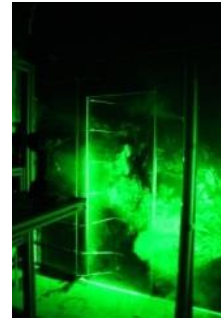


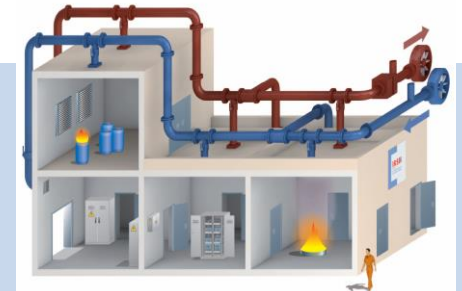
IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire



HOW EXPERTISE AND RESEARCH FEED EACH OTHER?



31 mai 2018
Jean-Christophe NIEL
© IRSN

Public expert on radiation protection and nuclear safety

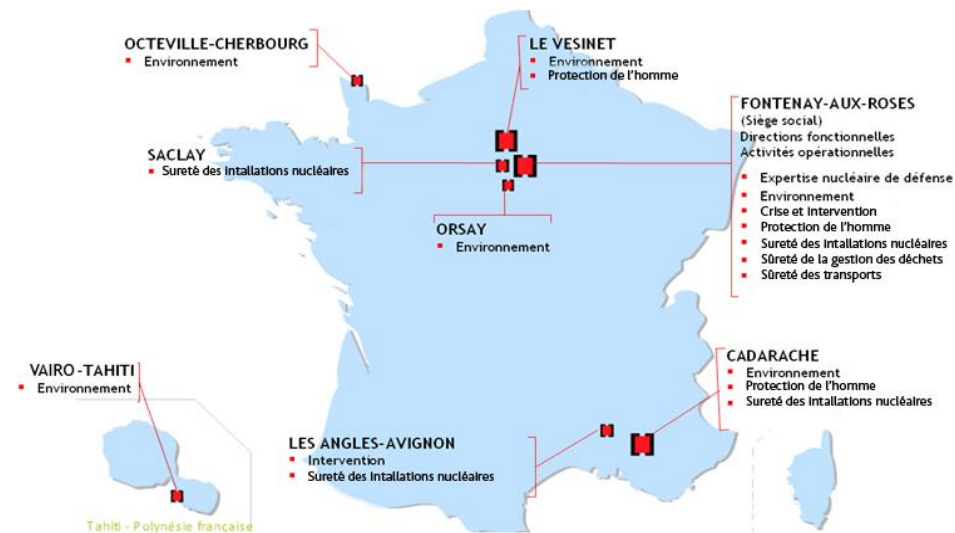
A public body placed under the joint authority of the Ministries of Environment, Defence, Energy, Research, and Health

National public expert for research and technical support on radiation protection and nuclear safety risks

1800 employees, including more than 1000 specialists: researchers, Ph.D. students, post-docs and engineers

A budget of €300 million

8 establishments in France, including 3 major sites: Fontenay-aux-Roses, Cadarache and Le Vésinet

