Modelling a vehicle to vehicle collision in Vampire

Vampire Virtual User Event - 14th June 2022

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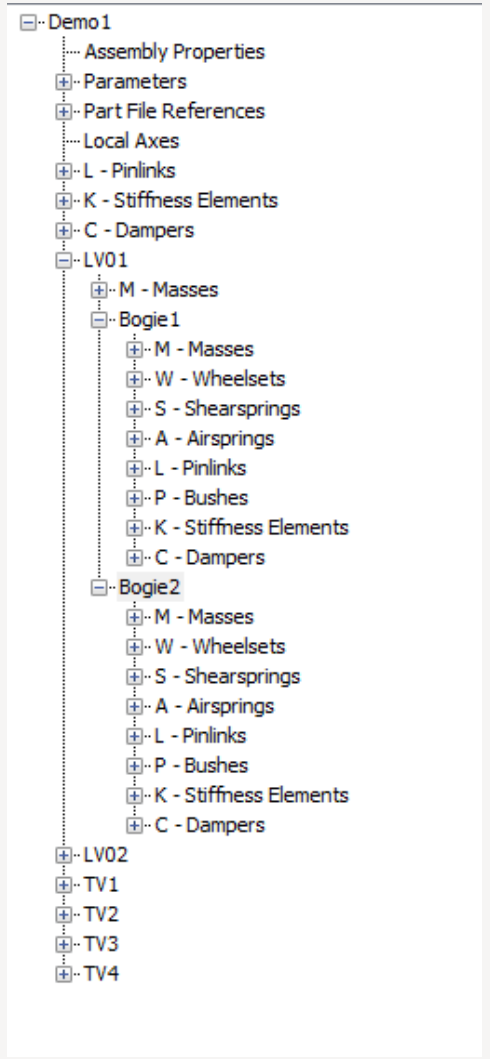
Introduction

- Vampire longitudinal dynamics allows vehicle models to change speed
- In fact, parts of a model can change speed relative to each other
- The parts of the model can then collide – so could we model two trains colliding and potentially derailing?

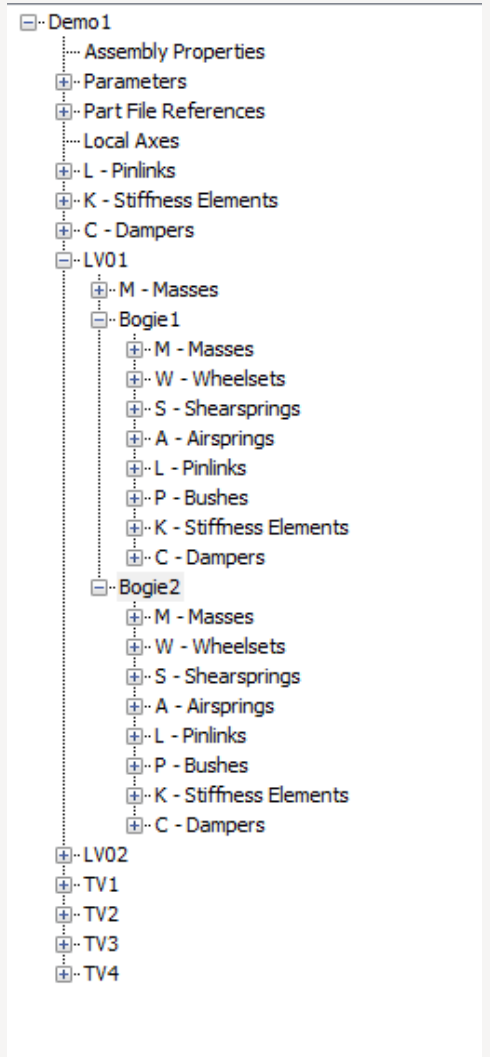
Vehicle model

- Multi-vehicle model based on FouraxPro – representing two trains separated by 17m
- Produced by Cloning the vehicle in the IVB:
  - Add the whole vehicle except ground stiffness and damper to a group
  - Clone the group
- 2 vehicles in leading train, 4 in following train
- End vehicles have increased mass to represent the rest of the train

