iSFFF Nantes 2024
International Symposium on Field- and Flow-based Separations
JUNE 3-6 2024

QUIZZ

OF FFF

BACK TO THE FUTURE OF FFF

Dear Friends

The history of the FFF is made up of so many major events, players and places that it's impossible for us to cover them all in just a few minutes.

That's why I'd like to sincerely apologize to all of you for any events, places or people I may have forgotten to mention...

WHO IS WHO?

SEE PART 2 TO ANSWER...

Who is this famous FFF researcher: Q1

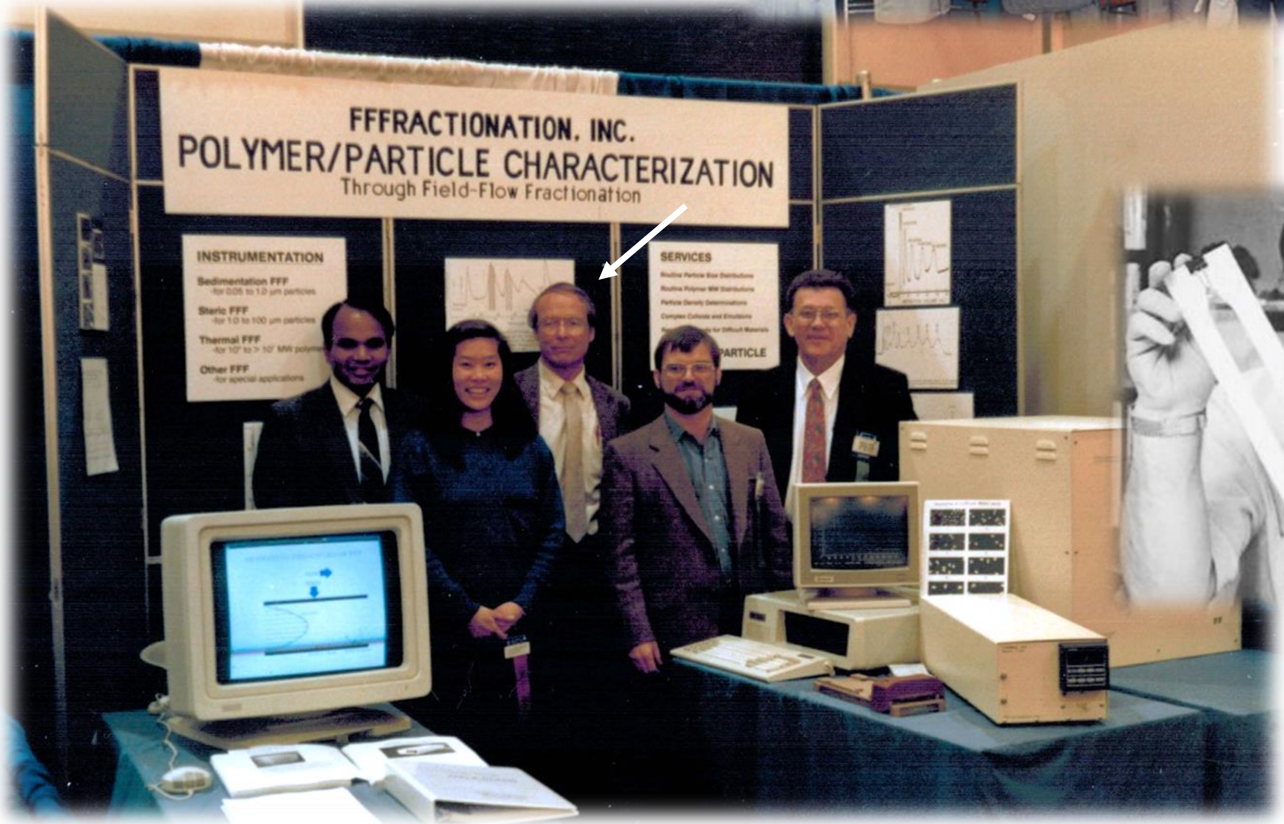
A : Steve Williams

B : John Calvin Giddings

