Advanced Diagnostics Of Electro-Hydraulic Flight Control Systems

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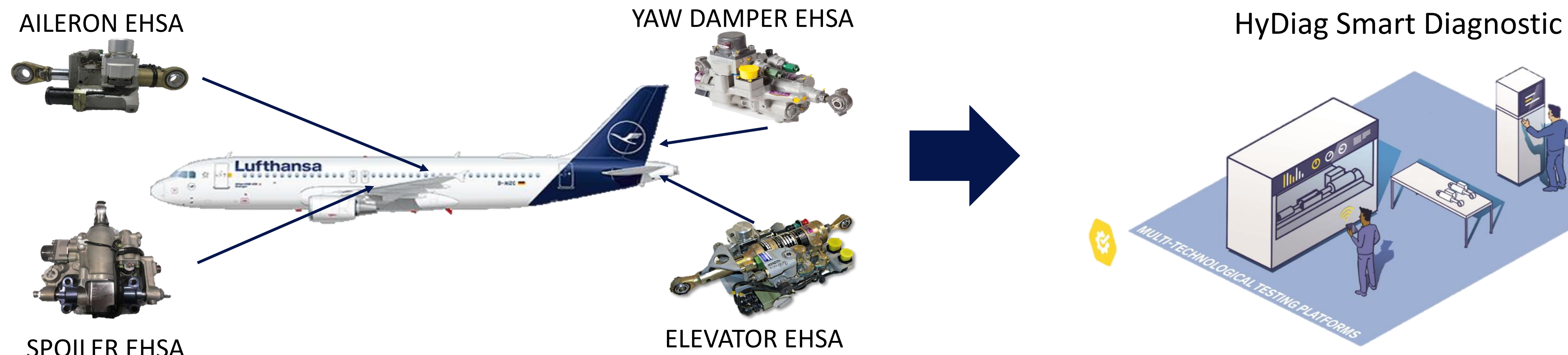Cycle: XXXIII Ciclo
