The IUAC Tandem-LINAC Control System

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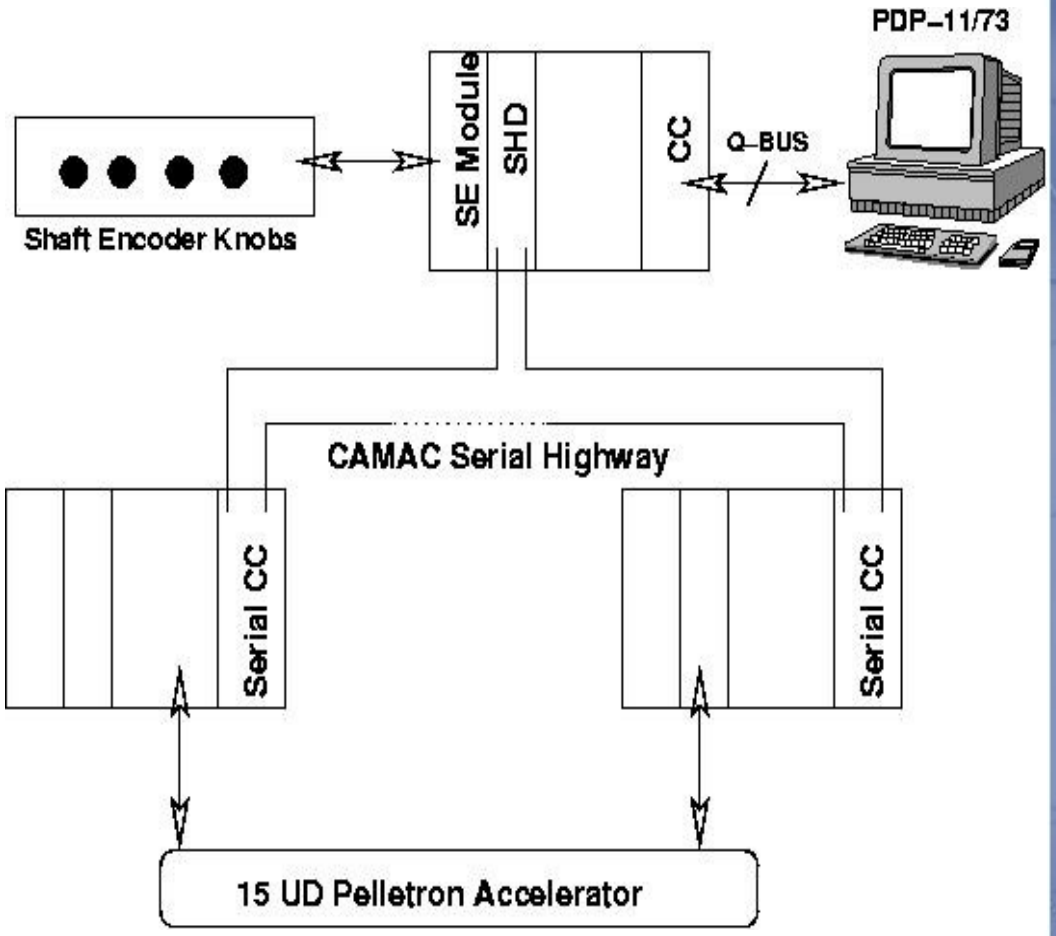
History:
The DEC PDP-11 based system (1988)

- The 15UD Pelletron was supplied with a DEC PDP11 control computer and CAMAC Serial Highway for interfacing
- RT-11 OS
- 64 KB RAM
- Pascal Compiler



Replaced before commissioning the Pelletron.

The first PC based system

- 80386 PC running MSDOS
- Code in Turbo-C
- PC ISA bus CAMAC Controller & CAMAC Serial Highway.
- In operation from **1989 to 1997**

One of the first accelerators to go for a PC based control system.

Addition of LINAC

To handle the new requirements we wanted to design a simple, scalable and cost effective system that is easy to maintain, based on our past experience.

Non-proprietary hardware and software.

- PCs connected over Ethernet
- CAMAC, VME & Custom interfaces
- GNU/Linux Operating System

Designing of a Control System

Role of Accelerator Control System

Control/monitor large number of signals from devices located at different places, from remote locations.

Devices are mostly controlled/monitored by:

- Analog voltages (ADC, DAC etc)
- Voltage Level s (Relay etc.)
- Interfaces like RS232, GPIB, USB etc.

Devices from User's point of view

- Identification: by Name & Location info.
- Description: Function , Unit, Data-type etc.
- Current Value/Status

Computer's point of view

- Nature of Signal (Analog, Digital)
- Hardware Address, Data Size
- Access mechanism, interfacing details.

Control System should organize this
to the satisfaction of both sides

We decided to expand on a scheme that is already familiar to our operators

- Name & Location Code, Function, Unit
  Data Type , Display Format, Value/Status
- Hardware address (C N A F), resolution

Example:

