REDUCING THE OCCURRENCES AND IMPACT OF FREIGHT TRAIN DERAILMENTS

D-RAIL

D-Rail dissemination Meeting 12th November (STOCKHOLM)

WP 3 – Derailment analysis and prevention

WP Leader : Michel PINEAU (SNCF)

Speakers : Michel PINEAU (SNCF) & Anders EKBERG (CHALMERS)

SNCF

SEVENTH FRAMEWORK PROGRAMME

WP OVERVIEW

INTRODUCTION

Deliverable Number [61]	Deliverable Title	WP number [53]	Lead beneficiary number	Estimated indicative person-months	Nature [62]	Dissemination level [63]	Delivery date [64]
D3.1	derailment Causes, impact and prevention assessment	3	4	20.00	R	PU	10
D3.2	Analysis and mitigation of derailment, assessment and commercial impact	3	7	30.00	R	PU	18
D3.3	Guidelines on derailment analysis and prevention	3	6	21.00	O	PU	18

PARTICIPANTS & ROLES

- VUT Technische Universität Wien
- CHALM Chalmer Tekniska Hoegskola AB
- POLIM Politecnico di Milano
- MMU The Manchester Metropolitan University
  replaced since July 2012 by
  HUD Huddersfield University
- LUCC Lucchini RS SPA
- DB Deutsche Bahn AG
- HARS Harsco Rail Limited
- SNCF Société Nationale des Chemins de fer Français

PARTICIPANTS & ROLES

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Task 3.1 – Analysis of derailment causes, impact and prevention assessment schemes

- Leader: VUT
- Participants: HARS

“top–down”

D3.1

Task 3.2 – Analysis & mitigation of derailment related to wheel/rail interaction

“bottom–up”

- Leader: POLIM
- Participants: DB, (MMU) HUD, CHALM, SNCF

Task 3.3 – Analysis & mitigation of derailment due to material fatigue & fracture

- Leader: CHALM
- Participants: LUCC, SNCF

“bottom–up”

closely integrated D3.2 and D3.3 (guideline)

all WP3 deliverables are public

DELIVERABLES

Theme [SST.2011.4.1-3]
Development of the Future Rail System to
Reduce the Occurrences and Impact of Derailment

Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

D-RAIL

Grant Agreement No.: 285162 FP7 – THEME [SST.2011.4.1-3]
Project Start Date: 01/10/2011
Duration: 36 Months

D3.1

Report on analysis of derailment causes, impact and prevention assessment

Due date of deliverable: 31/07/2012
Actual submission date: 30/05/2013

Work Package Number: WP3
Dissemination Level: PU
Status: Final F2

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DELIVERABLES

D3.1 Analysis of derailment causes, impact and prevention assessment schemes

- **Cause-consequence chains** of different derailment causes
- Identification of **potential mitigation measures** including estimation of application level
- Overall **evaluation approach** for mitigation measures to make a cost-benefit-analysis for the implementation of on-board and wayside train monitoring systems.

DELIVERABLES

Exemple of content for D3.1

showcases for mitigation measures for derailment cause

axle rupture

T - trackside
V - vehicle side (in general)
R - vehicle side (recording car)
Y - (shunting) yard
W - workshop

a - widely known/used measures
b - already known measures, but not widely applied
c - measures, which might be relevant for the future

1…9 - technology readiness level (TRL)

number of subcategory	subcategories of derailment causes	monitoring target	monitoring target type	T axle load checkpoint (Q)	T axle load checkpoint (Y and Q, resp. Y/Q)	T wayside crack detection	T hot box detection (infrared-based)	T acoustic bearing detection	T vehicle profile measurement	V acceleration/force measurement (vertical)	V stress detector	Y visual inspection	W visual inspection	W ultrasonic inspection	W magnetic particle inspection
1	axle rupture (in general)	cracks on axle	preceding causes			c - - 2							a 9 9	b 9 9	a
2	axle rupture (in general)	faulty running surface	preceding causes	a 8 7 5	b 8 - 1					c - 2		a 9 9	a 9 9		a
3	axle rupture (in general)	faulty suspension	preceding causes	a 8 9 5	b 8 - 1				b 6 9 1		c - 2	a 9 9	a 9 9		
4	axle rupture (in general)	faulty frame	preceding causes	a - 9 5	b - - 1						c - 2				
5	axle fatigue	overloading	preceding causes	a 9 9 5	b 9 - 1						c - 2				
6	axle fracture	overloading	preceding causes	a 9 9 5	b 9 - 1						c - 2				
7	axle rupture due to thermal stress	faulty bearings (before overheating)	preceding causes					b - - 5							
8	axle rupture due to thermal stress	faulty bearings (overheated bearings)	preceding causes				a 9 9 9								

