

Exercice de prospective nationale
en physique nucléaire, physique
des particules et astroparticules
Développements technologiques et applications associés

Données nucléaires pour l'énergie, de l'expression du besoin à l'évaluation

Contributeur(s) (et affiliations) de la proposition :

✕ LPSC - **A. Bidaud**, A. Billebaud, **G. Kessedjian**

✕ IJCLab - L. Audouin, **X. Doligez**

✕ SUBATECH - M. Estienne, M. Fallot, L. Giot, A. Porta

✕ CENBG - M. Aiche, B. Jurado, L. Mathieu

✕ IPHC - Ph. Dessagne, G. Henning, **M. Kerveno**

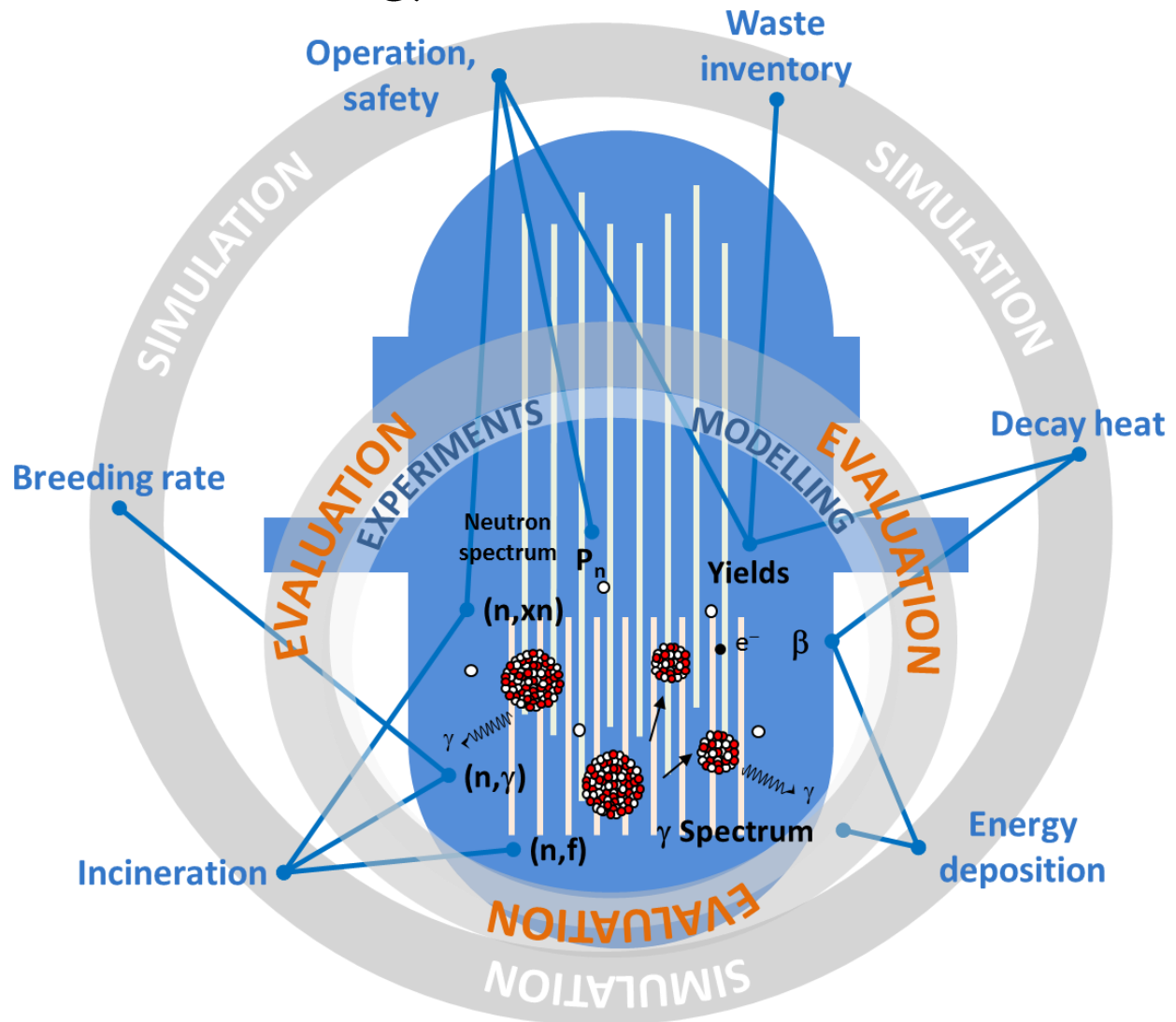
✕ LPCC - F.-R. Lecolley, J.-L. Lecouey, G. Lehaut, N. Marie

