Fission product yield compilation

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Methods for fission fragments yield measurements

–Measurements based on kinematic properties;

– Mass spectrometry;

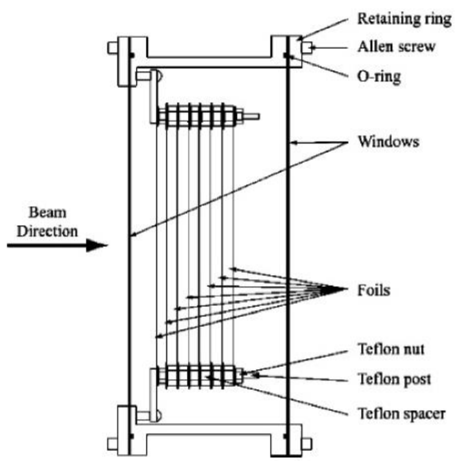
–Gamma spectrometry.

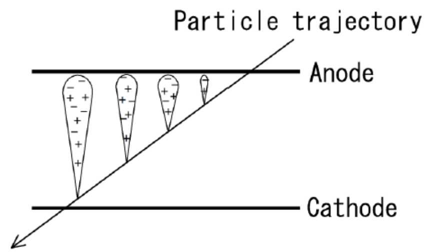
Detectors based on kinematic properties

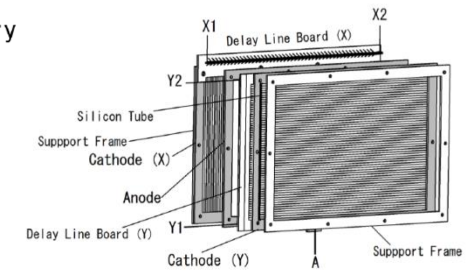
- Multiwire proportional counter (MWPCs) = Parallel plate ionization chamber and Parallel plate avalanche counters

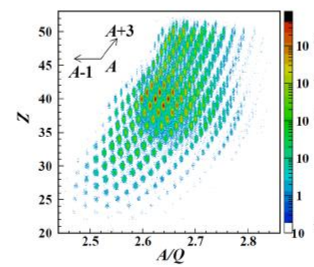
- Time projection chamber

Miltiwire proportional counters (MWPC) & Parallel plate avalanche counters (PPAC)



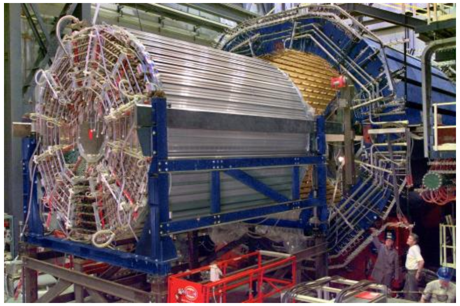


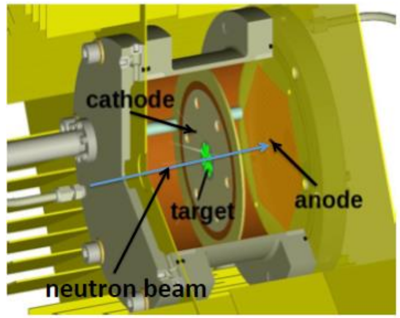




H.Kumagai et al. NIM/B,317,717,2013

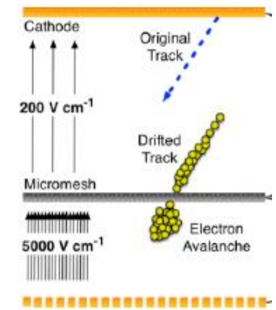
Time projection chamber

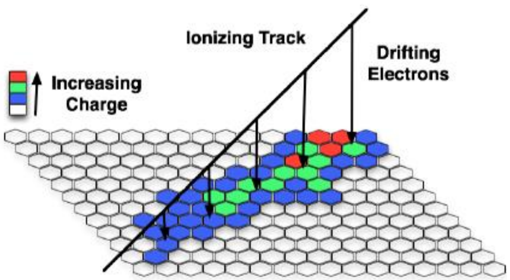


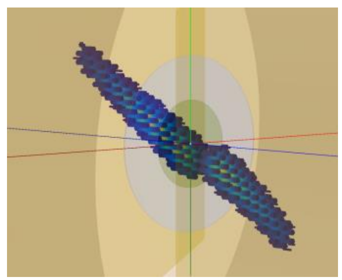


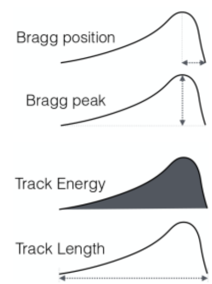
Two part system for ionization

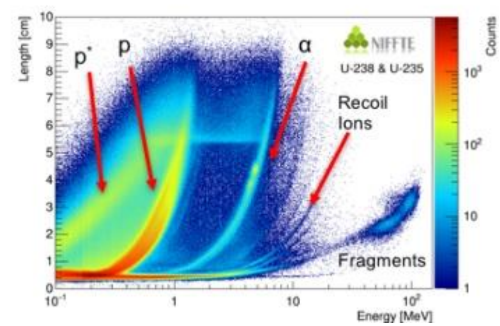
1. Particles drift in a 200 V/cm region
2. Particle passes through micromesh and enter a region with 5000 V/cm creating an electron avalanche amplification











