Physical measurements with free software

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Free as in freedom

- Most colleges that I know are using mostly proprietary software based on Windows.
- Free software exists for this environment: in both scientific and office domains.
- Physical measurements imply acquisition interfaces. Many providers sell rather “closed” tools.
- Now it is possible to use a few complete solutions, hardware and software, which feature less drawbacks and more liberty.

When is a software free-libre?

Free-libre software give four liberties:

Freedom # 0 The right to execute the program, for any usage.

Freedom # 1 The right to study how the program works, and to modify it.

Freedom # 2 The right to distribute copies of it.

Freedom # 3 The right to improve the program and to publish your improvements.

More info : `www.gnu.org/philosophy/free-sw.fr.html`

When is a tool free-libre?

There is currently no definition of a free-libre hardware. However I know more than a few ways to subdue clients with hardware.

- The hardware is not free-libre if you cannot make it work but with other hardware pieces or software from the same provider.
- The tool is not free-libre if there is no way to get data from it but in a closed and opaque format.
- The tool is not free-libre when it is a black box whose contents you must ignore.

Open formats : see more on this subject.

That works the same way

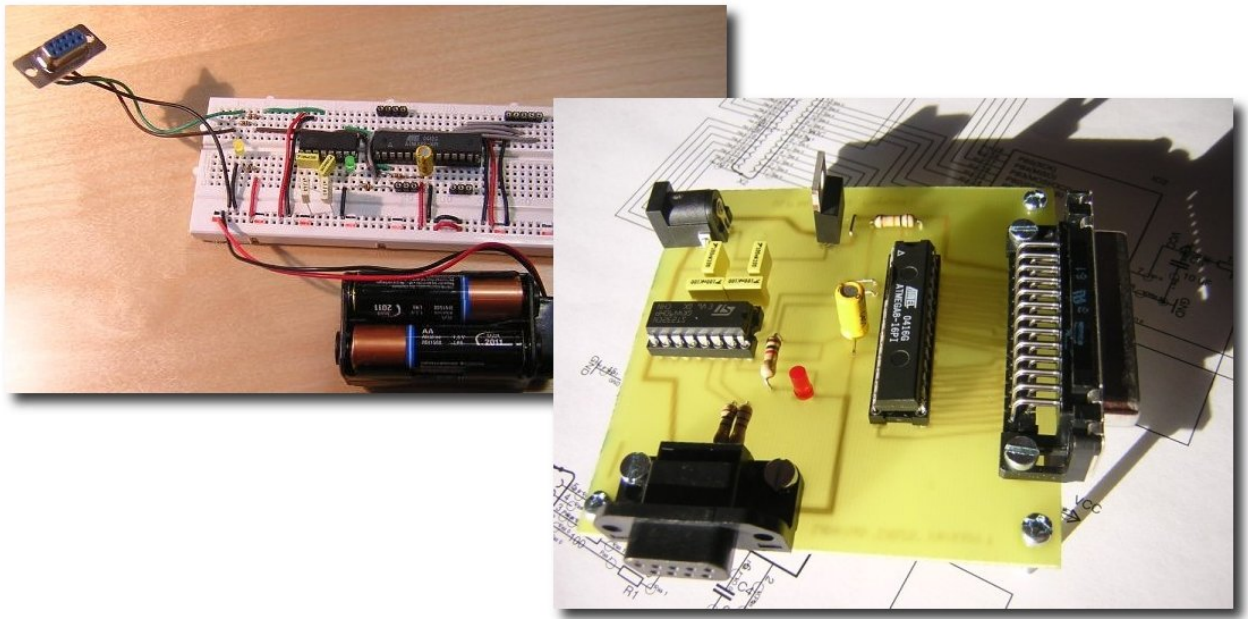
Students which use them become most adaptative

An acquisition interface: USBDUX

USBDUX is made in the United Kingdom, it was crafted by professors of the University of Stirling. It features 8 analogic inputs (12 bits, 8ksample/s max.), 4 analogic outputs, 8 programmable digital I/O.

