Efficiency Improvements on Simulation and Run Time

Abdelhakim Aissaoui

March 15th, 2011

Radtherm UGM Munich

Agenda

- Introduction
- Heat management
- Brake cooling
- Simulation time optimisation
- Conclusion

INTRODUCTION

The main stream use of Radtherm is to support vehicle program which applies

- **Full conjugate heat transfer analysis through coupling .**
- **Underhood detailed simulation.**
- **Simulate the brake cooling.**
- **Final drive unit cooling.**
- **Tailpipe gas modeling.**

Overview

Introduction

Heat protection

Brake cooling

Simulation time optimisation

- Heat protection
- Brake cooling

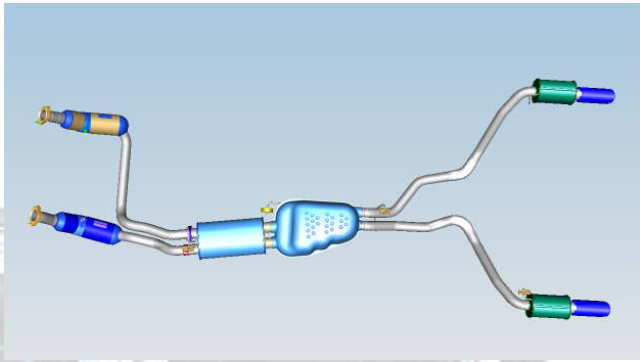
Conclusion

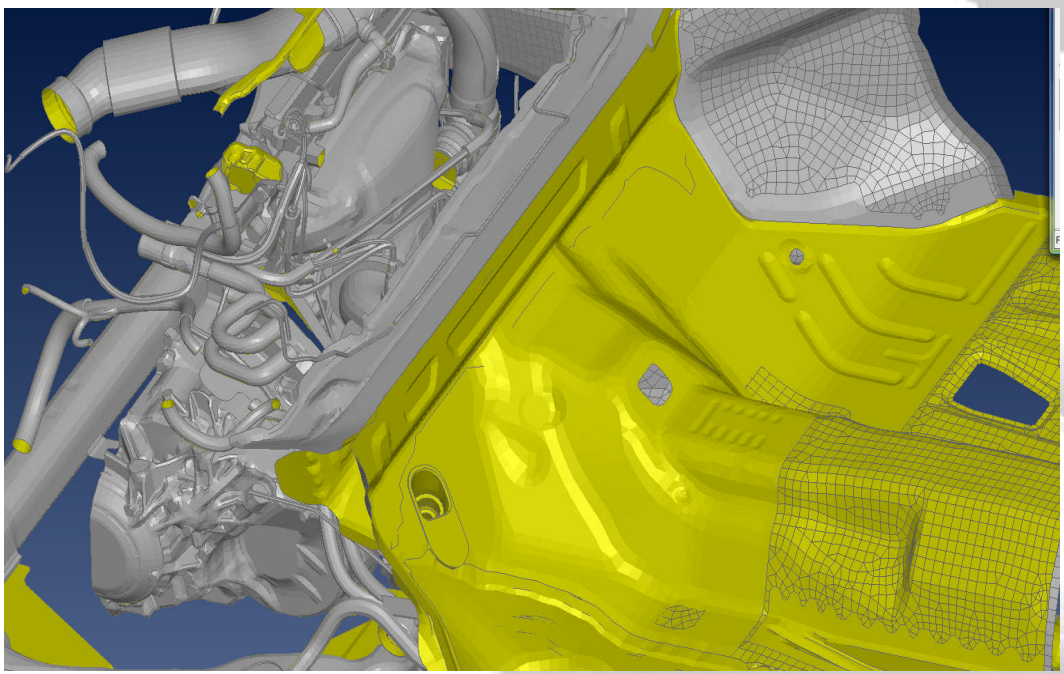
Heat management- Geometry

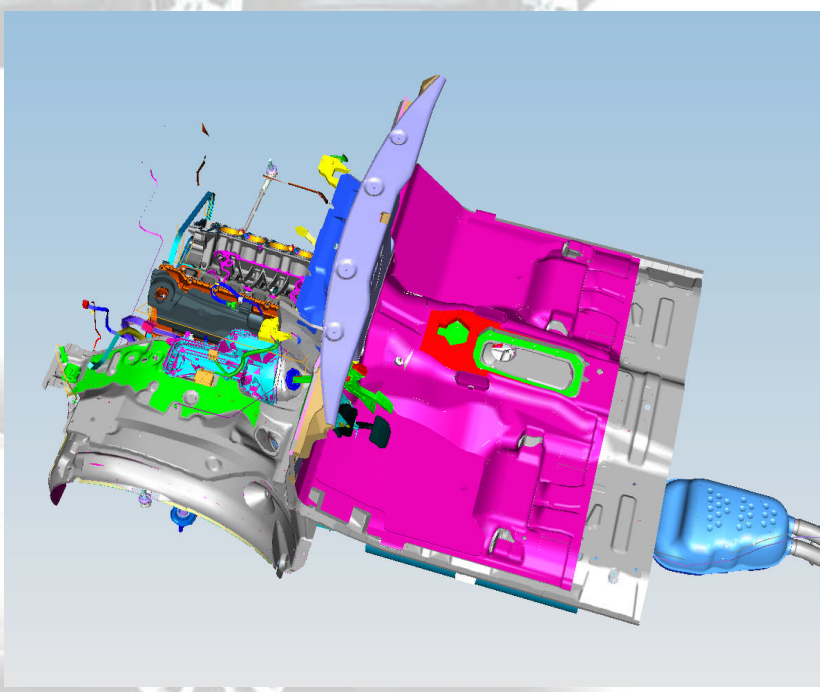
1- Run a clearance search around exhaust.

