A Data Acquisition for the TESLA Test Facility

GAN R&D Project at TTF 2
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Outline

- What is this project about?
- The TTF 2 Data Acquisition as a GAN
- The TESLA Test Facility at DESY
- (GAN-) Requirements, Design and Development
- Collaborative Technologies and Tools
- Where are we now?

What is this project about?

- Future linear collider is an international effort of various accelerator and HEP sites making using of worldwide knowledge, competence and ressources
- Design, development and building a large scale LC needs an international approach within a collaborative framework
- This projects concentrates on exploring and evaluating collaborative tools in the context of designing and building a data acquisition for a linear accelerator.

The TTF 2 Data Acquisition as a GAN Project

- TTF 1 made clear there is a need for a HEP-style data acquisition in a linear collider facility.
- Interest in TTF 2 grows not only as a LC R&D but also as a user facility (X-FEL) → more users and possible experiments → more data.
- Cornell, DESY and OSU initiated a joined project to design and develop a TTF 2 data acquisition by using collaboration technologies as an example for a possible future GAN scenario.

GAN Specific Project Goals

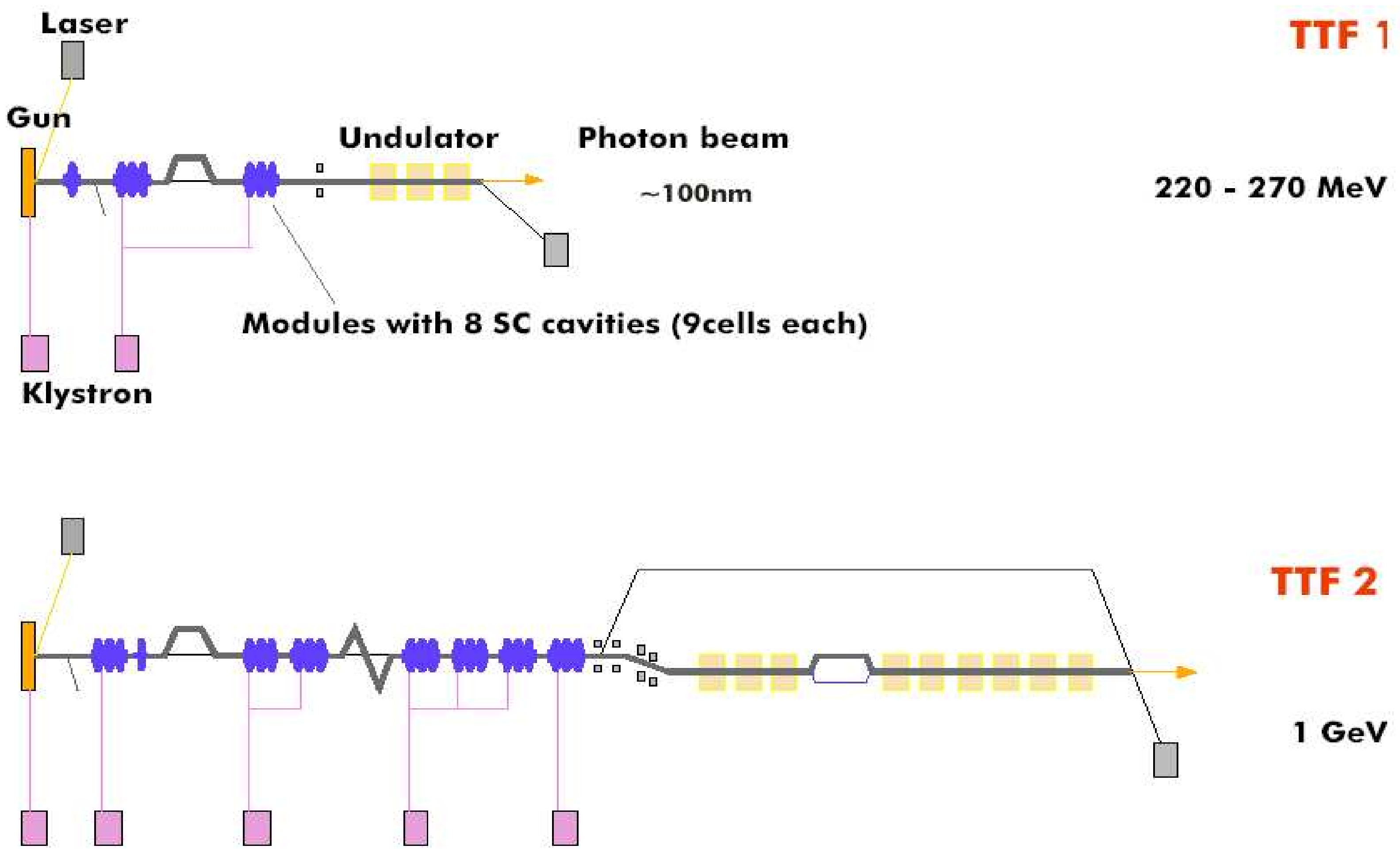
- Sociological aspects: learn how to work in virtual teams, trust, commitment, responsibility
- Organizational aspects: define and share responsibility, interfaces and tasks in international teams
- Collaborative technologies: learn from non-physics fields, communication experts and make use of worldwide competence and knowledge
- System aspects: reliability, accessibility, operations, etc.

