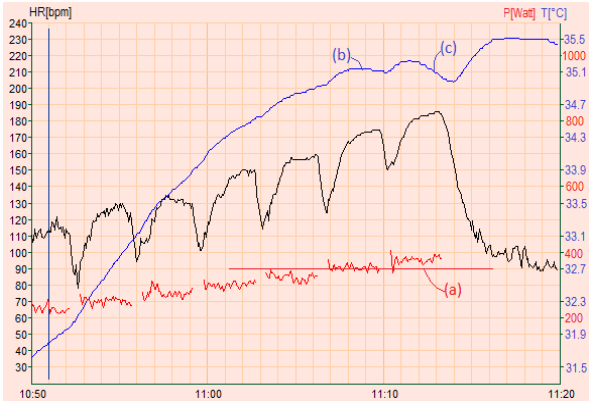
The mnsX

The athlete's energy generation like "enigma"

The control "algorithm" of athletes' energy generation is developed by the evolution, we don't know it exactly, that's why it is like enigmatic. It makes more complicated, the controlling mechanism depends on the individual, in addition it is changing in time individually. Up to the present time there wasn't any device or method with which a coach and athlete can monitor what ratio the athlete uses his aerobic and anaerobic energy generation at any given time during the training. Basically, even the new mnsX (**m**etabolic **n**ervous **s**kin refle**X**) sensor is unable to decode the controlling "program" of the energy generation, but it is able to show the controlling process' result, the aerobic/anaerobic ratio, which is indispensable to keep the dynamically changing zone boundaries and regeneration conditions. The energy generation's aerobic/anaerobic ratio is basically defined by the momentary sport intensity (running speed, cycling power, paddle force, etc.), but also the sport technic, the status of nervous system(sympathetic/parasympathetic ratio), fatigue, nutrition, dressing, weather conditions have a smaller influence. If the energy generation ratio not form according to the training protocol, first thing to do is changing the sport intensity, but with analysis other influential factors can be diagnosed which can caused by the nervous system, nutrition or other thing. The athletes' energy generation controlling algorithm as "enigma" still exists, but the problem can be handled with mnsX sensor, because we can measure the "output" parameter, the energy generation's aerobic and anaerobic parameters, and we influence the "input" parameters, primarily with sport intensity, secondly with sport technic, nerve system, nutrition, dressing, etc. conditions.

A physiological discovery

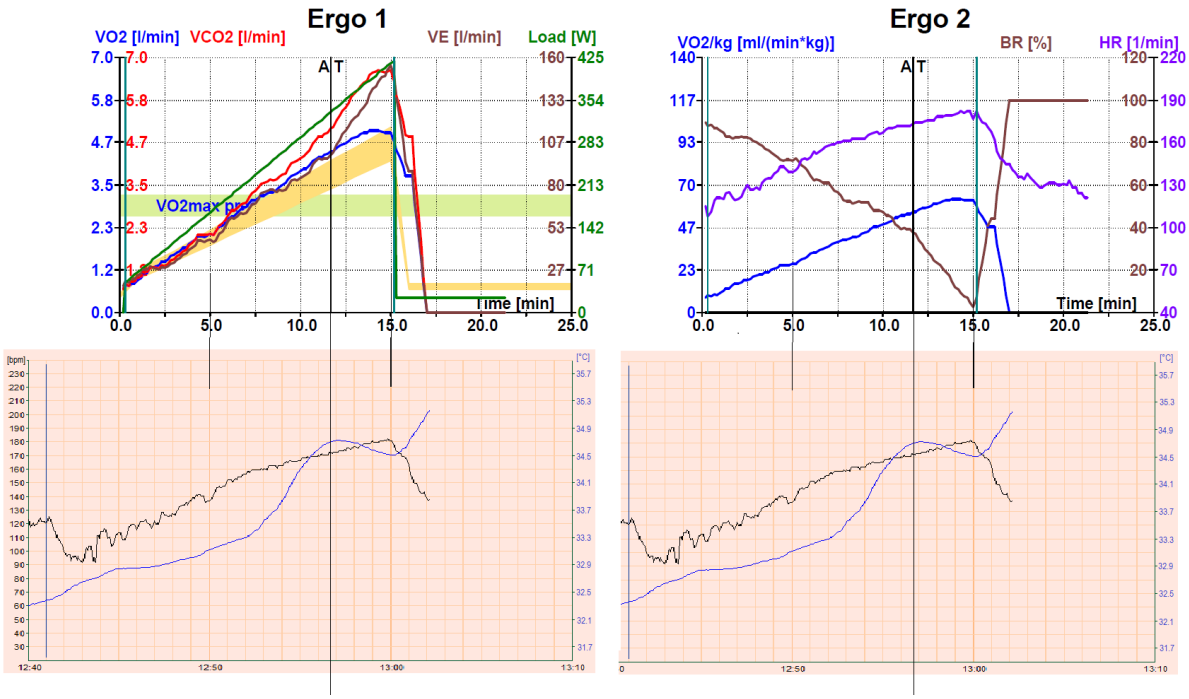
We noticed the change of sport intensity causes a skin-temperature change, which measure on skin surface, the position is depends on the sport. Analyzing different sports and differently prepared athletes' thousands of trainings, we discovered a relationship between the skin-temperature change and the type of the energy generation. We discovered that every athlete has a "critical" performance level. Below the level, the skin-temperature increases or decreases proportionally with the performance, and above the "critical" level the temperature decreases.



