Co-funded by the
Erasmus+ Programme
of the European Union

Estrategias de Enseñanza y Aprendizaje basadas en Laboratorios Remotos y Virtuales

cieti
centro de inovação
em engenharia
e tecnologia industrial

isep Instituto Superior de Engenharia do Porto

Gustavo Ribeiro da Costa Alves

UNR Universidad Nacional de Rosario

Rosario, FCEIA – UNR, 12 Septiembre 2017

P.PORTO

Estrutura

- Educação (ensino & aprendizagem) em Engenharia (EE)
- Atividades e competências laboratoriais
- Laboratórios presenciais (*hands-on*), remotos e virtuais (simulação)
- Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais
  - Exemplos na área da Engenharia Eletrotécnica: circuitos elétricos e electrónicos

Por outras palavras ...

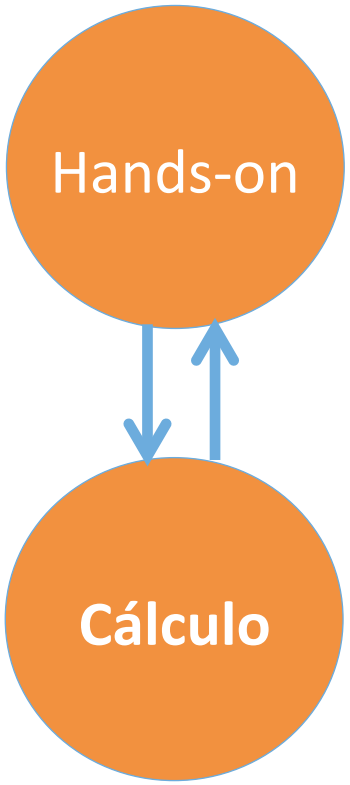
... de onde vimos, onde estamos, para onde vamos!

EE: Modelo ensino/aprendizagem

Royal Society motto 'Nullius in verba' (1660):
"… express the determination of its Fellows … to verify all statements by an appeal to facts determined by experiment."

Max Planck: *"An experiment is a question which science poses to Nature and a measurement is the recording of Nature's answer."*

Lyle Feisel (2005): *"The value of combining theory and practice traced back to the 1st engineering school in the US, the US Military Academy, founded at West Point, NY in 1802."*



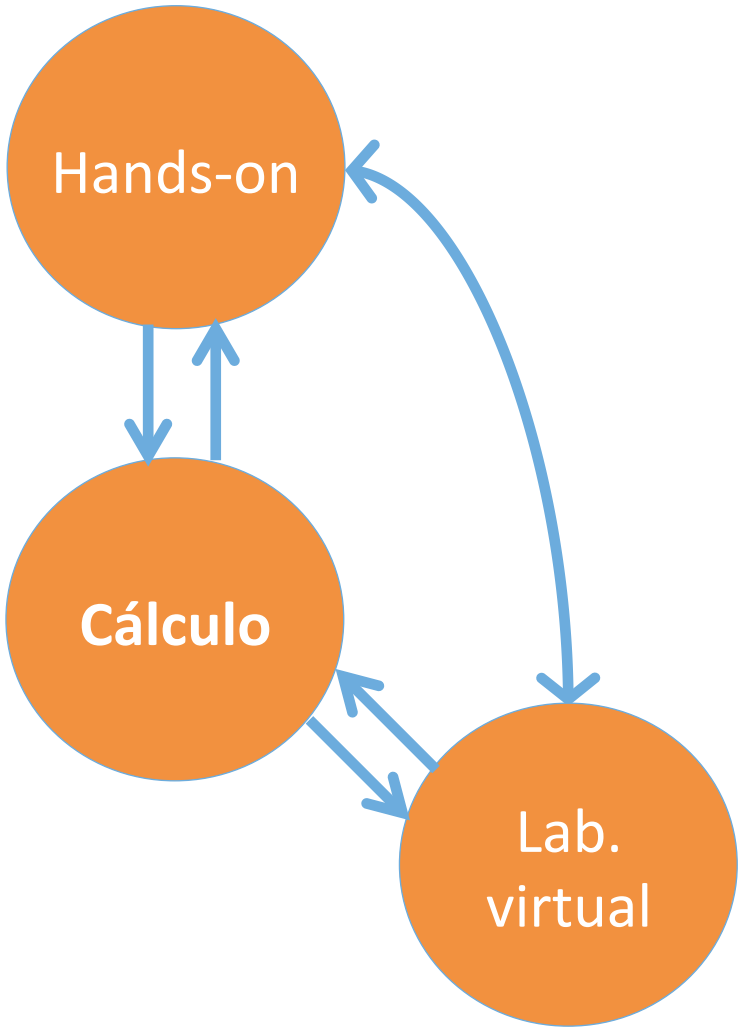
Primeiras Escolas de Engenharia Séc. XVIII

EE: Modelo ensino/aprendizagem

Séc. XX - Anos 70-80

Um novo ator:

O computador pessoal!



Simulações em computador

Meados do Séc. XX

Um PC por bancada laboratorial

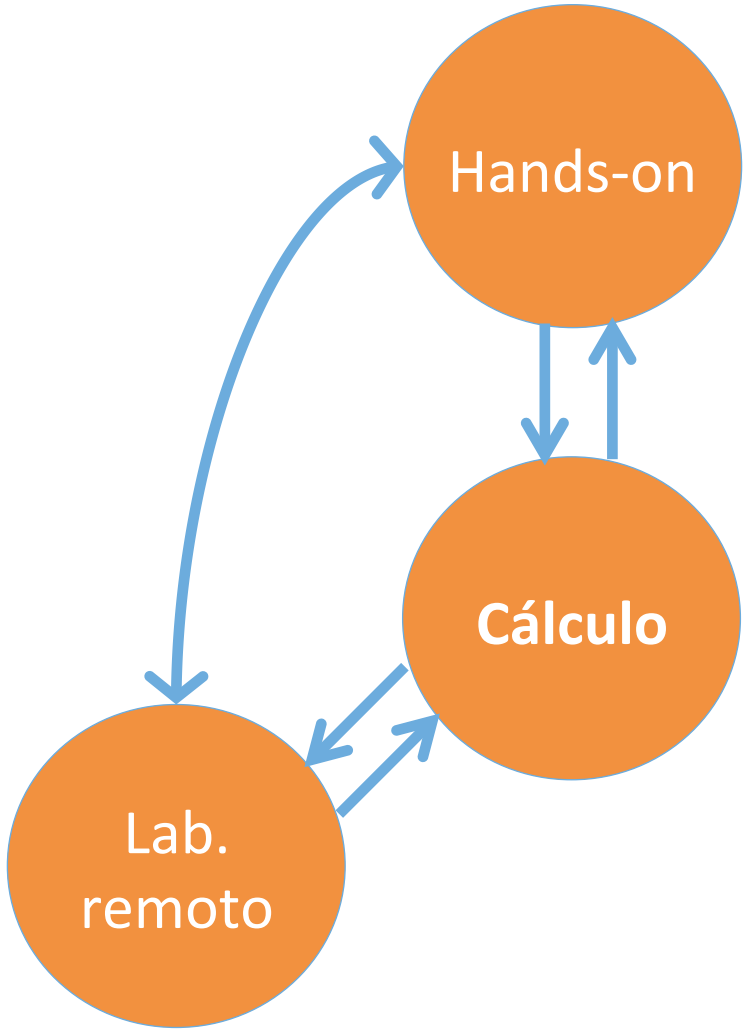
Finais do Séc. XX
Inícios do Séc. XXI

EE: Modelo ensino/aprendizagem

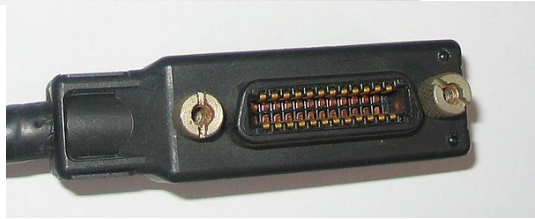
Instrumentação controlada por computador
Séc. XX - Finais dos anos 60

