SLIT LAMP IMAGING GUIDE
Superior technology – reliable instruments
On August 3rd, 1911, Alvar Gullstrand introduced the first rudimentary model of the slit lamp illuminator.

An occasion of tremendous significance to ophthalmology had just taken place. Gullstrand described a device with the potential to advance the understanding of the eye and its problems as profoundly as did the direct ophthalmoscope 50 years earlier. By 1916, Henker had developed a practical combination of Gullstrand’s illuminator and Czapski’s corneal microscope, marking the first major advance in methods of examining the external eye in more than a century. In 1936 Comberg established the co-pivotal and iso-centric relationship between the microscope and slit illuminator and, in 1938, Goldmann’s collaboration with Haag-Streit produced the first par-focal instrument which also featured the single control lever design in use to this day. Goldmann also influenced the shift to Köhler illumination, greatly improving the efficiency of the slit lamp illuminator, the very heart of this marvellous device.

These significant milestones, with contributions from a host of other individuals, have coalesced into the highly sophisticated instruments that are placed at our disposal today. In light of such capabilities in instrumentation, it follows that our results in slit lamp examination and slit lamp photography will rest on the level of sophistication we apply to the practice of these challenging and stimulating art forms.

Csaba L. Mártonyi, COPRA, CRA / Emeritus Associate Professor / University of Michigan, Ann Arbor
Haag-Streit Imaging Guide

This guide is intended to assist all those who seek to capture images of the eye, using the slit lamp, to improve the quality of their photography by using simple to follow illumination diagrams and high quality image examples. We hope this book provides inspiration and motivation to anyone who is involved in the art of documenting the unique properties and pathologies of the eye and through Haag-Streit we offer a number of instruments to help you.

Haag-Streit greatly appreciates and thanks all those who have contributed to this publication.
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Physical and optical conditions

The binocular examination of the eyes with the slit lamp takes place in a three-dimensional space with great depth of field. Normal slit lamp imaging is a two-dimensional documentation with a very small depth of field. The difference between the dynamic, stereoscopic clinical examination and the static two-dimensional image can be surprising and often disappointing. The use of this guide will tackle this issue and help users create high quality images.

Haag-Streit has developed specific imaging eyepieces with a cross hair which are available for all Haag-Streit imaging systems.

The accommodative abilities of the photographer’s own eye are normally not noticeable during examination. However it is important that the photographer establishes the correct eyepiece setting to compensate for any accommodation or refractive errors. Only viewing a sharp image of the cross hair overlaying a focused image of the eye ensures capturing of a sharply focused image.

It should also be considered that the examiner’s attention is focused on the details that are of interest and by selective viewing the brain suppresses certain artefacts. The camera however does not!

Types of illumination

The correct illumination will allow optimal recording of ocular pathology.

Diffuse illumination

The slit lamp beam should be completely opened and covered by the diffusing filter. The background illumination can be used in conjunction with the slit illumination for more uniform lighting. The diffuse illumination is normally used for overview pictures with low magnification (10x and 16x).

Direct focal illumination

Direct focal illumination refers to projecting the light on the subject at the plane of focus. Unlike diffused light, concentrated light penetrates transparent structures. With a centred slit beam there is always direct focal illumination.

Indirect illumination

With indirect illumination the light does not fall directly on the pathology. The slit beam is decentred and projected just adjacent to the subject area and it is illuminated by scattered internally reflected light.

Retroillumination

Retroillumination is a form of indirect illumination. Light reflected from the fundus or iris illuminates the pathology from behind. If the slit beam is decentred and higher magnification is used, unwanted reflections can be minimized.

Photography with three-mirror contact lens or 90-diopter lens

With these instruments there are more optical interfaces (air/glass and glass/cornea). All interfaces cause reflexes and therefore it is better to take images without the background illumination. Furthermore any scratches or damage to the lens will increase the number of image artefacts. If the space between the diagnostic contact lens and the slit illuminator is very small, the background illumination can be locked in the centre position.

