Product Summary - 2022

Introduction

At PDR a main focus has always been facilitating and encouraging a very deterministic and largely automated "assembly-line" from molecule development to purified molecules by: (a) rapidly screening separation methods, (b) selecting the best method for purification pragmatically, and then (c) purifying from milligrams to tons efficiently and with as much automation as possible. All PDR software applications share a common chromatographic-only user interface. Chromatographic parameters are translated into hardware-specific commands by device drivers, simplifying method transfer and staff training because user interface is always the same regardless of system differences. For example, HPLC and CCC systems are controlled by the same user interface. Additionally, our DALP (Digital Advanced Laser Polarimeter) accurately measures optical activity directly without regard for absorbance or chromophores. If you work with optically active compounds (chiral, antibiotic, sugar, etc.), you need DALPs.

Please review the following sections, contact me personally at email below to discuss your specific needs, and allow PDR to propose custom cost-effective improvements that increase your productivity noticeably. In most cases we use your pumps and UV detectors with our hardware modules and software to configure a new system with improved capabilities and walk-away automation. We continue our 20+ year tradition of building, installing, and supporting robust products with advanced capabilities. Most of our customers are repeat users of our products and services.

Contents:

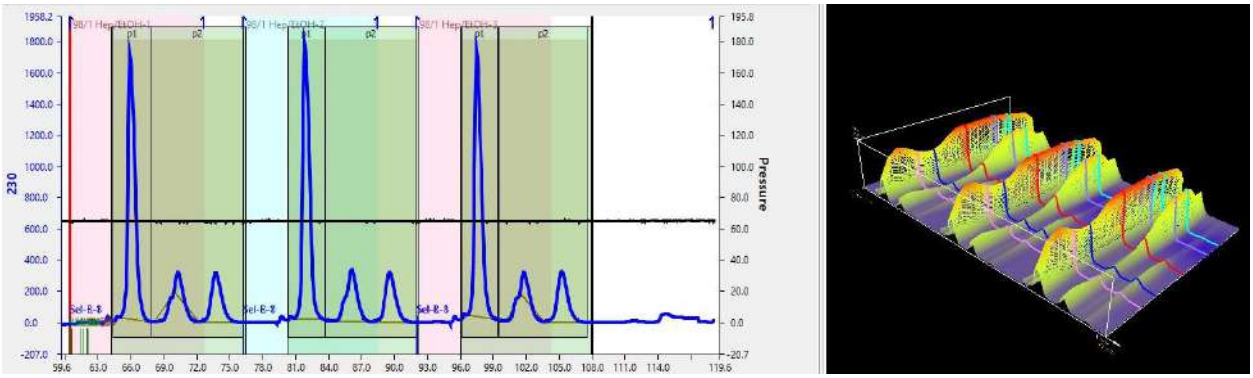
AutoMDS Systems (Automated Method Development)

PDR started developing AutoMDS and AutoPrep Software in 1998. PDR previously had developed the ALP (Advanced Laser Polarimeter), was operating a fast-pace contract purification service, and was unhappy with available software. PDR needed walk-away automation for method development and preparative purification to rapidly purify previously unknown compounds for big-pharma in the range of 1-1000 grams. PDR still continue aggressive development and improvement of AutoMDS and AutoPrep software. AutoMDS can run continuously without attention; assuming adequate solvent, waste, and sample solution. AutoMDS features include the following.

1. **Methods and sequences only contain chromatographic parameters** so all systems have same user interface whether analytical method development or larger-scale preparative purification. Our device drivers translate chromatographic parameters into device-specific commands. Methods, sequences, and user interface are independent of hardware idiosyncrasies. For example, HPLC and CCC/CPC applications have the same user interface, but much different methods.
2. **Each method can have multiple unique cycles** and each method and/or cycle can be repeated many times. For example, a CCC/CPC method usually contains 3 or 4 different cycles pumping different solutions at different flow rates and the method is repeated many times. Whereas an HPLC preparative purification method usually contains a single cycle repeated many times. Repeating a cycle is continuous, does not restart the method, and allows overlapping (stacking) of injections.
3. **Method Development and Preparative Purification software are identical**, except for configuration settings. User interface is consistent and software upgrades apply to all products. Software is modular so new features and improvements can be released often and upgrades are very easy to apply.
4. **Parameters can be changed during a run**. You can start a preparative purification run with conservative injection volume and injection spacing (stacking), then increase injection volume and reduce injection spacing to improve productivity as the system equilibrates and results are clear. This helps improve productivity in purification jobs requiring many injections and high purity. Stopping a run only to change parameters is never required.
5. **Peak collection decisions** can be made in real-time using derivative (slope) and +/- sign of DALP derivative, rather than time. Time works OK if elutions are stable, but peak derivative collections follow shifting or changing peaks accurately. This can be very important to purity and recovery during long-running purifications by compensating for minor changes in eluent and sample solution.
6. **Method and Sequence Editors** use a spreadsheet format that is very good for building, editing and monitoring methods and sequences.
7. **Repeats/Runtime** display clearly shows job progress and end times helping you schedule liquid management, other activities, and following jobs.

Repeats/Runtime			
Methods: waiting/done	9 /		2
Cycles: waiting/active/done	1 /	1 /	1
Minutes: done/remaining	12.02 /		9.48
Expected method end time:	Oct 11, 2022 3:16:24 PM		
Expected run end time:	Oct 11, 2022 6:30:41 PM		

8. **Realtime 2D and 3D Plots** show detector data in real time continuously.



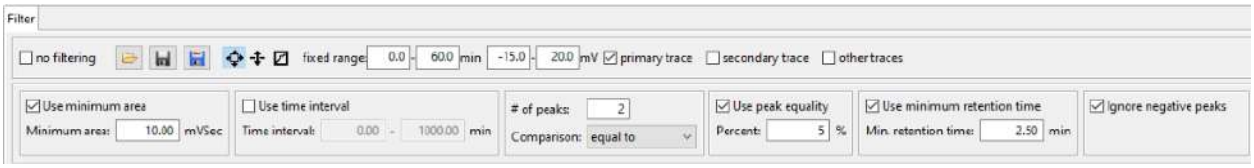
AutoPrep Example from 2019 job at PDR

AutoMDS:

AutoMDS is the ideal program for automated method development. Method and sequence editors use simple spread-sheet format making it easy to build, edit, and use large method screening sequences. An AutoMDS installation includes methods and sequences specifically built for your applications.

- Easily Write, Edit, and Run Methods and Large Sequences
- Single Keyboard Control of up to 88 Columns - including tandem configurations - and Random Gradient Mixing from up to 20 Solvent Bottles
- Supports 24/7 Continuous Unattended Operation
- Calculates Specific Rotation, Enantiomeric Excess, and a full-set of Achiral Chromatographic Parameters
- Sequences and Methods are Included for your applications

Data Processing Tool (DPT), see snip below, filters chromatograms based on area, time, number of peaks, peak equality (e.g., in chiral separations), etc. Thus, avoiding the necessity to review all chromatograms in a method screening sequence. Proper DPT searches usually return only a few methods for final consideration.