DELIVERABLES

Theme [SST.2011.4.1-3]
Development of the Future Rail System to
Reduce the Occurrences and Impact of Derailment

Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

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Project Start Date: 01/10/2011
Duration: 36 Months

D3.2

Analysis and mitigation of derailment, assessment and commercial impact

Due date of deliverable: 31/03/2013
Actual submission date: 03/06/2013
(15/11/2013 rev after int & ext review)

Work Package Number: WP3
Dissemination Level: PU
Status: Final after review and revision

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	Tore Vernersson	Chalmers
Verified by:	Michel Pineau	SNCF

Theme [SST.2011.4.1-3]
Development of the Future Rail System to
Reduce the Occurrences and Impact of Derailment

Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

D-RAIL

Grant Agreement No.: 285162 FP7 – THEME [SST.2011.4.1-3]
Project Start Date: 01/10/2011
Duration: 36 Months

D3.3

Guidelines on derailment analysis and prevention

Due date of deliverable: 31/03/2013
Actual submission date: 03/06/2013
(15/11/2013 rev after int & ext review)

Work Package Number: WP3
Dissemination Level: PU
Status: Final

	Name	Organisation
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DELIVERABLES

Table of Contents

RESULTS

Main European derailment causes:

- Poor track geometry
  - excessive track width
  - excessive track twist
  - track height/cant failure
- Poor vehicle conditions
  - skew loading
  - spring & suspension failure
- Failures
  - axle ruptures
  - wheel failure
  - rail failures

Major causes and key parameters!

Well-founded operational limits!

Monitor the right things at the right levels

RESULTS

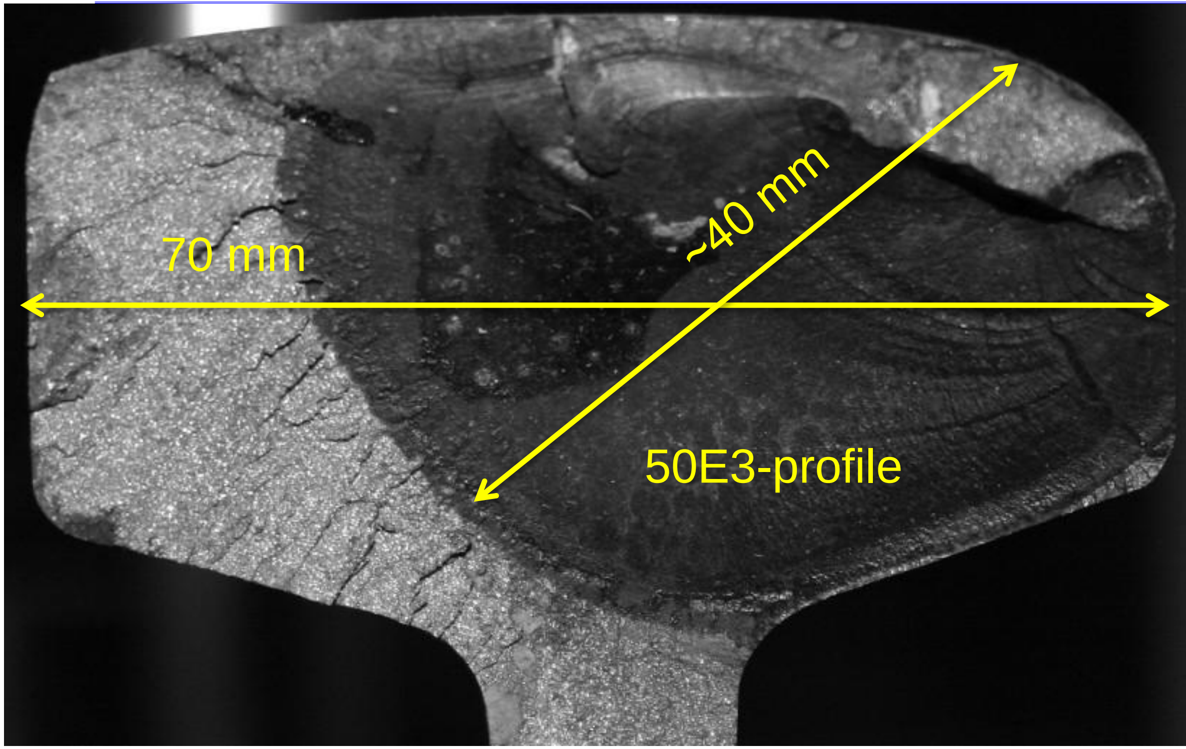
Implementable results from WP3 (as compiled in D7.1)

