Status and Reminder
SciFi Simulation and Reconstruction

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Status: Simulation and Reconstruction

Simulation

- 3 layers of squared fibres, tuned to measurements
- most recent geometry (12: 30 cm long ribbons)
- waveform handling present, only used for dedicated studies
- many parameters: crosstalk in fibres, SiPM channels, SiPM pixel; noise, ...
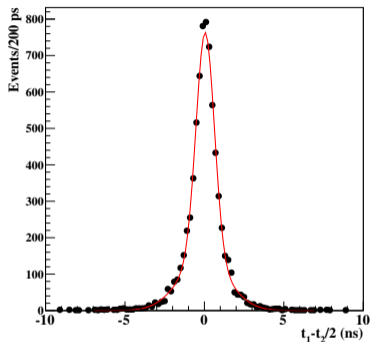- Attenuation length crosscheck

Reconstruction

- present by default
- results presented: obtained with full chain

Stand-Alone
bitbucket.org/corrodis/Mu3eFibres

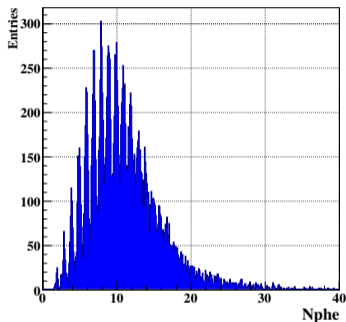## The Fibre Detector: Squared Results
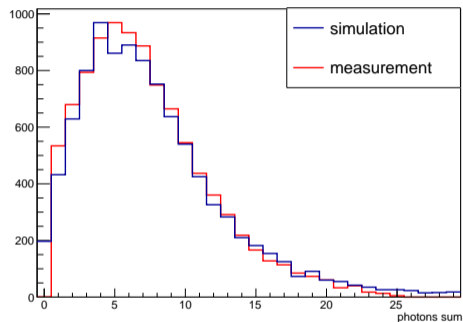
Time Resolution (single layer)

$\sigma = (t_l - t_r)/2 = \textbf{700 ps}$

Number of Photons (single layer)

Summed photons from both sides. (0.5 phe, AND)

Efficiency

$\varepsilon_{\text{single}}$ [%]	OR	AND
0.5 phe	97	71
1.5 phe	79	34

$\varepsilon_{\text{triple}}$ [%]	OR	AND
0.5 phe	>99	**95**
1.5 phe	97	67

The Fibre Detector: Simulation

Time Resolution (single layer)

$$\sigma = (t_l - t_r)/2 = \mathbf{680\,ps}$$

Efficiency

$\varepsilon_{\text{single}}$ [%]	OR	AND
0.5 phe	97 ✓	71 ✓
1.5 phe	79 ✓	34 $\sim$ 40 %

Number of Photons (single layer)

Summed photons from both sides. (0.5 phe, AND)

- simulated waveforms
- timing: constant fraction (CF)

The Fibre Detector: Clustering

clustering per side

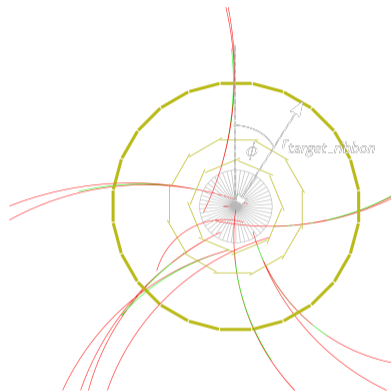- potentially on FPGA

- dark count reduction,
  bandwidth reduction

. . . .

match sides

. . . .
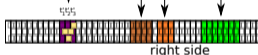
track to cluster matching

- current implementation
  $\varepsilon > 99\,\%$

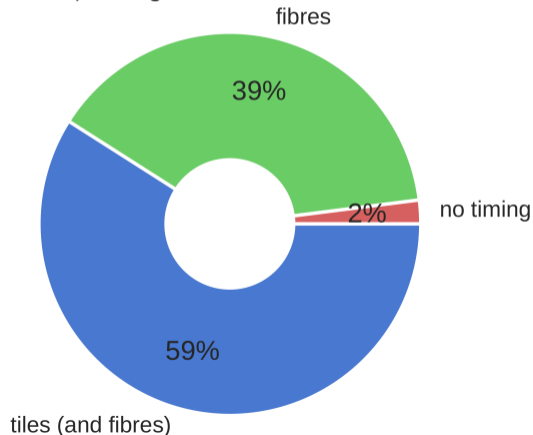- tracking information: extract
  best timing (path length)

Event display at $\sim 10^8$ stopped muons/s in one 50 ns frame.

