

Experiment control and data acquisition using BlackBox Component Builder

Wojtek Skulski

Department of Physics and Astronomy,
University of Rochester

and SkuTek Instrumentation

Rochester, New York USA

skulski @ pas . rochester . edu

Projects developed using BlackBox

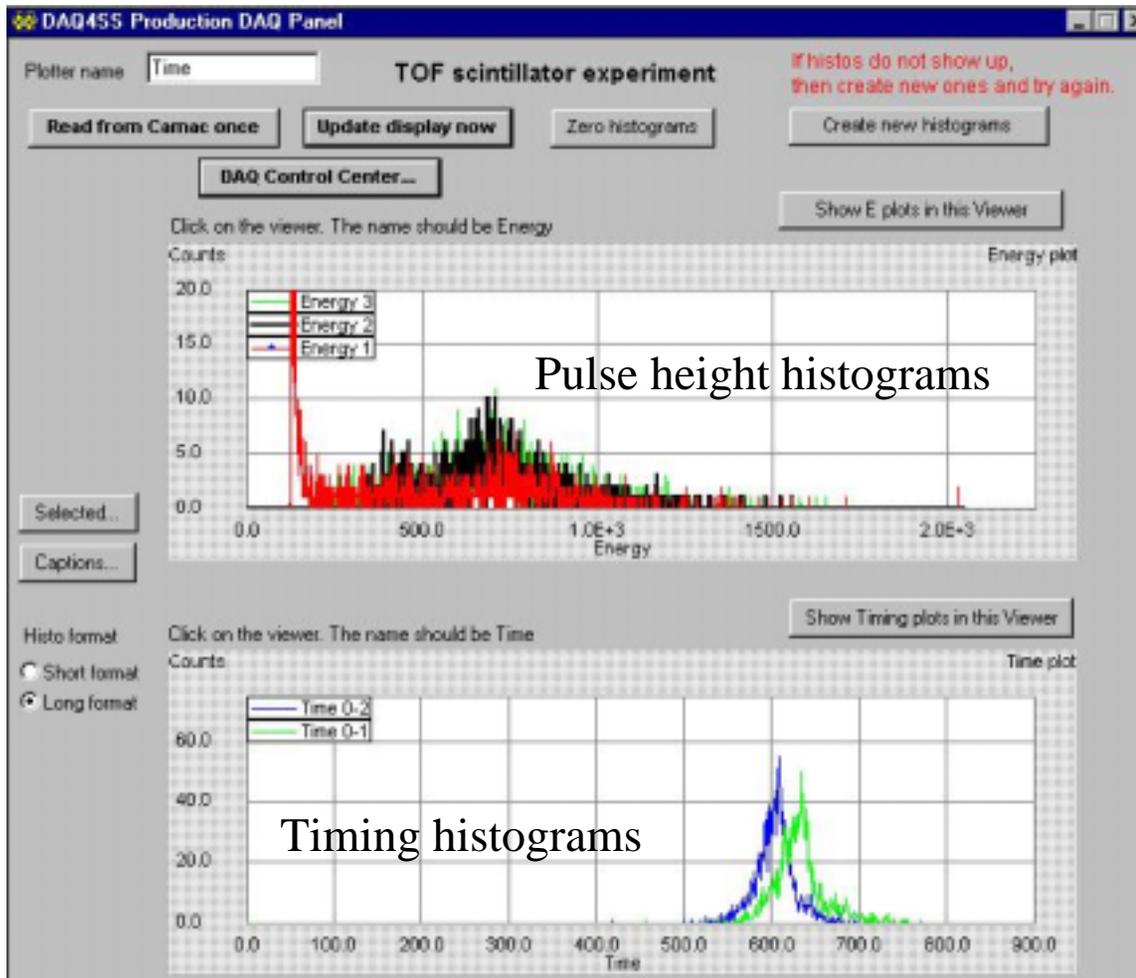
- Student projects at the Department of Physics and Astronomy, UofR.
 - Measurement of Light Attenuation in Plastic Scintillators.
 - Detection and Analysis of Stopping Muons.
 - Digital Signal Processing of Scintillator Pulses.
- R&D project at the Laboratory for Laser Energetics, UofR.
 - Adaptive Optics Control System for Tiled Diffraction Gratings.
- Industrial project, SkuTek Instrumentation.
 - Data acquisition and instrument control for multichannel waveform digitizer DDC-8.

Why BlackBox and Component Pascal?

- Very robust runtime environment.
- No memory leaks, no dangling pointers.
- Instantaneous compile/load/debug cycle.
- Comprehensive graphics.
 - Scientific plotting by Robert Campbell, BAE Systems.
 - Waveform graphics by Wojtek Skulski, University of Rochester.
- Comprehensive math libraries by Robert Campbell.
- Easy to interface with hardware.
- Excellent support from the vendor.
- Knowledgeable user community, quick response to questions.
- Free for educational institutions.