Séminaire thématique

Energie nucléaire et environnement

IPHC, Strasbourg, 5-6 Février 2020

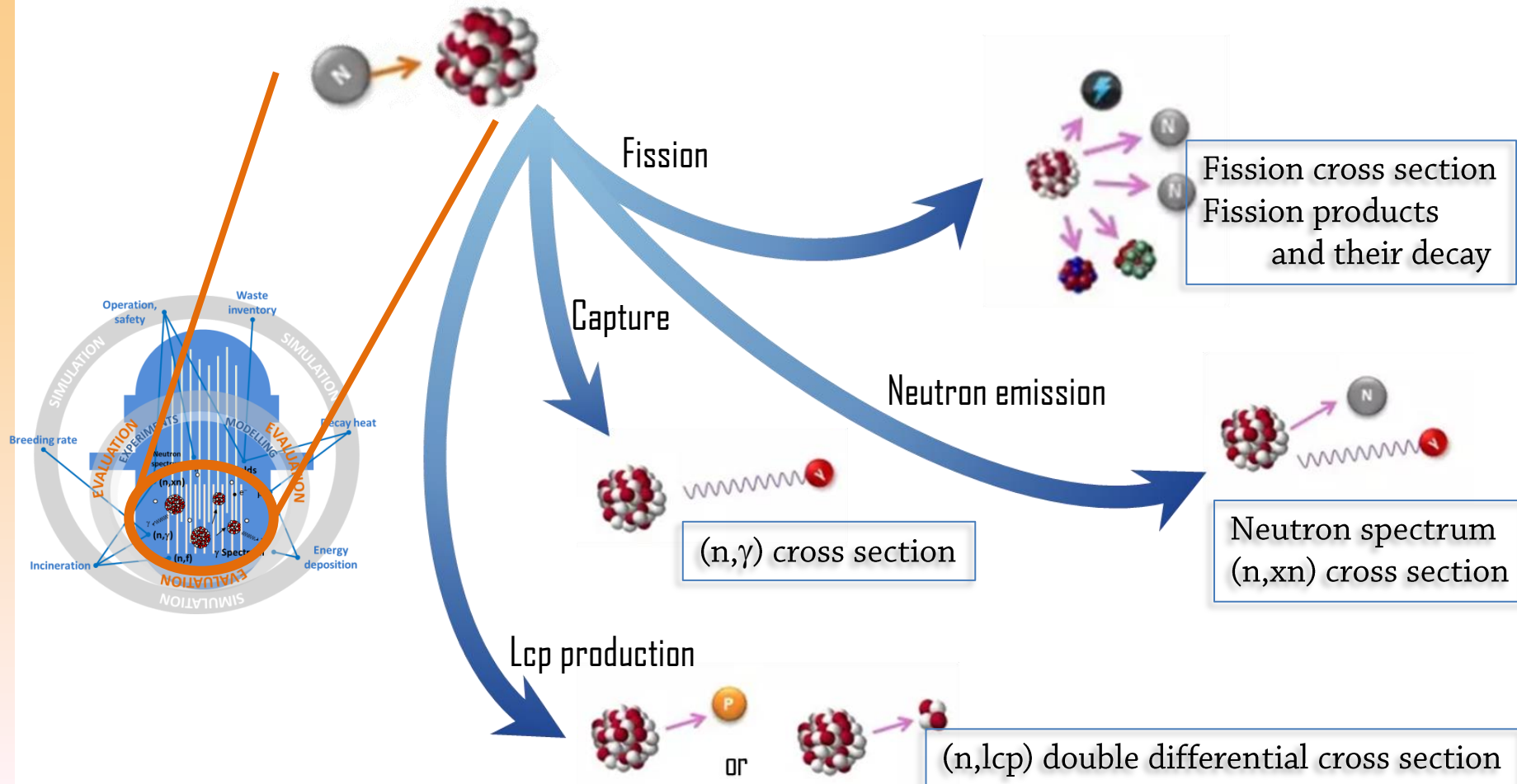
Nuclear data for nuclear energy



Nuclear data for nuclear energy

Better experimental knowledge of nucleus induced reactions

Especially on actinides but not only! (Energy appl.)



