Visual Signal v1.3 產品發表會

振動噪音及訊號擷取模組

SVM & DAQ Module

吳豐泰

逸奇科技

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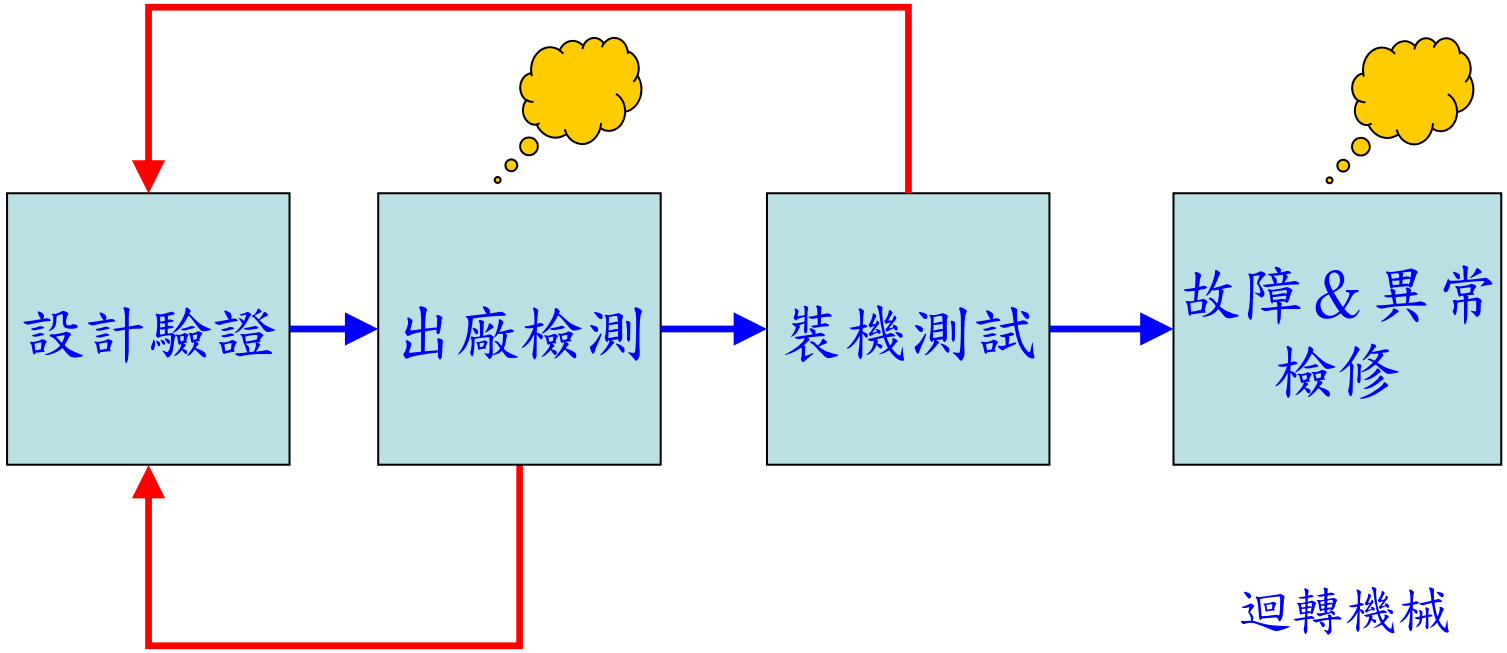
Contents

- Visual Signal
- Sound and Vibration Module (SVM)
- Time-Frequency Analysis (TFA)
- Empirical Mode Decomposition (EMD)
- Independent Component Analysis (ICA)
- Multi-Scale Entropy (MSE)
- Applications
- Data Acquisition (DAQ) Module

Why振動噪音檢測？



FEM模型
原型驗證
參數調測

生產履歷：
製造&組裝
品保資料庫
臨界轉速

客戶機台
動態特性
操作頻率
臨界轉速

迴轉機械
主軸
齒輪
軸承
馬達

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Why Visual Signal & SVM?

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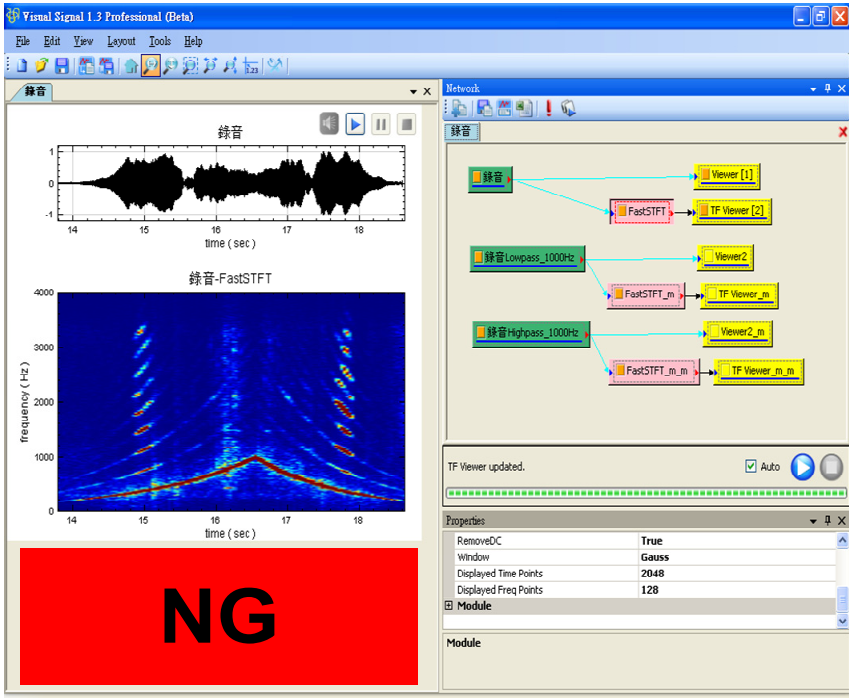
PC-based檢測系統架構

- 軟體
  - 檢測與監測操作平台(Visual Signal)
  - 資料擷取軟體(DAQ API)
  - 振動與噪音分析模組(SVM)

- 硬體
  - 資料擷取卡(NI DAQ)
  - 加速規
  - 麥克風



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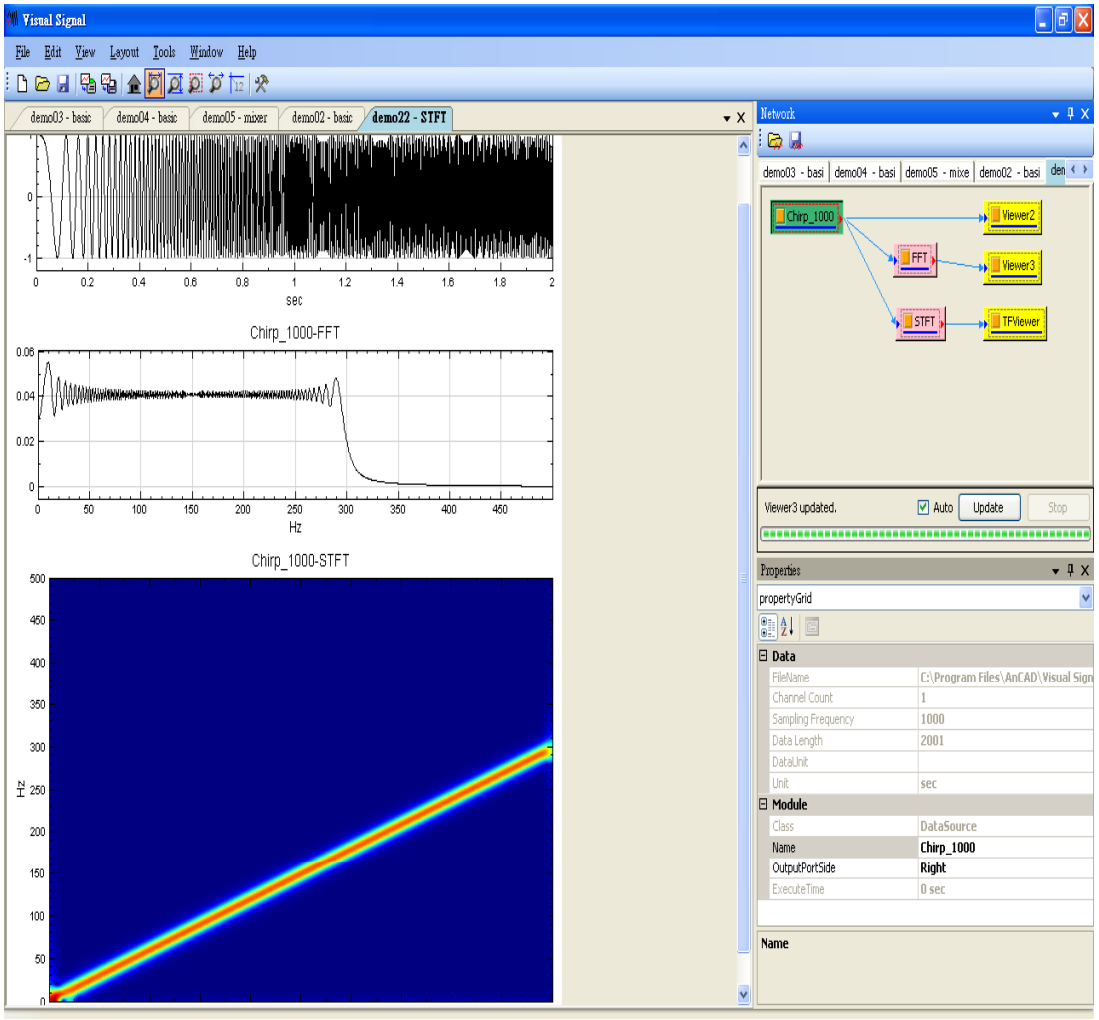
Visual Signal：軟硬體整合平台



輸入

資料擷取硬體
檔案
使用者自建函數

分析

雜訊濾除
趨勢移除
時間域分析
頻率域分析
時頻分析
統計分析
矩陣與數學運算
MATLAB, DLL

輸出

圖形
檔案
訊號產生器

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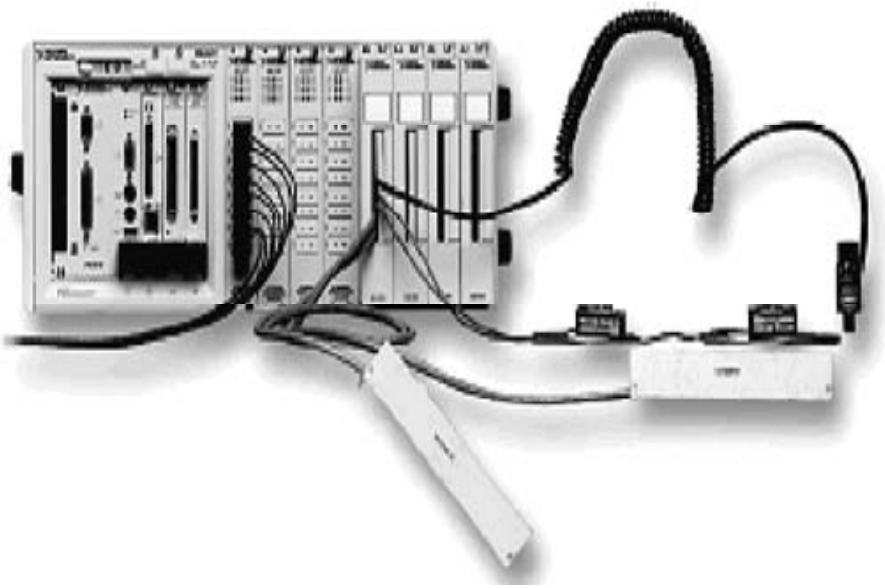
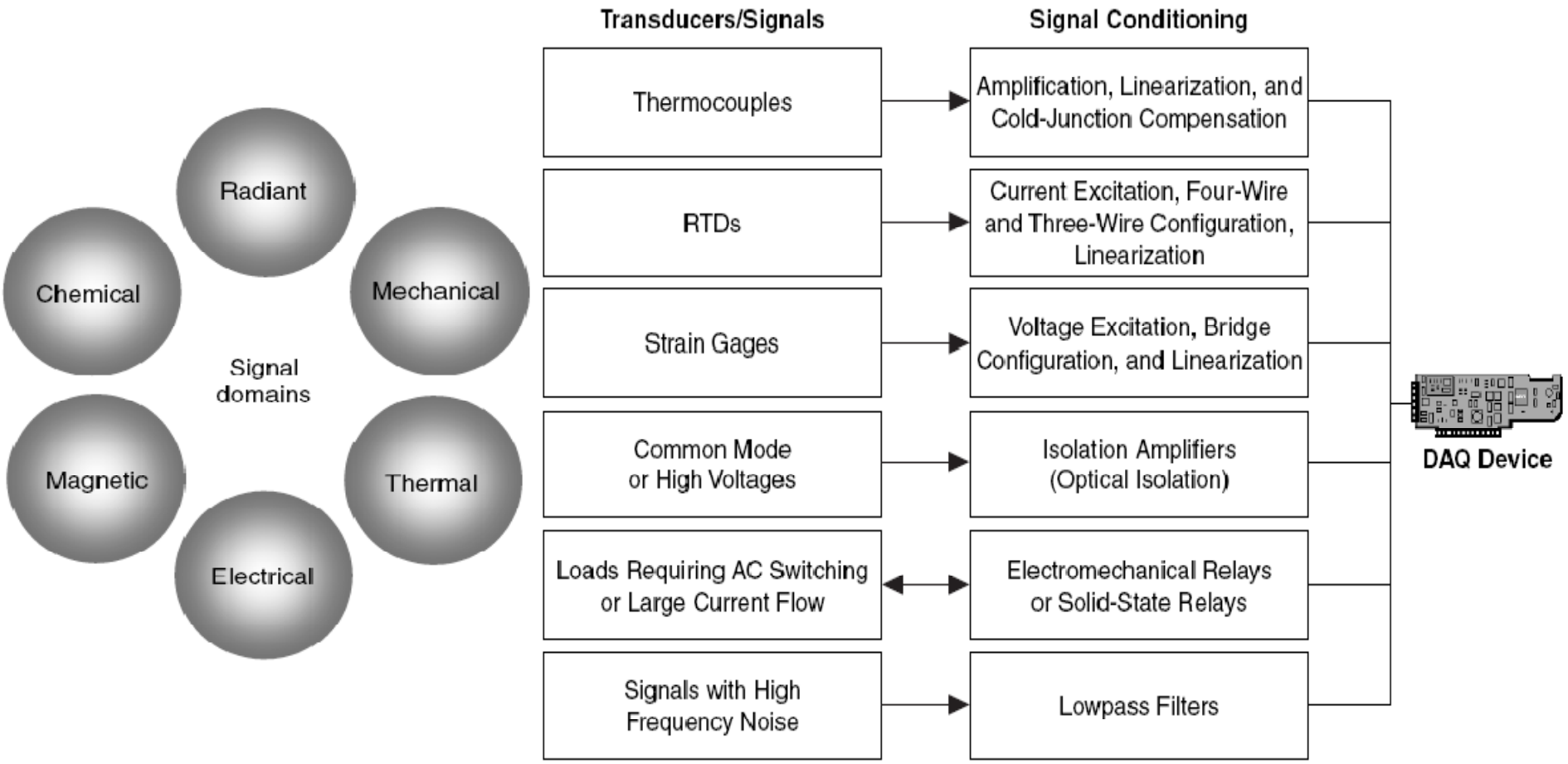
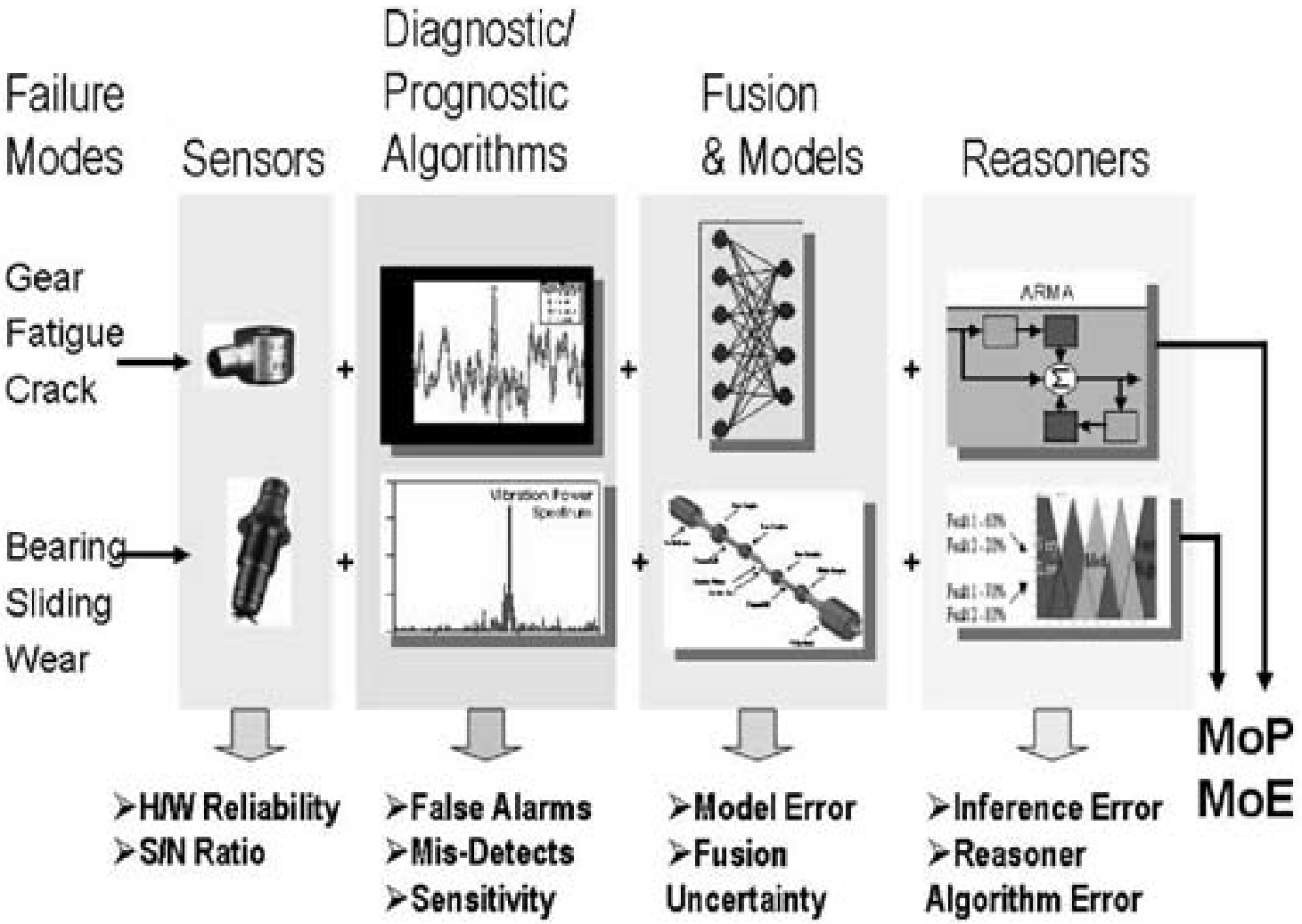
資料擷取卡擴充性：可攜式、工業用、分散式



