Next Generation Lab

A solution for remote characterization of analog integrated circuits

Norwegian University of Science and Technology (NTNU), Departement of Physical Electronics

Outline

- Background
- Goals
- Technologies
- Physical architecture
- Software architecture
- Conclusion

Background

- Based on work done in the field of remote laboratories at Norwegian University of Science and Technology and Rensselaer Polytechnic Institute (NY)
- Previous laboratories are dedicated to device characterization
- Bringing the remote laboratory to the circuit level

NGL Goals

- To provide a remote laboratory course for education in design of analog integrated circuits at our department.
- To create a platform for circuit experiments where it is easy to add new experiments.
- To create a prototype experiment that measures frequency response of operational amplifiers that have been designed by students.

Available Technologies

- Server-side:
  - PHP: Hypertext Preprosessor (PHP), Active Server Pages (ASP), Practical Extraction and Report language (PERL) , .NET Platform ....
- Instrument interface:
  - LabView, GPIB C libraries
- Graphical representation:
  - Bitmap, Java Applet, Scalable Vector Graphics (SVG) from Adobe

Choosing Technologies

- Main consideration: short develoment time
- Server-side (.NET Platform):
  - Explore a new technology
  - Promising features
  - Low learning threshold
- Instrument interface (C libraries):
  - Simple interfacing with .NET platform
- Graphical representation (SVG):
  - LAB-on-WEB

.NET Platform (1)

- New development technology from Microsoft
- Seamless integration between standard windows components and web applications
- Large class library
- Theoreticaly platform and language independent
- Supported by several languages. Visual Basic 7.0, Managed C++, C#, PERL and many more

.NET Platform (2)

- ASP.NET, sucsessor to ASP
- ASP.NET features:
  - Separation of presentation and code
  - Pagelets: reusable ASP.NET code
  - WebControls: Custom tags, written in pure C# as a object
  - WebServices: application logic that is programmatically available, and can be exposed over the Internet.

C# - The Prefered Language

- New object-orieneted language developed by Microsoft.
- Combines the power of C++ with low learning threshold.
- Garbage collection relieves the programmer from the burden of manual memory management.

Scalable Vector Graphics

- New graphics file format and web development language
- SVG features:
  - Not a proprietary standard
  - Zooming capabilities
  - Supports scripting
  - Based on XML, possible to manipulate SVG-files using standard API.
  - Small size

