Echo Value Calculator

Idea and method used in the EVc

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# Goal

* Assign a **precise value** to an Echo or an Echo-set (build)
* This value would reflect the strength **of the Echo and/or Build** for a given character in a given scenario, meaning that the value reflects how close the Echoes/Builds are compared to the best/ideal Echoes/Builds that a character can have in the given setting
* **User-friendliness and path of least effort without losing accuracy**

# Assumptions

For the analysis and Echo scores to make sense, here is a list of assumptions that should be **fully obvious** to the user but are stated explicitly anyway:

* User equips **reasonable weapons** (for example, no ER or HP% weapons on Atk scaling characters)
* User equips **reasonable echo main stats** (no Def% Echo main stats on Atk scaling characters
* User doesn’t go above 100% **effective** crit rate
* User use the characters in a **reasonable manner** (for example, only using Camellya’s burst and nothing else (or some extreme examples like this) is unreasonable). If it is something that changes the **damage profile** of a character significantly than the norm, the results become less reliable (a basic% roll on Camellya has very high value, unless you’re using her like this). Consequently, if a character has two viable playstyles with **significantly different** damage profiles (Jianxin or Encore as loose examples), they are essentially two different characters and their relative sub stat values are different.
* Reasonable **crit ratio**: **best attempt** has been made to get the ratio () as close to 2 as possible (range of minimum damage loss is 1.6 to 2.2, so anywhere in this range is acceptable, with preference to lower values if effective crit rate is below 75%) (Note that even best attempts will sometimes still land you outside this range. This is not an issue, as long as you’re not running crit rate weapon and 4 cost echoes, while having 99% crit but 180% crit damage – in this particular case, for example, switching the weapon **or** the 4-cost echo to a crit damage main stat will be considered as “best attempt”).

# Important notes for the document

1. Many **concerns or objections** that may arise when reading a part of this section may already be addressed in the **Assumptions** section above, or covered later in the section itself, and/or by putting them together. So fully reading a section is highly encouraged.

2. Paragraphs in *italics* and enclosed in square brackets “*[]*” provide **extra/optional information**.

3. *[Here is the* ***conceptual formula*** *that determines the* ***Echo Score*** *(see section below for detailed break-down):*

4. This core formula and concept seem simple and easy to use, but without understanding why specifically certain values and methods are chosen, or why the calculations are the way they are, there is a **significant risk** of getting false or significantly inaccurate results upon using this formula without the EVC. *[A major challenge lies in accurately determining and , which in turn affect and most importantly, ]*. If not done correctly, even for characters that **don’t** particularly have much to do with these values in particular, the results produced may be completely off and/or unsatisfactory anyway (as shown in the sections below).

5. As the focus of this document is the **justification of the core formula** as well as the **justification that this is** **the minimal level** of effort and/or computation used in determining the values, the document is rather wordy with strong focus on trying to convey the intuitive explanations. By “the minimal level” of effort and/or computation, it is meant that **it is not possible to skip or simplify any considerations discussed** in the document. Doing so will lead to results that are completely unusable and unstable in a non-negligible (30% to 50%) number of cases, at least if any similar method is being used to achieve the goal of EVC. In other words, if something seems “too thorough” or “too accurate” or “too much effort,” there’s most likely a very good reason for it, that significantly affects the usability of the EVC.

# Echo Value Calculator – Theory

Here is the main conceptual formula again:

where:

= Achieved Value / Total Relative Value of Median Sub Stat Rolls

= Echo Potential Value

= Sub Stat Roll value (the actual value displayed as the Echo’s sub stat)

= Sub Stat Median value (the median sub stat roll value of this sub stat)

= Relative value of this sub stat compared to other sub stats for this specific character

= Ordered Relative value (where the current relative values of the Echo are arranged in descending order, from highest to lowest).

The **Build Score** is simply the average Echo Score of the five Echoes of the set.

The following sections discuss these terms in detail.

## Total Relative Value of Median Sub Stat Rolls

The first step to determine the value of an Echo or Echo-set is to assign a numerical value to each sub stat.

This numerical value depends on the character and the character usage, and reflects how **useful** that stat is for the character and situation in question.

**DPS gained** from a sub stat (or an Echo overall) does **not** solely reflect how good an Echo/sub stat is. Even for main DPS characters that do not really have ER requirements, a DPS based value is **significantly** worse at gauging an Echo’s worth than a pure value-focused approach (examples shown below).

