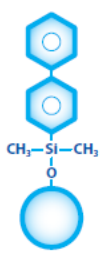
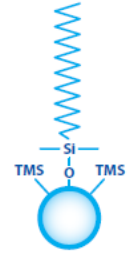
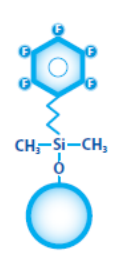




Restek's Force<sup>TM</sup> LC Column line is our new premium Liquid Chromatography product developed under our current new product procedures to ensure the highest quality and best performance in terms of lifetime, selectivity, and reproducibility. The product family consists of 3 particle sizes (1.8, 3, and 5µm) for scalability from UHPLC to HPLC. Some of the main targets for this line is penetration into sectors like Pharmaceutical, Food Safety, and Emerging Environmental where UHPLC (primarily Waters) dominates. Force surpasses our current Fully Porous Particle columns like the Pinnacle DB line in terms of the performance and reproducibility that are needed for today's markets.

Force<sup>TM</sup> is available in 3 phases: C18, Biphenyl, and FluoroPhenyl (also called PFPP or F5). The phase characteristics table and product dimension grid are shown below.

	<b>Biphenyl</b>	<b>C18</b>	<b>FluoroPhenyl</b>
			
<b>USP Phase Code</b>	L11	L1	L43
<b>Stationary Phase Category</b>	Phenyl	C18, octadecylsilane	Pentafluorophenyl propyl
<b>Ligand Type</b>	Biphenyl	End-capped C18	Fluorophenyl
<b>Particle Size</b>	1.8 µm, 3 µm, or 5 µm fully porous	1.8 µm, 3 µm, or 5 µm fully porous	1.8 µm, 3 µm, or 5 µm fully porous
<b>Pore Size</b>	100 Å	100 Å	100 Å
<b>Surface Area</b>	300 m <sup>2</sup> /g	300 m <sup>2</sup> /g	300 m <sup>2</sup> /g
<b>Carbon Load</b>	15%	20%	10%
<b>End-Cap</b>	yes	yes	no
<b>pH Range</b>	2.0 to 8.0	2.0 to 8.0	2.0 to 8.0
<b>Maximum Temperature</b>	80 °C	80 °C	80 °C

For 1.8µm column, the Ultrashield filter is recommended instead of a packed guard column. UHPLC users want short run times with limited extra-column volume. The Ultrashield adds less than 1µL of dead volume before the column. Additionally, customers using UHPLC and sub-2µm columns are already aware of the importance of sample prep, so they are likely to have done steps such as SPE, filtration, or centrifugation before injecting samples.

The 3 and 5µm columns use EXP guard cartridges and holders similar to Raptor. All guards are 5mm long and packed with 5µm silica.

Force Column Sizes				
<b>1.8 <math>\mu\text{m}</math></b>	30mm	50mm	100mm	
2.1mm	X	X	X	
3.0mm		X	X	
<b>3 <math>\mu\text{m}</math></b>	30mm	50mm	100mm	150mm
2.1mm	X	X	X	X
3.0mm		X	X	X
4.6mm			X	X
<b>5 <math>\mu\text{m}</math></b>	50mm	100mm	150mm	250mm
2.1mm	X	X	X	
3.0mm	X	X	X	
4.6mm		X	X	X

Force Guard Sizes		
<b>5 <math>\mu\text{m}</math></b>	5mm	Uses EXP Holder
2.1mm	X	
3.0mm	X	
4.6mm	X	

#### Some Frequently Asked Questions (FAQ)s:

- **Is Force™ going to replace the Pinnacle DB line?** Eventually, yes. We will promote and establish Force™ and then diminish Pinnacle DB. **If so, is Pinnacle DB going to be discontinued?** Pinnacle DB 1.9 $\mu\text{m}$  does not sell very well in any market. However, we have some high-volume customers who use Pinnacle DB products for specific assays and we will continue to provide this product to them as long as we can. These big customers are, however, transitioning to newer products like Raptor™. For any customers developing new methods using UHPLC, please promote Force™ 1.8 $\mu\text{m}$  columns.
- **What are the advantages of Force™ over the Pinnacle DB?** The new Force™ line is built on a high purity Type B silica that we source under contract. It is considerably more uniform in shape and dimension than Pinnacle DB making it easier and more consistent to pack and provides a higher degree of reproducibility. The phase chemistries that we perfected through the Raptor™ development are being applied to these products as well.
- **What are the advantages of Force™ over the competition?** We have found that the level of reproducibility and quality that we put into our Raptor™ product surpasses most of our competition. We are applying those same levels to Force™ and trust that its performance will also surpass the competition. True to form, we are focusing on selectivity and will have the only UHPLC fully porous Biphenyl on the market, as well as the most reproducible fully porous FluoroPhenyl phase.

