

Preliminary



3rd TrainDy Study

CEF UBS Action Project

29.11.2022 | CEF PSA UBS | Hybrid meeting

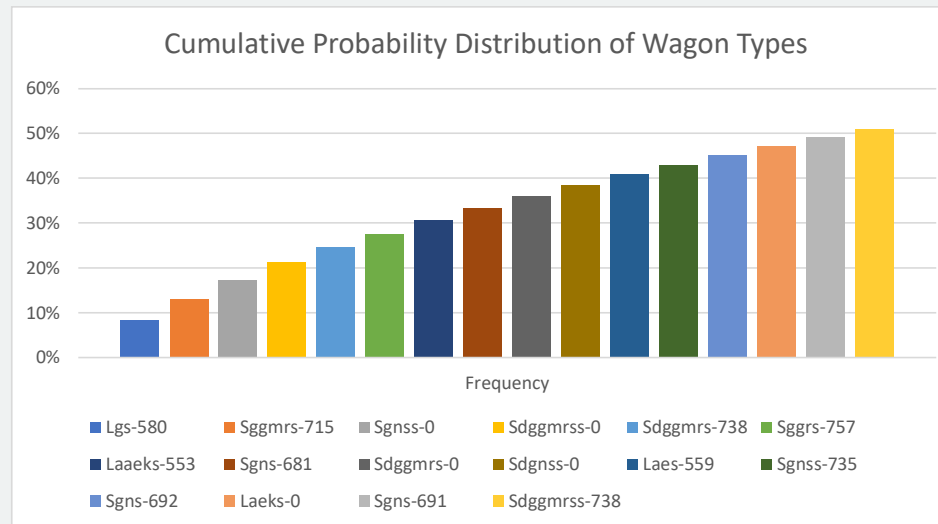
Systemtechnik

- 1. Working steps: how has the study been realized?**
- 2. Preliminary results**

Working Steps



1. Using Real train data from operation in 2016 as basis for virtual train formation
2. Filtering real train data → taking into account only trains containing at least 1 intermodal wagon
3. Gathering cumulative probability distributions from filtered data
 - Distribution of Wagon type

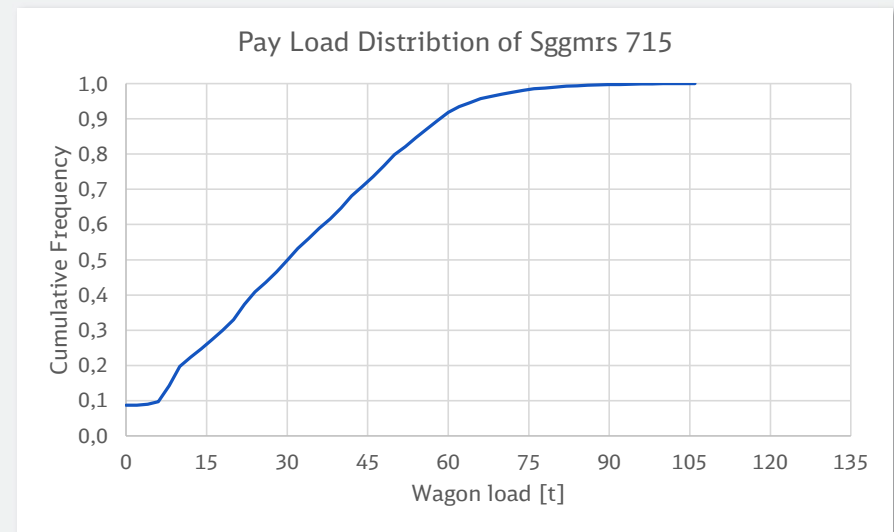
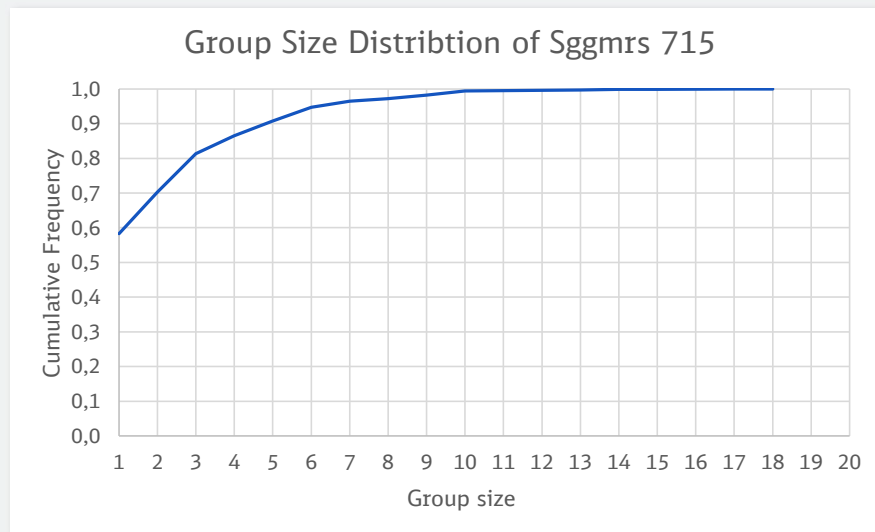


