Simulation of dynamic behaviour of the new low floor tram SIRIO for Milan

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- 6 Persons

Competencies

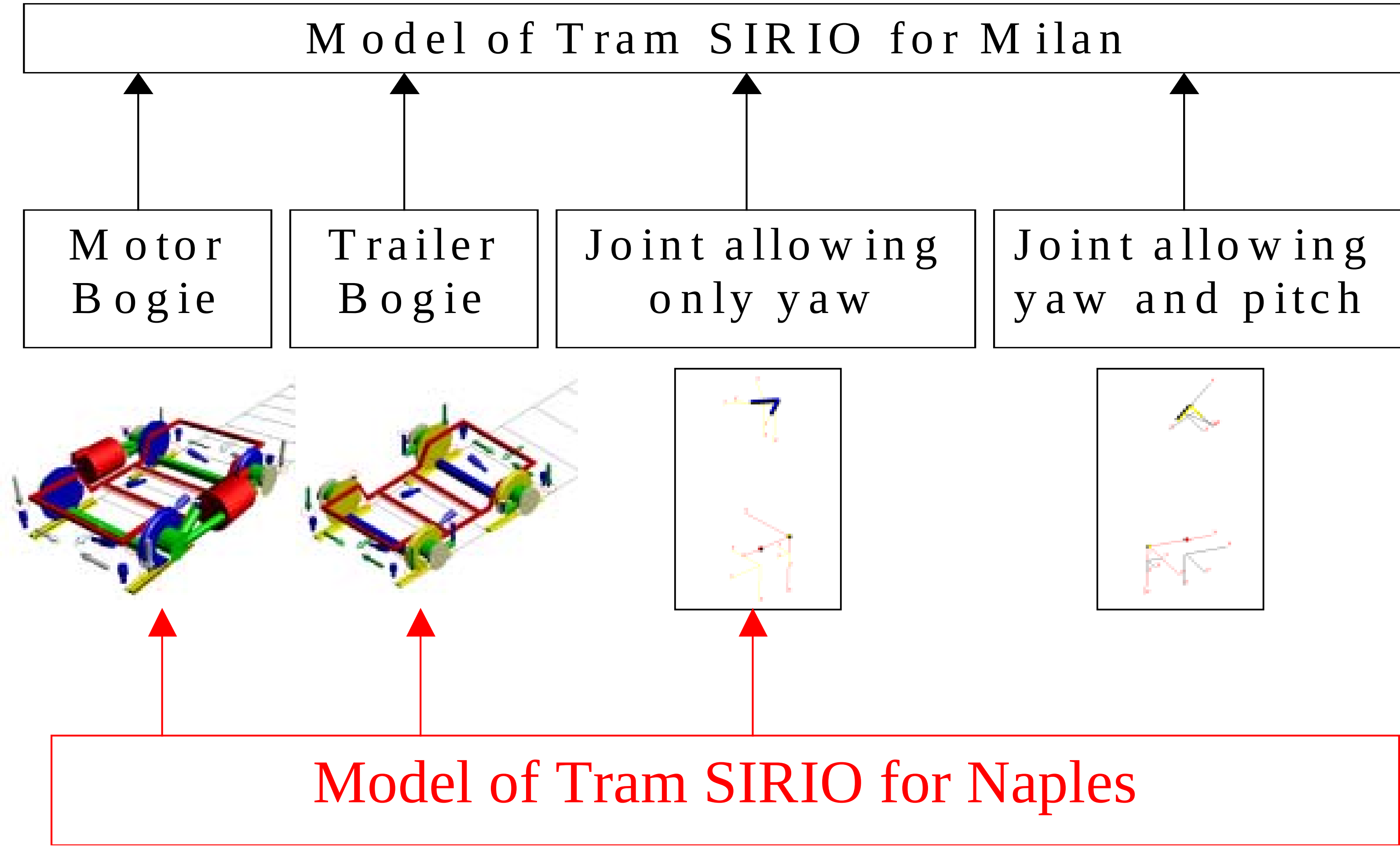
- Static analysis (linear and non linear)
- Fatigue analysis
- Dynamic analysis
- Running behaviour / Comfort
- Crash analysis