  $\Rightarrow$ testbed for the Global Accelerator Network

Project Collaborators

- Joint project between:
  - DESY Hamburg
  - Cornell University
  - The Ohio State University
  - DESY Zeuthen
  - Yerevan Physics Institute
  - University of Michigan (for collaborative tools)

TESLA Test Facility at DESY



Requirements for a TTF 2 DAQ

- Record all beam relevant data from the linac and provide it in a reasonable way to operators and experts online → fast processing and recording
- Understand, maintain and improve the accelerator by e.g.
  - recording error statistics, cause of failures
  - providing data for offline expert data analysis
  - record and provide data of experiments for users to correlate with machine data

Requirements for a TTF 2 DAQ cont'd: Data Rates

1. Raw data rate from VME ADCs ---> CPU memory
   1.1 9 MHz sampling of ADCs 8k * 2 byte * 8 ch. * 8 slots * 10 Hz ==> 10 MB / sec.
   ==> max 8 slots for ADCs per crate (DMA: max. 10 MB/ sec. for our ADCs)
   1.2 1 MHz sampling of ADCs (RF channels) 2k * 2 byte * 8 ch * 16 slots * 10 Hz ==> 5 MB / sec.
   ==> more than 16 ADCs per crate are possible

2. Required memory in VME CPU (assumption: buffer for 16 macro pulses)
   2.1 9 MHz sampling of ADCs 10MB/s*16/10 = 16MB raw data+ 2*16MB of converted floats ==> 48MB total
   2.2 1 MHz sampling of ADCs (RF channels) 5 MB/s * 16/10 = 8MB raw data + 4*8MB of converted (phase and amplitude) floats ==> 40MB tot

3. Total data rate (max.) from ADC server to central station
   3.1 data rate of 400 ADC channels at 9MHz 8k * 2 * 400 * 10Hz ==> 64MB/sec (= 5.5TB/day = 2PB/year)
   3.2 data rate of 400 ADC channels at 1 Mhz 2k * 4 * 400 * 10Hz ==> 32MB/sec (= 2.8TB/day = 1PB/year)

4. Filtered data rate
   4.1 rate from ADC to "Orbit server" (1+9MHz systems)@ 2Hz: 19.2MB/sec ==> update rate for operator of 2Hz
   4.2 rate from "Orbit server" to DAQ archive reduction: 1Hz and special events (interlock etc.), max 1000 samples for 9MHz ch. and 500 for 1MHz ch., 70% of ch. (1000*2*400 + 500*4*400)*0.7 = 1.12MB/sec., 97GB/day, 35TB/year
   4.3 goal was a mean value of < 50GB/day on disk and tape a further reduction of a factor of two is required

