

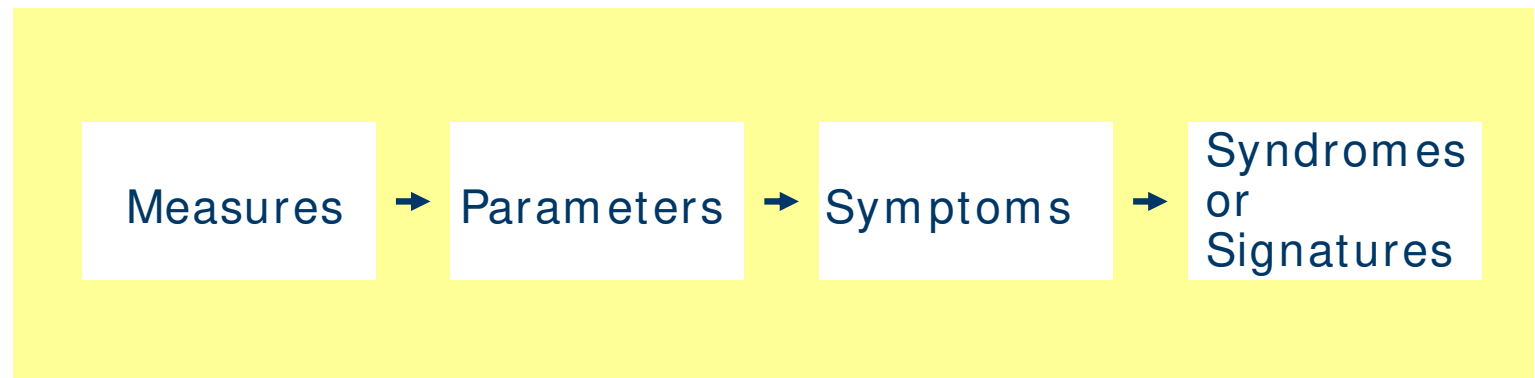
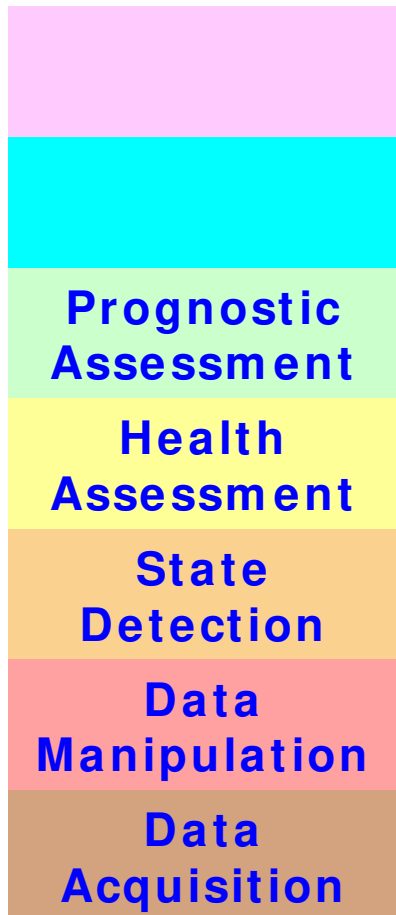


Studies in “Health Monitoring”

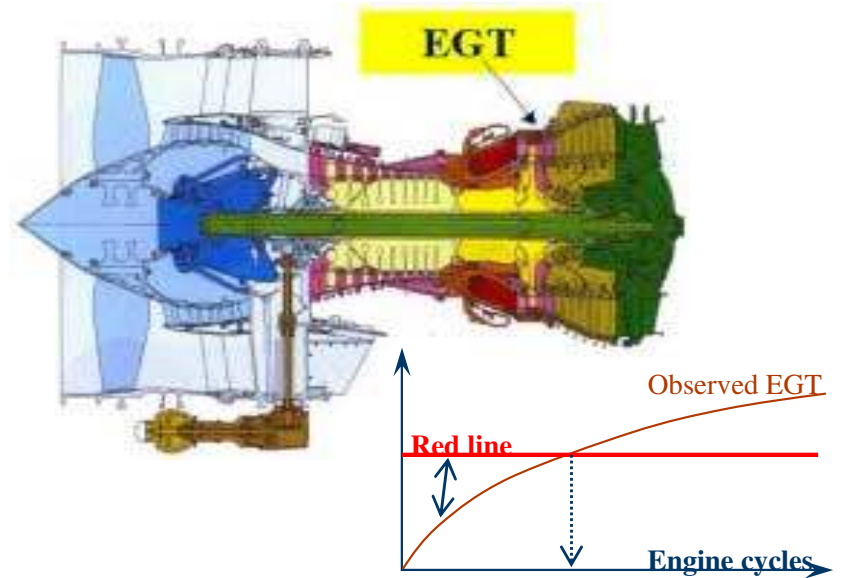
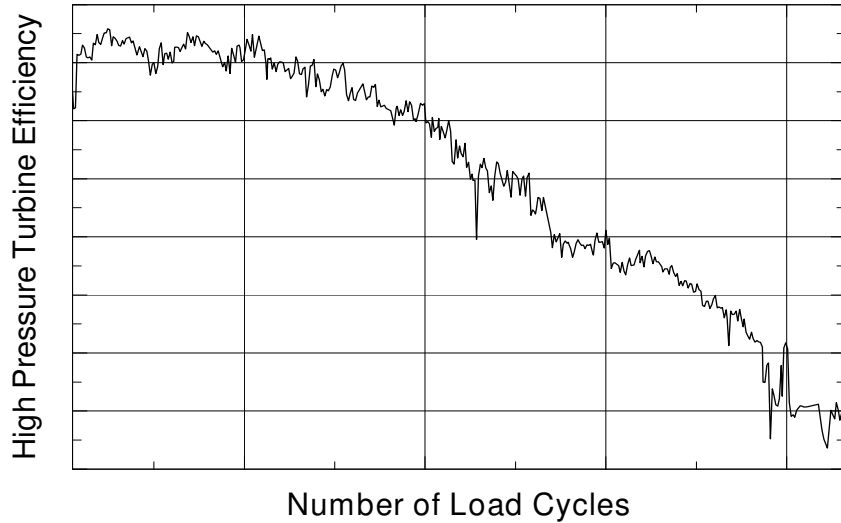


