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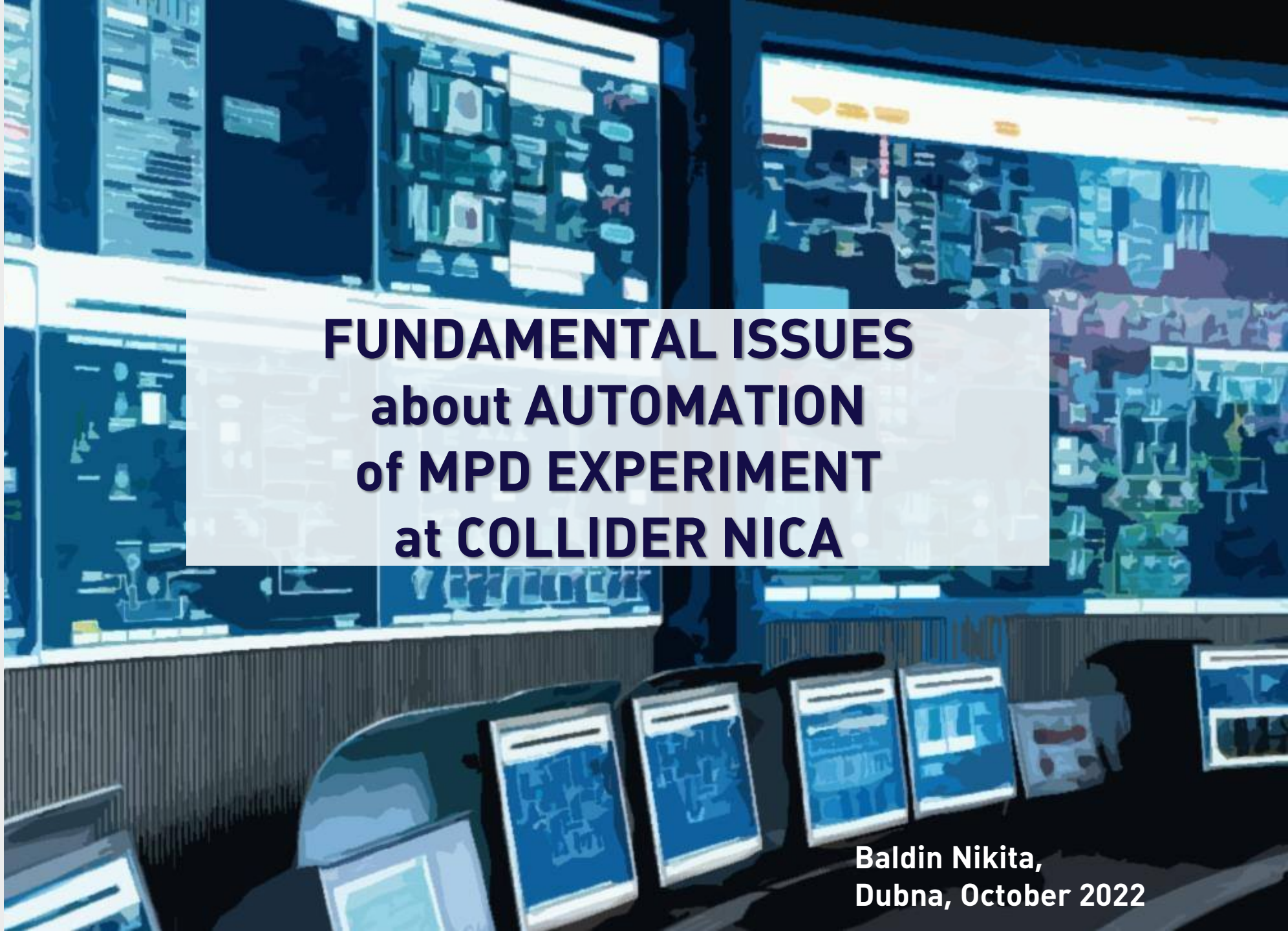
NICA MPD



FUNDAMENTAL ISSUES about AUTOMATION of MPD EXPERIMENT at COLLIDER NICA

Baldin Nikita,
Dubna, October 2022

SALUTATION

I am Nikita Baldin

I have the **education** of an accelerator technology automation engineer Moscow Engineering Physical Institute (MEPhI).

