

# CDI interface to real-time EtherCat

Uwe Ristau

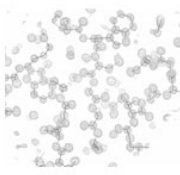
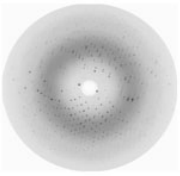
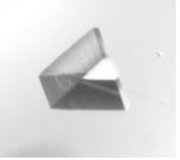
Petra III Instrumentation EMBL-Hamburg

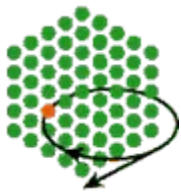
TINE Workshop 9/2007 27<sup>th</sup> September 2007



# Outlook

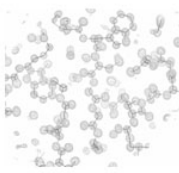
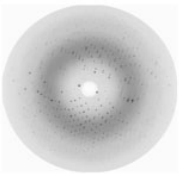
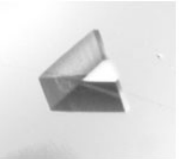
- **Multilayer Monochromator @ BW7A**
- **Announcements**
- **Future Projects**

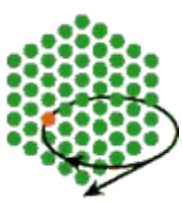




# The Beckhoff redundant real time ethernet based ETHERCAT fieldbus

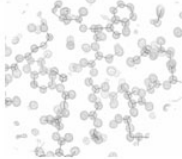
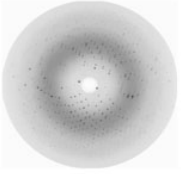
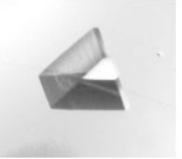
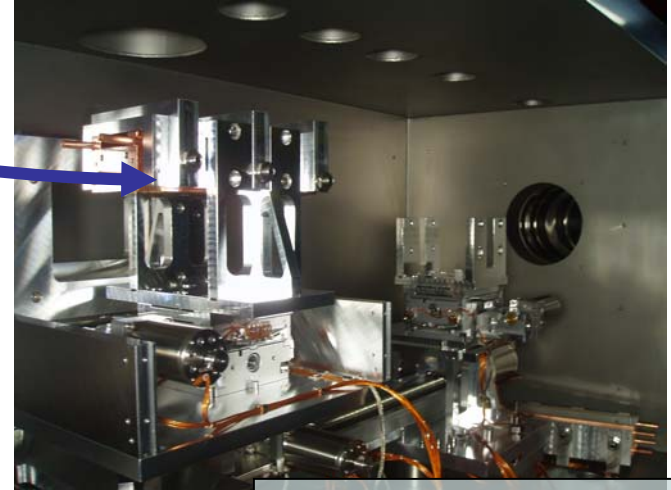
- In 12/2006 there was a Beckhoff TwinCat tutorial at the EMBL in Hamburg this was the start of the development with EtherCat and the K-Bus fieldbus at the EMBL
- The first test project was the BW7A Multilayer Monochromator which is 100% equipped with Beckhoff DAQ





# The Multilayer project @ BW7A (S.Fiedler)

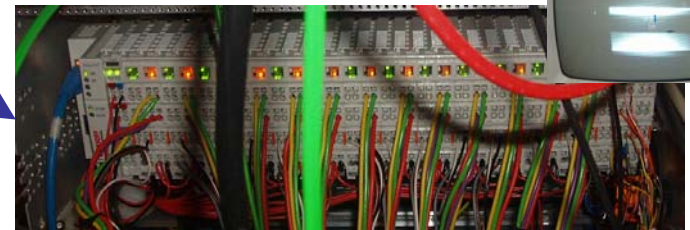
Vessel, motors, encoders(Renishaw, LVDT), substrates etc.



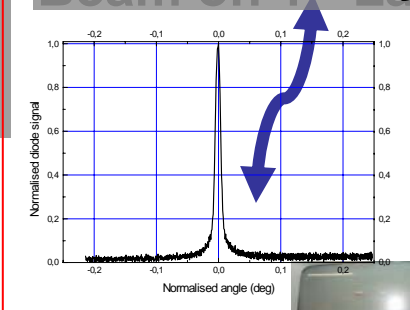
WIN-CE 2GHz, 1GB Computer  
TINE, MotorServer, CDI



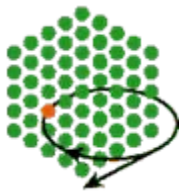
Beckhoff  
CX-1020



Beam on 1<sup>st</sup> Layer

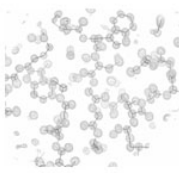
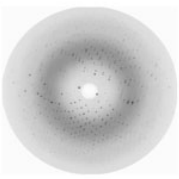
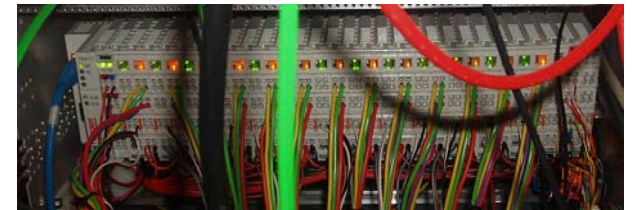


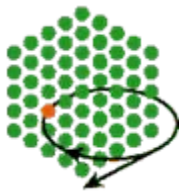
backside



# Control of the BW7A Multilayer

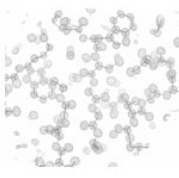
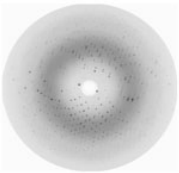
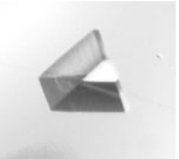
- 14 Stepper motors driver by
  - 5Ampere Stepper motor controllers with amplifiers
  - 2 puls direction stepper motor controller with Berger Lahr driver unit
- 18 Analog inputs
  - Thermocouples
  - LVDTs
  - Diodes
  - Potentiometer
  - Vacuum Gauges
- 24 Digital inputs and outputs
  - Vacuum valves
  - Shutter control
  - Trigger signals
- 4 Counters
  - Renishaw digital encoder

