



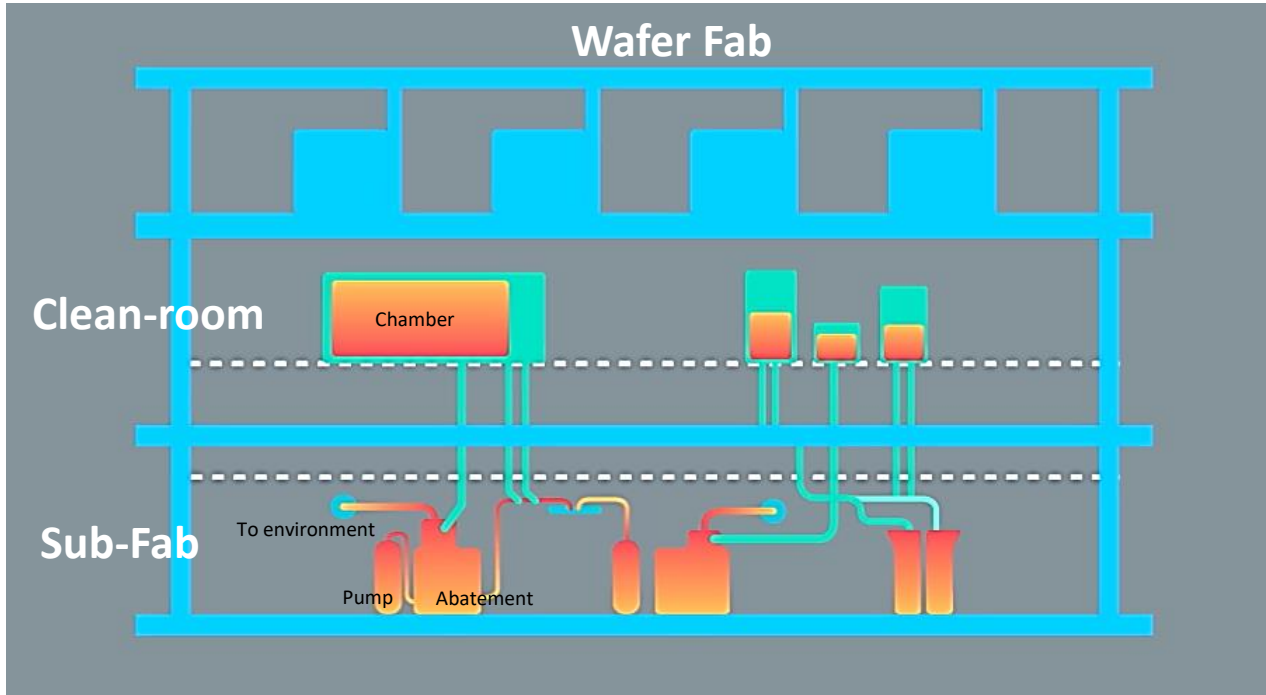
NEW APPROACHES AND INNOVATIONS TO IMPROVE EFFECTIVE USE OF VACUUM ASSETS IN CLEANROOM AND SUBFAB

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Semicon Europa 2024



Why Apply AI And Smart Manufacturing To Vacuum Assets?



Smart Manufacturing is key to Operational Excellence

Many critical steps in semi manufacturing need high vacuum or very controlled ambient conditions

- ✓ Key process parameter and always on
- ✓ Vacuum eco-system consists of a large number of pumps and associated equipment.
- ✓ Interconnected - Affecting each other and the process

