Informal Document - ACSF-15-05

Ministry of Land, Infrastructure and Transport

Korea Automobile Testing & Research Institute

Data Filtering Method

Korea Automobile Testing & Research Institute
Automated Driving Research Office

www.ts2020.kr

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Proposed draft of Data Filtering requirement

Paragraph 5.6.2.1.3 and 5.6.4.4., amend to read :

"5.6.2.1.3 Lateral acceleration

(c) The ~~moving average over half a second of the~~ lateral jerk generated by the system shall not exceed 5m/s^3"

"5.6.4.4 Lateral acceleration

The ~~moving average over half a second of the~~ lateral jerk generated by the system shall not exceed 5m/s^3"

Annex 8,

Insert a new paragraph 2.5, to read ;

"2.5 Data sampling and Filtering

2.5.1 All data is to be sampled at 100Hz.

2.5.2 Filter the measured data as following;

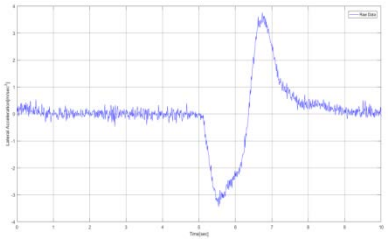
2.5.2.1 Lateral acceleration with a 6-pole phaseless Butterworth filter with a cut off frequency of 10Hz

2.5.2.2 Lateral jerk with a one-pass 200ms moving average technique with values that are performed using differential with respect to time of measurement of filtered lateral acceleration of 2.5.2.1.

2.5.2.3 Unless otherwise specified, the other data are not filtered and are used in their raw state.

2.5.2.4 An alternative filtering method may be allowed for type approval testing, provided it is agreed between the manufacturer and the Technical Service."

Justification of filtering



➢ **Sampling rate**

1) signal analysis frequency of measured(raw) data : 2.5Hz

- define period signal for raw data

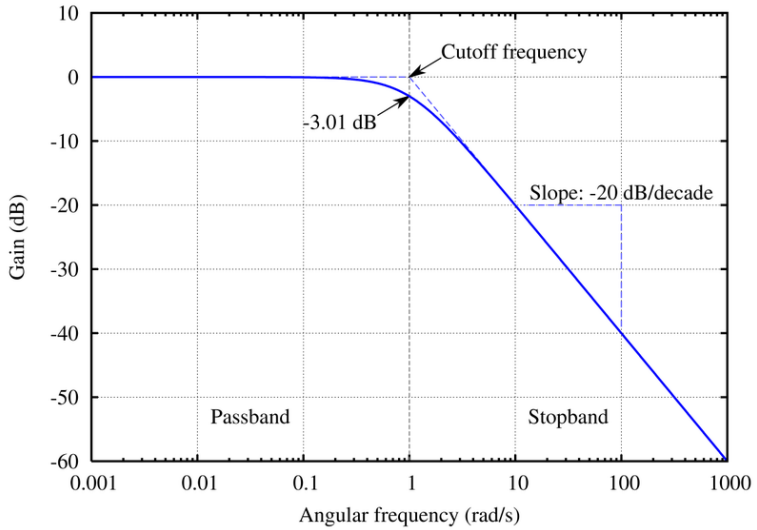
2) measured(raw) signal * 2 : 5Hz

- 5Hz passband frequency defined

3) Cutoff Frequency(fc) : 10Hz

4) Sampling rate : <u>100Hz</u>

– Signal($f_c * 10$)



Justification of filtering

- **definition of filter**

1) selecting Butterworth filter by purpose

- the smallest phase
- maximally flat magnitude in passband
- to easily apply for filter by formula

2) calculation of damping ratio

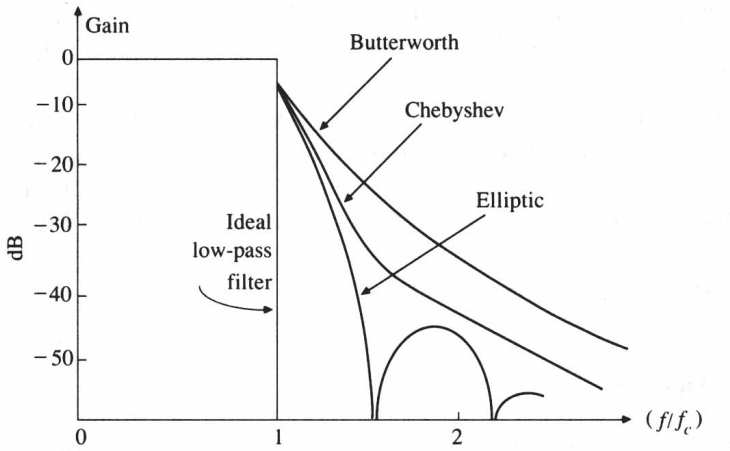
- dB per Octave
- transforms Vout to dB(20 log(V out/V in) = 40 dB)

