

**ADRIAN FIERGOLSKI<sup>1,2</sup>, MICHELE QUINTO<sup>1,3</sup>**

<sup>1</sup>INFN-Bari, Italy

<sup>2</sup>Warsaw University of Technology, Poland

<sup>3</sup>University of Bari, Italy

# **TRAINING SESSION**

## **READOUT FROM FPGA TO ONLINE**

*RD51 E-School, 3rd of February 2014*



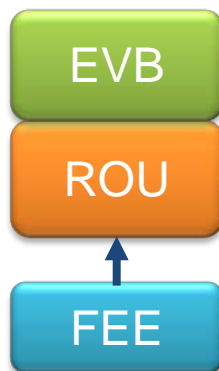
# DAQ concepts

Data acquisition software are applications designed to read data form front-end units and store on a medium. For some application DAQ software needs more functionalities such as monitoring and on-line processing.

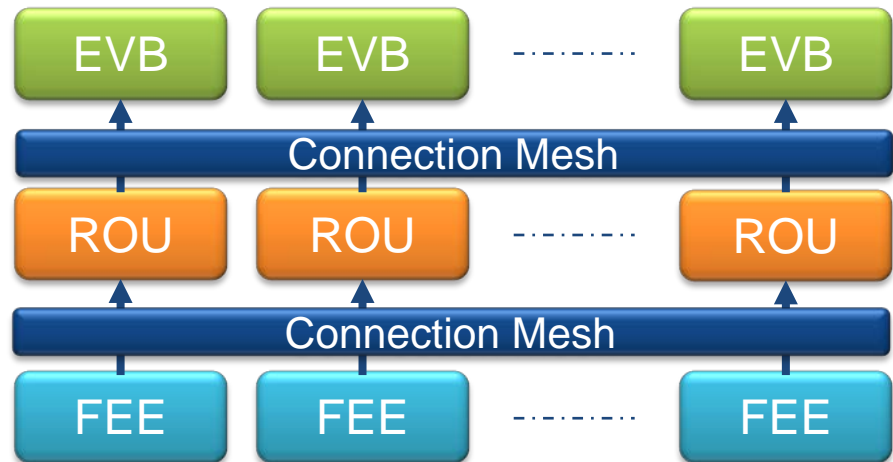
When the number of front-end units and channels become large the DAQ software needs to scale. Multi-process applications running on different nodes are preferred and take advantage of shared resources i.e.: CPU, storage, network, bandwidth, etc.

Data fragments are read out of different front-ends. Fragments that belong to the same event are collected together and stored in a data frame that identifies the specific event with timestamp information. Such a process, called *event building*, can be performed across network on many DAQ nodes.

Small scale monolithic DAQ application



Scalable DAQ architecture i.e.: DATE



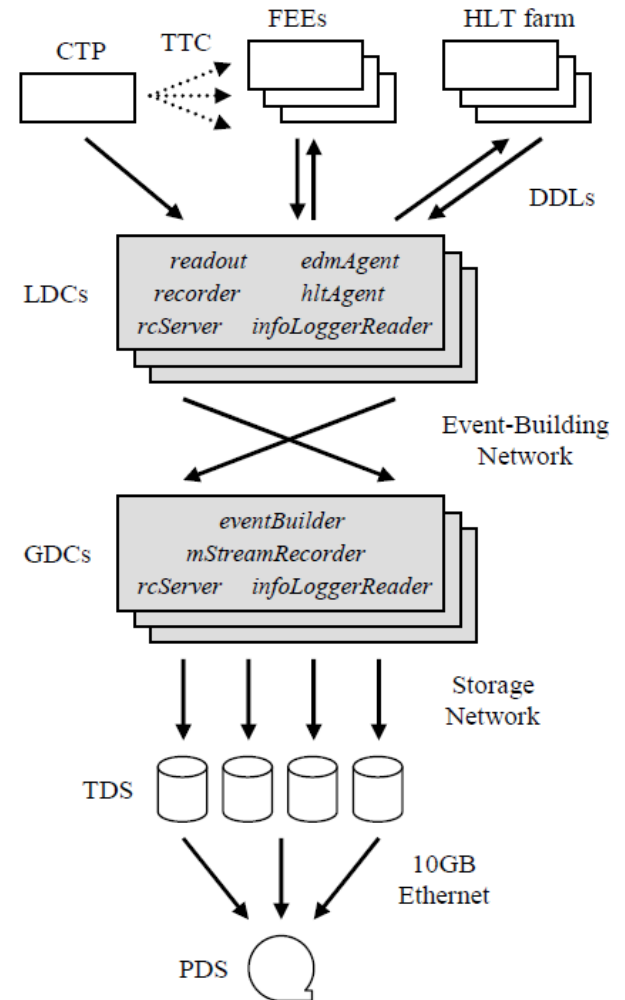
# Introduction to DATE data acquisition framework

