

# Core-Shell Technology for Improved LC Drug Screening



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# Requirements of Clinical Analysis

## 1. Speed

- Reduce labor/resource requirements and costs
- Increase sample throughput

## 2. Sensitivity

- Lower LOD and LOQ
- Smaller sample volumes
- Reduce solvent consumption

## 3. Accuracy and Precision

- Improve profitability
- Faster turn around time
- Delivery of accurate and precise data

## Factors that Improve Resolution

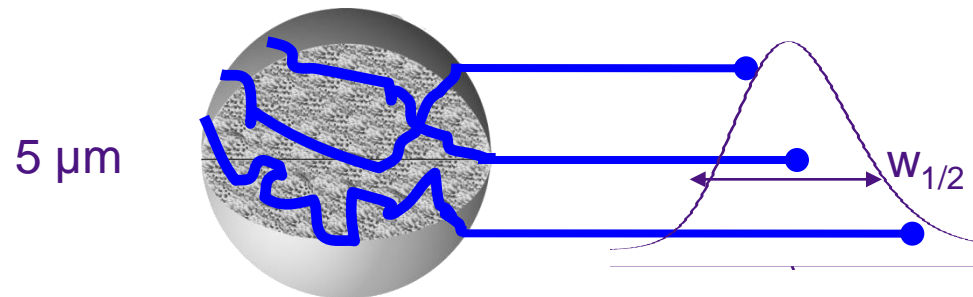
$$R = \frac{\text{Efficiency } \sqrt{N}}{4} \quad \frac{\text{Retention } k}{k + 1} \quad \frac{\text{Selectivity } \alpha - 1}{\alpha}$$

**Efficiency (N) = Particle size/-morphology, column length**

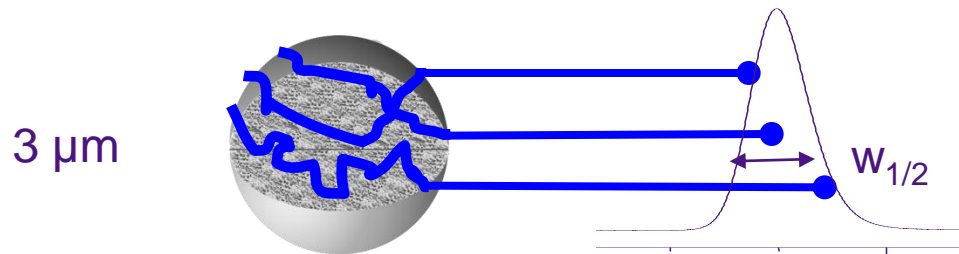
**Retention (k) = Mobile phase, stationary phase**

**Selectivity ( $\alpha$ ) = Stationary phase, mobile phase**

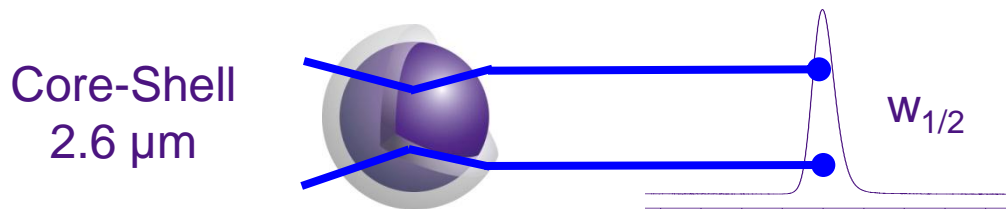
## Particle Size and Efficiency



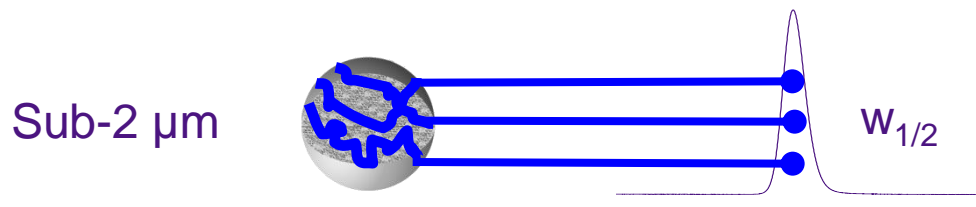
**N = ~100,000 plates/m**  
**Relative BP = 1**



