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COMPONENT DATABASE DEVELOPMENT FOR THE **CBM** EXPERIMENT

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Разработка компонентной базы данных для эксперимента CBM

В настоящей работе представлена реализация компонентной базы данных для эксперимента CBM. Рассматриваемая база данных предназначена для эффективного управления большим количеством компонентов детекторов CBM в процессе их производства, установки и эксплуатации. В этой базе данных хранится информация о компаниях-производителях, показателях качества, включая результаты тестирования, о местонахождении компонента, а также статусе, в котором находится или находился компонент. Приведены функциональная модель, дизайн схемы базы данных, описание таблиц и каталогов, а также графический интерфейс пользователя системы.

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Component Database Development for the CBM Experiment

This paper presents the implementation of the component database for the CBM experiment. The considered database is designed to effectively manage a large number of components for different CBM detectors during their manufacture, installation and operation. This database contains information about the production company, quality indicators, including test results, information on the whereabouts of the component and its status. A functional model, a design of the database schema, a description of tables and catalogs as well as a graphical user interface system are shown.

The investigation has been performed at the Laboratory of Information Technologies, JINR.

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1. INTRODUCTION

The new accelerator facility FAIR (Facility for Antiproton and Ion Research) is under construction at GSI (Darmstadt, Germany). FAIR will allow one to realize several physics programs including the CBM (Compressed Baryonic Matter) experiment [1], which is being developed by an international collaboration including scientists and specialists from JINR [2].

In a previous work we developed a conception of the databases for the CBM experiment [3]. For this purpose the main features of different DBMS were analyzed, including relative and object-oriented DBMS which are used in large experiments at the LHC in CERN. As a result, a set of databases and their use-cases for CBM were proposed.

This paper presents a realization of the Component DB (the Component Database) for CBM. User requirements for the implementation of this database were developed after negotiations with the working groups responsible for different CBM detectors [4]. We describe here how the user requirements were realized for the Component DB.

2. THE ANALYSIS OF THE SUBJECT

The goal of the Component DB is to enable an efficient management and survey of the large quantities of detector components making up the various CBM detectors during their production, installation and operation. The users of the database are the project leaders and their groups responsible for the development and deployment of the detectors. Typical information to be stored in the database is information about production companies, quality figures including test results, and tracing and other status information.

Due to the subject area, the realized system will involve the following features:

• The CBM experiment comprises a number of detector systems, like Silicon Tracking System (STS), the Transition Radiation Detector (TRD) or the Time-of-Flight Detector (TOF). These systems are henceforth called “detectors”.

• Each detector is a collection of a large variety of hardware (components).

• Each component can be simple or assembled [4].

• Each component is characterized by a set of common characteristics, such as name, description, status, information about the testing, shipping information, the way the item was delivered to the place of its construction, certificates, information about the production company, and others.

• Some components also have some specific properties — serial number, type, batch number, and information on the status of the component in terms of quality.

• Brief accurate information used in the process of information service concerned is stored in catalogs (such as names of production companies, component types, values of possible statuses, etc.); these can only accept pre-defined values.

• In the future we do not exclude the appearance of special parameters used only in a particular detector. In this case, the possibility to add the component settings only for the specific detector will be developed.

Basic entities of the subject area:

• **Component**: an element (logical unit) of equipment, which is stored in the database and has the following common characteristics: name, description, status, number of units, information about testing, shipping information, the way the item was delivered to the place of its construction, certificates, information on production companies, planned and actual start and end dates of the component production; and special features (not mandatory for individual detectors): serial number, type, batch number, information on the status of the component in terms of quality.

• **Position** — some brief and exact data concerning the subject domain.

• **Catalog —** list of unique positions rarely changing (or not changing).

We should highlight from the parameters the quality characteristic which is the information on the status of the component in terms of quality. That is a composite parameter which has two properties: a value and a unit measure. One component may have several quality criteria, i.e., several quality parameters with different unit measures.

Functionality:

• maintaining databases (read, write, modify, delete, archiving);

• providing the database integrity;

• providing data protection against unauthorized or accidental access (definition of access rights);

• implementation of typical queries.

Typical queries:

• obtain information on the detector as a whole;

• obtain information on the individual components;

• obtain information about the components fulfilling a set of criteria;

• add information about a new component into the database;

• edit the existing database components;

• edit the catalogs.