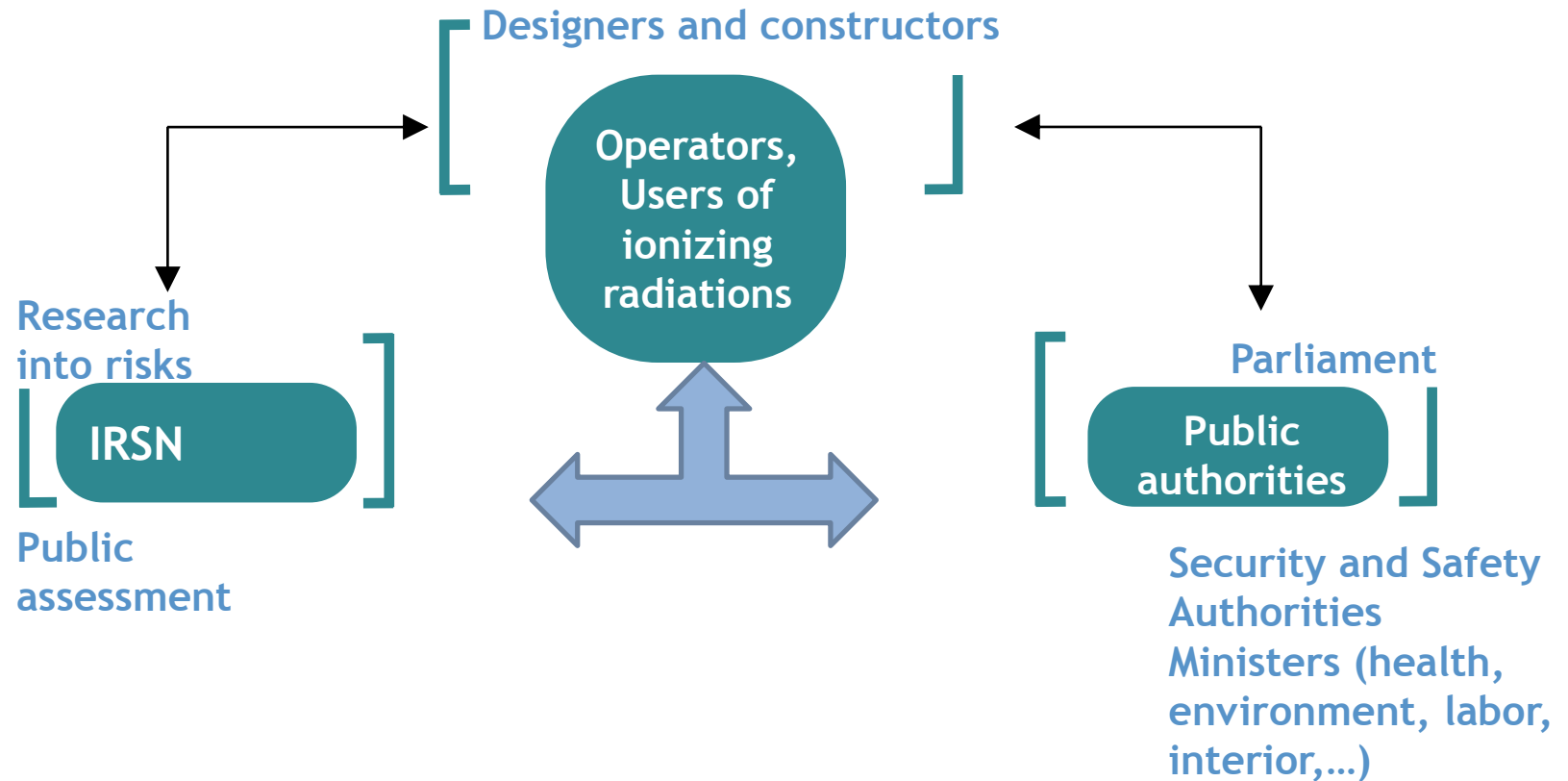


* Annuel report 2017

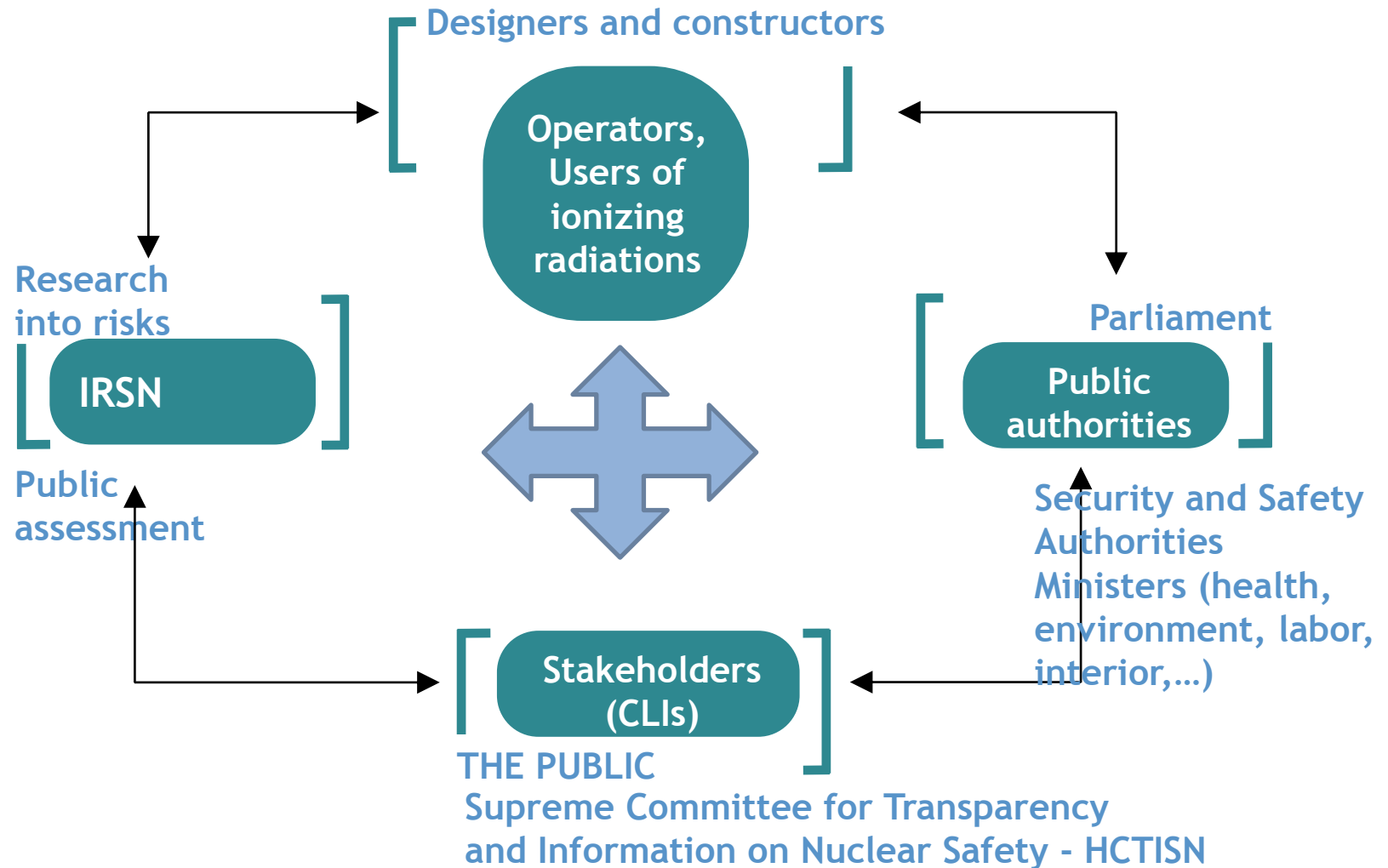
Field of activities

- Nuclear **safety**: reactors, fuel cycle, waste, medical applications and transports
- **Protection** of workers, patients, population and environment against ionizing radiation risks
- **Emergency** preparedness and post-accident operational support
- Protection and control of **nuclear sensitive materials**
- Protection of nuclear facilities and transport of radioactive and fissile materials against **malicious acts**
- **Training and Education**
- **Information** and interaction with stakeholders and civil society

Institutional environment



Institutional environment



Research and Assessment: Why?

The Law

« IRSN exercises assessment and research missions »

The regulation

« IRSN defines research programs to maintain and develop its knowledge and skills needed for its assessment activities »

- Development of knowledge and skills for assessment activities
- Development of tools and methods for assessment activities
- Improvement of nuclear installations safety level

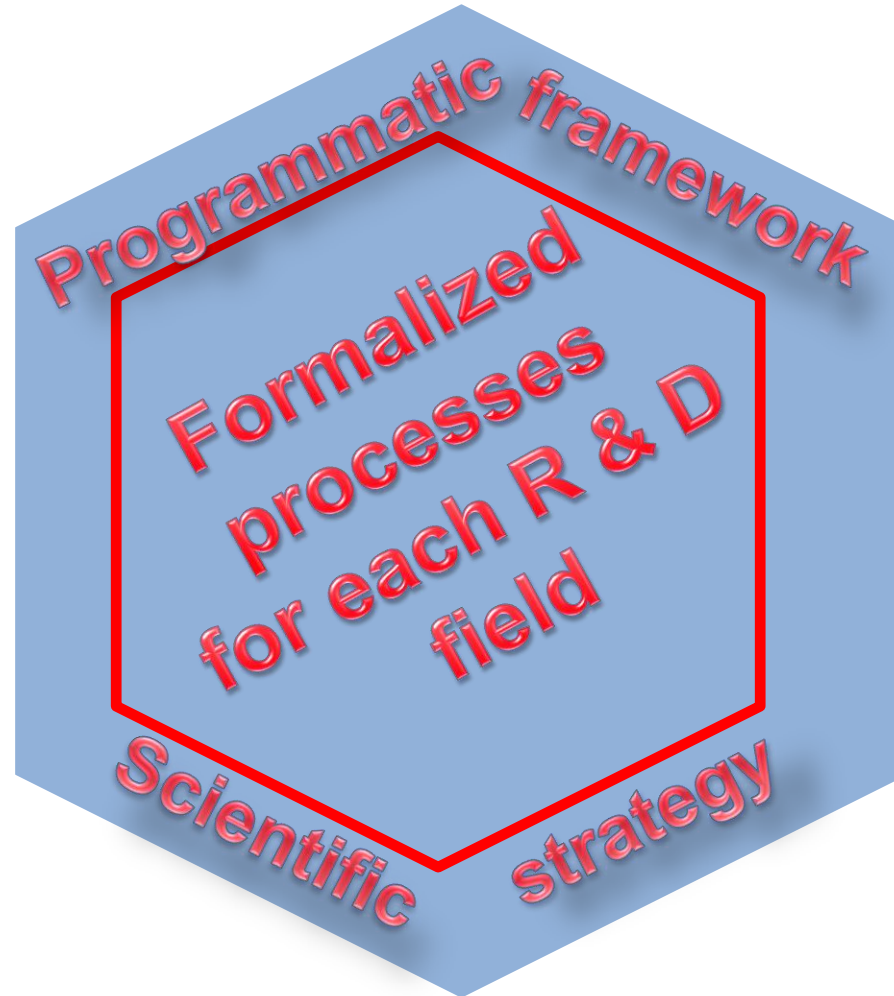
Research and Assessment: How?

