
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
DGA
La direction des centres
d ’expertise et d ’essais (DCE)
The systems evaluation and test directorate

RESEARCH PROGRAM FOR CIVIL AVIATION SAFETY

SEAT-FLOOR ATTACHMENT STRENGTH

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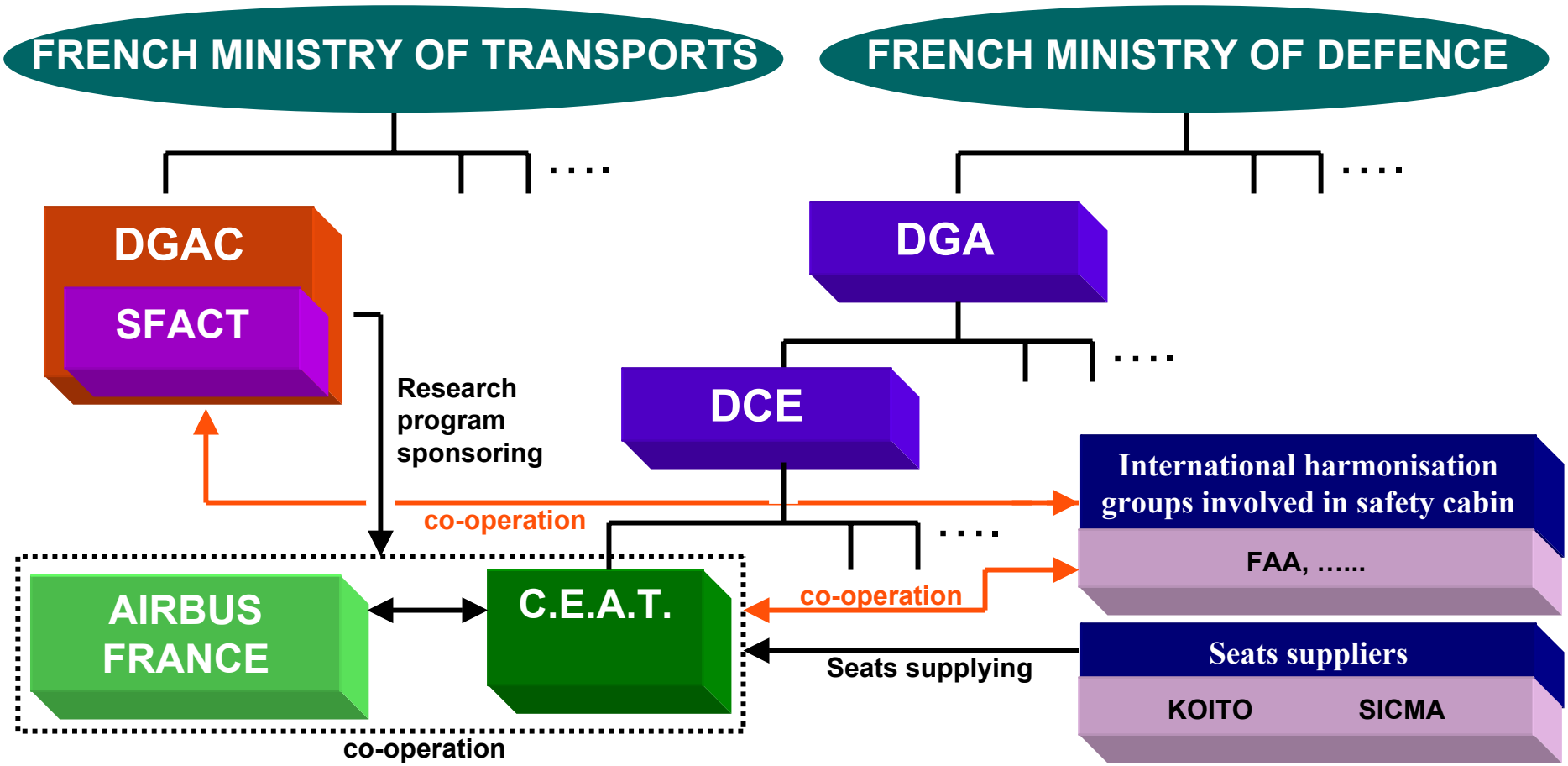
1 - CONTEXT



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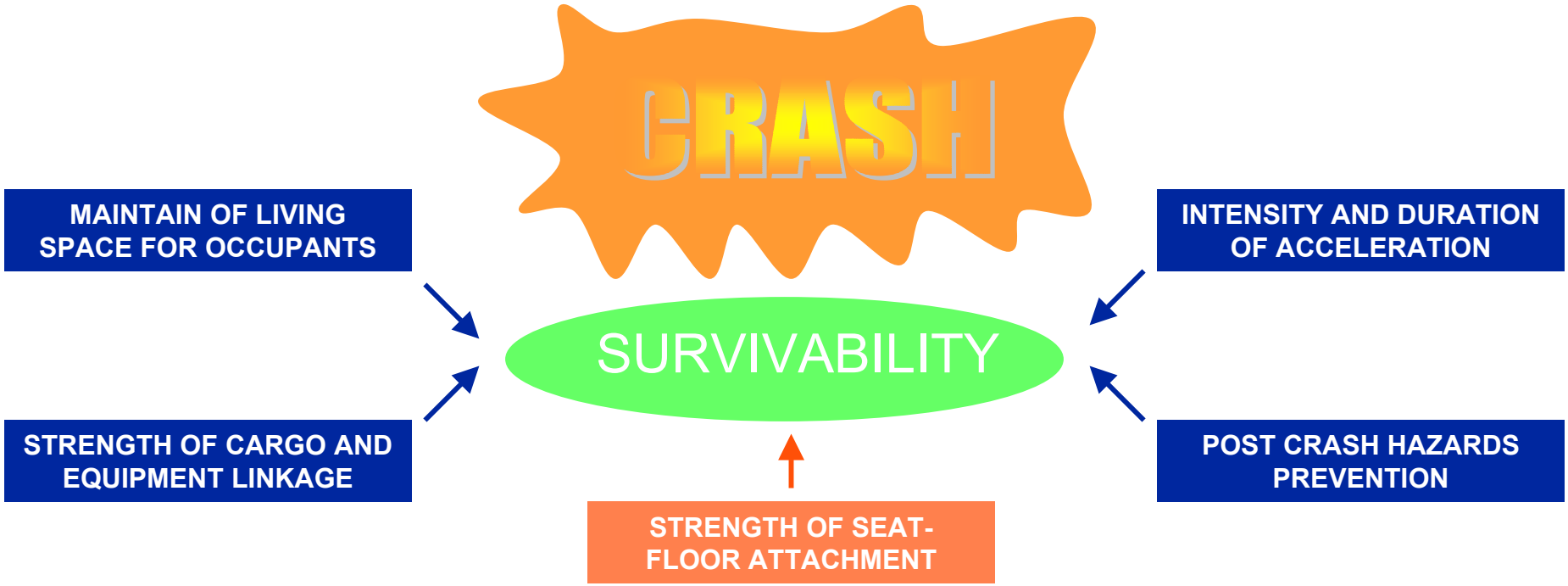
2 - INTRODUCTION

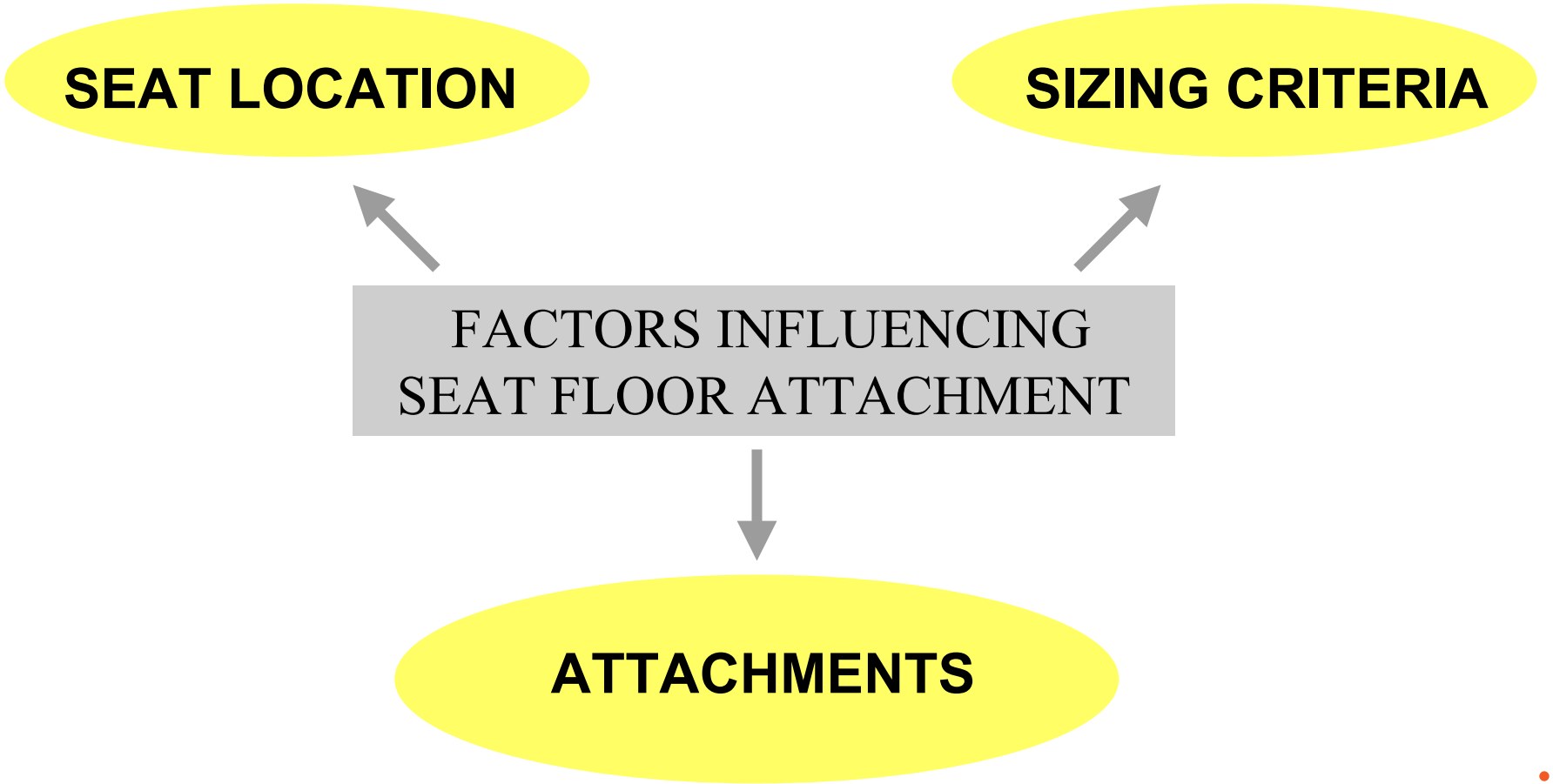


BUT SEAT-FLOOR ATTACHMENT FAILURES HAVE BEEN OBSERVED DURING ACCIDENTS

NECESSITY TO INVESTIGATE THE INTERFACE BETWEEN EQUIPMENT SUPPLIER AND AIRCRAFT MANUFACTURER

RETURN

3 - ISSUE IDENTIFICATION



3.1 - CRASH SIZING CRITERIAS

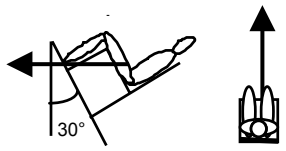
- SEATS : FAR/JAR § 25.562

Dynamic tests :

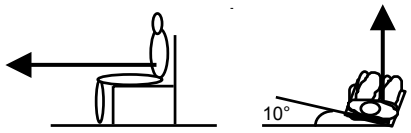
14g acceleration pulse - 80 ms duration

16g acceleration pulse - 90 ms duration

Imposed warping of the floor : pitch and roll of 10°



Dynamic test at 14g



Dynamic test at 16g

- Configuration :

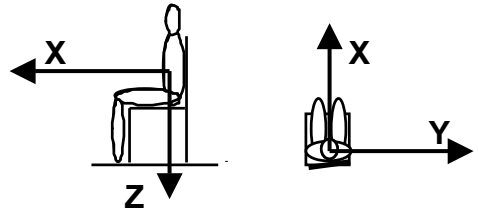
- Infinitely rigid floor
- Dummies and seats in motion
- Imposed warping of the floor (pitch and roll of 10°)
- Only upper part of seat rails (lips) represented

- FLOORS : FAR/JAR § 25.561

Static tests :

9g forward,1.5g rearward, 6g downward, 3g upward and 3g side static loading

Each static load case applied separately on centre of gravity of system (seat + occupant)



- Configuration :

- Seats and occupants supposed to be rigid
- Floor composed of cross beams and rails

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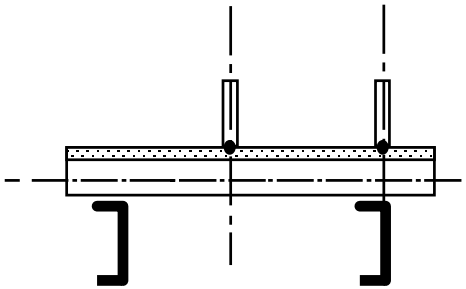
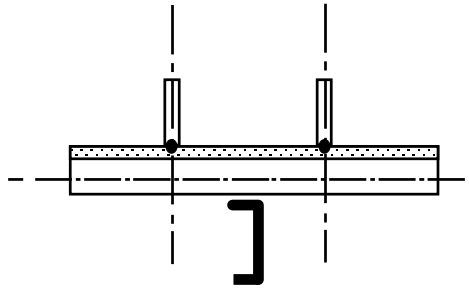
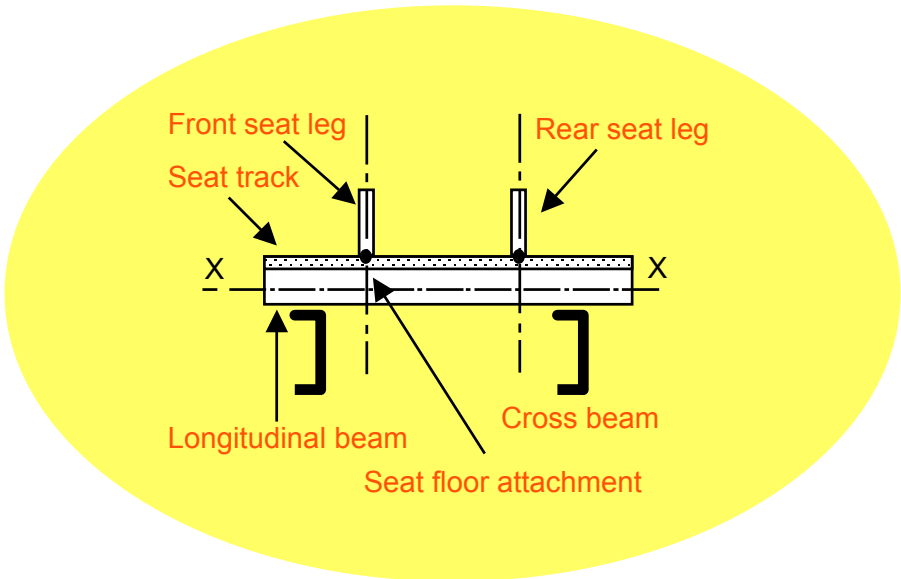
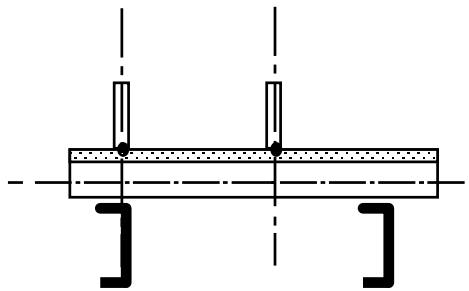
3.2 - SEATS LOCATION









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3.3 - INFLUENCE OF NUMBER OF ATTACHMENTS

DATA FROM TESTS PERFORMED AT FULL SCALE WITH SEATS SECURED ON EACH RAIL BY TWO ANCHORING POINTS

FAR §25.561

FAR §25.562

?

