Optical Spectroscopy and Microscopy
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Lecture – 56
Fundamentals of Optical Measurements and Instrumentation

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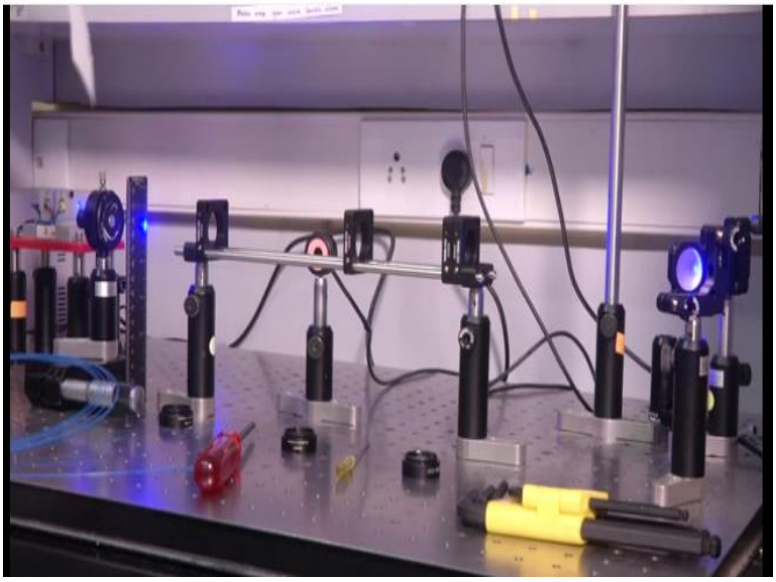

So, in the last lecture we were talking about aligning the optical setup and I told you about the optical axis how the lenses actually define this optical axis, so let us say and now let us see how if you had to start with right, start from the parts where will be starting right with nobody is going to have set it up for you and I remove these lenses here and kept it down, so the light you have to start from the first place of the mirror.

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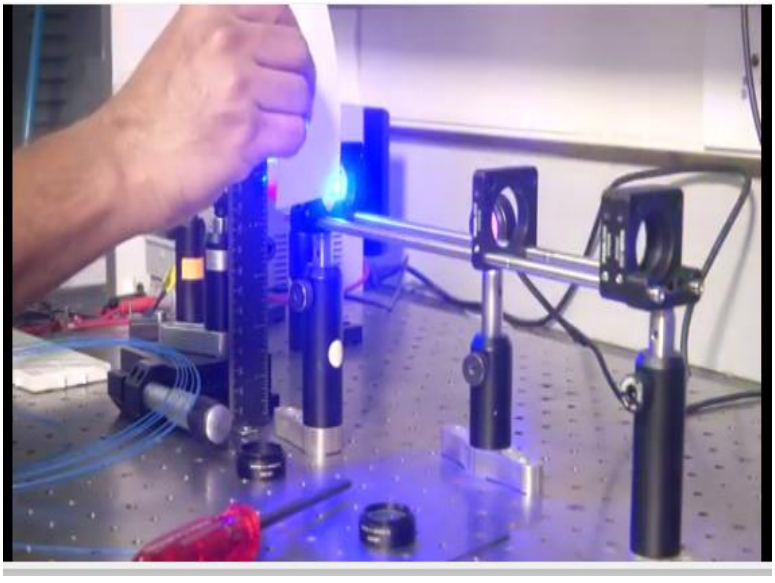

So, the light is coming out from here, you can actually see that light, right and the light beam travels through here and hits this mirror and this, now we want that light beam that is coming through here to go through the centres of this holders okay. So, the point is okay why do not we actually just; now, let us think about a very simple thing here which is 1 axis right, let us look at the vertical axis alignment with the same thing can be applied in the horizontal axis too. So, now let us look at the vertical axis and you say that okay, I need to; the beam to be at the centre here and at the centre here okay.

