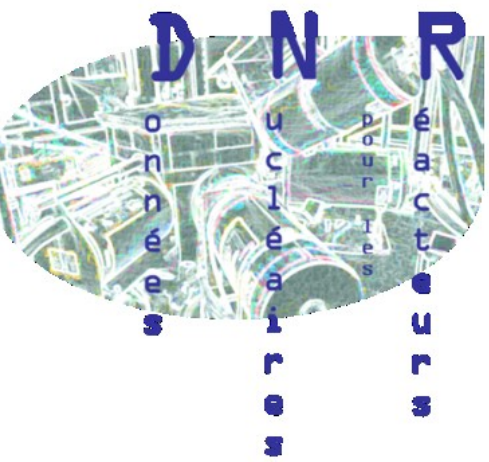
groupe

Données Nucléaires pour les Réacteurs

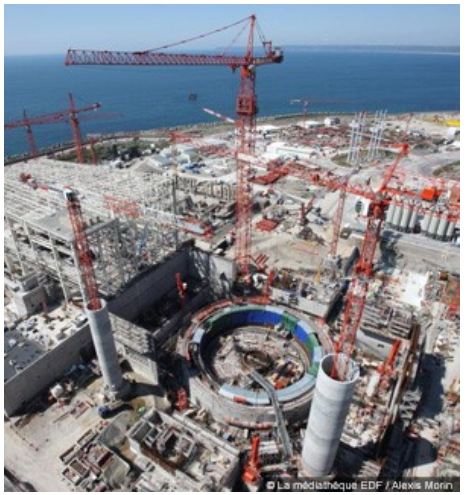
(Nuclear Data for Reactors)



Challenges for nuclear energy today

Economicals:

- A power plant costs several millions € to build
- The spent waste processing represent 2 to 6 % of the kWh price.



Safety:

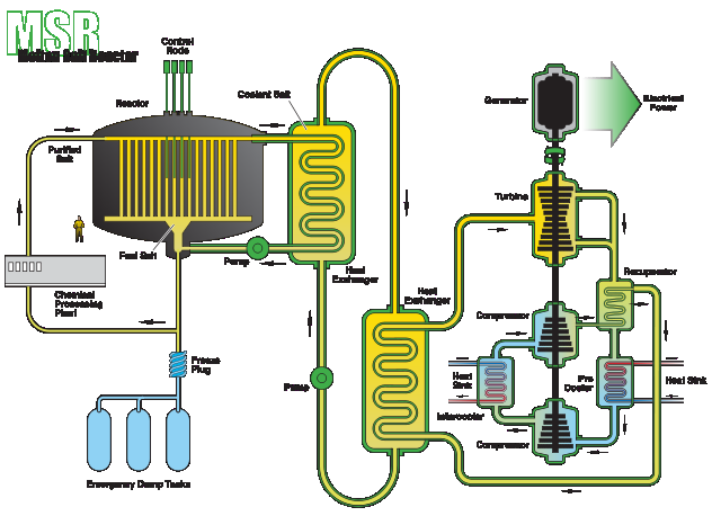
- Proliferation
- Accident prevention
- Handling of radioactive waste

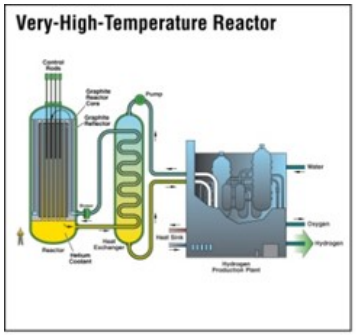
Sustainability:

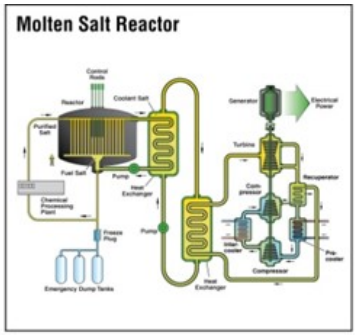
- Aging power plants
- Limited ressources in ^{nat}U
- Storage of radioactive waste

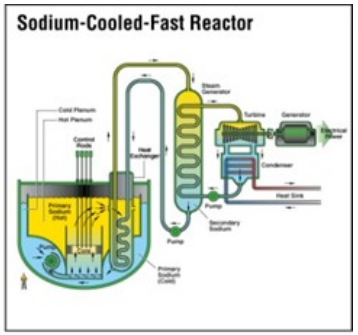
Tomorrow's reactors are already undertsudy