感測器擴充性：多物理場訊號擷取與整合

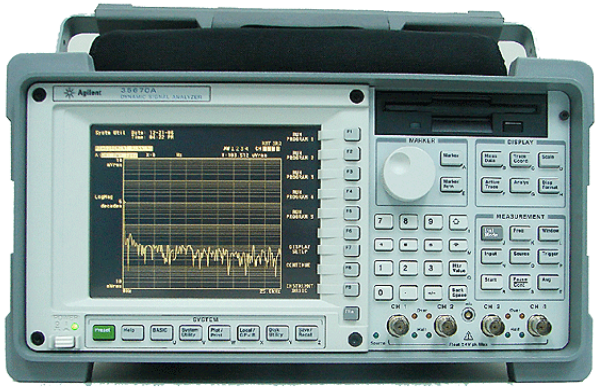


軟體擴充性：智慧型診斷系統



Why Sound and Vibration Module?

- Vibration Level
  RMS: RMS, Peak, Peak-to-Peak
  Crest Factor
  Peak : Max, Min, True Peak, True Peak-to-Peak
- Sound Level
  A, B, and C Weighting
  Octave
- Order Tracking
  Digital Tacho
  Order Tracking by STFT
  Order Tracking by EnMorlet
- Bearing Analysis
  Bearing Defect
  Envelope Detection
- Cepstrum
- Scale…



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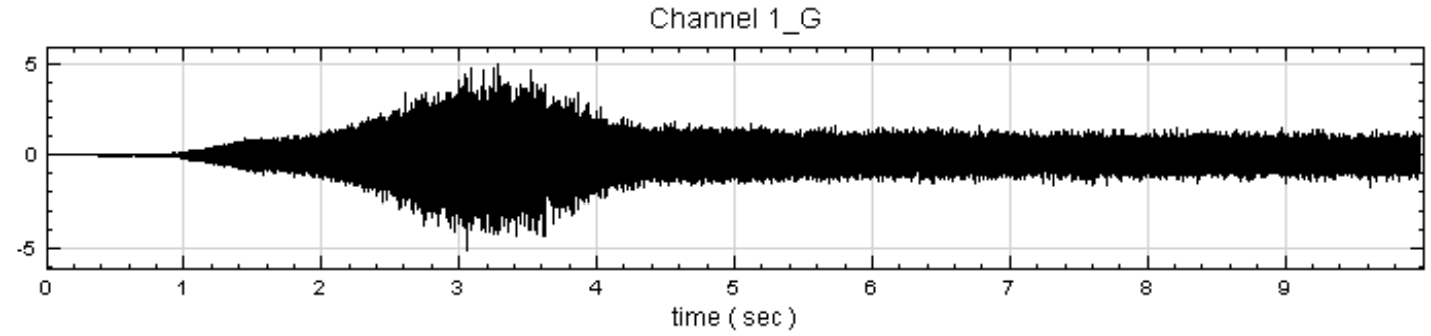
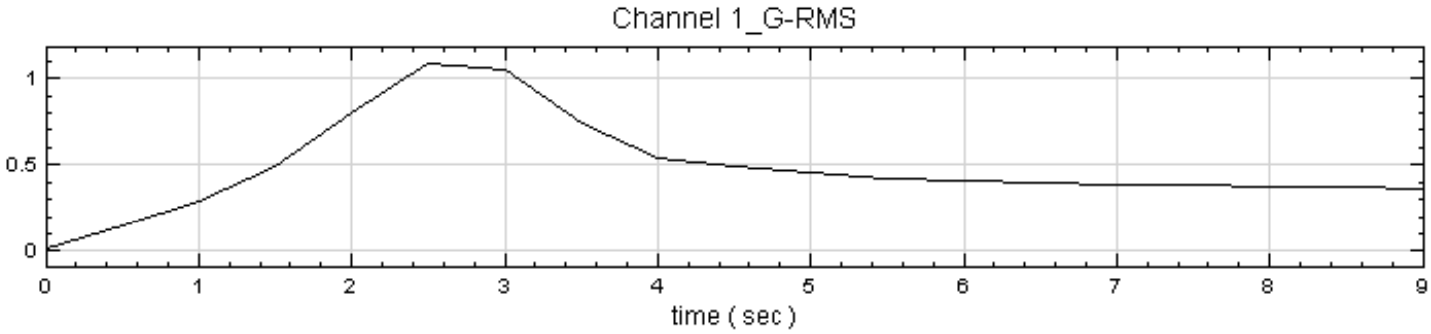
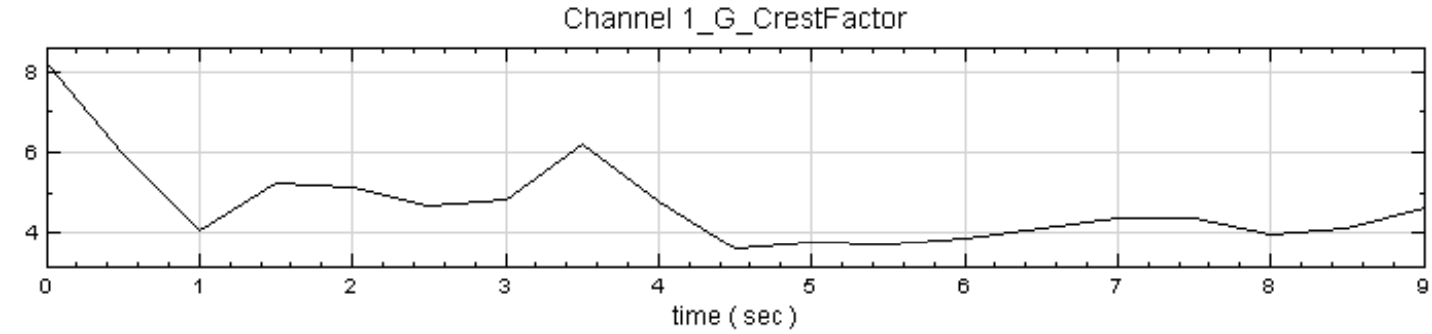
Vibration Level: RMS & Crest Factor





$$RMS = \sqrt{\frac{1}{T}\int_0^T a^2(t)\,dt}$$



$$CrestFactor = \frac{TruePeak}{RMS}$$

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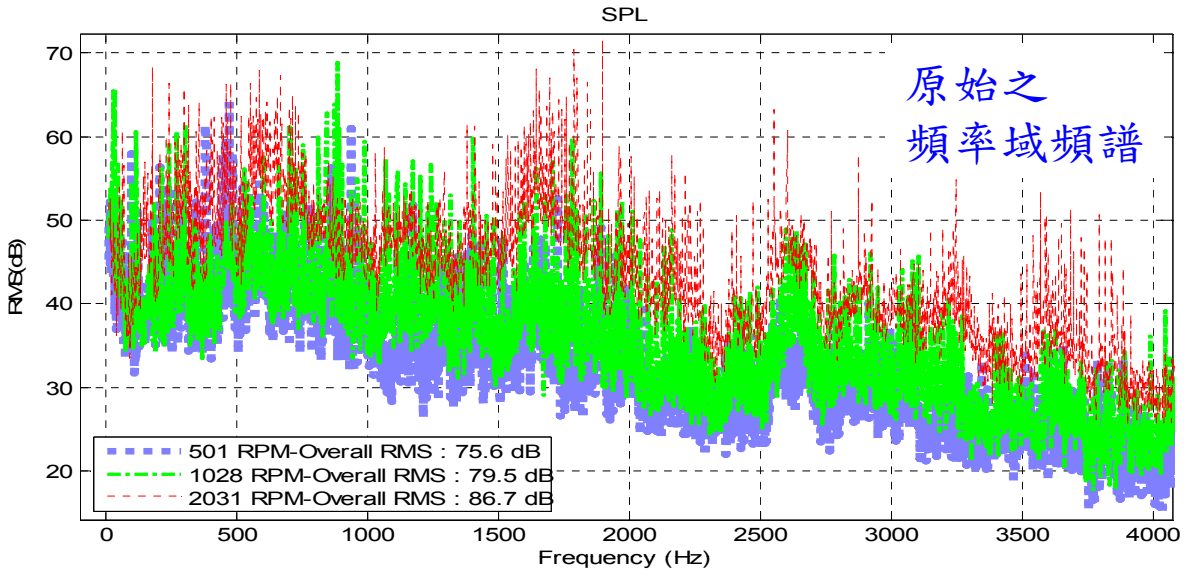
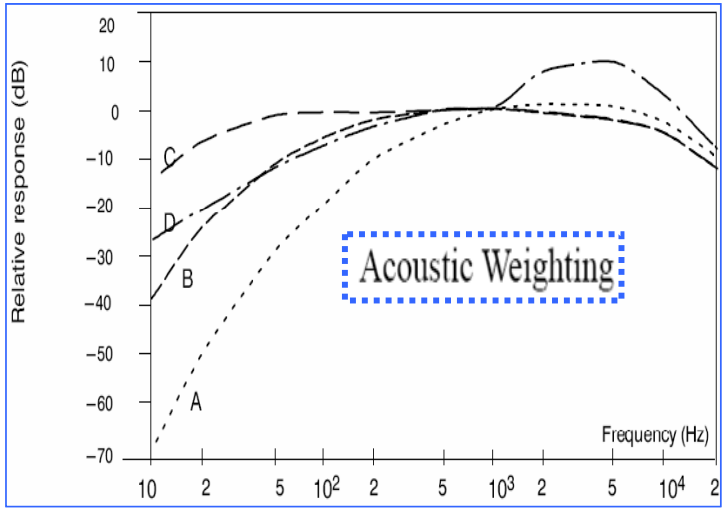
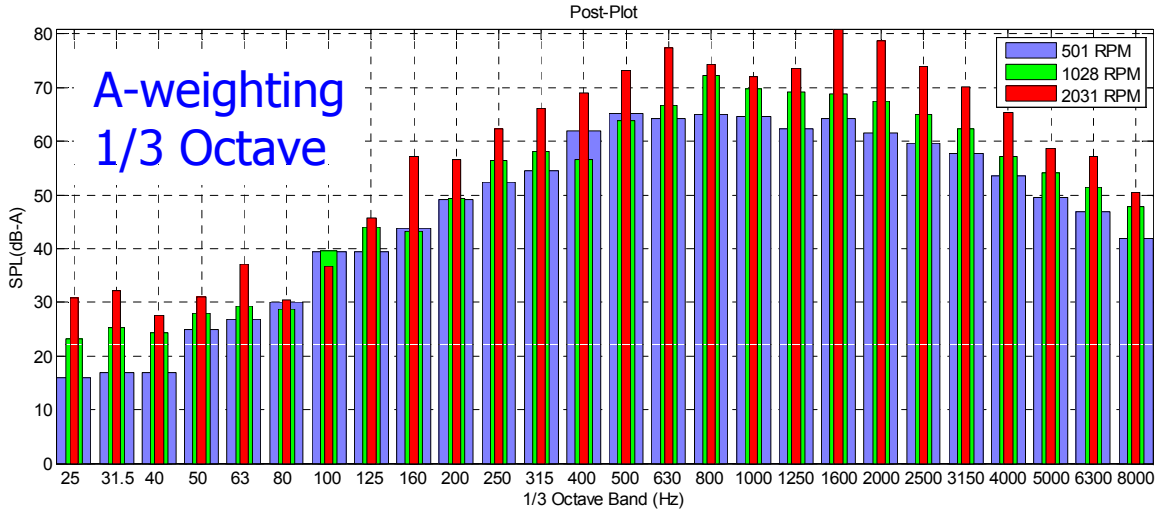
Sound Level: Weighting & Octave







ThirdOctave：$\frac{1}{3}$八度音

Octave：八度音

N_Octave：$\frac{1}{n}$八度音 $(n=\frac{1}{1},\frac{1}{3},\frac{1}{6},\frac{1}{12},\frac{1}{24})$

人耳效應

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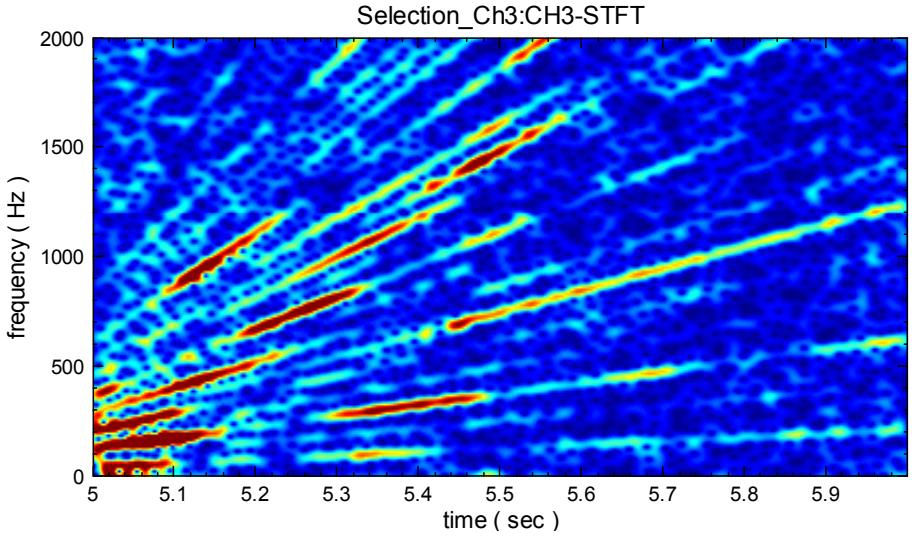
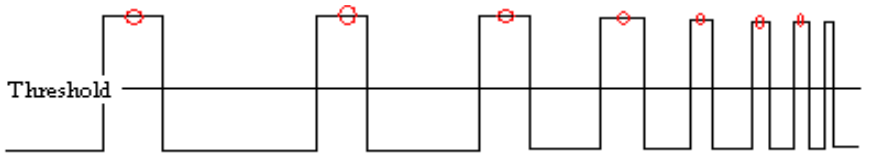
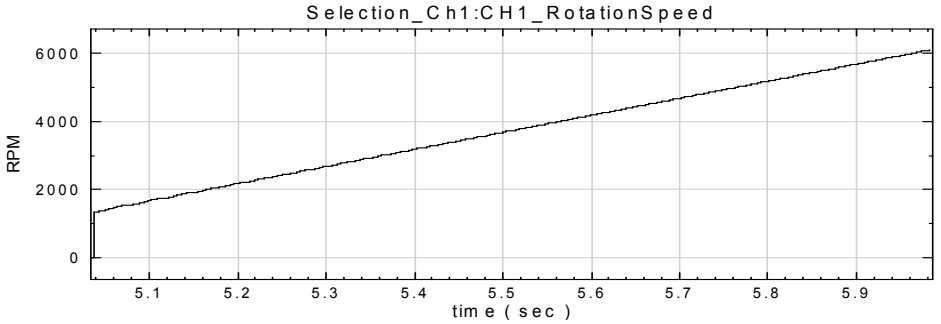
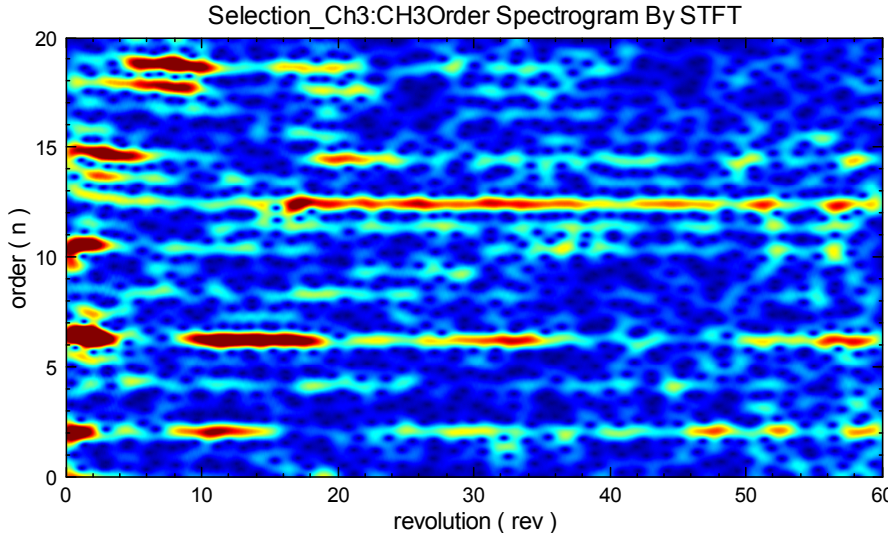
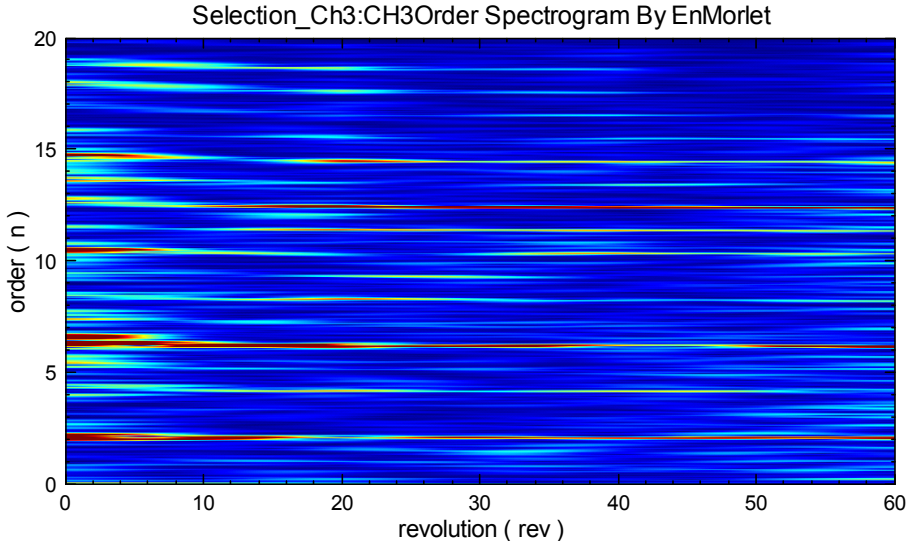
Order Tracking



