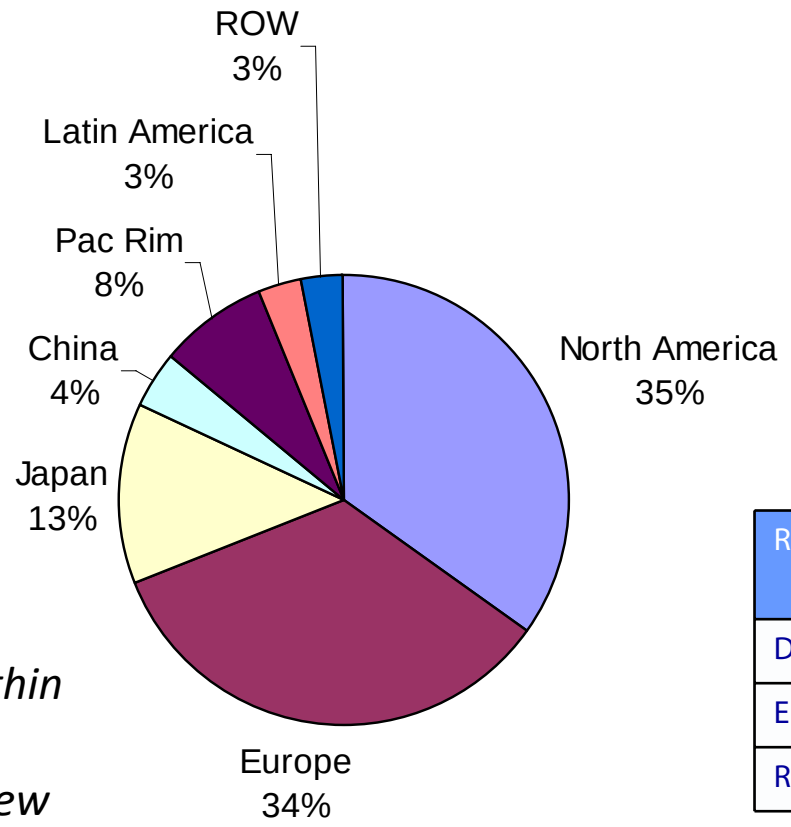
Selling Restek Chromatography Products into the Pharmaceutical Market

Outline

- Market trends
- Pharmaceutical Products for HPLC
- Pharmaceutical Products for GC

Liquid Chromatography Consumables Market by Geography



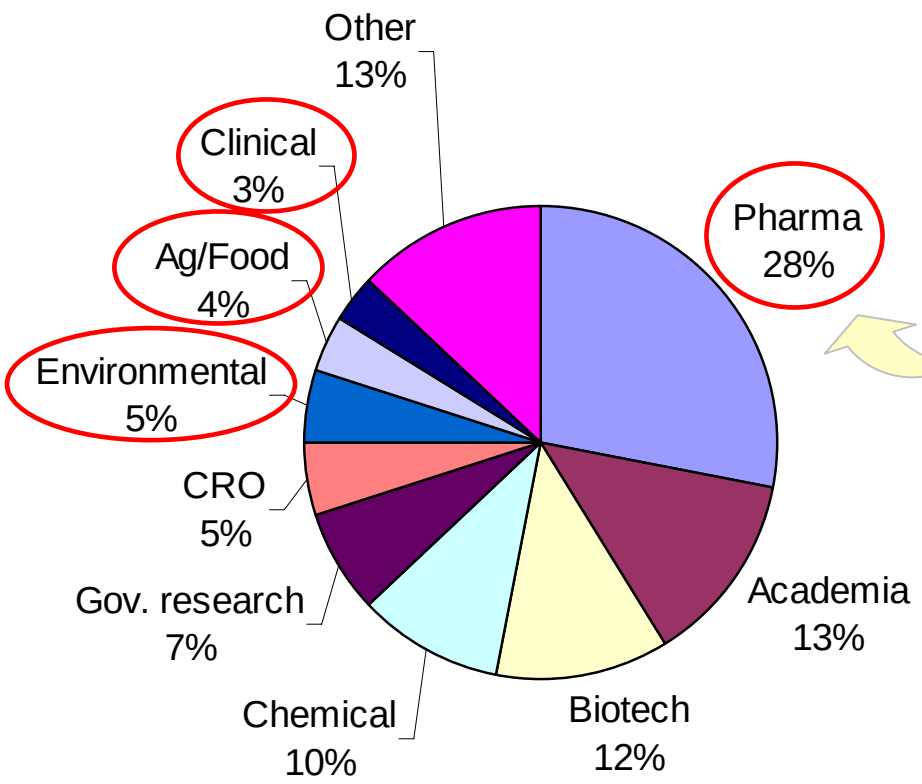
Large market opportunity within Restek reach, especially for new technology

Region	Percentage	Estimated TAM
Domestic US	35%	245
Europe	34%	238*
ROW	31%	217

** Potentially inflated by currency translation*

2007 SDI Market Forecast

Liquid Chromatography Consumables Market by Industry



Pharma is a major user of LC

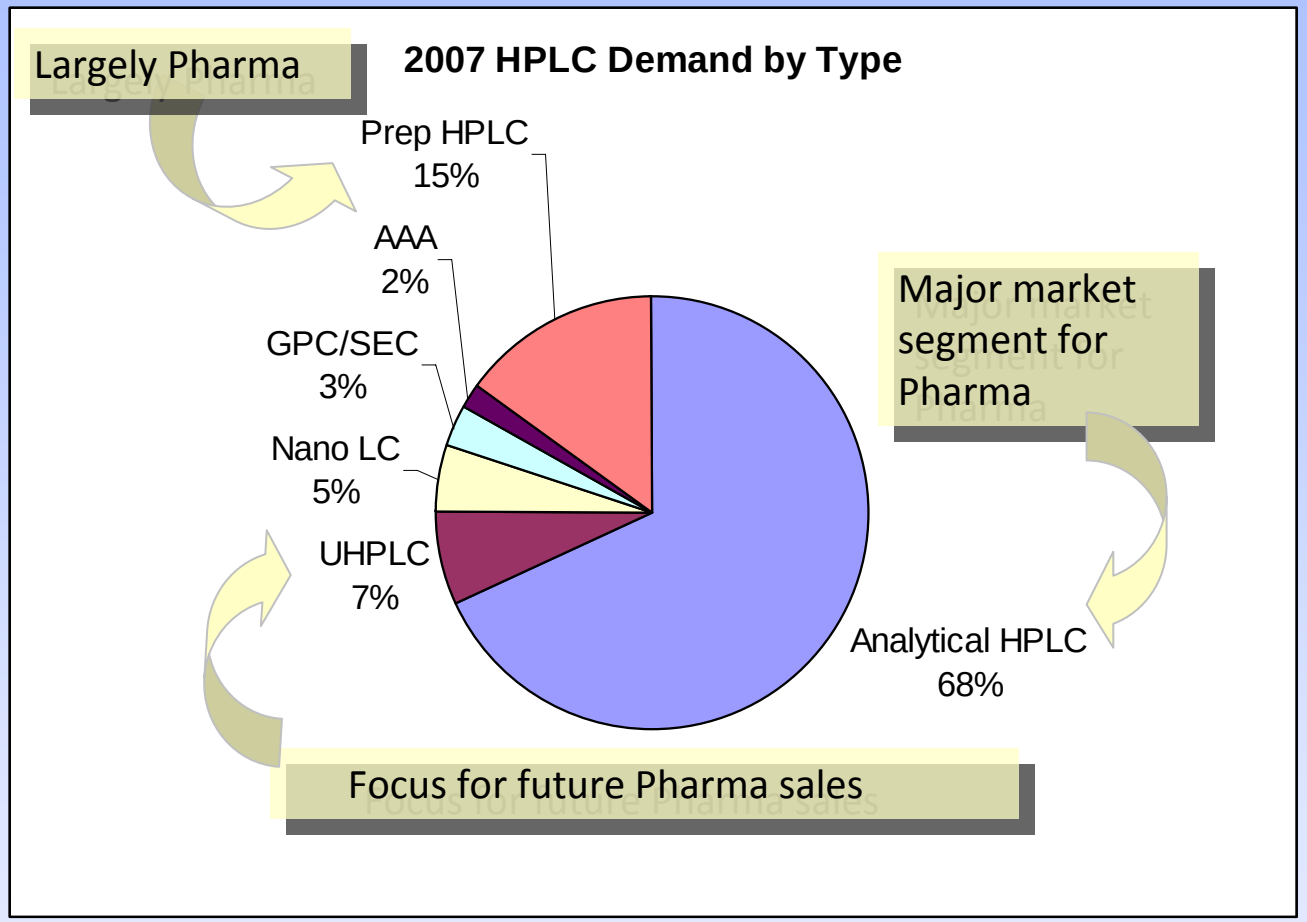
Opportunity to *expand our industry reach and focus –*

- *Ag/Food*
- *Clinical*
- *Environmental*

2007 SDI Market Forecast

** Potentially inflated by currency translation*

Market Assessment – HPLC Demand



2007 SDI Market Forecast

Technology Focus - Mass Spectrometry

SDI data on analytical instrument technology shows mass spectrometry is a $3B market and predicts…

Table V-2: Demand by Analytical Instruments Technology, 2005-2010

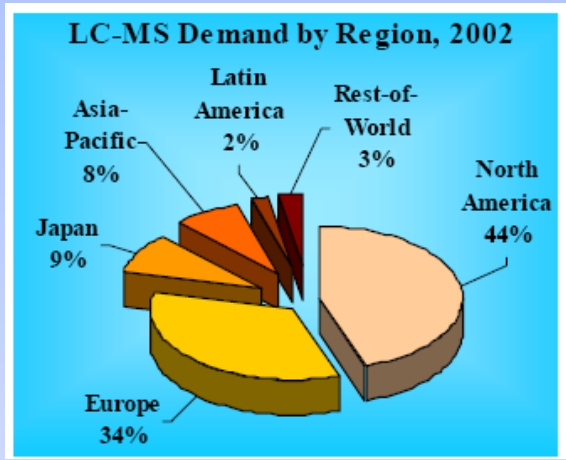
	2005		2006		2007		2010		'05-'10
	$ Mil	Percent	$ Mil	Percent	$ Mil	Percent	$ Mil	Percent	CGR
Separations	5,248	17%	5,529	17%	5,812	17%	6,666	16%	4.9%
Life Science Instrumentation	7,943	26%	8,529	26%	9,119	26%	10,815	26%	6.4%
Mass Spectrometry	1,809	6%	1,976	6%	2,146	6%	2,700	7%	8.3%
Molecular Spectroscopy	2,745	9%	2,908	9%	3,087	9%	3,700	9%	6.2%
Atomic Spectroscopy	2,207	7%	2,364	7%	2,495	7%	2,786	7%	4.8%
Surface Science	3,771	12%	4,019	12%	4,274	12%	5,198	13%	6.6%
Materials Characterization	1,803	6%	1,910	6%	2,023	6%	2,368	6%	5.6%
Laboratory Automation	2,669	9%	2,873	9%	3,082	9%	3,770	9%	7.2%
General Lab Instrumentation	2,610	8%	2,702	8%	2,798	8%	3,102	8%	3.5%
Total	**30,805**	**100%**	**32,810**	**100%**	**34,836**	**100%**	**41,106**	**100%**	**5.9%**

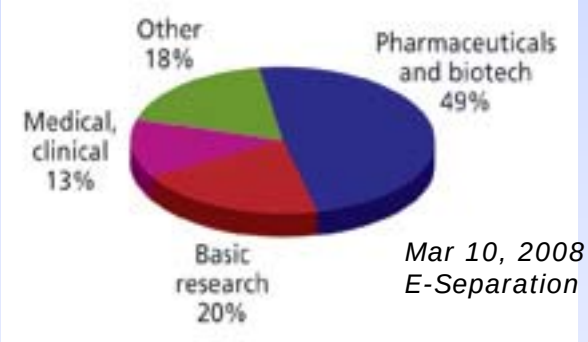
…that it will have fastest growth rate (8.3%) of any analytical instrument technology

