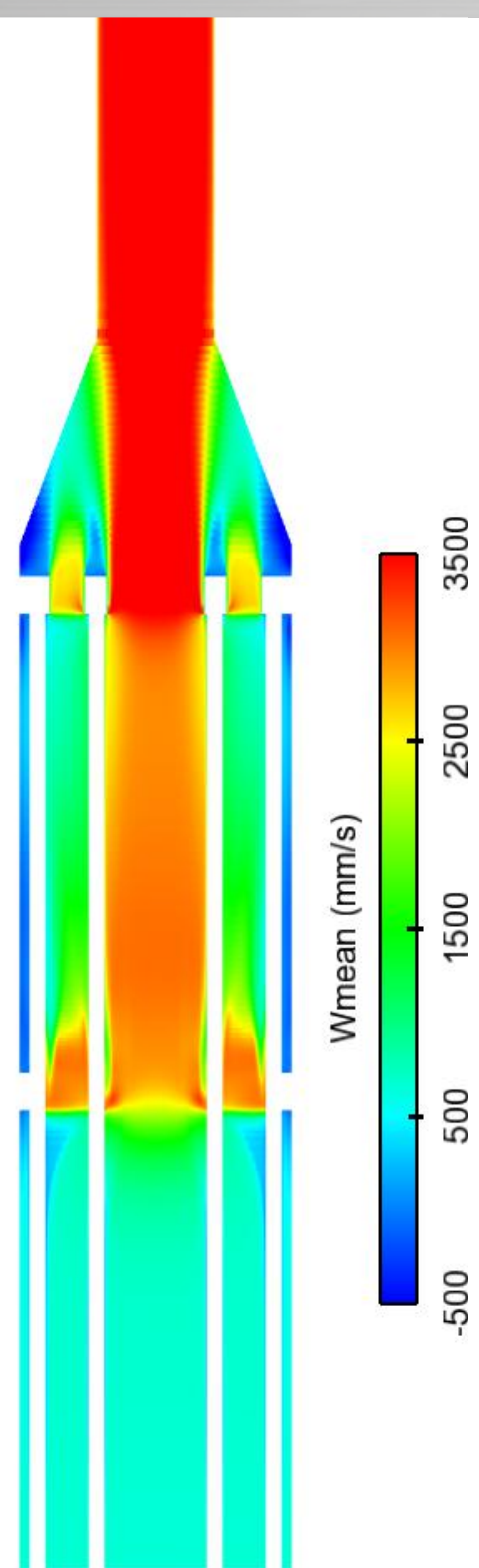