  * 1V(Vin) → 0.01V(Vout)

3) determination of filter order

- 36 dB : **6 Pole**

* 12dB → 2Pole, 24dB→ 4Pole, 36dB → 6Pole , 48dB → 8Pole

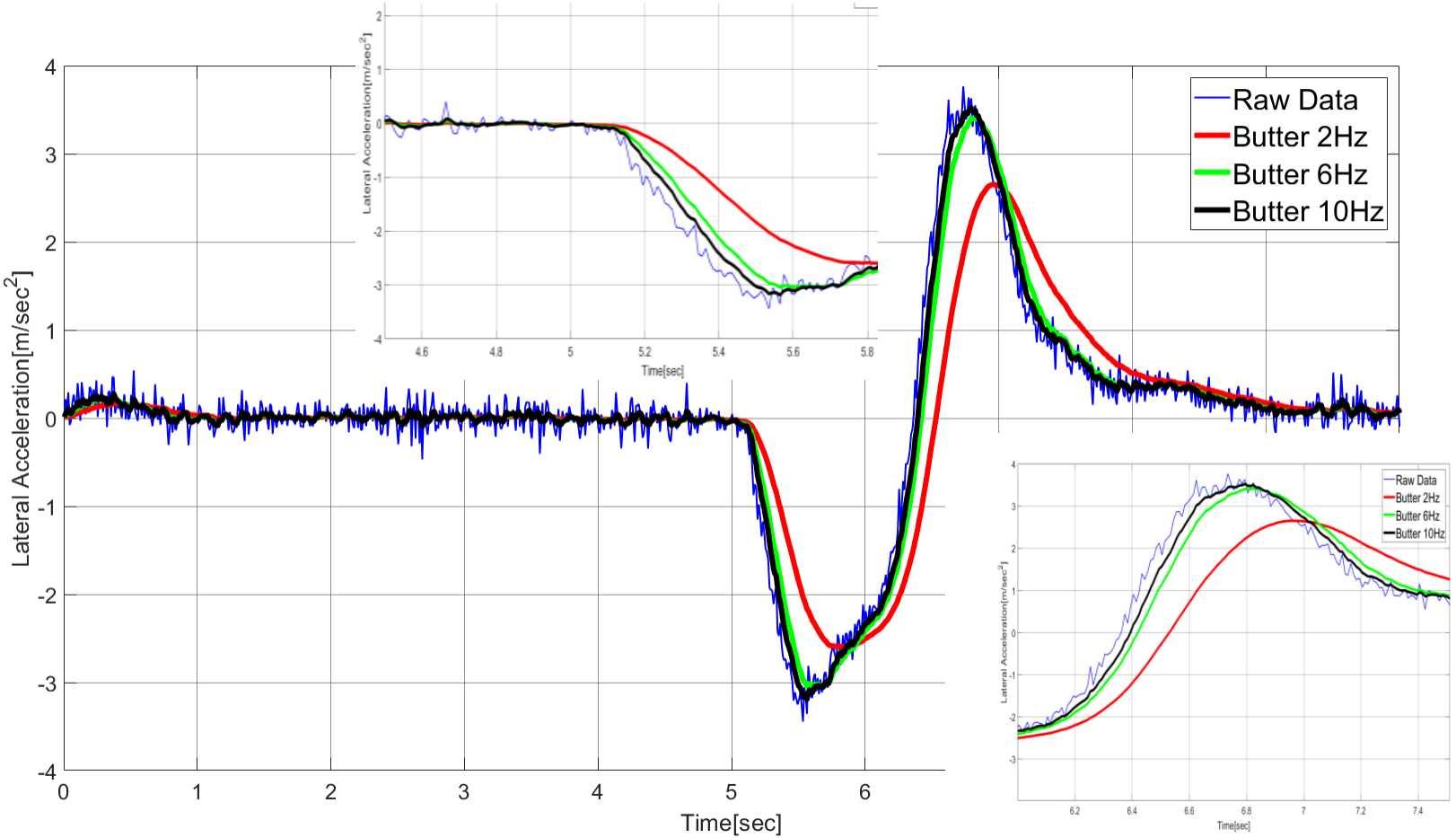


Ratio of Vout/Vin	20log(Vout/Vin)(dB)
0.000001	-120
0.00001	-100
0.0001	-80
0.001	-60
0.01	**-40**
0.1	-20
0.501	-6
0.707	-3
