In this communication, we present our activities relating to the use of the collections of scientific instruments for education carried out at the University of Rennes 1 (Brittany-west of France).

The culture and collections department of the University of Rennes 1

Culture and sports (« Diapason » building)

Scientific instruments

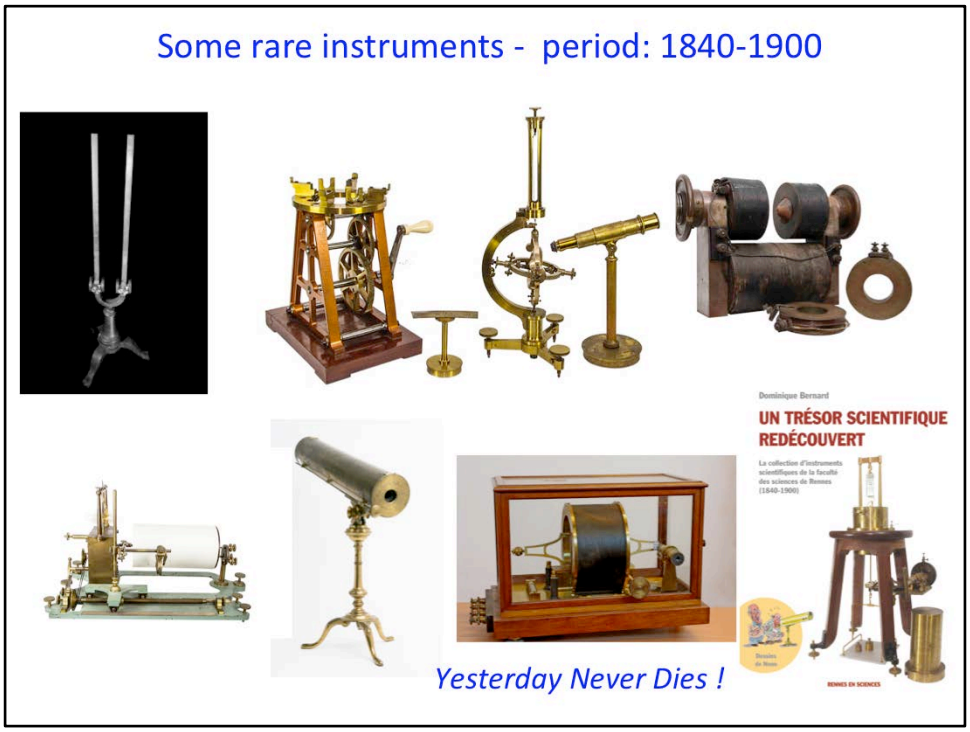
Zoology- Botany gallery

Geology museum

The university's culture and heritage department includes in particular a building devoted to culture and sports for students (le Diapason) but also rich collections in zoology-botany, geology and scientific instrumentation.

1) The scientific instruments collection

This collection has been the subject of several communications, so we will not detail it. From the year 2000, it was gradually reconstructed from the initial approach of two physics teachers from the University of Rennes 1: Dominique BERNARD and Jean-Paul TACHE. Around a thousand objects from the 19th century, to which are added several thousand pieces from the 20th century. All scientific disciplines are present but more particularly: physics, chemistry, electronics and computer science. The conservation area consists of a gallery located in the basement of a teaching building and several storage reserves scattered around various locations on the Beaulieu Scientific Campus.

