HELMHOLTZ GEMEINSCHAFT

DESY

The New Control System for the Future Low-Emittance Light Source PETRA 3 at DESY:

From Conceptual Design Work to Realization

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DESY, MST

PCaPAC 2006, Jefferson Lab, Newport News

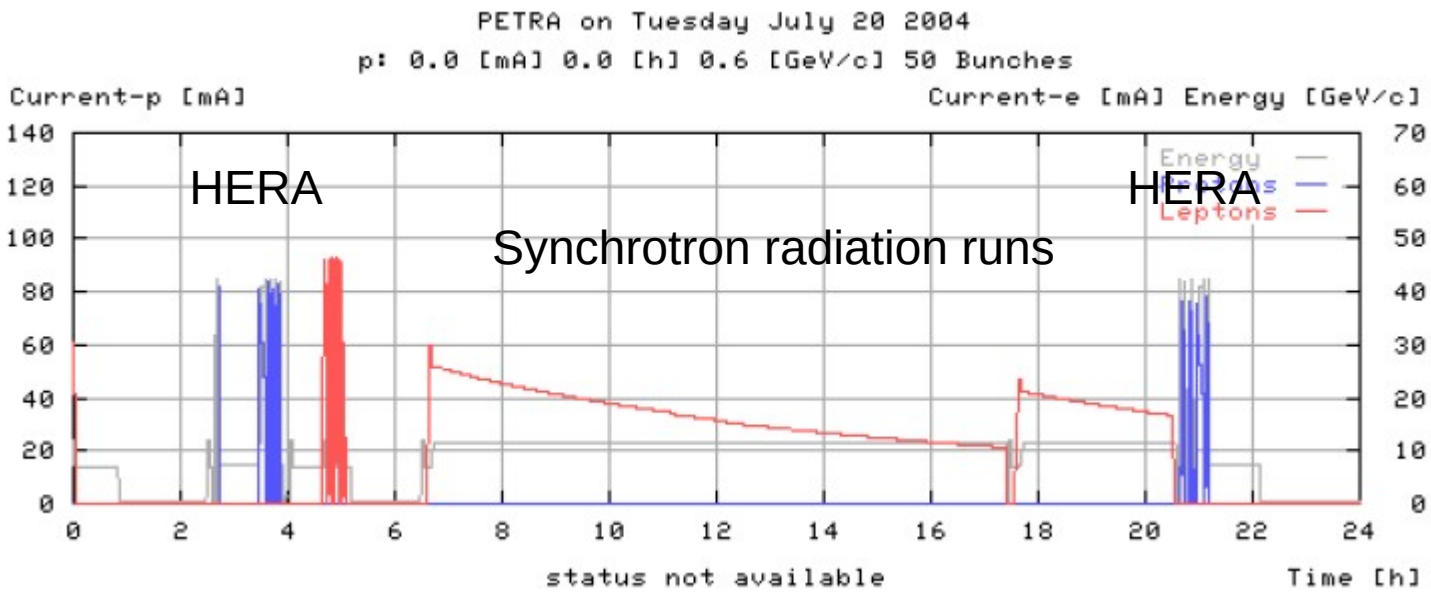
Outline

- Introduction to PETRA III
- Control System Architecture
- Front-End Electronics and Device Interfaces
- TINE Control System Software Suite
- Application Development
- Project Management

Goal for 2009: PETRA III

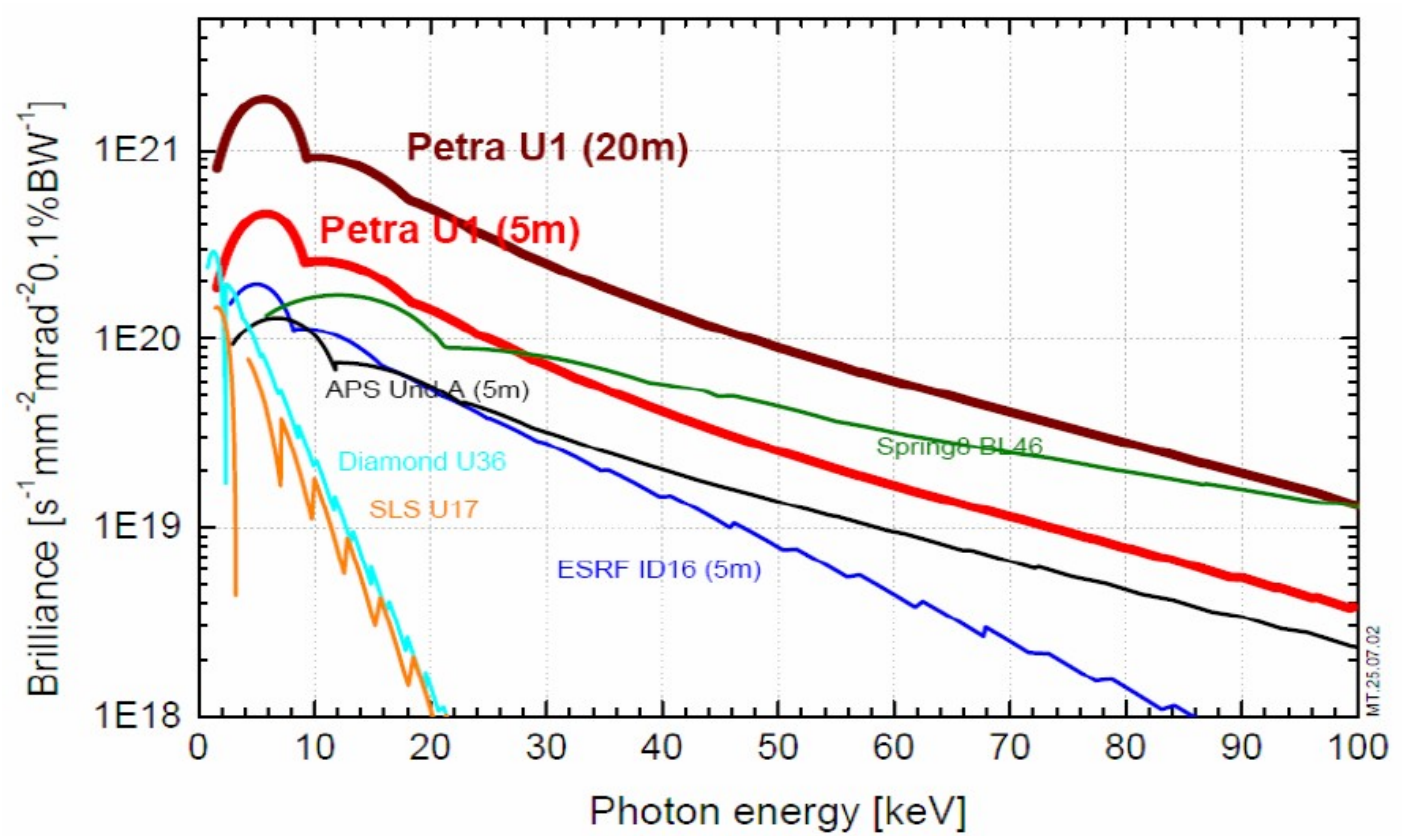
Present PETRA operation modes (until mid 2007):

