

Monitoring and Managing RCF and Rail Surface Conditions (ICRI and collaborative projects)

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Research Council, Canada**



Outline

- Origins – the ICRI
- Some ICRI projects
- Wear Mapping, Magic Wear Rate, Quantifying Surface Damage
- Where we go from here



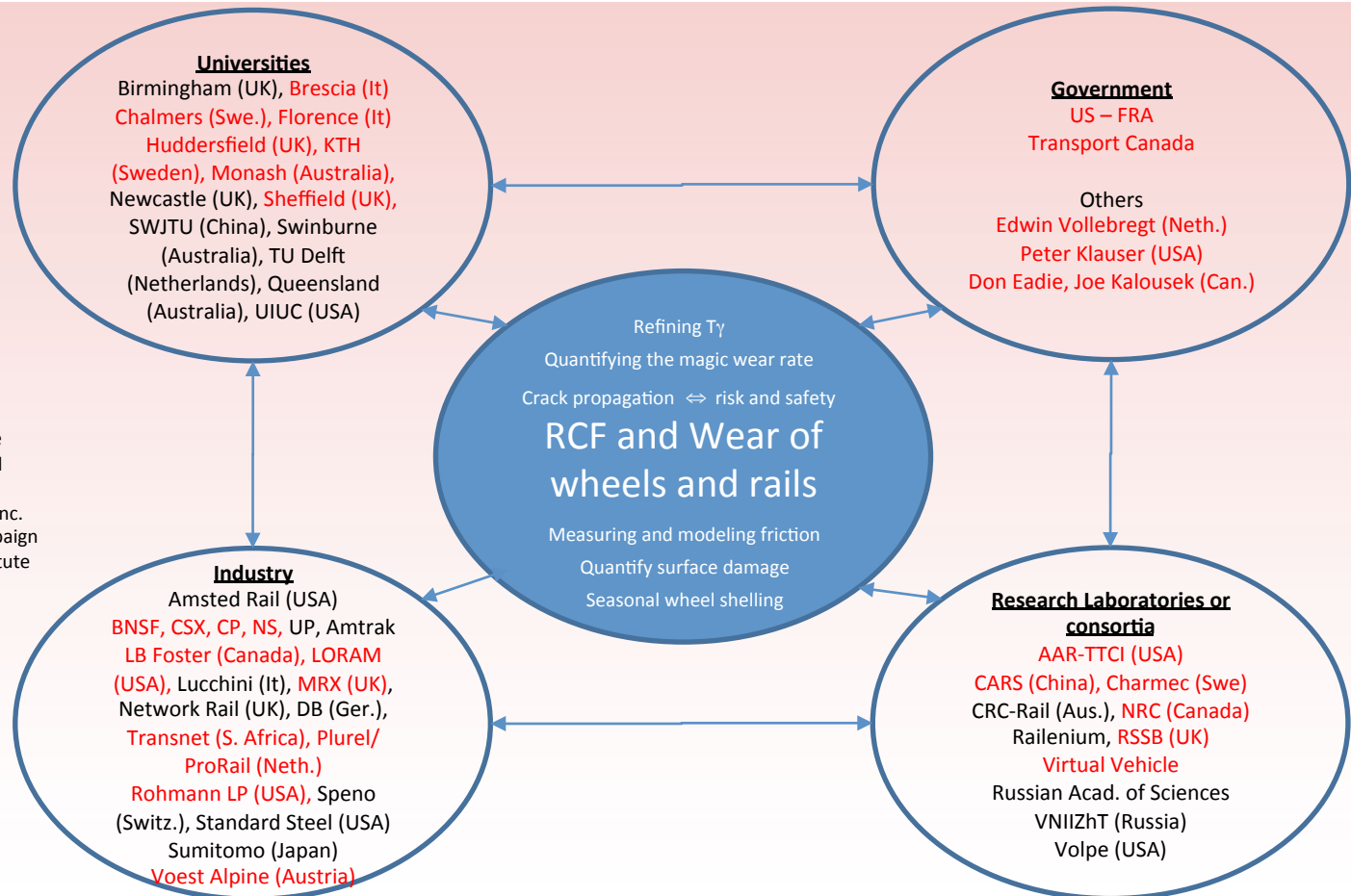
ICRI - how it came about (the short version)

- Summer 2011 FRA/TTCI RCF Workshop in Chicago
- Subsequent discussions at CM2012 in Chengdu
 - Identified Int'l needs for research, recognized overlap, collaboration started there
- Organizing team established
- Outline developed with input from team



**“signed up”
Active participants**

CARS – China Academy of Railway Sciences
 CRC – Cooperative Research Centre
 FRA – Federal Railroad Administration
 NRC – National Research Council
 RTRI – Railway Technical Research Institute
 RSSB – Railway Safety and Standards Board
 SWJTU – Southwest Jiatong University
 TTCI – Transportation Technology Center, Inc.
 UIUC – University of Illinois, Urbana Champaign
 VNIIZhT – All Russia Railway Research Institute