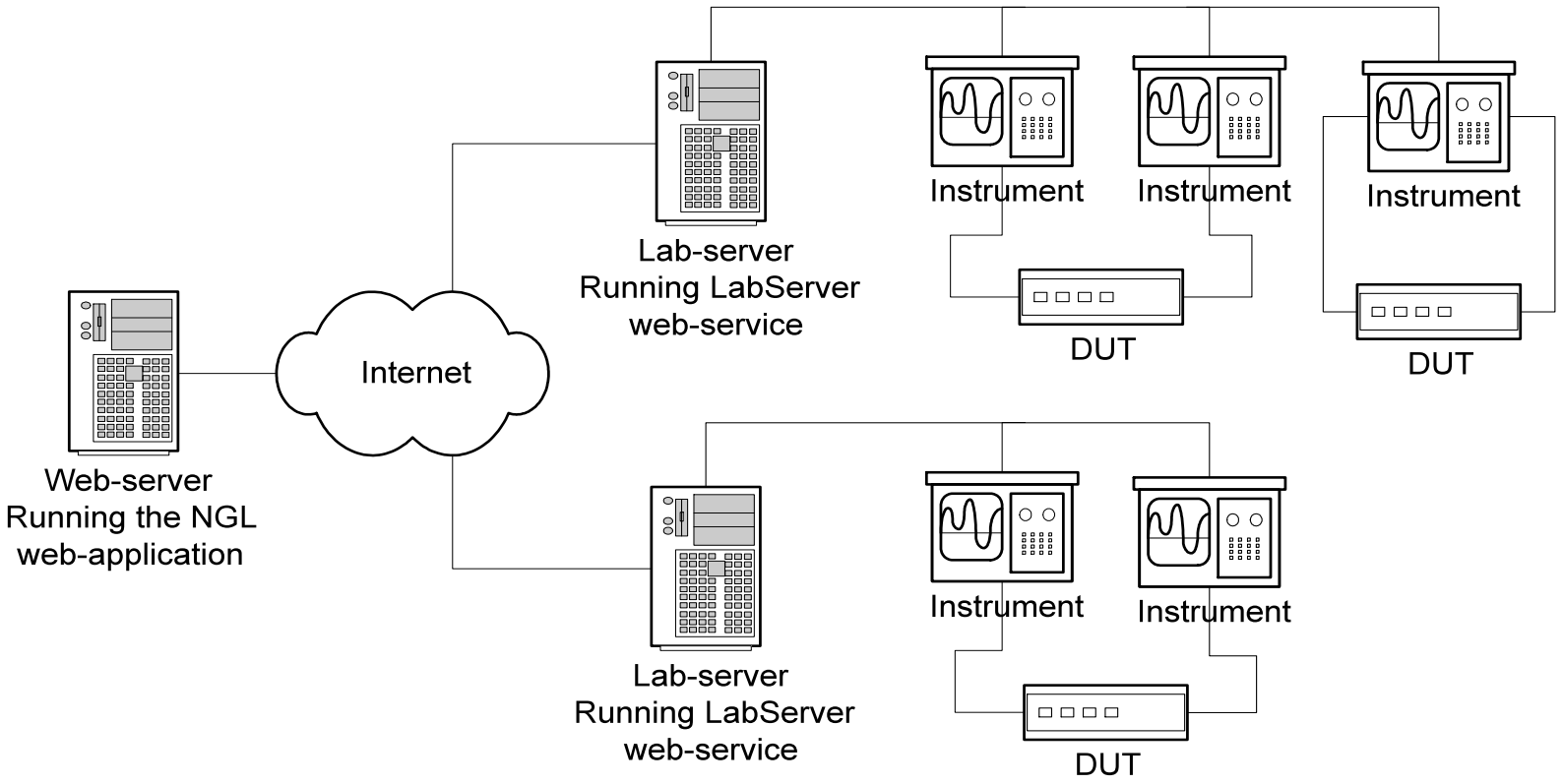
Other Tecnologies used

- Hypertext Markup Language (HTML)
  - Web pages
- Cascading Style Sheets (CSS)
  - Formatting of web pages
- JavaScript
  - Creating and controlling SVG output
  - Realtime feeback to user
- Extensible Markup Language (XML)
  - Internal application communication

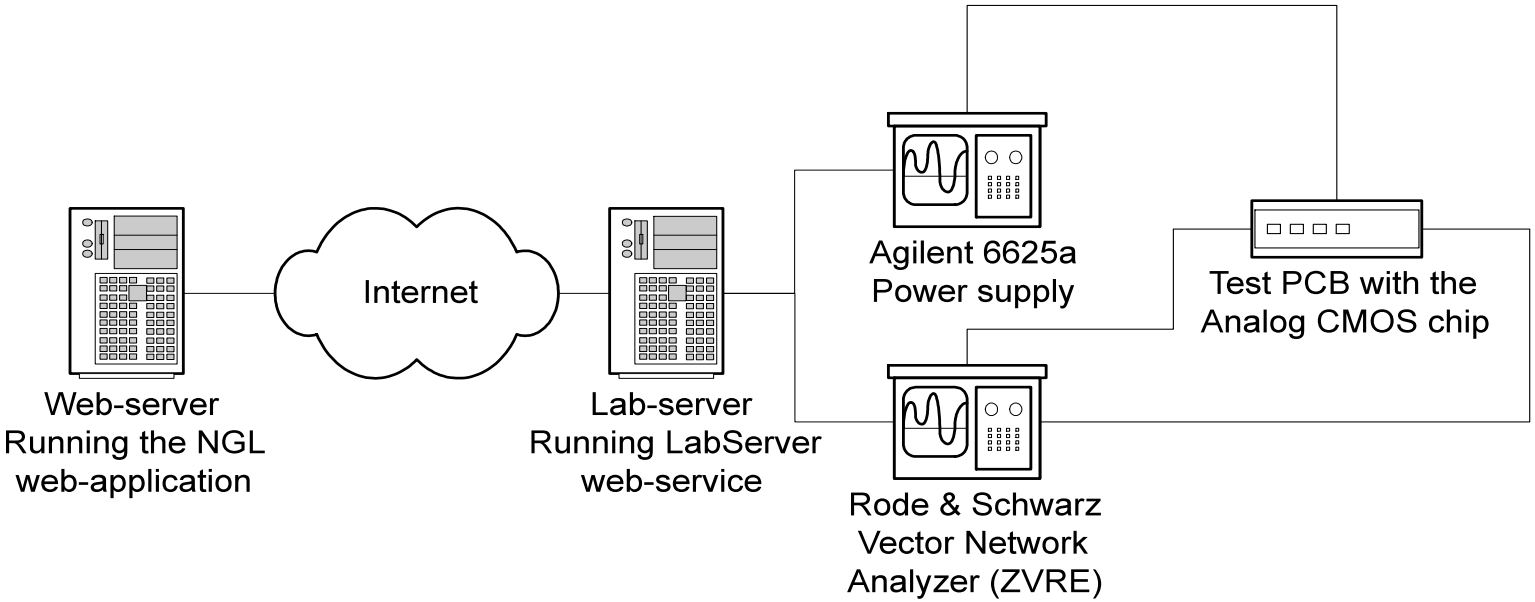
Physical Architecture (1)

