

Presentation outline



- **Requirements**
 - Basic requirements
 - RHIC/LEDA experience
- **Proposal**
 - Use PCI acquisition hardware on PC platform
- **PCI acquisition hardware details**
 - Overview, basic capabilities
 - Secondary capabilities
 - Selected design details
- **Platform details**
 - Hardware issues
 - Choice for HW development systems
 - Software issues
 - Choice for SW development components
 - Current Status

Diagnostic data acquisition

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Data acquisition platform requirements



- **Capable of acquiring 60hz pulsed beam**
- **Simultaneous acquisition on multiple channels**
 - 8 channels for phase/position
 - Other measurements not fully defined
- **1 ms pulse length**
- **At least 60Mhz sample rate**
 - 60mhz for current measurement
 - 40/20Mhz for phase/position measurement
- **No known real time requirements**

Experience from RHIC/LEDA



- **Stand alone instruments with interface to VME shared memory developed on RHIC**
- **VXI instrument on a card developed on LEDA**
- **Both use DSP for acquisition and control**
 - Flexible and powerful, but require special skills to modify and maintain. These skills can be difficult for a project to retain.
 - Reducing this dependency is desirable.
- **AFE daughter cards on LEDA design allow many instruments to share common a platform**
 - Phase/position
 - Wire scanner
 - High power RF protect

Proposal



- **Develop basic acquisition front end**
- **Utilize standard bus to move data to commercial motherboard**
- **Perform necessary calculations on system CPU using high level software**
- **Entire unit becomes stand alone instrument with ethernet (EPICS channel access) interface to outside world**

Proposal details



- **Use PCI as standard interface bus**
 - Choice of form factors (standard, compact, PMC)
 - Bridging between form factors easily accommodated
 - Excellent 3rd party hardware support
 - High performance (easily achieves >100Mb/s)
- **PC as instrument CPU**
 - Inexpensive, standard design
 - Good performance
 - Unmatched choice of software
 - Industrial, high reliability, and embedded variants available from many vendors

PCI acquisition hardware details



- **60Mhz bandwidth from AFE on 8 channels**
 - Capable of 80mhz on 8 channels
- **1mS buffer depth**
 - 60K samples at 60MHz
- **Sample memory implemented in 16 bit FIFOs**
 - Depths up to 256K available now
- **DMA upload to host memory**
 - Unloads main CPU from I/O bus bottleneck
- **Acquisition timing capability**
 - 10 internal timing channels provide acquisition gates
 - Multiple events per channel supported

Secondary hardware functions



- **Single Industry pack site**
 - Connects to timing triggers and AFE daughter card
 - 50 pin external connection
 - Intended for advanced timing of other AFE support functions
 - 8MHz IP standard, I/O, ID, and interrupt functions supported
- **Low speed utility bus**
 - Connects to AFE
 - Used to configure AFE functions

Design details



- **Implemented on standard PCI form factor**
- **Digital logic implemented in single FPGA**
 - Bus mastering PCI interface built in by vendor
 - Generous timing and utilization margins at this time
- **Programmable sequencers**
 - Execute simple programs to implement functions
 - Acquisition timing
 - DMA
 - IP and utility bus
 - Sequencer functionality can be changed on the fly
- **Two clock synthesizers**
 - Quartz stabilized fixed acquisition clock
 - Programmable digital acquisition clock
 - Allows direct decimation during acquisition

Platform details



- **Hardware issues**
 - Performance
 - Reliability
 - Form factor
- **Software issues**
 - Desired application development tools
 - Operating systems

Platform hardware issues



- **Performance**

- Standard motherboards offer best price/performance
- Passive backplane designs offer ease of maintenance
- Embedded units offer robust packaging and low power
- Compact PCI offers a standard robust package for high price

- **Reliability**

- Standard edge connectors have limited insertion life
- Requirement for disk storage for some software solutions
- Typical use of cheap power supplies in some form factors

- **Form factor**

- Rack mount
- Desk top
- Compact PCI

Platform choice for development



- **Standard motherboard**
 - Readily available
 - Best performance
- **Standard edge connectors**
 - Compatibility with vast selection of commercial hardware
 - Experience during development will help better quantify insertion life risk
- **Solid state disk**
 - PC type II (ATA) FLASH
- **Rack mount form factor**
 - Server chassis designed for industrial environments
 - Desktops can be used for most development

Platform software issues



- **Desired application development tools**
 - Supports large selection of hardware
 - Easily usable by existing diagnostics team
 - Good support for analysis
- **Operating systems**
 - Real time systems offer best performance, worst selection of development tools
 - Real time target system debugging can be difficult
 - Non real time systems offer best development tools, but variable response time
 - Non real time systems can be self targeted, easing debugging

Software choice for development



- **National Instruments Labview for application development**
 - Large selection of compatible hardware from many vendors
 - Already in use for many years by diagnostics team
 - Superior tools for analysis and display
- **Embedded Windows NT/2000 operating system**
 - Embedded toolkit allows custom versions to be generated, which only include desired functions
 - Extended functions allow for automatic login, running from read only media, remote administration, and message handling
 - Supports all hardware usable in regular NT/2000 systems
 - Real time extension available to handle acquisition and time stamping functions

Current status



- **PCI data acquisition board**
 - PC board completed
 - FPGA in final simulation testing
- **Test build of operating system completed**
 - Supports Labview development and run time
 - Supports operation from read only media
 - Allows remote administration
- **Interface to real time subsystem prototyped**
 - Mimics interface to DMA buffers
 - Simple library routines provide read access
 - Usable Labview interface completed