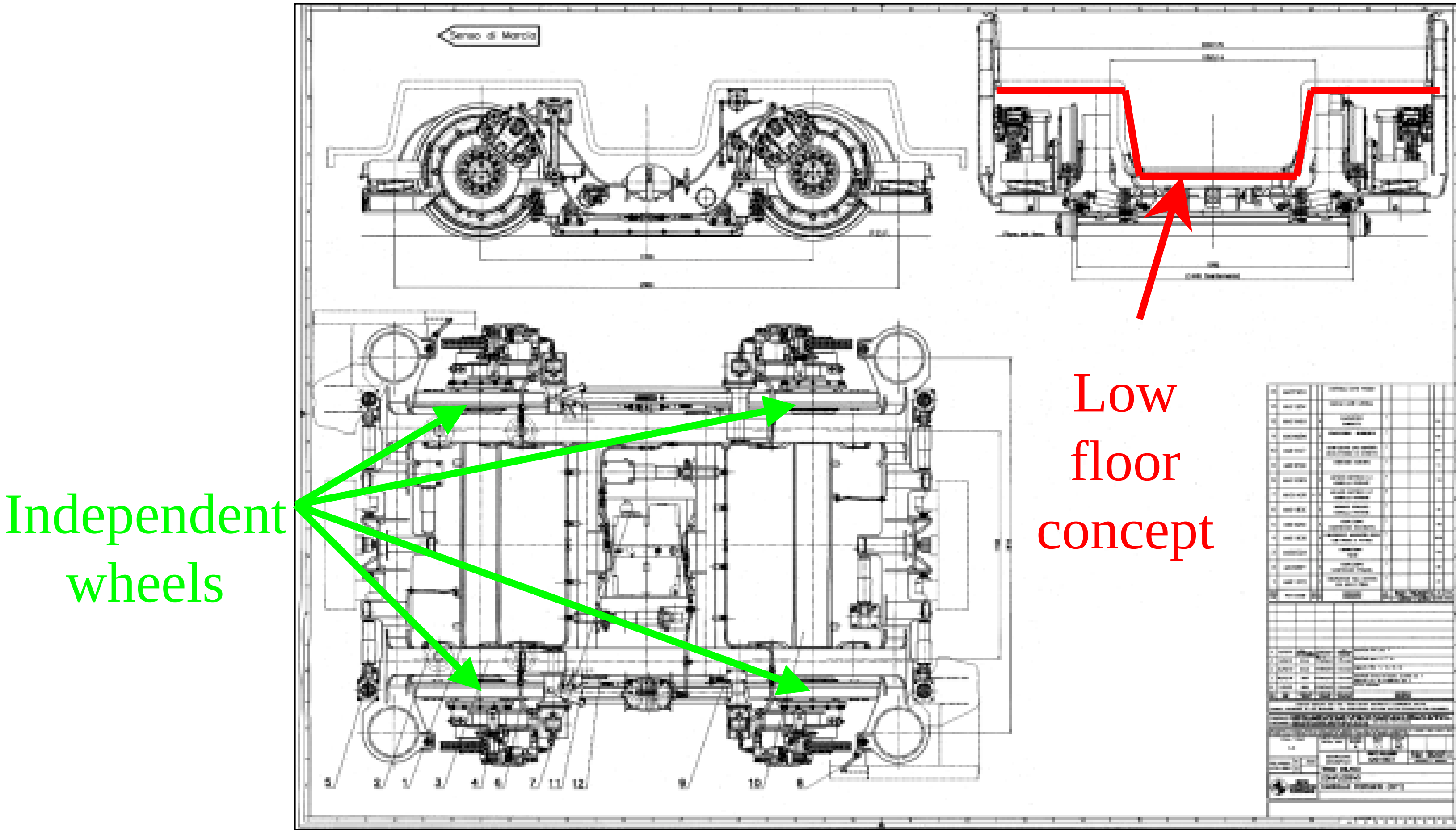
Introduction

- **Main features of SIRIO tram:**
  - Completely low floor tram, with pavement height at 350mm over the top of rail,
  - Architectural modularity,
  - Bogies having independent wheels.
- **Purpose of analyses:**
  - Simulation of SIRIO tram with SIMPACK.
- **The activities on this project are not finished yet**

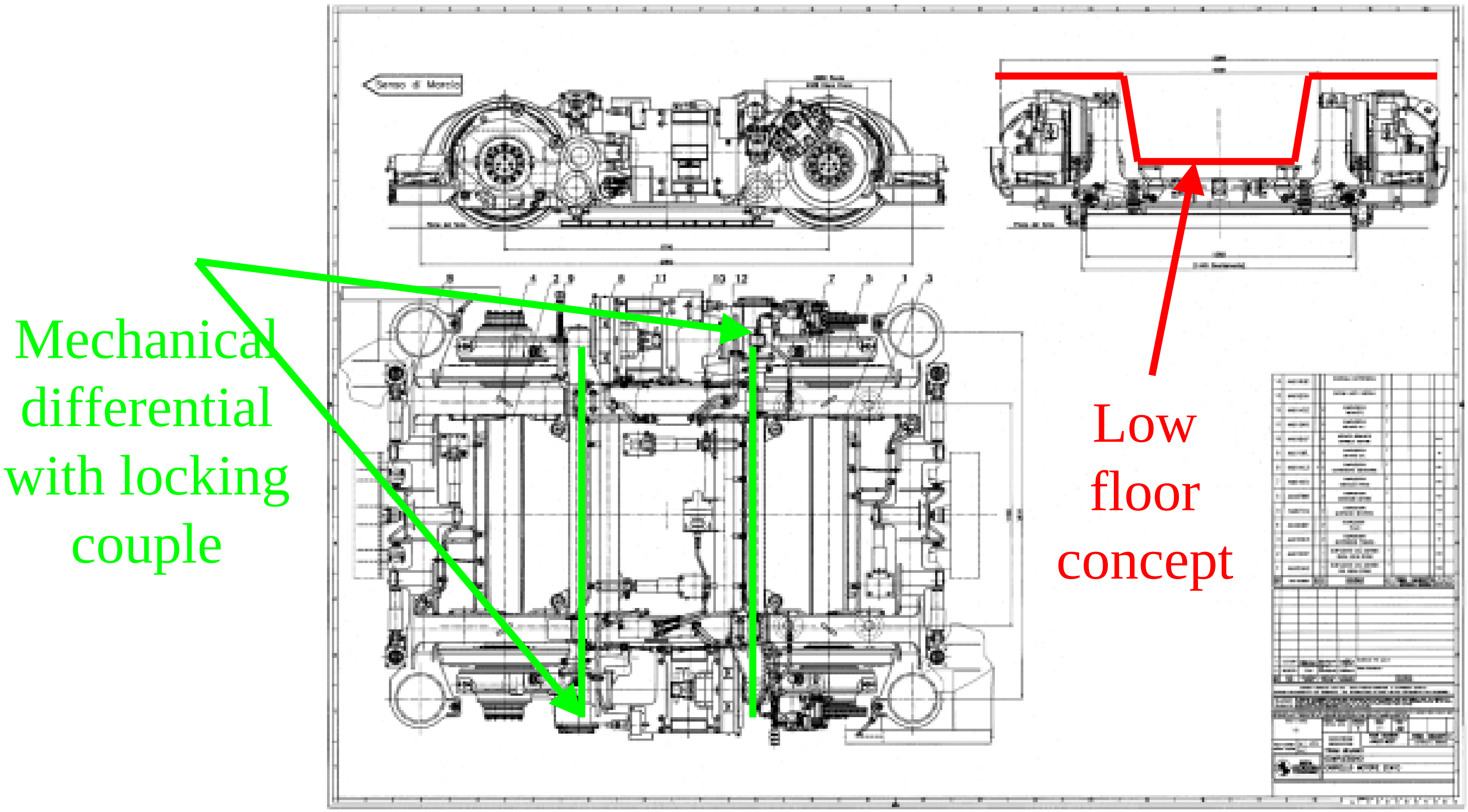
Tram model

In order to reuse the sub components of tram SIRIO for Milan in other projects the database concept of SIMPACK is very useful


Model of Tram SIRIO for Milan
Motor Bogie
Trailer Bogie
Joint allowing only yaw
Joint allowing yaw and pitch
Model of Tram SIRIO for Naples