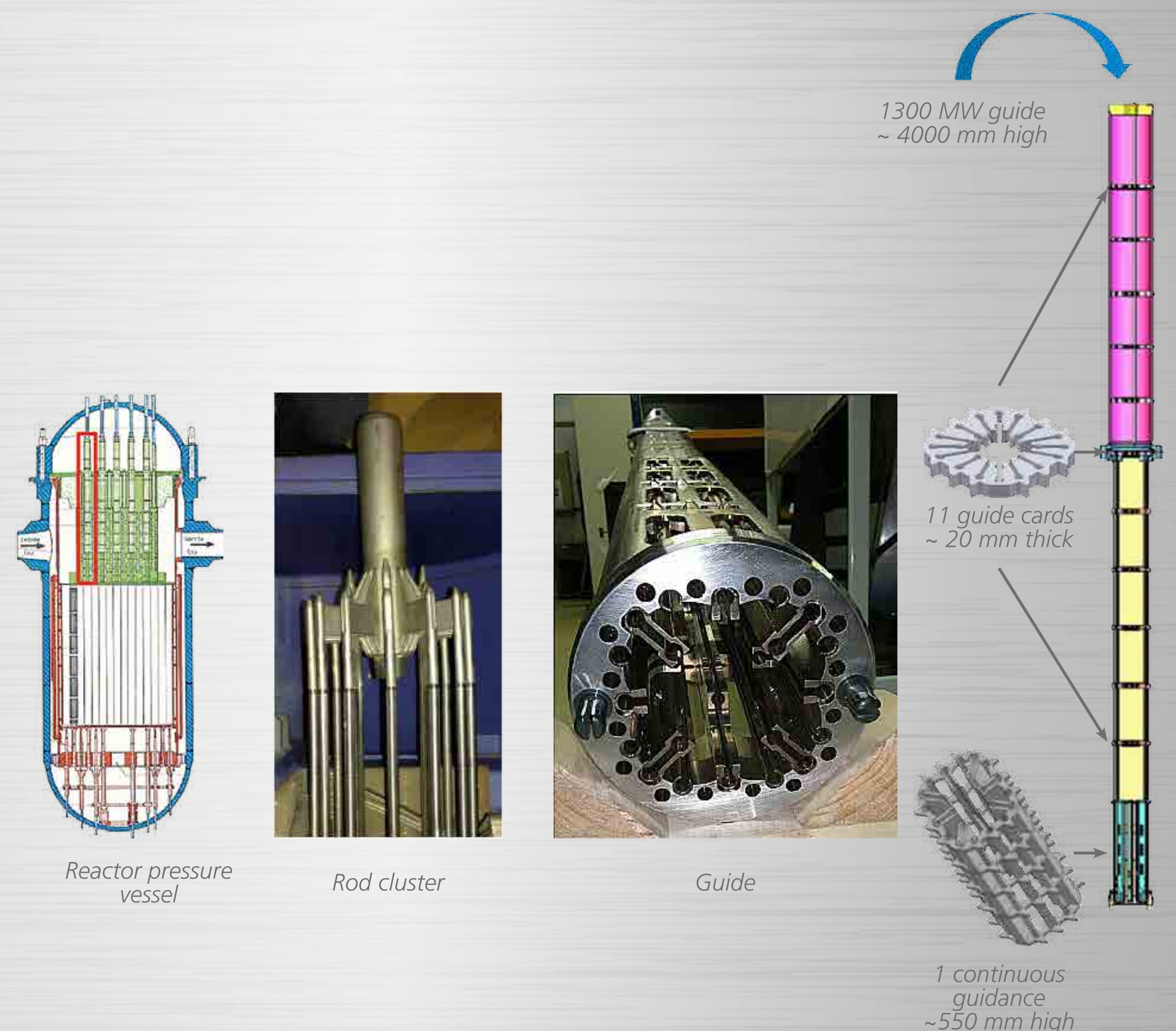


