

The EPICS Brick development, application, status

EPICS Collaboration Meeting – Embedded Controllers

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 **Office of
Science**
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managed by The University of Chicago*



Topics

- Hardware and supported modules
- Basic hardware solution
- Supported software
- Application development, IOC, boot environments
- Examples
- Status and future development

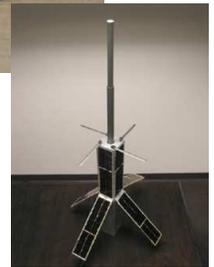


Hardware and supported modules

- Low-cost IOC, soft real-time, localized control
- PC104 bus based
- Fabricated for reliability, rugged, used in military, aerospace, sea and land vehicles, oilfields, and traffic control applications
- Diamond systems – Athena
 - 660Mhz (fan or fanless), 128MB (256MB)
 - Integrated DAQ
 - 16 ADC @ 16-bits (-10V..10V)
 - 4 DAC @ 12-bits (-10V..10V)
 - 24-bits TTL digital IO bits (programmable direction)
 - Watchdog timer, 4 USB, IDE, 4 serial ports, printer, VGA, mouse, keyboard, 10/100 Ethernet
 - \$850 (USD)



Military



Satellite



Athena processor



Hardware and supported modules

- Diamond systems – Ruby-MM-416
 - 4 channel 16-bits analog output
 - -10V..10V 330uV resolution
 - 24-bits TTL digital IO (programmable direction)
 - \$395 (USD)

- Diamond systems – Onyx-MM-DIO
 - 48-bits TTL digital IO (programmable direction)
 - \$90 (USD)



Ruby-MM-416



Onyx-MM-DIO

Hardware and supported modules

■ Sensoray Smart A/D model 518

- 8 channel sensor input @ 16-bits
- Individually programmable sensors
- Thermocouples (BCEJKNTSR), RTD's, strain gauges, voltage, thermistors, and resistors
- 22mS or 13mS A/D conversion
- \$295 (USD)



Smart A/D model 518

■ Diamond systems – Pearl-MM

- 16-bits relay output
- Screw terminals, pin headers
- NO, NC, C contacts
- AC / DC voltages
- 30VDC / 2A, 125VAC / 0.5A
- \$175 (USD)



Pearl-MM



Hardware and supported modules

■ Diamond systems – Emerald-MM-8P/4P

- 8 and 4 serial ports
- Configurable for RS232, RS485, RS422
- Maximum baud rate 460.8kbps
- /dev/ttySx
- 8 port \$250 (USD)
- 4 port \$130 (USD)



Emerald-MM

■ Pro-dex (OMS) PC78 Multi-Axis Motion Controller

- 2/4 axis stepper control
- PC104 or RS232 communication
- Encoder feedback
- \$1295 (USD)



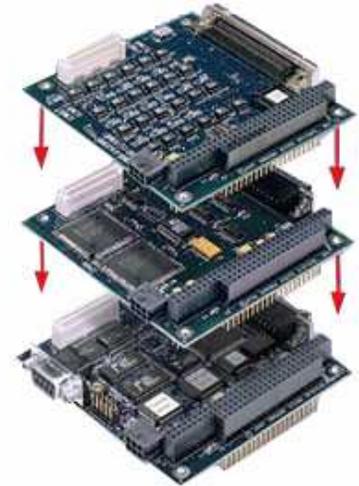
Motion Controller



Hardware and supported modules

■ Pro-dex (OMS) PC68 Multi-Axis Motion Controller

- 8 axis stepper control, no encoders
- PC104 or RS232 communication (performance diff negligible)
- \$1565 (USD)



Motion controller

■ Diamond systems – Panel IO

- Provides industry standard I/O connectors
- VGA, Ethernet, USB, Serial, Parallel, PS/2, and data acquisition, status LEDs.
- Power input options:
 - *Circular jack for an AC wall adapter*
 - *DB 9 connector*
- \$85 (USD)



Panel IO



Hardware and supported modules

- Hard disk drive

- Hard drive mount
- 40GB hard drive
- \$110 (USD)



Hard drive and mount

- Compact flash

- Compact flash mount
- 2GB compact flash
- \$110 (USD)



Compact flash mount

- Other hardware

- AC adapter
- \$25 (USD)