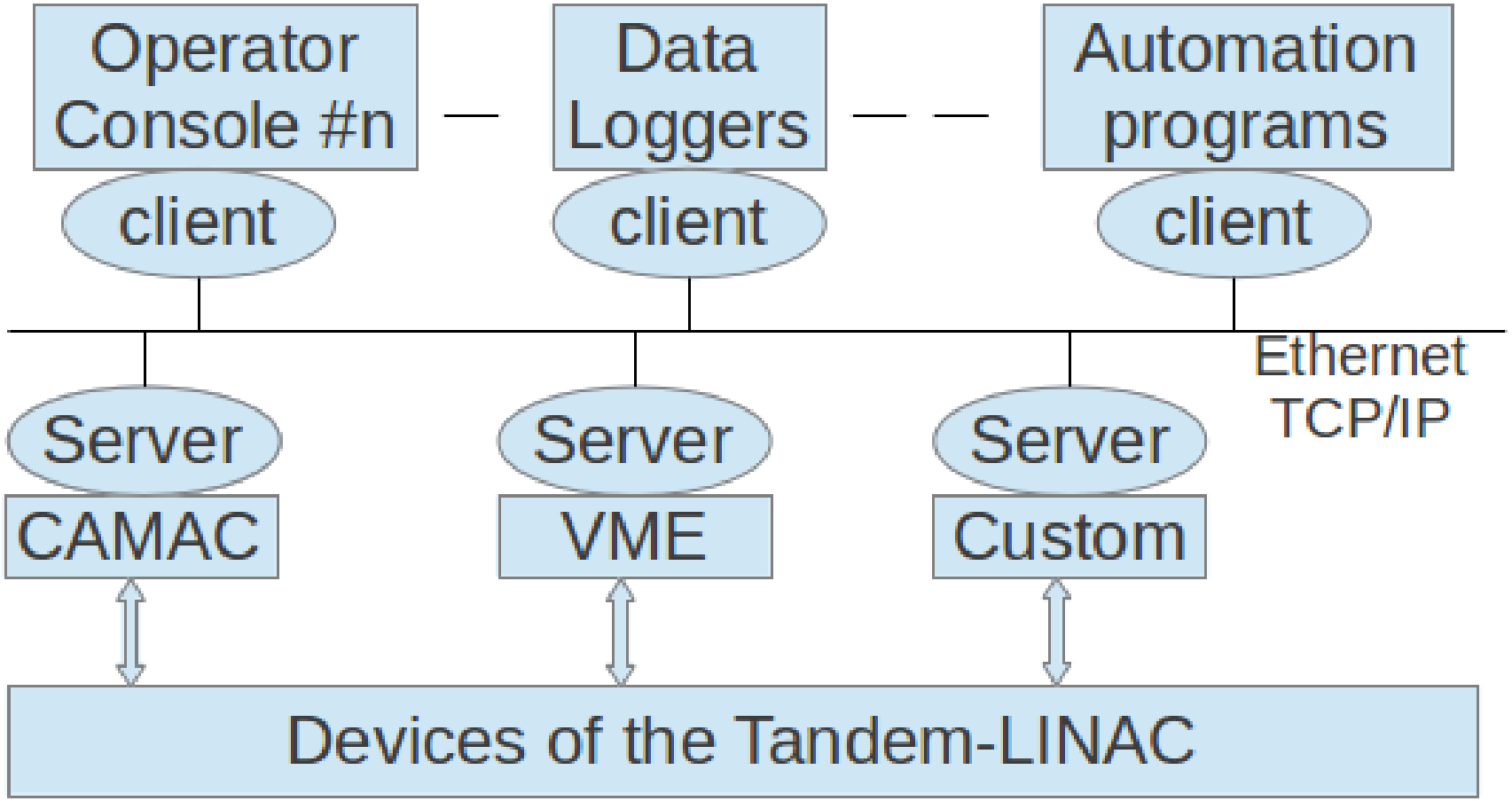
User: CPS-03-1 VC KV 0.0 50.0 LIN F1 R1

(charging power supply at section 03, 0 to 50kV, linear)

Computer: 2 4 0 16 12

(12 bit DAC on CAMAC crate 2, station 4, channel 0)

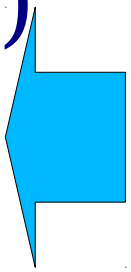
The hardware schematic of the distributed system



Each server maintains a small database of the signals managed, and makes them accessible over the Ethernet.

A message passing is used for accessing devices connected to server machines, using TCP protocol.

- Command (4)
- Result (4)
- Count (2)
- Name (10)
- Function (5)
- Unit (5)
- State (5)
- Value (8)



Unique Identification of a signal, using three character strings.

FC-03-1 CR A

(First Faraday cup at section 03, current read in Amperes)

Client side Programming:

Mainly 4 Functions to control / Monitor

For analog signals:

- get_value(name, function, unit)
- set_value(name, function, unit, newvalue)

For logical signals:

- get_state(name, function, unit)
- set_state(name, function, unit, newstate)

Searching & Authentication

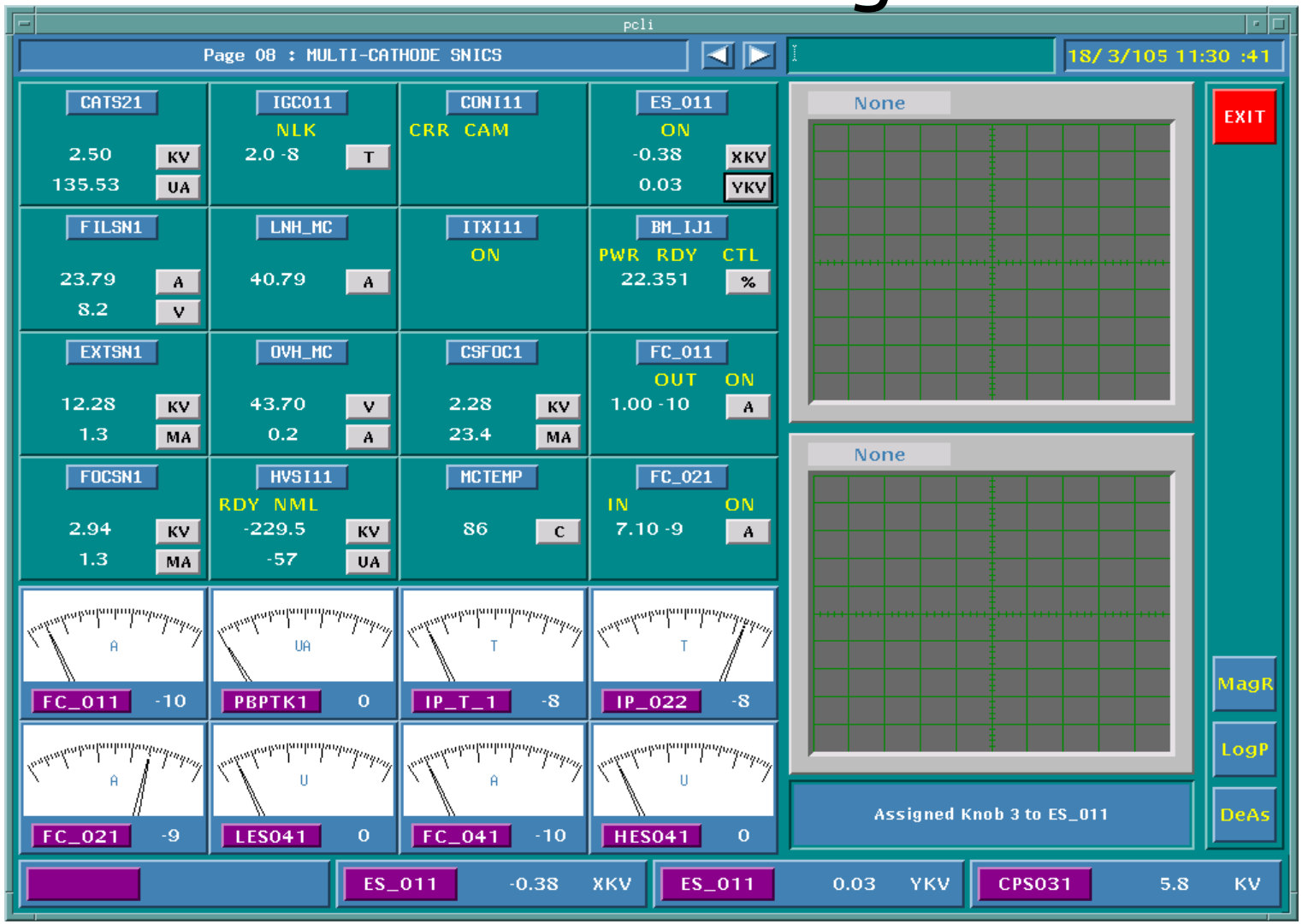
- Each Server keeps list of Authorized Clients
- Each Client keeps a list of Servers to Search

- During startup clients search and locate the desired signals using the “Name + Function + Unit” identification.

