

High Efficiency SPE/Fractionation Cartridges for Direct Mass Spectrometer Sample Preparation

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Introduction

The use of small particle sorbents of 3 micron or smaller, instead of the 50 micron diameter particles traditionally used in Solid Phase Extraction, presents the opportunity for Solid Phase Extraction to be extended in its capability and practicality. Firstly the smaller particles provide a more efficient separation of analytes from interfering matrix, the primary objective of traditional SPE. Their higher resolution can allow fractionation of the sample into classes or even chromatography baseline separations of defined components.

Micro SPE Cartridge Design (SPEed®)

Micro SPE cartridges incorporate a high pressure seal (fig 1.) to simply connect the SPE cartridge to a conventional syringe, mounted in an automated robotic system. The seal is rated to 1,500psi, easily allowing a syringe drive to deliver a constant high pressure flow supply to a small particle size high resolution cartridge or column.

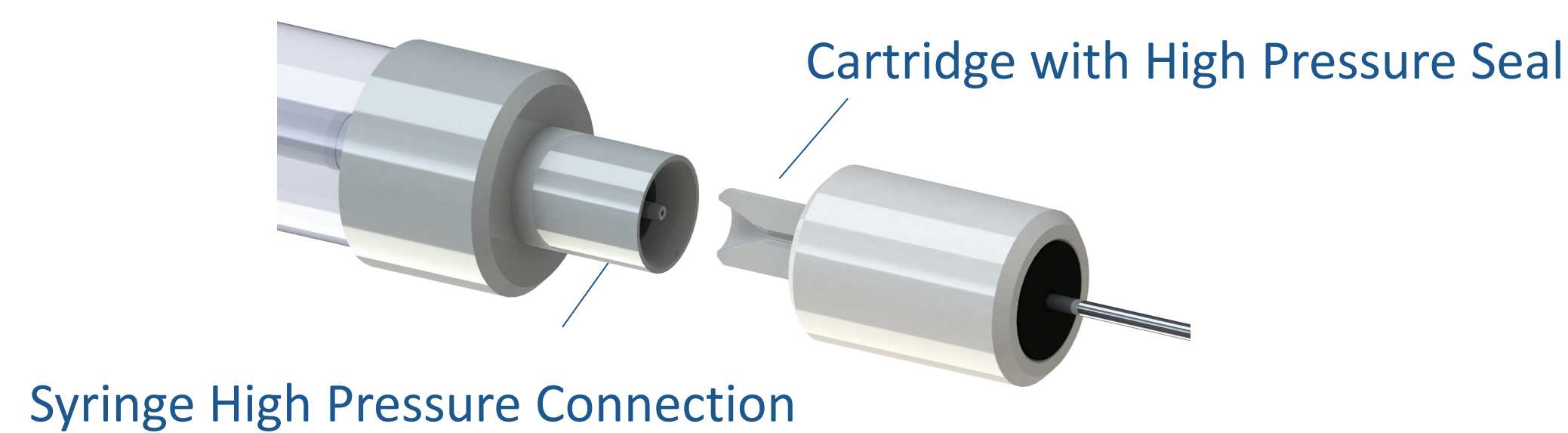


Figure 1 – High Pressure Seal

Micro SPE cartridges also incorporate a simple but elegant one-way micro check valve (fig 2) so that sample, reagents and solvents in a SPE workflow can be aspirated directly into the syringe barrel and on dispensing allowing liquid at high pressure to be directed through the sorbent bed.

