CAPSA'04

Roads - the arteries of Africa

TYRE-PAVEMENT INTERFACE CONTACT STRESSES ON FLEXIBLE PAVEMENTS – QUO VADIS?

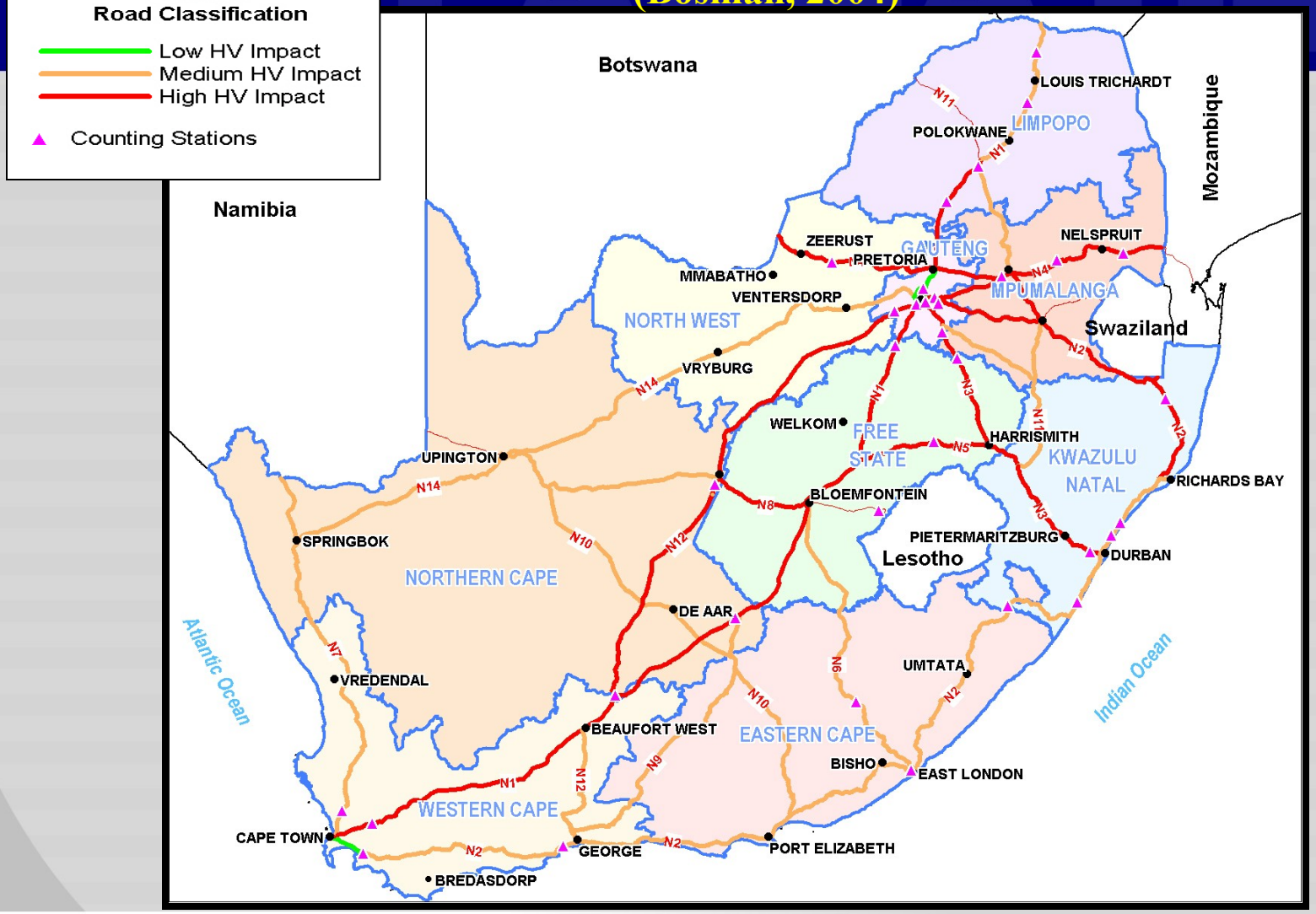
Morris De Beer, C. Fisher and L. Kannemeyer

CSIR TRANSPORTEK

CSIR TRANSPORTEK

HEAVY VEHICLE (HV) IMPACT IN SA ROADS (HV >3 500 kg)

(Bosman, 2004)



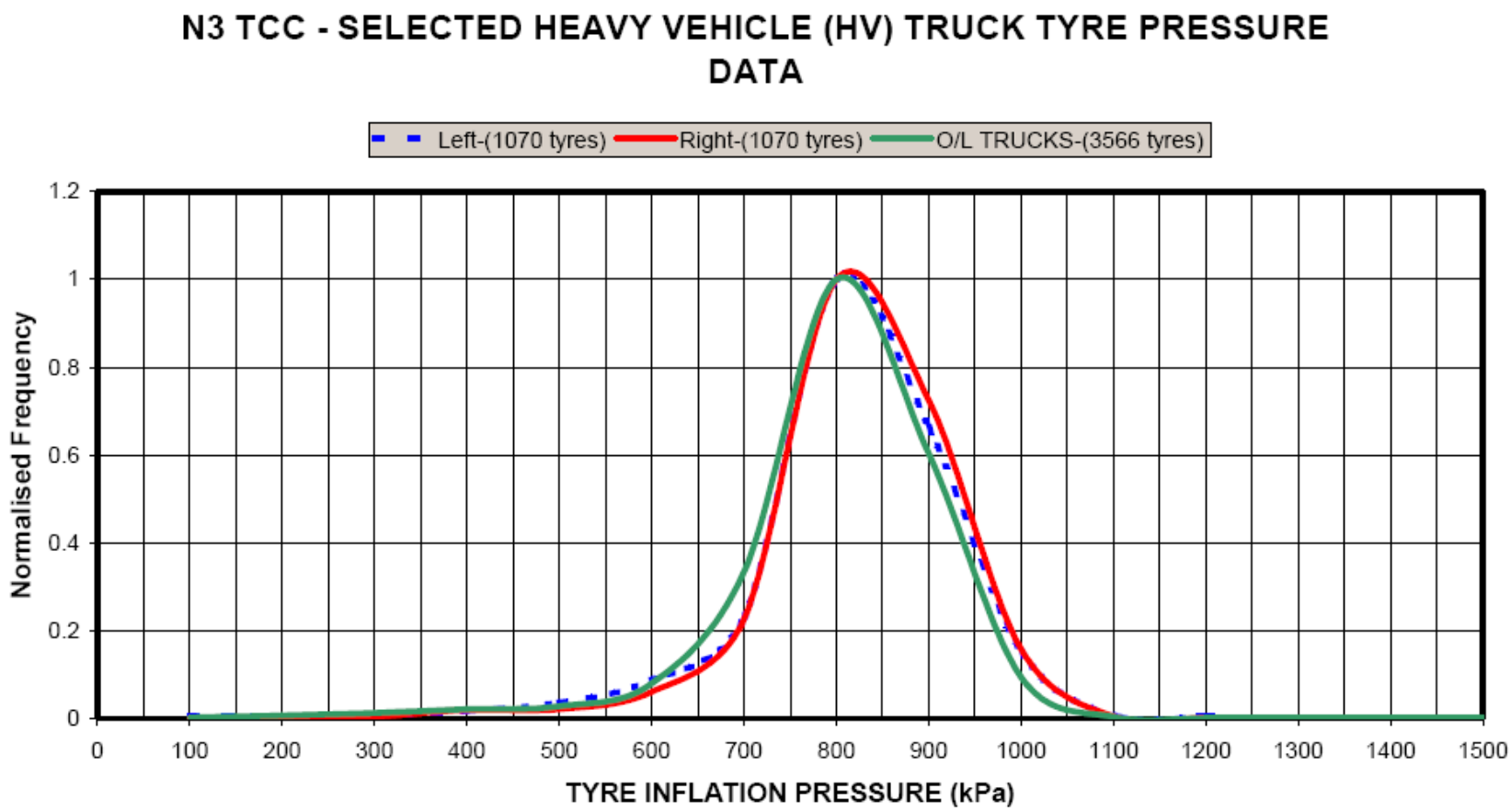
State of our Infrastructure..?

Roads - the arteries of Africa

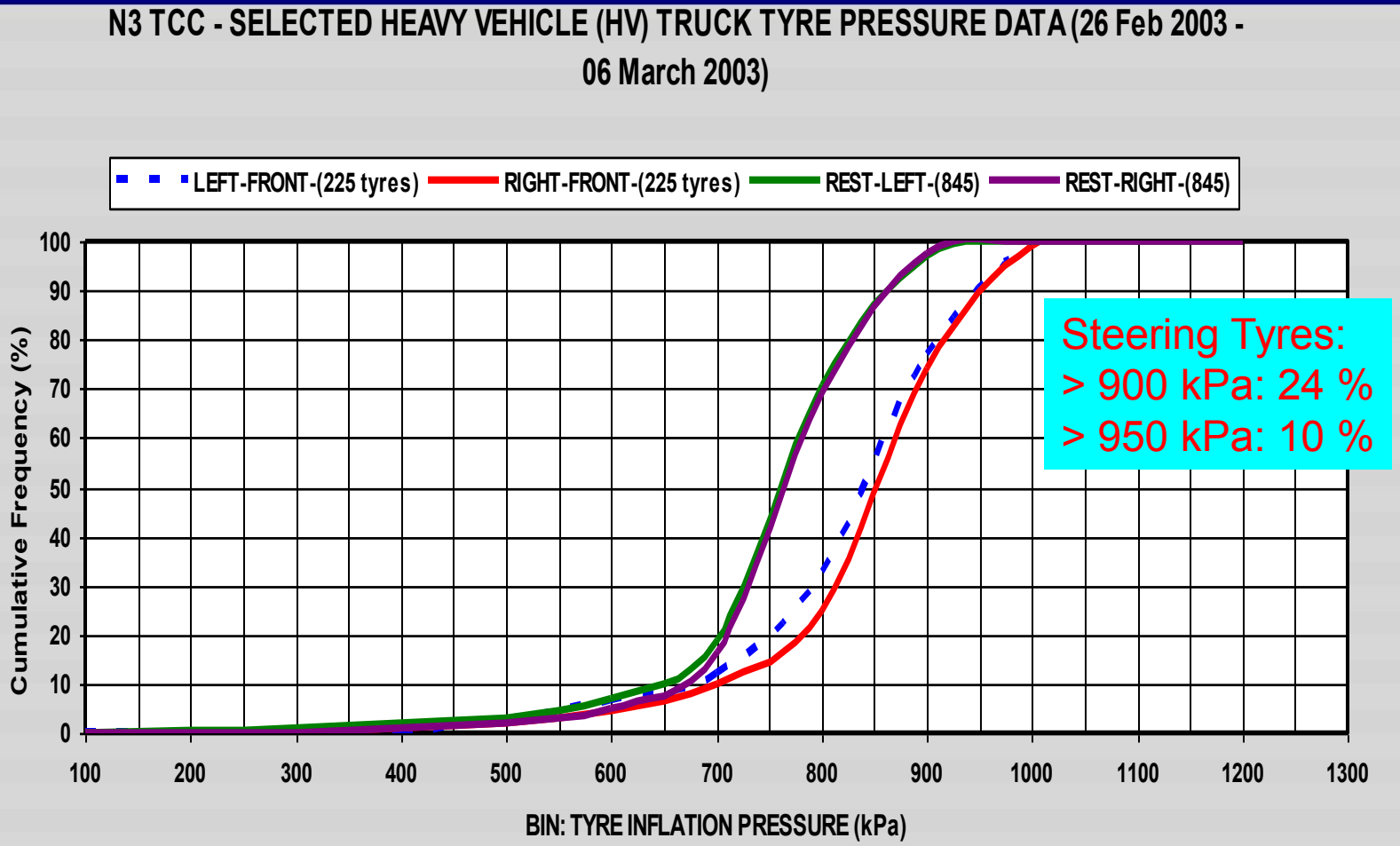
Design, Mix, Construction, Traffic loading ???

Longitudinal Flow of Asphalt

Inflation Pressure Distributions – N3 – TCC - 2003



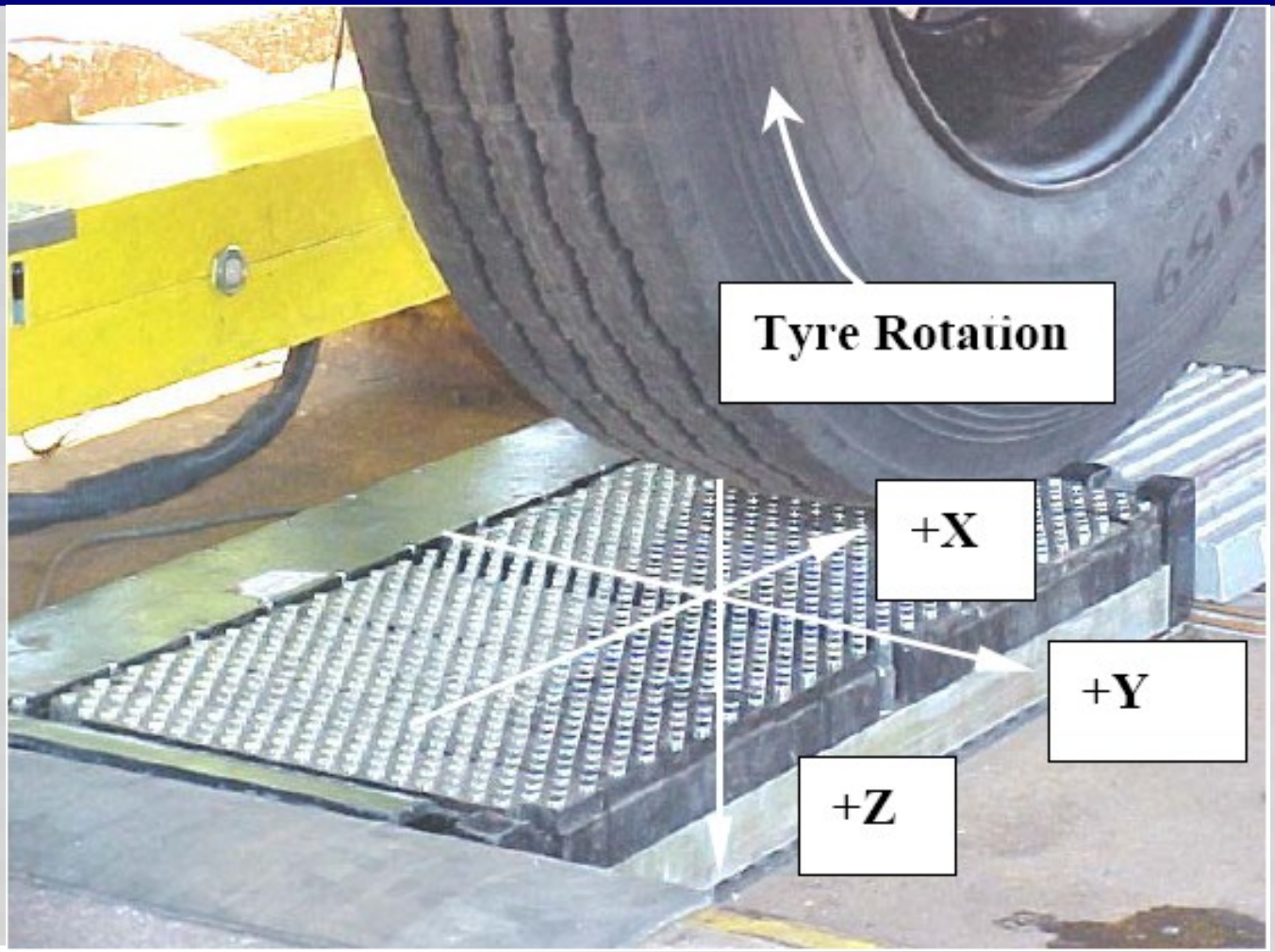
Inflation Pressure Distributions – N3 – TCC - 2003



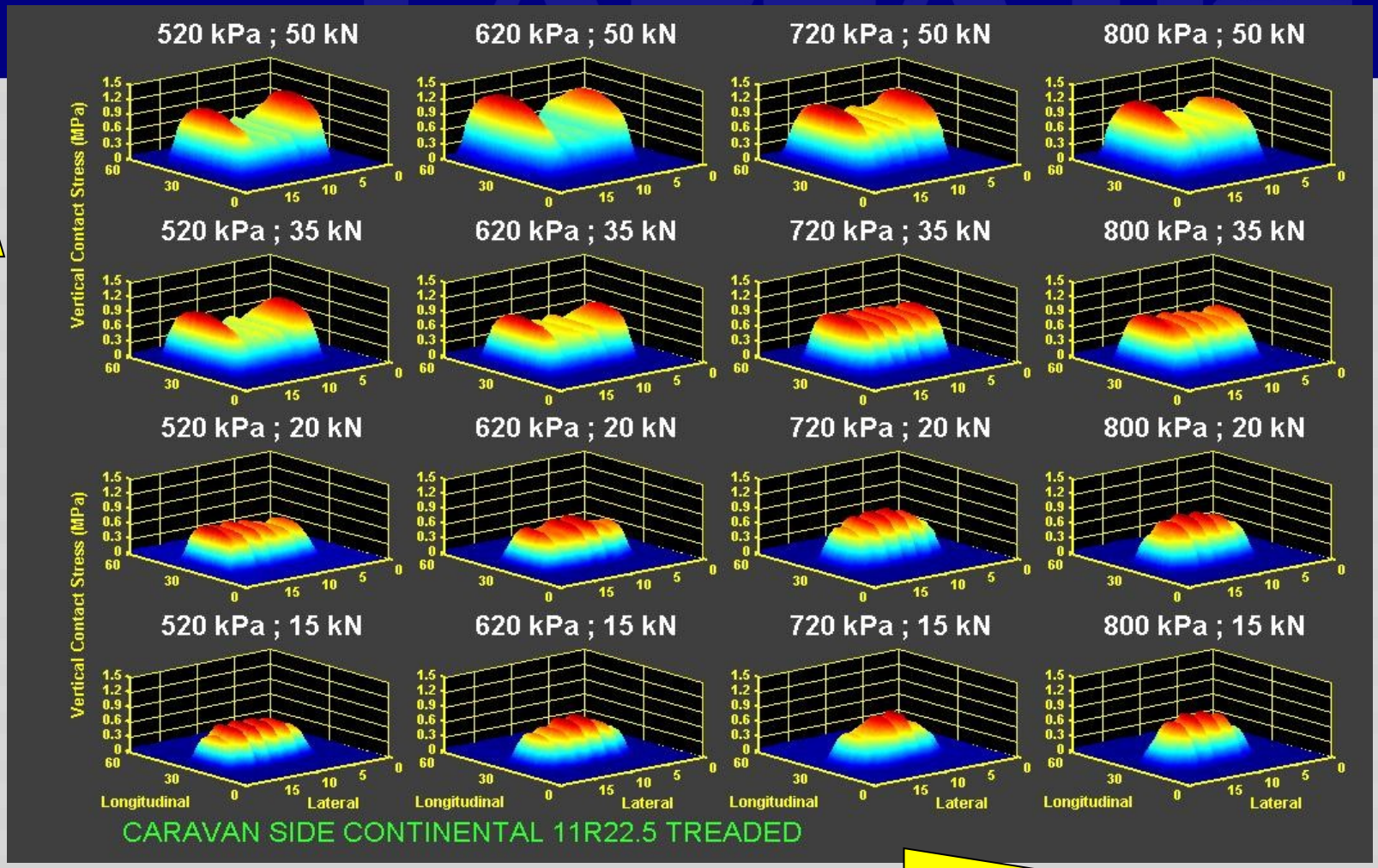
Stress – In – Motion (SIM) Technology – Single Pad – APT environment

