C196-E091A

SHIMADZU
Excellence in Science

LC Systems

Nexera-i
Prominence-i

i-Series Plus

intuitive
Achieving Easier Operation

innovative
Advanced
Interactive Design

i-Series Plus

intelligent
Smart Features Increase Work Efficiency

Shimadzu's integrated LC system has been reborn as i-Series Plus. Equipped with ACTO technology for even smoother migration of existing analytical methods, the Nexera-i MT method transfer system allows for easy method transfer between HPLC and UHPLC. Compatible with the method scouting system, method development can now be performed on an integrated LC system. Using i-Series Plus substantially improves method development efficiency, since i-Series Plus can be used to perform method development via rapid UHPLC analysis followed by method migration to HPLC systems at manufacturing departments. The autosampler is also equipped with an automated pretreatment function, which is capable of automated sample dilution, reagent addition, and co-injection analysis, to improve the efficiency of sample preparation operations.

i-Series Plus Product Line-Up

Method Scouting System to Support Method Development

Prominence-i / Nexera-i

Method Transfer System for HPLC and UHPLC in a Single Unit

Nexera-i MT

Detector-less Model Suitable As An LC/MS Front-End System

Prominence-i LT

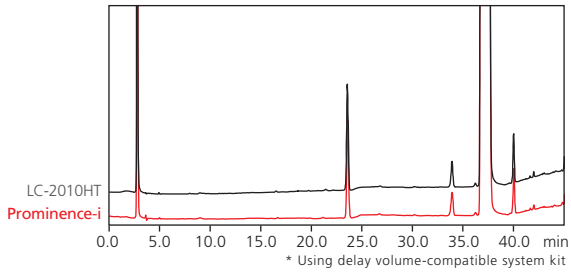
Using Existing Analytical Methods in the Latest Instruments

At first glance, an updated model of the same instrument is a sound choice if you wish to continue using existing analytical methods. But technology is always advancing and system performance aspects, such as instrument stability and ease of use, change in ways not apparent in the data. By upgrading to i-Series Plus, you retain compatibility with existing systems, but also acquire substantial improvements in the reliability and stability of your analytical results. i-Series Plus provides the optimum analytical environment for increasing the speed of analytical methods and other areas of method development.

Supporting Analytical Method Migration Operations at the Hardware Level

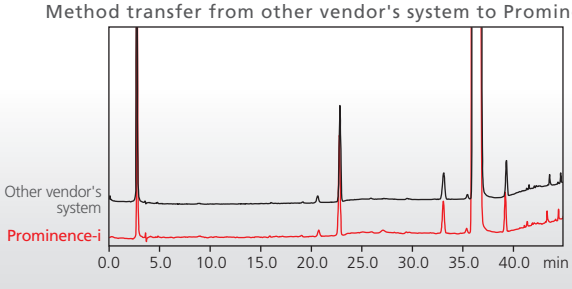
i-Series Plus system capacity is highly compatible with other systems, and analytical methods can be transferred with ease from competitor systems. An optional kit can also be used to make i-Series Plus compatible with Shimadzu's previous LC-2010 series, reducing the work involved in migrating existing analytical methods, and supporting the smooth startup of operations following instrument installation. Based on a given set of analytical results, the chromatograms below show compatibility between a standard i-Series Plus configuration and a competitor's system, and between the a standard i-Series Plus configuration and a previous Shimadzu instrument (LC-2010) when using the optional kit. The chromatograms show that i-Series Plus has been designed with a high level of compatibility.

Method transfer from previous Shimadzu LC-2010HT to Prominence-i



* Using delay volume-compatible system kit

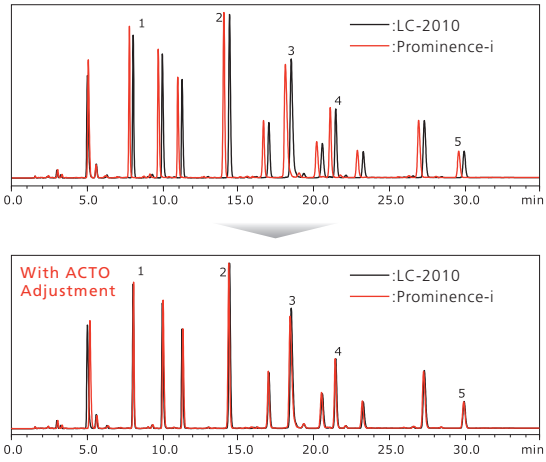
Method transfer from other vendor's system to Prominence-i



Compatibility Through Software Control (ACTO)

The ACTO (Analytical Condition Transfer and Optimization) function can be used to adjust gradient start times and allows analysis to be performed without any worries over the effects of piping volume. ACTO allows you to adjust gradient timings without having to edit the gradient program itself, and as shown in the example below, the same sort of analytical results can be obtained using an existing analytical method with a larger system capacity to Prominence-i. This gradient start time adjustment function can be used with all i-Series Plus models.

Note: The ACTO (Analytical Condition Transfer and Optimization) is the general name given to the method transfer/migration tools supplied by Shimadzu.



