

Gun Convergence Settings

Or how does the bullet get to its target?

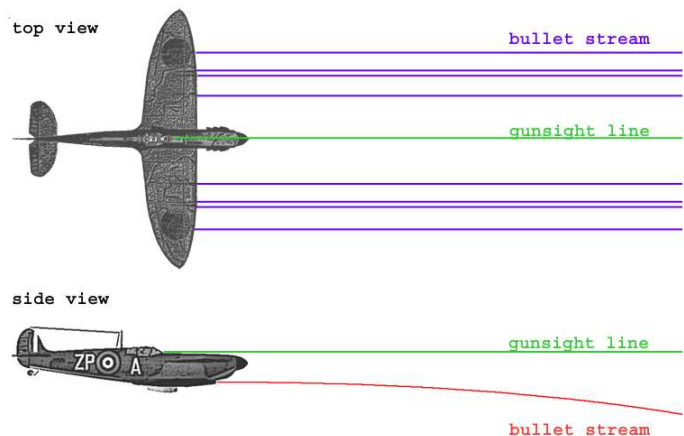
By Schatzi

Very often I am asked: What is the best convergence setting? Unfortunately, there is no easy and simple answer to this question. Your ideal convergence depends so much on personal style, gun type, plane that I can't really give you a straight out answer. Instead, I will try to make you understand what impact convergence has on your gunnery so you can answer your question for yourself.

What does convergence do?

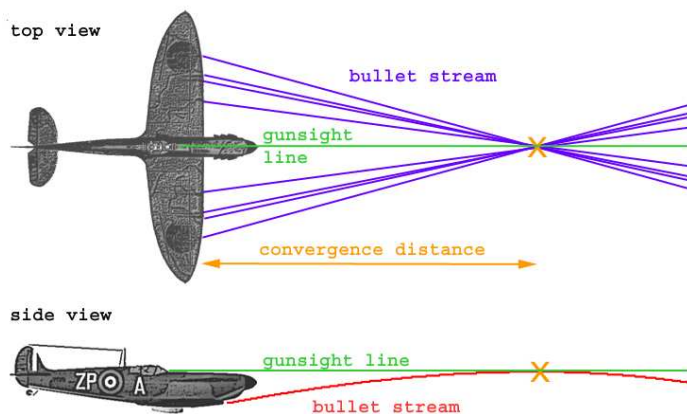
Well, that's easy to answer. Convergence is the virtual point in front of your plane where all your bullets meet up – where your gunnery points to.

Look at this picture of the Spitfire Mk I – no convergence is set, all guns are mounted straight on the wing. As you can easily see, the pilot would have a hard time shooting something.... His gunsight line (pipper) doesn't point where his bullets go, aiming would mostly be a good guess. Also, note that the guns are spread out on the wing and as such also "spread out" over the target.



On this Spitfire Mk I, the *convergence* has been set. The guns are mounted on the plane at angles – vertical as well as horizontal to adjust the

bullet streams direction. Now all rounds meet (converge) in the orange X, a point at *convergence distance* on the gunsight line. The pilot can now use his pipper to aim. Also note that the rounds are now more concentrated on target, provided the pilot's shooting range is close to his set convergence distance.



Now on to the more difficult question: What distance do I want my convergence set to?