Working Steps



4. Gathering cumulative probability distributions from filtered data

- Distribution of group size (number of wagons forming a group of the same wagon type)
- Distribution of Payload for each wagon type



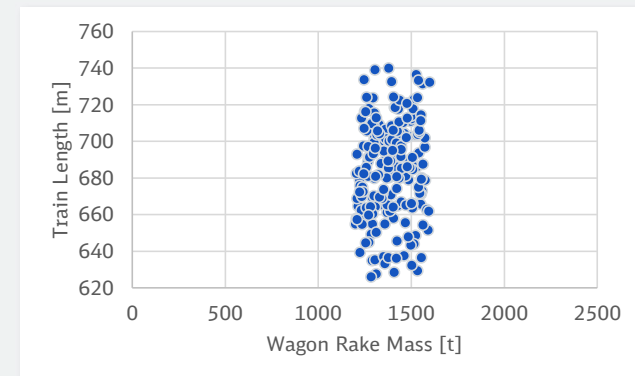
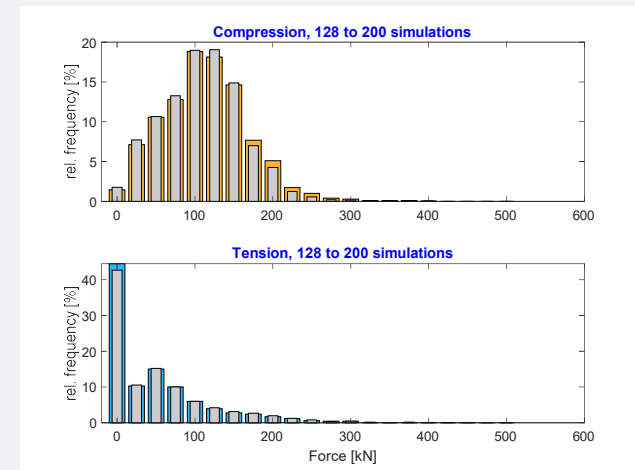
Working Steps



5. Building virtual data based statistics of filtered data and

- in accordance with IRS 40421
- applied manoeuvre:
Emergency Brake as first scenario
- applied brake blocks:
Mix of Cast iron and Composite blocks type K
- Train length between 650 and 740 m
uniformly distributed
- One locomotive
- Sample size is 200 train

6. Simulation of Reference virtual trains with a wagon rake mass of 1200 to 1600 tons with Brake Regime LL



7. Setting wagon mass to a **minimum of 32 tons** for trains with wagon rake mass > 1600 tons
- Mass Scaling of wagon rake in accordance with proposal of Prof. Cantone

$$M_{new} = M_{new,min} + \frac{(M_{new,max} - M_{new,min})}{(M_{ref,max} - M_{ref,min})} (M_{ref} - M_{ref,min})$$

