[CORTECS 1.6 µm COLUMNS]

ultimate efficiency unleashed

CORTECS® COLUMNS

Waters

THE SCIENCE OF WHAT'S POSSIBLE.®

A SUB-2-µm SOLID-CORE PARTICLE COLUMN THAT LIVES UP TO ITS POTENTIAL.

C_{18}+ | C_{18} | HILIC

SOLID-CORE PARTICLE COLUMNS THAT DELIVER ULTIMATE EFFICIENCY AND PERFORMANCE

With our unique understanding of how to harness the power of sub-2-µm particles, Waters brings you the latest addition to our family of sub-2-µm UltraPerformance LC® Columns. Based on 1.6 µm solid-core particle technology, CORTECS® Columns enable you to achieve new levels of efficiency and performance. Whether you're trying to resolve complex mixtures or maintain resolution while increasing throughput, CORTECS Columns will surpass ALL expectations.

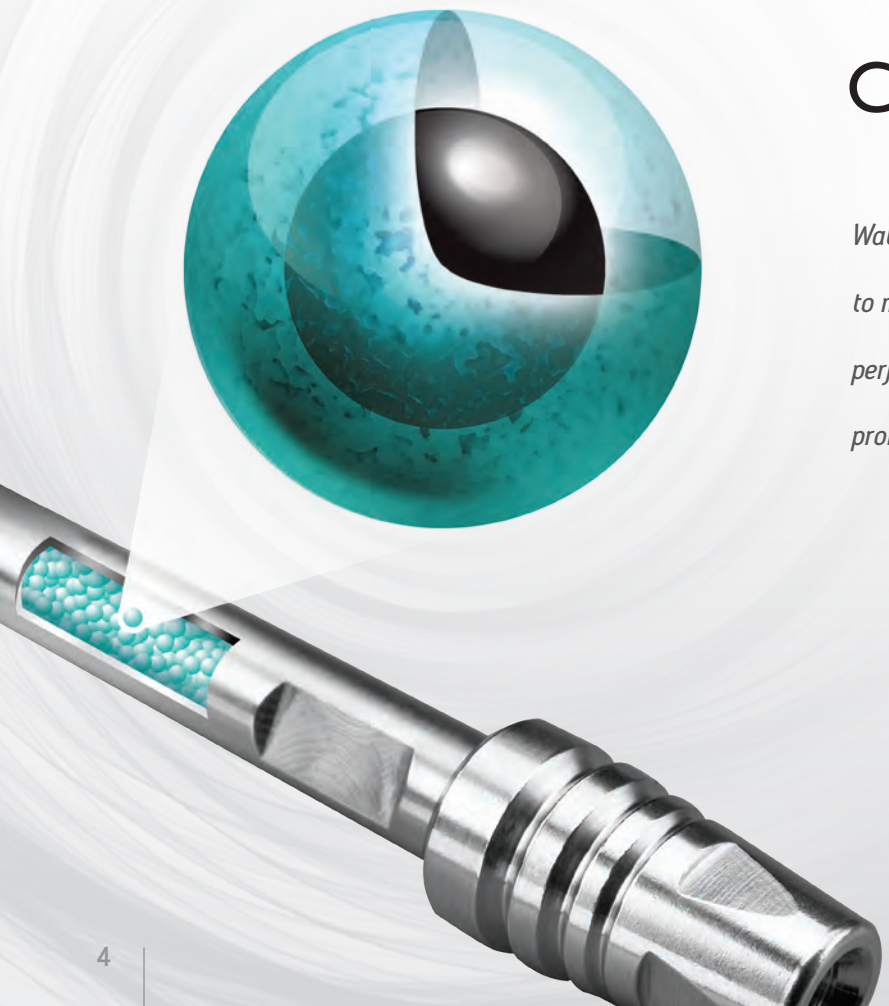
TRUTH BEHIND INCREASED EFFICIENCY WITH SOLID-CORE PARTICLES

Why do solid-core particles achieve higher column efficiency? Initial explanation previously credited the shorter diffusion path in solid-core particles versus fully-porous particles. A shorter diffusion path results in faster mass transfer kinetics. However, for analytes of low molecular weight which have high diffusion rates, mass transfer kinetics have been found to play a minimal role in efficiency improvement. Modern findings suggest that solid-core particles improve performance by lowering each of the three terms of the van Deemter equation:

- Solid-core particles may pack more uniformly—lowering the *A* term
- Their lower particle porosity reduces axial diffusion—lowering the *B* term
- Their solid core may improve heat transfer, diminishing radial temperature gradients—lowering the *C* term

$$HETP = A + \frac{B}{v} + C \cdot v$$

G. Guiochon and F. Gritti, J. Chrom. A ***1218****, 2011, 1915 - 1938.*



CORTECS® COLUMNS

Waters CORTECS Columns are designed to maximize efficiency, throughput, and performance as well as to fulfill the promise of solid-core particle columns.