Health monitoring

- ▶ Event future occurrence detection
 - ▶ Involved LRU localisation
 - ▶ System approach
 - ▶ Use of in-system existing parameters
- Protected by the MMEL (Master minimum equipment list)



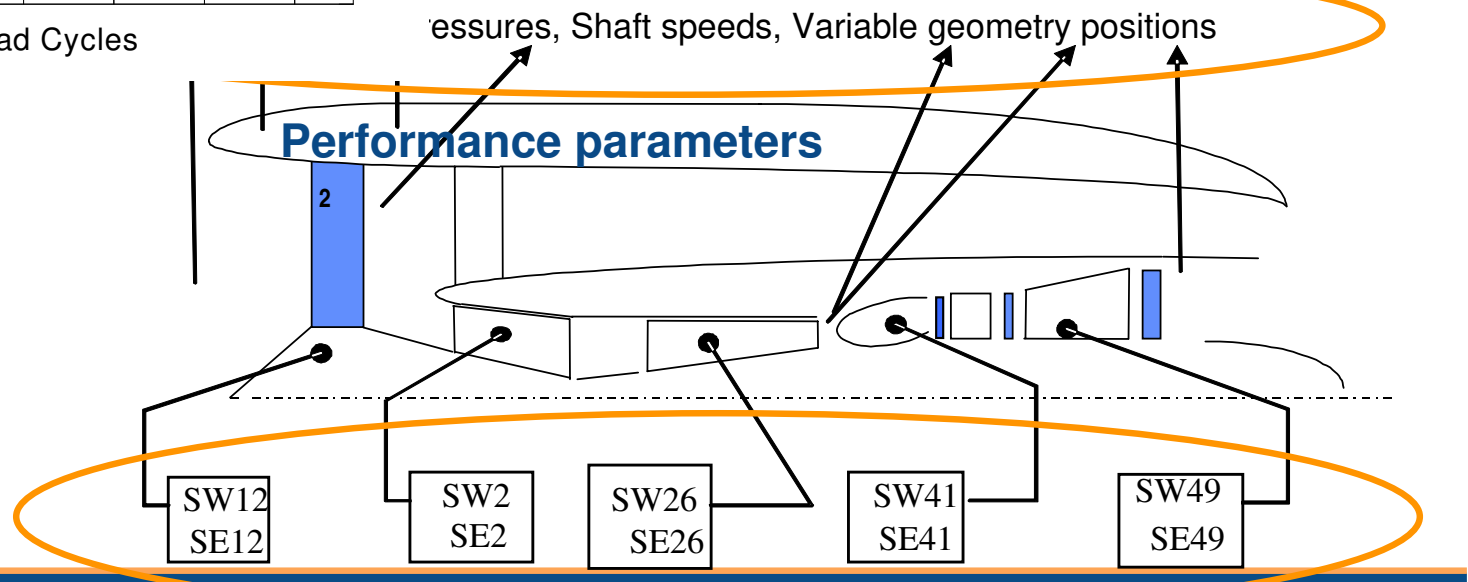
Modular performance Engine



measurements

Calculation

Health parameters



Direction / Reference / November 2008



