In year 1872 in USA two gentlemen, Leland Stanford and Frederick MacCrellish bet 25 thousands dollars. Stanford was holding, that it happens, that the trotting horse has all four hooves off the ground simultaneously. The photographer Eadweard Muybridge solved the puzzle, by making a sequence of photos with the series of cameras placed around the racetrack and triggered by the ropes pulled by a horse passing by. The photos confirmed without doubt, that the moment of suspension in the air indeed exists.

Muybridge converted, with a simple trick, a conventional photography into time-resolved method, e.g. the one providing access into time-dependency of the process. Scientists working in natural sciences know many excellent analytical techniques, whose slowness, however, reminds the early photocameras. The multidimensional NMR spectroscopy, which is a basic tool for determination of structure of a molecule up to the spatial coordinates of its atoms, can serve as a good example. Mathematics of the classical signal sampling theory, forces the NMR experiments to be carried out for many hours or even days to achieve interpretable results. However, simple modification of the way the NMR spectrometer is used opens the way to its application in the time-resolved measurments that require fast repetition of the experiment, similarly as the Muybridge's modification of the way the photocamera was used.

The main concept of the fast NMR spectroscopy is to omit certain sampling points during the acquisition of the signal, followed by their mathematical reconstruction based on the assumption that the resulting NMR spectrum is a compressible object. In the case of spectra of liquid samples this assumption is usually well fulfilled - the information content of a single spectrum can be compressed hundreds of times. Exploiting this fact during the experiment allows to accelerate it many times and use as a movie frame in the time-resolved study. Still however, such an"undersampled" experiment can take too much time comparing to the time scale of the studied phenomenon. Only the application of the time-resolved non-uniform sampling, being the key concept of this project, allows to extend the temporal resolution to few seconds.

The time-resolved non-uniform sampling is based on the division of the set of time-domain samples into the overlapping subsets and the reconstruction of the spectrum from each of them. In this way, from thousands of sampling points one can obtain hundreds of spectra that serve as frames of the movie visualizing the changes in the sample. The goal of the project will be the development of the freshly elaborated method, by creating the signal- processing tools, spectral visualization and analyis software that would work online i.e. in paralell to the studied process. Furthermore, the method will be extended to the benchtop mini-spectrometers, that are more feasible in the real applications, that is, directly in the chemical lab or in the production process,