DE LA RECHERCHE À L'INDUSTRIE

cea den

DETERMINATION OF ISOTOPIC RATIO AND ELEMENTARY COMPOSITION OF IRRADIATED NUCLEAR FUEL

CEA Saclay

Laboratory of Nuclear, Isotopic and Elemental Analytical development

*DEN / DANS / DPC / SEARS / **LANIE***



IAEA Presentation | Guillaume Stadelmann

OCTOBER 2015

SUMMARY

I - LANIE laboratory

II - Nuclear Spent Fuel Analysis

III – Other things you should know about me

I – LANIE Laboratory

- Missions :
  - doing specific analyses for the support and development of nuclear energy
  - developing innovative technics and protocols of radionuclides chemical analysis
- 4 axes of research and applications
  - **High-accuracy isotopic and elemental analysis** (by mass spectrometry)
  - **Development of analytical microchips**
  - **Laser-Induced Breakdown Spectroscopy** (LIBS)
  - **RN speciation analysis**
- The team: **18 permanent staff** (13 researchers, 4 technicians, 1 secretary) and about **2 post-doc researchers, 6 PhD students, and several undergraduate students**

I – LANIE LABORATORY

High Accuracy Isotopic and Elemental Analyses

- Various samples :
  - Civil Nuclear spent fuel (2nd, 3rd and 4th generation)
  - Military fuel : Naval propulsion
  - Irradiated pure isotope : elemental transmutation
  - Dosimeters
  - Reprocessing samples
  - Nuclear waste
  - Safeguard (IAEA)
  - …
- « Best Sellers » elements :
  - U, Pu, Minors Actinides, Lanthanide and Cs
- « Specific demands » :
  - B, Li, Cf, Ho



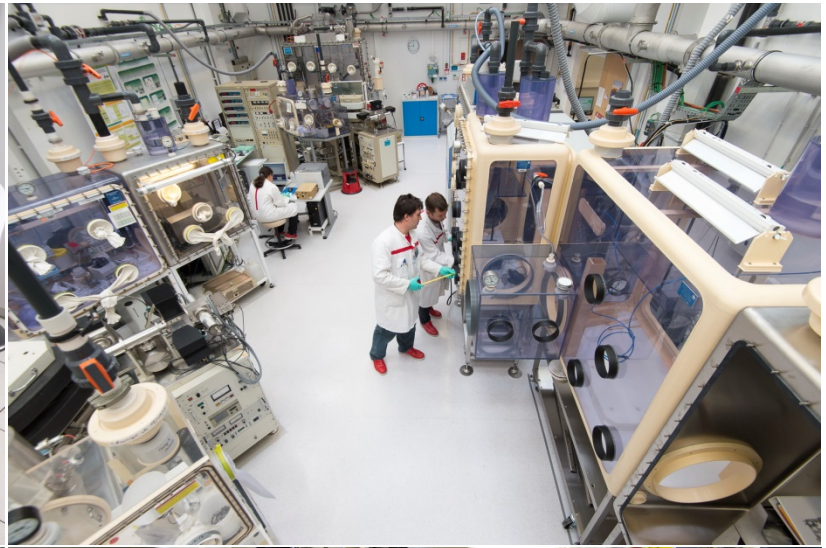
I – LANIE LABORATORY

Equipment and Laboratory

- 2 Laboratories :
  - "Cool Lab" : for analytical development and acid distillation
  - "Hot Lab Actineo" : Lab equiped with Glove Box for analysis of radioactive samples

- Instrumentation :
- Cool Lab
  - 1 Horiba-Jobin OES-ICP Activa
  - 1 Thermo Q-ICP-MS XSeriesII
  - 2 Thermo-Dione HPLC Ionic chromatography
- Actineo
  - 2 Thermo Q-ICP-MS XSeriesII and I
  - 1 Thermo MC-ICP-MS Neptune Plus
  - 1 VG Instrument MC-ICP-MS Isoprobe
  - 2 VG Instrument TIMS Isoprobe T and Sector54
  - 1 Thermo TIMS Triton
  - 4 Thermo-Dionex HPLC Ionic chromatography