International collaborations and platforms

ETSON, CSNI, international partners

National agency for research, Universities, Industrial actors

National collaborations and platforms



Needs and expectations

Operating experience feedback, Assessment feedback, Societal concerns

Skills, datas, tools and méthodes

Research and Assessment: The scientific strategy

- **9 Guidelines Used to Address Priority Scientific Issues**

1. **Justify the grounds for its scientific directions and the resources to be allocated to them**
2. **Involve the end beneficiaries in the research work**
3. **Take initiative to consolidate national, European and international research on nuclear and radiological risks**
4. **Develop academic partnerships and participate actively in the National Research Alliances**
5. **Develop cooperation with manufacturers and stakeholders in the medical sector wherever necessary**
6. **Acquire numerical simulation tools and skills to uses them**
7. **Ensure IRSN access to research and experimental facilities and databases**
8. **Develop operational decision-making support tools and methodologies**
9. **Perpetuate systematized knowledge and know-how to improve risk assessment**

+ 7 questions to radioprotection, 10 questions to nuclear safety




IRSN
INSTITUT
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ET DE SURETE NUCLEAIRE

IRSN Scientific Strategy

Enhancing nuclear safety, nuclear security
and radiation protection

Enhancing nuclear safety



Research and assessment: Governance

- The Board (CA), composed of 25 members:

 - validates the scientific program and the large research investment

- The Scientific Council (CS), composed of 12 leading scientists:

 - gives an opinion on the Institute's programs and checks the relevance of its research programs regarding research issues

- The Visit Committee (CV), composed of 15 leading scientists:

 - evaluates the scientific quality of research teams and programs

Research and assessment: Governance



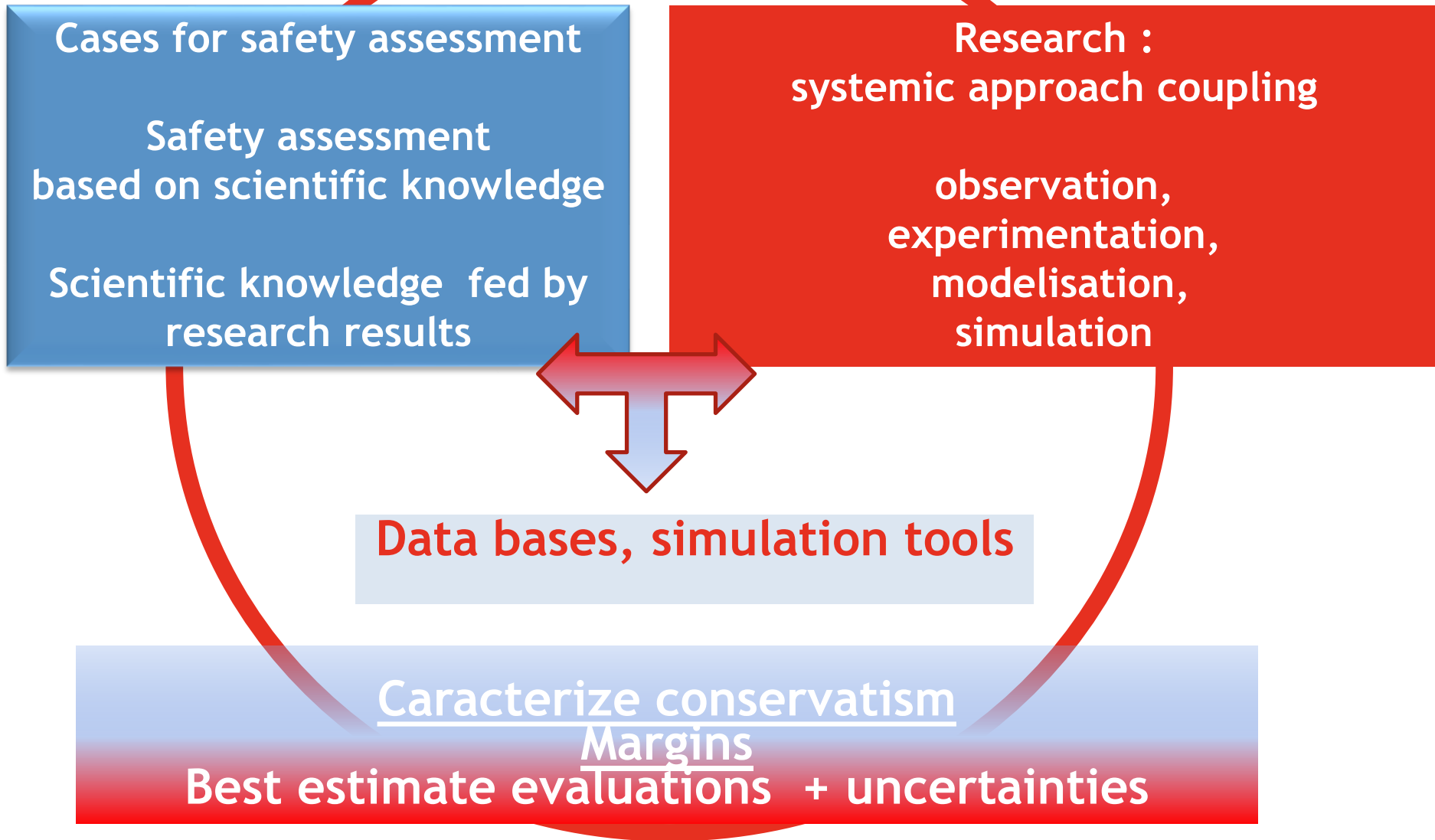
■ The Research Policy Committee (COR), with 43 members (research organisations, elected people, ministers, trade unions, ngo, industry):

gives an opinion to the board on the orientations of research to meet the expectations of public authorities and society and evaluates the relevance of IRSN's research programs regarding societal issues

■ The IRSN Operational Divisions:

realise the research and assessment programs.

