Range Report MERC - Maximum Effective Range Calculator

speedengineer · Sep 8, 2020

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speedengineer
Private
Minuteman

Sep 8, 2020 #1

I recently created a Microsoft Excel based tool that calculates your probability of hitting a target. It allows study of the effects of rifle and environmental variables and uncertainties on hit percentage.
Read below, and check out the screenshot to see what it's all about. I am sharing this with the community for free.

Note - you will need Microsoft Excel on a computer in order to run this tool. Versions of Excel for your phone will not work, as they don't support Excel Macros.

MERC Download Link

Introduction to MERC - Maximum Effective Range Calculator
In a perfect world, the bullets would always leave your barrel in the direction you intended with identical velocities, and there would be no uncertainty in your wind or range estimation - you would hit your target's center with every shot. Unfortunately, we have to contend with variation and uncertainty in the real world.

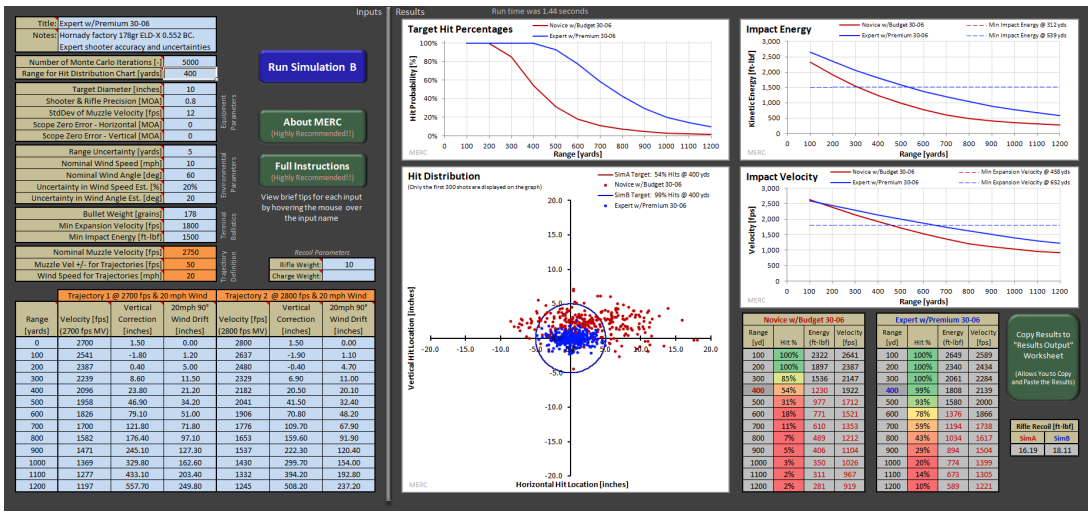
This calculator lets the user specify information about their rifle and the shooting conditions, including the uncertainty in each input. The calculator applies an amount of random variation based on those specified uncertainties, and determines where the bullet would have hit. It then repeats this process for many hundreds of shots, and calculates a hit probability based on the number of hits and misses. It also plots the hit locations for the first 300 of these shots on a graph, to visually show the distribution of their impacts.

What can I use MERC for?

MERC can be used to study many shooting situations. Here are some examples to get you started:

- Comparison of one cartridge/rifle/bullet to another. For a given set of conditions, which has better hit%, etc.
- Identify the longest range you would be comfortable hunting at, given a specific set of conditions and uncertainties.
- Estimating what hit rates to expect for a yardage that's farther than you've shot before.
- Comprehend how errors in your scope zero affect hit probability.
- How much does "x" variable matter. For example, does a 0.5 MOA rifle help my hit% for my shooting scenario? How about StdDev in MV?
- How accurately do you need to estimate range and wind in order to have consistent hits?
- For a desired hit percentage, how much extra range does using a higher BC bullet provide?
- Understanding how wind angle uncertainty can cause groups that aren't centered around your point of aim.

Special thanks to Scott B. (entoptics on LRH), who convinced me that it would be worthwhile to release this tool to the shooting community. Together, we jazzed up the user interface, design/layout, instructions, and many other details. Hopefully you find it useful!



Last edited: Sep 8, 2020

bfoosh006, Shawn1492, LastShot300 and 4 others

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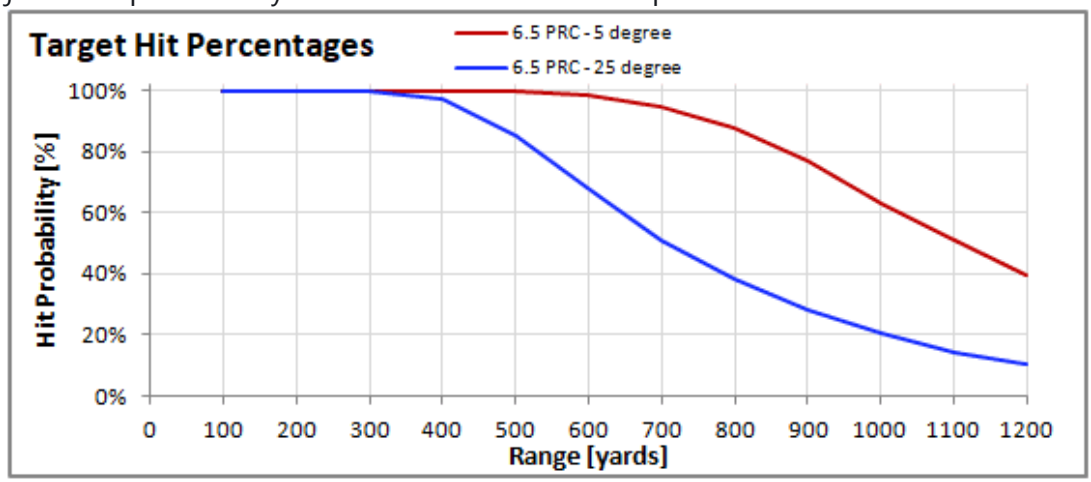
Sep 9, 2020 #2

Here is an example of one use for MERC. How much does wind angle uncertainty matter when you are shooting with a headwind or tailwind?