- Main objectives:
  - Scalability
  - Ease of adding new experiment setups
- Keyword:
  - LabServer webservice: Interface to GPIB and DAQ (Data Acquisition) boards on the lab server

Physical Architecture (2)



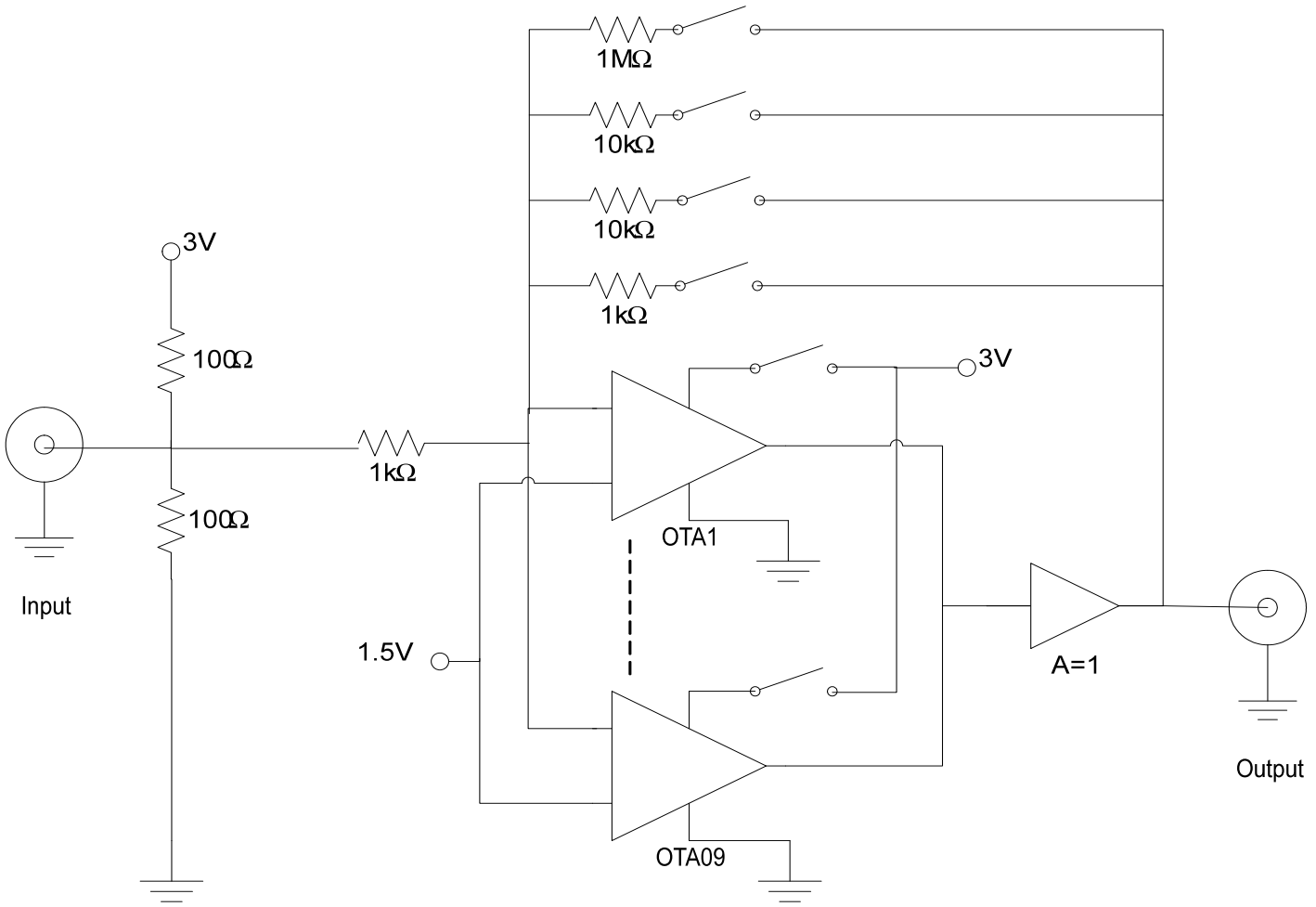
Physical Architecture (3)



