Sterowanie kontrola i monitorowanie eksperymentu

Osiągnięcia systemu

$$\text{Total Efficiency} = \frac{\#\text{ of interesting events on tape}}{\#\text{ of interesting events produced}}$$

$$= \text{Trigger efficiency} * \text{Deadtime} * \text{DAQ efficiency} * \text{Operation efficiency}$$

DAQ system not running

Detector problems: background, data quality

weighted by the Luminosity

- All the factors have equal importance. Therefore all of them need to be optimized.
- The performance needs to be monitored in order to detect problems and point where there is a need for improvement.

Sterowanie (kontrola) systemem

- **Run Control**
  - Configuration
    - Type of RUN, loading of parameters, enabling/disabling parts of the experiment
  - Partitioning
    - Ability to run parts of the experiment in stand-alone mode simultaneously
  - Error Reporting & Recovery
  - Monitoring
  - User Interfacing

Kontrola eksperymentu (ECS)

- Data Acquisition and Trigger (Run Control)
  - Configuration, ...
- Detector Control (Slow Control)
  - Gas, HV, LV, temperatures, ...
- Experimental Infrastructures
  - Cooling, ventilation, electricity distribution, ...
- Interaction with the outside world
  - Accelerator system, magnet, data storage provider, offline analysis

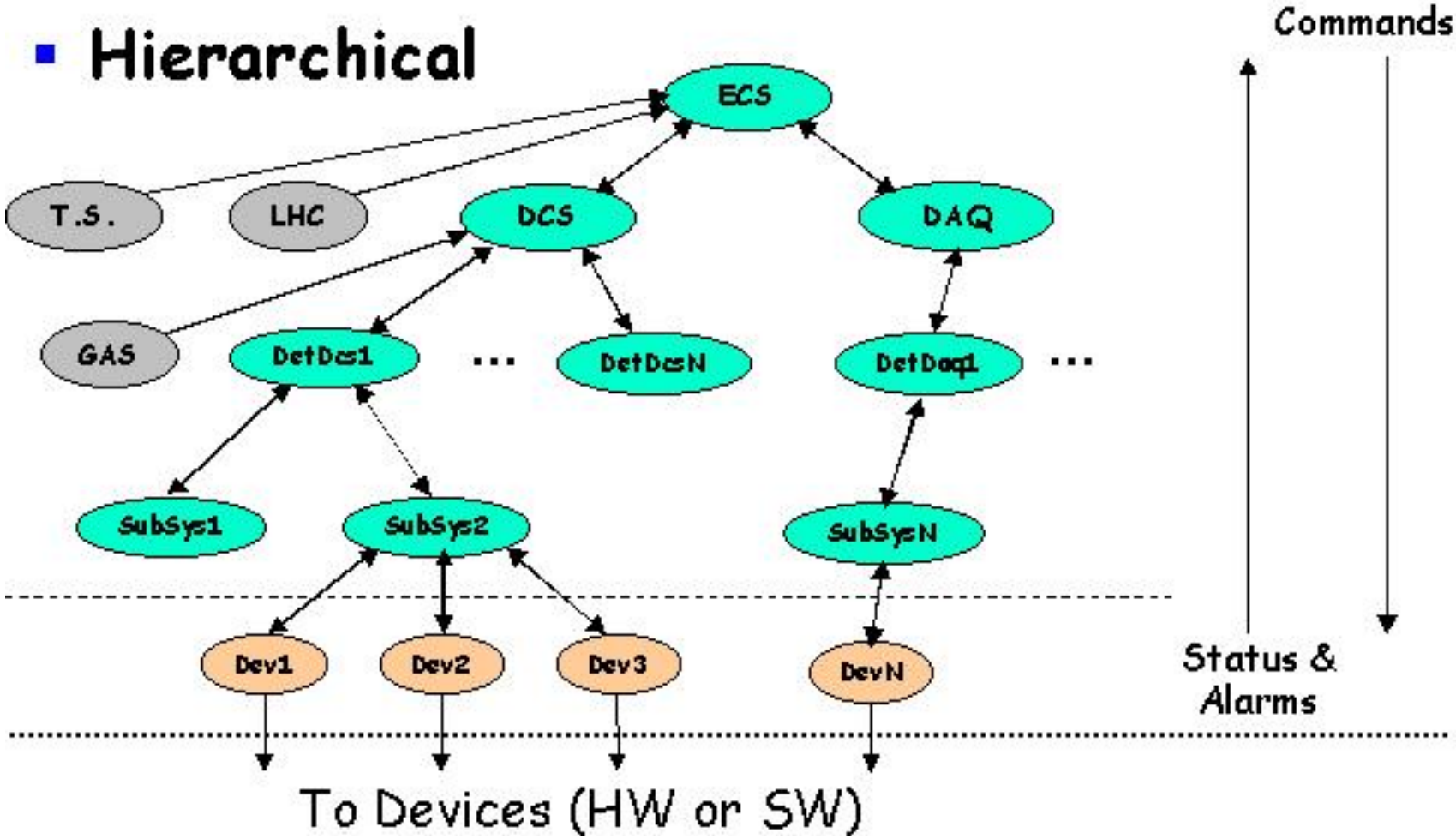
Wymagania dla ECS

- **Integrate the different activities**
  - Such that interlocks can be defined (ex: Stop DAQ when SC in Error)
- **Allow Stand-alone control of sub-systems**
  - For independent development and concurrent usage.
- **Automation**
  - Avoids human mistakes and speeds up standard procedures
- **Easy to operate**
  - Two to three operators (non-experts) should be able to run the experiment.
- **Scalable & Flexible**
  - Allow for the integration of new detectors
- **Maintainable**
  - Experiments run for many years

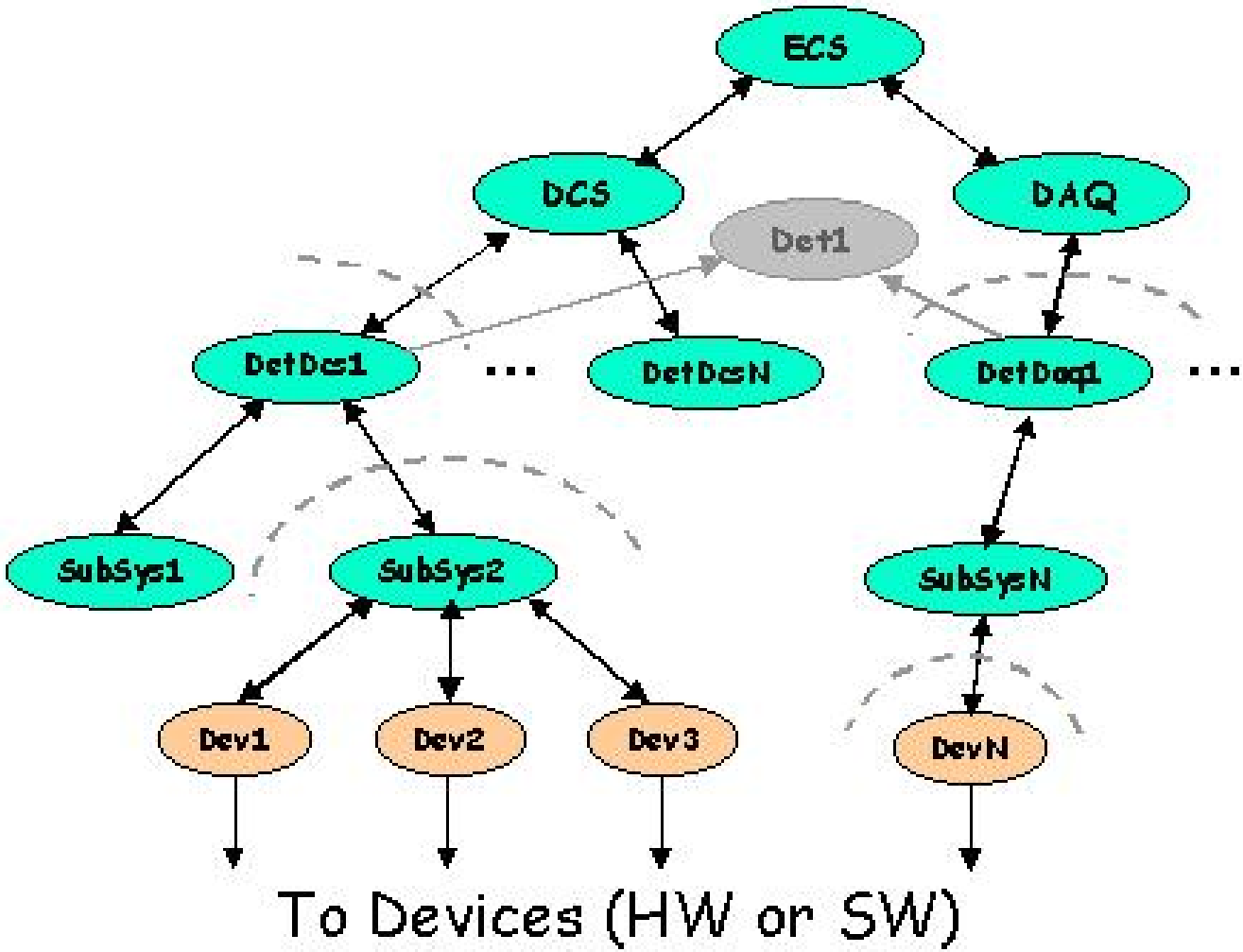
Jak to zrobimy ?

- **Keyword: Homogeneity**
  - A Common Approach in the design and implementation of all parts of the system:
    - Facilitates inter-domain integration
    - Helps providing an uniform Look and Feel
    - Allows an easier upgrade and maintenance
    - Needs less manpower

Architektura systemu kontrolnego



Podzielność (partitioning) 1



Konfigurowanie systemu 1

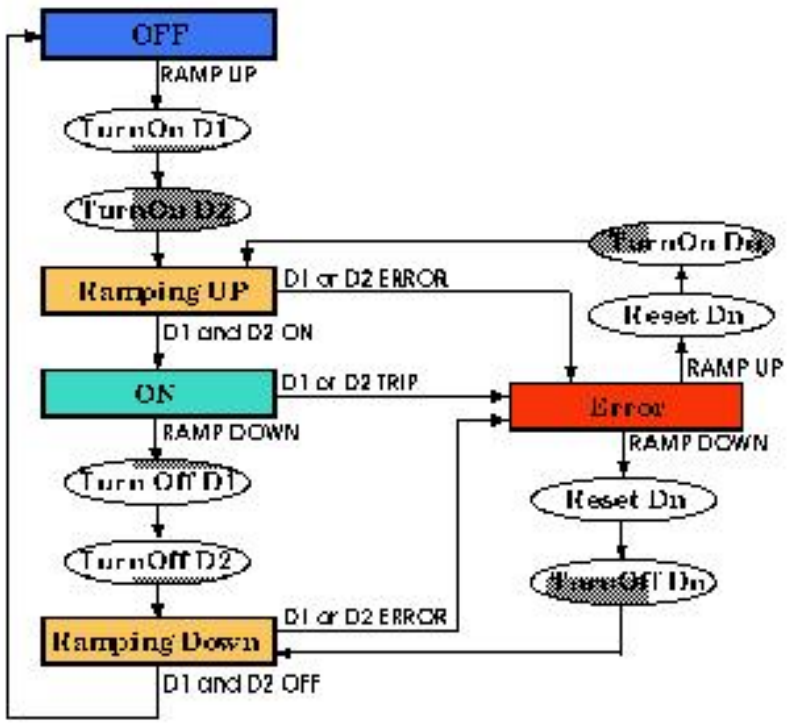
- All the components of the system need to be configured before they can perform their function.
  - Detector channels: thresholds, calibration constants need to be downloaded.
  - Processing elements: programs and parameters.
  - Readout elements: destination and source addresses. Topology configuration.
  - Trigger elements: Programs, thresholds, parameters.
- Configuration needs to be performed in a given sequence.