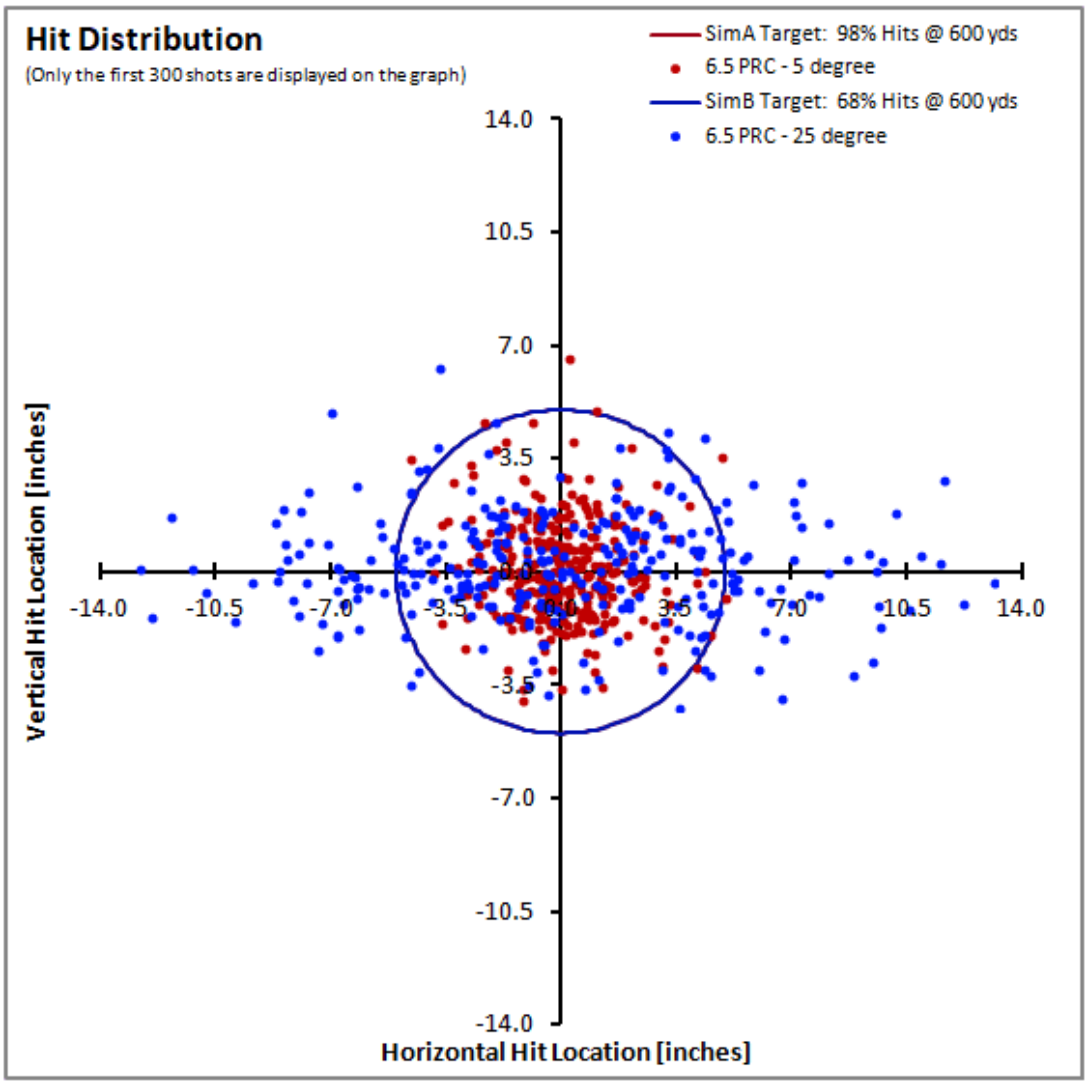
Situation: Shooting a 6.5 PRC with 143 ELDX into a 10mph headwind.
The shooter has to estimate the direction of the wind. There will always be some error in your wind direction call. Plus, wind is rarely steady and the direction is constantly changing. How does this uncertainty in wind angle affect the horizontal spread of your impacts?

Case A (Red): 10mph straight headwind with 5 degrees wind angle uncertainty
Case B (Blue): 10mph straight headwind with 25 degrees wind angle uncertainty

This simple example suggests that your estimation of the wind direction can be just as important as your estimation of the wind speed!



Hit dist plot at 600 yards



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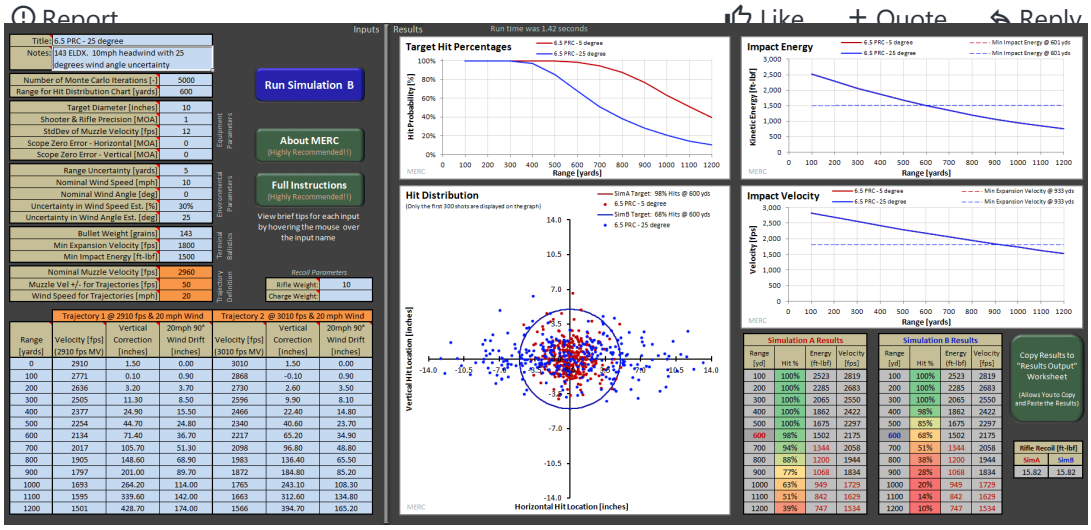

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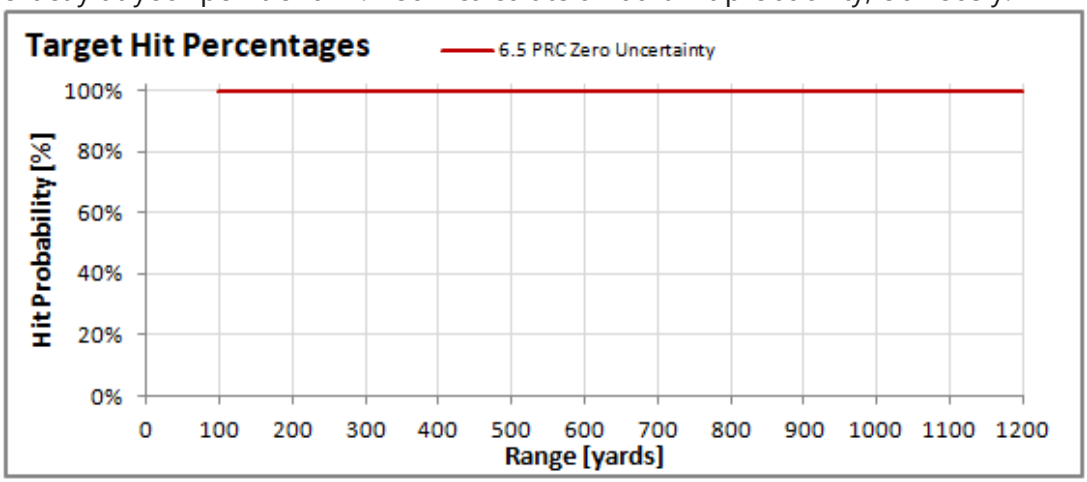
Sep 13, 2020 #3