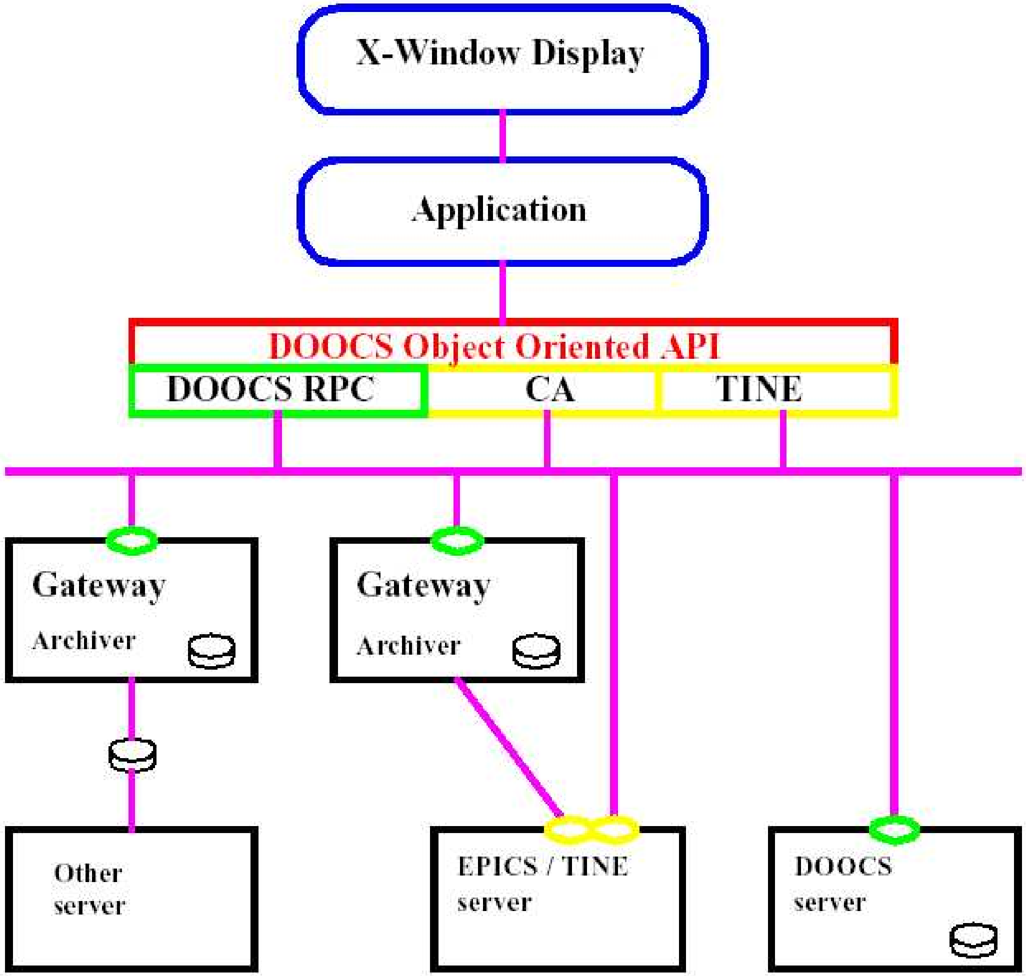
5. 800 ADC channels in total, 9MHz gives 8k samples per macro pulse, one sample has 2 bytes, linac runs with up to 10Hz, 8ch per ADC board