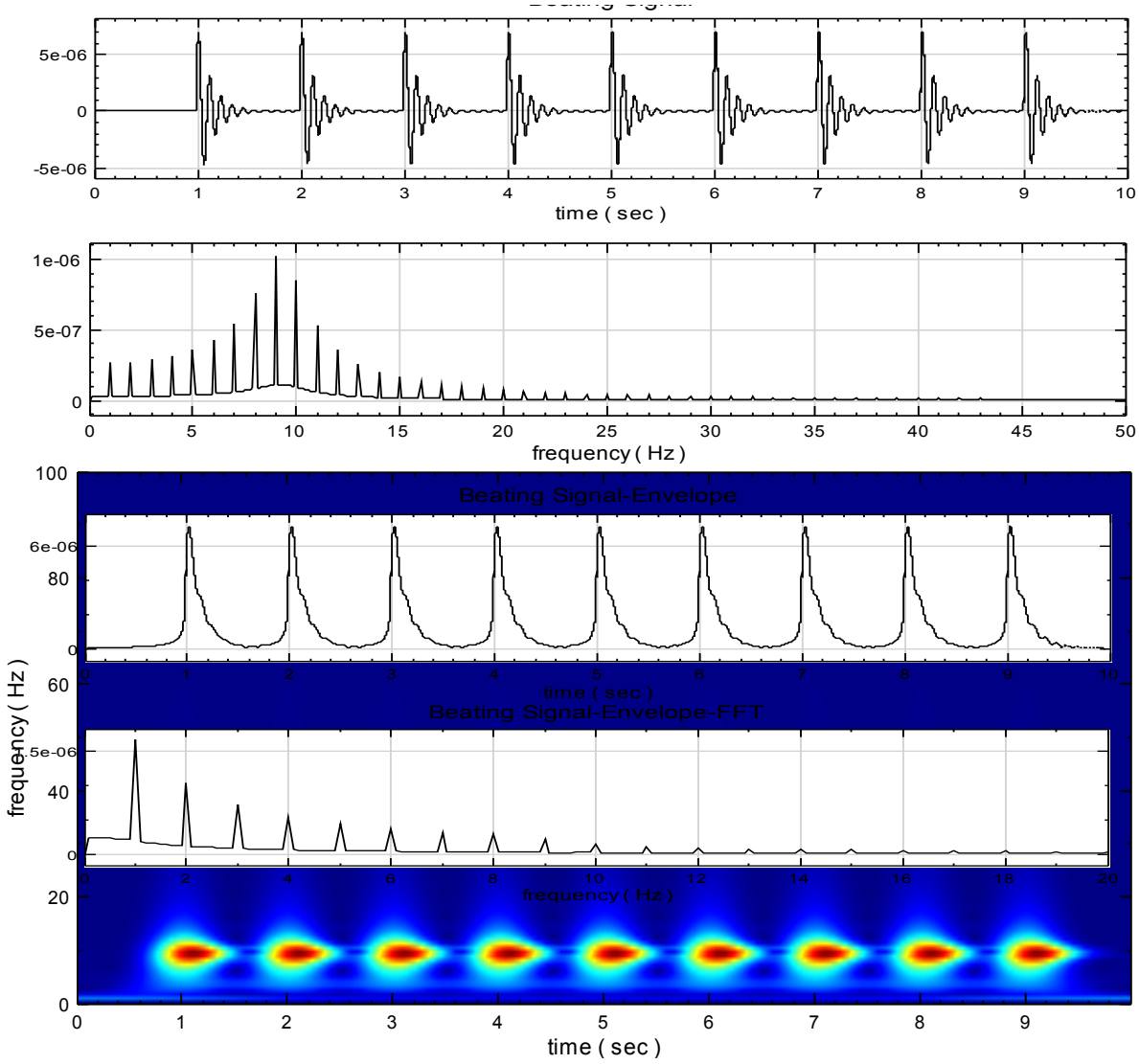


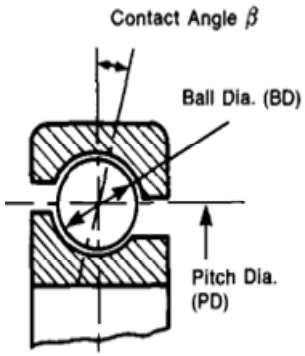






Bearing Analysis





n = number of balls or rollers

f_r = relative rev./s between inner and outer races

Impact Rates f(Hz) (assuming pure rolling motion)

For Outer Race Defect: $f(Hz) = \frac{n}{2} f_r \left(1 - \frac{BD}{PD} \cos \beta\right)$

For Inner Race Defect: $f(Hz) = \frac{n}{2} f_r \left(1 + \frac{BD}{PD} \cos \beta\right)$

For a Ball Defect: $f\ (Hz) = \frac{PD}{BD} f_r \left[1 - \left(\frac{BD}{PD} \cos \beta\right)^2\right]$

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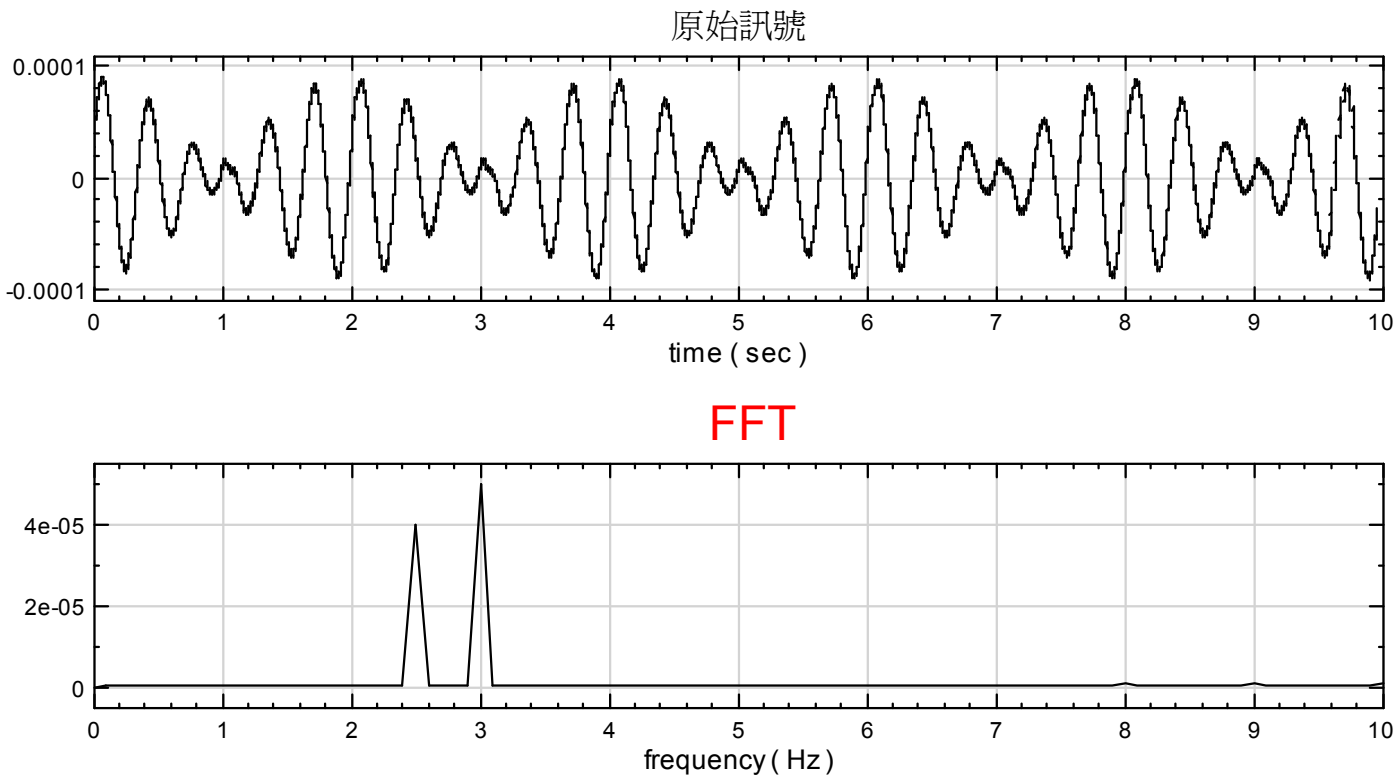
EMD

EMD 應用於微小損壞訊號偵測



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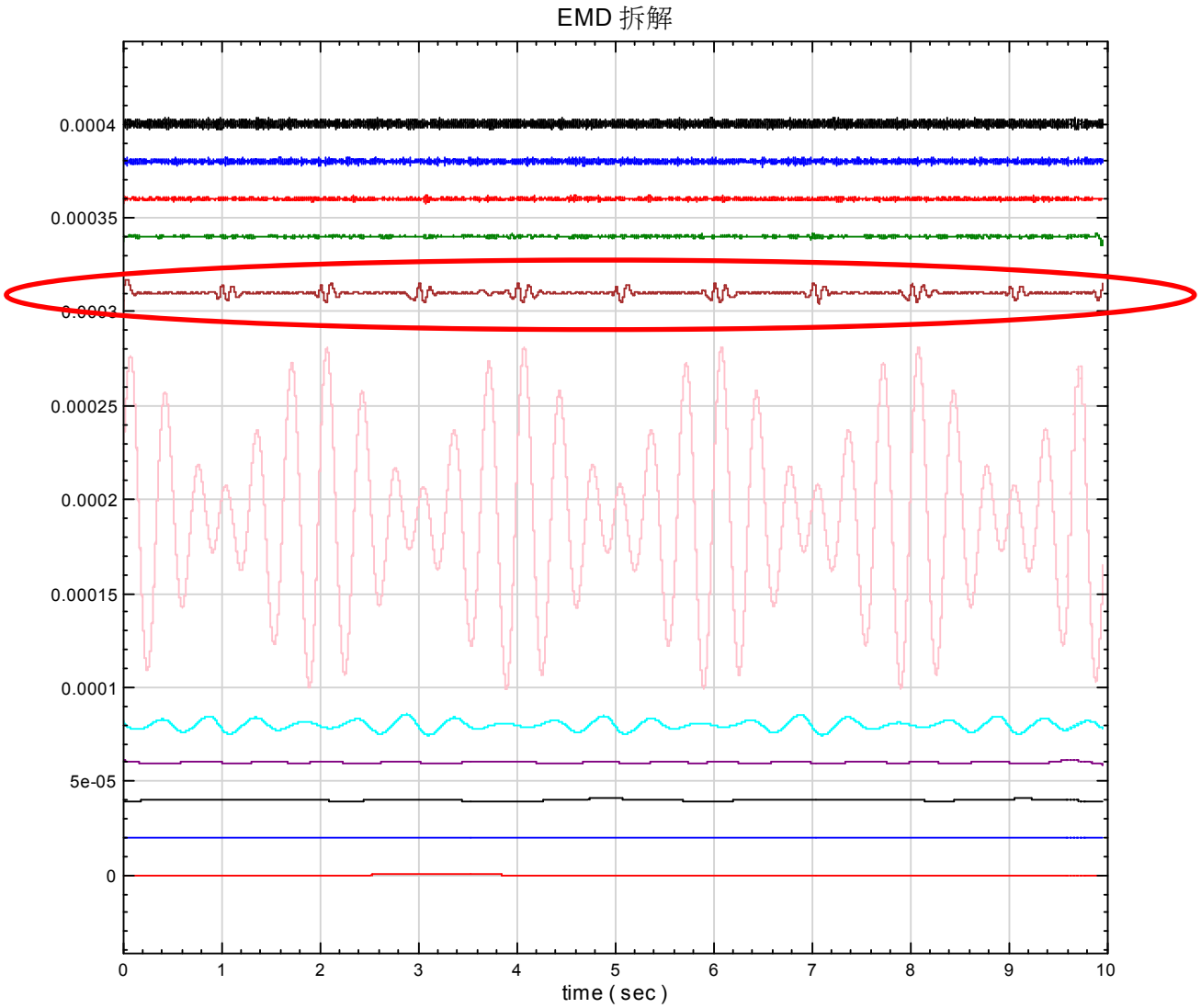
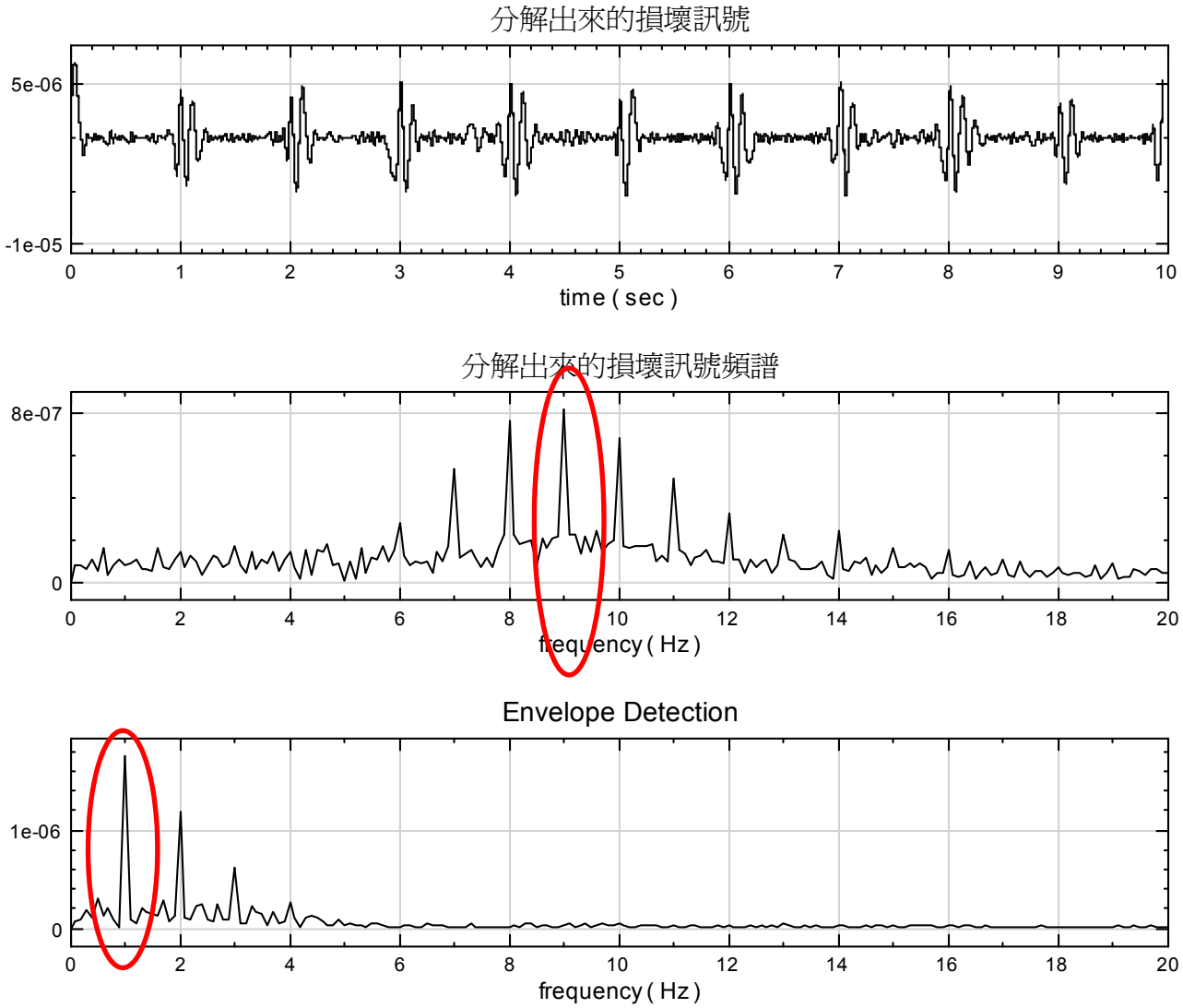
EMD 應用於微小損壞訊號偵測



