科勝科技
UTITECH TECHNOLOGY CO.,LTD.

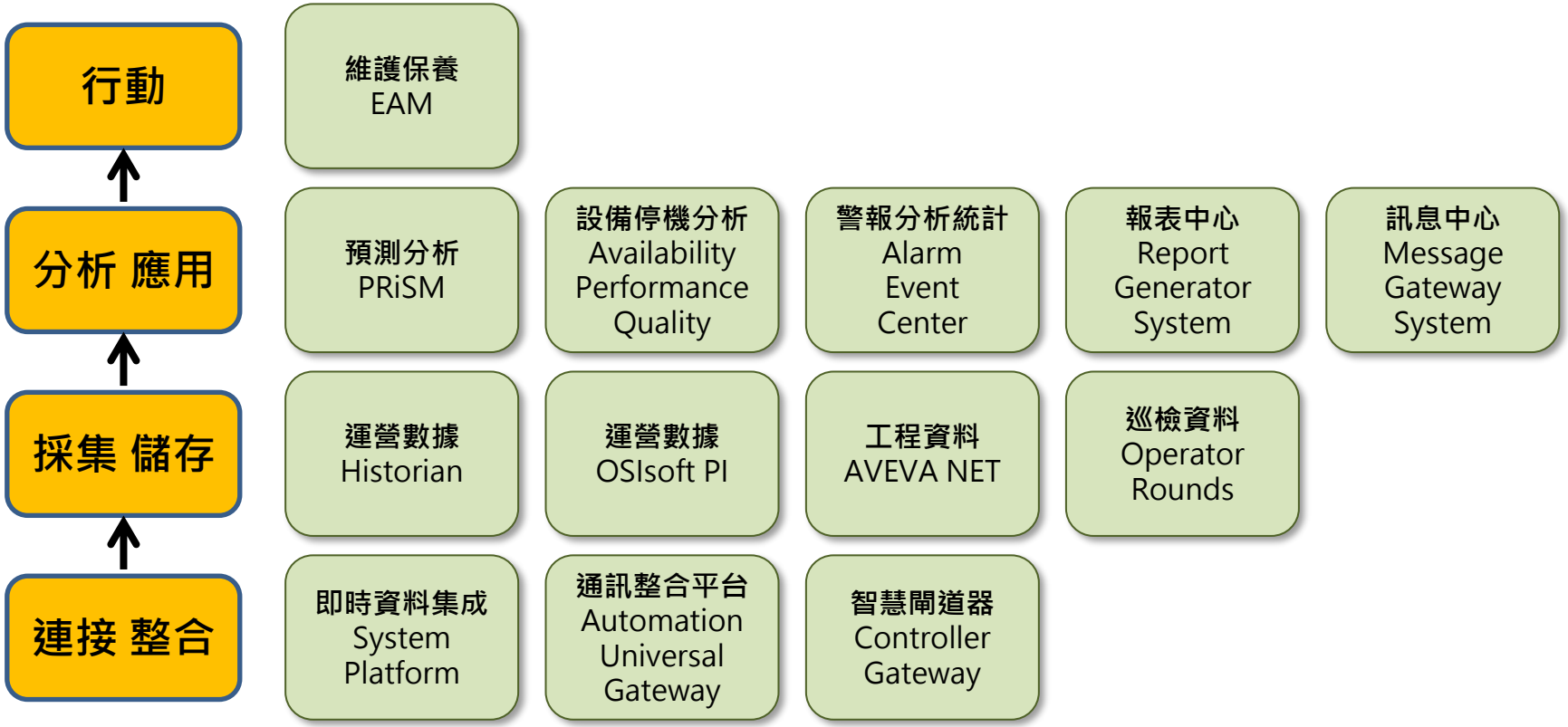
關鍵設備預測性保養

預測分析工具 PRiSM - Process Information Signal Monitor

CONTENTS

- 引敘
- 案例分享
- 關鍵性設備
- 操作說明
- 特色
- 系統架構

Asset Performance Management



多層/分散式 數據收集架構

PI OPC Server
PI OLEDB
PI ODBC
PI SQL Client
PI AF SDK
PI Web API

Azure · ArcGIS · SAP HANA

分析 應用

預測分析 · 報表中心 · 訊息中心 · 警報中心 · 戰情中心

PI System Access · PI Integrator

Plant Information

採集 儲存

(廠級推薦) Historian

(企業級推薦) PI Server

Middleware

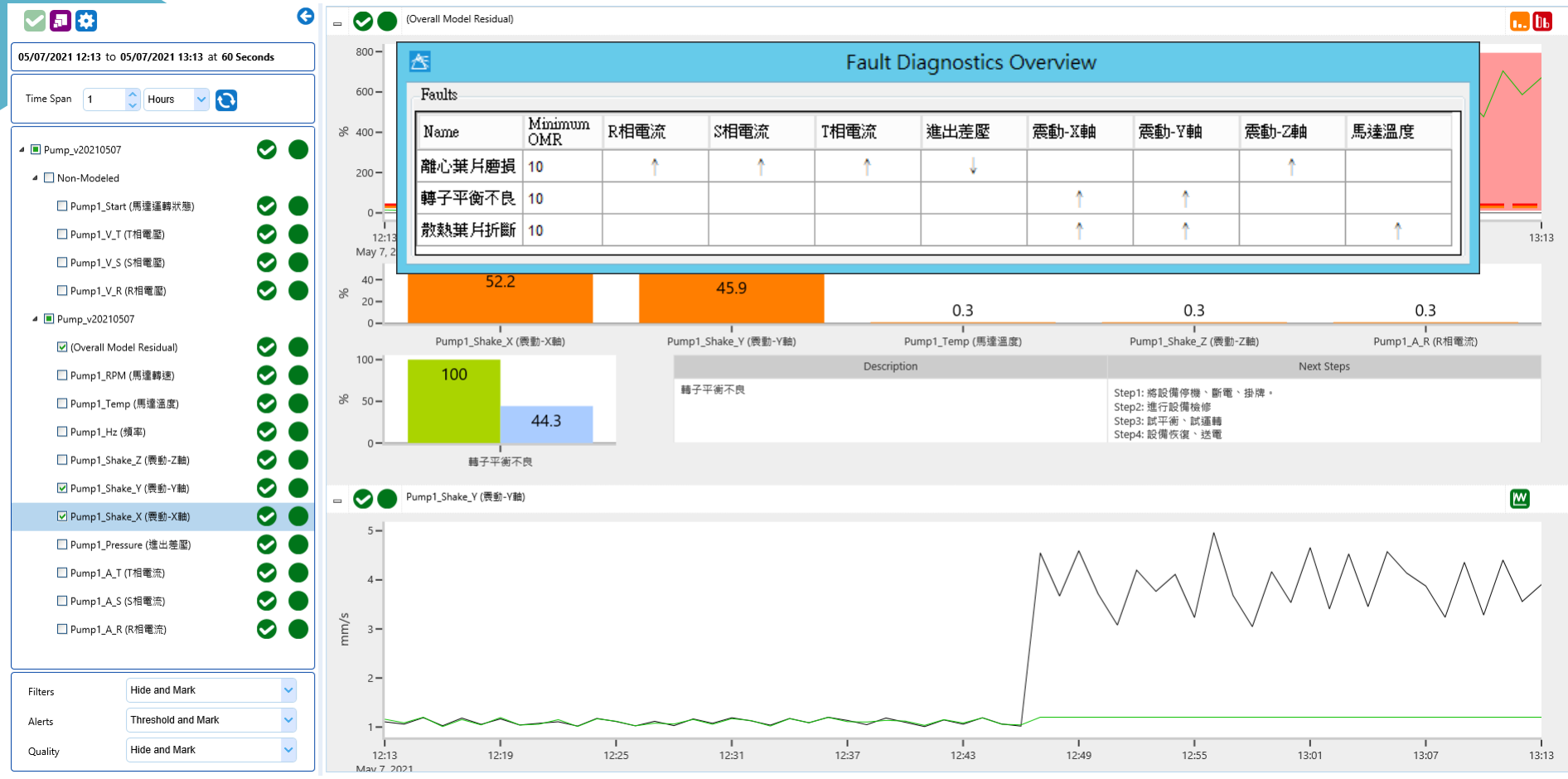
連接 整合

System Platform · Historian · Historian … Historian · PI Server … PI Server

Data Source

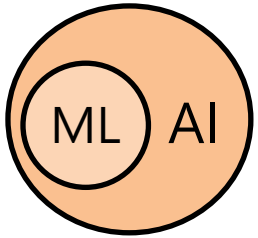
HART · PROFIBUS · BACnet · DeviceNet · PLC · 資料庫 · SCADA HMI DCS · 機台

APM 策略 - 分析


05/07/2021 12:13 to 05/07/2021 13:13 at 60 Seconds
Time Span 1 Hours
Pump_v20210507
Non-Modeled
Pump1_Start (馬達運轉狀態)
Pump1_V_T (T相電壓)
Pump1_V_S (S相電壓)
Pump1_V_R (R相電壓)
Pump_v20210507
(Overall Model Residual)
Pump1_RPM (馬達轉速)
Pump1_Temp (馬達溫度)
Pump1_Hz (頻率)
Pump1_Shake_Z (震動-Z軸)
Pump1_Shake_Y (震動-Y軸)
Pump1_Shake_X (震動-X軸)
Pump1_Pressure (進出差壓)
Pump1_A_T (T相電流)
Pump1_A_S (S相電流)
Pump1_A_R (R相電流)
Filters Hide and Mark
Alerts Threshold and Mark
Quality Hide and Mark
(Overall Model Residual)
Fault Diagnostics Overview
Faults
Name | Minimum OMR | R相電流 | S相電流 | T相電流 | 進出差壓 | 震動-X軸 | 震動-Y軸 | 震動-Z軸 | 馬達溫度
離心葉片磨損 | 10
轉子平衡不良 | 10
散熱葉片折斷 | 10
52.2
45.9
0.3
0.3
0.3
Pump1_Shake_X (震動-X軸)
Pump1_Shake_Y (震動-Y軸)
Pump1_Temp (馬達溫度)
Pump1_Shake_Z (震動-Z軸)
Pump1_A_R (R相電流)
100
44.3
轉子平衡不良
Description
轉子平衡不良
Next Steps
Step1: 將設備停機、斷電、掛牌。
Step2: 進行設備檢修
Step3: 試平衡、試運轉
Step4: 設備恢復、送電
Pump1_Shake_Y (震動-Y軸)
mm/s
12:13
12:19
12:25
12:31
12:37
12:43
12:49
12:55
13:01
13:07
13:13

