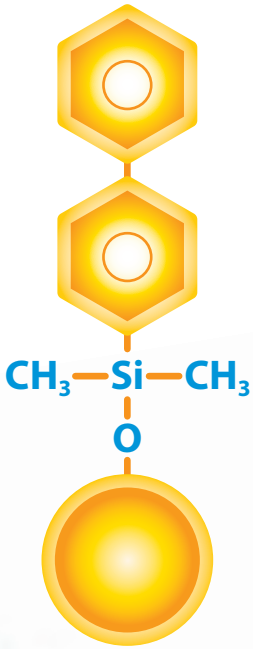
Raptor™
LC Columns

Selectivity Accelerated

Stationary Phase: **Biphenyl**



RESTEK®

www.restek.com/raptor

The Raptor™ Biphenyl Column

With Raptor™ LC columns, Restek chemists became the first to combine the speed of superficially porous particles (also known as SPP or "core-shell" particles) with the resolution of highly selective USLC® technology. This new breed of chromatographic column allows you to more easily achieve peak separation and faster analysis times without expensive UHPLC instrumentation.

Our top priority when developing our new SPP line was to create a version of our innovative Biphenyl. The industry-leading Biphenyl is Restek's most popular LC stationary phase because it is particularly adept at separating compounds that are hard to resolve or that elute early on C18 and other phenyl chemistries. As a result, the rugged Raptor™ Biphenyl column is extremely useful for fast separations in bioanalytical testing applications like drug and metabolite analyses, especially those that require a mass spectrometer (MS). Increasing retention of early-eluting compounds can limit ionization suppression, and the heightened selectivity helps eliminate the need for complex mobile phases that are not well-suited for MS detection.

Restek was the first to bring you the benefits of the Biphenyl ligand, and we have the experience to maximize the SPP performance of this premier phenyl chemistry for today's challenging workflows.

Column Description:

Stationary Phase Category:
Phenyl (L11)

Ligand Type:
Biphenyl

Particle:
2.7 µm superficially porous silica (SPP or "core-shell")

Pore Size:
90 Å

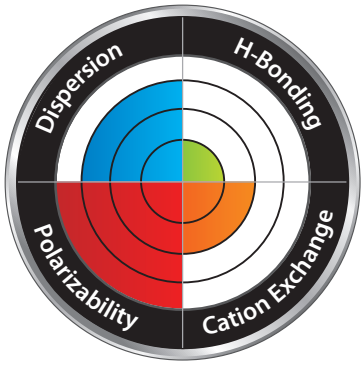
Surface Area:
150 m^2/g

Recommended Usage:
pH Range: 1.5–8.0
Maximum Temperature: 80 °C
Maximum Pressure: 600 bar (8,500 psi)

Properties:
- Increased retention for dipolar, unsaturated, or conjugated solutes.
- Enhanced selectivity when used with methanolic mobile phase.
- Ideal for increasing sensitivity and selectivity in LC-MS analyses.

Switch to a Biphenyl when:
- Limited selectivity is observed on a C18.
- You need to increase retention of hydrophilic aromatics.

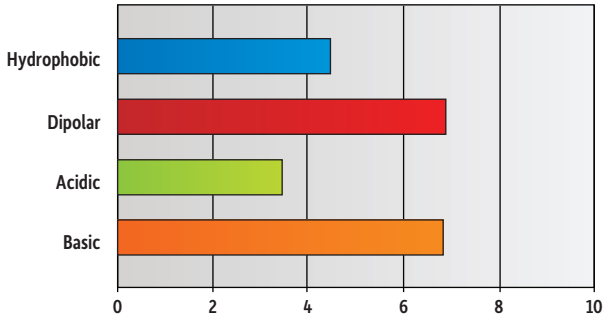
Column Interaction Profile:



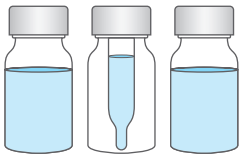
Defining Solute Interactions:
- Polarizability
- Dispersion

Complementary Solute Interaction:
- Cation exchange

Solute Retention Profile:



Target Analyte Structures:
- Aromatic
- Dipolar



Target Analyte Functionalities:
- Hydrophilic aromatics
- Strong dipoles
- Lewis acids
- Dipolar, unsaturated, or conjugated compounds
- Fused-ring compounds with electron withdrawing groups

More Aromatic Selectivity Than Ordinary Phenyl-Hexyls

SPP core-shell columns commonly employ traditional phenyl-hexyl stationary phases, but the innovative Biphenyl ligand, developed by Restek's chemists, is the next generation of phenyl column chemistry. It provides greater aromatic selectivity than commercially available phenyl-hexyl columns[1] and a greater degree of dispersion than conventional phenyls. As a result, the Raptor™ Biphenyl allows you to more easily separate bioanalytical compounds like aromatics (Figures 1 and 2), which elute early or are hard to separate on C18 or other phenyl chemistries.

[1] In-house testing based on: M. R. Euerby, P. Petersson, W. Campbell, W. Roe, Chromatographic classification and comparison of commercially available reversed-phase liquid chromatographic columns containing phenyl moieties using principal component analysis, J. Chromatogr. A 1154 (2007) 138–151.

Figure 1: Raptor™ Biphenyl columns exhibit the highest aromatic selectivity compared to other SPP phenyl columns.