- booster for HERA II (high energy physics)
- synchrotron radiation source with 1 insertion device
- interleaved operation



Goal for 2009: PETRA III

- 2009: High-brilliance 3rd generation synchrotron radiation source



Goal for 2009: PETRA III

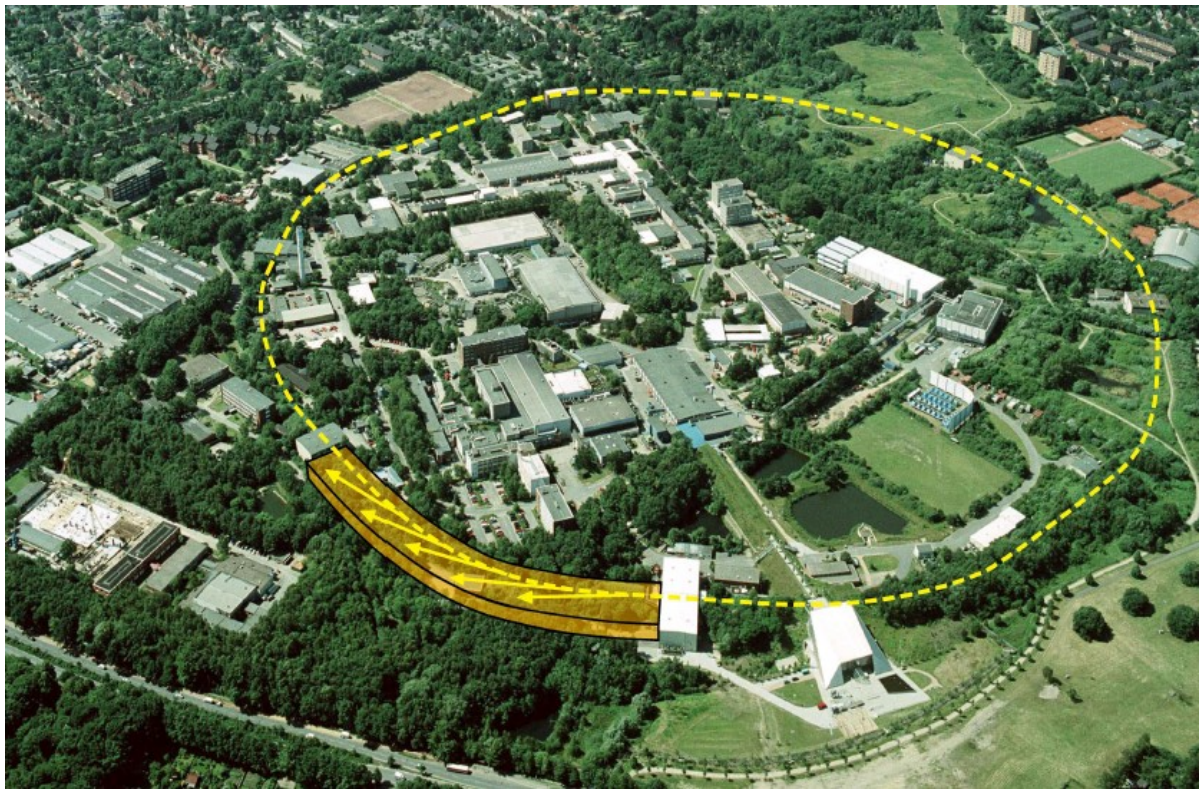
– Design parameters:

- Beam energy / current: E = 6 GeV / I = 100 mA
- Low transverse beam emittance: ε_x = 1nmrad
- Top-up injection scheme
- Damping wigglers to reduce emittance
- Undulator length: 2m, 5m, 20m
- 13 independent beamlines

