ICALEPCS 2007

Summary

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THANKS!

- All the speakers, authors, participants, committees, organizers, editors and support staff have made a very successful conference
- Thanks to everyone

The Numbers

- 362 registrants
- From 22 countries
- Europe 42%, America 48%, Asia 10%
- 261 papers: including 71 orals (23 invited) and 190 posters
- 10 industrial exhibitors
- 3 Pre-conference workshops

The Program

- Many excellent contributions
- Wide variety of talks and posters from many areas of controls
- New perspectives from related fields and academia

ICALEPCS 2007 - Theme

JAVA

Workshops - EPICS

- Collaboration still growing
- Java at all levels
  - Java front end (Java IOC)
    - Device hierarchy
    - New protocol possible
- Work on redundancy, higher reliability solutions
- Better time support
- Embedded IOCs common, many types – EPOCH
- Another Display Manager!

Workshops - TANGO

- 5 sites – accelerators + beamlines
- CORBA based - C++, Java, Python
- Device hierarchies
- constant evolution - multi-protocol
- Works for
- Proof of all theories (*Ken Peach*)

Collaborations Collaborate?

- **Control System Studio** – *(Clausen)*
  - A common studio for EPICS and TANGO (EPICS/TANGO common session)
- **EPICS to TANGO Translator** (*Sabjan*)
- Will we see EPINGO or TANICS?

Workshops - $(CS)^2$/HEP

- Control System **Cyber Security**
- Threat is real and increasing
- Cannot be ignored - stakes are high
- "Defense-in-Depth"
- Lack control over commercial products
- Requires diligence and $$$

Job Security

- Large new machines in design

  ITER **ILC**

- Multinational collaborations
  - Integration, management challenges
- Size implies need for higher reliability
  - Great round table discussion
- Also, many other smaller machines and upgrades in design or construction

Operations Tools

- Lots of development of general purpose, platform and control system independent GUI builders and tools
- Nice new ease of use features and are more interoperable than previous generations
- Provide a common look/feel/behavior
- Often used by only one project, even within collaborations

Databases

- Continued investment in development of databases and related tools
- Not yet exploiting full power of this technology
- Nice use of GIS from Spring-8
- Very informative lessons learned from SNS
- Data entry and maintenance continues to be a challenge
- Increased use of RDB for archiving

Software Technology

- Frameworks
- JAVA
- CORBA
- Eclipse
- CSS
- Oracle
- Grid
- Python
- XAL
- IDE

All possible combinations of the above

Hardware Technology

- Still a lot of VME
- More FPGA
- Embedded controllers everywhere
- Better timing systems
- Line between hardware and software blurs

As a community

- A lot of focus on technology
  - Software: frameworks, languages, methods
  - Hardware: processors, crates, chips, buses, networks
- Much less focus on
  - Customers, operations, human factors, process, metrics

Poster Prizes

- The Run-Time Customization of Java-Rich Clients with the COMA Class
  - *Piotr Karol Bartkiewicz* (DESY)

Poster Prizes

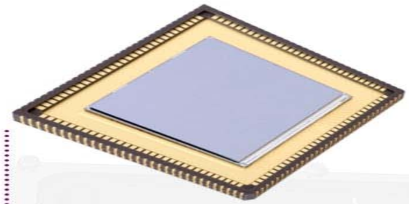
- The MIRI Imager Ground Support Equipment Control System Based on PCs
  - *Francoise Gougnaud* (CEA)

The MIRI Imager Ground Support Equipment Control System Based on PCs

dapnia
cea
saclay
ICALEPCS

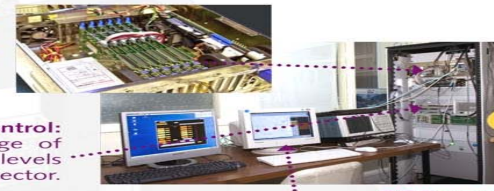
F. Gougnaud, Y. Lussignol, P. Mattei (SIS) *Software team*
Ph. De Antoni, Ph. Beauvais(SIS), A. Goetschy (SAP) *Electronics team*
D. Eppellé, D. Arranger, J. Da Costa , A. Donati, G. Durand (SIS) *Cryogenics CS team*
CEA-Saclay/DAPNIA

The Mid Infra Red Instrument MIRI is one of three instruments to be built for the James Web Space Telescope (JWST). JWST is the successor of Hubble in the infrared and will be launched in 2013. MIRI is a spectrometer and an imager. Our division, Dapnia, is in charge of the design and completion of the optomechanical part of the imager called MIRIM, and of its test bench called the Ground Support Equipment (GSE). This GSE consists of a warm telescope simulator, of the imager, of a cryostat to cool the imager down to its operating temperature, and of an infrared detector. The major part of the hardware architecture is based on PCs and COTS boards.