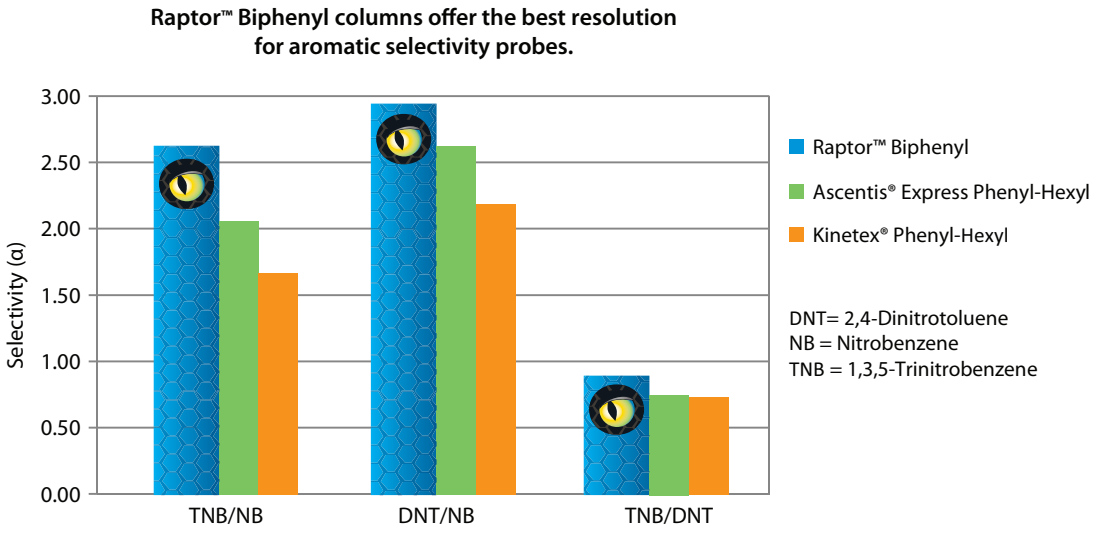
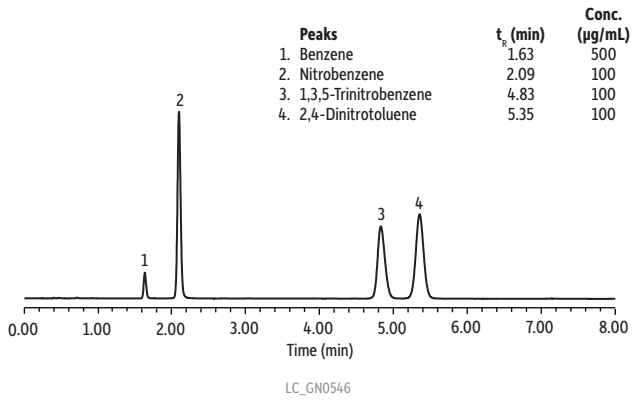


Figure 2: Raptor™ Biphenyl columns show increased retention for compounds containing electron withdrawing groups. Retention and elution order are dramatically different from a traditional C18.



Column: Raptor™ Biphenyl (cat.# 9309A55); Dimensions: 50 mm x 4.6 mm ID; Particle Size: 2.7 µm; Pore Size: 90 Å; Temp.: 40 °C; **Sample:** Diluent: acetonitrile; Conc.: 100-500 µg/mL; Inj. Vol.: 1 µL **Mobile Phase:** water: methanol (50:50); Flow: 1.2 mL/min; **Detector:** Waters Acquity® PDA @ 254 nm; **Instrument:** Waters Acquity® UPLC H-Class.

The New Standard for Performance and Durability for SPP Core-Shell Columns

Pressure Stability:

One of the greatest advantages of an SPP column is the ability to achieve fast, efficient separations by operating at higher linear velocities than are possible with a conventional fully porous particle column. However, these higher velocities can also result in higher back pressures. Raptor™ columns were designed to handle the increased pressures needed to achieve *Selectivity Accelerated*, and handle it far better than other SPP columns on the market (Figure 3).

Reproducibility:

To help keep your productivity high and your lab budget low, we know that Raptor™ Biphenyl columns must produce exceptional selectivity and fast analysis times not just once, but every time. Ruggedness and repeatability are essential, which is why from the silica and the bonding technique, to the packing process and upgraded hardware, every decision that went into creating this column was made to ensure superlative reproducibility, from injection to injection (Figure 4) and from lot to lot (Figure 5). We also adopted new quality control (QC) specifications to guarantee the retention time stability you need for worry-free MRM analyses.

Figure 3: At high pressures, competitor phenyl-hexyl columns experience a quick and sharp drop-off in efficiency, but Raptor™ Biphenyl columns are unaffected to at least 3,000 injections.

