I-Link suspension system

Considering the broad field of 4 bar suspension system, it's possible to split them into two classes of suspensions, which could be referred as LL4b and SL4b. The former stands for Long-Link 4-bar (FSR, ICT) , while the latter means Short-Link 4-bar. Well known examples of SL4b are VPP, DW-Link, etc.
As a SL4b suspension system, the **I-Link** represents an absolute innovation that distinguish itself clearly from the other competitors on the market.
We'll analyze in details the common characteristics of all system of suspension, in order to understand the behavior of the I-Link and other suspension systems that could appear similar to an ingenuous look.
The cinematic and dynamic behavior of a suspension system is characterized[1] by three main elements:

1. Antisquat.
2. Pedal feedback.
3. Compression ratio.

The comparison between the various schemas of suspension cannot therefore leave out of consideration any of these factors. Let's analyze these three characteristics.

Antisquat

The antisquat depends on the suspension geometry, characterized in a reference frame integral with the earth, on which both wheels rest. This geometric characteristics are:

1. The virtual pivot points paths:
    - The Center of Curvature (in short CC) of the rear axle path.
    - The Instant Center (in short IC) of rotation of the rear arm.

    These paths, for SL4b and LL4b, depends on the 4-bar pivot point configuration.
2. The straight line which identifies the chain line, depending on respective positions of:
    - The rear wheel axle (depends on the rear wheel diameter).
    - The bottom bracket.
3. The center of mass position of the whole system bicycle with rider.

Figure 1 represents the antisquat for the MDE Carver I-Link, with 130mm front and 135mm rear travel, with a sag of 30%, a 22x32 gear ratio, and the center of mass position determined with a rider of normal structure and 1,80m tall. As depicted, there is equilibrium between antisquat effect and weight transfer.
The following figures 1,1, 1,2 and 1,3 depict the 1, 2 and 3 above characteristics respectively.

1 Cinematica e dinamica della motocicletta, Vittore Cossalter, Edizioni Progetto Padova, ISBN: 8887331030. Effetto moto. Dinamica e tecnica della motocicletta, Gaetano Cocco, Nada Editore, ISBN: 8879113437. Motorcycle Handling and Chassis Design - The Art and Science, Tony Foale, Tony Foale Designs, ISBN: 8493328618.

