Understanding frictions: Methodological guidelines for measuring transmission efficiency

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R. Aubert[1,2,4], X. Roizard[1], F. Lallemand[2,3], F. Grappe[4]

[1] Institut FEMTO-ST, Université de Bourgogne-Franche-Comté, Besançon (France)

[2] Société AFULudine, Dole (France)

[3] Institut UTINAM, Université de Bourgogne-Franche-Comté, Besançon (France)

[4] Laboratoire Athlète Matériel Environnement (LAME), Centre de Performance Equipe Cycliste Groupama-FDJ, Besançon (France)

Contact: remiaubert@outlook.com

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The world's fastest chain coating
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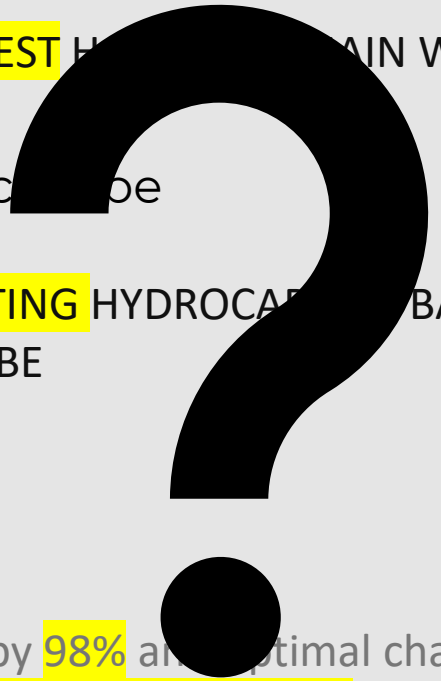
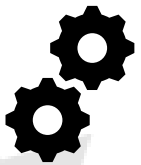


WORLD'S FASTEST & LONGEST LASTING HYDROCA BASED CHAIN LUBE

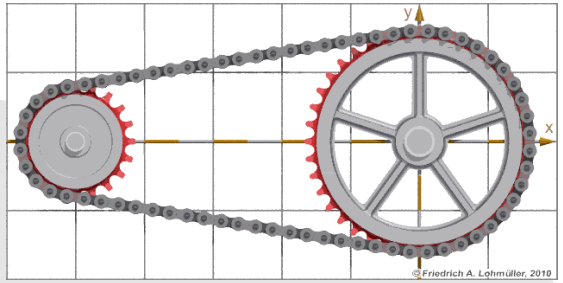
Reduced friction by 98% a timal chain length allow you to win up to 1 mn on a 20km time trial