- 37 potential modifications ranked (low, moderate, high) in terms of cost of implementation
- 29 means of influencing the risk of derailments

Examples of “not-too-high” hanging fruit

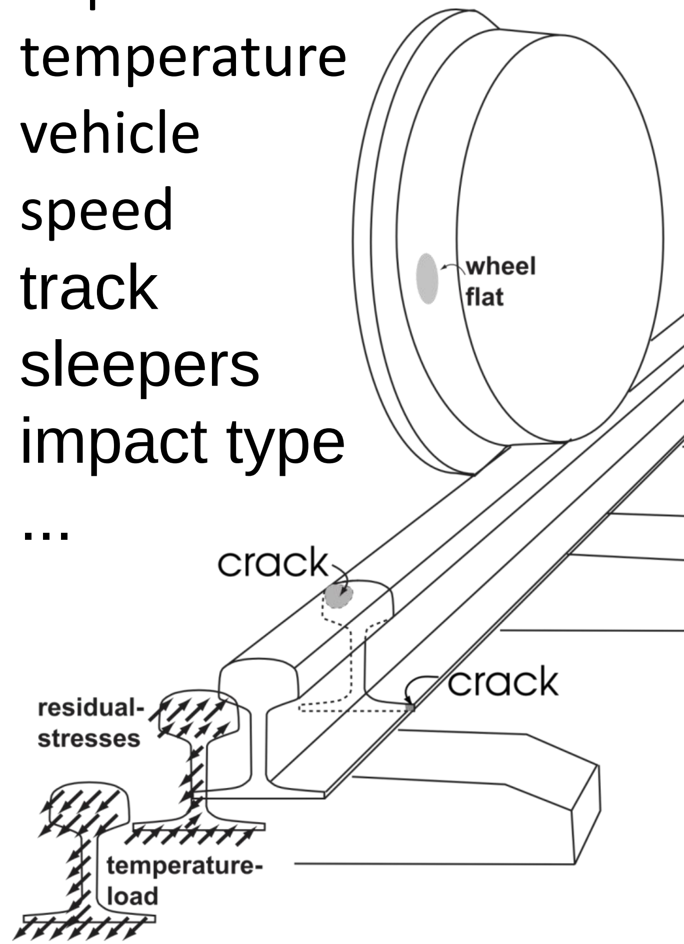
- Improved regulations (elaborated in the UIC-led HRMS project)
- Integrated prediction of crack growth in wheel load sensors to aid planning and maintenance
- Improved design / approval guidelines for wheels and running gear
- Improved and harmonized reporting guidelines and follow-up routines based on key parameters