Technology Focus - Mass Spectrometry

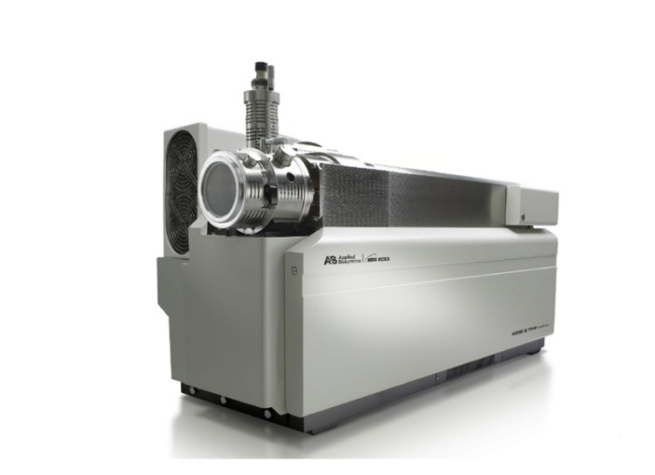
The use of Mass Spectrometry is creating industry growth opportunities

Industry	Percentage	Trending
Pharmaceutical and Biotech	49%	↓
Clinical	13%	↑↑
Basic Research	20%	↓
Environmental	18%	↑
Petroleum		
Forensics		
Food		





Mar 10, 2008
E-Separation Solutions

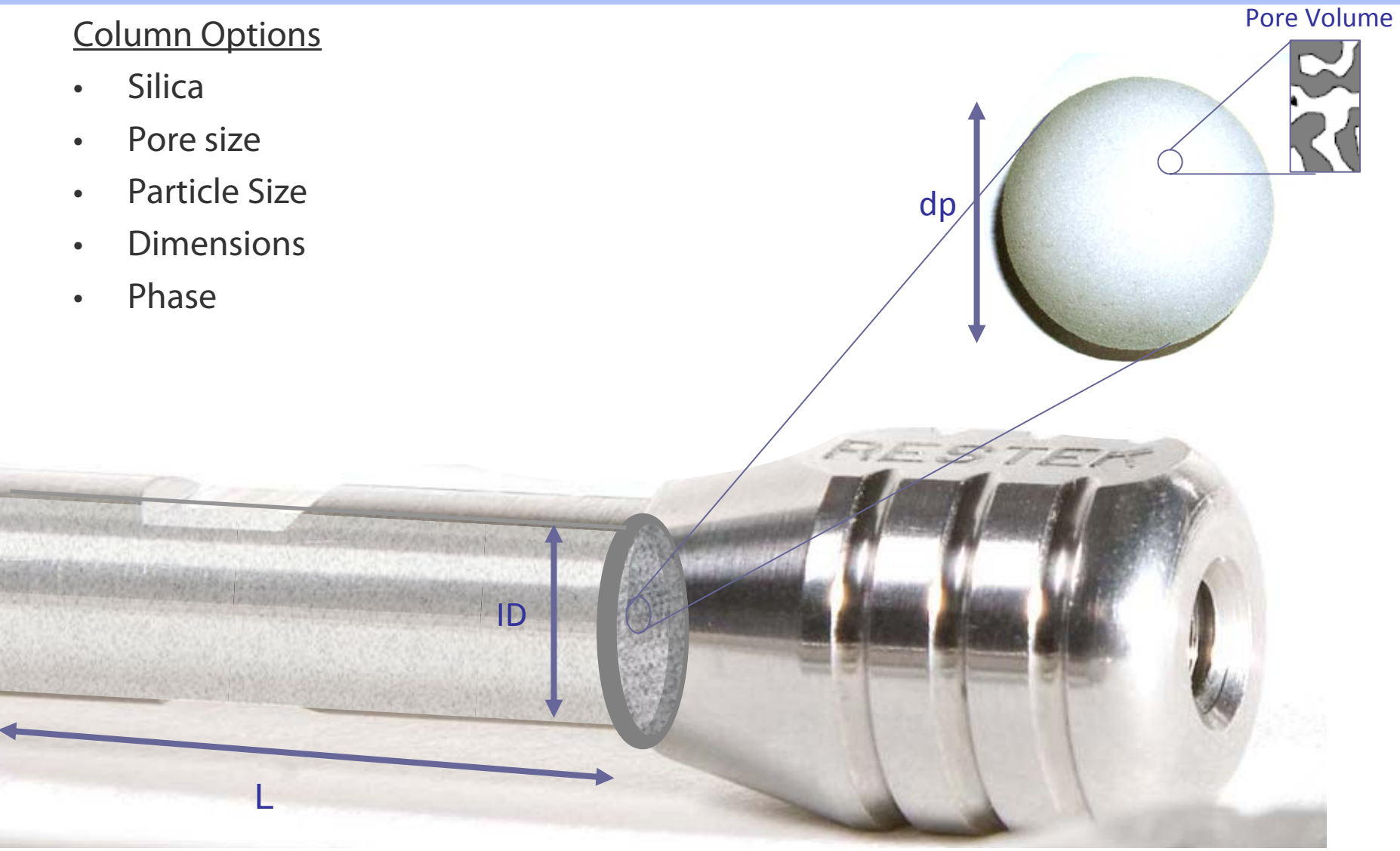


Focus product development and applications on MS

Determining Column Format

Column Options

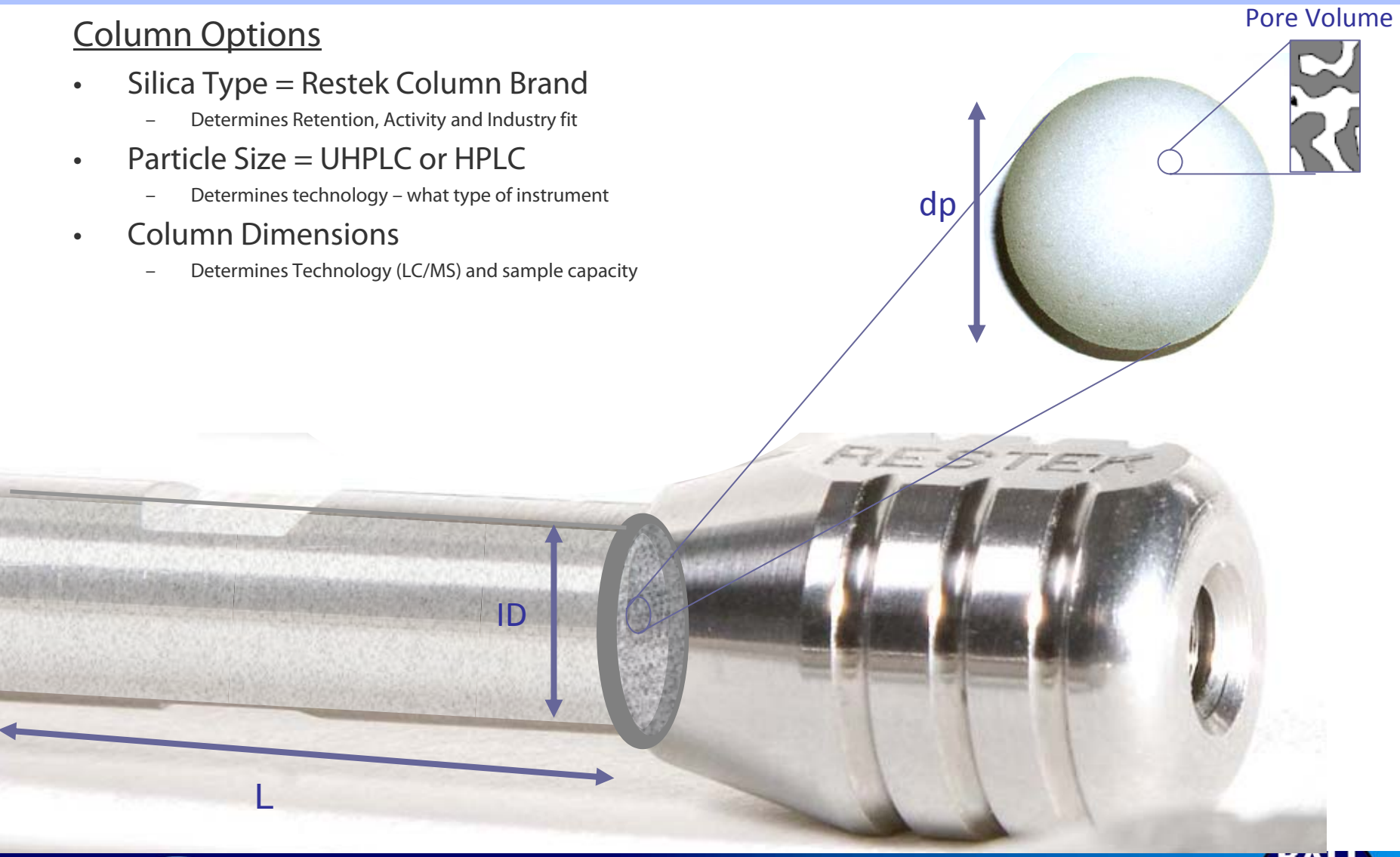
- Silica
- Pore size
- Particle Size
- Dimensions
- Phase



Determining Column Format

Column Options

- Silica Type = Restek Column Brand
  - Determines Retention, Activity and Industry fit
- Particle Size = UHPLC or HPLC
  - Determines technology – what type of instrument
- Column Dimensions
  - Determines Technology (LC/MS) and sample capacity



Restek High Purity LC Column Lines

Column Line	Pore Size (Å)	Surface Area (m2/g)	Carbon Load (%)	Usage
Allure	60	450	27	Very high retention (*highest convectional C18 in market)* High Purity Type B (super low metal content) 5 um particle size only (type B)
Ultra**	100	300	20	High Retention High Purity Type B (super low metal content) 3 and 5um particle size only
Pinnacle DB**	140	150	11	Mid- Retention Base Deactivated 1.9, 3 and 5um particle sizes **UHPLC and HPLC**

Good recommendations for all markets, including pharmaceutical

Restek LC Column Lines

Column Line	Pore Size (Å)	Surface Area (m2/g)	Carbon Load (%)	Usage
Pinnacle II	110	180	13	Mid – Retention Acidic Silica **(not for Reversed Phase in Pharma)** 3 and 5um particle size only

Type A Economical Silica – NOT intended for sale in the pharmaceutical market

Particle Size to Instrument Fit Chart

Manufacturer	Model	Recommended Particle Size (µm)	Recommended ID (mm)
Waters	Alliance	5 and 3	4.6 and 3.2
Waters	Acquity	1.9	2.1
Agilent	1100	5 and 3	4.6 and 3.2
Agilent	1200	5,3 (and 2.2)	4.6, 3.2 (and 3.0)
Agilent	1290	1.9	2.1
Shimadzu	Prominence	5 and 3	4.6 and 3.2
Shimadzu	UFLC XR	2.2	3.0
Shimadzu	Nexera	1.9	2.1
Jasco	XLC	1.9	2.1
Hitachi	La Chrom Elite	5 and 3	4.6 and 3.2
Hitachi	La Chrom Ultra	1.9	2.1
Dionex	Ultimate 3000	5 and 3	4.6 and 3.2
Dionex	Ultimate 3000 RS	1.9	2.1
Perkin Elmer	Flexar	1.9	2.1
Thermo	Accela	1.9	2.1

Capillary Columns Available

Becoming popular for Bio Analytical and Bio Pharma applications

Phase	Pore Size (Å)	ID (mm)	Length (mm)
Ultra Aqueous C18	100	0.3	50
Ultra Aqueous C18	100	0. 3	150
Ultra C18	100	0.3	50
Ultra C18	100	0.3	150
Viva C18	300	0.3	50
Viva C18	300	0.3	150

Restek Reversed Phase Column Listing

Phase Type	Phase Type	Usage
C1 through C18	Conventional Alkyls	General Purpose Alkyl Phases
Aqueous C18 ★	"Aqueous"	•Balanced Retention (retains the widest range of compounds) •100% compatibility with aqueous mobile phases – no de-wetting •Great for drug discovery and LC/MS/MS C18 •Rugged
AK ★	Combined Alkyl and Phenyl Properties	Intermediate C18 and Phenyl Selectivity
Phenyl	Conventional Phenyl	General purpose phenyl
Biphenyl ★	Advanced "special" Phenyl	•Higher retention and selectivity than phenyl •Great for aromatic or unsaturated compounds •Increased selectivity when compared to phenyl hexyl and diphenyl
Aromax ★	Maximum Aromatic Selectivity	•Specialty phenyl for maximum aromatic selectivity •High retention for LC/MS/MS in DMPK