### Relative Value of Sub Stats

*[****Note:*** *Some parts may start sounding intimidating but become completely obvious as you continue reading. I apologize for that and highly recommend to continue reading anyway if some things aren’t clear straight away]*.

For a value-focused approach, the sub stat that provides the **most** value to a character is assigned the value of **1** for **every** **median sub stat roll amount of that sub stat,** and all other stats are assigned a value **based on this scale** (in other words, **relative**).

Specifically, the most useful sub stat for most characters is **crit**, and when this is not the case (mostly relevant for supports), a different sub stat that provides the most value to a character is chosen instead – in any case, the underlying concept is the exact same. Crit is a DPS stat. **Hypothetically,** **if** Carlotta’s DPS goes up by **100** when you give her 8.4% crit rate (the median crit rate sub stat roll (not actually possible to get on an Echo)), **then** her DPS will go up by around **50** if you give her 9% Atk (the median Atk% sub stat roll) instead. Median sub stat values of both Crit Rate and Crit Damage (8.4% and 16.8% respectively) result in the exact same DPS gain in most characters (by 100 in our hypothetical), and this is true for Carlotta as well. There is no other stat that gives Carlotta more value per median sub stat roll than crit. So, every 8.4% crit rate sub stat is counted as 1 point, and every 9% Atk is counted as 0.5 points, because it is half as effective **relative to crit** in this scenario.

*[It also possible to use a so-called “max-scale” where the value of 1 is assigned to a max-rolled sub stat (meaning every 10.5% crit rate is counted as 1 point for characters with crit as their most effective stat). This so-called max-scale is available for use in the EVC (the “Overdrive Mode”). While this scale is just as functional for comparisons and accuracy, it is* ***really******unsatisfactory*** *to use. Echoes that we know to be* ***extremely*** *powerful and rare get a score that, while accurate and functional, look very disappointing (examples shown below, but you can also test it yourself by plugging the best Echo you have in both normal and overdrive modes). For the rest of the document, it is assumed that the normal scale (where the median value of the most effective sub stat is assigned the value of 1) is used unless otherwise stated]*.

For most main DPS (Atk scaling) characters, the fact that a median Atk% roll is **half** as valuable as a median crit (rate or damage) roll **always holds true** with more than reasonable accuracy (verified by direct calculations and multiple sources, gathered from Maygi’s calculations).

Below is a table for Carlotta showing the median roll and the relative importance of all the possible sub stats.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Crit Rate%** | **Crit Damage%** | **Atk%** | **Flat Atk** | **HP%** | **Flat HP** |
| **Median sub stat roll** | 8.4% | 16.8% | 9% | 45 | 9% | 450 |
| **Relative value for Carlotta** | 1 | 1 | 0.5 | 0.25 | 0 | 0 |
|  | **Def%** | **Flat Def** | **Basic Atk Dmg%** | **Heavy Atk Dmg%** | **Skill Dmg%** | **Liberation Dmg%** |
| **Median sub stat Roll** | 11.4% | 55 | 9% | 9% | 9% | 9% |
| **Relative value for Carlotta** | 0 | 0 | 0 | 0 | 0.425 | 0 |

These values can be verified by damage sheets of any TCs. For example, the damage increase for a median sub stat roll for Carlotta (according to Maygi) is 3.07%, 6.16%, 2.5%, 1.49% for Atk%, crit, skill dmg%, flat Atk (40) respectively. Note that these values fluctuate slightly based on the main echo setup, weapon, number of good sub stats already present etc. but due to the method of calculation as discussed below, it will be easy to understand why this has next to no effect on the result.

Adjusting these values on a scale where the most important stat (crit, in this case) has a value of 1, the relative value of all the sub stats is found to be:  
Crit Rate/Crit Damage: 1, Atk%: 0.498, Flat Atk (45): 0.272, Skill Dmg%: 0.422. These values are almost a perfect match for the values in the table above, and in fact, are slightly more accurate and easier to figure out.

The reason for generality of the above values is based on:

1. The empirical observation that the inner balance-relations between stats is changeless in any specific game over time, and

2. The motion values result in the following basic-fractions for equivalent median rolls (on a hypothetical where crit increases a DPS character’s damage by 100 per median roll):

Crit Rate/Damage: 100, Atk% (or HP% or Def%): 50, General attribute Dmg%: 50.