1. Figure

The 1. figure shows a cyclist step test, where the athlete's "critical" performance level is around 360 Watt. Around 360 Watt the skin-temperature curve(blue) is horizontal (b), above 360 Watt the temperature decreases (c). Base on thousands of training analysis we observed that, this "critical" level is the limit where the athlete can work stably, above that level he can work only for a short time, athlete becomes instable. Analyzing the skin-temperature change with other measurable and countable physiological parameters, we have experienced the "critical" performance level is the highest performance where the aerobic energy generation is able to work in balance against the anaerobic overweight, so this status is sustainable even for an hour, it depends on the athlete. However, above the "critical" performance level the instable anaerobic overweight is formed, which is sustainable only for short time, minutes.

We recognized too, in case of the athlete's aerobic system and specially his aerobic peripheral ability is strong, the "critical" performance level is well above the anaerobic threshold (AT), so the athlete is able to work continuously and stably in anaerobic zone.

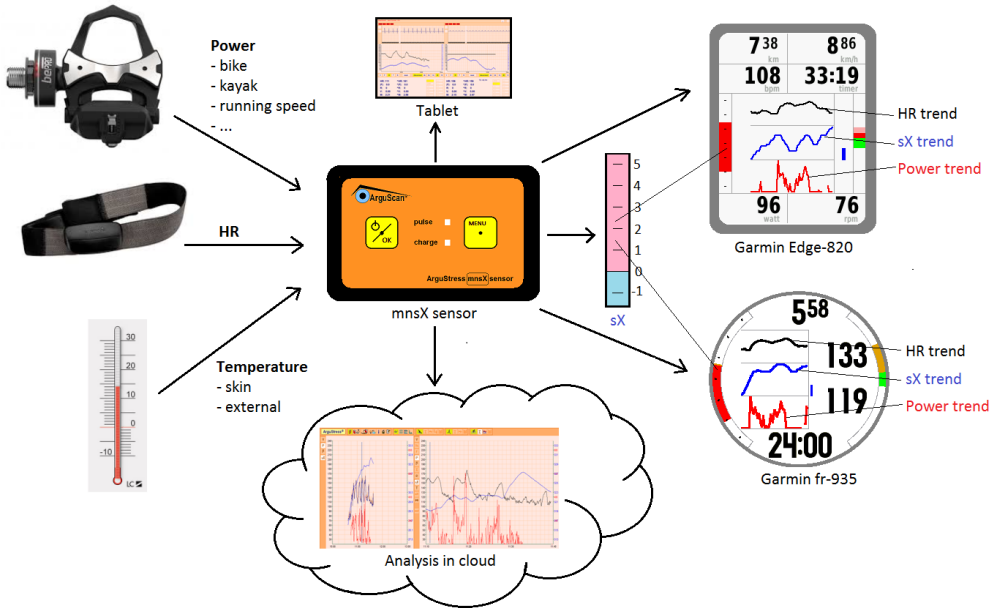


2. Figure

The 2. figure shows a road cyclist ergospirometry ramp test, who only trained below his AT performance level, that's why the "critical" performance level is the same as the AT, so he is unable to work stably above AT. But we have to notice the AT's performance is pretty high, it is around 340 Watt.

