The Definitive Guide to Digital Sensor Image Quality:
Line Pairs, Contrast Resolution, and Optimal Exposure

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If you've ever been in the market for a digital sensor you've probably heard terms like:

"line pairs or pixels"

"contrast resolution"

"optimal exposure"

being thrown around when describing a sensor's imaging capabilities.

This emphasis on digital sensor image quality is not arbitrary.

The difference between a sensor that can capture high-quality X-rays and one that can't is the difference between diagnosing small, difficult-to-discern intraoral pathologies and overlooking them entirely.

But the specs provided by the manufacturers of these sensors don't always tell the whole story. Companies often inflate their sensor's specs with theoretical resolutions and other empty claims.

So how can you cut through all the marketing hype and get to the truth?

And what's a "line pair," anyway?

What's really important when determining a sensor's imaging capabilities?

If you're looking to buy a digital sensor and want to base your purchasing decision on accurate information instead of manufacturers' exaggerated specs,

then this guide is for you.

Read on.

Spatial Resolution:

What does line-pairs per millimeter mean?

A line pair is

one white line

adjacent to a black line

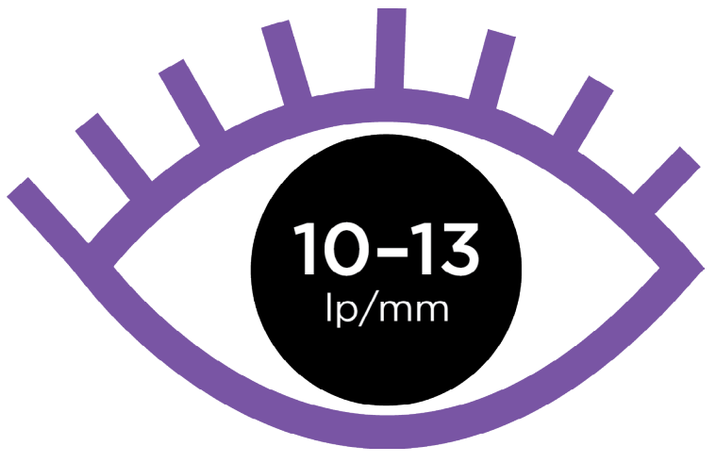
Simple as that.

The number of white and black line pairs that fit within 1 millimeter on an image determines the line-pairs per millimeter or lp/mm.

Lp/mm is a measure of the spatial resolution of an image. Spatial resolution is a measure of the fine detail that can be distinguished in an image. The higher the spatial resolution, the finer the detail you can detect in an image. Some manufacturer's boast of spatial resolutions over 20 lp/mm.[1]

But here's the thing...

The human eye can only discern approximately 10-13 lp/mm without any aids.[2] At a certain point, the fine details in a radiographic image begin to blur and the benefits of higher spatial resolutions diminish.



> "Line Pair is a term that dental sales representatives throw around when they are trying to sell digital sensors."
>
> *—James Ramey, Director of Digital Imaging, "Line Pairs in Digital Sensors"*

> "Spatial resolution is important if you want to see a very small item, such as the tip of a No. 8 endo file on a radiograph. It is not so important if you are looking for subtle changes in the density of enamel."
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> *—Larry Emmot, DDS, "Digital Radiography Myths"*

So what's a truer test of a digital sensor's diagnostic imaging capabilities?

Contrast Resolution:

Contrast resolution is a measure of the subtle gradations in the gray levels of an image. The higher the contrast resolution, the more easily you'll be able to detect subtle changes in the shades of gray in an image.[3]

“This type of resolution is important for caries detection.”

—Larry Emmot, DDS

“Most of the diagnostic tasks in dentistry require a large degree of C/D (contrast/detectability) perceptibility.”

“A previous study . . . found that the most desired characteristic for a new sensor was contrast resolution.”

—Department of Comprehensive Dentistry, University of Texas Health Science Center Study

Contrast resolution is a much more important gauge of a sensor’s diagnostic abilities. A sensor that captures X-rays with high contrast resolutions makes it easier to detect subtle changes in the density of enamel, facilitating more accurate diagnoses and better treatment plans for patients.

You can’t discuss a sensor’s diagnostic capabilities without discussing its Optimal Exposure.