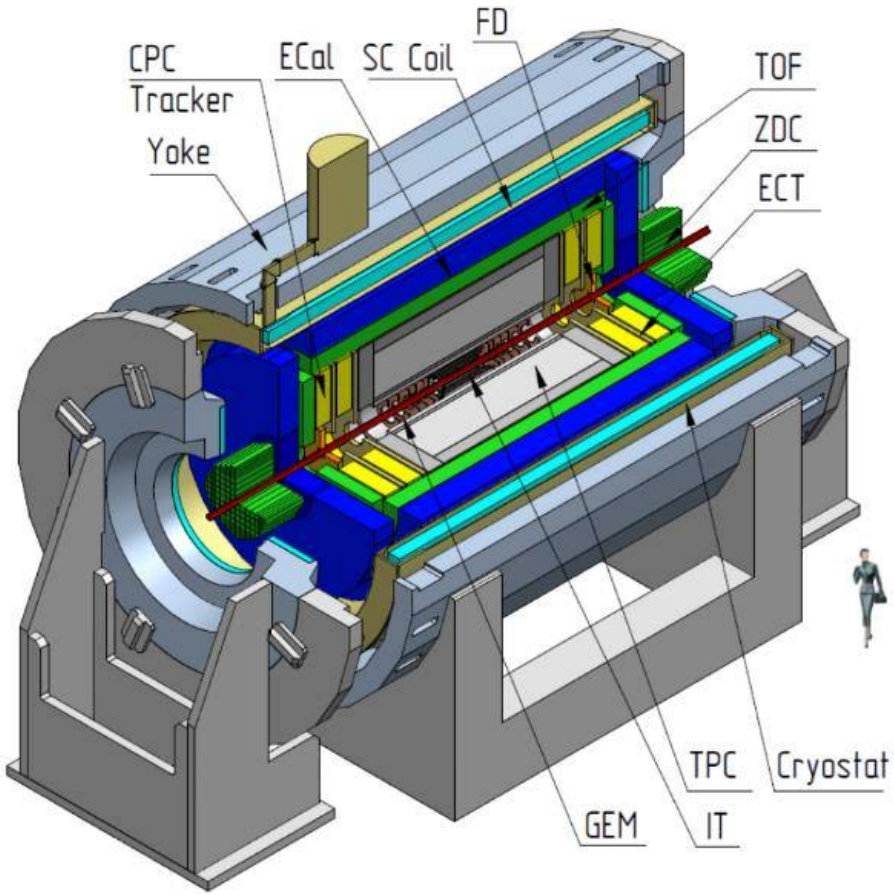
More than 10 years I worked for large **system integrators** of full-scale DCS in the power plant industry in Russia.

project in science that I did was automation of cryogenic liquefaction plants at the **NICA project in home institute JINR**, Dubna, Russia.

project in science that I did was DCS (detector control system) of ITS (inner tracker system) at **ALICE experiment In CERN** Geneve, Switzerland.

Automation object: MPD experiment facility

Multi-Purpose Detector



First stage Subdetectors:

- TPC, TOF, Ecal, FFD, FHCAL

Second stage Subdetectors:

- ITS, GEM, CPC

Infrastructure subsystems:

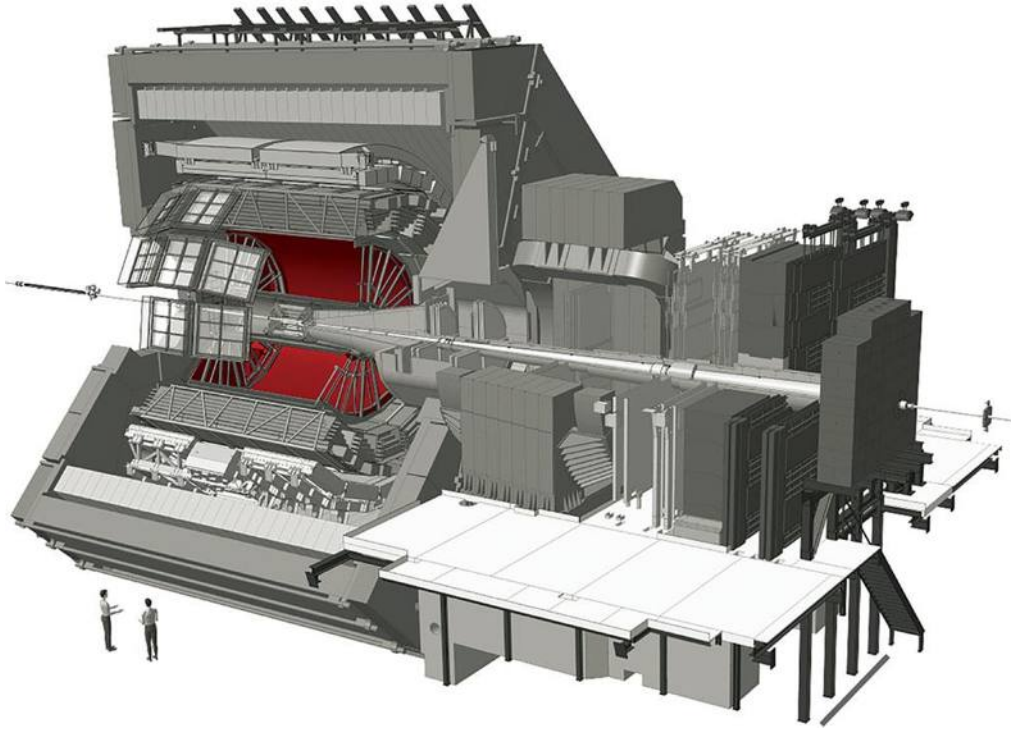
- Magnets, B-field, radiation, access control, ventilation, etc.

