Control and Data Acquisition System for ESRF Beamlines
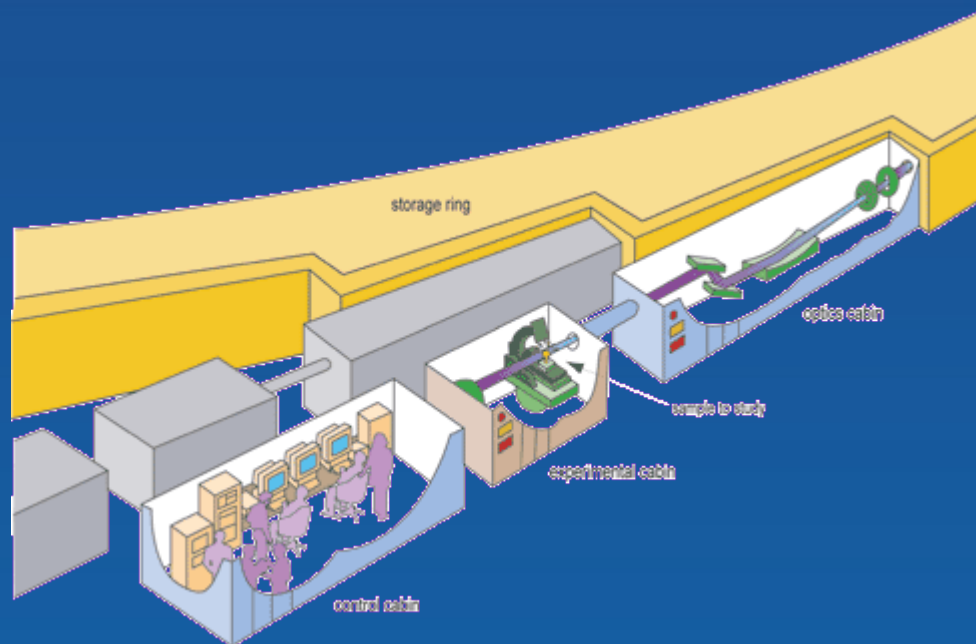

Presented by Laurent Claustre for the BLISS group

XFEL DAQ Workshop /DESY / 10-11 March 2008

About the speaker

- ID card:
  - Name: Laurent Claustre
  - Born in: France
  - Living in: Grenoble since 1991