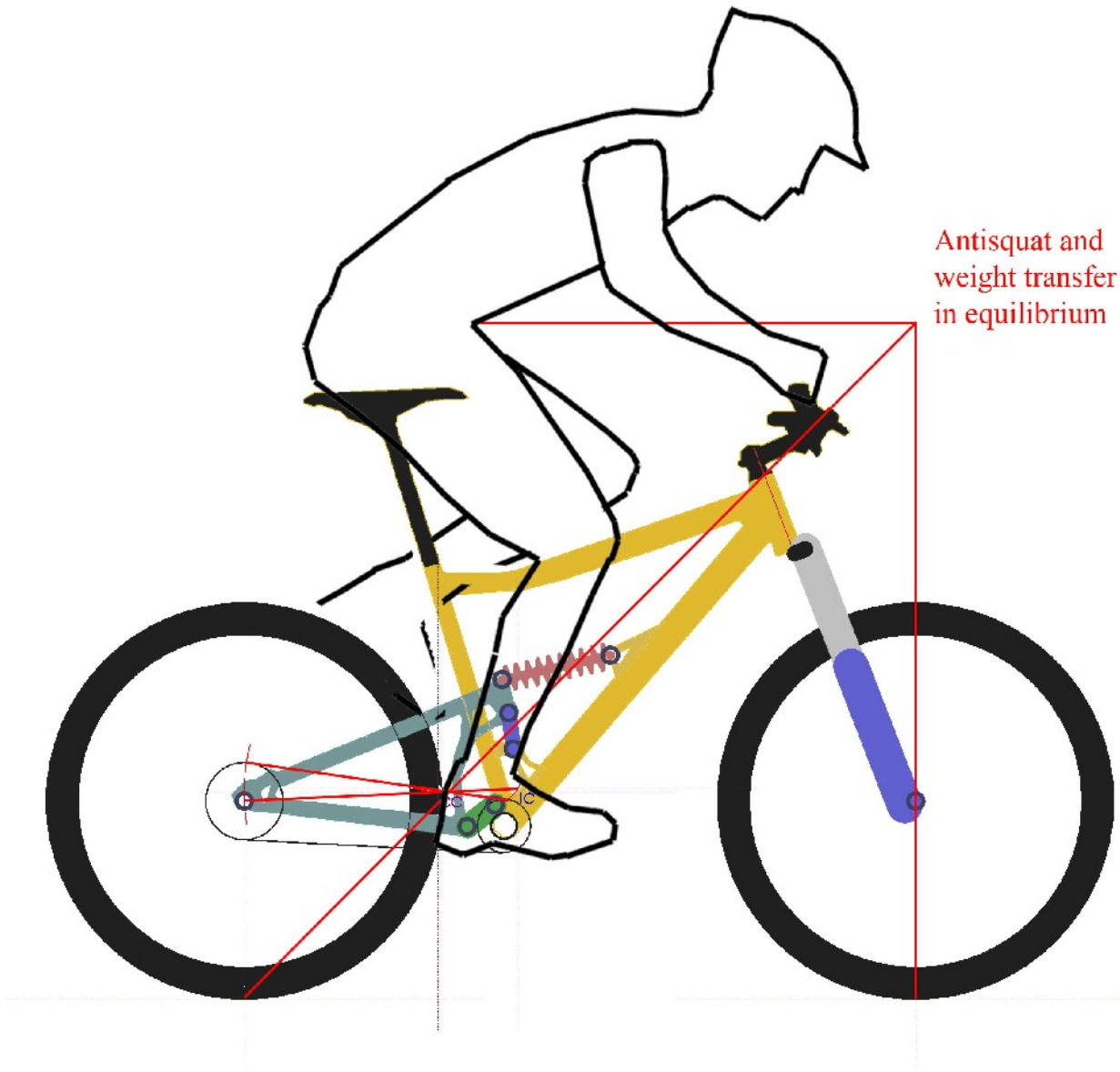

Figure 1: MDE Carver I-Link

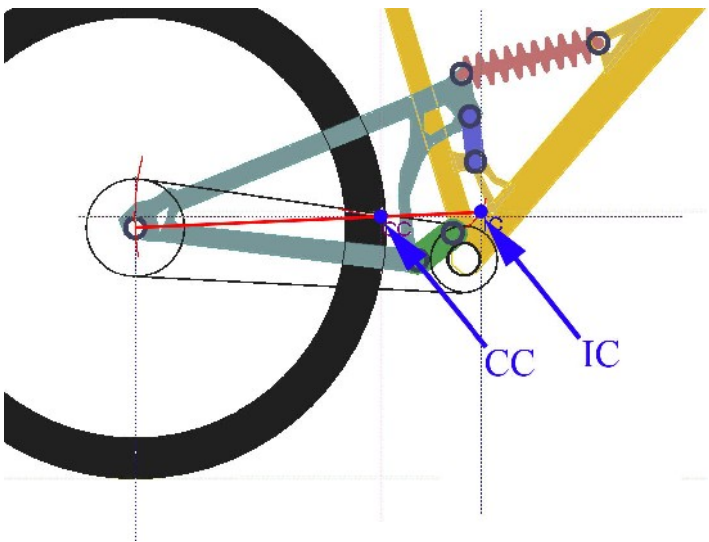

Figure 1.1: the CC and the IC

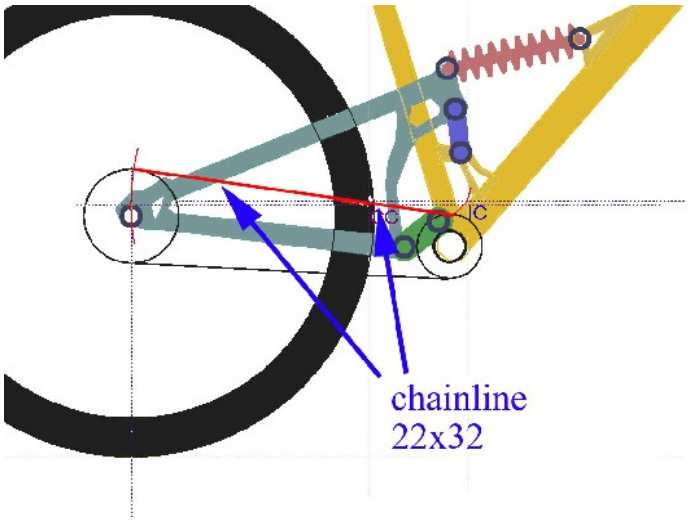

Figure 1.2: in red, the chainline

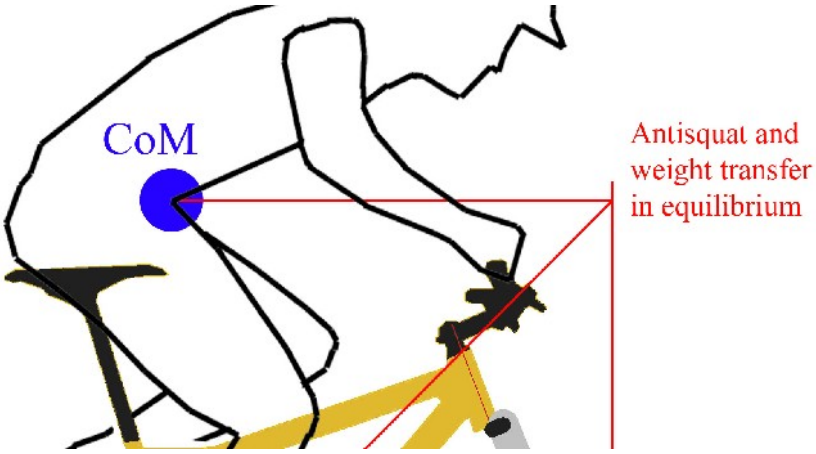

Figure 1.3: the center of mass or barycentre

Pedal feedback

The pedal feedback effect depends on:

1. Swingarm rotation (depends on respective positions of the IC and the rear swingarm itself).
2. Lengthening of the swingarm (bottom bracket-rear axle distance): depends on respective positions of the IC, swingarm and bottom bracket.
3. Chain line translation motion and rotation (depends on the above factors and on the gear ratio).

The pedal feedback can be evaluated using a software tool like Linkage (www.bikechecker.com), otherwise it'll require a great calculating effort. Figure 2 represents the pedal feedback for the MDE Carver I-Link with a gear ratio 22x32.

