Experiment control and data acquisition using BlackBox Component Builder

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Projects developed using BlackBox

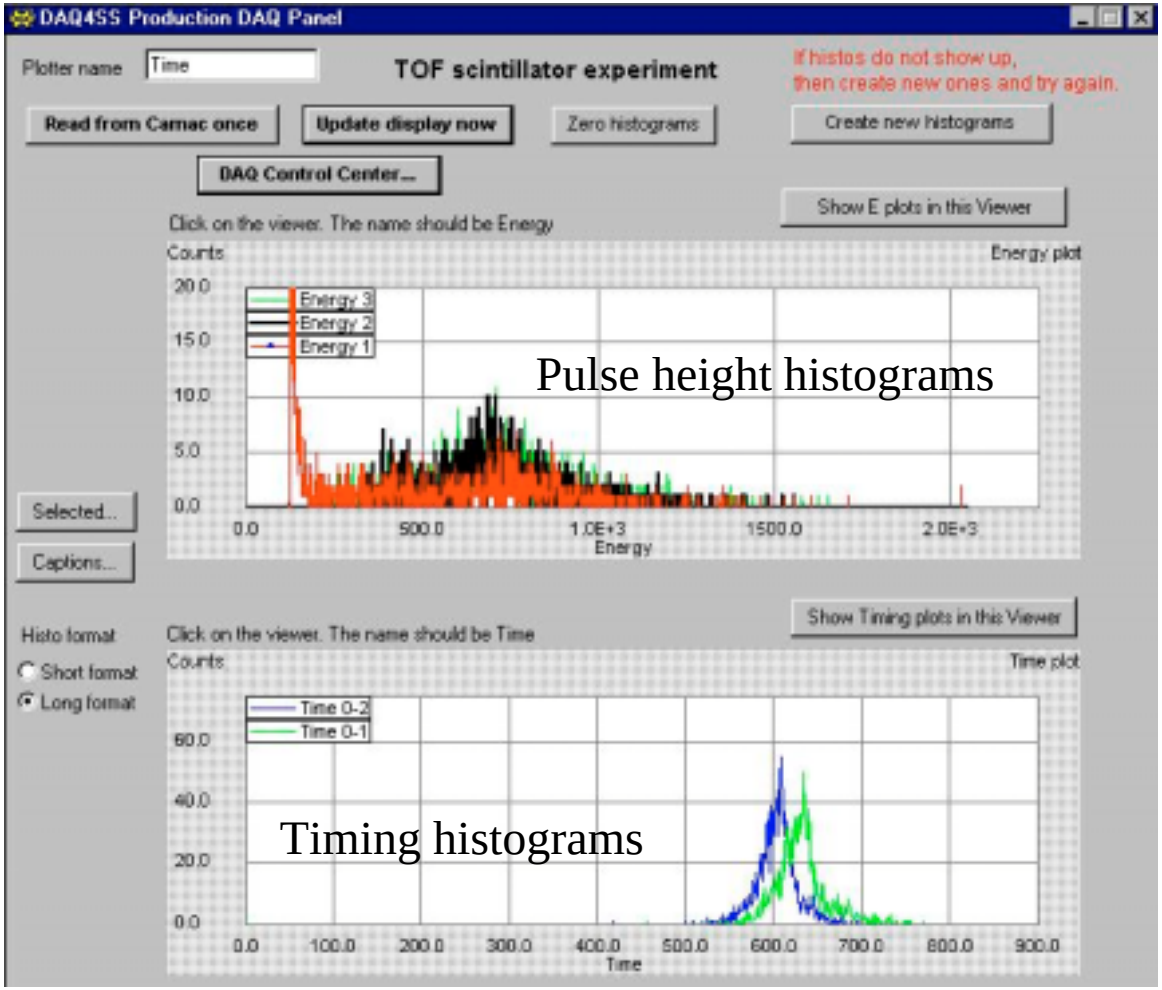
- Student projects at the Department of Physics and Astronomy, UofR.
  - Measurement of Light Attenuation in Plastic Scintillators.
  - Detection and Analysis of Stopping Muons.
  - Digital Signal Processing of Scintillator Pulses.
- R&D project at the Laboratory for Laser Energetics, UofR.
  - Adaptive 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