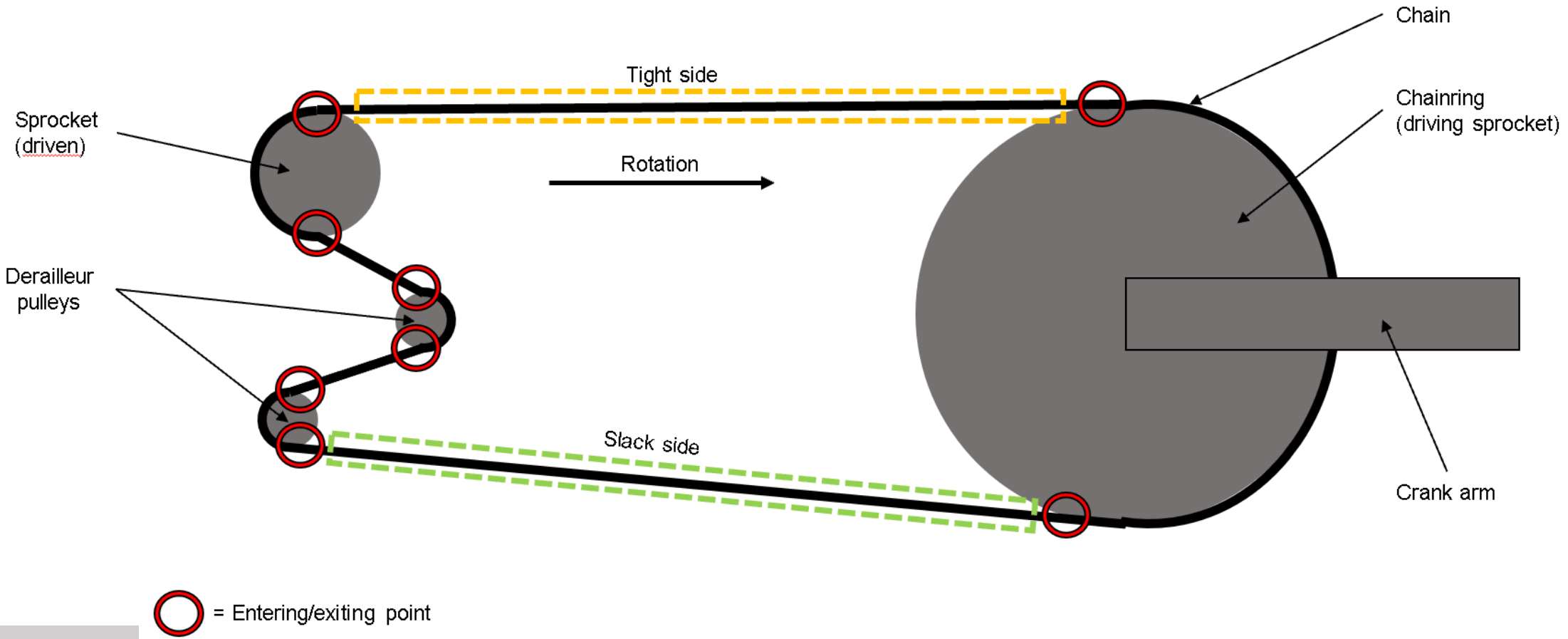


proven to be the fastest pulley system in the world, providing energy savings starting from 2.4 watts over standard […] systems

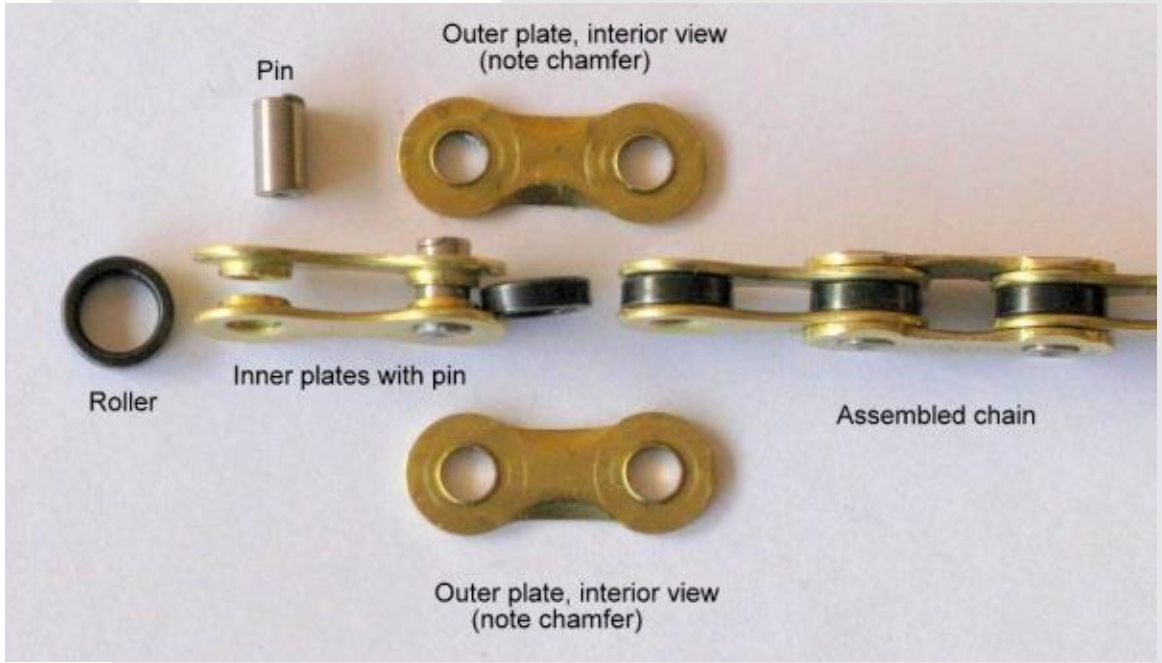
Quick reminder : frictions in chain drives