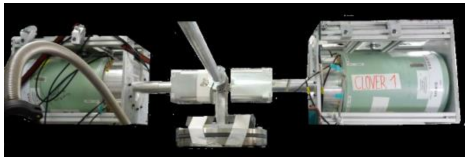
- Two volume ionization chamber with a segmented anode plane allowing detection of the track of an ionizing particle and neutron energy by TOF
- 3D ionization profile for individual tracks allows determination of: track length, location and value of max ionization; interaction vertex; track direction. And respectively particle identification and separation.
- The goal is to reduce systematic uncertainties to 1% or less

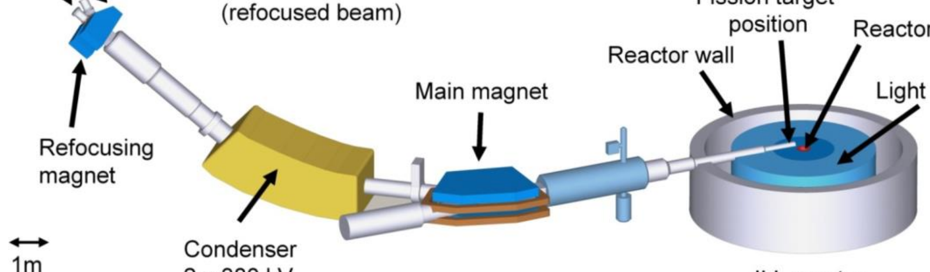
NIFFTE Collaboration, PR/C,97, 034618 (2018)

Mass spectrometry measurements LOHENGRIN + EXILL @ILL

Mass yields measurements with an ionization chamber

Isotopic yields measurements with Ge detectors





LOHENGRIN spectrometer:

Combination of magnetic and electric field: fission products selection by A/q and E/q

A –mass, q – ionic charge, E - energy

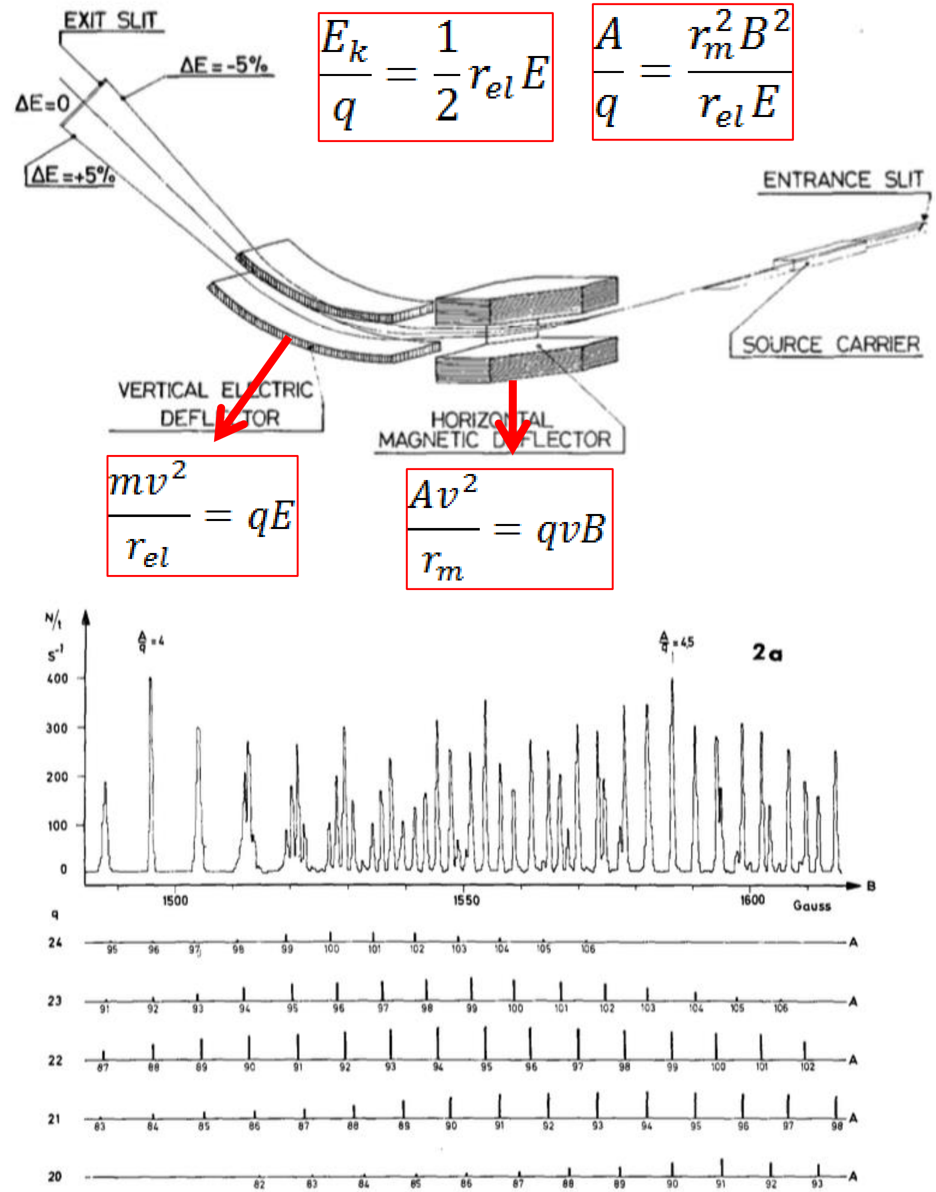
23 m length, travel time 2 μs: fission products detected before β decay