Az mnsX sensor

The continuous monitoring the operational ratio of the aerobic and anaerobic energy generation is a new thing, no one measured this parameter until now, it didn't have a name. We noticed, the skin indicates super fast like a reflex (2-3" delay!!!) the momentary change of the energy generation and autonomous nervous system. That's why we named the phenomena "mnsX" (metabolic nervous skin refleX), and this phenomena measure device is the mnsX sensor. The sX (skin refleX) value is calculated by the sensor which places on the skin above a muscle and uses our patented method. The mnsX sensor telemetry communicates with other sensors to collects data and devices to displays its measured and calculated data. The mnsX sensor's algorithm calculates the actual sX value from the actual telemetry received sport performance (cycling watt, running speed, etc.), from the actual heart-rate and from the skin and ambient temperature which is measured by the sensor (3. figure).



3. Figure

We defined numerically the sX value to be within -1.5 and 5.5. This value defines the skin reflex curve (sX curve) in time. During the work out sX value and its change indicate the change of the energy generation, the sX curve shows the whole workout metabolic parameters and the autonomous nervous system's status. Also the sX momentary value is meaningful, because it shows what intensity the athlete's aerobic energy generation operates, but the tendency of sX value change is more important, especially when the sport intensity is changing. If sX value is negative, the aerobic energy generation isn't adequate yet. Beside optimal environmental conditions (temperature, wind, dress, etc.) sX value within 0-2 range indicates the warm up. Value within 3-4 range is typical for aerobic extensive-intensive zone. While around 5 values can be measured in those athletes' stable anaerobic extensive zone, who has high aerobic capacity. In most cases if the value is above 5 it indicates the overheating or overdressing. At intensity change, if intensity is increasing and sX is increasing too, then the aerobic background is generating energy harder, however if intensity is increasing but sX is decreasing in case of normal conditions it is the sign of the anaerobic overload.

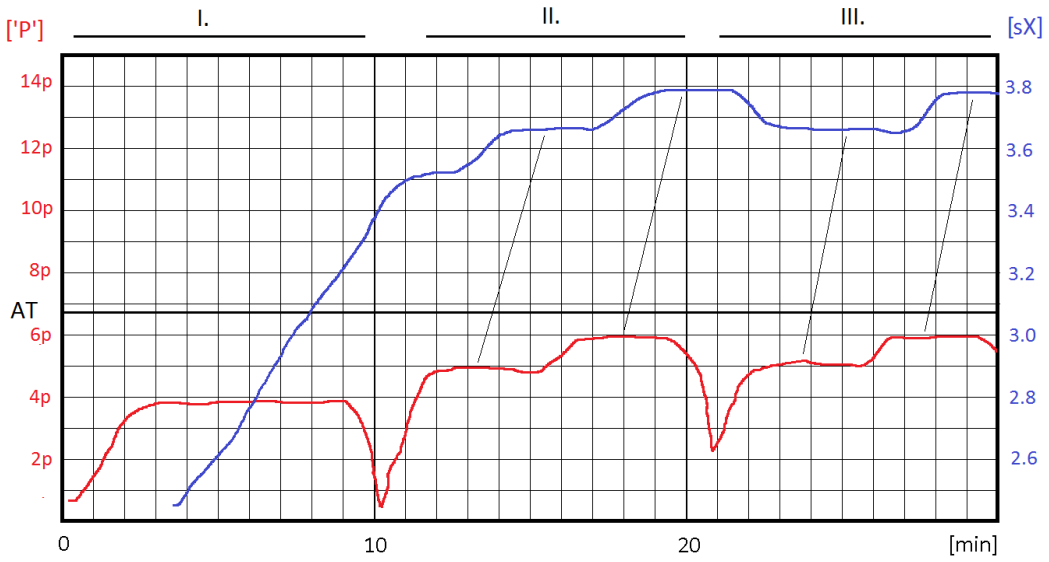
Sensor stores the measured and calculated data for the follow-up analysis and continuously telemetry transmits them to any Garmin sport-devices (Connect-IQ / Edge, Forerunner, Fénix, etc.) or to a tablet which works as an online coach terminal. These display devices continuously display the important measured data numerically and also their curves too. The sensor's stored data can be upload to the ArguStress cloud after training.