★ *Unique*

Restek Reversed Phase Column Listing

Phase Type	Phase Type	Usage
IBD ★	Polar Embedded	•RP and HILIC Modes •Great for DMPK (retention of polar acids) and QA/QC (excellent peak shape of bases) •Lessens needs for mobile phase modifiers
PFP	Fluorinated	*Not to be recommended over PFP Propyl unless PFP Propyl shows too much retention*
PFP Propyl	Fluorinated	•RP and HILIC Modes •Great for DMPK (retention of protonated bases and halogenated compounds) •Typically more versatile than Cyano columns in pH range •Lessens need for mobile phase modifiers
Amino	Amino	Traditional chemistry, highly used for the analysis of saccharides and sugars
Cyano	Cyano	Traditional column chemistry for the increased retention and selectivity of protonated bases

★ *Unique*

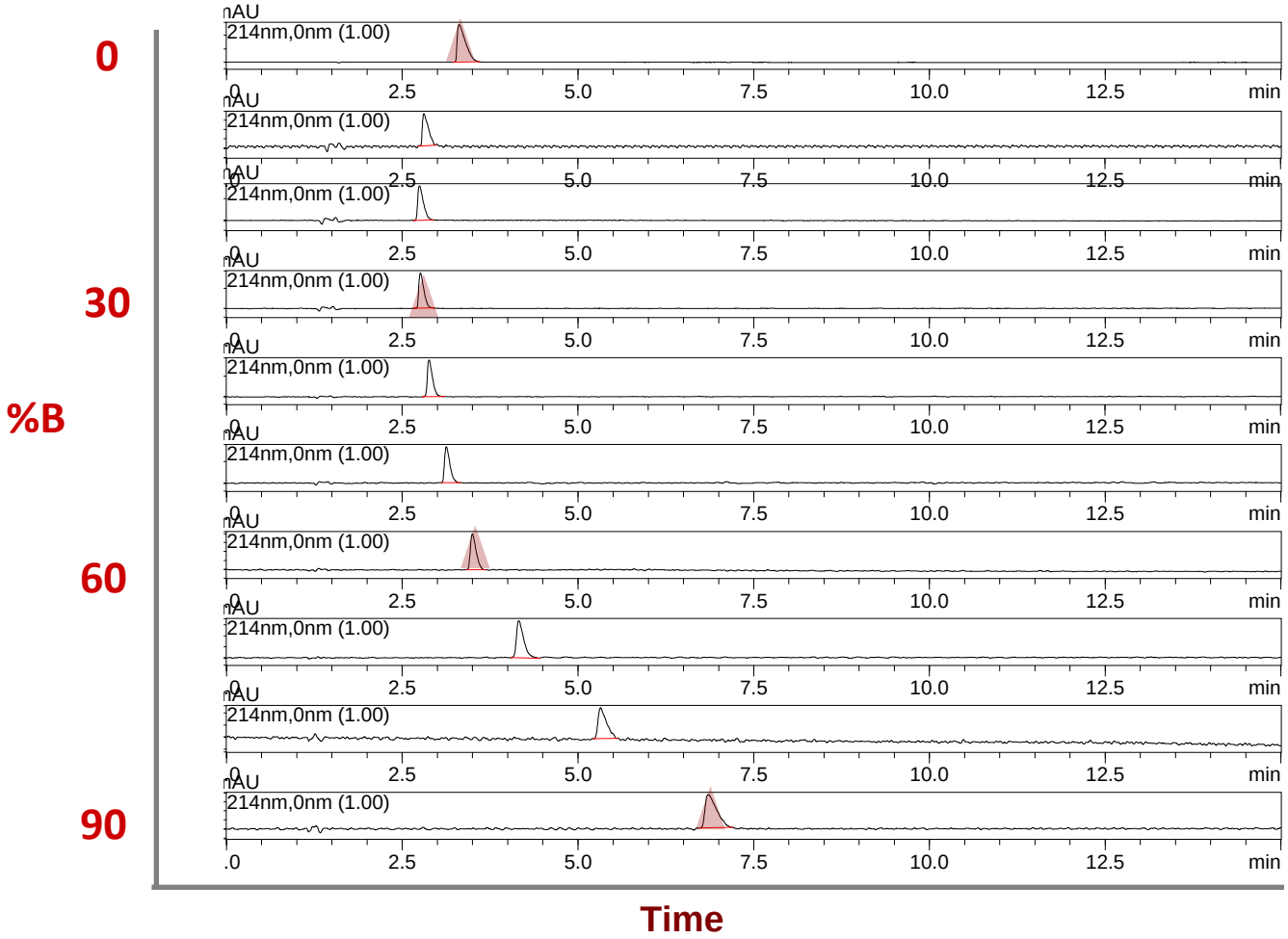
Multi Modal Analysis of 4-Methylimidazole (4MI or 4-MEI)

Ultra PFP Propyl
4.6 x 150mm,
5µm

1.5 mL/min,

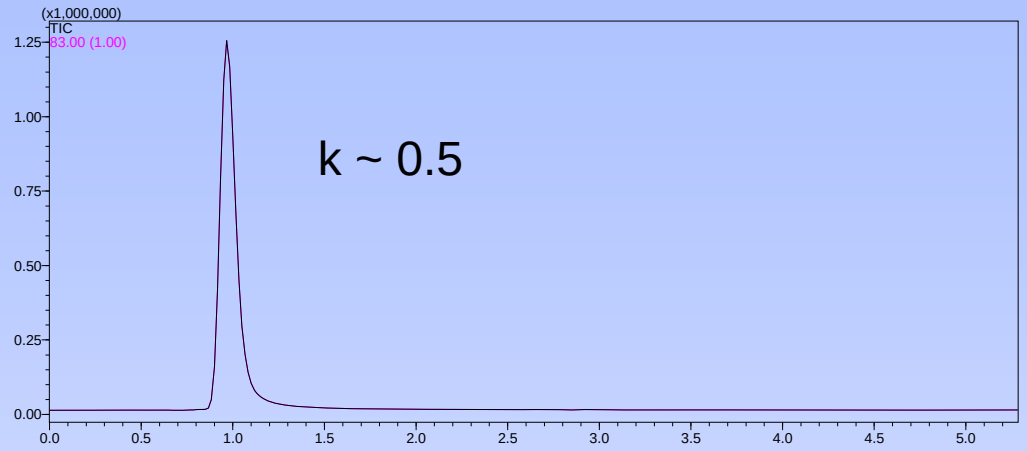
30ºC

A: 0.1% formic acid in water
B: 0.1% formic acid in Methanol

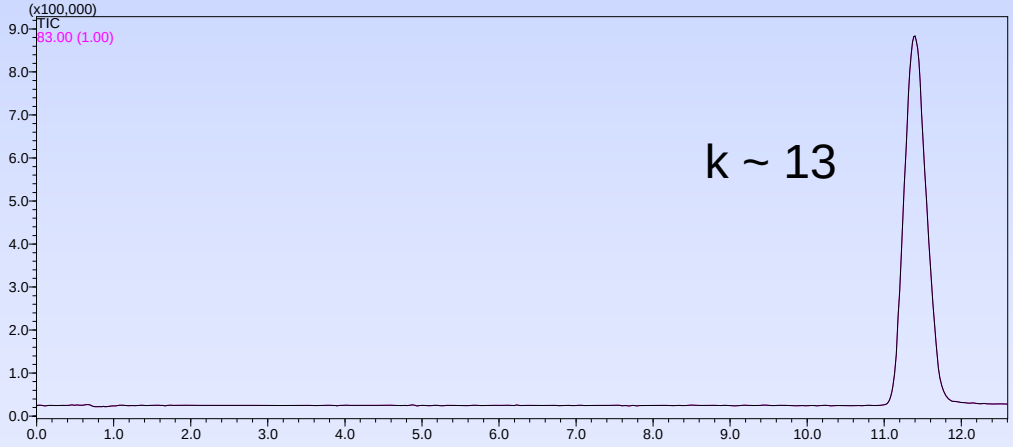


HILIC Retention

Ultra Silica
2.1 x 100mm, 3µm
0.4mL/min
80% MeOH
20% 10mM ammonium formate in water
30ºC
1µL injection
10µg/mL in 0.1% formic acid in water
SIM m/z=83



Ultra PFPP
2.1 x 100mm, 3µm
0.4mL/min
30% Water w/ 0.02% formic acid
70% MeOH w/ 0.02% formic acid
30ºC
1µL injection
10µg/mL in 0.1% formic acid in water
SIM m/z=83



Restek Normal Phase / HILIC Column Listing

Phase Type	Phase Type	Usage
IBD	Polar Embedded	•Can be used on NPC and HILIC modes •Excellent selling point for DMPK (RP and HILIC modes)
PFP	Fluorinated	*Not to recommended over PFP Propyl unless PFPP shows too much retention*
PFP Propyl	Fluorinated	•Can be used on NPC and HILIC modes •Excellent selling point for DMPK (RP and HILIC modes)
Amino	Amino	General purpose NPC / HILIC
Cyano	Cyano	General purpose NPC / HILIC
Silica	Silica	General purpose NPC / HILIC

Restek UHPLC

- Selling Points
  - Widest Variety of Stationary Phases
  - Cost – Effective
  - Improved Lifetime – innovative hardware design
  - Restek Manufactured Silica – total control

Actual E-mail to Sales Representative:

Darrel,
Just wanted to let you know we retired one of your uplc columns today. The column had over 13,000 injections on it and still passed all system suitability requirement. Just getting a little close. Just thought I'd give you a shout. Feel free to use that as an example to any potential customers if you want

- Manager of Quality Control,
Mylan Pharmaceuticals

Pinnacle DB UHPLC Columns

COLUMNS TESTED: UPLC® HSS T3 1.8 mm, 2.1/50 MM (Waters Corporation),
Acquity UPLC® BEH C18 1.7 mm, 2.1/100 mm (Waters Corporation)
Best Column → Pinnacle DB C18 1.9 mm, 2.1/50 mm (Restek U.S.)
VisionHT C18-P 1.5 mm, 2.0/50 mm (Grace)
Hypersil GOLD 1.9 mm, 2.1/50mm (Thermo Scientific)

using a validated (Bioanalytical method validation by FDA 2001) in GLP environment and OECD audited method.

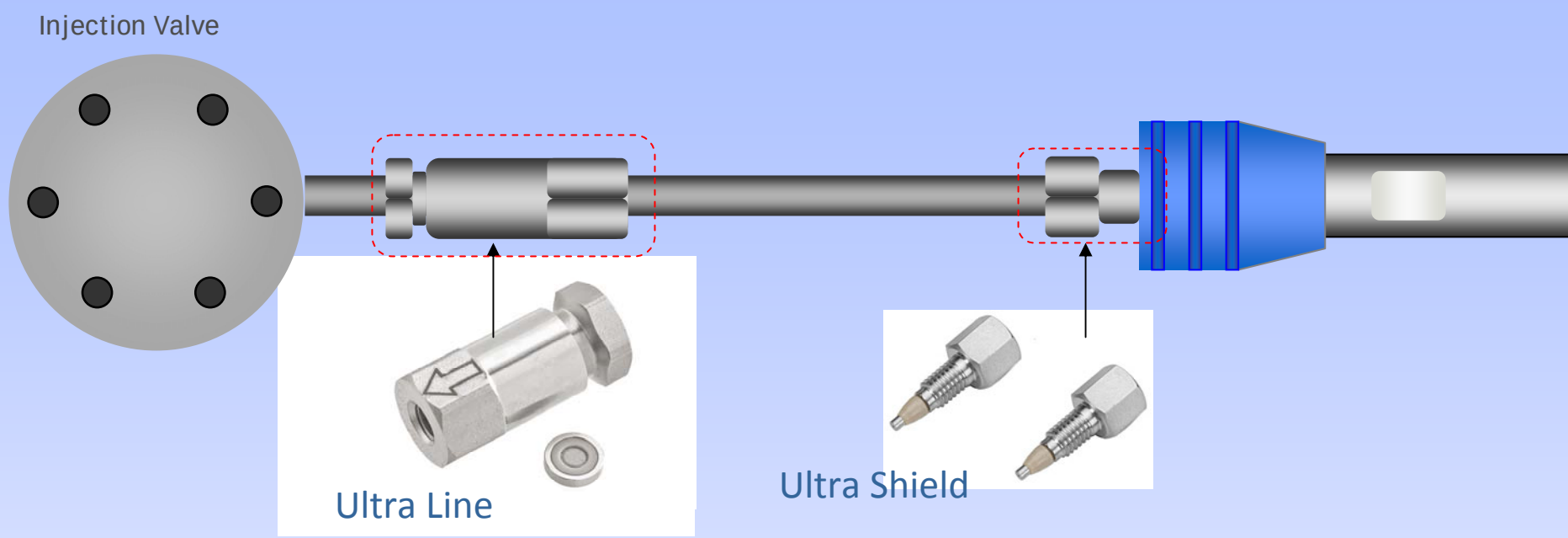
Title of article is:

APPLICATION OF ULTRA PERFORMANCE COLUMNS IN HIGH PERFORMANCE LIQUID CHROMATOGRAPHY FOR ALBENDAZOLE AND ITS METABOLITES DETERMINATION IN TURKEYS

Tomasz Grabowski a, Jerzy Jan Jaroszewski b , Anna Świerczewska a, Renata Sawicka a, Tomasz Maślanka b, Włodzimierz Markiewicz b, Hubert Ziółkowski b

a Centre of Pharmacokinetics Research FILAB, Ravimed Sp. z o.o., Łajski, (Poland)
b Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Warmia and Mazury, Olsztyn, (Poland)

Proper Filtration for UHPLC



Install 0.5um Ultra Line or
0.5um Ultra Shield

- Will not stop matrix
- Guard columns add volume and losses in efficiency
- 0.00625mm tubing compared to 0.175mm tubing for HPLC

Product Focus

RESTEK USLC™

Ultra Selective Liquid Chromatography™

- **USLC is the use of *Selectivity* on any instrument platform**
- **USLC phases offer the widest variety of selectivity for effective and fast method development**
- **USLC phases define a simple approach to column selection**
- **USLC offers a simplified product offering for column recommendations**

Restek Product Positioning

RESTEK USLC™

Ultra Selective Liquid Chromatography™

Discover Restek USLC™

Develop Methods Quickly and Easily Using Ultra Selective Chromatography

Ultra Selective Liquid Chromatography™

What is Ultra Selective Liquid Chromatography™? USLC™ is the directed application of selectivity—the most influential factor affecting resolution—to optimize separations and improve method performance. Restek has extensively studied reversed phase selectivity to provide practicing chromatographers with the most effective and widest range of USLC™ stationary phase chemistries available.

This is independent of column line. It differentiates our phases, not our column lines

Competitive Column Offerings

Figure 3: Restek offers the widest range of phase selectivities for HPLC and UHPLC.

	Column Line								
	Restek			Waters			Phenomenex	Agilent	
Column Type	Pinnacle DB	Ultra	Viva	Acquity CSH	Acquity HSS	Acquity BEH	Kinetex	Zorbax RRHD	Poroshell 120
Alkyl (C18 and C8)	●	●	●	●	●	●	●	●	●
Phenyl	●	●	●	●		●			
Polar Embedded Alkyl	●	●	●						
Fluorophenyl	●	●	●	●			●		

We have them all!

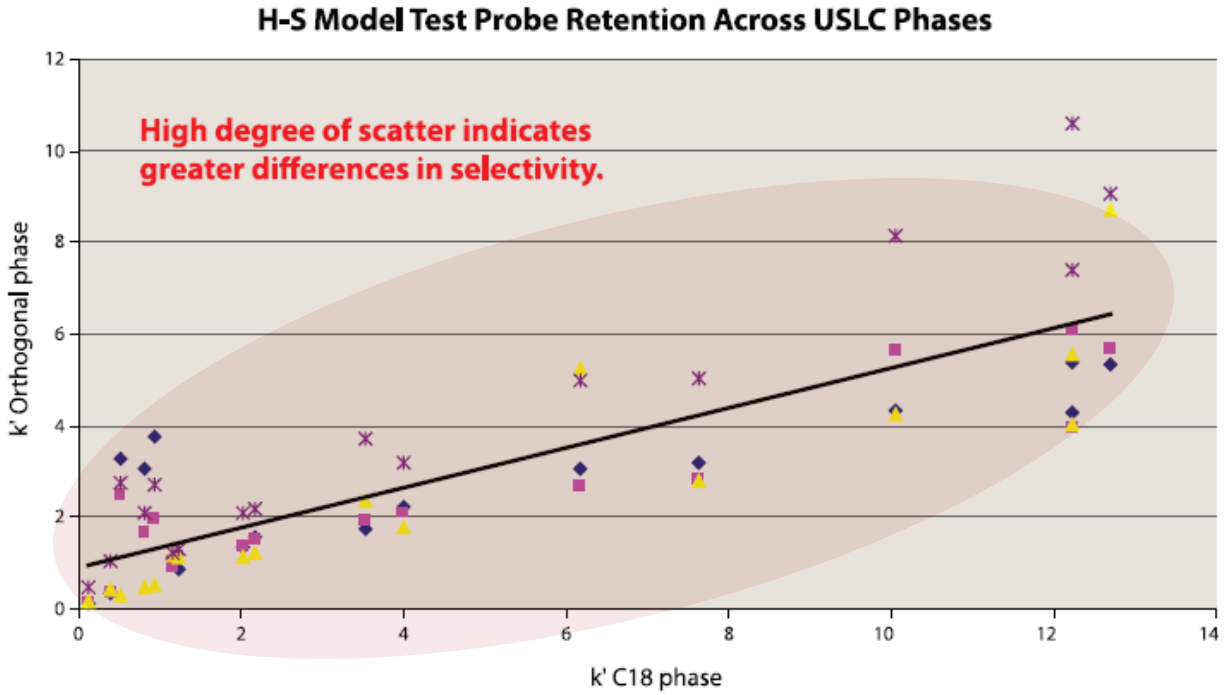
Selectivity on any Instrument Format

Figure 4: Restek USLC™ phases are available on several silica lines to accommodate any instrument platform or chromatographic application.

Column line (silica)	**Pinnacle DB** (Base deactivated, moderate retention silica for scalable UHPLC and HPLC analyses)	**Ultra** (Highest purity silica for traditional HPLC analyses)	**Viva** (Wide pore silica for biological separations using HPLC)
Particle diameters (µm) • UHPLC	1.9		
• HPLC		3 and 5	5
Stationary phases			
C18	●	●	●
C8	●	●	●
Aqueous C18	●	●	
Biphenyl	●	●	●
PFP Propyl	●	●	●
IBD	●	●	
Silica	●	●	●

The Value of Selectivity

Correlation of Orthogonal Phase Selectivity Relative to C18



$$\text{Selectivity (S)} = 100 \times \sqrt{1-r^2}$$

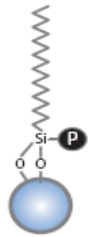
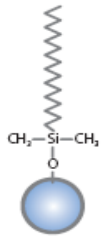
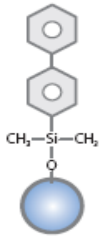
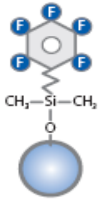
S = 53.5

[2] U.D. Neue, J.E. O'Gara, A. Mendez, J. Chromatogr. A 1127 (2006) 161.

Restek currently has the largest range of selectivity in HPLC and UHPLC

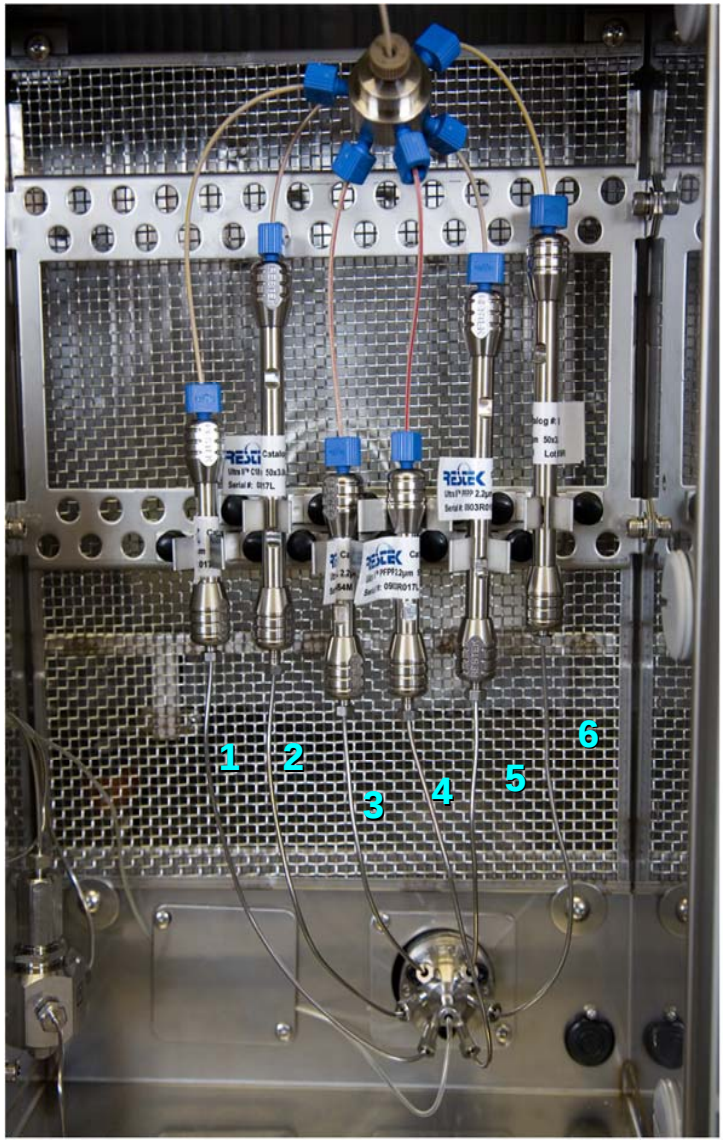
USLC Phases have the highest range of selectivity for RPC

Figure 1: Restek columns offer the widest range of unique and effective column chemistries to aid the chromatographer in fast and easy method development.

Restek phase (column class)	**Aqueous C18** (alkyl)	**IBD** (polar embedded)	**Biphenyl** (phenyl)	**PFP Propyl** (fluorophenyl)
	 Aqueous C18	 C18	 Biphenyl	 PFP Propyl
Ligand type	Proprietary polar modified and functionally bonded C18	Proprietary polar functional embedded alkyl	Unique Biphenyl	Proprietary end-capped pentafluorophenyl propyl
Characteristics and uses	• C18 phase for balanced retention of multiple solute types. • Compatible with up to 100% aqueous mobile phases.	• Enhanced retention of polar acids. • Moderate retention of both acidic and basic solutes.	• Increased retention of aromatic, unsaturated, conjugated solutes, or solutes containing an electron withdrawing ring substituent. • Enhanced retention and selectivity when used with methanolic mobile phases.	• Increased retention of protonated bases and solutes containing aromatic moieties.

Great for Column Switching

- Automated Column Selection
- Attach multiple mobile and stationary phases to system and systematically scout gradients
- Fast and effective method development
- Most Effective with Widest Variety of Stationary Phases



Courtesy of Shimadzu

Biphenyl Advantage

Biphenyl can provide improved selectivity and retention over competitive and traditional phenyls as well as phenyl hexyls and diphenyls

★ *Biphenyl columns are more retentive for drug compounds than conventional phenyl and C18 phases, and are an excellent choice for LC/MS or the analysis of complex biological matrices.* ★

★ *The versatility of a Biphenyl column makes it an invaluable tool for the practicing method developer and a great addition to column screening systems.* ★

Biphenyl has been, and continues to be, very successful in the domestic market

The Evolution of Resolution

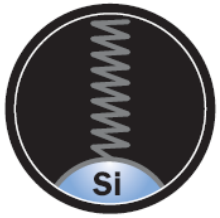
Figure 1 The Biphenyl phase provides higher retention of both hydrophobic and hydrophilic aromatic compounds and is capable of stronger pi-pi interactions than other phenyl phases.