Pictograms

- Narrow slit beam
- Moderate slit beam
- Wide slit beam
- Slit beam with diffusor
- Slit beam centred
- Slit beam decentred
- Background illumination
- Microscope
Slit lamp BQ 900

1. LED illumination head
2. Eyepiece with double cross hair reticule
3. Switch for beam splitter
4. Diffusor
5. Pivoting background illumination
6. Imaging Module IM 900
7. Illumination control
8. Release bar
Imaging Module IM 900
Intuitive imaging – best results

The Imaging Module IM 900 is the fully integrated compact imaging solution for the BQ 900 slit lamp. Its sensor designed for professional high end imaging provides the user with high sensitivity and a wide dynamic range, ideal for imaging under lower light conditions.

Furthermore, the IM 900 has been designed to provide intuitive and ergonomic operation. Four different capturing modes, an auto-brightness control as well as the freeze technology simplify the capturing process. A straightforward image editor offers efficient image editing.

Freeze Technology
Do not let a slow camera spoil your perfect moment for a slit image. Capture the image at the precise moment you press the trigger thanks to Freeze Technology.

History Trigger
Worry less about a patient blinking or moving when you take your image. The History Trigger function records the last few seconds of your image and allows you to freely select the one moment when conditions were perfect.

Depth of field control
Like any professional camera, the IM 900 is equipped with Depth of Field Control (DFC). Selecting a shallow depth of field when a maximum of light is required and a deep depth of field when the importance is to have different structures of the eye in focus. This allows to ideally adjust the camera regardless the location of the pathology.

Control Panel
The release bar is located in front of the joystick of the slit lamp. As a consequence, it can be blindly operated while searching for the perfect image. However, Easy Touch is much more than just a trigger as it allows simple, ergonomic management of the camera settings and to go back and forth between the images stored in the memory buffer.
Image exposure guide for IM 900

Overview – Diffuse illumination

<table>
<thead>
<tr>
<th>Magnification</th>
<th>10 x or 16 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>open, 45°, diffused</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>4</td>
</tr>
<tr>
<td>Background level</td>
<td>3</td>
</tr>
<tr>
<td>Aperture</td>
<td>6</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

The diffuse illumination with slit beam and background illumination gives a shadow-free illumination with natural colors and two light reflexes. This is most useful for low magnification overview images.

Conjunctiva – Diffuse illumination

<table>
<thead>
<tr>
<th>Magnification</th>
<th>10 x or 16 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>open, 45°, diffused</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>3</td>
</tr>
<tr>
<td>Background level</td>
<td>3</td>
</tr>
<tr>
<td>Aperture</td>
<td>6</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

Diffuse illumination provides evenly balanced lighting. Exposure control is more varied due to increased reflectivity.

Cornea – Narrow slit

<table>
<thead>
<tr>
<th>Magnification</th>
<th>16 x or 25 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>&lt;0.2 mm wide, &gt;60 degrees from microscope</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>1</td>
</tr>
<tr>
<td>Aperture</td>
<td>3</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

A narrow focal slit beam is projected at a 45° to 60° angle. It cuts an optical section through the cornea like a knife. With this technique it is possible to locate the layer of the pathological changes.

Cornea – Moderate slit

<table>
<thead>
<tr>
<th>Magnification</th>
<th>16 x or 25 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>1–2 mm wide, &gt;60 degrees from microscope</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>1</td>
</tr>
<tr>
<td>Aperture</td>
<td>4</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

The moderate beam produces two different layers of illumination, one on the epithelium and one on the endothelium.
Cornea – Tangential illumination

<table>
<thead>
<tr>
<th>Magnification</th>
<th>16 x or 25 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>&gt;4 mm wide, &gt;60 degrees from microscope</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>off</td>
</tr>
<tr>
<td>Aperture</td>
<td>6</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

This technique can provide more information as the oblique illumination is reflected and refracted by the cornea and any pathology. Experiment with the illumination angle slit beam width for optimum results.

Cornea – Retroillumination

<table>
<thead>
<tr>
<th>Magnification</th>
<th>16 x or 25 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>1 – 3 mm wide, decentred</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>off</td>
</tr>
<tr>
<td>Aperture</td>
<td>5</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

A moderate slit beam is decentred and angled to project onto the iris directly behind the pathology. The light reflects and backlights the cornea. If there is some cataract present the lens can also be used to reflect light directly onto the area of interest.

Lens – Narrow slit

<table>
<thead>
<tr>
<th>Magnification</th>
<th>16 x or 25 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>&lt;0.2 mm wide &gt;60 degrees from microscope</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>1</td>
</tr>
<tr>
<td>Aperture</td>
<td>4</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

A narrow focal slit beam is projected at a 45° angle to the lens as an optical section is made. Because of the problematic depth of field it is not possible to photograph the entire lens section in focus. It is therefore necessary to focus on the anterior or the posterior lens surface.

