# End station design update

# Geometry

- Assumes vertical beamline [C1 from CMs]
- Gas profiler incorportated into the vacuum system before the exit window to minimise beam scatter
- 25um Ti window for vacuum system
- Upsteam BPM (SciWire, Silicon strips etc.) currenty assumed to be 125um Polyester to match SciWire
- 100um plastic window into a box to control env conditions [C6]
- 1.1 mm Polyester cell dish base (+/- 0.1mm from measurements) [C4]
- 160 um glass coverslip (essential for cell work endpoints)
- 30um cell layer
- 2 mm water layer
- Cell dish lid
- Downstream BPM
- 1 cm thick plastic box surrounding components for environmnet

# Upstream BPM

- Current options are
  - Gas Profiler (2D in vacuum system)
  - SciWire
  - SiliconStrips
- Ellie Gaggs (UoB Y4 Masters student) investigated an old silicon strip setup we have but cyclotron issues prevented full analysis sadly.
- Sam Flynn (UoB PhD / NPL) previously used device at an x-ray linac.

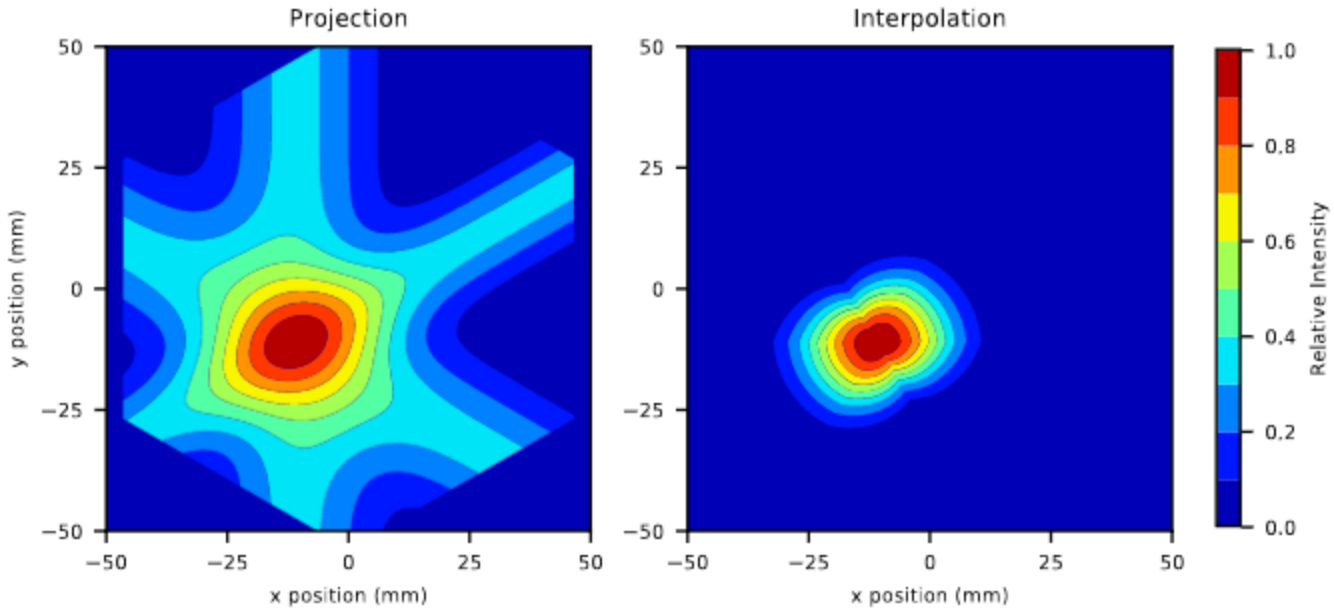



Figure 3.6: Comparison of the two PRaVDA tracker reconstruction methods.