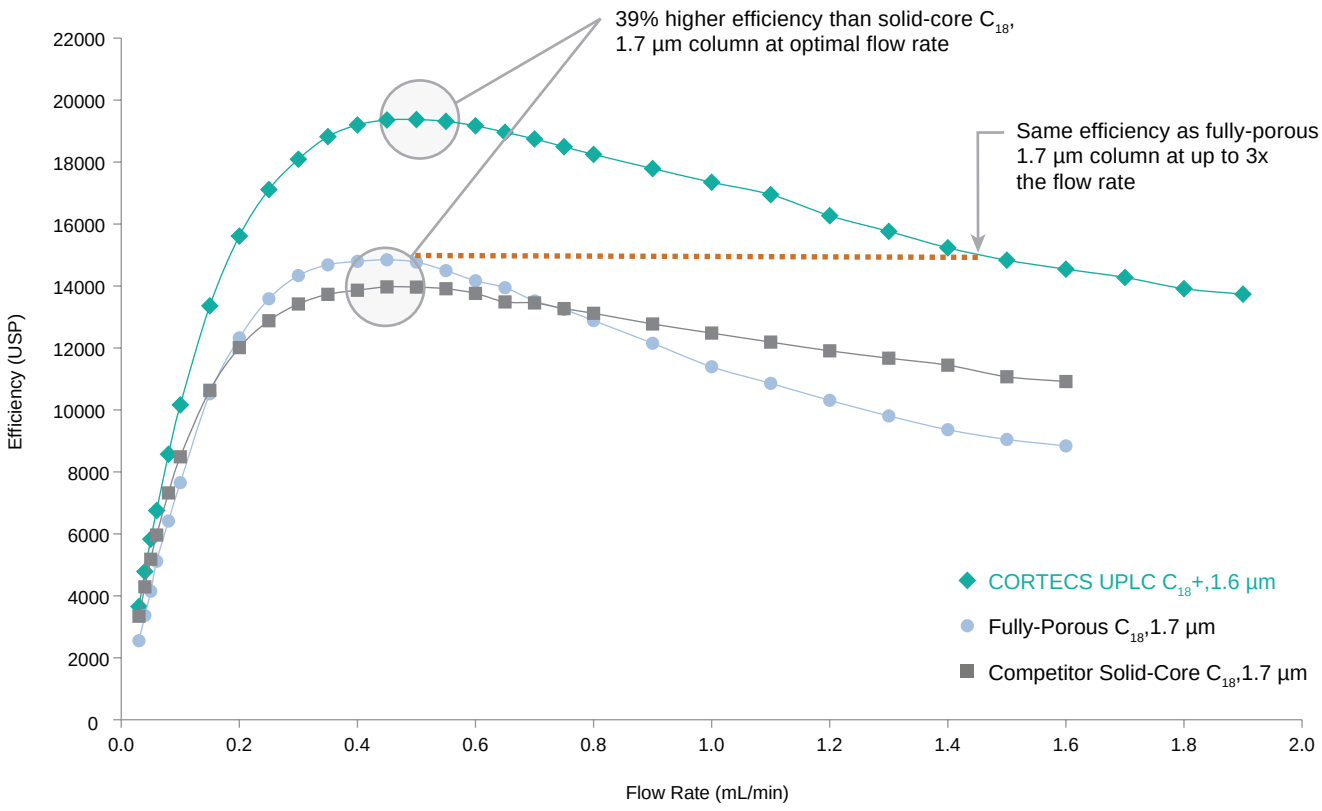
ACHIEVE A NEW EFFICIENCY STANDARD

Due to the characteristic duality of their morphology, solid-core particles hold the potential for higher efficiency when compared to fully-porous particles of a similar size. However, achievement of this theoretical potential requires the use of ultra-low dispersion column hardware and optimal packing techniques. By using unique column hardware and proprietary packing equipment and methodologies, Waters has set the efficiency standard for UPLC® Columns.

Backed by over a decade of knowledge and expertise in manufacturing sub-2-µm particle columns, CORTECS UPLC Columns deliver the full benefit of solid-core particle technology.

DESIGNED AND CONSTRUCTED FOR MAXIMUM EFFICIENCY AND THROUGHPUT

Efficiency Advantage of CORTECS UPLC Columns



Comparative separations may not be representative in all applications.

CORTECS UPLC Columns offer higher efficiency than columns containing sub-2-µm fully-porous particles as well as those containing 1.7 µm competitor solid-core particles. They also give chromatographers the option to more than double the throughput of their current sub-2-µm column separation while maintaining a similar efficiency. Data conditions—Columns: 2.1 x 50 mm; Analyte: acenaphthene; Mobile phase: 75:25 (v/v) acetonitrile/water; Temperature: 30 °C.

MAXIMUM EFFICIENCY FOR MAXIMUM RESOLUTION

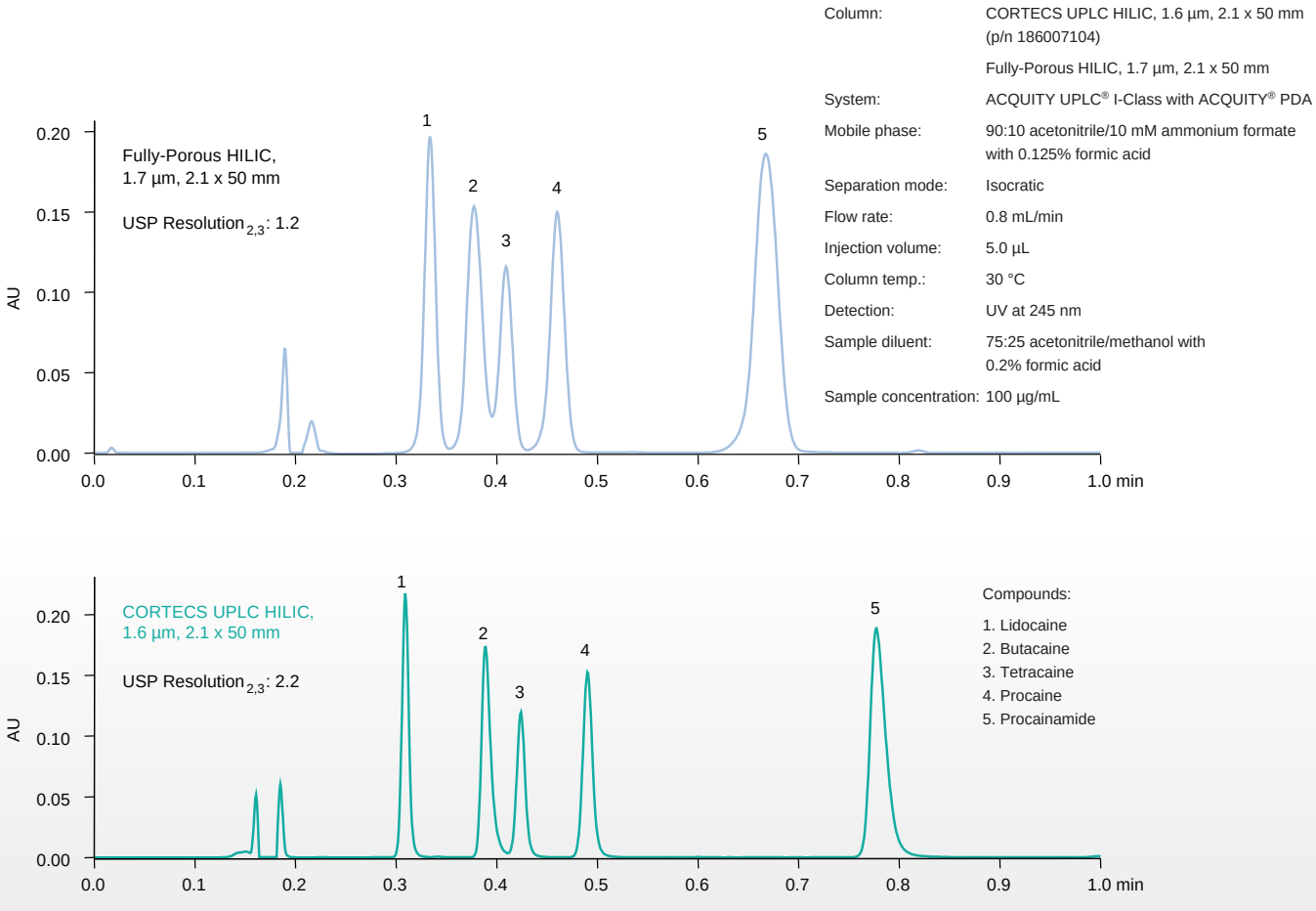
As described in this equation, resolution depends on three variables:

- the efficiency of the column/system (*N*),
- the selectivity between compounds (α), and
- the retention factor (*k*) of the analyte.

$$R_S = \frac{\sqrt{N}}{4} \frac{(\alpha\text{-}1)}{\alpha} \frac{k}{(k+1)}$$

Resolution increases in proportion to the square root of efficiency. So, the higher efficiency of CORTECS UPLC Columns gives you increased resolution when analyzing complex samples compared to fully-porous columns.

Improved Resolution of Local Anesthetics on CORTECS UPLC HILIC, 1.6 µm Columns



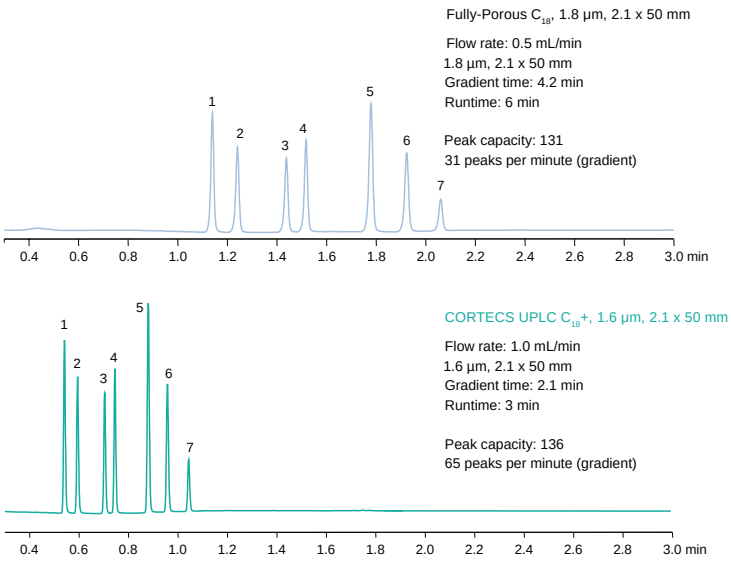
Comparative separations may not be representative in all applications.

Improved resolution for a separation of local anesthetics using a CORTECS UPLC HILIC Column compared to a fully-porous column, using the same method conditions.

FASTER SEPARATIONS FOR GREATER THROUGHPUT

Another benefit of CORTECS UPLC Columns is that they enable you to increase sample throughput with comparable or better peak capacities, simply by raising the flow rate of the method. Alternatively, the high efficiency of CORTECS UPLC Columns can enable the use of a shorter column length compared to the original separation, while maintaining similar peak capacities and providing faster re-equilibration time. This increased speed of analysis without sacrificing separation performance gives you the ability to run more samples in the same amount of time and obtain results faster—while decreasing the costs of analysis and lab operation.

Faster Separation and Similar Peak Capacity at Double the Flow Rate



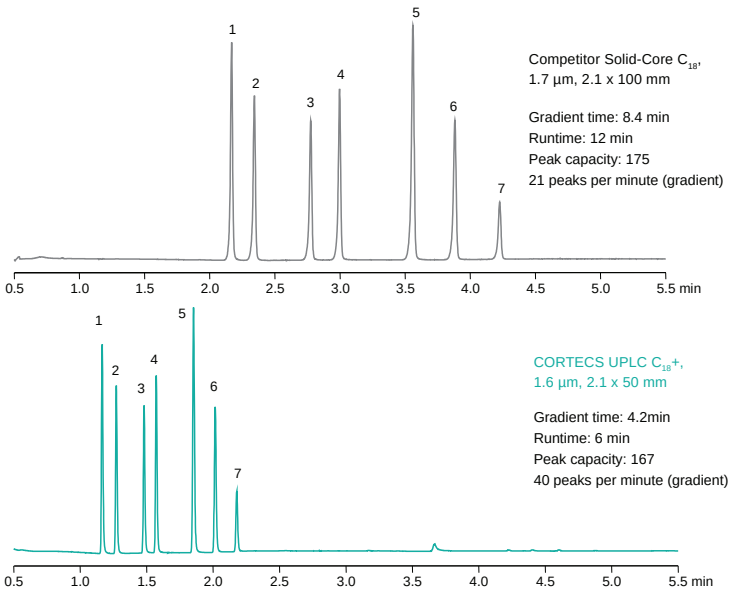
Comparative separations may not be representative in all applications.

Faster separation with similar peak capacity for sulfa drugs using a CORTECS UPLC C_{18}+ Column (p/n: 186007114) at double the flow rate, compared to a fully-porous column. Data conditions—System: ACQUITY UPLC H-Class; UV detection: 254 nm, scaling the gradient to account for the change in flow rate; Sample concentration: 10 µg/mL.

Compounds:

1. Sulfathiazole
2. Sulfamerazine
3. Sulfamethazine
4. Sulfamethoxypyridazine
5. Sulfachloropyridazine
6. Sulfamethoxazole
7. Sulfasoxazole

Higher Throughput With Shorter Column Length



Comparative separations may not be representative in all applications.

