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Rifle Scopes and Rifle Scope Technology - How to Choose a Hunting Rifle Scope

by Eben Brown

There is an old iron sight axiom that goes something like this: **The better you can see your sights and your target, the more accurately you will shoot.** But, that is only true as long as your sights are pointing in the same place from one shot to the next. Even though telescopic sights allow you to apparently see much better, there are aspects to them that create new sighting problems the old iron sights didn't have. And of course, scopes need to be pointing in the same place from

When choosing a rifle scope: First decide the magnification and whether or not you want parallax to be adjustable. Then, choose based on the features you like or dislike... Such as the type of reticle, fast focus eyepiece, windage and elevation knobs, objective size, tube diameter, length, weight, etc.

Parallax Error and Adjustable Objective Riflescopes

PARALLAX ERROR - Parallax error is when changing positions of your eye will change the point of aim of your scope. The error is related to the distance the target is from you. Most sporting rifle scopes are set to be Parallax Error-Free at 100 yards. That is, when aiming through your scope at a target 100 yards away, the point of aim stays the same regardless of the position or movement of your eye (side to side or up/down).

Parallax is One Thing, Focus is Something Else - Scope "Marketing" people often call parallax adjustment an "Adjustable Focus" or "Side-Focus". It's NOT. You set the scope to be parallax error free at a certain distance. And if the image is not in focus, you focus it with your eyepiece. This is where the "Fast Focus Eyepiece" comes in handy.

TEST FOR PARALLAX ERROR - It's pretty simple (and enlightening!) to test your scope for parallax error. Position your scope or scoped firearm in sand-bags so that it is aiming at a 100 yard target. Now, without touching the gun or the scope, move your head from side to side while looking through the scope. If the crosshair moves around on the target, you're seeing parallax error at that distance. How much error depends

one shot to the next like iron sights!

In this article, I'll try to touch on everything that you might think to ask about when choosing your own rifle scope...

What Makes a Scope Accurate?

Correction of Parallax Error; Adjustment Consistency; and a Solid, Well Aligned Mounting System.

What Makes a Scope See Better?

Lens Quality, Lens Coatings, and Objective Lens Size... And knowing how to use the Fast Focus Eyepiece.

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Mueller Parallax Adjustable Riflescopes



Swift Mildot Reticle Rifle Scopes

"focusing" because its really parallax correction. Its also important to note that the distance markings on the parallax adjustment are quite often not exact.

Set the parallax then focus the eyepiece.

This is partly due to the scope user's own eye optics, but also due to changes within the scope from one magnification setting to the next. In fact, some high end scope companies have addressed this by not putting specific distances on the parallax adjustment. Instead, they say use the test (above) to find the point of zero parallax error for each distance yourself. Use a silver or white paint pen to mark the positions. When all other features are equal, adjustable parallax can make a cheap scope a bargain by simply being able to exactly dial out all of the parallax error when aiming.

HOW CRITICAL IS PARALLAX? - For pinpoint aiming purposes, parallax error is most critical at under 100 yard distances. Rimfire and air rifles absolutely need adjustable parallax due to shooting under 100 yds. On the other hand, big game scopes are set to be parallax error free at 100 yards. At under 100 yards, BIG game are large enough that parallax won't throw you too far off

that distance. How much error depends on how much movement. I've seen some scopes where the movement was 4-6 inches! To find the distance where your scope is parallax error-free, do this experiment at 25, 50, 75, 100, and 125 yards. The distance where it is error free will also be the distance at which you shoot most accurately.

PARALLAX ADJUSTABLE SCOPES - Scopes with an adjustable objective (AO) allow you to set the distance at which they are parallax error-free. These scopes are also designated as Parallax Adjustable (PA), Side Focusing (SF), etc. It's misleading to call this feature

that parallax won't throw you too far off your aiming point. And beyond 100 yards, the error is simply less for the difference in distance. Adjustable Parallax scopes have a lot of adjustment under 100 yards but just a little as range increases over 100 yards. So, if your scope tests parallax error-free at 100 yards, it is going to work just fine for most big game hunting situations. But, if it shows a lot of parallax error at 100 yards, it is simply not going to shoot accurately and reliably. And, if you're hunting SMALL game at distances over 100 yards (ie. varmints and prairie dogs) the ability to dial out parallax error becomes a necessity.

A parallax adjustable riflescope doesn't have to be complicated. For general big game hunting you can leave it set for 100 yards just like any non-adjustable scope. However, the ability to dial out parallax error for any specific hunting situation or any particular shot is extremely valuable.

Adjustment Consistency and a Well-Aligned Scope Mount

ADJUSTMENT CONSISTENCY -

It stands to reason that if your scope reticle doesn't stay at the same point of adjustment, it will not give you the same point of aim from one shot to the next. Scopes adjust the reticle by screws which push the reticle tube against a spring. From one shot to the next, recoil might shift the reticle tube against the spring. As long as it returns to the same position, the scope will keep the same point of aim. But if it moves, your scope will not shoot accurately. A good scope will have little or no movement of the reticle tube and adjustments will stay consistent regardless of recoil.

