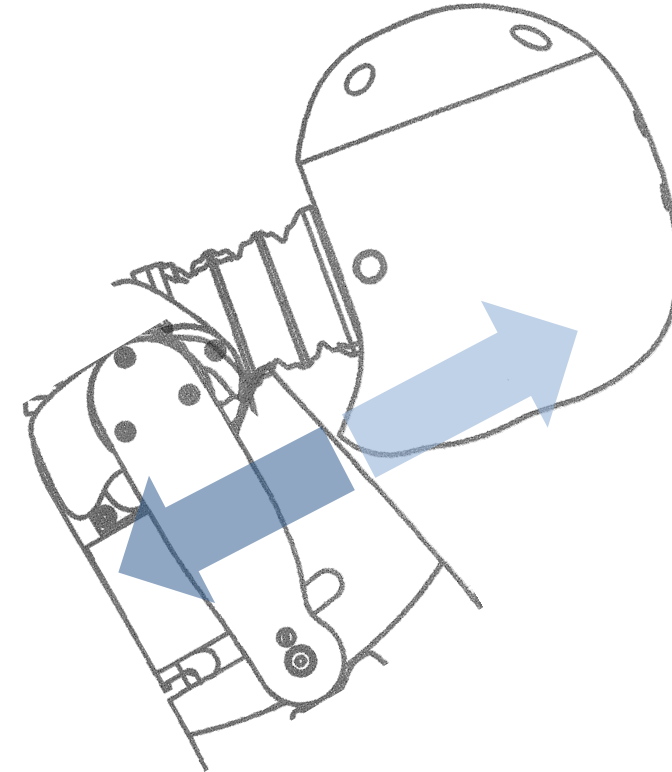
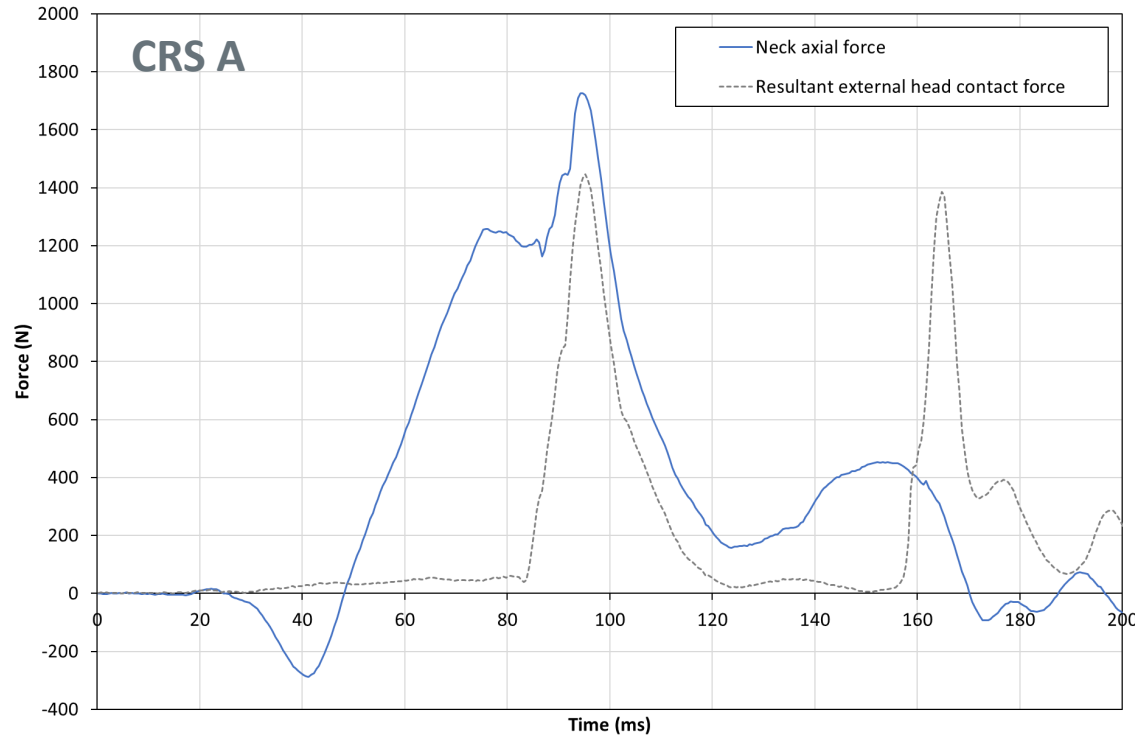