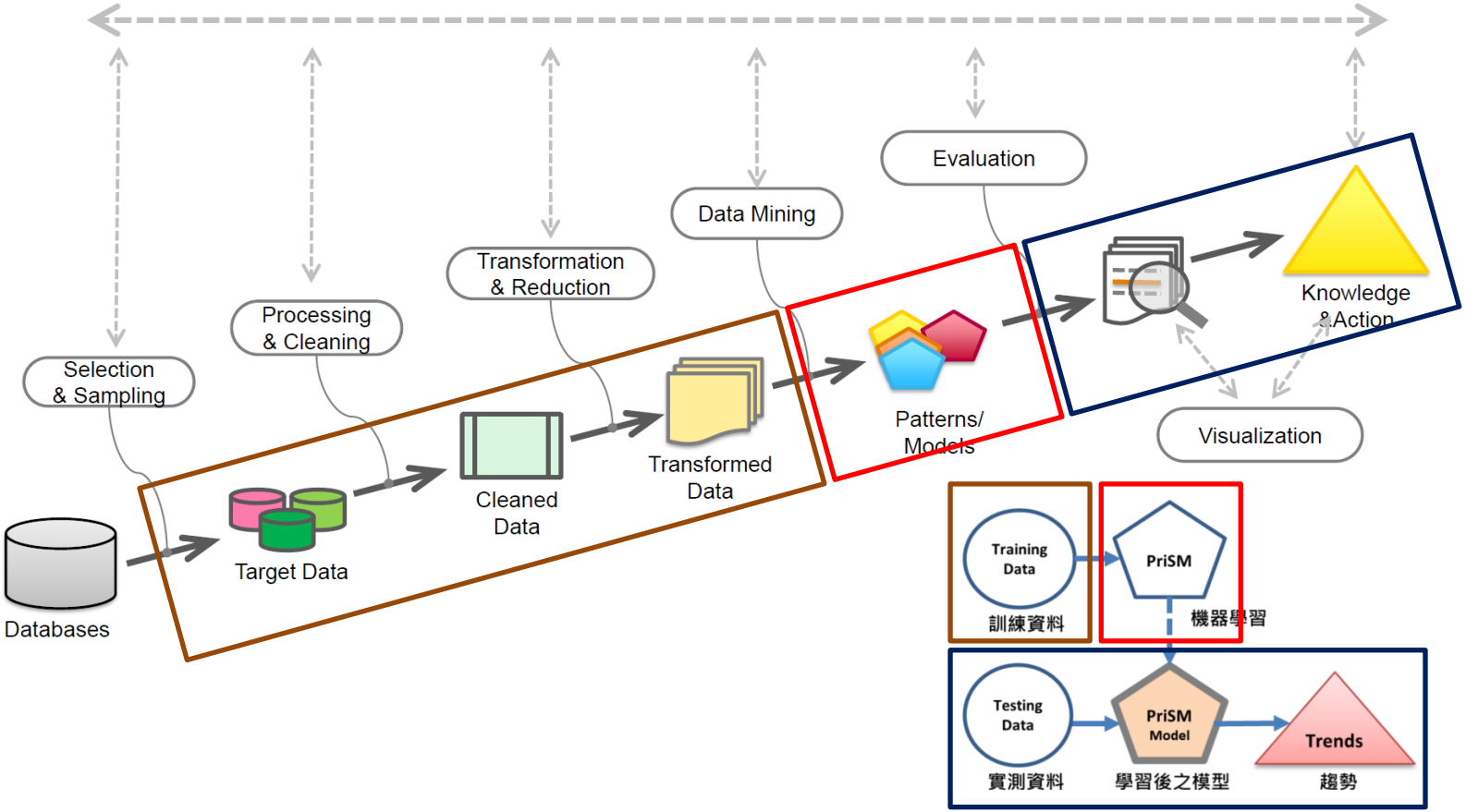
如何辦到

- Big Data / Data Mining / Machine Learning / Artificial Intelligence
- 資料探勘 - 利用分析技術來發掘資料間未知的關聯性與規則。
- 機器學習 - 學習必須有方法 (演算法)，
  從巨量資料中找出規則，經學習，進而有能力做辨別或預測。
- 人工智慧 - 將現場老師傅的經驗、智慧，透過學習，
  教電腦做正確、聰明的決策或預測。



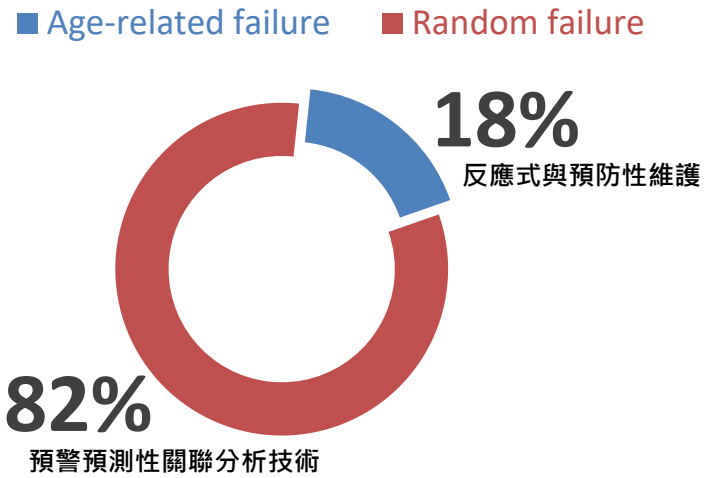
- 成功的大數據應用結合三方面專業 : **資料採集**、**資料探勘**、**領域專家**。

大數據資料探勘與工具選用



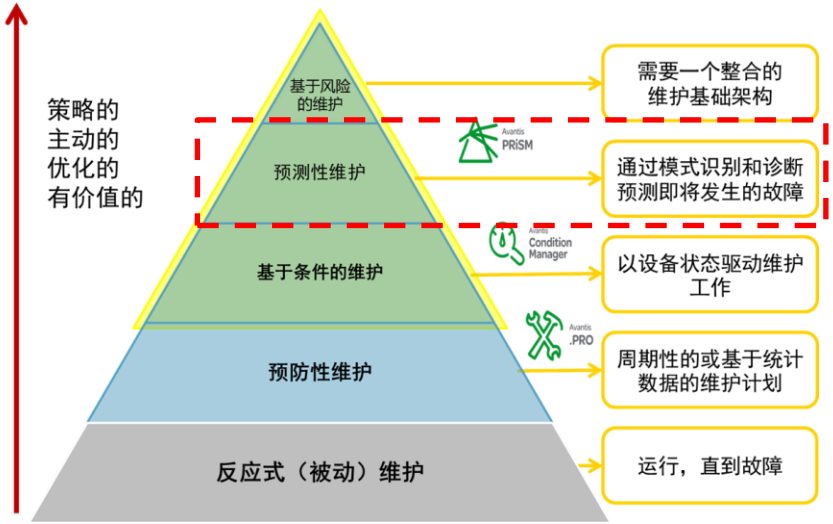
將傳統維護模式提升至預測性維護

設備故障模式



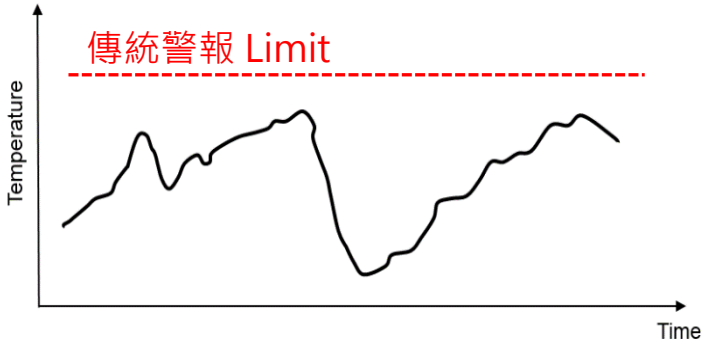
ARC studies show only 18% of asset failure is age-related. Based on these data, preventive maintenance provides a benefit for just 18 percent of assets, and monitoring for predictive maintenance is a recommended option for the rest. www.arcweb.com/Lists/Posts/Post.aspx?ID=260