The Raytheon infrared detector 1024x1024 pixels

Infrared detector fast acquisition: The software IRACE from the European Southern Observatory is used. A port has been carried out on COTS Spectrum boards.



Infrared detector slow control: This EPICS VME software is in charge of the setting for 13 biases and clocks levels and monitors the safety of the detector.

CA

BOB user interface: The ESO software tool BOB is the high-level interface. It operates on Observation Blocks Descriptions to execute exposures. Tcl object classes access to the subsystems.

Filter wheel

MPIA Heidelberg Electronics box

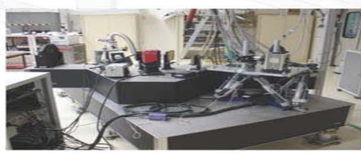
CA

Filter Wheel Control:
(Windows XP Visual C++ PC housing I/O Meilhaus board)

- API was provided by MPIA Heidelberg to interface MPIA classes with EPICS
- EPICS windows host-based IOC
- EPICS Channel Access client with callback calling the API.

Cryostat

The warm telescope simulator:
Controlled by a PC Linux running EPICS on a host-based IOC
Using streamPackage to drive devices through serial lines (RS232).



Optical bench

XPSC8 motion controller

Rack with device controllers

RS232

Extended IR source

CA

Mononochromator

Hexapod

Ethernet

Ethernet

PC web server Anibus-FBI

CAJ

WorldFIP

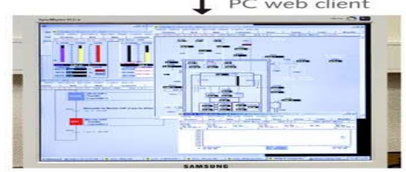
Cryogenics control:
Cryostat is controlled by a PLC through Anibus-FBI supervisory control system based on real-time fieldbus WorldFIP

CEA CABTF
θ° measurement device

PLC

Goal:
6-7K ± 30mK

PC web client



Anibus-FBI supervisory control

CA EPICS Channel access software is used by the different subsystems to communicate

Poster Prizes

- Machine Protection and Advanced Plasma Control in TORE SUPRA Tokamak
  - *Francois Saint-Laurent* (EURATOM-CEA)

Machine Protection and Advanced Plasma Control in TORE SUPRA Tokamak

F. Saint-Laurent, Ph. Moreau, S. Bremond, J. Bucalossi, G. Martin

Association EURATOM-CEA

CEA / DSM / Département de Recherches sur la Fusion Contrôlée

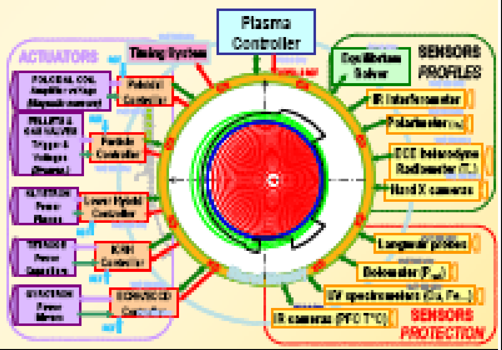
CEA-Cadarache, 13108 ST PAUL-LEZ-DURANCE (France)

Tore Supra Tokamak

- Cryogenic plant (LHe 1.7K)
- Toroidal (4T) and Poloidal magnetic fields (power supplies)
- Main water cooling loop (30b-120°C) Plasma Facing Components
- Auxiliary water loops for additional power systems
- 3 Plasma Heating & Current drive systems (ICRF, LH, ECRF)
- Gas fuelling
- Vacuum system (10-6Pa) turbomolecular pumps

Real Time Control System

- 1 Central Plasma Supervisor
- 15 passive nodes (Diagnostics), 5 active nodes (Controllers)
- SCRAMNet® from SYSTRAN Corp. 150MHz