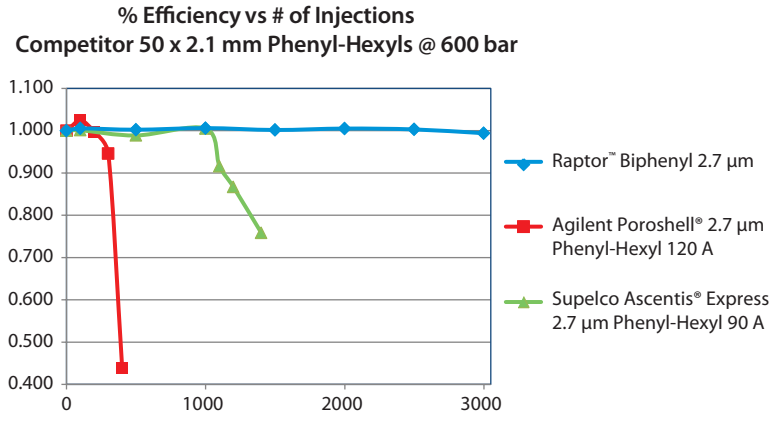
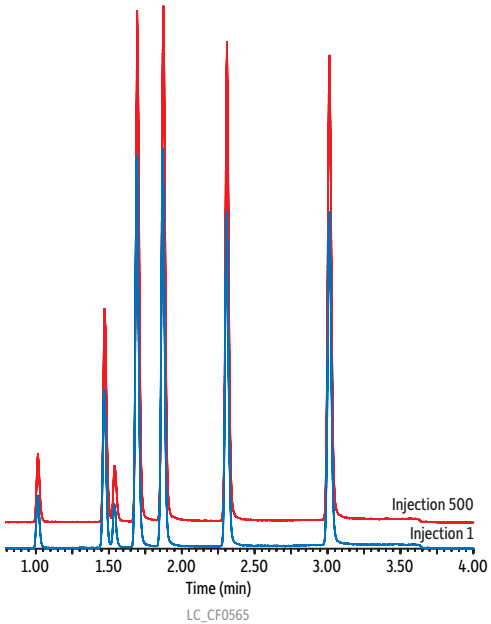


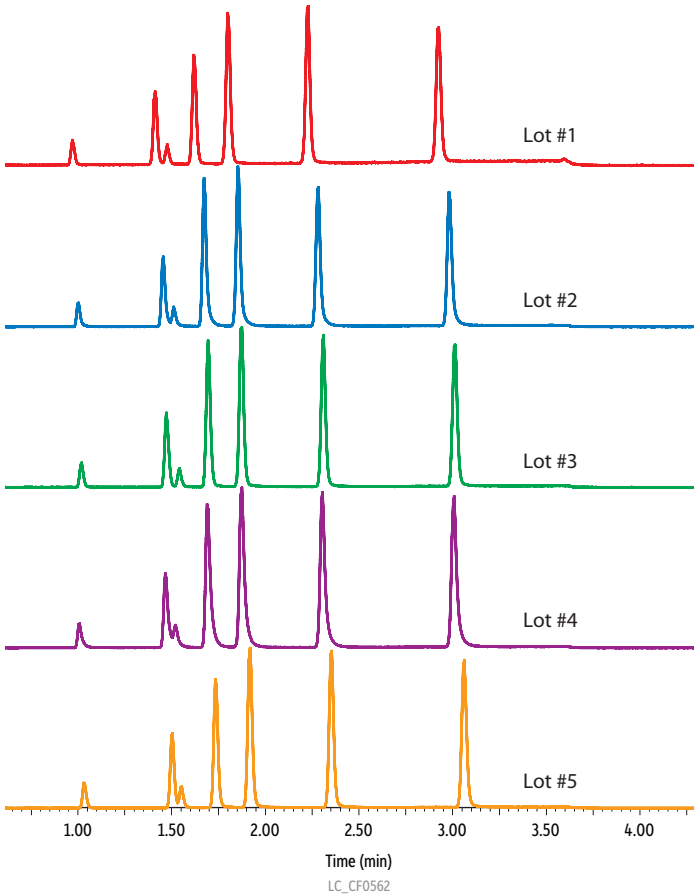
Figure 4: Even after hundreds of injections, a Raptor™ Biphenyl column will provide consistent, reliable data.



Peaks
1. Cortisol
2. 11-Deoxycortisol
3. Estradiol
4. Boldenone
5. Testosterone
6. Androstenedione
7. Progesterone

Column: Raptor™ Biphenyl (cat.# 9309A1E); Dimensions: 100 mm x 3.0 mm ID; Particle Size: 2.7 µm; Pore Size: 90 Å; Temp.: 30 °C; **Sample:** Diluent: initial mobile phase; Conc.: 50 ng/mL; Inj. Vol.: 5 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in acetonitrile; **Gradient (%B):** 0.00 min (40%), 3.00 min (80%), 3.01 min (40%), 5.00 min (40%); **Flow:** 0.700 mL/min; **Detector:** Waters Xevo TQ-S; Ion Mode: ESI+; **Instrument:** Waters.

Figure 5: From one lot to the next, every Raptor™ Biphenyl column you purchase will perform the same.



See Figure 4 for compound list and conditions.

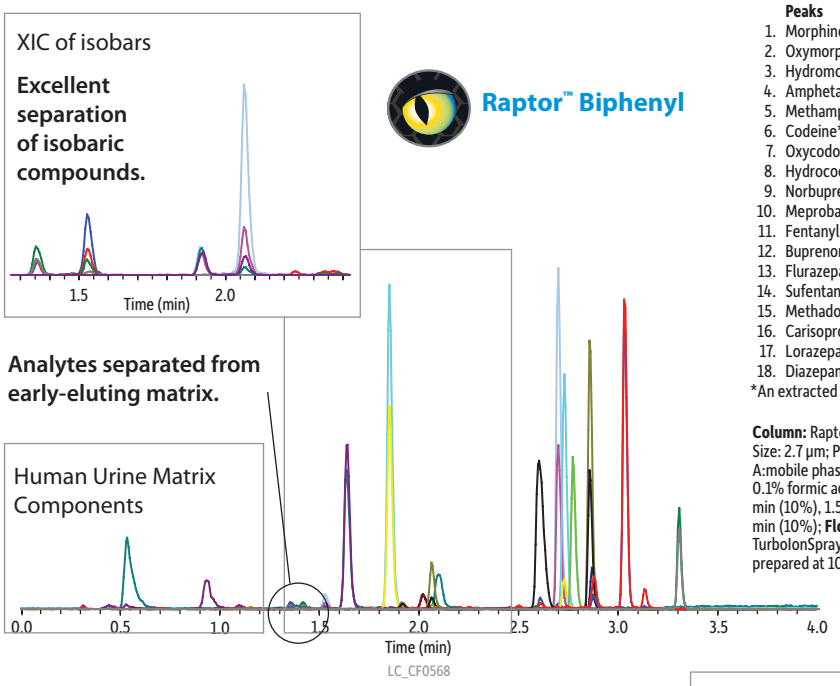
Clinically Proven to Optimize Your Bioanalytical Workflows

