# Time-resolved Raman spectroscopy for the detection of biomarkers among layered minerals

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**Abstract**

In our Solar System, Mars is considered one of the candidates to have potentially spawned life. Although the current climate on Mars is harsh, the planet is believed to have been more habitable in the past. Any possible current life on Mars must withstand extreme drought, radiation levels and temperature variations. Earth has examples of organisms that fit this profile, such as *D. radiodurans* [1], hence terrestrial habitats that host extremophiles are the subject of intense study. We currently focus on the detection of carotenoids, a widely accepted biosignature [2].
Due to high radiation levels on Mars, it is expected that any life would reside beneath the surface. Hence bacteria were measured through several millimetre thick minerals by means of time-resolved Raman spectroscopy (TRRS). In a TRRS experiment, a pulsed laser and delay-adjustable gated detection system are used to selectively detect the much weaker signals from deeper layers while the stronger, unwanted signals from superficial layers are rejected. Coincidentally, also longer-lived (nanoseconds) fluorescence signals are suppressed. Detection of *D. radiodurans* through a 5 millimetre thick translucent calcite layer has already been demonstrated using our TRRS setup[3]. For thicker samples, light transmission through the first layer becomes limiting, and for thinner samples, less than about 3 millimetres thick, the time differences between layers become extremely small (~10-25 ps), complicating the separation of the signals. Fortunately, successful separation is still possible by applying global analysis methods (as described in [4]) to our TRRS data.

A new setup is being developed with an improved flexibility in wavelength as well as other aspects. The setup will increase the mineral thickness we can use to measure through increasing the applicability of the method. Our end goals are to optimise our setup for the detection of biomarkers in a mineral environment and to develop future methods that increase the capability to detect possible life on Mars.

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