Controlo via Internet
Séc. XX - Década de 90

Second-Best to Being There (SBBT)
Aktan, Bohus and Shor (1996)



GPIB

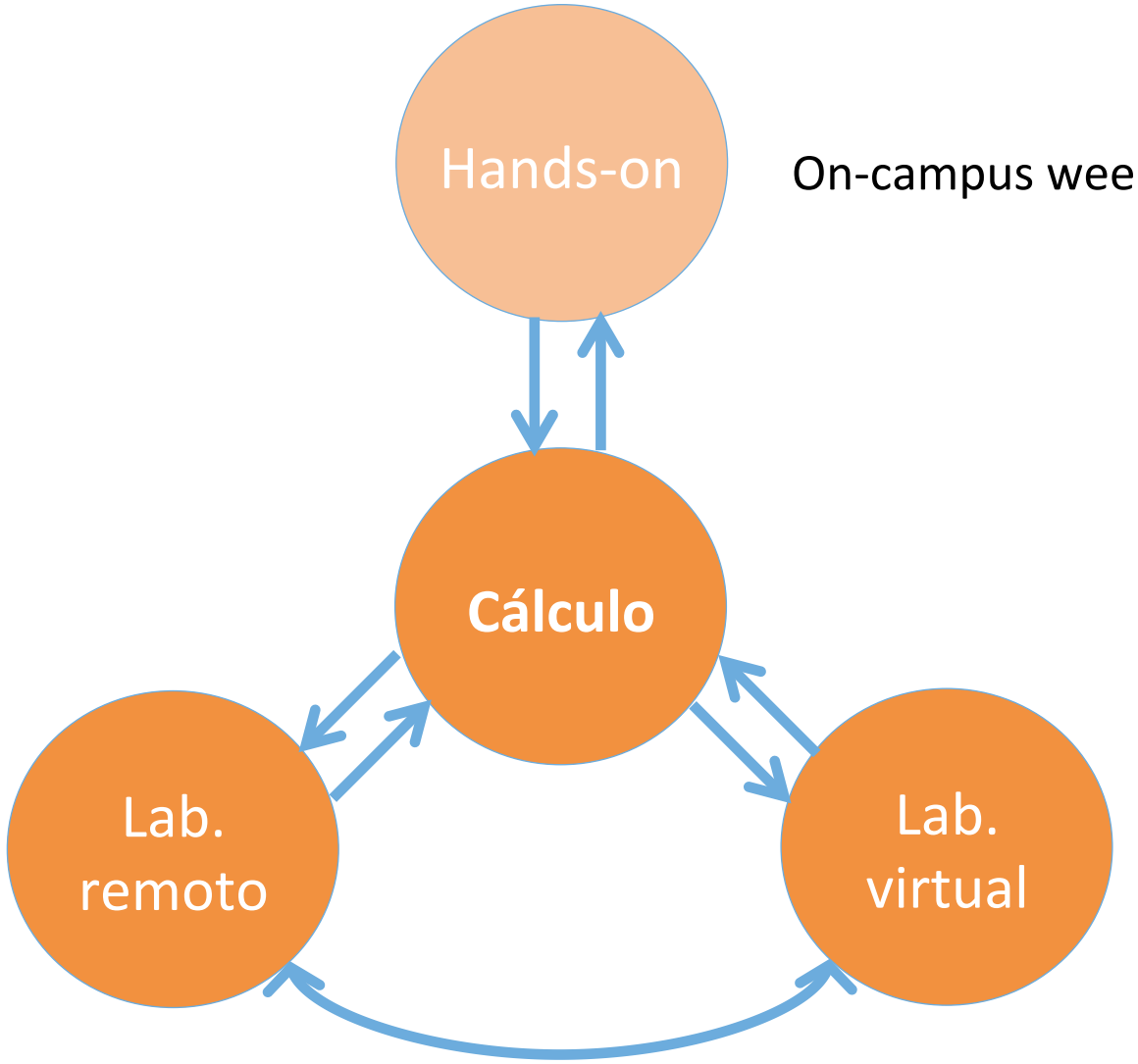


EE: Modelo ensino/aprendizagem

Distance education
Open Universities

Acesso à Internet a partir de casa.

Finais do Séc. XX
Inícios do Séc. XXI

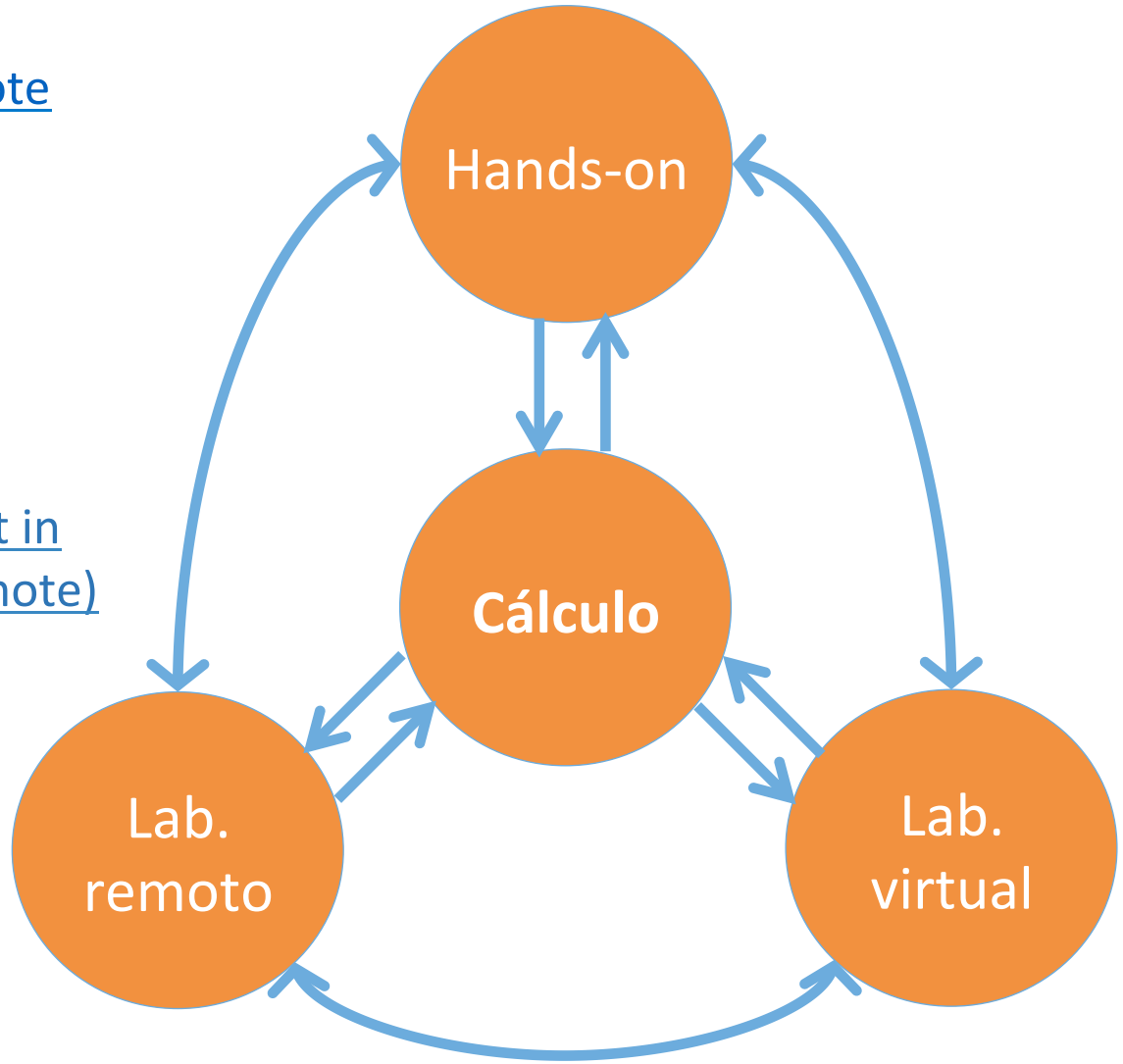


EE: Modelo ensino/aprendizagem

Hands-on, simulated, and remote labs: A literature review
Ma and Nickerson (2006)

