SHAOUL EZEKIEL: Even though laser light has some beautiful properties, one can easily ruin these properties by mishandling the laser light. One simple way of ruining these properties is by reflecting the laser light back into the laser. That's a no-no for a lot of laser applications.

So in this demonstration, I'm going to illustrate what the problem is, reflecting laser light back into the laser. We're going to look at the effect on the laser spectrum, as well as on laser intensity. So the setup is here.

We have our short laser here, our 22-centimeter laser with internal mirrors. And again, let me remind you of the setup. We have the light from the laser, then being reflected by this mirror and this beam splitter into the scanning [INAUDIBLE] interferometer to show the spectrum. And the spectrum, then, is displayed on the oscilloscope over there. There's the two modes and the little fella on the scope.

Now, we're also going to monitor the laser intensity. Again, the laser light coming in here gets reflected by this mirror, this time passes through this beam splitter, then reflected by the mirror here into a detector. And the output of this detector can be also displayed on the scope.

And then I push the button for the other channel, and there it is. It's a sort of constant output, but let me block the laser beam to show where 0 is. So 0 is about there, and here is the output of the detector.

So if I block the light again, here's the 0 of the detector. And here is the output of the laser. So this way, we can monitor both the spectrum and also the laser intensity.

So let me go back to the spectrum. So here, we have the spectrum displayed on the scope. So now I'm ready to reflect some laser light back into the laser, see what happens.

The way I'm going to do it is as follows-- I have a beam splitter over here to sample the light, the laser light. Say 50% of it actually gets reflected over here. And then, this mirror-- I have a mirror here to reflect the light back into the laser again via this beam splitter.

If I block this, then I have no reflected light into the laser. If I take this card away, then I have light reflected into the laser. So now let's bring in the spectrum on the scope.

So here's the laser spectrum. And you can see we have, let's say, three modes or so. And they're reasonably stable. So now what I'm going to do is take this card away and reflect some light into the laser. And

As you can see, the modes start to jump around, and sometimes others appear, and what have you. And I'm also going to play with this mirror a little bit here to see whether I can even enhance it. So you can see that it makes a mess with the laser modes.

Now again, just to make sure that this effect is coming from reflection, I block it again. And you see it's nice and quiet and the modes are stable. If I take it away, then the frequencies are jumping around. So if you have an experiment that depends a lot on the spectrum of the laser, you can have troubles if there's light reflected back into the cavity.

Let me block it again. And now, I'm going to switch to the laser intensity. So I'm going to go to laser intensity, and let me again check where 0 is.

Let's see 0 again on the scope. Then here is the output of the laser. As you can see, it's nice and quiet.

So now what I'm going to do is then remove this card so that we reflect some light back into the laser. So here we are. We remove the card, and we see that-- I have to pick up the alignment-- we can see that now we see some fluctuations in the laser intensity, up to about maybe 15%, 20% or so of the intensity.

So now, if I block it again, see, it's nice and quiet. And if I unblock it, you can see I get about this 15% or more intensity fluctuations. Again, let me remind you that 0-- again, 0 is over here. So there's the output without reflection, and again, here is the output with reflection.

Now, in order to dramatize this effect even more, I'm going to select only one frequency from the laser by using a polarizer. As we know, this laser puts out at least two modes, and each one is polarized orthogonal to the other. So by placing a polarizer here, I can select only one frequency from the laser.

So let me adjust the polarizer. And here we are. On this scope, we have one frequency.

Now what I'm going to do is take this card away to reflect some light back into the laser. So here we are. Light is reflected, and you can see that the frequency starts to jump around, and also, I get another frequency also appearing. We can see there's violent jumping around of this frequency. Now, let me block it again, and show you that it's nice and quiet, and then take it away. And you can see that it can jump around.

Now, let's look at the intensity when the laser is operating a single frequency. So what I'll do now is go to the detector, and increase my intensity a little bit, because the polarizer attenuates. Let me check 0, so we can see 0 is about here.

Let me increase intensity some more, and check 0 again. And let me set 0 to where we had it when we had it before over here, so we can have a direct comparison. Now, let's look at the intensity again.

So here we are, about two big divisions. This is when there's no reflection back into the laser. Now, let me take the card away, and pick up the reflection.

You can see now that we get about 30% or 40% fluctuation, sometimes even more when the laser is a single frequency. Here we are. Look. Look how noisy the laser output is when there is reflection back into the laser. Here we are. Look at that. Looks pretty awful. And if I block it, nice and quiet. Take it away, let the reflection go in, and you can get all kinds of fluctuations in the laser intensity.

So then, in summary, one of the no-no's, then, with lasers is reflecting its laser light back into the laser. Now, some experiments you can get away without reflecting the laser light back into the laser, but in some other experiments, you have to reflect light back into the laser because of the alignment of components. In that case, you would have to use an isolater. Otherwise, you've got frequency fluctuations as well as intensity fluctuations.

The thing that I have not told you is why. When you reflect laser light back into the laser, why does it have such dramatic effect on the laser frequency as well as on the intensity? So again, just like before, I'm going to leave you with this puzzle now, to figure this one out for yourself.