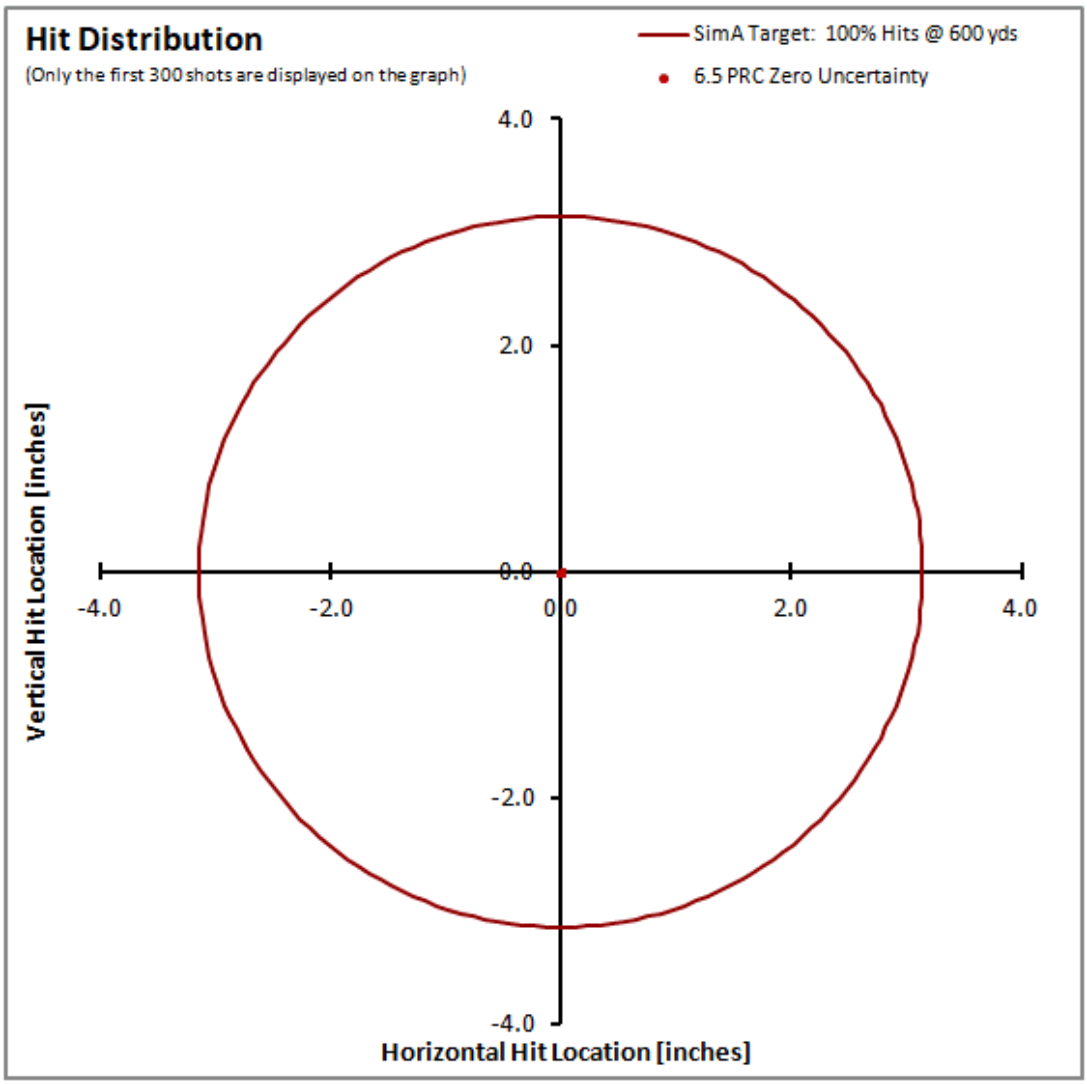
I wanted to demonstrate the effect of each one of the uncertainty parameters individually. It is helpful to understand how each parameter is contributing to your shot dispersion at range. For this analysis, I am using a 6.5 PRC with 143 ELDX shooting at a 6.282" diameter target (1 MOA at 600 yards). **Edit (I might not have used the 6.5 PRC trajectory data for this example...might be 30-06. But, the same trends apply, despite the label on the plots. I also didn't update the 'title' field for each plot. But just read the descriptions above each image...**

MERC is able to consider uncertainty in five parameters:

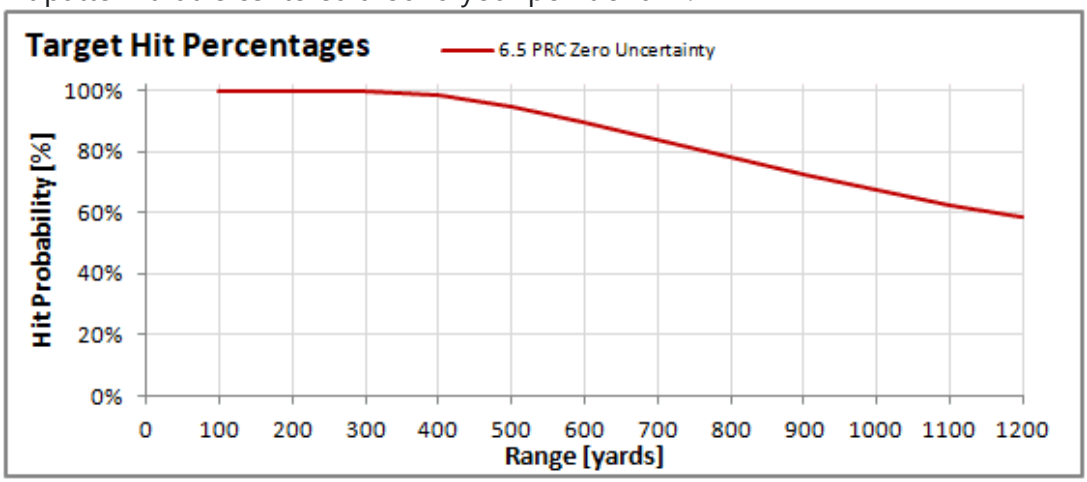
- Rifle (and shooter) Precision (MOA)
- Muzzle Velocity
- Range Estimation
- Wind Speed Estimation
- Wind Angle Estimation

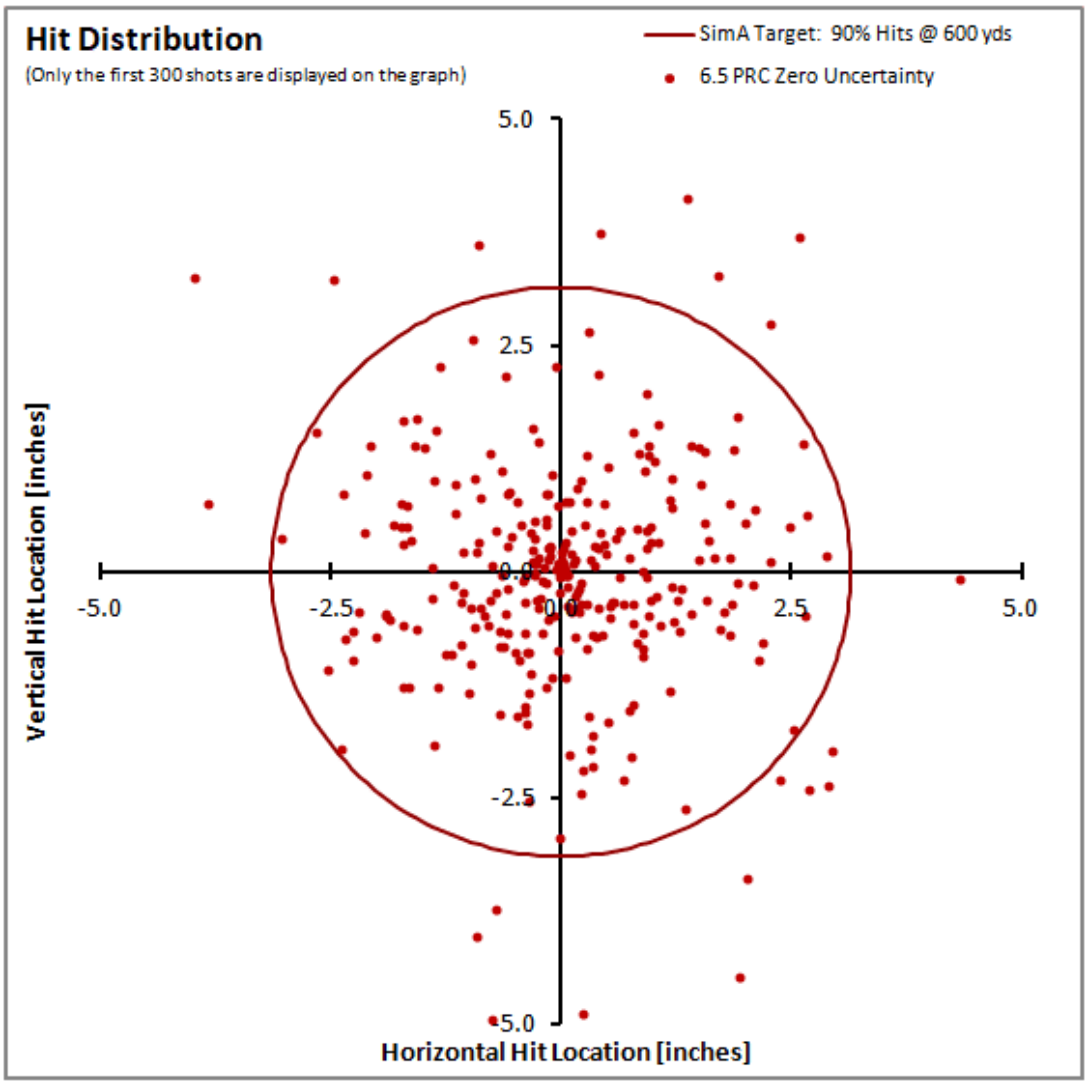
First, if you set all of the above uncertainties to zero, then all of your shots will hit exactly at your point of aim! You'll calculate a 100% hit probability, obviously.





