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Ketty PhDee

PART 6: *KETTIE* SHOOTING

Shot groups for precision versus accuracy

Let's start shooting, Forker to Athlete! In Part 3, we learned about the No 1 RULE, discussed aiming sights and P.A.M., Precision vs. Accuracy, which continued in Part 4 with pellet dynamics and gyroscopic stability, procession rotation (wobble), and axial form. In part 5, we touched on propulsion, aerodynamic pellet jump, wind, and gravity. Most importantly, we discovered the Circular Error Probable (CEP/circle of equal probability) as a measure of the *kettie's* precision, and the Median Error Radius (MER). We concluded to use the USSP universal standard for comparing performance. In this part, we do "Applied Shot Group Shooting" using: GP_POI and GA_POI.

Reminder memo!

To avoid lecturing and keep every part of the series a substantive and entertaining article, I typically refer in oversight to various subjects in every part of the series to provide context and functional guidance. As the series progresses, we revisit these subjects in more detail, sometimes as and where relevant in various parts. Note our reference and the objective of this series is to get you as a *kettie* athlete, to the 10 m standard discipline shooting range line, equipped with (a) core knowledge (technical understanding) and (b) critical equipment. You have to be open and ready for an expedient (c) elective knowledge learning curve (self-discovery) to be a competitive athlete, in one season.

But first ... noughts and crosses!

My life philosophy: you cannot win at an infinite game – hence infinite. If you try to win an infinite game, losing is the only outcome, period. The infinite game of the "methodical shooting matrix" is extremely complex – a maze of dynamic elements (metrics), a challenge with infinite degrees of variables and options for every metric (element), thus endless outcomes. If you really understand the scientific discipline of *kettie*, you will realise that the margin for perfection is incalculably small, and failure (imperfection) is simply prodigious. Only an insane person who lost his faculties would devote and sacrifice a lifetime to an infinite game, and yet here we all are! Looking to shoot that perfect score? The existential dilemma of the genuineness of practical *kettie* shooting is fabricated fiction (perfection) attributed to artificial value (winning), facilitated by our perceptual experience (satisfaction, of winning, of shooting the perfect score, etc). You cannot beat "noughts and crosses", but you can beat someone (opponent) at it. Likewise, you cannot beat *kettie* ballistics, but you can beat other shooting *kettie* athletes at it! Keep in mind that (A) ballistic perfection and (B) match play ("practical application") competition are two different things. This is where you need to make the mindset change: are you competing against yourself – or an opponent – to win a match, a tournament, a series, a league? You cannot compete against yourself; in effect you compete against a system – of improving your score/consistency. (We will circle back to this notion in the future). At the very least, you should clearly understand the practical and technical considerations for your shooting discipline (match play), the decisive ballistic objectives (requirements), and the expected benefits (results) are key. The conviction to stay in the game is recognised and transcended by one central theme, which I call optimal operational orientation (match ability). Champion recipe: It is not the best of things, but it is the right combination of (A) smart work (the athlete) and (B) efficient equipment fit for your purpose. In this series of articles, the purpose/objective is: 10 metre – Club Champion.

Kettie shooting is not a talent; it is a skill based on science that can be taught and learned. Of course, some people have a better aptitude and capacity. I love *kettie* shooting because of the intrinsic technical complexity, though by its simple design has a modest, honest polarisation by most people, unlike most "other perplexing shooting sports". *Kettie* is almost a "well-kept secret", as if "we (Forkers) know things"!

Small Shot Count (Group) prejudice:

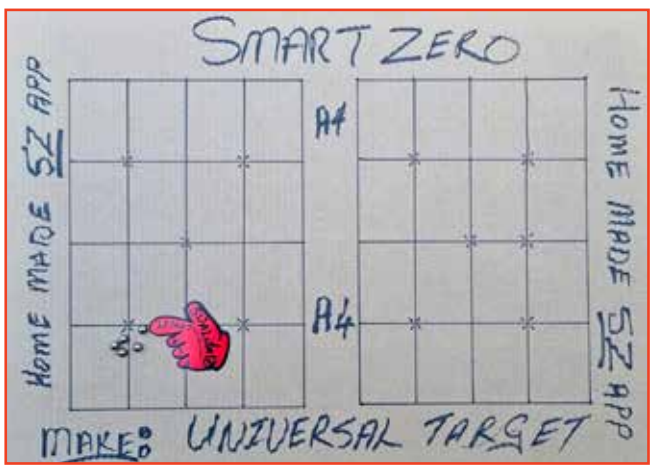
As mentioned in part 5, your *kettie* serves as a "random grouping POI (point of impact) generator". I see it regularly, where great Forkers shoot 3/3 knock-down shots at a 4 cm target at 10 metres, and superciliously assume their *kettie* precision is "OK", but they struggle at 15 and 20 metres to impact 7 and 8 cm targets, for no apparent reason. Sadly, they seem to rationalise it with dissolute remarks like "I pulled it", etc. Technically, it was a good shot – statistically, it missed. Small shot count string group samples are very deceptive, and play into various metrics like drag coefficient because the assumptions and deductions from the POI (apparent small group size) result in unsubstantiated decisions ("tunings" for example, to components, like flatbands, etc). You might (with experience – in time be comfortable with 20 shots), but, it is also absolutely crucial to understand that the longer the intended shot (shooting) distances, the larger the 10 m shot group sample data must be to obtain the same precise data (information) resolution, if you want to project that results at longer distances. The problem is that the decision to make critical metric adjustments (bands, pellets, velocity, etc.) is mostly baseless (unsubstantiated) with a small shot count. If you think shooting large shot samples is time-consuming (wasted effort), try the bigotry of small shot count sample groups – in the long run. You will be amazed, over the course of one season, how many shots you missed and dismissed with a plethora of excuses, whilst it is actually simple, precision, statistical basics! **Think:** Circular error probable (CEP), or **circle of equal probability**: Median Error Radius (MER).

The flight phases:

We have already touched on the five flight phases, and will discuss them in more detail later on in the series. (1) Pellet thrust (propulsion), (2) Pellet jump (release), (3) Aerodynamic pellet jump, (4) Down range pellet fight (trajectory), (5) Pellet impact (terminal effect). By now, we understand the two major elements (components) – balances of scale – of the P.A.M – (A) PRECISION (internal ballistics), and – (B) ACCURACY (external ballistics) which the latter is divided in "calculable" (also referred to as "deterministic") variables (pellet velocity, aerodynamic drag, gravity drop, etc) and "incalculable" (also referred to as "non-deterministic") variable elements – typically the "wind" in terms of "speed and direction". Before we can calculate the Circular Error Probable (CEP), or circle of equal probability, or the Median Error Radius (MER) to measure our *kettie's* precision as a measure of error, in a radius circle centred on the point of aim, we need to shoot shot groups. Shooting groups sound easy and straightforward, right? As with "anything *kettie",* you can over-simplify or complicate matters to a useless result, but there is the truthful (scientific) evidence requirement. Example – the statistically valid shot group data set of 30 to 50 shots.

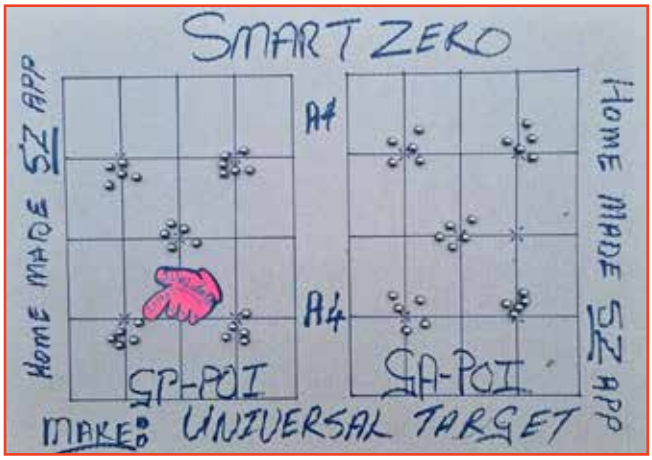
Practical tips on Shot groups:

Anyone who has tried to shoot 50 shots at one paper target will tell you: Most paper (target) types do not make neat round holes (due to modern paper fibre materials), but rather tear strips, and after five shots at a 2 cm circle, the impact zone is totally destroyed. I have tried many target solutions over the years for precision calculations – and my **No 1 takeaway:** Why try to shoot a hole, only to try and find the centre of these holes again for calculations, if all you actually need is the precise contact impact point/mark (indent)? In practical terms: Thin corrugated cardboard box material works well at 20 metres, because the dispersion of the pellets keeps the larger dispersion impact zone in tack with shot groups strings of 5 to 10 shots. At 10 metres, I suggest 3 mm pressed carton material backed by a solid wood board or steel plate. I have used PVC and other plastics and even thin soft metal sheeting for precise small indent impacts. If you should use a hard steel plate, give it a white wash coating to see the impacts easily. When the theoretical *kettie* ballistics stuff got obsessively serious, I used a very expensive camera setup, with thermal imaging to detect and plot 50 shots on one impact zone! Whatever target material you use, observe safely and remember rule No 1: Safety glasses, and reference part 2: TRS, since, these pellets will bounce back and could cause injury.



