Data based solutions for the nuclear sector

SNETP

Vincent Champain, june 2022

Linkedin.com/in/champain

Twitter : @vchampain

Did you know ?

= 13 x

Digital twins before digital

Lots of data in nuclear

X 1 million

X 40 millions

One page
5 Kb
Simple.

Image
1,5 Mb

3D Image
35 Mb

Video
5 Gb

Genome
200 Gb

Flight
500 Gb

Tweeter day
800 Gb
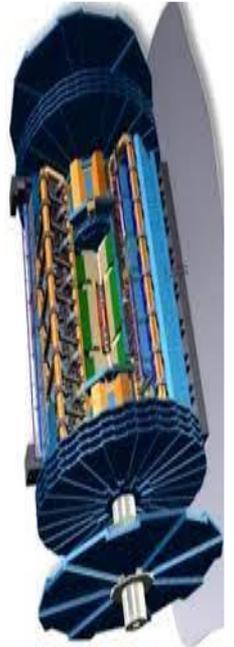
Nuclear
20 Pb

Lots of value expected from data
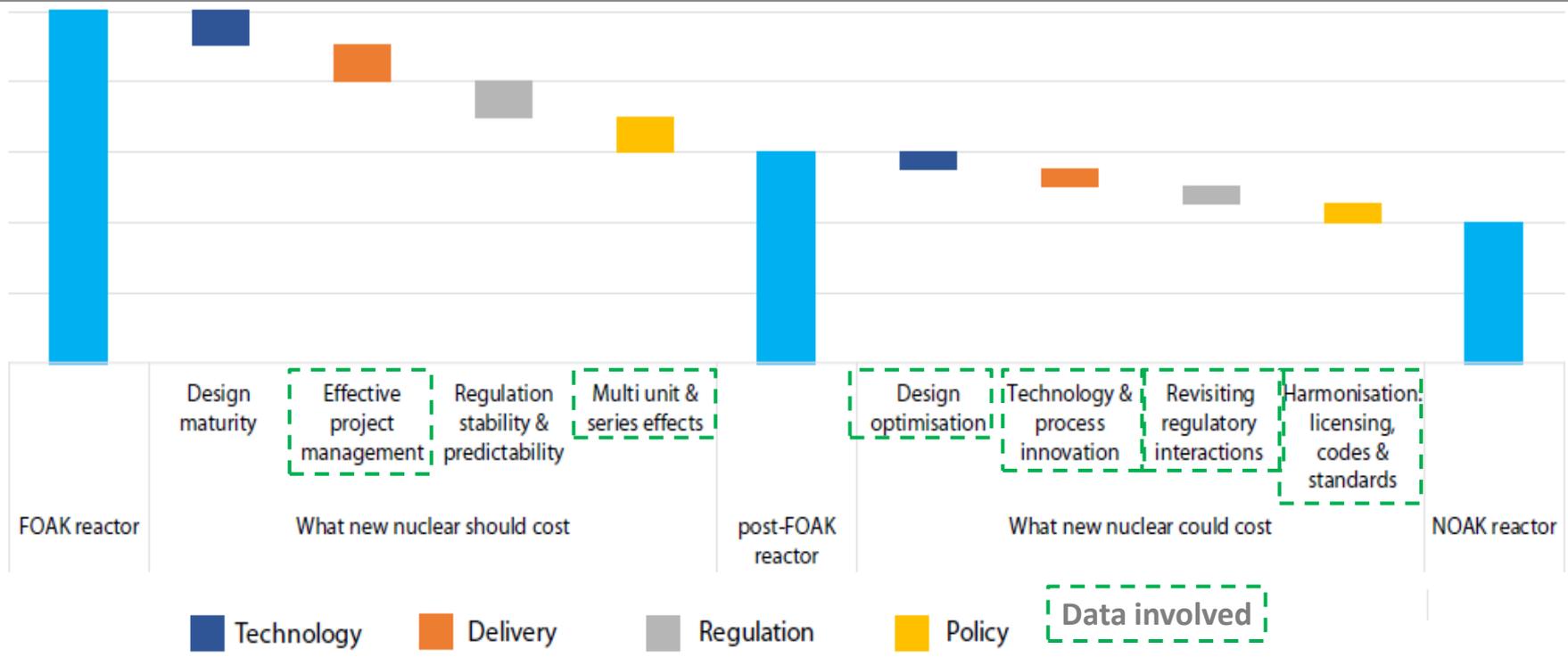
Creating value from data