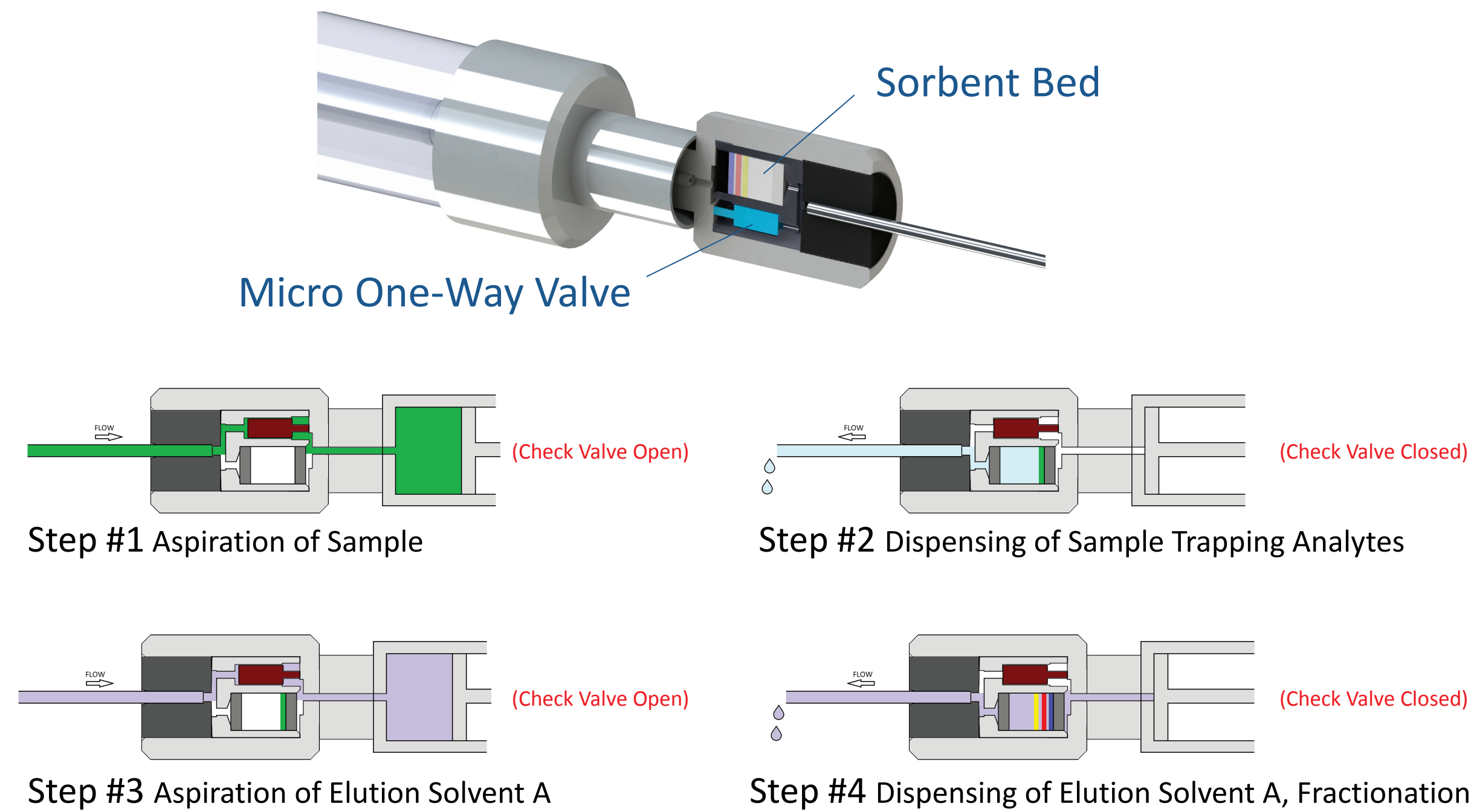


Figure 2 – One-Way Flow Valve and Sorbent Bed

Flow paths in the cartridge are minimal reducing traditional SPE solvent usage of millilitres down to microliters. With analytes focused on the top of the cartridge, elution of target compound(s) can be achieved in a few microliters. Solvent blowdown steps are eliminated and single step 1000 fold concentration factors are achievable.

Direct MS Interface

In reality LC separation before MS is often a sample preparation step to eliminate matrix and reduce ion suppression. However, a simple disposable syringe driven SPE cartridge using small particle sorbents can deliver analytes in the appropriate volume and concentration directly to the Mass Spectrometer, eliminating the need for conventional LC separations^{1, 2}. An interface (fig. 3) has been developed for direct interfacing of SPEed cartridges with a detector.

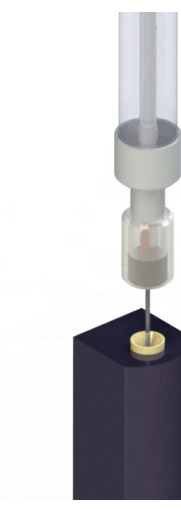


Figure 3 – Detector Interface

Automated SPE and Fractionation Sequences

Automation of the cartridges using a laboratory workstation like the EPREP (fig. 4), enables fractionation sequences to be programmed (fig .5).



