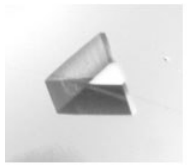
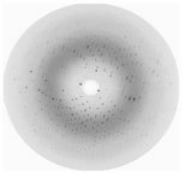
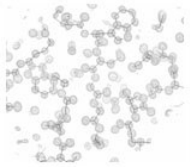


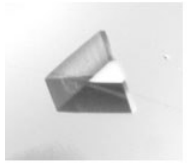

EMBL Beamline control at Petra III

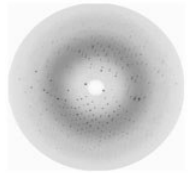
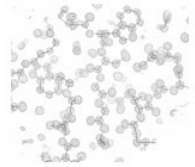
Uwe Ristau

PCaPAC 2008

Petra III Instrumentation EMBL-Hamburg

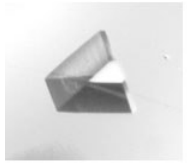
Content

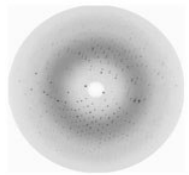
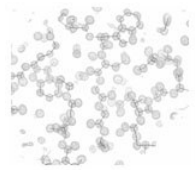



- Introduction
- TINE @ EMBL
- Control Concept for Petra III
- Control Electronic
- Beckhoff TwinCAT/EterCAT

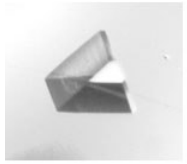
Introduction

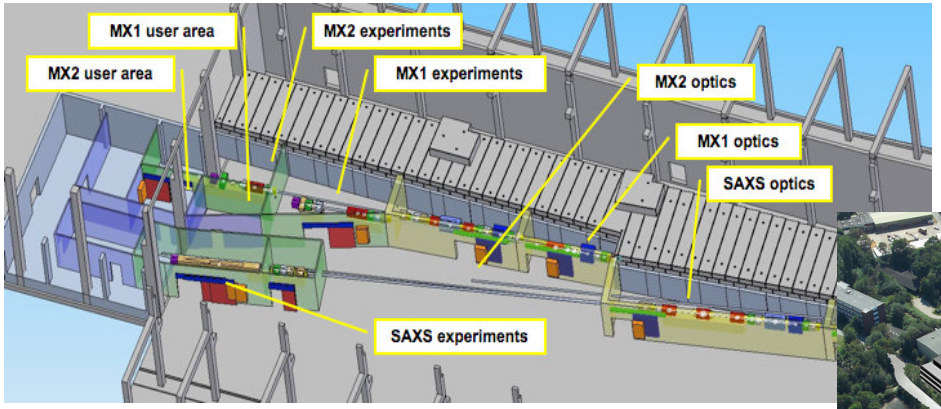


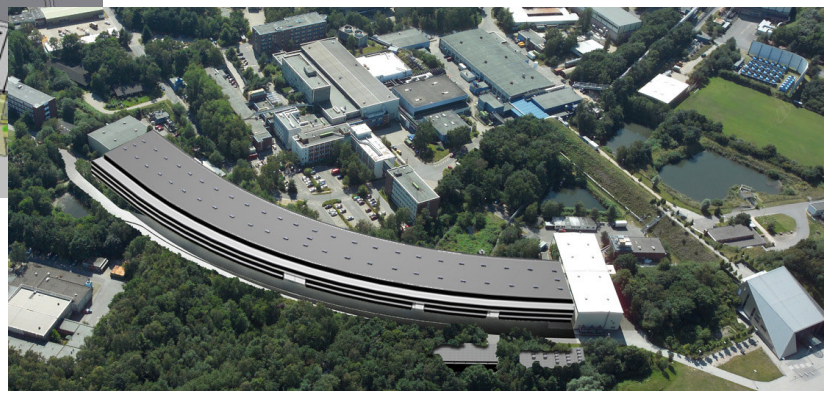
- The European Molecular Biology Laboratory EMBL-Hamburg will build and operate an integrated infrastructure for life science applications at PETRA III / DESY.

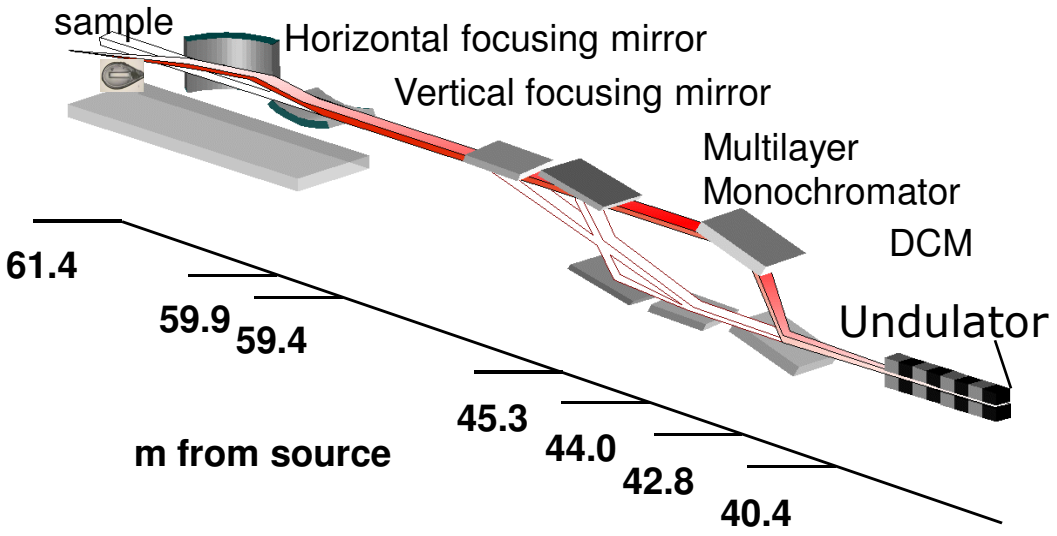
- Beside others the centre comprises two Beamlines for Macromolecular X-ray crystallography (MX1, MX2) and one for Small Angle X-ray Scattering (BioSAXS).
- The EMBL operates currently 6 Beamlines at the DORISIII/DESY synchrotron





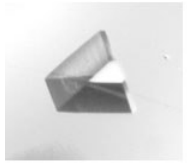
EMBL

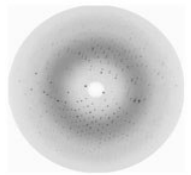
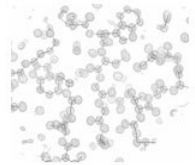




BIOSAXS Beamline
first experiment 4/2010

TINE @ EMBL



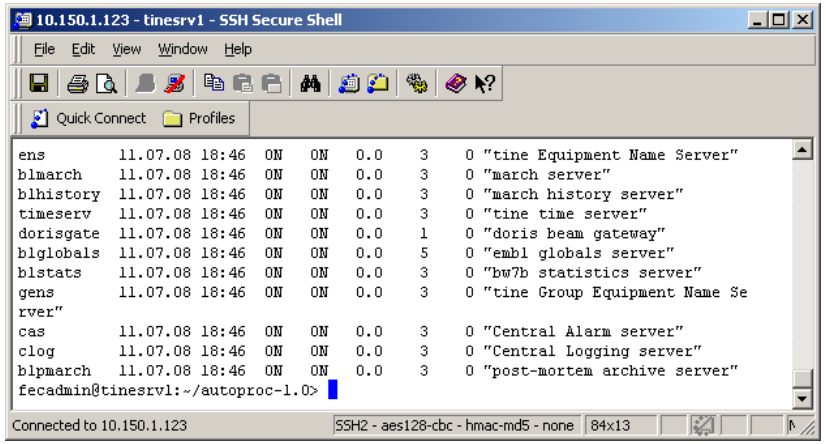




•TINE was first installed at the DESY/DORIS III Beamline BW7B in 2006. Since than the Beamline control module BCM, the experiment control and a robotic sample changer are controlled by TINE. Presented at the PCAPAC 2006.

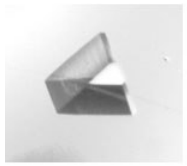
•Now TINE is integrated at the Doris Beamline for small angle scattering X33 and at the MX Beamlines BW7A and BW7B.

