Daniel Resnick: And then, if you get far away, you start to see less motion from the particle going along the cylinder and if I get.

350
00:56:47.130 --> 00:56:51.810
Daniel Resnick: even further away from this, you can actually distinguish the extra dimension anymore.

351
00:56:52.530 --> 00:57:04.740
Daniel Resnick: And you end up back in the space that we can observe, so this is a one dimensional model, but if you were to dimensionally reduce from a five dimensional model down to a four dimensional model.

352
00:57:05.580 --> 00:57:12.210
Daniel Resnick: This is effectively what you'd be doing so, a little bit more qualitatively, if you have the particle moving.

353
00:57:12.930 --> 00:57:17.280
Daniel Resnick: on a scale that small in your extra dimension, which I will label V.

354
00:57:17.670 --> 00:57:28.050
Daniel Resnick: The momentum associated with the extra dimension becomes quantization So if you write down the relativistic relationship for energy and momentum, you can express it as the components.

355
00:57:28.680 --> 00:57:41.730
Daniel Resnick: px P y Z and PV which i'm labeling as my extra dimension and effectively back in the picture here when you go from the second part of the cylinder to the third thing, where you can't really distinguish that it's a cylinder.

356
00:57:42.270 --> 00:57:45.930
Daniel Resnick: I it doesn't really make sense to interpret this as.

357
00:57:46.320 --> 00:57:57.570
Daniel Resnick: Five dimensions anymore, but the quantization from the momentum and your extra dimension has to go somewhere, so what we do is we stick it with the mass and interpreted as mass energy.

358
00:57:57.960 --> 00:58:13.530
Daniel Resnick: And since it becomes quantization the mass itself becomes quantization So what we end up with is in a three plus one dimensional space time we have an infinite tower of increasing masses and it's called a collusive client tower of masses so.

359
00:58:14.220 --> 00:58:18.510
Daniel Resnick: The specific model that I worked with is called a cylindrical compact vacation.

360
00:58:19.440 --> 00:58:27.390
Daniel Resnick: It starts in five dimensions and your extra dimension is one that effectively wraps up your space in a higher dimensional form of a cylinder.

361
00:58:27.960 --> 00:58:38.460
Daniel Resnick: And in the process of performing a dimensional reduction, you can write down a differential equation that gives you your collusive Klein masses and this one has a closed form solution to it, so I can.

362
00:58:38.760 --> 00:58:48.090
Daniel Resnick: write down the masses as a collection of constants relating to each part C and pi and add that to the mass and.

363
00:58:49.350 --> 00:58:55.890
Daniel Resnick: So you can see in the figure presented here the relationships, the mass have, as you increase the.

364
00:58:56.220 --> 00:59:03.540
Daniel Resnick: go up on your level of the collusive client tower, this is effectively like looking at an energy spectrum for like a particle and an infinite square well.

365
00:59:04.230 --> 00:59:14.490
Daniel Resnick: And there's a couple of key behaviors that we can look at here, so it gets asked them topically linear as you increase K, so you can see, at the start that you have.

366
00:59:15.120 --> 00:59:26.040
Daniel Resnick: The mass M and then you have a second dot and then the third dot and then the fourth dot and they're asking them toting to align the has a slight as slope of to pH fire over llc.

367
00:59:26.730 --> 00:59:36.240
Daniel Resnick: I also noticed that I use different dots on the ends of the cylinder this has to do with the fact that there are actually two states, the particle can be in.

368
00:59:37.350 --> 00:59:51.000
Daniel Resnick: At each level, except for the first one that corresponds to effectively moving in your compact dimension in one direction versus the other direction, but since they're moving with the same speed, they have the same magnitude of momentum.

369
00:59:51.630 --> 01:00:04.650
Daniel Resnick: And you end up with two particles at each level, except for the first, because the first level it's not moving at all with respect to your extra dimension and there's only one way, you can have a magnitude we're not moving and that's just zero.

370
01:00:05.220 --> 01:00:15.630
Daniel Resnick: And the other thing that's worth mentioning is that there's an offset on the graph related to em So if you were to imagine decreasing m, which is.

