



# Pioneer and Pioneer FE Systems

Get One Step Ahead in  
Biological Characterization  
and Fragment Screening

Simplifying Progress

**SARTORIUS**



# High-Performance Binding Kinetics and Fragment Screening Analysis

Pioneer and Pioneer FE systems provide high quality kinetics and affinity measurements from a single injection in a matter of minutes. Using surface plasmon resonance (SPR) technology, they rapidly characterize a wide variety of biomolecular interactions, from small molecule fragments to biologics, without compromising sensitivity. Pioneer systems provide rapid kinetics and affinity data directly from primary screens, significantly reducing the time and cost associated with secondary screening while enabling the prompt identification of lead candidates.

## Make Decisions Earlier

- OneStep® gradient injections can determine accurate kinetics ( $k_a$ ,  $k_d$ ) and affinity ( $K_D$ ) data directly from primary screens
- Perform kinetic screening of 768 small molecule fragments in a single experiment in 24 hours
- Obtain detailed, high-quality kinetic characterization of 64 samples in 29 hours
- Exquisite sensitivity with minimal baseline noise and drift for high affinity binding pairs
- Integrated, industry-proven data analysis software based on Scrubber and Clamp platforms
- Completely automated for 72 hours of unattended run time

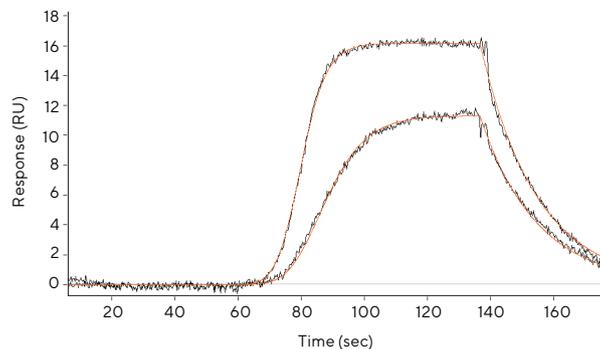


Figure 1: Kinetic analysis of a molecular interaction using OneStep® Injections using two different analyte concentrations.

## New Gold Standard in Fragment Screening

There are many technical challenges in fragment screening that primarily stem from the need to analyze a large number of low molecular weight compounds (< 300 Da). Furthermore, the affinities of these interactions can range between 10  $\mu$ M to 10 mM and analysis of these fragments at concentrations above  $K_D$  becomes a challenge due to poor solubility of these compounds in aqueous buffers. Additionally, in traditional single concentration primary screens, decisions have to be made on small square shaped response curves where kinetics are poorly defined.

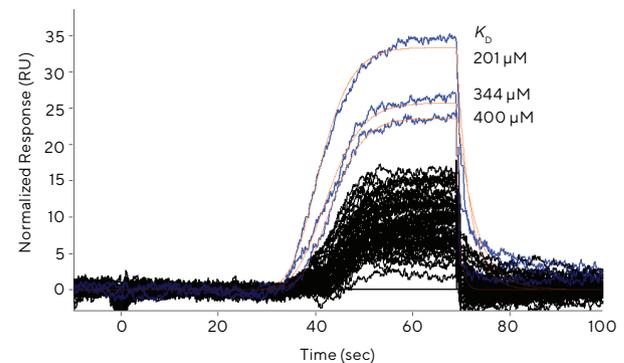


Figure 2: Fragment screen using OneStep®. Hits (blue) are shown analyzed (model fit in orange) with the real-time isotherm affinity model.

The Pioneer FE system changes the fragment based drug discovery paradigm with OneStep® Injection technology where a single analyte injection is sufficient to measure kinetic and affinity values accurately. In contrast to traditional SPR assays, OneStep® provides better resolved kinetic traces compared to traditional square-shaped traces. This is due to the unique ability of OneStep® to generate a continuous concentration gradient of 3 orders of magnitude from a single analyte injection (Figure 2). Therefore, OneStep® screening can derive kinetics and affinities from single concentration primary screens, eliminating the need for a secondary characterization screen providing significant time savings (Figure 3).