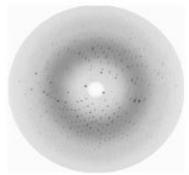
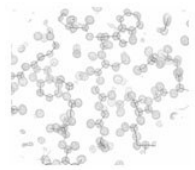
•Since the beginning of 2008 BW7A and BW7B became test Beamlines for the new Petra III project of the EMBL. At the moment the first applications with the Petra III control concept are implemented at this Beamlines.

TINE
Stand alone
Installation



Why TINE

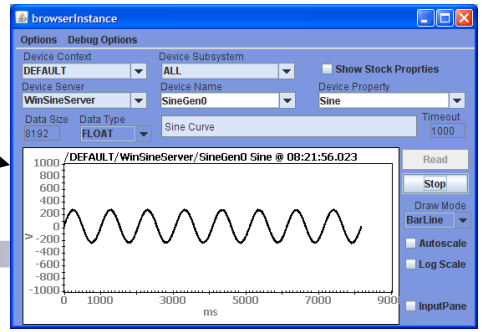



- Very good support of MCS
- TINE unique features:
  - Different transport protocols: UDP,TCP/IP….
  - Multicast Video server in UDP
  - Labview server API
  - WinCE support
  - Data types like <str,dbl,dbl>
  - ….

TINE additional tools

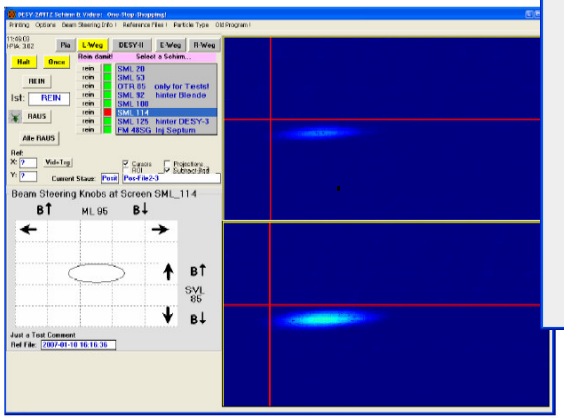
TINE
Instant
Client

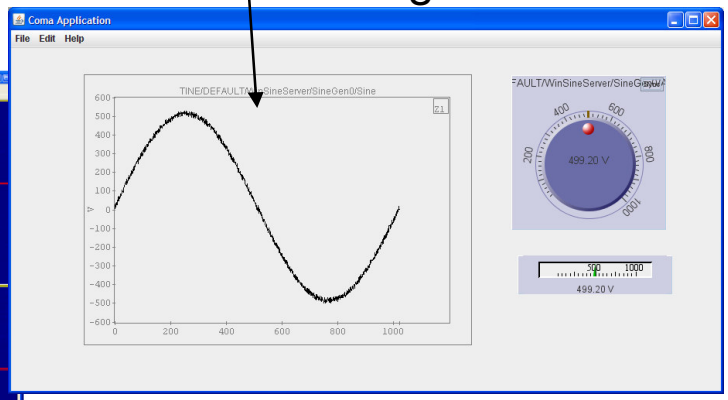


TINE JAVA
COMA TOOL

RUNTIME
Client generation!

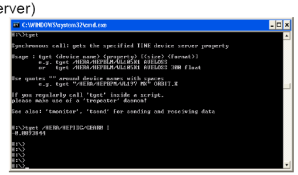
TINE Video
(Multicasting + Scheduling)





TINE command-line tools

- tservers (queries the ENS for registered servers)
- tdevlist (queries a server for its devices)
- tproplist (queries a server for its properties)
- tinfo (queries a server for property information)
- tget (synchronous read-only call to server)
- tsend (synchronous write/read call to server)
- tmonitor (asynchronous read-only poll to server)
- thistory (queries the archive server)



With 'tget' in tcl scripts
PLEASE use a tineRepeater !

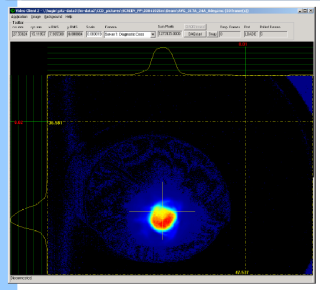
Secure Web access

Common device interface

TINE Workshop September 2007

TINE Video System

3: Video Client 2

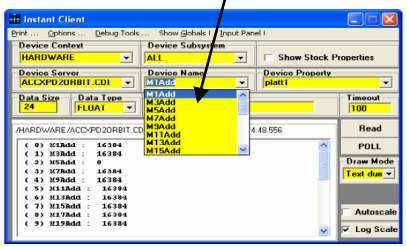


- main client-side tool
- data taking
- live monitoring
- image analysis
- image correlation

plate Devices:

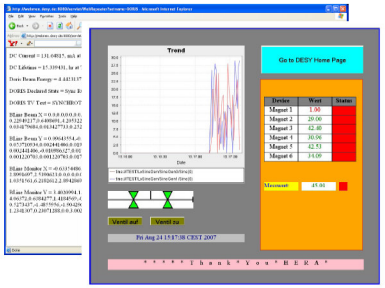
"abcd.xyz"

factored into
operty Query
cedent List =>



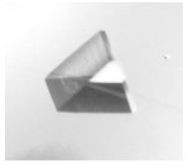
TINE Web Applications

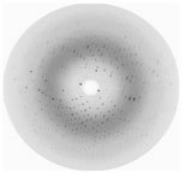
- TINE Client Servlet
- PHP Interface (Daresbury)
- Web2C (**Web**-based controls **c**lient)
  - Thin Ajax Client

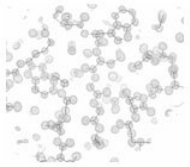


Stefan Weiße

Platforms for PetraIII







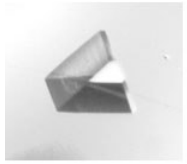
- WIN
- Linux
- MAC
- WinCE

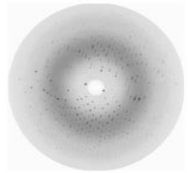
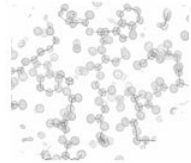
Talk by Andres Pazos

Server Programming tools

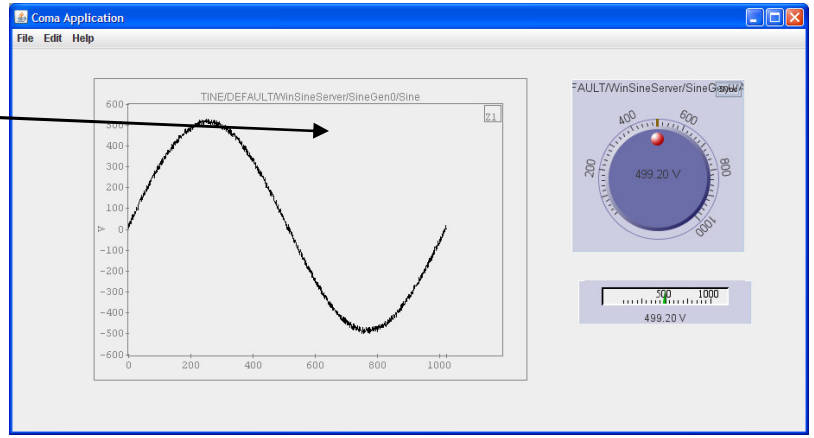
- C++ for server integration
- LabView device server
- CDI Tine Common device interface for hardware access
- Java hardware independent servers

