

A New Multi-Angle Light Scattering Detector



From Postnova Analytics

POSTNOVA ANALYTICS

Postnova Analytics, Inventors of FFF, is completely focused on Field-Flow Fractionation – FFF and offers a unique product portfolio of fully integrated FFF systems. Postnova combines the heritage of Prof. Giddings, the inventor of FFF, with over 20 year of history in FFF science and commercialization. The company has an unlimited commitment to Field-Flow Fractionation and Light Scattering excellence and is always striving to represent the center of excellence in FFF and LS business. Our customers can expect the most advanced and reliable analytical solutions for their demanding applications from nanotech, polymers, biopharmaceuticals and environmental science.



FFF HISTORY



Field-Flow Fractionation was invented in 1966 by Prof. Calvin Giddings (1930-1996) [01], an outstanding scientist and two-times Nobel-Price nominee (1984/1994) from University Utah at Salt Lake City, USA. He also was the founder of the FFFresearch Center at University of Utah, where he and his co-workers developed the complete theory of FFF and the different sub-techniques, such as Thermal FFF [02] in 1969, Sedimentation FFF [03] in 1974, Flow FFF [04] in 1976 and SPLITT in 1985 [05]. In 1987 Giddings/Wahlund published the first Asymmetric Flow FFF [06], which later became the modern version of Flow FFF today. 1984 Prof. Michel Martin from Univ. Paris published the world's first online coupling of FFF with Light Scattering [7,8]. Finally, in the year 1986, Prof. Giddings and his co-workers founded the world's first FFF company, the legendary FFFractionation Inc. in Salt Lake City. FFFractionation, as a pioneer developed and introduced the first commercial FFF instruments, which were the Model T100 Thermal FFF, S101 Sedimentation FFF, F1000 Flow FFF and SF1000 Split Thin Flow Cell Fractionation (SPLITT) [9,10,11,12].



In the year 1995 Dr. T. Klein developed and commercialized the world's first Asymmetric Flow FFF (AF4) out of Technical University of Munich, Germany. Two years later in 1997 he founded Postnova Analytics in Munich, and introduced the first complete commercial Asymmetrical Flow FFF (HRFFF-10.00 Series) into the market. In 2001 Postnova Analytics acquired FFFractionation to become the leading company in the area of Field-Flow Fractionation and the only one offering the complete range of FFF systems. Just recently, Postnova Analytics presented the world's first High Temperature [13] and Mid Temperature Asymmetric Flow FFF technology in 2006 and 2008.

Literature:

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- [4] J.C. Giddings, F.J. Yang, M.N. Myers, "Flow Field-Flow Fractionation: A Versatile New Separation Method", *Science*, **193** 1244-2145 (1976).
- [5] J.C. Giddings, "A System Based on Split-Flow Lateral-Transport Thin (SPLITT) Separation Cells for Rapid and Continuous Particle Fractionation", *Sep. Sci. Technol.*, **20** 749-768 (1985).
- [6] Giddings, J.C.; Wahlund, K.G.; "Properties of an Asymmetric Flow FFF channel having one permeable wall", *Anal. Chem.*, **59** 1332-39 (1987).
- [7] Martin, M.; "Polymer analysis by fractionation with on-line light scattering detectors", *Sep. Sci. Technol.*; *Sep. Sci. Technol.*; **19** 685-707 (1982).
- [8] Martin, M.; Hes, J.; "On-line coupling of thermal field-flow fractionation with laser light scattering", *Chromatographia*; **15** 426-432 (1984).
- [9-12] FFFractionation, Inc., Salt Lake City, Utah, USA "Model F1000", "Model S101", "Model T100", Model " SF1000", *Product Brochures*, (1986).
- [13] H. DeJonge, E. Mes, T. Klein, R. Welz, "High Molecular Weight Polyolefin Analysis by High Temperature Asymmetrical Flow Field-Flow Fractionation", *Oral Presentation/Poster 1st ICPC Conference, Houston, USA, Oct. 15th-18th* (2006).

The multi detector multi angle light scattering detector

Since the 1990's Postnova Analytics has been developing light scattering solutions for installation with our large number of Field Flow Fractionation systems all over the world.

Today, with an installed base of thousands of systems everywhere, we continue our mission to develop the most advanced detector technology for research, quality control and production environments. We have developed an advanced detector platform using a range of detector configurations to meet a wide variety of user requirements for macromolecular characterization.

We then supply our renowned application, and method-development knowledge support as well as on-site installation and training, to ensure your instrument investment is validated, correlates with your past results and provides these important answers upon system delivery.



Introducing the The Crown 21 Multangle Detector

This new Multi-angle Detector brings versatility and accuracy to the measurement of size, shape, absolute molecular weight and other characterization parameters of particles, proteins and biopolymers in solution.