DATE (Data Acquisition and Test Environment) is a software system that performs data-acquisition tasks in a **multi-processor distributed environment**. DATE fulfils the requirements of the ALICE data acquisition, therefore it has been designed with scalability features that **make it suitable for large systems**, involving hundreds of computers. Nevertheless, DATE can cope with a large variety of configurations; in particular, **it is well adapted to small laboratory systems** as well, where only few machines are used, or even just one [*ALICE DAQ and ECS Manual*].

- DATE was developed by the ALICE Collaboration and was adopted by RD51 to complement the SRS hardware platform.
- DATE can be installed on any machine running Linux connected on standard Ethernet networks.
- Installation based on pre-compiled packages (RPMs) is available.
- After DATE installation a minimal configuration is available readily to the user.
- DATE is a turnkey DAQ system.

# The DATE Architecture [1]

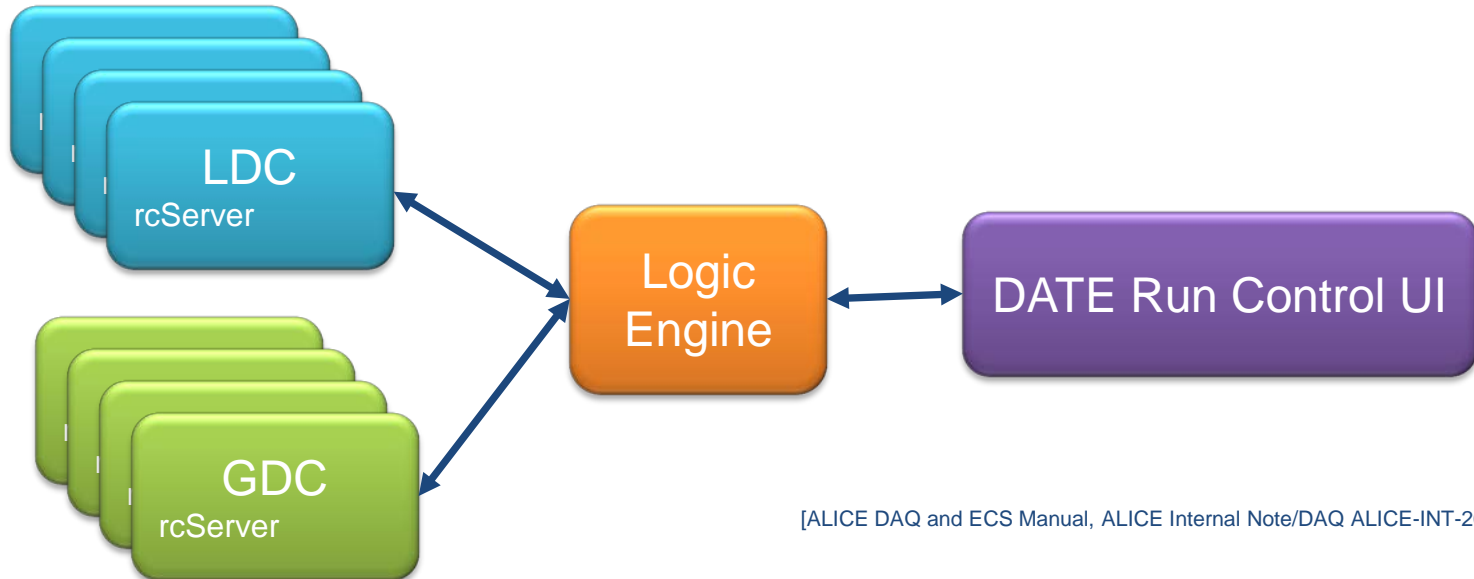
- DATE architecture is based on **multiple processes** that can be distributed over different working nodes.
- Data flow based on inter-process communication via fast shared memory and software FIFOs.
- Control and synchronization between processes is implemented using the DIM client/server communication protocol.
- LDCs** Local Data Collector read out data form the Front-End readout Electronics **FEE** (i.e.: SRS units).
  - Readout** process reads data form FEEs
  - Recorder** process send data to GDCs and record locally
  - The **edmAgent** process provides a load balancing algorithm to distribute events form the LDCs to the GDCs.
- GDCs** Global Data Collector collect event fragments form the LDCs and assemble the full event.
  - eventBuilder** process builds the whole event merging fragments form the LDCs
  - mStreamRecorder** records data