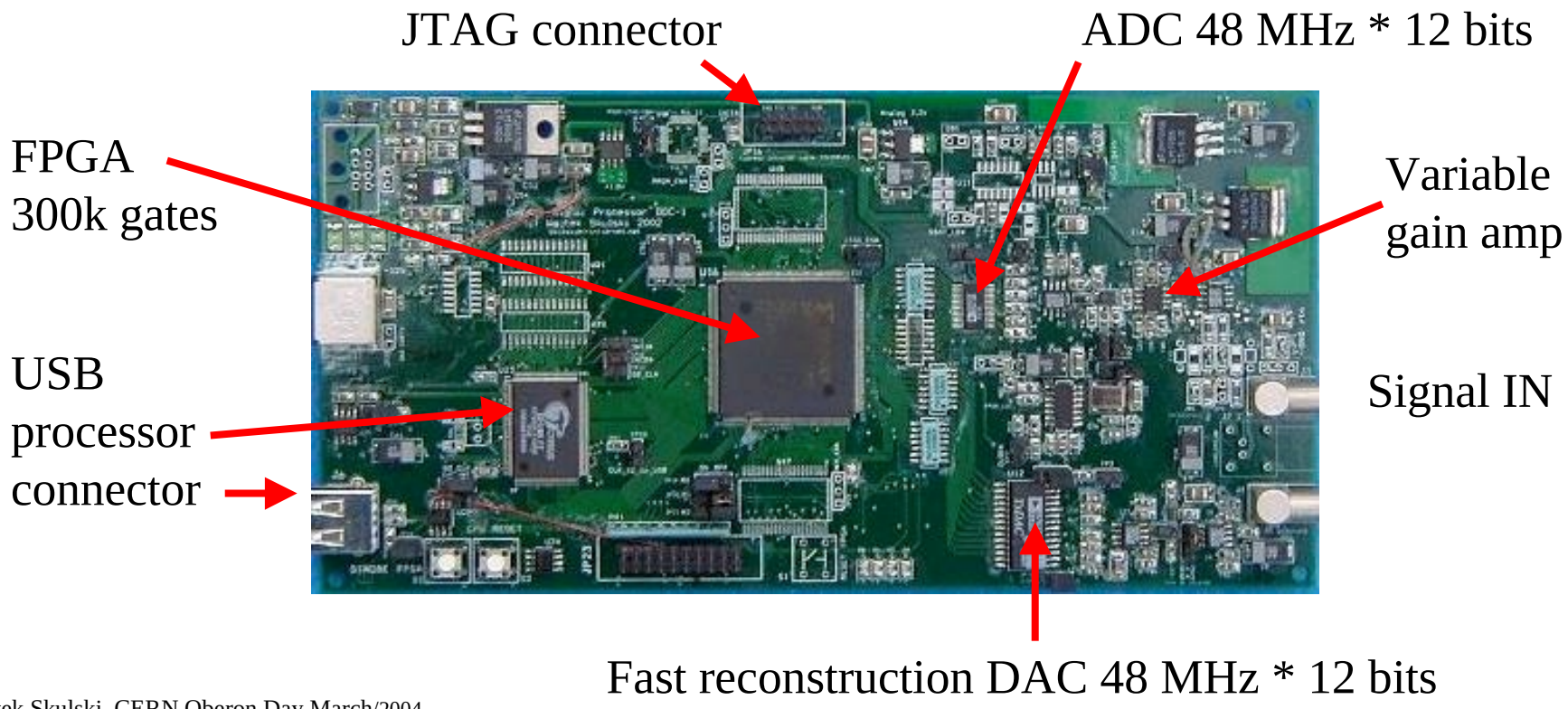


- Data acquired from CAMAC:
  - Jorway controller 73A.
  - ORTEC ADC AD811 .
  - LeCroy QDC 2249W.
- DAQ and experiment control:
- BlackBox Component Builder.
- Waveform graphics by WS.
- Radiation source: cosmic rays.
- Measured:
  - pulse height,
  - pulse timing.
- Analysis: correlation between amplitude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

