Status of the SmartPhantom Development

Plenary Meeting: 11/12/2019

Hin Tung Lau

Imperial College London

SmartPhantom

SmartPhantom is proposed to be a set of scintillating fibre detectors to characterise a beam impinging cell samples in a water phantom.

- Detectors will measure the energy deposition of a beam.
- Consists of 250 μm fibres.
- Several detector stations can be placed in set positions with respect to the position of the cells.

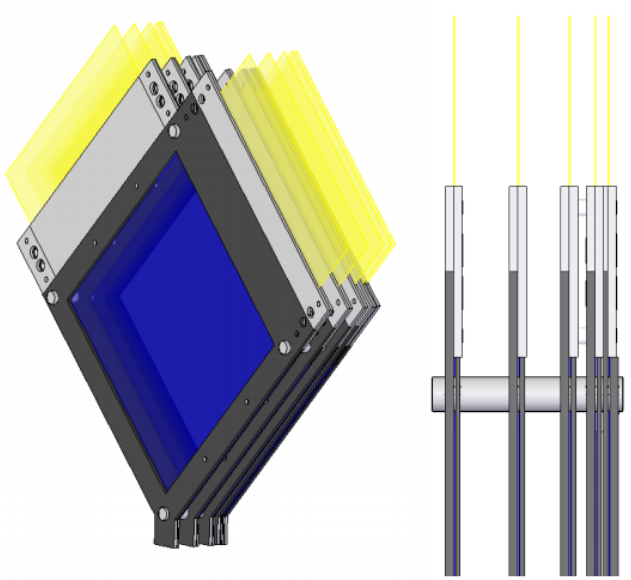

Figure: Concept of an early stage of the SmartPhantom.

Impact of Scintillating Fibre

Effect of the presence of scintillating fibres based on Geant4 simulations for protons:

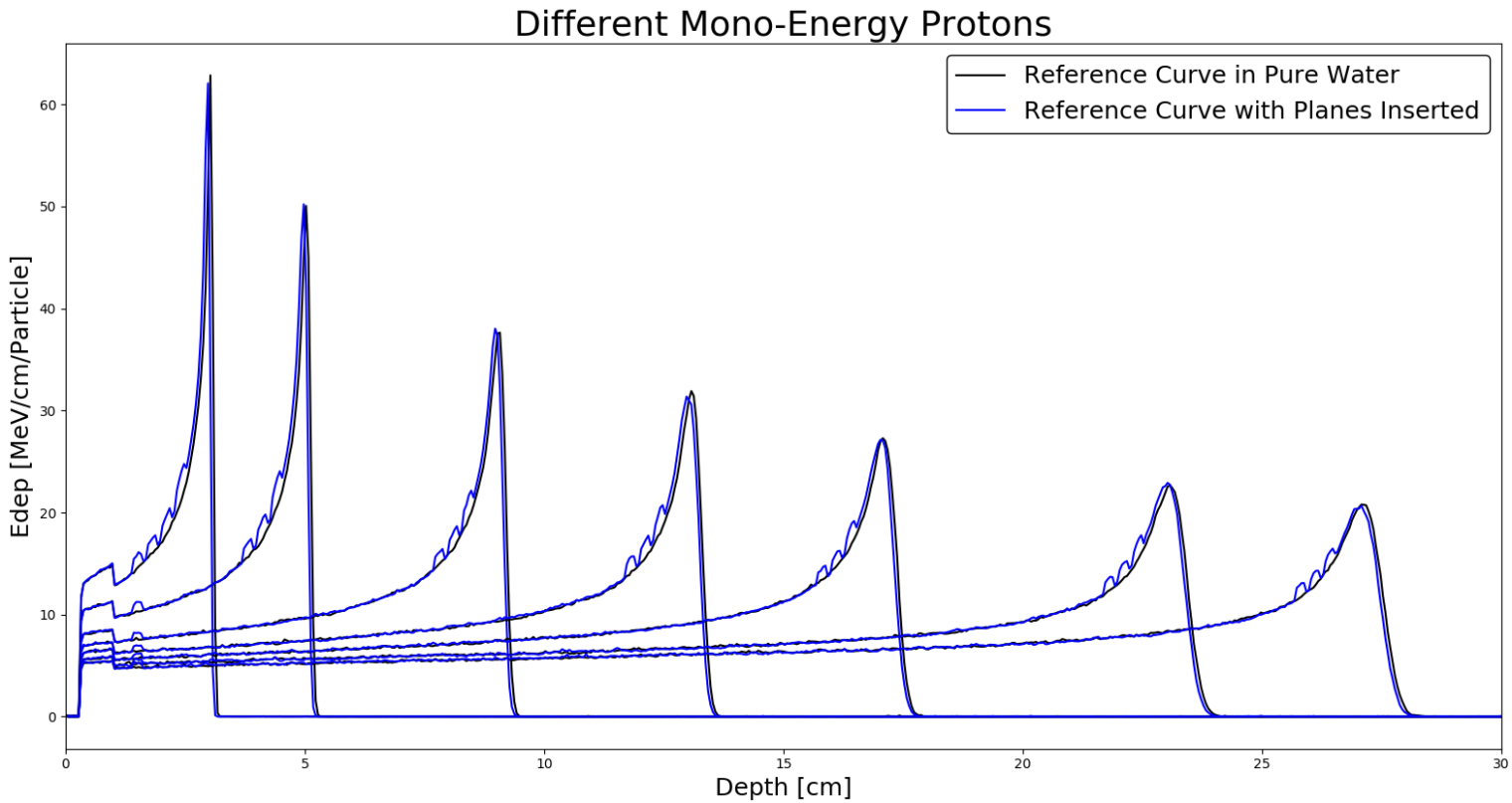

Figure: (Simulation) Comparison of the energy deposition of multiple energies of proton in a pure water phantom (black curve) against the energy deposition with four SmartPhantom stations present (blue curve). The initial bump at the start is due to the walls of the water phantom.

Read Out

A one-to-one mapping needed between scintillating fibre and clear fibre for readout to camera:

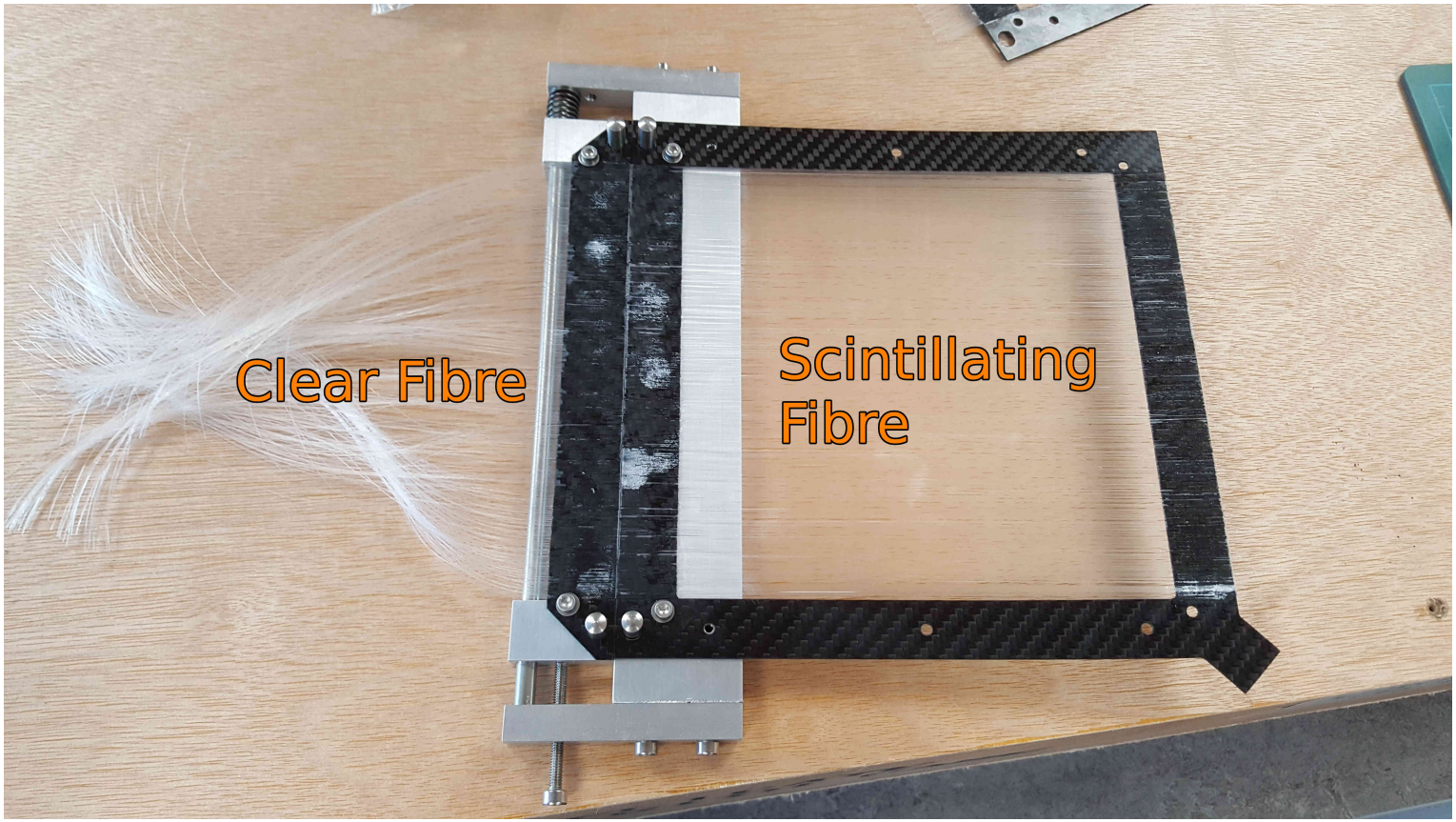

Figure: Example of the one-to-one mapping between clear fibre and scintillating fibre demonstrated with fishing wire.

Possible Analysis Results

May be possible to reconstruct the energy deposition curve based on the measurements:

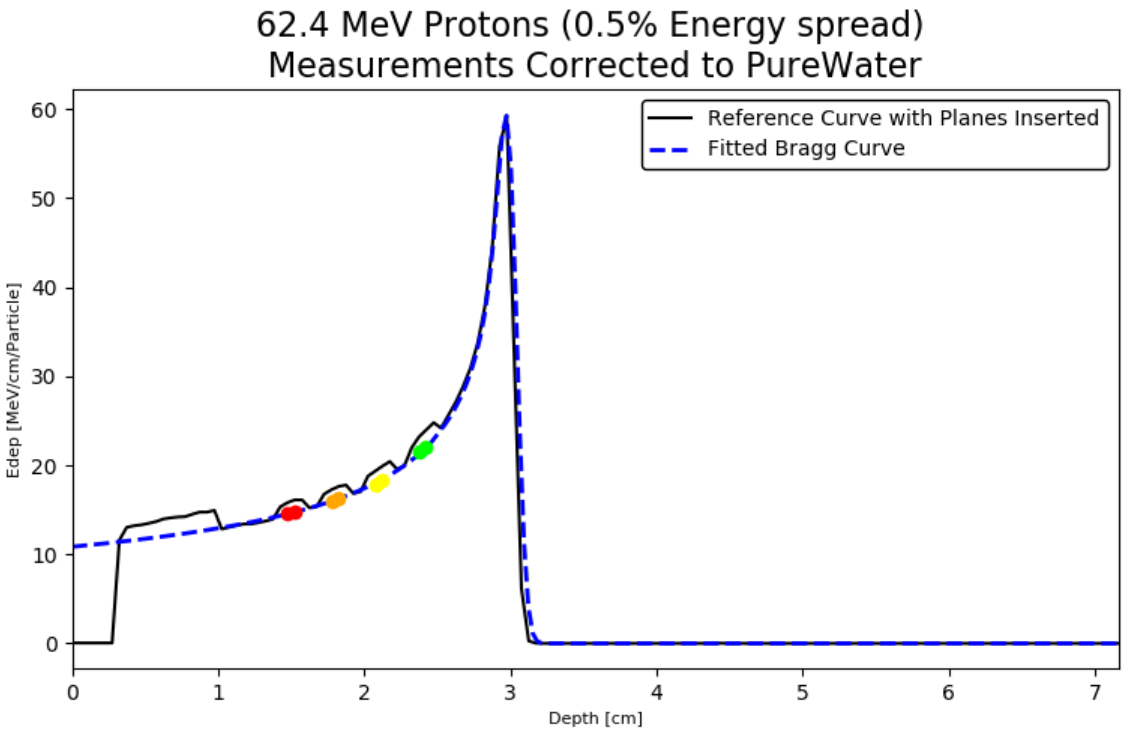

Figure: (Simulation) The black curve is the energy deposition from a simulation (i.e. what one would measure). The coloured points are what is measured. The curve in blue is fitted Bragg peak to the 8 measured points.

Possible Analysis Results

Would also be able to measure the beam profile:

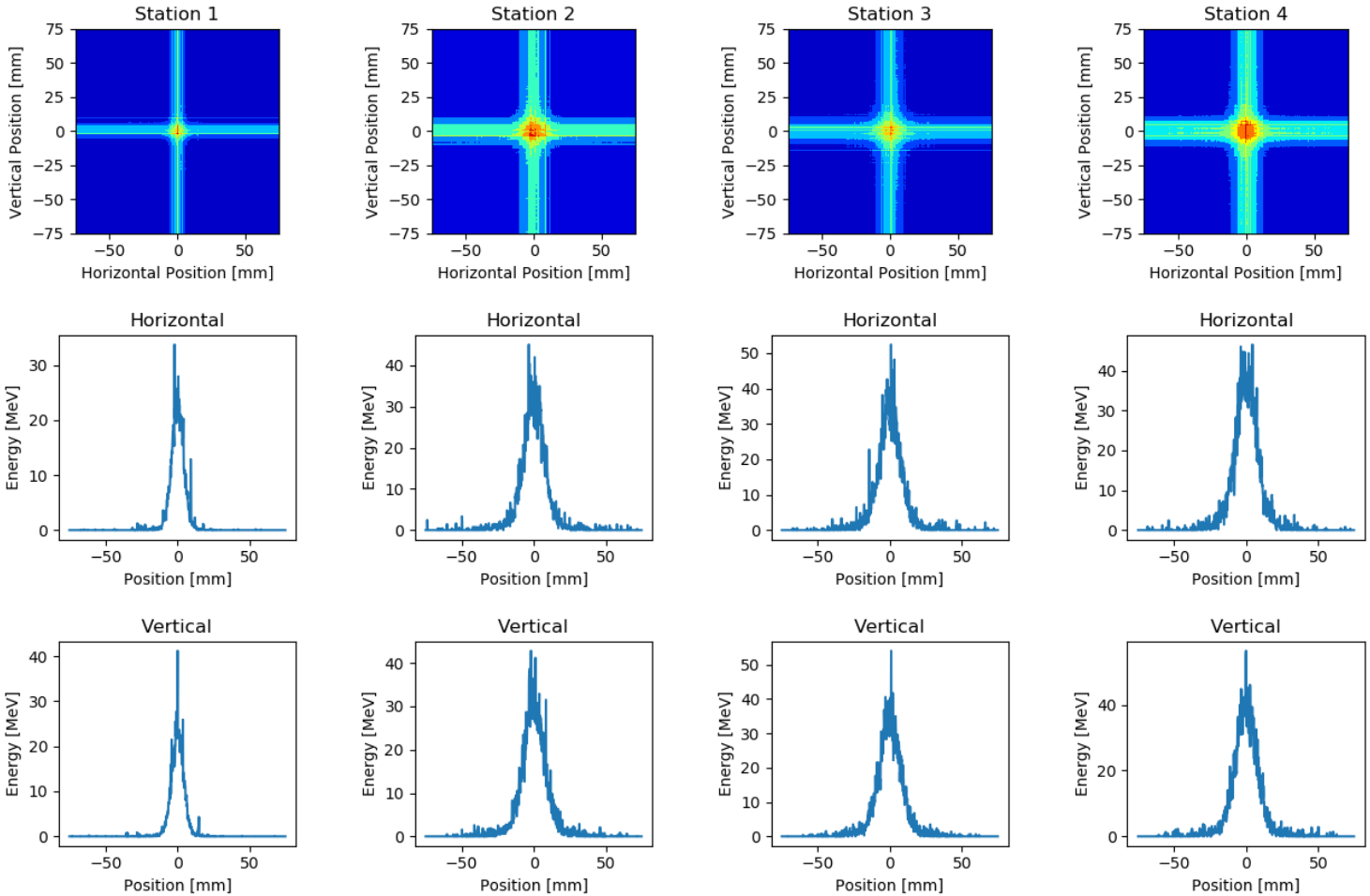

Figure: (Simulation) Example of beam profile measurements from four stations.

Winding

A winding jig was developed to help winding the fibres:

- PTFE lobes have grooves for fibre alignment.
- After fibres are winded, they are glued to the frames.

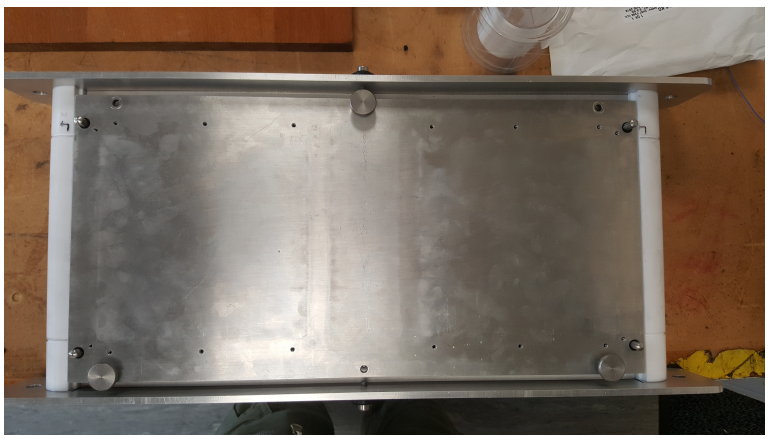

Figure: Winding jig viewed from top.

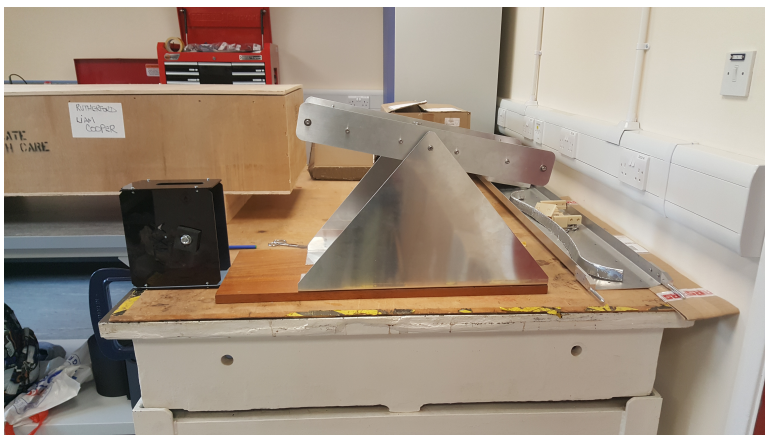

Figure: Winding jig viewed from side.

Fishing Wire Prototypes

- First prototype showed tension issues which caused the frame to bend.
- Second prototype wound with less tension but still some bending along with fibre alignment not being preserved.