Lens – Moderate slit

<table>
<thead>
<tr>
<th>Magnification</th>
<th>16 x or 25 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit illumination</td>
<td>2 – 4 mm wide, &gt;60 degrees from microscope</td>
</tr>
<tr>
<td>Slit illumination level</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>1</td>
</tr>
<tr>
<td>Aperture</td>
<td>6</td>
</tr>
<tr>
<td>EyeSuite exposure</td>
<td>auto-mode</td>
</tr>
</tbody>
</table>

A moderate slit beam is projected at a 45° angle to the lens pathology and is directly illuminated.
Lens – Retroillumination

Magnification 16x, 25x or 40x
Slit illumination level 1–2mm wide, <5 degrees
Slit illumination level 5
Background level off
Aperture 5
EyeSuite exposure auto-mode

The slit illuminator is positioned in an almost coaxial position with the biomicroscope. A wide slit beam is decentred and adjusted to a half circle by using the slit width and height controls. The decentred slit beam is projected near the pupil margin through a dilated pupil. Careful composition can minimise the direct reflection.

Iris – Tangential illumination

Magnification 16 x or 25 x
Slit illumination Wide open, > 60 degrees from microscope
Slit illumination level 10
Background level off
Aperture 6
EyeSuite exposure auto-mode

The wide slit beam is projected at an oblique angle of 80°–90° onto the iris. This illumination creates strong shadows and the surface texture is enhanced. If the headrest doesn’t allow a wide oblique angle it is sometimes necessary to turn the patient’s head a little away from the light.

Fundus

Magnification 10 x or 16 x
Slit illumination 2–4 mm wide
Slit illumination level 5
Background level off
Aperture 5
EyeSuite exposure auto-mode

A moderate slit beam in the almost coaxial position gives the best results.
BX 900 Photo Slit Lamp

1. Flash and LED illumination housing
2. Cable guide
3. Flash intensity changer for background illumination
4. Camera body
5. Objective tube
6. Eyepiece with double cross hair reticule
7. Mirror and Diffusion filter
8. Mirror housing
9. Background illumination
10. Shutter release bar
11. Photo control unit

The Haag-Streit Photo-Slit Lamp BX 900 is based on the Slit Lamp BQ 900. It is therefore possible to use the same instrument both for ocular examination and documentation. A photo-slit lamp is a combination of a biomicroscope, and illumination system and the photo attachment. The Photo-Slit Lamp BX 900 and the Slit Lamp BQ 900 share the same microscope. The illumination system of the photo-slit lamp has in addition a flash unit and a background illumination.

The different components will be explained on the following page.
1. The flash housing contains the flash tube. Firing the BX 900 trigger will simultaneously deliver a flash through the illumination system and, via a glass fibre cable, the fill background illumination, while synchronizing with the camera shutter.

2. The cable guide contains the high voltage cable for the flash light.

3. The Flash intensity changer for the background illumination has seven settings:
   - = 100%
   - = 50%
   - = 25%
   - = 10%
   - = 5%
   - = 0%
   - blue filter

4. Haag-Streit has selected a number of SLR cameras and has made the necessary adaptations. The correct function of the photo-slit lamp is guaranteed only by the use of cameras that are recommended by Haag-Streit. Note that the camera has to be in the «MANUAL» operating mode and the shutter speed should be set to 1/125 sec. The recommended ISO rating for general use is 500 and color temperature of the flash is 6000 k but users have the option to apply other settings as required.

5. The camera body is mounted on the objective tube on the top of the biomicroscope allowing full visibility of the patient’s eyes from either side of the microscope.

6. The 12.5x eyepiece with double cross hair reticule is inserted into the right ocular of the microscope. This must be correctly focused for the user’s eye to ensure sharp images are captured. Note that the setting on the eyepiece is not the user’s refractive error.

