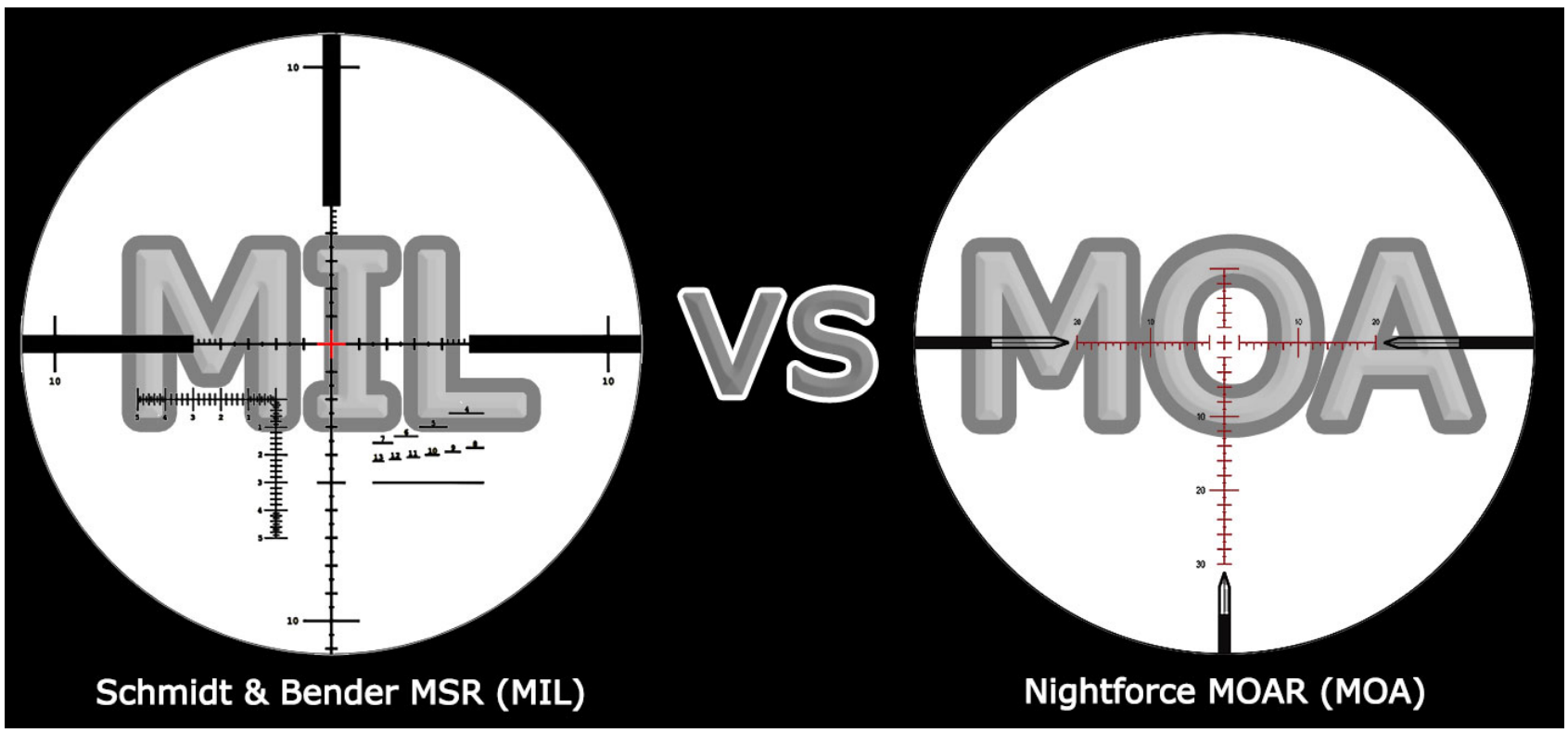
MIL vs MOA: An Objective Comparison



There are a lot of articles and forum threads out there comparing MIL and MOA, but most either aren't objective or they're overly complex. I'll try to avoid both of those pitfalls in this article.