Experimental Data

Differential & integral

Theoretical Models

Evaluated Data

Evaluated data reflect
the **experimental** and **theoretical knowledge**
of a **nuclear data**

Applications



Experimental Data

Differential & integral

Theoretical Models

Evaluated Data

*** 10 years can go by** from the microscopic measurement to the new evaluated data.

**N
E
E
D
S**

Applications





Mostly experimental programs are conducted to produce new and accurate nuclear data (activity started @IN2P3 in the 90's)

OPALE

- ✕ 6 teams from 6 lab.
 - ✕ 20 senior research.
 - ✕ 6 doc, 1 post doc
 - ✕ NSIP : ~14 ETP
- 2019 -

Fission Products

FP



Universities
& Engineering
schools



Fission Products Decays

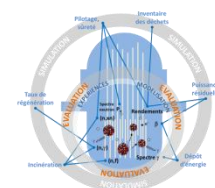
FPD

Cross Sections

XS

OPALE in its environment

NEEDS NACRE



le Noyau
Au
Cœur
du REacteur



IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

OPALE

Fission
Products



Universities
& Engineering
schools

Fission Products
Decays

Cross Sections



IAEA
International Atomic Energy Agency



NFRP 2018 - SANDA

SUPPLYING ACCURATE NUCLEAR DATA
FOR ENERGY AND NON-ENERGY APPLICATIONS
2019-2023

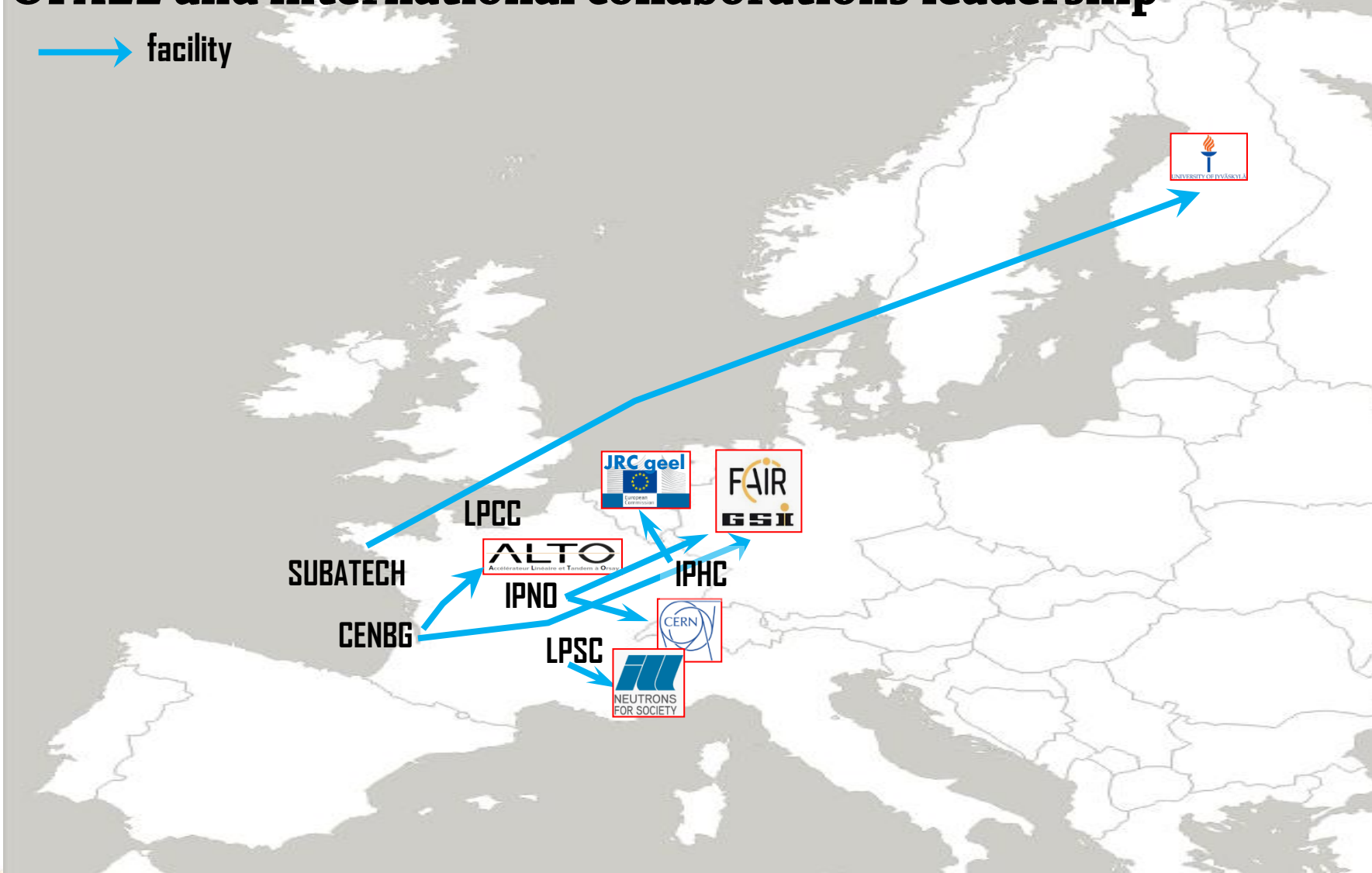
NFRP 2018 - ARIEL

ACCELERATOR AND RESEARCH REACTOR
INFRASTRUCTURES FOR EDUCATION AND
LEARNING 2019-2023

International collaborations for all projects

OPALE and international collaborations leadership

→ facility

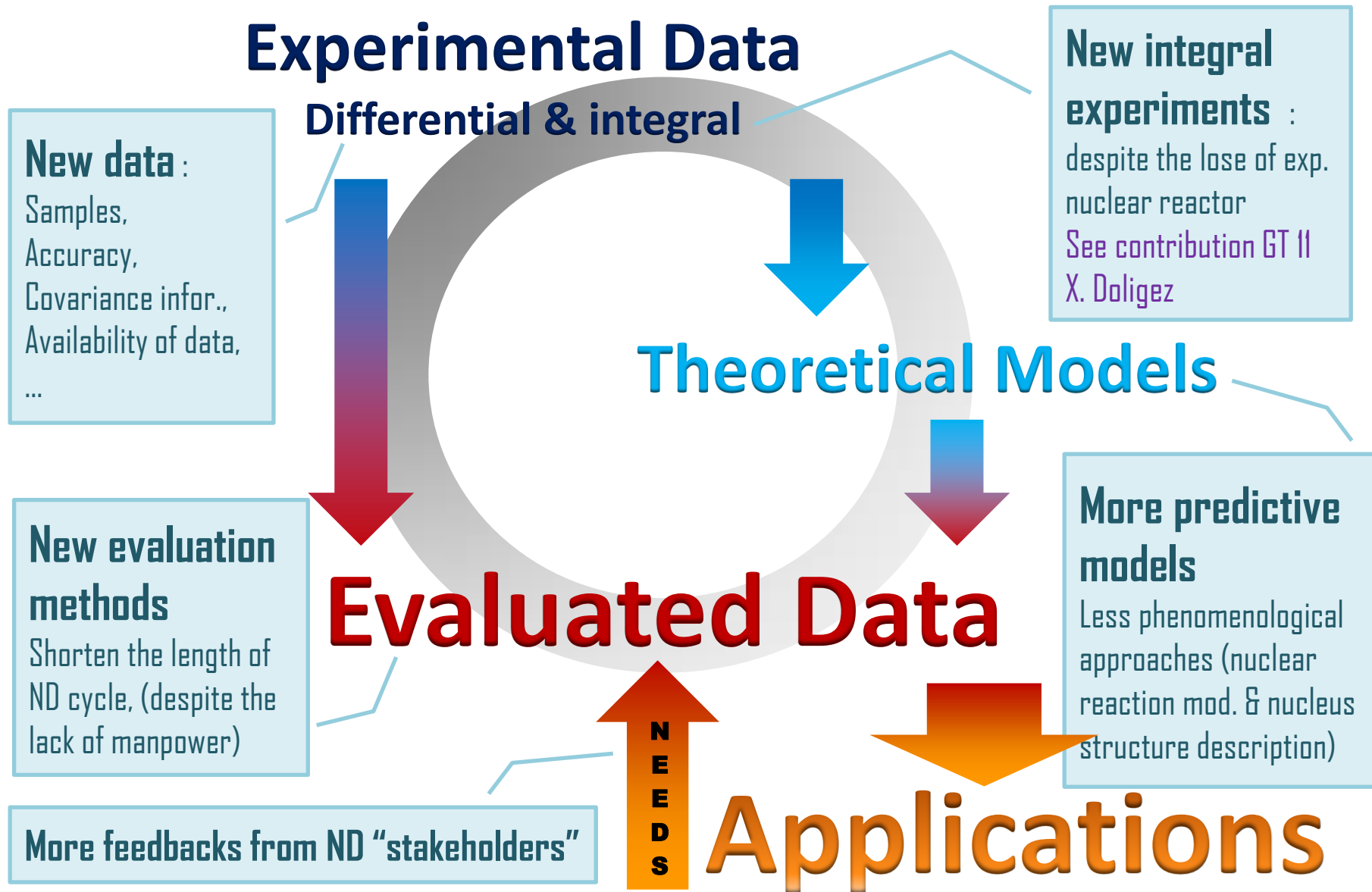


OPALE and international collaborations leadership

→ facility
→ laboratory



ISSUES (not exhaustive) IN NUCLEAR DATA FOR NUCLEAR ENERGY



PROSPECTIVES FOR NUCLEAR DATA – 10 YEARS

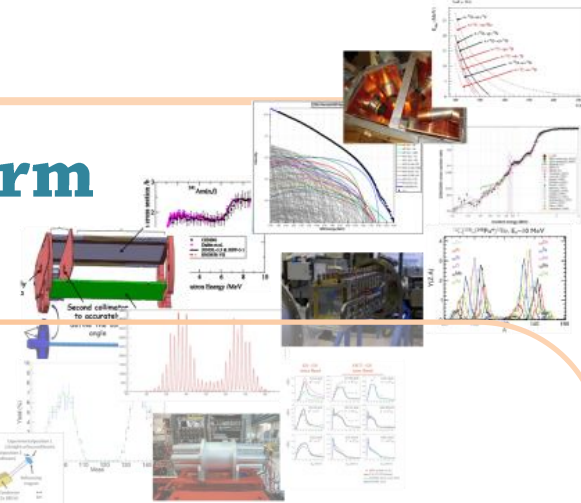
Experimental programs for new nuclear data

The heart of expertise

Mid term (at least)

CNRS has developed a **set of instrumental tools for XS, FP and FPD measurements** that can be used, as is or with upgrades, in the coming years to pursue the exp. programs.

