



Leak Detection Continuous Monitoring Machine Learning Tool

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OT Projects

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The image shows a modern building with a glass and metal facade. The word "exolum" is mounted on the building in large, 3D letters. The letters "exolu" are blue, and the letters "m" is green. The building has a grid-like structure of windows and panels. The sky is blue with some white clouds. A dark blue diagonal shape is overlaid on the left side of the image.

exolum

| About
Exolum

We are leaders
in Europe in
liquid product logistics
and one of the most
important companies in
this sector worldwide



+2,100 employees
help us improve each day

exolum



68 terminals
for product storage



46 airport facilities
at your disposal



+6,000 km
of oil
pipelines



11 M
cubic metres
of **capacity** across 8
countries

We are leaders in Spain in logistics services for oil products



4,007 km of oil pipelines



8,000,000 m³
storage capacity



39 storage terminals



37 airport facilities



8 refineries connected
to the Exolum network



13 port facilities



Pumping facilities



6 hydrant networks

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exolum

The image shows a modern glass and metal building facade. The word "exolum" is mounted on the upper part of the building in large, 3D letters. The letters "exolu" are blue, and the letters "m" are green. The building has a grid-like structure of windows and metal panels. The sky is blue with some white clouds. A large blue triangle is overlaid on the left side of the image, containing the text "Leak Detection".

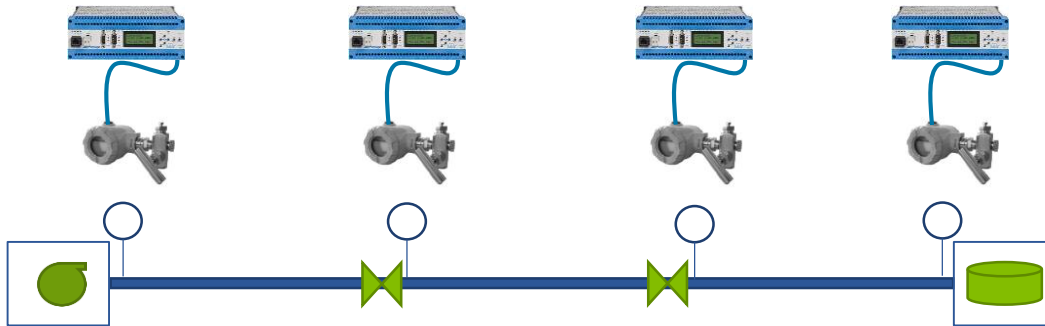
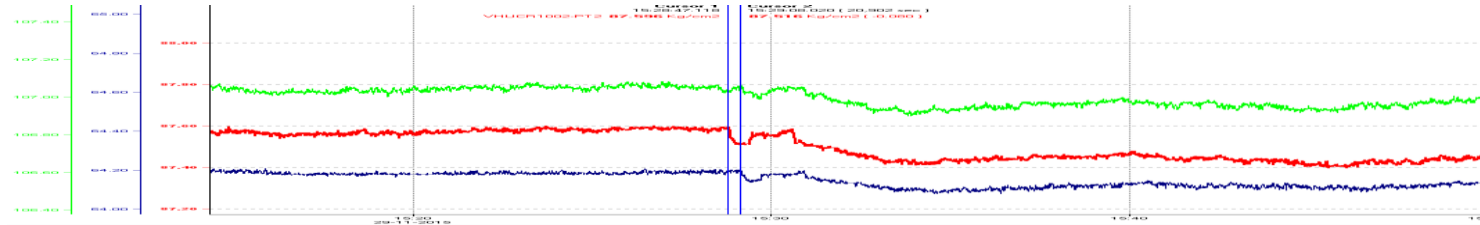
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Leak
Detection

Leak Detection Continuous Monitoring (LDCM)

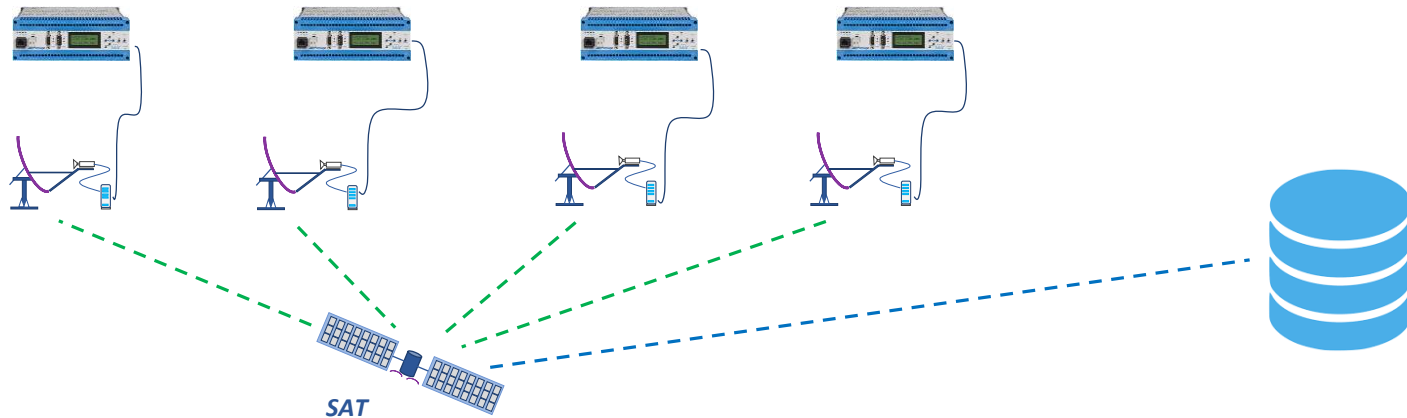
The objective of LDCM application is to detect small leaks in oil pipelines analysing the morphology and propagation of pressure waves