Upgrade 7/8 of PETRA

Rebuild 1/8 of PETRA

Goal for 2009: PETRA III

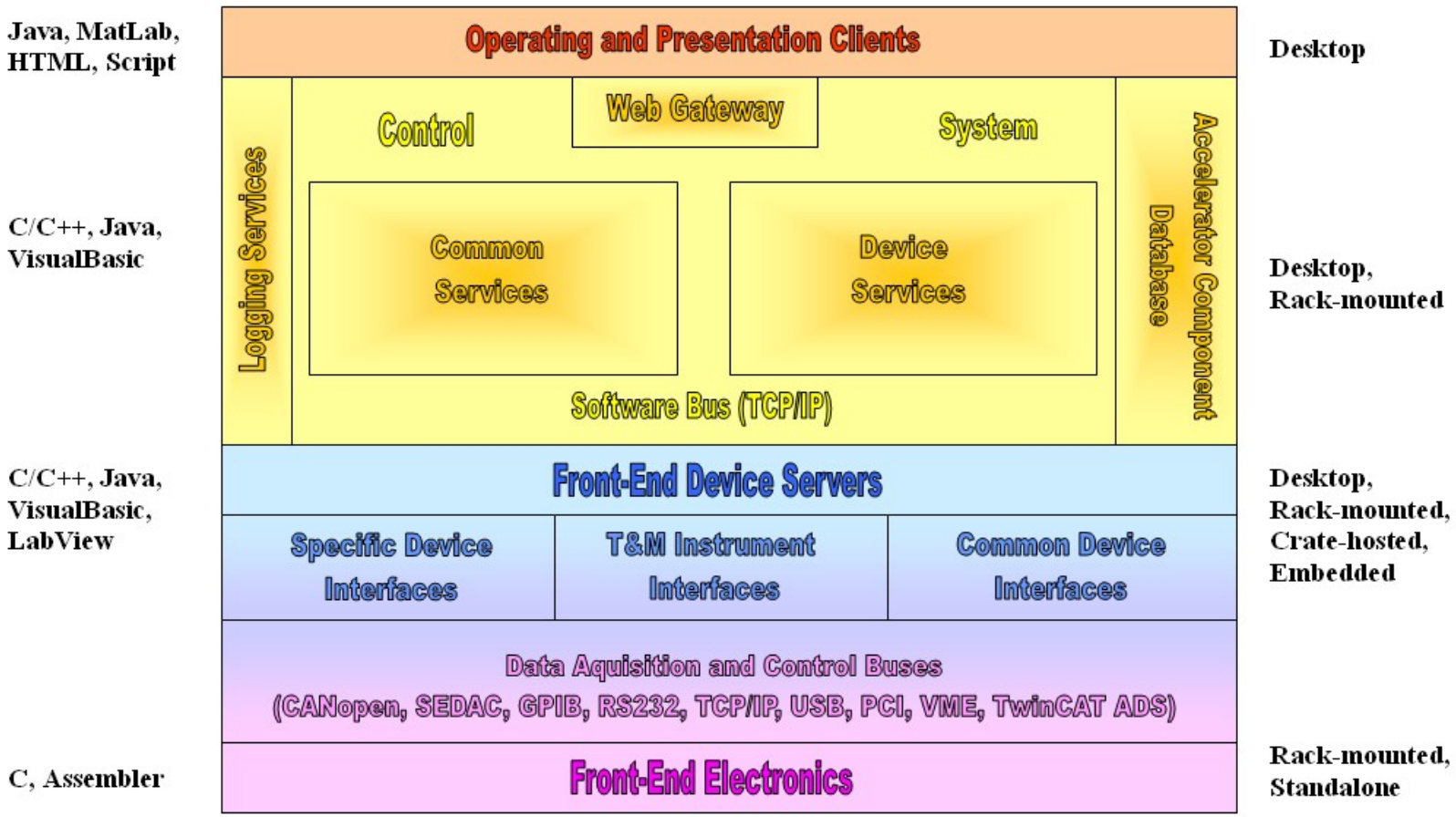


Technical Design Report: http://www-hasylab.desy.de/facility/upgrade/petra_tdr.htm

Goal for 2009: PETRA III

- Objectives of the PETRA III work package “Control System”:
  - Complete up-grade of the control system of PETRA and the pre-accelerators (LINAC 2, DESY 2)
  - Partial / complete up-grade of the front-end electronics of PETRA and pre-accelerators (LINAC 2, DESY 2)
- Shared Responsibilities:
  - Controls group is fully responsible for:
    - core software and services
    - control room applications
    - system integration, administration and infrastructure
  - Controls group is partially responsible for:
    - device server applications
    - front-end electronics

Control System Architecture

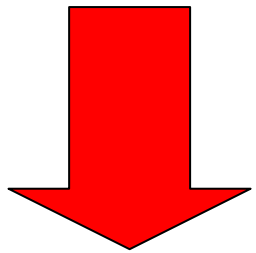


Front-End Electronics

- Computer Interfaces:
  - SEDAC (DESY specific)
    - Temperatures, power supplies (partially), RF (partially), water cooling, machine protection, diagnostics
  - CANopen
    - Power supplies (partially), vacuum, injection and ejection elements, synchronization, radiation interlock, stepping motors, alignment, diagnostics
  - USB
    - Fast orbit feedback
  - RS232
    - Timing

Front-End Electronics

- Computer Interfaces (cnt'd):
  - GPIB
    - Diagnostics
  - TwinCAT ADS (Beckhoff)
    - Photon beamline vacuum
  - PCI, cPCI:
    - RF (partially)
    - Diagnostics
  - TCP/IP
    - Diagnostics



Nightmare ?

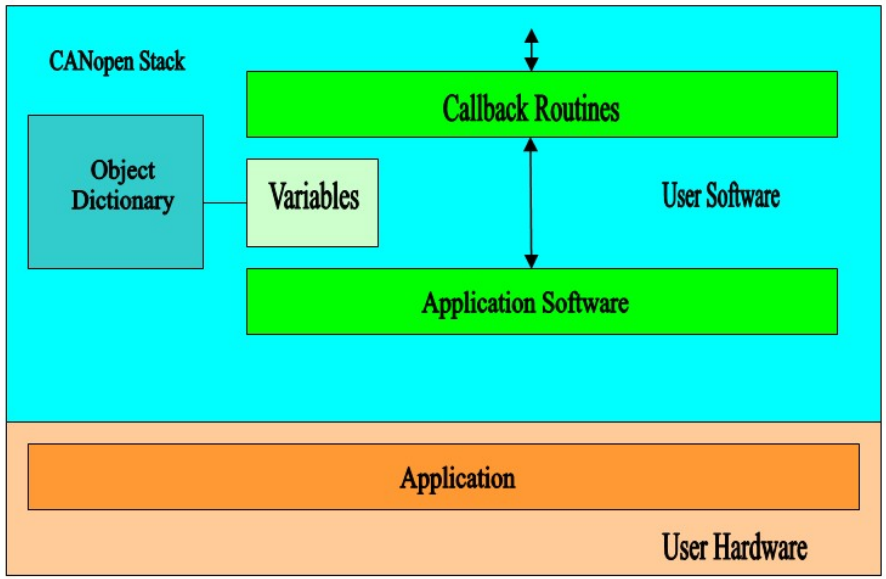
Must not!

Front-End Electronics

- Standardized electronic modules (if in responsibility of controls group):
  - SEDAC:
    - use existing modules
    - not used for further developments
  - CANopen:
    - new development line
    - crate hosted
    - modular design
      - controller board
      - equipment-specific interface board
  - CANopen-to-SEDAC adapters
    - for mixed operation
    - to re-use existing SEDAC modules
  - approx. 1000 units

Front-End Electronics (CANopen)

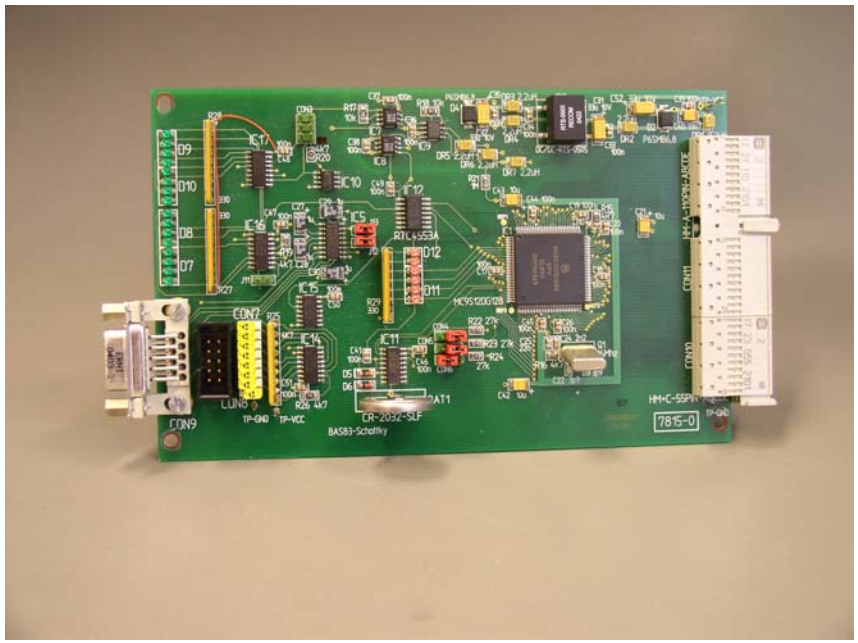
- Controller Boards:
  - Development lines:
    - HCS12
    - Coldfire
    - NIOS 2
  - CANopen Interface Software:
    - "same" for all 3 development lines



