Rugby Sevens

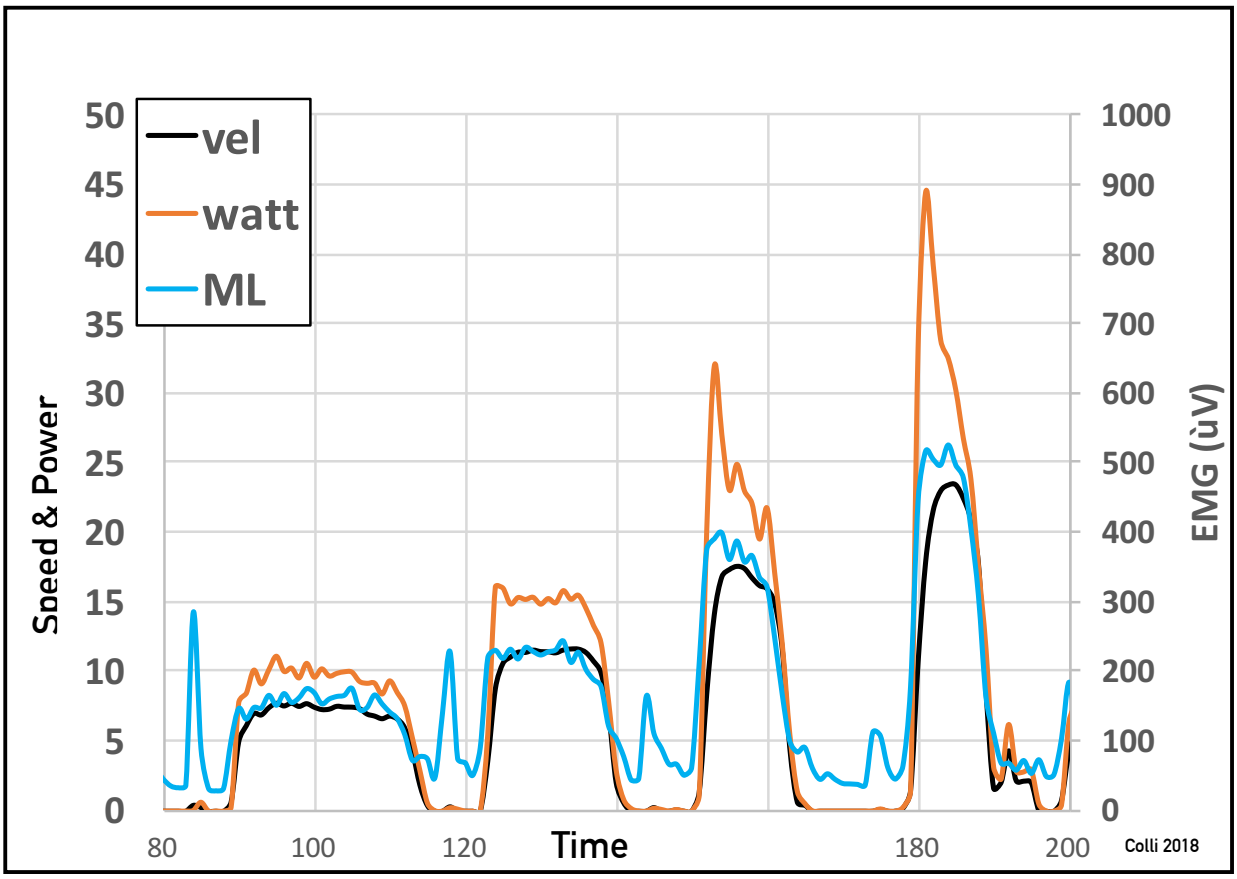
Study of the performance model

Index

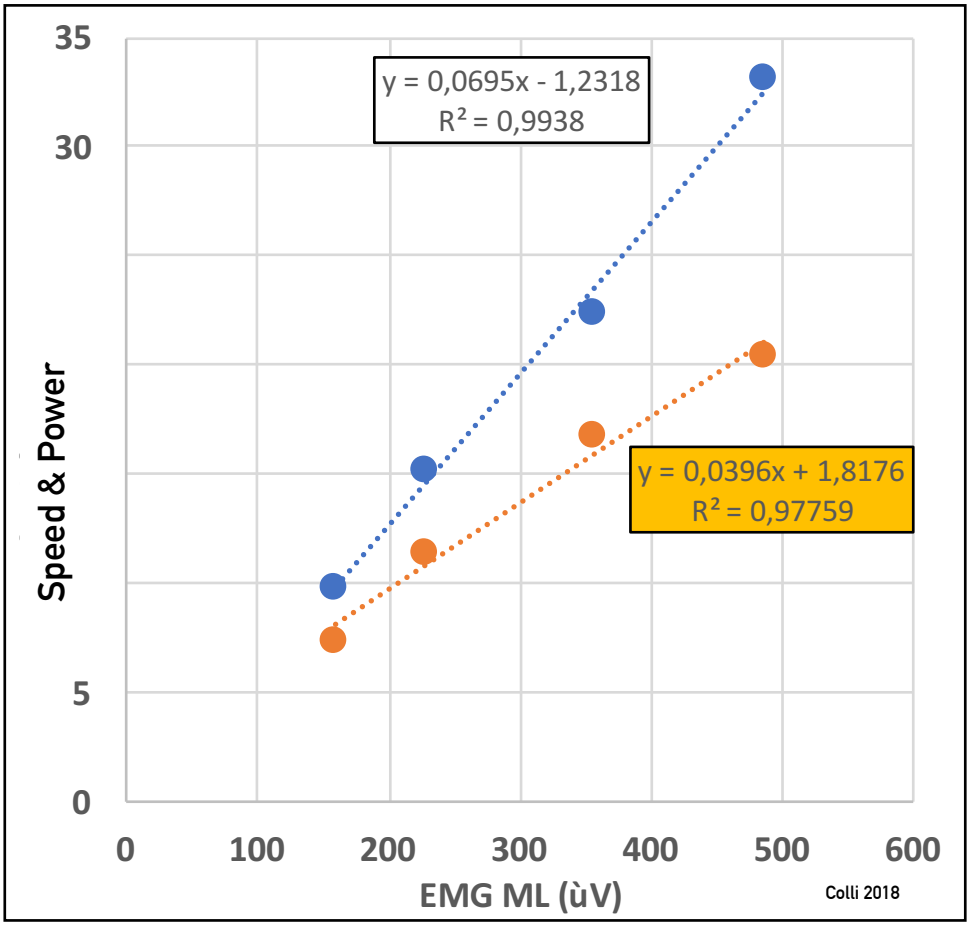
Pag. 3	Introduction
Pag. 4	Game sequences
Pag. 12	Distance
Pag. 20	Metabolic power
Pag. 27	Intense accelerations
Pag. 34	Speed
Pag. 50	Intense Actions
Pag. 67	Recovery
Pag. 70	Changes of direction
Pag. 72	Possession and score
Pag. 85	Fight/contact
Pag. 98	Union - Sevens
Pag.105	Conclusions

FIGHT/CONTACT PHASES

The data concerning the running phases of Rugby Sevens players were examined, identifying a performance model that describes the peculiarities of this sport.
However, during the game there are some fight / contact phases that increase the player's energy expenditure.
These tactical moments have been studied using a special shorts which, through an internal electromyographic system, receives the data of the 3 main muscle groups of the thigh (quadriceps, hamstring, glutei).
The first phase of the research made it possible to use the electromyograph data in comparison with those of the GPS.
To do this, 4 constant speed runs were carried out where the metabolic power and the nanoVolts of electrical activity of the muscles described above were recorded.