Data Processing Tool (DPT)

Methods should be selected for optimization based on intended application. Analytical applications are usually different from preparative purification applications. For example, additives are often used in analytical methods but are not desirable in preparative purification methods because the additive may be difficult to remove.

Method Optimization Considerations:

- Separation
- Elution Order (target peak should be first)
- Impurities
- Solubility in Eluent
- Stability in Eluent
- Recovery from Eluent (additives can be difficult to remove in preparative purification)
- Availability and/or cost of Solvents

Multi solvent bottle gradients (more than binary) can be used to maintain constant eluent additive concentration without requiring additive to be in every solvent bottle, see example in Gradient Mixer section below. For example, if all gradients are run against Hexane, then solvents could include 3 bottles with Hexane, one neutral, one with acid additive, and one with base additive. The 2 additive bottles would be mixed, for example, at 20 times the intended eluent concentration. As long as each method is run with a constant of 5% from the bottle containing Hexane + additive in the eluent, each eluent will maintain proper additive concentration without needing to put additive in all bottles. This technique allows us to screen a wide variety of normal, reverse, and polar organic phase eluents with neutral, acid, or base additives using only 20 bottles total. To avoid column + additive memory effects we often load column selectors with 3 sets of the same column, one for neutral, acid, and base eluents. This means we do not need to spend time equilibrating our columns because of eluent additive changes.

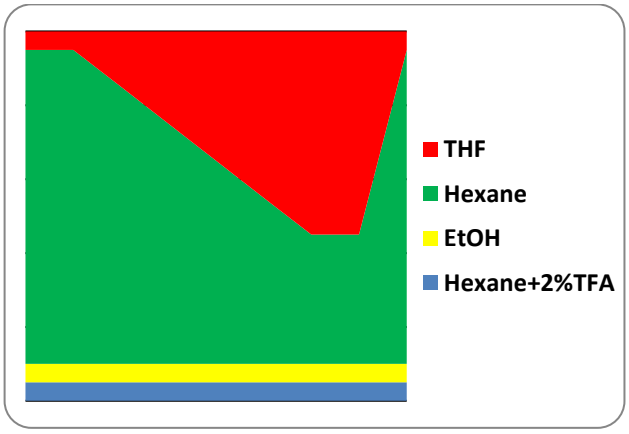
Gradient Mixer:

The PDR Gradient Mixer can proportion from 10 or 20 solvent bottles to create any requested mixture. Solenoid valves are microprocessor controlled and valves can be changed individually. We also have a valve control module that can control any type valve (electrical, pneumatic, etc.) for larger flows.

Multi solvent bottle gradients (more than binary) can be used to maintain constant eluent additive concentration without requiring additive to be in every solvent bottle. For example, to run gradients against Hexane mix 1 bottle of Hexane with additive at 20 times desired final additive concentration and run at constant 5%. Along with this 5% with additive, proportion Hexane and desired modifiers to make up the remaining 95%. Additive is only required in 1 bottle. See figure below on right. This technique permits screening a wide variety of normal, reverse, and polar organic phase eluents with neutral, acid, or base additives using 20 bottles total.

If using additives, it may be best to avoid column + additive memory effects by loading column selector with columns dedicated to a specific additive. Otherwise it takes time to wash additives from columns before next use. Larger labs with multiple systems usually dedicate different systems to different additives.

Gradient Mixer: 10w x 6h x 12d inches, 100-240 VAC, 50-60 Hz

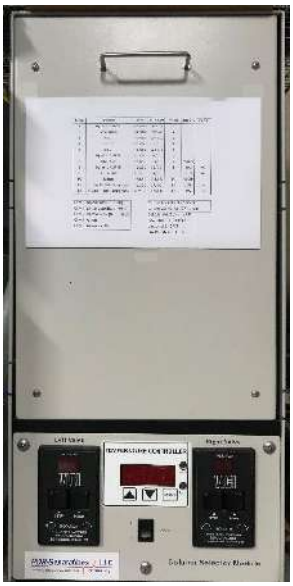


Gradient Profile using Additive in only 1 Bottle

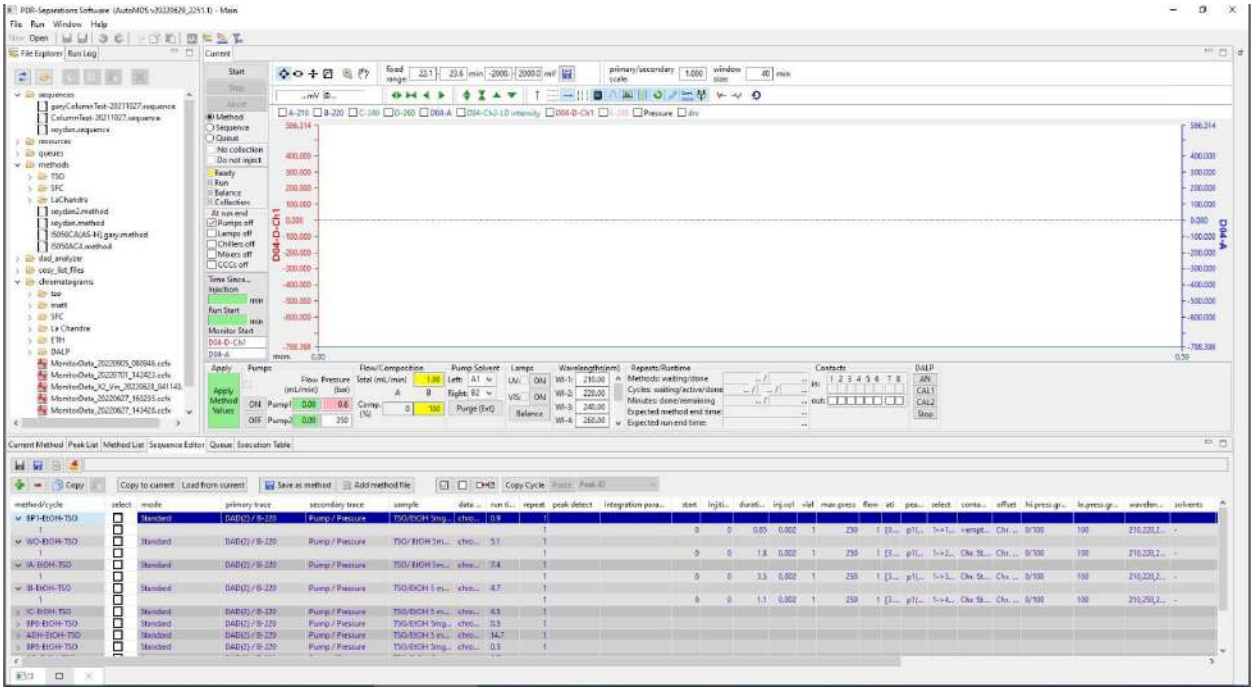
Column Selector:

Column Selector available with one or two valves, various port sizes, and with or without heat/cool. Pull door handle to release magnetic latches and set-aside door during column changes. Pull-out upper manifold for easy access to columns. Typically shipped with 0.010" ports and 2 valves each with 12 column positions for a total of 24 column positions. Other valves and port sizes are available. We usually plumb valve position 1 of each valve with bypass tubing for fast flushing during eluent composition changes, resulting in 22 useful column positions.