**N = ~150,000 plates/m**  
**Relative BP = 2x**



**N = ~300,000 plates/m**  
**Relative BP ~ 3x**



**N = ~300,000 plates/m**  
**Relative BP > 5x**

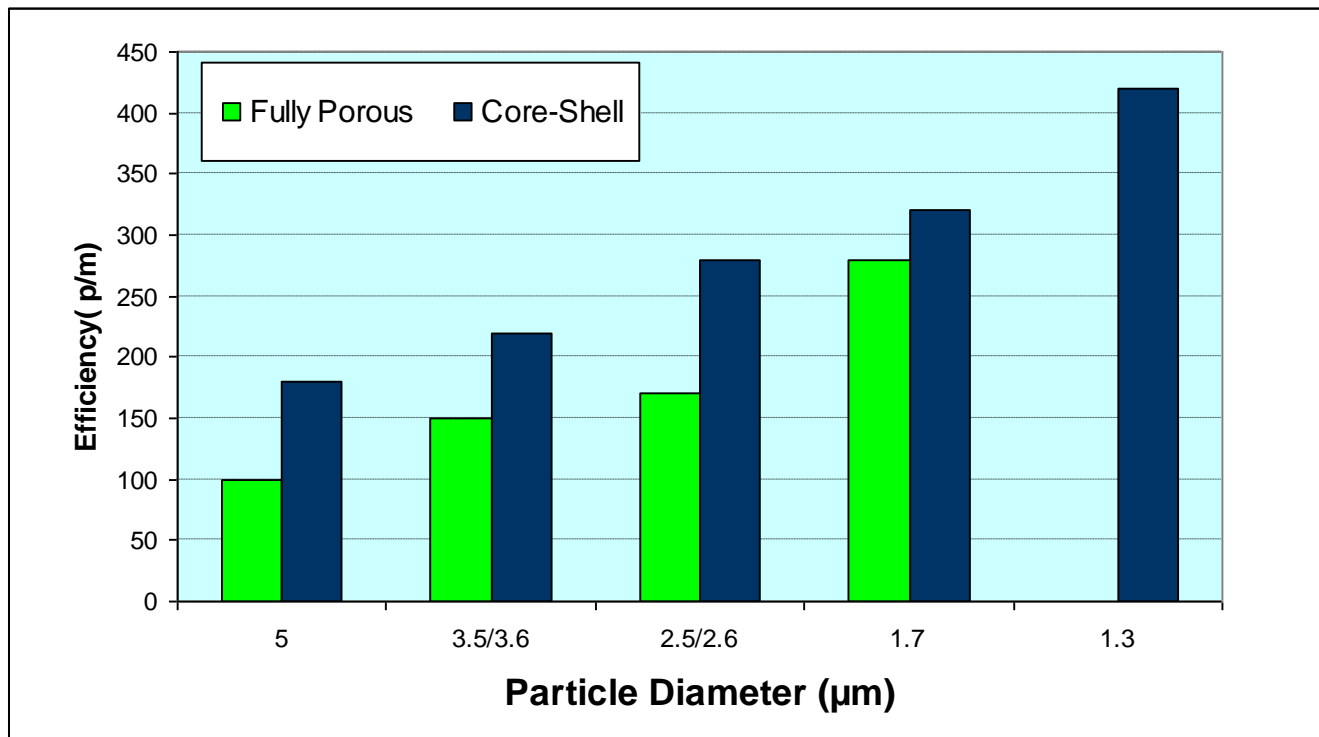
# Optimizing Column Length + Particle size

Column Length (mm)	Efficiency dp 5 $\mu$ m	Efficiency dp 3 $\mu$ m	Efficiency sub-2 $\mu$ m / Core-shell	%Reduction in Analysis Time
250	25,000	37,500		
150	15,000	22,500	45,000	33
100	10,000	15,000	30,000	60
50	5,000	7,500	15,000	80

- Use shorter columns packed with smaller particles to reduce analysis time while maintaining/improving efficiency!!

## Core-Shell Particles

***Columns packed with core-shell particles will deliver significantly higher efficiency (N) than columns packed with fully-porous particles of the same diameter.\****