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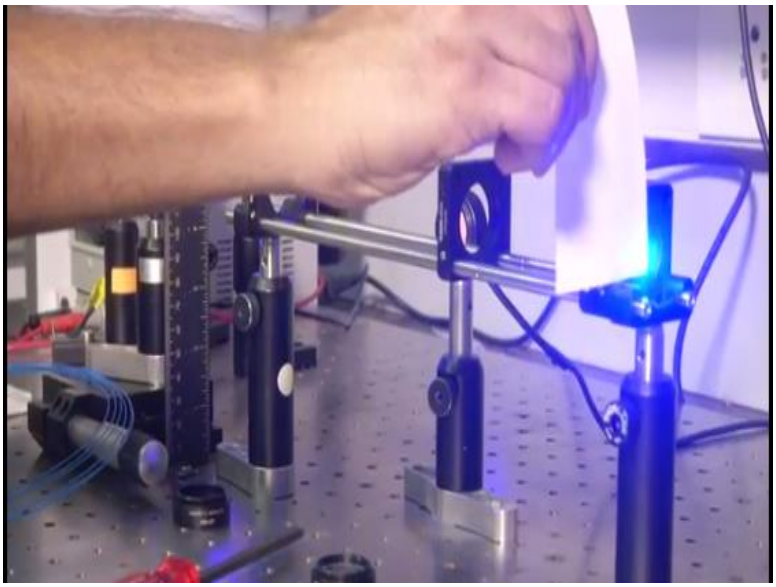

So, let us if you see this, so I am going to intentionally miss align it, so now if you see here, it is low down here and not that much in here, right because what you have done is that we have angled it this way, now okay it is a, when you put this mirror when you can get the laser out and I have to place the mirror, so then what do I do, first I do is first block the laser, laser beam place it in a get it as close as to the mirror as possible.

And clearly leave, as you are leaving the beam you have to; you should be able to capture the beam, the reflected beam right that is the goal here right, so usually we would be doing it from the other side just for the this purpose we are doing it now here but you can actually; the principle is exactly the same, the way you want to do that is that as you are removing the beam, so this is the main incoming beam as I am actually removing it, I am actually blocking the right beam.

So, the light is travelling from this light source all the way till here, now how do we place this and orient this mirror here; so normally, we would do it from the other side but now assume that you have fixed it at the place and so then you want to rotate and orient it.

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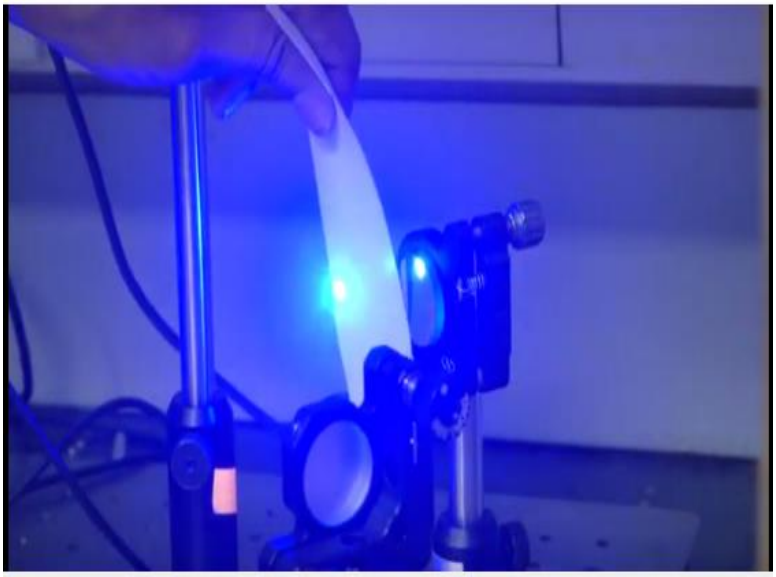

So, what you want to look at is that you want to trace this light, incoming light, block it and not let it because you do not know where the mirror is going to reflect and go as close as possible and start to release this beam, wherein you start to as the incoming beam is coming your card should be wide enough to capture the reflection, can you see the reflection here; so we have the incoming beam here and then the reflection here right.

So, this can happen when you are pretty close okay, it can happen when you are wider, right because either you would be capturing the reflection (()) (04:11), so that is why you want to go closer and that is safer because you know now where the mirror is reflecting the beam.

