DEVELOPMENT OF A NEGATIVE HELIUM ION SOURCE WITH NON-METALLIC CHARGE EXCHANGE

SFU

4D LABS

NSERC CRSNG

D-Pace

Philip Jackle, A. Bunevich, D. Silva Lopez, K. L. Kavanagh, and M. Dehnel
Simon Fraser University (Burnaby, BC Canada), D-Pace Inc. (Nelson, BC Canada)

INTRODUCTION

- He^- ion sources are commonly produced via He^+ ion transmission through alkali metal vapour (1~2% efficiency).
- The semiconductor industry cannot tolerate alkali metal contamination in their accelerators [1].
- Efficient charge exchange alternatives are highly desired.
- Non-metallic thin foils are being investigated for this purpose via a He ion microscope (HIM) at SFU.

HELIUM ION MICROSCOPE

The HIM produces and directs a He^+ beam (10 - 30 keV, < 20 pA) through a thin foil covering an aperture located after the first lens in the optical column. Figure 1 shows a schematic diagram of the HIM column showing the components.

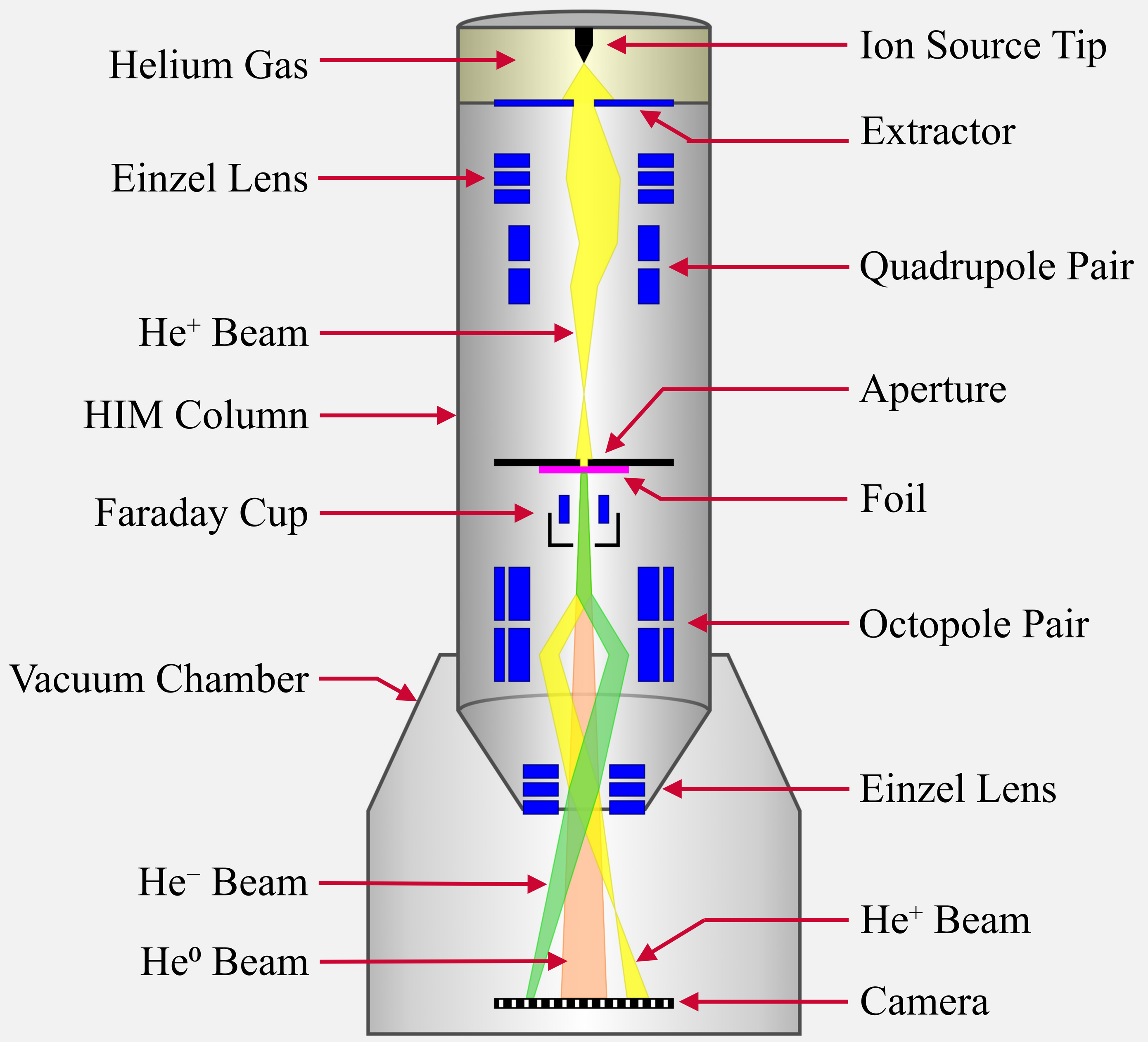

Figure 1: Schematic diagram of the HIM and experimental setup.

TRANSMISSION EXPERIMENTS

The transmitted beam is deflected and focused onto a Si CMOS camera (AdvaCAM MiniPIX) [2] located at the bottom of the vacuum chamber. Figure 2 shows an optical micrograph of one example of a graphite foil covering an aperture (100 µm diameter).

