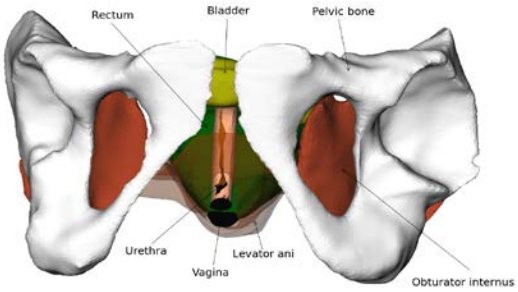
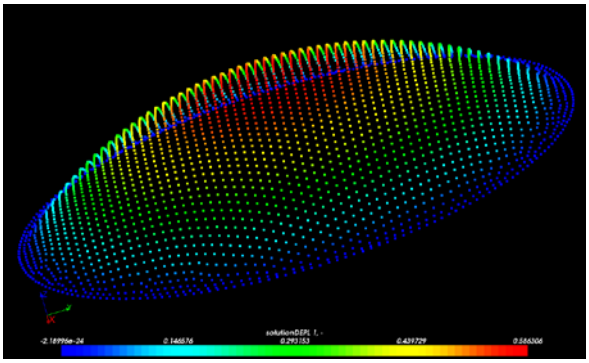
Application of *Code_Aster* in the Biomechanics Laboratory

We deal with soft biological organs like intestine, aortas, skeletal and cardiac muscles on tissue level. Besides some commercial codes we more and more employ the facilities in and around *Code_Aster* as this framework perfectly suits our needs including its extensibility. We can name two research projects where three PhD students currently successfully apply *Code_Aster* in the field of Biomechanics:

1. BINGO: This project started in January 2013 and aims to simulate and optimize surgical mesh implants in the female pelvic floor. The goal is to efficiently avoid urinary incontinence in women. We model organs, muscles, ligaments and the mesh implants in a geometrically and physically highly nonlinear framework in 3D. The organs are in contact without friction. But the large contact areas are a computational challenge .



2. Cardia$_{kytos}$: This project aims to measure prestress in cardiac myocytes. Using *Code_Aster* we simulate inflation experiments of thin cardiac tissue on extremely thin circular silicone membranes in order to determine the mechanical properties of the tissue and its response to medication. From a modeling point of view this application is a geometrically and physically nonlinear plate or shell problem.



Our own developments in *Code_Aster*

As we are mainly dealing with hyperelastic materials we implemented an incompressible anisotropic Holzapfel constitutive model that incorporates two separate fibre families in a neo-Hookean matrix and is widely used in biomechanics. Moreover since 2012 we are implementing a tissue growth model into the *Code_Aster* material library.

In order to deal with locking phenomena and accuracy deficiencies of the FEM when modeling soft biological tissues we also implemented so-called Smoothed Finite Element Methods for linear 2D and 3D analysis as well as nonlinear 2D, 3D and plate analysis in *Code_Aster*.

Contact: Prof. Dr.-Ing. M. Staat (m.staat(at)fh-aachen.de)

Website: http://www.fh-aachen.de/en/faculties/medical-engineering-and-applied-mathematics/einrichtungen/labor-biomechanik/