

Beam Expanders and Microscope Objectives

Beam expanders are available for 4.5mm spacing CS mount 12.5mm spacing cameras. The 4x beam expander is an expanding telescope that images the beam as it looks at 8mm from the end of the expander onto the CCD while enlarging the image 4x. In addition to the 4x beam expander, other microscope objectives are available for expanding the beam even more. There are objectives for 6x, 12x and 22x expansion. The various expanders allow the use of our 2% and 10% filters as well as the variable attenuator so as to accommodate the camera to a wide range of source intensities.

With a camera having 4.4µm pixel spacing using the beam expander, the effective resolution can be as good as 0.5µm.

The object plane that is imaged onto the CCD is located several mm in front of the assembly so even hard to get to focal spots and other small images are easy to image. The beam expanders are designed to accommodate up to 3 screw on filters or a variable attenuator behind them so a wide range of intensities can be accommodated.

For intensities too large to be accommodated by just filters, beam splitters are available to reduce the intensity before the beam expander. The beam expander is primarily intended for nonparallel beams such as focal spots and fiber tips. If small parallel beams are imaged, interference effects may occur.

The 4x Beam expander can also be fitted with a UV converter plate at its object plane so that you can look at small beams in the spectral range 193-360nm and expand them 4x. See ordering information for further details.



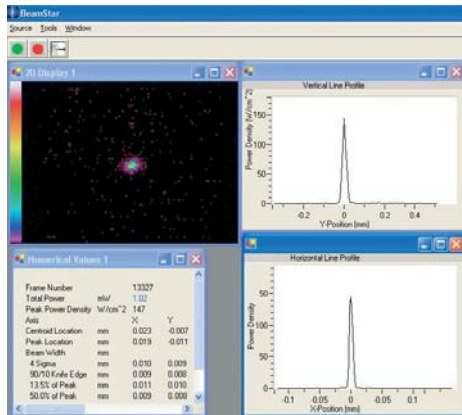
Camera with 4X Beam Expander



Microscope objective assembly with beam splitter mounted



UV converter assembly for 4X Beam Expander



Shown is an image of the tip of a single mode fiber of 9µm diameter. The beam width as measured on the profiles shows 4X the actual size so we see a resolution of ~2µm.

| Approximate expansion ratio | Spectral range | Distance from lens barrel to focus | Distance from focus to 1 st beam splitter | Distance of closest approach to focus with 1 beam splitter | Total length of assembly |
|-----------------------------|----------------|------------------------------------|--|--|--------------------------|
| 4X | 400 – 1800nm | 8mm | 18mm | 32mm | 50mm |
| 6X | 600 – 1064nm | 16mm | 10mm past 1 st surface | 4.5mm | 107mm |
| 12X | 600 – 1064nm | 6mm | 6mm | 20mm | 101mm |
| 22X | 600 – 1064nm | 2.4mm | 8mm | 22mm | 102mm |

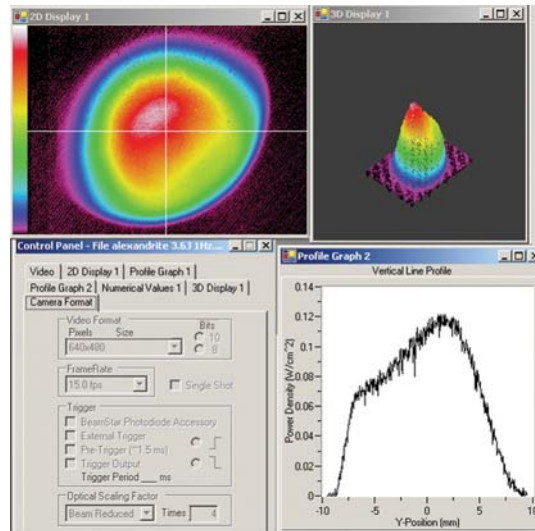
Beam Reducers

4X Reimaging Beam Reducer

The 4X Beam Reducer is an imaging system that images the plane 30cm in front of the reducer onto the camera CCD sensor while reducing the size 4 times and inverting it. The beam reducer uses the 3 screw on attenuators provided with the camera. Since the intensity of a beam after reduction will be increased by $4 \times 4 = 16$ times, it is advisable to attenuate the beam more than you would without beam reduction. This can be done with additional external beam splitters and attenuators which are available (see ordering information).