Stress – In – Motion (SIM) Technology – Dual Pad – APT environment

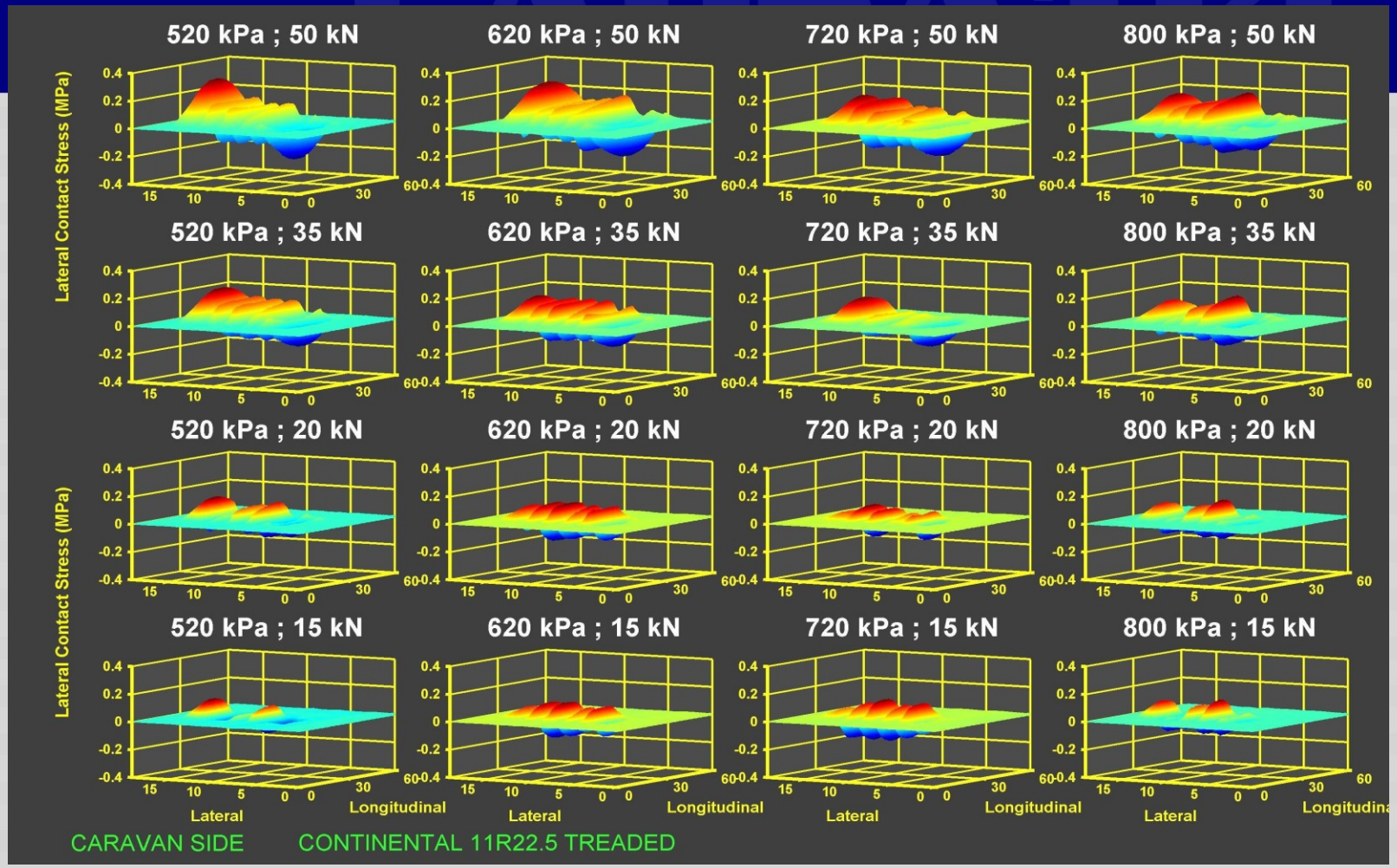
Stress – In – Motion (SIM) Technology – SAE Sign Convention



VERTICAL CONTACT STRESS: (TYRE FINGER PRINTING)



TYRE FINGER PRINTING - LATERAL STRESS

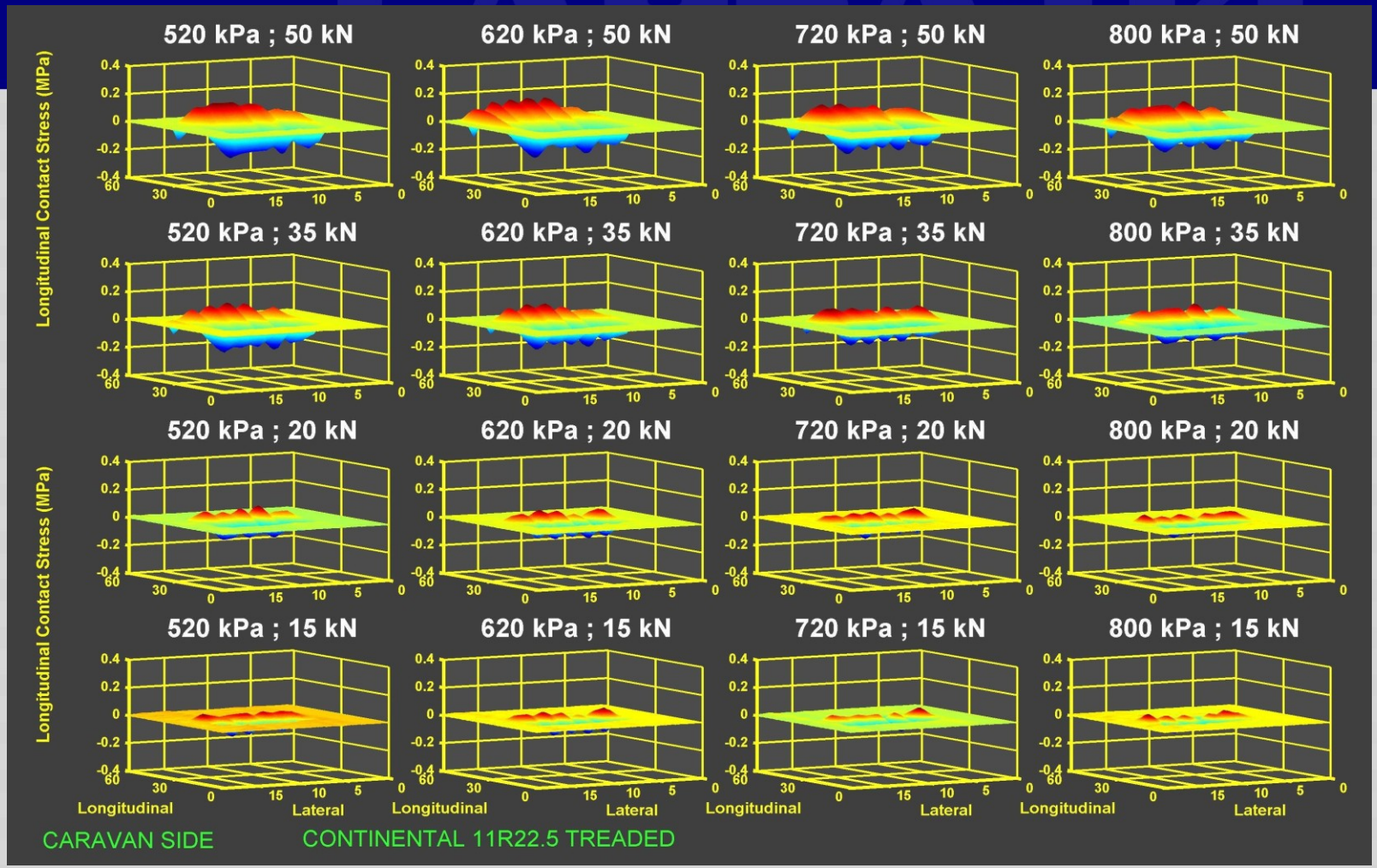


LOAD

INFLATION PRESSURE

Roads - the arteries of Africa

TYRE FINGER PRINTING - LONGITUDINAL STRESS



LOAD

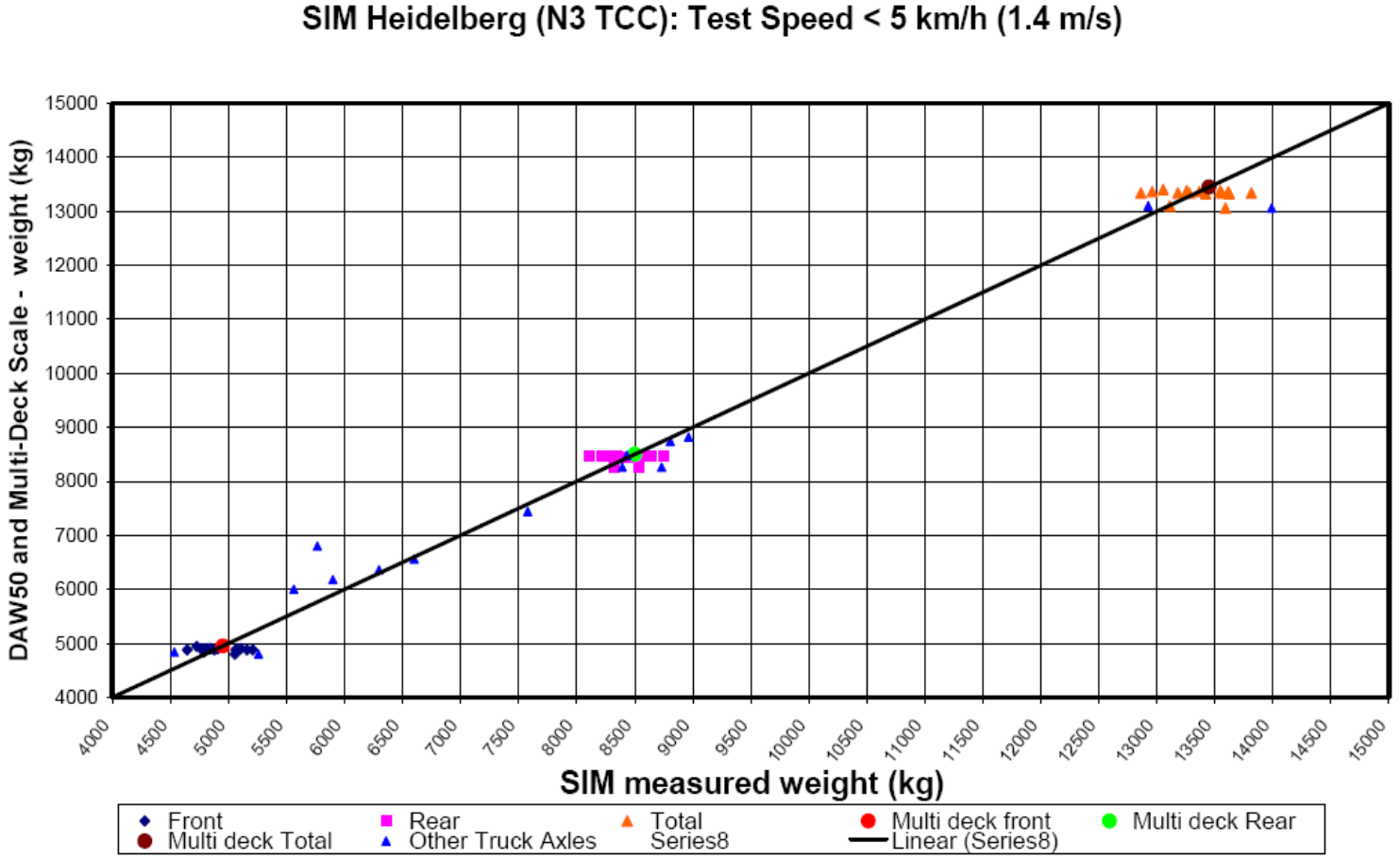
INFLATION PRESSURE

Roads - the arteries of Africa

Stress – In – Motion (SIM) Technology – 4 PAD –N3 - TCC

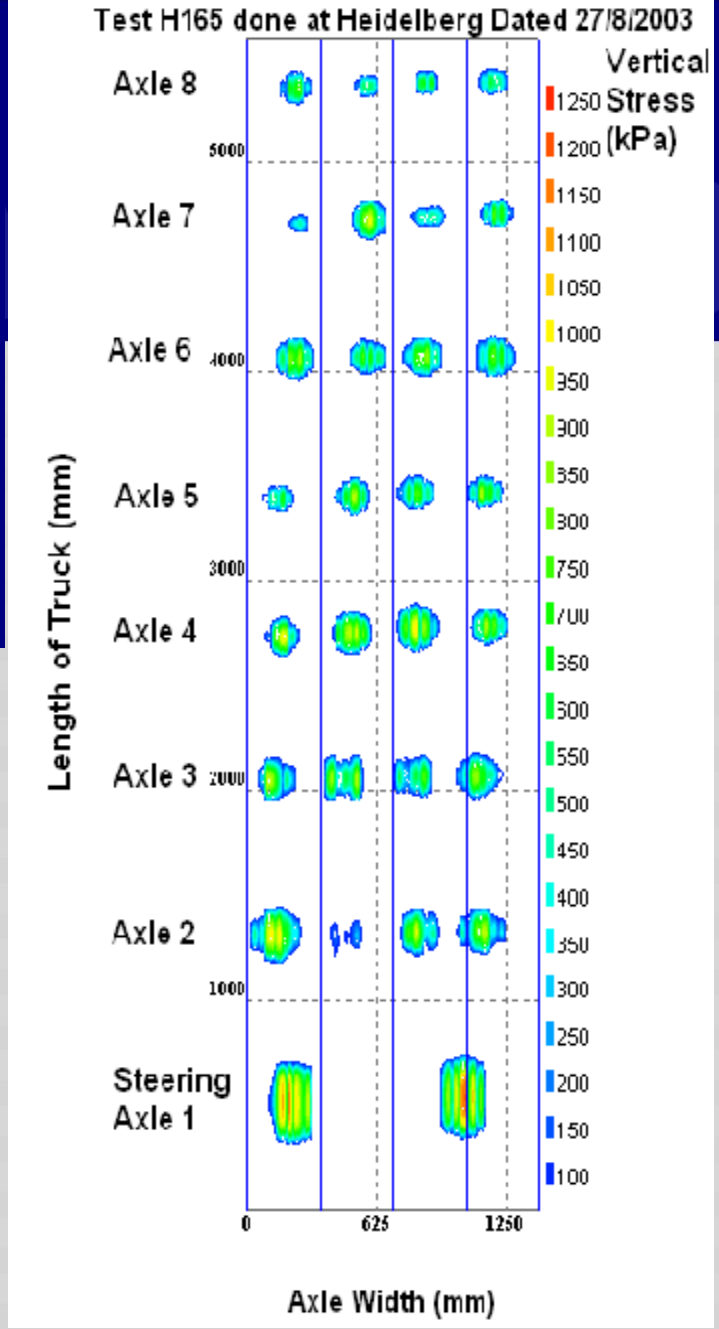
SIM vs DAW50 and Multi-Deck

N3 - TCC



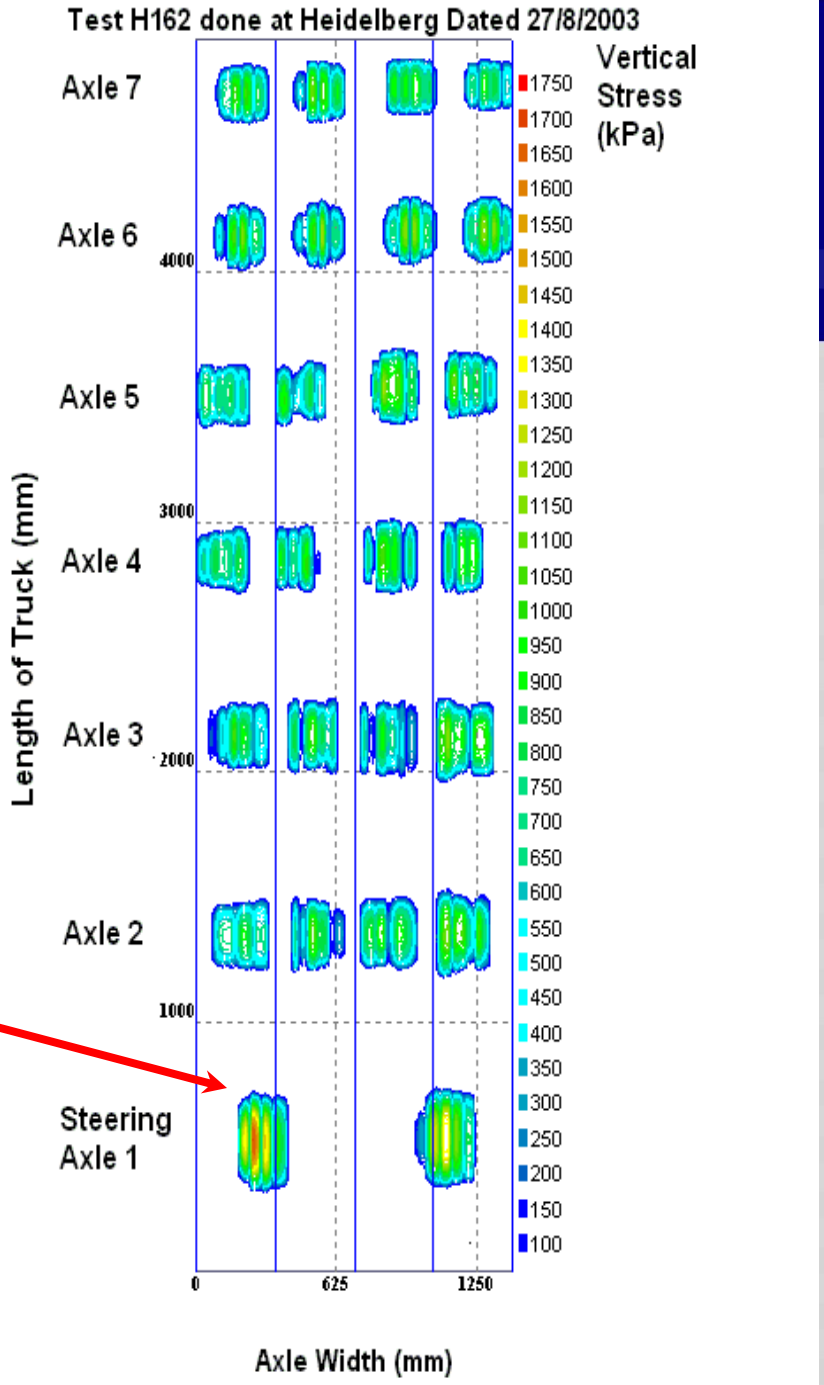
Example: 7 Axle EMPTY Truck (1:2:2:3)

