

How do we use Digital Twins for nuclear plant monitoring ?

11/24/21 - Aurelien SCHWARTZ – CEO of Metroscope

Metroscope is software start-up founded in Paris in 2018, with offices in Germany and the USA. We build Digital Twins for the monitoring and diagnostics of power plants.

As of November 2021, we equip 60 power plants around the world.

Metroscope is a member of the EDF Group 

Monitoring of Unit X

Name	Unit X
Design	Pressurized Water Reactor
Manufacturer	Framatome
Power Gen	900 MW
Initial operation	1980
Location	Europe

Monitoring is the act of observing the process and testing whether it functions correctly.

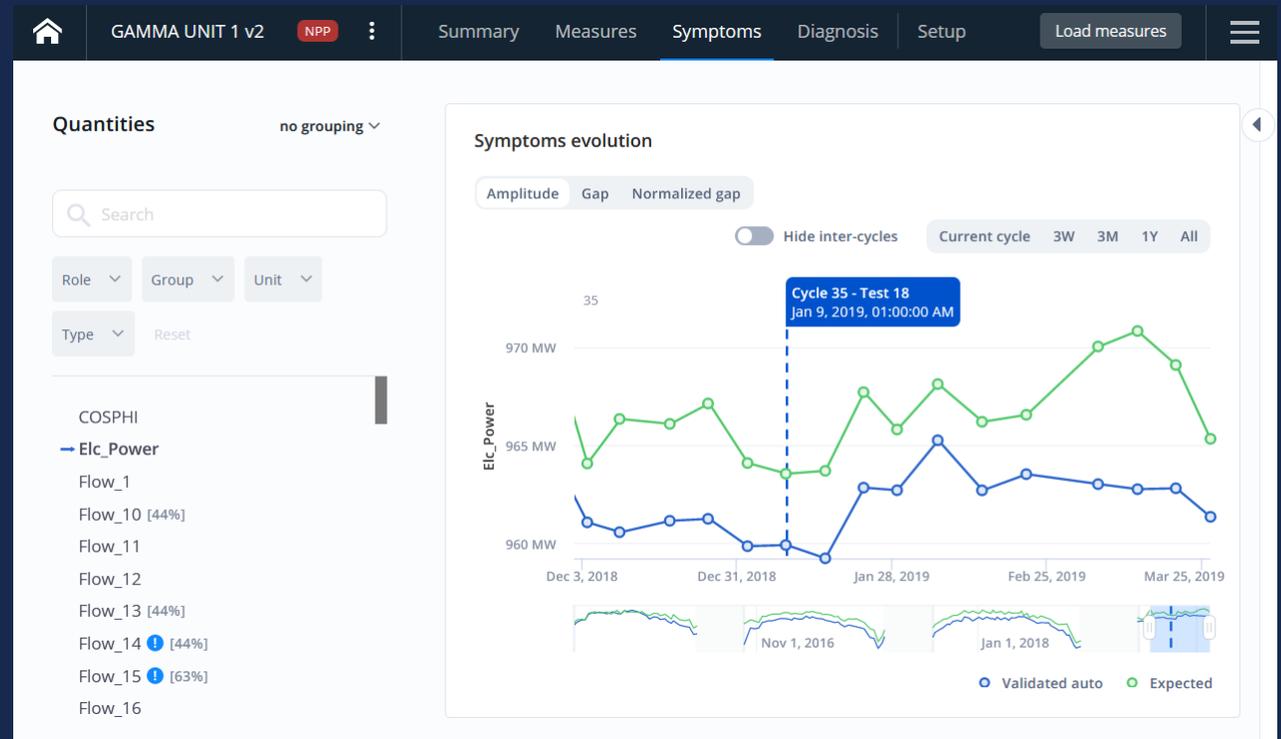
Diagnostics is the act of determining what's wrong with the process.



Monitoring of Unit X - Performance

On the 9th of January 2019

- UNIT X was performing at **959.9 MW**
- The Digital Twin calculates that the plant should be performing at **963.5 MW**
- **3.6 MW** are missing due to internal losses



Monitoring of Unit X – Diagnostic Example

On the 9th of January 2019

- The Digital Twin identified a **Tube rupture** in a Feedwater Reheater
- Initial detection on Dec 23 with a magnitude of 3kg/s
- Fixed by maintenance teams at the end of Feb, with a magnitude of the leak of 15 kg/s



Digital Twin - Definition

“A digital twin is a digital representation of a real-world entity or system.