GP-POI (GROUPS for PRECISION – POINT OF IMPACT) internal ballistics:

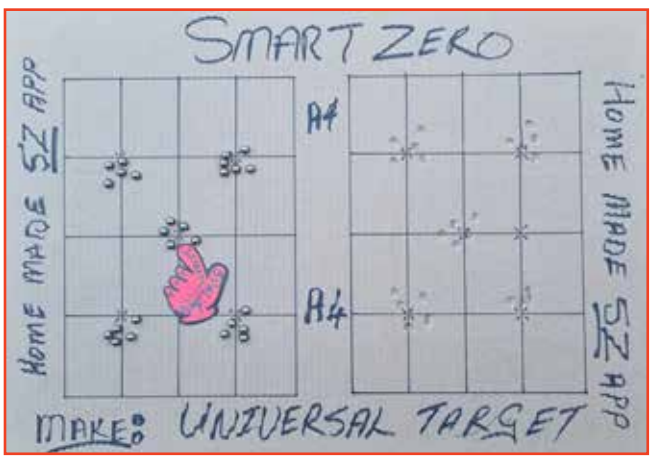
This is simply test bench (scientific laboratory) activities. This is a scientific technique to measure and calculate your *kettie's* actual grouping (determine CEP rating) with the current (particular) set-up. **Let's start off with what your slingshot sport shooting code requires?** SASF (South African Slingshot Federation) rules state 10 shots in 5 minutes. It provides a clear guideline for a GP-POI precision grouping validation exercise. Suggestion: Indoors, from a test bench ("benched"/"*kettie vice*"), clamp down the *kettie* and shoot 10 shots in 5 minutes (ideally time-spaced). Repeat this 5 times for a total of a 50 shot count and do the MR and Extreme



Spread calculations. If you plot the individual shot groups MR (and take an average) –and overlay the 5 x 10 shot groups and calculate the MR, it will confirm the precision capacity (CEP) of your *kettie*.

Kettie clamp/vice set-up:

Ideally for GP-POI the *kettie* must be set up (clamped) in a neutral position – free from your "freehand" external forces, on a workbench vice or a shooting sled, on a very sturdy platform like a concrete shooting table. The idea is that your *kettie* is set up (clamped down) 0°-180° vertical in all planes, and that you replicate your own draw length, at a perfect square draw to your *kettie prongs* and a consistent release. To facilitate the repetitive shots, it is ideal to have an observation base and side backboard with marked measurements on draw length and spirit level markings. You can, for example, make a wooden pedestal with a protruding shaft (tall nail, or dowel stick in a wooden block) as a rear gauge (reference point) for the draw length and height position. Thus, you would know your draw to the exact same spot every time. Grip and release of the pouch are very important. One tend to find (as in the actual shooting) that the athlete "over-grips" the pellet (finger tips – in front of the pellet) to secure a better grip – usually on a (too) heavy draw, which of course creates uneven release, such as Speed Bump effect (review part 1 of the series).