Design and Development

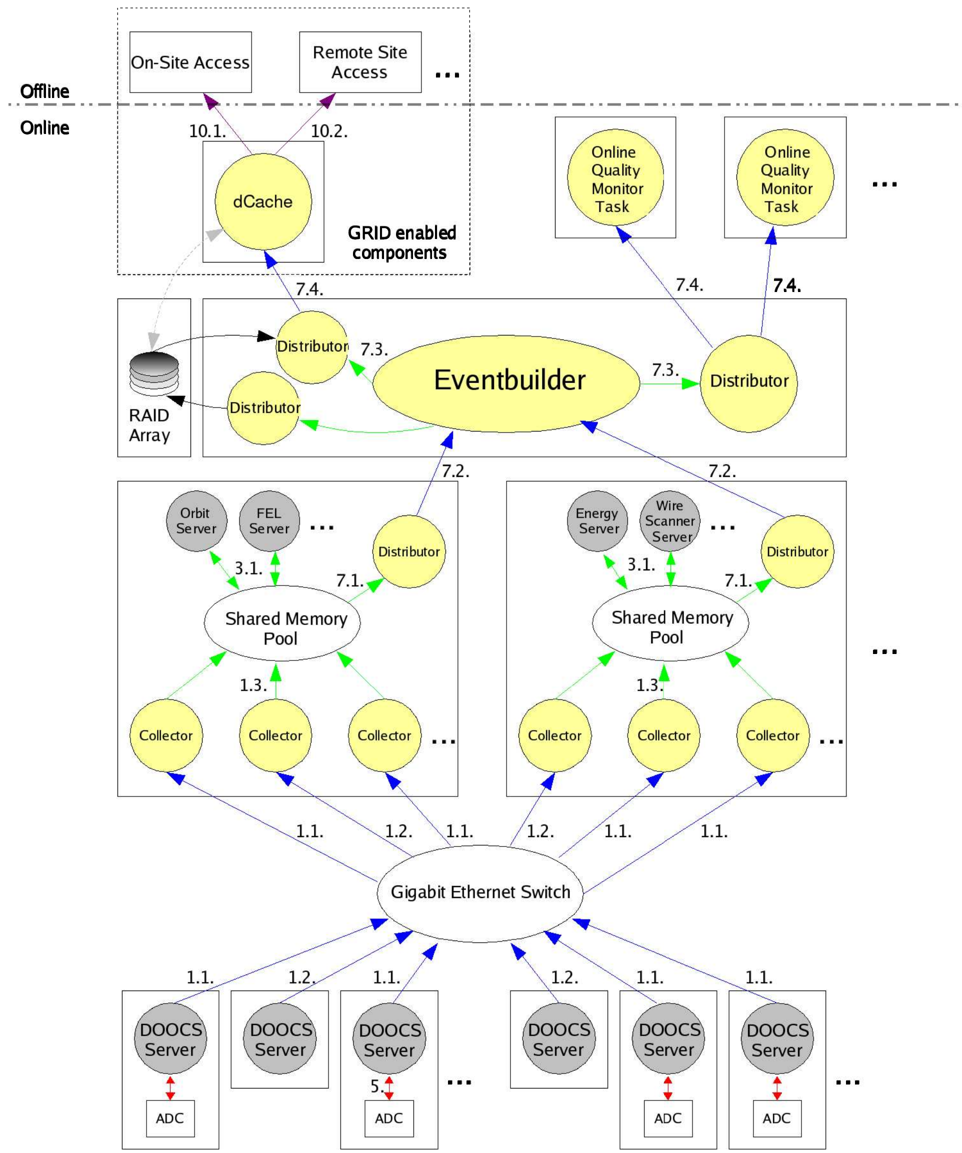
- High scalability to allow additional machine elements and user experiments added later
- Needs to cope with many different data rates, continuous transition between slow and event data and various format (floats or binary images,...)
- Usage of "future technologies" e.g. dCache (data storage cache project by FNAL/DESY, GRID)
- Build on top of existing accelerator controls architecture DOOCS at TTF: advanced object-oriented framework for accelerator controls

DOOCS at TTF 2

- Based on DOOCS (Distributed Object-oriented Control System, http://tesla.desy.de/doocs/doocs.html
- Display (X11) by default remote
- Devices *are* Objects
- OO API for all Apps
- Modular and scalable
- Online configuration
- Automated processes in middle layer
- Capable of many protocols (EPICS, RPC, TINE, …)
- Inherent remote operations capability



TTF 2 Data Flow Design



05/26/2003 Kay Rehlich, Tim Wilksen

Collaborative Technologies

- Technologies should enable:
  - access to people, information and instruments
- Synchronous vs. asynchronous:
  - Video conferencing, chat, messaging, streaming, sharing of desktop resources, awareness tools
  - Documentation archives, electronic logs, email, archived discussions
- Phases at TTF: Design/Development – Commissioning – Operations/User Facility

Collaborative Tools cont'd

- Design/Development Phase:
  - Meetings: awareness and calendars, video tools, shared desktops, whiteboards, messaging, presentation tools
  - Design documents: archive, notification, accessibility
  - Code work: shared repository, documentation
- Commissioning:
  - Remote operations and analysis of machine data
  - Meetings: as above