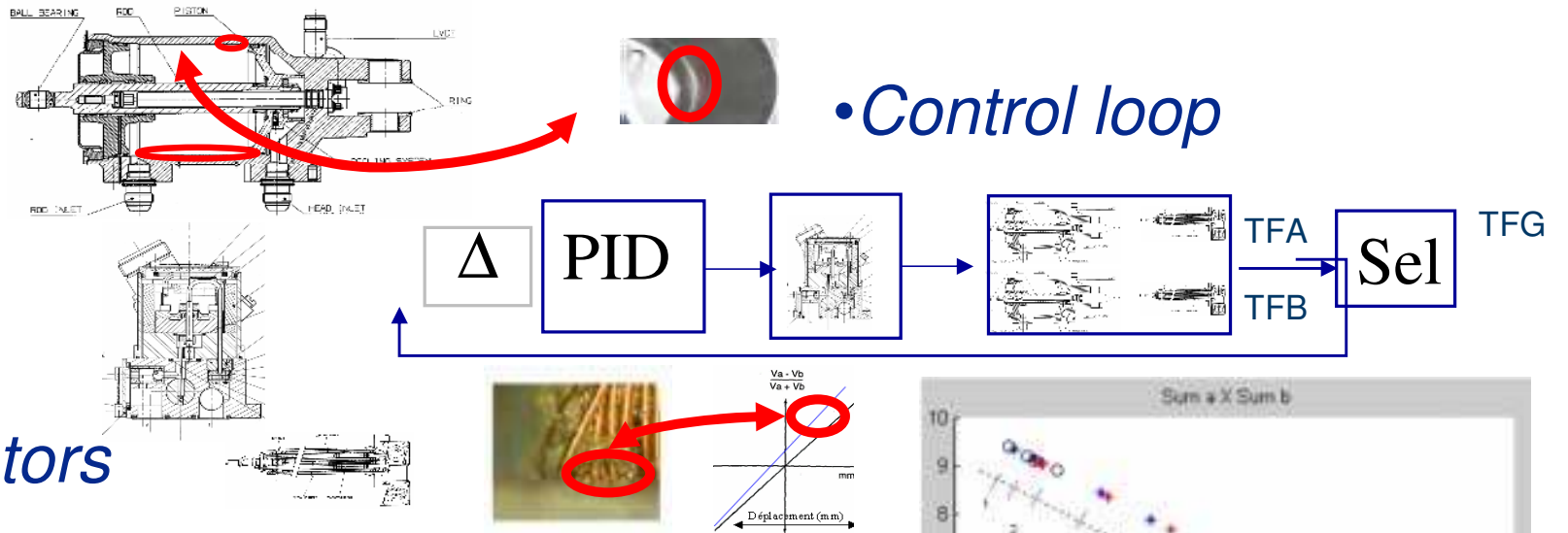
Engine systems

► Hydromechanics' actuation loop

• *Actuators*

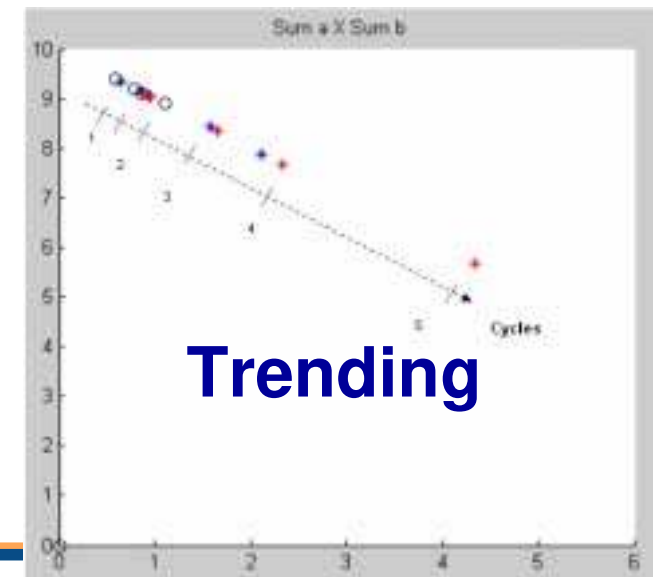
• *Servo-valve*

• *Position indicators*



Diagnosis

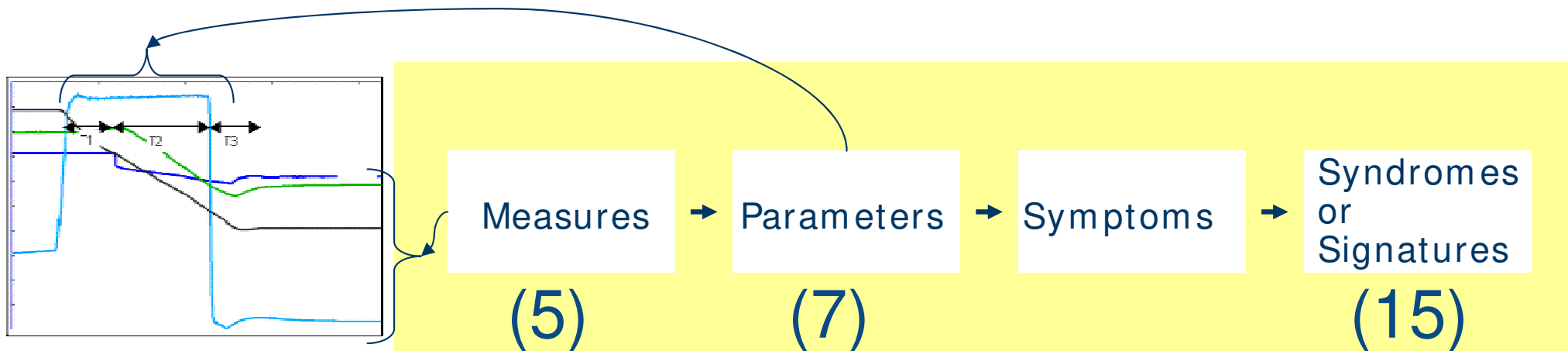
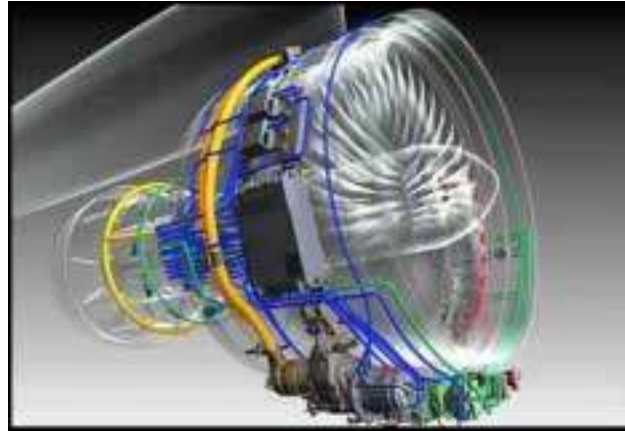
	TFG	TFA	Flight phase	Evolution
Servo	X		Stationary	Slow
Sensor		X	Any	Fast
Actuator	X		Cruise	Slow