STIFFER SEATS MANUFACTURING

?

COHERENCE OF THE TWO CHAPTERS WITH STIFFER SEATS EQUIPPED WITH MORE THAN TWO ATTACHMENT POINTS?

3.4 - STUDY PERSPECTIVES

Stiffer modern seats implying higher loads introduced on the cabin floors

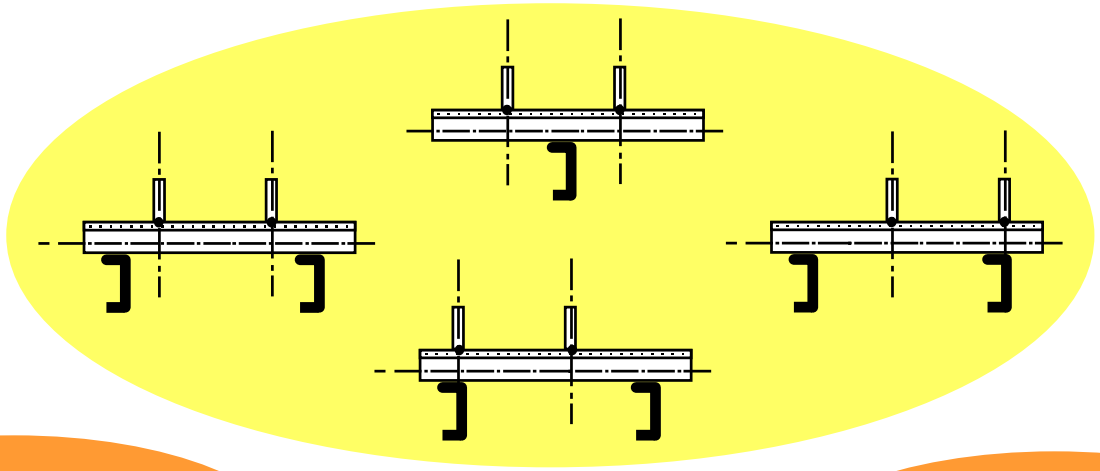
Analysis of different configurations

Assessment of this loading increase

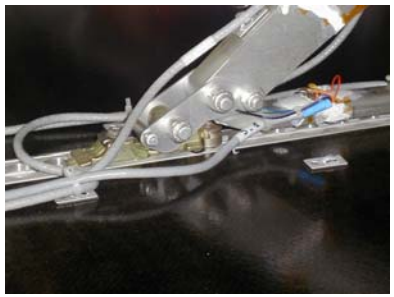
RETURN

4 - STUDY CONTENTS

4.1 - METHOD



Two studs attachment



Five studs attachment

FUNDAMENTAL CHOICE : MIXED APPROACH
NUMERICAL TOOL AND TESTING MEANS

4.2 - TOOLS

CHOICE OF SEATS

Triple tourist seats

Flexible SICMA seat
Stiffer KOITO seat

DEFINITION OF REAL CABIN FLOOR

With respect to test facility limitations

TOOLS

DYNAMIC LOADS MEASUREMENT

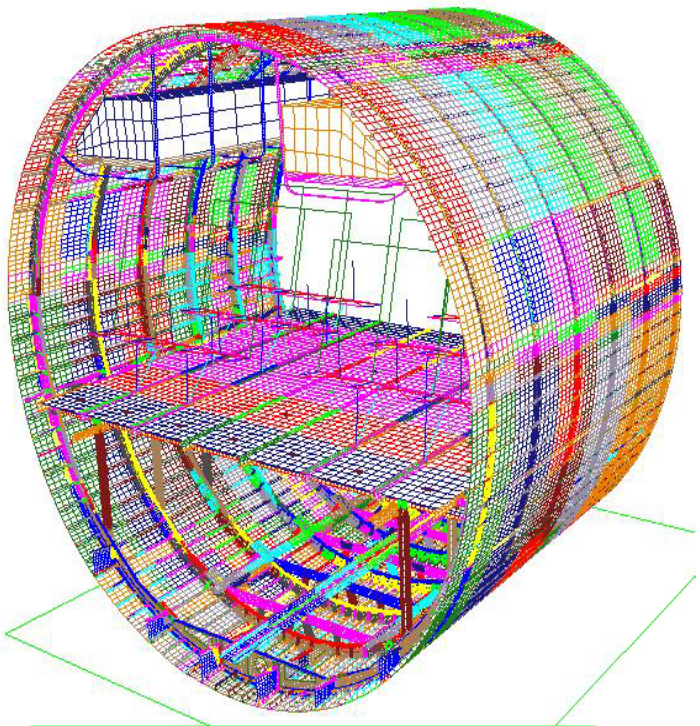
Strain gages
Accelerometers
Load transducers

DIFFERENT VIRTUAL TESTS CONFIGURATIONS
(NUMERICAL ANALYSIS)

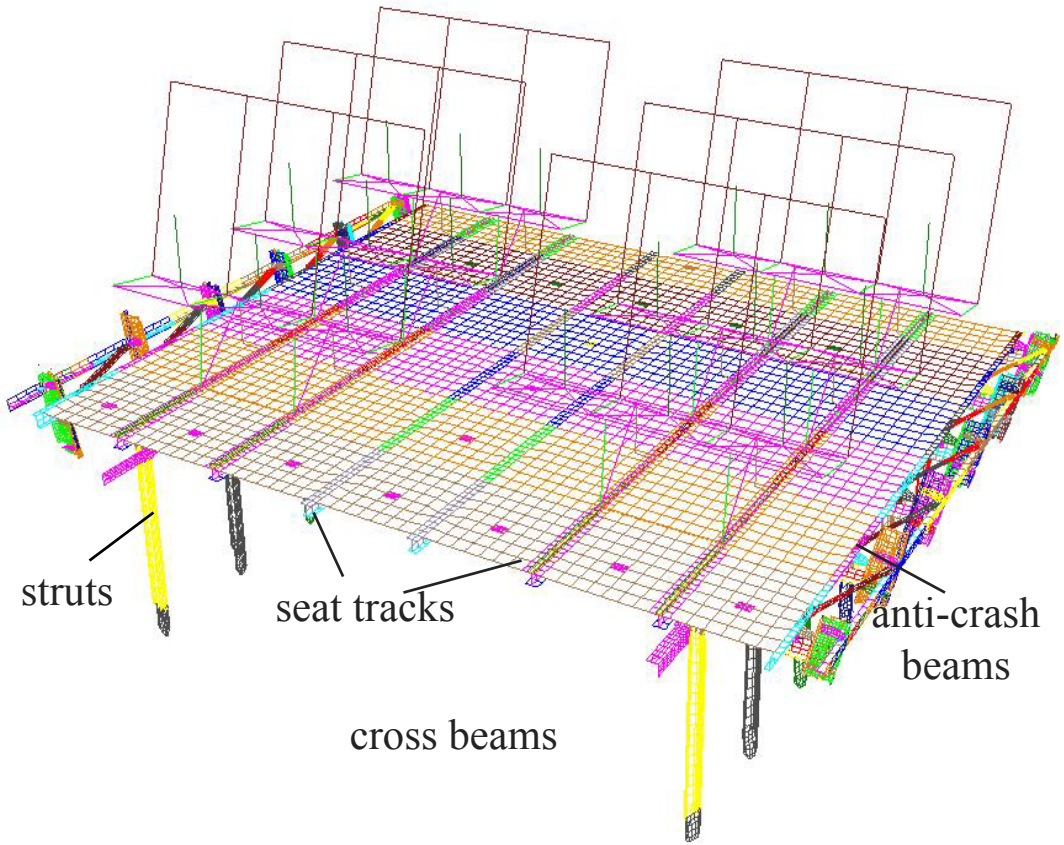
Seat location
Seats stiffness, ...

4.3 - NUMERICAL SIMULATION (1)

EXTRACTION OF A CABIN FLOOR MODEL



A320 vertical drop-test model

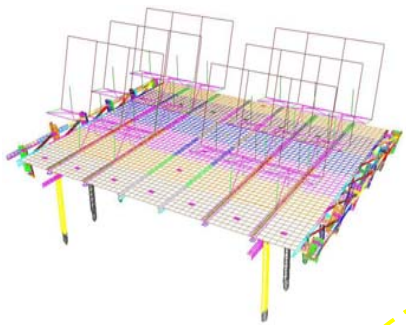


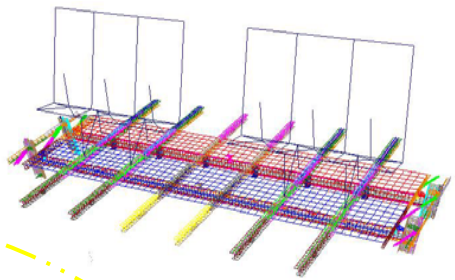
4.3 - NUMERICAL SIMULATION (2)

DEFINITION OF THE CABIN FLOOR FOR TESTING

Whole aircraft cabin floor

Representative floor for dynamic test



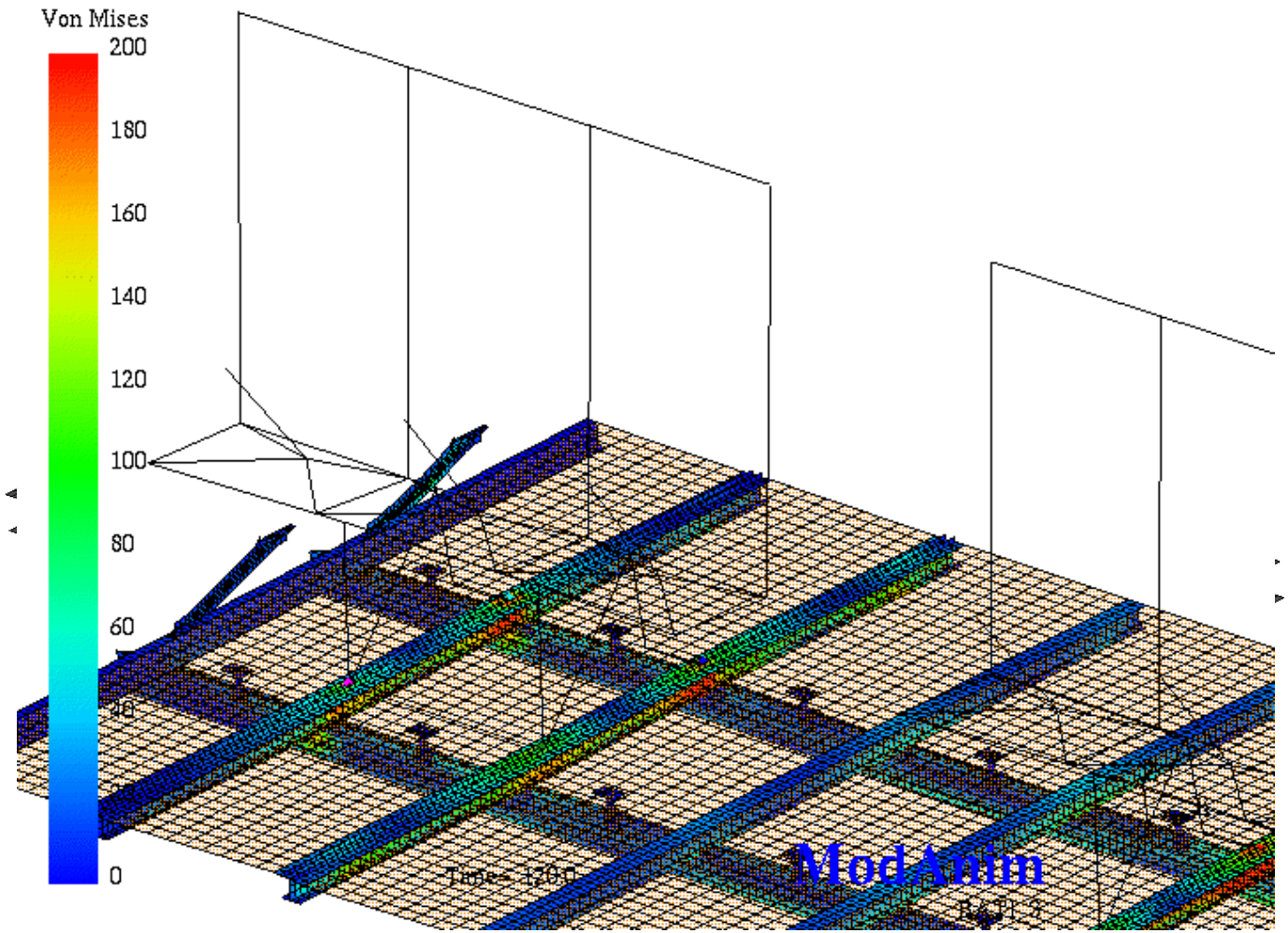


numerical 6 frames model

EQUIVALENCE

numerical 2 frames model

4.3 - NUMERICAL SIMULATION (3)