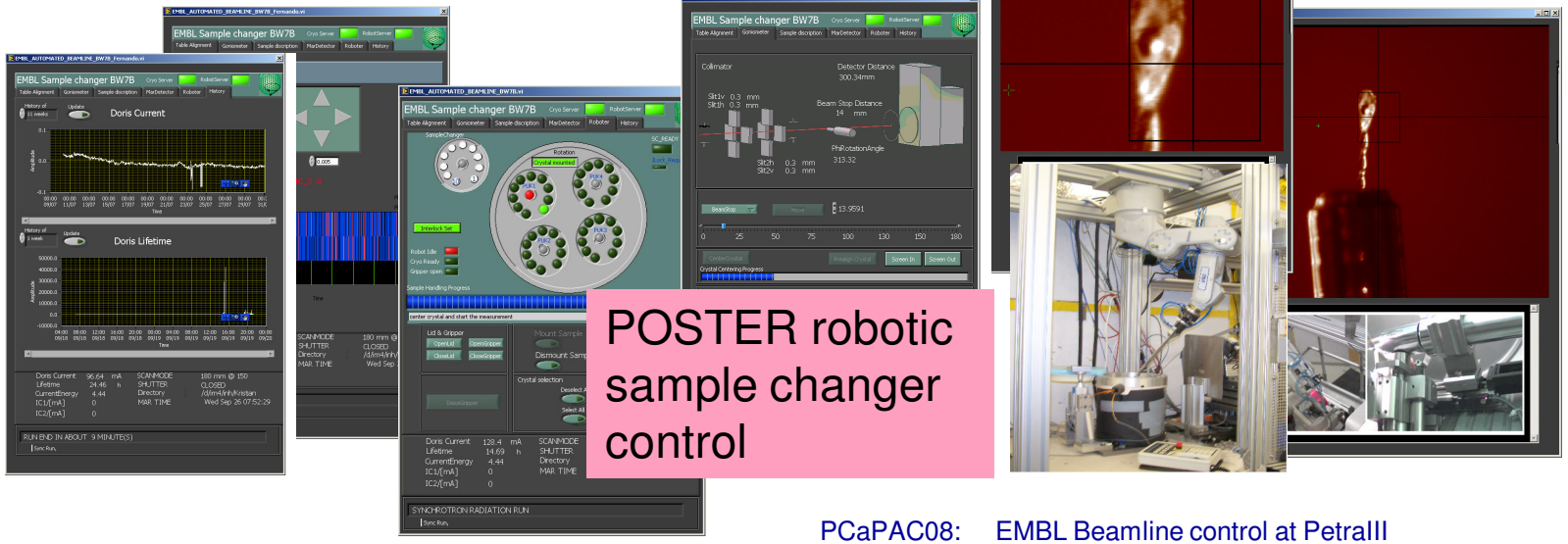
Client Programming tools




- TINE COMA-> client generation in runtime!
- Labview TINE API for Win/Linux/MAC
- TINE ACOP Java Win/Linux/MAC
- Web2C /Web service/Ajax

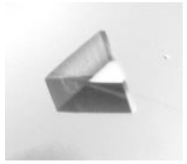


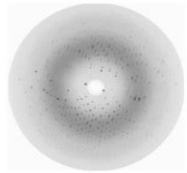
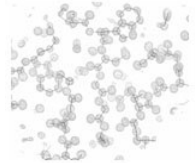


POSTER robotic sample changer control

PCaPAC08: EMBL Beamline control at PetraIII

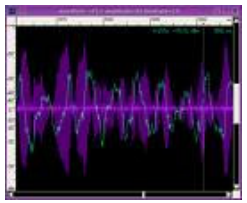
LabView and standard devices



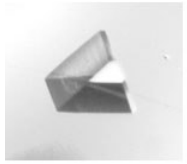

- Device control software for many standard devices like oscilloscopes (Tektronics, HP, LeCryo, etc..) ,function generators, multimeter (Fluke, Agilent, Keithley,…)

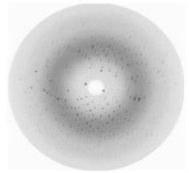
Spectrum analyzer are available for LabView as download at www.ni.com.



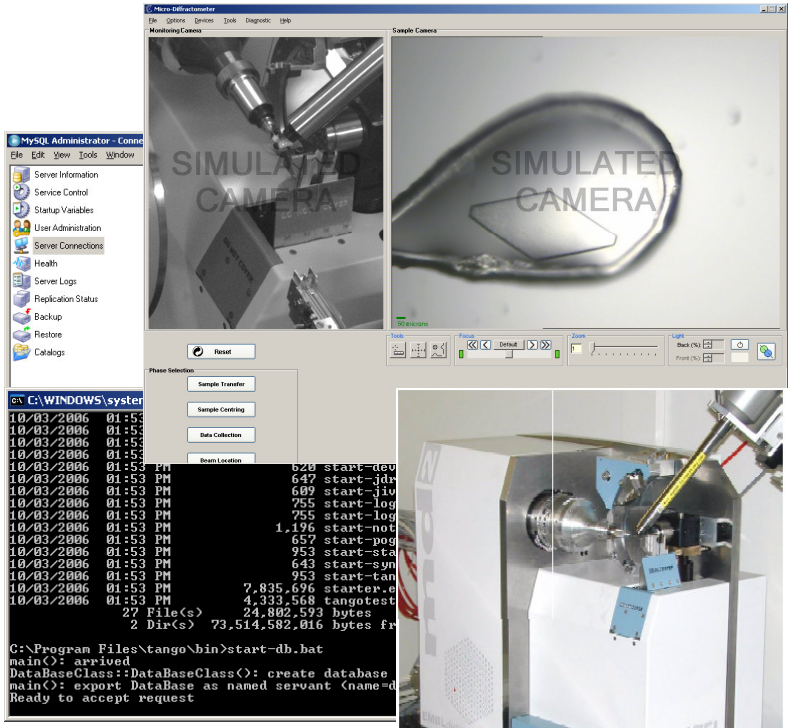
It is quick to create a TINE device server device driver is available

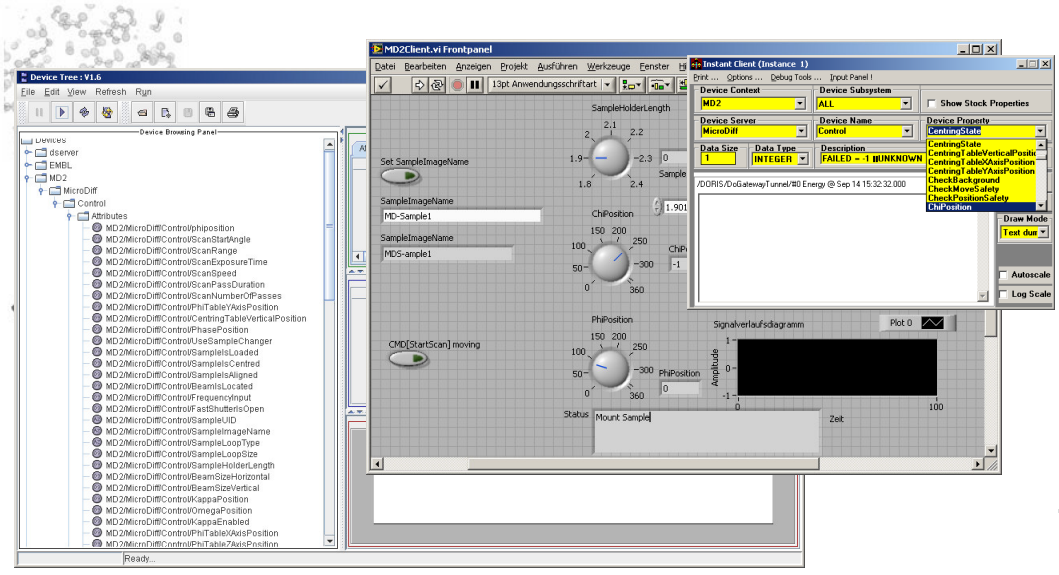
Interconnectivity





- TINE - TANGO Gateway
- TANGO - TINE Gateway
- by Cosylab / EMBL DESY MCS
- Single server translation
- Will be used for fast Tango server startup. Not permanently!