EMD 應用於微小損壞訊號偵測



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ICA

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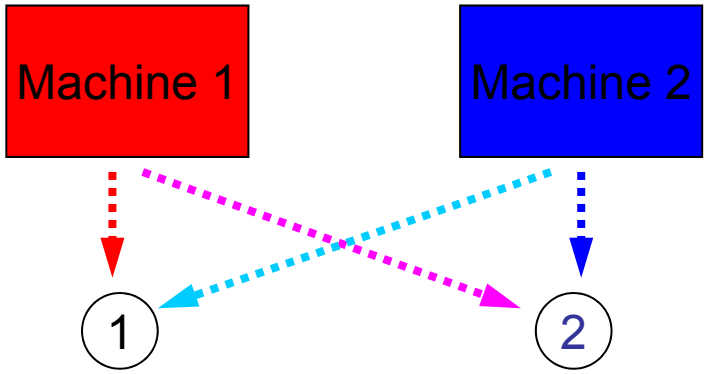
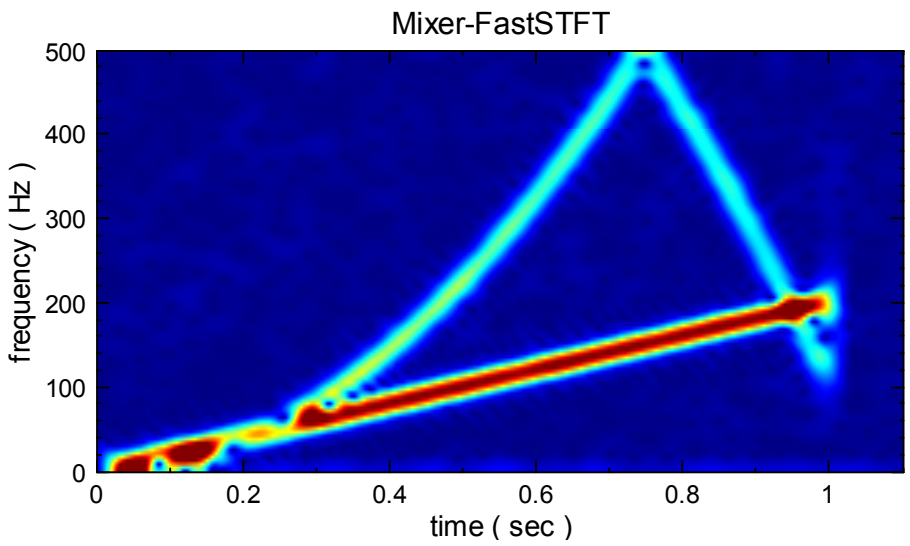
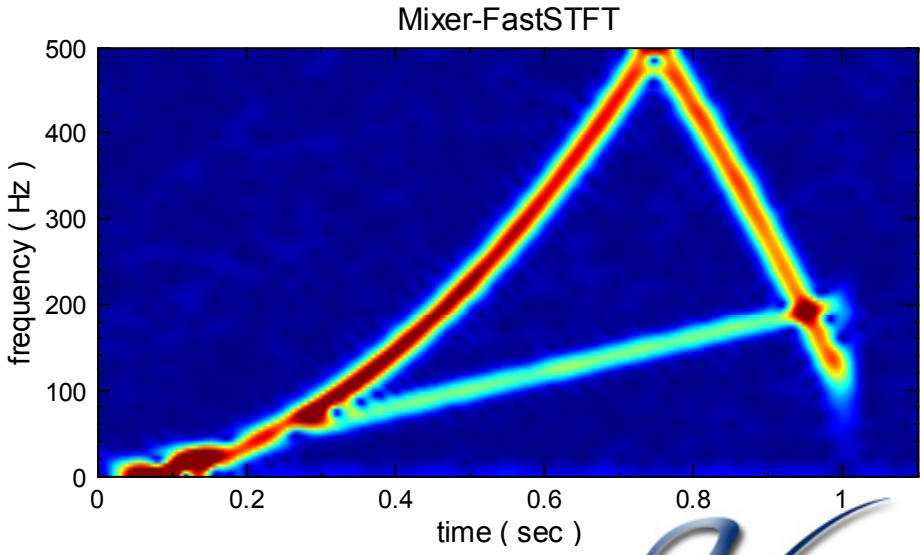
2個量測點之混合訊號





1



2

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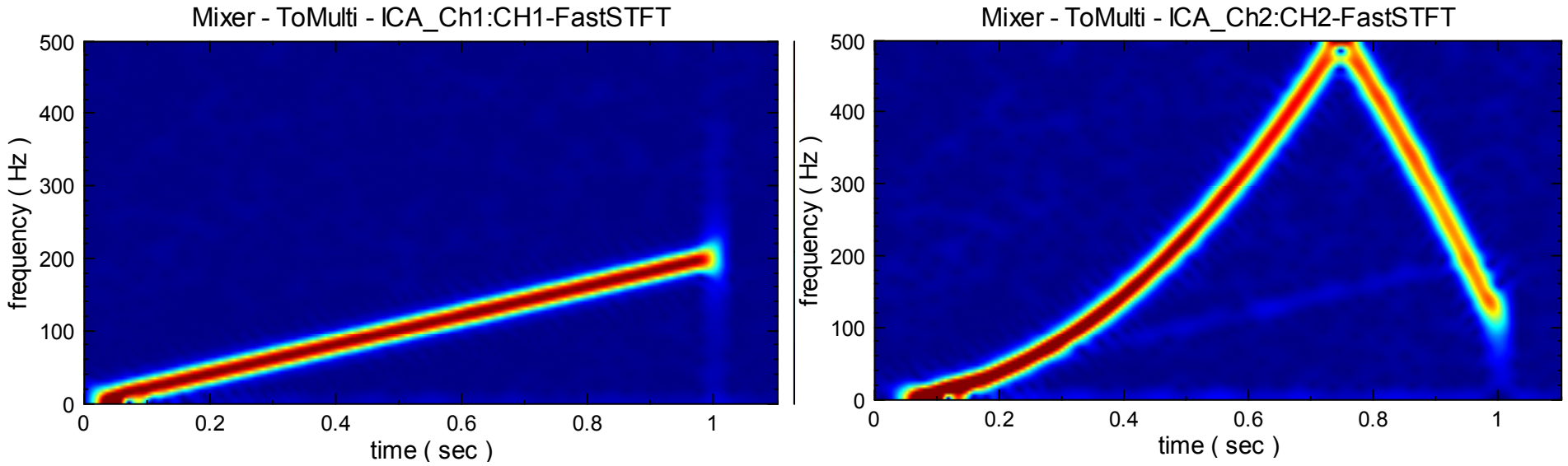
ICA分離 ⇨ 2個獨立振動源

Machine 1

Machine 2



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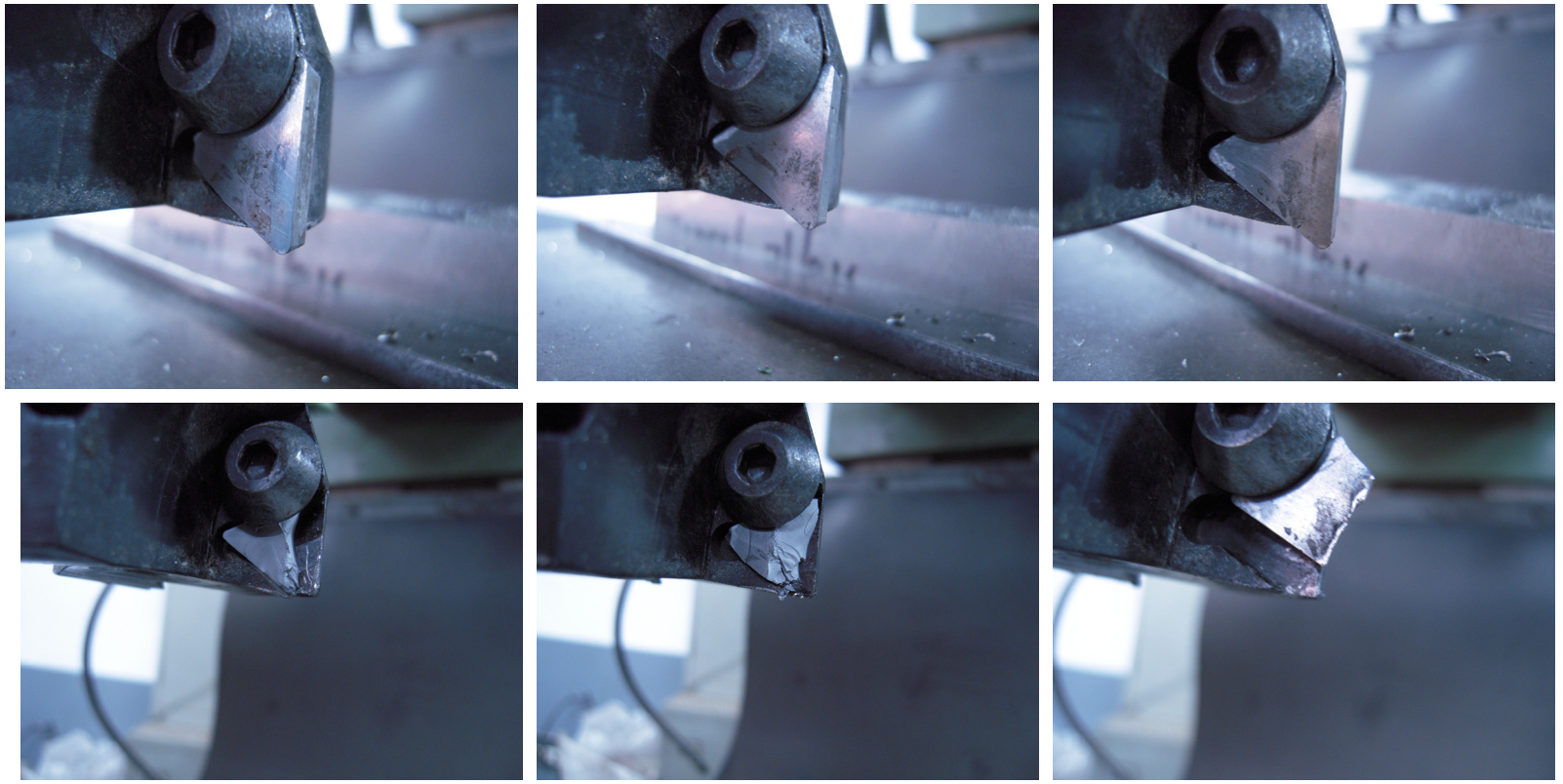
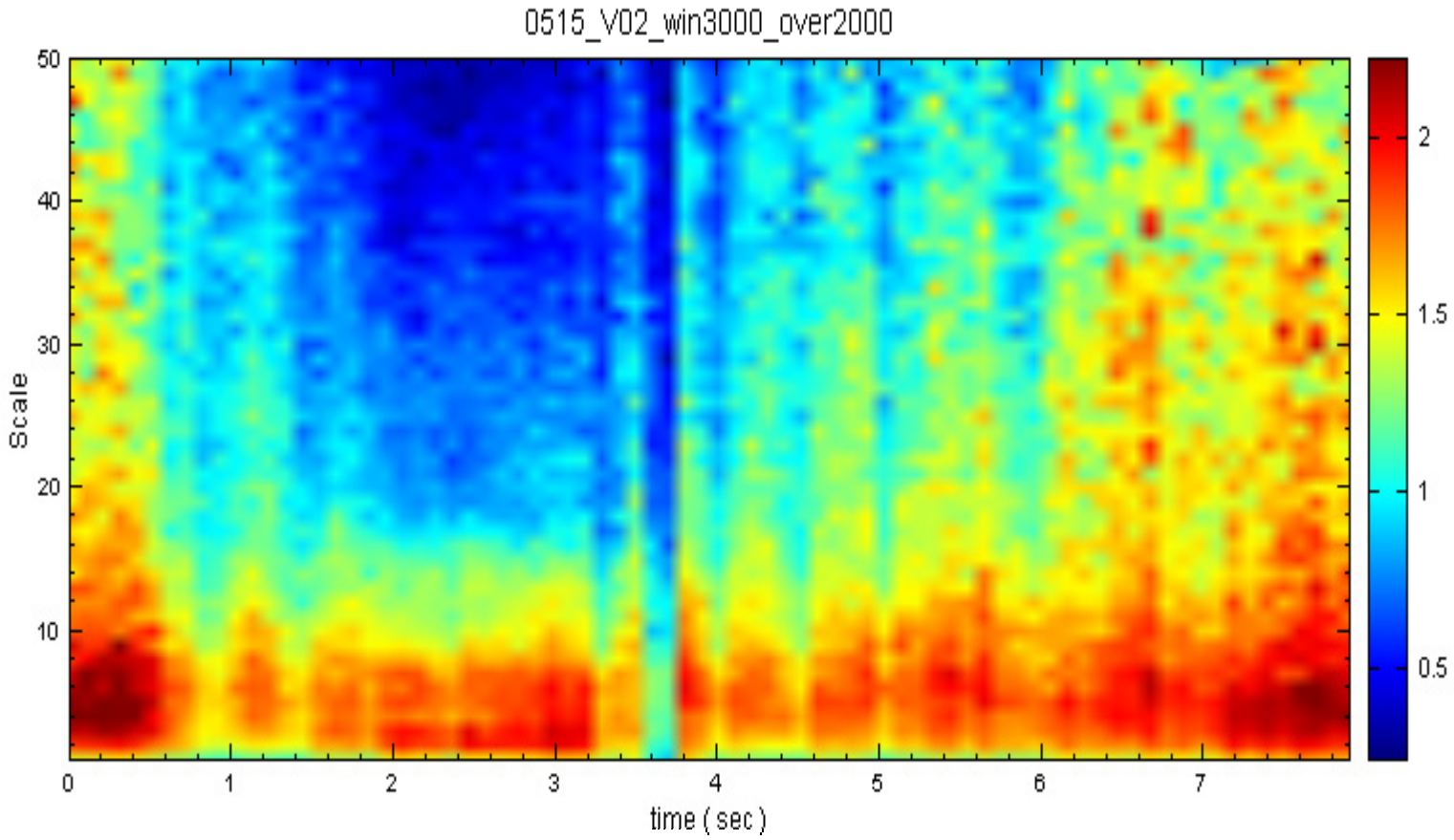
MSE