Available Client-side Options

- Interface in C (console GUI)
- Python Interface
- Web Interface (HTTP)
- Lab View (TCP/IP)

Operator Console Client Program



- Signals grouped into Pages
- Assignable control knobs

Python for client side programming

Enables accelerator people to study, organize and automate the system without much programming expertize.

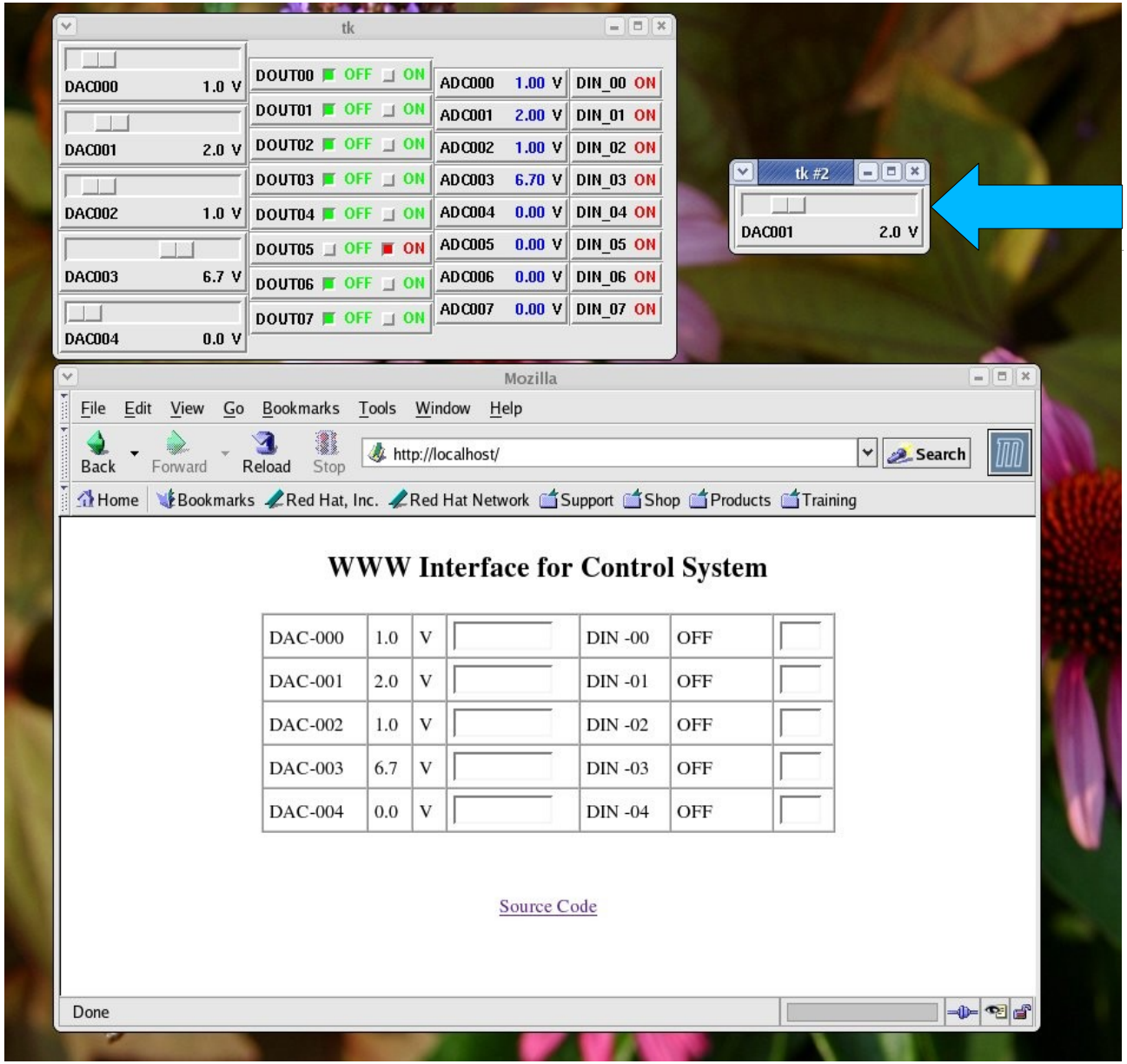
One line of code can access any signal, using its Unique Identifier.

```
import pelcon
p=pelcon.pserv()
p.set_value('CPS031', 'VC', 'V', 2.0)
```

Python code is currently used for:

- Data Logging
- Setting LINAC resonator parameters using calculated values.

Clients using Python & Web interface




```
import pelcon, time
p=pelcon.pserv()
from Tkinter import *

root = Tk()
p.an_control('DAC001', 'VC', 'V', root)
p.set_updates(root)
root.mainloop()
```

Hardware Interfaces Supported

- CAMAC

  Ethernet Crate Controllers booting from Linux Terminal Server and starts server program with appropriate database.

