The MYTHEN III strip detector prototypes

**What is MYTHEN?**
- silicon microstrip detector with 50 µm pitch, 8 mm long strips
- single photon counting
- for time-resolved powder diffraction, medical imaging, etc

**Why a strip detector?**
- less channels per area:
  - fast frame rates
  - high resolution
  - small pitches possible:
  - large angular coverage

**Why photon counting?**
- ideally noiseless
- large dynamic range
- fluorescence suppression

**What is MYTHEN?**
- small dead time → increased count rate capability
- improved noise performance
- reduced threshold dispersion

**What is new?**
- three comparators and three 24-bit-counters for:
  - energy-windowing
  - count rate improvement (track pile-up)
  - pump-probing with multiple time slots, counters are independently gateable
  - reduced threshold dispersion
  - improved noise performance
  - small dead time → increased count rate capability

**Threshold dispersion**

The threshold dispersion is given by the spread of the inflection points, i.e. the resulting thresholds, over all sensor-strips.

**Rate capability**

1. Plot the measured rate vs the reference rate $I_1$.
2. Estimate the ideal theoretical rate with a linear fit.
3. Fit the ratio $\varepsilon$ of the measured and theoretical rate $\Phi$ to find the dead time $\tau_d$ with:
$$\varepsilon = \exp(-\tau_d \Phi)$$

**Rate capability**

The dead time $\tau_d$ increases with the gain (Vrf) → allows for fast count rates

**Conclusion**

The noise decreases with increasing dead time:

<table>
<thead>
<tr>
<th>MYTHEN II @ 8.75 keV</th>
<th>MYTHEN III.01 @ 8.0 keV</th>
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<tbody>
<tr>
<td>@ Vrf = 250 DACunits</td>
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<tr>
<td>Standard settings</td>
<td>Fast settings</td>
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<tr>
<td>Untrimmed threshold dispersion [eV]</td>
<td>1623 ± 6</td>
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<tr>
<td>Noise [e-]</td>
<td>230 ± 7</td>
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<tr>
<td>Dead time $\tau_d$ [ns]</td>
<td>1170 ± 10</td>
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<th>MYTHEN 3.02</th>
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<td>Installation of the detector</td>
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<td>2020</td>
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- 2nd prototype with 8 different architectures
  - tune the Signal-to-Noise-Ratio
  - test different design options
- the chip is functional and under test

**References**