Friction in chain drives

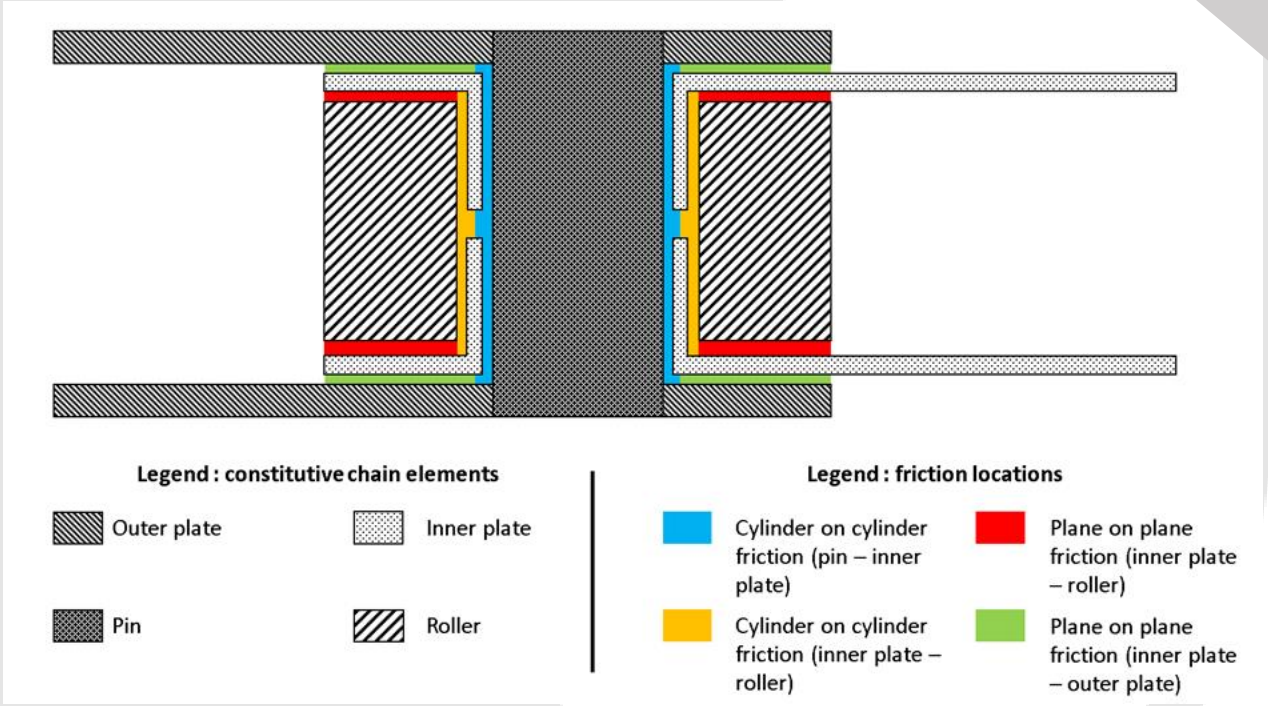




Friction in chain links

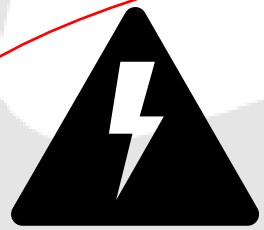


Source : zerofrictioncycling.com



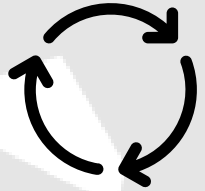
Kidd 2000, Spicer 2001

Parameters influencing frictions



Chain tension

Chain misalignment