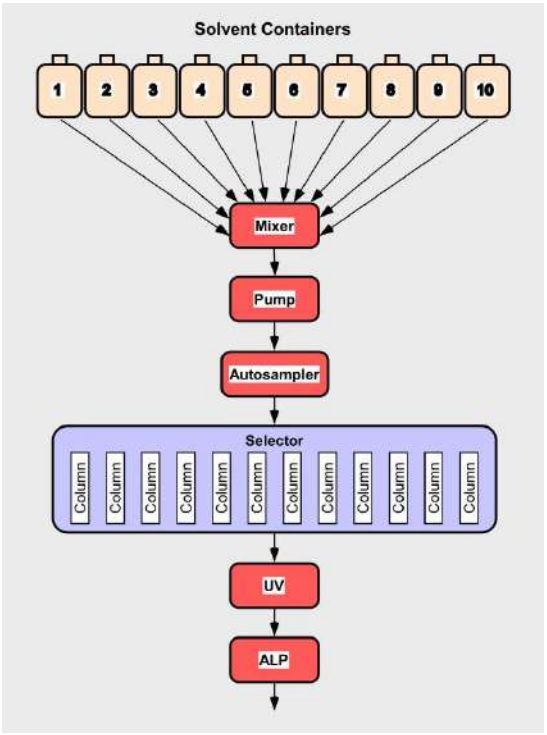
10w x 21h x 12d inches
100-240 VAC, 50-60 Hz



AutoMDS Examples:



7 – AutoMDS



Method Development Plumbing

AutoMDS on Agilent with ALP, 20 bottles/24 columns

AutoMDS on Agilent with old-style column selectors: 10 bottles/12 columns HILIC on left; and 10 bottles/24 columns Chiral on right with one column selector for neutral and the other for acid additives.

3 – AutoMDS & AutoPrep on Analytical/Semi-Prep CCC.

AutoPrep Systems (Automated Preparative Purification)

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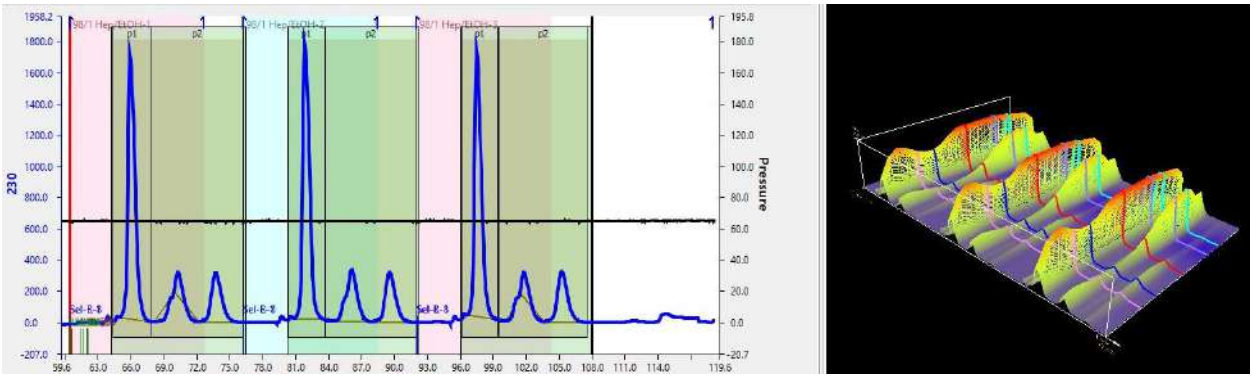
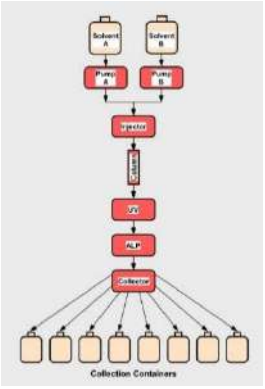


AutoPrep Example from 2019 job at PDR

AutoPrep:

AutoPrep is very easy to use and can reliably make 1000s of unattended injections for big jobs. The **Recalculate** feature instantly shows result of peak detection and collection changes on a test run chromatogram, eliminating the need for more test runs and making setup quick and easy to optimize. If method settings are changed while method is running, AutoPrep adapts appropriately and records changes.

AutoPrep Advantages:



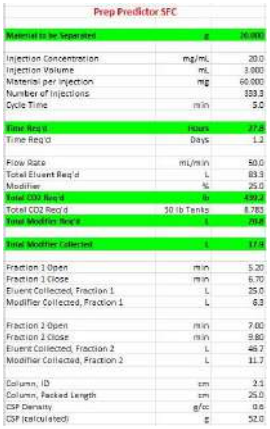
- Direct control of existing or new pumps and detectors.
- Injections made with syringe/loop/valve or another pump for large-scale installations.
- Collections made with rotary valve or open/close valves of any type or size.
- Setup, operation, and monitoring are very easy and robust.
- Recalculate feature instantly shows result of changing collection parameters on test run.
- Detection and Collection can adapt to variations in real-time.
- Collect based on time, voltage (amplitude), slope (derivative), +/- polarity, ee, and logical combinations.
- Parameters can be changed while method is running making it easy to optimize productivity as conditions equilibrate or change.
- Typical installation: AutoPrep software, Injector/Collector module, Custom Installation with your pumps and UV, Optimization for your applications, and Training.

Spreadsheets:

Prep Predictor spreadsheets predict number of injections, run time, and volumes, so jobs are predictable: you always know what to expect. Useful for pragmatically comparing methods, solvent management, project costing, scheduling, etc. Often the largest separation is not really the best method for purification.