The mnsX basis

During the exercise of different training types, it is noticeable below the anaerobic threshold(AT) with the increase or decrease of power the sX value increases or decreases. At those athletes, who has weak aerobic peripheral capacity, if the intensity exceeds AT the sX value starts decreasing, this means the aerobic/anaerobic balance is close to AT. That intensity level indicates the upper limit of the balance, where the sX is horizontal and the athlete is able to continuously work on that intensity. At those athletes, whose aerobic peripheral system is stronger, their energy generation's equilibrium points swift higher. Above AT intensity also the anaerobic energy generation starts working, but while the aerobic energy generation dominates the sX is increasing. When the two energy generation are balanced, the sX is constant (horizontal sX curve) on that intensity. Above that intensity there will be anaerobic domination and sX value decreases.

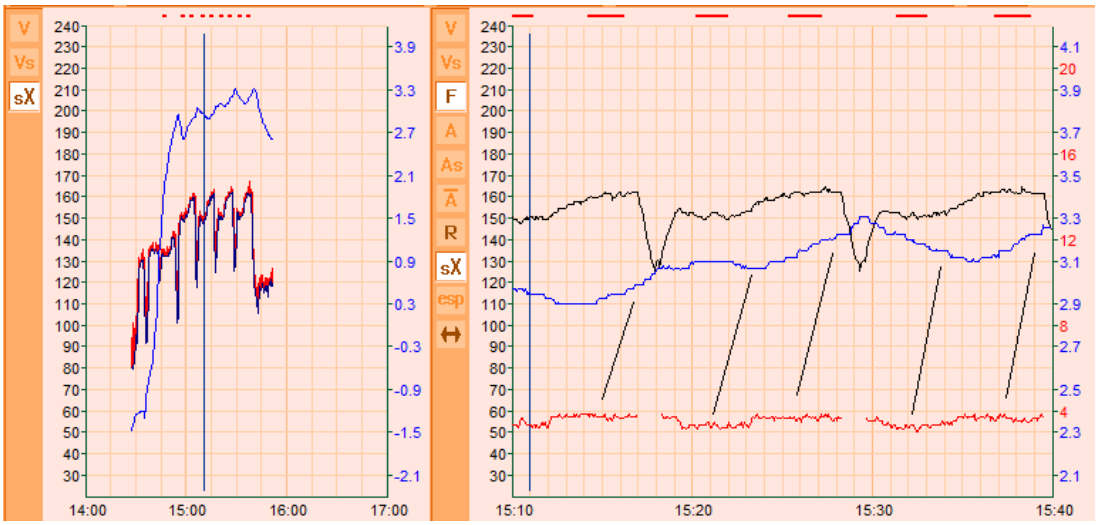
As a result of intensity change sX value always increases or decreases, it depends on aerobic energy generation how much "alive", the anaerobic energy generation how much "suppresses" the aerobic energy generation. Athletes with stronger aerobic capacity can stably workout for long minutes over AT intensity, above a 10mMol/l lactate level in aerobic/anaerobic balance.

On 4. figure the sX value is blue, the performance 'P' or intensity is red. There is no actual unit, because it depends on the sport, how we can measure the athlete's performance or intensity. (for runners the running speed, for swimmers the swimming speed, for cyclists the Watt, for kayakers the paddle force, etc.)



4. Figure

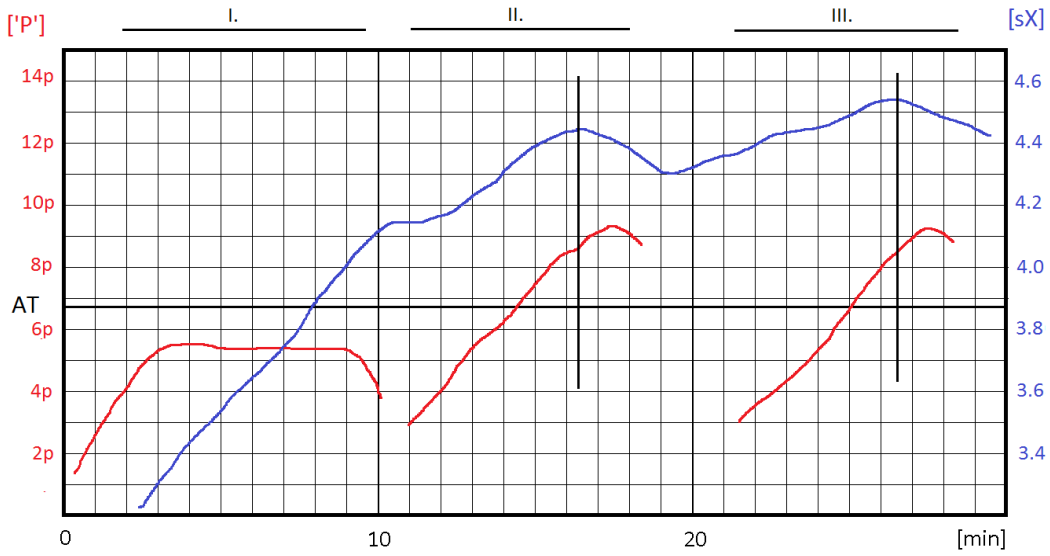
On 4. figure there is a part of a training, it has 3 phases: I. is the warm up with "4p" intensity, the II. and III. phases are same, changing intensity between "5p" and "6p". You can see, the athlete is staying below AT the whole time, during the warm up his aerobic system is "starting up", in II. and III. phases the change of sX is following the intensity change with a ca. 2 minutes delay. Based on our experiences, in case of aerobic domination the delay of sX change compared to intensity change is 1.5-2.5 minutes, while in case of anaerobic domination it is way faster, it can be 2-3 seconds. This is also true if the athlete stops, with a max. 2.5 minutes delay his aerobic energy generation system's efficiency starts decrease, so the sX drops.



