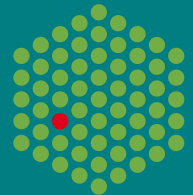


Progress Status for the EMBL Petra3

Beamlines

Uwe Ristau

EMBL



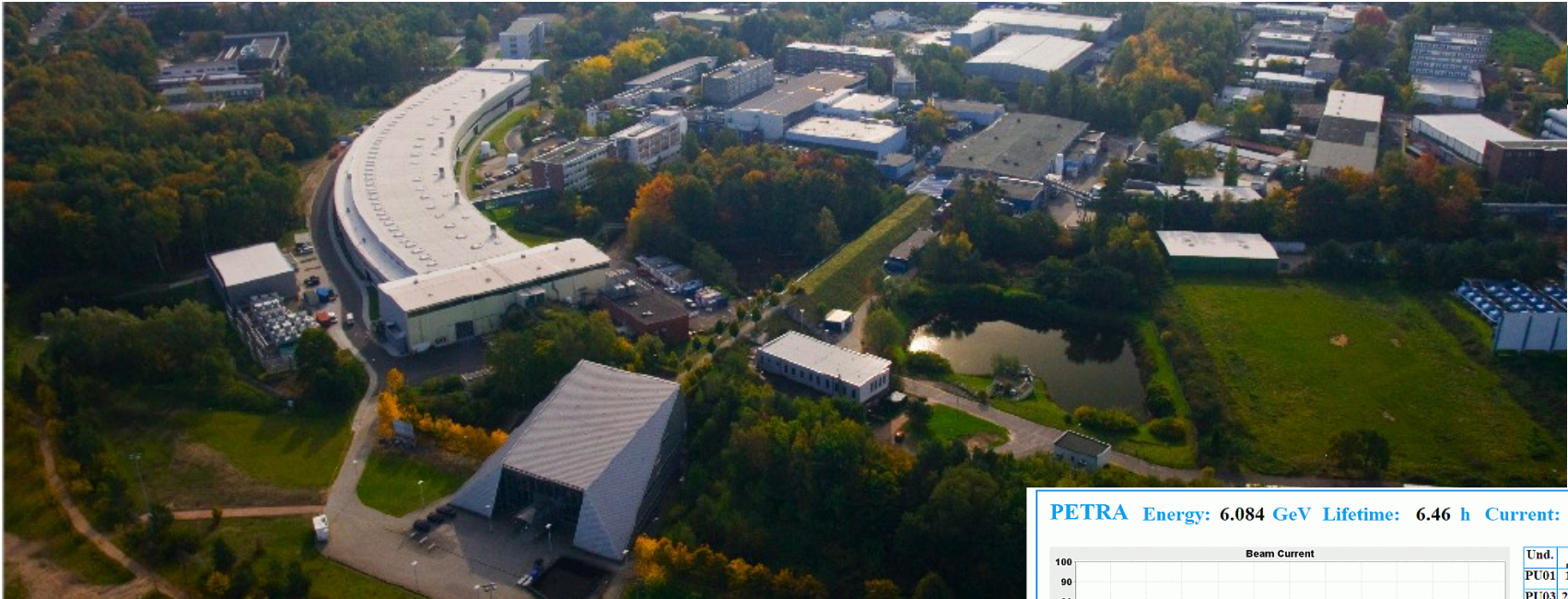
Overview

- Introduction
- Beamline control with TINE
- Software Architecture
- Control Electronic Architecture
- Example
- Outlook

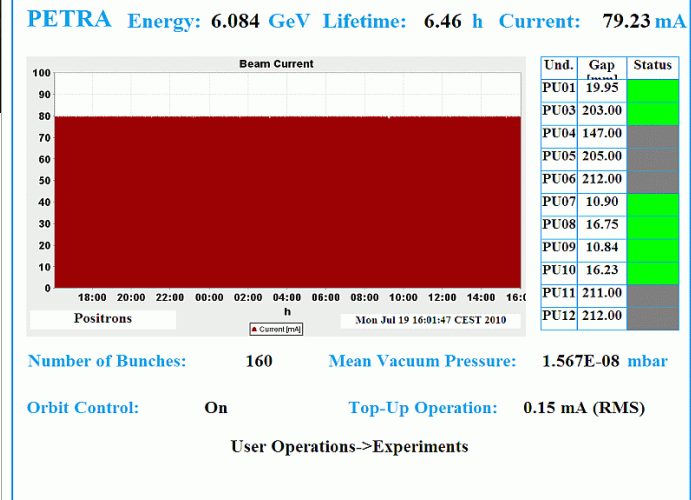
Introduction

- The European Molecular Biology Laboratory EMBL-Hamburg currently constructs an integrated infrastructure for life science applications at PETRA III / DESY.
- Beside others the centre comprises two Beamlines for Macromolecular X-ray crystallography (MX1, MX2) and one for Small Angle X-ray Scattering (BioSAXS).
- Two DORISIII/DESY wiggler beamlines are available as Test beamlines for hardware and software equipment

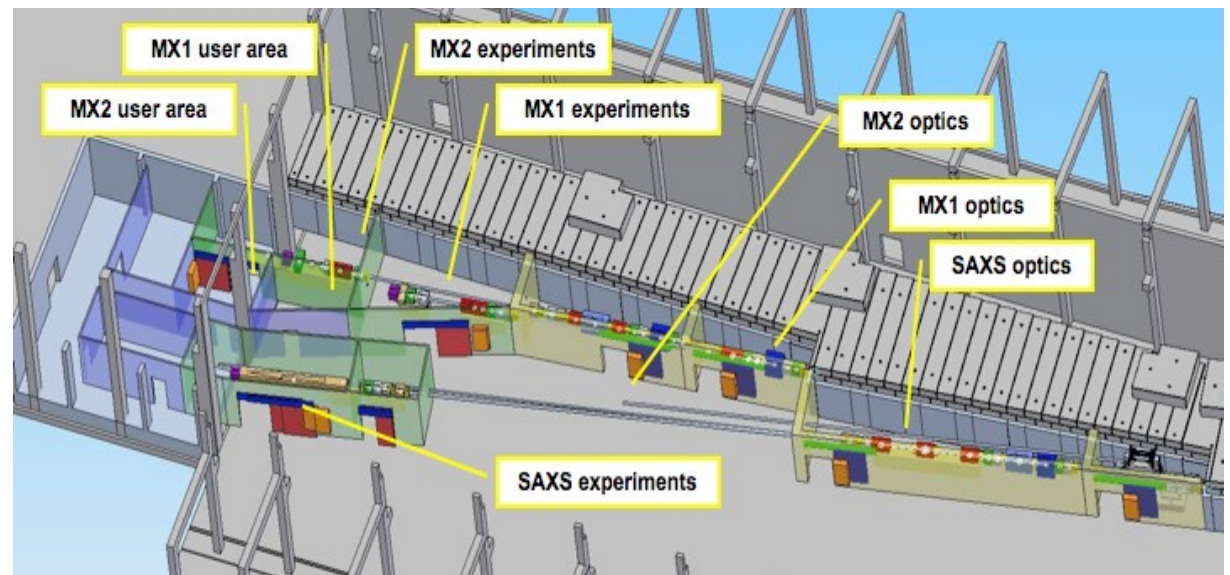
PETRA3 Beamlines



- Energy 6 GeV
- Current 100 mA (200 mA) – top-up
- Emittance 1.0 nm rad
- Coupling $\approx 1\%$
- Bunching 960 or 40 bunches
- Brilliance_u $\approx 10^{21}$ 1/s mm²mrad² 0.1%BW
- Circumference 2.3 Km