Governance & Monitoring		Automation	Datascience	Simulation	Knowledge Mangt
Compliance	**Business intelligence**	**Robots (RPA), Macros, Rules engines**	**Machine learning & Applied mathematics**	**Domain science High Performance Computing**	**Knowledge Management**
GDPR, Export, …	Easy to use tools so that non experts get some value from their data.	Leverages Accumulated Expert Knowledge.	Diverse methods (neural networks, clusterization,…).	Based on material science & domain Knowledge.	Training, Op. Excellence, Quality
Typical benefit:	**Typical benefit:**	**Typical benefit:**	**Typical benefit:**	**Typical benefit:**	**Typical benefit:**
Avoiding problems by ensuring data is protected & user know what not to do.	Automated reports, ability to do simple analysis (loss causes, walk between X & Y, …).	RPA (Robotic Process Automation) doing accounting consolidation tasks	Partially or fully automated quality control. Issues prediction	Safety studies for nuclear equipment.	Youth training, processus improvement,…
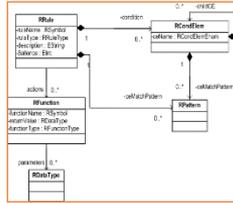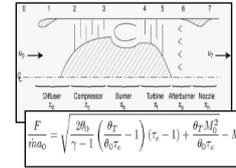
framat○me

Some examples

Data acquisition
- Special acquisition technologies
- Preprocessing

Data analysis
- IA/modeling/… applications to preventive maintenance, aging monitoring…

Simulation
- Real life data based simulation ("digital twin")
- Simulation for augmented engineering

Knowledge Management
- Knowledge management strategy
- Graphsight
- EQDB

framat⚬me
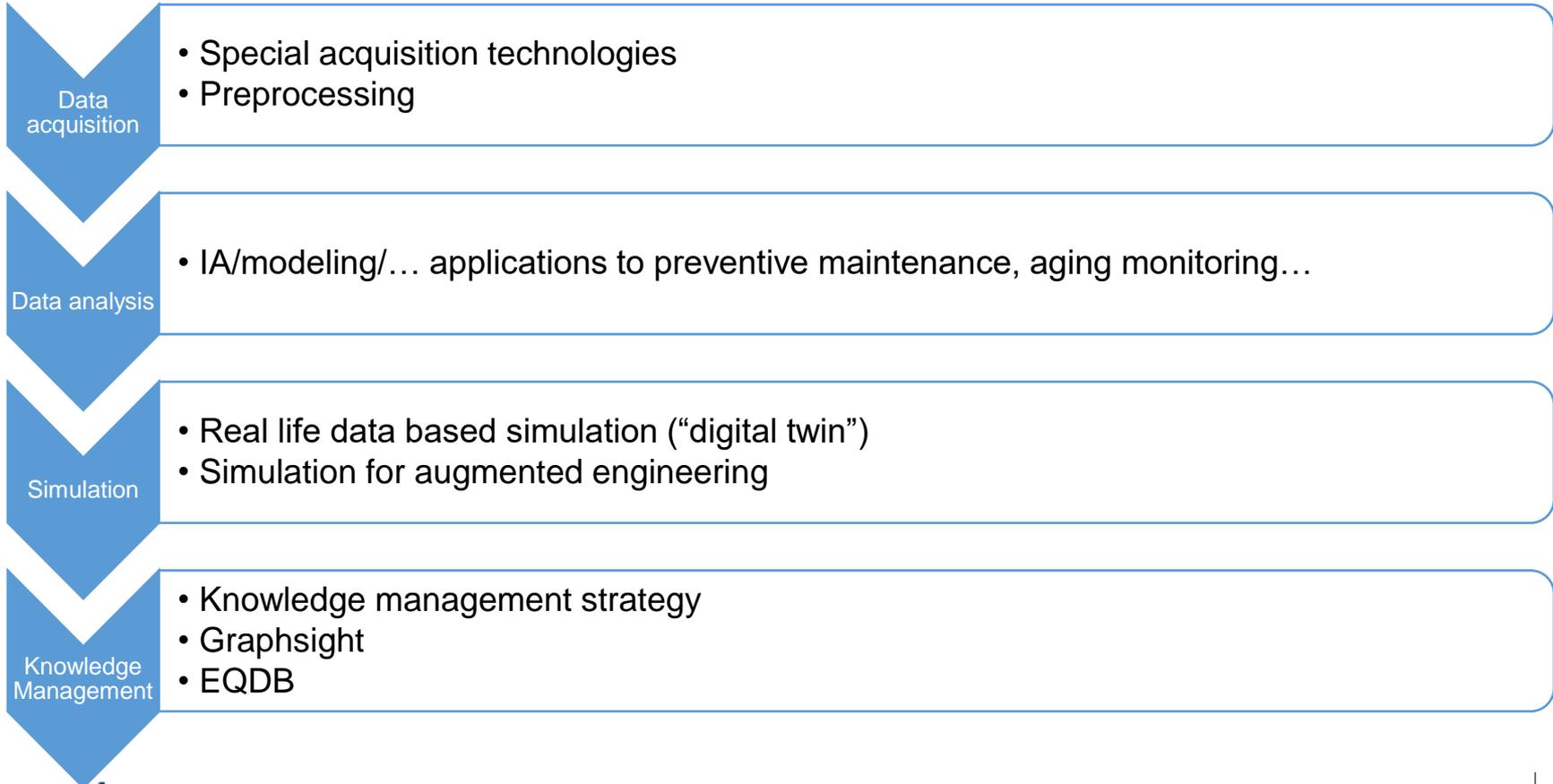
Acquisition & post processing

Nuclear specific data acquisition technologies

Inspection / ND Testing:
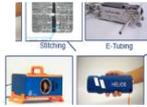
- Eddy/Foucault currents,
- Laser scans, X-Rays, PCD
- Visual controls