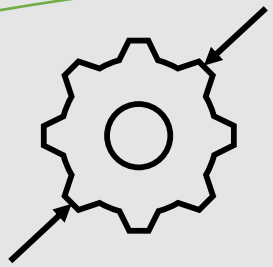


Rotation speed

Pollution

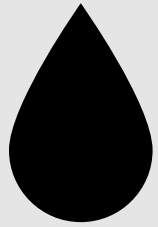
+ = +

$$Ff = COF * Fn$$



Sprocket/Ring size

+ = –



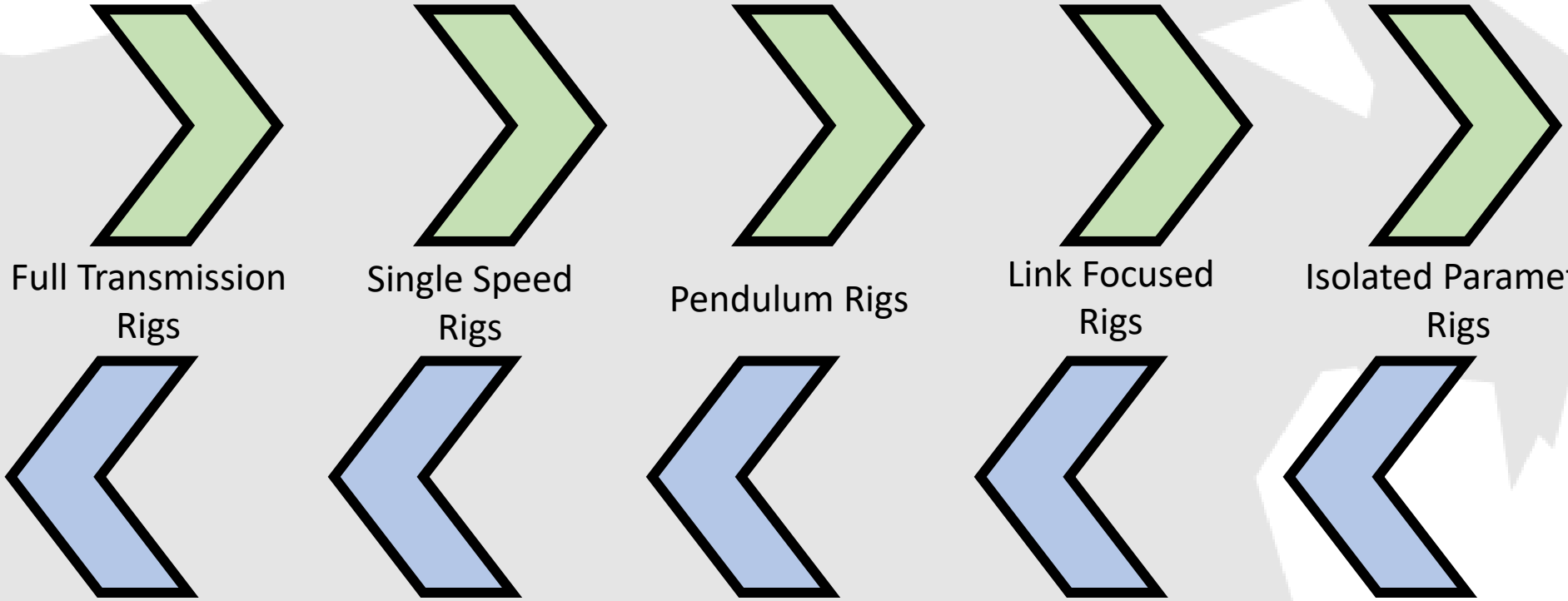
Lubrication

Kidd 2000, Spicer 2001

How were the frictions measured ?
What are the limits of the methods that were used ?