2- Quad dominated elements

3- Generate 210,000 elements



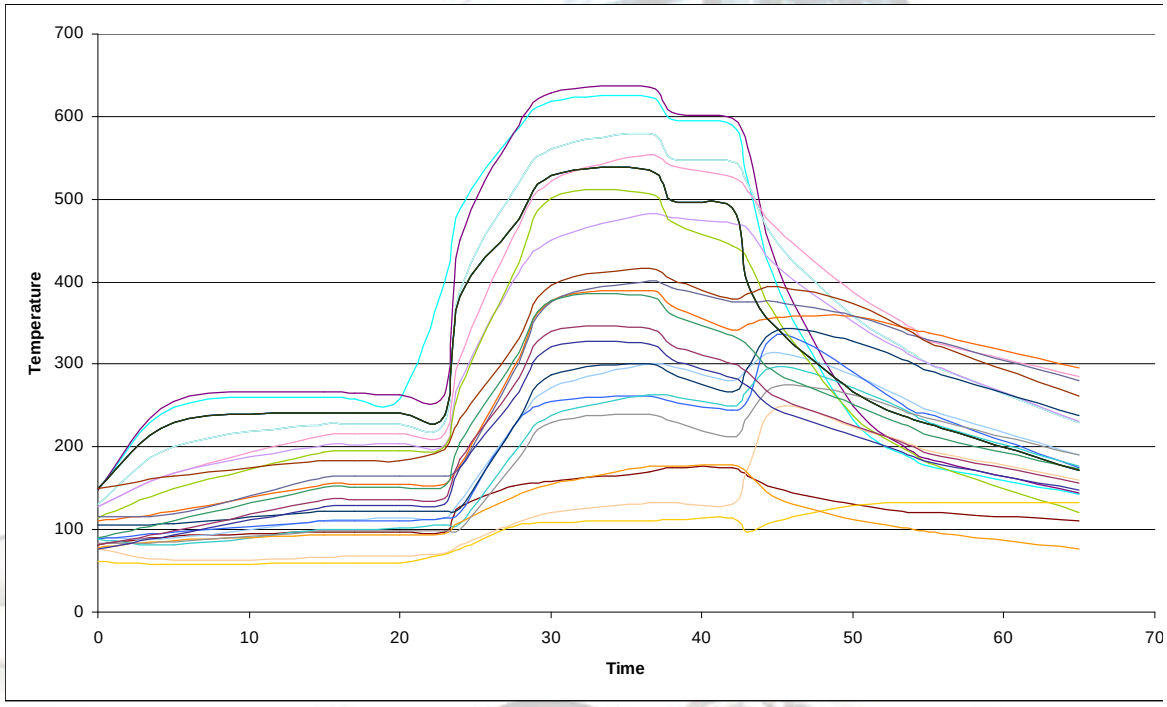




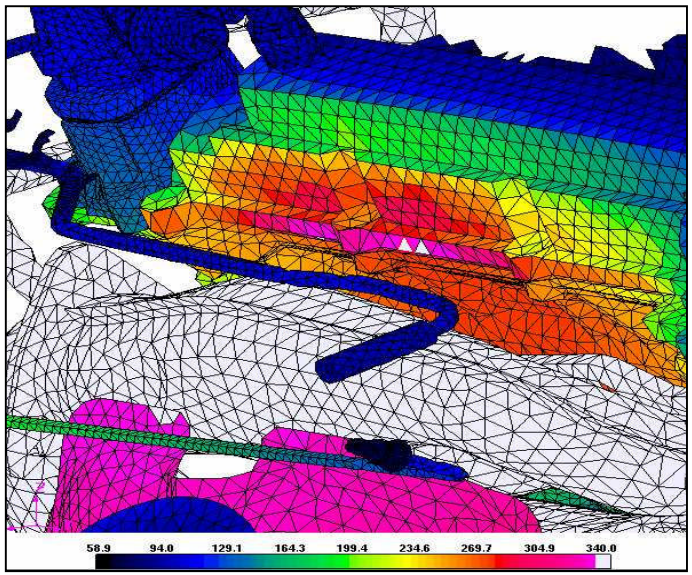
Heat management- Set up

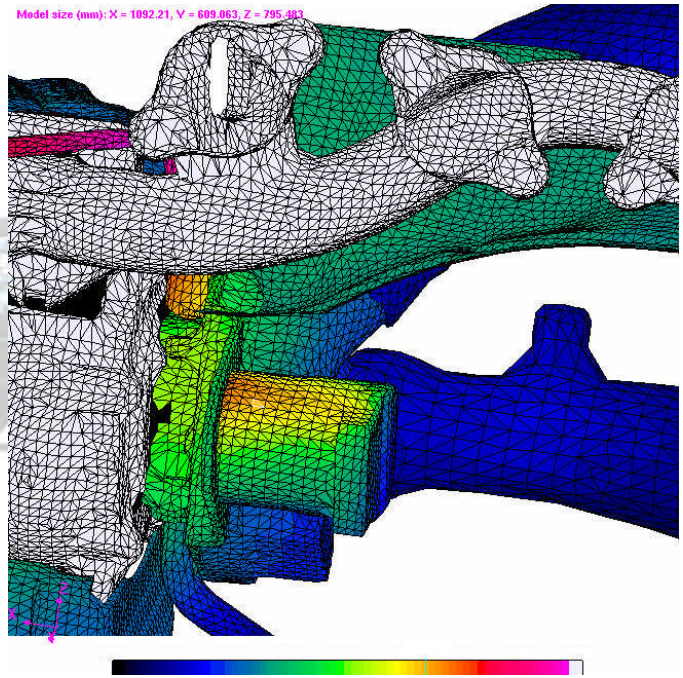
Input

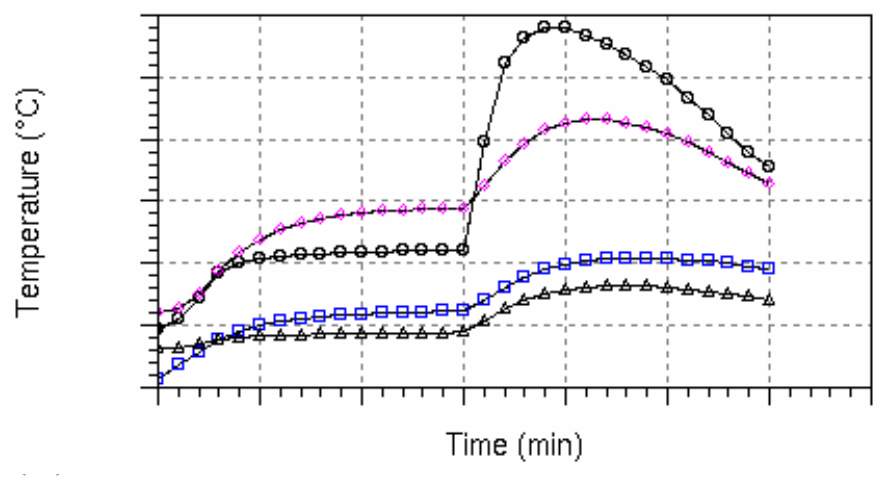
1. Material properties
2. Emission coefficients
3. Temperature curves

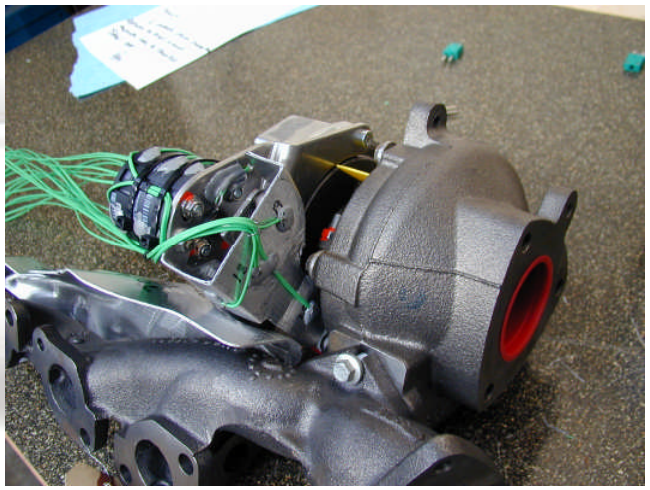


Thermal Management









Overview

Introduction

Heat protection

Brake cooling

Simulation time optimisation

- Heat protection
- Brake cooling

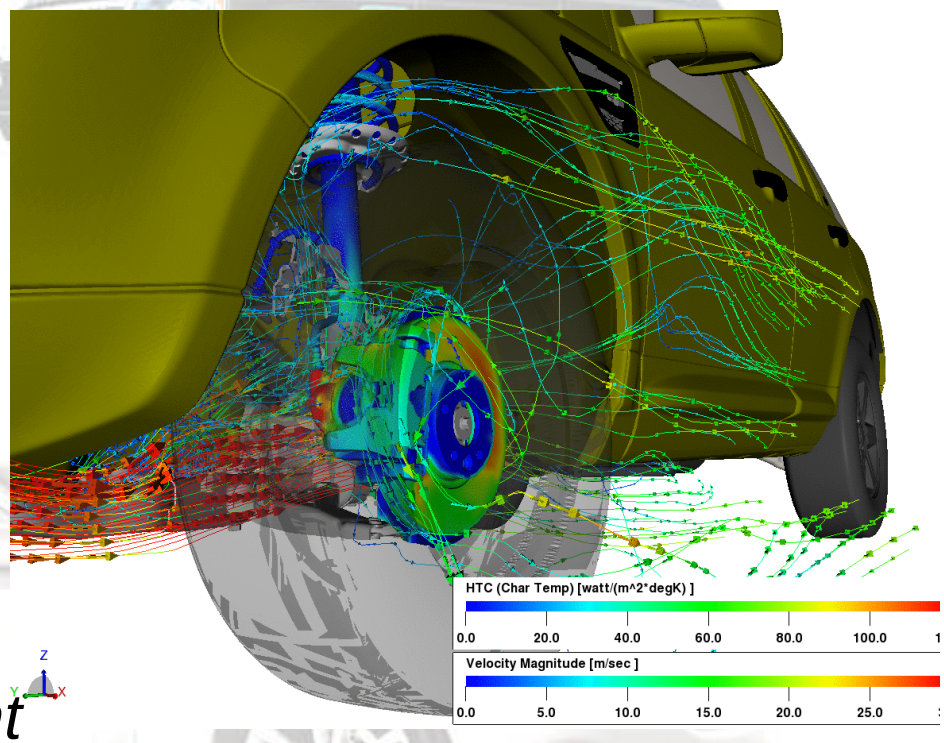
Conclusion

Objective

1. *Calculation the disc temperature during 25 brake cycle stops followed by a cooldown phase*
2. Including all the three heat transfer modes

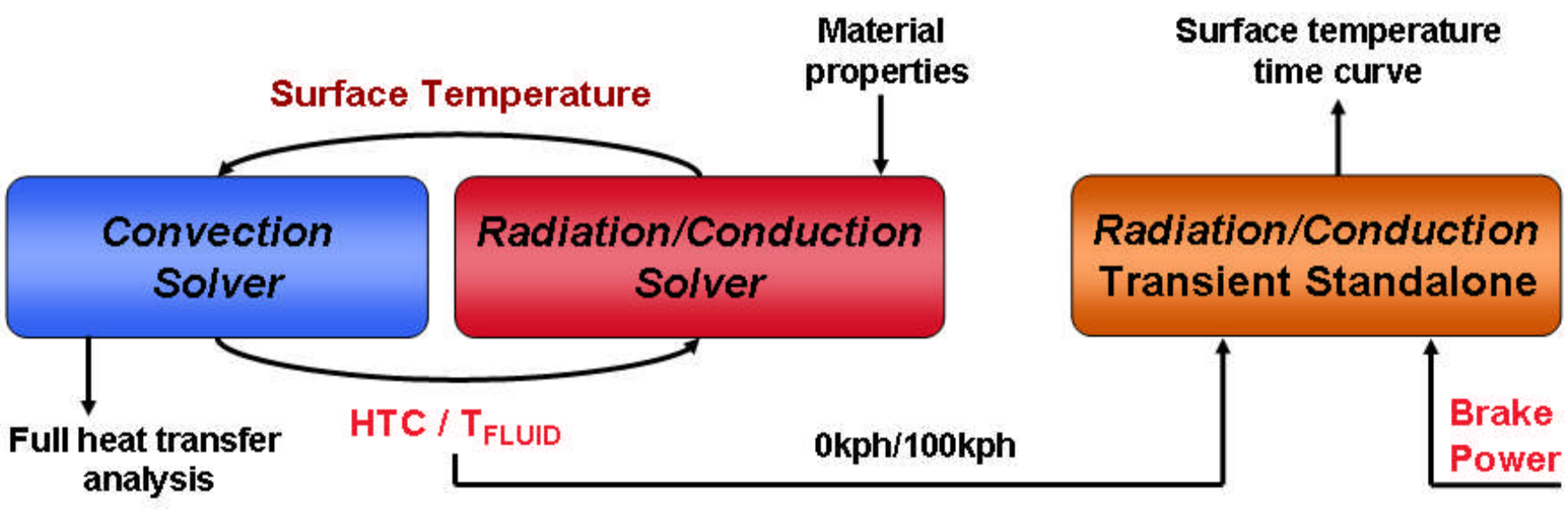
    - ✓ *Radiation*
    - ✓ *Conduction*
    - ✓ *Convection*