However, since any specific damage% bonus (like skill dmg%) only affects a **part** of the character’s overall dmg (unlike a general attribute dmg% bonus that is commonly found on weapons), this ratio must be multiplied to get the actual relative value of that sub stat (in case of Carlotta, where skill damage is 85% of her overall damage, as above). *[Of course, this value of 85% (sourced from Prydwen.gg, and approximated for general use) is a result of a specific rotation (or the sequence of ability usage over time). This means that if you are doing vastly different rotations than normal, and it is niche enough to not be widely known, the results from the EVC may not be relevant to you]*.

This result applies generally to **all characters** with more than reasonable accuracy. If a DPS character uses crit, the median value of the sub stat that the character scales off of (Atk%, HP% or Def%) is half as effective as the median value of crit. And their damage profiles allow the direct calculation of the relative values of median sub stat rolls of specific attributes like basic, heavy, skill and liberation, as above.

*[An important mathematical fact about sub stats that many will find interesting, and it follows from this relationship between stats, is as follows:  
The* ***sum*** *of the relative value of* ***all*** *the attribute bonuses (basic, heavy, skill, liberation) is* ***always*** *less than or equal to 0.5. This is simply because the sum of the overall damage contribution from these attributes is* ***always*** *less than or equal to 100% (as a matter of course). Since the (relative) value of a fully general attribute bonus is the same (on average) as Atk%, the relative value of a median roll of Atk% sub stat will* ***always*** *be greater than or equal to all the relative values of the median roll of attribute dmg% sub stats* ***combined*** *(This is a bit of a mouthful, but it is an extremely simple fact once you look past the necessary yet convoluted terms)]*.

### Example calculation (An Echo for Jinhsi)

Consider an Echo for Jinhsi with the following sub stats:

Crit Rate: 10.5%, Crit Damage: 15%, Flat Atk: 50 and Skill: 10.1%. The 5th sub stat is not used by Jinhsi (like Def%).

First, the number of median sub stat rolls for each stat line is counted ():

Crit Rate: , Crit Damage: , Flat Atk: , Skill: .

Next, these numbers are adjusted by their relative values ():

Crit Rate: , Crit Damage: , Flat Atk: , Skill: .

The sum of these values is **2.842**, which is the **achieved value**.

## Echo Potential Value

Upon understanding the above concept of total relative value of sub stat rolls, one may immediately want to use it directly as a method of scoring. But this causes major issues, as will be highlighted with the help of the following example:

An Echo for Carlotta with 9.3 crit rate, 15 crit damage and 10.1% Atk gets a total value of . An Echo for Phoebe with the exact same sub stat rolls also gets the total value of **2.561** because the calculation remains the same. Does this mean both of these Echoes are equally as good? It turns out, this is **not** the case, and the difference (and the reason behind this difference) both are not trivial and **very important** to understand intuitively.

A **hypothetical** **perfect** echo for Carlotta will have the **5 most useful stat lines** for her: crit rate, crit damage, Atk%, Skill% and Flat Atk (ER is also a factor but is ignored for its specific special section below). These are the 5 sub stats with the highest relative value median roll.

We **define** the Echo potential value as the total value of this hypothetically “perfect” Echo (“perfect” in quotes because median rolls are assumed, see previous section). For Carlotta, this is simply .

This “perfect” Echo is another way of asking what is the (practical) best possible Echo a character can get.

A similar calculation for Phoebe results in the Echo potential value of:

It is now easier to see why the Echo with the **same sub stats** is actually better on Phoebe than on Carlotta. If the Echo potential value for Phoebe’s Echo is 2.975, the actual value of our considered Echo (2.561) is much closer to this potential than it would be for Carlotta’s Echo potential value of 3.175. Additionally, if you roll an **absolutely crazy Echo** for Pheobe, the actual score it would get without considering the Echo potential **would not look as impressive** when comparing it with just a decently good Echo for Carlotta, even though in terms of luck and rarity and what is possible to achieve, this Echo is much better for Pheobe.

Not considering Echo potential value is the same as not considering percentages for an Exam result. Getting a score of 90 is impressive on a 100-point test (assuming you don’t have Asian parents), but not as impressive on a 200-point test.