- ✂ The **choice of isotopes and observables to measure** are made to fulfill requirements given by the **HPRL (NEA)**, or from **IAEA CRP, NEA WPEC** or for the new **JEFF-4 data base** (2023). *NB: from meas. to data in EXFOR ~4-5 years*
- ✂ Keep a **strong link** with **theoreticians** for nuclear reaction modeling
- ✂ CNRS is involved in a **4 years (2019-2023) EU project H2020-SANDA** with well defined objectives. The experimental programs can be also supported by the **H2020-ARIEL EU project** (WP3) which offers **transnational access** possibilities for **23 neutron facilities** (accelerator or reactors).
- ✂ For **target preparation**, WP3 SANDA to strengthen the target producer network, contacts with Ch. Stodel at a national level ([see contribution GT 7, Ch. Stodel](#))

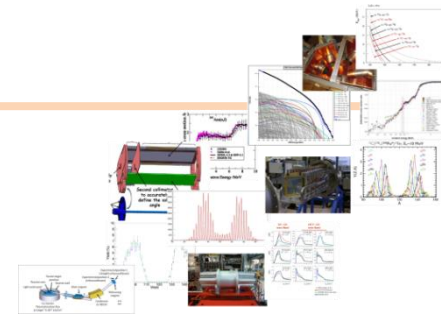


PROSPECTIVES FOR NUCLEAR DATA – 10 YEARS

Experimental programs for new nuclear data

Mid term

(at least)



