

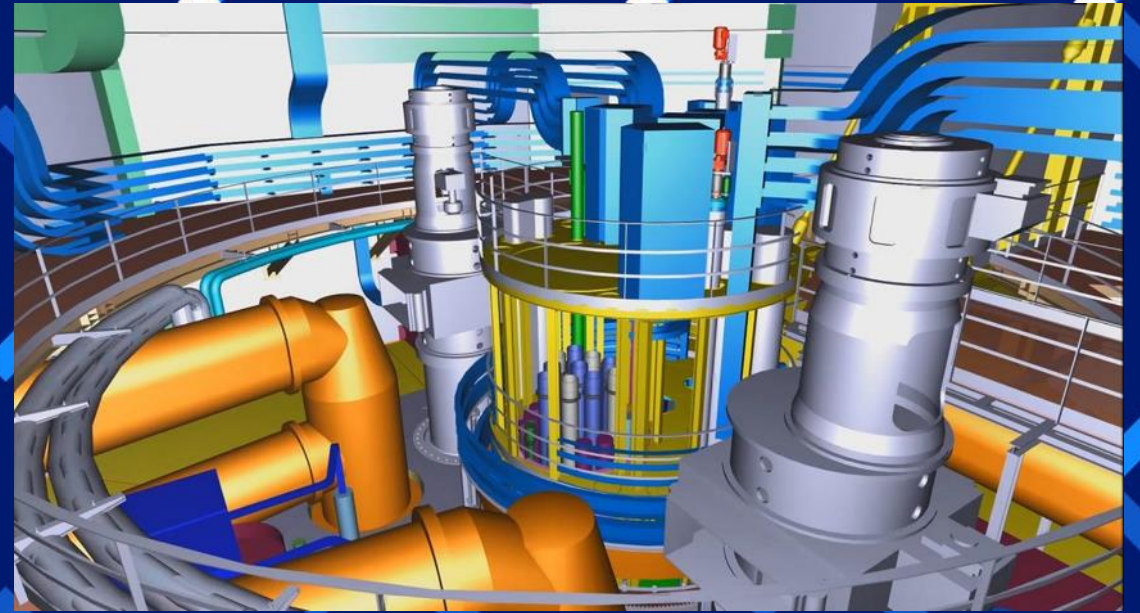
framatome

Advanced Reactors Design & Development

Jean-Marie HAMY

Advanced Reactors & Design School
Senior Manager

NIC 2024 – Amsterdam – June 5, 2024



NIC 2024

**NUCLEAR
INNOVATION²⁴
CONFERENCE**

JUNE 5-6

- ✓ In collaboration with the IAEA
- ✓ Showcase of the latest developments
- ✓ Live discussions with decisionmakers
- ✓ The ultimate networking event

A photograph of a modern glass-fronted building with the word 'framatome' in large white letters on the upper part of the facade. The building is partially obscured by green foliage in the foreground. A blue rectangular overlay is positioned on the left side of the image.

→ Framatome in Brief

Framatome

For over 65 years, Framatome's teams have been involved in developing safe, competitive, clean, low-carbon nuclear energy worldwide by:

- designing nuclear power plants,
- Supplying and commissioning nuclear steam supply systems,
- designing and manufacturing components and fuel assemblies,
- integrating automation systems,
- and servicing all types of nuclear reactors.

