The Versatile Acquisition System of Giano


INAF-OAA, INAF-OABO, INAF-CGG, INAF-IRA
Giano spectrometer

To be installed at

The TNG
The Galileo Italian National Telescope
La Palma
Main characteristics

• All Near-IR spectrum measured in a single shot

• High Resolution up to $R=46,000$ Range=$0.9-2.5\mu m$

• Low Resolution $R=400$ Range=$0.9-2.5\mu m$

• Very Low Resolution. $R=200$ Range=$0.7-2.5\mu m$

• Common users instrument: always at telescope
Giano Detector

- 2K x 2K Hawaii2
- 18 μm Pixel Pitch
- 0.7-2.5 mm range
- Multiple Modes
- Low Dark Current (<1 e⁻/sec)
- Low Read Noise (<10 e⁻)
- Q.E. > 60%
- 3-6 mV/e⁻
- Well Capacity ~ 10⁵ e⁻
- Low Glowing
The acquisition system development guidelines

- The system is divided in several *modules* with clear boundaries.
- We use, as far as possible, commercial parts at board level.
- We use largely accepted standards as boundaries, as a PCI bus, an industrial standard PC104 bus or an Ethernet connection.
- We designed the custom parts as concepts, not around a particular electronic device.
- The waveform generation is as flexible as possible.
- Design from Fasti, reusing as much as possible.
General Structure

- Detector board and preamplifier
- Bias and clock generation, conversion
- Data buffers, PC104 interface
- An embedded system as general controller
- The main data collection PC
- The user interface PC
Clock Generation

Two different approaches:

• Custom micro-controller based (patented), with specialized micro-assembler. It is implemented in a Altera FPGA. Software available: assembler, emulator, visualizer. Very flexible, precious in laboratory, steep learning curve.

• Programmable sequence of waveform macros. Also implemented in Altera FPGA, small and fast. Easy to use, but lack the 'what if' flexibility. To be used at telescope.
Sequence emulator display
Preamplifier

- Cold preamplifier.
- Discrete components based (U440 Dual-FET)
- Selection of FETs
- Noise proportional to $\sqrt{T/G_m}$
- Noise better than 2nVHz$^{-1/2}$
- Better read-out noise
- Better cross-talk immunity

The acquisition chain hardware

➢ The conversion board

➢ The buffer board

➢ The embedded system
The conversion boards

- 4 or more boards: one on each detector output
- Fast 18 bit AD7674, used at 500KS/Sec
- Faster 16bit+average option (up to 4MS/Sec)
- Fault-tolerant design
- Control logic on a Altera FPGA
- FlexConnect® to detector cold board
- Copper or fiber optics LVDS up link
- Hosts also the biases generation
The buffer board

- Control logic based on a FPGA
- 2 full frame memory capacity
- Up to 32 LVDS input capabilities
- Link to a PC104 or a PCI bus
- Fifo mode operation
- Movable memory window mode
The embedded System

- An industrial standard single board computer
- The actual device is a x86 based PC104 board
- Connected by means of PC104 bus and Ethernet
- Embedded Linux, Slax server version
- Flexible, rich in mature libraries and applications
- Possibility of remote maintenance
Giano software structure
Low Level Software - I Server104

- A network daemon inside the embedded system.
- It does all initialization, housekeeping and control for data acquisition.
- It communicates by means of a network socket.
- It programs the waveform generator for the current acquisition mode (correlated double sampling, single reading, multiple non destructive read-out, continuous dummy integrations) and process data.
- It collects and communicates some of the telemetry.
Low Level Software - II
Gbridge

- A middle-ware network daemon in the data acquisition computer.
- It acts as server for User Interface, and as client of Server104.
- It split high level commands in elementary operations, and sends the latter to Server104.
- It controls the integrations, assembles data and archives telemetry in FITS format and sends the resulting files to the archive.
- It has a technical human interface (GuiLab) for laboratory and testing purposes.
The internal communication protocol

- A single protocol format for all Giano internal communications
- All communications in packet form and only one packet format.
- Binary header with destination process ID and checksum.
- ASCII payload on command and messages for ease of debug
- Binary scientific data payload for efficiency.
More about Giano

- Web general:

- Web technical:

- This conference:
  - General  Oliva et al. 6269-46
  - Optics  Gennari et al. 6269-146  Bruno et al. 6269-148
  - Mechanics  Mochi et al 6263-141
  - Cryogenics  Gennari et al. 6269-147
  - Gui software  Rossetti et al. 6274-85
  - Calibration  D'Amico et al. 6269-197