



4K Vision. LED. Image Management. Integration.

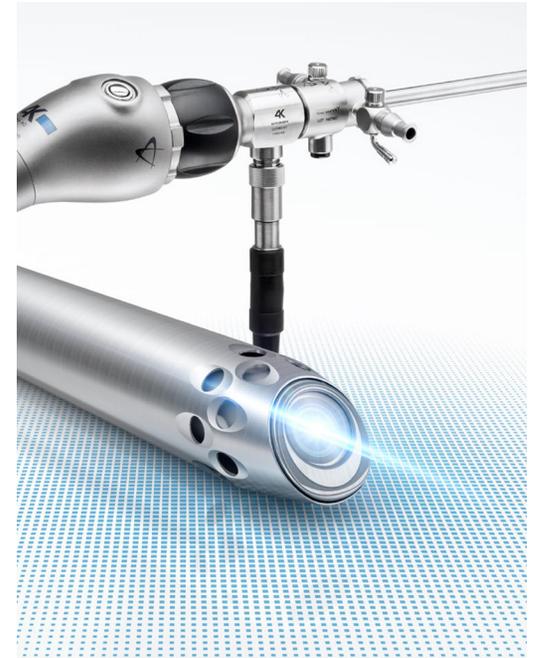
4K vs HD SCOPES

Advancements

Arthrex's advancements in minimally invasive surgery have truly molded the industry and modern medicine. The will to push the market in obvious and not-so-obvious areas make the company very unique and special. Helping surgeons see better aligns with our mission statement Helping Surgeons Treat Their Patients Better™ that our president and founder, Reinhold Schmieding, has followed his entire career.

It's this will to improve and innovate that permeates every team and product at Arthrex. The endoscope product line is no different and continual improvements are being made. Endoscopes are one of the most important links in the optical chain, and pushing to make a 4K version exemplifies our will to improve.

It is often asked how the scope is improved. The manufacturing techniques and tighter tolerances of the individual parts are a large component for improving the scope. As the technology improves with glass cutting, lens polishing, lens measuring equipment and assembly techniques, the performance of the scope improves. Once this was realized with the 10 mm scope, engineers began to expand the techniques to smaller diameter scopes. It is the tighter tolerances with the overall design that produces more efficient transfer of light from the target to the camera head. The results of the comparison test speak for themselves.



**30° 4 mm
4K C-Mount Arthroscope**

Performance

Measuring the scope's image quality requires several metrics to characterize clarity, distortion and optical transmission. An "endobench" is used to make precise and repeatable measurements of the image quality for every endoscope produced.

The most objective metric for clarity (or resolution) is the modulation transfer function (MTF), often reported in lines/mm. The higher the measurement, the more contrast or clarity between features in the image. The US Air Force resolution test chart is one way to characterize the resolving power of an endoscope.

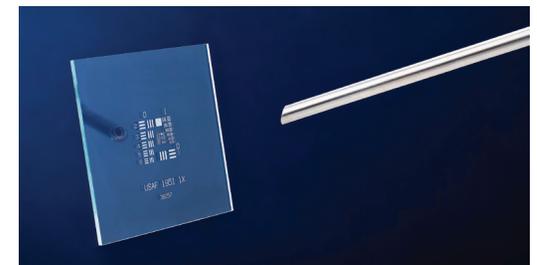
Distortion is an artifact of the optical design that warps the size of objects in the image. Endoscopes have "barrel" distortion that makes objects in the center of the image appear larger, and the endoscope design attempts to minimize this effect.

Optical transmission is the measurement, in percent, of light that makes it through the endoscope. The light reflects off anatomy in the scene, and then travels back through the endoscope's many lenses, each with thin film coatings to promote as much transmission as possible.

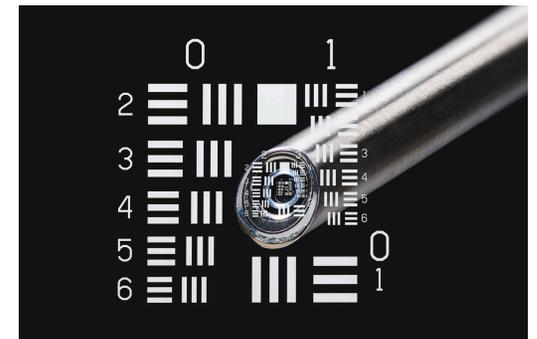
All of these factors are accounted for and optimized in the design to produce the best image possible.



Endobench: scope-measuring device



Standard Air Force target used in the endobench for measuring the optical performance of the scopes.



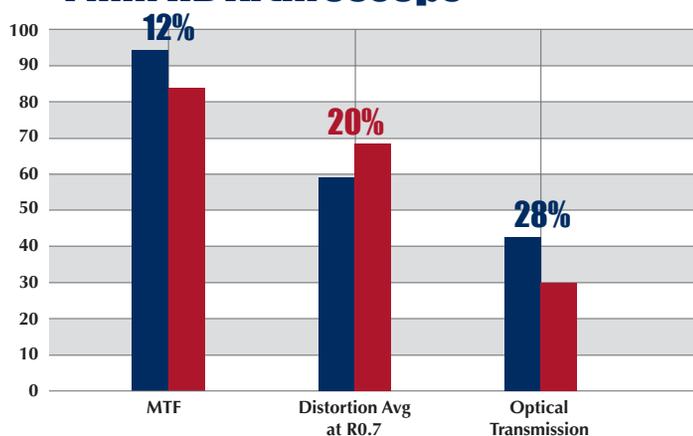
Close-up angle.

