The optimal high line rate grid

The introduction of digital detectors with smaller pixel sizes results in a demand for increased line rate in grids to eliminate moiré. Sadly, due to basic physical laws the efficiency of a high line rate grid (70-80) compared to an equal ratio low line rate grid (36-44 lines) is strongly diminished,

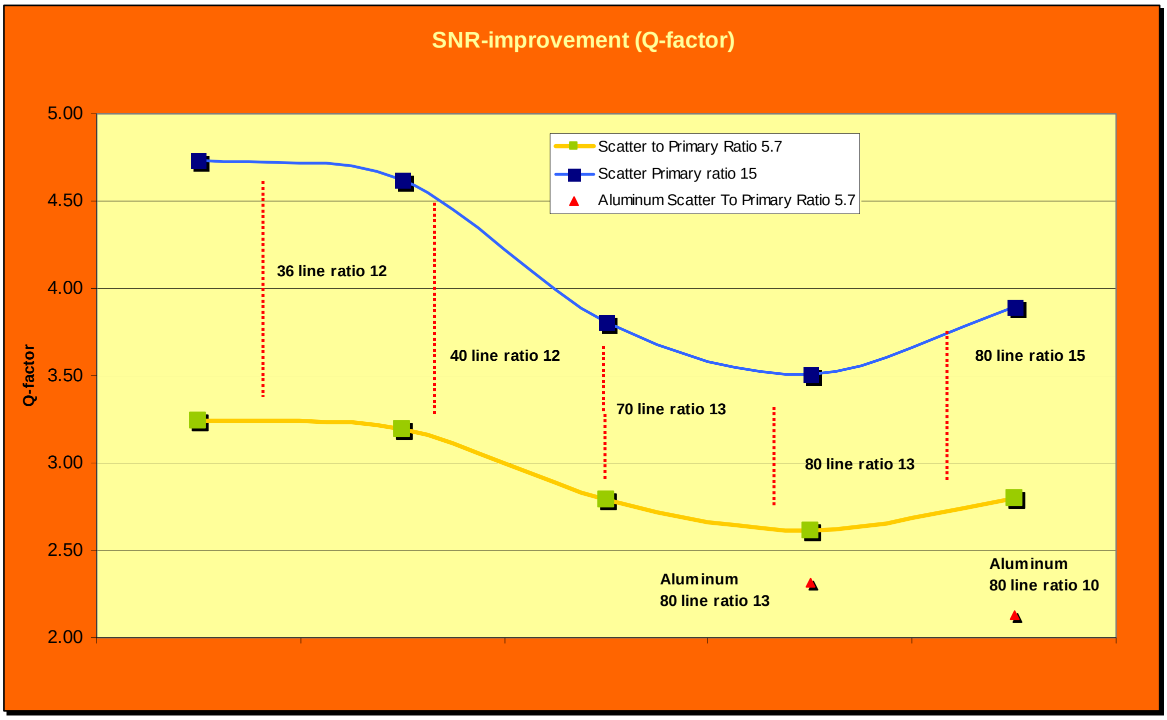
Intermezzo
The function of a grid has been shifted from basic contrast enhancement (called contrast improvement factor K) to signal to noise improvement because of the introduction of digital detectors.
Contrast deterioration caused by scatter can be compensated (although limited) by electronic image processing in a digital detector based system. But also the quantum noise of scattered radiation will be amplified resulting in a poor overall signal to noise performance of the system.
A better way to describe grid characteristics in a digital detector environment is to define a signal to noise improvement factor or Q-factor.

$$Q = \frac{t_p^2}{t_t}$$

t_p = primary transmission. t_t = total transmission

When optimizing a grid for scatter absorption the trade-off between reduction of primary transmission and total transmission must be carefully made. Low X-ray absorbing of interspace material (high t_p) is is pre-requisite for the best signal to noise improvement.

In the graph below the grid performance of different grid types at different scatter to primary ratios has been given. The reason for the difference in scatter to primary ratio is that with the increased



field of view size (43x43cm) and more obese patients the amount of scatter also increases. Studies at the Mayo Clinic in cooperation with Smit Röntgen have shown that the scatter to primary ratio (further called SPR) can easily exceed a factor 15 (40cm patient) up to 23 (50cm patient) compared to the “classical” IEC value of 5.7.

The yellow and blue lines visualizes the Q-factor of fiber interspaced grids at SPR’s of 5.77 and 15. The reduction in Q-factor due to the high line rate is unmistakably shown. When the line rate increases, despite equal ratio, the Q-factor is reduced 20%. At higher SPR’s this worsens to 30%

For comparison, aluminum interspaced grids (red triangles) have been added with ratio 13 and 10. The signal to noise (Q-factor) performance is another 20% deteriorated.

Conclusion:
To achieve optimal system performance without moiré artefacts in a digital system it is necessary to use high line rate high ratio (14:1 +) grids. In this way the digital detector advantages are utilized as much as possible.

Intensity cut-off.
The disadvantage of a higher ratio could be the increased intensity cut-off at the edges of the image when the grid is used in out of focus conditions. In IEC 60627 this is defined as the application range. In “classical” image intensifier systems there were several other cut-off sources like the II, optics and CRT monitors. In film environments the limited dynamic range of the film-processing was critical
In a digital detector system all these cut-off sources have been eliminated and together with image processing capabilities like harmonization this has become much less critical.

Conclusion:
The application range of high ratio grids is much larger in a digital system compared to classical II or film systems. It is advised to determine the acceptable intensity cut-off at system level.

For information
In IEC 60627 the application range is calculated by a mathematical formula to enable objective comparison of grids between different manufacturers. It is not defined to be a limitation in the use of the grid.

Smit Röntgen