► Start capability

- Experts knowledge
- Field event reports
- Test
- Simulation



Examples

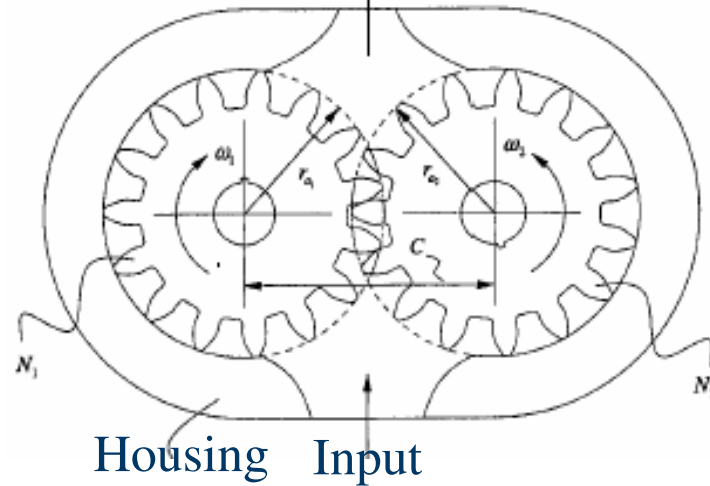
▶ Main Fuel Pump

$$Q = A_0 \cdot N_2 + A_1 \cdot \Delta P_{HP} + A_2 \cdot \sqrt{\Delta P_{HP}}$$

Known or measured

Evolve with ageing

Volumetric gear pump principle



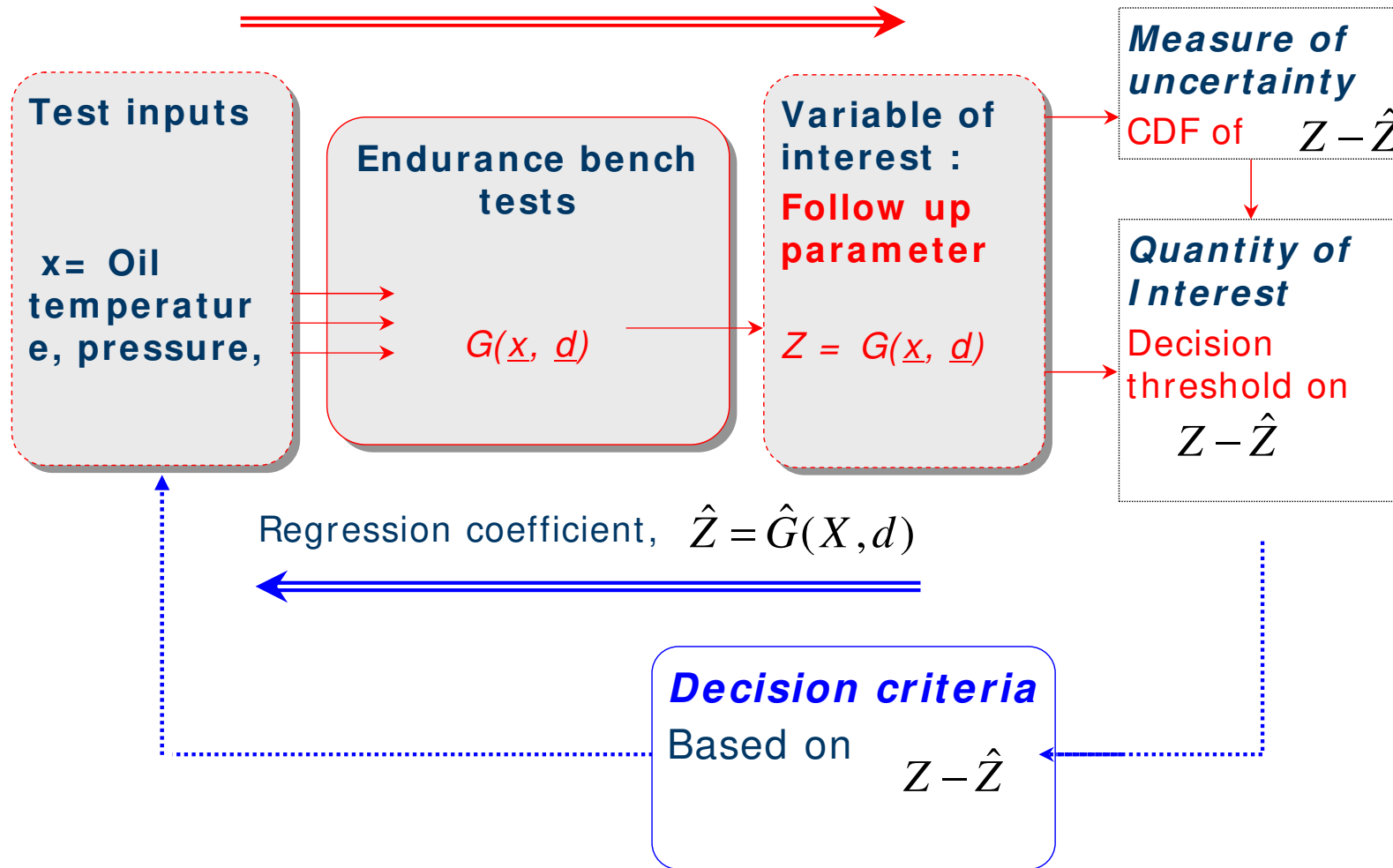
Bearings wear