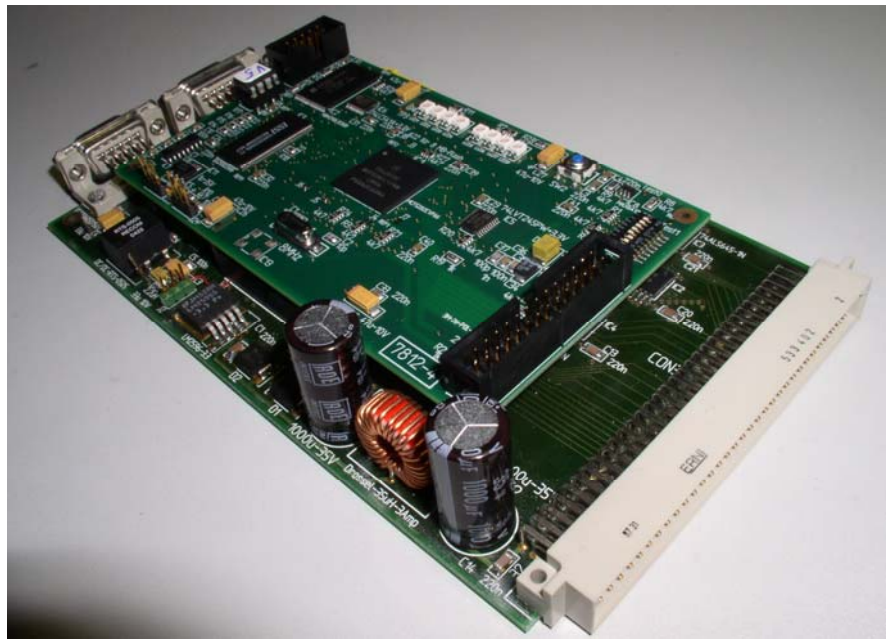
P.Bartkiewicz, P.Duval, S.Herb: The Common Application Programming Interface for Fieldbus Related Projects at PETRA III (WEP35 <abs071>)

Front-End Electronics (CANopen)

HCS12-based controller board

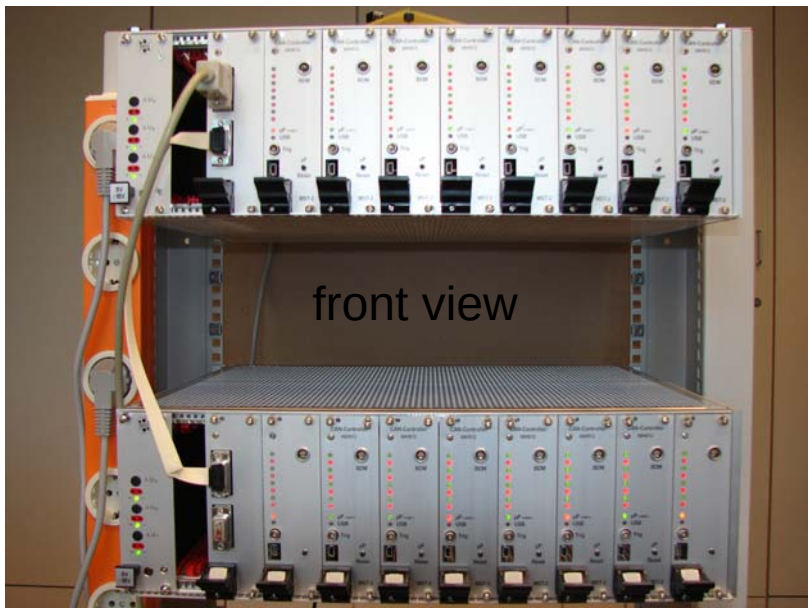


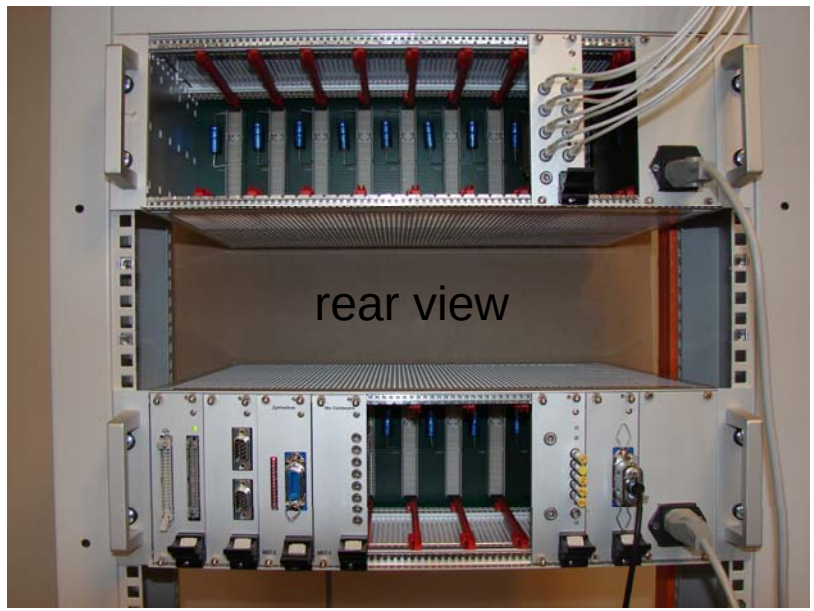
Coldfire-based controller board
with CANopen-to-SEDAC adapter



Front-End Electronics (CANopen)

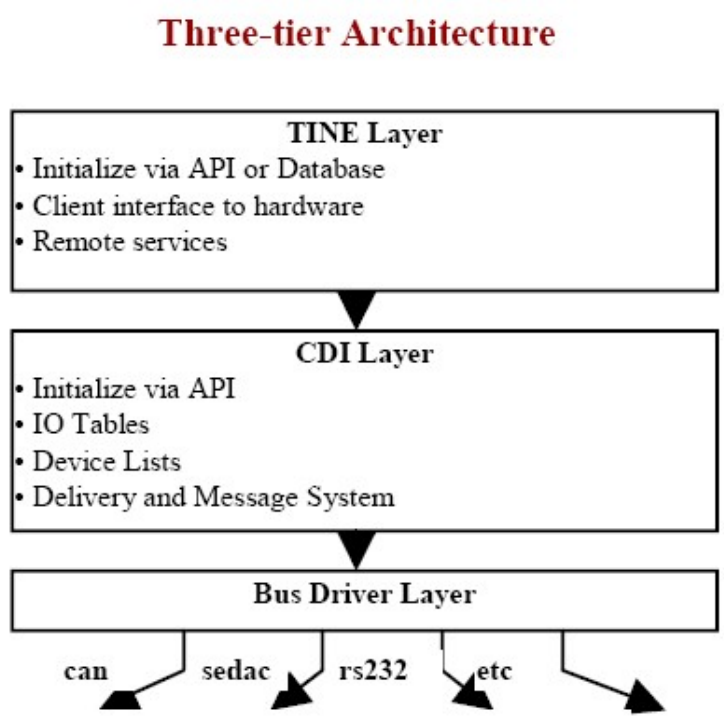
- Equipment-specific interface boards:
  - Various specific interfaces:
    - for trigger control
    - for vacuum control, …
  - Interfaces to user equipment:
    - in general unchanged
    - cabling from reverse





Common Device Interface

- Common Device Interface:
  - Implementations: C, JAVA und VisualBasic
  - Platform independence: Windows, Linux
  - Generic control system interface: TINE
- Data Bus / Fieldbus Driver Plugs:
  - available:
    - CANopen
    - SEDAC
    - RS232
  - under development:
    - TwinCAT ADS (Beckhoff)
    - GPIB
    - …..