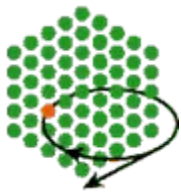




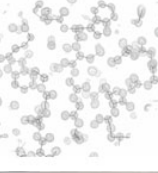
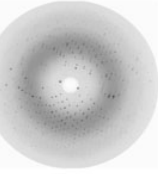
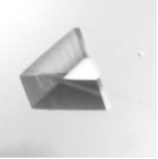
# The Multilayer control system

- Data acquisition with Beckhoff Ethercat realtime fieldbus system and the older K-Bus
- Running on a WIN-CE Computer
- Device servers for TINE are generated by CDI (Common device interface)
- Device server will run embedded on the PLC computer as soon as the WIN-CE Tine support is available



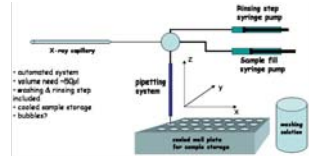
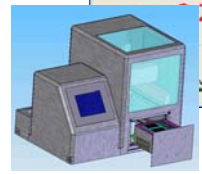


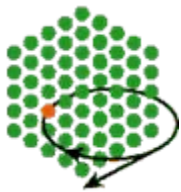
# PLC: Where are they used?



- Interlock control, Vacuum control, Machine interlock
- Undulator control for PetralIII
- ESRF uses WAGO also at the beamlines
- New possibilities because of the **stepper motor controller** available
- **EMBL started 2004 with CANOpen at the small angle scattering beam line X33 with good results.**
- Since than new ethernet based real time fieldbus systems have been developed
- Since 12/2006 EMBL tests the Ethercat fieldbus and has chosen the multilayer monochromator as a test case for the PetralIII project.

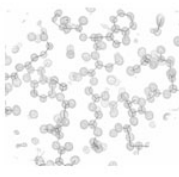
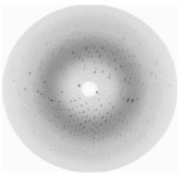
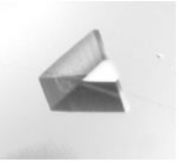
## X33 CANOpen GUI



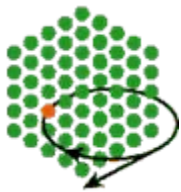


# Some EtherCat specifications

- Flexible small distributed units
- Clock synchronization of connected controllers up to 1 us
- Real time Ethernet based with cycle times down to 100 us possible
- Connected via CAT5 Ethernet cable and ordinary network switches
- Counter, DIO, AIO, Stepper, DC-motor control all in one system available
- High reliability, industrial standard, Computer without rotating parts (fans, hard disks, etc)
- Triggers and AI with XFC modules of Beckhoff synchronized by 100ns and incremental delays of 10ns possible, analog input up to 200kHz (15 bit, 0.5% precision)
- Cheap, fast delivery, long live products supported for many years
- (CAN, S5, SerCos, Profibus Gateways available)
- Easy interfacing between fieldbuses

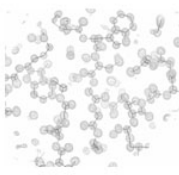
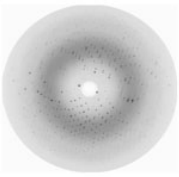
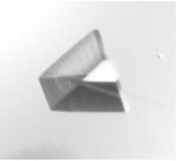


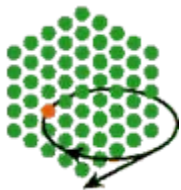




# Beckhoff motor control

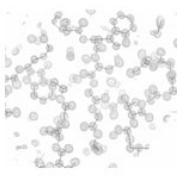
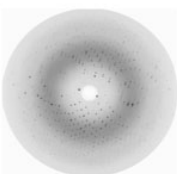
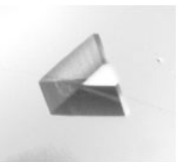
- Controller & Amplifier/Driver support closed loop operation of stepper motors
- KL-2541:5 A,64microStepping,100KHz, very integrated and small, 240Euro
- KL-2531:1.5A, no closed loop option available, 150Euro
- KL-2521: Puls-direction motor controller for single axis without closed loop option, 150 Euro
- In combination with the PLC (as many analog and digital signal inputs as needed), flexible product
- PLC allows ON-THE-FLY motor scans
- Read out of all parameters of the controller/ amplifier and Statuses and positions up to 10 Hz readout of all statuses and positions by a single call.
- Beckhoff offers also servo motor drivers we just started with the AX2003 module

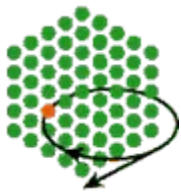




# Stepper motor control

- Chopped stepper motor amplifier offer up to 20 times micro stepping
- Linear amplifier are able to support up to 128 micro stepping
- Chopped amplifier are source of electromagnetic noise. Shielded cables and the use of disc motors which are 10% more expensive but do suppress the noise induced by the inductivity of the motors
- Chopped modules are smaller and produce less heat load

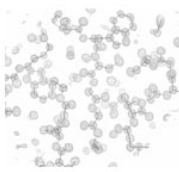
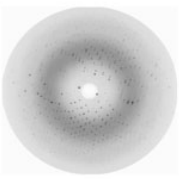
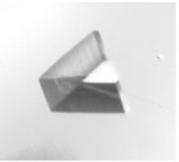
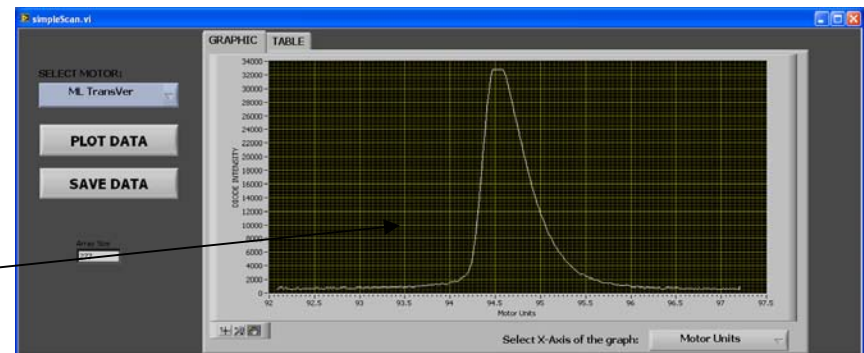


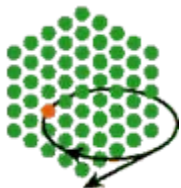


# On the fly Scans

- The structure of the PLC program is very flexible and allows to perform **On the Fly Scans**
  - after the start of a motor in each cycle of the PLC the data will be written into arrays.
  - Up to 32kB of data can be written to a array during one single move (diode analog input LVDT, Renishaw) .
  - The readout can be continuous or at once after finishing the move. This reduces the network traffic and is still fast.

