Future use of silicon photomultiplier for KAOS at MAMI and PANDA at FAIR

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*SIPM IN THE PANDA EXPERIMENT
A small fiber barrel read-out by SiPM has been discussed as an option for a time-of-flight start detector in PANDA and as the active target for the hypernuclear Physics programme. Such a detector might be also used as a time reference for the DIRC detector or for track deconvolution of the time projection chamber. For PANDA the time resolution is a main issue.

Requirements for a DIRC photodetector:
- \( dt < 100 \) ps
- \( dy \sim 1-2 \) mm
- \( dx \sim 5 \) mm
- single photon counting
- magnetic field immunity
- effective area > 70%

Fibre detector with 600 SiPM under construction

IRRADIATION SET-UP
14 MeV electrons were used to irradiate a sample of SSPM-0701 BG-T018 diodes. The beam current was 10 nA.

Electrons crossed a 0.3mm thick aluminum window at 15cm distance from the SiPM. Fluences ranged from 0.31 to \( 3.8 \times 10^{10} \) electrons/mm².

IRRADIATION EFFECTS
- Increase in leakage current
- severe loss of gain uniformity

PARTICLE DETECTION EFFICIENCY OF LONG FIBRES WITH SiPM

<table>
<thead>
<tr>
<th>Threshold (no. of pixels)</th>
<th>Efficiency</th>
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<tbody>
<tr>
<td>1</td>
<td>91 %</td>
</tr>
<tr>
<td>2</td>
<td>76 %</td>
</tr>
<tr>
<td>3</td>
<td>56 %</td>
</tr>
<tr>
<td>4</td>
<td>35 %</td>
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Gain | Max. B-field | Dark Current | Max. Rate |
-----|--------------|--------------|-----------|
Vacuum PMT | 10⁻⁷ - 10⁻⁸ | < 0.5 T | > 100 MHz | 10³ | 10⁻⁷ |
SiPM | 10⁻⁵ - 10⁻⁶ | 2.7 | 10⁻⁵ - 10⁻⁴ | 1 Mil / pixel | 10⁻⁷ |

TTS Efficiency Lifetime Price
Vacuum PMT | 350 ps | > 20 % | >100 C/m² | $500 - 1500 |
MCP-PMT | < 50 ps | < 15 % | < 1 C/m² | $1500 - 10000 |
SiPM | > 100 ps | < 15 % | Prob. High | $100 - 1000 |

TIME RESOLUTION OF AN SIPM/FIBRE ASSEMBLY
Measured left/right time differences with a 2m long SiPM/fibre set-up. For the 4 spectra the pixels N = 1,...,4 from the pulse height spectrum were selected.

TIME-OF-FLIGHT PARTICLE ID IN PANDA
Simulated kaon/pion separation in the PANDA hypernuclei programme using a fibre start counter and a barrel stop counter with 80 ps and 450 ps time resolution. Calculated with 1% momentum resolution and 2% error in track length.

SIPM IN THE KAOS SPECTROMETER
At the Institut für Kernphysik in Mainz, Germany, the microtron MAMI has been upgraded to 1.5 GeV electron beam energy. A large fibre detector set-up is under development for the KAOS spectrometer, covering an active area of 2000 x 300 mm². SiPM have been suggested as a possible candidate for a two-sided read-out for the long fibres in horizontal direction. We concluded that a 4 mm² double cladding fibre with 4 mm² SiPM read-out can be used as tracking detector.

Pulse-height spectrum from a fibre exited by \(^{90}\)Sr and read out by a SiPM.