P.Duval, H.G.Wu: Using the Common Device Interface in TINE (TUB3 <abs040>)

T&M Instruments

- T&M = Test & Measurement
  - Standardized instrument types:
    - oscilloscope, spectrum analyzer, digital multi meter, ….
  - Vendor-independent instrument API:
    - universal interface standards:
      - IVI standard (instrument type)
      - VISA standard (data bus type)
  - Successfully tested prototype implementations:
    - instruments: oscilloscope, digital multi meter
    - data bus: Ethernet, USB

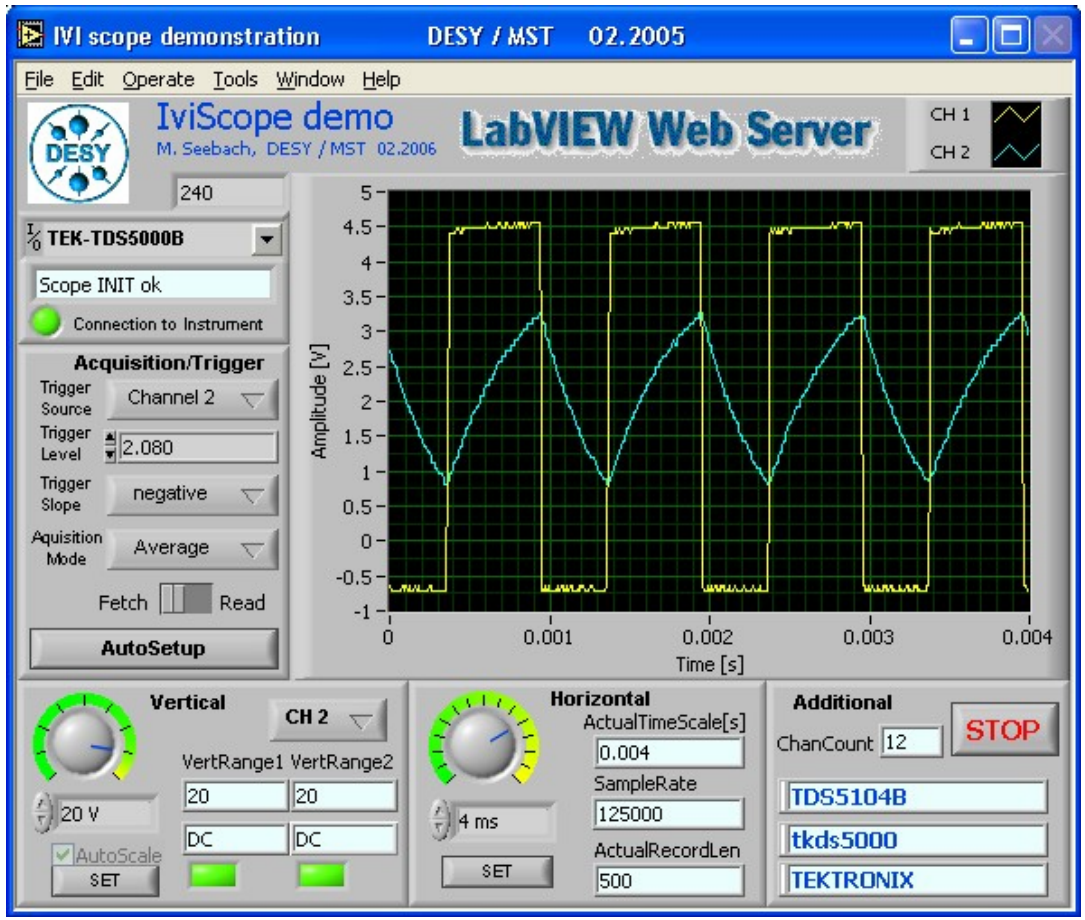
Note:

IVI = Interchangeable Virtual Instrument

VISA = Virtual Instrument Software Architecture

Generic Scope (Test) Application

- implemented with LabView
- based on IVI scope class libraries
- tested with:
  - NI USB-5102
  - TEK TDS5104
  - TEK TDS3054
  - LC WR 6200
- http-access via Web-publishing



