

Control Software at ESRF beamlines

BLISS group
Vicente Rey Bakaikoa

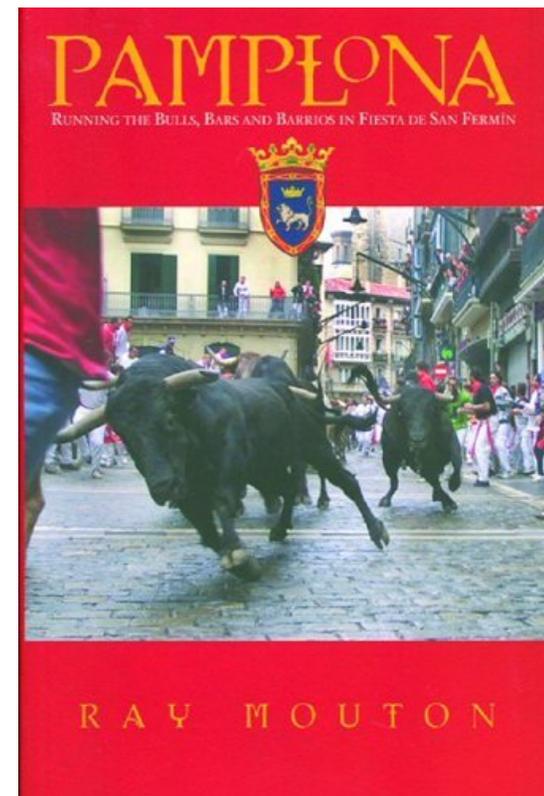
*APS / Beamline Controls Workshop
May 4th 2006*



About the speaker

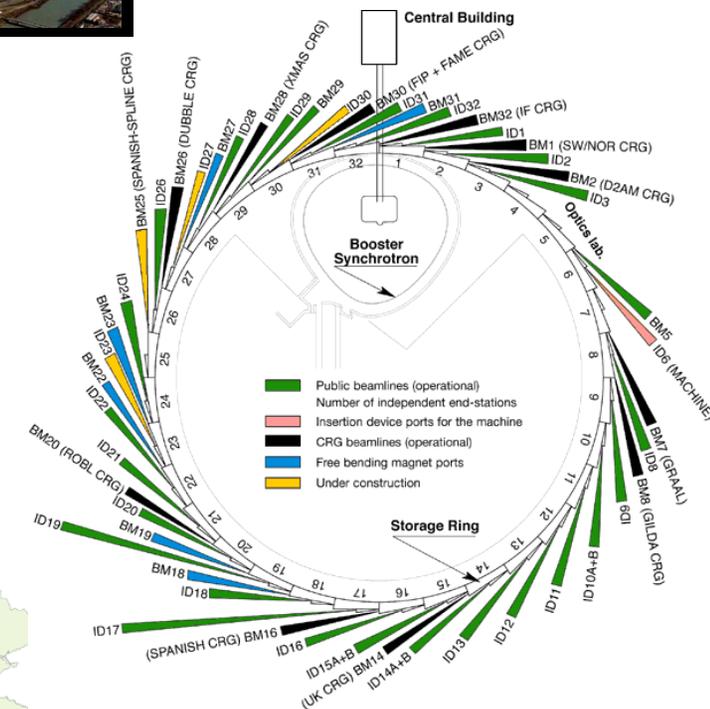
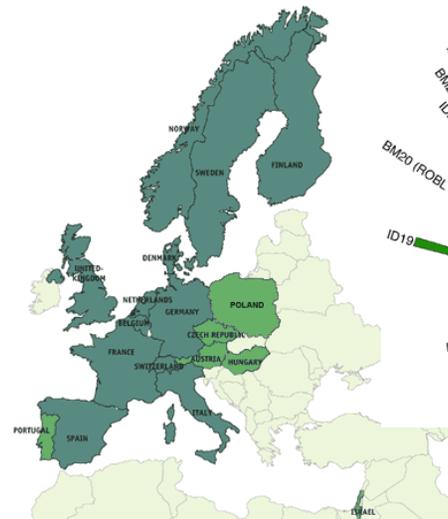


- ID card:
 - Name: Vicente Rey Bakaikoa
 - Born in: Pamplona / Spain
 - Living in: Grenoble since 1990
- Working in beamline control since 1992
- Heading BLISS group for the last two years



Outline

- Computing at ESRF beamlines
 - BLISS assignment and organization
 - Methods: software development / packaging and delivery
- Beamline control
 - Three layered control system
 - Taco/Tango
 - Experiments and sequences
 - Graphics / Data visualization / Analysis
- Experiments
 - Performance
 - Electronics developments
 - Detectors
- Automation
 - Optics
 - Experiment
- What next?



ESRF / Computing



TBS / Experiments Division

BLISS / Software development and support

17

C.E. / Electronics development and support

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SciSoft / Scientific Software

