Hearts and Arrows: Lighting specification

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Defining the light cone

To visualize the hearts and the arrows patterns a cone of diffuse white light, falling on the diamond from above, is needed. The patterns that can be seen are formed by the portion of the incoming light that is reflected back to the observer. In typical hearts and arrows viewing devices, besides white light from above, coloured light is falling in from the side through a colour filter. Common colours for this light falling in from the side are red and blue.

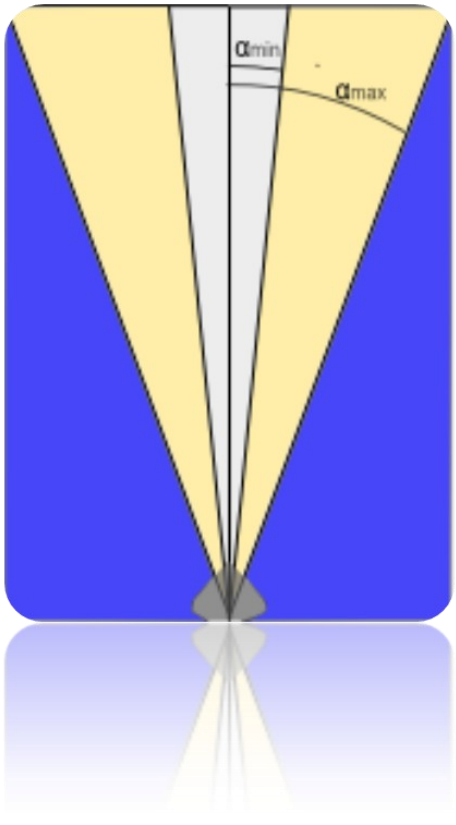

Figure 1: The diffuse white light from above and blue light from the side.

The minimal and the maximal angle, α_{min} and α_{max} (see figure 1), of the diffuse white light cone determine the subset of angles and proportions for round brilliants, for which the patterns are visible. Changing the light cone changes this subset. While a narrower light cone corresponds to a reduced subset of angles and proportions for which the patterns are visible, a wider light cone corresponds to an expanded subset.

This is important to keep in mind because the viewing devices available on the market (some examples in figure 2) show small differences for the angles of the diffuse white light cone. This results in small differences in the subsets of cut parameters for which the hearts and arrows patterns are visible with the different devices. For example for a border case it is possible that the arrows are clearly visible with one H&A viewer while they are only partly visible with a different H&A viewer.

A survey of several hearts and arrows viewing devices available on the market, has shown values ranging from 4.2° to 5.5° for α_{min} and 14.5° to 17.0° for α_{max}.

Are these differences in minimal angle, α_{min}, and maximal angle, α_{max}, significant? To answer this question the effect of changing the angles of the light cone is demonstrated in the next section.

The effect of changing the white light cone

The white light cone can be changed by decreasing or increasing the minimal and maximal angle, α_{min} and α_{max}. In figure 3, 4, 5 and 6 the effect, on both the hearts and the arrows pattern, of changing one of the angles is illustrated.

Effect of changing α_{max}

First the effect of increasing and decreasing α_{max}, while keeping α_{min} fixed is illustrated in figure 3. When α_{max} is de-

Figure 2: Three examples of typical H&A viewers available on the market

creased, starting at 16.4°, both the hearts and the arrows will first become yellow, then red brownish and finally they will disappear. Notice that the arrows already start to show colour at 15.7°, a decrease of less than 1°. In other words for a border case for the visibility of the arrows, white arrows will be seen in a viewer with α_{max} larger than 15.7° while the arrows will be coloured or not showing in a viewer with α_{max} smaller than 15.7°.

For the hearts to become yellow α_{max} needs to be decreased to 12°. This value for α_{max} lies outside the range of values found in commercial H&A viewers. This means that when viewing the hearts with the different viewers available on the market, one will not notice a difference for the hearts pattern as is the case with the arrows described above.

The cut parameters for the model used in the simulation showing the effect of decreasing α_{max} are listed in table 1.