In the Component DB a detector is represented as a tree of its components. The root of the tree is a component named "detector". The detector is divided into smaller elements which in the Component DB are provided with similar components. In turn, these elements can also be broken down into smaller pieces to form a new tree level. The number of tree levels may vary from detector to detector.

3. FUNCTIONAL MODEL OF THE SYSTEM

The most important indicator of the quality of the software is its functionality. As a result of interaction with the stakeholders, there have been identified and described the functional requirements of the system defining its behavior in terms of the end-user.

Table 1. **Identified use cases**

Main actor	Denomination	Description
Manager	Edit	Allow to make changes in the description of the detector components
Manager	Insert	Allow to make data on the new component
Manager	Delete	Allow to delete information of the component
Manager	Manage catalogs	Manage catalogs: equipment manufacturers, equipment procured parties, buyers, etc.
Manager	View (full)	View full information about the component
Guest	View (limited)	View public information about the component

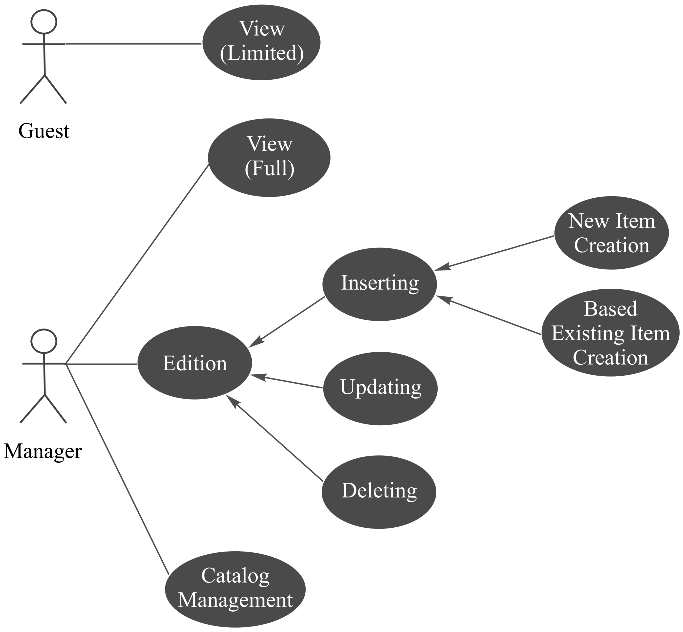

Fig. 1. Use Case diagram of the system

The consultations revealed two main actors: manager and guest. The manager produces the content of the system and, if necessary, may make operational adjustments into the descriptions of the detector components. The guest will view the data on the components of the detector. The identified use cases are presented in Table 1. A general view of the functional model of the system is presented in Fig. 1 as a Use Case diagram.

4. DESIGN OF DATABASE SCHEMA

Figure 2 presents the schema of the Component DB (realized in DBMS PostgreSQL). The choice of this DBMS is justified in [2]. The Component DB includes 11 tables, 6 of which are the catalogs described below.