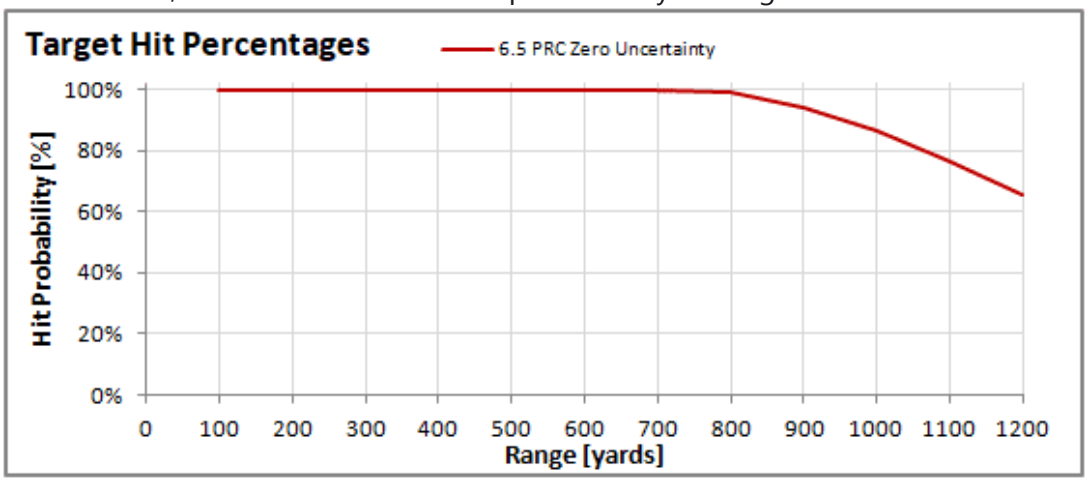
Second, if you set only the "Rifle (and shooter) Precision" value to be 1 MOA, you'll get 90% hits at 600 yards. This is because we defined a 1MOA rifle as hitting a 1MOA target 9 out of 10 shots. Notice the hit distribution plot shows a scattered hit pattern that is centered around your point of aim.

