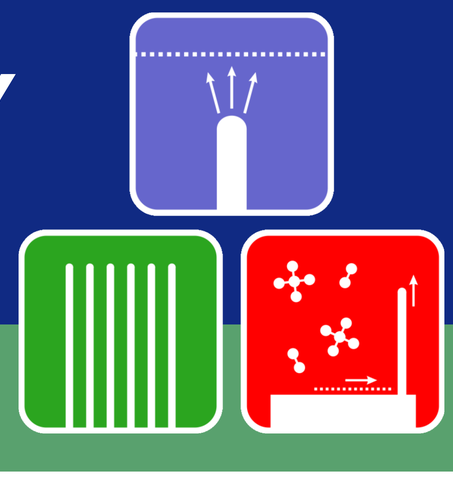
DESIGN, BUILD & TEST OF A NANO X-RAY GUN



J. E. Capper[1] & M. T. Cole[1*]

Introduction

This project is in collaboration with the Nanomaterials group who are developing a variety of carbon nanotube (CNT) emitters. This project focusses on creating a basis for the evaluation of different CNT structures and their impact on the emitted X-rays by iterating a previous design.

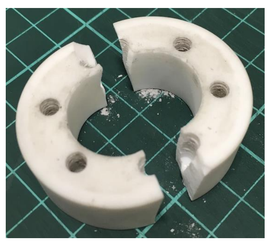
Function

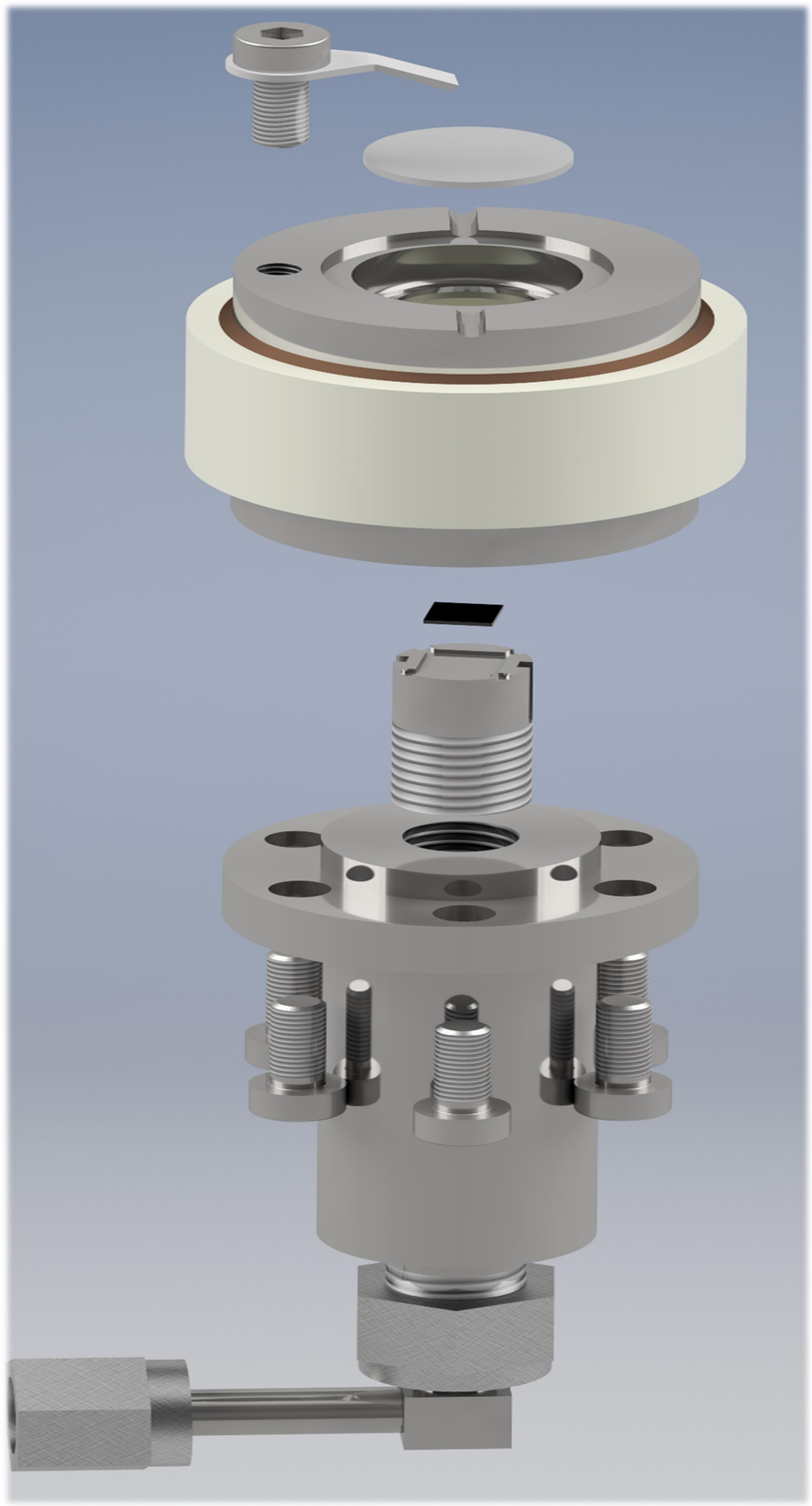
The tube works by creating an electric field which compresses around the tips of the CNTs and causes electrons from the CNT emitter to accelerate towards the anode. On collision with the anode, the energy lost by the electron is released in the form of an X-ray photon.