[ALICE DAQ and ECS Manual, ALICE Internal Note/DAQ ALICE-INT-2010-001]

# DATE Control [1]

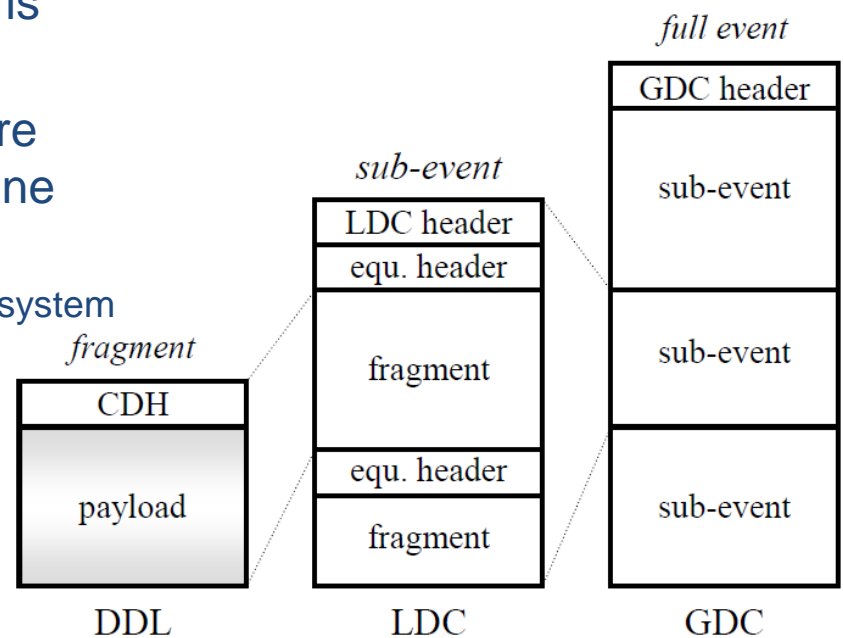
- The DATE run control interface sends commands to a Logic Engine running a Finite State Machine (FSM)
- The Logic Engine propagates commands, using DIM, to all DATE hosts on which a server process named *rcServer* is running
- *rcServer* starts and stops the DATE processes
- *rcServer* controls a shared memory segment for inter-process communication in which run status informations are constantly updated.



[ALICE DAQ and ECS Manual, ALICE Internal Note/DAQ ALICE-INT-2010-001]