# R129 NECK LIMITS: EFFECT OF CHIN-TO-CHEST CONTACT AND POTENTIAL SOLUTIONS

*Submitted by the experts from CLEPA*

*70<sup>th</sup> session of GRSP, 06 – 10<sup>th</sup> December 2021*

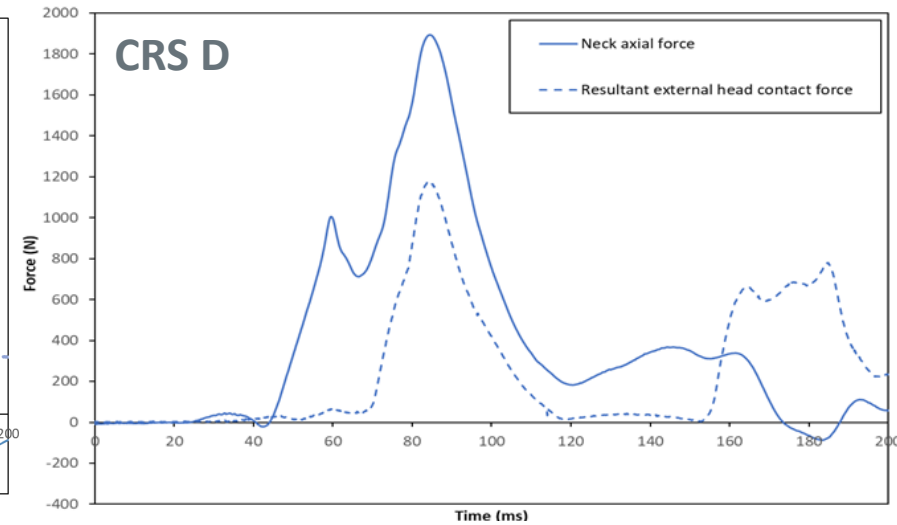
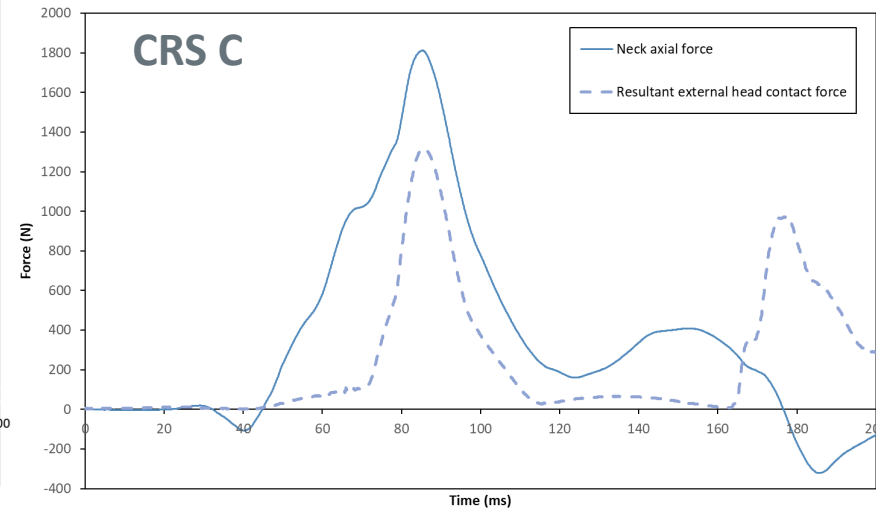
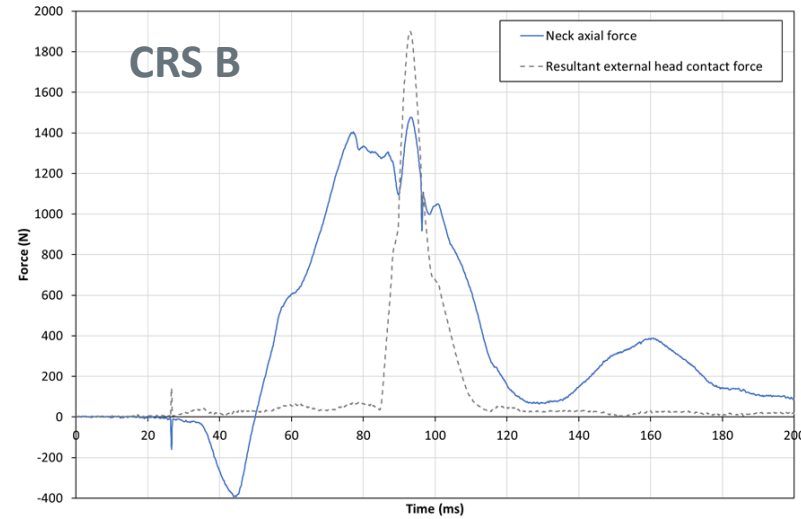
# CHIN-TO-CHEST CONTACT OCCURS IN FF CRS IN FRONT IMPACT AND RF CRS IN REAR IMPACT



**Q1.5 FF Integral harness – R129 Front impact**

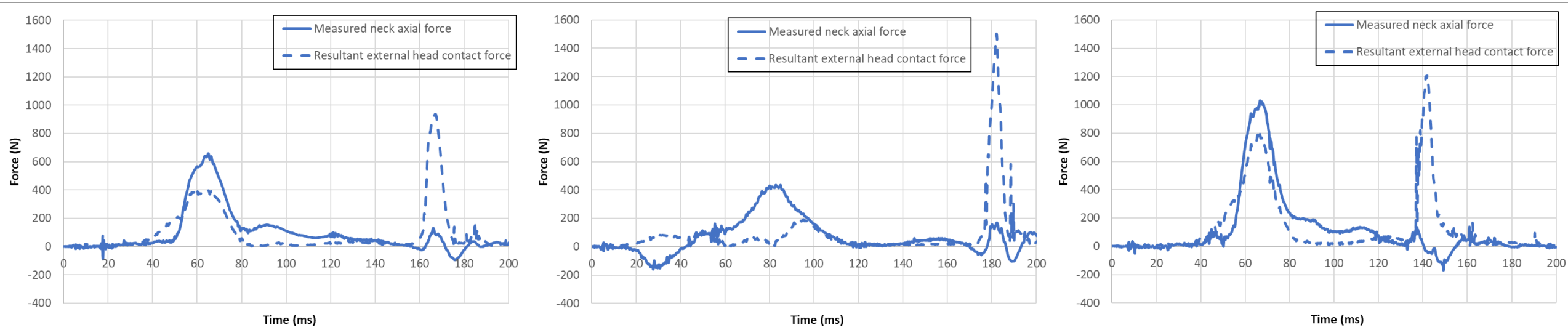
Chin-to-chest contact **increases tensile neck force**, potentially beyond the purely inertial peak

