

NPL – Data Capture and Signal Processing in Hostile Working Environments

Dave Rhodes

ISVR Consulting, University of Southampton

June 2006



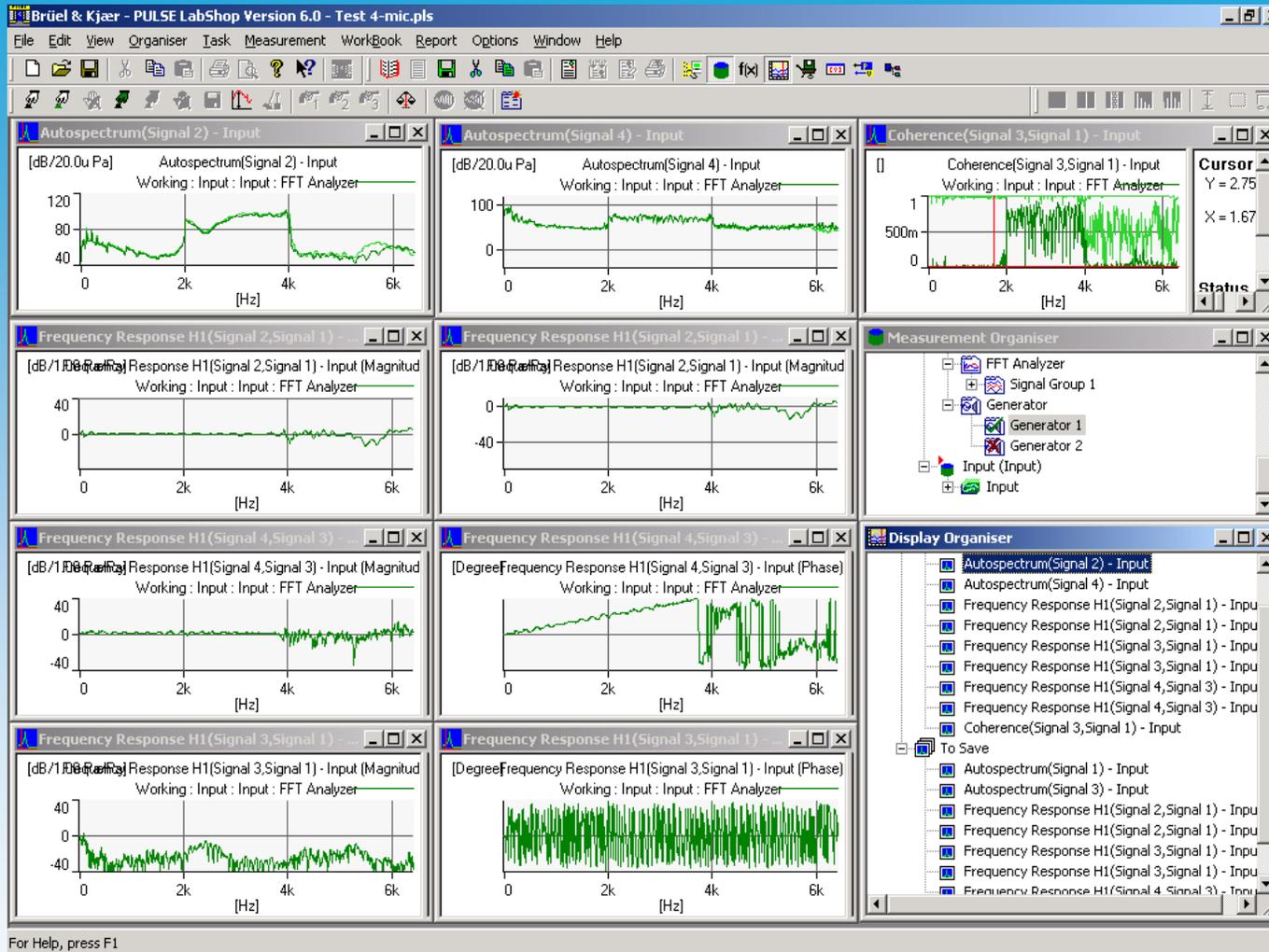
Early Brüel & Kjær Measuring Equipment

Minimal Signal Processing Options



Brüel & Kjær 2032

Virtually all analysis options visible on screen



Brüel & Kjær PC based 'Pulse' System

Powerful and flexible, but not easy to use



Typical Working Environment

“Not easy to do reliable signal processing here”

isvr



- **Limited access to test machines**
- **Repeat tests expensive or even impossible**
- **Can analyse recorded data in detail later**
- **Must know immediately if data is good**
 - **“Go home or instant repeat needed”**
- **For new and unusual work must be prepared for Real Time Investigation of Signal Processing options**

