Effect of wheelbase and centre of gravity height variances on the control functions “Directional Control” and “Roll-over Control” within a vehicle stability function

Consideration of a +/-20% allowance between the vehicles actually tested for the Annex 19 test report and the vehicle(s) for which the test report can be utilized at the time of type-approval.

- **Directional Control is influenced by the wheelbase**
- **Roll-over Control is influenced by the centre of gravity height**

Directional Control – Wheelbase Variance +/-20%

- Directional Control assists the driver in over-steer and under-steer conditions to maintain the desired direction of travel. The vehicle yaw rate, which is used as a measurement of over-steer and under-steer, is influenced by the vehicle wheelbase.
- The vehicle stability function algorithm adapts to the actual vehicle wheelbase, by being provided with the actual wheelbase value, as part of the end-of-line programming procedure.
- Based on the reference yaw rate and the wheelbase there is an intervention threshold – see black 'intervention threshold nominal' line in Diagrams I, II and III. The actual measured yaw rate is shown by the red line and its intersection with the black line indicates the start and stop of the directional control intervention.
- The effect of a +20% and –20% change in wheelbase is shown by the blue and green lines respectively. The green and blue lines indicate the adaption of the algorithm due to a change in the wheelbase. With a longer wheelbase the intervention starts earlier as a vehicle is less agile due to the longer the wheelbase, which means more time is required to reverse the yaw of the vehicle. Conversely, the shorter the wheelbase, the later the start of the intervention can be due to quicker response of the vehicle to intervention actions.
- Diagram I shows +/-20% on a 4.50m wheelbase, Diagram II -20% on a 3.60m wheelbase and Diagram III +20% on a 6.68m wheelbase.

Directional Control – Wheelbase Variance +/-20%

The slight difference in the start of interventions, shows the small effect a 20% difference in wheelbase has on directional control functionality.

Therefore, due to the logistical difficulties of having suitable vehicles available at the time of conducting the vehicle testing for the test report, an allowance of 20% is deemed to be an appropriate value in support of the maximum and minimum wheelbase values stated in the system manufacturer information document, which are in turn supported by system manufacturer test results.