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Computing Services

Digital Electronics

9

System Admin and Networks

15

Software Engineering Group

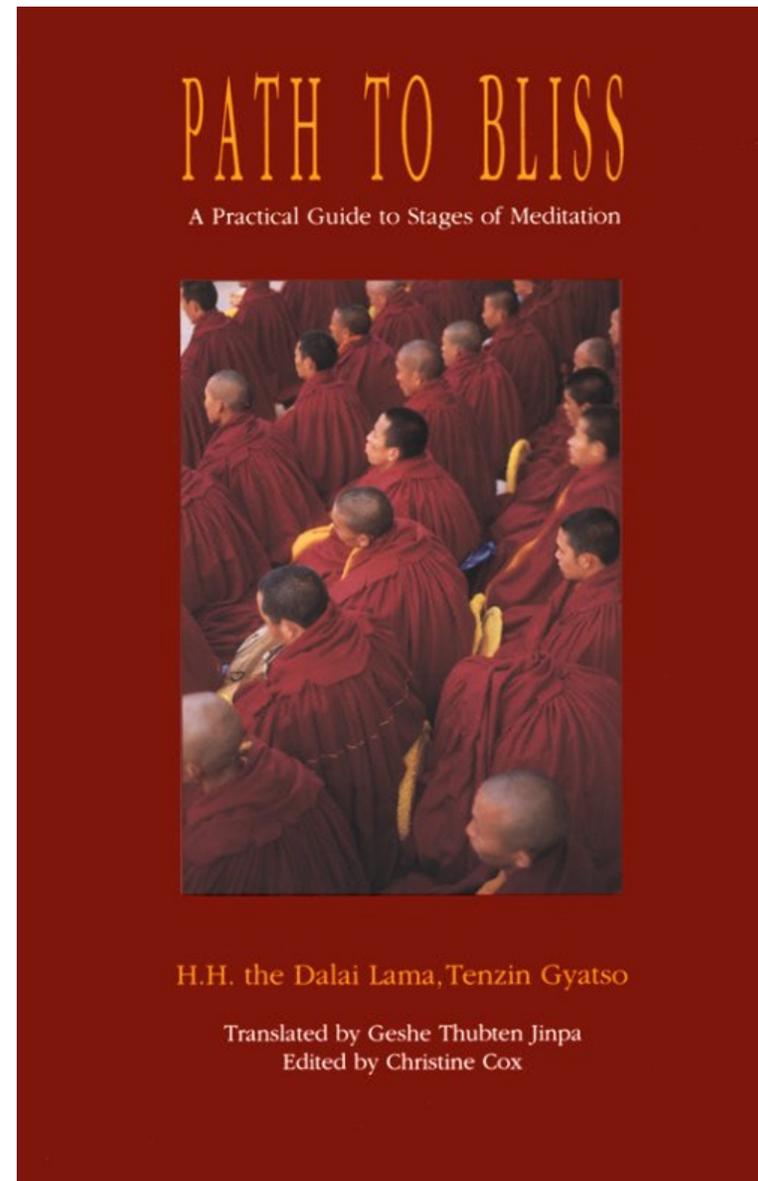
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Management Information System

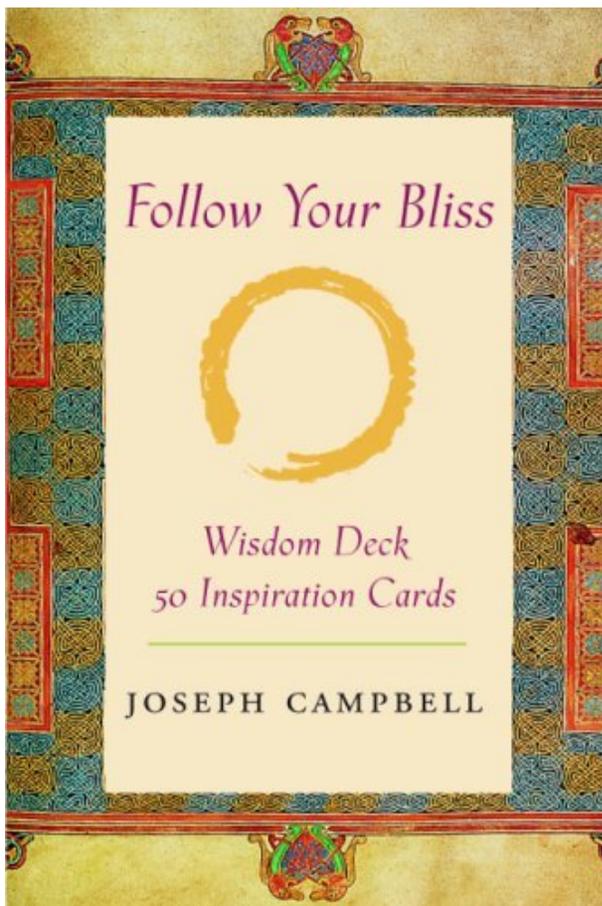
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BLISS

- Beamline Instrument Software Support
- Giving service to ALL ESRF beamlines including CRG's
- 1 engineer time (rough approx.)
 - 2 Beamlines + specialist work
 - 50% development / 50% support
- Standby service
 - All days from 7am to 11pm



BLISS developments



- Scope:
 - From low-level drivers to data analysis / visualization as far as concerns the successful running of the experiments
- Four development areas:
 - Hardware support software
 - Graphical interfaces
 - Automation projects
 - Infrastructure software
- Method:
 - eXtreme programming inspired

BLISS / Support

- Beamline instrumentation projects:
 - Participate to beamline instrumentation projects
 - Small software developments
 - Experiment macros
 - Beamline specific GUI
- Software consulting / auditing
- Contact person for all computing issues
- Beamline support : installation and problem resolution



BLISS software distribution

- Some numbers:
 - 673 different software packages (do not include beamline specific software)
 - 40 beamlines
- Policy:
 - Guarantee software evolution
 - No automatic spreading of software
- Blissinstaller/blissbuilder based on RPM
 - Package generation / installation
 - Handle versioning / dependencies / platform compatibility
- Centralized database of software installations at beamlines
 - web interface for application history, beamline search, latest changes...

Blissinstaller



The image displays the Bliss Installer 3.5 application window and an overlaid installation dialog box.

Bliss Installer 3.5 Main Window:

- Menu: File View Options Help
- Toolbar: ? (Help), [Icons], [Refresh]
- Platform: laue : redhate4
- Installed Packages:**
 - Control
 - bliss_control
 - Driver
 - HWR
 - Spec
 - Core
 - CPLLOT
 - SPEC

- Available Packages:**
- Remote Server:
 - Admin
 - Applications
 - Beamlines
 - Control
 - bliss_control
 - Driver
 - Drivers
- Buttons: Remove, Update, Verify, Install
- Checkbox: Install dependencies

Installation Dialog Box:

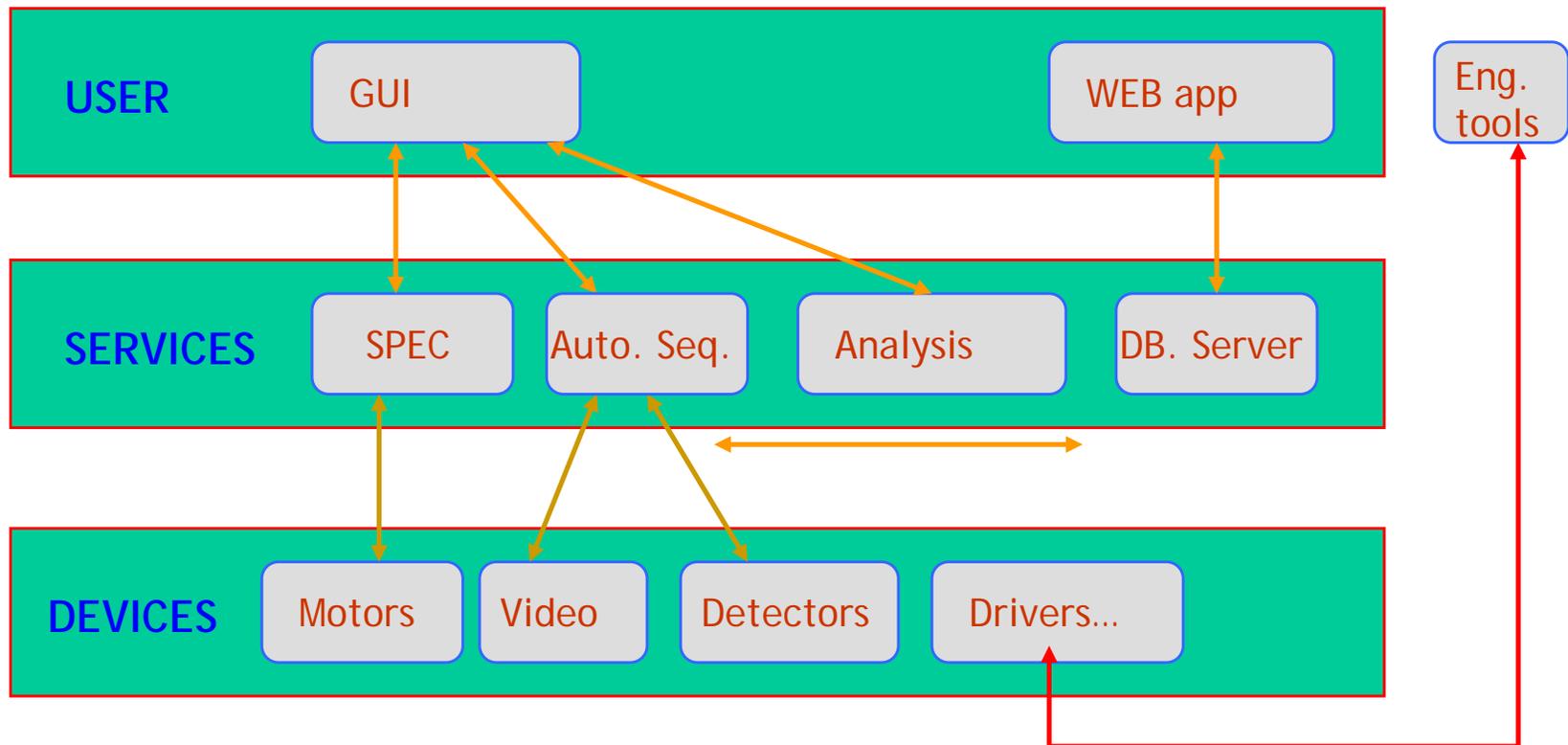
- Change Platform Selection:
 - redhate4 (Default)
 - hpux102 (Apply)
 - solaris8 (All)
 - src
- Package information (click on the package number to show):
 - Project name : SPEC
 - Project Description : ESRF local SPEC Distribution
- Table:

	Package	Platform	Version	Installation Status	Type
4	<input type="checkbox"/> SPEC	redhate4	6.310	6.310 installed	Control/Spec/Core
6	<input type="checkbox"/> tango_lib	redhate4	3.1	3.1 installed	Control/Tango/Cor
9	<input type="checkbox"/> blissrc	src	8.1	8.1 installed	Admin

- Progress: [Empty progress bar]
- Checkbox: Verbose progress
- Buttons: Install Now, Stop, Close

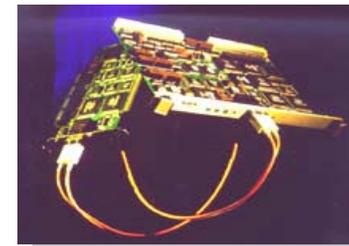
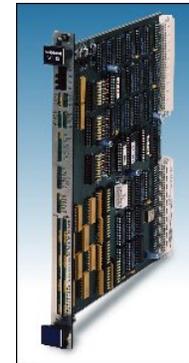
Beamline Control System...

Software structure



Electronics and computers

- Front-end computers
 - VME (os9) on Motorola 680x0
 - Linux and PCI / cPCI
 - PCI to VME and cPCI integration with bus extender cards
- Console
 - Solaris / Linux
- Electronics
 - Motors:
 - VPAP (soon Icepap)
 - but also Galil, Micos, PI, Newport, Newfocus...
 - Counter/Timer:
 - VCT6 and P201
 - but also Lecroy / Ortec...
 - I/O
 - ICV712 / ICV150 / ICV196
 - Wago
 - Serial line / GPIB
 - VME now PCI
 - ...
- Detectors
 - Canberra MCA / XIA / Oxford
 - CCD and image plates (all flavours)

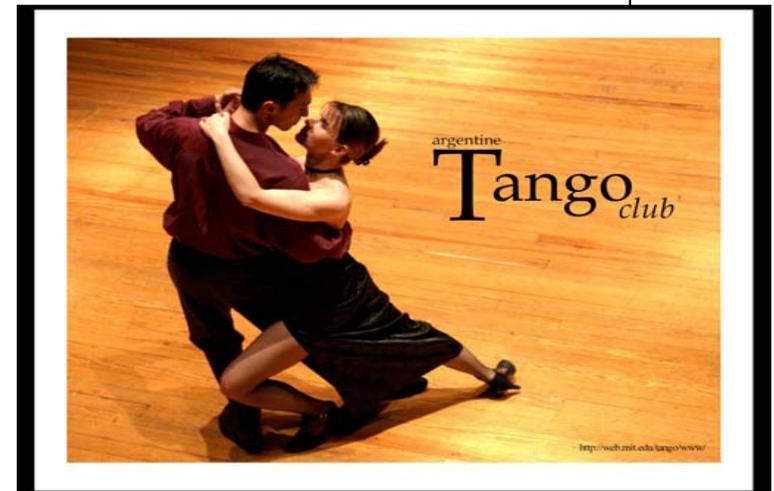


TACO

- Inter-process communication via **SUN RPC**
- Clients and servers exists in OS9, UNIX (HP-UX, Solaris, Linux), Windows... **only C**
- **Tools** include HDB, configuration tools
- **Developed at ESRF**. Used also in FRM-II neutron source (Garching-Munich) and Hartebeesthoek Radio Astronomy Observatory (South Africa).