Note Variation in Vertical Contact Stresses on all 30 tyres



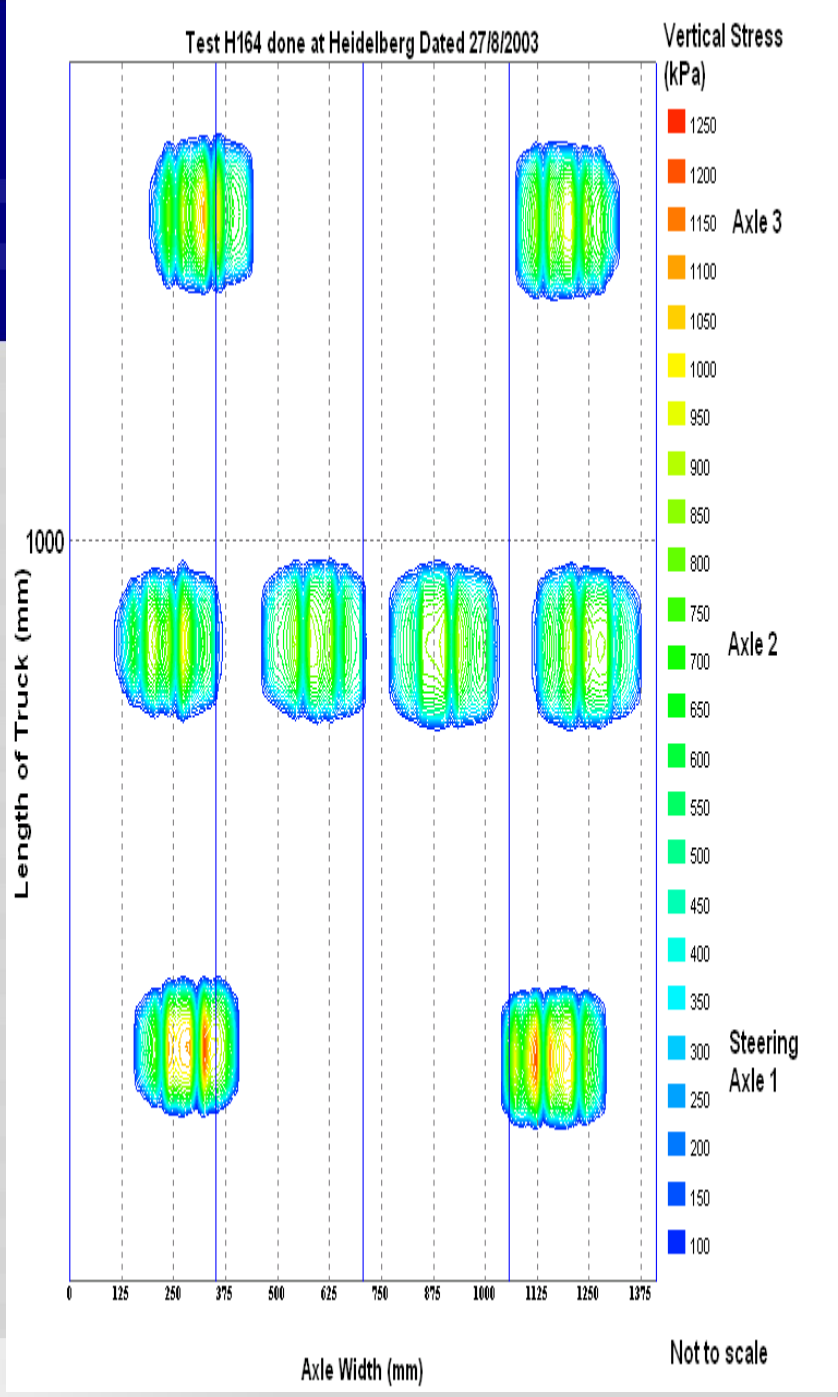
Example: 7 Axle Truck (1:2:2:2) fully loaded with cement

Note Contact Stresses on Steering Tyres



Example: Passenger Bus (1:1:1)

(FIGURE NOT TO SCALE)



Example: 7 Axle Truck (1:2:2:2)

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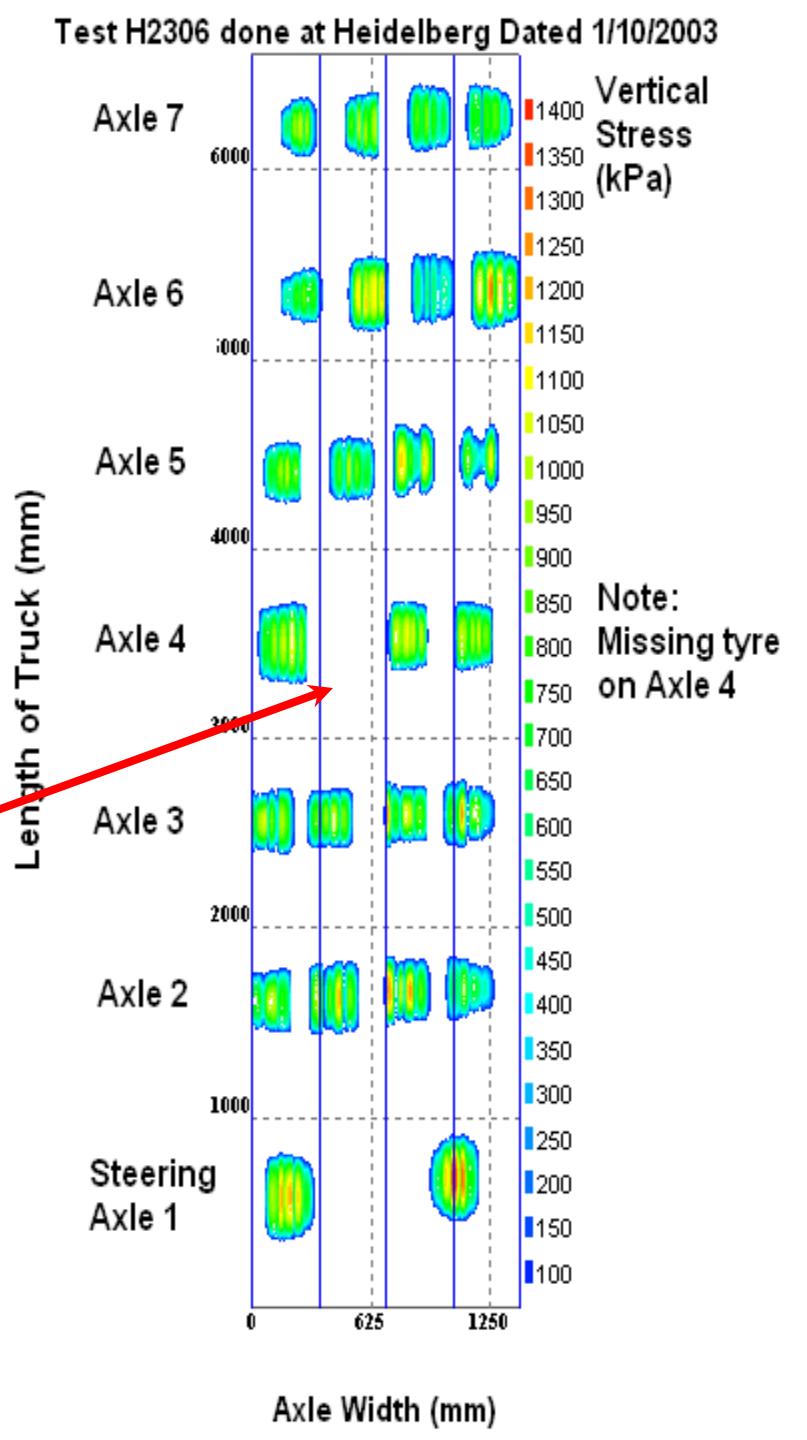
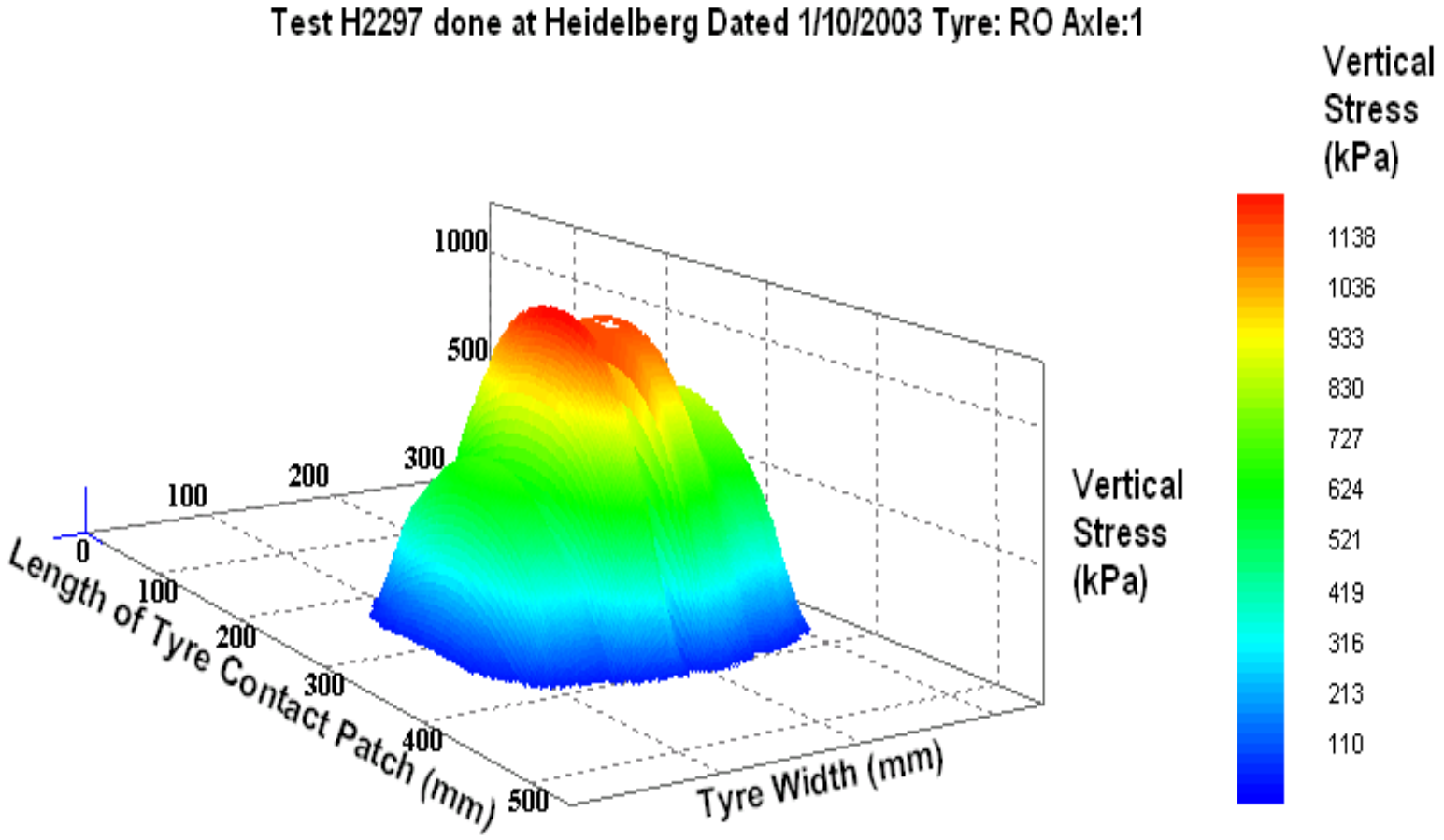
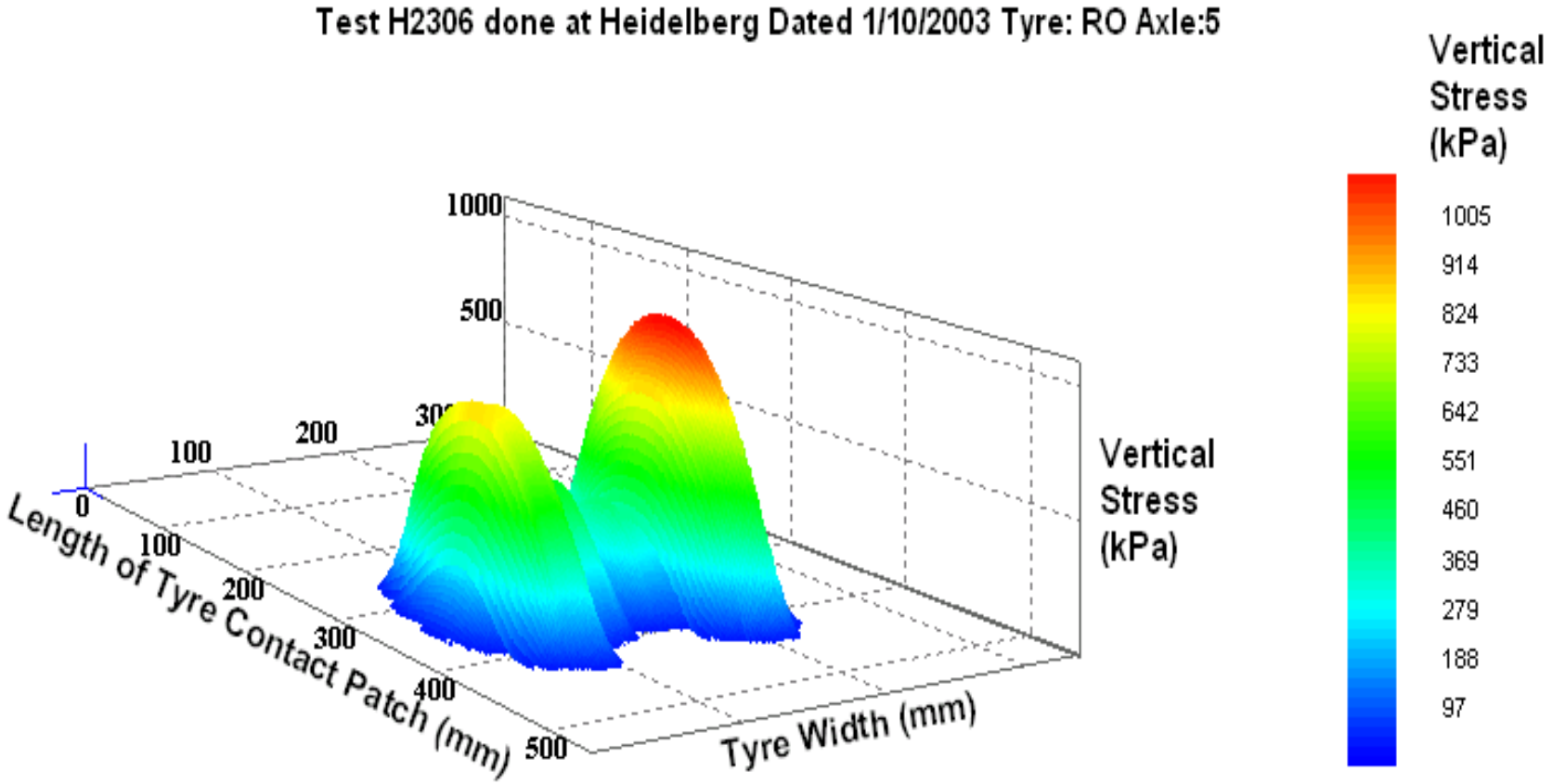
Note missing tyre

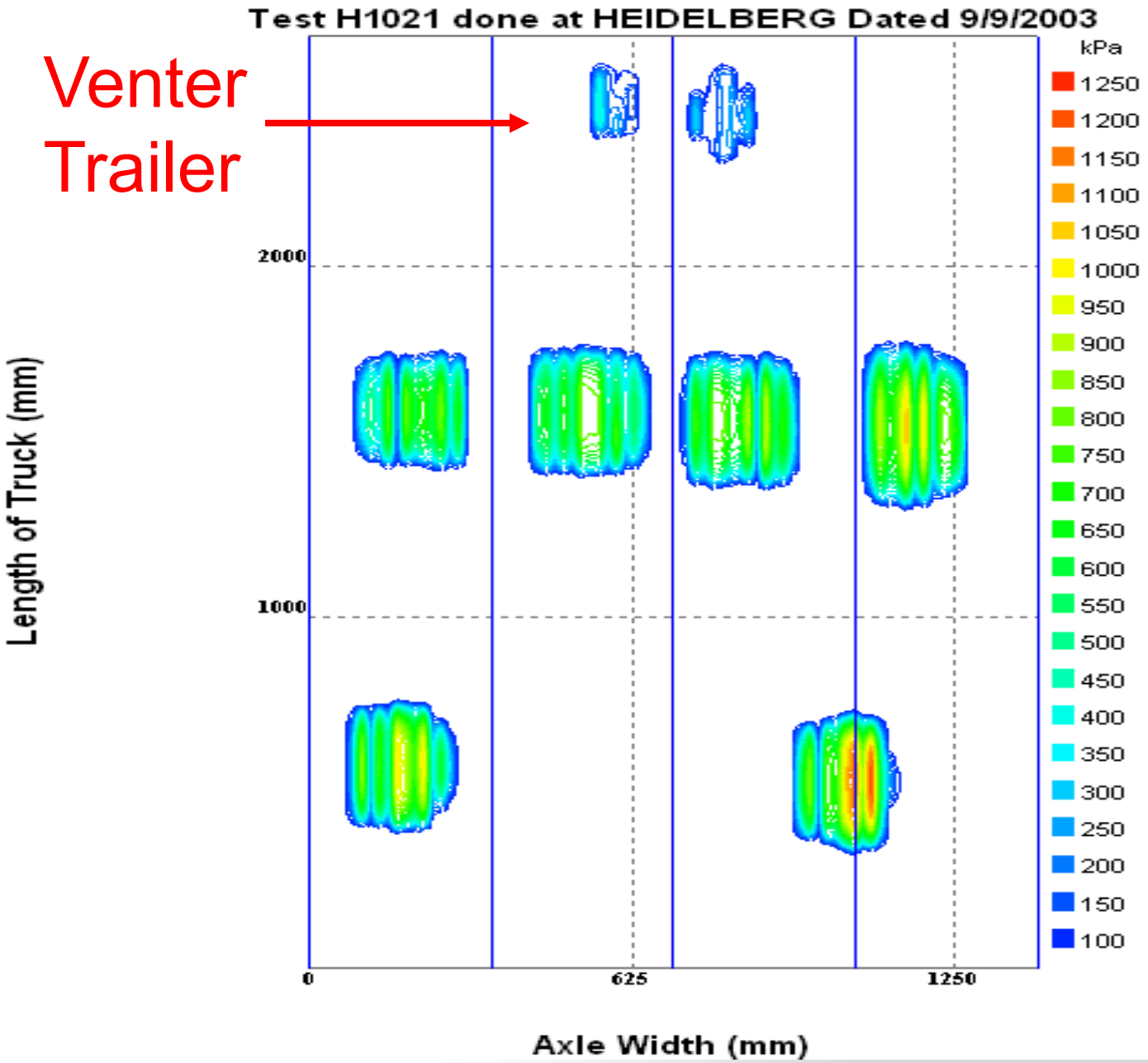


Vertical Contact Stress – "n" Shape



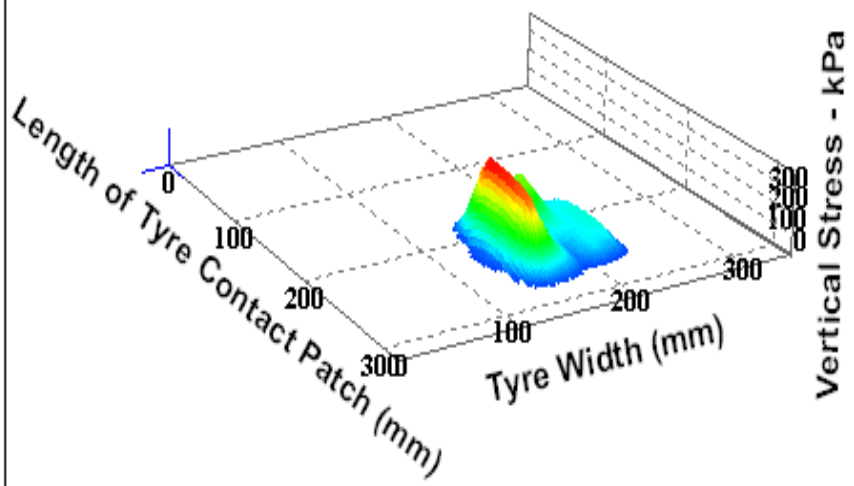
Vertical Contact Stress – "m" Shape

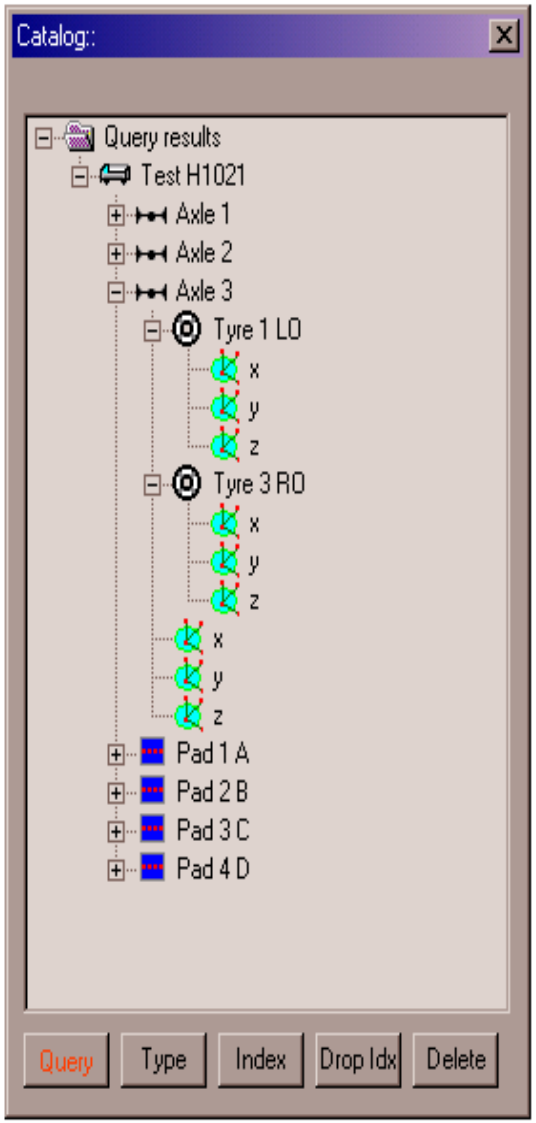


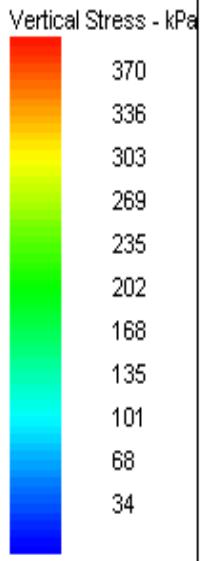

Test H1021 done at HEIDELBERG Dated 9/9/2003
Venter
Trailer
kPa
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
2000
1000
0
625
1250
Length of Truck (mm)
Axle Width (mm)