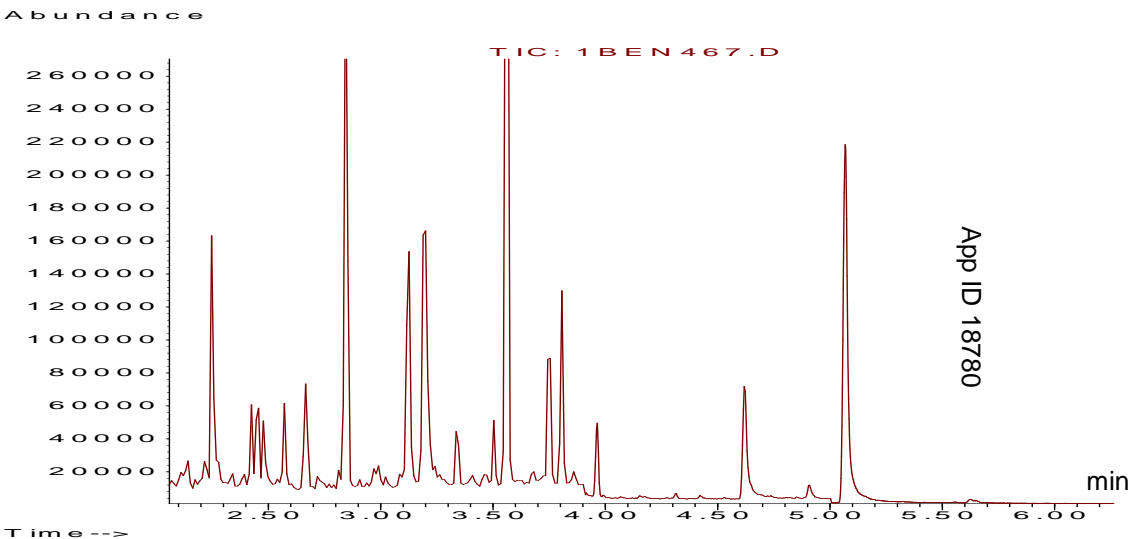


# Speed: GC/MS vs. LC/MS

**GC Drug-1**  
**10 m x 0.18 mm x 0.18  $\mu$ m**

## Benzodiazepines

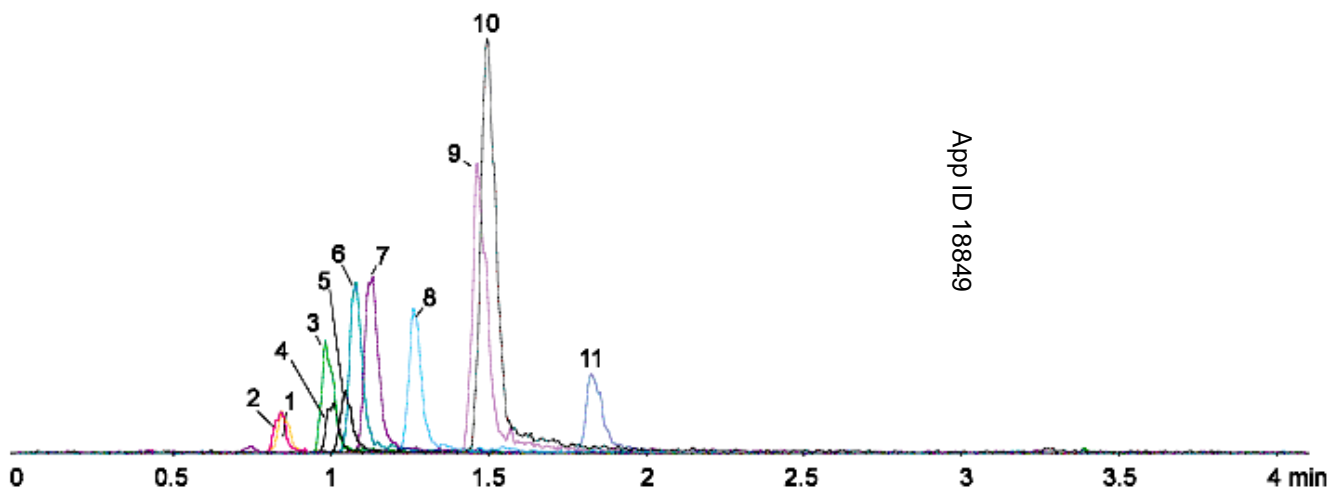
1. alpha-Hydroxyalprazolam
2. D5-alpha-Hydroxyalprazolam
3. D5-Oxazepam
4. Oxazepam
5. D5-Nordiazepam
6. Nordiazepam
7. Lorazepam
8. Clonazepam
9. D5-Temazepam
10. Temazepam
11. Diazepam



