R&D on MRPC for STAR MTD

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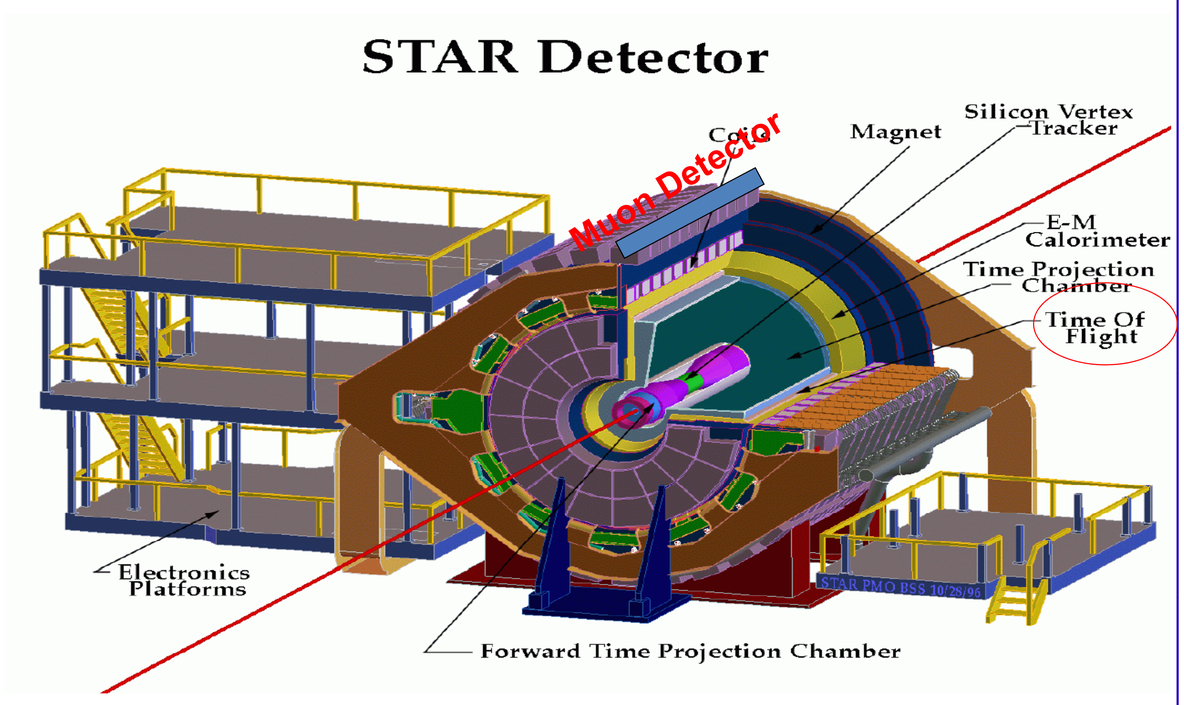
Abstract: A Muon Telescope Detector (MTD) is proposed for the upgrade of the STAR (the Solenoidal Tracker At the RHIC) experiment at RHIC. By the measurement of muons of a few GeV/c, the MTD will allow the detection of di-muon pairs from Quark Gluon Plasma (QGP) thermal radiation, quarkonia, and light vector mesons. The correlation of quarks and gluons as QGP resonances, Drell-Yan production, and the measurement of heavy flavor hadrons via semi-leptonic decays into single muons are also possible. These measurements will advance our knowledge of the nuclear matter formed in the relativistic heavy ion collisions at RHIC.

MRPC (Multi-gap Resistive Plate Chamber) with long-strip readout will be used as the detector for the MTD with its excellent performance and relatively low cost per channel. This first prototype of LMRPC (Long-strip MRPC) has 10 gas gaps of 250 μm and the signal is read out by six 90 cm long strips of 2.5 cm wide. The test performance with both cosmic ray and test beam shows that the time resolution is around 70 ps, the detection efficiency is higher than 95% and the spatial resolution along strips is less than 1 cm. The "real size" prototypes have 6 (or 5) gaps of 250 μm and the readout strips are 3.8 cm wide. The cosmic ray test shows the efficiency is higher than 90% and time resolution is around 90 ps which are good enough for the MTD requirements. Both the first prototype and "real size" detectors have been installed in STAR and taken data successfully from 2007. The mass production of the LMRPC will start soon in this year.

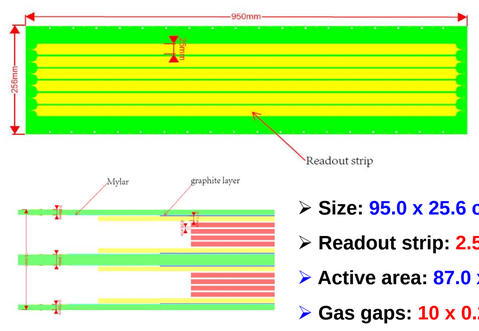


The MTD locates behind the iron bars of the magnet and uses them as absorbers. With the successful operation in the STAR-TOF upgrade, the MRPC technology has been selected as the detector for MTD.