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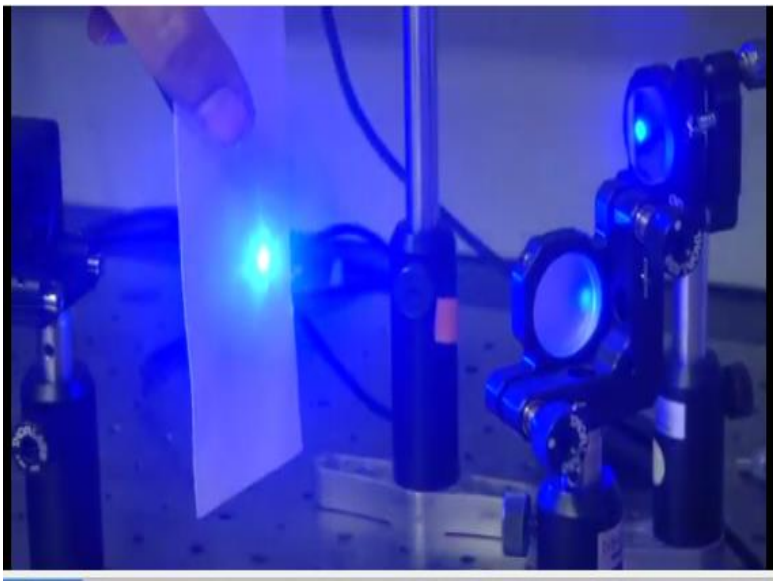

Now at that point as long as you are not there or your friends are not there, then you can actually start to place this mirror and once you place that again, the same argument and you take the beam path now, you know it is going in this direction, so we know we are safely in the direction but now what do with that.

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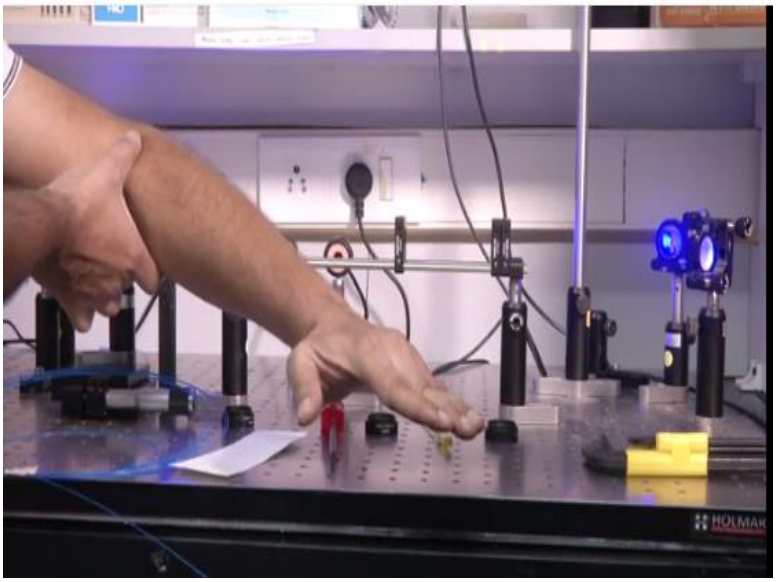

So, first thing you see is that the beam in here is hitting a little bit more on the top edge, then this, so we can actually go ahead and measure where it is actually hitting and if you actually look at it, it is around 5 right, the reading would be around 5 right and here it is a well below 5, it is a 4 and 1/2 or so, so clearly the beam is compared to that is traveling at this direction. So, now and we also know this point where my elbow is right located is also not at the centre of the lens.