I – LANIE LABORATORY

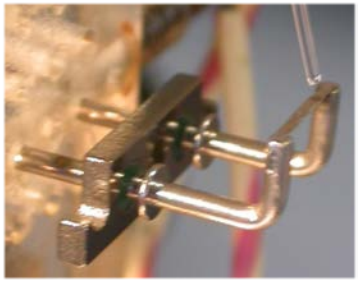





II – Nuclear spent fuel analysis

- Objectives :
  - Determination of fine isotopic ratio and elementary concentration (uncertainties < 1%)
  - Elements of interest : U Pu Nd Cs Am Cm Eu Gd Sm Ce Np Pm
- Process of analysis:





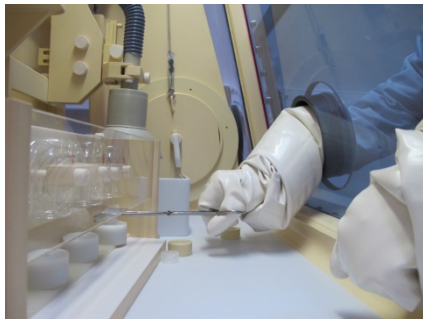
Sample Reception

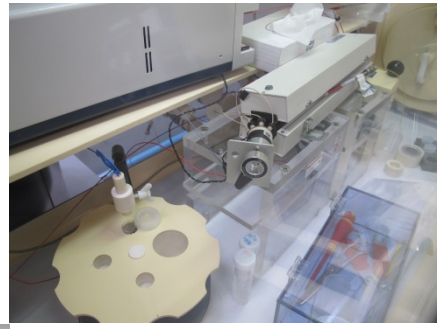
« Screening »

1st Purification
ion exchange resin

2nd Purification
HPLC

Measurement
Mass Spectrometer

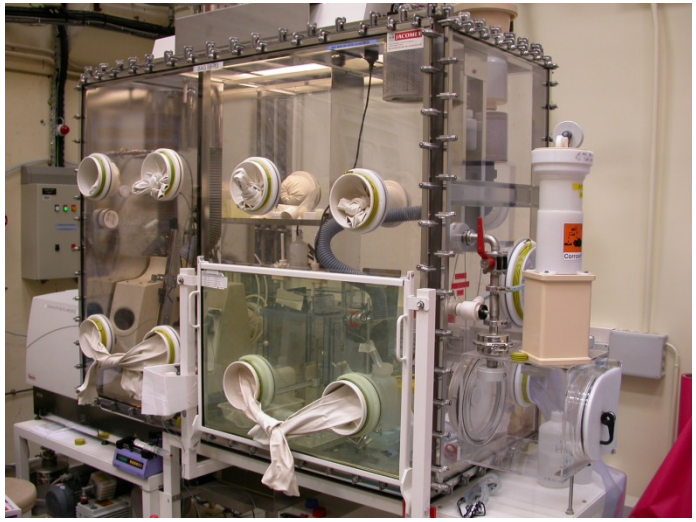


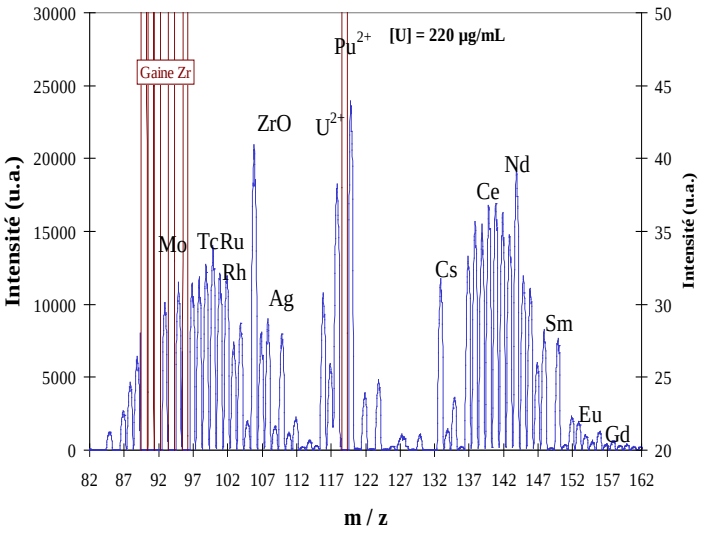




II – NUCLEAR SPENT FUEL ANALYSIS

- Sample reception
  - Decontamination of Lead container
  - Registration in the LIMS
- « Screening »
  - Survey of the mass range from 4 to 250amu (check of no major pollution or contamination)
  - Semi-quantification of elements of interest (preparation of the sampling volume and determination of critical element)