371
01:00:16.110 --> 01:00:35.280

Daniel Resnick: Lowering how much mass you have in your scale or field originally down to not having a mass at all, this goes to being centered at the origin, this is important to remember, for a second model because this might not be true in every single case so.

372
01:00:36.840 --> 01:00:45.570
Daniel Resnick: In terms of large scale predictions the slope of this line has a factor of H bar oversee which is on the order of magnitude of 10 minus.

373
01:00:45.960 --> 01:00:53.670
Daniel Resnick: 43 kilograms per meters, which is really tiny so What this means is that, in the expression for the mass.

374
01:00:54.600 --> 01:01:03.330
Daniel Resnick: Each masses very, very closely related to the original one that you have that's propagating and five dimensions, so you might ask the question.

375
01:01:03.720 --> 01:01:09.630
Daniel Resnick: Why don't we observe masses that have this kind of trend in a laboratory setting and it's because.

376
01:01:10.260 --> 01:01:23.940
Daniel Resnick: The slope or the slope of the line also scales with one over l so in order to space out the masses more to something that we couldn't see in a laboratory we would need the size of the compact to fight dimension to be exceptionally tiny.

377
01:01:25.140 --> 01:01:35.760
Daniel Resnick: So the other thing that's worth mentioning is the limiting behaviors of this kind of this graph So if you let me go into infinity.

378
01:01:36.540 --> 01:01:44.280
Daniel Resnick: You can imagine that the denominator of your slope gets really large unless your slope goes down to zero, and you end up with.

379
01:01:45.180 --> 01:01:52.650
Daniel Resnick: a bunch of masses at each level that have the same mass and it no longer makes sense to interpret the compact vacation as.

380
01:01:52.980 --> 01:02:01.650
Daniel Resnick: Mass energy, because your new dimension is just as large as your other ones, so you go back to four plus one dimensional physics, which is where we started and.

381
01:02:01.950 --> 01:02:18.450

Daniel Resnick: Similarly, if you let l go to zero your slope blows up and the next part of the mass be or the next part of your mass tower becomes infinitely far away from your starting mass and you just get conventional four dimensional physics, without this weirdness.

382
01:02:25.470 --> 01:02:26.940
Daniel Resnick: Okay, so.

383
01:02:29.310 --> 01:02:32.310
Daniel Resnick: This is a an example of a relatively trivial.

384
01:02:33.570 --> 01:02:35.250
Daniel Resnick: dimensional reduction.

385
01:02:36.690 --> 01:02:42.570
Daniel Resnick: For math reasons, this is effectively like analyzing just five dimensions, with no weirdness but.

386
01:02:43.260 --> 01:02:49.980
Daniel Resnick: In incorporating the background curvature of space time you get something a little bit more complicated called a warped compacted vacation.

387
01:02:50.430 --> 01:02:58.710
Daniel Resnick: And this model effectively what you have is you have your extra dimension that propagates from along a scale of zero to one.

388
01:02:59.220 --> 01:03:05.610
Daniel Resnick: And if you, you can think of restricting yourself to a specific point along your.

389
01:03:06.120 --> 01:03:23.850
Daniel Resnick: V direction, and then the plane that's and then it reduces down to three plus one dimensional space, but if you were to pick another V and then move along V to that point, you would also reduce the three plus one dimensional space, but you'd be stretched by some function relating to.

390
01:03:24.870 --> 01:03:39.120
Daniel Resnick: Your extra dimension and then, since this is also have a finite size, if you were to look at a length scale that's much larger than this V, then you don't really see this warp stretching at all, and you just have three plus one dimensional space so.

391
01:03:40.230 --> 01:03:46.950
Daniel Resnick: Similar to how you get a differential equation that describes your masses in the cylindrical compact invocation.

392
01:03:47.820 --> 01:03:57.630
Daniel Resnick: You also get one for here, however it's not analytically solvable this time due to the complications you get from incorporating the background curvature of space time.

393
01:03:58.470 --> 01:04:14.220
Daniel Resnick: And when you do that, we need to solve it numerically so I used the finite differences method to solve it analytically and I put that in mathematica and I can obtain a table of masses.

