# Phase dispersions

A gait parameter calculated by CatWalk XT

A white paper by Noldus Information Technology

# WHAT ARE PHASE DISPERSIONS?

Phase Dispersion is the moment of Initial Contact of a target paw, expressed as a percentage of the Step Cycle time of an anchor paw.

Phase Dispersion is a parameter that describes the temporal relationship between the placement of two paws in a single Step Cycle and tells you something about the coordination between those two paws.

## PERFECTLY BALANCED WALK

In a perfectly balanced walking pattern, there should be no differences between one side of the body or the body axis in comparison with the opposite side or axis.

## WHEN CAN WE NOTICE THE DIFFERENCES IN WALK

The difference between one and another side of the body will occur for example in a situation with antalgic gait in which the animal tries to put the painful paw on the ground for the shortest duration possible. This can be achieved by placing the uninjured paw on the ground earlier then normally. The changes of phase dispersion value of this paw pair are revealing an abnormality in movement - limping.

Phase Dispersions also play an important role when we want to distinguish different gates like walking, trotting, and galloping.

## PHASE DISPERSIONS IN DETAIL

*Phase Dispersions* is the moment of Initial Contact of a target paw, expressed as a percentage of the Step Cycle time of an anchor paw.

*Step Cycle* of every individual paw starts with first initial contact of the paw, continues through the whole stand phase and the swing phase of the paw and ends at the moment of another initial contact of the paw.

*Anchor and target paws:* In CatWalk XT, 6 pairs of paws are displayed. Within diagonal pairs (RF-LH, LF-RH) and ipsilateral pairs (RF-RH, LF-LH), the anchor is always one of the front paws. Within girdle pairs (LF-RF, LH-RH), the anchor paw is always one of the left paws.

# WHAT IS CSTAT AND WHAT DOES IT TELL US?

Cstat is an average calculated according to the Circular statistics.

Circular data has a periodical nature. For example, months of the year are circular. First month, January, is closer to the twelfth month of the previous year, December, than it is to the sixth month, June.

In contrary, most familiar statistics assume that variables are linear (the lowest value is the farthest from the highest value).

Circular data has a periodical nature.

## EXAMPLE OF CIRCULAR STATISTICS

Let's imagine that we have a flower which is bursting in December or January. If we would calculate the average of bursting time for this particular flower with linear statistics, we would get a value that most flowers burst in June, which is obviously not a correct conclusion.

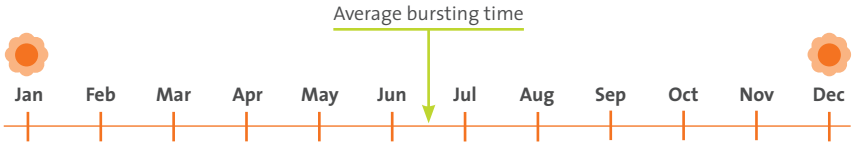


*Figure 1. Linear statistic would calculate that the average bursting time is in June.*

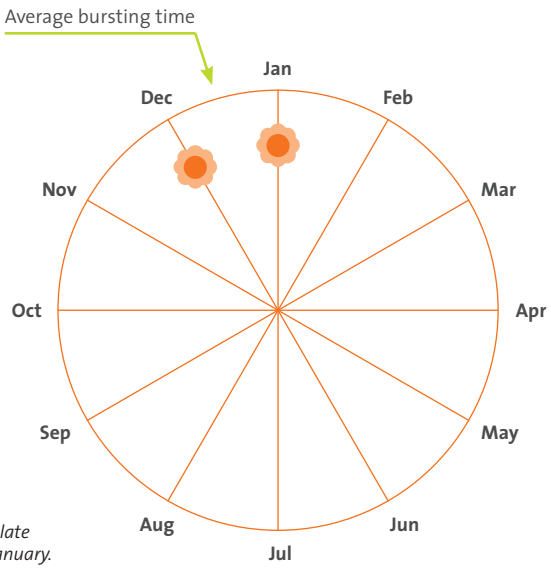


*Figure 2. Circular statistic would calculate that the average bursting time is in January.*

On the other hand, Circular statistics takes into account that December is actually close to January because of the periodical nature of the months and calculates the correct average bursting time.

## HOW DOES CSTAT APPLY TO PHASE DISPERSIONS?

Circular statistics applies also in the Phase Dispersions because of the periodical Step Cycle of a paw.

The values of Phase Dispersions vary from -50% to 75%. Positive value indicates that the Initial Contact of the target paw happened soon after the initial contact of the anchor paw while negative value reflects that the Initial Contact of the target happened later, just before the next Step Cycle of the anchor paw.

Are you interested in what other advanced gait parameters are calculated with CatWalk XT? Visit our website.

# EXAMPLES OF PHASE DISPERSIONS

If the Initial Contact of the target paw is at 0.22s of the anchors' Step Cycle, the Phase Dispersion is 50% (0.22/0.44 * 100).

