Remotely Controlled Laboratories (RCL)
Experimenting from a distance

Principle of an RCL

Features
- free access without booking via java capable browser
- no need for additional software or plug-ins
- about 15 experiments, available 24hrs a day, 7 days a week
- traditional experiments demonstrated by teachers can be executed by students themselves
- intuitive operation and interactive experimenting
- website of each RCL experiment containing information on set-up, theory, experimenting problems, sample measurements and evaluation, discussion/questions and material
- elaborated examples of teaching units and comprehensive collections of problems around the topic with solutions
- all experiments available in German and English
Example: Millikan’s experiment

- Determination of elementary charge by raising oil droplets with and by falling without electric field
- Measurement of raising and falling times by integrated stop watch
- Implementation in teaching, e.g. experimenting of a students group at home via Internet; alternating measuring, discussing, evaluating
Example: Photoelectric effect

Experimental set-up

Laboratory web site

- Determination of Planck’s constant $h$ by means of five monochromatic filters for mercury lamp
- Convincing measurement of the fact that the energy of released photo-electrons do not depend on intensity by means of grey filters
- Implementation in teaching, e.g. as one station in learning cycle, as experimental homework
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Available RCLs

- Electron diffraction
- Photoelectric effect
- Diffraction and interference of light (I)
- Millikan’s experiment
- Radioactivity
- Oscilloscope
- Diffraction and interference of light (II)*
- Rutherford’s scattering experiment *
- Speed of light *
- Wind tunnel
- U-I-characteristics
- Computed tomography
- Toll system
- “Hot Wire” Game
- Robot in a maze
- World pendulum *
- Order/disorder (crystal structure analysis) *
- Optical Fourier analysis *

RCL – didactics

- Authentic, real-time controllable experiment:
  Watch experimental results, read values from apparatuses (can also use “apparatus”), follow change of technical parameters.
  Abandon automatic experimenting and data analysis in favour of inquiry-based learning.
  Intuitive operation and interactive, flexible experimenting.

- New ways of teaching and learning:
  RCL as one station within a learning cycle and RCL as teaching project for lessons.
  RCL as an entrance in a teaching unit, as homework to exercise experimental capabilities.
  RCL as a substitution of experimental set-ups not available in school or of experiments not working.

- Build up RCLs on your own: students’ project:
  Simple and cheap version by open source software (PHP, Apache web server, video server).
  Standardized and flexible interface with common programmable micro controller.

- Further aspects:
  Fast collection of series of measurements in face-to-face teaching.
  Performance of comprehensive measurements at home via the Internet.
  Usage opportunities for distance learning and self-paced learning.

Contact:
University of Technology Kaiserslautern · Department of Physics - Prof. Dr. Jodl
http://www.physik.uni-kl.de/jodl · E-Mail: jodl@physik.uni-kl.de

http://rcl.physik.uni-kl.de