Status of the MPD project

Viacheslav Golovatyuk
(JINR)
MPD 1st stage

- $2\pi$ acceptance in azimuth
- 3-D tracking (TPC)
- Powerful PID (TPC, TOF)
  - $\pi/K$ up to 1.5 GeV/c,
  - $K/p$ up to 3 GeV/c,
- Low material budget
- High event rate (up to ~ 6 kHz)

V. Golovatyuk, Status of the MPD, IVth MPD Collaboration Meeting, Warsaw, October 21-25 2019
Milestones for the next year

1. Subdetectors assembling and testing
2. TPC assembling and installation
3. Solenoid installation and switching on
4. Magnetic Field measurements
5. Support Frame production and installation
6. Electronics cooling system
7. Electronics Platform
8. Beam pipe - high vacuum ($10^{-10}$ torr)
Magnet fabrication: ASG (Genova) & Vitkovice HM

Before to transport Solenoid to JINR a low temperature checks with a liquid nitrogen has to be performed.

All elements of Magnet Yoke are at JINR

Solenoid assembling

yoke control assembly at HM Vitkovice
Mapper for Magnetic Field measurements

\[
\left| \frac{B_r}{B_z} \right| = 5.2 \times 10^{-4}
\]

\[
\int_{-1700}^{1700} \frac{B_r}{B_z} \, dz \leq 1,5 mm
\]
MPD Dubna
Alignment of Magnetic Field Measurement Bench in B164 (CERN)
Measurement date: 15.05.2019
MPD Time Projection Chamber

Testing FEC v1.0 finished  
Receive SAMPA V4 chips at Dubna 4500 (all)  
32 preproduction version 2.1 FE Card assembled (1/2ROC)  
Testing of half ROC equipped with FE Cards  
Production FE Cards for 1 ROC and Testing 2020  
Instrumentation and test ROC 2, 3, 4  
Production FE Cards for the first 10 ROCs (Total 14)  
Production FE Cards for the second 10 ROCs (Total 24)
Cooling system for TPC

Total power \( P \sim 10 \text{ kW} \)
System type – low pressure (NO water leak)
Water in: \( T=18 \text{ degree} \), expected water out: \( T=(25-27) \text{ degree} \)
Water flow=(40+60 )m3/h -> up to 1 m3/min
N of controlled cooling channels – about N=72pc
Requirements for TPC gas volume temperature stabilization: \( T=(T_0 +/- 0.25) \text{ degree} \)
So far 20% of all mRPCs are assembled. At the end of October 2020 all mRPCs will be assembled. Problems with leaks of gas box has been solved. Assembled half sectors of TOF are under Cosmics tests.
Electromagnetic Calorimeter (ECAL) for Multi Purpose Detector (MPD)

ECal – THU – Tsinghua University, Yi Wang
SDU – Shandong University
HU – Huzhou University Fuqing Wang

There is expectation that ECal modules assembling (75%) in China will be financed beginning 2020.
Production of 25% modules in Russia is going on according to the Plan

Prototype of one module
Support Frame for detectors inside of the Solenoid

The structure of Support Frame is made of carbon fiber which allows for deformation less than 3 mm under load with detectors (~80 T). The thickness of the walls is 2-4 mm.

Producer - The Central Research Institute for Special Machinery, Khotkovo, Moscow region is a leading Russian enterprise in design and production of structures on the basis of advanced polymer composite materials for rocket & space engineering, transport, power, petrochemical machinery and other industries.

- design is ready,
- mechanical strength calculations are finished
- the contract with Company on construction of the Support Frame is under preparation
- according to schedule the Frame will be transported to Dubna in November 2020
- Representatives of the Company will participate in the process of installation of Support Frame into MPD and its alignment
- Electronics platform have 4 levels with 8 racks on each level
- Each Rack provides cooling, fire safety and radiation control system

- Cable ducts connect detectors inside of MPD and Electronics Platform

Team from WUT (leader - Marek Peryt) is a good example when group takes a full responsibility for design and construction the system

The mechanical part of the Platformed is ready
MPD Cosmic Ray Detector (MCORD)
NCBJ, Swerk - WUT, Warsaw (Poland)
18 scientists + 12 engineers

As soon as we plan to start tests of MPD subsystems before Collider operation, the Cosmic Ray Detector will be requested for Commissioning and tests of the MPD. The signals from MCORD will be used for TPC and TOF tests after their installation. We’ll need the elements of MCORD (as scintillation panels with readout electronics) as soon as March 2021.

