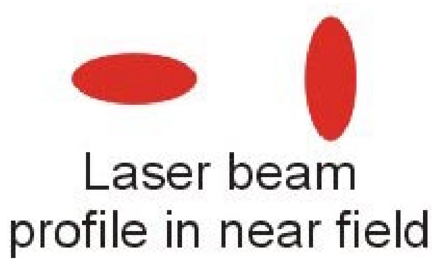
Using a PBS Cube

A PBS cube is a Polarising Beam Splitting cube, which is made up of a pair of prisms contacted together to form a cube. In its intended form the cube will take a single randomly polarised laser beam and split it into two separate beams with opposite polarisation. One neat side effect of this is that we can use the idea in reverse to join two oppositely polarised beams together into a single beam. This is common industry practice these days and may commercial laser modules use this principal.

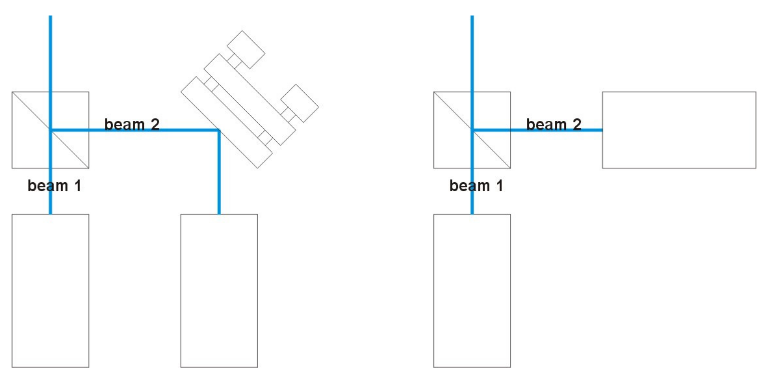
This is no place to go into a deep explanation of the physics of polarised light and anyway to be able to use the properties of this phenomena we don't need to know how it works we just need to know it does work. After all you don't have to have an understanding of how a car engine works to be able to drive the car.

All you need to know is that the beams must be polarised and with laser diodes we can assume this is the case. We need to mount the lasers in such a way that they enter the PBS cube in a certain way and can then be combined accurately to make a single higher-powered beam. A laser beam from a laser diode is elliptical – unless it has beam corrective optics in the diode itself, which is quite rare. So we will assume that the beam you are using is elliptical. See image below



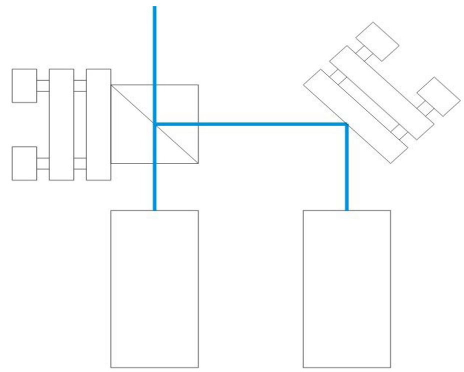
As can be seen in the image we want the beams to be placed 90 degrees to each other so that the cube will work properly. If the laser is in a round housing we don't really need to worry about this now as the housing can be rotated later to get the best output. If it is not possible to rotate the housing due to a fixed mount or it being square for example then the diode must be fitted in the housing so that when its all assembled the beams look like the image in relation to each other. You will need to find out how each laser is placed with respect to the cube and to do this take one laser and aim the beam through the cube. If the laser can be rotated then by rotating it you will see that sometimes the beam passes right through the cube and other times it turns 90 degrees inside the cube. You will see this happens every 90 degrees of the rotation of the laser. Make a note of the orientation of the beam (as in the image above) as it passes right through the cube. The beam that is this way round we will call beam 1, the other beam needs to be set at 90 degrees to beam 1 and we will call this beam 2.

