A Gas Jet Beam Halo Monitor for LINACs

O. Stringer [1,2], H. Zhang [1,2], N. Kumar [1,2], C. Welsch [1,2]

1 - University of Liverpool, Liverpool, United Kingdom 2 – Cockcroft Institute, Warrington, United Kingdom

The gas jet beam profile monitor is a non-invasive beam monitor that is currently being commissioned at Cockcroft Institute. It utilises a supersonic gas curtain which transverses the beam at an angle of 45 degrees and measures beam-induced ionisation interactions of the gas to produce a 2D transverse beam profile image. The use of a novel double-slit skimmer is shown to provide a mask-like void of gas over the beam core, increasing the relative intensity of the halo interactions for measurement. Alternative halo diagnostic devices are conventionally destructive (scanners, scrapers and screens) or require high beam energies such as coronagraphing synchrotron radiation [1,2]. The Beam Gas Curtain can provide an alternative option and could be better suited to some linac beamlines.

Beam Gas Curtain IPM

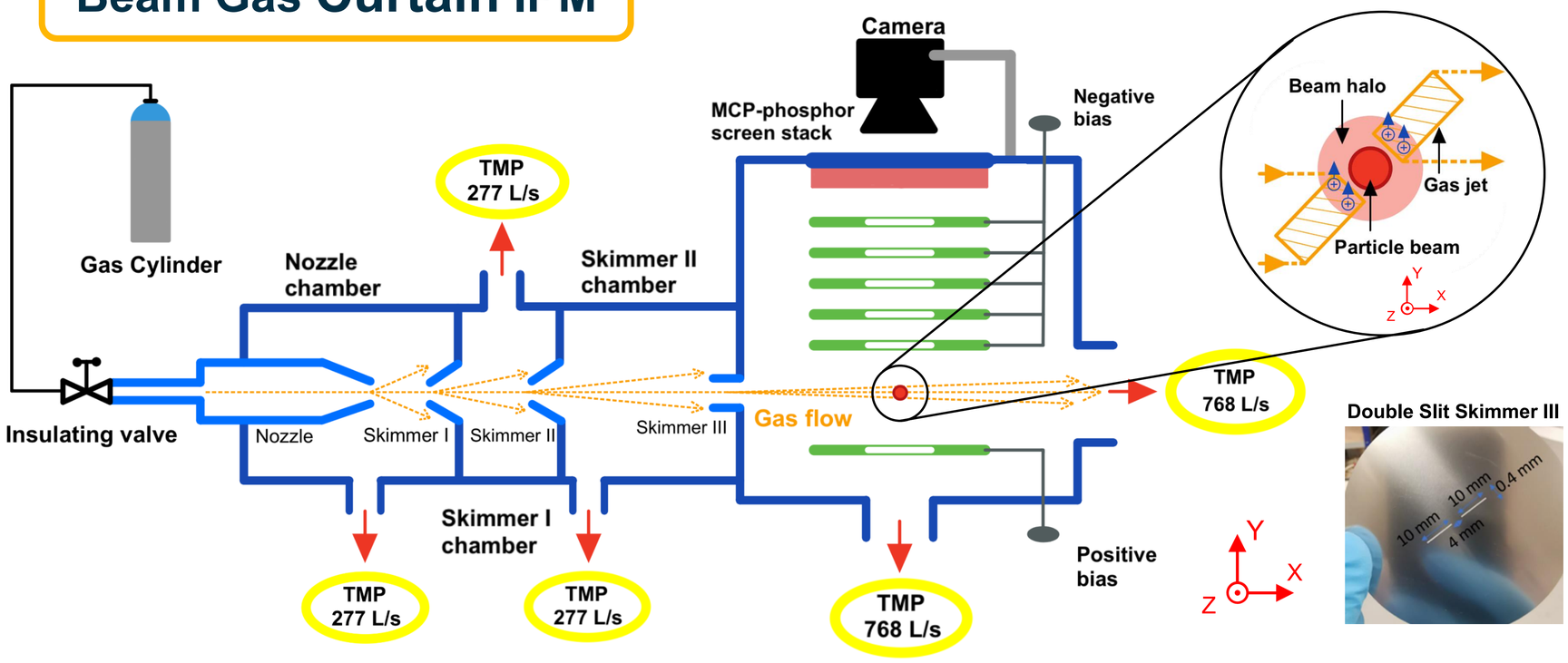

Figure 1: The layout of the Beam Gas Curtain setup configurated as an Ionization Profile Monitor (IPM) for halo monitoring.

Benefits

- **Non-invasive beam diagnostic**
- **Low residual pressure (10^{-8} mbar)**
- **Real-time halo measurements**
- **Low cost**
- **Low maintenance**

Double Slit Skimmer

- Double slit skimmer creates a mask of gas over the central beam path
- Low-intensity halo interacts with the gas jet, producing ions for imaging [3, 4].
- Non-invasive to the beam, gas is expended but a dynamic system replenishes gas indefinitely [3].

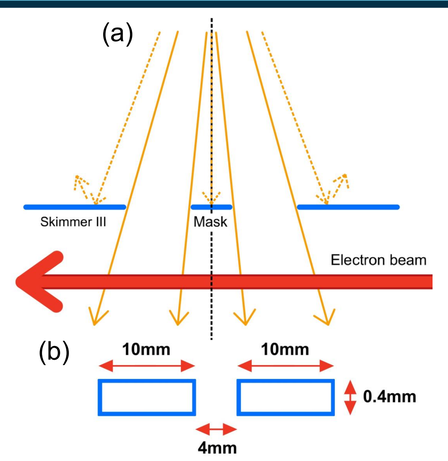

Figure 2: Double slit skimmer (a) Gas propagation; (b) Geometry dimensions.