Tango

- Inter-process communication using **Corba**
- Client and server API in **C++**, **Java** and **Python**
- Compatible with Taco
- **Features** include:
 - graphical development tools, event notification, automatic polling thread for each device, graphical java toolkit, remote administration of servers and configuration...
- Developed as a **collaboration** between ESRF, Elettra, Soleil and Alba



SPEC

- **Commercial** Program by Certified Scientific Software (CSS).
 - ESRF holds a source license.
 - Used at ALL ESRF beamlines (including CRG's). Distributed with our tools.
- **Sequencer** and experiment **application**
 - Diffractometer geometries included
 - Accumulated knowledge on synchrotron experiments
 - Hundreds of devices supported
- **Evolution** (often triggered by BLISS)
 - Support added for Taco, Tango (and EPICS)
 - Support for 2D detectors and arrays
 - GUI on spec: Integration evolution (pipes then full server mode)
 - Macro and pseudo device support
- **But...**
 - Basic command line interface and programming features
 - Not for surveying or polling devices

BLISS graphical framework

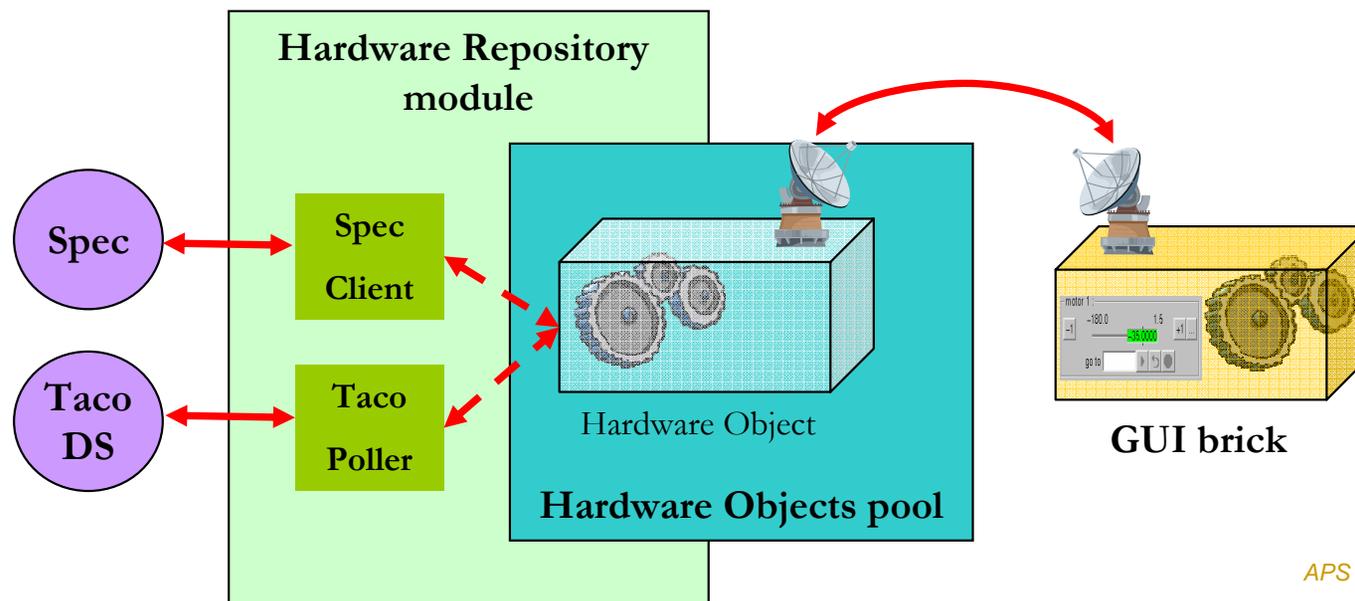
- Python / Qt
- Components
 - Hardware repository / hardware object classes
 - Graphical Bricks
 - Application editor
- Hardware objects classes exists to communicate with SPEC (through spec server features) and TACO/TANGO servers... but anything can fit

The **BLISS Framework** Project

A beamline GUI is made of “cemented” bricks

- ▶ bricks ensure a standard *look & feel*
- ▶ bricks improve reliability

GUI Bricks communicate with Hardware Objects, thus creating a link between hardware (control software) and graphical elements



Framework at work



The screenshot shows the control interface for ID14-EH2. It includes a top navigation bar with 'Logout', 'MCCARTHY E.S.R.F. Dates: 2005-07-06 to 2005-07-09 Local contact: MONACO', and 'Expert mode'. Below this are tabs for 'Hutch', 'Sample changer', 'Collect', 'Results', 'User commands', and 'Expert commands'. The main area is divided into several sections: 'Phi' (900.0), 'Phi Vert' (-0.12), 'Front Vert Gap' (0.1), 'Front Hor Gap' (0.1), 'Front Vert Offset' (-0.005), 'Front Hor Offset' (0.006), 'Back Vert Offset' (-0.005), 'Back Hor Offset' (0.006), 'Hutch' (Enter hutch, Leave hutch), 'Transmission' (Current: -, Set to: Filters), 'Beamstop' (in, Set in, Set out), 'Safety shutter' (closed), 'Fast shutter' (closed), and 'Cryostream' (in). A central image shows a sample holder with a red crosshair. The bottom status bar shows 'Information messages', 'Details (1)', 'Submit feedback', and 'Debug (91)'. A message box at the bottom contains the text: 'Feel free to report any comment about this software; an email will be sent to the people concerned. Do not forget to put your name or email address if you require an answer. Message: Submit'.