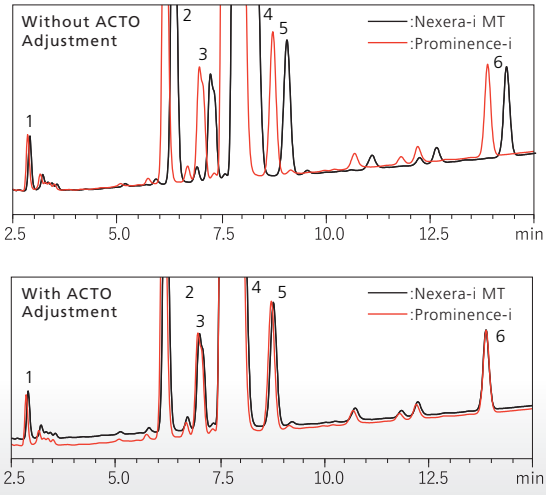
Retention Time Difference (%)

	Without ACTO Adjustment	With ACTO Adjustment
1	-3.13%	0.31%
2	-2.63%	-0.39%
3	-2.08%	-0.38%
4	-1.71%	-0.17%
5	-1.19%	-0.10%

Using ACTO to Confirm Compatibility of Prominence-i and Previous Shimadzu System (LC-2010HT)

Utilizing ACTO for US Pharmacopeia-Compliant Method Migration

Maintaining method compatibility during gradient analysis can be difficult due to differences in gradient delay volumes between models. Adjustment of the initial hold time using the gradient start time adjustment function (ACTO) enables method transfer compatible with USP <621>. Even when instrument models have different gradient delay volumes, analysis can be performed without replacing piping, etc



HPLC Conditions

Column	: Phenyl silyl silica gel column (50 mm L. × 4.6 mm I.D., 1.8 µm)
Mobile phase A	: Water/TFA=2000/3
Mobile phase B	: Acetonitrile/TFA=2000/3
Flowrate	: 1.2 mL/min
Gradient	: B Conc. 40% (0 min) → 40% (3 min) → 51% (16 min)
Column temp	: 30°C
Injection volume	: 10 µL
Sample	: Montelukast sodium

Comparison of Retention Time Difference (%) With and Without ACTO Adjustment

Component	Without ACTO Adjustment	With ACTO Adjustment
1, impurity A	1.3	1.1
2, impurity B	2.7	0.3
3, impurity C, D	3.1	0.2
4, Montelukast Sodium	2.7	-0.1
5, impurity E	2.8	-0.1
6, impurity F	2.5	-0.3

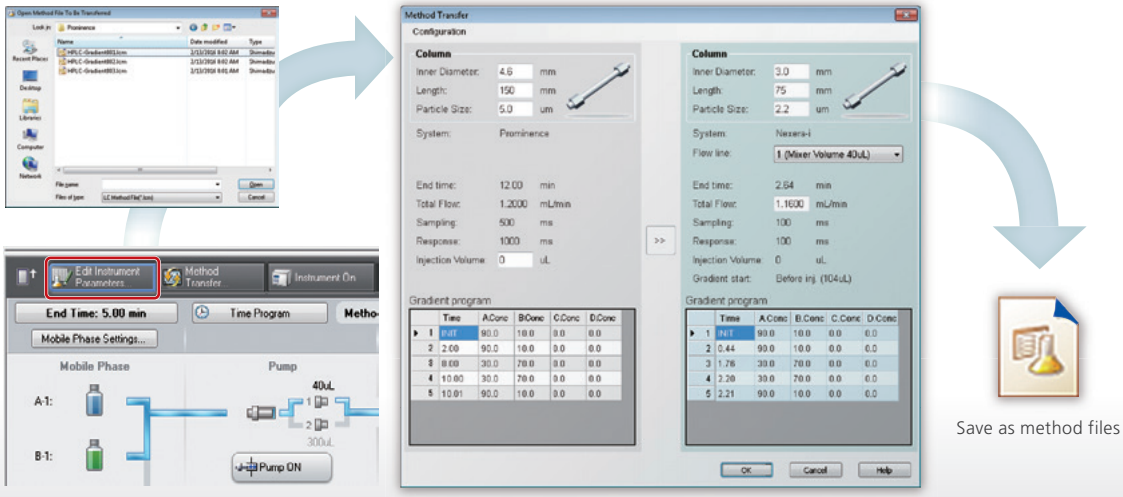
i-Series Plus for Method Development

i-Series Plus is now even easier to use for departments that develop analytical methods due to the Nexera-i MT which has two channels for HPLC and UHPLC analysis on a single system and the Method Scouting System that automatically finds the optimum combination of column and mobile phase for new compounds. Using the i-Series Plus to perform operations from product development to quality control enables highly reliable and stable analysis without worrying about differences in models.

Transfer Methods with a Single Button Operation: ACTO Function

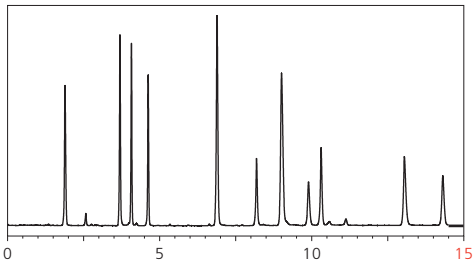
Once a UHPLC method has been transferred to an existing HPLC method, the flowrate and gradient program must be calculated according to the column size. When using the method transfer/migration support tool ACTO, the software automatically calculates the optimum parameters*. The results are output directly as a LabSolutions analytical method, so they can be used in analysis without modification.

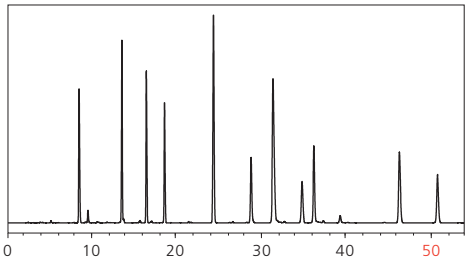
* This is a dedicated function for the Nexera-i MT.