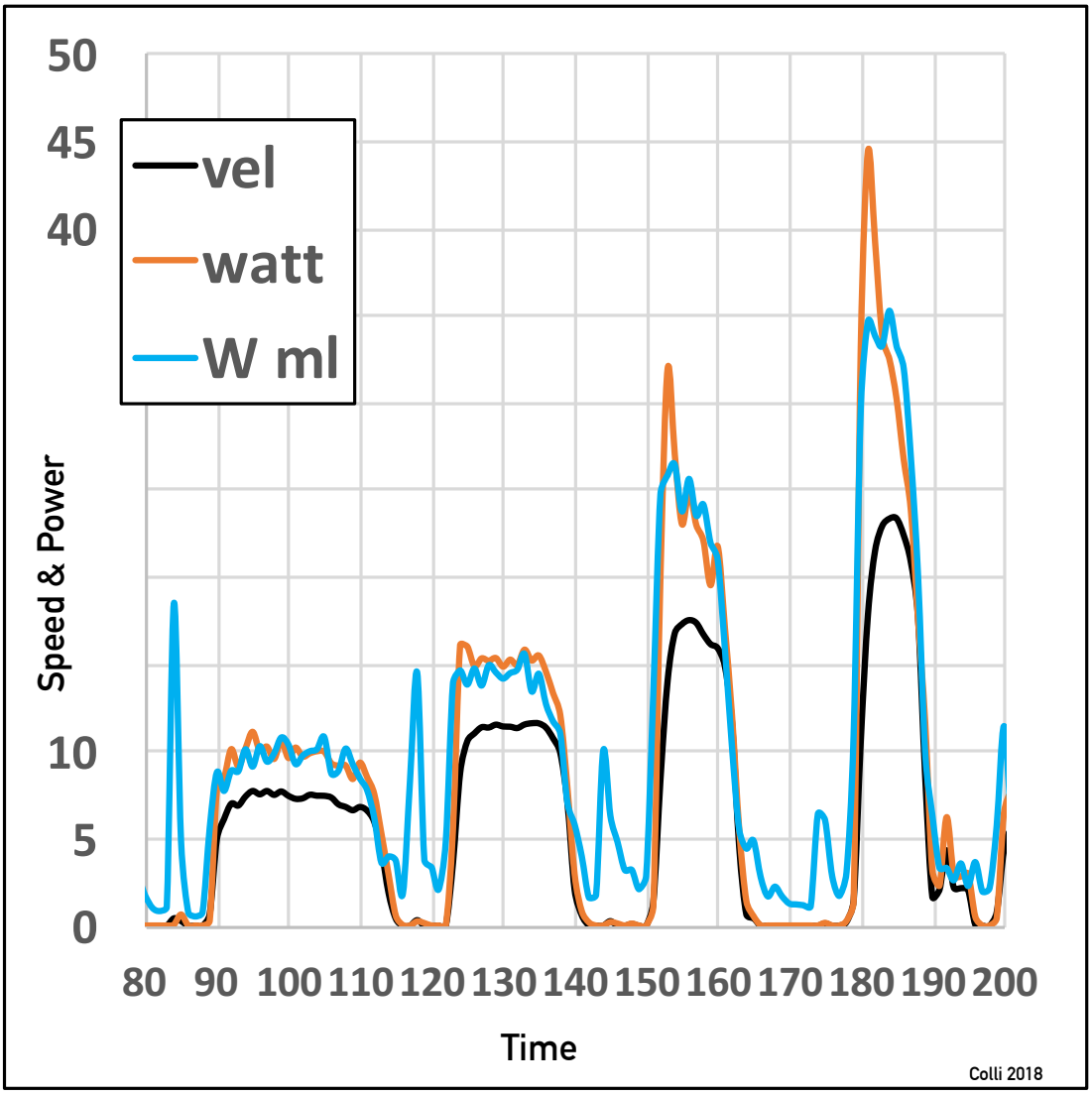


In this way it was possible to obtain a relationship between the two values described by a function.



