MPD

Software & computing development status

ROGACHEVSKY Oleg
for MPD collaboration

MPD Coll. meeting
April 24, 2020
Dubna
Nuclotron based Ion Collider fAility

- Beams: from $p$ to $Au^{79+}$
- Luminosity: $10^{27} \text{ cm}^{-2}\text{s}^{-1}$ (Au), $10^{32}$ ($p$)$^\uparrow$
- Collision energy: $\sqrt{s_{NN}} = 4 - 11 \text{ GeV}$, $E_{lab} = 1 - 6 \text{ AGeV}$
MPD experiment: 1 stage
MPD.jinr.ru → mpdroot.jinr.ru

THE MPD EXPERIMENT
MPD (Multi-Purpose Detector) experiment on ion collisions will operate at the storage rings of the NICA facility.

THE MPDROOT
MpdRoot is the off-line software framework for simulation, reconstruction and physics analyses of the simulated or experimental data for MPD experiment. It is based on the FairRoot and ROOT packages and uses their capabilities for building all necessary applications.
mpdroot.jinr.ru → Software → Mpdroot → Git access
mpdroot.jinr.ru → Software → Mpdroot → Git access

![GitLab screenshot](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Last commit</th>
<th>Last update</th>
</tr>
</thead>
<tbody>
<tr>
<td>bbc</td>
<td>new FairSoft release; FairRoot was separated from MpdRoot</td>
<td>2 years ago</td>
</tr>
<tr>
<td>bmd</td>
<td>fixed conflict mcstack with fairroot examples</td>
<td>3 months ago</td>
</tr>
<tr>
<td>clustering</td>
<td>new FairSoft release; FairRoot was separated from MpdRoot</td>
<td>2 years ago</td>
</tr>
<tr>
<td>cmake</td>
<td>NicaFemto update 1</td>
<td>3 months ago</td>
</tr>
<tr>
<td>config</td>
<td>change branch name cbmsim-&gt;mpdsim</td>
<td>5 months ago</td>
</tr>
<tr>
<td>cpc</td>
<td>fixed conflict mcstack with fairroot examples</td>
<td>3 months ago</td>
</tr>
<tr>
<td>dch</td>
<td>new FairSoft release; FairRoot was separated from MpdRoot</td>
<td>2 years ago</td>
</tr>
<tr>
<td>emc</td>
<td>fixed conflict mcstack with fairroot examples</td>
<td>3 months ago</td>
</tr>
<tr>
<td>etof</td>
<td>fixed conflict mcstack with fairroot examples</td>
<td>3 months ago</td>
</tr>
<tr>
<td>eventdisplay</td>
<td>fixed conflict mcstack with fairroot examples</td>
<td>3 months ago</td>
</tr>
<tr>
<td>ffid</td>
<td>Adding ffid detector</td>
<td>1 week ago</td>
</tr>
<tr>
<td>fsa</td>
<td>new FairSoft release; FairRoot was separated from MpdRoot</td>
<td>2 years ago</td>
</tr>
</tbody>
</table>
MpdRoot is the off-line software framework for simulation, reconstruction and physics analyses of the simulated or experimental data for MPD experiment. It is based on the FairRoot and ROOT packages and uses their capabilities for building all necessary applications.

THE MPD EXPERIMENT

MPD (Multi-Purpose Detector) experiment on ion collisions will operate at the storage rings of the NICA facility.
mpdroot.jinr.ru → Software → Databases → MPD database

LHEP NICA cluster
LIT EOS file system
## Event generators & reco data databases in HybriLIT farm

<table>
<thead>
<tr>
<th>Generator</th>
<th># of events M</th>
</tr>
</thead>
<tbody>
<tr>
<td>QGSM</td>
<td>4</td>
</tr>
<tr>
<td>UrQMD</td>
<td>~ 15</td>
</tr>
<tr>
<td>PHSD</td>
<td>4</td>
</tr>
<tr>
<td>vHLLE_UrQMD</td>
<td>~ 4</td>
</tr>
<tr>
<td>3FD(Theseus)</td>
<td>5</td>
</tr>
<tr>
<td>Hybrid UrQMD</td>
<td>3</td>
</tr>
</tbody>
</table>
# Detectors simulation status