To consider Echo potential value, we must divide the total relative value of the median sub stat rolls (henceforth called **the “achieved value”**) by the Echo’s potential value. We then also multiply it by 100 to turn a ratio (scale of 1) into a 100-point scale that we are more familiar with. This value can now be used without any problems, and is called the **Echo Score** (% sign is avoided even though it makes sense to use, because on this scale extremely high-rolled Echoes can go beyond 100 which may cause confusion).

The score of our considered Echo is for Carlotta and for Phoebe.

To understand the result more **intuitively**, consider how valuable each sub stat is compared to crit for both of these characters. Carlotta’s overall DPS is mostly skill damage, so a Skill% sub stat roll is going to be way more valuable (or closer to crit’s relative value) than what a the Heavy% sub stat roll is for Phoebe. Phoebe **does do** majority of her damage as Heavy Atk damage, but it contributes much less to her overall DPS and therefore is also valued much less, individually, as compared to crit or Atk. Since an Echo **can only have 5 sub stats**, this means the potential damage or value increase is higher for characters who’s damage scale from as few stat lines as possible.

*[Imagine you have two different bags filled with 10 balls each. The balls come in two types, S-tier balls, and B-tier balls. Your task is to pick 3 balls from each bag such that each set is as high quality as possible. If one bag has eight S-tier balls and two B-tier ball, it is expected that you pick at least two but most likely three S-tier balls, and you’re kinda unlucky if you don’t. If the other bag has four S-tier balls and six B-tier balls instead, it is* ***quite lucky*** *if you pick two or three S-tier balls. Let’s say you pick two S-tier balls and one B-tier ball from both bags, the quality of both is the hands is the* ***same****, but the latter is* ***more impressive*** *than the prior. If this nuance is missed, one’s reaction to picking, for example, three S-tier balls from the second bag may be “eh – that’s cool I guess.” rather than “woah I got really lucky!”]*

Note that when considering **two different** Echoes for Carlotta and Phoebe, both with a score of 100, Carlotta’s Echo will result in a **higher DPS gain** for Carlotta as compared to Pheobe’s Echo for Pheobe, despite the Echo scores being **exactly** the same *[with the ball bag analogy, if your task was to pick the best five balls instead of three, the best possible result for the first bag is all five S-tier balls, but the best possible result for the second bag is four S-tier balls and one B-tier ball, as there are only four S-tier balls available. Both the hands* ***are still the best possible hand you can get*** *(i.e. a score of 100), but the first hand is still stronger than the second]*. This is a **feature** of the system that prioritizes the quality **of an Echo/Echo-set**, which is a criterion that’s a **superset** of other criteria like DPS gain, as opposed to systems that focus solely on DPS, where God-like Echoes may still be valued at much less even though it would not even be possible to find better Echoes.

### Jinhsi’s Echo (continued)

The following Echo was considered for Jinhsi:

Crit Rate: 10.5%, Crit Damage: 15%, Flat Atk: 50, Skill%: 10.1.

Jinhsi’s achieved value was calculated to be 2.842. Jinhsi’s Echo potential is calculated by summing the highest relative values of median sub stat rolls:

Therefore, the final Echo Score is ! This falls into “Extreme” tier (tiers discussed in later sections), and is an incredible, high value Echo!

Note that if, for example, Jinhsi had rolled higher CD and flat Atk (say 21%CD and 60 Flat Atk), Jinhsi’s achieved score would be 3.258, and the final Echo Score would be 104, demonstrating the ridiculous nature of Echoes needed to go beyond 100, even when using median scale rather than max value scale.

On the max-value scale, the initial Echo would score 72.0 and this Echo would score 82.4. The nature of these scores is much more disappointing and unhelpful to understand an Echo’s true worth.

## Energy Regen (ER) and Static vs Dynamic Values

Thus far, all the sub stats and calculations have assumed the values to be **static** values. For example, how good Atk% is on Carlotta as compared to crit or Skill% does not change based on how much Atk%, crit% or Dmg% Carlotta already has. This is technically not true, but if we assume users are not ~~complete idiots (for lack of better phrasing)~~ making grave mistakes, this becomes practically true for all intents and purposes, especially when considering Echo sub stats. There may be people who are running an Echo-cost setup of 11111 or 41111, or maybe 43311 with two Atk% main stat 3 cost Echoes, or with 120% crit rate, or running HP% or Def% weapons and main stats etc. on Carlotta. Unfortunately, if similar issues as the ones described here are present, the Echo Score may lose its accuracy to a non-negligible point and it will not be of any help ~~just like most other options~~. For any error types that are less severe than the ones mentioned above, it is completely fine to accept the above values as static with fully negligible effects that produce practically accurate scores.