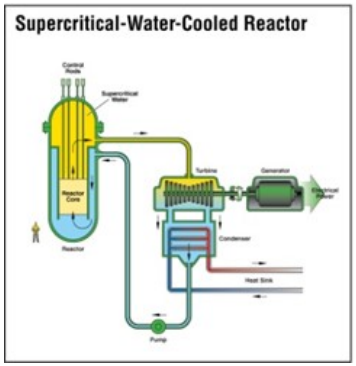
- New designs
- New fuels

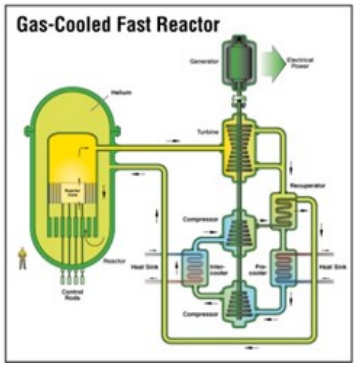


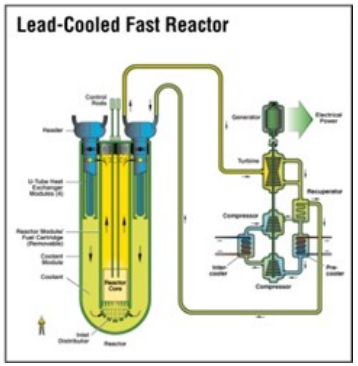










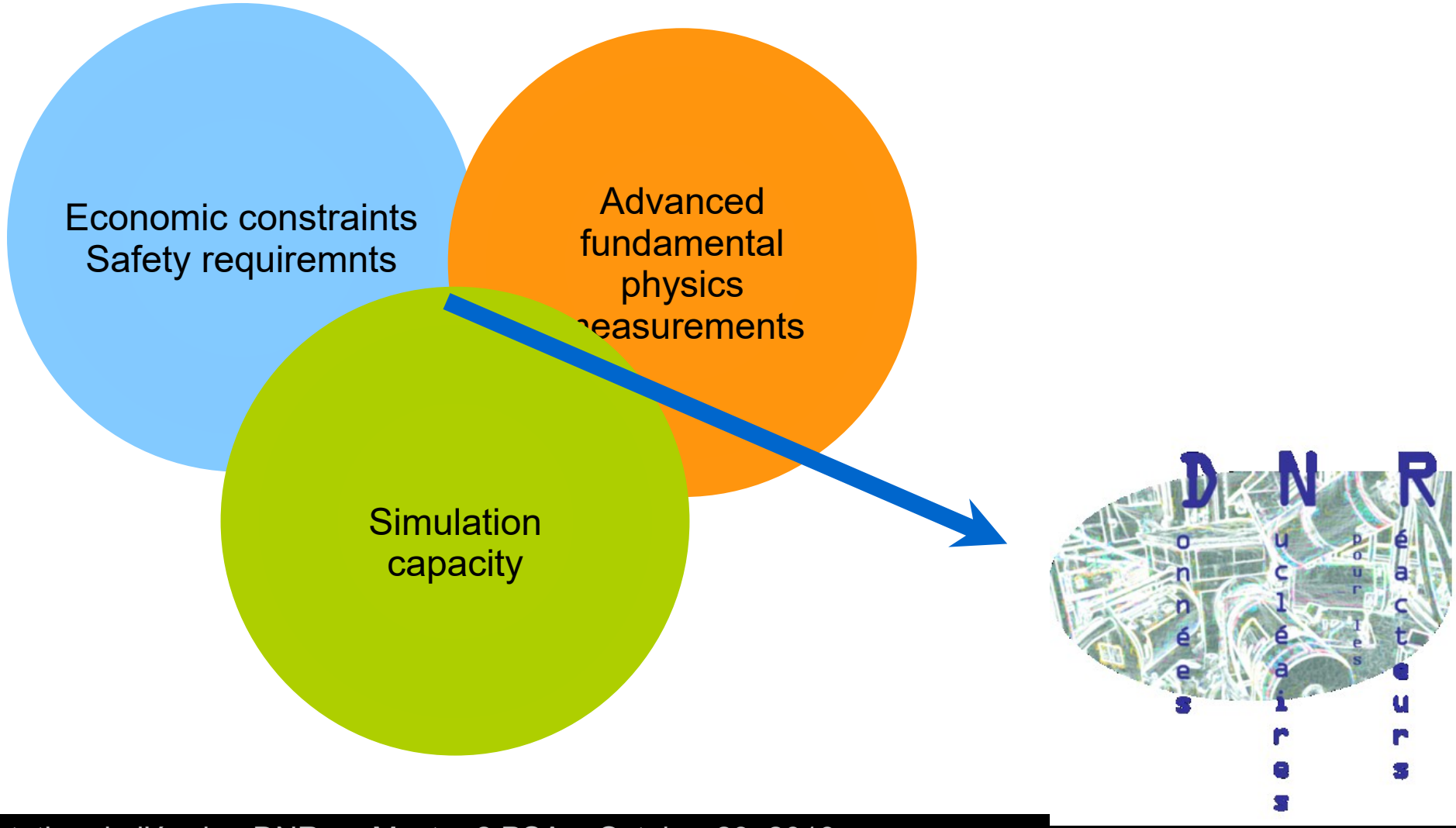