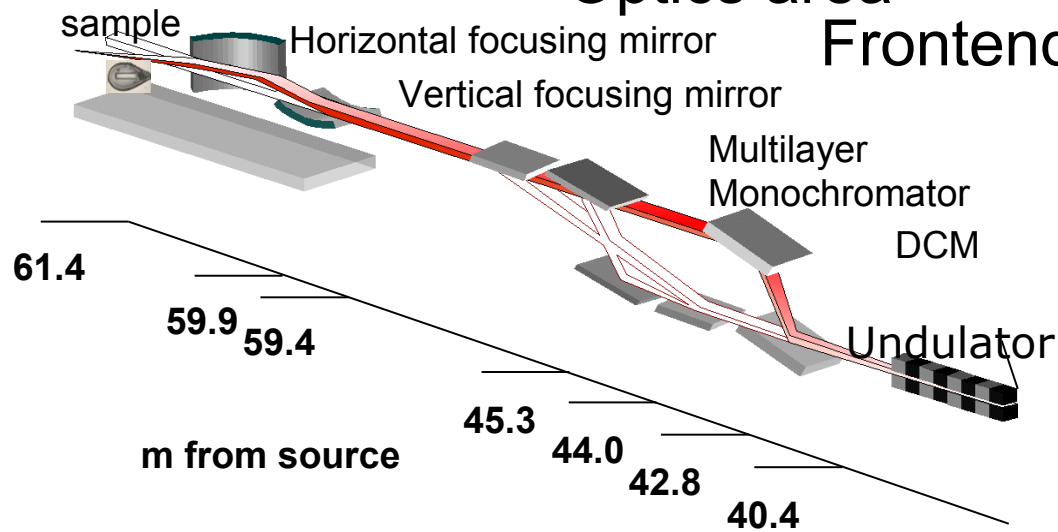
Operated in top-up mode



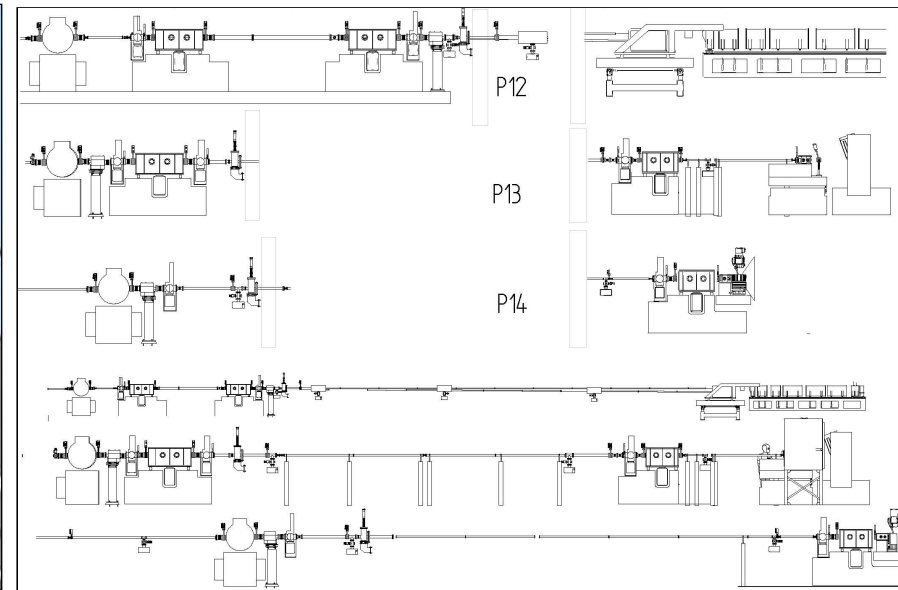
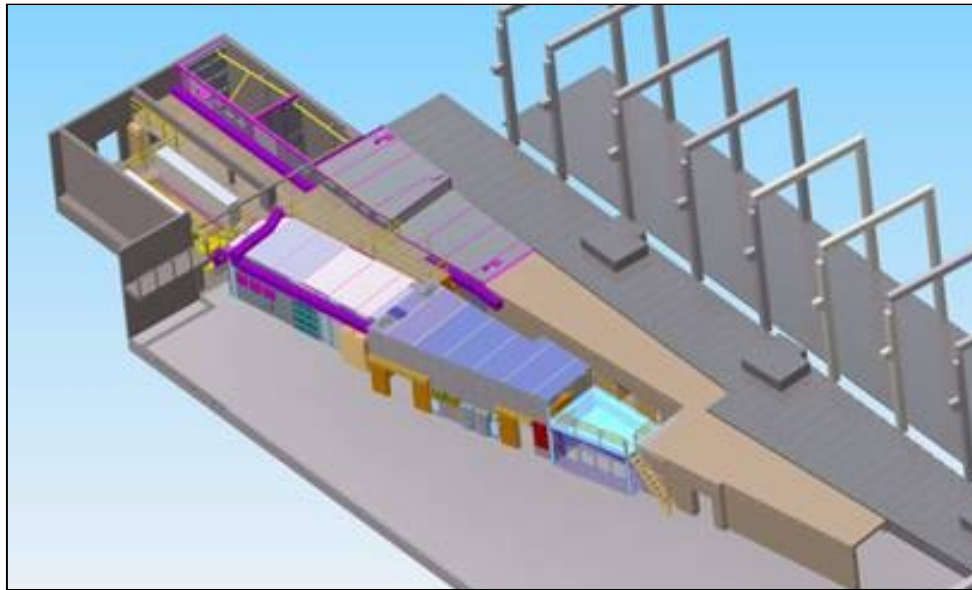
Experimental area

Optics area

Frontend



EMBL@PETRA III beamlines for structural biology



- 3 out of 14 PETRA beamlines operated by EMBL.
- One beamline for biological SAXS (P12) and two for macromolecular biology (P13 & P14).
- Standardized layout, optics & controls for all beamlines.