BIPHENYL
- Incorporates aryl linker to the surface silica
- Highest hydrophobic retention of all phenyl phases
- Highest aromatic selectivity of all phenyl phases

PHENYL HEXYL
- Incorporates hexyl linker to the surface silica
- Increased hydrophobic retention
- Increased aromatic selectivity

DIPHENYL
- High density phenyl stationary phase
- Higher hydrophobic retention than conventional phenyl phases
- Capable of more aromatic selectivity than conventional phenyl phases

PHENYL PROPYL
- Conventional phenyl stationary phase
- Weak to moderate hydrophobic retention
- Capable of aromatic selectivity



ODS (OCTADECYLSILANE) OR C18
- Most popular reversed phase column
- Strong hydrophobic retention (dispersive interactions)
- Not selective towards aromatic compounds

Viva - Wide-Pore Silica for Bio Pharma

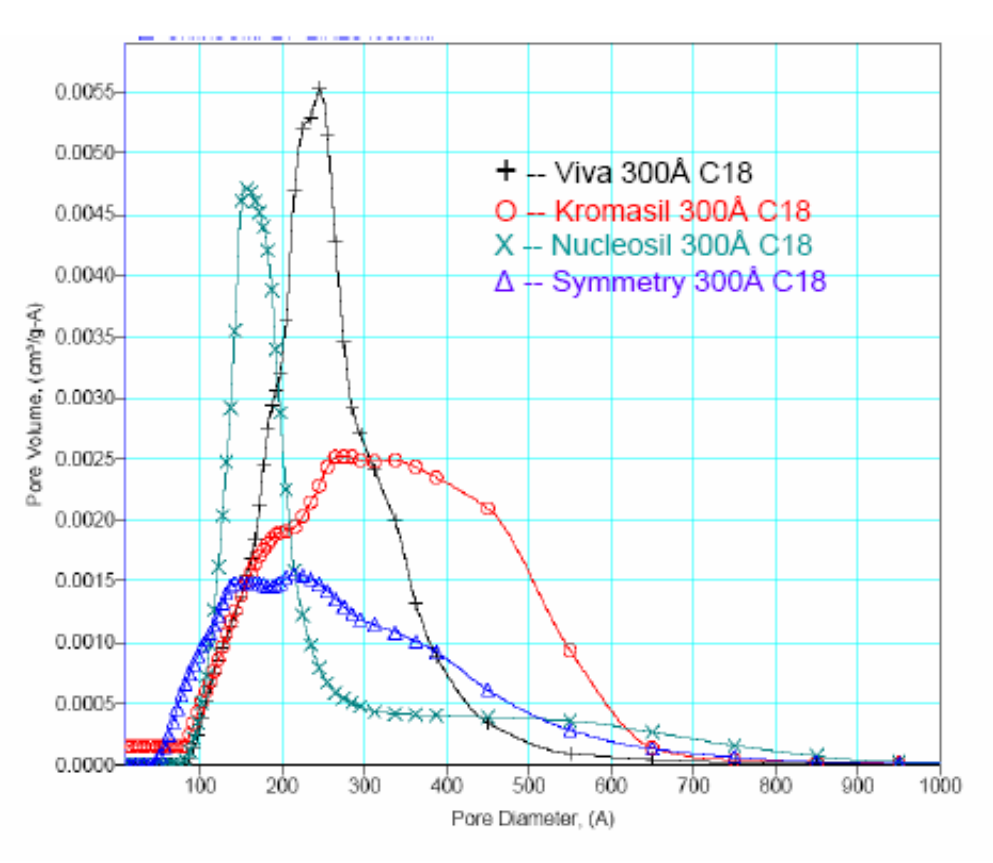
For the separation of compounds of MW greater than approximately 2000Da – Proteins and Bio Pharma

Selling Points:

- Restek manufactured and tightly controlled for effective chromatography and reproducibility - Accurate and precise pore volume

- Wide Variety of stationary phases available
  - C4, C8, C18, Silica, Biphenyl, PFP Propyl, IBD

BJH Desorption dV/dD Pore Volume



- Restek manufactured for control
- If they wont fit, they wont separate
  - Wide distribution means molecules may not fit

Only Viva™ silica has a narrow distribution with the majority of pores falling within the 250-350Å range.

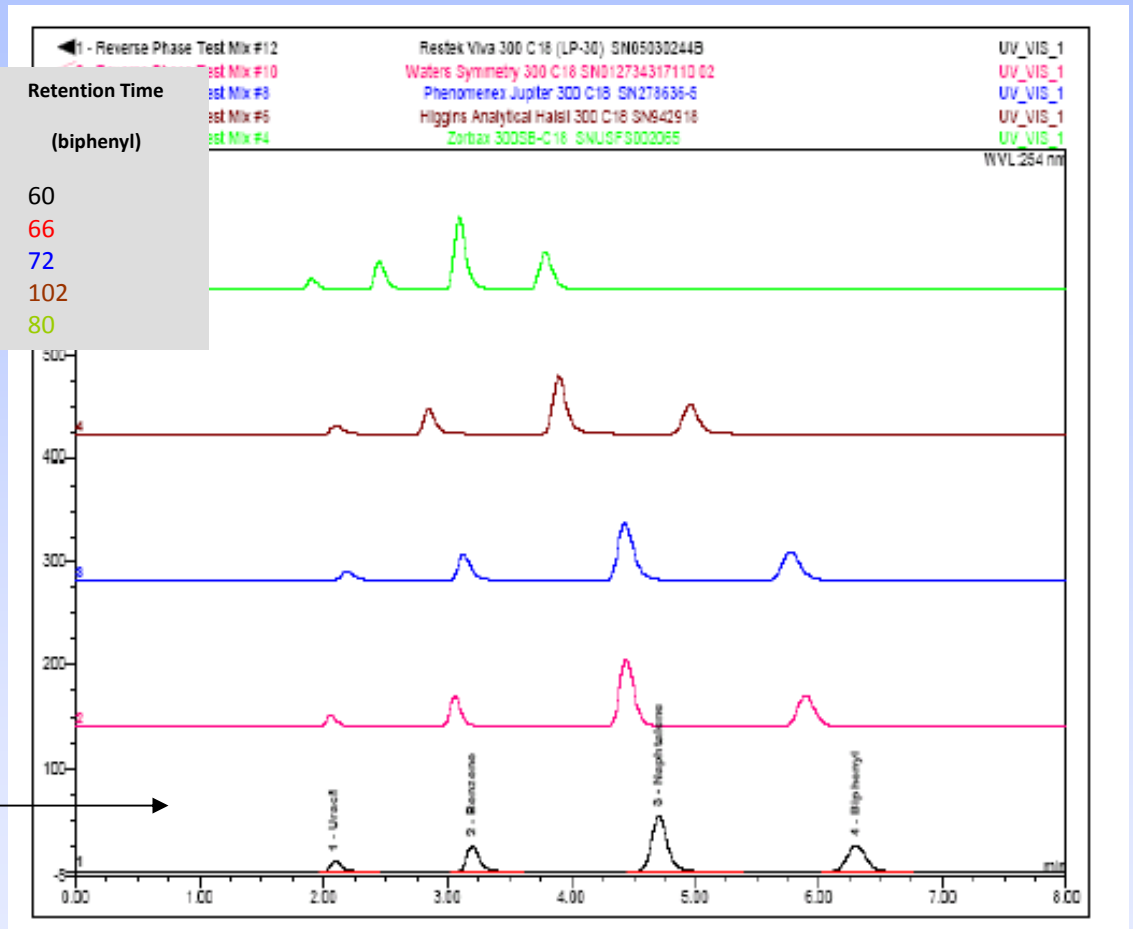
Viva Competitive Comparison

Viva™ wide pore C18 columns provide the best overall performance among five tested columns (reversed phase test mix; 150 x 2.1mm C18 phase columns, 5µm particles).

	Pressure (bar)	Efficiency (plates/meter)	Asymmetry (biphenyl)	Retention Time (biphenyl)
Viva™ 300 C18	52,146	1.16	6.30	60
Waters C18	57,326	1.30	5.89	66
Phenomenex C18	49,720	1.46	5.77	72
Higgins C18	51,813	1.46	4.96	102
Zorbax C18	41,666	1.49	3.79	80

Column: Viva™ C18, 150 x 2.1mm, 5µm (cat.# 9514562)

Mobile Phase: water:methanol, 25:75
Flow Rate: 0.2mL/min.
Detector: UV @ 254nm
Sample: 10µL Reversed Phase Test Mix (cat.# 35005)

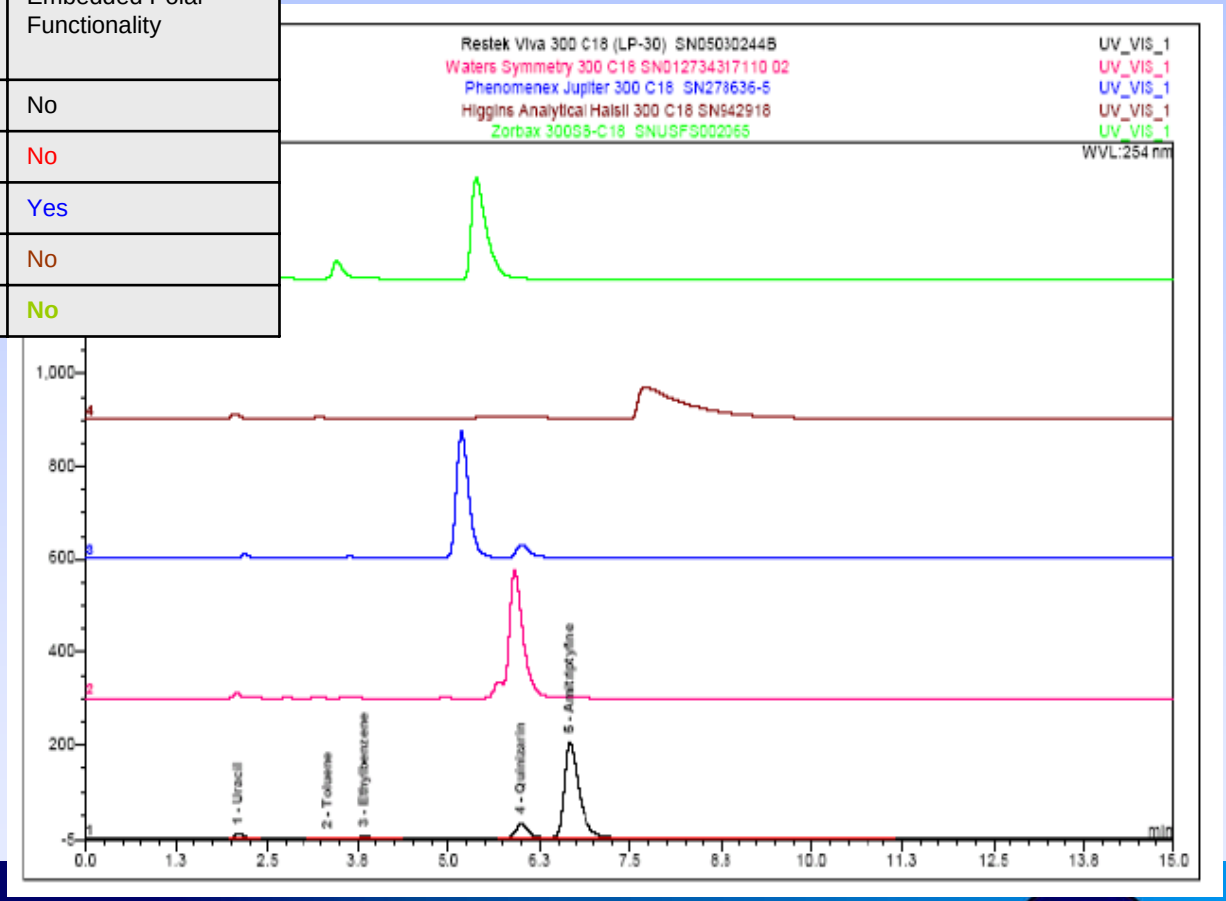


Widest spread, most symmetrical peaks

Viva Competitive Comparison

Viva™ wide pore C18 columns provide low silanol activity and low metals activity

	Silanol Activity	Metal Activity	Embedded Polar Functionality
Viva 300 C18	Low	Low	No
Waters 300 C18	Low	Low	No
Phenomenex 300 C18	Low	Low	Yes
Higgins 300 C18	High	High	No
Zorbax 300 C18	**Low**	**Low**	**No**



Column: Viva™ C18, 150 x 2.1mm, 5µm (cat.# 9514562)
Mobile Phase: A=20% 5mmol $K_xH_yPO_4$, pH = 7.0
B=80% Methanol
Flow Rate: 0.2ml/min.
Detector: UV, 254nm
Injection: 1ml SRM870 test mix