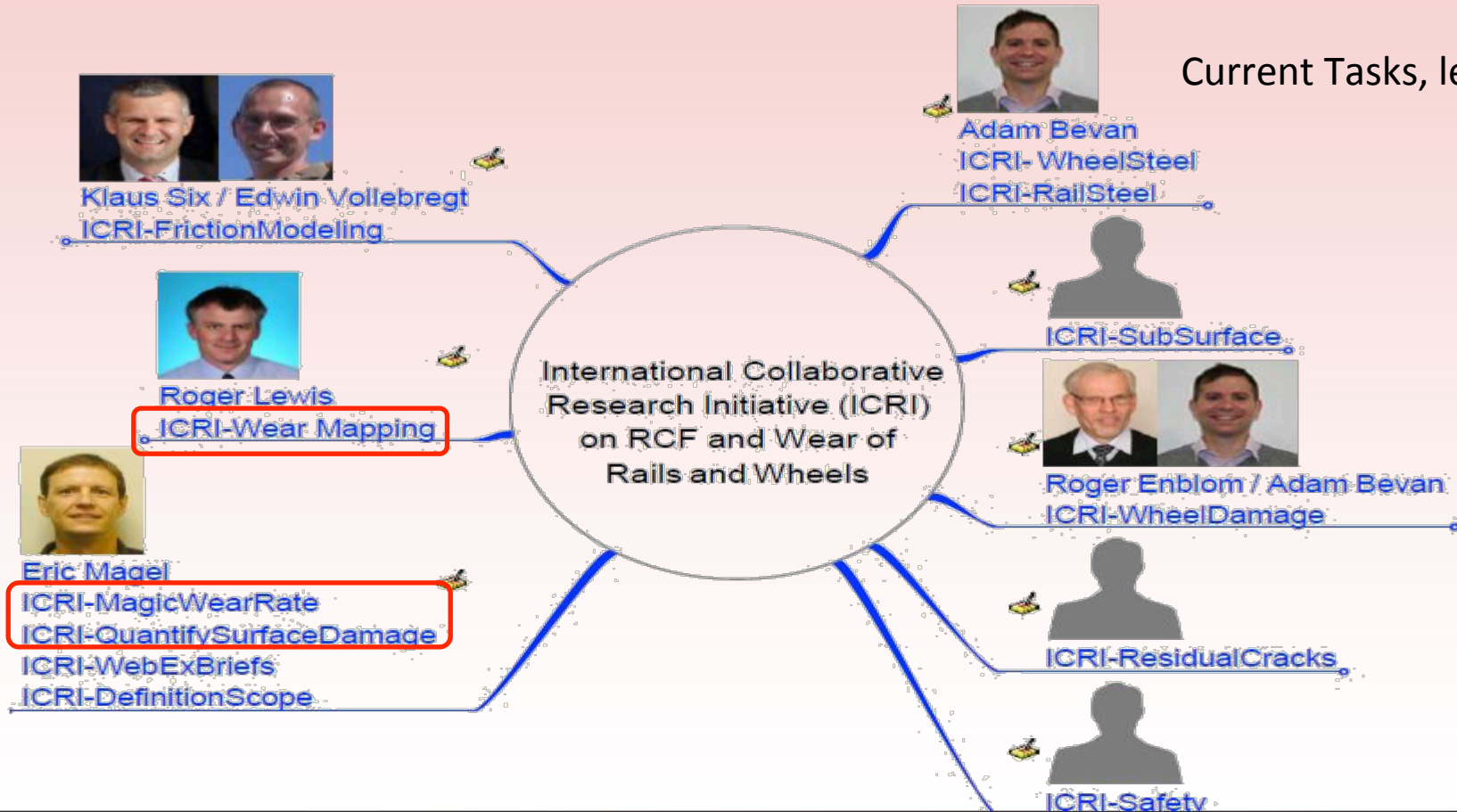


An International Collaborative Research Initiative

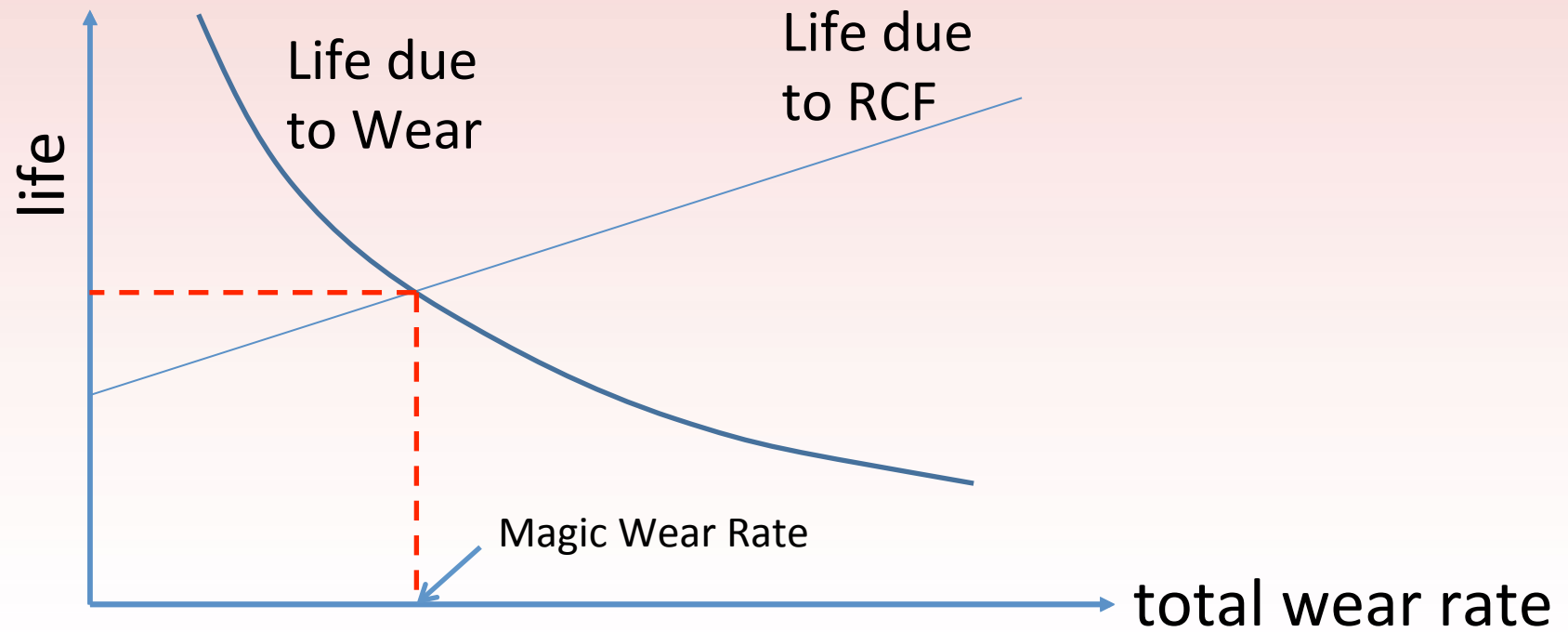
- Develop “open” source modules
 - coding
 - calibration data (field and test)
 - validation



Current Tasks, leaders



Description

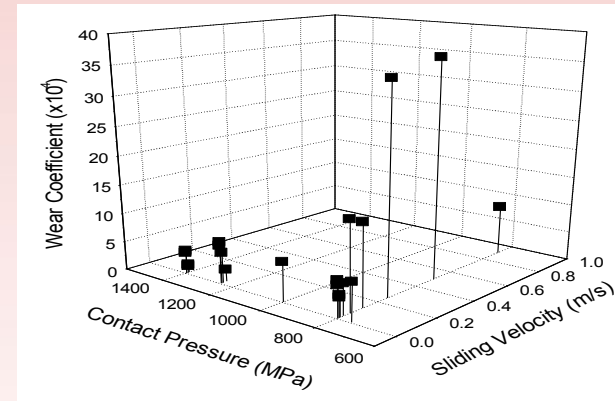
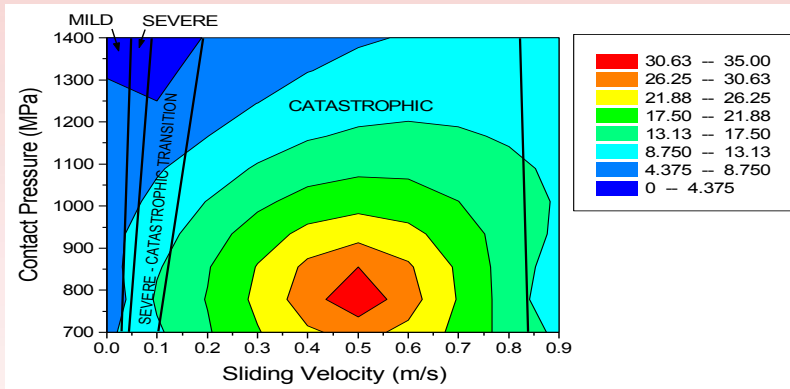


The Development of Universal Wear Maps

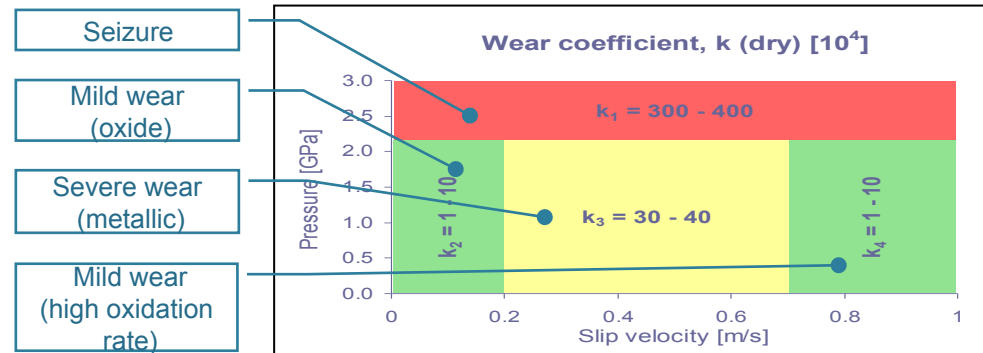
Roger Lewis (Sheffield University)



