The new hybrid tracking system of the BM@N experiment at JINR

QM-2019, Wuhan, China, 4-9 November 2019

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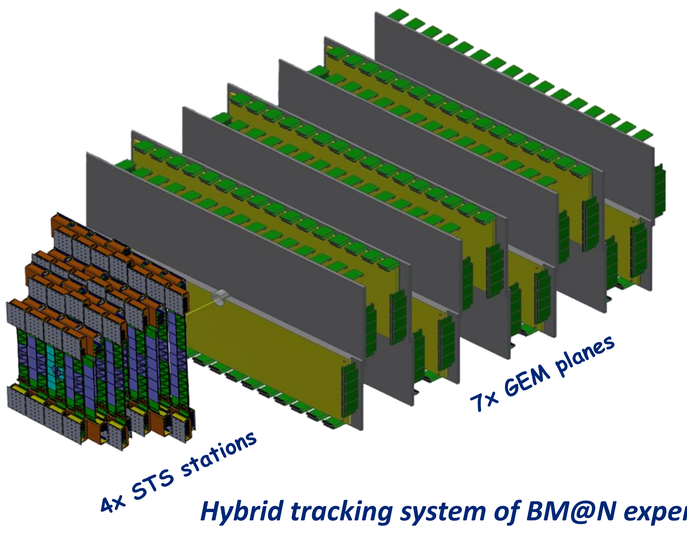
Hybrid tracking system



Hybrid tracking system of BM@N experiment (located inside BM@N dipole magnet)

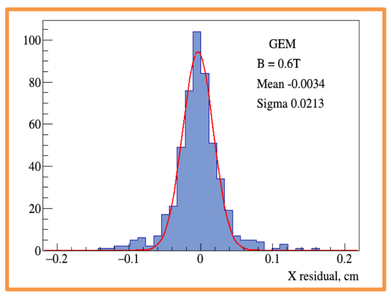
- Track point measurement for Au+Au collisions with energies up to 4.5A GeV and beam intensities up to $5 \cdot 10^6\ Hz$
- 4x STS stations based on CBM-type modules and developed in collaboration with CBM STS group
- 7x GEM planes (partially already exists)
- Momentum resolution ΔP/P≈ 0.6% (P > 0.5 GeV/c)
- Reconstruction efficiency is ≈ 88 %

Details on physics performance simulations in the poster by G. Pokatashkin

GEM tracking system

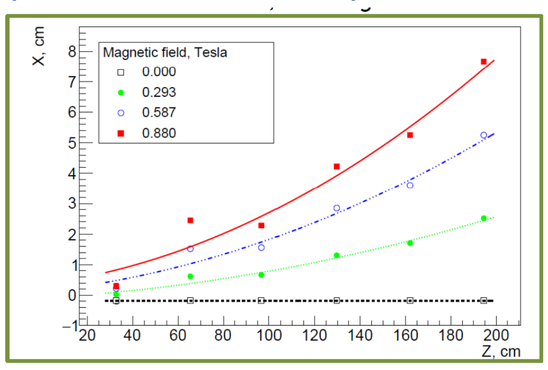
GEM tracking system at Ar and Kr beams in March 2018

GEM group



Magnetic field 0.6 T, Ar beam

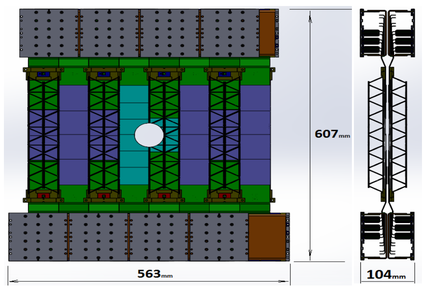
Setup comprised 6 half-planes of GEM detectors produced at CERN workshop and installed into BM@N setup



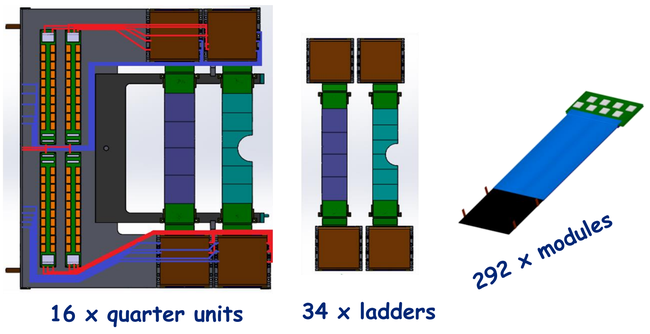
The average trajectories of the deuteron beam and the average Lorentz shifts of an electron avalanche in 6 GEM planes measured for four values of the magnetic field.