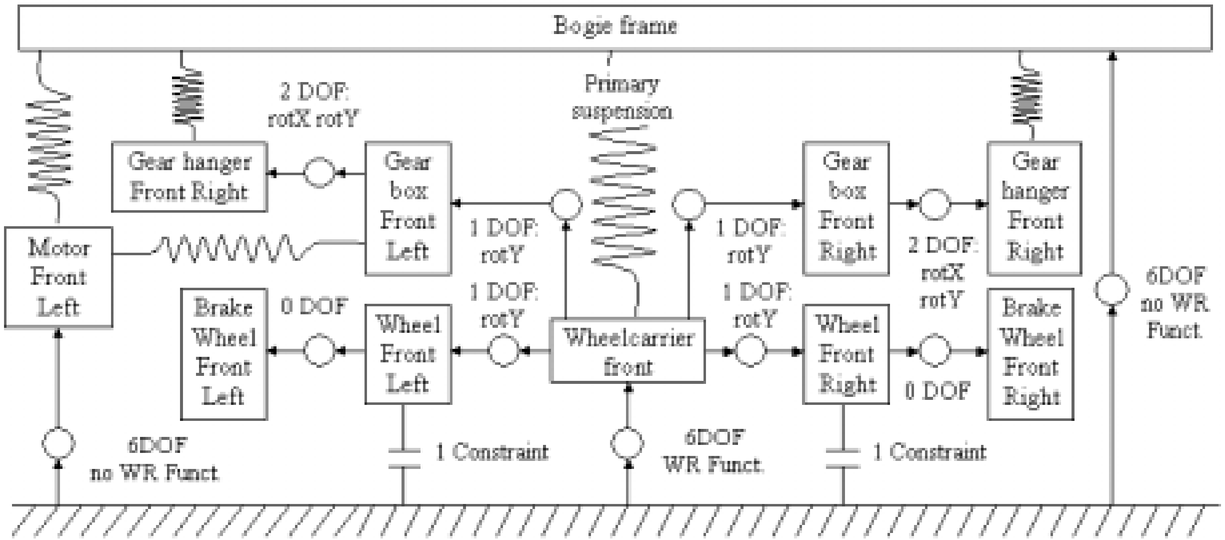


- Trailer bogie drawing



- Motor bogie drawing

Independent wheels topology

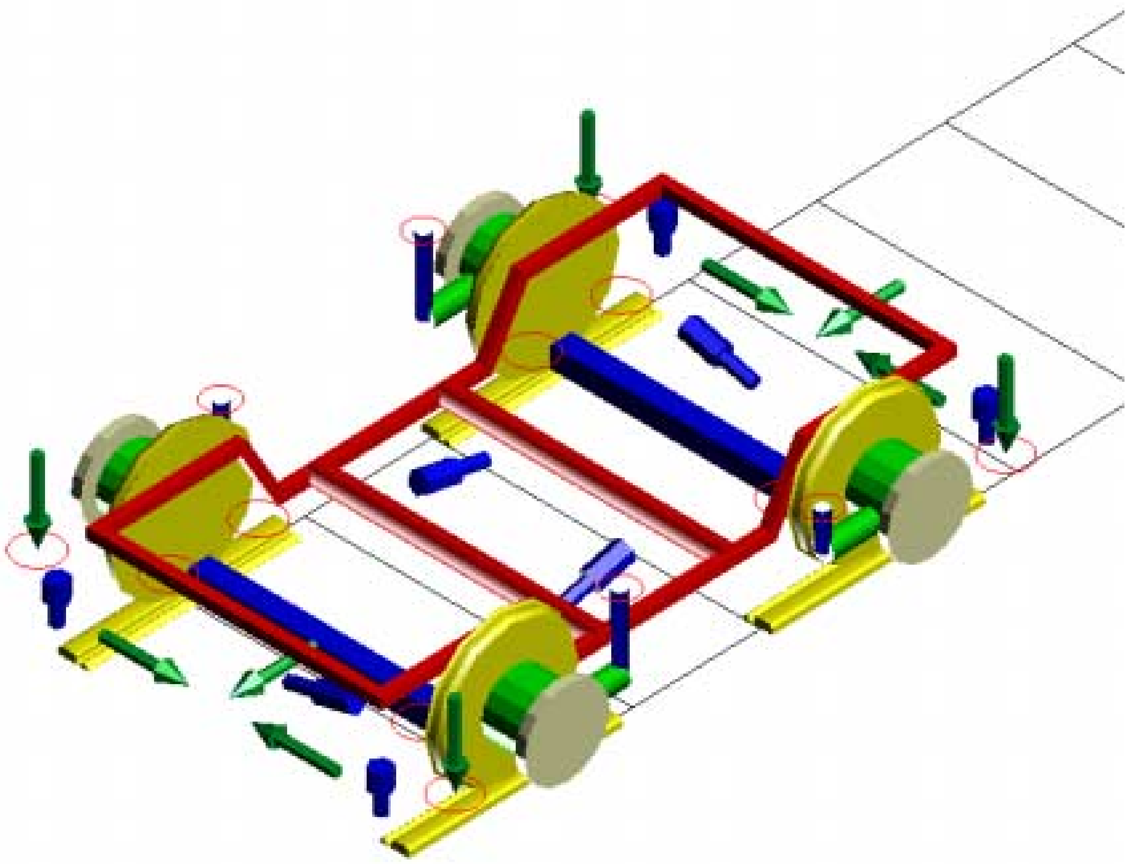


Motor bogie wheelsets

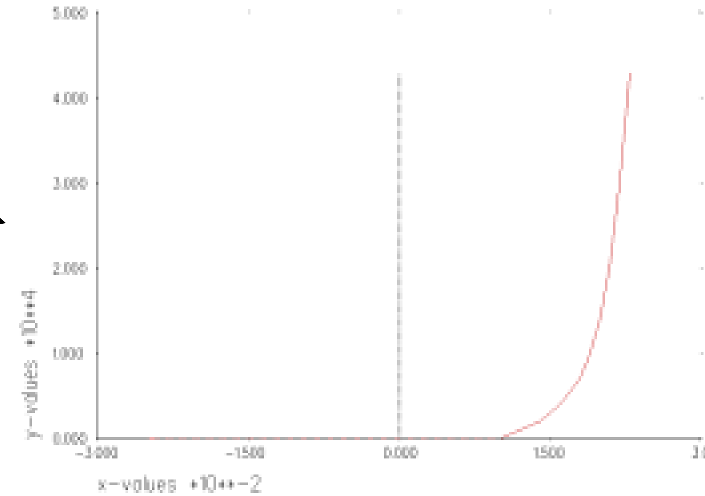
- A) Independent wheels
- B) Connected wheels