5 categories of measuring rigs

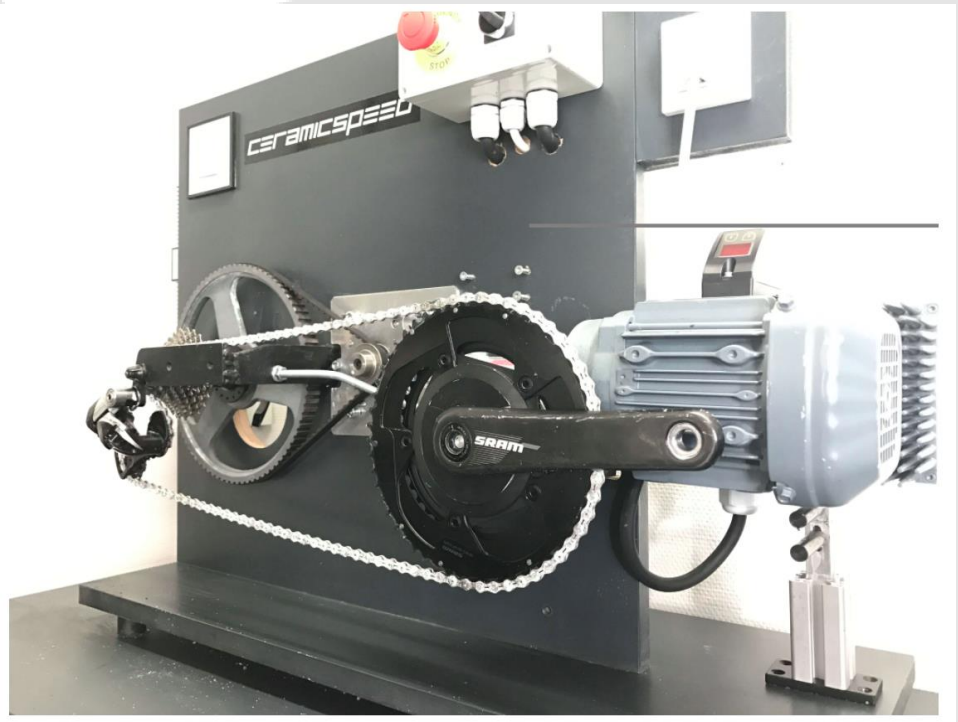
Link with « real cycling » complexity



Precision of measurement

Full Transmission Rigs

=> Motorised rigs with the whole transmission tested



Friction Facts, CeramicSpeed, Denmark

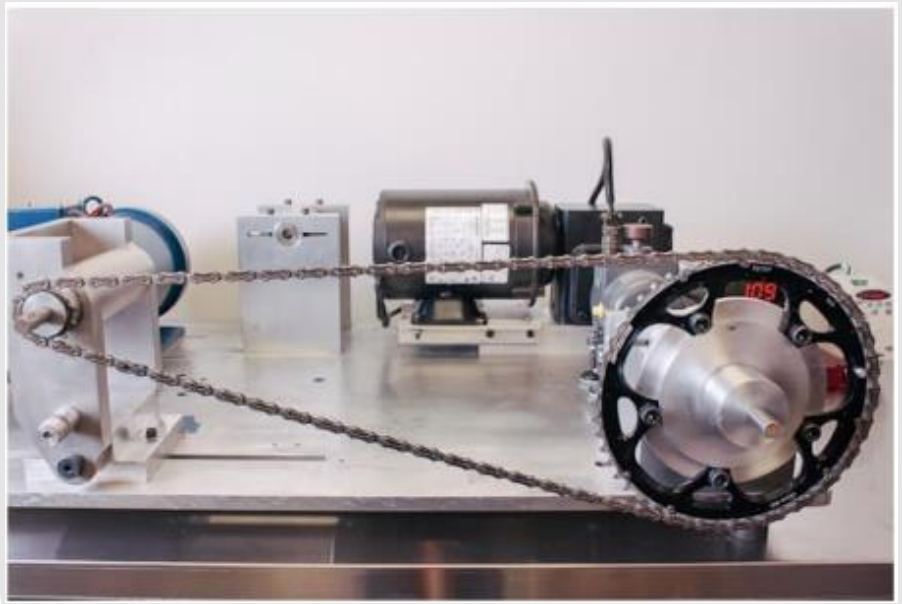
- Chain drive efficiency
- Chain wear

- Close to real locomotory conditions
- Every parameter can be tested

- Subjected to variability because of the number of elements involved
- Needs accurate measuring devices

Single Speed Rigs

=> Motorised rigs in single speed setup



Friction Facts, CeramicSpeed, Denmark

- Chain drive efficiency (track cycling)
- Chain wear

- Close to real locomotory conditions
- No derailleur involved

- Subjected to variability because of the number of elements involved
- Needs accurate measuring devices
- Both sides of chain under tension so different pattern