Academic Advisor: **Prof. Massimo Sorli**
Industrial Advisor: **Ing. Michael Burke, Ing. Francesco Marino**
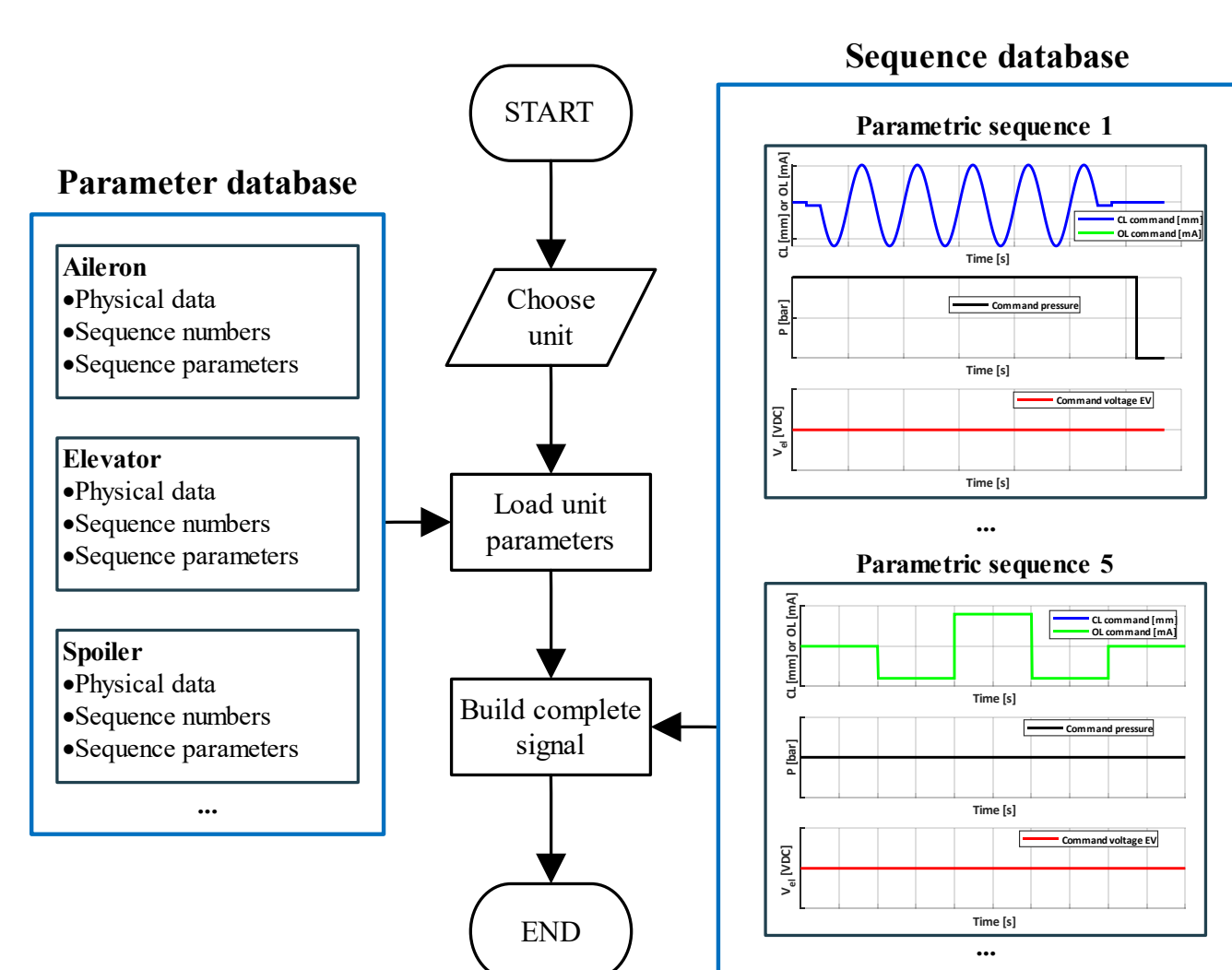*DIMEAS - Politecnico di Torino*