運維金字塔

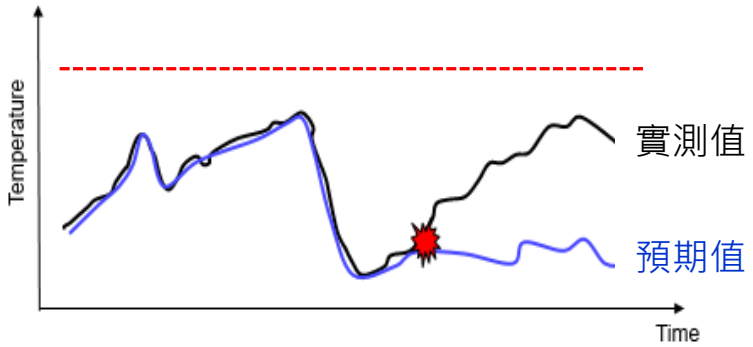


監測方法的不同

- 傳統監測



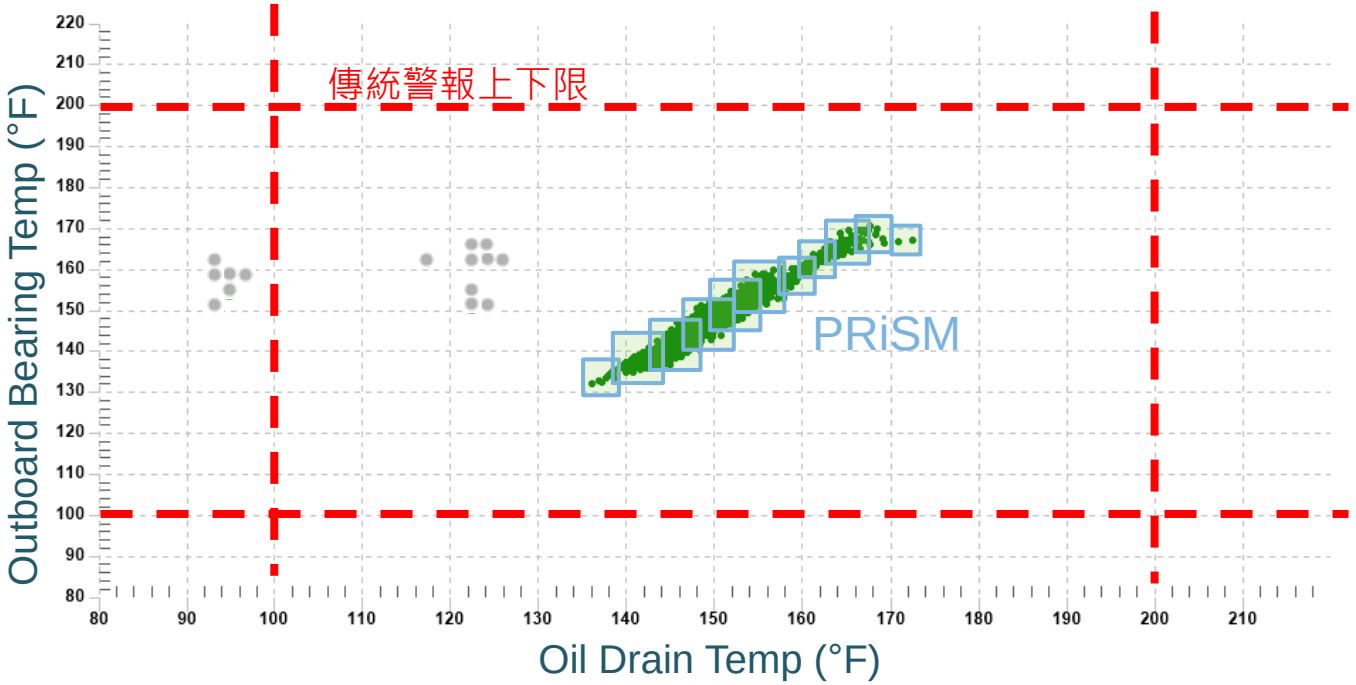
- 預測性監測



實測值 - 預期值 = 偏移量

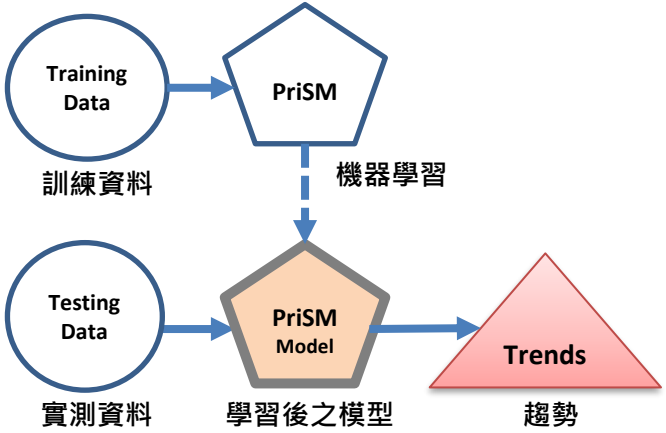
整體偏移量 (Overall Model Residual)