### Conventional workflow



### OneStep® workflow



Figure 3: Top) Conventional fragment screening workflow. An initial screening process is followed by a secondary screening process where samples have to be prepared at different concentrations and analyzed separately to allow for affinity characterization and fragment hit confirmation. Bottom) Optimized workflow using OneStep® and NeXtStep™. Initial compound screening is followed by a specificity test analysis that leads to full characterization of the identified hits. The selected compounds can then be used in various applications in medicinal chemistry.

### NeXtStep™ Competition Assays

Competition assays are very useful in drug discovery, yielding the ability to find active site binders directly by competing fragment hits with a control molecule. NeXtStep™ Injection technology has the unique ability to determine full kinetics and affinity in the presence of a competitor from a single analyte concentration injection. This allows site-specific competition to be clearly seen as a modulation of binding in the presence of the competitor molecule.

### Rapid Data Analysis

Data analysis of SPR-based fragment screens can be cumbersome and require days of an analyst's time for a single plate screen. Qdat analysis software uses a unified approach for selection of hits from non-hits and allows normalizing of screening data across different days and instruments, so an entire screen campaign can be compared rapidly. This integration results in a major reduction in post-processing time, from hours|days to seconds|minutes. The software provides models incorporating kinetics, mass transport corrections, and multi-site binding as required to fit the interaction. Primary screening data are ready for  $K_D$  analysis without having to perform laborious, time consuming, and potentially error-prone secondary screening.

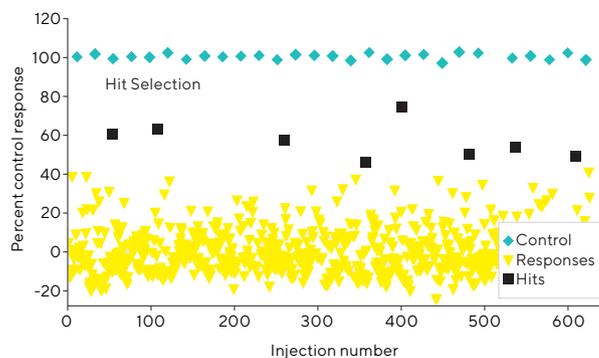


Figure 4: Qdat software has an integrated hit selection tool for automatic identification of hits from screening data (Pioneer FE only). Hits identified in the selection process are then analyzed for kinetics and affinity.

### OneStep® Injection Advantage

In conventional SPR analysis, a standard multi-cycle kinetics (MCK) assay provides a flow of different analyte concentrations. Pioneer systems use OneStep® Injection technology to diffuse the analyte solution into a moving stream of buffer to create a concentration gradient during the injection. With this dynamic approach, an analyte titration of 3 orders of magnitude can be recorded in one continuous injection. This eliminates the need to prepare a full dilution series required with traditional MCK assays. It also changes the paradigm for fragment screening as kinetics and affinity analysis can be performed on primary screening data. Additionally, diffusion coefficients of analyte molecules can be estimated, allowing aggregation information about the molecules being tested to be collected.

### Protein-Small Molecule Interactions

Interactions between proteins and small molecules are at the center of academic and drug development research. The exquisite sensitivity of the Pioneer systems coupled with novel surface chemistries allow kinetics measurements on molecules as small as 70 Da. Quantitative data at this level enables researchers to gain more information about new drug candidates.

### Antibody Characterization and Aggregation

The Pioneer platform's superior sensitivity with baseline noise at  $<0.035$  RU (Pioneer FE) and minimal drift enable calculation of reliable kinetic and affinity values for high affinity binders. As the biopharmaceutical industry moves towards generating very high affinity molecules, Pioneer systems provide an indispensable solution with the ability to differentiate between molecules with very slow off-rates down to  $10^{-6}$  s<sup>-1</sup>.

Characterizing the kinetics, affinity and aggregation profile of antibody interactions is of great importance in application areas such as biotherapeutic discovery, development and quality control. OneStep® Injections can simultaneously detect both antibody aggregation and perform full kinetics and affinity characterization in a single standard experiment. As the analyte concentration gradient is generated with OneStep®, analyte diffusion coefficients can be calculated which provides a rapid and reliable assessment of aggregation formation. There is a high correlation relationship between diffusion coefficients derived from OneStep® Injections versus aggregate composition as determined by SEC from the same sample. This novel capability of OneStep® Injection technology can directly impact many applications in drug development by allowing process optimization previously not possible.