MSE：刀具損壞



MSE： Rolling MSE



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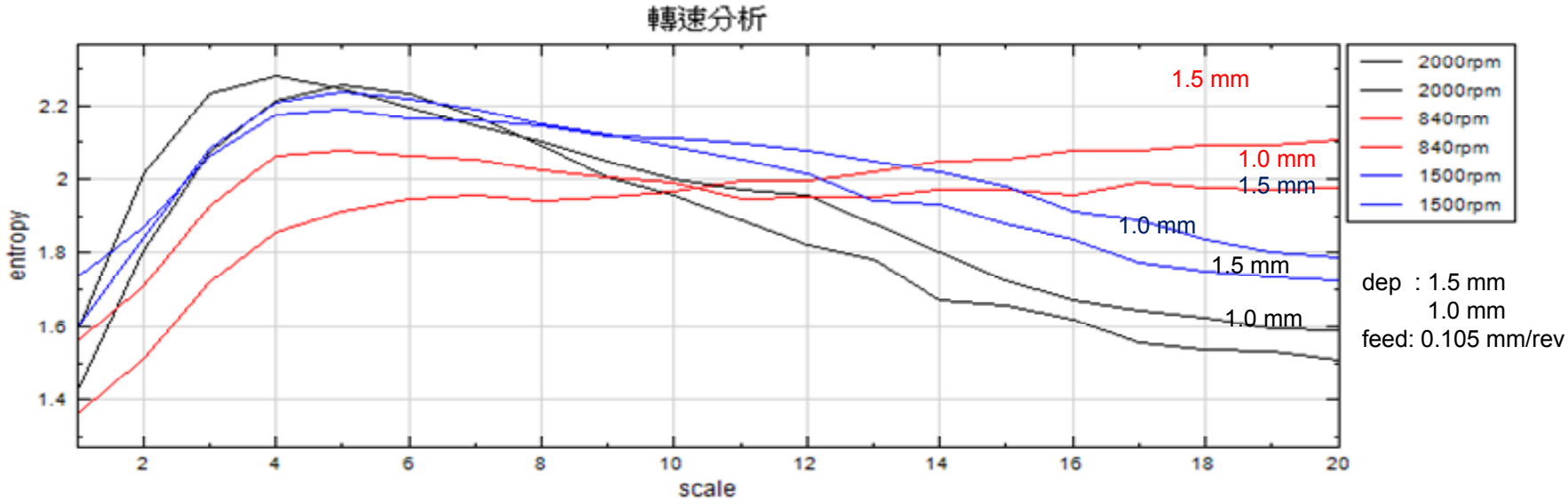
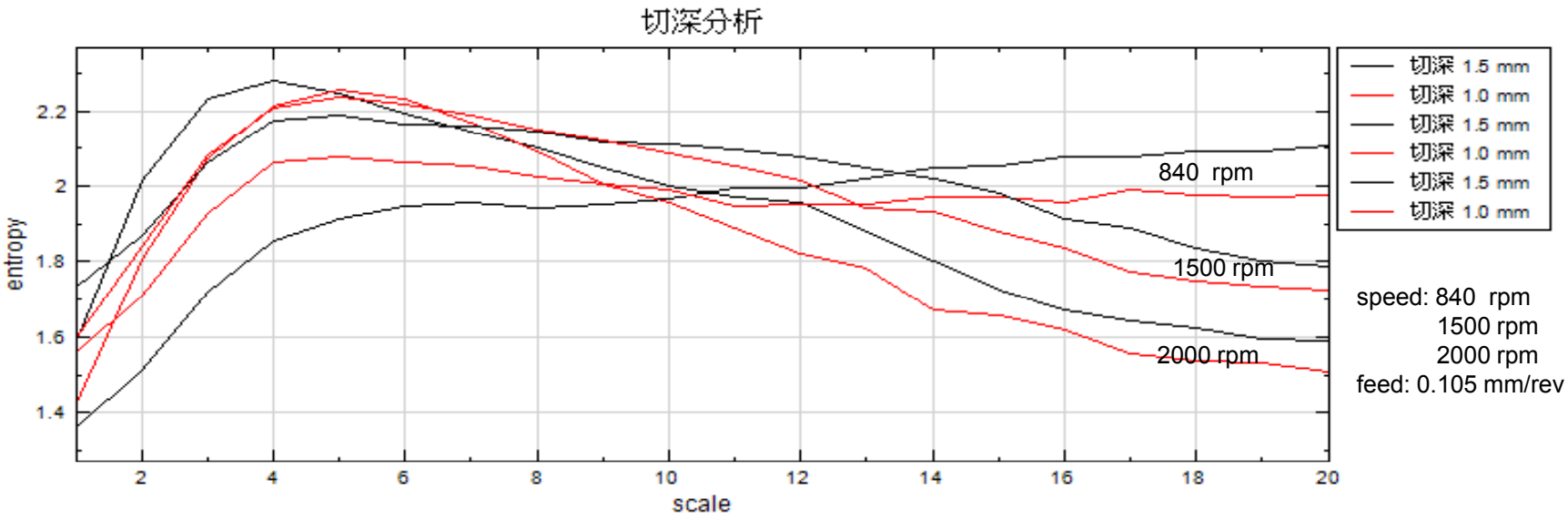
MSE：轉速分析



MSE - 轉速分析

1. 產生較明顯的變化與資料相似度。
2. 轉速在MSE上的表現明顯(決定整體趨勢線走向)。

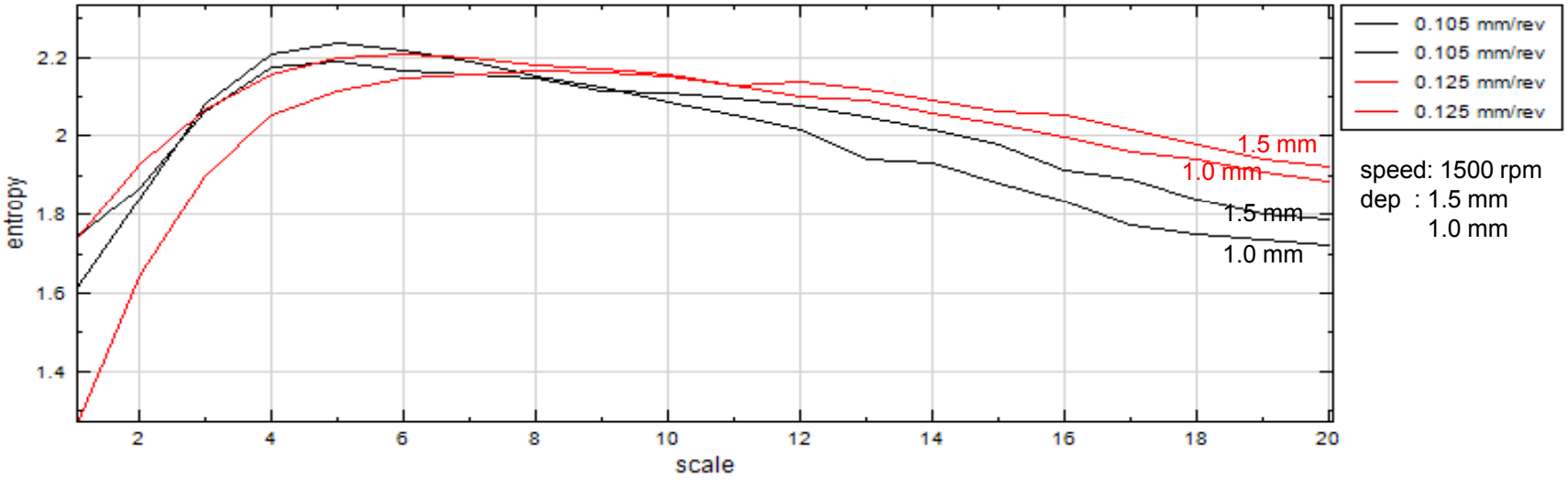
MSE：切深分析



MSE - 切深分析

1. 淺切深的趨勢線較低，穩定度相對較高。

MSE：進給分析



MSE - 進給分析

1. 進給的MSE趨勢線比轉速及切深的趨勢線不明顯。

明顯度判別: 轉速>切深>進給

Applications

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應用實例：系統整合平台

應變儀

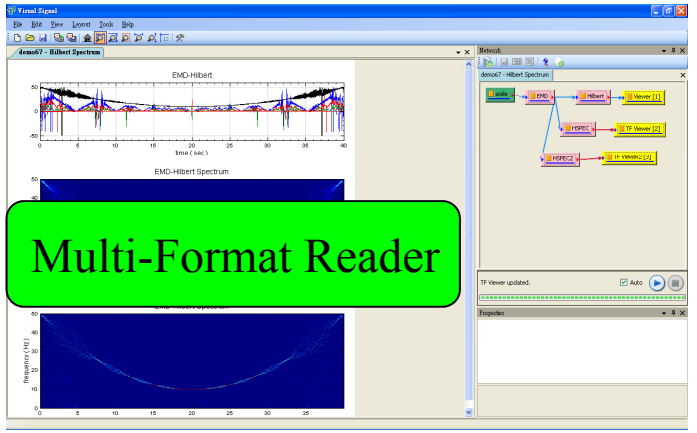
應變規格式

振動儀

振動儀格式

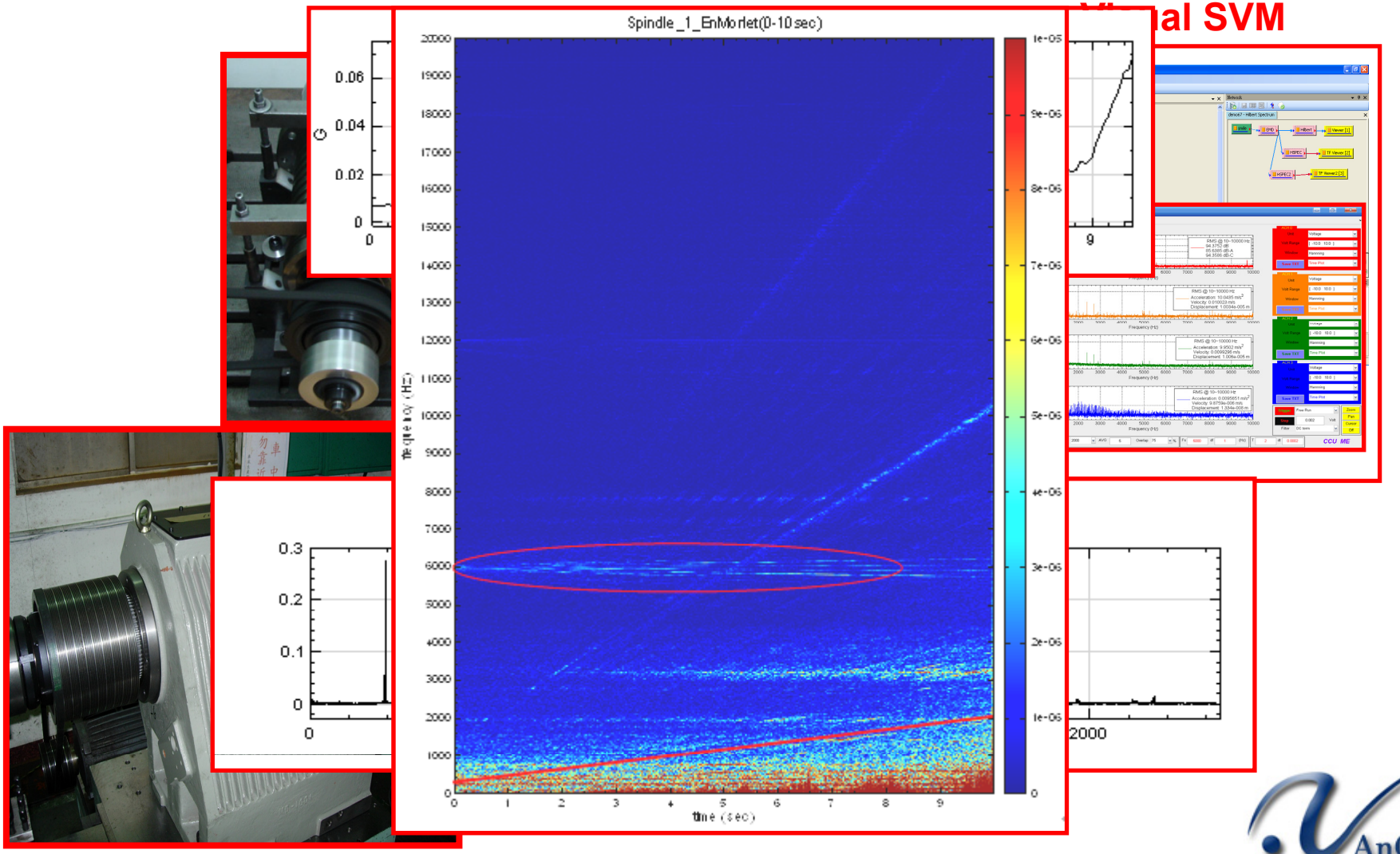
轉速計

轉速計格式



Visual Signal 分析

應用實例：主軸 QA 檢測系統



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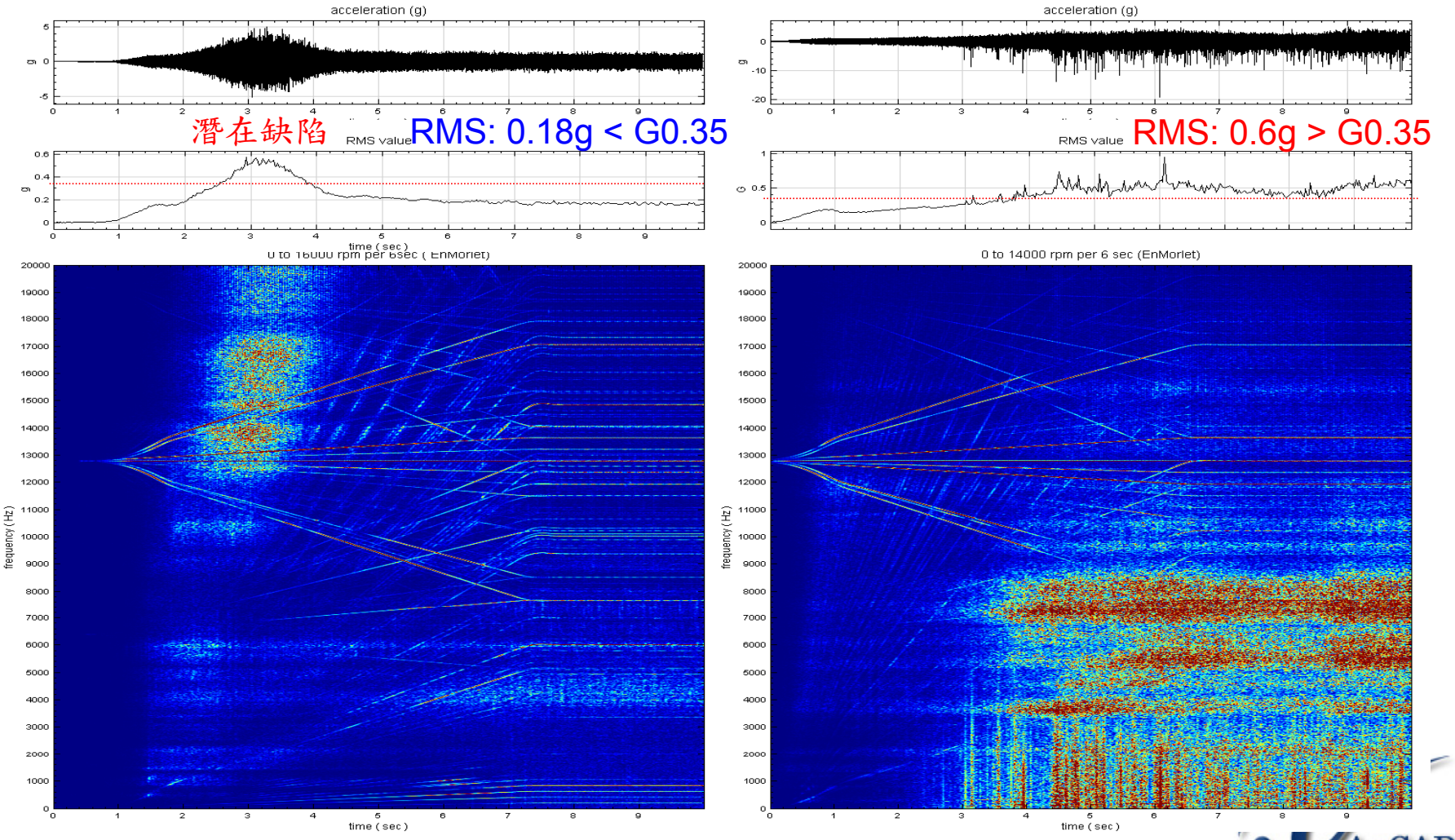
Why變轉速時頻分析？⇨ 潛在缺陷檢出 故障排除