Measurement/Capture

- Nuclear instrumentation (incore & excore)
- Process instrumentation (manufacturing)

Monitoring/Analysis :

- Valves & leakages
- Loose Parts
- Motors

Remote inspection :

- Secured remote inspection
- Inspection robots

Product certification/quality:

- Welding monitoring
- Nuclear pellets quality analysis

Product integrity

- Securing transportation
- Anti-tampering

framatome

Digital radiographic testing
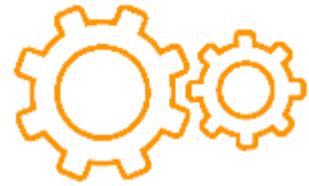
- High Energy Photon Counting Detecor (HE PCD) allows to improve considerably accuracy and speed of radiographic inspections by proposing a detector capable of generating a quality image with very few photons.

- Real time monitoring of both image formation and operating conditions.

- HE PCD is well suited to be used with holding and moving devices, for positioning detector between several inspection points with respect to a part to be controlled.

- Operators presence in orange zone will be reduced.

- HE PCD can be used with radio isotopes of Selenium 75, Iridium 192, and of Cobalt 60; as well with X-ray tubes, linacs or Betatrons, HE PCD represents a real revolution by its flexibility.

- **Uses laptop computer and detector**
- **No chemical**
- **Real time monitoring**

framatome

◆ **Visual inspection compatible with all materials and surfaces**

◆ **Get more information about the surface condition and indications:**

- **Length**
- **Depth**
- **Roughness**
- **Profile…**

◆ ***3D repeatibility* up to 5 %**
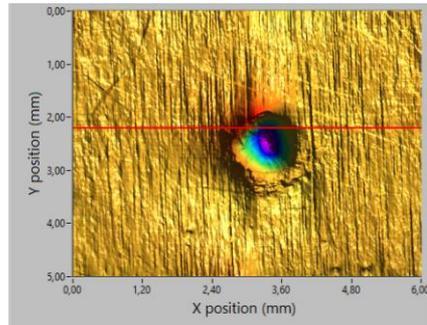
▪ **Value drivers:**

- Save time through simplified analysis all-in-one features
- Optimize resources through a quantified analysis interpreted by non-skilled operators
- Secure the analysis through 100% traceability
- Save costs with a very fast inspection

framat●me

STITCHING Software: televisual inspection analysis

- ❑ **The issue**
  - ❑ **After-manufacturing and in-service inspections are highly human factor dependent**
    - ❑ **Need to ensure the operator is focusing during all the process**
    - ❑ **Need to ensure 100% effective analysis of video acquisitions**

- ❑ **The solution**
  - ❑ **STITCHER software solution allows to generate panoramic static images from videos:**
    - ❑ **The operator has a vision of the whole component**
    - ❑ **The reliability and productivity of the overall process is improved**
    - ❑ **Transformation of a video into a static panomaric image without any loss of data**

- ❑ **Applications**
  - ❑ **Drastically speed up analysis process**
  - ❑ **Reduce operator fatigue**

- ❑ **ISI experience**
  - ❑ **BMI inspection**
  - ❑ **Bolt Inspection**
  - ❑ **Pressure Vessel Inspection (on going)**

- ❑ **Key benefits**
  - ❑ **Time saving on analyses and technical control**
 - ❑ **Reduction human factor**

framatome
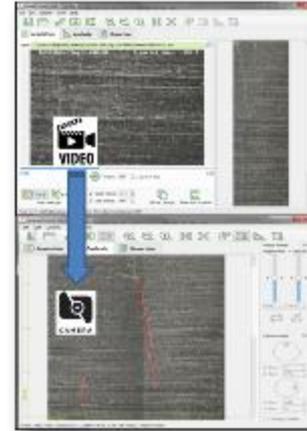
Analysis

Classifying Zirconium alloys microstructures

- Zirconium alloy product lines undergoing a quenching step after forging
- Final microstructure in form of a variable mixture of "basketry" or "platelets"
- Images classified to date by experts: long process, potentially "dependent person" and not exhaustive
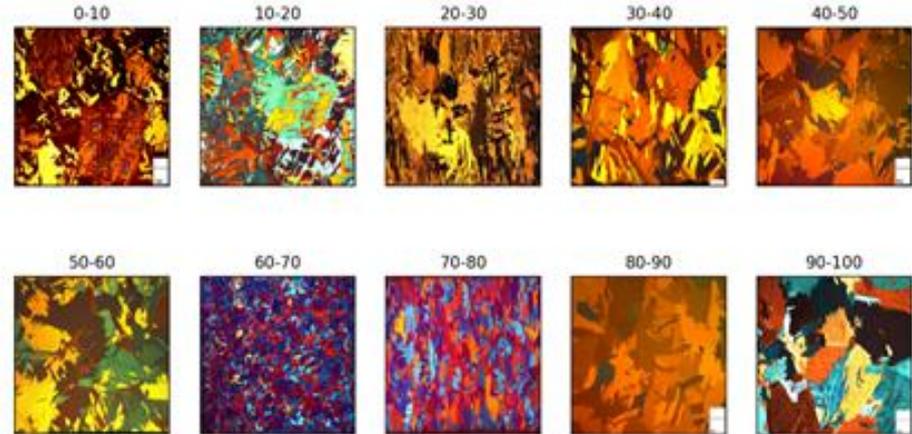
Development of a tool to automate the micrograph analysis process:
- Time saving
- Ability to analyze many more microstructures
- Analysis of process parameters influencing the ratio of platelets to basketry