Research and assessment: A systemic approach



Research and assessment: A systemic approach

Exploitation / large scale validation

Define the formalisation of problems/systems/ objects / experiences to simulate incidental and accidental configurations

Studies of application cases
Simulation of phenomena/ global systems /consequences / uncertainties

Exploration

Discovery research activities (numerical and experimental) / most analytical
Knowledge of phenomena, Fondamental data bases (microscopic scale, théoretical studies)

Data bases
Simulation tools

Validation

Vérify / validate
Typical simple cases, Separate tests

Develop some tools and methodologies
Physical models, Methods, Algorithms, Numerical work

Development

Research and assessment: Synergy

■ Integrated thinking

Units organized by technical specialty, leading both activities

■ Exchange on the needs and associated programs

« interface committee »

■ Direct feedback of the assessments

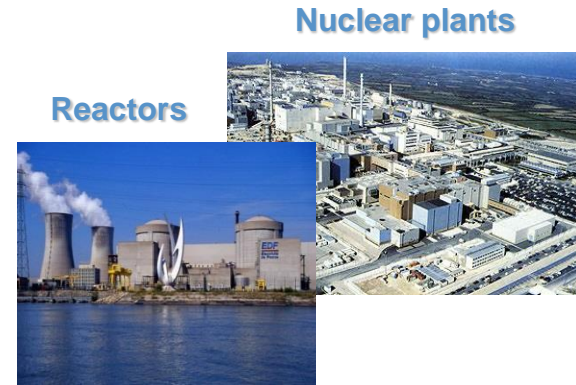
Structured knowledge needs identification

■ Synthesis of research results

Synthesis results sheets and expert systems adapted to the expertise

Research and assessment: Programs for nuclear safety

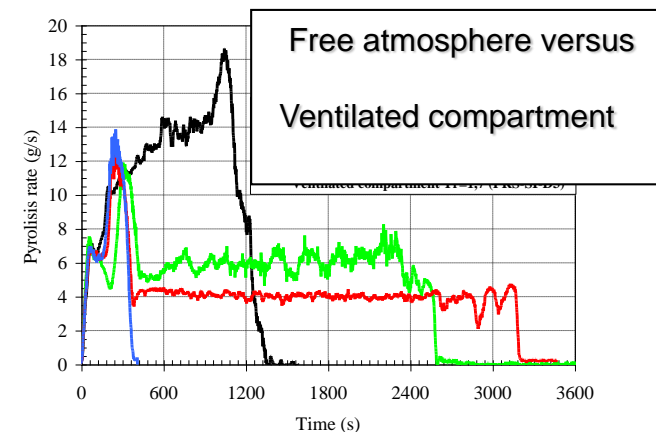
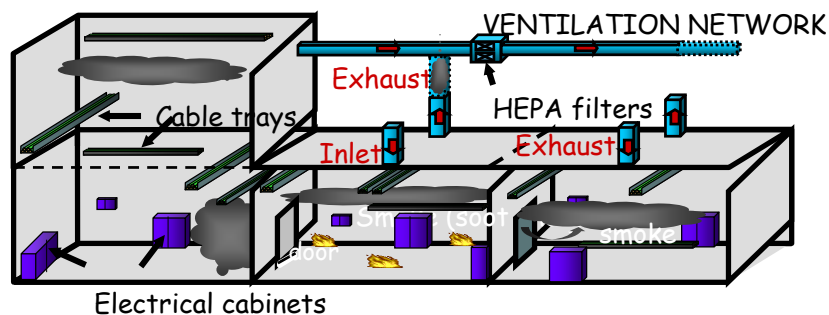
- Severe accidents
- Nuclear fuels behaviour
- Containment
- Explosion and fire
- Criticality/neutronic
- Ageing
- New generations of reactors (SMR...)
- Human and Social Sciences



Research and Assessment: Fire and containment

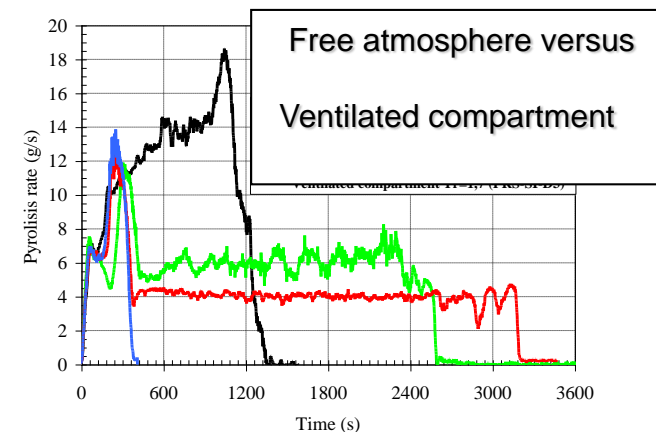
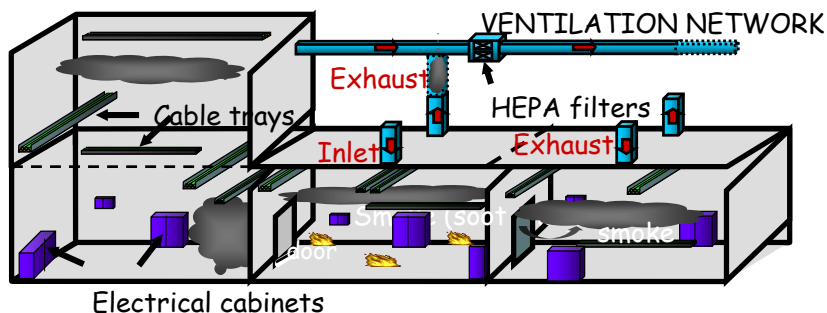
Nuclear Safety Question 2

How can we better characterize and model the loads placed on the facility by internal or external stresses or hazards (including natural ones), and which could have an impact on safety?