Figure 4 – EPREP Laboratory Workstation

Compound class fractionation can be used as a precursor for direct MS infusion for proteomics, metabolomics and a range other clinical, environmental and food applications.

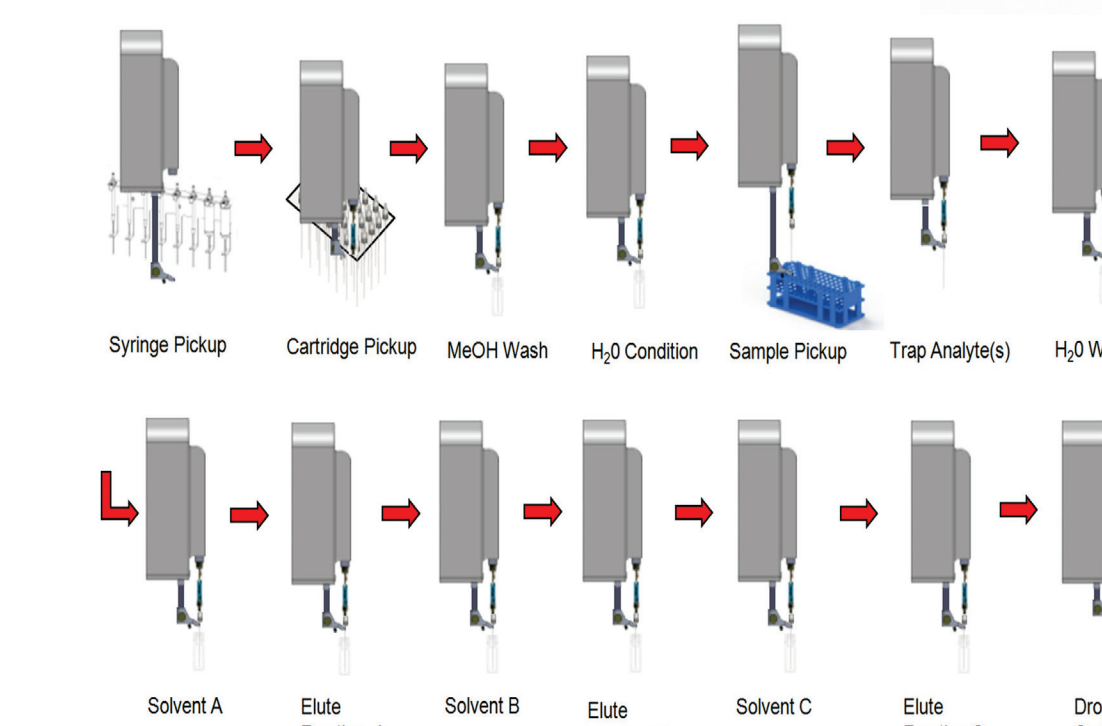


Figure 5 – Fractionation Stepped Elution

Experimental

1) Small Particle Size Efficiency and Cartridge Reproducibility – SPEed cartridge were used to confirm effect of sorbent particle size on retention of methylbenzoate on C18 packing. Conventional 40-60µm packing showed no retention. Cartridge reproducibility was excellent.