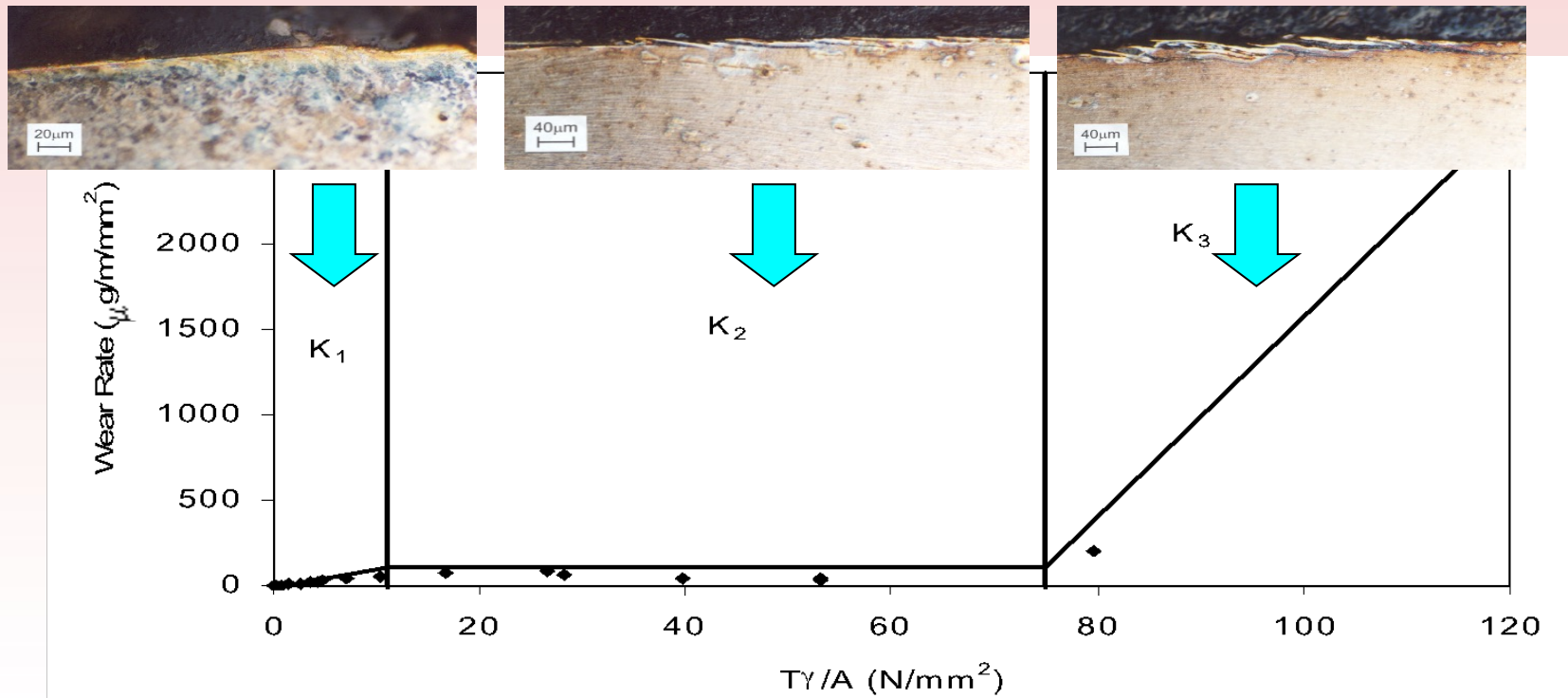
Previous Wear Maps



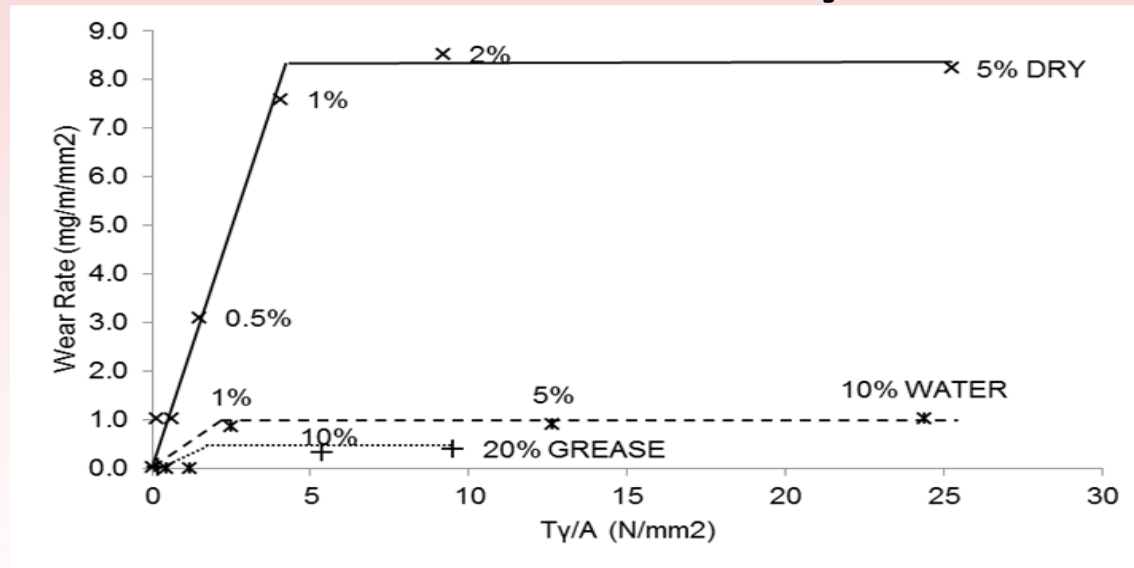
- KTH Archard wear coefficient map extensively used



Wear Regimes and Transitions



Effect of Third Body Materials



- Wet and grease conditions compared with dry



Summary of Progress

- Specs. produced for data collection
- Contact modelling in progress
- Wear data collection underway
- Wear debris collection packs developed
- Wear debris collected from full-scale tests
- Full-scale vs lab scale data compared
- New data on hardness effects
- Abstracts submitted for Railways 2016 on hardness effects and scaling



ICRI Wear Mapping Project: Needs

- More wear data
- More contact data
- More wear debris
- Input on scenarios – where are the issues?
- Have we missed anything?