Benefits:

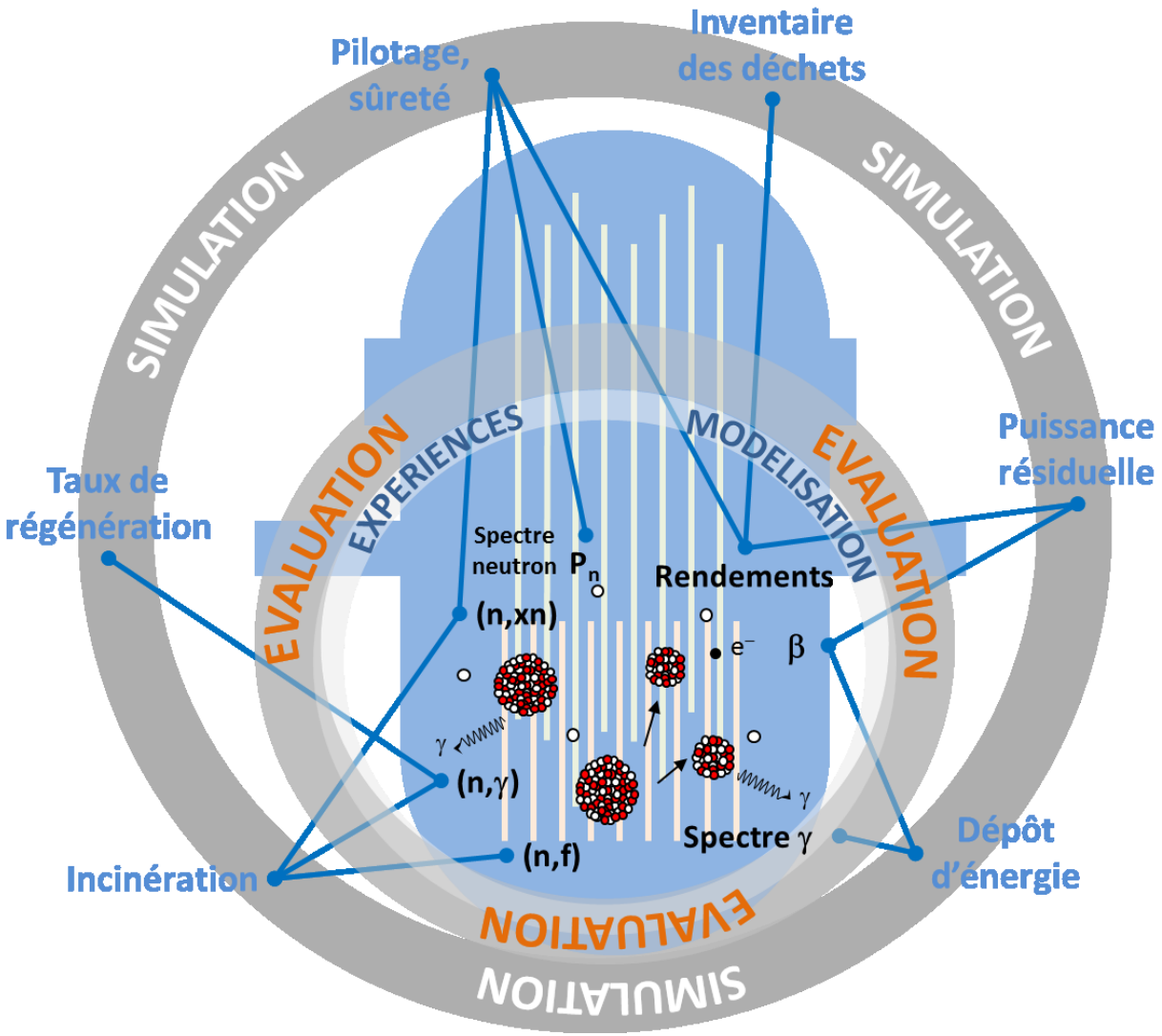
- ✓ Fast neutrons → Waste transmutation
- ✓ ^{232}Th → Reduce actinides production
- ✓ ^{232}Th, ^{238}U → sur-generator cycles