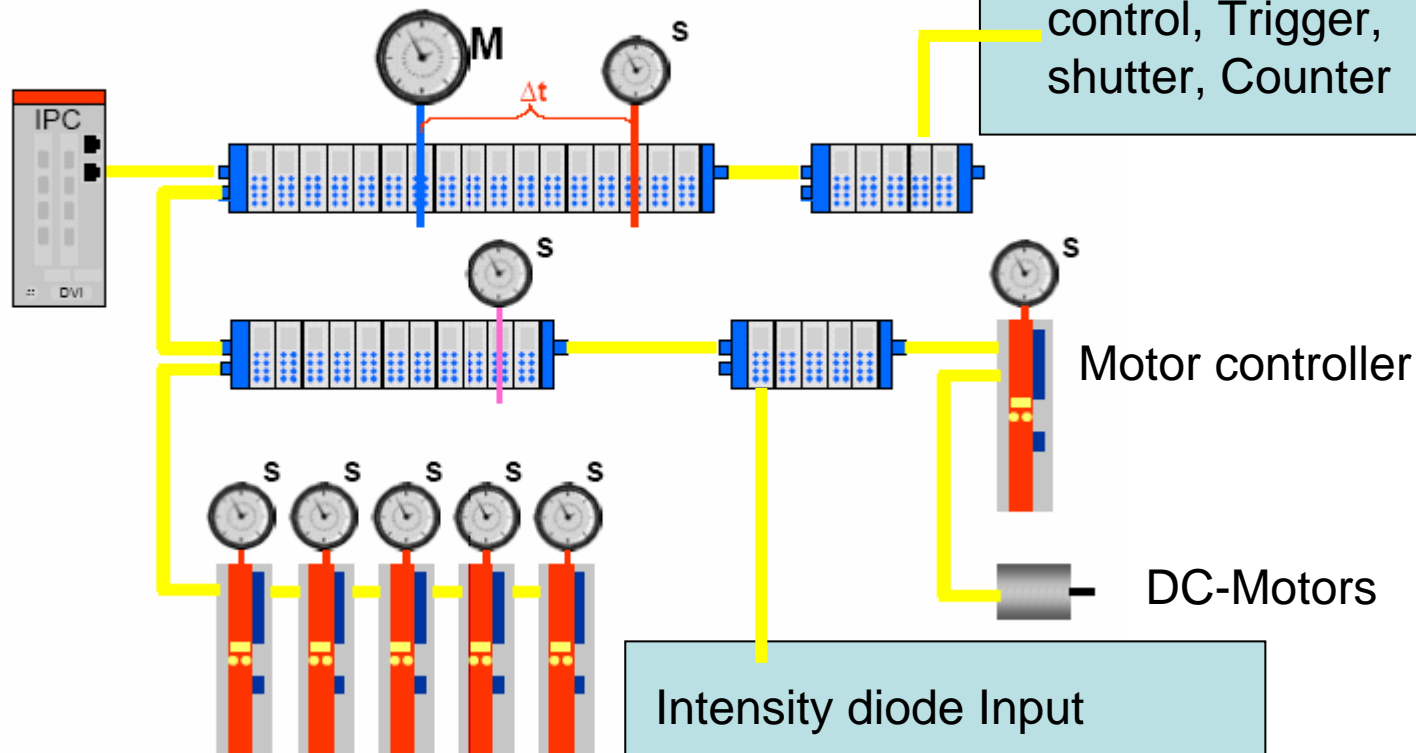
The start of a 'On The Fly' scan is proceeded by selection of the axis to scan and performing a move.





# The synchronization problem

Precise Synchronization ( $\ll 1 \mu\text{s}$ !) by exact adjustment of distributed clocks



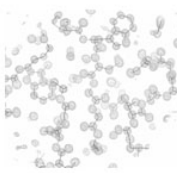
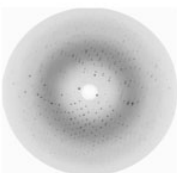
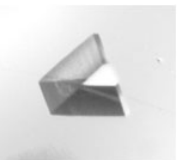
DIO – valve control, Trigger, shutter, Counter

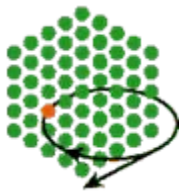
Motor controller

DC-Motors

Intensity diode Input  
LVDT input  
POTI  
Renishaw encoder

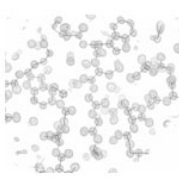
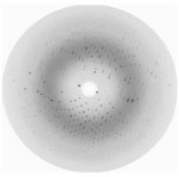
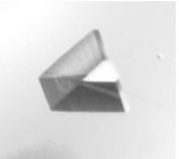
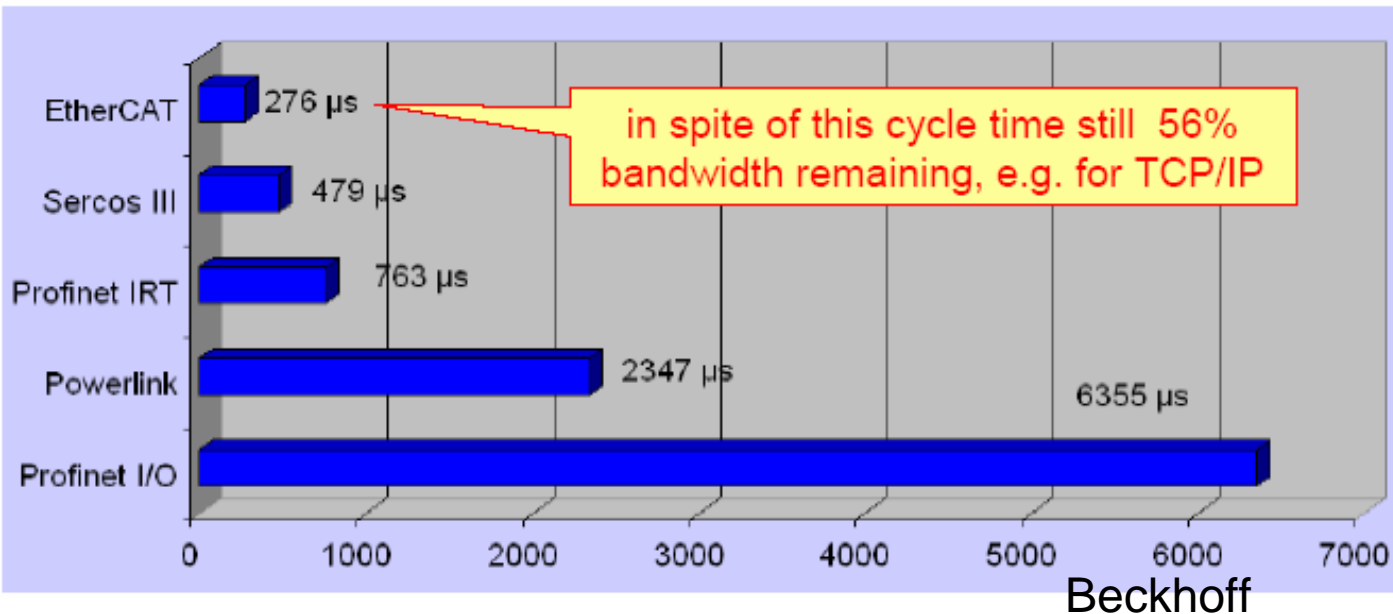
EtherCat offers Redundant Installation by not using a line configuration but a ring