1 Pressure data extraction



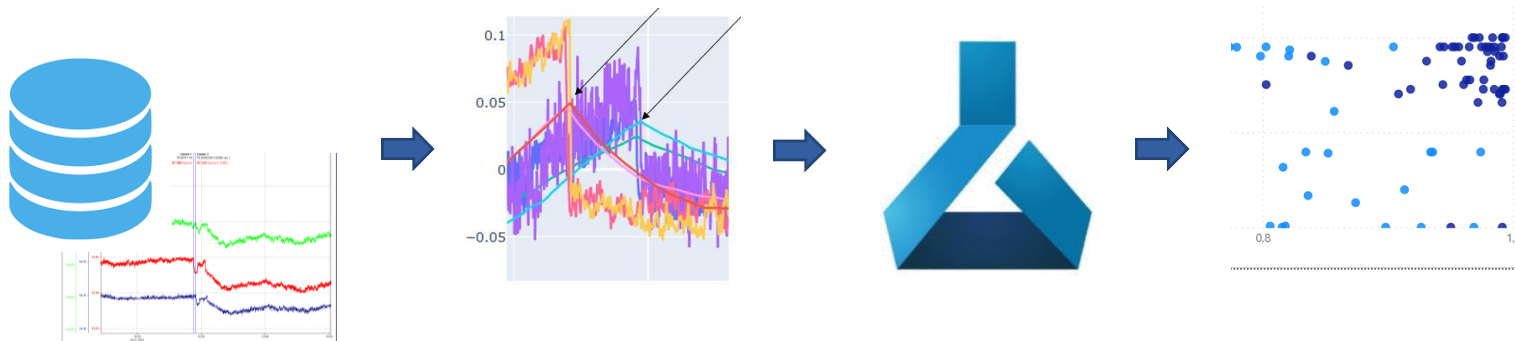
LDCM overview

- 1 Pressure data extraction
- 2 Send data to Exolum's datalake



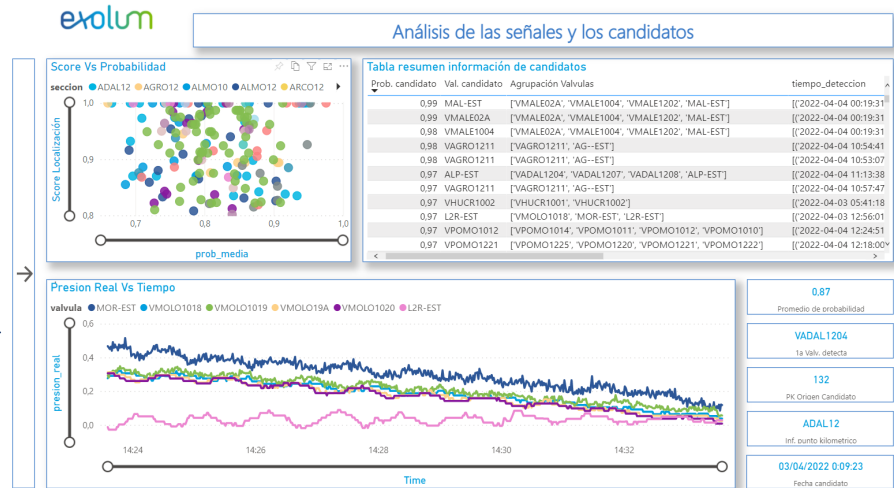
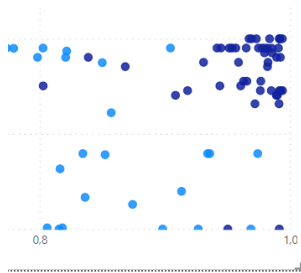
LDCM overview

- 1 Pressure data extraction
- 2 Send data to Exolum's datalake
- 3 **Data analysis with Artificial Intelligence**



LDCM overview

- 1 Pressure data extraction
- 2 Send data to Exolum's datalake
- 3 Data analysis with Artificial Intelligence
- 4 Dashboard in PowerBI



Beginnings on Leak Detection

DATA PRODUCTION



Dataloggers installation



Small sample time (20 ms)