Plasma Safety Control System

Part of the RTC system, 4 levels of alternative strategies

- **Avoid the premature shutdown of subsystems**
  - Never reach the internal hardware limits
  - ⇒ Automatic reorganization of the subsystem loads : Control of the load margin : "intelligent" controller
- **Operate close to the technological limits**
  - Perform discharge with a high injected power...
  - ⇒ Need to react as quickly as possible
  - ⇒ Need a reliable and robust safety control
  - Specific controls dedicated to the protection purpose
- **Avoid machine damages**
  - Water or air leakage, First wall melting...
  - ⇒ Robust & soft plasma shutdown procedure
    - when subsystem limits are reached
    - when a subsystem fails (Water loop cooling...)
  - ⇒ Fast "Killer" plasma procedure in case of emergency
    - Automatic (wired or soft)
    - Enable heating sub-systems

Four levels of alternative strategies

First Level

- Detect an abnormal event
- Treat the event
- ✎ Recover the nominal state

Second Level

- Modify parameters to preserve plasma discharge
- ✎ Plasma in a degraded mode
  - Try to go back to nominal

Third Level

- Detect irreversible conditions
- No strategy to recover (known or implemented)
- ✎ Soft plasma shutdown:
  - switch off additional powers
  - switch off gas fuelling
  - decrease plasma current
  - plasma position under control

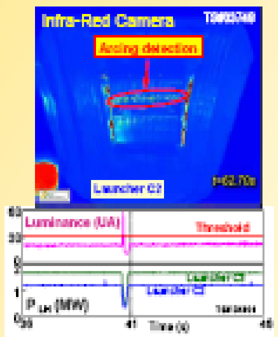
Fourth Level

- Uncontrollable loads
- High Disruption probability (confinement losses in few millisec.)
- ✎ Fast plasma shutdown:
  - Massive gas injection
  - Disruption under control
  - Mitigate the disruption effects

Abstract

A tokamak is a complex device combining many sub-systems. All of them must have a high reliability and robustness to operate together. Sub-systems include their own safety protections, but a more integrated level of protection is required to ensure the safety of the full device. Moreover, plasma operation with several megawatts of additional injected power requires a highly reliable advanced control system, as off-normal events may seriously damage the in-vessel components. Such an integrated control system, including protection algorithms, has been developed on Tore Supra. In the following the implementation of the Plasma Safety Control system is described as well as its real time network topology. The hierarchy of strategies applied, when more and more severe failure appears, is detailed. Finally few examples of active protections daily used in Tore Supra are given.

IR Thermography Dedicated to Safety



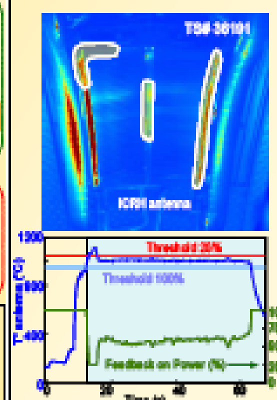
- 8 IR cameras
- 7 endoscopes
- RT controller

Arcing Detection

- Survey of the launcher,
- Specific IR signature (spatial & temporal)

✎ PSC reduces the LH power down to 25%.

Real Time IR Controller



- Record IR frames,
- Apply masks (zones of interest),
- Compute surface temperature,
- Compare to technological limits,
- Provide instructions to PSC.

Between 100% and 25% thresholds the Real Time IR controller provides information to modulate the additional power.

✎ PSC modulates the ICRF power (100%-25% range)
⇒ Nominal plasma power is not recovered.

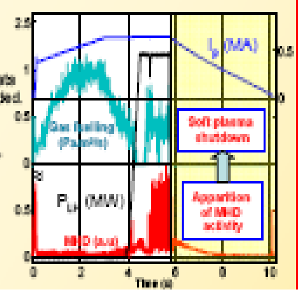
Soft Plasma Shutdown

- When no recovery strategy exists
- or parameters too much degraded.

PSC initiates a Soft stop

- Plasma position still controlled,
- Stop gas fuelling,
- Stop additional heating,
- Decreases plasma current.