3. *Comparison with experiment*



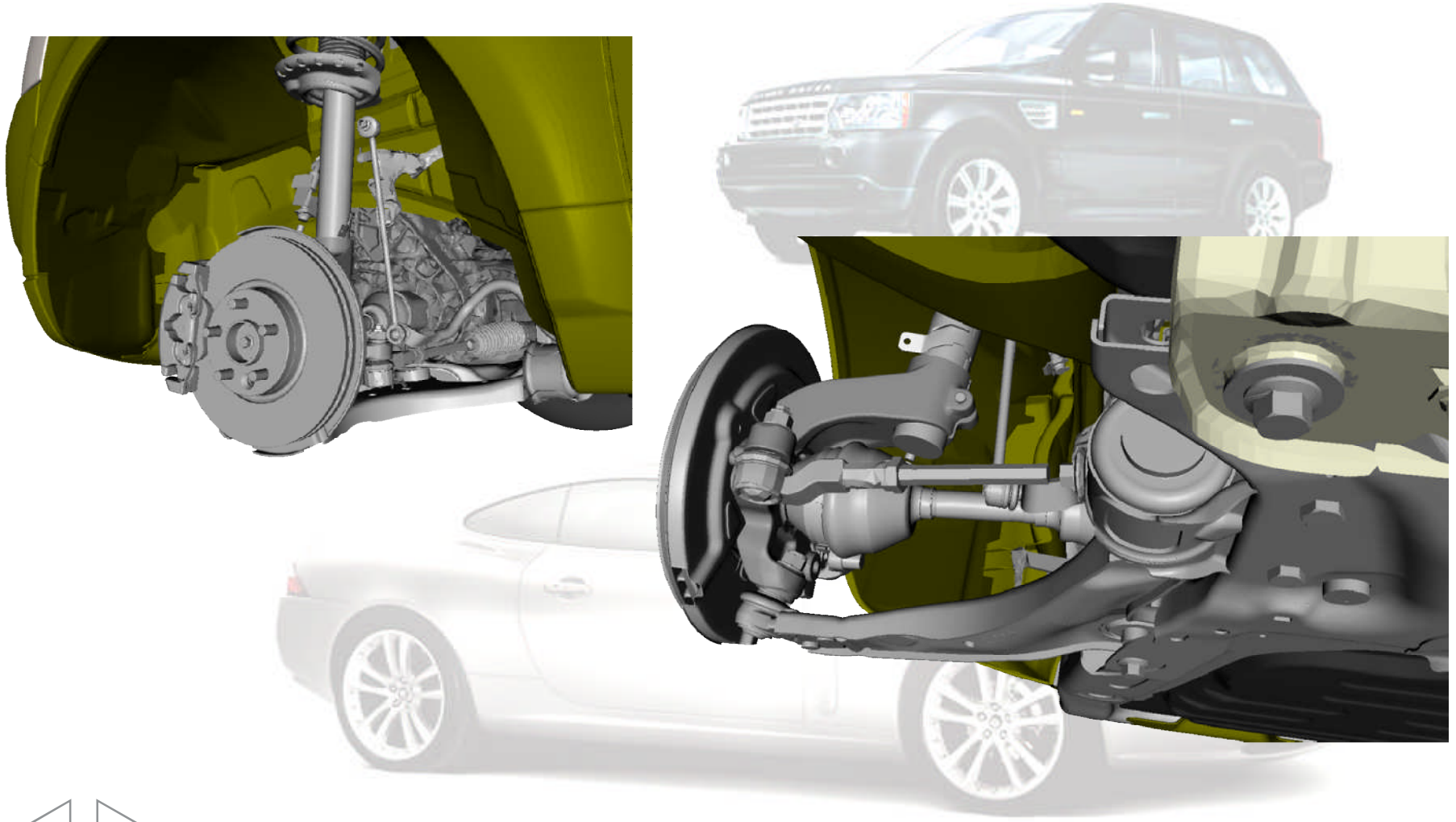
Numerical Method

- Coupled process
  - 3D Flow solver: PowerFLOW
  - 3D Radiation/Conduction solver: Radtherm



Set up

- Geometry



Powerflow set-up

- **Simulation conditions**

  - **Freestream velocity:**
    - 100 km/h and 0 km/h (no fan)
    - Ambient temperature
  - **Brake disc temperature**
    - 500°C
  - **Simulation strategy**
    - Coarse→Fine→Boundary Seeding ¼ vehicle

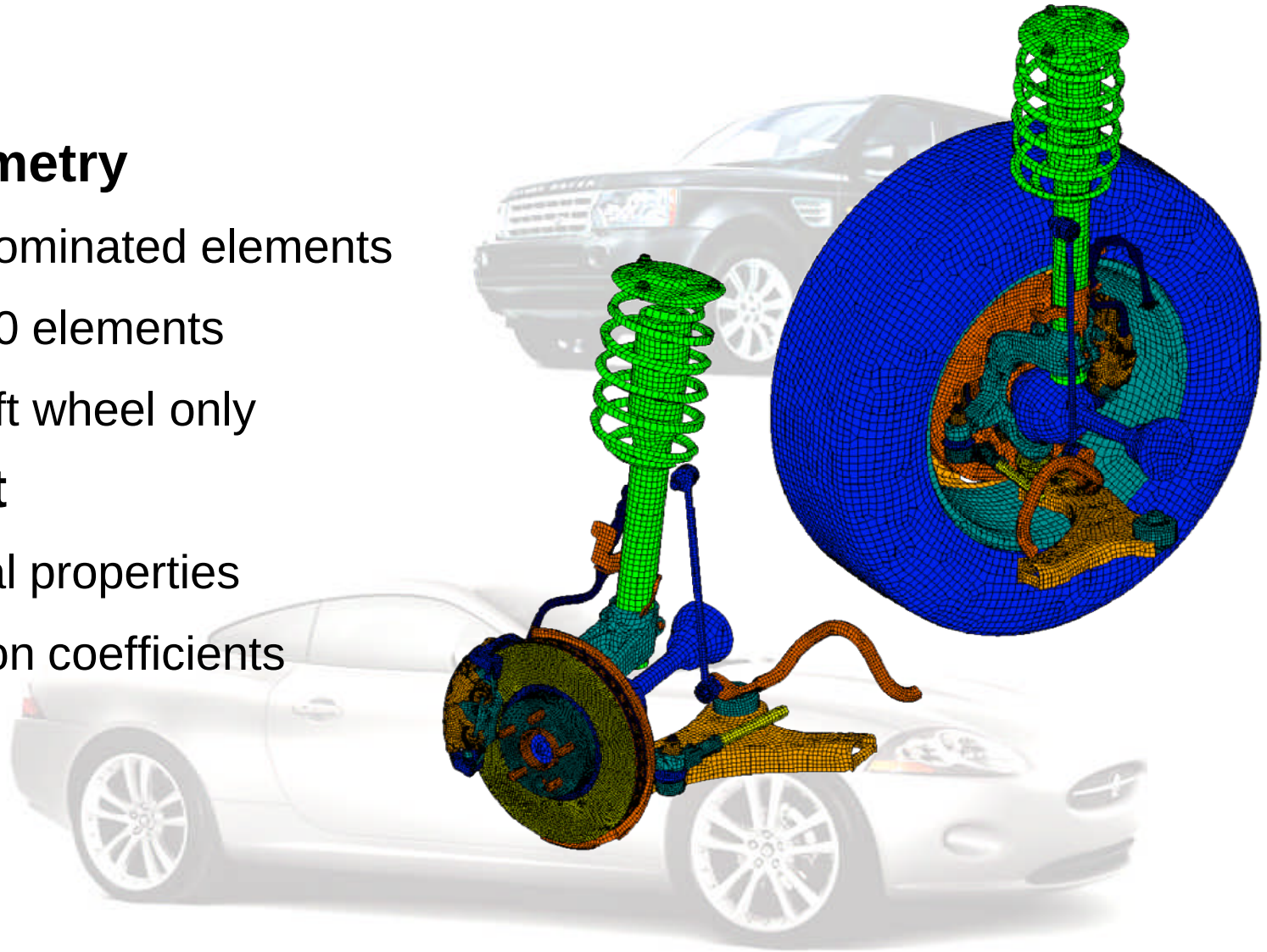
Radtherm Set-up

Geometry

- quad dominated elements
- 159,000 elements
- front left wheel only

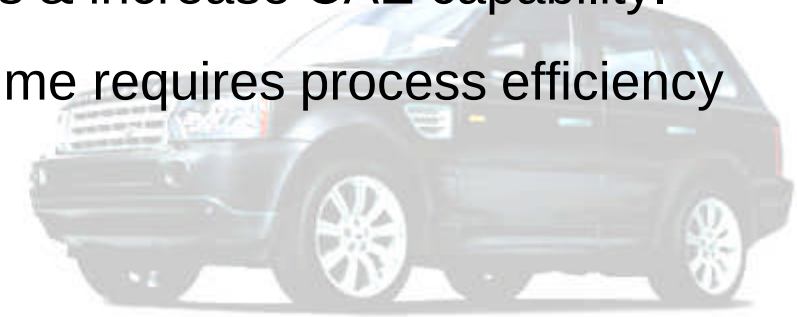
Input

- material properties
- emission coefficients

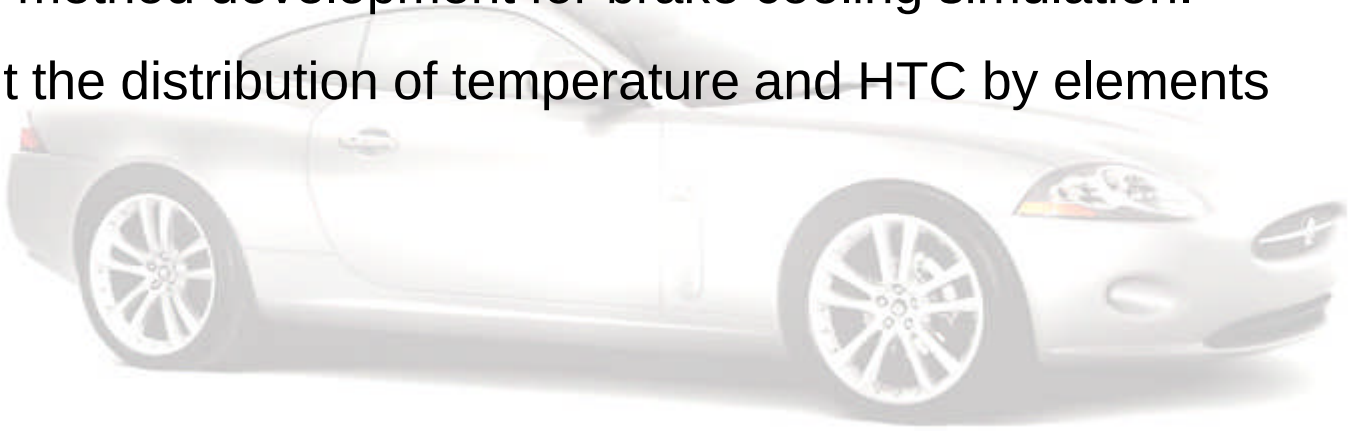


Areas of improvements

- Increase the number of iterations & increase CAE capability.
- Reduce program development time requires process efficiency improvements