Considering the low multiplicity of muon tracks, Long-strip MRPC will be used. The required performance includes:

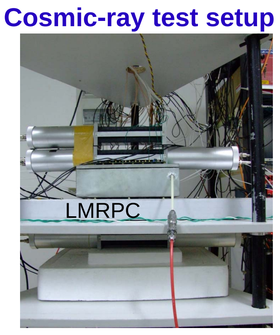
- ✓ Good timing: < 100 ps
- ✓ High efficiency: >90%
- ✓ Spatial resolution: ~ 1 cm
- ✓ Cost-effective for large area coverage

The first LMRPC prototype

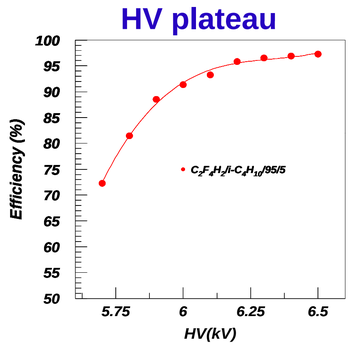


- Size: 95.0 x 25.6 cm²
- Readout strip: 2.5 cm
- Active area: 87.0 x 17.0 cm²
- Gas gaps: 10 x 0.25 mm, in 2 stacks

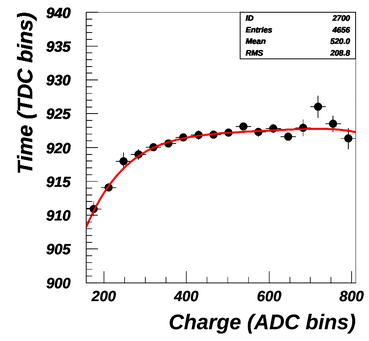
Cosmic-ray test setup



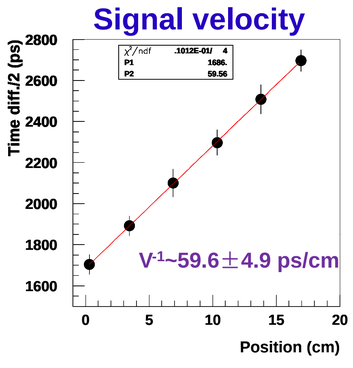
HV plateau

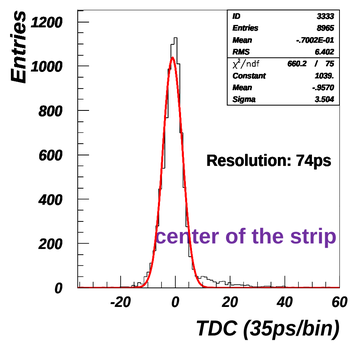


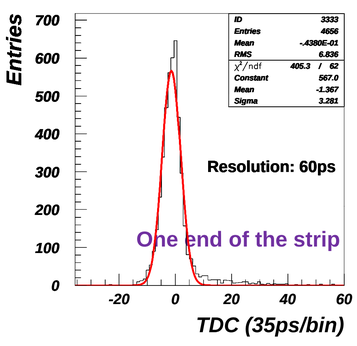
T-A correction & Time resolution



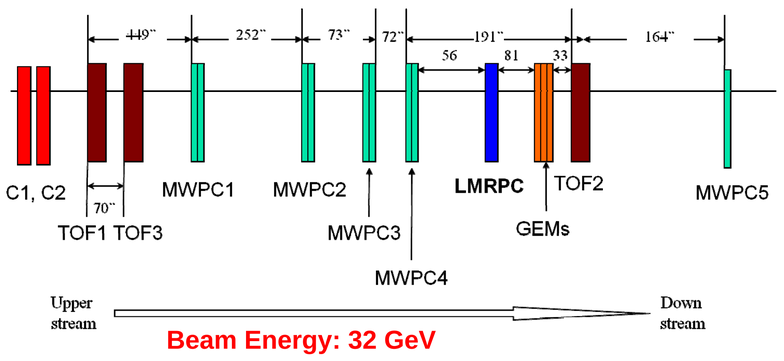
Signal velocity





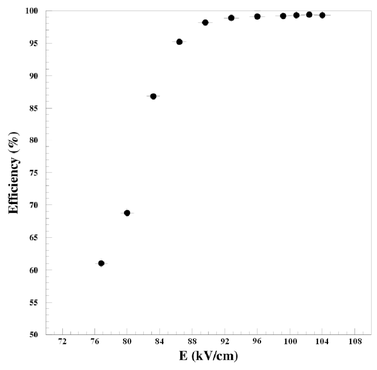


FNAL Beam Test (T963)