# EtherCAT Performance Example

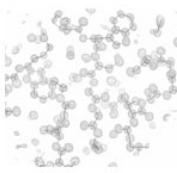
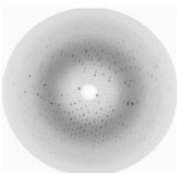
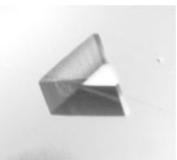
- 40 Axis (each 20 Byte Input- and Output-Data)
- 50 I/O Station with a total of 560 EtherCAT Bus Terminals
- 2000 Digital + 200 Analog I/O, Bus Length 500 m
- Performance EtherCAT: **Cycle Time 276 $\mu$ s** at 44% Bus Load, Telegram Length 122 $\mu$ s
- For comparison:  
Profinet IRT 763  $\mu$ s,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





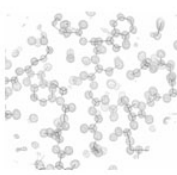
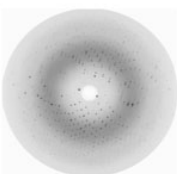
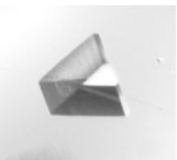
# CDI and TINE device server

- CDI uses in a csv file defined variables, TwinCat/EtherCat devices and Templates for automatic device server generation.
- Only one line of code per device or variable is necessary to export this function as device server property.





# The TINE CDI csv file for automatic server generation



Motor template →

Templates for hardware Device groups →

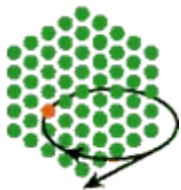
The screenshot shows a text editor window with a TINE CDI csv file. The file contains a list of motor templates and device groups. The motor templates include variables like `start`, `incmd`, `tgtPos`, `curPos`, `type`, `status`, `mSteps`, `fSteps`, `rps`, `rms`, `rfs`, `mvInvt`, `rcurPos`, `tgtPos`, `maxVel`, `minVel`, `maxAcc`, `thrAcc`, `lwrLmtV`, `uprLmtV`, `regCont`, `errFor`, `numError`, `dataI`, `regStat`, `exStat`, `endStops`, `regCtrl`, `regPos1`, `sync`, `Mot1` through `Mot10`, `Mot11` through `Mot14`, `istAry1`, `istAry2`, `dataAry1`, `dataAry2`, `se1Motor1`, `se1Motor2`, `se1Encoder1`, `se1Encoder2`, `se1Analog1`, `se1Analog2`, `se1CMBALL`, `Ren1shw`, `Ren1shwLATCH`, `Ren1`, `Ren2`, `Ren3`, `AI_1`, `AI_2`, `AI_3`, `AI_4`, and `AI_5`.

The Instant Client window shows the following configuration:

Device Context		Device Subsystem	
MD2	ALL		<input type="checkbox"/> Show Stock Properties
Device Server		Device Name	
MicroDiff	Control		
Data Size		Data Type	
1	INTEGER	Description	
		FAILED = -1 UNKNOWN	
/DORIS/DoGatewayTunnel/#0 Energy @ Sep 14 15:32:32.000			

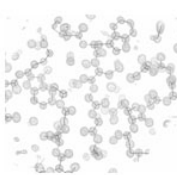
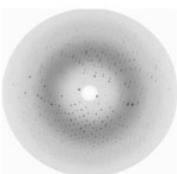
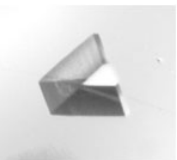
The Device Property list includes: CentringState, CentringTableVerticalPosition, CentringTableXAxisPosition, CentringTableYAxisPosition, CheckBackground, CheckMoveSafety, CheckPositionSafety, and ChiPosition.

After the start of the CDI Server  
All variables will be exported in the TINE  
Instant Client the TINE General System Client which allows to access all  
Data of Servers connected to the Control system



