MARK HARTMAN: So here, I have just regular white light. And then I have a blue filter. And we said that if we put a diffraction grading in front, we can spread the white light out into its different colors. This essentially is an energy-- it detects the energy of the photons and it makes them go in different directions.

So if I put my grading down in front, I can see that my white light gets spread out into all these different colors, just like we saw before. My blue light, however-- I can see this is part of the issue that we had yesterday. The blue light, if it was a perfect blue filter, would only let through blue. But right now, it's letting through some purple, some blue, some green, maybe a little bit of orange, and there's no red. So it is blocking out the red.

We can't make a perfect filter that filters out exactly everything, but this isn't just dark red, there's actually no light there. But we're going to think about how could I-- and could I get a couple of the square grid patterns-- how could I represent this-- how can I represent the number of counts that I'm getting from different colors as a histogram?

How can I represent those different colors? And ideas? [? Asif? ?]

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: Again, nice and loud. I can't hear you.

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: What do you mean-- what's less-- what's first and last? Tell me what's first.

AUDIENCE: The first one is purple.

MARK HARTMAN: Purple.

AUDIENCE: Then comes green.

MARK HARTMAN: OK.

AUDIENCE: [INAUDIBLE] blue [INAUDIBLE]

MARK HARTMAN: Well, purple, kind of green, blue, yellow.

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: OK. And what would I represent? What would be the thing that I'm counting?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: OK. So at first you said, the power. We don't want to use words that we don't know exactly what they mean, but Juan?

AUDIENCE: Maybe we can take that thing [INAUDIBLE] and split up the image and get the number of the counts of [? the protons ?] and then we can get that data and [? get ?] graph.

MARK HARTMAN: Fantastic. So what I can do I could put a detector here-- very well done. I could put it detector here and I could say, well, over here, on this side, is where I'm getting blue, so add up all the counts from there, there, there, there, there, there, and there. And then I'll add up all the ones that are green on this strip. And then add up all the ones that are yellow on this strip. Then all the ones that are orange on this strip, and all the ones that are red on that strip.

So if I had a detector there, I could make myself a histogram-- let me make sure I'm putting this on the right way-- I'm just going to go ahead and do it right here. I'm going to say-- move this down just a little bit. If I made a histogram, I'm going to measure-- I'm going to count up the number of photons of a certain color collected.

And then over here, I'm going to represent the color. Or what is the word that we use to say color? What is color our experience of?

AUDIENCE: Light.

MARK HARTMAN: What about light?

AUDIENCE: Uh-- [INAUDIBLE] flux?

MARK HARTMAN: Flux, luminescence, color-- throw them all out. Maybe we'll get one right. David?

AUDIENCE: Energy.

MARK HARTMAN: Energy. So this is going to be the energy. And I could just-- I'm just going to start with this is say, blue down here. This is green. This is yellow, orange, and red. Except that's not the way I wanted to go, but that's OK.

AUDIENCE: You can just make a bigger one.

MARK HARTMAN: So what I can do is I can say, all right, let me count up the number of purple photons that I got. In this case, it kind of looks like they're all about the same amount. They all look about the same brightness. So I'm going to say for blue, I'm going to put a-- I'm going to use a better marker first.

I'm going to say there's my blue and make it like that. Green looks about the same. Yellow-- there's my histogram. Orange and red. I'm just drawing a little bar there. Now, I can draw them so that they're kind of right next to each other if I wanted to, but then, I'd have to add in a few more colors.

What about down here? If I have my blue filter and I spread that light out, how could I represent my histogram, again, of this is the energy and it goes blue-- again, blue, green, yellow, orange, and red. And I'm still going to record the number of photons collected. How would this one be different?

AUDIENCE: It should only be blue.

MARK HARTMAN: Well, let's actually look at what we've got here. How is it-- how is this purple part, or this blue part, here, how is it different from this blue up here?

AUDIENCE: It's fainter.