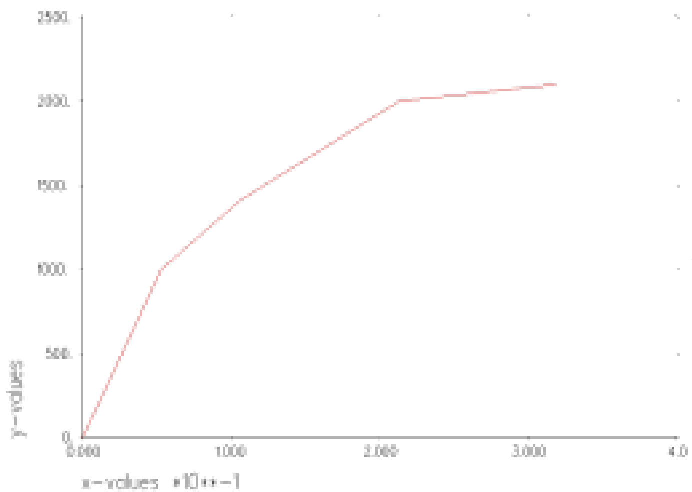
Trailer bogie model

- Stiffness of primary and secondary suspension stage
- Dampers characteristics
- Bumpers behaviour
- Rubber joints stiffness