# The CDI Templates: Example Motor

```
NUMBER, NAME, BUS, LINE, ADDRESS, ACCESS, FORMAT, LONG_NAME, LIMIT, PATTERN, END
0, MOTOR:Start, TEMPLATE, 0, , , short, Motor [].Run, 1:01, , -1
0, MOTOR:CMD, TEMPLATE, 0, , , long, Motor [].inCmd, 6:04, !=1:04, -1
0, MOTOR:fltCMD, TEMPLATE, 0, , , float, Motor [].inRealCmd, 6:04, !=1:04, -1
0, MOTOR:TgtPos, TEMPLATE, 0, , RD, long, Motor [].solIPositionAbs, 1:01, , -1
0, MOTOR:CurPos, TEMPLATE, 0, , RD, long, Motor [].IstPositionAbs, 1, , -1
0, MOTOR:Type, TEMPLATE, 0, , RD, short, Motor [].regAry[8], 1, , -1
0, MOTOR:Status, TEMPLATE, 0, , RD, short, Motor [].Status, 1, , -1
0, MOTOR:mSteps, TEMPLATE, 0, , RD, short, Motor [].microSteps, 1, , -1
0, MOTOR:fSteps, TEMPLATE, 0, , RD, short, Motor [].fullSteps, 1, , -1
0, MOTOR:Rps, TEMPLATE, 0, , RD, float, Motor [].Rps, 1, , -1
0, MOTOR:Rms, TEMPLATE, 0, , RD, float, Motor [].Rms, 1, , -1
0, MOTOR:Rfs, TEMPLATE, 0, , RD, float, Motor [].Rfs, 1, , -1
0, MOTOR:mVeloc, TEMPLATE, 0, , RD, float, Motor [].travelVelocity, 1, , -1
0, MOTOR:rCurPos, TEMPLATE, 0, , RD, float, Motor [].rIstPosition, 1, , -1
0, MOTOR:rTgtPos, TEMPLATE, 0, , RD, float, Motor [].rsolIPosition, 1, , -1
0, MOTOR:maxVel, TEMPLATE, 0, , RD, float, Motor [].Max_velocity, 1, , -1
0, MOTOR:minVel, TEMPLATE, 0, , RD, float, Motor [].Min_velocity, 1, , -1
0, MOTOR:maxAcc, TEMPLATE, 0, , RD, float, Motor [].Max_Accelaration, 1, , -1
0, MOTOR:thrAcc, TEMPLATE, 0, , RD, float, Motor [].Accelaration_Threshold, 1, , -1
0, MOTOR:LwrLmtV, TEMPLATE, 0, , RD, float, Motor [].limitMinVelocity, 1, , -1
0, MOTOR:UprLmtV, TEMPLATE, 0, , RD, float, Motor [].limitMaxVelocity, 1, , -1
0, MOTOR:UprLmtA, TEMPLATE, 0, , RD, float, Motor [].limitAcceleration, 1, , -1
0, MOTOR:regCnt, TEMPLATE, 0, , RD, short, Motor [].regAry, 59, , -1
0, MOTOR:Error, TEMPLATE, 0, , RD, short, Motor [].Error, 1, , -1
0, MOTOR:NumError, TEMPLATE, 0, , , short, Motor [].NumError, 1, , -1
0, MOTOR:dataIdx, TEMPLATE, 0, , RD, short, Motor [].dataIndex, 1, , -1
0, MOTOR:regStat, TEMPLATE, 0, , RD, byte, MotorReadReg [].motorStatus, 1, , -1
0, MOTOR:ExStat, TEMPLATE, 0, , RD, short, MotorReadReg [].motorExStatus, 1, , -1
0, MOTOR:EndStops, TEMPLATE, 0, , RD, short, Motor [].EndStops, 1, , -1
0, MOTOR:regCtrl, TEMPLATE, 0, , WR, short, MotorWriteReg [].motorCtrl, 1, , -1
0, MOTOR:regPosi, TEMPLATE, 0, , RD, short, MotorReadReg [].motorPosition, 1, , -1
0, MOTOR:sync, TEMPLATE, 0, , RD|WR, short, Motor [].syncRunFlag, 1, , -1
```







# The CDI definition csv file

```

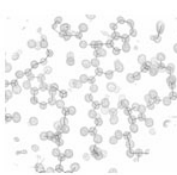
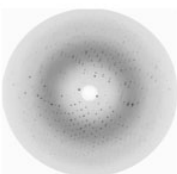
30, selAnalog2, TWINGAT, 1, 1.0:1:5:1:100:230:1:1, , short, . selAnalog2, 1, , -1
31, CMDALL, TWINGAT, 1, 1.0:1:5:1:100:230:1:1, , long, . incmdAlle, 6:04, !=1:04, -1
0, Renishaw:Status, TEMPLATE, 0, , , short, Counter []. Status, 1:01, , -1
#0, Renishaw:Value, TEMPLATE, 0, , , long, KL5101CounterAry [], 1:01, , -1
0, Renishaw:Latch, TEMPLATE, 0, , , short, KL5101ReadReg []. Latch, 1:01, , -1
41, Reni1, TWINGAT, 1, 1.0:1:5:1:100:230:1:1:<Renishaw>, , short, , , -1
42, Reni2, TWINGAT, 1, 2.0:1:5:1:100:230:1:1:<Renishaw>, , short, , , -1
43, AnalogIn:Status, TEMPLATE, 0, , , short, AnalogInValReg []. Status, 1:01, , -1
44, AnalogIn:Value, TEMPLATE, 0, , , short, AnalogInValReg []. Value, 1:01, , -1
45, ReniAry, TWINGAT, 1, 1.0:1:5:1:100:230:1:1, RD, long, . KL5101CounterAry, 5, , -1
46, AnalogIn:Latch, TEMPLATE, 0, , , short, AnalogInValReg []. Latch, 1:01, , -1
47, AI_1, TWINGAT, 1, 1.0:1:5:1:100:230:1:1:<AnalogIn>, , short, , , -1
48, AI_2, TWINGAT, 1, 2.0:1:5:1:100:230:1:1:<AnalogIn>, , short, , , -1

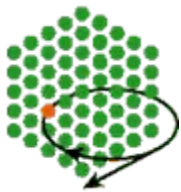
```

Hardware Type  
 Input Line  
 IP-address of Device to connect  
 Name of the variable in TINE  
 Type of variable

Additional : Limits, scaling factors, display format , etc can be defined inside this table