C : Marcus Myers

Who is this famous FFF researcher: Q1

A : Steve Williams
B : John Calvin Giddings
C : Marcus Meyrs



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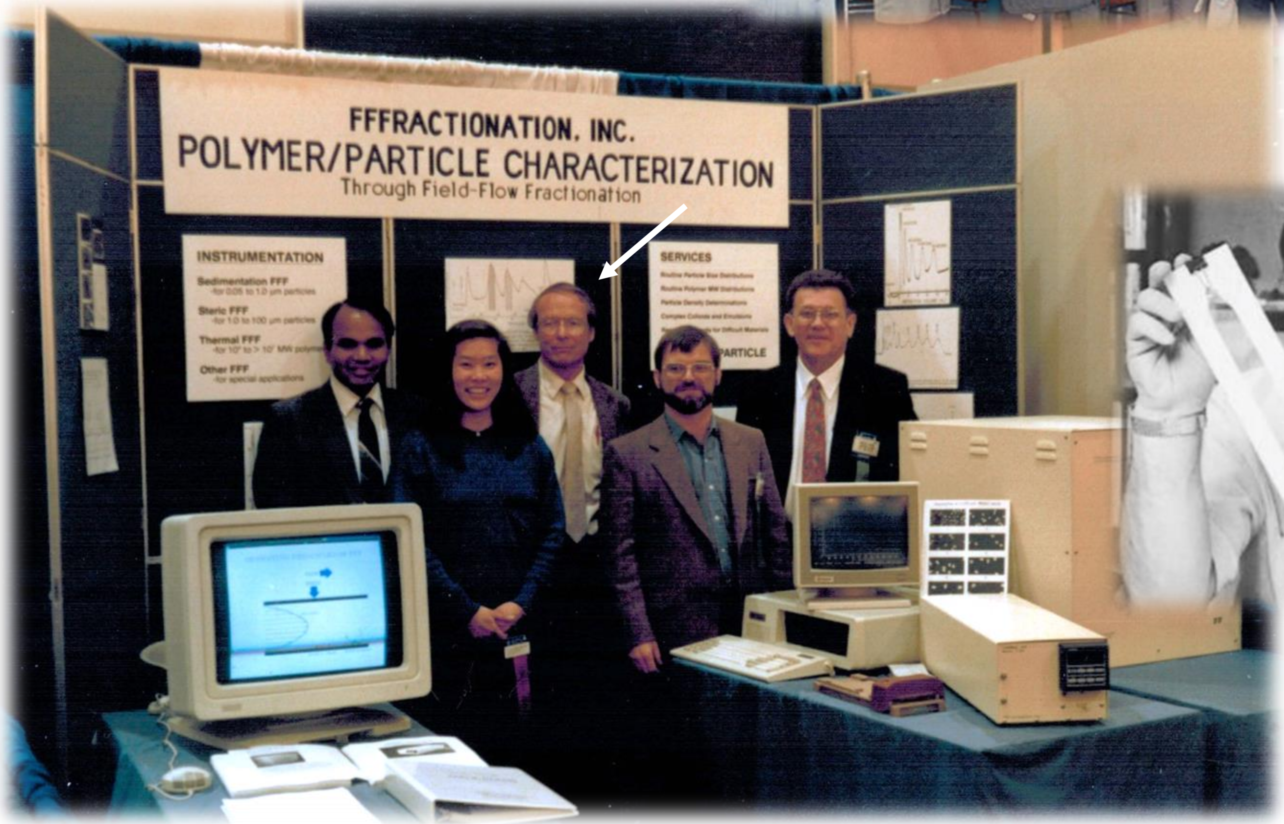
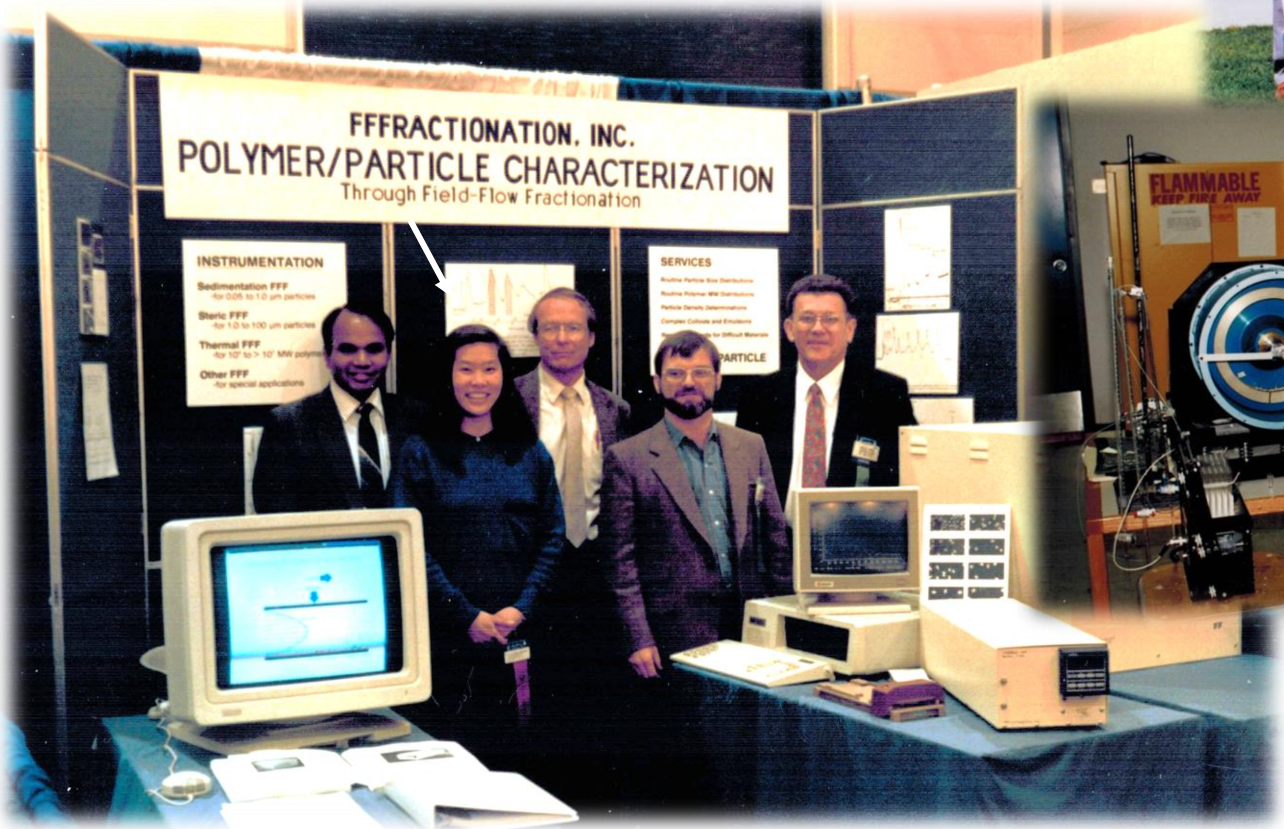
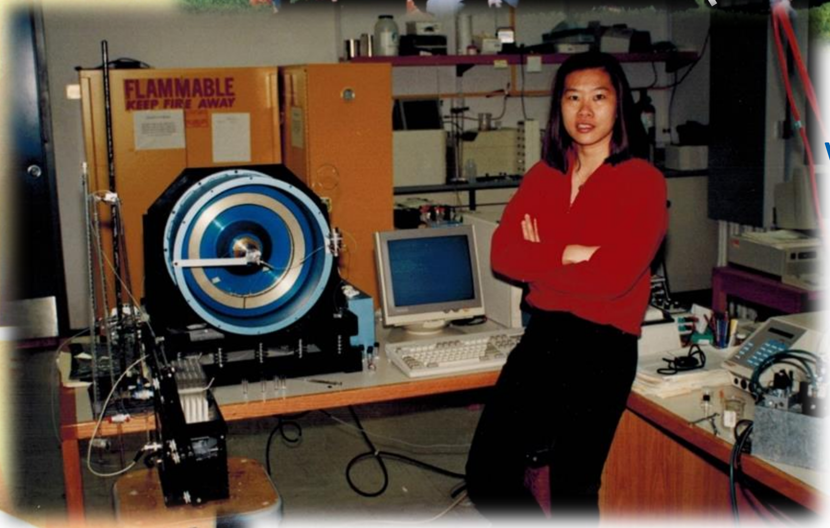