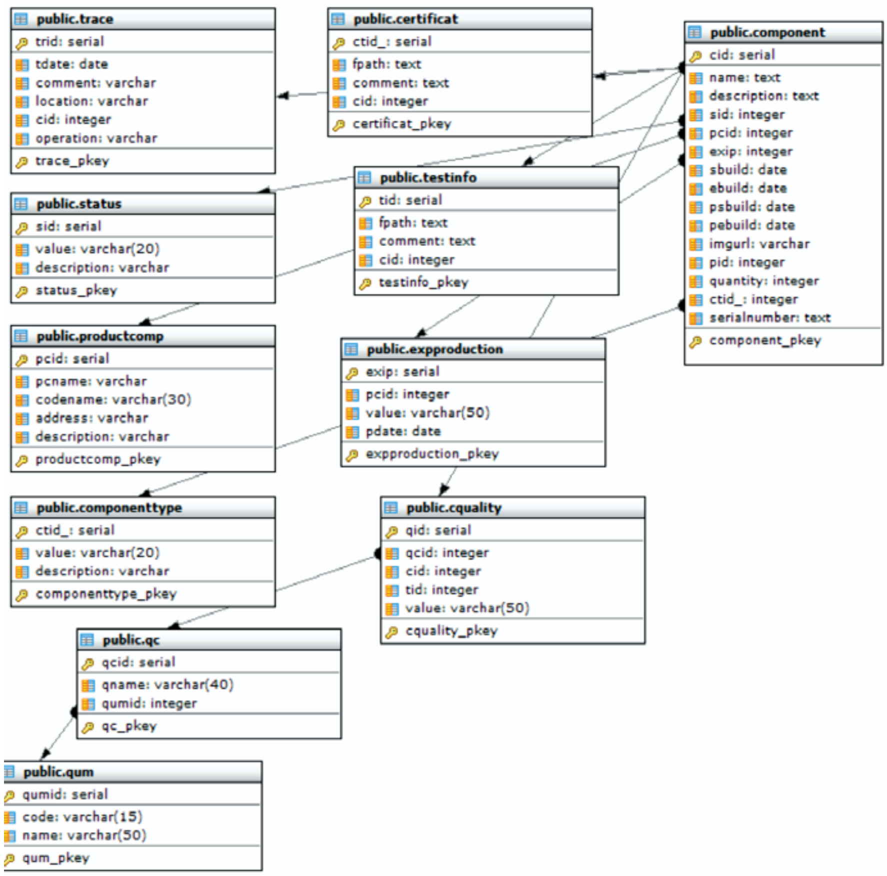

Fig. 2. The schema of the Component DB

4.1. The Catalogs. The catalogs are implemented as tables that store the predetermined values of certain types. These values are the same for all the components within a single detector, but may differ significantly for different detectors. Below is a list of the catalogs for the Component DB at the current moment:

- Catalog of production companies (Table 2);
- Catalog of components categories (Table 3);
- Catalog of components batches (Table 4);
- Catalog of values for possible statuses (Table 5);
- Catalog of units of measurement of quality (Table 6);
- Catalog of quality criteria (Table 7).

Table 2. **The catalog of production companies**

Data	Denomination	Description
pcid	Service	Automatically
pcname	Full company name	
codename	Brief company name	
address	Address	
description	Description	Optional

Table 3. **The catalog of components categories**

Data	Denomination	Description
ctid	Service	Automatically
value	Value	
description	Description	

Table 4. **The catalog of components batches**

Data	Denomination	Description
exip	Service	Automatically
pcid	Link to production company	
value	Value	
pdate	Date of production	

Table 5. **The catalog of statuses**

Data	Denomination	Description
sid	Service	Automatically
value	Value	
description	Description	

Table 6. **The catalog of units of measurement of quality**

Data	Denomination	Description
qumid	Service	Automatically
code	Code	
name	Name	

Table 7. **The catalog of quality criteria**

Data	Denomination	Description
qcid	Service	Automatically
qname	Name of criteria	
qumid	Link to unit of measurement QualityMeasurementUnits	

4.2. Tables. The **Table Component** is the main table in the Component DB (see Table 8). The **Table Certificate and Testinfo** (see Table 9) has the same structure and is designed for storing different files with certificates and test results. The **Table Trace** (see Table 10) stores the history of moving the component to different places. The **Table Quality** (see Table 11) stores information about the component quality.

Table 8. **Table Component**

The component name	Type	Description
cid	integer	Unique identifier of the component
name	string	Name of the component
description	string	Description of the component
sid	integer	Unique identifier of the status
pcid	integer	Unique identifier of the company
exip	integer	Unique identifier of the batch number
sbuild	date	Start of construction
ebuild	date	End of construction
psbuild	date	Planned start of construction
pebuild	date	Planned end of construction
imgurl	string	Path to the file on the local disk
pid	integer	Unique identifier of the component parent
quantity	integer	Quantity
ctid_	integer	Unique identifier of the component type
serialnumber	string	Serial number

Table 9. **Table Certificate and Testinfo**

Data	Denomination	Description
ctid_/tid	Service	Automatically
fpath	Path to the file	
comment	Comments	
cid	Link to the component	

Table 10. **Table Trace**

Data	Denomination	Description
trid	Service	Automatically
tdate	Date of operation	
comment	Comments	
location	Location	
cid	Link to the component	
operation	Name of operation	

Table 11. **Table Quality**

Data	Denomination	Description
qid	Service	Automatically
qcid	Link to the criteria	
tid	Link to the test	Optional
cid	Link to the component	
value	Value	

5. GRAPHICAL USER INTERFACE

The Component DB has a web interface which provides an acceptable level of performance and easiness of use. This allows one to work with the system from any location with internet connection, including the possibility to access the information from mobile devices. To operate the system, the user needs only a web browser. The web interface is represented by several blocks (see Fig. 3): the main menu (for navigating within the detector), the login box, and the main area (for displaying and editing data).