This detector design combines cell design attributes which are tried and tested, combined with 21 detectors with the flexibility of our Professional lightscattering system. The cell has been optimized to accommodate the power of a 532 nm. green laser with angles chosen to provide the highest level of precision and accuracy in the Rayleigh Scattering Domain. With the benefit of reducing the dependence upon model fitting to approximate size, found in other similar systems.

Whether your analysis tasks are for research, quality control or production, the Crown 21 multi-detector will give you molecular weight and size faster, more accurately and more easily.

Designed for significant performance advantages

Our unique multi-detector systems employ multiple light scattering detection technologies in an advanced sample cell, and state of-the-art optical, mechanical and electronic configurations that result in . . .

- the highest sensitivity,
 - excellent reproducibility
 - virtually zero band-broadening,
 - greater accuracy,
 - better operating convenience,
 - rapid validation of past results,
 - easy disassembly for cleaning,
 - new levels of long-term stability
- . . . and, unique configuration versatility, to satisfy a wide range of characterization situations.

Postnova FFF Systems

Postnova Analytics has become the ideal, trusted solution to assist users with Particle and Molecular characterization tasks in organizations and applications such as:

- biotech and pharmaceuticals,
- nanoparticles and polymers,
- proteins and polysaccharides,
- paints and coatings,
- petrochemicals, lubricants, additives,
- food production, environmental
- academia, government and other laboratories.

The Crown 21 Multi-Angle Detector

Light scattering technology has increasingly become the detection technique of choice in both the lab and plant environment as the answers achieved are considered absolute and not based on analysis by comparison with calibration curves.

The concept behind the Crown 21 is to provide a multi-angle multi detector platform which will provide Zimm and Debye plots and offer simultaneous dynamic light scattering measurements in the future.

Postnova's commitment to Innovation

Postnova Analytics origin is based on the desire to innovate, it began with the development of the first commercial Asymmetrical Field Flow Fractionation System.

The continued development of the focus pump and cross flow syringe pumps system, produced a world-class platform for reproducible AF4 system with unparalleled capabilities.

Then the development of a Thermal FFF system that can be used instead of a GPC system which not only separates by size, mass, and morphology. This award winning design can also determine gel content.

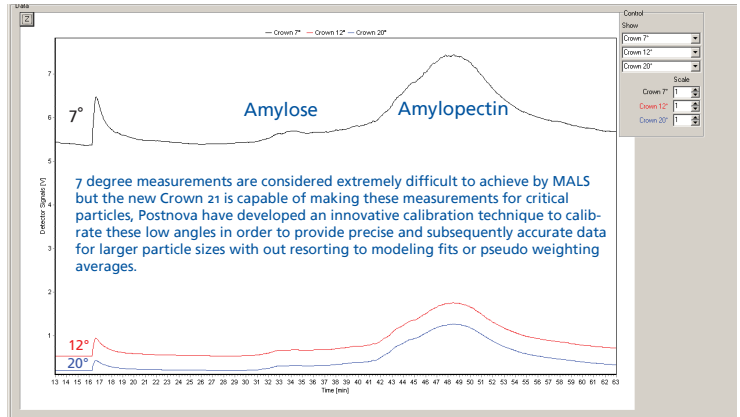
In 2010 the New CF2000 Centrifugal FFF system, took on the area of classical Sedimentation FFF to a higher level providing the reproducibility and reliability never seen before. For Nano-particles

The consequence of these innovations have led to the ultimate challenge to produce a MALs with the primary objective of operating with our family FFF systems.

1. Postnova have chosen a wavelength that will provide the highest sensitivity and precision for size measurements.
2. Postnova have designed the system with an arrangement of the angles to operate in the lower to mid range of $\sin^2(\theta/2)$ region where linearity of the fit provides the most accurate size and shape determinations independent of models used by other systems.
3. Postnova have chosen a flow path that allows for easy removal of bubbles and debris without having to resort to ultra-sonification and the subsequent down time.
4. Future DLS measurements will be independent of flow correction.