- Working in beamline control since 2000

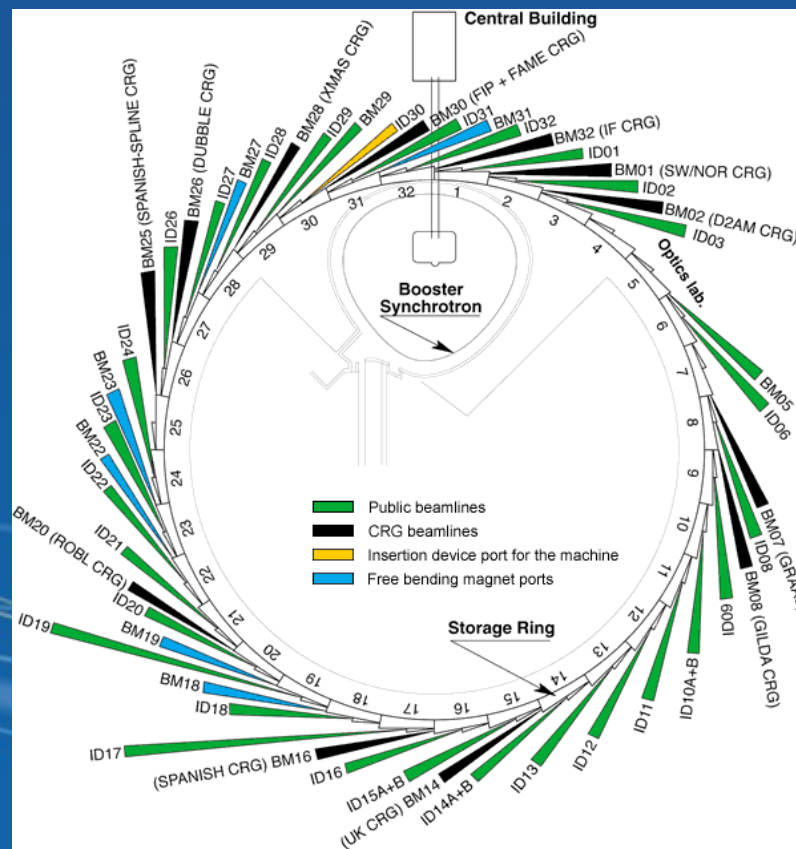- Heading BLISS group since jan. 2008

Outline

1. **ESRF, Beamlines, BLISS**

2. **Control system overview**

3. **Future challenges**

ESRF & Beamlines

- 29 ESRF beamlines

- 12 CRG's

ESRF / Computing

TBS / Experiments Division

BLISS / Software development and support — 18

SciSoft / Scientific Software — 8

C.E. / Electronics development and support — 13

Computing Services

Software Engineering Group — 10

System Admin and Networks — 15

Digital Electronics — 9

Management Information System — 8

BLISS

* Beamline Instrument Software Support

* 18 software engineers

* Giving service to ALL ESRF beamlines including CRG's

BLISS developments

Follow Your Bliss

Wisdom Deck
50 Inspiration Cards

JOSEPH CAMPBELL
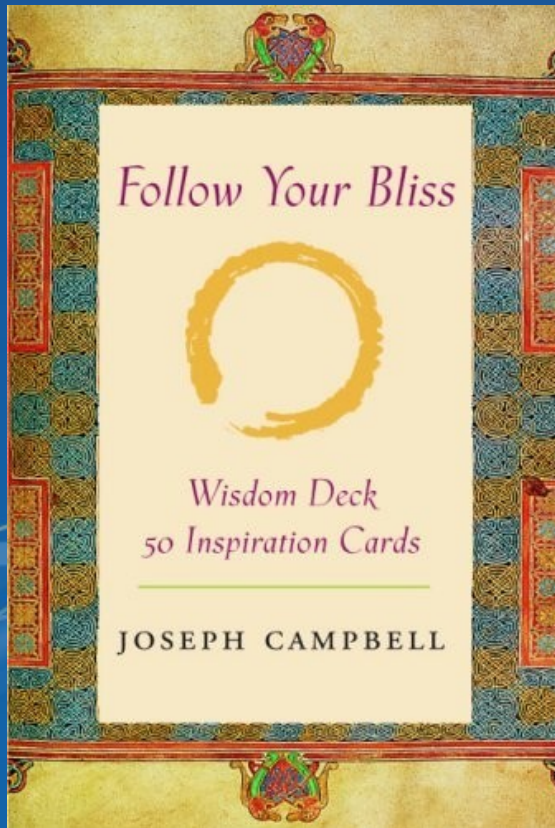
* Scope:
    * From low-level drivers to data analysis / visualization as far as concerns the successful running of the experiments

* Four development areas:
    * Hardware support software
    * Graphical interfaces
    * Automation projects
    * Infrastructure software

BLISS / Support

* Beamline instrumentation projects:
  * Participate to beamline instrumentation projects
  * Small software developments
  * Experiment macros
  * Beamline specific GUI

* Software consulting / auditing

* Beamline support: installation and problem resolution

Beamline Control System

A brief history of BL control system

- 1990
  - Control choices: VME (os9) / HP + Sun
  - Taco development for accelerator control

- 1994
  - First beamlines open. Control system based on VME / Taco
  - SPEC used as main control program

- 2001
  - Modernization efforts
  - ID31 control uses only Linux

- 2004
  - BLISS graphical framework
  - Tango on beamlines

- 2005-2007
  - Automation efforts
  - Icepap, musst, frelon 2k, medipix

- 2008+ : ESRF Upgrade program

…and there be light (at the beamlines)

"In the beginning there was TACO & spec"