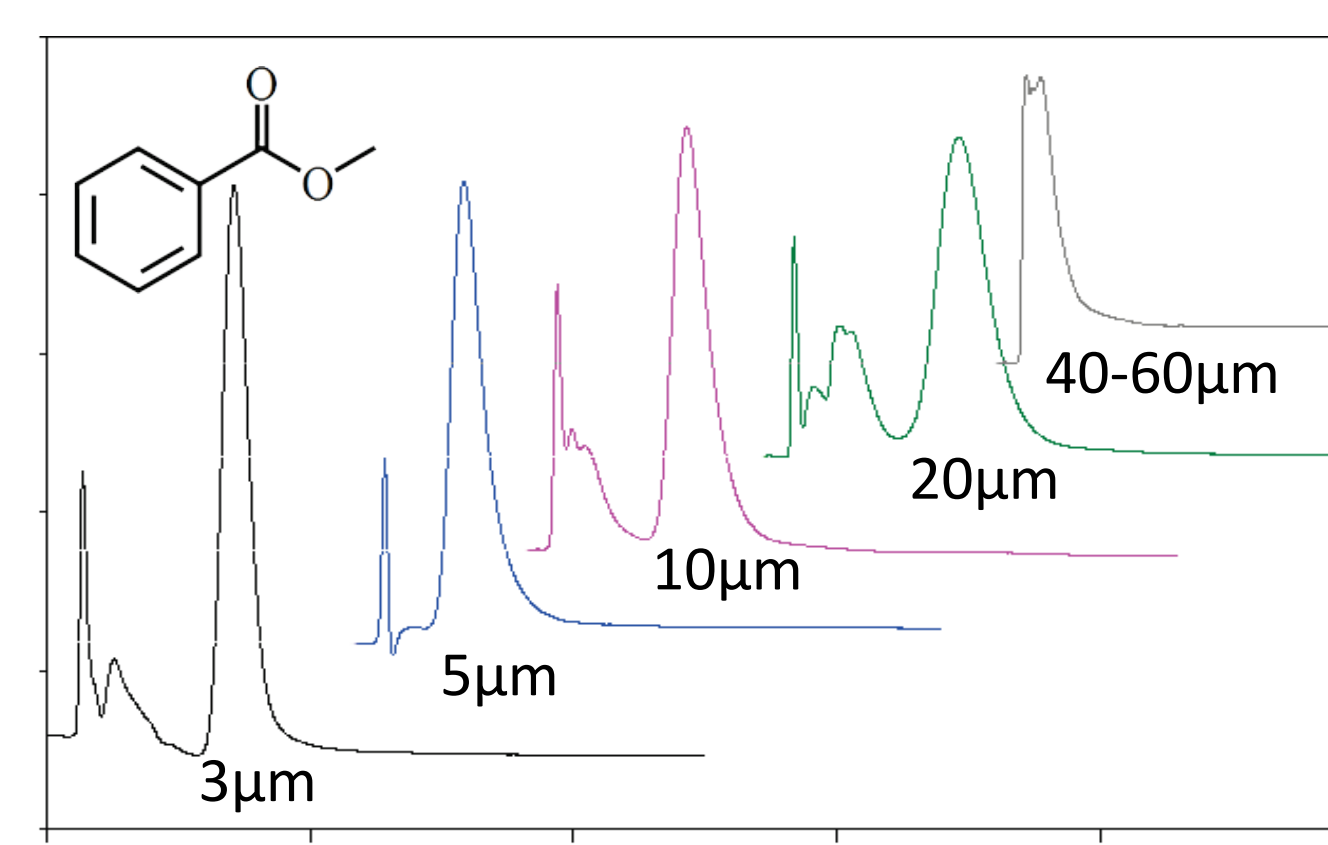


Figure 6 – Packing Size Effect

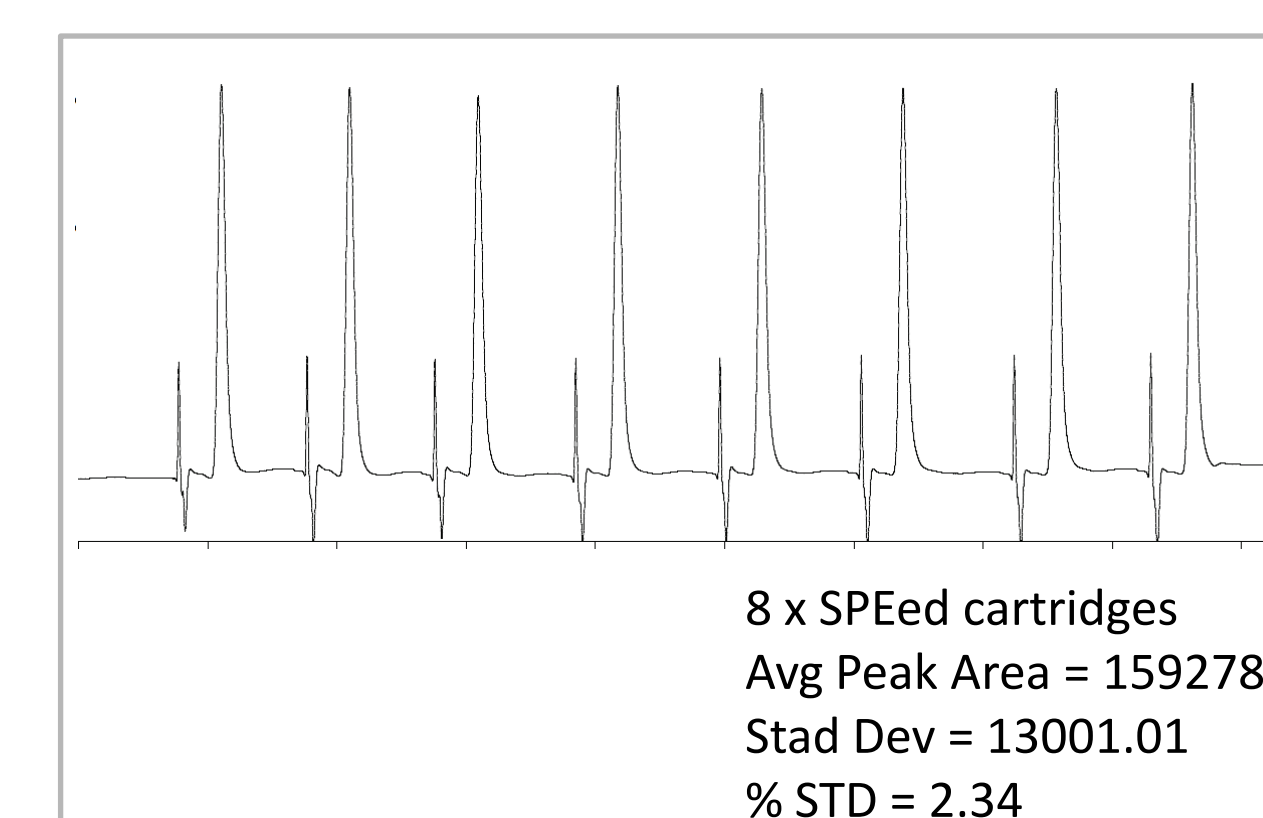


Figure 7 – Cartridge Reproducibility

2) Opiates in Urine - Opiate standards showed high recoveries, low detection limits and good linearity. ESI source of a Bruker micrOTOF-Q.