Prep Predictor LC

Material to be Separated	g	200.000
Injection Concentration	mg/mL	80.0
Injection Volume	mL	3.000
Material per Injection	mg	00.000
Number of Injections		2222.2
Cycle Time	min	10.0
Time Req'd	Hours	370.4
Time Req'd	Days	15.4
Flow Rate	mL/min	20.0
Total Eluent Req'd	L	444.4
Solvent B	%	55.0
Total Solvent A Req'd	L	288.9
Total Solvent B Req'd	L	155.6
Total Eluent Collected	L	333.3
Fraction 1 Open	min	5.00
Fraction 1 Close	min	7.00
Eluent Collected, Fraction 1	L	88.9
Fraction 2 Open	min	8.00
Fraction 2 Close	min	18.00
Eluent Collected, Fraction 2	L	222.2
Column, ID	cm	2.1
Column, Packed Length	cm	25.0
CSP Density	g/cc	0.6
CSP (calculated)	g	52.0



Prep Predictor SFC

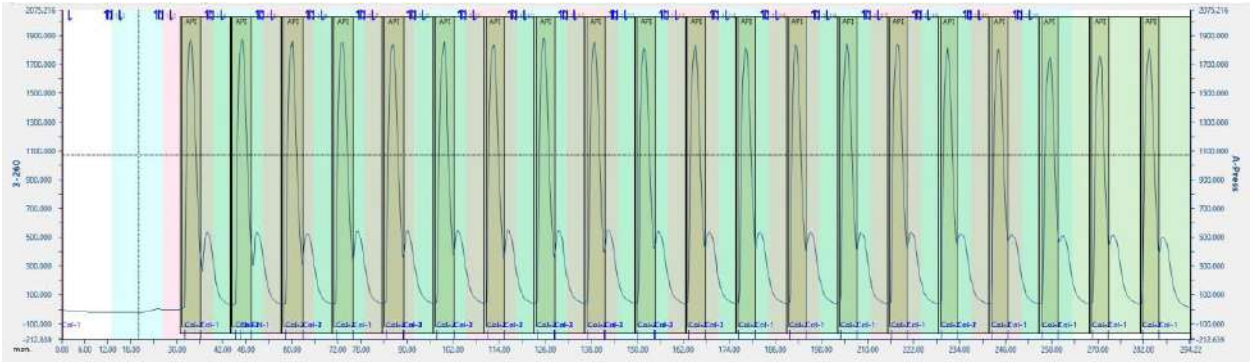
Material to be Separated	g	30.000
Injection Concentration	mg/mL	20.0
Injection Volume	mL	3.000
Material per Injection	mg	60.000
Number of Injections		333.3
Cycle Time	min	9.0
Time Req'd	Hours	27.8
Time Req'd	Days	1.2
Flow Rate	mL/min	60.0
Total Eluent Req'd	L	83.3
Modifier	%	25.0
Total CO2 Req'd	lb	499.2
Total CO2 Req'd	50 lb Tanks	8.783
Total Modifier Req'd	L	20.8
Total Modifier Collected	L	17.0
Fraction 1 Open	min	5.20
Fraction 1 Close	min	6.70
Eluent Collected, Fraction 1	L	25.0
Modifier Collected, Fraction 1	L	6.3
Fraction 2 Open	min	7.00
Fraction 2 Close	min	9.80
Eluent Collected, Fraction 2	L	46.7
Modifier Collected, Fraction 2	L	11.7
Column, ID	cm	2.1
Column, Packed Length	cm	25.0
CSP Density	g/cc	0.6
CSP (calculated)	g	52.0

Injector/Collector:

Injector/Collector, see photo at right, can be built for 1/16- or 1/8-inch OD tubing and any size loop. Sample solution is drawn in at top of loop and pump flows into bottom of loop. Thus, sample solution does not get diffused traveling length of loop and sample solution does not go into syringe because syringe sucks eluent from bottom of loop drawing sample solution into top of loop.

For larger tubing sizes and/or customers preferring open/close (rather than rotating) collection valves we have a universal valve driver module that can actuate any size or type of valve (electrical, pneumatic, etc.).

AutoPrep Examples:



AutoPrep Example from 2019 job at PDR
Notice blue injector markings at top and blue collection markings at bottom: all actions are recorded.

AutoPrep with Agilent

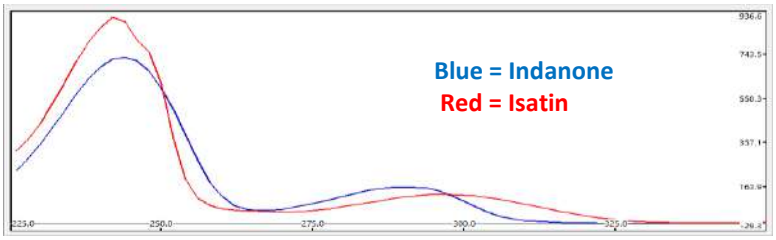
AutoPrep with SD1 pumps and Knauer UV

AutoPrep with JCT 1L CCC

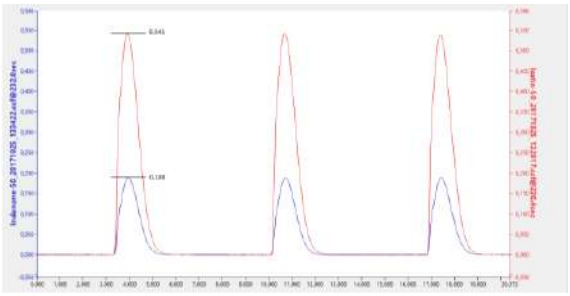
Spectral Deconvolution:

Real-Time Spectral Deconvolution:

PDR's Spectral Deconvolution is real-time and can plot concentration of individual molecules, even if spectra are very similar. The example below shows real-time deconvolution using the WL range of 220-350 nm of triplicate FIA (flow injection analysis, no column, no separation) injections on Agilent HPLC with DAD using Indanone and Isatin analytes.

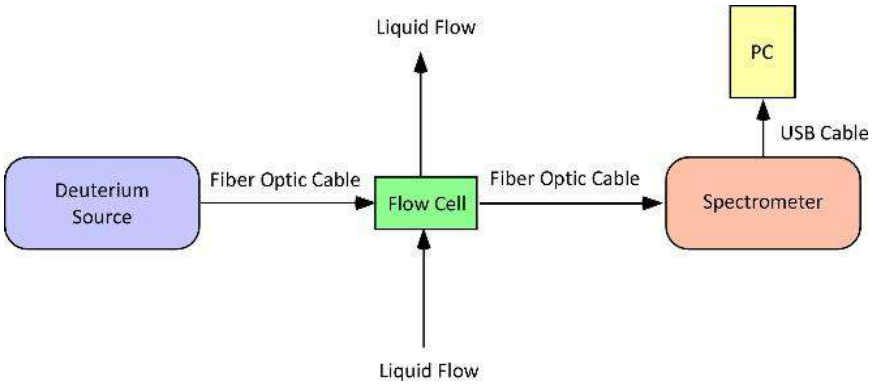


Spectra of Indanone and Isatin



Deconvolution of Indanone and Isatin (2017.10.25)

PDR's Spectral Deconvolution can be applied at any scale from analytical using Agilent DAD to large scale using an inline fiber-optic spectrometer as diagrammed below. Applications from analytical peak purity to process monitoring.