Research and Assessment: Fire and containment

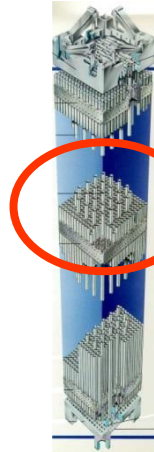
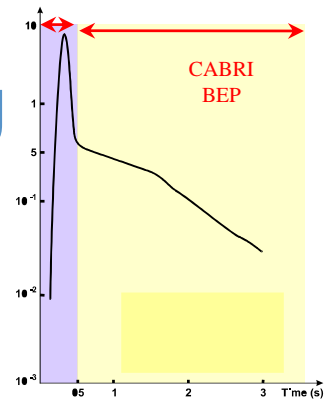
- Collaborate with various universities and CNRS: ETIC joint laboratory
- Develop simulation tools: SYLVIA (venting network + fire) ISIS (fire, CFD)
- Propose new programs of interest: link to operational concerns
- Lead international programs: PRISME program (OECD framework)
- Maintain experimental platforms: GALAXIE platform
- Develop an expert system to help in the assessment process



Research and Assessment: Damage to cladding

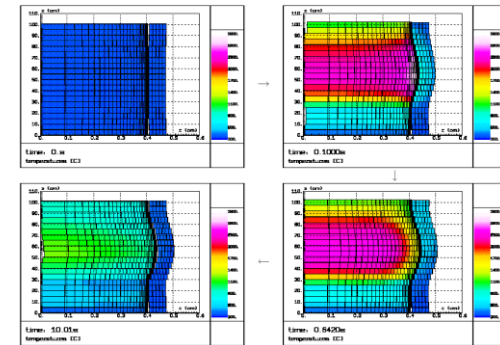
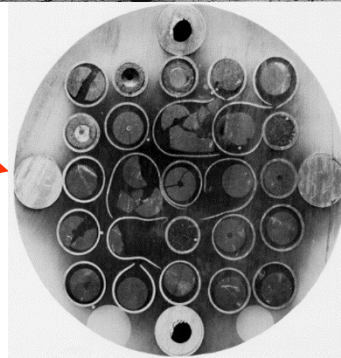
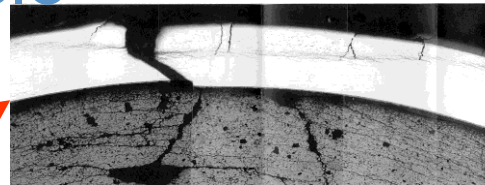
Nuclear Safety Question 5

Do we have all the knowledge we need to assess the risk of damage to the fuel cladding (first barrier) under normal and accident situations, taking account of the changing operating conditions for the fuel in the reactor and in the back-end cycle



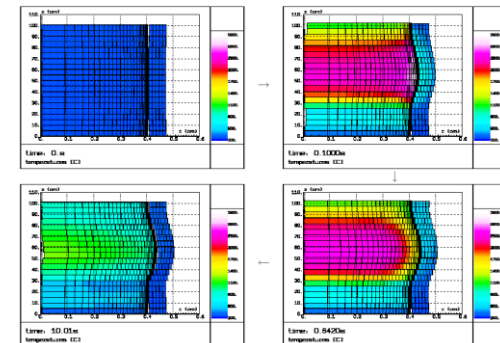
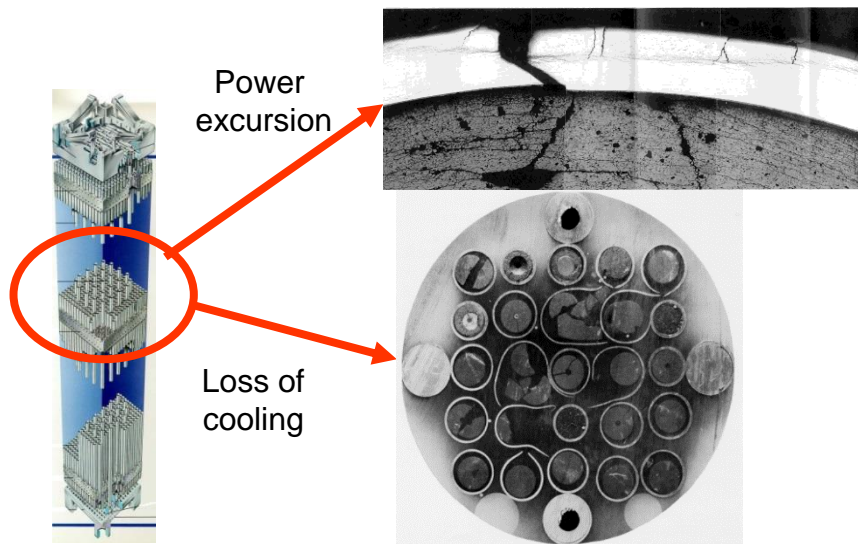
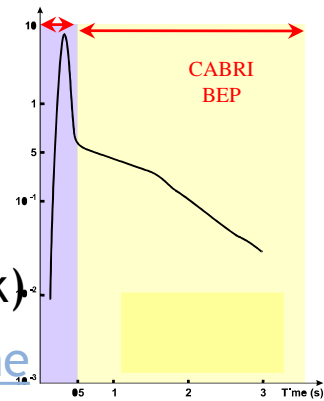
Power excursion

Loss of cooling



Research and Assessment: Damage to cladding

- Collaborate with various universities and CNRS: MIST joint laboratory
- Develop simulation tools: DRACCAR (APRP), SCANAIR (RIA)
- Propose new programs of interest: Fukushima feedback (PERFROI, DENOPI)
- Lead international programs: CIP program (OECD framework)
- Maintain experimental platforms: [Cabri reactor in Cadarache](#)



Research and Assessment: Ageing

Nuclear Safety Question 4

How can we realistically assess the safety impact of changes to the characteristics of the facilities throughout their lifespan?