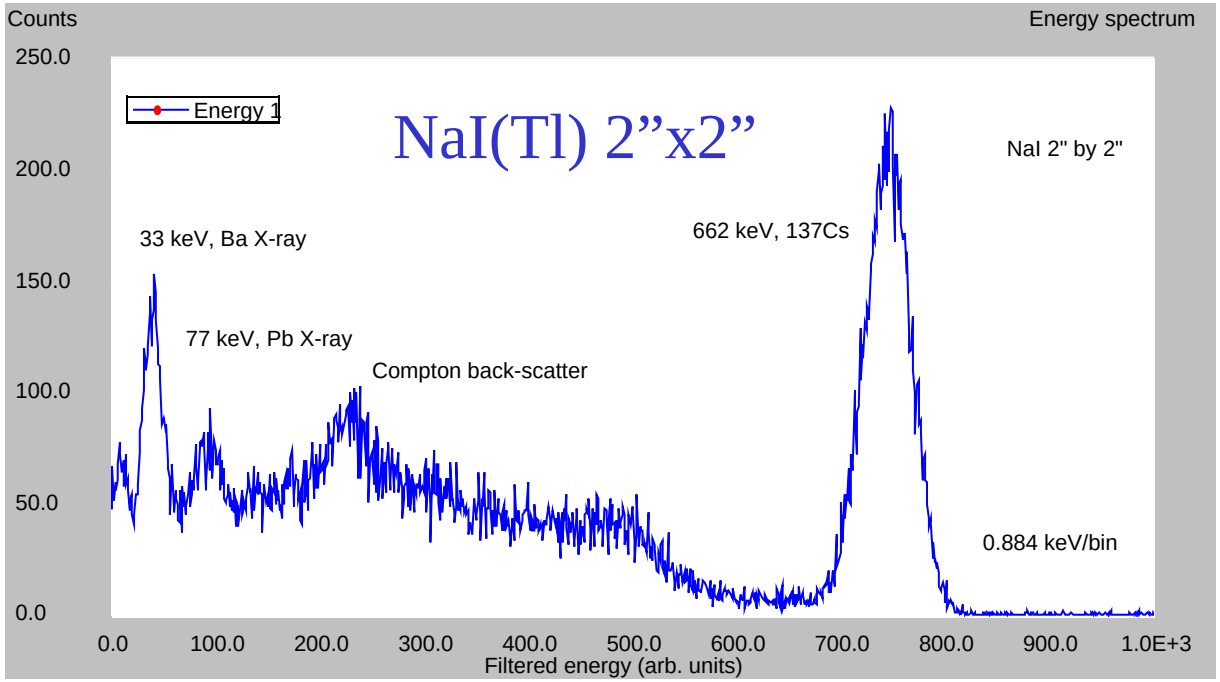


Digital Signal Processing of Scintillator Pulses

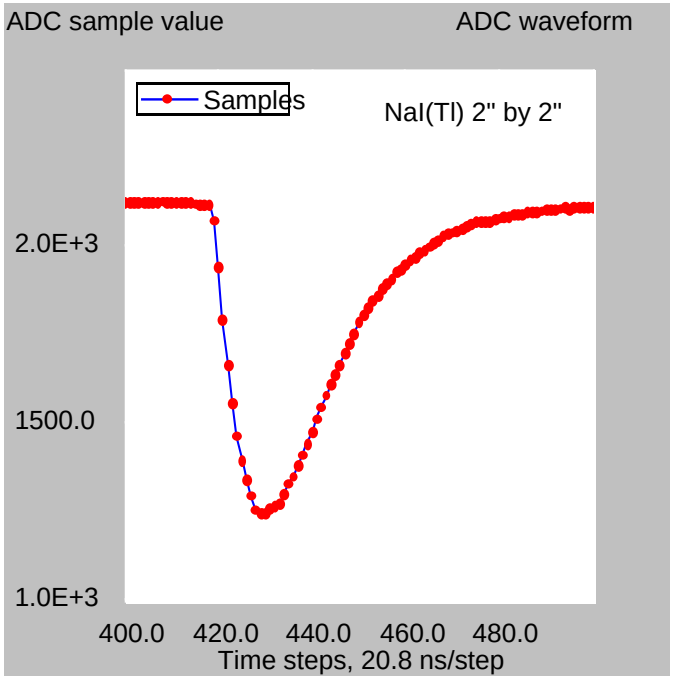
Best Senior Thesis Award ‘03 in the Department of Physics and Astronomy

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

^{137}Cs pulse-height histogram

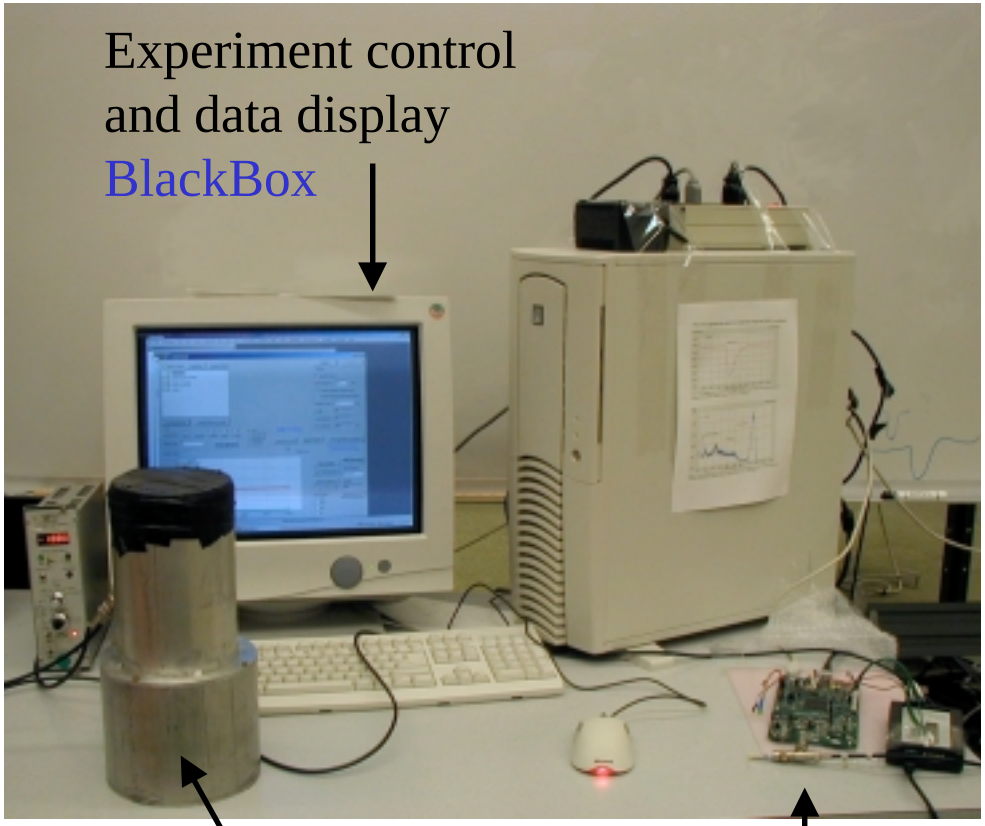


Waveform from NaI(Tl)



Detection and Analysis of Stopping μ-mesons

2003 Summer Research Experience for Undergraduates



- 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.

