UNIVERSITY OF BIRMINGHAM

Centre for Railway Research and Education

Birmingham Centre for Railway Research and Education

Engineering and Physical Sciences

School of Electronic, Electrical and Computer Engineering

Birmingham Centre for Railway Research and Education

The University's research programme contributes to improving Britain's railways now and into the future.

Dr Jeff Allan, Rail Safety and Standards Board

Leading expertise in:

- Aerodynamics
- Condition monitoring
- Data integration
- Environmental engineering
- Geotechnical engineering
- Metallurgy and NDE
- Modelling and computation
- Power and energy
- Risk and safety
- Systems engineering
- Railway capacity
- Real-time traffic management
- Railway education

Existing Collaborations

Types of collaboration:

- Directly funded contract research
- Industrial ‘Strategic Partnerships’
- Collaborative co-funded research
- Government funded research (EPSRC, DfT)
- European Commission funded research

Research collaborations in:

UK, France, Germany, Italy, Sweden, Netherlands, Portugal, Greece, Spain, Belgium, USA, Japan, China, Hong Kong, Malaysia, Singapore

Network Rail · SNCF · DB · JR · UNDERGROUND · GE

Department for Transport · ALSTOM · Land Transport Authority · invensys

AnsaldoSTS · ARUP · HITACHI · REFER · TRAFIKVERKET

Group Overview

Largest railway research group in Europe:

17 Academic staff, 18 Research staff, 3 Support staff,
45 PhD students, ~100 MSc/MRes students

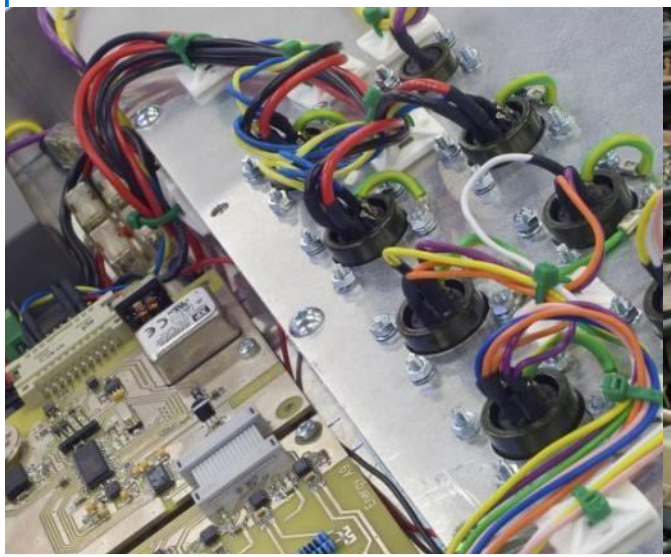
A number of bespoke test rigs:

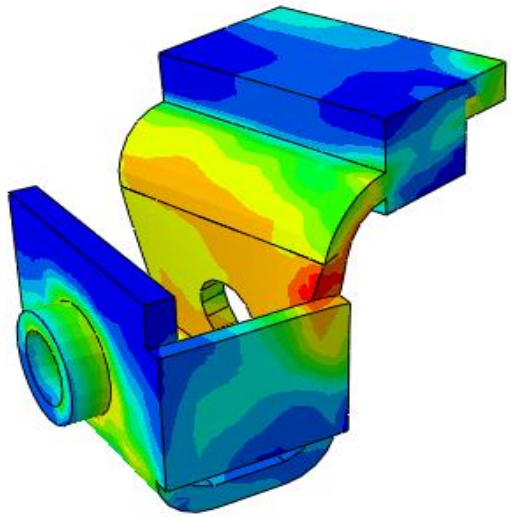
Aerodynamics rig, track bed rig, non-destructive test equipment, traction test laboratory, train door test rig, level crossing rig, spinning rail rig, robotic inspection equipment, in-service measurement trains, switch rig, environmental chambers, bearing test rig, anechoic chamber for acoustic tests




Railway Condition Monitoring (to automatically detect faults)

