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Inexpensive & Non-Disruptive Retrofitting of a PDP-11 Based Microprobe System with Modern Automation Software

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Cost efficiency is a constant concern in the world of microanalysis and advanced instrumentation, where it can often be difficult and time consuming to secure the funds needed to purchase a new analysis system. Well maintained analytical hardware can last for decades but the associated computer and software systems are generally not supported for such extended periods by their original vendors. Fortunately it is sometimes feasible to make considerable software additions to satisfy new needs, even with such antiquated platforms.

In this case, a JEOL SuperProbe 733 electron microprobe paired with a Tracor Northern PDP-11 based computer data acquisition system, originally delivered in 1986, was retrofitted to conduct very large scale elemental mapping operations through an accessible cross-platform graphical user interface application. Here, the microprobe remained an operational tool in a multi-user facility throughout the development process and retained all original interface functionality so that no retraining was necessary for most users.

The original JEOL/TN configuration provides a text terminal on a custom operating system and includes an RS-232 compliant serial port for external I/O operations. The standard software setup supplies an interpreted programming language called FLEXTRAN that gives access to most hardware features through built-in routines and provided libraries. For this project, a server program was written in FLEXTRAN to directly conduct the hardware and transmit data in compressed form over the slow external serial connection to the main PC application written in C++, which collates and visually renders the data in real time as well as providing pause/resume functionality, fault tolerance for the attached old hardware, data storage in an efficient binary format, and various other features.

A set of many open source tools were used to develop the main application, including the Qt4 framework and its associated IDE, Qt Creator (using gcc and gdb through MinGW), the compact Code::Blocks IDE for some separated non-GUI modules, Subversion revision control, and the Notepad++ text editor for configurable FLEXTRAN syntax highlighting. The only proprietary (and single platform) tool used was the Microsoft Windows Script Host, to conveniently provide some optional features like e-mail alerts through scripts triggered by various events.

With the use of this new software it became possible to fulfill the needs of the Florida Department of Transportation contract that spawned it, which demanded accurate profiling of the ingress of chloride species through concrete, using decades-old hardware. Combined with additional offline methods implemented in Python, the raw data collected were processed to calculate diffusivities that very closely matched with reference values from quantitative wet chemistry. Previously, such experiments had only been possible on much more recent microprobe systems [1]. A more thorough understanding of the concrete/chloride system has clear benefits, allowing for safer and more efficient maintenance scheduling on infrastructure using rebar reinforced concrete [2].

References:

[1] D Mori *et al*, Journal of Advanced Concrete Technology **4** (2006), pp. 369-383.
[2] This research was supported by the Florida Department of Transportation (FDOT) under contract BDK75 977-15. The authors gratefully acknowledge Wayne Acree (MAIC) for his aid in collection of microprobe data.

