**SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC**

0. INTRODUCTION

0.1 Industry first proposal for helmet-speakers compatibility was provided early 2021 and was, basically, as follows:

- EPS pockets of 5+2mm depth (8mm proposed)
- Rigid speaker simulator of 5 mm thick
- Speaker requirements as in the graphic:

This approach worked well acc to the tests performed
by the industry.
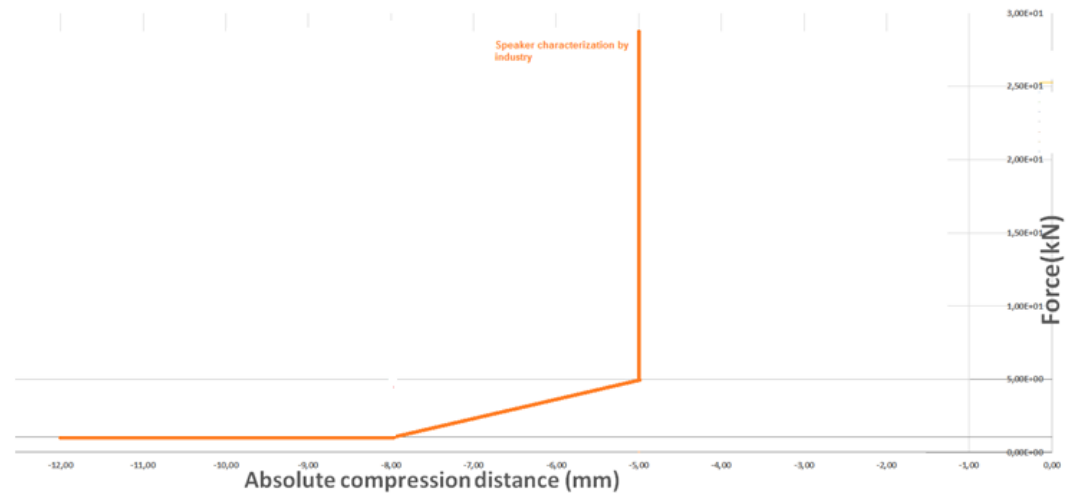
However, still there were some doubts among the TSs about the performances.

Together with the above, also the 8mm EPS pocket requirement was withdrawn. At this point, this proposal could not work any longer and further tests would be needed to demonstrate that is still, or not, valid.
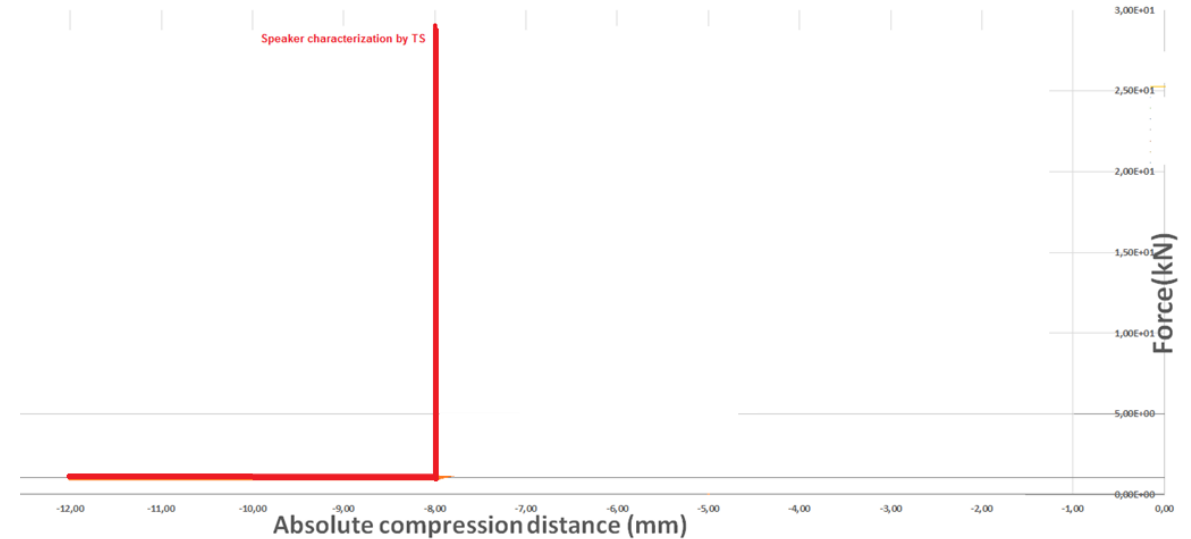
SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