Konfigurowanie systemu 2

- **Databases**
  - The data to configure the hardware and software is retrieved from a **database system**. No data should be hardwired on the code (addresses, names, parameters, etc.).
- **Data Driven Code**
  - Generic software should be used wherever possible (it is the data that changes)
  - In Delphi all sub-detectors run the same DAQ & DAQ control software

Konfigurowanie systemu 3

- Finite State Machine methodology
  - Intuitive way of modeling behaviour, provide:
    - Sequencing
    - Synchronization
  - Some FSM tools allow:
    - Parallelism
    - Hierarchical control
    - Distribution
    - Rule based behaviour

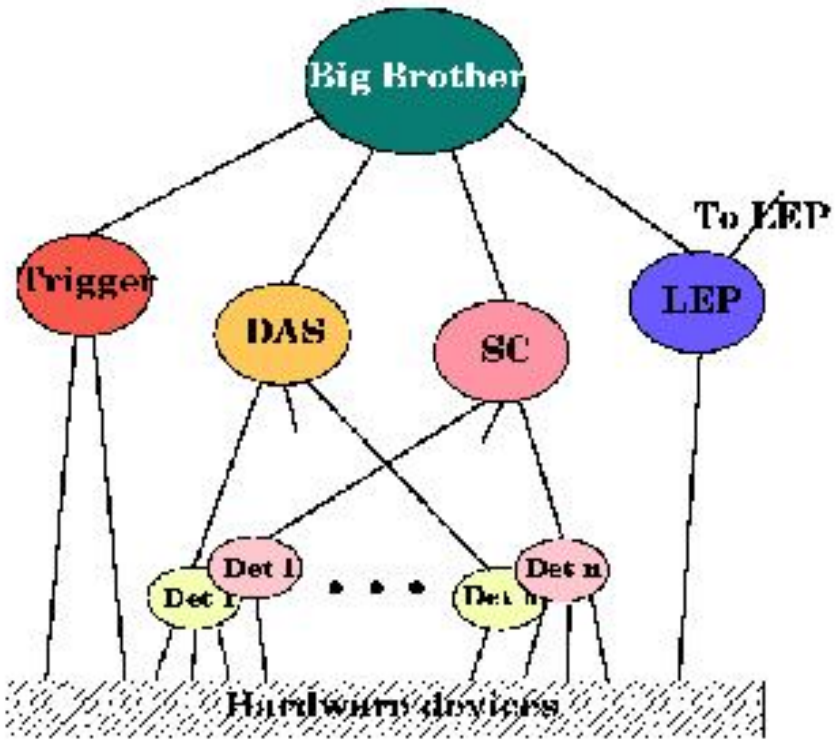


Automatyzacja

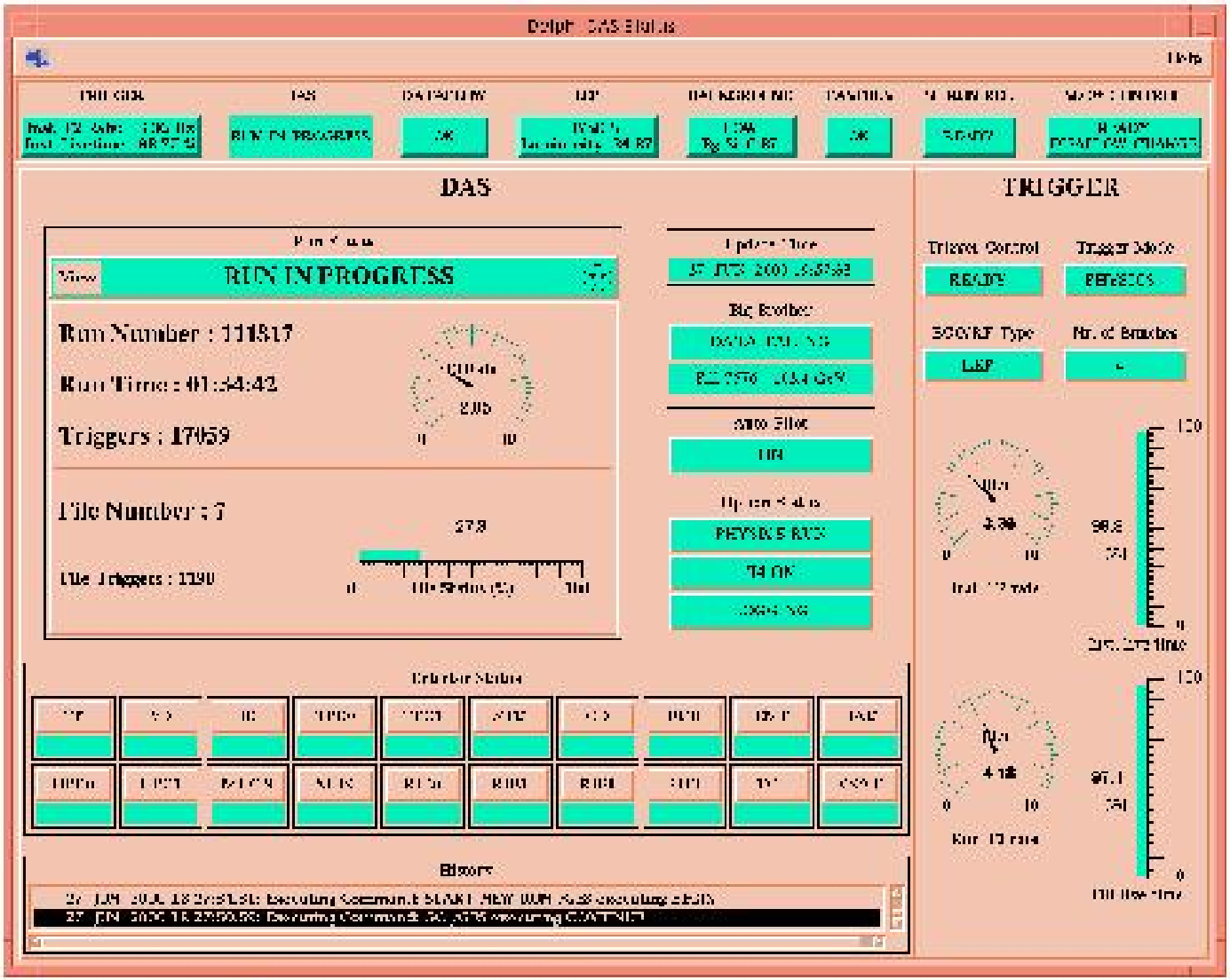
- **What can be automated**
  - Standard Procedures:
    - Start of fill, End of fill
  - Detection and Recovery from (known) error situations
- **How**
  - Expert System (Aleph)
  - Finite State Machines (Delphi)

System kontrolny DELPHI

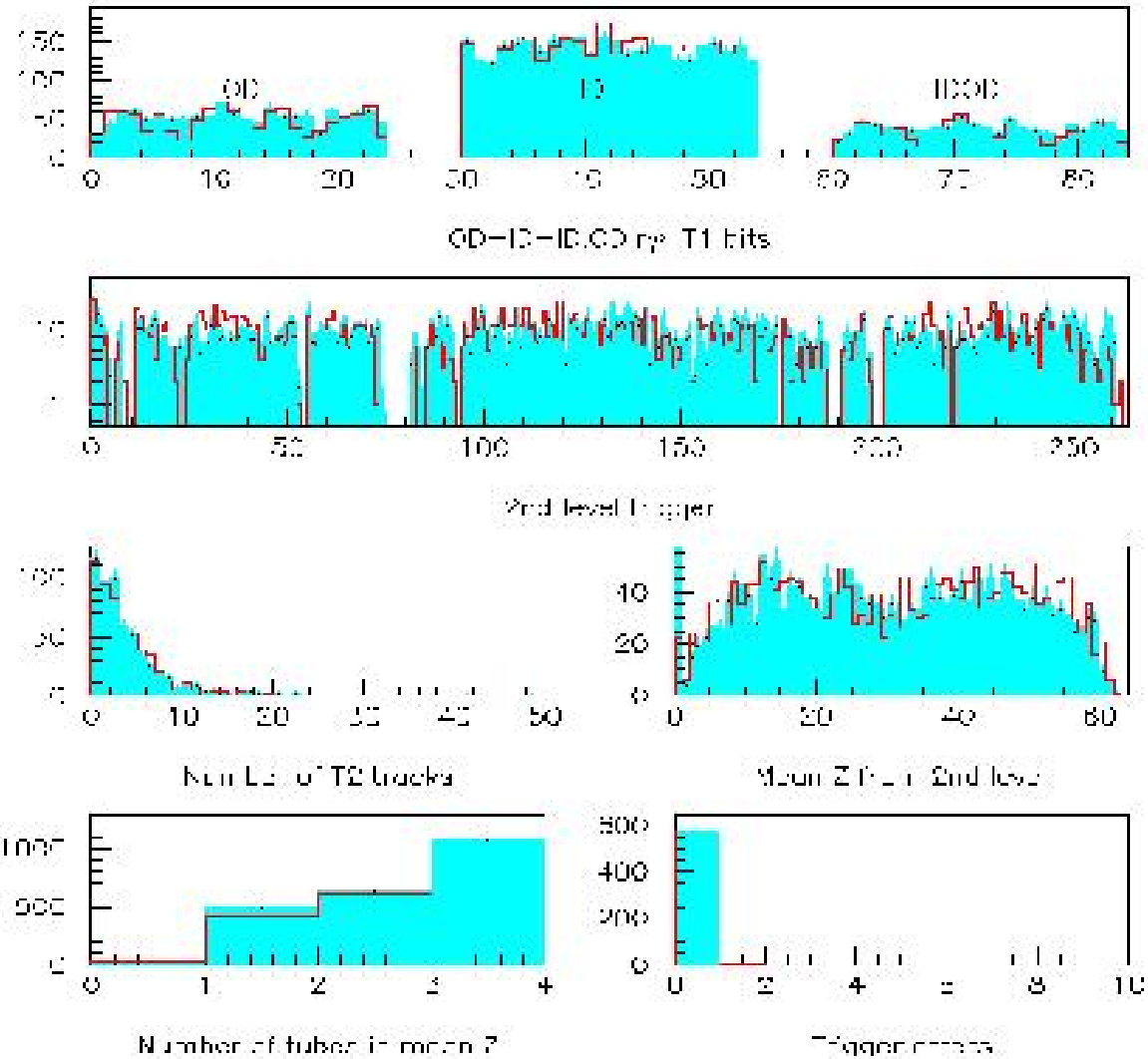
- Hierarchical
- Fully Automated
- Homogeneous
  - One single control mechanism
  - One single communication system
  - One user interface tool



Interface użytkownika (UI)



Narzędzie kontroli



System kontrolny na LHC

- **Based on Commercial SCADA Systems (Supervisory Control and Data Acquisition)**
  - Commonly used for:
    - Industrial Automation
    - Control of Power Plants, etc.
  - Providing:
    - Configuration Database and Tools
    - Run-time and Archiving of Monitoring Data including display and trending Tools.
    - Alarm definition and reporting tools
    - User Interface design tools

Podsumowanie

- Trigger and Data Acquisition systems are becoming increasingly complex as the scale of the experiments increases. Fortunately the advances being made and expected in the technology are just about sufficient for our requirements.
- Requirements of telecommunications and computing in general have strongly contributed to the development of standard technologies and mass production by industry.
  - Hardware: Flash ADC, Analog memory, PC, Helical scan recording, Data compression, Image processing, Cheap MIPS, ...
  - Software: Distributed computing, Integration technology, Software development environment, ...
- With all these off-the-shelf components and technologies we can architect a big fraction of the new DAQ systems for the LHC experiments. Customization will still be needed in the front-end.
- It is essential that we keep up-to-date with the progress being made by industry.