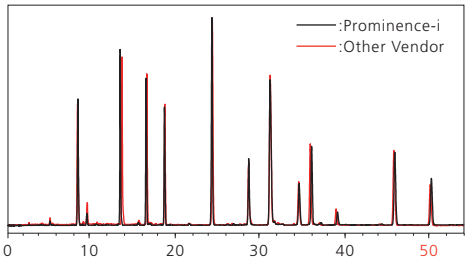


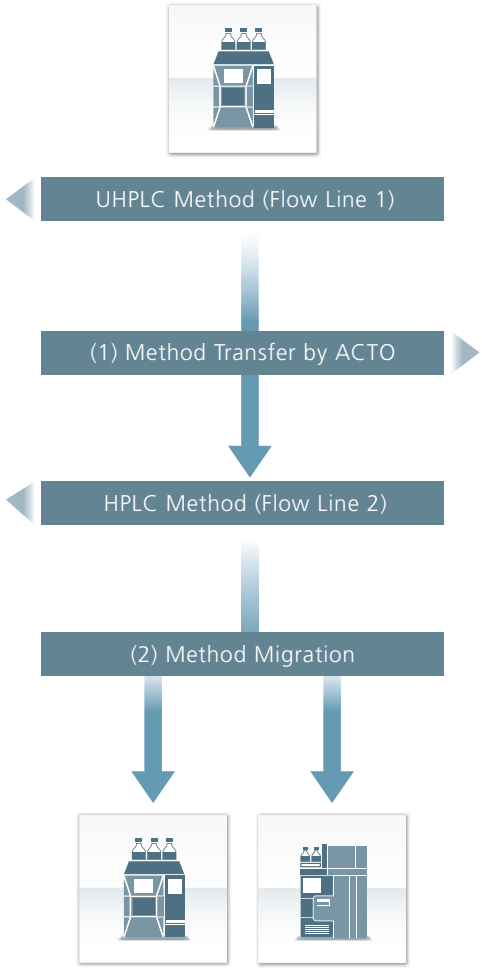
A cephem-based antibiotic was analyzed by UHPLC with the Nexera-i MT. The UHPLC method was then converted to an HPLC method with ACTO (1). This illustrates how an HPLC method created by the Nexera-i MT can be migrated unaltered to Prominence-i or a competitor's system (2).

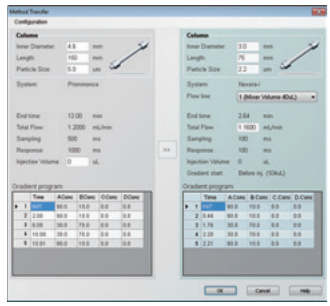
With the Nexera-i MT, a single system can be used for both method development by rapid UHPLC and HPLC method conversion for migration.











Method transfer/migration support tool ACTO

Utilizing Method Scouting for Method Development

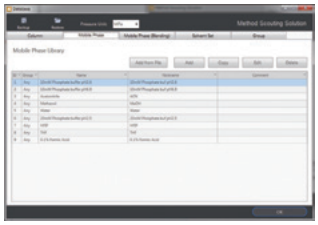
i-Series Plus is now compatible with method scouting systems.* Attaching a flow line switching valve allows up to six columns and four mobile phases to be switched automatically for analysis and to obtain optimum conditions for separation.

Many i-Series Plus systems are used in manufacturing departments and other areas due to their simplicity, and performing method development with the same system improves the efficiency of method migration operations.

* Not including Nexera-i MT

Mobile Phase and Column Database

Preregistering the mobile phases and columns to be used can make it easy to specify method settings. In addition, the database includes a sort function that makes it easy to find the desired mobile phase or column even if a large number have been registered.

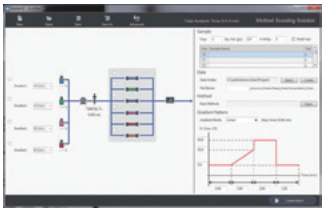


Evaluating Gradient Conditions

An extensive range of gradient patterns, such as isocratic, multilinear, or stepwise, can be specified. Concentration conditions for specific locations can be easily changed and up to 100 gradient patterns can be evaluated.

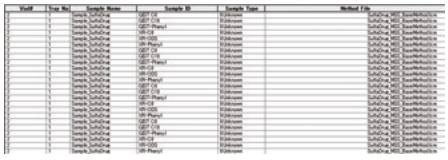
Evaluating Mobile Phase and Column Conditions

The estimated analysis end time is displayed based on the specified method and conditions being evaluated. Therefore, condition settings can be specified based on operating plans, such as by adjusting the number of samples or number of injections (both with a maximum of 10).



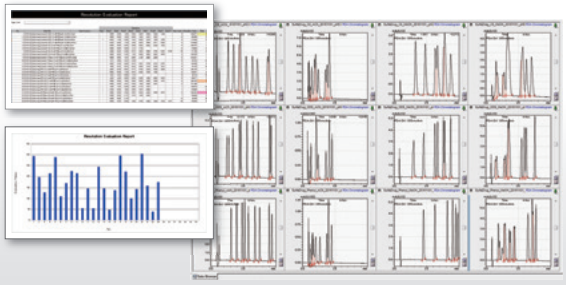
Automatic Batch Settings

Batch files are created automatically based on the condition settings being evaluated.
The created batch file can be edited before analysis starts, or analysis the analysis can be automatically started without editing the file. Processes performed after analysis can also be automated by specifying column rinsing and shutdown settings.



