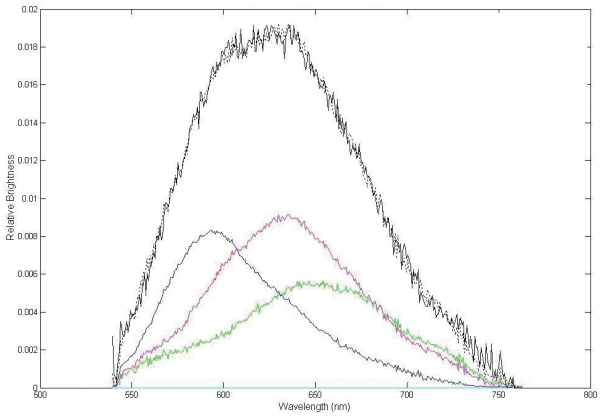
Seeing is Believing

In an NSF project in collaboration with Montana State University (MSU), Dr Rand Swanson at Resonon and Dr Edward Dratz at MSU are developing an imaging spectrometer that can simultaneously quantify multiple fluorescent dyes with highly overlapping spectra, enabling numerous proteomics experiments to be performed on single electrophoresis gels

ALTHOUGH STILL A relatively new field, the possibilities extended by hyperspectral imaging techniques are considerable. This method allows the mining of information from hundreds of bands across the electromagnetic spectrum, providing a wide array of data as hyperspectral images, which are analysed and deconvoluted to provide new types of information. Applications range from enhancing biological sources of clean energy and identifying new targets for more specific drug compounds, to preventative medicine. Indeed, hyperspectral imaging is extremely pertinent in the area of Proteomics, which is an important current frontier for understanding the underlying biological mechanisms at work in the onset, prevention, and progression of disease. Nevertheless, current technology is hard pressed to provide the information needed to advance modern biology.

Led by resonon President Dr Rand Swanson and Dr Edward Dratz, Professor of Chemistry and Biochemistry and Director of the Center for the Analysis of Cellular Mechanisms and Systems Biology at Montana State University, The Small Business Technology Transfer (STTR) Phase II project, building on the work achieved in Phase I, has developed an enhanced hyperspectral imaging spectrometer that overcomes many of the limitations of existing devices. The system is a macroscopic fluorescent scanner with enhanced capabilities for reading and separating the contributions of each colour in multicoloured data from 2D gels, multi-well plates, and micro-arrays, enabling a fourfold increase in colour channels measured simultaneously, and a tenfold enhancement both in sensitivity and in the speed of data acquisition. Such development could have a dramatic impact on a wide range of research areas, including understanding of cellular mechanisms, microscopic analysis in cell biology, and fluorescence detected cell characterization. "Hyperspectral imaging enables curve-fitting algorithms to accurately separate the signals from many fluorescent dyes with closely overlapping emission spectra, while also removing the background fluorescence; this provides greater 'signal-to-noise', higher information content and increased through-put of information that is highly desirable in proteomics experiments," outlines Dratz. "The system utilizes novel optical design to provide more efficient light gathering and less aberration for better imaging, versus conventional hyperspectral optical designs."



FLUORESCENCE SPECTRUM OF PROTEINS LABELLED WITH A MIXTURE OF THREE DYESTHAT HAVE STRONGLY OVERLAPPING EMISSION SPECTRA (DATA CURVE, BLACK SOLID LINE) MEASURED WITH THE HYPERSPECTRAL IMAGER. THE DECONVOLUTED COMPONENT SPECTRA ARE SHOWN BELOW (COLORS) AND THE SUMMATION OF THE COMPONENT SPECTRA IS THE DASHED LINE OVERLAYING THE EXPERIMENTAL SPECTRUM.

PROTEOMIC REVOLUTION

When combined with new fluorescent dyes developed at MSU to label differences in protein levels, specific protein modifications, and differences in enzyme activities, the hyperspectral scanner can process proteomic data with more accuracy and speed - this is particularly important for the weaker signals from lower level protein components, as Dratz explains: "Proteins and modified forms of these proteins that occur at low levels tend to be the switches and control elements in biology and these need to be tracked in the presence of the high level structural and production protein elements." Moreover, there are environmental and safety benefits offered by optical detection methods, as compared to radioactive tracer methods that were widely used previously; this bodes well for the economic viability for widespread application of hyperspectral detection. Bolstered by such innovation, proteomics can provide an abundance of additional data elements that will add a great deal of penetrating mechanistic information to systems biology models which are now primarily based on genomic and some metabolomic data.

However, Swanson is keen to point out that, supported by a new grant from NIH STTR, the team's work to improve the dynamic range of detection in the scanner is ongoing: "The current hyperspectral gel scanner is an excellent starting point," he explains. "We are building a foundation for more powerful systems with higher dynamic range for gel scanning, a wider range of laser excitation wavelengths, more versatile systems with temperature control for microwell plate reading of enzyme activities and for maintenance of live cells, and higher spatial resolution versions for optimized multicolour reading of microarrays." It is hoped that the significant contribution to the knowledge of biological signalling, metabolic and response networks enabled by this research will impact upon preventive and palliative medicine in the future.

INTELLIGENCE

PROECT TITLE

STTR PHASE II : A NEW HYPERSPECTRAL IMAGING SPECTROMETER

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