Directional Control – 4.50m Wheelbase +/-20%

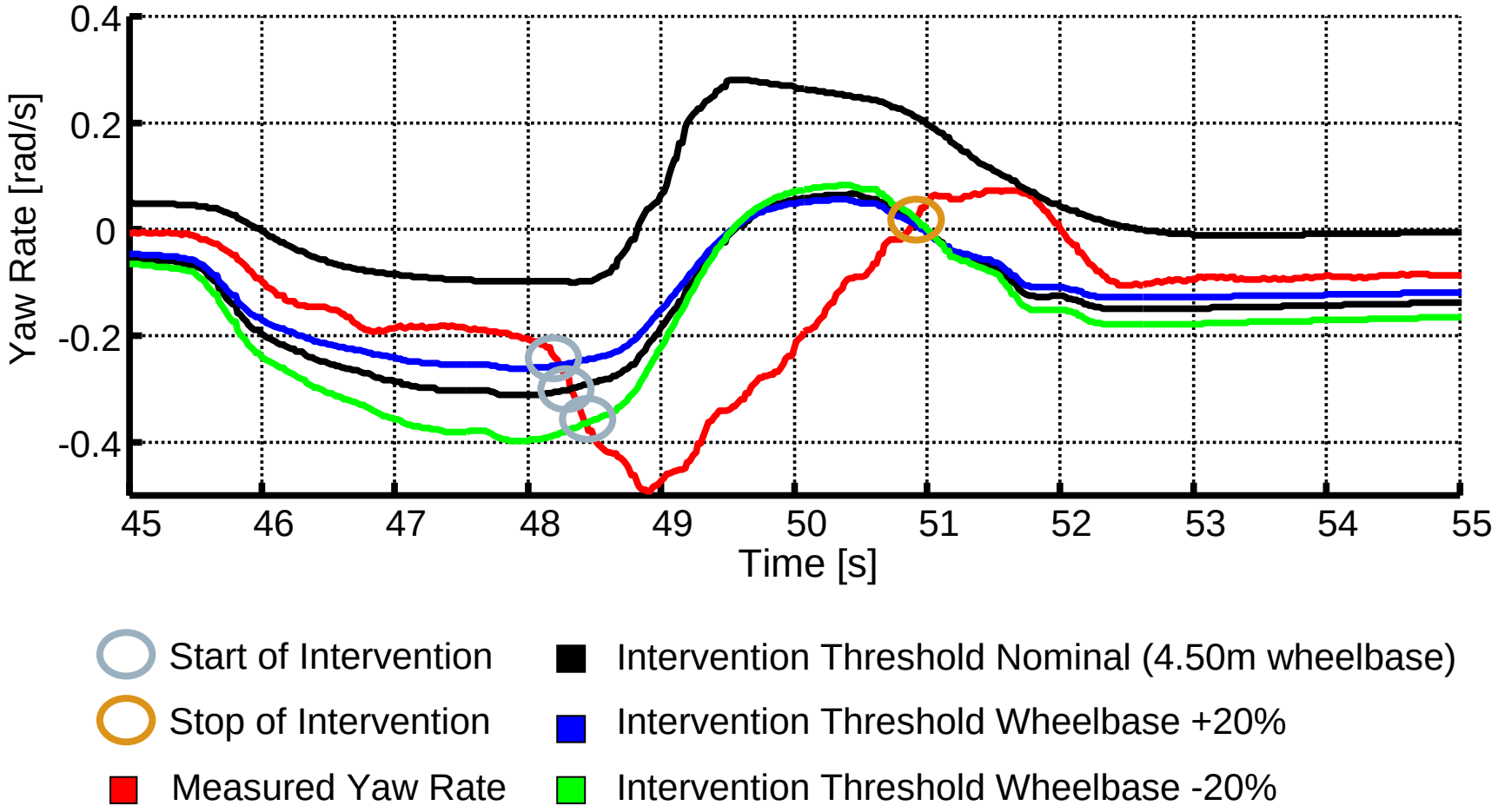

Diagram I

Directional Control – 3.60m Wheelbase -20%

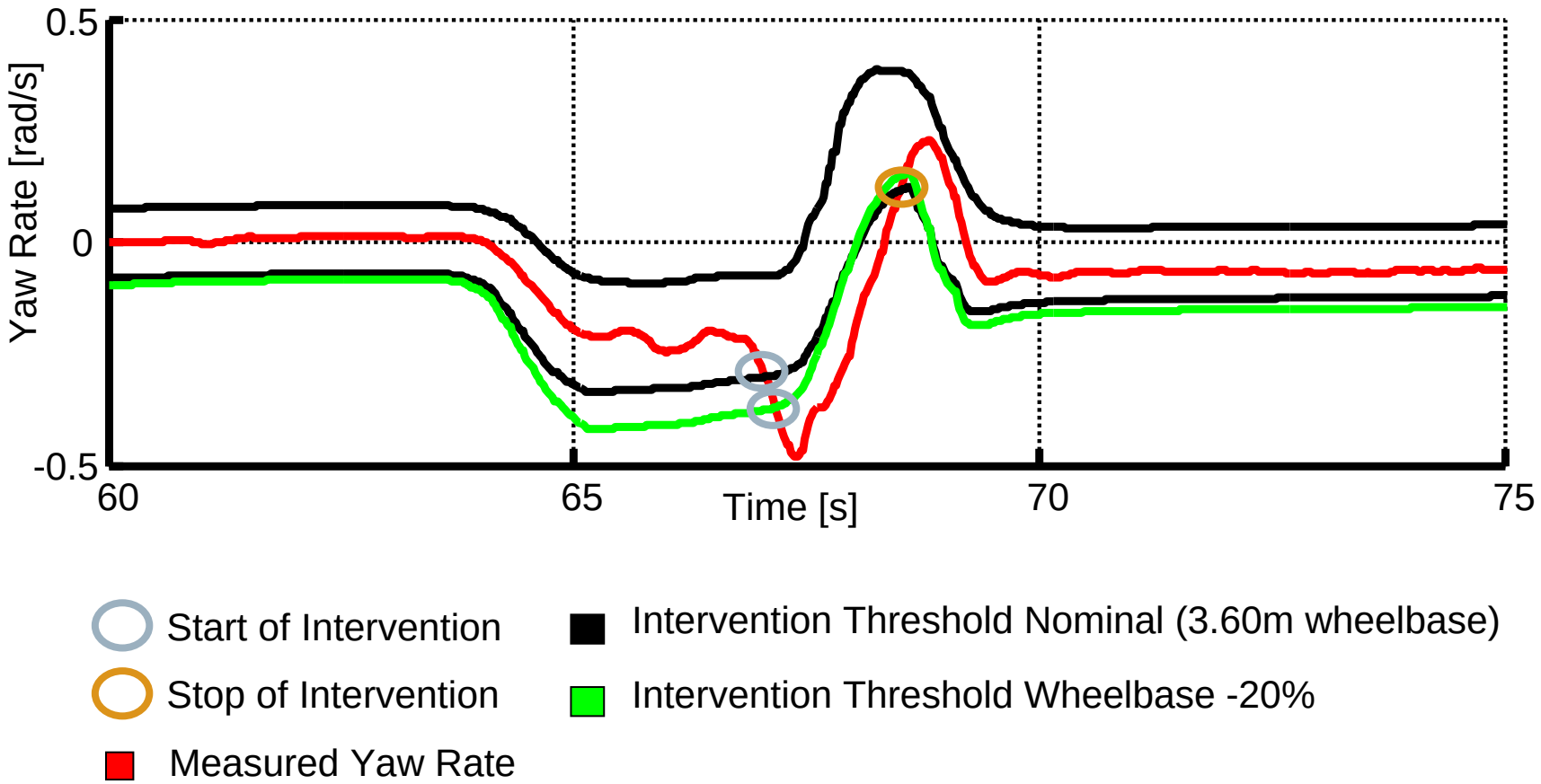

Diagram II

Directional Control – 6.68m Wheelbase +20%

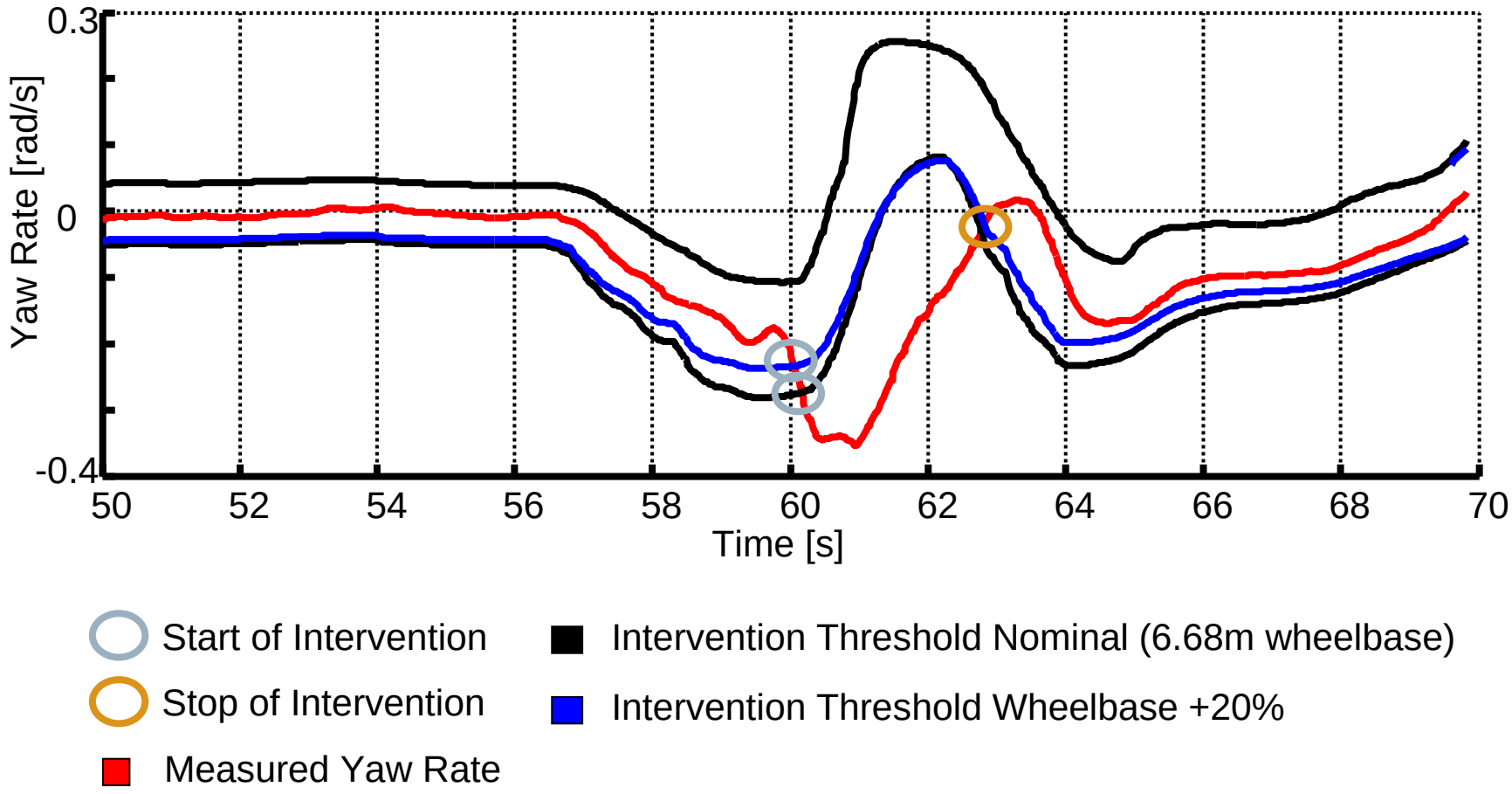

Diagram III

Roll-over Control – Centre of Gravity Height Variance +/-20%

- Roll-over Control takes corrective action in the event of impending roll-over to prevent the roll-over within the physical limits of the vehicle. The lateral acceleration of the vehicle is used as the initial measure of the impending roll-over.
- The lateral acceleration at which the system intervenes (the intervention threshold) is derived from a number of different parameters and signals – vehicle type, loading condition, fast/slow steering, travelling uphill/downhill, demanded engine torque by the driver – and by taking into account other influences such as frame stiffness, suspension, tyres. It is also influenced by driver acceptability considerations.