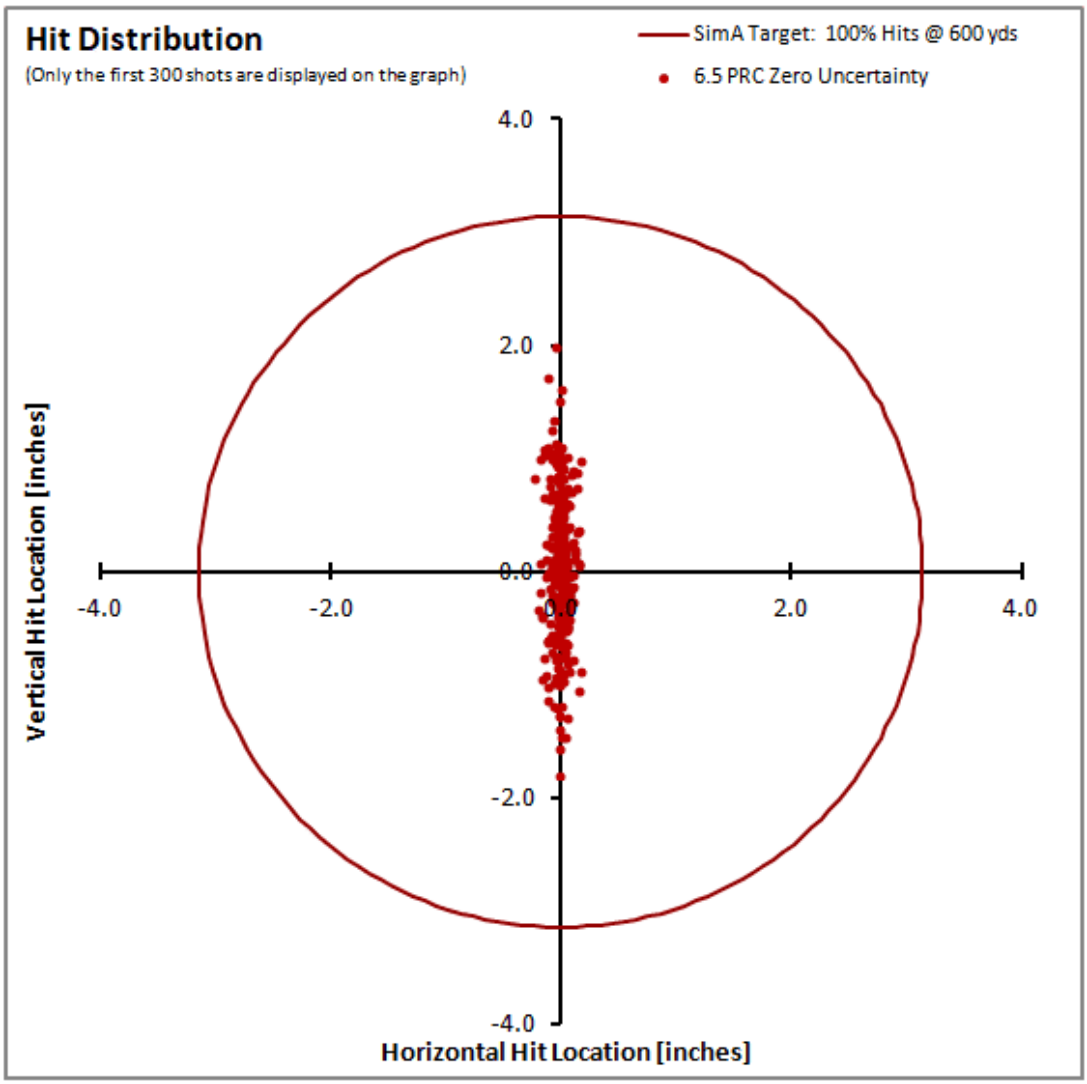




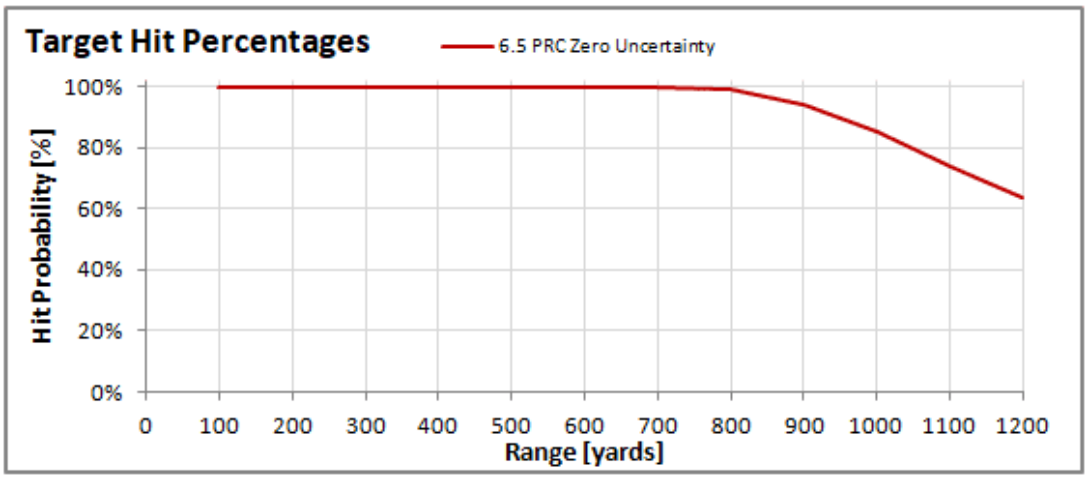
Next, let's set the Rifle/Shooter Precision value back to zero. Actually, let's put it at 0.05 MOA (almost zero) since it'll make viewing the shot dispersion of the subsequent examples easier (shots won't all be on a single line).

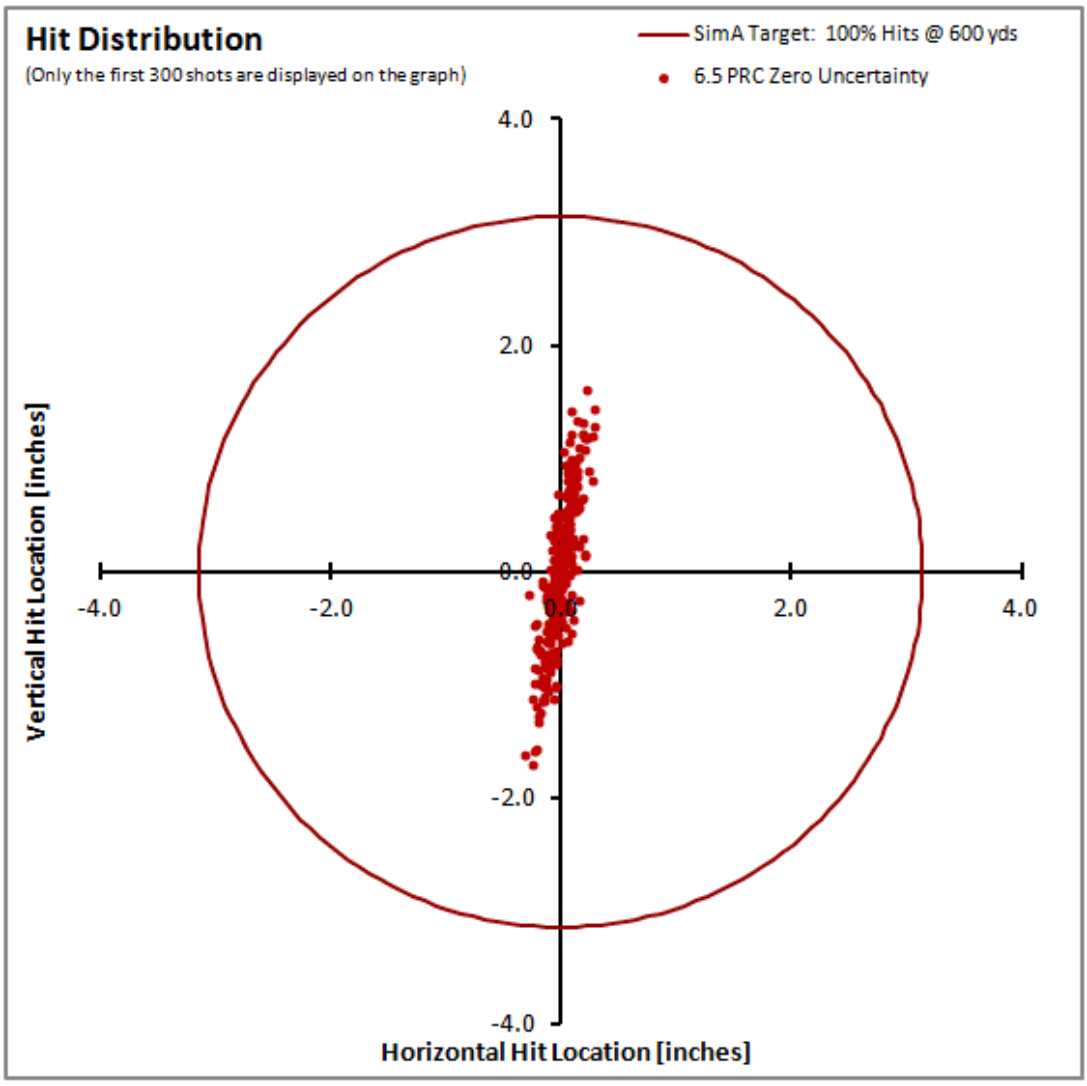
Now, let's specify 10fps of muzzle velocity standard deviation. In this situation, with no wind, MVSD causes vertical dispersion on your target.