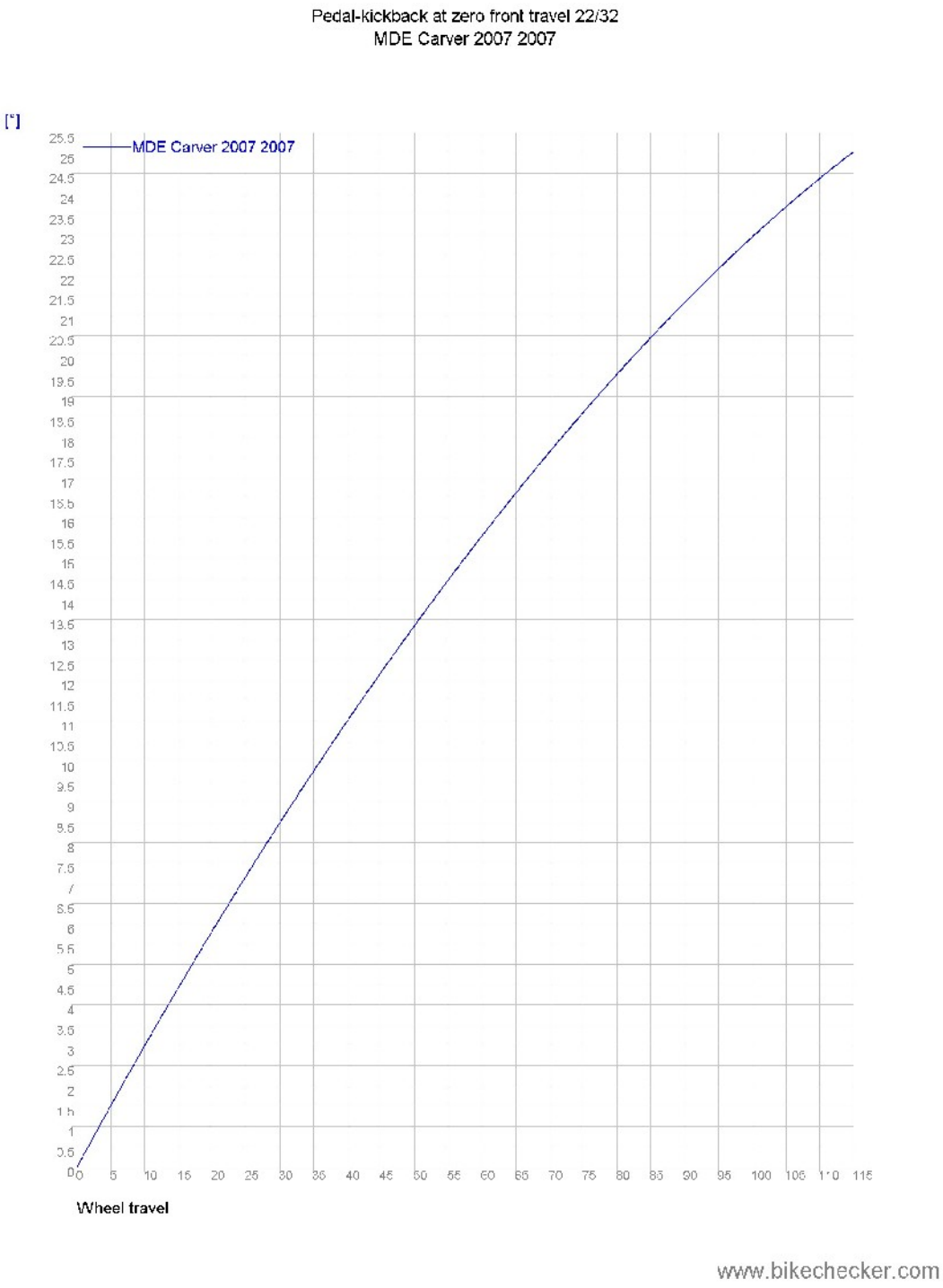

Figure 2: Pedal feedback for the MDE Carver with gear ratio 22x32

It is clear that the slope of the pedal feedback graph is always decreasing.

Compression ratio

The Compression ratio[2] depends on the path of the rear wheel and on shock's eyes. Supposing a configuration with one shock eye fixed on the frame, there are two different possibilities:

1. The shock absorber is being pushed by one of the two “short bar”.
2. The shock absorber is being pushed by the swingarm.

2 The Shock Absorber Handbook, John C. Dixon, SAE International, ISBN: 0768000505.

In the first case, there is only one degree of freedom to define the compression ratio, while in the second case there are two degrees of freedom (respective to the cinematic of the rear swingarm determined by the two short bar).
In figure 3, the compression ratio for the MDE Carver.

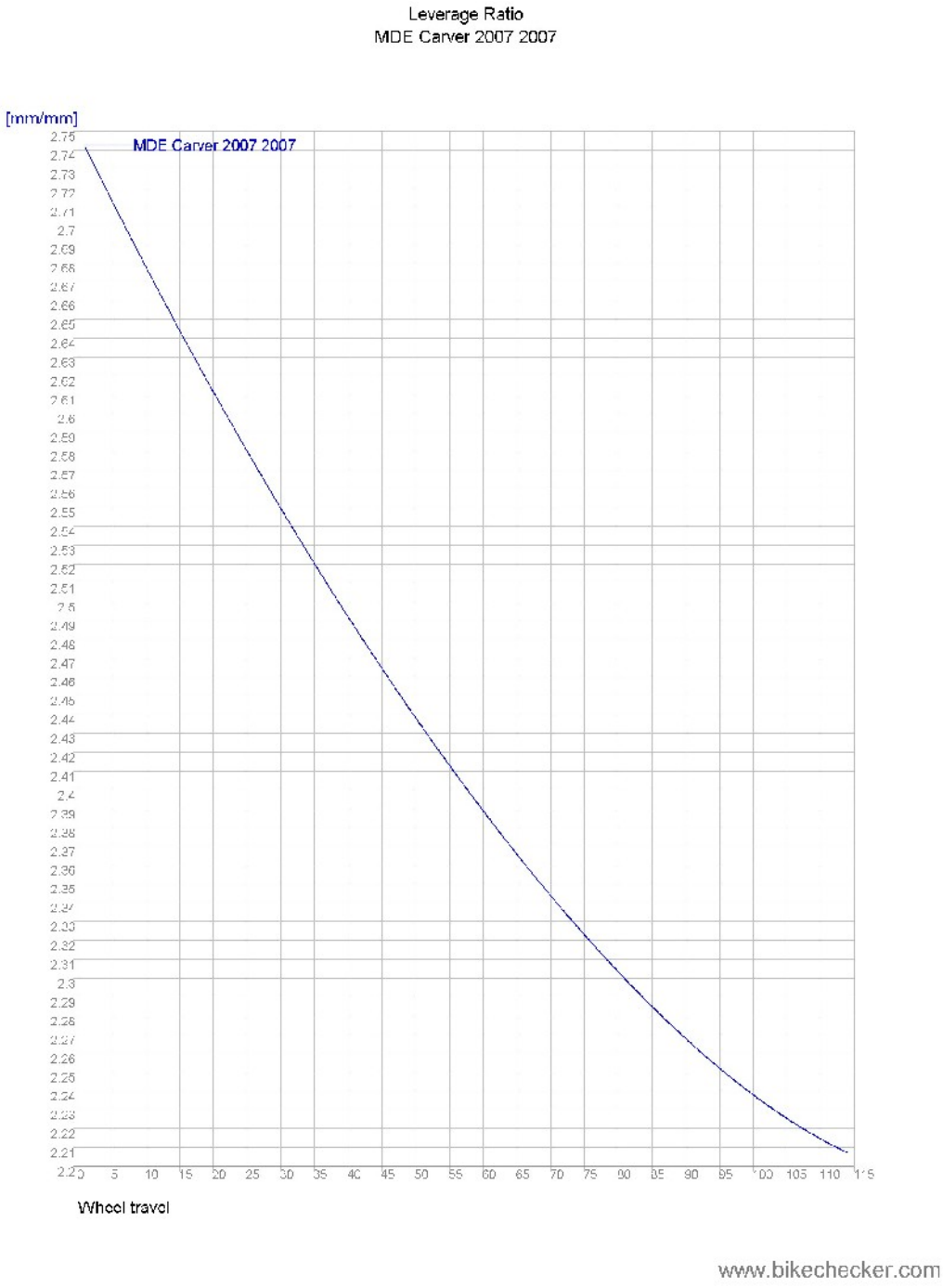

Figure 3: the compression ratio of the MDE Carver

Also note the linear and smooth rising rate along its travel.