1. Time step method development for heat protection simulation.
2. Time step method development for brake cooling simulation.
3. Implement the distribution of temperature and HTC by elements



Overview

Introduction

Heat protection

Brake cooling

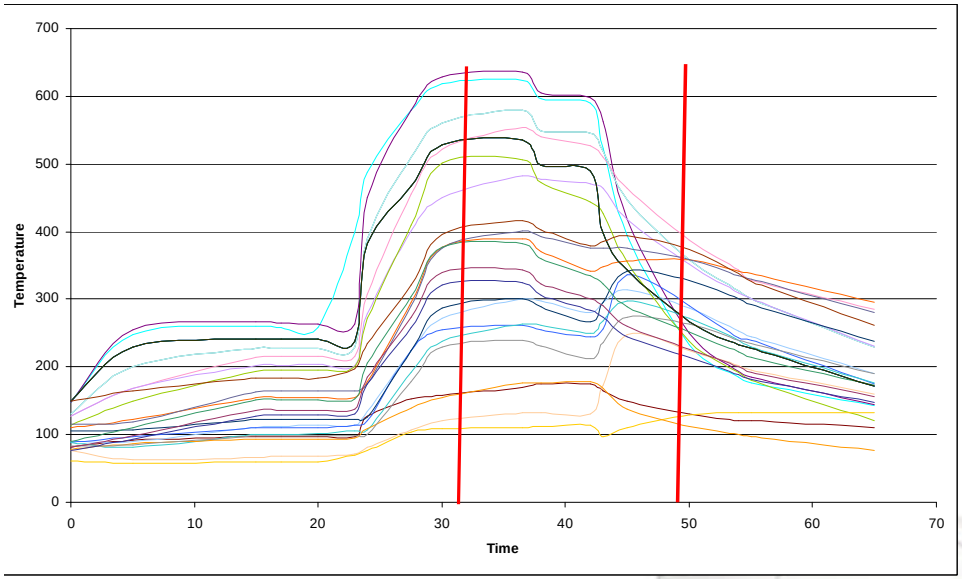
Simulation time optimisation

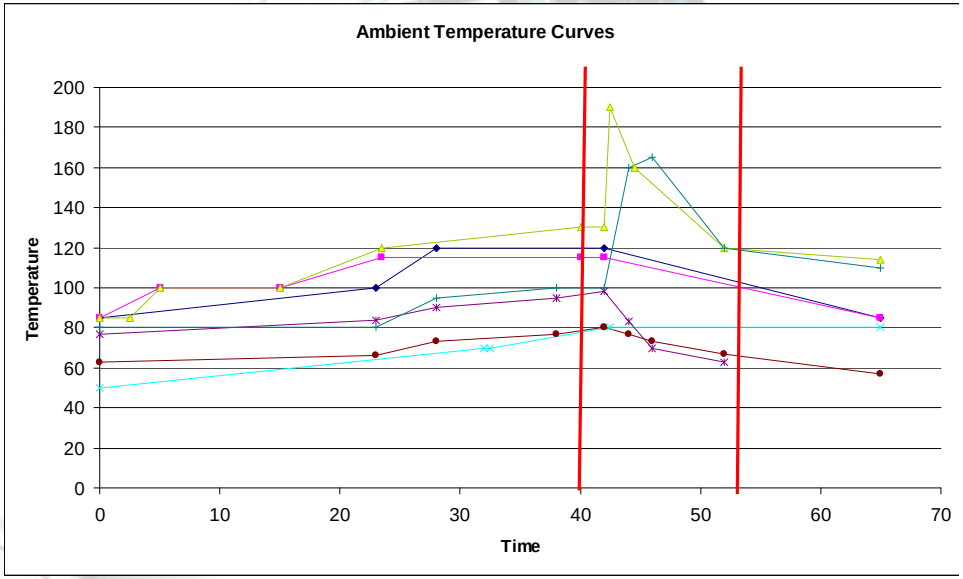
- Heat protection
- Brake cooling

Conclusion

Simulation time optimisation

✓Heat protection simulation

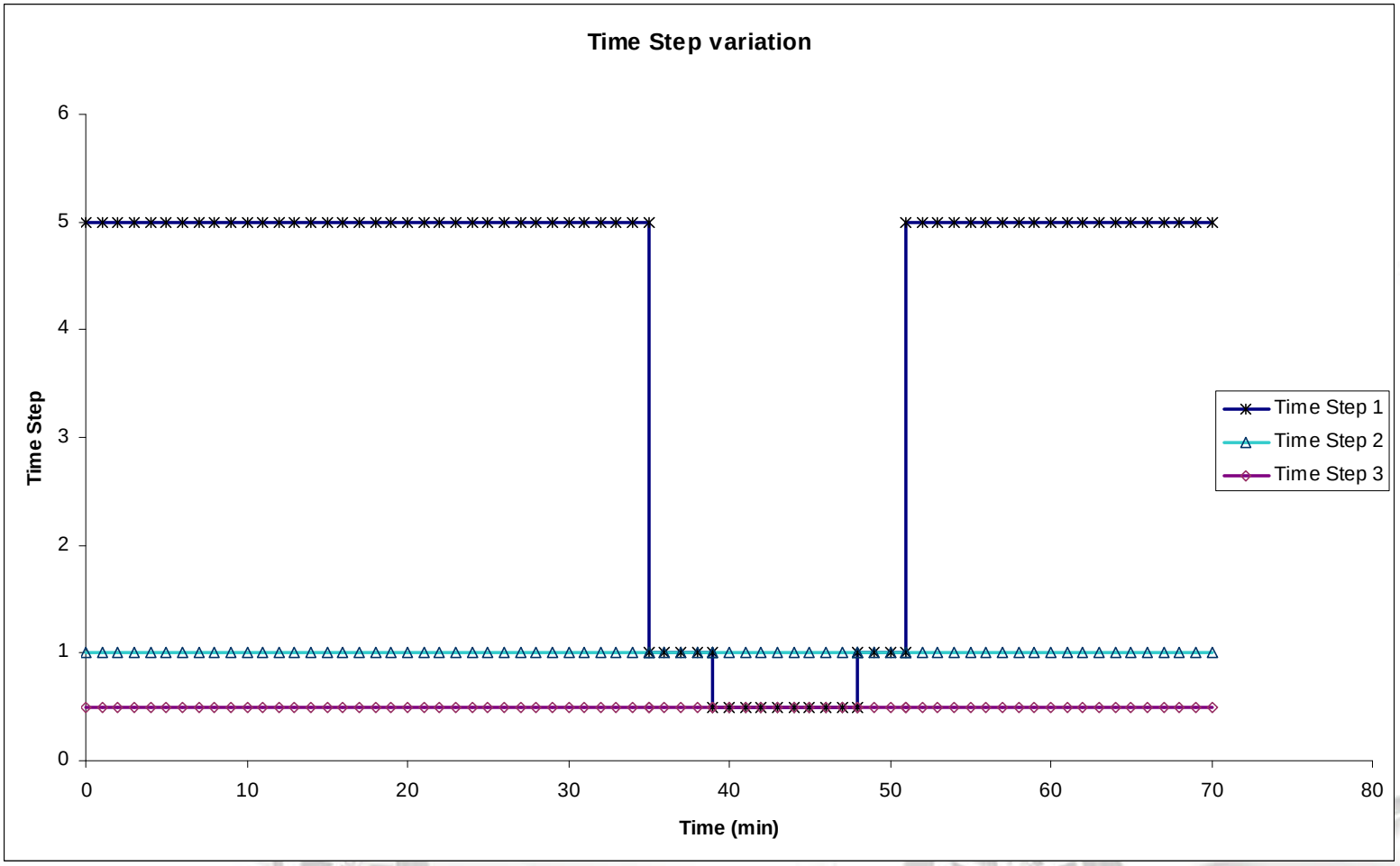




Combination of the data to create time step

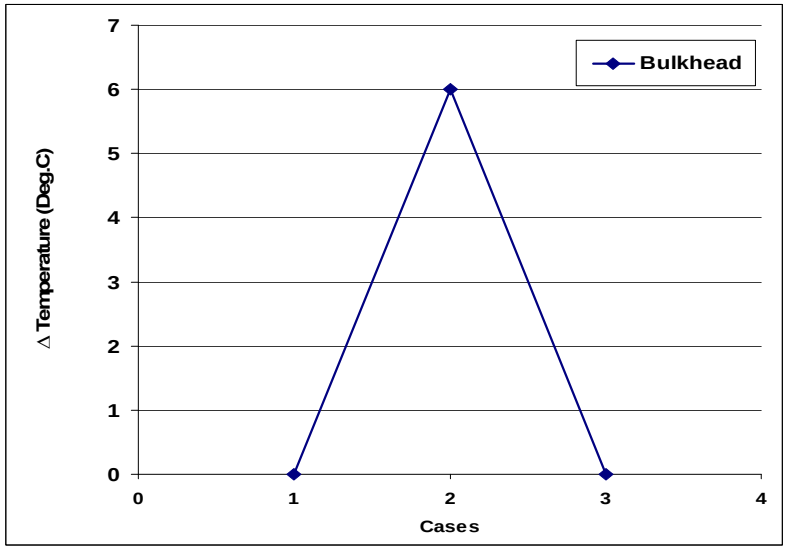
Area of interest to assess the thermal design

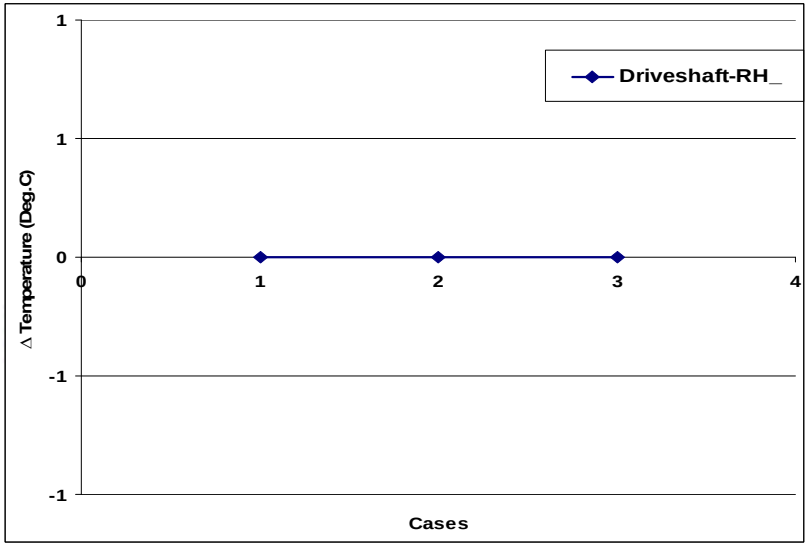
Heat protection simulation time optimisation