- TACO:
  - Developed at the ESRF
  - Objects in C. RPC communication.
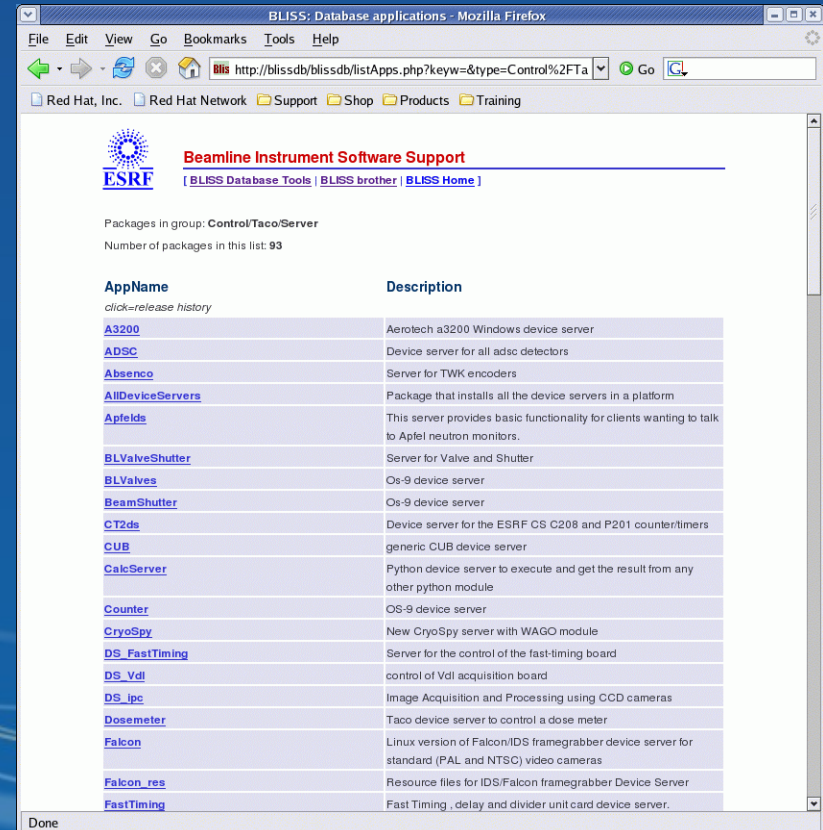
- spec:
  - Commercial program for diffractometer control
  - And some other features…

Taco

- Developed at the ESRF
- Used also at :
  - FRM-II neutron source (Garching-Munich)
  - Hartebeesthoek Radio Astronomy Observatory (South Africa).
  - Anka

- Used massively at all ESRF beamlines:
  - 92 different servers distributed
  - 7000+ devices exported

Taco : Device Servers

Client / Spec
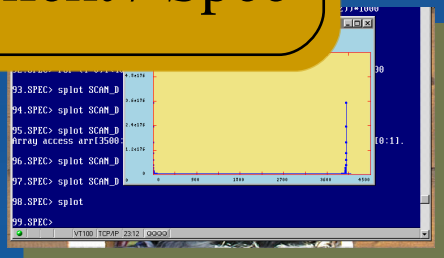
Client / Slits

1. Register in DB

2. Client asks DB

3. Client / Server Communication

Manager/ Database
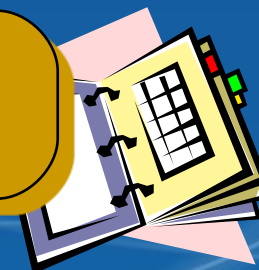
Device Server
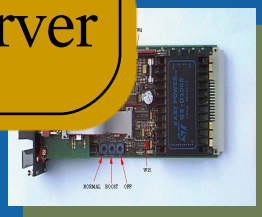
spec

* Move, Count, Take data, Plot, and Save
* Built-in macro language
* Built-in code for diffractometers (kappa, fourc, sixc, surf, ...)