Comparisons

Having clear the previous points, it is obvious that the suspension systems of SL4b type (ie I-Link,

DW-Link, VPP, FPS2) differ from those of LL4b type (ie FSR, ICT), at least because they can obtain a greater variation of the IC and CC paths, and also of the rear axle path. As a consequence, the other correlated characteristics, that is antisquat, pedal feedback and compression curve, can also have a great variation. Therefore, between the suspensions of SL4b type, different behaviors can be had, even between schemas that could appear similar in the aesthetic appearance, but that in practical operation are absolutely different.

Compression Curve

Figure 4 compares the compression curve of the Carver I-Link (in blue) and of the Santa Cruz VPP Blur LT (in green).

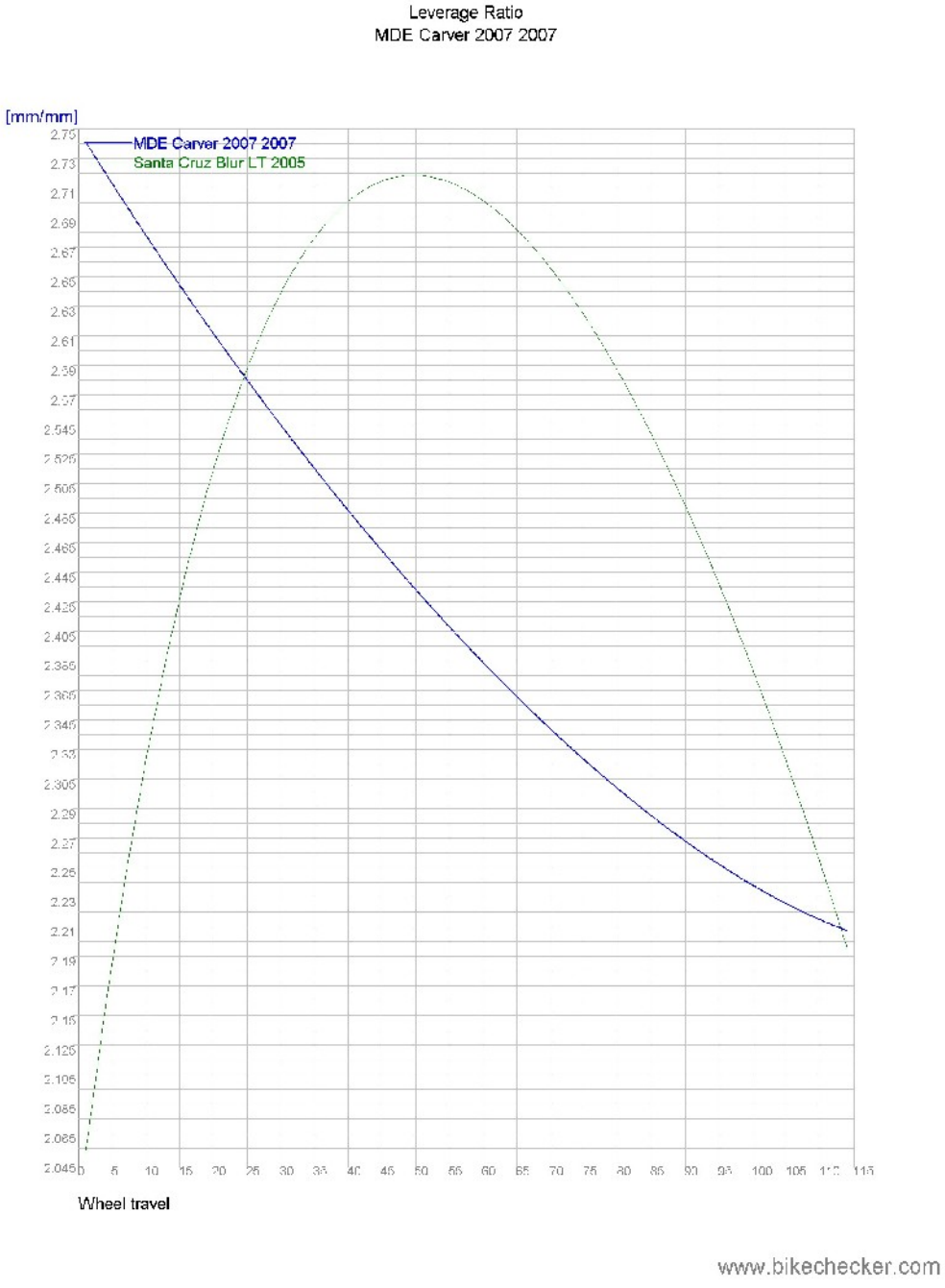

Figure 4: the compression curves of the MDE Carver and the Santa Cruz Blur LT to comparison.

Figure 5 compares the compression curve of the MDE Carver I-Link (in blue) and the Iron Horse MK III DW-Link (in green).