External services:

- Electricity, cryogenic, cooling, gas etc.

Automation scale of ALICE at CERN

ALICE at CERN



Quantitative measures:

- 1 control room
- 100 servers (WinCC OA)
  *12 TPC servers
- 270 crates
  *more 60 cabinets
- 1.200 network-attached devices
- 3.000.000 parameters
  *ATLAS 12.000.000

AUTOMATION AT CERN

A MAJOR MULTI-LEVEL DCS PROJECT ON SCADA WINCC OA AT CERN ON LHC

5
CONTROL ROOMS

over **680**
SUBSYSTEMS

over **45 mil.**
PARAMETERS

over **1400**
DEVELOPERS

CURRENT DCS DESIGN SOLUTIONS FOR MPD

+ Letter of intent for MPD
+ CDR for MPD facility
+ TDR for TPC and other detectors
+ TDR for DAQ
- No CDR and TDR for other automation: DCS, DSS, ECS

documented developed design solutions?

Process design

Engineering design

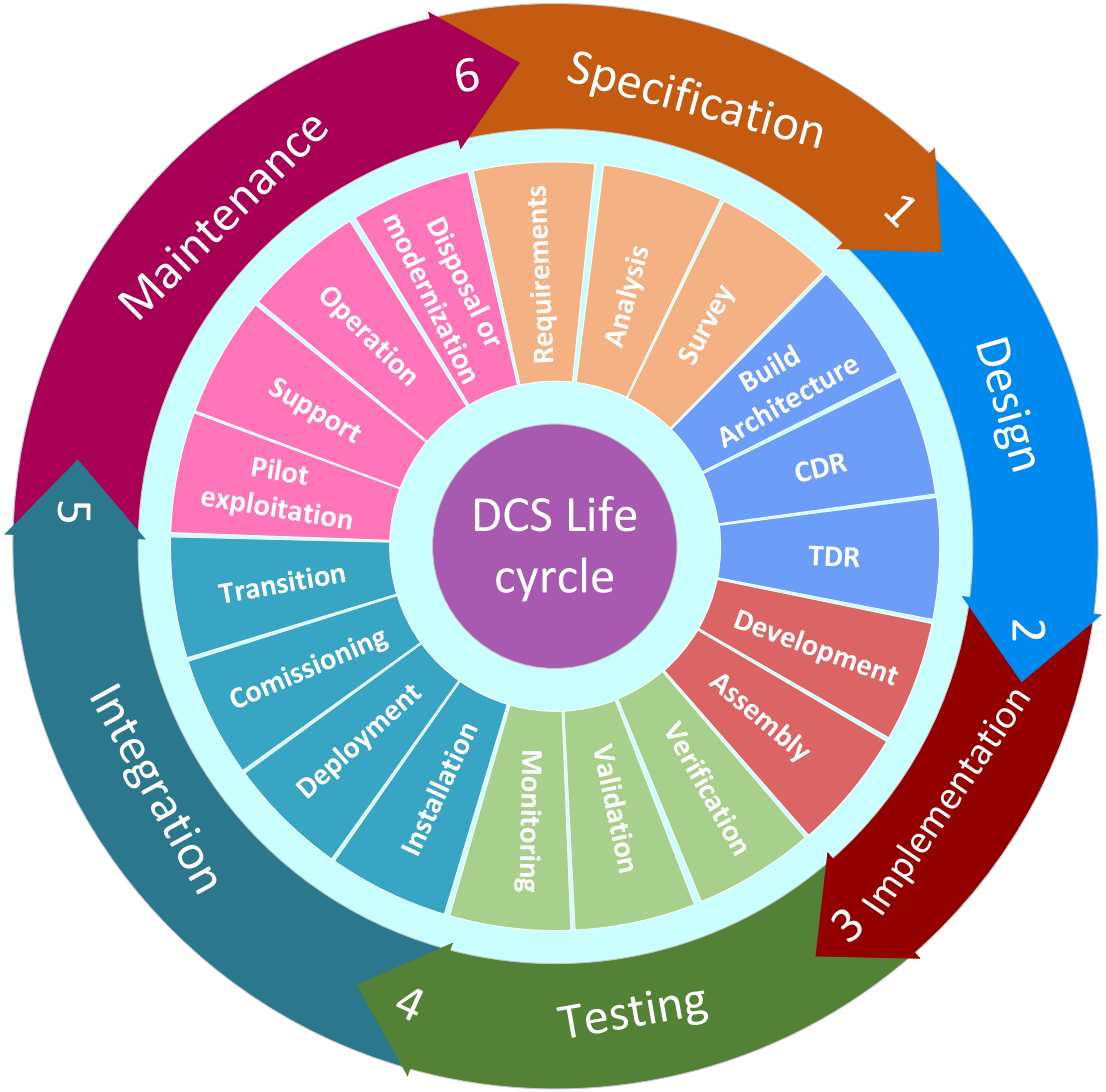
?

