Software contribution from MIPT: Development of software systems for BM@N

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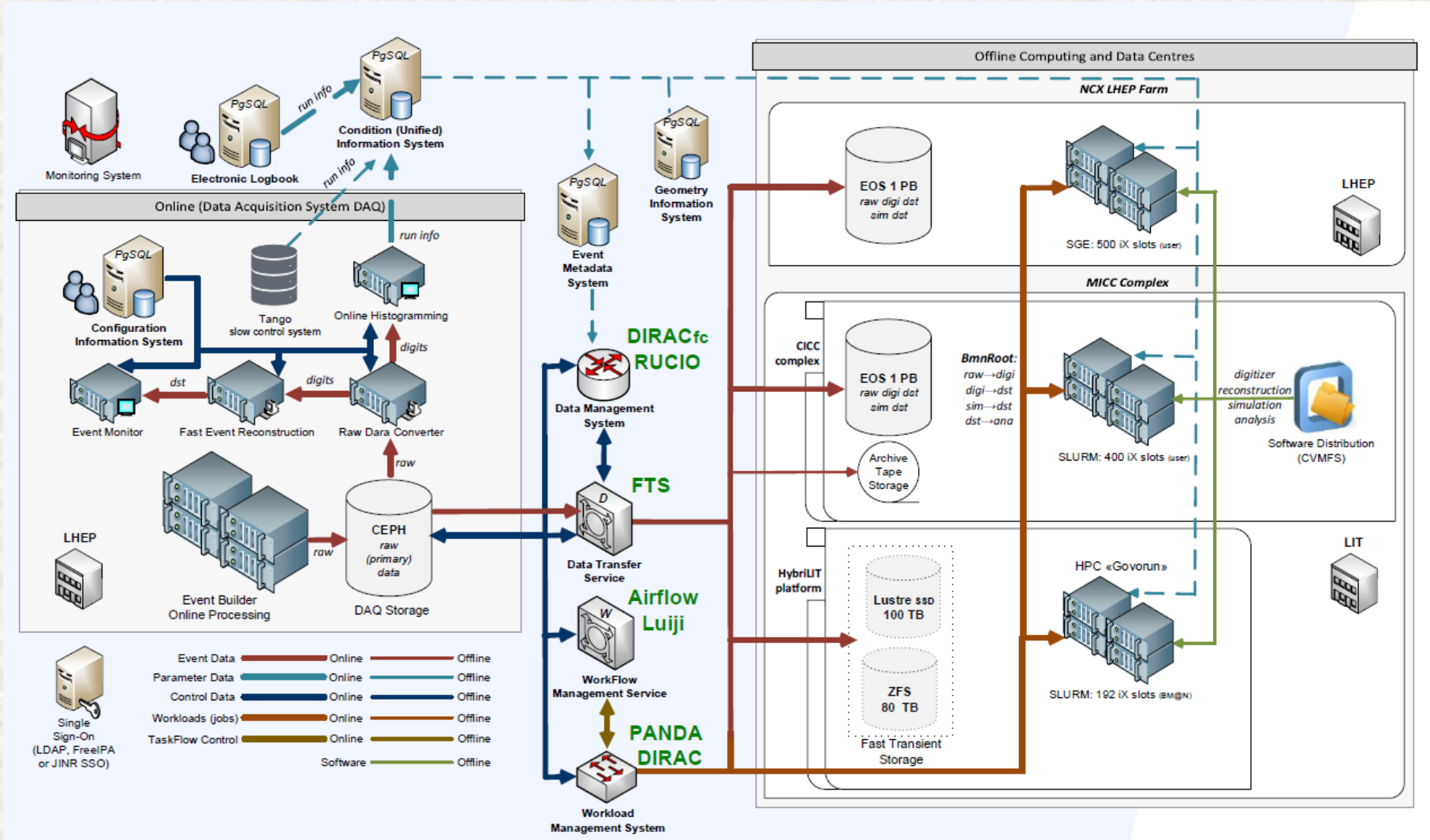
for the MIPT team