Developing the TriLab
Abdulwahed and Nagy (2010)

Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research
Brinson (2015)



The Impact of Remote and Virtual Access to Hardware upon the **Learning Outcomes of Undergraduate Engineering Laboratory Classes**
Euan Lindsay's PhD (2005)

Weighting and sequence of use of different lab environments in the teaching-learning process
Alves et al. (2008)

Five Major Shifts in 100 Years of EE

1. A shift from hands-on and practical emphasis to engineering science and analytical emphasis
2. A shift to outcomes-based education and accreditation
3. A shift to emphasizing engineering design
4. A shift to applying education, learning, and social-behavioral sciences research
5. <u>A shift to integrating information, computational, and communications technology in education</u>

Froyd, Wankat, and Smith (2012)

Five Major Shifts in 100 Years of EE

5. <u>A shift to integrating ICCT in education</u>
   - content delivery: television, videotape, and the Internet
   - programmed instruction: individualized student feedback
   - personal response systems (clickers)
   - computational technologies
   - intelligent tutors: second phase of individualized student feedback
   - **<u>simulations</u>**
   - games and competitions
   - **<u>remote laboratories</u>**
   - grading

Froyd, Wankat, and Smith (2012)

The Fundamental Objectives of Engineering Instructional Laboratories

- **Lyle D. Feisel** and George D. Peterson, “A Colloquy on Learning Objectives For Engineering Education Laboratories”, Proceedings of the American Society for Engineering Education, p. 12, 2002.
- **Lyle D. Feisel** and Albert J. Rosa, ”The Role of the Laboratory in Undergraduate Engineering Education," Journal of Engineering Education, pp. 121-130, January 2005.

The Role of the Laboratory in Undergraduate EE

The Fundamental Objectives of Engineering Instructional Laboratories

- Objective 1: Instrumentation
- Objective 2: Models
- Objective 3: Experiment
- Objective 4: Data Analysis
- Objective 5: Design
- Objective 6: Learn from Failure
- Objective 7: Creativity
- Objective 8: Psychomotor
- Objective 9: Safety
- Objective 10: Communication
- Objective 11: Teamwork
- Objective 12: Ethics in the Lab
- Objective 13: Sensory Awareness

Feisel and Rosa (2005)

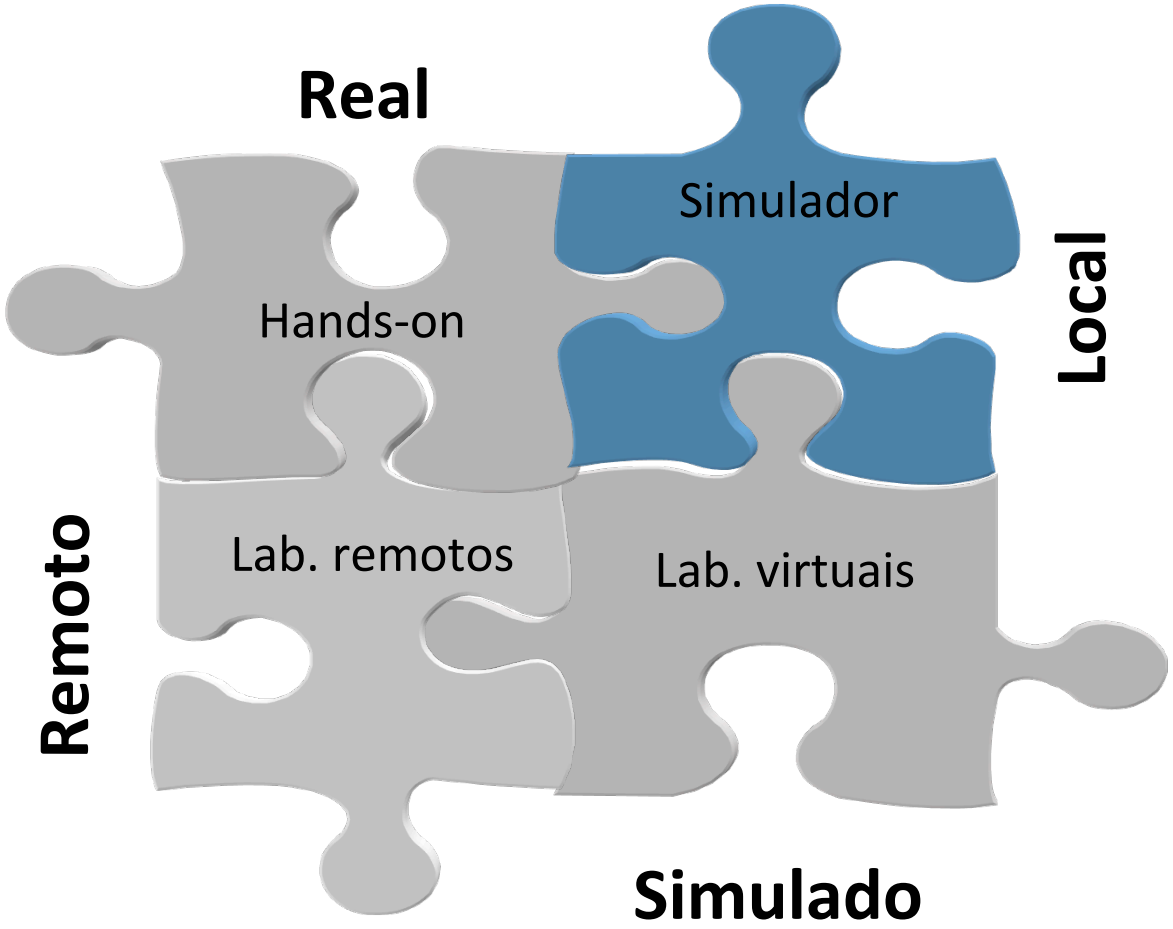
Objective 2: Models

Identify the strengths and limitations of theoretical models as predictors of real-world behaviours. This may include evaluating whether a theory adequately describes a physical event and establishing or validating a relationship between measured data and underlying physical principles.

Objectivo 2: Modelos

Identificar as potencialidades / limitações dos modelos teóricos como ferramentas de previsão de comportamentos do mundo real. Pode incluir a capacidade de avaliar se uma dada teoria é capaz de descrever adequadamente um dado evento físico e ainda estabelecer ou validar uma relação entre dados obtidos por medição e princípios físicos subjacentes.