Thanks to this relationship, a muscle metabolic power has been identified, that is, a power that derives from the electrical activity of the muscles and not from movement. This power is related to the metabolic power recorded through GPS devices directly at constant speed. In the acceleration and fight / contact phases, however, the ratio changes in favor of one or the other.

The next graph shows this relationship in the 4 constant speed runs, used to define the ratio itself (the orange line describes the metabolic power trend - the blue one the power trend given by the muscle load).



Having found this report, it was possible to use the analysis system during 6 games of a tournament to identify the "hidden load" of the fight / contact phases that is not recorded with only GPS devices.
As a practical example, 4 game sequences will be shown in which the moments in which muscle activity was high will be indicated, despite the fact that there was no real movement on the pitch.

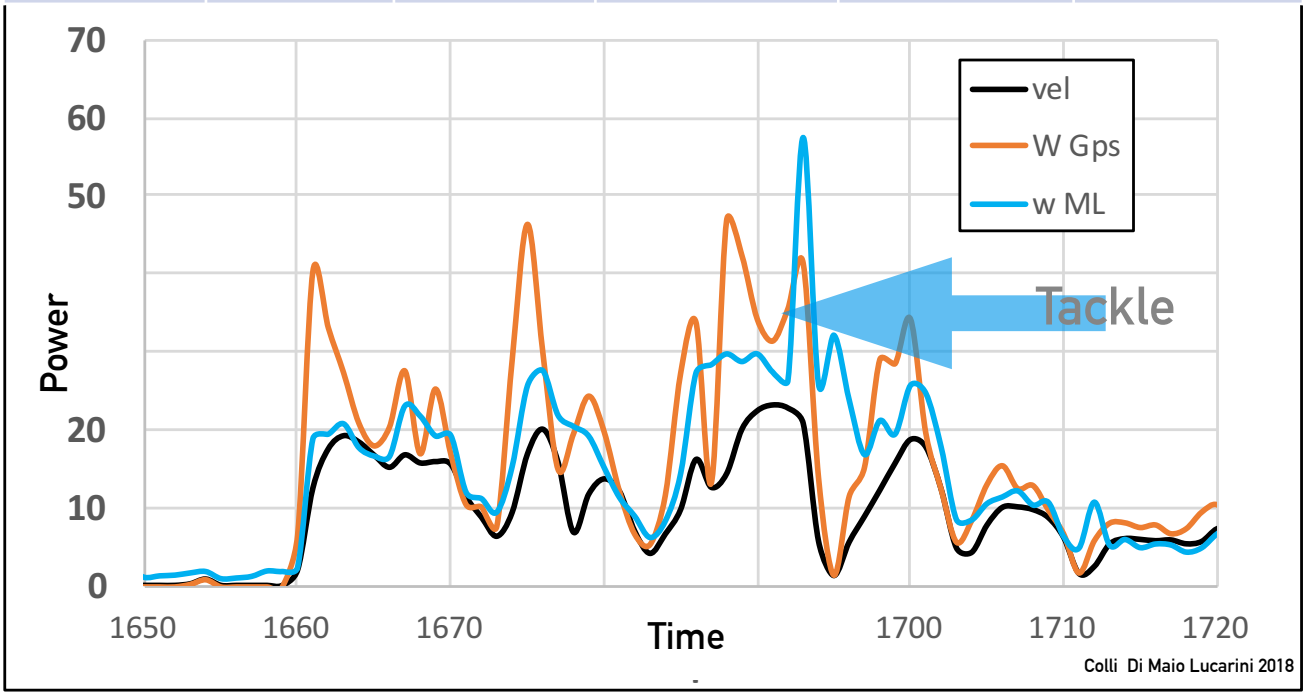
1st game sequence

In the first sequence it can be observed how all the moments of acceleration are identified by a spike of the metabolic power.