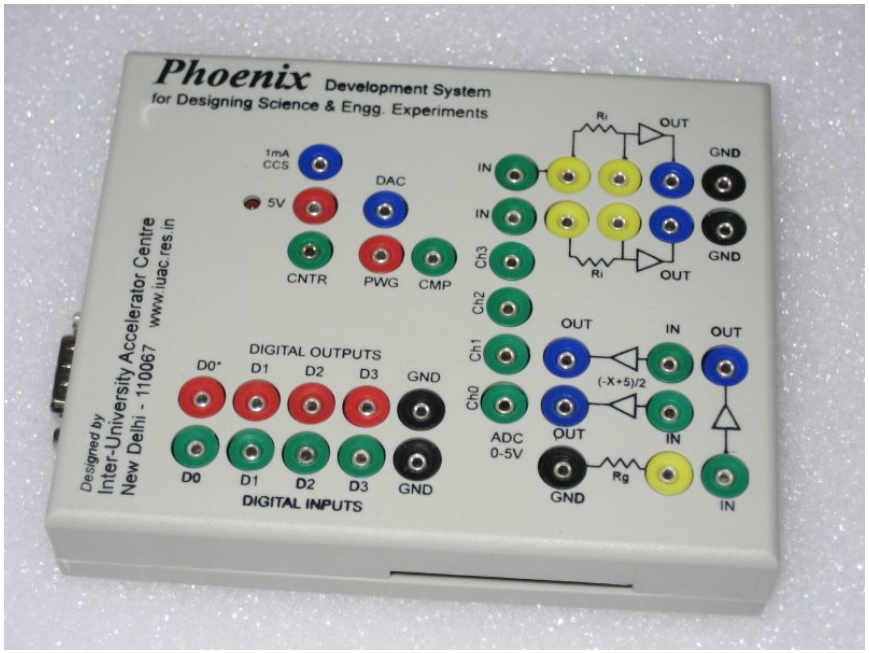
An acquisition interface: LIBERLAB

LIBERLAB is made in the University Louis Pasteur of Strasbourg in France, thanks to François Scnell's work. It features 4 analogic inputs (10 bits, 500 samples/s), and 6 digital i/O.



An acquisition interface: Phoenix

Phoenix is made in India, thanks to a team of professors/researchers, C.E. Pramode, Ajith Kumar, who invented it. 10 bit 4 channel ADC, one 8 bit PWM DAC, 8 Digital Inputs/Outputs, one Waveform Generator, one Constant Current Source, 2 Variable gain Amplifiers, 2 fixed gain amplifiers.



Integration with free software

Each of the features acquisition interfaces come with a library allowing to author programs and applications.

USBDUX and many other interfaces	$\Leftrightarrow$	Libcomedi, python-comedi
LIBERLAB	$\Leftrightarrow$	python-liberlab
PHOENIX	$\Leftrightarrow$	python-phoenix

Utilities delivered with the interfaces

These acquisition interfaces come with basic applications, which feature some awaited basic functions:

- acquiring a series of data
- driving a digital-analogic converter
- driving the digital I/O
- measuring accurately time spans

Higher level applications

Existing libraries enhance the usability of applications developed with them. For example an application developed with Libcomedi should behave similarly with USBDUX, or a card PCI-1710HG of Advantech, or a card RTI-800/815 of Analog Devices.
There are such applications making a numeric oscilloscope, or a programmable signal generator.
LIBERLAB and PHOENIX come with their own “oscillo” application, written in Python language.

Data processing

The free programs driving these interfaces communicate with simple open standards, so they are easily embedded in powerful applications to process their data, and make significant plots. We can use:

XmGrace: a very powerful data processing and plotting tool, usable for high quality publications.

LabPlot, Qtiplot: another data processor and plotter, with similar features, with a more friendly interface for beginners.

SciLab: a complete environment for numerical and symbolic computing, and signal processing. The most powerful among them.