Laboratórios presenciais (*hands-on*), remotos e virtuais (simulação)



- Critério
  - Tipo de acesso
    - Local
    - Remoto
  - Natureza
    - Real
    - Simulada
- Comp. experimental vs. tipo de lab.
    - Soysal (2000) – Eng. Elétrica
    - Ma & Nickerson (2006)

Estrutura

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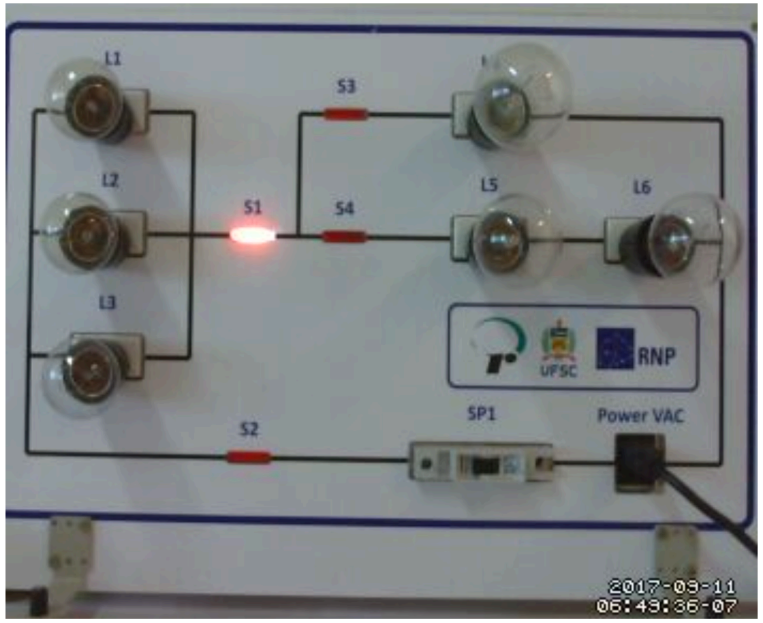
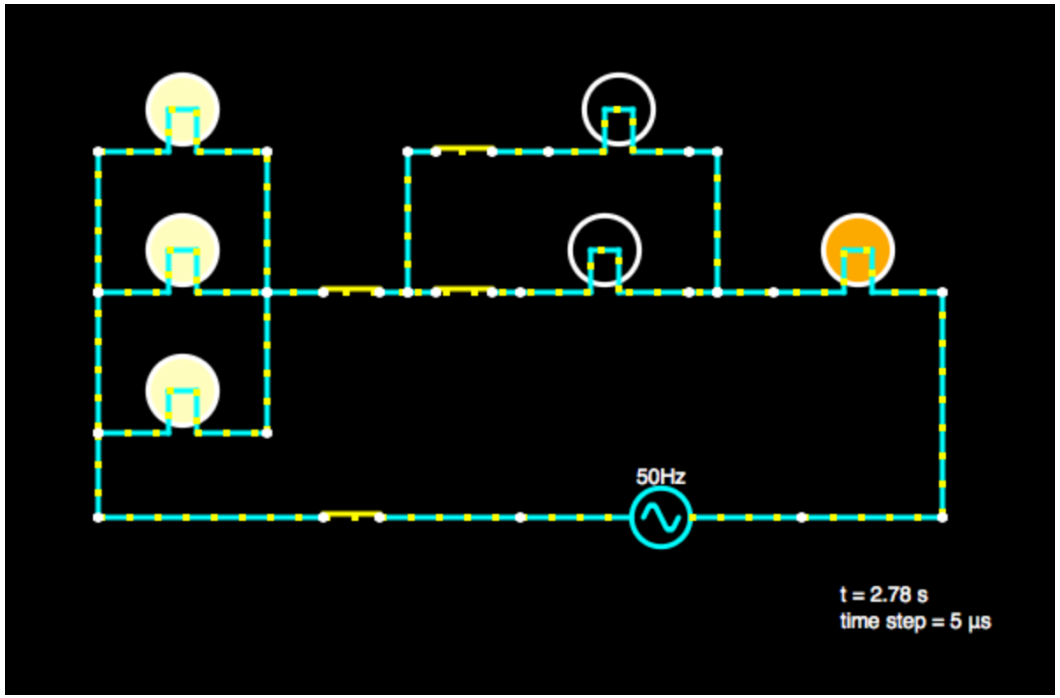
Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

- Aspectos a considerar:
  - Plano curricular: objectivos e resultados da aprendizagem!
  - Recursos (materiais, infraestrutura, ambientes disponíveis, etc.)
    - Considerar tempo de aprendizagem / adaptação aos recursos disponibilizados
  - Estilos de aprendizagem e métodos de ensino
    - Diversidade!
    - Feedback constante e rápido.
  - Avaliação
    - Combinar elementos comuns e individuais. Garantir igualdade de oportunidade e níveis aproximados de dificuldade.
  - Promover trabalho colaborativo na fase de aprendizagem e independência de resultados na fase de avaliação (individual)

Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

- Exemplos na área da Engenharia Eletrotécnica: circuito com lâmpadas



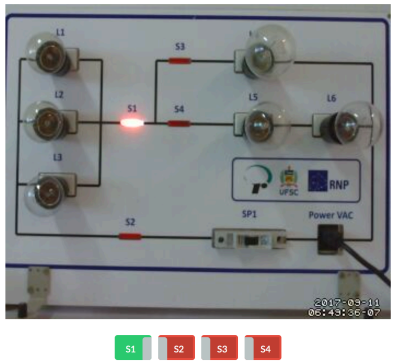


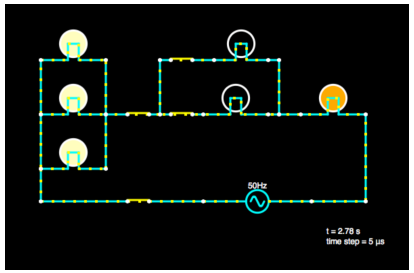
RexLab: UFSC: http://relle.ufsc.br/labs/2

Falstad: circuit simulator: http://www.falstad.com/circuit/circuitjs.html

Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

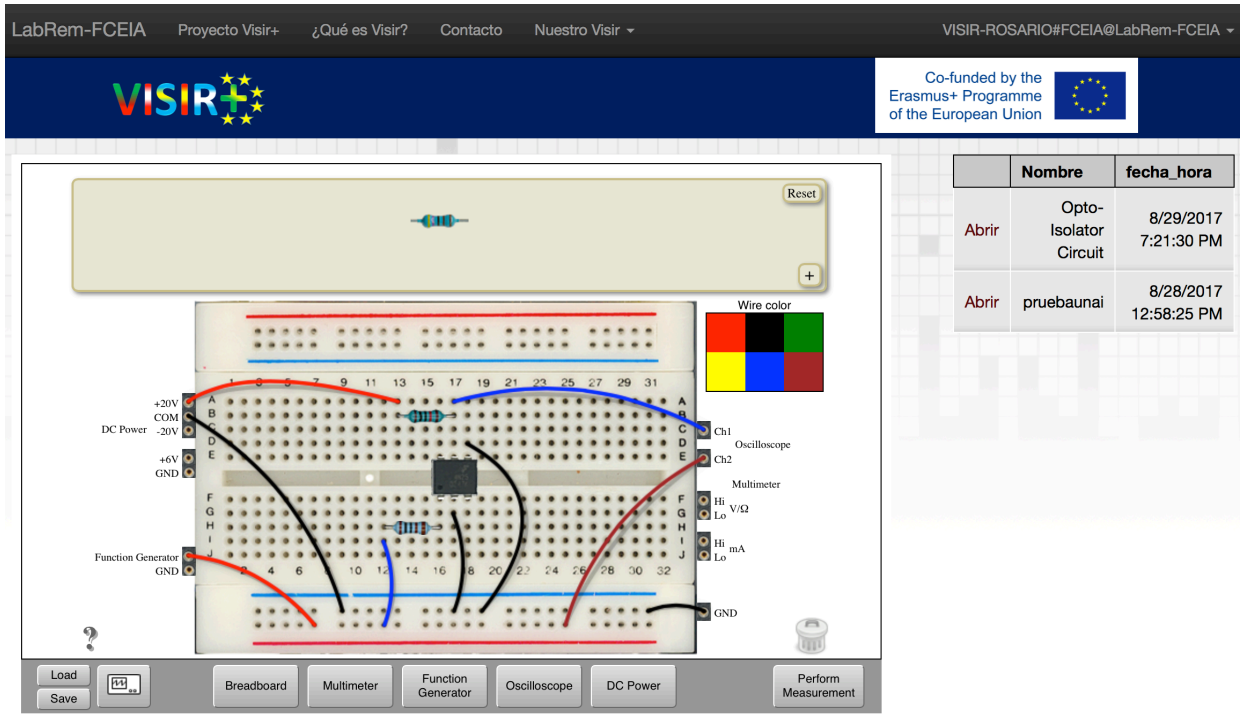
- Exemplos na área da Engenharia Eletrotécnica: circuito com lâmpadas
- Laboratório virtual (manipulação do tempo)(partilha do circuito)
  - http://tinyurl.com/y8vslbxc
- Laboratório remoto (real): realidade dos resultados (modo interativo)
  - A resistência da lâmpada depende das condições do circuito
  - Potência nominal / tensão nominal
  - Tempo de simulação (t*ime step* = 5 μs)
- Laboratório real: impossível medir (diretamente) a resistência da lâmpada
- Cálculos: simples (potência | tensão nominal) ou complexos (resistência em função da temperatura do filamento [$R = R_0 \cdot (1 + \alpha \cdot \Delta t)$])