Collaborative Tools cont'd

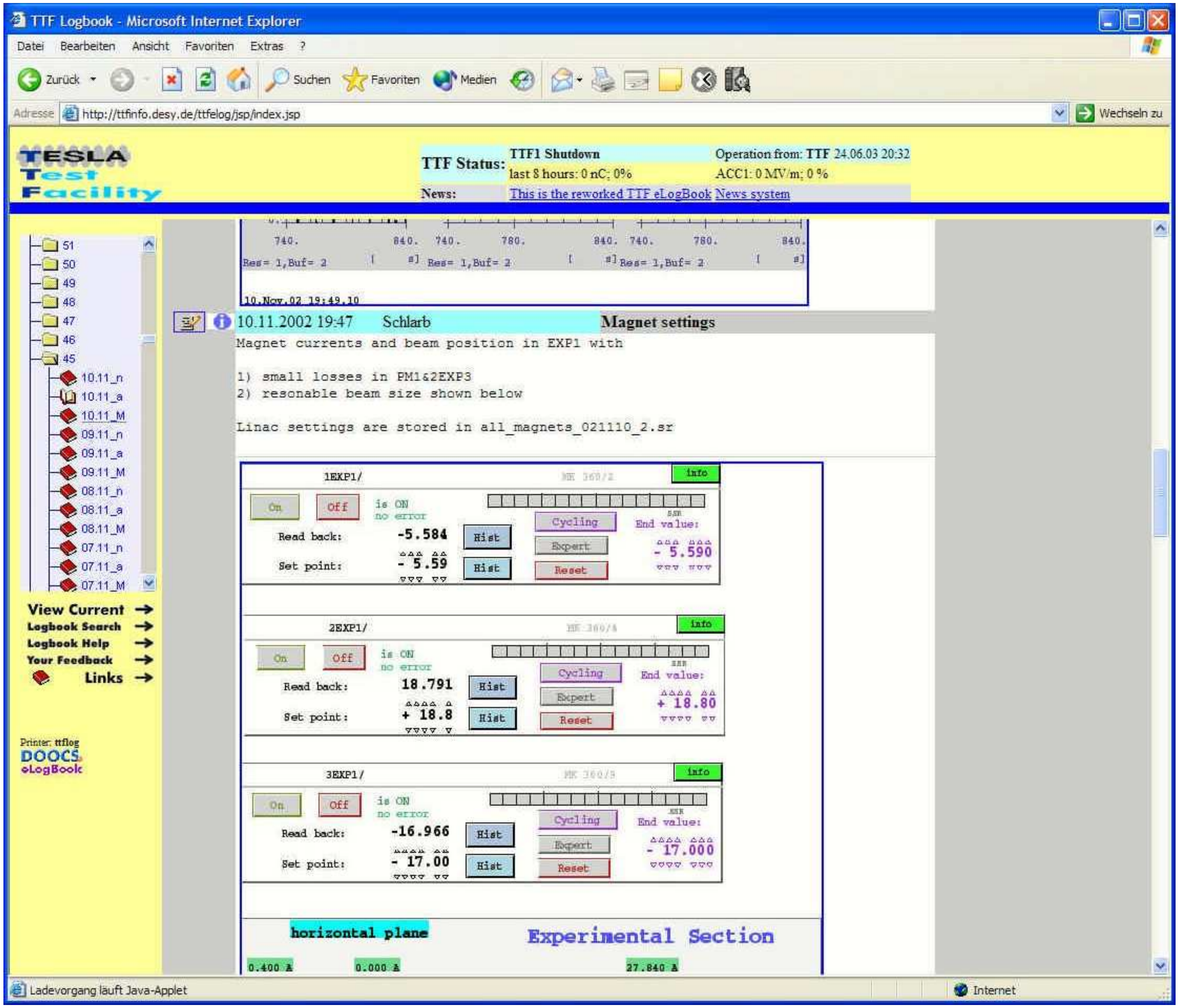
- Operations/User Facility:
  - Remote operations, maintenance
  - Analysis of user specific data

Currently: Design Stage

- Meetings supported by VRVS and VNC (desktop sharing) and TTF E-Log which acts as document archive and log facility for design and development work, Web server for access

TESLA TTF2

TTF Electronic Logbook



Where are we now?

- Design phase is ongoing, general overall design is there, implementations are being worked out now
- Frontend controls are going in place and software is pretty much available (DOOCS based)
- Development of collaborative tools is ongoing (TTF E-Log tools will be enhanced), VRVS is in use, shared source code
- Core needs of the DAQ needs to be available end of the year, most parts of the DAQ including storage mid of of 2004 when full commissioning of TTF 2 starts
- User interfaces and tools (based on ROOT and Matlab, eventually GRID) will come in 2004/05