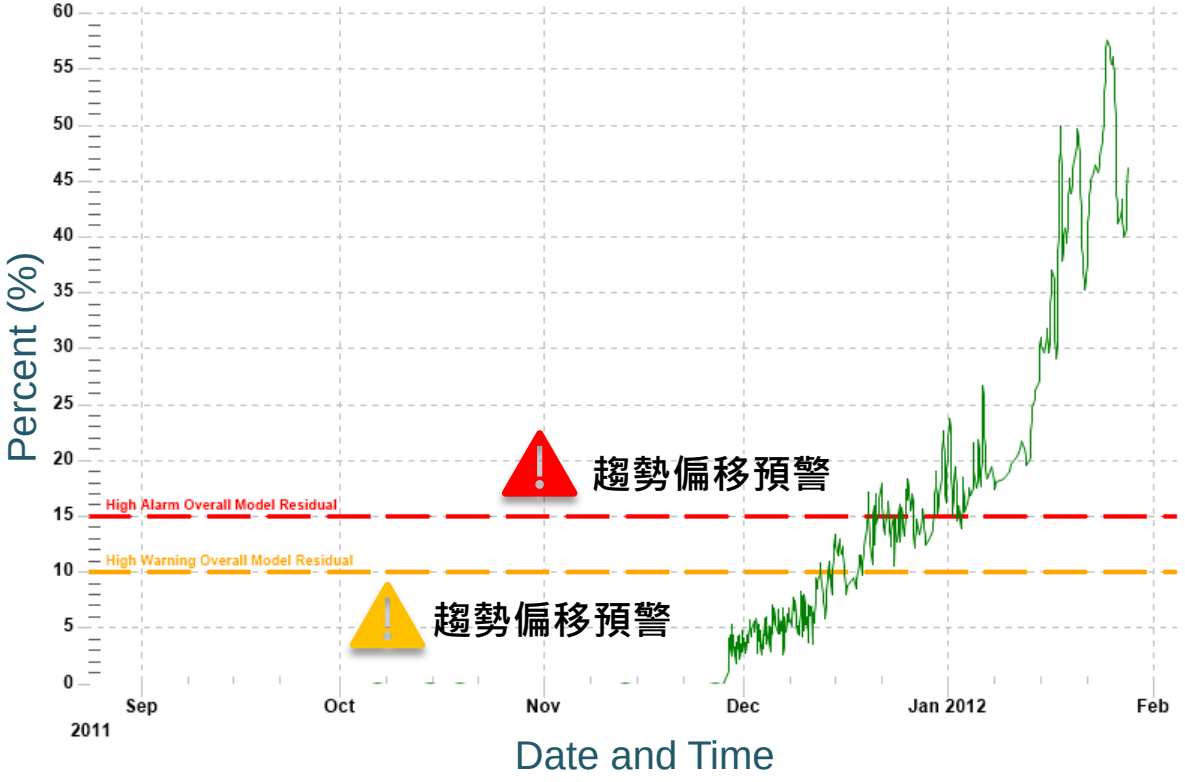
模型概念



先清洗不合理數據、離散數據，**保留正常運行的數據**，再建立模型。

整體趨勢偏移量 Overall Model Residual

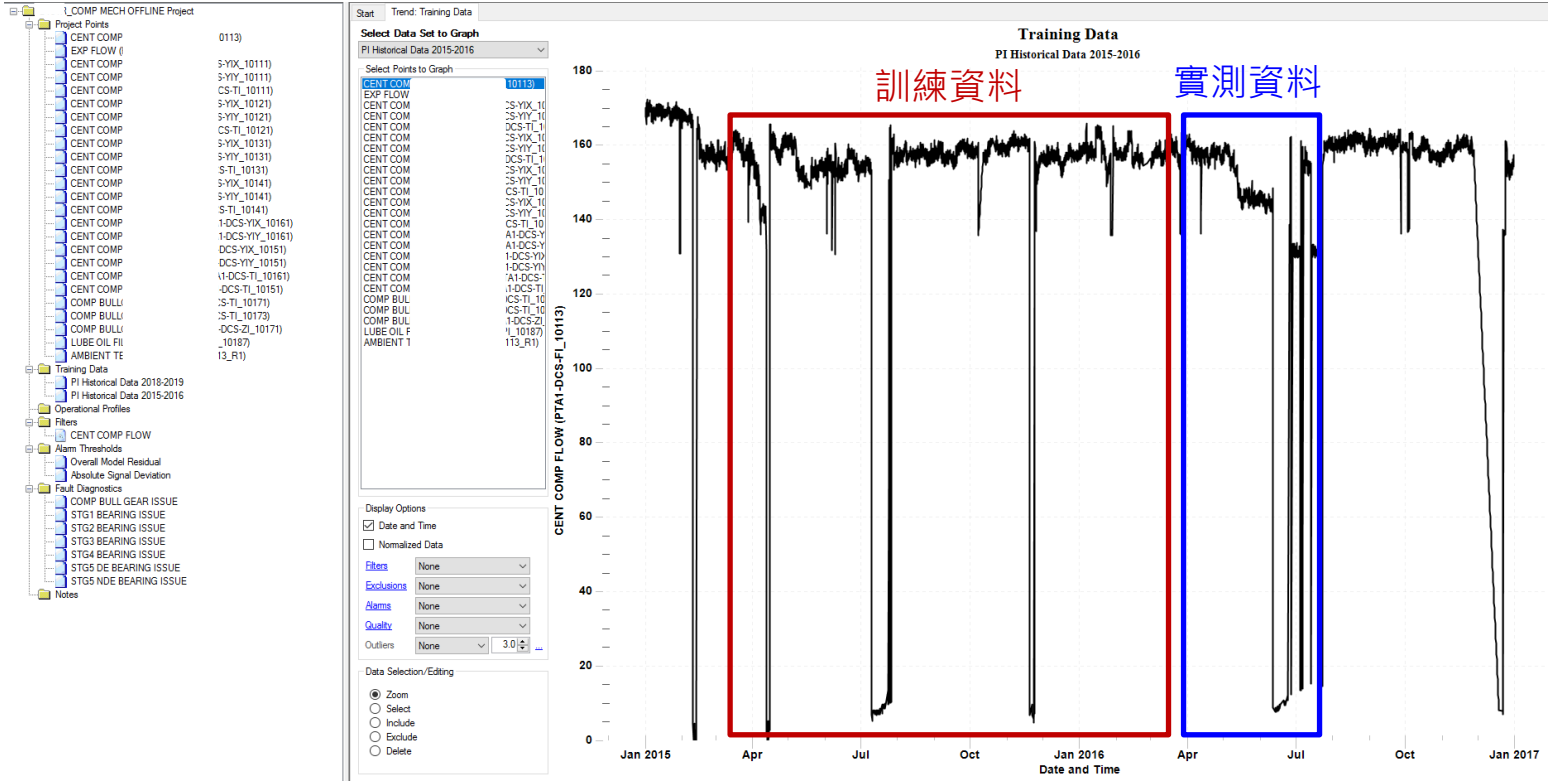




案例分享

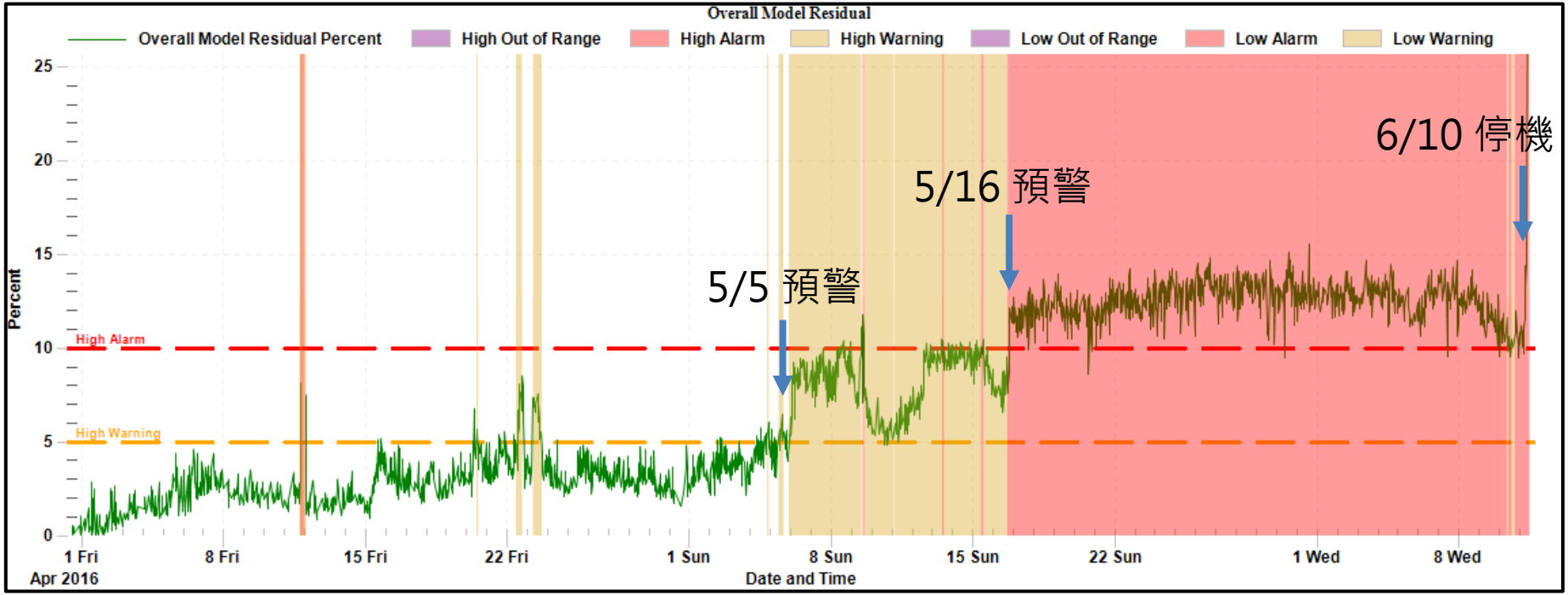
案例分享 - 壓縮機膨脹機資料回測

2015年1月 到 2016年底，共2年數據，每5分鐘一筆。



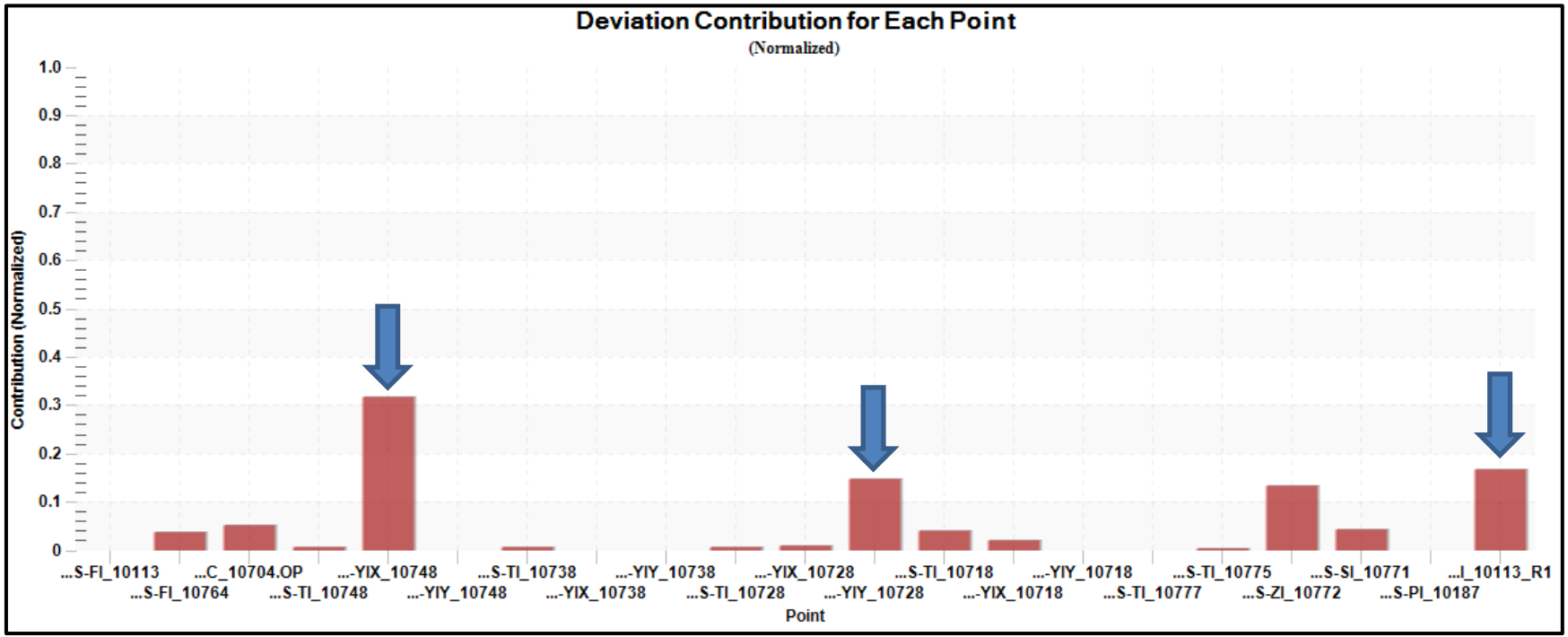
資料回測結果

OMR 預警



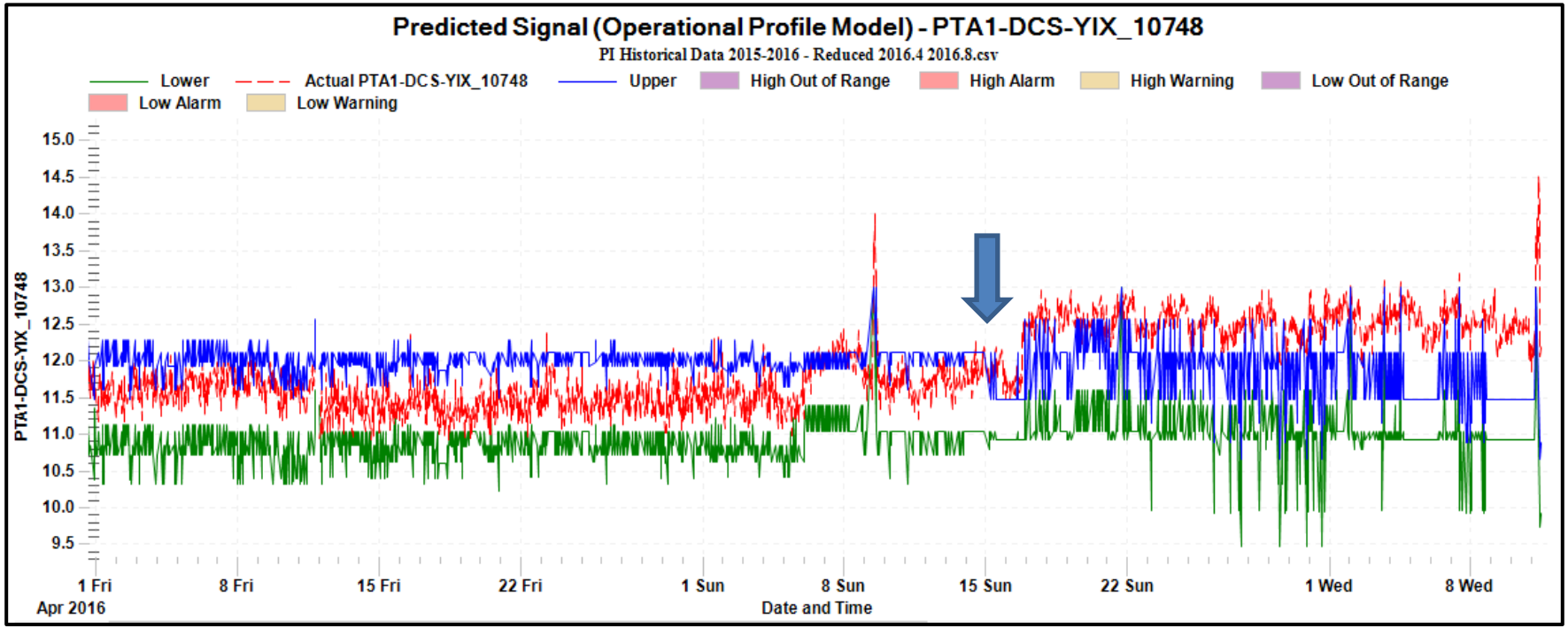
偏移原因分析

引起該預警的主要測項：**YIX10748**、**YIY10728**，即膨脹機一段驅動端X向振動和膨脹機二段驅動端Y向振動。而 TI_10113_R1 為環境溫度，作為參考。