For nearly a decade, the Restek® Biphenyl has been the column of choice for clinical testing because of its ability to provide highly retentive, selective, and rugged reversed-phase separations of drugs and metabolites. By bringing the speed of SPP to the Biphenyl family, the Raptor™ Biphenyl provides clinical labs with an even faster option for a wide variety of clinical assays.

Rugged Pain Panels From Urine in Under 3.5 Minutes

Pain panels can be difficult to optimize and reproduce due to the limited selectivity of C18 and phenyl-hexyl phases, but not on the Raptor™ Biphenyl. Complete your pain panel analysis with a 5-minute cycle time and complete isobaric resolution using Raptor™ Biphenyl columns (Figure 6). Popular competitor columns offer tailing peaks, longer run times, and coelutions; only the Raptor™ Biphenyl exhibits the selectivity and performance needed for this critical analysis.

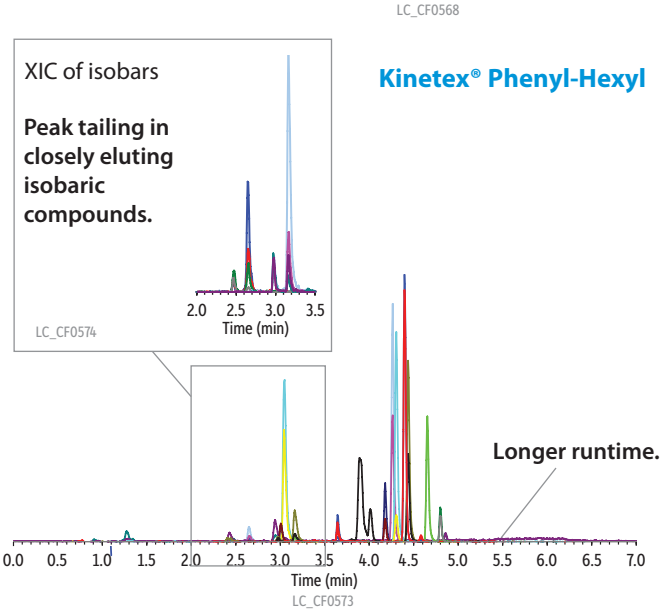
Figure 6: Raptor™ Biphenyl columns offer pain panel analyses with complete isobaric resolution in under 5 minutes!



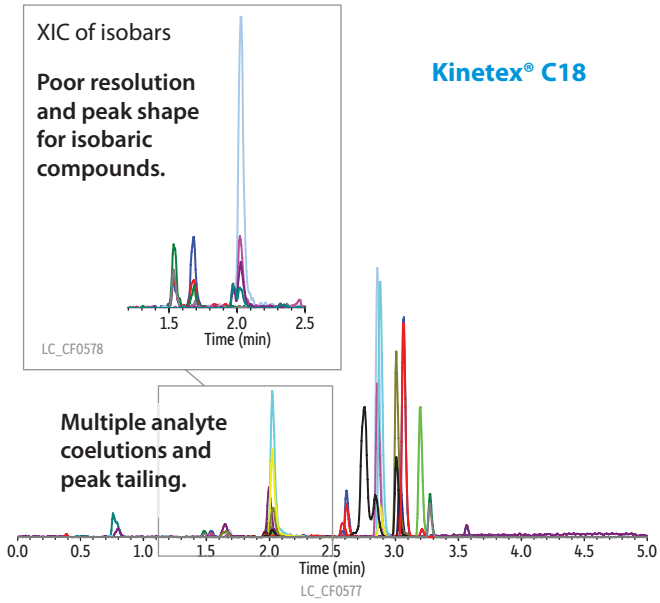
	Peaks	t_R (min)	Precursor ion	Product ion 1	Product ion 2
1.	Morphine*	1.34	286.2	152.3	165.3
2.	Oxymorphone	1.40	302.1	227.3	198.2
3.	Hydromorphone*	1.52	286.1	185.3	128.2
4.	Amphetamine	1.62	136.0	91.3	119.2
5.	Methamphetamine	1.84	150.0	91.2	119.3
6.	Codeine*	1.91	300.2	165.4	153.2
7.	Oxycodone	2.02	316.1	241.3	256.4
8.	Hydrocodone*	2.06	300.1	199.3	128.3
9.	Norbuprenorphine	2.59	414.1	83.4	101.0
10.	Meprobamate	2.61	219.0	158.4	97.2
11.	Fentanyl	2.70	337.2	188.4	105.2
12.	Buprenorphine	2.70	468.3	396.4	414.5
13.	Flurazepam	2.73	388.2	315.2	288.3
14.	Sufentanil	2.77	387.2	238.5	111.3
15.	Methadone	2.86	310.2	265.3	105.3
16.	Carisoprodol	2.87	261.2	176.3	158.1
17.	Lorazepam	3.03	321.0	275.4	303.1
18.	Diazepam	3.31	285.1	193.2	153.9

*An extracted ion chromatogram (XIC) of the isobars is presented in the inset.