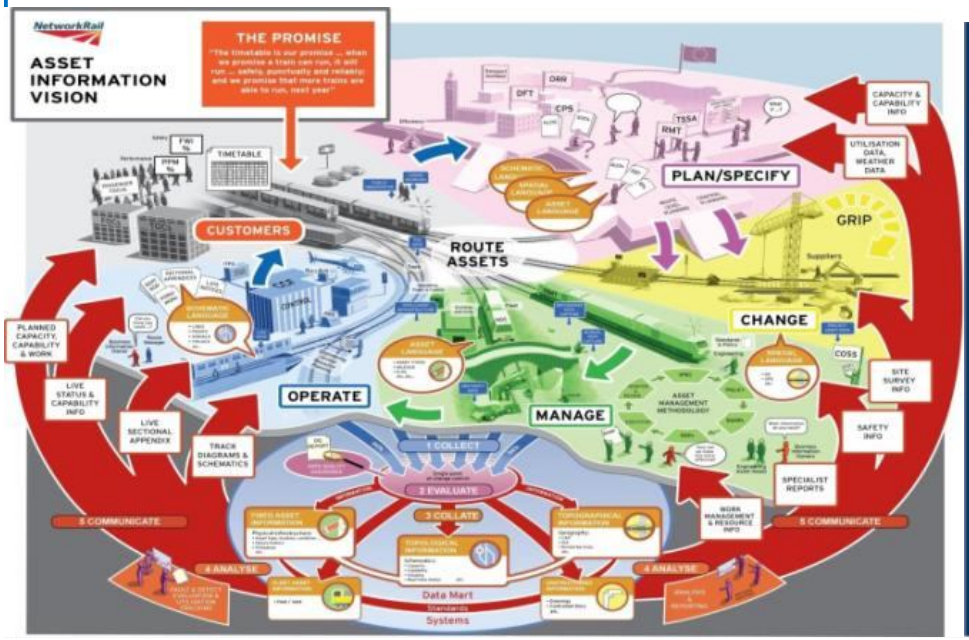
- Developed algorithms for fault detection and diagnosis of point machines used on 5,000 switches for Network Rail – similar work is now being undertaken with Japan Central Railways
- Monitoring energy usage on the MerseyRail DC power network to quantify losses
- Instrumentation of in-service trains in the UK to measure track geometry and develop automatic event detection
- Development of condition monitoring for train doors
- In-service bearing test equipment developed for Hitachi

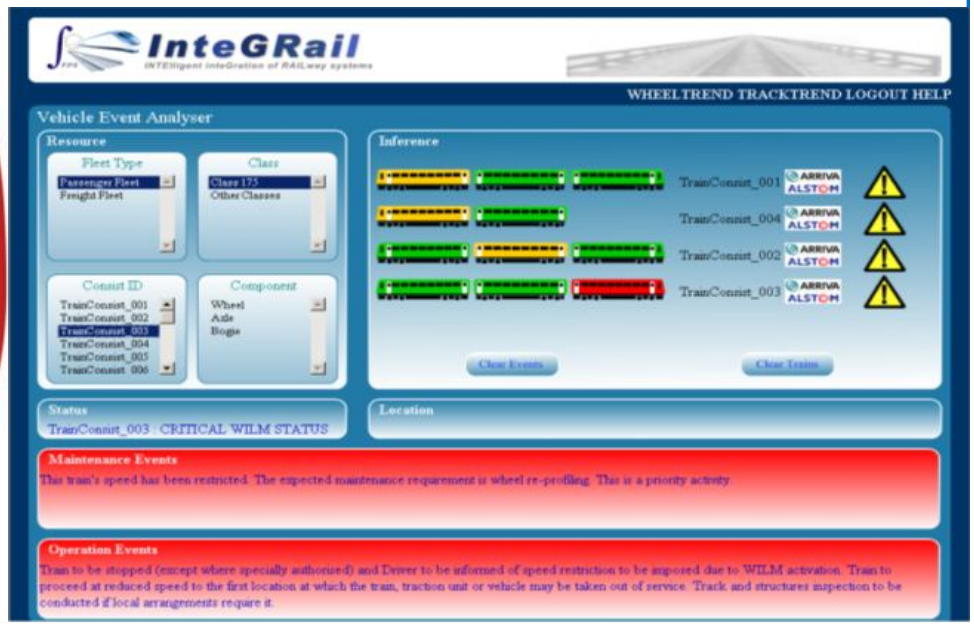




Data Integration and Management (to connect systems and get value from data)