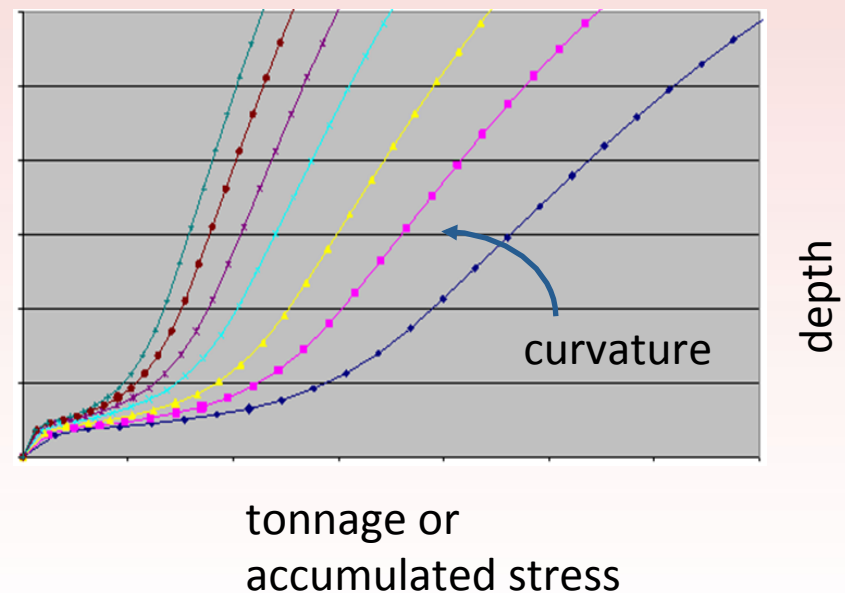


Quantifying the Magic Wear Rate



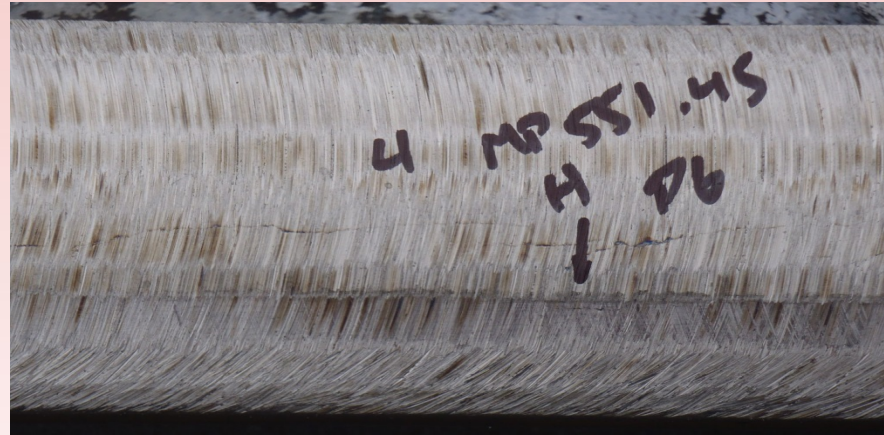
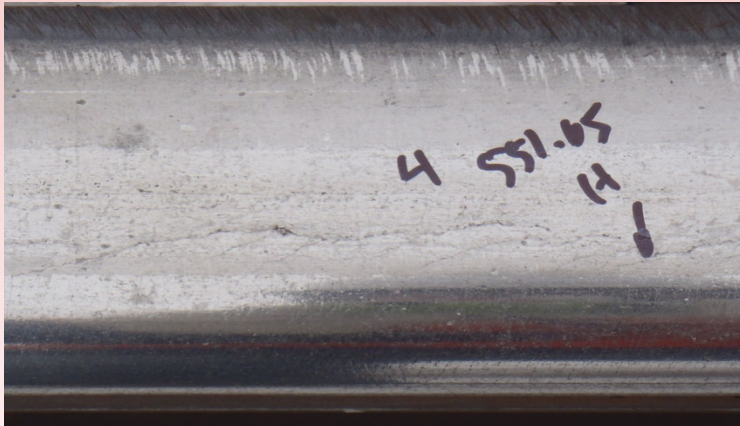
A family of crack growth curves

- probably differs for
 - rail steels
 - curvatures
 - traffic types (e.g. passenger, transit, freight)
 - environmental conditions
 - friction regimes

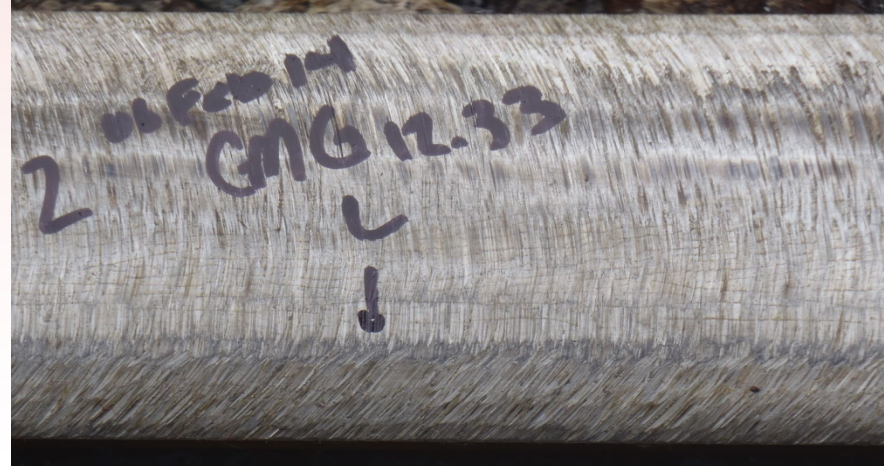
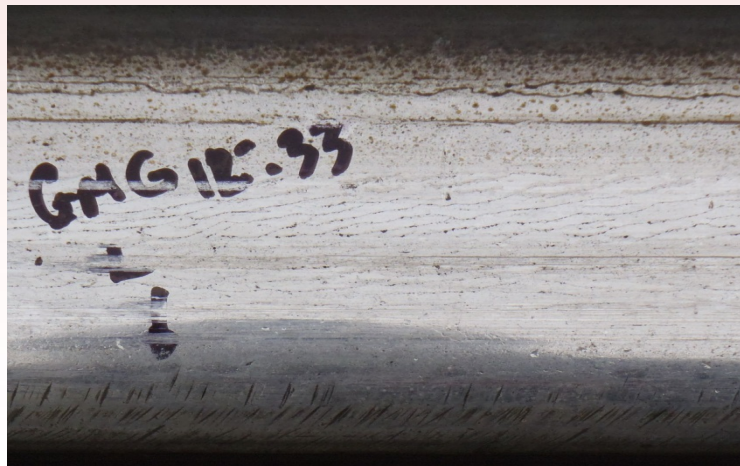


Quantifying Surface Damage





High Rail
1.55 mm
of metal
removed
at crack
location
(6 passes)



Low Rail
0.67 mm
of MR at
crack
location
(3 passes)



Electromagnetic Measuring Systems



MRX



Sperry



Rohmann

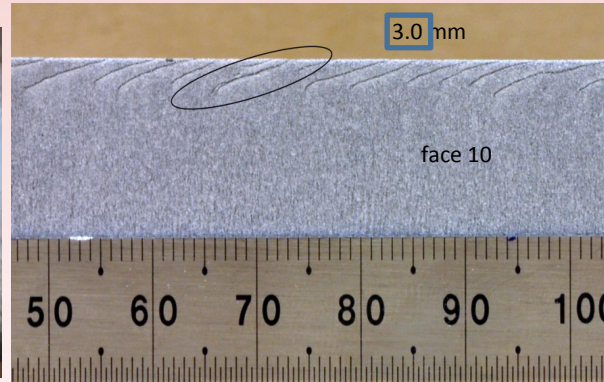


Participating Railroads

- CP (2012-2014), BNSF (Nov 2014): Minnesota
- CN (Current): Wisconsin
- NS (Feb 2014): Virginia
- CSX
 - June 2013 – Bluefield Mountains, TN
 - Feb 2014 - Cincinnati and Big Sandy
 - Current – Waycross, GA

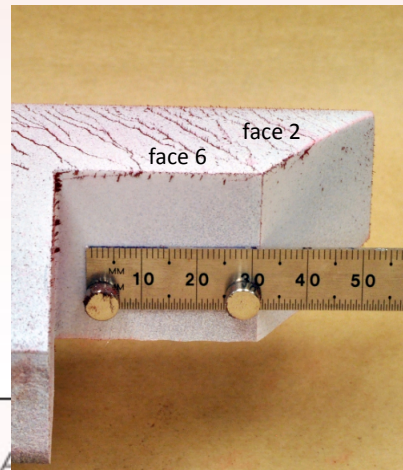
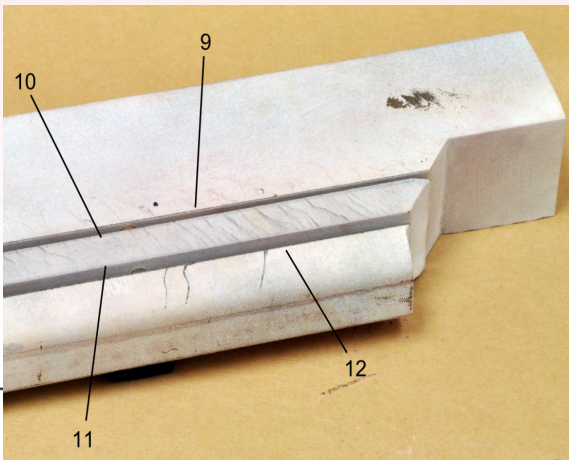


CSX Blue Ridge Subdivision Sample #12



MP T247.79 RIGHT
 Rail Manufacturer: Tennessee
 Rail Year: 1975
 Rail Type: CC
 Rail Weight: 132