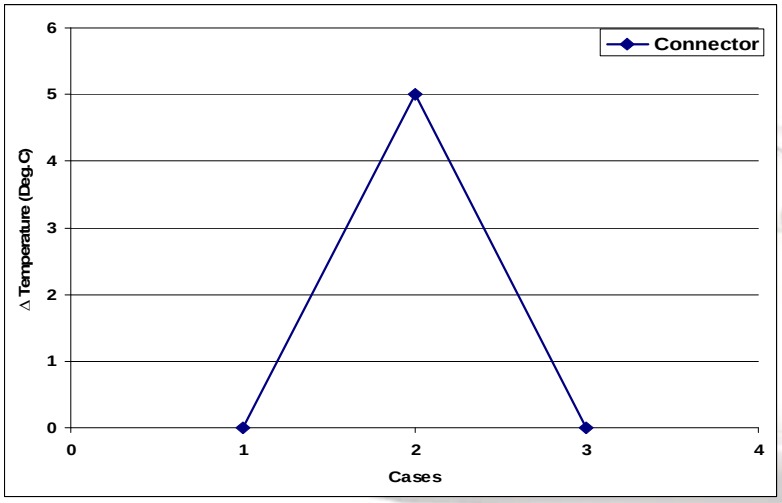


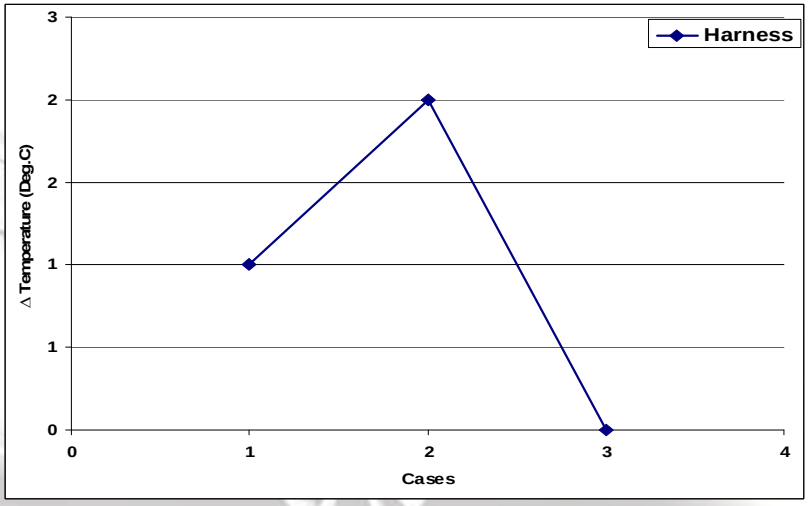
Time step curves

Heat protection simulation time optimisation



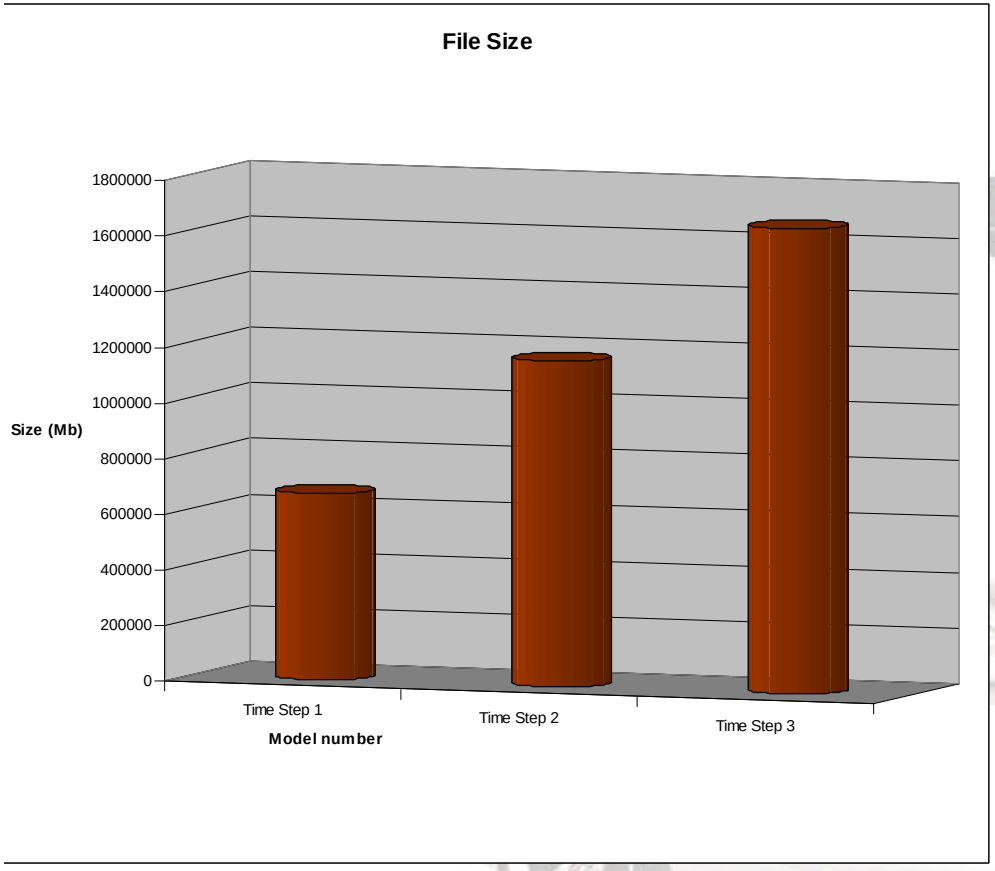


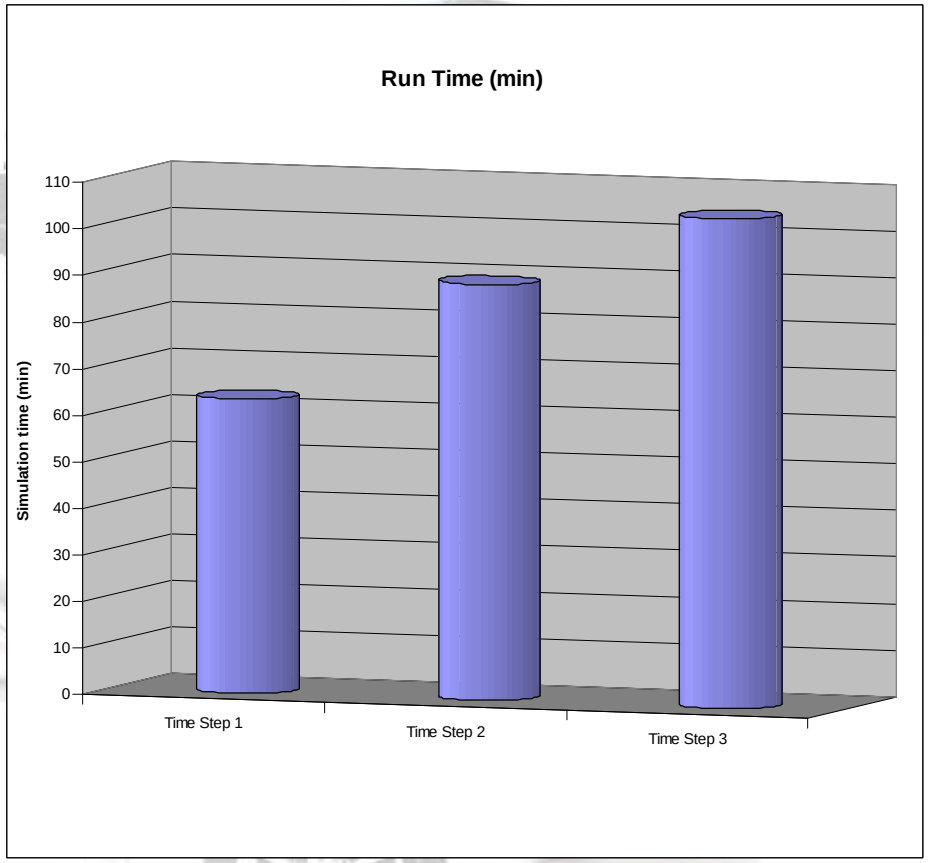




Comparison of temperature of different components

Heat protection simulation time optimisation





The time step methods reduces the file size and the run time

Overview

Introduction

Heat protection

Brake cooling

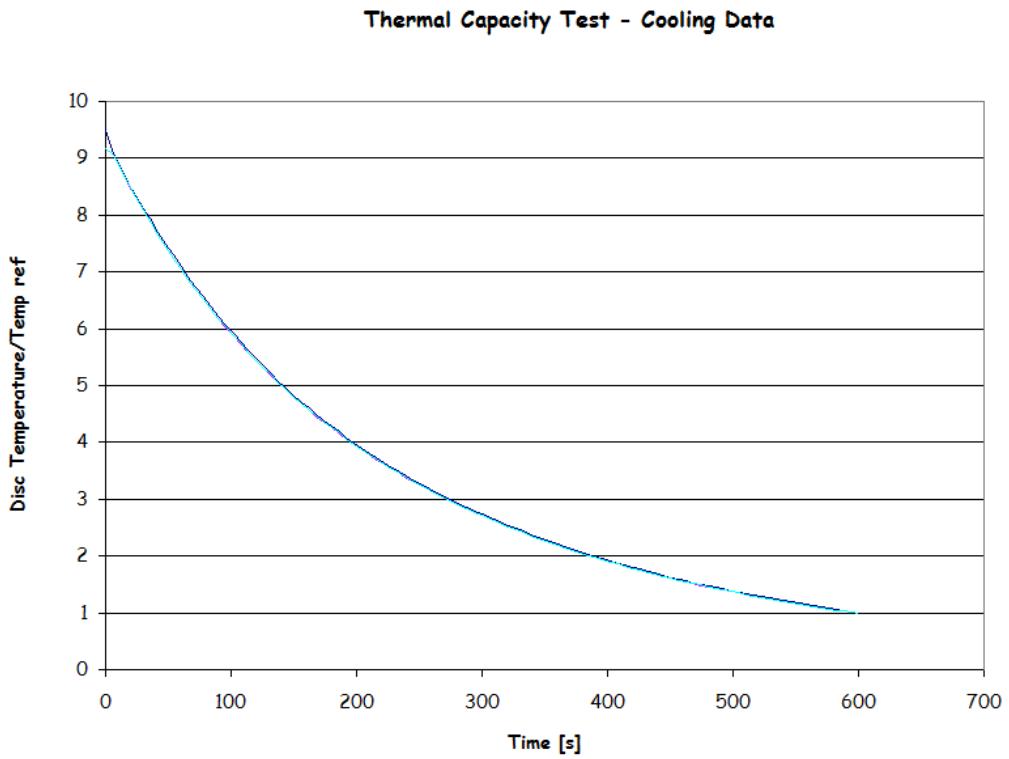
Simulation time optimisation