Workplan

Schedule

- Parameters list, types, calibrations
- Architecture, Deployment diagram
- Requirements, Technical specification

LIFE CYCLES OF AUTOMATED SYSTEMS



GOALS AND OBJECTIVES

1. Provide stable units operation

2. Ensure safety equipment

Experimental data

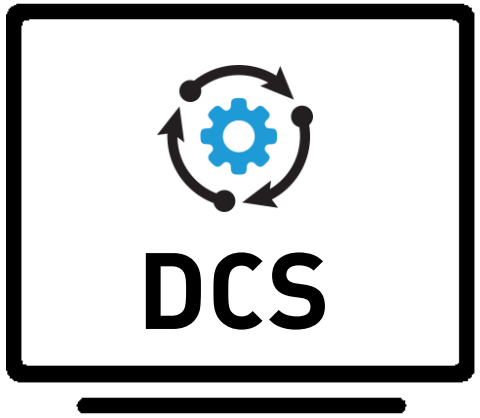
Education activity

3. Achieving highest output quality

4. Providing an optimal operational mode

CERN STYLE DECOMPOSITION

Detector Control System



- Status equipment
- Parameters technology process
- Equipment modes

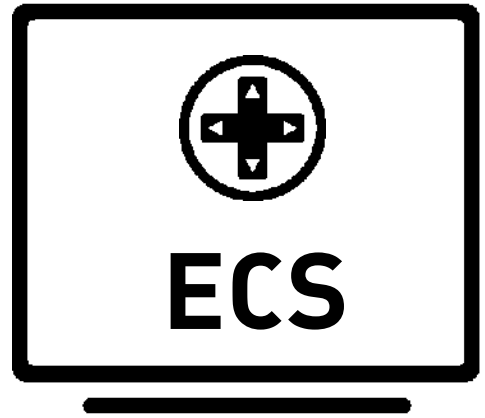
Detector Safety System

- Interlocks
- Setpoints
- Process protection
- Locks and blocks

Data Acquisition System

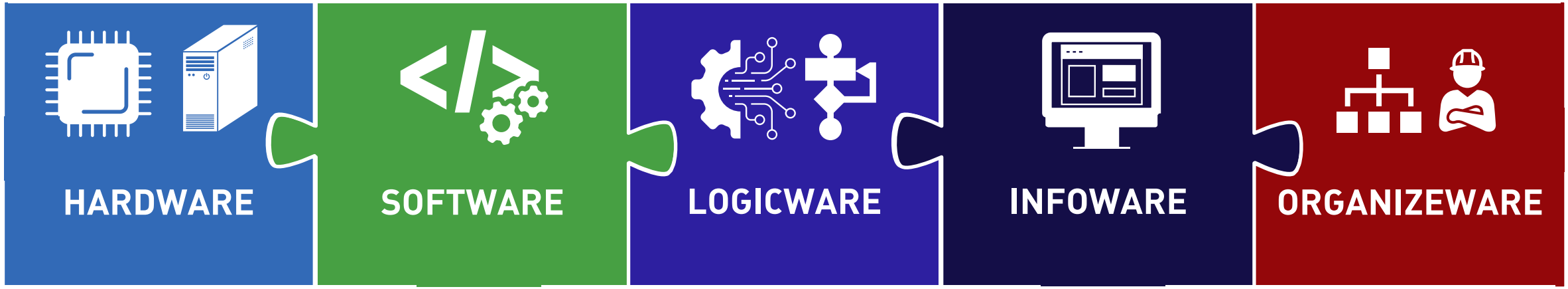
- RAW data science
- Quality control
- Correct data