Higher throughput with similar peak capacity for sulfa drugs using a 50 mm length CORTECS UPLC C_{18}+ Column (p/n: 186007114), compared to a 100 mm length competitor solid-core particle column. Data conditions—System: ACQUITY UPLC H-Class; UV detection: 254 nm, scaling the method to account for the change in column length; Sample concentration: 10 µg/mL.

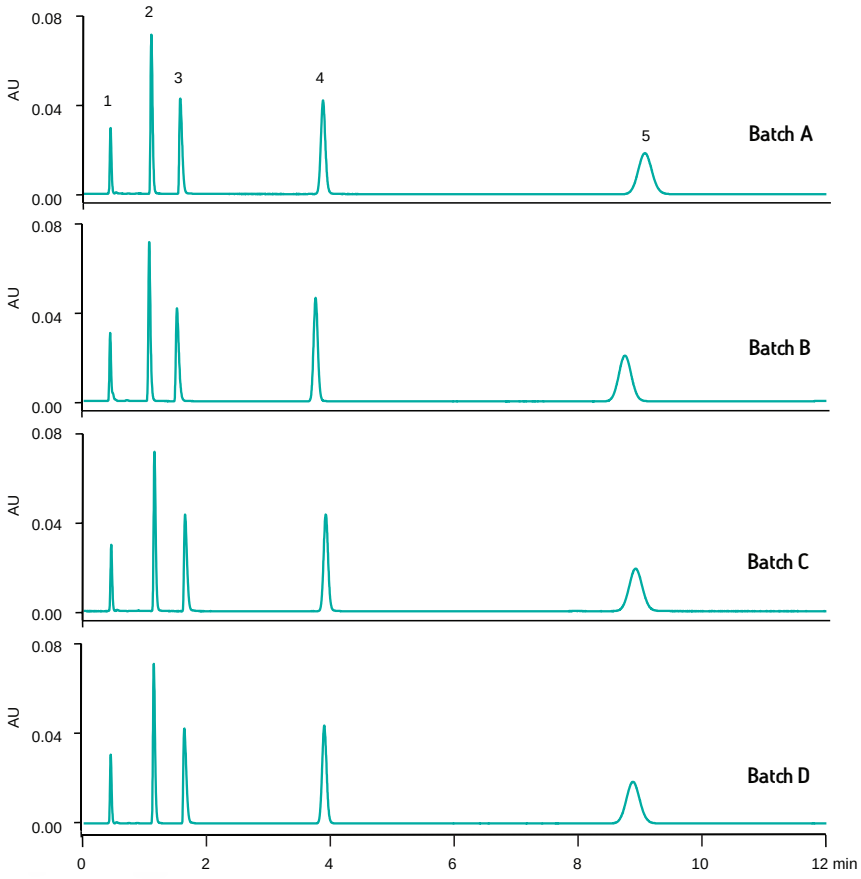
Compounds:

1. Sulfathiazole
2. Sulfamerazine
3. Sulfamethazine
4. Sulfamethoxypyridazine
5. Sulfachloropyridazine
6. Sulfamethoxazole
7. Sulfasoxazole

REPRODUCIBILITY YOU CAN DEPEND ON

With more than fifty years of experience in the separation sciences, Waters' chromatographic media sets the standard for quality. As a primary manufacturer of chromatographic media, Waters monitors and controls each step of the manufacturing process to maintain unparalleled reproducibility. The result is consistent performance year-after-year—the hallmark of reliability.

Excellent Batch-to-Batch Reproducibility for CORTECS UPLC C_{18} Columns

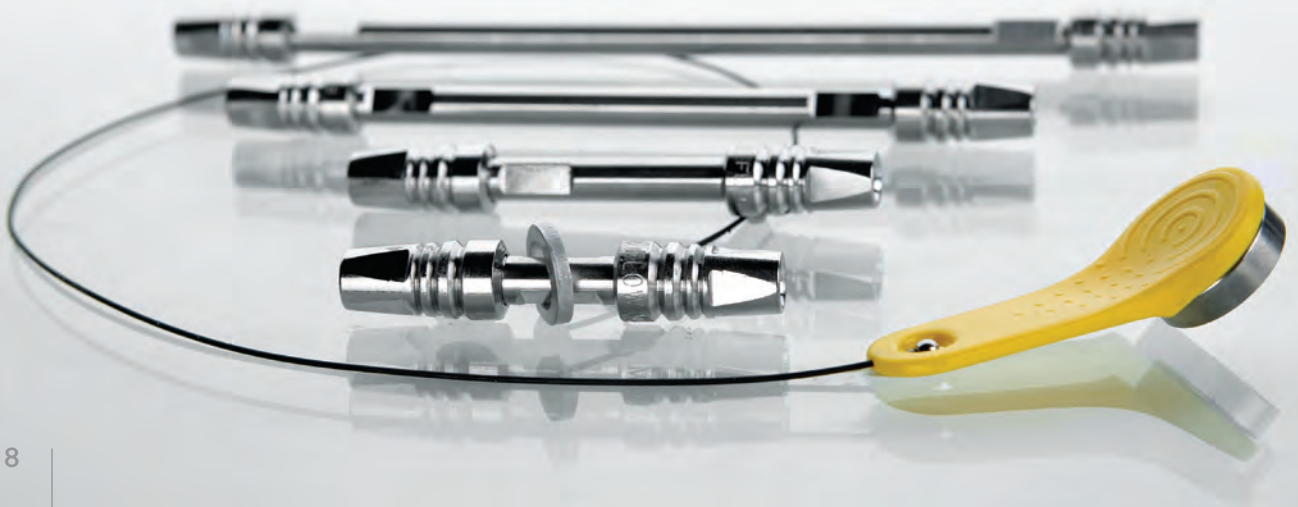


System:	ACQUITY UPLC H-Class System with ACQUITY PDA
Column:	CORTECS UPLC C_{18}, 1.6 µm, 2.1 x 50 mm (p/n 186007093)
Mobile phase:	Acetonitrile/15.4 mM ammonium formate, pH 3 (35/65, v/v)
Flow rate:	0.25 mL/min
Injection volume:	3 µL
Column temp.:	30 °C
Detection:	UV at 254 nm
Sample diluent:	Mobile phase

Compounds:

1. Uracil (1 µg/mL)
2. Promethazine (3.0 µg/mL)
3. Amitriptyline (8.0 µg/mL)
4. Butylparaben (3.5 µg/mL)
5. Naphthalene (20 µg/mL)

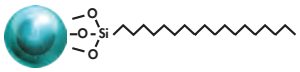
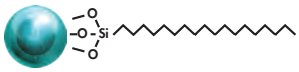
Separations obtained using columns containing four different batches of bonded material demonstrates the solid reproducibility that can be expected from CORTECS UPLC Columns, assuring the long-term reproducibility of your analytical method.