- Mass scaling is only applied if wagon's maximum pay load* is not exceeded
8. Simulation of Variants:
- Variant 1: Reference + Brake Regime XLL (Locomotive and first 7 wagons in Brake Position G)
 - Variant 2: Variant 1 + Mass shift to mass range **1600 to 2200 tons**
+ 32 tons minimum mass of wagons
 - Variant 3: Variant 2 + shifting articulated and permanently coupled wagons to end of train
 - Variant 4: Variant 3 in reverse order

* Maximum pay load does not correspond to axle mass limit of 22.5 tons but to the maximum load observed in the statistical database from real operation

9. Ratio of Occurring Force versus Tolerable Force for each wagon:

- in accordance with IRS 40421
- Determination of relevant load L_{Low} for articulated or permanently coupled wagons:

$$L_{High} = \min\left(L, \frac{L_{Wagon,max}^*}{2}\right)$$
$$L_{Low} = L - L_{High}$$

10. Comparison Preliminary Results of Reference and Variants

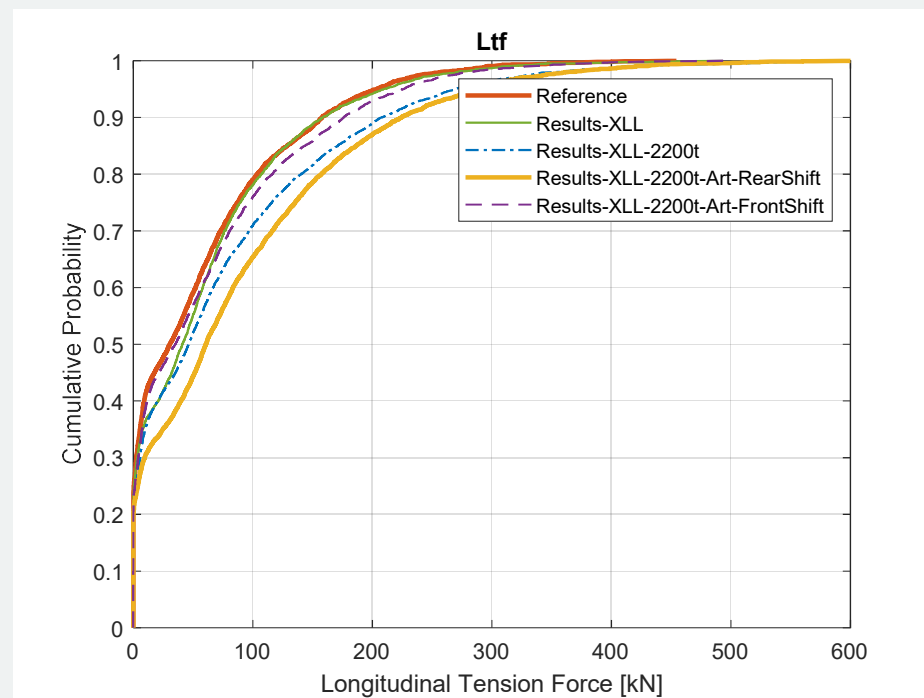
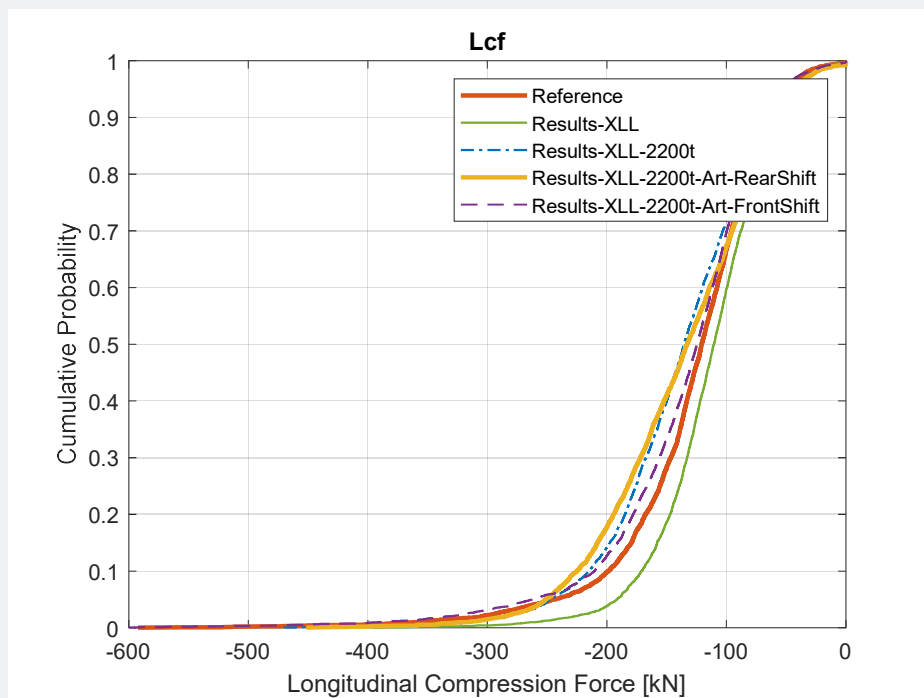
11. Discussion of Results within TrainDy Working Group → Modifications & Optimisations