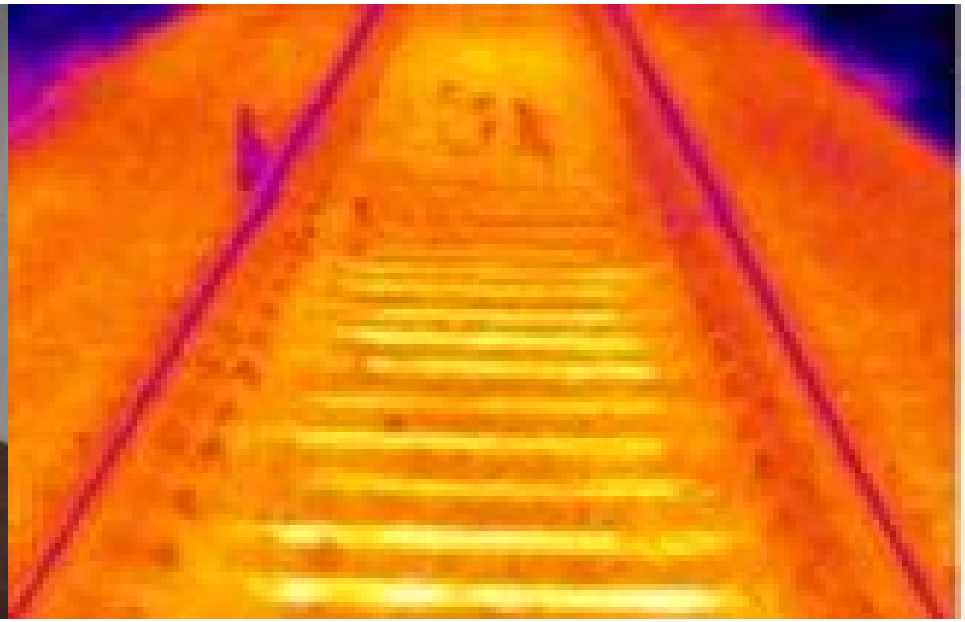
- Strategic Partnership with Network Rail in the area of Data Integration
- Development of a data architecture and models for future European Train Control Systems
- Signalling data architecture for Invensys
- Integration of train delay and climate data to predict and mitigate future disruption
- Further development of the RailML standard





Environmental Engineering (forecasting and mitigating against climate)

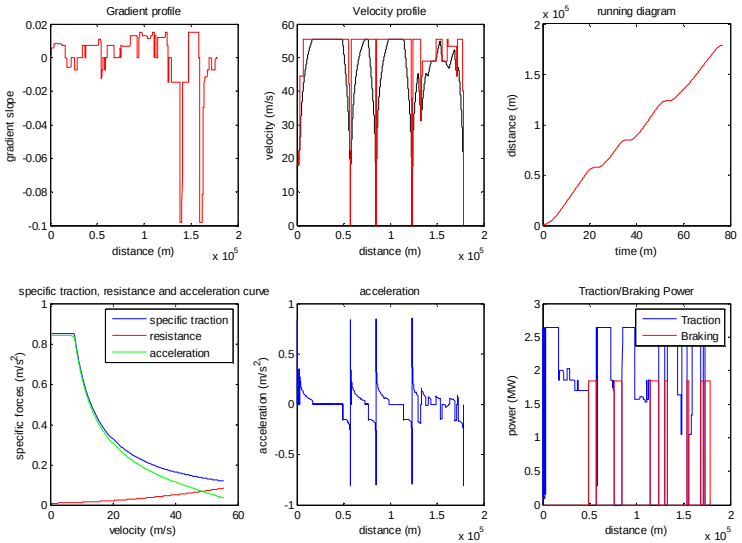
- Development of winter preparation procedures for network rail
- Facility to testing switches in freezing conditions
- Practical test to measure the effect of the impact of temperature on rail infrastructure
- Undertaken a national project to spatially identify locations of track prone to railway buckling
- Modelling of economic costs of increased temperatures on the rail network in terms of increased track failures and thermal comfort



Power and Energy
(to gain energy savings)

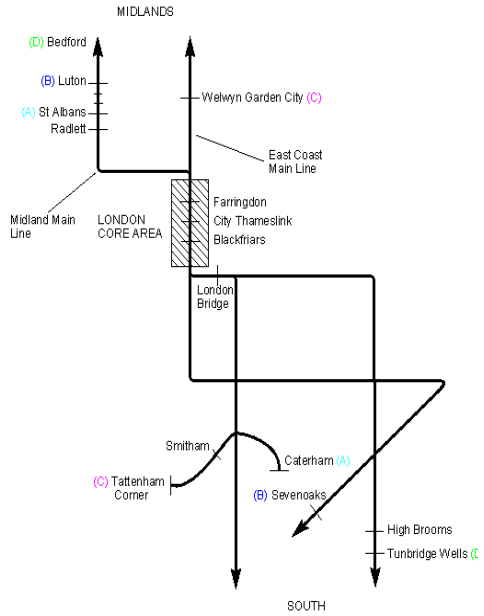
- Single train simulator for calculating power and energy requirements and comparing new rolling stock designs
- Developed widely used multi-train simulator to understand power flows in AC and DC railway power networks
- Electrical Storage Integration Laboratory part-funded by ERDF
- Supporting the UK Department for Transport and Singapore Land Transit Authority with train procurement
- Development of methods for energy efficient timetables
- Helping industrial partners with the design of battery, hybrid (diesel-electric) and hydrogen powered trains