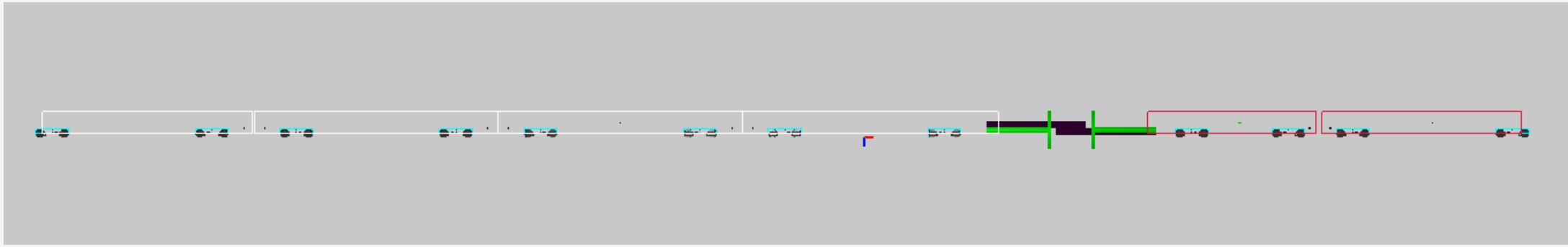


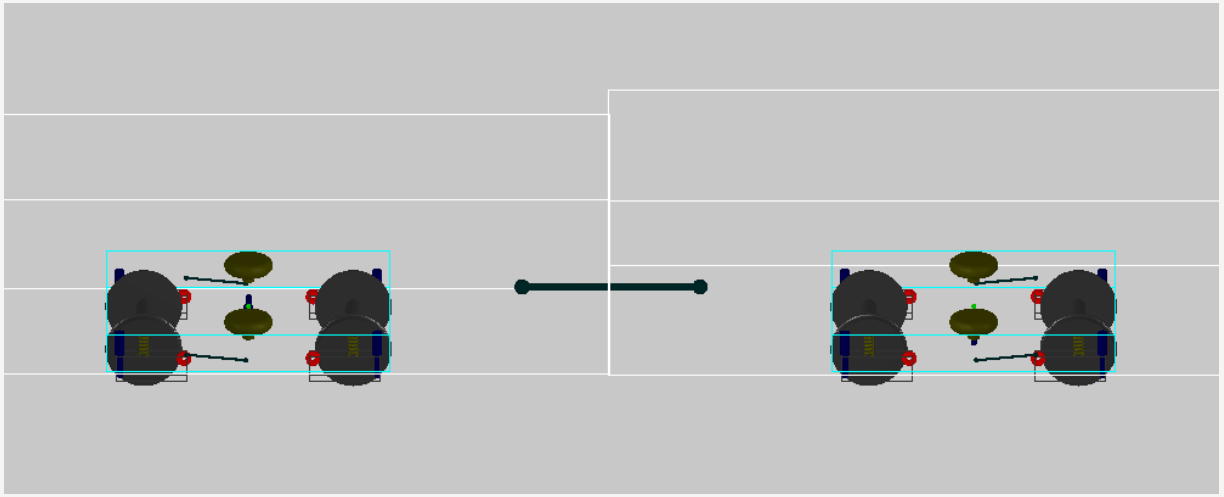
Vehicle model

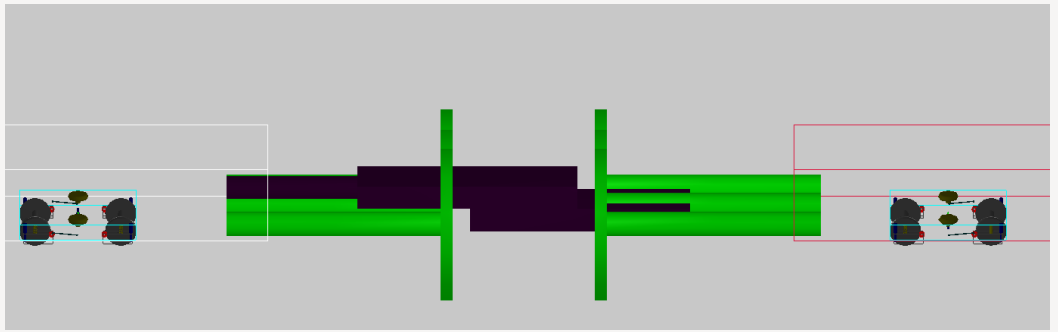
- Simple Pinlink couplers added
- Long Bumpstops and Friction elements allow collision
  - Notional characteristics at this stage
  - 17m clearance!
- Note: Wheelset pitch inertia has to be added manually to text file
- Very soft stiffness to ground on leading train (to prevent it being dragged by the accelerating axis system



Vehicle model







Run file

- Simulation of two trains colliding – following train accelerates into leading train
- Uses longitudinal dynamics
- External yaw torques applied with forcing file