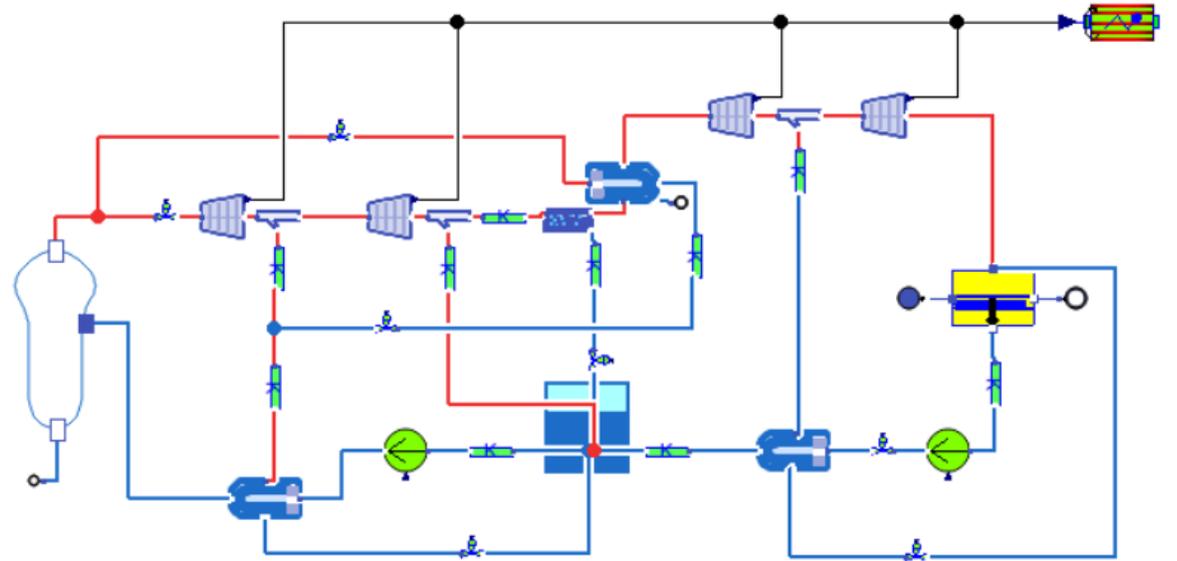
The implementation of a digital twin is an encapsulated software object or model that mirrors a unique physical object, process, organization, person or other abstraction”

Gartner 2021

Digital Twin of Unit X - Model

UNIT X nominal model simulates the generation of the plant from the steam generator to the alternator

- 12 000 physical equations embedded
- 135 components
- 95 measurements
- 5 years of data history