Executive Summary

A few months ago I asked Bryan Litz whether he personally used MIL or MOA. Bryan is an expert among experts in the shooting community, and after reading his books I've gained a respect for his scientific approach to decisions like this. His response was so concise and objective, I thought it could serve as the executive summary for this whole comparison:

> *"**You can't really go wrong with either (MIL or MOA). They're both equally effective, it comes down to how well you know the system.** If you're comfortable with MOA, I wouldn't recommend switching to MIL. I have a few MIL scopes but primarily because they're on rifles used for military evaluation projects, and that community is now mostly converted to MILS, so when in Rome…*
>
> *So if you have a hunting buddy that you want to be on the same page*

> *with, that might be a factor. But for your own use,* ***neither has an inherent advantage****."*
>
> *– [Bryan Litz](), Author of Applied Ballistics for Long Range Shooting & Chief Ballistician at Berger Bullets*

There are a handful of minor differences/trade-offs between MIL & MOA, but there are no inherent advantage to either system. **Most people blow the small differences WAY out of proportion**. So if you are like I was and stressing about what to go with … relax, neither is the wrong decision. Here are the biggest differences and things to keep in mind. The rest of the article will expand on these in more detail:

- 1/4 MOA adjustments are *slightly* more precise than 1/10 MIL
- MIL values are *slightly* easier to communicate
- If you think in yards/inches the math for range estimation is easier with MOA. If you think in meters/cm the math is easier with MIL.
- If you have a friend that is already using one, there is some advantage to being on the same system.
- Around 90% of the pros use MIL
- More product options in MIL
- Whatever you decide, go with matching turret/reticle (i.e. MIL/MIL or MOA/MOA)

The Factual Differences

There are only a couple differences between the systems that have much merit. They are very slight, and barely worth mentioning.

1/4 MOA Is *Slightly* More Precise Than 1/10 MIL

The most common adjustments are 1/4 MOA or 1/10 MIL. Technically, 1/4 MOA clicks provide a little finer adjustments than 1/10 MIL. This difference is very slight and it'd be hard to claim you could "shoot between those numbers." It only equates to 0.1" difference in adjustments at 100

yards or 1" of at 1,000 yards, and there are very few shooters who could hold well enough to notice that difference (or isolate it to that single factor). I can't.

Precision of 1 Click @ 1,000 Yards	
1 MIL = 36"	1/10 MIL = **3.6"**
1 MOA = 10.475"	1/4 MOA = **2.6"**

If finer is better, why not go to 1/8 MOA clicks? Some scopes have that, but most long-range shooters feel like that is too fine. In fact, at the 2013 Steel Safari competition **Ray Sanchez said he actually thinks 1/4 MOA is too fine, and actually prefers 1/2 MOA adjustments on his scopes**. Ray is a very accomplished shooter, having won national long-range shooting competitions and is well respected in the shooting community. He thought for practical long-range shooting he would rather be able to dial quickly (15 MOA of adjustment is 60 clicks with 1/4 MOA adjustments, but only 30 with 1/2 MOA), and his experience has taught him that having adjustments as fine as 1/4 MOA just isn't as important as the rest of the things that go into executing a good shot. I can't say I totally agree with him but there does seem to be a balance point there somewhere, between too fine of an adjustment but fine enough to dial in the spot you want to hit. **Most shooters agree that 1/4 MOA or 1/10 MIL are both right around that sweet spot, which is evident in the scopes used by the pros.**

MIL Values Are *Slightly* Easier To Communicate

You can see in the range card examples below, 1/4 MOA adjustments take up more room and are a little harder to read than 1/10 MIL adjustments. The adjustment for 725 yards is "22.75" MOA (4 digits), or "6.6" MIL (2 digits). That is essentially the same angular adjustment (dope cards are both for the same ballistics), but MILs are larger units so they are represented by significantly smaller values than MOA. Also units in 10ths fit our numerical system (base 10) more naturally than fractional units. Not only does that make a range card simpler and quicker to read, it also is

slightly easier to communicate elevation values to a partner. It's just easier to process "6.6" instead of "22.75".

Range Card Examples

Both are based on real ballistics for a 308 Win firing Federal's Gold Medal Match Ammo with 175gr Sierra MatchKing bullets at 2600 fps

MIL

Range (yd)	Elev (mil)	Wind (mil)
600	4.8	1.5
625	5.2	1.6
650	5.5	1.7
675	5.9	1.8
700	6.3	1.9
725	6.6	2.0

2 digits

MOA

Range (yd)	Elev (MOA)	Wind (MOA)
600	16.50	5.2
625	17.75	5.5
650	19.00	5.8
675	20.25	6.1
700	21.50	6.4
725	22.75	6.7

4 digits

How Do You Naturally Think?

