Our experiment aims to investigate the dynamics of electrons and nuclei in molecular systems using UV-XUV light pulses in a one colour pump-probe scheme with a delay controlled with sub-femtosecond precision. The traditional split mirror design consisting of two halves will not allow to resolve the relative phases of the light pulses after focusing due to the diffraction effects [1]. Thus, the phase sensitive experiment requires a special split and delay unit which becomes the key element of the setup. Simulations of different split unit designs were performed and showed that utilization of a multipixel reflective split unit allows to avoid the phase uncertainty in the area of a tight focus and perform the phase resolved experiments. The comparative performance of the two types of a split mirror design are shown in the Figure 1. One can observe a destructive interference corresponding to the $\pi$ phase shift occurring in the center of the focus. The dark central spot is accompanied by two bright spots of constructive interference on the sides arising due to diffraction. The interaction area of the target with the excitation pulse must be restricted to the size of region with a well defined phase of the light field (the "dark" spot), otherwise the phase uncertainty will not allow to record an interferometric autocorrelation trace. As seen from the picture such a restriction can hardly be achieved with a traditional split mirror design since the target size is usually larger than the separation between the areas of constructive and destructive interference. The multipixel split mirror design can solve this problem.

In the first stage of the experiment we plan to use UV and VUV light pulses as an excitation source. A commercial Micro Electro Mechanical System from the Fraunhofer Institute for Photonic Microsystems in Dresden was selected for this purpose. This device consists of a 240x200 array of vertically displaceable square micro-mirrors each with size of 40\(\mu\)m. These systems are successfully implemented as adaptive optics for phase control and find their application in astronomy, ophthalmology, microscopy. The spatial light modulator is well suited for application in our setup.
in the UV-VUV range. However the surface properties of the pixels do not fulfill the requirements for operation at wavelengths below 50nm. Therefore an alternative split and delay unit design was developed and successfully manufactured. Since the control of a split mirror motion on a nanometer scale requires a precise knowledge of a position of the mirror surface, diagnostics by means of a White Light Interferometry (WLI) was developed. The precise control of phase delay between the excitation pulses will allow to monitor the dynamics of electronic motion in molecules and observe electronic relaxation processes depending on the phase of the electric field by means of electron and ion spectroscopy. $C_{60}$ fullerenes are well suited for prototypical studies of electronic correlation phenomena due to many correlated electrons and the large amount of experimental and theoretical data on their photophysical behaviour [2, 3]. Having 174 nuclear degrees of freedom, 60 essentially equivalent delocalized, and 180 localized electrons $C_{60}$ can be considered a model of a large but still finite system with many degrees of freedom. Experiments using femtosecond laser pulses in a collaboration with the group of M. Drescher are planned for Spring 2014.

References