7. With the diffusion filter the slit beam can be covered allowing overview pictures with diffuse illumination.

8. The principal component of the Haag-Streit Photo-Slit Lamp BX 900 is the mirror housing with its built-in diaphragms. It mounts between the magnification changer and the binocular tube. When capturing an image all light is directed, via a mirror, to the camera. This allows the maximum utilisation of the available light: 100% for the examination and 100% for the image. The built-in diaphragm setting with five apertures is applied automatically on image capture. For the aperture intervals: Step 1 = largest aperture, Step 5 = smallest aperture. The small knobs on each side of the mirror housing can be used during examination to quickly activate the diaphragm to the preset position. This allows a preview prior to capture so that the image subject and depth of field may be checked.

9. The background illumination is swivel-mounted on a horizontal level and is illuminated through a glass fibre cable. The flash fill illumination is delivered from the illumination head and the modeling light is produced by the LED. The modelling light is used to show where any reflection of the fill flash will fall.

10. The shutter release bar is conveniently positioned in front of the joystick on the cross-slide. It can be used either right or left-handed.

11. The photo control unit is mounted under the left hand side of the table. On the front side there are two switches and four error light indicators. The power switch is only for the photo control unit. With the flash-intensity switch in the high position, the flash light increases by one aperture step. Optical and acoustic warning signals will be activated in the case of an error when the shutter release bar is pressed. Once the cause of the problem has been removed, press the shutter release bar and the optical warning signal will be cancelled and the camera will be ready for use.

### Technical data

#### Biomicroscope
- **Magnification changer**: 6.3x, 10x, 16x, 25x, 40x
- **Ocular magnification**: 12.5x
- **Range of adjusting oculars**: +7 to -7 dioptres
- **Reticule**: Right ocular
- **Inter-pupillary distance**: 52 – 78 mm

#### Slit lamp illumination
- **Slit height**: 1 – 8 mm
- **Slit width**: 0.2, 1, 2, 3, 5, 8 mm diameter
- **Horizontal arc**: +/-90°
- **Vertical arc**: 5°, 10°, 15°, 20°
- **Filters**: Blue, green (red free), grey 10%
- **Slit beam diffuser**: Yes
- **Light source**: LED 24 VDC / 1 A

#### Photo attachment
- **Image delivery**: Quick return mirror 100% light for examination or photography
- **Objective tube focal length**: 170 mm
- **Light source flash light**: Normal 200Ws, high 400Ws

#### Depth of field
- Dependent on magnification and aperture.

<table>
<thead>
<tr>
<th>Magnification</th>
<th>Extent of focus (+/- in mm) with aperture</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3x</td>
<td>1.3, 1.8, 2.6, 3.6, 5.2</td>
</tr>
<tr>
<td>10x</td>
<td>0.5, 0.7, 1, 1.4, 2</td>
</tr>
<tr>
<td>16x</td>
<td>0.2, 0.3, 0.4, 0.5, 0.8</td>
</tr>
<tr>
<td>25x</td>
<td>0.1, 0.1, 0.15, 0.2, 0.3</td>
</tr>
<tr>
<td>40x</td>
<td>0.05, 0.05, 0.05, 0.1, 0.15</td>
</tr>
</tbody>
</table>

Values will be increased by 35% in transparent media of the eyes.

#### Image and magnification data

<table>
<thead>
<tr>
<th>Setting at magnification changer</th>
<th>Magnification in plane of the sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3x</td>
<td>1.3</td>
</tr>
<tr>
<td>10x</td>
<td>0.5</td>
</tr>
<tr>
<td>16x</td>
<td>0.2</td>
</tr>
<tr>
<td>25x</td>
<td>0.1</td>
</tr>
<tr>
<td>40x</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Circles: visible field of the eyepiece.
Standard settings

The BX 900 has many different adjustments in order to give optimal illumination and exposure. It is best to always start with a standard setting and to make adjustments after each image captured. An example for a standard setting is the diffuse illumination:

1. Main switch on, photo control unit POWER ON and camera body on
2. After waiting a few seconds, set the Flash intensity on HIGH
3. 100% Background illumination 45°angle between microscope and background illumination
   - Slit beam vertical
   - Slit beam fully open (slit width and height)
   - Slit beam centred (screw tightened)
   - 100% slit illumination (without filter)
   - Slit beam covered with the diffusion filter
   - Angle between microscope and illumination device 30° – 45°
4. Define the image field, close the left eye (note the difference between eyepiece and photo tube picture)
5. Focus control (eyepiece setting correct?)
6. Capture Image