- VME

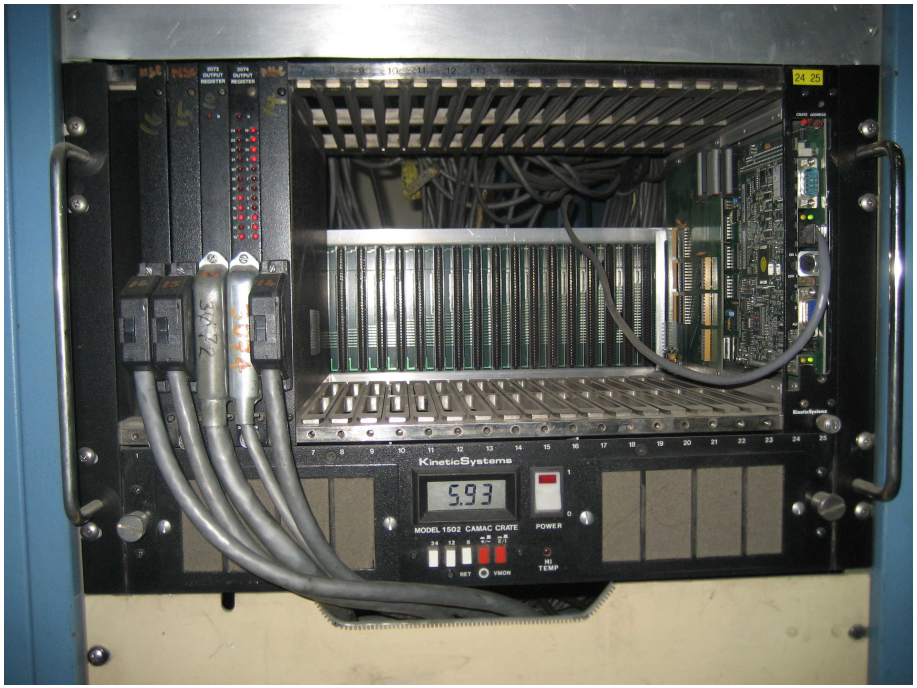
  Controllers with embedded PC

- Custom hardware

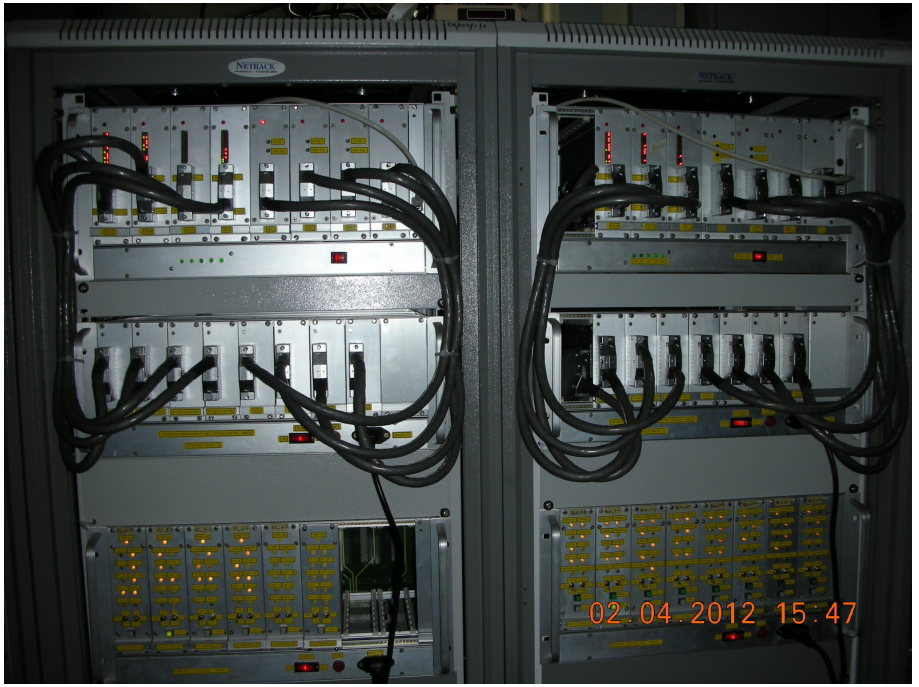
  Low power substitute of CAMAC

  ExpEYES

  Ethernet based HV power supplies



CAMAC



CAMAC Substitute

Salient features

- Simple and easy to maintain (~5000 lines of C)
- Control from multiple locations, without conflict.
- Client code can be added quickly, in Python
- Distributed database in text format
- Hardware details hidden from user programs
- Easy software upgrades using the LTS.

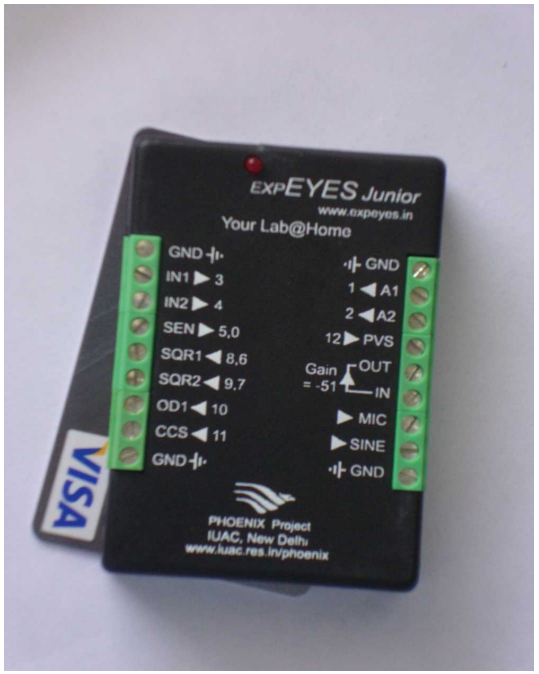
Running fine, for the past 15 years.

ExpEYES, a miniature control system

Teaching computer interfacing to students

Low cost science experiments.

Open Hardware
http://expeyes.in



There are more number of schools/colleges in this world than accelerator labs.

What is expEYES ?

A low cost device that can
generate/measure voltages
as a function of time and generate graphs.

A tool for learning by exploring.

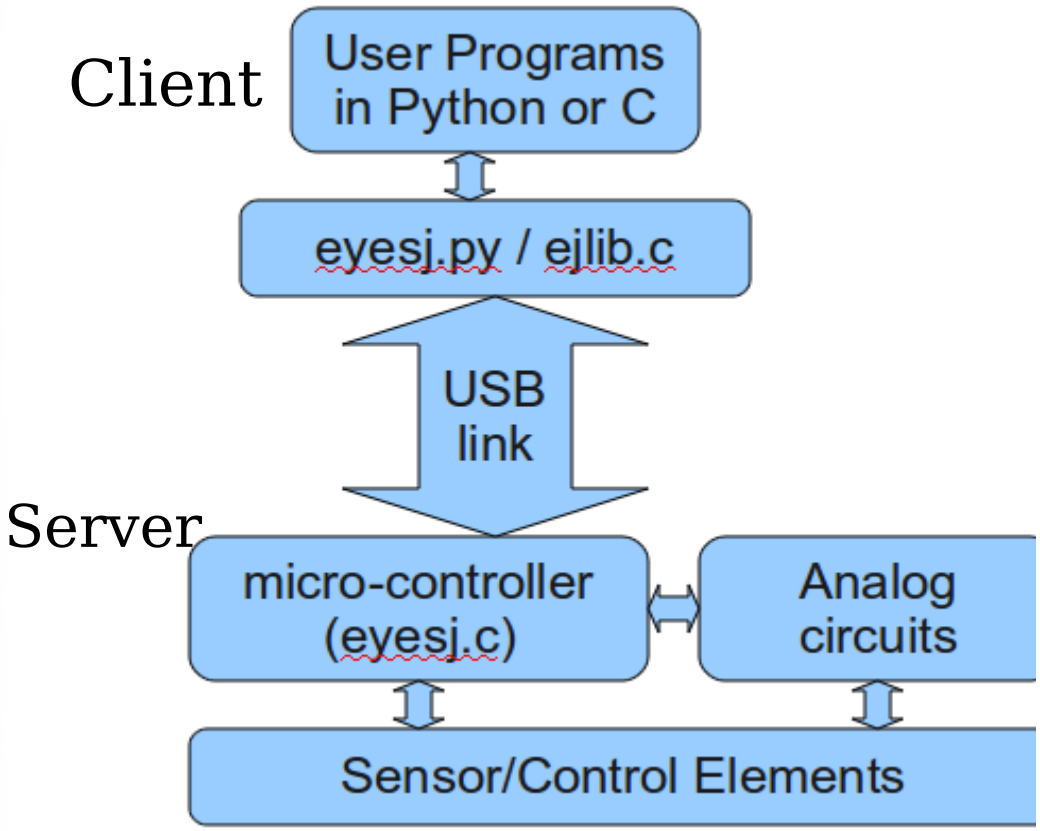
Supports Science & Engineering experiments from
High School to Post Graduate level.