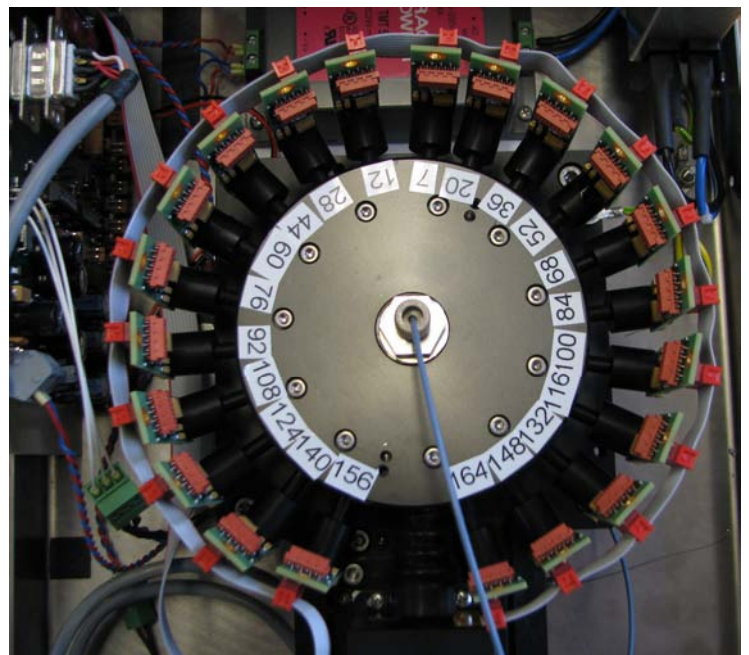
Postnova have considered the needs to the customer when designing the optics, light source, mechanics and construction required to achieve the absolute measurement values expected for government certifications.

Different Scattering angles (7, 12, 20°) of native Amylose + Amylopectin in Water + 0.1 M NH4Ac



The Crown 21 is capable of accommodating 21 static angles or 20 static angles and 1 dynamic light scattering angle (future option) the distribution of these angles are critical as they have been chosen to maximize the most accurate extrapolation to the zero angle

Crown 21 Optical Bench with all 21 Angles Labeled to Identify Detector Positions



Older designs of multi-angle MALS are based on traditional angle positioning required for outdated dissymmetry measurement tables. Postnova's approach relies on the chosen angles distributed around the cell so that the angles in the low to mid-range are maximized. The Crown 21 design requires that there are 14 angles between 7 and 108 degrees to achieve an optimal extrapolation. The Raleigh equation demands that the actual determination for the slope intercept to determine R_g and Molecular weight for the correct determination, must be determined at the zero angle. Back angle extrapolations often lead to erroneous results. Postnova have intentionally placed the angles in the region of 7 to 180 degrees for precise and accurate size determinations.

UNIQUE FEATURES OF Crown 21

Laser Design

The Crown series of MAL's detectors uses a high performance pumped laser at 532 nm with a highly coherent collimated beam design, the 50 mWatt power exceeds the power of normal lasers in the 658 - 810 nm range as the power is proportional to $1/\lambda^4$. Therefore providing an exceptional laser performance compared to conventional MALs

Cell Design

The Crown cell design utilizes a vertical flow path, thus limiting stray particles from passing through the optical path more than once. Unlike horizontal flow cell designs that have a path length dependency for noise generated by stray particles, which can travel through the optical path multiple times. The design allow easy access for cleaning and bubbles and debris rise to the top of the cell and leave with out fouling and leave the detector with out blocking the flow path.

Angle Positioning

Angle positioning has been optimized to allow the most linear portion of the Debye fit for mass and size determinations thus improving precision and accuracy with out relying on model fits.

Material Constuction

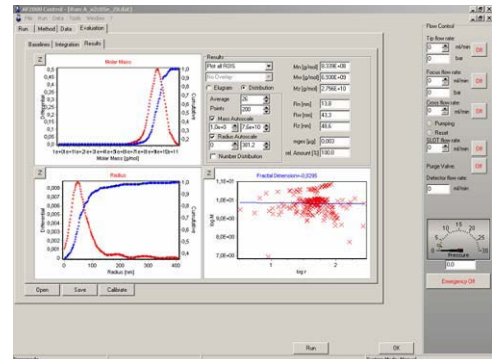
The optical housing and plate design that accommodates the cell housing, laser and detectors is manufactured from high quality in Invar which provides very low metal expansion characteristics. This material is used in professional electro-optic design provides greater stability for reliable measurements at acute angles. Therefore it was chosen to provide a high quality optical platform.

NovaFFF SOFTWARE

The NovaFFF software is based on a single platform strategy, incorporating system control, data collection and data evaluation as well as reporting.

Set-up & Handling & Security

The NovaFFF is easy to use and incorporates the complete knowledge of over two decades in FFF and Light Scattering technology. It is very flexible, as different hardware components, such as autosampler, pumps and various detectors can be selected by the user with just a few mouse clicks. Various security and monitoring functions have been built into the software. The pump and channel pressure is actively monitored. The system can be shut down manually or automatically when a set maximum pressure value is exceeded. The main actions and controls done by the software are stored in a log history file. Also, all important data such as pressures, flows and additional analog detector signals are collected and stored with the run data.