ATLAS TRT DCS - Artist view

Central DCS (ID central station ?)

Cooling

LAN

Subdetector Control Stations

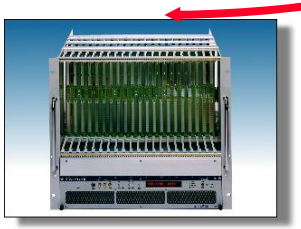
HV system

RS-232 ?
LAN ?
CAN ?

LAN

LAN

CAN fieldbuses



Crates
Racks

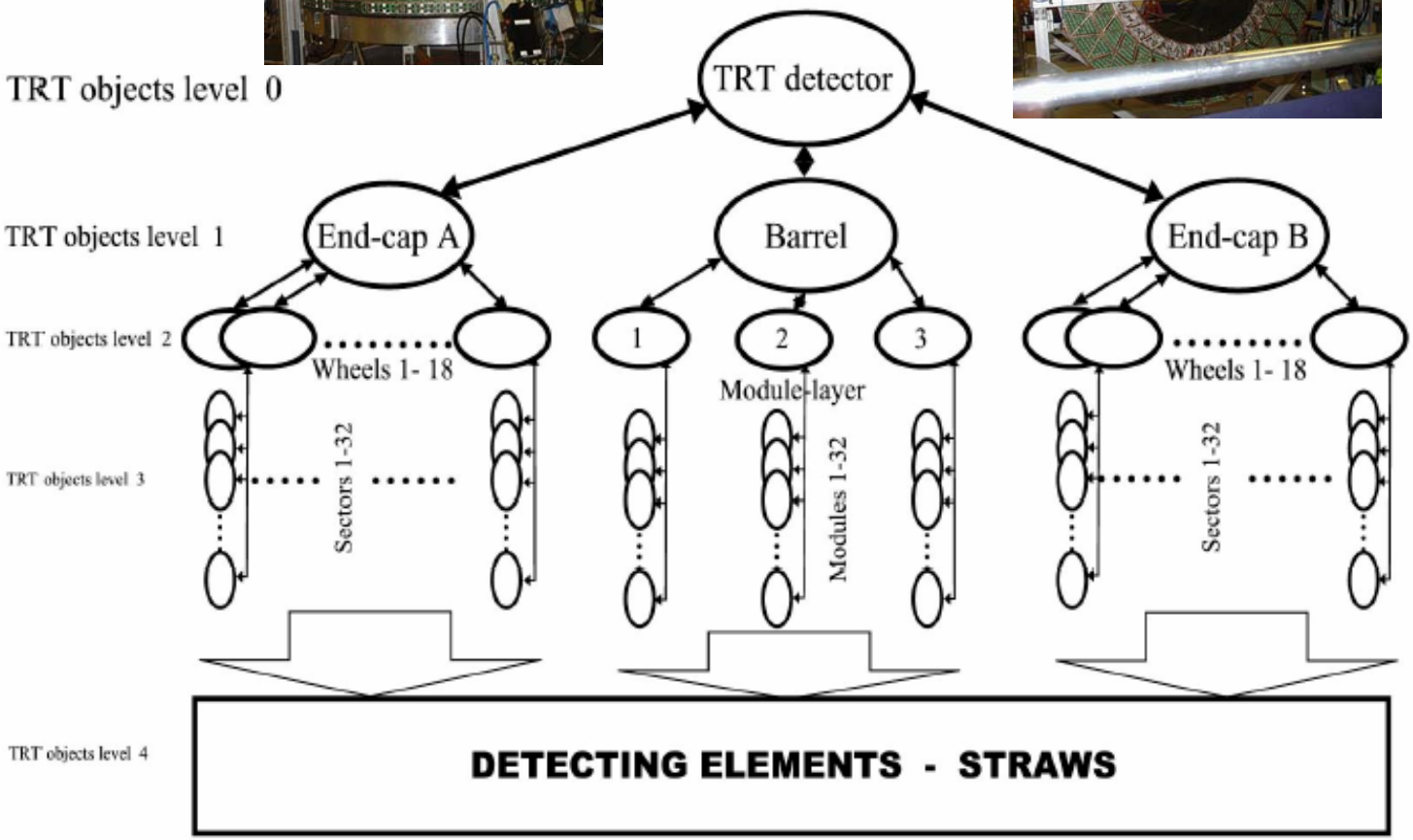
Temperatures

LV system

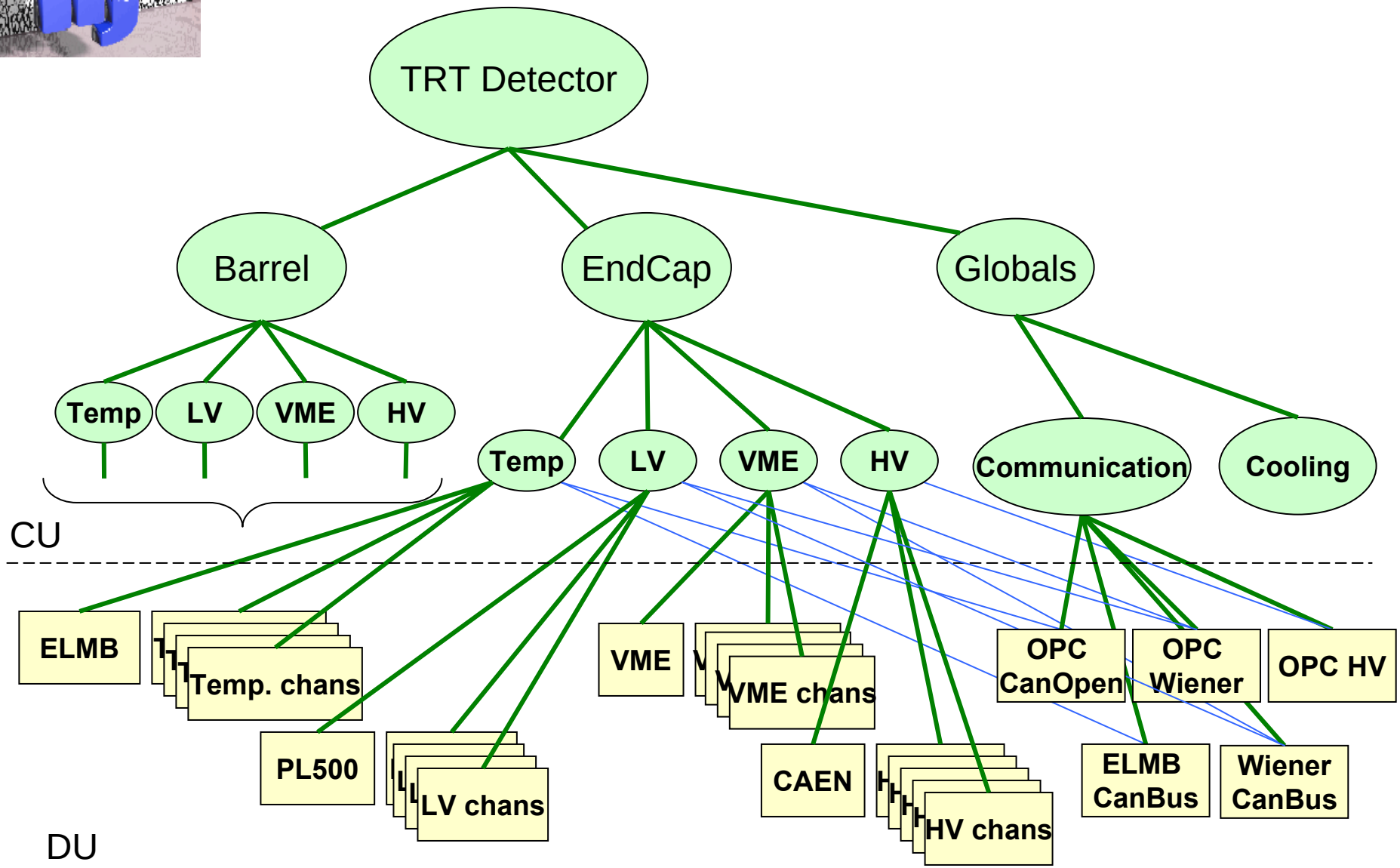
GGSS

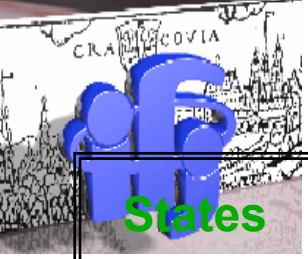
Active
Gas

Architektura



Detektor TRT w SR1 – Hierarchia FSM





FSM (*TRT* type) and Statuses

UNKNOWN

UNCONFIGURED

CONFIGURE

CONNECT or spontaneous

RECONFIGURE

CONFIGURING

STOPPED

START

STOPPING

STARTING

STOP

NOT_READY

GET_STB

GETTING_NOT_READY

GETTING_STB

BACK_NOT_READY

STANDBY

GET_READY

GETTING_STB

GETTING_READY

BACK_STB

READY

DAQ status: data taking ON

DAQ status data taking OFF

RUNNING

Statuses

FATAL

ALARM

WARNING

OK

spontaneous

Legend:

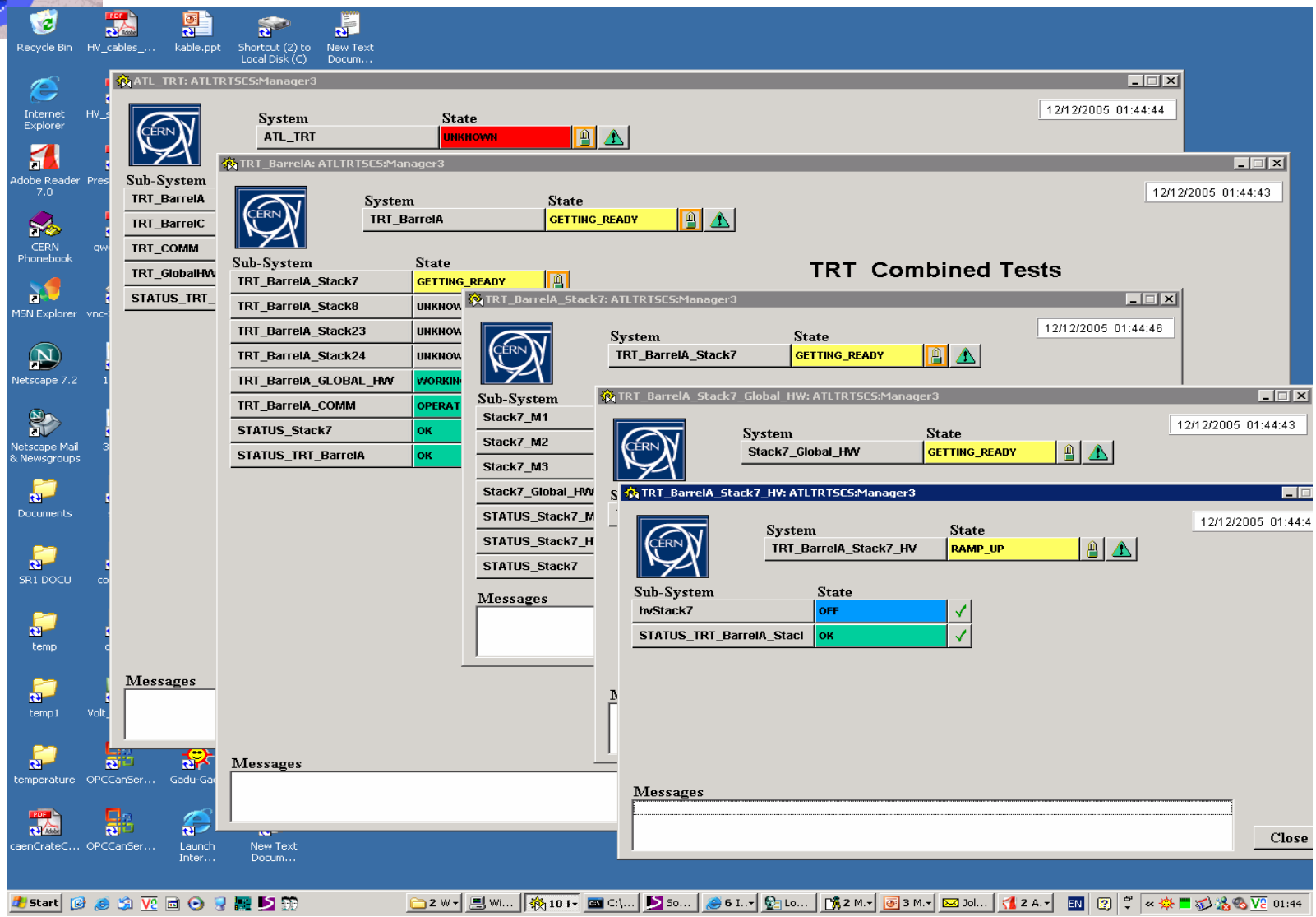
READY

Stable state

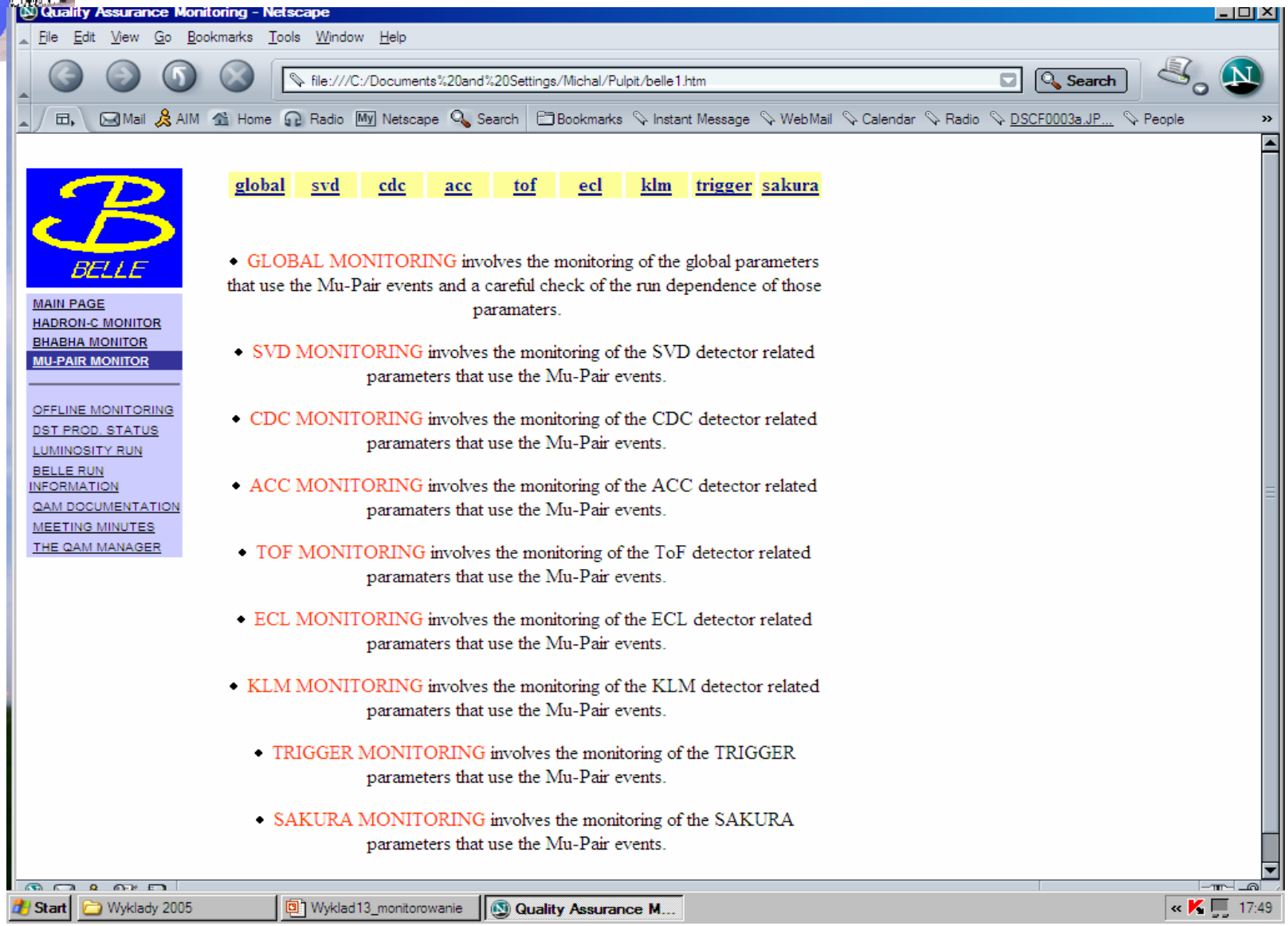
STARTING

Transient state

Firsts Tests



Belle


Quality Assurance Monitoring - Netscape
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Search
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BELLE
MAIN PAGE
HADRON-C MONITOR
BHABHA MONITOR
MU-PAIR MONITOR
OFFLINE MONITORING
DST PROD. STATUS
LUMINOSITY RUN
BELLE RUN INFORMATION
QAM DOCUMENTATION
MEETING MINUTES
THE QAM MANAGER
global svd cdc acc tof ecl klm trigger sakura
GLOBAL MONITORING involves the monitoring of the global parameters that use the Mu-Pair events and a careful check of the run dependence of those paramaters.
SVD MONITORING involves the monitoring of the SVD detector related parameters that use the Mu-Pair events.
CDC MONITORING involves the monitoring of the CDC detector related paramaters that use the Mu-Pair events.
ACC MONITORING involves the monitoring of the ACC detector related paramaters that use the Mu-Pair events.
TOF MONITORING involves the monitoring of the ToF detector related paramaters that use the Mu-Pair events.
ECL MONITORING involves the monitoring of the ECL detector related paramaters that use the Mu-Pair events.
KLM MONITORING involves the monitoring of the KLM detector related paramaters that use the Mu-Pair events.
TRIGGER MONITORING involves the monitoring of the TRIGGER parameters that use the Mu-Pair events.
SAKURA MONITORING involves the monitoring of the SAKURA parameters that use the Mu-Pair events.
Start
Wyklady 2005
Wyklad13_monitorowanie
Quality Assurance M...
17:49

Belle

Netscape

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Search

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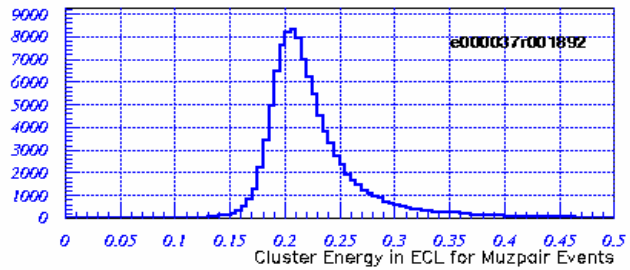
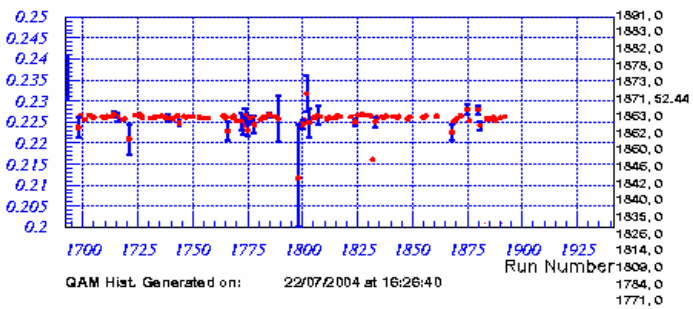
MAIN PAGE
HADRON-C MONITOR
BHABHA MONITOR
MU-PAIR MONITOR
ecl
Cluster Energy

OFFLINE MONITORING
DST PROD. STATUS
LUMINOSITY RUN
BELLE RUN INFORMATION
QAM DOCUMENTATION
MEETING MINUTES
THE QAM MANAGER

global svd cdc acc tof ecl klm trigger sakura

Histogram ID: 511

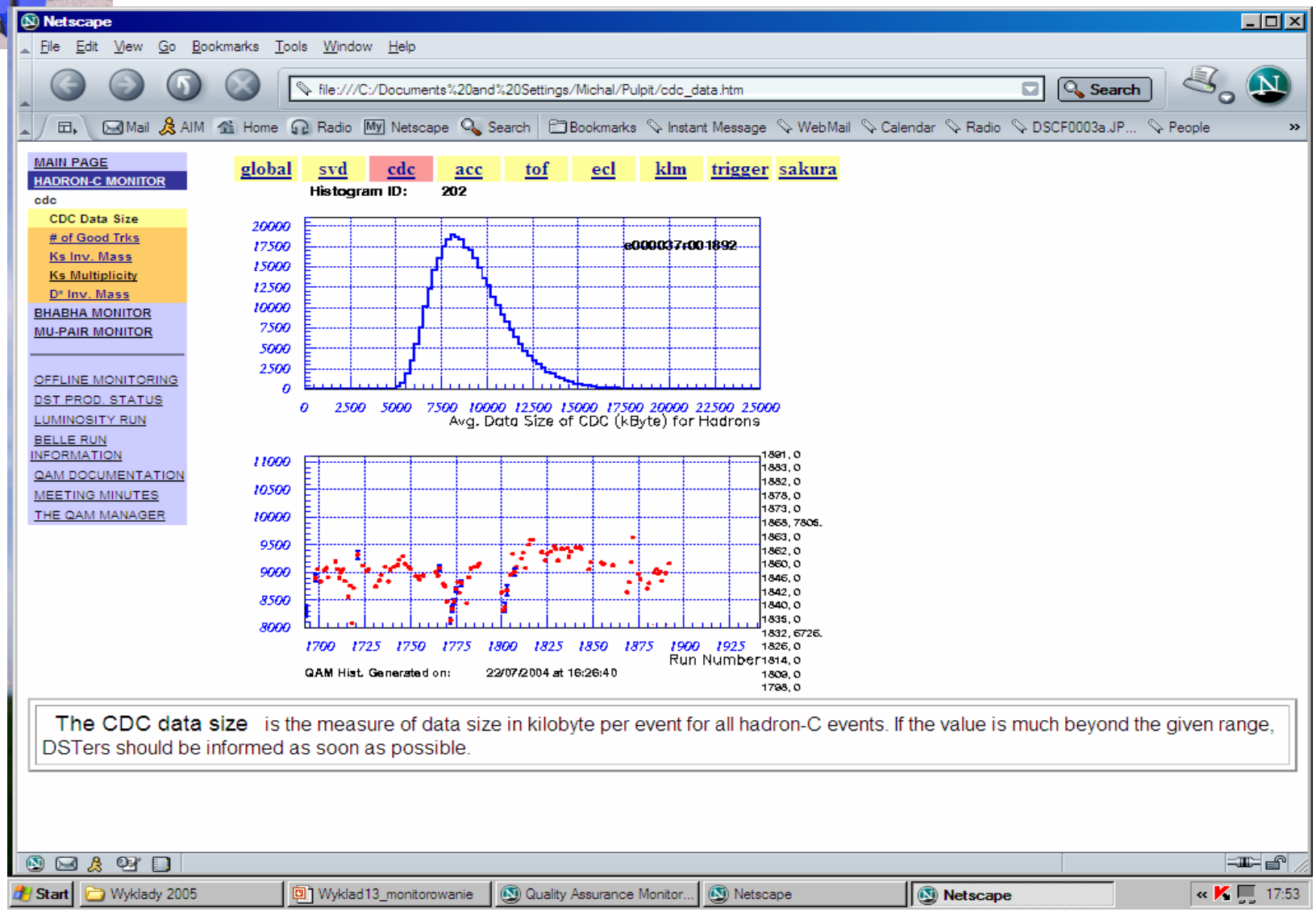




Cluster energy (GeV) :