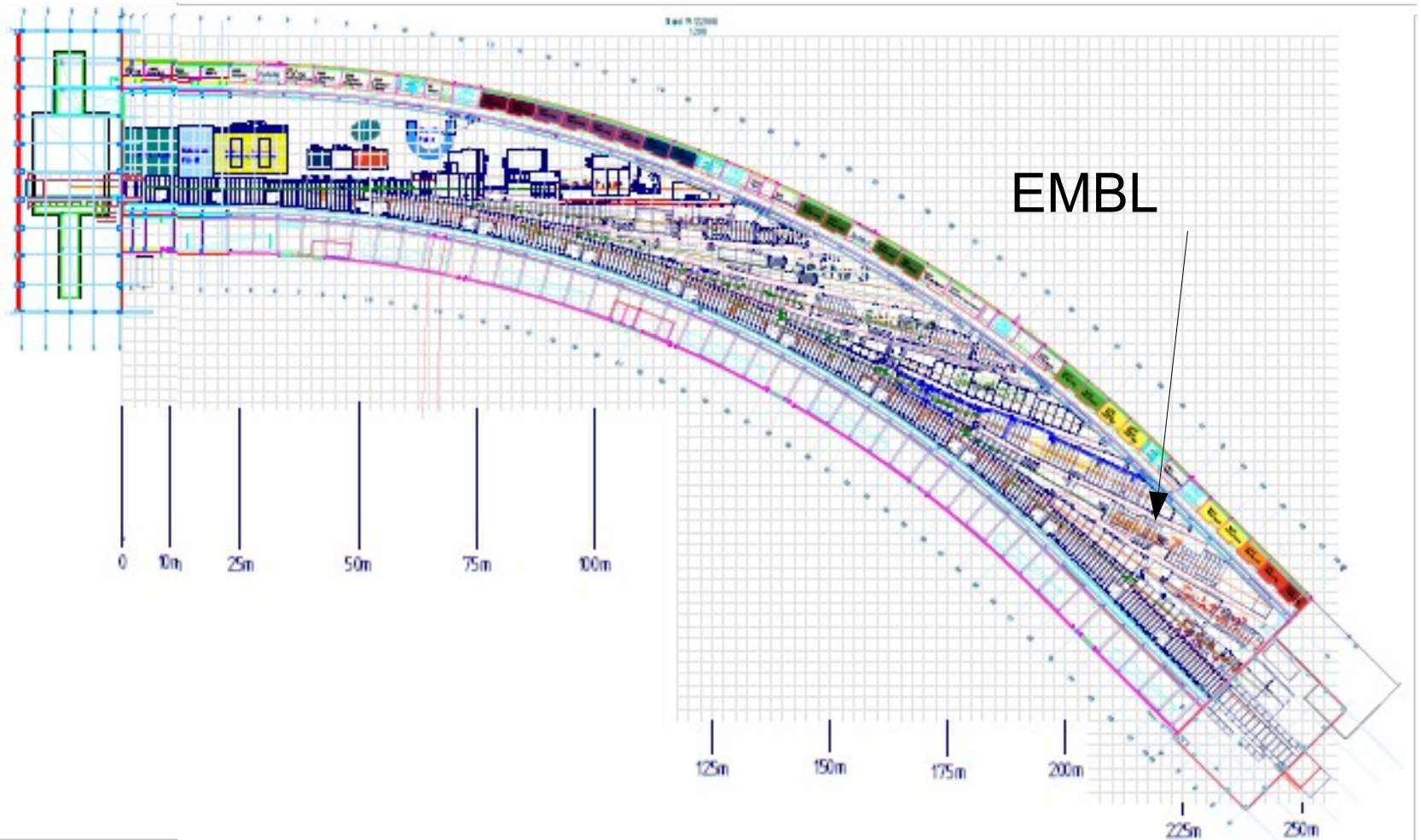
EMBL@PETRA III: Integrated facility for structural biology



- High Throughput Crystallisation Facility
- Wetlab for sample preparation and characterisation
- Computing facility for Data Analysis.
- Workshop, offices and seminar room.



Petra3 Beamlines



Instruments: (standard) double crystal monochromator



- All Double Crystal Monochromators installed and operational
- Motion control by fieldbus modules (exception Bragg axis) operational.
- BioSAXS & MX2 DCM: in beam commissioning started.

First beam

BioSAXS beamline

- First beam on frontend (white beam) on 15.7.2010
- First monomchromatic beam on 22.7.2010



MX2 beamline

- First beam on frontend of BioSAXS beamline on 9.9.2010
- First monomchromatic beam on 17.9.2010



MX1 beamline

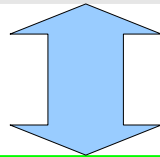
- Expected in 11/2010

Network Topology

TINE DESY 131.169.....

Repeater server for all important
Petra data are via the TINE GATEWAY
accessible at the EMBL
dataflow through the DMZ with communication
through defined ports

TineGateway



DESY DMZ

EMBL DMZ

EMBL

Standalone TINE installation

10.150.....

Experimental area Optics

MX1

MX2

BioSaxs

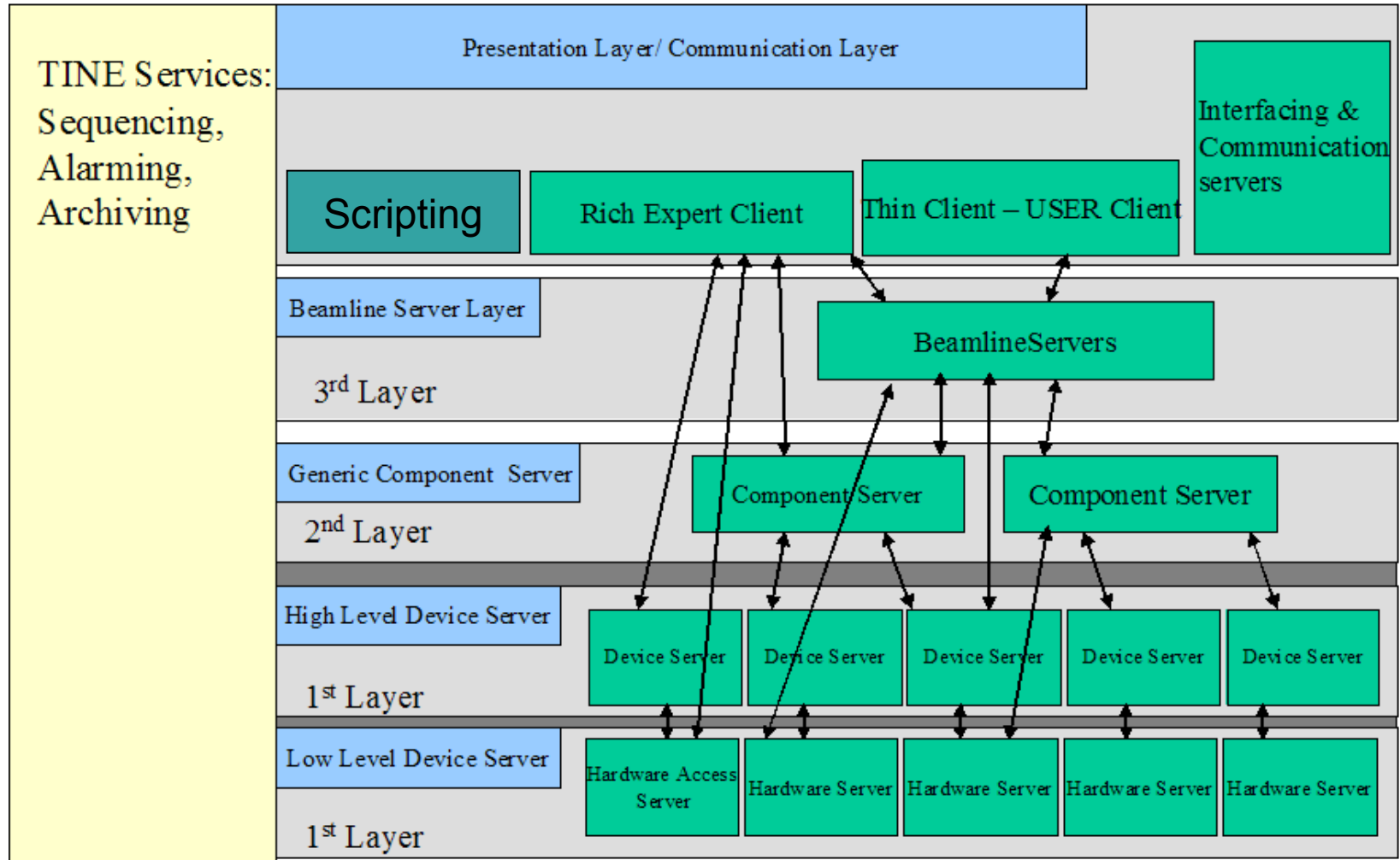
Hasylab

Frontend

Petra synchrontron

Undulator Beamlines

Software Architecture



Data Access Rights with TINE

- DelicateControl system data can easily be protected by:
 - Client Username (PC)
 - Client IP address
 - Server Property (Channel)