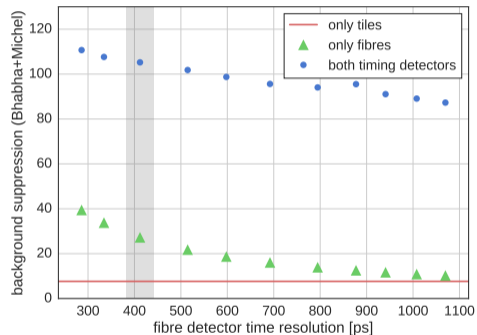# The Timing Detectors: Motivation

Situation

Fraction of reconstructed tracks (Michel decay, $\geq$6 hits) with **dominant** timing from corresponding detector.

fibres

39%

2% no timing

59%

tiles (and fibres)

Impact: Background Suppression

Accidental: Bhabha pair + Michel

Legend:
- only tiles
- only fibres
- both timing detectors

x-axis: fibre detector time resolution [ps]
y-axis: background suppression (Bhabha+Michel)

$\sigma_{tiles} = 70\,\text{ps}$, ε_{fibre} and λ_{fibres} as in squared fibres.

Impact: Charge Identification

Time resolution $\leq 0.5\,\text{ns}$ allows reliable charge identification for recurling ($\geq$8 hits) tracks.
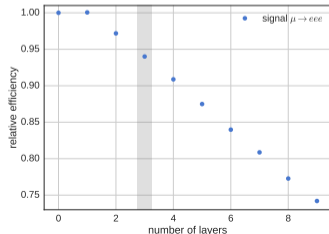
The Fibre Detector: Number Of Layers (squared)
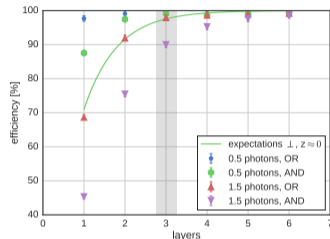
Implications on Tracking

invariant mass (m_{eee}) resolution
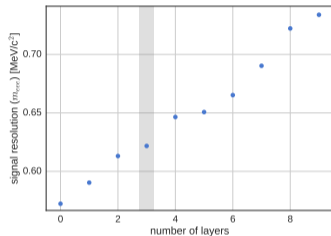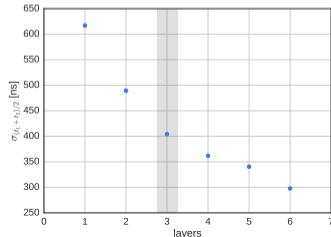

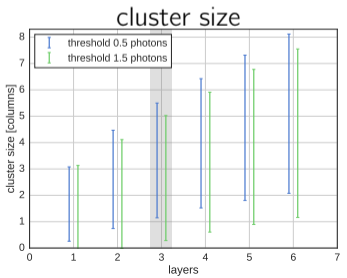relative efficiency for $\mu \to eee$ ($\sim \varepsilon_{track}^3$)
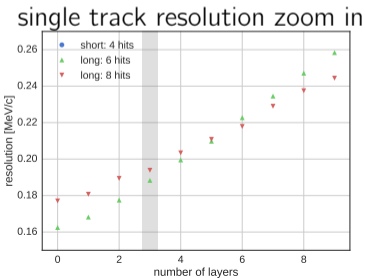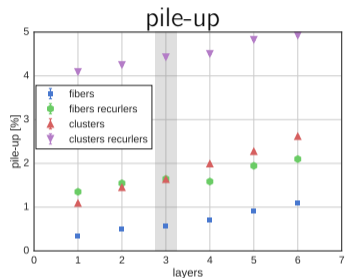