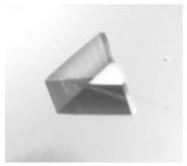
MD2 server (TANGO)

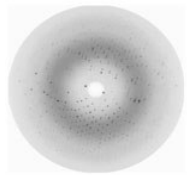
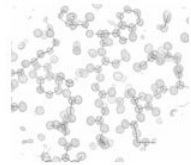
translation

MD2 server (TINE)

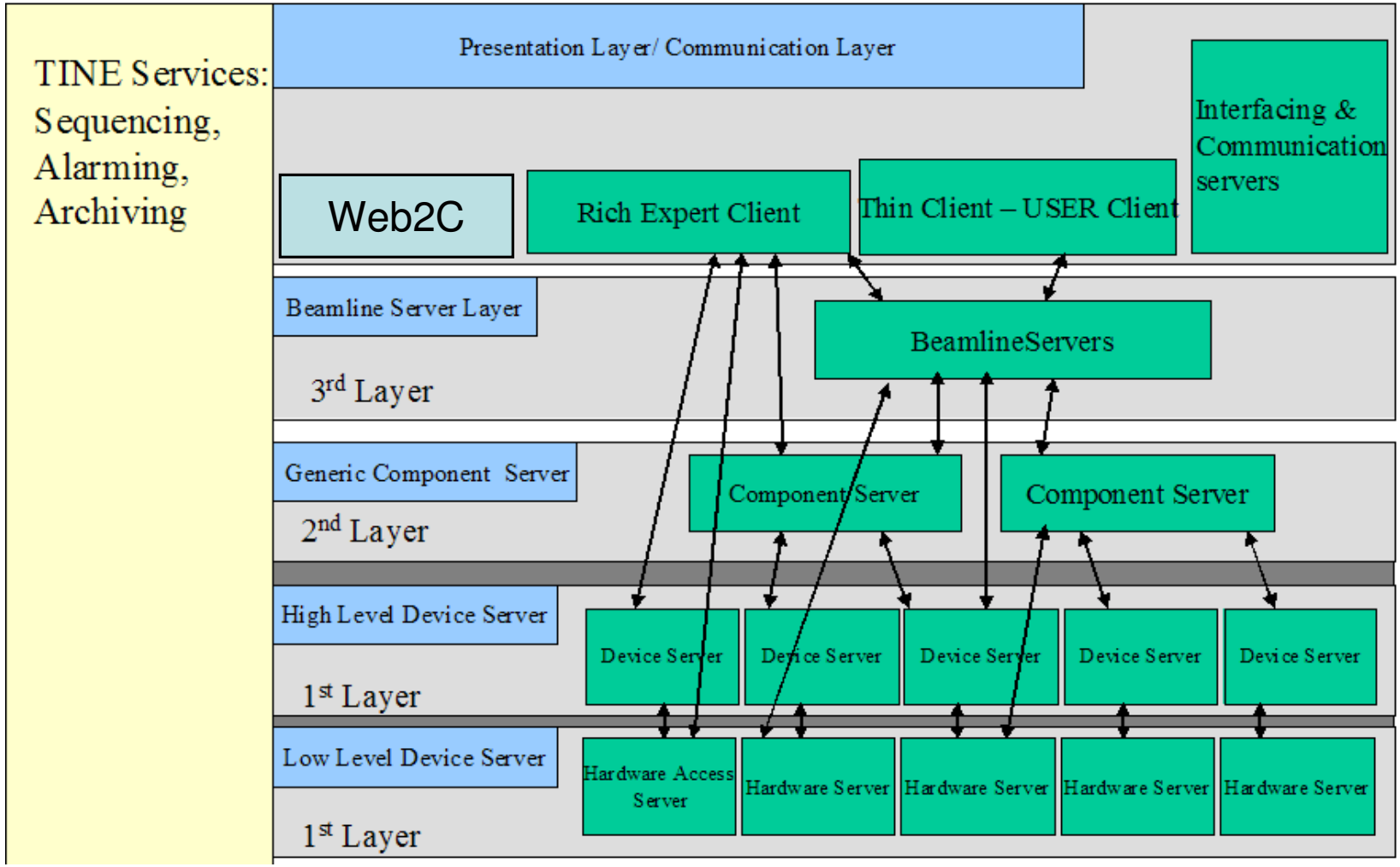
TINE Client

EMBL Control Software Concept

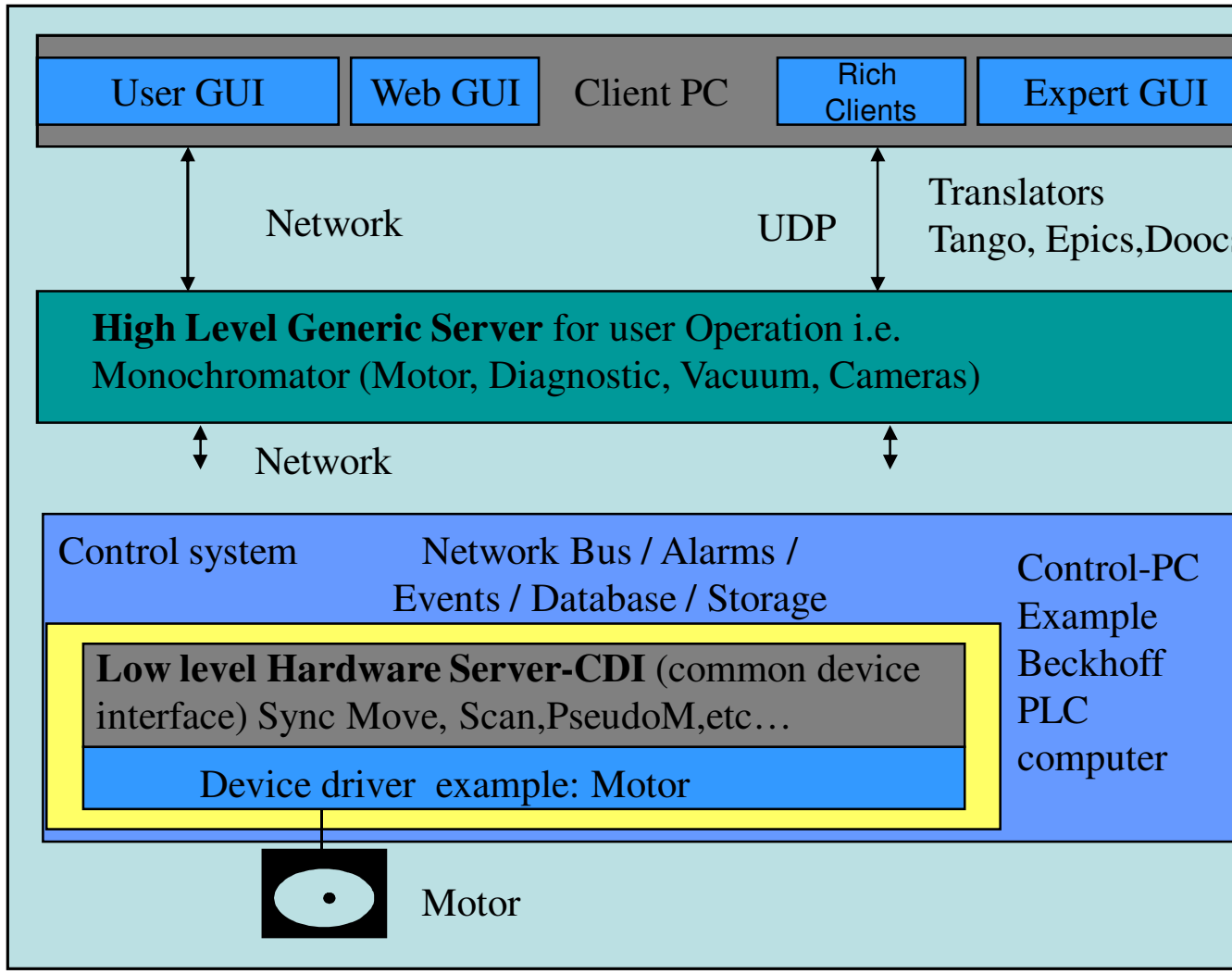


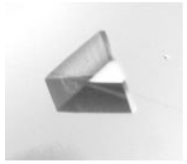

TINE Services:
Sequencing,
Alarming,
Archiving

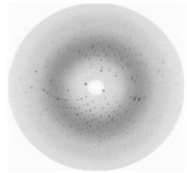
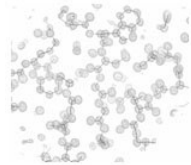


Example Server Hierarchy

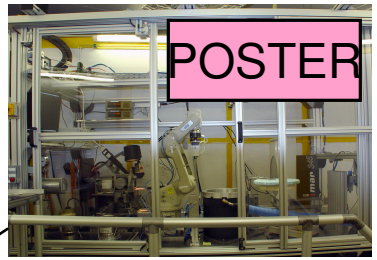


Beamline Software



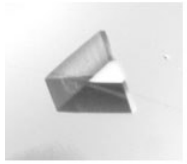
- Beamline Server
  - Feedback
  - Alignment
  - User Database
  - Data processing
  - ….
- Component Server
  - Monochromator
  - Mirror
  - Collimator
  - Sample Changer
  - Diffractometer
  - ….
- Device Server
  - Beckhoff
  - Goniometer
  - Centering
  - Video