Great precision



Transfer data to
pipeline Control Center

CALIBRATION



Replacement and
calibration of pressure
transmitters



Modifications on tubing
and cabling



Stabilization of PCVs

ANALYSIS



Manual Analysis



Learning process

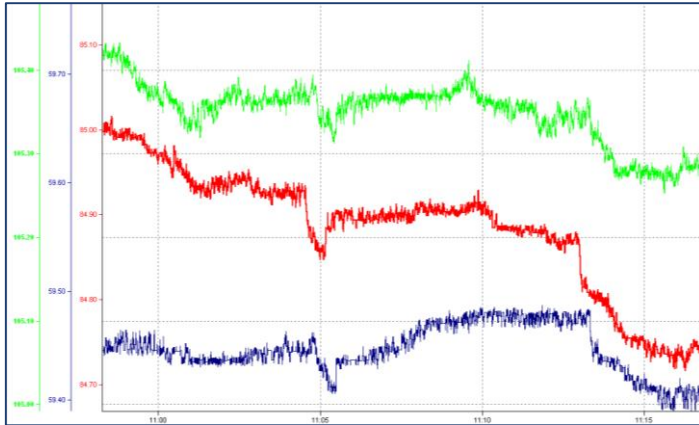
Creating additional “real” data

Product extraction was made directly from pipelines to test the procedure and validate the usefulness of the dataloggers

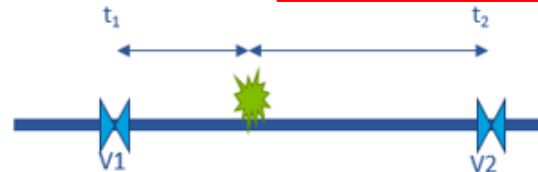
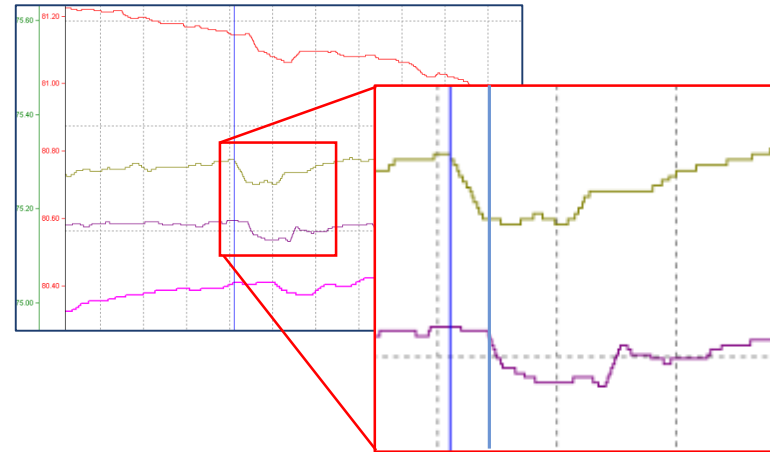