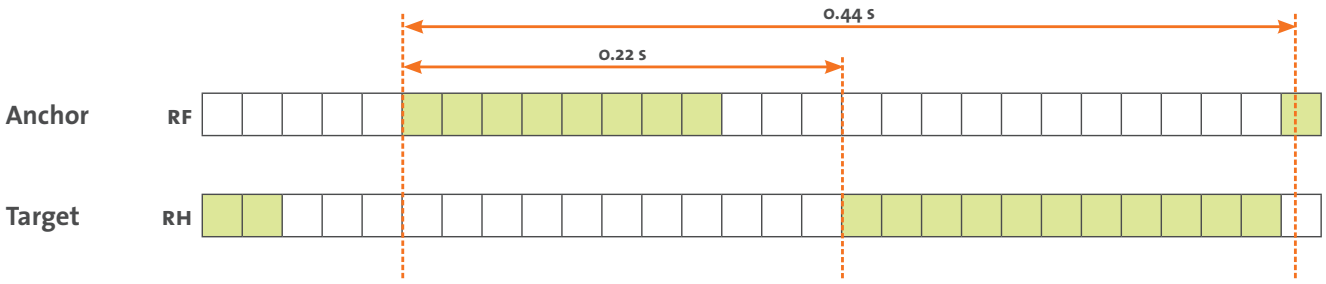


*Figure 3. Target paw initiates contact at half way of the Step Cycle of the anchor paw (Kloos et al., 2005).*

If the Initial Contact of the target paw is at 0.22s of the Step Cycle of the anchor paw, the value of Phase Dispersion exceed the 75% (0.22/0.28 * 100 = 78.5%). In this case, target paw is assigned to the next Step Cycle of the anchor paw, resulting in a Phase Dispersion value of -25% (-0.06/0.24 * 100).

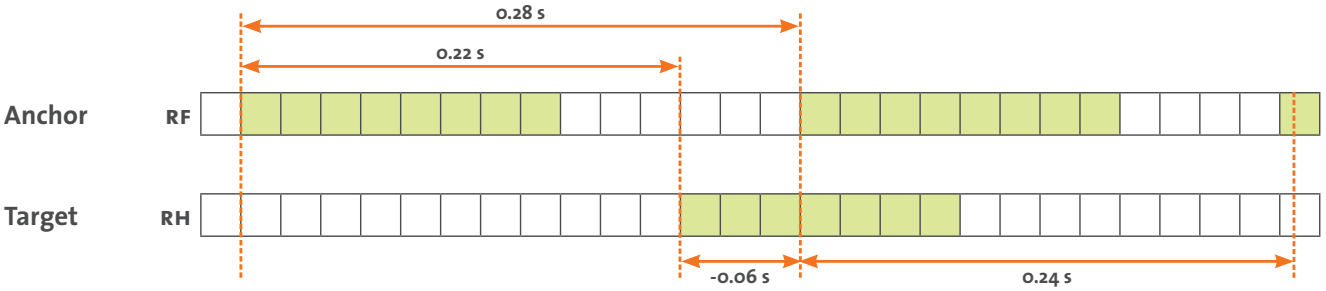


*Figure 4. Initial Contact of the target paw is closer to the start of the next Step Cycle of the anchor paw than to the first one (Kloos et al., 2005).*

# PHASE DISPERSIONS IN PUBLICATIONS

Many researchers are using Phase Dispersions values as an important input in their research. Below you can read some of the examples.

## STUDY OF SPINAL CORD INJURY IN RATS

Kloos *et al.* (2005) used the Phase Dispersions to study inter-paw coordination in rats with spinal cord injury (SCI). If we look at the diagonal paw pair of a normal animal at a moderate speed, the target paw typically moves synchronously with the anchor paw, meaning that the Initial Contact occurs simultaneously. This results in a Phase Dispersions value of 0%. When observing the girdle pairs, Phase Dispersions value is usually 50%. After the injury researchers found that inter-paw coordination followed different patterns, depending on the severity of SCI.

## RESEARCH IN RATS WITH FEMORAL NERVE INJURY

Heinzel *et al.* (2020) did a research on functional recovery in rats with femoral nerve injury. They observed ipsilateral, diagonal and girdle pairs and found increased Phase Dispersions values for hind girdle, right ipsilateral, and left diagonal pair, which were most noticeable immediately after surgery. The values returned to normal at around 5-6 weeks after surgery.

You can read more about this research in a blog post by Johannes Heinzel.

## STUDY IN MICE WITH MULTIPLE SCLEROSIS

In another research, Bernades *et al.* (2017) investigated walking impairment in exercised and non-exercised mice with multiple sclerosis. Looking at the Phase Dispersions values for diagonal paw pairs and other results, they concluded that previously exercised animals still showed decreased inter-paw coordination.

These are just few of many more examples. To find out how CatWalk XT is used in a wide range of other studies and how it can elevate your research please visit: www.noldus.com/catwalk-xt/resources.

# WHAT WE LEARNED IN SHORT

Phase Dispersions values enable us to gain an important view on what is happening within the placement of two paws before and after the injury and treatment. They are calculated with the help of circular statistics due to the periodical Step Cycle of the paw. The values of Phase Dispersions are presented in a percentage based on the Initial Contact of a target paw in a Step Cycle time of an anchor paw.

Researchers all over the world are using CatWalk XT and its parameters to be able to investigate and observe the gait behavior to its finest. In conclusion, Phase Dispersions give you an excellent insight on inter-limb coordination.

Feel free to contact us or one of our local representatives to request a free white paper, client lists, or for more detailed information about phase dispersions or CatWalk XT in general.

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**INTERNATIONAL HEADQUARTERS**
Noldus Information Technology bv
Wageningen, The Netherlands
Phone: +31-317-473300
Fax: +31-317-424496
E-mail: info@noldus.nl

**NORTH AMERICAN HEADQUARTERS**
Noldus Information Technology Inc.
Leesburg, VA, USA
Phone: +1-703-771-0440
Toll-free: 1-800-355-9541
Fax: +1-703-771-0441
E-mail: info@noldus.com

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