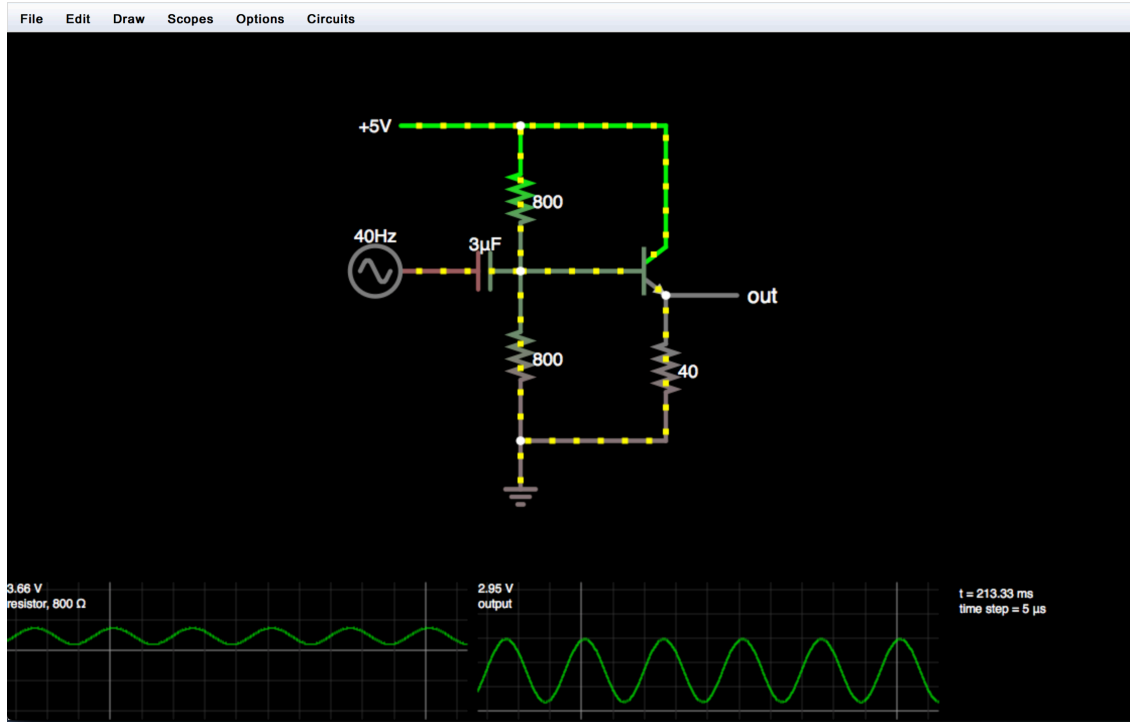




Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

- Exemplos na área da Engenharia Eletrotécnica: circuitos elétricos e electrónicos





VISIR@UNR: https://labremf4a.fceia.unr.edu.ar/labs/visirnet/default.aspx

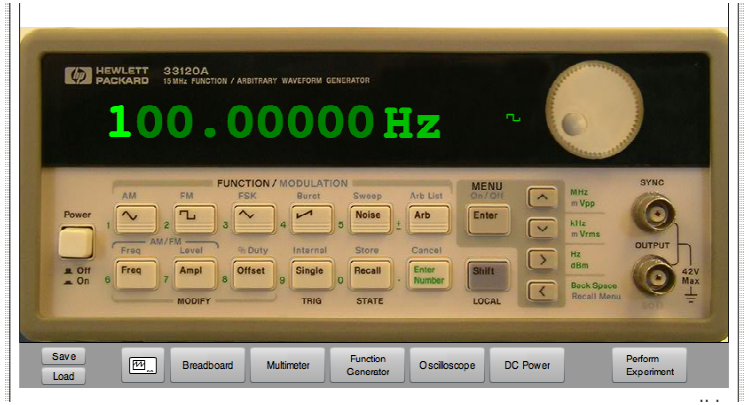
Falstad: http://www.falstad.com/circuit/circuitjs.html

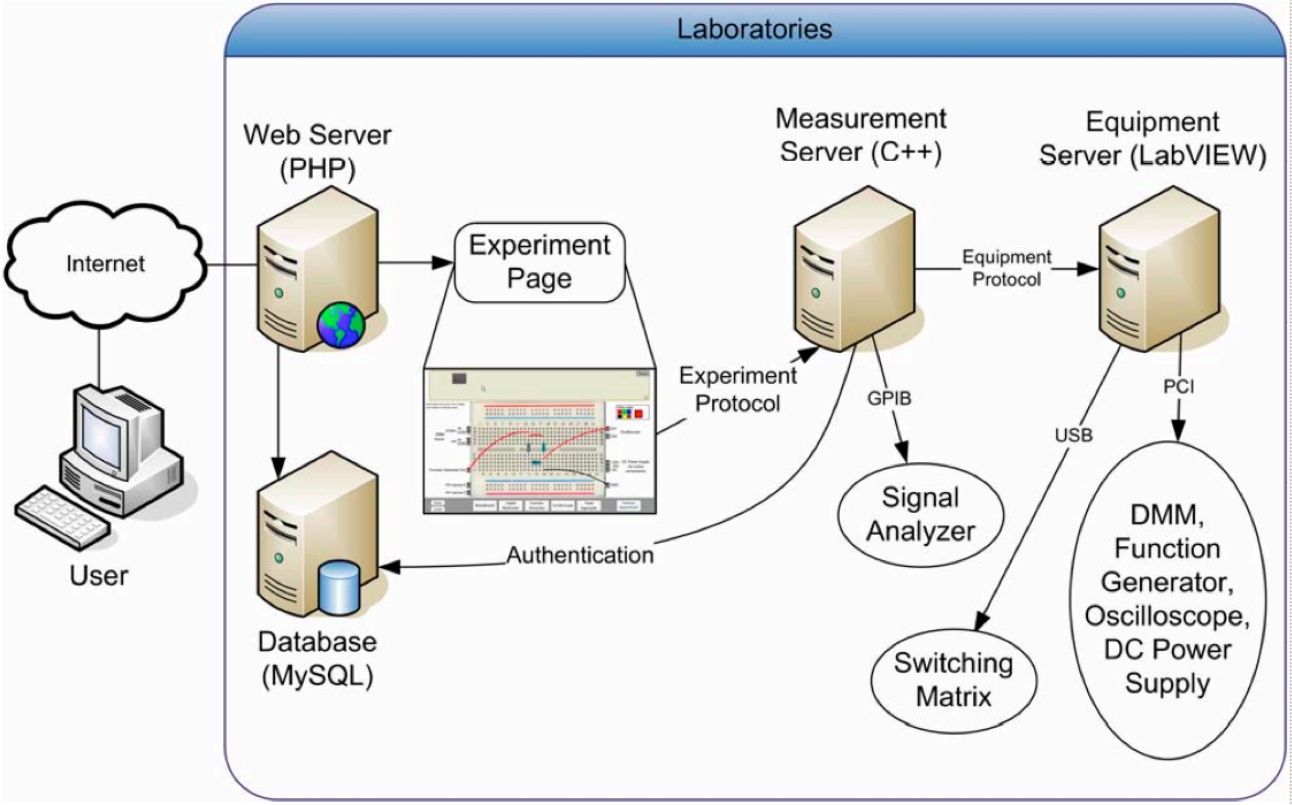
Virtual Instrument Systems in Reality (VISIR)