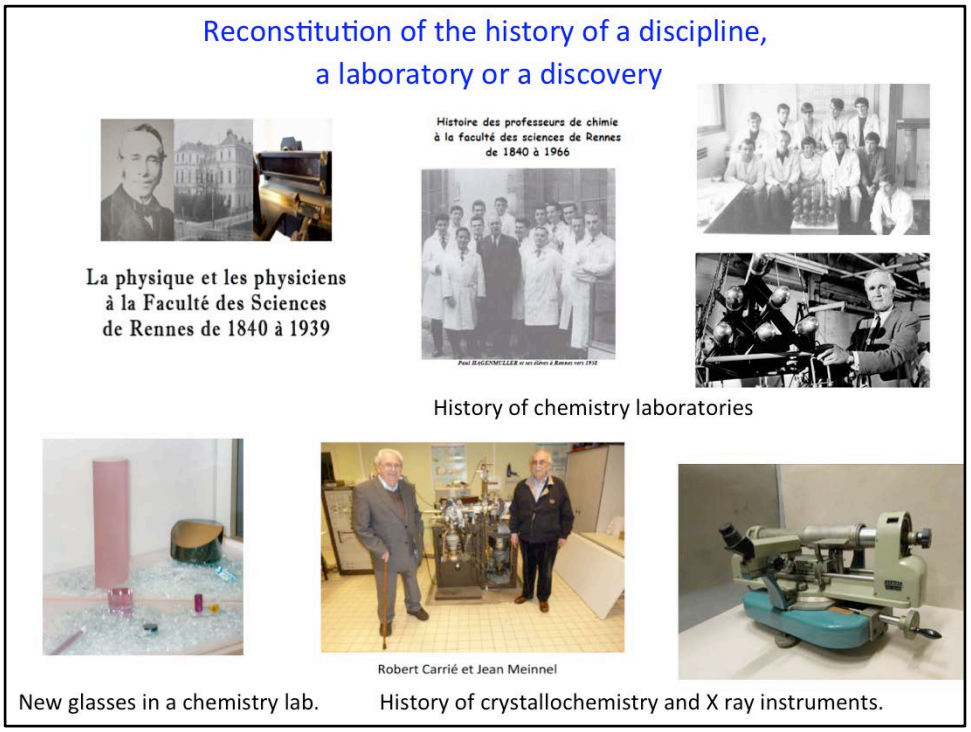


Some very rare instruments are worth a look: large tuning fork by Koenig, gyroscope by Léon Foucault, electromagnet by Pierre Weiss, telescope by James Short (1740) etc ... They have been detailed in the book by D. Bernard recently published on the collection (period 1840-1900 - 2019 scientific information prize of the Academy of Sciences).

An inventory and promotion program called PATSTEC (Scientific and Technical Heritage Contemporary) has been set up in collaboration with the Conservatoire National des Arts et Métiers - CNAM-Museum des Arts et Métiers.
The PATSTEC mission is presented in detail on the website http://www.patstec.fr
In this national program, the University of Rennes 1 is a pilot for the Brittany region.

2) Students and scientific instruments heritage

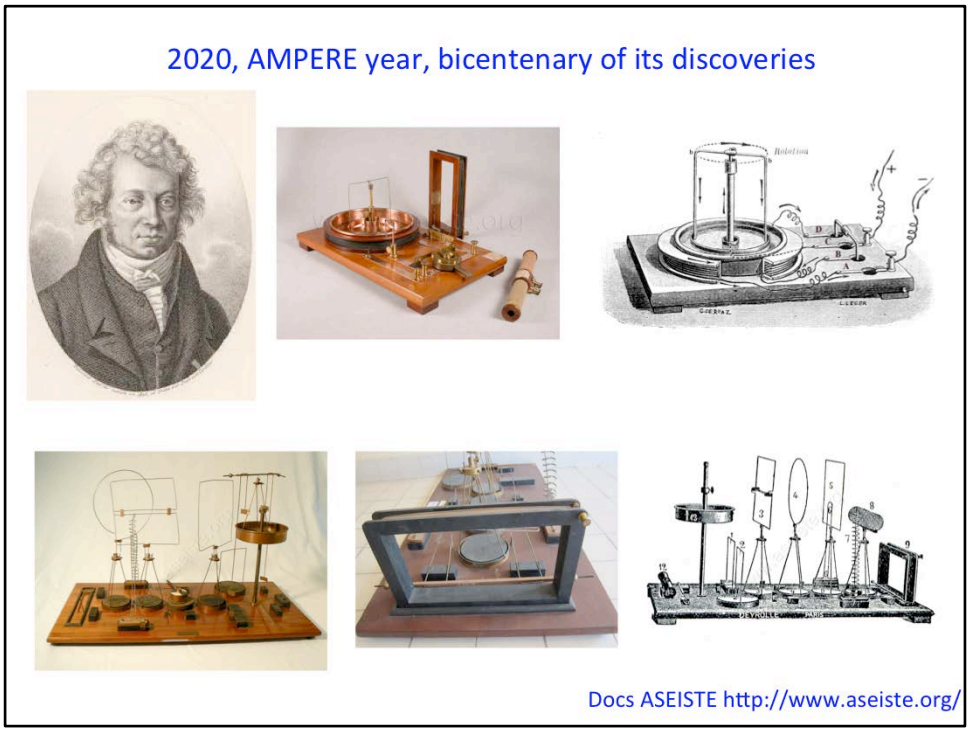
Shortly after the collection was created, we designed to offer internships of up to 3 months as part of the training of undergraduate and master's students in physics and chemistry. We had no difficulty in finding very passionate students, but we had to be persuasive with the responsible teachers during the first attempts. The interest of this project did not seem at all obvious to many that we had to convince.
About forty students took part in this action until 2020. They were able to develop their knowledge in the history of science, carry out bibliographic work, compare old experimental results with the latest experimental techniques in research laboratories and also present these devices and their stories to the public. A very good preparation of the students for their future profession of teacher or researcher. Here are a few examples of this work. Some have given rise to publications and communications, in particular to the SIC.