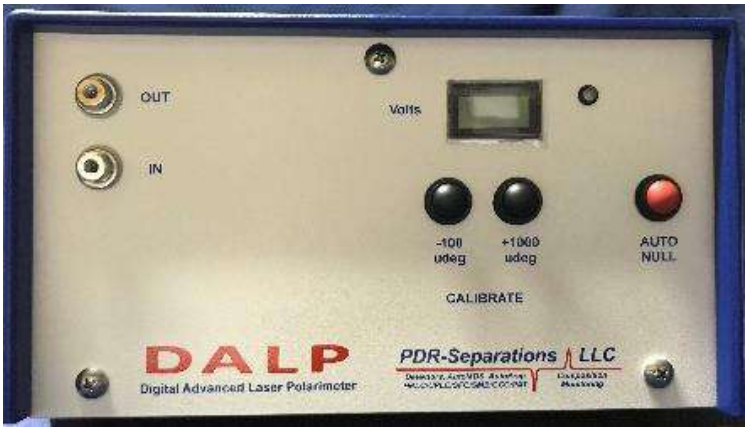


Block Diagram of Fiber Optic Spectrometer

In 2013 PDR was encouraged by a big-pharma company to monitor and control the purification of UV absorbing compounds on SMB. They wanted to isolate trace impurities in APIs for proper analysis and characterization, and wanted to make short runs using very little time to develop methods. A poster was presented at Prep 2015 and an oral presentation was given at Prep 2016 on this work. PDR inserted a flow cell before the recycling pump, connected flow cell to a spectrometer and light source via fiber optic cables, collected UV spectra, and mathematically deconvolve the UV spectra based on known spectra of components. PDR continued development of algorithms to simplify setup, compensate for UV non-linearities, and extract spectra of coeluting unknowns. Spectral Deconvolution plots component concentrations in real-time and collection decisions can be queued to any component.

DALP (Digital Advanced Laser Polarimeter) Optical Activity Detector

DALP is a new digital implementation of our traditional ALP (Advanced Laser Polarimeter) that has been in production for more than 20 years. DALP uses digital signal processing (DSP) with our proprietary algorithms to successfully ignore changes in laser power and absorbance to consistently delivery improved sensitivity, drift, and accuracy. PDR's companion **DALP App** sets time constant and supports on-site optimization, calibration, and software upgrades. Existing ALPs can be upgraded to be DALP with all-new electronics and improved capabilities. for about $10K.



100 - 240 VAC 50/60 Hz
20 watts
10 x 6 x 16 inches
20 lbs
CE, UL, CSA, TUV
Flow Cells: HPLC, UHPLC, SFC, Prep, CCC/CPC, SMB/MCC, PAT, etc.

DALP responds to optical activity with a unique positive or negative deflection. Amplitude is proportional to concentration and specific rotation while +/- sign indicates clockwise or counterclockwise rotation: regardless of elution order, eluent, or separation method. Operating at 635 nm, DALPs only respond to optical activity and ignores absorbance – all peaks are optically active, gradients do not affect the baseline, and no chromophore is required. Detection is based on polarization (optical phase) changes not absorbance (amplitude) changes. In method development applications DALPs show elution order of enantiomers and confirms that peaks are optically active. In preparative purification applications DALPs control peak collection based on peak +/- polarity and amplitude, rather than just amplitude. DALPs do not suffer from the overload (if too much light is absorbed, there is nothing left to detect) and non-linearity problems of absorbance-based detectors.

DALP Advantages:

- Universal Optical Activity Detector
- HPLC, UHPLC, SFC, CCC/CPC, SMB/MCC, PAT, etc.
- Pharmaceuticals, Antibiotics, Pesticides, Proteins, Foods, Flavors, Fragrances, etc.
- No Chromophore Required, no Absorbance effects
- Sensitive, Large Linear Dynamic Range (> 100,000)
- Robust (10+ year MTBF at 24/7/365)
- Analog and Digital Output, can be connected to any data system
- DALP can be optimized and calibrated onsite using DALP App and a Calibration Shim
- Fully Automatic, No User Adjustments or Stop Flow Scans required
- Consistent Assignment (+/-) for Enantiomers
- Real Time Data – Multiple Scans Not Required
- Two "real" Calibration Peaks that rotate plane of polarization same as Analytes
- Flow Cells available for Any Application
- Confirm Enantiomeric Separation in Method Development
- Measure Specific Rotation from Chromatogram Peak
- Control Fraction/Peak Collection in Preparative Purification

Theory of Operation:

DALP measures the rotation of a highly-polarized 635 nanometer laser-beam passing through a flow cell with microdegree sensitivity in microliter volume – without absorbance anomalies or interferences, and no chromophore is required. See Figure DALP-01 below of typical chromatogram. Calibrates are real rotations exactly same as analytes. DALP's rotational calibration is based on geometry using a mechanical shim, not chemistry. DALPs are very accurate and specific rotation can be calculated directly from a chromatogram peak.

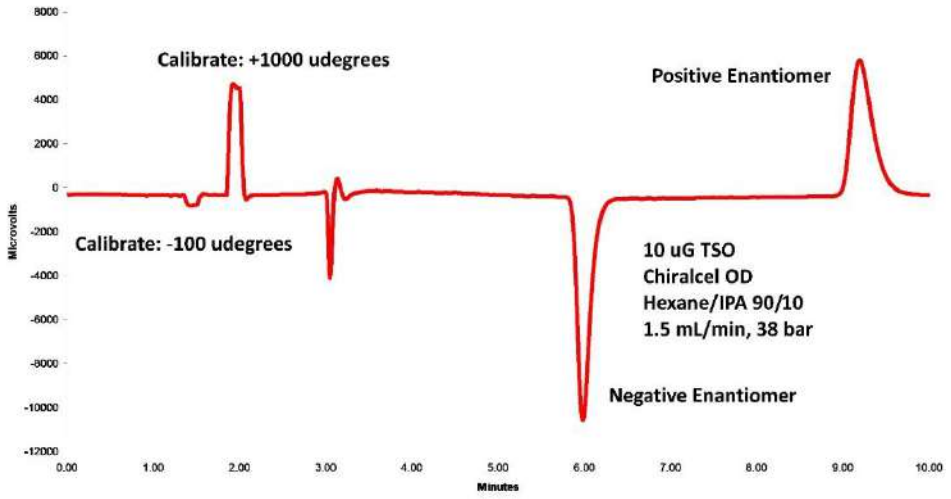


Figure DALP-01: Typical DALP Chromatogram of Separated Racemate

Measured optical activity for a particular analyte depends on a variety of parameters including wavelength. At wavelengths between 200 and 400 nm optical activity values typically changes quickly with wavelength and zero crossings (sign inversions) are not unusual. Variations in measured optical activity and zero crossings are not common above 500 nm. Traditional polarimeters use the sodium D line emission at 590 nm and DALP uses laser diodes at 635 nm. Measurements at these wavelengths (590 and 635 nm) have proven to be extremely stable and reproducible with no absorbance-related interferences while shorter wavelengths prove problematic in many cases. Measured optical activity is affected by sample matrix (including the diluent) and to a lesser extent by temperature.