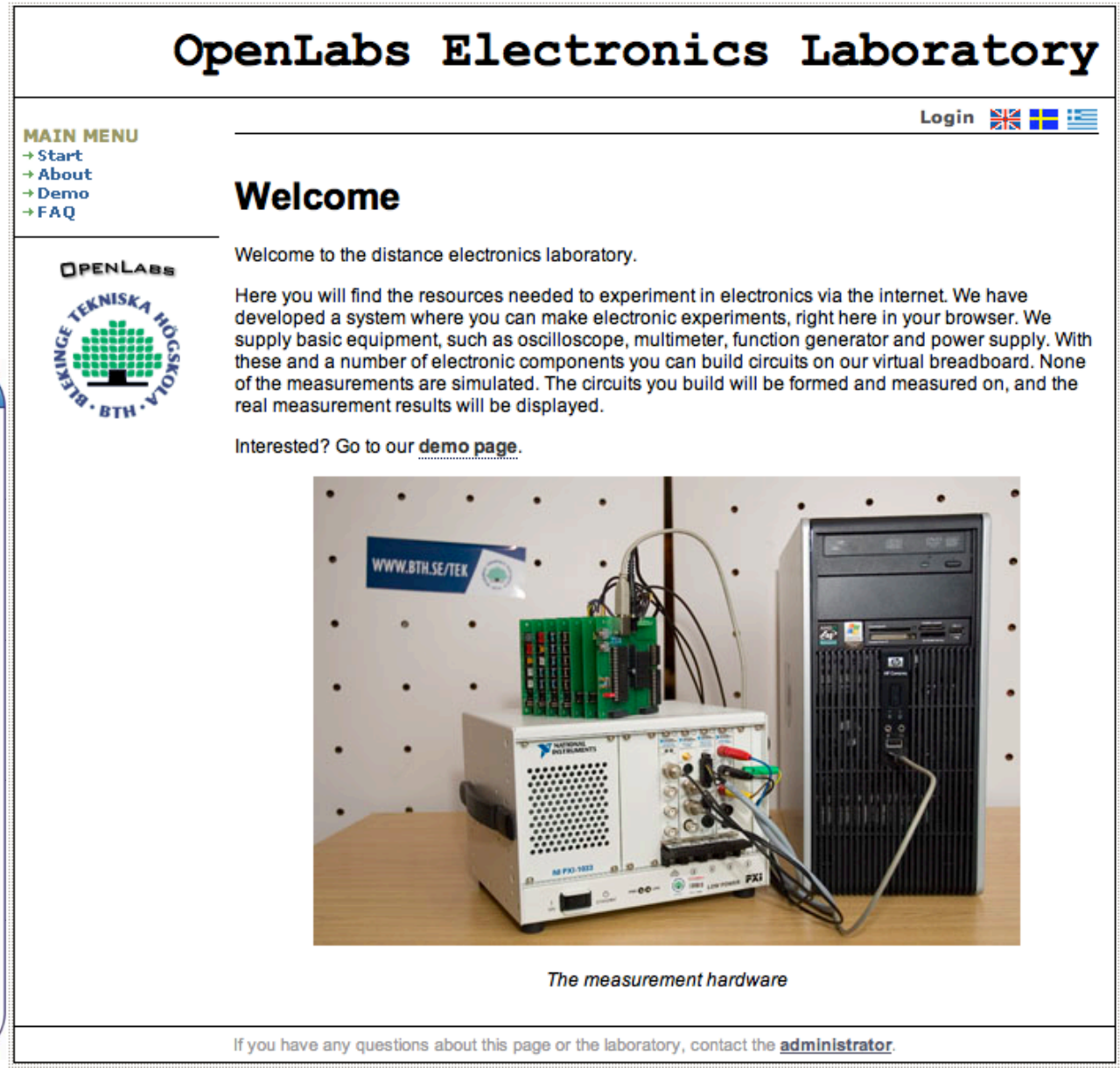
- Ingvar Gustavsson (inspired in Max Planck):

"Experimenting could be compared to a conversation with nature. The experimenter asks and nature answers. The tricky thing is formulating a useful question and above all interpreting the answer. The only way to learn the language of nature is performing many experiments in laboratories that can be hands-on ***or remote.****"*

Virtual Instrument Systems in Reality (VISIR)







OpenLabs Electronics Laboratory

Login

MAIN MENU
- Start
- About
- Demo
- FAQ

Welcome

Welcome to the distance electronics laboratory.

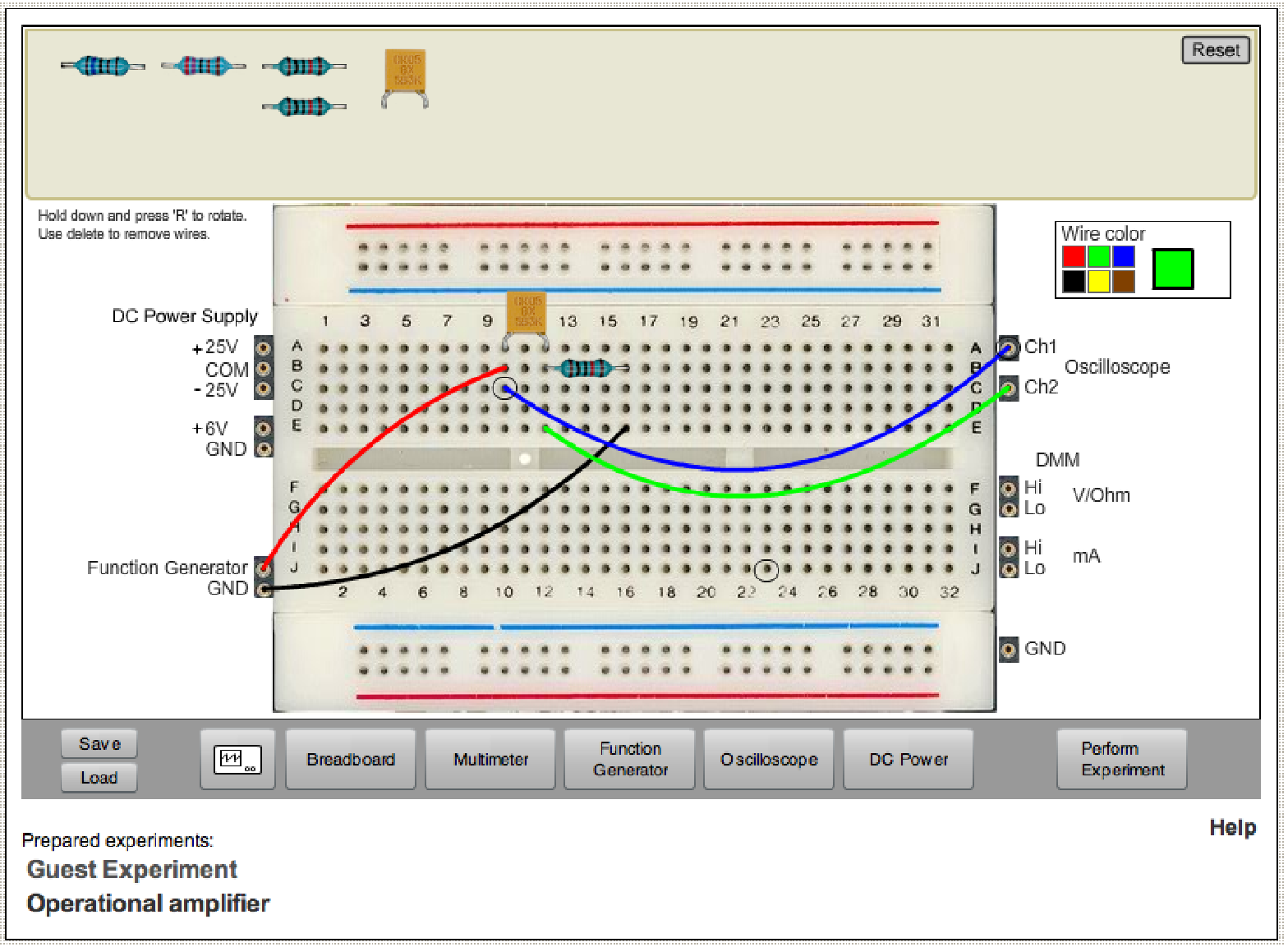
Here you will find the resources needed to experiment in electronics via the internet. We have developed a system where you can make electronic experiments, right here in your browser. We supply basic equipment, such as oscilloscope, multimeter, function generator and power supply. With these and a number of electronic components you can build circuits on our virtual breadboard. None of the measurements are simulated. The circuits you build will be formed and measured on, and the real measurement results will be displayed.