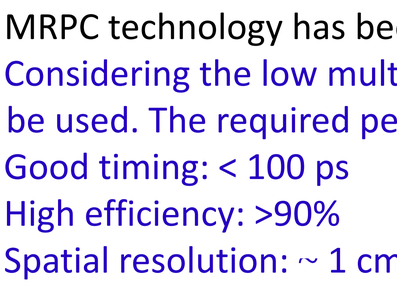


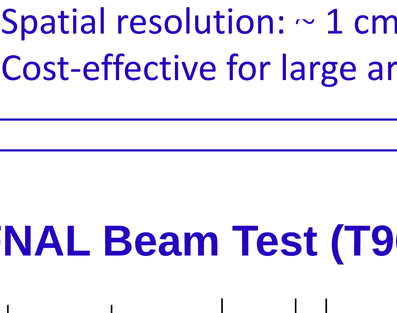
Beam Energy: 32 GeV

Efficiency plateau

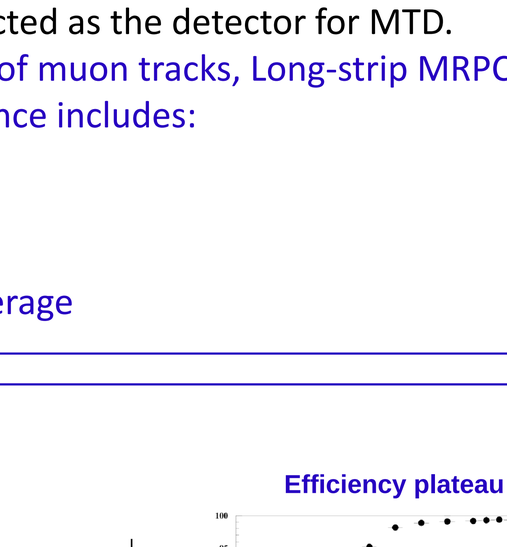


Spatial resolution

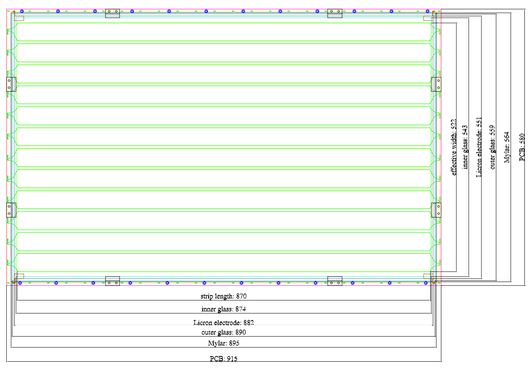


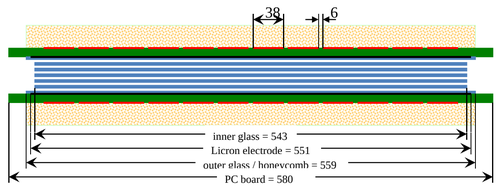


Time resolution



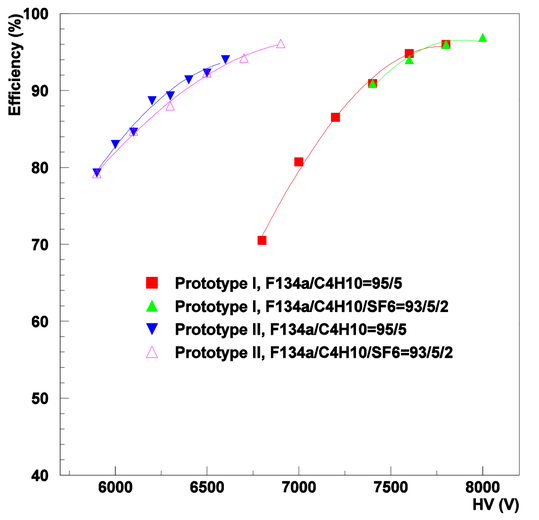
Prototype of "real size"

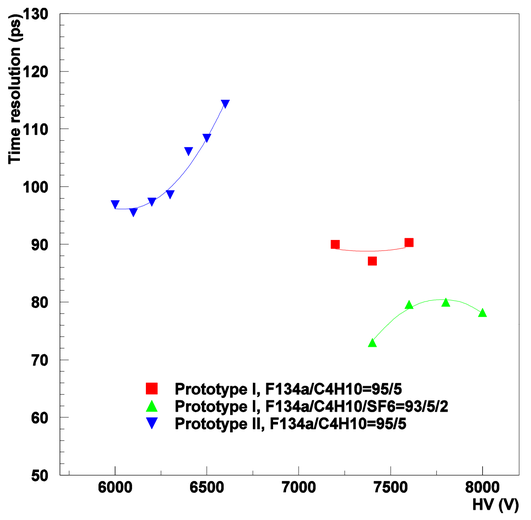




- "real size" module: 91.5 x 58 cm²
- Readout strip: 3.8 cm
- Active area: 87.0 x 52.2 cm²
- Gas gaps: 6 (5) x 0.25 mm, single stack

Prototype I: 250μm × 6 gaps
Prototype II: 250μm × 5 gaps





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2. L. Ruan et al., Journal of Physics G: Nucl. Part. Phys. 36 (2009) 095001; 0904.3774;
3. Y. Sun et al., NIMA 593 (2008) 430.
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