The original equipment manufacturer of **84** nuclear power plants in operation

framato**me**

Activities



Engineering & Design Authority



Fuel



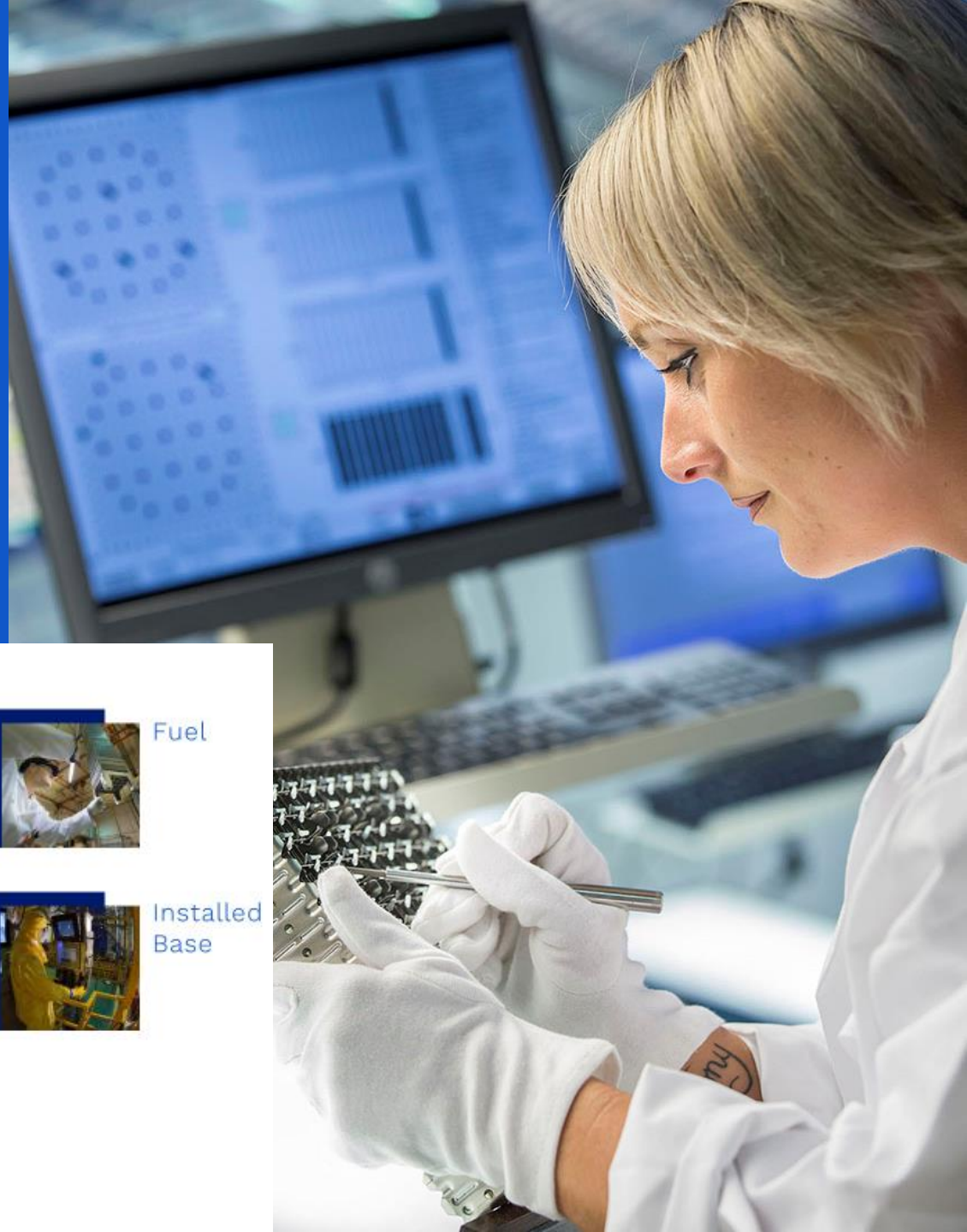
Projects and Components Manufacturing



Installed Base



Instrumentation & Control





Values

- SAFETY
- FUTURE
- PERFORMANCE
- PASSION
- INTEGRITY



Our values define our identity. More than just principles, they guide our actions and determine how we work with our customers, partners and employees.

Worldwide presence

France

- Beaumont
- Chalon-sur-Saône
- Cherbourg
- Frans
- Grenoble
- Jarrie
- Jassus-Riot
- Jeumont
- Le Creusot
- Les Achards
- Lyon
- Marseille
- Massy
- Maubeuge
- Montbard
- Montreuil-Juigné
- Orsan
- Paimboeuf
- Paris
- Romans-sur-Isère
- Rugles
- Rungis
- Saint-Marcel
- Saint-Paul-lez-Durance
- Sully-sur-Loire
- Ugine