BM@N Software High-Level View



Recent Projects Summary

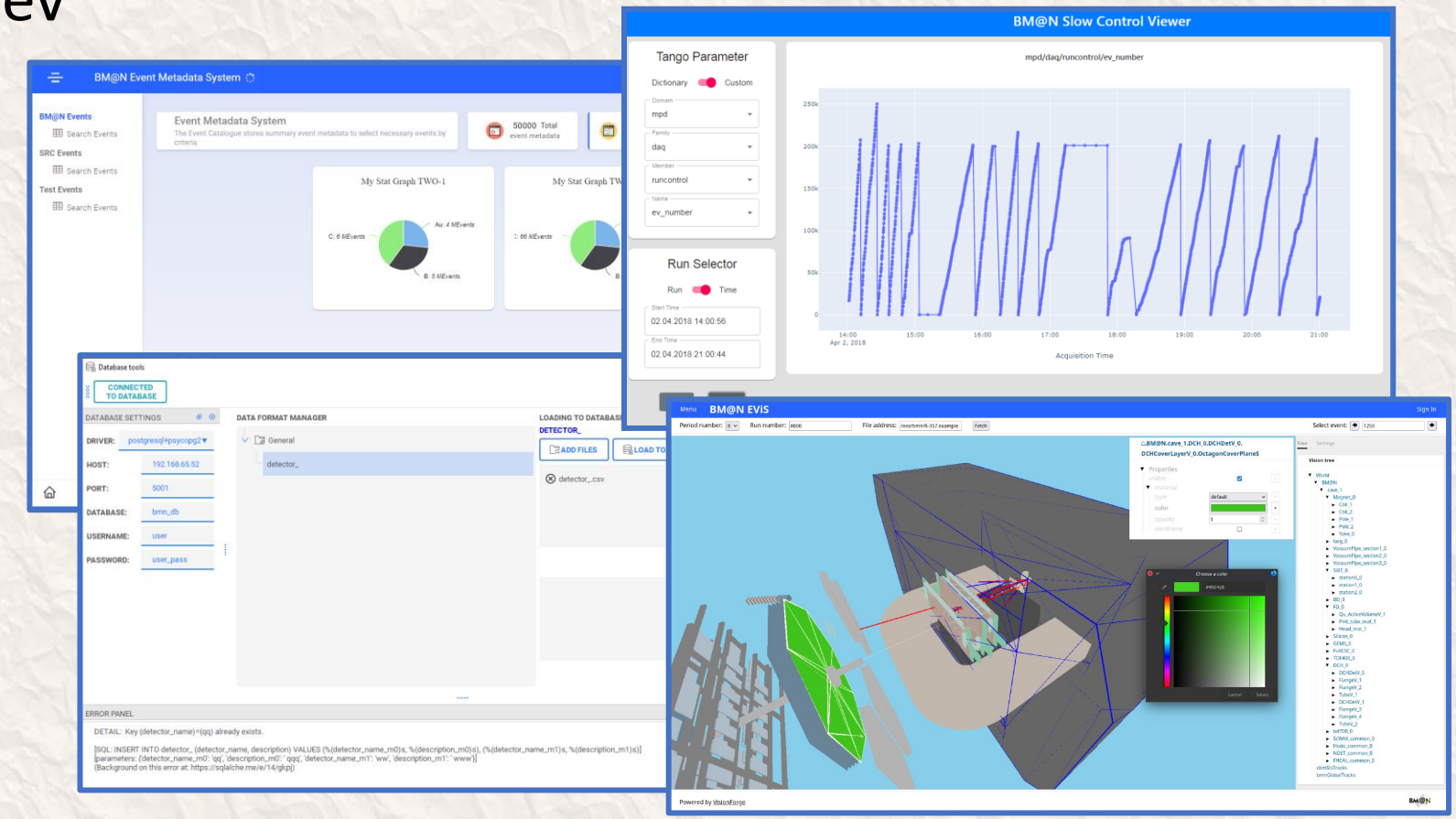
Project	URL
Development of Event Metadata System components, incl. automated recovery and automated deployment solutions	https://git.jinr.ru/nica_db/emd https://git.jinr.ru/pklimai/ems-stat-collector https://git.jinr.ru/pklimai/ems-deploy
Development of a service for monitoring software systems of the BM@N experiment	https://git.jinr.ru/pklimai/mon-service-deploy
Development of next-generation event display solution for BM@N, incl. reading ROOT files with event data and detector geometry	https://git.jinr.ru/idunaev/visionforge https://git.jinr.ru/pklimai/visapi
Development of REST API service for slow control system	WIP See also https://bmn-tango.jinr.ru

MIPT Software for BM@N Team

Supervision: T. A.-Kh. Aushev

Team members:

- P. Klimai
- A. Nozik
- I. Dunaev (student 5y)
- E. Blinova (student 3y)
- O. Nemova (student 5y)
- A. Degtyarev (PhD st. 1y)
- S. Efimov (student 6y)



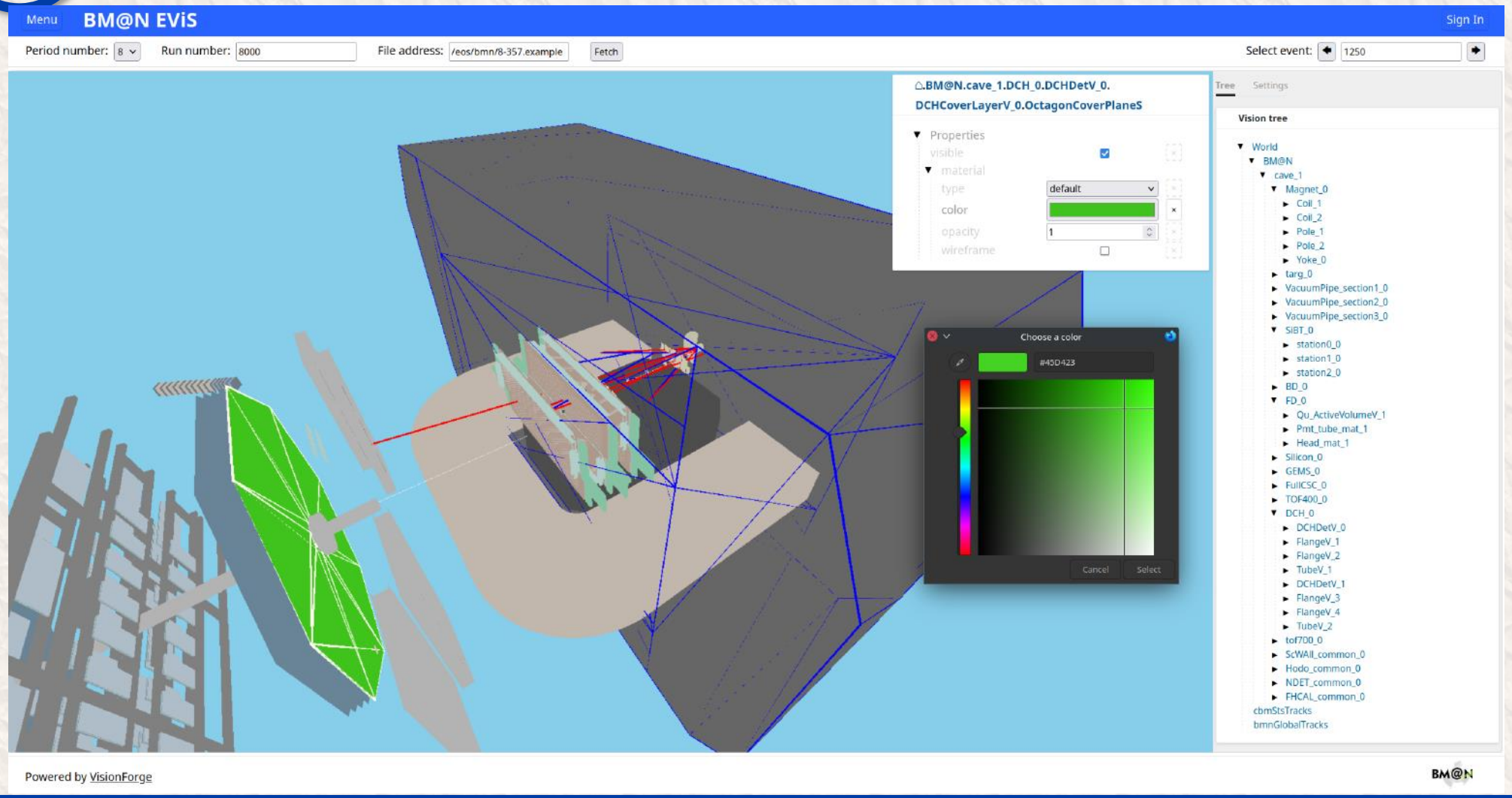
Development of Next-Generation Event Visualization Platform for BM@N