Light can be described as having properties similar to that of a traveling wave, see Figure DALP-02A below. Wave motion results from vibrations (oscillations) that produce crests and troughs. The distance between successive crests or troughs, called wavelength, corresponds to light's color. The magnitude of vibration, see Figure DALP-02B, corresponds to its intensity or amplitude. Most light sources emit waves of light vibrating in many different planes, see Figure DALP-02C.

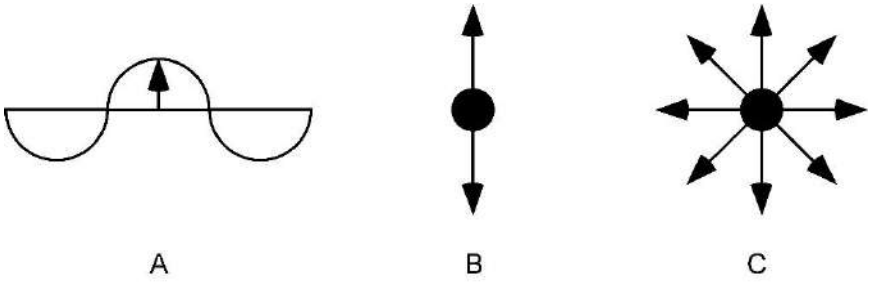


Figure DALP-02: Wave-Motion of Light

If passed through a polarizing filter the emerging light will be limited primarily to waves vibrating in a single plane, see Figure DALP-03 below. The resulting light is called plane-polarized because the light is primarily polarized in a single optical plane.

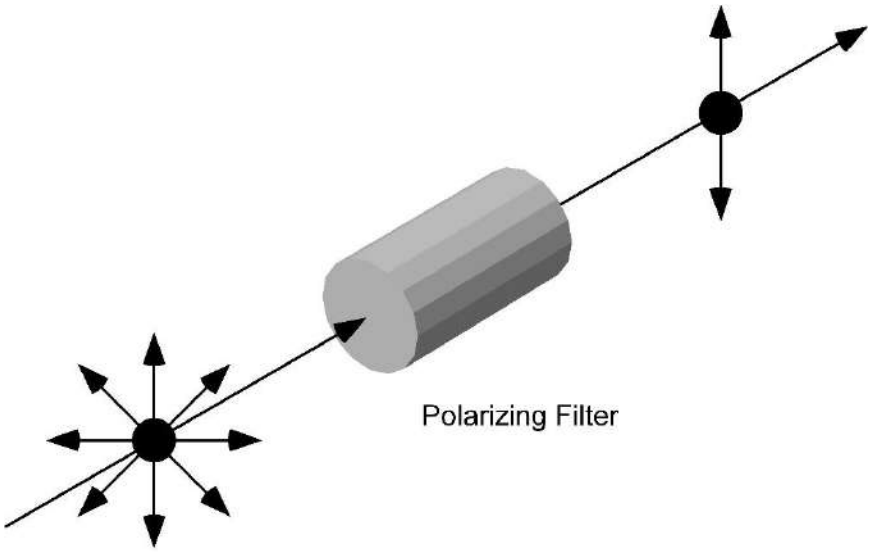


Figure DALP-03: Producing Plane Polarized Light

So, what is optical activity? To answer that question, we shift from physics to chemistry. Some organic compounds have a molecular geometry that affects plane polarized light. These compounds contain a carbon atom to which is attached four different functional groups (see Phenylalanine example in Figure DALP-04 below). Because a single bonded carbon atom has a tetrahedral geometry, the functional groups can be attached in either of two configurations with one molecule being a mirror image of the other (similar to your right and left hands). Otherwise the molecules are structurally identical. This geometry rotates (changes) the angle of the plane of polarized light passing through, is called optical activity, and is unique. The "rotation" of the plane of polarization is actually an optical phase phenomenon that locally affects the light beam inside the flow cell. Optical activity is defined as the ability of a compound to rotate plane polarized light in one direction or another (positive versus negative rotation).

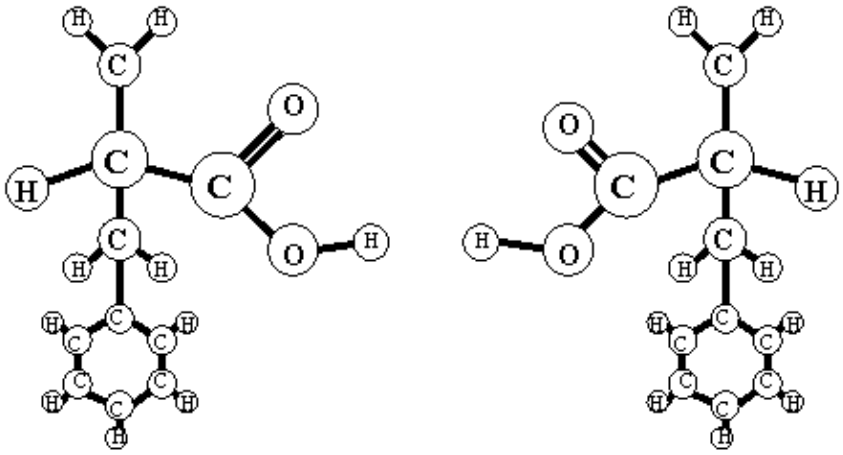


Figure DALP-04: Phenylalanine Chiral Geometry

Mirror image, non-superimposable isomers are called enantiomers. Enantiomers are chemically identical but contain a difference in 3D molecular geometry that produces an equal but opposite rotation of plane polarized light. Using a polarimeter we can measure the optical rotation produced by a liquid or gas phase sample, see Figure DALP-05 below.

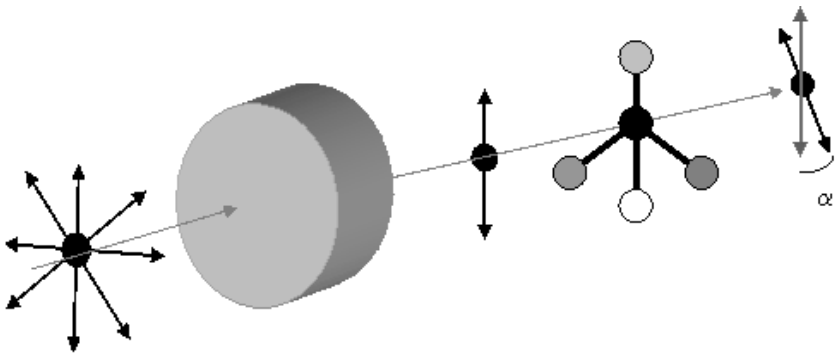


Figure DALP-05: Rotation of Plane-Polarized Light by Analyte

DALP optical system is illustrated in Figure DALP-06 below and consists of a laser diode, polarizing prism, Faraday rotator, flow cell, analyzing prism, and photodiode.