Experiment Control System



- Run start/stop
- Run coordination
- Run processing

CONSTITUTION OF AUTOMATED SYSTEMS



- Front-end electronics
- i/o modules
- PLC
- Servers
- ARM

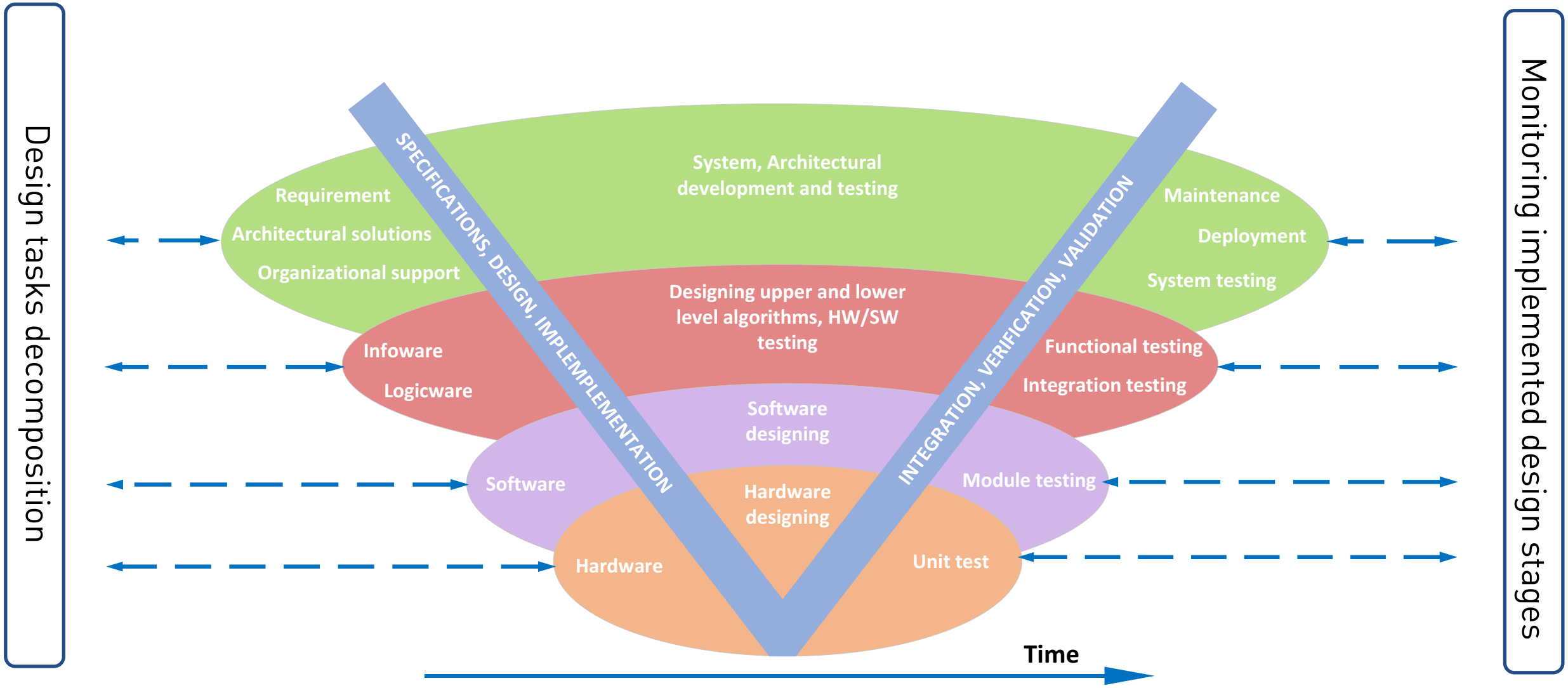
- Operation systems
- Protocols
- SCADA
- Developing studio

- Firmware
- Logical components
- Algorithms
- Procedures
- Technological functions

- User interface
- MIMICS
- Graphical panels
- Graphics, trends
- Alarm table

- Organization structure
- Personnel tasks
- Duties
- Rights
- Responsibilities
- Instructions
- User manual

V-model


Design tasks decomposition
Monitoring implemented design stages
SPECIFICATIONS, DESIGN, IMPLEMPLEMENTATION
INTEGRATION, VERIFICATION, VALIDATION
System, Architectural development and testing
Requirement
Architectural solutions
Organizational support
Maintenance
Deployment
System testing
Designing upper and lower level algorithms, HW/SW testing
Infoware
Logicware
Functional testing
Integration testing
Software designing
Software
Module testing
Hardware designing
Hardware
Unit test
Time

First surface planning

Survey of the facility

- Subsystems list
- Objects table
- Signals table

Development of conceptual solutions

- Process design
- Deployment diagram
- Engineering design

Tasks decomposition

- Subprojects list
- Gantt diagram

Subprojects development

- Technical specifications
- Subprojects portfolio

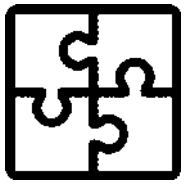
SUMMARY

Automation of an experimental facility - a massive task

- over 1000 hardware units
- over 100.000 lines of software code
- linking software tools, configuring protocols

At the moment there are no design solutions worked out

- no CDR
- no TDR
- no any diagrams, etc.