0. INTRODUCTION

0.2 Italian proposal on March 2021:

- EPS pockets of 8mm
- Rigid speaker simulator of 8 mm thick
- Speaker requirements as in the graphic:

This approach worked well acc to the tests performed
by some of the TS.

However, this approach could punish some of the helmet models, not allowing to install actual speakers due to the fact that the
simulator testing condition is much more severe than it would be with actual speakers acc to the industry tests.

SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

0. INTRODUCTION

0.3 New proposal for use of deformable speaker simulators (idea proposed to TSs by mid august 2021 and presented in september AHG meeting)

- No more need to take any assumptions on behaviour of materials or need to do any extrapolation
- No need to consider any EPS pocket for the compatibility condition to work.
- Speaker requirements as in the graphic:

New proposal for speaker simulator and
speaker characterization.

Need to be studied and tested.
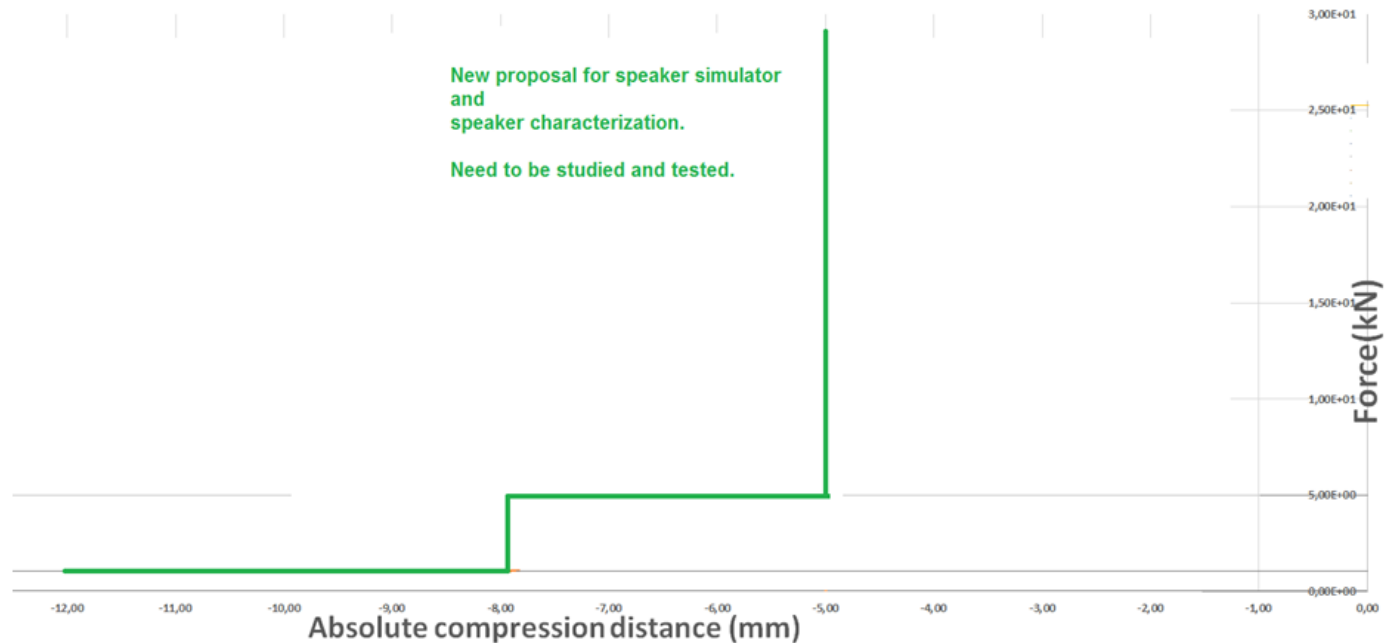
SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