framat**o**me

CADIS
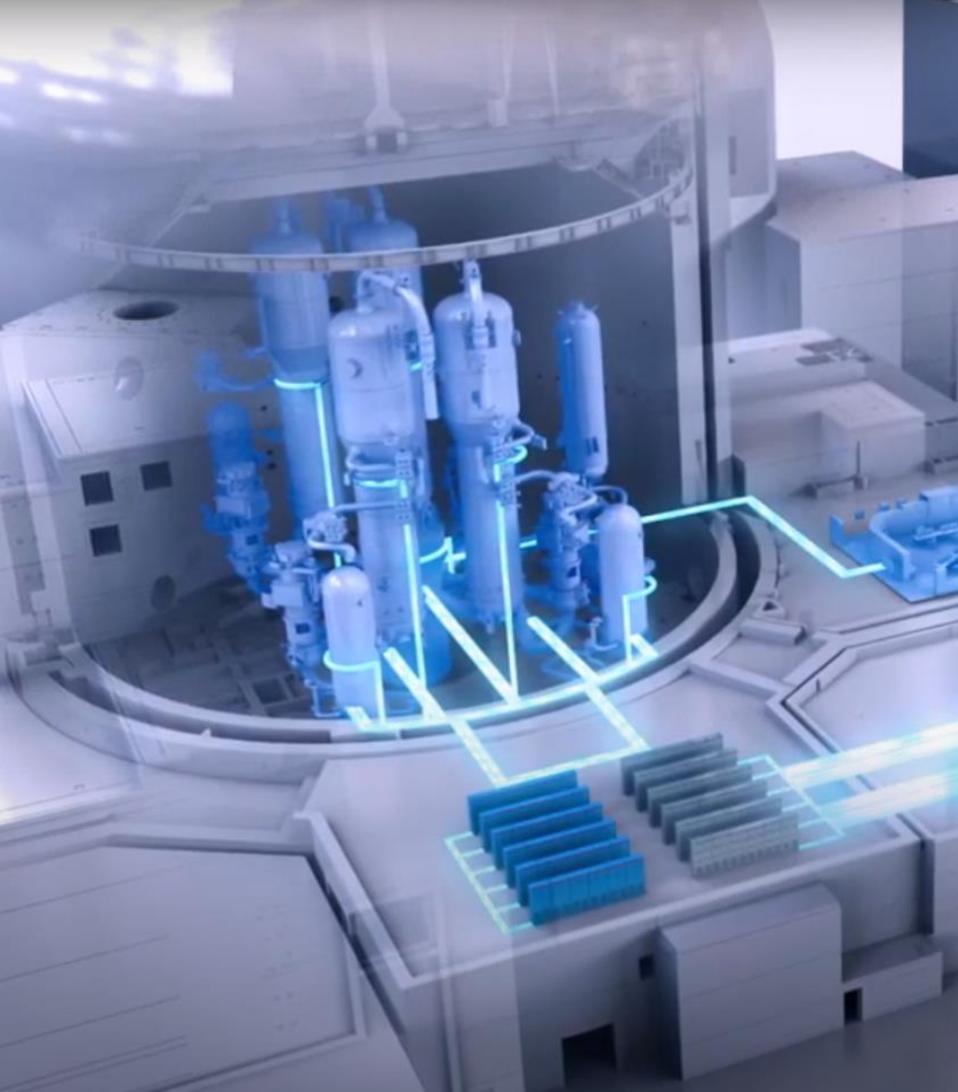
Central Asset Data Intelligence System

Business Intelligence solution improving equipment operational reliability, availability & maintainability and enabling Condition-Based and Predictive Maintenance.