II – NUCLEAR SPENT FUEL ANALYSIS



2 Samples + 1 Blank /
Sample quantity based on the critical element determined previously

1st separation
Ion exchange resin
(AG1-X10, AG1-X4)





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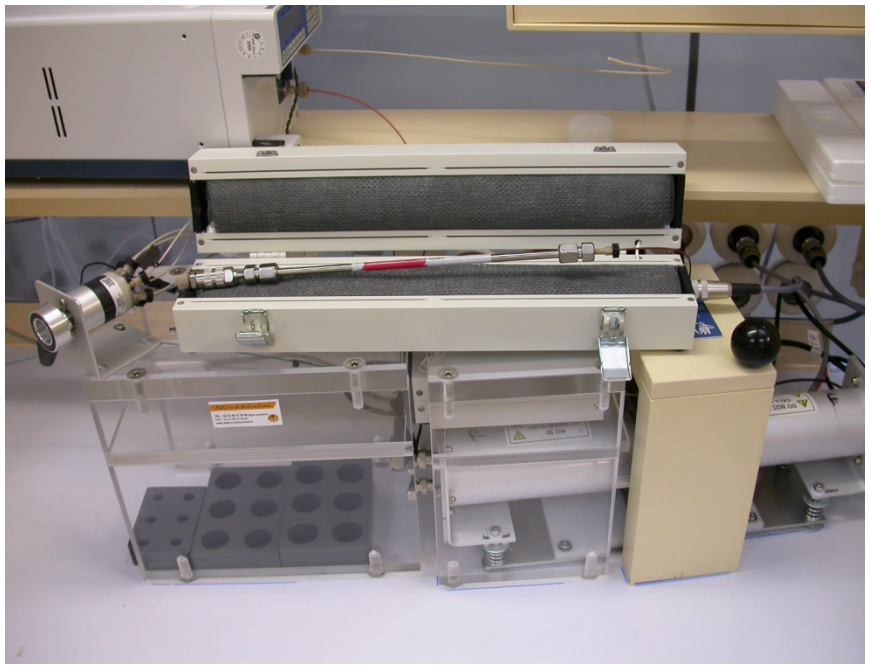
Pu