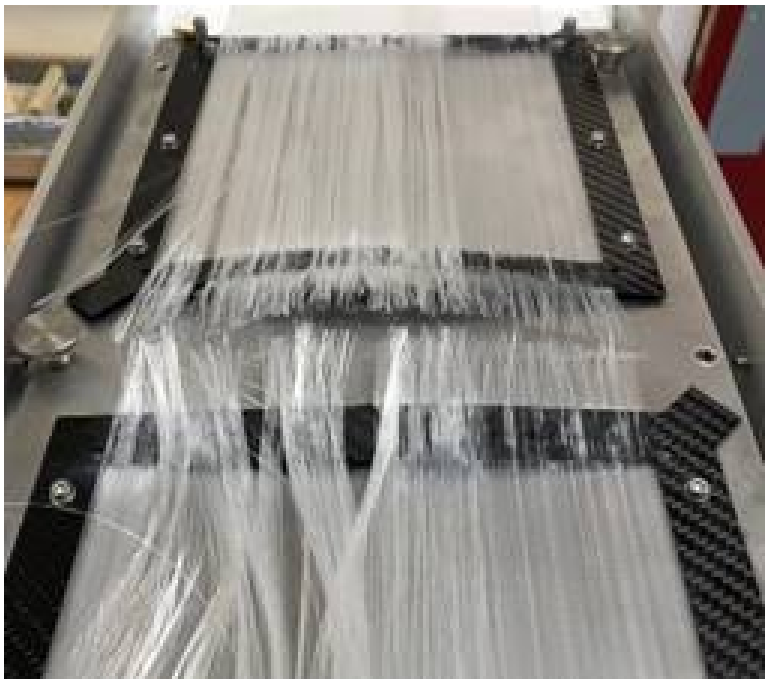

Figure: First prototype showed excess tension caused frames to bend when wires cut.

Figure: Second prototype still shows bending along with fibre misalignment after wires cut.

Fishing Wire Prototypes

Modifications were made to address the previous issues:

- Frame aperture changed to a circle and made smaller.
- Lobes on winding jig moved closer to better preserve fibre alignment.

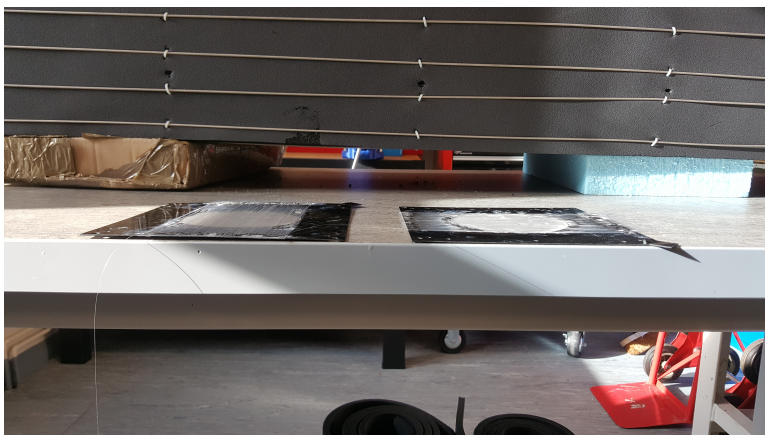

Figure: Two gluing methods were tested, with the method on the right showing little to no bending.

Figure: The fibre alignment is also preserved quite well.

However, polishing the ends caused the wires to be pulled upwards.

Fishing Wire Prototypes

Current iteration of prototype:

- Enlarges circle aperture slightly to satisfy experiment parameters.
- A recess is introduced into the frames

