# Multi-Beam Magnetic Sector Mass Spectrometry Utilizing Spatially Coded Apertures

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Mass spectrometers are widely considered to be the gold standard of elemental analysis techniques due to their ability to resolve atomic, molecular, and biological species. Expanding the application space of mass spectrometry often requires the need for miniaturized systems for use in field work or harsh environments, or for integration with other complex metrological equipment. While only requiring "sufficient" mass resolution to meet the needs of their application space, these miniaturized systems suffer from poor signal to background ratio which limits their sensitivity as well as their usefulness in field applications[1].

Spatial aperture coding techniques have been used in optical spectroscopy to achieve large increases in signal intensity without compromising system resolution. In this work similar computational methods are used in the application of these techniques to the field of magnetic sector mass spectrometry. Experimental demonstrated gains in signal intensity of 10x and 4x were achieved for 1D[2] and 2D[3] coding techniques (respectively) using a simple 90 degree magnetic sector test setup. Initial compatibility with a higher mass resolution double focusing Mattauch-Herzog mass spectrograph is also demonstrated both experimentally and with high fidelity particle tracing simulations [4]. A novel electric sector lens system was designed to stigmate a 50 beam coded aperture patterned spectrograph which shows simulated gains in signal intensity of 50x compared to conventional methods.

1. D. T. Snyder, C. J. Pulliam, Z. Ouyang and R. G. Cooks, Anal Chem (2015).
2. E. X. Chen, Z. E. Russell, J. J. Amsden, S. D. Wolter, R. M. Danell, C. B. Parker, B. R. Stoner, M. E. Gehm, J. T. Glass and D. J. Brady, J Am Soc Mass Spectr 26 (9), 1633-1640 (2015).
3. Z. E. Russell, E. X. Chen, J. J. Amsden, S. D. Wolter, R. M. Danell, C. B. Parker, B. R. Stoner, M. E. Gehm, D. J. Brady and J. T. Glass, J Am Soc Mass Spectr 26 (2), 248-256 (2015).
4. Z. E. Russell, S. T. DiDona, J. J. Amsden, C. B. Parker, G. Kibelka, M. E. Gehm and J. T. Glass, J Am Soc Mass Spectr, 1-7 (2016).

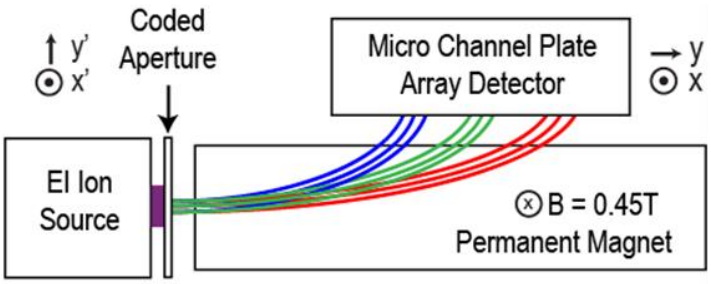


*Figure 1:* Schematic of simple mass spectrograph used.

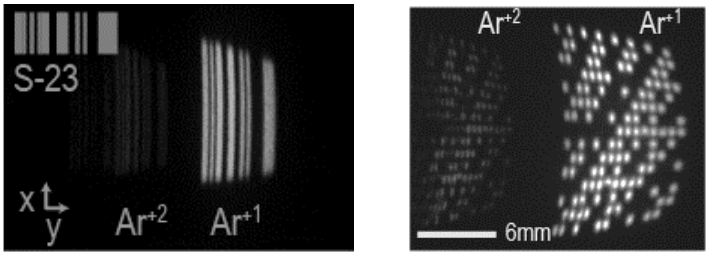


*Figure 2:* Raw 1D Coded Spectra (left) and 2D Coded Spectra (right)

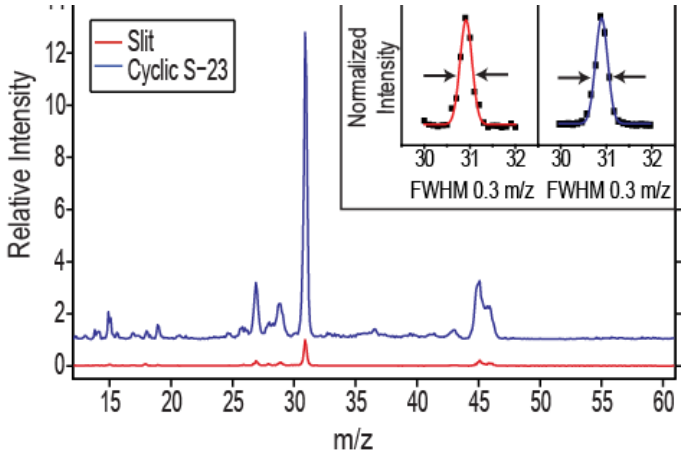


*Figure 3:* Reconstructed coded spectra showing 10x gain with no loss in mass resolution

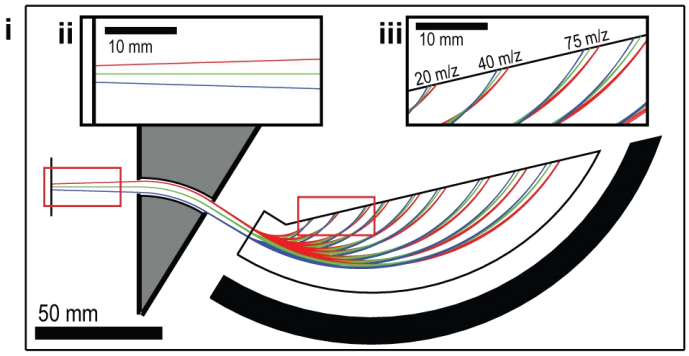


*Figure 4:* Simulated Mattauch-Herzog spectrograph compatibility with aperture coding.