Viva Competitive Comparison

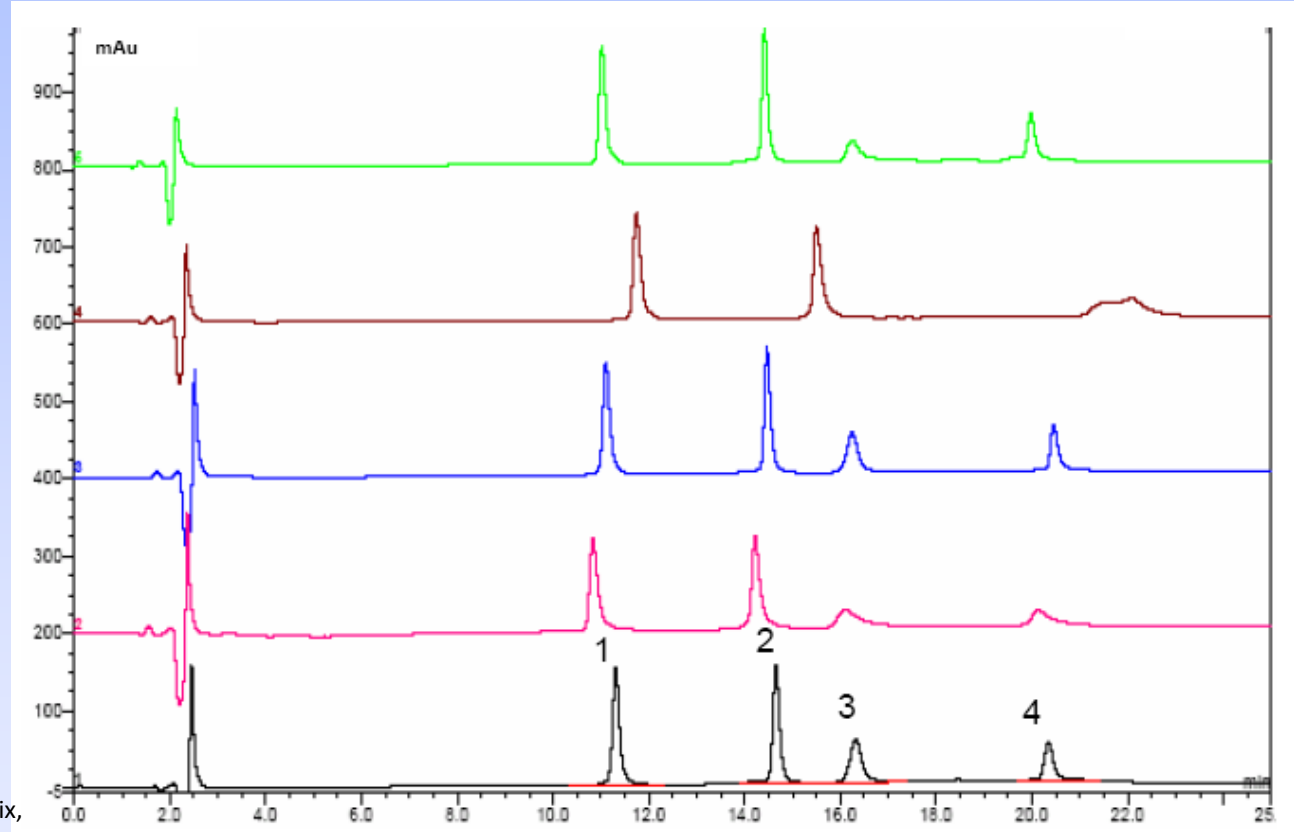
Analysis of a four-protein test mix shows the superior performance of the Viva™ C18 column

Waters Symmetry 300 C18,
150mm x 2.1mm, 5µm

Phenomenex Jupiter 300 C18,
150mm x 2.1mm, 5µm

Higgins Analytical Haisil C18,
150mm x 2.1mm, 5µm

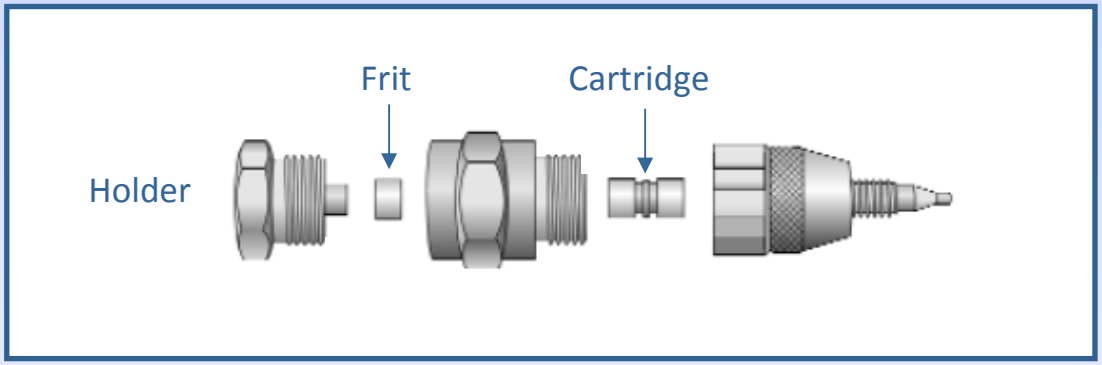
Zorbax 300SB-C18,
150mm x 2.1mm, 5µm



Column:	Viva™ C18, 150 x 2.1mm, 5µm (cat.# 9514562)
Mobile Phase:	A: 0.1% TFA in water, (pH 2.0 B: 0.1% TFA in acetonitrile 20% B to 70% B in 30 min.
Flow Rate:	0.2mL/min.
Detector:	UV @ 214nm
Injection:	Four Protein Standard Test Mix, Sigma Aldrich #H2899

Guard Columns can be great a selling opportunity

- Usually same packing material as analytical column
- Inexpensive
- Sample compatibility
- Low sample dispersion
- Adequate capacity
- Minimal loss of efficiency



Guard Column Options

Trident Direct Guard Cartridge System

Restek's Exclusive Trident Integral System

Trident HPLC In-Line Guard Cartridge Holders

Other LC products of Interest

Individual product line promotions that can be easily applied for cross-selling opportunities

GC in Pharmaceutical Market

- Organic volatile impurities
  - Widely used to verify contaminates in solvents used to make pharmaceutical products
- Restek developed new column phase
  - Rxi-624Sil MS
- Column selectivity has been carefully tuned to give the best performance for analysis of solvents

Rxi GCColumns

3-IN-1 TECHNOLOGY

Highest Inertness • Lowest Bleed • Exceptional Reproducibility

- Literature
  - Promotional Brochures
    - Rxi Flyer – GNFL1173
    - Rxi-5Sil MS – GNFL1061
    - Rxi-624Sil MS – PHFL1245
    - USP <467> - PHFL1018A
  - Application Notes and Technical Articles
    - Outsourcing Solvent Methods – PHTS1262
    - USP <467> - On-line
    - How Column Inertness Improves…PHAN1259
    - PGI Analysis – On-Line

http://www.restek.com/aoi_pharm_main.asp

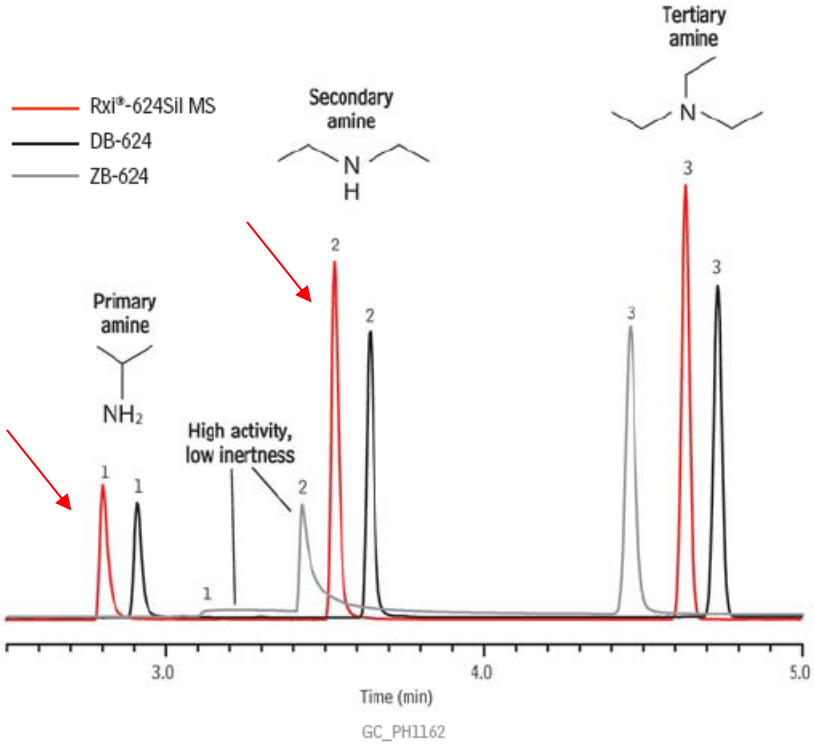
- Webinars

  Practical Method Development for gas Chromatography

Balanced Inertness

Balanced Inertness Gives Higher Data Quality—
Excellent Peak Symmetry and Reproducibility for Active Compounds

Figure 2 Innovative Rxi® deactivation technology provides excellent peak symmetry at 5 ng on-column for primary, secondary, and tertiary amines, which is not possible on competitive columns.



Highly inert Rxi®-624Sil MS columns give excellent peak symmetry.

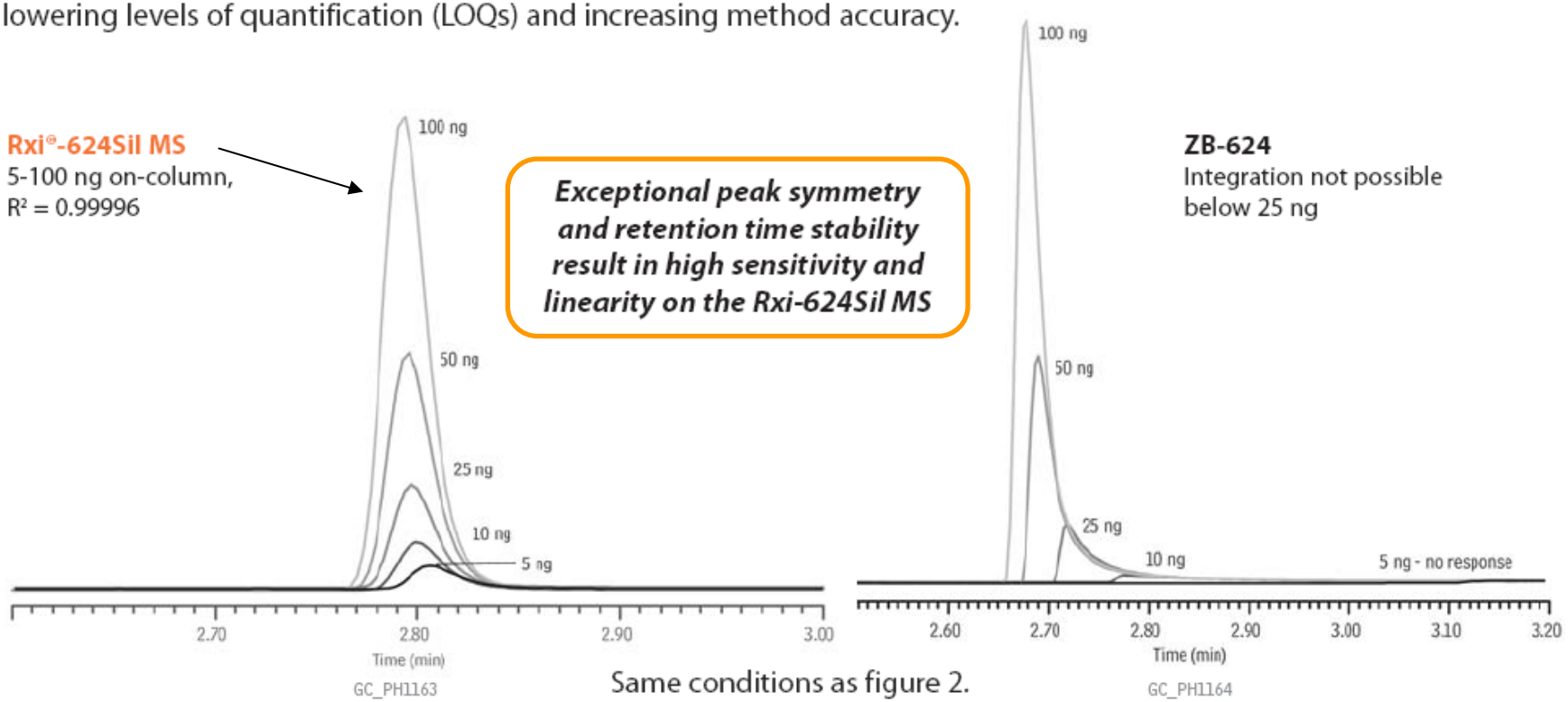
Peaks	Conc. (µg/mL)
1. Isopropylamine	100
2. Diethylamine	100
3. Triethylamine	100

Column	30 m, 0.32 mm ID, 1.8 µm (cat.# 13870)
Sample	Isopropylamine
Diluent:	DMSO
Conc.:	100 µg/mL
Injection	
Inj. Vol.:	1 µL split (split ratio 20:1)
Liner:	5mm Single Gooseneck with Wool (cat.# 22973-200.1)
Inj. Temp.:	250 °C
Oven	
Oven Temp:	50 °C (hold 1 min.) to 200 °C at 20 °C/min. (hold 5 min.)
Carrier Gas	He, constant flow
Linear Velocity:	37 cm/sec.
Detector	FID @ 250 °C
Instrument	Agilent/HP6890 GC

Balanced Inertness -

Balanced Inertness Gives Higher Data Quality—
Excellent Peak Symmetry and Reproducibility for Active Compounds

Figure 3 Primary amines, such as isopropylamine, can be more accurately integrated on an Rxi®-624Sil MS column, lowering levels of quantification (LOQs) and increasing method accuracy.