Research Objective

Diagnostic System for Failure Recognition in EHSA is of great interest in aviation MRO market. The goal of this research is to define a technological breakdown for standard Maintenance procedures of these components.

AILERON EHSA

YAW DAMPER EHSA

HyDiag Smart Diagnostic
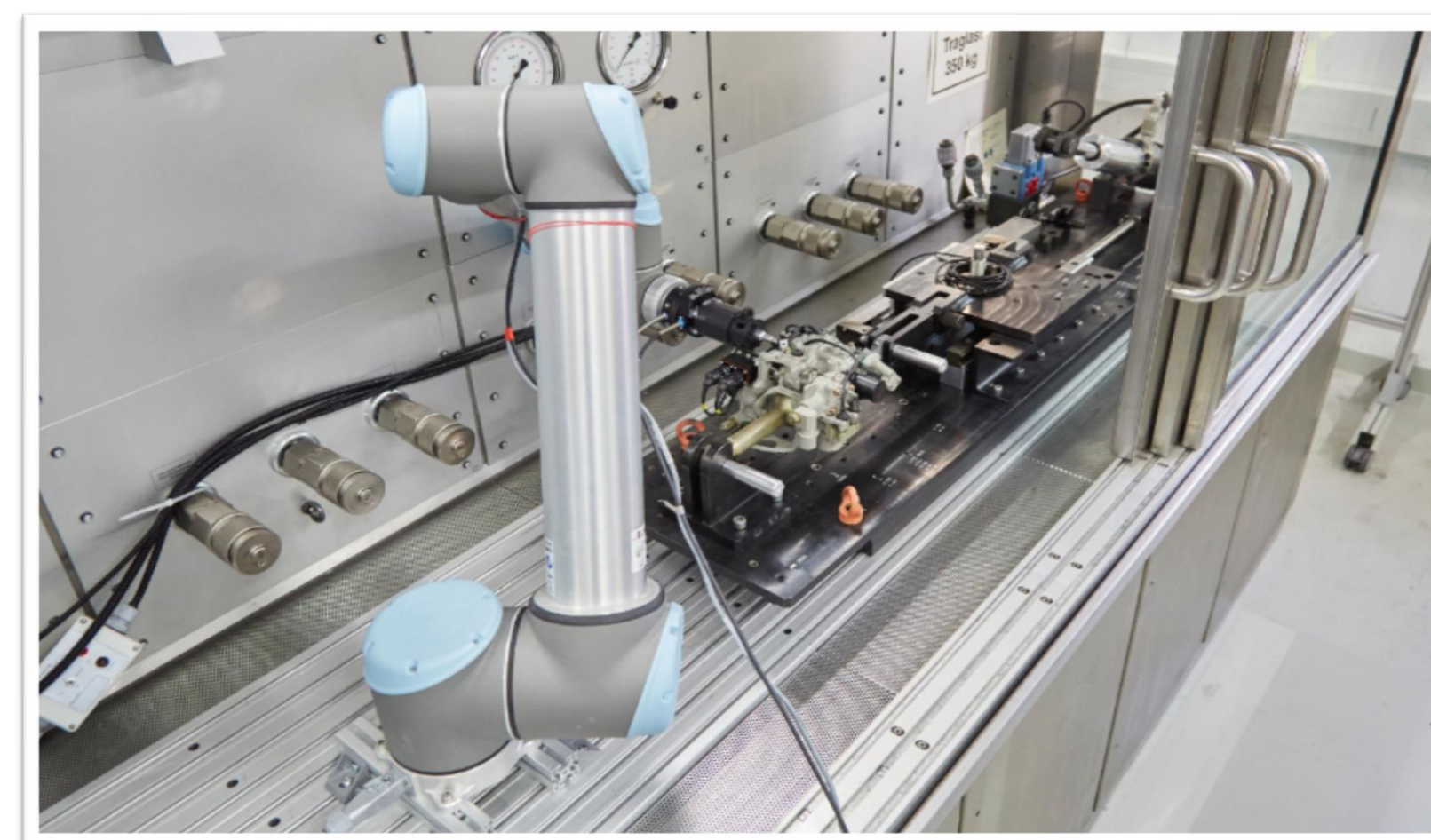
SPOILER EHSA

ELEVATOR EHSA
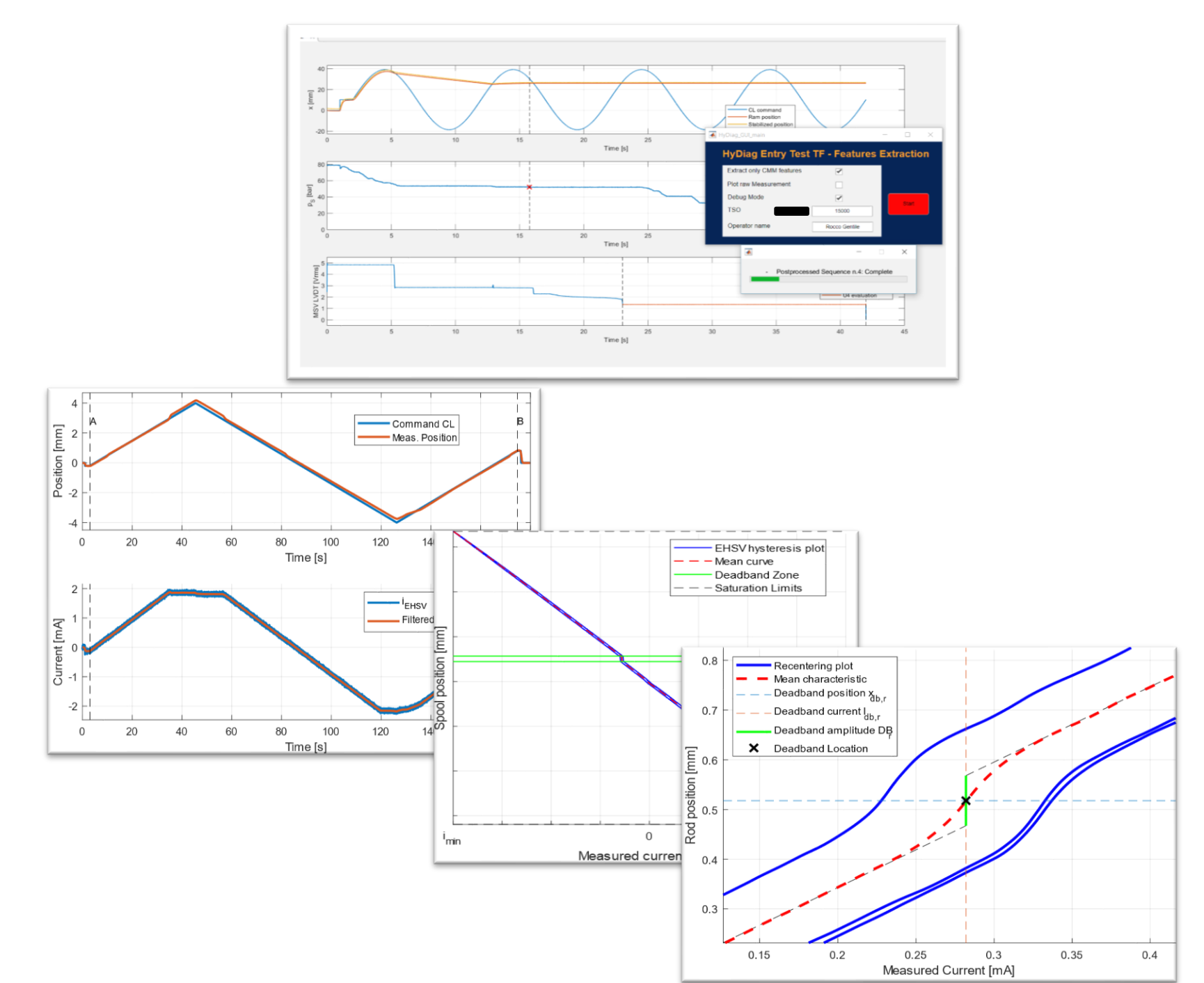
State of Research - Testing

- Development of an Automatic Entry Test for Failure recognition, designed in a Modular way through a specific Test Signal. This modular structure reduces cost and time of more than 80%, compared to the standard OEM procedures.
- Each tests include both the extraction of Traditional Health Features (THF) and of New Health Features (NHF), in order to increase the knowledge on the unit condition.