On the contrary, when the player makes a tackle (indicated by the arrow) a spike of muscular power is created. This indicates an important activity despite the movement being tending towards zero.

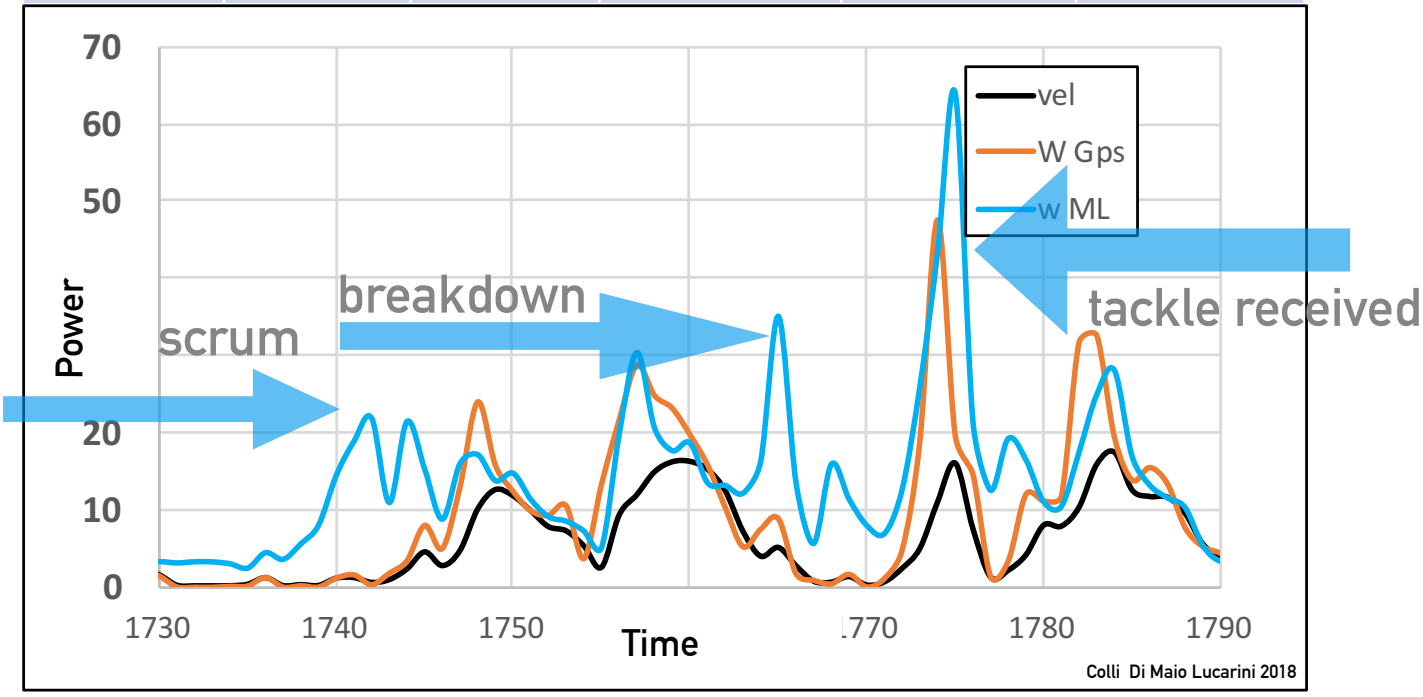
The table summarizes the general data of the 48 seconds of sequence. In this case, the Watts of metabolic power are higher precisely due to the presence of many acceleration phases.

