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# Automated tissue boundary detection

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**Abstract:** To address the challenge of tissue differentiation during cranial perforation surgery, presented research aims to integrate optical illumination and detection capability into rotating assemblies of surgical tools. 

## 1. Introduction

Cyto-reductive surgery of brain tumours requires removal of a portion of the cranium. This step in the procedure is termed craniotomy and carries an increased risk of brain tissue damage due to accidental plunging of the cranial perforator (CP) [1–4]. Our previous investigations where optical sensing was integrated with rotating drills and burrs showed that the boundary between the bone and underlying tissue can be detected directly, in real time using diffuse reflectance spectroscopy [5, 6]. The drawback of the previous instruments was the noisy, inefficient coupling of light between the rotating drill attachments and stationary source-detector components as well as lengthy optical fibres and electrical wires.

The aim of current research is to develop a wireless and "fibreless" instrument capable of two-wavelengths tissue illumination as well as light collection, data processing and automatically stopping the drill prior to crossing the tissue boundary. By placing the illumination sources, detectors as well as micro-controllers on a PCB mated to the rotating CP, it will be possible to create a compact tool with direct measurement capability and solve the inefficiencies associated with light coupling into rotating optical elements.

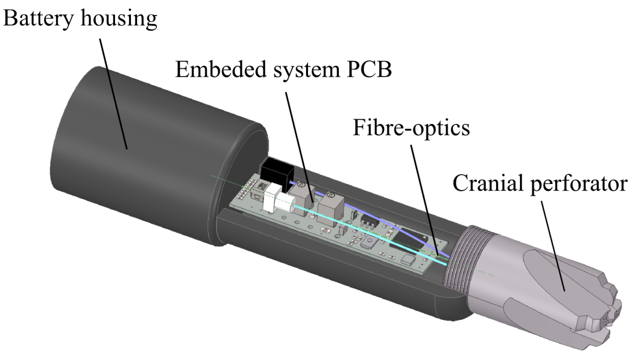


Fig. 1. Envisioned wireless CP attachment. The PCB and optical element are designed to fit inside a narrow cylindrical enclosure and rotate together with cranial perforator.

## 2. Hardware development

### 2.1. *Cranial perforator*

Figure 2(a) shows a custom burr (14mm DIA) with geometry suitable for cranial perforation was machined from stainless steel. Two 1mm openings for were also created in a single relief surface of the cutting tool to allow integration of short optical fibres.

### 2.2. *Embedded source-detector*

Figure 2(b) shows a custom 10x30mm PCB designed and manufactured for the application. The PCB layout allowed integration of two light emitting diodes with 530 and 850nm wavelengths, a single photodiode and a micro-controller as well as supporting SMD components.

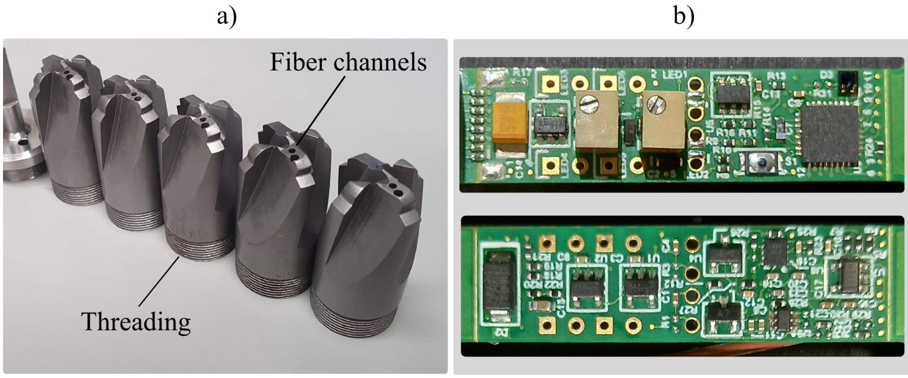


Fig. 2. a) Custom machined threaded cranial perforators. b) LED control and data acquisition PCB (top and bottom).

### *2.3. Ongoing instrument characterization*

The PCB is currently undergoing characterization of individual electronic sub-systems including LED drivers, signal digitization and synchronization. The micro-controller software is also under development and will allow the collected DRS data to be processed in real time on the PCB. We are aiming to be able to present a range of prelimenary results early 2022.

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