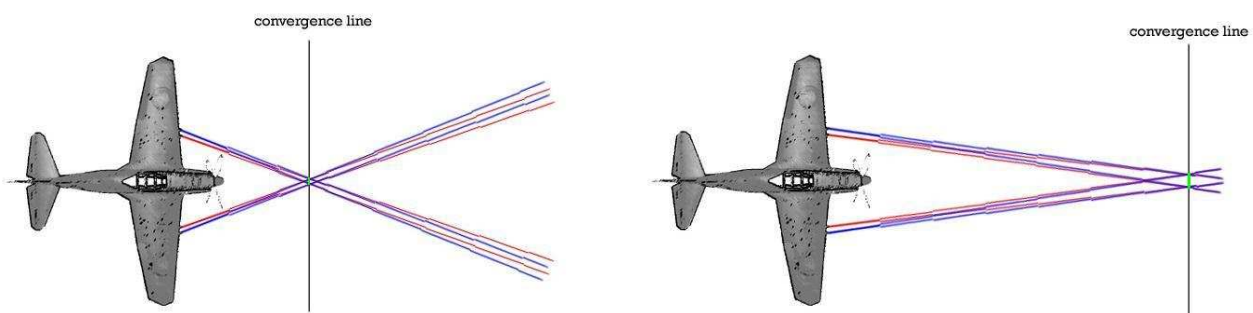
When thinking about gunnery, we have mostly one goal in mind, The fastest way to do lethal damage to a vital part of our opponent's plane – we want to score a kill. I will try and keep the ballistics part of the explanation as simple as possible, but we do need to take a look at some of its characteristics to understand how it affects our shooting.

How much damage a bullet does depends on its mass and energy (speed) on impact .We will leave out explosive rounds like cannon - of course they do more damage than a simple piece of lead

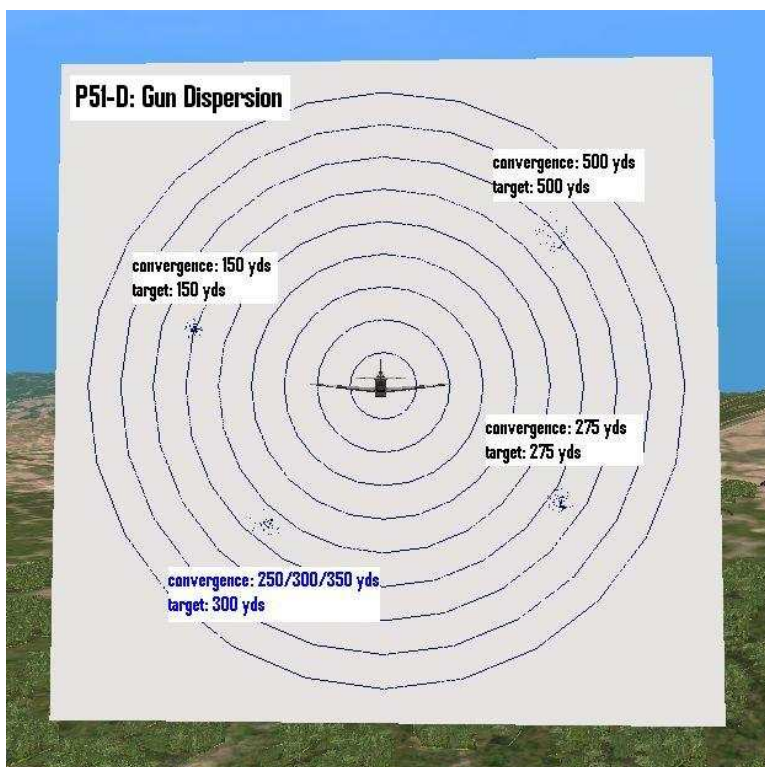
with the same calibre. Convergence settings aren't as much of an issue for those guns, let me get to that later. Back to mass and energy. The first one is rather easy.... that's the caliber of the gun. A cal .50 round of a P51-D (diameter 0.5 inch) will do more damage than a cal .303 of a Spitfire MkI (diameter 0.303 inch), the bigger the round, the bigger the hole it leaves. The second aspect gets more difficult - muzzle speed, drag, gravity drop, shooting distance and a lot of other effects come into play when talking about the "Energy" of a bullet after it leaves the barrel – generally yiz can say the further it travels, the greater the influences and the lower the energy level of the bullet gets.

Why is that important for our gunnery and convergence setting? Simply put: a single bullet fired out of the same gun does more damage hitting at 100 yards than it does at 1000 yards. Or the other way round: at 1000 yards distance you need a lot more bullets to do fatal damage to an opponent's plane part than at 100 yards. The further out we shoot, the less effective our guns are.