If you naturally think & talk in terms of meters and centimeters, the math for range estimation is easier with a MIL system. But if you naturally think & talk in terms of yards and inches, the math is easier with a MOA system. If you don't plan to do range estimation with your scope (which few do), then both are equally effective.

Here are a couple questions to help you figure out what you naturally think in:

- When asked how far away a target is, would you answer in yards or meters?
- When asked how wide a target is, would you answer in inches or centimeters?
- Is your rangefinder set to give units in yards or meters?
- Is your dope card in yards or meters?

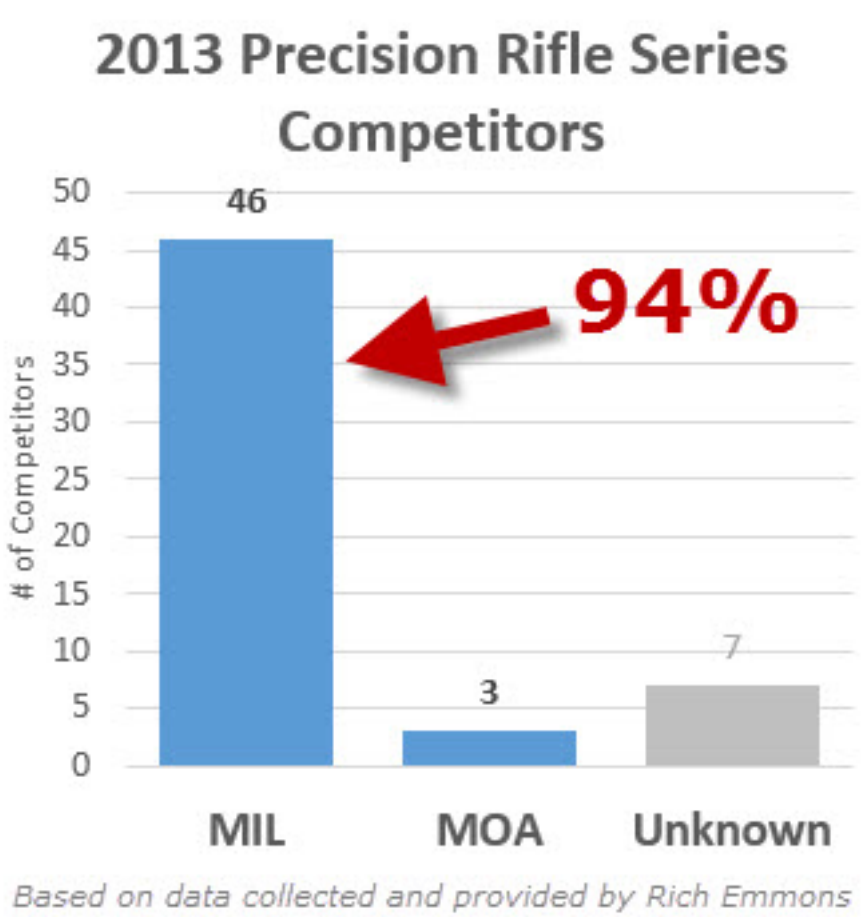
If you typically think in yards & inches (i.e. U.S. Standard Units), that doesn't mean you can't go MIL. But if you are around guys like Todd Hodnett or members of the military that use that system … you will quickly notice they talk in terms of meters (i.e. metric units). Overtime you can

train your brain to think in metric, but it is almost like learning to speak another language. It just takes time/discipline and/or immersion in the new system to make the switch.

If you try to do range estimation in yards with a MIL based system, the math will be more difficult. I've provided several examples that illustrate this at the end of this article. It is actually too difficult for a lot of people to do in their head, so they end up relying on an index card filled with sizes of targets in inches, the measured size in MILS and the range those equate to. In fact there are even many tools out there to address this exact problem (e.g. Whiz Wheel, Mildot Master Slide Rule). You can avoid needing to carry something like that altogether if you simply **stick to doing range estimation in meters with a MIL based system, and in yards with an MOA based system.**

Like Bryan Litz mentioned, if you have a friend that you shoot with a lot that has already committed to either a MIL or MOA system, there is some advantage to you both being on the same page. I have friends that shoot both (2 of us MIL, and 2 of us MOA) … and I can testify firsthand that it can get confusing when asking what someone's wind hold was. If you compete as a team, then the communication you need to have to compete makes it virtually a must to use the same system.