Gear cavitations



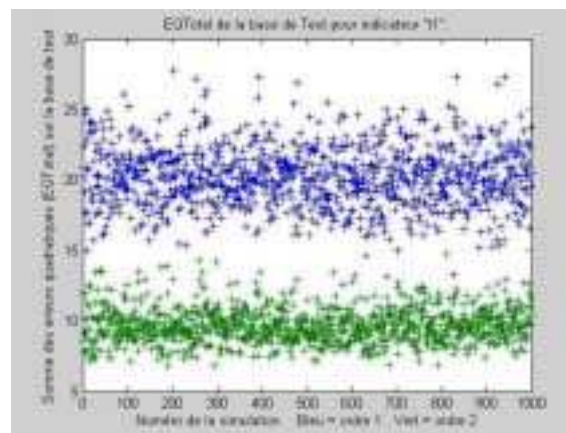
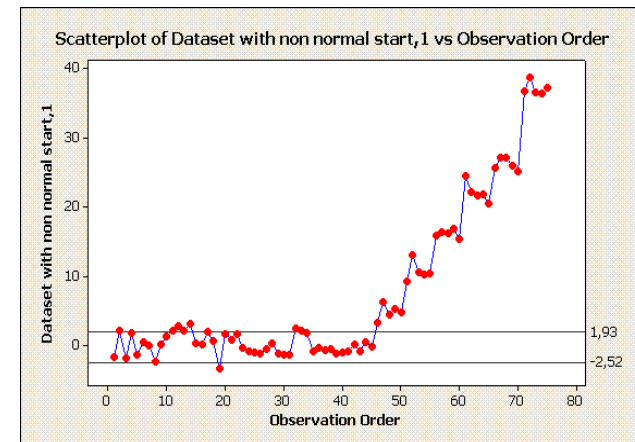
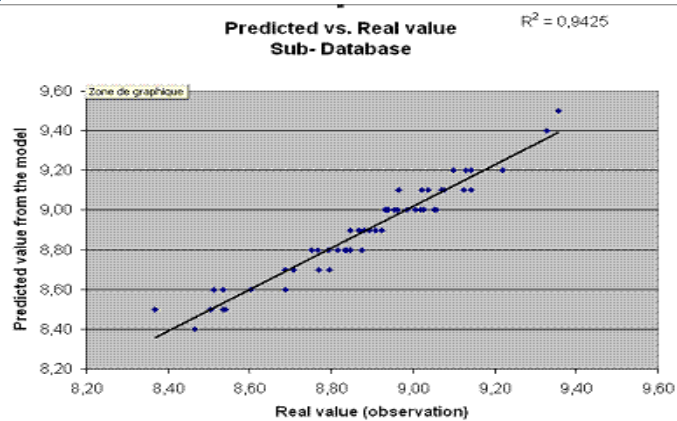
Symptom extraction



Symptom extraction

Start capability

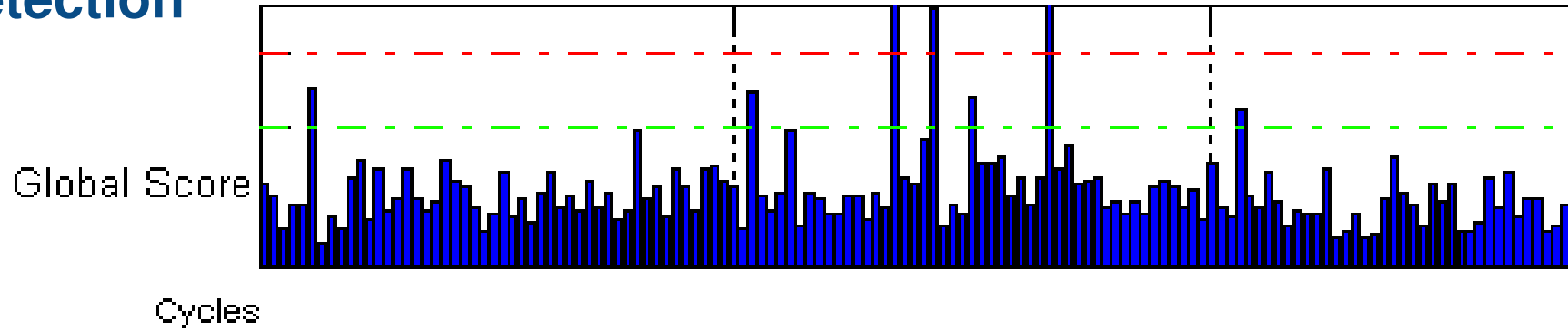
$$T1 = 7,85 - 2,65 \text{ PASTAR} + 0,00806 \text{ PressAtm} - 0,00557 \text{ Toil} - T1 - 0,0304 \text{ TAMB}$$