Start | Wyklady 2005 | Wyklad13_monitorowanie | Quality Assurance Monitor... | Netscape | 17:52

Belle


Netscape
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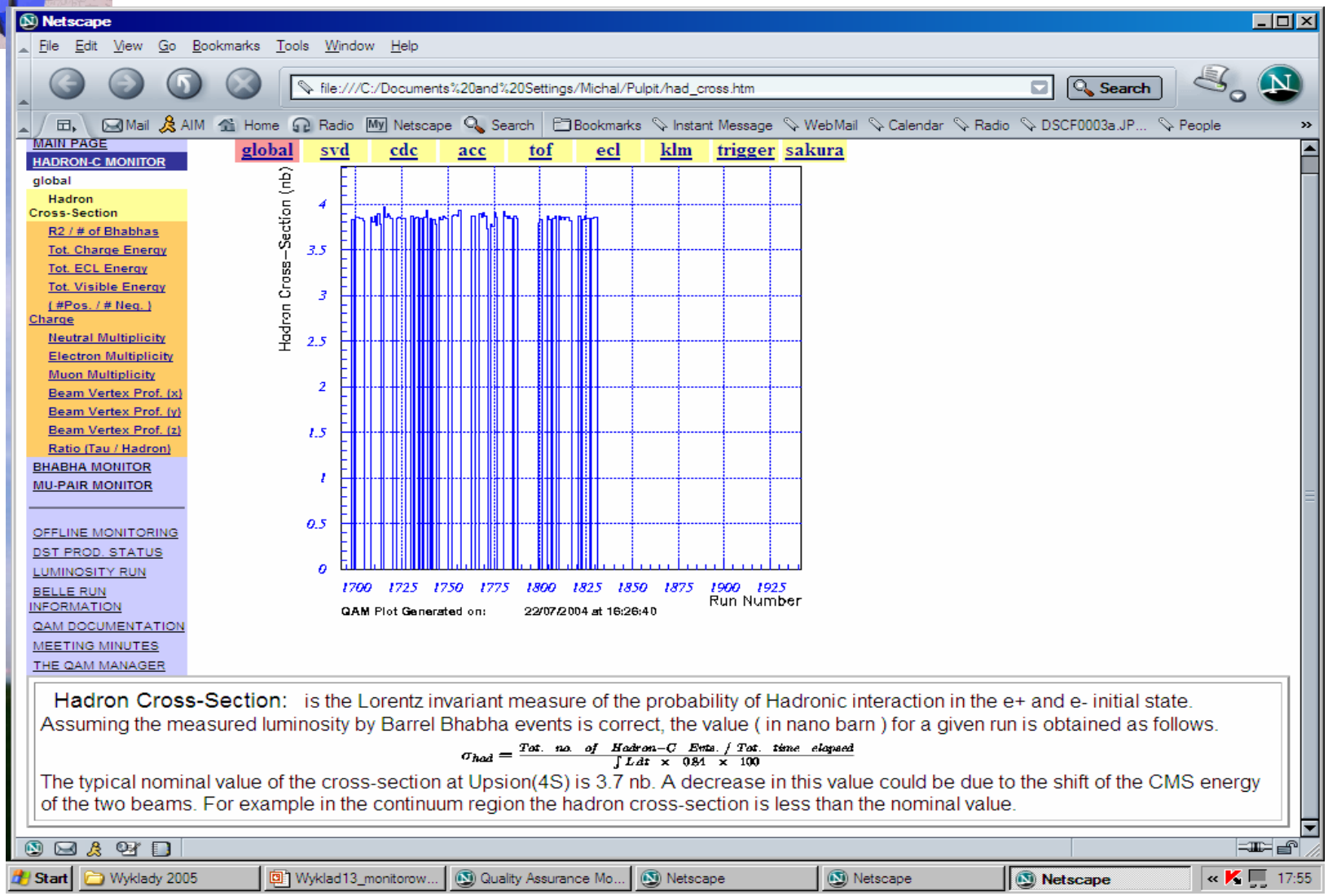
Search
MAIN PAGE
HADRON-C MONITOR
cdc
CDC Data Size
# of Good Trks
Ks Inv. Mass
Ks Multiplicity
D* Inv. Mass
BHABHA MONITOR
MU-PAIR MONITOR
OFFLINE MONITORING
DST PROD. STATUS
LUMINOSITY RUN
BELLE RUN INFORMATION
QAM DOCUMENTATION
MEETING MINUTES
THE QAM MANAGER
global svd cdc acc tof ecl klm trigger sakura
Histogram ID: 202
e000037r001892
Avg. Data Size of CDC (kByte) for Hadrons
Run Number
QAM Hist. Generated on: 22/07/2004 at 16:26:40
The CDC data size is the measure of data size in kilobyte per event for all hadron-C events. If the value is much beyond the given range, DSTers should be informed as soon as possible.
Start
Wyklady 2005
Wyklad13_monitorowanie
Quality Assurance Monitor...
Netscape
Netscape
17:53

Belle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Search
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MAIN PAGE
HADRON-C MONITOR
global
Hadron Cross-Section
R2 / # of Bhabhas
Tot. Charge Energy
Tot. ECL Energy
Tot. Visible Energy
(#Pos. / # Neg.) Charge
Neutral Multiplicity
Electron Multiplicity
Muon Multiplicity
Beam Vertex Prof. (x)
Beam Vertex Prof. (y)
Beam Vertex Prof. (z)
Ratio (Tau / Hadron)
BHABHA MONITOR
MU-PAIR MONITOR
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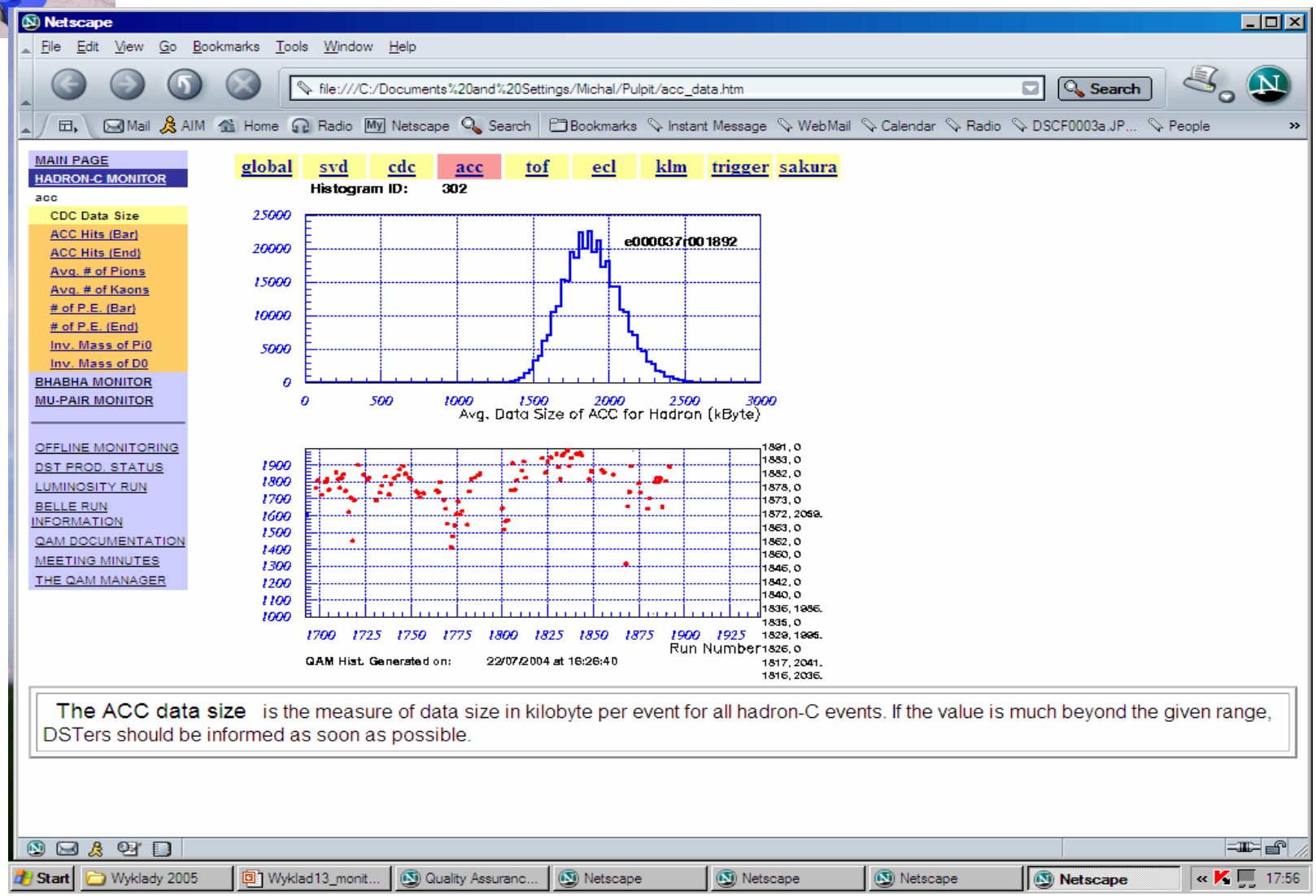
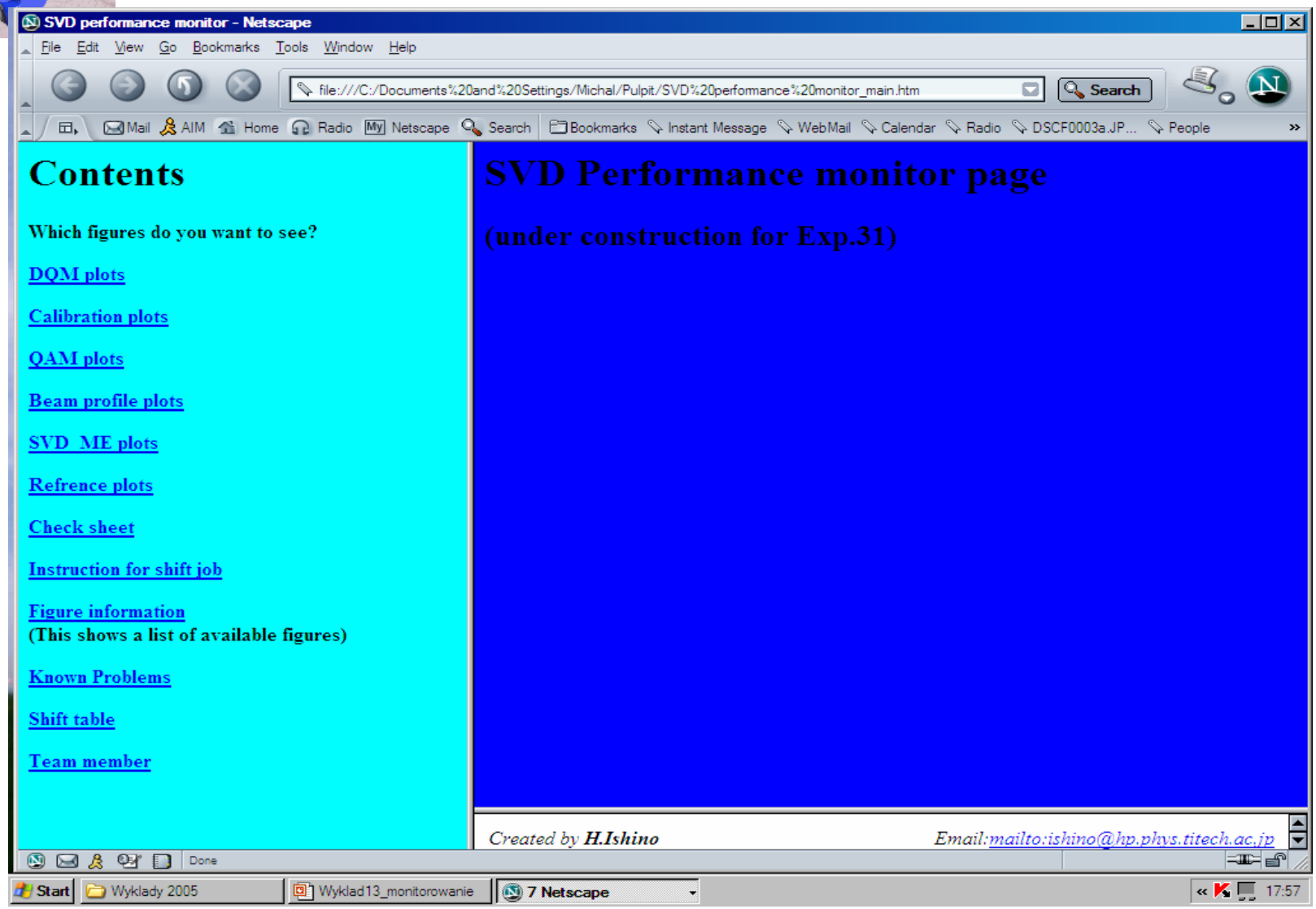
BELLE RUN INFORMATION
QAM DOCUMENTATION
MEETING MINUTES
THE QAM MANAGER
global svd cdc acc tof ecl klm trigger sakura
Hadron Cross-Section (nb)
0 0.5 1 1.5 2 2.5 3 3.5 4
1700 1725 1750 1775 1800 1825 1850 1875 1900 1925
Run Number
QAM Plot Generated on: 22/07/2004 at 16:26:40
Hadron Cross-Section: is the Lorentz invariant measure of the probability of Hadronic interaction in the e+ and e- initial state.
Assuming the measured luminosity by Barrel Bhabha events is correct, the value (in nano barn) for a given run is obtained as follows.
$\sigma_{had} = \frac{Tot.\ no.\ of\ Hadron\text{-}C\ Evts. / Tot.\ time\ elapsed}{\int Ldt \times 0.84 \times 100}$
The typical nominal value of the cross-section at Upsion(4S) is 3.7 nb. A decrease in this value could be due to the shift of the CMS energy of the two beams. For example in the continuum region the hadron cross-section is less than the nominal value.
Start
Wyklady 2005
Wyklad13_monitorow...
Quality Assurance Mo...
Netscape
Netscape
Netscape
17:55