Illumination and exposure settings

The following table shows the different settings of illumination and exposure adjustments. This table is also used for practical examples and will give a starting point.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500 (Standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high / normal</td>
</tr>
<tr>
<td>BGI* intensity</td>
<td>100%, 50%, 25%, 10%, 5%, 0%, blue filter</td>
</tr>
<tr>
<td>BGI* angle</td>
<td>0° – 90°</td>
</tr>
<tr>
<td>Slit beam</td>
<td>0 (closed) – 8 mm (fully open)</td>
</tr>
<tr>
<td>Filter</td>
<td>blue, red free (green), grey 10%, diffused</td>
</tr>
<tr>
<td>Illumination angle</td>
<td>0° – 90°</td>
</tr>
<tr>
<td>Magnification</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td>Aperture</td>
<td>1 – 5</td>
</tr>
</tbody>
</table>

BGI* = Background Illumination

Pictograms

Narrow slit beam
Moderate slit beam
Wide slit beam
Slit beam with diffusor
Slit beam centred
Slit beam decentred
Background illumination
Microscope

Diffuse illumination with slit and background illumination

The diffuse illumination with slit beam and background illumination gives a shadow free illumination with natural colors and two light reflexes. This is most useful for low magnification overview images.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>100%</td>
</tr>
<tr>
<td>BGI* angle</td>
<td>30° – 45°</td>
</tr>
<tr>
<td>Slit beam</td>
<td>fully open</td>
</tr>
<tr>
<td>Filter</td>
<td>diffused</td>
</tr>
<tr>
<td>Magnification</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td>Aperture</td>
<td>4 4 3 2</td>
</tr>
</tbody>
</table>
Diffuse illumination with background illumination only

The diffuse illumination with only the background illumination increases the contrast. The structures of the iris are more visible and there is only one light reflex.

<table>
<thead>
<tr>
<th>ISO</th>
<th>BGI angle</th>
<th>30°–45°</th>
<th>Illumination angle</th>
<th>–</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity high</td>
<td>Slit beam closed</td>
<td>Magnification</td>
<td>10x</td>
<td>16x</td>
</tr>
<tr>
<td>BGI intensity 100%</td>
<td>Filter –</td>
<td>Aperture</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Lids – Diffuse illumination

Diffuse illumination provides evenly balanced lighting.

<table>
<thead>
<tr>
<th>ISO</th>
<th>BGI angle</th>
<th>30°–45°</th>
<th>Illumination angle</th>
<th>30°–45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity Normal</td>
<td>Slit beam fully open</td>
<td>Magnification</td>
<td>10x</td>
<td>16x</td>
</tr>
<tr>
<td>BGI intensity 50%</td>
<td>Filter diffused</td>
<td>Aperture</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Conjunctiva – Diffuse illumination

Diffuse illumination provides evenly balanced lighting. Exposure control is more varied due to increased reflectivity.

<table>
<thead>
<tr>
<th>ISO</th>
<th>BGI angle</th>
<th>30°–45°</th>
<th>Illumination angle</th>
<th>30°–45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity Normal</td>
<td>Slit beam fully open</td>
<td>Magnification</td>
<td>10x</td>
<td>16x</td>
</tr>
<tr>
<td>BGI intensity 50%</td>
<td>Filter diffused</td>
<td>Aperture</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Conjunctiva – Narrow slit

A centred, narrow slit beam projected at a 45° angle demonstrates surface topography and trans-illumination of the lesion. The background illumination gives the position of the slit beam.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>30°–45°</th>
<th>Illumination angle</th>
<th>45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>0.1mm</td>
<td>Magnification</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>10%</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>3  2  2  1</td>
</tr>
</tbody>
</table>

Conjunctiva – Indirect illumination

A moderately wide and decentred slit beam is projected just adjacent to the border of the lesion. The light penetrates conjunctiva and illuminates the clear fluid below. In the presence of blood or scar tissue, the light is absorbed.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>30°–45°</th>
<th>Illumination angle</th>
<th>decentred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>2–4mm</td>
<td>Magnification</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>10%</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>2  2  1  1</td>
</tr>
</tbody>
</table>

Cornea – Diffuse illumination

This illumination technique can only be used in the presence of dense corneal pathologies because diffuse light does not penetrate very well through the cornea. Dilating the pupil can enhance pathology by creating a darker background.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>30°–45°</th>
<th>Illumination angle</th>
<th>30°–45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>fully open</td>
<td>Magnification</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>100%</td>
<td>Filter</td>
<td>diffused</td>
<td>Aperture</td>
<td>4  4  3  2</td>
</tr>
</tbody>
</table>
Cornea – Wide slit, tangential illumination