CDI supports CANOpen, TwinCat/EtherCat, SEDAC, RS-232, Siemens S5/S7





# TwinCAT system manager

Manages the hardware connected

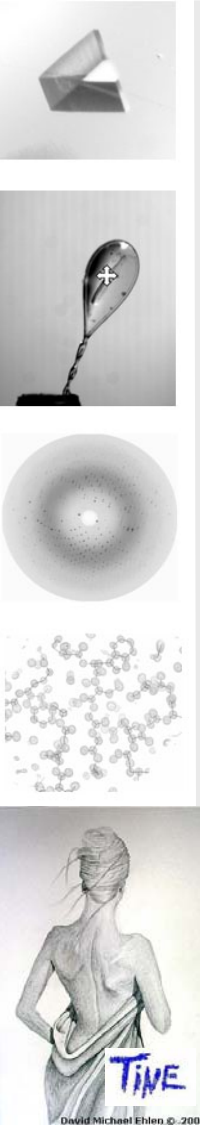
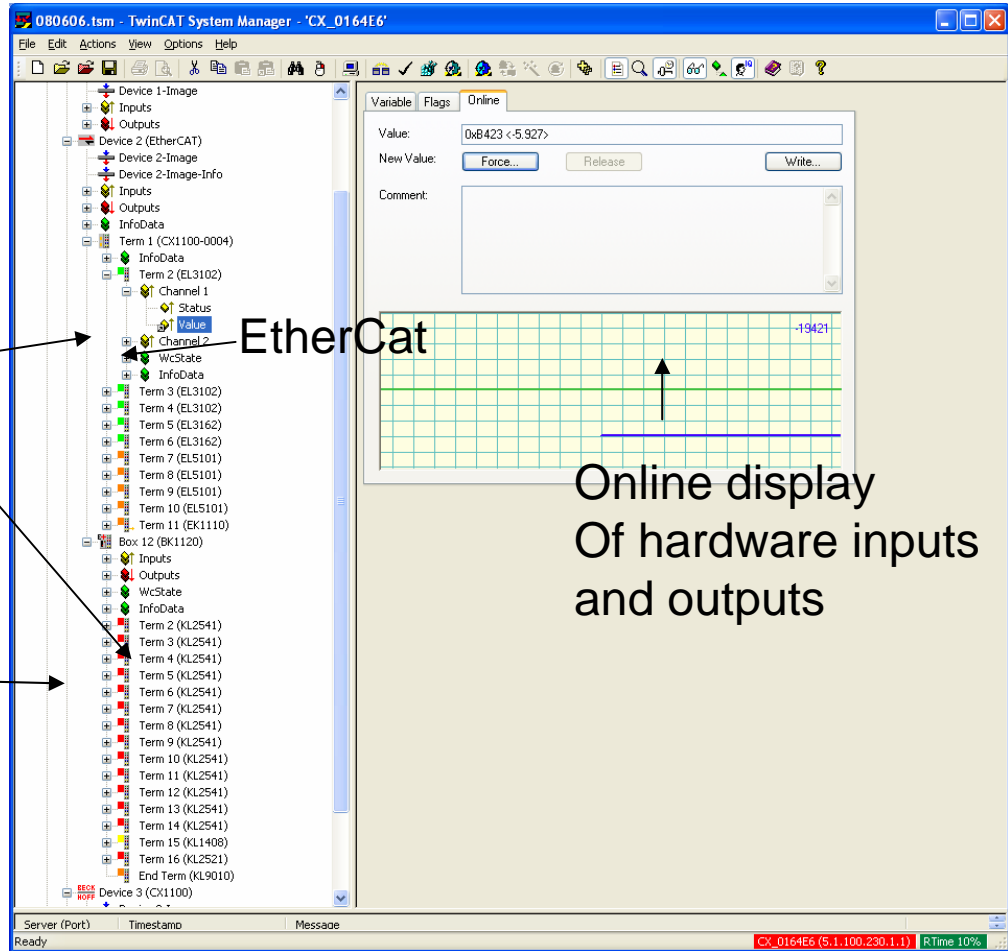
Links hardware inputs and outputs with associated variables which then can be accessed either directly or with the PLC.

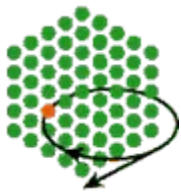
Hardware connected

K-Bus

EtherCat

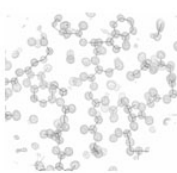
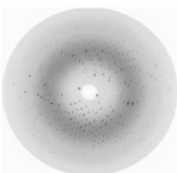
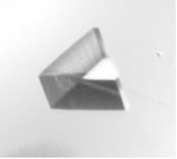
Online display  
Of hardware inputs  
and outputs





# TWINCAT PLC Cycle time etc

The PLC collects all connected hardware input and output signals connected to the PLC with shortest cycle times of 100us for EtherCat and 10ms for the TwinCat system.



Advantage of PLC programming:  
Easy programming in FUP, AWL, Kontaktplan or STRUCTURED TEXT.

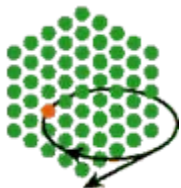
Structured Text is the language Used for complex tasks

The screenshot shows the 'Global Variables' window in TwinCAT. The left pane shows a tree view with 'Global Variables' selected. The main pane lists variables with their addresses and data types. An arrow points from the text 'Direct monitoring of variables which are linked in the System Manager to hardware inputs and outputs' to the 'selMotor1 = 1' variable.

Address	Variable Name	Data Type
0004	AnalogOutValReg	%QB102
0005	KL5101ReadReg	%IB200
0006	KL5101WriteReg	%QB200
0007	Status	
0008	MotStepPos	
0009	EncoderPos	
0010	inCmdAlle	
0011	selMotor1	= 1
0012	selMotor2	= 1
0013	selEncoder1	= 2
0014	selEncoder2	= 1
0015	selAnalog1	= 9
0016	selAnalog2	= 1
0017	KL5101CounterAry	
0018	IstPosAry1	
0019	IstPosAry2	
0020	AnalogValueAry1	
0021	AnalogValueAry2	
0022	EncValueAry1	
0023	EncValueAry2	
0024	Motor	
0025	SystemInfo	%MB32768
0026	runTimeNo	= 1
0027	projectName	= 'Motor'
0028	numberOfTasks	= 1
0029	onlineChangeCount	= 82
0030	bootDataFlags	= 16
0031	systemStateFlags	= 200
0032	SystemTaskInfoArr	%MB32832
0033	SystemTaskInfoArr[1]	
0034	active	= TRUE
0035	taskName	= 'Standard'
0036	firstCycle	= FALSE
0037	cycleTimeExceeded	= FALSE
0038	cycleTime	= 100000
0039	lastExecTime	= 76
0040	priority	= 25
0041	cycleCount	= 7204780
0042	SystemTaskInfoArr[2]	
0043	SystemTaskInfoArr[3]	
0044	SystemTaskInfoArr[4]	
0045		

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

Cycle time X100ns.