Pendulum Rigs

=> Hanging chain articulating around a chainring

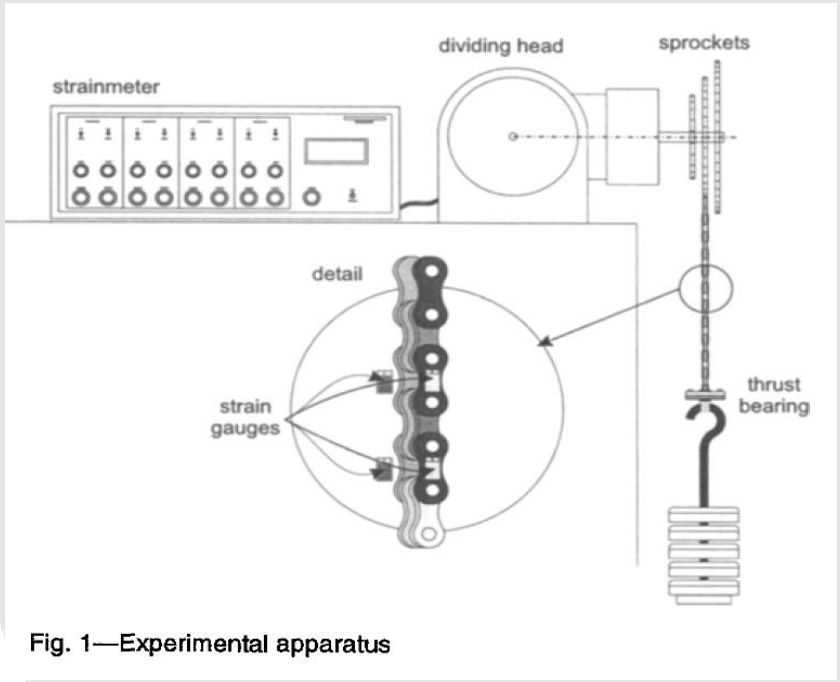


Fig. 1—Experimental apparatus

Kidd, 1999

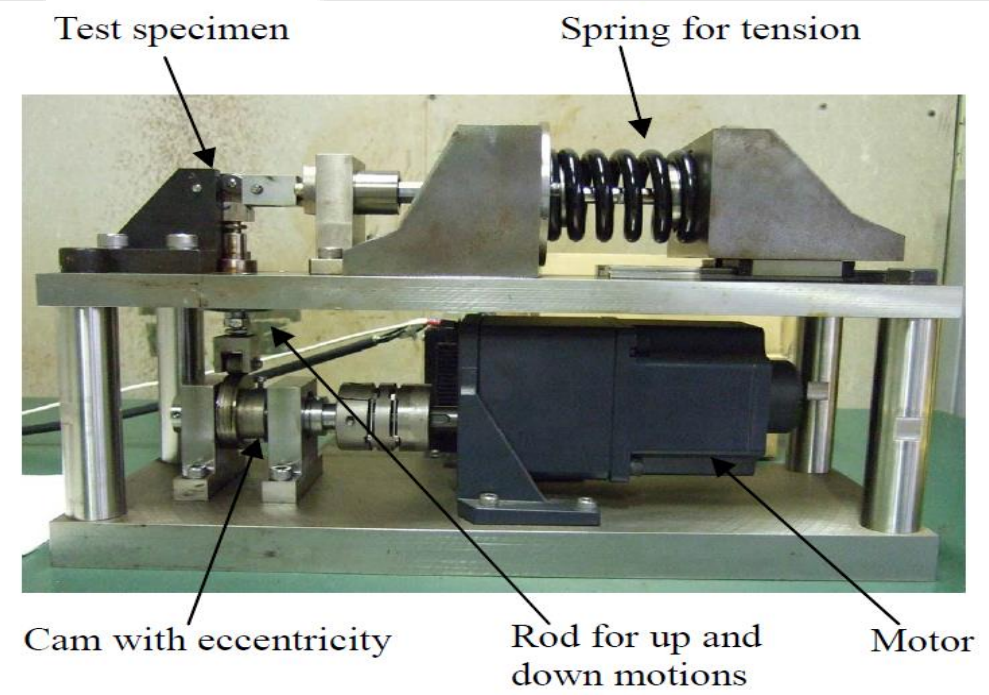
- Load in links
- Friction force during the articulation

- Focused on an articulation