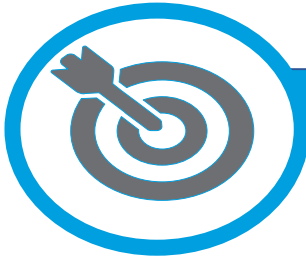
Manual Analysis and learning process

Shape and size of the pressure wave



Location of the origin of the wave





Confirmation of some suspicions of theft

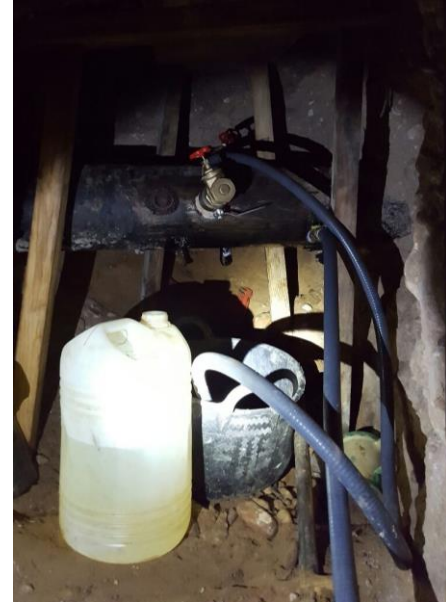


Location accuracy less than 500 meters



Significant decrease in illegal connections

Results

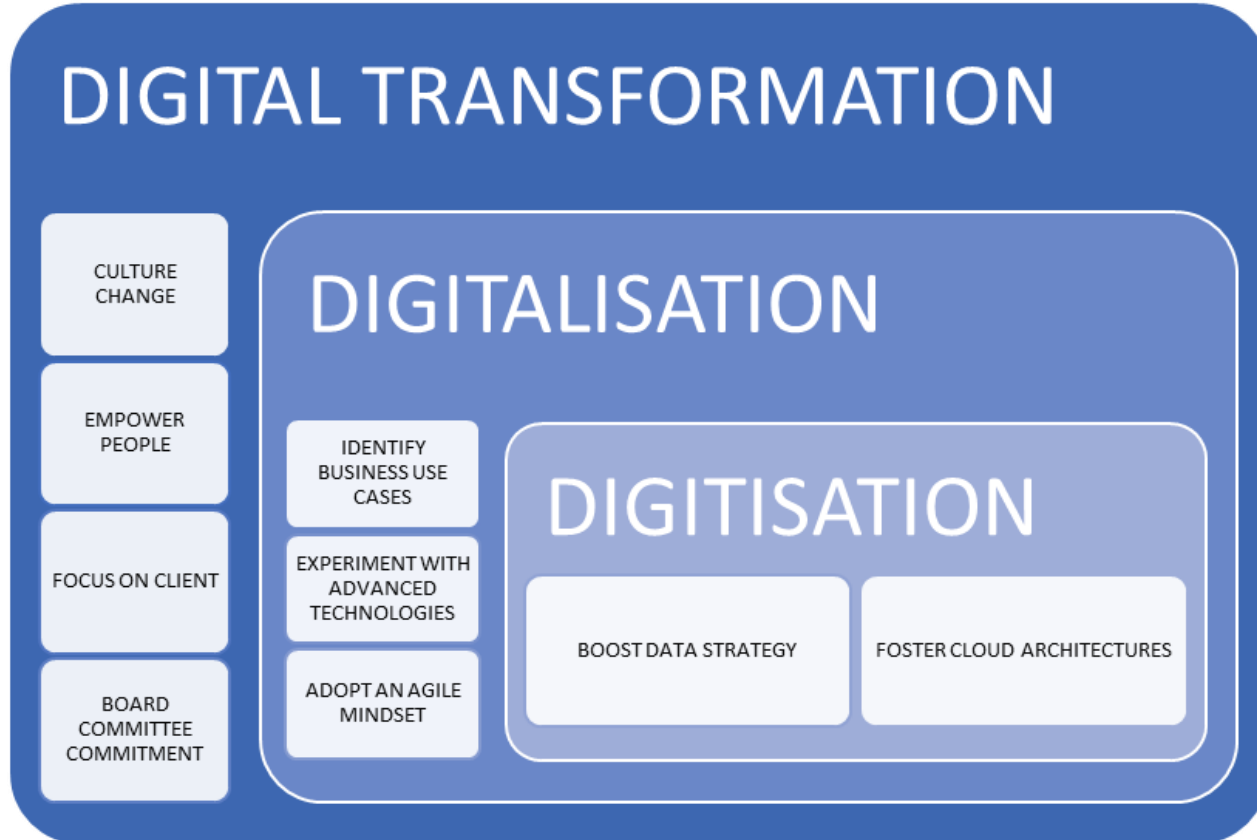


Significant decrease in illegal connections