PERSPECTIVE VIEW Z-Direction

Test H1021 done at HEIDELBERG Dated 9/9/2003 Tyre: LO Axle:3

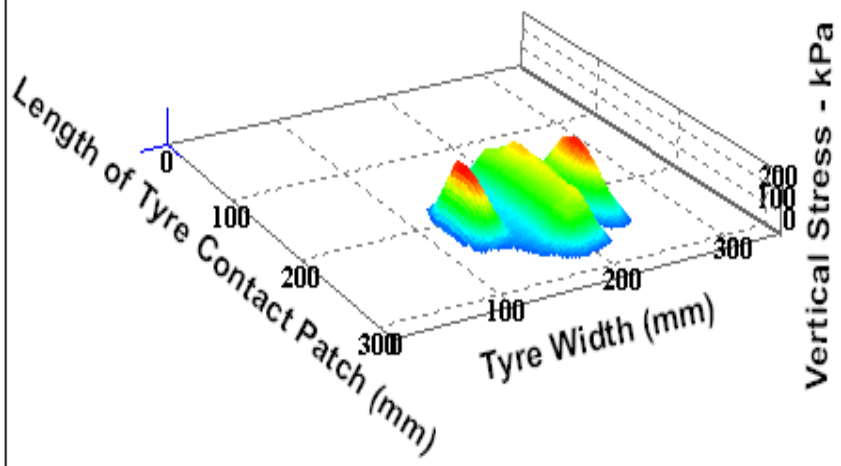


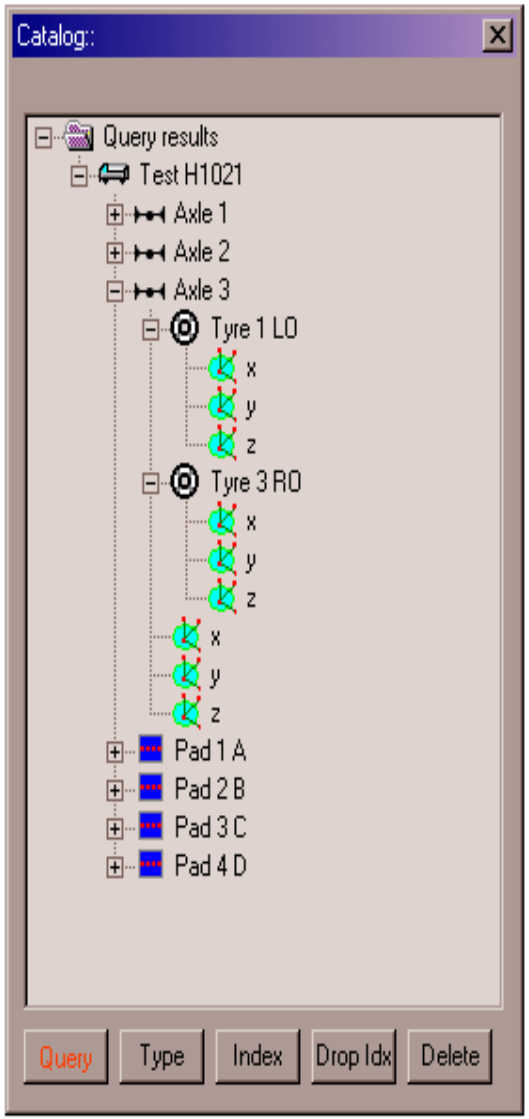


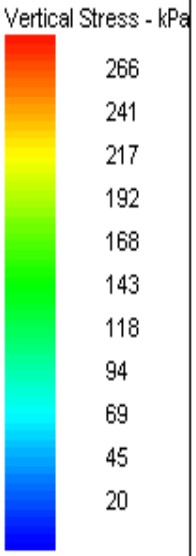


PERSPECTIVE VIEW Z-Direction

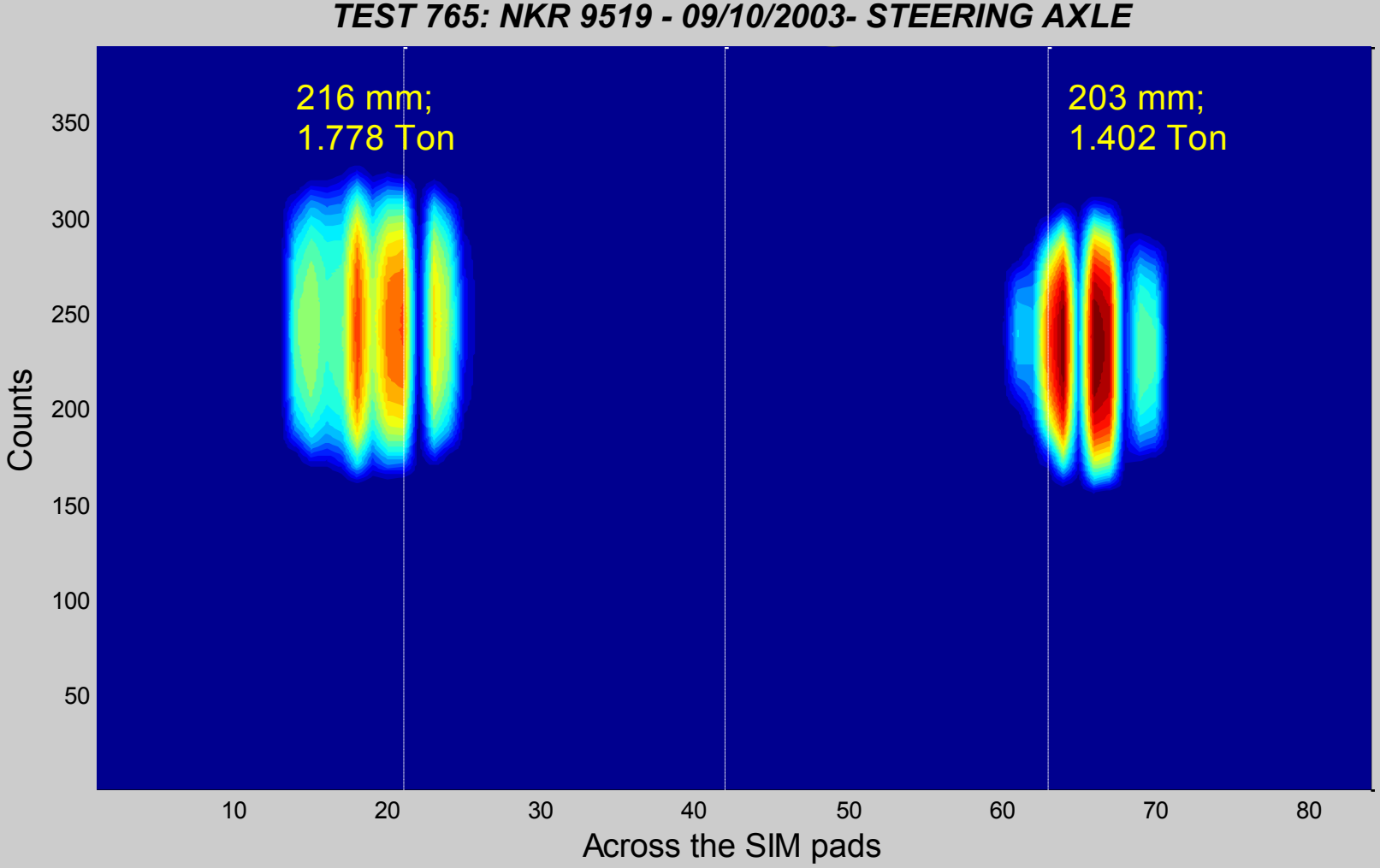
Test H1021 done at HEIDELBERG Dated 9/9/2003 Tyre: RO Axle:3