1. DEFORMABLE SPEAKER SIMULATOR PROPOSAL

- Made with different layers
  - ➢ Layer 1: Aluminium rigid surface. e= 1mm
  - ➢ Layer 2: Aluminium honeycomb 120 psi (0,83 MPa). e= 6mm   [With 40 mm diameter, F = 1000 N]
  - ➢ Layer 3: Aluminium rigid surface. e= 1mm
  - ➢ Layer 4: Aluminium honeycomb 535 psi (3,69 MPa). e= 3,4mm   [With 40 mm diameter, F = 4625 N]
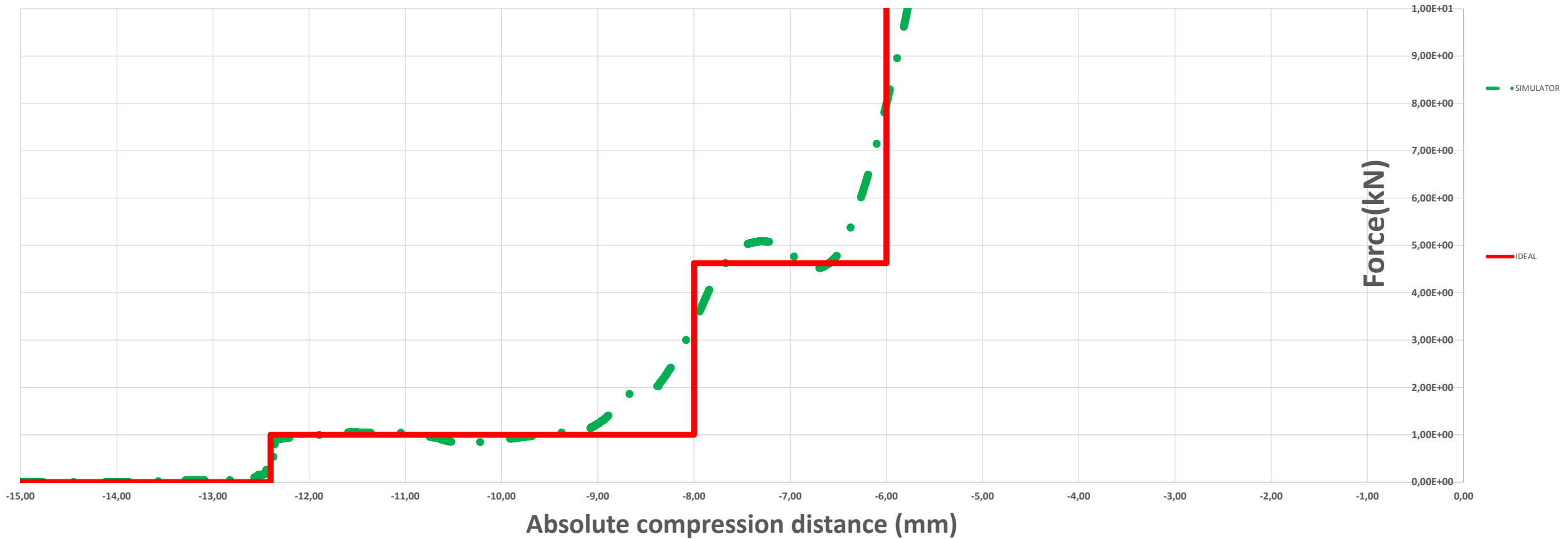 - ➢ Layer 5: Aluminium rigid surface. e= 1mm

  Initial total thickness= 12,4 mm (to be discussed)