- Simple and accurate measurement

- Speed is low
- Short tests only

Link Focused Rigs

=> One link articulating around another, one degree of movement



Noguchi, 2009

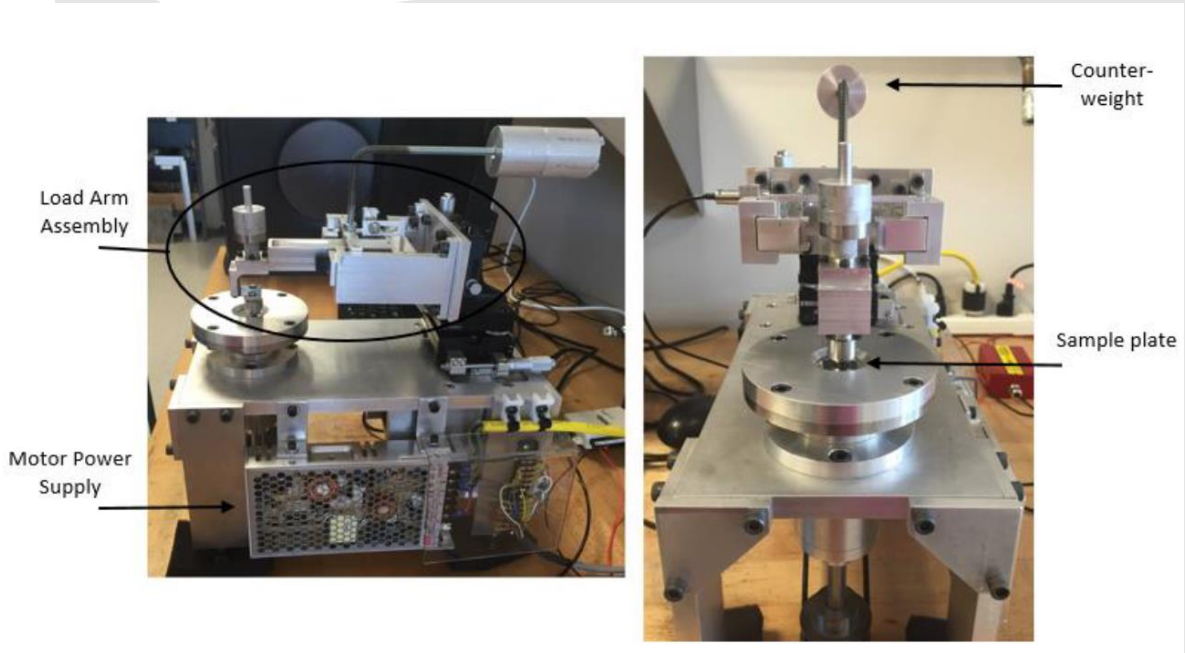
- Friction force in the link during articulation
- Wear in link