Germany

- Erlangen
- Karlstein
- Lingen

USA

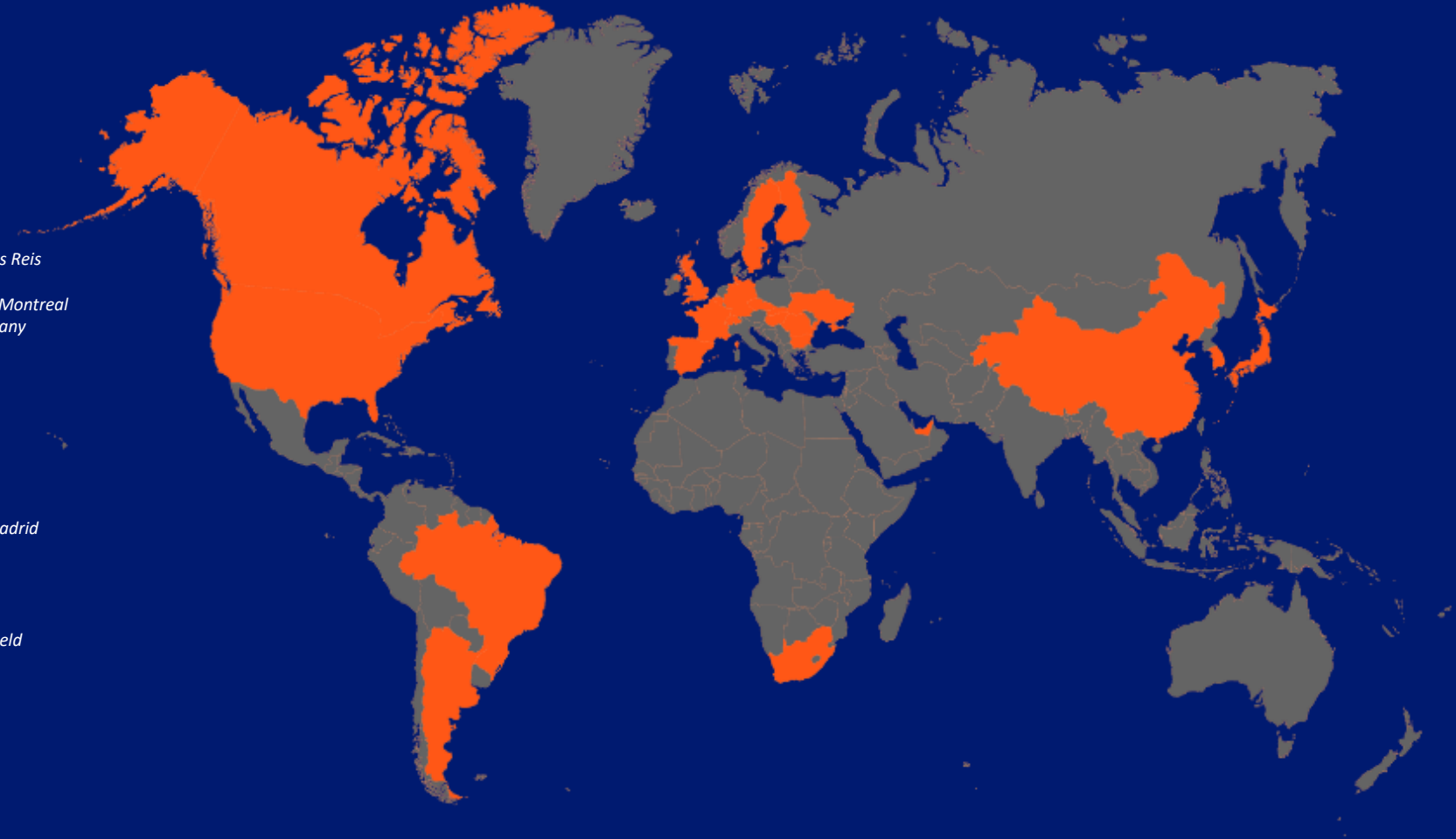
- Benecia
- Charlotte
- Christiansburg
- Cranberry Township
- Jacksonville Houston
- Lynchburg
- Mansfield
- Richland

China

- Beijing
- Daya Bay
- Deyang
- Haiyan
- Lianyungang
- Shanghai
- Shenzhen
- Taishan

Rest of the world

- Belgium: *Brussels*
- Brazil: *Rio de Janeiro, Angra dos Reis*
- Bulgaria: *Sofia, Kozloduy*
- Canada: *Pickering, Kincardine, Montreal*
- Czech Republic: *Prague, Dukovany*
- Finland: *Olkiluoto*
- Hungary: *Budapest, Paks*
- Japan: *Tokyo*
- Romania: *Bucarest*
- Russia: *Moscow*
- Slovakia: *Bratislava*
- South Africa: *Cape Town*
- South Korea: *Seoul, Daejeon*
- Spain: *Zaragoza, Tarragona, Madrid*
- Sweden: *Helsingborg*
- Switzerland: *Leibstadt*
- Ukraine: *Kiev*
- United Arab Emirates
- United Kingdom: *Bristol, Cranfield*



+18,000
employees

+70 sites*

20 countries

* Locations can have multiple sites

New reactors construction and plants commissioning

MANAGEMENT OF LARGE PROJECTS

Design, procure, supply, and commission new-build nuclear reactors.

Edvance: a joint EDF and Framatome engineering subsidiary dedicated to new-build reactor projects.

NEW ORDERS for EPR2

6 EPR2 to be deployed in France : sites selected



New build projects ongoing

Flamanville 3 - France

Hinkley Point C - United Kingdom

Sizewell C - United Kingdom

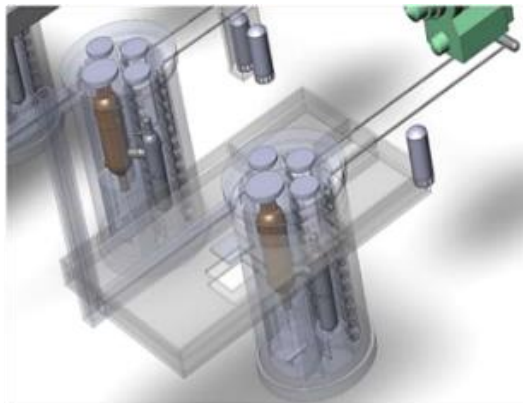
Angra 3 - Brazil



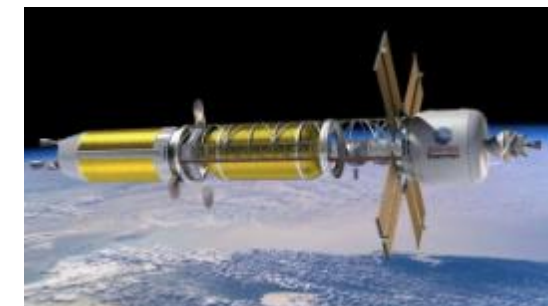
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Framatome :
industrial leader
deeply involved in
Advanced Reactors
projects