# Multilayer control available

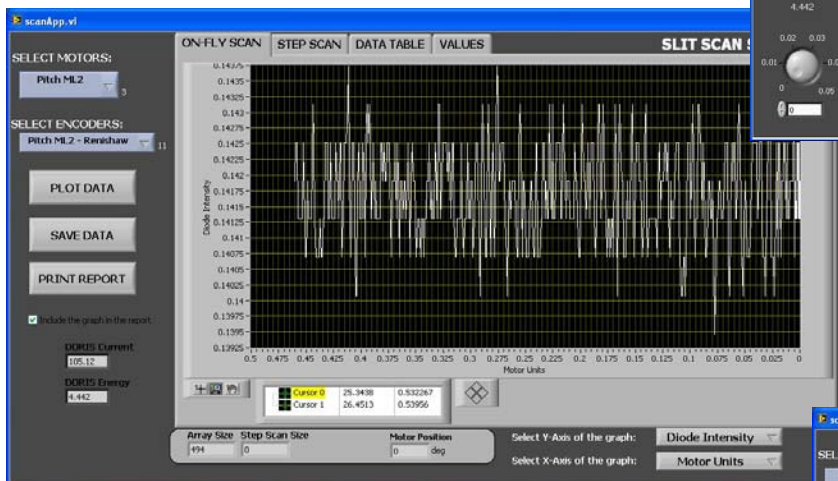
Motor control unit.  
Encoder readout.  
Multi axis move, pseudo axis  
Softlimits etc

MotorControllerApp.v1

Encoder Position: 225.008 mm  
Motor Position: 225 mm

MOTOR	ENCODER	MOTOR-ENCODER	ENERGY
Axis Names	Encoder (mm)	Motor (mm)	Error
Longitudinal	225.01	225	0.0093 (mm)
ML 1 roll	0.01	0	-0.0062 (deg)
ML 1 Pitch	0	0	0 (deg)
ML 2 Roll	0	0	-0.003 (deg)
ML 2 Pitch	0	0	0 (deg)
ML 2 Roll	0	0	0 (deg)
ML 2 Lateral	0.02	0	-0.02 (mm)
ML 2 Gap	33.05	33	-0.054 (mm)
ML Height	5.07	-157.84	-160 (mm)
ML CalBottom	0.08	1	0.021 (mm)
ML SE Top	1.01	3	-0.013 (mm)
ML SE BW7B	10.05	10	-0.046 (mm)
ML SE DW5	3.99	4	0.0059 (mm)
ML SE 2-Trans	16.59	16.6	0.0051 (mm)
ML Screens	0	10	10 (mm)

DORIS Current: 105.1  
DORIS Energy: 4.442



Raw scan data presentation

Example scan. For every move  
The data can be read out if wanted

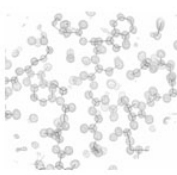
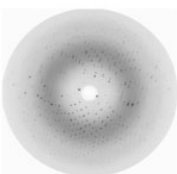
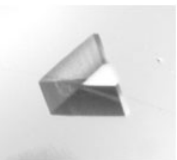
scanApp.v1

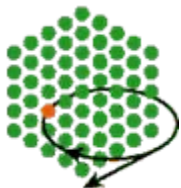
ON-FLY SCAN | STEP SCAN | DATA TABLE | VALUES | SLIT SCAN SYSTEM

DIODE	MOTOR STEPS	ENCODER VALUE	MOTOR UNITS	ENCODER UNITS	ERROR
0.143738	816997	11937	0.279933	0.279618	0.003655
0.143127	816021	11917	0.275033	0.278630	0.003597
0.141907	815373	11897	0.274020	0.277642	0.003622
0.141907	814797	11876	0.273120	0.276665	0.003484
0.142517	814149	11857	0.272108	0.275666	0.003558
0.142517	813672	11838	0.271206	0.274728	0.003521
0.142517	812922	11820	0.270191	0.273789	0.003484
0.141907	812339	11801	0.269289	0.272790	0.003420
0.141296	811896	11783	0.268275	0.272011	0.003326
0.141907	811116	11764	0.267269	0.271193	0.003378
0.140076	810474	11746	0.266266	0.270383	0.003281
0.141296	809895	11727	0.265261	0.269575	0.003289
0.141907	809252	11709	0.264256	0.268767	0.003201
0.141296	808672	11686	0.263250	0.267920	0.003270
0.141907	808030	11666	0.262247	0.267082	0.003268
0.141907	807450	11647	0.261241	0.266293	0.003263
0.141907	806806	11628	0.260234	0.265485	0.003271
0.141907	806227	11610	0.259229	0.264666	0.003276
0.141296	805583	11591	0.258222	0.263827	0.003204
0.140686	805004	11572	0.257219	0.262989	0.003270
0.140686	804425	11553	0.256211	0.262150	0.003209
0.142517	803780	11533	0.255204	0.261312	0.003266
0.143127	803137	11512	0.254202	0.260425	0.003274
0.142517	802558	11491	0.253199	0.259588	0.003259
0.140686	801912	11471	0.252197	0.258760	0.003213
0.141907	801332	11451	0.251191	0.257912	0.003212
0.141907	800699	11432	0.250177	0.257074	0.003297

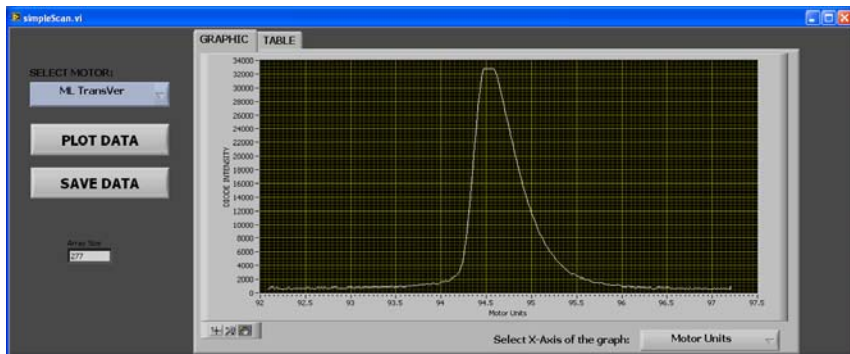
Array Size: #94 | Step Scan Size: 0 | Motor Position: 0 deg

DORIS Current: 105.12  
DORIS Energy: 4.442





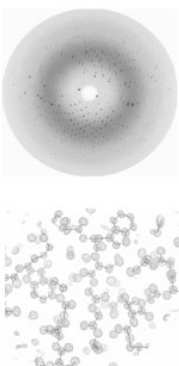
# Multilayer Control Scan application

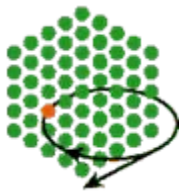


- Scanning on the fly up to 32kByte data points per scan
- Option to scan and save to disk

The motor control tool Client  
Enables to set all motor and controller  
parameters