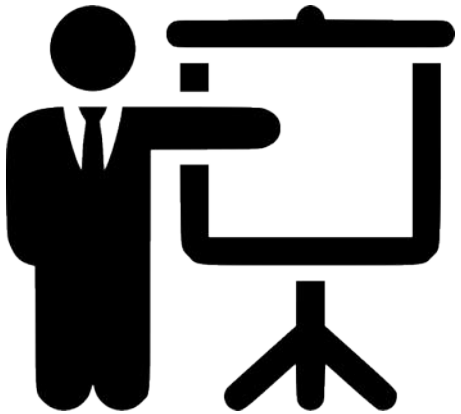
Types of automated systems and their components

- Goals and objectives: experimental data, operability, safety, quality, optimality
- Systems types: DCS, DSS, DAQ, ECS
- Components: hardware, software, algorithmic, informational, organizational

A step-by-step approach to creating automation systems

- Conduct a survey of the automation object
- Define the requirements for the automation system
- Develop design solutions (CDR, TDR)

Next presentations



1. **Subsystems TPC analysis**
   - subsystems list
   - technology
   - Units, objects, signals

2. **How the TPC automatics on ALICE works**
   - subsystems list
   - deployment diagram
   - other features

3. **Functionality of automated systems**
   - alarm function
   - archiving function
   - technology functions, etc.

4. **What the CDR for automatics should include**
   - content
   - document sections
   - schematics

5. **Workplan and schedule**
   - task decomposition
   - Gantt chart
   - etc.