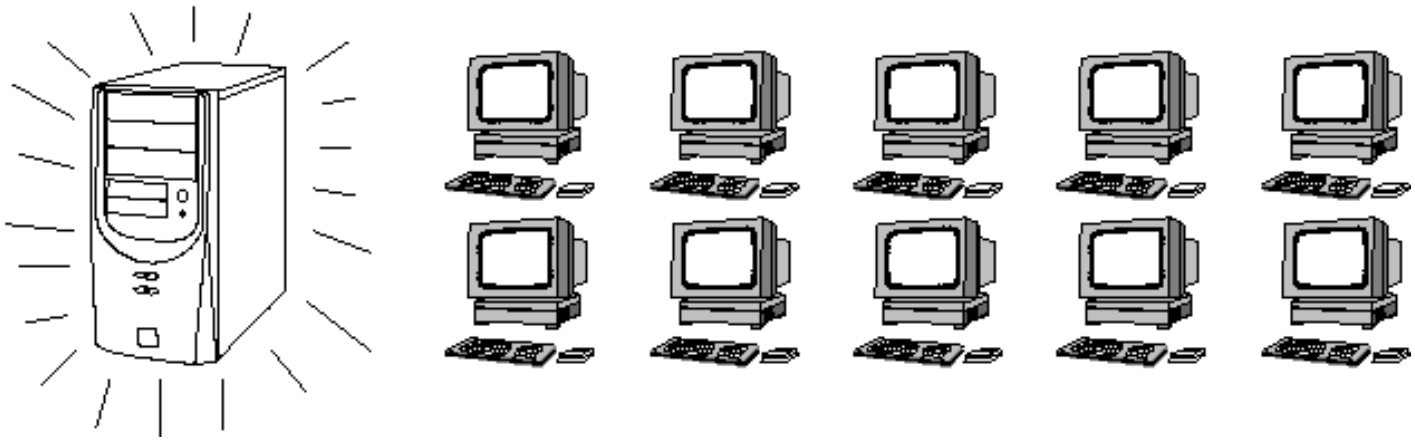
We equipped our room with thin clients or diskless clients.

In the default configuration, the "thin clients" only work to refresh their screen and manage keyboard and mouse events. All the applications run inside the server which shares its computing power between ten clients.

When acquiring data, the individual computers are booted as "diskless clients": then every application runs at the client's level, and directly accesses its hardware. So they can drive data acquisition devices. The measured data are written on the server's disk.

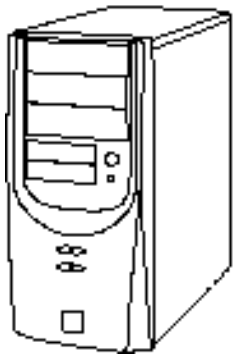
Switching between both modes is a matter of minutes. Our students organize their time in successive periods.

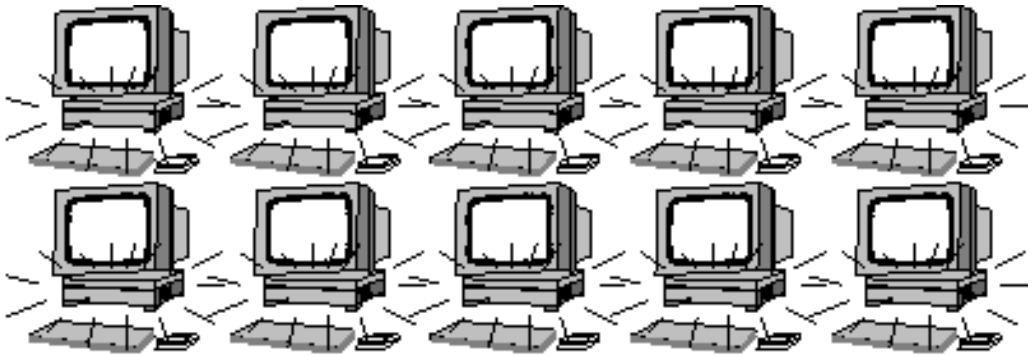
Our terminals, as GNU/Linux thin clients



The “thin client” mode is perfect for data processing and publishing reports. Amazingly, users experience sometimes a quicker speed with such configurations than when working directly with a computer like the server: the application which they open often lies in the silicon memory of the server because someone else has launched it earlier.

Our terminals, as diskless clients





The “diskless client” mode is appropriate to drive local peripherals plugged at a parallel or serial (COM or USB) port. Processing with CPUs at a frequency of 500 MHz is slower, but well sufficient for applications driving acquisition devices as we own. Faster acquisition devices feature buffering capabilities, so the speed is no problem.