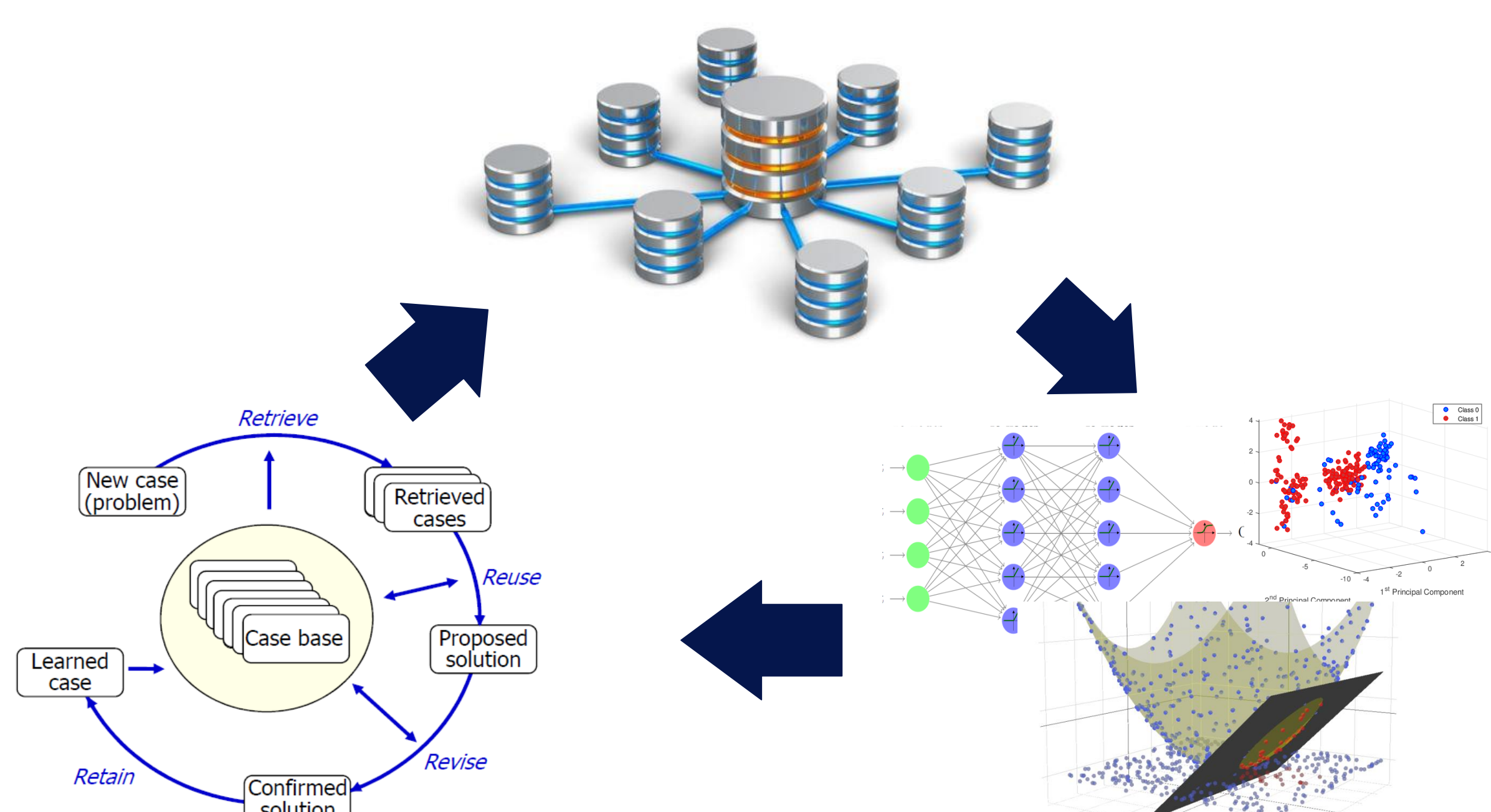Modular Signal generation architecture

Automatic testing in LHT facility

Automatic post-processing code for THF and NHF extraction

State of Research – Data collection and analysis
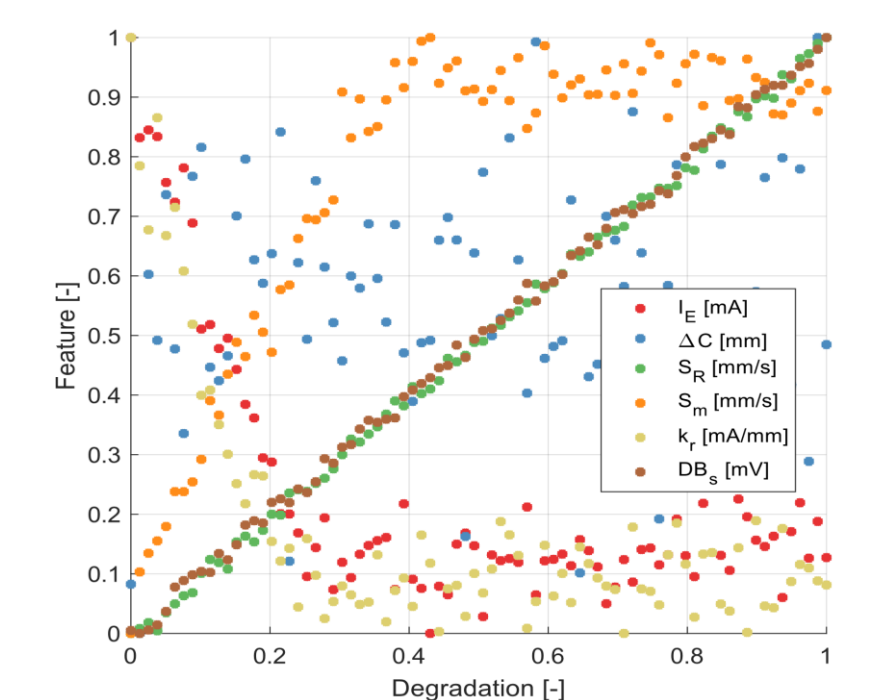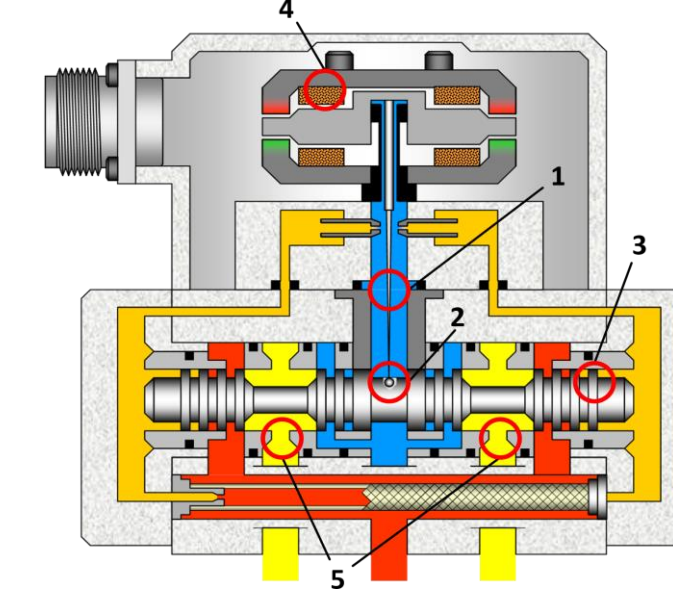
Measured Results

Data collection and Maintenance Database building as "a-priori" knowledge for Case Based Reasoning (CBR) Diagnostic Module.

Simulated Results

Extensive simulation campaign through an High-Fidelity Model of the unit under test. These simulations explore the potential of the NHF in identification of the root of the failure in a specific sub-component (f.e: Servovalve).

Simulations with single degradation type
- $N = 80$ increasing levels of degradation D
- 80×5 failures = 400 total simulations
- Extracted 36 HF related to EHSV

	FB Spring	Spool backlash	Spool clearance	1° stage hysteresis	Control ports wear
ρ	EHSV gain k_{sv} Rec. speed S_R	EHSV deadband DB_s Rec. speed S_R	Leakages Q_2	Resolution r_x EHSV hyst. h_i	Max speed S_m
ΔF	EHSV gain k_{sv}	EHSV deadband DB_s	Threshold U_{11}	Resolution r_x	Rec. speed S_R

Next Steps

- Validation of THF and NHF extraction through real measurement campaign