In response to the inquiries that we frequently receive from other researchers or laboratories, internships can be directly linked to a historical approach to the disciplines or to the creation of laboratories.. Here are a few examples:

* Axel Petit did a Master 1 internship and undertook original work on the history of physics and physicists at the Faculty of Science in Rennes from 1840 to 1939. This work led Axel to a doctoral thesis in epistemology of science and technology defended on December 11, 2013 at the University of Nantes.

* With two Masters students in chemistry, Benjamin Gallon and Julie Priser, we set out to write a history of chemistry in Rennes from 1840 to 1980. Julie Priser, so passionate about the enhancement of scientific heritage, is now assistant in charge of collections of scientific instruments at the Faculty of Science of Rennes and ... first author of this communication.



The year 2020 marks the 200th anniversary of the birth of the fundamental discoveries made by André-Marie Ampère (1775-1836) and which gave birth to electrodynamics. We suggested to Graziella Guy, a 3rd year student in physics and chemistry, to do an internship in the collections of scientific instruments, focusing more specifically on those relating to the work of Ampère and other physicists of the time. (Oersted, Arago, Biot, Faraday…). Graziella manipulated some of these devices built by Deyrolle like the Table Ampère, the Table Ampère Modified Bertin, and the Obellianne device ...

Unfortunately, the coronavirus epidemic severely disrupted the year 2020 and activities were halted.

The "QUESACO project" for students (2018-2019)

The selected instruments : sound analyser of R. Koenig and Jules 'Violle's actinometer

The winning student groups

In partnership with the university's Fablab, we have designed a project called QUESACO (Questioning scientific collections: from heritage to innovation). This challenge is mainly aimed at students.

Each year, we select an instrument from our collection, it serves as a challenge object for a student competition. Students are invited to meet this challenge by working together in interdisciplinary teams of 3 to 4 people. The game consists of imagining and building an innovative device that improves and responds to the object of historical science that we have selected. What the student teams produce to meet this challenge is open: modern prototype; artistic and / or scientific mediation (video, presentation…) or take a mew form that we have not imagined.

The university library of the Faculty of Sciences, located very close to the gallery of instruments, is a very suitable place to meet students. You can present rare and precious objects and books, tell stories because the place, very popular with students, lends itself well to demonstrations. Thanks to the constant collaboration of the team of the central documentation service of Campus Beaulieu, we have been able to organize numerous exhibitions whose theme is linked to the current International Year of the United Nations, such as:

- From natural history to biodiversity (2010),
- From mineralogy to crystallography (2014),
- 25 centuries of light (2015),
- Minitel, the ancestor of the Internet? (2015)
- Discovering legumes (2016),
- Mendeleev's classification of chemical elements (2019).