Syndromes extraction

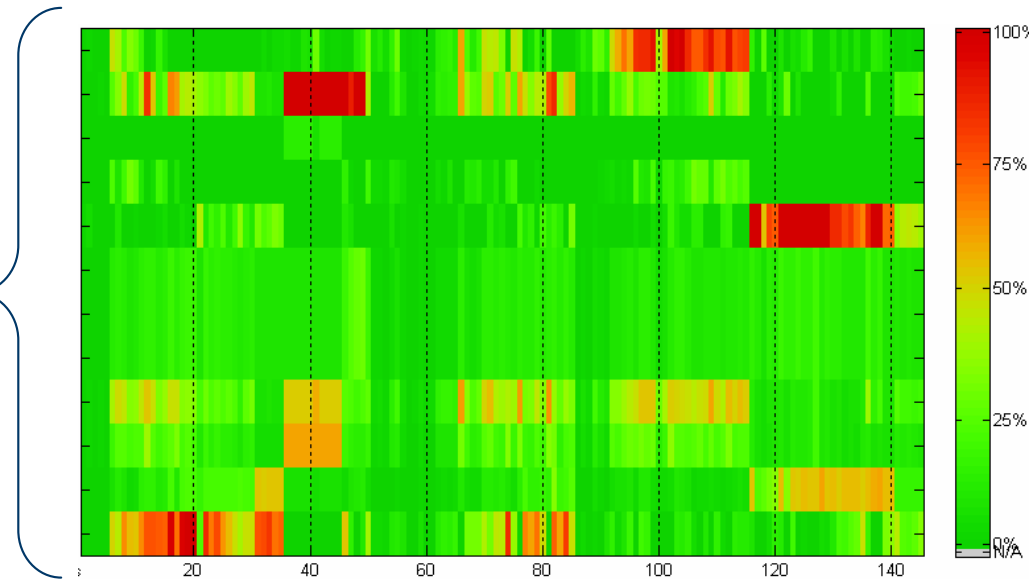
Start capability

Detection

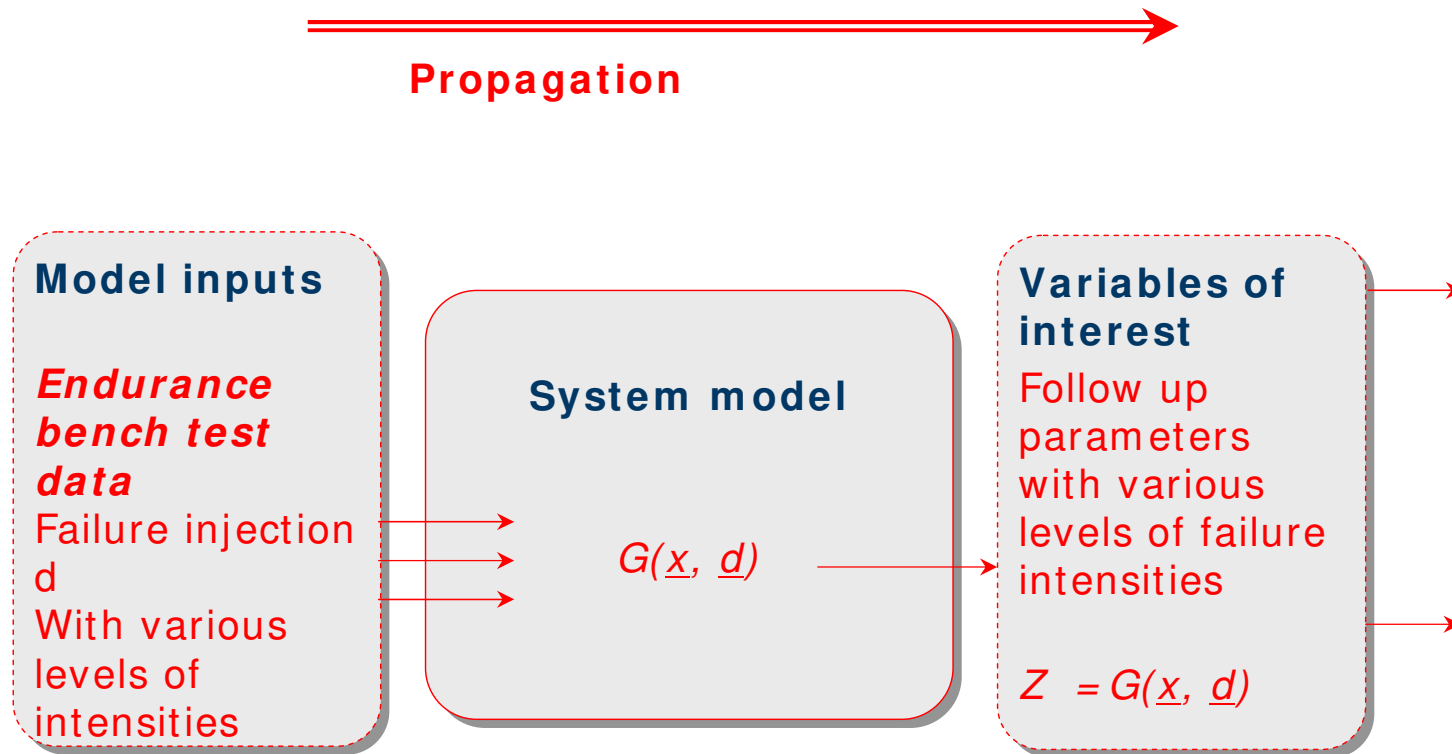


Localisation

12 LRU



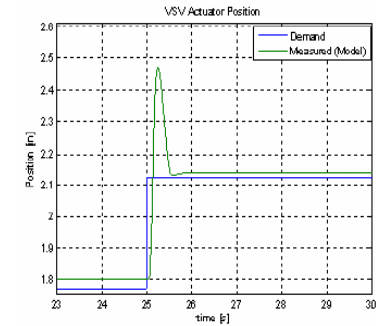
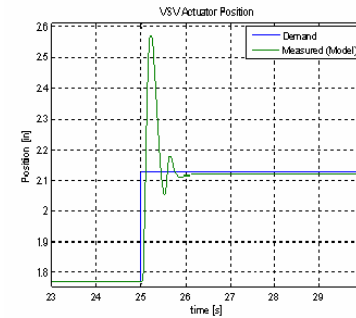
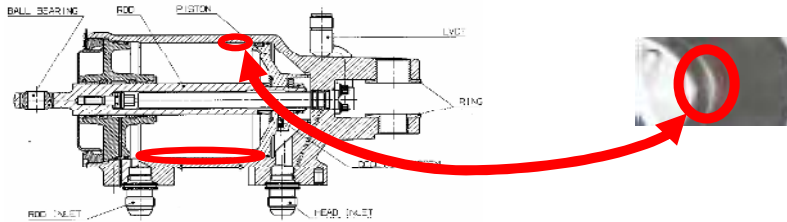
Training data generation