VisionForge Project

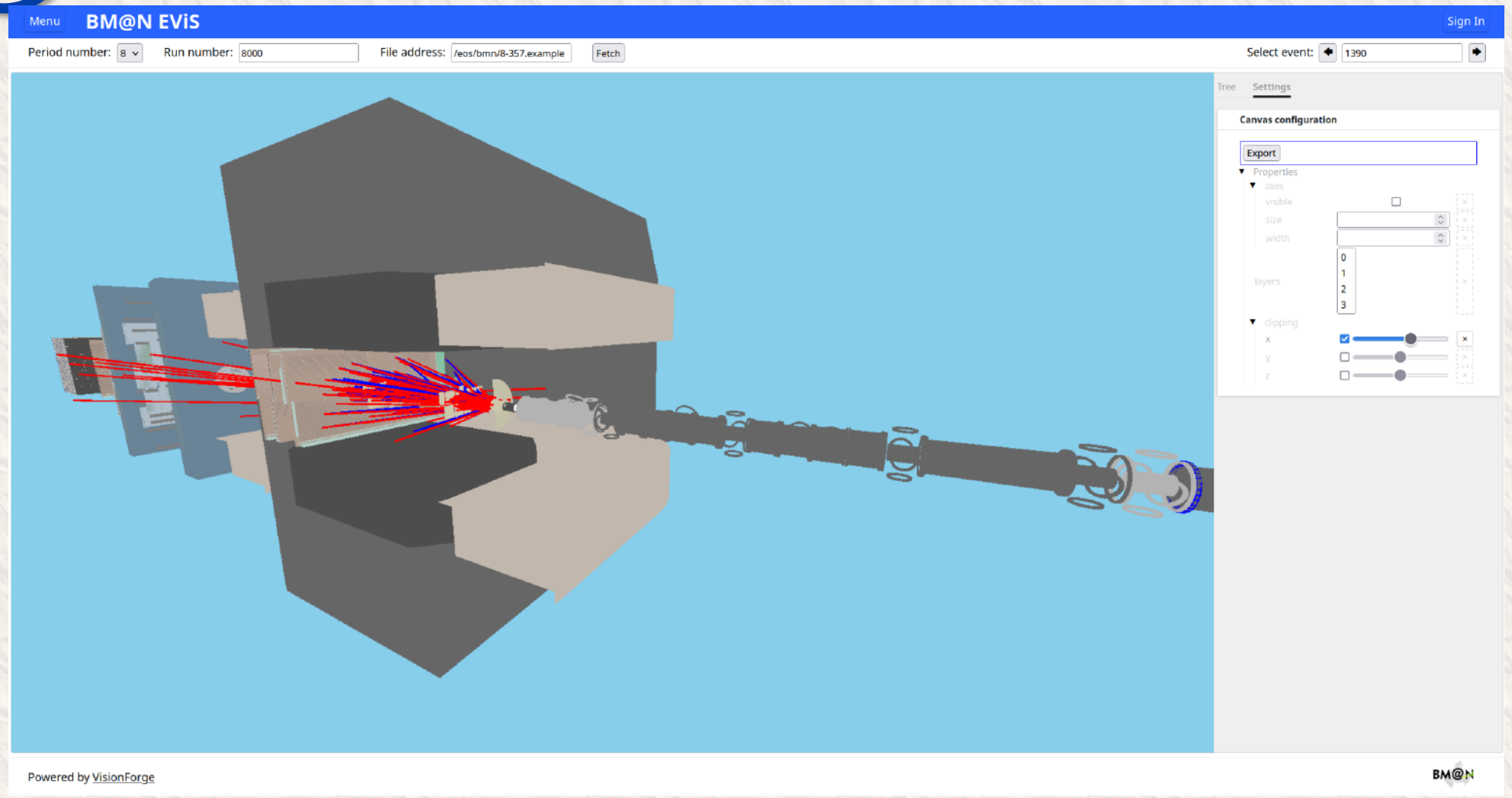
See also: **Alexander Nozik** — Unbearable lightness of data visualization in Kotlin full stack
https://www.youtube.com/watch?v=uT5j-xOXC3E&ab_channel=JPoint%2CJoker%D0%B8JUGru

- VisionForge – platform for creating next-gen visualization systems
  - Distributed dynamic system
    - Visualization model can be created on one node, transferred to another node and rendered there
    - Nodes can exchange **updates** to the model
    - Changing one element or attribute only requires sending this small change
  - Performance and optimizations
    - BM@N geometry model includes more than 400 000 elements
    - Geometry can be defined as **prototype** that is used by a set of objects, in this case rendering is simplified – only required properties can be changed if needed
  - Using Kotlin-Multiplatform