Different Failure Modes Require Different Predictive Approaches

Deposition



Corrosion



Powder



The Benefits Of Predicting Failure - TCoC



Wafer Loss



**Unplanned Maintenance
of Process Tools**
(Venting chamber,
Recovery, Metrology)



Life of Pumps



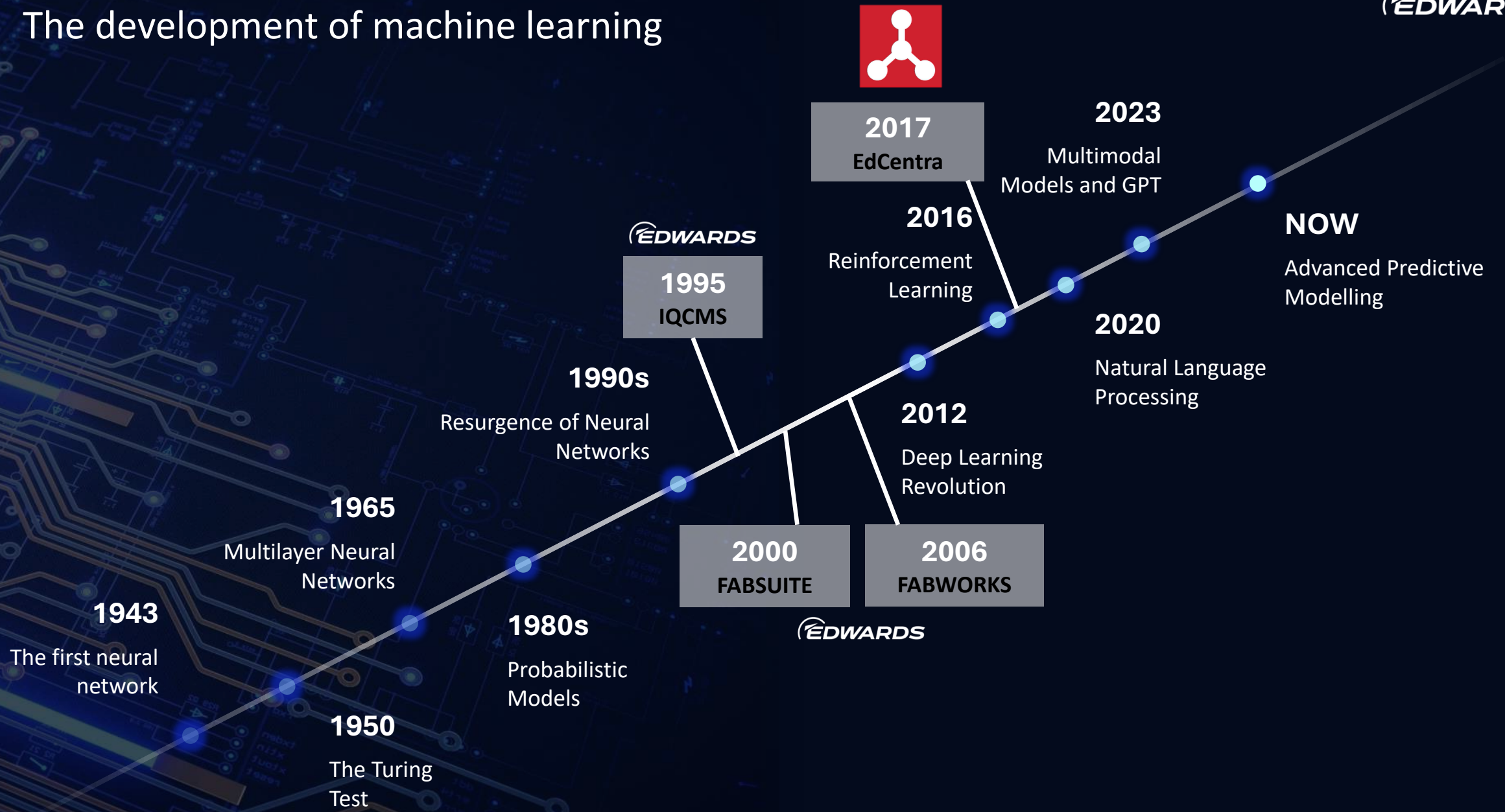
Inefficiencies of Process Tool PMs
vacuum pump replacement and
Process Tool maintenance are not
aligned



Inventory



The development of machine learning



Introducing...