# MOST TESTS EXAMINED WITHIN CLEPA SHOW SOME INFLUENCE OF CHIN-TO-CHEST CONTACT



Q1.5 FF Integral harness – R129 Front impact

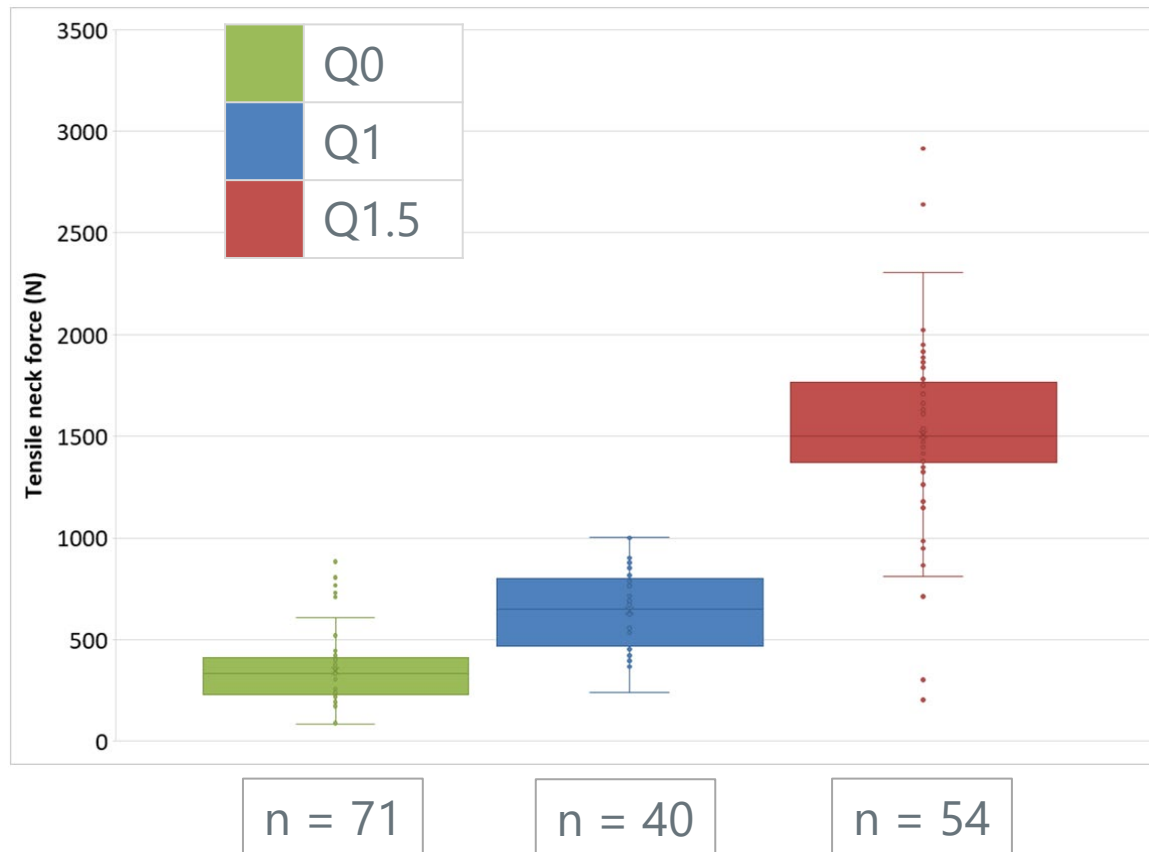
# MOST TESTS EXAMINED WITHIN CLEPA SHOW SOME INFLUENCE OF CHIN-TO-CHEST CONTACT



## Q0 RF Integral harness – R129 Rear impact

Chin-to-chest contact typically aligned with peak neck force in RF CRS in rear impact – **harder to distinguish effects reliably**

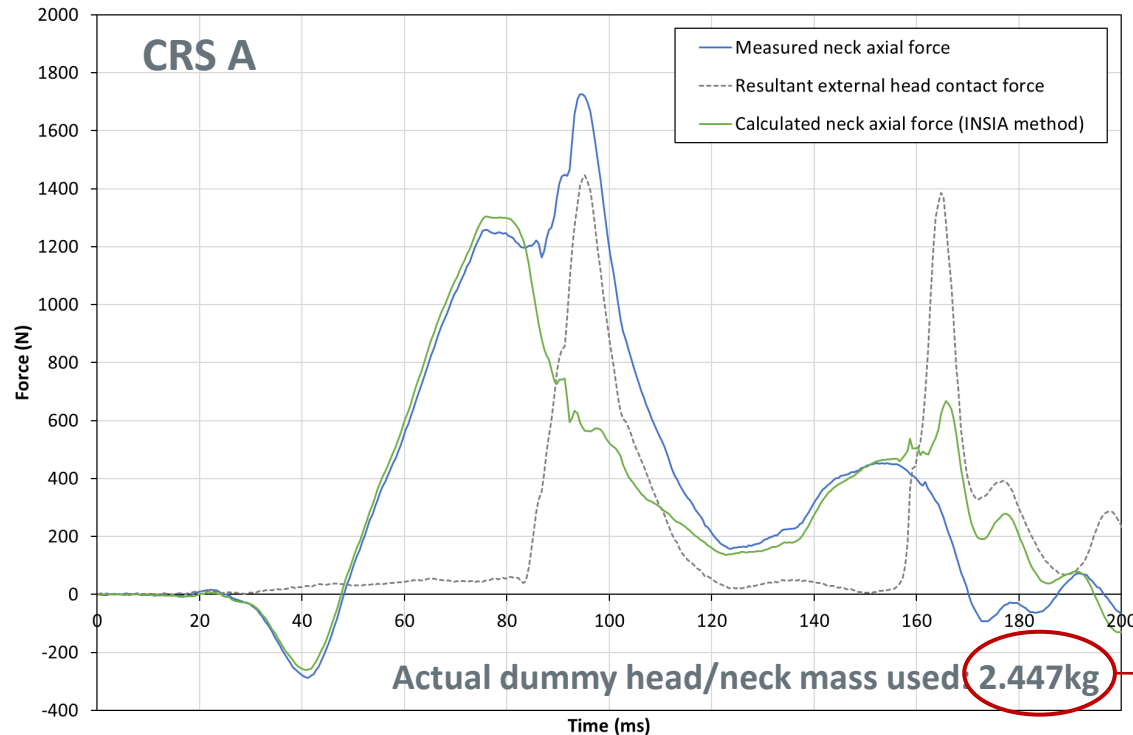
# WE CAN'T CHECK THE FREQUENCY OR EFFECT OF CHIN-TO-CHEST CONTACT ON OUR ANALYSIS SAMPLE OR LIMIT PROPOSALS



If a large part of the sample was affected, our limit values would be **skewed upwards** – as would subsequent measurements

Mitigating chin-to-chest contact may be prioritised over inertial neck loading

# INSIA PROPOSED A METHOD TO CALCULATE INERTIAL NECK FORCE (HEAD MASS\*VRT. HEAD ACCELERATION)



To compute only inertial forces

$$F_Z|_{IA} = M_{H+\frac{1}{2}\cdot LC} \cdot A_Z$$

$F_Z|_{IA}$  : Neck force for Injury Ass.

