

SURVEY AND RESULTS OF THE INCINERATION CAMPAIGN

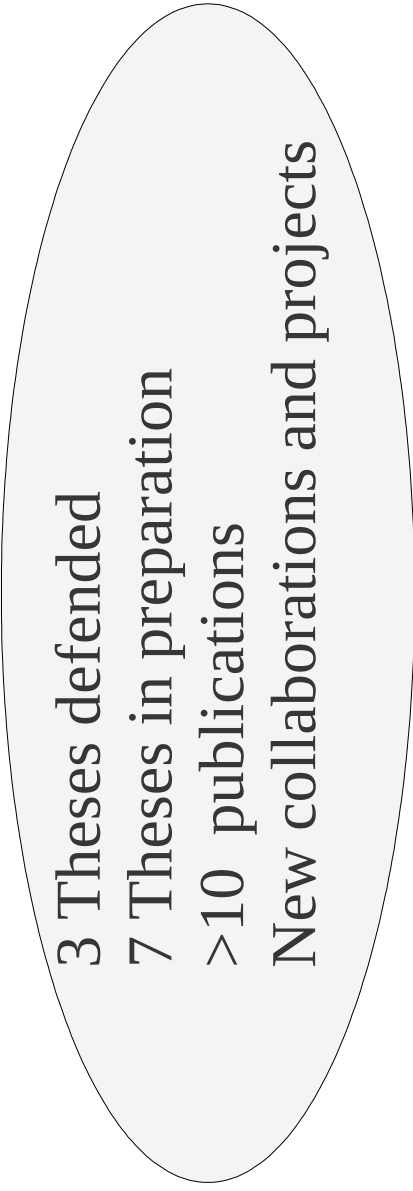
Test experiments

$^{238}\text{U}(1 \text{ A GeV}) + ^{208}\text{Pb}$ (Nov 1996)
 $^{197}\text{Au}(0.8 \text{ A GeV}) + \text{p}$ (Feb 1997)
 $^{208}\text{Pb}(0.5 \text{ A GeV}) + \text{p}$ (Apr 1999)

Main experiments

$^{238}\text{U}(1 \text{ A GeV}) + \text{p,d}$ (Jul 1997)
 $^{208}\text{Pb}(1 \text{ A GeV}) + \text{p,d}$ (Oct 1997)
 $^{56}\text{Fe}(0.3...1.5 \text{ A GeV}) + \text{p,d}$ (Oct 2000)

Collaboration GSI, U. Santiago, IPN Orsay, SPhN Saclay, U. Jyvaskyla,
CENBG Bordeaux



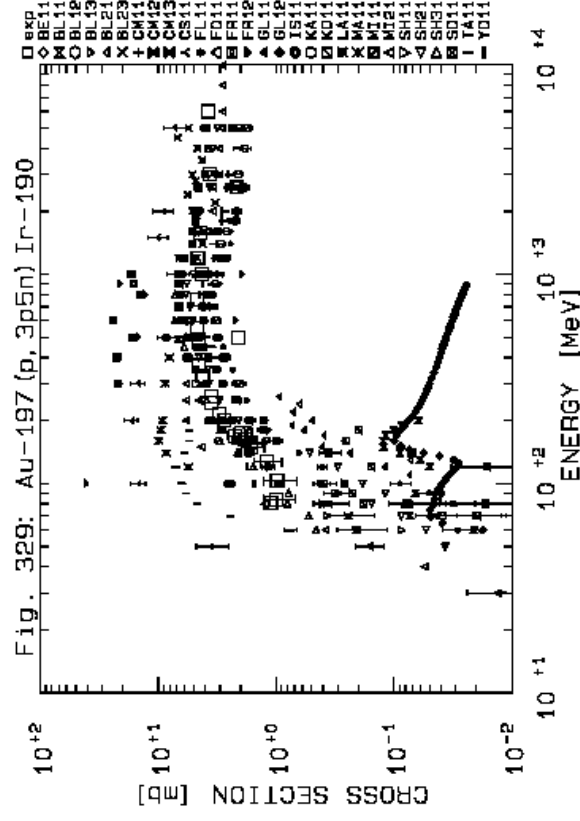
3 Theses defended
7 Theses in preparation
>10 publications
New collaborations and projects