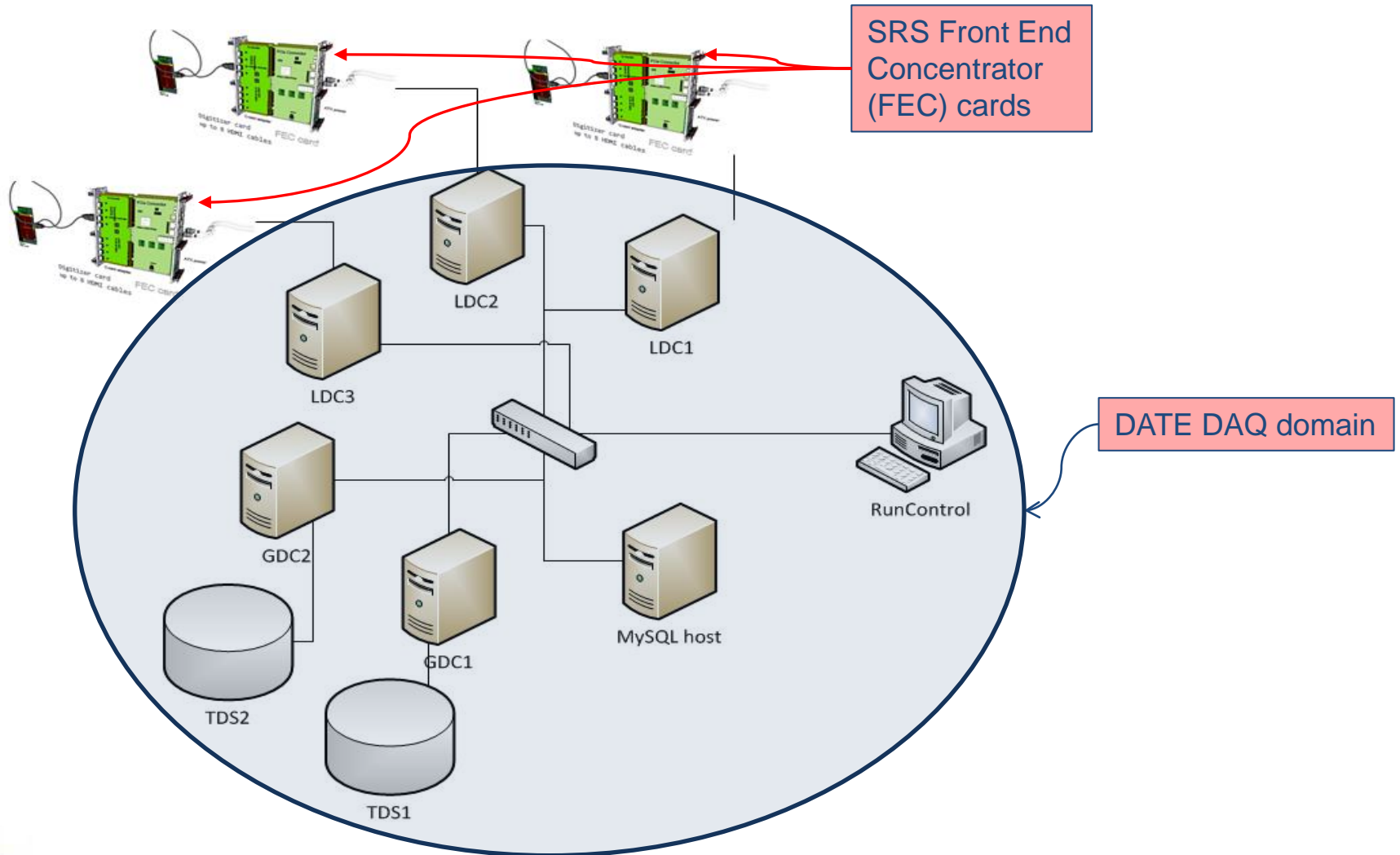
# DATE Data Format [1]

- DATE Data Format is scalable
- Nested data structure reproduces the full tree of hardware:
  - nodes (LDCs, GDCs)
  - equipments (FFEs) attached to each LDC.
- Data format is binary
- Monitoring library for data extraction is available
- Many higher level monitoring tools are available to perform off-line and on-line monitoring
  - AMORE framework and plug-ins for SRS system (follow training with Kondo Gnanvo).



