PARTICLE INDUCED X-RAY EMISSION (PIXE) REVEALS CRUCIAL INFORMATION IN HIP ENDOPROSTHESES FAILURES. MEV ION BEAMS FOR IMPROVING MEDICAL DIAGNOSTICS

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Worldwide, approximately one million hip replacements take place every year. This number is expected to grow, due to increased life expectancy and ageing population. Despite the rapid development of cutting-edge materials, there is an increased number of injuries linked to prosthesis failure during recent years. In response to this, the European Commission is working on a database, EUDAMED[1], to monitor the safety and performance of medical devices.

The insufficient understanding of physiological processes leading to prosthesis failure call for the use of complementary tools. Diagnostic techniques currently applied in hospitals, such as X-ray scans or optical tissue microscopies, are able to distinguish metal particles, but they are not able to identify their specific metallic origin (Ti, V, Al, etc.) and concentration.

Aiming to achieve better diagnostic tools to identify causes of hip prosthesis failure, TissueMaps[2] project was launched. The project was a multidisciplinary project of Jožef Stefan Institute and University Medical Centre Maribor, both in Slovenia, and it counted with the financial support of Marie Skłodowska-Curie Actions. The research has recently continued thanks to the RADIATE Transnational Access[3] by including new clinical cases from Switzerland.

Micro-PIXE has proved to be a valuable tool for mapping the distribution and quantification of metallic particles released from degraded prostheses, helping identify which prosthesis component is causing the failure, and to what extent.

The Micro-beam end station available at Jožef Stefan Institute 2MV tandetrom accelerator is especially suited for this type of research. With a high-brightness (14 A m^{-2} rad^{-2} eV^{-1}) focused proton beam, it allows the reduction of the object-slit aperture and acceptance angle, resulting in a reduced beam size. In addition, its high elemental sensitivity, with a detection limit down to 0.1 µg/g, and a lateral resolution down to 600 nm, makes it especially suited for this type of experiments.

[1] https://ec.europa.eu/tools/eudamed/#/screen/home
[2] This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 799182.
[3] https://www.ionbeamcenters.eu/radiate/radiate-transnational-access/