Developpement and risk analysis with numerical simulations

Nuclear Data for Reactors



Nuclear Data for Reactors

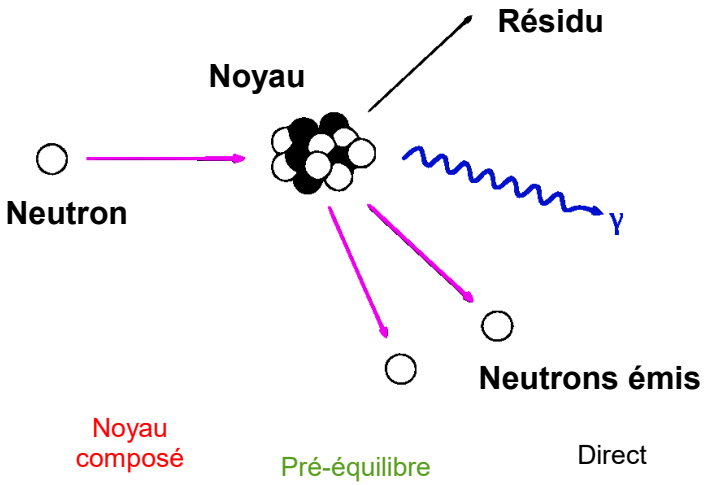


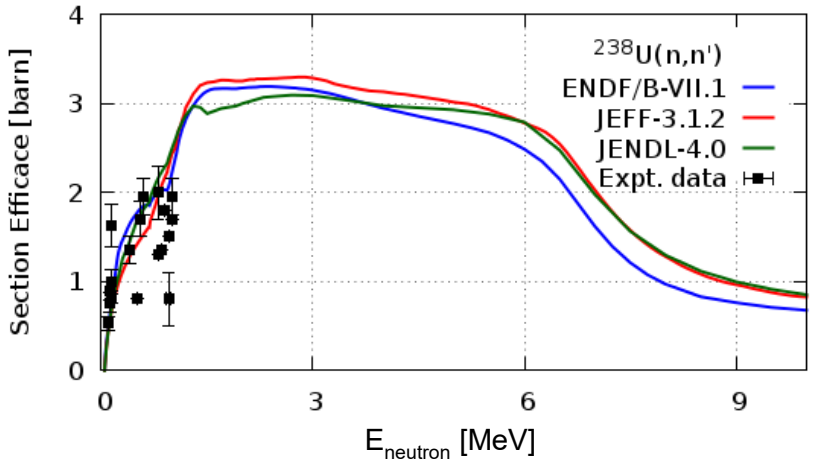
(n, xn) : reactions of interest for evaluations

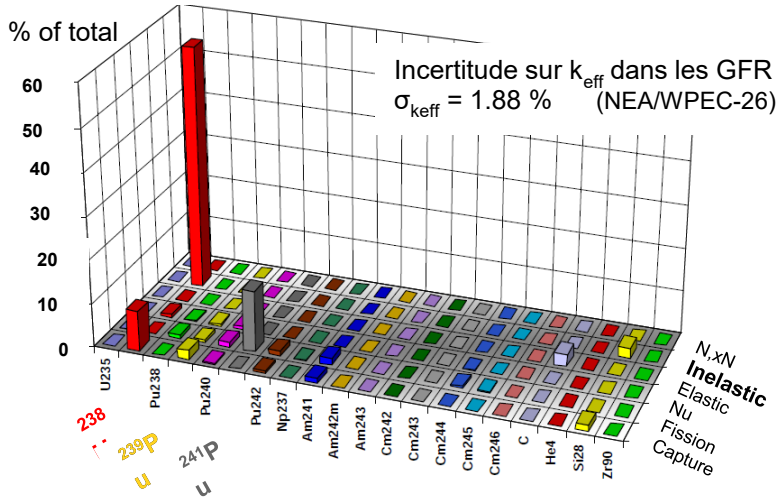
Change the number of neutrons, their energy and produce new isotopes.

Uncertainties on $\sigma_{238U(n,n')}$ limit the precision of criticity and power calculations.

Few experimental data for isotopes of interest in next generation reactors.