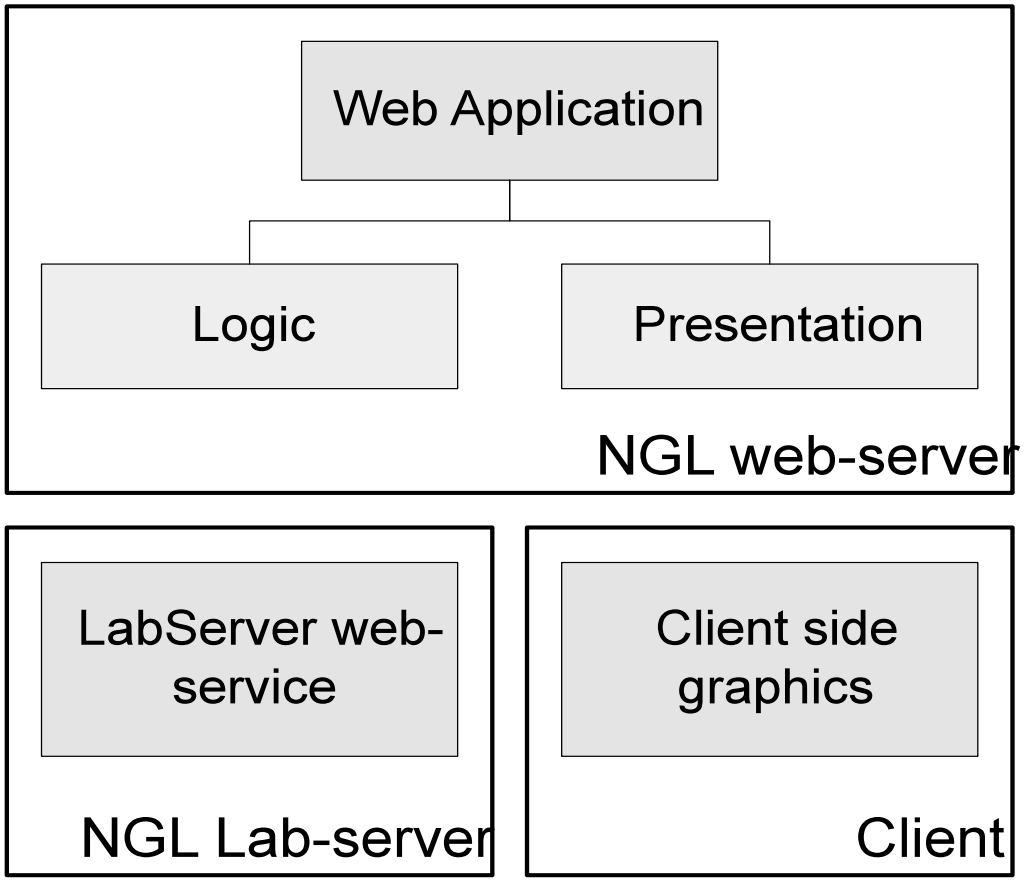
Test PCB (1)

- Analog CMOS ic containing 9 opamps created by students as project work
- Ability to select any of the 9 opamps for testing
- Ability to select 4 different resistors for controlling gain in a closed loop configuration
- Adjusting bias current to opamp
- Adjusting offset from common mode level at positive input

Test PCB (2)



Software Architecture (1)



Software Architecture (2)

- Server-Side:
  - Written in C#
  - Provides real-time feedback to the user
  - Provides a framework for new experiments
  - Controls running of experiments
  - All experiments are automatically available on the menu through the use of reflection

Software Architecture (3)

- LabServer webservice:
  - Written in a combination of Managed C++ and Unmanaged C++
  - Provides easy to use functions for accessing GPIB and DAQ boards
  - 250 lines of code

Software Architecture(4)

- Client-side graphics:
  - Server-side logic feeds data to a JavaScript which draws the plots
  - Handles logarithmic and linear values on x and y axis
  - Handles values between 1E-25 and 1E27
  - Auto scaling of values