* Configuration
* Many motor controllers, counter-timers, CCD, Mca's integrated
* Generic I/O through CAMAC, VME, GPIB, Serial Line, Socket, Bus coupler and I/O ports

```
dtterm                                                           _ □ ✕
Number: <>Controller       0:    NONE  1+--------+  2:    NONE  3:    NONE
Unit/Channel                      0/0  |    IP28|        0/1         0/0
Name                             Mono  |   ITL09|     Y Tilt   HP 66xPS
Mnemonic                         mono  | ITL09_E|        yti        volt
Steps per degree/mm              2000  |     IXE|       2000        2000
Sign of user * dial                 1  |  KS3112|          1           1
Backlash [steps]                   50  |  KS3116|         50          50
Steady-state rate [Hz]           2000  |  KS3195|       2000        2000
Base rate [Hz]                    200  |    MAXE|        200         200
Acceleration time [msec]          125  | MAXE_DC|        125         125
Motor accumulator               20400  | MAXE_E |      20000       30000
Restrictions                     NONE  | MAXE_S |       NONE        NONE
                                       |     MC4|
Dial = accumulator / steps             |     MCB|
  High limit              500.0000      |     MCU|   180.0000    180.0000
  Current                  10.2000      |   MCU_E|    10.0000     15.0000
  Low limit              -500.0000   -| |   MCU_H|  -180.0000   -180.0000
User = sign * dial + offset            |   MCU_O|
  Offset                    0.0000      |  MM2000|     0.0000      0.0000
  'High' limit            500.0000      |MM2000_E|   180.0000    180.0000