Belle monitor



Belle monitor



Belle monitor

SVD performance monitor - Netscape

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DQM histograms

Exp Number = exp049

Run Number = 000013

Ave. Noise (ADC counts) vs chip
Ave. Common-mode (ADC counts) vs chip
Ave. occ.ratio vs chip
RMS for Common-mode Level vs chip
Trancated Error rate
Total Data Length (words)
Total Occupancy (%)

Go to Time Variation Plots

Go to other plots

Go to Calibration plots
Go to Svd_me plots
Go to QAM plots
Go to Beam Profile plots
Go to S/N plots

Go to other runs

SVD Performance monitor page

(under construction for Exp.31)

Created by ***H.Ishino*** *Email:mailto:ishino@hp.phys.titech.ac.jp*

Done

Start | Wyklady 2005 | Wyklad13_monitorowanie | Gazeta.pl - portal internet... | SVD performance monitor... | SVD performance mo... | 18:10

Belle monitor

SVD performance monitor - Netscape

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Search

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Calibration histograms

Exp Number = exp027

Run Number = 001633

Pedestal (crate 1-Halny 1,2)
Pedestal (crate 1-Halny 3,4)
Pedestal (crate 1-Halny 5,6)
Pedestal (crate 1-Halny 7,8)
Pedestal (crate 2-Halny 1,2)
Pedestal (crate 2-Halny 3,4)
Pedestal (crate 2-Halny 5,6)
Pedestal (crate 2-Halny 7,8)
Pedestal (crate 3-Halny 1,2)
Pedestal (crate 3-Halny 3,4)
Pedestal (crate 3-Halny 5,6)
Pedestal (crate 3-Halny 7,8)
Pedestal (crate 4-Halny 1,2)
Pedestal (crate 4-Halny 3,4)
Pedestal (crate 4-Halny 5,6)
Pedestal (crate 4-Halny 7,8)
total noise (crate 1-Halny 1,2)
total noise (crate 1-Halny 3,4)
total noise (crate 1-Halny 5,6)
total noise (crate 1-Halny 7,8)
total noise (crate 2-Halny 1,2)
total noise (crate 2-Halny 3,4)

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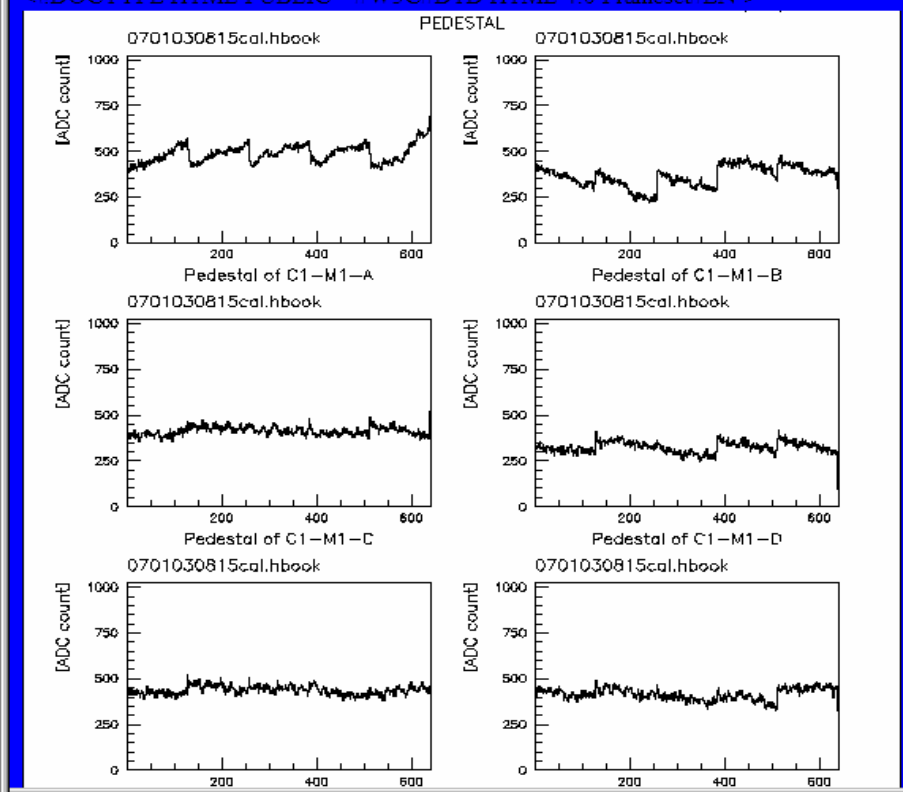