This technique can provide more information as the oblique illumination is reflected and refracted by the cornea and any pathology. Experiment with the illumination angle slit beam width for optimum results.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>45°</th>
<th>Illumination angle</th>
<th>60° – 80°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>fully open</td>
<td>Magnification</td>
<td>10 x 16 x 25 x 40 x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0 – 25 %</td>
<td>Filter</td>
<td>10 %</td>
<td>Aperture</td>
<td>– 4 3 2</td>
</tr>
</tbody>
</table>

Cornea – Moderate slit

The moderate beam produces two different layers of illumination, one on the epithelium and one on the endothelium. Note the corneal changes are closer to the posterior reflection and therefore they lie deep in the cornea.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>30°</th>
<th>Illumination angle</th>
<th>45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>2 – 3 mm</td>
<td>Magnification</td>
<td>10 x 16 x 25 x 40 x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0 – 25 %</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>– 3 3 2</td>
</tr>
</tbody>
</table>

Cornea – Narrow slit, optical sectioning

A narrow focal slit beam is projected at a 45° to 60° angle. It cuts an optical section through the cornea like a knife. With this technique it is possible to locate the layer of the pathological changes. These examples demonstrate endothelial and surface pathology.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>45°</th>
<th>Illumination angle</th>
<th>60° – 90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>0,1 mm</td>
<td>Magnification</td>
<td>10 x 16 x 25 x 40 x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>5 %</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>– 2 1 –</td>
</tr>
</tbody>
</table>
Cornea – Direct retroillumination from the iris

A moderate slit beam is decentred and angled to project onto the iris directly behind the pathology. The light reflects and backlights the cornea. If there is some cataract present the lens can also be used to reflect light directly onto the area of interest.

<table>
<thead>
<tr>
<th>ISO</th>
<th>BGI angle</th>
<th>Illumination angle</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>–</td>
<td>decentred</td>
<td>10 x</td>
</tr>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam 1–2 mm</td>
<td>16 x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0 %</td>
<td>Filter –</td>
<td>25 x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40 x</td>
</tr>
</tbody>
</table>

Cornea – Indirect retroillumination from the iris

The moderate slit beam is now decentred even more and angled to project onto the iris adjacent to the area behind the area of interest. The background is dark and the edges of non-pigmented lesions are well defined by the diffuse light reflecting from the iris.

<table>
<thead>
<tr>
<th>ISO</th>
<th>BGI angle</th>
<th>Illumination angle</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>–</td>
<td>decentred</td>
<td>10 x</td>
</tr>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam 1–2 mm</td>
<td>16 x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0–10 %</td>
<td>Filter –</td>
<td>25 x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40 x</td>
</tr>
</tbody>
</table>

Cornea – Sclerotic scatter

The wide decentred slit beam is projected onto the limbus. The light striking the limbus is internally reflected through the corneal tissue like a fibre optic. Corneal changes or abnormalities can be visualized by reflecting the scattered light. Careful post capture cropping can enhance images.

<table>
<thead>
<tr>
<th>ISO</th>
<th>BGI angle</th>
<th>Illumination angle</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>–</td>
<td>decentred</td>
<td>10 x</td>
</tr>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam 2 mm</td>
<td>16 x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0 %</td>
<td>Filter –</td>
<td>25 x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40 x</td>
</tr>
</tbody>
</table>
Cornea – Topical administration of Sodium Fluorescein

Sodium fluorescein is applied gently to the bulbar conjunctiva. The patient should blink once or twice for the dye to be dispersed over the eye. If the epithelium of the conjunctiva or the cornea is damaged, the fluorescein stains the underlying tissue. The remaining dye fluoresces a yellow green color when excited by the blue light. Healthy epithelium does not stain.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>30°</th>
<th>Illumination angle</th>
<th>60°–80°</th>
<th>Flash intensity</th>
<th>high</th>
<th>Slit beam</th>
<th>fully open</th>
<th>Magnification</th>
<th>10 x</th>
<th>16 x</th>
<th>25 x</th>
<th>40 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGI intensity</td>
<td>blue filter</td>
<td>Filter</td>
<td>blue filter</td>
<td>Aperture</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Anterior chamber – Aqueous flare, Tyndall’s phenomenon