Geometry, tracks, scene graph, tuning



Configuration export example

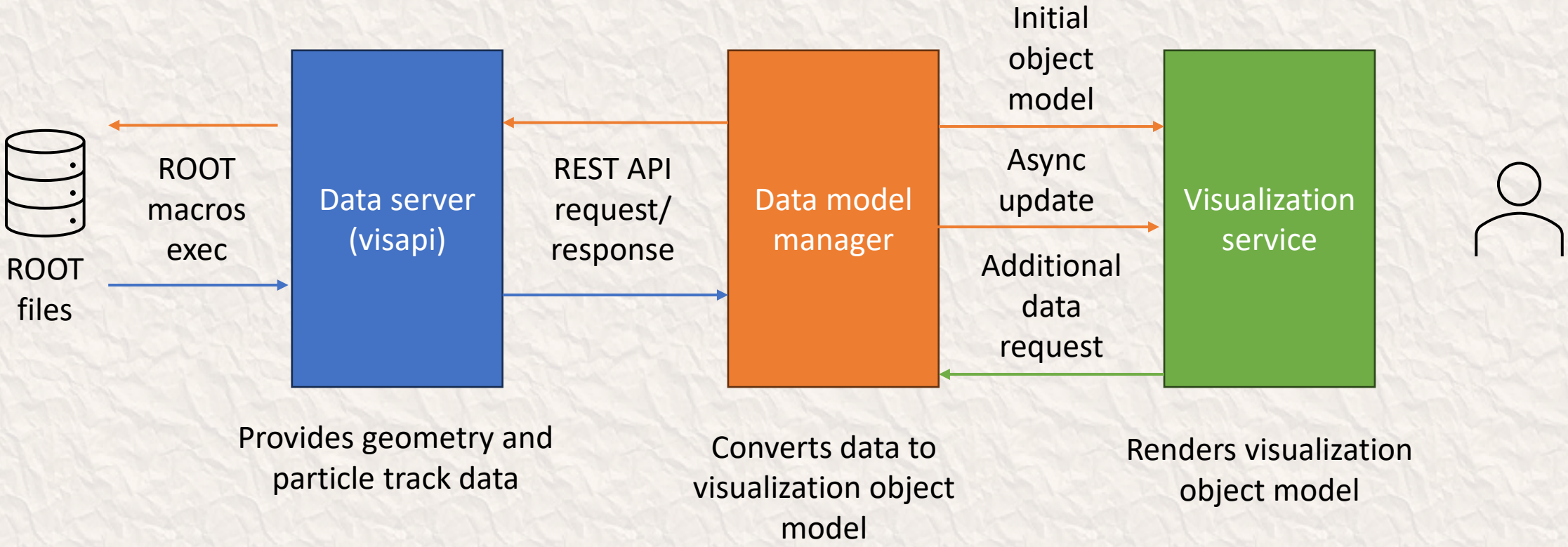


CERN ROOT integration

Possible approaches:

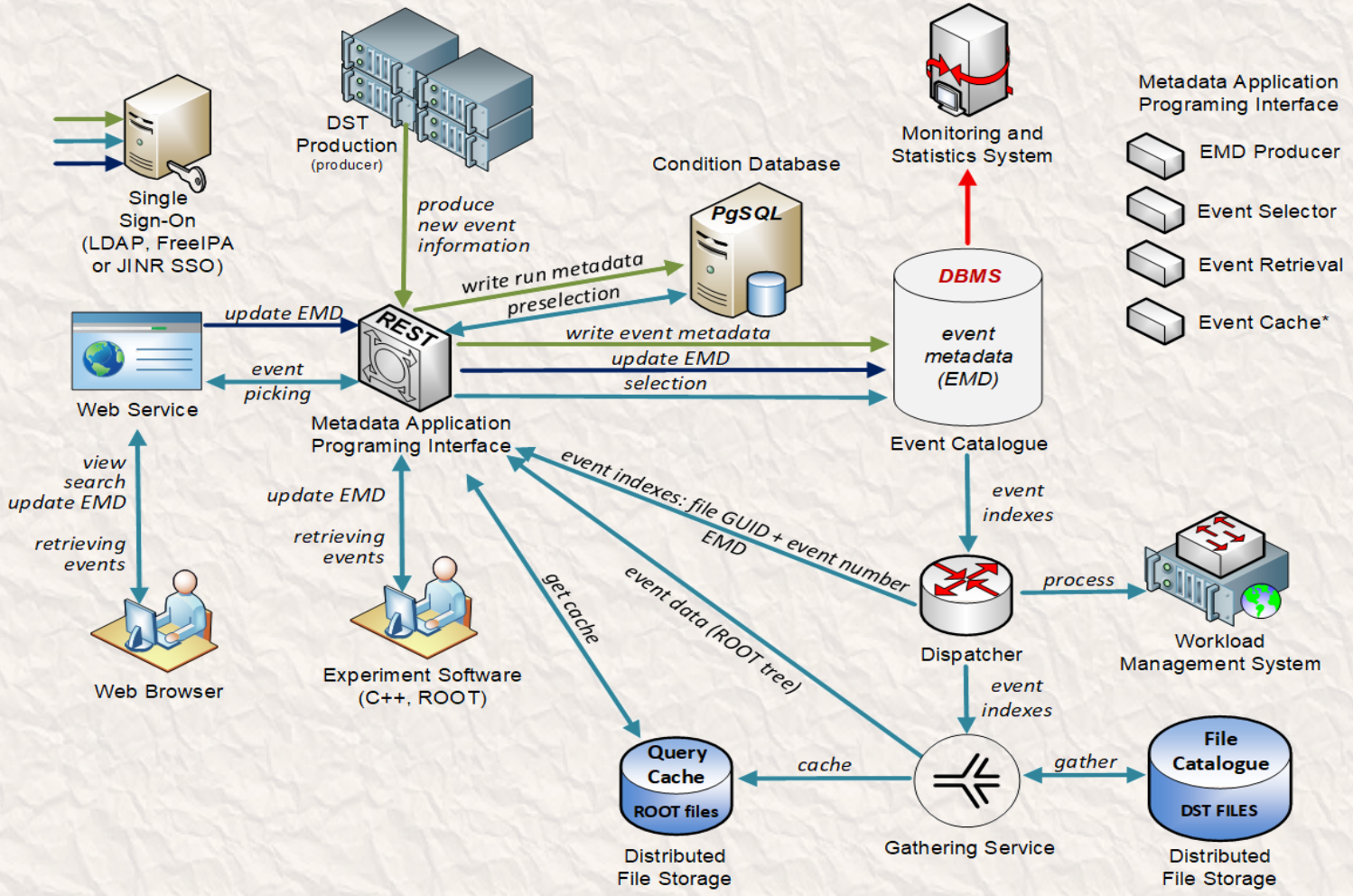
- Read ROOT format and convert it to Vision Object Model (**KRootIO** project)
- Create a ROOT plugin that converts TGeoManager to VOM on the ROOT side.
- Convert TGeoManager to JSON via TBufferJSON (**visapi** project)