RESULTS – RAIL BREAKS



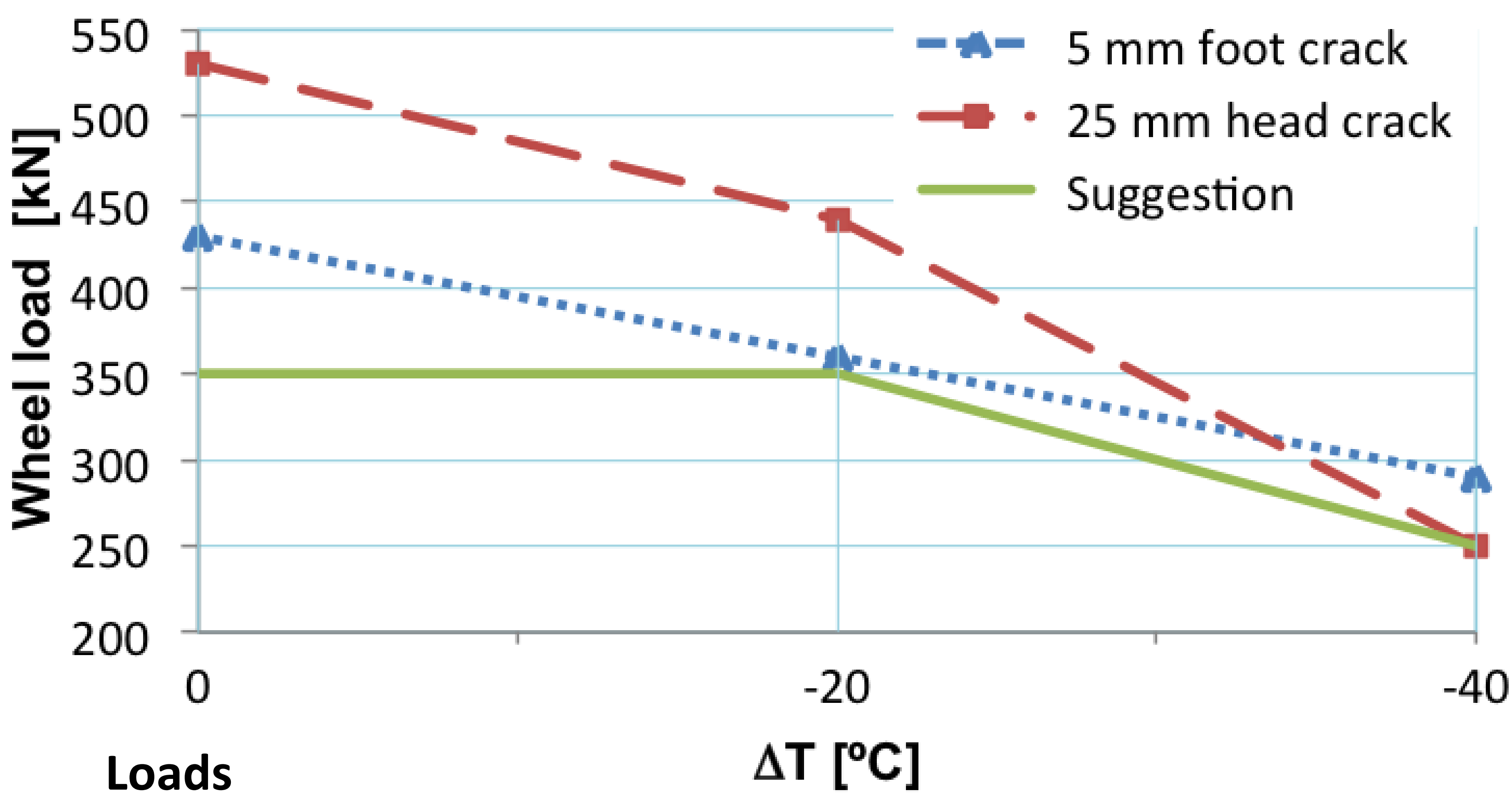
Influencing parameters

impact load
temperature
vehicle
speed
track
sleepers
impact type
...