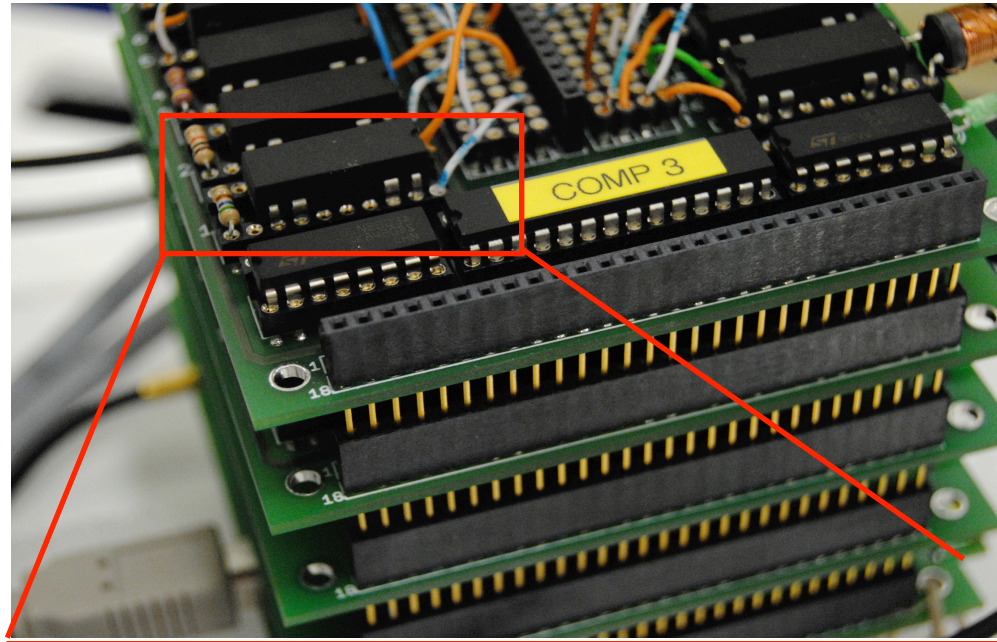
Interested? Go to our demo page.

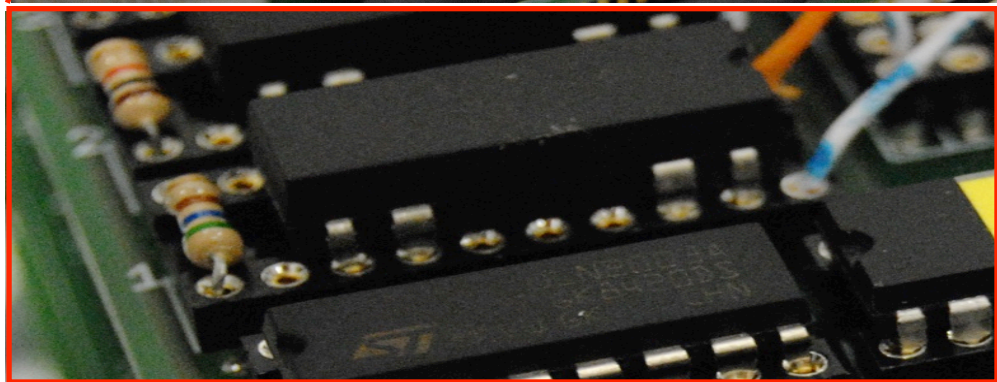
The measurement hardware

If you have any questions about this page or the laboratory, contact the administrator.

Virtual Instrument Systems in Reality (VISIR)







VISIR Laboratories

- Blekinge Institute of Technology (BTH), Sweden (VISIR+) (PILAR)
- University of Deusto (UD), Spain (VISIR+) (PILAR)
- FH Campus Wien University of Applied Sciences, Austria
- Carinthia University of Applied Sciences (CUAS), Austria (VISIR+) (PILAR)
- School of Engineering – Polytechnic of Porto (IPP-ISEP), Portugal (VISIR+) (PILAR)
- National University for Distance Education (UNED), Spain (VISIR+) (PILAR)
- Indian Institute of Technology Madras (IIT-Madras), India
- Batumi Shota Rustaveli State University, Georgia
- Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil (VISIR+)
- Federal University of Santa Catarina (UFSC), Brazil (VISIR+)
- Federal Institute of Santa Catarina (IFSC), Brazil (VISIR+)
- **National University of Rosario (UNR), Argentina** (VISIR+)
- National University of Santiago del Estero (UNSE), Argentina (VISIR+)
- University of Hassan 1st , Morocco

Global Online Laboratory Consortium

GOLC

2015 Online Lab Award

The GOLC Online Laboratory Award 2015 in the category

„Remote Controlled Lab“

is presented to

VISIR (Virtual Instrument Systems in Reality)

Submitted by:

Ingvar Gustavsson, Gustavo Alves, Thomas Fischer, Javier Garcia Zubia, Felix Garcia, Manuel Castro

Awarded during the 12th International Conference on Remote Engineering and Virtual Instrumentation (REV2015) in Bangkok, Thailand

Abul K. M. Azad
President

Michael E. Auer
Secretary General

GOLC – Mission Statement

"The mission of the consortium is the creation of sharable, online experimental environments which increase the educational and scientific value of learning which may not be accessible, scalable or efficient through traditional methods."

This means especially:

- to encourage and support the creation of new online labs and associated curricular materials;
- to sponsor the design of an efficient mechanism for sharing, exchanging and trading access to online labs by creation of a global network of shareable experiments;
- to support communities of scholars created around online laboratories; and
- to lead the evolution of an architecture that enables the sharing of online labs by unified standards.