Platforms for PetraIII

- Linux
- WinXP/XPE

Programming tools

- C/C++ server programming
- LabView device server, Clients, Rich Clients remote Beamline software access
- TINE Common Device Interface CDI for Device access
- TINE Command line tools
- PyTINE Scripting
- MxCube Graphical Beamline User Interface ESRF

Software Modules

- Generic tine motor server
 - Beckhoff/TwinCAT motor K-Bus
 - Beckhoff/NC EtherCAT Plugin
 - Generic Detector server
 - Pilatus
 - Rayonics MX225
 - MAR 345, MAR165
 - Endstation software
 - Marvin SC device server
 - MD2 Tine device server
 - Data collection server
 - Instrument protection system
 - Vacuum control
 - Experiment server
 - Metaserver
 - General Beamline tools
 - Scope
 - Function generator
 - ...
 - Experiment Web access
 - ISPY_B connectivity
 - GUI Experiment control MX beamlines
 - Bliss Framework/ MX-Cube
- Scripting tools
- PyTine
- Slit scanning server
- Mirror server
- Remote Beamline Access
 - TINE Videoserver

GOAL

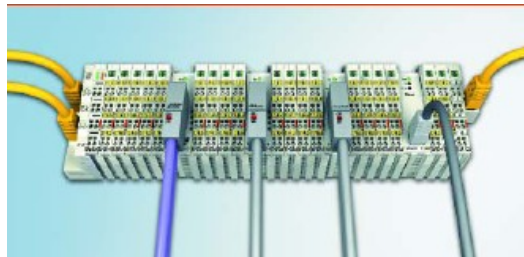
- Distributed electronic
- All Signals, Monitors, Motor parameter etc synchronized to each other

PLC Electronics

- Distributed-> short signal lines
- New Ethernet based
 - signal synchronization <1ms
 - acquisition cycle <1ms
- Servo and Stepper motor control
- Requirement: AI 16 bit
- Counter : 5MHz

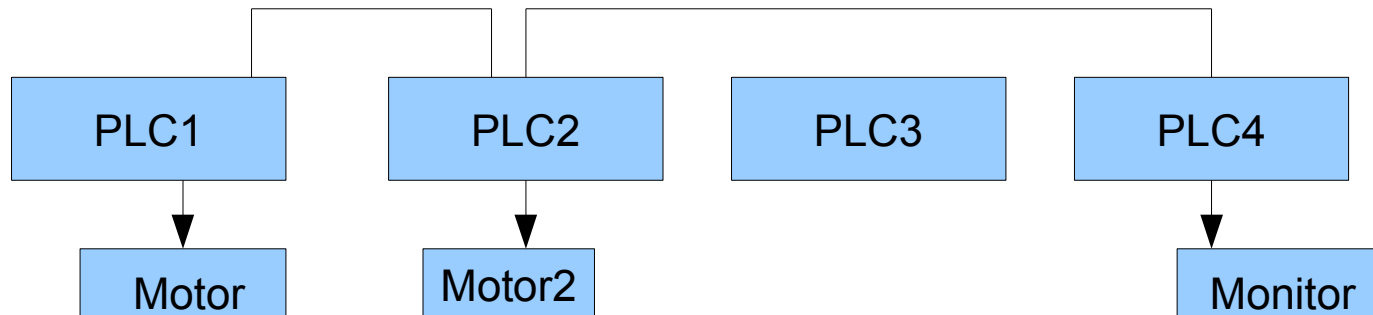
TwinCat/EtherCAT Features

- EtherCAT=CANOpen over Ethernet ->open protocol
- real time software PLC cycle times 100 us
- Master Master Clock synchronization 1 us.
- interfacing to (CAN, S5, SerCos, Profibus Gateways available)
- Counter, DIO, AIO
- NC numeric motor control of TwinCAT operates servo motors, stepper motors, dc motors,....
- DIO XFC (extreme fast controls) modules of Beckhoff timing to 100ns. Incremental timing with 10ns steps possible,
- Analog input up to 200kHz (15 bit,0.5%precision) Overclocking
- 24 bit AI available
- EtherCAT open protocol
- www.EtherCAT.org



EtherCAT PLC Signal Synchronisation

Data Bridge Beckhoff EL6692

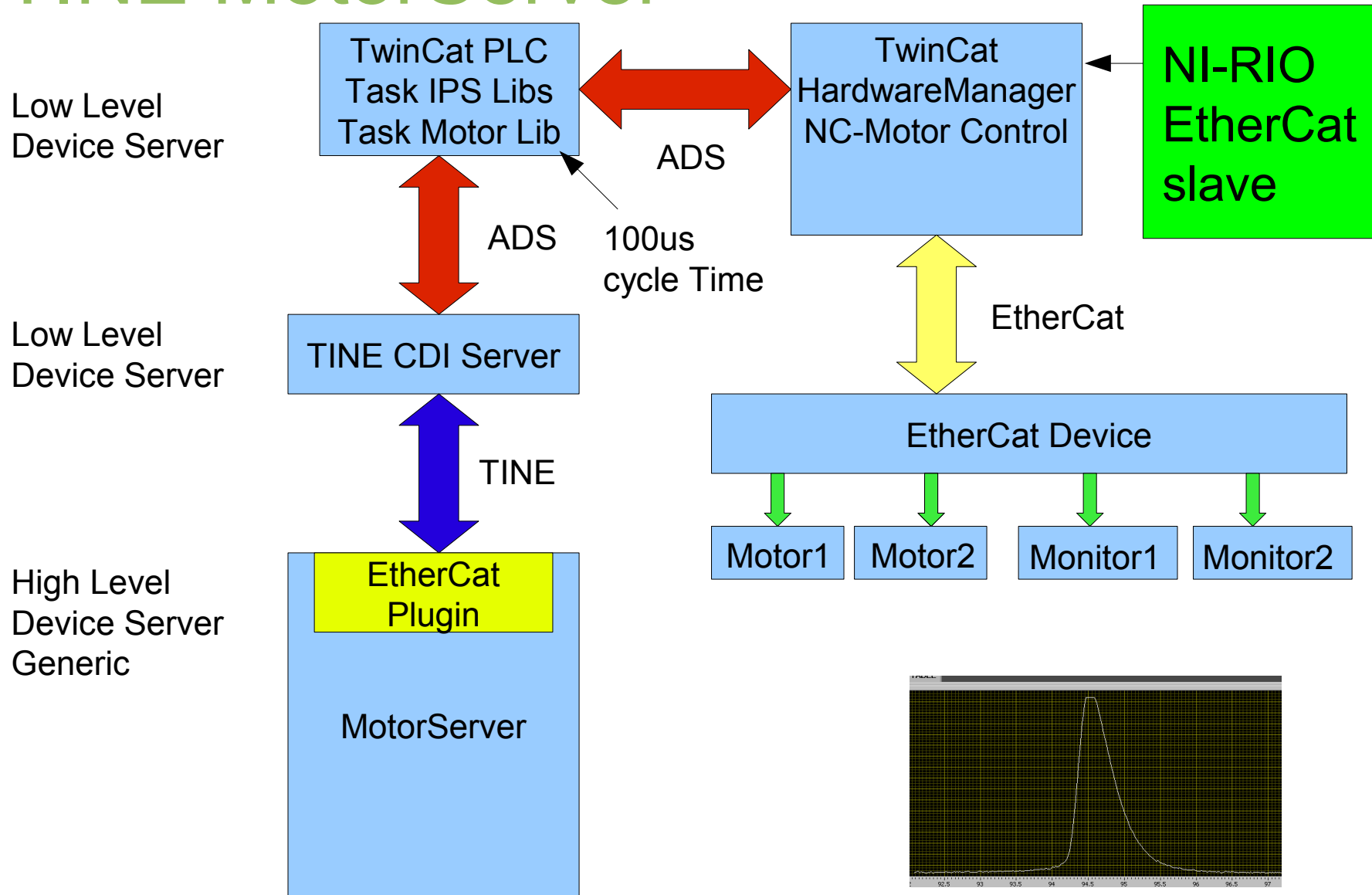


PLC clock synchronization Cycle synchron up to 100 kHz
NEW: NI - RIO series

TINE Generic Motor Server EtherCat Plugin

- Support for closed and open loop motor control
- Definition of MotorGroups (Pseudo motor axis in file)
- Motor configuration in file
- 'Step scan' for motors or Motor Groups
- 'OnTheFlyScans' of motors or predefined Motor groups
WaitTime zero enables the PLC to store Axis position and Monitor Value to PLC array.
- Scan(StartPosition,StopPosition,MoveIncrement,WaitTime,Monitor[])