EdCentra 2.0

01

Ground Up Redevelopment Of The Application Layer With ML Models At The Core

02

Retains Data Acquisition Expertise Developed Over Almost 30 Years

03

Uses Modern Web Frameworks For Interoperability

The Edwards Approach

Team of experts

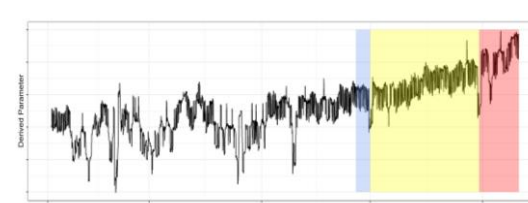
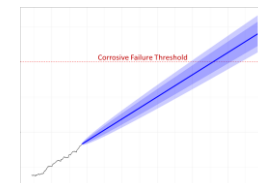
Process Type	Dry Pump Fault Modes (DP-FM)				Abatement fault Modes (A-FM)			Facilities Fault Modes (F-FM)		
	Deposition	Corrosion	Blockage/Leak	Poor Vacuum	Nozzle Blockage	Combustor Blockage & Degradation	Water System Performance	Foreline Leak	Chamber Leak	N2 Facilities Issues
LP-CVD	DP-FM1	DP-FM2	DP-FM3	DP-FM4	A-FM1	A-FM2	A-FM3	F-FM1	F-FM2	F-FM3
PE-CVD	DP-FM5	DP-FM6	DP-FM7	DP-FM8	A-FM4	A-FM5	A-FM6	F-FM4	F-FM5	F-FM6
HDP-CVD	DP-FM9	DP-FM10	DP-FM11	DP-FM12	A-FM7	A-FM8	A-FM9	F-FM7	F-FM8	F-FM9
AL-CVD or ALD	DP-FM13	DP-FM14	DP-FM15	DP-FM16	A-FM10	A-FM11	A-FM12	F-FM10	F-FM11	F-FM12
Implant Source	DP-FM17	DP-FM18	DP-FM19	DP-FM20	A-FM13	A-FM14	A-FM15	F-FM13	F-FM14	F-FM15
SA-CVD	DP-FM21	DP-FM22	DP-FM23	DP-FM24	A-FM16	A-FM17	A-FM18	F-FM16	F-FM17	F-FM18
BE-CVD	DP-FM25	DP-FM26	DP-FM27	DP-FM28	A-FM19	A-FM20	A-FM21	F-FM19	F-FM20	F-FM21
MO-CVD	DP-FM29	DP-FM30	DP-FM31	DP-FM32	A-FM22	A-FM23	A-FM24	F-FM22	F-FM23	F-FM24
eHARP	DP-FM33	DP-FM34	DP-FM35	DP-FM36	A-FM25	A-FM26	A-FM27	F-FM25	F-FM26	F-FM27
Asher/Stripper	DP-FM37	DP-FM38	DP-FM39	DP-FM40	A-FM28	A-FM29	A-FM30	F-FM28	F-FM29	F-FM30



1. Onsite data collection

2. Digital Twin Model selection or development

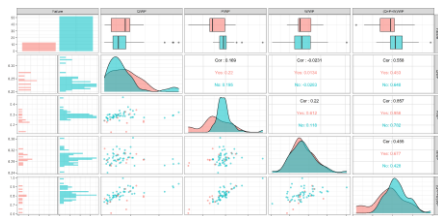
3. Fault Prediction & RUL



6. Conduct Technical Evaluation

5. Configure or Update digital twin

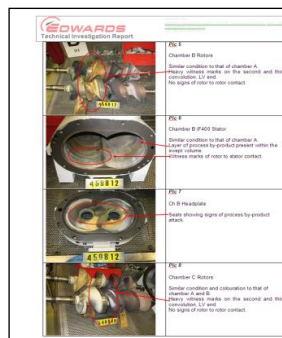
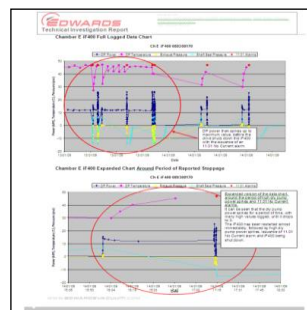
4. Collaborative resolution