* $L_{wagon,max}$ is the maximum pay load observed in the statistical database from real operation

Longitudinal Forces

Preliminary Results

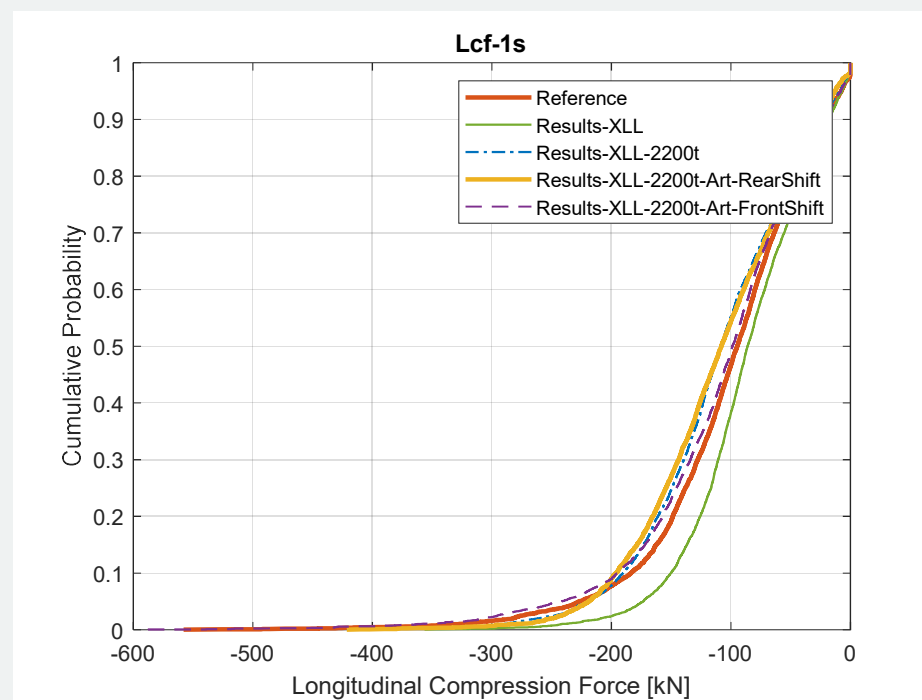
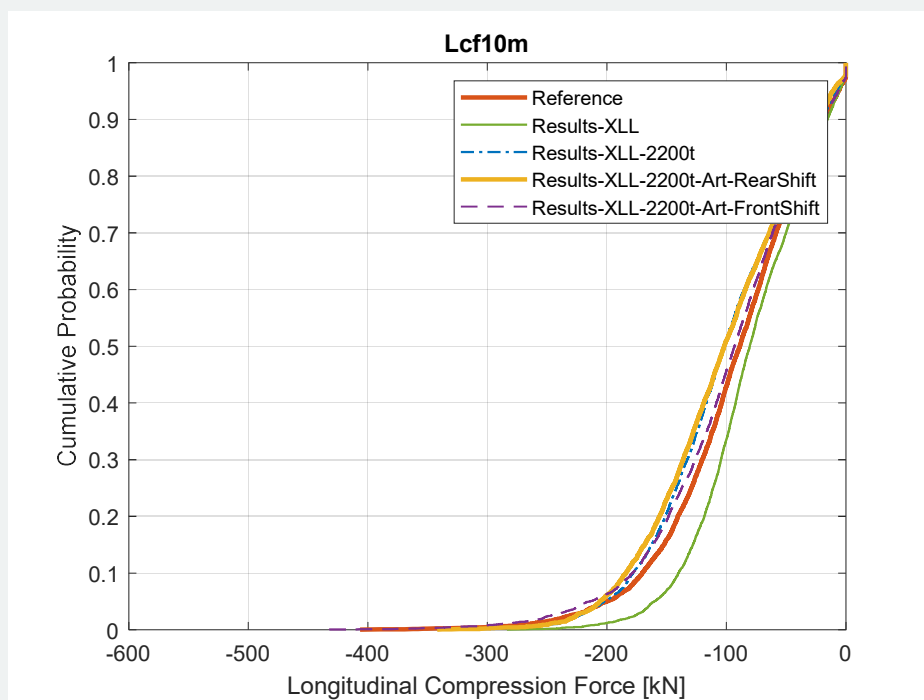
Longitudinal Forces of all Wagons