Time	dist	vel	W gps	W ml	ML
48	170	12.7	21.5	19.6	299



2nd game sequence

Time	dist	av. speed	W gps	W ml	ML
44	91	7.5	12.8	17.2	266



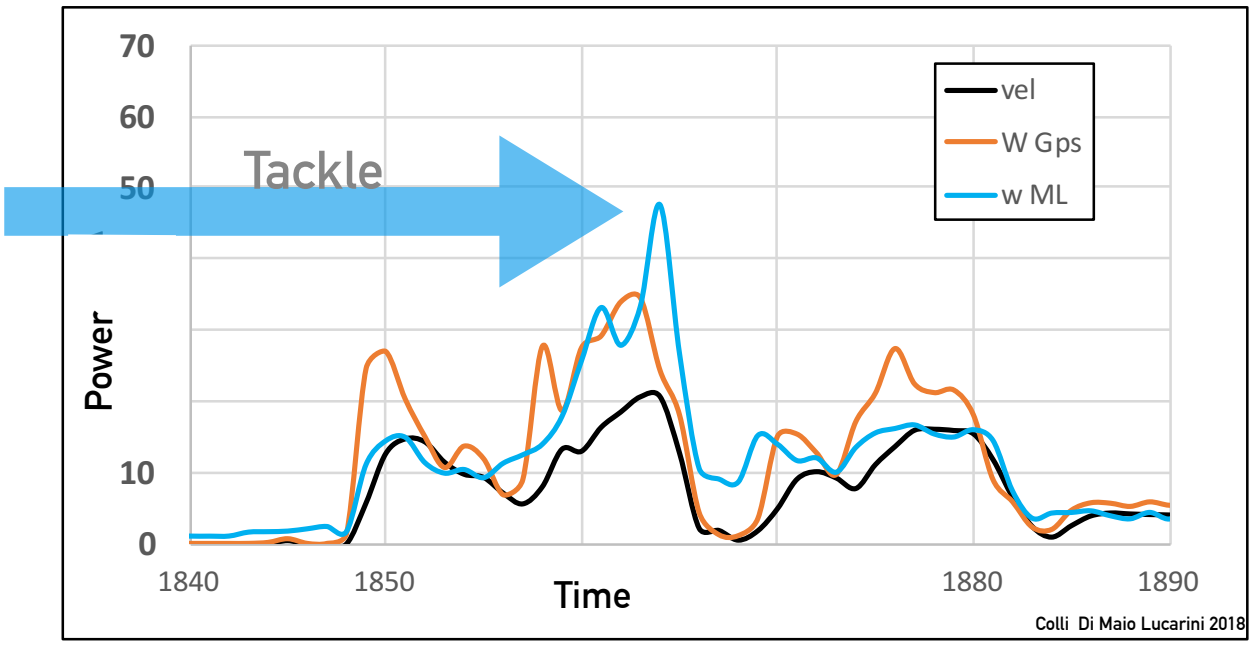
In the second sequence taken into consideration, the player performs 3 technical fighting / contact actions.
On all three occasions, muscle power surges as opposed to metabolic power which decreases or remains at very low levels.

The most significant case is that of the melee, where obviously the GPS does not give us the power data while the muscular electrical activity is high and lasts about 5 seconds.
In this case, in the total 44 seconds of the sequence, the muscle power is about 35% higher than the metabolic power.

At the moment of the tackle, the player is accelerating (peak orange line) but immediately after the deceleration, a peak of muscular activity is evident due to the endurance work and the subsequent availability of the ball.