The team *Données Nucléaires pour les Réacteurs* @ IPHC

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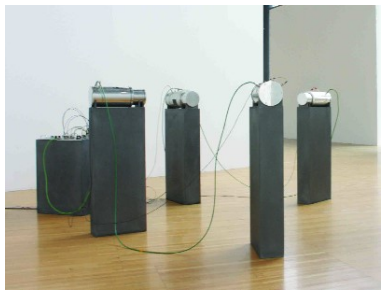
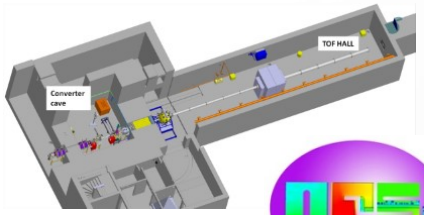


Collaborations

- Developpement of experimental setups
- Complementary measurements
- Interpretation of results
- Improvement of models



European programs
Link with NEA, AIEA

JRC
EUROPEAN COMMISSION

IPIN-HH

D N R

DEN et DAM

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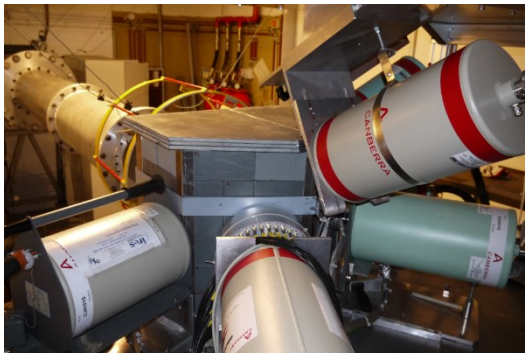
Experimental setup

- Electrons accelerated on Uranium target
- Fission induced neutrons
- Pulsed beam (800 Hz)
- E_n between eV and 20 MeV
- Our setup at 30 m



- Fission chamber to measure the incoming flux.
- Large Sample (∅ > 55 mm)
- Détection of γ rays emitted in (n,xn) reactions by 6 planar HPGe