4.4 - DYNAMIC LOADS ASSESSMENT

DIRECT MEASUREMENT OF LOADS IMPOSSIBLE DURING REPRESENTATIVE CABIN FLOOR

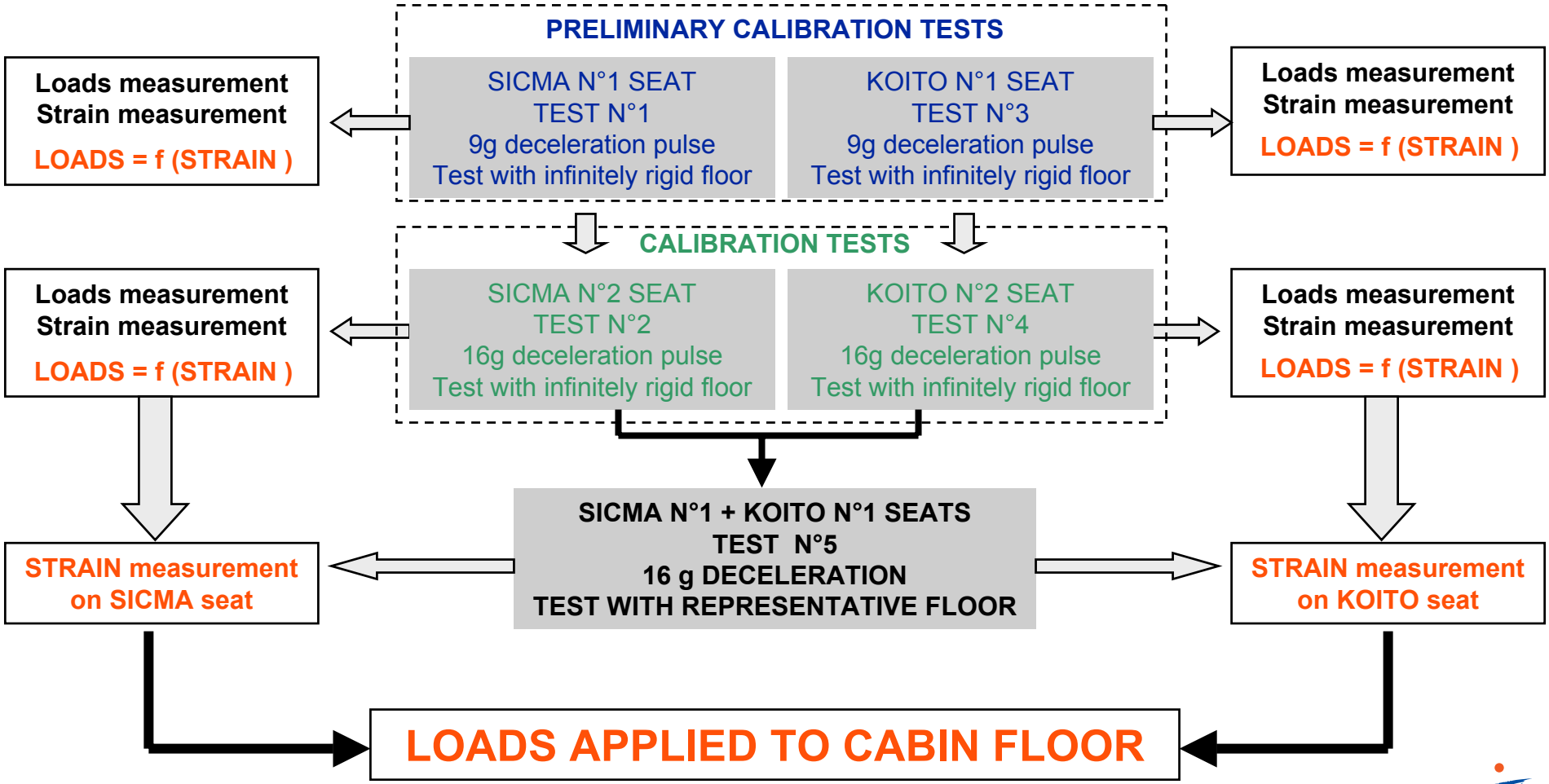
TESTS WITH INFINITELY RIGID FLOOR → **LOADS versus time**
STRAIN versus time
LOADS versus STRAIN

+

TEST WITH REPRESENTATIVE CABIN FLOOR
Seats acting as "load transducers" → **STRAIN versus time**

LOADS APPLIED TO CABIN FLOOR

4.5 - DYNAMIC TEST CAMPAIGN



4.6 - FIRST RESULTS

No rupture nor plastic deformation of any cabin floor parts during the representative 16g - test

Stiffness difference of seats not significant according to comparison between loads introduced by each one into the cabin floor

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5 - INVESTIGATION

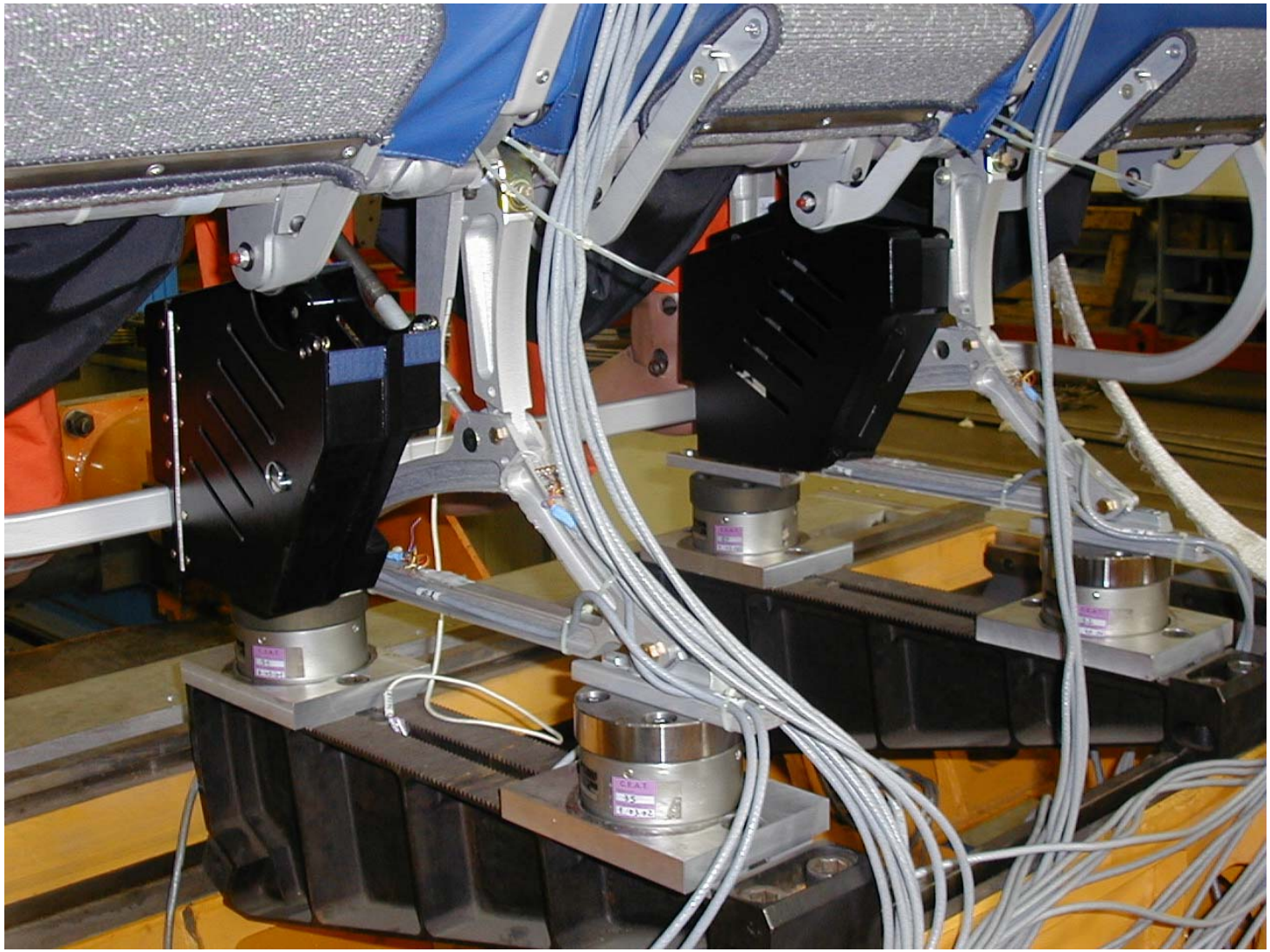
Demonstration of imposed warping floor influence on seats stiffness under dynamic solicitation

Conclusions

Calibration of the FE model with regard to tests results

Analysis of some virtual tests configurations with reduced costs

Possibility to extrapolate these conclusions to a whole aircraft cabin floor



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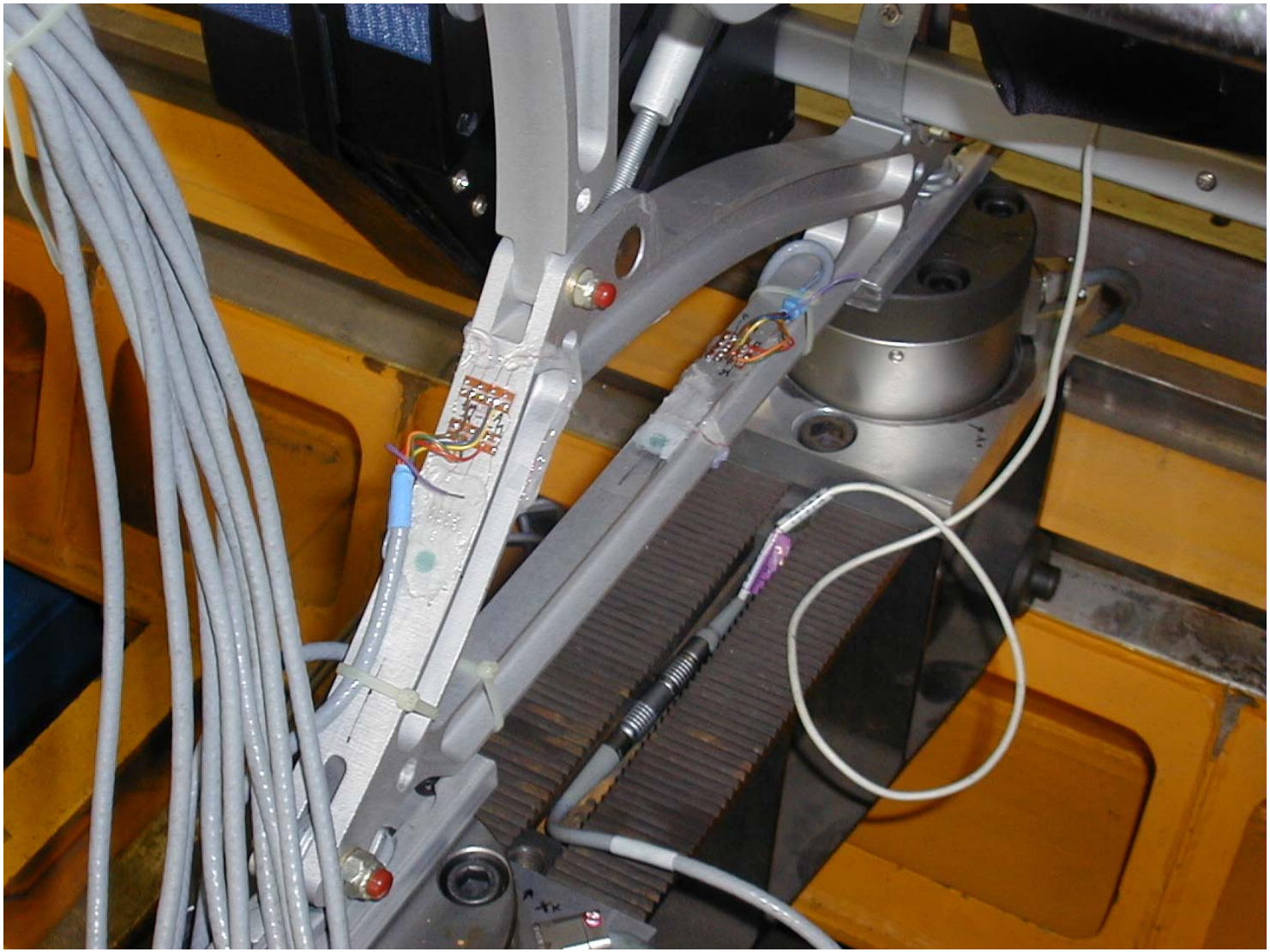

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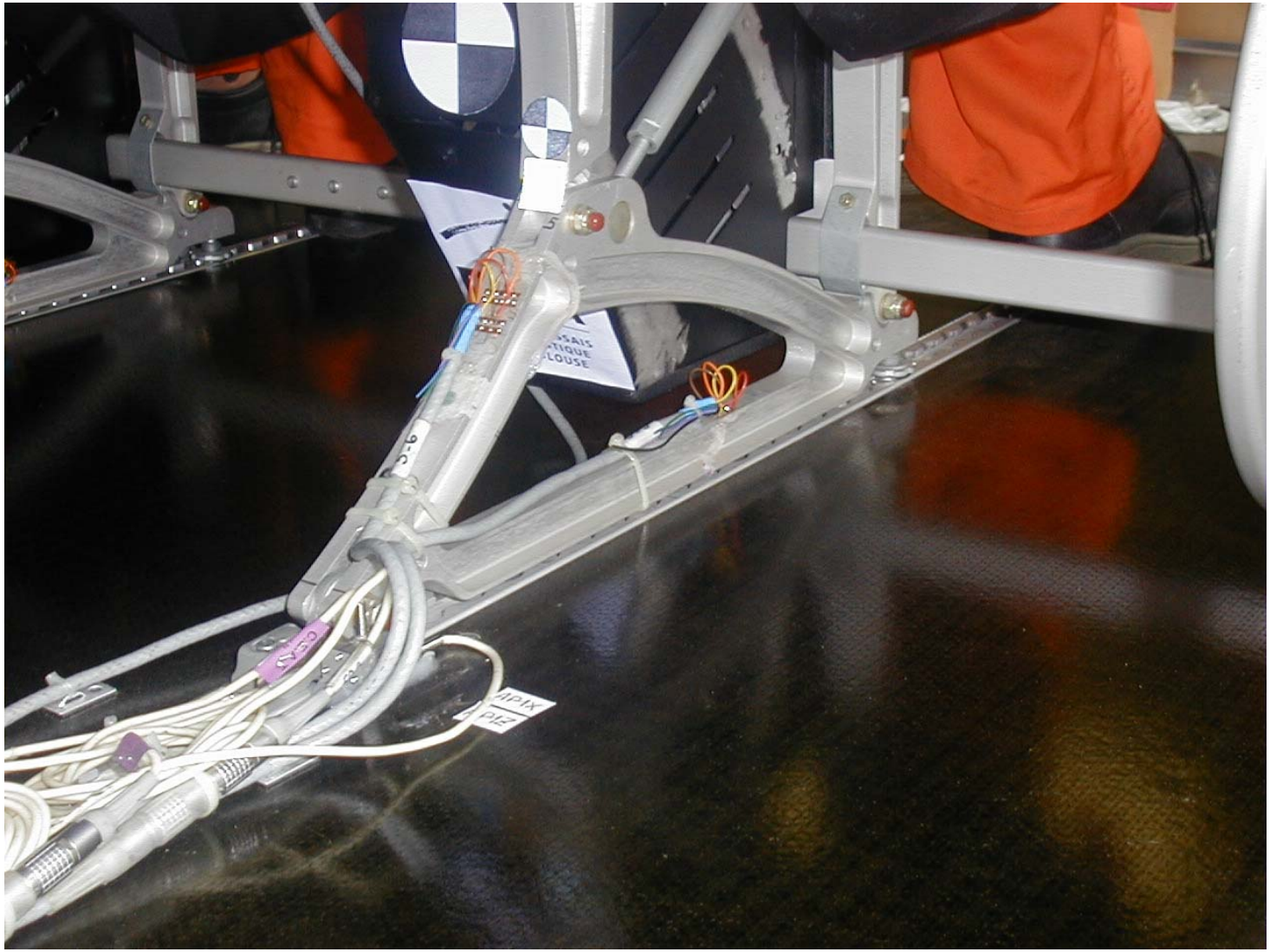

