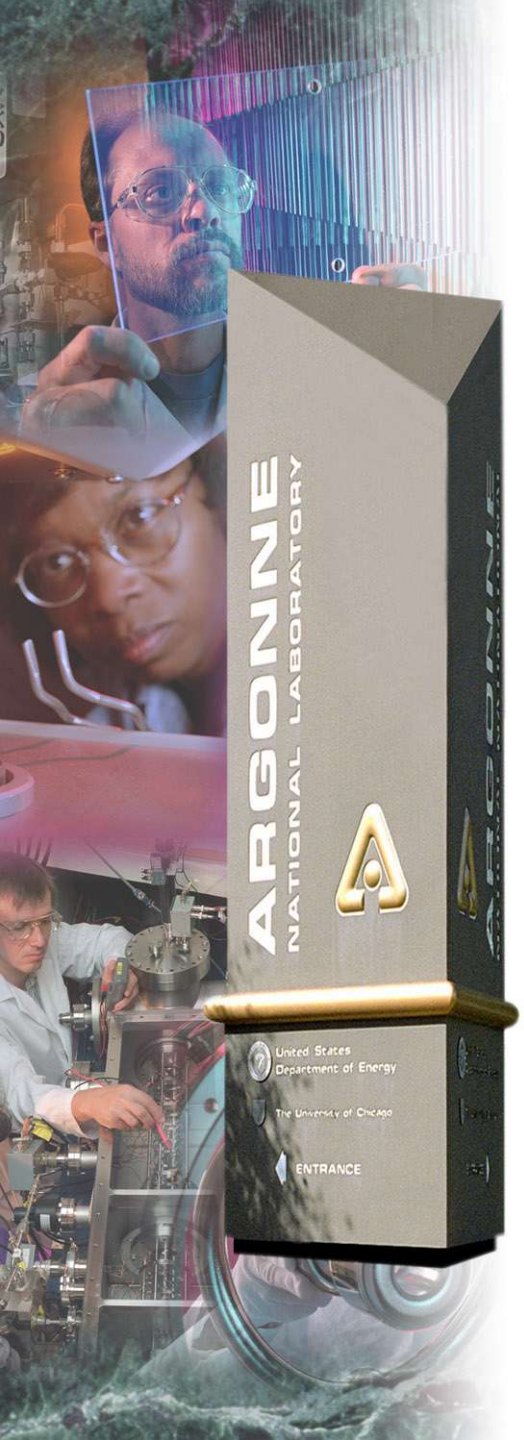

Architecture and highlights of control system for GM/CA CAT macromolecular crystallography beamlines

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Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science
Laboratory Operated by The University of Chicago

What is GM/CA CAT?

The GM/CA Collaborative Access Team (CAT) at the Advanced Photon Source is established by the National Institutes of Health's National Institute of General Medical Sciences (GM) and National Cancer Institute (CA) to build and operate a national user facility for crystallographic structure determination of biological macromolecules.

One bending magnet and two undulator beamlines at a canted undulator are being constructed.

More info at:

http://www.gmca.aps.anl.gov

Canted undulator beamlines

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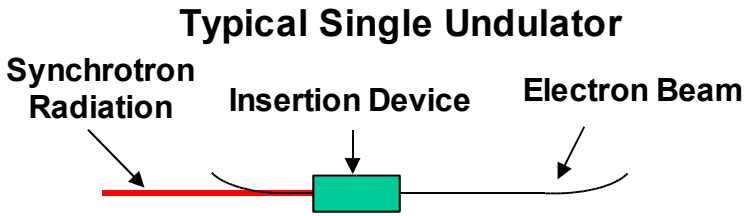