Combining M&D solutions with data-driven and expert-based diagnostics tools

- Detection of abnormal events and component faults
- Prediction of the remaining useful lifetime and/or health state of plant components
- Reduction of engineering and periodic maintenance efforts
- Data-driven decisions using enhanced reporting

Analysis and evaluation of complex events for reliable Data-Driven decisions and maintenance strategies
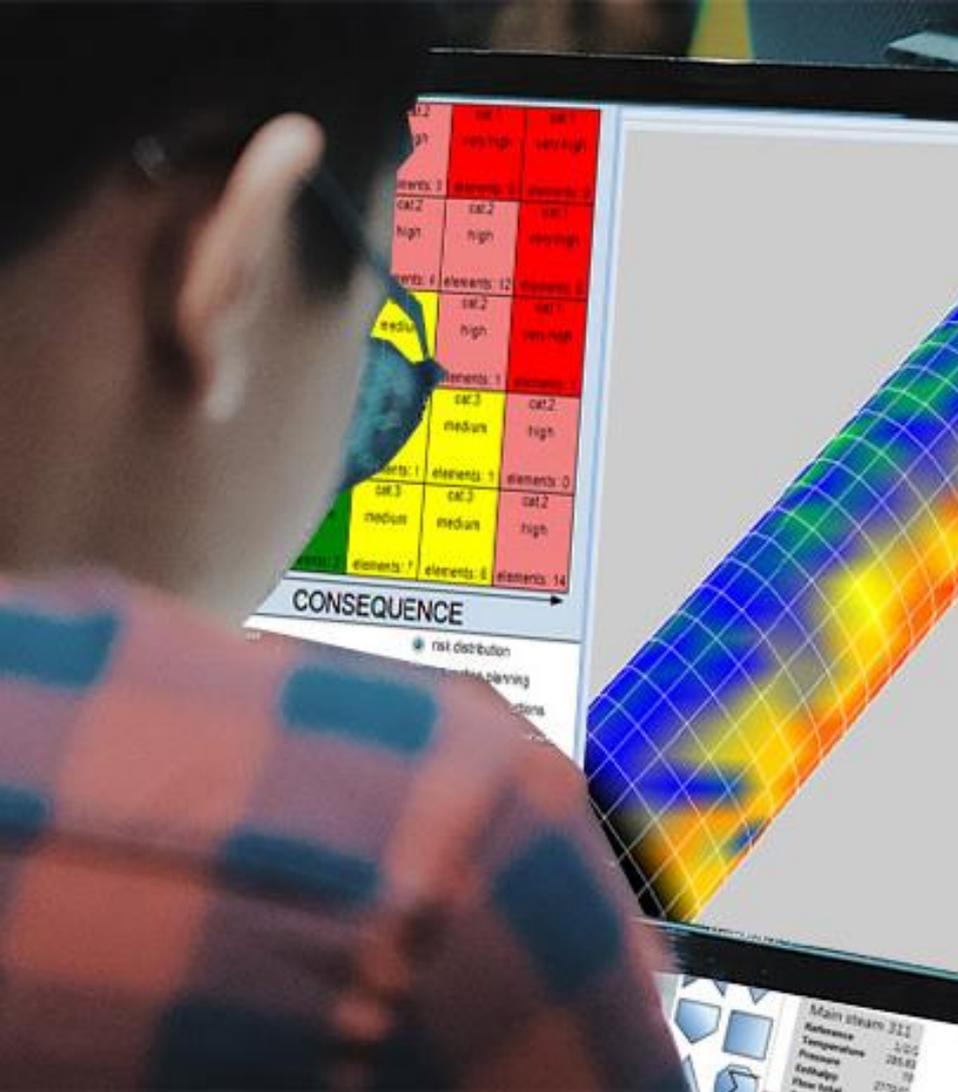
COMSY

Condition-Oriented ageing Management SYstem

**Modular software solution for aging management
and aging surveillance of power plant systems,
for an efficient assessment and control of aging effects**

- Predicts degradation and optimizes inspections for mechanical components
- Determines the remaining life of electrical and I&C components
- Allows systematic maintenance management of civil structures
- Optimizes maintenance scope and intervals based on operational experience
- Supports Aging Management Review assessment and Aging Management Program evaluation in accordance to NRC GALL or IAEA IGALL