Conclusion

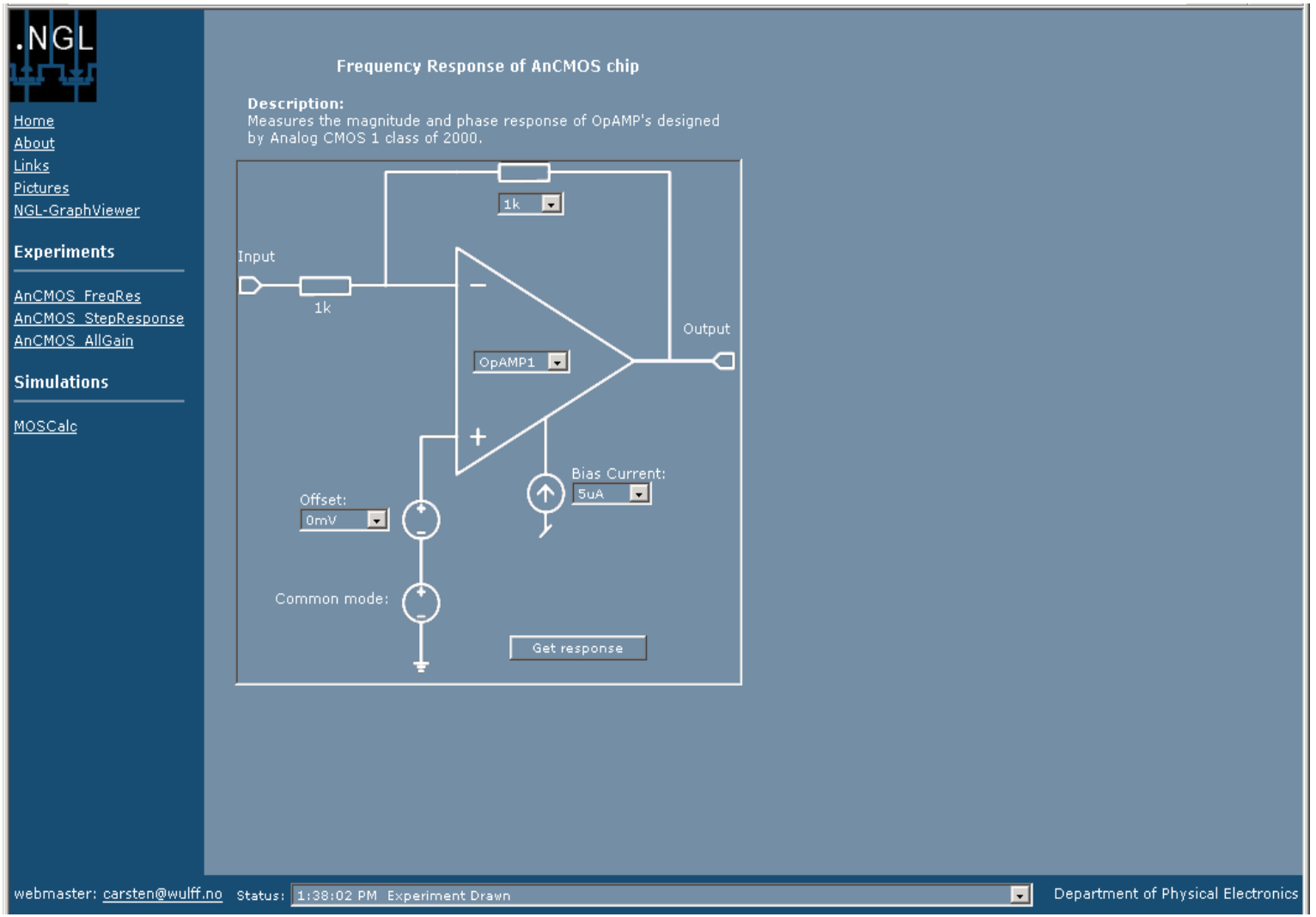
- The NGL gives the users a reliable and efficent tool for analog CMOS integrated circuit experiments
- The NGL provides a framework for distributed experiments spanning wide geographical areas
- Choosing the .NET platform for development provides ditributed architecture with no additional cost