A test equipment for electronics hobbyists.

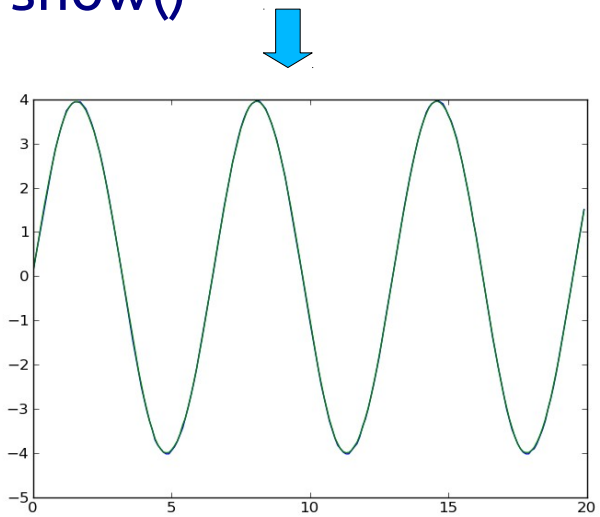
All with Open Software & Hardware

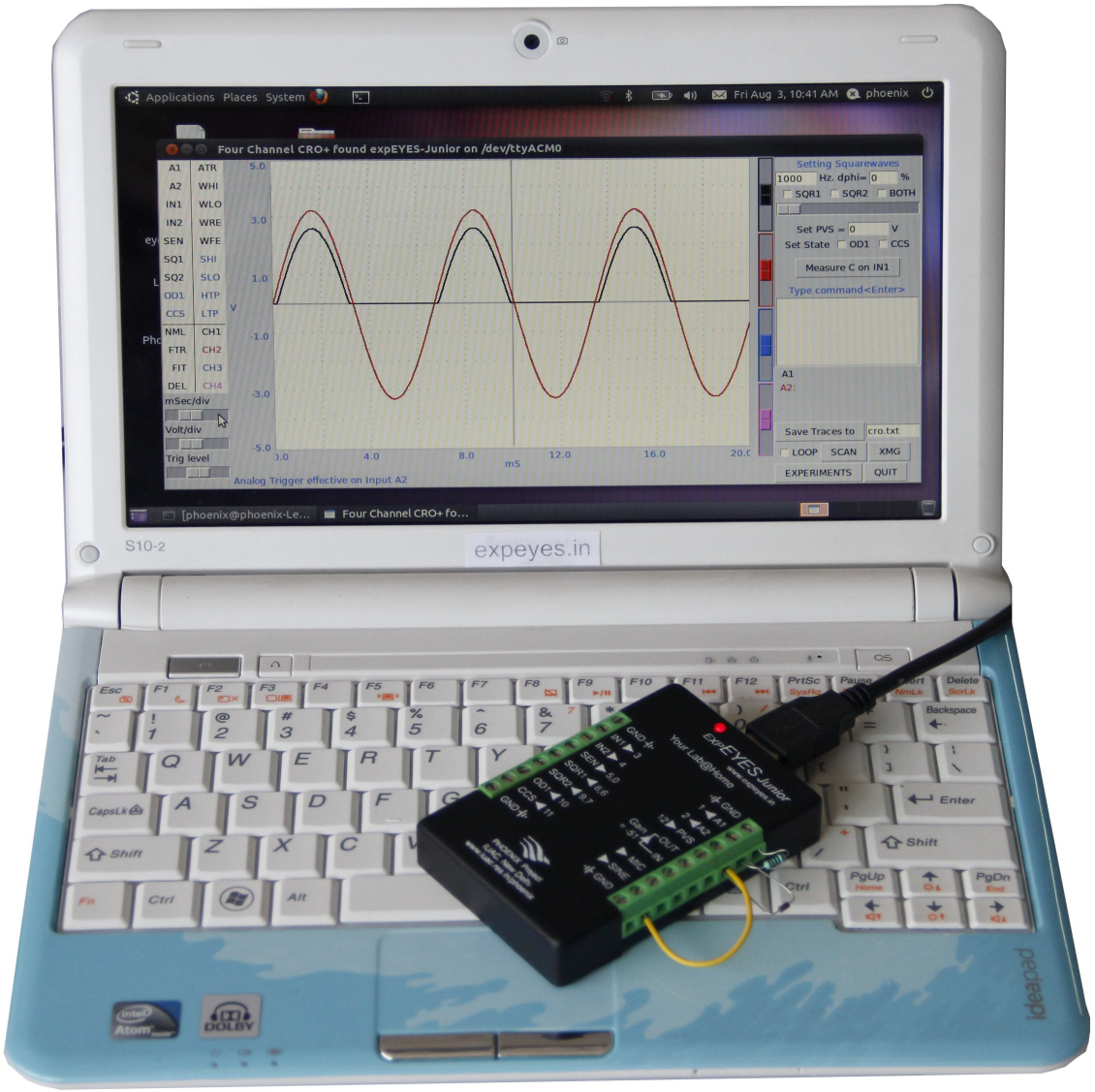
Design of expEYES Junior

Real-time measurement features of Micro-controller
+
Computational and Graphics capability of Python.




```
import expeyes.eyesj
p = expeyes.eyesj.open()
from pylab import *
t,v = p.capture(1, 200, 100)
plot(t,v)
show()
```