MARK HARTMAN: It's fainter, but what word would we use to describe that?

AUDIENCE: The photons aren't as strong.

MARK HARTMAN: The photons all have the same energy. Blue photons, regardless of whether they're up here or down there, have the same energy. What is it that's different? What am I-- What is my y-axis here?

AUDIENCE: Flux.

MARK HARTMAN: It's actually related to flux, and we're going to get to that in a second. But we're looking at the number of photons collected. If we put our detector up here in this same area, would we collect more or less photons than if we put our detector here?

AUDIENCE: Less.

MARK HARTMAN: We collect less because there's less flux of the color blue. So in comparison, we don't want to make our histogram bar that tall. We maybe want to make it blue. Let's maybe make it-- can I have another couple of markers please?

AUDIENCE: There's one right--

MARK HARTMAN: This one seems to work a little bit better. And I'll throw that one out.

What about green? Is there as many photons getting through here down here? No, so I want to make my green one a little bit shorter, still about the same as blue. What about yellow? Here, I've got yellow in this part. Here, I've still got some yellow. So maybe I'll make it still not very tall.

What about orange and red?

AUDIENCE: [INAUDIBLE]

MARK HARTMAN: You don't have any orange and red. So my histogram would be down here at zero. So this is a way that I can represent the difference between this spectrum and this spectrum. So I'm going to give you a couple of definitions. Juan actually jumped right to the point when he said, well, we are collecting the number of photons of a certain color. But we're going to call-- we're going to review and we're going to say that this is-- so these are definitions.

We said that flux is the number of photons collected. And again, I just want to make sure everybody knows when I write this little symbol, this pound sign, that means number. You can actually physically write out the order number if you want to. So the number of photons collected per second divided by the area of the collector. That's what we said before. It's just the total number of photons collected every second divided by the area of your collector.

We're going to define-- what's the difference on this axis here? It's the number of photons collected, but it's the number of photons of a certain color. We are going to define intensity to be the number of photons of a certain color collected per second per area of collector.

So what's the difference? Flux is just the total. We don't care about which color they are. That's what we had in our detector-- in our images, because we didn't always-- we just collected the numbers of photons. We couldn't tell what their energy was. Well now, if we know what their energies are, intensity is number of photons of a certain color collected per second divided by the area of the collector.

Another way to write that, if we wanted to be a little more specific, we can also say it's the number of photons in a certain range of energy collected per second, per area of the collector. So these two phrases of a certain color and in a certain range of energy, those mean the same thing.

Because remember, we said our experience of color or color to us, is just the way that we experience photons of different energy. And we just happen to say well, this range of energy right here, we're going to call this purple. This range of energy right here, we're going to call this blue. This range of energy we're going to call green.

So it's kind of just based on the way that our bodies work. But what we really want to look is intensity. It's the number of photons in a certain range of energy. These two definitions are essentially the same thing.

And then lastly, we're going to define what a spectrum is. We had talked yesterday about the electromagnetic spectrum. We're talking about these are spectrums. A little kid-- you can just say a spectrum is a rainbow, because this is what it looks like. For us though, a spectrum is going to be the composition of light from a source.

We said, any time that we are collecting light, there must be a source that gave off that light, and we're going to figure out what is that light composed of? A simple way you can say is well it's composed of different colors. But colors are just the way that we experience, so we really want to say certain energies.

So the spectrum, if you wanted to play Jeopardy, like and they said, blah, blah, blah, and you'd say what is a spectrum? The answer to the question, what is a spectrum or spectrum is the answer to the question, how many photons of each energy do we receive-- I'm sorry-- not do we receive, but do we collect.

So if I were to ask you how many photons of each energy do we collect from a source, and you would say spectrum. We can-- we've already seen that we can represent the spectrum in two different ways. We can actually draw a picture of it or we can represent it as this histogram. And it's a histogram of the number of photons of a certain color, which we're going to call this intensity. Intensity versus energy is what a spectrum is.