TINE MotorServer



TwinCAT NC Hardware Management system

TwinCAT Numeric Control
Servo axis control
closed and open loop

The screenshot displays the TwinCAT System Manager interface on the left, showing a project tree with various components like NC-Task 1, Jack1, Jack2, Jack3, and Jack4. The main window shows the configuration for Jack2, including parameters like Setpoint Position, Actual Velocity, and Target Velocity. The Instant Client (Instance 1) window is open, showing the device context (TEST), device subsystem (ALL), device server (MotorSteering), and device name (Mot1). The device property is set to Position. The data size is 7 and the data type is DOUBLE. The description is motor position. The status bar shows the current position of Mot1 as 1.33413597941399E-02.

Instant Client (Instance 1)

Print... Options... Debug Tools... Monitor... Input Panel!

Device Context: TEST

Device Subsystem: ALL

Device Server: MotorSteering

Device Name: Mot1

Data Size: 7

Data Type: DOUBLE

Description: motor position

Device Property: Position

PositionMaximum

PositionMinimum

PositionOffset

PositionScale

Reset

RotationMoveAllowed

ScanMove.PAUSE

/TEST/MotorSteering/Mot1 Position @ Sep 28 13:40:55.243

(0) Mot1 : 1.33413597941399E-02

(1) Mot2 : -4.45599985122681

(2) Mot3 : -8.23999345302582E-02

(3) Mot4 : 0

(4) Mot5 : 0

(5) Mot6 : 0

(6) Mot7 : 0

draw mode

Text dun

transport

udp (default)

```

C:\WINDOWS\system32\cmd.exe
>
StatusBits <READ ACCESS> -> motor status
IncrementGroupMove.RESUME <READ|WRITE ACCESS> -> m
VelocityMaximum <READ|WRITE ACCESS> -> m
StepMove.STATUS <READ ACCESS> -> Status 0
IncrementGroupMove.START <READ|WRITE ACCESS> -> m
MicroStepsPerStep <READ ACCESS> -> Motor
Move.PAUSE <READ|WRITE ACCESS> -> Pause M
IncrementGroupMove.STATUS <READ ACCESS> -> m
FreeMove.PAUSE <READ|WRITE ACCESS> -> Pau
target <-
StepMove.PAUSE <READ|WRITE ACCESS> -> Pause Move to target <-
PositionOffset <READ|WRITE ACCESS> -> motor position offset <-
IncrementMove.RESUME <READ|WRITE ACCESS> -> Resume Increment Move to tar
get <-
IncrementMove.START <READ|WRITE ACCESS> -> start Increment Move to target
position <-
IncrementMove.STOP <READ|WRITE ACCESS> -> Stop Increment Move to target
<-
Move.START <READ|WRITE ACCESS> -> start Move to target position <-
RotationMoveAllowed <READ|WRITE ACCESS> -> Linear Rotation Moves (end sw
itc <-
FreeMove.PROGRESS <READ ACCESS> -> Progress (seconds remaining) of Free
Move (no endswitch control) <-

```

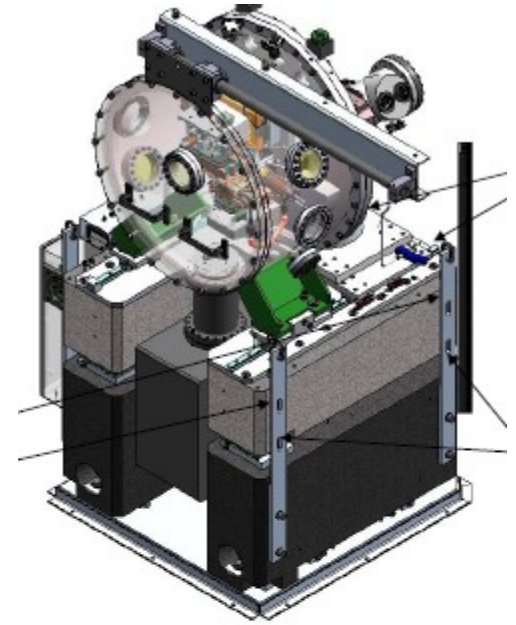
servers are automatically generated
by the TINE MotorServer and CDI.

EMBL – FMB Oxford Monochromator

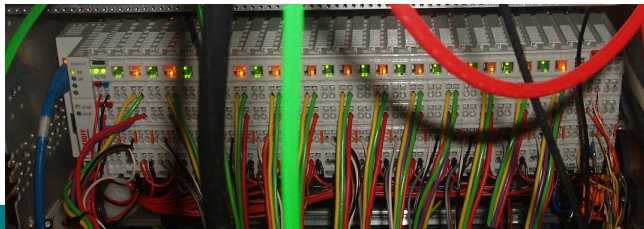


FMB Oxford
Bragg axis: PMAC

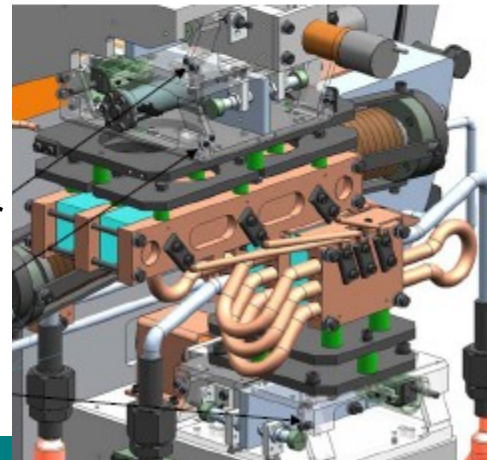
Fine adjustment :
Piezo motors,
PI controller