General scheme of operation of the VisionForge visualization system when displaying data from ROOT files



Development of Event Metadata System components

BM@N Event Metadata System



- Event Metadata System
  - Event Catalogue is based on PostgreSQL
  - Integrates with BM@N Condition database
  - REST API and Web UI developed based on Kotlin multiplatform
  - Configurable to support different metadata
  - ROOT macro to write BM@N events in the catalogue
  - Role-based access control implemented
  - Monitoring

For more details:
E. Alexandrov, I. Alexandrov, A. Chebotov, A. Degtyarev, I. Filozova, K. Gertsenberger, P. Klimai and A. Yakovlev, "Implementation of the Event Metadata System for physics analysis in the NICA experiments", J. Phys.: Conf. Ser. 2438, 012046 (2023).

New REST API scheme for EMS

- The new scheme is unified for different BM@N Information Systems

GET
POST
DELETE

https://bmn-event.jinr.ru/event_api/v1/event?

run_number=3950:4000&beam_particle=Ar&target_particle=Al
energy=3.16:3.18&target_particle=SRC%20Lead

HOSTNAME / SERVICE / VERSION / ENTITY?parameter_set

HOSTNAME=https://bmn-[SYSNAME].jinr.ru

SERVICE=[SYSNAME]_api

VERSION=v1 (v2…)

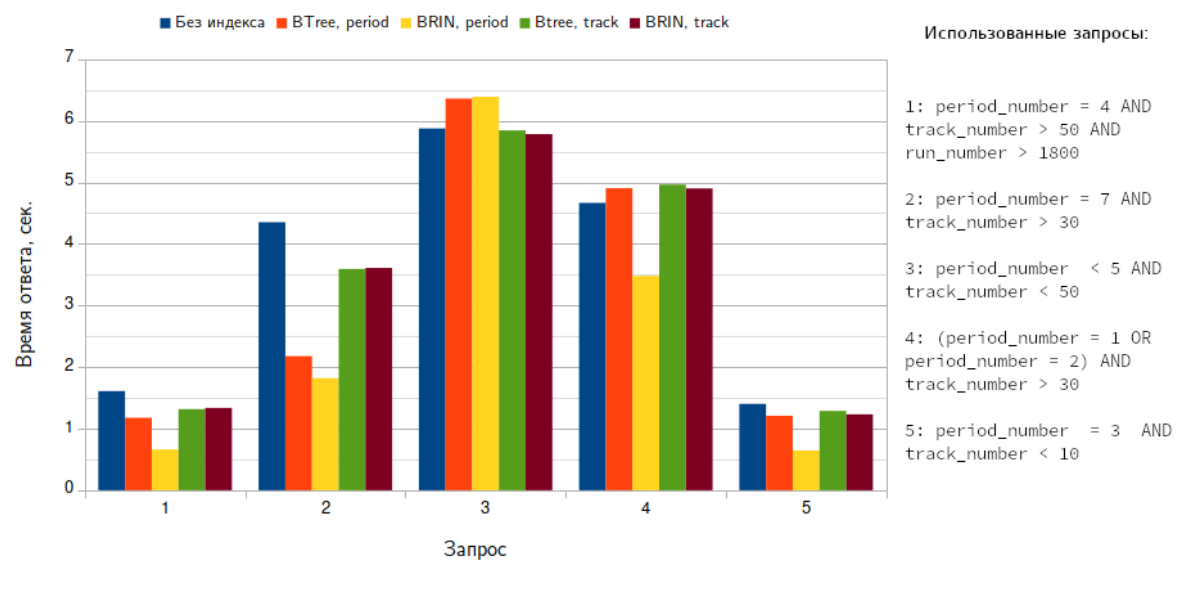
ENTITY=tablename without last '_' (if present)

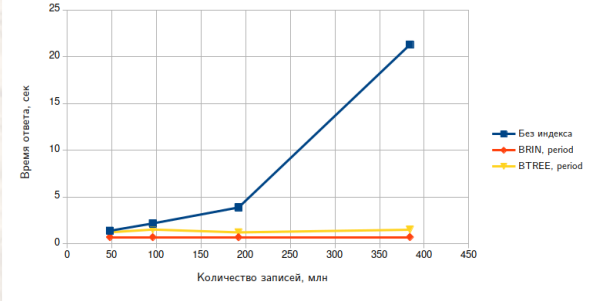
parameters are separated by '&'
ranges: min:max → >=min AND <=max
min: → >=min :max → <=max

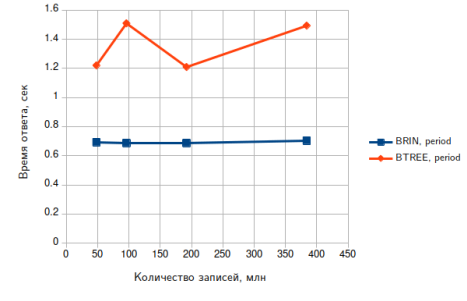
For the Unified Condition Database (UniConDa), SYSNAME = uniconda
For the Event Metadata System (EMS), SYSNAME = event