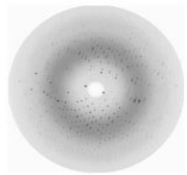
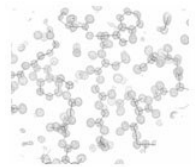


- Generic Detector server
  - MAR 333
  - Pilatus
  - MAR 555
  - MAR 165
  - ….
- Generic Motor server
  - Beckhoff
  - Delta Tau
- DAQ
  - TwinCAT EterCAT
  - NI PXI/FPGA
  - Tektronix Scope

POSTER

Software Modules for the PETRA3 Beamline control




- Generic motor server
  - Beckhoff/TwinCAT motor control and DAQ
  - Delta Tau PMAC
  - Aerotech
  - Attocube
  - PXI/NI
- Generic Detector server
  - Pilatus
  - MAR333, MAR555
  - MAR 345, MAR165
- Endstation software
  - SC3 Tine device server
  - MD2 Tine device server
  - Goniometer server

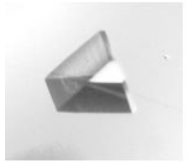
- General Beamline tools
  - Scope
  - Function generator
  - …
- Oracle data base connectivity
  - User/Experiment info
- Data processing
  - eDNA connectivity
  - …..
- Experiment Web access
  - ISPY_B connectivity
- GUI Framwork
  - Bliss Framwork/ MX-Cube
  - BLUE ICE
  - EMBL-HH LabView Framework

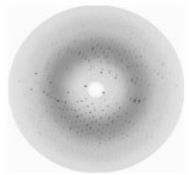
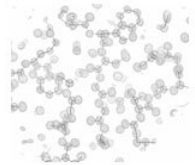
In evaluation

•To be created

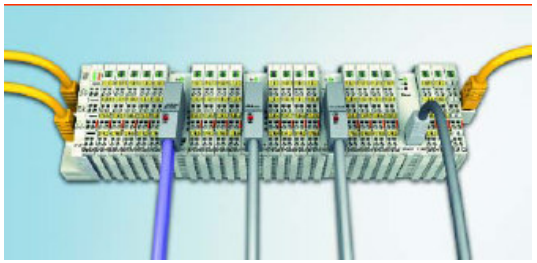
•existing

TwinCAT/EterCAT specifications



- Ethernet based real time software PLC with cycle times down to 50 us
- Clock synchronization of connected I/O hardware by 1 us precision.
- Connected via CAT5 Ethernet cable and ordinary network switches
- Industrial standard, high reliability, Computer without rotating parts (fans, hard disks, etc)
- Cheap, fast delivery, long live products supported for many years
- Easy interfacing to other Fieldbus systems (CAN, S5, SerCos, Profibus Gateways available)
- Counter, DIO, AIO, Stepper motor controller, DC-motor control all in one system available — K-Bus only
- NC numeric motor control of TinCAT noperates 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%precission)
- 24 bit AI available- Prototyp Beckhoff – in test at the EMBL
- EterCAT open protocol EMBL-Hamburg member www.EterCAT.org



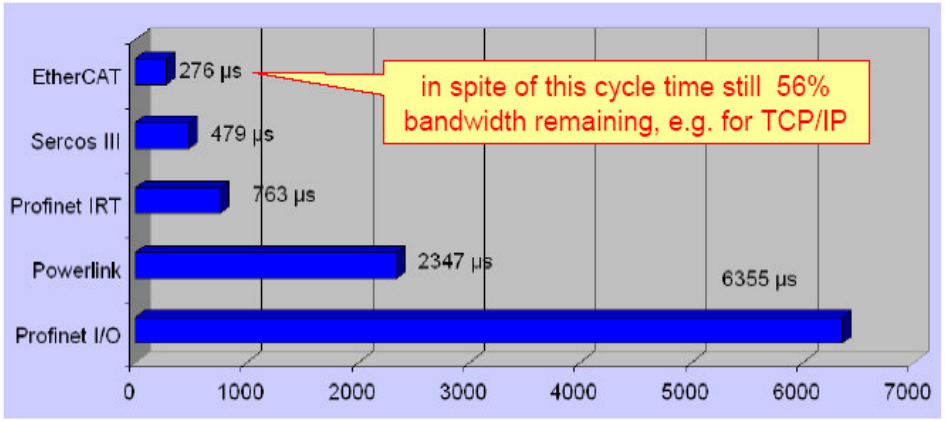
Ethernet based real time software PLC -> TwinCAT
www.Beckhoff.com

EterCAT: Open Protocol

EtherCAT Technology Group Members (9/2006)

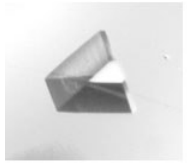
EtherCAT Performance Example

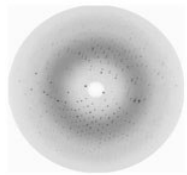
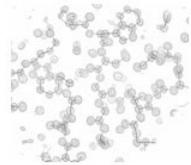
- 40 Axis (each 20 Byte Input- and Output-Data)
- 50 I/O Station with a total of 560 EtherCAT Bus Terminals
- 2000 Digital + 200 Analog I/O, Bus Length 500 m
- Performance EtherCAT: Cycle Time **276µs**
  at 44% Bus Load, Telegram Length 122µs
- For comparison:
  Profinet IRT **763 µs**, Powerlink V2 **2347µs***, Profinet RT **6355 µs**



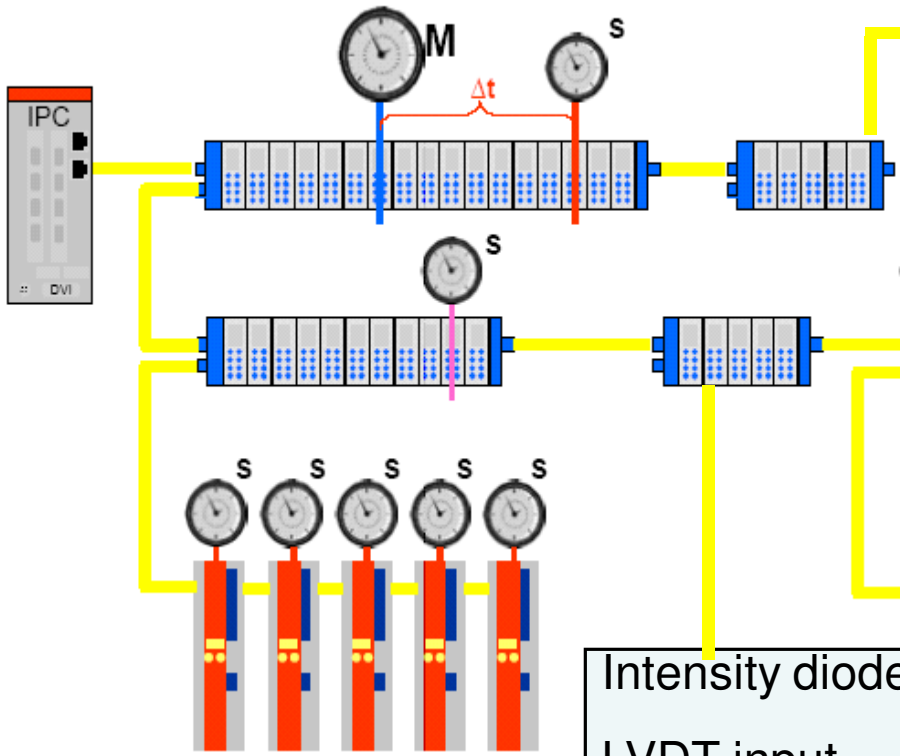
There is a bunch of hardware of 3rd parity vendors for EterCAT available.