Framatome motivation: our continuous engagement towards sustainable nuclear energy and Gen4 systems design and deployment



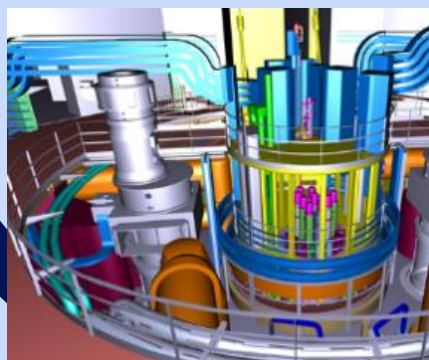
LW-SMR : NUWARD™



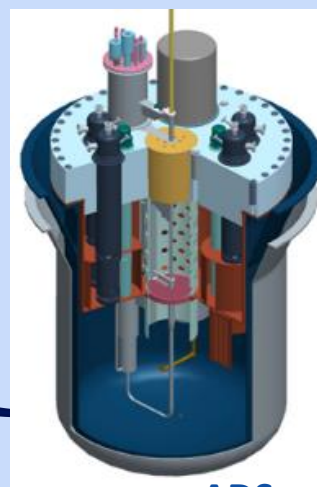
NTP: NASA / ESA

Framatome
SC-HTGR

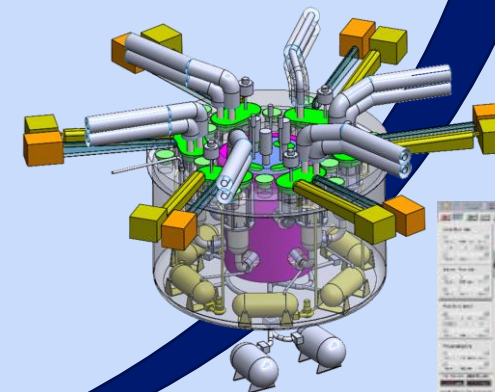
Framatome
Track Record in
Gen IV Reactors
design



SFR : ASTRID
CEA-Framatome



ADS



MSR



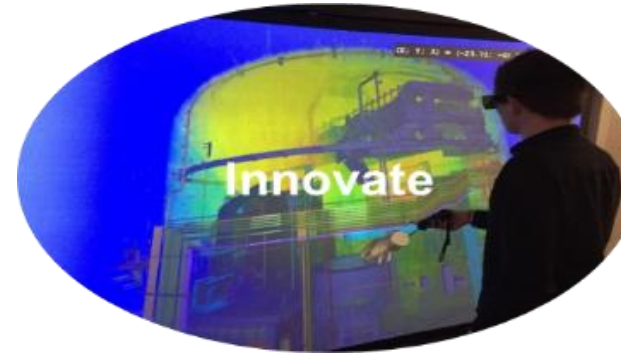
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Framatome
Value Proposition
to sustain
Advanced Reactors
Projects

Framatome Value Proposition and Innovation to sustain Advanced Nuclear Systems deployment



- Unique industrial experience from design to maintenance
- International industrial footprint and supply chain



- Long term perspectives
- Disruption for 'Fast Track' routes



- Standardization
- Qualified & licensed products
- Technology Centers
- Advanced Manufacturing methods



Nuclear Industrial Innovation Hub (NIIH) by Framatome

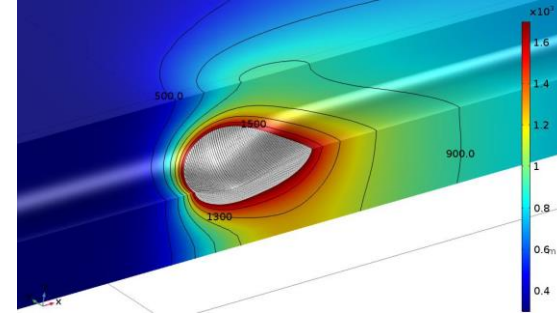
A stylized logo consisting of three overlapping loops in blue, green, and orange, resembling a nuclear symbol or a dynamic path.