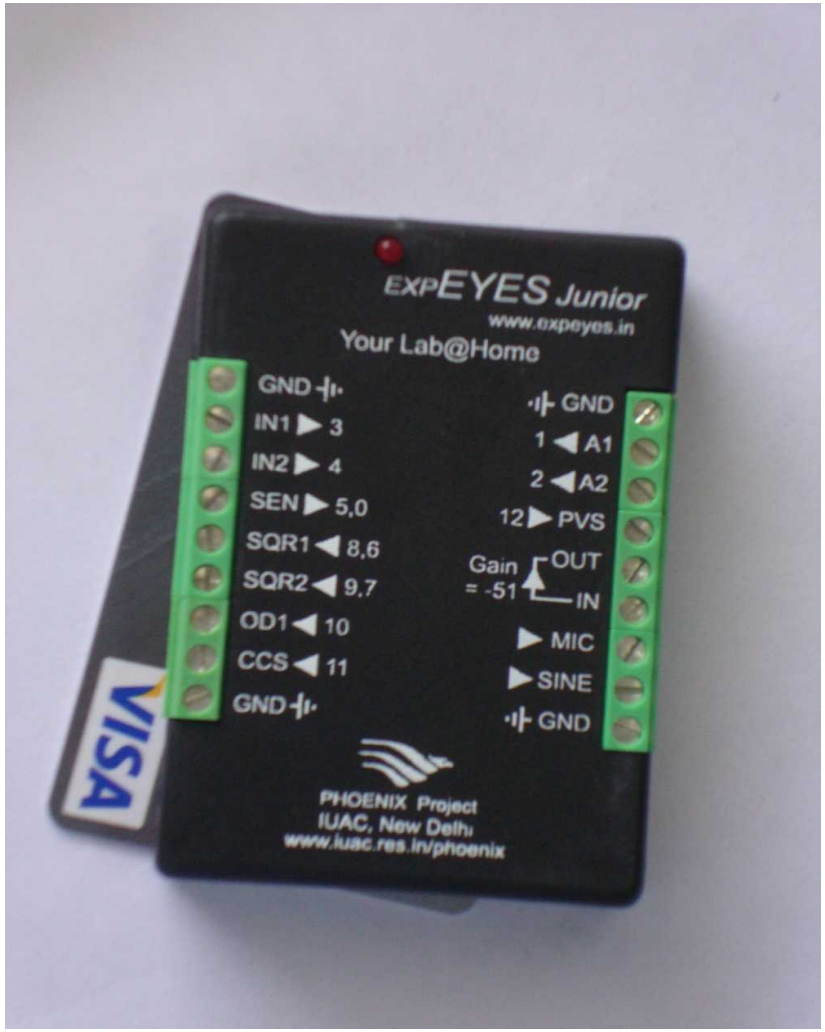




ExpEYES on a netbook, studying a PN junction Diode

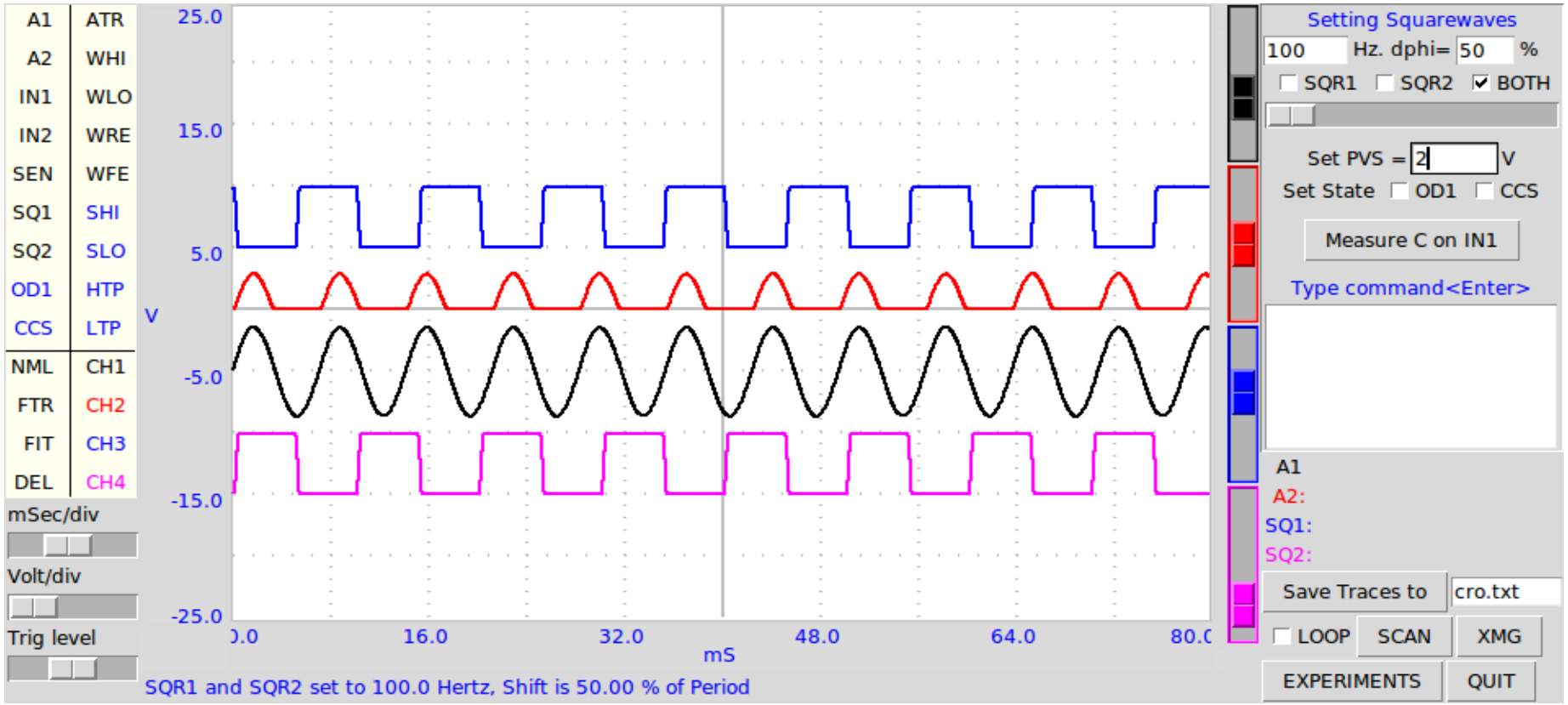
Features:

- 12 bit Analog Input/Output
- Digital I/O
- Time interval measurements
- Waveform Generation
- USB Powered
- GUI for 50 experiments
- Python Programmable
- Works as a Test Equipment
- 8.6 x 5.8 x 1.5 cm^3, 60 gm.