TINE Control System Software Suite

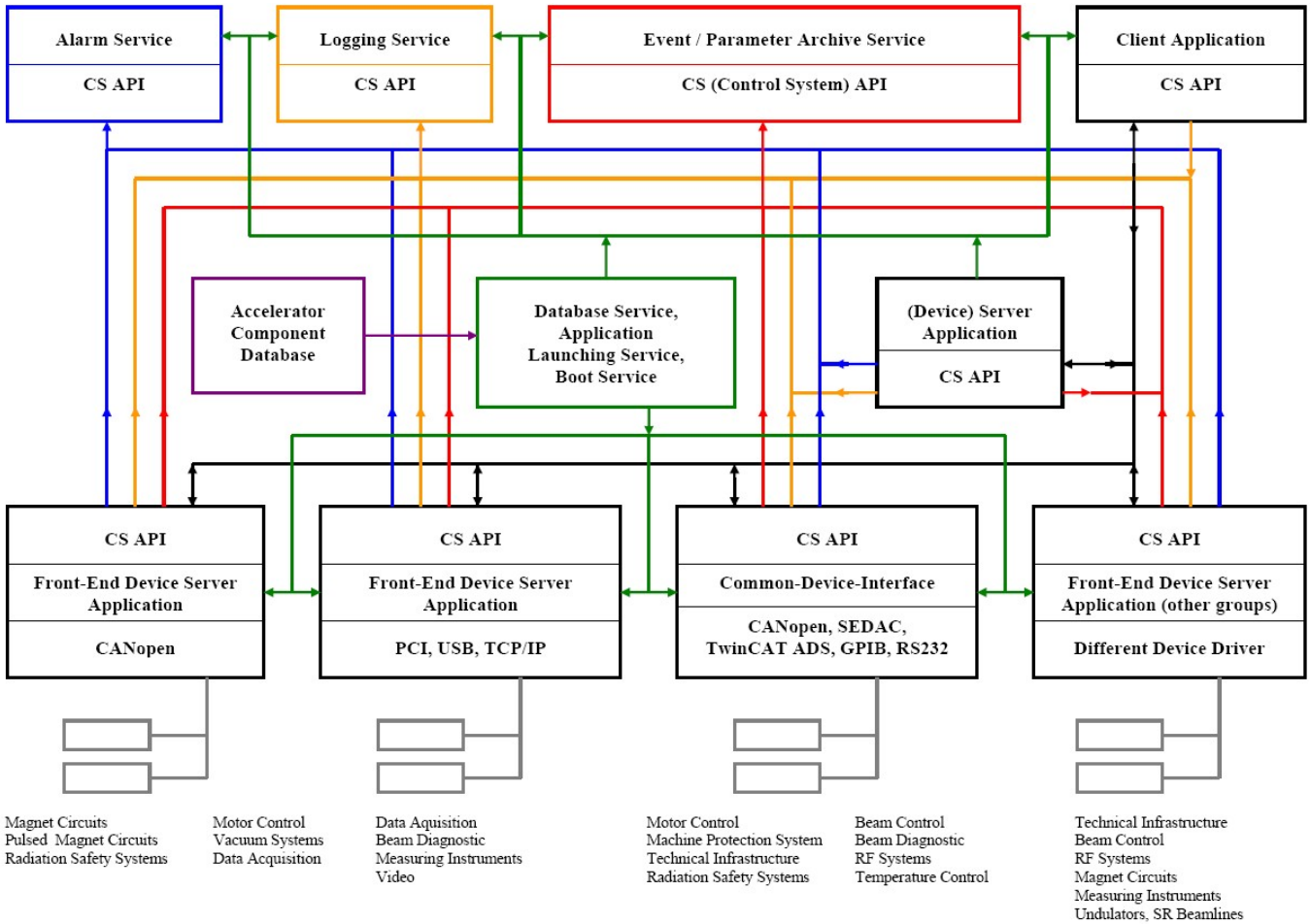
- Multi-platform: runs on Windows, Linux, Unix, MACOS, VxWorks, NIOS
- Multi-architecture: data exchange via client-server, publisher-subscriber, broadcast and multicast communication
- Multi-protocol: supports UDP, TCP/IP and IPX transport protocols
- APIs: provided for Java, VisualBasic, C/C++, LabView, MatLab and command line interface for script languages
- Client / Server implementation: in C and Java
- Name services: with plug-and-play automated server registration and user access control

TINE Control System Software Suite

- TINE = Threefold Integrated Network Environment
  - Mature development state
  - New release: version 3.31.21
  - Documentation and software download: http://tine.desy.de
- Associated services:
  - Alarms
  - Archives (central, local):
    - event-driven
    - periodic
  - Logging

S. Herb, P. Duval: Device Address Redirection as a Tool in the TINE Control System (WEC-PP5 <abs022>)

TINE Control System Software Suite



Tools for Application Development

- ACOP = Accelerator Component Oriented Programming
  - Simple RAD Tool
  - Graphical interface for data access and rendition
  - ACOP Chart implemented in VisualBasic and JAVA
  - Under development in collaboration with Cosylab (JAVA only):
    - ACOP Grid / Table
    - ACOP Label / Picture Box
    - ACOP Text Box
    - ACOP Slider

H.G. Wu, P.Duval, M.Plesko, I.Kriznar: The ACOP Family of Beans (WEP33 <abs056>)

Tools for Application Development

- Frameworks:
  - client application (JAVA)
  - server application (JAVA)
- Wizards / Generators (JAVA):
  - device server

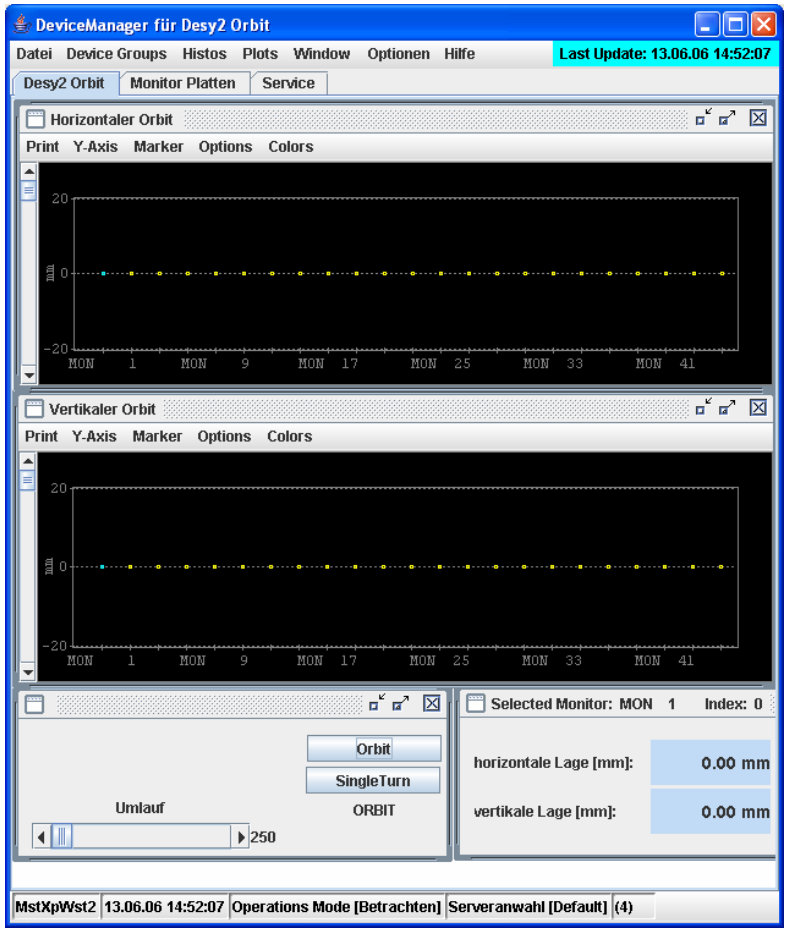
J.Wilgen, P.Duval: A Device Server Generator for Control Systems (WEP17 <abs021>)