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INSTRUMENTATION

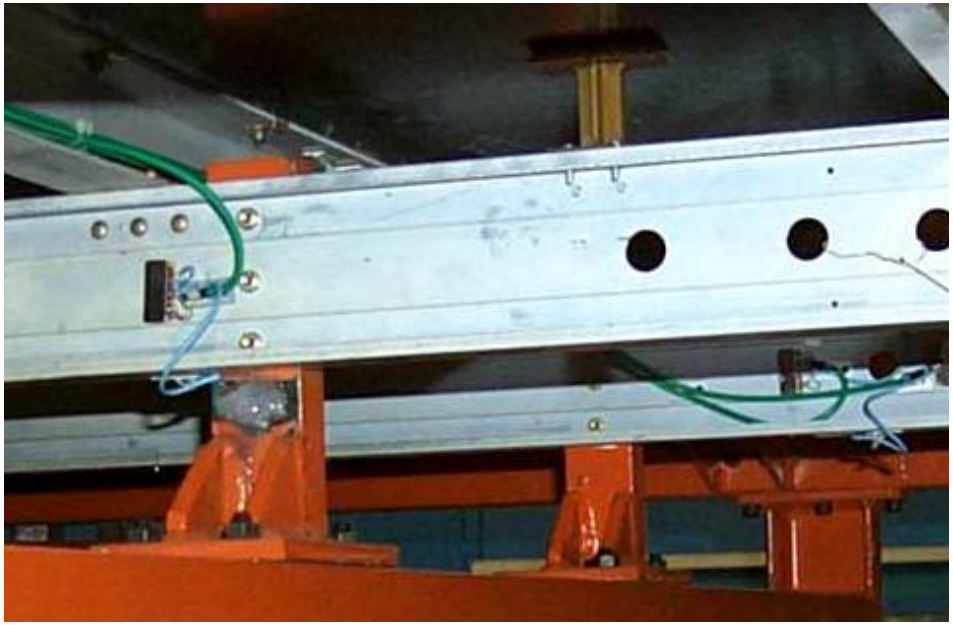
Anthropomorphic dummies for seat loading representation

INSTRUMENTATION

Accelerometers on tourist seats

Accelerometers on representative floor

INSTRUMENTATION



Strain gages on representative floor

Loads transducer on safety belts

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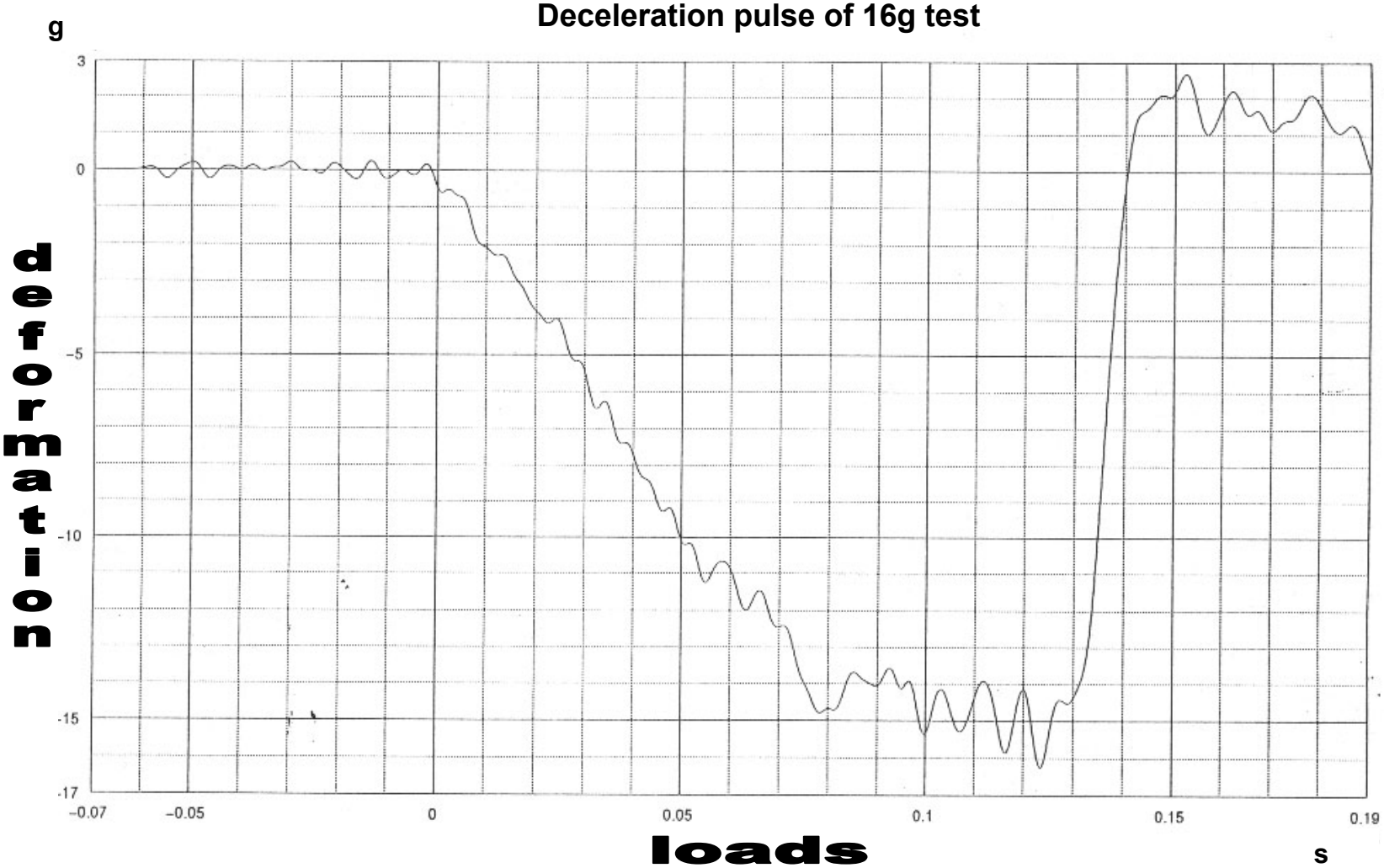
Deceleration pulse of 16g test



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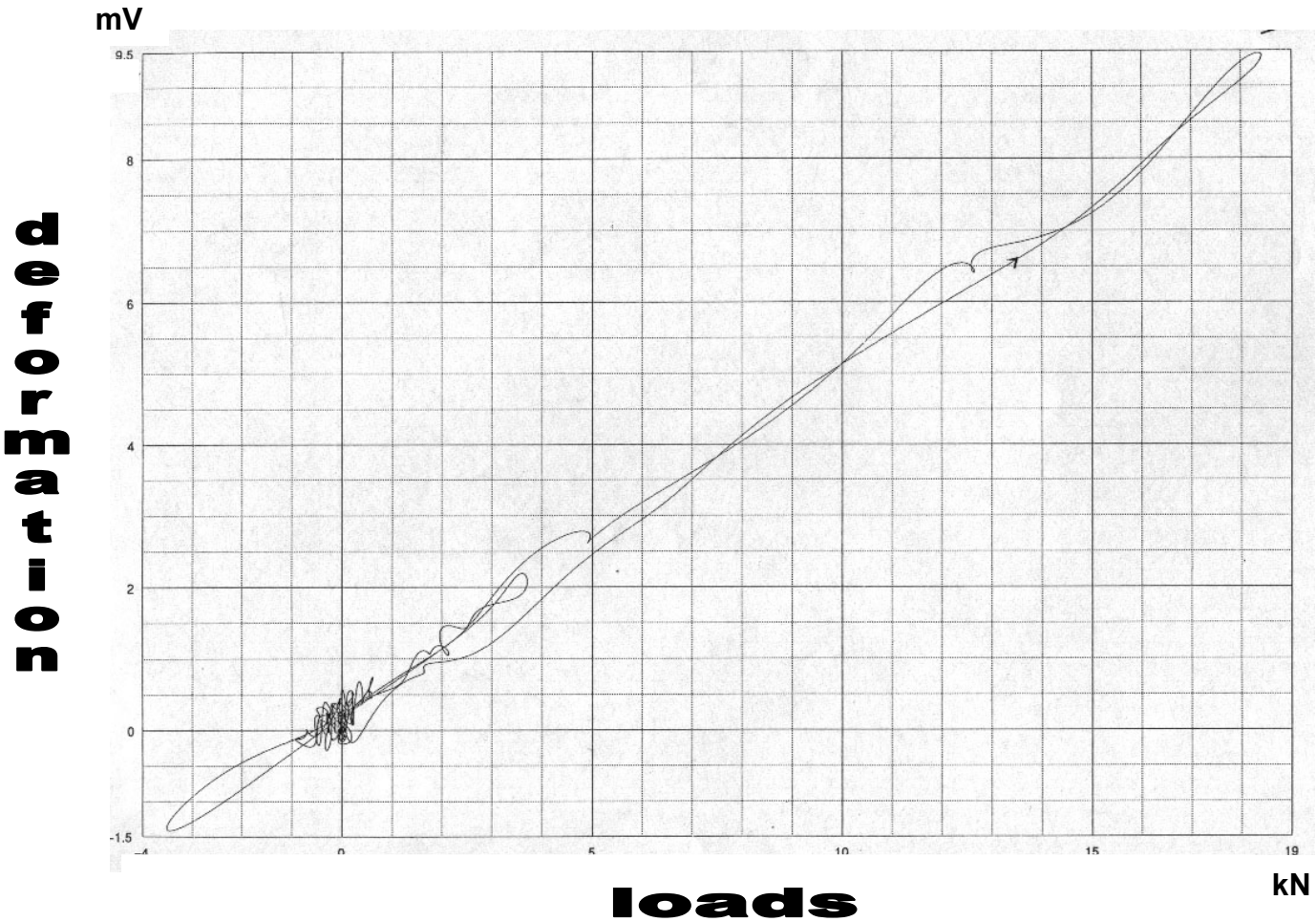
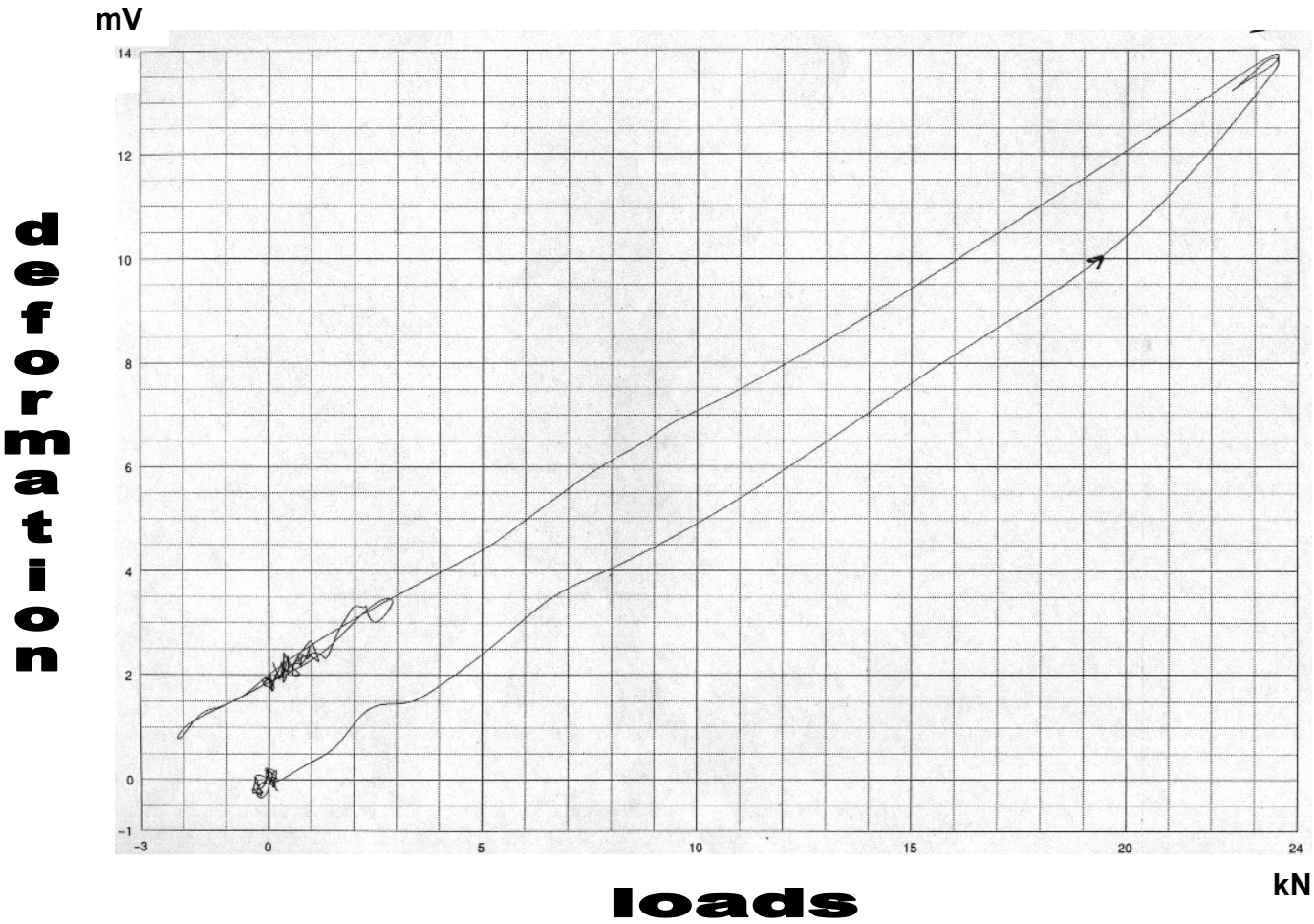
SICMA 9g - Rear right seat leg



