Miniaturization of machine tools is especially of benefit for small parts manufacturing using smaller tools. Smaller machine tools are potentially faster and more precise, but one has to deal with flexibility and sensitivity to disturbances too. Challenged in this project is the mechatronic design of a demonstrator consisting of a high speed spindle equipped with active magnetic bearings and a planar dual stage that should improve machining time and machining accuracy by using high bandwidth control of both motion and process.

The tool is fixed in the rotor while the workpiece is mounted on the planar stage. The planar dual stage consists of a long- and short stroke positioning unit.

In this research, the active nature of Active Magnetic Bearing (AMB) spindles is employed to realize online process monitoring and process control. The information already available in the signals from the AMBs is used to estimate the cutting forces. Process control techniques are also realized through the possibilities provided by AMB technology.

A miniaturized AMB spindle is designed and built. A small AMB spindle enables extremely high rotational speeds in combination with very high accuracy. The high speed is required for good cutting results with small diameter tools. The small spindle, and thus low mass enables monitoring of the cutting process using the AMB sensor system.

Air bearings are an alternative option to support the high-speed spindle. Air bearings have a low friction coefficient and are just as magnetic bearings contactless. The lubrication air has a low viscosity, which results in a low load capacity. Due to the high-speed the compressibility leads even to a limited value of the load capacity. The compressibility and other phenomena like shock waves influence the performance of the air bearings. In what way and how much these phenomena influence the performance is studied in this research.