ER, however, does not work like the other stats we’ve used thus far.

### Why even consider ER?

ER is **really important**. For some characters like Carlotta, using liberation every rotation is mandatory to do any damage. She is **not** a character like Brant or the Shorekeeper (who value ER even more), and her ER requirements can be as low as 5% with Zhezhi/Yangyang, or as high as 20 to 25% without them. But regardless, if she does not have this ER, she will always waste enough time to lose her buffs before her final liberation hit, which is a major chunk of her damage. An Echo that does not recognize ER properly will be **severely** undervalued (or overvalued, which is just as bad). For characters with optional bursts like Jinhsi, this burst is still a significant portion of her damage even if it is casted every other rotation. For other characters like Camellya, the burst still does a non-negligible portion of Camellya’s damage but more importantly, generates concerto that allows her to do her rotations well.

Even if we **trust users** to make sure they have an appropriate amount of ER for their characters, the issue of determining the value of an Echo **still remains**. For example, in most cases the users will not **exactly** have the required amount of ER that is considered safe for a certain character/team/rotation (and even if they do, what numerical value should be assigned to it? There is a solution, but the problem itself is too specific and the result diverges away in general cases). It is shown later that even minute differences of 5% more/less ER can **significantly** impact the Echo Scores because 5% is still **more than half** the median sub stat roll for ER.

### What is the value of ER?

Since all the previous values were DPS focused, it was easy to adjust them onto the same scale by considering how good they were relative to each other to their specific job (of increasing DPS). ER affects a character’s DPS only indirectly, and are valuable in other aspects like rotation smoothness and comfort, and hence some further assumptions should be made to adjust ER on this scale.

*[One “scientific” way of determining this (which is* ***not*** *used) would be to consider the amount of unmodified resonance energy generated by the character in question on field, on average or per ability, in a certain time-frame. Combining it with the ER they actually have, it would be possible to convert a point of ER to an equivalent amount of time in seconds. This can then be used to determine the DPS lost in a rotation in an ER deficit situation, which can then be multiplied by the median sub stat value and then converted to the relative value on our scale. This requires lots of character specific data, used in non-specific ways, in a not-so-simple calculation and conversion which has a huge variation range even for a small domain. Furthermore, this method is also subject to many more considerations and improvements if considered seriously. As compared to the alternative method discussed next, this method requires far more effort to increase the accuracy by an insignificant amount]*.

### ER in achieved value

The alternate, more practical, method to evaluate ER would be to assume that the **value** of a median sub stat roll of ER (9.6%) **is dynamic** and is equal to the value of the highest relative value of median sub stat rolls of the other stats (which will always be 1) adjusted by how much of that **ER is being used/discarded**, and further adjusted with the **relative importance** of ER.

Dynamic means that the initial **tentative** relative value of ER used, **is changing based on how much ER is already present**. A new value **net ER** is defined to be the difference between the total ER a build has minus the recommended ER for the character. With this definition, net ER is positive if the build has more ER than necessary. Knowing the net ER allows us to consider if the ER sub stat roll on an Echo is useful, not useful, or precisely how useful.

**If net ER is negative, this means all the ER from the Echo sub stat is being used and valuable. The sub stat roll is divided by ER median roll just like for other sub stats and instead of a relative value multiplier, it is multiplied by a relative importance multiplier (discussed below). If net ER is zero or positive, the sub stat roll is subtracted from net ER. If this new net ER value is (still) positive, all the ER from the echo sub stat is useless and is considered as a dead or non-useful stat. The new net ER value is passed further if a full Echo build is being processed. If the prior net ER was positive, but becomes negative after subtracting the ER sub stat roll, this means a portion of the sub stat roll was useful, and it is exactly equal to the current negative net ER value. This value is now considered as the actual sub stat roll, and then processed like normal as described above. The net ER is then set to 0 because exactly all the ER that is in excess is discarded.**