3) Teachers and scientific instruments heritage

Scientific instruments: a wonderful tool for teachers

Handling of instruments by teachers and interventions by experts.

For teachers, whatever the level of the classes they supervise (from elementary school to high school), the collections are always a place of welcome. Contacts are well established with their associations such as the Union of Professors of Physics and Chemistry (UDPPC) or directly with their institutions. Special visits are organized for them to prepare for their classes.

For certain visits or exhibitions, we also welcome scientific experts such as William Tobin and Alain Faisant working on Léon Foucault's instruments. In chemistry and X-rays, we also benefit from the skills of chemistry professors or researchers such as Jacques Lucas, Christiane and André Perrin and members of the Rennes en Sciences association.

From the collections, we were able to design a “House for Science in Brittany” project (House for science in Brittany at the service of teachers). Approved by the “Main à la Pâte” Foundation, supported by the Academy of Sciences and all of Brittany's teaching and research partners, it opened for the start of the 2014 school year and is based on the scientific campus of Rennes, not far from the gallery of collections of scientific instruments.
For teachers in the primary cycle, who have little or no practice in scientific disciplines, practical and simple experiences offered during internships can boost their motivation or overcome their fear of science.

Old scientific instruments, by their simplicity, are excellent teaching aids that teachers can usually handle without too much difficulty or risk of deterioration.
For example, subject to training such as "the concept of energy and its conservation", one can easily use a Lavoisier calorimeter, a Hero fountain, study the operation of a Watt steam engine, and attempt to perform very simple by using them as models.
This type of training combining old devices, history of science and a summary reconstruction of the founding experiences is highly appreciated by teachers.

Among the courses offered include:
- *Let's get in tune! sound at the crossroads of disciplines*
- *The progress of measurement:* units, old and contemporary devices, precision, data acquisition and processing …

Teachers can manipulate the devices in the gallery and design small, simple experiments that they could carry out with their pupils, when they will come back in their schools.

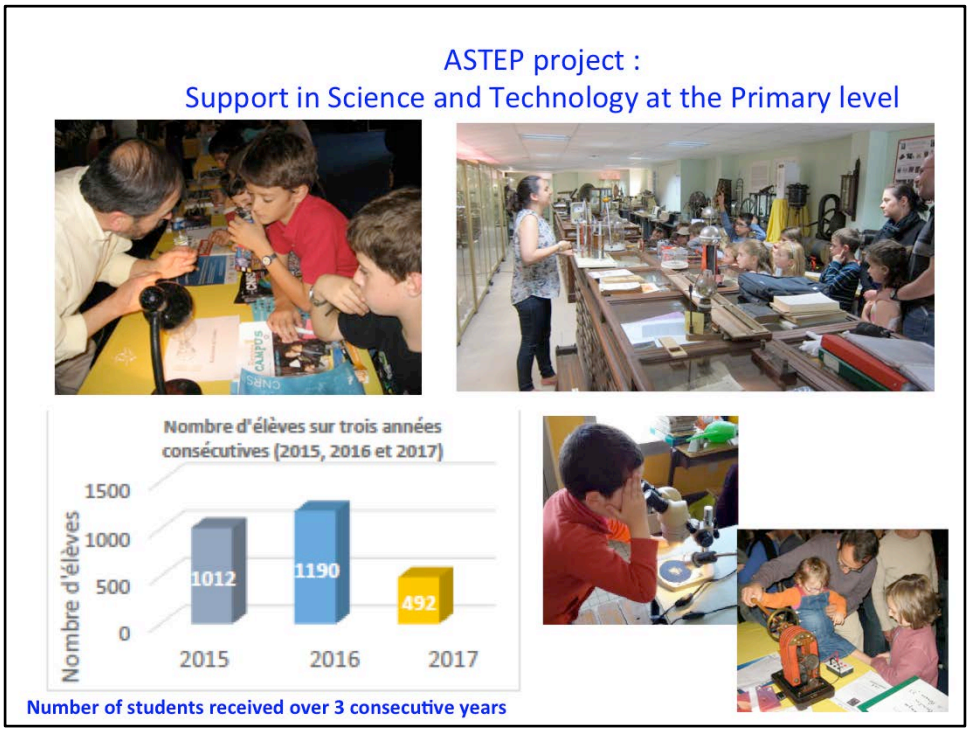
These internships are also an opportunity to make teachers aware of the issue of safeguarding and enhancing the scientific and technical heritage to which they can have access when they return to their colleges or high schools.