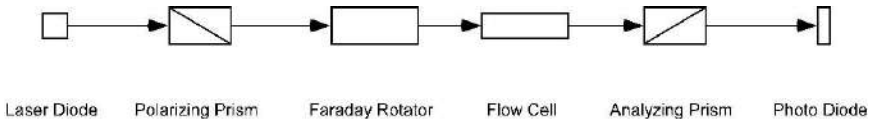


Figure DALP-06: DALP Optical System

Polarized light from a laser diode is further filtered with a polarizing prism and this highly polarized light passes through a Faraday rotator and then a flow cell. The Faraday rotator imparts an oscillating rotation to the plane of polarization. A sample exhibiting net optical activity flowing through the flow cell will offset the average oscillating rotation. Advanced electronics and mathematical algorithms extract the magnitude and sign of net optical activity from the photodiode signal. Faraday oscillation is above 300 Hz, so integration of results is not required and real time values are available continuously. Faraday oscillation is part of our phase detection and noise rejection scheme.

DALP in Method Development:

DALPs are useful in method development to differentiate enantiomer peaks from achiral peaks, track enantiomer elution order, identify peaks in multiple chiral center compounds, detect optically active compounds, etc.

DALPs confirm enantiomeric separation by showing the characteristic positive and negative enantiomeric peaks. UV cannot differentiate enantiomeric peaks from unseparated racemate and/or achiral peaks. DALPs only reacts to optical activity, not absorbance. Compounds with multiple chiral centers exhibit noticeable differences in specific rotation between enantiomer pairs, see Figure DALP-07 below. This characteristic makes it easy to properly identify and quantitate peaks in diastereoisomer (and more complex) separations. Using a DALP along with UV/DAD in method development and analysis provides instant verification of enantiomers, showing amplitude and unique +/- polarity that is not dependent on elution order or eluent composition. DALPs ignore peaks and gradients with no optical activity.

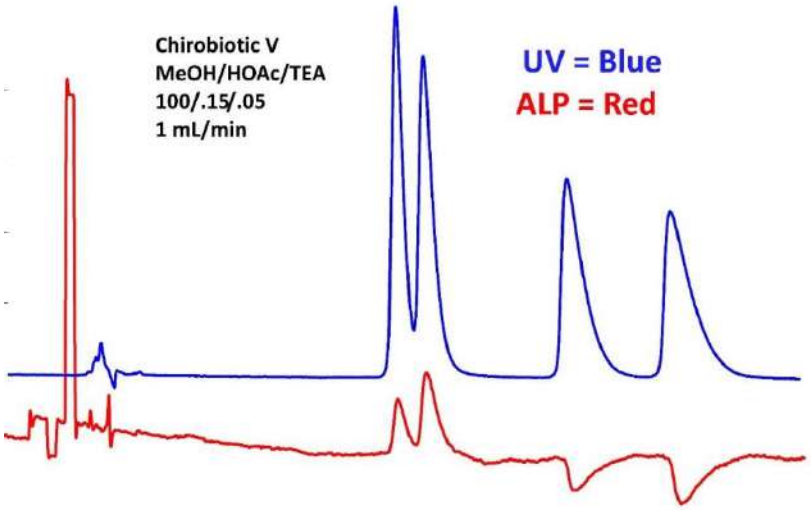


Figure DALP-07: Labetalol Diastereomer

See Figure DALP-08 below where an ALP was used to purify cypermethrin enantiomers using SFC. Cypermethrin has three chiral centers and eight enantiomers. There are no commercially available cypermethrin single enantiomer standards. The ability of ALP to identify enantiomers by peak polarity and area was a big help in interpretation of chromatograms and peak identification for preparative purification separations. The last peak in the UV chromatogram is an impurity, not a cypermethrin enantiomer. This was easy to see on the ALP trace.

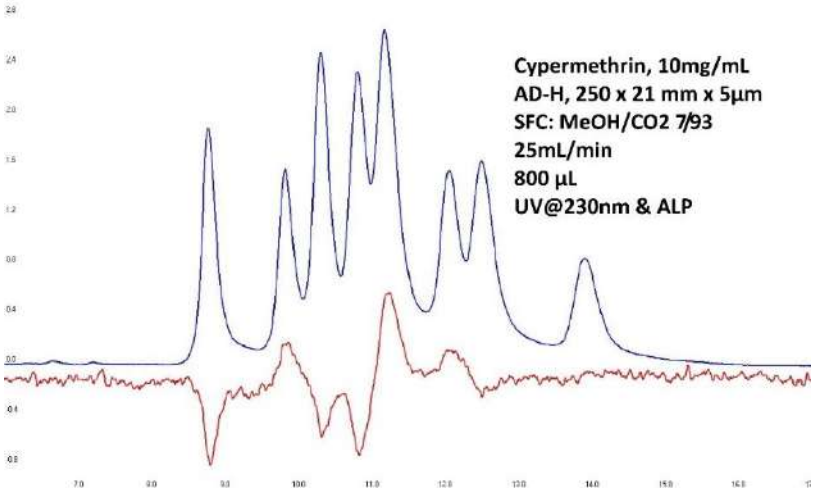


Figure DALP-08: Cypermethrin Separation, 4 chiral centers, ALP+UV, SFC

See Figure DALP-09 below where an ALP was used to purify Gentamicin analogs using HPLC. UV detection is challenging because these compounds lack a UV absorbing chromophore. All analogs (C1A, C2, C2A, C2B, C2A, and C1) were separated along with impurities and sisomicin.

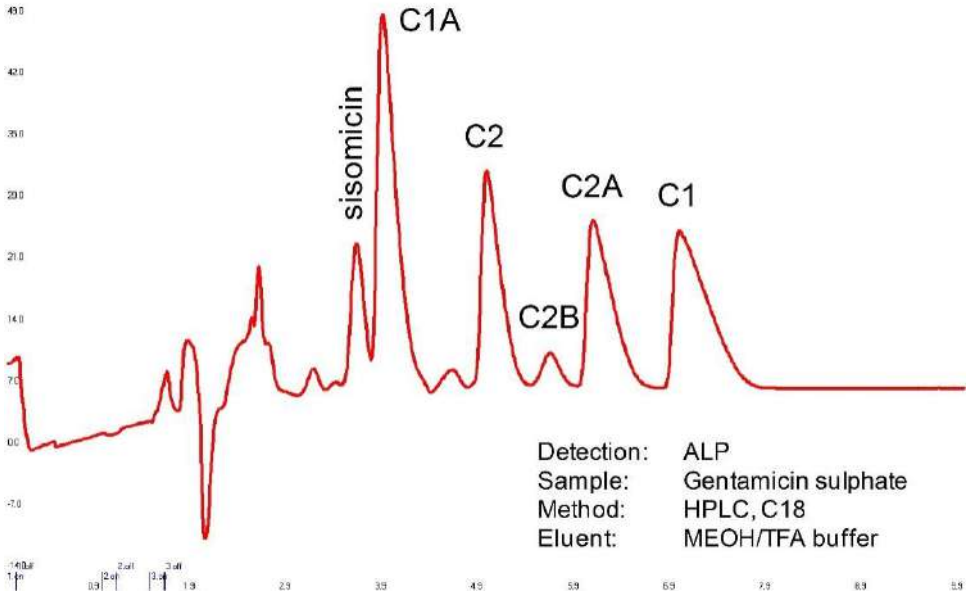


Figure DALP-09: Gentamicin Preparative Purification Separation with ALP Detection

See Figure DALP-10 below where an ALP was used to separate 4 Sugars.