Quickly and Immediately Check Results When Analysis Is Finished

Data Browser can be used to display multiple chromatograms by simply dragging and dropping multiple sets of acquired data to the window. This enables quick comparison of the analytical results for more efficient decision-making.
Using the multi-data report function improves the visibility of data when considering a large number of results. It can be used to compare a large number of conditions based on the same criteria, such as resolution and number of peaks, and then to assign values accordingly to determine the optimal conditions.
Results for all the conditions considered can be automatically output as an Excel file, which provides powerful support for medium and long-term data management.



Analytical Columns that Support Method Development

The scalability of columns used in method scouting is important for method development. Shim-pack GIS/GIST/GISS series columns are available in sizes from 5 mm, suitable for HPLC analysis, to 2 mm, suitable for UHPLC analysis, allowing smooth transfer of analytical methods obtained by UHPLC method scouting for HPLC analysis. The series is also available with a wide range of modified groups, which are powerful tools in method development.

Shim-pack GIS Series

Genuine Ideal Symphony Ideal Generic HPLC Columns

Highly regarded throughout the world, Shim-pack GIS series HPLC columns are packed with high-purity silica gel.
A highly uniform pore size ensures a good mobile phase flow path and excellent low pressure performance. Not only can this substantially reduce mobile phase solvent costs, but system load can be reduced.
The silica gel surface is uniform and chemical modifications are stable, providing excellent reproducibility.

Shim-pack GIST Series

Genuine Ideal Symphony Tenacity Highly Stable, Highly Durable

Shim-pack GIST series columns are packed with high-purity porous spherical silica. Their increased inertness not only improves peak shapes, but also increases durability. The series columns also have a large working pH range (1 to 10), and are designed for ease-of-use during analysis of a wide variety of compounds.
Reproducibility between production lots is also excellent, with the series columns recommended not only for quality control and research and development, but also for people just starting out in analysis.
This series is available in a variety of pore sizes, which makes it easy to migrate methods between conventional and ultra-high-speed analysis.

Shim-pack GISS Series

Genuine Ideal Symphony Speed Robust Inertness, High-Speed Analysis

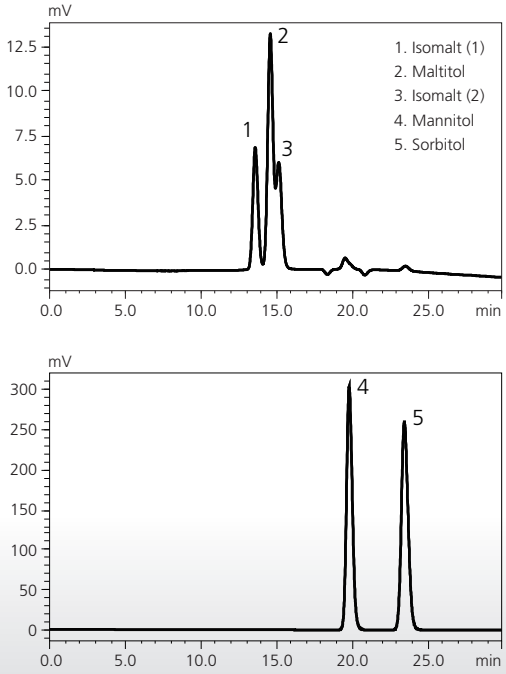
Shim-pack GISS series columns are designed with the robust inertness and wide working pH range of the GIST series, while also delivering rapid elution times and sharp peaks.
Packing surface area, pore size, and chemical modification have been optimized for excellent peak shapes, making these columns ideal for high-sensitivity LC/MS/MS analysis.
This series also includes the 1.9 mm and 3 mm HP series for UHPLC analyses.

Greater Efficiency, Greater Ease of Use

i-Series Plus incorporates the technology developed for the Prominence (LC-20A) series, and provides a high level of basic performance with improved ease-of-use. The column oven has a larger adjustable temperature range and the autosampler is equipped with automated pretreatment functions for sample dilution and co-injection of internal standard substances. The i-Series Plus will not only improve analysis throughput, but will also automate human work for improved operational efficiency.

Reliable Data Acquisition Even During High-Temperature Analysis

The i-Series Plus column oven has a maximum temperature setting of 90°C. Using mannitol analysis as an example, the US Pharmacopeia method notes to control temperature at 85°C for analysis. i-Series Plus can be equipped with a 300 mm long column, and can easily accommodate high-temperature analysis with this column.



System Suitability Test Results

System Suitability Evaluation Items	Target Component	Reference Value	Analysis Results
Retention time	Mannitol	20	19.9
Relative retention time for mannitol	Isomalt(1)	0.6	0.69
	Maltitol	0.69	0.74
	Isomalt(2)	0.73	0.77
	Sorbitol	1.2	1.2
Resolution	Mannitol Sorbitol	2.0	4.8
Relative standard deviation of peak area	Mannitol	1.0%	0.25%

Even though i-Series Plus is equipped with an additional detector, the compact footprint of the system has been preserved.

Using an Automatic Pretreatment Function to Improve Operational Efficiency

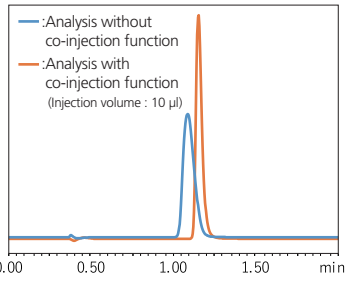
The automatic pretreatment function of the i-Series Plus performs operations such as sample dilution and reagent addition before analysis starts. Automated pretreatment operations eliminate incorrect operations and improve the efficiency of the overall analysis routine.