[ALICE DAQ and ECS Manual, ALICE Internal Note/DAQ ALICE-INT-2010-001]

# DATE medium size configuration with SRS system



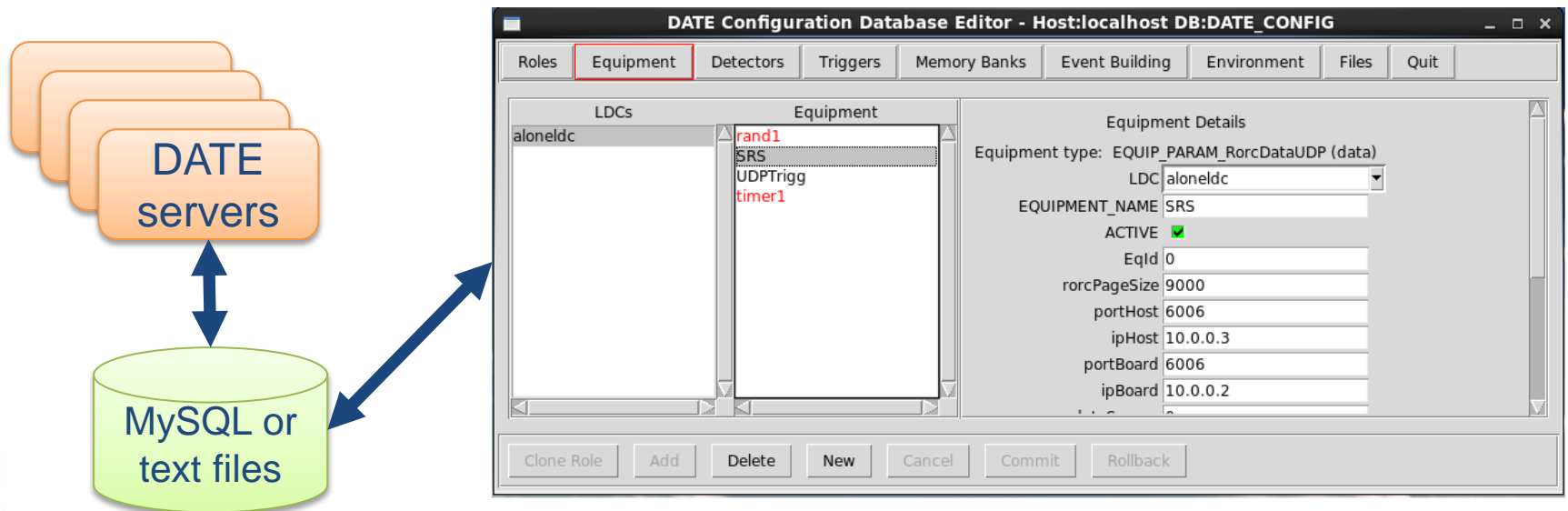
# DATE Configuration

DATE provides a system to host the DAQ system configuration including the readout electronics connected to it.

- MySQL based configuration
- Text file based configuration

The database editor application (editDb) allows users to edit part of the system settings:

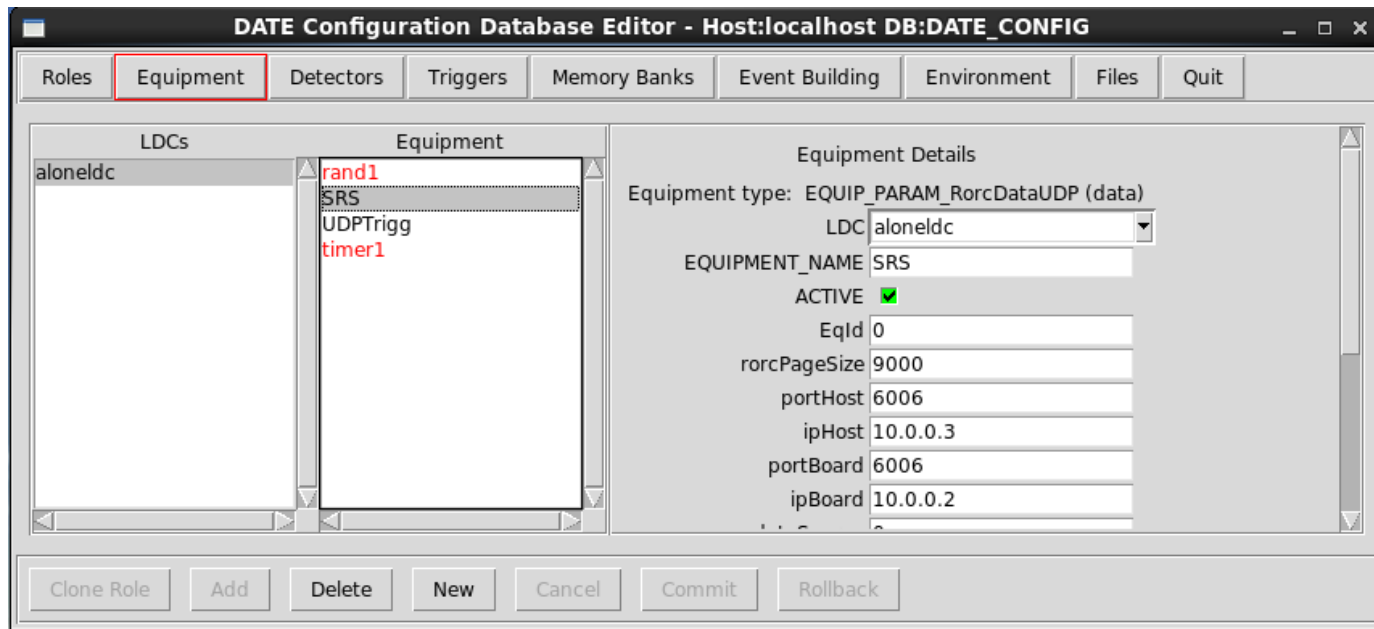
- Roles: LDC, GDC, detectors
- Detectors: composition of detector
- Memory banks: memory configuration for each Role
- Event building: event building policy
- Readout equipments: type, parameter for each LDC.





# DATE Configuration for UDP equipment

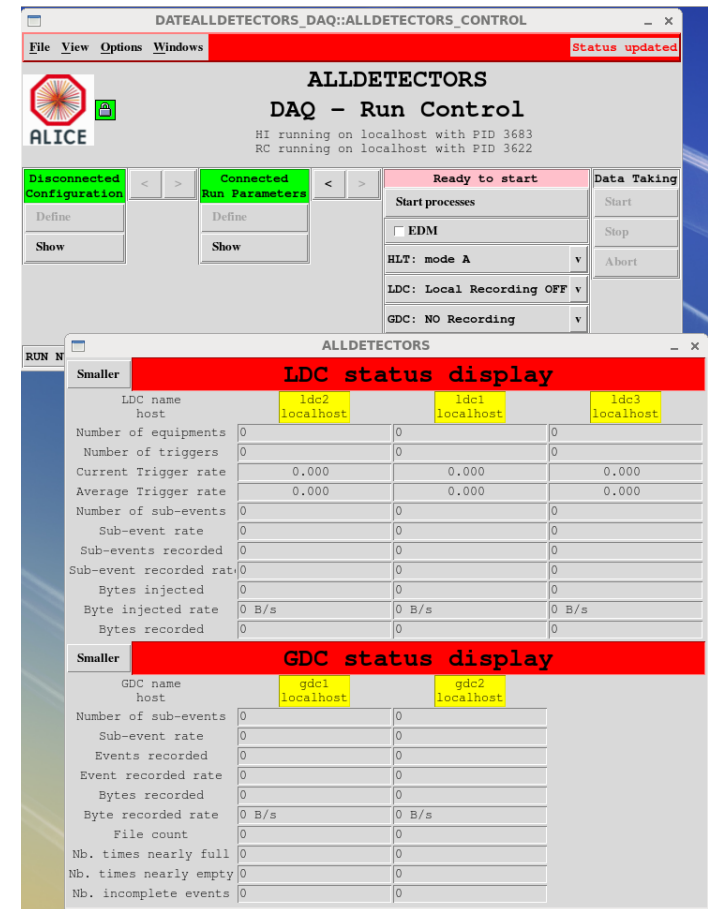
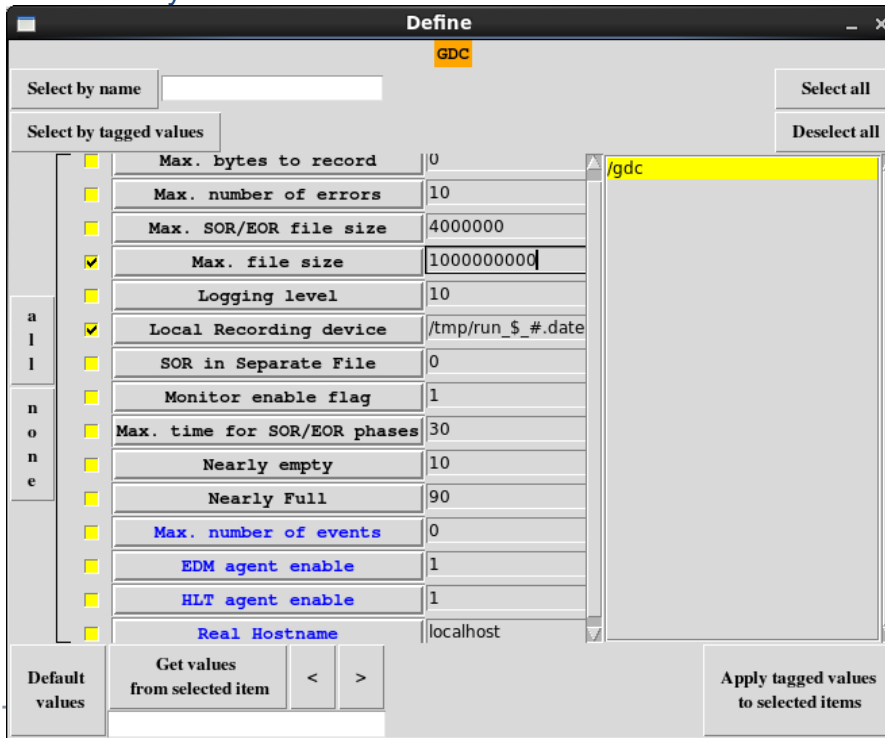
- UDP based FEE equipment is supported by DATE [4]
- UDP equipment allows SRS system readout
- Main UDP configuration parameters are:
  - EqId: an ID form 0 to 11
  - portHost: host port number
  - ipHost: LDC IP address related to the NIC connected to the SRS
  - portBoard: SRS board port number used for data streaming
  - ipBoard: SRS board IP address