➤ Maturity of Technology + Industrial Supply Chain drives the Time-to-Market

Some Framatome major techno bricks for Advanced Reactors

Component Manufacturing

- Integrated organization and processes with unique industrial assets (forge, welding excellence center, quality engineering, Non-Destructive Examination...) for advanced manufacturing



Fuel

- Safe, economic and reliable enhanced **Fuel** solution for SMRs securing fuel reloads and long-term operation



NUWARD™



NuScale

I&C

- All I&C features including unrivaled **Cybersecurity** solutions



Framatome experience = project certainty

300+
comprehensive
I&C systems

(including TELEPERM XS, TRICON and SPEC200) in different reactor designs across the world

100+
complete nuclear
instrumentation

systems in operation worldwide

190+
full-scope
new power
plant simulators

delivered over the last 28 years



HOLTEC

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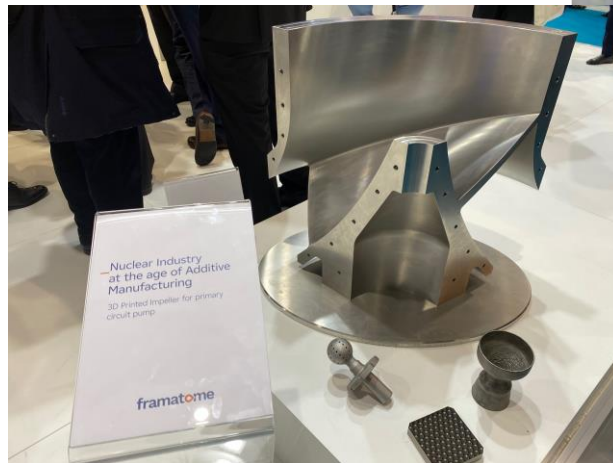
Innovation
to Secure and
Accelerate
Advanced Reactors
Deployment

Advanced Reactors: Secure and accelerate TRL progress

through

- *Standardization*
- *Our technology bricks and qualified licensed products*
- *The support of our technology centers for testing, validation and qualification*
- *The benefits of Nuclear-adapted advanced manufacturing methods*

Qualification of Additive Manufacturing for nuclear grade components



Fluid-structure interaction test of new reactor design



I&C and cyber security solutions



New Practices and New Engineering tools :

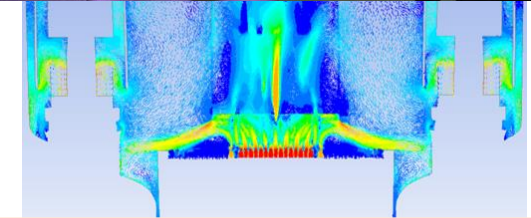
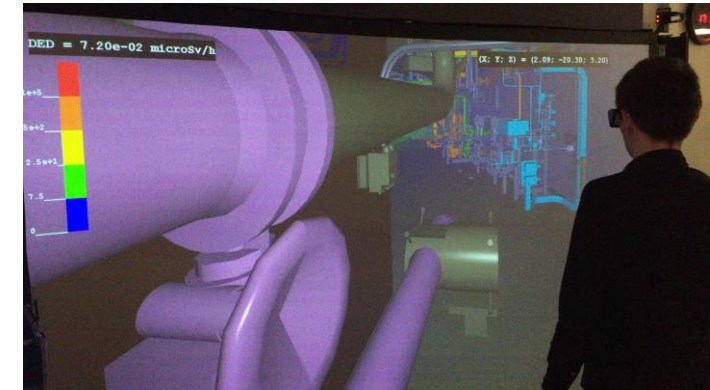
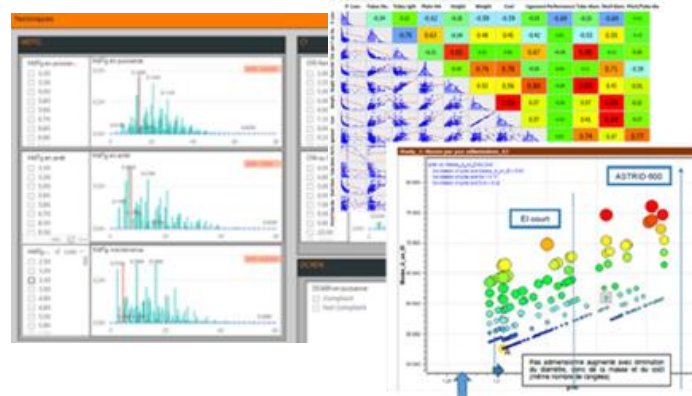
- ✓ Engineering sequences reduction
- ✓ Accelerate prototyping with digital or physical make-ups, with simulators

Capitalization of new methods for Advanced Reactors in the new and innovative Framatome Design School

Agile Design



Design Exploration and Optimization, Architecture Selection



Advanced Digital Simulation (meta models, AI, VR, digital twins)

CRIL
(Cerca Research Innovation Lab)

- Advanced Fuel prototyping and characterization
- Innovation: 3D printing of Fuel

Complexity Mastering

Early Prototyping



Design to Manufacturing



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Focus on
Open Innovation
Initiatives