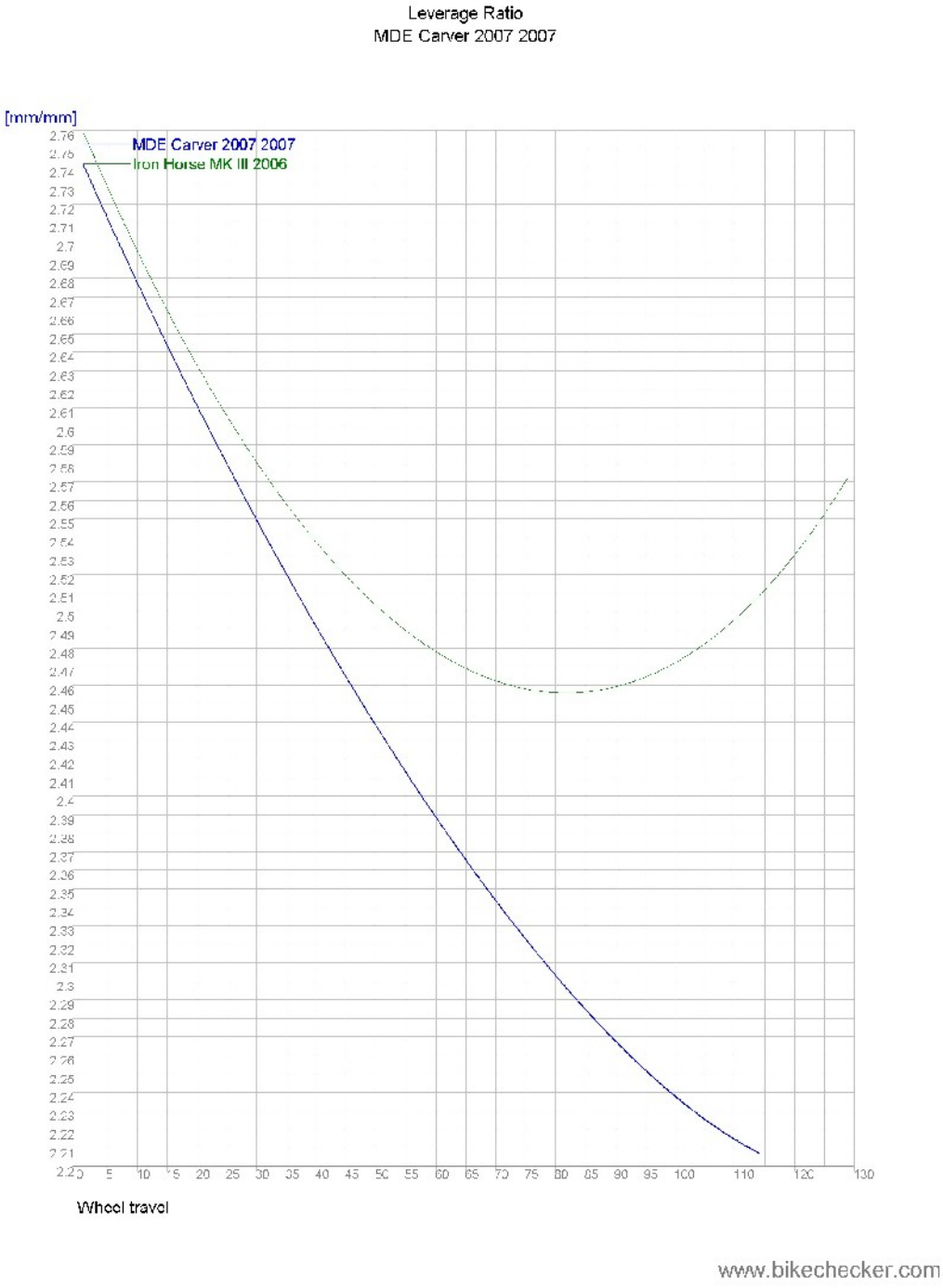

Figure 5: the compression curves of the MDE Carver and the Iron Horse MK III to comparison.

Figure 6 compares the compression curve of the MDE Carver (in blue) and Lapierre FPS2 X-160 (in green).