- Non linear bumpers behaviour

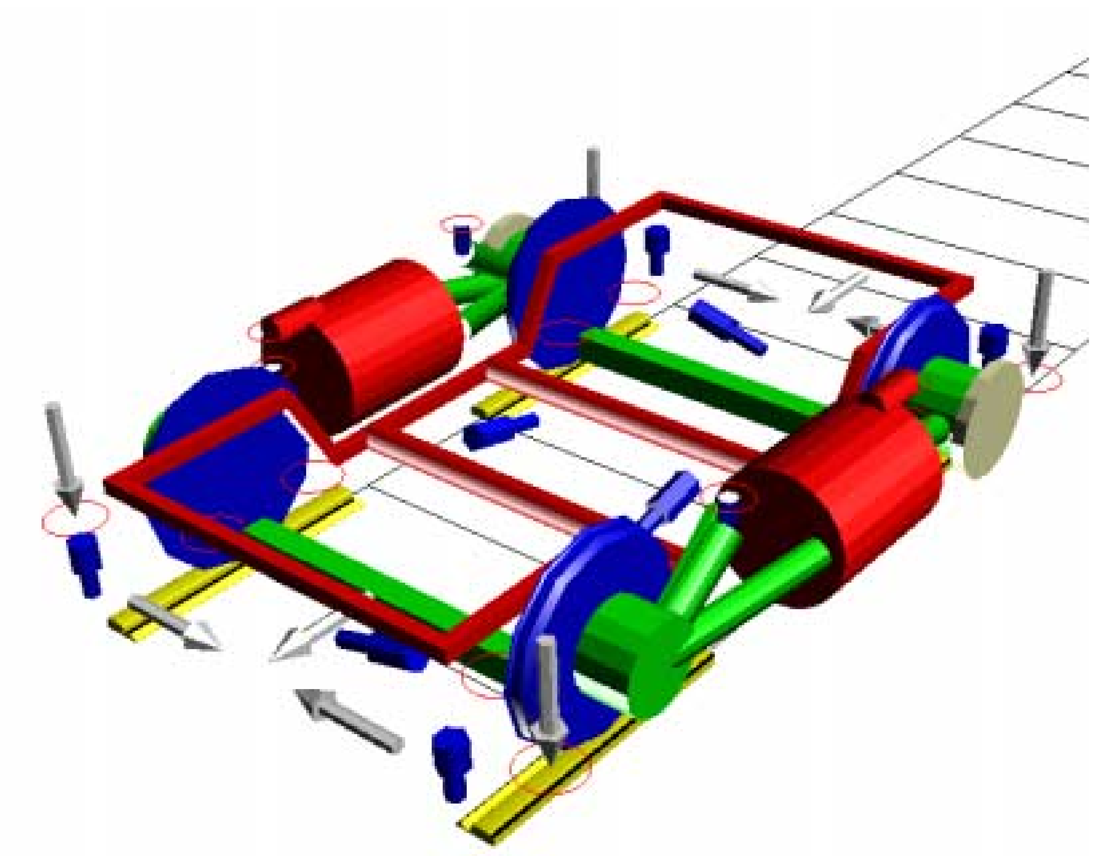




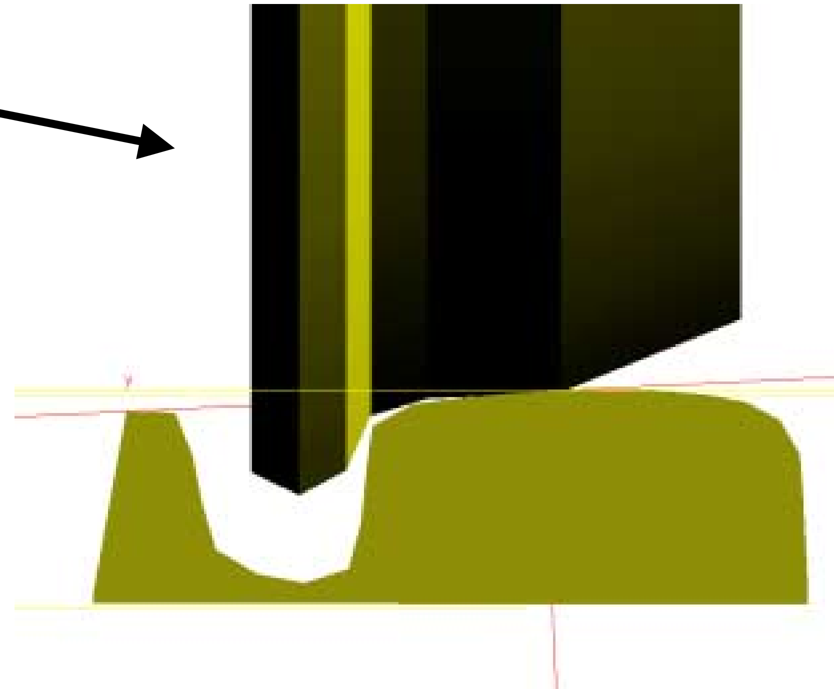
- Non linear dampers characteristics

Motor bogie model

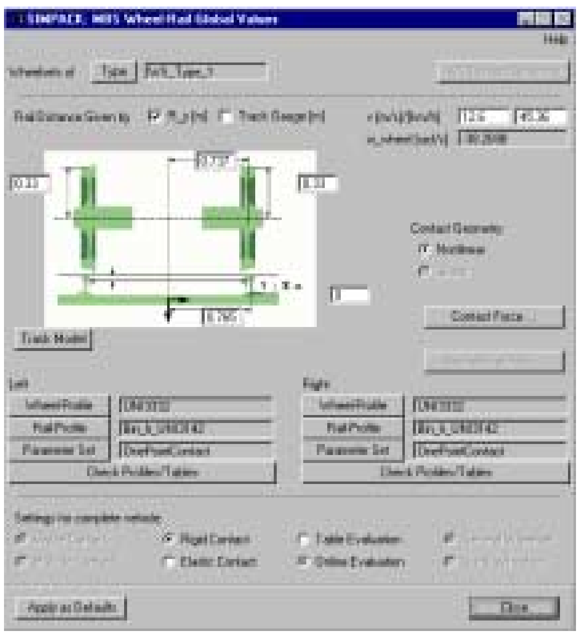
- Stiffness of primary and secondary suspension stage
- Dampers characteristics
- Bumpers behaviour
- Rubber joints stiffness