MOTIVATIONS

Applications of spallation reactions with very intense beams $\sim 10\text{mA}$

- Radiotoxicity of the spallation target (maintenance, handling)
- Corrosion induced by the reaction products
- Production of gas elements
- Embrittlement of the materials due to recoil (dpa)
- Improvement of simulation codes :

Describe on a broad energy range the transportation of spallation particles and their interaction with the target and the surrounding materials

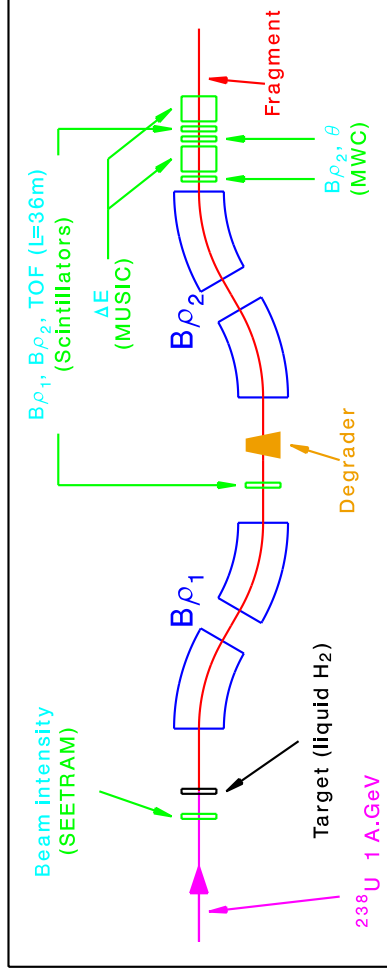


NEED OF ACCURATE
DATA !

METHODS

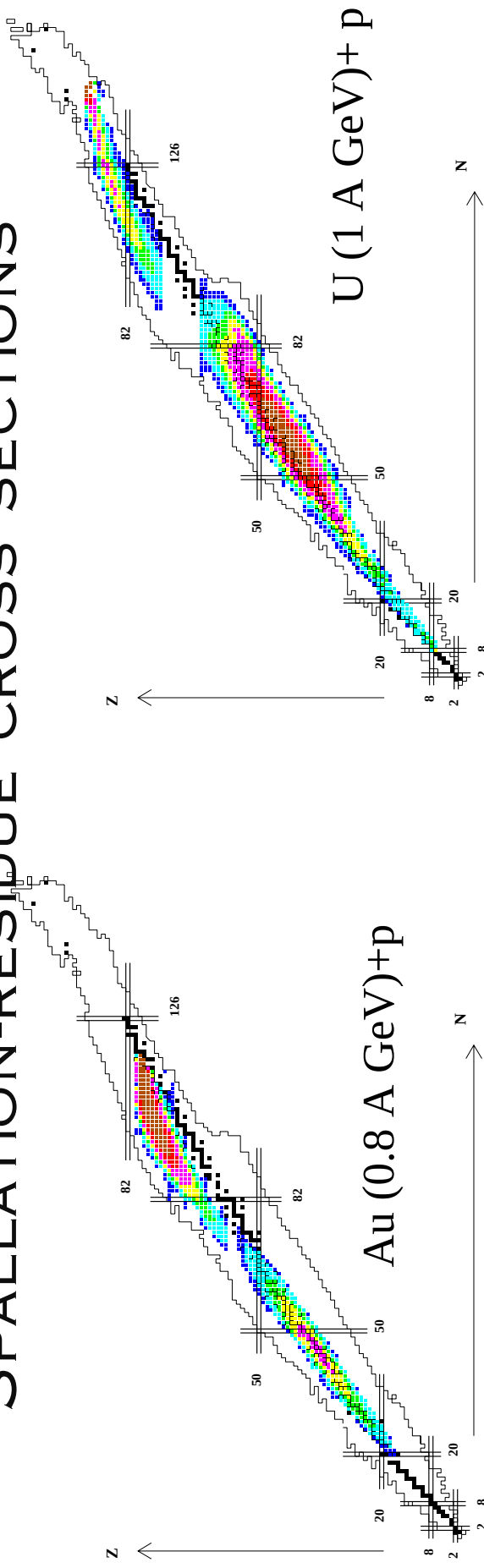
Inverse kinematics using the **FRS** at GSI Darmstadt

