PhD Project (e.g. P1)	Host institution	Start date (e.g. Month 6)	Duration (e.g. 48 months)	Supervisors (primary and co-supervisor)
P3	**TUW**	**1**	**48**	**M. Gföhler/T. Czerny/A. Otto**

Project Title: Impact of stent design on hemodynamics and vascular cell growth

Hypotheses/Aims:

After implantation of a vascular stent into an artery, the smooth surface with endothelial lining of the lumen is interrupted, non-physiological mechanical loads and flow disturbances contribute to local tissue damage, thrombi formation and vascular cell-growth, increasing the risk of re-stenosis. Aim of this project is to investigate, how design parameters of the inserted stent influence loads, local flow conditions and vascular cells and to determine design parameters that may reduce the likelihood of re-stenosis.

Short Description of the PhD project and Role of both Organizations (TUW & FHCW):

Task 1: Effect of mechanical loads and flow characteristics on vascular cells (lead: FHCW)
Selected materials will be tested for survival of vascular endothelial cells and smooth muscle cells. The cells will be analysed for survival, proliferation and inflammation markers (NF-kB and IL-6) by microscopic observation, flow cytometry, ELISA tests and integrated fluorescent protein- or luciferase reporters. Furthermore, the cells will be exposed to defined mechanical loads and flow stress and analysed for the same parameters. Results of these experiments will serve as a basis for later model building (see task 2).
Task 2: Computational investigation of loading and flow characteristics (lead: TUW)
A CAD model of the artery with inserted stent will be established, FEM will be used to determine wall deformation and mechanical loads on the vessel with inserted stent. Computational fluid dynamics (CFD) will be applied to determine local flow fields (velocities and stresses). Regions with unfavourable combinations of mechanical loading and flow characteristics, which may affect vascular cells (see task 1) will be identified as well as dead zones in the flow, which may facilitate thrombi formation. Different designs with varied stent strut geometry and cross section (triangular, rectangular) will be investigated and evaluated.
Task 3: Experimental investigations of flow characteristics and optimal stent design (lead: TUW)
A flexible transparent model of an artery will be generated from silicone for optical accessibility and implemented into a mock circulation loop available at TUW. A stent will be inserted into the vessel and the flow field determined using particle image velocimetry on micro (µPIV)- and macroscale (3D PIV). Flow characteristics (velocities and stresses) will be evaluated for different stent designs and in an iterative process with CFD (task2) the most favourable designs to reduce the likelihood of re-stenosis will be determined.

Expected Results:

- Influence of local flow and loading conditions on vascular cell growth and characteristics
- Stent design parameters and associated loading and flow conditions that contribute to reducing the likelihood of re-stenosis

Participating Faculty: M. Gföhler, A. Otto (TUW), T. Czerny (FHCW)

Planned lab rotations:
TU Wien: 36 months (CAD, FEM modelling, experimental flow investigations, with lab rotation to Technical Chemistry for CFD)
FHCW: 12 months (investigations on vascular cells)