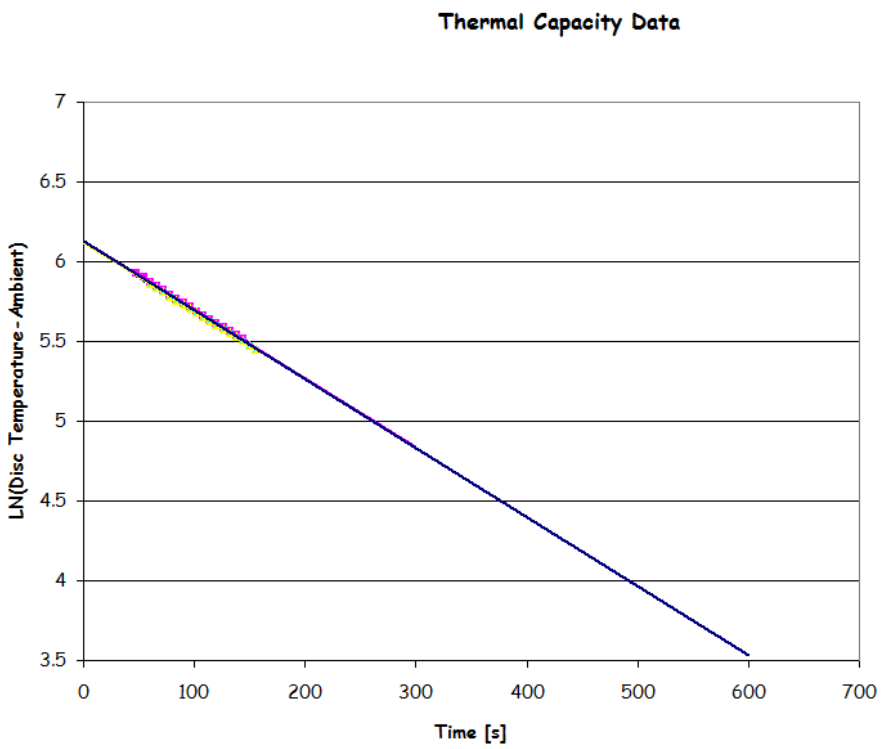
- Heat protection
- Brake cooling

Conclusion

Simulation time optimisation

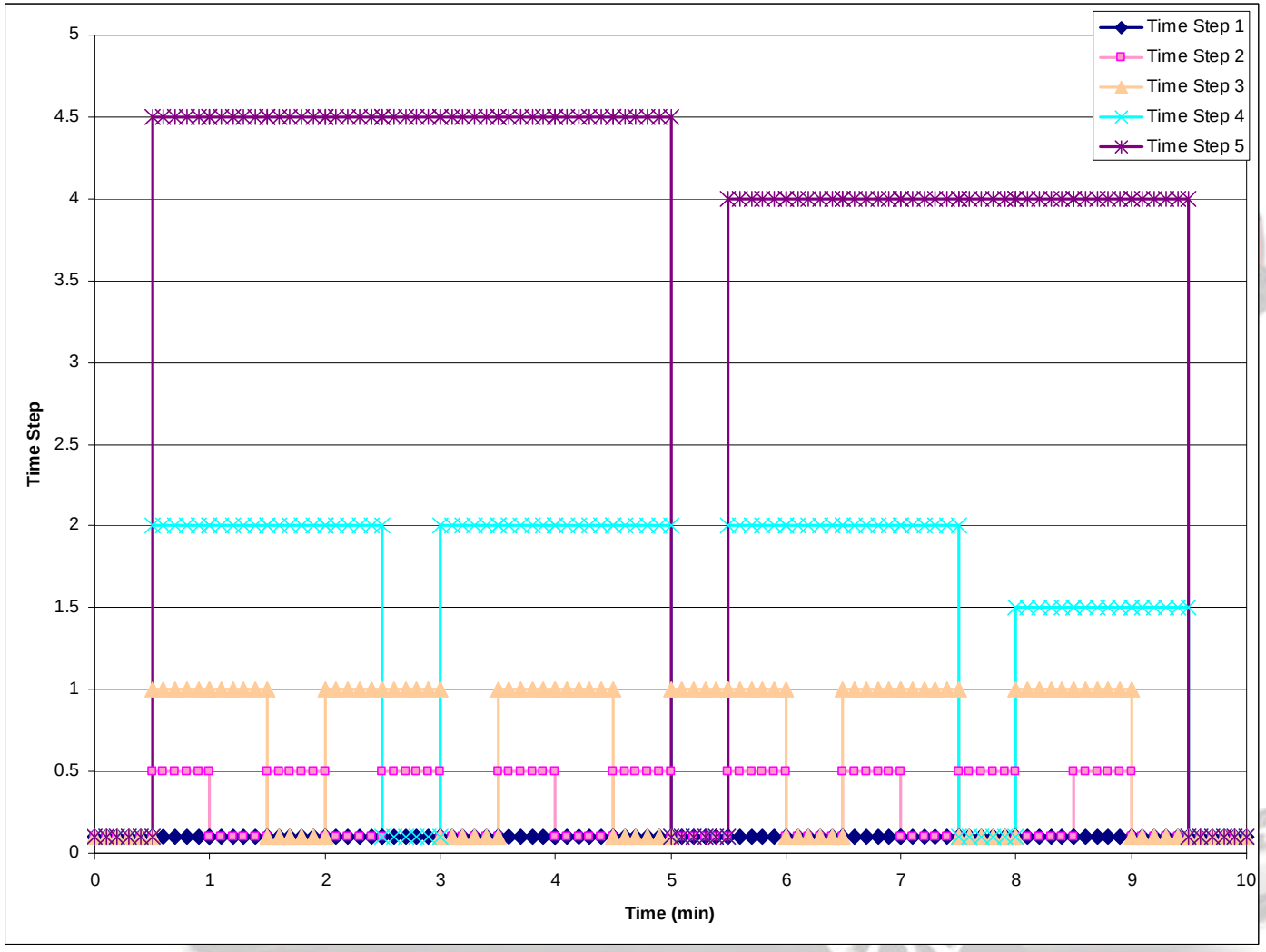
Data to calculate cooldown coefficient





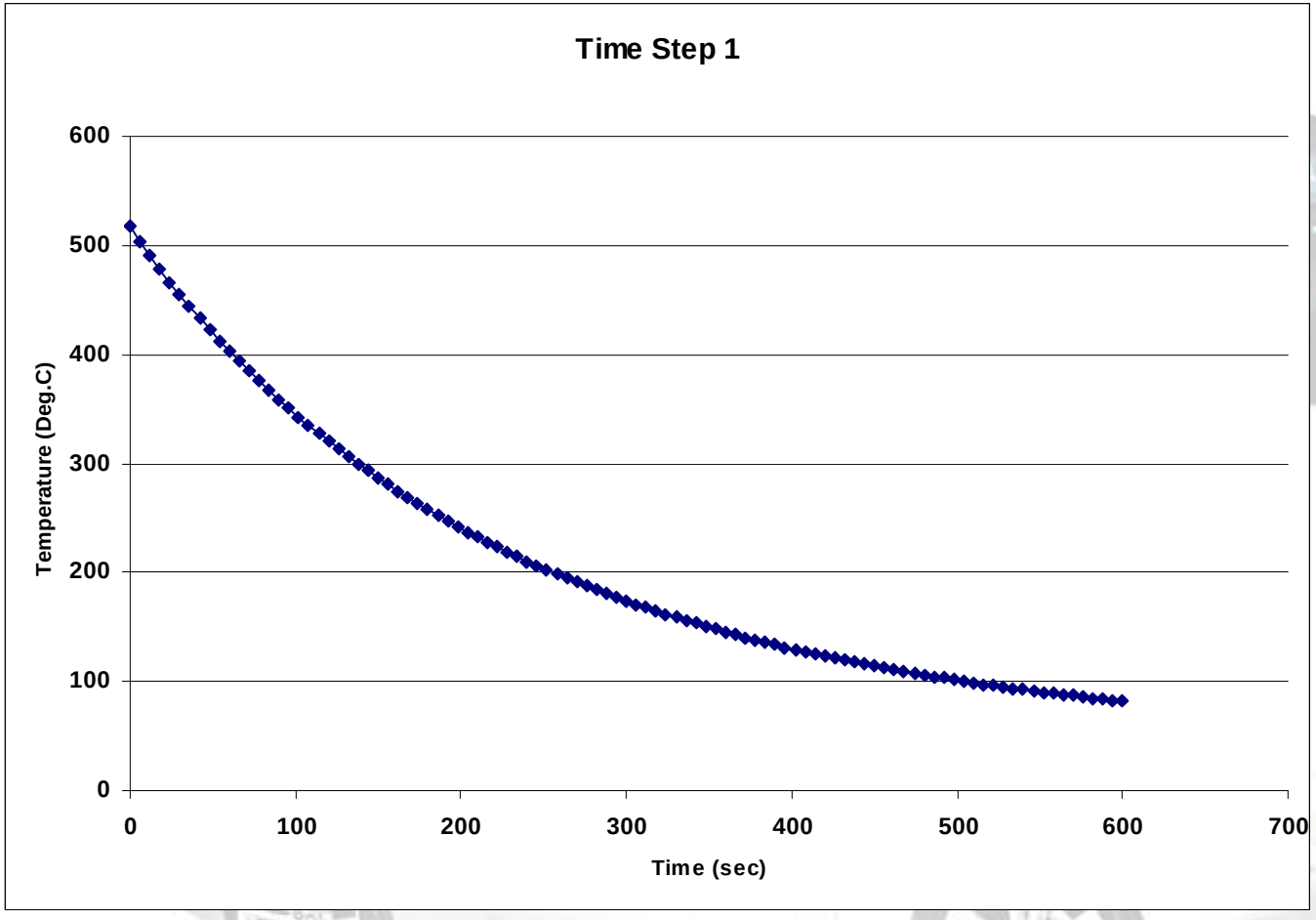
Brake cooling curves results

Simulation time optimisation



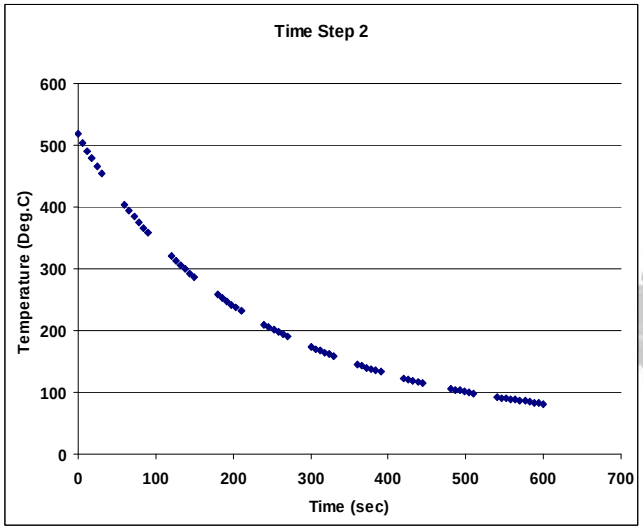
Time step curves

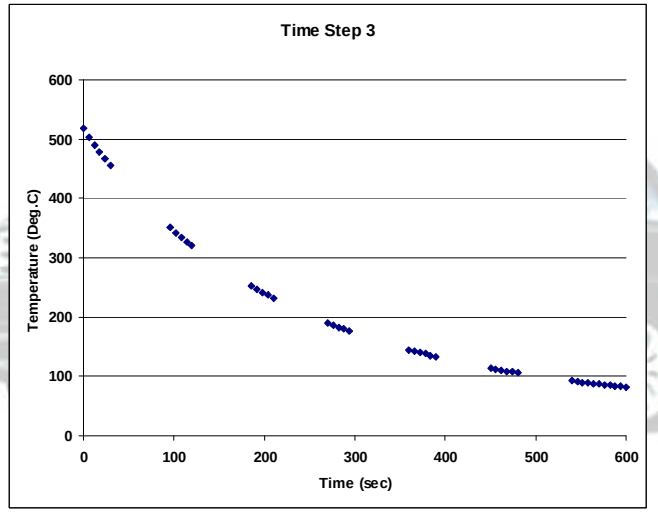
Simulation time optimisation

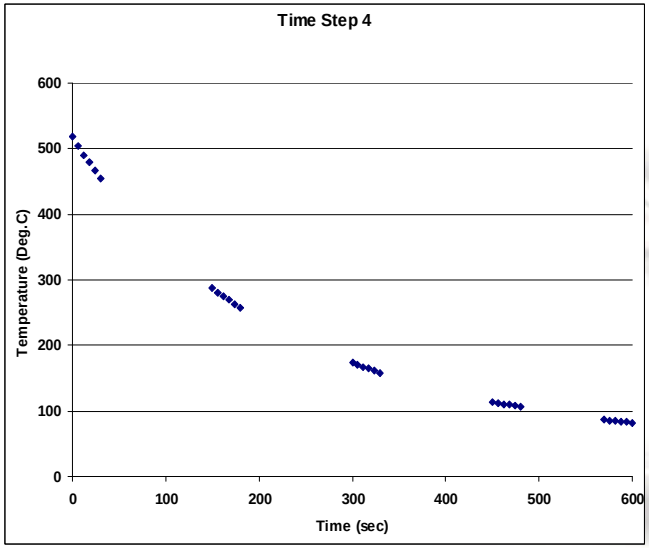