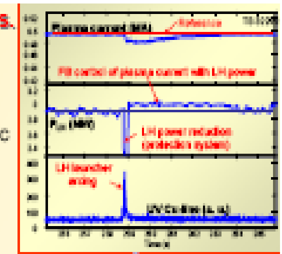
Need several seconds to stop the plasma.



Impurity Spectros.

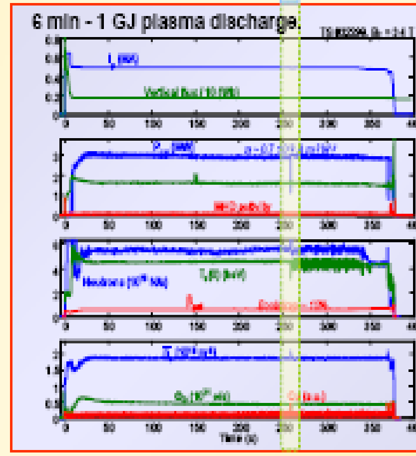
- Analyse Cu et Fe rays (UV spectroscopy)
- Take density into account
- Compare to threshold
- Provide instructions to PSC

✎ Reduce rapidly Power
✎ Reapply progressively



⇒ Nominal plasma parameters are recovered
New $T_e(0)$ fluctuations ⇒ current profile has changed

6 min - 1 GJ plasma discharge



Fast Plasma Shutdown

- When disruption probability becomes too large
- loads closed to be uncontrollable

PSC initiates a controlled disruption by Massive Gas Injection ⇒ Kill the plasma

Benefits :

- Disruption effects are mitigated
- MGI characteristics adjusted to deal with the disruption effects
- With Helium gas, no formation of decoupled electron beam

Disruption:
Loss of the plasma confinement in few milliseconds.
✎ Mechanical stresses induced on structures
✎ Plasma stored energy released on the first wall
✎ Decoupled electron beam (E=10-20 MeV, several hundred kA)

Future Plans

- Create a separate PSC unit,
- Expert system approach for implementation
- The PSC will address the individual sub-system controllers
- Develop advanced recovery strategy for MHD activity (use ECRH current drive capability to modify current profile)
- With the help of integrated tokamak modeling, develop advanced scenarios to recover nominal plasma after events.
- Take advantage of modeling to develop control strategies.

Poster Prizes

- Realization of a Custom Designed FPGA Based Embedded Controller
  - *Freddy Severino* (BNL)

Poster Prizes

- Initial Design of a Global Fast Orbit System for ALBA Synchrotron
  - *David Beltran* (ALBA)

Poster Prizes

- The Data Acquisition System (DAQ) of the FLASH Facility
  - *Raimund Kammering* (DESY)

The Data Acquisition system (DAQ) of the FLASH facility

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MC
Machine C
Syste

Abstract

Nowadays the photon science experiments and the machines providing these photon beams, produce enormous amounts of data. To capture the data from the photon science experiments and from the machine itself we developed a novel Data AcQusition (DAQ) system for the FLASH (Free electron LASer in Hamburg) facility [1].

Meanwhile the system is not only fully integrated into the DOOCS[2] control system, but is also the core for a number of essential machine related feedback loops and monitoring tasks.

A central DAQ server records and stores the data of more than 900 channels with 1MHz up to 2GHz sampling and several images from the photon science experiments with a typical frame rate of 5Hz.

On this server all data is synchronized on a bunch basis which makes this the perfect location to attach e.g. high level feedbacks and calculations.

Introduction

The FLASH is not only a permanent user facility providing laser like X-ray beams in a before unmatched wavelength regime, but also serves as a R&D study for exploring the superconducting cavity technologies to be used at future linear accelerators.

The requirements for both of these efforts demand a very high level of diagnostic and electronic instrumentation.

To get a deep and clear understanding of the machine, we developed a data acquisition system capable to record all relevant data from about 900 ADC channels distributed over tenths of VME crates with the full machine repetition rate (5 Hz with up to 800 bunches per cycle).

The data acquisition system

The core of the DAQ system is formed of a multiprocessor SUN Fire E2900 hosting 32 GB of memory (the DAQ server) and a SUN Fire X4500 providing 22 TB RAID file space (ZFS).

For the necessary network connections the existing infrastructure of the FLASH accelerator (1 Gigabit Ethernet) is used.

