# Control algorithms, data visualisation and data base for NICA

**Maciej Ławryńczuk**

**Institute of Control and Computation Engineering**
**Warsaw University of Technology**

# Specialised control algorithms for NICA MPD

**Classical control algorithms (PID)**

- Efficient for simple Single-Input Single-Output (SISO) processes
- Low control quality for Multiple-Input Multiple-Output (MIMO) processes
- Unable to effectively take into account constraints
- Low control quality when measurements are delayed

**Model Predictive Control (MPC) algorithms**

- Advanced process control: the optimal control policy is found
- Very good control quality
  - for MIMO processes
  - for processes difficult to control. e.g. with delays
  - take into account all constraints of variables in a systematic way

# Specialised control algorithms for NICA MPD

**What we can do**

- Development of specialised MPC algorithms for slow control NICA MPD
- Development of a software system for efficient development of the MPC algorithms
- Development of a hardware system which will act as a real-time controller
- Implementation of MPC algorithms for slow control NICA MPD

# Specialised SCADA systems for NICA MPD

**Supervisory Control and Data Acquisition (SCADA)**

- A control system architecture that uses computers, networked data communications and graphical user interfaces for process supervisory management
- These systems are used as a upper level of control systems
- The SCADA system is dedicated to monitoring and control technical process and support acquisition data

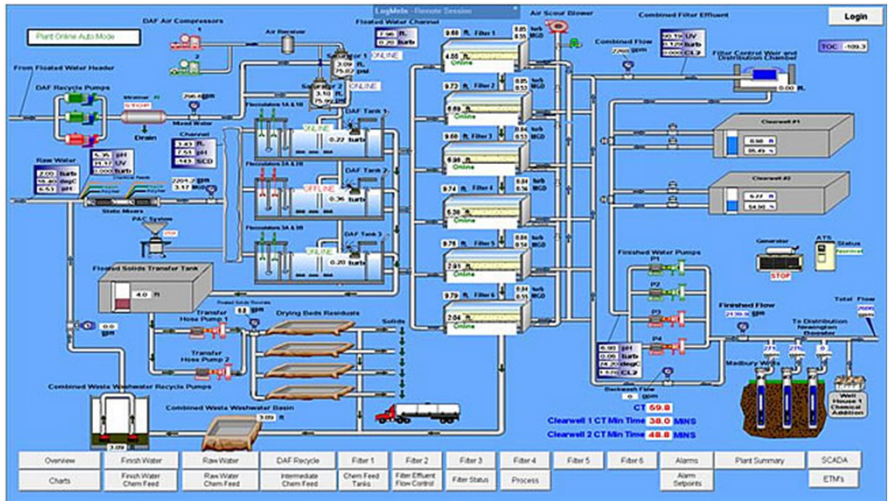
Before SCADA

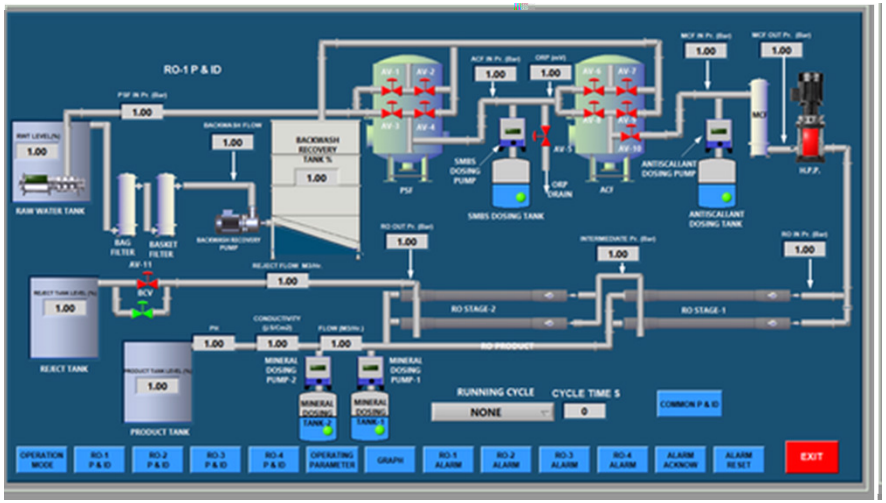
SCADA example

# Specialised SCADA systems for NICA MPD

## What we can do

- Develop the SCADA system for NICA MPD
- Develop High performance Human Machine Interaction system (HMI)
- Develop process simulator
- Develop Monitoring, Diagnostics and Preventive Maintenance tools
- Develop cebersecurity mechanisms