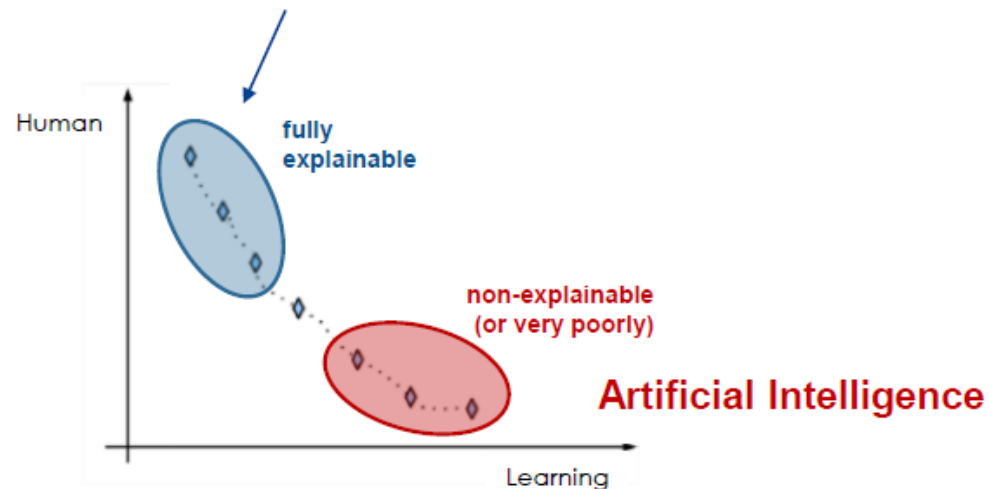
Complexity Mastering & Architecture Trade-off

- Concurrent Engineering



Open Innovation

AN **UNIQUE** KNOW-HOW BASED ON
A PROVEN **METHOD**



Open Innovation



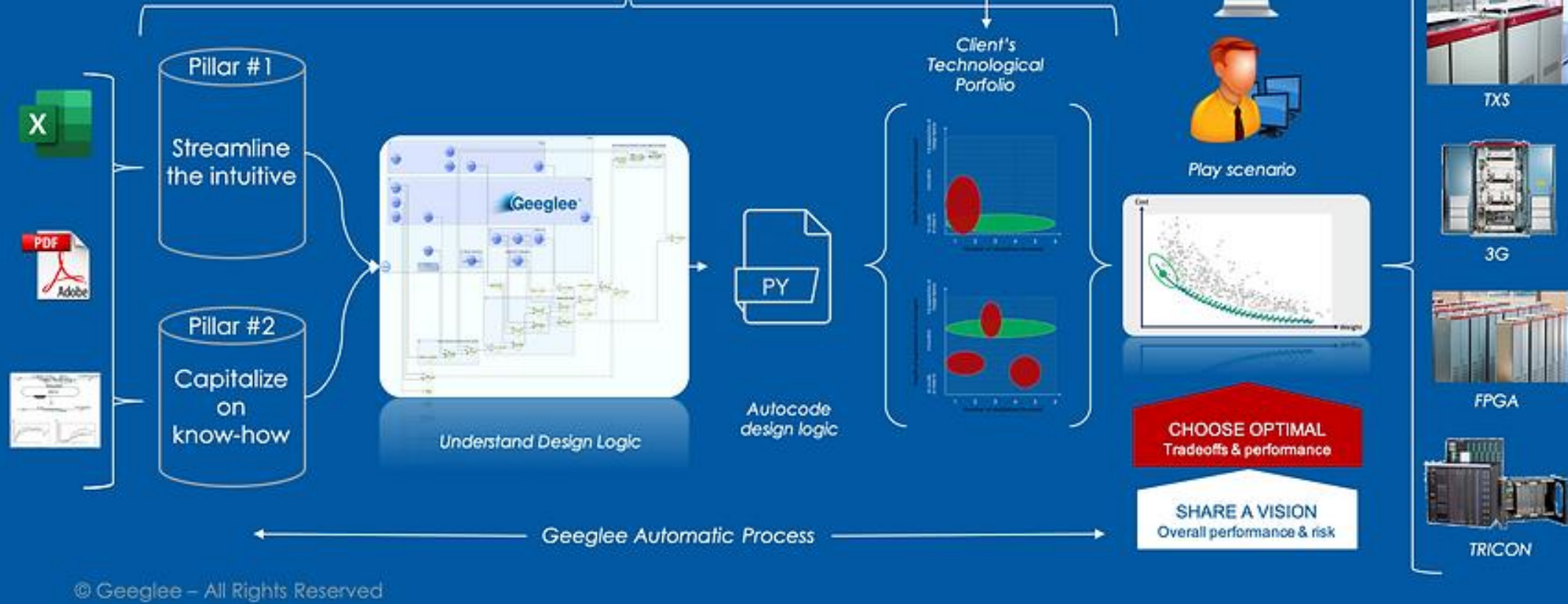
Concurrent Engineering

'Augmented Human Intelligence'

Architecture

...

with Geeglee




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Acceleration of Numerical Simulations



- Added Value of a next generation of IA ('IA 3.0') to address the 'reduction of models' to be applied to highly non-linear physics and strongly accelerate numerical simulations

- Application to the coupling of CFD + System Code



ADAGOS
PARSIMONIOUS NEURAL NETWORKS

NeurEco build finished OK.