Crystal stage



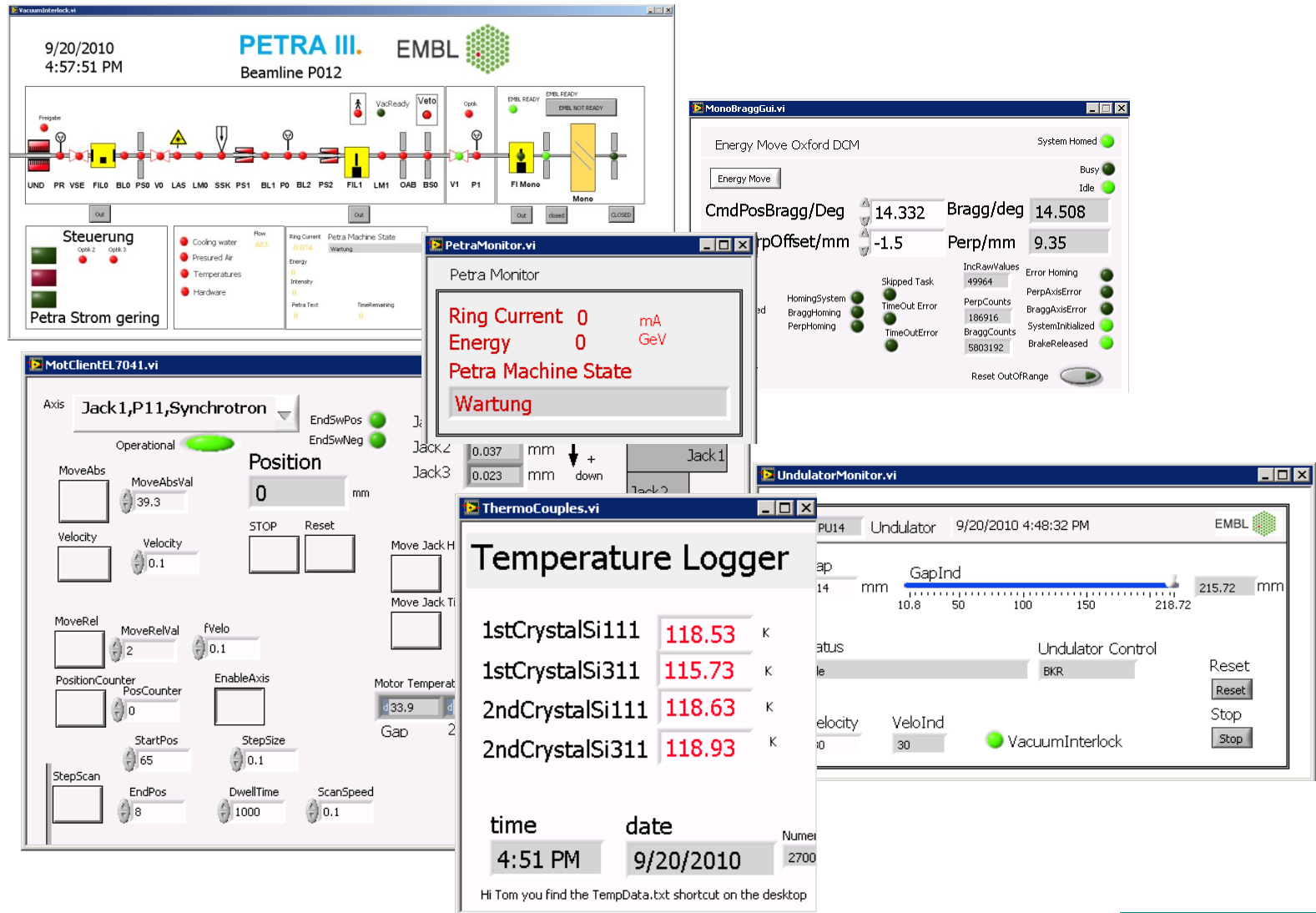
Motor



Stepper Motor control :
Ethercat motor controller
Renishaw encoder

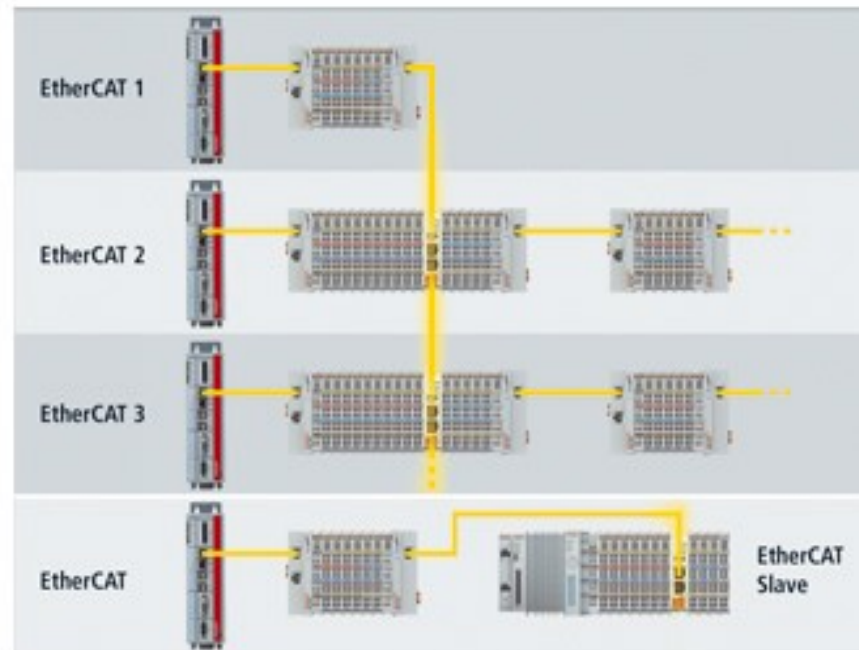
Beckhoff EtherCAT control electronic

Beamline Frontend GUIs Status



The EtherCAT bridge terminal EL6692

- data exchange between EtherCAT strands with different masters.
- synchronization of the distributed clocks



Beckhoff @ the Petra Synchrotron

Ring: Undulator control

Positioning of the Petra Dipol magnets

Beamlines Hasylab:

Vacuum interlock

Control of the large offset Monochromator

GKSS :

Detector tube for the BIOSaxs Beamline

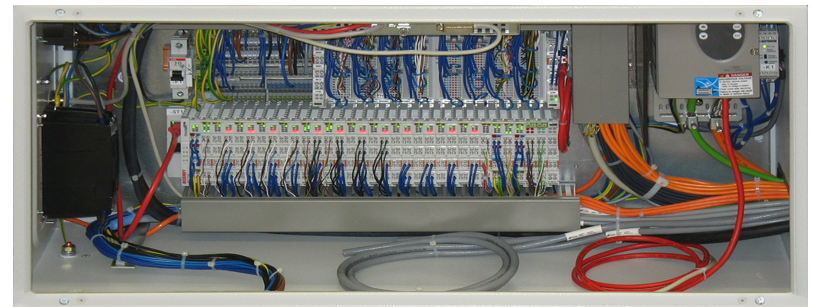
EMBL:

Monochromator

Mirrors

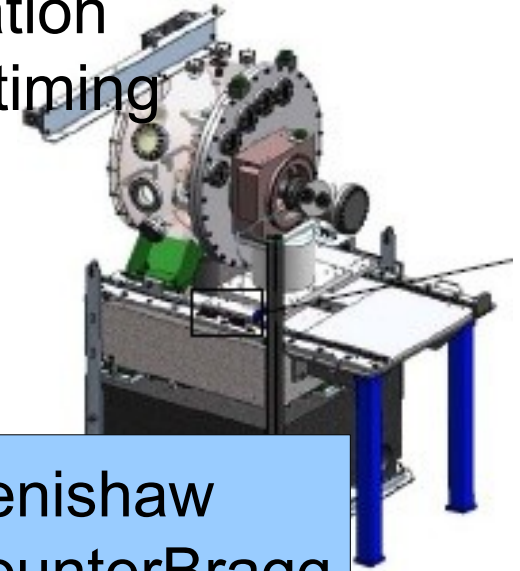
Slits

Tables

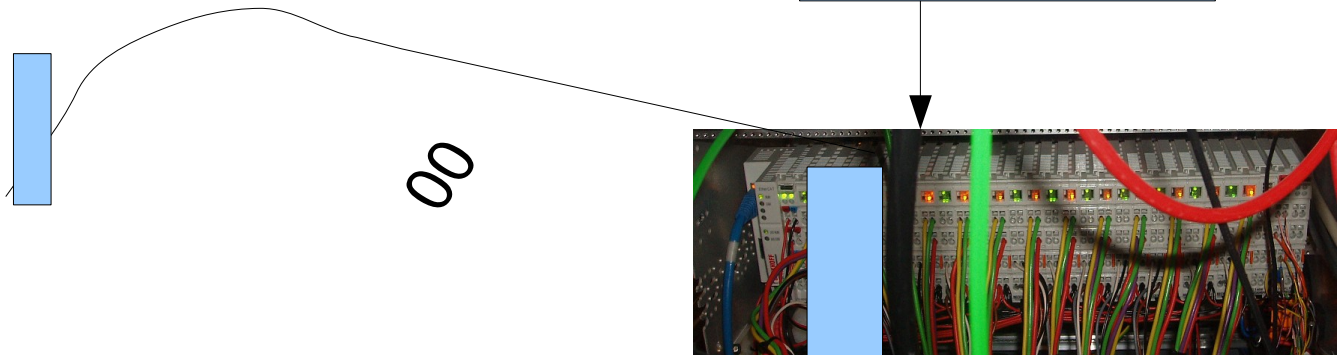


Monochromator - Undulator synchronization

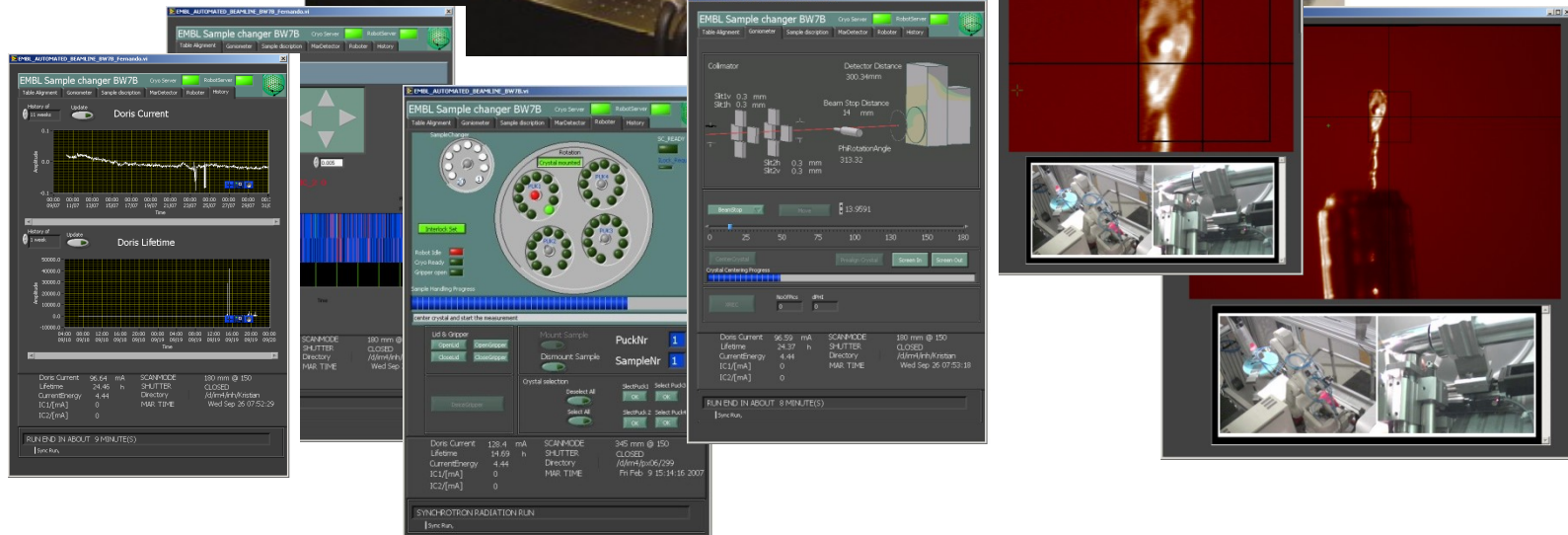
Hardware synchronization
With EL6692 Communication
Box PLC cycle synchron timing