# DATE Run Control

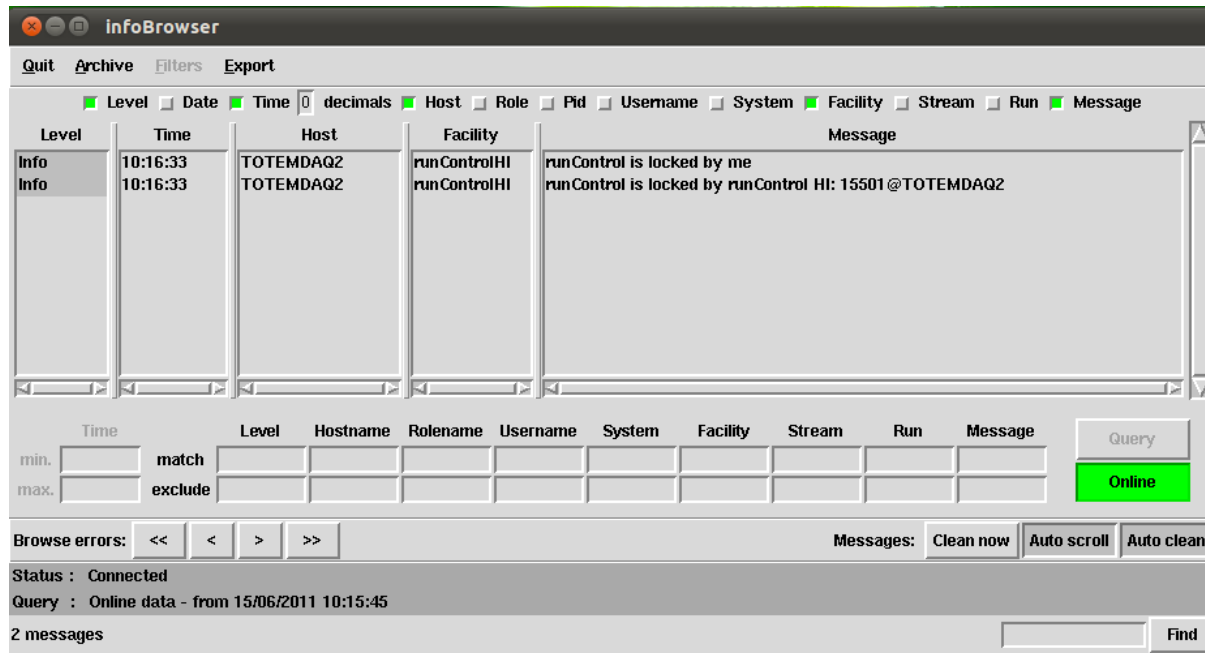
DATE run control has a user friendly GUI to control and configure the run operations such as:

- Run Start/Stop
- Run status display
- Set number of connected nodes LDCs and GDCs as described in the database
- Set file naming scheme and output directory
- Set maximum file size
- Set recording options
- Set maximum event size
- Dynamic status display configuration
- and many more ...



# DATE Logbook

- DATE provides a logbook system based on a MySQL database.
- The *infoBrowser* application allows to access the logs in both on-line mode and off-line mode. Query expression are extremely useful to retrieve information about past runs and operations on the system.



# DATE Logbook (2)

- Example of DB query using infoBrowser
  - Time min: 2014-01-21 10:50:00
  - Severity: F
  - Hostname: localhost

It will retrieve all FATAL error logs generated by the localhost node after 21 Jan 2014 10:50:00

Severity	Date	Time	Host	Facility	ErrCode	Message
FATAL	21/01/14	12:52:02	localhost	equipmentList_	12204	Arming RorcData: (ERROR 12204) the readout board (10.0.0.2) is not responding to the ping end of
FATAL	21/01/14	12:52:02	localhost	readout	12204	Error in routine ArmHw active equipment 2
FATAL	21/01/14	12:52:02	localhost	readout	14007	Error in SOR phases
FATAL	22/01/14	11:39:43	localhost	equipmentList_	12202	Arming RorcTrigger: (ERROR 12202) no paged data flag
FATAL	22/01/14	11:39:43	localhost	readout	12202	Error in routine ArmHw active equipment 1
FATAL	22/01/14	11:39:43	localhost	readout	14007	Error in SOR phases

min. 14-01-21 max.   
 match F exclude localhost   
 Browse errors: << < > >> Messages: Clean now Auto scroll Auto clear   
 Status: Idle   
 Query: SELECT `severity`,`level`,`timestamp`,`hostname`,`rolename`,`pid`,`username`,`system`,`facility`,`detector`,`partition`,`run`,`errcode`,`errline`,`errsource`,`message` from messages WHERE ( `severity`="F" ) AND ( `hostname`="localhost" ) AND timestamp>1390297800 AND level<=6 and level is not null ORDER BY timestamp limit 10000   
 6 messages, 6 fatals

# Conclusions

1. DATE is a turnkey scalable data acquisition software
2. DATE supports the readout of UDP front-ends such as the SRS system
3. DATE is able to scale from small size laboratory set-up to large experiment DAQ systems.
  - From one machine to several hundreds
4. Small size DAQ set-ups still profit from all DATE facilities:
  - Configuration database
  - Runs history
  - Logbook

# References to DATE

1. ALICE Collaboration, TDR of the Trigger, Data Acquisition, High-Level Trigger, and Control System, CERN-LHCC-2003-062.
2. <https://ph-dep-aid.web.cern.ch/ph-dep-aid/>
3. ALICE DAQ and ECS Manual, ALICE Internal Note/DAQ ALICE-INT-2010-001
4. F.Costa et al., The new frontier of the DATA acquisition using 1 and 10 Gb/s Ethernet links. TIPP 2011 conference, Chicago, June 2011, Physics Procedia 37 ( 2012 )



Thanks for your attention,  
let's get our hands-on DATE!