GUIDE CARDS WEAR UNDERSTANDING:

Origin of vibrations and correlation vibrations/ worn volume

Because of turbulent flow, Rod Cluster Control Assemblies (RCCAs) vibrate in the Control Rod Guide Assemblies (CRGAs or simply guide), causing wear of the guides. It is an issue for safety because guides worn beyond the criterion may lead to control rod blockage and for plant performance because of maintenance costs. The objective of the "Guide cards wear" project is to answer to the following questions:

- Which flows are responsible of the vibrations?
- What is the link between the mechanical solicitations and the worn volume?
- What are the physical mechanisms responsible of wear?



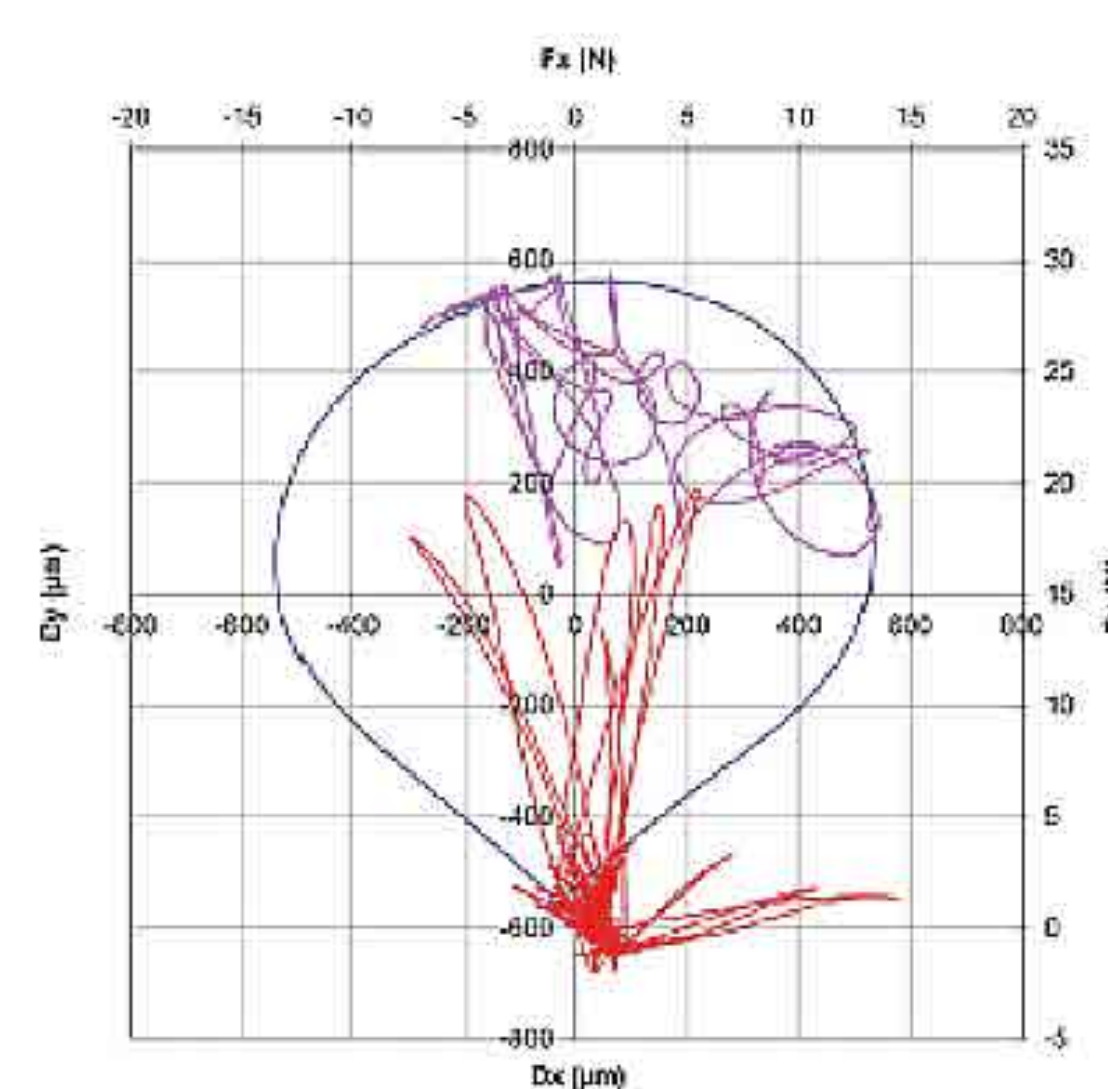
1. Thermohydraulics and mechanics modelling to better understand the origin of vibrations causing wear

Computational Fluid Dynamics calculations of part of a CRGA (3 successive guide cards) giving flow rate, turbulent flow, pressure load. Mechanical modelling to deduce an order of magnitude of displacement amplitude and impact characteristics.