SICMA 9g - Rear left seat leg



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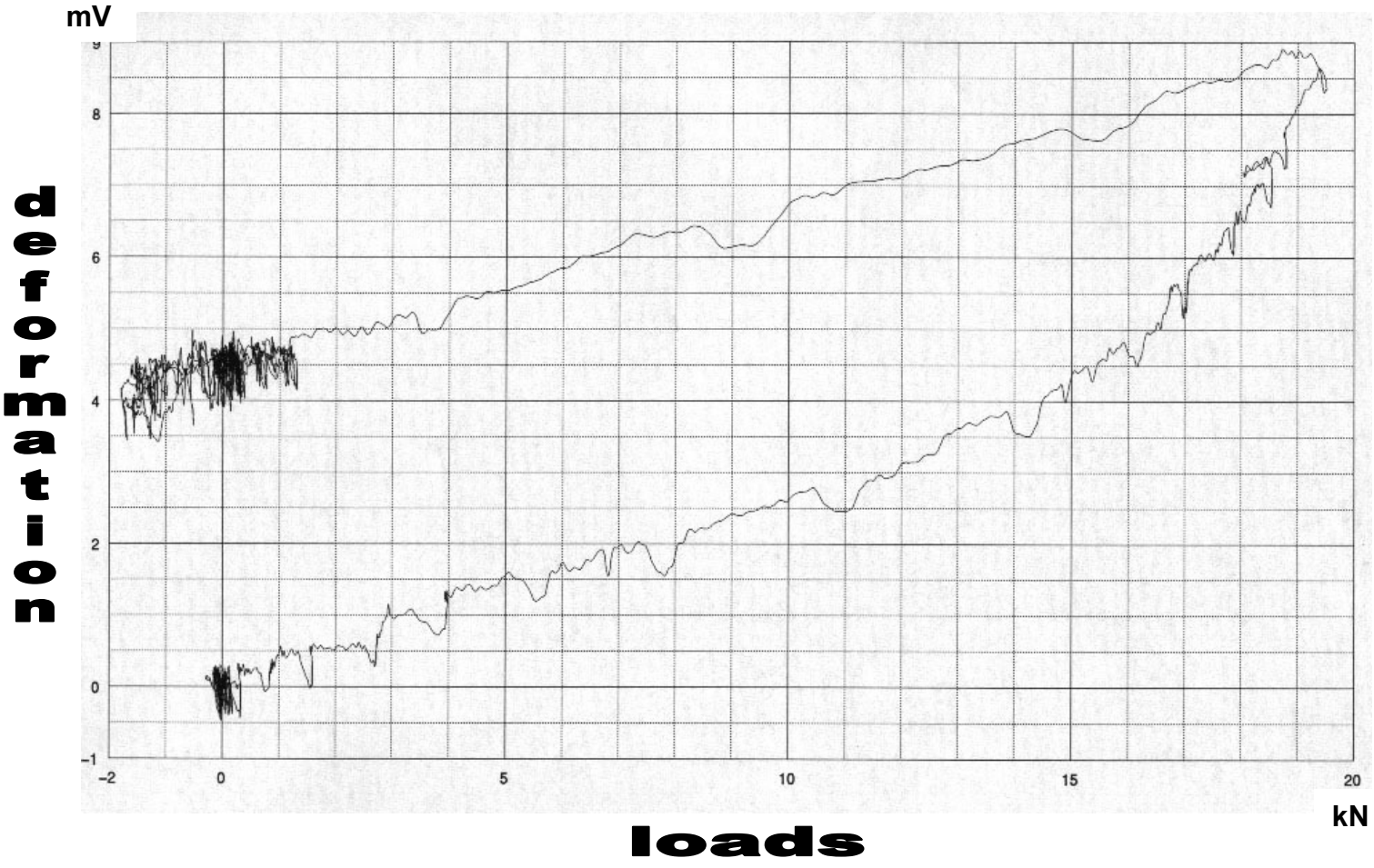
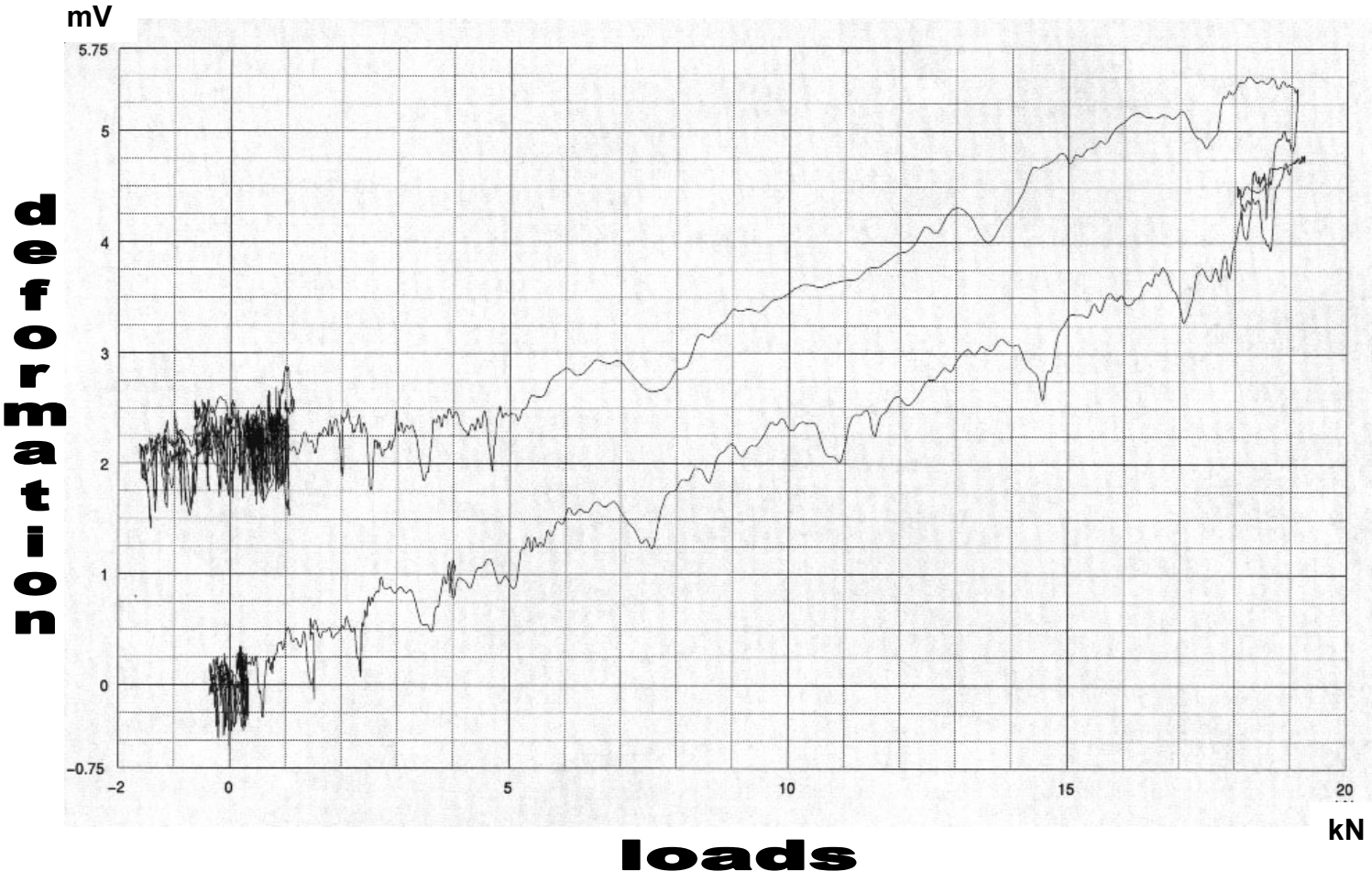
KOITO 9g - Rear left seat leg



KOITO 9g - Rear right seat leg



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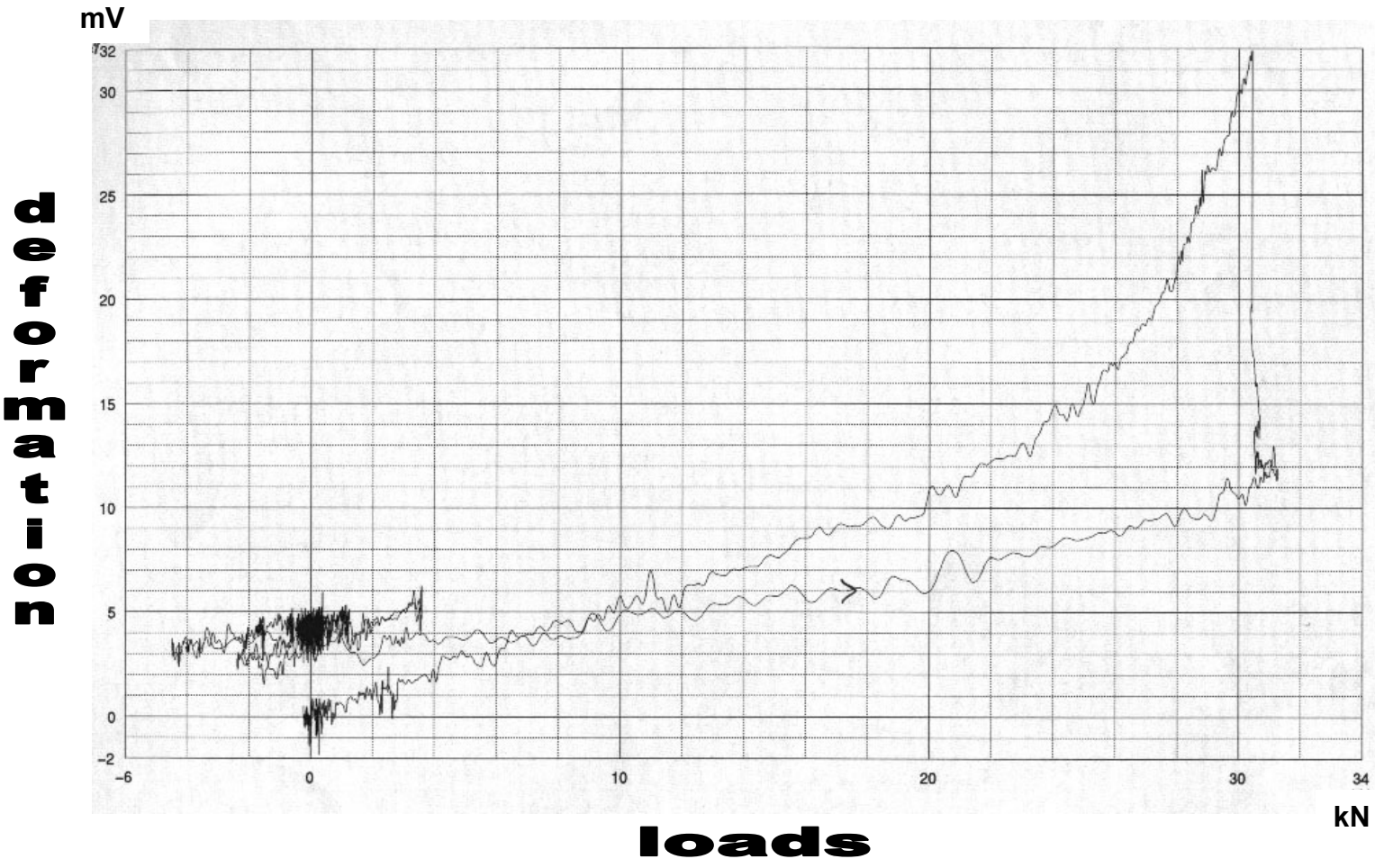
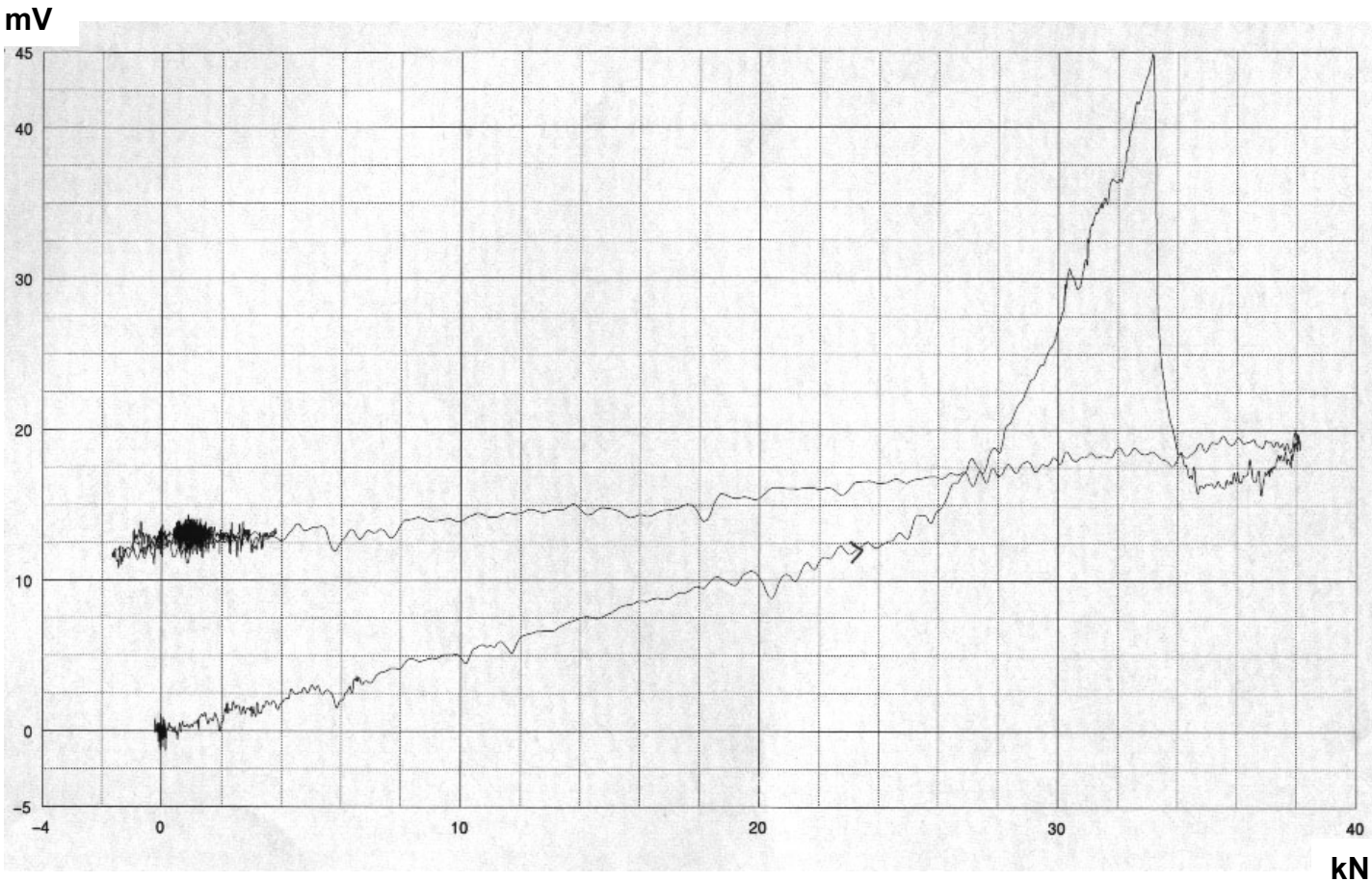
SICMA 16g - Rear right seat leg