Issues: Mica Spacer

During the project, the original mica spacer fractured due to too much torque applied to the bolts.

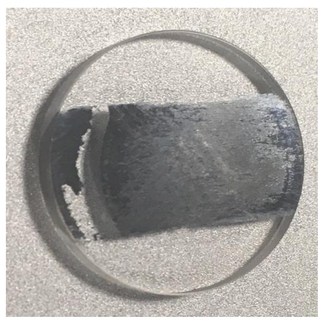
A new spacer was then designed, which utilized brazed seals between the mica spacer and titanium flanges.





Transmission Window

The previous device used an aluminium target window. This project investigated the benefits of both quartz and beryllium windows, both with significantly improved X-ray transparency.



30 nm of aluminium (Al) was deposited onto 15 mm diameter quartz windows using the thermal evaporation method.

Quartz has good X-ray transparency and the Al allows for the electrical connection to the anode necessary to set up the field.

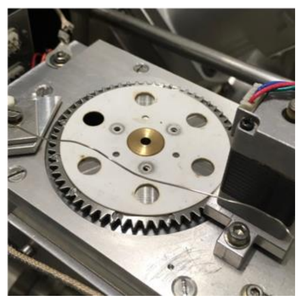
Beryllium, an impressive material, can be toxic to manufacture.
The beryllium windows were cut using the following water-jet cut settings:

Pressure: 60000 pi
Water mix: Water & 80 Grit Garnet

Nanotube Electron Source

The CNT sample, grown by fellow research Greg Spratt, was tested using a field emission test rig to attain the I-V characteristics.

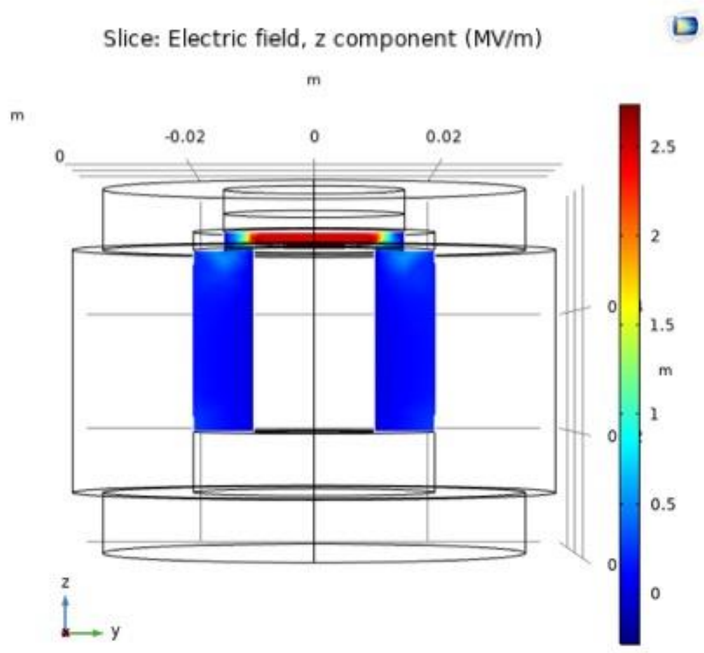
It was found that the anode current achieved would successfully emit X-ray photons.



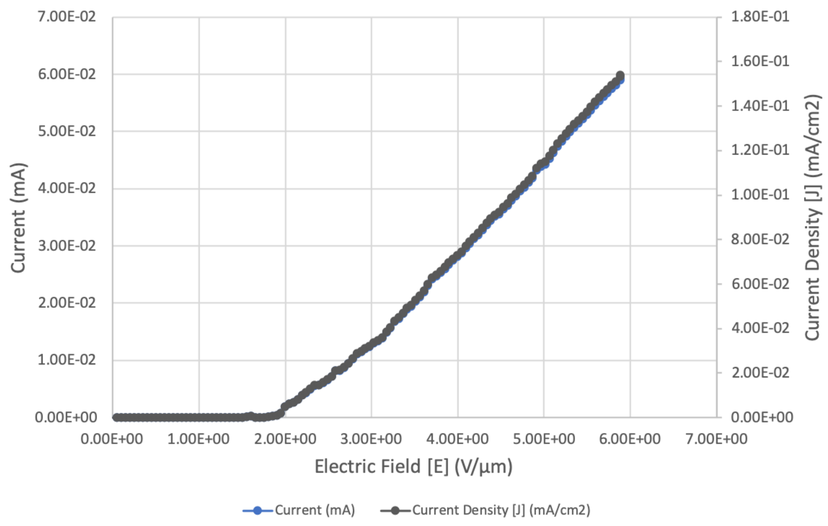
Simulation

A Comsol simulation model was developed to accurately model the electric field within the device.

A graphite sample was used instead of a CNT sample due to limitations in the Comsol software.



Field Electron Emission



Department of Electronic & Electrical Engineering

UNIVERSITY OF BATH

[1] Department of Electronic & Electrical Engineering, University of Bath, Claverton Down, Bath, BA2 7AY, United Kingdom

* mtc47@bath.ac.uk