偏移原因分析

YIX10748 的實測值(紅線) 於 5/15 後明顯高於其預期值的上限值(藍線)，之前都在預期期間內波動。膨脹機轉速約10000轉，偏移約1um需要引起足夠重視。



資料回測結果

設備檢修報告

- 2016/6/27 空壓機膨脹機第一段高振動葉輪斷裂損壞異常。
  經委外破損分析，造成葉輪破損原因推論為：
  膨脹機運轉期間葉片接觸環境中腐蝕因素致使葉片表面孔蝕，導致孔洞出現應力集中而產生疲勞裂紋，最終斷裂。

- 利用設備故障前約2個半月的資料回測，
  提早於 2016/5/5 預測出設備異常跡象。

結論

- 以此案例，PRiSM 的 OMR 在 **設備失效前約一個月** 即提示預警，並可通過趨勢查看劣化的演變，並發現問題，系統提示是膨脹機一段驅動端軸承振動為主要原因，方便分析人員判斷膨脹機可能的失效原因。

- 假設事故期間有 PRiSM 在其中監測，所呈現 **OMR 逐步升高**，以及連續無間斷的預警都會引起設備人員的足夠重視，從而有可能減小葉片斷裂造成的周邊零部件的損失。

關鍵性設備

關鍵性設備

- 渦輪
- 壓縮機
- 發電機
- 泵浦
- 變頻器
- 風扇、鼓風機
- 熱交換器、鍋爐、烤箱
- 空氣加熱器
- 熱水器
- 渦輪膨脹機
- 粉碎機、破碎機、磨碎機
- 冷凝器
- 蒸餾塔
- 變壓器、斷路器、電容器
- 攪拌機、混料機
- 變速箱
- 冰水主機
- 密封系統

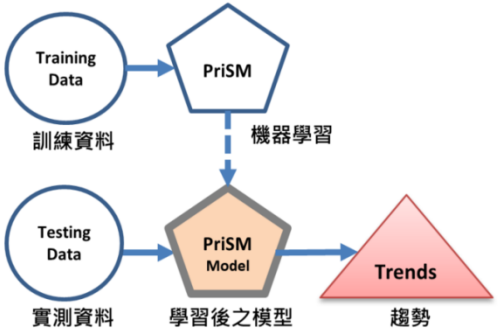
關鍵性設備

設備機組	關鍵測項 舉例
空壓機	進氣量、排氣壓力、排氣温度、流量、環境溫度、負載率、電流、振動..等
蒸汽輪機	壓力、溫度、流量、流量控制閥%、葉片角度、轉速、軸承溫度、振動 ..等
膨脹機	進出口壓力、進出口溫度、流量、轉速、徑向振動、止推位移、軸承溫度 ..等
泵浦	進出口差壓、流量、轉速、電流、軸承溫度、振動 ..等
變頻器	設定頻率、輸出頻率、輸出電流、DC-BUS電壓、輸出電壓、散熱器溫度、運轉狀態、轉速、轉矩 ..等
鍋爐	進風量、空氣預熱溫度、引風量、燃燒器送料量、爐膛壓力、爐膛溫度、爐膛出口煙溫、排氣空氣品質、蒸汽溫度、蒸汽壓力、蒸汽流量、供水水位、供水流量 ..等

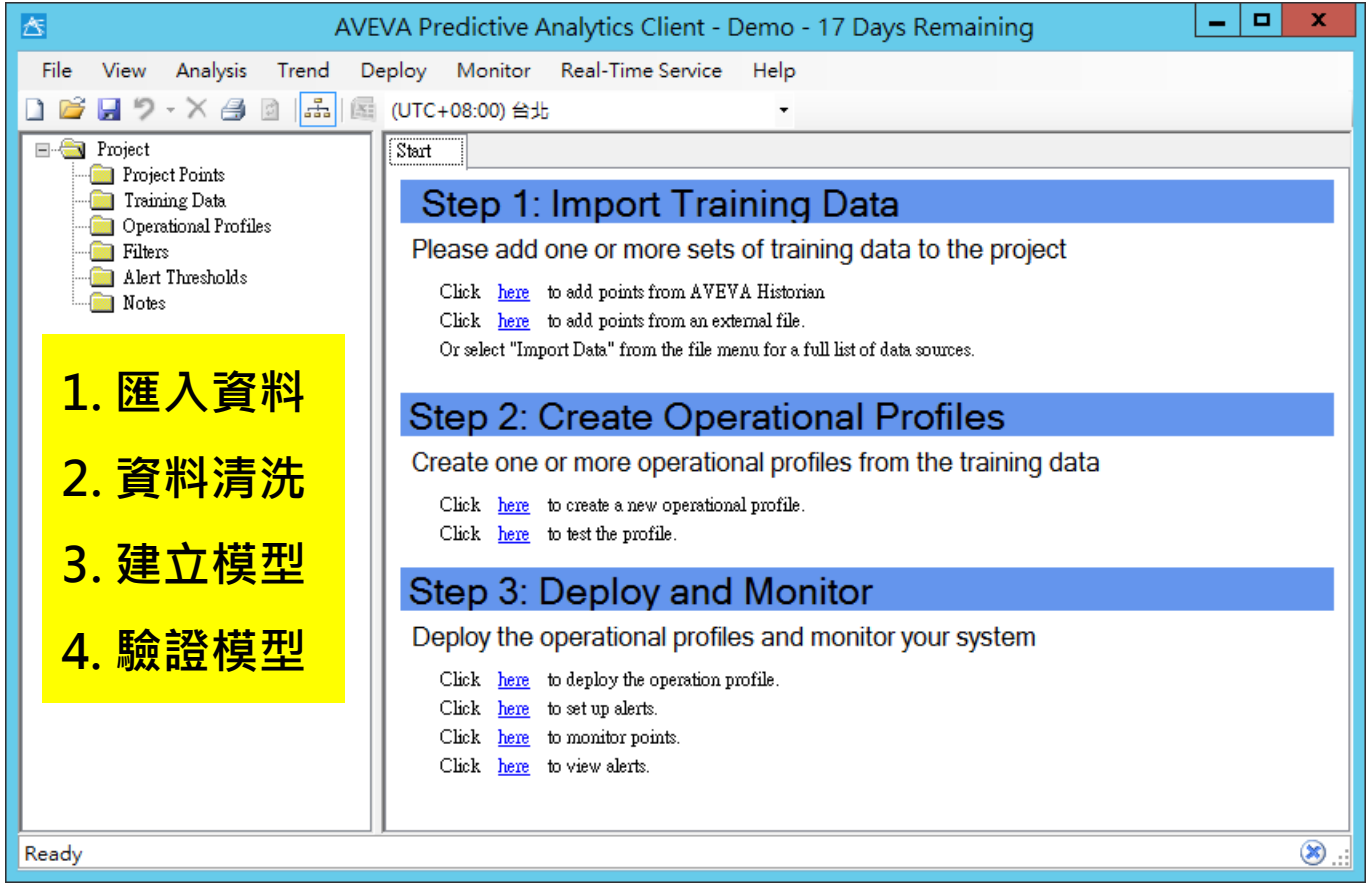
- 效能模型 可用 △P、△T、△Folw 來實現。
- 機械模型 可用 關聯性測項 來實現。