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Digitalisation



Thanks to Digitalisation the process has evolved looking for these improvements

Old process

- Review of all data
- Great effort
- Difficult scalability

LDCM process

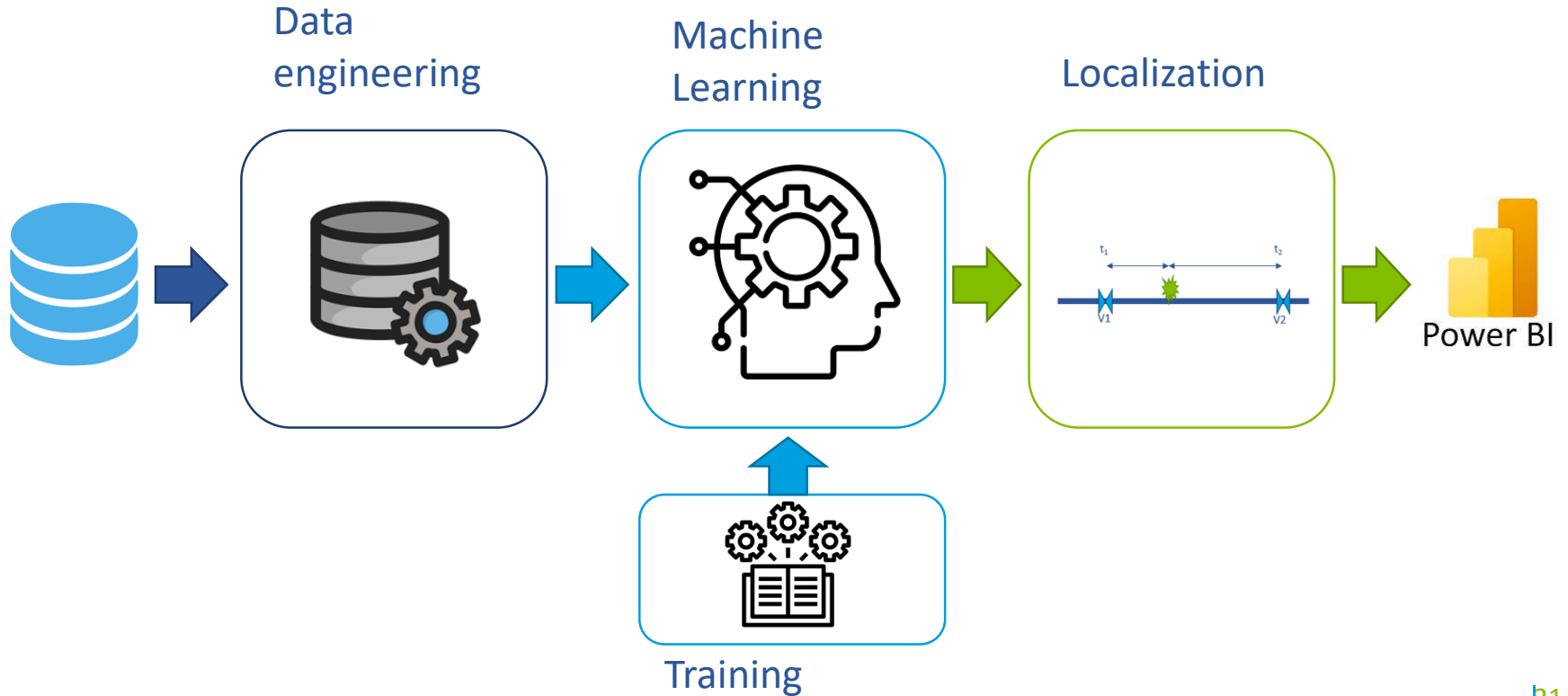
- Less operator effort
- Optimization of dedicated time
- Increase chance of detection
- Easy scalability