5. Figure

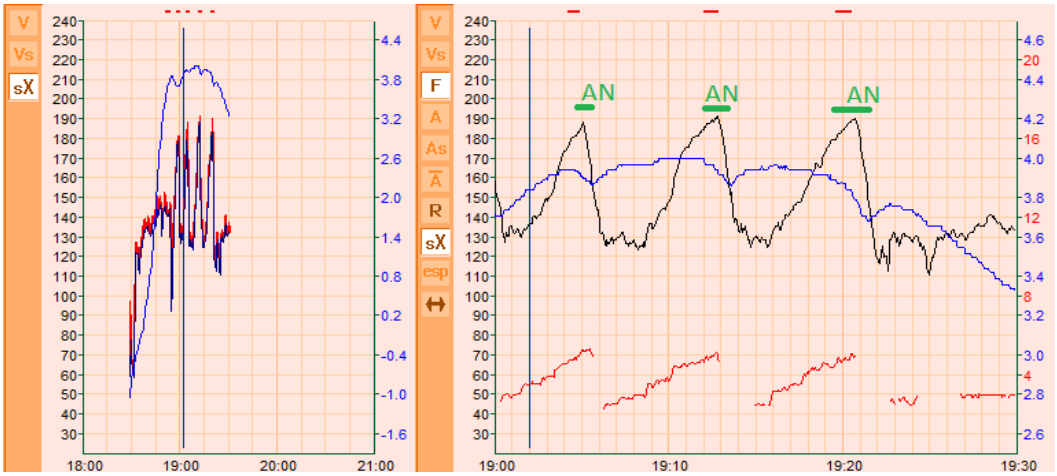
On 5. figure you can see a kayak training similar like 4. figure, the black curve is the pulse, the blue is sX, the red is the paddle force, which is measured by the blade average transmits force. You can see, after the warm up the aerobic system's intensity (the sX) is going together with the kayaker's average paddle force and pulse.

On 6. figure, the work out's I. phase is the warm up on "5.5p" intensity, in II. and III. phases the task is continuously increase the intensity from "3p" to above "9p".



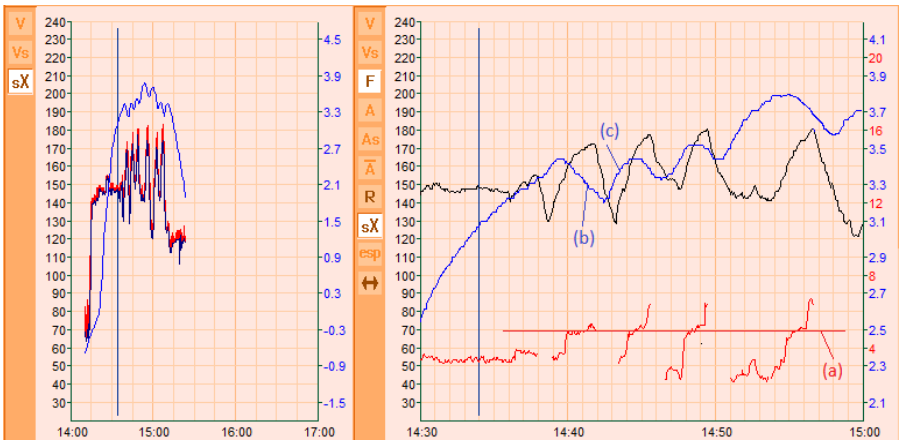
6. Figure

The athlete has strong aerobic peripheral capacity, that's why he is showing aerobic domination (as the intensity increase the sX increase too) above AT="6.8p", and way above AT, around level "8.5p" intensity his anaerobic system is starting to become dominant (as intensity increase the sX decrease).