> Optimal Exposure: “the lowest exposure where maximal spatial resolution and contrast/detail detectability [are] achieved.”
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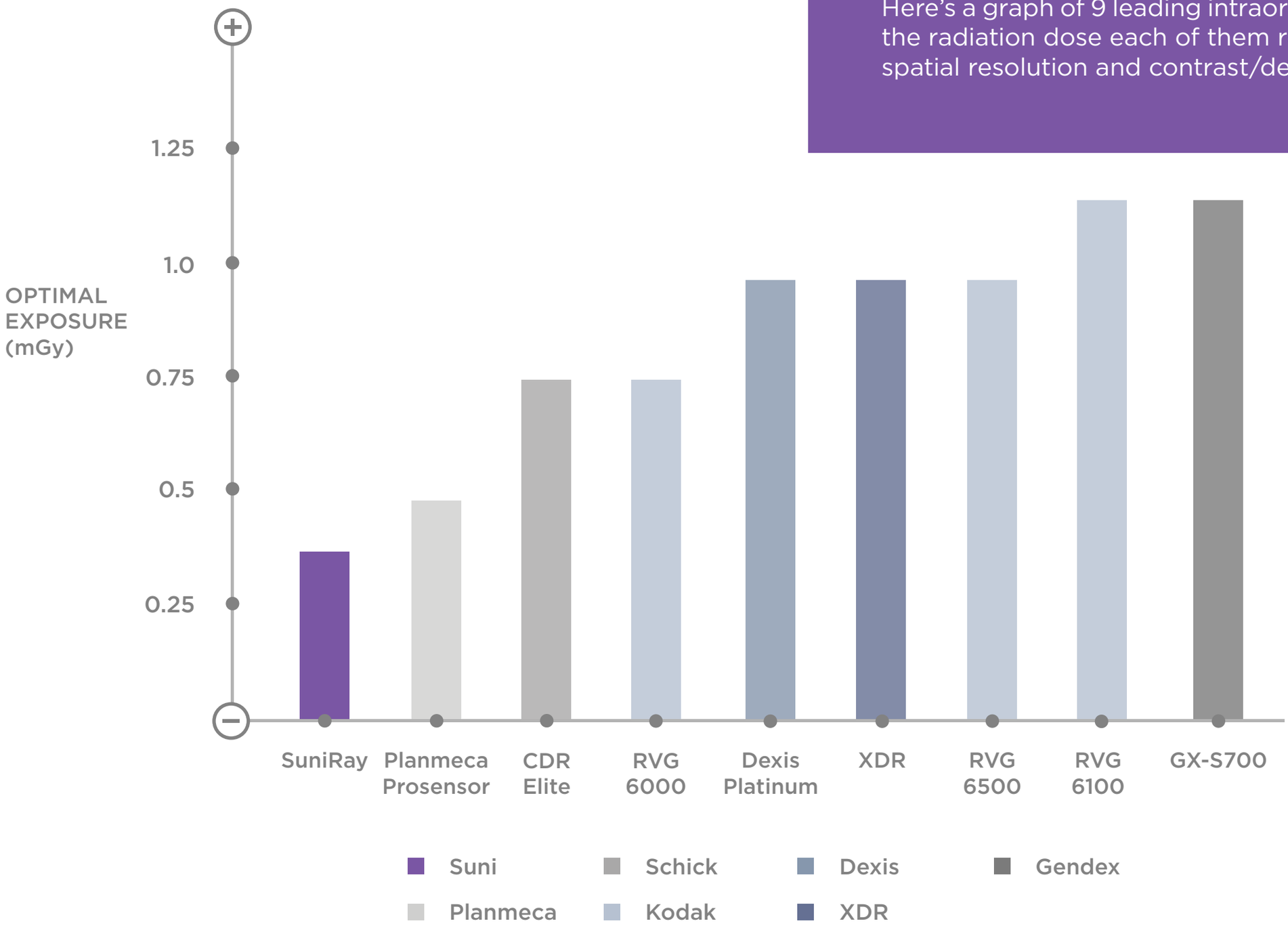
> *—Department of Comprehensive Dentistry, University of Texas Health Science Center Study*

Because of the ALARA Principle (As Low As Reasonable Achievable), a digital sensor with truly exceptional diagnostic capabilities will capture radiographs with high spatial and contrast resolutions using the lowest radiation doses possible.

Here's a graph of 9 leading intraoral digital sensor brands and the radiation dose each of them requires to achieve maximal spatial resolution and contrast/detail detectability.



Source: University of Texas Health Science Center at San Antonio, TX, USA

As you can tell from the graph, SuniRay2 uses the lowest radiation exposure levels to achieve its highest spatial and contrast resolutions. This sort of balance between high-quality imaging and optimized exposure is an important but often overlooked aspect of digital sensors, and it should factor into practitioners decision making when looking for a new digital imaging system.

Sources

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2. Hema Udupa, Peter Mah, Stephen B Dove, William D McDavid—Evaluation of image quality parameters of representative intraoral digital radiographic systems.
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