  Current                  10.2000      |  MM2500|    10.0000     15.0000
  'Low' limit            -500.0000   -| |MM2500_E|  -180.0000   -180.0000
                                       +--------+
Number of motors                    4       Type ? or H for help, ^C to quit
```

```
dtterm                                                           _ □ ✕
961.VICENTE> wa

Current Positions  (user, dial)
  Hexa X     Hexa Y     Hexa Z    Motor 3    Motor 4      Mono
    del        gam        chi         m3         m4       mono
 1.0000     7.0000     2.0000     8.0000     1.8870     1.1200
 1.0000     7.0000    -2.0000     8.2260     1.8870     1.1200

962.VICENTE> umvr m3 5

     Motor 3
         13

963.VICENTE> ct 1

Mon May 15 14:43:03 2000

     Seconds = 1
     Monitor = 0 (0/s)
    Detector = -20.846 (-20.846/s)
   Counter 3 = 0 (0/s)
   Counter 4 = 0 (0/s)

964.VICENTE> █
```

Tango

- Inter-process communication using Corba

- Client and server API in C++, Java and Python

- Objects include commands, attributes and properties

- Features include: graphical development tools, event notification, automatic polling thread for each device, graphical java toolkit, remote administration of servers and configuration...

- Compatible with Taco

- Developed as a collaboration between ESRF, Elettra, Soleil DESY and Alba

Configuration Monitoring Logging Archiving

Users
Environments :
MATLAB, IGOR,
python, Labview

Bindings

TANGO Software Bus

Device Device

Hardware Hardware

(E/S…) (motor…)
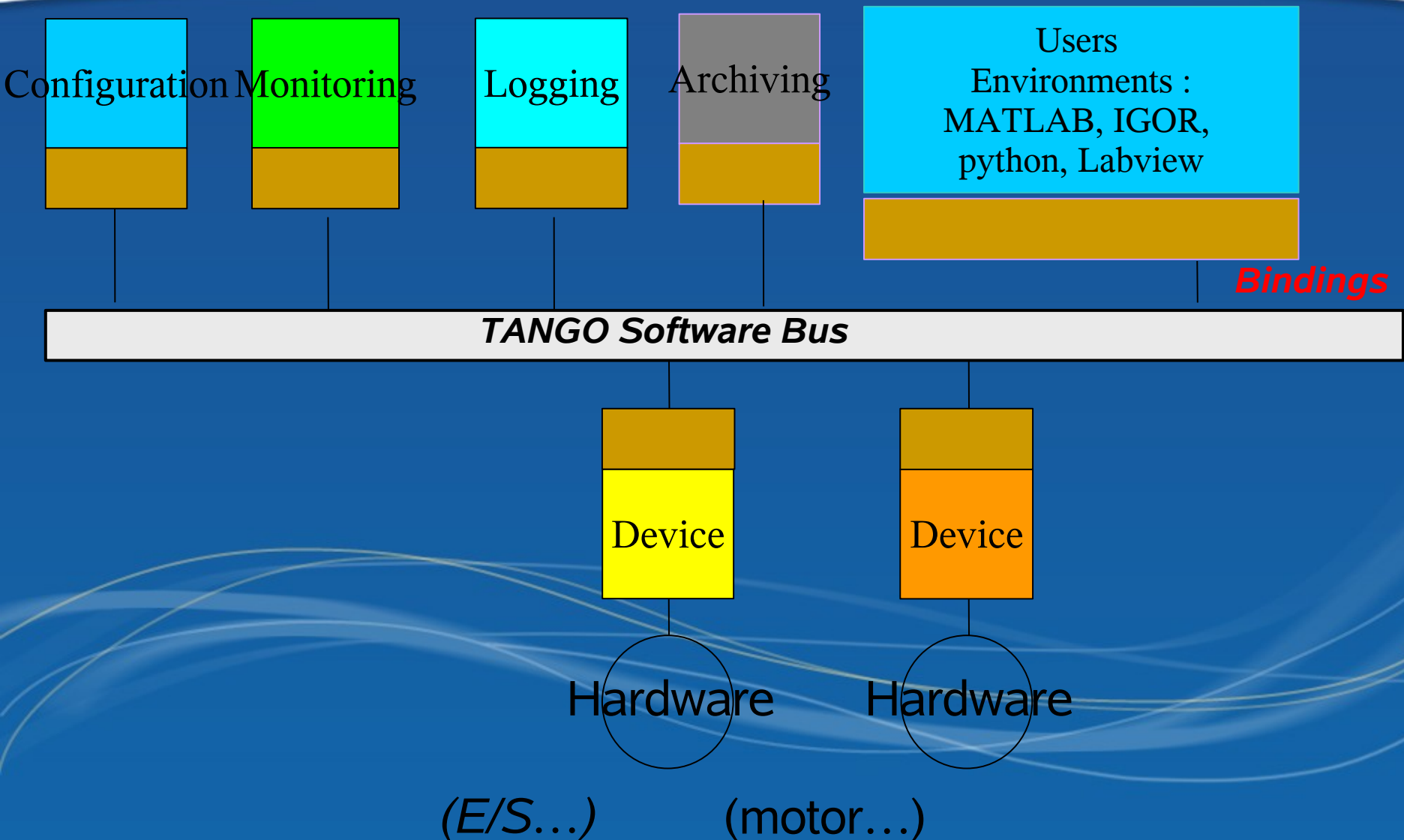
Experiment visualization / evaluation