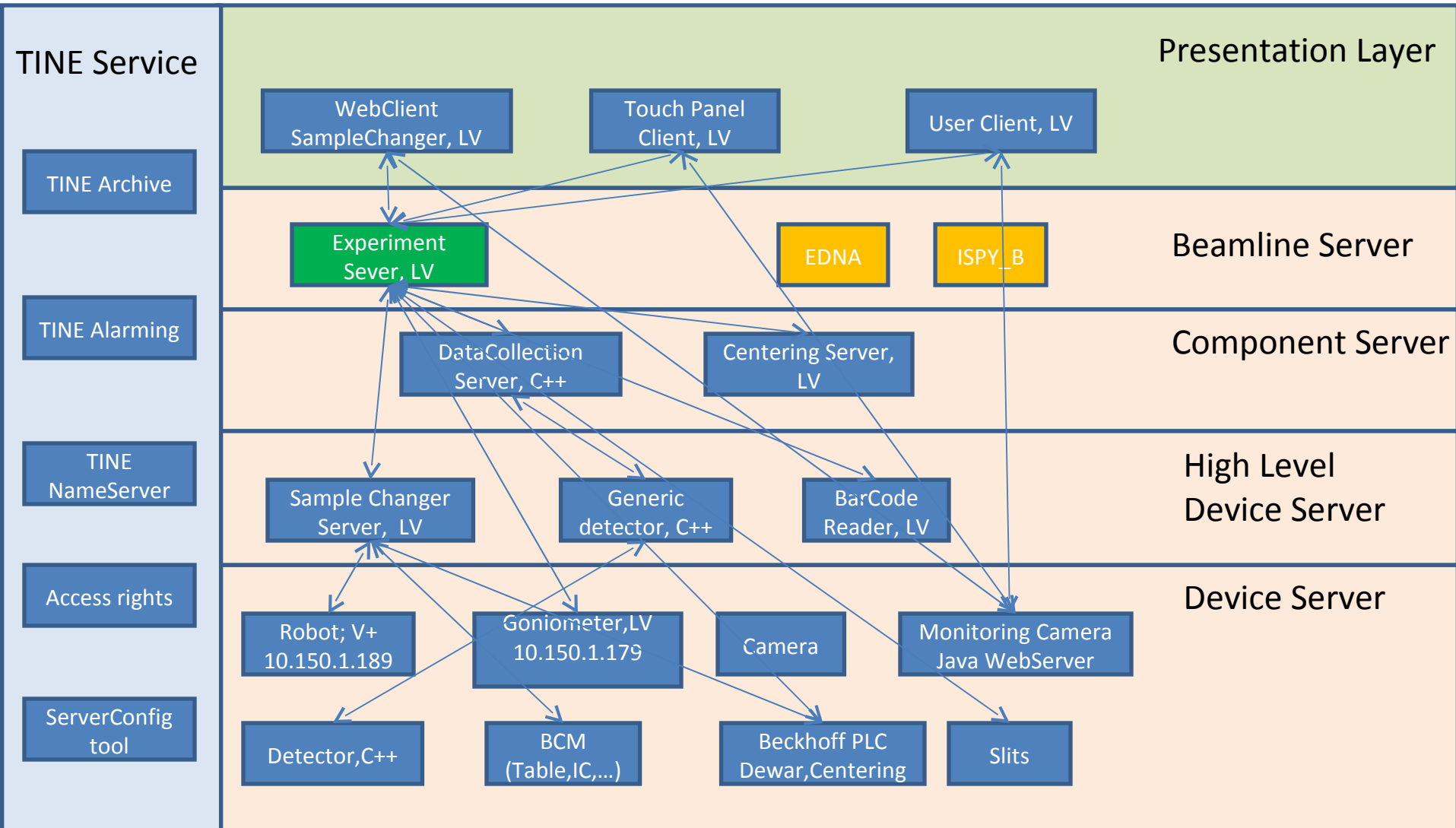
Renishaw
CounterBragg



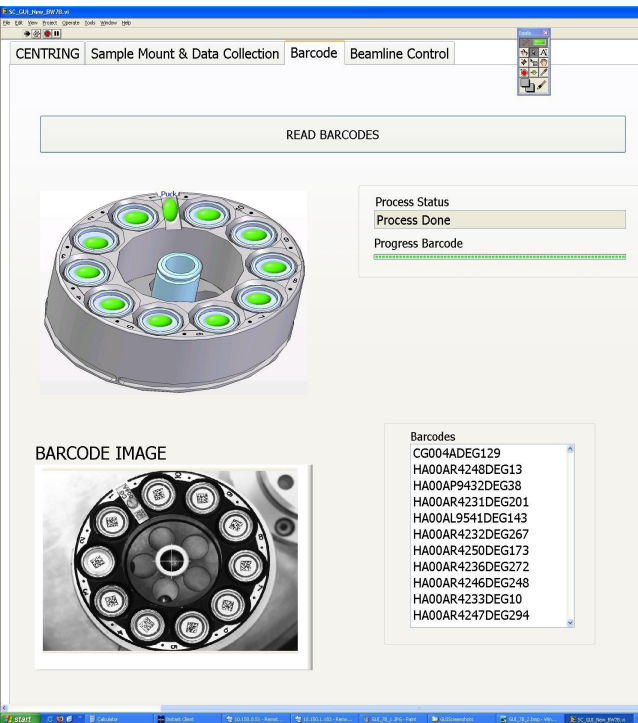
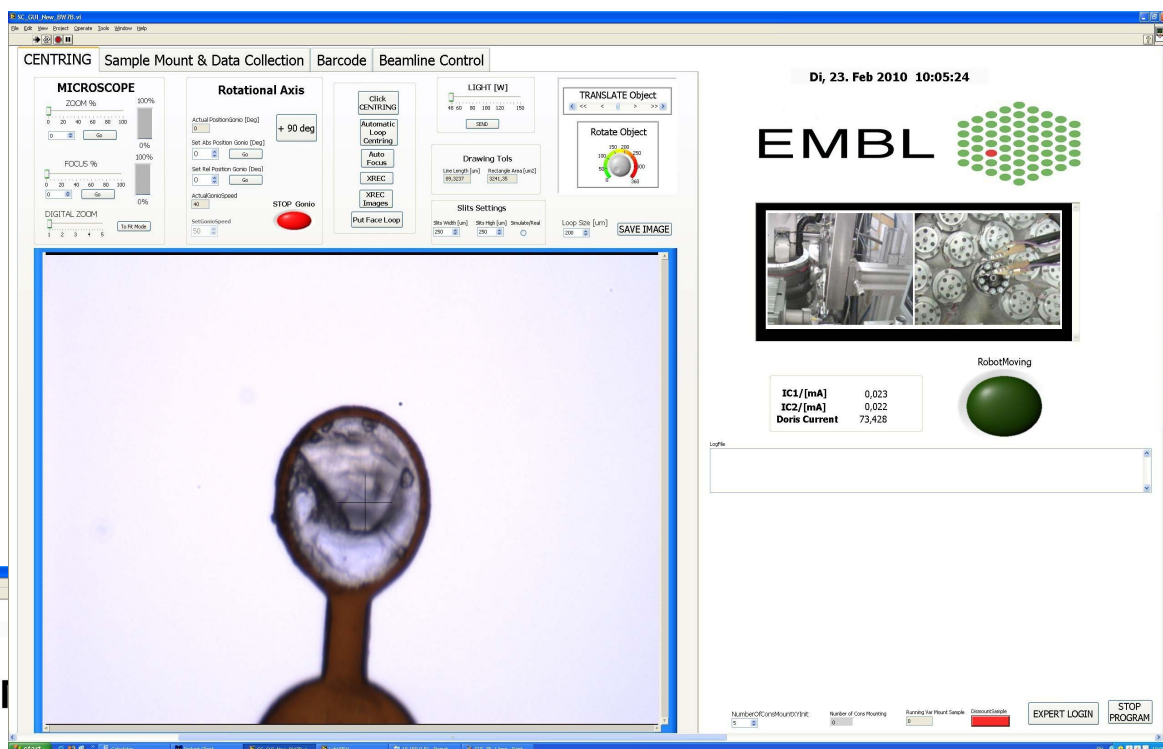
Robotic Sample Changer development



SC Software Integration



EMBL MARVIN



Experiment control

SC_GUI_New_BW7B.vi

File Edit View Project Operate Tools Window Help

CENTRING Sample Mount & Data Collection Barcode Beamline Control

Di, 23. Feb 2010 10:07:52

SC Activity

PositionNr

Load Puck from Load position to Center Position

Eject Puck From Center Position to Load Position

Put Puck to Position Nr from Load Position

Eject Puck from Position Nr to Load Position

Put Puck From Center Position to Position Nr

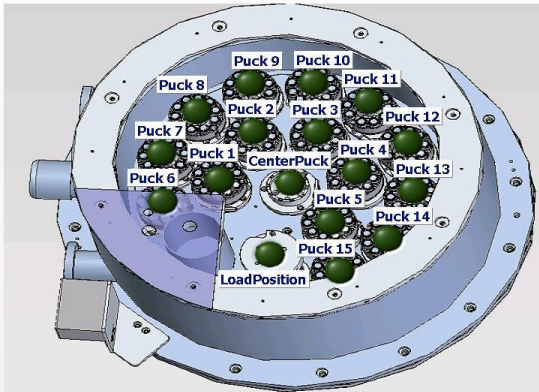
Get Puck From Position Nr to Center Position

Dry Gripper

Open Lid

Close Lid

CRYO Storage Dewar



Sample Number

Mount Sample Dismount Sample Take Data

Process Status

Sample Handling Progress

Screening

Samples to Process



Process Status

Sample Handling

Cycle Repetition: Val Nr Processed: Cycle Count:

Wedge ID: Duration: Range/Deg:

Start Position: Start Frame: end Frame:

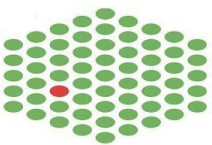
File Name Extension:

Image Directory:

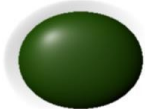
File Name:

Start Cycle Stop Cycle

EMBL



RobotMoving



IC1/[mA] 0,023
IC2/[mA] 0,022
Doris Current 85,186

LogFile

NumberOfConstMountYInit: Number of Const Mounting: Running Var Mount Sample: DismountSample:

EXPERT LOGIN STOP PROGRAM

start calculator Instant Client SC_GUI_New_BW7B.vi LabVIEW 10.150.0.51 - Remot... GUI_7B_2.bmp - Paint Test_VREC_2_10_Mb... GUIscreenshots

EN 10:07

Acknowledgments

- Petra3 Instrumentation Group
- Groupleader Stefan Fiedler
- Andres Pazos
- Mario DiCastro
- Bernd Robrahn
- Lifu Gao

and

- Philip Duval MCS, DESY

Outlook

EMBL is the Pioneer for TINE Beamline control

others should follow - TINE is a excellent choice