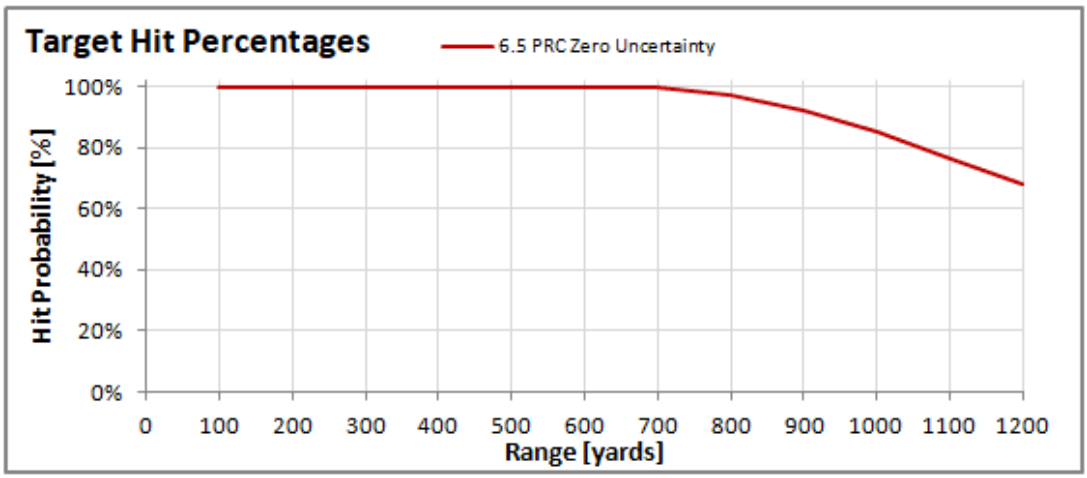


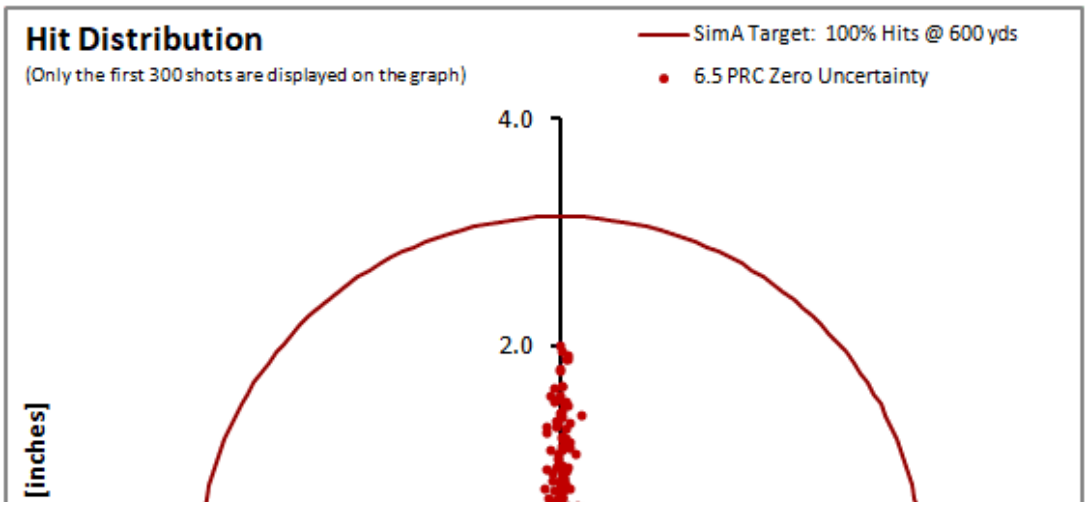
Now lets add in some 10mph crosswind from right to left. BUT, still zero uncertainty in wind speed estimation and wind angle estimation. With the addition of a crosswind, you can observe that SDMV results in hits that trend at an angle on the target! What this is showing is that when the rifle has a round that fires at a faster velocity than nominal, it hits the target high (less drop than anticipated) but it also hits that target to the upwind side! Since it was traveling faster, it experienced less wind drift than you held for. Rounds that leave the muzzle at a lower velocity than nominal will hit low, and be blown farther to the downwind side!





Set MVSD back to zero, and specify 10 yards of range uncertainty. Much like MVSD, range uncertainty causes vertical dispersion of the impact points. When the actual range is different from the range that you dialed for, your shot will hit the target either high or low.





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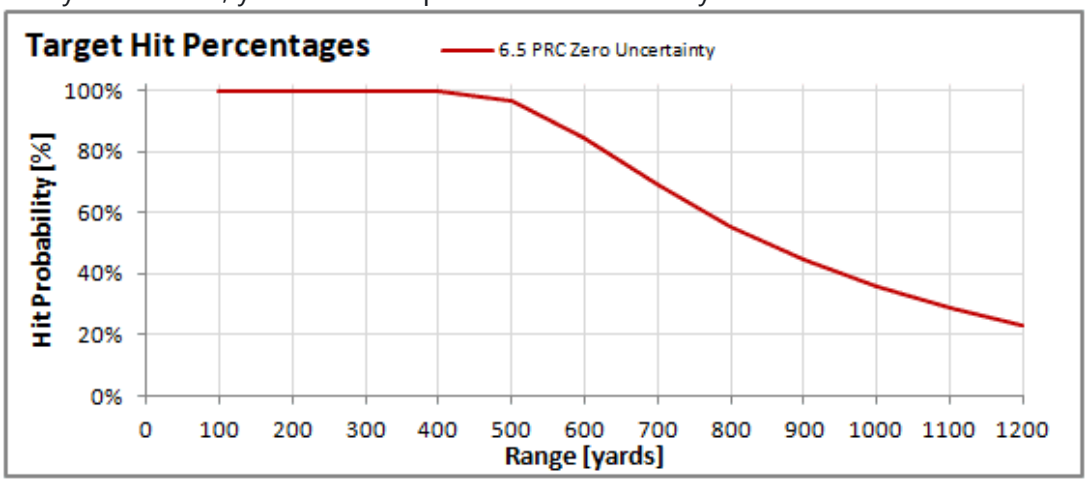
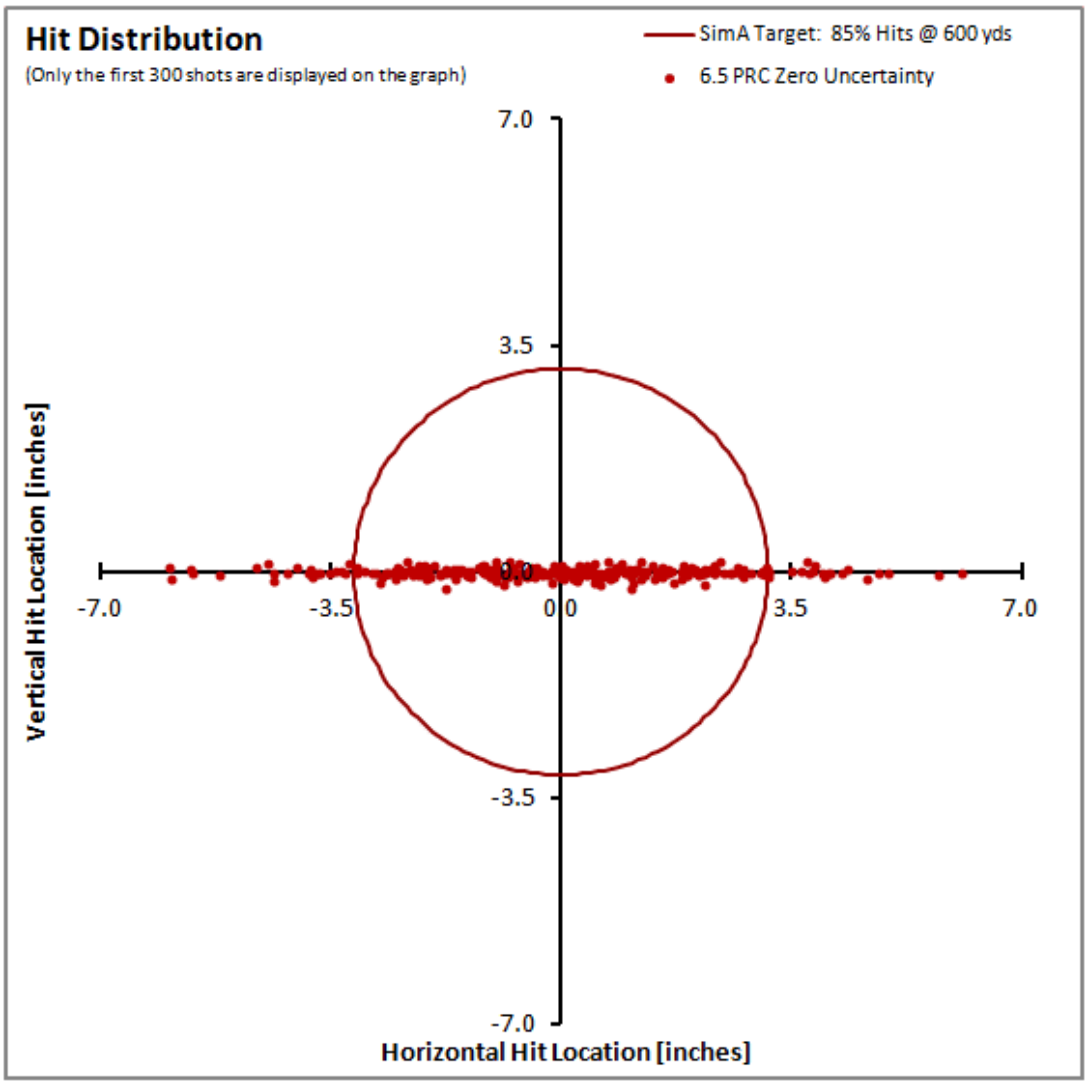
...continued...