Minimum Compression Forces in interval (10m or 1s)

Preliminary Results

Filtered Compression Forces of all Wagons

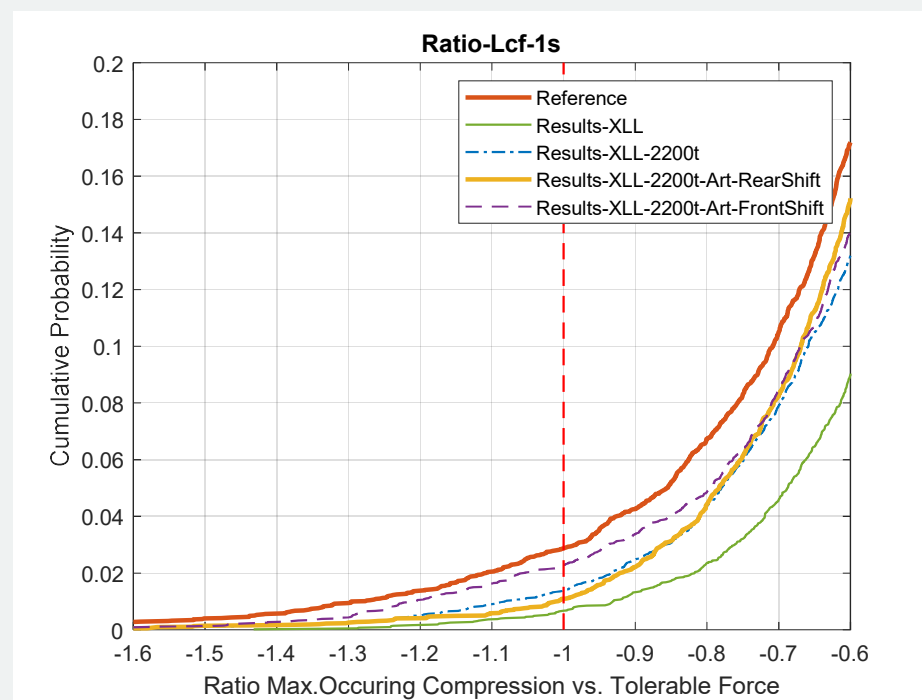
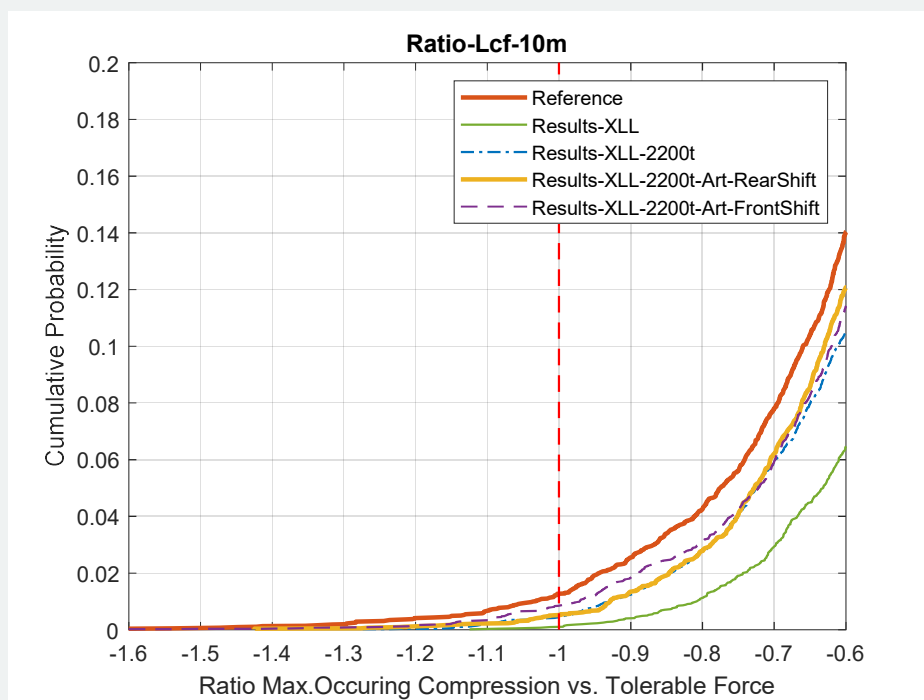