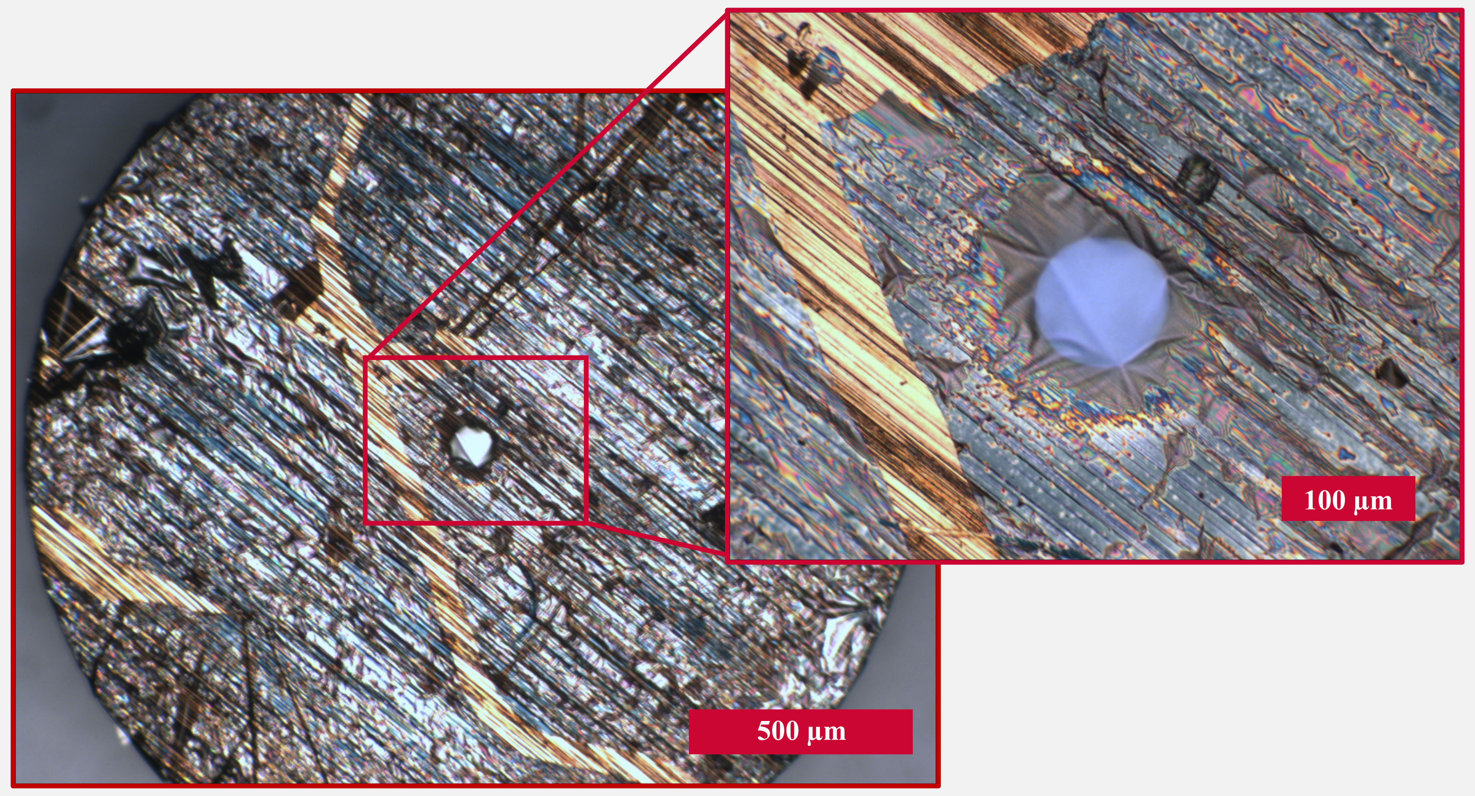

Figure 2: Optical image of laser-machined copper aperture disk with 25 nm thick graphite foil covering a 100 µm diameter aperture.

CONCLUSIONS

- HIM able to separate He^- from He^+ and He^0.
- Experiments with carbon foil match other works.
- Experimental setup can be used for examining other foil materials: Si, C/Si, C/B.

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RESULTS

Figure 3 shows an example image which shows three distinct beam spots identified. The He^+ and He^- spots are equal distance from the He^0 as controlled by the deflection direction and angle.

Figure 4 shows a profile plot of the average counts along the line in Figure 3. Summing the counts per spot gives ratios of transmitted beam which compare with [3] and [4]: (He^+, He^0, He^-) = (7.4, 92.2, 0.03), 0.3 unattributed.