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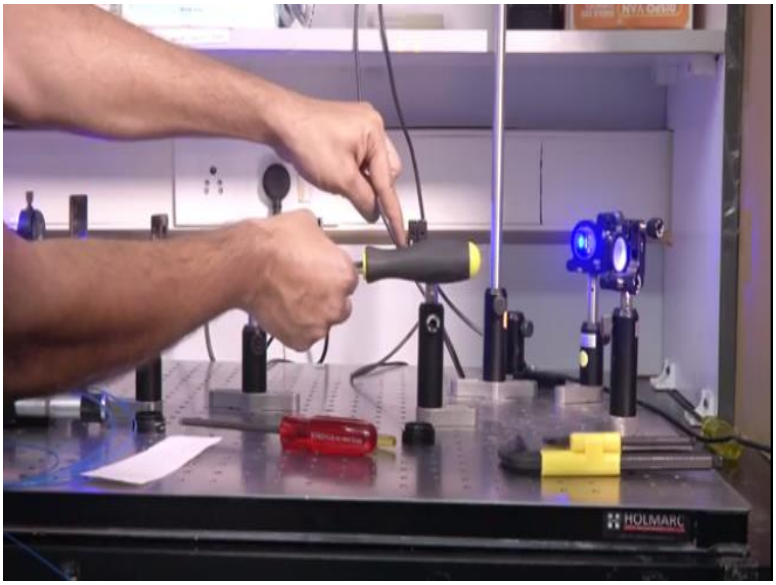

So, if you think of this representing the light beam, with this representing the light beam, so it is not just this, it is actually traveling like that, so that is because if you extend it all the way, it is coming from the mirror something like that, I am clearly exaggerating but that is just to give you the geometrical picture of how things are. So, now since it is like travelling like this, what we need to do is; first we bring it down, so that it is hitting at the right place on this mirror.

Then, so it will be meeting like something like that then you rotate it, so now bringing it down we call it as intercept in the course and then rotating it back as the slope, so clearly this is not a one-time process, we have to do it iteratively because when you bring it down and then bring it back up, you see that the physical placement of this beam actually moves right, so the way we do that is through iterative means.

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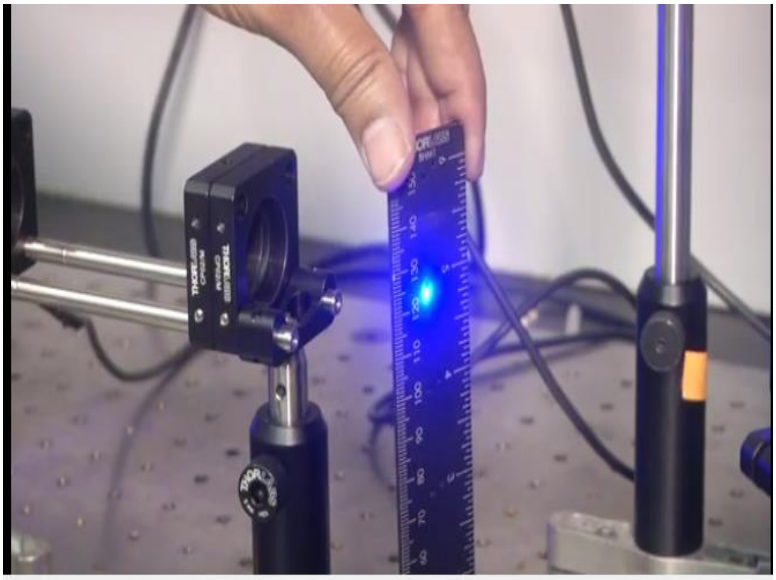

And so what I am going to do is here start with this process here, so let us go ahead and can you see it, measured the; then to bring it up okay, what I am going to do is so, we need to know how much we have to bring it up right, so let us go ahead and measure where this centre is, so that centre is pretty much close to 5 okay, so if you look at it, here little down here.

So, I am going to bring it up, so bringing this up here is actually an intercept again, what you want to do is you want to actually do it straight here, ideally what you would do is an aperture, you put in an aperture but then here for better visualization purposes, we are actually doing this but the idea remains the same, so to get that is an movement on this mirror so that is equivalent of our intercept right, intercept being moved here, now that is close to 5.