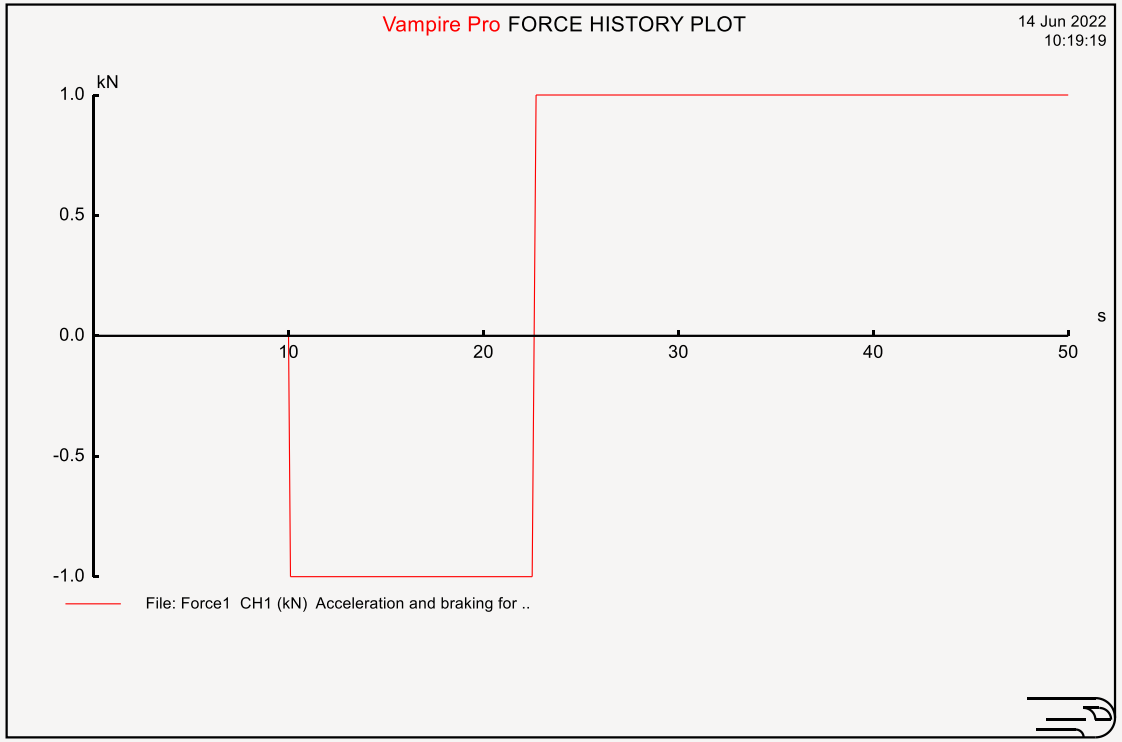
Run file sections

```
*TRANSIENT
DISTANCE     200.00
INTEGRATE    0.00010
OUTPUT    0.02000
STARTOUTPUT       0.00
SPEEDMPH       5.000
TRACKIRREGULARITY track160.dat
ALLOWDERAIL
*CREEP
NON-LINEAR
PROFILE   CEN56E1-20_P8_127.con
FRICTION    0.30000    0.30000    0.30000    0.30000
0.30000    0.30000
**
*XDYNAMICS
CURV_RESISTANCE
**
```

```
**
** Forcing file includes traction followed by braking
**
*FORCE
F \TV2\Bogie1\W\Wheelset1 P
FILE  Force1.csv
CHANNEL   1
FACTOR    6.0
**TIMEDELAY 10
F \TV2\Bogie1\W\Wheelset2 P
FILE  Force1.csv
CHANNEL   1
FACTOR    6.0
**TIMEDELAY 10
F \TV2\Bogie2\W\Wheelset3 P
FILE  Force1.csv
CHANNEL   1
FACTOR    6.0
```