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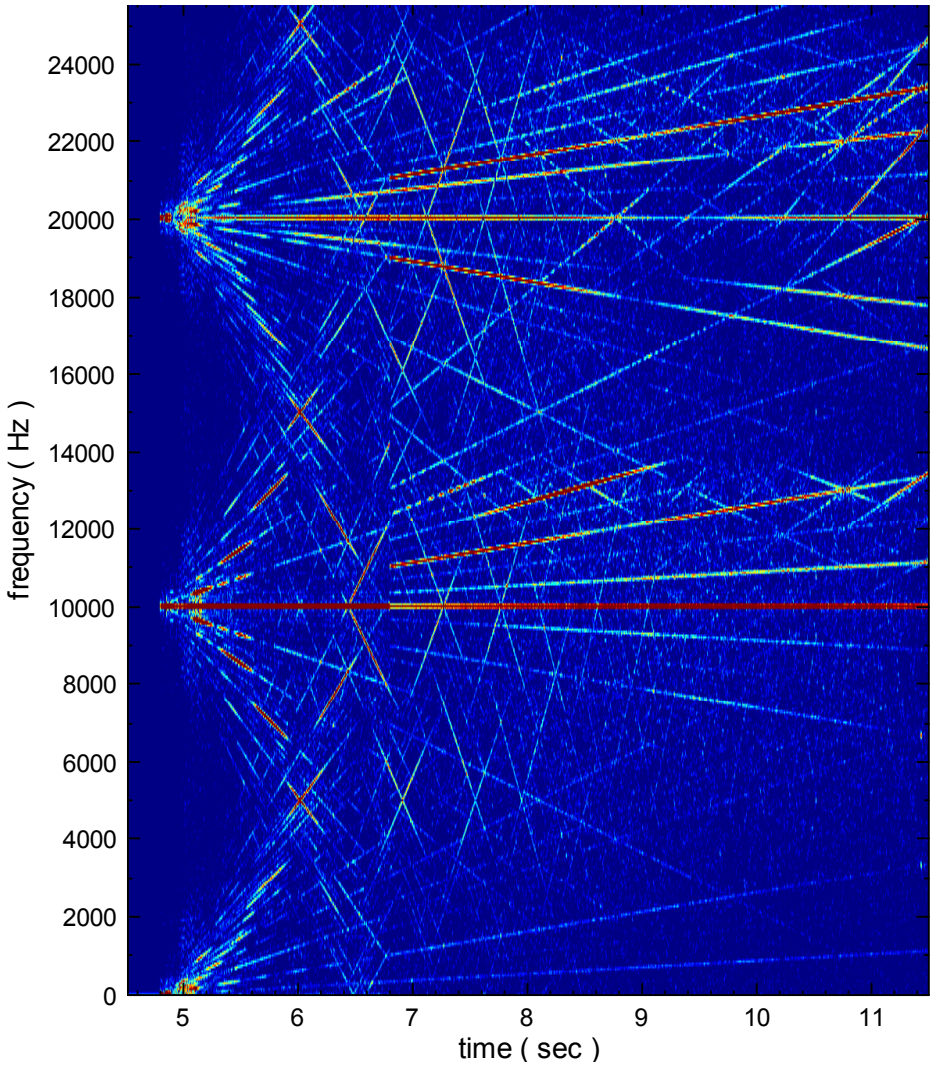
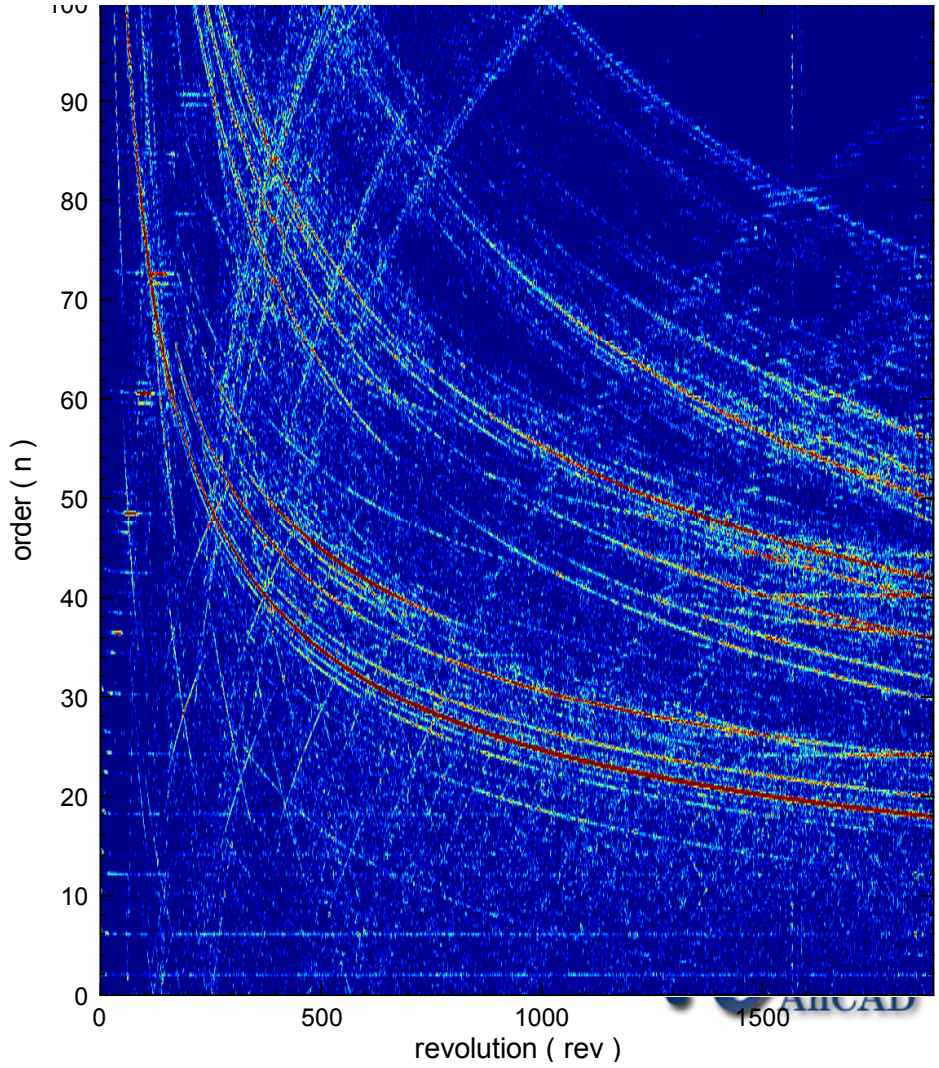
主軸之動態特性檢測
轉速倍頻、共振頻段、異常激振、頻率調變

變轉速時頻分析



轉速階次分析

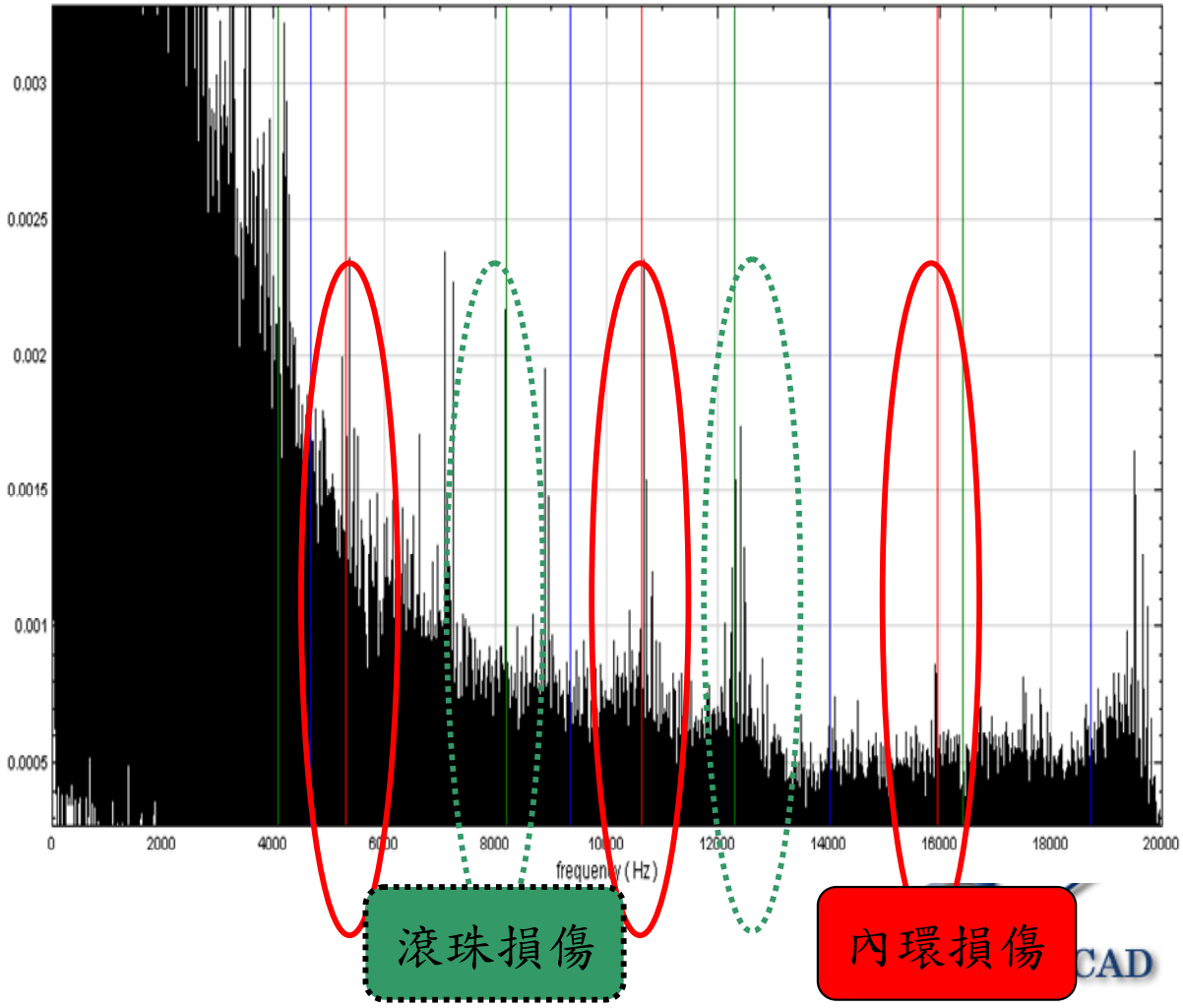


軸承之損壞特徵檢測
依據軸承規格自動計算內外環或滾珠損壞特徵頻率

Properties

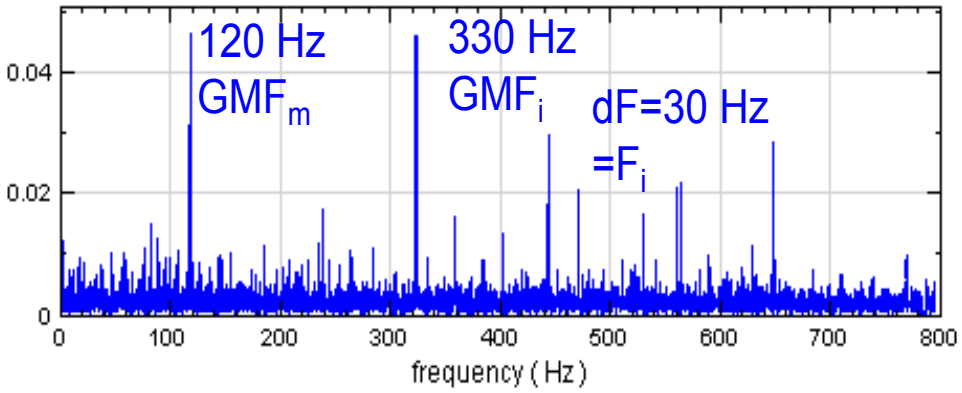
內環損傷頻率	4889.3940246405655
外環損傷頻率	4110.6059753594345
滾珠損傷頻率	4092.8338640344609
參數	
轉速	360
軸承規格	
軸承平均直徑	100
接觸角	25
滾珠直徑	8.73
滾珠數量	25
模組	
類別	BearingDefect
名稱	Bearing Defect

轉速
主軸每秒轉幾圈，單位爲(RPS)。



變速齒輪箱之嚙合異常檢測
偏心、對心、鬆脫、背隙、磨損、斷齒

正常齒輪箱之包絡線頻譜



異常之
轉速調變頻率

異常之
嚙合頻率

異常之齒輪
12齒

GMF$_i$=330 Hz

F$_i$=30 Hz

馬達輸入
1800RPM

11齒

GMF$_m$=120 Hz

12齒

10 Hz

13齒

GMF$_o$=52 Hz

33齒

F$_n$=4 Hz

30齒

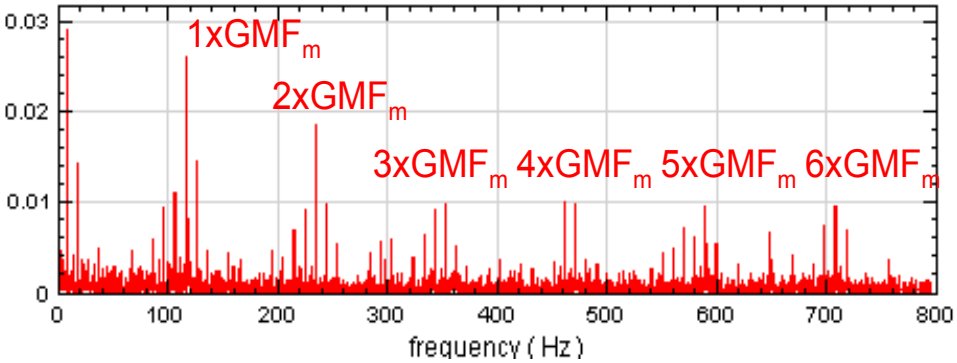
出力軸

F$_o$=1.67 Hz

31齒

dF=10 Hz
=F$_m$

異常齒輪箱之包絡線頻譜



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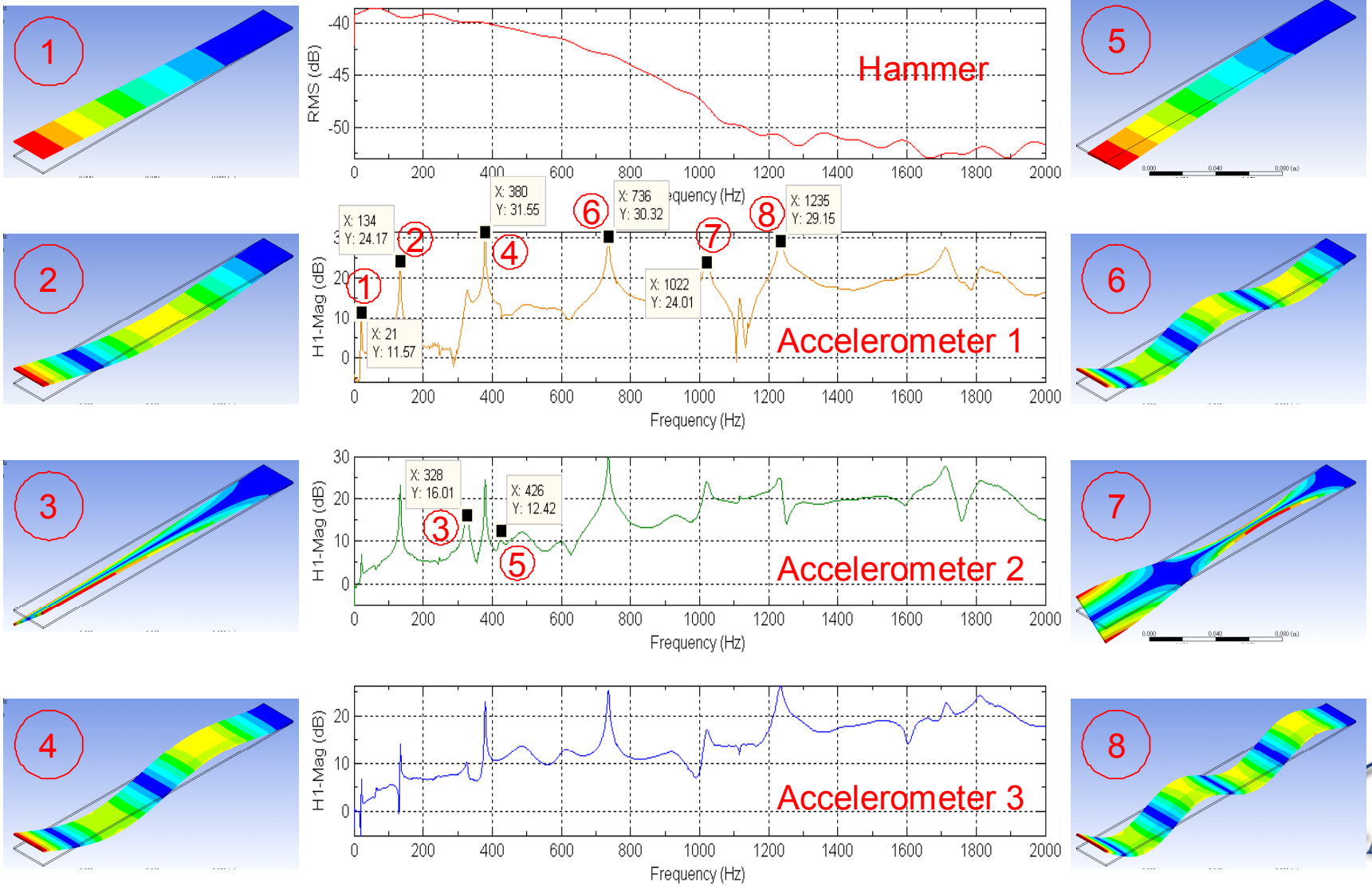
結構之自然頻率檢測
利用敲擊測試之自然頻率驗證有限元素分析之正確性