EMPOWERING METHOD DEVELOPMENT

There are several factors to consider when developing a method. Parameters that influence your separation include mobile phase composition, temperature, and column chemistry. With three phases to choose from, CORTECS UPLC Columns offer both complementary and orthogonal selectivity, giving you flexibility and power to develop methods faster. With different particle characteristics including innovative charged surface modifications, CORTECS UPLC Columns are suitable for use in a wide variety of applications.

CORTECS UPLC CHEMISTRY CHARACTERISTICS

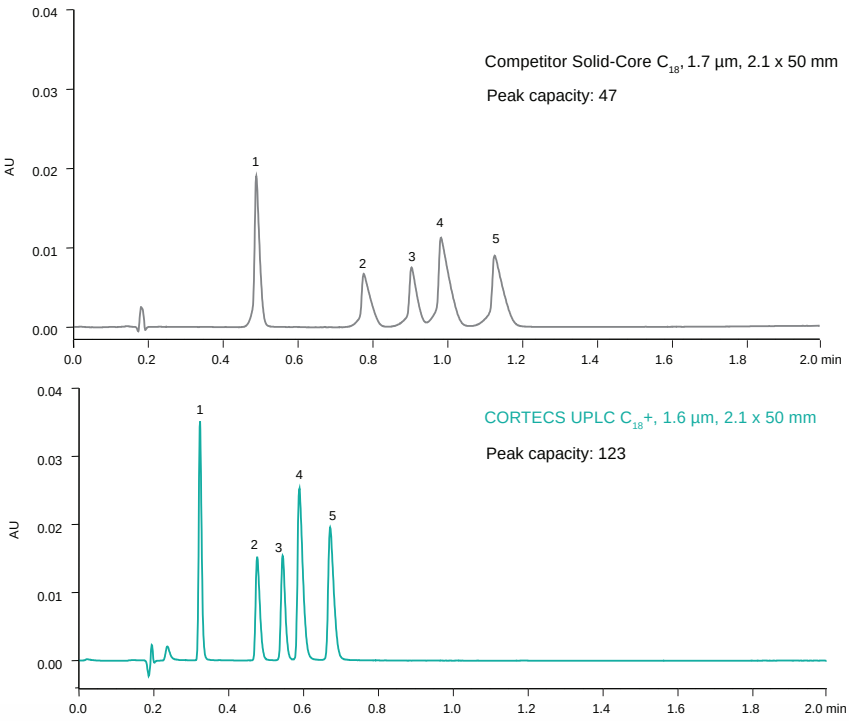
	C_{18}+	C_{18}	HILIC
Chemistry			
Intended Use	General purpose, high-efficiency, reversed-phase column. A positively charged surface delivers excellent peak shape for basic compounds at low ionic strength acidic mobile phases.	General purpose, high-efficiency, reversed-phase column. Balanced retention of acids, bases, and neutrals at low- and mid-range pH.	High-efficiency column designed for retention of extremely polar analytes. Offers orthogonal selectivity vs. C_{18} columns.
Ligand Type	Trifunctional C_{18}	Trifunctional C_{18}	None
Surface Charge Modification	+	None	None
Endcap Style	Proprietary	Proprietary	None
Carbon Load	5.7%	6.6%	Unbonded
Ligand Density	2.4 µmol/m^2	2.7 µmol/m^2	N/A
pH Range	2-8	2-8	1-5
Temperature Limits*	Low pH = 45 °C High pH = 45 °C	Low pH = 45 °C High pH = 45 °C	Low pH = 45 °C High pH = 45 °C
Performance Standard	Neutrals QCRM	Neutrals QCRM	HILIC QCRM
Application Standard	Reversed-Phase QCRM	Reversed-Phase QCRM	HILIC QCRM

**Recommended temperature limits when operating at the extremes of the pH range. Higher temperatures may be used when the pH is not near the limits.*

ENHANCED PEAK SHAPE AND LOADING CAPACITY FOR BASIC ANALYTES

The greatest benefit of CSH™ Technology is improved peak shape and loading capacity for basic analytes using low-ionic strength, acidic-mobile phases. This technology imparts a low-level positive charge to the CORTECS particle surface which enables the use of low-ionic strength formic acid mobiles in place of ion-pairing reagents such as trifluoroacetic acid.

Improved Peak Shape of Basic Analytes with CORTECS UPLC C_{18}+ Columns



Column:	CORTECS UPLC C_{18}+, 1.6 µm, 2.1 x 50 mm (p/n 186007114) Competitor Solid-Core C_{18}, 1.7 µm, 2.1 x 50 mm
System:	ACQUITY UPLC H-Class with ACQUITY PDA
Mobile phase A:	0.1% formic acid in water
Mobile phase B:	0.1% formic acid in acetonitrile
Gradient:	28–35% B over 3 minutes
Flow rate:	0.6 mL/min
Injection volume:	1.0 µL
Column temp.:	40 °C
Detection:	UV at 254 nm
Sample concentration:	10 µg/mL

Compounds:

1. Nordoxepin
2. Protriptyline
3. Nortriptyline
4. Amitriptyline
5. Trimipramine

Comparative separations may not be representative in all applications.

Improved peak shape of basic compounds using a CORTECS UPLC C_{18}+ Column, compared to a competitor C_{18} solid-core particle column results in much higher peak capacity for the CORTECS UPLC Column separation using the same method conditions.