GitLab repository: https://git.jinr.ru/nica/mpdroot

<table>
<thead>
<tr>
<th>Detector</th>
<th>MC Geometry</th>
<th>Hits/digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPC</td>
<td>Ver. 8 (2018)</td>
<td>hitproducer</td>
</tr>
<tr>
<td>TOF</td>
<td>Ver. 7 (2016)</td>
<td>hitproducer</td>
</tr>
<tr>
<td>ECAL</td>
<td>Ver. 8 (2018)</td>
<td>hitproducer</td>
</tr>
<tr>
<td>FHCal</td>
<td>Ver. 2 (2018)</td>
<td>hitproducer</td>
</tr>
<tr>
<td>ITS</td>
<td>Ver. 3 (2015)</td>
<td>hitproducer</td>
</tr>
<tr>
<td>FFD</td>
<td>Ver. 6 (2020)</td>
<td>hitproducer</td>
</tr>
<tr>
<td>BBC</td>
<td>Ver. 2 (2019)</td>
<td>MC points</td>
</tr>
</tbody>
</table>
Event Displays v.0.4 for Run Control System & Detectors Control System

based on:
TPC geometry ver.8

- Drawing

- Root geometry

35 000 nodes
TPC Electronics Simulation

Each board:
---------------------------------
-------------------------
2+1 mm Copper
---------------------------------
-------------------------
3,5 mm Textolite

Flat cable:
---------------------------------
-------------------------
0,1+0,1 mm Polypropylene Insulation
---------------------------------
-------------------------
0,15 mm Copper wire

Connector to Pads plane:
---------------------------------
Plastic + Air gap
TPC material budget

Looking in TPC detector with geantino

Material budget for all MPD detectors

Material budget for TPC
TPC gas and ROC properties

Garfield++
Version 2019.3

Drift view
ROC chamber

Gate
Cathode
Anode
Pad Plane
FHCal

FFD
TPC laser calibration

Half of TPC

Laser “planes” 4
Micro-mirrors bundles per plane 4
Beams from micro-mirrors bundle 7
Laser “tracks” 224
TPC alignment (preliminary)

MC points on the border of sectors

Rikhvitsky V.S. method
The MPD beam-beam monitoring system is considered as a part of level-0 trigger. Its time resolution is expected to be around 30 ps. To fulfill the trigger requirements the BE-BE geometry consists of two hodoscope detectors, each located 2 meters away from the interaction point, at opposite sides. Each detector consists of an array of 162 hexagonal plastic scintillator cells arranged in six concentric rings. It covers a pseudorapidity range of $1.9 < |\eta| < 3.97$.

The BE-BE's trigger signal will be useful to generate a trigger logic to identify and discriminate beam-beam events, either for minimum bias or with a given centrality, from background and beam-gas interactions.
Computing structure of NICA complex

1. Mexico
2. Poland
...
Example communication LHEP and LIT sites of the NICA complex on two independent optical line

The core of the network system, switching will be performed on the Cisco Nexus 9504 4 x 100Gbps
LHEP clusters

NICA on-line cluster

- Mean data flow 10 Gb/c
- Disk space 0.5 PB for 24 h.
- 100 Gbps

10 PB Disk space
5K CPU
LIT: off-line cluster for NICA

LIT Network center

Up to 10 PB/year

Supercomputer “GOVORUN”

ultrafast disk memory system

LIT type robot
Super computer GOVORUN

GOVORUN tasks distributions for NICA
Computing for MPD in HybriLIT

Data storage organization

“Hot” Data Storage
- Lustre FS

“Cold” Data Storage
- EOS FS
- ZFS FS

Data flow organization

Particles Generator
- internal
- external

MpdRoot
Simulation & reconstruction framework

Experiment

Data Management System
DIRAC Interware

The DIRAC Interware is an open source software which provides various interfaces, services and tools for the integration of distributed heterogeneous computing and storage resources.

DIRAC is “All in one” tool. It provides:

- Workload Management
- Data Management
- Workflow management
- Resource management
- Accounting
- Monitoring

DIRAC development was originally started by LHCb experiment. Later it became open source general purpose tool developed by international consortium of developers from: LHCb, Belle2, BES-III, CLIC, ILC, and others.

DIRAC is installed and studied in JINR since 2016
JINR computing resources integration

The DIRAC Interware is a software which provides various interfaces for the integration of distributed heterogeneous computing and storage resources. Instead of using all JINR storage and computing resources individually, DIRAC allows processing of large amounts of data through unified single system.

Monte-Carlo for MPD were successfully performed on the integrated system. It works right now. Jobs use Tier-1, Tier-2 and Govorun via DIRAC. Govorun was added recently to DIRAC. JINR and Member-States cloud resources have been tested and ready to accept jobs. NICA Cluster is the next on the list.

~120000 MPD Jobs done using DIRAC

- Tier1(29%): 33496
- Tier2(56%): 65654
- Govorun(15%): 18182

Running Running Tests done Running To be included
Current & Future Tasks

- Manpower
- Boost clustering in detectors,
- Boost tracking,
- Detectors alignment and calibrations,
- Cloud computing for the MPD experiment,
- Virtual organisation for MPD in GRID,
- ....

rogachevsky@jinr.ru
Thank for your attention

You are welcome