Wheel Rail Profiles

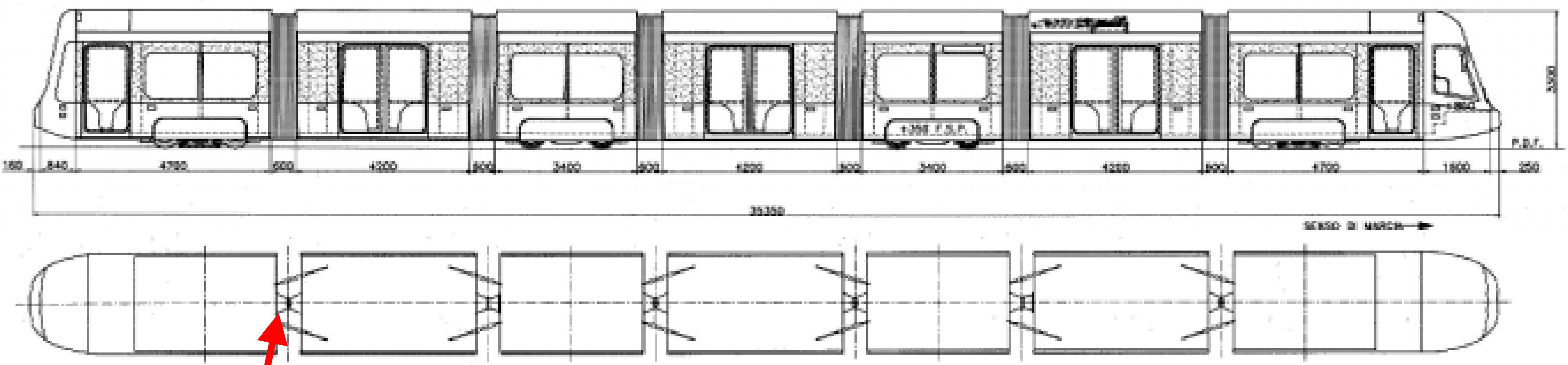


- Rail profile: lr UNI3142
- Wheel profile: UNI3332

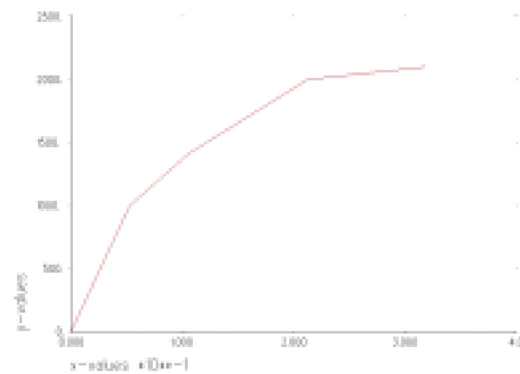


Wheel Rail Global Values

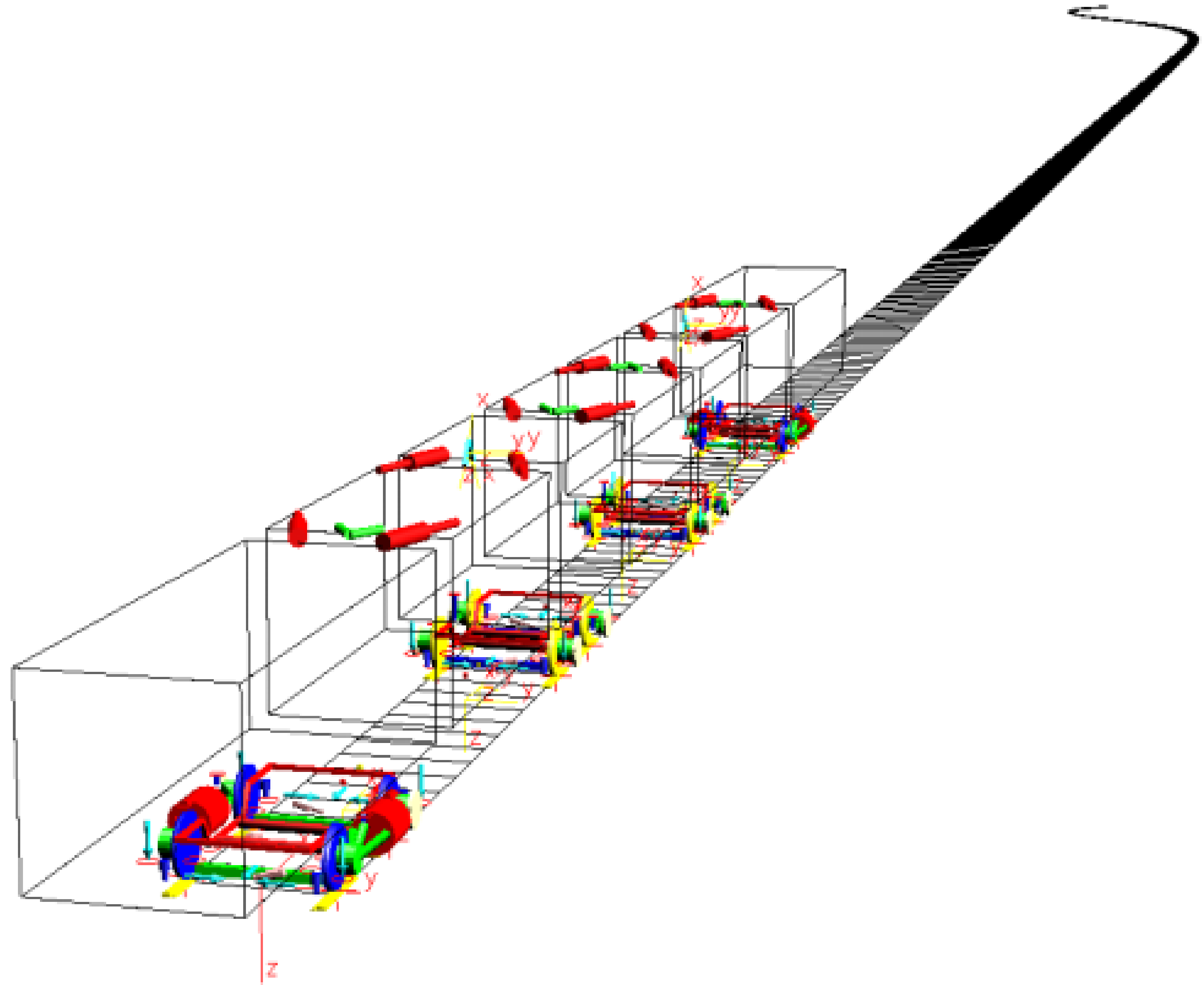
- Layout of tram SIRIO for Milan



Dampers between coaches



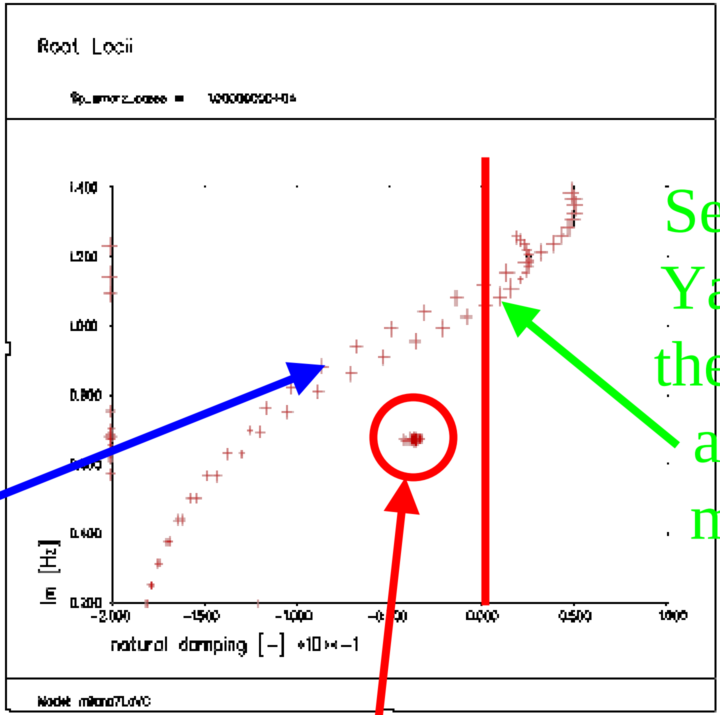
Model of tram SIRIO for Milan



Linear analyses

Instability analyses

- Modal analysis
- Parameter variation
- Transient phenomena



Second mode: Yaw mode for the front coach and the first motor bogie

Third mode: Yaw mode for the rear coach and the last motor bogie

First mode: Roll mode is not influenced by speed

Modal analysis

First mode:

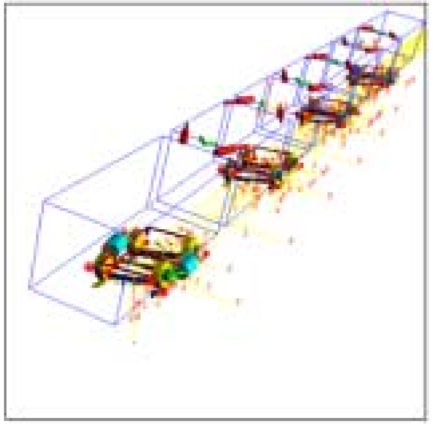
Roll mode

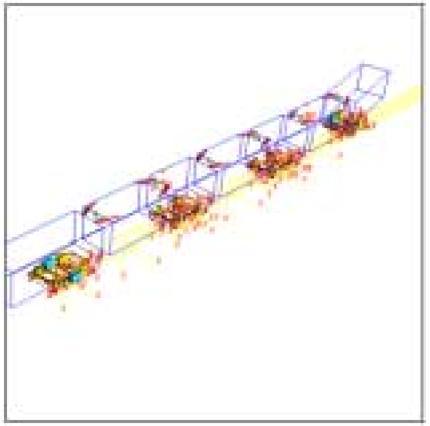
Second mode:

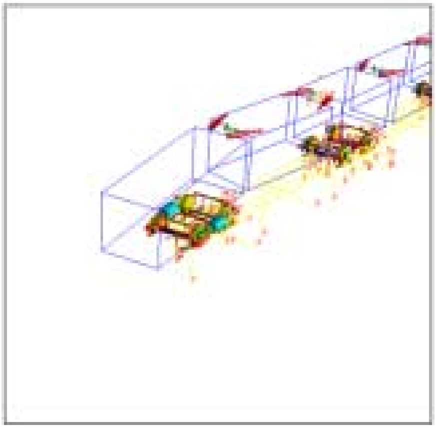
Yaw mode for the front coach and for the first bogie plus roll mode

Third mode:

Yaw mode for the rear coach and for the last bogie plus roll mode

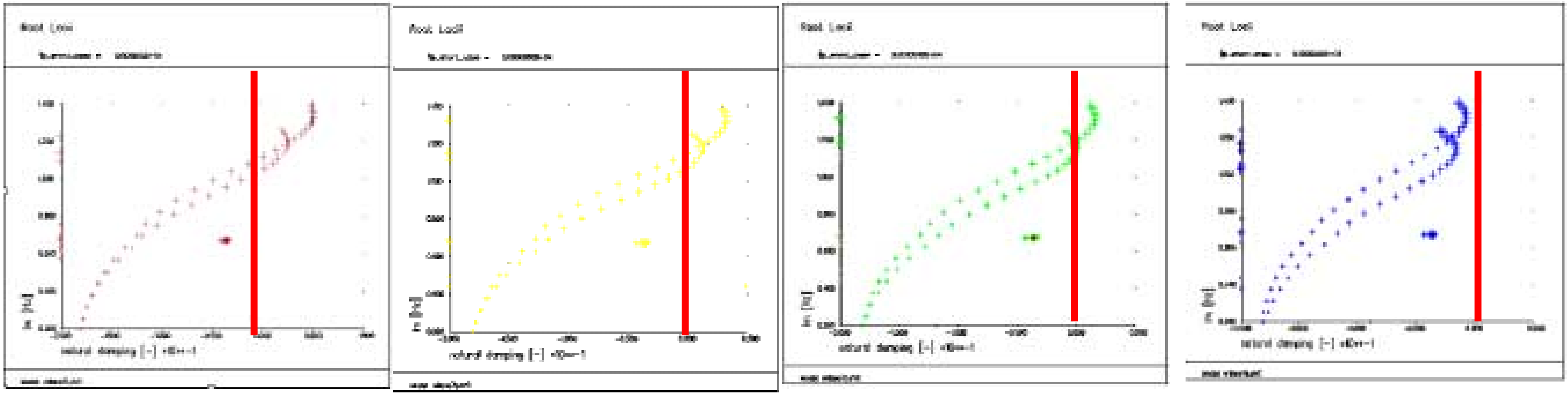






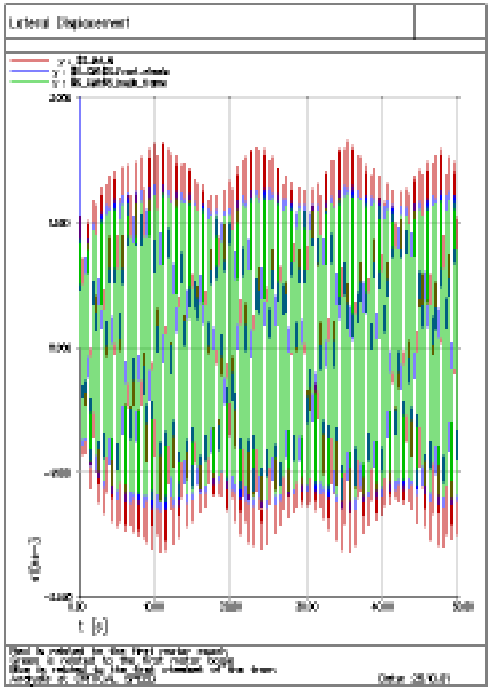
Parameter variations

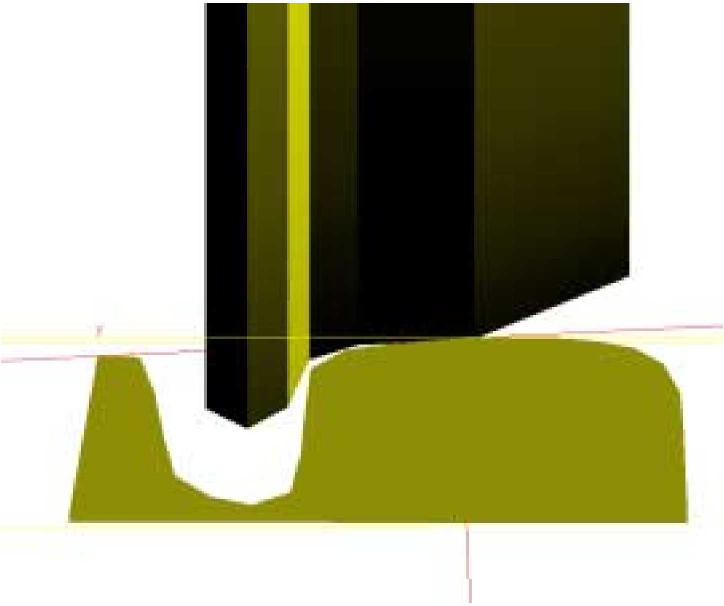
- The damping of the longitudinal damper doesn't change the critical speed
- The damping of the dampers between coaches has a big influence for the critical speed

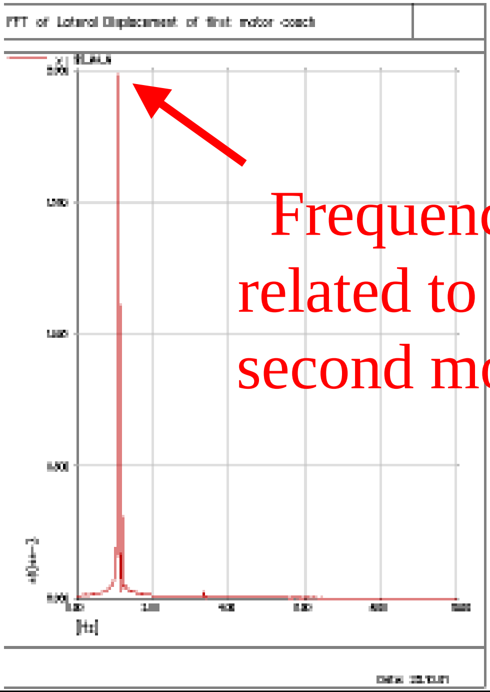


Transient phenomena

The tram is running over a straight and perfect track; but it is introduced one initial condition in order to study the transient phenomena due to it.