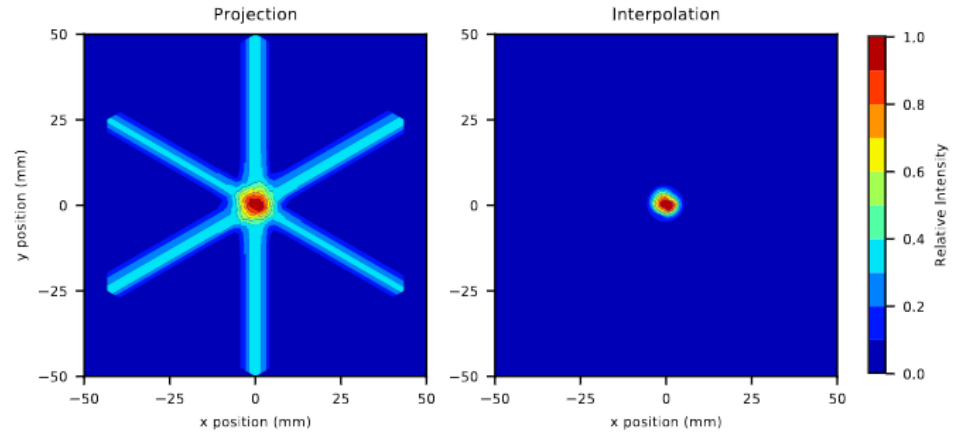



Figure 3.19: Reconstruction of $10 \times 10$ mm$^2$ 6 MV X-ray field.

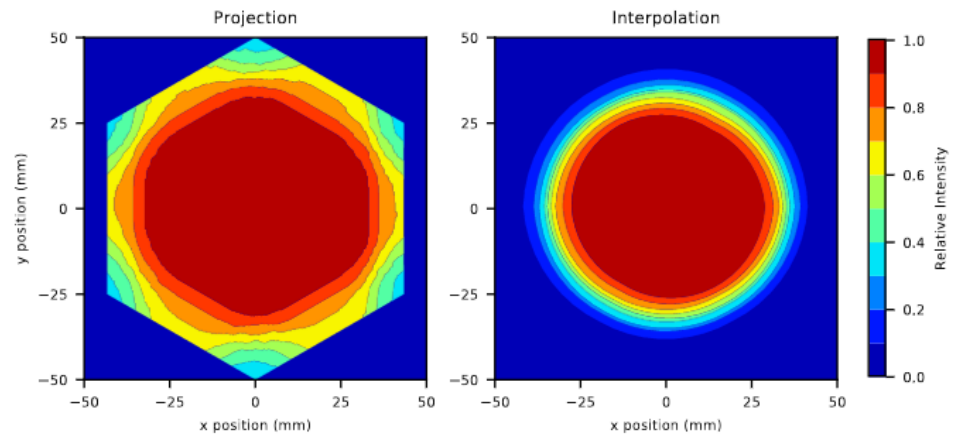


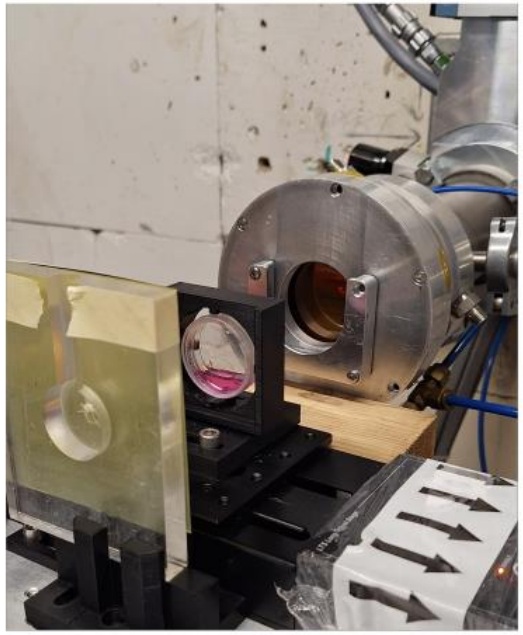

Figure 3.20: Reconstruction of $30 \times 30$ mm$^2$ 6 MV X-ray field.

