Development of a New Class of Scintillating Fibres with Very Short Decay Time and High Light Yield

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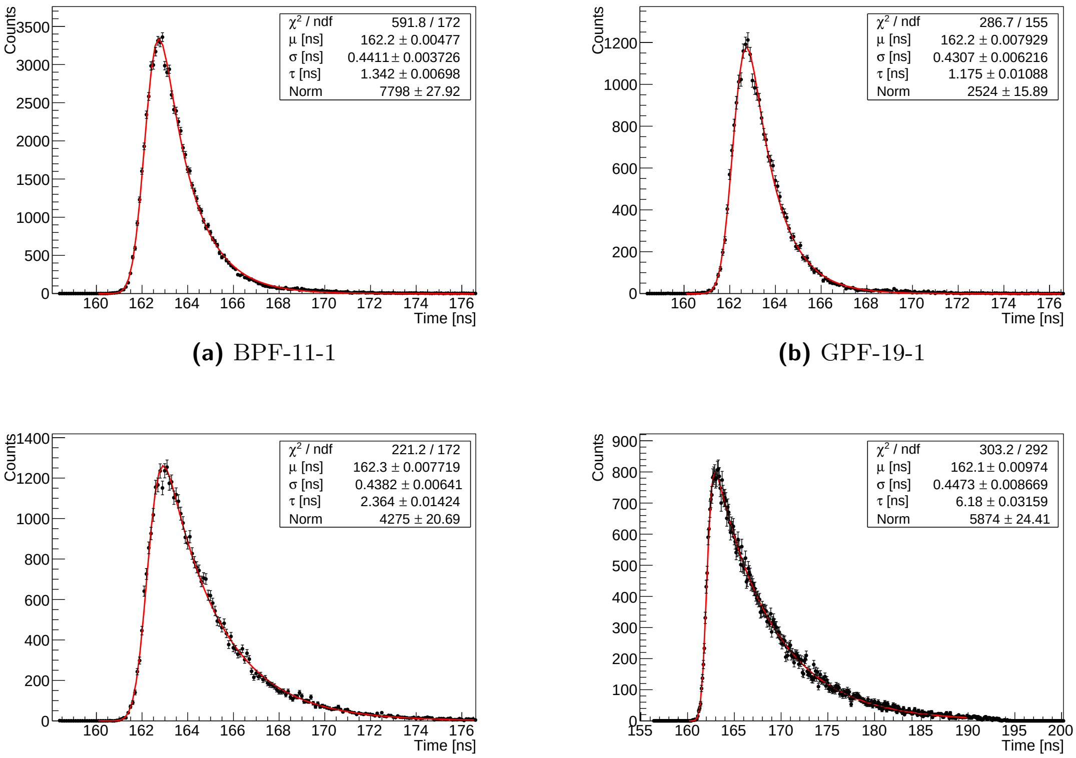
The availability of high performance SiPM detector arrays has boosted the interest in scintillating plastic fibres as active elements in tracking detectors. Their key features are low mass budget and fast response. The possibility of producing them with small diameters provides good spatial resolution and a high degree of geometrical adaptability.
We will present the current stage of an ongoing R&D program aiming to develop a new class of scintillating fibres. These fibres are based on a novel type of highly efficient luminophores called Nanostructured Organosilicon Luminophores (NOLs) admixed to a polystyrene core matrix. The R&D focuses on the development of very fast and high light yield scintillating fibres with emission spectra in the blue-green to green wavelength region, well adapted to modern SiPMs. Two prototype fibres were characterised in terms of decay time, light yield, optical transparency and radiation hardness, and compared to the well-established Kuraray SCSF-78 and SCSF-3HF fibres.
Even though the two prototype fibres mark just an intermediate step in an ongoing development, their performance is already on a competitive level. In particular their decay time constants are about 50% shorter than the fastest known fibres, which makes them promising candidates especially for time critical applications.

In order to measure the decay time the fibre under test was laterally excited with a fast pulsed UV-LED and read out at one extremity with a fast PMT. A pulse generator drove the LED and provided the start signal, whereas the PMT signal gave the stop signal for each single event. The resulting time distributions can be well described by an exponential function containing the decay time constant τ of the scintillation light, convoluted with a Gaussian with a width of $\sigma \sim 450\,\text{ps}$ accounting for the overall time jitter of the experimental setup. The measured and fitted time distributions for the prototype and reference fibres are shown in Figure 1. The decay time constants of 2.4 ns and 6.2 ns obtained for the blue and green reference fibres, respectively, are in good agreement with the catalogue values of 2.8 ns and 7 ns for SCSF-78 and SCSF-3HF given by Kuraray. The measurements of the prototype fibres yield a decay time of $1.2 - 1.3\,\text{ns}$ which is about a factor two faster than the best standard fibre and demonstrates the potential of using NOLs for very fast scintillating fibres.



(a) BPF-11-1 **(b)** GPF-19-1

(c) SCSF-78 **(d)** SCSF-3HF

Figure 1: Decay time of prototype (top) and reference fibres (bottom).