Figure 4 shows the effect of increasing α_{max}, starting at 15.5°. The effect in the hearts pattern is minimal and is situated on the outside near the girdle. For the arrows a gradual increase in virtual fac-

Cut parameter	
Pavilion angle	40.9°
Table size	58%
Crown angle	35.1°
Star facets length	41.2%
Pavillion half length	77.0%
Crown height	16.0%

Table 1: Cut parameters in figure 3

Cut parameter	
Pavilion angle	40.8°
Table size	56%
Crown angle	35.1°
Star facets length	50%
Pavillion half length	77.0%
Crown height	16.0%

Table 2: Cut parameters in figure 4

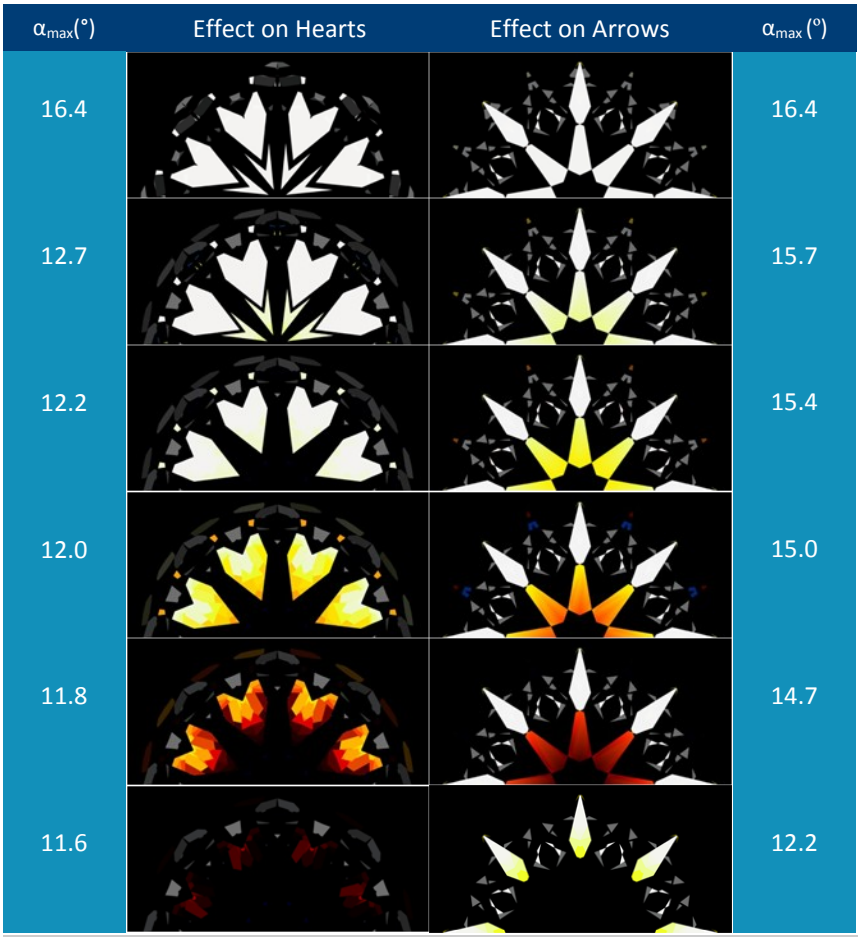

Figure 3: The effect of decreasing α_{max}

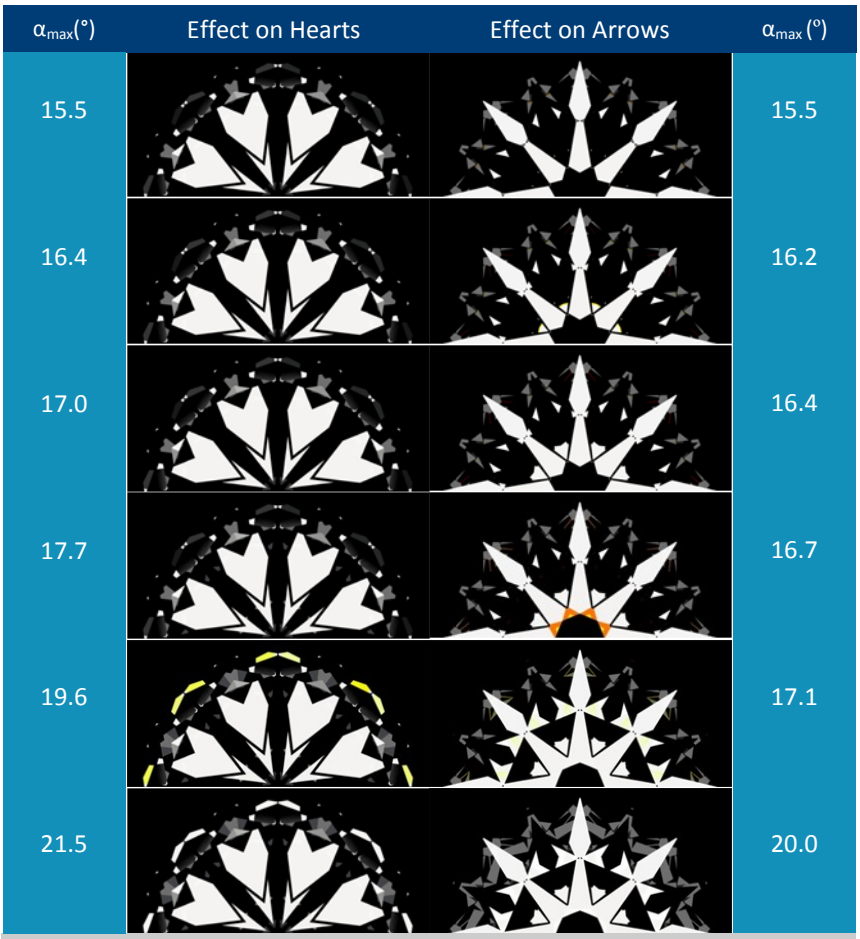

Figure 4: The effect of increasing α_{max}

ets that light up around the arrows can be seen. This effect is called clustering and disturbs the arrows pattern. For the brilliant cut shown in figure 4, the clustering effect already starts to show up at 16.2°. As this value for α_{max} lies within the range of values found in commercial H&A viewers, it is possible that, for border cases for the clustering effect, the clustering is visible with one viewer and not visible or less pronounced with another viewer.

Effect of changing α_{min}

The effect of decreasing α_{min} is illustrated in figure 5. Only In the extreme case where the minimal angle, α_{min}, becomes close to zero a disturbance of