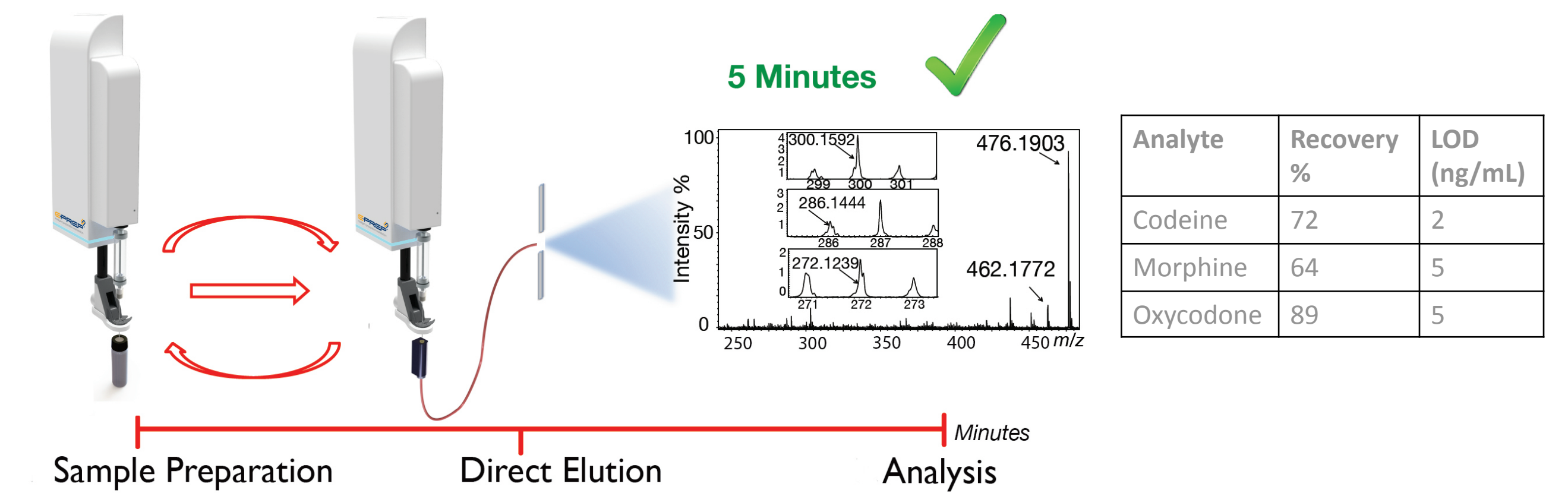


Figure 8 – Direct MS, Opiate Standard in Urine

3) Metanephrines in Plasma – SPEed cartridges were used for phospholipid /protein cleanup and trapping/concentration of Metanephrines prior to analysis.