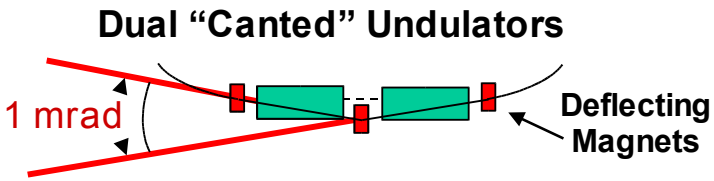

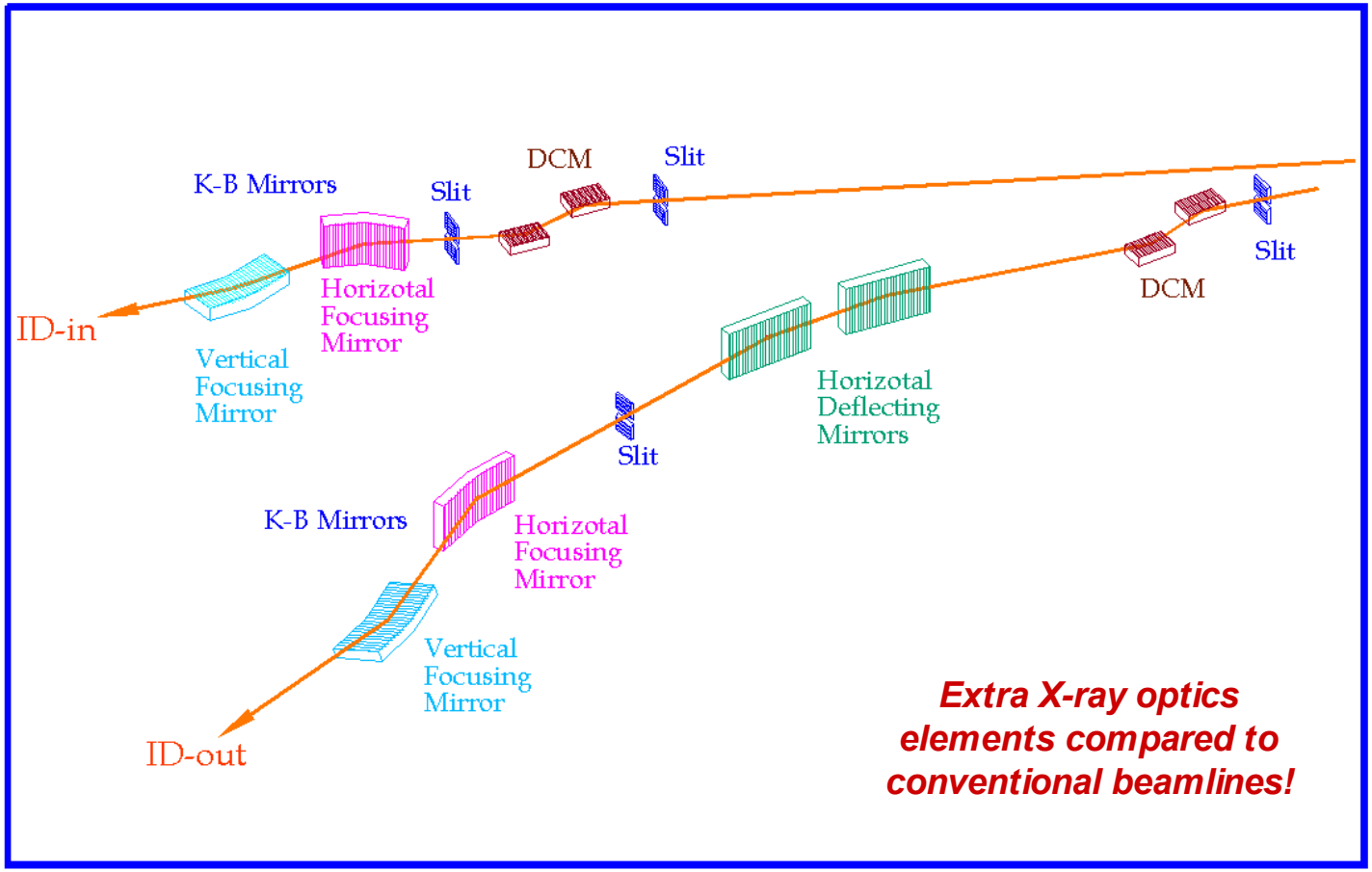

Extra X-ray optics elements compared to conventional beamlines!

Challenges to GM/CA control system

- automated beamline alignment (important for fast throughput and because of extra optical elements on canted undulator beamlines! fast scans)
- accommodation of small crystals down to 10μm in size (extra requirements to beam focusing bimorph mirrors, and beamline stability PID loops),
- automated sample centering (small crystals, high throughput fast scans, computer controlled on-axis visualization & image recognition)
- interface to robotics sample changers, and ergonomic GUI (fast throughput!)
- data acquisition with provisions for remote control and FedEx crystallography (firewalls, Access Grid)
- big detectors (8TB ultra fast storage!)

GM/CA approaches to beamline control system

Basic approach: use a combination of well established mainstream solutions that guarantee long lifetime and support from the community.

Do not re-invent the wheel!

- EPICS as the bottom layer (huge community; used throughout APS)
- Blu-Ice by SSRL as a user interface for data acquisition preferred by the community
- 8TB Storage Area Network (SAN) per beamline for data (ultra-fast fiber-based industrial solution)

Choice of Blu-Ice as user interface – user friendliness

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BLU-ICE Beamline gmca23id

File Component Shutter Network View Options Help

Hutch | Collect | Screening | Scan | Users | Setup

Scan Mode

- MAD Scan
- Excitation Scan

Scan sample to determine peak, inflection and remote energies for MAD.

Scan Parameters

Edge: Se-K

Energy: 12658.0 eV

Time: 1.0 sec

Start Scan

Stop Scan

Stop Motors

Periodic Table | Plot

Select an X-ray Absorption Edge

Edge: Se-K

Energy: 12658.0 eV

11 Jun 2003 12:36:53 NOTE: This client may now issue commands.

Idle | Energy: 13598.26 eV | Network: Active | Shutter: Open | 12:42:35 PM

Control system architecture – initial design

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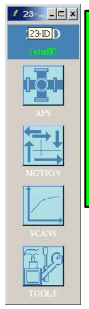
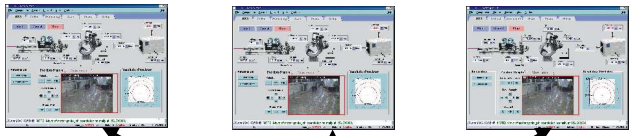
Staff beamline automation tasks



-automated beamline setup and alignment.

-BPM-based intensity and position feedback systems.