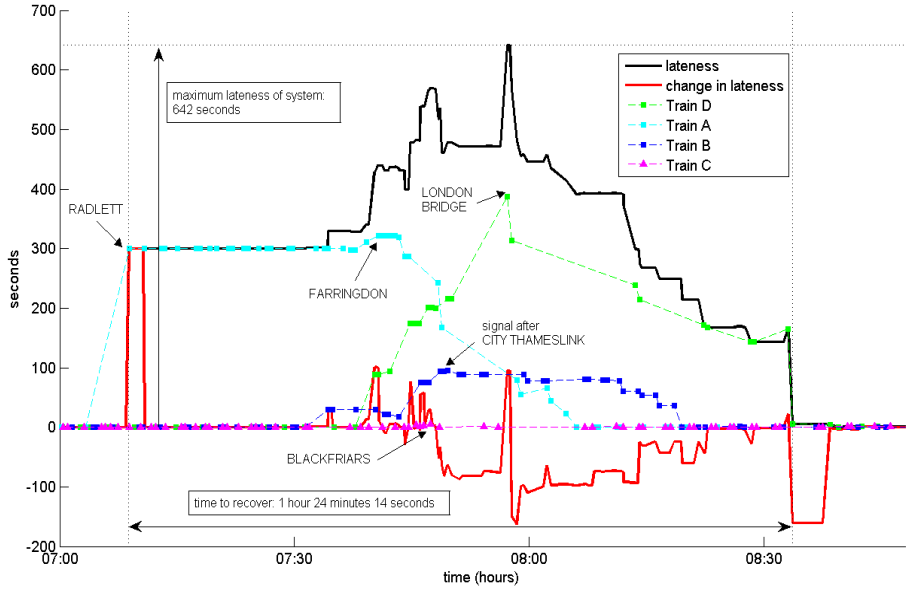
investing in **your** future
European Regional Development Fund
European Union

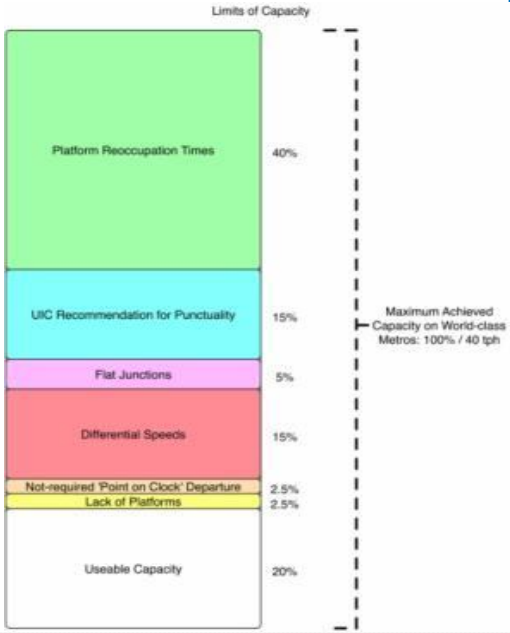


Railway Capacity
(to understand the complexity of operations)

- Reports for the UK Department for Transport on improved methods for capacity analysis
- Helping with capacity planning on London's Thameslink line
- Development of new capacity analysis methods, now used by Network Rail, SNCF, RFI, Trafikverket
- Assessing timetables for robustness, resilience and stability
- Development of a new capacity measure to replace UIC406