NGL Front Page

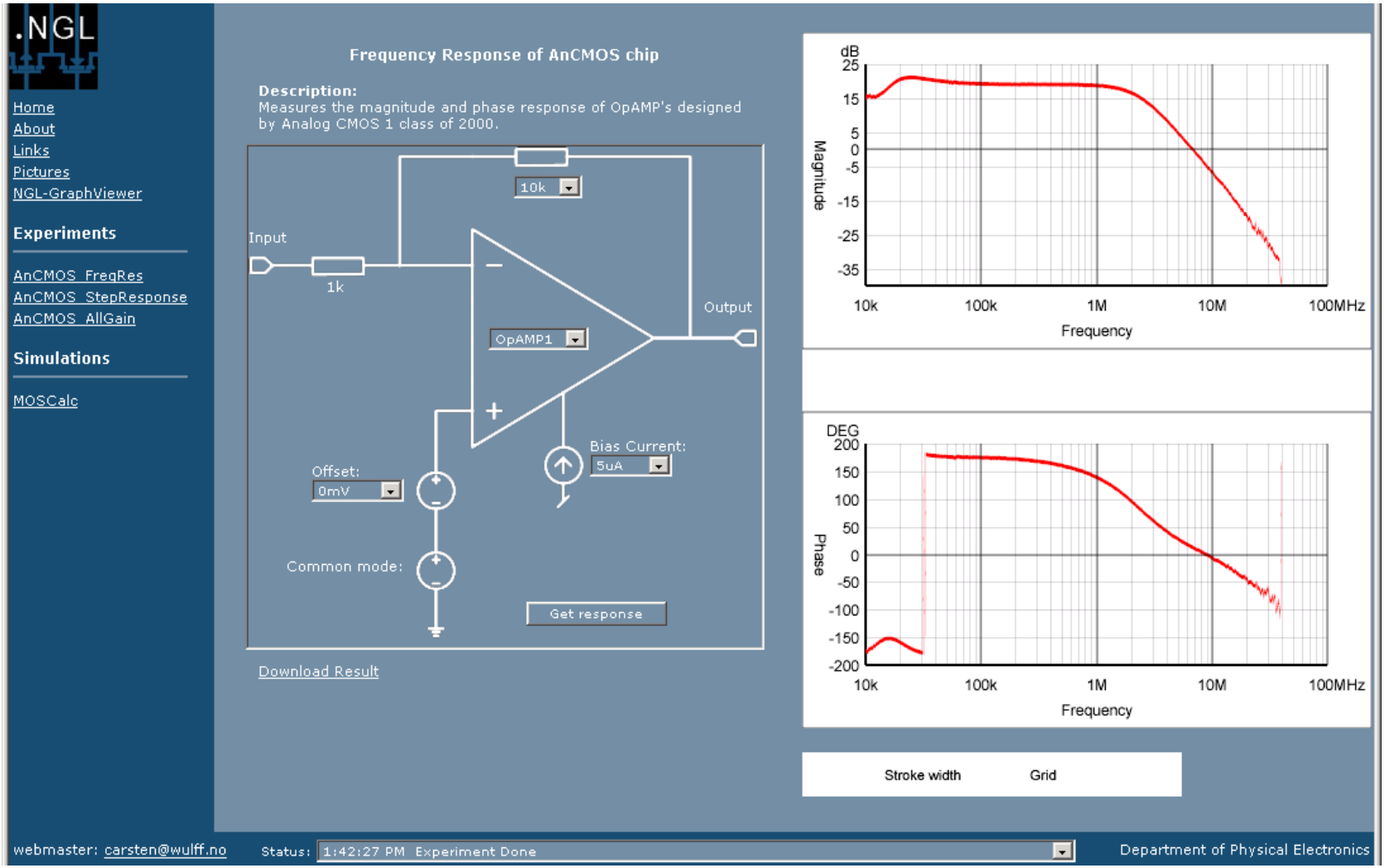
Next Generation Lab

http://www.ngl.fysel.ntnu.no

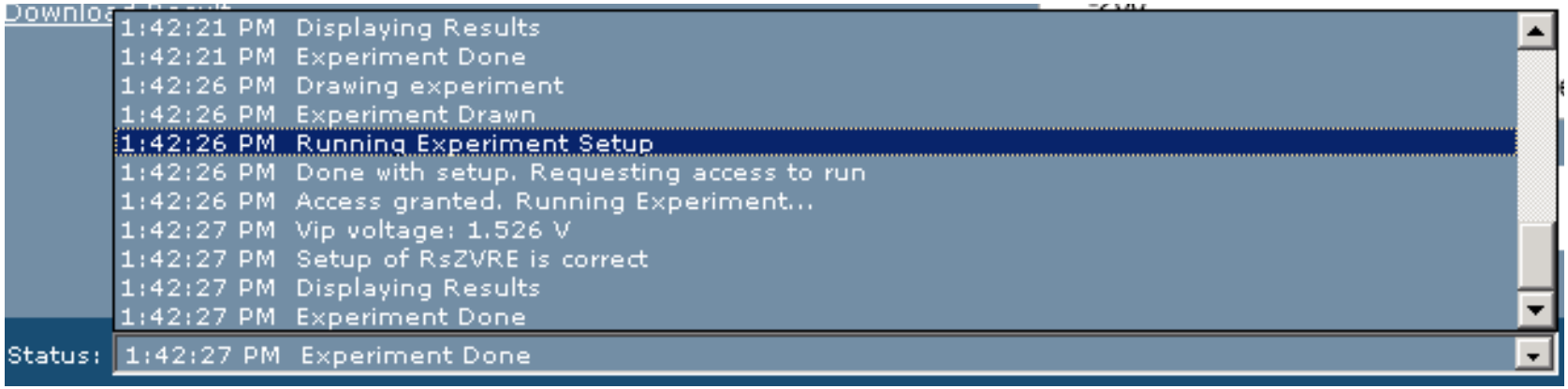
NGL Frequency Response Measurement (1)



