Ю.А. Мурин
ЛФВЭ ОИЯИ

Внутренние кремниевые трекеры установок MPD, CBM и BM@N
Two major objectives to study heavy-ion collisions at intermediate energies

Superdense nuclear matter

SIS-300 and NICA task

Strange nuclear matter

SIS-100 and Nuclotron-M task
## Experiments on strange nuclear matter

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Observables for beam energies below $\sqrt{s_{NN}} = 12$ GeV (highest X-section region for hyper-nuclei production)</th>
<th></th>
<th>Hyperons</th>
<th>Hyper-nuclei, single/double</th>
<th>Memos</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hadrons correlations, fluctuations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STAR@RHIC</strong></td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no/no</td>
<td>no</td>
</tr>
<tr>
<td>BNL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NA61@SPS</strong></td>
<td>yes</td>
<td>yes</td>
<td>Yes</td>
<td>? /no</td>
<td>no</td>
</tr>
<tr>
<td>CERN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MPD@NICA</strong></td>
<td>yes</td>
<td>yes</td>
<td>Yes</td>
<td>yes/no</td>
<td>no</td>
</tr>
<tr>
<td>Dubna</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CBM@SIS100</strong></td>
<td>yes</td>
<td>Yes</td>
<td>Yes</td>
<td>yes/yes</td>
<td>yes</td>
</tr>
<tr>
<td>Darmstadt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BM@Nuclotron</strong></td>
<td>yes</td>
<td>Yes</td>
<td>Yes</td>
<td>yes/yes</td>
<td>yes</td>
</tr>
<tr>
<td>Dubna</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The need for modern fast and high precision instrumentation based on microstrip sensors

Supermodule („the ladder“)= Sensitive modules on light weighed CF support frames with FEE in cooled containers at the rare ends

Meeting at JINR, August 30, 2012
The need for modern fast and high precision instrumentation based microstrip sensors

Sensitive module = 2 X 1024 channel double sided silicon microstrip Sensor (58 um pitch) with readout via long (up to 55 cm) ultralight microcable to GSI designed FEE

Meeting at JINR, August 30, 2012
CBM/BMN fixed target experiment = Silicon Tracking System, Target, Beam pipe, Superconducting Dipole Magnet

**Tracking Stations**

- **STS:**
  - 8 detectors stations in thermal enclosure

- **MVD:**
  - 2 detectors stations in vacuum vessel

**Current Layout:**
- Total area, 8 stations: ~4 m²
- Total number of r/o sectors: 1052
- Total number of r/o channels: 2.2M
- Total number of FE chips: ~16800
- Total FE boards: ~2100
The BM@N or CBM STS: supermodule layout
Hyperon and hypernuclei with STS with CBM-like STS at Nuclotron existing SP-42 magnet

- Silicon tracker: 8 stations microstrips (400 µm each)
- Strips with 50 µm pitch and 7, 5° stereo angle
- Full event reconstruction

Central Au+Au collisions at 4 AGeV:

Invariant mass: $^3H \rightarrow \Lambda + \pi^-$

- Total efficiency: 8%  
- S / B = 2.13

Invariant mass: $^3H \rightarrow \Xi + \pi^-$

- Total efficiency: 2%  
- S / B = 3.84
The CBM-MPD STS Consortium Since Nov 2008
CBM-MPD STS Consortium

- 8 institutes
- 5 countries

- GSI, Darmstadt, Germany
- JINR, Dubna, Russia
- IHEP, Protvino, Russia
- MSU, Moscow, Russia
- KRI, St.Petersburg, Russia
- University, St.Petersburg
- SE SRTIIE, Kharkov, Ukraine
- NCPHEP, Minck, Belarus Rep.
- PI AS, Prague, Czech Rep

• Components
  • Modules assembly
  • Ladder assembly
  • Radiation tests
  • In-beam tests

• CBM in Darmstadt
• MPD and BM@N in Dubna
Mechanics hardware: Punch@Mould Produced in SPb with a dozen CF space frames manufactured @ CERN

Punch and Mold for production of true CBM supporting frames
Demonstrators and prototypes
Change of vendors for production of sensors after receiving in 2012 additional funding from BMBF in Germany (200K Eu) and at JINR-BMBF grant (135 kEu) - involvement of Hamamatsu

**DSSD**: German Party responsibility - CiS, Erfurt (62x62) + Hamamatsu, Japan (42x62), double metalization on P-side

**SSSD-sandwich**: the Consortium responsibility Hamamatsu, Japan (42x62), On-SemiConductor, Czech Rep. (62x62) + auxiliary chip cable (SE RTIE) + RIMST, RF in 2013
Device for sensor locker precision positioning manufactured at PLANAR, Minsk, Rep. of Belarus, 2012
The German forced change in tentative WP of the Consortium: TDR Jun 2013 - Commissioning Oct 2017

ROADMAP to LARGE AREA SILICON TRACKER TECHNOLOGY

at JINR

MILESTONES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BTT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A postgrad. student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BM@N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A mech. designer, BMBF-JINR ladder ass, lab, a technician</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>same + one researcher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shared Activity @ 3M € towards CBM STS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- beam tracking telescope (4 stations)
- SSD TRACKER for SP42
  4-6 stations (together with German Party)
- one SSD cylinder
  two SSD discs
- CBT STS (together with German Party)
A stand-alone problem - absence in RF of read-out electronics based on ASIC technology

- No exact solution yet found but an agreement with the CBM collaboration on inheriting their R@D project on CBM-exciter ASIC launched by GSI at AGH University, Krakow, Poland

Caution! Legal support is needed to import radiation hard ASICs to RF and Ukraine!

- Recently IHEP proposed to organize the needed ASIC design in RF (MIPHI-SINP-IHEP perspective planning) with its subsequent production elsewhere: suggestion is under consideration
Prototype CBM silicon detector in physics experiment at IHEP Protvino (50 GeV protons)

by CBM-MPD STS Consortium, 19 Nov. - 1 Dec. 2008

IHEP, U70 accelerator and beam lines

Si microstrip detector prototype CBM01B2

STS demonstrator 0b

assembled CBM tracker test station

SVD-2 beam tracker with CBM test station

SVD-2 experiment: Spectrometer with Vertex Detector

p beam, up to 70 GeV

spectrometer vertex detector beam tracker

X beam profile Y spatial resolution ~ 25 µm

hit cluster size ~ 1.2 strips

preliminary
Preparations for the in-beam tests at Nuclotron

- Equipment of JINR test bench with n-XYTER readout
- Mechanics preparation
- Slow Control for Protvino in-beam
- Logic Init for recording the external DAQ information into the ROC

Status: 3 more FEBs and 1 ROC are needed to be fully ready
The Conclusions

- Through years 2008-2012 the CBM-MPD STS Consortium demonstrated self-sustained growth of R&D activity which could be successfully accomplished within 1.5 - 2 years.

- However, decisions should be taken at high level and resources (@around 5 M USD) released to develop corresponding infrastructure for massive production of modules and, especially, supermodules at LHEP JINR in 2013-2016 for the BM@N and CBM STS projects, firstly, and NICA-MPD ITS, afterwards.

- Some costs could be shared with the CBM Collaboration which plans to invest up to 3M Eu in production of parts for the CBM STS by the Consortium.

Thank you for your attention!