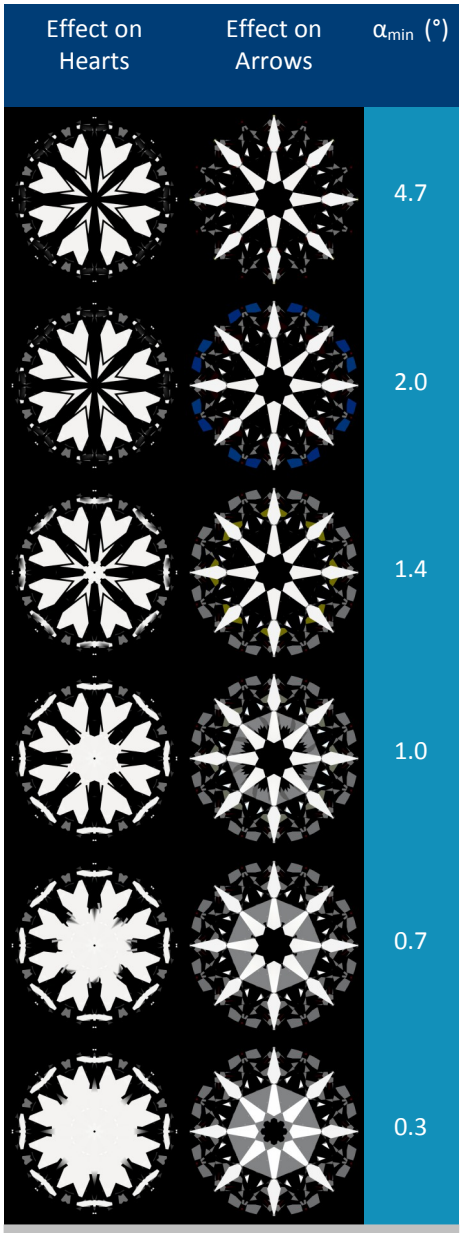

Figure 5: The effect of decreasing α_{min}

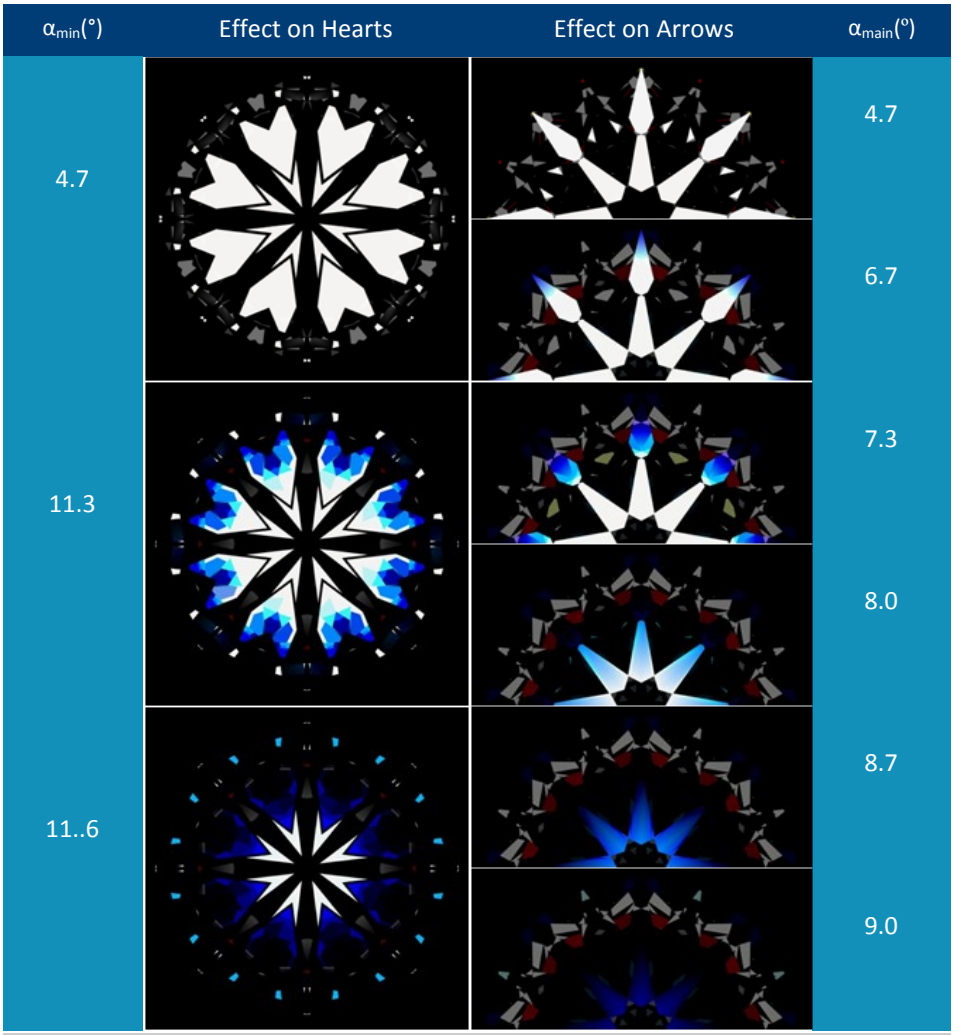

Figure 6: The effect of increasing α_{min}

the patterns can be seen, due to the reflection of the light falling in from a direction almost perpendicular to the table. For the arrows we also notice extra virtual facets in the outer zone near the girdle when α_{min} is smaller than 2°.

When the minimal angle, α_{min}, is increased, both the hearts and the arrows will first become blue and finally disappear. The colouring of the arrows starts much sooner, at 6.7°, than the colouring of the hearts, at 11.3°. This is illustrated in figure 6.

The effect of the coloured filter

Colour of the filter

A typical hearts and arrows viewer has a red or blue filter that adds coloured light falling in from the side at an angle ranging from α_{max} to 180°. Besides adding the typical red or blue colour in the hearts and arrows patterns, as shown in the figure 7 on the left, there is also an important side-effect that depends on the colour of the filter. A coloured filter has the same effect as a small increase of the maximal angle of the white light falling in from above.

A possible consequence of this side-effect is that yellow-brown coloured arrows in a viewer without side light, might become white arrows in a viewer with the same white light cone but with a blue or a red filter. This positive effect on the visibility of the arrows is more pronounced with a blue filter than with a red filter. It is common practice to disable the effect of the coloured filter by reducing the amount of light falling in from the side by shielding the viewer with the hands at the height of the filter. This will show the true visibility of the pattern. Instead of shielding the