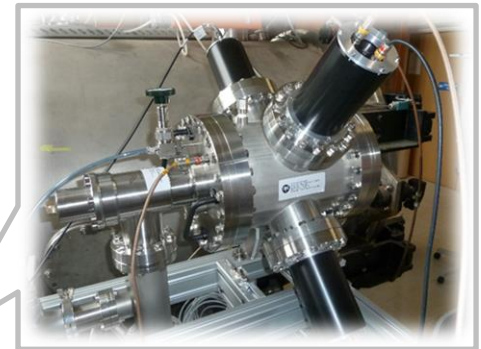
The heart of expertise

✂ Cross sections

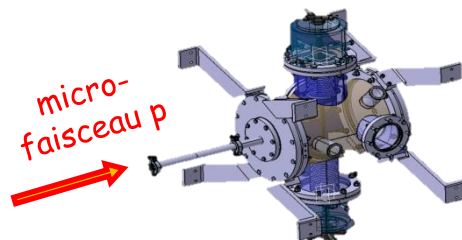
* **Inelastic scattering** ^{233}U , ^{239}Pu ,
with GRAPhEME (**IPHC**) @ GELINA (EC-JRC Geel)



* **Fission & capture by surrogate reactions**
 ^{240}Pu , ^{241}Pu , ^{242}Pu , ^{243}Pu @ ALTO, (**CENBG**)



* **Fission** ^{242}Pu normalize to $\text{H}(\text{n}, \text{p})$ (**CENBG**)



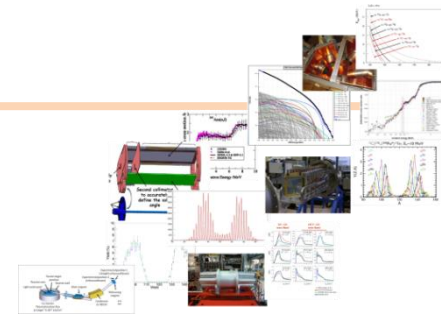
* ^{19}F , $^{16}\text{O}(\text{n}, \alpha)$ with SCALP (**LPCC**)
@ n-ELBE (HZDR, Dresden),
@ GELINA (EC-JRC Geel)

PROSPECTIVES FOR NUCLEAR DATA – 10 YEARS

Experimental programs for new nuclear data

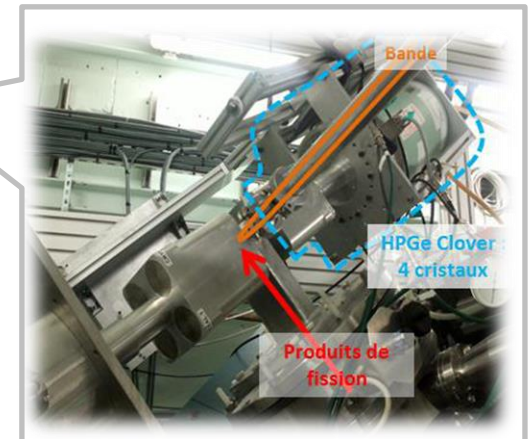
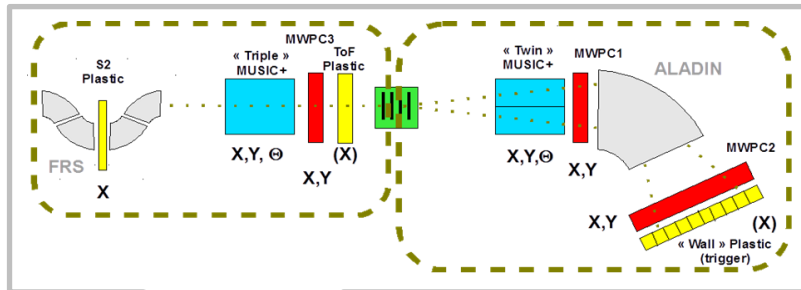
The heart of expertise

Mid term
(at least)



✂ Fission Yields & Decay data

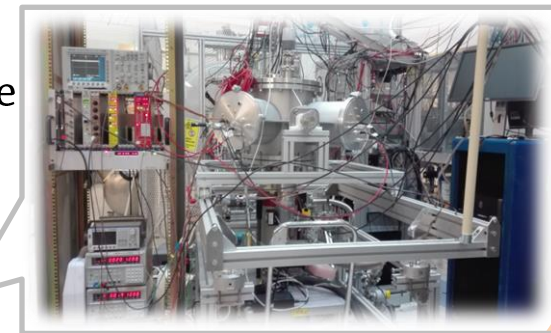
* **Isomeric ratio** $^{233,235}\text{U}$ et $^{239,241}\text{Pu}$ (**LPSC**)
with Lohengrin @ ILL