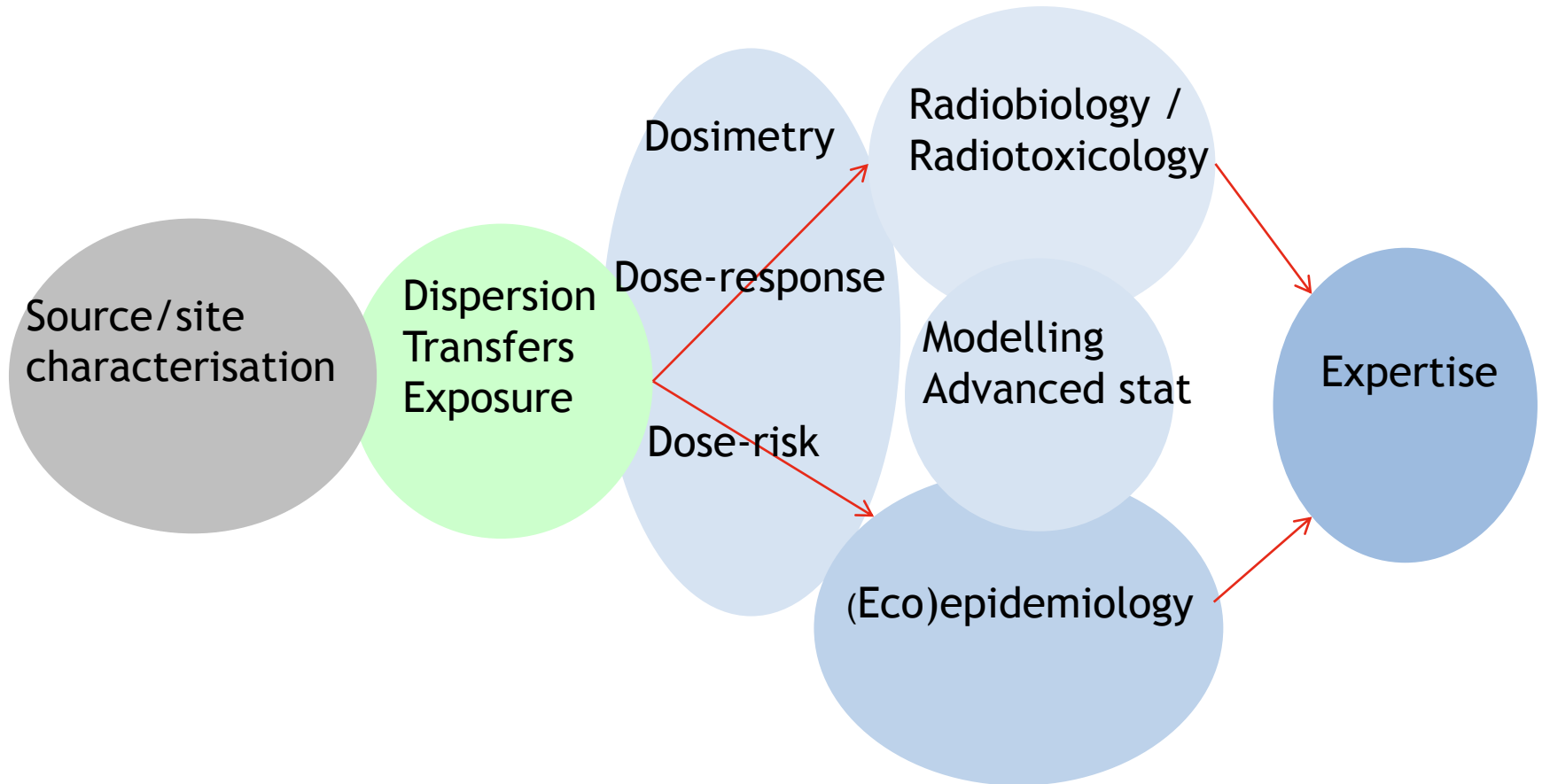


Research and Assessment: Aging

- **Collaborate** with various universities and CNRS: CONCRETE joint consortium (under discussion)
- **Develop models** for aging acceleration process
- **Lead international programs**: ODOBA focused on swelling pathologies and corrosion pathologies (carbonatation) on large concrete structure encountered in nuclear facilities
- **Maintain experimental platforms**: ODE platform



Research and assessment: Programs for radioprotection

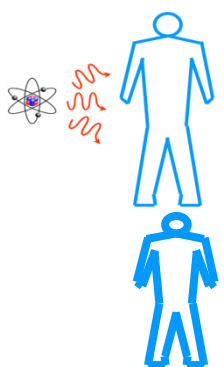


Research and Assessment: Pathologies from external exposure

Radioprotection Questions 5 & 6

5-How can the side effects from the use of ionizing radiation for diagnostic therapeutic purposes be better identified and prevented?

6- What innovative therapeutic approaches to answer the various pathologies associated to exposure to high radiological doses?

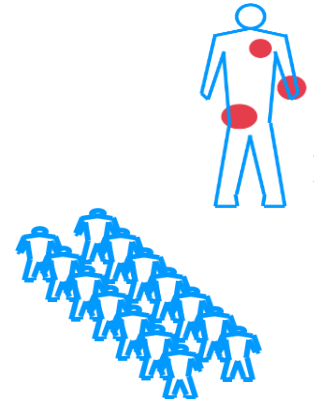


The diagram shows a blue outline of a human figure. To the left, a red atom symbol emits red wavy lines representing ionizing radiation. Below the main figure is a smaller, solid blue outline of a human figure.