3rd game sequence

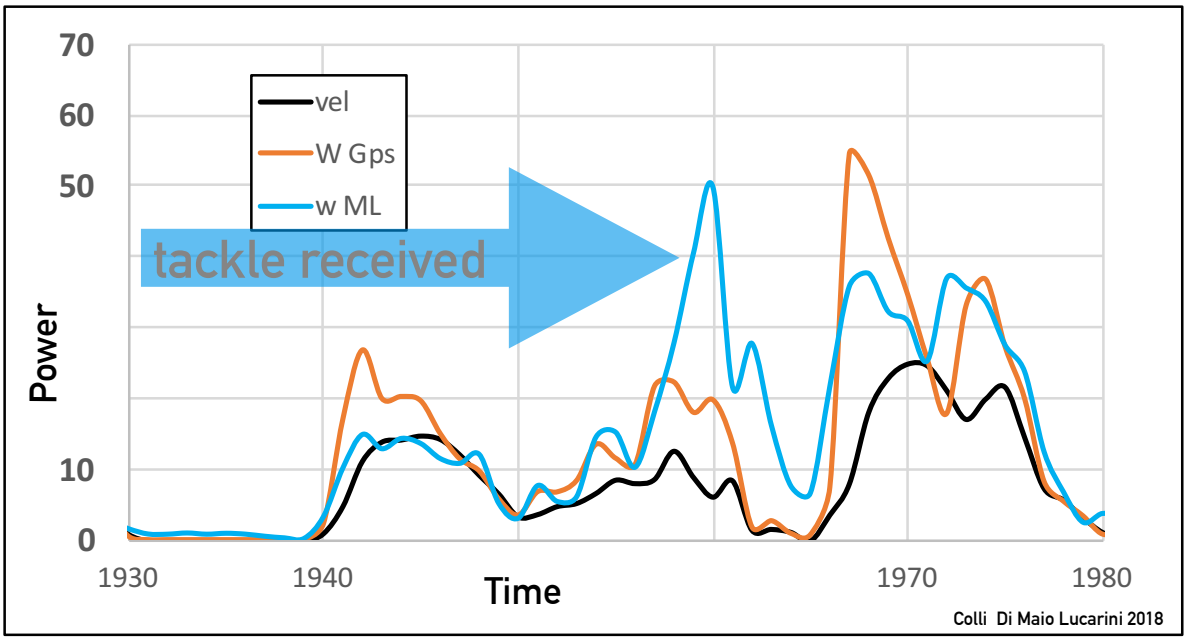
Time	dist	av. speed	W gps	W ml	ML
34	93	9.8	16.1	15.4	240



The third sequence features only one tackle as a technical intervention. Once again at the moment of execution we find a peak of muscle activity simultaneous with a sudden decrease in the values of metabolic power and speed. It should be noted that all increases in speed (black line) are preceded by a peak of metabolic power (orange line) demonstrating how acceleration most influences its performance and how high powers can be expressed even at low speeds.

4th game sequence

Tim	dist	av. speed	W gps	W ml	ML
38	109	10.3	17.6	19.6	299



- In the last sequence used as an example, in 38 seconds of activity, the player suffers a tackle.

Overall muscle power is however higher for two reasons:

- In the moment in which he suffered the tackle his speed was low but the fight derived from this technical moment was very intense.

- In the second part there were 2 important accelerations with 2 important decelerations. Remember that deceleration tends to decrease metabolic power because the energy cost of running during deceleration is lower than running in line. On the contrary, deceleration is, at a muscular level, a very important job which is therefore perfectly recorded by electromyography.

In a match time the monitored player has accumulated the following tactical interventions with contact:

1° Half Player 1	progressive time from kick-off	Duration
tackle	32	
scrum	80	5''
breakdown	104	2''
tackle recived	114	
tackle	203	
tackle recived	299	
scrum	343	4"
tackle	356	
tackle	374	

In total, therefore, 9 interventions, which add up to the running work carried out.
But how can we use this data to add the right load to the data we already know on the volume and intensity of the stroke?
The first important step is to quantify the difference in power recorded in these moments between the GPS and the electromyograph.

The following table compares the powers in the tactical moments taken into consideration, revealing the average difference, which we can then use to add the load of the fight / contact moments to the load of the race.
The average data was obtained from the analysis of an entire tournament (6 games) of a single player.