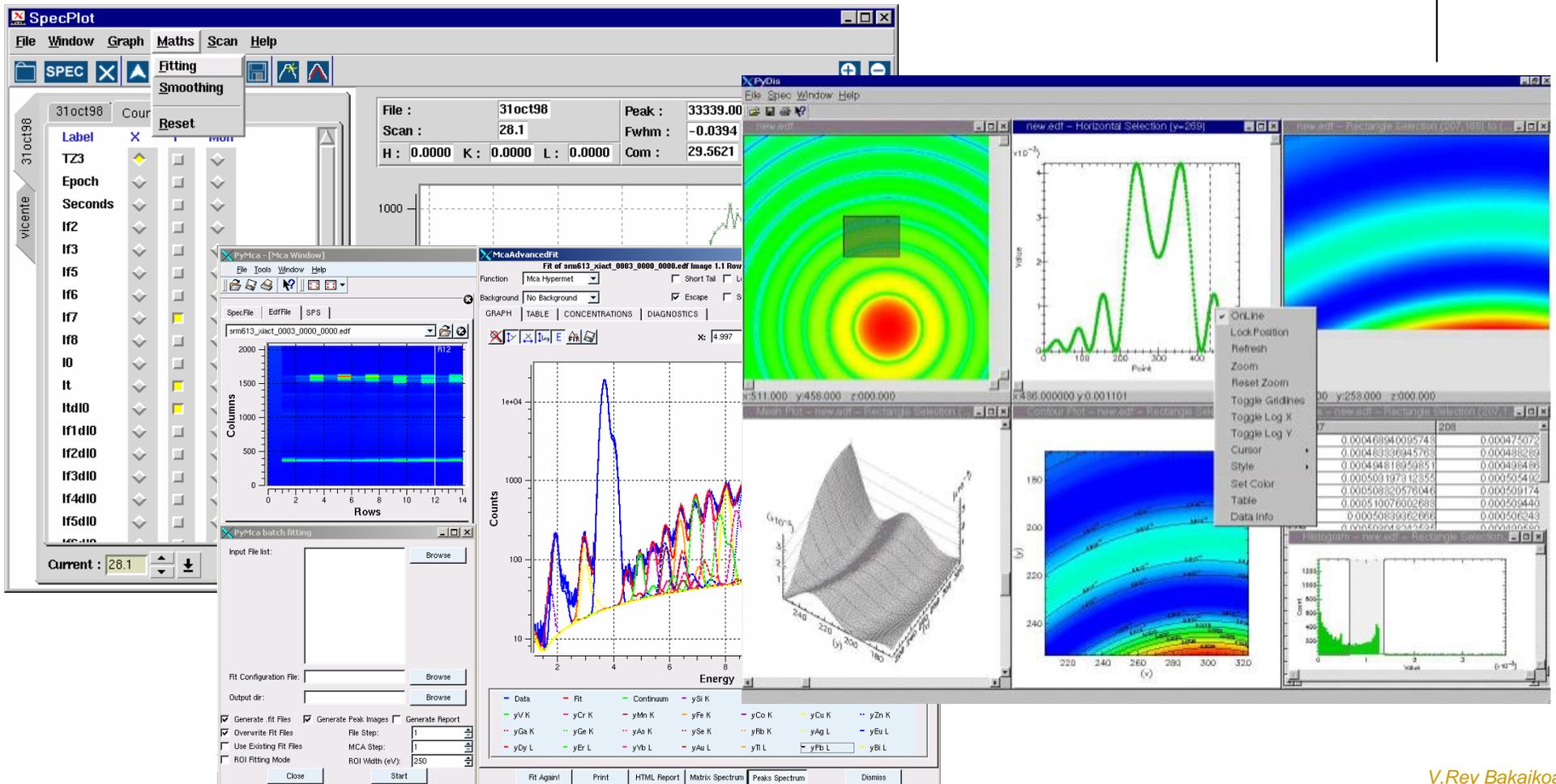
The screenshot shows the control interface for ID14-EH2 in 'Ready to operate' and 'Sample is loaded' states. The top navigation bar is the same as in the previous screenshot. The main area is divided into two sections: 'Ready to operate' and 'Sample is loaded'. The 'Ready to operate' section shows a 'Reset' button. The 'Sample is loaded' section shows 'Selected Basket' and 'Selected Sample' both with 'current: 1 matrix id: ?'. Below this are 'Change' buttons and a 'Scan basket for data matrix' button. A diagram shows a circular arrangement of 10 baskets, with basket 1 highlighted in red. Below the diagram is a 'Holder length (mm)' field set to 2 and an 'Unload sample' button. The bottom status bar shows 'Information messages', 'Details', 'Submit feedback', and 'Debug'. A log of messages is visible at the bottom: '2005-10-04 12:30:59 Oct 4 12:30 Refilling;', '2005-10-04 12:38:37 Oct 4 12:38 Delivery:Next Refill at 18:30;', '2005-10-04 16:07:45 Switching to expert mode', '2005-10-04 16:15:03 Switching to expert mode', and '2005-10-04 16:17:29 Switching to expert mode'.

Data Visualization



- Online data visualization for scans, spectra and detector images.
- Communication transparent and overhead-free.
- Based on shared-memory segments
- Only basic analysis