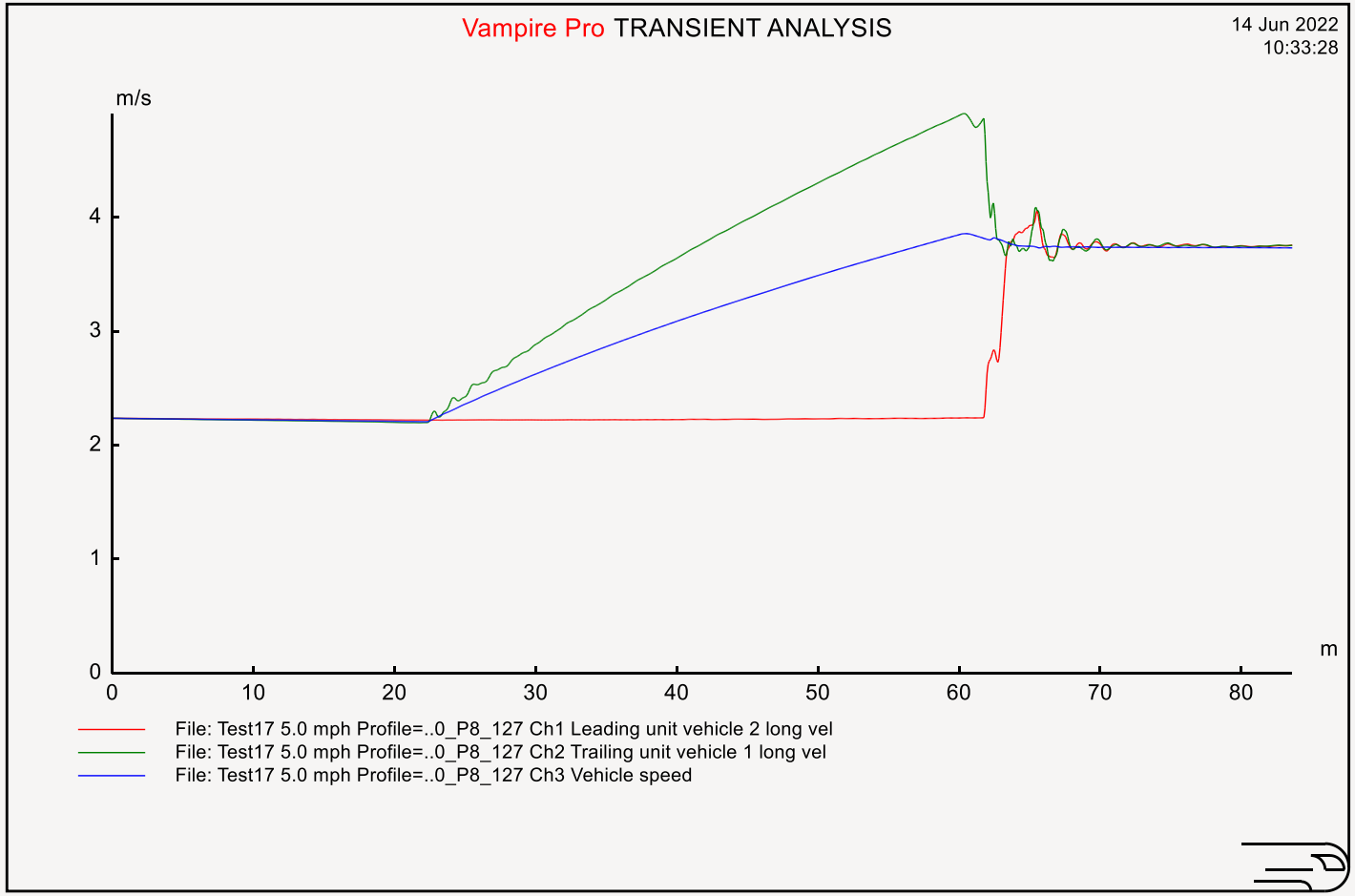
Forcing file - .csv

FORCE
UNITS VAMPIRE
Acceleration and braking for collision example - apply factor in run file (Neg torque is traction)
TIME, CH1
0.00, 0.000
10.00, 0.000
10.10, -1.000
22.50, -1.000
22.60, 0.000
22.70, 1.000
50.00, 1.000