viewer with the hands, it is better to replace the blue or red filter by a non-reflecting, non-transparent material to prevent light falling in from the side.

The described side-effect of the colour filter can be explained by a complex combination of dispersion of white light and the filtered coloured light falling in at an angle close to α_{max}.

Figure 7: Typical Hearts and Arrows patterns seen in viewer with red, blue and green filter

Height of the filter

The height of the filter determines the maximal light angle of the white light cone. As explained in the previous section, changing the maximal angle can have an effect on the visibility of the arrows pattern and the presence of clustering in the arrows pattern. Therefore the **height of the filter should not be changed** and the filter should always be in the **correct position** in the tube when using a classical hearts and arrows viewer.

The lighting specifications for the Hearts and Arrows by HRD Antwerp grading

Fundamental to the grading of hearts and arrows diamonds is the light that is used to make the patterns visible. Stable conditions and fixed specifications for the viewing and measuring devices are essential to any consistent grading. For the grading of Hearts and Arrows diamonds HRD Antwerp has therefore defined the following fixed light conditions:

1) A cone of diffuse white light falling in form above with: α_{min}= 5.3° α_{max}= 16.3°
2) No coloured light falling in from the side

Table 3: Light specifications for the Hearts and Arrows by HRD Antwerp grading

The specified values for α_{min} and α_{max} were not only chosen to lie within the range of values found for the classical hearts and arrows viewers available on the market but are also a result of comparisons made between simulations and real diamonds.

The absence of coloured side light is essential to disable the dependency on the colour of the side light when viewing border cases.