The image shows a modern glass and metal building facade under a blue sky with light clouds. The word "exolum" is mounted on the upper part of the building in large, 3D letters. The letters "exolu" are blue, and the letters "m" and "u" are green. The building has a grid-like structure of windows and metal panels.

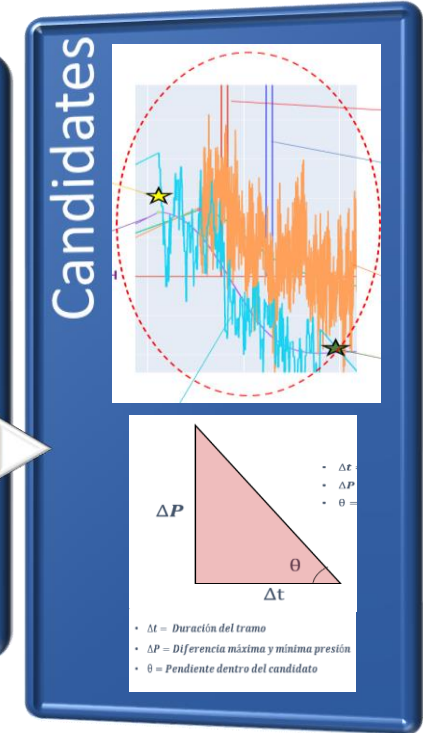
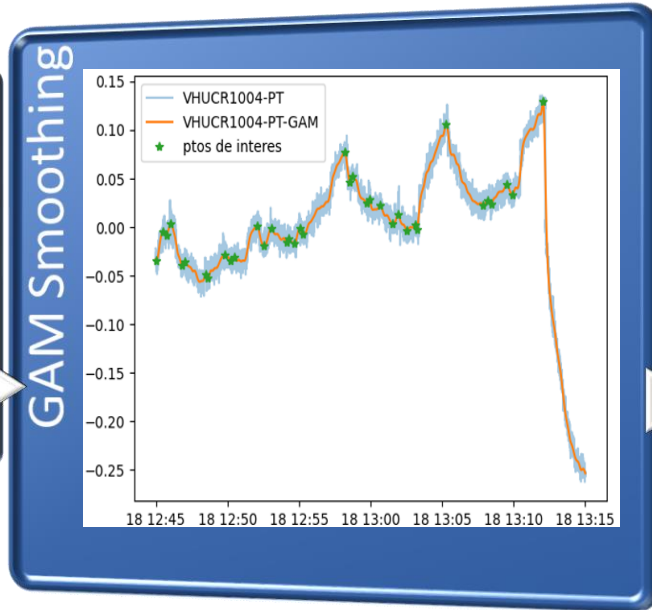
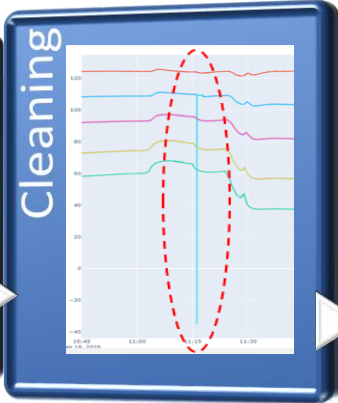
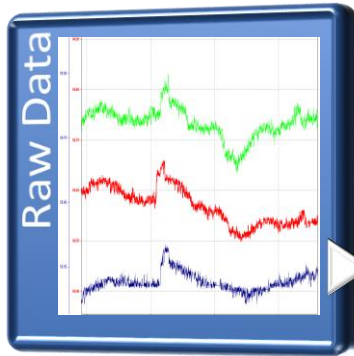
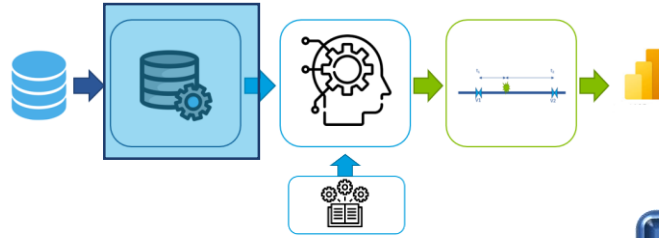
exolum