What Do the Pro's Use?



That's right, 46 people in the 2013 Precision Rifle Series said they used a MIL based reticle, and only 3 said they use a MOA based reticle. 7 said they used a reticle that is available in both MIL & MOA, so I threw those out because I couldn't say with certainty which camp they fell in. But a 49 person sample size containing people willing to compete in up to 15 national matches each year can be very telling.

This does NOT mean MIL is better. It just means MIL based scopes are more popular, even among the top 1% of shooters out there. It also might be a chicken and egg question or even almost a self-fulfilling prophecy, because high-end MIL scopes are more readily available.

Military & Manufacturer Influence

The popularity of the MIL system is undoubtedly heavily influenced by the military standardizing on the MIL system. When the military standardizes on something, it suddenly becomes very popular in the civilian world as well (sometimes regardless of how it compares to other options available). For example, look at the popularity of the civilian equivalent of NATO-based cartridges like the 223 Rem, 308 Win, 300 Win Mag, 338 Lapua, and 50 Cal. There may be other cartridges that are ballistically superior to some of those rounds … but that short list still continues to outsell every

other cartridge year over year.

Many manufacturers choose to focus on MIL-based systems because they are competing (or hoping) for military contracts. And since the two systems are so similar, and there isn't an inherent advantage to either … why have to tool your entire assembly line to offer both? Also since there doesn't appear to as high of demand for MOA based systems, companies may make a business decision to only offer MIL based systems to reduce their internal complexity and increase efficiency. Many of the high-end scopes are made by European companies like Schmidt & Bender, and virtually every country outside the U.S. has switched completely to the metric system. So it may not be as big of a sacrifice in their eyes to only offer MIL based systems.

The fact remains, whatever the reason, that **there are more products based on MIL than MOA**. For example, try to find a spotting scope with a MOA based reticle (used for ranging targets). I personally looked a couple months ago, and slowly became convinced they simply don't exist (at least at that time).

Matching Reticle & Turrets

Whatever you decide, **don't mix reticle & turrets of different units**. Many entry-level scopes may have a mildot reticle (MIL based), but the turret adjustments are in 1/4 MOA clicks. That doesn't make a lot of sense, and can limit how quickly you can make 2nd round corrections. If you are using a reticle/turret system that is either MIL/MIL or MOA/MOA, and you see your 1st bullet splash impacted low, you can quickly measure how far low using your reticle and dial that extra adjustment for a speedy follow-up shot. For example if it was 1 MOA or even 1 MIL low, just turn your knob an extra 1 MOA or 1 MIL respectively and you should have a second round hit. You could alternatively hold high by whatever amount you measured instead of dialing it and avoid the conversion, but I like to know what the correct dope should have been so next time I can dial it in and get a 1st shot hit.

When you mix the units you are essentially trying to live with one foot in each camp, and it can make life harder than it needs to be. For example, if you had a scope with a mildot reticle and MOA adjustments and saw the bullet splash was 1.5 mils low. You would have to do some math to figure out what the equivalent adjustment would be in MOA. The math below would indicate you need to dial an additional 5.25 MOA (if you were using 1/4 MOA clicks).

$$\textbf{\textit{Conversion Formula}}: 1\ mil = 3.438\ MOA$$
$$\textbf{\textit{Calculation}}: 1.5\ mil = 3.438 \times 1.5 = 5.157\ MOA$$

I have a very smart friend that is an accomplished long-range shooter, and he actually prefers a MIL reticle with MOA turrets. It blew my mind when he said that, but he prefers to talk about wind holds in mils because that is what most other people are talking in. But he prefers the finer adjustments 1/4 MOA clicks provide, and to him the dope card is just a number he turns his scope turret to … he doesn't care if it is MOA or MIL. So on his dope card, his elevation adjustments are in MOA and his wind adjustments are in MIL. I've had to do that for one of my scopes in the past, and I personally didn't like it. But there are at least a few opinions out there on this.