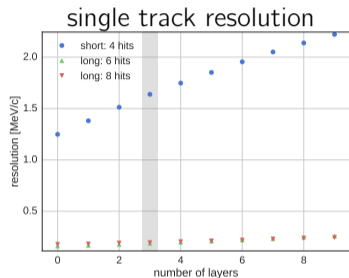## Impact on Timing (from target region)
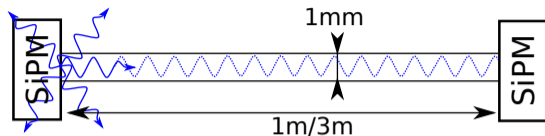
fibre detector efficiency

fibre detector time resolution

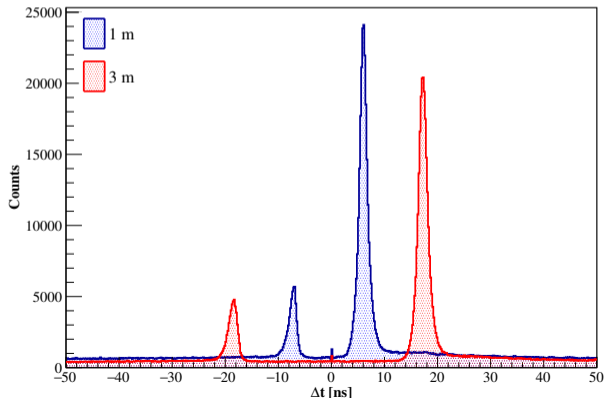# The Fibre Detector: Number Of Layers

Fibre Mediated Dark Counts ($\mathcal{O}(5\%)$)

- "old" $3 \times 3\,mm^2$ SiPM
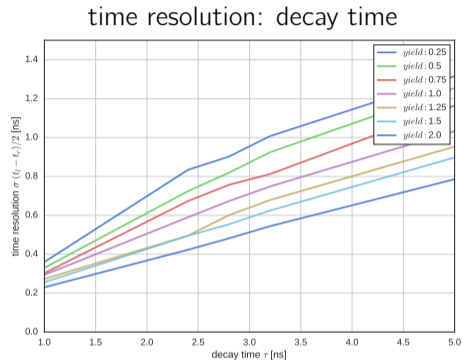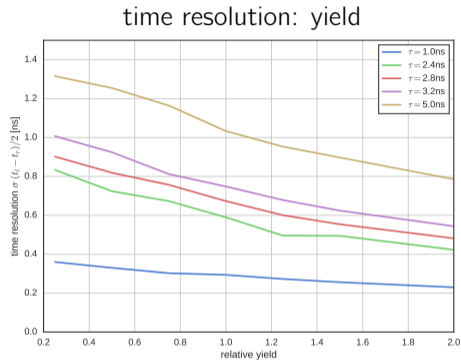 (no trenches, high dark count rate)

	Overvoltage [V]		
	3.0	4.5	5.5
fraction [%]	2.40	6.25	7.38

- overvoltage
  - $\rightarrow$ larger gain
  - $\rightarrow$ more "photons"
  - $\rightarrow$ larger cross talk (pixel, channel)

APPENDIX

Decay Time vs Light Yield

time resolution: yield

time resolution: decay time

type	τ_{decay} [ns]	yield
BCF-12	3.2	
78M	2.8	$\sim$ BCG-12
81M	2.4	< BCG-12

Charge Identification
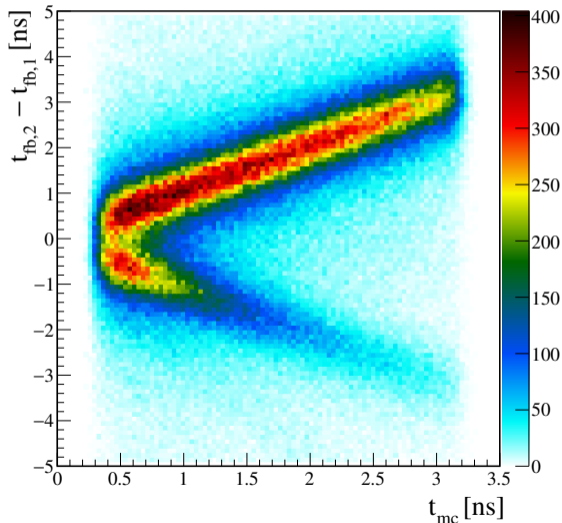
Time difference between fibre clusters assigned to **recurling** (long 8-hits track) as function of distance along trajectory. The upper branch corresponds to the correct charge assignment and direction of rotation and the lower branch to the wrong charge assignment.