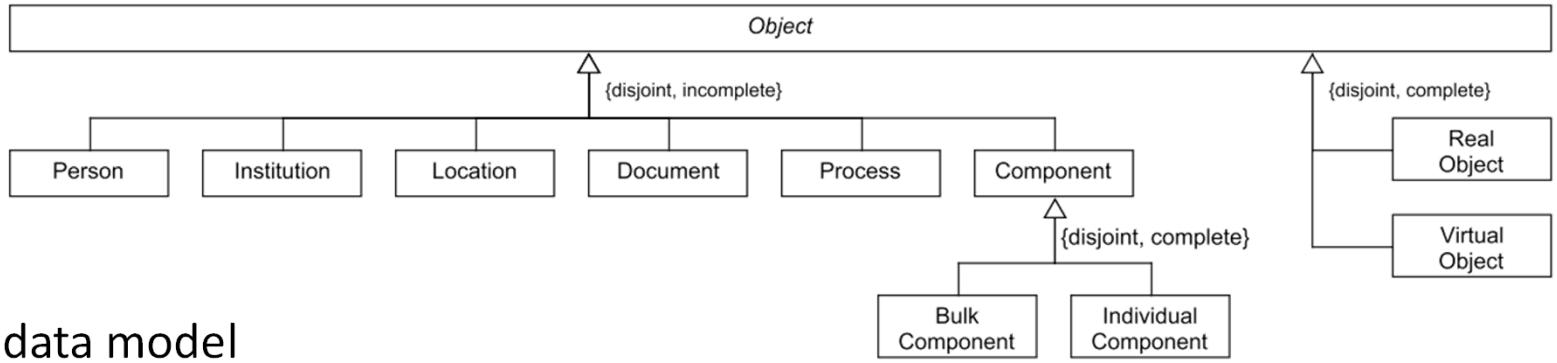
# EqDb – Equipment Database for NICA MPD (work in progress)

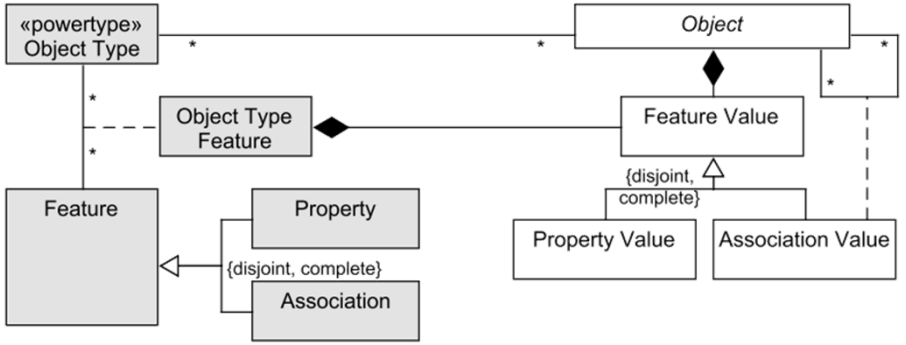
- **Goals**
  - intended to support construction, assembly & operation of MPD equipment
  - can be used also as a calibration database for the detector
  - may become a backbone for slow control system
- **Highly flexible solution**
  - generic (definable, metadata-driven) data structures & applications
  - easily customizable to support any other complex equipment
- **Technology**
  - conceptually object-oriented
  - implemented using proven Oracle relational database
  - highly scalable

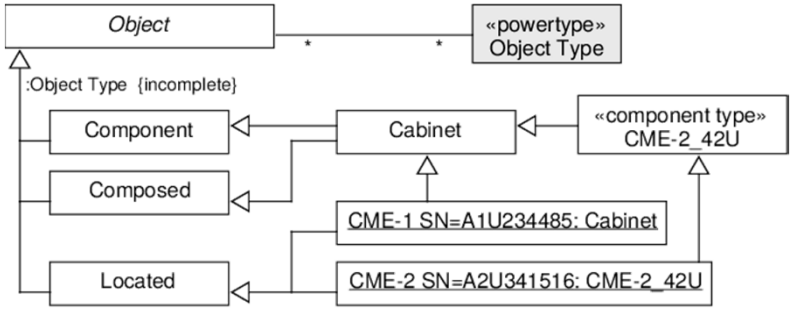
http://nica.fizyka.pw.edu.pl/do/view/Main/EqDb/

## EqDb data model

- Generic object-oriented data model
- Several predefined subclasses
  - for common object categories,
    e.g. persons, institutions, components
- Definable (generic) object types
  - with definable properties and associations
  - to represent type-specific features, e.g.
    - parameters of a given component model
    - results of specific measurements
- Definable hierarchies of types
  - inheritance of properties and associations
  - multiple inheritance allowed
  - object instances can inherit directly from many types