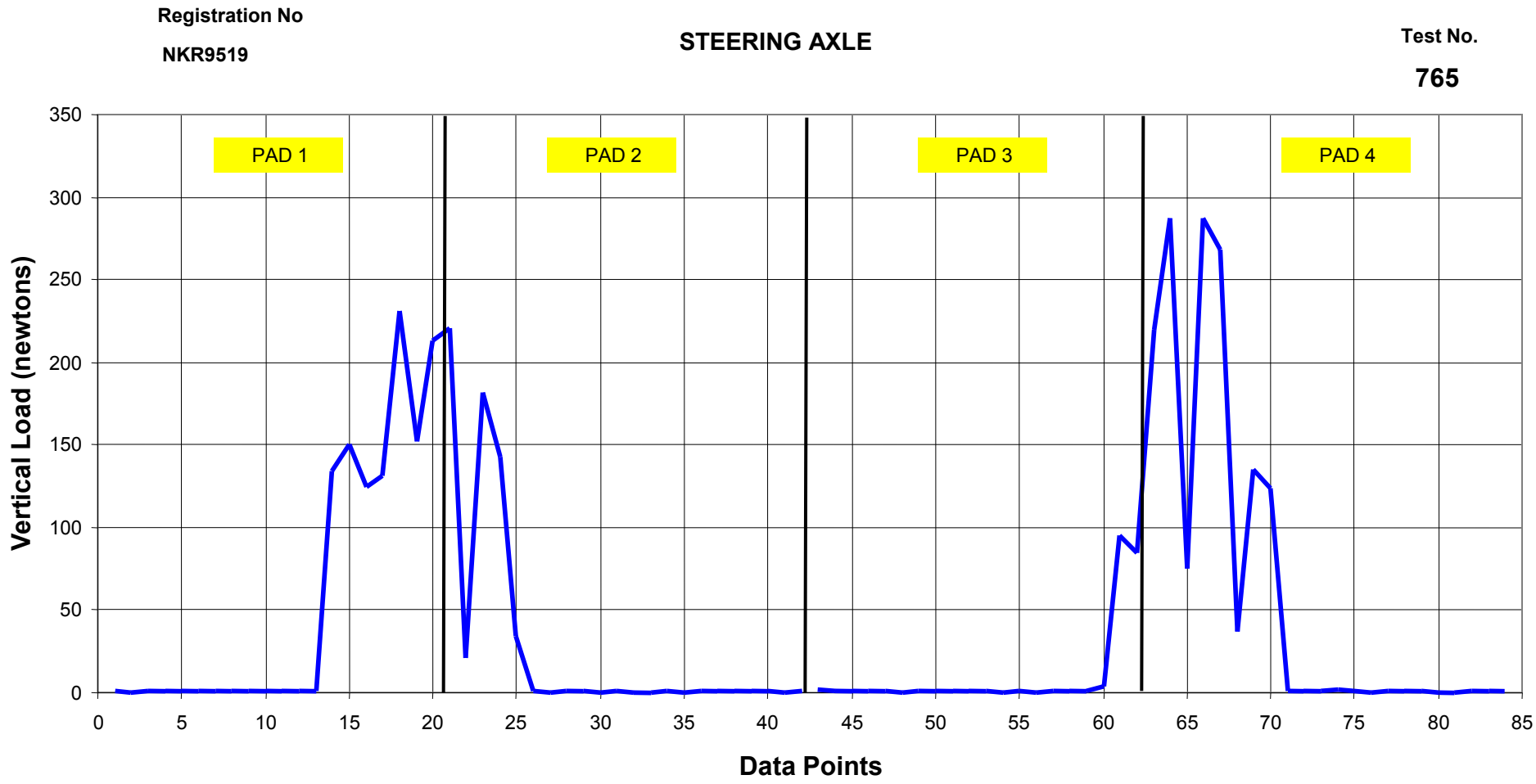




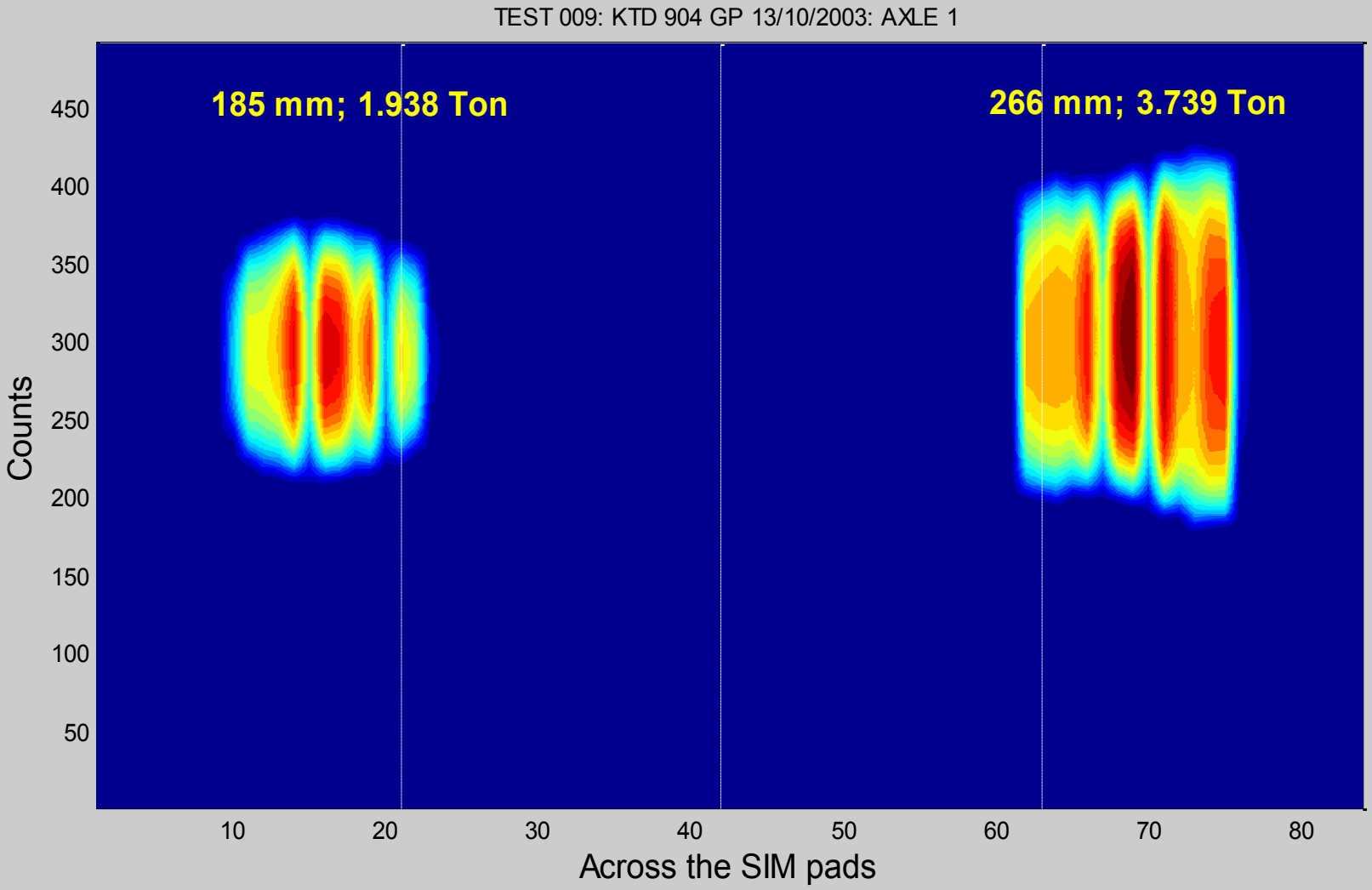
STEERING AXLE – EQUAL LOADING



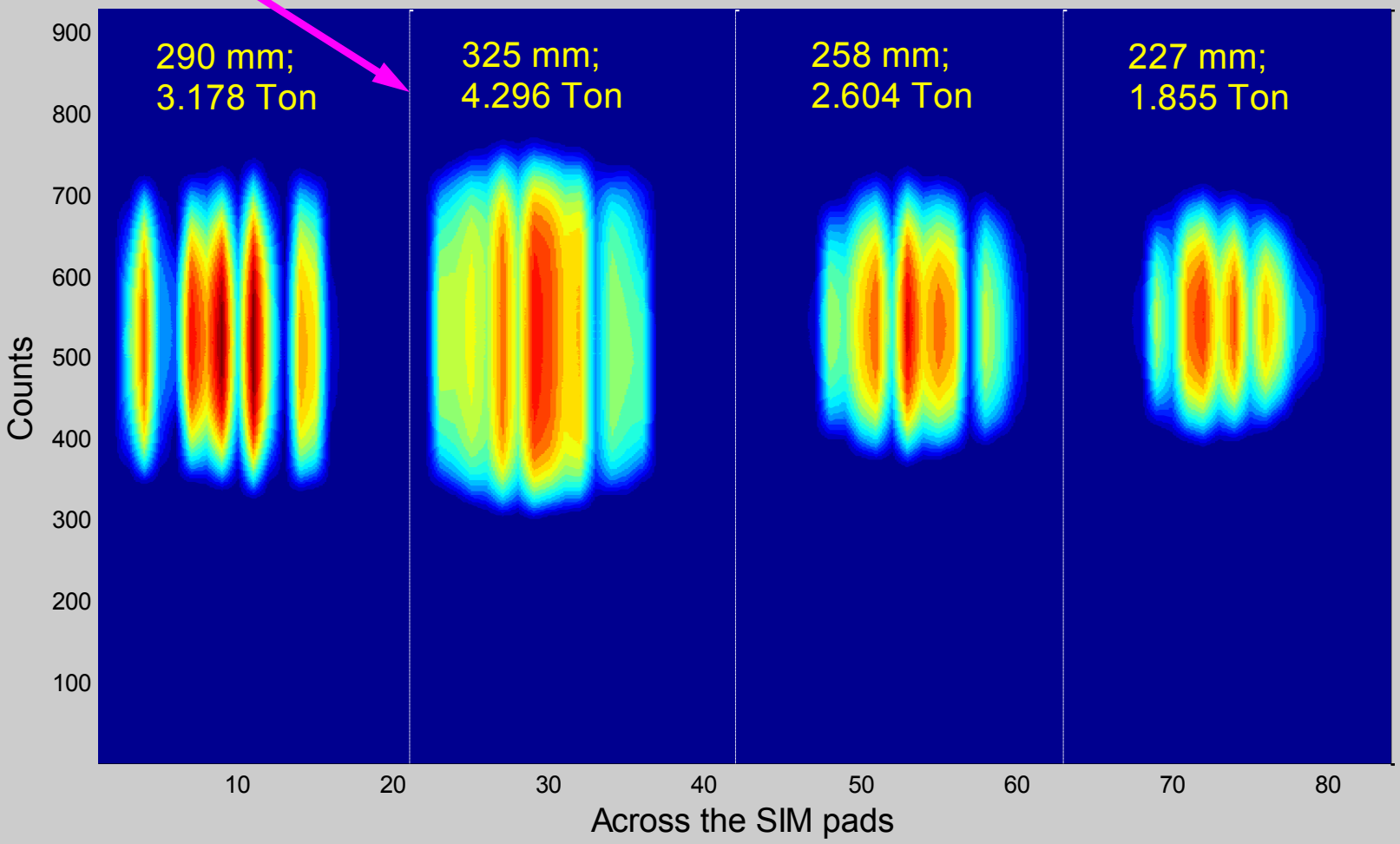
STEERING AXLE – UNEQUAL LOADING



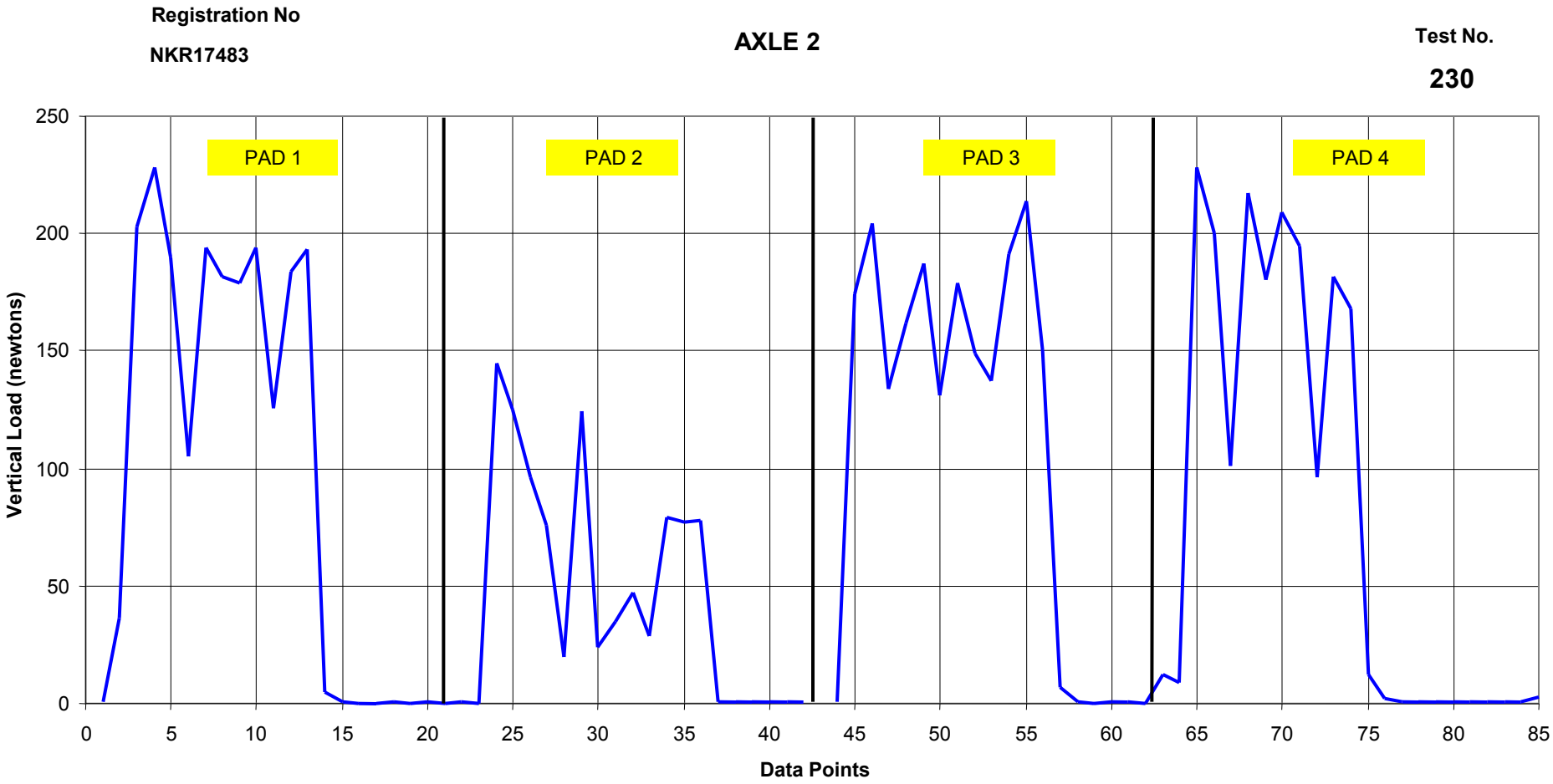
STEERING AXLE – UNEQUAL LOADING



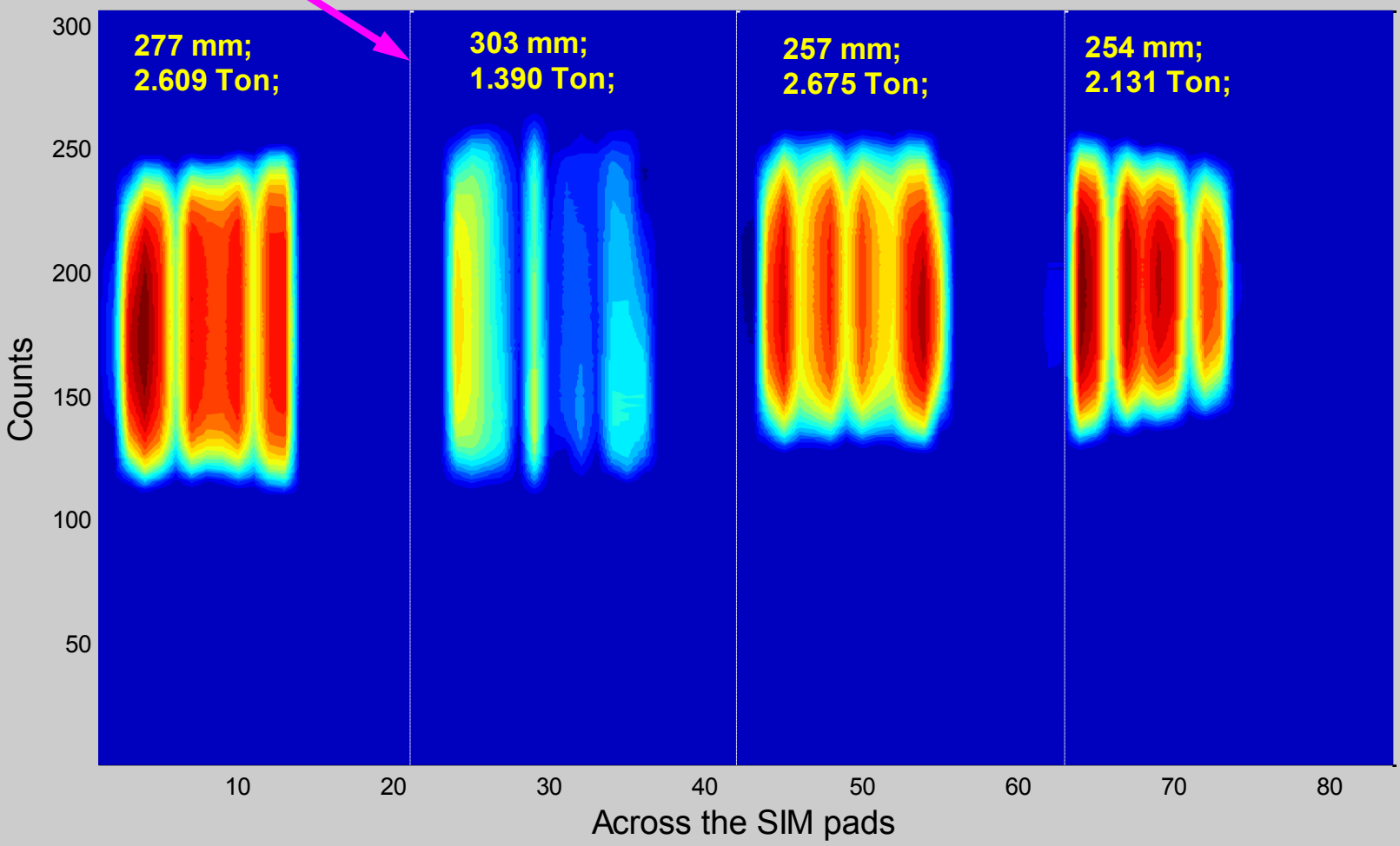
REAR AXLE – UNEQUAL LOADING



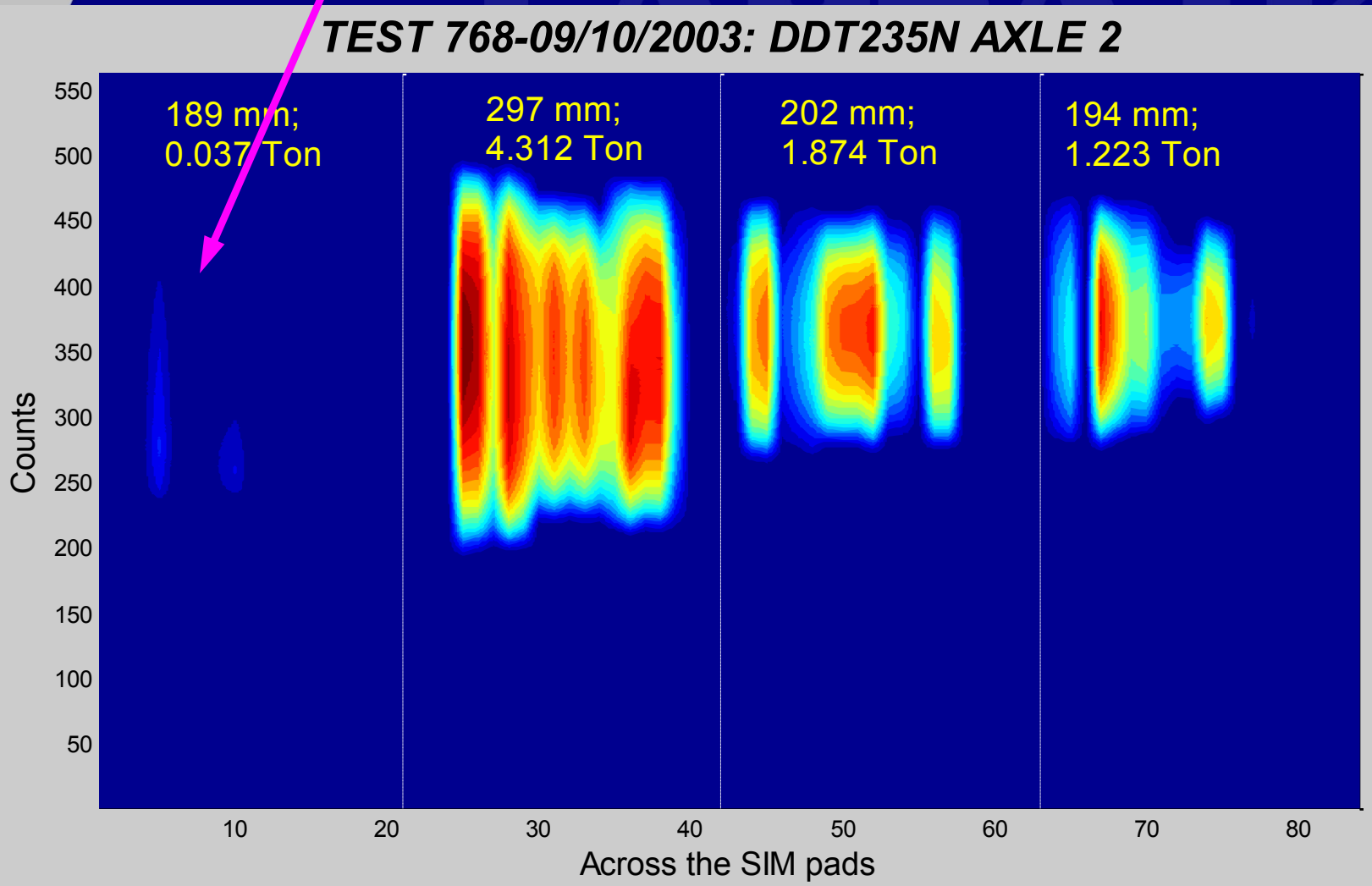
REAR AXLE – UNEQUAL LOADING



REAR AXLE – UNEQUAL LOADING

