



**HAL**  
open science

## **A new experimental setup to measure absolute cross section for electron emission from atoms, molecules or nanoparticles upon ion collisions**

N. Sens, M Ryszka, A. Mery, J.-C. Pouilly, Jean-Yves Chesnel, V Vizcaino

### ► **To cite this version:**

N. Sens, M Ryszka, A. Mery, J.-C. Pouilly, Jean-Yves Chesnel, et al.. A new experimental setup to measure absolute cross section for electron emission from atoms, molecules or nanoparticles upon ion collisions. 31st International Conference on Photonic, Electronic and Atomic Collisions (ICPEAC XXXI) 23-30 July 2019, Deauville, France, Jul 2019, Deauville, France. pp.152088, <10.1088/1742-6596/1412/15/152088>. <hal-03345546>

**HAL Id: hal-03345546**

**<https://hal.science/hal-03345546v1>**

Submitted on 27 May 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY 4.0 - Attribution - International License

PAPER • OPEN ACCESS

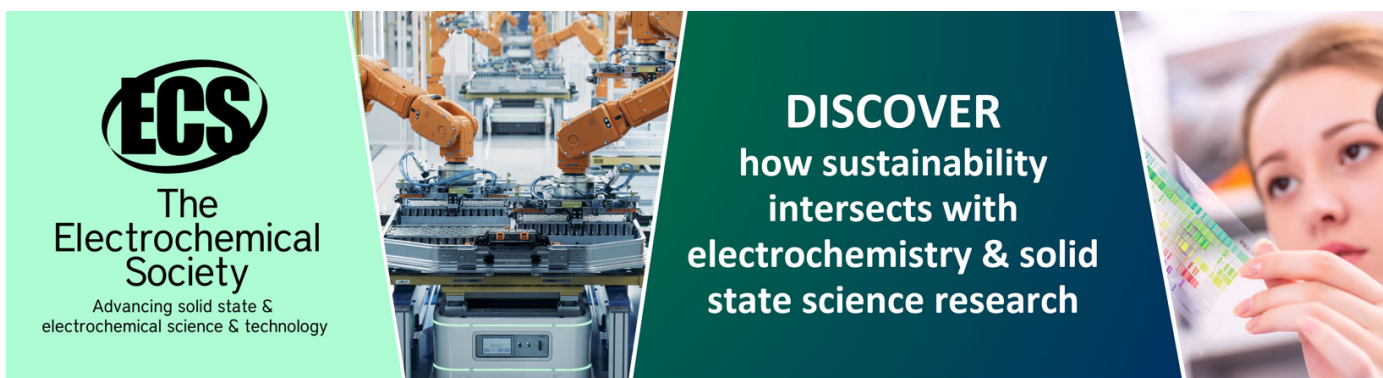
## A new experimental setup to measure absolute cross section for electron emission from atoms, molecules or nanoparticles upon ion collisions

To cite this article: N Sens *et al* 2020 *J. Phys.: Conf. Ser.* **1412** 152088

View the [article online](#) for updates and enhancements.

You may also like

- [Nuclear fission: a review of experimental advances and phenomenology](#)  
A N Andreyev, K Nishio and K-H Schmidt
- [Nucleon transfer reactions with radioactive beams](#)  
K Wimmer
- [Nuclear structure features of very heavy and superheavy nuclei—tracing quantum mechanics towards the 'island of stability'](#)  
D Ackermann and Ch Theisen



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

## A new experimental setup to measure absolute cross section for electron emission from atoms, molecules or nanoparticles upon ion collisions

N Sens<sup>1</sup>, M Ryszka<sup>1</sup>, A Mery<sup>1</sup>, J-C Pouilly<sup>1</sup>, J-Y Chesnel<sup>1</sup> and V Vizcaino<sup>1\*</sup>

<sup>1</sup>Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), Normandie Univ, ENSICAEN, UNICAEN, CEA, CNRS, 14000 Caen, France

**Synopsis** A newly developed crossed beam experimental setup that utilizes a velocity map imaging technique to simultaneously measure both emission energy and angle of electrons ejected from atoms, molecules or nanoparticles upon ion collision will be presented. The incident ion beam is produced at the GANIL facility with incident energies from a few keV to a few MeV and the target beam density is monitored by a quartz crystal microbalance allowing for estimating absolute single or double differential cross sections.

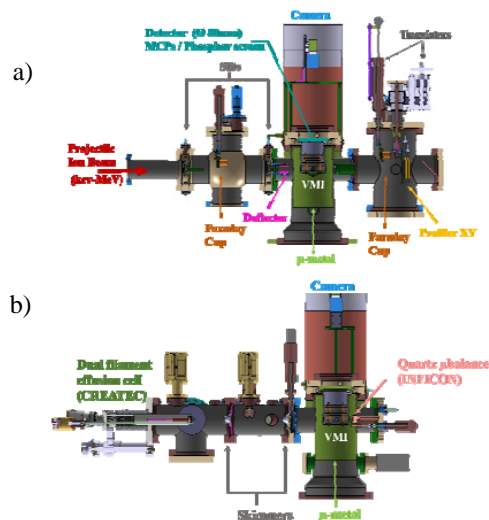
Electron emission following ion collisions with atoms or molecules has been studied for several decades to better understand fundamental ionization mechanisms (soft collisions, binary encounter...) [1] but also for its wide range of applications including radiation cancer therapy. In particular, electron emission might explain the efficiency of nanoparticles (NP) when used as radiosensitizers, to enhance tumor destruction [2]. However, the abundance and energy of these electrons have never been measured. In this project, we aim to quantify electron emission from various targets (atoms, biomolecules and NP) following ion beam irradiation.

To do so, the target beam crosses orthogonally the projectile ion beam produced by the GANIL beamlines with typical kinetic energies from a few qkeV to a few MeV. Emitted electrons with energies up to 200 eV are extracted and analyzed by a multi-electrode velocity-map-imaging (VMI) spectrometer. By monitoring the target density, the projectile ion beam intensity and the beam overlap with the use of a quartz crystal microbalance and an ion beam profiler, we are able to estimate absolute double (vs. energy and angle) or single (vs. energy) differential cross sections for electron emission.

The setup allows us to produce a wide range of target beams. A supersonic jet source allows for measuring electron emission from noble gas atoms, e.g. the well-defined electrons from autoionizing states of Ar<sup>+</sup> emitted in the range from 1 eV to 20 eV are used for calibration purposes. With the use of an effusive cell, we were also able to produce in the gas phase a steady effusive beam of biomolecules (e.g. uracil) as well as metallic atoms (e.g. silver). Moreover,

we are developing a nebulizer – aerodynamic lens system dedicated to experiments on metallic nanoparticles of various sizes (from nm to few tenths of nm).

In this contribution, we will present the development and characterization of the set-up in particular the design of the new NP source.



**Figure 1.** Outlines of the experimental setup : a) Projectile beam section, and b) Target beam section with an effusive cell installed.

The authors acknowledge the support of both the ANR (grant ANR-16-CE30-0006) and the Normandy Regional Council.

### References

- [1] Stolterfohl N, DuBois RD, Rivarola RD, 1997 *Springer-Verlag, Berlin Heidelberg*
- [2] Porcel E *et al.* 2014 *Nanomedicine Nanotechnol. Biol. Med.* **10** 1601–1608

\* E-mail: violaine.vizcaino@ganil.fr