Blu-Ice interfaces for beamline users



DCSS
(Distributed Control System Server)

Scripting Engine

EPICS-DHS

DHS

VIDEO CAMERA

Automated sample centering

EPICS IOC

CCD

Robot

motors

electronics: scalers, digital I/O DAC, ADC

Bimorph mirrors control

APS controls:
-undulator
-ring status
- EPS, etc.

bridge between the two systems that has to be developed

Interaction between Blu-Ice and EPICS

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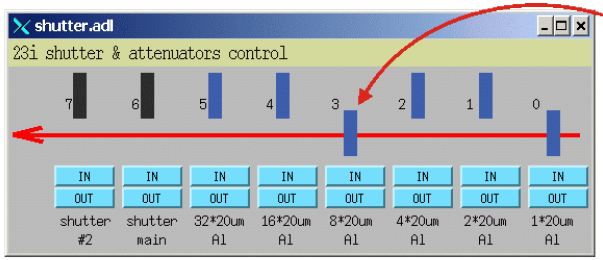
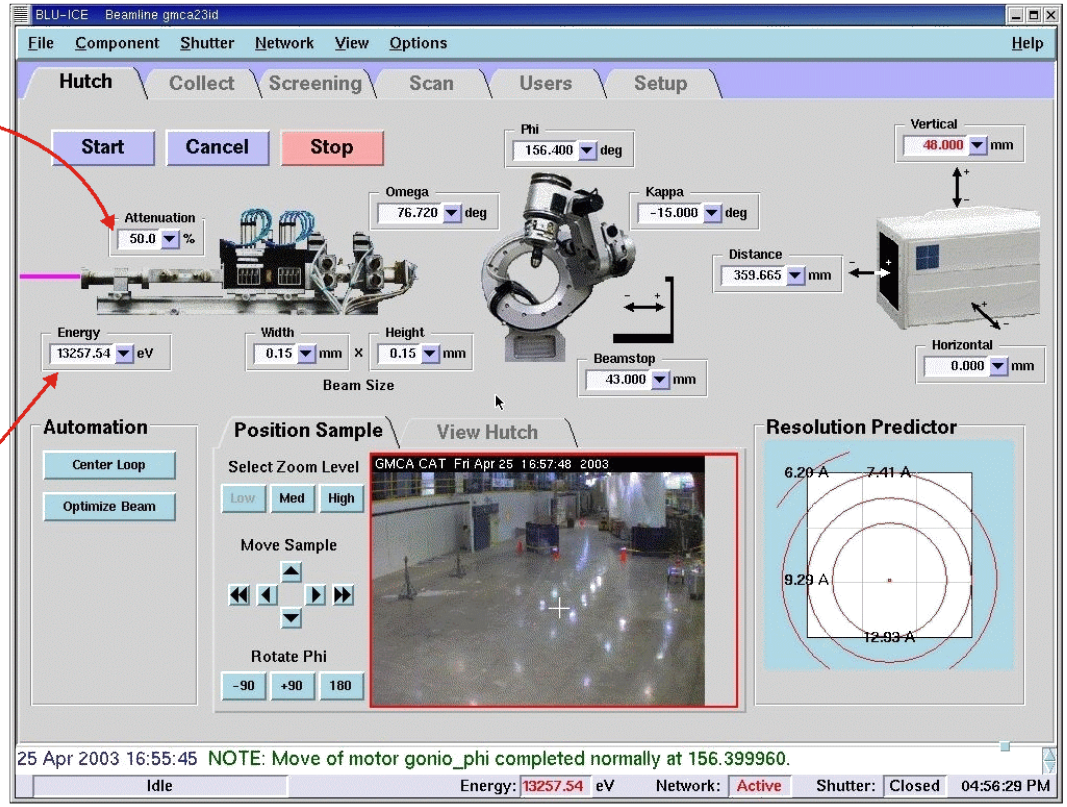
EPICS