Newplot / PyMca / PyDis

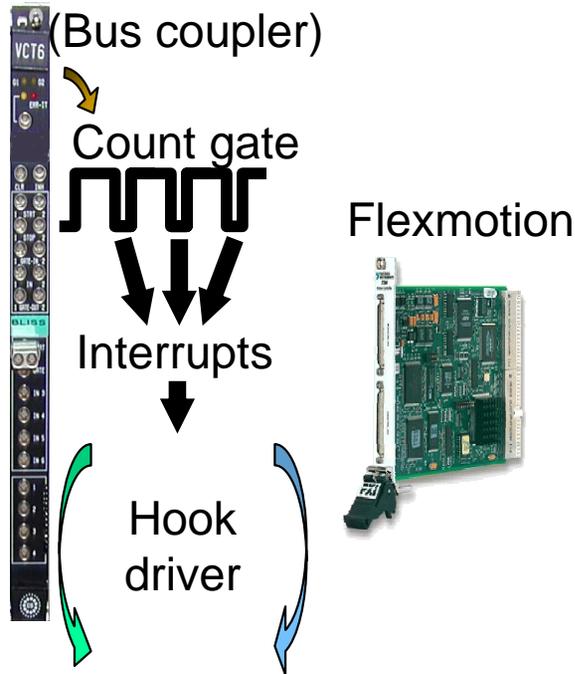




Experiments

Fast: standard counters: hook

VCT6 Counter/Timer

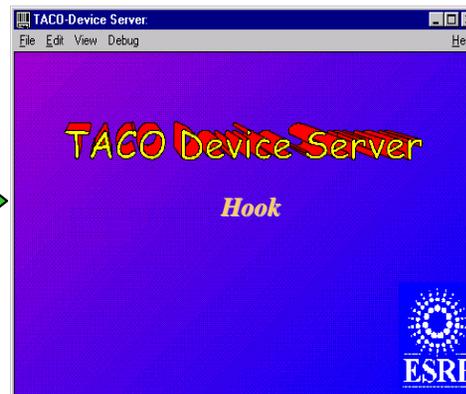


Int. time: 100 μ s
Data rate: 1.5 MB/s

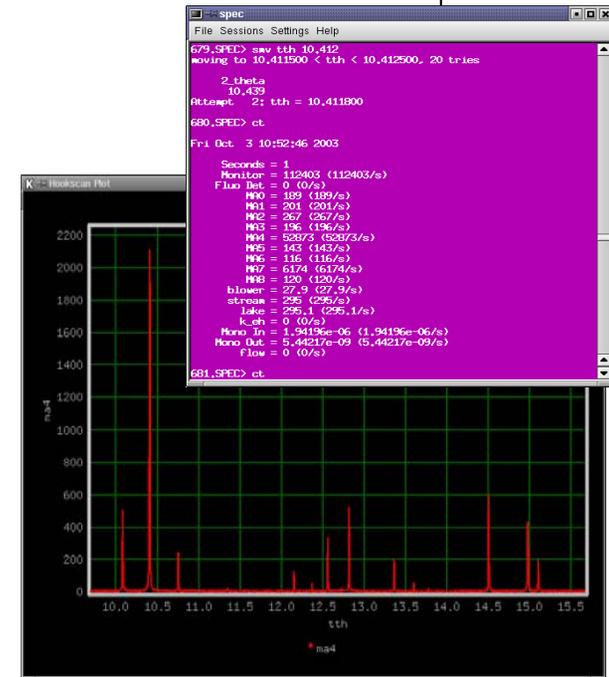
0	Counts	Motor Pos.
1
2

Hook kernel
buffer

System
call



TACO call

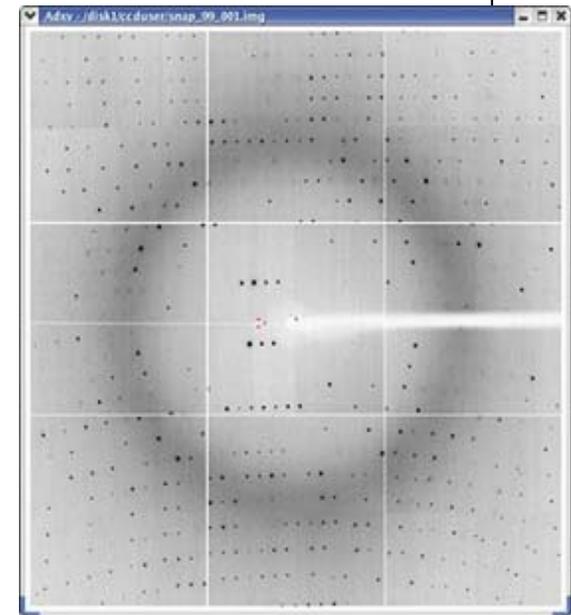


MUSST / ICEPAP...

- Developed at ESRF
- MUSST
 - Fully programmable acquisition card with histogramming memory, counters, encoders and I/O channels
 - Used already for shutter synchronization and diagnostics at MX beamlines
 - Does also fast MCA acquisition
- ICEPAP
 - Under development
 - Features will include synchronization and diagnostics, software selection of motor for fast scanning, feedback through programmable embedded controller.
 - For example: motor feedback loop on the error signal from a BPM.
 - Price consideration
 - Compatible with existant cabling: preserving investment consideration
- Other cards: Opium (for signal handling), APD/ACE for avalanche photodiodes and energy discrimination, BPM developments
- Towards a framework for all continuous scans

ADSC Quantum 315r

- 6140 x 6140 – 16 bit:
 - 18 MB / image (bin. 2x2)
 - 75 MB / image (full frame)
- Current operation @ ID23:
 - 40 fr/min (bin. 2x2) \Rightarrow 12 MB/s
 - 20 fr/min (full frame) \Rightarrow 24 MB/s
 - Limit rate to central disk server: 60 MB/s
- But:
 - Images read for display & data analysis while writing
 - NFS \Rightarrow poor online display
 - High throughput!! 1800 images/day (full frame) \Rightarrow 130 GB



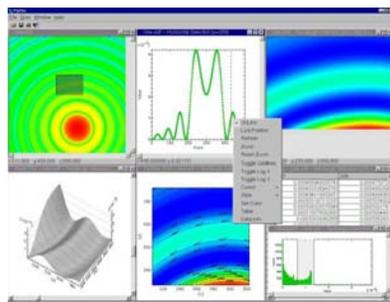
Fast 2D imaging / Frelon



spec>

Taco server

Linux driver



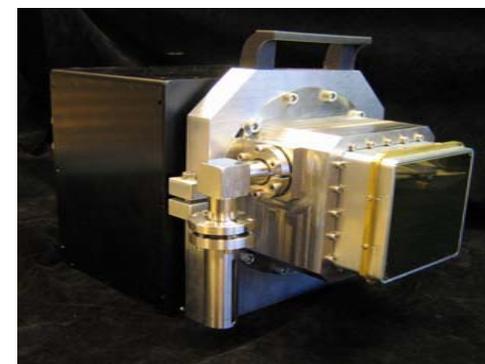
PyDis

DMA



Espia

FReLoN camera



Fiber optic

Frelon

- ✓ FTM
- ✓ Kinetics Rol
- ✓ Ring buffer
- ✓ Big buffer
- ✓ *Full* PC memory
- ✓ Write online
- ✓ Display online

- ✓ Real time & Stability

ID19 (tomography)

- ➔ 2048x1024
- ➔ 800 (450) images
- ➔ 1800 MB
- ➔ Save on local disk
- ➔ > 10 image/s

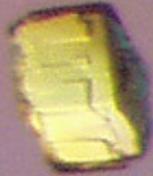
- ✓ 62 ms / image

ID24 (spectroscopy)