When analyzing a full build, the net ER value is updated repeatedly, giving more meaning to the term “dynamic.” For example, if a character has 140 total ER, and their ER requirements are 125, then their net ER is +15. Let’s say they have three Echoes with 10% ER each. For the first Echo, the full 10% ER must be ignored, for the second Echo, only 5% ER from the 10% sub stat roll is considered, and for the third Echo, the full 10% ER is considered. Let’s additionally assume that all these Echoes have the exact same sub stats. For a character who must use their liberation per rotation and it contributes a lot to their role (meaning their relative importance multiplier is high), the difference in the three Echo Scores is very **significantly different**, despite having the exact same sub stat line (example calculations shown later)!

Relative importance is a multiplier of ER that scales down the relative value based on the consequences of not using Liberation (made clear with specifics below), and is anywhere between 0 and 1, and it itself is a static value.

**Both** the dynamic nature and the relative importance multiplier are required because in practical testing, many Echoes produced completely unjustified and unsatisfactory results when ER was not handled at **least** this thoroughly (again, this is true even for characters where ER is not a big deal like Carlotta with Zhezhi).

It is possible to be even more thorough as mentioned above, but that does **not** actually produce results that are noticeably and/or practically better/more accurate than the once produced with this method (unless someone can figure out a way to handle this, or is willing to do all that research and testing and data collection for every character).

Therefore, the relative value of ER is (one multiplied by) the **dynamic** factor (that considers the current ER surplus/deficit as above), multiplied by the **importance** factor (that considers DPS loss when the Liberation button is not pressed).

### ER calculation example

Considering Camellya, her ER requirement is 115 to 120%. The safest value (120%) is used. If she has 125% ER in total, and the Echo being evaluated has 10% ER as a sub stat, then 5% of that ER is discarded, and the useful 5% is considered as the actual sub stat line. This is then divided by the median sub stat roll (9.6%) resulting in 0.521 tentative relative value. Since Camellya loses around 20% of her damage if liberation is not used every rotation, the tentative value is multiplied by 0.2 to produce the final achieved value of 0.104 for ER for this particular Echo. Compared to crit or Atk%, who can increase the achieved value by 1 or 0.5 on average respectively, the value of ER seems very small as it should be for Camellya. However, this same 5% useful ER produces an achieved value of around 0.35 for Carlotta, which is higher than flat Atk and already very close to Skill%. And if the full 10% ER is useful (when Carlotta is not paired with ER boosting outros like Zhezhi), the achieved value goes to around 0.65 to 0.7, becoming the second strongest stat after crit!

### ER in Echo Potential Value

The achieved value is not the only aspect affected by ER, and it has significant impact on an Echo’s Potential value as well. Remember that Echo’s potential value is the value of the top 5 most important stats, so depending on the relative values, an Echo’s potential value may change depending upon whether a character’s 5th most useful sub stat has a value higher or lower than **ER’s potential relative value**. This value is slightly different than the other ER values calculated before. When following how this value is calculated in the next paragraph, remember that this value is supposed to make sure that the Echo potential value is truly at the “max” potential.

**If a character’s build has negative net ER (meaning they don’t have enough ER), this negative net ER amount is divided by the ER median roll. If this value (Value A) is less than or equal to -1, the ER’s potential relative value is (1 multiplied by) the character’s ER importance multiplier. The ER stat median is added to the net ER before passing it for further processing. This is because if multiple Echoes are considered, the potential of ER is already accounted for in this Echo (DONE). If the value (Value A) is greater than -1 (but less than zero since net ER is negative), than this value (Value A) is multiplied by -1, and then multiplied by the ER importance multiplier to get the ER potential relative value. The net ER is set to 0 for further processing if required (DONE). If net ER is greater than or equal to zero, the ER sub stat roll is subtracted from this net ER amount. If this value (Value B) is still positive or zero, the ER potential relative value is 0, and the new net ER value is passed (DONE). If this value (Value B) is negative, it is multiplied by -1, then divided by the ER sub stat median. Now, if this new value (Value C) is greater than 1, the ER potential relative value is (1 multiplied by) the ER importance multiplier, and the net ER value is set to Value B + ER sub stat median (DONE). Else, this value (Value C) must be in between 0 and 1, and it is also multiplied by the ER importance multiplier and is now the ER potential relative value, and net ER is set to 0 because all the potential of the ER is accounted for (DONE).**

Once ER’s potential relative value is calculated, it can then be compared with all the other relative values and the five highest values are added together to finally produce the Echo potential value.