Measurement of Light Attenuation in Plastic Scintillators

Student project #1

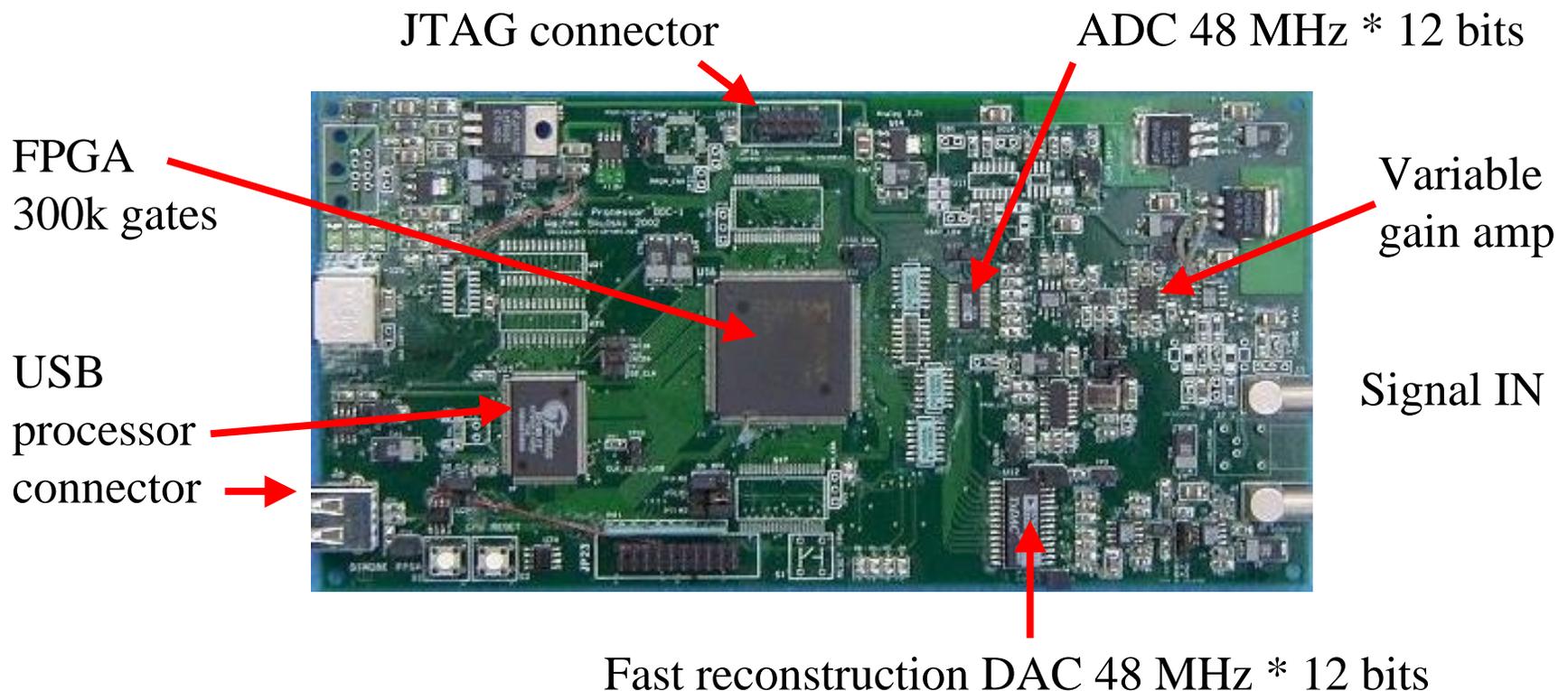


- Data acquired from CAMAC:
 - Jorway controller 73A.
 - ORTEC ADC AD811 .
 - LeCroy TDC 2249W.
- DAQ and experiment control:
 - BlackBox Component Builder.
 - Waveform graphics by WS.
- Radiation source: cosmic rays.
- Measured:
 - pulse height,
 - pulse timing.
- Analysis: correlation between amplitude and timing.