- The centre of gravity height is a measure that indicates the tendency of a vehicle to roll-over. As it is not possible to directly measure the centre of gravity height for different 'real world' loading conditions and types of load, it is estimated using known vehicle parameters e.g. frame height, unladen vehicle centre of gravity height, with assumptions for load density and load height.
- The vehicle stability function algorithm adapts to the actual loading condition of the vehicle (centre of gravity height) by estimating the vehicle mass from engine torque (engine management system information modified to take into account drive-line losses) and vehicle acceleration (driver demand and wheel speed sensor information).

Roll-over Control – Centre of Gravity Height Variance +/-20%

- Once the lateral acceleration exceeds the intervention threshold, vehicle speed is reduced (brakes automatically applied and engine power reduced). If wheel ‘lift off’ is also detected, maximum vehicle speed reduction is demanded.
- The relationship between the intervention threshold and the roll-over threshold is shown in Diagram IV for a number of different fully laden vehicles under the conditions of a J-turn test conducted at 60 km/h.
- The roll-over threshold nominal centre of gravity height is shown by the black line in Diagram V and the effect of a +20% and –20% change in centre of gravity height is shown by the blue and green lines respectively. The actual lateral acceleration threshold at which an intervention starts and stops is shown by the light blue line.
- As the centre of gravity height increases, the roll-over threshold approaches the intervention threshold, and once the measured lateral acceleration crosses the roll-over threshold the vehicle will roll-over. Therefore, either the threshold is lowered or the roll-over control is centre of gravity height limited.

Roll-over Control – Centre of Gravity Height Variance +/-20%

The difference in roll-over threshold, in terms of lateral acceleration, for a 20% variation in centre of gravity height is relatively small. As the centre of gravity height increases, it approaches the intervention threshold and either the threshold is lowered or the roll-over control is centre of gravity height limited.