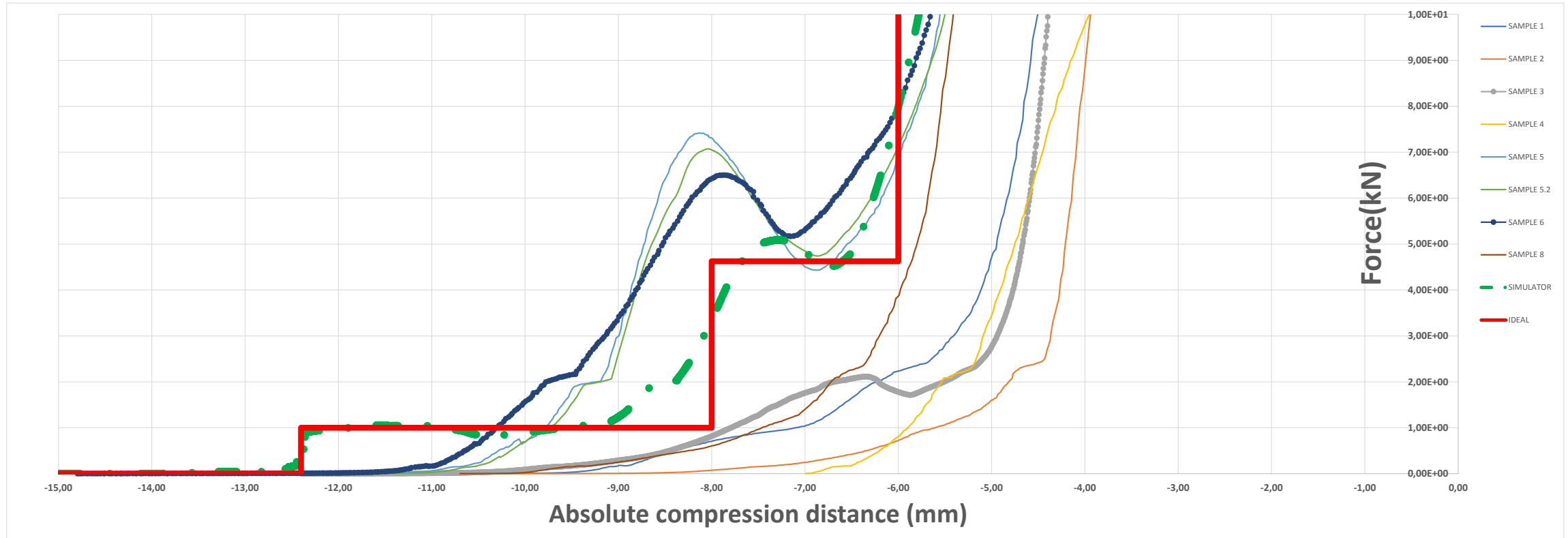# SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