Range Estimation Math Examples

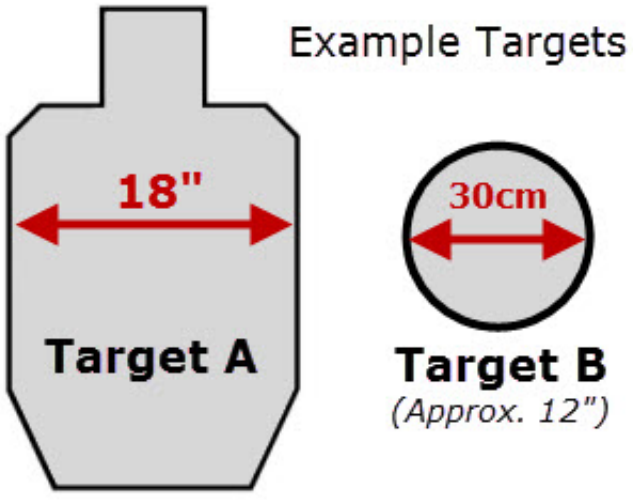
The examples below illustrate how easy it is to use the MOA system to do range estimation in yards, and how well the MIL system can do range estimation in meters. **There are also some examples that illustrate how difficult the math can be if you try mix the metric/standard systems by trying to use the MIL system to do range estimation in yards.** Here are the range estimation formulas we'll use for these examples:

$$\text{Range in } \textbf{yards} = \frac{\text{Target size in } \textbf{inches}}{\text{Target size in } \textbf{MOA}} \times 100$$ ← **Easy**

$$\text{Range in } \textbf{yards} = \frac{\text{Target size in } \textbf{inches}}{\text{Target size in } \textbf{MIL}} \times 27.8$$ ← **Hard**
MILs & yards don't mix well

$$\text{Range in } \textbf{meters} = \frac{\text{Target size in } \textbf{centimeters}}{\text{Target size in } \textbf{MIL}} \times 10$$ ← **Easy**

You can see in the formulas that we have to multiple some things by 10 or 100 … but when you mix yards and MILS you end up with strange constants like 27.8 to account the necessary conversions between the standard and metric systems. Some people even show that number to be 27.778, but that level of precision just isn't necessary for range estimation when using small arms. Multiplying by 10 or 100 is simple compared to multiplying things by 27.8. Even the best math whiz would have difficulty doing this level of math in the field under any type of stress or time constraint.



MOA Example 1: Simplest Math Scenario

Using your MOA reticle, you measure Target A to be 2.0 MOA wide. You know the actual target is 18" wide, and you want to find the range in yards.

$$\text{Range in } \textbf{yards} = \frac{\text{Target size in } \textbf{inches}}{\text{Target size in } \textbf{MOA}} \times 100 = \frac{18"}{2\ MOA} \times 100 = 9 \times 100 = 900\ yards$$

MOA Example 2: Complex Math Scenario

Using your MOA reticle, you measure Target A to be 3.5 MOA wide. You

know the actual target is 18” wide, and you want to find the range in yards.

$$Range\ in\ \textbf{yards} = \frac{18"}{3.5\ MOA} \times 100 = 5.14 \times 100 = 514\ yards$$

MIL Example 1: Simplest Math Scenario

Using your MIL reticle, you measure Target A to be 1 MIL wide. You know the actual target is 18” wide, and you want to find the range in yards.

$$Range\ in\ \textbf{yards} = \frac{Target\ size\ in\ \textbf{inches}}{Target\ size\ in\ \textbf{MIL}} \times 27.8 = \frac{18"}{1\ MIL} \times 27.8 = 18 \times 27.8 = 500\ yards$$

Not easy

MIL Example 2: Complex Math Scenario

Using your MIL reticle, you measure Target A to be 0.7 MIL wide. You know the actual target is 18” wide, and you want to find the range in yards.

$$Range\ in\ \textbf{yards} = \frac{18"}{0.7\ MIL} \times 27.8 = 25.7 \times 27.8 = 714\ yards$$

Not easy

MIL Example 3: Sticking with Metric (Size in CM & Range in Meters)

Using your MIL reticle, you measure Target B to be 0.4 MIL wide. You know the actual target is 30 cm wide, and *you want to find the range in meters*.