Potential Derailment

Preliminary Results

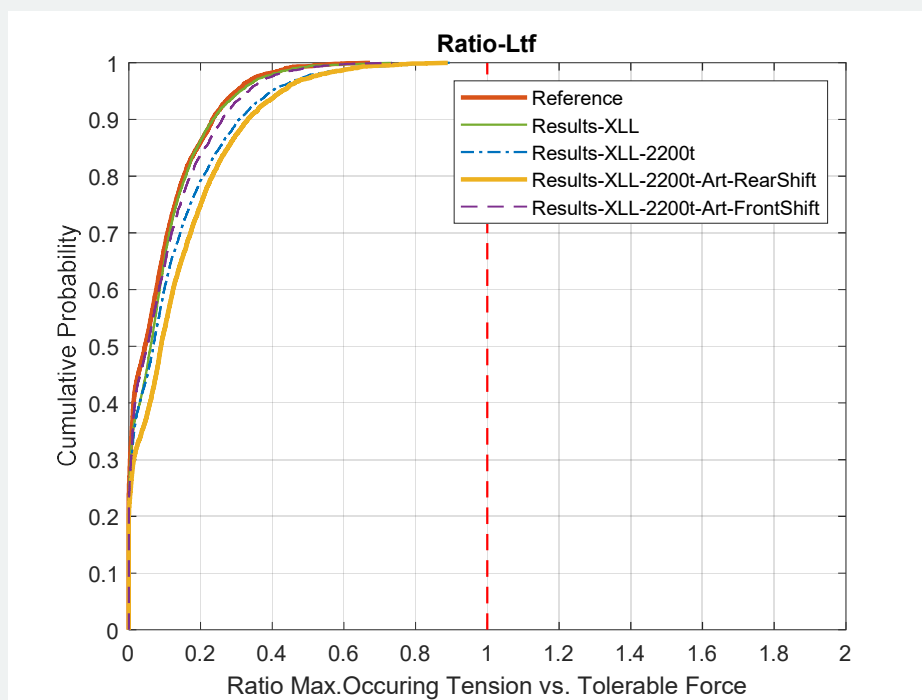
Ratio Occurring vs. Tolerable Force for each wagon



Potential Disruption

Preliminary Results

Ratio Occ. Vs. Tolerable Tension Forces, all Wagons



- Limit Tension: 675 kN
in accordance with EN 15566
- fatigue criterion
 - referring to 1450 load cycles (associated with 20 years of operation)

3rd TrainDy study

Preliminary results



Thank you for your attention!