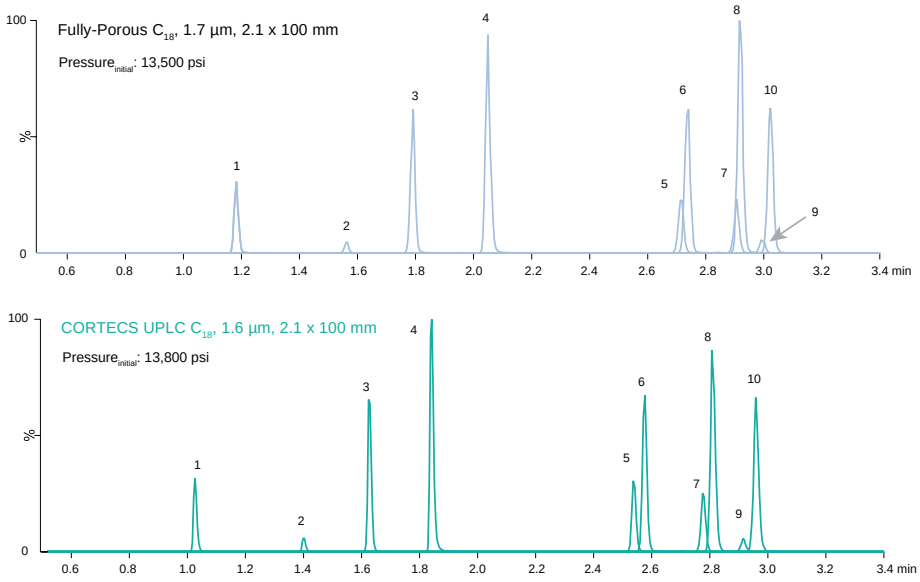
Implement the appropriate Waters Quality Control Reference Material (QCRM) into your workflow to benchmark system performance and gain confidence in your results.

For more information, visit **www.waters.com/QCRM**

EXCELLENT RESOLUTION AND RETENTION WITH CORTECS UPLC C_{18} COLUMNS

Most chromatographers choose C_{18} ligands for their excellent retention and stability. The CORTECS C_{18} material is a traditional C_{18} bonded phase that exhibits balanced retention of acids, bases, and neutrals at low- and mid-range pH, and provide superb efficiency, resolution, and retention for complex analyte mixtures.

Greater Resolution for Synthetic Cannabinoids on a CORTECS UPLC C_{18} Column



Comparative separations may not be representative in all applications.

UPLC-MS/MS analysis of synthetic cannabinoids and metabolites at 10 ng/mL using a CORTECS UPLC C_{18} Column, compared to a Fully-Porous C_{18}, 1.7 µm, 2.1 x 100 mm column at 0.6 mL/min. The analysis was performed on an ACQUITY UPLC System with a Xevo® TQD Mass Spectrometer, using the same method for both columns. Co-elution is evident on the fully-porous column for peaks 5/6, 7/8 and 9/10 (isobaric), but these are sufficiently resolved for quantitation on the CORTECS UPLC C_{18}, 1.6 µm Column.

System:	ACQUITY UPLC
Column:	CORTECS UPLC C_{18}, 1.6 µm, 2.1 x 100 mm (p/n186007095)
Column temp.:	30 °C
Injection volume:	10 µL
Flow rate:	0.6 mL/min
Mobile phase A:	0.1% formic acid in Milli-Q® water
Mobile phase B:	0.1% formic acid in acetonitrile

Gradient:

Time (min)	%A	%B	Curve
Initial	70	30	–
2.0	50	50	6
3.0	50	50	6
7.0	10	90	6
7.2	70	30	6
8.0	70	30	6

Compounds:

1. AM 2223
2. RCS-4, M10
3. RCS-4, M11
4. AM 1248
5. JWH-073 4-butanoic acid metabolite
6. JWH-073 4-hydroxybutyl metabolite
7. JWH-018 5-pentanoic acid metabolite
8. JWH-073 (+/-) 3-hydroxybutyl metabolite
9. JWH--10 50hydroxypentyl metabolite
10. JWH-018 (+/-) 4-hydroxypentyl metabolite

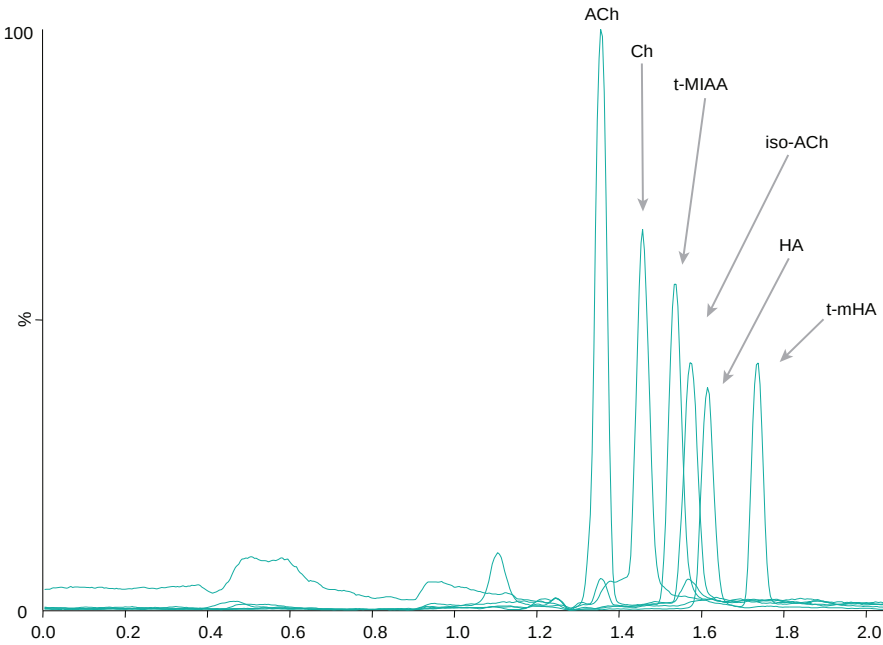
Waters Column Advisor recommends the most appropriate columns for your specific application requirements.

For help with choosing a column, visit **www.waters.com/columnadvisor**

RETENTION OF POLAR ANALYTES WITH CORTECS UPLC HILIC COLUMNS

Hydrophilic-interaction chromatography (HILIC) is a separation mode that can be used to improve the retention of extremely polar analytes. CORTECS UPLC HILIC Columns are unbonded solid-core particles specifically designed for this application. HILIC uses mobile phases with a high concentration of organic solvent which enables effective desolvation of analytes in the MS source, resulting in improved MS response and sensitivity.