A list of component names is displayed in a hierarchy on the left. To activate, click any component on the right, and full information about the component will be displayed (Fig. 3). Authorization is needed for inserting and editing. Only authorized users have access to the system modifying operations such as:

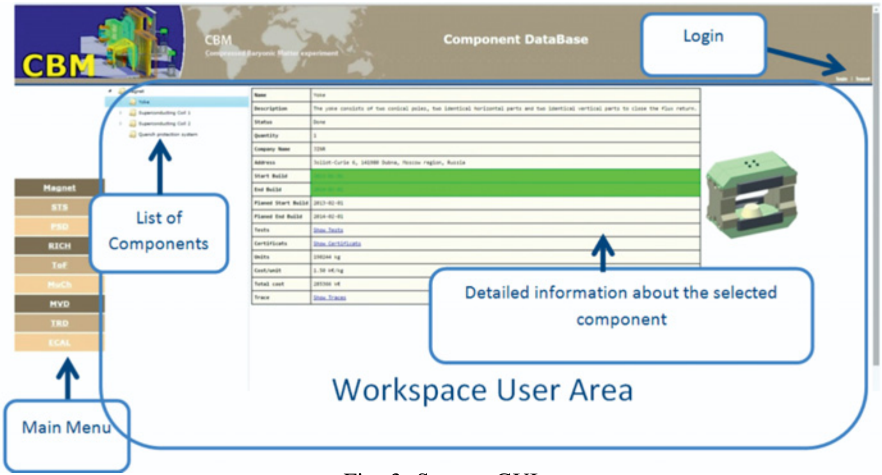

Fig. 3. System GUI

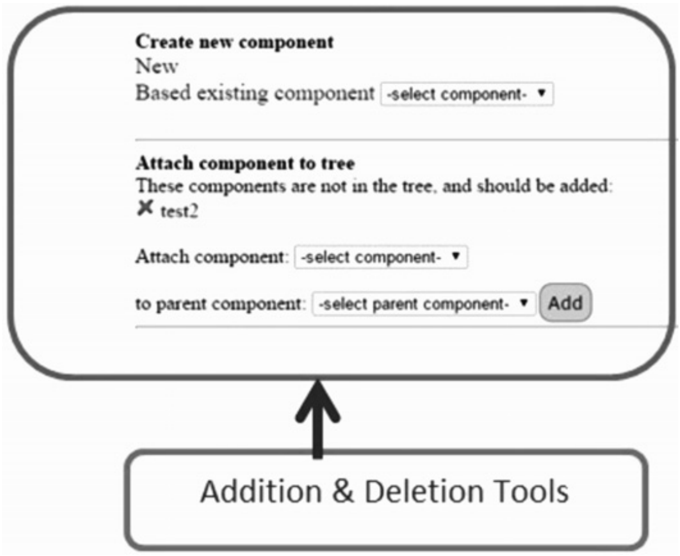

Fig. 4. Edit mode

- edit,
- insert,
- delete,
- manage the catalogs.

To switch into the edit mode, click the link “Edit” in the upper right side. The page shown in Fig. 4 will be displayed. The tools for inserting and deleting the data are on the left, the tools for editing the data are on the right.

6. CONCLUSIONS

A working prototype of an information system has been designed and implemented on the basis of the user requirements for the Component DB of the CBM experiment. The current implementation corresponds to the task and goal which is to automate and simplify data management of record-keeping for the CBM set-up. Any detector is represented as a hierarchy of components that makes it easy to keep the content of the system. The functionality of the system is planned to be extended so as to include filtering, information retrieval, report generation, etc., with taking into account the revised requirements of the users.

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