$M_{H+\frac{1}{2}\cdot LC}$  : Head and LC part mass

$A_Z$  : Head Z acceleration

$$M_{H+\frac{1}{2}\cdot LC} = 2.2 \div 2.18 \text{ kg}$$

$$F_Z(N) = 2.2 \cdot A_Z(g) \cdot 9.80665$$

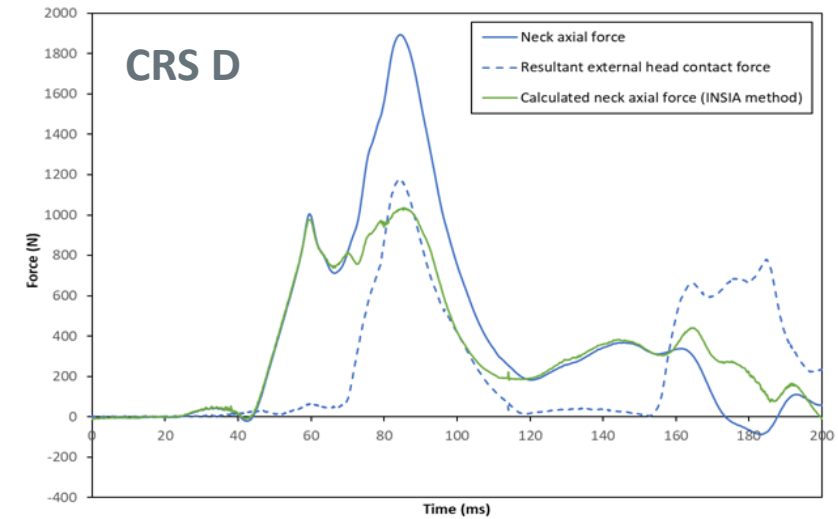
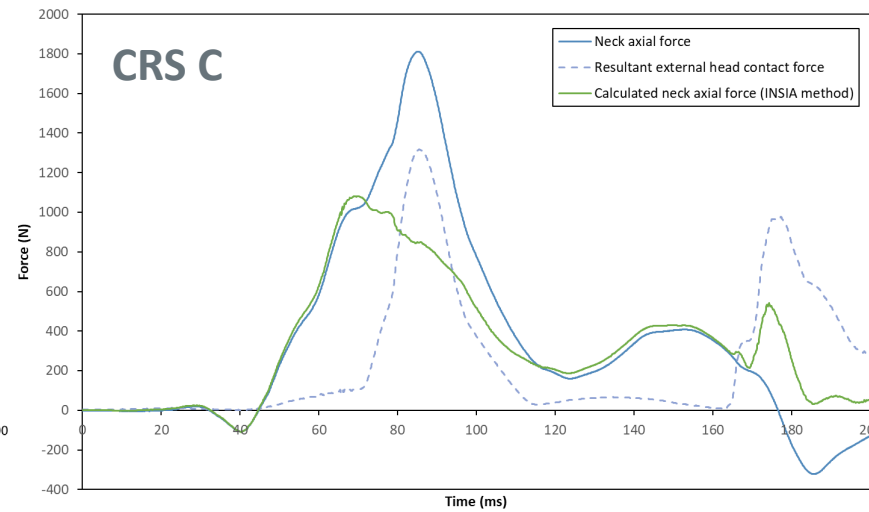
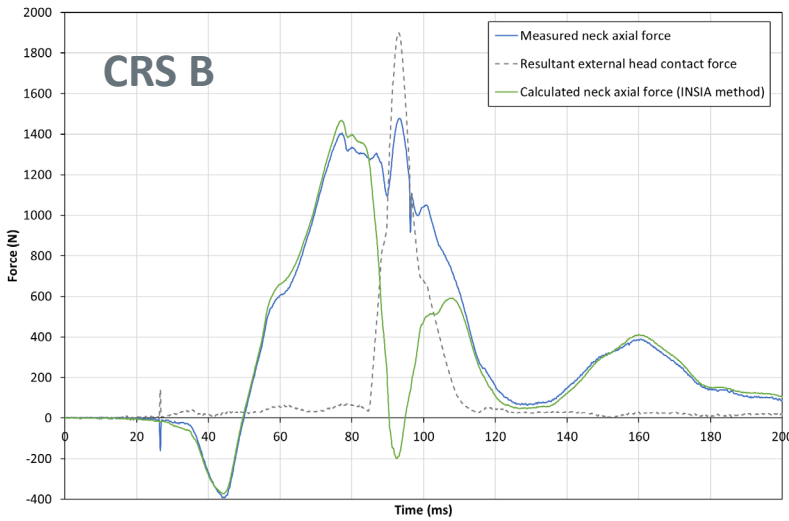
68th GRSP, 8th December 2020.

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## Q1.5 FF Integral harness – R129 Front impact

Can the method guarantee that neck force would not be higher if contact had not occurred (or if nature/timing of contact was different)?

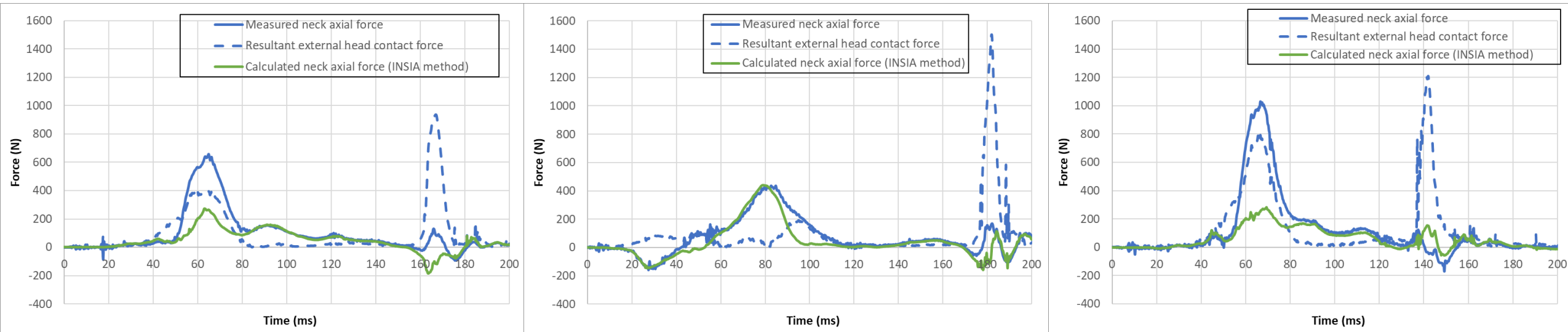
# INSIA METHOD CAN PREDICT PRE-CONTACT NECK FORCE MEASUREMENT



**Q1.5 FF Integral harness – R129 Front impact**

What would happen if there had been no contact, or the timing was different?

# INSIA METHOD CAN PREDICT PRE-CONTACT NECK FORCE MEASUREMENT



Q0 RF Integral harness – R129 Rear impact

What would happen if there had been no contact, or the timing was different?



# EFFECT OF CHIN-TO-CHEST CONTACT

## Experiments



**Standard head**

Vs.