**More than 5 minutes on GC, plus time to derivatize!**

## Speed: GC/MS vs. LC/MS

Core-Shell 2.6  $\mu\text{m}$  C18  
50 x 2.1 mm



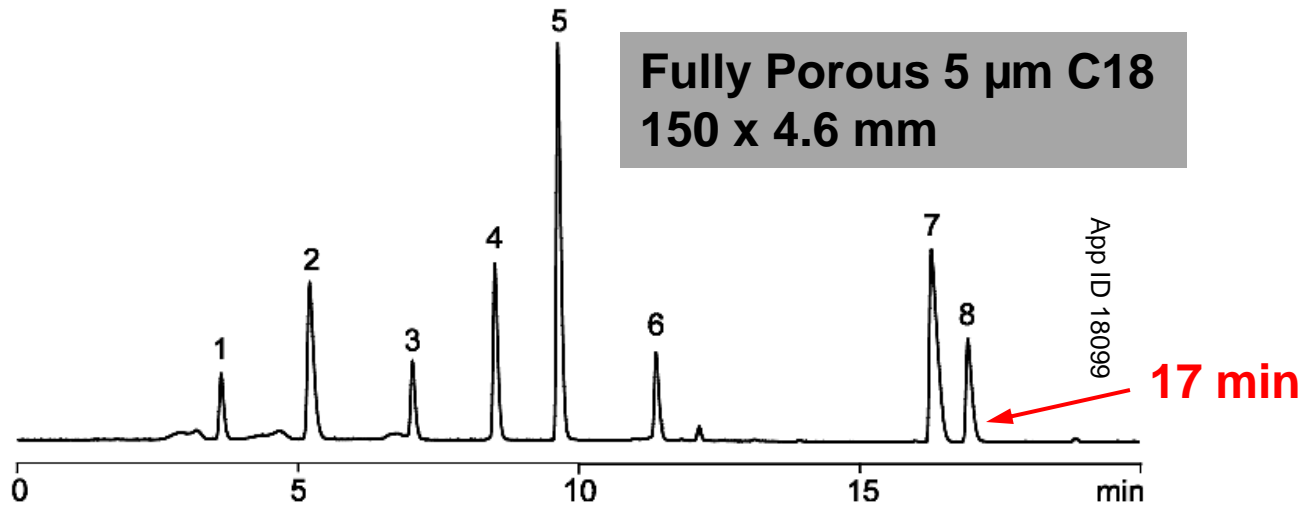
### Benzodiazepines

1. alpha-Hydroxyalprazolam
2. D5-alpha-Hydroxyalprazolam
3. D5-Oxazepam
4. Oxazepam
5. D5-Nordiazepam
6. Nordiazepam
7. Lorazepam
8. Clonazepam
9. D5-Temazepam
10. Temazepam
11. Diazepam