Sometimes the point of impact can change simply by zooming the magnification on a variable power scope. However, this situation doesn't happen much in the scopes we have now-a-days.

SOLID, WELL ALIGNED MOUNTS -

If your scope moves in your mount, it will change your point of aim. When a riflescope is tensioned, bent, twisted or torqued in its scope mount, it is just waiting for any influence to change your point of aim... temperature, a slight bump, a little recoil... even the pressure you impart on it by twisting the zoom or adjusting the objective. Finally, if your scope mount doesn't align your scope with the direction your muzzle is pointing, your reticle adjustments will have to be pushed to outside extremes

to sight in your point of aim with your point of impact. I became aware of the importance of scope mounts to accurate shooting when we were developing our Tri-Force scope mounts for handguns.

These mounts use three rings and you can really spot bad ring alignment when a scope has to make contact with three mounting points. Generally speaking, rings that are machined show a lot of alignment problems. Maybe that's why we now hear about "Lapping" of rings in scope installations. What we found was that we got the best alignment from rings manufactured by extrusion processes. Extrusion is very much like the Play-Dough Factory little kids use. Aluminum is pressed through a die and comes out a big long tube shaped like a scope ring. Individual rings are cut from this "extrusion". Since it all comes out of the same die, alignment from one ring to the next is identical! The same holds true for scope mounting bases. There are folks who want steel scope mounts just because they trust steel more than aluminum. But steel can't be extruded... it has to be molded or machined...

neither of which process works as well as extrusion for alignment purposes. The truth is, extruded aluminum scope mounts hold scopes super solid, they don't weigh a ton, and they offer the alignment advantage of having been made identical from one to the next by extrusion.



Mueller APV Riflescopes



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Swift Magnum Recoil Rifle Scopes



Tasco Mildot Rifle Scopes



Mueller Parallax Adjustable Riflescopes



Swift Mildot Reticle Rifle Scopes

Hawke Illuminated Reticle Riflescopes

Objective Lens Size, Lens Quality, and Lens Coatings

OBJECTIVE SIZE - Everything we see is really just "light" being reflected off objects in our field of view. The less

from Vietnamese sand/glass and that also explains why there are so many fine optics manufactured in Asian countries

light there is, the less we see. A term you will see quite often associated with optics is "light gathering". It refers to the ability of an optical device to capture as much light as possible. It is a common mis-conception that magnification is what allows us to see more through a tele-scope. But magnification only makes things bigger. In fact, magnification reduces the field of view, reducing the amount of reflected light, and letting you see less! Try it sometime with a really high powered zoom rifle scope. The higher you zoom, the darker your sight picture becomes! Generally speaking, the larger the objective (front) lens of a scope, the more light it can gather, and the more you can see. This is the rea-soning behind the 50mm scopes we see being offered in recent years. As with anything, the size of the objective can reach a point where the improvement isn't significant compared to other optic-al considerations. For example, I'm con-vinced that 50mm objectives only make a significant difference over the 40mm when riflescopes are used at the higher magnifications of 14-36X.

LENS QUALITY - Did you know that one of the chief exports from Viet Nam is sand? Sand is what you make glass out of, and Viet Nam has such exceptionally pure sand that other countries actually buy theirs rather than purify their own! There are a lot of scope lenses made

(And yes, there are some absolute junk optics from there, too). It stands to reason that the optical clarity of the lenses in a telescopic sight will have a lot to do with how much light is gathered... and how much you can see. Poor quality glass will also present distortions and distractions. "Chromatic Aberration" is a distortion you'll see around the edges as you look through a low quality scope. Combine a distortion with some parallax error and you'll have a real tough time shooting accurately. Good quality glass makes a scope cost more. But you don't have to pay alot.

LENS COATINGS - Being highly polished, a glass lens not only gathers light... it also reflects it away. And the more that is reflected away, the less you can see through the scope. Lens coatings are used to reduce reflection and improve light gathering. As you look at a coated lens from the side, you will see a colored hue to what is reflected in the lens face. Most coating hues are blue. Some are green. And some are pinkish. Some manufacturers have enhanced coating systems that use multiple coating layers and materials to give even better light gathering and the least possible reflection. Suffice it to say, lens coatings make such a big difference that no high quality optics are offered without them. The best in lense coatings is called: "Fully Multicoated".



Mueller APV Riflescopes



Mueller Silver APV Riflescopes

General Rifle Scope Information and Personal Preferences

Magnum Recoil Riflescopes - We're often asked if a particular scope will hold up to the heavy recoil of this or that hard kicking magnum cartridge. The truth is that all centerfire rifle scopes are designed to withstand the recoil of all centerfire rifle cartridges. However, some combinations of rifle and cartridge can be especially punishing... (For instance a 325 WSM in a pencil barreled mountain rifle). A general rule of thumb is that you can't expect the cheapest priced riflescope to hold up under the heaviest possible recoil.