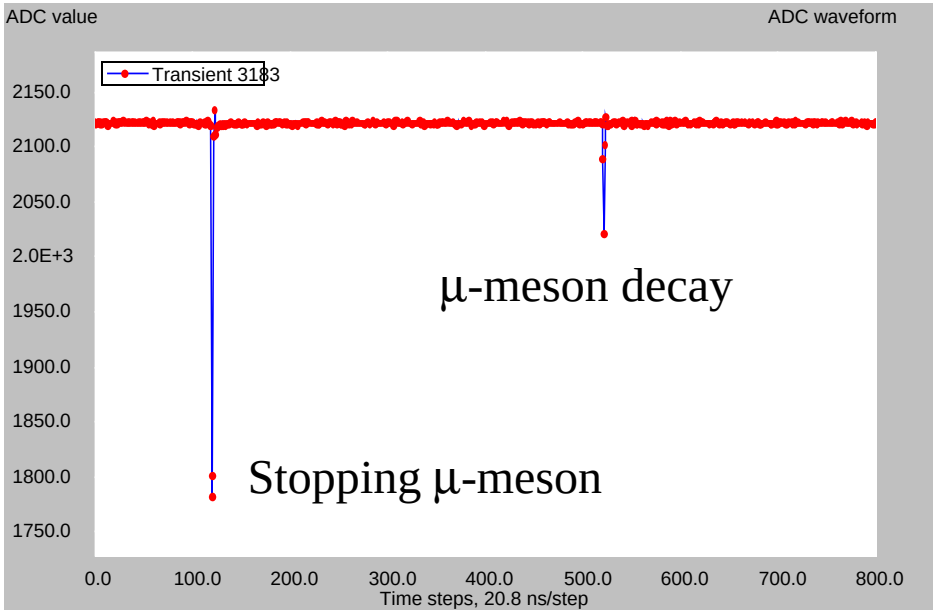
Detection and Analysis of Stopping μ-mesons

2003 Summer Research Experience for Undergraduates

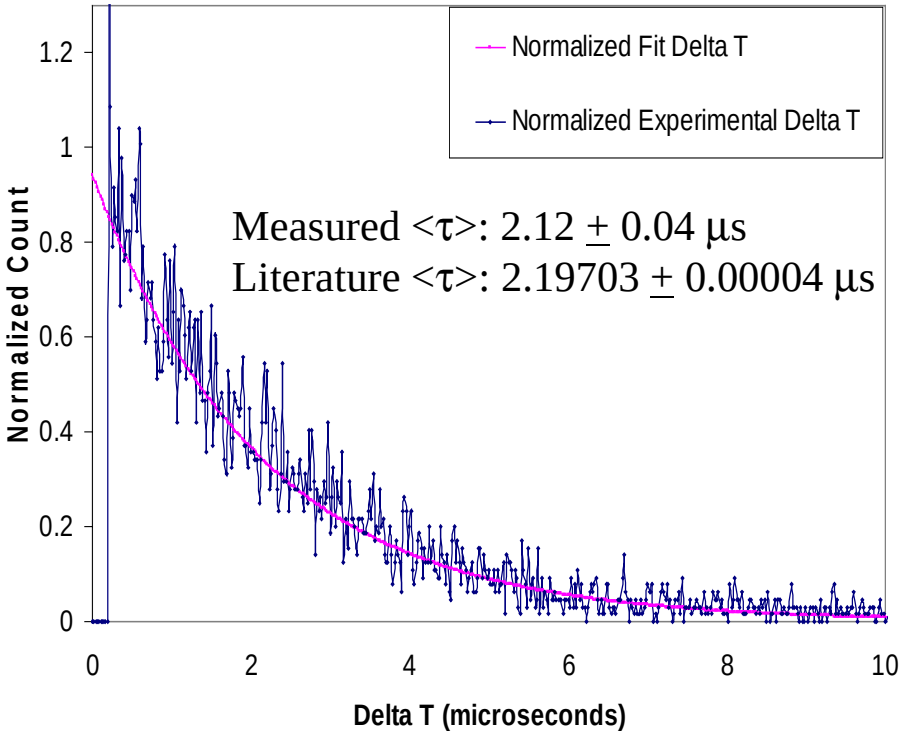
Signals from a BC-400 5”x6” scintillator recorded using DDC-1 waveform digitizer from SkuTek, and displayed using BlackBox waveform graphics.