And something else comes into play: gun dispersion. A bullet stream leaving a muzzle will not be a straight line, each round following the **exact** path of the other one. The bullet stream will look like a cone - the further out the target is, the wider the cone, i.e. the more spread out the hit area. Convergence cannot make up for that. Notice the larger hit area (bright green) in the right drawing with the farther set convergence. Bullets will be more spread out on the target (the cones are same size in both pictures!) despite the target line being in convergence in both cases.



This is what the target area looks like at different ranges:



Note that the further away the target bullseye is, the larger the hit area, despite the target being in convergence distance each time.

Dispersion of the rounds is also a characteristic of the gun type. There are guns that have a higher dispersion (Mk 108 on a 109-K4) and some that concentrate bullets better (NS 37 on a Yak-9T), both being high caliber cannons, shots fired at same distance from target.



Now, why is convergence and dispersion important for us at all?

Especially with the lower caliber guns, you'll need a considerably amount of bullets in one place for the damage to add up enough to be fatal. Lets take a look at the extreme case of 303s... on a good shot position you will need about 300 - 400 rounds fired to do damage to a wing - now you see where the concentration of firepower in a small area is important.

If you look at the bullseye above: take the shot at 500 yards for example: Now imagine the size of a Spit at that distance and "overlay" it on the hit area.... a very high percentage of your bullets will miss, the rest will be spread out all over the plane – the percentage of rounds hitting the wing will be rather small. Now do the same with the 150 yard shot. Target size relative to hit area is a lot higher. more of your bullets will hit the target and more on one part.

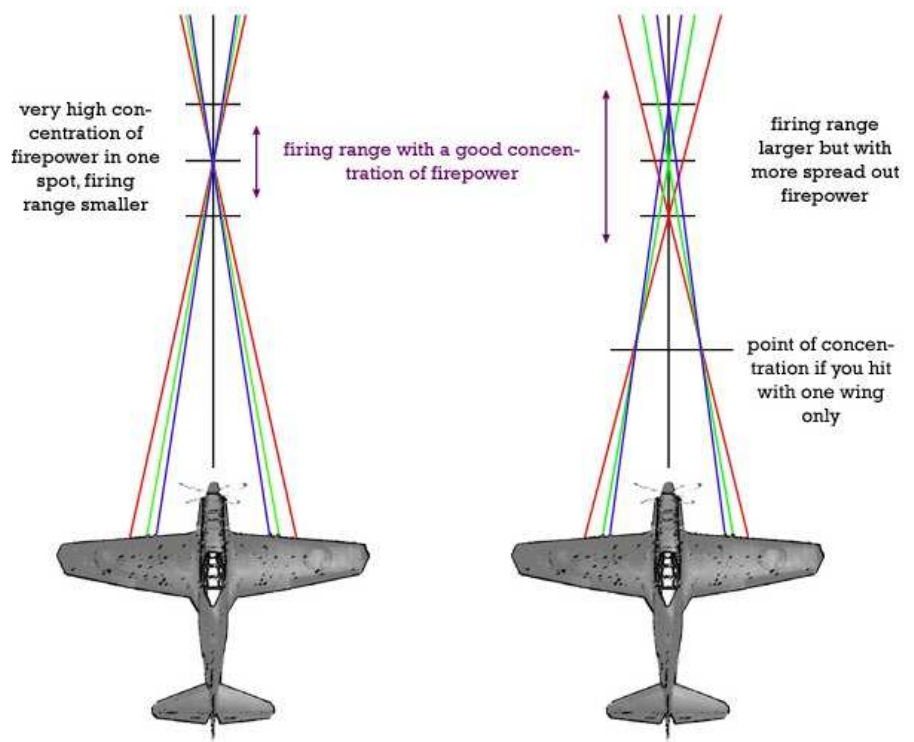
This is where hit percentage comes into play. Hitpercentage is the ratio of bullets fired to bullets that actually hit the target - its one of the parameters your score is calculated with - you can check that on the "scores" page. Lets do some maths: Your hit percentage at close range will be a lot higher – let's say 10% for easier calculations - then it would be further out. 10% is a **lot** - check your stats for comparison, mine usually is around 5-8%. Let's further assume you need 50 rounds to do fatal damage. That would mean you have to fire 500 rounds out of your guns at d100 (with 10% of them actually hitting) to do fatal damage. Now at 1000 yards your hitpercentage will drop to around 1% due to the higher dispersion and smaller target - that means you'll now have to fire a total of 5000 bullets to do fatal damage..... And this isn't even taking into account that at d1000 the rounds will already have lost a lot of their impact energy and your going to need more then 50 rounds for fatal damage.