Modern System Control

State-of-the-art modern communication protocols are standard in this software solution. The communication of the program with PC and the system components is achieved via TCP/IP Ethernet protocol and no data acquisition boards or external controllers are necessary. As the FFF system has it's own IP address, thus the complete system can be operated via the local network in the user's environment.

Seamless FFF-LS Integration

The software uniquely combines the system control of FFF and the selected Light Scattering detector in just one application. Start-up of two programs, copy and pasting of methods between the different programs or problems about the stability of the multitasking capabilities of the PC operating system are history when using NovaFFF.

SPECIFICATIONS

Temperature Range:

Typically Room Temperature, Limits: 5°C to 50°C

Measurement Range Size:

Proteins, Polymers Nanoparticles: 7 nm - 380 nm (Rg)
(Based on Green Laser)

Measurement Range Mass:

100 to 10000000 Daltons (without Mie Corrections)

Flow Cell Size

Vertical Flow Cell 45 µL

Applicable Solvent Systems:

All typical organic and aqueous solvents

Static Angles Max :

21 or 20 (with DLS)

Angle Positioning :

7, 12, 20, 28, 36, 40, 52, 60, 68, 76, 84, 92, 100, 108,
116, 124, 132, 140, 148, 156, 164

Flow Rate Ranges / Pressure:

Main Flow 0.01 – 5.0 mL/min

Laser

Green 532 nm 50 mWatt Standard (Optional 100 mWatt 658 nm)

Detectors

A/D DSP's Individually Programmed for Maximum Stray Particle Noise Rejection

Electrical Power Requirements:

100-230 V / 0.6 kW / 50-100Hz

PC Requirements:

Windows XP, min.1024 MB RAM, 2 Ethernet ports

Software System:

Unique NovaFFF system control, Data acquisition, Calibration, Data Analysis of MALS for Rg and Molecular weight determinations.
Graphing and interfacing to Refractometer, DLS, UV, DAD, Fluorescence Detectors and ICP-MS systems

Specifications are subject to change

UNIQUE FFF PRODUCT RANGE

Postnova Analytics offers the most comprehensive product range in the area of Field-Flow Fractionation combined with various detections principles, such as DLS, MALS, UV and RI for the most demanding applications from Biopharma, Nanotech, Polymers, Food and Environmental Science. We offer completely integrated analytical and prep FFF systems, services and supplies.



CF2000 Series – Particle Separator

Centrifugal FFF System for high resolution separation, characterization and fractionation of particles in aqueous and organic solvents. Separation size range from 7 nm up to 40 µm depending on sample characteristics and density.



AF2000 AT Series – Universal Separator - Basic

Flow FFF System for high resolution separation, characterization and fractionation of polymers, proteins and particles in aqueous/organic solvents. The most versatile FFF technology for a broad application range from 1 nm – 100 µm and 1 - 10E9 kDa depending on sample nature. Ambient temperature system.



AF2000 MT Series – Universal Separator - Advanced

Flow FFF System for high resolution separation, characterization and fractionation of polymers, proteins and particles in aqueous/organic solvents. The most versatile FFF technology for applications from 1 nm to 100 µm and 1-10E9 kDa depending on sample nature. Temperature controlled system.



AF2000 HT Series – Polyolefin Separator

Flow FFF System for high resolution separation, characterization and fractionation of polyolefin polymers, such as polyethylene and polypropylene in organic solvents. The most advanced FFF technology for polyolefins from 50 - 10E9 kDa depending on sample nature. High temperature system.



TF2000 Series – Polymer Separator

Thermal FFF System for high resolution separation, characterization and fractionation of natural/synthetic polymers/gels in organic solvents. The most advanced FFF technology for applications from 1 - 10E9 kDa depending on sample nature/chemical composition. Temperature controlled system.



SF1000 Series – Particle Collector

Gravitational Split FFF System for continuous separation and fractionation of microparticles in aqueous solvents. The most advanced FFF technology for applications from 1 – 300 µm depending on sample nature/chemical composition. Preparative system for mg to gramm range.

WORLD CLASS SUPPORT



Postnova Analytics is located where its customers are located. Beside our facilities in Germany (HQs) and America (USA), we have established a local support network of highly qualified partner organizations. If you just need a spare part, if you are looking for a special training course, or if you need immediate help for a demanding application, Postnova can assist you like no other in the FFF - LS business.



EAC – European Application Center



The European and the American Application Centers (EAC / AAC) which are located in our German and US offices are playing a central role in our

AAC – American Application Center



support activities. These centers provide the highest quality application support to the scientific community and host the training and educational services, which are offered for all our product lines on a frequent basis, as well. The long history in FFF and the broad FFF product range are building the basis for this unsurpassed, extensive scientific support offered. This is underlined by the significant number of former scientists and PhDs coming from Prof. Giddings group, which have been employed by FFFractionation/Postnova over the years.

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