RESULTS – ALARM LIMITS FOR RAIL BREAKS

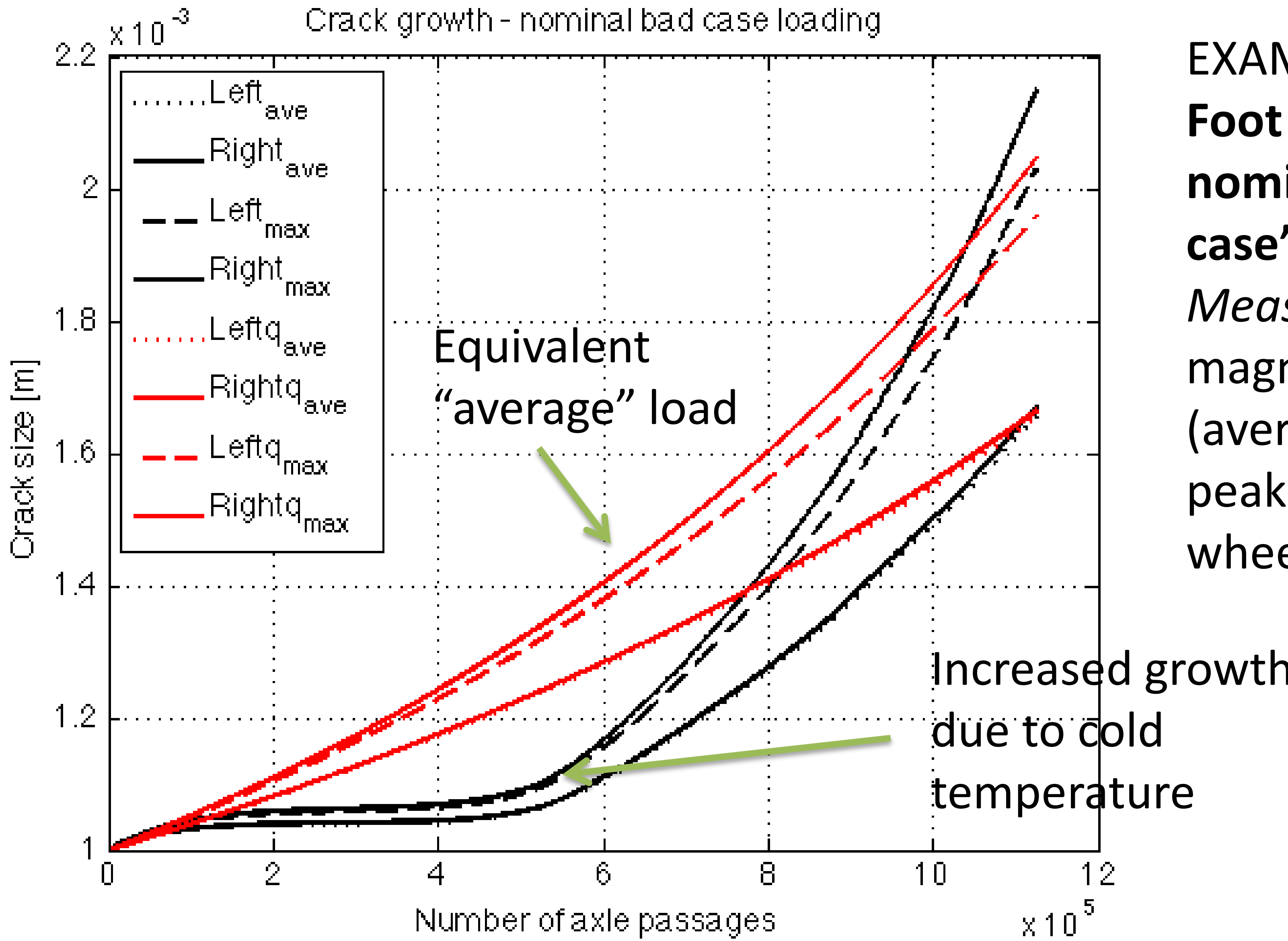
Impact load limits *versus* rail crack size



Loads

- bending from impacting wheel flat
- tension from thermal loading

RAIL BREAKS – CRACK GROWTH



EXAMPLE:

Foot crack – nominal "bad case" scenario

Measured load magnitudes (average or peak for each wheel)

RESULTS – FLANGE CLIMBING

Some key parameters

- wheel/rail friction
- suspension characteristics
- track twist
- side bearer vertical bump stop clearances
- geometry of isolated track defects

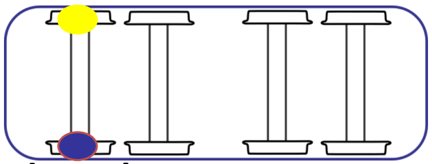
Some current derailment related regulations

- GM/RT 2141 (tentatively too severe)
- EN 14363 (tentatively too lenient)