The structure of thin clients / diskless clients allows a uniform usage of software: everybody accesses the same environment in both configurations and the programs are chosen in the large collection of scientific programs of the Debian distribution (`http://www.debian.org`), and some additional programs not yet integrated in this official distribution, available at association OFSET's Debian repository (`http://debian.ofset.org`).

It is possible to distribute the totality of the interesting programs to the students, we have done that in lycée Jean Bart with the CD-ROM Freeduc-CD (`http://www.ofset.org/freeduc-cd`).

Applications we use most frequently

Moodle and Wims : Wims is an excellent server to assign exercises to the students.

Labplot : much better than an office spreadsheet for scientific applications.

Texmacs is like a word processor, with most powerful scientific plug-ins.

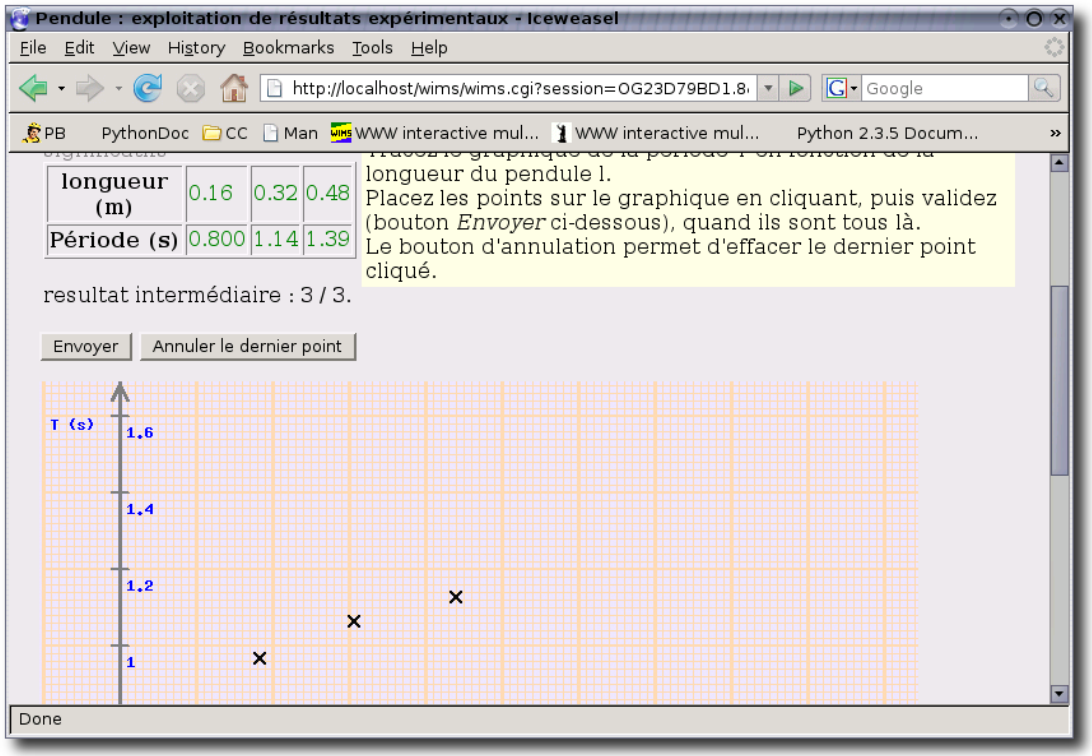
Ghemical is a 3D viewer featuring molecular dynamics.

Kalzium is a chemical database browser organised with a periodic classification of the elements.

Xem : a simulation tool for acido-basic titrations.