Now we need to set the whole lot up, 2 lasers PBS and mount – there are 2 ways this can be done (see image below)



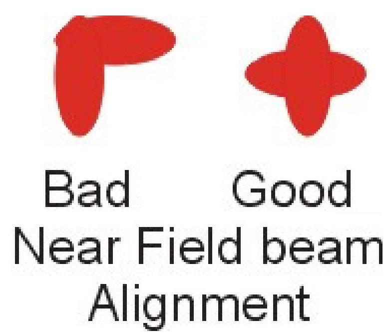
The only difference in the 2 set-ups is that the right hand image shows beam 2 coming from a fixed laser diode module. This is fine if you have enough accuracy and can be certain that the beams will cross where the cube is shown at exactly the same heights. The left hand image shows a set-up with beam 2 reflecting off a mirror on an

adjustable mount. This then allows for some inaccuracy of the diode mount and gives us some means of adjusting the near field alignment. Without this (as in the right image) the near field alignment will have to be done by means of positioning of the PBS cube.
With the lasers mounted but the cube not fitted, the beams must be positioned so that they cross each other. When the cube is put in place the internal diagonal face inside the cube must also cross the beams at the same point (As shown in the previous diagram). If the beams and the diagonal internal face of the cube do not all match up then you will need to position the cube so that they do. You can now mount your cube which should be done using an adjustable mount, without adjustment you wont be able to match the exiting beams and you will not achieve your goal of a single output beam. Place the mount so that the flat face where the cube will be mounted is parallel to beam 1 as seen on the image here. Ideally the face should be half the cube width away from the beam so that the beams and the internal diagonal face, all converge in the centre of the cube. This is not critical but if you aim to get it as close as possible that would be preferred. So to place the cube you need to position it along the axis of beam 1 (up and down in the image right) so that the 2 beams and the internal diagonal face all converge in the centre of the cube. To fix the cube you can use a very tiny amount of superglue (a pin head drop size) but remember super glue can cause a bloom that damages optics so a small amount is better. We use superglue as it allows an instant hold of the cube into position. Once set you can build up the mechanical strength of the fixing by application of epoxy resin above and below the cube on the dull faces. One thing to be very careful of when mounting the cube is that you keep it straight. If it droops from front to back (front being where the beam exits and back being where beam 1 enters) then beam 2 will be reflected off at an undesirable angle and may be too far out to correct by adjustment – so keep this in mind when you are fixing the cube to the mount.



If your lasers can be rotated as soon as the cube is in place you need to rotate each one in turn (with the other off or blanked out) so that the maximum beam power for each exits the front of the cube. This is the ensuring that they are polarised correctly for their path through the cube and you will achieve minimal losses.
Once you have done all this you can set about aligning fully. Firstly near field alignment should be carried out. As stated previously this will be more easily achieved if you have done a good job in positioning the beams and the internal diagonal face to converge at the same point.

At the beam exit the beams should form a cross type pattern as shown in the right of the image. To see this it is best to reduce the laser power and place a piece of white paper very close to the cube where the combined beams exit. If you see a cross shape that is even then your near field looks good. If the output looks more like the image in the left of the picture then more work is needed on the near field. To adjust this use the adjustable mount that directs beam 2 toward the cube. If you don't have this adjustment then you will need to reposition the laser diode or the cube to get good near field alignment.



Note the elliptical shape is shown here exaggerated for clarity.

Once the near field is good you can adjust the far field alignment using the adjustable mount that the cube is mounted to. Pick a suitably far point where you can still see the beam spots and bring them together. Once you have done this its always a good idea to recheck your near field alignment as this may be lost slightly as you move the cube. The less you have to move the cube for far field then the less likely it will be that the near field has been lost. You may need to repeat each procedure a couple of times to home in on the best alignment, you should find that each time the adjustments needed will get smaller and smaller. The more accurate your set-up is in the first place then the less need there will be for large adjustments so take time to build the whole dual set-up accurately and it will pay off when it comes to adjustment.
Finally run the beam through a set of scanners and draw a simple shape such as a circle and note if there is any double tracking or separation of the beams. If so then a small adjustment of the far field alignment should suffice.

<u>Using DPSS lasers and a PBS.</u>
All of the principles applied above will work with dpss lasers, however the lasers are likely to be polarised in an identical way so that mounting them both normally on their mounts would not work. What you can do is mount one laser at right angles to the other or use a ¼ waveplate to change the polarisation of one beam. Some manufacturers such as Laser-wave will build a pair of dpss lasers for you with opposite polarity from the factory so that the modules can be mounted flat side by side and the beams will combine using a PBS with minimum of fuss.