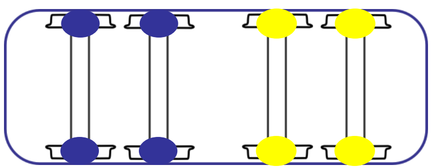
RESULTS – ALARM LIMITS FOR RAIL CLIMB

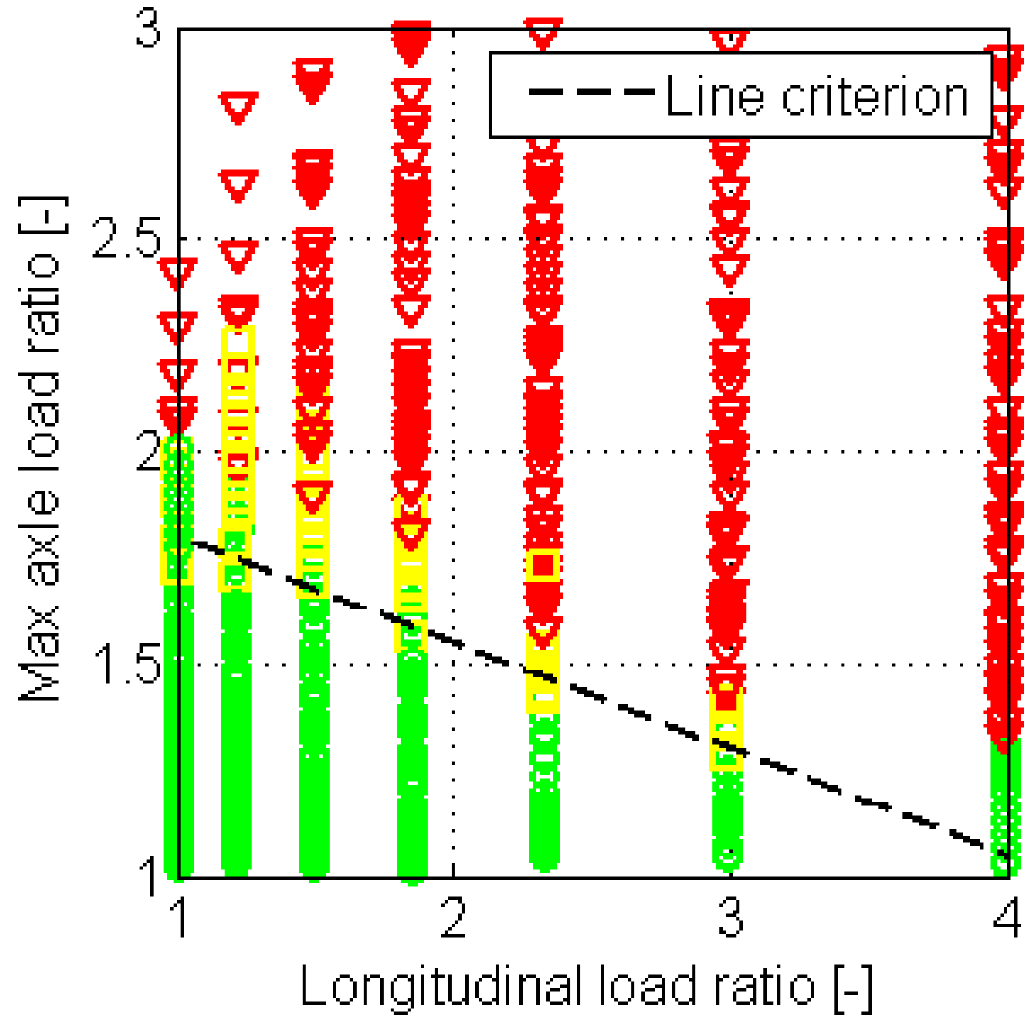
Flange climbing

- axle



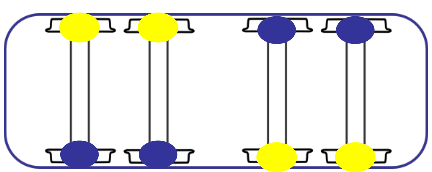
- longitudinal





Chassis twist (tare)