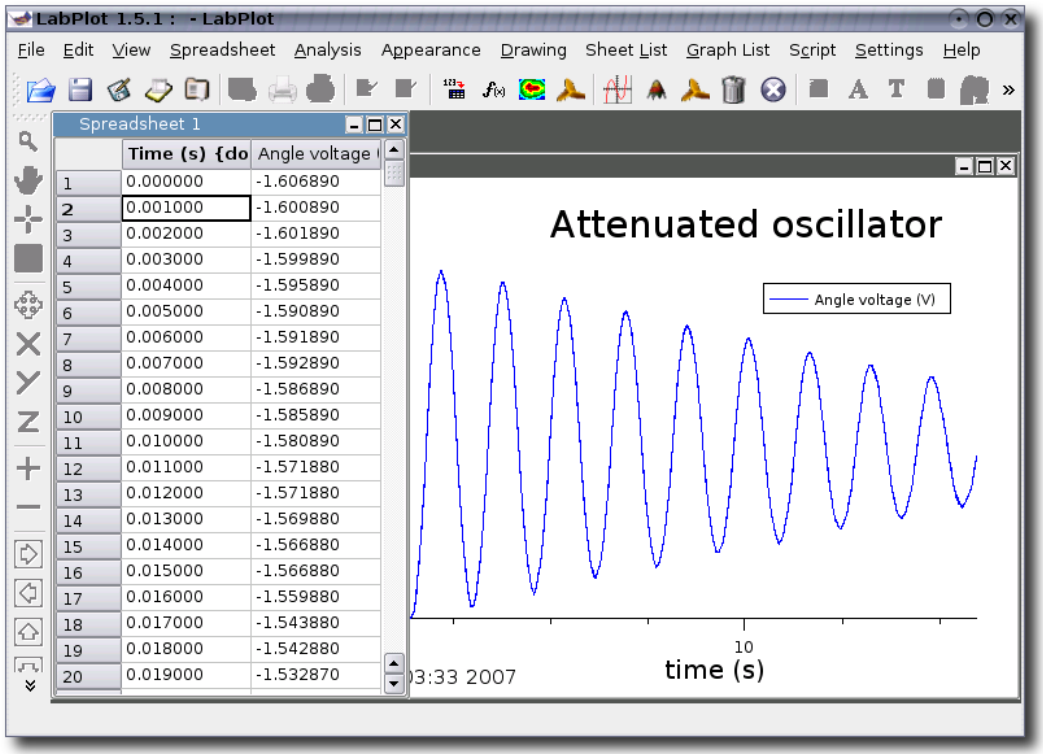
Moodle and Wims

Wims is an excellent server to assign exercises to the students. It can be coupled to Moodle, which takes care of the educational community and has many other management features.



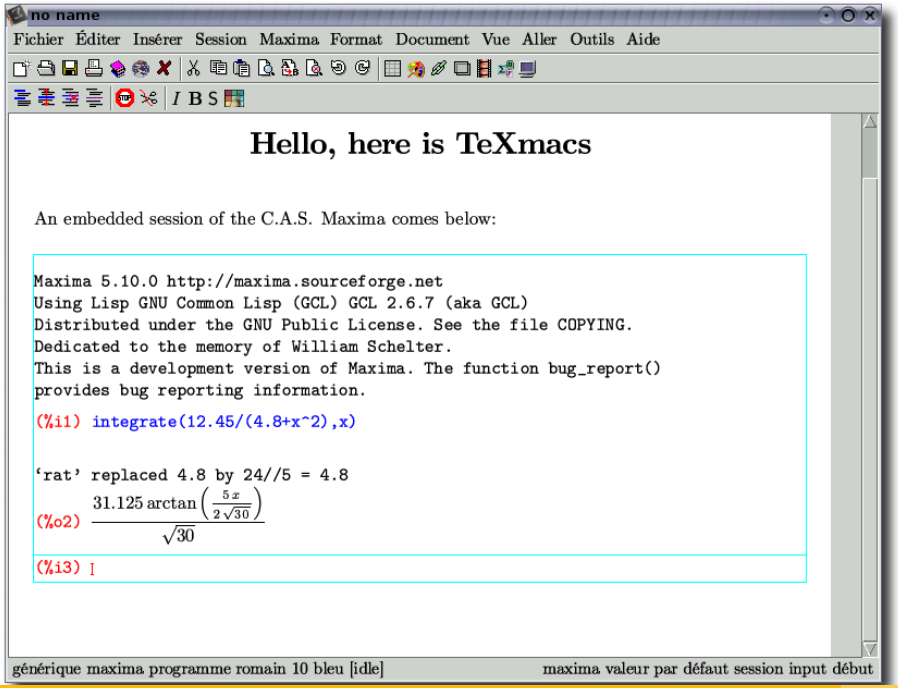
Labplot

Using office programs like a spreadsheet to manage scientific data or simulations is often a loss of time. Operations which require two training session with an office spreadsheet (create an XY plot, make a linear regression) are just one click away with Labplot.