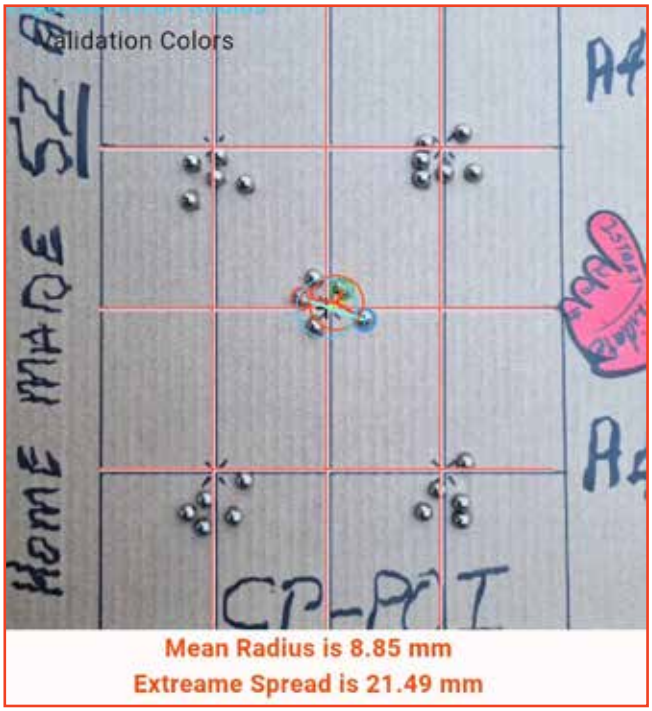


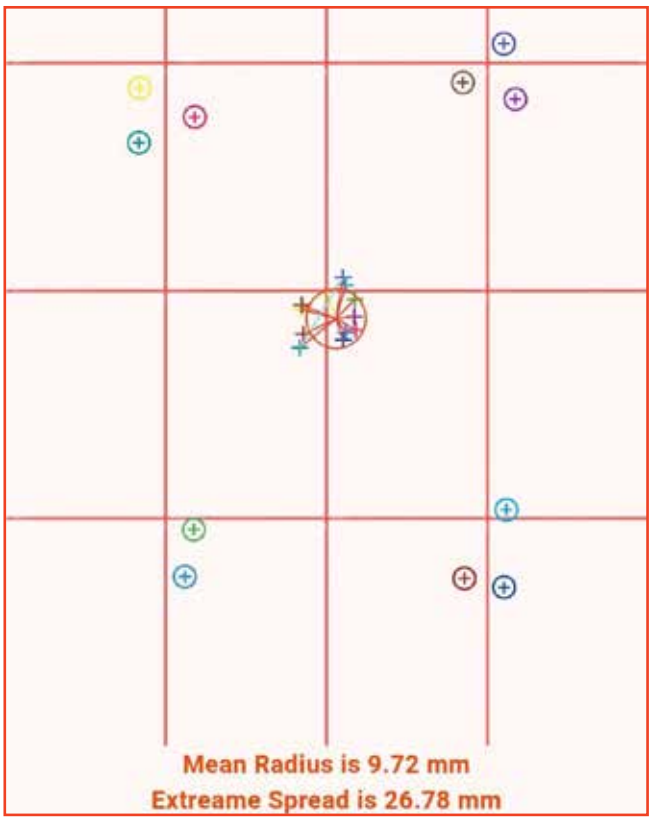
Shooting GP-POI:

Place your target exactly at 10 metres from the fork of your *kettie*. Technically, you do not shoot to hit the bull; the aiming point or target point for the purpose of GP-POI is just a small dot (or cross). Do not manipulate the draw to improve the group size. The idea is to shoot the *kettie* as scientific mechanically as possible with absolute shot mechanism repeatability. After every shot string (sequence of 5 -10 shots), if you like, move the target, not the *kettie* – so that the next shots will have a clean impact spot and start the next shot string. If you have your shot data carefully measure the shot impact groups and calculate the average Extreme Spread (ES) and Mean Radius (MR). Remember MR is calculated to the centre of all the impacts, thus you find the centre point in the shot group impacts, from where to measure. Velocity: If possible, you should also measure the velocity of the shot string, as it would be very handy for calculating the SD (Standard Deviation).

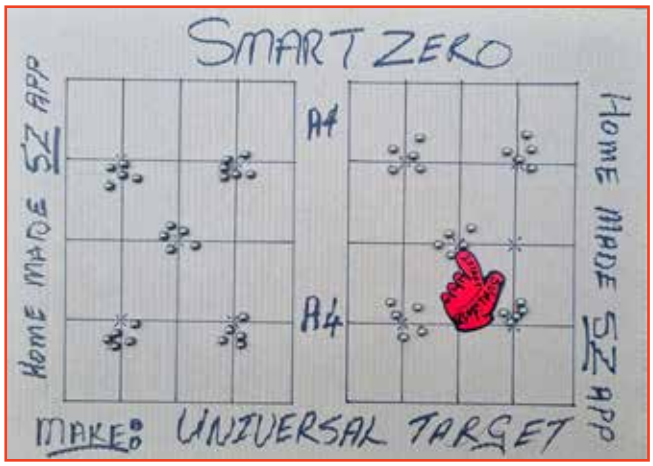
GP-POI Results:

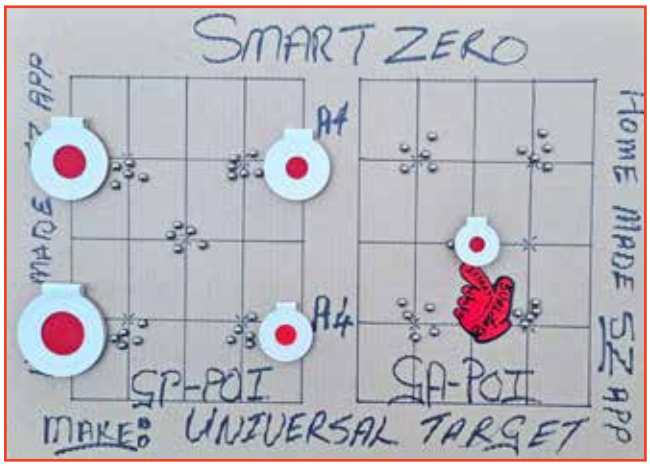
Ideally, we want the shot group(s) – (1) round (what seems to be a circular – even dispersion) – and – (2) as small as possible. You would have noticed that slower velocity shots impact lower, and faster velocity shots impact higher. If your shot groups' geometry are more vertical, your speed is inconsistent, caveat all – such as consistent release, hysteresis (see part 2), no wind, round spherical balls, etc. If the measured speed is consistent to a very small margin (< less than 5%) and the groups are vertical, then it is inconsistent release, some form of Speed Bump. Ideally and statistically, we want round dispersion; either way, do the group size measurement calculations. The GP-POI results are a clear indicator of the best precision (for down range precision) probability, with the current *kettie* set-up, like bands, etc. (In effect, it means your





skill set cannot improve your down range accuracy better than the MR. Thus, if you have a 100% skill set, this is the best your *kettie* will perform, as a matter of fact, it usually deteriorates due to Athlete inconsistencies. On your test bench for optimization – change only 1 metric at a time and test and evaluate the results, "fit for purpose". Example: Do not change the flatband thickness and the geometry (such as taper, etc). We will circle back to these metrics in future.





GA-POI (GROUPS for ACCURACY – POINT OF IMPACT) external ballistics:

Actual real-world application, shoot at 10 m the same shot sequence but in match position (free hand), aiming at a fixed point, to shoot a group (instead of the *kettie* in a vice/bench as with GP-POI). This will validate the real-world accuracy and capability (you, the athlete), as a part of the shooting platform (system) represents. The difference in actual grouping measurements between GP-/GA-POI will provide a guideline for your technical shooting skill improvement goals. If the results match up, you are an excellent shot, with a 100% athlete form and technique. Champions, in match shooting, have mastered the art and skillset (ability) to take high-precision small shots groups and place them on target – and even improve the accuracy (high confidence), actually shooting smaller groups than what the *kettie* (precision) MR & CEP suggests. Mimic your shooting sport match play when shooting GA-POI for your particular *kettie* sport code (discipline), etc. We will circle back to shooting techniques.

Of course, if the objective in the match shooting exercise (match play) is to shoot a small group, of course, you would manipulate the POA (point of aim) – influenced by conditions to obtain the smallest possible POI group.

The target:

What is the precision goal? How to determine the "precision objective"? To determine the target size and effectively the "precision objective" – for scientific testing and calculations, I use the following rule: Use the radius of the (smallest intended) target as the diameter for the MER 50% first circle error probable impact (bell curve) model. Thus, if the smallest (no 5) target is 4 cm in diameter, the radius is 2 cm, use the 2 cm diameter as the actual target size diameter (1 cm radius) that should log 50% of the shot impacts. Incidentally, exactly the USSP (Uniform Standard slingshot Precision) method. That means the next 43.7% of shots will be in the outer 2 cm (to the rim) of the circle (target), providing 94% predictability/high confidence. The odds increase significantly with higher (bigger) targets No's 4,3,2, and No1 at 8 cm in diameter. But, also remember, the group size natural statistical spread becomes bigger the further the distance to 15 m and 20 m, significantly reducing impact probability at the small target 5. This could, for example, suggest the match play plan: The opening 2 to 4 shots on target 5 on 10 m, but target 4 at 15 m and target 3 at 20 m, for the best statistical performance.