Event Catalogue Database Optimization

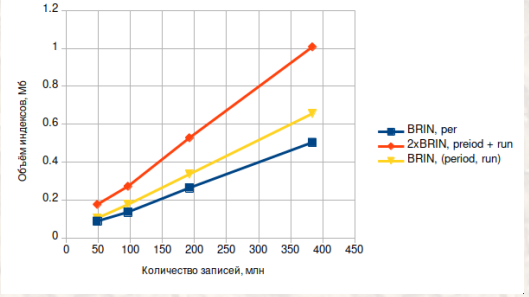
- Measurements with test database instance are shown (50M events)

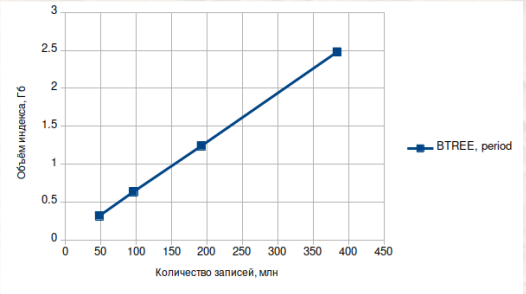






- Adding more periods to test database





- Размеры индексов на диске

- BRIN vs. BTREE
  - Overall, BRIN (Block Range Index) works better for indexing columns having some natural correlation with their physical location within the table

Statistics Collection

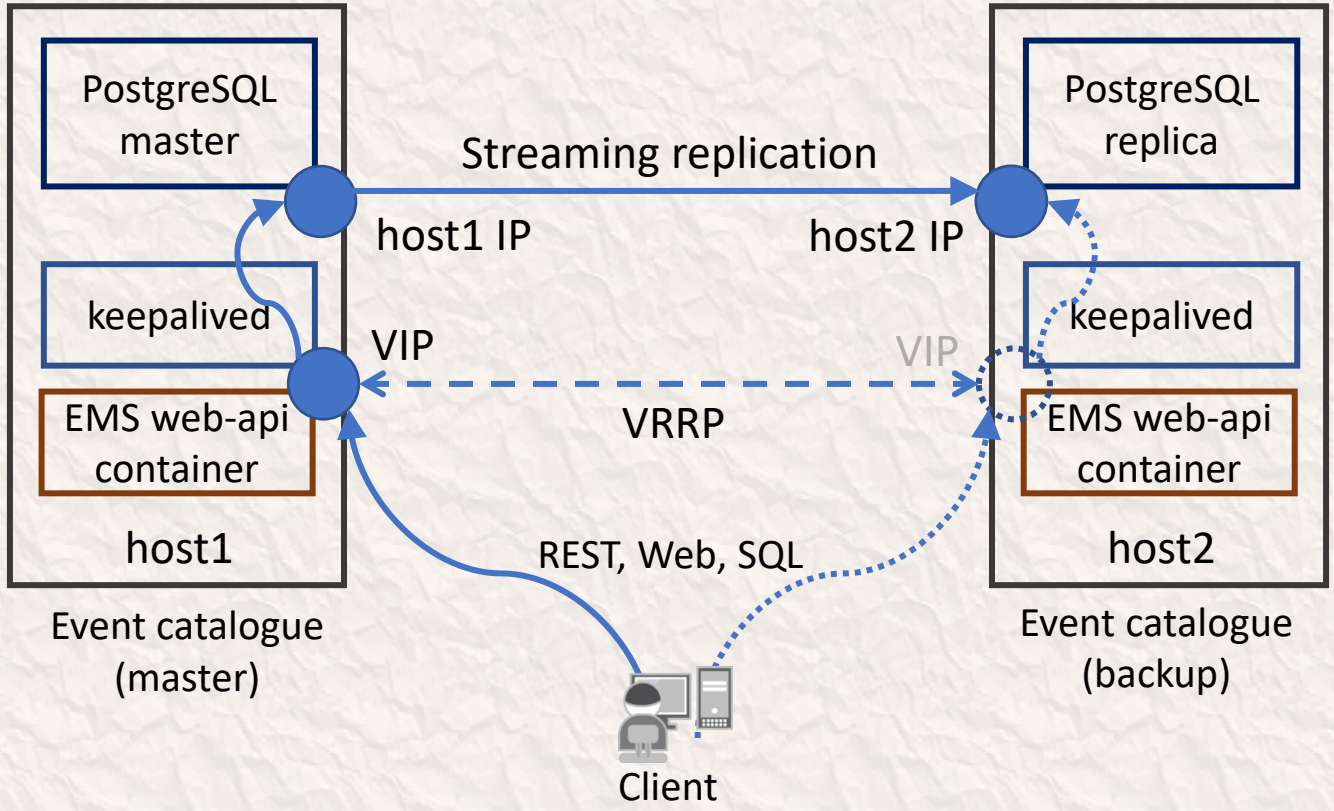
- Statistics collection script for EMS Event Catalogue
  - Statistics is saved to database and displayed in Web-interface
  - Script run to be scheduled periodically

High Availability – Task

- Need for HA
  - EMS as well as other IS are essential for timely obtaining physical results of the experiment
  - From client point of view, connection must be initiated to single IP / domain name
    - We do not want to ask client to keep several addresses like primary/secondary ones
  - Considering 2 to 1, active/passive redundancy
  - Need to avoid split brain and no brain scenarios

HA and Automatic Deployment for EMS

- After running Ansible playbooks:

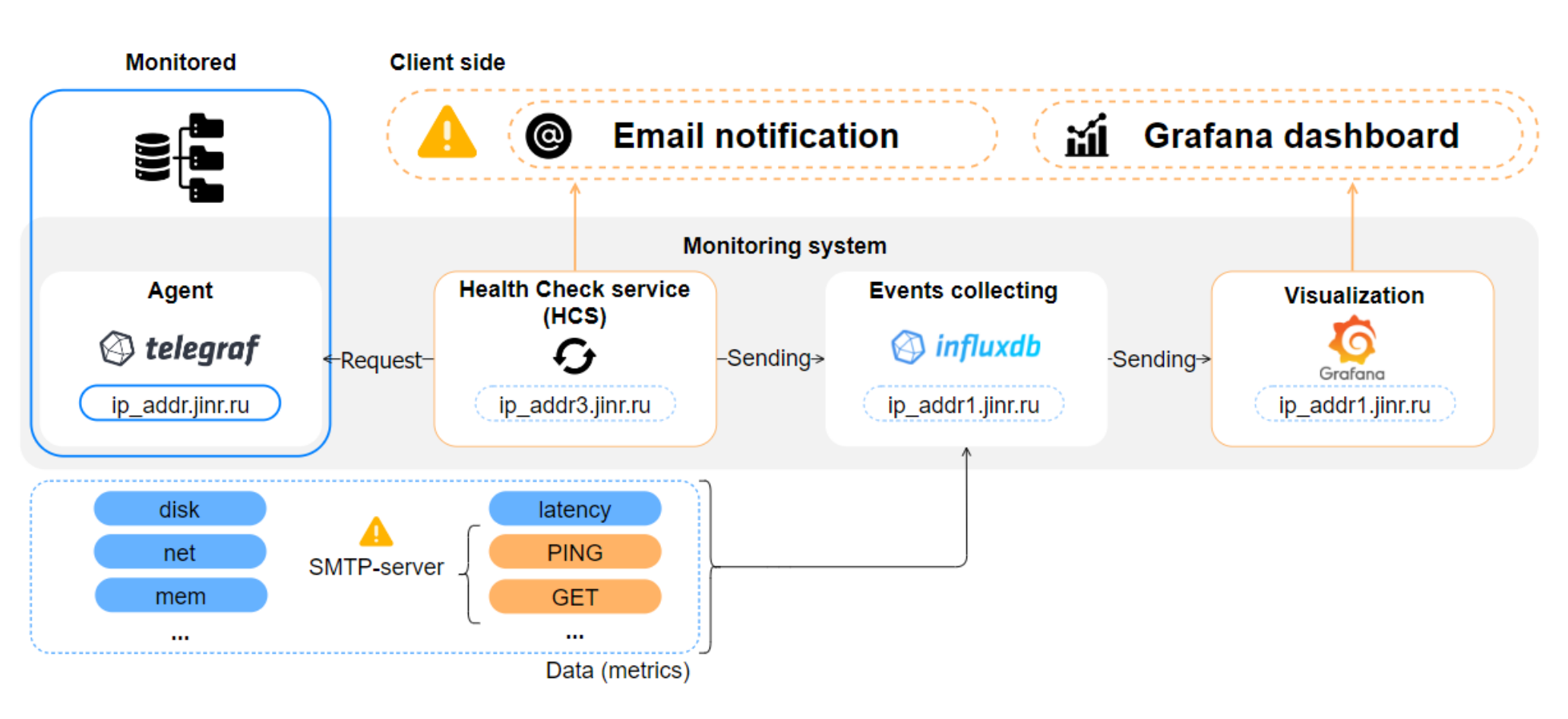


Development of a service for monitoring software systems of the BM@N experiment

Monitoring Service – Task

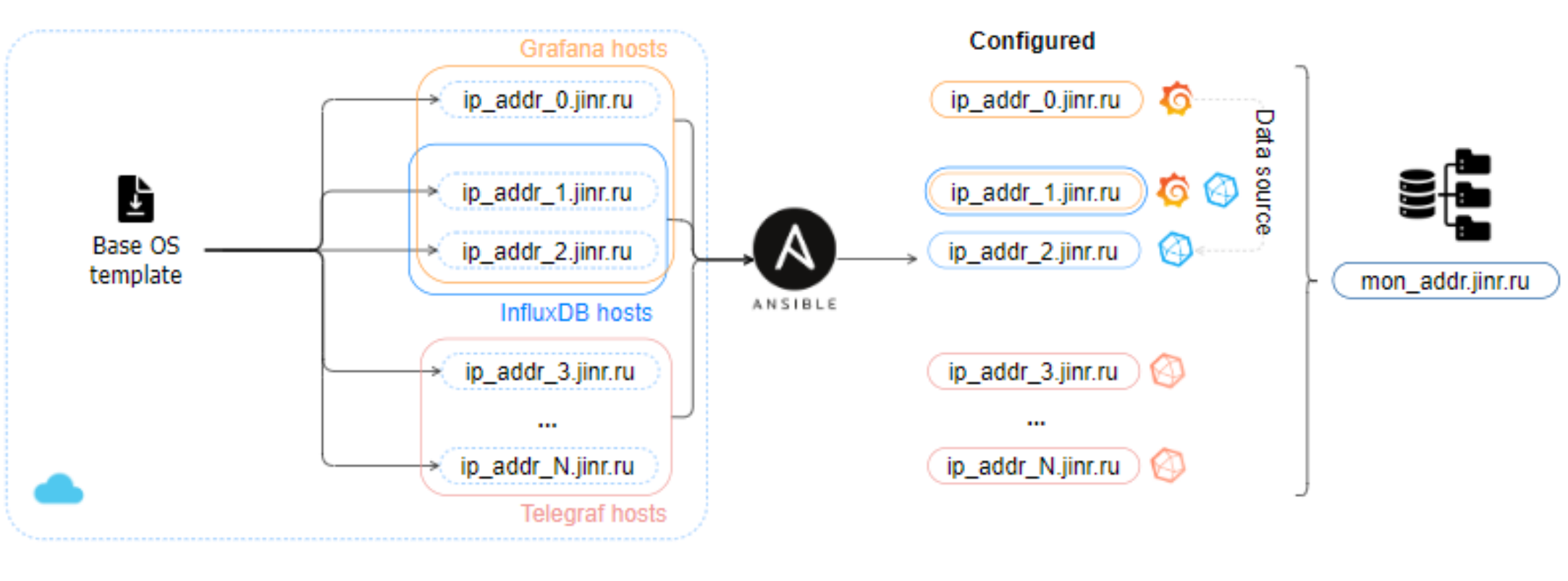
- Monitoring Service Features
  - Ping, PG-SQL, or HTTP request to check server reachability
  - Usage of Disk, CPU, Memory, etc. to check health
  - Configurable via JSON file
  - Email notifications
  - Telegraf as host agent
  - InfluxDB for metric storage
  - Grafana for visualization and additional alerting
- Automatic Deployment
  - Ansible-based
  - JSON Dashboards and Alarms auto-generated
  - Software components provisioned automatically