Same conditions as figure 2.

Highest Thermal Stability of its Class

High Thermal Stability and Low Bleed for GC/MS Compatibility

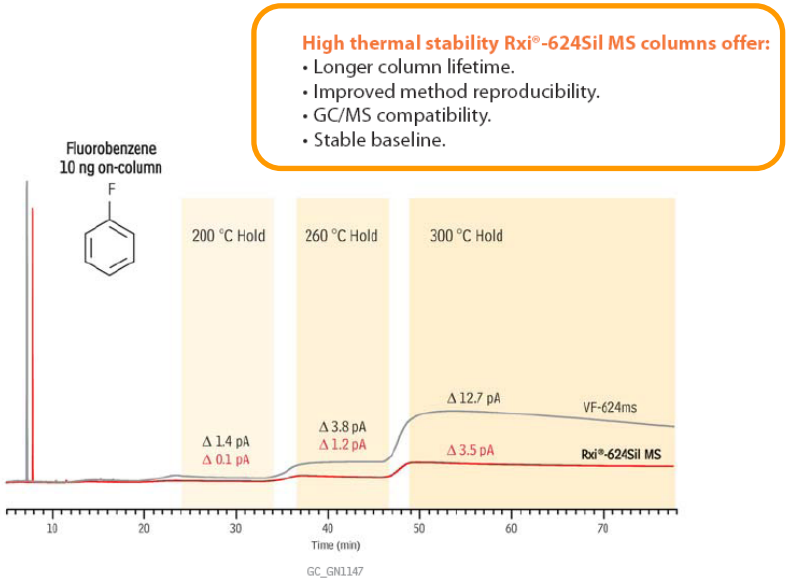
Table I The Rxi®-624Sil MS column has the highest thermal stability of any 624 column.

Column	Manufacturer	Highest Temperature Limit (Isothermal)
Rxi®-624Sil MS	Restek	320 °C
VF-624ms	Varian	300 °C
DB-624	Agilent J&W	260 °C
ZB-624	Phenomenex	260 °C

Data obtained from company website or literature for a 30 m x 0.25 mm x 1.4 µm df column.

- Low Bleed, high thermal stability polymer
- MS compatibility – no need to change columns when converting FID to MS
- Stable baselines for consistent results
- Longer column lifetimes

Figure 5 The Rxi®-624Sil MS column has the lowest bleed of any column in its class, providing true GC/MS capability.



Rxi Essentials Marketing

NEW!

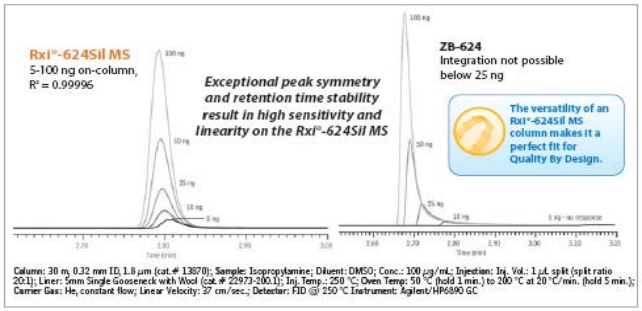
Rxi®-624Sil MS

The *Go To* GC Column for Fast, Effective Volatile Impurities Method Development

Go To… the right column first
For better retention of polar analytes and improved accuracy, peak shape, and response for active compounds.

Go To… mass spec directly
With the lowest bleed 624 column available; stable up to 320 °C, for easy transfer of methods to GC/MS.

Go To… the next batch faster
With the best-in-class G43 for USP methods.



Column: 30 m, 0.32 mm ID, 1.8 µm (cat.# 13870); Sample: Isopropylamine; Diluent: DMSO; Conc.: 100 µg/mL; Injection: Inj. Vol.: 1 µL split (split ratio 20:1); Liner: 5mm Single Gooseneck with Wool (cat. # 22973-200.1); Inj. Temp.: 250 °C; Oven Temp: 50 °C (hold 1 min.) to 200 °C at 20 °C/min. (hold 5 min.); Carrier Gas: He, constant flow; Linear Velocity: 37 cm/sec.; Detector: FID @ 250 °C Instrument: Agilent/HP6890 GC

Rxi®-624Sil MS Columns (fused silica)

- Low bleed, high thermal stability column—maximum temperatures up to 320°C.
- Inert—excellent peak shape for a wide range of compounds, including acidic and basic compounds.
- Selective—highly selective for residual solvents, great choice for USP<467>.
- Manufactured for column-to-column reproducibility—well-suited for validated methods.

Rxi 3-IN-1 TECHNOLOGY

(mid polarity Crossbond® silarylene phase; equivalent to 6% cyanopropylphenyl/94% dimethyl polysiloxane)

ID	df (µm)	temp. limits	20-Meter		30-Meter		60-Meter	
0.18mm	1.00	-20 to 300/320°C	13865	$405				
0.25mm	1.40	-20 to 300/320°C			13868	$500		
0.32mm	1.80	-20 to 300/320°C			13870	$540	13872	$900
0.53mm	3.00	-20 to 280/300°C			13871	$615		

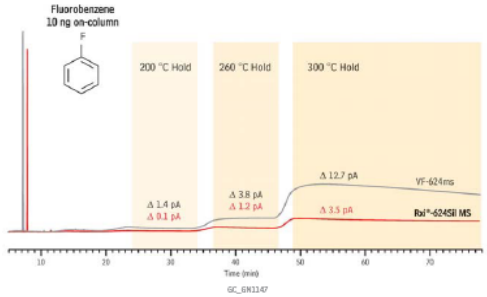
Not all "624s" are Equivalent

High thermal stability Rxi®-624Sil MS columns offer:

- Longer column lifetime.
- Improved method reproducibility.
- GC/MS compatibility.
- Stable baseline.

Ideal for use with FID and MS detectors.

Column	Manufacturer	Highest Temperature Limit (Isothermal)
Rxi®-624Sil MS	Restek	320 °C
VF-624ms	Varian	300 °C
DB-624	Agilent J&W	260 °C
ZB-624	Phenomenex	260 °C



Couple the right column with the right liner. Visit **www.restek.com/liners** for a complete selection.

Custom Residual Solvent Mixes

A perfect match for validated residual solvent methods

Save time and money with mixes prepared to your specific solvent set and concentrations. The more you buy the less you pay per ampul!

Easy Online Order Form!
www.restek.com/customusp

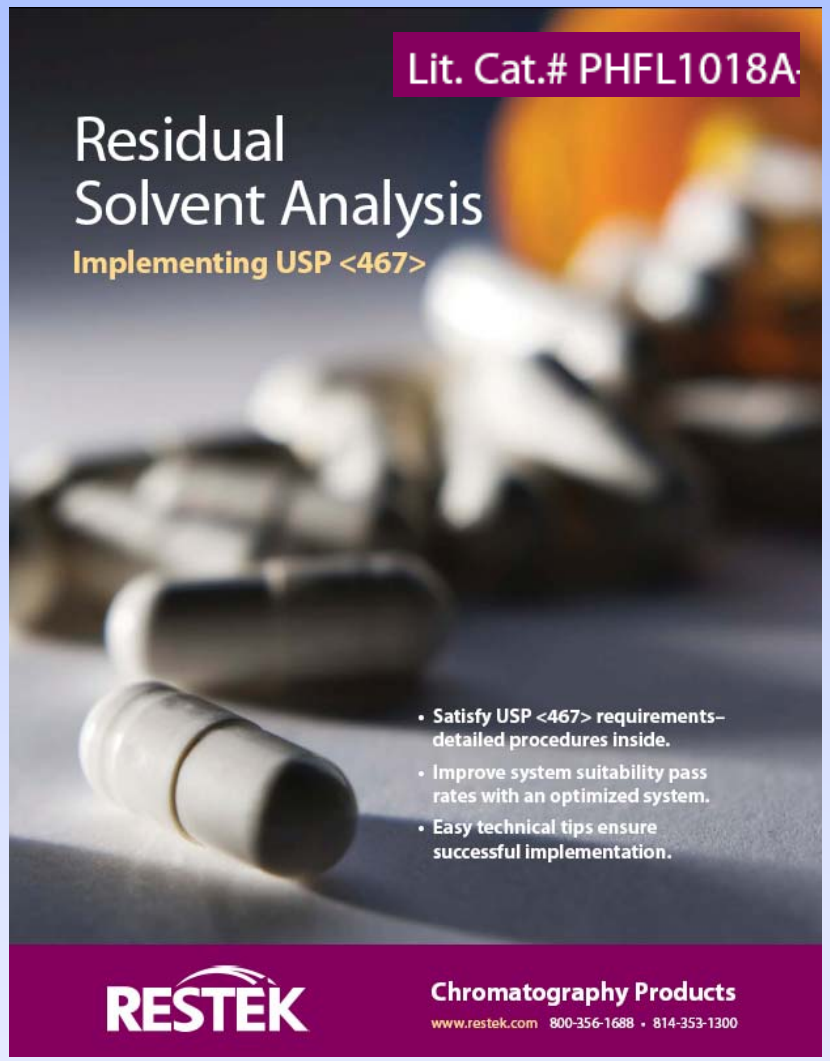
Make the Switch to Rxi® columns!

Experience what Rxi® did for many others

- Lower detection limits
- Better peak shape
- Accurate results

www.restek.com/rxi

Rxi Marketing Campaign



Updated brochure for the USP <467>

This is the technical flyer meant to assist customers in implementing the method

Selling Opportunities for USP<467> Standards

USP-equivalent Standards

Residual Solvents - Class 1

benzene	10mg/mL	1,1-dichloroethene	40
carbon tetrachloride	20	1,1,1-trichloroethane	50
1,2-dichloroethane	25		

In dimethyl sulfoxide, 1mL/ampul

cat. # 36279 (ea.) $30

Residual Solvents Class 2 - Mix A

acetonitrile	2.05mg/mL	methylcyclohexane	5.90
chlorobenzene	1.80	methylene chloride	3.00
cyclohexane	19.40	tetrahydrofuran	3.45
cis-1,2-dichloroethene	4.70	toluene	4.45
trans-1,2-dichloroethene	4.70	*m*-xylene	6.51
1,4-dioxane	1.90	*o*-xylene	0.98
ethylbenzene	1.84	*p*-xylene	1.52
methanol	15.00		

In dimethyl sulfoxide, 1mL/ampul

cat. # 36271 (ea.) $30

Residual Solvents Class 2 - Mix B

chloroform	60μg/mL	nitromethane	50
1,2-dimethoxyethane	100	pyridine	200
n-hexane (C6)	290	tetralin	100
2-hexanone	50	trichloroethene	80

In dimethyl sulfoxide, 1mL/ampul

cat. # 36280 (ea.) $30

Residual Solvents Class 2 - Mix C

2-ethoxyethanol	800μg/mL	2-methoxyethanol (methyl Cellosolve)	250
ethylene glycol	3,100	N-methylpyrrolidone	2,650
formamide	1,100	sulfolane	800
N,N-dimethylacetamide	5,450		
N,N-dimethylformamide	4,400		

In dimethyl sulfoxide, 1mL/ampul

cat. # 36273 (ea.) $30

USP <467> Singles

Volume is 1mL/ampul.