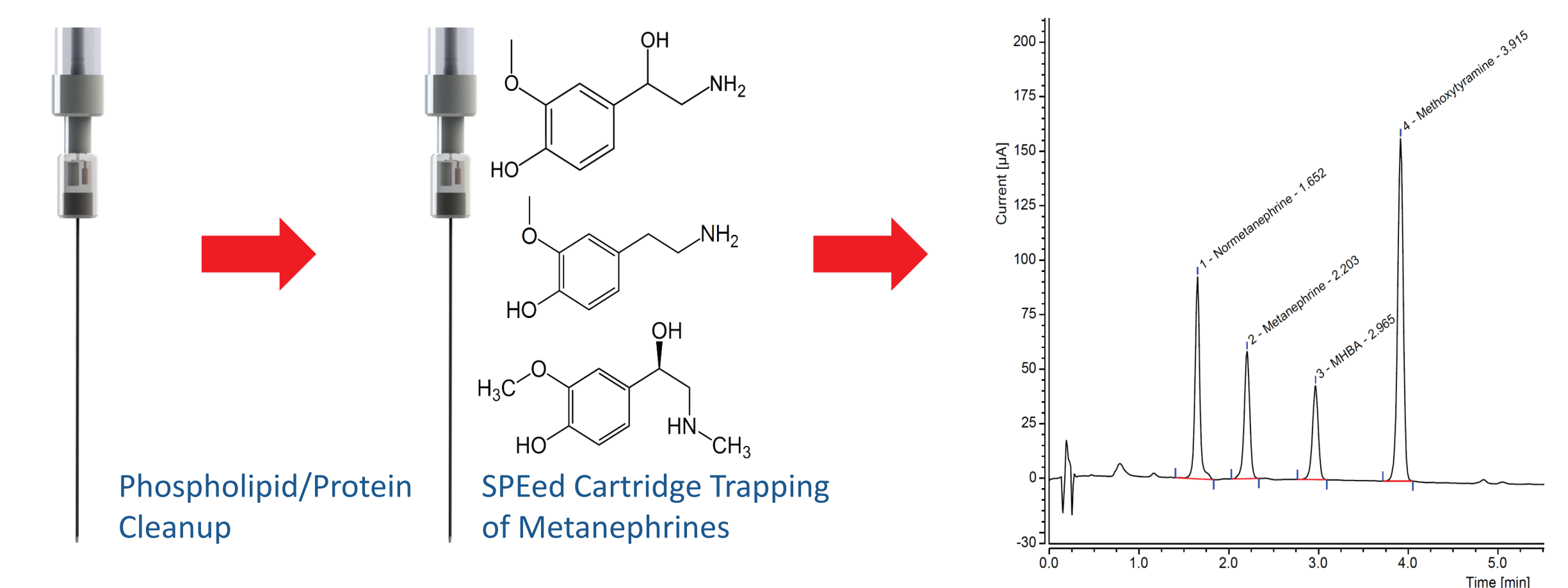


Figure 9 – Metanephrine in Plasma cleanup and microSPE

Conclusions

A range of sample preparation applications in clinical, environmental and food analysis are being developed using the micro valve SPE cartridge device. Automated sample preparation using the cartridges can be demonstrated utilising a sample preparation robot for pickup and drop off of the cartridges. Automated sequences include the use of stepped gradient elution for selective elution and fractionation.

Acknowledgements

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REFERENCES

- [1] Candish E. et al., At-line Approach to Direct Solid Phase Extraction – Mass Spectrometry, ASMS 2013
- [2] Dawes E. et al, A simplified at-line approach to direct solid phase extraction – mass spectrometry. Journal of Separation Science. 35, 2399-240