$$Range\ in\ \textbf{meters} = \frac{Target\ size\ in\ \textbf{cm}}{Target\ size\ in\ \textbf{MIL}} \times 10 = \frac{30cm}{0.4\ MIL} \times 10 = 75 \times 10 = 750\ \textbf{meters}$$

Much easier

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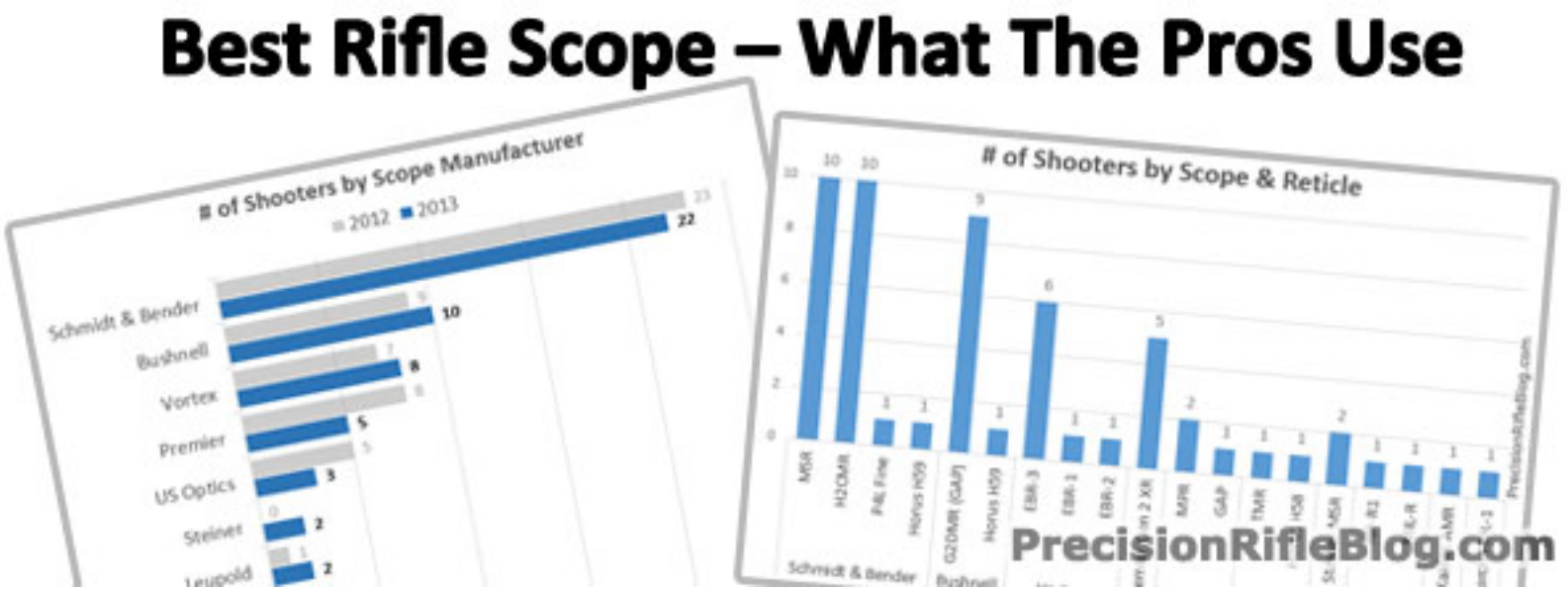

[Best Rifle Scope – What The Pros Use]: This post shows the scopes and reticles the best precision rifle shooters in the country are using. It is based on what the top 50 long-range shooters brought with them to the most recent Precision Rifle Series (PRS) Finale. Target engagements for a PRS match can range from 25 to 1,200+ yards, but there is definitely a focus on the "precision" rifle part regardless of the range. This is some unique "hard data" about what the optics the pros are using.

[Best Long-Range Scope: Buyers Guide & Features To Look For:] Advertising around long-range scopes can be misleading. This post boils it all down to the biggest features you should focus on when comparing long-range scopes. This guide explains what all the different features mean, gives you an idea of which are more important important, and helps you filter out some of the marketing noise when researching rifle

scopes. I also make specific recommendations for different price points, to help you get the best rifle scope for the money.