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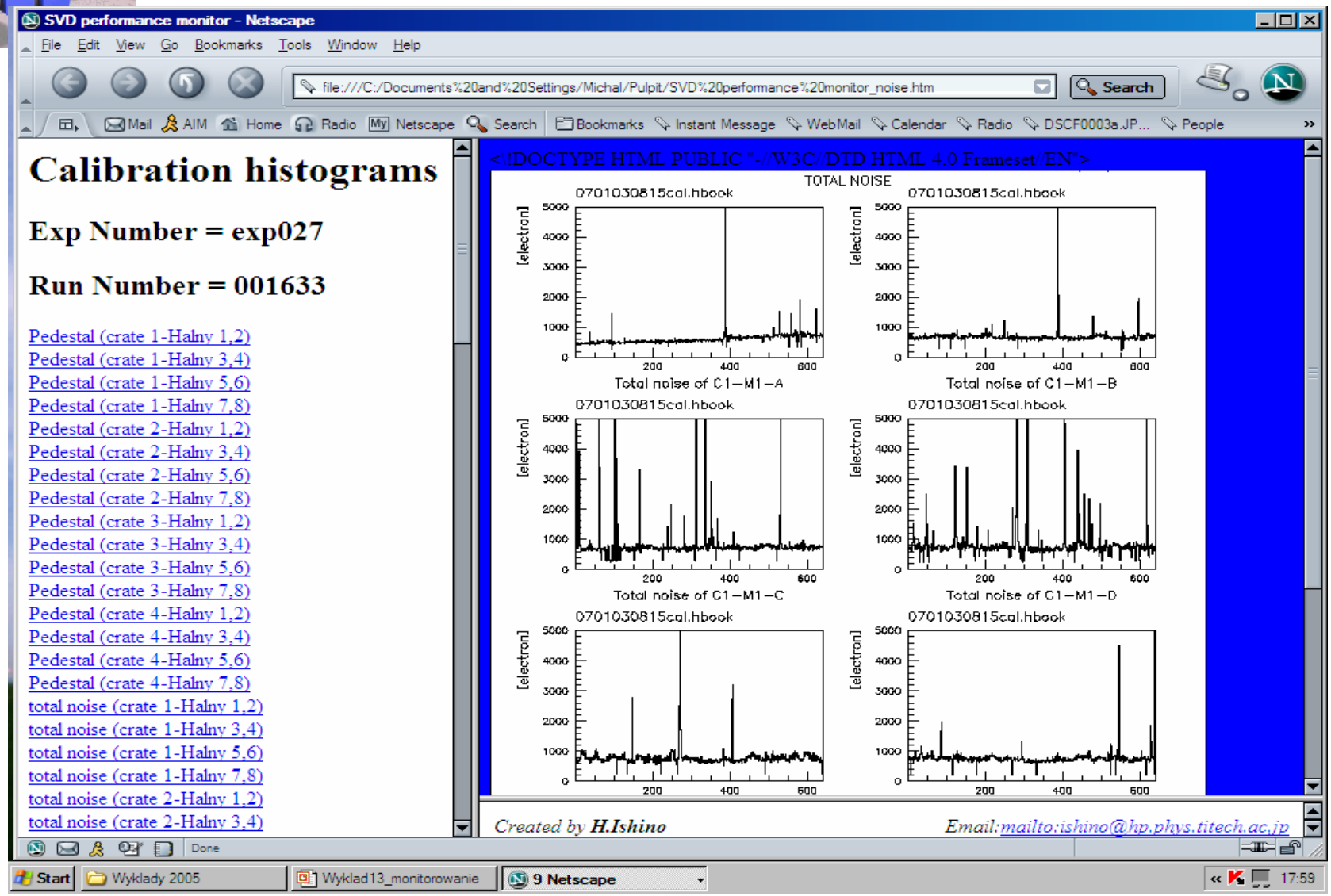
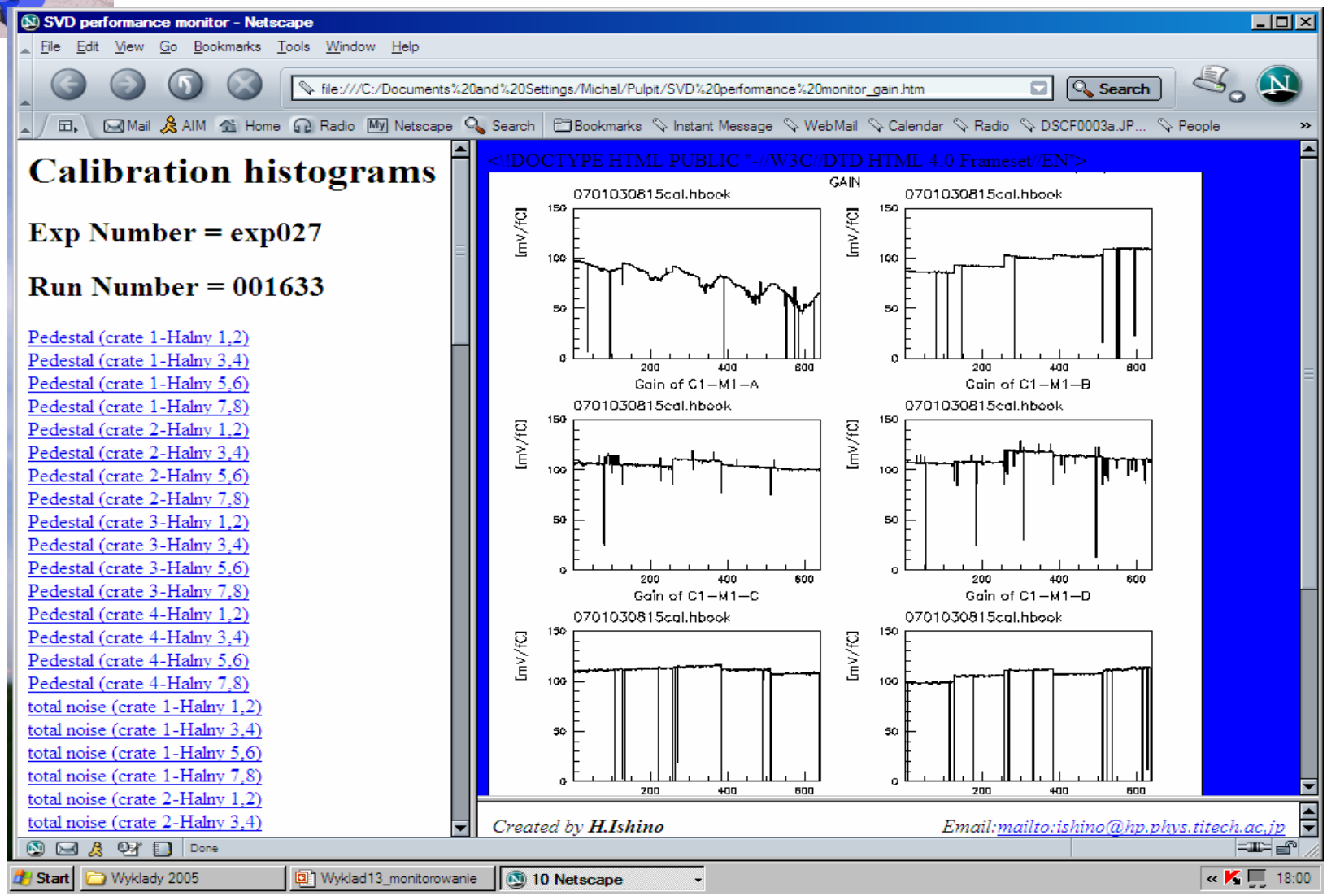
Done

Start Wyklady 2005 Wyklad13_monitorowanie 8 Netscape 17:58

Belle monitor



Belle monitor



Belle monitor

SVD performance monitor - Netscape

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Search

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DQM histograms

Exp Number = exp049

Run Number = 000013

Ave. Noise (ADC counts) vs chip
Ave. Common-mode (ADC counts) vs chip
Ave. occ.ratio vs chip
RMS for Common-mode Level vs chip
Trancated Error rate
Total Data Length (words)
Total Occupancy (%)

Go to Time Variation Plots

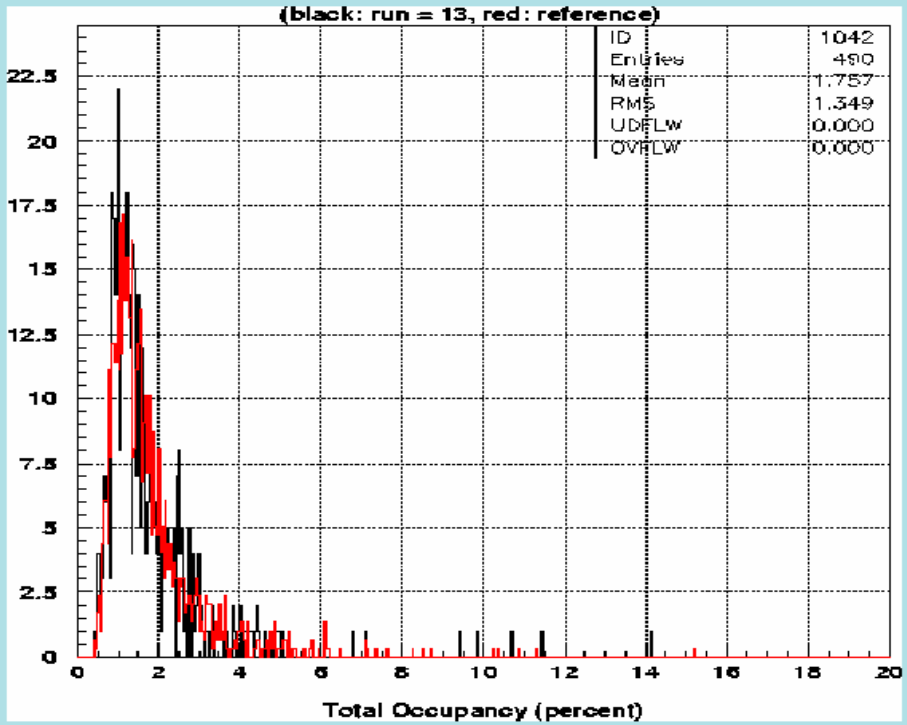
Go to other plots

Go to Calibration plots
Go to Svd_me plots
Go to QAM plots
Go to Beam Profile plots
Go to S/N plots