AC adapter

Hardware and supported modules

- Diamond systems – Pandora
 - Compact, lightweight
 - Various depths, 1.7in, 3in, 5in, 7in, and 10in
 - Available only in black (no purple, sorry)
 - \$80 (USD) 3in



Pandora enclosure
Model T's Only



- Rack mountable
 - Uses faceplate of Pandora enclosure
 - BNC connectors for Athena's DAQ
 - Application specific connectors in back

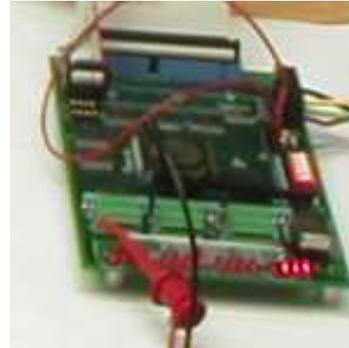


BC-043 Rack mountable enclosure

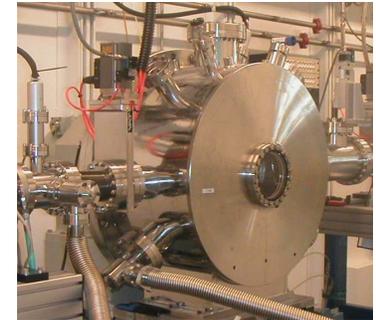


Hardware and supported modules

- Generic Digital IO
 - Developed by Steve Ross
 - Altera FPGA-based (*FLEX10K*)
 - 16 32-bit Up / Down counters
 - Asyn-based serial link protocol
- Other supported hardware
 - Love controllers
 - MDrive
 - XIA Huber slits
 - Femto current amplifier
 - Kohzu monochromator
 - White beam slits
 - Peizo motors



Generic Digital IO



Kohzu monochromator



Temp. controller



White beam slits



Current amplifier



Basic hardware solution

- Hardware,
 - Athena 660Mhz processor board with fan, DAQ
 - AC adapter
 - Pandora enclosure
 - Panel IO board
 - Mass media
 - 40GB hard drive
 - 2GB compact flash
 - Mounts
 - Total cost ~\$1200 (USD)



PC104 stack



Pandora enclosure



Panel IO



AC adapter



Hard drive and mount



Athena processor



Compact flash mount



Supported software

■ ~~Corelinux, Fedora, DSC Slackware~~, VectorLinux distributions

■ VectorLinux STD 5.1

- Slackware based
- Easy package, configuration management
- Active forum
- Small foot print (~1.2GB)
- Fast boot ~50s



■ Development tools

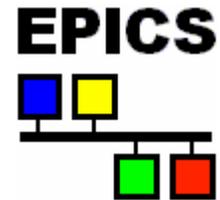
- GNU compiler/linker
- Editors (nano, nedit, vi)
- CVS and TkCVS
- X11, XDMCP, ssh, scp, IceWM
- NFS client
- Mozilla Firefox web browser



Supported software

■ EPICS support

- Base 3.14.7 (3.14.8.2 summer)
- synApps 5.1 modules
- Extensions, Probe, MEDM
- Asyn-based driver support
 - *Athena integrated DAQ*
 - *Supported hardware modules*
 - *Motor controller support (BT,RS)*
- IOC examples
- MEDM screens, diagnostics, commissioning, operations



■ Screen application

- Remotely connect to an IOC, attach to iocsh, detach
- IOC application runs under screen, started in rc.local
- Logging



Supported software

- “launch” application
 - Taken from Eric Norum
 - Wrapper app
 - Opens IO ports
 - IOC app passed to launch

- Logrotate application
 - Daily cron job
 - Compress, manage screen log files



Application development, IOC, boot environments

■ Development environment

- Uses the 40GB HDD
- Development tools
- EPICS base 3.14.7, synApps 5.1 modules
- epics application (xxx) or specific IOC application
- Accounts root, epics, epicsioc

■ epics account hierarchy

- EPICS Base tree
- synApps support tree
- IOC tree
 - *epics application (xxx)*
 - *Specific IOC applications (makeBaseApp)*

```
/home/epics
  /EPICS
    /base → 3.14.7
    /synApps
      /support
      :
    /ioc
      /epics
      /sector
      :
      :
```



Application development, IOC, boot environments

■ epicsioc account hierarchy

- epics directory
- IOC application

```
/home/epicsioc
  /epics
    /db
    /dbd
    /iocBoot
    :
    :
```