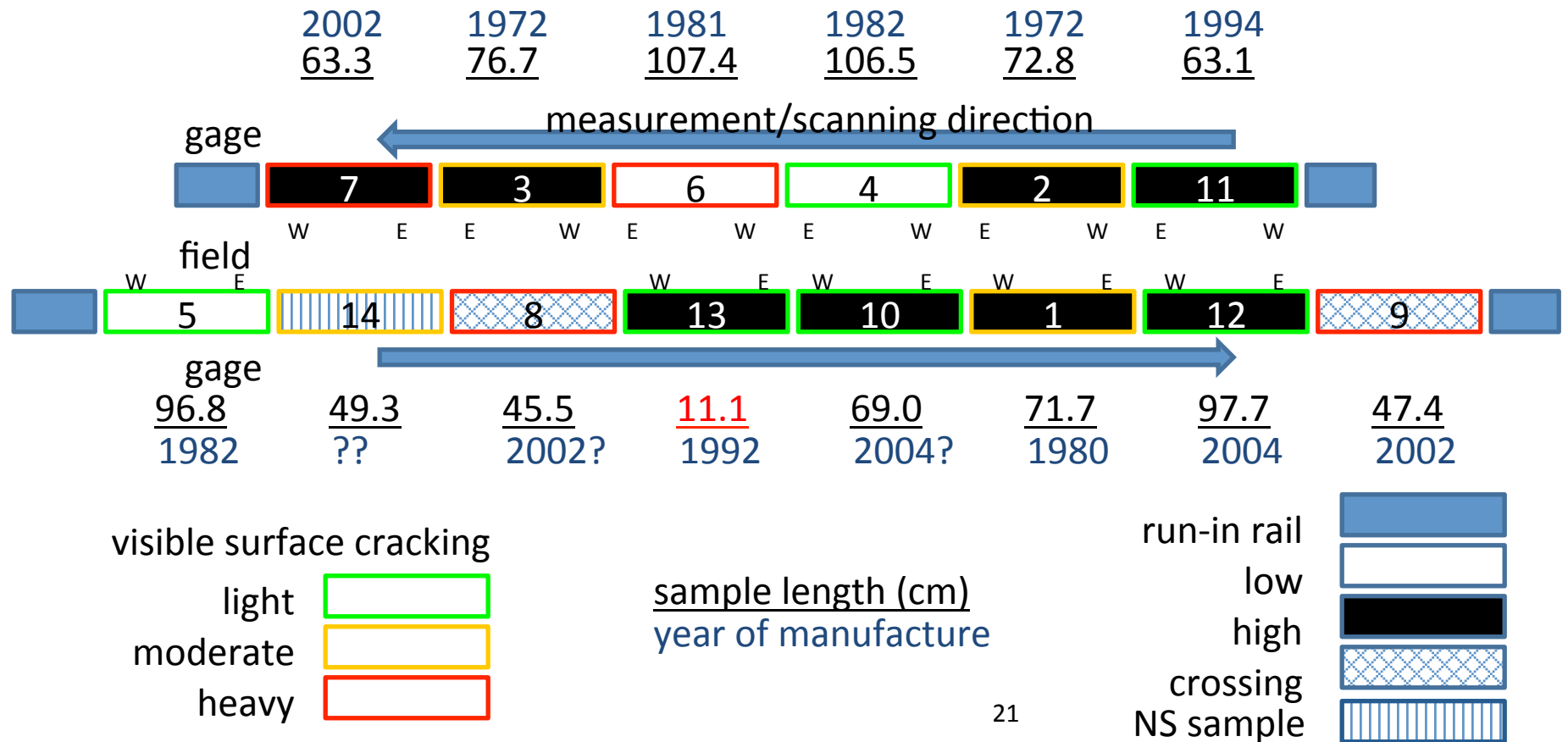
Measured crack depth
 MRX: 6.9
 Rohmann: >5.0



<u>Magnetic Particle Inspection</u>		
	Face 2	Face 6
Max Length (mm)	3.8	2.0
Crack Angle (deg)	23	75
Max Depth (mm)	1.5	2.0
Surface Angle (deg)	46	46