* **Fission Yield** for pre-actinides region
(neutron deficient) with SOFIA @ GSI (**IPNO**)

* Meas. (TAGS) of **FPD** @ ALTO, CERN/ISOLDE, JFL from the lists of IAEA expert group for decay heat and antineutrino spectra (**SUBATECH**)

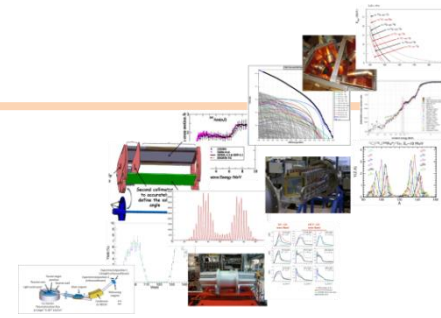
* Measurement of the **shape of the electron** spectra from forbidden decays with E-shape (**SUBATECH**) @ Jyväskylä



PROSPECTIVES FOR NUCLEAR DATA – 10 YEARS

Experimental programs for new nuclear data

10 years



The heart of expertise

⌘ The opportunity of new beam facilities



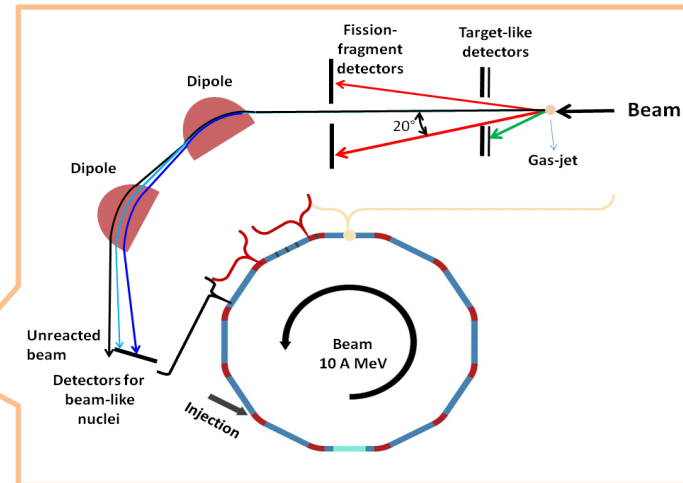
* **SPIRAL2/NES :**

(n,2n), (n, α) XS measurement programs, (IPHC, LPCC) more to come (fission) from CNRS?

* **GSI/FAIR :** (see contribution GT 02, B. Jurado)

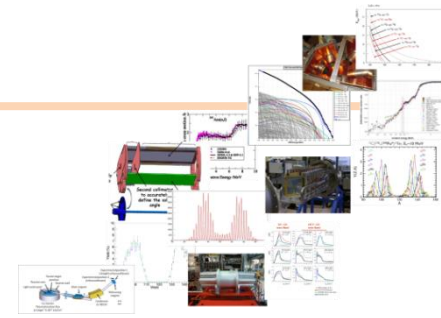
- Access to **many radioactive nuclei**, the storage ring **CRYRING @ GSI** is suitable for indirect surrogate reactions (CENBG).

- New study of the fission process with ^{242}Pu beam (in negotiation) (IPNO)



Experimental programs for new nuclear data

10 years



The heart of expertise

⌘ Preparation of the future

* EURATOM:

CNRS is involved in WP6 in SANDA which aims to prepare a **framework** for the coordination of the **European nuclear data research** in a **sustainable structure** well beyond the duration of the project

From GA SANDA DoW WP6 – p. 128 (pdf file)

Task 6.2: Sustainable framework for the coordination of the European nuclear data research; CIEMAT, CEA CNRS and JRC

This task will include:

- the identification of potential partners and contact points at the different Member States, MS.
- the follow-up and identification of **tools for joint programming for FP9**: EJP or similar
- the identification of **potential program for the ND community in a 5 to 10 years horizon** covering all the domains of applications of nuclear data
- the preparation of documentation and visits to Member States (MS) representatives with influence on the EURATOM programs, European technological platforms and other bodies of influence on the EURATOM programs, to explain the ND community, its **needs of a long-standing framework for coordination**, and the possible instruments to establish that framework
- the preparation of one meeting of the ND community with interested Member States (MS) representatives, European technological platforms and other relevant stakeholders
- maintaining and clarifying **the link to the JEFF project**
- the identification of ways and frameworks to maintain our community effort and to **reinforce links between experimentalists, theoreticians and evaluators around a common ambition**