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

Waveform from plastic scintillator



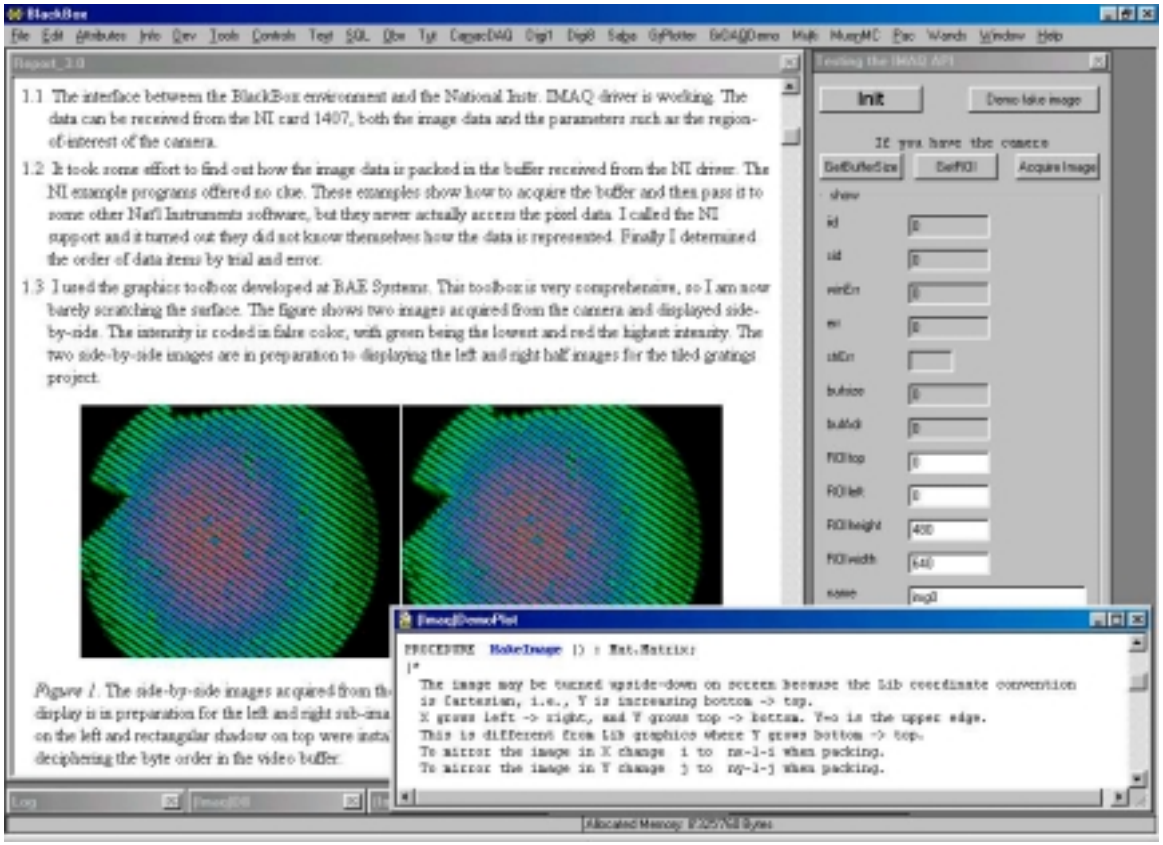
Time between leading and trailing pulses



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.



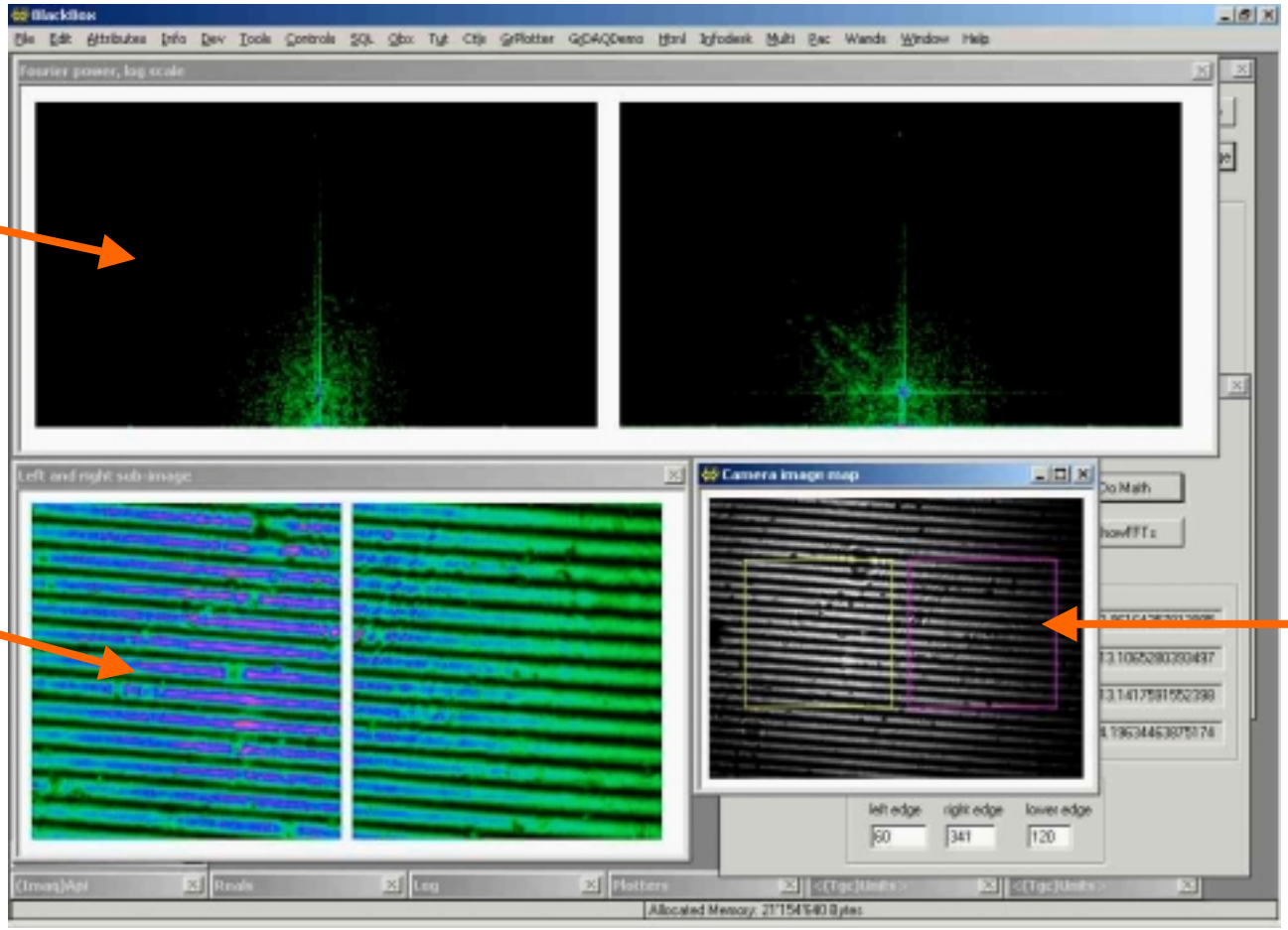
Adaptive Optics Control System for Tiled Diffraction Gratings