Note that the custom designed beam reducer gives better image quality than tapered fibers since it does not introduce graininess or uneven pixel response. Also the image distortion of $\sim 1\%$ is considerably lower than with most tapered fibers. The beam reducer is not compatible with CS mount cameras.

Shown is an image of an Alexandrite laser with beam diameter of 18mm. As can be seen, it is easily seen with the FX50 camera with the 4X beam reducer.



LBS-100 combined with 4X beam reducer



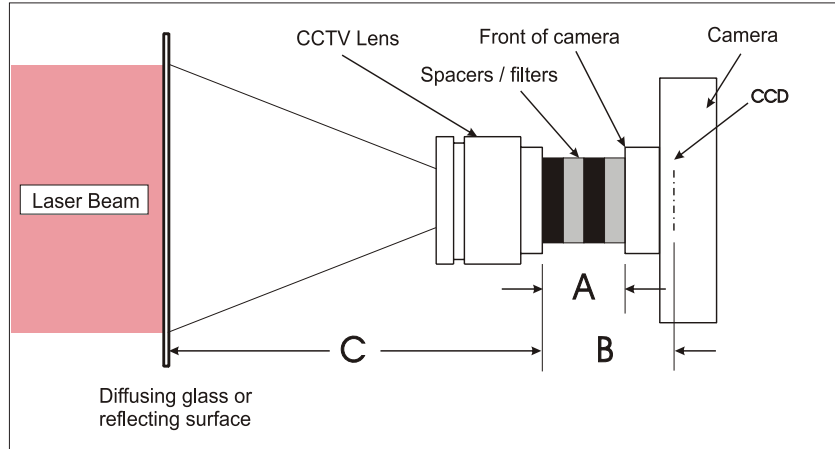
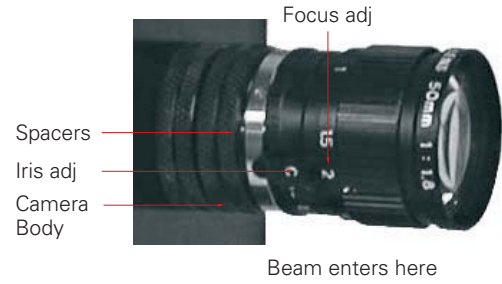
4X beam reducer

The 4X beam reducer can be combined with the LBS beam splitter/attenuator system described above to attenuate higher power beams before reducing them in size

| Specifications of 4X beam reducer | |
|-----------------------------------|---|
| Spectral Range | 390nm to 1100nm |
| Antireflection Coating | Antireflection coating optimized for 1064nm and 532nm |
| Beam reduction Accuracy | $\pm 3\%$ |
| Size | $\varnothing 60$ mm dia x 94mm length |
| Aperture | 50mm |
| Maximum Beam Size | SP 503/FX50: 25x19mm, FX 33: 18x14mm, SP 620 Scor 20: 28x21.2mm |
| Distortion of Beam | Less than 1% over 80% of diameter |
| Damage Threshold | 30mJ per pulse for nanosecond pulses |

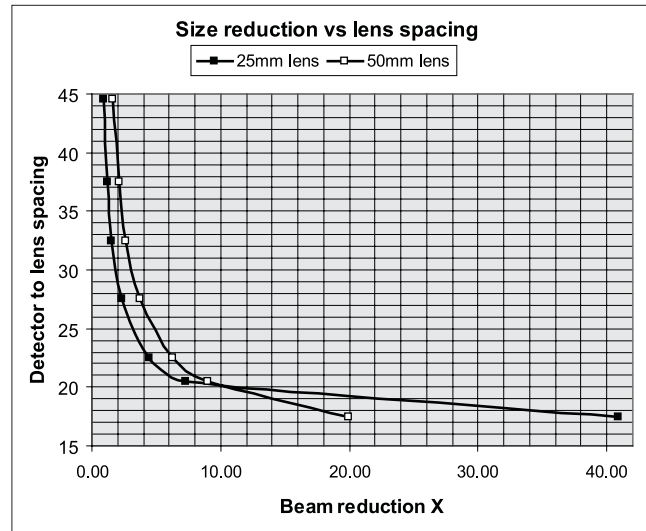
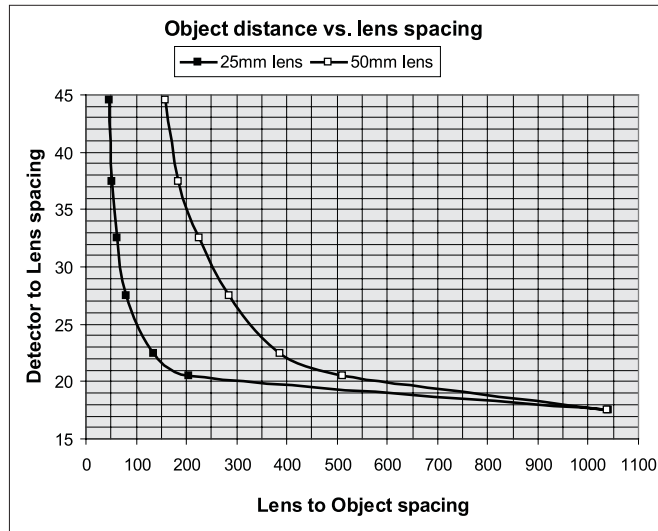
CCTV lens for front imaging through glass or reflected surface

