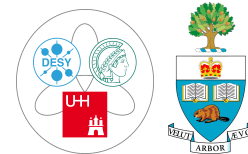


# RELATIVISTIC ELECTRON GUN FOR ATOMIC EXPLORATION REGAE FOR FEMTOSECOND ELECTRON DIFFRACTION



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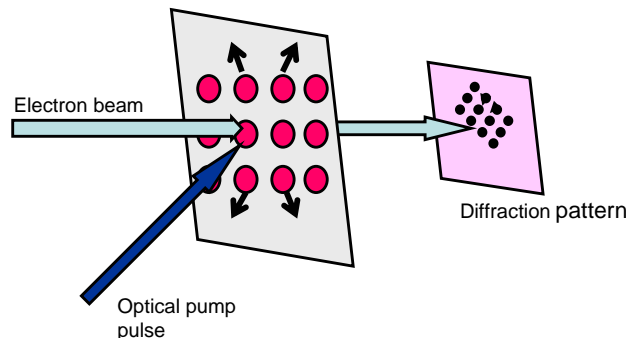
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## Introduction

The study of dynamics of phase transitions and the breaking of chemical bonds in a reaction is an important and rapidly growing area of modern science. The interest to this topic is gained both by its fundamental aspect and possible applications in fast switching. Some structural changes may occur on a timescale of tens of femtoseconds and the detection of their dynamics requires an advanced measuring technique. The most widely used method for study of the structural dynamics is an all-optic technique, on which the material is excited by a light pulse. The induced structural changes are accompanied by a change in the optical properties of the material that can be measured by second optical probe pulse. Unfortunately, the optical properties of a studied material are not always directly linked to the atomic order and can be influenced by other factors. The direct access to the atomic motion can be obtained by time-resolved x-ray and electron diffraction.

Femtosecond electron diffraction experiments with an atomic resolution provides the foundation to watch atoms move and structures change in real time. Here we present the development of a new powerful tool for studying the electron diffraction on a timescale of few tens of femtoseconds: a Relativistic Electron Gun for Atomic Exploration (REGAE). This machine is under construction at DESY site (building 23). REGAE will operate with relativistic electrons which improve the temporal and spatial resolution. The improved beam parameters open the door to a new class of pump-probe experiments comprising more complex structures such as proteins in the crystalline and liquid phase. REGAE is expected to show the first atomic movies by the summer 2011.

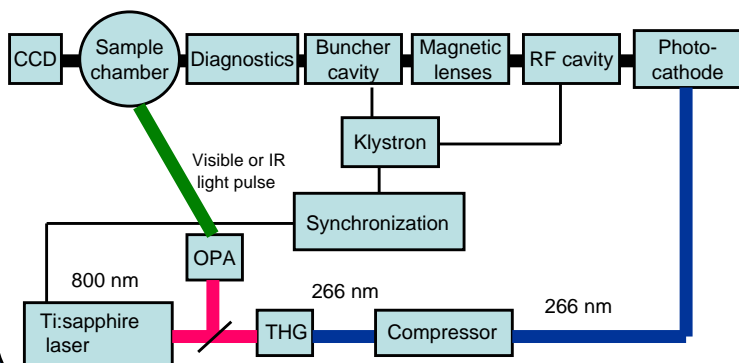
## Electron pump-probe diffraction



## Advantages of relativistic electrons

- > **Large coherence length:**  
improved resolution and contrast in diffraction image
- > **Small emittance:**  
shorter pulse length, higher electron density
- > **Small focal size:**  
advantage for small samples

## REGAE layout



## Desired parameters

Pulse repetition: 50 Hz.  
Energy: 5 MeV  
Number of electrons:  $\sim 10^6$  electrons/bunch  
Pulse duration:  $\sim 40$  fs

## Beam parameters for long Gaussian beam