- diagonal

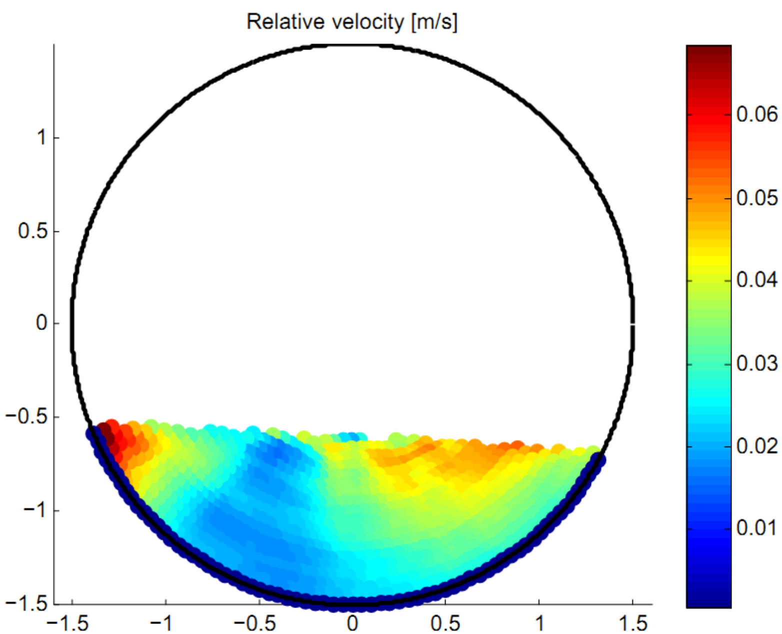


- 1:1.7 – stop
- 1:1.3 – maintenance

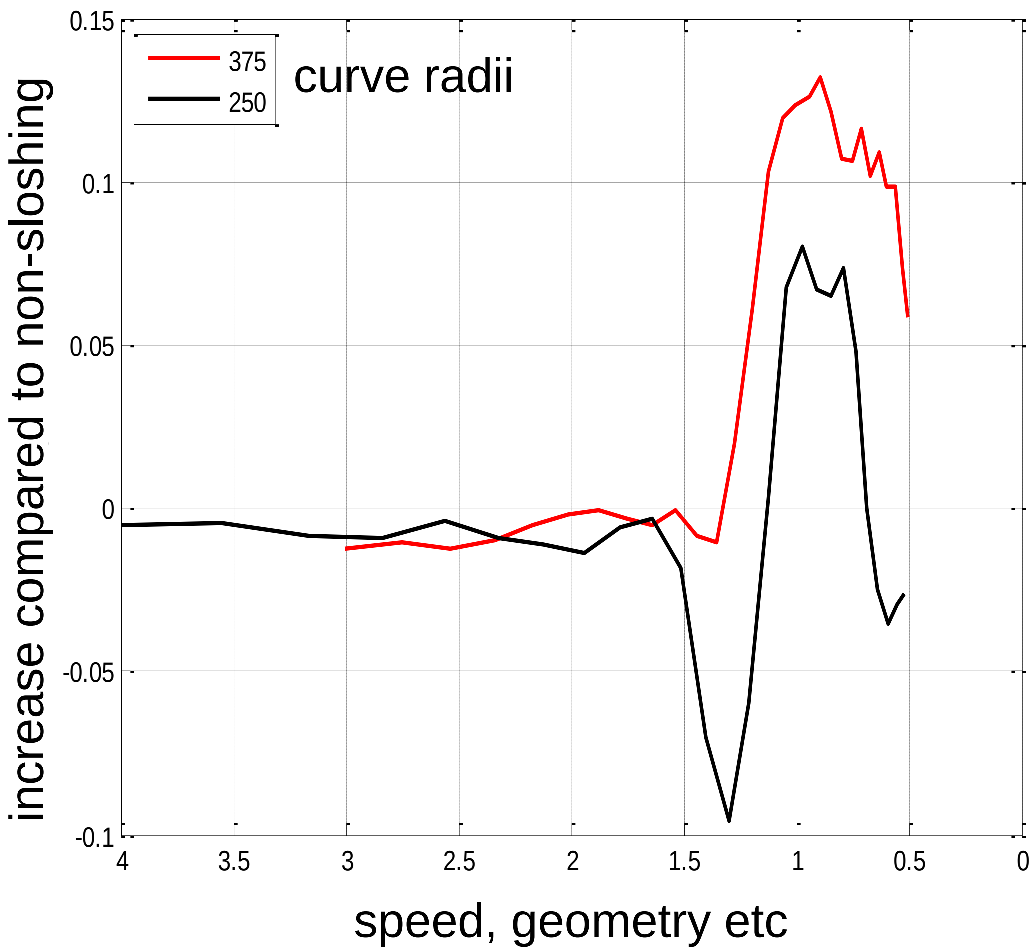
RESULTS – SLOSHING

Influence of sloshing

- increases risk of rollover (not flange climbing)
- S-curves and ~50% fill levels are worst cases
- <20% increase