Applied in over 50 NPPs worldwide

Manages up to 500.000 SSCs

Over 30 years of operational experience

Failures evolution

Legend: Fouling_17, Valve_Leakage_14, Valve_Leakage_21, Valve_Leakage_3

Sep 4, 2018, 08:08:00 AM

○ Suspected   ● Confirmed / False detection

Symptoms evolution

Amplitude   Gap   Normalized gap

3W   3M   1Y   All

Sep 4, 2018, 08:08:00 AM

○ No symptom   ○ Symptom   ▢ Confidence area
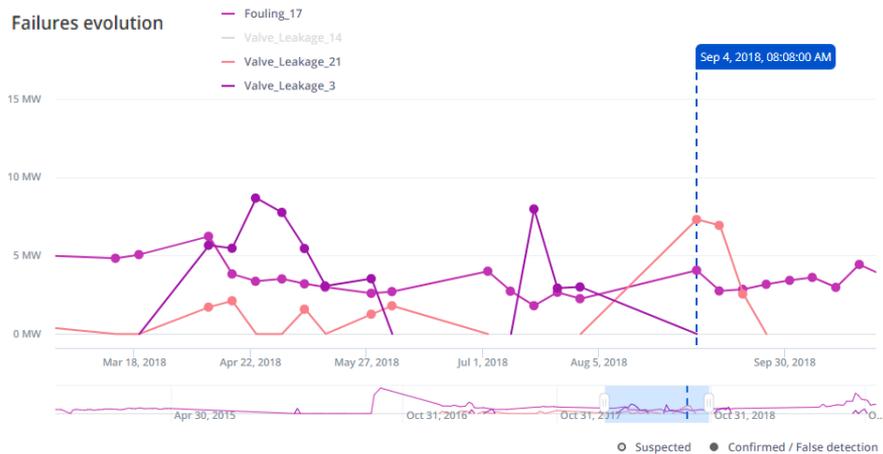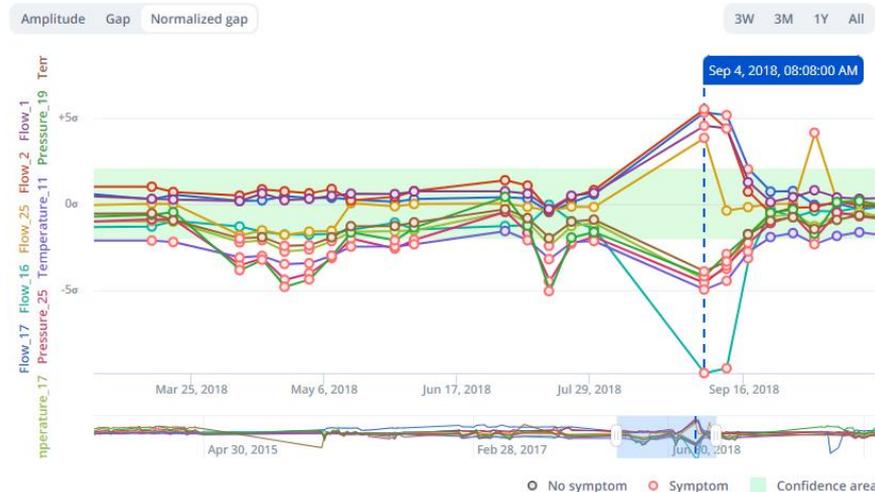
Better efficiency, Less maintenance.

Online plant thermal performance monitoring and diagnostics system, identifying and quantifying causes of output losses and other forms of degradation

- Automatic and early detection of simultaneous plant secondary side and thermal performance degradation (loss of MWt)
- Analysis of live impact of flexible operations
- Prevention from damage to system/equipment, unplanned outages and loss of megawatts
- Support for condition-based maintenance
- Easy implementation: with existing sensors and plant display system, no modifications required
- Value added operating experience from the fault library
- Built-in plant-specific operating experience