■ IOC environment

- Uses the 40GB HDD or 2GB compact flash
- Application only, uses standard directory structure
- Accounts root, epicsioc

■ Distribution

- Local copy (mounted mass media)
- USB-based Pendrive
- tar / gzip scp



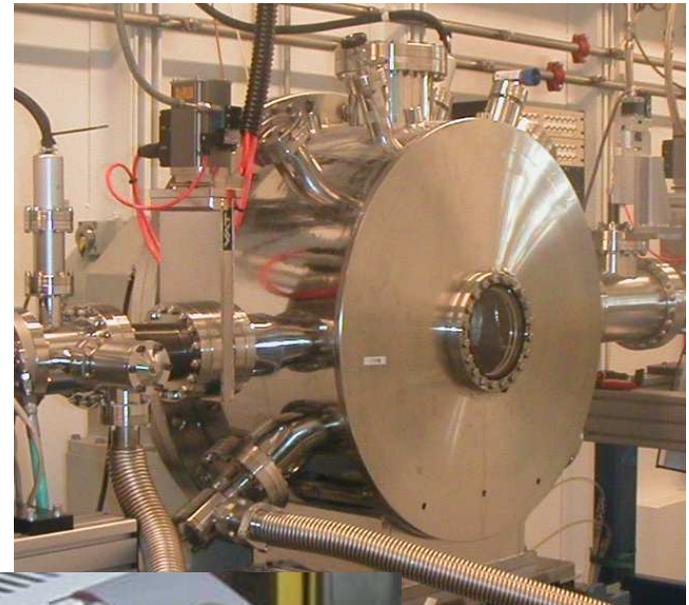
Application development, IOC, boot environments

- Boot environment
 - Controlled by run-levels
 - RL2 – IOC iocsh prompt @ serial, no X
 - RL3 – IOC iocsh prompt @ VGA, no X
 - RL5 – Development @ VGA, X, no IOC
 - RL7 – IOC iocsh prompt available after login, X,
 - Screen application



Example: 26ID Beamline Kohzu Monochromator

- Basic configuration/w 40GB
- Motor control, serial to OMS Motion Controllers /wo encoders
- Standard EPICS support
 - Motor record
 - Kohzu sequencer
 - MEDM displays
- Extra capacity
 - ADC, DAC, digital IO, 2 serial ports...



Example: 26ID Beamline White Beam Slits

- Basic configuration/w 40GB
- Motor control, serial to OMS Motion Controllers /w encoders
- Standard EPICS support
 - Motor record
 - MEDM screens
- Extra capacity
 - ADC, DAC, digital IO, 1 serial port



Example: 33ID USAXS Instrument

- Basic configuration/w 40GB
- 19" rack mounted
- 2 DSC Ruby-MM-416
 - DACs for PZT positioners
- Digital IO for Femto DLPCA current amplifiers
- Standard EPICS support
 - Femto sequencer
 - MEDM screens
- Extra capacity
 - ADC, DAC, digital IO, 4 serial ports...
- Future:
 - Digital IO for XIA PF4 filters
 - DSC PMM-S module for shutter control



Filter



Current amplifier



Example: 33ID USAXS Instrument

The image displays three software control windows for the 33ID USAXS instrument:

- 33idd_usaxs.adl (UNICAT 33ID-D USAXS Plan View):** Shows a schematic of the instrument components including shutter, AS, HS, H, slits, diode, and IO. It includes status indicators for LAX and T1, and a 'stop lax motors' button.
- femtopd.adl (USAXS Femto Current Amplifier Photodiode Controls):** Controls the photodiode amplifier. It shows operating mode (manual, automatic, auto+background), range setting (1mA, 10nA, 100nA, 1nA, 10pA), and a table of gain and background levels for five ranges.
- femto.adl (Femto Current Amplifier Controls):** Controls the femto current amplifier. It shows a block diagram of the amplifier circuit and a table of gain settings for various frequencies.

Red arrows indicate the flow of control signals from the Plan View window to the Photodiode Controls window, and from the Photodiode Controls window to the Femto Current Amplifier Controls window.