2. DEFORMABLE SPEAKER SIMULATOR CRUSH TEST
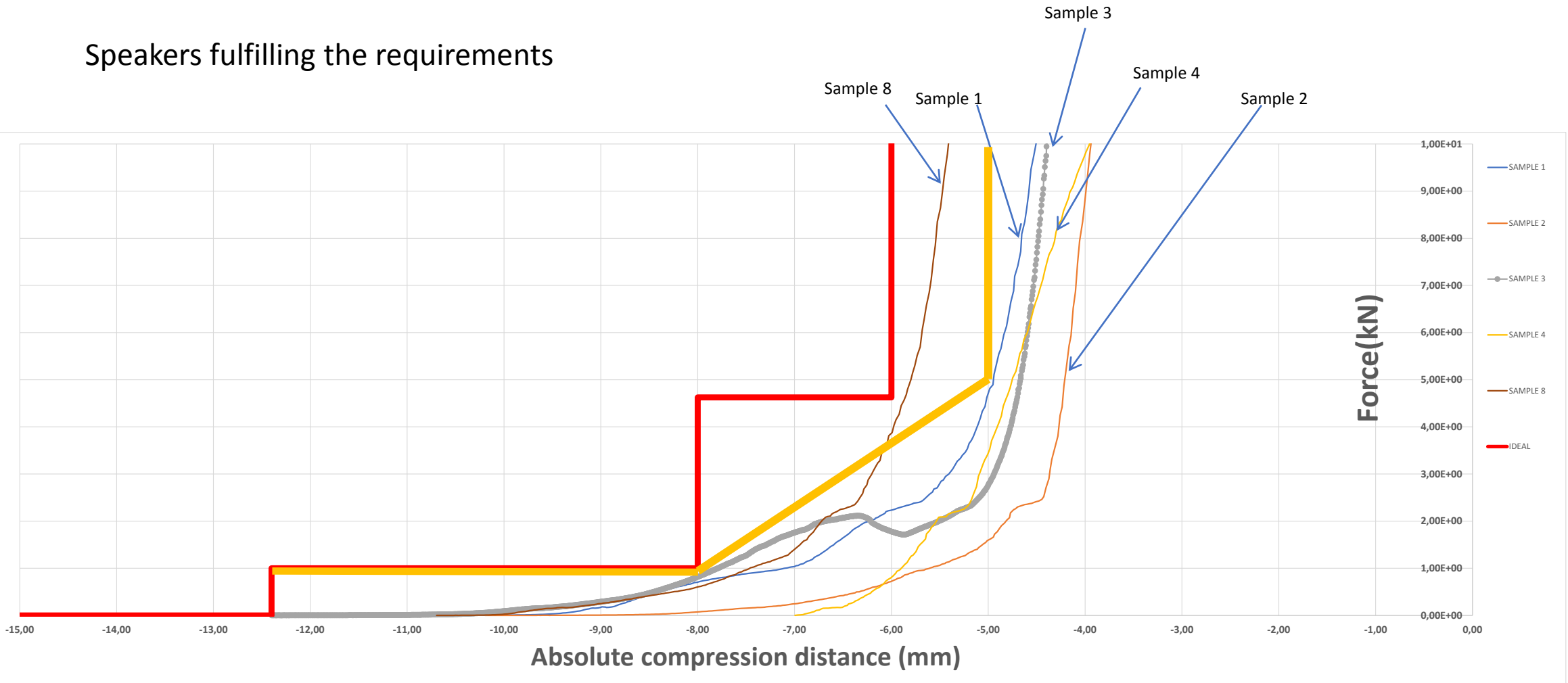### Ideal vs Actual behaviour

SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

Speakers with crush test result above the red line will not fulfill
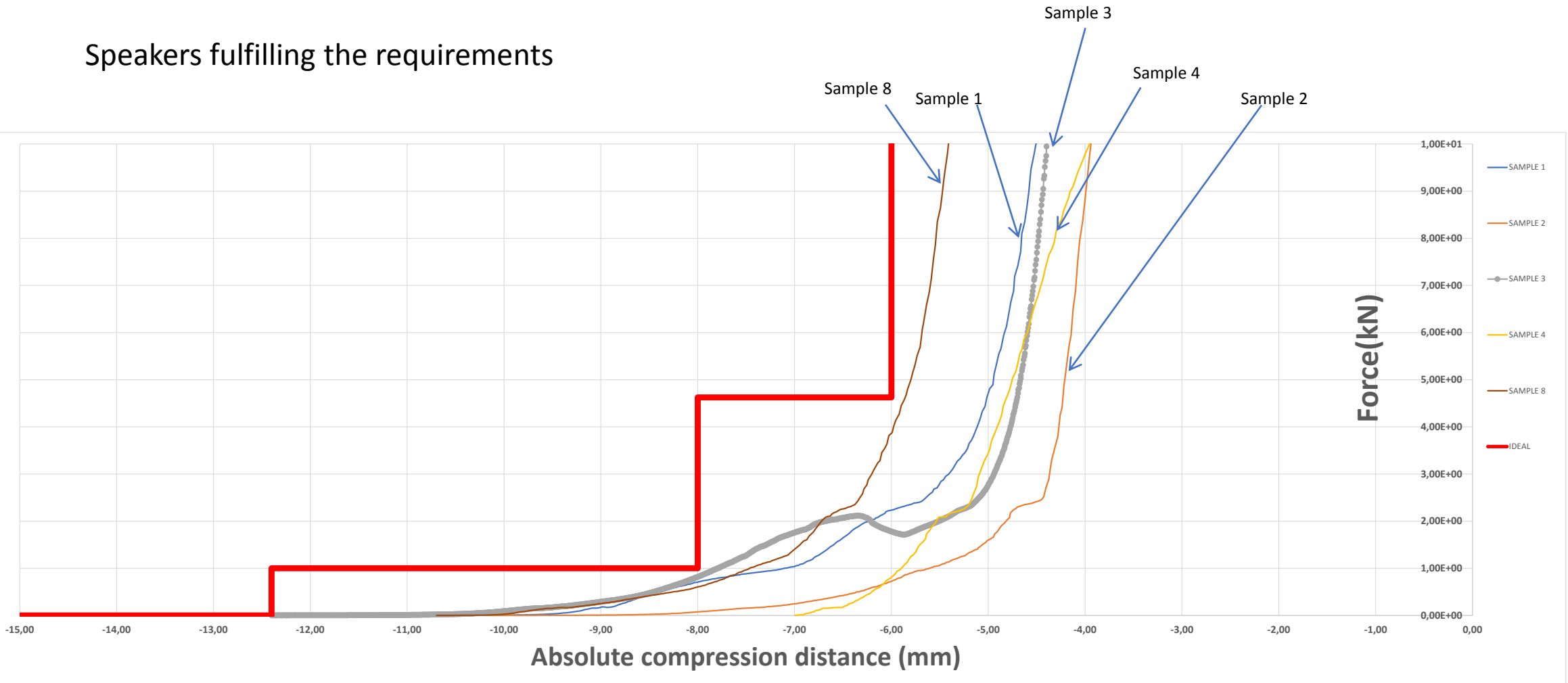
SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

