ATLAS sMDT achievements and plans

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Achievements of the 2022 GIF++ test-beam campaign
Bipolar shaping is employed for the sMDT read-out in order to avoid baseline drifts.

Muon hits falling into the negative tail of a preceding γ hit get deteriorated leading to a degradation of the spatial resolution.

Main topic of the 2022 test-beam campaign: Study of the impact of improved signal shaping on the spatial resolution.
Present “legacy” ASD chip in 500 nm Agilent technology (obsolete).

New ASD chip:
- In 130 nm Global Foundries CMOS technology.
- Design follows legacy chip with a fix of a specific design error of the legacy chip in the output logic.

Block diagram of the new ASD chip

- Differential charge sensitive preamplifier.
- Bipolar shaping with ion tail cancellation.
- Wilkinson ADC for time-walk corrections to discriminated signals.
The new ASD chips were tested on a sMDT chamber with 1.6 m long in CERN's Gamma Irradiation Facility GIF++.
Spatial resolution as a function of the $\gamma$ background rate

- Gain drop compensated by the adjustment of the operating voltage.
- Degradation of the spatial resolution caused by signal pile-up.

**Low $\gamma$ background**
- Better resolution with the new chip than the legacy chip due to the shorter peaking time.
- Resolution improvement of 10 $\mu$m by time-walk corrections for the new chip.

**High $\gamma$ background**
- Substantially smaller resolution degradation with increasing background rates for the new than the legacy chip thanks to the improved pulse shaping.
- High spatial resolution, 140 $\mu$m, even at the highest rate of 1.7 MHz/tube.
- Angular resolution at the highest FCC-hh background rates: 61 $\mu$rad!
Plans for 2023
Test programme

Tests requiring a muon beam

- Test of evolutions of the new ASD chip in the beam periods with the same set-up as in 2022.
- Test of ATLAS prototype RPCs produced by a new manufacturer. Plan to integrate two $1\times2$ m$^2$ RPCs into the sMDT set-up requiring additional 20 cm along the beam line.
- Preferred beam periods: May 2023, July 2023, October 2023.

Tests not requiring a muon beam

- Test of smaller size RPCs ($50\times50$ cm$^2$) produced by the new manufacturer with cosmic ray muons at different $\gamma$ background levels.
  - These RPCs can be put into the existing sMDT test stand.
- Aging test of 10 pieces of the $1\times2$ m$^2$ RPCs from the new manufacturer.
  - Required space along the beam line: 1.5 m.
  - Time period: March/April 2023 to March/April 2024.