Data Acquisition

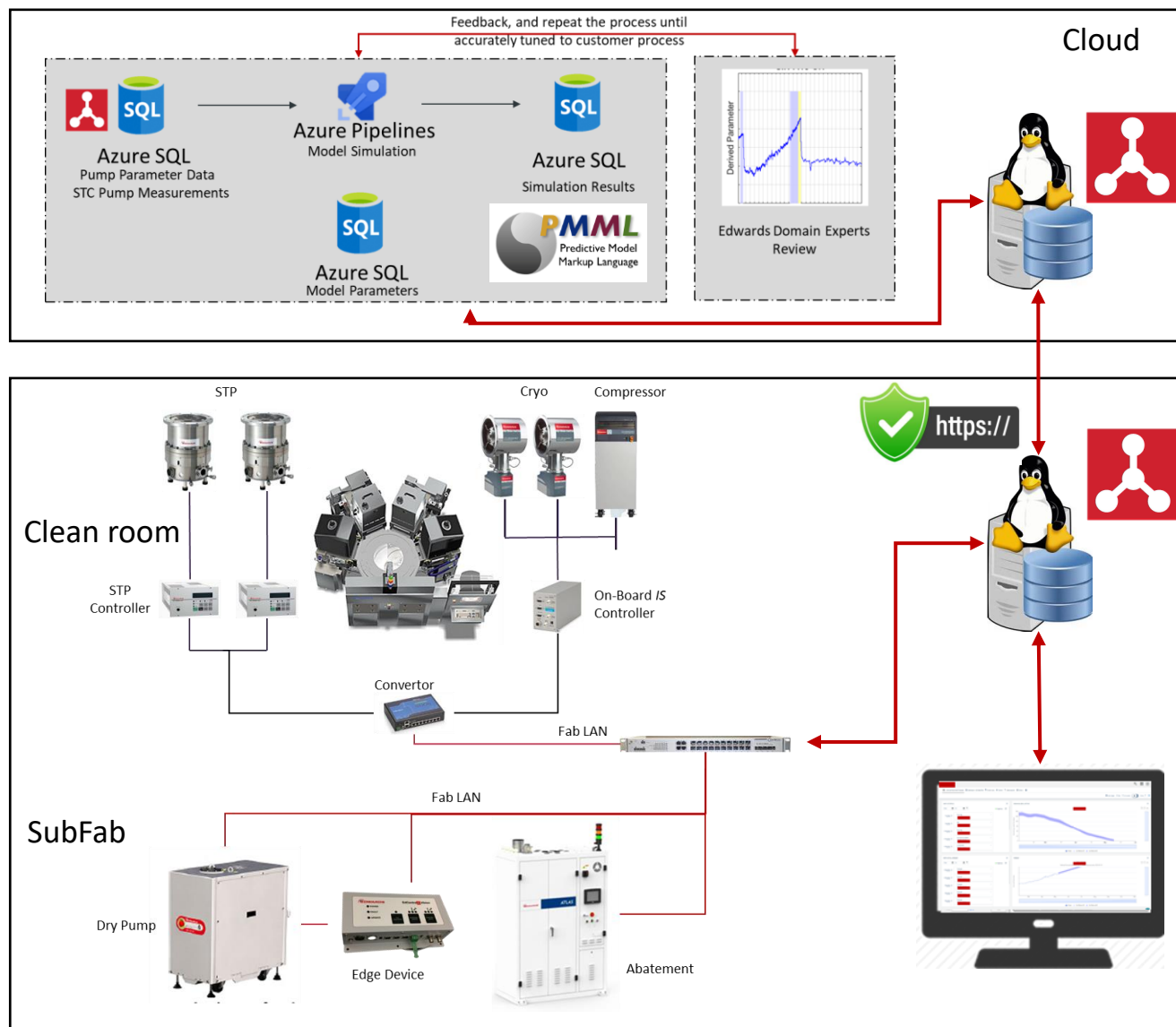
Creating the model

Running the model



Building a Predictive Model Isn't Enough

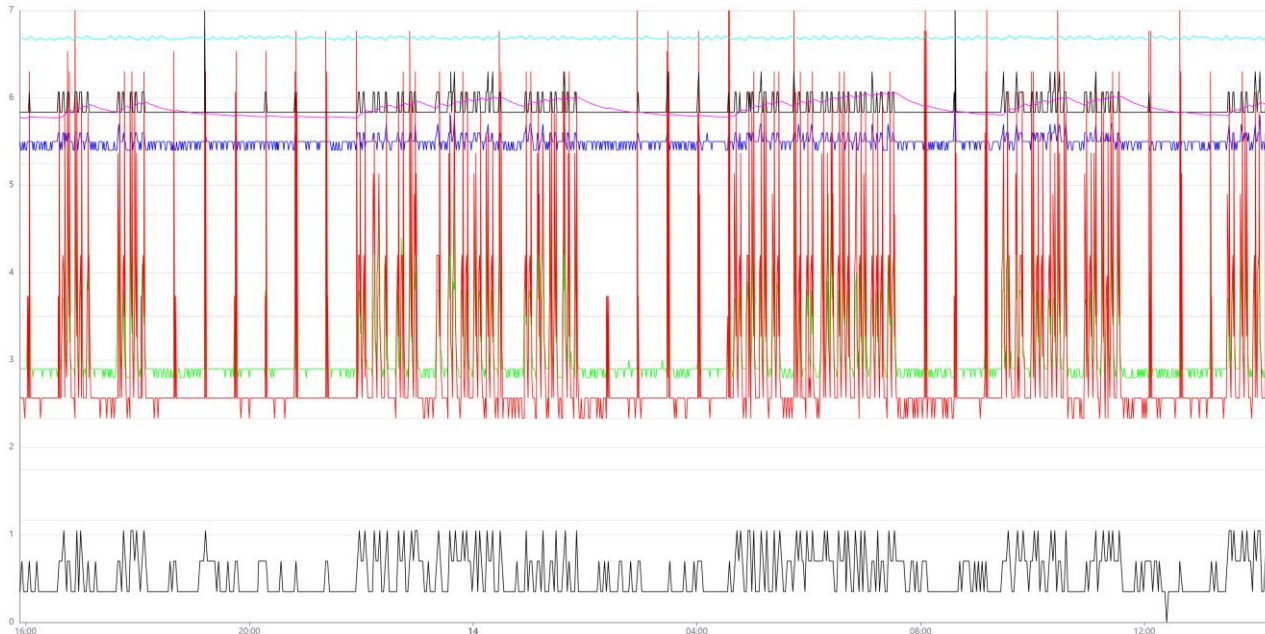
Data Acquisition



- Acquires data from a huge number of systems
- Able to manage increasing volumes of data
- Predictive Model Agnostic
- Cloud-based to improve scalability

Augmenting Artificial Intelligence With Real Intelligence

- Some things that are trivially easy for humans are very difficult for AI
- AI will find recurring patterns, without understanding context