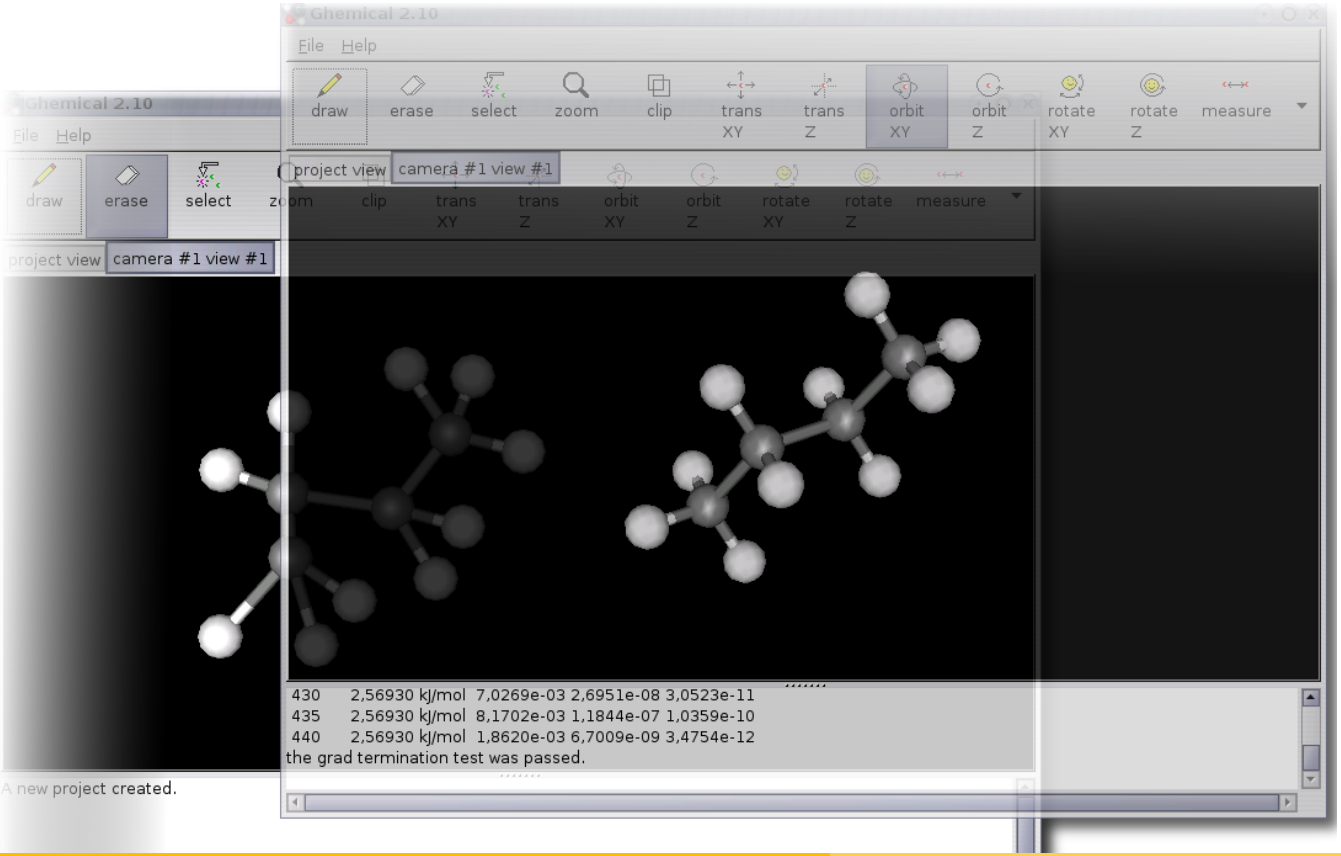
Texmacs

Texmacs appears first like a word processor, with strong features for publishing well structured reports. But just light on some of its plug-ins, and it becomes a central workplace for every mathematic or science document: 2D or 3D plotting, computer algebra systems, etc.