Dilution Function Automates the Process of Calibration Curve Creation to Unknown Sample Quantitation

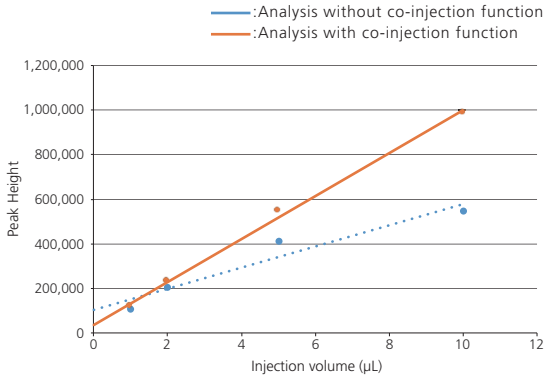
The dilution function can dilute a sample to a specific dilution ratio. As an example, the dilution function can be used to automatically create a calibration curve by simply placing a standard stock sample solution in the autosampler and specifying the desired dilution ratio. It also performs analysis on unknown samples using calibration curves created in batch analysis and outputs the quantitation results, and this enables the automated analysis procedure.

The Co-injection Function Prevents Peak Shape Degradation by Co-injecting the Sample and Diluted Solution Together

As an example, when the sample solvent is a high-concentration organic solvent, the injection volume can affect the sample solvent and lead to a degradation of peak shape. In these situations, co-injecting the sample and diluting solvent together can prevent peak shape degradation. This problem is more pronounced the smaller the internal diameter of piping used in the UHPLC system, but the co-injection function allows analysis to be performed without replacing piping.

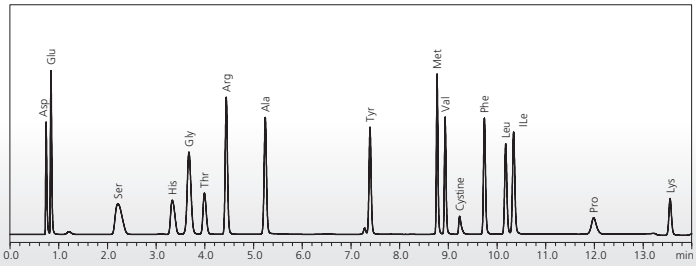


Column : Shim-pack XR-ODS 75 mmL. × 3.0 mmI.D., 2.2 µm
Mobile phase : Water / Methanol = 7 / 3 (v/v)
Sample solvent : Water / Methanol = 4 / 6 (v/v)
Diluted solution : Water
Sample : Caffeine
Instrument used : Nexera-i MT



Pre-Column Derivertization for Amino Acid Analysis

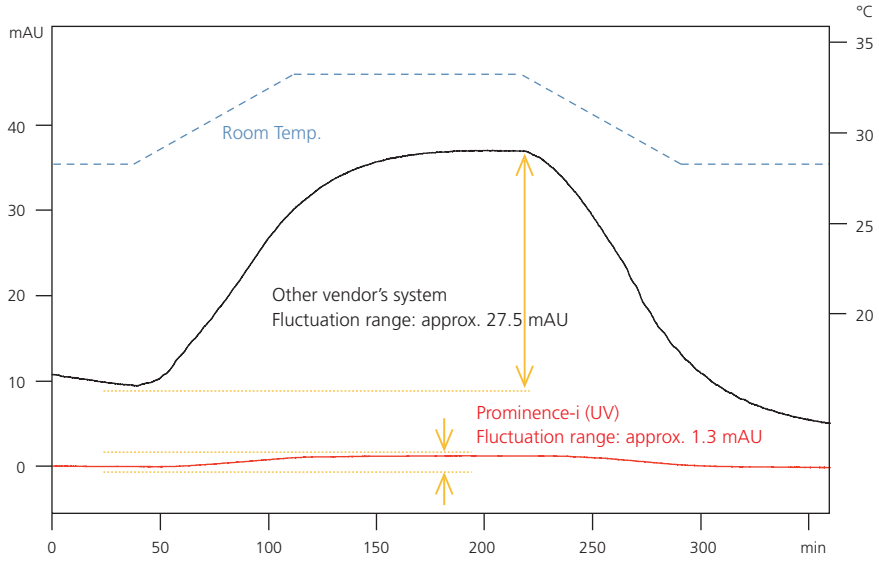
Using the co-injection function allows a sample to be reacted with a reagent in the sample loop. The chromatogram below shows the results of pre-labeling derivatization reaction with amino acid OPA/FMOC reagent. The entire aspirated sample is delivered for analysis, reducing the sample and reagent volumes required by analysis to a minimum and also allowing for a highly sensitive analysis.



Analytical Conditions
Column : Shim-pack XR-ODS II, 2.2 um
Mobile phase : Acetate buffer solution / Acetonitrile, Gradient elution
Flow rate : 1.0 mL/min
Column temp : 40°C
Detection : Fluorescence
Sample : 17 amino acid components
Sample injection volume : 1 µL
Instrument used : Prominence-i

Excellent Baseline Stability: Dual-Temp Control with TC-Optics and Flow Cells

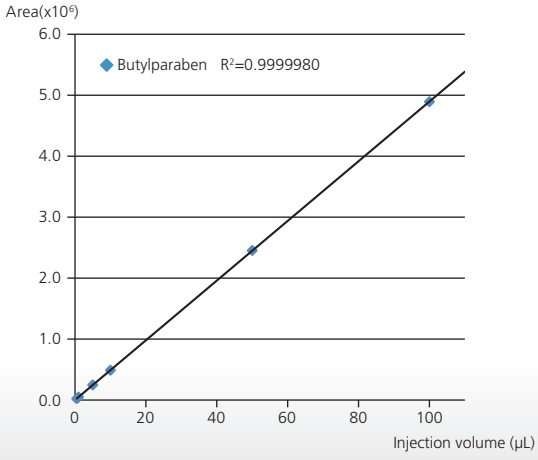
In addition to the temperature control function in flow cells, the i-Series Plus employs new temperature control technology for detector optical systems, known as TC-Optics (Temperature Controlled Optics). Measurement with a stable baseline, hardly affected by room temperature fluctuation, ensures high precision of validation and quantitation tests on trace components.