Jet Formation

- In-house Monte-Carlo simulation to predict gas jet density and size for the BGC [5].
- High density gradient between gas jet and background.
- Output can be used in extraction field simulation.

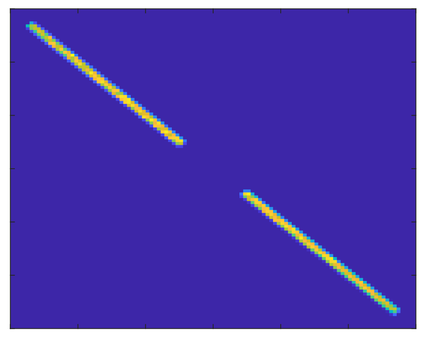

Figure 3: Simulated 2D jet profile at interaction point in plane of jet propagation.

Extraction Field Simulation

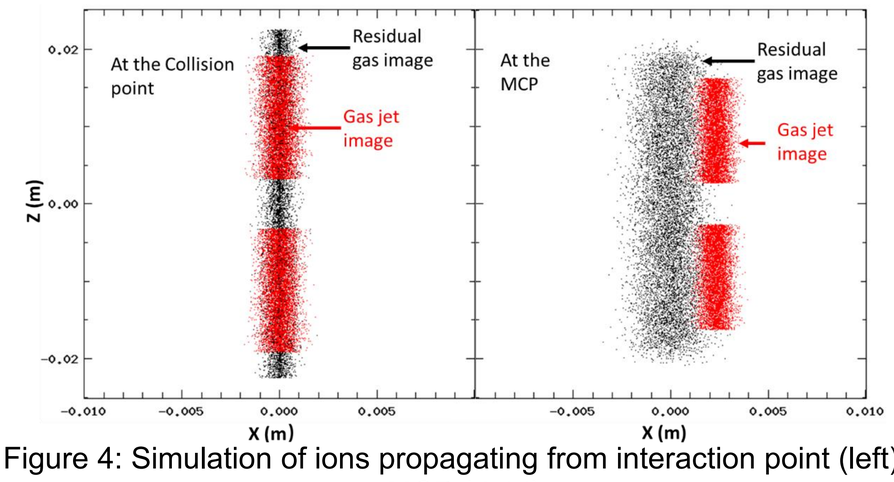

Figure 4: Simulation of ions propagating from interaction point (left) to MCP (right).

- WARP code [6] simulation to model external fields generated by ion extraction system.
- Focusing effect seen near MCP which agrees with experimental data.
- Thermal velocity causes broadening of residual and gas jet.

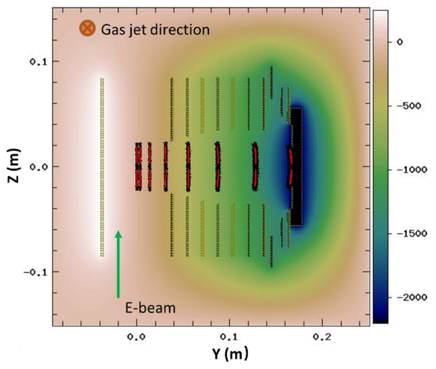

Figure 5: Simulated external field generated by ion extraction system

Experimental Results

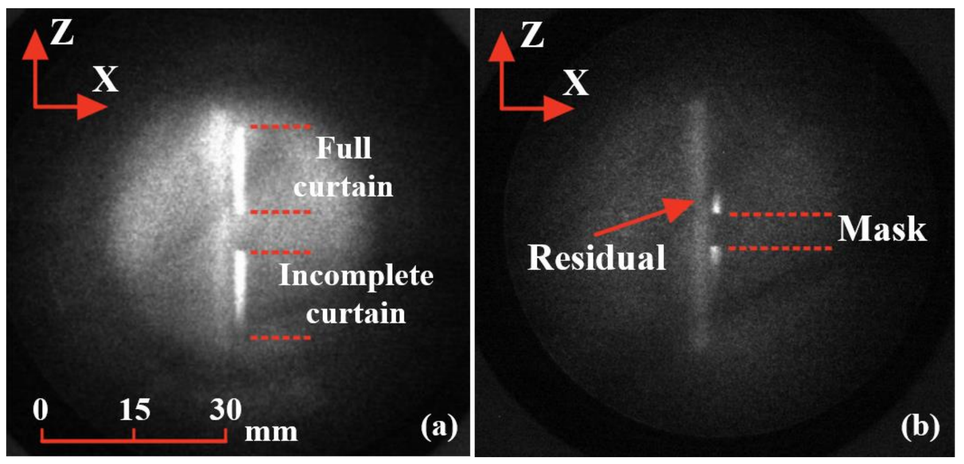

Figure 6: Beam-Gas interaction imaged on phosphor screen. (a) Full jet ionisation; (b) Central mask to represent beam halo.

- Proof of concept results.
- Double slit skimmer successfully masks beam core.
- Focusing effects of ion collection system reduce jet dimensions as expected [5].

Table 1: Comparison of measured length of the jet.

Measurement	Upper Slit	Mask	Lower Slit
Simulated Jet	15.36 mm	6.92 mm	15.36 mm
Experimental	13.59 mm	5.46 mm	13.59 mm

References

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