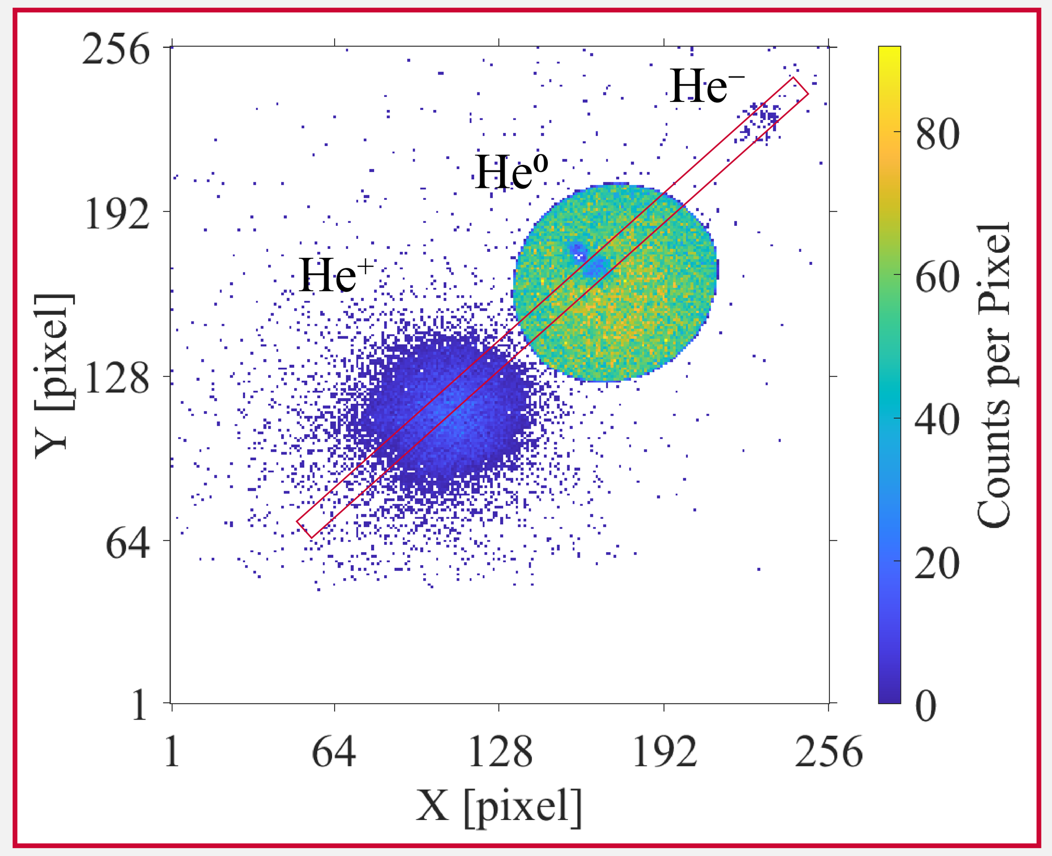

Figure 3: Beam detected by radiation camera over 50 sec exposure. 4 pA of 25 keV He^+ beam incident on a foil of approx. 20 nm of many-layer graphene covering a Ø25 µm aperture.

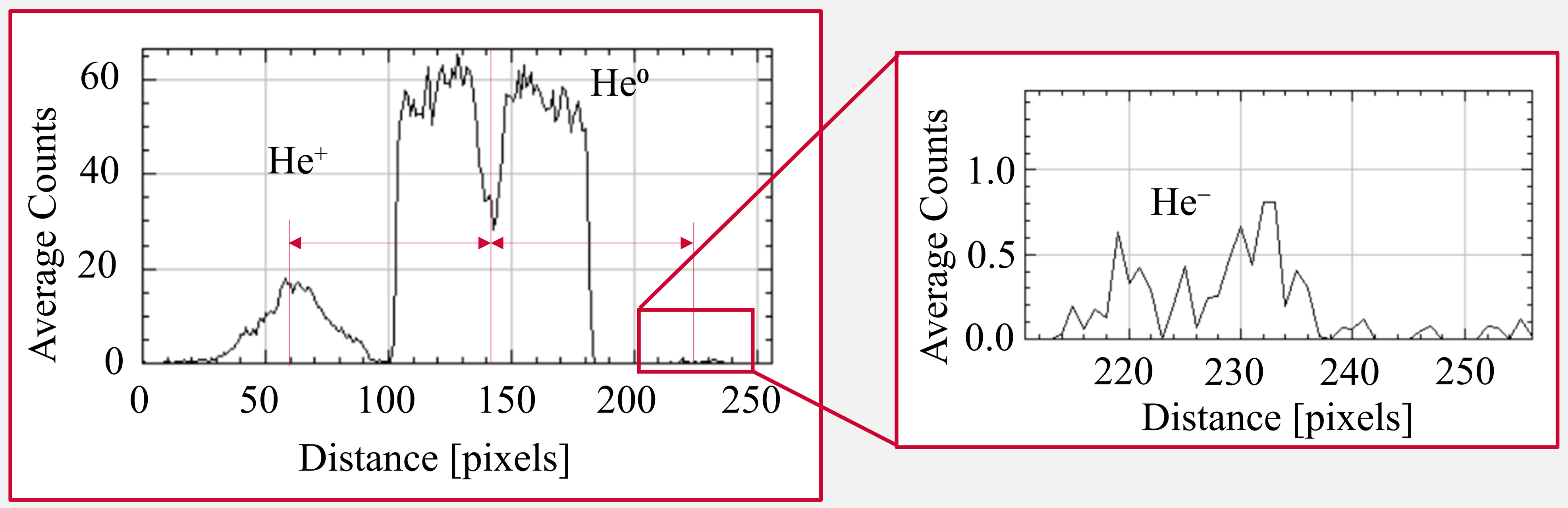

Figure 4: (Left) Profile plot of the averaged counts per pixel along the line in Figure 3. (Right) Expanded view of profile plot in the region of suspected He^- beam.

REFERENCES

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