PRiSM 操作說明

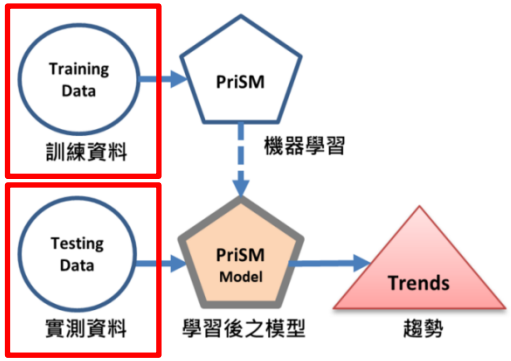
PRiSM 使用簡單 - 4個步驟

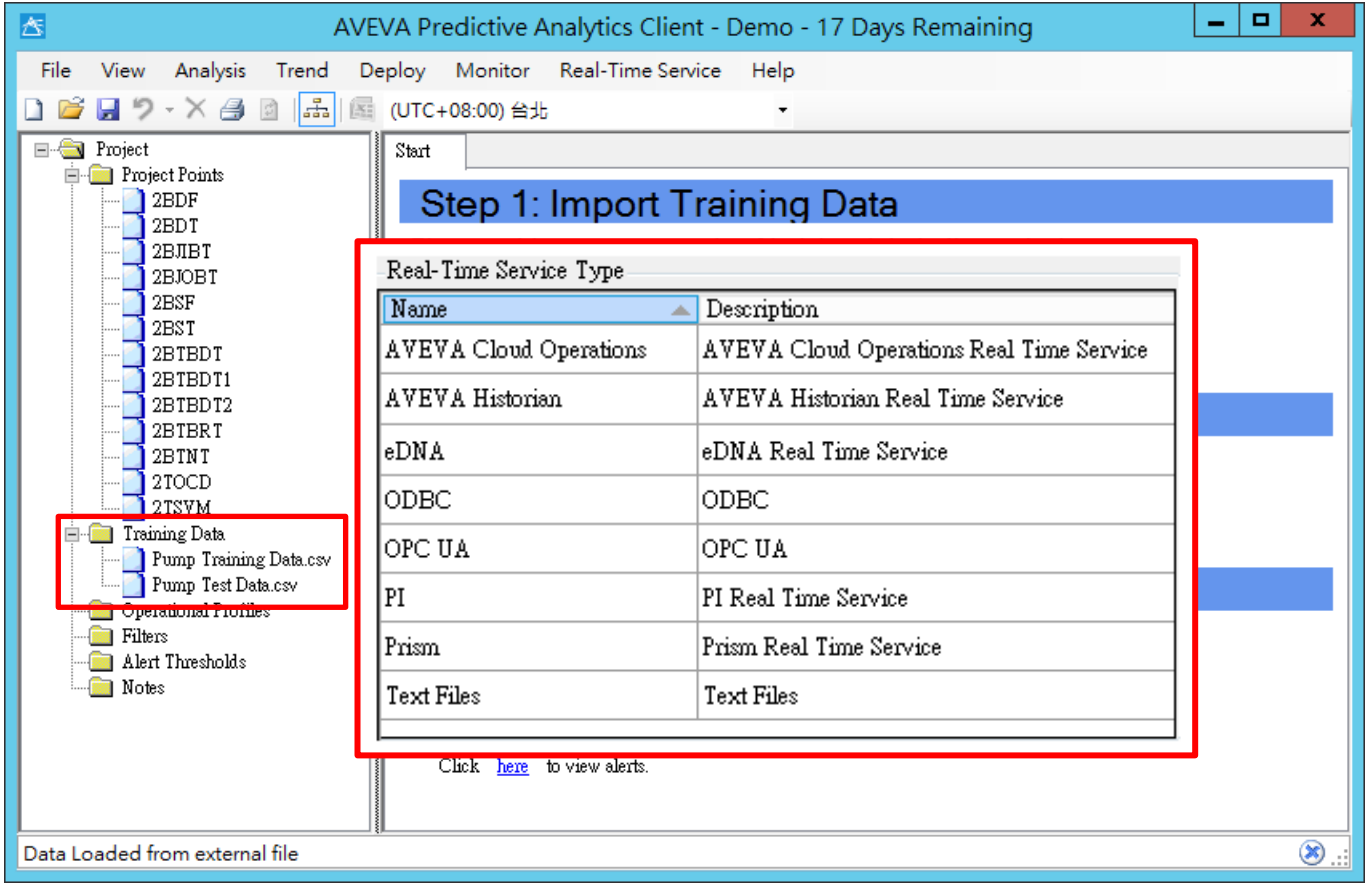


1. 匯入資料
2. 資料清洗
3. 建立模型
4. 驗證模型

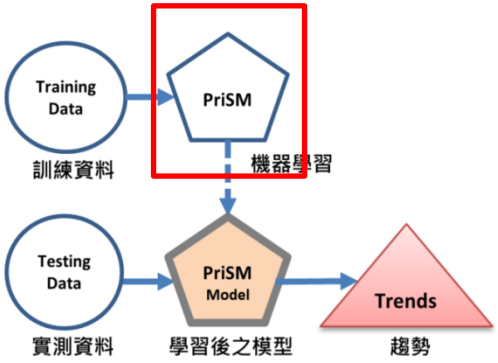


步驟1 - 匯入資料


Training Data
訓練資料
PriSM
機器學習
Testing Data
實測資料
PriSM Model
學習後之模型
Trends
趨勢


AVEVA Predictive Analytics Client - Demo - 17 Days Remaining
File
View
Analysis
Trend
Deploy
Monitor
Real-Time Service
Help
(UTC+08:00) 台北
Project
Project Points
2BDF
2BDT
2BJIBT
2BJOBT
2BSF
2BST
2BTBDT
2BTBDT1
2BTBDT2
2BTBRT
2BTNT
2TOCD
2TSVM
Training Data
Pump Training Data.csv
Pump Test Data.csv
Operational Profiles
Filters
Alert Thresholds
Notes
Start
Step 1: Import Training Data
Real-Time Service Type
Name
Description
AVEVA Cloud Operations
AVEVA Cloud Operations Real Time Service
AVEVA Historian
AVEVA Historian Real Time Service
eDNA
eDNA Real Time Service
ODBC
ODBC
OPC UA
OPC UA
PI
PI Real Time Service
Prism
Prism Real Time Service
Text Files
Text Files
Click here to view alerts.
Data Loaded from external file

步驟2 - 資料清洗



Correlation: Training Data

Training Data

All Training Data

Pump Training Data.csv

Point for X-Axis

2BDF
2BDT
2BJIBT
2BJOBT
2BSF
2BST
2BTBDT
2BTBDT1
2BTBDT2
2BTBRT
2BTNT
2TOCD
2TSVM

Point for Y-Axis

2BDF
2BDT
2BJIBT
2BJOBT
2BSF
2BST
2BTBDT
2BTBDT1
2BTBDT2
2BTBRT
2BTNT
2TOCD
2TSVM

Display Options

Show Overview

Date and Time

Filters: None

Exclusions: Mark

Alerts: None

Quality: None

Outliers: None 3.0

Data Selection/Editing

- Zoom
- Select Overview
- Select Comparison
- Include
- Exclude
- Delete

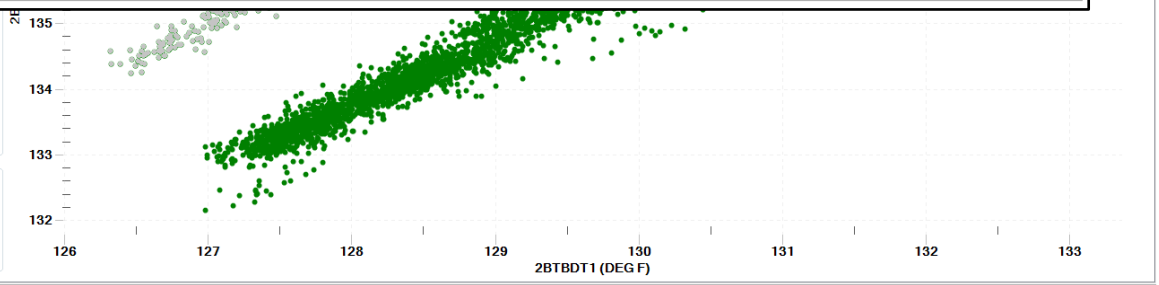
Training Data Overview

2BTBDT1 2BTBDT

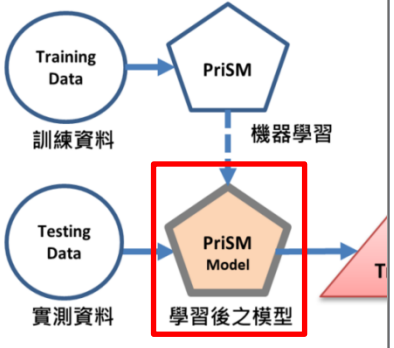
Correlation

The correlation between multiple points is shown below.

Point	2BTBDT1	2BTBDT2	2BTBDT	2BTBRT	2BTNT	2TSVM	2TOCD	2BJIBT	2BJOBT	2BDT	2BST	2BDF	2BSF
2BTBDT1	100.00%	95.11%	99.11%	95.30%	85.19%	41.03%	89.30%	92.67%	93.92%	88.48%	75.20%	69.72%	19.48%
2BTBDT2	95.11%	100.00%	96.00%	99.74%	87.05%	50.04%	91.94%	92.11%	92.75%	92.71%	79.84%	71.56%	20.25%
2BTBDT	99.11%	96.00%	100.00%	95.93%	90.83%	51.29%	87.29%	95.12%	96.51%	90.43%	78.71%	74.22%	19.28%
2BTBRT	95.30%	99.74%	95.93%	100.00%	86.51%	48.99%	93.31%	90.73%	92.00%	92.04%	78.37%	69.44%	19.24%
2BTNT	85.19%	87.05%	90.83%	86.51%	100.00%	71.21%	70.36%	91.85%	93.76%	86.30%	80.42%	79.56%	19.54%
2TSVM	41.03%	50.04%	51.29%	48.99%	71.21%	100.00%	39.83%	51.80%	54.05%	44.92%	40.07%	39.42%	13.65%
2TOCD	89.30%	91.94%	87.29%	93.31%	70.36%	39.83%	100.00%	73.34%	75.96%	73.84%	53.75%	39.82%	22.04%
2BJIBT	92.67%	92.11%	95.12%	90.73%	91.85%	51.80%	73.34%	100.00%	98.95%	94.31%	89.68%	87.36%	21.60%
2BJOBT	93.92%	92.75%	96.51%	92.00%	93.76%	54.05%	75.96%	98.95%	100.00%	94.24%	88.10%	85.55%	20.46%
2BDT	88.48%	92.71%	90.43%	92.04%	86.30%	44.92%	73.84%	94.31%	94.24%	100.00%	91.48%	88.60%	10.16%
2BST	75.20%	79.84%	78.71%	78.37%	80.42%	40.07%	53.75%	89.68%	88.10%	91.48%	100.00%	93.49%	5.16%
2BDF	69.72%	71.56%	74.22%	69.44%	79.56%	39.42%	39.82%	87.36%	85.55%	88.60%	93.49%	100.00%	2.25%
2BSF	19.48%	20.25%	19.28%	19.24%	19.54%	13.65%	22.04%	21.60%	20.46%	10.16%	5.16%	2.25%	100.00%