Blu-Ice



Implemented in the fall of 2003

Control system architecture – evolution of design

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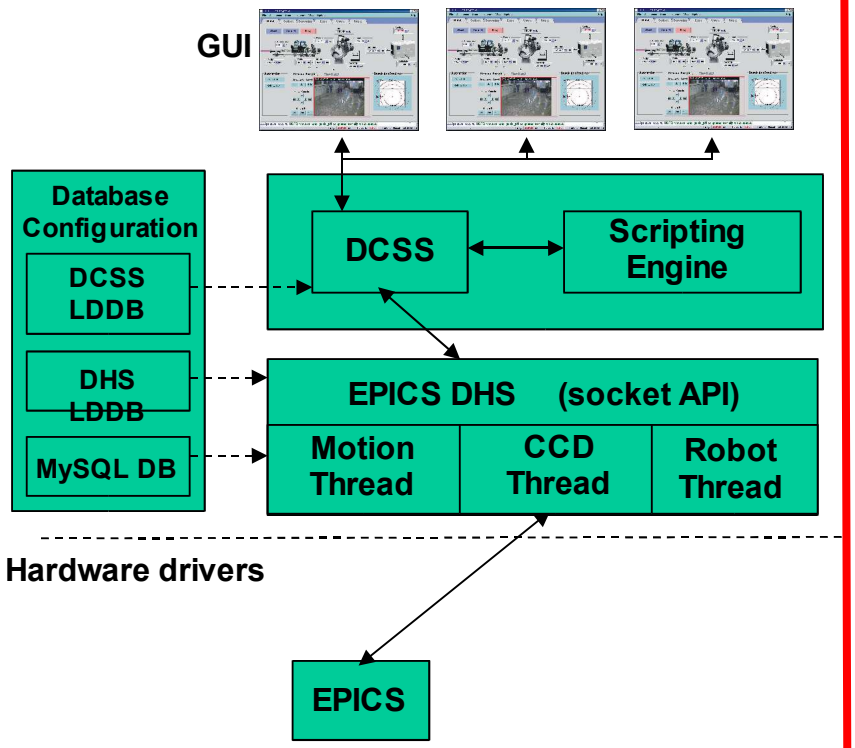
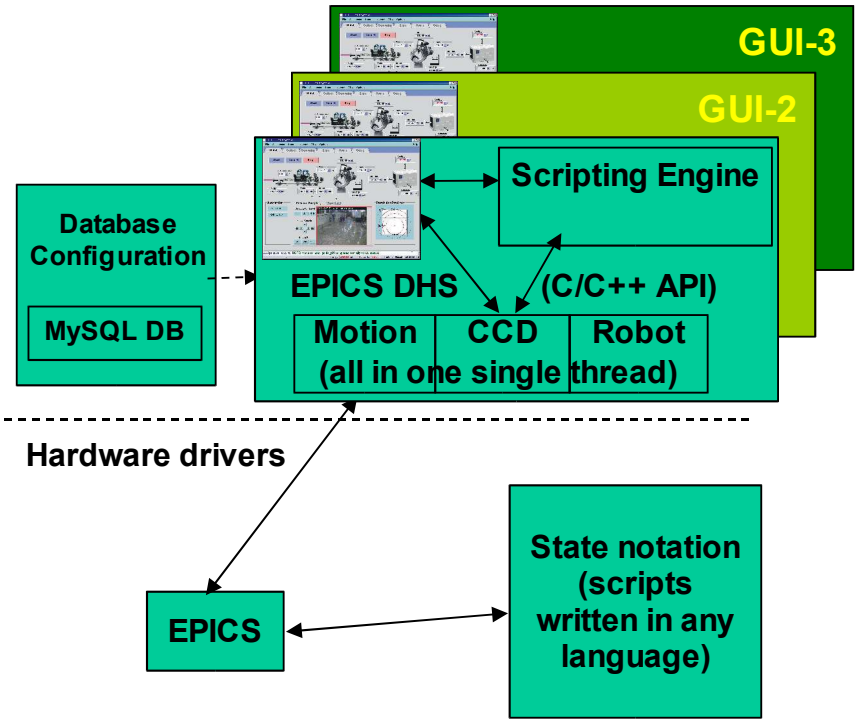
Original



Now



- *Exchange between GUI(s) via EPICS!*
- *Converted Blulce into client like MEDM!*

Details of Blu-Ice integration

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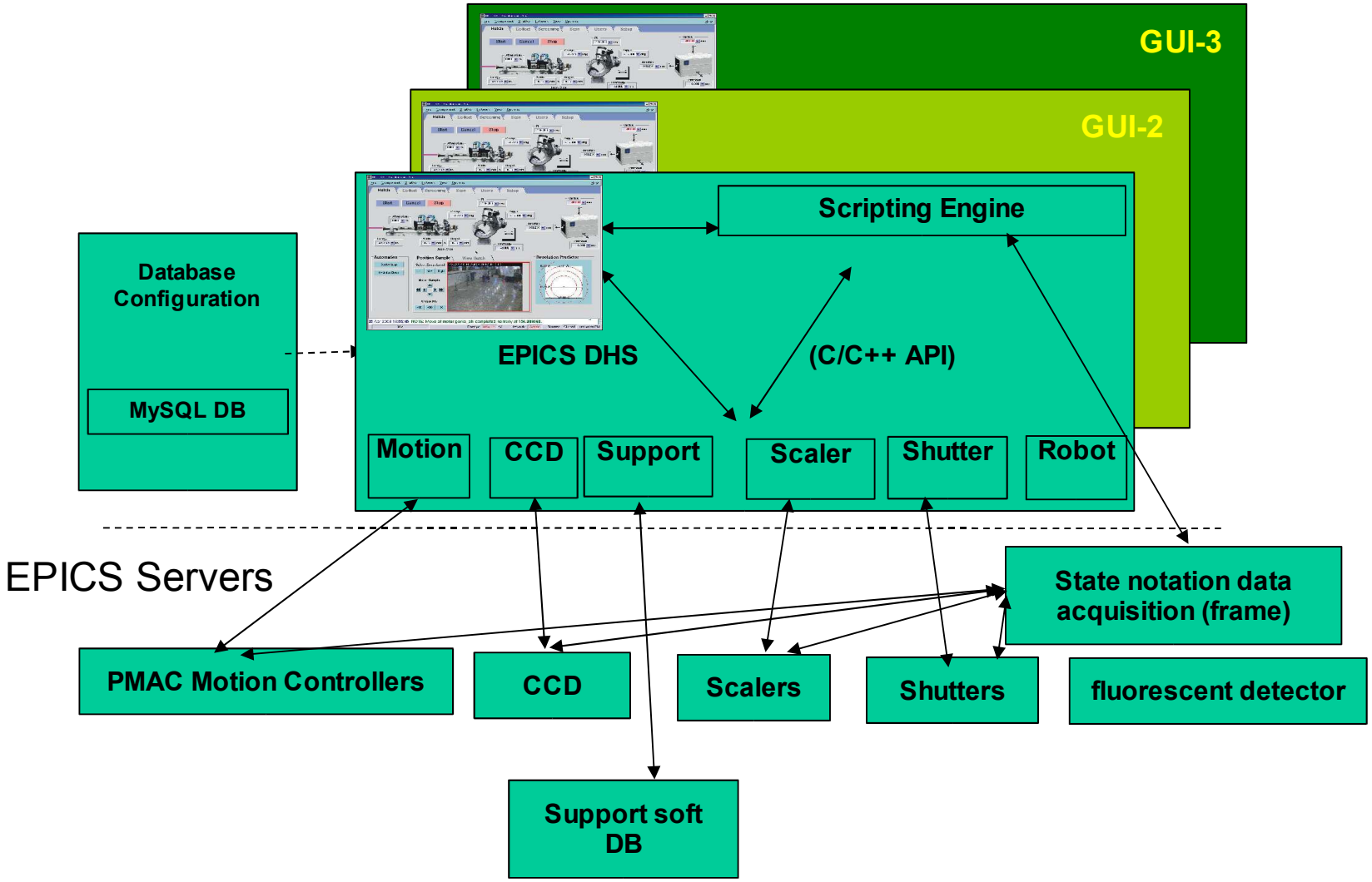