The synchronization problem




Precise Synchronization (<< 1 µs!) by exact adjustment of distributed clocks



DIO – valve control, Trigger, shutter, Counter

Motor controller

DC-Motors

Intensity diode Input

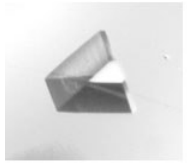
LVDT input

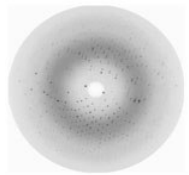
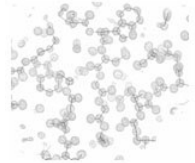
POTI

Renishaw encoder

EterCAT is redundant
If a ring topology is applied

TwinCAT system manager

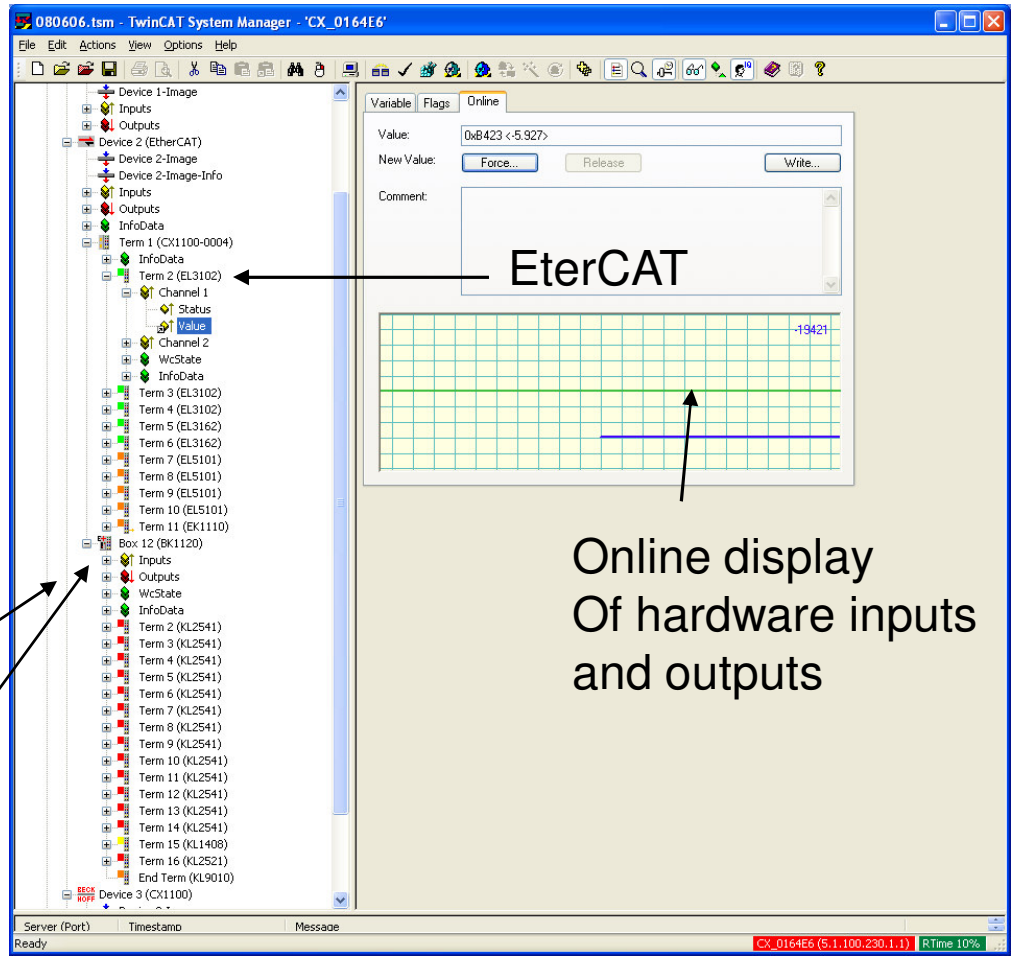


- Manages the hardware connected
- Links hardware inputs and outputs with the PLC variables
- Updates cyclic the variables offered by the hardware connected to TwinCAT

Hardware connected

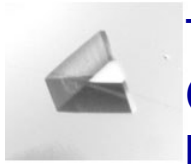
K-Bus



Features:

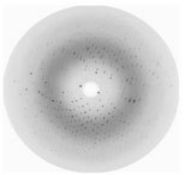
- Disable hardware for test option
- Simulate hardware option

TwinCAT PLC Cycle time etc

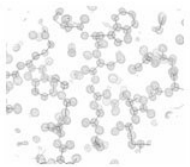


The TwinCAT PLC runs cyclic. During a PLC cycle by EterCAT or K-bus Connected variables are read or set. Additional the PLC user program or function blocks are executed. The shortest cycle times are 50us for EterCAT and 10ms for the K-bus.

Advantage of PLC programming: STRUCTURED TEXT.

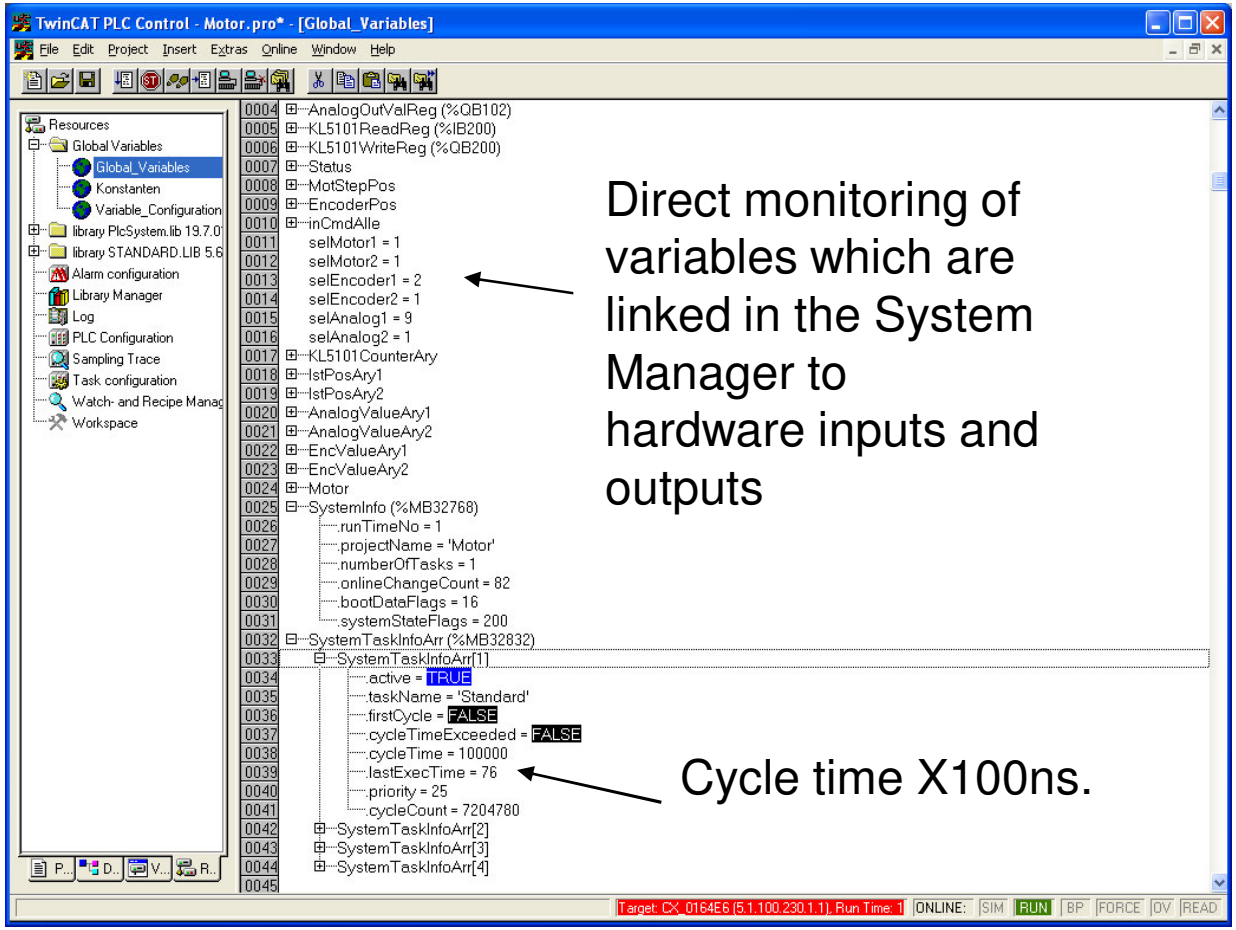


Up to 4 tasks per PLC
Up to 3 PLC's per TwinCAT installation



Monitoring of cycle times etc.