- Standalone tools for visualization
- Should work both online or offline
- Applications that users can bring along with their data
- Emphasis on performance.
- Non-intrusive
- Evolution with time and technologies…

Gra

Automation

* Optics automation
  * Beam delivery
  * Mirror alignment

* Experiment and sample handling
  * Mx data collection
  * Automatic (EMBL) and assisted sample centring

* Data analysis

* Experiment annotation, bookkeeping

* Remote access

Bliss Installer 3.5

BLISS: Database applications - Mozilla Firefox

File   Edit   View   Go   Bookmarks   Tools   Help

http://blissdb/blissdb/listPackageVersions.php?appname=Ccd1394   Go

Red Hat, Inc.   Red Hat Network   Support   Shop   Products   Training

Beamline Instrument Software Support

[BLISS Database Tools | BLISS brother | BLISS Home]

App. Name:	Ccd1394
Description:	TANGO device server for IEEE 1394 (firewire) cameras
Belongs to group:	Control/Tango/Server
Contact:	Andy Gotz
Last built by::	goetz

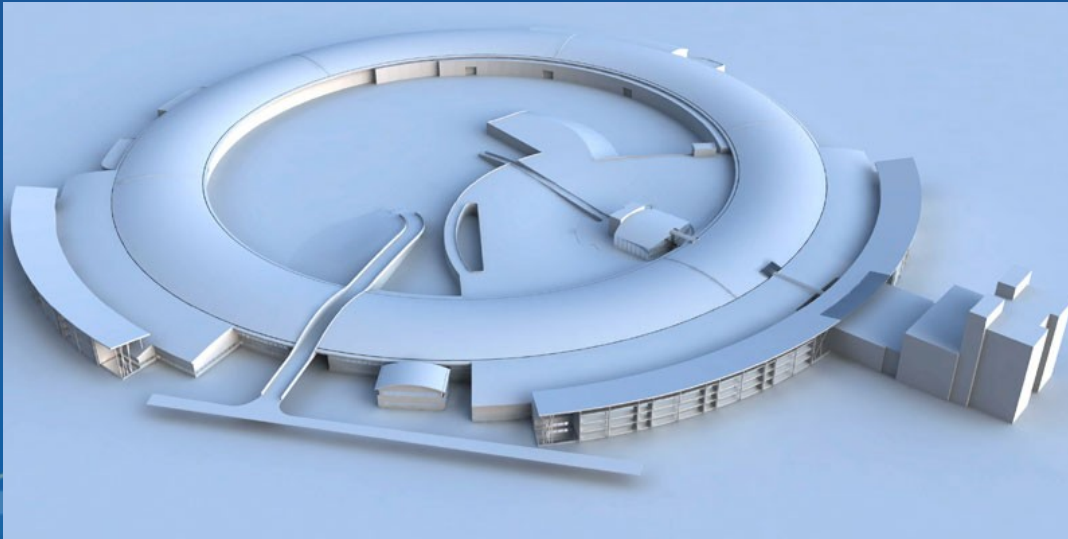| Pack	Ver - Rel	Date	Release Notes	Enable (Y/N)	Created by
click=computer installs					
Ccd1394	2.15 - 1	2007-08-02 14:05:39	added 8 bit bayer color coding	1	goetz
Ccd1394	2.14 - 1	2007-05-22 22:33:20	bpm bug with border exclusion fixed	1	goetz
Ccd1394	2.13 - 1	2007-04-26 15:12:44	bpm calculates for every image even in single shot	1	goetz
Ccd1394	2.12 - 1	2007-04-25 11:11:41	wait for new image do not poll	1	goetz
Ccd1394	2.11 - 1	2007-04-25 06:39:40	do not set video mode at every start; removed mutex when acquiring an image this speeds up acquisition	1	goetz
Ccd1394	2.10 - 1	2007-04-24 16:34:34	protected all ieee1394 bus access with a mutex; replaced state with global variable	1	goetz
Ccd1394	2.9 - 1	2007-04-20 21:53:43	added ResetRoi command	1	goetz
Ccd1394	2.8 - 1	2007-04-18 07:36:23	fix speed to 400	1	goetz
Ccd1394	2.7 - 1	2007-04-17 14:22:05	do not reset bus; improved startup and shutdown; print	1	goetz

Done

BLISS: Database applications - Mozilla Firefox

File   Edit   View   Go   Bookmarks   Tools   Help

http://blissdb/blissdb/listInstalled.php?packname=&macname=lid06ctrl&plt   Go

Hat Network   Support   Shop   Products   Training

Beamline Instrument Software Support

[BLISS Database Tools | BLISS brother | BLISS Home]

Showing packages installed on:

Computer:	lid06ctrl
Beamline:	ID06
BLISS Contact:	Vicente Rey Bakaikoa
Platform:	redhate4
Nethost:	yes
Description:	

Package	Inst.Date	Latest
click=other computers where installed		
SPEC-redhate4-7.303-1	2007-09-05 23:06:32	7.303
taco_lib-redhate4-2.16-1	2007-09-05 23:05:59	2.16
jdraw-src-1.0-1	2007-09-05 12:03:08	1.0
tango_java_lib-src-3.6-1	2007-09-05 12:02:54	3.6
qtblissgraph-src-3.4-1	2007-09-05 12:02:27	3.4
SpecClient-src-1.61-1	2007-09-05 12:02:26	1.61
BlissFramework-Core-src-2.49-1	2007-09-05 12:02:11	2.52
MotorSpinBoxBrick-src-2.8-1	2007-09-05 12:02:10	2.8
PyMca-src-4.12-1	2007-09-05 12:02:10	4.13
MotorListBrick2-src-2.8-1	2007-09-05 12:02:09	2.8
Oxidis-src-2.7-1	2007-09-05 12:02:09	2.8
Icons-src-2.21-1	2007-09-05 12:02:08	2.23
GraphBrick-src-2.4-1	2007-09-05 12:02:07	2.4
qtmca-src-3.16-1	2007-09-05 12:02:07	3.18
CommandBrick-src-2.9-1	2007-09-05 12:02:06	2.9
QPeriodicTable-src-1.9-1	2007-09-05 12:02:06	1.9
MultiAxisAlignement-src-1.6-1	2007-09-05 12:02:05	1.7
Qub-src-1.10-1	2007-09-05 12:02:05	1.13
CameraBrick-src-1.6-1	2007-09-05 12:02:04	1.7

talled.php?packname=tango_java_lib

Help   < Back   Next >   Cancel

Stop   Close

Core
Core

The fun continues…

…some challenges ahead

What beamline software in next years?