Machine
Learning

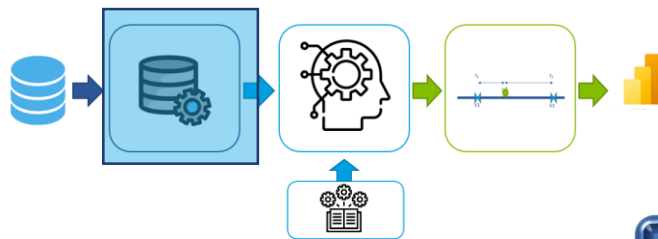
LDCM. Machine Learning Tool



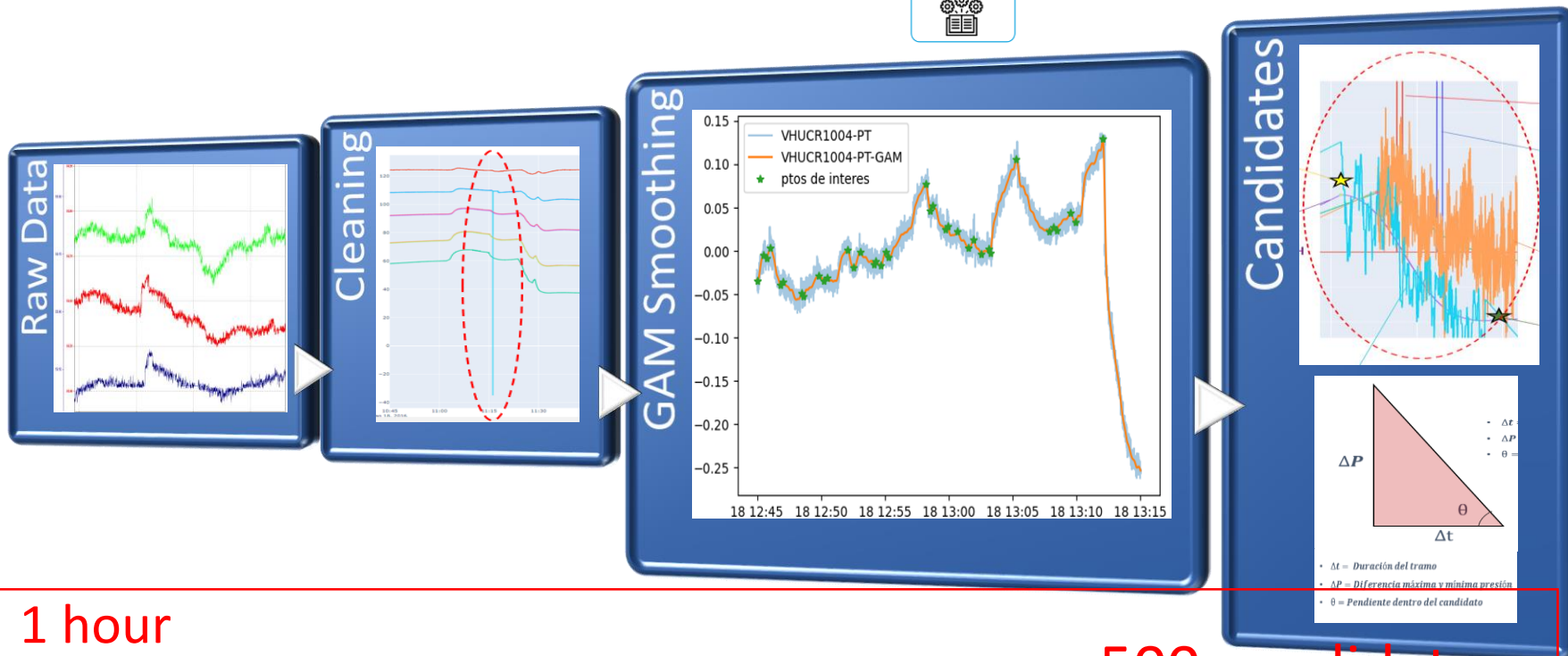
Data Engineering



Data Engineering



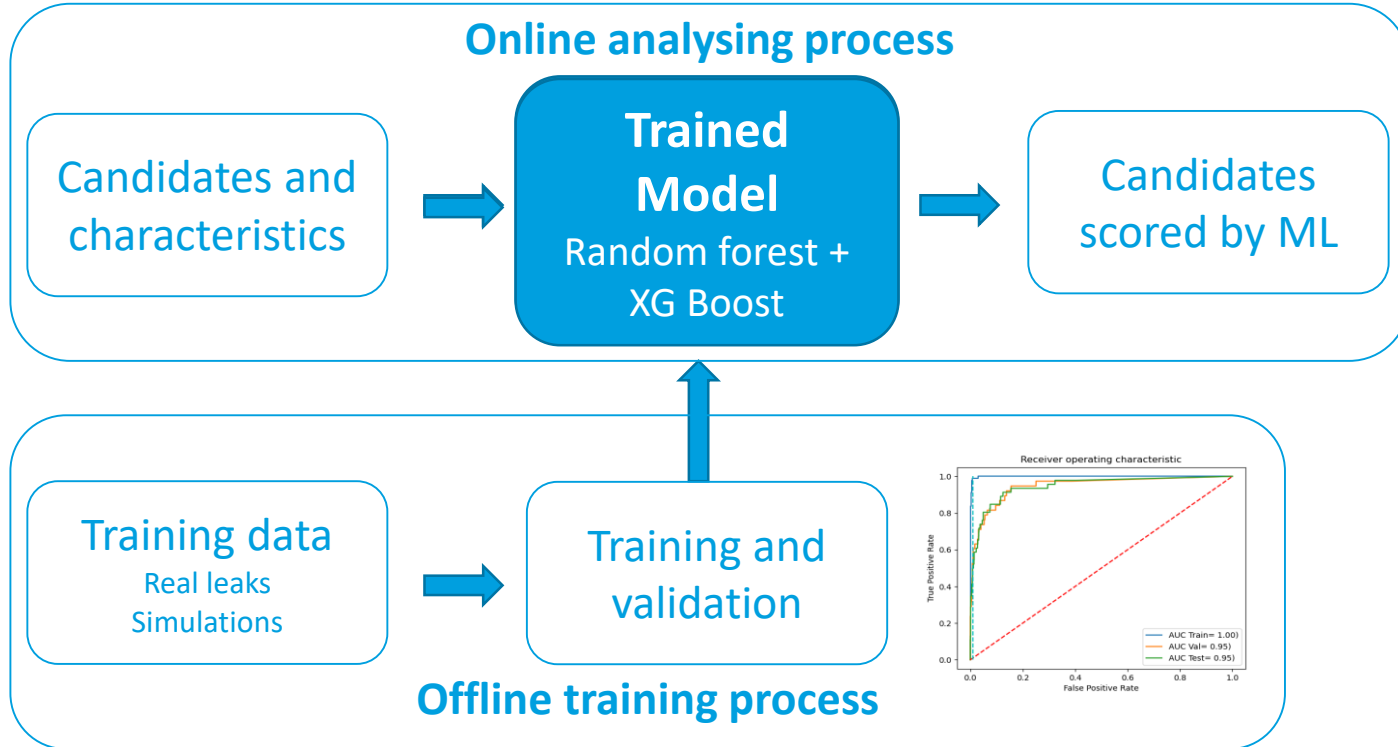
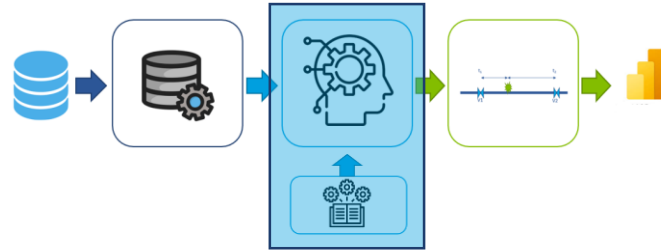
exolum