In June 2018, a large animation evening called "LA NUIT DES PROFS" (Teachers' Night) was organized by the "Maison pour la Science" and the Cultural Service. It brought together around 70 teachers around animations and of course visits to the collections.

4) School children visits and scientific instruments



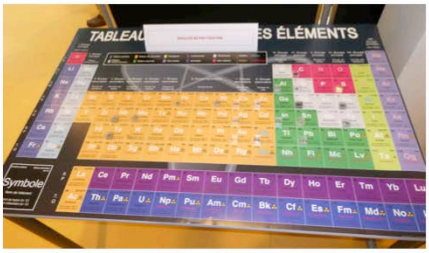

The reception of classes, from primary to high school, has always been considered an important activity of the cultural service because it puts young schoolchildren in contact with the university environment for the first time. We do little publicity because we have enough requests and our human resources are insufficient to meet the many requests. On arrival, the classes are divided into small groups (around 10 to 15 students) and each group, by rotation, visits the different sections of the collection (scientific instruments, zoology, geology). The guided tour by a curator lasts between 40 minutes and an hour. The theme of each visit is tailored to the school program, informed by an in-depth discussion with teachers prior to the visit.
It is widely illustrated by experiments sometimes carried out by pupils (when possible!) and by demonstrations made by the curator. These meetings are an opportunity to make teachers and high school students aware of the need to conserve and promote contemporary scientific heritage and the importance of teaching the history of science.



The collections department was able to accommodate up to 1,200 students in 2016 (24 classes). This maximum reception was achieved thanks to the implementation of a planned action with the city of Rennes called ASTEP (Support for Sciences and Technologies at the Primary). This very positive approach was not able to continue at such a level in the following years (500 schoolchildren welcomed in 2017, 200 in 2018). This drop in participation results from the drastic reduction of service personnel in the collections.

When high school students are presented with the evolution of computing methods, from the slide rule to desktop computers (like APPLE II), including mechanical calculators, it is astonishment and surprise that dominate. When we present various forms of recording and storage of data from the cylinders of Marey (1900), 1930’s music records to the usb sticks or the “cloud”. The students realize how technology evolves in response to scientific discoveries

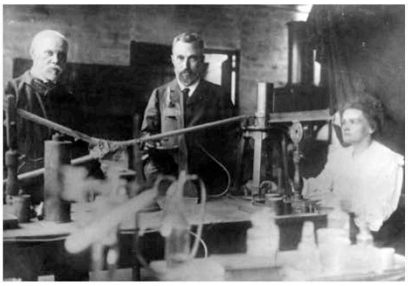
5) Public and scientific instruments heritage

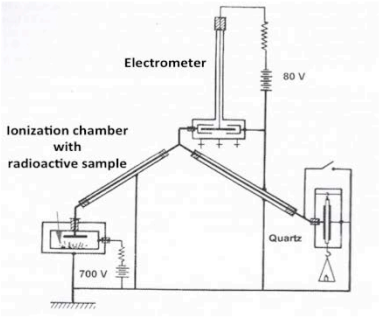


The university being a place dedicated to the training of students and to research, it is only open to the public occasionally during events to disseminate scientific culture such as: the Fête de la Science1 (21,000 people including 2000 schoolchildren over three days in 2019), the European Night of Museums, the Heritage Days or even the European University Collections Day piloted by the UNIVERSEUM Network of which we are a part.