30mm Tubes vs. 1 Inch Tubes - In recent years we've seen an increase in the popularity of 30mm riflescopes. Judging from the specification charts, there doesn't seem to be much difference in light gathering, field of view, etc. However, the military and police sniper world prefers 30mm tubes because they have a wider adjustment range for wind-age and elevation. You never want to be adjusting right to the maximums but the

bad for accuracy. With the limited field of view and reduced eye relief of handgun scopes in the over 7X magnification, I recommend them primarily for bench rest target and varmint shooting.

PERSONAL PREFERENCES - I do recommend the scopes we sell but it isn't a prejudice. First, any scope brand that has a lot of defects doesn't stay in our line very long. We don't like problems anymore than you do! Second, I like to get as much quality as I can for my money and figure you do, too.

With that in mind, here are my thoughts on what to consider when purchasing a scope:

50mm Objectives - These are most significant when using highest magnification scopes of the 18X-36X variety. But, they certainly don't hurt when you're zoomed up in 12-16X scopes either.

40mm Objectives - The best value for features and quality on scopes with magnifications up to 18X.

sweet spot in the middle adjustment range is bigger on 30mm scopes. Target and varmint shooters may like this, too.

The next consideration in a 30mm tube scope is that you will need 30mm rings. At least on our [Warne 30mm Rings](#), we've found that a medium height 30mm ring will put the center of the scope at the same height as a high ring will do in 1" scopes. As a result, the 30mm scope appears to be mounted lower... And this brings up a final consideration: The Rifle scopes with 30mm tubes *look* really tough, compact, and beefy.

Ballistic Reticles/Special Reticles - Standard on most riflescopes is a Plex-Style reticle that's wider on the outside and narrower on the inside of the cross-hairs with a single, centered aiming point. In contrast, Ballistic Reticles feature multiple aiming points to allow accurate shot placement at more than one distance. Nowadays, you can download "Apps" to your phone that will calculate the aiming points for any centerfire, rimfire, airgun, muzzleloader, slug gun, or even crossbow ammunition.

There are various standards as well as proprietary ballistic reticles, a "Ballistic Plex" reticle (by Burris) has been licensed and standardized on several brands of scopes and is support-ed by Burris with a wide range of precalculated cartridge data.

Last but not least, the original Mildot reticle is intended for range finding but can be used for multiple aiming points. To use it for range finding, see our [Mildot Technical Report](#). Again, there are smart phone Apps for many popular Ballistic Reticles... Lots of choices!

EYE RELIEF IN HANDGUN SCOPES

- Since a handgun is held at arms length away from your sighting eye, the "eye relief" of a handgun scope is set for a longer distance than it is on a rifle scope. What a lot of folks don't realize is that variable power (zoom-magnification) scopes change their eye relief as the magnification zooms from low to high. A scope that is an arms length away at 2-3X has to be sucked back to 10-11 inches away on 7-9X. Since a hand-gunner is most accurate when he maintains a consistent hold, having to change his hold for a variable scope is

Parallax Adjustable - I highly recommend it when the other features of a scope meet with your needs. Parallax adjustment simply dials out the optical aiming error at exact shooting distances. You can set it for a general distance when hunting. Or you can set it to an exact distance when shooting groups.

Magnification - I hunt deer in Minnesota using scopes set for 2-4X in the woods. I hunt Antelope in Montana using scopes set from 4-12X on the open range. Anything over 12X and I lose my ability to find what I'm aiming at as I shoulder my rifle. So, a 4-12X40mm is the best all-around scope for me. I like this magnification range for Varmint shooting as well. For targets and group shooting, I like scopes that zoom up close... 18-32X. For a handgun, 2X is best for off-hand. 6X for bench shooting.

Mueller Scopes - Made from the finest Japanese glass with high end German lens coatings. These scopes are famous for their [unique reticles](#) as well as superb optics at a low price.

Bushnell - Now combined with Bausch and Lomb. Their [Trophy XLT](#) lines of scopes are top quality optics at a reasonable price.

When 2-7X is Best - If you hunt in the Minnesota woods, a 2-7X Wide Angle scope would be an excellent choice. Same with a 1.5-4.5x32mm. At 1.5-2X magnification you can find your target fast when its up close, in the brush, and moving. A scope objective captures a HUGE amount of light in the low magnification range. And you generally wouldn't need more than 6-7X magnification for shots in open areas of the Minnesota woods.

PERSONAL CHOICE HANDGUN SCOPE - The Bushnell Trophy XLT 2-6X gives me the same 2X eye relief when I zoom it up to 6X magnification. Its a tough scope with perfect pistol optics.

IN CONCLUSION - I hope this Technical Report is helpful in making your choice for a good scope sight for your rifle or handgun. And, I hope you will order your scope from E. Arthur Brown Company!
Sincerely, Eben Brown