59 plants equipped worldwide

2000 GWh losses detected in 2020

90% reliability reported by customers

Simulation

USING SIMULATION IN THE PRODUCT LIFECYCLE

HMI functionnal validation

Commissioning procedure validation

Allocation on PLCs Hardware I&C functions

Hardware In the Loop

framat⬣me
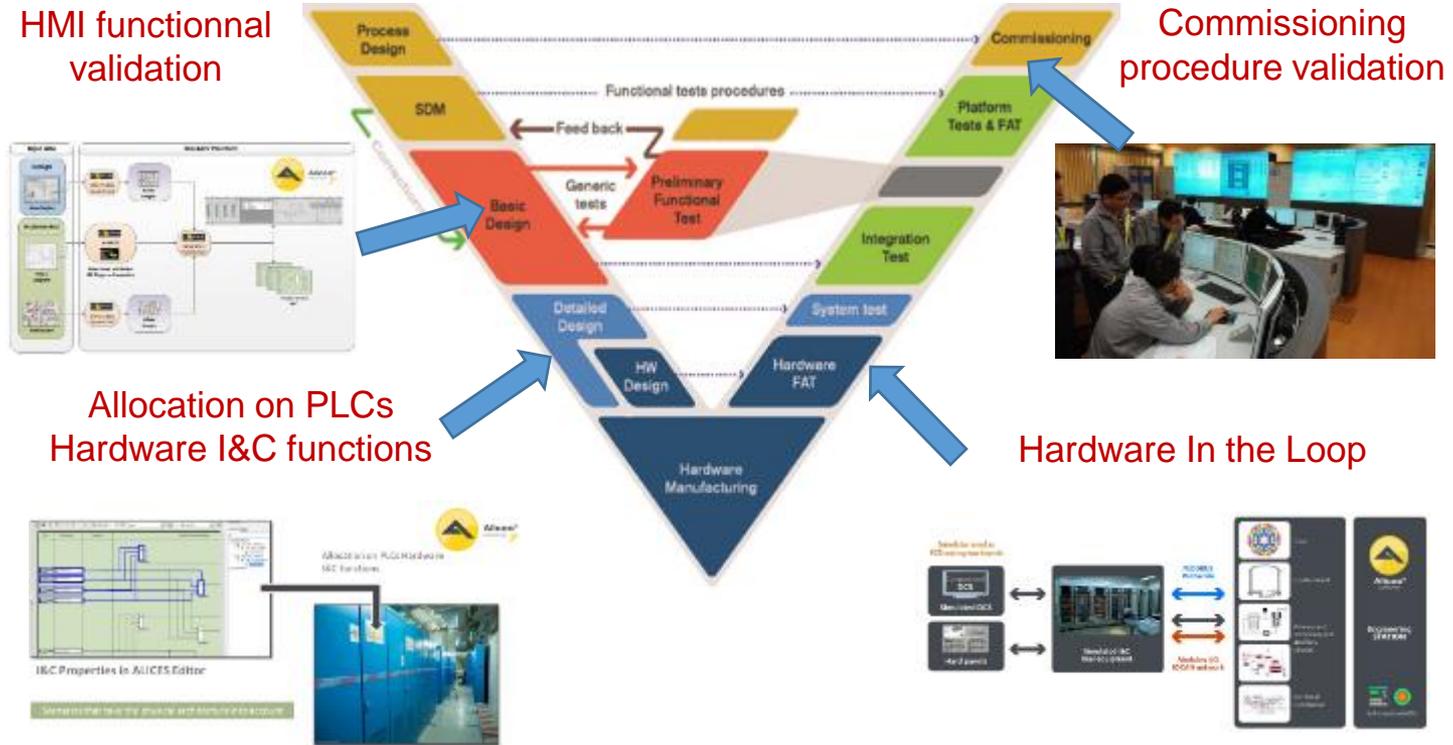
1. Quenching simulation

**Manufacturing data acquisition :**
- **Water temperature**
- **Process duration**
- **Fluid speed…**
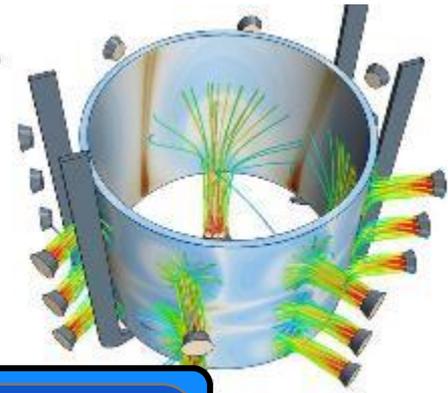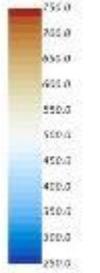
Quencing real timesimulation
based on manufacturing data

Digital twin

Knowledge management

Knowledge Management at Framatome

5 themes & 15 topics to become a learning organization

KNOWLEDGE TRANSFER	COLLABORATION & KNOWLEDGE SHARING	KNOWLEDGE FROM LESSONS LEARNED	KNOWLEDGE STORAGE	KNOWLEDGE DISTRIBUTION
Transfer experts or key people's knowledge	Foster communities across BU	Manage lessons learned processes	Harmonize content classification	Operate the search platform
Develop on-demand and on-line training	Appoint knowledge owners in BU	Deploy lessons learned tools	Create knowledge databases	Deploy a rich employee directory
Develop learning paths on key competences	Integrate KM in project management organizations	Implement lessons learned in Standards	Perform archiving process	Deploy collaborative knowledge platforms

framatome

Augmented engineering: Graphsight

Problem

- Engineering studies require to establish **set of documents** that will serve as study data input.
- It is always an **extensive and painful work to get it**, out of approximately 2 millions of documents.
- Even worse with employee's turnover between studies

Solution

- **Using NLP** (Natural Language Processing), **GraphSight extract references** (and only references) from documents stored in ECM including confidential documents
- Applicable to text and image documents via OCR production line (Optical Character Recognition)
- NLP is used again to develop links between documents and display them instantly in Graph GUI developed for engineers