(see contribution GT 10, M. Vanstalle)

PROSPECTIVES FOR NUCLEAR DATA – 10 YEARS

Nuclear data evaluation

10 years

A new activity

NACRE



✗ A first attempt

- * Evaluation activity already started at **LPSC** for **FY** (but will stop soon – in the frame of LPSC - with the leaving of G.K. to CEA...)
- * Collaboration **IPHC** with **CEA/DEN** and **CEA/DAM** for inelastic XS evaluation (PhD co direction-> a wish to pursue and develop activities in this field beyond the thesis)
- * Collaboration **SUBATECH** with **CEA/LNHB** to transfer knowledge about evaluation of decay data
- * **CENBG** participates to the evaluation effort via collaboration with **CEA/DAM**, **DEN** for surrogate exp. interpretation and by the dev. of the GEF code

Assets of CNRS/IN2P3 teams

- Good nuclear physics skills (obviously) and knowledge of exp. techniques
- Good (even strong) relations with expert actors of evaluation for sharing/transfer knowledge and expertise to IN2P3 teams, (CEA, NEA, IAEA)
- IN2P3 is a good environment to develop new methodologies
- Provide new opportunities to participate to the definition of some future exp. programs

Comment arriver à une approche unifiée pour la structure et les réactions ?
D. Bouland CEA/DEN, L. LEAL IRSN

Sensitivity studies to Nuclear Data

10 years

A “new” activity upstream



✗ A first attempt of collaboration

Development of sensitivity calculation tools are under development at IN2P3,

See contribution GT 11 X. Doligez

- A thesis (E. Party, 09/2019, Univ. Strasbourg) directed by a « ND team » (**IPHC**) and followed by **IPNO** has been defended with a significant part dedicated to sensitivity study -> promising experience
- For reactor antineutrinos and decay heat problematic, **SUBATECH** develops their own calculation tools

In the coming 5 years

Possibility to evaluate the **sensitivity**

OF each reactor physics observables

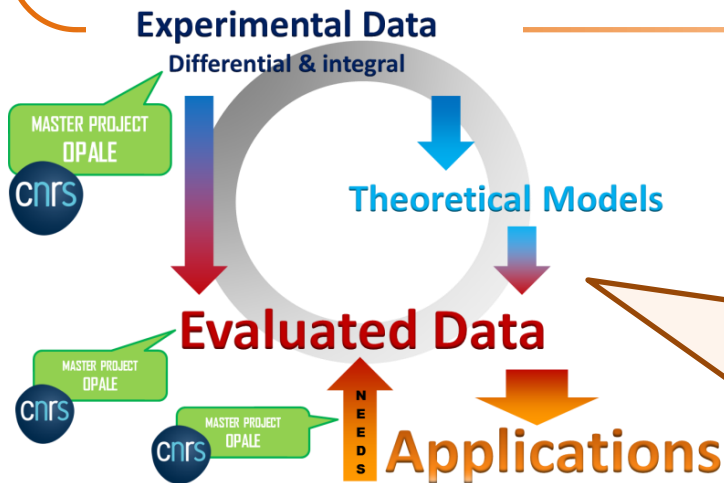
TO each nuclear and reactor physics data

will exist. This means

- 1/ improvement and control of the multiphysics coupling
- 2/ possibility to calculate sensitivity for evolution calculations (FY and decay)
- 3/ study/define the needs of new measurements by evaluating their possible impact

CONCLUSIONS : how to reach the objectives?

- ✂ **Support from IN2P3** : budget and manpower (stabilize at least the manpower for the experimental part only, increase to develop efficiently the new activities (included PhD)); link with fundamental nuclear physics is essential
- ✂ **Support from NEEDS** : to maintain the very efficient frame of collaboration between CEA and CNRS (useful especially to develop the evaluation part of the proposal)
- ✂ **Support from GDR** : to emphasize the exchanges between IN2P3 “energy actors”
- ✂ **Support from EURATOM** : to maintain essential Euro input, to benefit from target network, to provide support for access to facilities and maintain European collaborations



This proposal

- will increase the impact, at different levels, of the IN2P3 in the nuclear data for energy field,
- will emphasize interactions between actors inside IN2P3,
- is challenging since not only science is involved.

Thank you for your attention...