7. Figure

On 7. figure there is a similar training like on 6. figure. You can clearly see, next to pulse and intensity increase when the sX starts to decrease, the athlete how much time spends in anaerobic domination (AN). From 19:15, the sX absolute decrease tendency indicates the aerobic background's energy generation ability starts decreasing because of the athlete's fatigue.

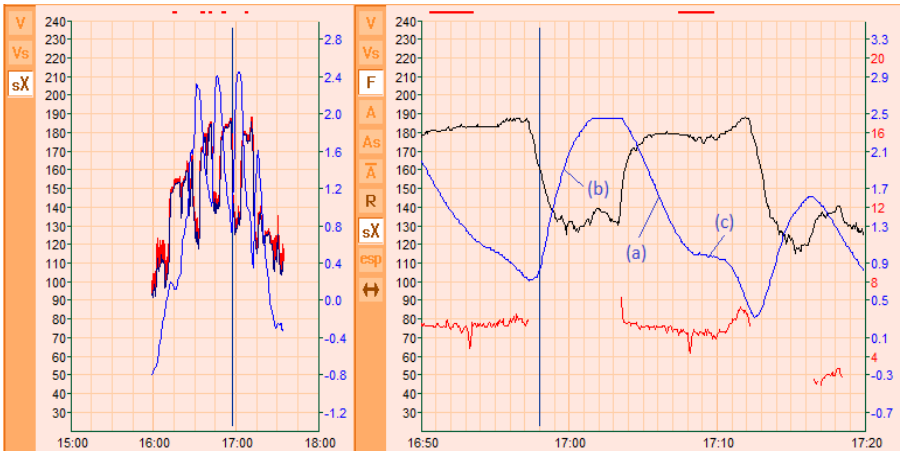


8. Figure

On 8. figure, you can see, as the athlete starts paddling on level 5 intensity (a) the sX decrease (b) indicates the anaerobic domination almost instantly (5-10 seconds delay) and as the athlete stops the paddling, with a 15-20 seconds delay, the aerobic domination appears and sX starts increasing (c). When the athletes see on the display the sX value and its gradient, they can instantly (5-10 seconds delay) notice, that is an intensity with anaerobic domination and with an intensity decrease they can

instantly see as they go back an aerobic dominant intensity zone. The fact sX is able to indicate very quickly the anaerobic domination, is really important, because by this help the athlete is able to work above AT in anaerobic domination and develop his aerobic peripheral capacity to a high level. Without this fast feedback athlete is unable to notice that critical threshold, he will regularly overstep that (anaerobic intensive zone), which destroys his aerobic background very quickly.

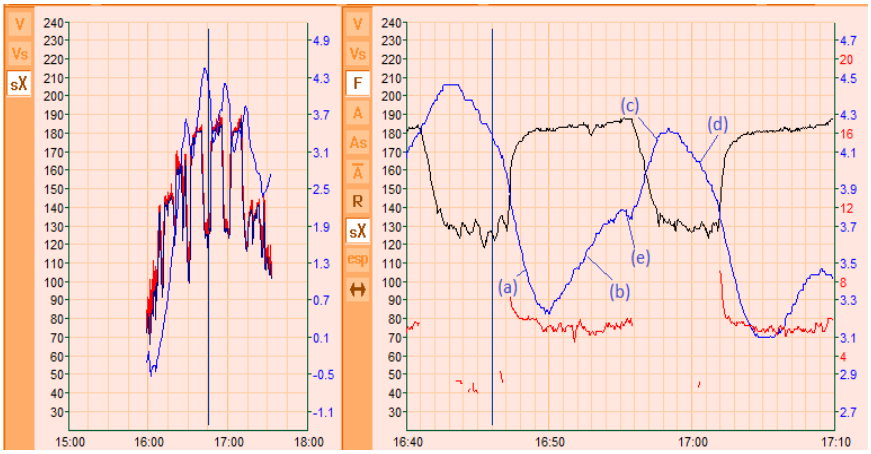
On 9. and 10. figures there are two athletes' training who goes side by side 3 x 2000m on competition intensity. The intensities are the same, but their metabolic energy generation systems' operation is totally different.