Muffin or Chihuahua

Creating
the
model

**We don't just manufacture vacuum pumps,
we understand them**

Finding The Needle In The TEOS Process Haystack – The Problem

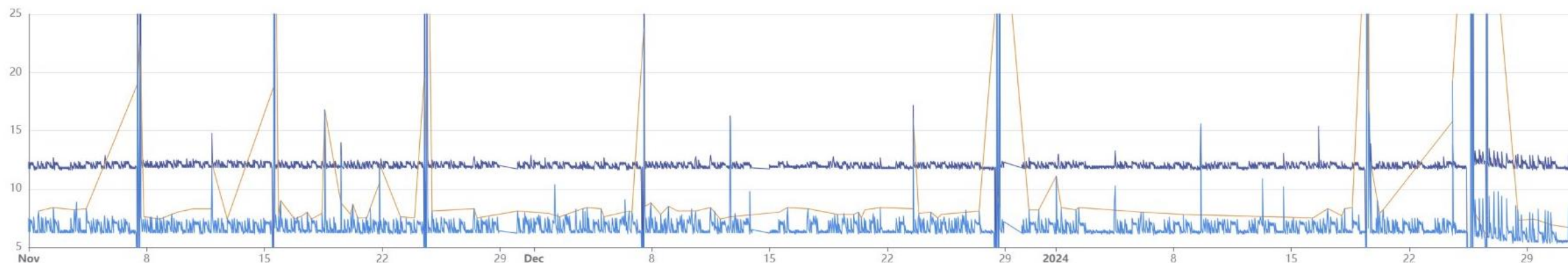


Chemical Vapor Deposition Process

Very controlled deposition in the process chamber

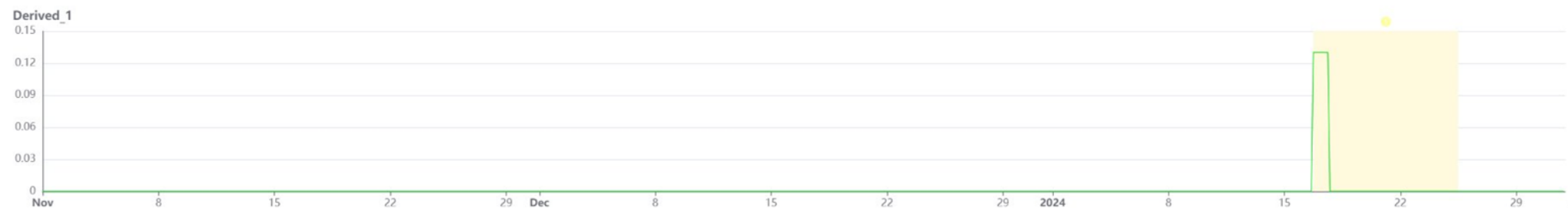
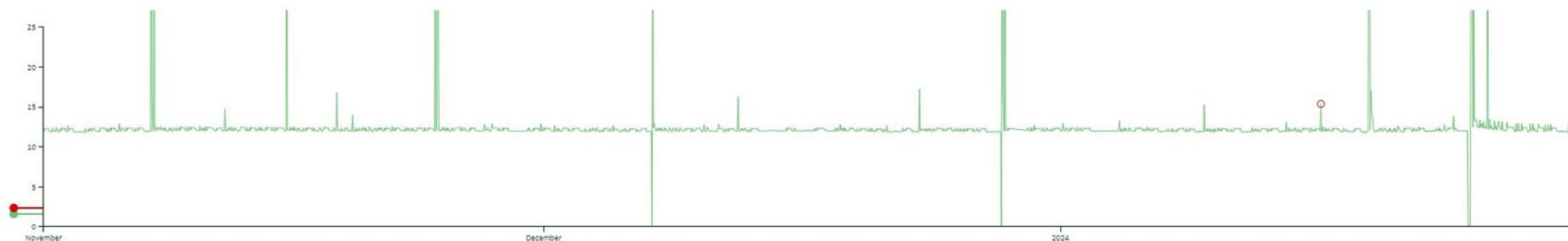
Much less controlled deposition downstream of the chamber and in the vacuum pumps

Methods successfully deployed on other processes unable to predict unscheduled pump downs on the TEOS process