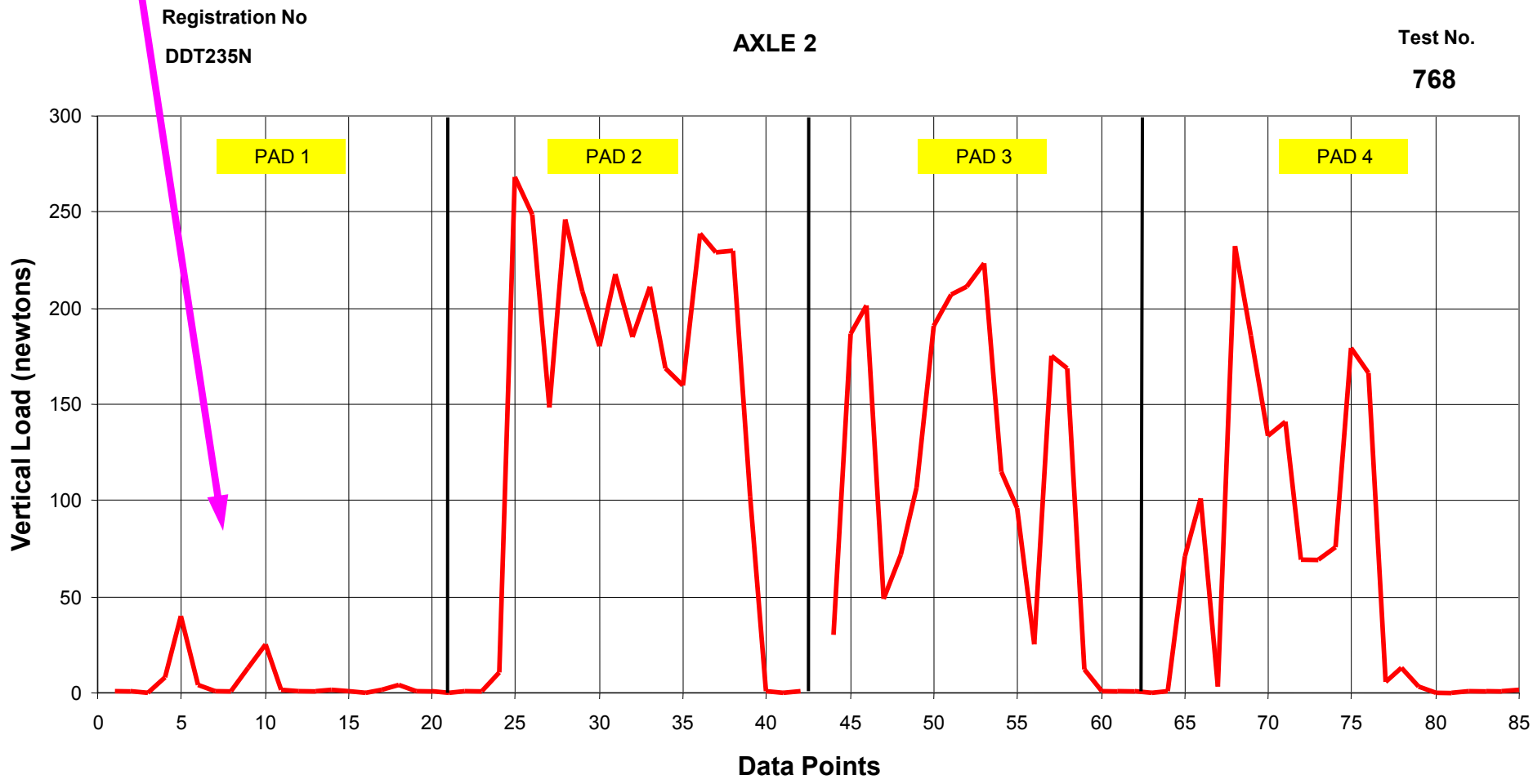


TYRE barely in contact with surface

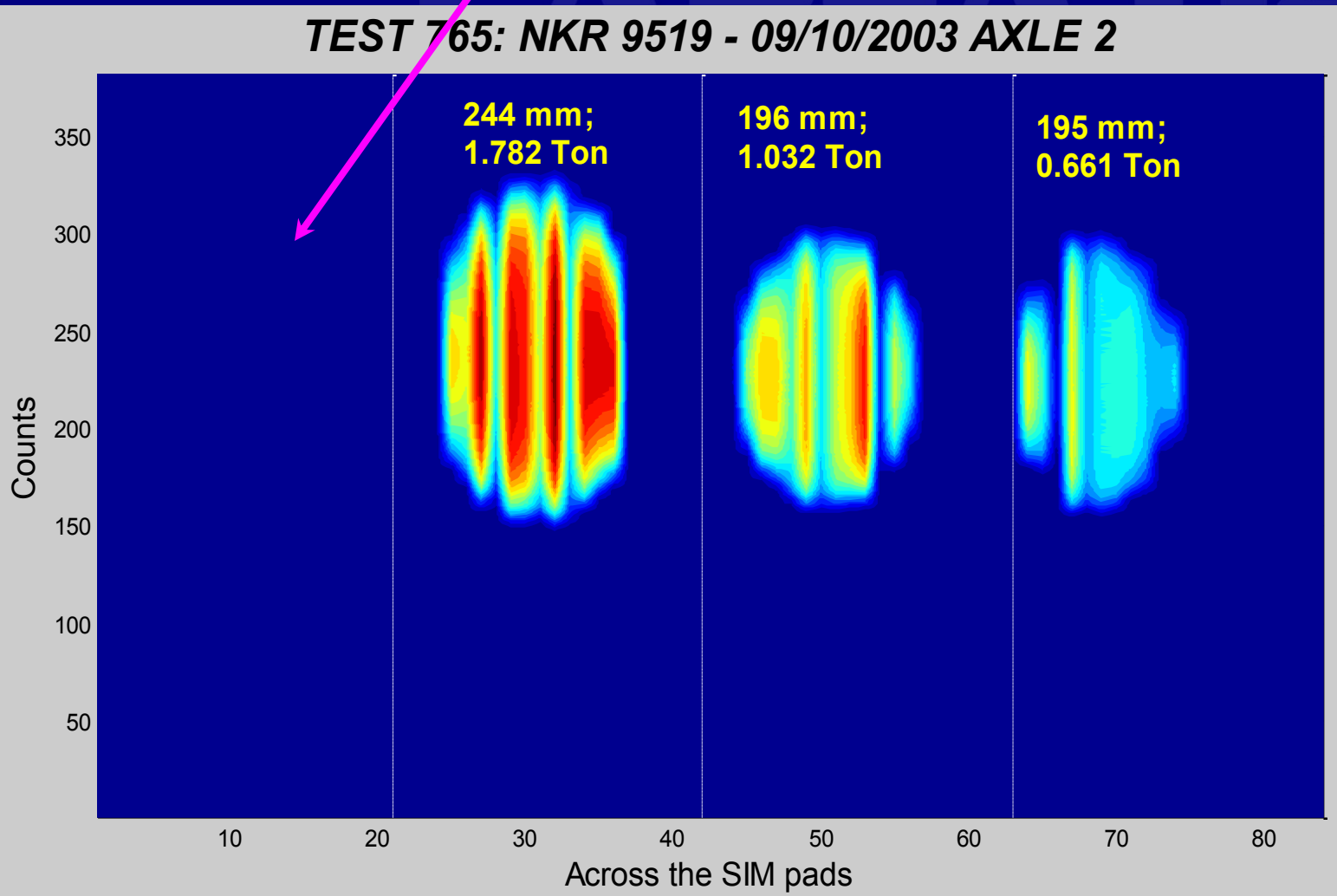


MAXIMUM VERTICAL STRESS

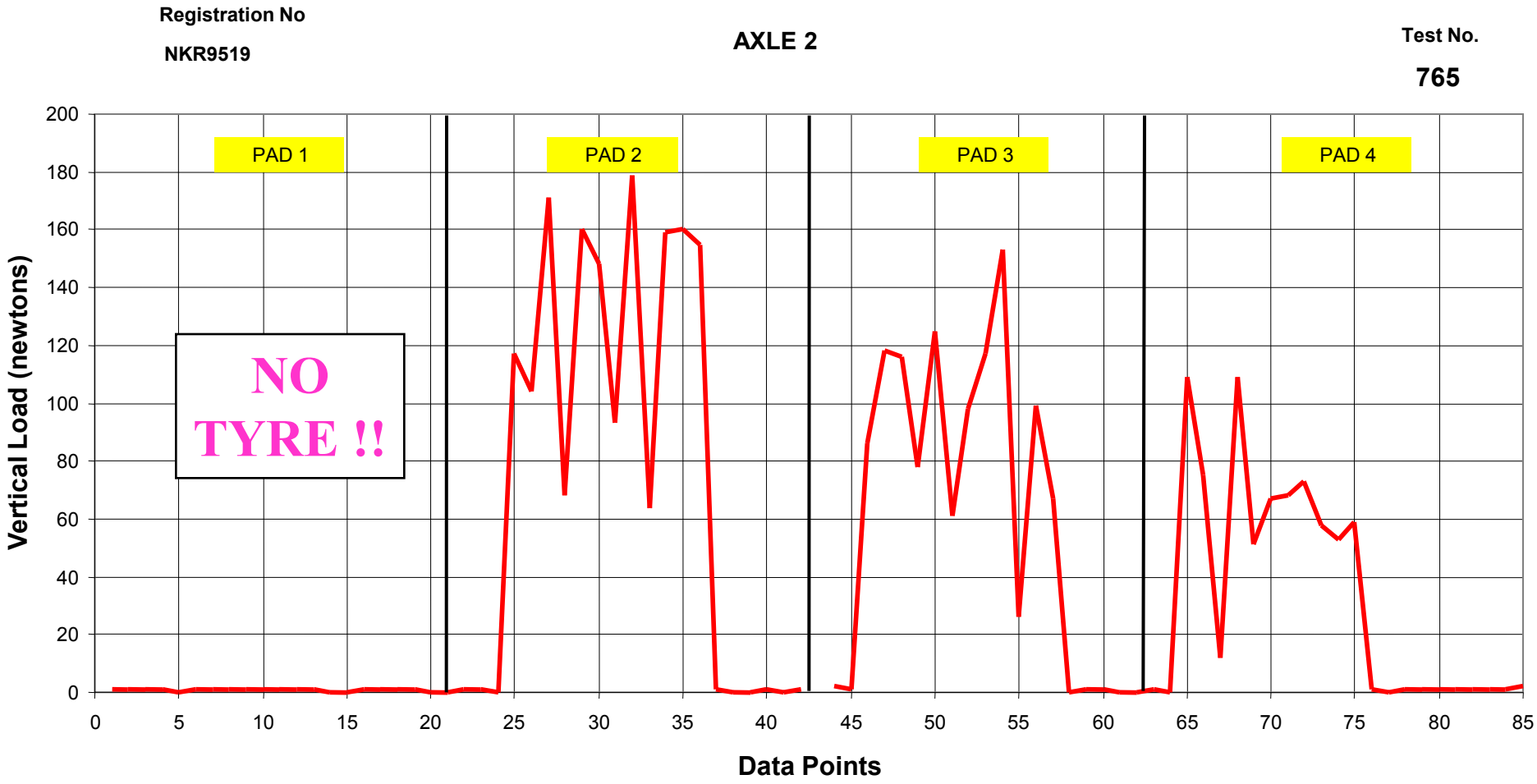
TYRE barely in contact with surface



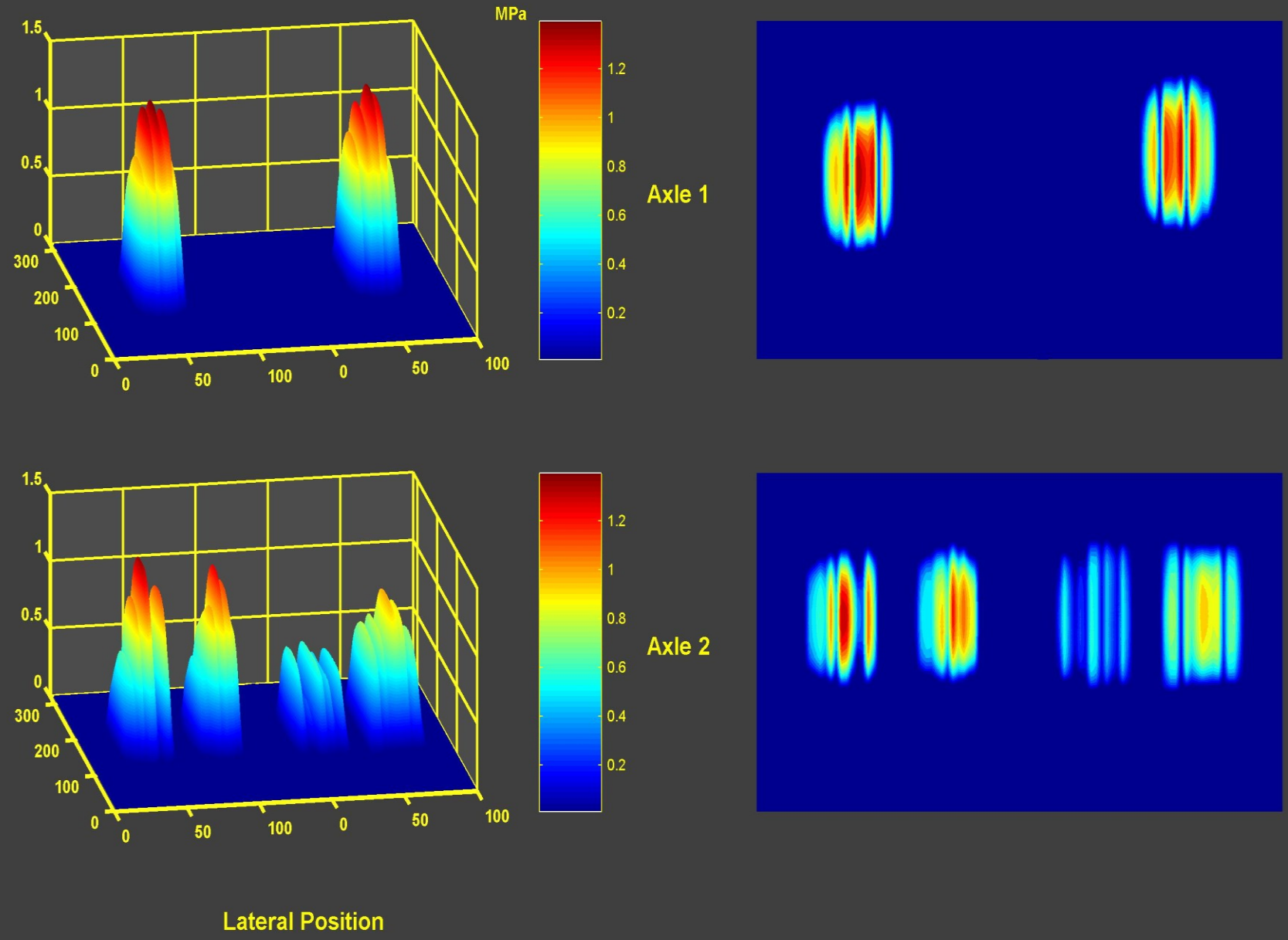
AXLE 2: MISSING TYRE !!



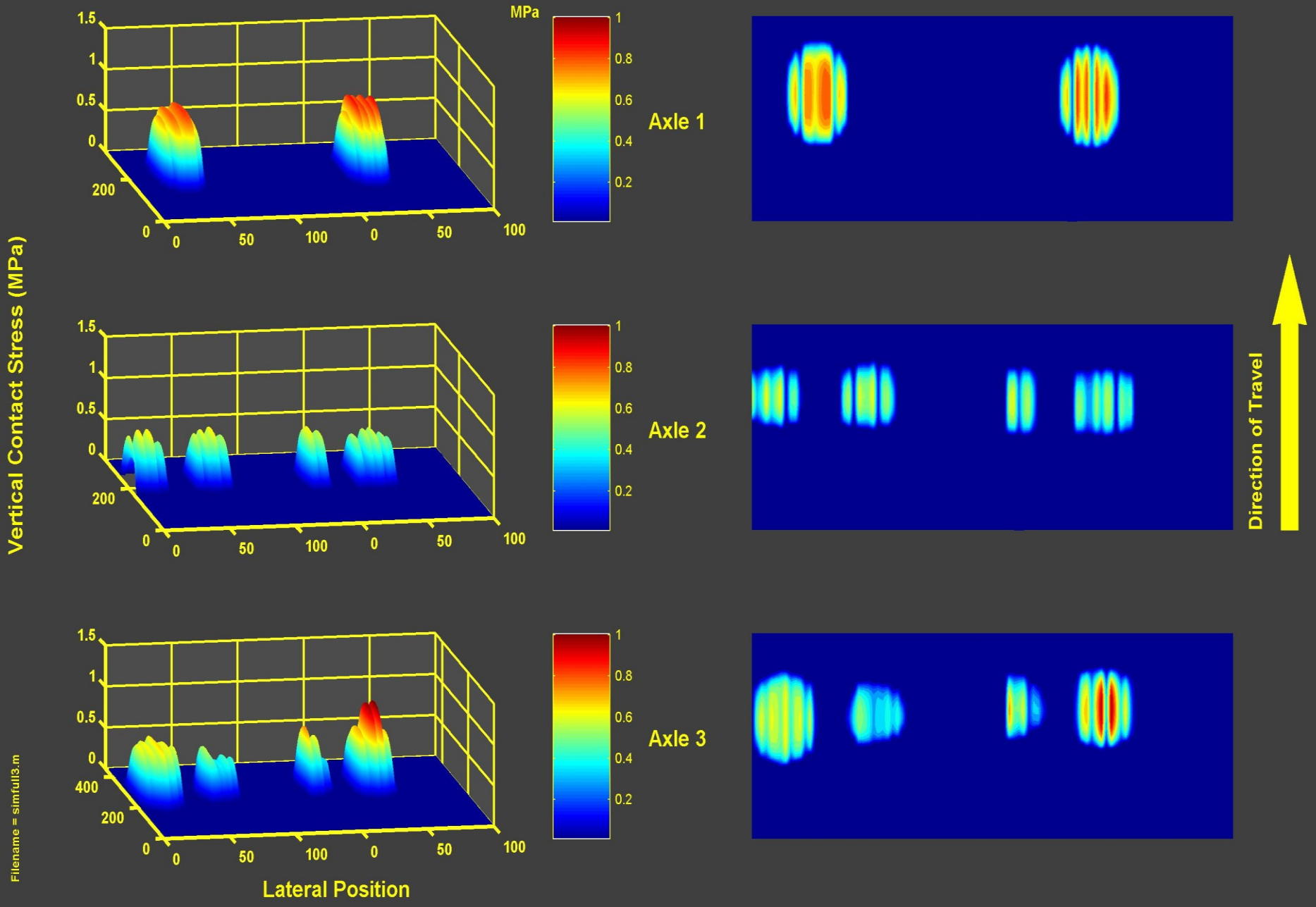
TEST 765: NKR 9519 – 09/10/2003
AXLE 1 (COLIN TO CHECK)



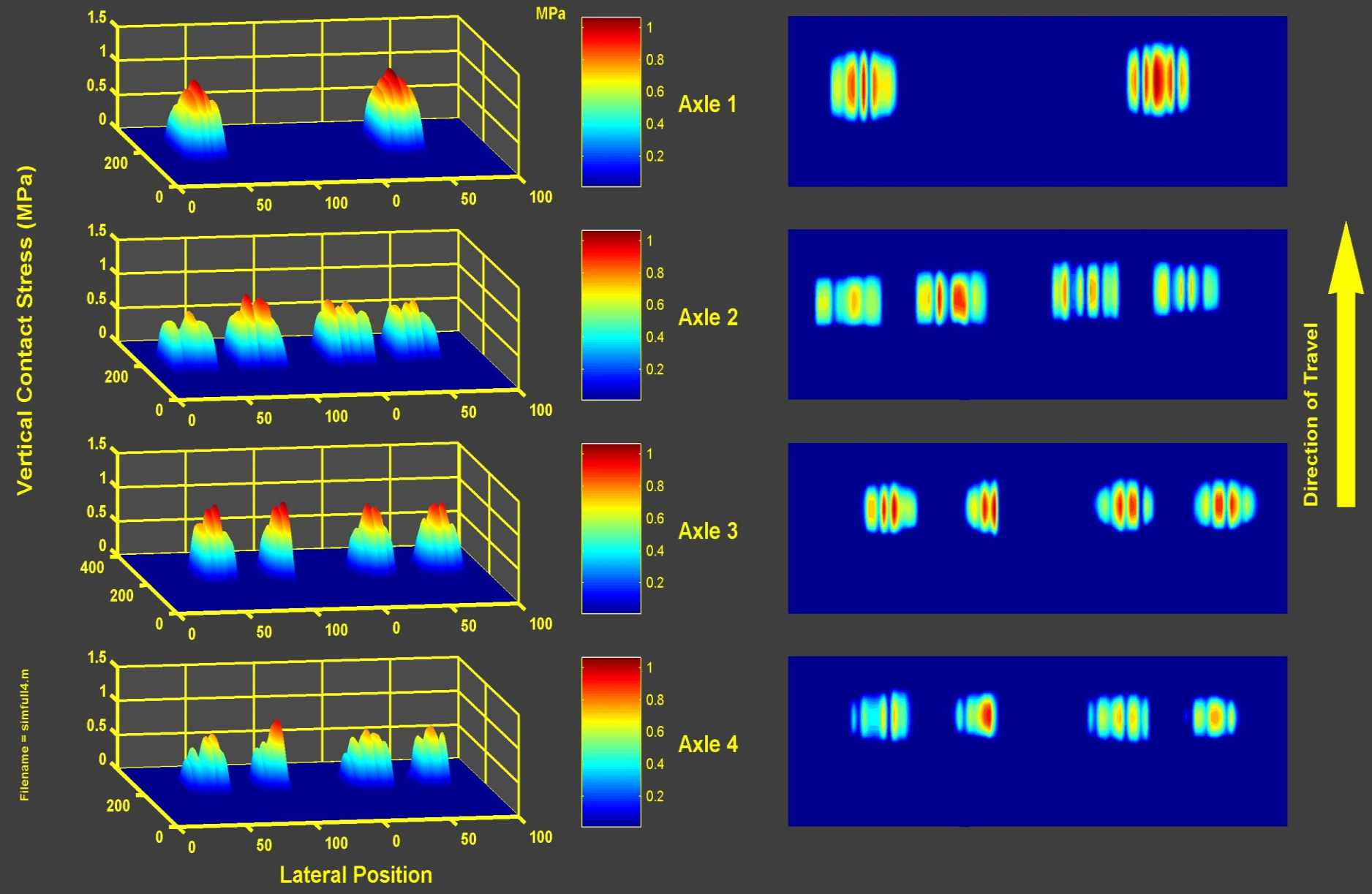
Test H451 done at Heidelberg : Date 04/09/2003