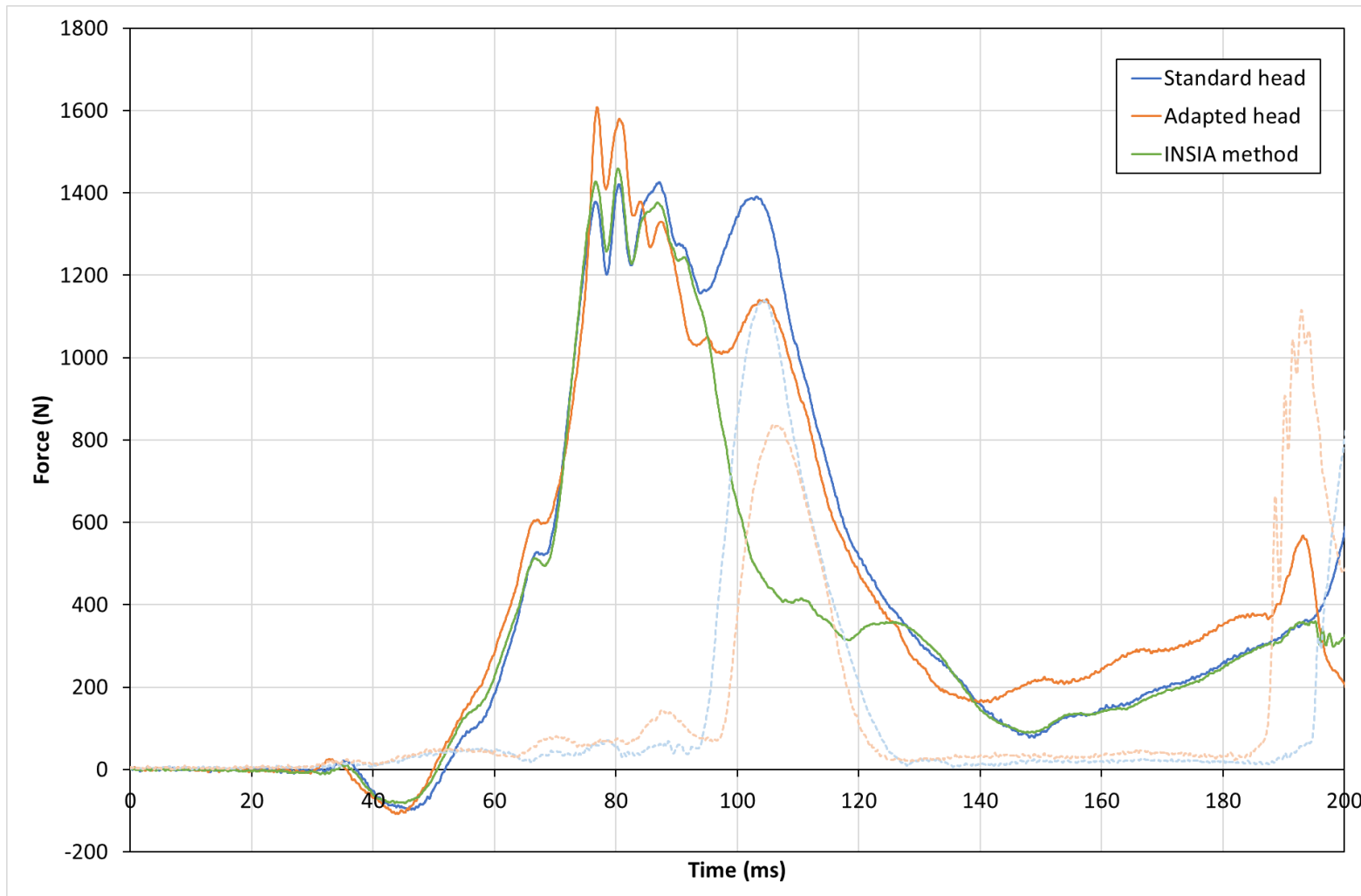


**Adapted head**

Adapted head created by Cellbond (currently Q3 and Q6 only)