Therefore, due to the logistical difficulties of having suitable vehicles available at the time of conducting the vehicle testing for the test report, an allowance of 20% is deemed to be an appropriate value in support of the maximum centre of gravity height value stated in the system manufacturer information document, which is in turn supported by system manufacturer test results.

Roll-over Control – Roll-over and Intervention Thresholds

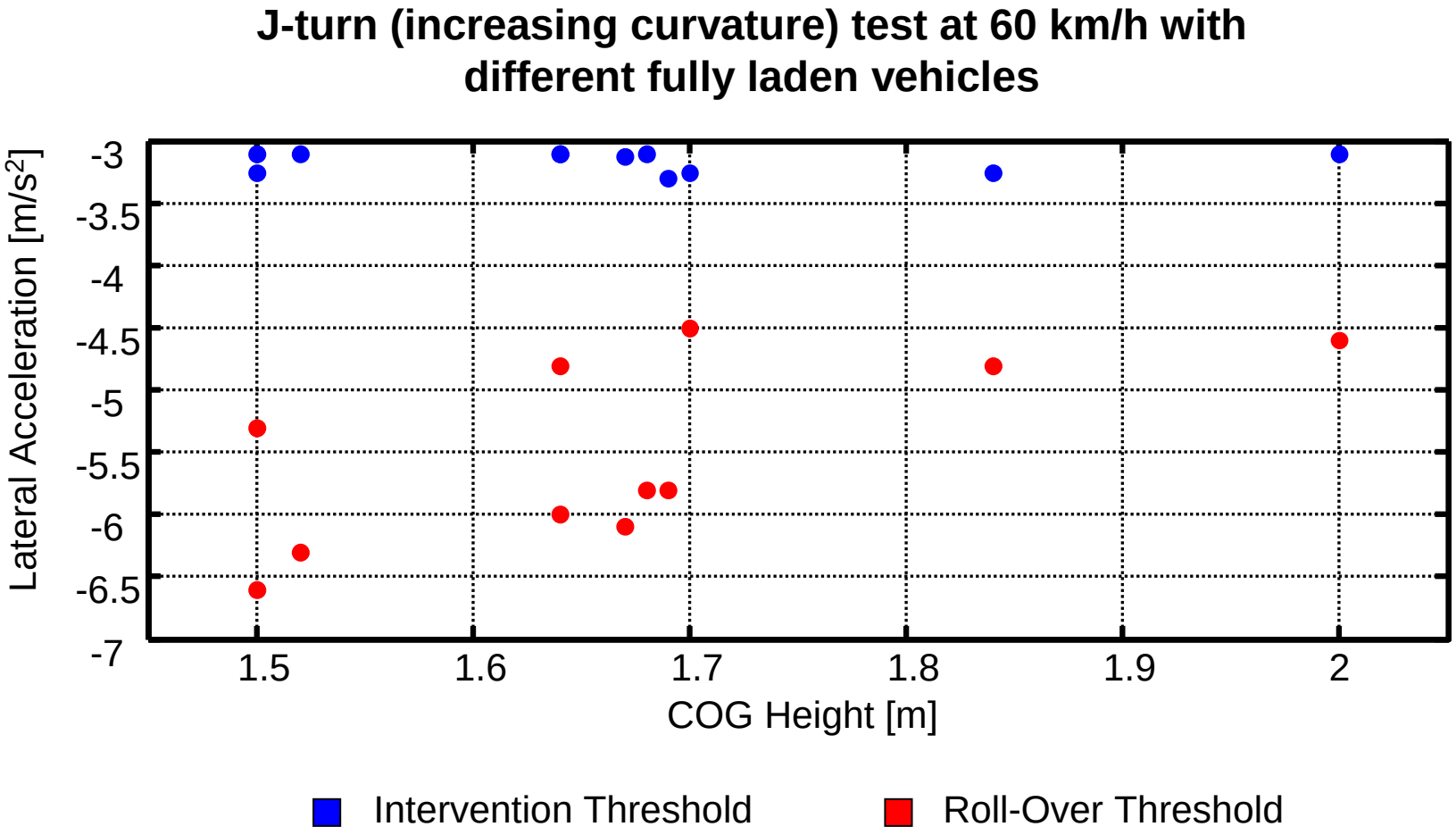

Diagram IV

Roll-over Control – 1680 mm Centre of Gravity Height +/-20%

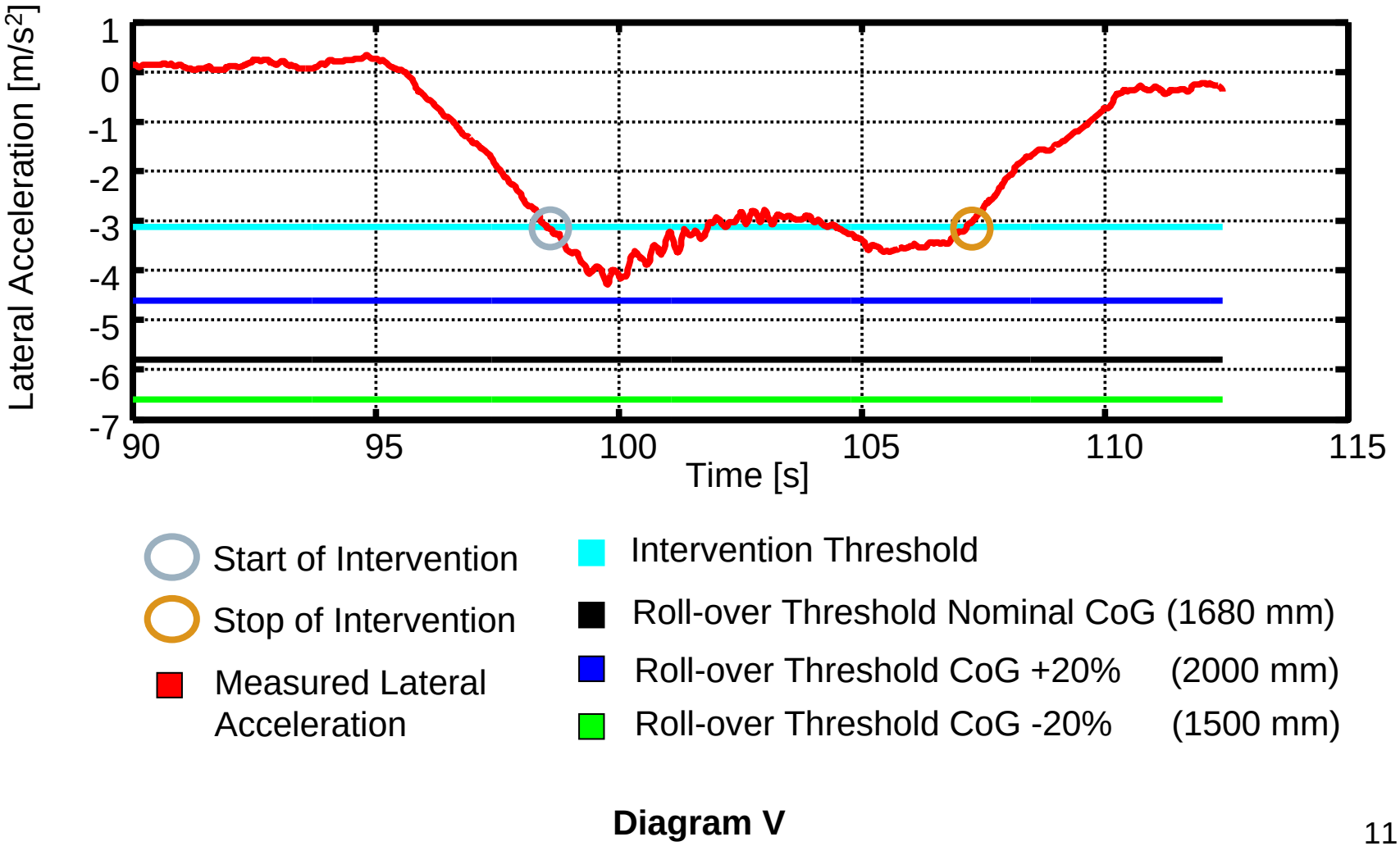

Diagram V