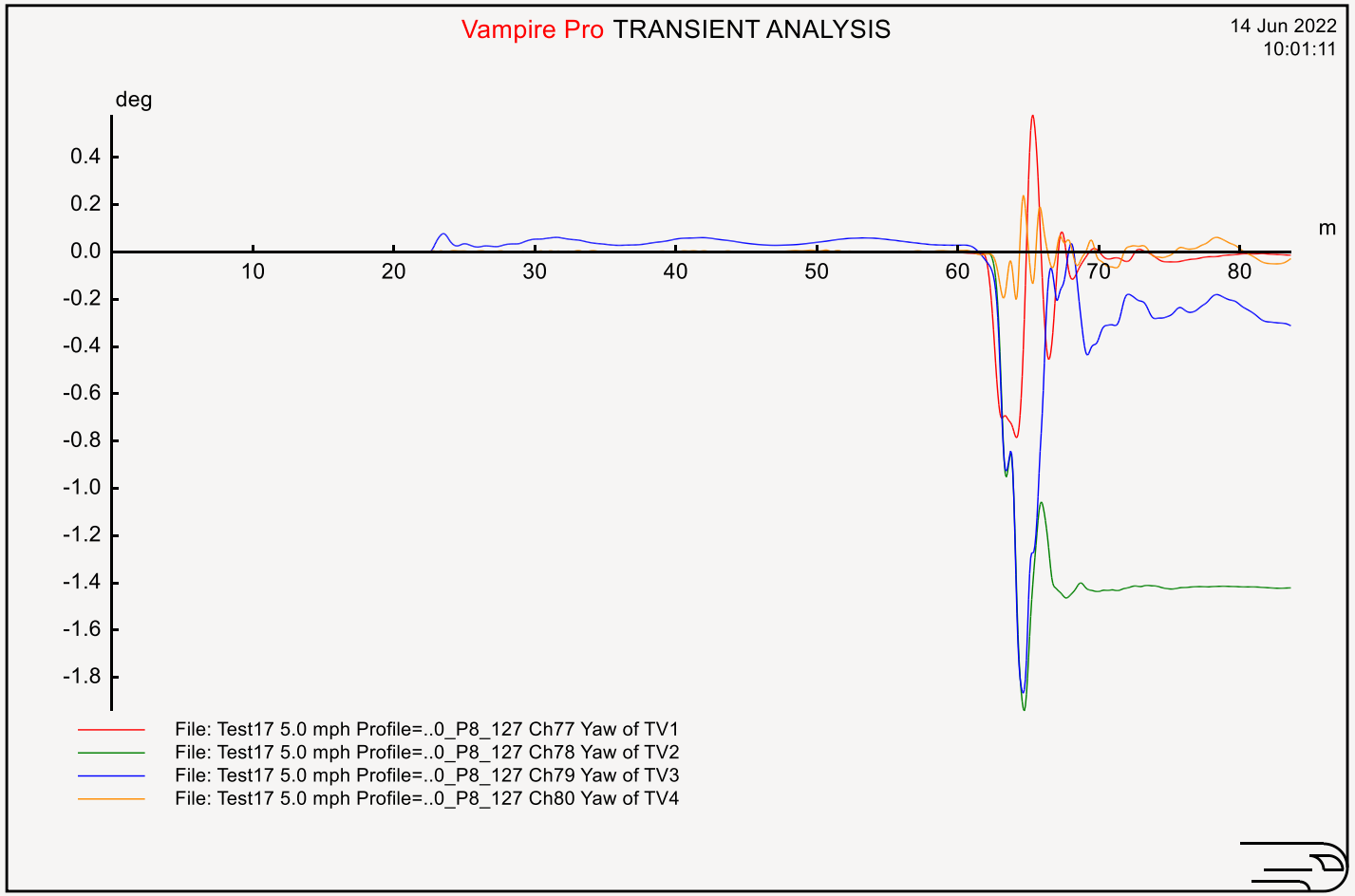
Vampire Plot

Results – vehicle speeds



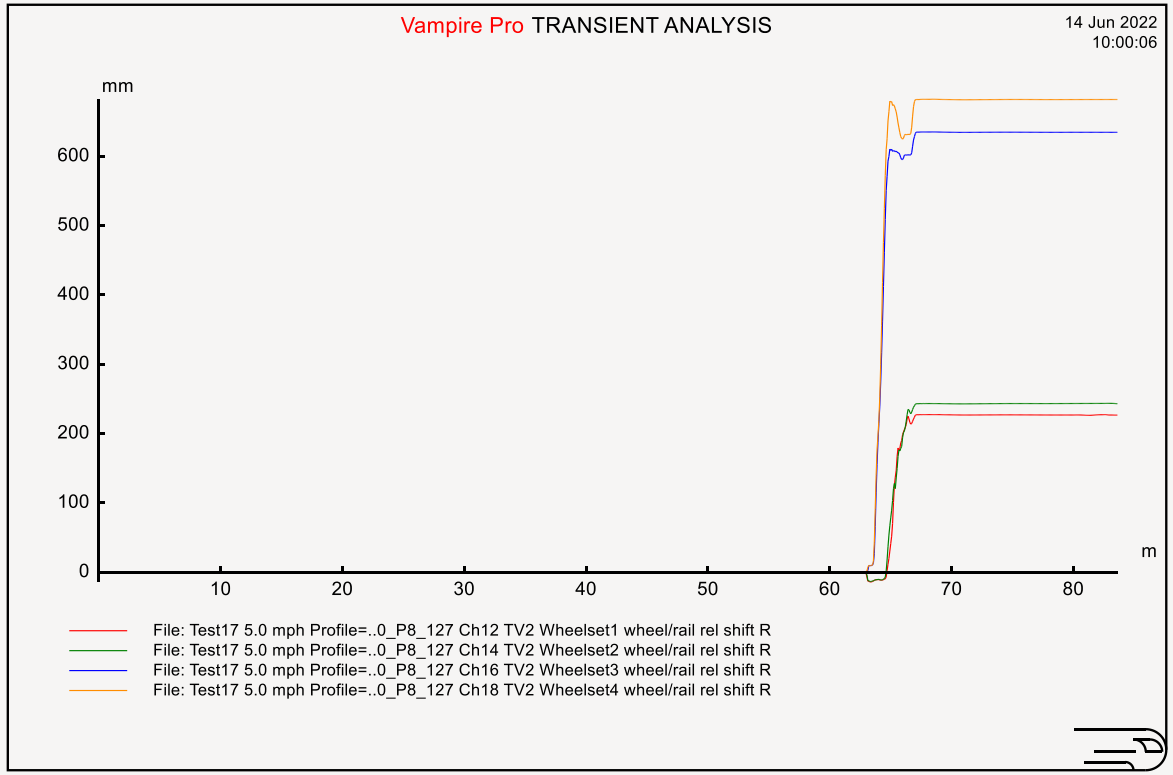
Vampire Plot

Results – carbody yaw

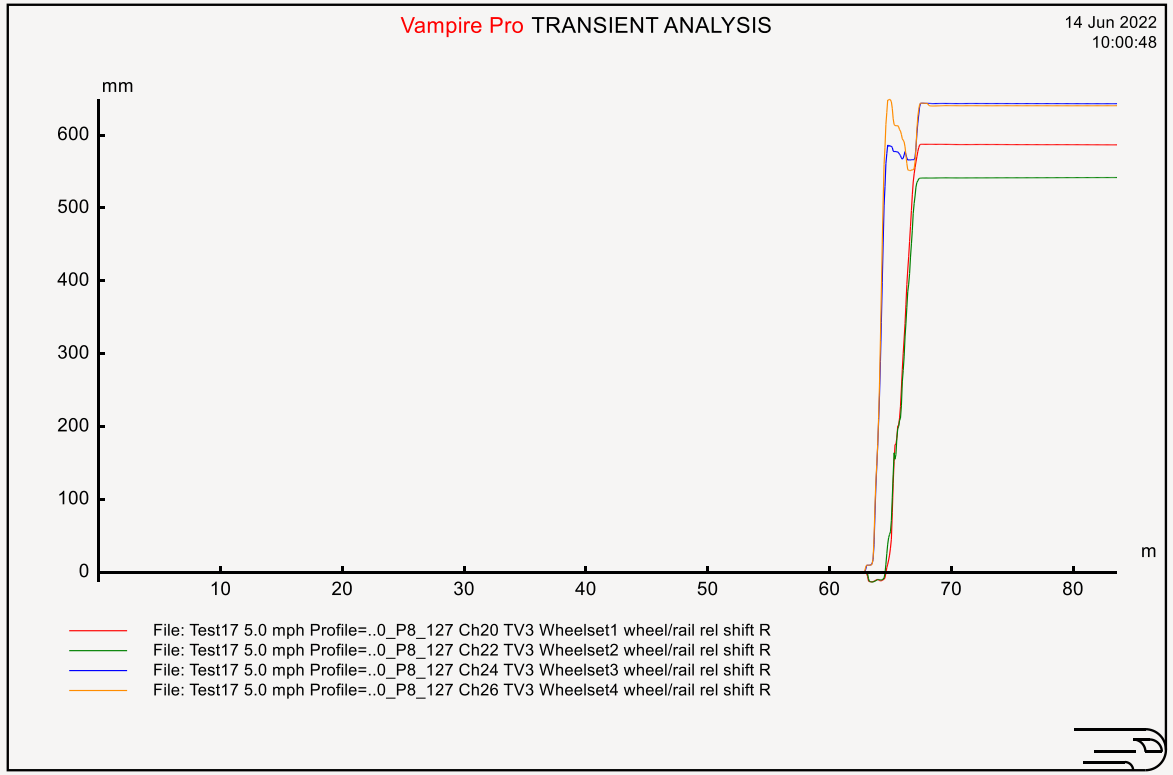