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NICA MPD

Nikita Baldin

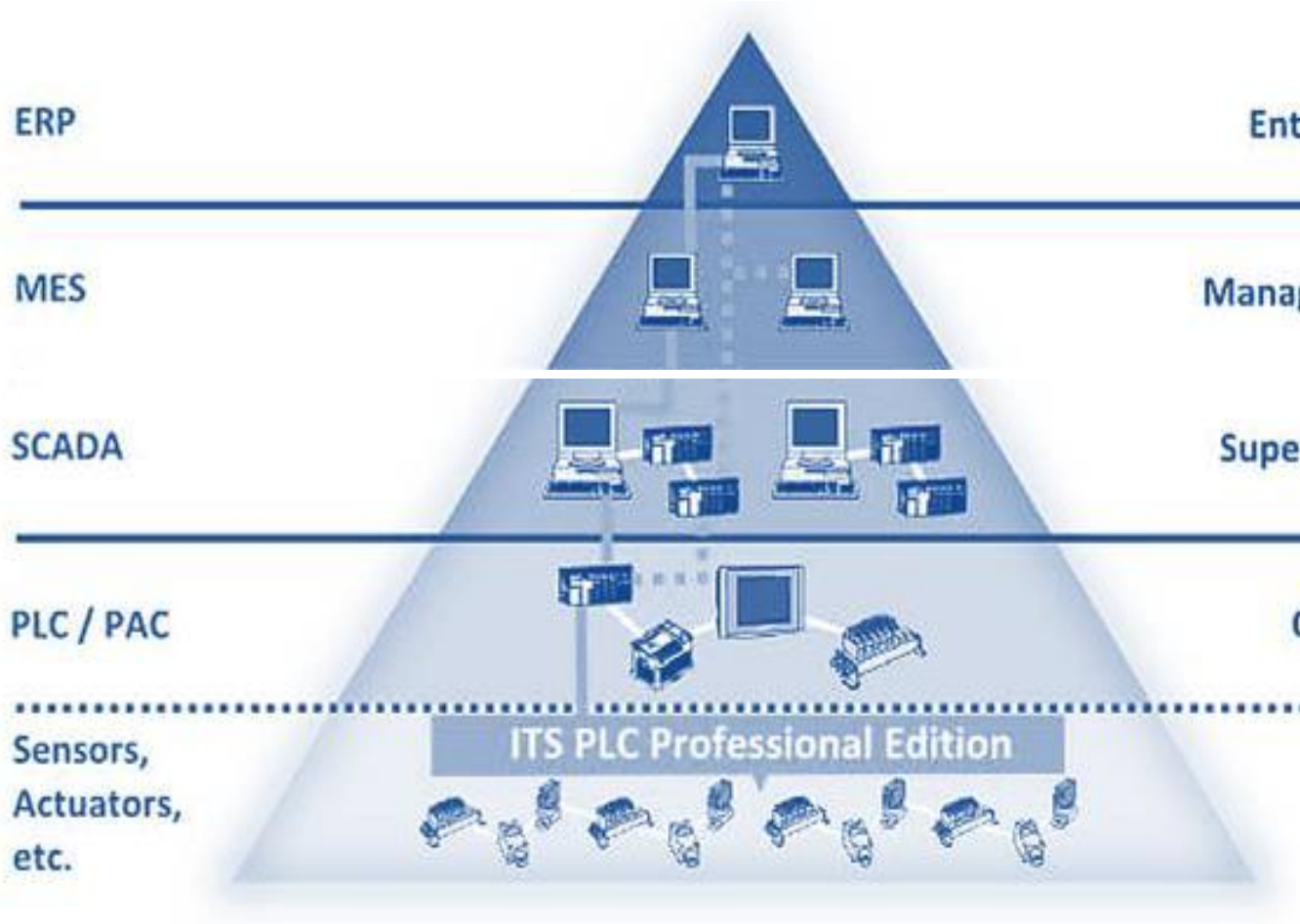
automation lead engineer

nabaldin@jinr.ru

+7(926)5630684

Thank you !!!

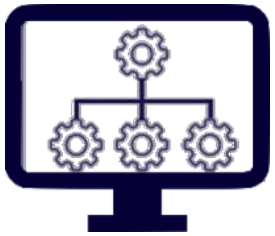
Hierarchy of automated systems



Enterprise Level	detailed planning, inventory management, sales, finance, purchasing
Management Level	monitoring the status and allocation of resources, process quality, performance analysis
Supervision Level	process control and management, production dispatching
Control Level	primary signal processing and logic of algorithms for automatic control of equipment
Field Level	technological equipment, facility, sensors, actuators

