PROFESSOR: Now, I'd like to demonstrate multi-slit diffraction patterns. Now, normally one would take a, let's say, piece of glass with a ruling on it-- many, many lines, many dark lines on a piece of glass-- and then one would shine the laser light through it, and look on the screen, and see the multi-slit diffraction pattern. But we're going to do it a little differently. What we're going to do, we're going to introduce one slit at a time until we've build up to the many slits, so you can see the contribution of each slit.

And we're going to do it in this way. We have the same setup as before. Here's our laser, and the two mirrors, and the lens to expand the beam. Here's the expanded beam.

Now, over here, we have two things. First of all, we have a pair of jaws here, which are two razor blades, which I can adjust the spacing between the razor blades. I can adjust with this translation stage over here. And then, right behind the razor blades, there is a piece of glass, which is a Ronchi ruling-- just a piece of glass with black lines. The thickness of each black line is about 75 microns, and the spacing between the black lines is about 125 microns. It's about 250 lines per inch, if you want.

So this is then this Ronchi ruling, this piece of glass with all these narrow slits on it. The screen is, as before, 200 centimeters away. And, again, the wavelength of light is 6,328 angstroms.

So now, let's look at-- first of all, let's close down the jaws, look at the screen, and see if we can see the single-slit diffraction pattern. Here we have the single-slit diffraction pattern. I have to apologize, because when we close down the jaws, we don't have much light. But I hope you can still see the single-slit diffraction pattern.

Now, on the screen we have the circles. The circles are the 5 centimeter markers. And the little arrow tips, as you can see, they mark the 0s of the central lobe of the single-slit diffraction pattern associated with the 50 micron or so slit on this Ronchi ruling.

So now what I'm going to do, I'm going now to separate the jaws to admit one more-- the second slit. Now, those of you who understand this theory will quickly verify that, indeed, you'll see three lobes then within the single-slit principle lobe. Now, I'm going to add one more slit by again opening up the jaws. As I bring in one more slit, now we have three slits.

And look at the pattern now. It generates some weaker lobes in between. And the lobes themselves are getting narrower.

Now, we'll add one more. Here it is four. And here it is five, six, seven, and so on. I'm just going to keep enlarging the spacing, and you can see that, first of all, the principle three lobes get narrower and narrower. And then you get a lot more little side lobes in between.

So as I widen the spacing between the jaws, you can see that those three lobes will get narrower and narrower. And, of course, you'll see the ones from these other side lobes also. There's little dots to the side.

Now, the intensity is so bright that it's saturating our camera. So what we'd like to do, we take a little close up so we can resolve the lobe. So if you can go in and take a close look at the three lobes in the center, here we are. Then we go back again to when I had only two slits in there. Now, I've added a third, a fourth, a fifth, and so on.

As you can see, the width of the three principal lobes are getting narrower and narrower. And now I have lots of slits now. And, again, the intensity is high, so I can't really tell how narrow, but I know this looks very narrow. So maybe we can cut down the sensitivity a little bit on the camera. And let's see if we get a feel of how narrow these spots will be.

Again, all I can say, they look pretty narrow. And I'll leave it to you to calculate how narrow they become. Because I've given you all the data. I've given you the spacing between the slits, I've given you the width of the slits, and the wavelength of the light, and the distance between the slits and the screen. So, in summary, this is a very, very cute experiment demonstration of how the addition of each slit contributes to the Fraunhofer diffraction pattern.

Now, we're going to look at multi-slit diffraction as a function of line spacing. What we have here are Ronchi rulings, which are pieces of glass with lots of lines drawn on them. This one here has about 100 lines per inch. So we're going to put this Ronchi ruling in here, in our setup. And the setup is the same as before, with this lens here to enlarge the beam so we can illuminate as many of the lines as possible. We've also added this attenuator here so that we can adjust the intensity of the light when we need to.

So now let's look at screen and see what we can see with this Ronchi ruling of 100 lines per inch. As you can see, there are plenty of very narrow dots. And, in fact, if you want to get a feel for this scale, the little circles just below the diffraction pattern are the 5 centimeter markers that we've had before.

Now, if I attenuate the intensity a little bit, you can see that the ones in the center are the brightest, of course. And, also, as I reduce intensity, you can see that the spots are really very small. Now, if I've given you the number of lines per inch, and the spacing between the Ronchi ruling and the screen is, again, 200 centimeters, and the wave length is 6328 angstroms, you should be able to check on the spacing between the fringes and also on their widths.

So here they are when I overexpose them. So we can see the ones way out in the wings. So this is then the diffraction pattern-- the Fraunhofer diffraction pattern-- associated with a Ronchi ruling of 100 lines per inch.

Now, let's look at 200 lines per inch. So here is the 200 lines per inch. And you can see that the spacing now is different. But I leave it to you to check on it. And, again, if I reduce the intensity, and you get at least a little bit of a feel for how narrow these dots are. They're indeed very bright, because they're saturating our camera. So that's for then 200 lines per inch.

Now we go to 300 lines per inch. Again, the spacing is different. And, also, if I change the orientation of the lines, you can see that the diffraction pattern also changes. So that's then for 300 lines per inch.

The next one is 2,000 lines per inch. Now, when I put it over here, you can see that the spacing between the fringes are about 10 centimeters. And, again, that gives you a check on the number of lines per centimeter or per inch, as we have it.

Now, let me see. If we pull back a little bit-- pull back on the camera-- to see the other dots. Yes, here they are. But they're so widely space, that it's difficult to get them all on the camera at once.

So if we go back to the original position. If we go in again. Here we are. And now I'm going to again reduce intensity. You can see how narrow the spots are.

So this then sums up multi-slit diffraction pattern as a function of line spacing. In the next demonstration, we're going to show the opposite effect. Instead of slits, we're going to use thin wires. And then when we come back, we'll show you what the Fraunhofer diffraction pattern for very thin wires looks like.