Project title:

Smart Biopsy for Precision Therapeutics in Prostate Cancer: MRI/CBCT Fusion and Robotic Guidance to Improve Molecular Adequacy of Bone Metastasis Biopsies

Project Summary:
Bone metastases from prostate cancer are among the most challenging lesions to biopsy. Standard CT-guided approaches often yield insufficient tumour content, with molecular adequacy rates of only 40–60%, particularly in sclerotic disease. This limits access to precision therapies and clinical trials, increases repeat procedures, and risks misclassification of tumour biology.

Whole-body MRI (WB-MRI) has transformed prostate cancer staging by providing functional and microstructural information about biologically aggressive lesions. Integrating WB-MRI into biopsy workflows, an approach termed *smart biopsy*, has already improved molecular adequacy, but current cognitive fusion methods remain suboptimal.

This project aims to develop a next-generation *smart biopsy* platform that integrates advanced MRI biomarkers, direct MRI/cone-beam CT (CBCT) fusion, and robotic guidance. The goal is to achieve molecular adequacy above 90%, enabling reliable tissue for genomic profiling, treatment stratification, and clinical-trial enrolment.

Using the IDEAL (Idea, Development, Exploration, Assessment, Long-term follow-up) framework for interventional innovation, the fellow will perform:

- **Phantom validation:** Validate MRI/CBCT registration accuracy and robotic needle targeting against freehand guidance in a controlled phantom environment (IDEAL stage 0–1).
- **Retrospective analysis:** Analyse existing imaging–histology datasets to identify MRI and CBCT features predictive of high tumour cellularity and molecular adequacy.
- **Prospective development study:** Conduct a first-in-human feasibility study of MRI/CBCT-guided robotic biopsy in patients with prostate bone metastases, evaluating procedural safety, adequacy, and user acceptability (IDEAL stage 1/2a).

Parallel correlation of MRI biomarkers (Apparent Diffusion Coefficient, Fat Fraction, VERDICT) with digital pathology will support development of *digital biopsy*—a non-invasive, imaging-based assessment of tumour biology.

Supervisory Team:
The supervisory team unites interventional radiology, oncology, imaging biomarker science, and medical robotics across the Royal Marsden, ICR, and Imperial College London. The fellow will gain convergent training in image-guided intervention, quantitative imaging, and translational biomarker science, directly addressing CRUK priorities in precision treatment, data-driven healthcare, and convergence science.

- **Dr Edward Johnston –** Consultant Interventional Radiologist, Royal Marsden; Group Leader, Computer Assisted Interventional Radiology (CAIR), ICR *(Primary Supervisor)*

- **Dr Matt Blackledge –** Reader, Computational Imaging Group, ICR *(Imaging Biomarkers)*

- **Professor Ferdinando Rodriguez y Baena –** Professor of Medical Robotics and Co-Director, Hamlyn Centre, Imperial College London *(Engineering)*

- **Professor Johann De Bono –** Regius Professor of Cancer Research and Head, Prostate Cancer Targeted Therapy Group, ICR *(Clinical Translation)*

Clinical Specialities:

Diagnostic and Interventional Radiology, Oncology (with an interest in imaging and translational therapeutics), Nuclear Medicine.