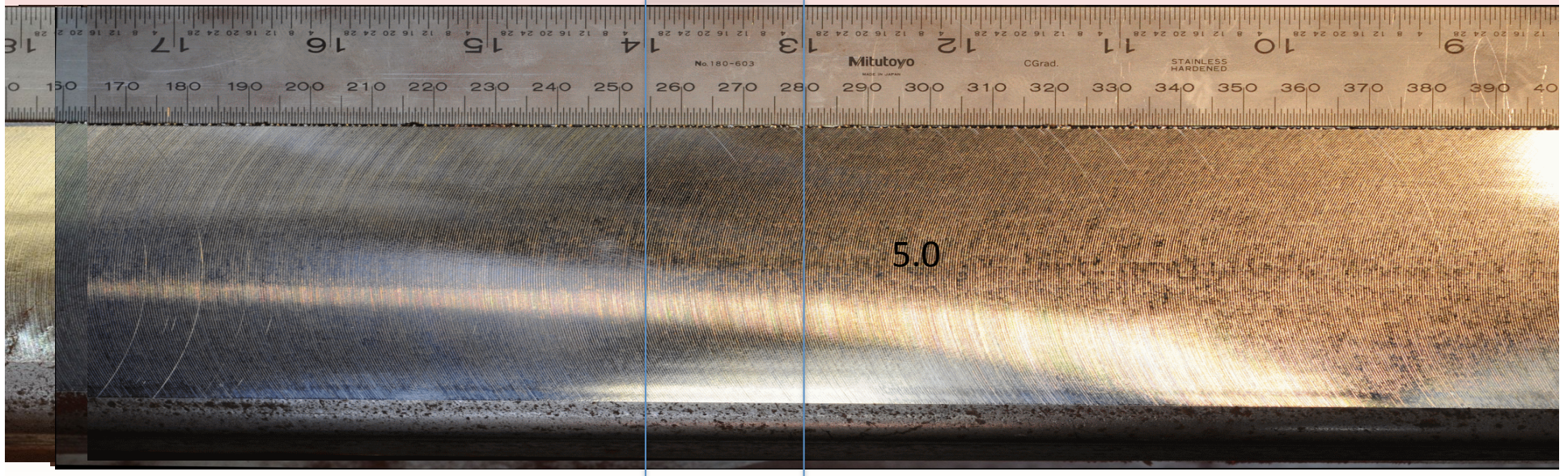


BNSF Staples Subdivision Rail Samples

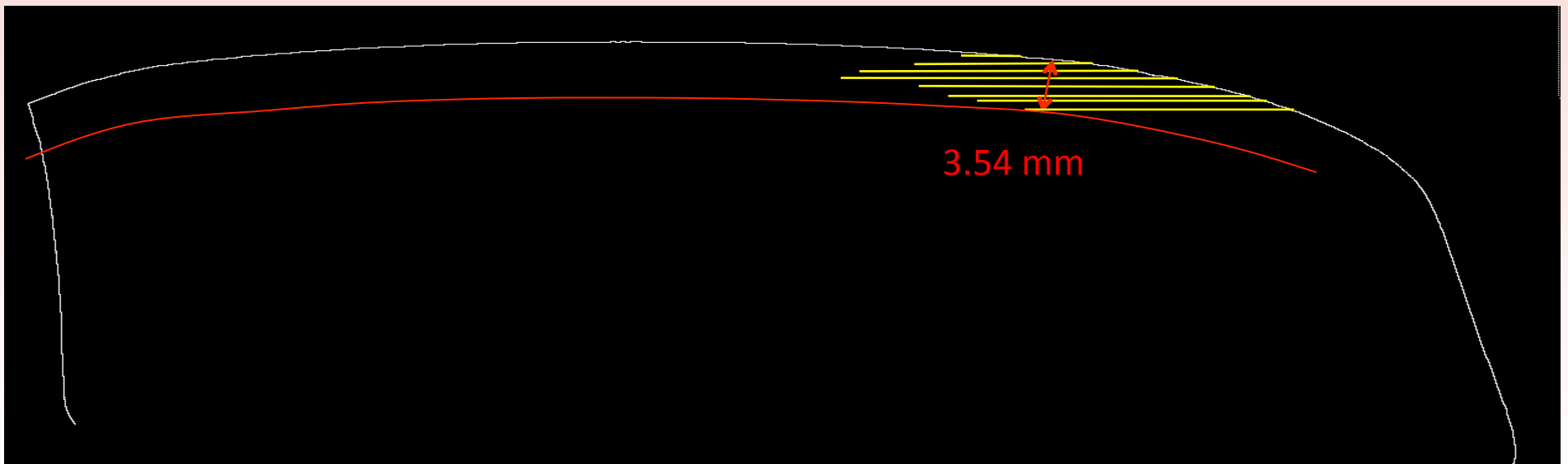


Sample 3

field side

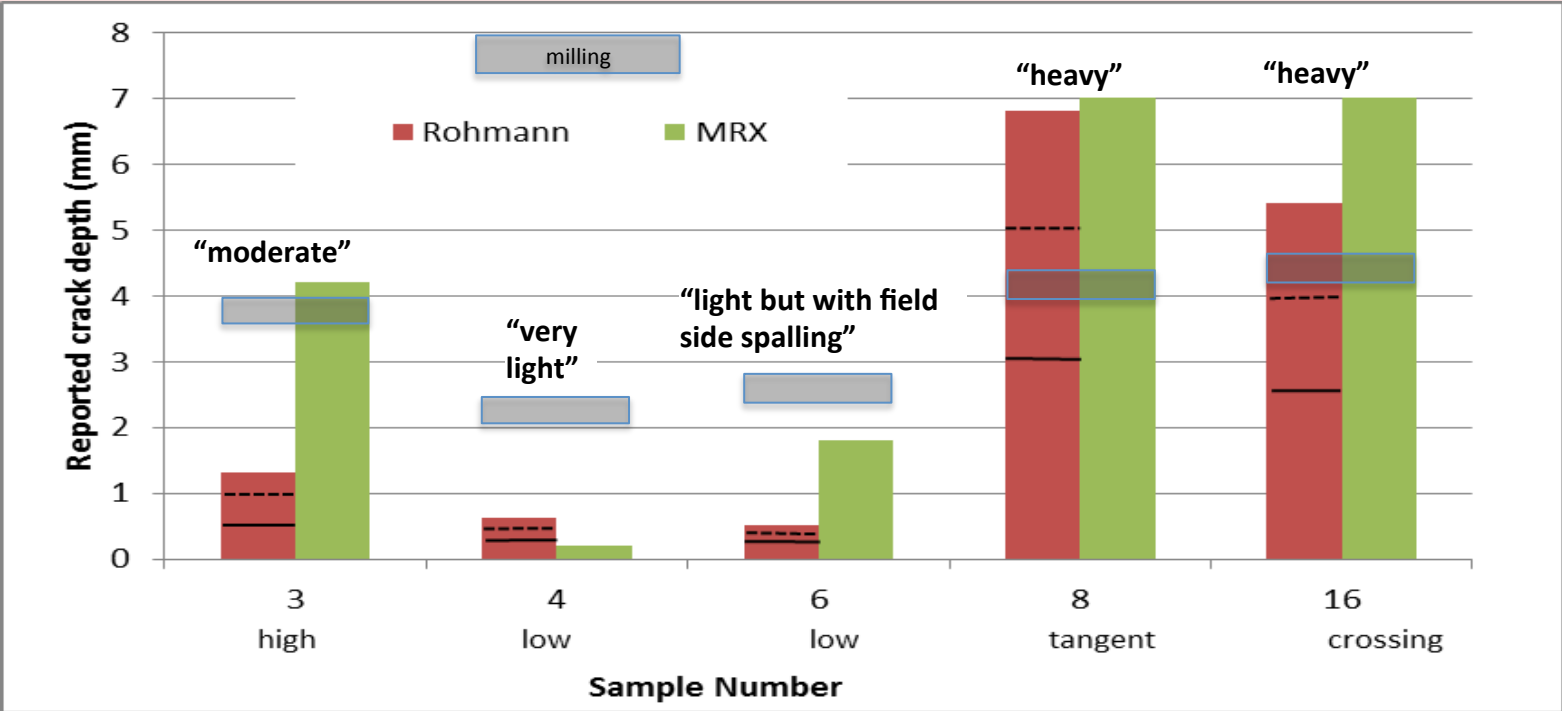
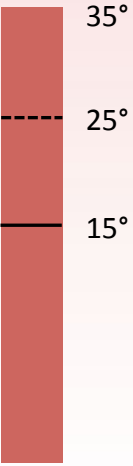