Go to other runs

Exp number = exp049 run number = 000013

Next Run figure Previous Run figure Other figures of this run

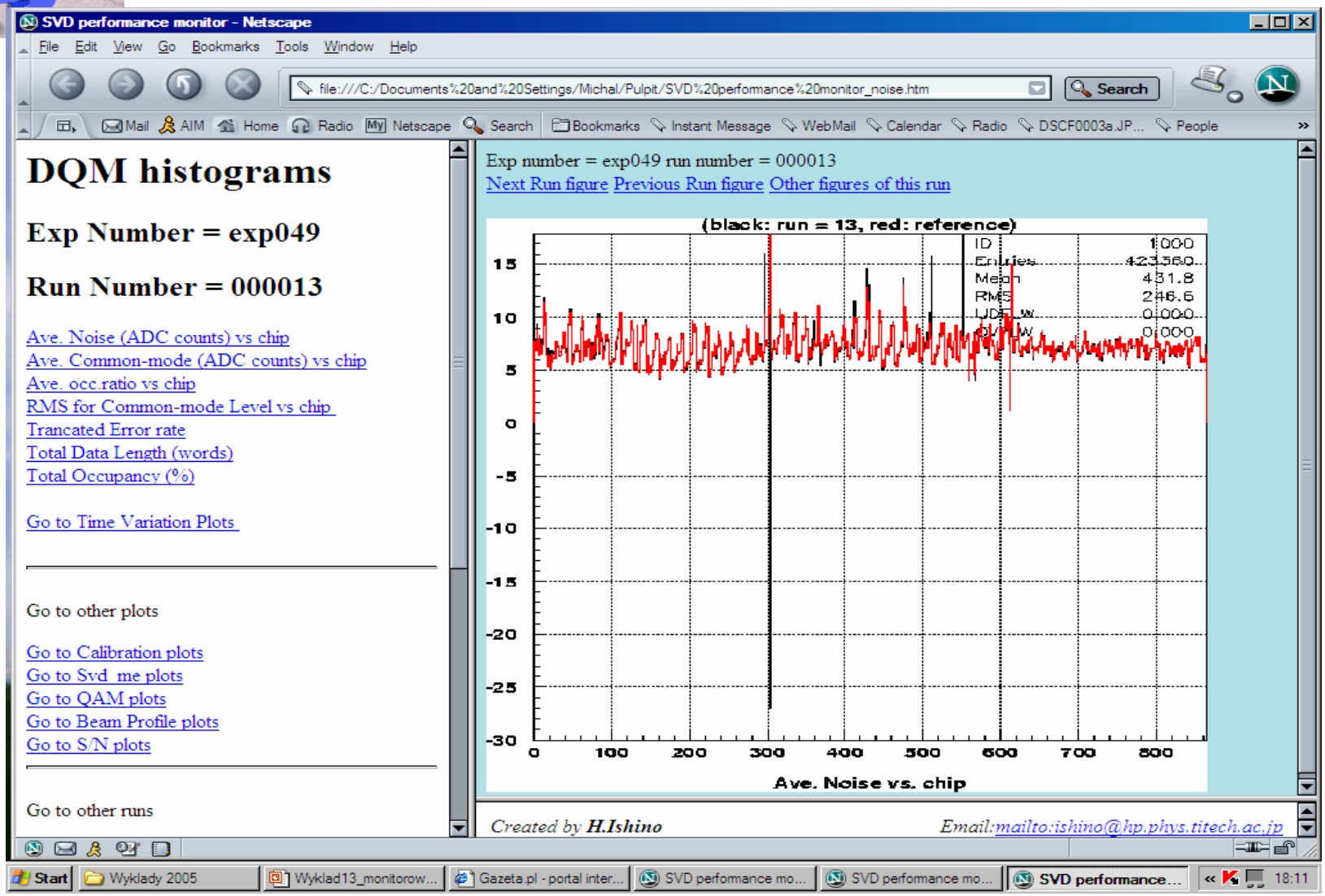


Created by ***H.Ishino*** *Email:mailto:ishino@hp.phys.titech.ac.jp*

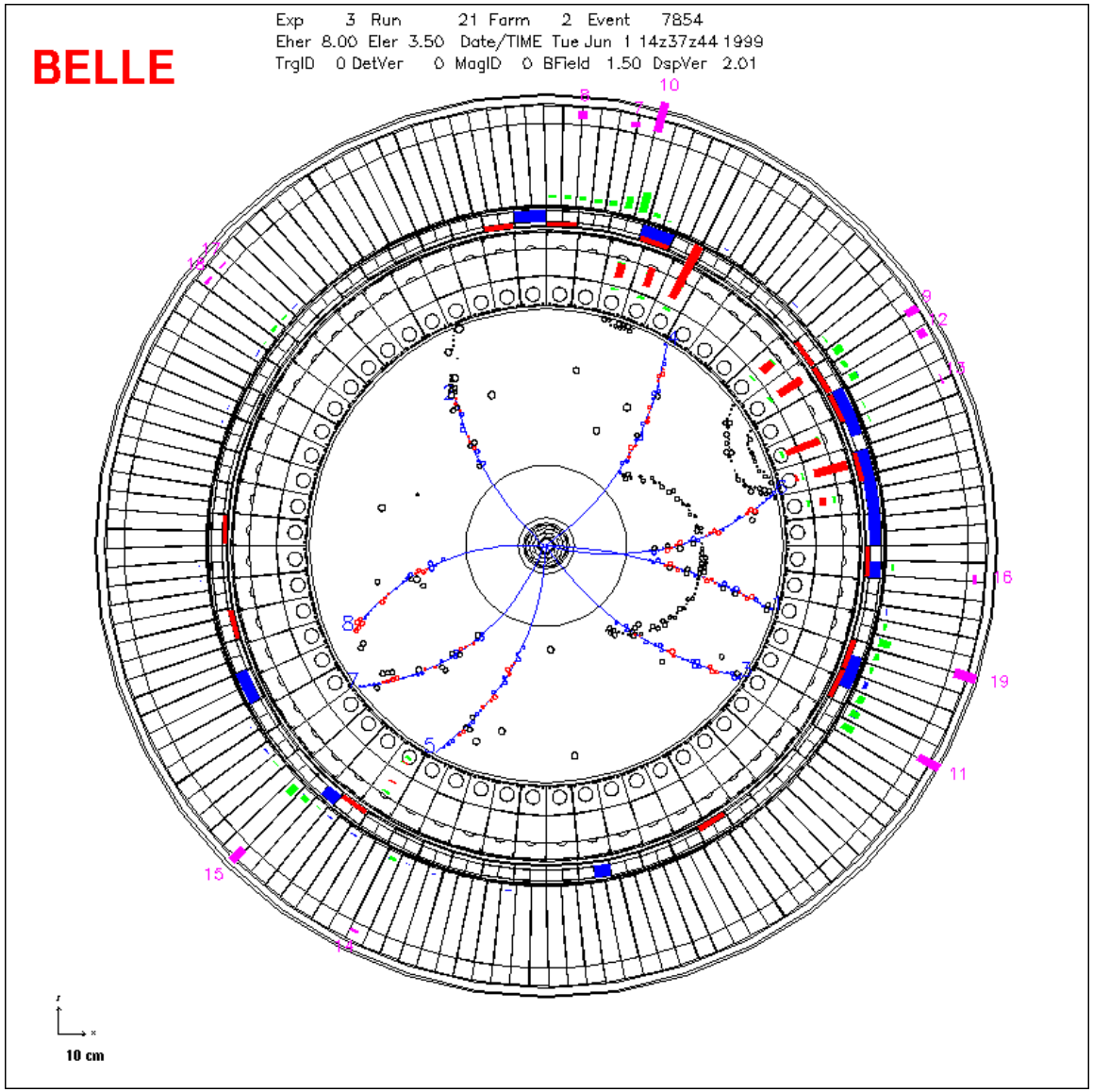
Done

Start | Wyklady 2005 | Wyklad13_monitorowanie | Gazeta.pl - portal internet... | SVD performance mo... | 18:10

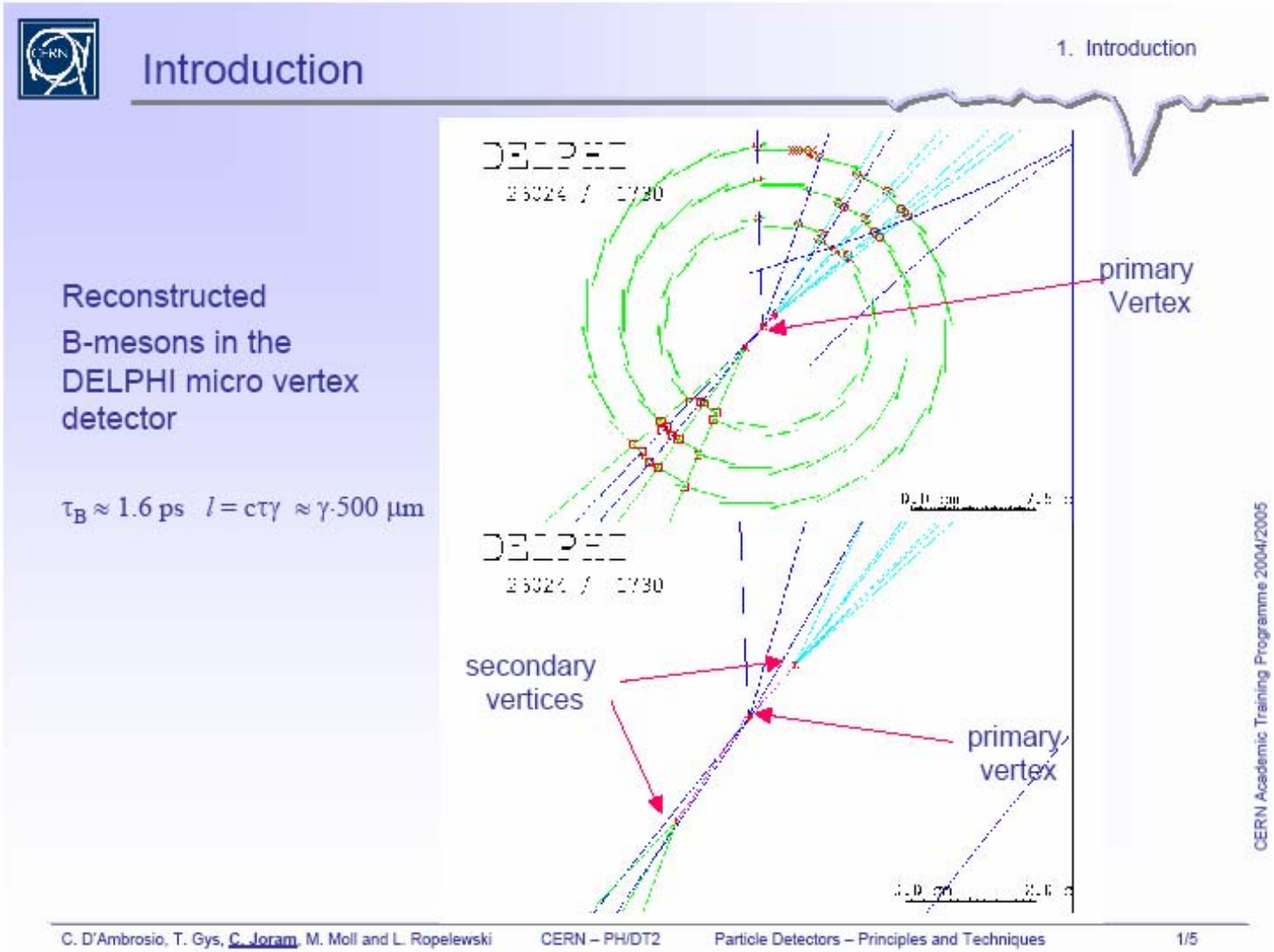
Belle monitor



Belle event display



DELPHI event display

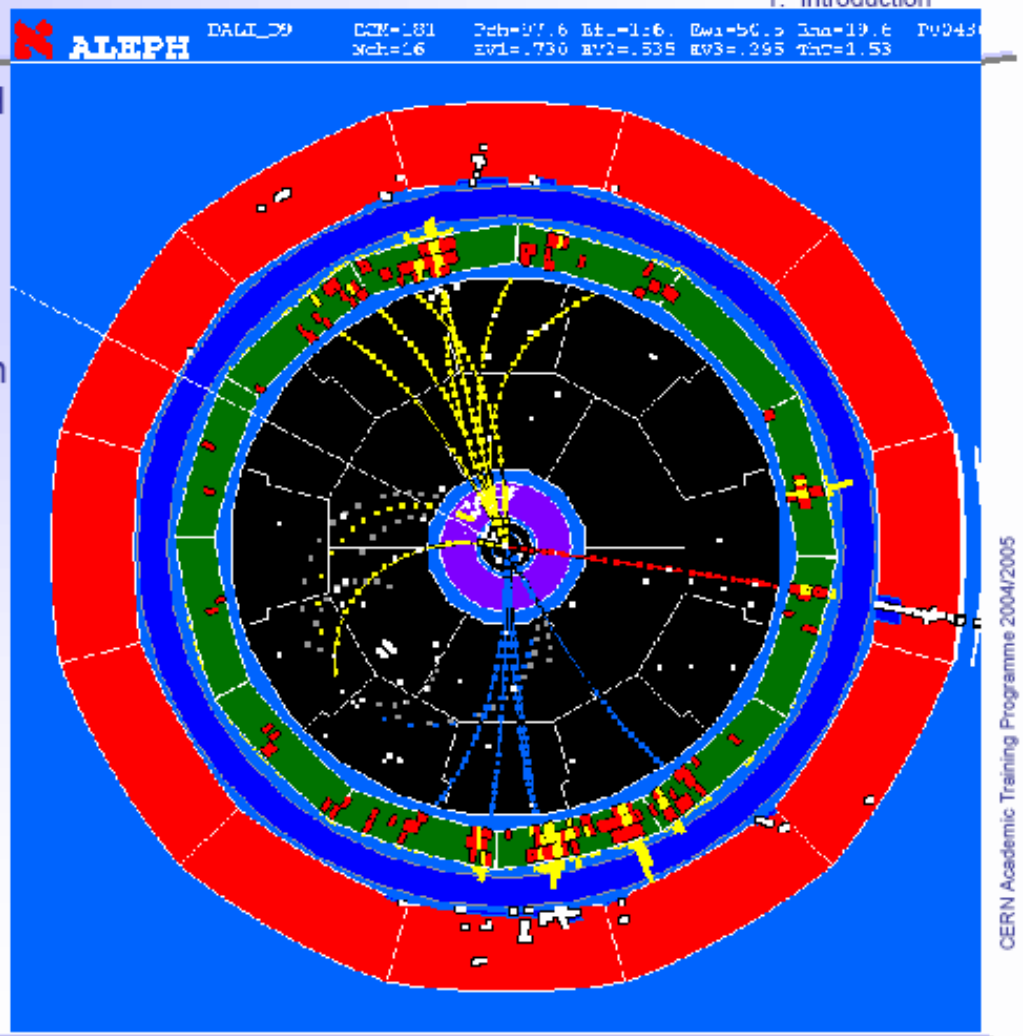


ALEPH event display

Introduction

A W^+W^- decay in ALEPH

e^+e^- ($\sqrt{s}$=181 GeV)
→ $W^+W^- \rightarrow qq\mu\nu_\mu$
→ 2 hadronic jets
+ μ + missing momentum



CERN Academic Training Programme 2004/2005