Cells, pigment or proteins in the aqueous humour reflect the light like a faint fog. To visualize this the slit illuminator is adjusted to the smallest circular beam and is projected through the anterior chamber from a 40° to 90° angle. The strongest reflection is possible at 90°.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>–</th>
<th>Illumination angle</th>
<th>50°</th>
<th>Flash intensity</th>
<th>high</th>
<th>Slit beam</th>
<th>0,1–1 mm</th>
<th>Magnification</th>
<th>10 x</th>
<th>16 x</th>
<th>25 x</th>
<th>40 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGI intensity</td>
<td>0 %–25 %</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>–</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Anterior chamber – Goniophotography

The desired mirror of the gonioscopy lens is positioned opposite to the area of pathology. A wide slit beam is projected in the desired mirror from a near coaxial position to the biomicroscope. Light reflections can be eliminated by tilting the lens.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>–</th>
<th>Illumination angle</th>
<th>10°</th>
<th>Flash intensity</th>
<th>high</th>
<th>Slit beam</th>
<th>2 mm</th>
<th>Magnification</th>
<th>10 x</th>
<th>16 x</th>
<th>25 x</th>
<th>40 x</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGI intensity</td>
<td>0 %</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>–</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Iris – Wide slit, tangential illumination

The wide slit beam is projected at an oblique angle of 80° – 90° onto the iris. This illumination creates strong shadows and the surface texture is enhanced. If the headrest doesn’t allow a wide oblique angle it is sometimes necessary to turn the patient’s head a little away from the light.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>45°</th>
<th>Illumination angle</th>
<th>80°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>fully open</td>
<td>Magnification</td>
<td>10x 25x 40x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0%–10%</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>5 4</td>
</tr>
</tbody>
</table>

Iris – Transillumination

The slit illuminator is positioned coaxially to the biomicroscope and adjusted to provide a small circular beam of light. This beam is projected through the pupil which should be at mid dilation. The light reflects from the fundus and backlights the iris. Normally the iris pigment absorbs the light, but pigmentation defects let the red fundus light pass through.

<table>
<thead>
<tr>
<th>ISO</th>
<th>800</th>
<th>BGI angle</th>
<th>45°</th>
<th>Illumination angle</th>
<th>coaxial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>1–2mm</td>
<td>Magnification</td>
<td>10x 25x 40x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>0%–10%</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>2 1</td>
</tr>
</tbody>
</table>

Iris Angiography

The illumination technique of the iris angiography is like the tangential illumination with the background illumination opposite the slit beam. Both slit illuminator and background illumination have a blue excitation filter. The yellow barrier filter is positioned between the magnification changer and the mirror housing. The barrier filter only works on the image from the right eyepiece which is directed to the camera. Control of the focus of the image during the angiography is possible through the left eyepiece.

<table>
<thead>
<tr>
<th>ISO</th>
<th>800</th>
<th>BGI angle</th>
<th>45°</th>
<th>Illumination angle</th>
<th>45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>fully open</td>
<td>Magnification</td>
<td>10x 25x 40x</td>
</tr>
<tr>
<td>BGI intensity</td>
<td>blue filter</td>
<td>Filter</td>
<td>blue filter</td>
<td>Aperture</td>
<td>1</td>
</tr>
</tbody>
</table>
Lens – Narrow slit, optical sectioning

A narrow focal slit beam is projected at a 45° angle to the lens as an optical section is made. Because of the problematic depth of field it is not possible to photograph the entire lens section in focus. It is therefore necessary to focus on the anterior or the posterior lens surface.

<table>
<thead>
<tr>
<th>ISO</th>
<th>Flash intensity</th>
<th>BGI angle</th>
<th>Slit beam</th>
<th>Illumination angle</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>high</td>
<td>45°</td>
<td>0.1 mm</td>
<td>45°</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td></td>
<td>Background</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>– 1 1 –</td>
</tr>
</tbody>
</table>

Lens – Moderate slit, direct illumination

A moderate slit beam is projected at a 45° angle to the lens pathology and is directly illuminated. Dilation of the pupil is required for effective imaging.