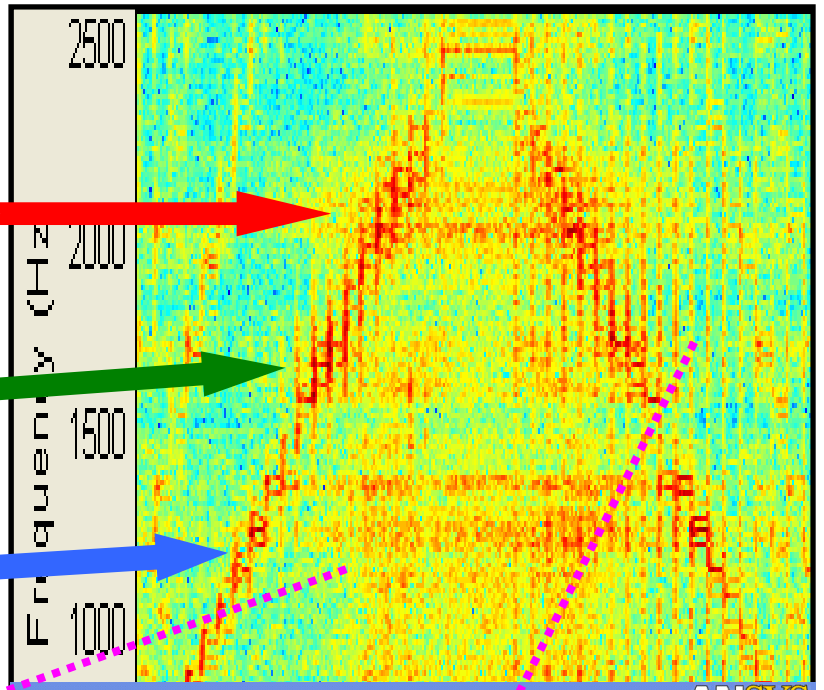


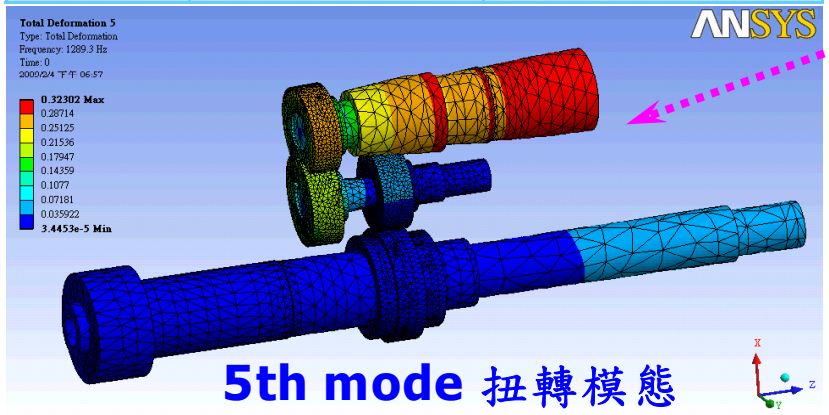
結構之自然頻率檢測
利用變轉速時頻驗證有限元素分析之正確性

FEM模擬結果：

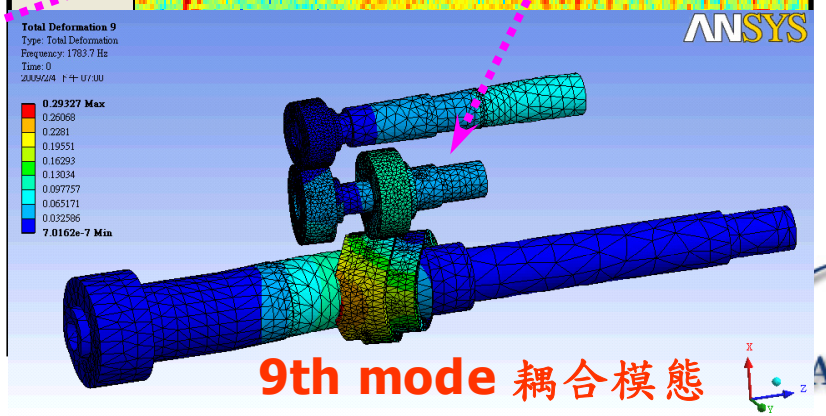
模態	模態形式	自然頻率 (Hz)
12	Coupling	2289
11	Coupling	2176
10	Coupling	2003
9	Coupling	1784
8	Torsion	1541
7	Bending	1421
6	Bending	1415
5	Torsion	1289