When direct imaging in front of the camera, like imaging a Macken Plate, or an image projected onto a defusing surface, like a ground glass plate, it is necessary to reduce the image so that it completely fits onto the CCD chip surface. The 25mm and 50mm CCTV lenses image an object from a given plane in front of the lens onto the CCD while reducing the size. The lens can image such objects at distances from about 10cm in front of the lens (20 cm for the 50mm lens) to 1 meter or more depending on the distance from the lens to the camera. The distance from lens to camera depends on the camera type and spacers placed between the lens and the camera.



A – Total length of spacers added to system
 B – Detector to Lens spacing. Distance 'A' plus the CCD inset for the camera type
 C – Lens to Object spacing

CCD inset for Camera Types
 C mount (Camera front to CCD = 17.5mm) for nominal lens magnification, use without spacers.
 CS mount (Camera front to CCD = 12.5mm) for nominal lens magnification, use 5mm spacer.
 SP mount (Spiricon-Ophir cameras. Camera front to CCD = 4.5mm) for nominal lens magnification, use with 13mm spacers.



| ITEM | DESCRIPTION |
|--------------------------------------|---|
| 25mm focal length CCTV lens kit | 25mm focal length lens assembly with locking iris and focus adjustment. Includes 1 ea - 8mm spacer and 2 ea - 5mm spacers |
| 50mm focal length CCTV lens kit | Same as above except 50mm focal length lens |
| 4mm spacer | Screw on spacer to add 4mm spacing to optical system |
| 5mm spacer | Screw on spacer to add 5mm spacing to optical system |
| 8mm spacer | Screw on spacer to add 8mm spacing to optical system |
| ND1 stackable filter (red housing) | Screw on 4mm spacer with ND1 glass filter transmission of between 20% and 5% depending on spectral range |
| ND2 stackable filter (black housing) | Screw on 4mm spacer with ND2 glass filter transmission of between 7% and 0.5% depending on spectral range |
| ND3 stackable filter (green housing) | Screw on 4mm spacer with ND3 glass filter transmission of between 1% and 0.05% depending on spectral range |

| Imaging Systems | | |
|--|---|----------|
| Beam Expanders | | |
| 4X reimaging beam expander | Screw optical assembly that images the plane 8 mm in front of the expander onto the CCD while enlarging it 4X. Fits 4.5mm recess and CS mount cameras. | SPZ17022 |
| Fiber adapter bracket for 4X beam expander | Screw on bracket to use with Ophir fiber adapters so fiber is held in correct position to image fiber tip onto camera. Will give exact focus with FC type fiber. | SPG01649 |
| UV converter assembly for 4X beam expander | Screw on assembly which has UV plate that converts 193 - 360nm radiation to visible. This plate is at the object plane of the 4X expander so it produces a 4X enlarged image on the CCD | SPZ17019 |
| 6X expanding microscope objective | Screw optical assembly that images the plane 16mm in front of the lens onto the CCD while enlarging it ~6X. Fits 4.5mm recess and CS mount cameras. Needs spacer assy below. | SPZ08257 |
| 12X expanding microscope objective | Screw optical assembly that images the plane 6mm in front of the lens onto the CCD while enlarging it ~12X. Fits 4.5mm recess and CS mount cameras. Needs spacer assy below. | SPZ08259 |
| 22X expanding microscope objective | Screw optical assembly that images the plane 2.6mm in front of the lens onto the CCD while enlarging it ~22X. Fits 4.5mm recess and CS mount cameras. Needs spacer assy below. | SPZ08260 |
| Spacer assy for objectives | Spacer assembly for above. One only needed for all expanders above | SPZ08261 |
| Beam splitter for expanders above | 45 degree angle wedge beam splitter which mounts onto beam expander. Reduces beam intensity by ~20 times. For spectral range 190 – 2500nm. Introduces 35mm extra beam path to object plane. | SPZ17027 |
| Additional beam splitter for above | Additional beam splitter to mount to 1st beam splitter | SPZ17026 |