Column: Raptor™ Biphenyl (cat.# 9309A5E); Dimensions: 50 mm x 3.0 mm ID; Particle Size: 2.7 µm; Pore Size: 90 Å; Temp.: 30 °C; **Sample:** Diluent: urine:mobile phase A:mobile phase B (17:76:7); Conc.: 10-100 ng/mL; Inj. Vol.: 10 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in methanol; **Gradient (%B):** 0.00 min (10%), 1.50 min (45%), 2.50 min (100%), 3.70 min (100%), 3.71 min (10%) 5.00 min (10%); **Flow:** 0.6 mL/min; **Detector:** AB SCIEX API 4000™ MS/MS; Ion Source: TurboIonSpray®; Ion Mode: ESI+; **Instrument:** API LC-MS/MS; **Notes:** Lorazepam was prepared at 100 ng/mL; all other analytes are 10 ng/mL.



Column: Kinetex® Phenyl-Hexyl (cat.# 00B-4495-E0); Dimensions: 50 mm x 4.6 mm ID; Particle Size: 2.6 µm; Pore Size: 100 Å; Temp.: 22 °C; **Sample:** Diluent: urine:mobile phase A:mobile phase B (17:76:7); Conc.: 10-100 ng/mL; Inj. Vol.: 10 µL **Mobile Phase:** A: 10 mM ammonium formate in water, B: 0.1% formic acid in methanol; **Gradient (%B):** 0.00 min (5%), 4.00 min (100%), 5.00 min (100%), 5.10 min (5%), 7.00 min (5%); **Flow:** 0.6 mL/min; **Detector:** AB SCIEX API 4000™ MS/MS; Ion Source: TurboIonSpray®; Ion Mode: ESI+; **Instrument:** API LC-MS/MS; **Notes:** Lorazepam was prepared at 100 ng/mL; all other analytes are 10 ng/mL.

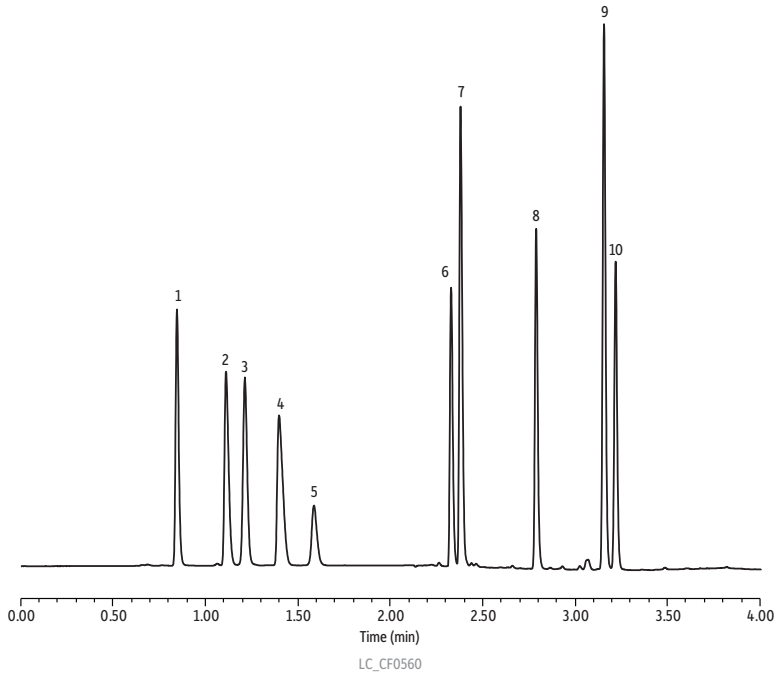


Column: Kinetex® C18 (cat.# 00B-4462-Y0); Dimensions: 50 mm x 3.0 mm ID; Particle Size: 2.6 µm; Pore Size: 100 Å; Temp.: 25 °C; **Sample:** Diluent: urine:mobile phase A:mobile phase B (17:76:7); Conc.: 10-100 ng/mL; Inj. Vol.: 10 µL **Mobile Phase:** A: 10 mM ammonium formate in water, B: 0.1% formic acid in methanol; **Gradient (%B):** 0.00 min (5%), 3.00 min (100%), 4.00 min (100%), 4.10 min (5%), 5.00 min (5%); **Flow:** 0.5 mL/min; **Detector:** AB SCIEX API 4000™ MS/MS; Ion Source: TurboIonSpray®; Ion Mode: ESI+; **Instrument:** API LC-MS/MS; **Notes:** Lorazepam was prepared at 100 ng/mL; all other analytes are 10 ng/mL.

Catecholamines and NSAIDs Without Ion Pairing, HILIC, or Complex Mobile Phases

Analyzing catecholamine compounds can be problematic by liquid chromatography and often forces chemists to turn to aqueous normal phase / HILIC or ion-pairing reagents that are not well-suited for mass spectrometry (MS). Raptor™ Biphenyl columns easily retain and separate these difficult compounds using simple, MS-friendly mobile phases in a time frame that maximizes your productivity (Figure 7). Raptor™ Biphenyl also offers fast, efficient analysis of nonsteroidal anti-inflammatory drugs (NSAIDs) with LC-MS friendly solvents.

Figure 7: Separate catecholamine and other neurotransmitter compounds fast without ion pairing or HILIC.