BlackBox used as an interface for Digital Pulse Processor

Student projects #2 and #3

- Single-channel Digital Pulse Processor DDC-1 from SkuTek Instrumentation
- Field-programmable gate array (FPGA) for waveform triggering and storage
- **BlackBox** controls DDC-1 and reads the waveforms over USB link

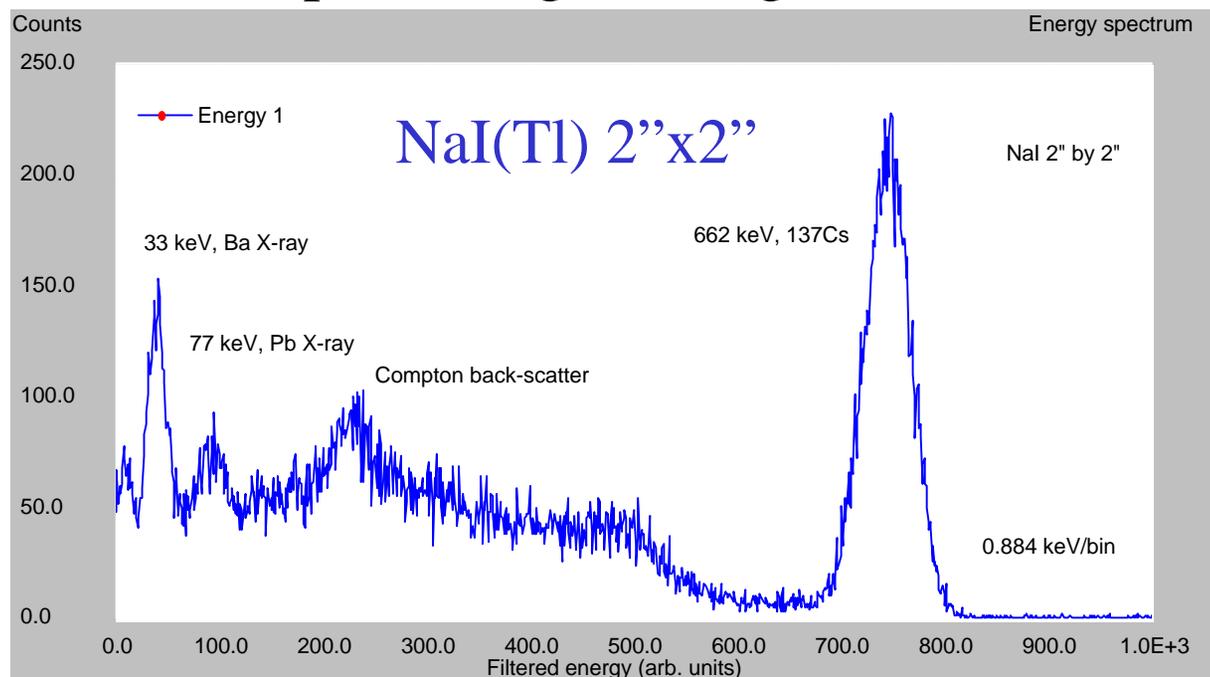


Digital Signal Processing of Scintillator Pulses

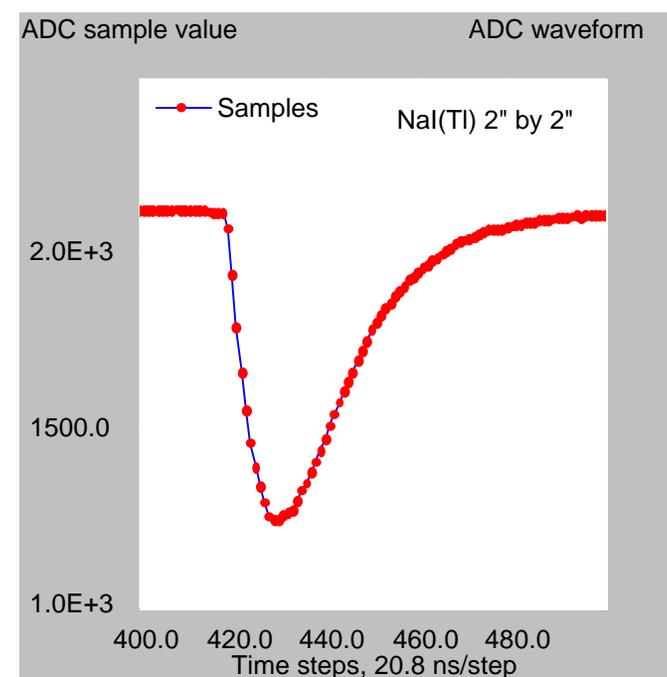
Best Senior Thesis Award '03 in the Department of Physics and Astronomy

- Signals from scintillation detectors recorded with DDC-1.
- Waveforms displayed and processed using **BlackBox**.