Sample 3: Crack depth

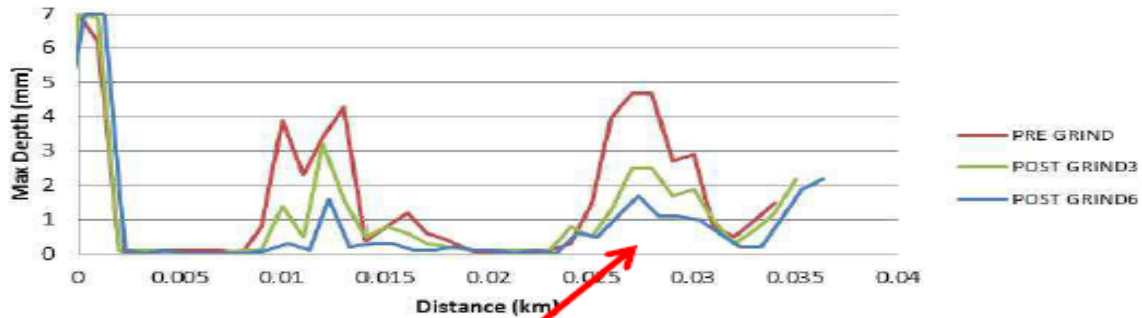


BNSF Staples - Results

Rohmann

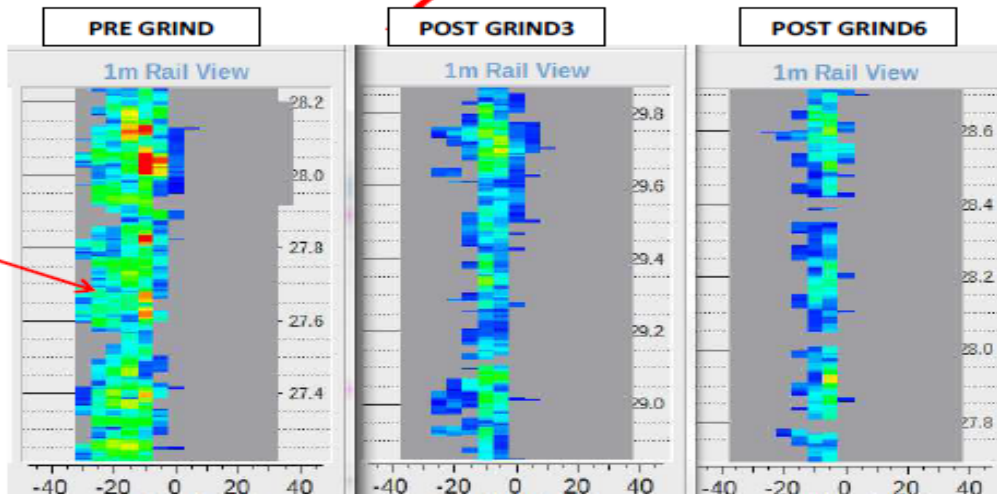


2ND CURVE, HIGH RAIL



Accept that

- “measurements” are indicators
 - light
 - moderate
 - heavy
- trends are valid

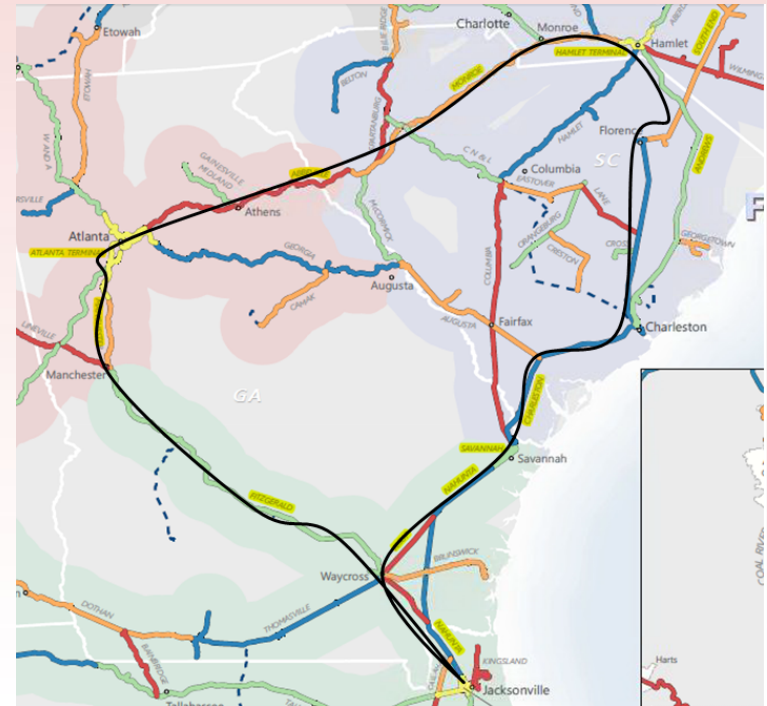


BAND OF RCF CRACKING



CSX RCF monitoring

- 1000 mile loop
- Loram grinding, RIV
- MRX, Rohmann, Sperry
- Will review broken rails, SSC, defects where/when possible



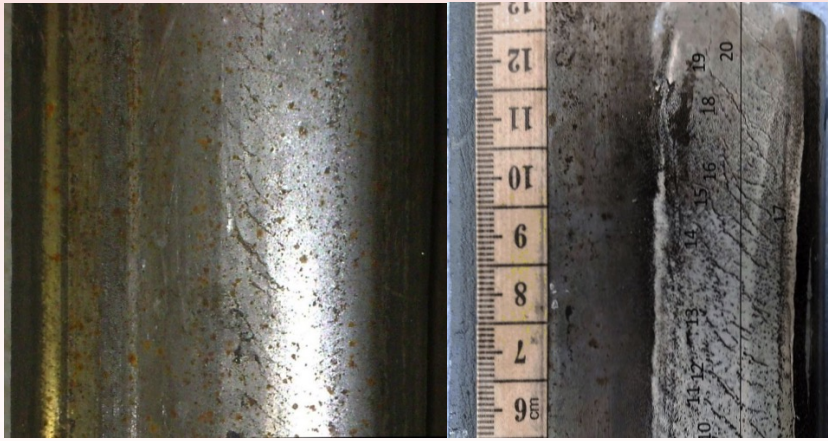
CN Steelton Hill

- Regular monitoring (photos, profiles, MRX)
- Brand new rail installed – will monitor
- So Far: November 2015, April 2016
- Rail samples from Exeland Subdivision
 - “moderate” and “light” RCF on samples
 - Will be sectioned



Atlas of Rail Surface Fatigue

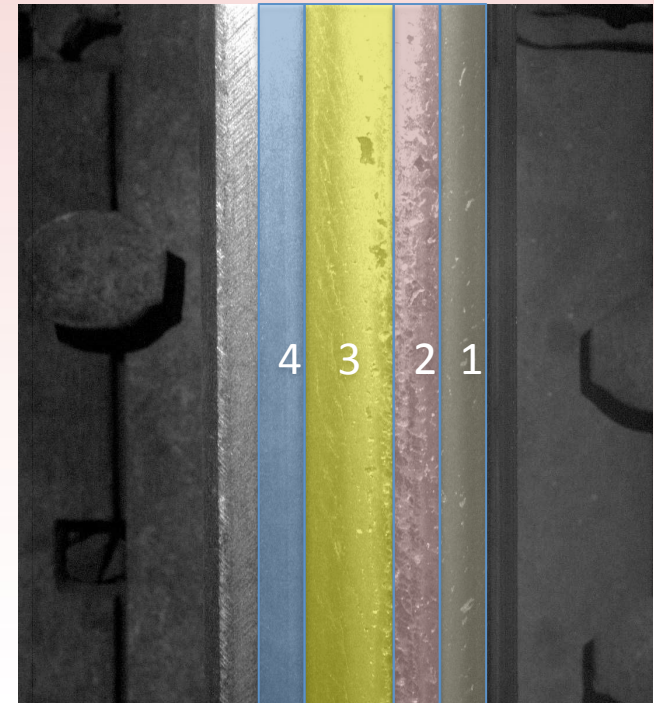
- FRA Project
- Document all samples
- Provide reference photographs
- Represent wide range of conditions
- Possible analytics

High	Low	Tangent	S&C	Railroad: BNSF	Date: removed from track
Metallurgy: 13225 USS Illinois 1972 I				Subdivision: Staples	25NOV14
				MP: 210.7 M1	
				Curvature: 1°	
					
Surface crack length				10 to 17 mm	
Start/end position				8 to 22 mm	
Surface Angle				Approx. 45 degrees	
Crack depth (milling)				1.7 to 2.8 mm	
Spacing (avg) = 4.14 mm					