SICMA 16g - Rear left seat leg



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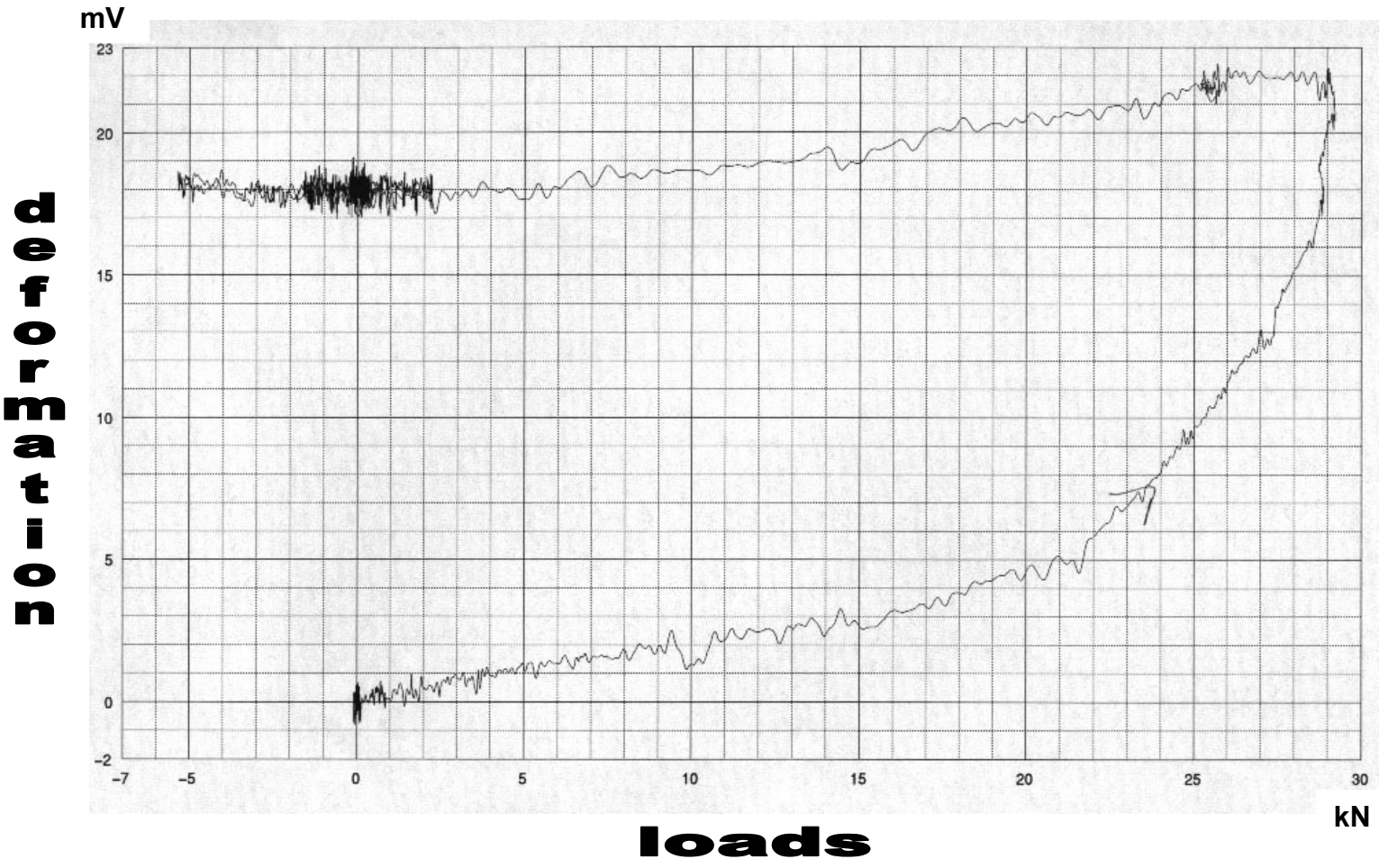
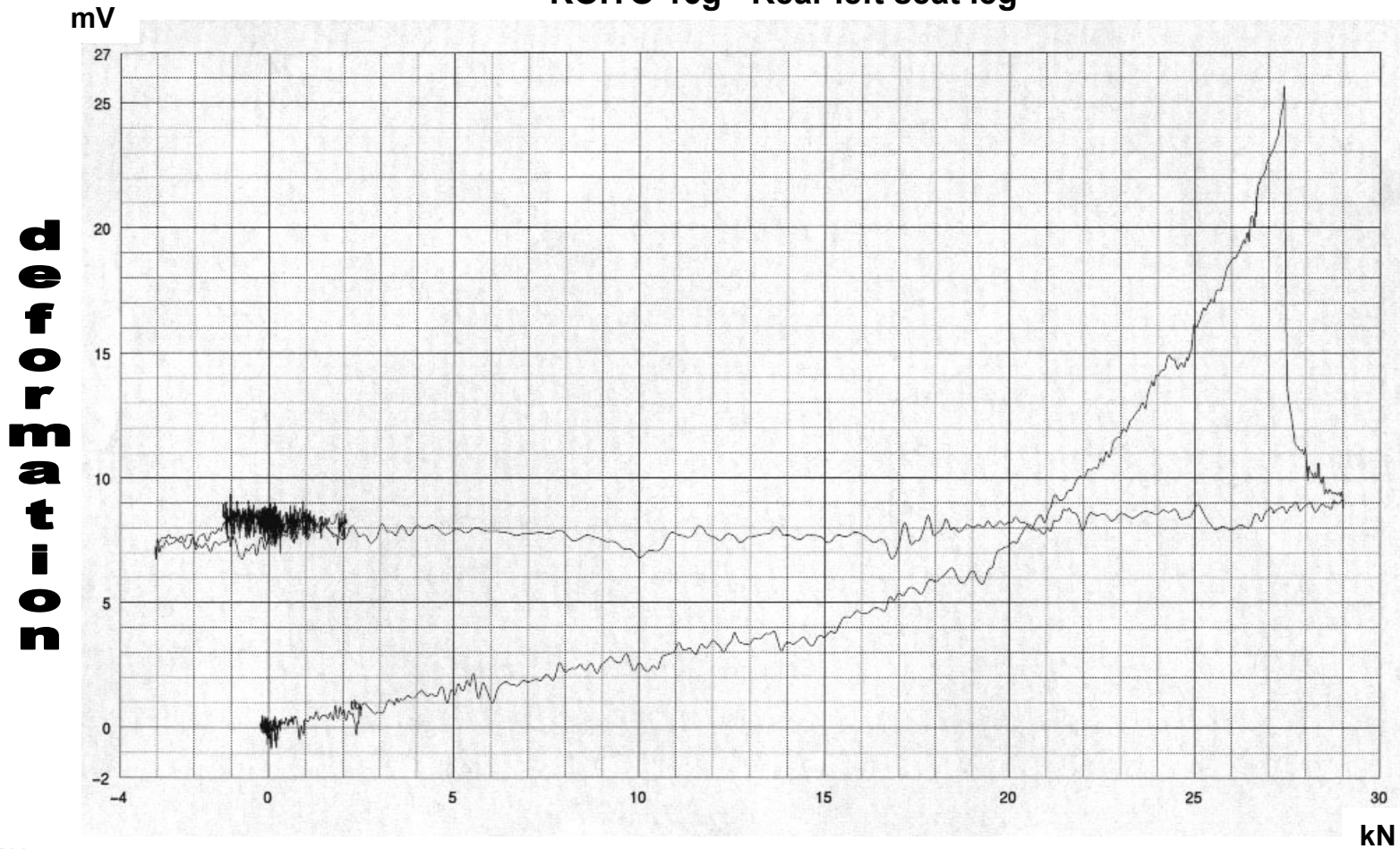
KOITO 16g - Rear right seat leg



KOITO 16g - Rear left seat leg



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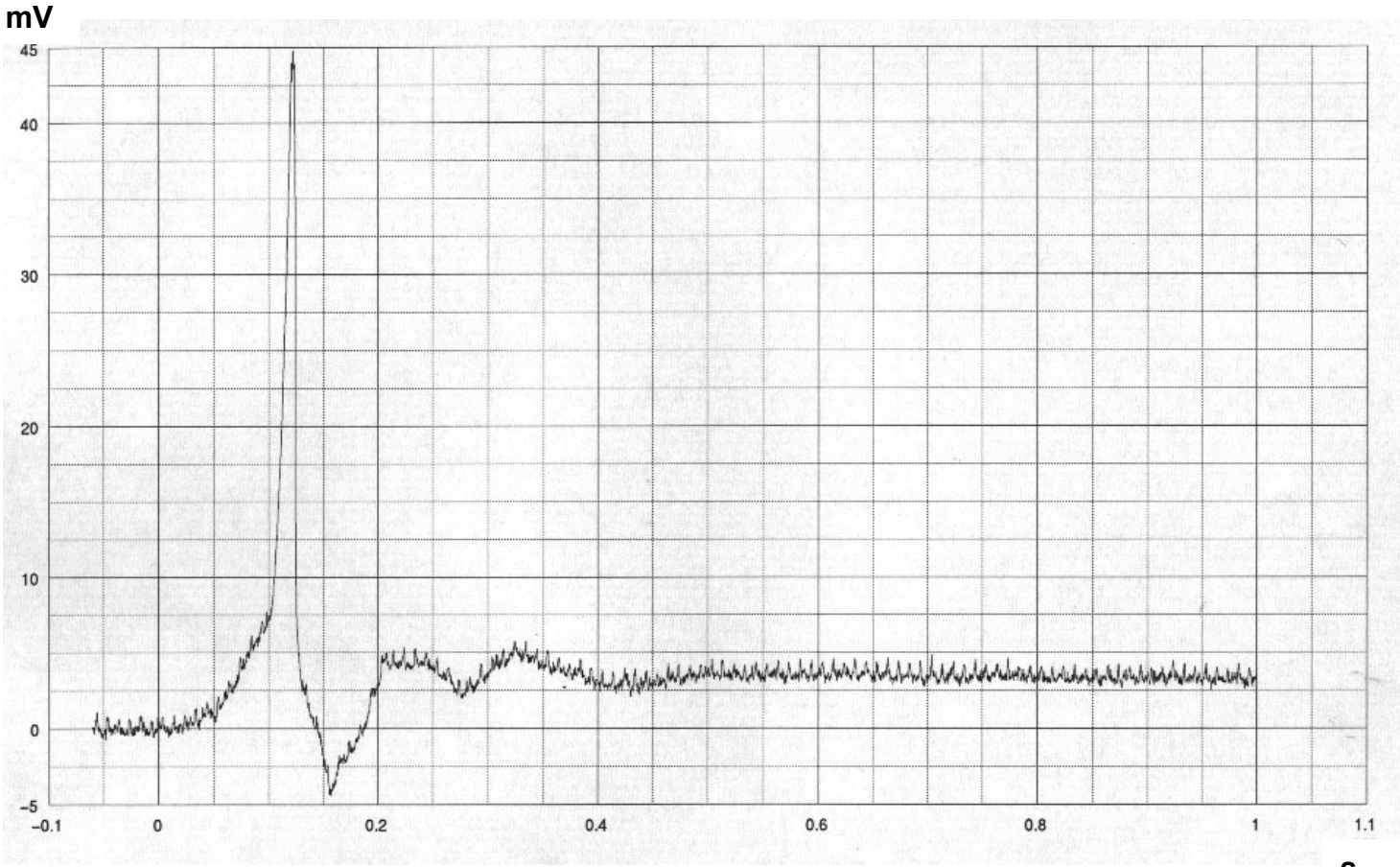
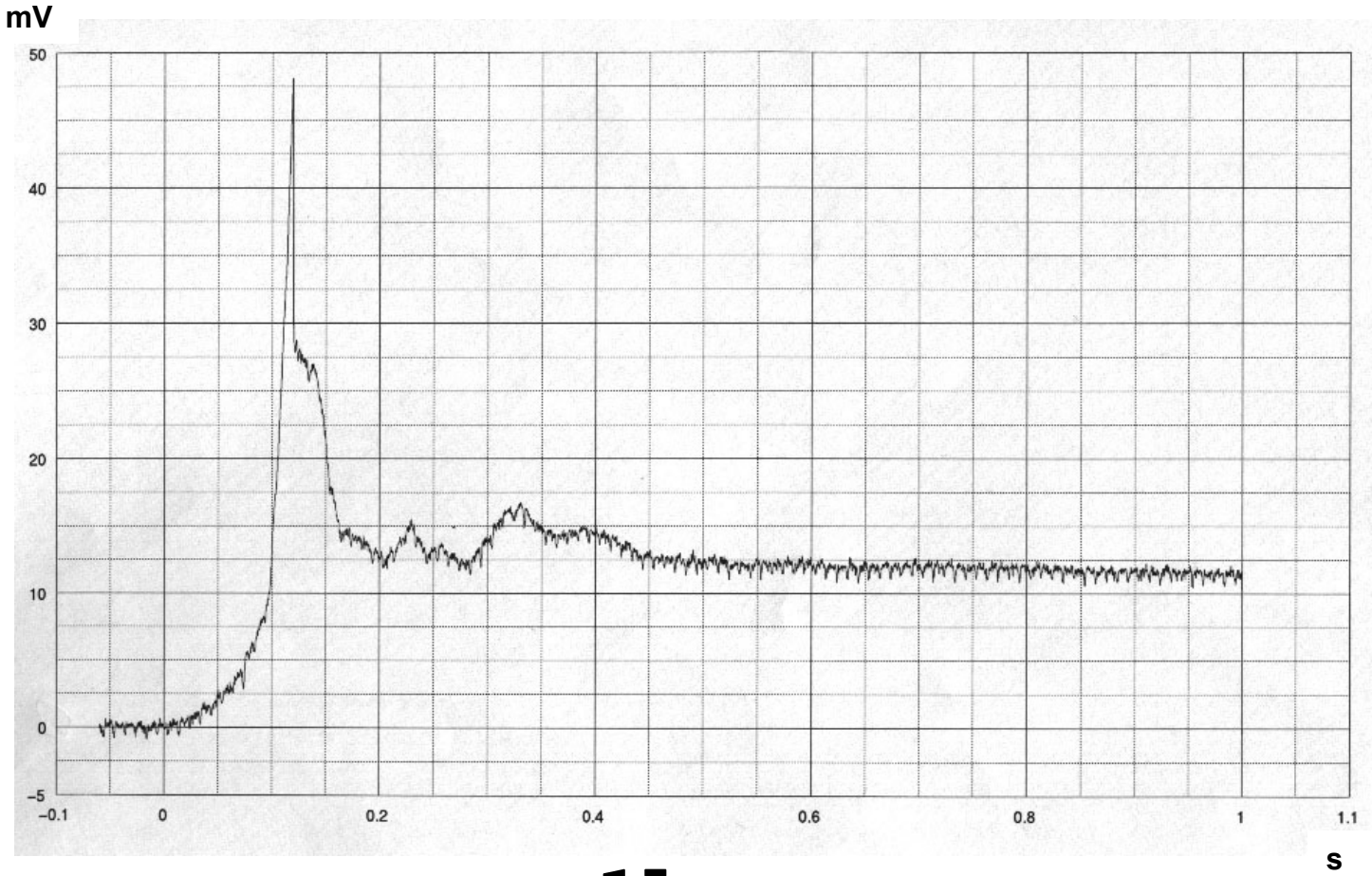
KOITO final 16g test - Rear right seat leg