Measurement campaigns

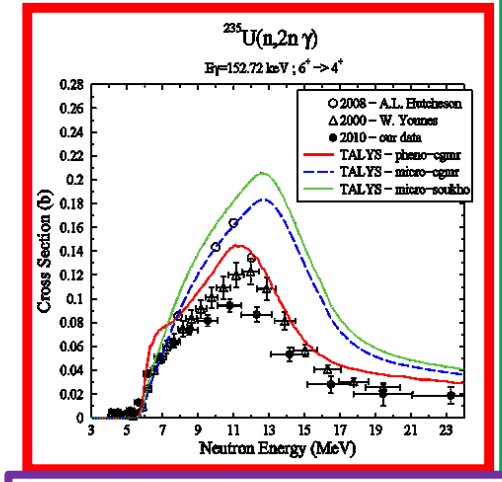
2005 – 2010 :
^{235}U

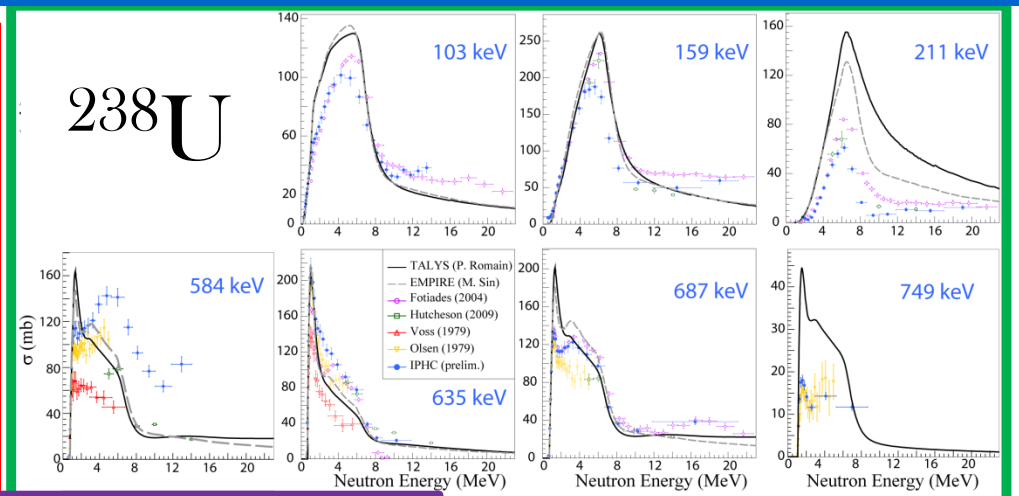
2009 – 2010 :
^{232}Th

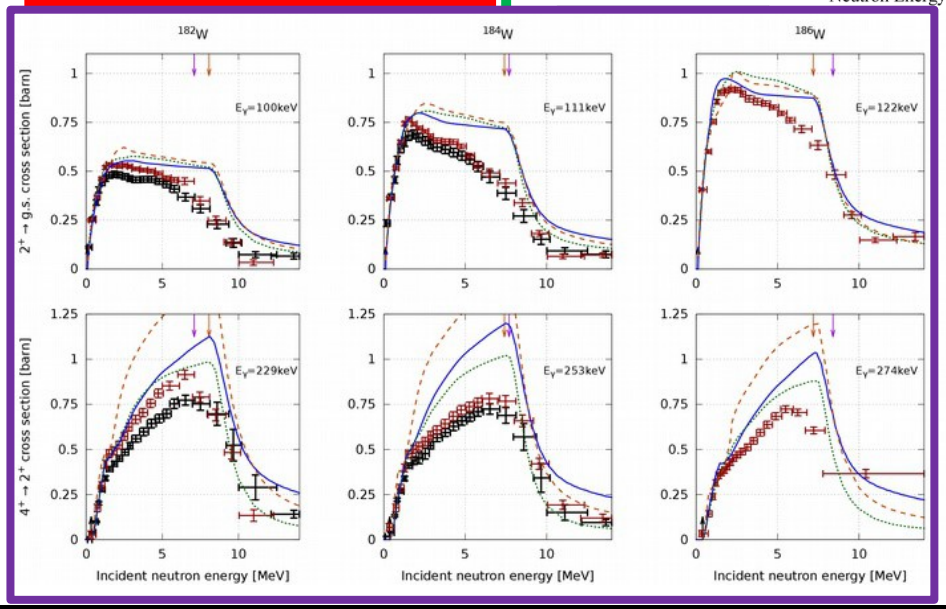
2009 – 2012 :
nat,182,183,184,186W

2011 – 2012 – 2013 :
^{238}U

2014 :
natZr







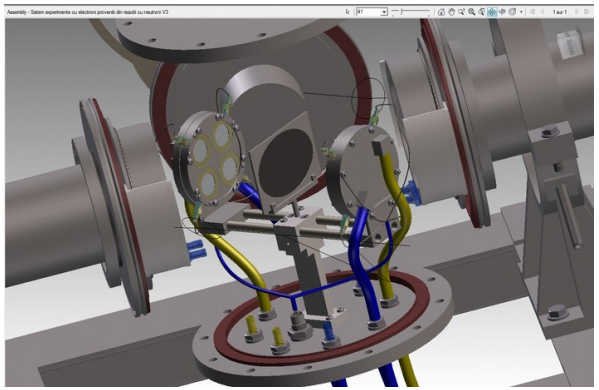
Challenges ahead

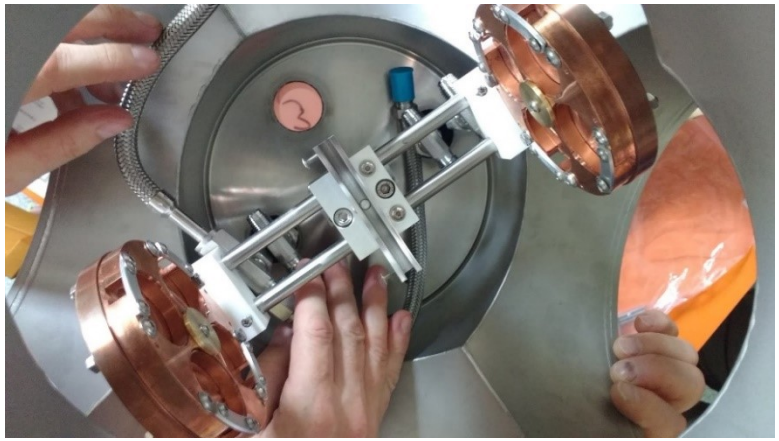
- Low energy gamma rays are hard to detect because they are *converted.*
- (n, *x*n γ) gives only a partial picture: we need theory to go back to the total (n, *x*n) cross section.
- Many other nuclei of interest, but highly radioactive.