Blu-Ice: using EPICS as DCSS

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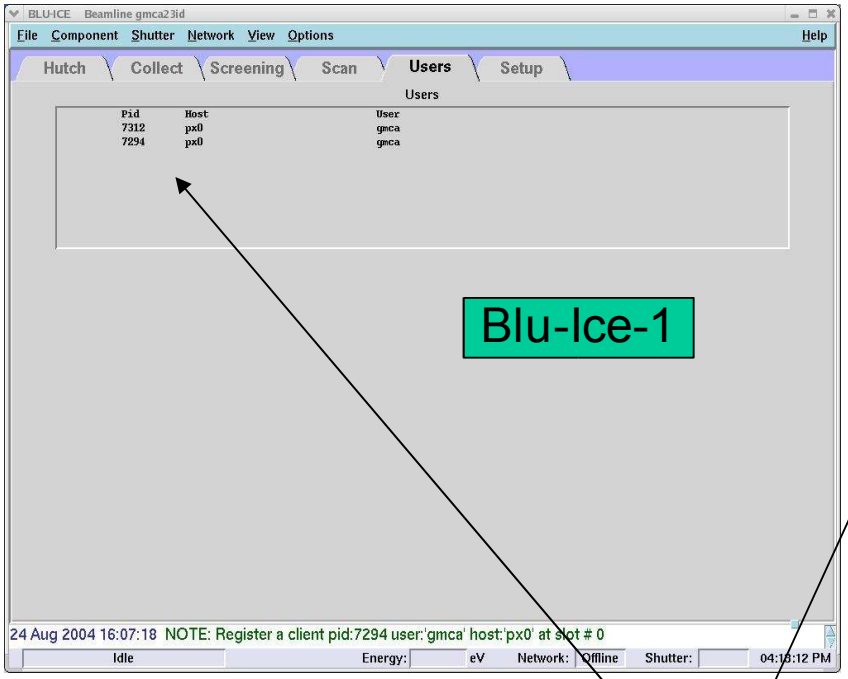

