Research

Aim and Scope
Our team develops new methods, frameworks and modeling architectures, techniques and algorithms, for the safety and risk analysis of complex engineered systems, based on a holistic and systemic viewpoint. The modeling, simulation and optimization methods, frameworks, architectures, techniques and algorithms that we develop, integrate a number of competences for viewing and solving the problems from the different, multidisciplinary system perspectives (topological and functional, static and dynamic, etc.) that are needed, and giving due account to the existing uncertainties. In-house softwares that implement the problem solutions found are developed and applications are done on industrial systems like aircrafts, nuclear power plants, oil and gas systems, automotive and railway transportation systems.

Topics
Our research is organized around 3 main topics:

1. **Energy network systems**, focusing on modeling, simulation and optimization of electrical network systems. The analysis of these systems cannot be carried out only with classical methods of system decomposition and logic analysis; a framework is needed to integrate a number of methods capable of viewing the problem from different perspectives (topological and functional, static and dynamic, ...), properly treating uncertainties by probabilistic and non-probabilistic methods.

2. **Aging and failure processes in components of energy production plants**, aiming at assessing component degradation, analyzing and building maintenance solutions, and carrying out system simulation for reliability, availability, maintainability and safety (RAMS) analysis by multi-state physics, Bayesian and Markov chains models, Monte Carlo simulation. A particular focus is on failure prediction and prognostics of critical components, by data-driven approaches, e.g. adaptive artificial neural networks, support vector machines and the like.

3. **Dependable embedded systems**, consisting in developing concepts, methods and tools to design dependable embedded systems, with a special focus on avionic systems. The state-of-the-art Fault Tree assessment tools Aralia (now commercially distributed by Dassault Systemes) and XFTA have been created and are continuously developed and updated.

Key figures in 2014

- **25 members**
- **2 research chairs**
- **3 PhDs achieved**
- **41 journal papers**
- **24 conferences**

3 PhDs achieved

- **Ronay Ak**: Neural network modeling for prediction under uncertainty in energy system applications
- **Elisa Ferrario**: System-of-systems modeling and simulation for the risk analysis of industrial installations and critical infrastructures
- **Elizaveta Kuznetsova**: Microgrid agent-based modelling and optimization under uncertainty

5 faculties: Marc Bouissou, Yanfu Li, Nicola Pedroni, Antoine Rauzy, Enrico Zio

15 PhD students: Benjamin Aupetit, Yiping Fang, Fangyuan Han, Mélissa Issad, Siwar Kriaa, Benoît Lebeaupin, Anthony Legendre, Yanhui Lin, Jie Liu, Xing Liu, Chung-Kung Lo, Rodrigo Mena, Muxia Sun, Pietro Turati, Tairan Wang

3 post-docs: Elisa Ferrario, Elizaveta Kuznetsova, Ionela Prodan

1 engineer: Loic Peletan

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## Publications

(selection of 7 out of the 41 journal papers published)

### Energy network systems

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<th>Author(s)</th>
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<th>Journal/Conference</th>
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### Aging and failure processes in components of energy production plants

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### Dependable embedded systems

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## Collaborations

### Academic collaborations

**Europe**: ETH Zurich, Liverpool John Moores University, Manchester University, Norwegian University of Science and Technology, Politecnico di Milano, Technical University of Denmark, Universitat Politècnica de València and others.

**Rest of the world**: Beihang University, City University of Hong Kong, North China Electric Power University, Wuhan University of Technology and others.

### Invited professors:

Shubin Si, Northwestern Polytechnical University, China
Min Xie, City University of Hong Kong, China

### Associated industrial chairs:

Chair Blériot-Fabre, SAFRAN

### Associated research institutes:

Paris-Saclay Éfficacité Énergétique (PS2E), http://institut-ps2e.com/
Institut de la Science de Risque et Incertitude (ISRI), CentraleSupélec
Laboratorio Analisi di Segnale e Analisi di Rischio (LASAR), Politecnico di Milano, www.lasar.polimi.it

## Organization of...

### 3rd PhD School:


### International workshop:

“’Young Researchers in Reliability and Risk Analysis” 26-28 May 2014, Donaufugata, Italy.
Workshop “Risk in complex systems: do we know and have everything we need for assessing them and managing them?” 11 September 2014, at Ecole Centrale Paris, France

### International conferences:

European Safety and Reliability ESREL 2014 Conference, 14-18 September 2014, Wroclaw, Poland
8th Summer Safety and Reliability Seminar (SSARS), 15 September 2014, Wrocław, Poland.