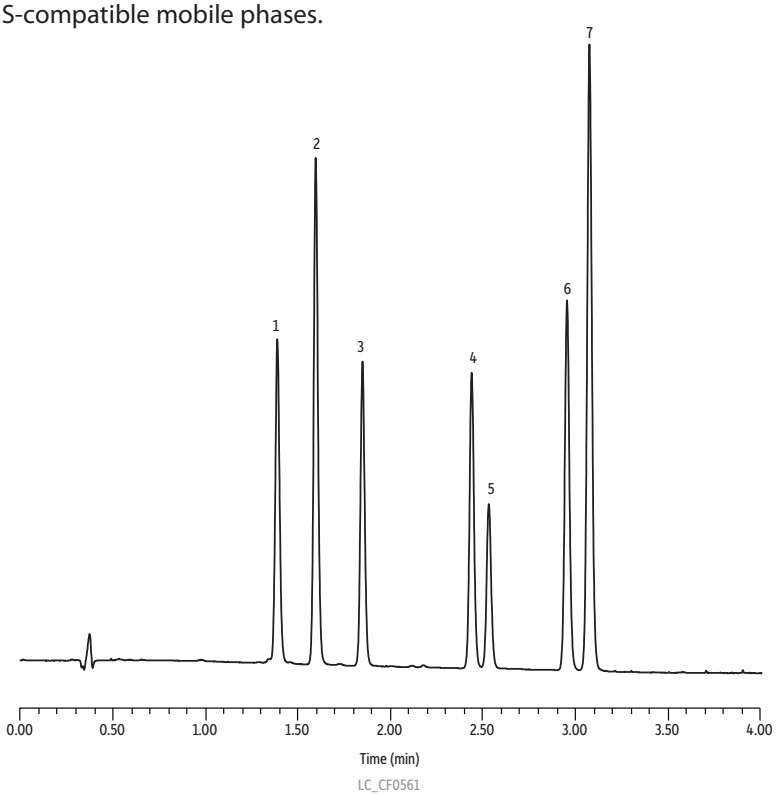


	Peaks	t_R (min)
1.	Norepinephrine	0.85
2.	Epinephrine	1.11
3.	L-Dihydroxyphenylalanine	1.21
4.	Dopamine	1.40
5.	Tyrosine	1.59
6.	3-Methoxytyramine*	2.33
7.	Serotonin	2.38
8.	(3,4-Dihydroxyphenyl)acetic acid*	2.79
9.	5-Hydroxyindoleacetic acid**	3.16
10.	Homovanillic acid*	3.22

* Dopamine metabolite, ** serotonin metabolite

Column: Raptor™ Biphenyl (cat.# 9309A62); Dimensions: 150 mm x 2.1 mm ID; Particle Size: 2.7 µm; Pore Size: 90 Å; Temp.: 30 °C; **Sample:** Diluent: water; Conc.: 50 µg/mL; Inj. Vol.: 1 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in acetonitrile; **Gradient (%B):** 0.00 min (0%), 4.00 min (70%), 4.01 min (0%), 5.00 min (0%); **Flow:** 0.4 mL/min; **Detector:** Waters Acquity® PDA @ 280 nm; **Instrument:** Waters Acquity® UPLC H-Class.

Figure 8: Nonsteroidal anti-inflammatory drugs (NSAIDs) are also easily resolved with Raptor™ Biphenyl using UV- and MS-compatible mobile phases.



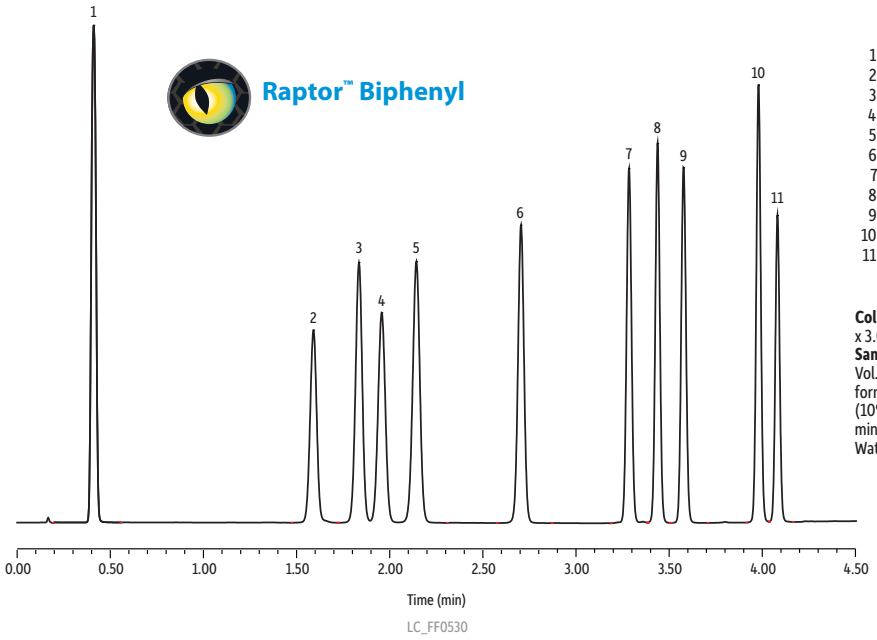
	Peaks	t_R (min)	Conc. (µg/mL)
1.	Piroxicam	1.39	25
2.	Sulindac	1.60	25
3.	Naproxen	1.85	25
4.	Fenoprofen	2.44	100
5.	Ibuprofen	2.54	200
6.	Diclofenac	2.96	25
7.	Indomethacin	3.08	25

Column: Raptor™ Biphenyl (cat.# 9309A12); Dimensions: 100 mm x 2.1 mm ID; Particle Size: 2.7 µm; Pore Size: 90 Å; Temp.: 40 °C; **Sample:** Diluent: water:acetonitrile (65:35); Conc.: 25-200 µg/mL; Inj. Vol.: 2 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in acetonitrile; **Gradient (%B):** 0.00 min (35%), 4.00 min (60%), 4.01 min (35%), 5.00 min (35%); **Flow:** 0.6 mL/min; **Detector:** Waters Acquity® PDA @ 270 nm; **Instrument:** Waters Acquity® UPLC H-Class.