- ➔ 2048x1 - binning 32
- ➔ 10000 spectra
- ➔ 40 MB

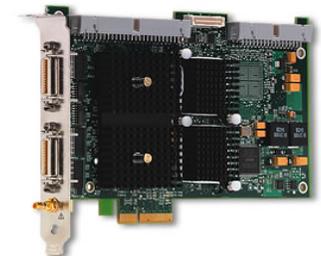
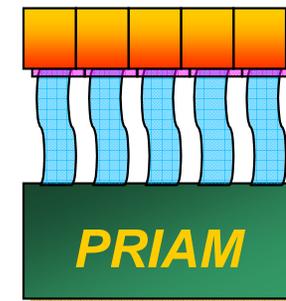
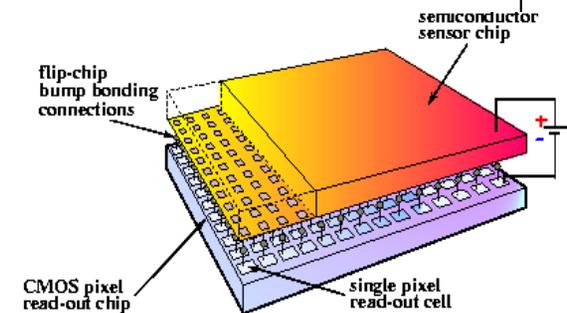
- ➔ Whole buffer

- ✓ 2 ms / image



Medipix

- Features:
 - 256 x 256 – 14 bit pixel detector
 - 1000 fps \Rightarrow 130 MB/s
- Connection & control:
 - PRIAM (ISG/ESRF)
 - Espia
- Configuration possibilities:
 - 1280 x 256 @ 1000 fps \Rightarrow 650 MB/s
 - PCI Express (?)

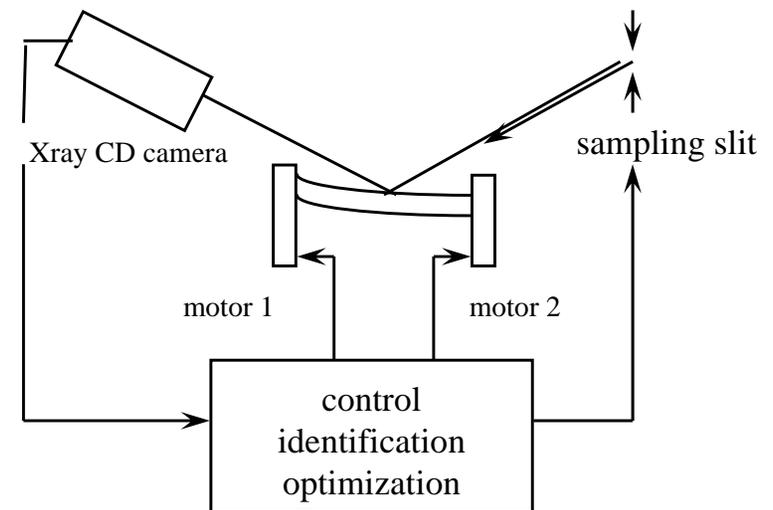




Automation

Optics automation

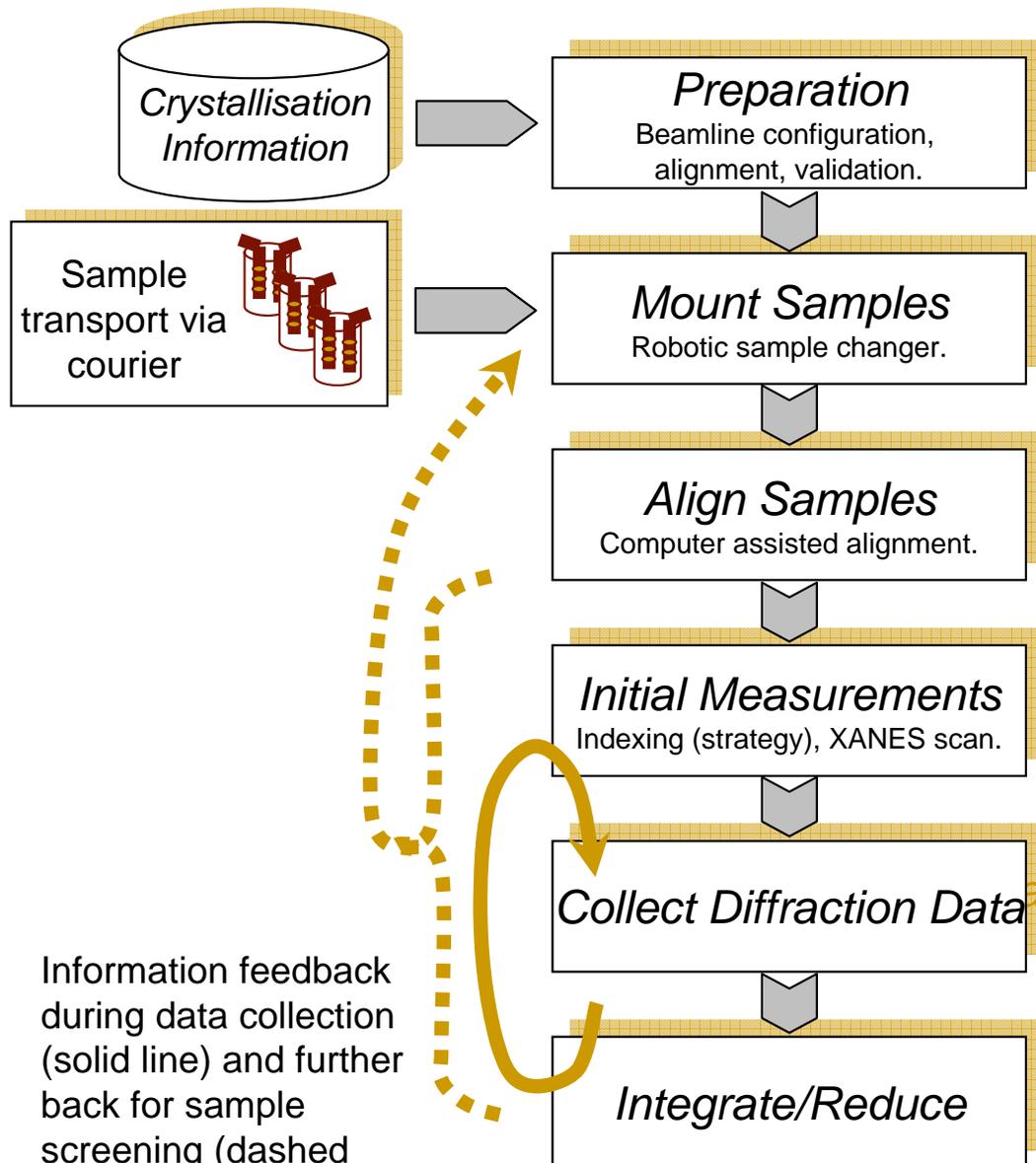
- Hardware developments and beamline design essential to get right diagnostics
 - Wago, beam viewer lines, beam position monitors
- Based largely on simple spec scans with basic data analysis
- Based on beamline layout: get scientist knowledge into the software
- Sophisticated analysis (wavefront) developed for mirror focusing



Experiment automation: MX



- Motivation
 - High-throughput
 - Sample changers / diffractometers
 - Standardization at all MX beamlines
- Includes
 - Beam delivery
 - Sample mounting and handling
 - Data collection
 - Sample and experiment database
 - Data analysis
- Results
 - Faster and easier experiments when done manually
 - Pipeline mode for unattended experiments
 - 50 datasets collected in one single day
 - MXPress service
- Now working on remote access



Information feedback during data collection (solid line) and further back for sample screening (dashed line).