The collections of instruments lend themselves well to all kinds of surprising or educational demonstrations. This is the opportunity to present original experiences of old and contemporary instruments on information stands. In this process, our friend Paolo Brenni always serves us as examples to follow with the many experiences he has set up at the Fondazione Scienza e Tecnica in Florence, with his team.

Reconstitution of the historical experience of measuring the radioactivity by Pierre and Marie CURIE (1898)

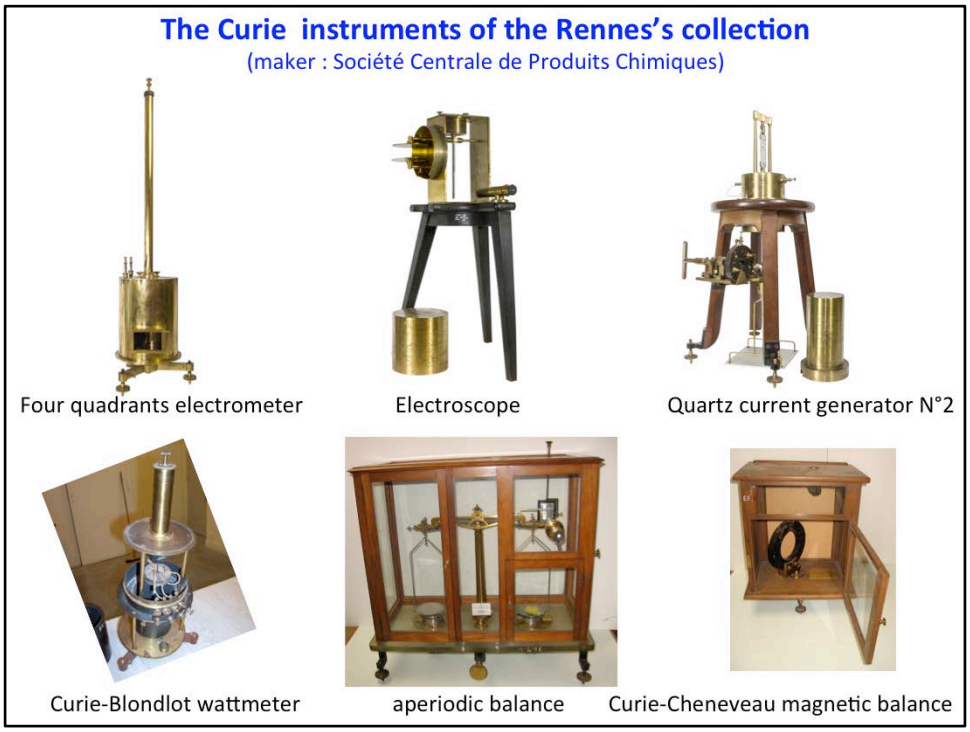




Pierre and Marie CURIE, Jacques CURIE , their laboratory and the original electric diagram

Among the scientific activities presented to different audiences (students, schoolchildren and Maison Pour La Science), the reconstruction of the experience of radioactivity measurements by Pierre and Marie Curie figures prominently. We have already presented this achievement on several occasions and we cannot detail it here.

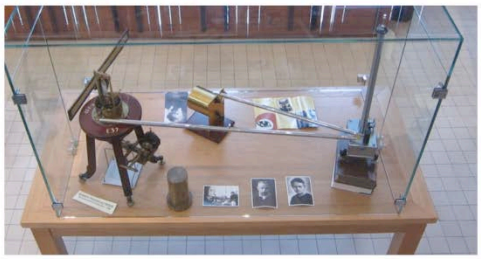
We present the historical experience of measuring radioactivity by Pierre, Marie (with the help of Jacques Curie). They made wonderful discoveries and received two Nobel Prizes (1903 and 1911). The original electrical assembly combines an ionization chamber containing the radioactive sample, quartz and the electrometer.