Monitoring Service Stack and Architecture



Automatic Deployment

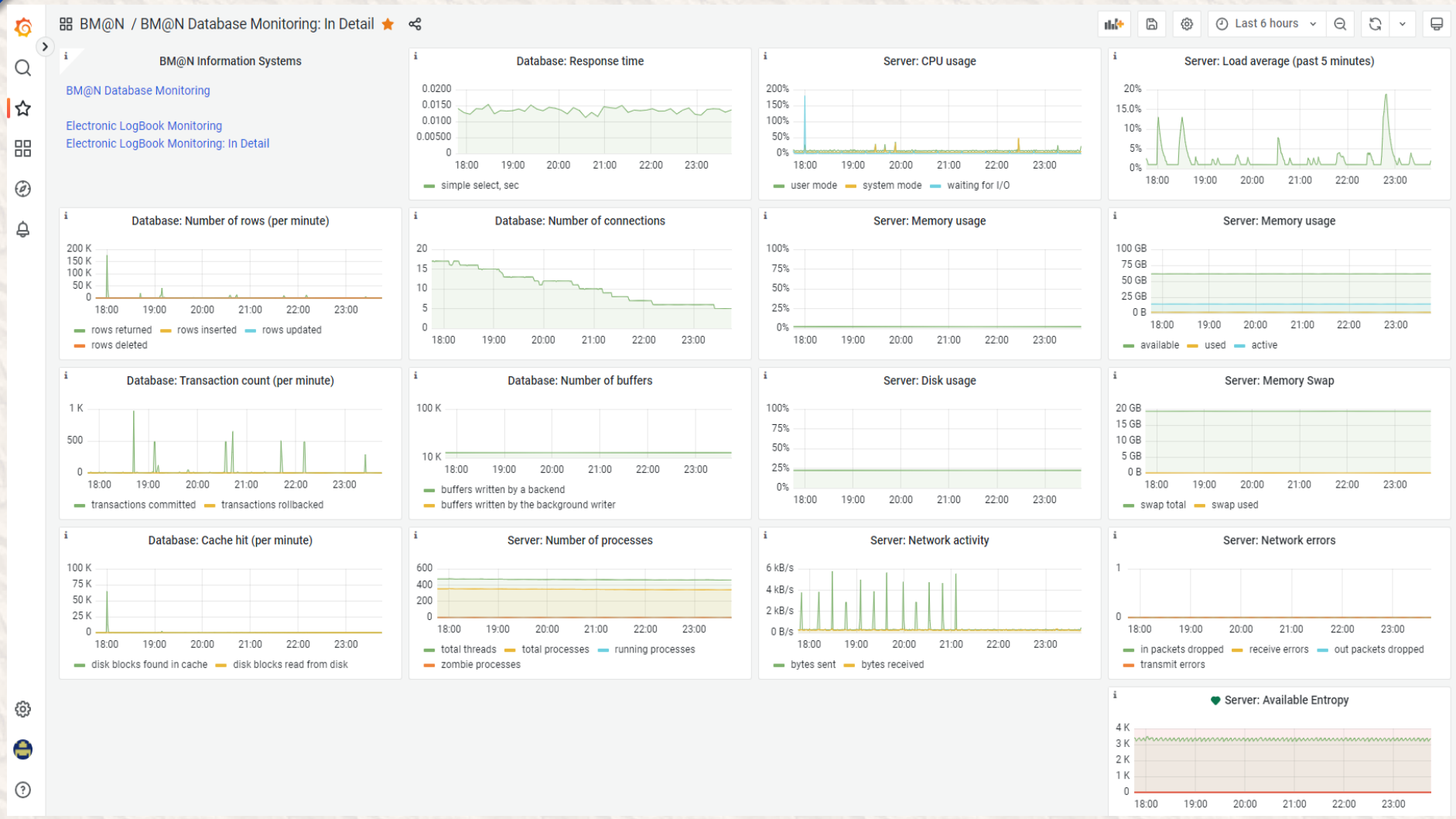
- Ansible Playbooks are used to deploy all service components



Configuration File Example

```
{
  "PING": {
    "server1": {
      "IP": "192.168.65.116",
      "NOTIFY": "mail1.jinr.ru"
    },
    "router1": {
      "IP": "10.254.0.41",
      "NOTIFY": "mail2.jinr.ru"
    }
  },
  "DATABASE": {
    "server1": {
      "SERVER": "192.168.65.116",
      "DBMS": "PGSQL",
      "PORT": 5432,
      "DBNAME": "testdb",
      "USER": "testuser",
      "PASS": "***",
      "NOTIFY": "mail3.jinr.ru"
    },
    "server-centos2": {
      "SERVER": "192.168.65.62",
      "DBMS": "PGSQL",
      "PORT": 5432,
      "DBNAME": "books_store",
      "USER": "bookuser",
      "PASS": "***",
      "NOTIFY":
"mail5.jinr.ru,mail6.jinr.ru"
    }
  },

  "OUTPUT": {
    "DBMS": "INFLUXDB",
    "SERVER": "192.168.65.52",
    "PORT": 8086,
    "DBNAME": "pgsqltest",
    "USER": "influx",
    "PASS": "***",
    "NOTIFY":
"mail1.jinr.ru,mail2.jinr.ru"
  },

  "INTERVAL_SEC": 60,

  "MAIL": {
    "SERVER": "smtp.yandex.ru",
    "PORT": 587,
    "USER": "***",
    "PASS": "***"
  },

  "LOG": "mail1.jinr.ru,mail2.jinr.ru",
  "NAME": "Monitoring Service"
}
```

Monitoring Service View Example



https://mon-service.jinr.ru

Thank You!