Speakers fulfilling the requirements

Speakers characterization first industry proposal (compatible with 5 mm rigid speaker simulator)

Speakers characterization industry proposal for deformable speaker simulator
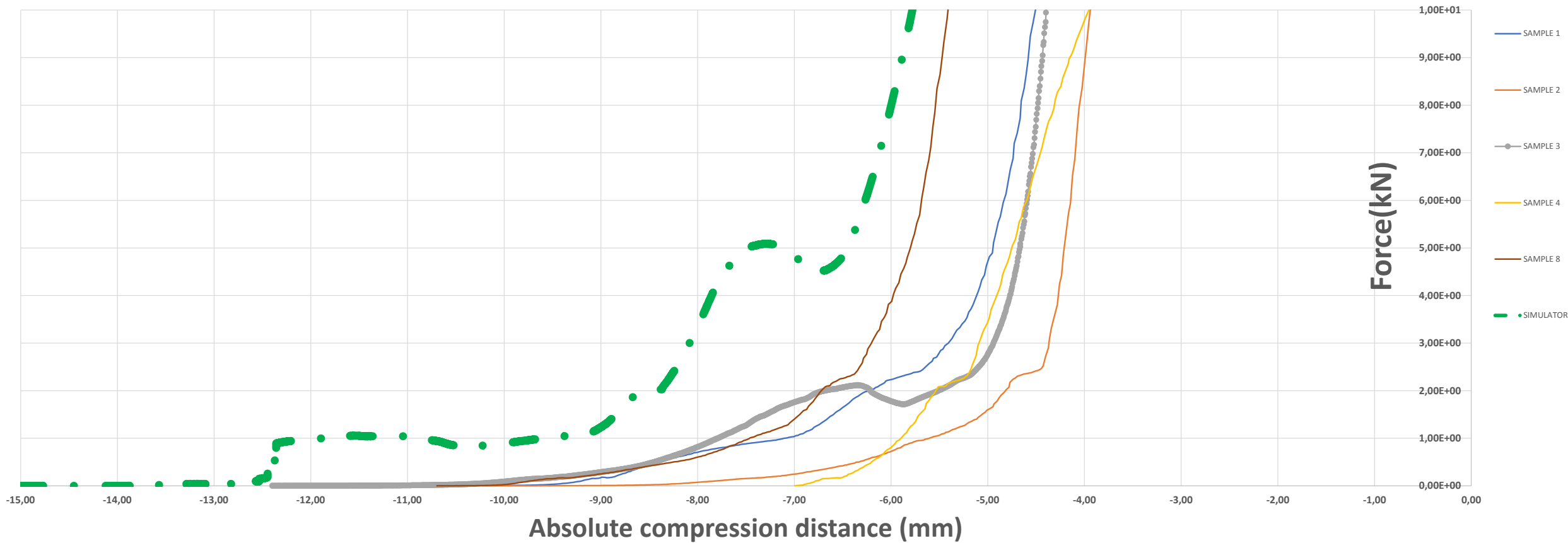
SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