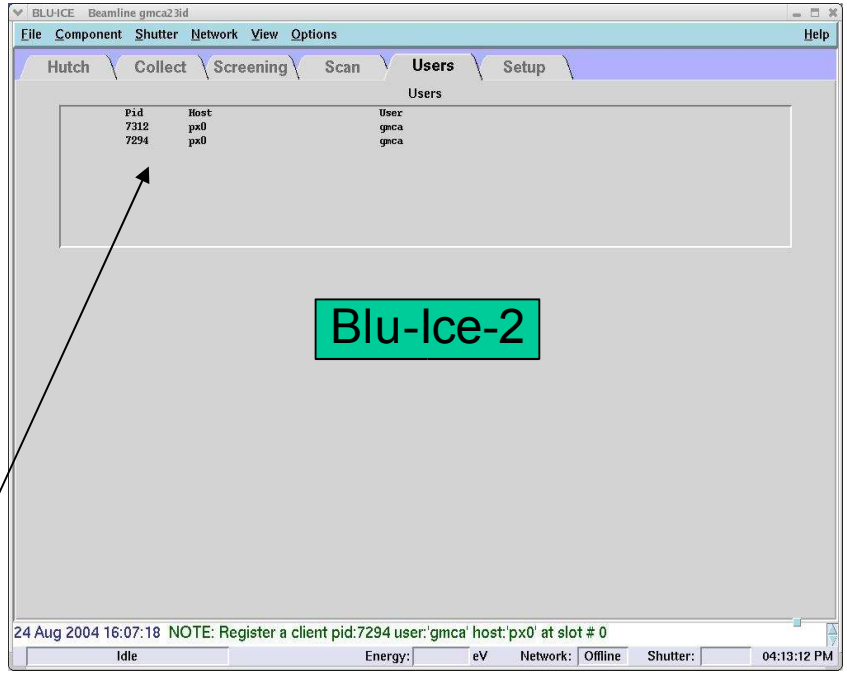

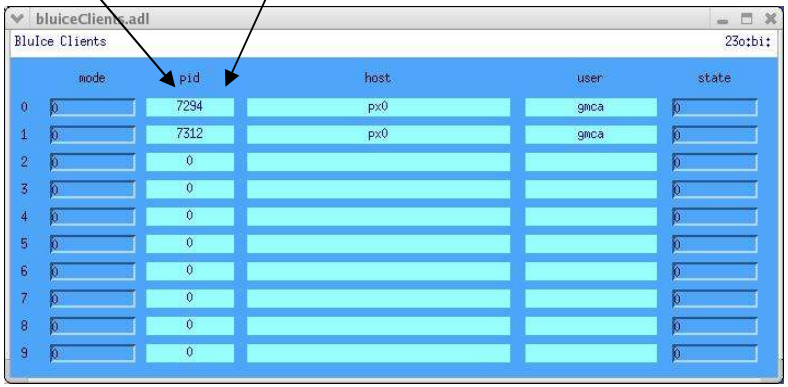

EPICS

Example:

users registration stored in EPICS DB

Highlights of EPICS-level controls

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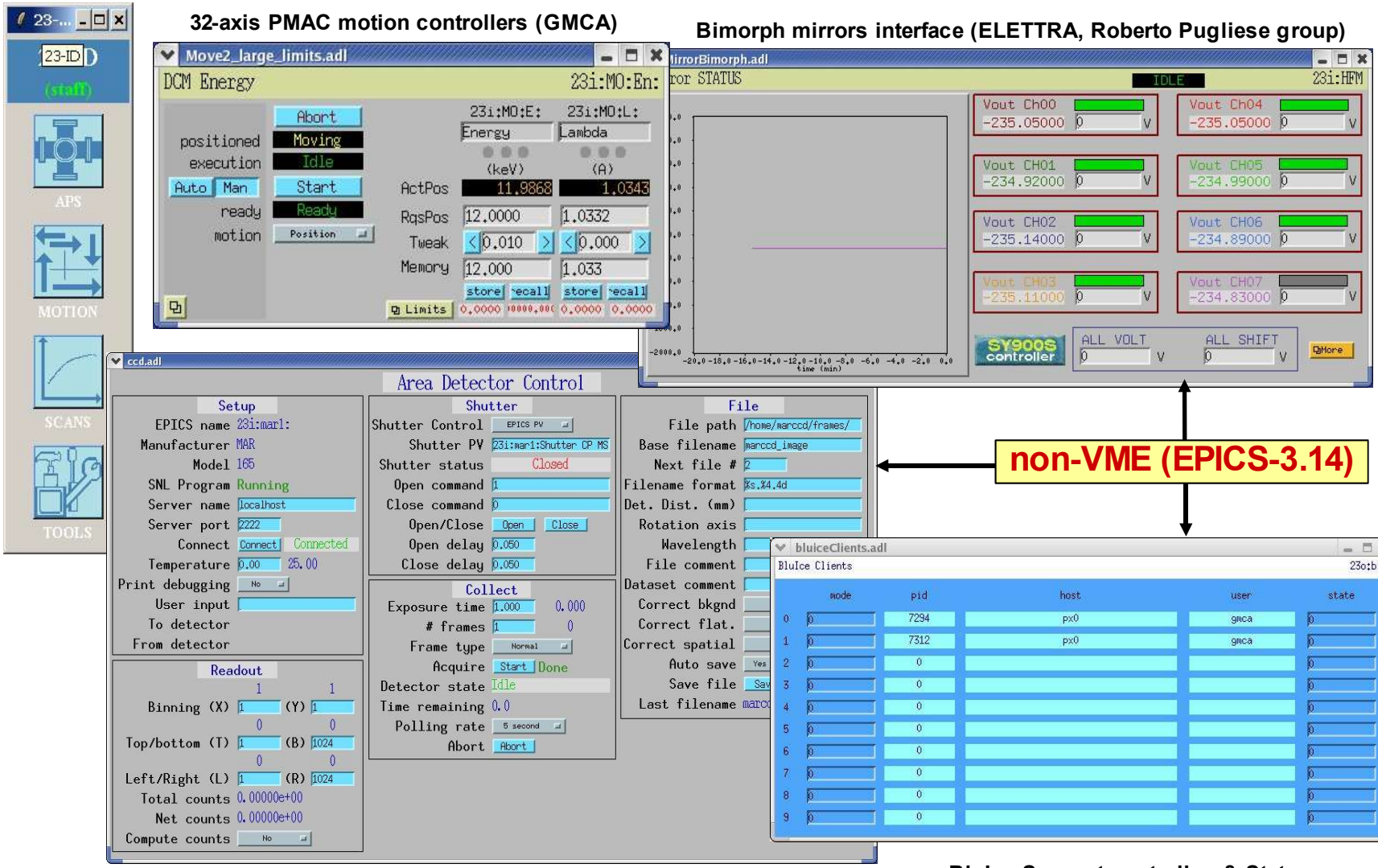
32-axis PMAC motion controllers (GMCA)