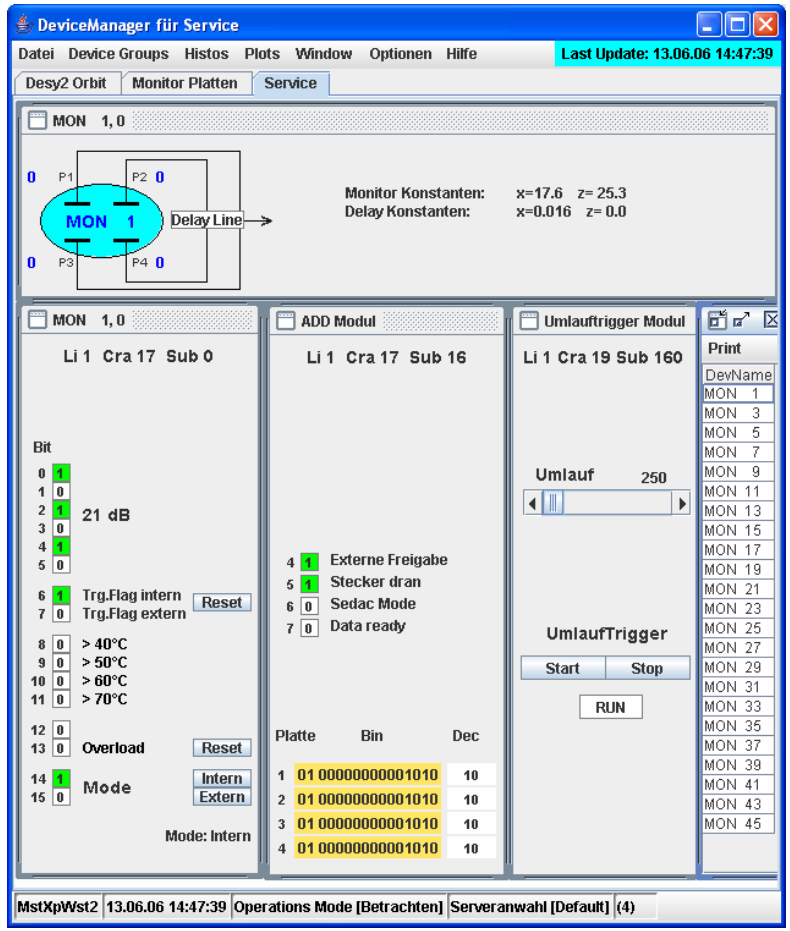
- Device manager (JAVA):
  - standard operator panel
- Resize manager (JAVA):
  - resizes Swing-based applications

- Build / Deployment and launching service (JAVA):
  - ANT Script
  - WebStart

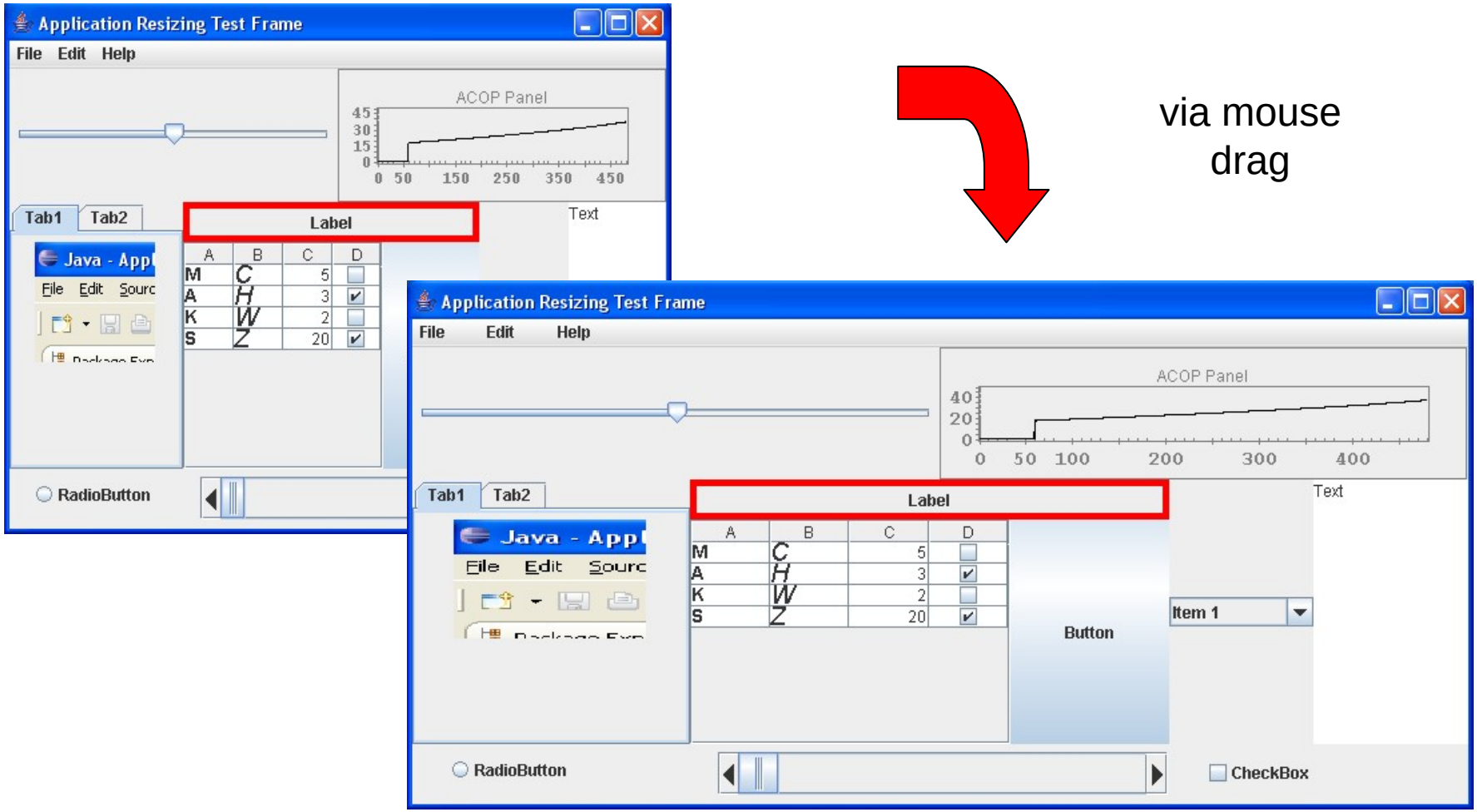
A.Labudda: Building and Deploying loosely Coupled Console Applications (WEP19 <abs029>)