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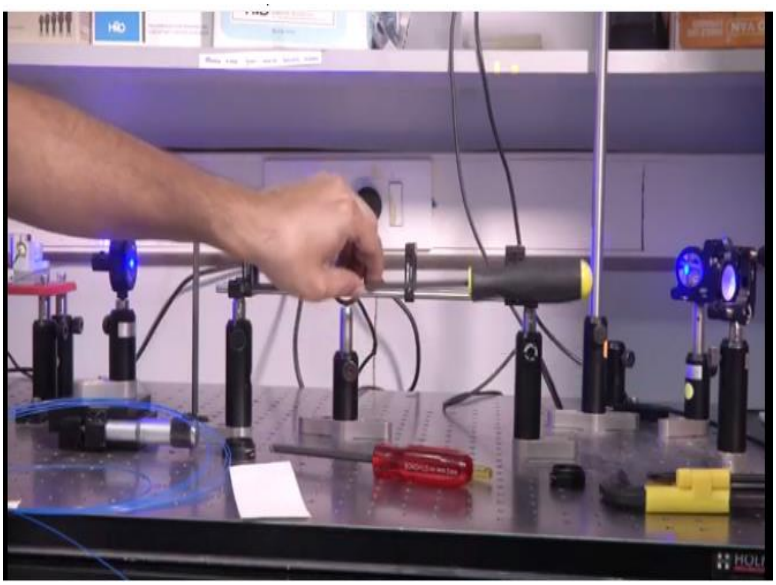

And that moves the beam on where this I mean, where the beam is hitting on this mirror, now if you look here, so it is a slightly more than 5, so what are you going to do is; see that is what you would have expected right, so because the beam was going in like this now and then hitting it lower, so we brought it up, okay and so what you have done is that you are reaching it below where you want to actually reach it.

Now it is and I am adjusting this, so I go slightly above 5, since it is an iterative process and now, so then once you go there and then at this point actually, you are pretty good, so you have to do it few times and when you do it few times, then you can once you see that you are pretty close to the same place both at a distant place and near place to the last mirror, you know that your straight line is met, right.

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Because the straight line is going like this right, so we did that for the vertical axis and a good test of that is when you actually put in a lens in its path right, please note where the beam is hitting, when you put the lens in its path you should see minimal movement of its position, actually you should not see any movement of its position and that is exactly what you see. So with and without lens you see that the beam nicely makes it through the apertures that we have put in.

So and of course, I mean since it is already pre-made, it got done quickly but also video we cannot I mean, it is a lecture that we cannot keep shooting how many times we keep iterating, so but the rough idea I hope that you would have gotten of how we actually go about doing

that, that is only in one axis okay, you have to do it in the other axis too, when you once you do that and what you have is this nicely aligned beam.

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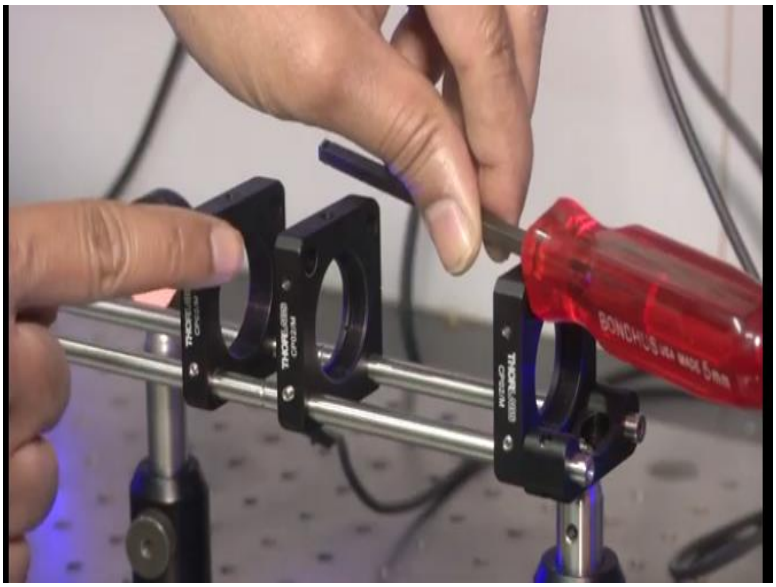

So, now what we are doing; going to do is that align the telescope right, telescope alignment requires that the beam is travelling straight as well as the distance between the lenses alright, are f1 + f2; the sum of the 2 focal lengths okay. So to do that, the cage assembly is really; really helpful even the rails are very helpful why; because as we can see this is called as a cage assembly because this is slightly different from the post, post holder assembly thing.