# EFFECT OF CHIN-TO-CHEST CONTACT

## Front impact: Q3 in FF Integral Harness CRS

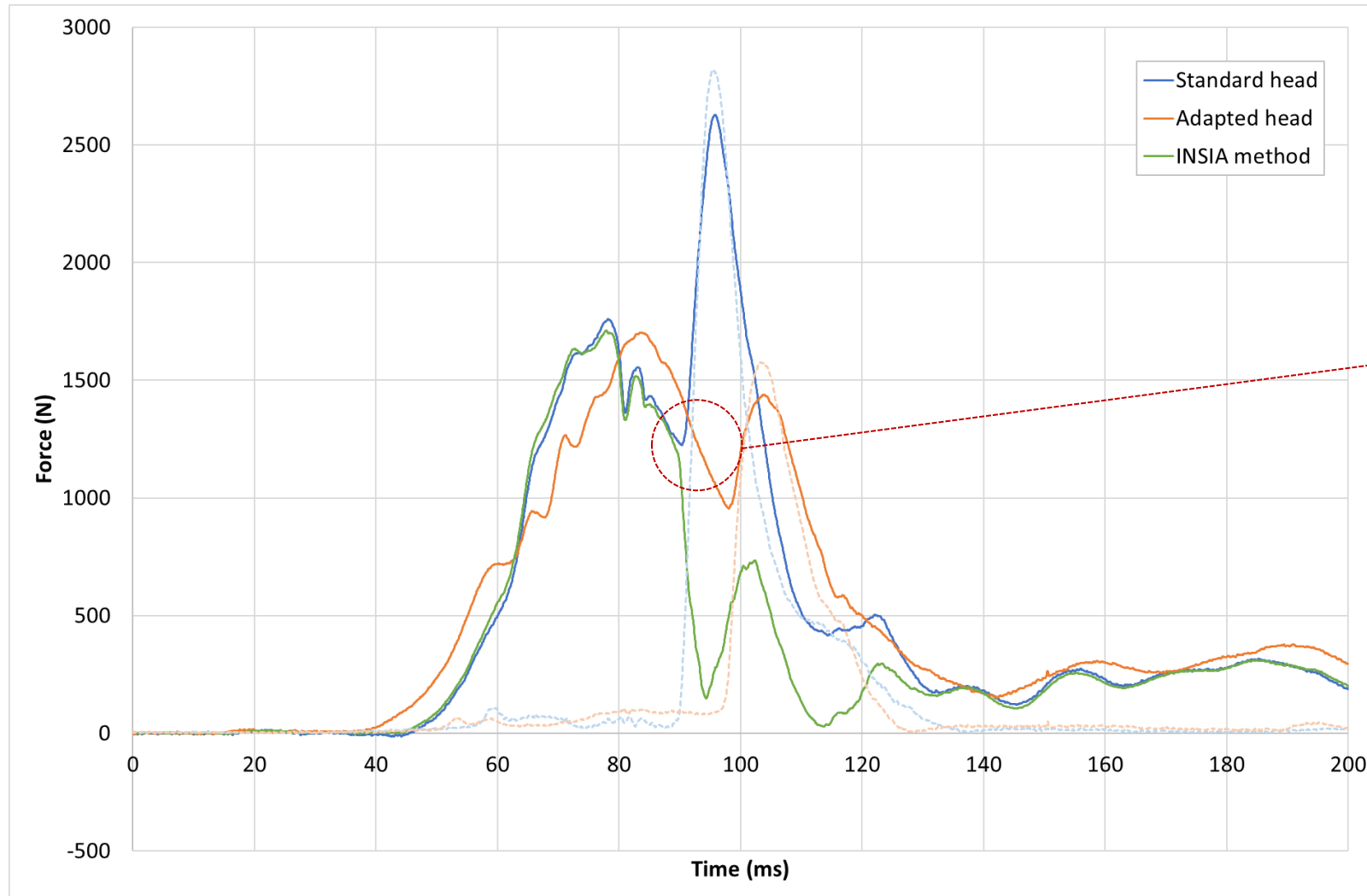


All methods give the same result (i.e. standard head ignoring contact phase, adapted head or INSIA method)

# EFFECT OF CHIN-TO-CHEST CONTACT



## Front impact: Q3 in Booster Seat A

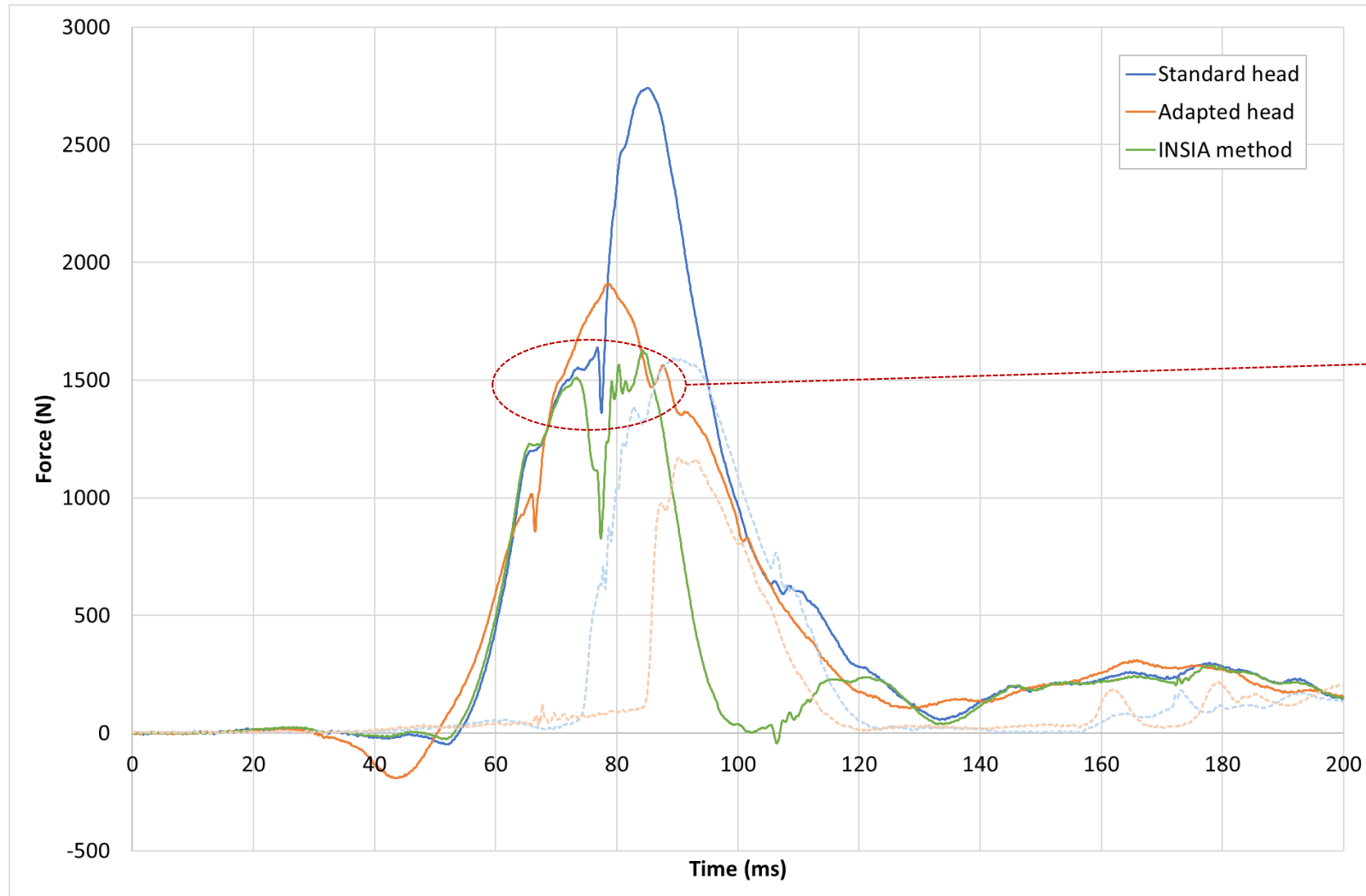


Rapid drop-off in INSIA calculated inertial force seems unrealistic and suggests contact itself can influence vertical head acceleration (and hence this calculated force)