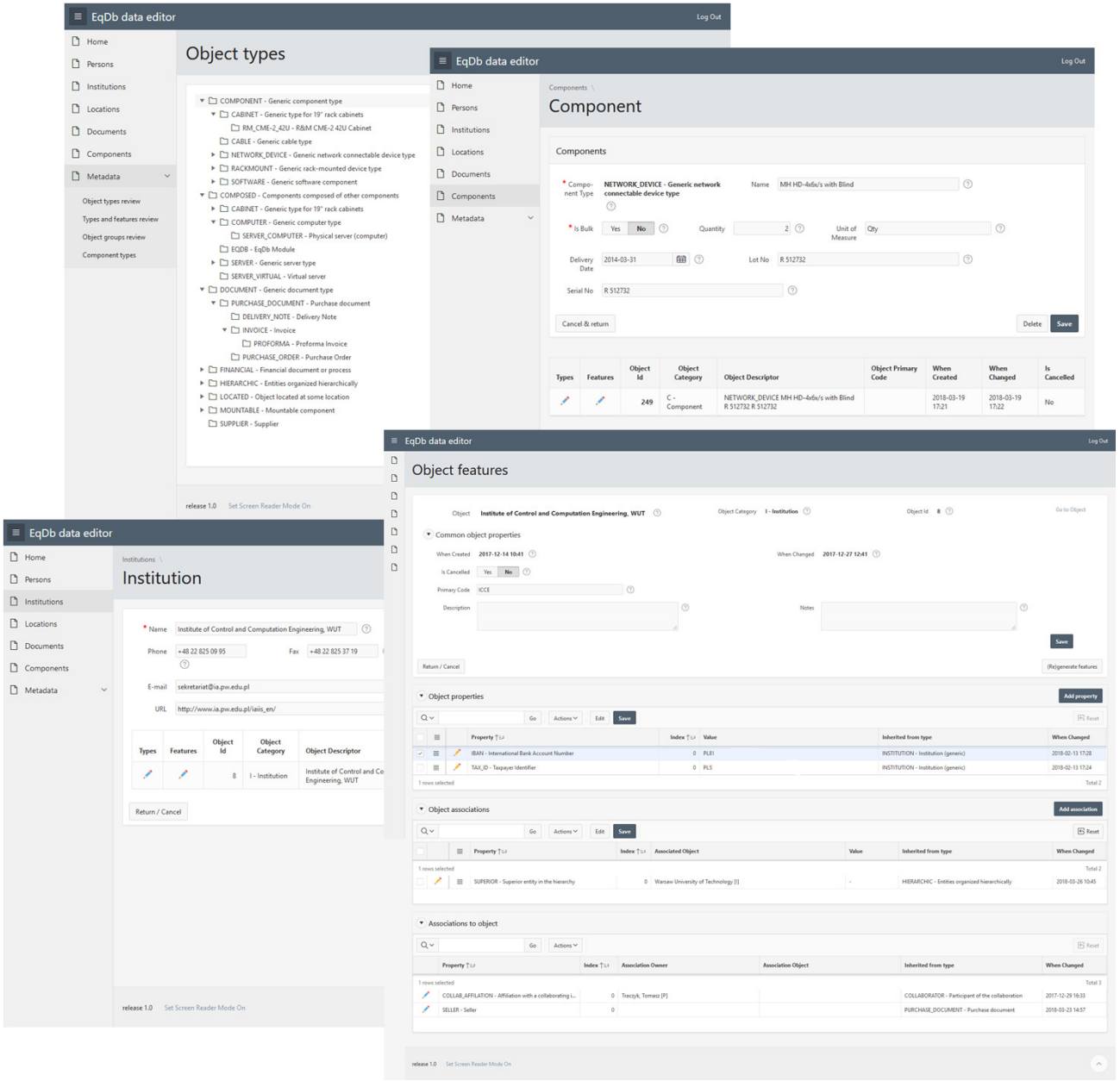



## EqDb modules

- EqDb Inventory – operational (2018)
- EqDb Extension for Cabling – in progress
- EqDb Extension for Equipment Assembly – planned
- EqDb Integration with Slow Control System – planned

## EqDb applications

- System Data Editor – operational
- Metadata Editor – operational
- Data Editor (generic) – operational
- Specialized applications for cabling & interface to R&M intelliPhy – in progress
- Imports from external data sources (e.g. measurements) – in progress
- Interface to slow control system – planned



## What can EqDb be used for?

- **Detector construction**
  - support for equipment assembly
  - tracking assembly of components & utilization of parts
  - support for cabling
  - storage for component measurements/test results
- **Logistics**
  - support for parts ordering
  - repository of documents
  - inventory of parts and components
  - directory of involved persons and institutions
- **Equipment operation**
  - tracking equipment modifications
  - monitoring cabling changes
  - storage for calibration data
  - setting parameters for slow control systems
  - storage for data received from slow control / SCADA systems

# What we can do for slow control NICA MPD

**Process control**

- Advanced control algorithms
- Software and hardware solutions for control algorithms

**SCADA system**

- Data visualisation
- Human Machine Interaction system
- Monitoring, Diagnostics and Preventive Maintenance tools
- Cebersecurity mechanisms

**EqDb database**

- Repository of all process data, documents, settings