1	0

Application of filter to raw data (lateral acceleration)

➢ **Lane Change Manoeuvre(by human driver)**

- 6 pole Bf filter with fc = 2/6/10Hz



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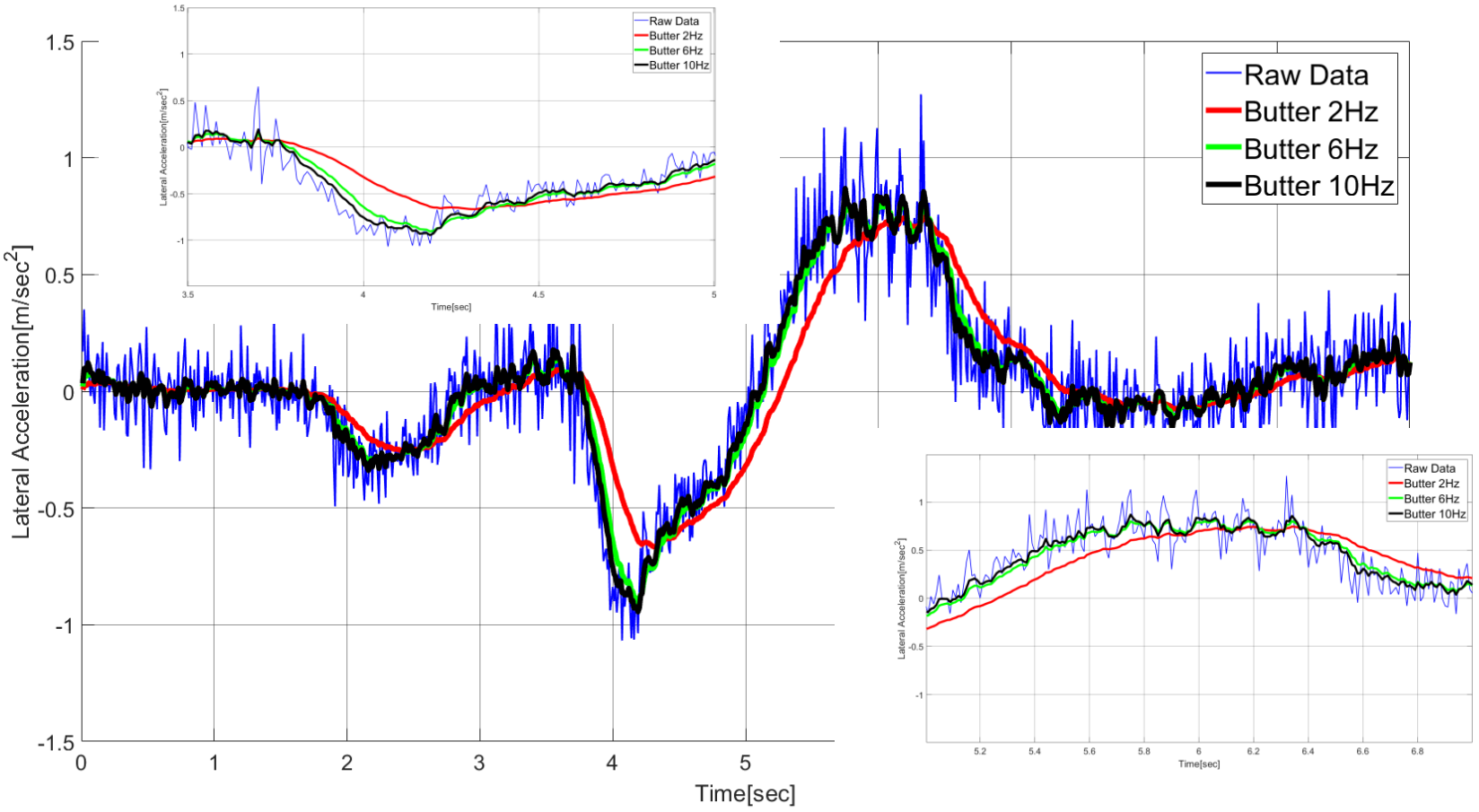
Application of filter to raw data (lateral acceleration)