Fast Analysis of Sulfur Antibiotics Without Coelutions

Even with high-efficiency UHPLC particles, C18 and ordinary phenyl columns fail to achieve baseline separation of sulfonamides. Not only does the Raptor™ Biphenyl have the selectivity to easily and completely separate these difficult compounds (Figure 9), it does so in well under 5 minutes!

Figure 9: Sulfonamides pose no problems for analysis, even at high linear velocities. Increased retention of early-eluting sulfanilamide also helps limit ionization suppression.

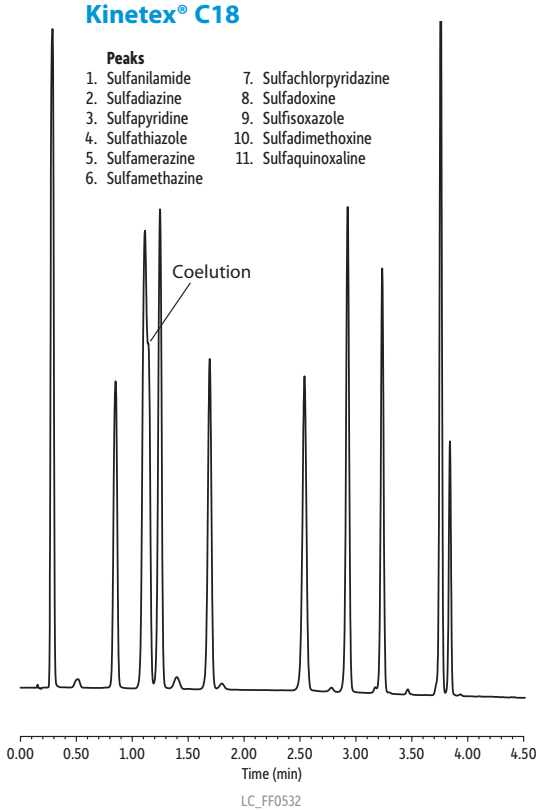


Peaks	t_R (min)
1. Sulfanilamide	0.41
2. Sulfadiazine	1.59
3. Sulfapyridine	1.84
4. Sulfathiazole	1.96
5. Sulfamerazine	2.14
6. Sulfamethazine	2.71
7. Sulfachlorpyridazine	3.29
8. Sulfadoxine	3.44
9. Sulfisoxazole	3.58
10. Sulfadimethoxine	3.98
11. Sulfaquinoxaline	4.08

Column: Raptor™ Biphenyl (cat.# 9309A5E); Dimensions: 50 mm x 3.0 mm ID; Particle Size: 2.7 µm; Pore Size: 90 Å; Temp.: 20 °C; **Sample:** Diluent: 0.1% formic acid in water; Conc.: 50 µg/mL; Inj. Vol.: 5 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in acetonitrile; **Gradient (%B):** 0.00 min (5%), 2.00 min (10%), 4.50 min (35%), 4.51 min (5%), 5.50 min (5%); **Flow:** 1.5 mL/min; **Detector:** Waters Acquity® PDA @ 260, 4.8 nm; **Instrument:** Waters Acquity® UPLC H-Class.

Kinetex® C18

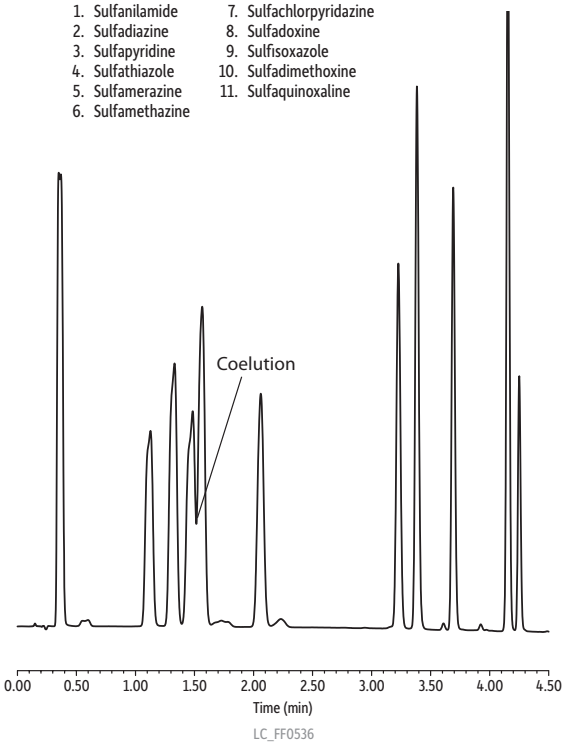
Peaks
1. Sulfanilamide
2. Sulfadiazine
3. Sulfapyridine
4. Sulfathiazole
5. Sulfamerazine
6. Sulfamethazine
7. Sulfachlorpyridazine
8. Sulfadoxine
9. Sulfisoxazole
10. Sulfadimethoxine
11. Sulfaquinoxaline



Column: Kinetex® C18 (cat.# 00B-4462-Y0); Dimensions: 50 mm x 3.0 mm ID; Particle Size: 2.6 µm; Pore Size: 100 Å; Temp.: 20 °C; **Sample:** Diluent: 0.1% formic acid in water; Conc.: 50 µg/mL; Inj. Vol.: 5 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in acetonitrile; **Gradient (%B):** 0.00 min (5%), 2.00 min (10%), 4.50 min (35%), 4.51 min (5%), 5.50 min (5%); **Flow:** 1.5 mL/min; **Detector:** Waters Acquity® PDA @ 260, 4.8 nm; **Instrument:** Waters Acquity® UPLC H-Class.