	Average duration	Average Watt EMG	Total Joule from EMG	Average Watt GPS	Total Joule from GPS	Joule difference between EMG and GPS
scrum	5"	20 W	100 J	6 W	30 J	70 J
breakdown	2"	31 W	62 J	10 W	20 J	42 J
tackle	2"	36 W	72 J	23 W	46 J	26 J
tackle recived	2"	50 W	100 J	20 W	40 J	60 J

The major differences between GPS and electromyograph obviously occur in the scrum where the players are practically stationary in one point.
Even the tackle received turns out to be demanding from a muscular point of view, probably for all the work that is done after contact with the opponent.
Each of these events therefore brings an increase in energy expenditure, which in this way can be added to that recorded with the GPS parameters.

Let's take for example the playing time of the table on the previous page and add the average working difference (Joule) that was detected with these calculations.

In the monitored match the player had an average metabolic power of 10.4 Watts for a time duration of 7 minutes and 30 seconds.
Its total work was therefore 4680 Joules.
The carried out interventions are summarized in the table in which the work not present in the calculation of the metabolic power is calculated in detail.

1° Half Player 1	Number	Joule difference between EMG and GPS	Muscle work to add
scrum	2	70 J	140 J
breakdown	1	42 J	42 J
tackle	4	26 J	104 J
tackle recived	2	60 J	120 J
Total work to add			406 J

The total additional work deriving from muscleload is therefore about 9% compared to the work recorded via GPS.

In summary, it is possible to calculate the total power expressed over time by adding the muscular work to the metabolic one:

1° Half Player 1	
Metabolic work	4680 J
Muscle Work	406 J
Total Work	5086 J

The total work done in 7 minutes and 30 seconds gives us a total power of 11.3 Watts (9% more than just the metabolic power).

This value is linked to the individual efficiency of each player. In fact, if effectiveness indicates the ability to achieve the set goal, efficiency evaluates the ability to do so using the minimum indispensable resources. So, in this sense it is not only important to know how to reach the goal but also to do it with a minimum cost.

This goal is reached through the repetition of the gesture in game conditions. Repetition causes an adaptation that involves all systems: from the cognitive to the neuromuscular one, from the coordinative to the biomechanical one.

All these adjustments increase the effectiveness of the gesture and at the same time the efficiency of the same.

Total power is also related to the number of interventions the player makes during the match.

So let's see what are the average values of the interventions made in an internal match (if the player stays all 14 minutes on the pitch) divided by roles.

	Prop	Hooker	N°9	N°10	Centre	Wing
Tackle	4	4	4	3	4	3
Tackle recived	3	3	2	3	3	3
Breakdown	3	3	3	3	2	2
Scrum	3	3				
Catch & pass	3	3	3	6	4	2

The table shows us a rather homogeneous situation.
The biggest difference concerns the passes, which are more numerous for the medians.
The players of the forward department have a higher energy expenditure given by the scrums.
This data is clearly influenced by possession which can "move" the data towards a greater number of tackles or towards a greater amount of tackles taken and passes.
The role does not seem to be a determining factor for the volume of work of the fight / contact aspects.
The general average that emerges from the data is therefore:

	Tackle	Tackle recivede	Breakdown	Catch & Pass	Scrum (only for forwards)
Average Match	4	3	3	4	3

The average of the work to be added to the GPS data is therefore 620 Joules.
The average duration of the matches (given in the chapter "SEQUENCES") is 950 seconds (15 minutes and 50 seconds) so the power to be added is on average 0.7 Watt.
The average data of metabolic power in a game (data in the chapter "METABOLIC POWER") indicate that a player develops an average power of 10.5 Watts.
The average total power is therefore 11.2 Watts where tactical contact situations represent 7%.
The one represented is an average figure.

As shown in the case of the single player (where the muscular power gave a contribution of 9% on the total power) the data is variable and dependent on factors related to the game itself.
Hypothetically, a player who plays for all the matches of a tournament and for the entire duration of the match therefore follows this number of interventions:

	Tackle	Tackle recivede	Breakdown	Catch & Pass	Scrum (only for forwards)
Average Tournament	24	18	18	24	18