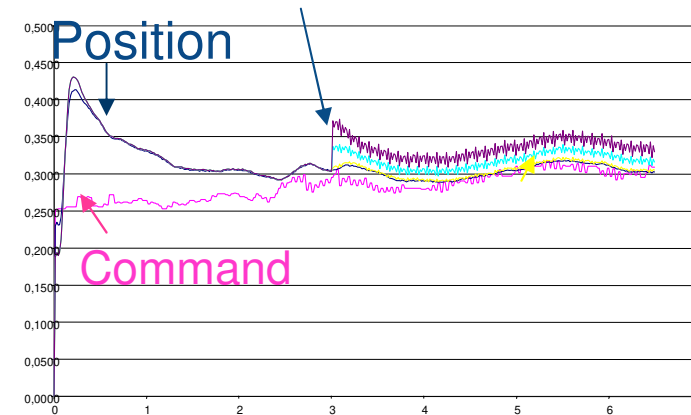
Training data generation

Local control loop

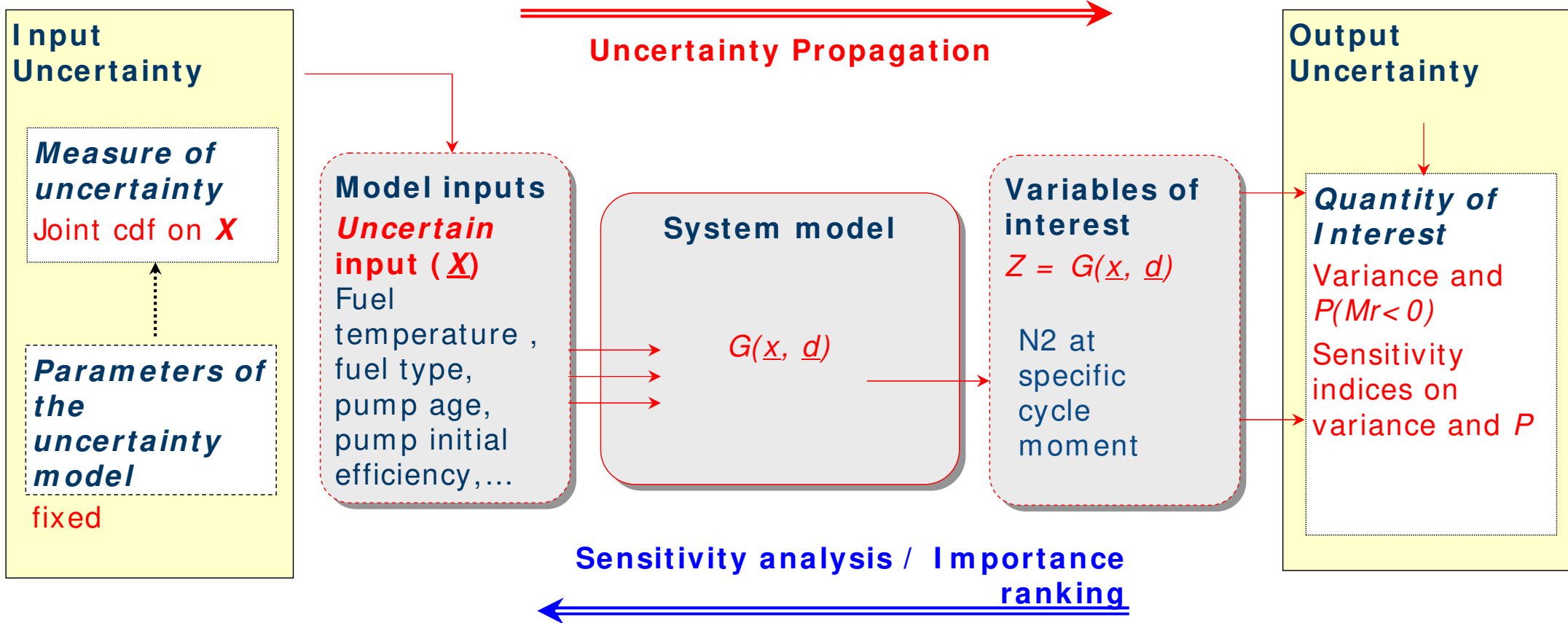
Actuators



Position indicators

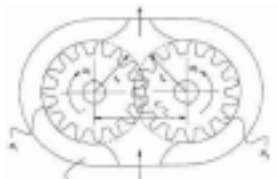


Sensitivity analysis

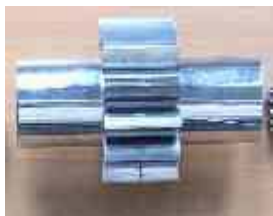


Sensitivity analysis

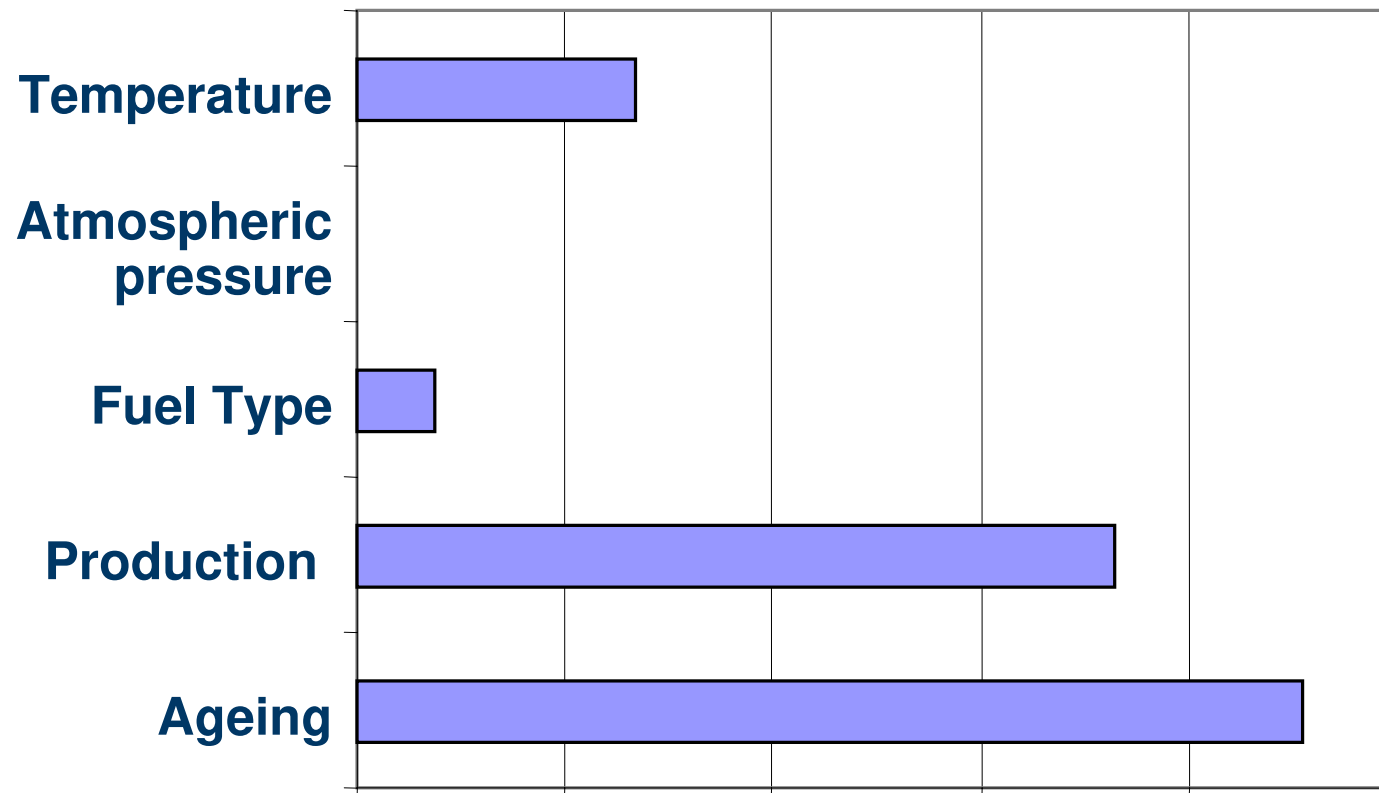
► Main Fuel Pump



Cavitation

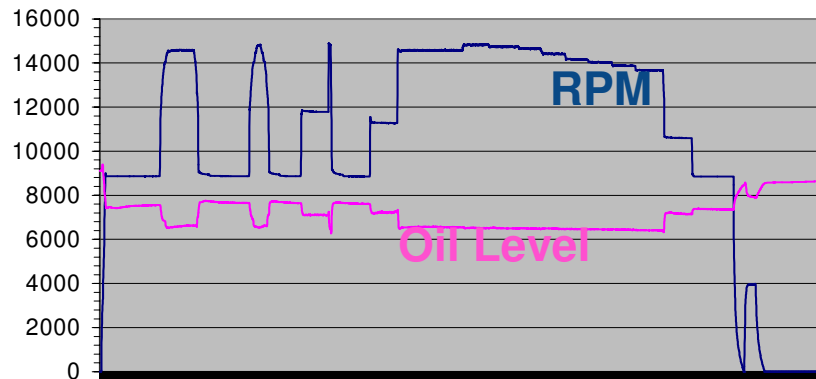


Wear



Degradation follow up