FRS Spectrometer



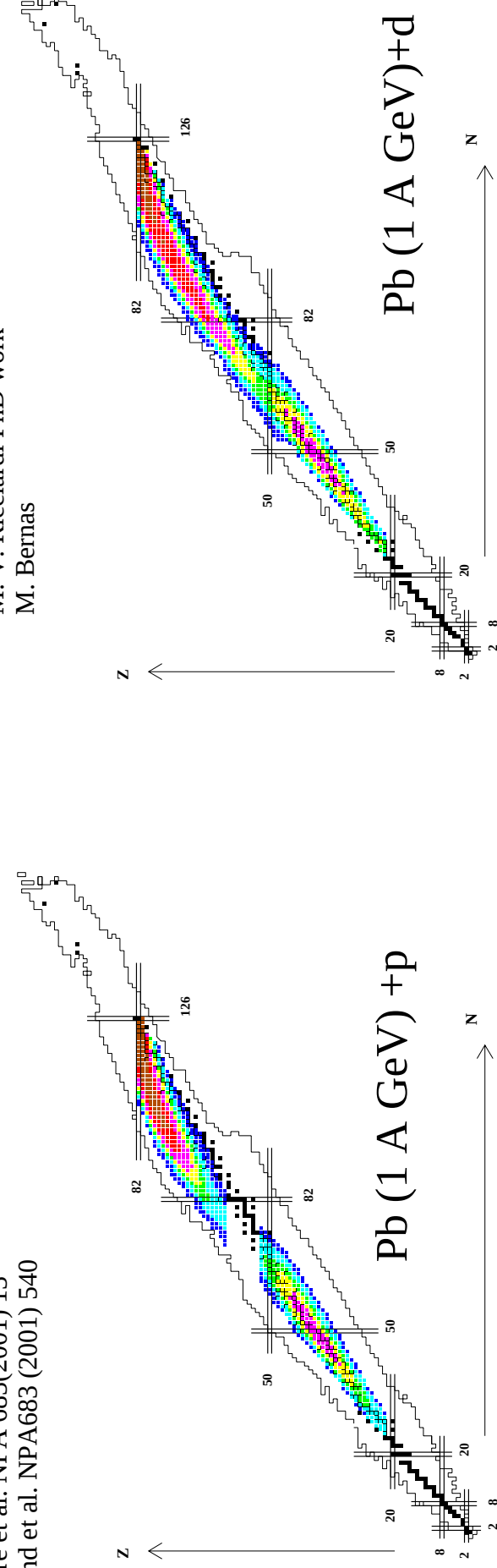
- Identification in Z , A using the ToF, $B\rho$, ΔE technique
- Precise monitoring of the beam intensity
- Measure the full velocity distribution of the fragments