量測結果：





5th mode 扭轉模態

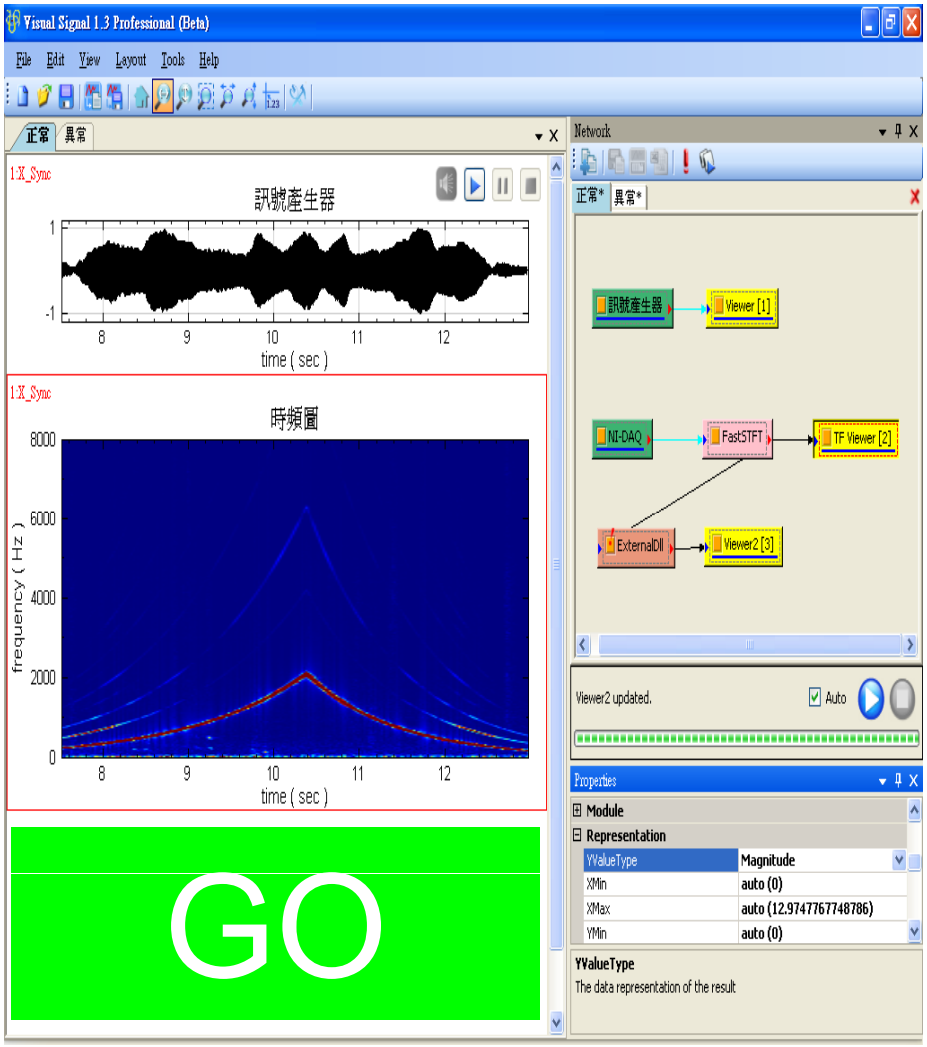


9th mode 耦合模態

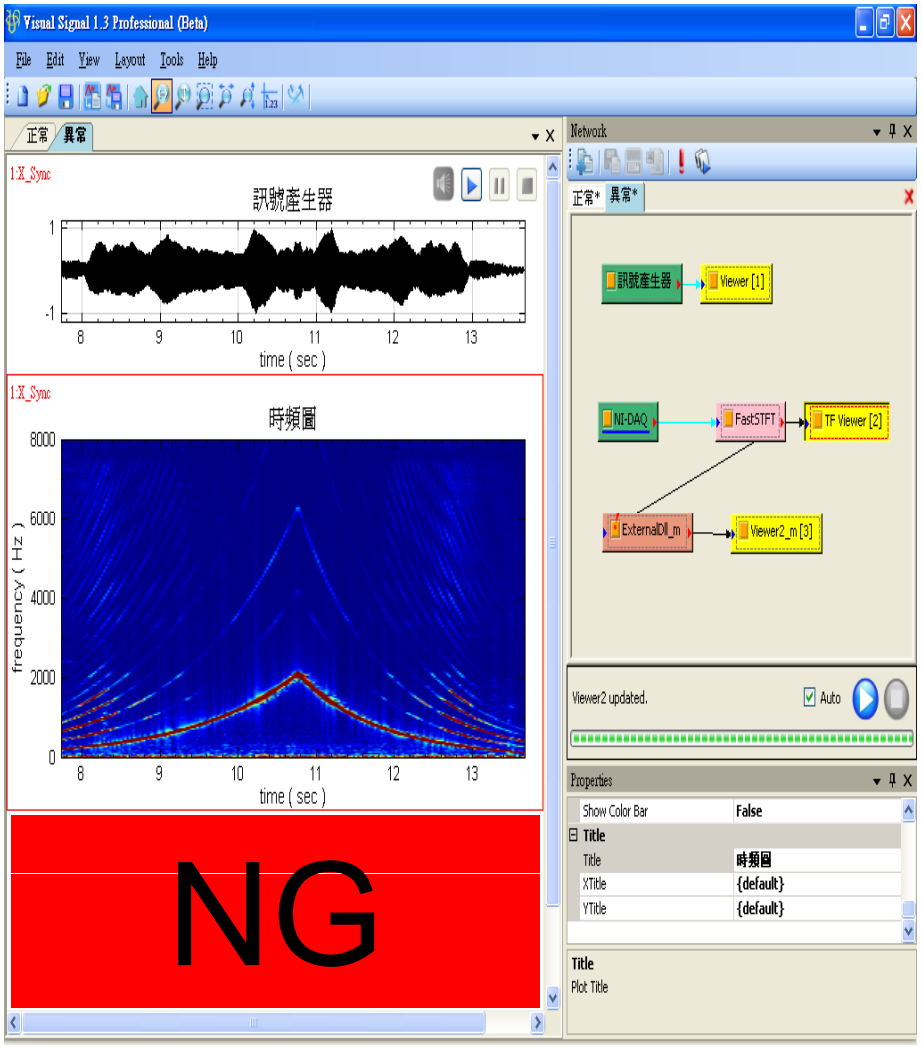
出廠之振噪品管檢測

客製化自動檢測流程、訊號產生器、客製化品管介面

出廠異音檢測：合格



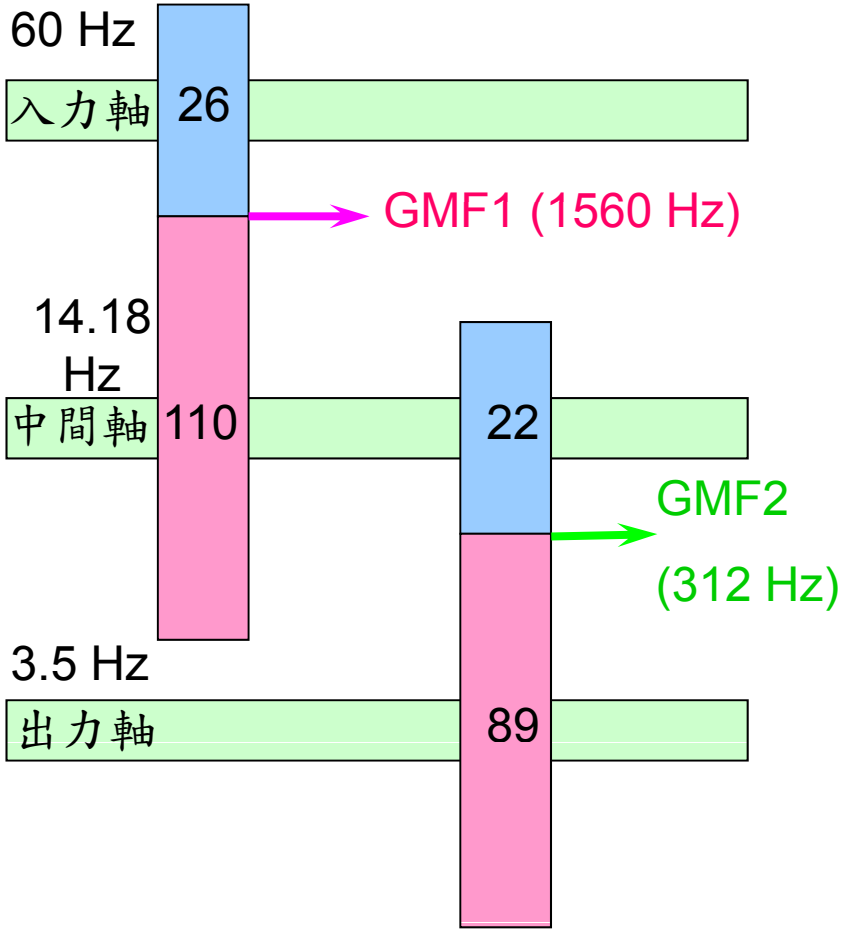
出廠異音檢測：不合格

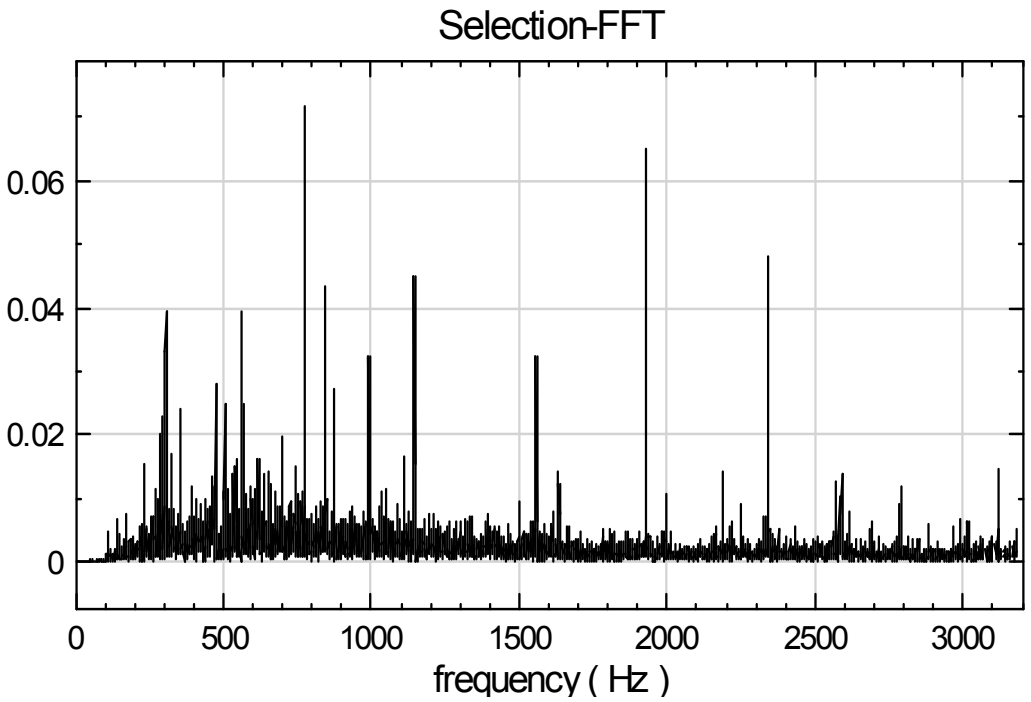


齒輪箱時頻分析

AnCAD

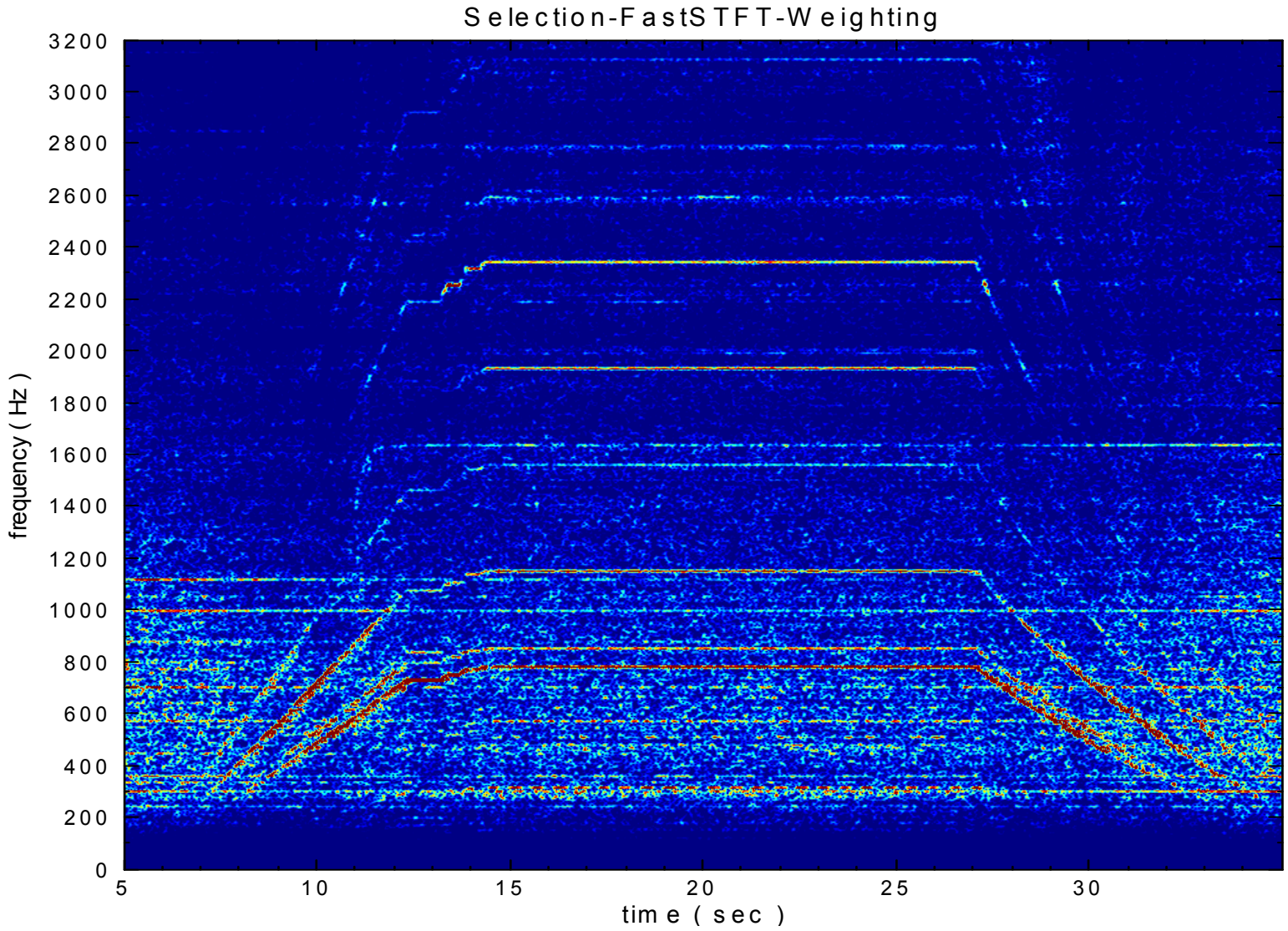
60Hz-轉軸頻率及嚙合頻率





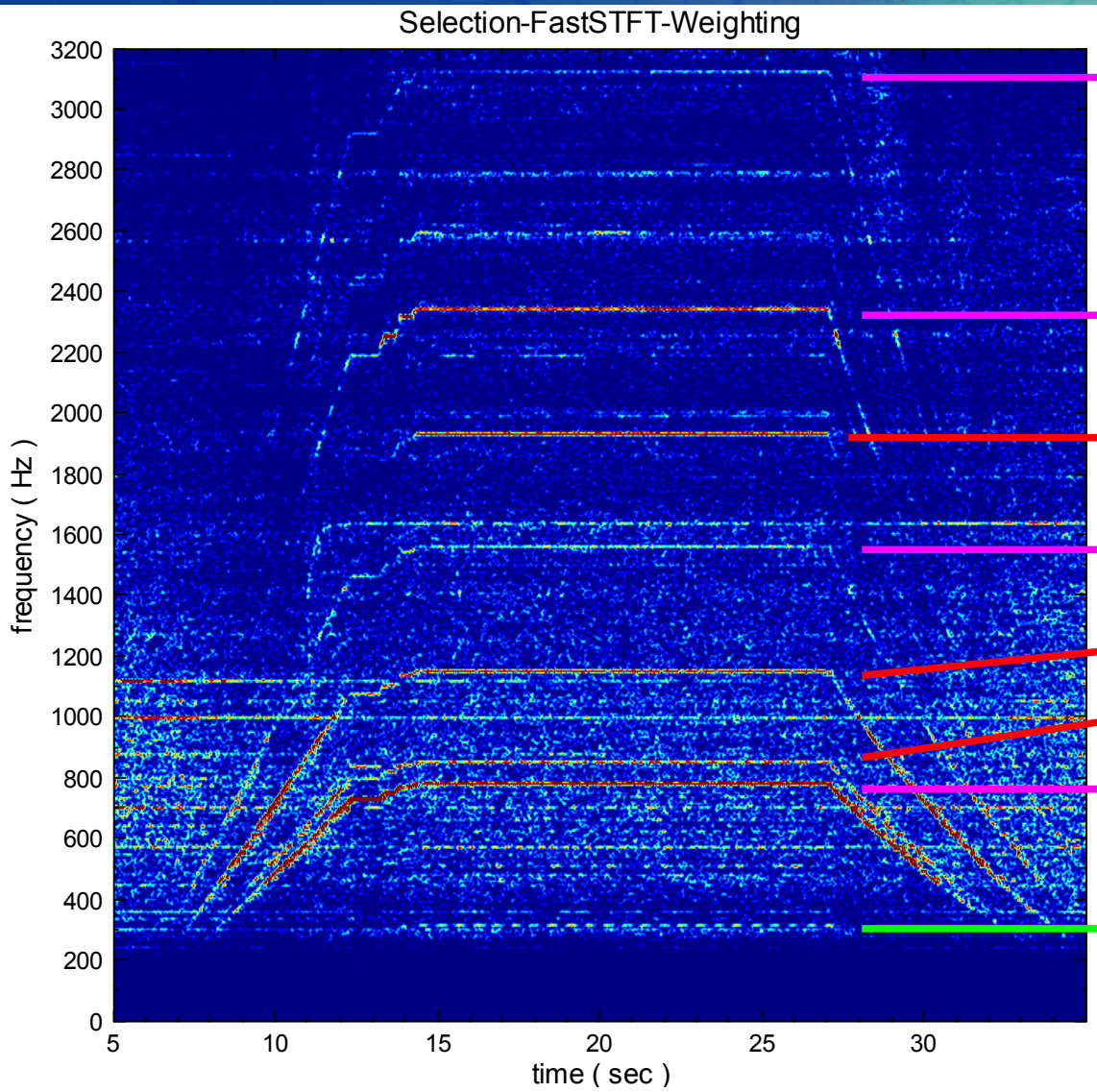
AnCAD

60Hz-正常生產運轉方向
聲音原始頻譜



AnCAD

60Hz-正常生產運轉方向
聲音A加權頻譜➔人耳感受



2×GMF1 (3120 Hz)

1.5×GMF1 (2340 Hz)

1930 Hz ((60+14.18)×26)

1×GMF1 (1560 Hz)

1150 Hz

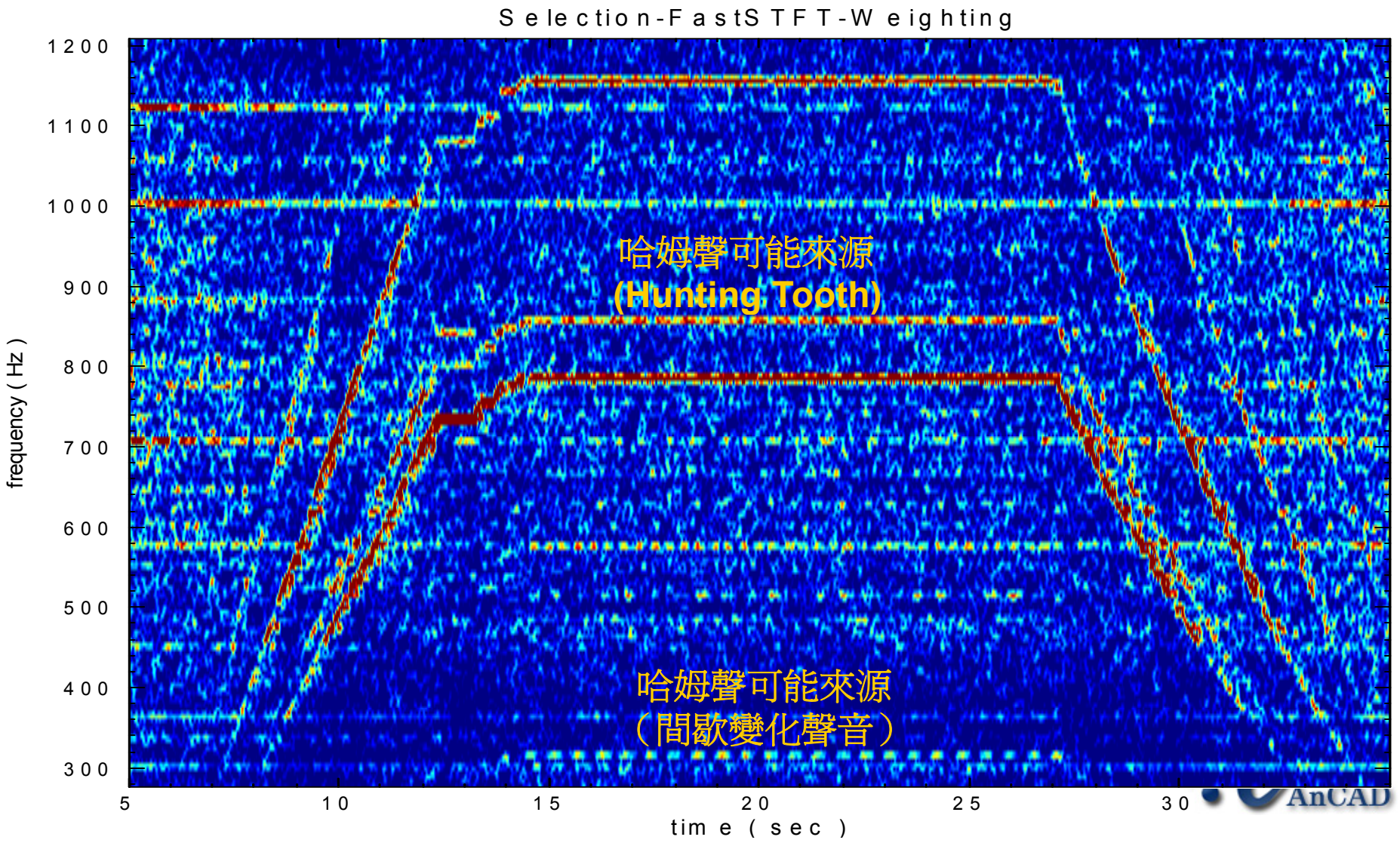
852 Hz (60×14.18)

0.5×GMF1 (780 Hz)

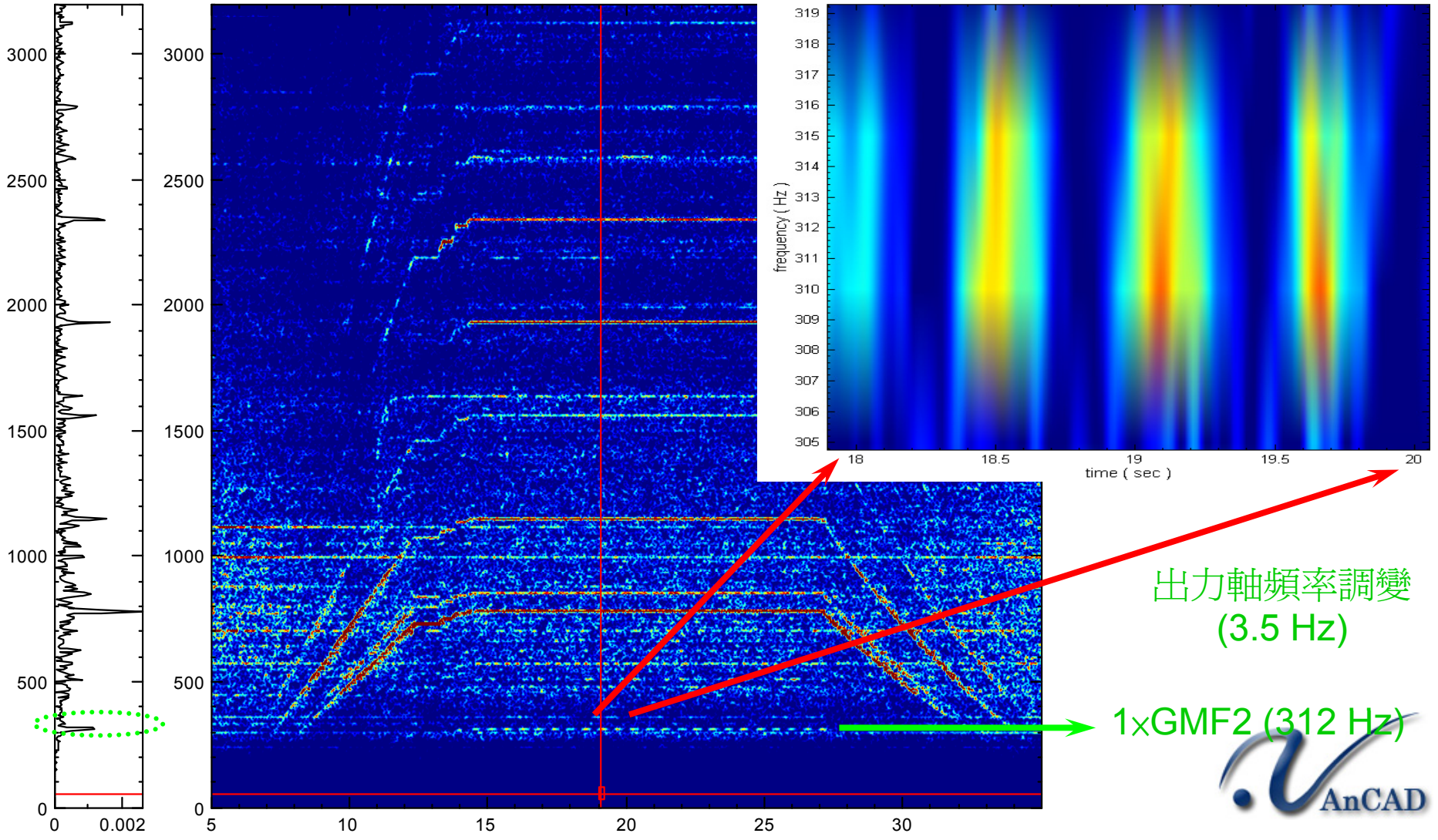
1×GMF2 (312 Hz)

AnCAD

60Hz-正常生產運轉方向
聲音A加權頻譜➔低頻區域

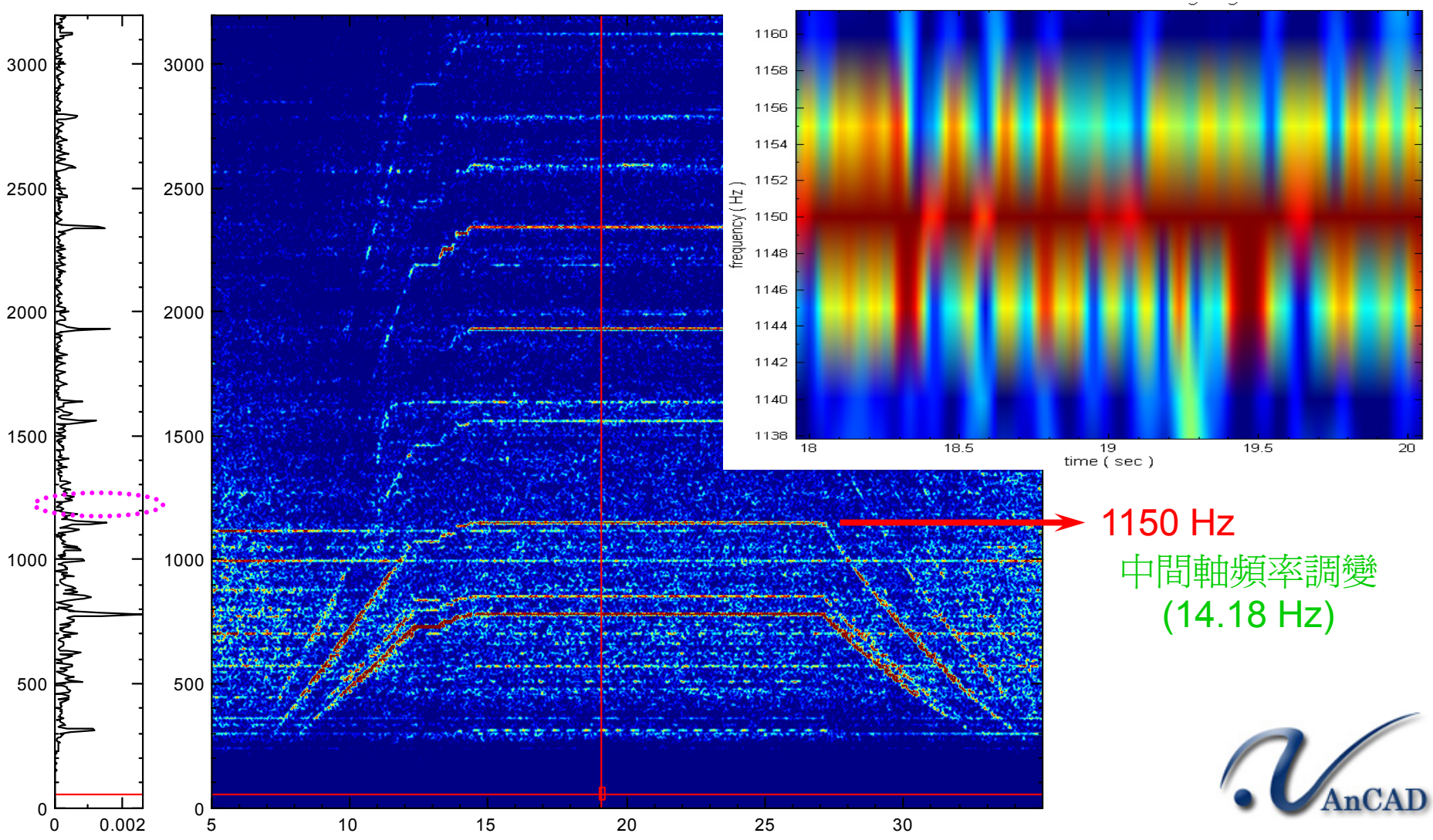


60Hz-正常生產運轉方向
中間軸與出力軸之嚙合頻率



AnCAD

60Hz-正常生產運轉方向
其他問題頻率



1150 Hz

中間軸頻率調變
(14.18 Hz)

AnCAD

Thank you

AnCAD