Ionizing Radiation Experiments as a Mobile Lab

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ABSTRACT

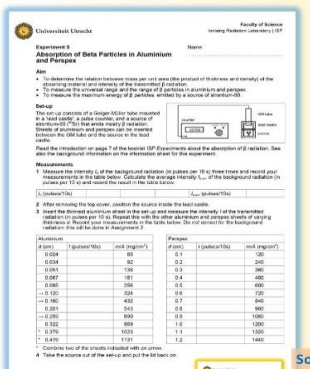
Initiated by the Dutch Ministry of Education, the Ioniserende Stralen Practicum at the Freudenthal Institute, Utrecht University, developed a mobile lab around 45 years ago. While currently equipped with three mobile labs, students from the tenth through twelfth grades throughout the Netherlands familiarize themselves with radionuclides, the produced ionizing radiation and some of the processes involved. We describe the unique character of the experiments in their simple and easy to troubleshoot set-ups.

The schools are offered closed lab instructions or open lab instructions, in which students design experiments using the limitations as given by the provided lab equipment. We will discuss (i) how the experiments support a Physics curriculum, (ii) our unique approach of offering labs regarding ionizing radiation, and (iii) evidence of their positive impact on student concepts. In addition, we will share some early plans for implementing the use of smartphones and tablets to acquire and process data.

Keywords: radionuclides, ionizing radiation, experiments, physics curriculum

Students at Work

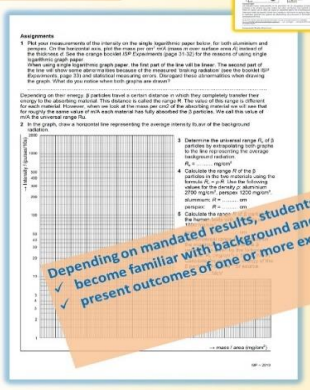
A Closed Activity Instruction or An Open Activity Guidance



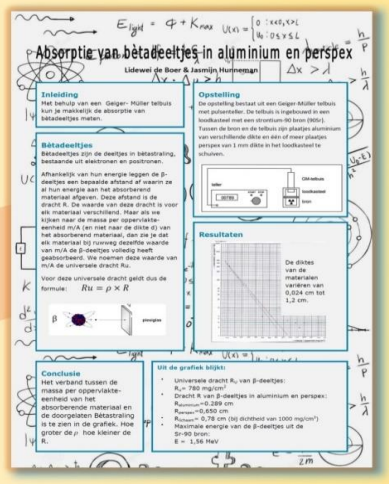
Activities require students to interact with equipment, radio-isotopes and their safe handling.

Some experiments require also common physics knowledge, such as the electrical force in a magnetic field or interference of waves.

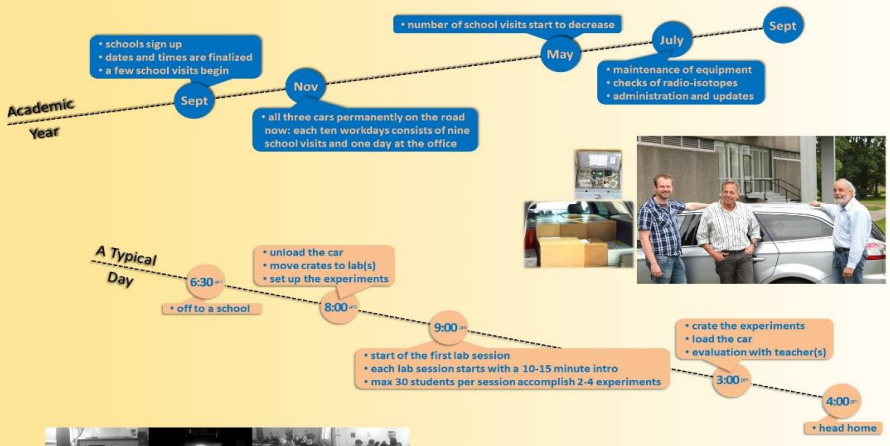
Each activity has a set of student instructions including background and procedural information, required tasks, and questions.



Depending on mandated results, students may be required to
- ✓ become familiar with background and instructions in advance
- ✓ present outcomes of one or more experiment using a
  - • slide presentation
  - • lab report
  - • poster presentation



Logistics



Advantages of this Mobile Lab

- Outreach to 350+ high schools and over 18,000 students throughout the Netherlands.
- Mobile lab instructors certified for safe handling of radionuclides and expertise about radio-activity.
- Use of robust, high-quality equipment.
- Safe storage and transportation of low activity radio-isotopes.
- Students are limited to an extra exposure of maximum 0.2 µSv/hour.
- Twenty-two different, but simple setups for easy trouble shooting and repairing.
- Topics covered are: i. half-life with e.g. age of an isotope, parent-daughter system,
  ii. absorption with e.g. detection of lead, identifying isotopes, different thicknesses of a rubber band,
  iii. X-rays with e.g. ionization of air, Bragg reflection,
  iv. diverse other with e.g. working of a GM-tube, backscattering, distance vs intensity, cloud chamber.

Disadvantage of this Mobile Lab

- Insecurities of annual funding are: i. the Ministry of Education, Culture, and Science's budget, and
  ii. a required fee per student.

Evaluations, Status and Future Plans

Previous Evaluation by teachers and management

Around 15 years ago the results of a survey done regarding doubts of the usefulness of the ISP:
- the vast majority of schools supported the significant importance of this unique lab
- schools found it worthwhile to pay a small fee per student to keep the ISP on the road

Still today teachers regularly voice their sincere gratitude.

Evaluation by students

A recent pilot survey among 200 students suggests that the ISP:
- is well received by students for use with the subject
- provides students with necessary knowledge about radioactivity

It is often that some students individually or by group express their appreciation.

Current Status

After 45 years the project development continues, but has slowed down since:
- the variety of the 22 experiments give students lots of choices to get familiar with the subject
- all experiments are proving their usefulness to students
- the experiments are simple in their set-up and easy to trouble shoot

Future Development

Plans will include:
- larger scale research on motivation and learning outcomes by the Freudenthal Institute
- development of experiments that make use of tablets or smartphones to acquire data
- collaboration with the: COVRA (Nuclear Waste Facility) – Nieuwdorp – NL
  URENCO (Uranium Enrichment and Stable Isotopes) – Almelo – NL
  Reactor Institute Delft – Delft University of Technology – Delft – NL