- Specific for one articulation
- Lowest scale on a link

- Far from the complexity of chain drives
- Specific for one articulation

Isolated Parameter Rigs

=> Device dedicated to COF measurement



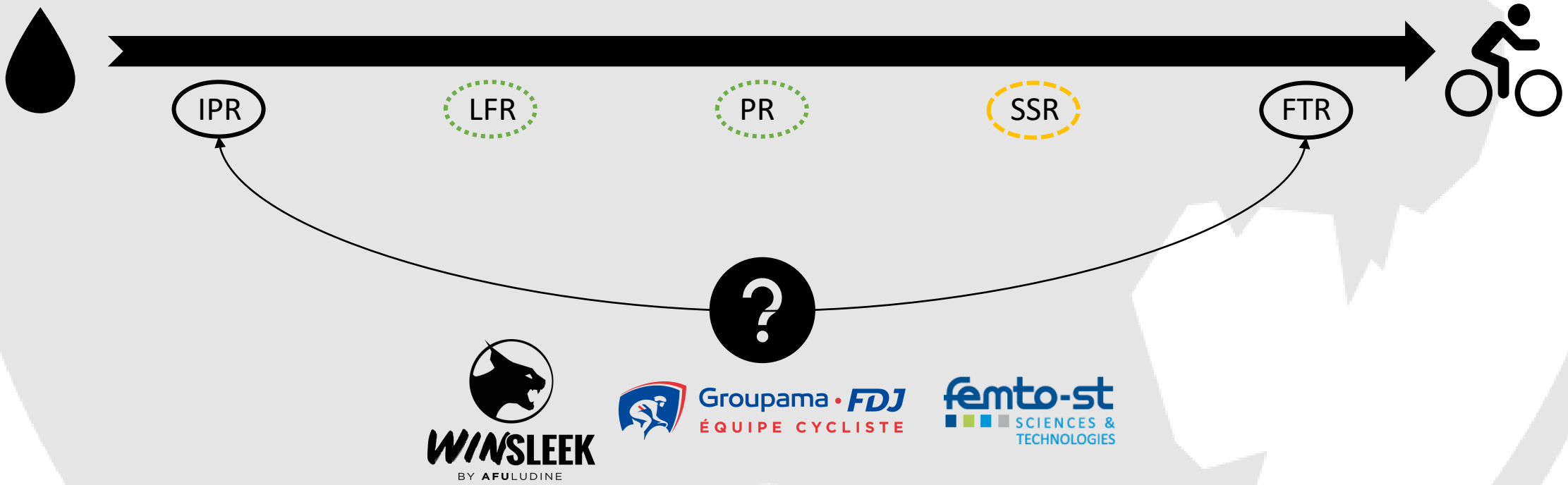
Michelsen, 2015

- Coefficient of friction of a lubricant
- Wear of the sample

- Isolated measurement so low variability
- Standardised comparison

- Far from drive trains complexity
- Difficult to correlate with real locomotory conditions

Conclusion



Take home message

- Set your objective (parameter to measure => precision)
- Use the adequate(s) rig(s)
- If you compare, make sure the comparison is possible
- Be careful when extrapolating to real cycling
- Think global : other parameters may balance your results

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Thank you for your attention !