- **LKA activation in straight road**

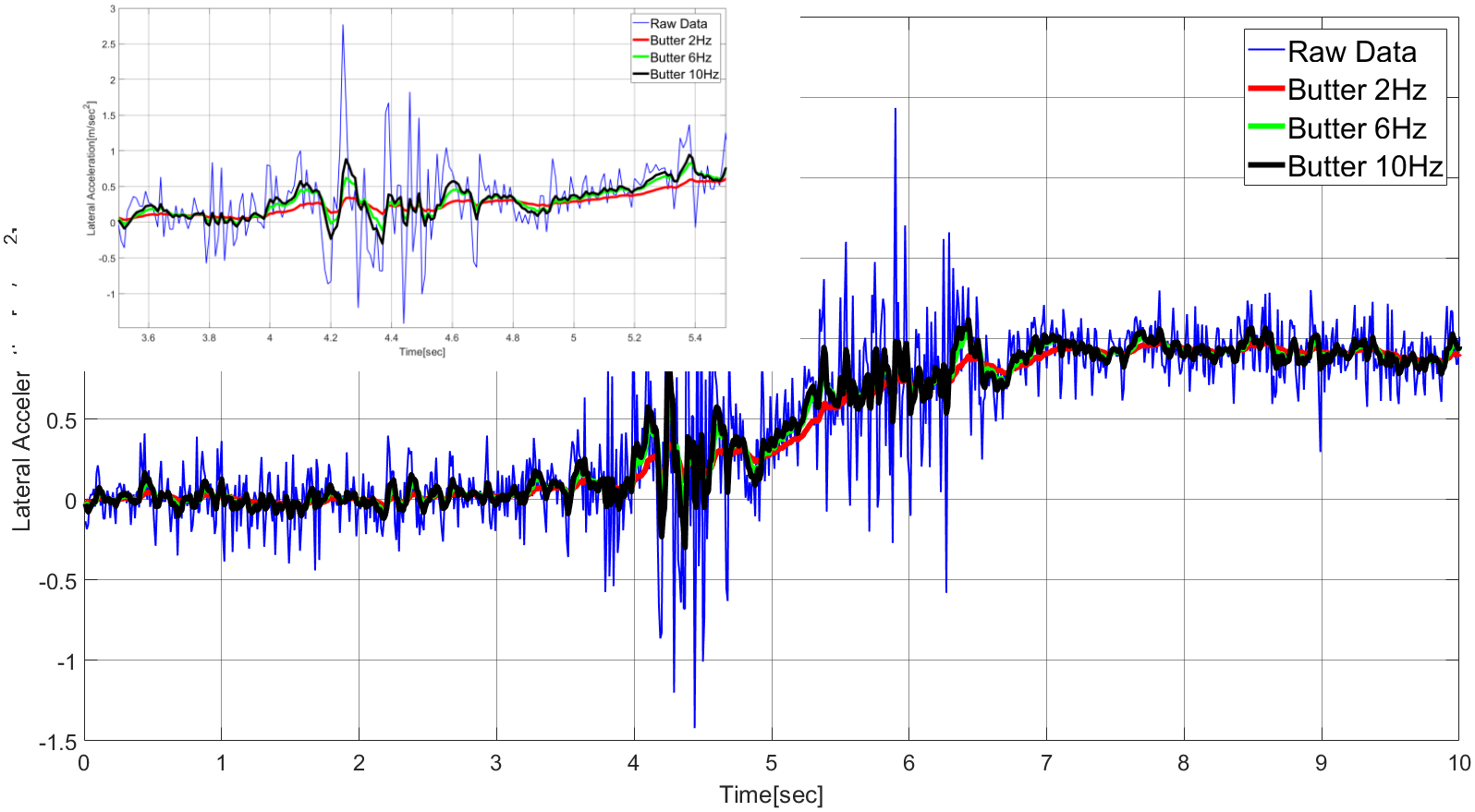
- 6 pole Bf filter with fc = 2/6/10Hz



Application of filter to raw data (lateral acceleration)