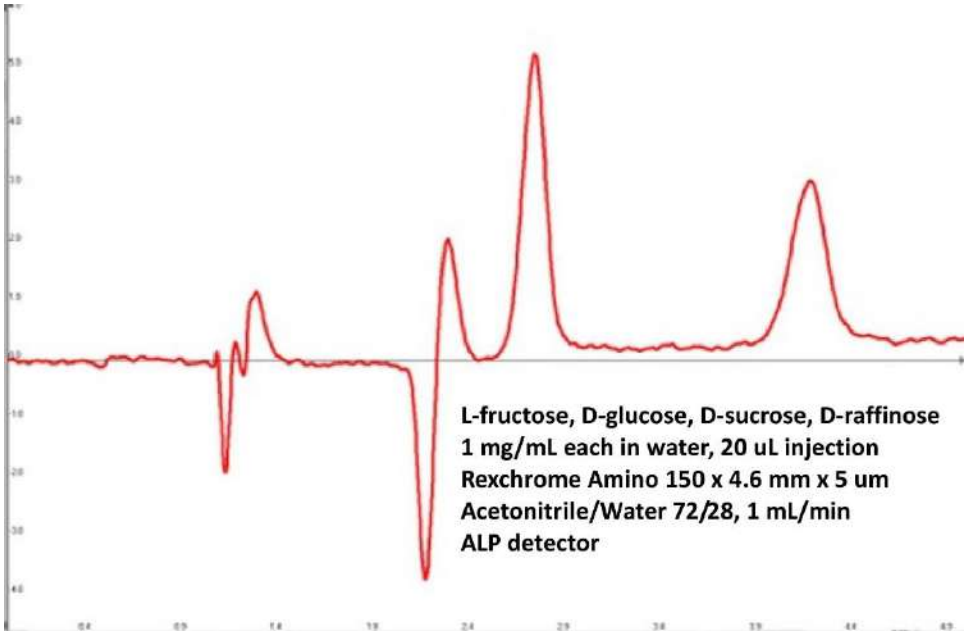


Figure DALP-10: Separation of 4 Sugars

DALP in Preparative Purification:

In preparative purification applications the tendency of UV and other absorbance-based detectors to overload makes a DALP the preferred detector (DALPs have huge linear dynamic range). Chiral preparative purification performance is best when a DALP is used to detect and collect enantiomeric peaks and a UV detector is used to track impurities that are to be avoided in collected fractions. Flow cells are available to accommodate any application at any scale.

Figure DALP-11 below shows the end of an SFC stacked injection preparative purification run where sample bottle was being sucked-dry resulting in smaller injections. UV (Blue) and ALP (Red) traces shown with peak collection by ALP derivative. This robust AutoPrep + ALP collection mode always puts the (+) enantiomer in the (+) bottle regardless of elution order and dynamically adapts to variations in loading and retention time. This purification mode does not use time, except to define time between injections. Notice that the smaller injections on the right are collected correctly without manual intervention.

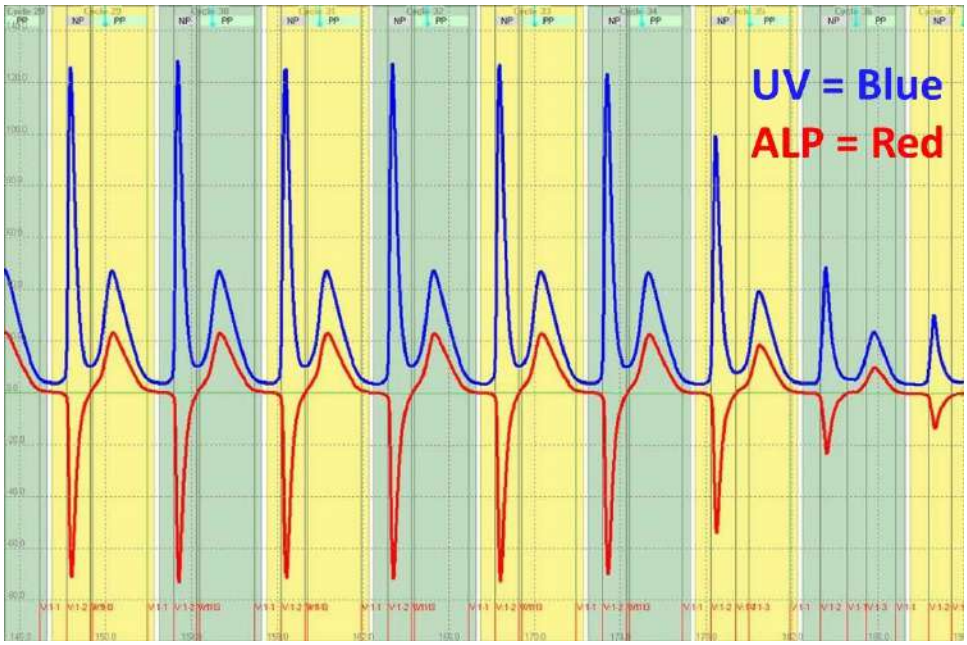


Figure DALP-11: Preparative Purification Stacked Injections, SFC job at PDR 2006.11.06

Using AutoPrep + DALP to purify enantiomers means a new job can usually be started by specifying only: injection volume, number of injections, time between injections, eluent composition, and flow rate (assuming column and solvents are proper). Elution order and collection via time windows are not required because AutoPrep + DALP will send positive peaks to the positive-designated collection port and negative peaks to the negative-designated collection port consistently based on real-time amplitude and +/- sign of DALP signal derivative. This mode of collecting enantiomers is very easy to use and very efficient. In most cases concentration and purity of collected fractions will be better than other techniques because each collection is actively controlled by conditions inside the DALP flow cell. Collections never start or stop too soon or too late, but just right consistently.

Services:

Training and Support:

Most PDR sales include hands-on training after installation and optimization. Ongoing Training and Support as needed remotely via email, phone, and SOIP (Service over Internet Protocol). SOIP means we can usually connect to your PC remotely to solve problems and teach instantly. Our SOIP support does not necessarily need to be a PDR-Separations system, we have broad knowledge and experience with most systems and situations.

Purifications:

1-1000 grams, larger jobs can be arranged as needed.

Installations, Upgrades, Repairs:

Personalized technical support specializing in planning, installation, repair, and on-going support of hardware and software systems.

Custom HW/SW Systems:

PDR delivers and supports custom hardware and software systems with an emphasis on automation and productivity.