^{137}Cs pulse-height histogram

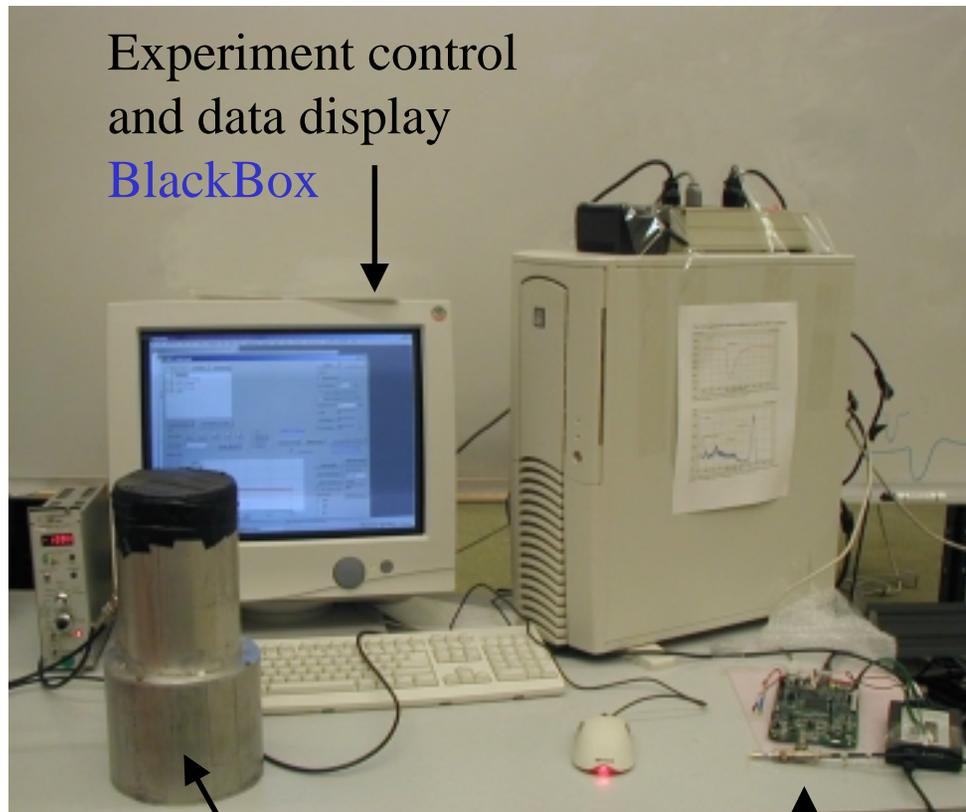


Waveform from NaI(Tl)



Detection and Analysis of Stopping μ -mesons

2003 Summer Research Experience for Undergraduates



Experiment control
and data display
BlackBox

BC-400 5" x 6"
& phototube

DDC-1 digitizer board

- Radiation source: cosmic rays.
- Detector: BC-400 5" x 6"
- Data recording: DDC-1.
- DAQ and control: **BlackBox**.
- Analysis: **BlackBox**.
- Cosmic ray μ -mesons stop and decay.
- Energies and lifetimes are measured.

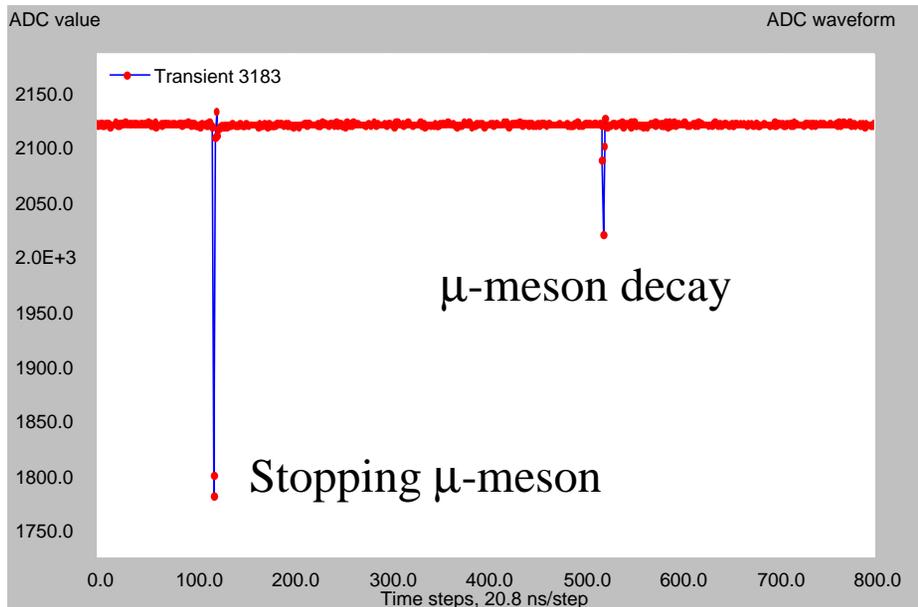
Detection and Analysis of Stopping μ -mesons

