SPD Information systems

Current status

SPD Information Systems

- The SPD Experiment have to produce large amounts of data, both collected from the detector and simulated
- The processing of the experimental data requires a wide variety of auxiliary information from many systems
- Huge numbers of the detector condition and management data should be stored in the databases
  - should be used in every stage of data taking, processing and analysis
  - are essential at nearly every stage of data handling
  - for use in number of versatile applications each with its own requirements

SPD Information Systems

- Databases can not be considered as the thing in itself, but as a part of complex information system that include
  - Data collection tools
  - Data transportation tools (messaging services, etc)
  - Application layer between the client and the database server
  - Client software including GUI
  - APIs for access from the producton and analysis software
  - Supervisors and monitoring
- Databases and applications should be designed aiming for scalability, long term operation in the varying conditions, data flows and rates.
- Information systems are related to each other and to the detector components, this defines the priorities in development

SPD Information Systems

Some of the information systems will be shared with or inherited from other experiments, or provided by JINR

- Hardware Database 
- Mapping Database 
- Conditions and Calibration Databases
- Monitoring information system
- Logging and Bookkeeping

Detector

- Physics Metadata Databases
- Event Index 
- Distributed Computing and Data Management

Data

- Personal and publication databases

Hardware Database

- A catalog of hardware components that SPD detector consist of.
- It should contain the information about the detectors and the electronic parts, cables, racks, and crates, as well as the location history of all items
- It include equipment models, provider, parameters and other (semi)permanent characteristics
- This should help in maintenance of the detector systems and especially helpful in knowledge transfer between team members.
- A prototype system is being developed, including PostgreSQL as a back-end, that is bein accessed through the REST API from the web interface

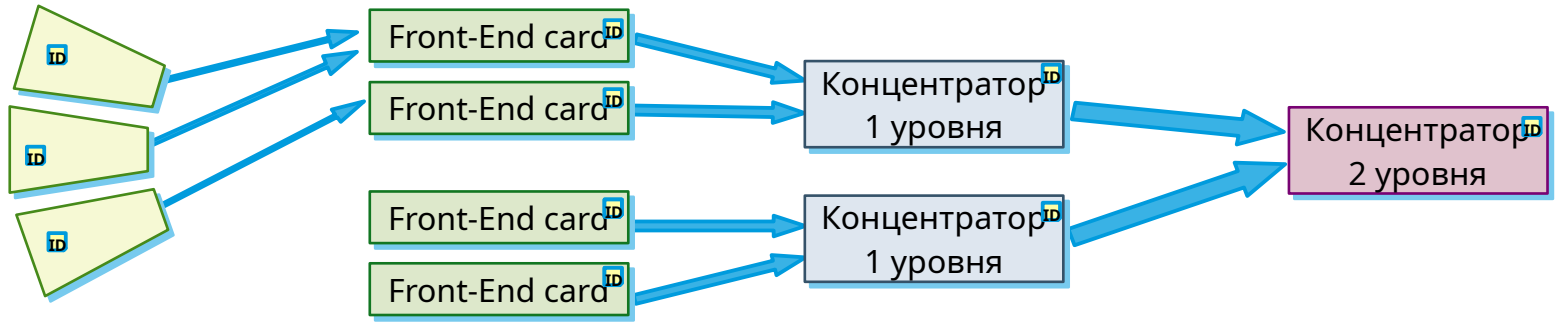
Hardware Database

- For each type of device, a set of parameters are defined that are common to all devices of this type,
  - Each parameter has type as well as optional ranges of allowed values
- There can be common values for all devices of the same type
- Each device has unique ID assigned to it, and specific values of the parameters can be specified for it, based on its type.

- A Input for the further development of the HWDB is required
- Most of the subsystems are in the very early stage of the development
- For some detectors, like Range System, design of the system and components are already defined to some extent
- The development of the HWDB can be based on the input from them

DAQ Mapping

- The number of data collection channels of the SPD installation will be several hundred thousand
- The signals from the detector will pass through several communication devices



- It is necessary to have a mapping of the data collection system that establishes the correspondence of the channel addresses at the DAQ outputs with the devices from which this signal came

Building of mapping

- Due to the large number of elements in the system, it is almost impossible to build mapping manually
- For the elements involved in the transmission of digital signals, an automatic mapping procedure should be implemented
  - The element must issue a HW ID over the data channel in response to a special signal
- For parts of the system that are not equipped with automatic source ID recognition, an interface must be provided that allows data entry by groups.

Performance requirements

- It is expected that the filling of the hardware database will take place gradually, and updates will be rare
- The construction of the connection diagram and its changes will also be performed rarely (no more than once a week)
- The requirements for the speed of recording information in the database are low
- Mapping information may be required when processing each file. It is possible that tens of thousands of processes will try to simultaneously access the system.
- It is necessary to ensure their processing, avoiding database overload due to too high frequency of requests

Conditions and Calibration Data

- Conditions data - non-event data representing the detector status
  - Detector hardware conditions
  - Detector calibrations
  - Detector read-out conditions
  - Detector alignments
  - Physics calibrations
  - Luminosity and polarization measurements

} Should be used together with HWDB data

- Conditions data usage
  - Subsystem calibration
  - Online data processing, reconstruction and reprocessing
  - User analysis