# Downstream BPM addition

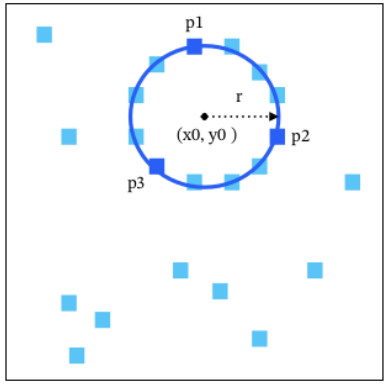
- Amber Jones (UoB Y4 project) realised that a cell dish is thick enough to fully stop a 15 MeV proton beam (with or without media or cover slip)
- Small env chambers will need to move, or samples in a large chamber would need to move. Need to verify position of sample.
- 35 mm beam diameter for stage 1
- Question: Would a downstream BPM allow for beam halo to be measured and sample position calculated?

# Downstream BPM

- Designed and 3D printed a holder for a cell dish and GaFChromic EBTXD film to set alignement
- Irradiations performed at MC40 running a scattered 18 MeV beam (14 MeV onto sample).
- Reinforcement Learning algorithm developed to identify circles within circles and calculate centre offsets and radii
  - Canny edge detection
  - Subset of edge pixels selected
  - 3 pixels selected N times and circles fitted to this
  - Circle compared to all edge pixels to calculate a metric of how well circle matches edges



Dish alignment experimental setup



# Downstream BPM

- Toy MC developed of concentric circles
- Known parameters allow for the algorithm to be validated
- Central r=35mm circle moved in X through an outer r=50mm circle
- Can see we can reconstruct the X position without impacting Y and r
- For real EBTXD profile algorithm found required circles so algorithm has legs to verify cell dish positioning

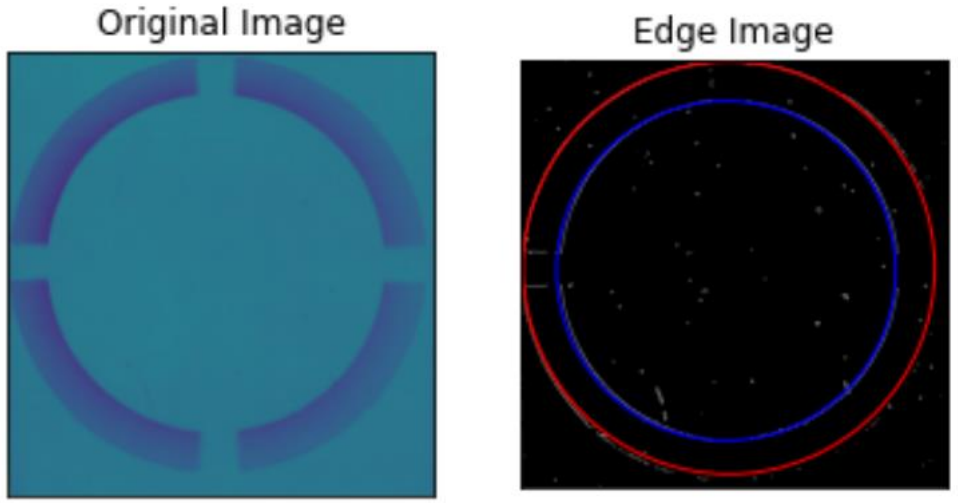
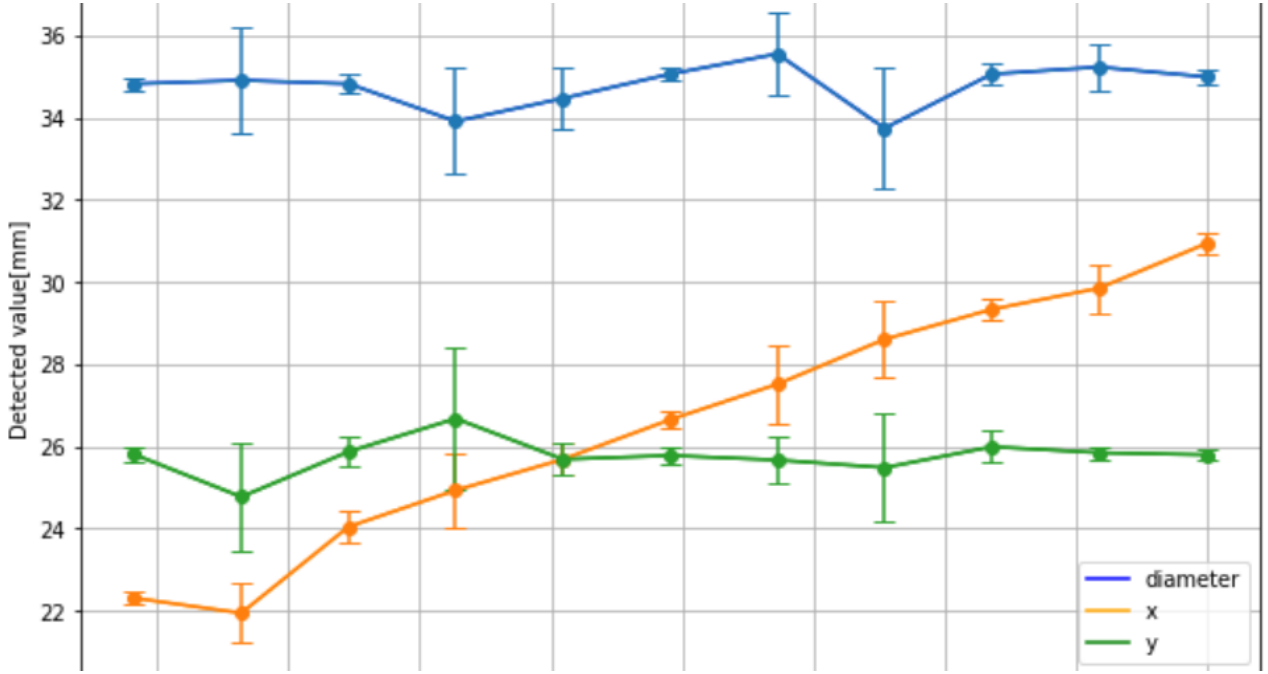