### Examples (continued)

For Camellya, her top 5 stats have relative values of 1, 1, 0.5, 0.35, 0.25. Camellya’s ER can at most have the relative value of 0.2, meaning that even if Camellya has no ER, the Echo potential value for Camellya will **always** be a static 3.1, **however** if her Echo has **useful ER sub stat roll**, it will still be counted towards the achieved value and therefore contribute to the **Echo Score**, even if it has no impact on the Echo potential value.

For Carlotta, who’s top 5 stats have relative values of 1, 1, 0.5, 0.425, 0.25, and who’s ER can at most have the relative value of (approximately) 0.65, her top 5 stats can easily change the Echo’s potential value from anywhere between 3.175 to 3.530 depending on the net ER (which is quite a significant and undisputable difference for the Echo Score).

# Additional Required Theory

This section covers some additional concepts used for the theory, code, and assumption sections.

## Crit Ratio Equivalency

Critical hits work similarly in most games, and the generally accepted crit ratio for optimal DPS is the 1:2 ratio for critical rate and critical damage respectively. However, the critical damage stat that is used here is a percentage increase (as it works in Genshin Impact) as opposed to a critical damage multiplier that is seen on the stat screen in Wuthering Waves.

The point of this section is to show that these two stats are the exact same thing and that you can convert between the two by adding or subtracting 100, and therefore you can apply the optimal crit ratio logic here as well. In mathematical terms, we want to show the following:

where is the crit damage as seen in Wuthering Waves and is the crit damage that is seen in Genshin Impact.

By definition, is a **percentage increase** in damage. If you have 150% , your damage **increases** by 150%. If your normal hits do 75 damage, 150% of 75 is 112.5, meaning you will do 75 + 112.5 = 187.5 damage on critical hits. In general, for X damage on normal hits, your crit hits will do damage.

By definition, is a **damage multiplier**. If you have 250% , your damage is **multiplied** by 250%. If your normal hits do 75 damage, 250% of 75 is 187.5, which is the damage you’ll do on critical hits, the same as above. In general, for X damage on normal hits, your crit hits do .

To prove this in general with the above definitions, we consider a scenario with a normal hit damage of X, and a critical hit damage of Y. We then define both versions of Crit Damage using the same scenario:

Making Y the subject in both equations and equating them, we have:

proving the above conjecture.

With this, we can modify the known result of the optimal crit ratio for Wuthering Waves by simply converting it to the ones used in games like Genshin Impact. The ratio of crit rate with (crit damage - 100) should be 1:2, with optimal ranges being 1:1.6 to 1:2.2 (also a previously well-known result).

## Resonance Cost and Energy Requirements

One setting allows recalibration of Energy Requirements for a character in question if the user knows that they’re giving an Energy related outro buff to this character. Most common example is probably Zhezhi’s or Yangyang’s buff that activates on Outro for a character like Carlotta.

This part is speculative, but the idea is that during a rotation, the character needs to generate a certain amount of Resonance Energy **particles** to cast their Liberation (for Carlotta, her Liberation has the Resonance cost of 125, meaning she needs 125 particles). Assuming that the Energy Regen% is a multiplier (so that 200% ER means 2 particles are generated whenever 1 would normally be generated), we can know the particles generated in a rotation.

Taking Carlotta’s example specifically, her recommended ER amount is 115 to 125% (sourced from Prydwen.gg), and her Resonance cost is 125. If she generates X particles in her rotation and assuming 125% total ER as the safe amount, we have , meaning she generates 100 particles. Zhezhi’s ability reads like a flat restoration of 15 particles, unaffected by ER. This reduces her Resonance Cost to 110 particles. Given that she generates 100 particles, we have , where Y is the new total resonance energy required. This is simply 110, meaning 110% ER is the safe ER required with Zhezhi.

In general, for a character with the Resonance Cost of RC, a flat reduction of X from outros, and the initial ER requirements of iER, the new ER requirements, nER can be found by (equating particles generated per rotation):

This equation basically reads: the same percentage reduction occurs in the required ER as the percentage reduction in Resonance Cost.

(incomplete)