It is actually what we are doing is; we are using the post, post holder to hold the cage assembly, what do you mean by cage assembly; you have these rods right, there is rods govern the way in which or the relative positions in which the these plates are put, these are called cage plates and now, the benefit of this is that it ensures that all of them, the centres are all aligned, they are all concentric, right.

And now when you have that then this is a very useful thing to have because if you want to adjust the focal length and while you are moving it back and forth something like what I will be doing here, you do not want the beam to be travel to hitting at the lens at the different place. Imagine the length; the beam at to be coming at an angle like that right, so depending on whether you are meeting the lens here or placing the lens here either the beam will be hitting at the centre or away from the centre.

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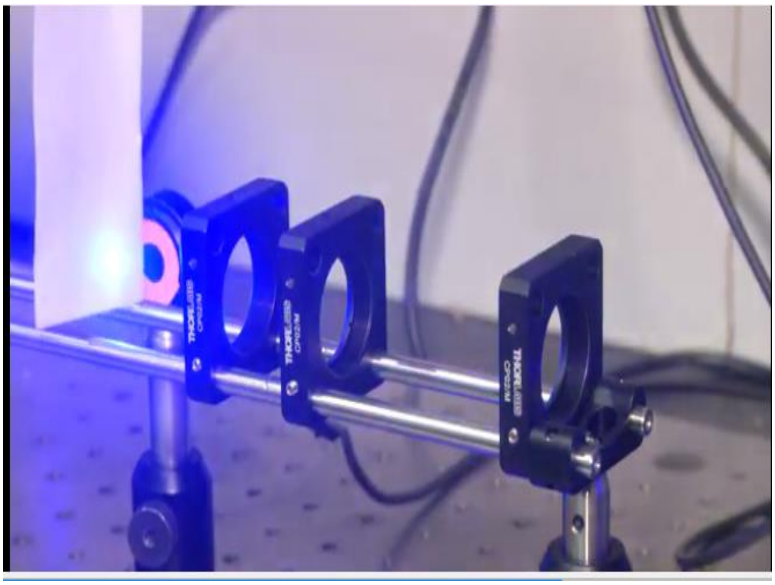

So, we do not want that now that has been ensured by us making sure that the light actually goes through this centre of this cage assembly and we checked it by putting in the lens and making sure it is going through and going through without changing its path.

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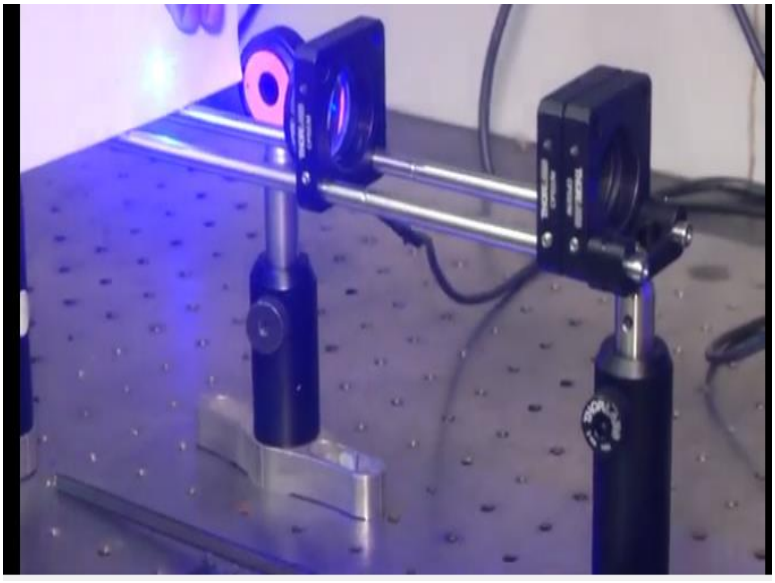

Then what we do is that we put in the lenses okay, so again the way you do that is you block it now, when you do this you will see that the; first thing you will see is that it is an incoming beam is collimated beam, so you see that is where the focus is alright. So, the focal length of this lenses 50mm okay, so now you can see that this is roughly at this place right, it is hitting at this place.