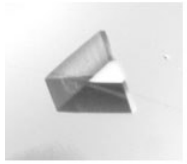
Communication with CDI via the ADS protocol

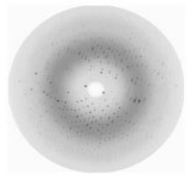
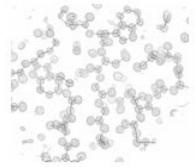


Direct monitoring of variables which are linked in the System Manager to hardware inputs and outputs

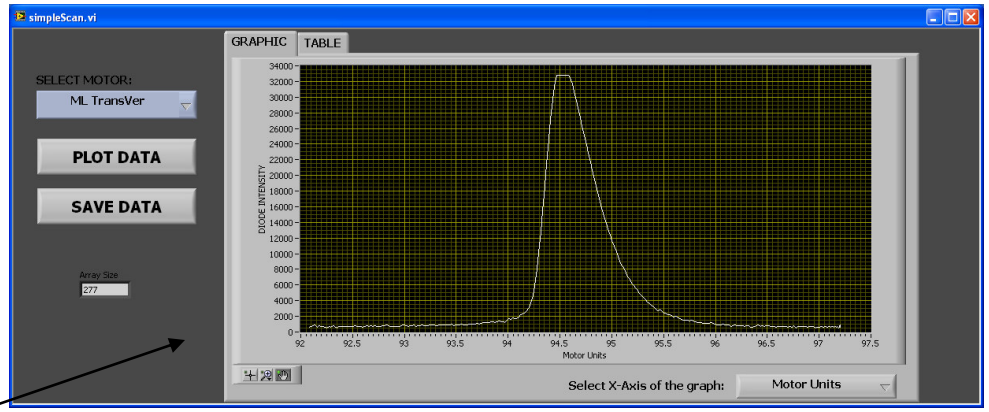
Cycle time X100ns.

EMBL/DESY CDI/TwinCAT PLC library features



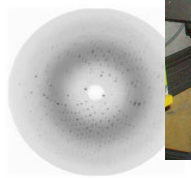
- Synchronous move of n-motors
- Continuous motor scans
- Motor step scan
- Initialization of the connected hardware (server)



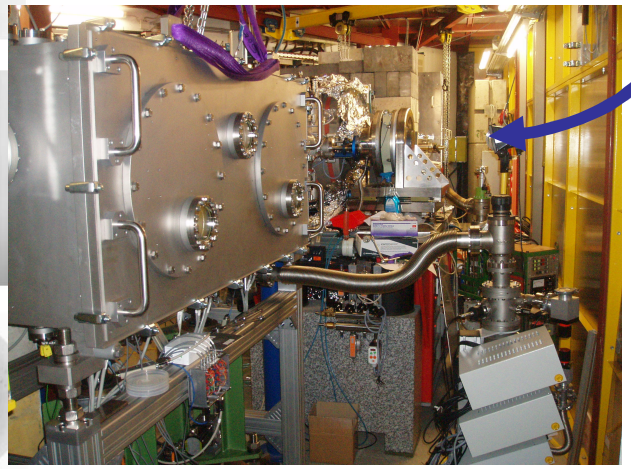
The start of a 'On The Fly' scan is proceeded by selection of the axis to scan and performing a move.

Multilayer project @ BW7A (S.Fiedler)

POSTER BY A.PAZOS

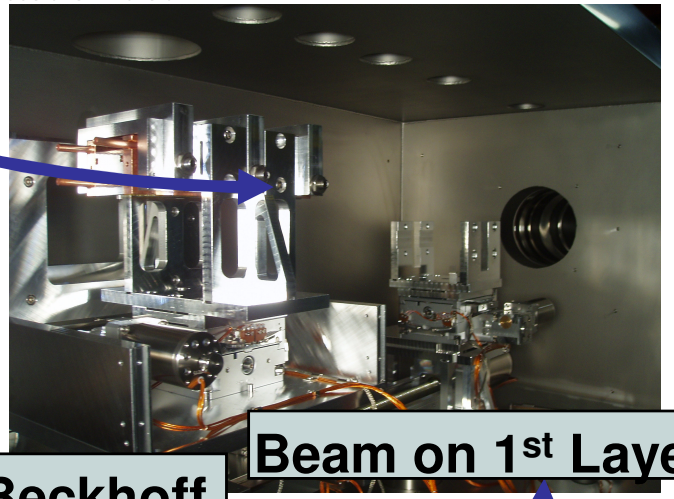


TINE



Vessel, motor, encoder (Renishaw, LVDT), substrates etc.

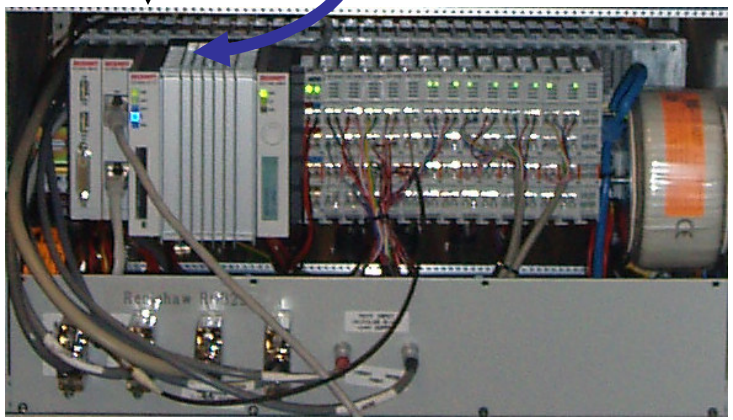
Motors
Counter
AIO,DIO
VIDEO



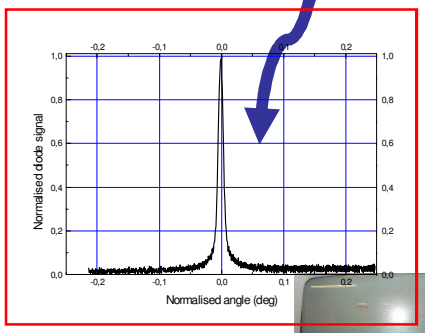
Beam on 1st Layer

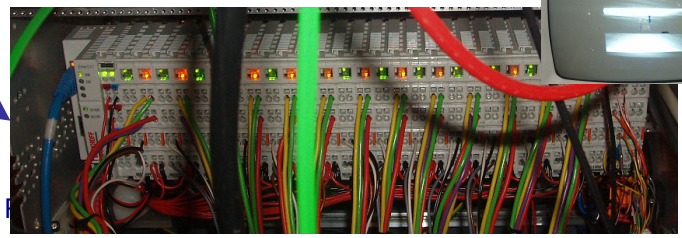
Beckhoff CX-1020

WIN-CE 2GHz,1GB Computer
TINE, MotorServer, CDI

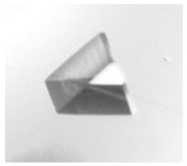


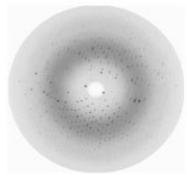
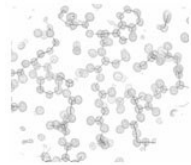
backside