Conditions Data organisation

- Various pieces of information are heterogeneous both in data type and in time granularity
- The data should be organized by "Intervals of Validity" (IOV), which is the span in time over which that data is valid
- Can be recomputed later if the understanding of the detector behavior improves or the quality of the input data increases.
  - except for the detector and trigger configurations
- Careful versioning of groups of conditions data for production use cases is a critical item to guarantee reproducibility.
- Conditions data are typically written once and read frequently
  - read-rates up to several kHz must be supported for distributed computing use

Monitoring and logging

- Monitoring information system yet have to be developed
  - Will become necessary as detector components become ready
  - Will use various source of data from the subsystem and other databases
  - Data will be transferred in JSON format with variable schema
    - Only few mandatory fields required (source id, time stamp, etc..)
  - Data transfer through the HTTP requests have to be used
  - Time series database should be used as a backend
  - Commonly used solution like Grafana for use for visualization of data
  - Solutions that worked well on the other NICA experiments should be used
- System for logging and bookkeeping can be also common for the NICA experiments

Physics Metadata

- Contain information about
  - Datasets and data samples,
  - Provenance chains of processed data with links to production task configurations,
  - Cross-sections and configurations used for simulations,
  - Online filter and luminosity information for real and simulated data.
- Should collect a great part of its information from other IS's and provide links to data there
- As MC data generation started, development of this IS is actual
- Conventions for the runs and dataset naming have to be defined, as well as for software and MC configuration versioning

SPD Event Index

- SPD Event Index is a system designed to be a complete catalog of SPD events, real and simulated data
- SPD Event Index is a information system that should provide:
  - obtaining information about experimental events and simulated data by indexing data files containing information about these events
  - transfer of this information and write to databases
  - access to information for data processing and analysis programs via API
  - access to information to users through interactive and asynchronous interfaces.
- An entry for an event in EventIndex must contain the following fields:
  - Event ID, online filter solutions, UID of the RAW data file containing this event, ID of the dataset this file is included in
  - UIDs of files with reconstructed events (AOD) will be added when ready.
  - Important event parameters that can be used for classification and selection.

Event Index

- The estimated data flow from tens k up to 150 k events per second
- PostgreSQL DBMS is used for storage and processing of data
  - Various optimization methods were investigated to speed up the process of writing data to tables
- A convenient and efficient program interface was developed and implemented that performs data exchange uses the RESTful API.
- The front-end part of the client interface using the Angular framework
- For the server side was chosen a fastAPI: a light weighted asynchronous RESTful framework for Python
- For asynchronous task processing RabbitMQ and Celery were used to improve system performance.

Further development

- Further development of the Event Index project:
  - Development of user authorization and authentication, group access policies
  - API development (REST, Python, C++, ...)
  - Optimization of user request processing, with synchronous or asynchronous output of results, depending on the volume of requested data
  - Development of mechanisms for transmitting “EventIndex” data obtained by indexing files located on remote nodes of a distributed computing network
  - Supervisor - software for managing, collecting and importing data
  - Development of an EventIndex component monitoring system, with graphical representation of data based on popular platforms (Grafana, etc.)
- The implementation of these tasks will be carried out in parallel with the development of other Information Systems of the experiment.

Database of personnel and documents

- About 400 people are currently participating in the SPD project,
  - number of participants is expected to grow close to experiment start
- In order to organize effective cooperation with the shared use of computing and other resources, it is necessary to have IS for
  - handling of a personnel and organizations data
  - support for working groups: membership, access rights,
  - accounting of the contribution (if implemented)
  - generating reports broken down by various parameters
- Procedures for creating, approving and editing related documents
  - Registration and changes of membership in the collaboration
  - Creating and editing lists of groups and privileges
  - Inclusion in the author's lists

Database of publications

- SPD already produced some publication and conference reports
- An IS is necessary for preparing and publishing results
  - Tracking the progress of publications,
  - Organizing the exchange of messages between authors, reviewers and curators
  - Searching through documents
  - Tracking of SPD publications in external information systems.
  - Repports on the number of publications, broken down by authors, topics...
- Organization of presentations and reports at conferences and meetings:
  - Compiling a list of conferences and available reports
  - Organization of call for speakers and selection
  - Acceptance, review and approval of titles, abstracts and slides
  - Tracking the publication of proceedings

Identification and autorisation

- To identify employees, JINR authentication services should be used
  - Providing possibility of access by external employees who do not have an JINR account
  - Introducing group and robot accounts for use in automated tasks
  - A role and privilege management system should be implemented as well as group access policies
- Procedures for including users in groups and revoking membership
  - Information should be provided by the experiment to the JINR IT services
- The resources of the working groups should use a single authentication and authorization system

Contribution required

- If you willing to participate in the Database, API or user Interface development, please join
- As it was mentioned before, Information systems should be tailored to the needs of the project and to the nature and amount of data
- We need input both from hardware and analysis groups to create information systems fitting their need
  - If you created some database for your subsystem, please share your experience so it may be implemented elsewhere
  - If you have list of hardware (with parameters) that will be used in your system, contact us so we may adjust database and interface to it
  - The same if you system needs API to one of the information systems

Contribution needed

- What we desperately need from the detector subsystems
- More details about detector calibration procedures and constants
  - Details and naming convention for geometry description
- Input for the database design
  - Detector hardware database (detector elements, cabling etc)
  - Run database
  - Offline DB: Geometry versions, Calib&Align, Magnetic feld, …
- We need all it rather early to have time for proper design, performance tests and tuning