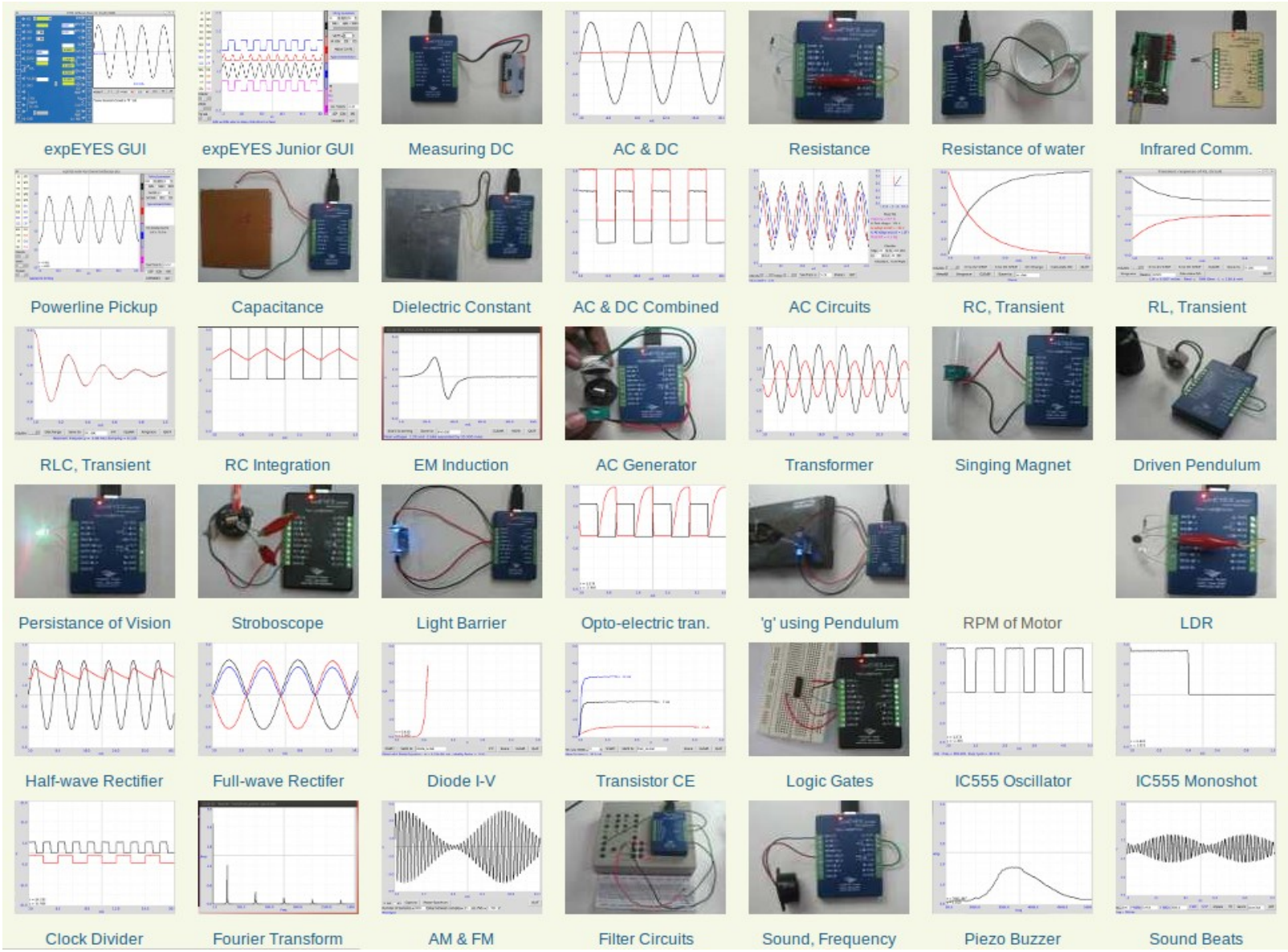
US$ 30/-

GUI programs available for around 50 experiments



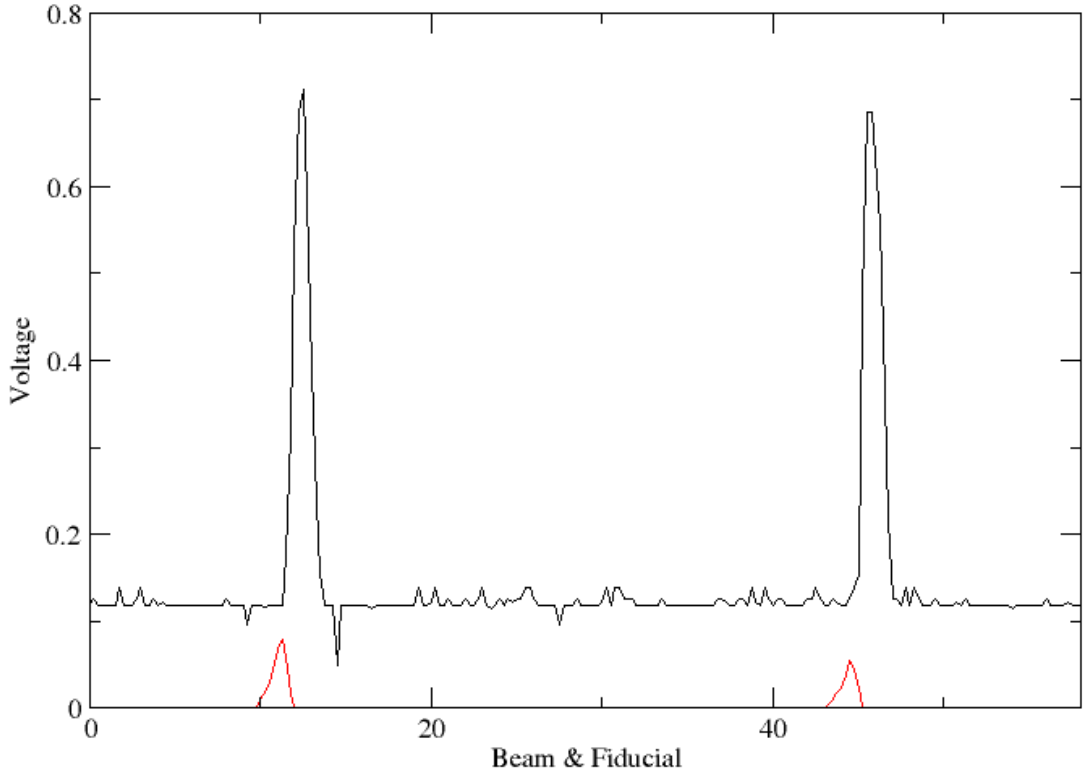
Example 1: Four channel CRO, in audio range

And many more experiments... http://expeyes.in



How we use it:

- For measuring the LINAC resonator error frequency.
- Capturing NEC Beam Profile Monitor output



For details visit http://expeyes.in

Hardware Availability

8 + 1 sources, More are welcome

ExpEYES is currently available from the following firms:

Shankar Systems
Plot 21, Gali 6/2, Block C,
Dechave Enclave,
Najafgarh, NEW DELHI-110043.
Ph: 9810841403
email : sankar_systems at sify.com

Zyxware Technologies Pvt. Ltd.
3/2457(6), TDK Road, Marappalam
Pattom P.O.
Thiruvananthapuram
Kerala 695004
email : info at zyxware.com