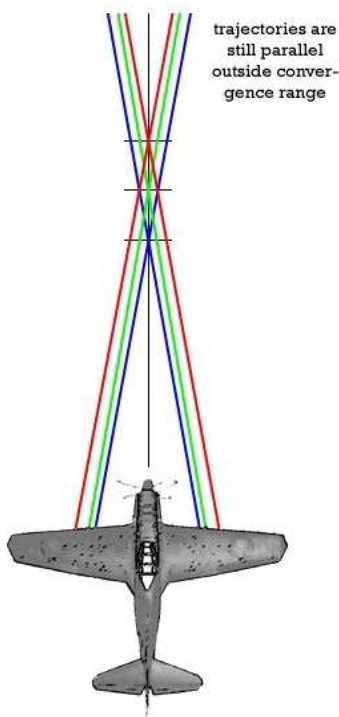
So, generally speaking - the closer shooting range, the better the chance of damage. 200 or closer is great, 400 good, 600 is lucky, 800 is tickling. Set your convergence at your usual shooting range, but a maximum thats still reasonable in my humble opinion would be 400. (after that dispersion is higher then difference between the bullet streams).

I would take 250 on turnfighters and 300 on BnZ planes (Depending on which tactic **you** use mostly for a certain plane!) and go adjust from there.

You can also stagger your convergences. Keep the distances close though - as in 250 on the outer pair (red), 275 on the middle pair (green) and 300 on the inner pair (blue). Staggering has the advantage of a larger firing range, but the concentration of bullets overall is not as good.

When staggering the convergence, you have two options. You can do it as in the picture to the right and have the inside guns set furthest out. This will give you an additional





point of converging bullet streams (of one wing only) at a relatively close range. I have found this setting to be useful in MG armed planes, when I know I'll be fighting close range and take some of my shots up close, inside convergence range.

The other option is to have the outside gun set furthest like on the plane to the left. This will not result in this second converging point, but advantage of that setting is that the bullet trajectories of the guns stay parallel for basically the whole guns range – as opposed to the above setting, where outside optimum firing range, the guns start to spread out. When bullet concentration isn't all that important (for example in cannon armed planes) and you find yourself taking shots over a very wide range of distances, this is a good setting to try.

Now I promised to say something about cannon and convergence. Clearly, for those types of explosive rounds, the concentration of bullets in one place isn't as much an issue. But convergence in term of where the bullets go relative to our aiming sight (pipper) is, since cannon rounds have a much higher drop due to their size and

considerably slower muzzle speed. This means the vertical convergence is the bigger factor here then the horizontal one. Generally I have them set out a bit further for that reason – it reduces the lead I have to pull when shooting.

Now what to do with planes that have mixed gun types? For those you have to think of how you generally use the guns. Do you fire both at the same time? Do you use the cannon on good shots and the MG for “spooking”? Or do you use the MG generally and the cannon only when you have a sure shot?

When considering those questions, keep in mind that MGs have a much higher muzzle speed then cannons. The bullets will be on target a lot faster, that means when shooting both types at the same time, the cannon will generally hit “behind” the MG (distance the target travels in the time delay between gun types hitting) – this is referred to as harmonic convergence. You can make up for that by setting the cannons convergence a little further out (50-75 yards) then the MG. This is mostly useful in nose mounted guns (like on the P38s), where the horizontal convergence is of a little less importance.

I hope I could give you some insight into how to choose your convergence in fighters. Generally speaking, the lower the calibre and the further out on the wings the guns are, the more you need to pay attention to your convergence settings and firing range.