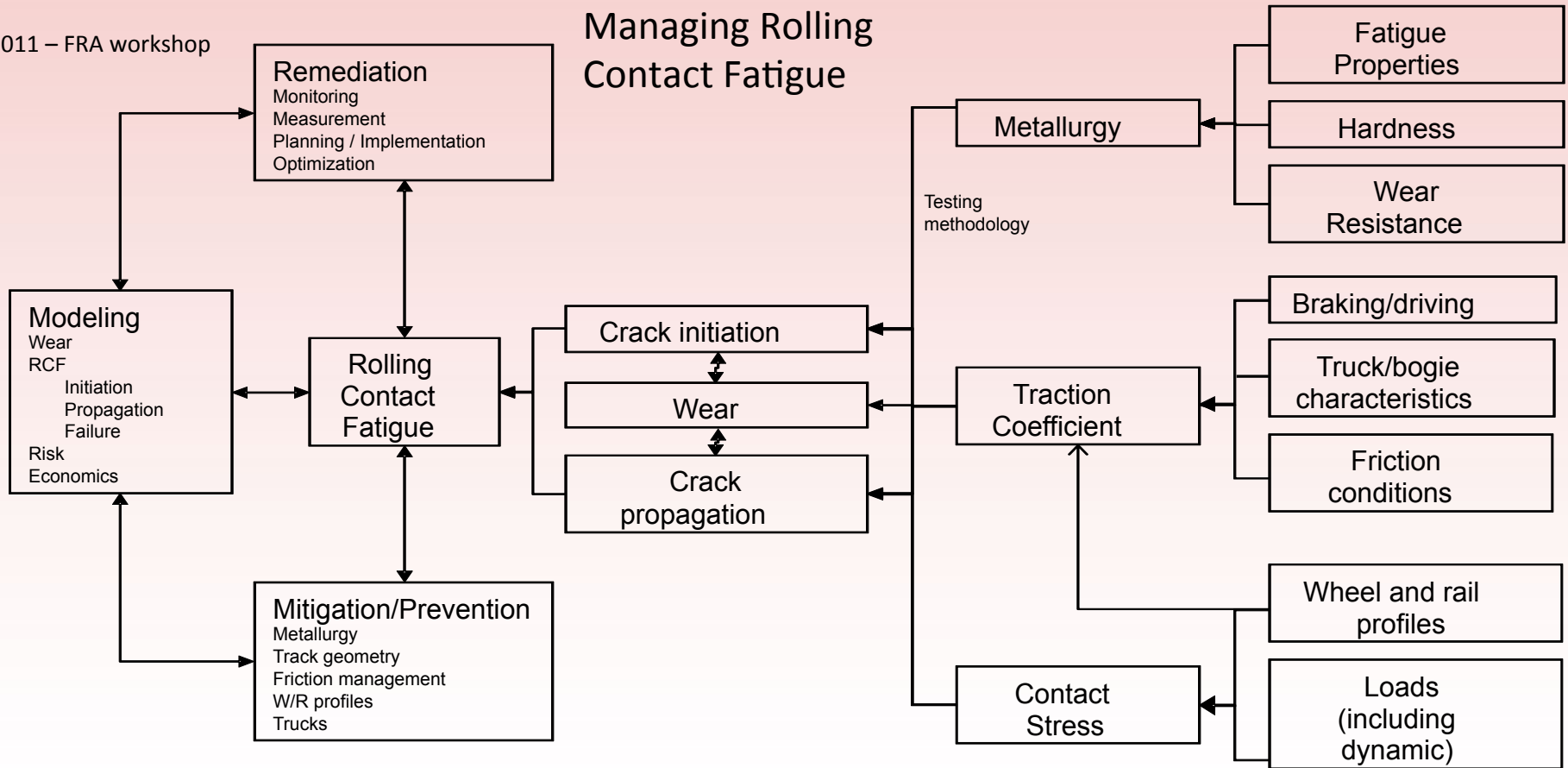
Machine Vision Systems

- 0 None
- 1 barely perceptible, but clearly regular pattern (preventive grinding < 0.5mm).
- 2 clear, well-defined, distinct individual cracks – but no pitting at tip (maintenance, depth < 1.0 mm)
- 3 clear cracking, pits up to 4 mm diam (corrective grinding 1.0-2.5 mm deep),
- 4 pitting greater than 4mm < 10 mm (preventive gradual, up to 3.5 mm deep), or “heavy” cracks with clear lifting of metal or separation of crack faces
- 5 isolated pitting/shelling/spalling > 10, diam (up to 5 mm deep)
- 6 Shelling/spalling: regular pitting, >10mm diam (busted, near impossible to catch up on)
- 7 Shelling/spalling: any defect > 16 mm diam, >20mm length



2011 – FRA workshop

Managing Rolling Contact Fatigue



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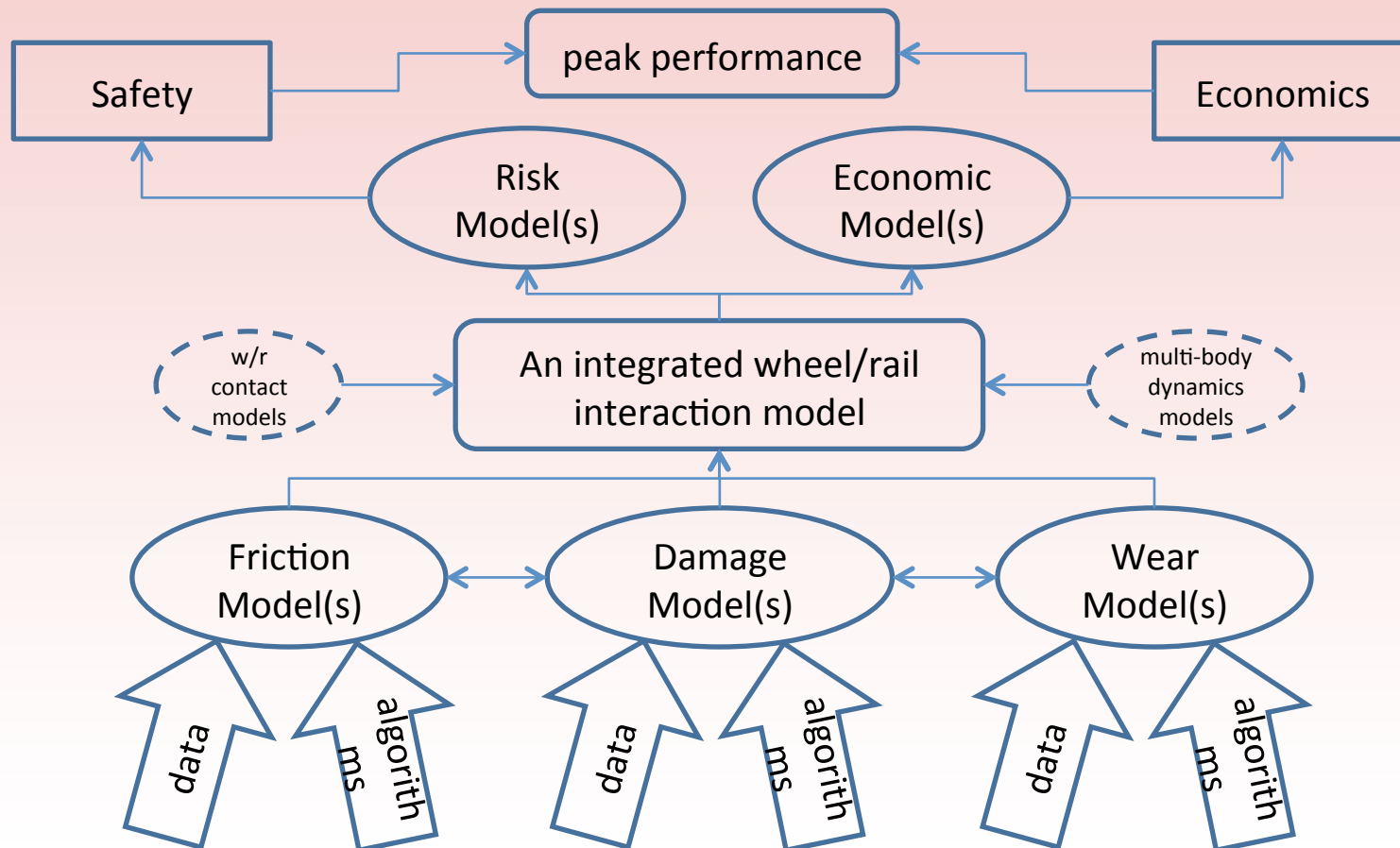


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- Loram
- Rohmann, MRX, Sperry



AWRRISE



Notice: ICRI workshop

ICRI Workshop on
Wear and RCF



RCF and Wear

Rolling contact fatigue (RCF) and wear are inevitable in the wheel/rail system, but resulting failures, derailments and excessive maintenance costs need not be. Understanding why and under which conditions broken rails and derailments are likely to occur will focus research, inspection and maintenance efforts to minimize their probability.

An International Collaborative Research Initiative (ICRI) was created in 2014 to bring together researchers, railroaders and regulators to collaboratively tackle problems of RCF and wear of rails and wheels. This workshop represents approximately the 3 year anniversary of the effort. A strong technical program has been developed and leading experts from North America, Australia and Europe recruited to support the workshop goals. Presentations, facilitated discussions and breakout teams will be used to identify research needs and hopefully lead to the development of additional collaborative research teams.



The ICRI Workshop on RCF and Wear will take place on the University Campus of UBC (University of British Columbia) in the beautiful City of Vancouver between August 2nd and August 4th 2016.

For registration and accommodation please refer to the according links in the top-menu.

We are looking f

icri-rcf.org

Vancouver, Canada

August 2-4

\$100 US registration fee

Sponsors: ARM, Loram, LB
Foster

Organizers: Eadie, Kalousek,
Magel, Stock



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WRI 2016

Thank you!

Eric Magel

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