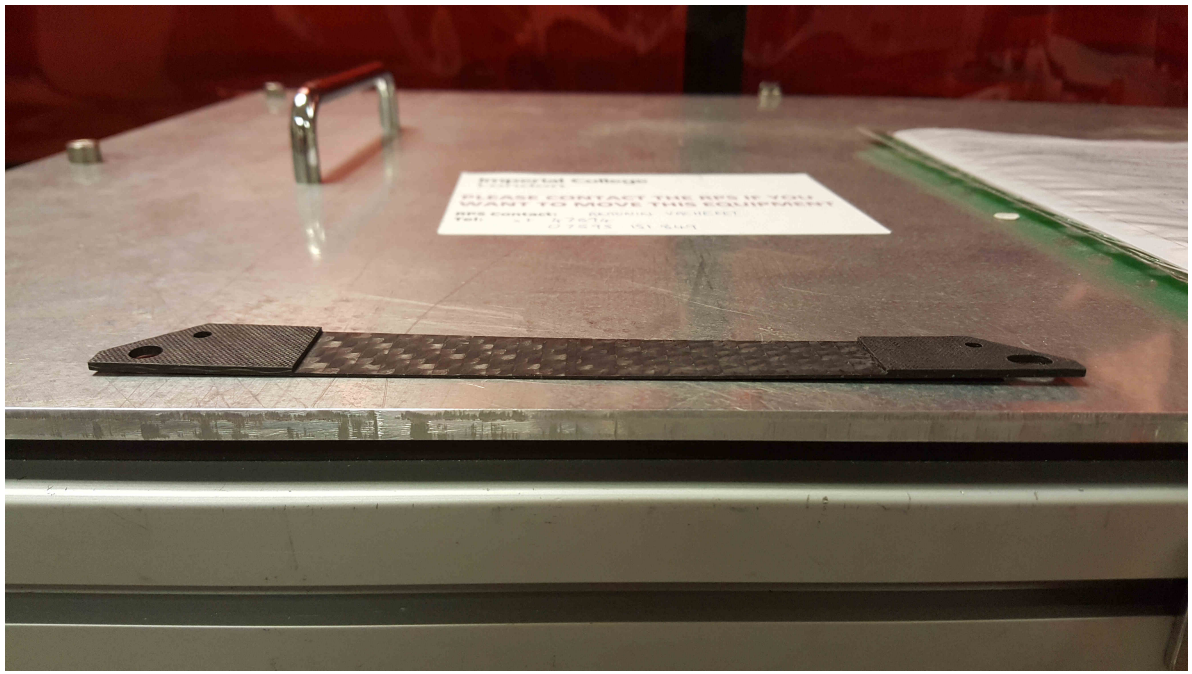

Figure: New prototype of the clear connector which introduces a recess.

Sr-90 Source Fibre Tests

Previous tests of SciWire with the collimated Sr-90 source saw no noticeable scintillation of fibres.

- Seek to verify with a single fibre to see if a signal can be obtained.

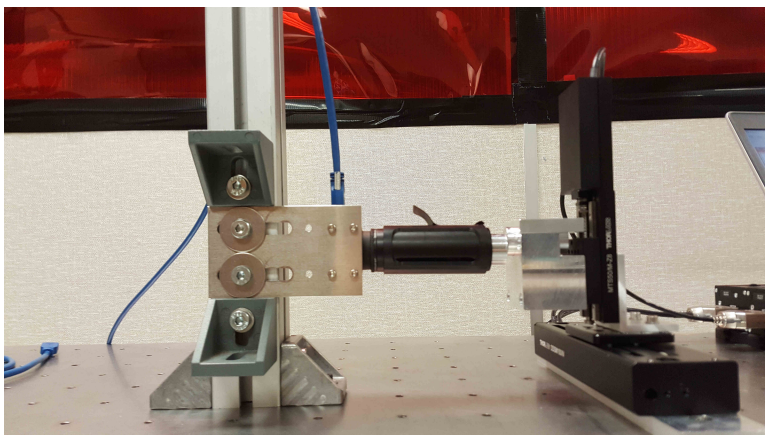

Figure: Side view of single fibre setup.