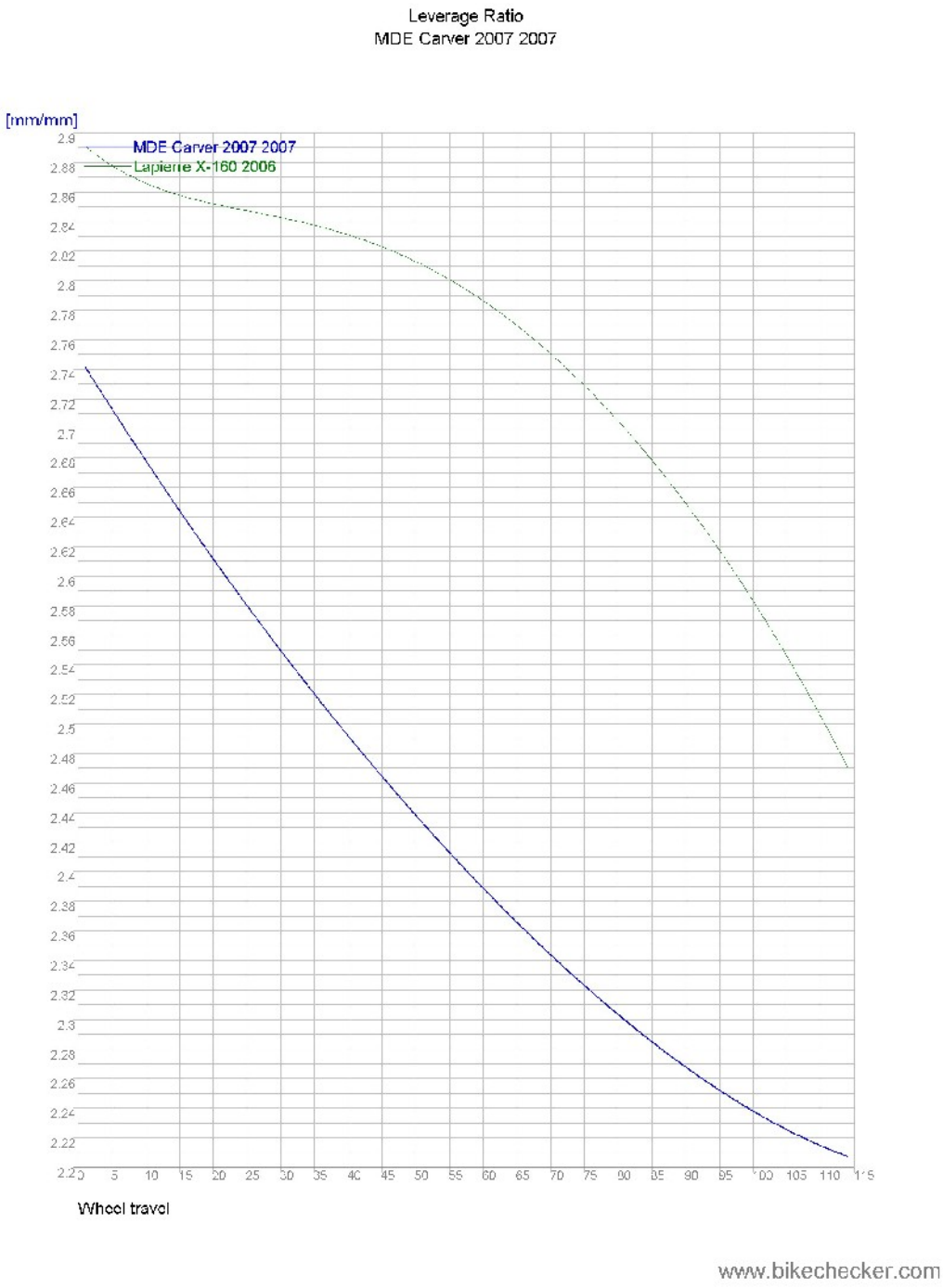

Figure 6: the compression curves of the MDE Carver and the Lapierre X-160 to comparison.

Between the compared suspension systems, only the MDE Carver I-Link has got a compression curve totally progressive and at the same time with a smooth, uniform and linear increase.

Comparisons between the values of pedal feedback

Figure 7 depicts a comparison between the pedal feedback, with the gear ratio 22x32, of the MDE Carver (in blue) with the Santa Cruz Blur LT (in red), the Iron Horse MK III (in green) and the Lapierre X-160 (in rose).

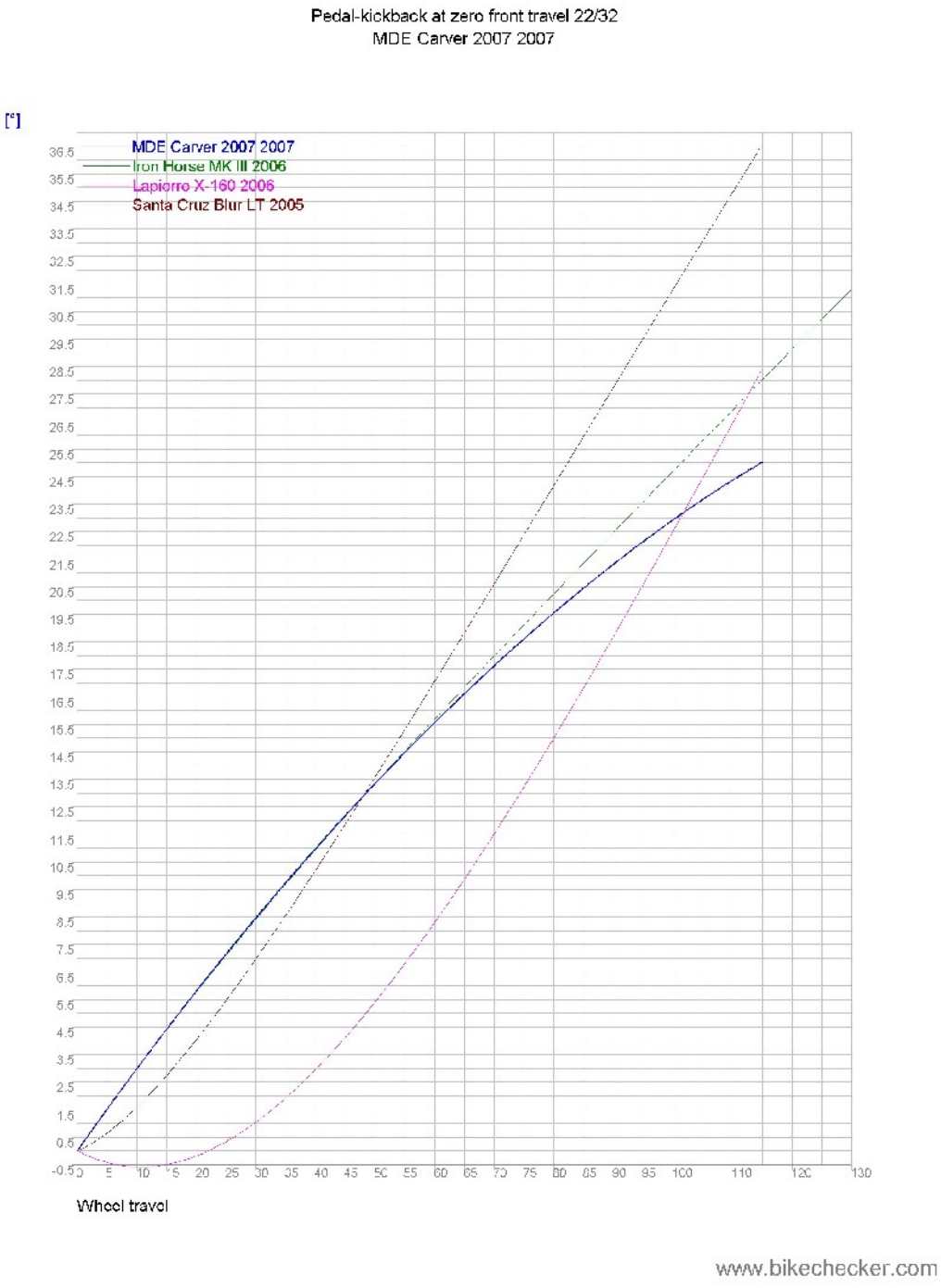

Figure 7: pedal feedback of the MDE Carver compared to X-160, Santa Cruz Blur LT, the Iron Horse MK III and the Lapierre X-160

The pedal feedback of the Carver I-Link is similar to that of the contenders (excluding Lapierre) in the first part of travel, but it has the advantage of being decreasing with the compression, therefore diminishing the interference with the pedaling action.