Whole body irradiation:
Medium to high dose

- Hematopoïetic Syndrom
- Intestine lesions

➤ Urgent treatment needed

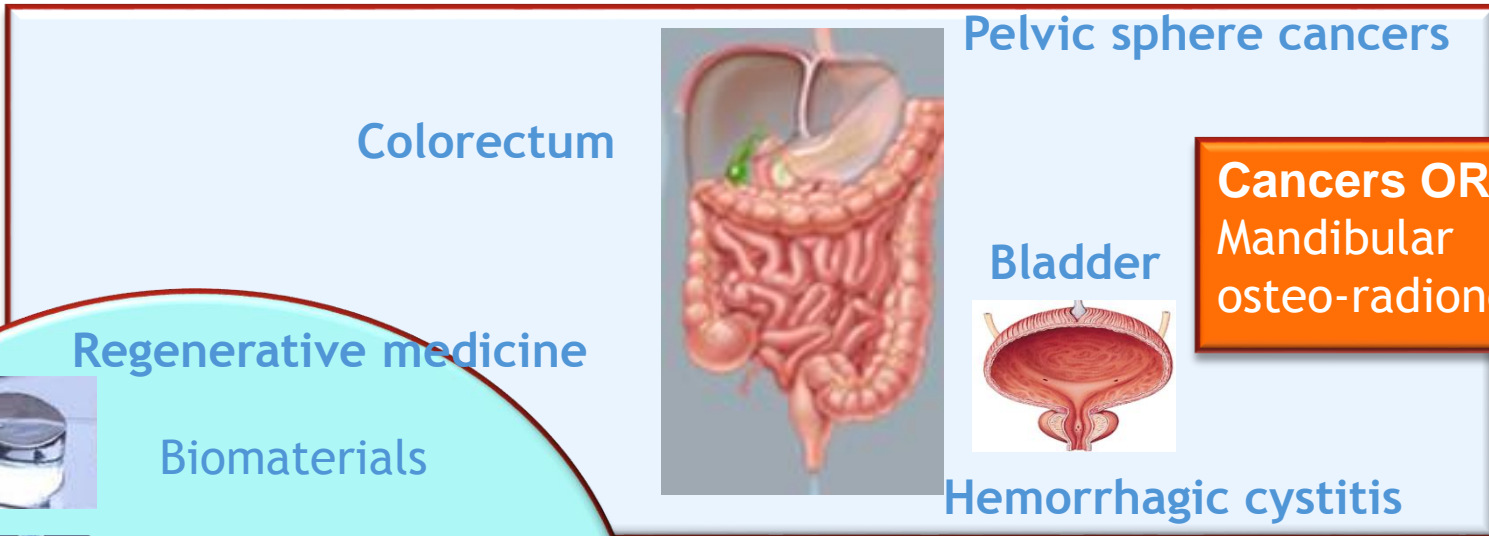


The diagram shows a blue outline of a human figure with three red circles on the chest and abdomen, representing localized irradiation. Below it is a group of smaller blue outlines representing a population of victims.

Localised irradiation: ➤ Radiological Burns
High dose

➤ Treatment of a high number of victims

Research and Assessment: Pathologies from external exposure



Cancers ORL
Mandibular
osteo-radionecrosis

Regenerative medicine

Biomaterials

Cotreatments (probiotics/ molecules)

Cotreatments with other types of stem cells

« mini gut »

This circular area contains three images and their corresponding text. The top image is a petri dish with a white, gelatinous substance. The middle image shows several blue, rod-shaped bacteria. The bottom image is a small, irregular, light-colored mass labeled '« mini gut »'. The text 'Regenerative medicine' is at the top, followed by 'Biomaterials', 'Cotreatments (probiotics/ molecules)', and 'Cotreatments with other types of stem cells'.

STEM CELLS

Research and Assessment: Exposure to low doses

Radioprotection Question 1

What are the effects of exposure to low doses?

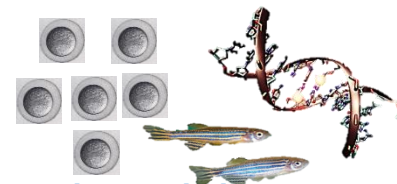
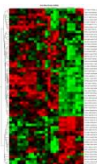
Research and Assessment: Exposure to low doses

Early biomarkers acting as alarm signal for later effects

Search for a molecular fingerprint for gamma irradiation using an approach integrated through time and biological scales

High through-put data :
(epi)genomics, proteomics

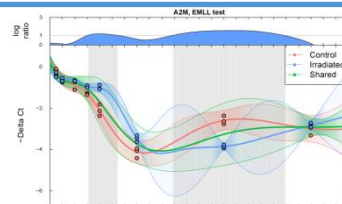
« omics »



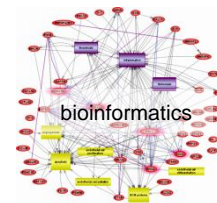
Various biological models



Use of system biology for
integrated data treatment



Mathematical models
Kinetic analyses



Biological networks

Research and Assessment: Experimental platforms

Saclay

Cadarache

GALAXIE

fires

BOREE
(STARMANA)

filters and
equipments
tests

Réacteur
Cabri (CEA)

transients on
fuel

CHROMIA

chemistry and
radiochemistr
y

MAESTRO

thermo-
mechanical
materials

THEMA
(PEARL)

thermo-
hydraulic

THEMA
(MEDEA)

fuel thermo-
hydraulic

MARIN
(BACCARA)

aerosol
metrology

BOREE
(PERSEE)

filters and
equipments
tests

MISTRAL
(TOSCAN)

transfer of
gases and
aerosols

ODE

concrete
ageing

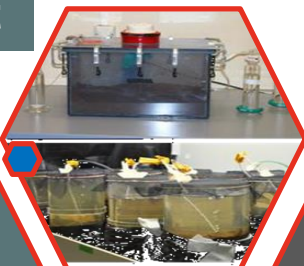
privileged
access to
external
platforms

Research and Assessment: Experimental platforms

FAR, Orsay, Vésinet

Cadarache

LUTECE
physico-chemical
characterisation
of soils, rocks,
solutions



MICADO-LAB
external gamma
irradiator for
chronic
exposure

SARRP
small animal
Radiation
Research
Platform

ALPHEE
linear
accelerator for
medical
applications

AMANDE
national
reference for
Neutron
metrology

ECORITME
physico-
chemical-
biological
characterisation
of matrices



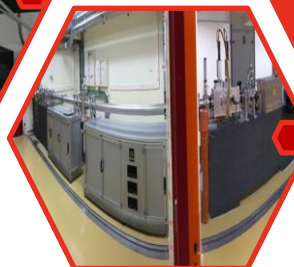
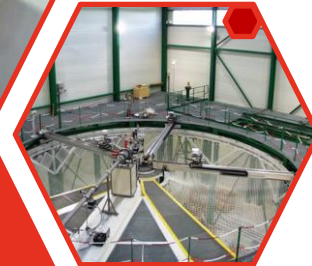
PARISII
lab for internal
contamination
of small
mammals



MICROSCOPY
imaging
platform for
biology



MIRCOM
microbeam for
research in
Radiobiology



Research and Assessment: some prospectives

- High level of safety based on high level scientific expertise
- Scientific expertise needs skills, datas, methods, tools
- These are fed by research

■ Major issues

- Enhanced collaboration among safety and rp bodies
- Interaction with stakeholders
- Capability to attract young scientists
- Central role of research experimental platforms...
 - Concern about their future
- Key role of European research
 - Attention to FP9