- **LKA activation in curve road**

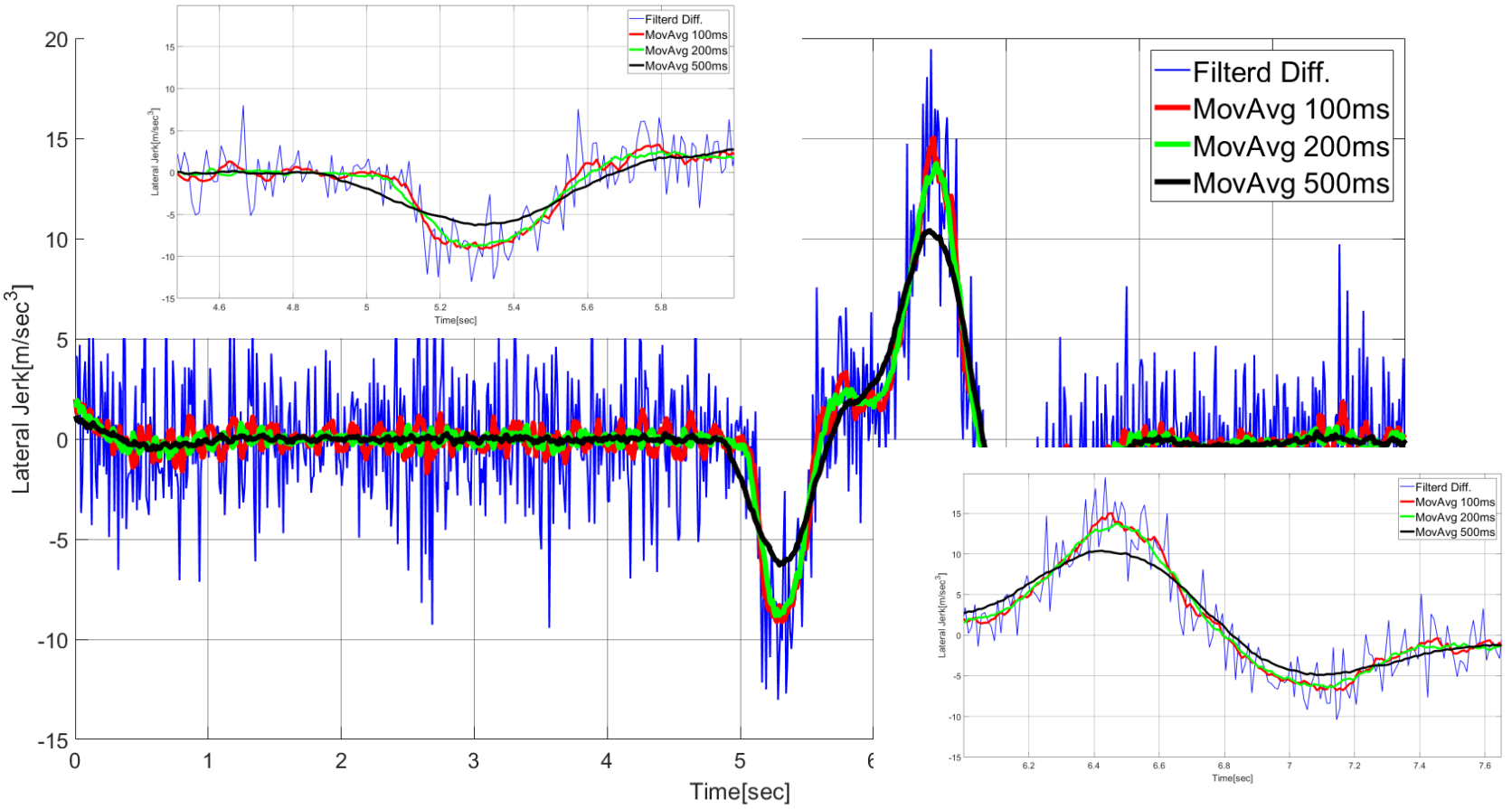
  - 6 pole Bf filter with fc = 2/6/10Hz



Application of moving average filter to filtered lateral acc.(lateral jerk)