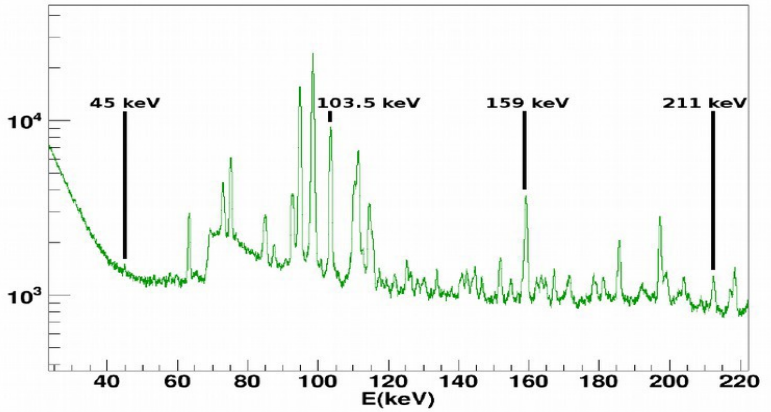
Converted transition spectroscopy

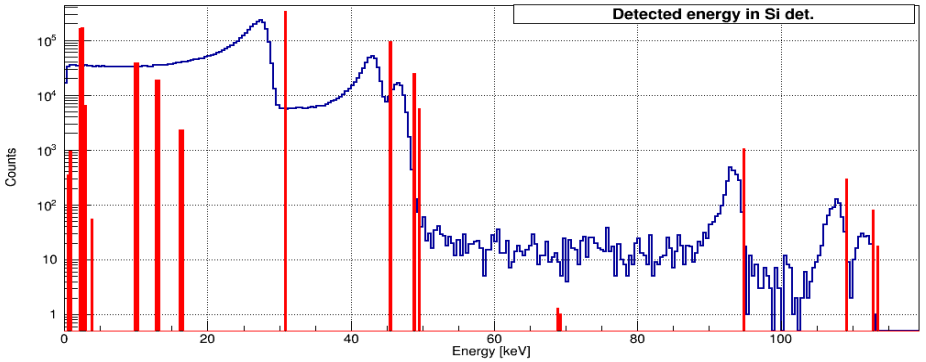
Conversion electron spectroscopy

- For higly converted transitions
- Within European program CHANDA.





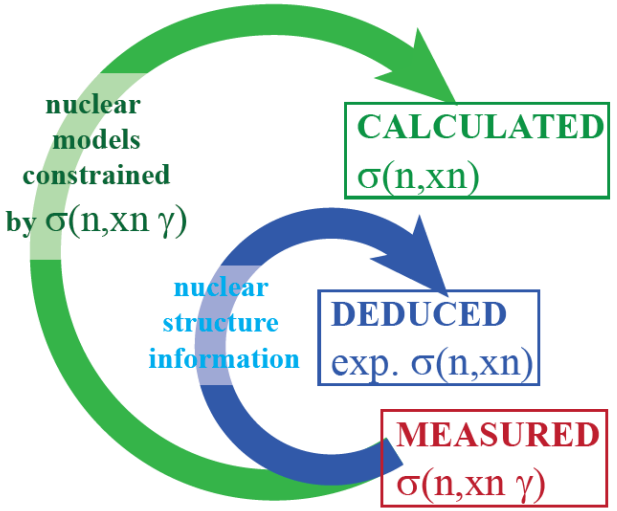




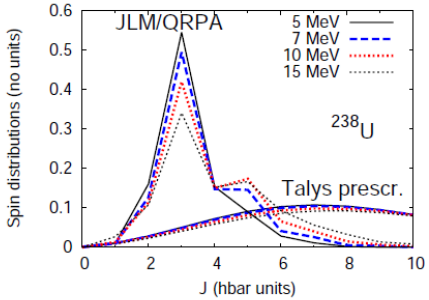
Topic of TIPP to come

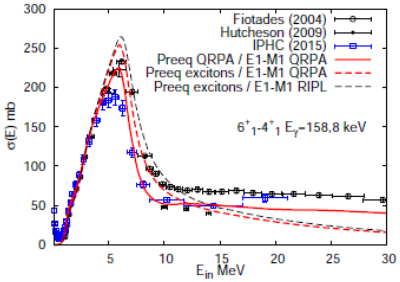
From (n,xn gamma) to (n,xn)

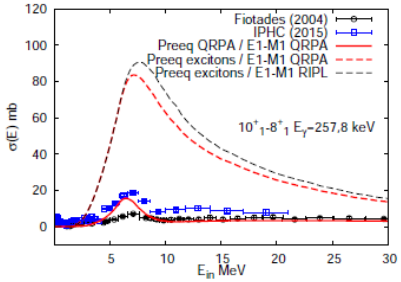
- (n, *x*n γ) gives only a partial picture: we need theory to go back to the total (n, *x*n) cross section…
- Need input of nuclear structure, reaction codes.