2003 Summer Research Experience for Undergraduates

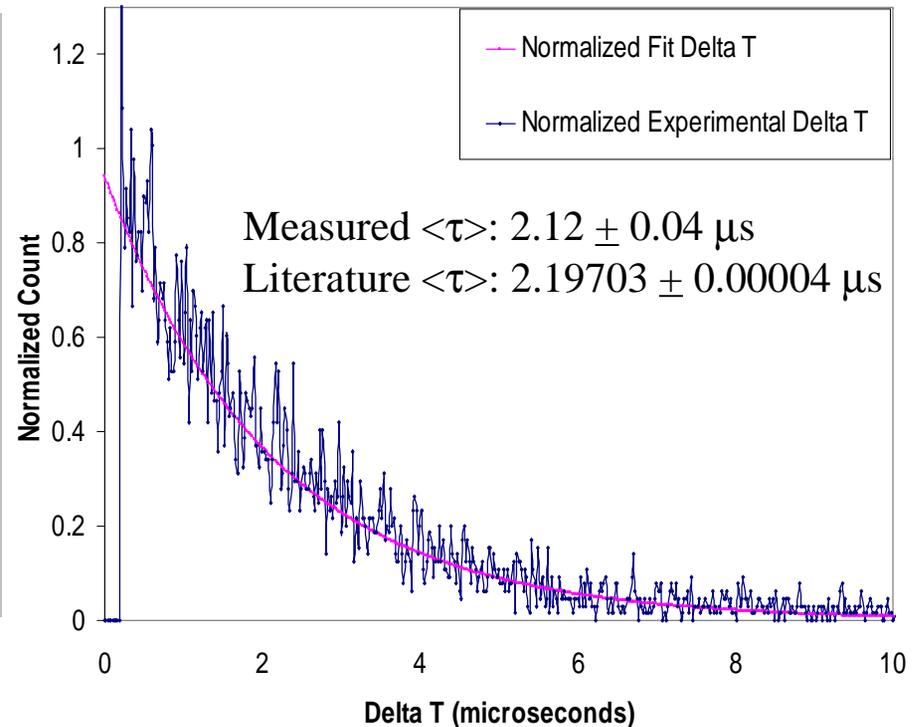
Signals from a BC-400 5"x6" scintillator recorded using DDC-1 waveform digitizer from SkuTek, and displayed using BlackBox waveform graphics.

After 4% capture correction the measured and accepted lifetimes agree to within 0.35%.

Waveform from plastic scintillator



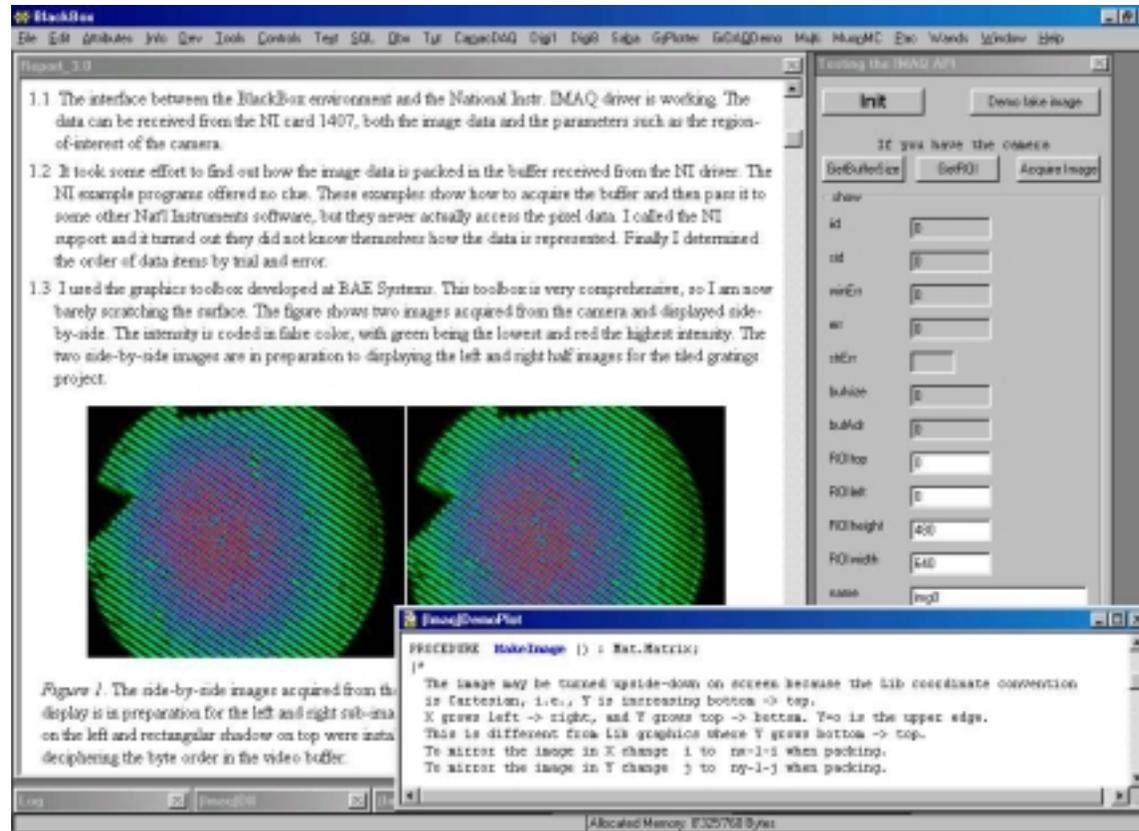
Time between leading and trailing pulses