**Complete analysis in less than 2 minutes and without derivatizing!**

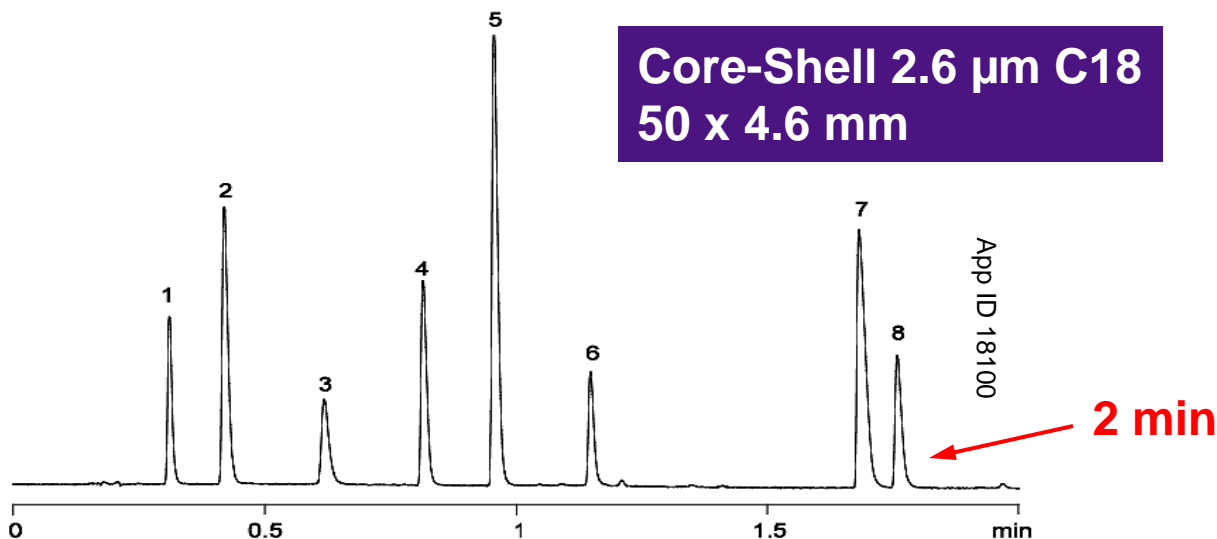


# Speed: LC Comparison



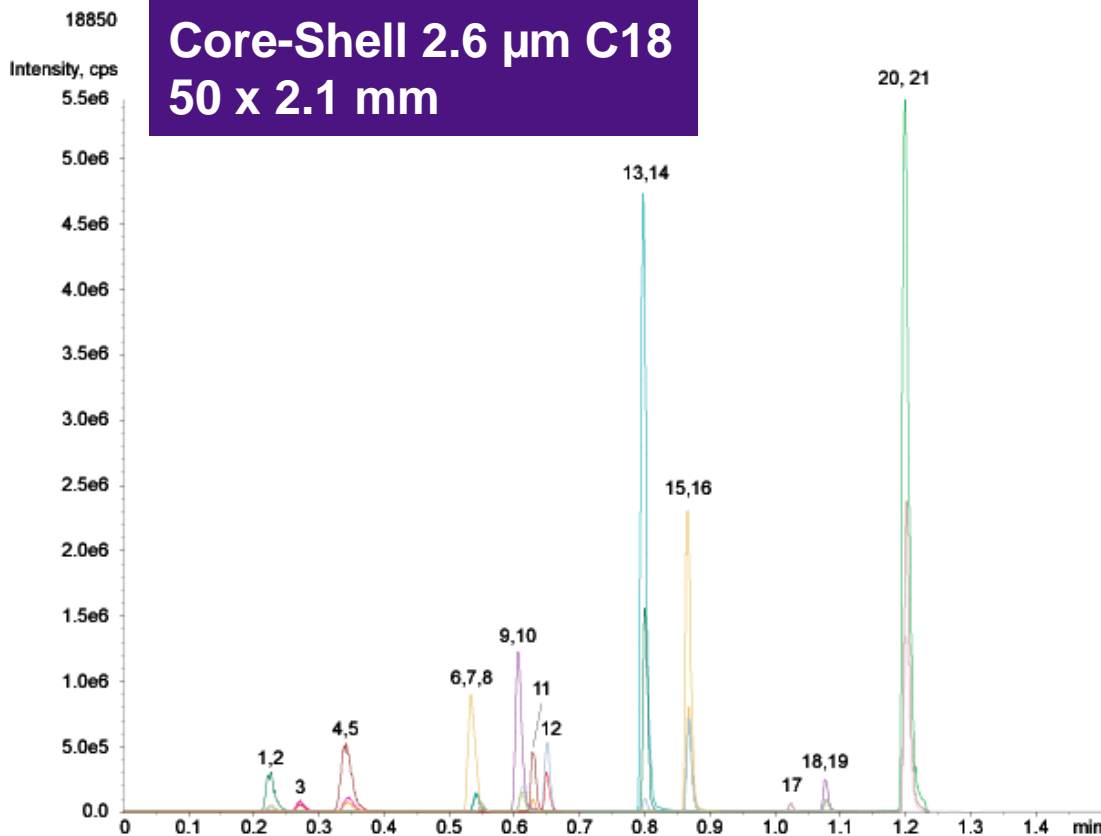
## Extracted Narcotics

1. Normorphine
2. Morphine
3. Hydromorphone
4. Norcodeine
5. Codeine
6. Hydrocodone
7. Cocaine
8. Norcocaine



Pressure < 400bar

# Speed and Sensitivity



< 1.5 minutes run time; 1.2mL/min 500bar

50ng/mL each

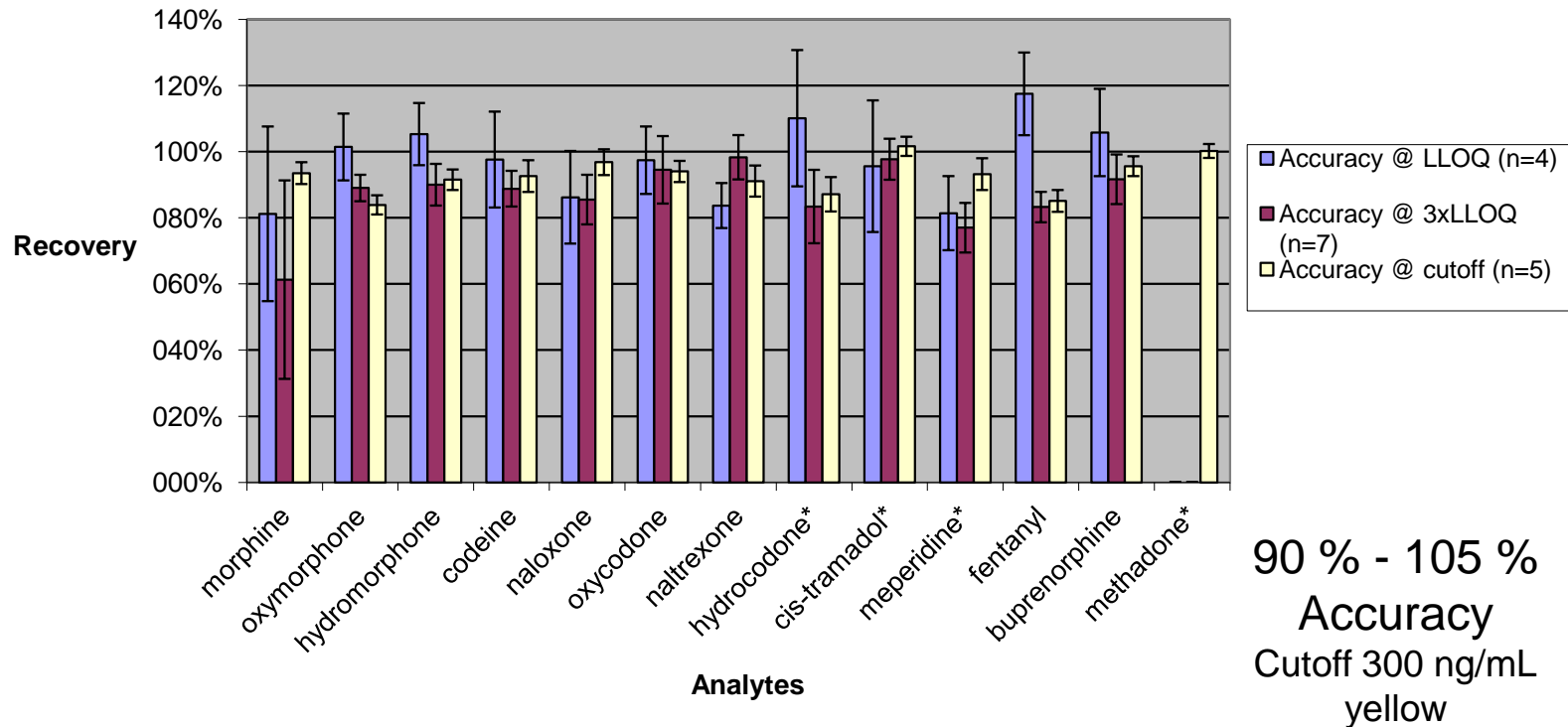
\* diluted

## Case Study: Pain Panel

1. Morphine