KOITO final 16g test - Rear left seat leg



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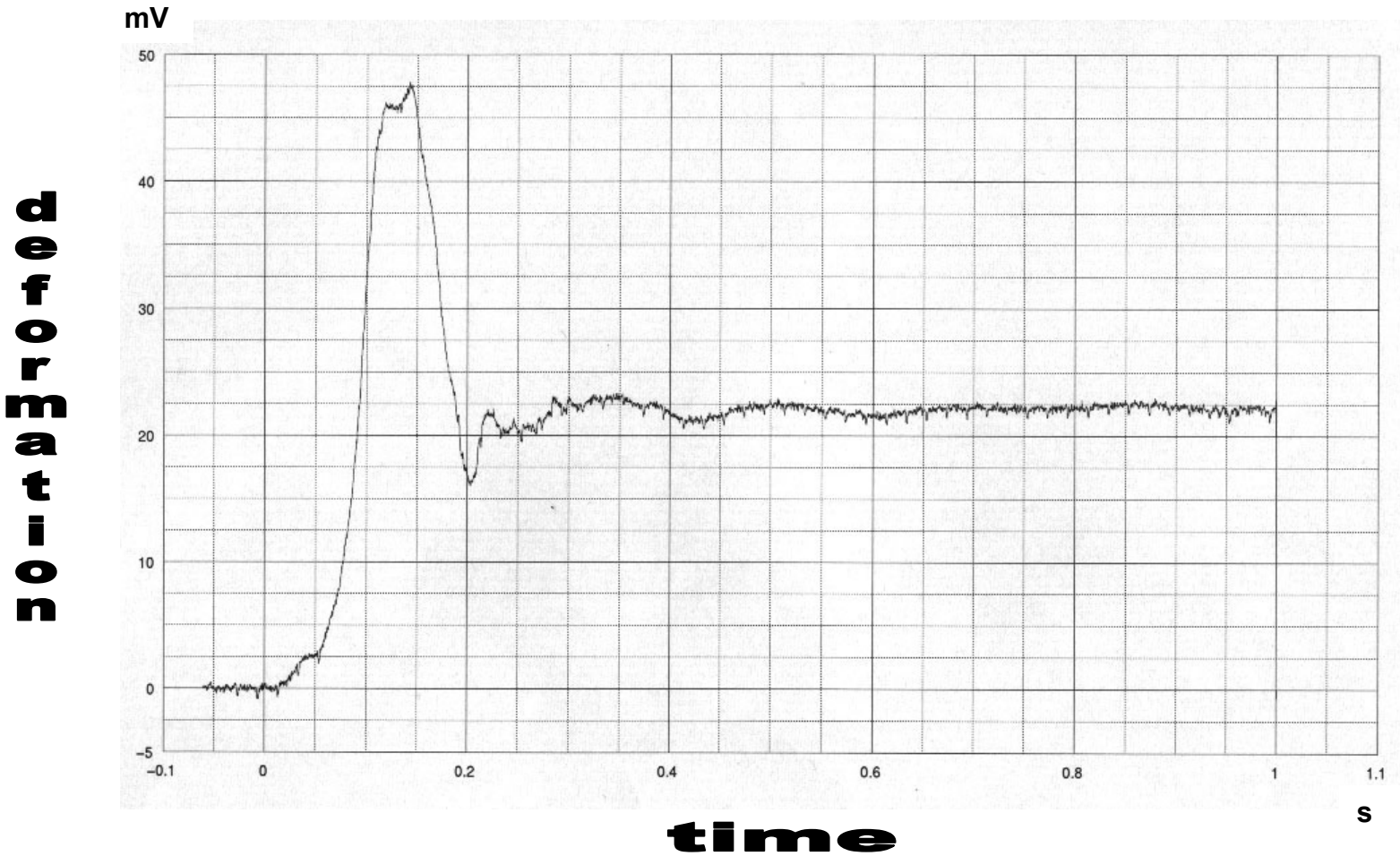
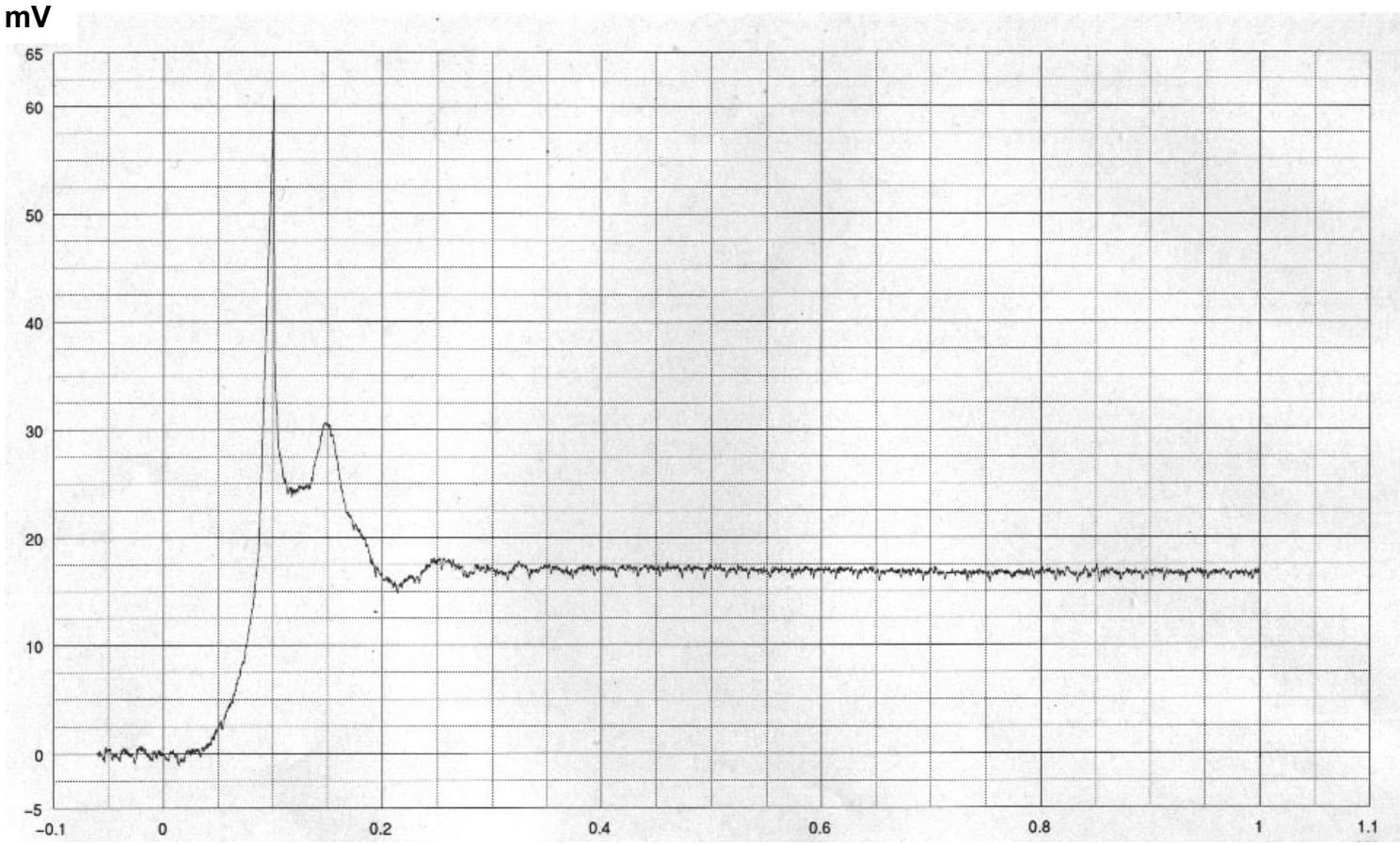
SICMA final 16g test - Rear right seat leg



SICMA final 16g test - Rear left seat leg



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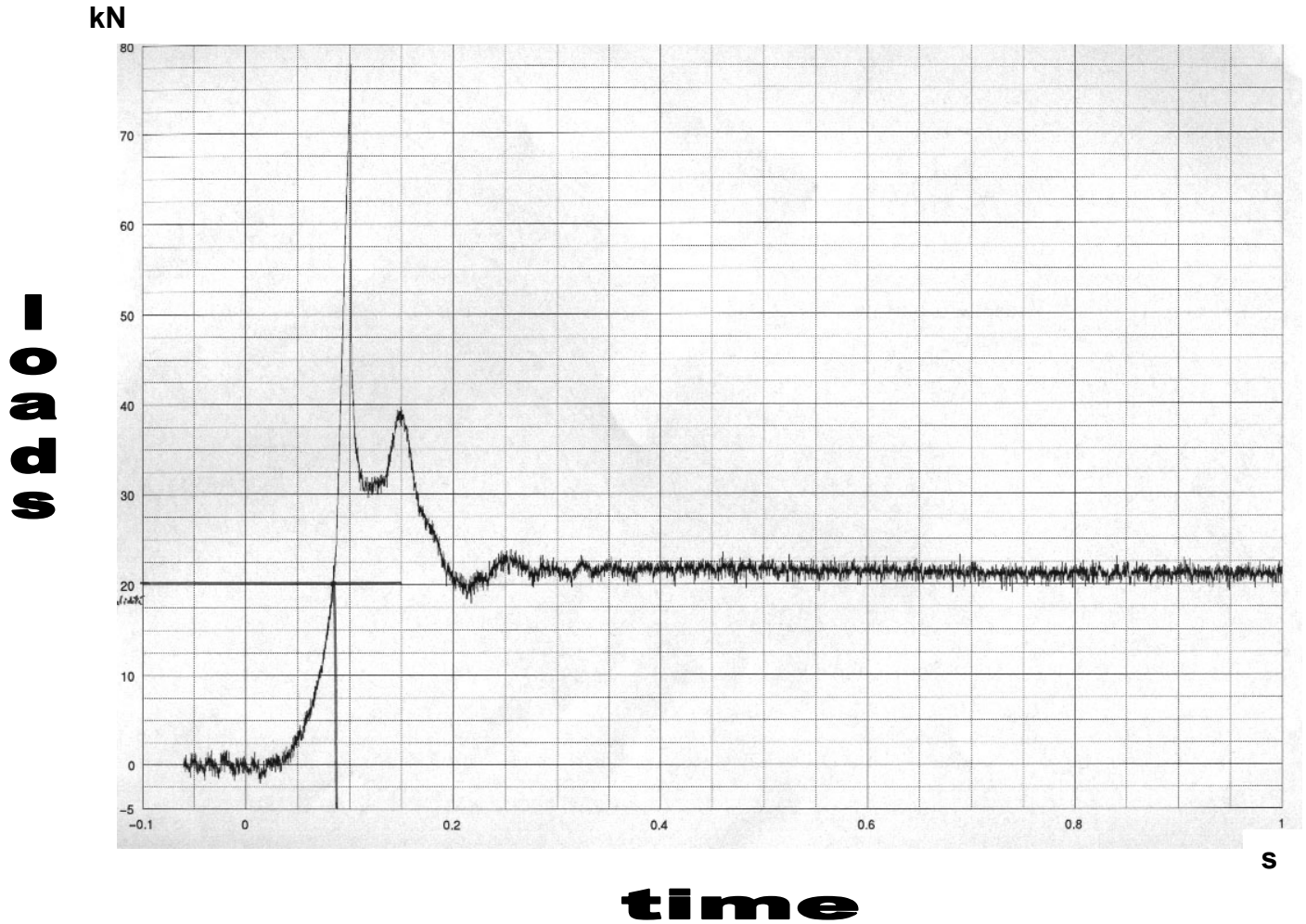
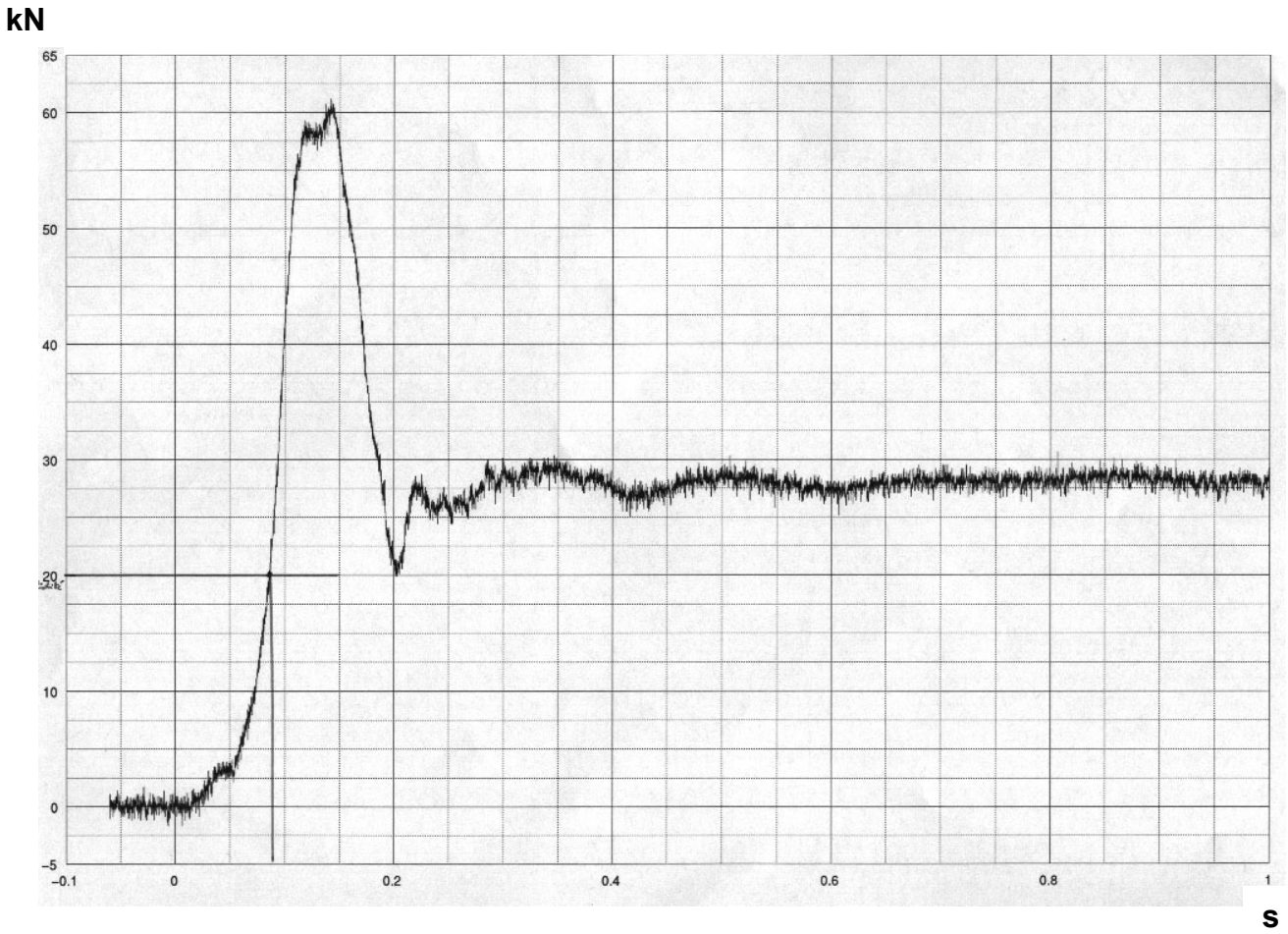
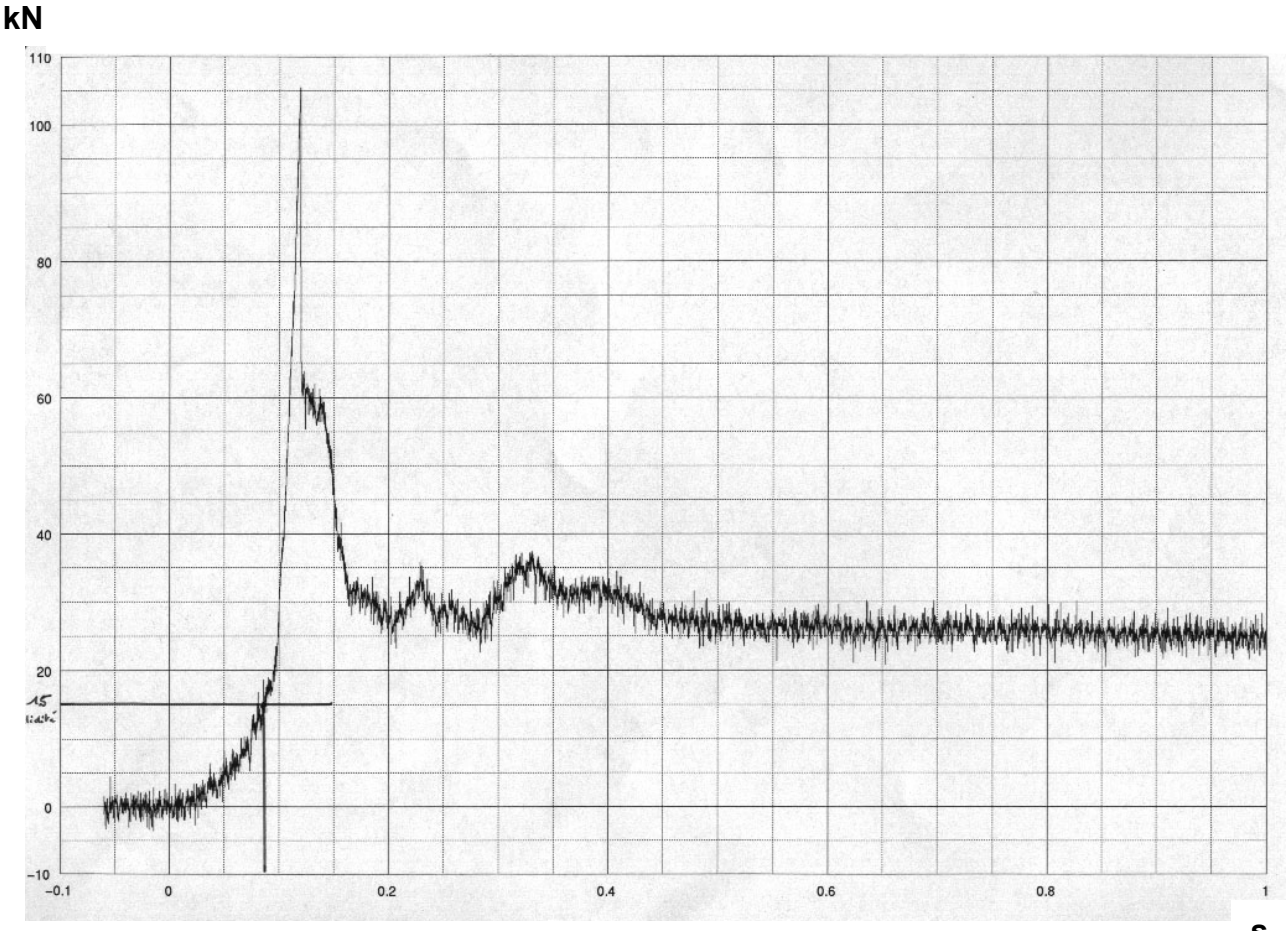
SICMA final 16g test - FZ on left seat leg