Figure 18: Circles detected from scan of Gafchromic-XD film superimposed on the processed image.



# Another energy warning

+5cm between cell dish and film.

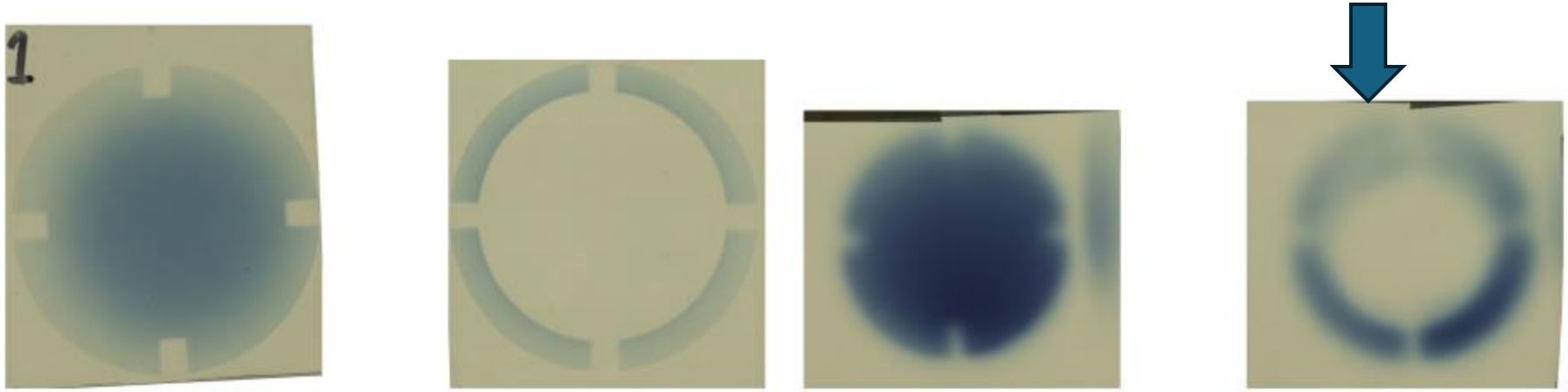



Figure 13: Film scans taken at the MC40 cyclotron facility. (a) film is inserted into cell dish holder without cell dish in place, (b) film is inserted into cell dish holder with cell dish in place, (c) set up as in Figure 12 without cell dish, (d) set up as in Figure 12 with cell dish.