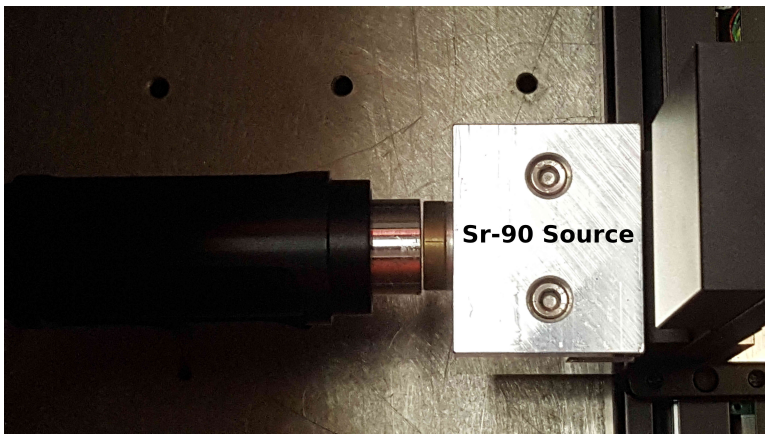

Figure: Top-down view of setup with the Sr-90 source installed.

Sr-90 Source Fibre Tests

- A UV LED acting as a source was used before the Sr-90 source for positioning seemed to show scintillation.
- However, nothing visible when Sr-90 source used.

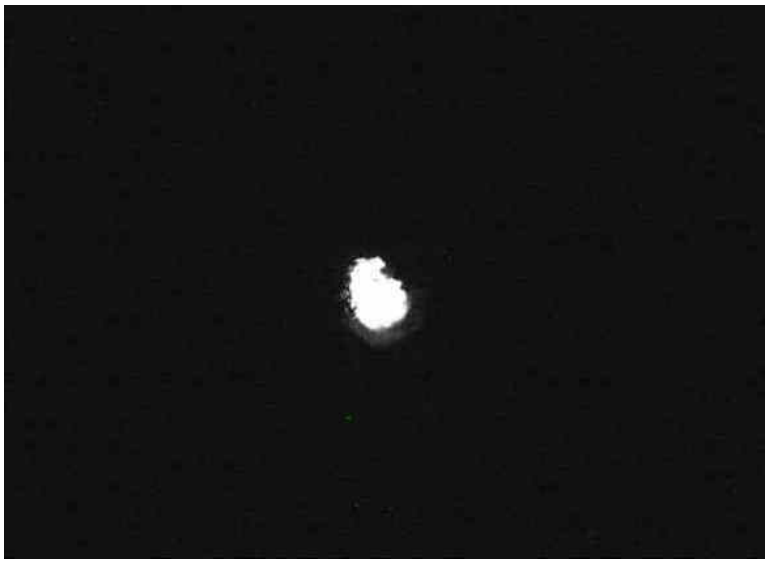

Figure: Image output from UV LED source.

Figure: Image output from Sr-90 source.

Fibre Dongle

Bundle of fibres consisting of both scintillating and clear fibre to be brought to a proton beam to see if a signal can be detected.

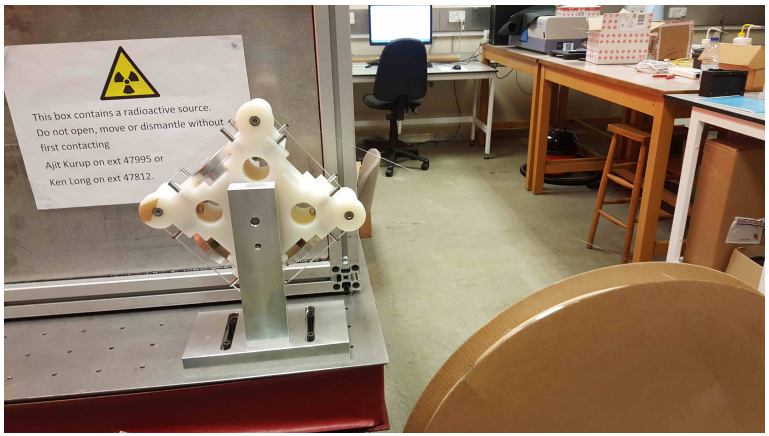

Figure: Repurposed winding jig from SciWire to wind fibres.

Figure: Bundle of scintillating and clear fibres into heat shrink, ready to be potted.

Thanks for Listening!