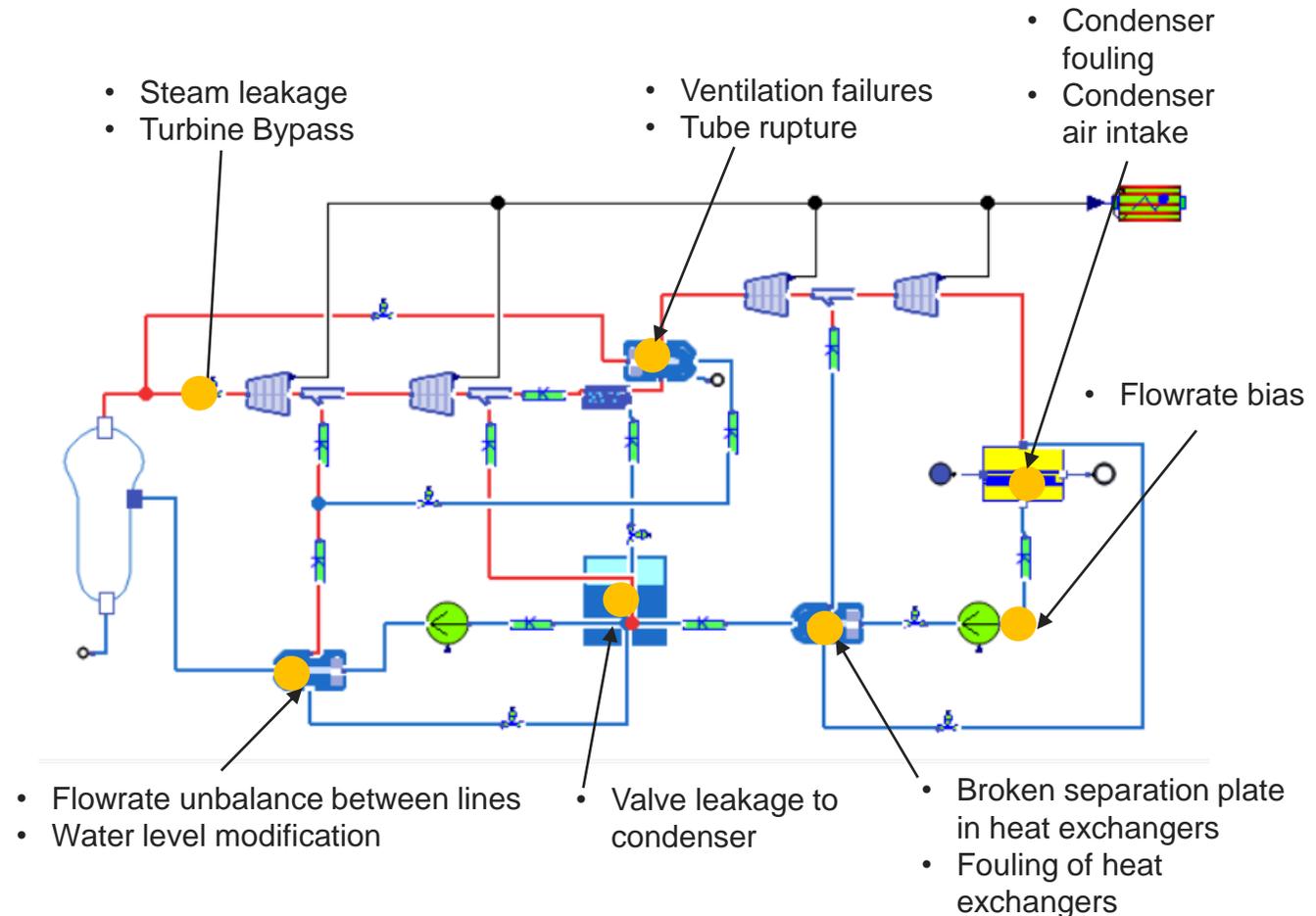


Digital Twin of Unit X - Faults

75% of faults happen on the secondary side

Over 80 faults embedded in the Digital Twin

- Flowrate bias
- Steam leakage
- Turbine bypass
- Valve leakage to condenser
- Heat exchanger tube rupture
- Heat exchanger broken separation plate
- Heat exchanger water level mis-regulation
- Heat exchanger fouling
- ...