Compound	Solvent	Conc.	cat.# (ea.)	price
acetonitrile	DMSO	2.05mg/mL	36281	$26
benzene	DMSO	10mg/mL	36282	$26
carbon tetrachloride	DMSO	20mg/mL	36283	$26
chlorobenzene	DMSO	1.8mg/mL	36284	$26
chloroform	DMSO	0.3mg/mL	36285	$26
cyclohexane	DMSO	19.4mg/mL	36286	$26
1,1-dichloroethene	DMSO	40mg/mL	36287	$26
1,2-dichloroethane	DMSO	25mg/mL	36288	$26
cis-1,2-dichloroethylene	DMSO	4.67mg/mL	36289	$26
trans-1,2-dichloroethylene	DMSO	4.67mg/mL	36290	$26
1,2-dimethoxyethane	DMSO	0.5mg/mL	36291	$26
N,N-dimethylacetamide	DMSO	5.45mg/mL	36292	$26
N,N-dimethylformamide	DMSO	4.4mg/mL	36293	$26
1,4-dioxane	DMSO	1.9mg/mL	36294	$26
2-ethoxyethanol	DMSO	0.8mg/mL	36295	$26
ethylbenzene	DMSO	1.84mg/mL	36296	$26
ethylene glycol	DMSO	3.1mg/mL	36297	$26
formamide	DMSO	1.1mg/mL	36298	$26
hexane	DMSO	1.45mg/mL	36299	$26
methanol	DMSO	15mg/mL	36401	$26
2-methoxyethanol	DMSO	0.25mg/mL	36402	$26
methylbutylketone	DMSO	0.25mg/mL	36400	$26
methylcyclohexane	DMSO	5.9mg/mL	36403	$26
methylene chloride (dichloromethane)	DMSO	3mg/mL	36404	$26
N-methylpyrrolidone	DMSO	2.65mg/mL	36405	$26
nitromethane	DMSO	0.25mg/mL	36406	$26
pyridine	DMSO	1mg/mL	36407	$26
sulfolane	DMSO	0.8mg/mL	36413	$26
tetrahydrofuran (THF)	DMSO	3.6mg/mL	36408	$26
tetralin	DMSO	0.5mg/mL	36409	$26
toluene	DMSO	4.45mg/mL	36410	$26
1,1,1-trichloroethane	DMSO	50mg/mL	36411	$26
trichloroethene	DMSO	0.4mg/mL	36412	$26
m-xylene	DMSO	6.51mg/mL	36414	$26
o-xylene	DMSO	0.97mg/mL	36415	$26
p-xylene	DMSO	1.52mg/mL	36416	$26

DMSO=dimethyl sulfoxide

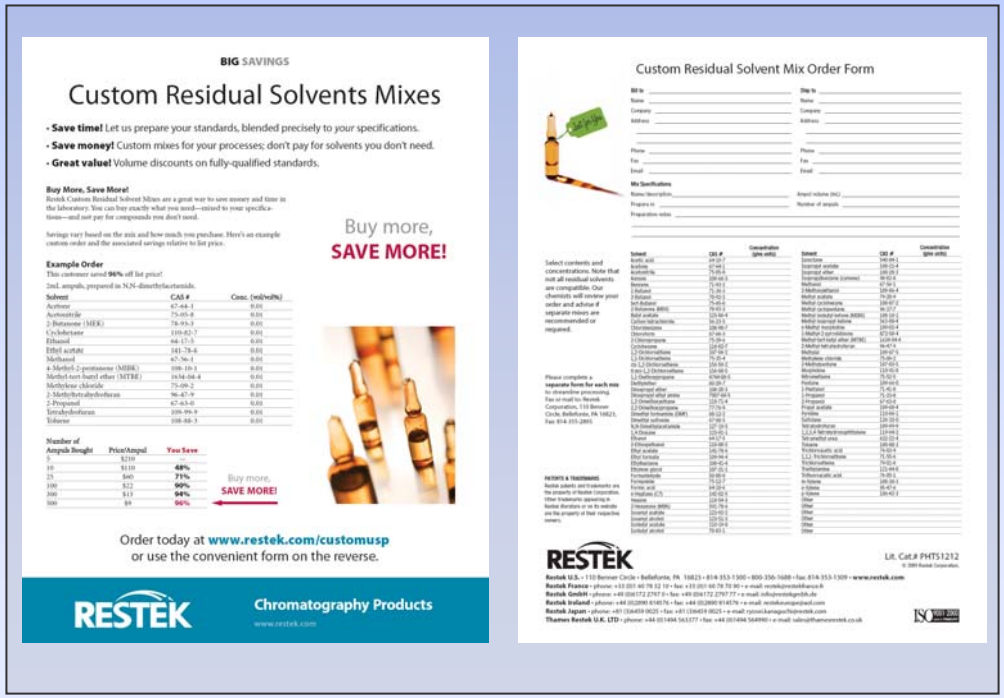
Selling Opportunities for USP<467> Standards

Custom Standards

Restek is your #1 source for custom reference standards!

- **Save time!** Let us prepare your standards, blended precisely to *your* specifications.
- **Save money!** Custom mixes for your processes; don't pay for solvents you don't need.
- **Great value!** Volume discounts on fully-qualified standards.

Order form available on-line



BIG SAVINGS

Custom Residual Solvents Mixes

- **Save time!** Let us prepare your standards, blended precisely to your specifications.
- **Save money!** Custom mixes for your processes; don't pay for solvents you don't need.
- **Great value!** Volume discounts on fully-qualified standards.

Buy More, Save More!

Restek Custom Residual Solvent Mixes are a great way to save money and time in the laboratory. You can buy exactly what you need—mixed to your specifications—and not pay for compounds you don't need.

Savings vary based on the mix and how much you purchase. Here's an example custom order and the associated savings relative to list price.

Example Order

This customer saved **96%** off list price!

2mL ampuls, prepared in N,N-dimethylacetamide.

Solvent	CAS #	Conc. (vol/vol%)
Acetone	67-64-1	0.01
Acetonitrile	75-05-8	0.01
2-Butanone (MEK)	78-93-3	0.01
Cyclohexane	110-82-7	0.01
Ethanol	64-17-5	0.01
Ethyl acetate	141-78-6	0.01
Methanol	67-56-1	0.01
4-Methyl-2-pentanone (MIBK)	108-10-1	0.01
Methyl-tert-butyl ether (MTBE)	1634-04-4	0.01
Methylene chloride	75-09-2	0.01
2-Methylbutyraldehydefuran	96-47-9	0.01
2-Propanol	67-63-0	0.01
Tetrahydrofuran	109-99-9	0.01
Toluene	108-88-3	0.01

Number of Ampuls Bought	Price/Ampul	You Save
5	$210	
10	$110	48%
25	$60	71%
100	$22	90%
300	$13	94%
500	$9	96%

Buy more, SAVE MORE!

Buy more, SAVE MORE!

Order today at www.restek.com/customusp
or use the convenient form on the reverse.

RESTEK Chromatography Products

www.restek.com

Custom Residual Solvent Mix Order Form

Bill to: Name, Company, Address, Phone, Fax, Email

Ship to: Name, Company, Address, Phone, Fax, Email

Mix Specifications: Name/Description, Program #, Preparation notes, Ampul volume (mL), Number of ampuls

Select contents and concentrations. Note that not all residual solvents are compatible. Our chemists will review your order and advise if separate mixes are recommended or required.

Please complete a separate form for each mix to streamline processing. Fax or mail to: Restek Corporation, 110 Benner Circle, Bellefonte, PA 16823, Fax 814-353-2805

Solvent	CAS #	Concentration (g/mL units)	Solvent	CAS #	Concentration (g/mL units)
Acetic acid	64-19-7		Isoamyl acetate	123-92-2	
Acetone	67-64-1		Isoamyl alcohol	123-51-3	
Acetonitrile	75-05-8		Isoamyl ether	1640-89-7	
Anisole	100-66-3		Isopropylbenzene (cumene)	98-82-8	
Benzene	71-43-2		Methanol	67-56-1	
1-Butanol	71-36-3		1-Methoxy-2-propanol	107-98-2	
2-Butanone	78-93-3		Methyl acetate	79-20-9	
tert-Butanol	75-65-0		Methyl cyclohexane	108-87-2	
2-Butanone (MEK)	78-93-3		Methyl cyclopentane	96-37-7	
Butyl acetate	123-86-4		Methyl isobutyl ketone (MIBK)	108-10-1	
Carbon tetrachloride	56-23-5		Methyl isoamyl ketone	563-80-4	
Chlorobenzene	108-90-7		4-Methyl morpholine	109-02-4	
Chloroform	67-66-3		1-Methyl-2-pyrrolidinone	872-50-4	
1,2-Dichloroethane	107-06-2		Methyl tert-butyl ether (MTBE)	1634-04-4	
1,2-Dichloroethane	107-06-2		1-Methyl tetrahydrofuran	96-47-9	
1,1-Dichloroethane	75-34-3		Mesityl oxide	141-79-7	
1,1-Dichloroethene	75-35-4		Methylene chloride	75-09-2	
cis-1,2-Dichloroethene	156-59-2		2-Methylbutane	107-83-5	
trans-1,2-Dichloroethene	156-60-5		Morpholine	110-91-8	
1,2-Dichloropropane	78-87-5		Nitromethane	75-52-5	
Diethylether	60-29-7		Pentane	109-66-0	
Diisopropyl ether	108-20-3		1-Pentanol	71-41-0	
Dimethyl acetamide	127-19-5		1-Propanol	71-23-8	
1,2-Dimethoxyethane	110-71-4		2-Propanol	67-63-0	
2,2-Dimethoxypropane	77-76-9		Propyl acetate	109-60-4	
Dimethyl formamide (DMF)	68-12-2		Pyridine	110-86-1	
Dimethyl sulfoxide	67-68-5		Sulfolane	126-33-0	
N,N-Dimethylacetamide	127-19-5		Tetrachloroethylene	127-18-4	
1,4-Dioxane	123-91-1		1,2,3,4-Tetrahydronaphthalene	119-64-2	
Ethanol	64-17-5		Tetramethyl urea	632-22-4	
2-Ethoxyethanol	110-80-5		Toluene	108-88-3	
Ethyl acetate	141-78-6		1,2,4-Trichlorobenzene	120-82-1	
Ethyl formate	109-94-4		1,1,1-Trichloroethane	71-55-6	
Ethylacetate	141-78-6		Trichloroethene	79-01-6	
Ethylene glycol	107-21-1		Trifluoroethanol	75-89-8	
Formamide	75-12-7		Trifluoroacetic acid	76-05-1	
Formic acid	64-18-6		n-Xylene	106-42-3	
2-Heptanone (C7)	110-43-0		o-Xylene	95-47-6	
Hexane	110-54-3		m-Xylene	108-38-3	
2-Hexanone (MBK)	591-78-6		Other		
Isobutyl acetate	110-19-0		Other		
Isoamyl alcohol	123-51-3		Other		
Isobutyl acetate	110-19-0		Other		
Isobutyl alcohol	78-83-1		Other		

RESTEK

Lit. Cat.# PHTS1212

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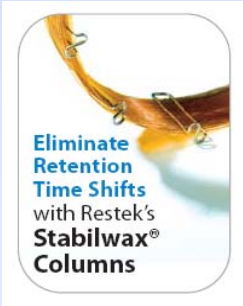
GC Column Mix for Pharma Method Development

	Rxi-5Sil MS	Rxi-17Sil MS	Rxi-624Sil MS	Stabilwax
				
Phase:	Non-polar →			Polar
Thermal Stability:	High (360)	350	320	Low (260)
Inst. Compat.	GC/MS			GC/FID only
Deactivation:	Balanced Amine (follow with same deactivation for liners)			DA vs DB option

Four GC column phases recommended for organic volatile impurities
- Wide variation in selectivity
- Highly thermally stable columns
- Very inert
- Reproducible from column to column



Summary

- HPLC
  - USLC campaign
    - Ultra Selective Liquid Chromatography
  - Focus on:
    - Ultra (Type B silica, more inert)
      - 3um and 5um particles
    - Pinnacle DB (Type A silica)
      - 1.9um particles
    - Viva (large molecules, Proteins and Bio Pharma)
- GC
  - Organic volatile impurities
    - Rxi-624Sil MS
    - Best selectivity choices
      - Rxi-5Sil MS, Rxi-17Sil MS, Rxi-624Sil MS, Stabilwax