Introduction
Assessing the biogenicity of potential bacterial fossils is not an easy task, as recently shown by the controversy concerning “Earth's oldest fossils” [1]. A thorough investigation of the geological setting and the morphology and chemical properties of the potential microfossils is essential in order to assess them as bona fide microfossils.

In this context, stable carbon isotopes play a certain role in the interpretation of biological activity, particularly when the fossil record is studied. It is known that stable carbon isotope fractionation is associated with the fixation of CO₂ in autotrophic organisms [2]. The fractionation is dominated by the 13C depletion associated with the uptake of CO₂, but also with enzymatic discrimination in the synthesis of biomass from inorganic carbon [2]. The isotopic composition of preserved organic carbon in potential microfossils may therefore be useful in the assessment of the biogenicity, as well as in the interpretation of the biological activity.

Experimental tests
The experiments have been performed at the Lund Nuclear Microprobe facility [3]. The beam energy used was 2.75 MeV with a typical current of 0.5 to 1 nA. He-ions was extracted and transported through the standard microprobe line into the microprobe chamber. Beam size was typical 10 μm.

Test 1
Pure carbon standard (13C = -25.0±2 vs. PDB).
A typical spectrum from such a standard is shown in figure 1 top. The 13C resonant peak is clearly seen and well separated from the 12C continuum.

Yield from this RBS technique, with optimised solid angle and beam conditions, has the correct order of magnitude. A useful geological and paleontological tool if the precision is better than about 2‰.

Test 2
Good statistics implies a detector solid angle as large as possible. Angular yield distribution was measured, shown in figure 2. The angular interval to be used should cover at least 150-180°.

Test 3
In the final test experiments the sample was sectioned and placed on grids. Both a Cu-grid and a Be-grid were tested. In figure 1b and figure 3 the advantage of this technique is obvious. Thin samples (TEM-sectioned) should be used for the analysis.

Future development
The data has to be extracted with well-defined fitting routines.
Different ways to normalise the data with high enough precision have to be investigated. Variation in thickness of the sample will introduce effects especially in the 13C yield.
The energy stability of the method has to be investigated. Does the accelerator energy need to be recorded for each event?
Does different sample thickness influence the 14C yield or is there some tolerance when selecting beam energy?

Summary
The possibility to use the 13C α-resonance at 2.75 MeV has been experimentally investigated.
A multi-detector system based on annular detectors has been designed and tested.
The possible integrated yield fulfills the statistical requirement for measuring the 13C/12C ratio with precision better than 2‰.
Further development is needed for evaluation and normalisation.

References