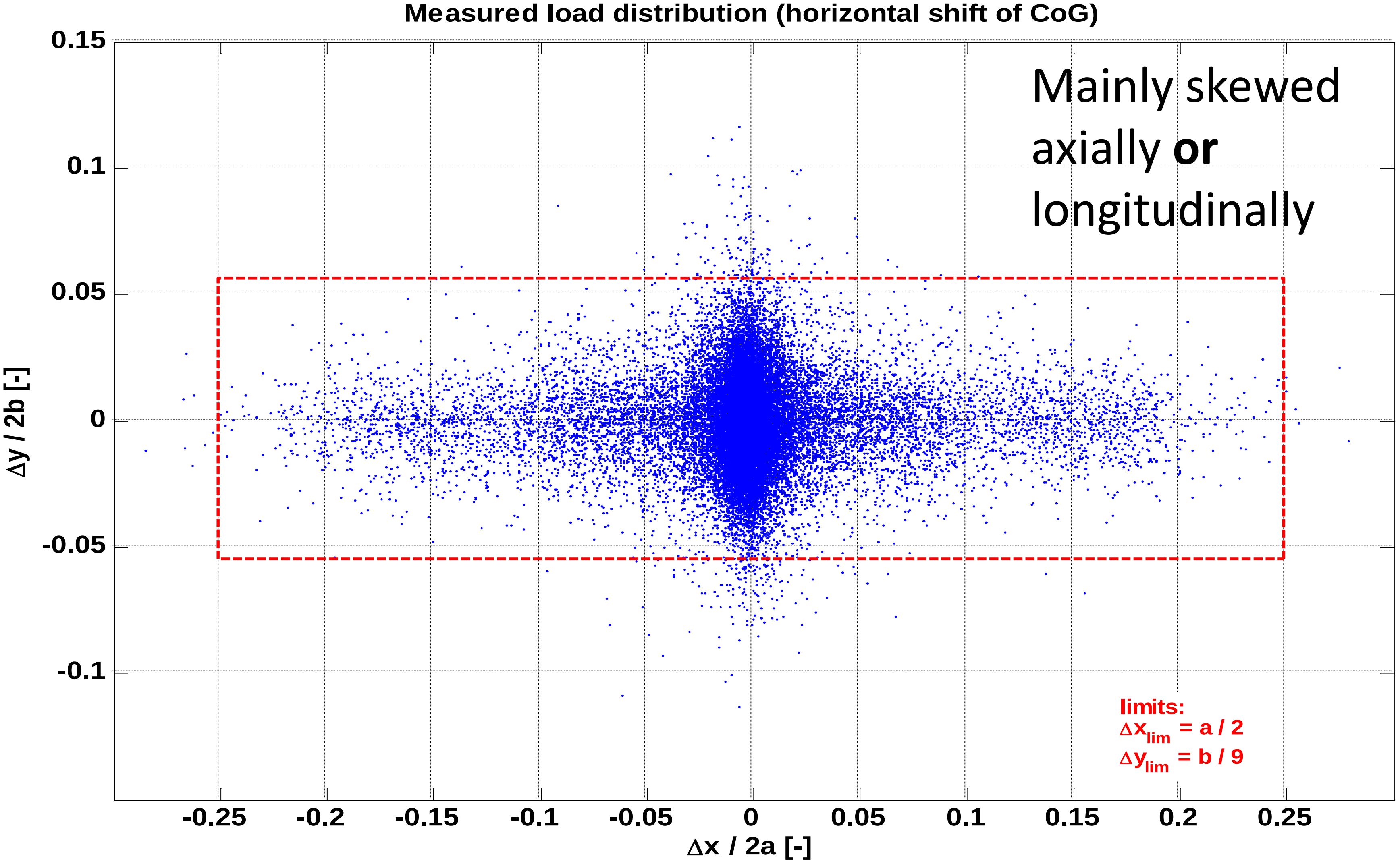


(a) χ=25%



RESULTS – CURRENT SITUATION

Why don't we derail today?



RESULTS – WHEEL DESIGN

Some key findings for web cracks

- Very slow growth in depth direction.
- For the crack to grow in the depth direction, it must be very extended circumferentially

Fatigue sensitivity

- Increase of vertical loading
  - **straight track**: minor increase of fatigue
  - **curving and negotiation of points and crossings:** substantial increase in fatigue stresses.
- Low-stress wheels
  - better for thermal load resistance
  - more sensitive to mechanical fatigue especially due to wheel flats away from the rolling circle

WP3 – Final remark

- The Guideline D3.3 is extensively backed by background details in D3.2
- Recommendations and suggested limits are scientifically based. This means:
  - Background assumptions and analyses are documented
  - The analyses can be extended to new and/or altered operational scenarios
  - The consequence of any deviations to recommendations can be quantified

  This promotes a sound technical discussion to obtain consensus
- The working group included representatives from across Europe (and USA), which aids in obtaining a broad view

Thank you for your kind attention