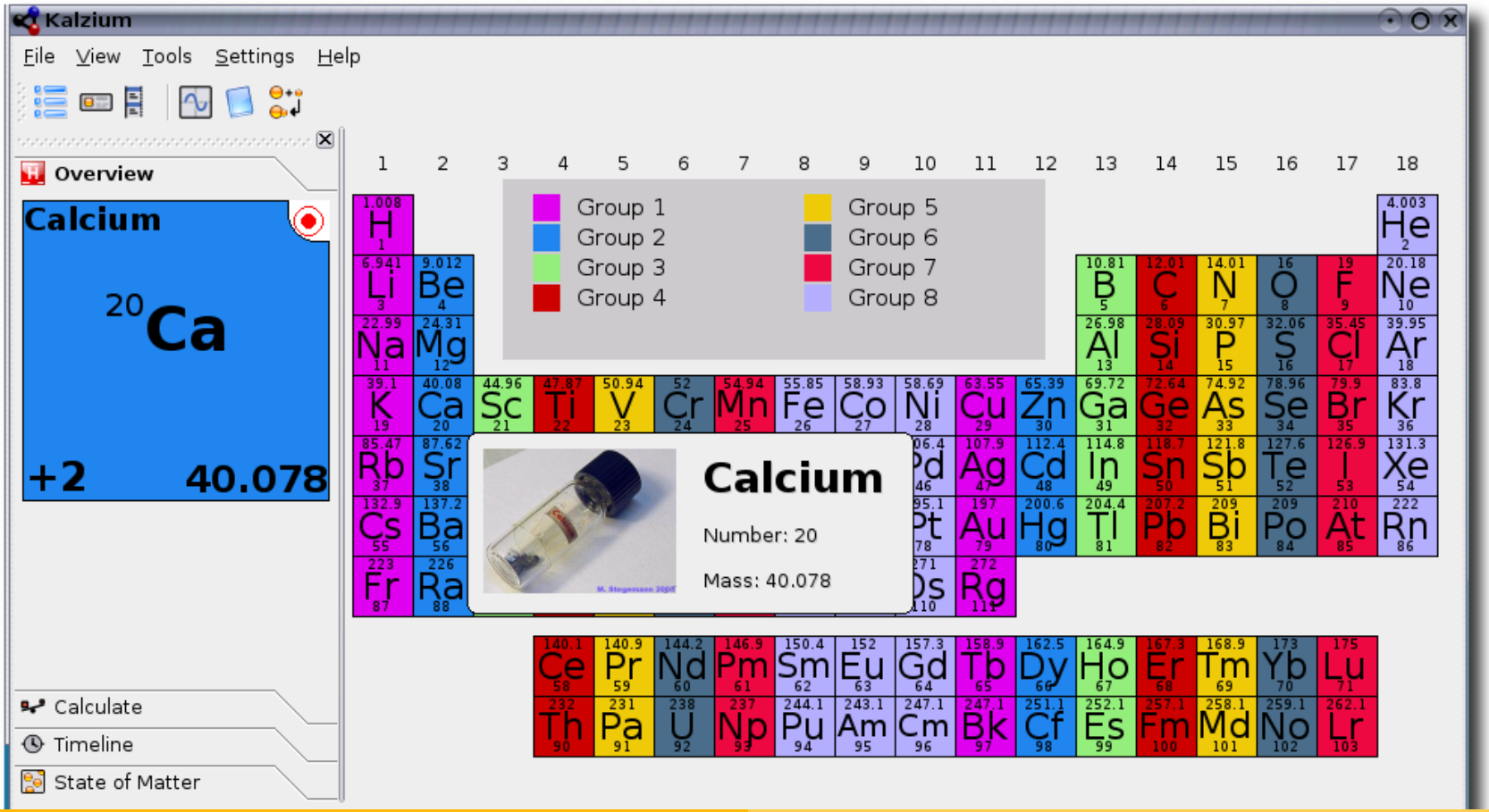
Ghemical

Ghemical comes at a first glance as a molecule 3D viewer. However, you can run immediately molecular dynamics, and much more.