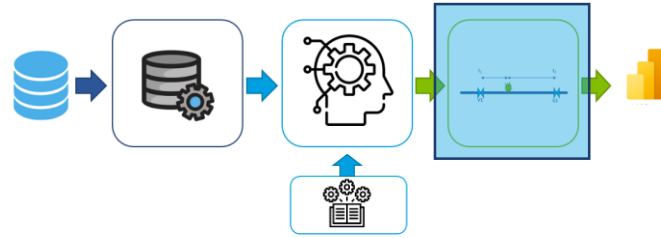
1 hour
360.000 values

500 candidates

Machine Learning



Localization

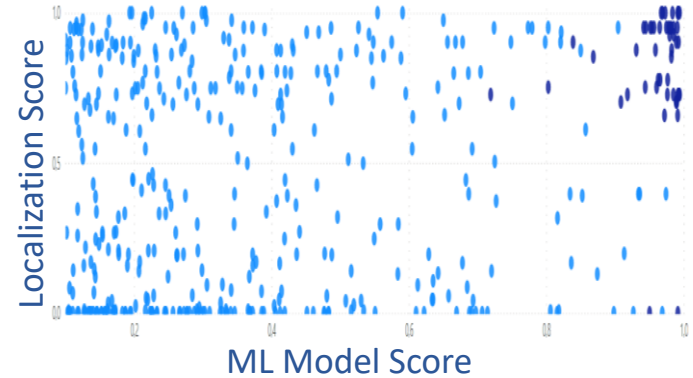


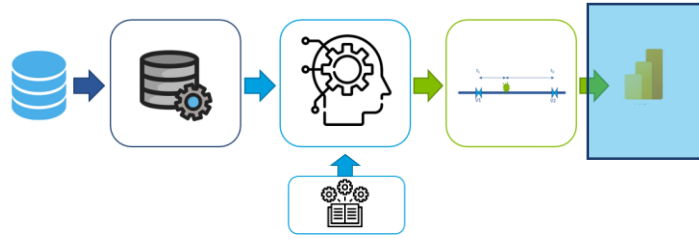
Candidates scored by ML

Prob. candidato	Val. candidato	Agrupación Valvulas
0,99	MAL-EST	['VMALE02A', 'VMALE1004', 'V
0,99	VMALE02A	['VMALE02A', 'VMALE1004', 'V
0,98	VMALE1004	['VMALE02A', 'VMALE1004', 'V
0,98	VAGRO1211	['VAGRO1211', 'AG--EST']
0,98	VAGRO1211	['VAGRO1211', 'AG--EST']
0,97	ALP-EST	['VADAL1204', 'VADAL1207', 'V
0,97	VAGRO1211	['VAGRO1211', 'AG--EST']
0,97	VHUCR1002	['VHUCR1001', 'VHUCR1002']
0,97	L2R-EST	['VMOLO1018', 'MOR-EST', 'L2
0,97	VPOMO1012	['VPOMO1014', 'VPOMO1011']
0,97	VPOMO1221	['VPOMO1225', 'VPOMO1220']



Localization process programmed in Python





Análisis de las señales y los candidatos

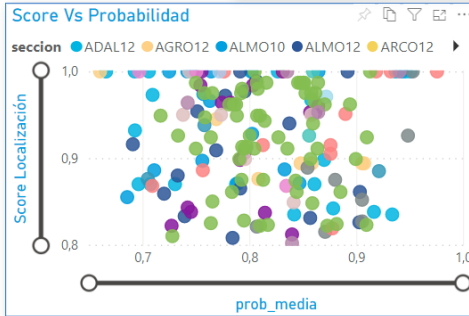
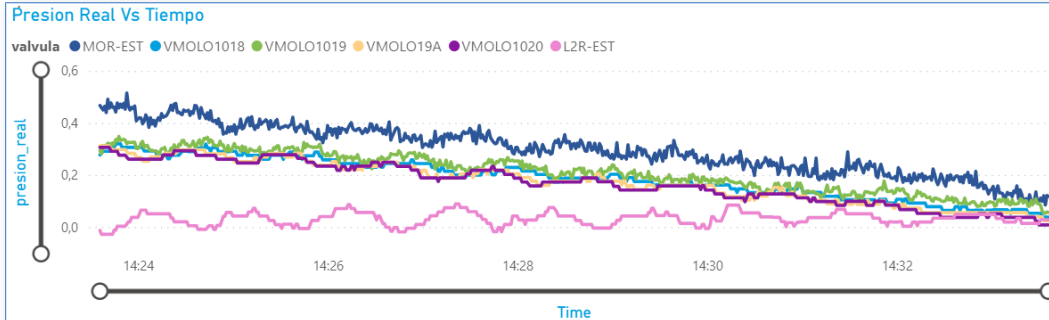


Tabla resumen información de candidatos

Prob. candidato	Val. candidato	Agrupación Valvulas	tiempo_deteccion
0,99	MAL-EST	['VMALE02A', 'VMALE1004', 'VMALE1202', 'MAL-EST']	[['2022-04-04 00:19:31
0,99	VMALE02A	['VMALE02A', 'VMALE1004', 'VMALE1202', 'MAL-EST']	[['2022-04-04 00:19:31
0,98	VMALE1004	['VMALE02A', 'VMALE1004', 'VMALE1202', 'MAL-EST']	[['2022-04-04 00:19:31
0,98	VAGRO1211	['VAGRO1211', 'AG--EST']	[['2022-04-04 10:54:41
0,98	VAGRO1211	['VAGRO1211', 'AG--EST']	[['2022-04-04 10:53:07
0,97	ALP-EST	['VADAL1204', 'VADAL1207', 'VADAL1208', 'ALP-EST']	[['2022-04-04 11:13:38
0,97	VAGRO1211	['VAGRO1211', 'AG--EST']	[['2022-04-04 10:57:47
0,97	VHUCR1002	['VHUCR1001', 'VHUCR1002']	[['2022-04-03 05:41:18
0,97	L2R-EST	['VMOLO1018', 'MOR-EST', 'L2R-EST']	[['2022-04-03 12:56:01
0,97	VPOMO1012	['VPOMO1014', 'VPOMO1011', 'VPOMO1012', 'VPOMO1010']	[['2022-04-04 12:24:51
0,97	VPOMO1221	['VPOMO1225', 'VPOMO1220', 'VPOMO1221', 'VPOMO1222']	[['2022-04-04 12:18:00



0.87

Promedio de probabilidad

VADAL1204

1a Valv. detecta

132

PK. Orioen Candidato

ADAL12

Inf. punto kilometrico

03/04/2022 0:09:23

Fecha candidato

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Thank you

Edition:

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