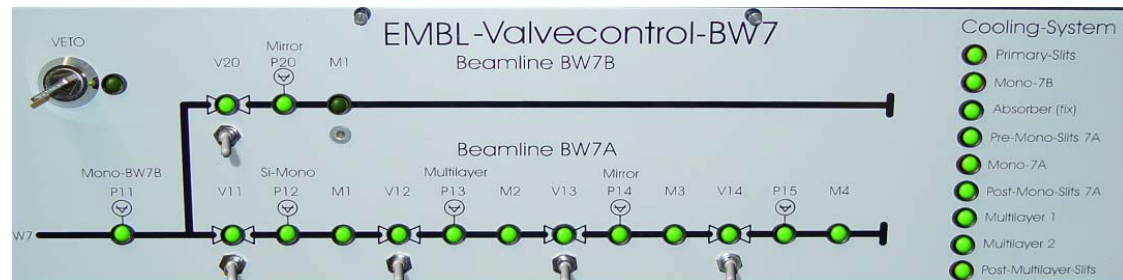
Register	Name	Value	Mode
R11	Signal Channels	296	RO
R12	Minimum Data Length	10280	RO
R13	Data Structure	4	RO
R14	reserved	0	RO
R15	Alignment register	32640	R/W
R16	Hardware version number	0	R/W
R17	reserved	0	RO
R18	reserved	1319	RO
R19	reserved	25680	RO
R20	reserved	60	RO
R21	reserved	0	RO
R22	reserved	0	RO
R23	reserved	0	RO
R24	reserved	0	RO
R25	reserved	0	RO
R26	reserved	0	RO
R27	reserved	0	RO
R28	reserved	0	RO
R29	reserved	0	RO
R30	reserved	0	RO
R31	Code Word register	4661	R/W
R32	Feature Register 1	2078	RO
R33	Full Motor Steps	200	R/W
R34	Encoder Increments	4000	R/W
R35	Maximum coil current A	100	R/W
R36	Maximum coil current B	100	R/W
R37	Number of latch Values	20	R/W
R38	Min. Velocity (v.min)	10	R/W
R39	Max Velocity (v.max)	1250	R/W
R40	Max Acceleration (a.max)	1000	R/W
R41	Acceleration Threshold (a.th)	1023	R/W
R42	Coil current (a>a.th)	50	R/W



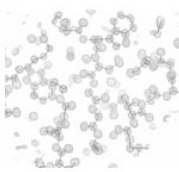
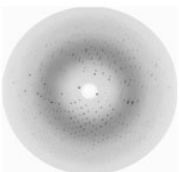


# Graphical user interface of the Vacuum controls

Monitoring of Valves, Temperatures, Pressures etc



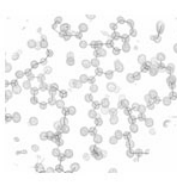
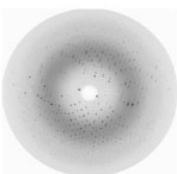
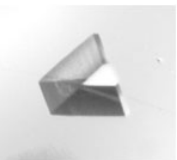
In future control will also be possible

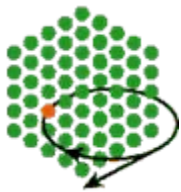




# Stepper motor control

- Chopped stepper motor amplifier offer up to 20 times micro stepping
- Linear amplifier are able to support up to 128 micro stepping
- Chopped amplifier are source of electromagnetic noise. Shielded cables and the use of disc motors which are 10% more expensive but do suppress the noise induced by the inductivity of the motors
- Chopped modules are smaller and produce less heat load





# Control of the EMBL-HH beam lines at DORIS

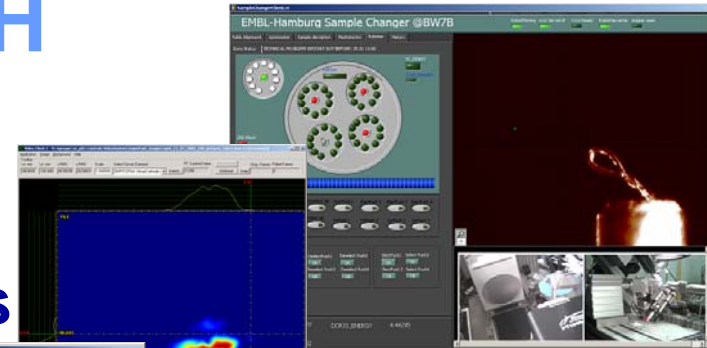
- **Control System of the EMBL is TINE (DESY/MCS)**

- **Highlights**

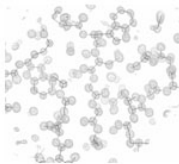
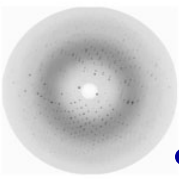
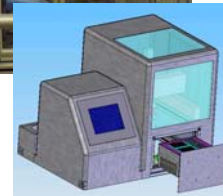
- Robotic Sample Changer BW7B
- X33 Sample Changer
- Multilayer Monochromator Beckhoff/EtherCat

- **Next Projects**

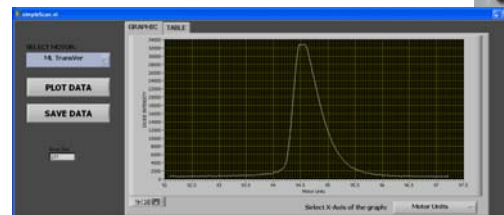
- Generic TINE Detector server for the Pilatus 500k and the MAR 555 Flat panel Detector
- PXI integration of a Fast digitizer 1GS/s and a FPGA (NI)



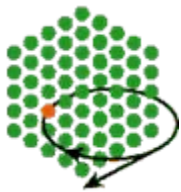
Parameter	Value
DOENERGY	4.442059
DOCURRENT	91.75361
DOLIFETIME	22.19172
BW7B_IC1	0.000
BW7B_IC2	0.000
BW7A_IC1	0.000
BW7A_IC2	0.000
BW7A_EOB	-0.052
BW7A_ENER	12176.856



David Michael Ehlen © 2001







# Acknowledgements

## Instrumentation group PetralII

Group leader: Stefan Fiedler

- Andres Pazos Pilatus
- Mario Di Castro since 7/2007

## Doris Instrumentation group

Group Leader: Christoph Hermes

- Bernd Robrahn Beckhoff PLC programming
- Lifu Gao
- Fernando Ridoutt

## Dimitri Svergun SAXS group

- Timo, Alexej, Daniel Franke X33 SC, Pilatus, CANOPEN

- COSYLAB (Roc Stefanic TANGO2TINE)

- Phil Duval, Reinhard Bacher, Mark Lomperski DESY/MCS  
Hong Gong Wu Beckhoff integration CDI
- Stefan Weisse DESY Zeuthen Video system