2. D3-Morphine
3. Oxymorphone
4. Hydromorphone
5. D6-Hydromorphone
6. Codeine
7. D6-Codeine
8. Naloxone
9. Oxycodone
10. D6-Oxycodone
11. Naltrexone
12. Hydrocodone
13. Cis-Tramadol
14. Cis-C13-D3-Tramadol
15. Meperidine
16. D4-Meperidine
17. Fentanyl \*
18. Buprenorphine
19. D4-Buprenorphine
20. Methadone \*
21. D3-Methadone

## Accuracy and Precision

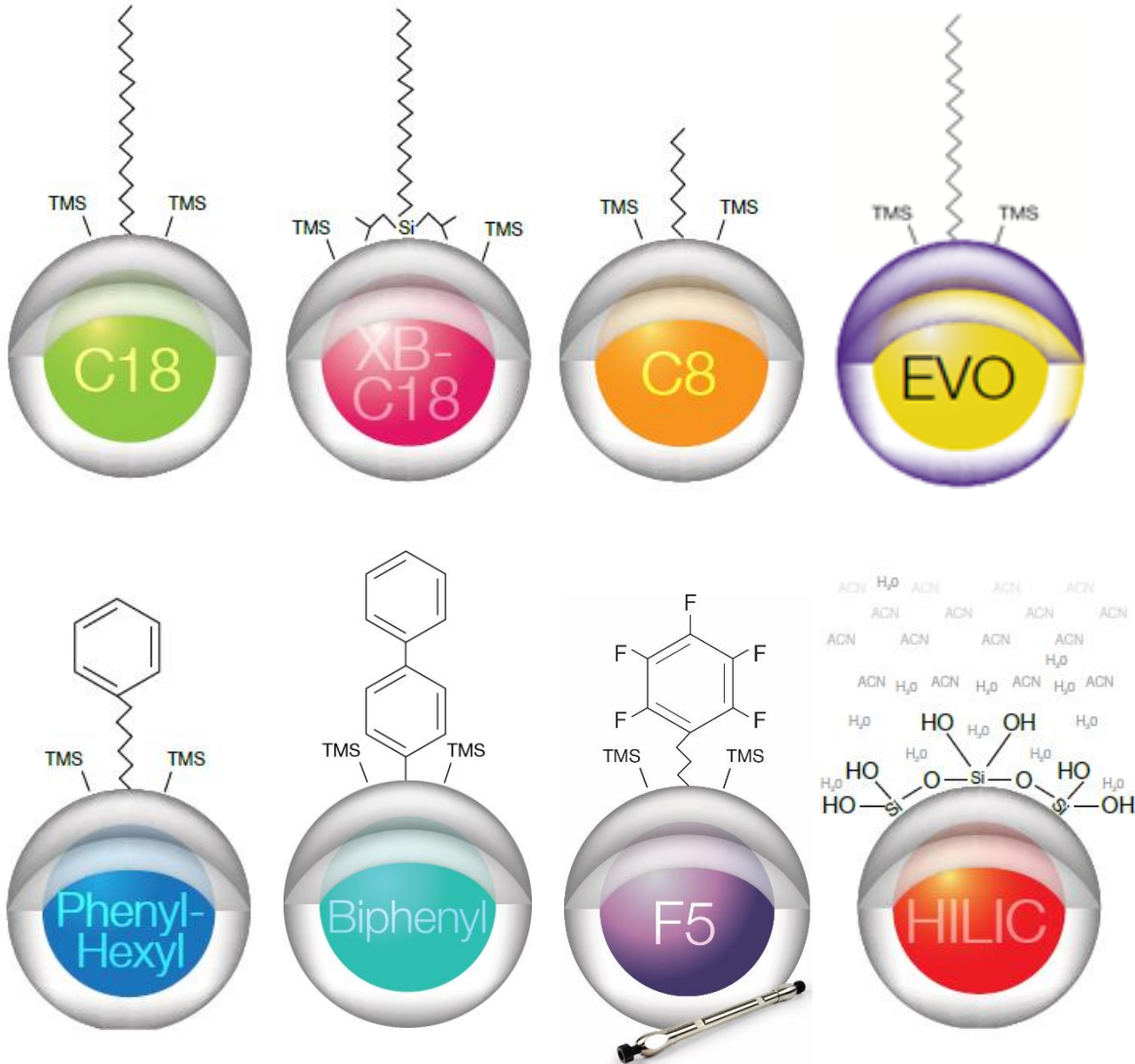
**Pain Panel on Kinetex Core Shell Technology:  
Accuracy and Reproducibility**