During the distribution by the Société Centrale de Produits Chimiques of the devices designed by the Curie, the physics professors at the Rennes science faculty acquired the first devices on the market between 1890 and 1900. We thus found six devices in the Rennes collections: four quadrants electrometer, electroscope, quartz current generator (N°2), Curie-Blondlot wattmeter, aperiodic balance, Curie-Cheneveau magnetic balance.
The idea then came to us to try to reconstruct the original historical experience from these devices. With the help of Bernard Pigelet, Denis Beaudouin and the staff of the Musée Curie, we were able to achieve this reconstruction.

The Curie setup reproduced in Rennes 1 University

Ionization chamber



Operated by B. Pigelet

Inauguration by Hélène Langevin-Curie and Pierre Joliot (november 2015)

Installed in the geology gallery of the scientific campus, this experience is part of the regular program of visits. The various possible experiments are carried out directly by the curators (Julie, Jean-Paul and Domi). The public can see the preparation (handling and positioning of very weak radioactive sources), independent operation of the various devices, then observe on the light ruler the displacement of the spot proportional to the electric current

It requires historical and scientific support that we carry out. It deals with the history of the great discoveries of the beginning of the 20th century, the scientific method such as trial and error, nuclear energy and its applications. Always astonishing to see the reactions of the public, when they are shown old devices in perfect working order and which have remarkable sensitivities even now (electric currents measured in the order of a pico-amps)

The opportunity for very enriching exchanges with a public which, at the beginning, is often frightened by the vision of physics and chemistry which they consider to be very difficult sciences and which appreciates being able to better understand phenomena such as radioactivity. The reactions of those present are generally very enthusiastic, with the pleasure of viewing a historical experience live and understanding its functioning and purpose.

A few videos are available online and an exhibition presents the history of the Curie family.

This reconstruction obtained the second prize awarded by UMAC in 2017 (president Marta Lourenço)

Thank you for your attention and reading

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Short Bibliography

- Ian Flemming, Casino Royale, J. Cape Ed., London, 1953

- Bernard D., Tobin W., Canard A., Taché J-P., The Physics Instrument Collection at the University of Rennes 1, *Scientific Instrument Society Bulletin*, December 2011, N°111. Pp. 34-39.

- Bernard D. edited the book: *Un trésor scientifique redécouvert- Les collections d'instruments scientifiques de la Faculté des Sciences de Rennes (1840-1900),* éditeur : Rennes en Sciences, 2018, 250 pages, 90 devices

- Faisant, A., Bourles, S., Bernard, D., « Historical instruments as tools to develop the curiosity of young people : the example of Heron's Fountain », XXVII SIC Symposium, 2008, Lisbonne.

- Jules Violle's actinometer : a simple instrument to deduce the temperature of the surface of the sun », Olympe Jouet, Axelle Amon, Dominique Bernard, *Scientific Instrument Society Bulletin*, March 2012, N°112, pp. 28-31

- D. Bernard and J.F. Loude: «Laboratory electromagnets from Michael Faraday to Pierre Weiss ». 22-23 july 2013, Manchester, SIC/ ICHSTM

- B. Pigelet and D. Bernard, XXXVII Scientific Instrument Symposium, Leiden & Haarlem, the Netherlands, 3-7 september 2018, of "Reconstitution of the historical experience of measuring the radioactivity by Pierre and Marie Curie".

- J.F. Loude (EPFL Lausanne), D. Bernard (Université Rennes 1*) Laboratory Electromagnets* (E-Ms), Deutschen Physikalischen Gesellschaft, München, 2019, 20 mars.

Internet and Exhibitions:

* The University internet site : https://www.univ-rennes1.fr/
* https://bibliotheques.univ-rennes1.fr/les-expositions-virtuelles-0
* The PATSTEC mission is presented in detail on the website http://www.patstec.fr
* QUESACO : https://www.youtube.com/watch?v=WSqEGuFFy7U

and https://esir.univ-rennes1.fr/actualites/lesir-recompensee-au-challenge-quesaco

* Maison pour la Science : https://www.maisons-pour-la-science.org/fr/bretagne
* Curie experiments :

Video movies of Florence Riou - Rennes en Sciences : https://www.youtube.com/watch?v=Hsp5TljXzBU