Retention and Resolution of Neurotransmitters on CORTECS UPLC HILIC Column



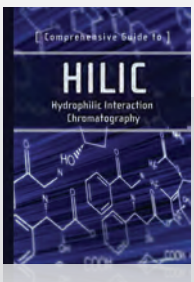
System:	ACQUITY UPLC
Column:	CORTECS UPLC HILIC, 1.6 µm, 2.1 mm x 100 mm (p/n 186007106)
Mobile phase A:	100 mM ammonium formate, pH 3
Mobile phase B:	Acetonitrile

Gradient:

Time (min)	%A	%B	Curve
Initial	10	90	–
0.75	40	60	6
1.00	40	60	6
1.25	70	30	6
1.90	10	90	11

Flow rate:	0.5 mL/min
Column temp.:	45 °C
Sample temp.:	6 °C
Injection volume:	10 µL
Run time:	2.5 min

UPLC-MS/MS analysis of neurotransmitters at 280–1100 pg/mL in artificial cerebrospinal fluid (aCSF) using a CORTECS UPLC HILIC, 1.6 µm, 2.1 x 100 mm Column and a Xevo TQ-S Mass Spectrometer. These compounds are highly polar and will typically be poorly retained in reversed-phase LC.

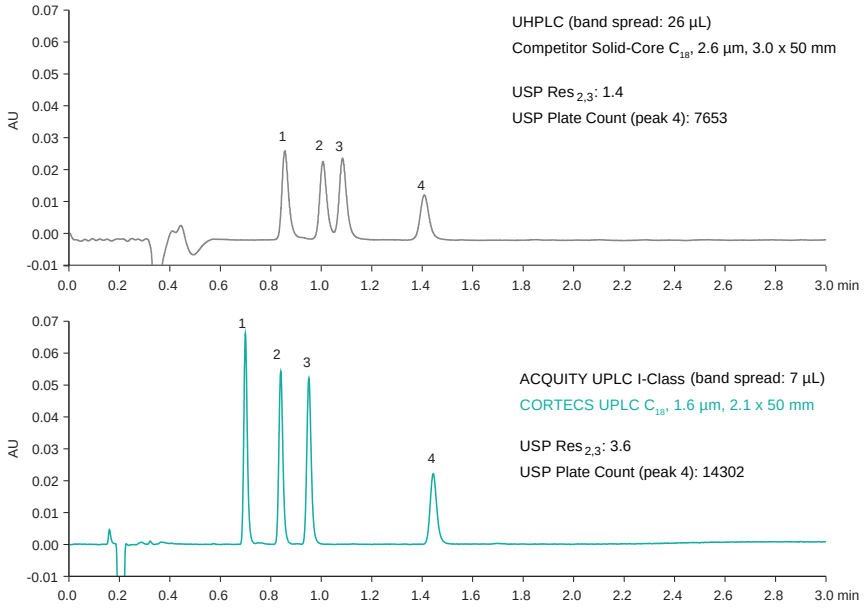


To learn more about Waters Comprehensive Guide to HILIC (Hydrophilic Interaction Chromatography), visit **www.waters.com/HILIC**

MATCHING COLUMN CONFIGURATIONS WITH LC SYSTEMS

Selecting an appropriate column for your system is very important. The dispersion (extra-column band spreading) of the system will have considerable impact on the observed performance of the column, especially for columns of smaller internal diameter. As system dispersion decreases, peaks become narrower and taller and the efficiency of a separation increases. High-efficiency CORTECS Columns can be paired with any LC system, but when paired with an ultra-low dispersion instrument such as the ACQUITY UPLC I-Class Systems, you can experience new levels of performance.

Impact of Particle Size and System Dispersion on Efficiency



System:	ACQUITY UPLC I-Class with ACQUITY PDA;
	Competitor UHPLC
Column:	CORTECS UPLC C_{18}+, 1.6 µm, 2.1 x 50 mm (p/n 186007114)
	Competitor Solid-Core C_{18}, 2.6 µm, 3.0 x 50 mm
Separation mode:	Isocratic
Mobile phase:	55:45 water/acetonitrile with 0.1% formic acid
Flow rate:	0.5 mL/min (1.6 µm, 2.1 x 50 mm)
	0.69 mL/min (2.6 µm, 3.0 x 50 mm)
Injection volume:	1.0 µL (1.6 µm, 2.1 x 50 mm)
	2.0 µL (2.6 µm, 3.0 x 50 mm)
Column temp.:	30 °C
Detection:	UV at 220 nm
Sample concentration:	20 µg/mL

The separation of estradiols on a 2.6 µm competitor solid-core particle column using a UHPLC system with 26 µL system band spread, compared to the same separation on a CORTECS UPLC 1.6 µm Column using an ACQUITY UPLC I-Class System with 7 µL system band spread.

Band Spread Values for Modern Chromatographic Systems and the Recommended Column i.d. for the Best Column Performance

		Column i.d. (mm)	
System	**Band Spread (µL)***	**1st Choice**	**2nd Choice**
HPLC	25–50	4.6	3.0
UHPLC	15–25	3.0	2.1
UPLC	8–15	2.1	3.0

* Determined at flow rate of 0.5 mL/minute using acetonitrile/water (50/50, v/v) as the mobile phase and caffeine (160 µg/mL) (p/n 700002642) as the sample. A 0.5 µL injection was used and the peak was detected at 273 nm using a data rate of 80 Hz or highest available for the system. The peak width was measured at 4.4% of peak height.

VERSATILITY IN SUB-2-µm PARTICLE DESIGN

Scientists are often challenged by the need to analyze mixtures of compounds that vary in their polarity, molecular weight, functionality, and complexity. While screening columns with different ligands is an essential strategy in method development, choosing the particle with the appropriate attributes for the separation is even more crucial. This is why we have added CORTECS Solid-Core Particles to our growing family of innovative particles.