步驟3 - 建立模型



Mode Visualization

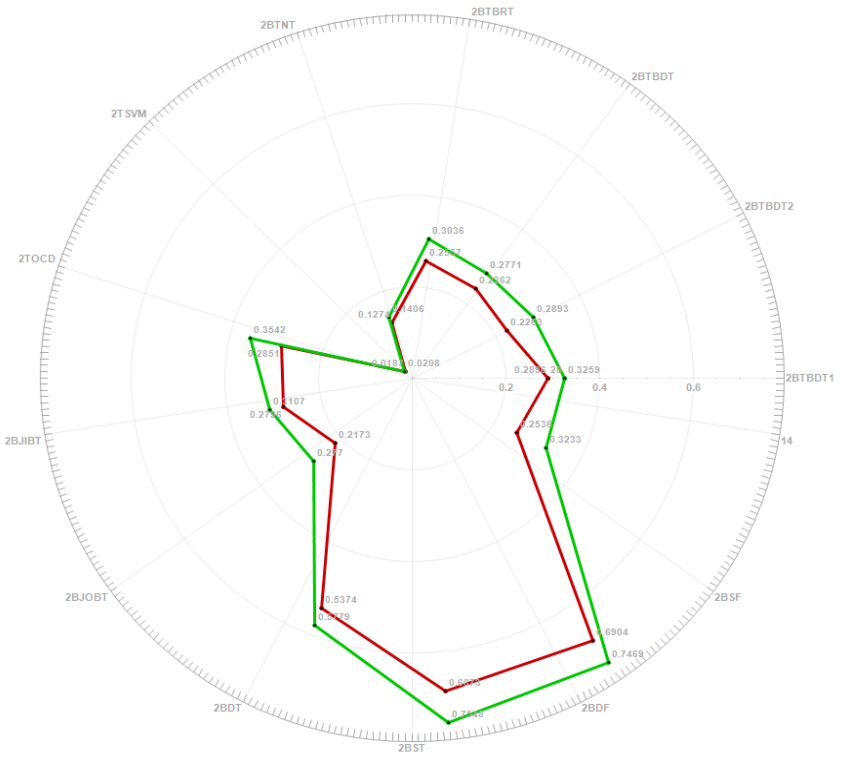
LSH

Pump Training Data.csv

Number	Density (Count)	Density (Percen
1	11	0.25 %
2	39	0.89 %
3	3	0.07 %
4	3	0.07 %
5	3	0.07 %
6	19	0.44 %
7	4	0.09 %
8	4	0.09 %
9	2	0.05 %
10	2	0.05 %
11	5	0.11 %
12	4	0.09 %
13	5	0.11 %
14	4	0.09 %
15	3	0.07 %
16	4	0.09 %
17	9	0.21 %
18	2	0.05 %
19	2	0.05 %
20	5	0.11 %
21	2	0.05 %
22	3	0.07 %
23	3	0.07 %
24	4	0.09 %
25	2	0.05 %
26	2	0.05 %
27	4	0.09 %
28	2	0.05 %
29	4	0.09 %
30	3	0.07 %
31	2	0.05 %
32	3	0.07 %
33	2	0.05 %

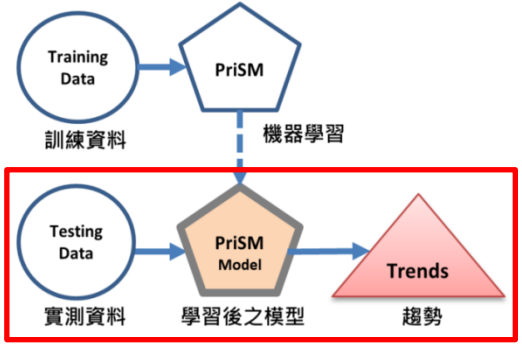
Lower Bound Upper Bound

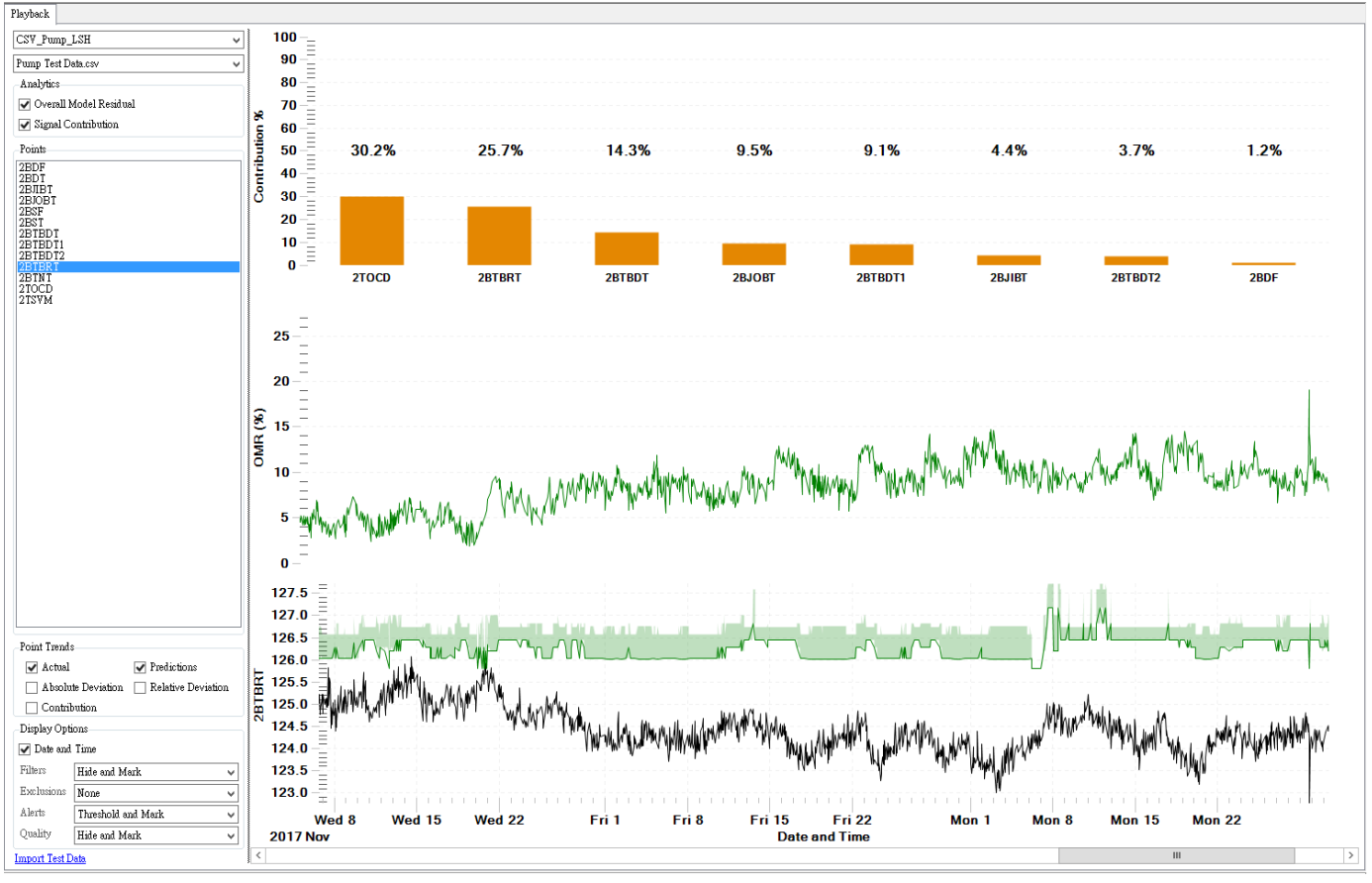
Operational Profile Glyph
(Mode 1)



Trend Individual Mode Shape (Glyph)