Assists Analysis over Wide Concentration Range: Linearity and Reproducibility of Injection Volume

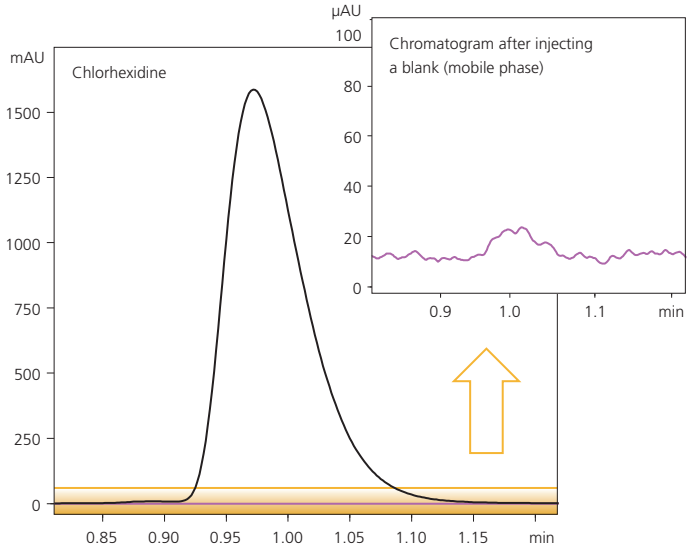
The i-Series Plus provides highly precise data in micro volume injections of 1 µL or less. This system allows the direct injection of the concentrated samples without dilution to save the preprocessing operation. In addition, the superior injection volume linearity improves the reliability of data for a wide range of injection volumes.

Injection Volume (µL)	Area Reproducibility (%RSD)
0.5	0.121
1	0.076
5	0.020
10	0.006
50	0.006
100	0.006



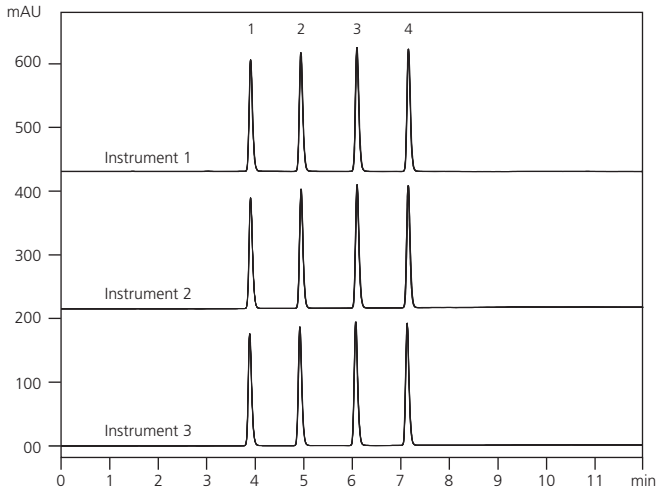
Ultra-Low Carryover Performance Enables High-Sensitivity Analysis

Due to Shimadzu's proprietary flow channel design, carryover effects from residual samples are reduced to nearly zero. The carryover specification has been improved to 0.0025%, thereby providing highly precise quantitative performance when analyzing a complex sample.



System-to-System Reproducibility Improves Data Compatibility

In addition to its reproducible performance on a single system, the i-Series Plus's excellent system-to-system reproducibility further improves data reliability. With its unsurpassed performance in areas such as solvent delivery precision, concentration accuracy, and injection volume accuracy, the i-Series Plus is now a new industry standard for global labs.



	Peak 1		Peak 2		Peak 3		Peak 4	
	R. time	Area	R. time	Area	R. time	Area	R. time	Area
Instrument 1	0.031	0.032	0.057	0.065	0.049	0.032	0.055	0.022
Instrument 2	0.044	0.027	0.068	0.018	0.064	0.052	0.053	0.037
Instrument 3	0.054	0.062	0.056	0.035	0.055	0.022	0.043	0.040

Retention time and area reproducibility (%RSD) of each instrument

Applications Utilizing i-Series Plus

i-Series Solutions Package

i-Series Solutions Package is a method package that encompasses pretreatment methods, analytical conditions, and printout of judgment results. The kit supports workflow automation with a CD-ROM containing optimized pretreatment methods and analytical conditions for target components, and analytical columns that allow for sample analysis immediately after purchase.

Pretreatment

Optimized pretreatment methods are included in the CD-ROM.

Analysis

LabSolutions method files are included in the CD-ROM, so analysis can begin immediately.

Confirmation of judgment results

Analytical methods are preregistered in method files. Templates to output screening results and reports are also included, so screening results and reports can be checked as soon as analysis is complete.

Screening Judgment Report

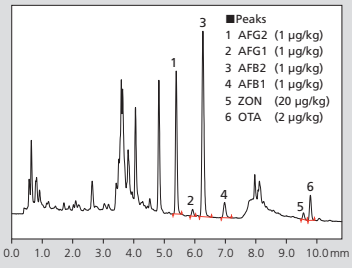
XR Control Chart

Mycotoxin Screening System

The mycotoxin screening system is a package that can detect mycotoxins with high sensitivity at concentrations specified by EU standards. The package includes pretreatment methods optimized for grains (soft wheat flour and rice flour), milk, and apples. A troubleshooting section includes considerations for each process step, from extraction to analysis, which helps ensure that reliable data can be acquired even when analyzing samples for the first time.