Status and future development

■ Status

- Ready for prime time
- Nano's Kohzu, White-beam slits
- USAXS instrument
- Other sectors are interested, detector pool

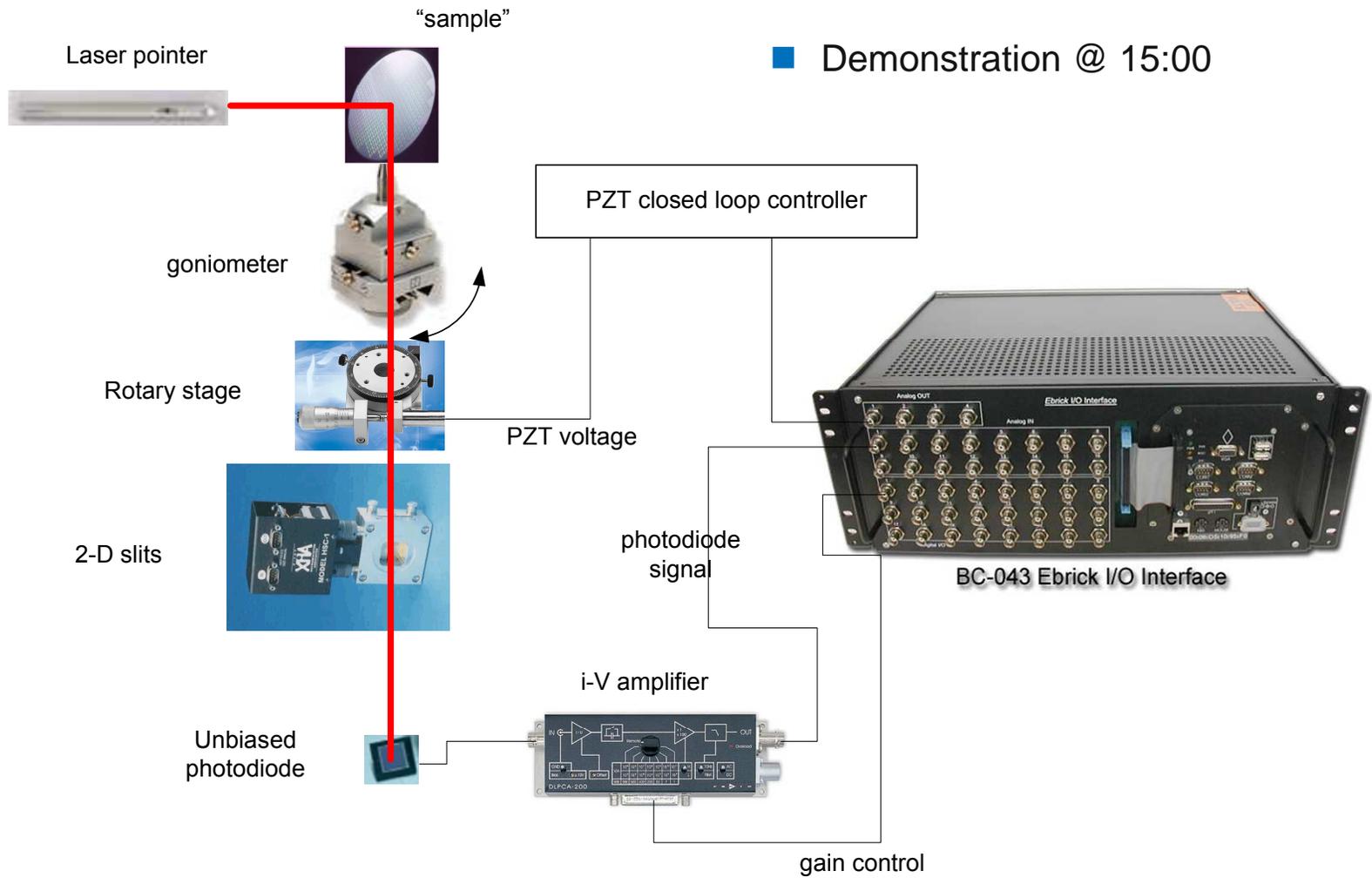
■ Future

- USAXS mirrors
- GPIB support, PC104-based IP carrier
- NFS or flash boot
- Installation CD
- Love controller replacement
- USB-to-VME bridge
- DSC Athena II, 800MHz, 256MB; Poseidon, 2GHz, 512MB



Poseidon

Beamline application demonstration





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Thank You