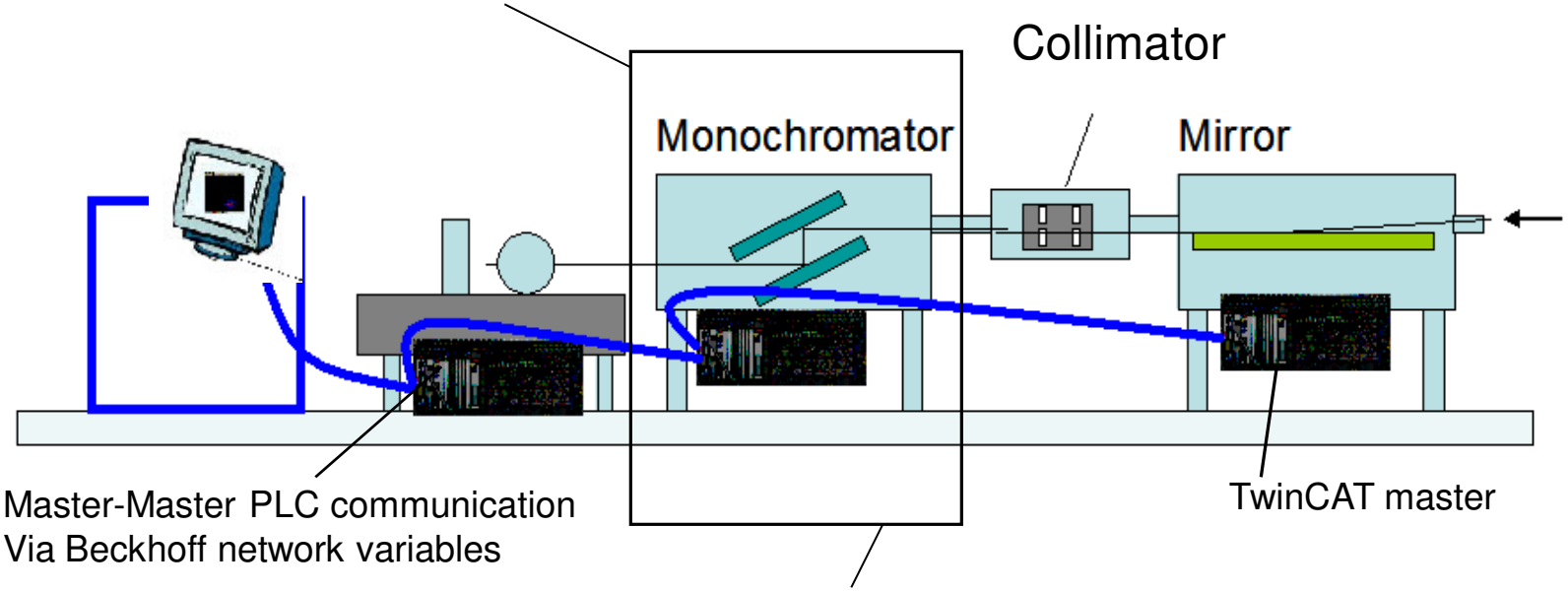


ELECTRONIC DISTRIBUTION



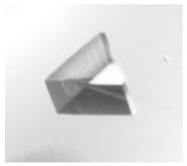



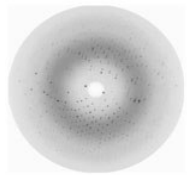
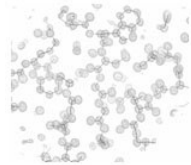

Commissioning: all in one !



- PLC COMPUTERS ARE THE Beckhoff CX-1020,CX-1030 or BC9010
  - Operating system is WinCE or WinXP embedded
  - TINE
  - CDI common device interface
  - Component server
  - Client
  - Video server and other servers can run here

MULTICAST for large file transport with TINE




TINE UDP Multicast @ EMBL

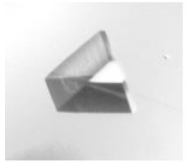
- DORISIII Parameter (current, status of Beamline etc) all EMBL user can start this client.
- Robotic sample changer 3 click centering min 2 Video Clients

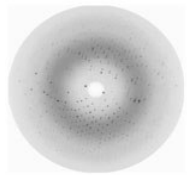
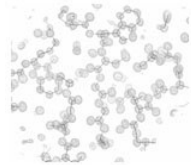
SWITCH

5MB/sec

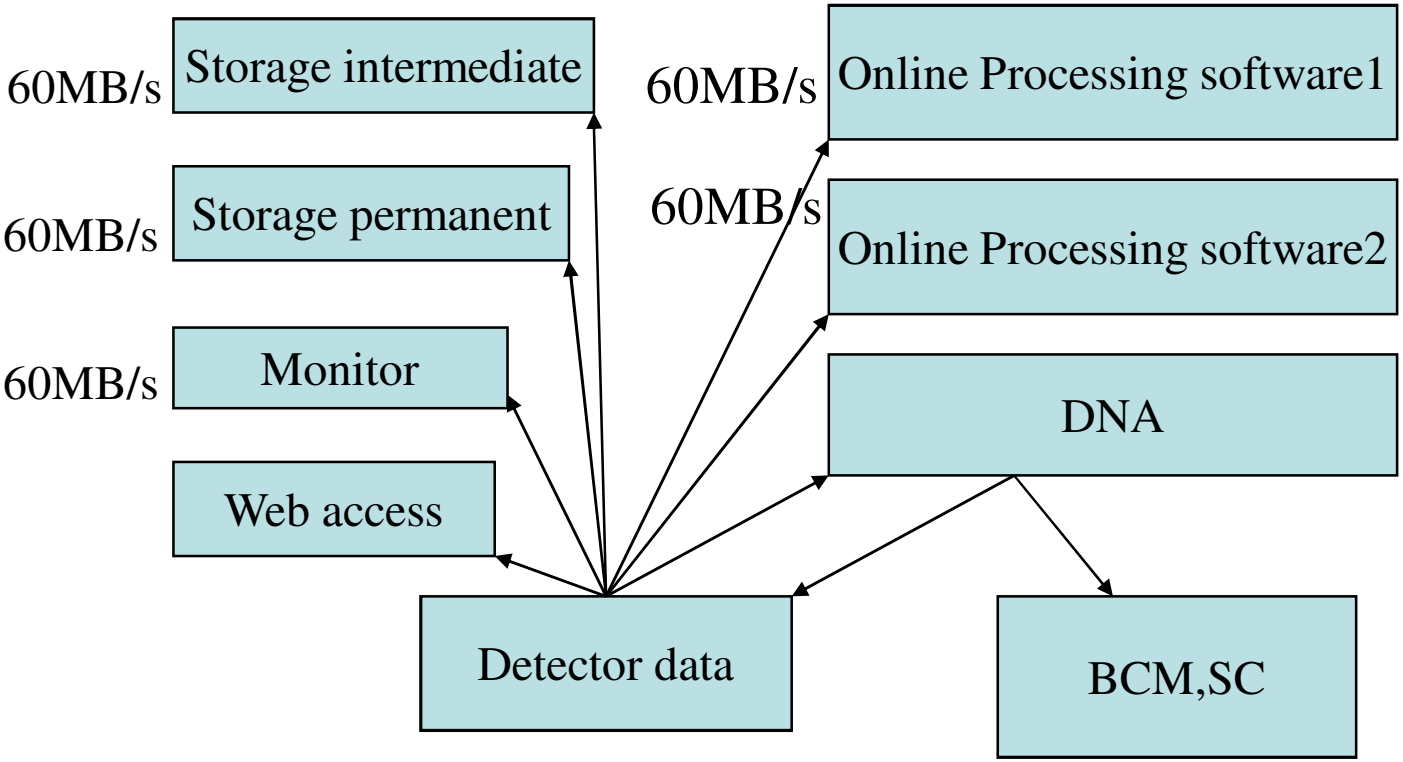
ESRF Detector data streams max. 200MB/s
Pilatus 6 M pixel detector 60MB/sec

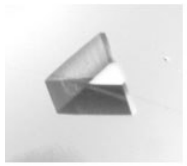
Experimental data transported by the control system

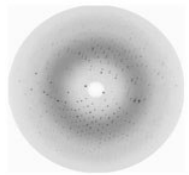
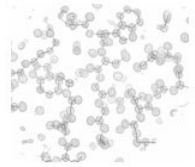



*SLS&GKSS: display and redundant storage of experiment data acquired by the Pilatus pixel detector
-> 10 GBE network and TINE UDP Multicast??

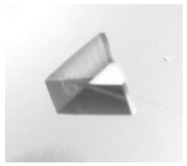


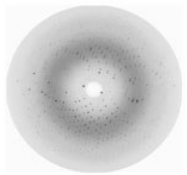


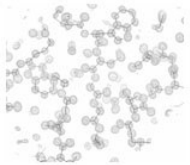




Acknoledgement

- Stefan Fiedler Group Leader
- Andres Pazos Software Engineer
- Mario Di Castro Electronic Engineer
- Lifu Gao Automation Engineer
- Fernando Ridoutt Physicist
- Daniel Franke X33







- THANK YOU