MX collection Full sequence

ISPyB



The screenshot displays the ISPyB web interface with the following components:

- Navigation:** Shipment, Samples, Data collection, Reports, Help.
- Shipment Information:**
 - Laboratory: pipeline_test_Aug_25
 - Shipping Date: 2005-08-25
 - Buttons: [Back to this Shipment](#), [Add a Dewar to this Shipment](#)
- Dewar Information:**
 - Label: none
 - Status: opened
 - Buttons: [Back to this dewar](#), [Add Container to Dewar](#)
- Container Information:**
 - Label: AAA326A
 - Type: Basket
- Sample List Table:**

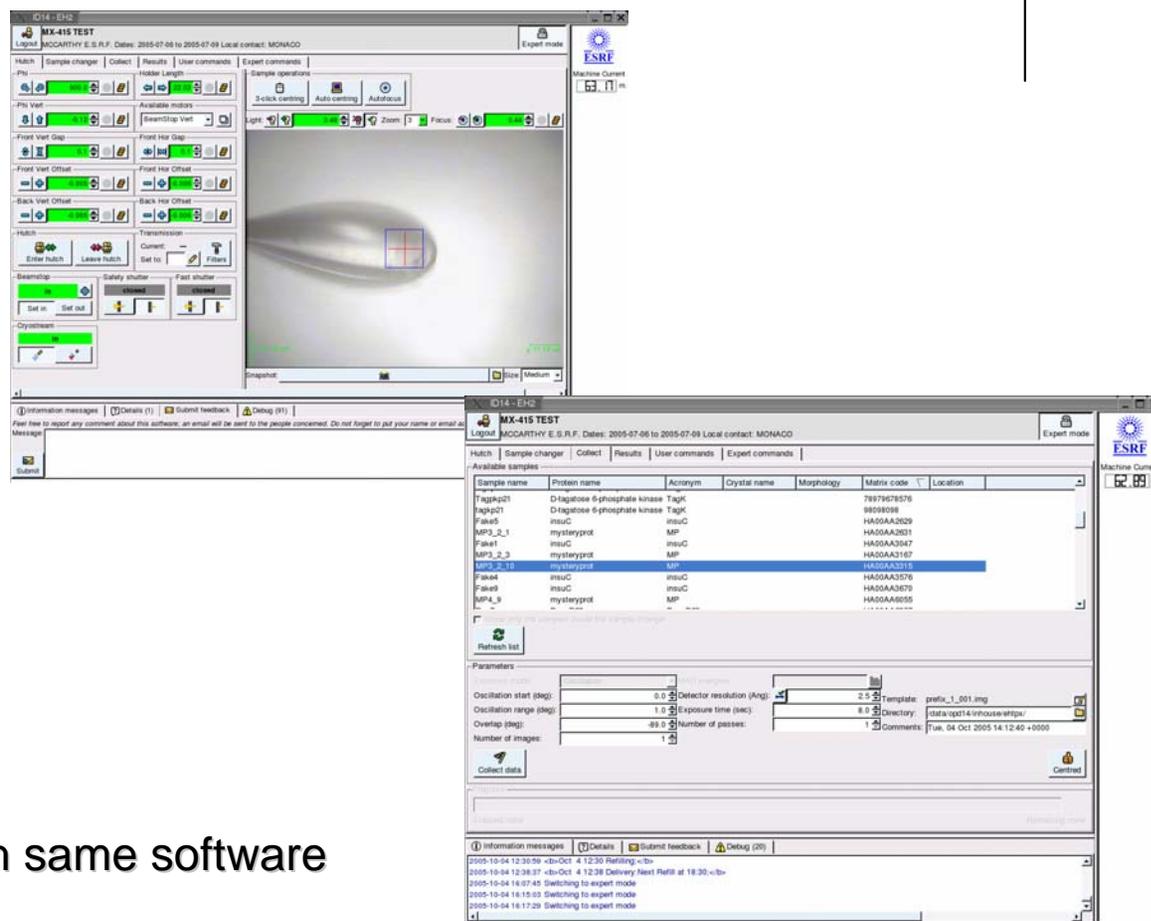
Name	Code	Location in container	Protein	SpaceGroup	Holder Len
MP1	HA00AC7078	MP			22.0
MP2	HA00AC7080	MP			22.0
MP3	HA00AC7083	MP			22.0
MP5	HA00AC7086	MP			22.0
MP6	HA00AC7074	MP			22.0
MP7	HA00AC7077	MP			22.0
- Data Collection Summary:**
 - Selected Session:** Start Date: 11-03-2005, Beam ID: ID29, Buttons: [Back to this session](#), [Back to sessions](#)
 - Selected DataCollection:** Start Time: 15-09-2005, Image Prefix: ref-byt->land01, Run Number: 2, Buttons: [Back to this data collection](#), [Back to data collection](#)
 - Buttons: [View sessions](#), [Search data collections](#), [Back](#)
- Experiment Parameters:**
 - Buttons: [display DNA Files](#)
- Images Collected:**

Image	Image name	Image location
	ref-byt->land01_2_001.img	/data/d29/inhouse/pipeline1

Data Collection / mxCuBE



- User / expert mode
- Sample mounting / centering
- Start alignment sequences
- Beam centering
- Collect / MAD experiments
- Connect with DB and DNA
- All MX beamlines equipped with same software



What next?



- Detectors
 - Ever faster (Dalsa, Sarnoff)
 - Flat panel and pixel detectors
- Nano-positioning / nano-focusing
- Automation
 - Remote access
 - Web services
- Further deployment of BLISS framework and Tango
- Beamline auditing
- Beamline configuration editor and associated database



The End

And thanks for your attention