The CEP kettie performance measurement:

Circular Error Probable (CEP) in the universal scientific definition and calculation of *kettie* precision. In essence, the circular error probable (CEP) or "circle of equal probability", with Gaussian (normal) distribution, is a measure of the *kettie* platform precision as a "measure of error" – for example in a radius circle (e.g. 2 cm/10 m) centred in the (from) the middle of the POA (point, where it is expected that 50% of rounds will impact (enclosed / e.g. 2 cm/10 m). Think of it as the Median Error Radius (MER) as a measure of precision (not accuracy). Remember, CEP can be calculated and published as a performance factor – in terms of any circular radius, 0.5 cm – 2 m, etc. CEP can be defined as the square root of the mean square error (MSE), pooling the sum of all sources of variance error (azimuth, etc), geometrically corresponding to the radius of a circle within which 50% of rounds will impact. There is a lot more to it, but let's keep it practical: If we refer to a particular *kettie* precision measurement – example "2 cm precision", the statistical expectation at distance (industry standard 10 m/imperial 10 yards) is that 50% of the pellets fired will impact within that "2 cm centre circle" and that the rest will naturally disperse in a radial pattern, 43,7% will impact in the next 2 cm circle band and 6,1% will impact in the next 2 cm circle band (i.e. a total of 6 cm). Carefully consider what the inferences propose – even on an 8 cm target if you are aiming centre target.

USSP

USSP (Uniform Standard for Slingshot Precision). You can classify/rank your slingshot rig CEP (circle error probable) against your fellow athletes using the USSP universal index, which has a CEP baseline set at 2 cm diameter (1 cm radi-

us circle) at 10 metres at mean sea level (MSL) as an international performance standard. Based on 50 50-shot string data set, results/standard: 50% (25) shots in a 2 cm circle (diameter) at 10 meters. This is the standard against which a *kettie* (slingshot) set-up (rig) should be measured. Example: At least 25 Shots (of the 50 total) must be in 2 cm on 10 metres –100% rated (10/10), or, for example, if only 12 shots, a 50% rating (5/10) as a precision slingshot. Statistically, 43.7% (21.5) of the 50 shots will be naturally distributed in the next cm circle (ie 4 cm diameter) in total, and 6.1 % in the next 2 cm circle (total of 6 cm).

Extreme Spread (ES):

As apposed to MR (mean radius), which is (measured from) the centre point of the shot impacts in the group, ES is only the distance between the **two** furthest outlying pellet impacts on the target, measured from the centre pellet impact to the other centre pellet impact, thus measuring the extreme spread of dispersion, providing a "group size" and effectively ignoring all the other alluding data points (shot impacts). In other words, irrespective of the shot count (data points), you only measure two! In comparison, the MR is the average measurement from the actual (true) **centre of the group** of the actual shots (not from the centre of your aiming point) to the centre of **each** shot (pellet impact), which will provide a much higher confidence measure of precision than the extreme spread. The extreme spread (ES) of the actual group size is useless except for a competition scoring model. The classic saying, "Aim small, shoot small," may be true, but it starts with a precise zero technique. "A precise zero is accurate shooting." Since the MR will be closer to the same value for 5 and 10-30 shots, this actual centre should be used as the zero sighting point.

Component variation:

What to do – if the *kettie* is not on par with your expected – or the match play required CEP? We need to understand that different components and elements (metrics) have dramatic interaction effects on the *kettie* platform or *kettie* shooting system (which includes the athlete!). Example: The same pellet will have a significant interaction variance, with an increase in velocity, or aerodynamic pellet jump, etc. Thus, if you are exploring to optimise (exploit) one metric, make sure you generate a full data set, as the next text phase baseline, before you introduce more variables.

Create a data set baseline:

I suggest you do a GP/GA-POI test data set immediately, irrespective of where you are or want to be – in the slingshot space, with the current equipment, irrespective of potential upgrades – to SET A DATA REFERENCE Baseline! Even if you do not fully understand or comprehend the scientific significance of the results yet, shoot these two GP & GA data sets, for future reference. As the Ketty PHDee series progresses and you improve and make technical upgrades, this starting data set will become very valuable – and indeed a motivation and inspiration as you see the results improve.

Thank you for joining us on this "Ketty PhDee" journey as we explore precision *kettie* shooting. Now that you understand what to do, for your "objective – fit for purpose", let's figure out how to do it! Next time, we will explore component deviation metrics and start off with flatband technical stuff and how to exploit flatbands for optimal performance. Till next time, safe shooting!