Errors Associated with Data Capture, Data Analysis and Signal Processing

Types of Error:

- **Real Error: Defective data**
- **Suspected Errors: data can not be believed**
- **Inadequately documented data**

All may lead to a need to repeat testing

Sources of Error

1. Defective cables and connectors

Auto scale/ auto calibration may “find” a defective signal despite major errors.

2. Poor documentation during result taking

3. Various small frequency response errors

4. Calibration errors

“TEDS” can help

Sources of Error (Cont)

5. Loose accelerometers and “abused” microphones are a real problem
6. Real or suspected incorrect analysis settings
 - Sample rate
 - Frequency range and resolution
7. Inadequate understanding of Window and Trigger requirements
 - Primarily during impact testing and other transient capture

Sources of Error (Cont)

8. Failure to understand limitations of filters.
Not appreciating filter time domain characteristics.
9. Aliasing
10. Poor use of Dynamic Range

Sources of Error (Cont)

- Difficulty in seeing any computer screen when working outdoors.

This substantially increases the probability of all of the above errors going unnoticed.

Solutions

- **Highly skilled engineers with a good knowledge of what results to expect.**

In most cases a measurement should not be made unless the engineer has a good idea of what the result will look like.

- **A fundamentally different software architecture is required when working in the field**

Conventional systems

Current systems optimised for comprehensive features and flexibility

Most suitable for laboratory use

- Very flexible and powerful ... but
 - Complex screen displays
 - Far too many options
 - Far too many “hidden options”

Requirements of Systems for Field Data Capture & Analysis

- Simple screen display
- Simple and obvious system architecture
- Major analysis options displayed on screen and easy to change
- Avoid “Hidden Destructive” options
- Modular architecture
- Immediate visual feedback of results
- Flexible real time display of spectra/results
- Ability to record time histories for detailed analysis later
- Audit trail – saving of all analysis settings within data format
- Encourage comprehensive note taking

Possible Future Developments

- On screen display of obvious errors
 - Overload
 - “Underload”
 - Unusual settings (e.g. no windows)
- Intelligent help with common tasks
- Checking against database of typical results

The screenshot displays a Windows desktop environment with the following software windows open:

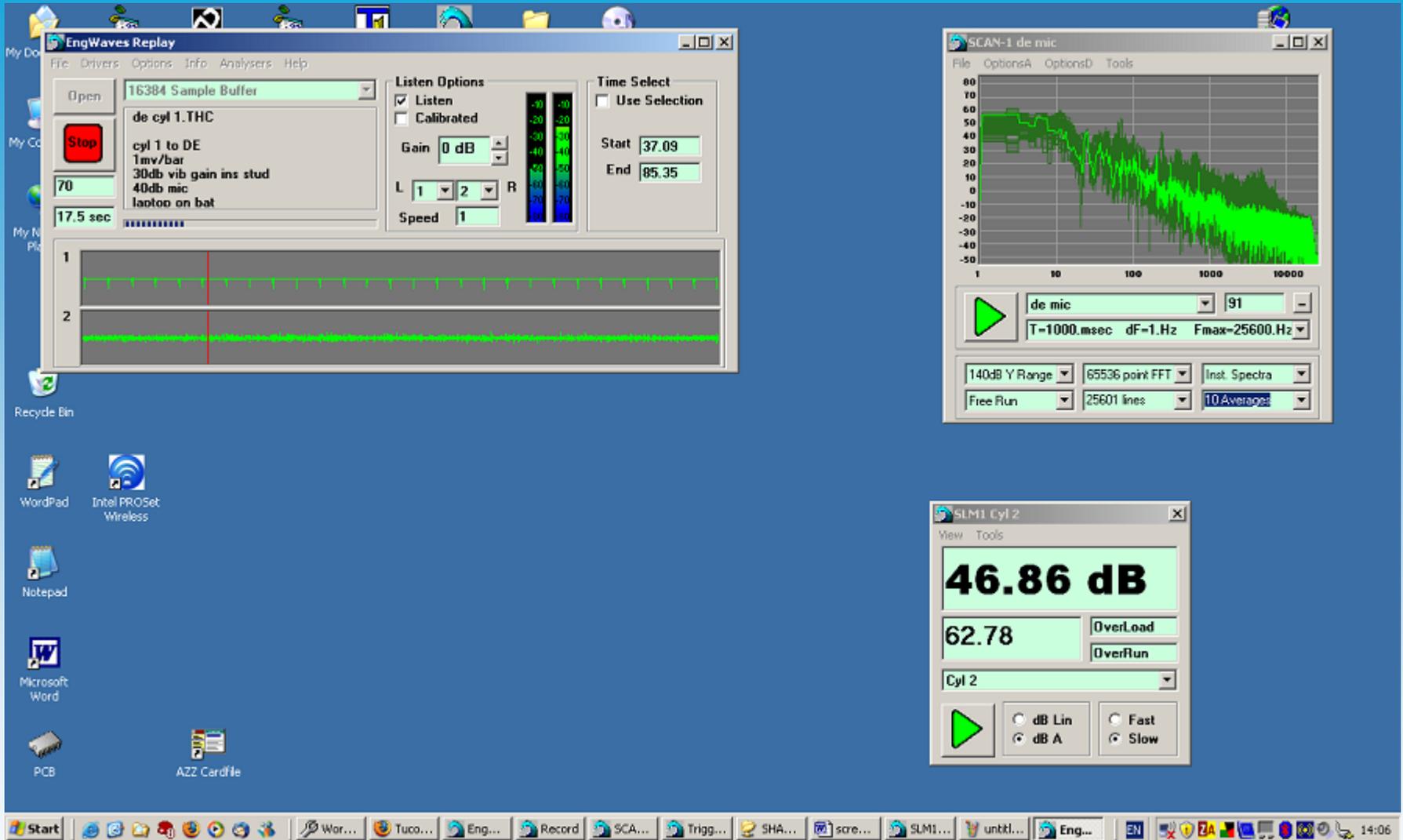
- EngWaves Record:** A window with a menu bar (File, Drivers, Options, Analysers, Tools, Help) and control buttons (Record F5, Reset, STOP). It shows recording parameters: 2 channels, 65536 samples/sec, and 16384 Sample Buffer. A pink box indicates "Displaying Data: 16 bit.. UA-1EX". Two waveforms are visible, with the top one showing a clear sine wave.
- SCAN-1 Internal Microphone:** A window showing a frequency spectrum plot with a green line. Below the plot are controls for a "Stop" button, input selection (Internal Microphone), level (140), and various analysis parameters like T=1000.msec, dF=1.Hz, and Fmax=25600.Hz.
- EngWaves Input Control:** A window with two tabs: "Range and Gain" and "Calibration". It contains a table for input configurations:

Name	Range	dB Gain	dB Gain
1 Internal Microphone	0dB	20	0
2 OPR	0dB	0	0

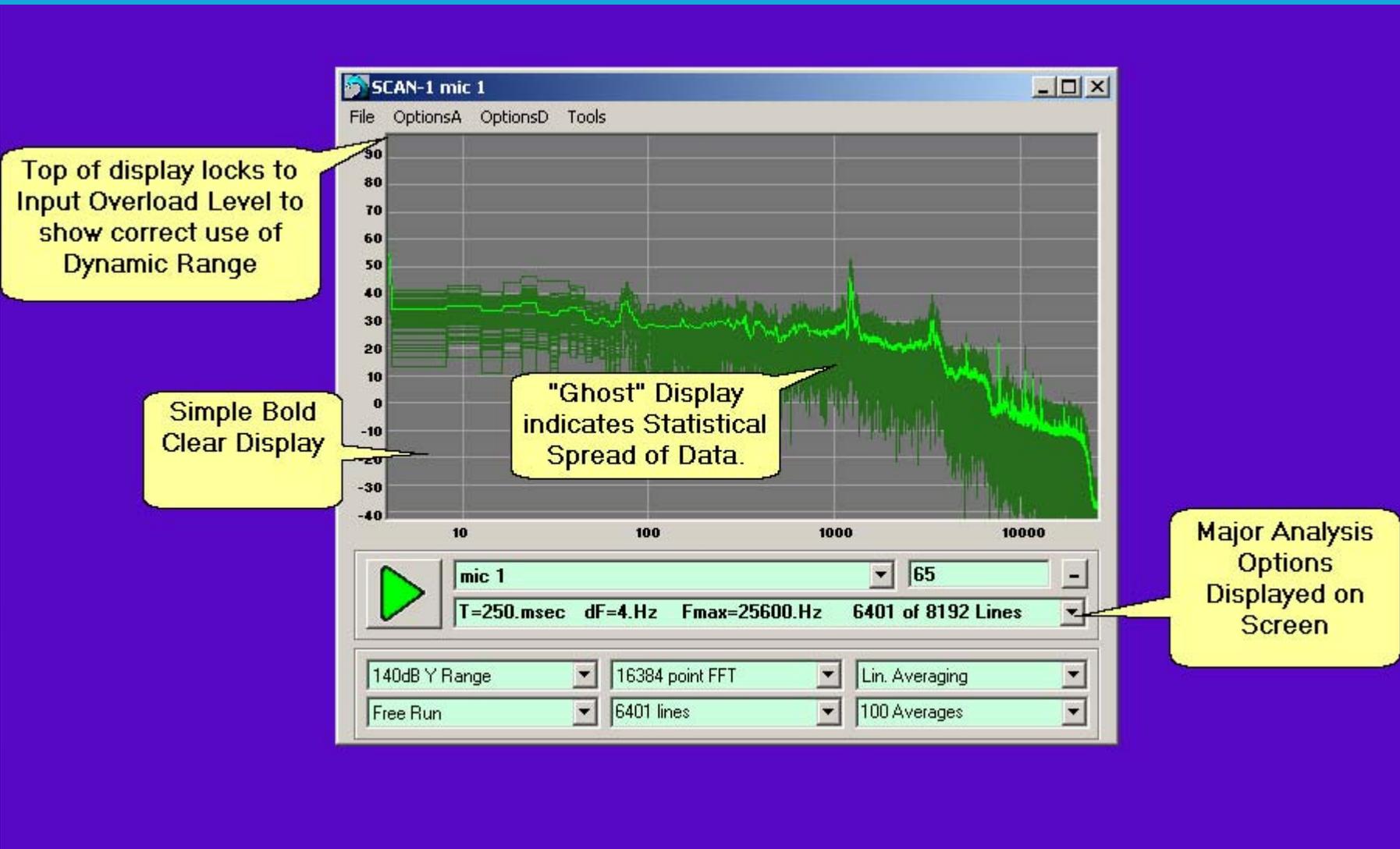
Additional controls in this window include a "Cal Tone" button.

The taskbar at the bottom shows the Start button and several open applications: Worker..., Tucows..., EngWa..., SCAN-1..., Trigger..., SHARED..., screen..., SLM1 In..., and EN. The system clock shows 14:01.

EngWaves Record



EngWaves Replay



EngWaves Analyser

“An analyser module showing some of the ‘integrity’ features

isvr

Saving: SCAN-1 FULL SPREADSHEET

Ident Text :
User can type descriptive test here
This gives details of test conditions etc.

Format
GDS Ascii
 Number (optional)

5 Narrow Band Spectra

Data Type
measured spectrum

Spectrum

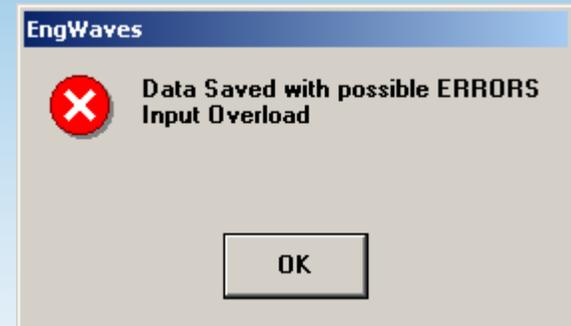
dB Reference

X Units

Y Units

Z Units

User Encouraged to Document ALL Data Daves.



Data Saving

User encouraged to document all data, and clear warnings of all 'integrity' issues

Summary

1. Achieving high integrity in field data capture is a very real issue.
2. Signal processing plays a major role in this.
3. 'Low tech' and mundane issues are often as important.
4. Making signal processing robust in the hands of non-experts, or experts working under pressure, is an important and over looked subject.