Laboratory for Laser Energetics, University of Rochester

Fourier transform maps calculated by BlackBox, based on data acquired by a BlackBox program directly from a CCD camera. Many thanks to Robert for his magnificent graphics!

Fourier transforms

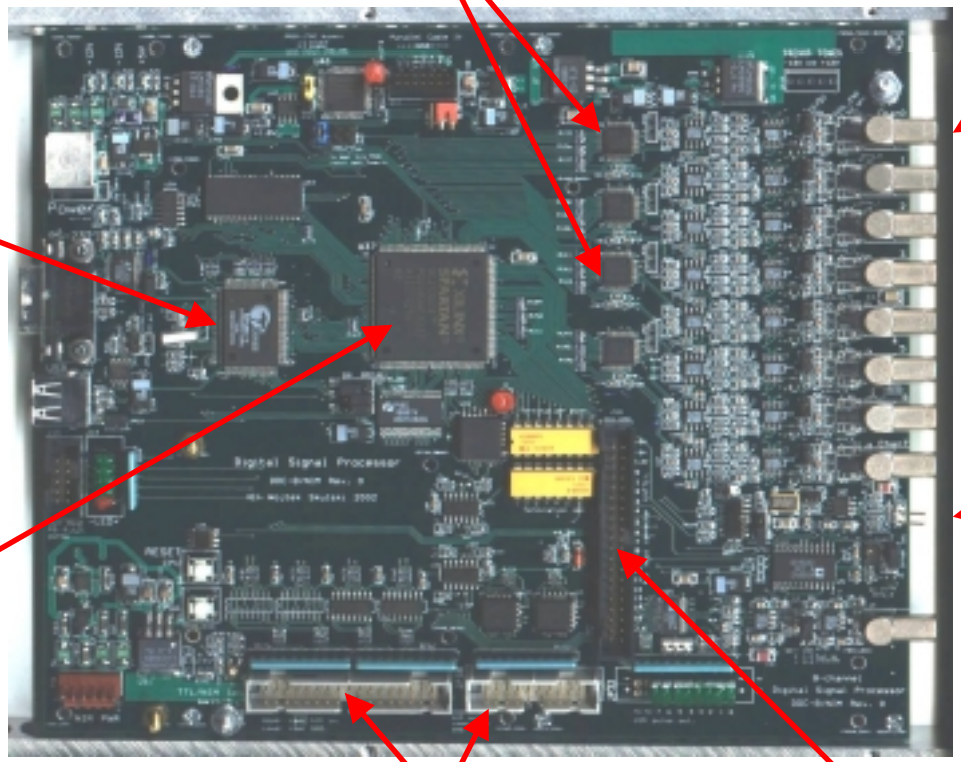
Left/right sub-images



Main camera image

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**

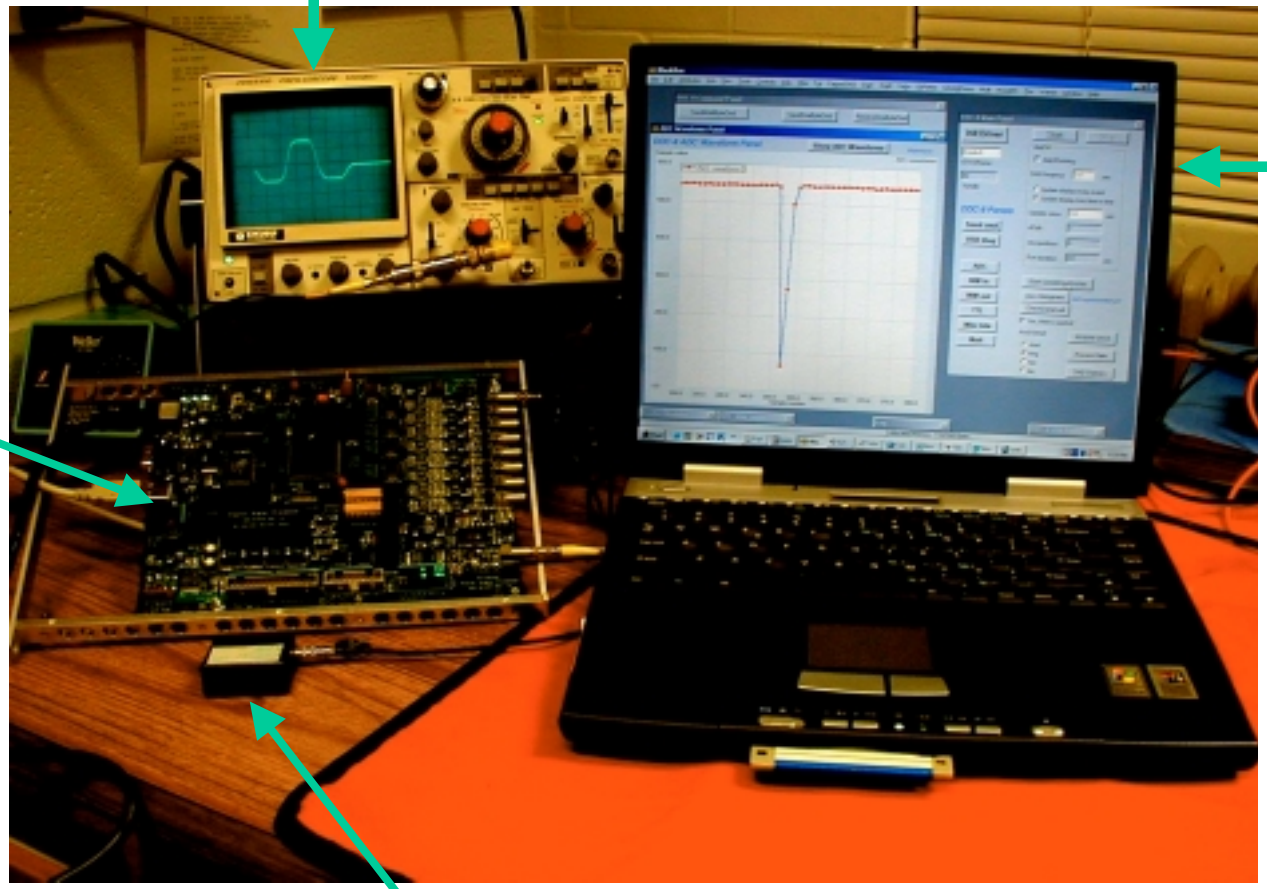
Logic signals NIM
16 lines IN, 8 lines OUT