SURFACE FUCTIONALITY OF SYSTEMS

DISPLAY COMPREHENSIVE INFORMATION

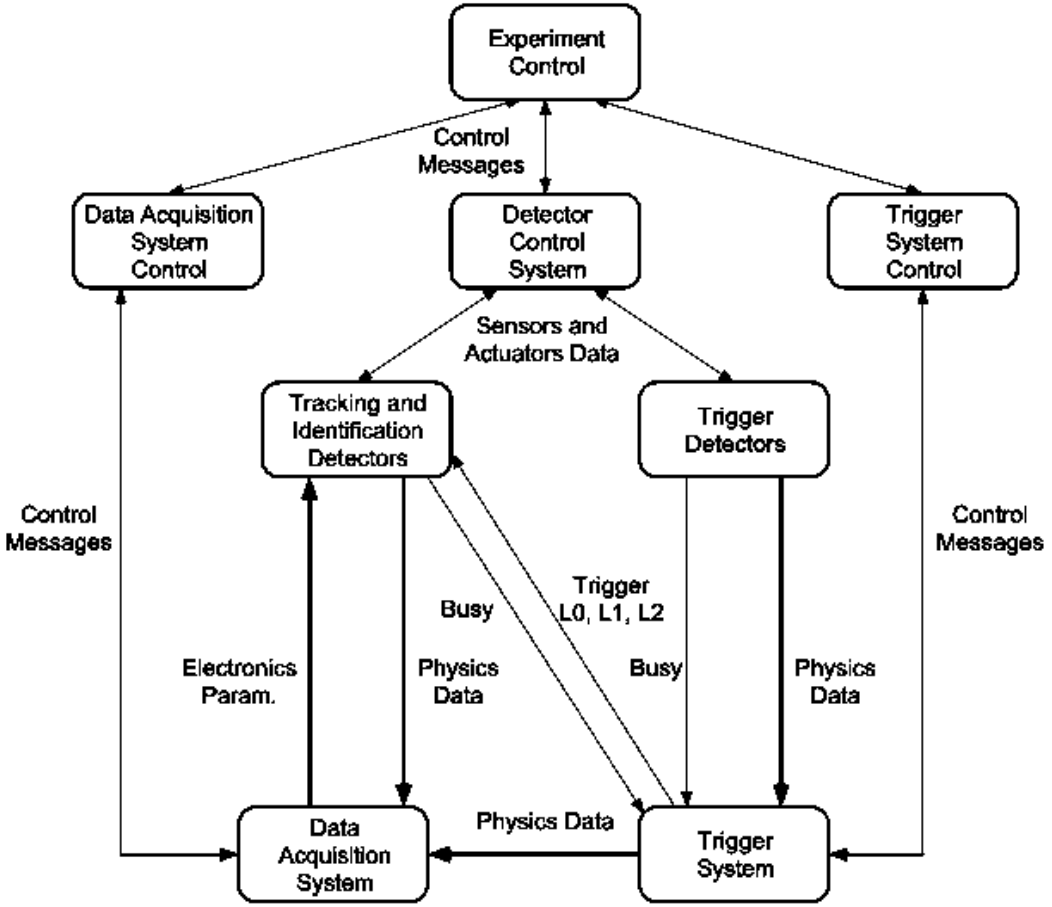
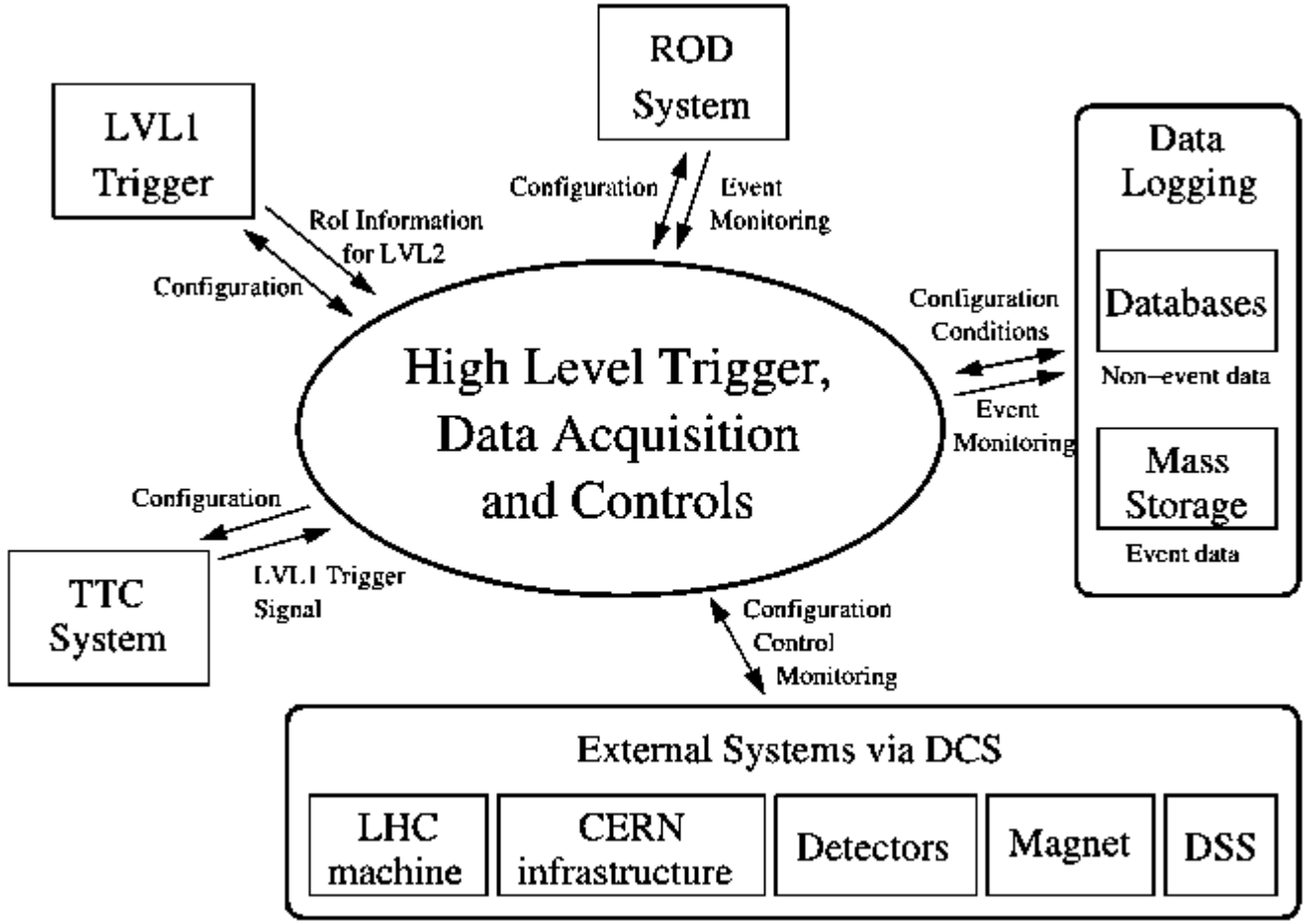


ALARM, ERROR WARN EVENT NOTIFY

CONTROL FUNCTION AND ADJUSMENT

ORIENT OPERATOR IN EMERGENCY SITUATIONS

ARCHIVE DATA AND LOG OPERATOR ACTIONS

GENERATE REPORTS

EXAMPLE OF DIAGRAMS