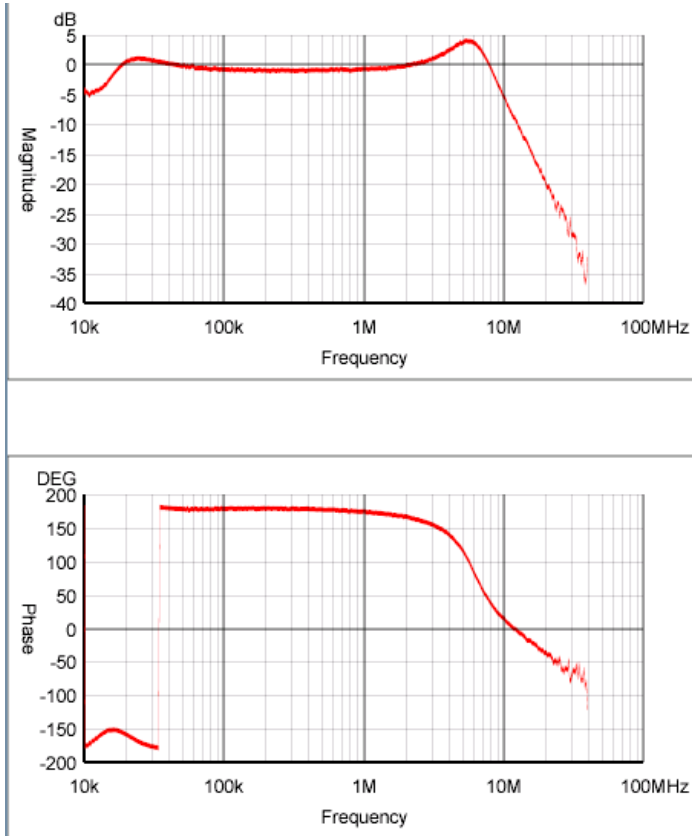
NGL Frequency Response Measurement (2)



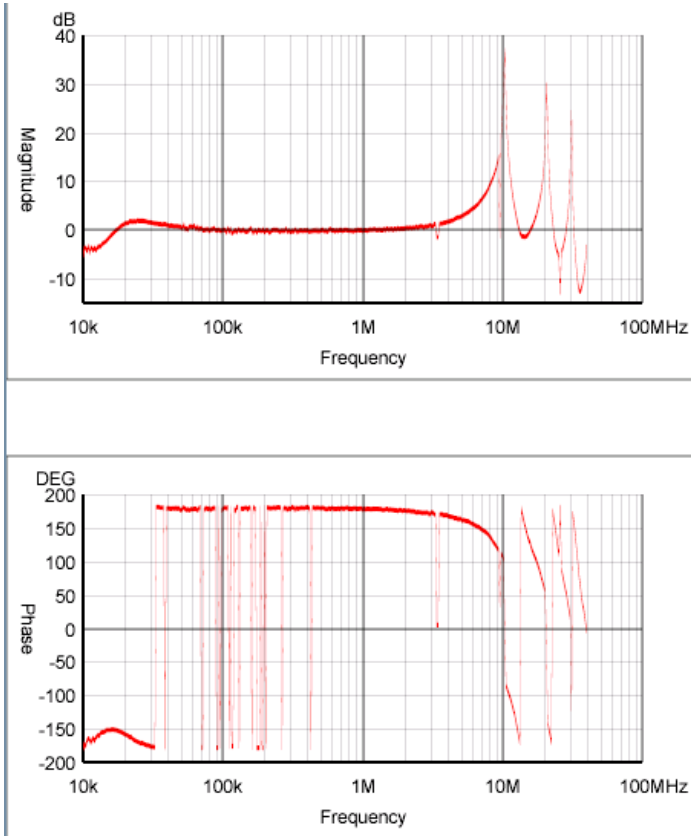
Realtime Feedback



Example Results (1)