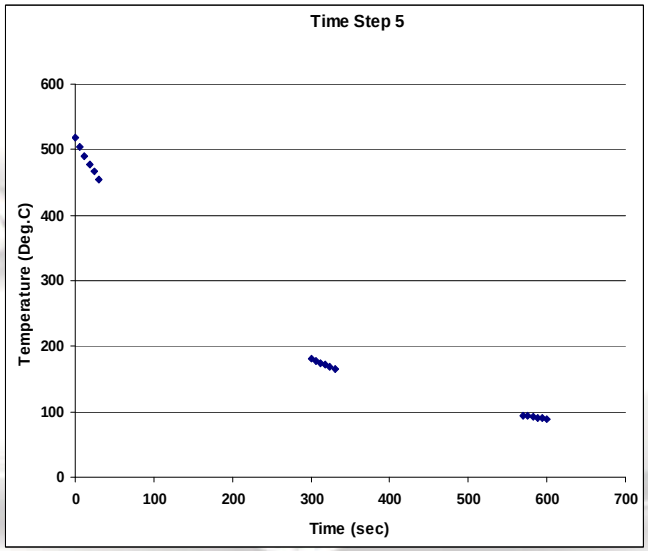
Brake disc temperature curve

Simulation time optimisation





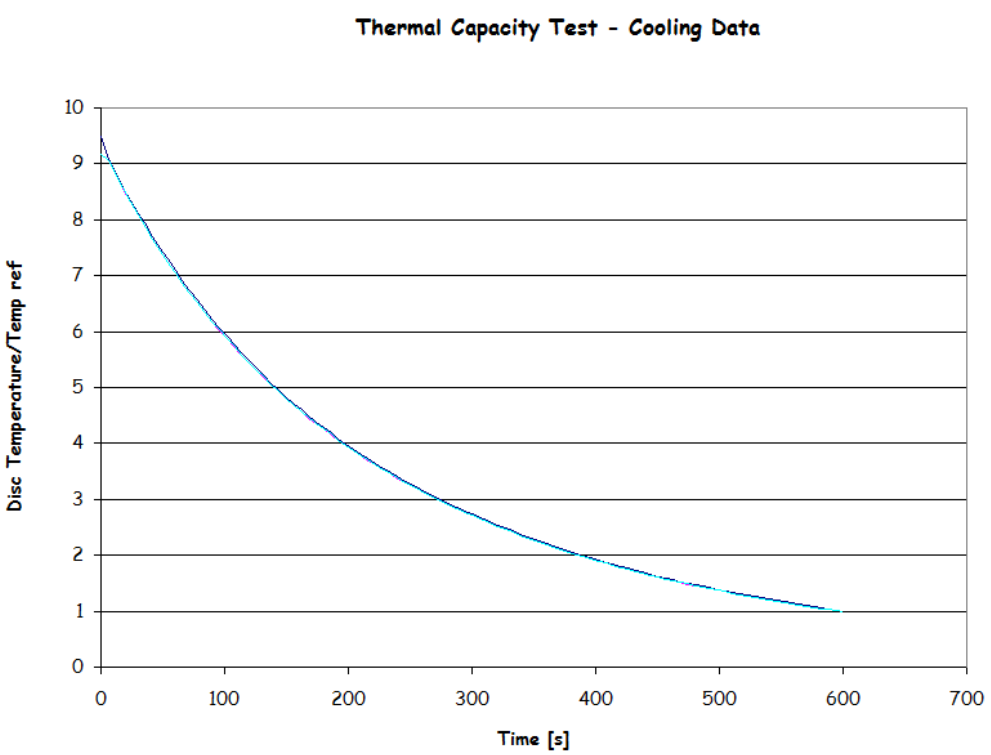


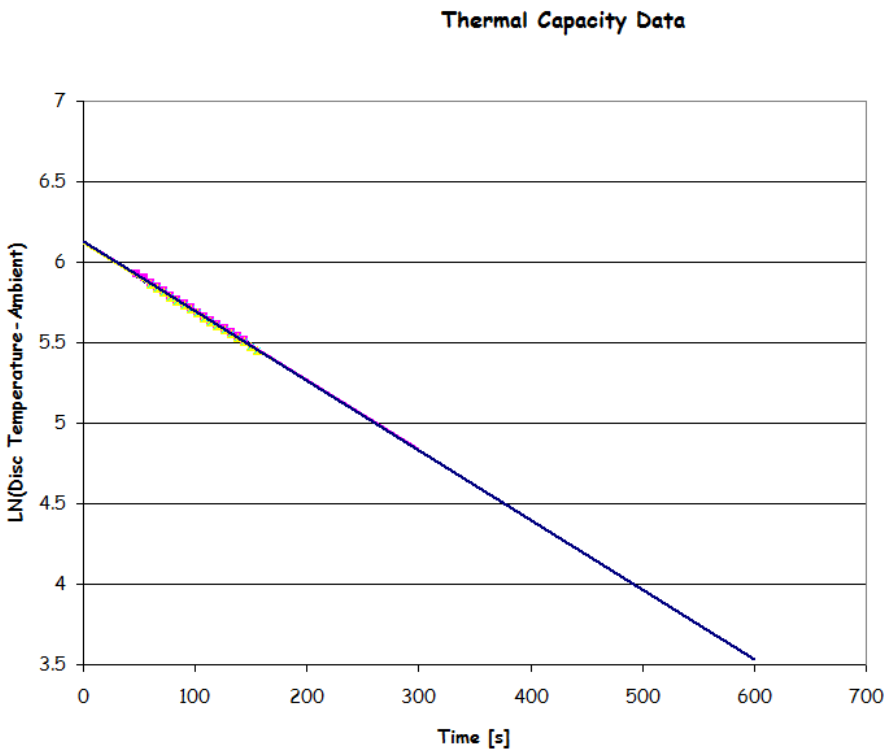


Brake disc temperature curves

Simulation time optimisation

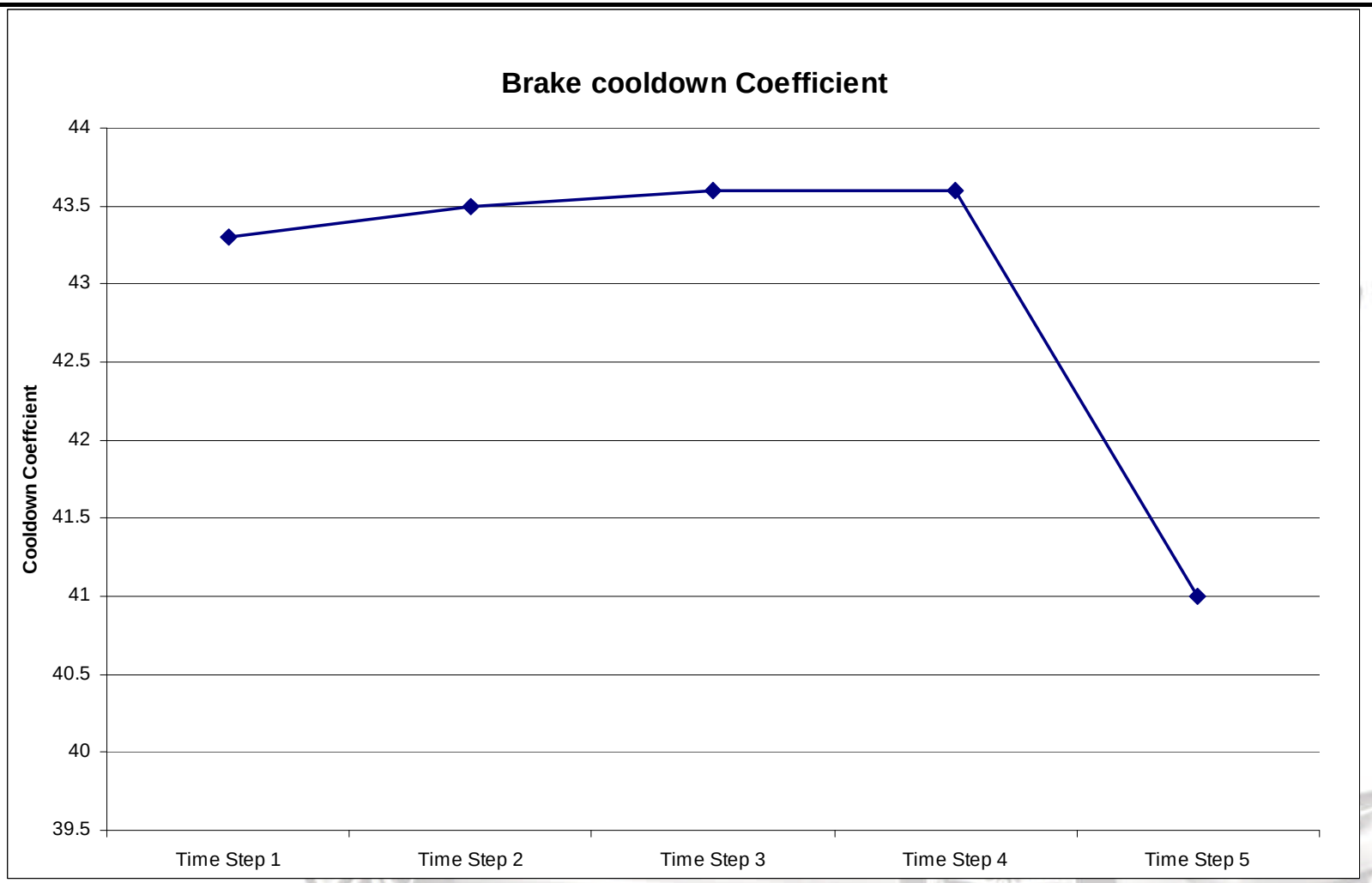
Macro is created to interpolate the temperature values





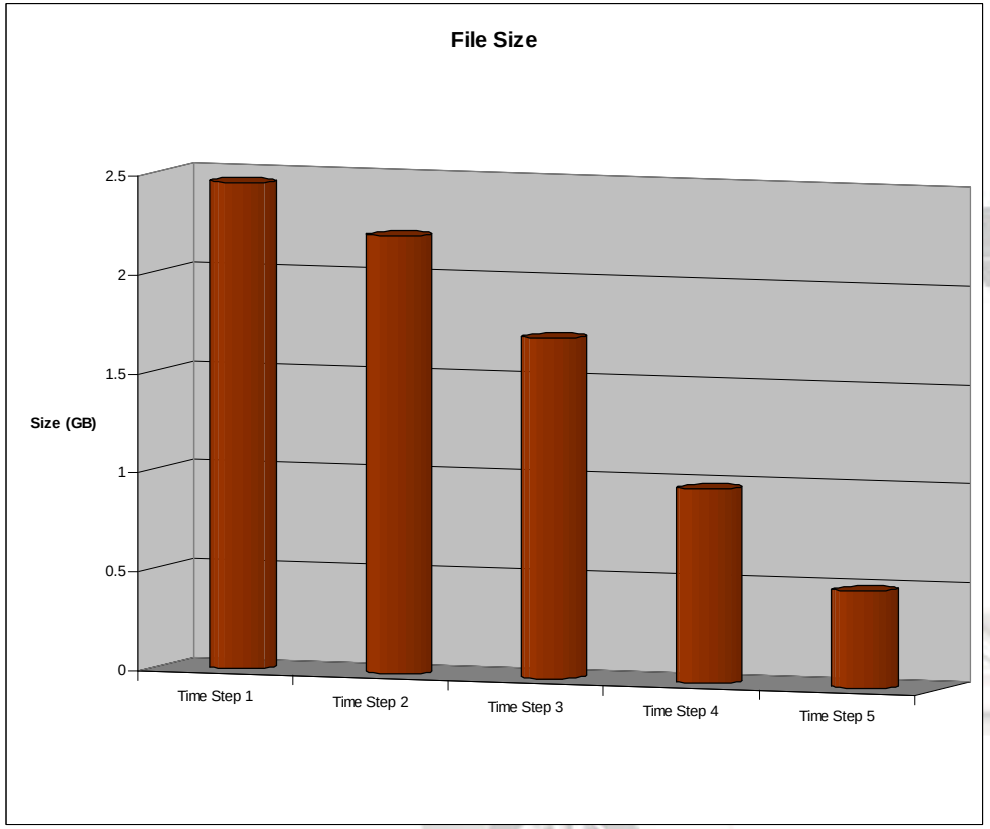
Brake cooling curves results

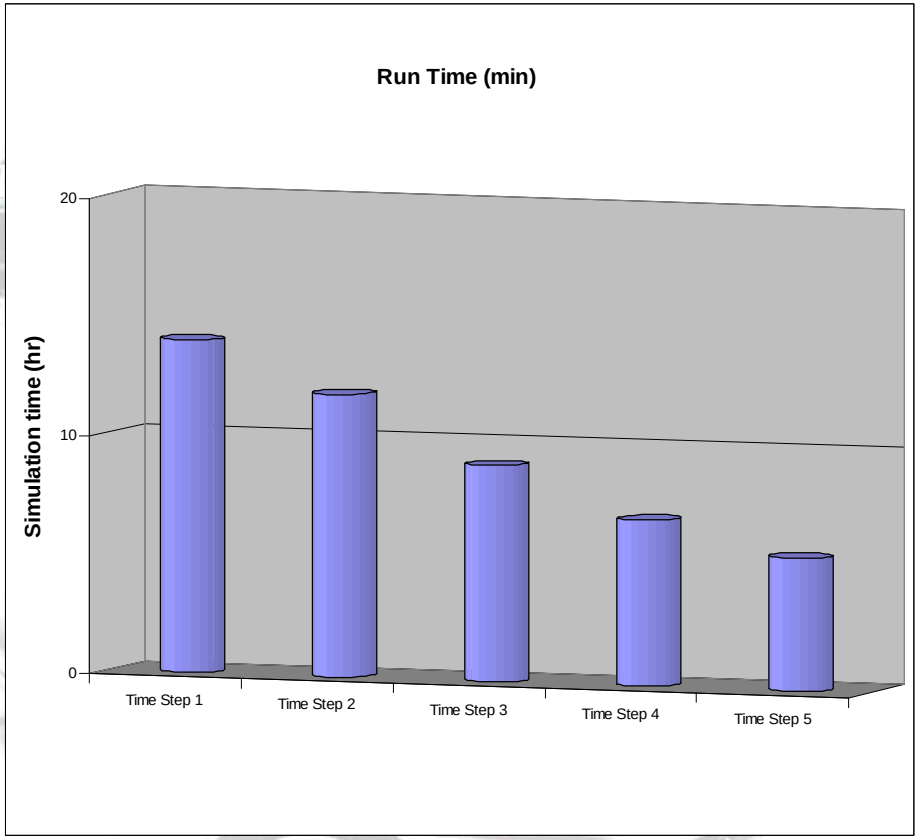
Simulation time optimisation



time step curve

Simulation time optimisation





The time step methods reduces the file size and the run time

Overview

Introduction

Heat protection

Brake cooling

Simulation time optimisation

- Heat protection
- Brake cooling

Conclusion

Conclusion

- ✓ **Efficiency improvements play a vital role in delivering the CAE vehicle program phase.**
- ✓ **Time simulation can reduce the file size by 60%.**
- ✓ **Time simulation can reduce the run time by more than 50%.**

Q & A session

Abdelhakim Aissaoui

March 15th, 2011

Radtherm UGM Munich