Cosmic Ray Detector consists of plastic scintillators with SiPM (Fototubes) light converters

5. MCORD Detector

**SCINTILLATORS**
- Number of scintillators: 660 pcs
- Dimensions of scintillators: 95x25x1500 [mm]
- Dimensions of detector: 100x30x1554 [mm]
- Scintillators are placed in the rectangle profile: 10x30x2.5 [mm]
- Weight of detector: 6.5 kg
- Material of scintillators casing: Aluminum alloy

**MODULES**
- Number of detector in one module: 18
- Number of Modules: 28
- Dimensions of module: 730x90x4700 [mm]
- Weight of one module: 150 kg

**SiPM/MMPC**
- Number of SiPMs (Channels): 1320
- Number of SiPMs (with two fibers): 2640

**RESOLUTION**
- Position resolution: In X axis – up to 5 cm, In Y axis – 5-10 cm
- Time Resolution – about 300-500 ps
- Number of events (particles): about 100-150 per sec per m2
- Calculated Coincidence factor: about 98%
Forward Hadron Calorimeter (FHCal)
Leaders: A.Ivashkin, F.Guber (INR, Troitsk) + MiPhi

- Two-arms at ~3.2 m from the interaction point.
- Each arm consists of 45 individual modules.
- Module size 150x150x1100cm$^3$ (55 layers)
- Pb(16mm)+Scint.(4mm) sandwich
- 7 longitudinal sections
- 6 WLS-fiber/MAPD per section
- 7 MAPDs/module

1. We have 100 modules ready (need 88+12 are spare)
   Produced modules are under test on Cosmic

2. FE Electronics is under production – will be ready at the end of 2019

3. Design of the Support platform for FHCal is under development
Assembling of the FHCal in the pole

Conception of FHCal Integration
Beam Pipe Stage I:

Our requirement for vacuum in the straight part of MPD is not worse than $10^{-10}$ torr. Working version of pipe will consist of three parts – central made of Beryllium and two end parts made of Aluminum allow. So far we have contract with Institute of Beryllium in Moscow for production two Be beam pipes with inner diameter 62 mm. For Aluminum beam pipes (pc) we have prepared contract with two Companies in Moscow.

We plan to start work of MPD with Aluminum beam pipe in order to get experience with installation.

We need in the MPD team one or two experts on Ultra High Vacuum Technics
- to care beam pipes,
- to communicate with vacuum group of Collider
- communicate with experts in CERN to get experience
Milestones of MPD assembling

1. MPD Yoke parts are in Dubna
2. April 2020 - MPD Hall and pit are ready to store and unpack Yoke parts
3. May-June 2020 - Magnet Yoke is assembled for alignment checks
4. June 2020 - Solenoid is ready for transportation from ASG (Italy)
5. July 2020 - Solenoid is in Dubna
6. August 2020 - Assembling of Magnet Yoke and Solenoid at JINR
7. September 2020 - Preparation for switching on the Solenoid (Cryogenics, Power Supply et cet.)
8. Oct - Nov 2020 - Magnetic Field measurement
9. December 2020 - Installation of Support Frame
10. Jan - April 2021 - Installation of subsystems, Electronics Platform, Cabling
11. May 2021 Commissioning
Thank you!
Summary

- Progress in MPD project realization in 2017 – 3Q 2019 (Magnet, Solenoid, TPC, TOF, FFD, FHCAL)

- Our goal is to start data taking with MPD in the 2Q 2021

- We need one expert and 2-3 engineers for Cooling system

- We need more young engineers for MPD running (cooling system, vacuum, technical and engineer design, engineering support)

- It is time to involve more students and young scientists in each subsystem group to prepare them for work in the shifts and to study parameters of MPD. They should learn MPD Root, tracking, clusterization, calibration and many other things before MPD starts running
<table>
<thead>
<tr>
<th>Item</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of the TPC</td>
<td>340 cm</td>
</tr>
<tr>
<td>Outer / Inner radius of vessel</td>
<td>140 cm / 27 cm</td>
</tr>
<tr>
<td>Outer / Inner radius of the drift volume</td>
<td>133 cm / 34 cm</td>
</tr>
<tr>
<td>Length of the drift volume</td>
<td>163 cm (of each half)</td>
</tr>
<tr>
<td>Electric field strength</td>
<td>~ 140 V/cm</td>
</tr>
<tr>
<td>Drift gas</td>
<td>90% Ar+10% CH₄ / 80% Ar+20% CO₂</td>
</tr>
<tr>
<td>Gas amplification factor</td>
<td>~ 10⁴</td>
</tr>
<tr>
<td>Drift velocity</td>
<td>5.45 cm/µs;</td>
</tr>
<tr>
<td>Drift time</td>
<td>&lt; 30 µs;</td>
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<tr>
<td>Temperature stability</td>
<td>&lt; 0.5°C</td>
</tr>
<tr>
<td>Number of readout chambers</td>
<td>24 (12 on each side)</td>
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<tr>
<td>Number of pads</td>
<td>95232</td>
</tr>
<tr>
<td>Maximal event rate</td>
<td>&lt; 7 kHz (at Lum. = 10²⁷)</td>
</tr>
<tr>
<td>Electronics shaping time</td>
<td>~180 ns</td>
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<tr>
<td>Signal-to-noise ratio</td>
<td>30:1</td>
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<tr>
<td>Signal dynamical range</td>
<td>10 бит</td>
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<tr>
<td>Signal sampling</td>
<td>10 МГц</td>
</tr>
<tr>
<td>Two-track resolution</td>
<td>~1 cm</td>
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