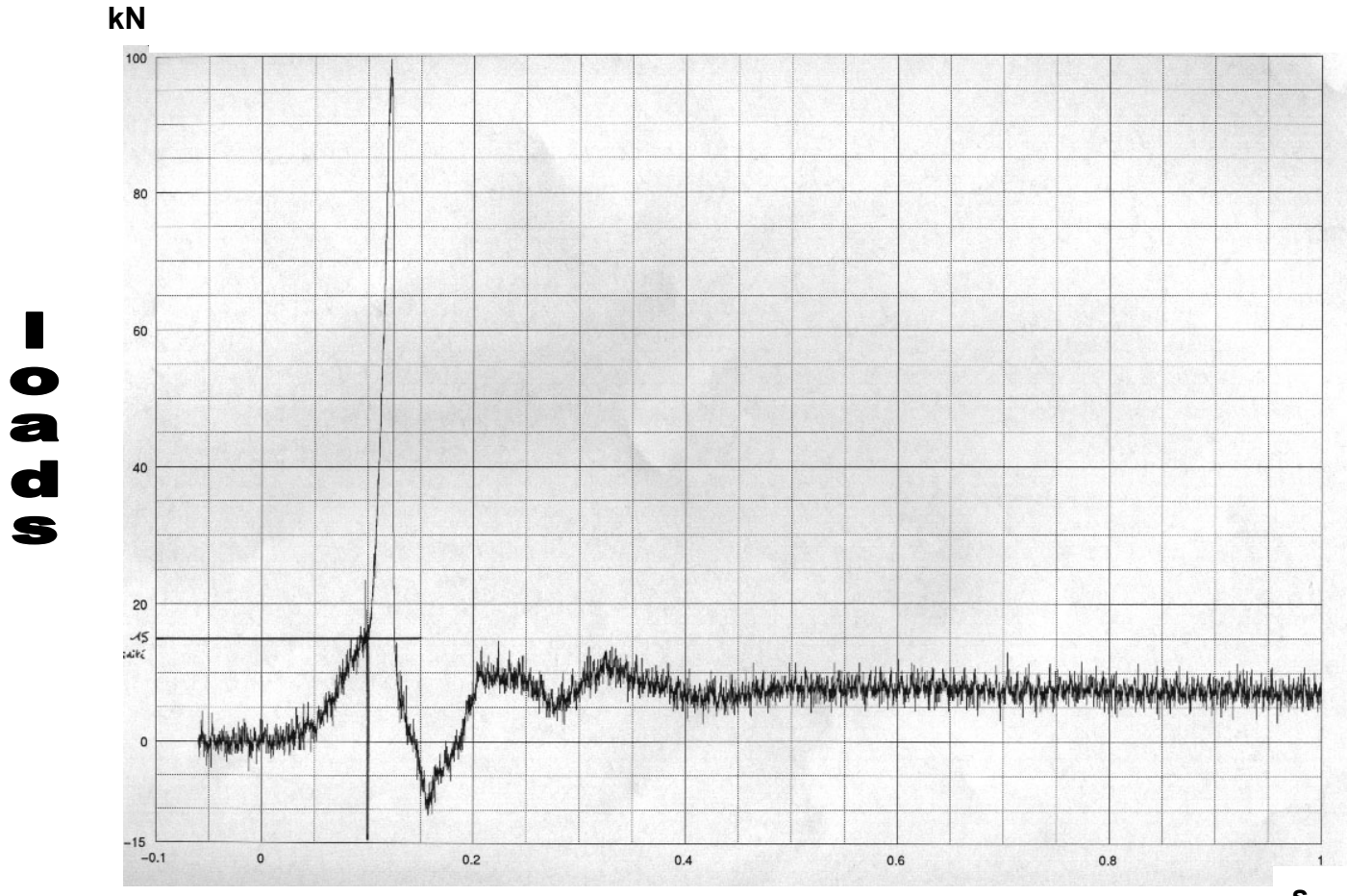
SICMA final 16g test - FZ on right seat leg



KOITO final 16g test - FZ on left seat leg



KOITO final 16g test - FZ on right seat leg



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Assessment of FX and FY under process

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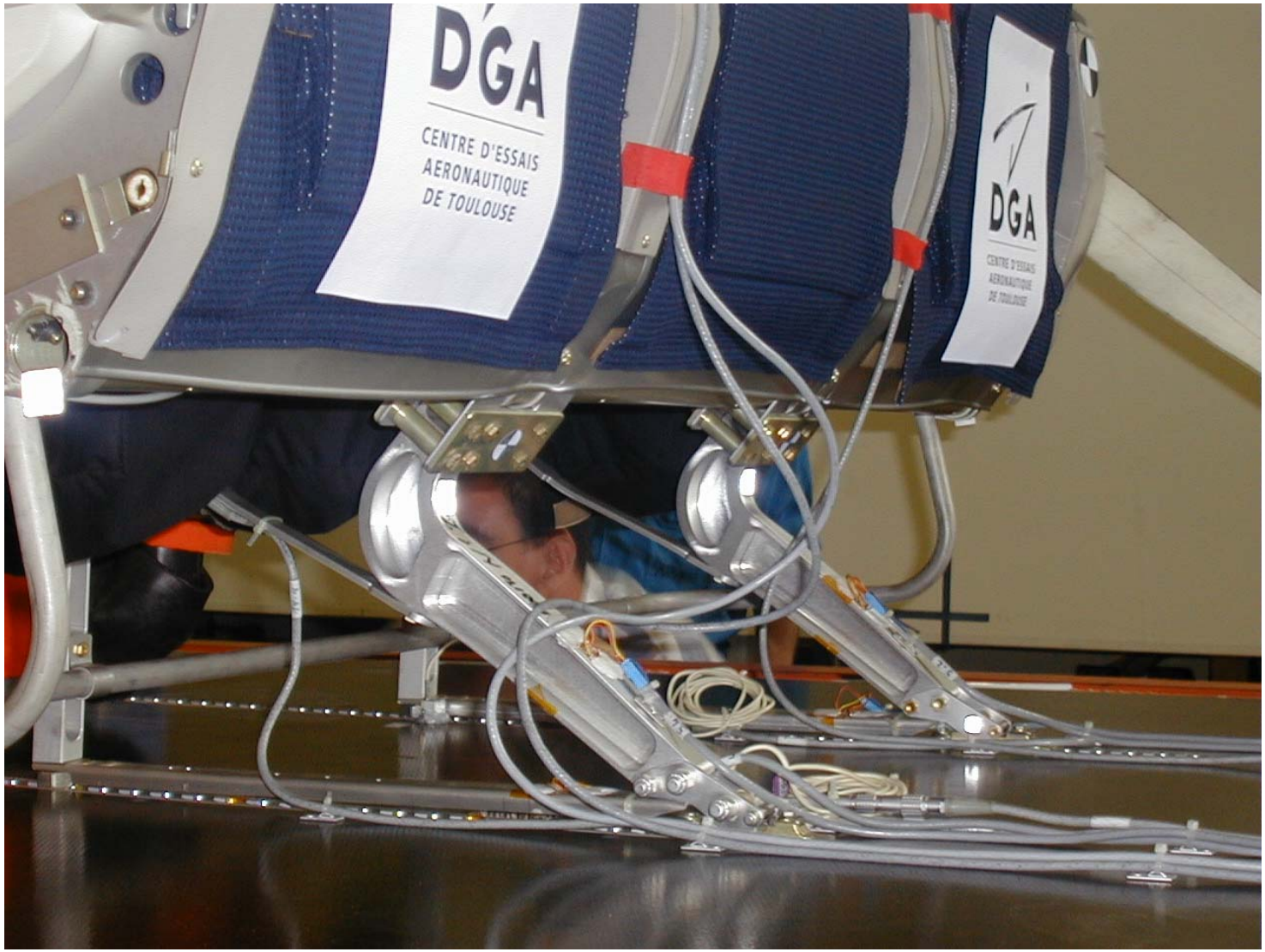
SICMA SEAT after the test

KOITO SEAT after the test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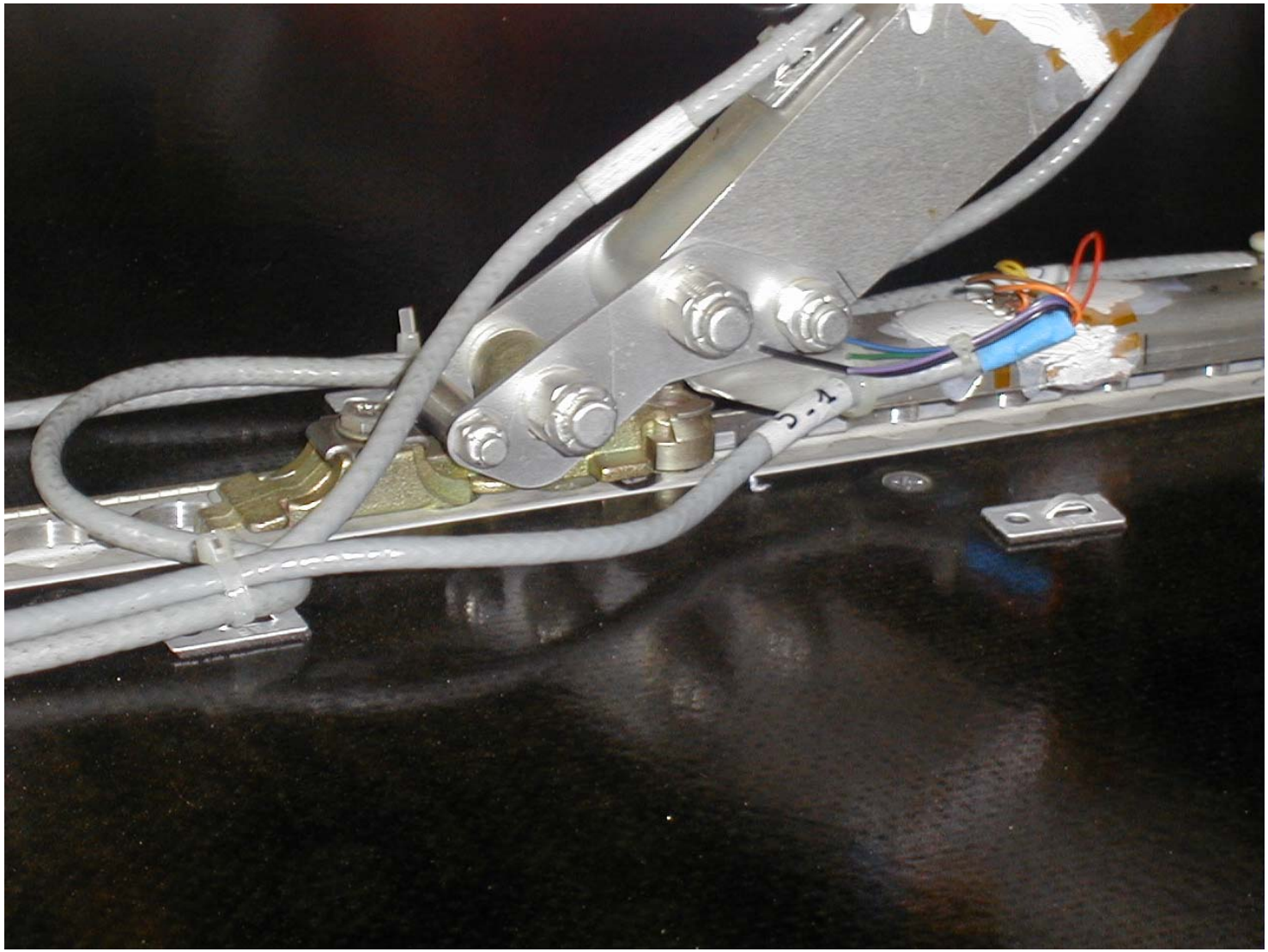
CENTRE D'ESSAIS
AERONAUTIQUE
DE TOULOUSE
DGA



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