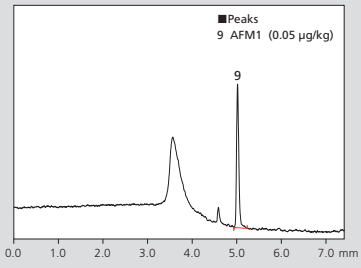
Grain (Soft Wheat Flour)

Fluorescence detector



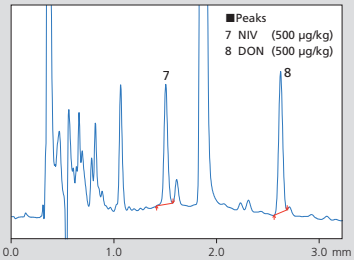
Milk

Fluorescence detector



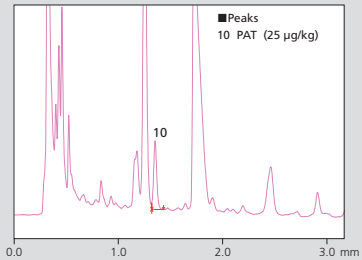
Grain (Soft Wheat Flour)

PDA detector



Apples

PDA detector

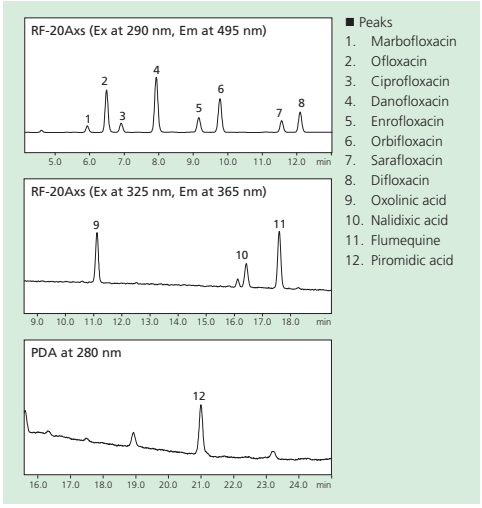


All added mycotoxin concentrations are converted for foods.
* For more details, refer to the product catalog or to Application News L512.

Antimicrobial Screening System

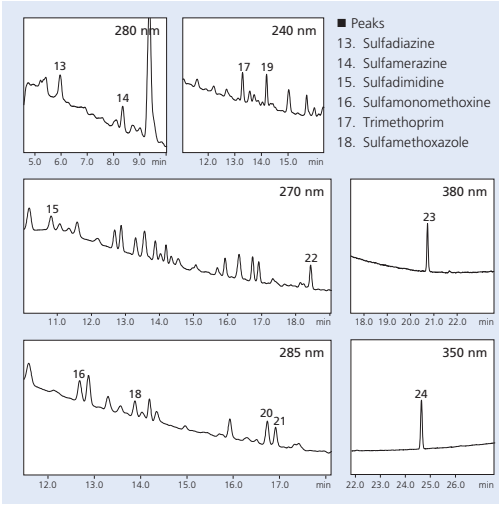
Synthetic antimicrobials are types of veterinary drugs and food additives, and residue levels of these antimicrobials are specified to avoid adverse effects on health. With a pretreatment method that minimizes the influence of contaminant components in meat (muscles of beef, pork, and chicken), the synthetic antimicrobial screening system enables screening of 24 synthetic antimicrobials in meat that are identified as regulated substances in Japan and Europe.

Quinolone Agents



■ Peaks
1. Marbofloxacin
2. Ofloxacin
3. Ciprofloxacin
4. Danofloxacin
5. Enrofloxacin
6. Orbifloxacin
7. Sarafloxacin
8. Difloxacin
9. Oxolinic acid
10. Nalidixic acid
11. Flumequine
12. Piromidic acid

Sulfa Drugs



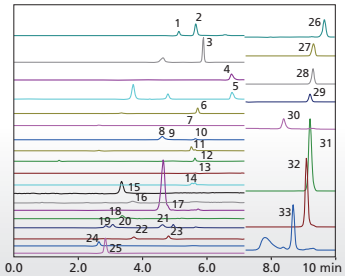
■ Peaks
13. Sulfadiazine
14. Sulfamerazine
15. Sulfadimidine
16. Sulfamonomethoxine
17. Trimethoprim
18. Sulfamethoxazole
19. Ormetoprim
20. Sulfadimethoxine
21. Sulfaquinoxaline
22. Pyrimethamine
23. Difurazon
24. Nicarbazin

(A standard solution was added to chicken meat by an amount equivalent to the standard concentration.)
* For more details, refer to the product catalog or to Application News L509, L510.

i-Series Plus as a Front-End for LCMS

Mass spectrometers are used in a variety of sectors, from pharmaceuticals to food. i-Series Plus (LC-2030C LT) features a compact size and the ability to process multiple samples, and combining these strengths with the superior qualitative analytical performance of Shimadzu's single quadrupole LCMS-2020 produces a system that supports powerful quantitative and qualitative analyses. Amino acids are often a target of analysis in the food sector, but are difficult to detect with UV detectors due to their normally poor light-absorbing properties. Mass spectrometers can easily analyze amino acids, so a LCMS system with excellent ease-of-use can be built by combining a detector-less i-Series Plus model with the LCMS-2020.