<table>
<thead>
<tr>
<th>ISO</th>
<th>Flash intensity</th>
<th>BGI angle</th>
<th>Slit beam</th>
<th>Illumination angle</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>high</td>
<td>45°</td>
<td>2–4 mm</td>
<td>45°</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td></td>
<td>Background</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>– 2 2 1</td>
</tr>
</tbody>
</table>

Lens – Moderate slit, tangential illumination

A moderate to wide slit beam is projected at an angle greater than 45 degrees to provide oblique tangential illumination that can enhance detail by providing shadows. Pupil dilation will aid this illumination technique.

<table>
<thead>
<tr>
<th>ISO</th>
<th>Flash intensity</th>
<th>BGI angle</th>
<th>Slit beam</th>
<th>Illumination angle</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>high</td>
<td>45°–60°</td>
<td>2–6 mm</td>
<td>45°–60°</td>
<td>10x 16x 25x 40x</td>
</tr>
<tr>
<td></td>
<td>Background</td>
<td>Filter</td>
<td>–</td>
<td>Aperture</td>
<td>– 2 2 1</td>
</tr>
</tbody>
</table>
Lens – Retroillumination, red-reflex photography

The slit illuminator is positioned in an almost coaxial position with the biomicroscope. A wide slit beam is decentered and adjusted to a half circle by using the slit width and height controls. The decentered slit beam is projected near the pupil margin through a dilated pupil. Careful composition can minimise the direct reflection.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>--</th>
<th>Illumination angle</th>
<th>decentered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>2 mm</td>
<td>Magnification</td>
<td>10 x 16 x 25 x 40 x</td>
</tr>
<tr>
<td>Background</td>
<td>0%</td>
<td>Filter</td>
<td>--</td>
<td>Aperture</td>
<td>-- 2 1 1</td>
</tr>
</tbody>
</table>

| Vitreous – Narrow slit |

Without diagnostic lenses it is only possible to examine and to document the anterior part of the vitreous. Anterior Vitreous pathology can be seen with a narrow slit beam. Only when the clopotic power of the eye is reduced is it possible to focus more posteriorly.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>45°</th>
<th>Illumination angle</th>
<th>45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>0.1–1.0 mm</td>
<td>Magnification</td>
<td>10 x 16 x 25 x 40 x</td>
</tr>
<tr>
<td>Background</td>
<td>0%–10%</td>
<td>Filter</td>
<td>--</td>
<td>Aperture</td>
<td>-- 1 1 --</td>
</tr>
</tbody>
</table>

| Fundus – Central retina with a three-Mirror contact lens |

The slit illuminator is positioned in an almost coaxial position with the biomicroscope. A wide slit beam is decentered and adjusted to a half circle by using the slit width and height controls. The decentered slit beam is projected near the pupil margin through a dilated pupil. Careful composition can minimise the direct reflection.

<table>
<thead>
<tr>
<th>ISO</th>
<th>500</th>
<th>BGI angle</th>
<th>--</th>
<th>Illumination angle</th>
<th>5°–10°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash intensity</td>
<td>high</td>
<td>Slit beam</td>
<td>2 mm</td>
<td>Magnification</td>
<td>10 x 16 x 25 x 40 x</td>
</tr>
<tr>
<td>Background</td>
<td>0%</td>
<td>Filter</td>
<td>10%</td>
<td>Aperture</td>
<td>-- 2 1 1</td>
</tr>
</tbody>
</table>
Without diagnostic lenses it is only possible to examine and to document the anterior part of the vitreous. Anterior vitreous pathology can be seen with a narrow slit beam. Only when the dioptic power of the eye is reduced is it possible to focus more posteriorly.

<table>
<thead>
<tr>
<th>ISO</th>
<th>Flash intensity</th>
<th>BGI angle</th>
<th>Illumination angle</th>
<th>Magnification</th>
<th>Aperture</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>high</td>
<td>–</td>
<td>5° – 10°</td>
<td>10x 16x 25x 40x</td>
<td>– 2 1 –</td>
</tr>
</tbody>
</table>
Recommended Reading
Clinical Slit Lamp Biomicroscopy and Photo Slit Lamp Biomicrography / Martonyi, Bahn & Meyer
Time One Ink, Ltd. / Sedona, AZ
Copies of this and other books of interest to the Ophthalmic Photographer can be found at:
www.twinchimney.com

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Haag-Streit, Bern, Switzerland
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University of Glasgow, Scotland