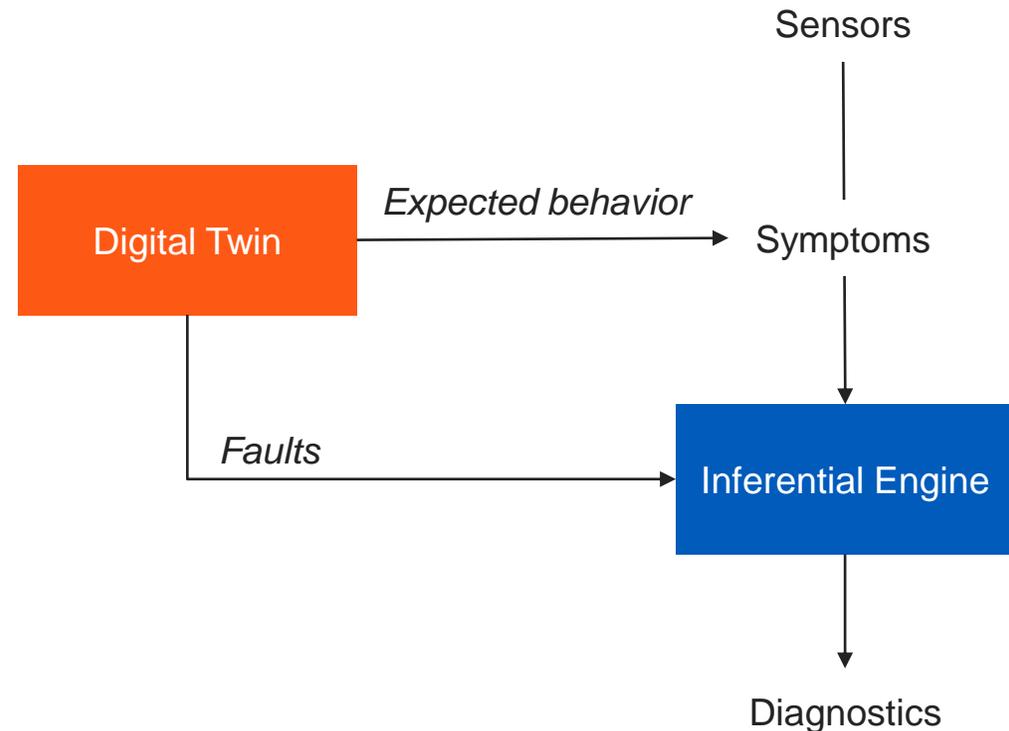


Digital Twin – Decision making

The digital twin is encapsulated in our software and governed by an inferential engine in charge confronting the twin to the process data resulting in a trustful state estimator.

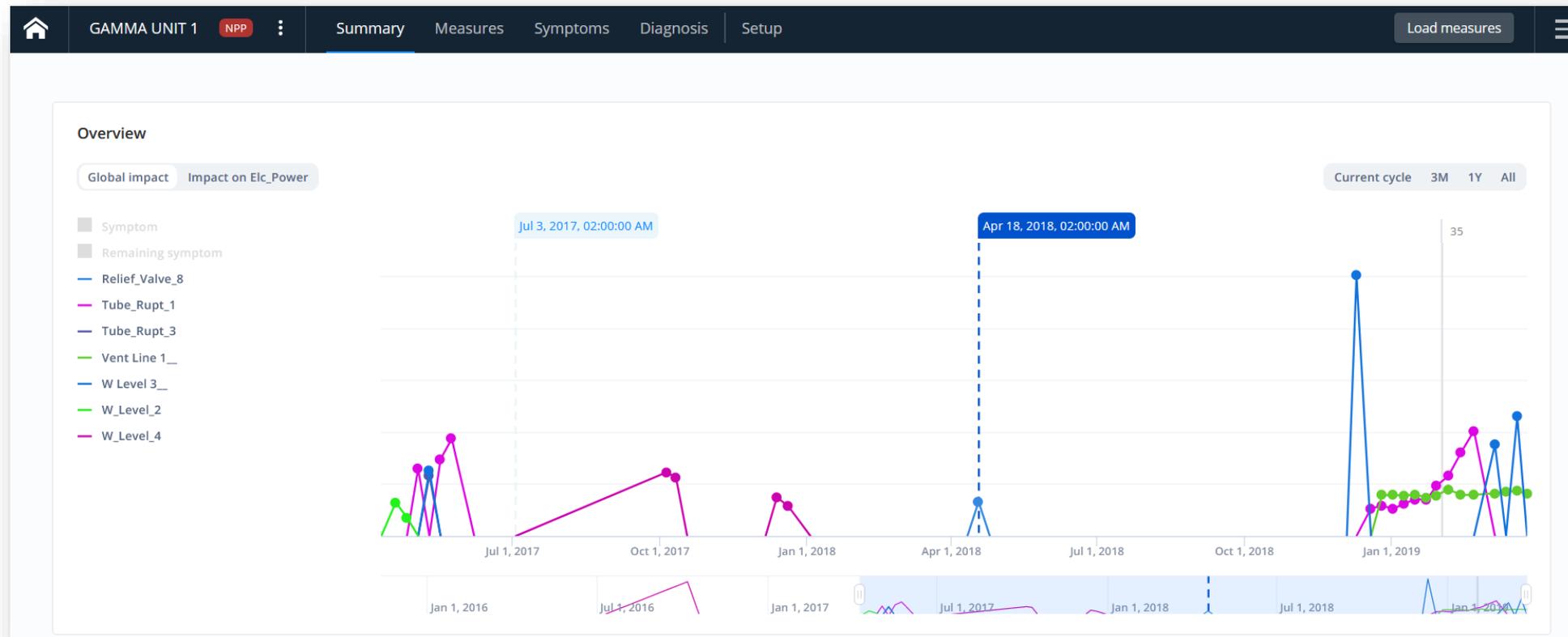
Any fault impairing the process is automatically located and classified by order of likelihood. Its magnitude is quantified and its impact on generation is qualified.

$$\text{diagnostics} = P(\text{faults} \mid \text{symptoms})$$



Retrospective health study of Unit X

7 faults diagnosed over 2 years with 90% reliability



metroscope

Thank you for your attention