Mass resolution 0.3%

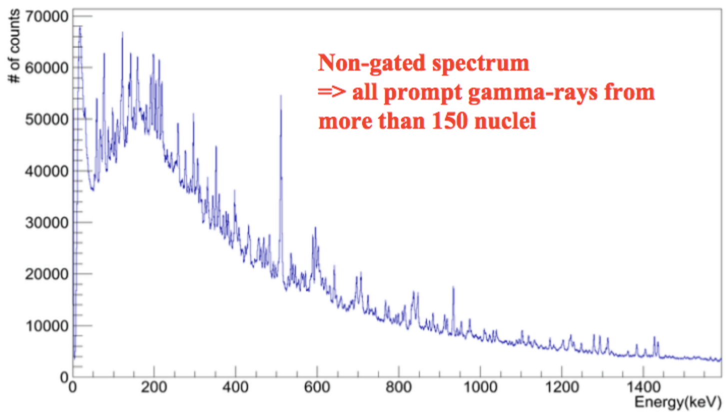
Energy resolution 1 %

- Determination of the counting rate for a given mass A, ionic charge q and kinetic energy E.
- Integrate over E and q :

  E distribution at the mean q and q distribution at the mean E
- Determination of the correlation between E and q : scan on E for three different ionic charges



Spectrometry of the gamma-emission following the b-decay of the fission products



Complex gamma-ray spectra including spectral interferences leading to multiplet peaks, high background, high counting rates.

- -Radiochemical separation
- -Mass separation
- -De-convolution of the overlapping peaks

The mathematical model describing the abundances and activities in a decay chain as a function of time *t* is the so called the Bateman equation

$$\frac{dN_i}{dt} = -\lambda_i N_i + \lambda_{i-1} N_{i-1}$$

(*i*=2,n), assuming zero concentration of all daughters at time zero the concentration of the *n*th nuclide after time *t*:

$$N_n(t) = \frac{N_1(0)}{\lambda_n} \sum_{j=1}^{n} \lambda_i \alpha_i exp(-\lambda_i t) \qquad \alpha_i = \prod_{j=1, j\neq i}^{n} \frac{\lambda_j}{(\lambda_j - \lambda_i)}$$

End of part II

PHYSICAL REVIEW C **84**, 034605 (2011)

Isotopic yield measurement in the heavy mass region for ^{239}Pu thermal neutron induced fission

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Despite the huge number of fission yield data available in the different evaluated nuclear data libraries, such as JEFF-3.1.1, ENDF/B-VII.0, and JENDL-4.0, more accurate data are still needed both for nuclear energy applications and for our understanding of the fission process itself. It is within the framework of this that measurements on the recoil mass spectrometer Lohengrin (at the Institut Laue-Langevin, Grenoble, France) was undertaken, to determine isotopic yields for the heavy fission products from the ^{239}Pu(n_{th},f) reaction. In order to do this, a new experimental method based on γ-ray spectrometry was developed and validated by comparing our results with those performed in the light mass region with completely different setups. Hence, about 65 fission product yields were measured with an uncertainty that has been reduced on average by a factor of 2 compared to that previously available in the nuclear data libraries. In addition, for some fission products, a strongly deformed