Adaptive Optics Control System for Tiled Diffraction Gratings

Laboratory for Laser Energetics, University of Rochester

The project started in February/2004. Positions of tiled diffraction gratings will be controlled by BlackBox in a closed loop, based on CCD camera images. The screenshot shows false-color diffraction images embedded in the BlackBox document editor. The images were acquired by a **BlackBox** program directly from a CCD camera.



DAQ and control for 8-channel waveform digitizer DDC-8

Industrial project, SkuTek Instrumentation

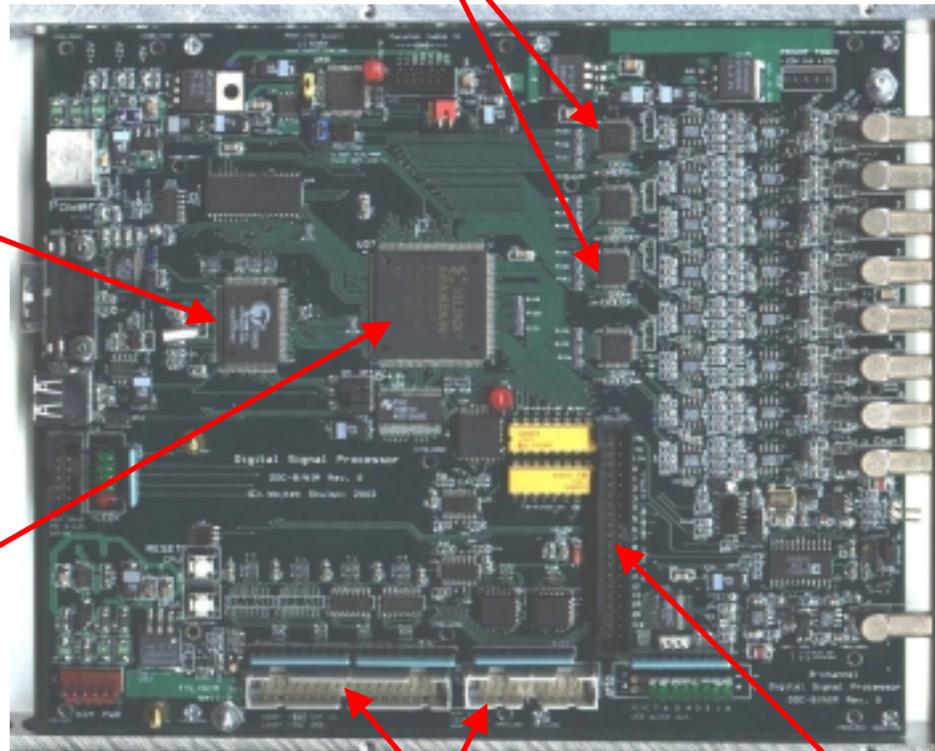
ADC 40 MHz * 10 bits, 8 channels

micro
processor

RS-232

USB

FPGA



Analog
signal IN
8 channels
with
digital offset
and gain control

ECL clock IN
(optional)