- ✓ Detector systems
- ✓ Beamline control evolution
- ✓ Nano: positioning, sample environment
- ✓ Graphical interfaces
- ✓ Automation projects
- ✓ Fast acquisitions
- ✓ Data: visualization, online analysis, large dataset handling

- ✓ Accrued beamline support

Detectors & Computing

- Essential on upgrade program / cutting edge technologies
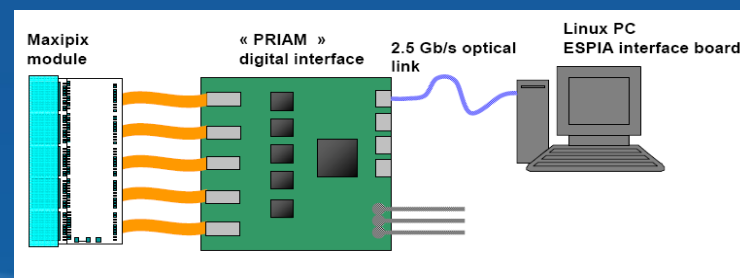- Commercialization / collaboration

- CCD:
  - Growing size: Mar / ADSC
  - Growing speed: Sarnoff CCD / 1 tomography in 0.8s
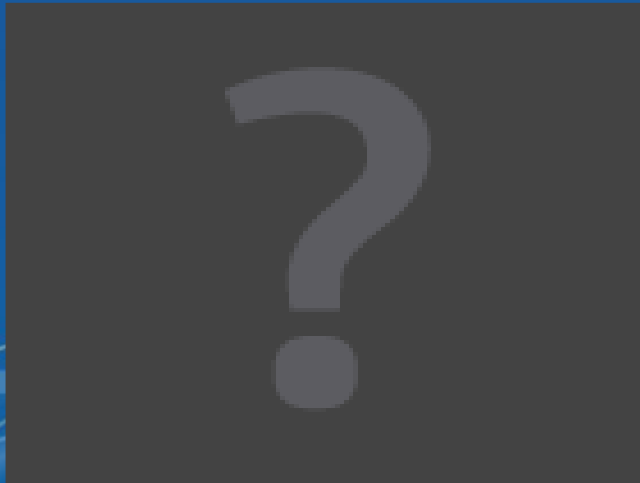   - 500 frames/sec = 125 MB/sec

- Pixel detectors
  - Maxipix (5 x 256 x 256 pixels) – ESRF -
    - 1000 frames / sec = 600 MB/sec
      - Expected limit: datalink / disk speed
    - Today
      - 1000 frame / sec for 1 x 256 x 256 (ID10)
  - Pilatus 6M (2400 x 2328 pixels) – SLS/ PSI -
    - 2ms readout ~ 500 fr / sec = 5 GB/sec
    - Today: 20 frame / sec = 200 MB/sec

- And more…

Maxipix module — « PRIAM » digital interface — 2.5 Gb/s optical link — Linux PC ESPIA interface board

Detectors / and still more to come

CMOS Photron Ultima

10 bits

Example: 4000 fps

Already tested at ID15 at 10000 fps (512 x 256)

2 Gb/sec

BEAM LINE CONTROL EVOLUTION

Issue

- Ensure the evolution of the beamline control system for constant modernization
- Follow up with functionalities offered by electronics developments
- Participate from/to developments in other European synchrotrons / XFEL

Software

- Evolution with linux kernels, hardware protocols.
- Consider embedded solutions
- Tango: participate to / profit of the advantages of the collaboration
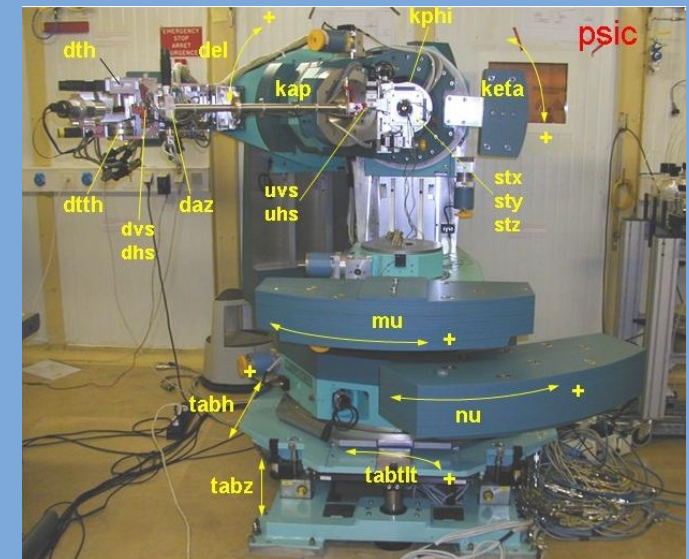
ID32 PSIC DIFFRACTOMETER

