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## PROJECT EXAMPLE: ULTRASOUND CHARACTERIZATION OF MUSEUM CULTURAL HERITAGE

### Background and preliminary work

The digitalization of cultural heritage such as literature, music and film enables easy access via the internet for everybody. A look into the repositories of German museums reveals, however, that many objects are not accessible to the public, and, to a limited extent only, to researchers. Although there are a number of optical methods to digitize sculptures and analyze their status, they have not been used extensively in the closed environment of a museum. Ultrasound offers excellent methods to gain information non-destructively from the depths of opaque materials, however, they are very time and personnel-intensive.

Fraunhofer IBMT has been collaborating for several years now with museums in ultrasonic characterization of sculptures. Between 2010 and 2013 a project with the Rathgen Research Laboratory of the Berlin State Museums was funded by the DBU. Here it was possible to demonstrate the application of classical diagnostic imaging, generating images of cracks and flaws in marble sculptures. Since 2015 the board of the Fraunhofer-Gesellschaft funds a joint project of several institutes and the Dresden State Art Collection. The aim is the consolidation of technologies to capture the surface of sculptures as quickly as possible in three dimensions, and to gain information about their condition, inner structure or possible damage.

### Approach

Fraunhofer IBMT benefits here from technology transfer between biomedical and technical ultrasound. The power output of single and multi-channel systems such as the Digital Phased Array System DiPhAS can be extended for this special purpose. Techniques for diagnostic imaging and tomography

established in medical applications are combined with approaches in signal processing for the detection of cracks and flaws. Ultrasonic single- and multi-element probes or arrays are matched to the material properties of cultural objects of interest such as marble or sandstone. Techniques developed for three-dimensional ultrasound are used for the automated and rapid position tracking of the sensors.

### Potential

Depending on the sculpture, traditional manual ultrasound tomography can take several days. This is due to variable surface geometries, many manually registered transducer positions and complex data analysis. With the development of a rapid, automated, non-destructive, ultrasonic measurement procedure for the first time it would be possible to survey whole inventories of sculptures and to make the results available in digital form to laymen and specialists.

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1 A look into a part of the repository of the Staatliche Kunstsammlungen Dresden.

2 Ultrasound examination of "Mercury and Psyche", Alte Nationalgalerie, Staatliche Museen zu Berlin.