步驟4 - 驗證模型


Training Data
PriSM
訓練資料
機器學習
Testing Data
PriSM Model
Trends
實測資料
學習後之模型
趨勢

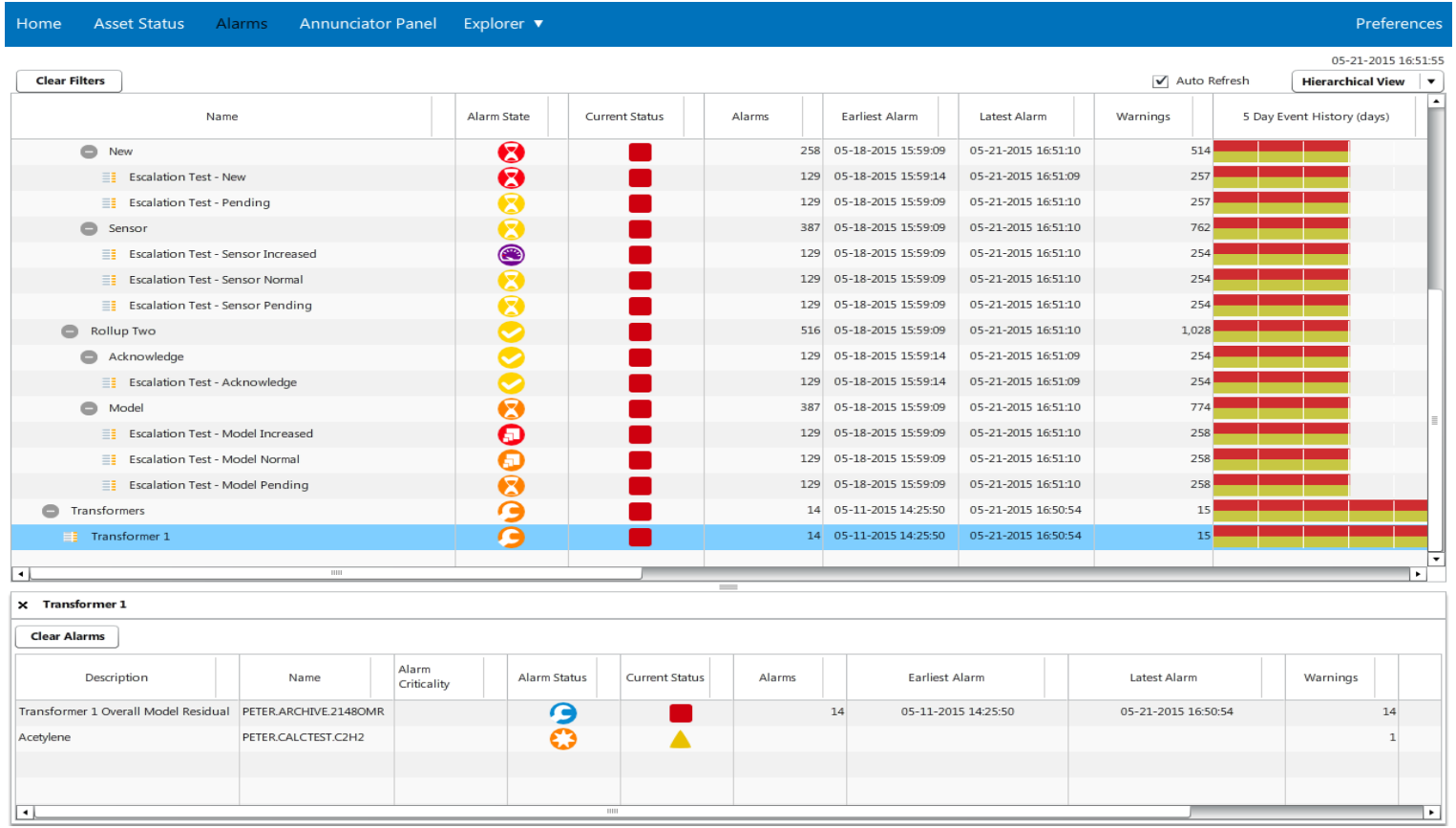

Playback
CSV_Pump_LSH
Pump Test Data.csv
Analytics
Overall Model Residual
Signal Contribution
Points
2BDF
2BDT
2BJIBT
2BJOBT
2BSF
2EST
2BTBDT
2BTBDT1
2BTBDT2
2BTBRT
2BTNT
2TOCD
2TSVM
Point Trends
Actual
Predictions
Absolute Deviation
Relative Deviation
Contribution
Display Options
Date and Time
Filters
Hide and Mark
Exclusions
None
Alerts
Threshold and Mark
Quality
Hide and Mark
Import Test Data
Contribution %
30.2%
25.7%
14.3%
9.5%
9.1%
4.4%
3.7%
1.2%
2TOCD
2BTBRT
2BTBDT
2BJOBT
2BTBDT1
2BJIBT
2BTBDT2
2BDF
OMR (%)
2BTBRT
Wed 8
Wed 15
Wed 22
Fri 1
Fri 8
Fri 15
Fri 22
Mon 1
Mon 8
Mon 15
Mon 22
2017 Nov
Date and Time

特色

特色

- 不須撰寫程式的能力，簡單、易學、好上手
- 資料來源多樣化
- 視覺化關聯數據清洗
- 內建演算法，快速建模 (如: 效能模型、機械模型)
- 數據回測，驗證模型
- 偏移原因分析，故障診斷
- Web 即時監看設備狀態
- Case 管理
- 可整合訊息中心 (MGS)
- 提供 REST API

Web Client 即時監看設備狀態



偏移原因分析、失效原因分析

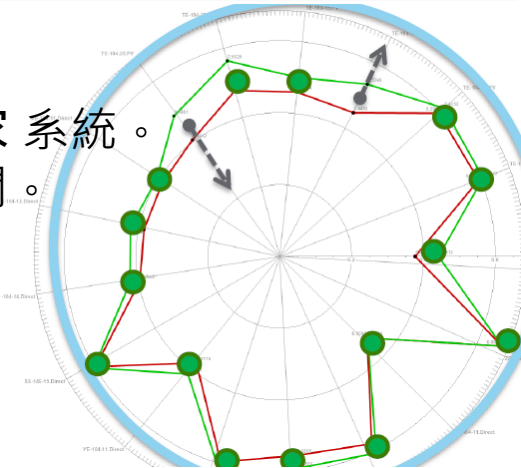
故障診斷知識庫配置

Fault Diagnostics Overview

Faults

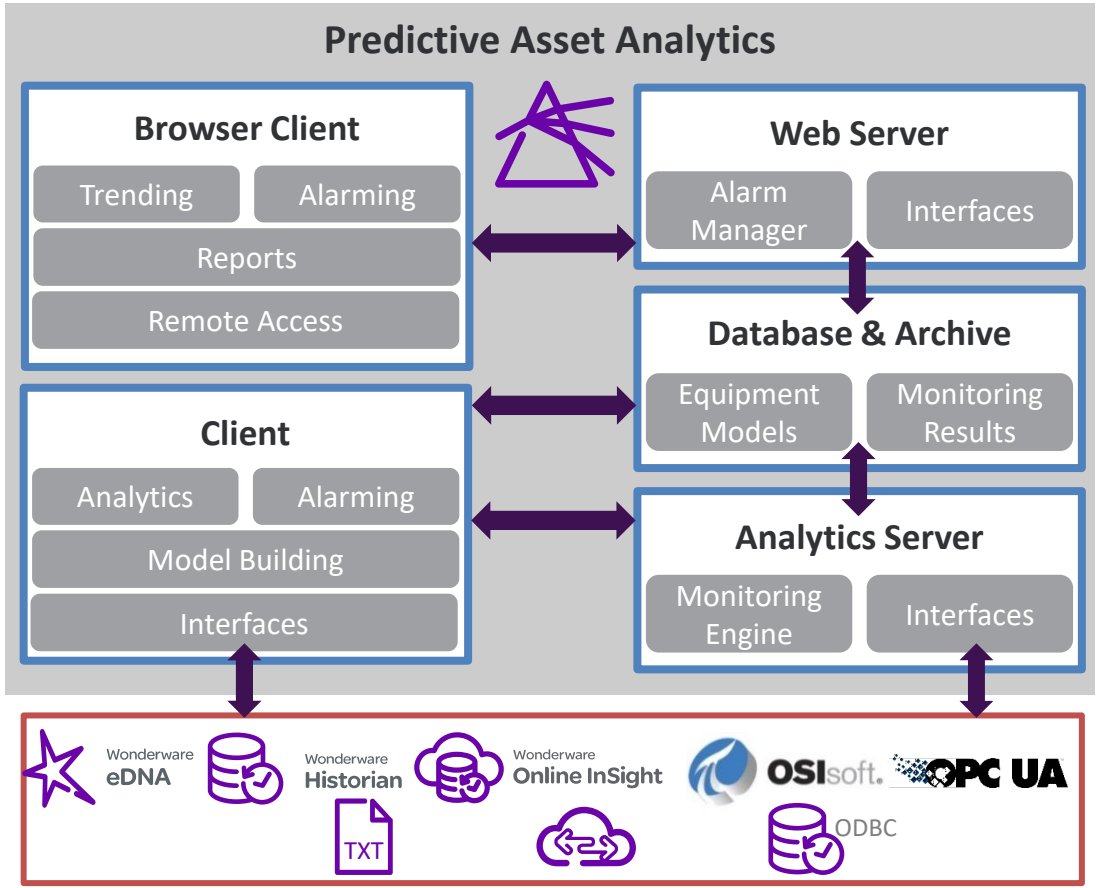
Name	Minimum OMR	AIR COMP 1STG BRG TEMP	AIR COMP 1STG BRG VIB	AIR COMP 2STG BRG TEMP	AIR COMP 2STG BRG VIB	AIR COMP 3STG BRG TEMP	AIR COMP 3STG BRG VIB	AIR COMP 4STG BRG TEMP	AIR COMP 4STG BRG VIB	AIR COMP LUBE OIL SPLY TEMP	AIR COMP MTR DE BRG TEMP	AIR COMP MTR NDE BRG TEMP	AIR COMP POWER CONSUMPTION	AIR COMP THRUST BRG AXIAL MVMT
Bearing Temperature Problem 1-2 STG	5	↑		↑						-				
Bearing Temperature Problem 3-4 STG	5					↑		↑		-				
Bearing Vibration Issue 1-2 STG	5	-	↑↓	-	↑↓									
Bearing Vibration Issue 3-4 STG	5					-	↑↓	-	↑↓					
Motor Bearing Temperature Issue	5									-	↑	↑		
Thrust Bearing Issue	5												-	↑↓

結合 **現場維保經驗** (可使用 現場歷史故障數據 反推各測項走向)
產出屬於自家的 Knowledge，逐漸演進成為 **設備醫生**、**設備專家** 系統。
方便 維護人員 做 **設備失效原因診斷**，縮短查修、待料、修復時間。



系統架構

系統架構


Predictive Asset Analytics
Browser Client
Trending
Alarming
Reports
Remote Access
Web Server
Alarm Manager
Interfaces
Database & Archive
Equipment Models
Monitoring Results
Client
Analytics
Alarming
Model Building
Interfaces
Analytics Server
Monitoring Engine
Interfaces
Wonderware eDNA
Wonderware Historian
Wonderware Online InSight
OSIsoft.
OPC UA
TXT
ODBC
REST API
Alerts email
Source Historical Data
Analytics results output (optional)

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THANK YOU !

Smart Technologies Driving Tomorrow's Production.