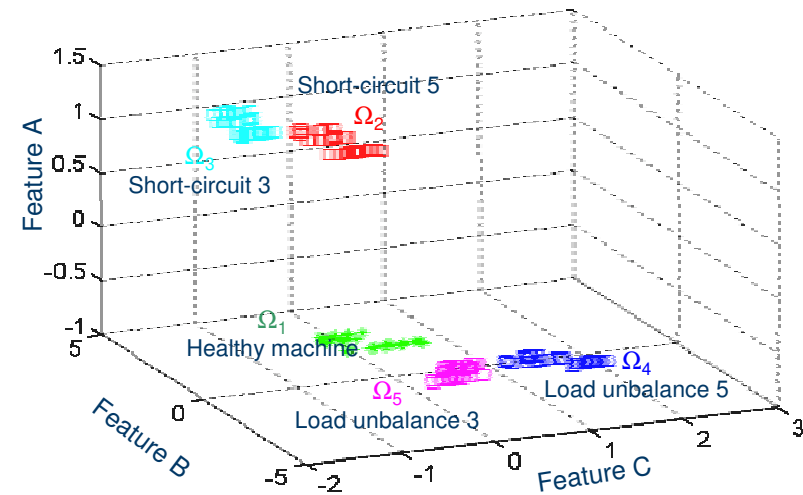
Other studies



- Lubrication oil quantity track



- Electrical motor follow up



Join us !

▶ A set of stochastic and algorithmic topics
candidate for training & thesis



From the left to the right, D. Kettler, F. Delamour, A. Ausloos, A. Dupuis (trainee), X. Flandrois, J-R. Massé, R. Meuret, J. Benitah, M. Vernochet



H. Blum, G. Lejeune, C. Arousseau, Ph. Galozio, F. Demaison, A. Martin-Matos