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

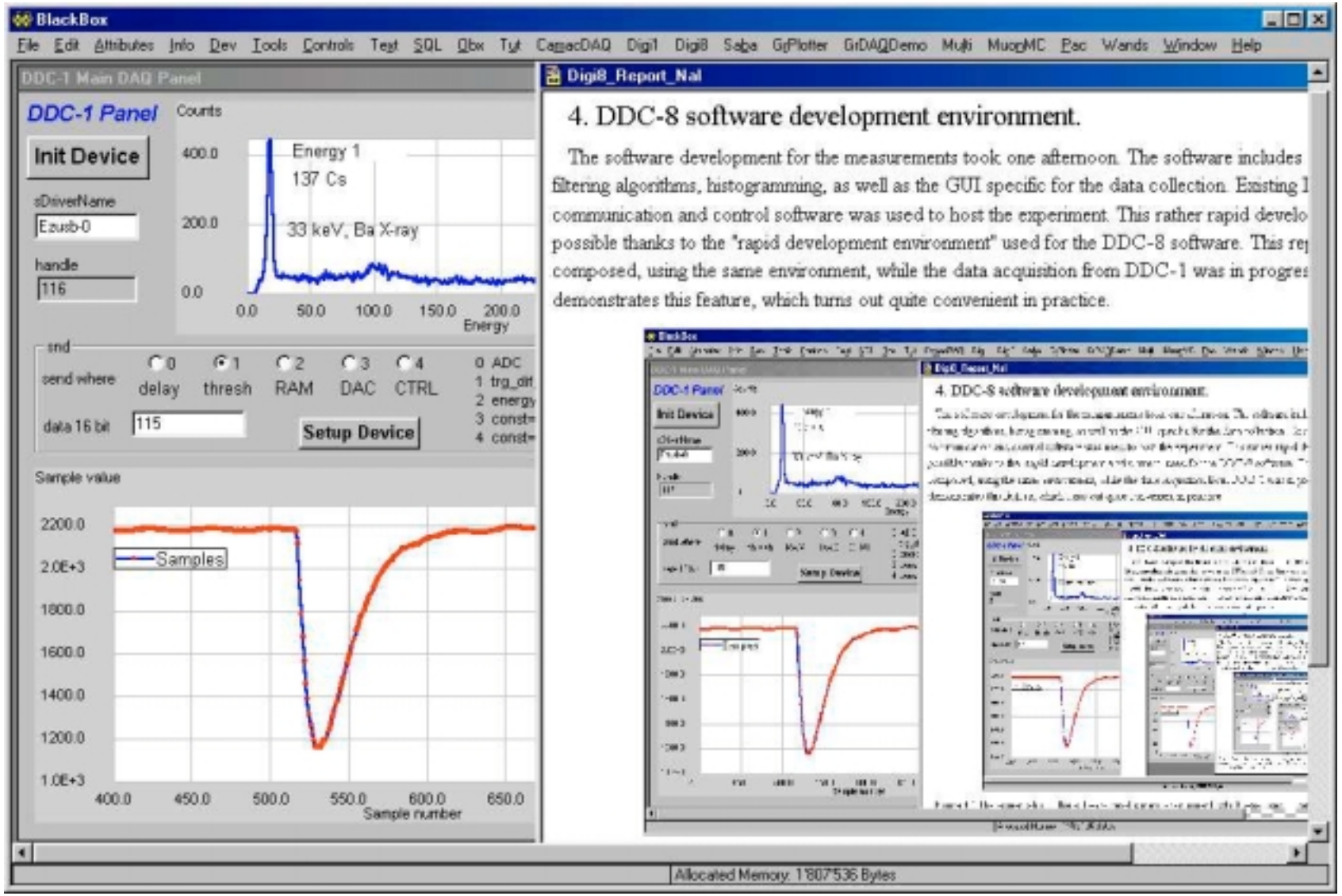


Control & waveform display: BlackBox

DDC-8