Signal OUT
40 MHz * 10 bits

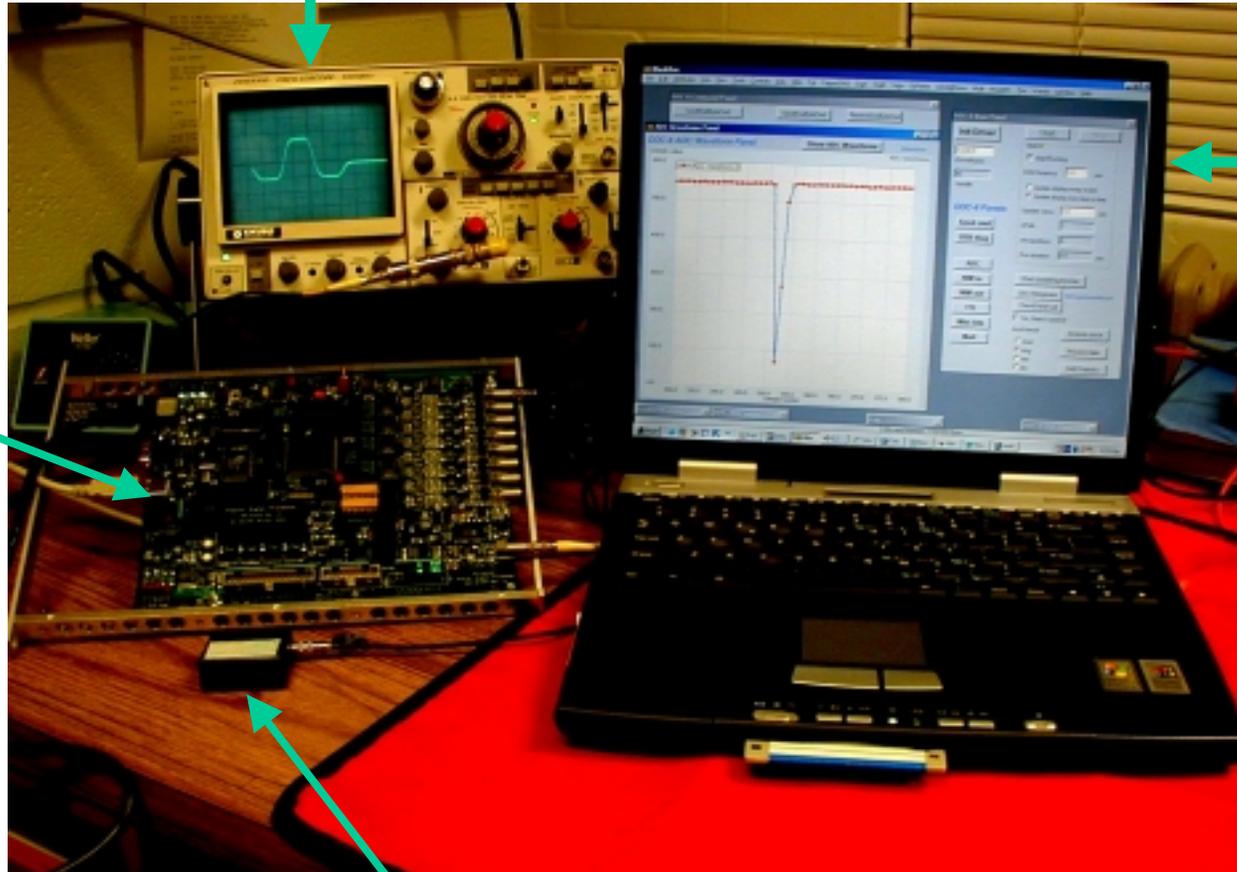
Logic signals NIM
16 lines IN, 8 lines OUT

16 bidirectional TTL lines + 1 in
(fast parallel interface to VME)

DDC-x development system using BlackBox

Industrial project, SkuTek Instrumentation

Analog signal reconstruction: digital FIR filter output



Control &
waveform
display:
BlackBox

DDC-8

NIM pulser

DDC-x software development using BlackBox

The screenshot displays the BlackBox software interface. The main window is titled "DDC-1 Main DAD Panel" and contains several components:

- DDC-1 Panel:** Includes an "Init Device" button, a text field for "sDriverName" (Ezusb-0), and a text field for "handle" (116). Below these are radio buttons for "send" (0-4) and "send where" (0-4), and a "Setup Device" button.
- Energy Spectrum:** A plot of "Counts" vs "Energy" showing a peak at 137 Cs (33 keV, Ba X-ray) and another peak at 400.0.
- Sample value:** A plot of "Sample value" vs "Sample number" showing a step function with a dip.