≤ 15 % bias 100 ng/mL (ppb) red

≤ 20 % bias 30 ng/mL (ppb) blue

## Functional Ligands



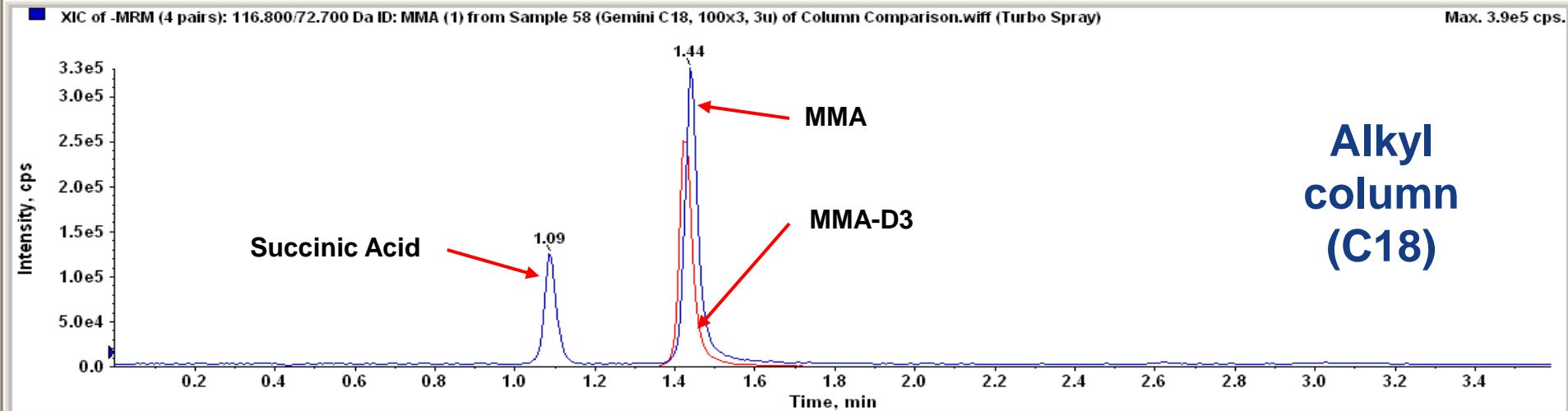
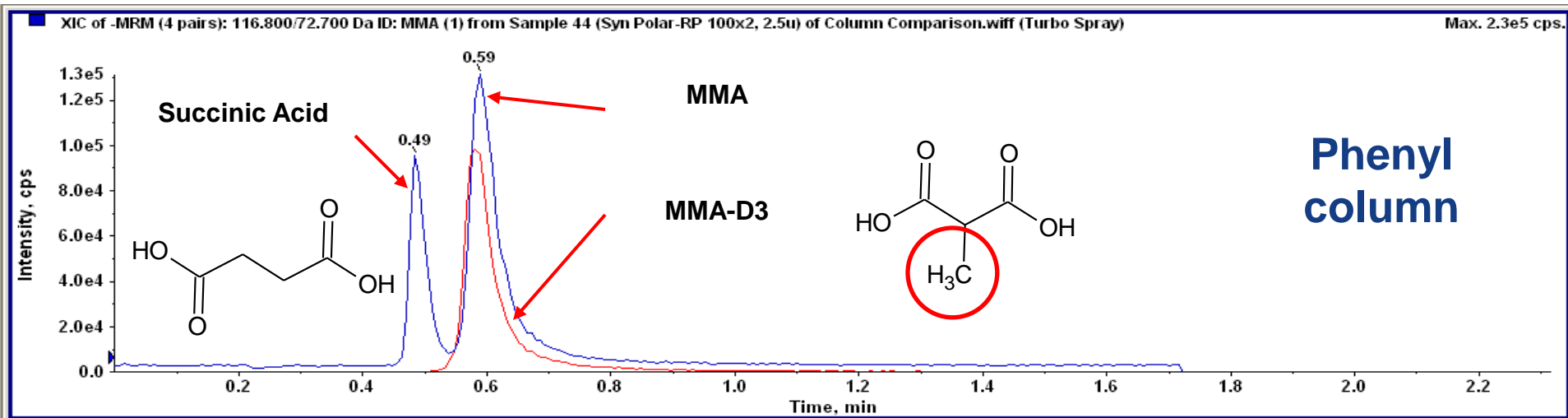
### Alkyl phases