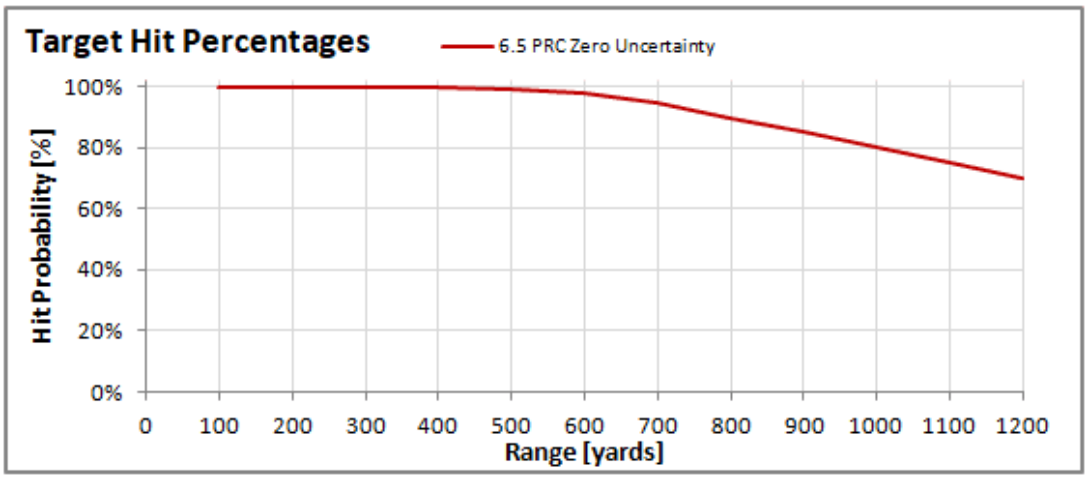
Ok, set Range uncertainty back to zero. Now let's set wind speed uncertainty to 20%.

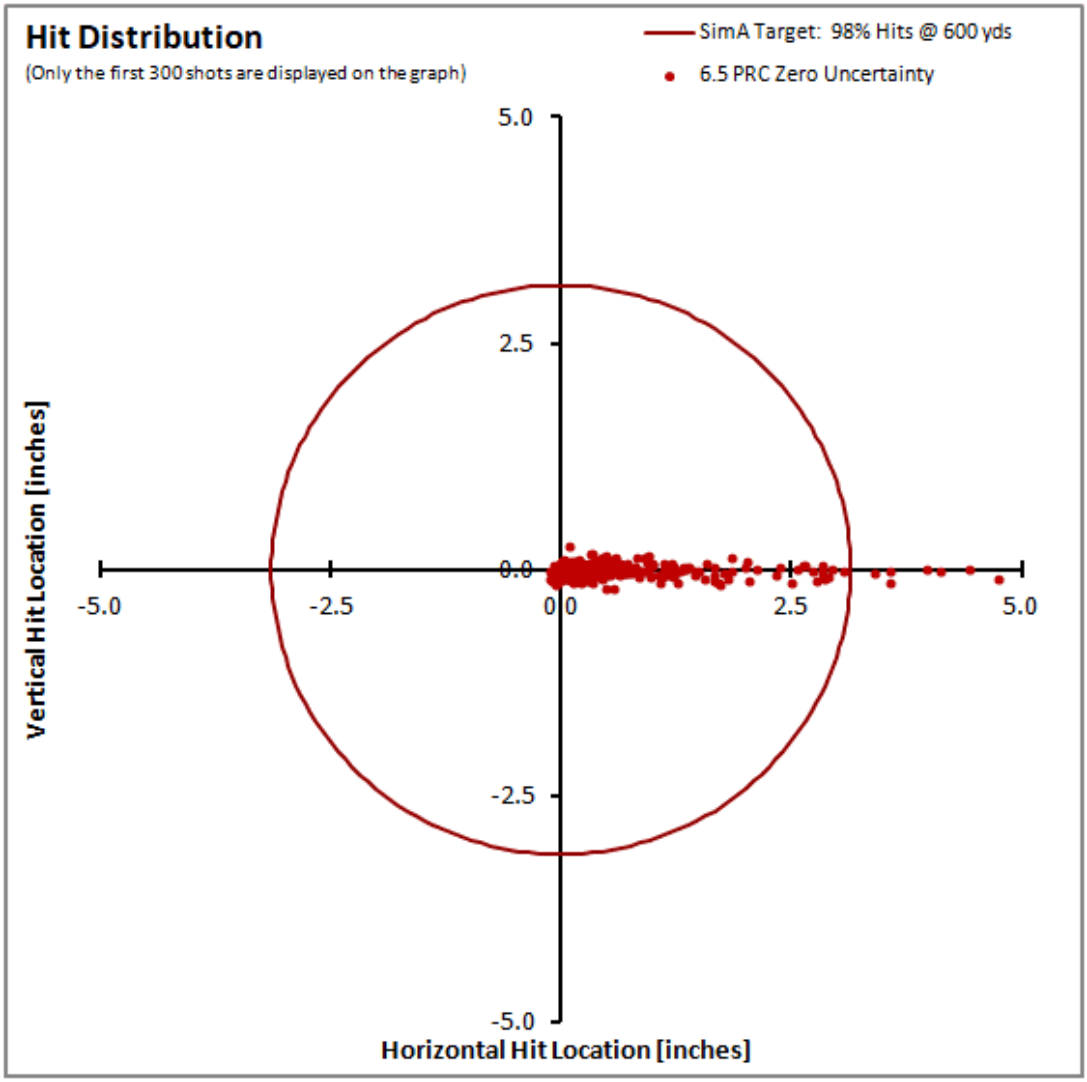
Because the wind speed for each shot is different than the nominal wind speed that you hold for, your hits will spread out horizontally.