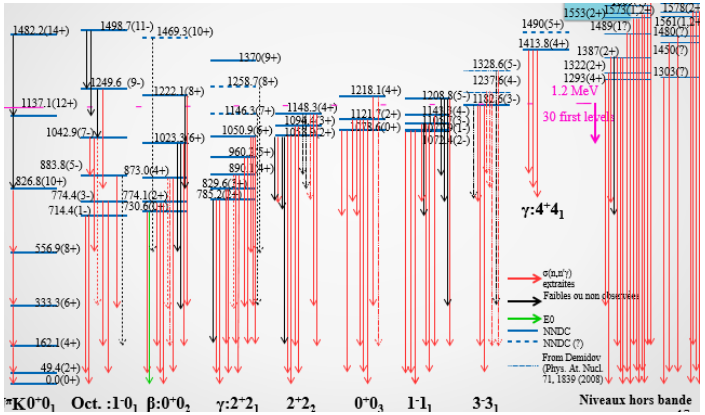


- Inferring the (n, *x*n) cross section requires work, attention to the uncertainties and possible correlations between measurements.
- Collaboration with theoreticians and evaluators to improve the models.



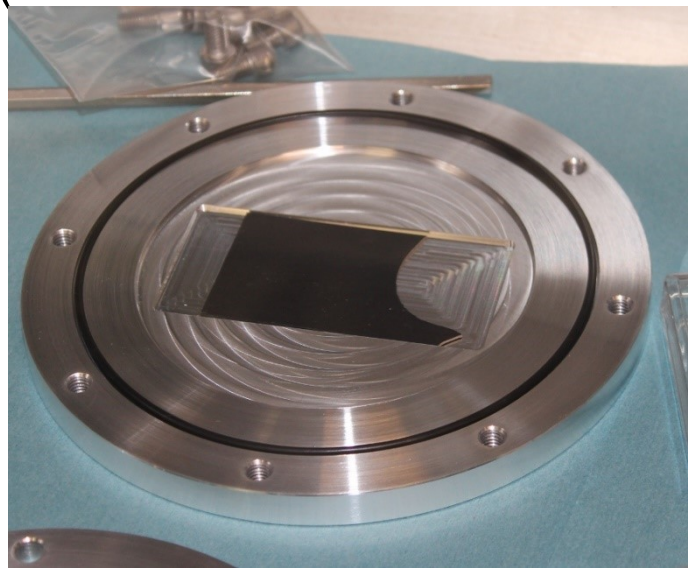


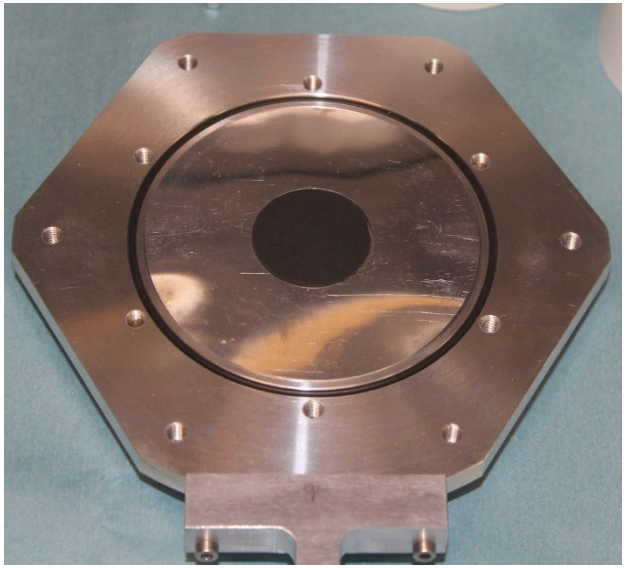




Highly radioactive nuclei

- Many other nuclei of interest, but highly radioactive.
- Upgraded the setup a few years ago, and the acquisition in September 2018.
- ^{233}U (4500 times more radioactive than ^{235}U) recorded 2016-2018





- ^{239}Pu (29500 times more radioactive than ^{235}U) : target in preparation.

Internship and Thesis Subject

Determining the neutron inelastic scattering cross section off 232-thorium from measured (n,xn γ) cross sections.

- Based on the thesis work of E. Party (defended Sept 2019).
- From data recorded at JRC-Geel using Grapheme in 2009-2010.
- From extracted (n, n' γ) cross section, with the help of
  - Level structure information
  - Model predictions

  You will try to deduce the total inelastic scattering (n, n') cross section
- With a special attention to uncertainties.

Come discuss with us in building 24

http://www.iphc.cnrs.fr/Offres-de-stage-these.html