Comparisons between the Antisquat values

Like noticed in figure 1, the Carver I-Link has a antisquat value at sag that balances the weight transfer in acceleration. But the behavior of a suspension depends also on the variation of the

antisquat that it has during compression and the extension of the suspension. This depends on the IC path.

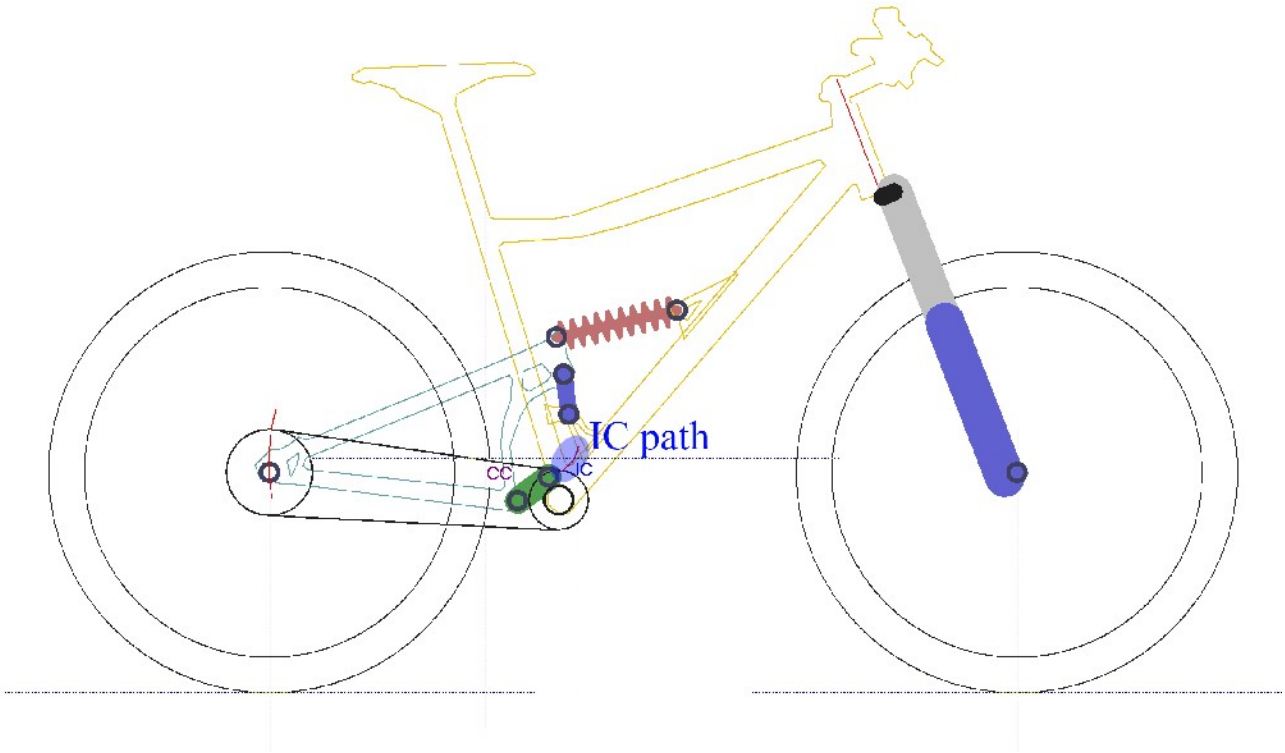

Figure 8: the MDE Carver I-Link: the zone in which the IC path is found

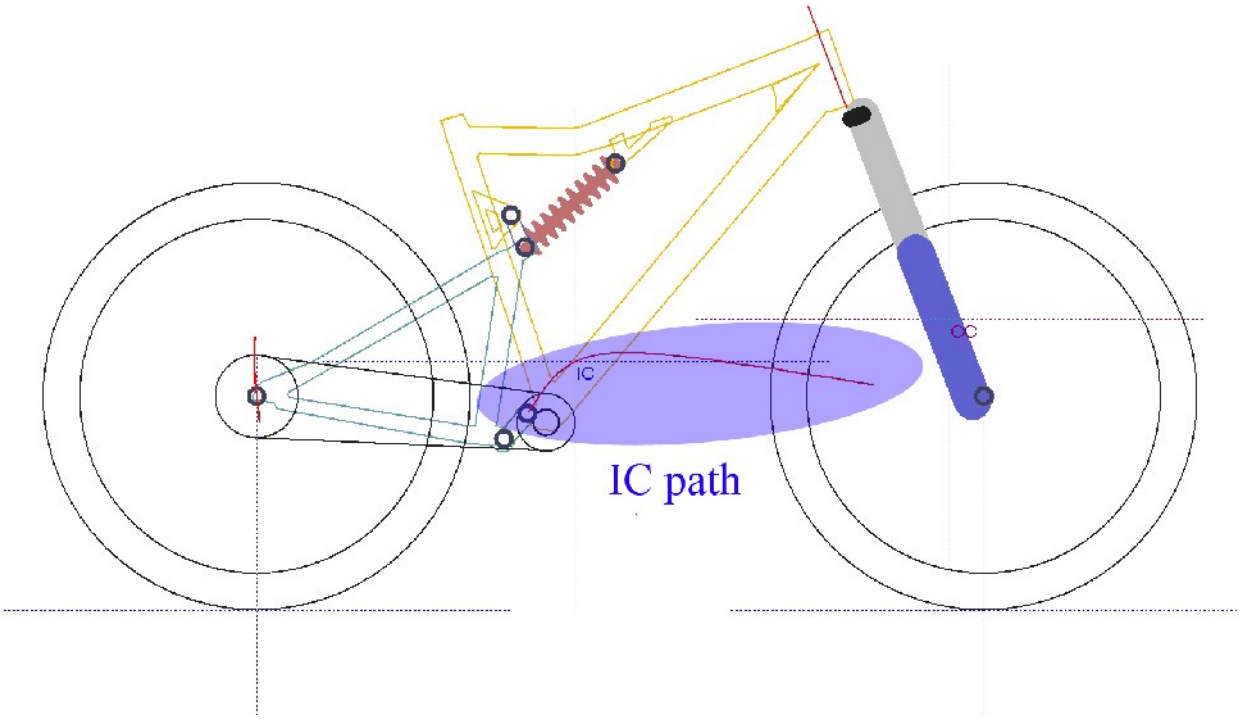

Figure 9: the Santa Cruz Blur LT: the zone in which the IC path is found.