# EFFECT OF CHIN-TO-CHEST CONTACT



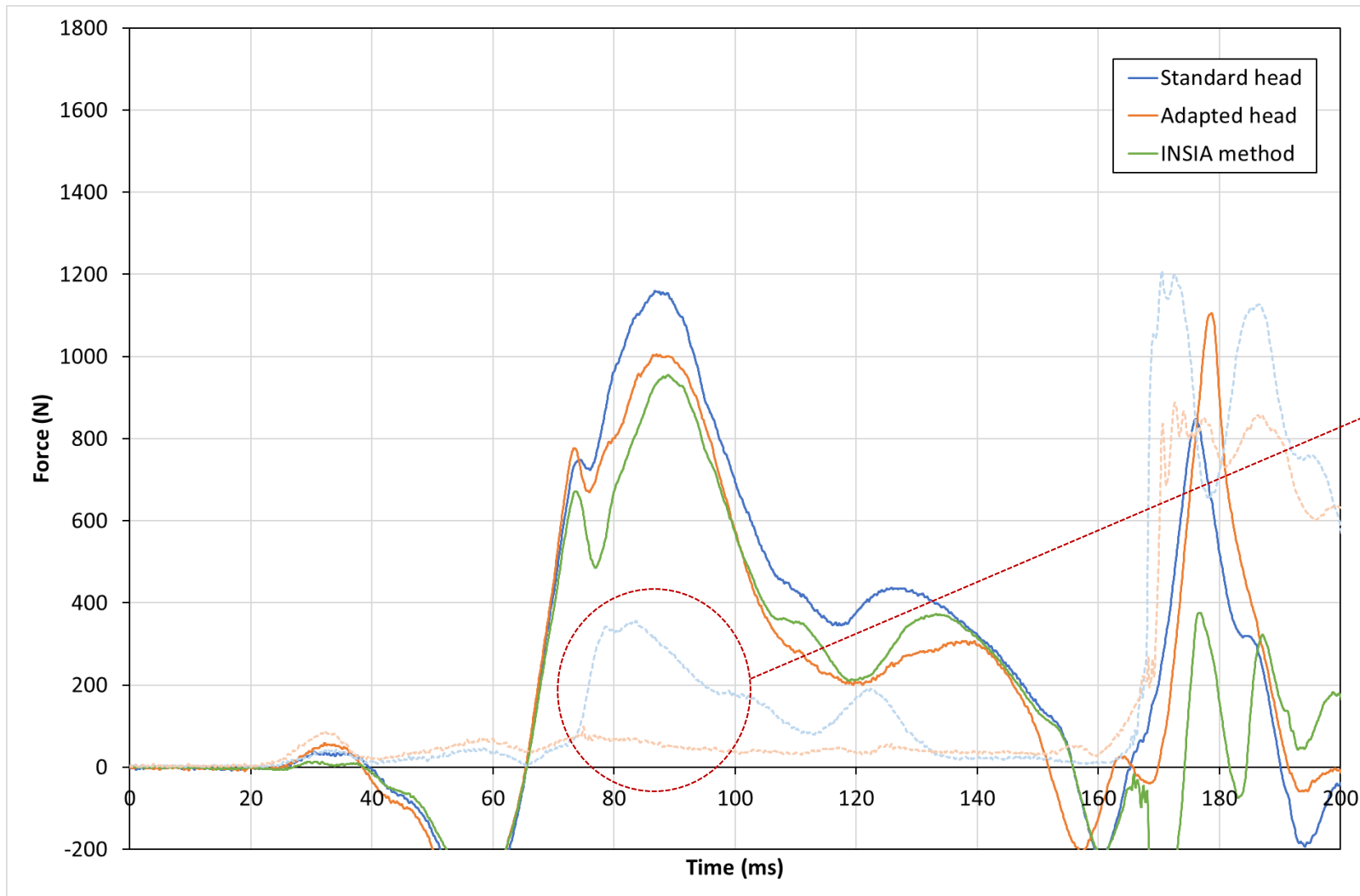
## Front impact: Q3 in Booster Seat B



Broad peak duration in INSIA method seems unrealistic and may be masking true inertial force had contact not occurred (as suggested by adapted head with lesser contact)

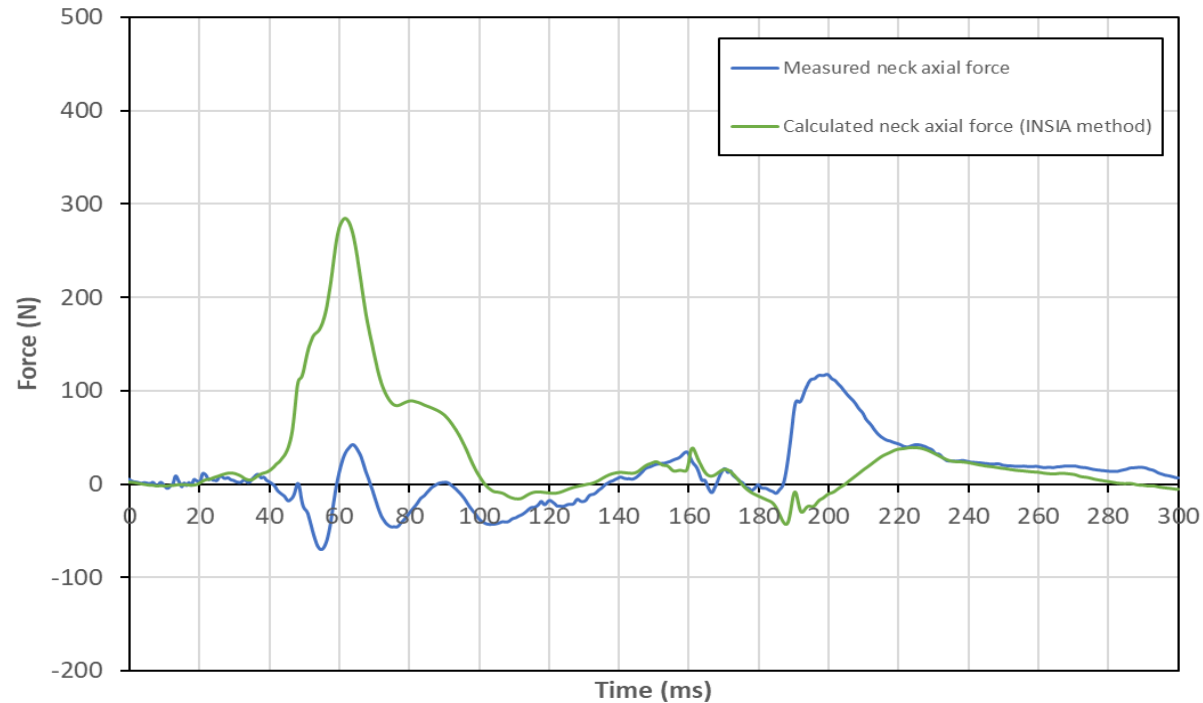
# EFFECT OF CHIN-TO-CHEST CONTACT

## Rear impact: Q3 in RF Integral Harness CRS



Marginal contact with standard head (i.e. <500 N), reduced to negligible level with adapted head. INSIA method predicts inertial force reasonably well