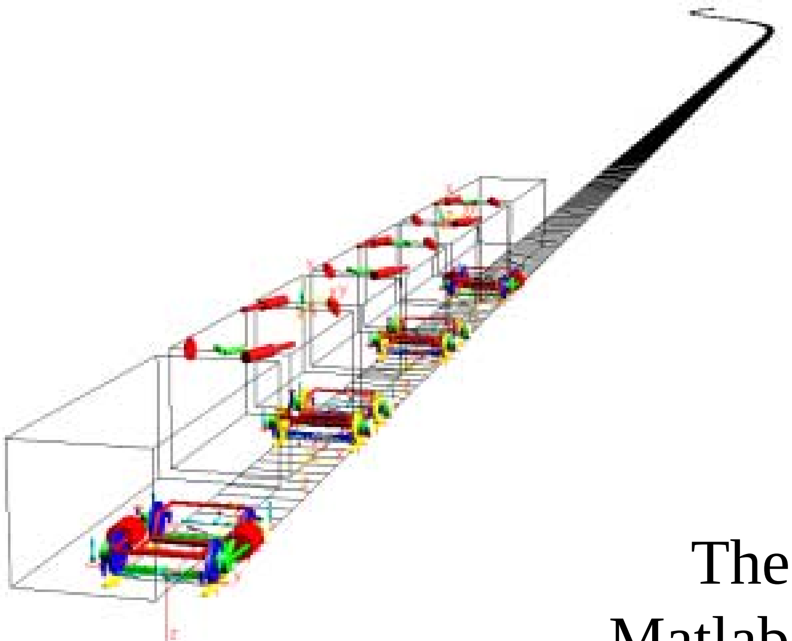


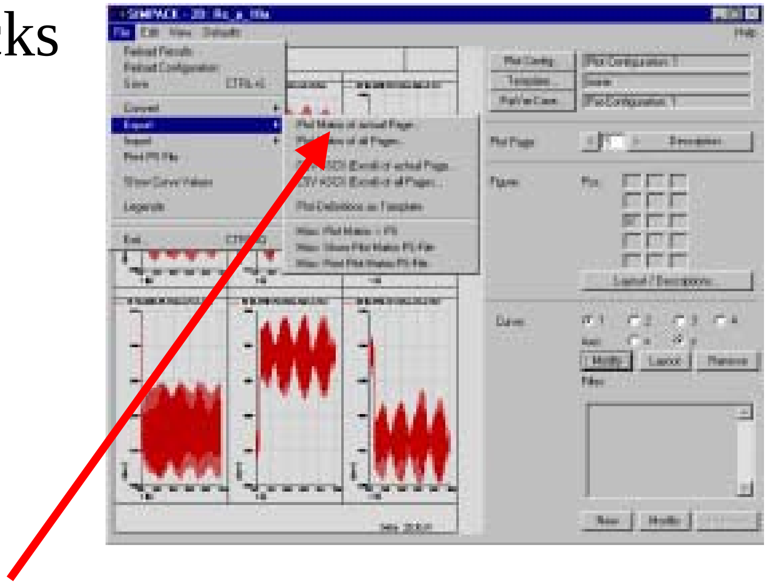


Frequency related to the second mode

Non linear analysis

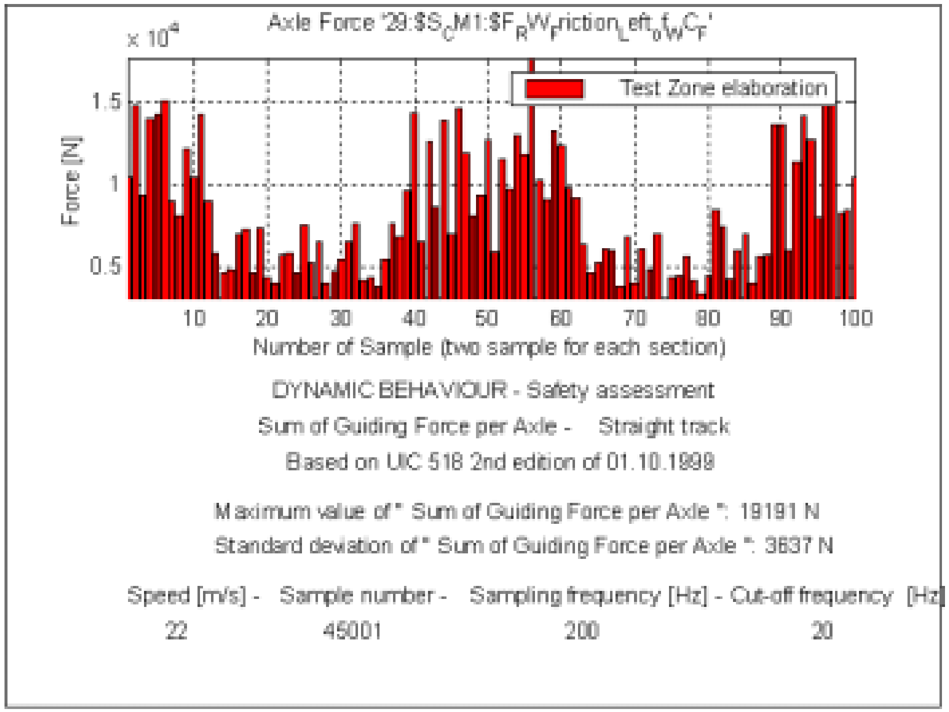
Time integration analysis of the runs of the tram over some curved and irregular tracks





The analysis of WR forces is done with a Matlab elaboration, which reads the file created with the graphical 2D post processing

Post processing of the WR forces



Works in progress

- Adding into the simulation the model of mechanical differential with locking couple
- Study of tram behaviour in case of worn WR profiles
- Comparison between calculation and test results

Conclusions

- SIMPACK is very useful for the design of rail vehicles
- The parameter variations module is a power method to explore the design configuration.
- The time integration module is fast