Fast/Continuous Acquisitions

- Enabled by electronics
  - Detectors with data buffering and near- zero readout (kinetics, pixel, mca buffering…)
  - Synchronization cards
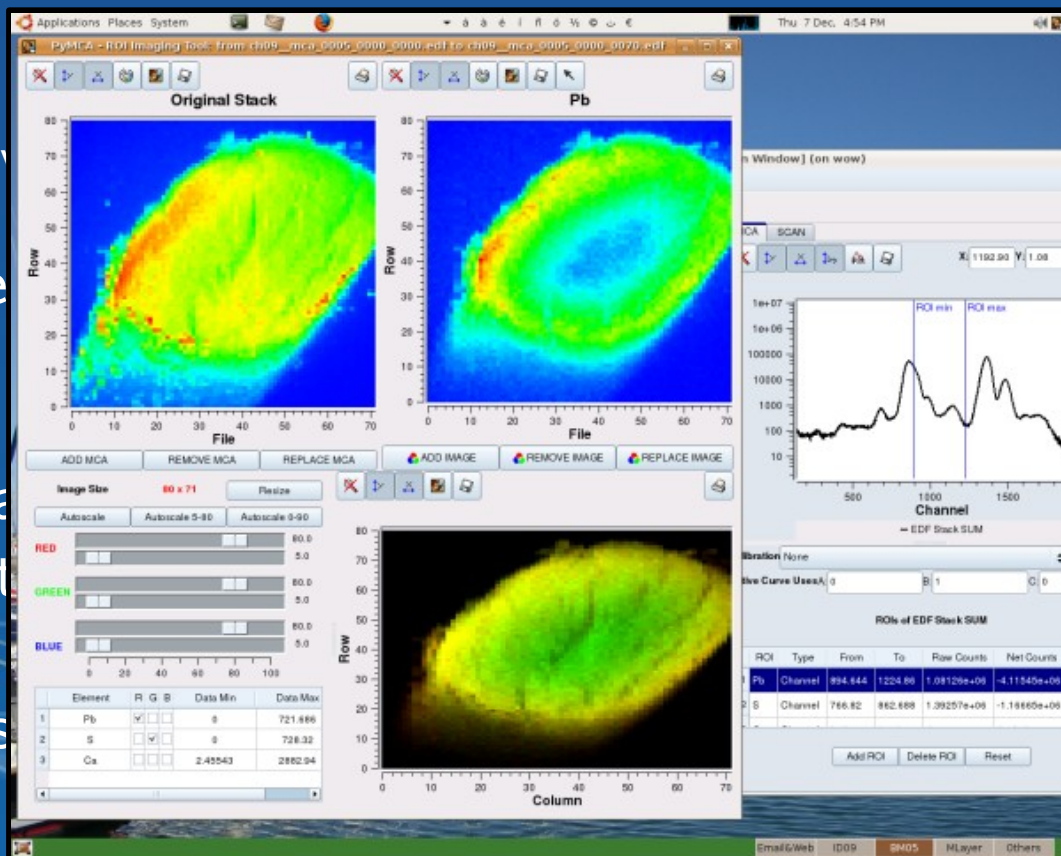 - Intelligent motor controllers

- Synchronization + buffering
  - From VCT6 synchronization to ISG suite:
    - MUSST for signal synchronization
    - Fully programmable features in Icepap
  - Software must handle them
  - Experiment sequences must be reconsidered

13-element detector
4xXIA DXP-XMAP

DATA HANDLING

- Visualization:
  - multi-dimensional, instruments

- Online analysis and estimation

- Navigate through data

- Data formats and met

- Experiment databases

European Synchrotron Radiation Facility

Thank you