| Beam Reducers | | |
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| 4X reimaging beam reducer | Screw on beam reducer for beams in the wavelength region 360 – 1100nm that reimages the beam 30cm in front of the unit onto the CCD while reducing the beam size 4X. Entrance aperture is 50mm. Fits 4.5mm recess cameras only | SPZ17017 |
| Stand alone beam splitter for above | Large size Wedge beam splitter which mounts to standard ¼" thread ½" laboratory rod. Reduces beam intensity by ~20 times. For spectral range 190 – 2500nm. For mounting in front of 4X beam reducer. | SPZ17018 |
| Filter holder and 50x50 filter set for 4X beam reducer | Filter holder with set of 4 standard Schott 50X50mm neutral density filters. Useful to further reduce intensity after beam splitter before inputting into 4X beam reducer. Mounts to standard ¼" thread, ½" diameter laboratory rod. | SPZ08240 |
| LBS-100 to 4X beam reducer adapter | This adapter enables mounting of the LBS-100 beam splitter / attenuator assembly in front of the 4X beam reducer. The combined assembly can image large high power beams in one unit. See illustration on page 149. | SPZ17029 |
| YAG Focal Spot Analyzer accessory (1 set for system) | Screw on accessory to beam splitter system which allows user to look at focal spots of YAG lasers of up to 400W average power. The set consists of an AR coated for 1064nm and a dielectric full reflector for 1064nm 45deg incidence and well as mounting hardware. It needs one of the lenses below as well as 2 -3 stackable beam splitters above. | SPZ17021 |
| -100mm FL lens assembly | -100mm negative lens mounted in lens holder for mounting to YAG FSA assy. | SPZ08248 |
| -125mm FL lens assembly | -125mm negative lens mounted in lens holder for mounting to YAG FSA assy. | SPZ08249 |
| -150mm FL lens assembly | -150mm negative lens mounted in lens holder for mounting to YAG FSA assy. | SPZ08250 |
| -200mm FL lens assembly | -200mm negative lens mounted in lens holder for mounting to YAG FSA assy. | SPZ08251 |
| -50mm FL lens assembly | -50mm negative lens mounted in lens holder for mounting to YAG FSA assy. | SPZ08254 |
| FL-50-CCTV LENS | 50mm focal length lens assembly with built in iris and focus adjustment. Used to view reflected large beams or beams projected thru a translucent plate. Comes with various spacers. For imaging distances between 15cm and 1 meter in front of the lens with beam reductions from 2.3 to 20 times. | SP90038 |
| FL-25-CCTV LENS | As above except lens focal length is 25mm | SP90085 |

| UV converters | | |
|--|---|----------|
| 1X UV image converter | Screw on imaging telescope that converts UV image to visible and images same size on CCD. For beam intensities from 50µJ/cm ² to 15mJ/cm ² . Fits 4.5mm recess and CS mount cameras | SPZ17023 |
| Beam splitter for above | 45 degree wedged beam splitter to reduce intensities on image converter by ~20X. For beam intensities of up to 300mJ/cm ² at 193nm | SPZ17015 |
| 4X reducing UV image converter | Screw on imaging telescope that converts UV image to visible reduces the size 4X and images on CCD. For beam intensities from 1µJ/cm ² to 15mJ/cm ² . Fits 4.5mm recess cameras only. | SPZ17024 |
| UV converter assembly for 4X beam expander | Screw on assembly which has UV plate to convert 193 – 360nm radiation to visible. The plate is at the object plane of the 4X expander (P/N SPZ17022) and produces a 4X enlarged image on the CCD | SPZ17019 |
| Beam splitter for above | 45 degree wedged beam splitter to reduce intensities on by ~20X. For beam intensities of up to 300mJ/cm ² at 193nm. | SPZ17007 |
| 20mm diameter UV imaging plate | Ø20mm diameter UV image conversion plate only. For customers that have own imaging system. Converts UV image to visible. For beam intensities 50µJ/cm ² to 10mJ/cm ² | SPF01177 |