Impact

- It is then possible to drastically reduce time to create list of applicable documents or update set of documents for engineering studies
- Impact analysis when a document is revised is accessible with a few clicks
- Engineers can focus on their expertise and not loose time in non-value added activities
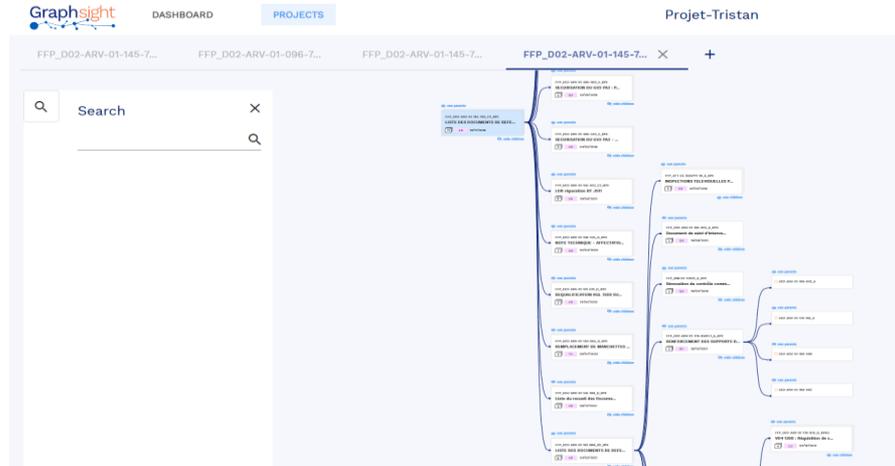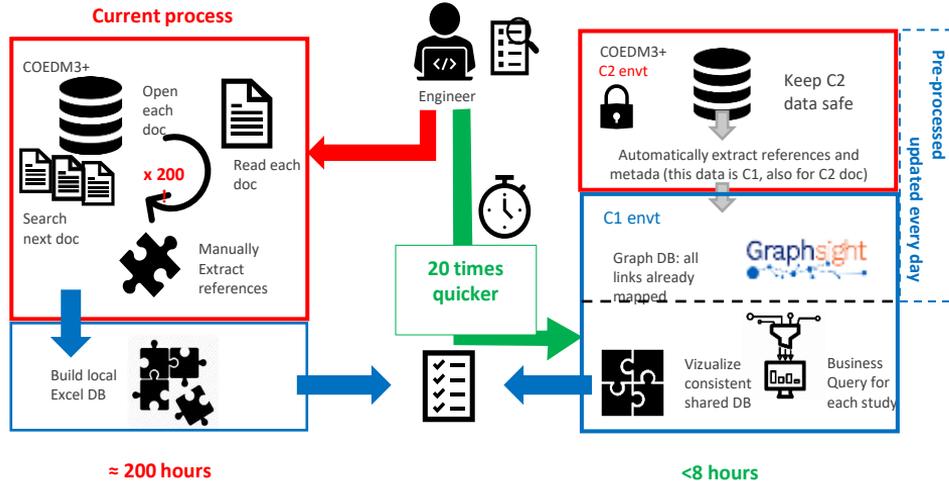
# Equipment Qualification Data Base (EQDB)

- **Challenge**: Qualification of Electrical, I&C and Active Mechanical Equipment is always costly and time consuming within nuclear projects and also for nuclear power plant operators. Non-conformances during qualification endanger power plant availability and project time schedules. Such situations often lead to significant unplanned costs.

- **Solution**: Framatome's Equipment Qualification Data Base saves cost and time by reducing the risks of equipment qualification. Framatome's EQDB provides access to more than 1000 pre-qualified listings including Electrical, I&C and active mechanical equipment with a Web Interface.

Customer have the choice to either ask EQDB to be customized for their needs (incl. administrator support) or to access a large library of pre-qualified equipment that fits their application (incl. engineering support):

- ➢ Type of equipment
- ➢ Select a manufacturer
- ➢ Via the required test or analysis
- ➢ By defining desired codes & standards
- ➢ Select tested Parameters
- ➢ Check, if the required technical data is available

Project Request
- ➢ Equipment
- ➢ Manufacturer
- ➢ Technical Data
- ➢ Harsh or Mild Environment
- ➢ Kind of Test
- ➢ Codes & Standards
- ➢ Seismic/LOCA Parameter
- ➢ Qualification Lifetime

EQDB

New Equipment | Partly Qualified Equipment | Qualified Equipment
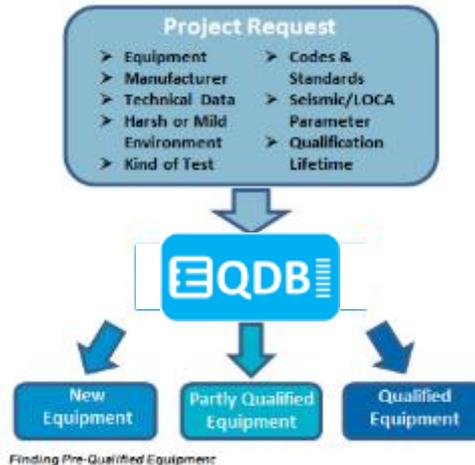
Finding Pre-Qualified Equipment

Customer benefits

- • **Flexibility** in terms of usage,
- • **Simplifies** finding existing qualifications,
- • **Reduces** project risk by using pre qualified equipment,
- • **Reduces** qualification cost
- • **Provides** qualification evidence for the authority

framatome

Questions ?

Let's stay in touch :

Linkedin: linkedin.com/in/champain
Twitter : vchampain

framat⚬me

Any reproduction, alteration, transmission to any third party or publication in whole or in part of this document and/or its content is prohibited unless Framatome has provided its prior and written consent.

This document and any information it contains shall not be used for any other purpose than the one for which they were provided.

Legal and disciplinary actions may be taken against any infringer and/or any person breaching the aforementioned obligations.

Backups

What is different in this industry ?

Feature	What is new ?	Nuclear Challenge
Data access	Data lakes making data access & correlation easier Extended enterprise made easy with standard ERPs	Limited connectivity & strong barriers to data exchange → The industry was historically the first to leverage computer simulation, but is lagging for supply chain digitalization
Computation power & standard software components access	Cloud solutions Standard components for many standard uses (text or image recognition, fraud detection, etc.)	Sovereign concerns limiting use of public solutions Standard solutions only cover some use cases (e.g.: document search), others are very specifics
Organizational complexity	Agile methods & decentralizing decision at the shop floor level (Toyota methods)	Security limits decentralization Complex norms limit operators' ability to change

framat⚫me