Vampire Plot

Result – Wheel/rail shifts, showing derailments

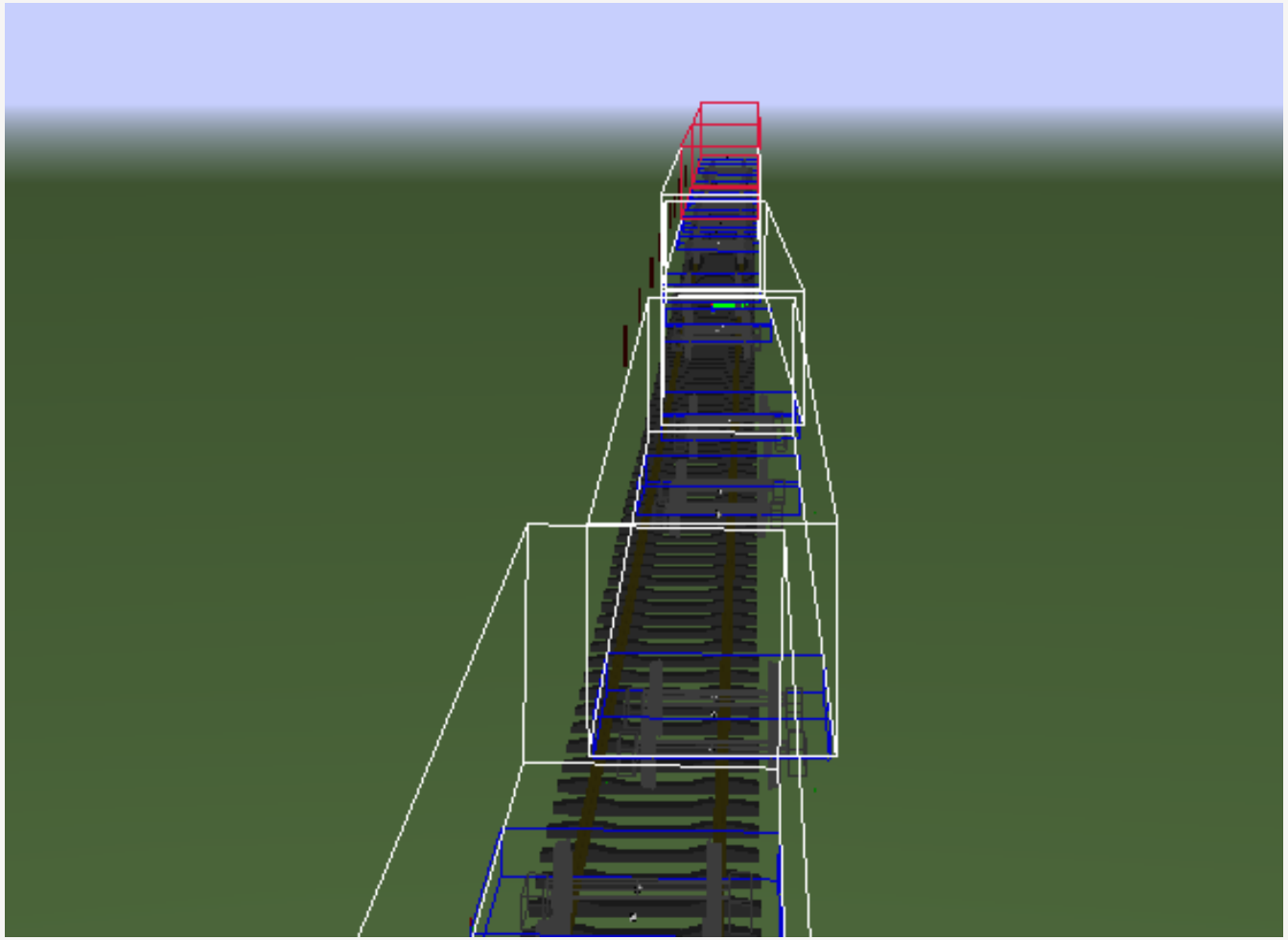


Vampire Plot



Vampire Plot

Result – Vehicle positions, showing derailments



Conclusions

- Simulation method works as ‘proof of concept’
- Would need force/displacement characteristics of vehicle ends and couplers for definitive test
- Could Usersub version run ‘in the loop’ with a more complex collision model?
- Could be applied to ‘rough shunt’ time cases

Thank you

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ATKINS
Member of the SNC-Lavalin Group