The Results of Our Testing

The chart below illustrates the different improvements comparing the 4K and 4 mm high-definition (HD) scope. The optical engineers discuss the desired performance of the scope and design it to improve certain characteristics. The results below speak volumes about the technical expertise and commitment to improve visualization in the medical field.

■ 4 mm 4K Arthroscope

■ 4 mm HD Arthroscope



Definitions for Graph

MTF (Resolution): The ability of an imaging system to resolve detail in the object that is being imaged.

Distortion: The alteration of the original shape of the object.

Optical Transmission: Measures the throughput of illumination light from the target through the scope.

Does a 4K Scope Mean 4K Picture?

The answer is no. The 4K resolution is created at the camera head, behind the scope, and continues through the console and onto the monitor. The endoscope is the most crucial component in the chain. The scope provides the image to the camera head, so the higher resolution from the scope results in a higher starting point for the system.

The endoscope transmits the light from the target/object to the prism inside the camera head, which portrays on the chip set. If you measure the entire chain, including the optics and digital processing, you are looking at the system as a whole from scope to monitor. We measured this optical transmission using a 1080p system compared to the Ultra HD 4K system.

Optically measured, the 4.8 mm 4K scope on a 4K camera has 59% increase* in lines of resolution compared to the 4 mm HD scope on a 1080p camera. This is a drastic improvement that can be a huge benefit to surgeons.

*data on file

| Scope | 4K Camera and 1080p Monitor | 4K Camera and 4K Monitor |
|-----------------------|-----------------------------|--------------------------|
| 4 mm HD Arthroscope | 12% Improvement | 26% Improvement |
| 4.8 mm 4K Arthroscope | 41% Improvement | 59% Improvement |



HD Arthroscope
with Synergy^{UHD4™} Camera



Synergy^{UHD4™} 4K Camera
with 4.8 mm 4K Arthroscope

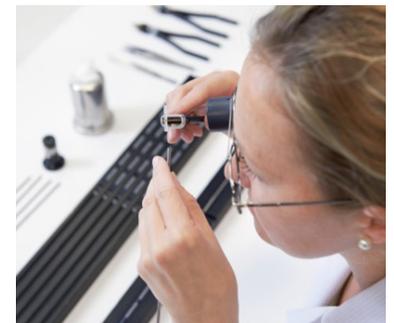
Recent History of the Endoscope

When high definition cameras were introduced into the medical market around 2004, it was realized that the scope was a limiting factor. The HD scope was produced to optimize the performance of the system. Fast forward 10 years, Arthrex was developing the world's first 4K camera and went to work on the scope to ensure it would not be the limiting factor in the chain. In 2015, the 4K camera released along with the world's first 4K 10 mm laparoscopes. Release of the 5.5 mm laparoscopes and 4.8 mm arthroscopes soon followed. Today, we have an arthroscope as small as 4 mm and we will continue pushing this technology to even smaller sizes.

Complexity of a Scope

Endoscopes are highly sophisticated medical devices manufactured from numerous precision components. The technicians who assemble the scopes require special skills to work in this environment and hone their skills over many years. Each manufacturing step, including alignment, assembly and testing, is crucial to ensuring the perfect end result.

As tighter tolerances are achieved, the more efficiently the scope transfers light to the camera head. Significant investments in equipment are required to accomplish these technological improvements and push the market to greater heights.

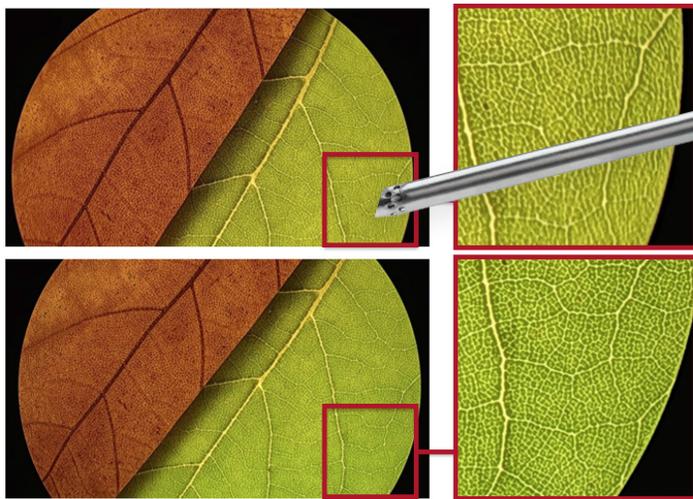


AR-3352-5500
5 mm, 0° 4K Laparoscope

Why 4K?

One important question is why spend the time and money to make the improvement. The HD 4 mm scope was standard for the market. No user asked for better because they don't know that better is possible. This is the Arthrex difference and it aligns with the mission statement of Helping Surgeons Treat Their Patients Better™. This not only means providing surgeons with the best instrumentation, implants, techniques and education, but also the best visualization possible. We offer the most technologically advanced tools available and we push to get the tools into surgeons' hands. Accepting the status quo is not acceptable for Arthrex, and helping the surgeon see better aligns our products with the Arthrex mission.

If you don't know it's there, then you cannot fix it.





This description of technique is provided as an educational tool and clinical aid to assist properly licensed medical professionals in the usage of specific Arthrex® products. As part of this professional usage, the medical professional must use their professional judgment in making any final determinations in product usage and technique.

In doing so, the medical professional should rely on their own training and experience, and should conduct a thorough review of pertinent medical literature and the product's Directions For Use. Individual results will vary and not all patients will experience the same postoperative activity level and/or outcomes.

<http://www.arthrex.com/imaging-resection/fluid-management>

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