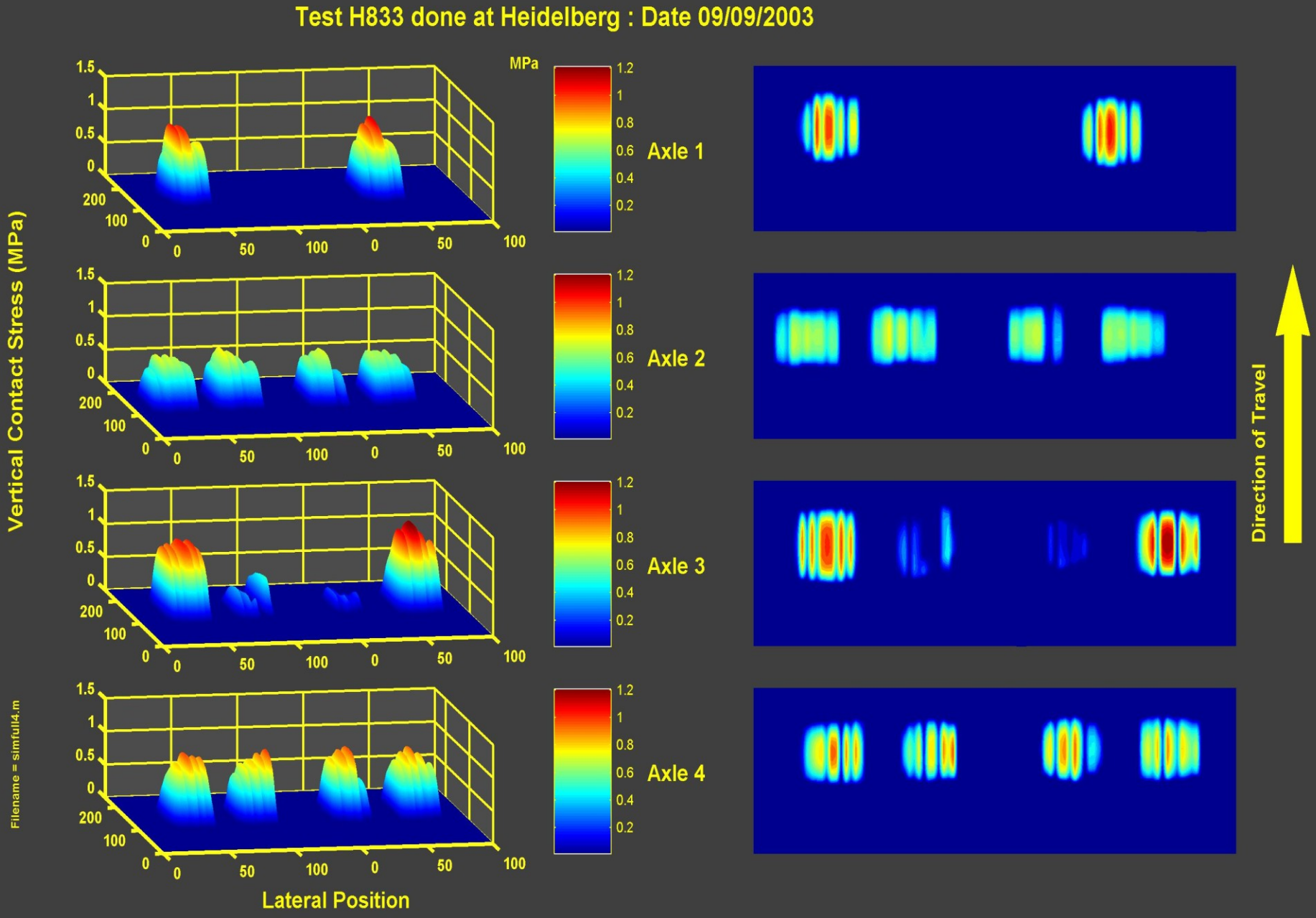


Test H1062 done at Heidelberg : Date 10/09/2003

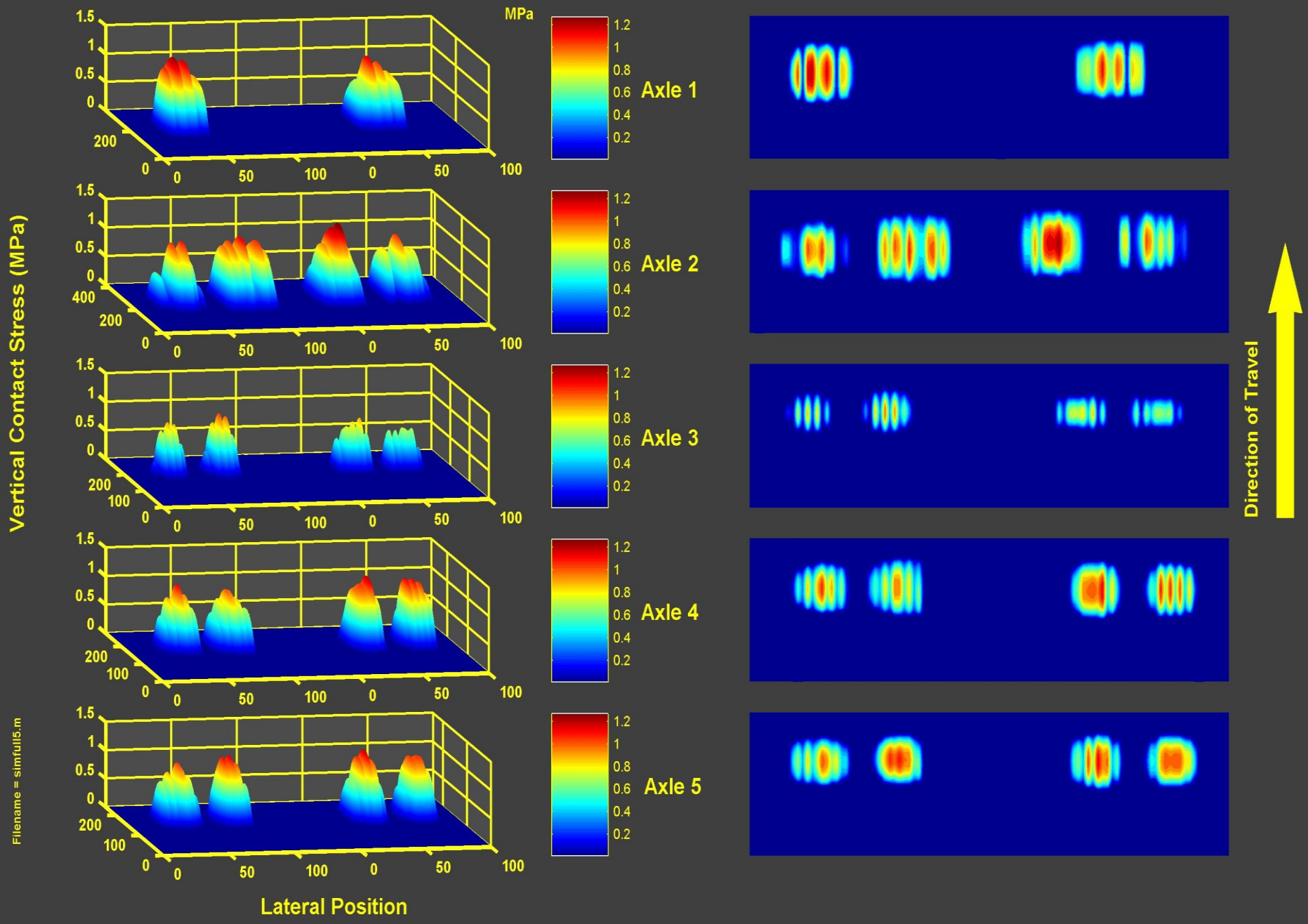


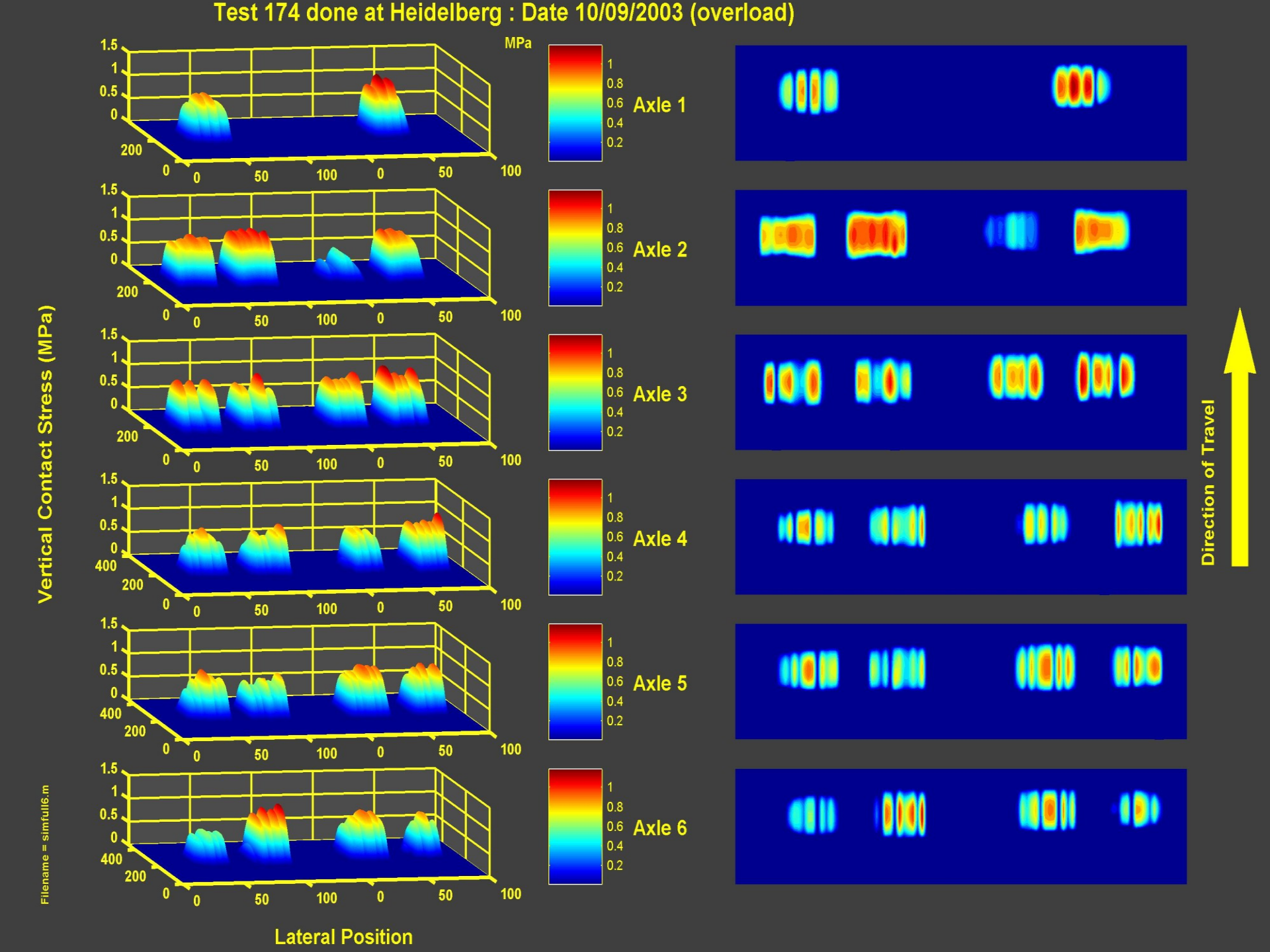
Test H1070 done at Heidelberg : Date 10/09/2003



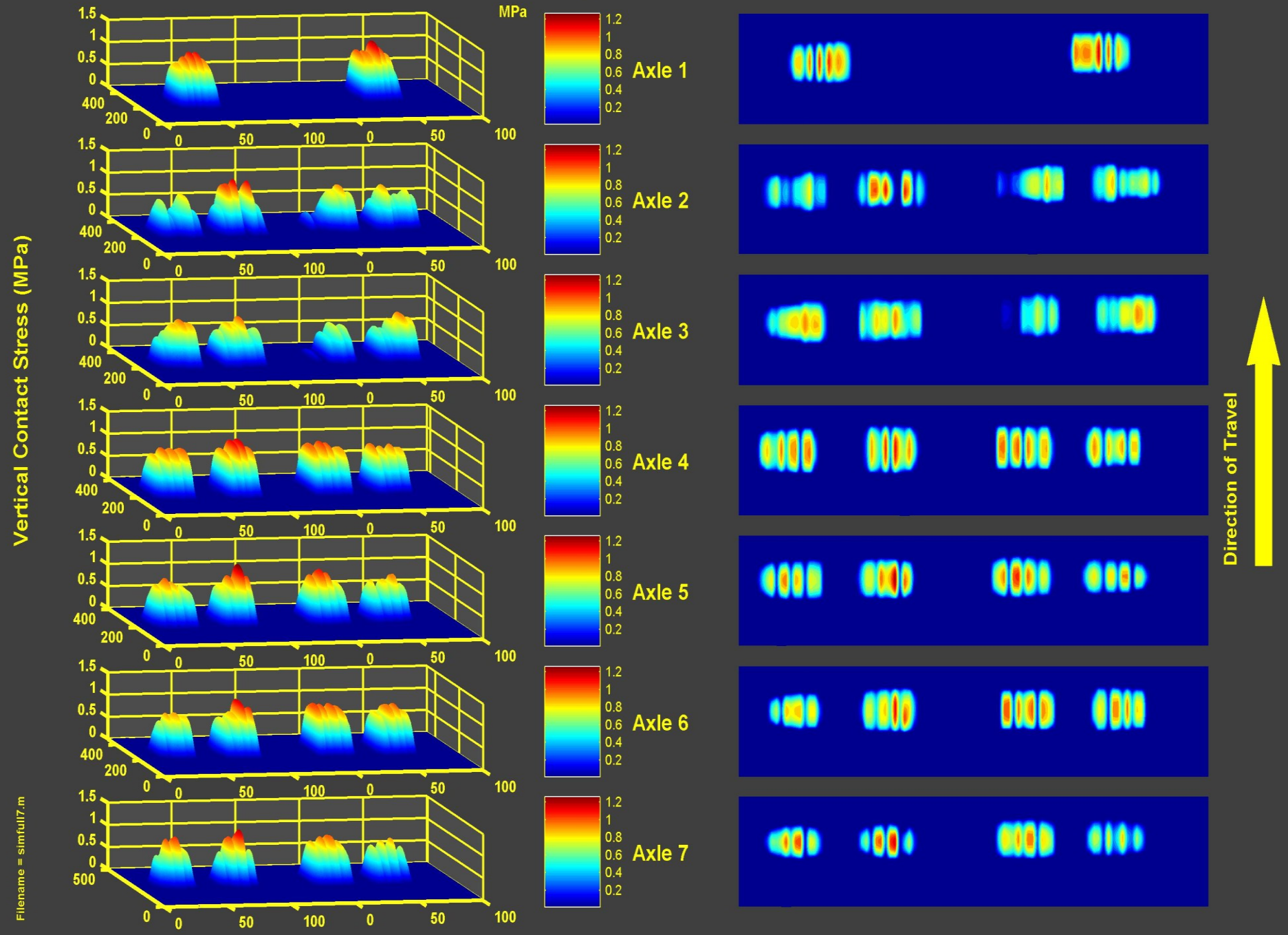

Test H833 done at Heidelberg : Date 09/09/2003
Vertical Contact Stress (MPa)
MPa
Axle 1
Axle 2
Axle 3
Axle 4
Lateral Position
Direction of Travel
Filename = simfull4.m

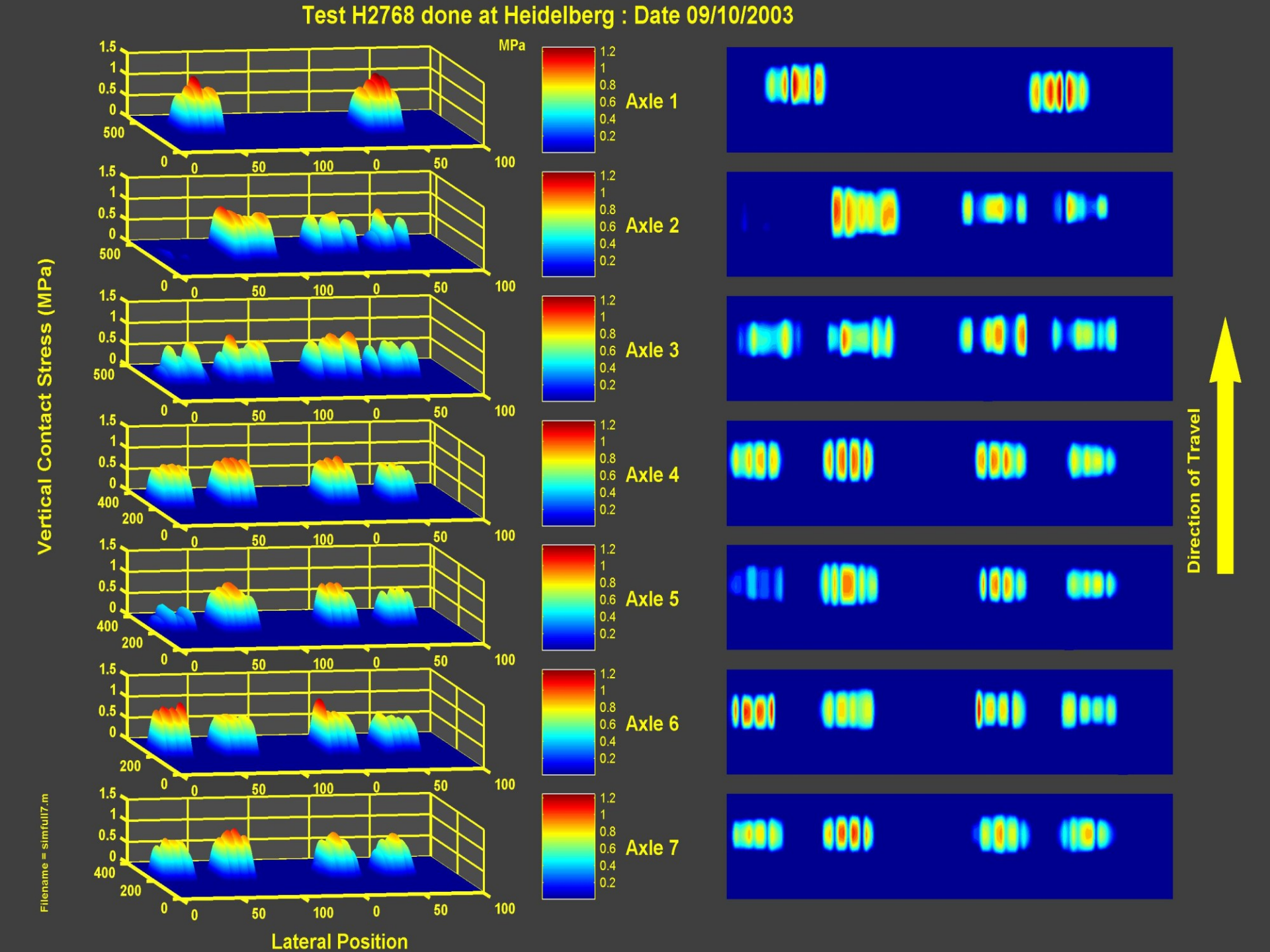
Test H1077 done at Heidelberg : Date 10/09/2003

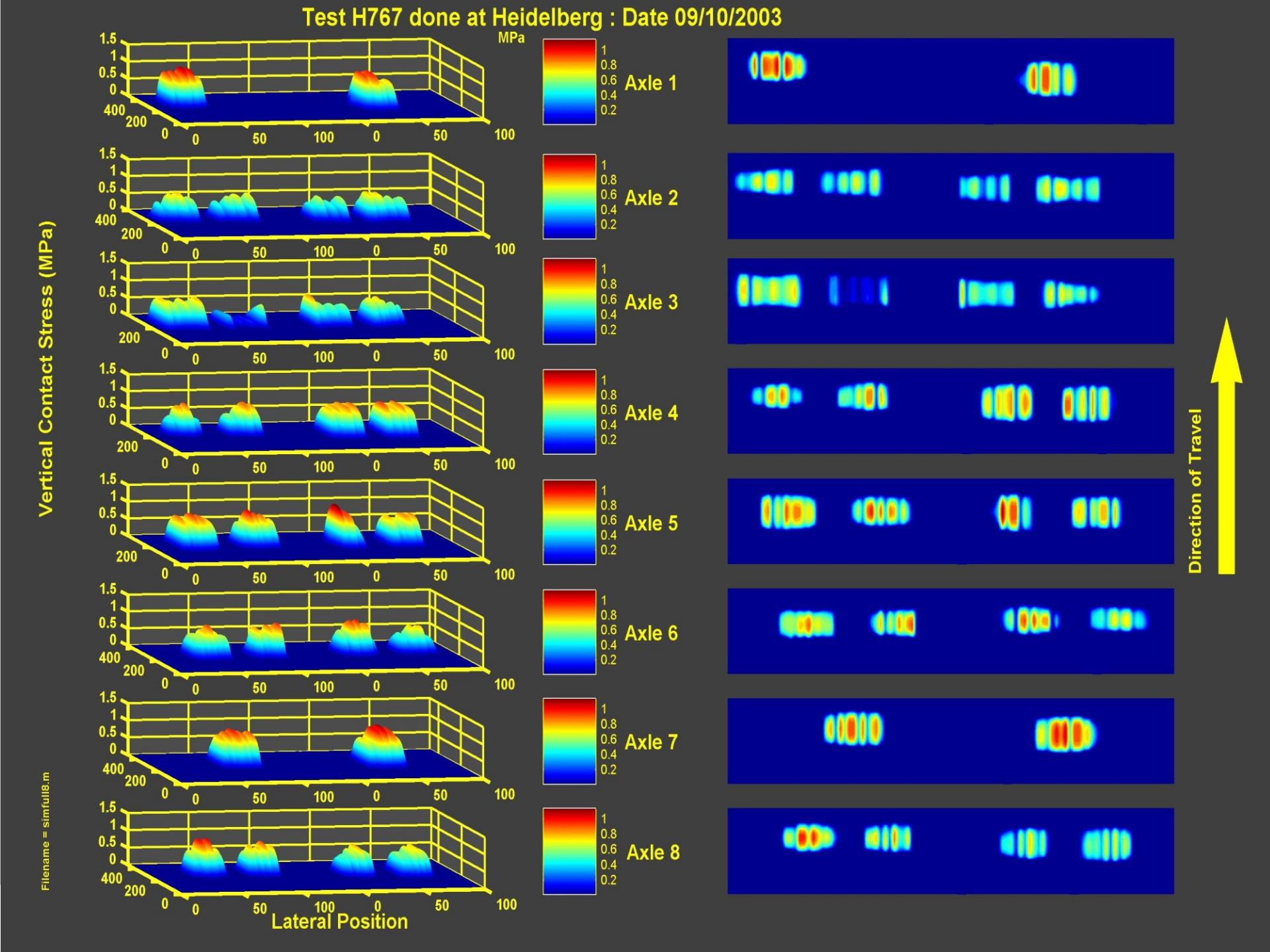



Test 174 done at Heidelberg : Date 10/09/2003 (overload)
Vertical Contact Stress (MPa)
MPa
Axle 1
Axle 2
Axle 3
Axle 4
Axle 5
Axle 6
Direction of Travel
Lateral Position
Filename = simfull6.m