Mumbai
Amit Dhakulkar
Ph : 9819350953
email : damitr at gmail.com

S2S2 Services
TV 33/268, Third Floor Elite Complex
Netaji Road, Kannur 670 001
Kerala
Ph: 9447449107
email : s2s2service at gmail.com

Vibrant Systems and Softwares
1/4869H, 1st Floor Koyisco Building,
Wyanad Road, East Nadakkavu,
Calicut-673011.
Ph: 9847193371.
email: vibsys_n_soft at yahoo.com

Sys-Con Engineering
53B Mirza Galib Street
Kolkata 700 016
Ph: 9830417377 , 033 40014680
email : sceskm at yahoo.com

Hackable Devices
40 passage des panoramas
75002 Paris
France
(online store)

S V Techno Crafts
86, J.D.Nagar, Patamata
Vijayawada - 520010
Ph: +91 866 2553364
email : info at svtechnocrafts.in

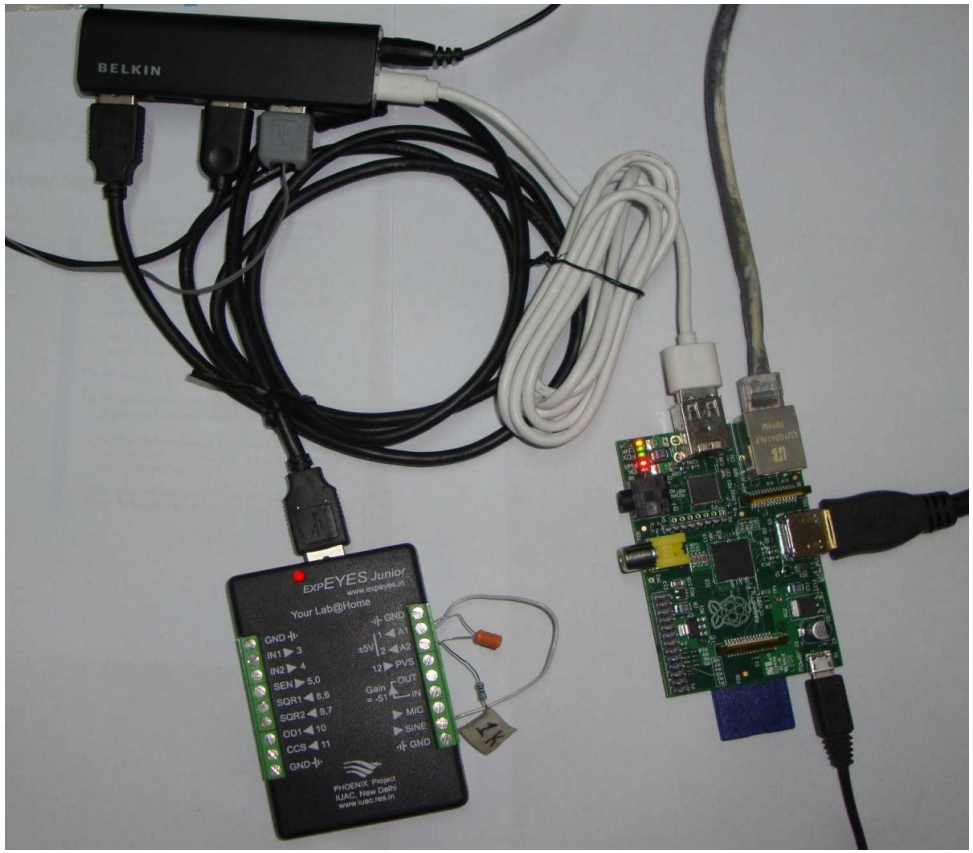
Fab to Lab *(Order Online)*
#41, Pentagon Passiflora
Sarjapur, Bangalore - 562125
Ph: +91 80 95782777
email: sales at fabtolab.com

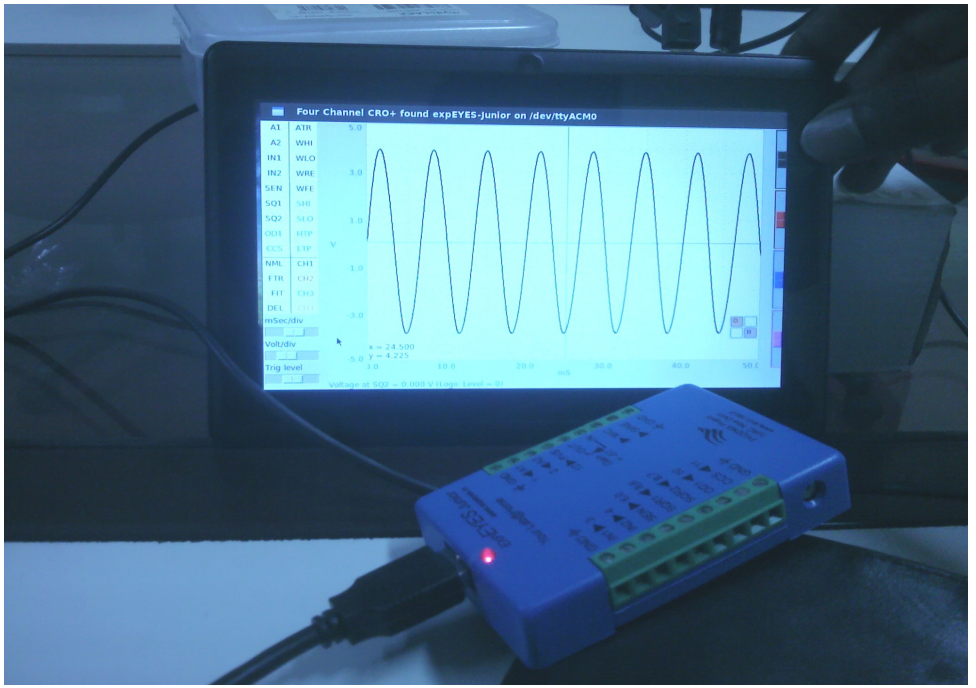
Open Hardware. Royalty-free Manufacturing permitted

Software Distribution:

- LiveCD
- Debian Packages (part of Debian & Ubuntu repositories)
- Python Source files (for Windows etc.)

Reducing total cost: cheaper computers.
Tested on Raspberry Pi and Aakash2





By Aakash2 team, IIT, Bombay

Conclusion

The distributed control system, following a very simple design, has been operational since 1997 with high reliability.

The addition of Python language interface for client programs is found to be very useful.

The expertise gained also resulted in a very successful spin-off product for science education.


Discover the Joy of Science
with expEYES Junior
Convert your PC to a Science Laboratory
Learn by exploring and experimenting.
Open Hardware & Software
More than 50 experiments
Flexible & Expandable
Using expEYES you can perform science and engineering experiments and demonstrations ranging from high school to post graduate level. It is a tool that can grow with you.

Thank You