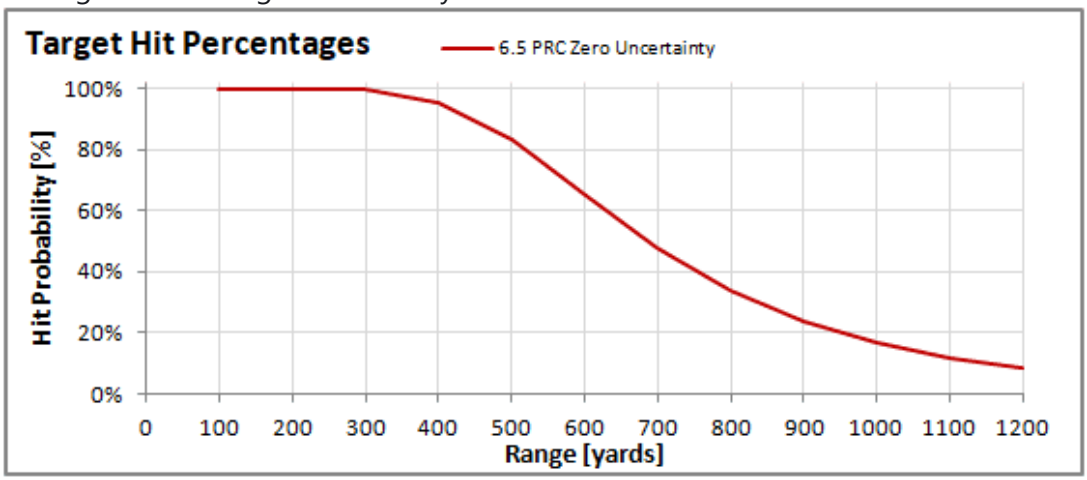
Let's set wind speed uncertainty back to zero, and set wind angle uncertainty to 25 degrees.
Because we are shooting in a 10mph 'full value' crosswind, any error/deviation in wind direction from that 90 degrees results in LESS crosswind speed than the shooter held for. Example, if wind direction uncertainty for a particular shot was 20 degrees less than actual, then the wind angle used for the shot would be 70 degrees, which will result in less crosswind speed than 10mph. Actually for this case, it would be 9.4 mph. Because of this effect, and wind angle uncertainty with a crosswind will results in shots impacting the target only towards the upwind side!!! Very interesting to note this, as it means that your groupings can become non-centered around your point of aim when shooting in a crosswind situation with variable wind direction! You may even attain a better hit percentage by aiming slightly downwind of your target center. You can experiment with this by entering a 'horizontal scope error' value into MERC.

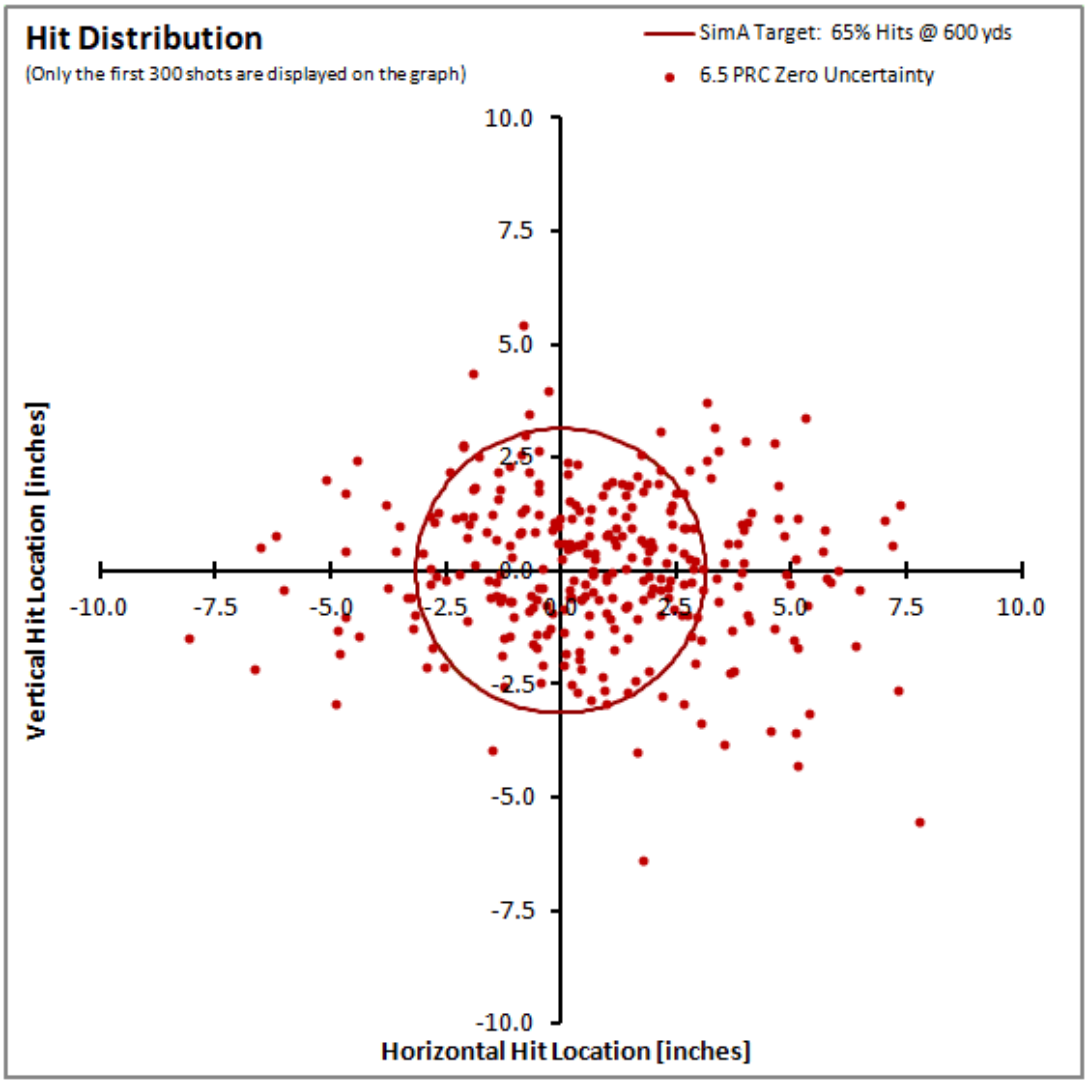




Lastly, let's combine all of the above mentioned uncertainties together. This shows the total combined effect of everything acting together to affect your rifles accuracy, hit locations, and resulting hit percentage!
1 MOA
10fps MVSD
10yd Range Uncertainty

20% Wind Speed Uncertainty
25 degree Wind Angle Uncertainty





spife7980
Luchador
PX Member
Minuteman

Sep 14, 2020 #5

entoptics

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Ledzep
Chancellor
PX Member
Minuteman

Nov 1, 2020 #6

Very cool. This type of tool should be just as prevalent as ballistic calculators, IMO. ESPECIALLY for hunters. This fad of slinging shit at 1200yd at deer/elk/etc.. with hordes of people, ignorant of the size of cone of fire being produced, justifying it is nearly sickening.

Also very valuable tools for deciding on loads, ammo types, cartridges, etc... Any tool that gives insight into what matters and what doesn't is a good one, and will let the end user streamline processes and optimize for their purpose.

Steel head, speedengineer and entoptics

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ACard
Supporter
Supporter
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Minuteman

Nov 1, 2020 #7

WOW! Just an amazing sim, thank you!

entoptics

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M

mjphawk
Private
PX Member
Minuteman

Nov 6, 2020 #8

This is really cool. Thank you for the investment of your time and efforts!

speedengineer

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barnjs
Private
Minuteman

Nov 6, 2020 #9

What an awesome tool! Really puts it into perspective for hunting. I rarely shoot over 100 yards her in Louisiana. Not sure I would want to chance anything over a 400-500 yard shot let alone a 1200 one as you mentioned, seeing as it's already a 65% shot at 600. Probably less, as adrenaline and shooting position pushes the 1 MOA higher as well.

entoptics and speedengineer

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Shawn1492
Sergeant of the Hide

Nov 8, 2020 #10

Very cool

FORUM STATISTICS

Threads: 346,932

Sniper's Hide is a community of Snipers of all kinds, focusing on long range shooting, accuracy, and ballistics. Founded by Frank Galli in 2014, Sniper's Hide has been offering informational videos, podcasts, and other support to it's users in one location.

Messages:	4,638,822
Members:	166,730
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