Bimorph mirrors interface (ELETTRA, Roberto Pugliese group)



MAR CCD interface (CARS, Mark Rivers)

BluIce Support controller & State Notation data acquisition (GMCA, in development)

EPICS support for 32-axis Turbo PMAC2 Ultralite motion controller

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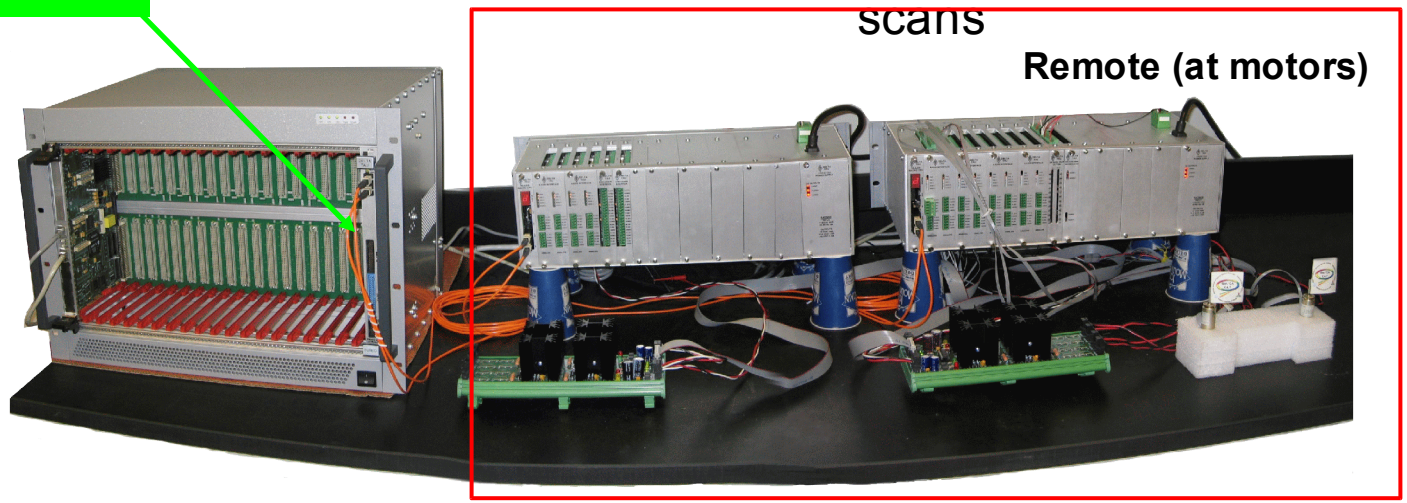
Turbo-PMAC:

- any type of motors
- provisions for fast scans

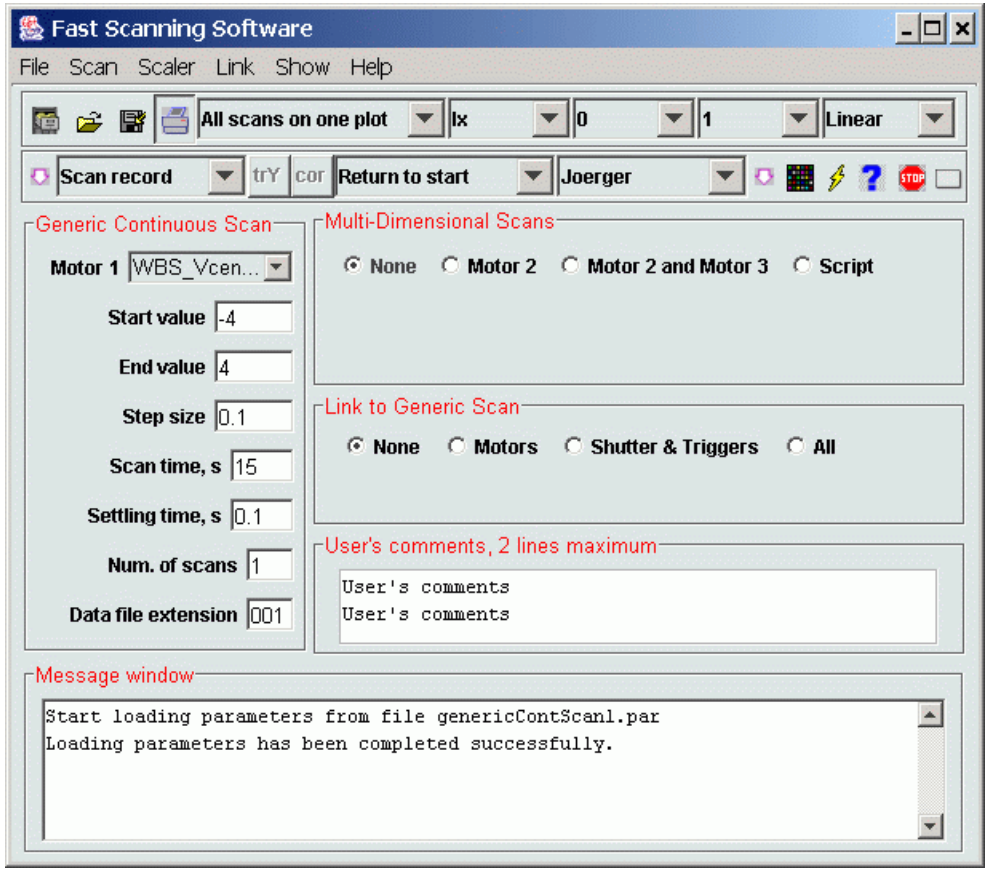
2-3 cards control one beamline



See separate talk by Oleg Makarov!

