The ELBE Control System – Experience with Commercial Control, SCADA and DAQ

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The ELBE Accelerator

ELBE is a multiple-user electron accelerator facility the Helmholtz-Zentrum Dresden-Rossendorf, Germany. It consists of a 250 kV thermionic DC gun, two accelerator modules with two 9-cell TESLA cavities each (a). Electron beam parameters are given in table 1.
From 2001 on, beam was delivered to the following experimental sites (fig. 1):

(a) Bremsstrahlung facility (< 17 MeV)
(b) channeling X-Ray source (10…100keV)
cell irradiation & detector test site (e^- < 33 MeV)
(c) two IR FELs (5…280 µm)
(d) neutron time-of-flight experiment (0.1…10 MeV)
(e) positron source (0.2…30 kEV)
(f) electron-laser interaction chamber (150TW laser)

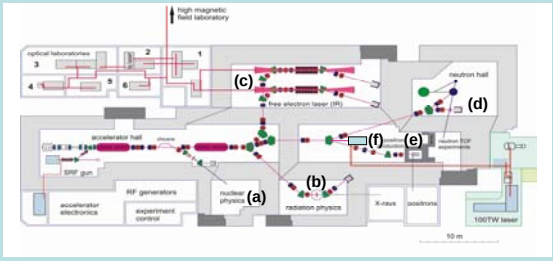

Fig. 1: ELBE facility overview

Table 1: ELBE beam parameters (values for max. bunch charge)*

electron energy (pc)	5.5…33 MeV	**puls length**	1…10 ps
bunch charge	< 77 pC	**repetion rate**	100 kHz … 13 Mhz
transv. emittance *	20 mm·rad (rms)	**single bunch mode**	free programmable
longit. emittance *	140 keV·ps (rms)	**macro bunch mode**	1…25 Hz, t/T = 10^{-4}…0.9

ELBE Control System until 2011

Referring to the IEC 62242-1 control system classification [1], ELBE uses mainly commercial automation technology on the typical automation levels (see fig. 2):

0: distributed I/O system with Profibus DP [2], frontend electronics (Beckhoff terminals [3], Simatic ET200 [2], OEM devices)
1: Simatic PLCs [2], PXI/PC DAQ hardware using LabVIEW & LabWindows/CVI [4], machine protection system hardware (fig. 4)
2: WinCC SCADA system with Profibus, DAQ host applications
3: web-based tools (logbook, beam schedule, shift schedule,...)
4: central on-site proposal management

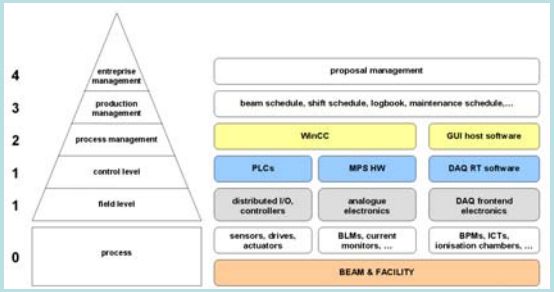

Fig. 2: ELBE control system classification

PLC CPUs	12
PLC data points	4500
PLC plain machine code	1.5 MB
PLC development software	Step7 V5.5
MPS fast channels	80
WinCC process tags	7000
WinCC client PCs	25
WinCC software	V7.0
OPC items	250
LabVIEW development software	2009
PC / PXI DAQ systems	10
PC / PXI DAQ applications	15
MPS fast hardware channels	80

Table 2: Control system key figures

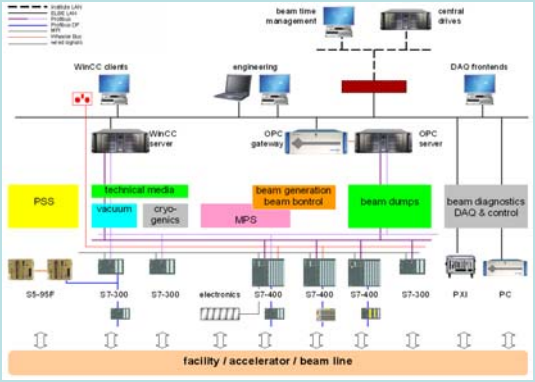

Fig. 3: ELBE control system architecture

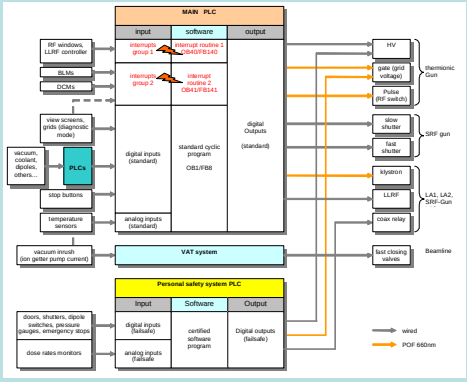

Fig. 4: ELBE machine protection system and PSS

Experience and System Upgrade

ELBE, in conjunction with TW/PW high power lasers, will be extended towards a centre for high power beam sources until 2014. Commercial S7 PLC technology has been experienced as reliable and robust, both in hardware and programming. Availability and durability of WinCC projects and PC based data acquisition software suffer from frequent changes in operating system, IT and hardware constraints. Concerning the MPS, we experience that merging hardware electronics and PLC interrupt techniques reduces safety and will not suffice our needs for the increased electron beam power. Thus we plan the following system modifications of the system:

- aged out S5 PLCs (PSS) are replaced by S7 failsafe PLCs
- PLCs will be segregated according to beam line segment more than before
- PLC and WinCC software will partly be redesigned with a higher degree of object oriented coding
- PLC / SCADA interconnection will use Industrial Ethernet
- the MPS is being redesigned with more emphasis on fast hardware
- WinCC functionality will be extended with server redundancy and web access
- DAQ systems will mainly be PXI frontends with real time controllers plus remote host application
- Interfaces between PLC and DAQ (or other systems) will be able to use direct TCP/IP to replace stringent OPC [5] administration
- an EPICS subsystem will be installed and connected to ProfiNet [2] to gain experience with specific control systems specifically designed for accelerators

References:

[1] IEC 62242-1 "Enterprise control system integration – Part 1: Models and Terminology", Geneva, Switzerland, 2003 (http://www.iec.ch)
[2] http://www.automation.siemens.com
[3] http://www.beckhoff.com/
[4] http://www.ni.com
[5] http://www.opcfoundation.org/

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