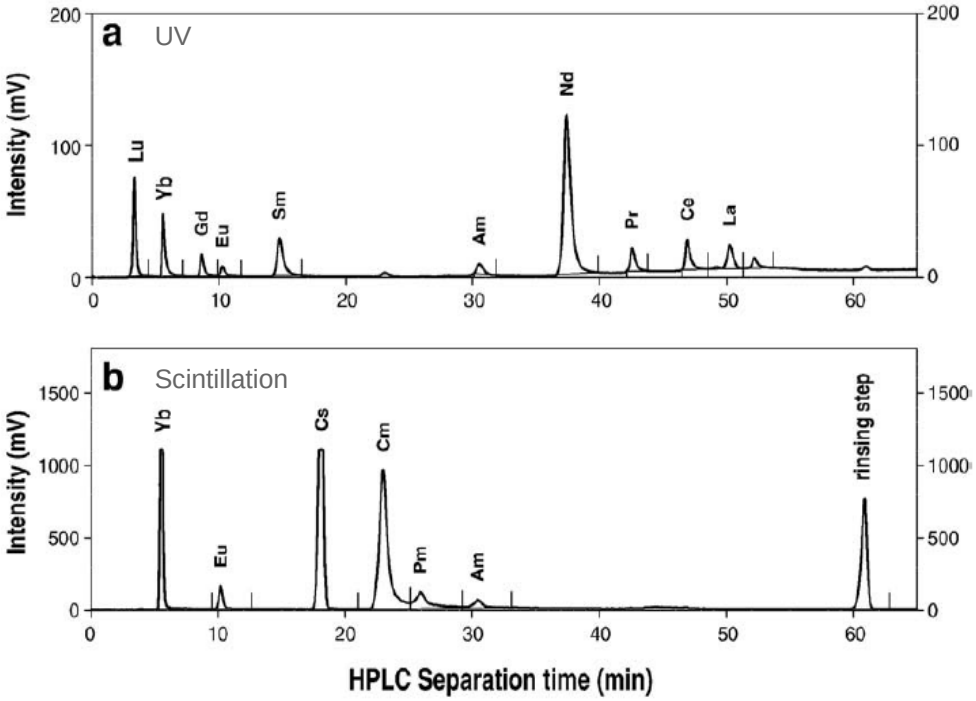
PF+
Am Cm

TIMS measurement

2nd Purification

II – NUCLEAR SPENT FUEL ANALYSIS



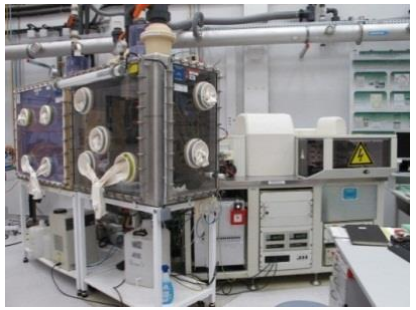


- Second separation by liquid chromatography
  - Strong Cation eXchange column (SCX)
  - Separation using a gradient in concentration of HMB (Hydroxy Methyl Butiric Acid)
  - Double detection : UV and liquid scintillator
  - Separation of every PF, minor actinides and Cs

II – NUCLEAR SPENT FUEL ANALYSIS

- Pure elementary fraction measurement
- Targeting low uncertainties
  - ‰ for Isotopy and concentration (Isotopic Dilution)
  - % Concentration (with Q-ICP-MS)
- Measurement with TIMS
  - External Calibration (Sequential Method) for Isotopy
  - Total Evaporation for Isotopic dilution
- Measurement with MC-ICP-MS
  - Bracketing with CRM
- Measurement with Q-ICP-MS
  - External calibration with Matrix matching
  - Standard Addition

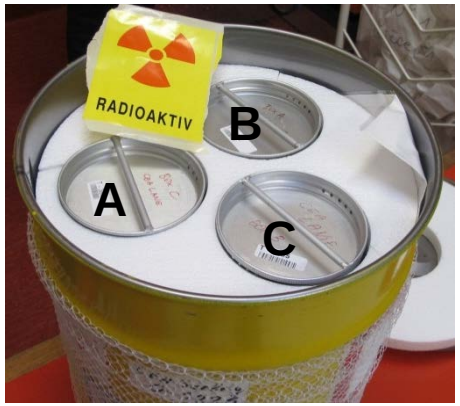




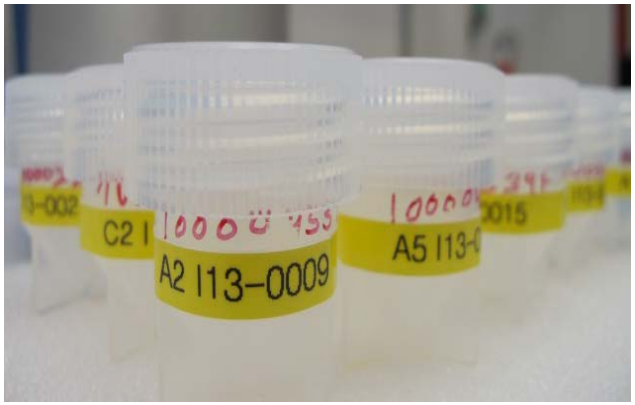


II – NUCLEAR SPENT FUEL ANALYSIS

- From Nuclear spent fuel to Safeguard samples analyses
  - Qualification process began in 2013
  - Participation to Nuclear Material Round Robin (2013 and 2015)







  - IAEA qualification obtained in February 2015 for U and Pu isotopic analysis

III – OTHER THINGS YOU SHOULD KNOW ABOUT ME

Some little things to help you know me a bit better

- Born in Colmar (Alsace- France)
- Studied chemistry and analytical chemistry
- Worked for car industry (Peugeot Citroen)
- Was a Scout leader
- Play Basketball with CEA sport association
- Like Food and Wine
- Very happy to join your team !







THANK YOU FOR YOUR ATTENTION

Commissariat à l'énergie atomique et aux énergies alternatives
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