An inset window titled "Digi8_Report_Nal" is open, displaying the following text:

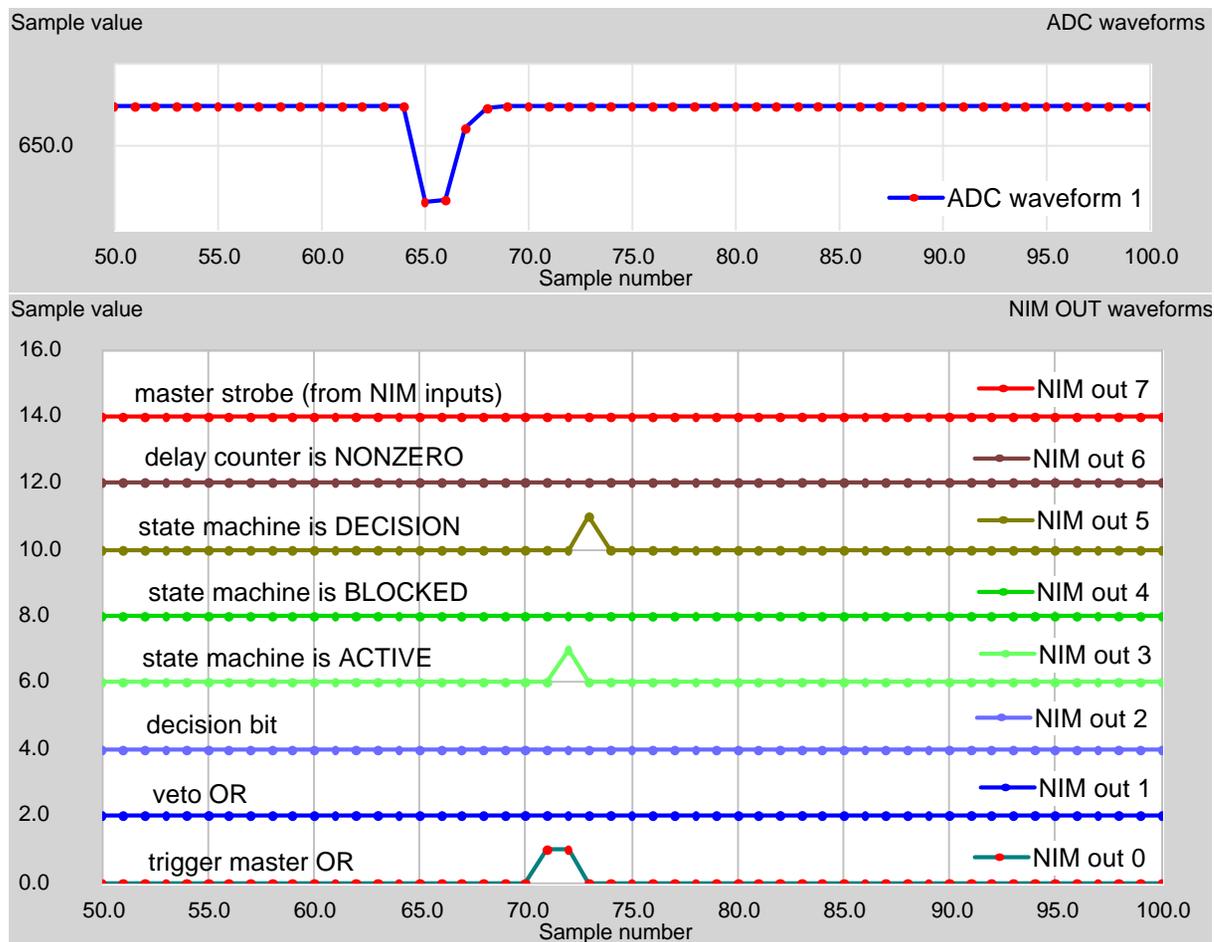
4. DDC-8 software development environment.

The software development for the measurements took one afternoon. The software includes filtering algorithms, histogramming, as well as the GUI specific for the data collection. Existing communication and control software was used to host the experiment. This rather rapid development was possible thanks to the "rapid development environment" used for the DDC-8 software. This report was composed, using the same environment, while the data acquisition from DDC-1 was in progress. This demonstrates this feature, which turns out quite convenient in practice.

The inset window also shows a smaller version of the DDC-1 Main DAD Panel and a "Sample value" plot.

Example of real-time waveform display

DDC-8 control and graphics: BlackBox Component Builder



Summary

- Several projects were successfully developed using BlackBox.
- Students could learn BlackBox programming very rapidly.
- BlackBox and Component Pascal provide robust development system: excellent debugger, no memory leaks, no dangling pointers.
- Instantaneous compile/load/debug cycle helps to meet deadlines.
- BlackBox is easy to interface with hardware.
- Excellent support provided by the vendor.
- Knowledgeable user community, quick response to questions.
- Free for educational institutions.

Acknowledgements

- I wish to thank the following persons and institutions:
- Oberon Microsystems for making BlackBox freely available to educational institutions, for their generous help, and for many discussions.
- Robert Campbell for help and many discussions.
- Fyodor Tkachov for never giving up.
- Professor Frank Wolfs, University of Rochester.
- BlackBox user community.
- SkuTek Instrumentation.
- Students: Susanne Levine, Daniel Miner, Len Zheleznyak , Saba Zuberi.