- Hydrophobicity
- Inertness
- pH stability

### Polar phases

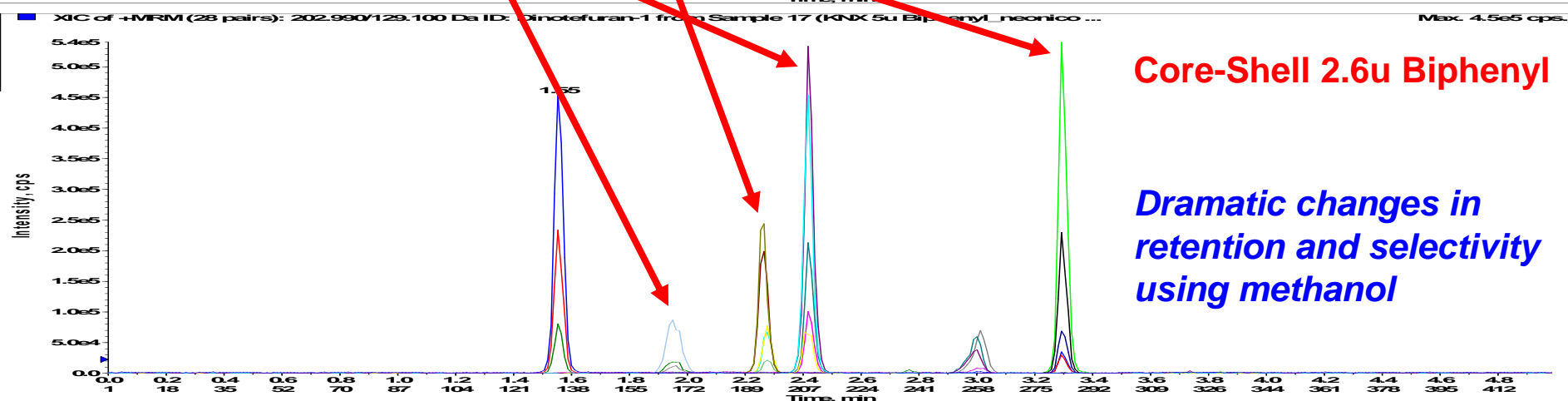
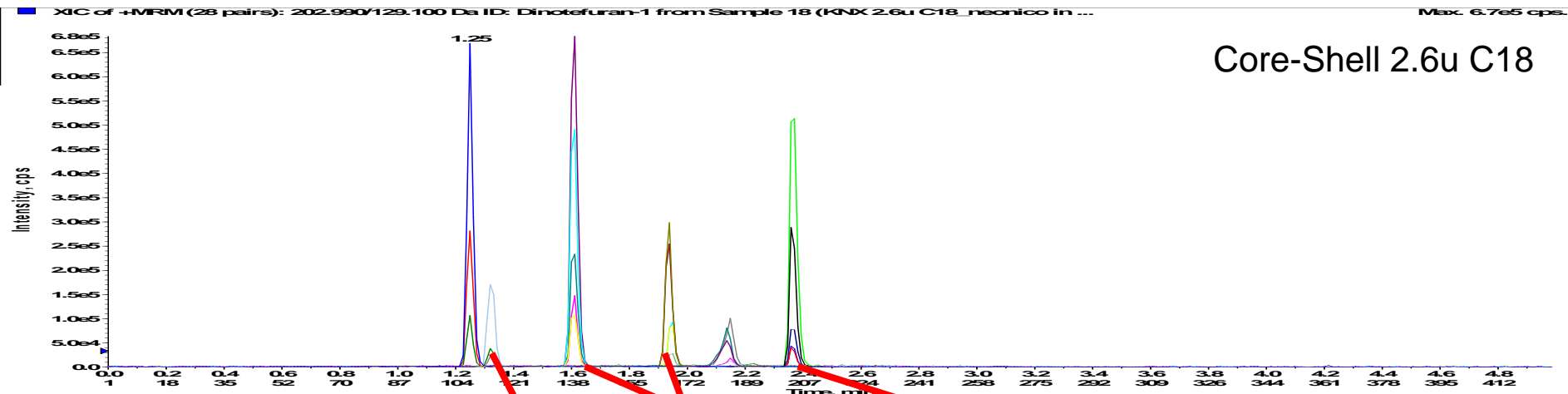
- orthogonal selectivity
- Polar Retention
- Often 100 % aqueous stability

## Hydrophobic Selectivity: MMA



## Phenyl Selectivity: Steroide

Neonicotinoids using **Methanol:**



Application Guide

## CLINICAL RESEARCH



- Complete solutions for vitamins, steroids, hormones, pain management drugs, therapeutic drug monitoring, and more
- Simplified, rapid cleanup procedures
- Accurate, reproducible results

- Application guide for clinical research
- Complete solution incl. HPLC + MS/MS-conditions and sample preparation

**Thank You!**

**Questions?**