Example Combination of a Detector-less Model (LC-2030C LT) and Single Quadrupole Mass Spectrometer (LCMS-2020)



1. 3-Aminoisobutyric acid
2. GABA
3. Citruline
4. (Cys)2
5. Cystathionine
6. Asp
7. Thr
8. Sar
9. Ala
10. β-Ala
11. α-aminoadipic acid
12. Gln
13. Ser
14. Glu
15. Pro
16. Val
17. Theanine
18. Met
19. Leu
20. Ile
21. Hydroxyproline
22. Tyr
23. Methionine Sulfone
24. Phe
25. Trp
26. Arg
27. Hydroxylysine
28. Orn
29. Lys
30. His
31. Carnosine
32. Anserine
33. Methylhistidine

Mass Chromatogram of Amino Acid Standard Sample

Maximum Reliability and Stability
— Fundamental functions assure analysis results —

Use of Multiple Detectors Expands Application Range

In addition to the UV-visible (UV/VIS) absorbance detector or photodiode array (PDA) detector included as standard, a fluorescence detector or differential refractive index detector can be added.

Excellent Baseline Stability Unaffected by Circumstances

The UV/VIS detector and the PDA detector employ dual-temperature control (TC-Optics and flow cell) and provide measurements with a stable baseline hardly affected by room temperature fluctuation.

Supports High-Speed Multi-Analyte Processing

A 14-second injection cycle maximizes the number of samples that can be processed. Moreover, a total of 1536 samples can be accommodated in right and left sample racks.

Autosampler Enhances Data Reliability

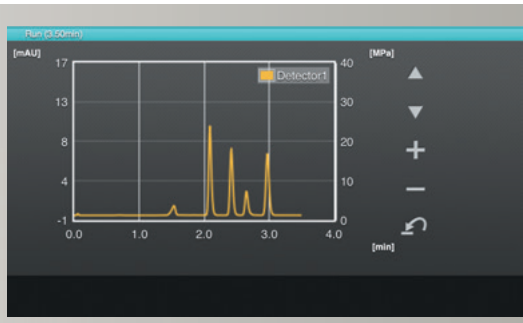
Excellent reproducibility for injection volumes less than 1 µL, wide linearity range and ultra-low carryover (<0.0025%) improve the reliability of data, especially for analyses of precious biological samples and direct analyses of concentrated samples.

Open Access Sample Placement

A direct access mechanism on sample racks allows the user to place the sample on racks that are not involved in sample injection even during analysis.
Furthermore, racks can be shared by multiple analysts, without interrupting the analysis of samples placed by others. Overall, this function enhances work efficiency.

System Monitoring via Smart Devices

System status and chromatograms can be viewed remotely from smart devices and home computers. Situations can be checked without needing to visit the laboratory.



Window on a Smartphone

Refined Usability

Control panel with a color LCD touch panel allows anyone to operate the instrument, regardless of experience level. Easily and reliably perform routine maintenance following on-screen instructions.

Displays Chromatogram in Real Time

The chromatogram real-time monitor allows the user to immediately confirm the success or failure of data, even in a computer-less laboratory environment.

Large-Capacity Column Oven Supports Up to 90°C

The Forced-air circulation method enhances column temperature stability. Maximum operating temperature of 90°C allows high-temperature analyses such as sugar analysis. Moreover, three 300 mm long columns or six 100 mm long columns can be accommodated.

Quaternary Solvent Delivery Unit

A 10 µL micro plunger ensures accurate quaternary gradient delivery. Optional reservoir switching valve further extends the solvent selection to seven so that the solvent for the flow path rinsing can be set.

Auto Shutdown Function Reduces Power Consumption

After analysis is complete, the auto shutdown function minimizes power consumption in standby mode and can reduce power consumption by at least 95% compared to normal standby mode.

Compact Footprint

The i-Series Plus brings together all the functions required for LC analysis in an integrated form. With its space-saving design, which is only 410 mm wide, three units can be installed on a laboratory bench compared to only two comparable instruments from other companies. The instrument footprint does not change even if another detector is installed.

From HPLC to UHPLC
– Extensive Lineup of Shimadzu LCs –

Shimadzu's extensive LC lineup fulfills a wide range of analytical needs, from conventional to ultra-high speed analysis.

Nexera-i

The UHPLC system perfect for multi-analyte processing such as drug dissolution testing. Autosampler accommodates a total of 216 standard vials and features a direct access mechanism that allows the user to place the sample even during analysis.

Routine Analysis
Easy Operation

Prominence-i

The HPLC system perfect for checking synthetic compounds, quantitative testing with standard operative procedures, etc. This system is suitable for a wide range of industries, such as pharmaceuticals, chemicals, foods and the environment. It can be operated as a single-use system or a shared system. Its small footprint facilitates the management and relocation of systems.

Nexera X2

The flagship UHPLC system supporting columns with sub-2 µm particle packing materials, realizing both ultra-high speed and ultra-high separation. Excellent reproducibility of low injection volume and ultra-low carryover ensures reliable data, even with ultra-sensitive LC/MS/MS methods.

Nexera XR

The UHPLC system supporting most commercial UHPLC and HPLC columns. Superior gradient performance and minimized delay volume enable ultra-high speed analyses with excellent reproducibility. The Method Scouting System can be constituted to support more efficient method development.

Versatile LC Expandability

Prominence

The standard HPLC system with excellent expandability. It can be configured to meet a variety of analytical conditions. This system offers reduced maintenance costs while still enabling high-speed analysis by using short columns with 2 µm particles.

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