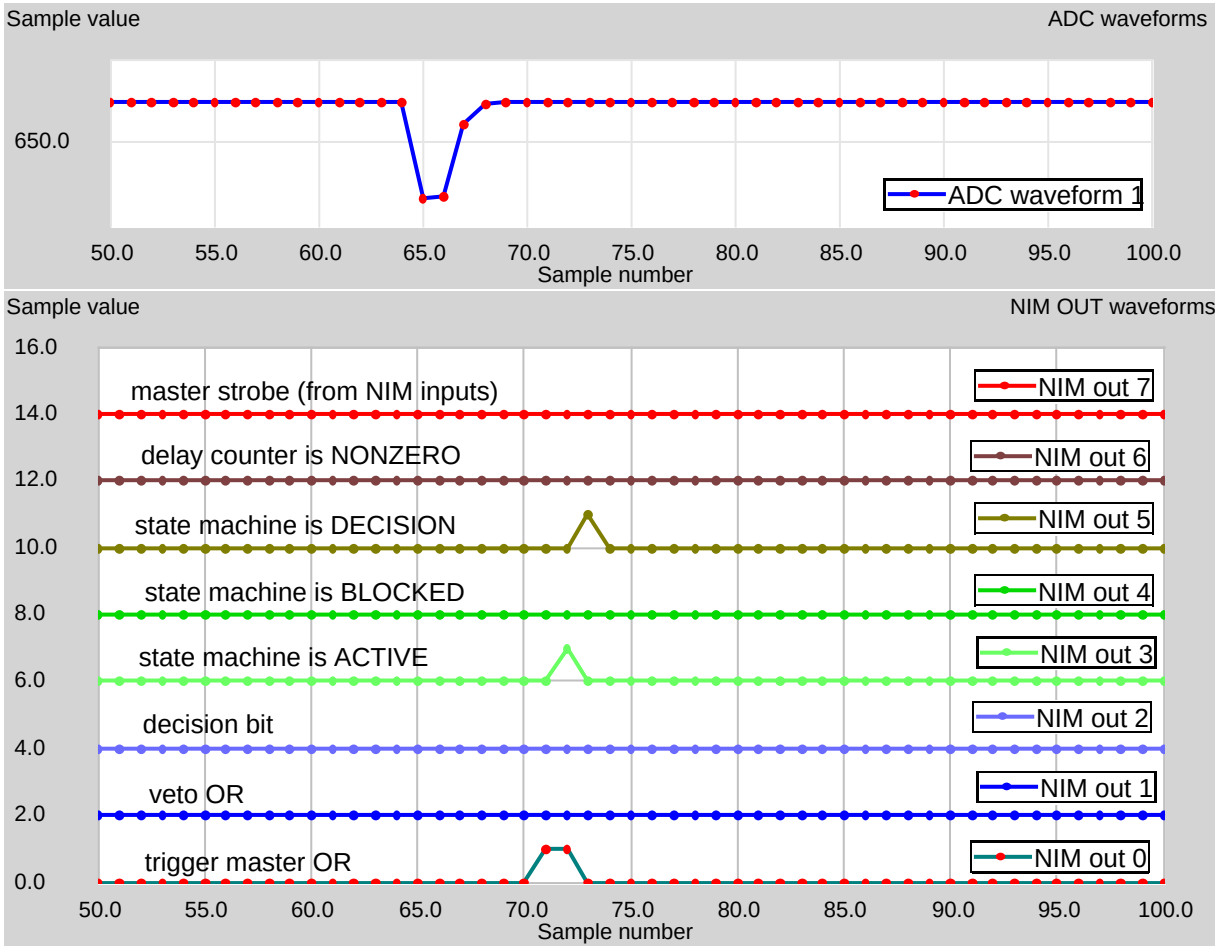
NIM pulser

DDC-x software development using BlackBox



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.