

# SkinBall – Skin Tumour Detection by using a Millimeter-Wave Photonic Spectroscopy System

*Innovation Project within the INTERREG-V-A Program “ROCKET Reloaded”*

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## Executive Summary

The SkinBall project focuses on health care. SkinBall will develop a mobile millimeter-wave (mm-wave) spectroscopy instrument to enable mobile skin monitoring. Because being mobile, the SkinBall instrument will eventually be used by registered doctors for in-vivo screening of their patient’s skin. This is expected to be beneficial for two reasons: first to reduce the number of unnecessary biopsies and second to support early skin-cancer detection. Of course, the SkinBall instrument will also support in-vitro monitoring, e.g., performed by skin-cancer surgeons in specified clinics or in larger laboratories. Here, one may assume a more powerful instrument. A precise analysis of skin cancer can potentially provide sufficient data on the size and depth of the tumour. Especially for facial tumours, this may help to reduce unnecessary deep cuts or to avoid multiple operations on the other hand. It may even allow plastic surgery to be carried out right after the cancer treatment in one surgical intervention, which would be a great relief for patients.

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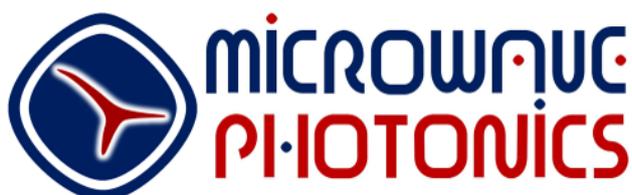
### **Introduction**

In the recent past, a considerable interest has been shown in detecting and managing various types of cancer by means of non-ionizing electromagnetic waves. Applied research into this area has shown that cancer modifies the water content of the skin, which has a direct impact on the skin's permittivity [1]. For that reason, the microwave range (in particular within the 300 MHz - 10 GHz frequencies) has been exploited for imaging breast cancer [2] and lung cancer [3]. In comparison to microwaves, millimeter waves (30-300 GHz) exhibit shorter wavelengths and thus penetrate only a few millimeters or waves into the human body [4], making them highly efficient for sensing pathological variations in different skin layers in which skin tumours primarily occur [5]. Additional biomedical applications include non-invasive-dental-caries detection, blood-glucose monitoring, corneal-hydration assessment, wound-healing monitoring, and vital-sign observation [1]. Even though the concepts are very promising, more accurate, more reliable, and more stable mm-wave monitoring systems still have to be developed. This also includes the development of a high-accuracy skin-monitoring instrument.

### **SkinBall Project**

The SkinBall project will develop such a mobile mm-wave spectroscopy-imaging (MMWSI) system based upon advanced photonic technologies and an innovative mm-wave spectroscopy-system concept. The SkinBall MMWSI system will be used to monitor the permittivity of the human skin in vivo and in vitro. The technological challenge is to develop a mobile and high-resolution MMWSI system that could operate over an extremely wide bandwidth (>50 GHz) and provides sufficient contrast for reliable skin-tumour detection and analysis.