GOLC

About GOLC

Leadership

Members

Membership

Mailing Lists

Online Lab Award

Latest News

Conclusão

- A integração de laboratórios remotos e virtuais no contexto de uma unidade curricular depende de vários aspectos:
  - Individuais: a vontade do responsável da UC (professores) e o grau de adesão dos alunos e alunas
  - Institucionais: disponibilização de recursos e suporte à sua integração
- Objectivos:
  - dotar os alunos de mais e melhores competências experimentais
  - permitir a realização de mais experiências de forma <u>sustentável</u>

Recursos: Laboratórios remotos e virtuais

VISIR+

VIRTUAL LABS

An Initiative of Ministry of Human Resource Development (MHRD)
Under the National Mission on Education through ICT

Home

Name of Lab | Broad Area | Any | Search

PARTICIPATING INSTITUTES

- IIT DELHI
- IIT BOMBAY
- IIT KANPUR
- IIT KHARAGPUR
- IIT MADRAS
- IIT ROORKEE
- IIT GUWAHATI
- IIIT HYDERABAD
- AMRITA UNIVERSITY
- DAYALBAGH UNIVERSITY
- NIT KARNATAKA
- COE PUNE

Labs developed by Nodal Centers new

NODAL CENTERS new

Objectives of the Virtual Labs:

- To provide remote-access to Labs in various disciplines of Science and Engineering. These Virtual Labs would cater to students at the undergraduate level, post graduate level as well as to research scholars.
- To enthuse students to conduct experiments by arousing their curiosity. This would help them in learning basic and advanced concepts through remote experimentation.
- To provide a complete Learning Management System around the Virtual Labs where the students can avail the various tools for learning, including additional web-resources, video-lectures, animated demonstrations and self evaluation.
- To share costly equipment and resources, which are otherwise available to limited number of users due to constraints on time and geographical distances.

The Philosophy Read More

Salient Features Read More

Labs Ready For Use Click here

Broad Areas of Virtual Labs

- Electronics & Communications
- Computer Science & Engineering
- Electrical Engineering
- Mechanical Engineering
- Chemical Engineering
- Biotechnology and Biomedical Engineering
- Civil Engineering
- Physical Sciences
- Chemical Sciences

Announcements

University, Bhopal has been successfully completed on August 27, 2016.

-)- State-level workshop on Virtual Labs at Global Institute of Management & Emerging Technologies, Amritsar has been successfully completed on Feb 21, 2017.

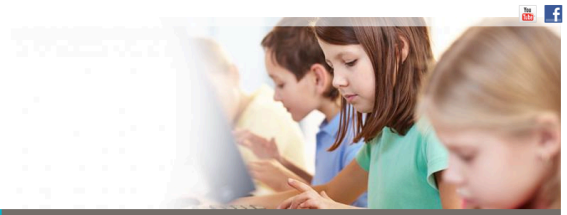
-)- State-level

- LAB FEEDBACK FORM
- LAB ASSESSMENT FORM new
- FAQ
- SHAKSHAT PORTAL

Contact Us
support@vlab.co.in

GO-LAB

GLOBAL ONLINE SCIENCE LABS INQUIRY LEARNING AT SCHOOL



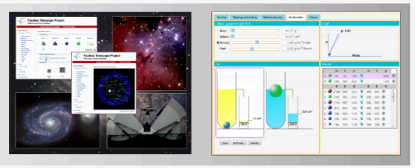
Home | Project | Go-Lab Portal | Teachers | Research | Partners | Keep in touch

Online Labs

The Go-Lab Portal aims at supporting teachers and students in their inquiry learning activities offering a wide range of online tools to work on scientific problems in a virtual environment. Using the Portal, teachers can utilize online laboratories and supporting learning applications to build Inquiry Learning Spaces customized for a certain class.

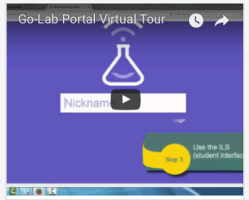
The online laboratories offered by Go-Lab can be remotely-operated or virtual. ***Remote labs*** can be used by the students to gather data from a real physical laboratory setup, including real equipment, from remote locations. Those labs include, for example, the WebLab-DEUSTO Aquarium, whose main learning objective is the Archimedes' Principle. There, students can throw balls filled with different liquids in an aquarium (using a web interface) to observe different buoyancy behaviors. Another example is the Faulkes Telescope that offers a database of astronomic pictures as well as the opportunity for the students to remotely operate the telescope and to take their own pictures of the cosmos.

The other kind of online labs are ***virtual labs***. They enable the students to simulate real equipment and experiments. Virtual labs include, for instance, Galaxy Crash simulating collisions of galaxies to make it possible to compare them to students' predictions that are made in advance for the experiment; LHC Game simulating the whole process of a particle accelerator like the Large Hadron Collider used at CERN; and Splash, the virtual buoyancy laboratory, in which students can learn in a virtual way about Archimedes' Principle simulating the same experiment as conducted with the remote Aquarium lab described above.



Go to the Portal

News Blog



Quick Links

- Go-Lab Summer School
- Go-Lab Teacher Contest
- Big Ideas Challenge
- Go-Lab Online Course
- Instructions & Support
- Go-Lab Newsletter

Next-Lab Project

Next-Lab (Next Generation Stakeholders and Next Level Ecosystem for Collaborative Science Education with Online Labs) is a European research project co-funded by the European Commission in the framework of the Horizon 2020 Programme. Next-Lab focuses on introducing inquiry-based science education (IBSE) in schools and continues the mission of the project Go-Lab, promoting innovative and interactive teaching methods in primary and secondary schools.

Next-Lab provides a varied portfolio of advanced online learning tools in science topics, which contains hundreds of virtual and remote science laboratories, inquiry learning applications and Inquiry Learning Spaces. Furthermore, there is an authoring tool for teachers they can use to create own cross-curriculum learning scenarios and share them with their students.

Using Next-Lab, students benefit from the rich, challenging learning experiences, shaping their science and technology knowledge together with social competencies. The innovative tools of Next-Lab guide students though the research process, helping them to acquire in-depth understanding of scientific topics as well as 21st century collaboration and reflection skills.

labshare

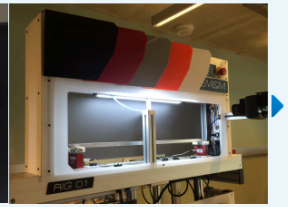
Search

About | Catalogue | Resources | Remote Labs | Getting started

Remote Labs
Enriching digital education

Wind Tunnel

To allow students to visualise and measure parameters associated



Engineering Mechanics & Materials Rig

Labshare Channel

Click here to see additional videos the experiments in action

The Labshare Institute

The Labshare institute was wound up by mutual agreement in early 2015. This website, the rig catalogue and the Labshare helpdesk are now maintained by the UTS remotelab group. Please submit requests for trials, feedback and support requests as per instructions 'getting started'. If you require UTS remotelab consulting services, please proceed as for 'support' but change the subject line to 'request consulting services'.

Partnered with:

UNIVERSITY OF TECHNOLOGY SYDNEY | Curtin University | University of South Australia | RMIT UNIVERSITY

As seen in:

About	Catalogue	Resources	Remote Labs	Getting started
TLI	Rig catalogue	Community	About	Getting started
People	Lesson catalogue	Publications	Benefits	Support
Services	Library	Newsroom		Feedback
Partnerships				
Sectors				

labshare

A etapa em curso | Futuro

- Criação de federações de Laboratórios Remotos
- Evolução do modelo de negócio associado
  - Aumento da oferta e da procura
- Laboratórios remotos = parte da missão das Instituições de Ensino Superior
- Amadurecimento de algumas tecnologias associadas
  - Realidade virtual combinada com acesso a equipamento real (e.g. jogos digitais)
  - Modelos híbridos (virtual | remoto)
  - Dispositivos hápticos | percepção de odor | etc.

Gustavo R. Alves

IPP – ISEP - CIETI

gca@isep.ipp.pt

Obrigado pela atenção!

Estratégia(s) de E&A baseadas em laboratórios remotos e virtuais

- Exemplos na área da Engenharia Eletrotécnica: Unidade curricular de Eletricidade: circuito com lâmpadas

Programa da Disciplina
DEM-Auto - Electricidade - 2 Semestre

1. Noções básicas sobre electrostática, magnetismo, electromagnetismo, electricidade, circuitos e sistemas elétricos, instrumentos de medição, e máquinas elétricas (3 hrs)
2. Componentes e circuitos elétricos em corrente contínua (5 hrs)
3. Métodos de análise de circuitos elétricos em corrente contínua (2 hrs)
4. Componentes e circuitos elétricos em corrente alternada (3 hrs)