Acquity® CSH™ Phenyl-Hexyl

Peaks
1. Sulfanilamide
2. Sulfadiazine
3. Sulfapyridine
4. Sulfathiazole
5. Sulfamerazine
6. Sulfamethazine
7. Sulfachlorpyridazine
8. Sulfadoxine
9. Sulfisoxazole
10. Sulfadimethoxine
11. Sulfaquinoxaline



Column: Acquity® CSH™ Phenyl-Hexyl (cat.# 186005406); Dimensions: 50 mm x 2.1 mm ID; Particle Size: 1.7 µm; Temp.: 20 °C; **Sample:** Diluent: 0.1% formic acid in water; Conc.: 50 µg/mL; Inj. Vol.: 5 µL **Mobile Phase:** A: 0.1% formic acid in water, B: 0.1% formic acid in acetonitrile; **Gradient (%B):** 0.00 min (5%), 2.00 min (10%), 4.50 min (35%), 4.51 min (5%), 5.50 min (5%); **Flow:** 0.75 mL/min; **Detector:** Waters Acquity® PDA @ 260, 4.8 nm; **Instrument:** Waters Acquity® UPLC H-Class.

Raptor™ Biphenyl LC Columns

Length	2.1 mm cat.#	3.0 mm cat.#	4.6 mm cat.#
30 mm	9309A32	9309A3E	9309A35
50 mm	9309A52	9309A5E	9309A55
100 mm	9309A12	9309A1E	9309A15
150 mm	9309A62	9309A6E	9309A65

EXP® Reusable Fittings for HPLC & UHPLC

for 10-32 fittings and 1/16" tubing

- Hand-tight fitting style achieves effortless HPLC seals—no tools needed for a 8,700+ psi seal.
- Both hand-tight and hex-head styles wrench-tighten for reliable UHPLC use up to 20,000+ psi!
- Patented ferrule can be installed repeatedly without compromising high-pressure seal.
- Hybrid design combines the durability of titanium with the sealing ability of PEEK.
- Cutting-edge system provides ZDV (zero dead volume) connection to any 10-32 female port.
- Compatible with 1/16" PEEK and stainless steel tubing.

Description	qty.	cat.#
EXP Hand-Tight Fitting (Nut w/Ferrule)	ea.	25937
EXP Hand-Tight Fitting (Nut w/Ferrule)	10-pk.	25938
EXP Hand-Tight Nut (w/o Ferrule)	ea.	25939

Hybrid Ferrule U.S. Patent No. 8201854, Optimize Technologies. Optimize Technologies EXP Holders are Patent Pending. Other U.S. and Foreign Patents Pending. The EXP, Free-Turn, and the Opti- prefix are registered trademarks of Optimize Technologies, Inc.

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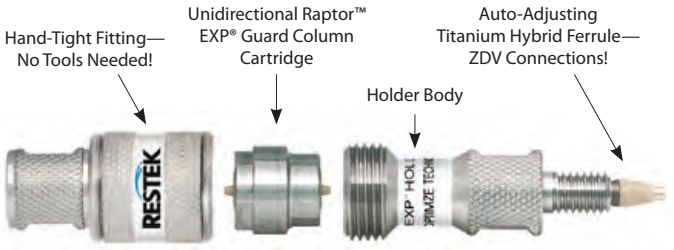
Raptor™ EXP® Guard Cartridges

To help protect your investment and further extend the life of our already-rugged LC columns, Restek offers the patent-pending guard column hardware developed by Optimize Technologies. A Restek® guard column cartridge in an EXP® direct connect holder is the ultimate in protection.

- Free-Turn® architecture lets you change cartridges by hand without breaking inlet/outlet fluid connections—no tools needed.
- Patented titanium hybrid ferrules can be installed repeatedly without compromising the high-pressure seal.
- Auto-adjusting design provides ZDV (zero dead volume) connection to any 10-32 female port.
- Guard column cartridges require EXP® direct connect holder (cat.# 25808).
- Pair with EXP® hand-tight fitting (cat.# 25937–25939) for tool-free installation.



EXP® Direct Connect Holder

Description	qty.	cat.#
EXP Direct Connect Holder (includes hex-head fitting & 2 ferrules)	ea.	25808

Raptor™ EXP® Guard Column Cartridges

Description	Particle Size	Size	qty.	cat.#
Raptor Biphenyl EXP Guard Column Cartridge	2.7 µm	5 x 2.1 mm	3-pk.	9309A0252
Raptor Biphenyl EXP Guard Column Cartridge	2.7 µm	5 x 3.0 mm	3-pk.	9309A0253
Raptor Biphenyl EXP Guard Column Cartridge	2.7 µm	5 x 4.6 mm	3-pk.	9309A0250

RESTEK®

Lit. Cat.# GNBR1891-UNV

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