- **What is the pressure limit of the different Force™ columns?** There is not a pressure limit specified for any particle size. The brochure and sales sheet show a graph of lifetime testing of the 1.8µm Force™ C18 with 1000 injections at 12,000 psi and less than 10% change in efficiency. The silica itself is mechanically stable at higher pressures, but we cannot guarantee lifetime/longevity performance at pressures above our test protocol. Several other factors are also involved: the UHPLC instrument and tubing dimensions, sample prep, mobile phase and buffer additives, temperature, etc.
- **Can I call it “The Force”?** No, please do not, Disney (Lucas Film) would not appreciate that.
- **What are the targeted markets?** Life, Food, Environmental. In the Life market for Pharmaceutical customers, the targeted users are those doing method development work on UHPLC systems who then transfer methods to other parts of the facility with 400 bar HPLC instrumentation.

Other targets are any customers who are upgrading their 400 bar instruments like Shimadzu VP Series or Prominence to Nexera, Agilent 1100 or 1200 to 1290, or Waters Alliance to Acquity. The reasons are to obtain shorter run times, and to reduce solvent consumption and waste disposal costs.

You can also approach customers currently using Pinnacle DB 1.9µm (especially PFPP) and offer Force™ 1.8µm FluoroPhenyl as a replacement. The more uniform particle shape, modern packing techniques, and column to column / lot to lot reproducibility is a marked improvement over Pinnacle DB 1.9µm.

- **What is the intended pricing vs. Pinnacle DB?** It will be somewhat higher: \$100 or more depending on the dimensions.
- **Who are the current competitors to Force™?**
  - Phenomenex: Luna Omega (1.8µm) and Luna (3 and 5µm)
    - 100Å pore size, 440 m<sup>2</sup>/g surface area (260 for Omega)
    - Omega 1.8µm is only available in C18 and C18 Polar
  - Waters: Acquity HSS (1.8µm) and Symmetry (3 and 5µm)
    - 100Å pore size, 335 m<sup>2</sup>/g surface area (230 for HSS)
    - HSS matches Force™ with C18 and PFP/FluoroPhenyl only
  - Thermo: Hypersil Gold 1.9, 3, and 5µm
    - 175Å pore size, 220 m<sup>2</sup>/g surface area (all sizes)
    - Hypersil Gold matches Force™ with C18 and PFP only
  - Agilent: ZORBAX Eclipse Plus 1.8, 3.5, and 5µm
    - 95Å pore size, 160 m<sup>2</sup>/g surface area (all sizes)
    - Eclipse Plus matches Force™ with C18 only

NOTE that we are the only manufacturer who offers C18, Biphenyl, and FluoroPhenyl in a fully porous, sub-2µm particle. This greater selection of phase chemistries is important for customers doing method development work with UHPLC.

- **Is there any other information?** In an article that was recently published in the Annual Industry Trends issue of LCGC magazine it was stated in the featured article, “Real-World Chromatography Applications: Current Trends in Cannabis, Environmental, Food, Pharmaceutical, and BioPharmaceutical Analysis,” that method transfer between HPLC and UHPLC (and vice versa) are stressing the need for columns of different particle sizes with “exact bonded phase chemistry.” Also, there is a need for similar UHPLC column dimensions “packed with “orthogonal” phases of different selectivity” for method development screening. And finally, that UHPLC is the “modern standard platform in HPLC” and “In a few years, all HPLC will be some kind of UHPLC.” Granted this is one opinion, but a published opinion from a Subject Matter Expert in small molecule drug development and CMC testing.
- Apply FORCE to your LC methods.
- If you are having trouble resolving the components in your complex analytical mixtures, add a little FORCE to your chromatographic system.
- FORCE isobars apart with the most reproducible FluoroPhenyl phase on the market.
- FORCE your LC-MS/MS selectivity with the best fully porous UHPLC Biphenyl, FluoroPhenyl, and C18 on the market today.
- FORCE is the scalable solution for predictable method transfer.
- FORCE is packed with performance on any HPLC or UHPLC system.

(Spec)

$$\text{FORCE} = \text{Mass} \wedge \text{x Acceleration}$$