Tools for Application Development





Tools for Application Development

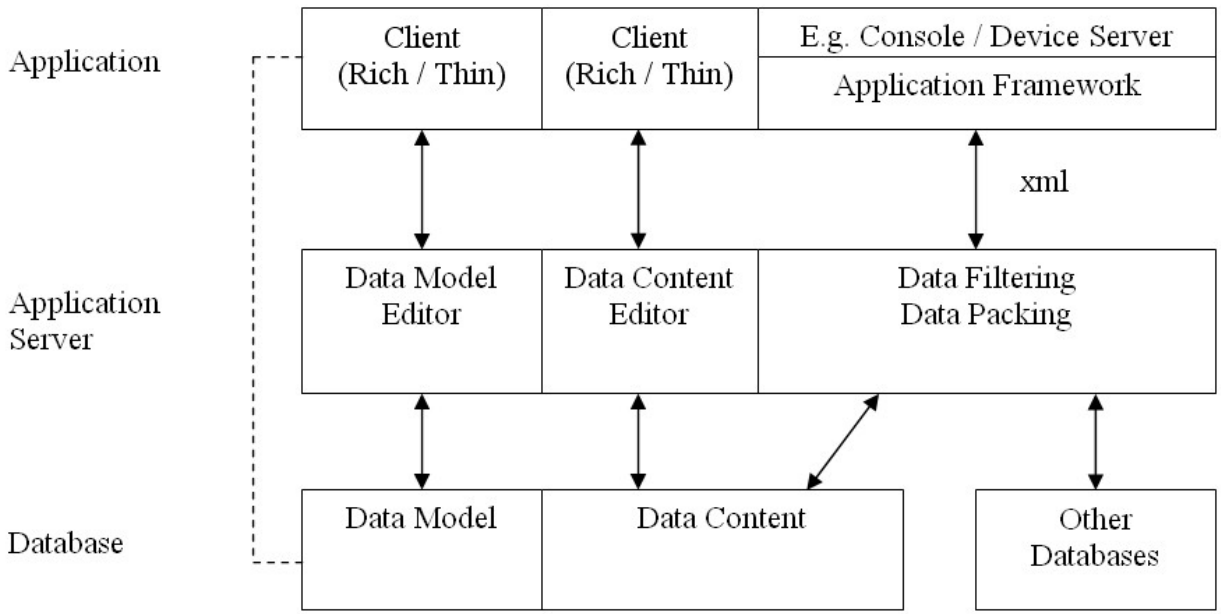


Integrated Development Environments and Editors

- **Eclipse:**
  - language: JAVA
  - version: 3.2
  - plug-in:
    - GUI development: Visual Editor 1.2
    - Testing: JUnit 4.1
    - UML Design: Enterprise Architect 6.5
    - Versioning: Subclipse 1.0
- **VisualStudio:**
  - language: VisualBasic, VisualC++
  - version: 6
- **LabView:**
  - version: 8.0
- **MathLab:**
  - version: 7.1
- **Emacs:**
  - language: C, C++
- **oXygen:**
  - language: XML
  - version: 6.0

Accelerator Component Database

- Conceptual design:

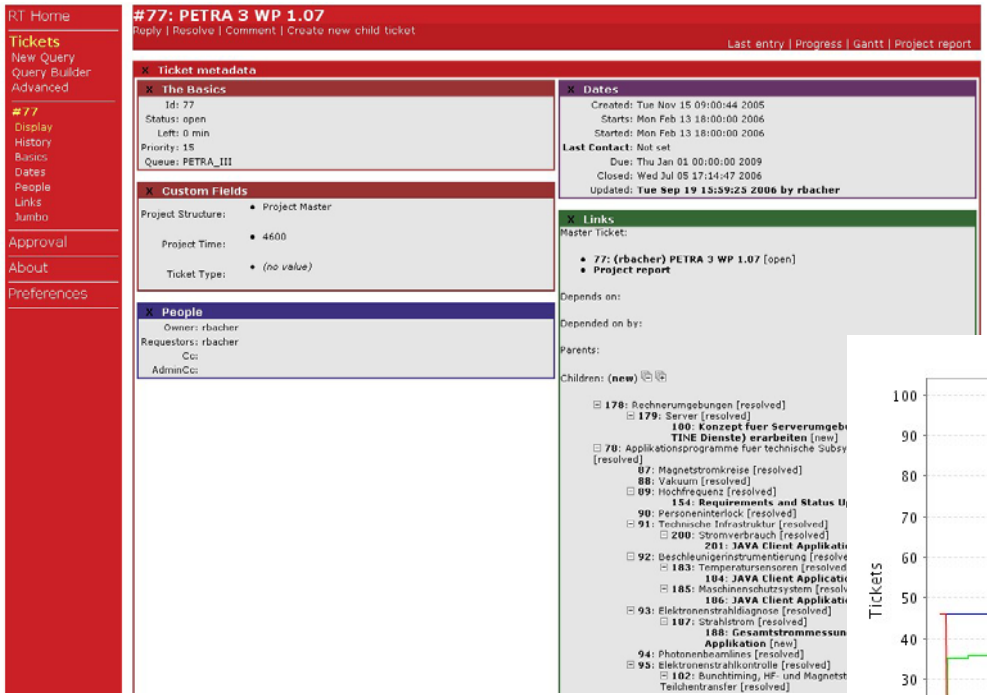


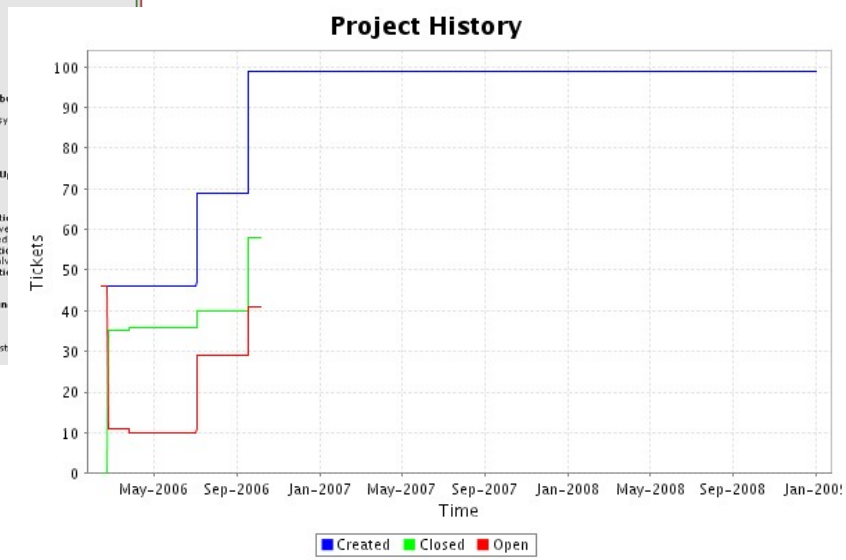
Project Management

- Cosy Project Manager from Cosylab, Slowenia
  - Web-based application
  - collaborative tool based on e-mail correspondence to distribute task tickets
  - work progress unit is “minutes worked”
- Adapted for use in a scientific environment for acceptance reasons
  - metrics changed from absolute to relative units
  - report form simplified

M.Plesko, I.Verstovsek, J.Kamenik, P.Kolaric, Cosylab, Slowenia: A Tutorial on Project Management (WEC2 <abs085>)

Project Management





Thanks to the PETRA III Controls Team:

- R. Schmitz
- P. Duval
- W. Gerhardt
- P. Bartkiewicz
- S. Herb
- V. Soloviev
- Y. Netchaev
- H. Lehmann
- U. Lauströer
- G. Smirnov
- U. Glöer
- M. Walla
- F. Wedtstein
- H.G. Wu
- W. Schütte
- M. Seebach
- K. Hinsch
- G. Mann
- J. Schwarz
- J. Maass
- A. Labudda
- J. Wilgen
- R. Stadtmüller
- B. Kühl
- O. Koschig
- H. Schulz
- L. Becker
- P. Nommensen
- C. Gindler
- C. Jaekel
- B. Pawlowski
- T. Delfs
- H. Fischer
- J. Möller
- P. Pototzki