Speakers fulfilling the requirements

SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

All speakers with Force-deformation charts laying below the def speaker simulator chart will be ok if helmet is tested with the def speaker simulator

SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

3. HELMET TESTS WITH DIFFERENT SIMULATORS AND ACTUAL SPEAKERS (in helmets close to the limit)

Size: M. Test cond: Flat, Amb. J	Model 1 Flip up	Model 1 Flip up	Model 1 Flip up	Model 1 Flip up	Model 1 Flip up	Model 1 Flip up
Speaker mock-up EPS pocket depth= 6mm	**NO**	45 mm diameter **8 mm thickness** rigid	45 mm diameter **5 mm thickness** rigid	**Deformable simulator 12,4 mm**	**REAL SPEAKER (SAMPLE 1)**	**REAL SPEAKER (SAMPLE 8)** (over the limits of the first industry proposal, now within the limits)
PLA (G's)	247	**303**	242	**277**	259	**281**
HIC	2037	**2703**	2075	**2429**	2160	**2415**

Size: XL. Test cond. Flat, Amb. O	Model 2 Flip up	Model 2 Flip up	Model 2 Flip up	Model 2 Flip up	Model 2 Flip up	
Speaker mock-up EPS pocket depth= 6mm	**NO**	45 mm diameter **5 mm thickness** rigid (EPS pocket depth-1mm)	45 mm diameter **4 mm thickness** rigid (EPS pocket depth-2mm)	**Deformable simulator 12,4 mm**	**REAL SPEAKER (SAMPLE 5)** (over the limits proposed for speakers)	
PLA (G's)	**277**	**296**	**277**	276	**277**	
HIC	2221	**2421**	2263	2228	2366	

Size: S. Test cond: Flat, Amb. E	Model 4 Flip up	Model 4 Flip up	Model 4 Flip up	Model 4 Flip up		
Speaker mock-up EPS pocket depth= 6mm	**NO**	45 mm diameter **5 mm thickness** rigid	**Deformable simulator 12,4 mm**	REAL SAMPLE SAMPLE 8		
PLA (G's)	244	253	251	235		
HIC	2347	**2468**	**2426**	2191		

SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

3. HELMET TESTS WITH SIMULATORS AND ACTUAL SPEAKERS (in helmets close to the limit)

Images of the speakers after the tests:

Images of the deformable speaker simulators after the tests:

4. SUMMARY

The proposed deformable speaker simulators have shown that can behave as actual speakers and obtain the values that helmets will obtain when tested together with actual speakers, whose F-def chart lays below the deformable speaker theoretical behaviour.

This proposal does not need to consider any EPS pocket for speakers since will behave as actual speakers upper limit.

SPEAKER SIMULATORS AND SPEAKER CHARACTERIZATION TOPIC

5. FURTHER WORK (If AHG agrees on it)

To perform additional tests, if any TS is interested in, with deformable speaker simulators.

To perform tests with **helmet simulator** (already ordered since the previous one was lost) by the industry to check the device.

To define the deformable speaker characteristics to be included in the Regulation as an additional Annex and adopt it as the final solution for the compatibility condition.