CORTECS SOLID-CORE PARTICLE

- High efficiency
- Increased throughput at similar efficiency*
- Higher performance at same backpressure*
- UPLC to HPLC scalability

** Compared to fully-porous particles*

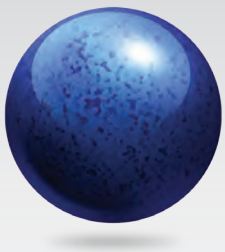
CSH TECHNOLOGY

- Superior peak shape for basic analytes
- Exceptional loading capacity
- UPLC to HPLC scalability

BEH TECHNOLOGY

- Unparalleled pH stability
- Mobile phase and temperature versatility
- UPLC to HPLC scalability

HSS TECHNOLOGY



- Maximum retention
- Enhanced selectivity
- UPLC to HPLC scalability

ORDERING INFORMATION

CORTECS UPLC Columns

Chemistry	Particle Size	Dimension	Part No. 1 Pack	Part No. 3 Pack
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 30 mm	186007113	176003166
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 50 mm	186007114	176003167
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 75 mm	186007115	176003168
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 100 mm	186007116	176003169
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 150 mm	186007117	176003170
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 30 mm	186007118	176003171
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 50 mm	186007119	176003172
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 75 mm	186007120	176003173
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 100 mm	186007121	176003174
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 150 mm	186007122	176003175
CORTECS UPLC C_{18}	1.6 µm	2.1 x 30 mm	186007092	176003146
CORTECS UPLC C_{18}	1.6 µm	2.1 x 50 mm	186007093	176003147
CORTECS UPLC C_{18}	1.6 µm	2.1 x 75 mm	186007094	176003148
CORTECS UPLC C_{18}	1.6 µm	2.1 x 100 mm	186007095	176003149
CORTECS UPLC C_{18}	1.6 µm	2.1 x 150 mm	186007096	176003150
CORTECS UPLC C_{18}	1.6 µm	3.0 x 30 mm	186007097	176003151
CORTECS UPLC C_{18}	1.6 µm	3.0 x 50 mm	186007098	176003152
CORTECS UPLC C_{18}	1.6 µm	3.0 x 75 mm	186007099	176003153
CORTECS UPLC C_{18}	1.6 µm	3.0 x 100 mm	186007100	176003154
CORTECS UPLC C_{18}	1.6 µm	3.0 x 150 mm	186007102	176003155
CORTECS UPLC HILIC	1.6 µm	2.1 x 30 mm	186007103	176003156
CORTECS UPLC HILIC	1.6 µm	2.1 x 50 mm	186007104	176003157
CORTECS UPLC HILIC	1.6 µm	2.1 x 75 mm	186007105	176003158
CORTECS UPLC HILIC	1.6 µm	2.1 x 100 mm	186007106	176003159
CORTECS UPLC HILIC	1.6 µm	2.1 x 150 mm	186007107	176003160
CORTECS UPLC HILIC	1.6 µm	3.0 x 30 mm	186007108	176003161
CORTECS UPLC HILIC	1.6 µm	3.0 x 50 mm	186007109	176003162
CORTECS UPLC HILIC	1.6 µm	3.0 x 75 mm	186007110	176003163
CORTECS UPLC HILIC	1.6 µm	3.0 x 100 mm	186007111	176003164
CORTECS UPLC HILIC	1.6 µm	3.0 x 150 mm	186007112	176003165

CORTECS UPLC Columns Method Validation Kits (MVK)*

Chemistry	Particle Size	Dimension	Part No.
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 30 mm	186007176
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 50 mm	186007177
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 75 mm	186007178
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 100 mm	186007179
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 150 mm	186007180
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 30 mm	186007181
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 50 mm	186007182
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 75 mm	186007183
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 100 mm	186007184
CORTECS UPLC C_{18}+	1.6 µm	3.0 x 150 mm	186007185
CORTECS UPLC C_{18}	1.6 µm	2.1 x 30 mm	186007156
CORTECS UPLC C_{18}	1.6 µm	2.1 x 50 mm	186007157
CORTECS UPLC C_{18}	1.6 µm	2.1 x 75 mm	186007158
CORTECS UPLC C_{18}	1.6 µm	2.1 x 100 mm	186007159
CORTECS UPLC C_{18}	1.6 µm	2.1 x 150 mm	186007160
CORTECS UPLC C_{18}	1.6 µm	3.0 x 30 mm	186007161
CORTECS UPLC C_{18}	1.6 µm	3.0 x 50 mm	186007162
CORTECS UPLC C_{18}	1.6 µm	3.0 x 75 mm	186007163
CORTECS UPLC C_{18}	1.6 µm	3.0 x 100 mm	186007164
CORTECS UPLC C_{18}	1.6 µm	3.0 x 150 mm	186007165
CORTECS UPLC HILIC	1.6 µm	2.1 x 30 mm	186007166
CORTECS UPLC HILIC	1.6 µm	2.1 x 50 mm	186007167
CORTECS UPLC HILIC	1.6 µm	2.1 x 75 mm	186007168
CORTECS UPLC HILIC	1.6 µm	2.1 x 100 mm	186007169
CORTECS UPLC HILIC	1.6 µm	2.1 x 150 mm	186007170
CORTECS UPLC HILIC	1.6 µm	3.0 x 30 mm	186007171
CORTECS UPLC HILIC	1.6 µm	3.0 x 50 mm	186007172
CORTECS UPLC HILIC	1.6 µm	3.0 x 75 mm	186007173
CORTECS UPLC HILIC	1.6 µm	3.0 x 100 mm	186007174
CORTECS UPLC HILIC	1.6 µm	3.0 x 150 mm	186007175

*Each kit contains three columns from three batches of material.

VanGuard Pre-Columns (Guard Columns) 3 Pack

Chemistry	Particle Size	Dimension	Part No.
CORTECS UPLC C_{18}+	1.6 µm	2.1 x 5 mm	186007125
CORTECS UPLC C_{18}	1.6 µm	2.1 x 5 mm	186007123
CORTECS UPLC HILIC	1.6 µm	2.1 x 5 mm	186007124

Quality Control Reference Materials (QCRM)

Description	Part No.
Reversed-Phase QCRM	186006363
Neutrals QCRM	186006360
HILIC QCRM	186007226
QDa QCRM	186007345
LCMS QCRM	186006963

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