Finding The Needle In The TEOS Process Haystack – The Solution

Running the model

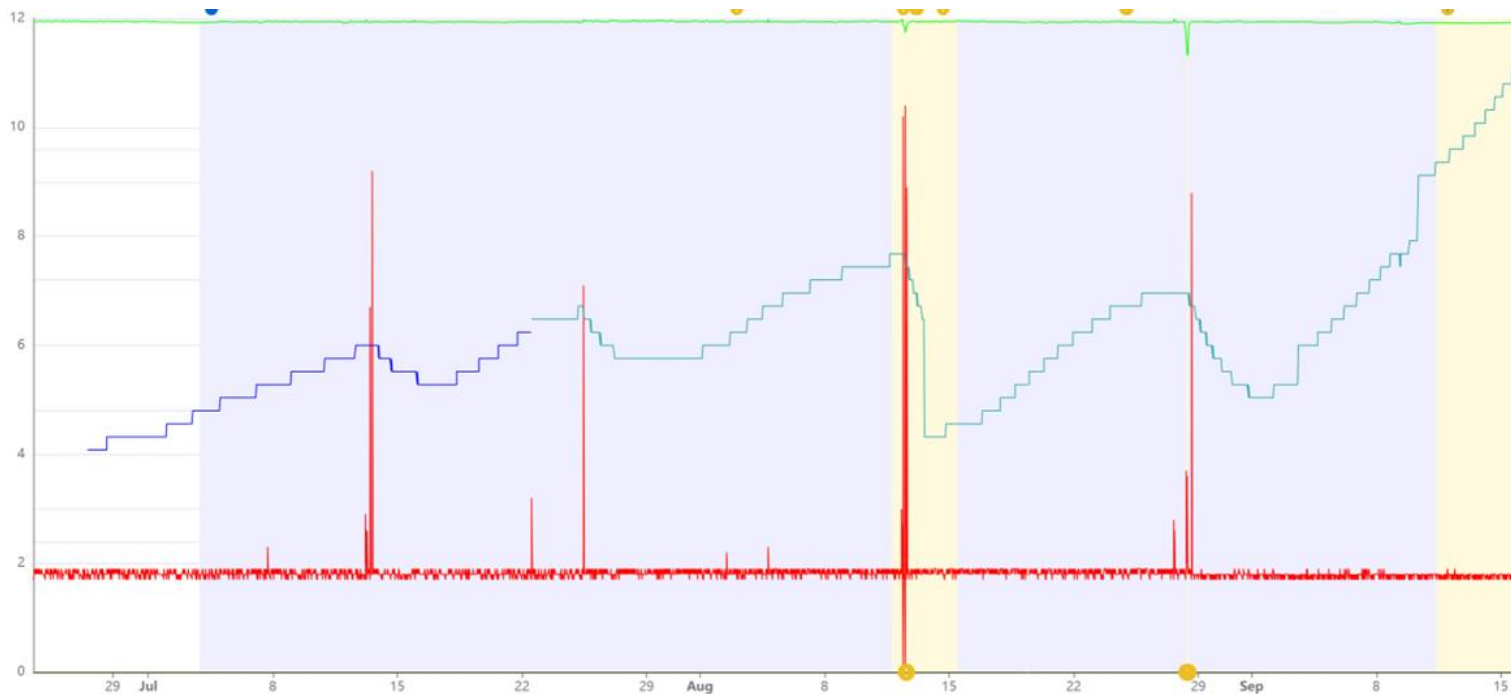


Model Hit Rate Went 20% -> 100%

Metal Etch Dry Pump - Competing Operational and Fault Mechanisms

Etch Process

- Process gasses will tend to **etch material** from internal pump mechanisms
- Etching can **increase** internal clearances and affect relevant parameters



Blue: Advisory Yellow: Warning

Conclusions

Applying Smart Manufacturing is key to Operational Excellence and the reduction of risk and uncertainty

Data Acquisition



Intelligent data acquisition and System re-architecture for more targeted data



Cloud and on-premise flexibility to meet customer preferences



Custom simulation environment for iterating models with accuracy by real outcomes comparison

Creating the Model



Human knowledge matters

Running the Model

Model which can truly reflect needs:



Identifying relevant sequences of data



Knowledge about the process and product

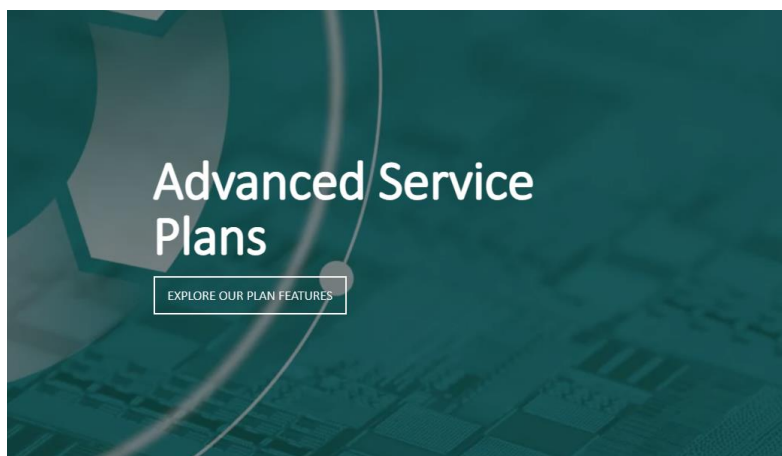


Machine Learning enabled by new system architecture

Questions?



Scan to read more about how
Predictive maintenance saves
you more from downtime lost



Scan to know more about
Edwards advanced service plans



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