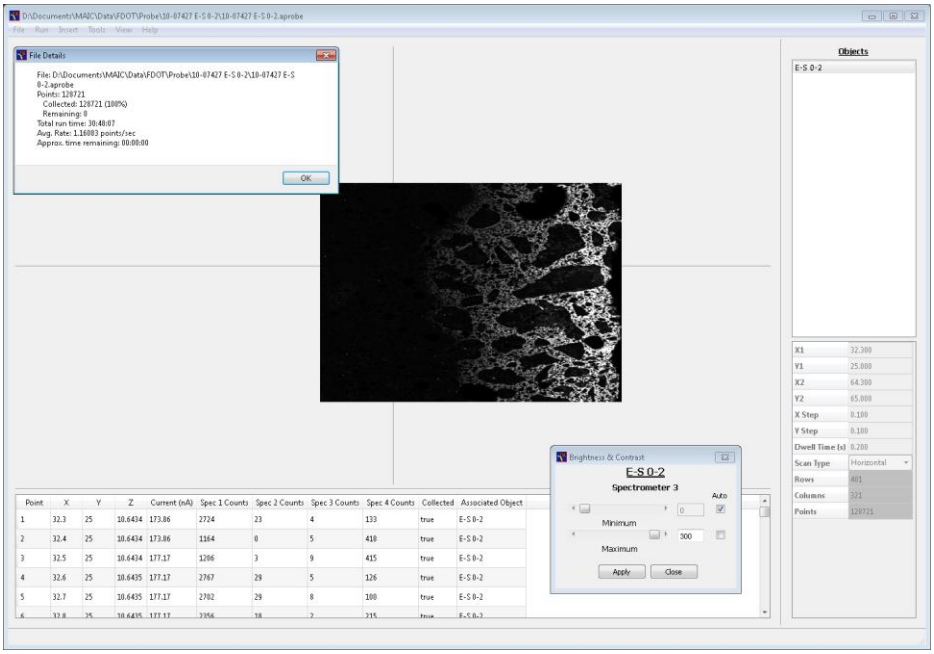

Figure 1. Overview of application user interface.

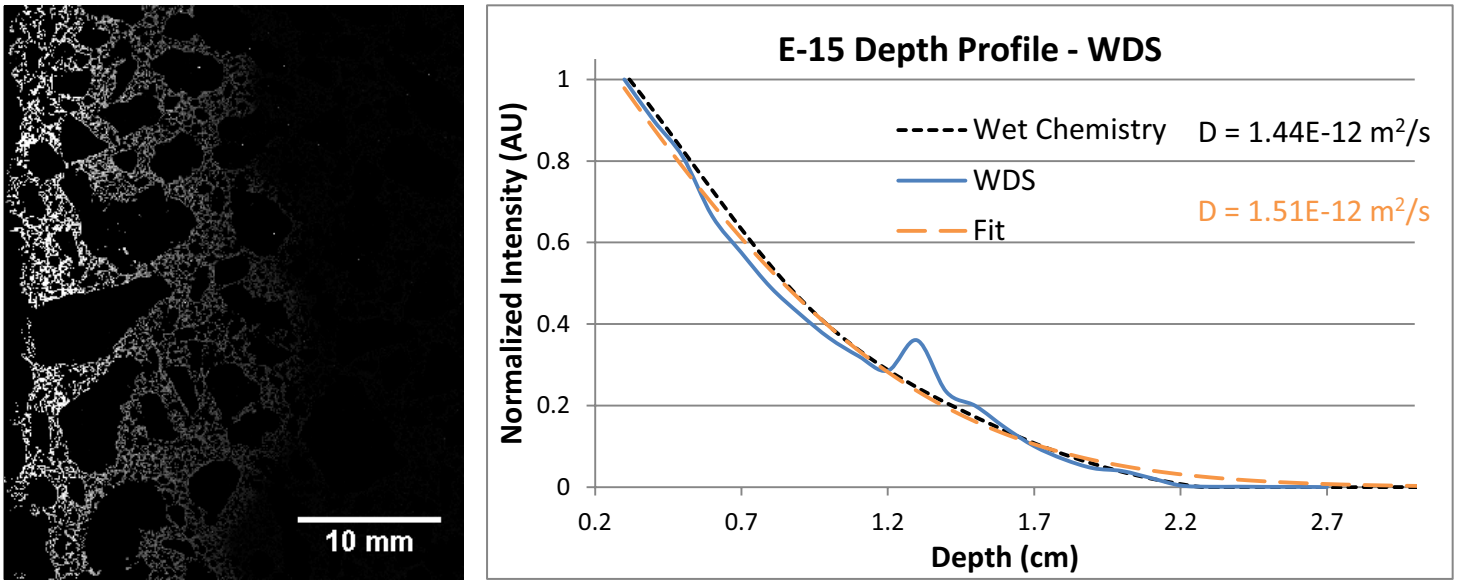

Figure 2. Processed output – chlorine elemental map and corresponding depth profile with reference wet chemistry data and calculated diffusivities.

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