- Investigation for most suitable Machine Learning algorithm for further CBR Diagnostic Module

Scientific Publications

- Ritter, O., Wende, G., Gentile, R., Marino, F., Bertolino, A. C., Raviola, A., & Jacazio, G. (2018). Intelligent Diagnostics for Aircraft Hydraulic Equipment. Presented at the Fourth European Conference of the PHM Society, Utrecht, Netherlands;
- Ritter, O., Wende, G., Marino, F., Raviola, A., Gentile, R., Bruno, D., Jacazio, G., Sorli, M. (2019). Automatization of primary flight control actuators maintenance procedures using collaborative robotics. Presented at the 7th International Workshop on Aircraft System Technologies (AST 2019), Hamburg, Germany.
- Bertolino, A.C., Gentile, R., Jacazio, G., Marino, F., Sorli M. (2018). EHSA Primary Flight Controls Seals Wear Degradation Model. Presented at the ASME 2018 International Mechanical Engineering Congress and Exposition IMECE2018 , Pittsburgh, USA.
- Gentile, R., Jacazio, G., Sorli, M. (2018) Advanced Diagnostics and Prognostic of Electro-Hydraulic Flight Control Systems. Poster presented during the Annual Conference of the Prognostic and Health Monitoring Society, Philadelphia, USA.