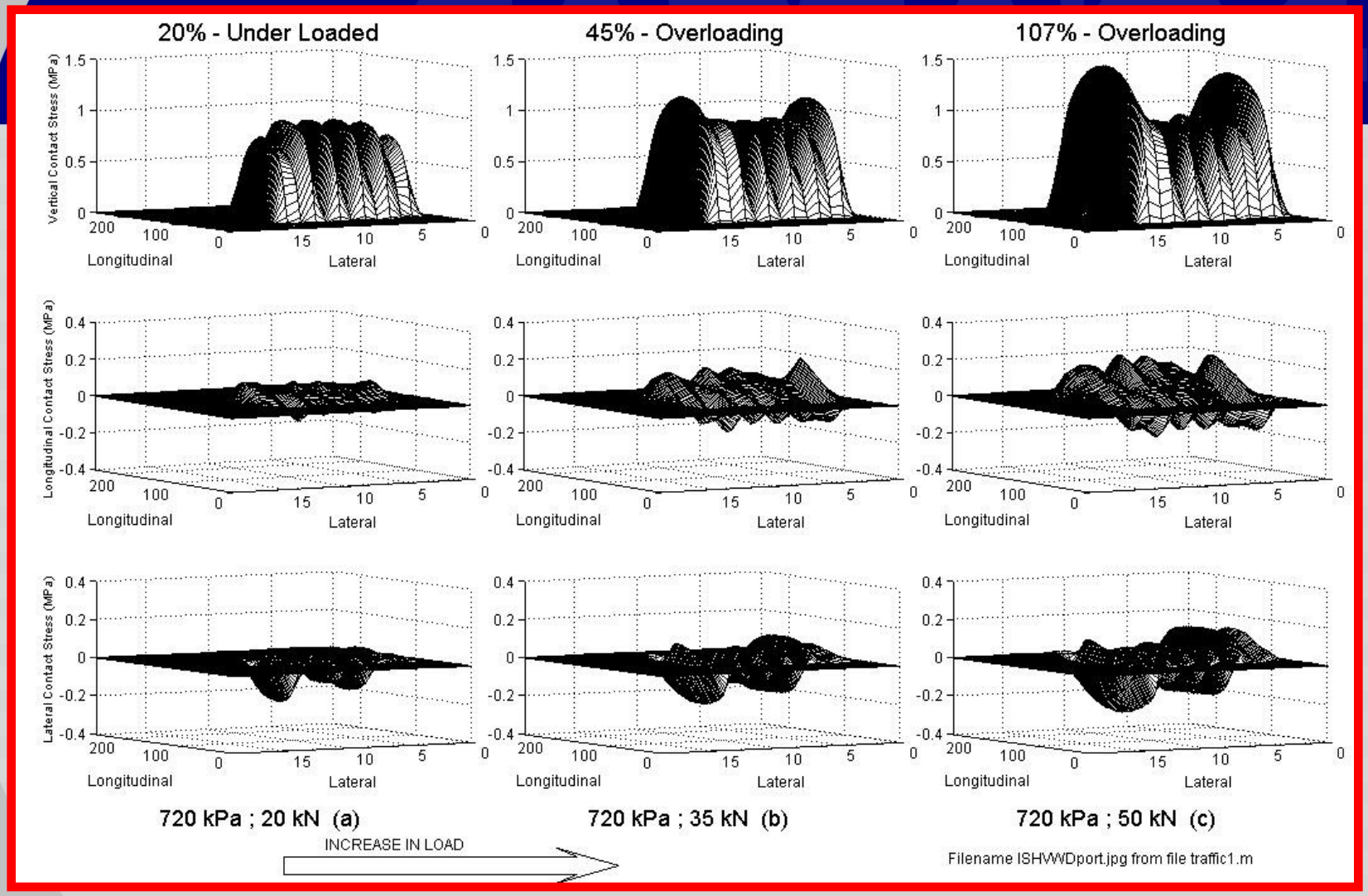
Test 120 done at Heidelberg : Date 15/10/2003



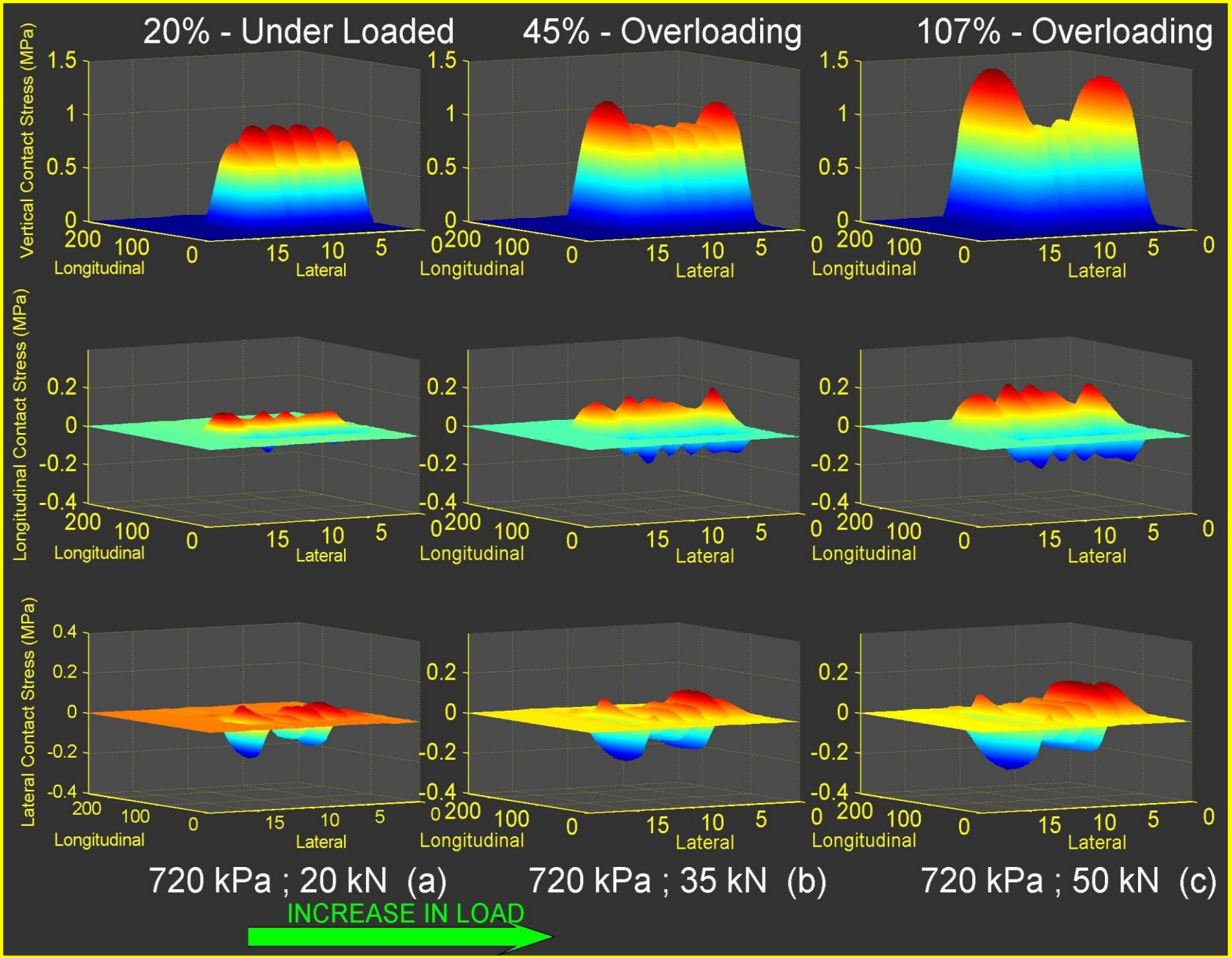

Test H2768 done at Heidelberg : Date 09/10/2003
Vertical Contact Stress (MPa)
Lateral Position
MPa
Axle 1
Axle 2
Axle 3
Axle 4
Axle 5
Axle 6
Axle 7
Direction of Travel
Filename = simfull7.m


Test H767 done at Heidelberg : Date 09/10/2003
Vertical Contact Stress (MPa)
MPa
Axle 1
Axle 2
Axle 3
Axle 4
Axle 5
Axle 6
Axle 7
Axle 8
Lateral Position
Direction of Travel
Filename = simfull8.m

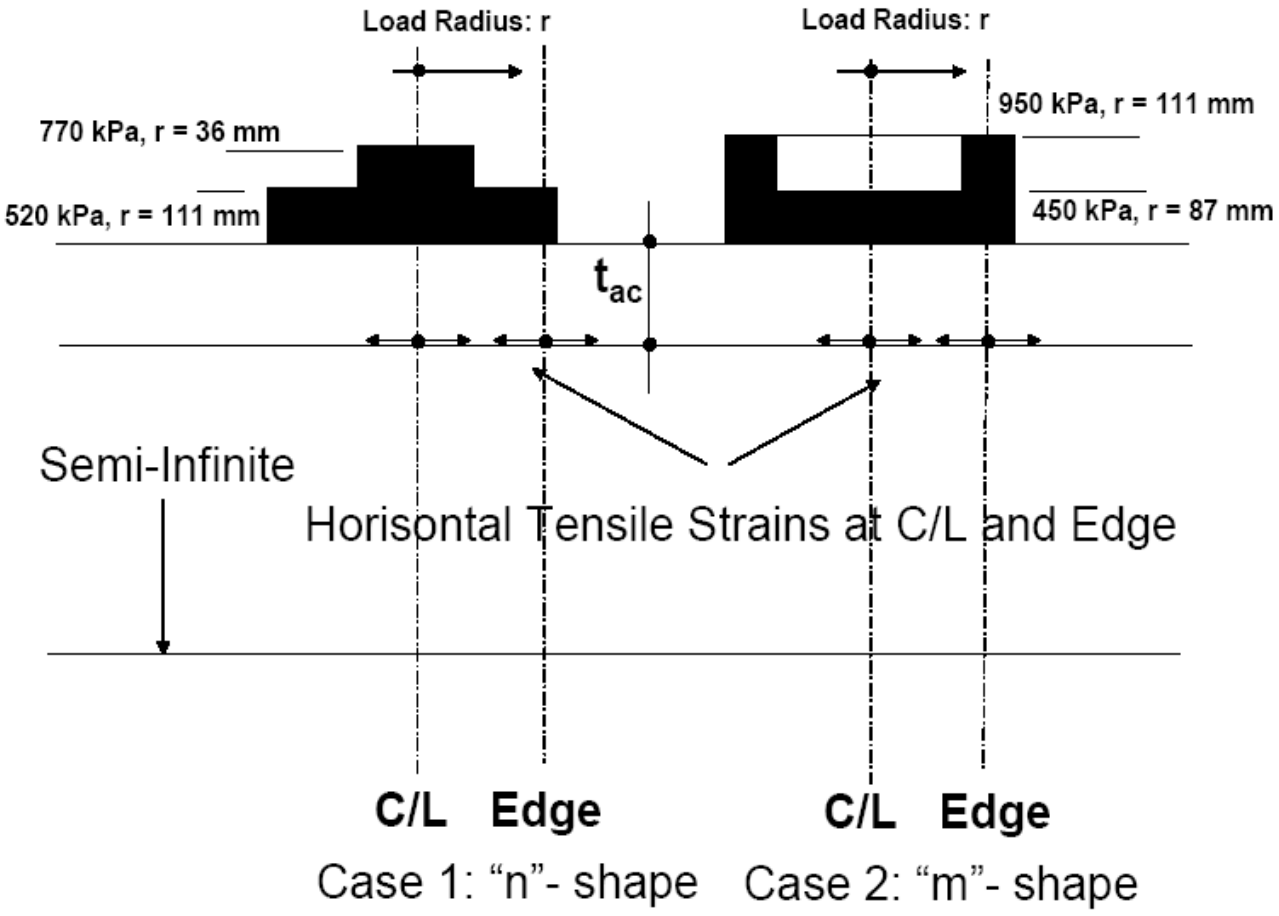
LOADING CASES ANALYSED



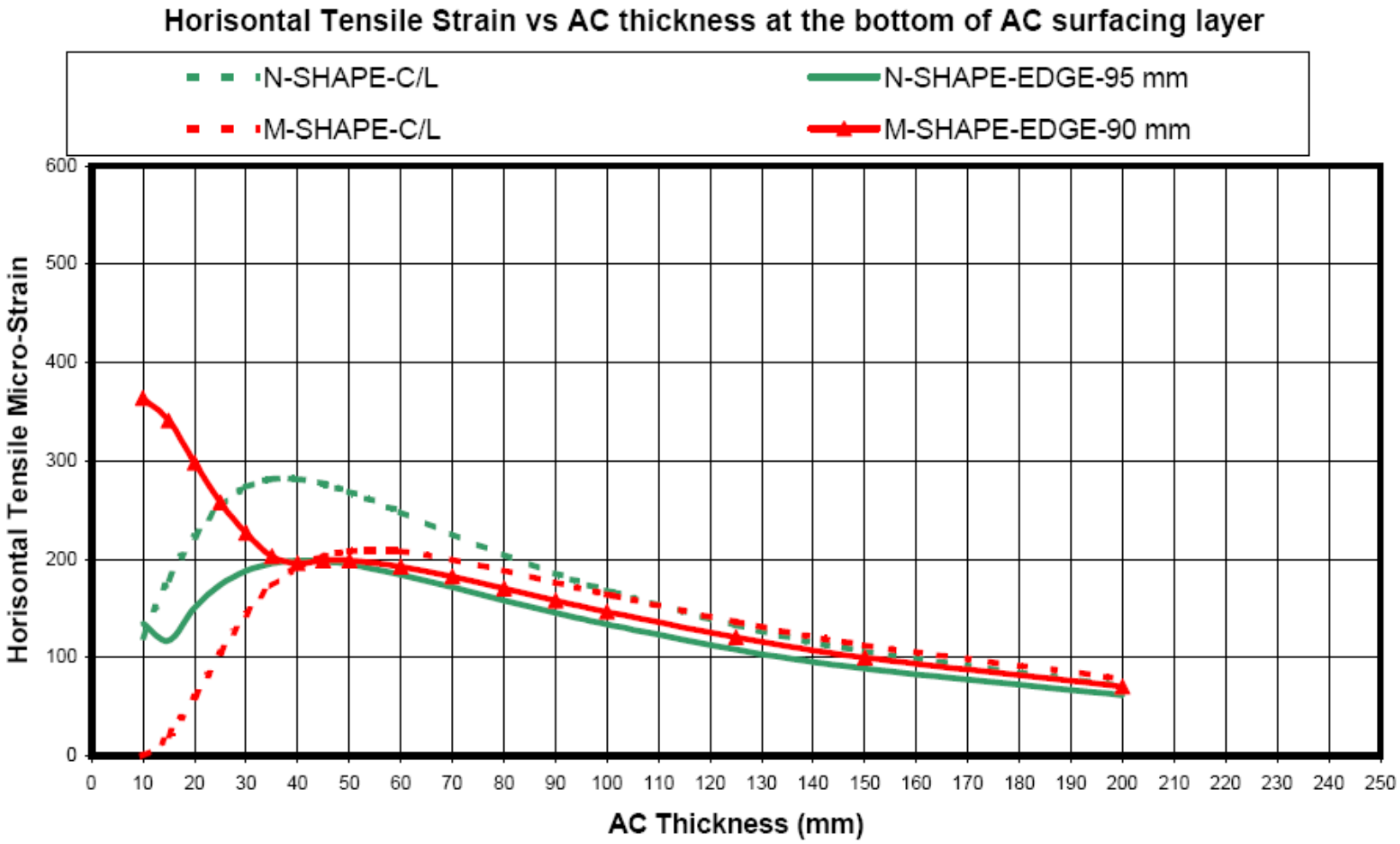
Tyre Loading/Stress Conditions: CAPSA 2004



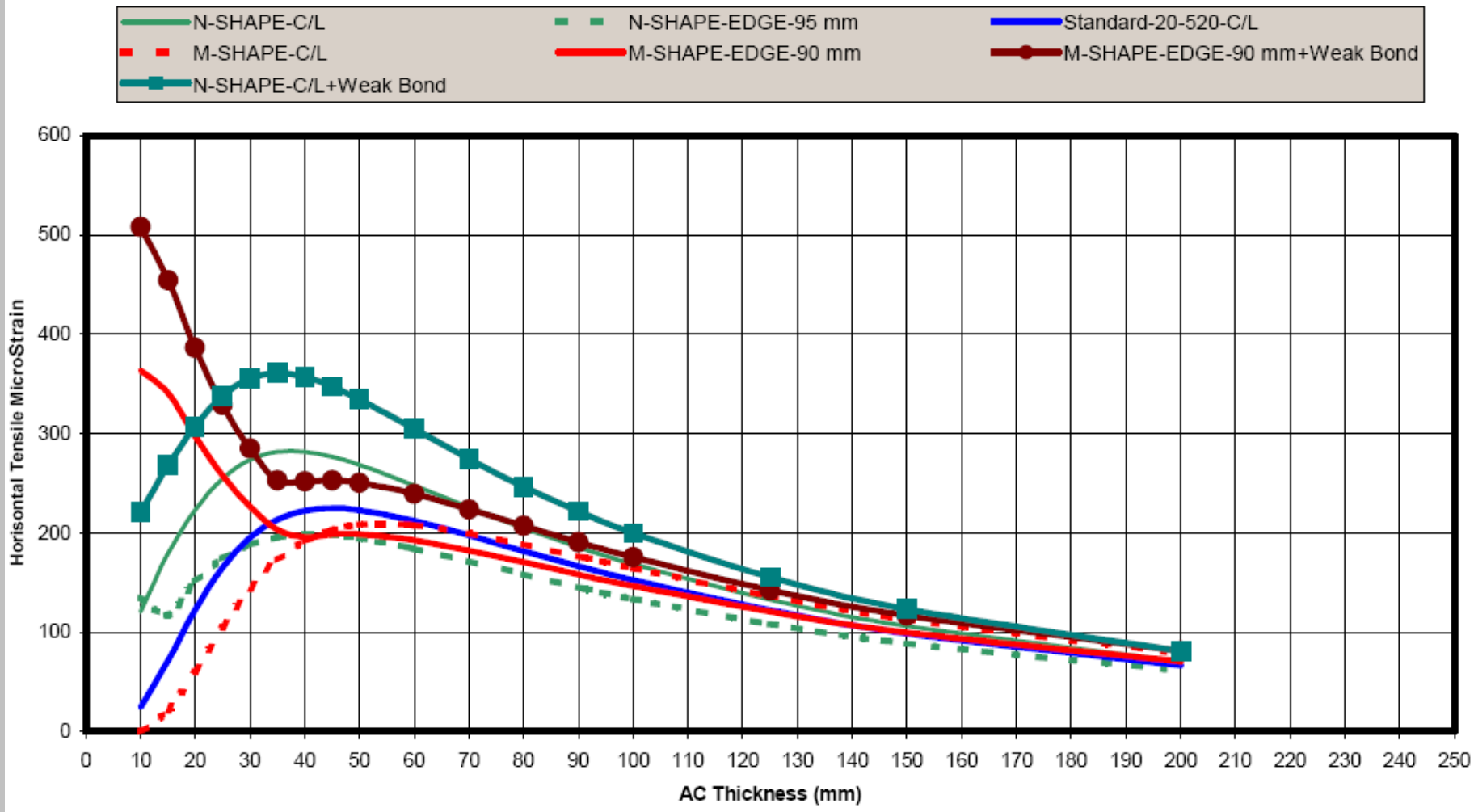
Simplified Loading Cases: “n”- shape and “m”- shape



Horisontal Tensile Strain @ bottom of AC layer



Horisontal Tensile Strain @ bottom of AC layer AND weak layer



The Way Forward

The challenge for the way forward will be mainly two-fold:

- Implementation of improved "tyre" load models for everyday pavement structural design and analysis, including textured seals, and
- Additional SIM measurements on a wider range of vehicles and typical routes in SA;

CONCLUSIONS & RECOMMENDATIONS - 1

- SIM Technology well established in SA;
- Tyre inflation pressure only not enough ! – combine with SIM;
- Road Freight growth - > 4 % p.a. – increased damage on roads;
- Improved tyre loading models;
- Re-consider use of “thin” ACs (30 mm – 50 mm) ??;
- Overloaded/under inflated tyres (“m” shape) – increased damage;

CONCLUSIONS & RECOMMENDATIONS - 2

- Thin layered surfacings – case is worsening with weak layers (or bonds) between AC and base – increased damage potential;
- Actual traffic loading to be determined or measured using WIM etc;
- Development of Road Maps indicating real impact of HVs – assist with road maintenance, upgrading, law enforcement, etc;
- Replacement/enhancement of the E80 – concept to include contact stress sensitivities