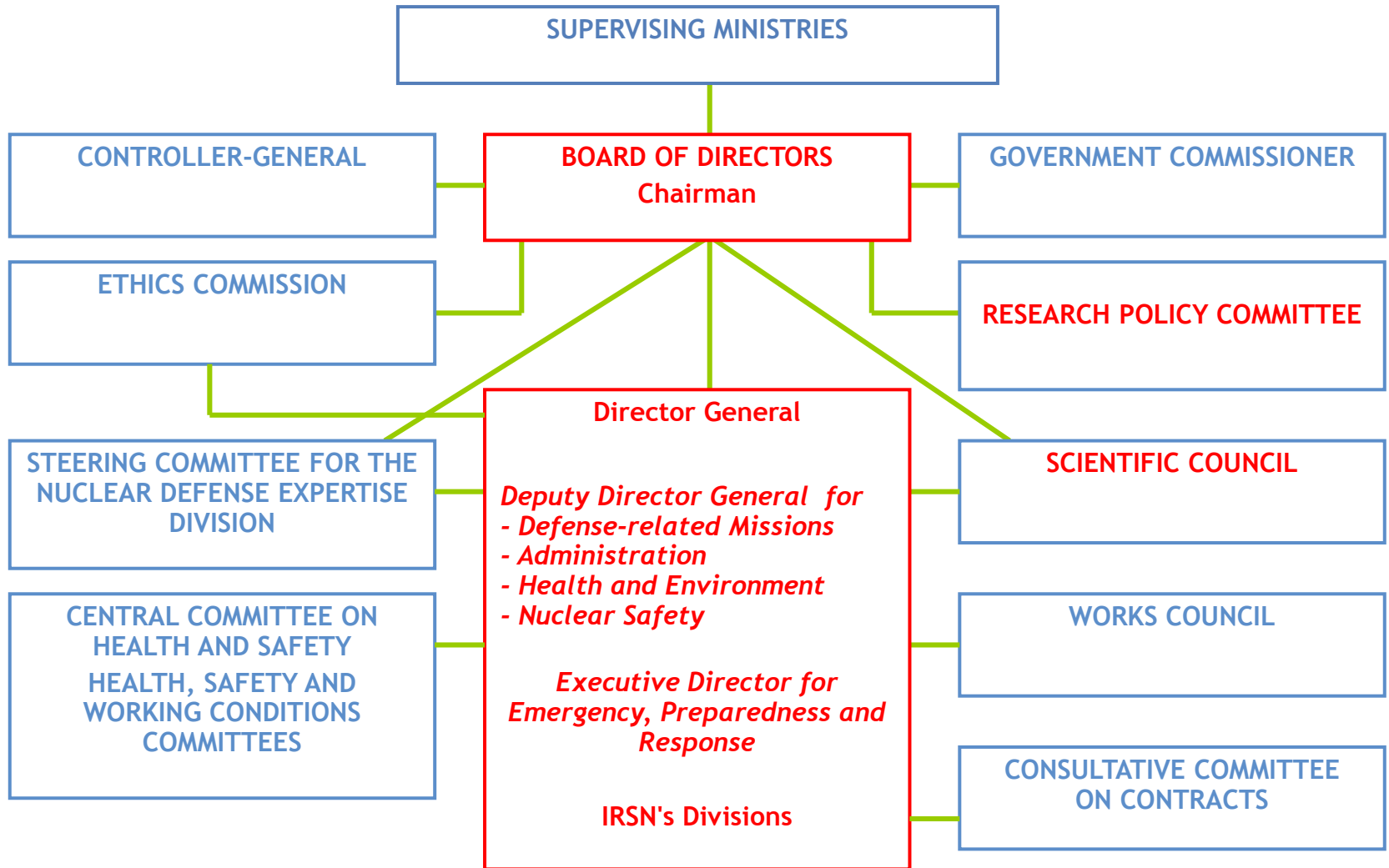
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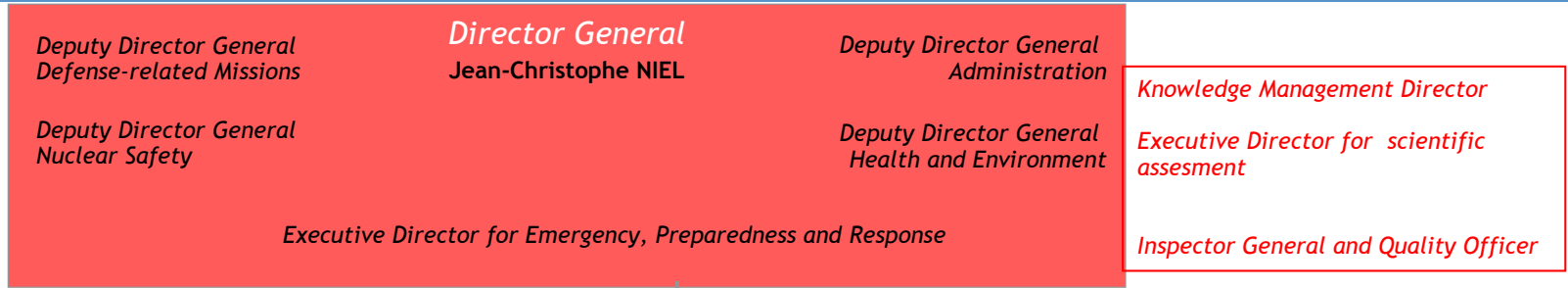
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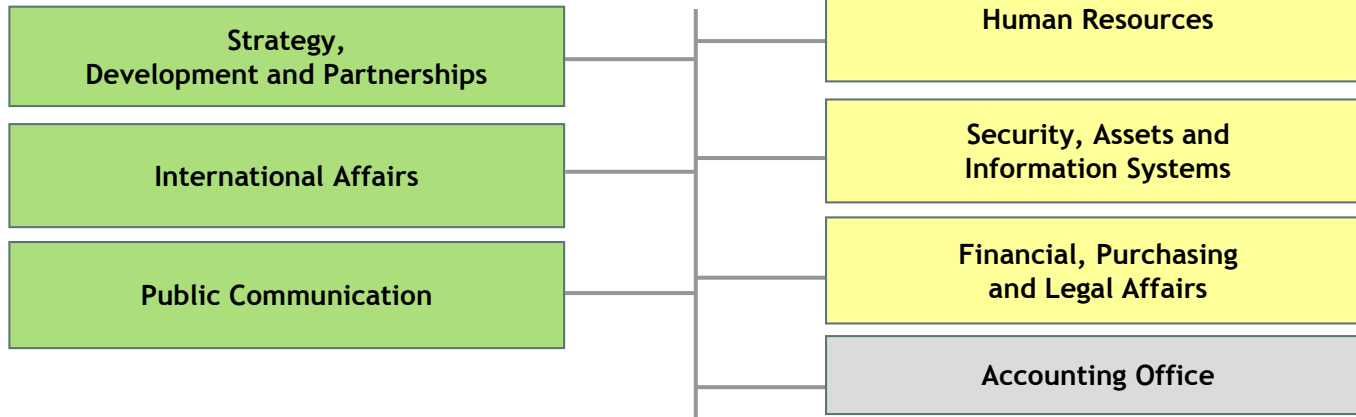
Enhancing nuclear safety

Institutional structures overseeing the operation of IRSN





Executive and Support Departments



Operational Divisions