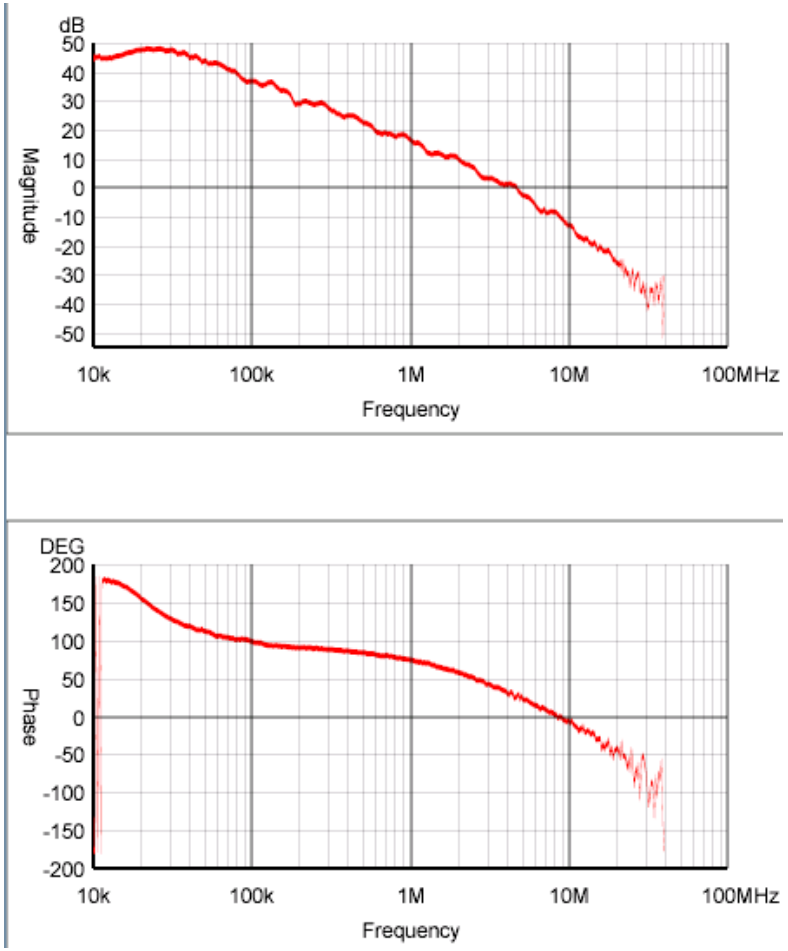


Opamp=1, Bias=**5uA**, Gain=0dB

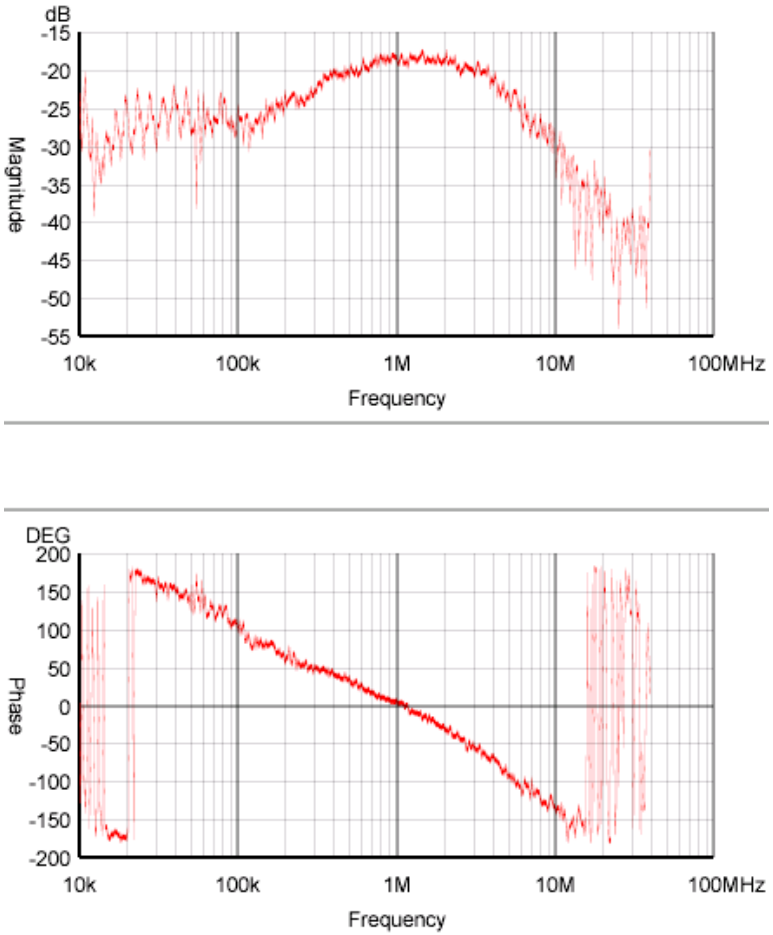


Opamp=1, Bias=**25uA**, Gain=0dB

Example Results (2)



Opamp=1, Bias=5uA, Gain=0dB, Offset=**0mV**



Opamp=1, Bias=5uA, Gain=0dB, Offset=**+10mV**