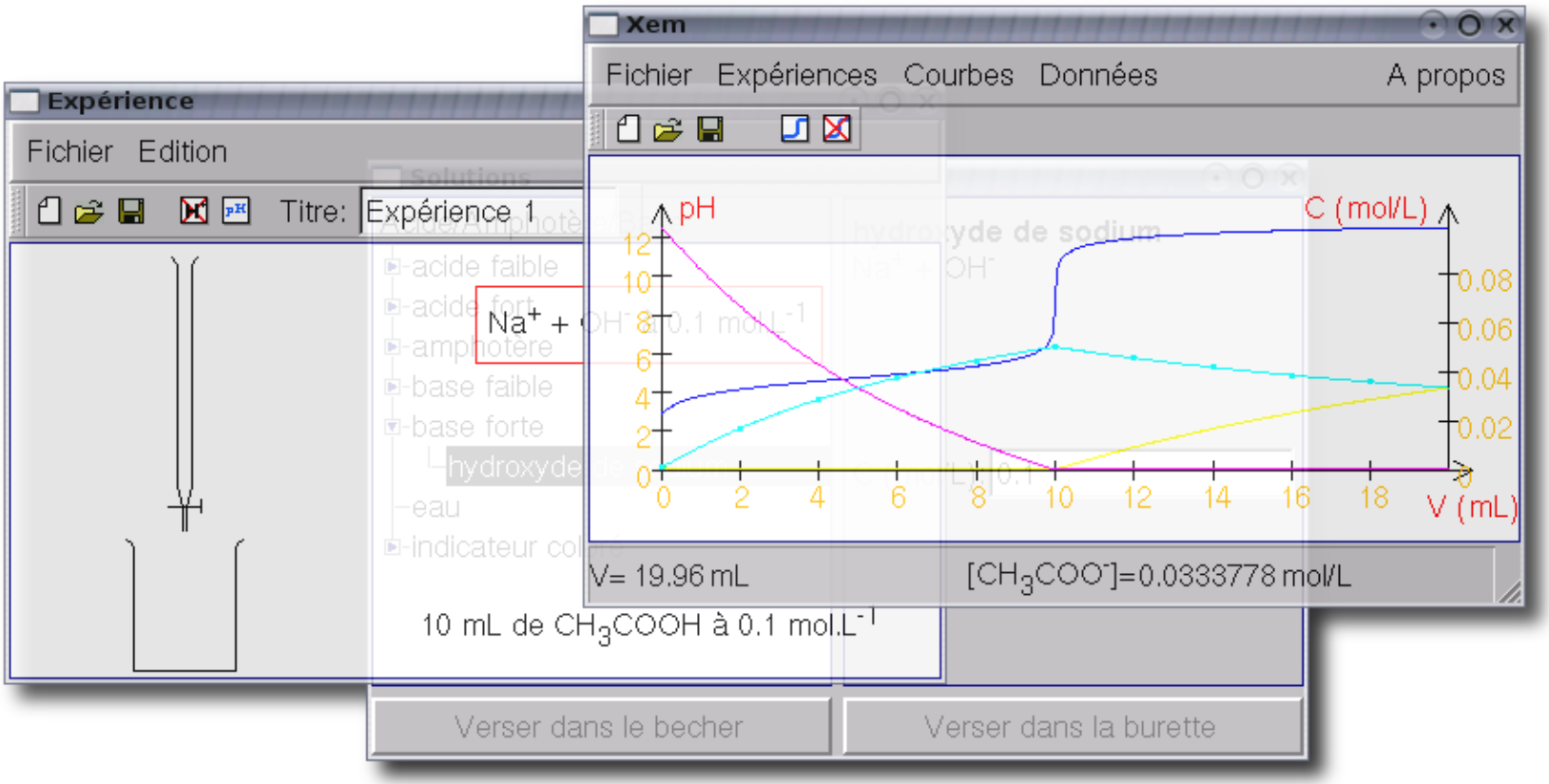
Kalzium

Kalzium is organised around a diagram of the periodic classification of the elements. It may be used to explore many chemical data.



Xem

Xem a simple and straightforward tool to simulate reactions between acids and bases.



Some links

- Past communications of OFSET's members : `http://speeches.ofset.org/` (georges)
- The library Comedi : `http://www.comedi.org/`
- The educational project Liberlab: `http://www.liberlab.net`
- The educational project Phoenix: `http://www.nsc.res.in/~elab/phoenix/`
- GNU/Linux thin clients: `http://www.ltsp.org/`
- OFSET's scientific project: `http://community.ofset.org/wiki/Freeduc-science`