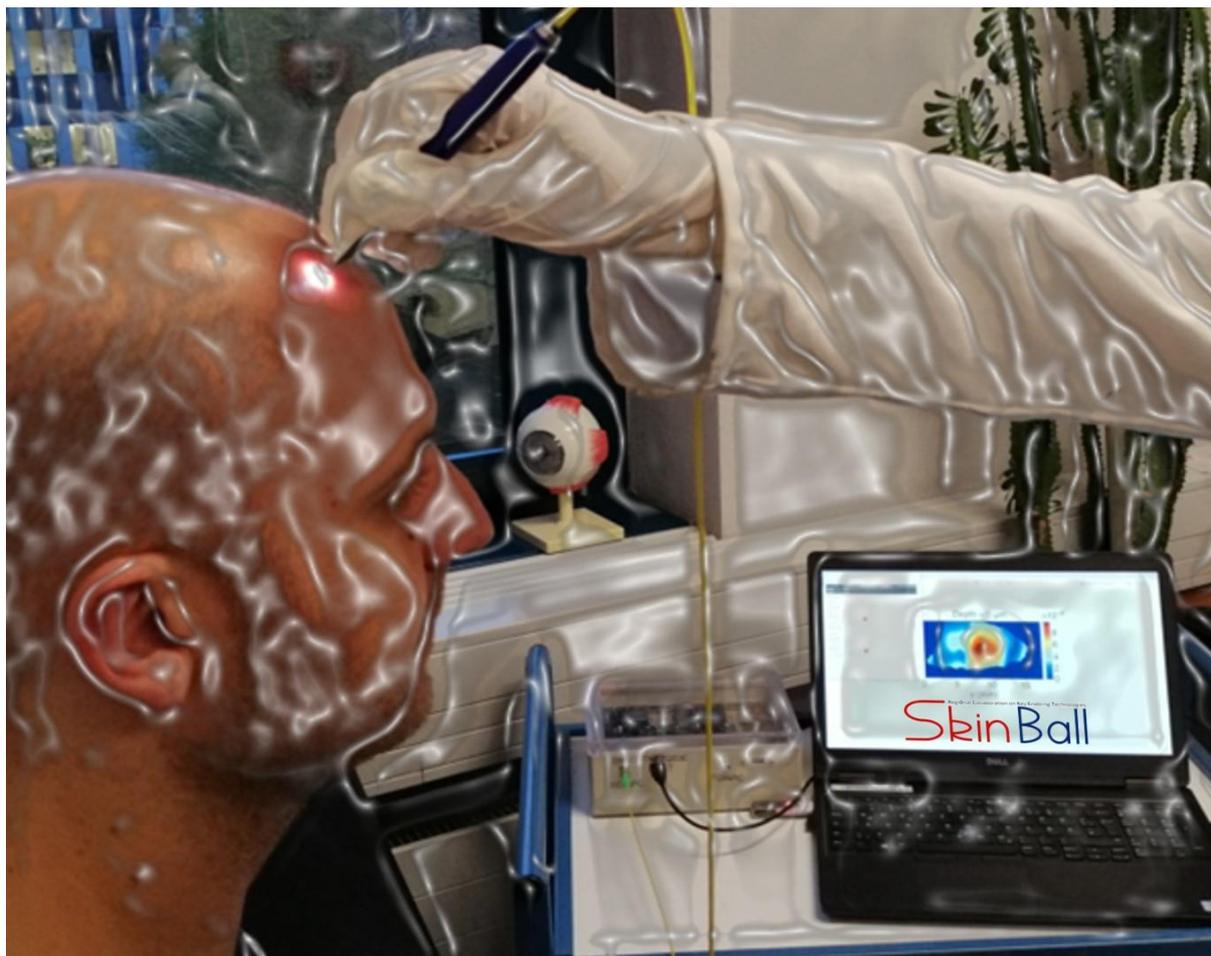
In general, photonics is the best-known technology for providing low-phase-noise reference signals (see Nobel Prize for T. W. Hänsch et al. in Physics 2005) and for providing ultra-broadband mm-wave generators and detectors. These two features are fundamental prerequisites for a successful development of a stable MMWSI system. Therefore, for the first time, SkinBall will develop a mobile photonic MMWSI system for enabling in-vivo and in-vitro skin monitoring (see figure below). If successful, the SkinBall MMWSI system will support skin-tumour detection, potentially reducing the number of unnecessary biopsies and it may also assist surgeons by providing precise data on the tumour's size and depth.



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Practitioner examining a patient's skin using the lightweight, mobile, and fiber-coupled mm-wave spectroscopy instrument to be developed in **SkinBall** (re-enacted scene for visualizing the project's key objective).

## Project Partners



For realizing the innovative approach, the SkinBall partners Microwave Photonics GmbH and Mintres BV will join their forces. For high-power operation, Mintres BV will integrate a photonic InP chip provided by ZHO/Optoelectronics on a CVD diamond carrier (chip-on-carrier, CoC) for thermal Joule-



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heating management in the high-power source. Mintres BV will provide the photonic CoC to Microwave Photonics GmbH where it will be packaged with optical fiber. The University Hospital Essen in Germany will provide skin samples to the project partners and will also provide an expert evaluation of the measured spectroscopic and image data.

## Conclusion

In summary, the focus of the SkinBall project is the development of a photonics-based mm-wave spectroscopy instrument for mobile skin-cancer identification and screening. For this, the project proposes a number of innovations with respect to photonic processes, modules, and systems. The project also addresses smart materials and new process development for fabricating hybrid integrated chiplets.

## Acknowledgment

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