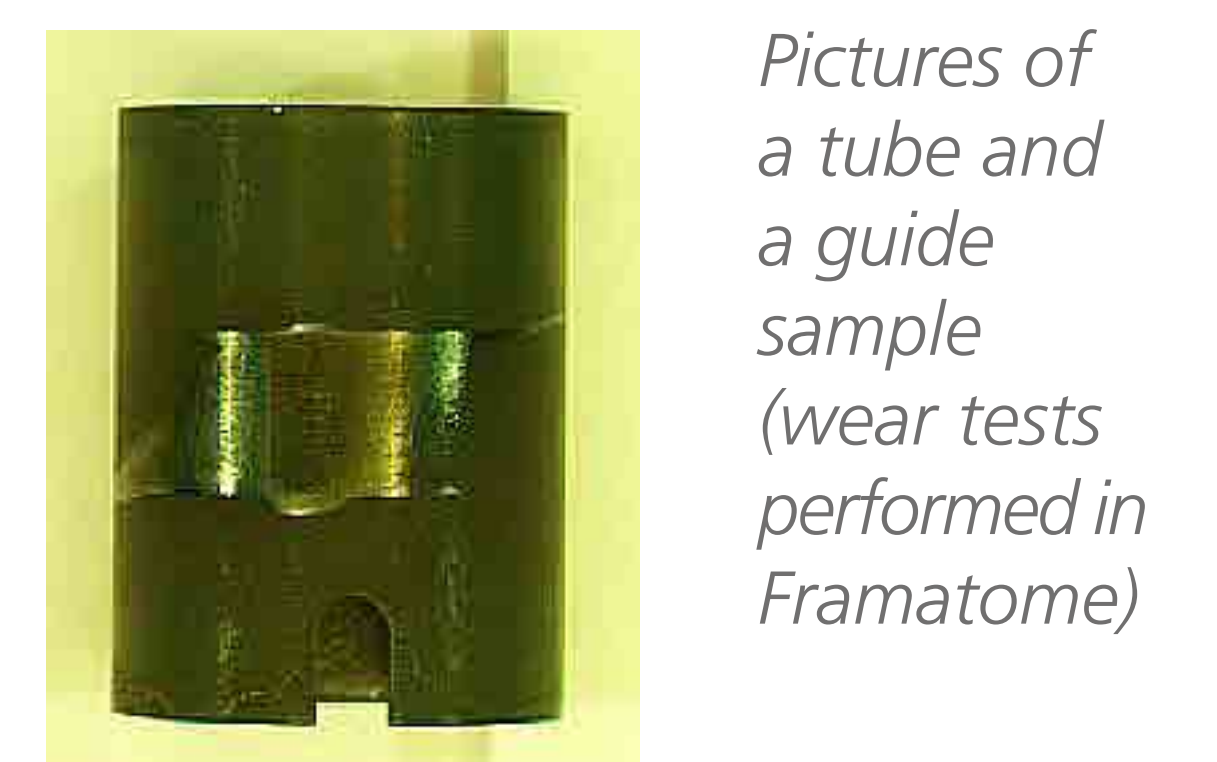
Preliminary RANS calculation with a non representative 2 cards mock-up giving the flow rate

2. Wear tests to improve wear modelling

Correlation of wear volume in function of mechanical solicitations based on impact-sliding wear tests in primary water of tube samples against guide samples.



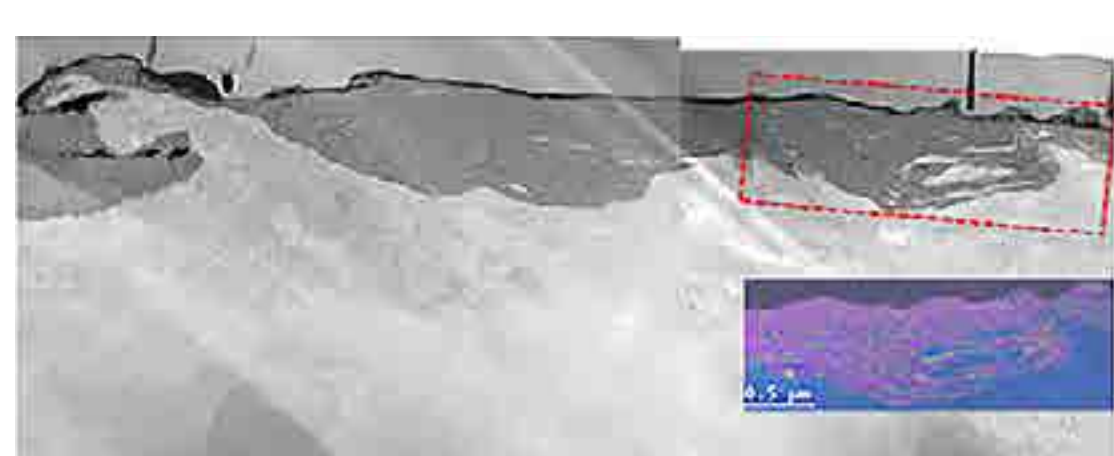
Displacement (purple) and contact forces (red) measured all along the test



Pictures of a tube and a guide sample (wear tests performed in Framatome)

3. Material expertise to understand wear mechanisms and validate wear tests

Destructive expertise of real worn components compared to expertise of wear tests



(EFTEM : Fe, Cr, O)

TEM images on thin cross-sections prepared by FIB. Guide sample after laboratory wear test (EFTEM composite image corresponding to the surrounded area with dashed lines).

Created value

- Direct economic value by reducing maintenance costs through a better understanding of wear which will help to reduce it.
- Implicit value through scientific credibility towards safety authority with regard to wear understanding.