9. Figure

On 9. figure athlete has weak aerobic peripheral capacity, he is doing every 2000m continuously in anaerobic domination, his sX value is dropping down to level 2.2 under 8 minutes (a). The sX curve shows a typical anaerobic dominant training: for work load sX is decreasing, in rest time aerobic system is trying to awake and sX is increasing (b).

On 10. figure athlete has high aerobic peripheral capacity, at every 2000m after a hard start (a) his sX value is continuously increasing (b), so he is working in anaerobic domination. In rest time he isn't paddling and typically after 2.5 minutes (c) his aerobic energy generation is starting decreasing and so his sX value is also decreasing (d).



10. Figure

In terms of skill improvement, the training had totally different effect on the two athletes, because they worked out in different zones, despite of the same intensity and pulse curves, and they completed the 2000 meters under the same times.

If we remove the sX curve from 9. and 10. figures, according to pulse response and sport intensity (performance) we see an almost same training profile. During this training the coach followed the two athletes with motorboat, but he didn't see any differences between the two athlete's performance. Only after the training, the athlete, who worked in anaerobic domination, said he didn't do well and got exhausted, while the other didn't have any problem. So the sX parameter next to intensity/pulse parameters is really important, because it shows really good how much did the train cost for the athlete, what type of energy generation operated during the training.

In laboratory or during the training we can measure plenty of parameters (performance, oxygen intake, pulse response, lactate in blood, etc.), but actually none of them show as precisely the athlete is how much being overloaded as the sX curve. Back to the previous example, on 9. figure according to sX we can see very well, when the paddling intensity drops down for only 2 minutes, from 17:08 (c), the athlete is able to stabilize so aerobic anaerobic balance evolves (horizontal sX), otherwise the stroke requires an unstable (not sustainable) anaerobic domination. The other athlete on 10. figure, only in the finish (after 16:55) goes into anaerobic domination (e), the rest is in stable aerobic domination.

sXct: Classic scheme vs. mnsX revolution

In terms of energy generation aerobic/anaerobic ratio, as shorter the race distance the athlete uses his anaerobic energy generation in a larger ratio, but the aerobic is always operating too. The improvement of the two energy generation capacities must be specified according to the race distance and improve them with trainings for the competition the ration will be already as planned. The main point is next to the sport specific technic and technology the athlete's energy generation systems' planned operation needed for the successful racing. Because the continuous and fast change of the energy generation depends on the sport intensity, the most optimal option the energy generation, which needs improvement, is checking with monitoring during the training. Based on the skin physiological reflex the mnsX sensor makes the progress of energy generation measurable, so with the most important parameter we are able to accurately control by feedback the training progress, which our goal to create the most effective. Before mnsX technology only indirect information was available about the energy generation rations during the training, that was enabled a more inaccurate result. The mnsX made the energy generation controllable as measuring the skin reflex and with the change of sport intensity the aerobic/anaerobic ration is exactly adjustable as the training protocol specifies. We called the method "sXct" (sXct = skin reflex controlled training).

The sXct will revolutionize the endurance and power endurance athletes' preparation, because sX data gives online information about the aerobic/anaerobic energy generation ratio, whereof there were only presumption during the training. During the previous years, new unknown training protocols and unused concepts were added to the Olympic and World Champion kayakers' training. Measured aerobic/anaerobic ratio it became evident how to improve the aerobic peripheral capacity in an anaerobic extensive zone which is higher than AT or how to make the athlete work in a higher anaerobic zone with aerobic domination. By using th sXct athlete is able to avoid the aerobic background destruction next to sequential high intensity anaerobic dominated trainings. It becomes measurable, the autonomous nervous system's sympathetic domination enhances the anaerobic energy generation's reflexes while parasympathetic domination favors for aerobic reflex. By using the sXct athlete is able to avoid the unplanned anaerobic overload with even a 5-10 seconds resting time change between intervals. We made verifiable with sXct the optimal intensity, resting time and repetition at interval trainings. We made measurable the warm up's progress, and uniquely specified its optimal protocol, and specified the warm up conditions before key trainings. We determined with sXct the conditions of the cool down part of training, which secures the fastest regeneration between trainings.