And from here to here, there are 2 holes at 50mm and that is where you see the focus, the light coming into focus and it is diverging right and again it is a nicely centred onto that the beam that we have put in and the aperture that we have put in.

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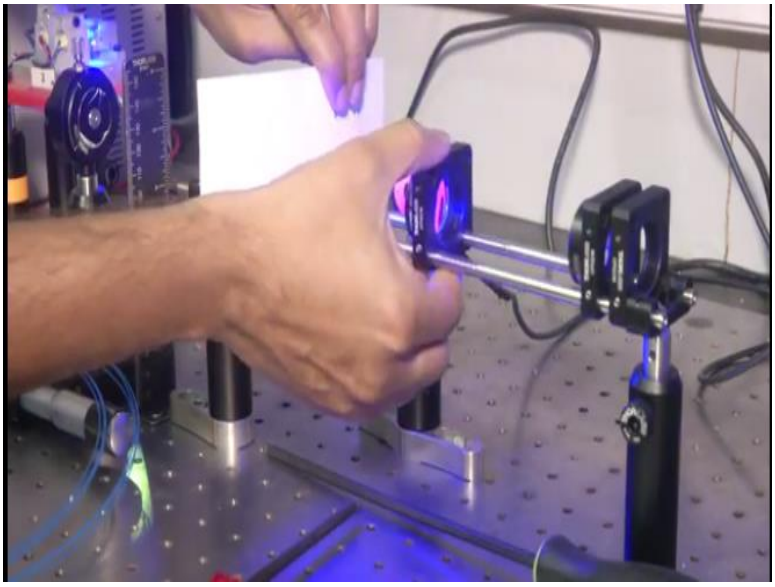

Now, we can actually place the second lens alright, same way and this second lens; this lens is about 35 mm, so as I was telling you in the previous lecture we are putting in this telescope assembly just to ensure not so much of magnification many times you would do it, when we go to infrared beam and ultra-fast laser in setup, we will see that you have to expand the beam.

But here we are actually making sure it is collimated and for this collimation, what we are doing is we are using a 35mm lens now, this 35mm lens actually if you see it is going to focus shorter at this distance and then it expands and at this point you actually see that you need to be able to; if you go here, it is a very fastly diverging beam, you want to see and at this point, you see it is again still diverging and you keep going until a point where right now we reach the physical limit of that space.

So, we are going to; I am going to tighten this in place and what I am going to demonstrate to you is that at some, there will be a point at which you start to see its start converging alright, so when we start moving, you can actually see it is changing its behaviour, so that behaviour is true at a point, sum of these 2 being 85, right. So, you would see it is about slightly more than 3 holes, so that is the first hole, 25, 50, 75.

And if you see here that is where it is somewhere in between, so you could lock them down so that would complete our alignment of the incoming beam and adjusting the size such that light is a collimated beam that comes through this lens and then focuses down onto the fiber. So, this is a very simple thing where you want to couple it to the fiber end but many times what happens is that you are not coupling it to a fiber end.

But you are focusing into your sample and trying to get, so often what happens is that instead of this fiber end what we will be putting in is sample and we will be measuring the emission or scattering or something associated to that and in fact one of the usefulness of this card is that when you are wearing the goggles, then you do not see the incoming laser light but you can see the fluorescence originating from here.

So, since I am going to talk to you about the emission path now, what I am going to do is; I am going to turn off this laser and here what we going to do is that we are going to place a fluorescein solution okay, we are going to place the fluorescence solution then I am going to show you the fluorescence elicited by the blue light focusing through this lens and we are going to build small spectrometer okay in this path and to tell you that you can actually, see this emission and how the spectrometer works okay, so that we will see right down.