Fast scans

- possible with PMAC (motors synchronization by controller)
- May be as fast as 1 second when using multichannel scalers
- Collaborate with BIOCAT – *see talk by Sergey Kozyrenko*



GM/CA CAT Network configuration

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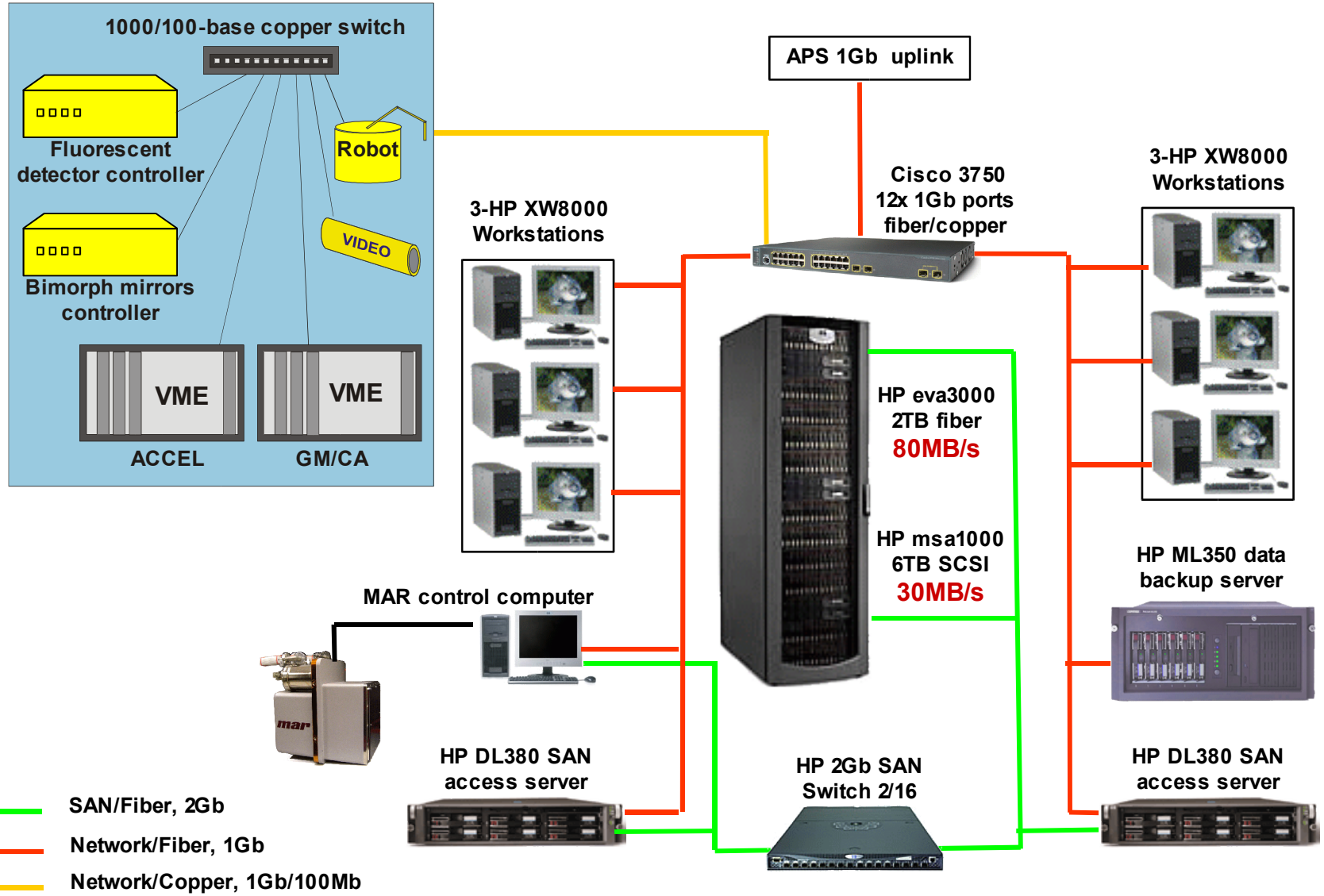

Plans

- finishing port between BluIce and EPICS (implementing Collect and Scan tabs).
- installing and interfacing sample mounting robot (ALS robot & EPICS controls by NSLS?).
- implementing sample centering (several algorithms under consideration; also work with commercial company on).
- setting up remote access (Citrix or Access Grid – use SER-CAT experience.
- setting up web-accessible beamtime scheduling database (port someone's system – CARS?).