- 7x Planes of two-coordinate GEM detectors
- Aperture of one plane is 1632 x 840 mm²
- Strip pitch is 0.8 mm, strip inclination angles are 0, 15°
- Hit spatial resolution ≈ 127 μm (without magnetic field)
- Triggered readout electronics with maximum trigger rate up to 50 kHz

STS integration

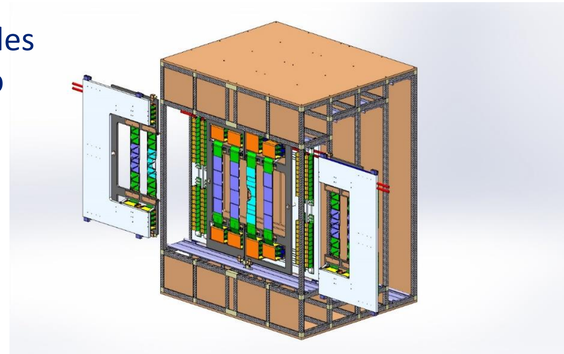


Layout of the 1st Station



Exploded view of the STS

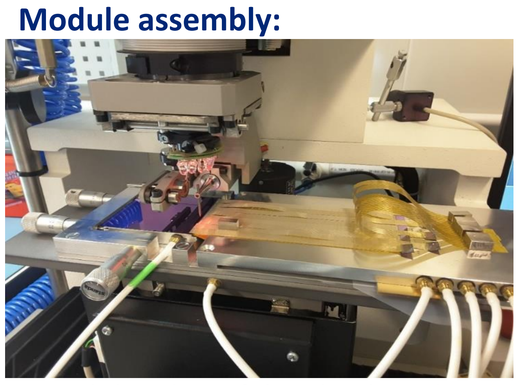
- 4x Stations based on CBM-type modules
- Modules with double-sided microstrip silicon sensors
- Hit spatial resolution ≈ 25 μm
- Time stamp resolution ≈ 10 ns
- Self-triggering front-end electronics
- Material ≈ 0.3% – 1.5% X_0 per station
- Total number of channels ≈ 60 k
- Total power consumption ≈ 15 kW



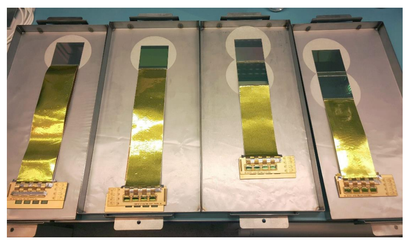
Mainframe of the BM@N STS

Module and ladder assembly

Module assembly:



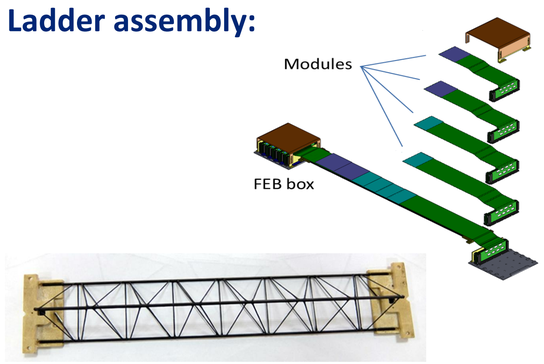
Tab-bonding of the Al-polyimide cables between sensor and ASICs



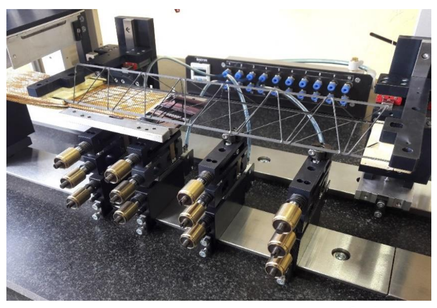
Assembled mockups of the modules

Assembled modules are covered with aluminum shielding

Ladder assembly:

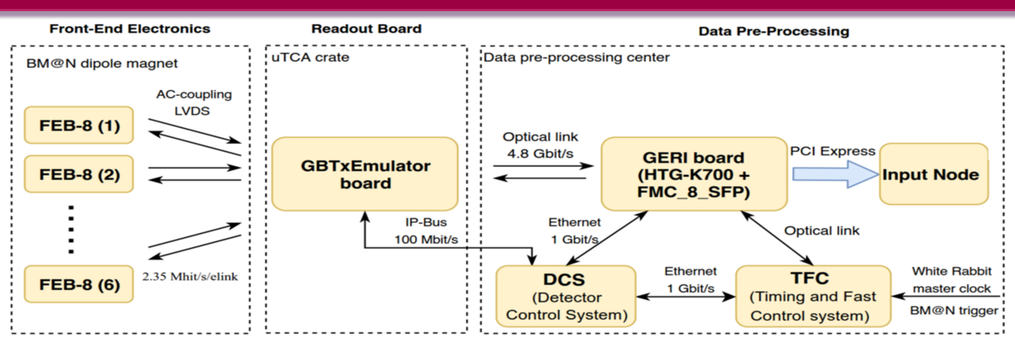


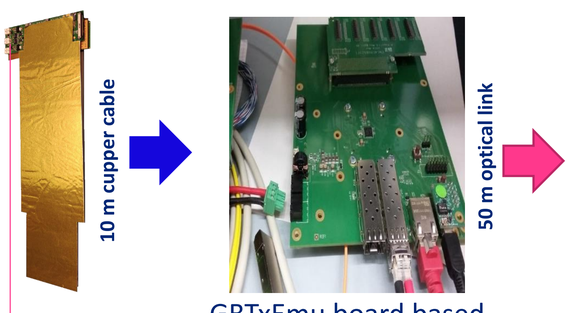
Modules are in groups installed on CF trusses with mounting blocks



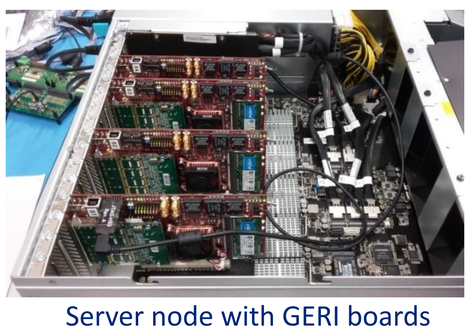
Factory acceptance test of the device for the ladder assembly

STS readout electronics



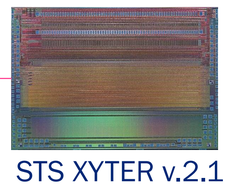


GBTxEmu board based on Xilinx Artix FPGA



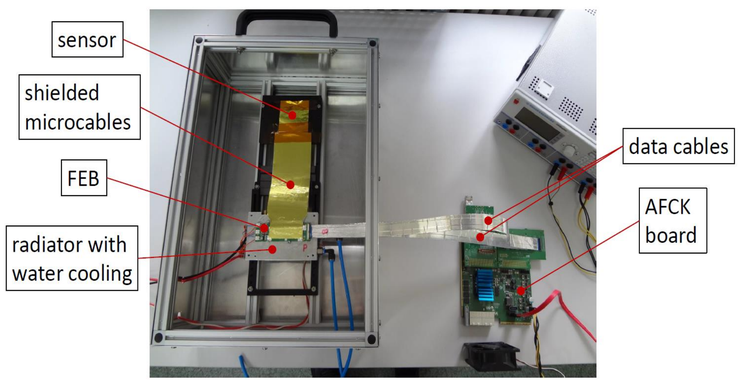
Server node with GERI boards

Front-end Board with 8 STS XYTER ASICs



STS XYTER v.2.1

Demonstrators



Test bench for the module prototypes

performance:

- noise: 1090 ±150 e (n)
  1350 ±200 e (p)
- r/o threshold: 7000 e
- signal mean: 16720 e (n)
  20300 e (p)
- signal-to-noise: 15±3
- hit detection eff.: > 95%

STS project timeline

- Production Readiness : Jun. 2020
- Detector construction 2020 – 2022
- Commissioning of Stations 1,2 – Nov. 2021
- Commissioning of Stations 3,4 – Nov. 2022

Work supported by RFBR grant #18-02-40047