394
01:04:15.480 --> 01:04:24.270
Daniel Resnick: Mass eigenvalues which are the same as we had before, just in a different system and on this table, I have the parameter and N, which effectively.

395
01:04:25.470 --> 01:04:37.740
Daniel Resnick: determines my numerical accuracy of each eigenvalue and each eigenvalue going up the Tower from so, for example, from m zero to one and then all the way up to em five it gets.

396
01:04:38.040 --> 01:04:52.740
Daniel Resnick: More numerically taxing to calculate it, so I have to increase the end value in order to get a more accurate result in in tandem with it getting harder to calculate and I only got up to seven before my computer.

397
01:04:54.120 --> 01:05:06.030
Daniel Resnick: decided that didn't want to calculate them anymore, so I plotted these on another graph and then fit and align to them, and these ones like the ones in the cylindrical compacted vacation are also linear.

398
01:05:06.870 --> 01:05:17.430
Daniel Resnick: Though the important thing to notice is that also like that graph there's an offset at the cake equals zero layer corresponding the mass in your four dimensions which is.

399
01:05:18.030 --> 01:05:36.630
Daniel Resnick: weird because this particular system started with a mass lists and field in five dimensions, so in dimensionally reducing from five dimensions to four dimensions, the curvature of space time manifested by creating masses and four dimensions.

400
01:05:38.160 --> 01:05:47.520
Daniel Resnick: Though it's also hard to say whether or not the behavior is going to continue to be linear because I can only calculate up to seven, but so far, it looks pretty convincingly linear.

401

01:05:49.260 --> 01:06:01.980
Daniel Resnick: So for further work that I could do in this project, I only looked and what i'm talking about on scale or fields, but you can also have particles that are described by vector fields and tensor fields.

402
01:06:02.550 --> 01:06:10.350
Daniel Resnick: And i'm in the process of doing vector fields, right now, but in curved space time and it's hard.

403
01:06:11.460 --> 01:06:25.410
Daniel Resnick: But also, this is mostly a classical field theory it doesn't account for a potential that comes from interactions between particles and other effects that are associated with quantum field theory and that's what I did for thesis Thank you for listening.

404
01:06:27.390 --> 01:06:29.490
Daniel Resnick: And my sources.

405
01:06:33.300 --> 01:06:37.740
Chad Orzel: Okay, thank you so Questions for for Dan.

406
01:06:47.460 --> 01:07:03.630
Chad Orzel: So now like you're doing this for a model that just has one extra dimension that you're then rolling up in a fairly simple way, if you have like you know what I hear string theory, there should be like you know six of these extras and then.

407
01:07:05.400 --> 01:07:11.400
Chad Orzel: Does it like matter if you have more than one does it matter like what order you do them in and things like.

408
01:07:12.120 --> 01:07:23.550
Daniel Resnick: I don't know if it matters, the order you dimensionally reduce them in but the so the system that's associated with these masses I originally started out as 10 dimensions, it was a.

409
01:07:24.000 --> 01:07:35.040
Daniel Resnick: Type two string theory in the background curvature that came from was associated with what's called a black pea brain and that's like an extra dimensional version of a black hole.

410
01:07:36.180 --> 01:07:51.030
Daniel Resnick: I think it comes from the sekai sushi moto model, though i'm not sure about that and, by the time I started working on it, the five other dimensions have already been dimensionally reduced so I only saw this version of it.

411

01:07:53.940 --> 01:07:55.290
Chad Orzel: Okay, so.

412
01:07:58.590 --> 01:07:59.460
Chad Orzel: Other questions.

413
01:08:05.730 --> 01:08:09.030
Chad Orzel: Going once going twice so.

414
01:08:11.490 --> 01:08:13.680
Chad Orzel: Okay, well, in that case.

415
01:08:14.820 --> 01:08:26.580
Chad Orzel: that's That completes our senior thesis session, so thank you to Dan and jake and Ellen and Jasper, for very nice talks and.

416
01:08:28.140 --> 01:08:38.790
Chad Orzel: We will i'll stop the recording will save this, it will be part of the virtual steinmetz symposium and I will see you all around the department I hope so, so.