➢ Lane Change Manoeuvre

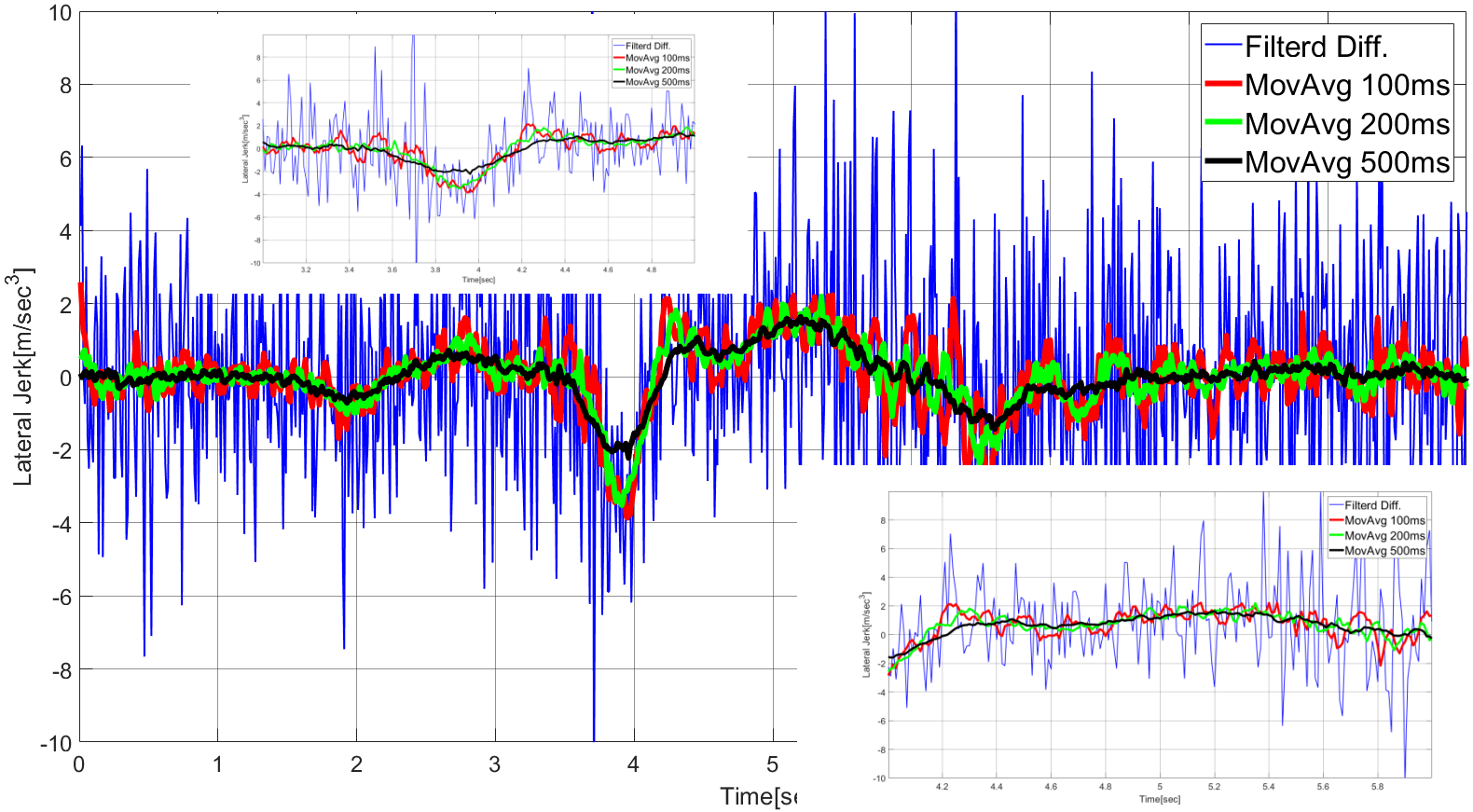
- moving average 100/200/500ms using deferential with filtered acceleration



Application of moving average filter to filtered lateral acc.(lateral jerk)

➢ **LKA activation in straight road**

- moving average 100/200/500ms using deferential with filtered acceleration



Application of moving average filter to filtered lateral acc.(lateral jerk)

- **LKA activation in curve road**

  - moving average 100/200/500ms using deferential with filtered acceleration