Classification: False

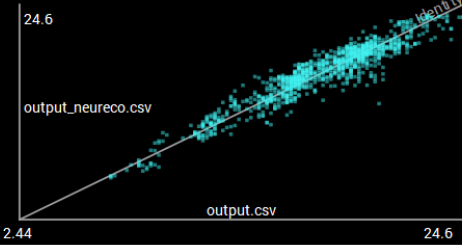
Input data: + /input.csv Separator X

Output data: + /output.csv Separator X

Write model to: model.dr

Plot reference vs. prediction

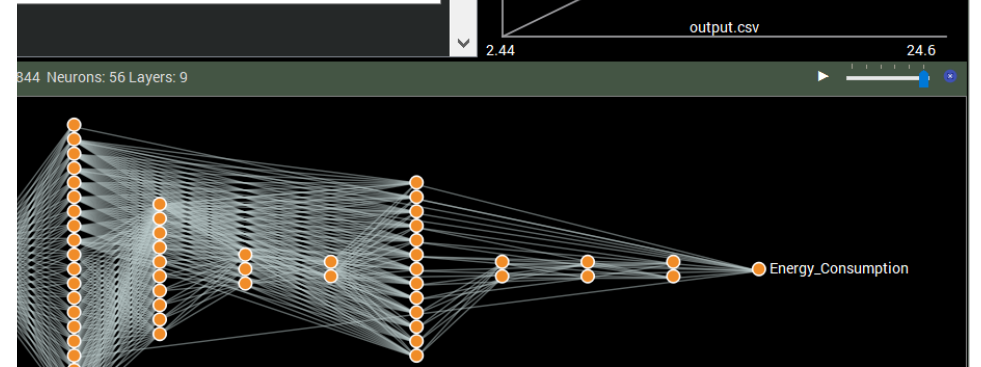
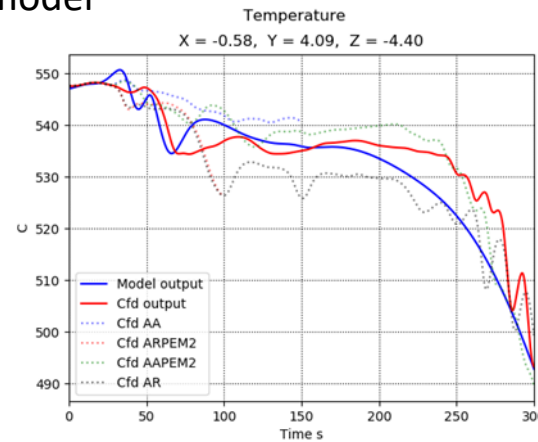
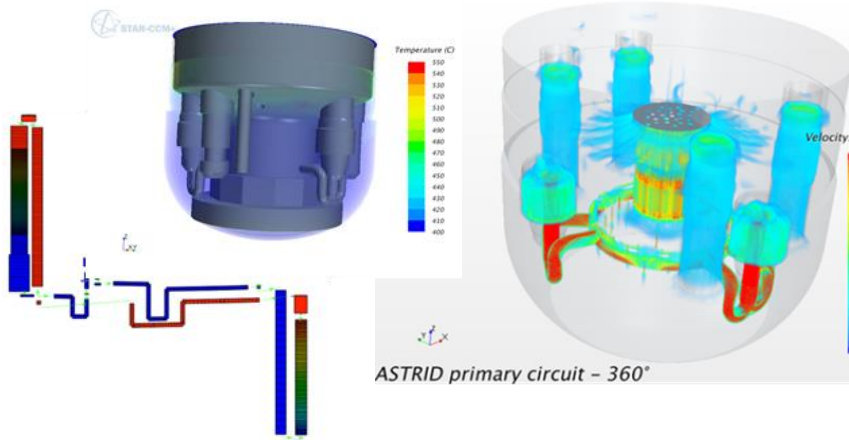
n/tmp/output_neureco.csv Filter: Energy_Consumption