SPALLATION-RESIDUE CROSS SECTIONS



B. Mustapha, PhD, Orsay
 J. Benlliure et al. NPA 683(2001) 13
 F. Rejmund et al. NPA683 (2001) 540

J. Taieb PhD, Orsay
 M. V. Ricciardi PhD work
 M. Bernas



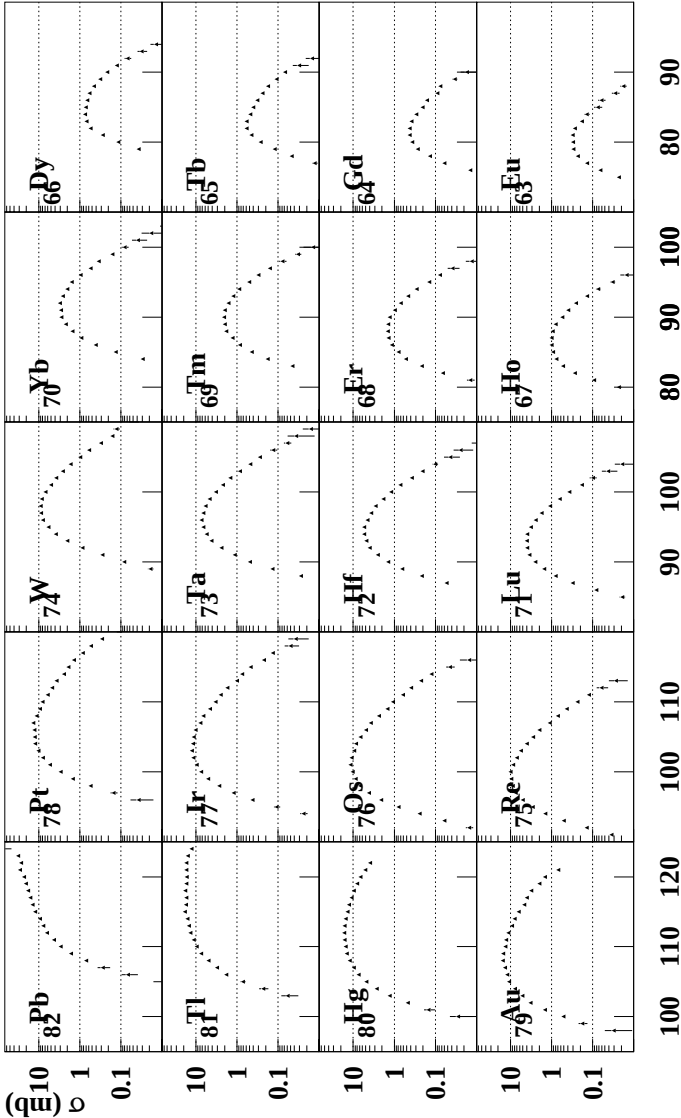
T. Enqvist et al.NPA. 686 (2001) 481

T. Enqvist et al .NPA. (2002).

Uncertainty of the measure 10 to 30 %

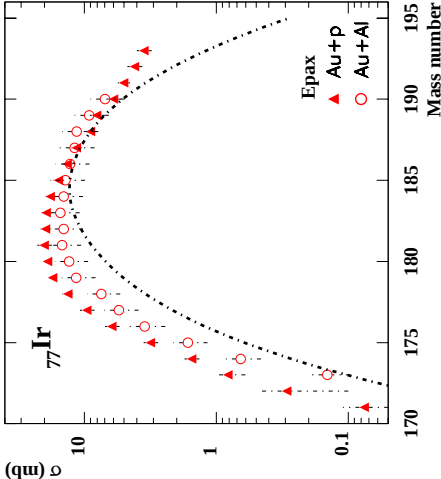
ISOTOPIC CROSS SECTION DISTRIBUTIONS

Pb 1 A GeV+p



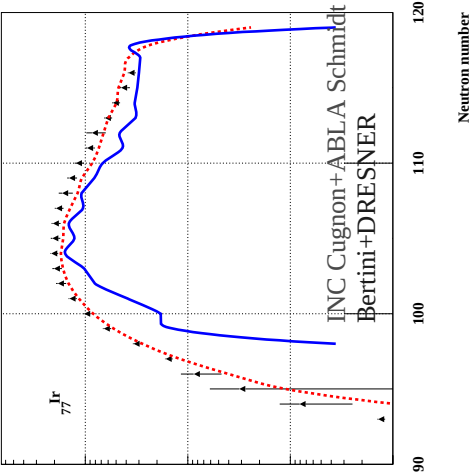
T. Enqvist et al.NPA. 686 (2001) 481

Au 0.8 A GeV+p



Energy deposited in the nucleon-nucleon collisions is higher when triggered by one single nucleon