## Key Features

- Automatic analyte titration over 3 orders of magnitude
- Association ( $k_a$ ), dissociation ( $k_d$ ) and affinity ( $K_D$ ) from single gradient injections
- Two 384-well microplates for samples
- Three sensing channels
- Real time reference curve subtraction
- High mass transport
- Detection down to 70 Da
- Wide variety of surface chemistries
- Sophisticated, easy-to-use data analysis software

## Pioneer FE Specifications

Refractive index range	1.33-1.40
Short term noise	< 0.035 RU
Long term noise	< 0.3 RU/min
Molecular weight cutoff	No lower limit for organic molecules
Working ranges	$k_a$ $10^2 - 10^9$ M <sup>-1</sup> s <sup>-1</sup> $k_d$ $10^{-6} - 2.5$ s <sup>-1</sup> $K_D$ $\sim 10^{-3} - 10^{-12}$ M Concentration $\sim 10^{-3} - 10^{-12}$ M
Sample capacity	2 sample racks, 2 reagent racks
Sample configuration	96 vial, deep well and PCR formats, 384-well microplates, custom high volume
Sample temperature control	4 to 40°C (max 15° below ambient)
Sample loading	Automatic
Number of channels	3
Flow path	1, 1-2, 1-2-3, 3, 3-2, 3-2-1
Flow channel volume	< 90 nL
Channel-channel dead volume	< 20 nL
Real time reference curve subtraction	Yes
Injection volume	2-700 $\mu$ L
Injection rise and fall time	< 0.75 second @ 25 $\mu$ L/min
Simultaneous injections	Yes, dual sample loops
Gradient injections	Yes, OneStep®, NeXtStep™
OneStep® Injections in high throughput mode	Yes
Flow rate	0.1-200 $\mu$ L/min
Inline buffer degassing	Yes
System temperature control	4-40°C (Max 15° below ambient)
Variable data rate	1-40 Hz
Automation capabilities	> 72 hour unattended operation
Qdat hit selection feature	Yes

## Sensor Chip Chemistries

Immobilization by amine coupling	COOH1, CDH, CDL, PCH
Streptavidin-biotin based immobilization	SADH
Affinity capture surface for histidine-tagged proteins	HisCap

## Pioneer Specifications

Refractive index range	1.33-1.40
Short term noise	< 0.1 RU
Long term noise	< 0.3 RU
Molecular weight detection	No lower limit for organic molecules
Working ranges	$k_a$ $10^2 - 10^8$ M <sup>-1</sup> s <sup>-1</sup> $k_d$ $10^{-6} - 2.5$ s <sup>-1</sup>
Sample capacity	2 sample racks
Sample configuration	96 vial, deep well and PCR formats, 384-well microplates, custom high volume
Sample temperature control	4 to 40°C (max 15° below ambient)
Sample loading	Automatic
Number of channels	3
Flow path	1, 1-2, 1-2-3, 3, 3-2, 3-2-1
Flow channel volume	< 90 nL
Channel-channel dead volume	< 20 nL
Real time reference curve subtraction	Yes
Injection volume	2-700 µL
Injection rise and fall time	< 0.75 second @ 25 µL/min
Simultaneous injections	Yes, dual sample loops
Gradient injections	Yes, OneStep®, NeXtStep™
OneStep® Injections in high throughput mode	No
Flow rate	0.1-150 µL/min
Inline buffer degassing	Yes
System temperature control	4-40°C (Max 15° below ambient)
Variable data rate	1-20 Hz
Automation capabilities	> 72 hour unattended operation
Qdat hit selection feature	No

**Germany**

Sartorius Lab Instruments GmbH & Co. KG  
Otto-Brenner-Strasse 20  
37079 Goettingen  
Phone +49 551 308 0

**USA**

Sartorius Corporation  
565 Johnson Avenue  
Bohemia, NY 11716  
Phone +1 888 OCTET 75  
Or +1 650 322 1360



For further contacts, visit  
[www.sartorius.com/octet-support](http://www.sartorius.com/octet-support)