output_neureco.csv

output.csv

Meta-model

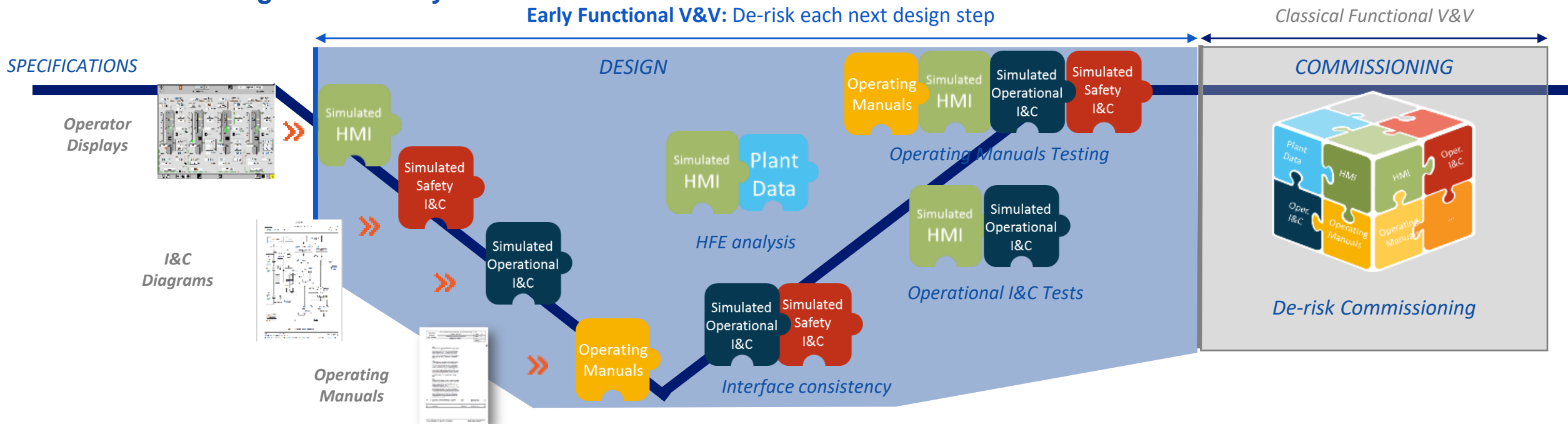




Early Launch of Validation via an Evolving Engineering Simulator

An integration platform with combinable simulation blocks able to:

- **grow** with the maturity of the deliverables (*from a low-fidelity simulator to Full Scope Simulator capabilities*)
- be **available** for the design team since the design phase
- support **early and iterative** validations (*Open and Closed-loop Testing*)
- ensure **digital continuity**



HFE: Human Factors Engineering, I&C: Instrumentation & Control

ask framatome

Question & answer platform to
share and secure tacit knowledge



Save time
by providing
quick answers



Derisk
by providing
right answers



Secure
knowledge
continuously



Scale
across complex
organisations

ask
for
the
moon

Open Innovation

ask
for
the
moon

Address new
needs

Framatome Nuclear
Industrial Innovation
Hub : NIIH

to address the Key
Challenges for the
Future

framatome

3 Pillars of the Framatome Nuclear Innovation Hub - NIIH



Survey
Detect
Observe & Listen

→ **UNDERSTAND**

New Ecosystem
New Customers



Connect
Exchange & Share
Enrich each other

→ **COLLABORATE**

Internal &
External Ecosystem



Experiment
Test & Learn
Generate (success) stories

→ **DOING THINGS**

Agility & Lean
Entrepreneurship Mindset

Framatome NIH: New Action Modes

A disruptive infrastructure: Le SPOT

A unique dedicated collaborative space gathering Labs for brainstorming and creativity sessions, rapid prototyping, robotics and virtual reality immersive experiences



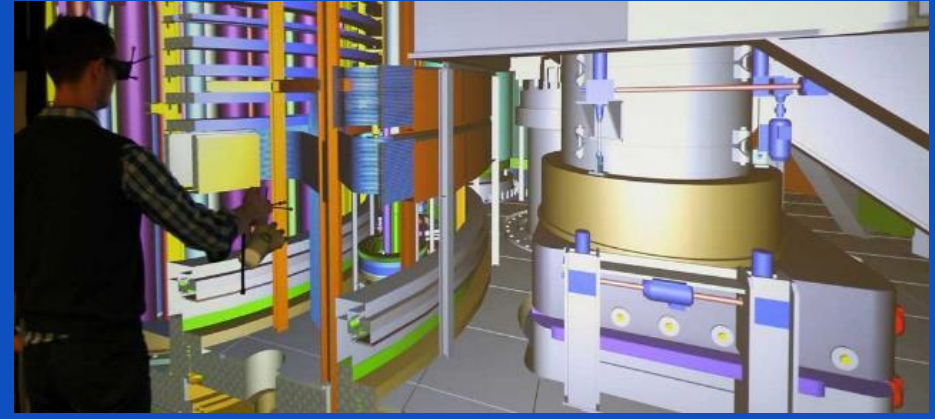
New SPOT: collaborative and open space in the new Framatome premises at Lyon Gerland



“

Engaged to Deliver
the Low Carbon Energy
the world needs

”





Thank
you

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