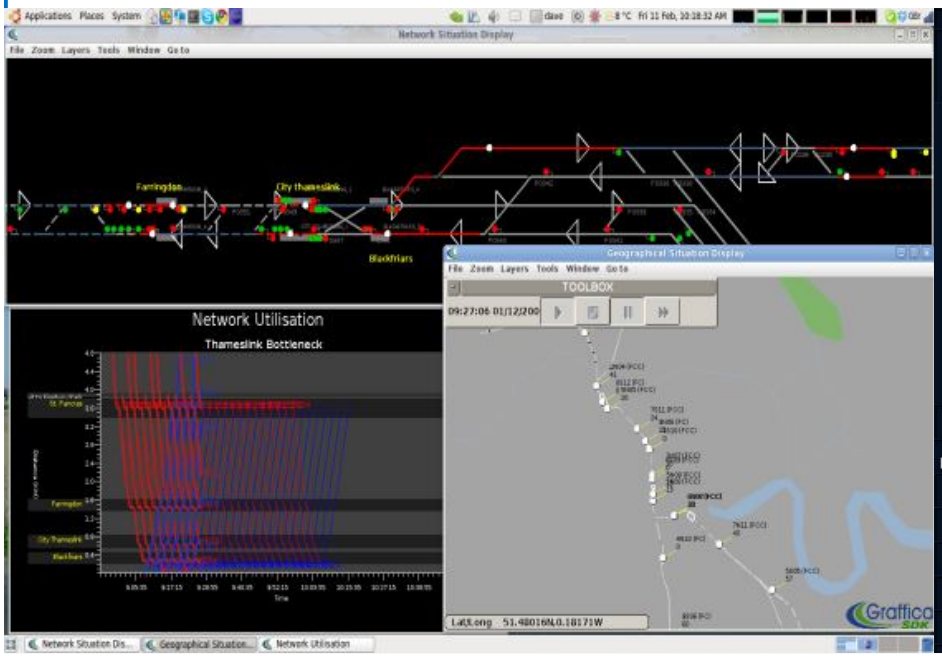


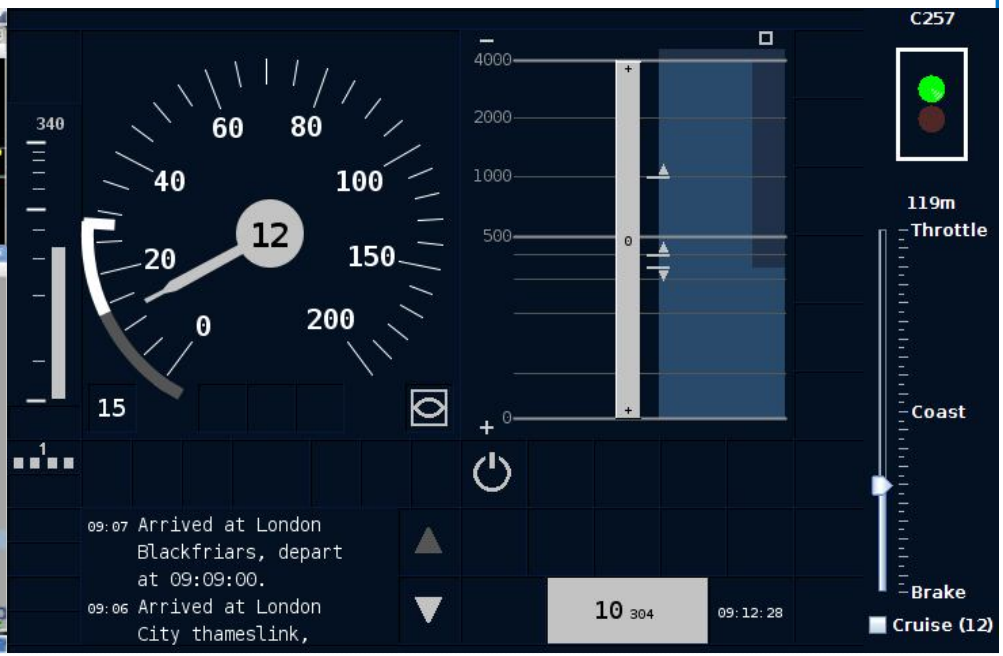




Real-time Traffic Management (to develop the next generation of train control)