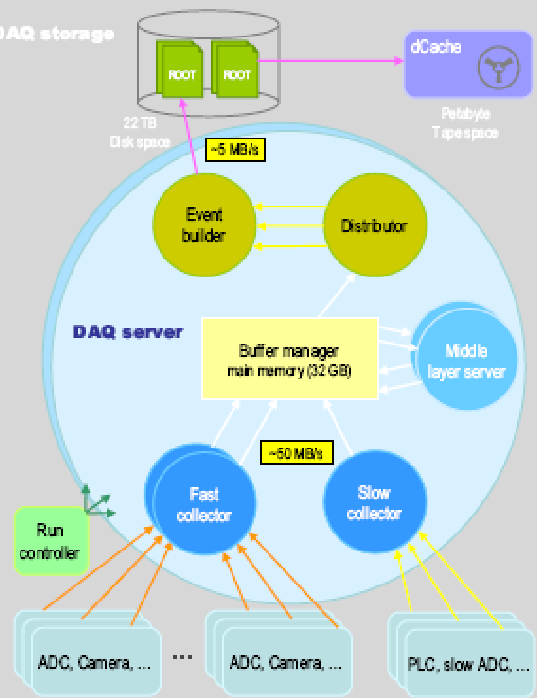
DAQ architecture

DAQ storage
The event builder writes the data to be stored to the DAQ storage machine. Here the beam relevant data of the last ~ 30 days is kept, for having good performance on data retrieval. By default the data is written in ROOT[4] file format.

dCache
Finally data older than 30 days or in case of unusual high data output stream sizes, all data from the DAQ storage is moved to a central tape, hosting a sophisticated long-term archive architecture called *dCache* [3].

Distributor, Event builder processes
To have a maximum flexibility in control of the data passed to the final storage destinations, a *distributor process* passes a set of streams to an *event builder* process which actually writes the data to discs.

Buffer Manager
The core of the DAQ is the buffer manager. It controls all read write operations to and from the main memory.



Middle Layer processes
Since all beam relevant data is passing through the buffer managers main memory, this is a perfect place for attaching slow feedback and monitoring processes. A number of high level control and monitoring programs have been implemented this way already.

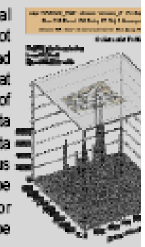
Run controller
All clients participating in a *DAQ run* get the configuration (repetition rates, number of bunches, ...) transmitted by XML strings. A finite state machine implemented in all clients, for synchronization, is supervised by the Run controller.

Data collectors
There are two sorts of collector processes: A *slow collector* for pulling slowly varying data from systems like PLC, etc., and a multiple instances of *fast collector* processes listening to the multicast streams send by the fast front-ends.

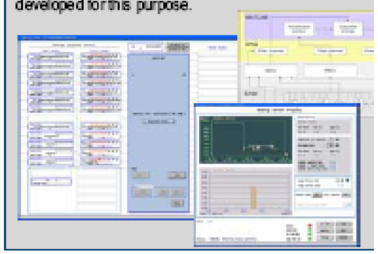
The front-ends
At the FLASH most of the fast monitoring hardware is readout and digitized by VME crates controlled by SPARC CPUs running Solaris OS. To ship the data efficiently to the main DAQ server machine the multicast UDP protocol is used.

Usage examples

Different from the original expectations, it showed that not the machine physicists but instead the photon experiments done at FLASH are heavily making use of this possibility for mass data storage. Here the huge data volume produced by various camera systems needs to be stored and methods for comfortable data retrieval must be provided.



The middle layer servers unique position within the da triggered a number of developments for implem monitoring and slow feedback applications. Some of th already part of the standard machine operation. A easily attach C++ and MATLAB based applications ha developed for this purpose.



Conclusions

The DAQ system developed and now already running than a year reliable at the FLASH facility, has extend possibilities for understanding and controling a comple accelerator like this.

The novel combination of High Energy Physics techniques and an accelerator control system succ shows that such an integrated framework can sol requirements demanded by the high data rates and nu components.

The FLASH DAQ system was developed in a collabora three institutes: DESY Zeuthen, DESY Hamburg and Cornell University, Ithaca, NY, USA

References

[1] http://flash.desy.de
[2] http://doocs.desy.de
[3] http://dCache.desy.de
[4] For ROOT see: http://root.cern.ch