# INSIA METHOD CAN LEAD TO STRANGE RESULTS WHEN NO CHIN-TO-CHEST CONTACT OCCURS



**Q0 FF Integral harness – R129 Front impact**

The calculated inertia force can be higher than the measured force – Technical Services would need to determine if/when the method is appropriate

# CONCLUSION



## Using measured force vs. calculated inertial force

- Chin-to-chest contact likely skewed type-approval monitoring analysis of measured neck tension force
  - Limit values and subsequent measurements likely to be skewed upwards
- INSIA's calculated inertial force method would reduce limit values and measurements; but
  - Neck force is not really measured (only vert. head acceleration)
  - It doesn't work very well when contact occurs at the same time as peak inertial loading (especially RF CRS in rear impact)
  - Chin-to-chest contact may reduce the calculated inertial force – **dummy chin-to-contact would be incentivised by regulation**

# PROPOSAL



## For discussion with Contracting Parties

- Adopt neck tension force limits in R129 based on measured type-approval monitoring data as proposed in GRSP-68-05
  - No reanalysis of data required
  - Simple for technical services
- Investigate Q-Series chin adaptation as per Cellbond prototypes
  - Neck force limits could be revised down if dummy changes
- Limits are validated values based on CRS performance in current R129 test conditions
  - Changing the test conditions would necessitate new analyses and limits





European Association of Automotive Suppliers

## Further reading

Sochor MR, Faust DP, Anderson KF, Barnes S, Ridella SA, Wang SC (2006). Assessment of 3 and 6-year-old neck injury criteria based on field investigation, modeling, and sled testing. *SAE Trans.* 115: 183–209.

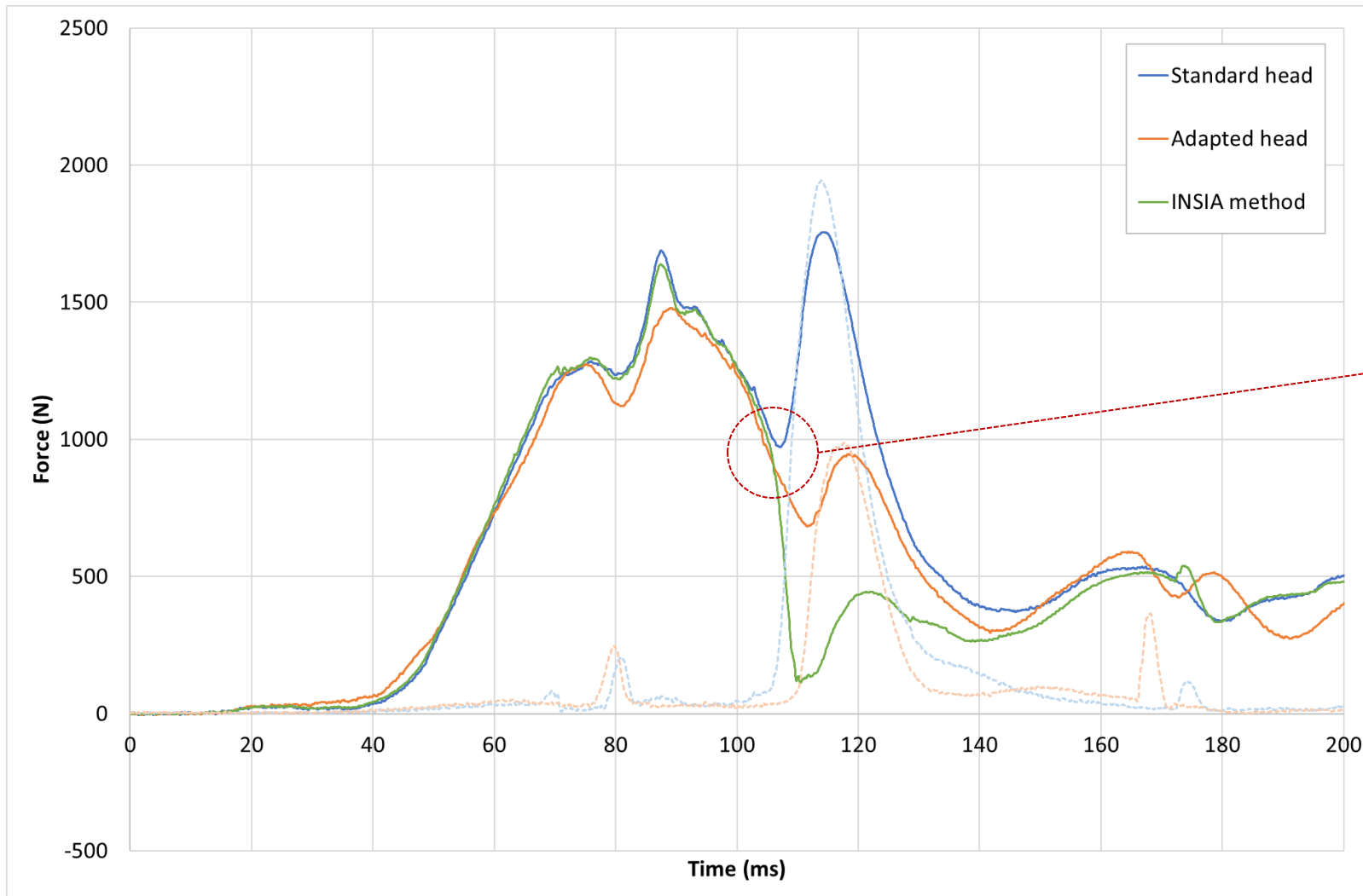
Stammen JA, Bolte JH, Shaw J (2012). Biomechanical impact response of the human chin and manubrium. *Ann Biomed Eng.* 40(3): 666–678. doi:10.1007/s10439-011-0419-x.

Visvikis C, Thurn C, Kettner M, Müller T (2020). The effect of chin-to-chest contact on upper neck axial force in UN Regulation No. 129 frontal impact tests of child restraint systems. *Traffic Inj Prev.* 21(sup1):S173-S176. doi: 10.1080/15389588.2020.1829923.

Visvikis C, Thurn C, Müller T (2021). The effect of Q-Series dummy adaptation on the prevalence of chin-to-chest contact and its influence on upper neck tension force in UN Regulation No. 129 tests. Proceedings of the 19<sup>th</sup> International Conference Protection of Children in Cars, Munich, Germany.

# EFFECT OF CHIN-TO-CHEST CONTACT

## Q6 in Booster Seat A



Another rapid drop-off in INSIA method force

# EFFECT OF CHIN-TO-CHEST CONTACT

## Q6 in Booster Seat B