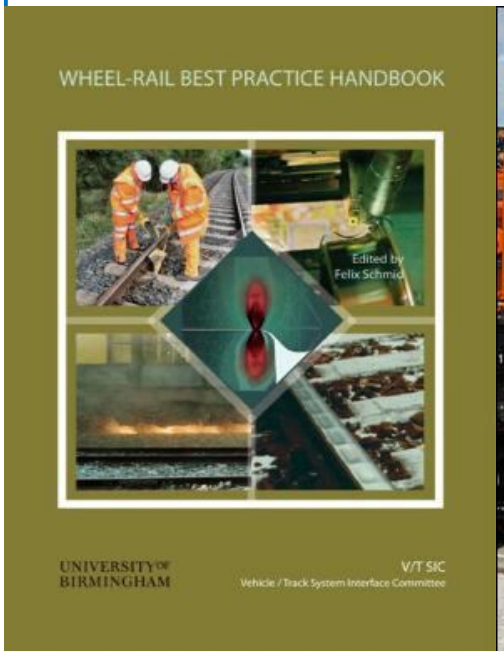
- Supporting Network Rail with traffic management investment decisions
- Comparison and benchmarking of traffic management algorithms
- Development of a new traffic simulator for testing traffic management systems – hardware and humans in the loop
- Establishment of benchmark lines for comparing commercial systems in UK, France, Italy and Sweden
- Technical lead of the EU ‘ON-TIME’ project





Railway Education
(to educate and develop railway engineers)

- International MSc programme in Railway Systems Engineering with students from around the world
- Sponsored students from: UK, Ireland, Norway, Turkey, USA, Australia, China, Hong Kong, Malaysia, Singapore, Thailand
- MRes programme established in 2011
- Additional courses for: London Underground, Bechtel, Alstom and Department for Transport
- Railway text books published



Example of student projects

Joint MEng project with GE wind power conversion systems 2013

- Design process relies on software at the concept design stage
- Project idea developed during my placement and expected to start in Graduate training scheme
- Project also is a part of knowledge development and continuity to future projects

Renewable generation

GE 690 V 2.3 MW wind converter

UK designed and built

3.5 GW delivered in 2010

(Converteam Annual Report 2010)

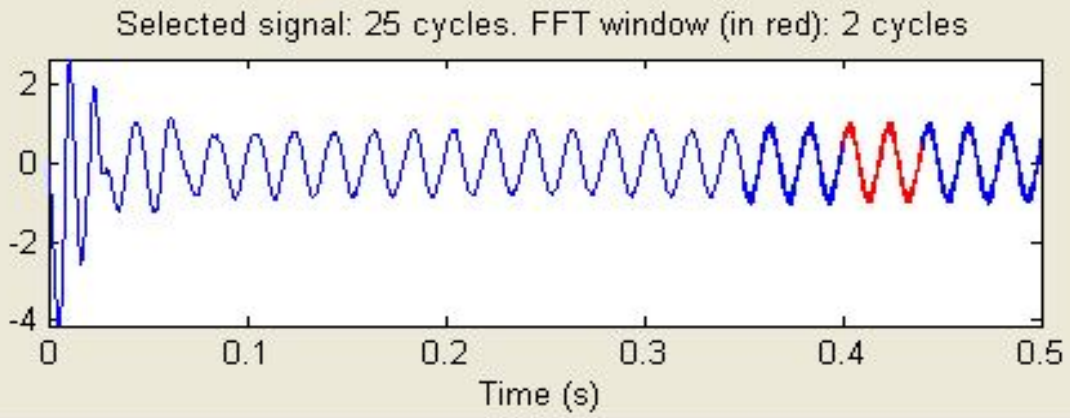
10% of 35.8 GW global annual installed capacity

(GWEC Global Wind Report – Annual Market Update 2010)

imagination at work

Signal to analyze

Display selected signal Display FFT window



FFT analysis

```
Sampling time      = 8e-007 s
Samples per cycle  = 25000
DC component       = 0.001247
Fundamental        = 0.9033 peak (0.6387 rms)

Total Harmonic Distortion (THD) = 11.30%

Maximum harmonic frequency
 used for THD calculation  = 624950.00 Hz (124

      0 Hz   (DC):          0.00    270.0°
     25 Hz                  0.00    233.7°
     50 Hz   (Fnd):         0.90     30.0°
     75 Hz                  0.00    151.3°
    100 Hz   (h2):          0.03    253.5°
    125 Hz                  0.00     23.9°
    150 Hz   (h3):          0.00    194.2°
    175 Hz                  0.00     54.3°
    200 Hz   (h4):          0.00     75.1°
```

Available signals

Structure :

scope_B2

Input :

input 2

Signal number:

1

FFT window

Start time (s): 0.4

Number of cycles: 2

Fundamental frequency (Hz):

50

FFT settings

Display style :

List (relative to specified ba...

Base value: 1.0

Frequency axis:

Hertz

Max Frequency (Hz):

3000

Display Close