Au 0.8 A GeV+p



Emission thresholds of the charged particles

F. Rejmund et al. NPA683 (2001) 540

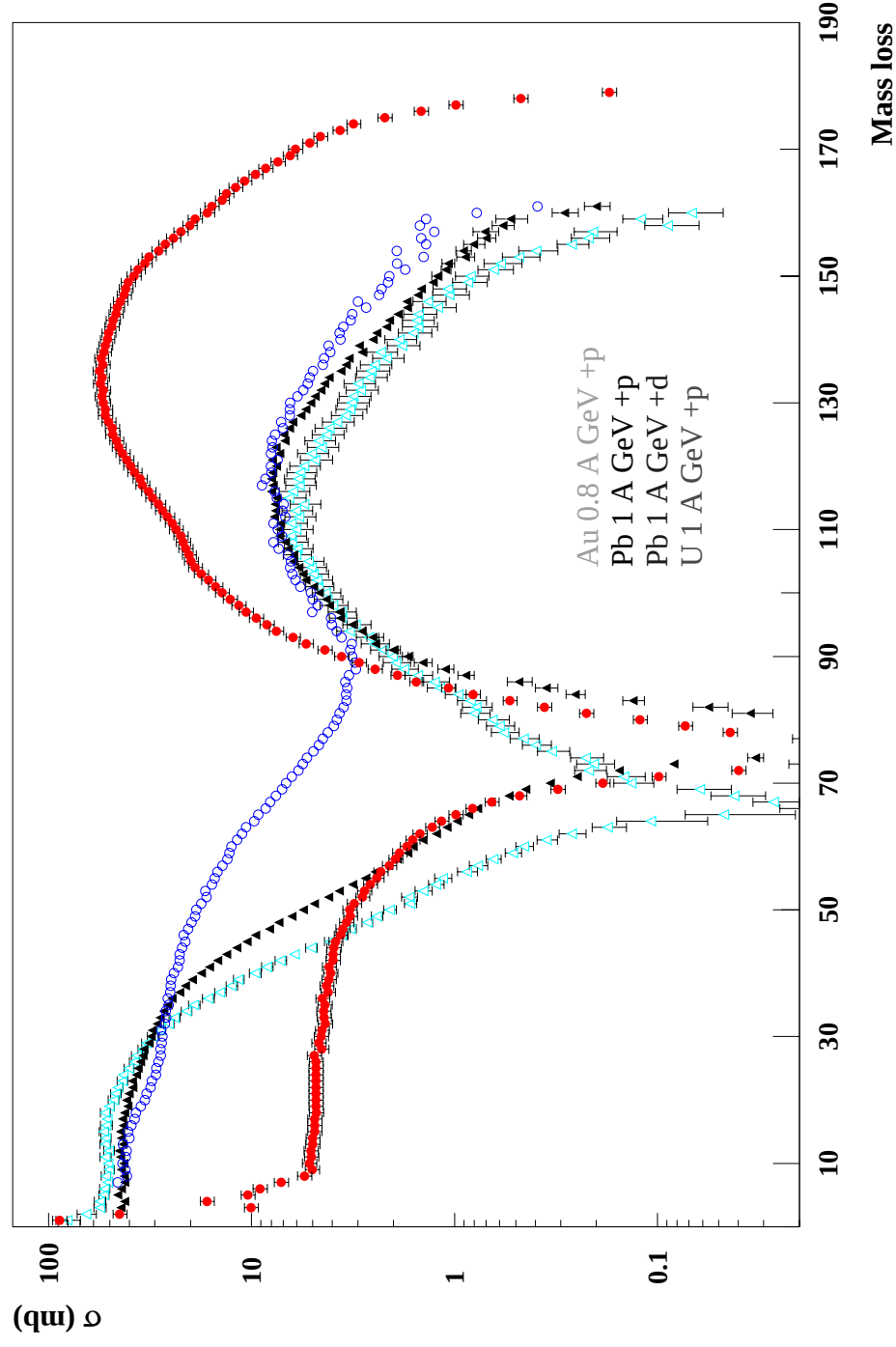
B. Mustapha, PhD work

MASS DISTRIBUTIONS

Effect of the Increasing
Incident energy

Complex reactions with
deuteron

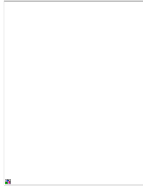
Competition fission to
particle evaporation



VELOCITY DISTRIBUTIONS

U(1 A GeV) +Pb

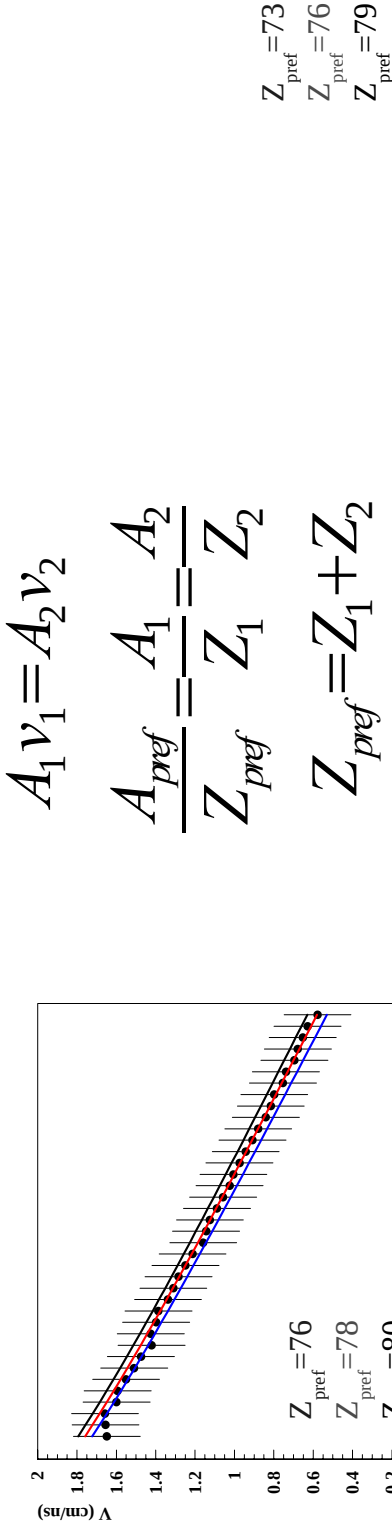
Separate and measure the
contribution of the evaporation
and of the fission processes



FISSION AT HIGH EXCITATION ENERGY

Pb 0.5 A GeV + p

Au 0.8 GeV +p



B. Fernandez, PhD work

$$IKE \sim \frac{Z_1 Z_2}{R_1 + R_2 + d} \sim \frac{1}{2} A_1 v_1^2 + \frac{1}{2} A_2 v_2^2 \rightarrow v_1 = f(Z_{pref}, Z_1, A_1)$$

J. Benlliure et al. NPA 700 (2002) 469

Spallation -> (Prefragment) -> evaporation /fission (residue)

Determination of the fissioning system

CONCLUSIONS AND PERSPECTIVES

Huge amount of high precision data

-> Informations on

- energy deposited in the Intra Nuclear cascade
- deuteron induced reactions
- particle emission
- fission to evaporation competition
- ... (talks of J. Benlliure, J. Pereira, P. Napolitani, B. Jurado).

Determine energy deposited in the collision => Spalladin experiments

Study the spallation reaction over a broad energy range

=> Presentation of L. Audouin.