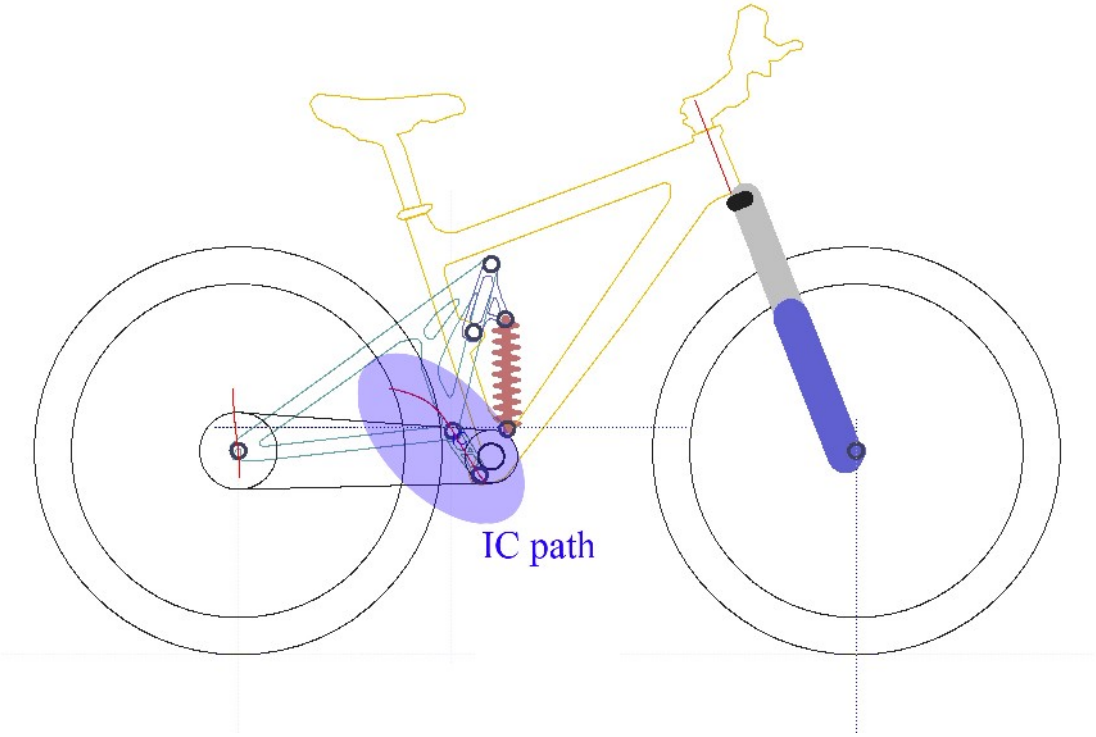

Figure 10: the Lapierre X-160: the zone in which the IC path is found.

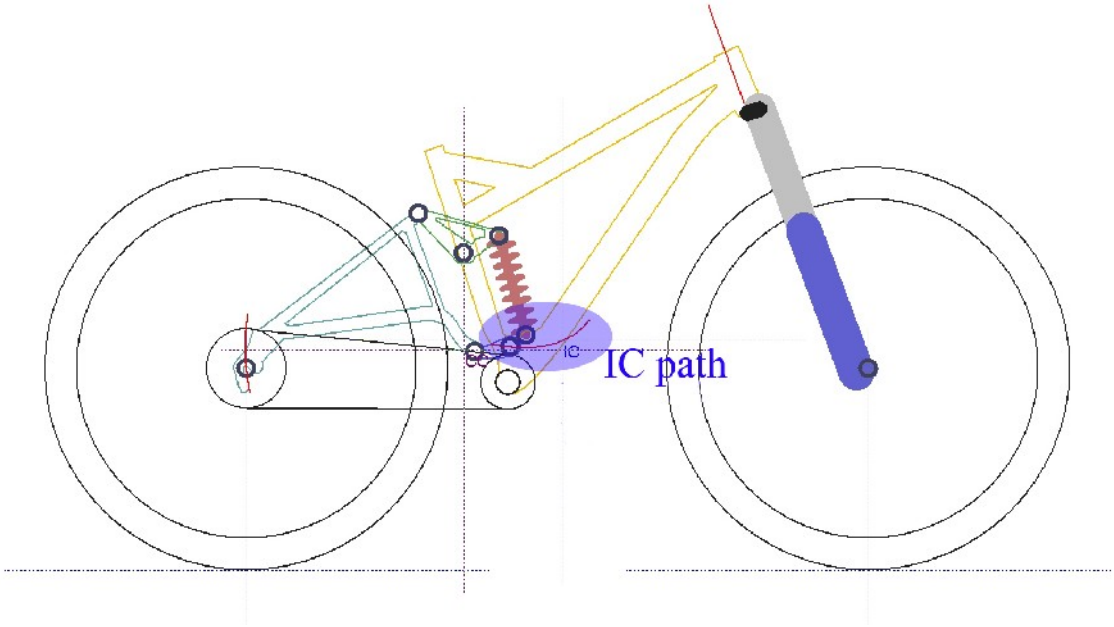

Figure 11: the Iron Horse MK III: the zone in which the IC path is found.

The IC path of the MDE Carver I-Link is the more circumscribed, and its antisquat turns out almost independent from the compression of the suspension, that gives rise to a behavior very consistent consistent along its travel. Moreover he turns out independent from the used value of sag, so that every pilot can choose the calibration that he/her prefers without risk of annoying side effects.

It can be asserted that the I-Link differs clearly from the other SL4b systems on the market in all the characteristics and features of a suspension system, which are:

- Antisquat - independent from the suspension compression.
- Pedal feedback - decreasing with the suspension compression.
- Compression ratio - progressive with the suspension compression.