Who is this famous FFF researcher: Q2

A : Karin Caldwell
B : Kim Williams
C : Marcia Hansen

With the Giddings' Lab… what a nice concentration of brillant people





With a small SdFFF

Who is this famous FFF researcher: Q2

A : Karin Caldwell
B : Kim Williams
C : Marcia Hansen

With George Karaiskakis on her left

With Luigi Reshiglian and Seungho Lee on her right

With Catia Contado on her left

Who is this famous FFF researcher: Q2

A : Karin Caldwell

B : Kim Williams

C : Marcia Hansen

With Soheyl Tadjiki, Mauricio Hoyos and many other famous FFF members….

With Albena Lederer, Suzanne Boye, William Smith, Frédérique Violleau ….

And now…Who is this famous FFF researcher: Q3

A : Martin Schimpf

B : Karl-Gustav Wahlund

C : Ron Beckett

To the left of Kim in the foreground

With John Calvin and Karl-Gustav who think about A4F?

And now…Who is this famous FFF researcher: **Q3**

A : Martin Schimpf
B : Karl-Gustav Wahlund
C : Ron Beckett

With Francesco Dondi on his left

With Mauricio Hoyos on his left

And now…Who is this famous FFF researcher: Q3

A : Martin Schimpf

B : Karl-Gustav Wahlund

C : Ron Beckett

With Francesco Dondi with two other friends, including two next persons to discover

And now…Who is this famous FFF researcher: Q4

A : Karin Caldwell
B : Karin Fromell
C : Marcia Hansen

With Soheyl on her right…

With Ron on her left…

With a special guest chef!
Marcus Myers…

And now…Who is this famous FFF researcher: Q4

A : Karin Caldwell

B : Karin Fromell

C : Marcia Hansen

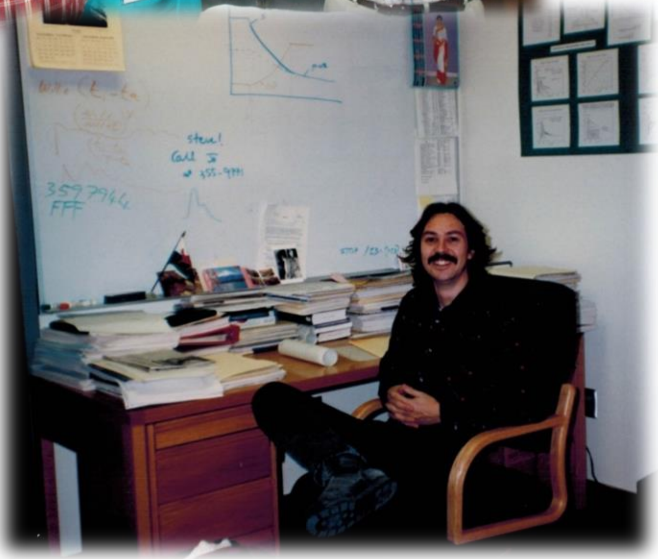
With Karl Gustav…

And now…Who is this famous FFF researcher: **Q5**

A : Mauricio Hoyos
B : Steve Williams
C : Josef Chmelik

Now, as you know Ron, Karin, Francesco, who his the last guy on the picture…? He started with FFF a long time ago… with a famous moustache!

With Luigi, Kim and Seungho!…



And the power programmed field decay!…

And Kim in Amsterdam…

And now…Who is this famous FFF researcher: Q5

A : Mauricio Hoyos

B : Steve Williams

C : Josef Chmelik

To the left of Maciej Zborowski…

To the left of Carmel, and with Ron, Mauricio…

To the left of Catia Contado…

With Karl-Gustav and the next *FFFFFR**! **Famous French FFF Researcher*

And now…Who is this famous FFF researcher: **Q5**

A : Mauricio Hoyos

B : Steve Williams

C : Josef Chmelik

To the left of Maciej Zborowski…

To the left of Carmel, and with Ron, Mauricio…

To the left of Catia Contado…

With Karl-Gustav and the next *FFFFFR**! **Famous French FFF Researcher*

International Symposium on Field- and Flow-based Separations
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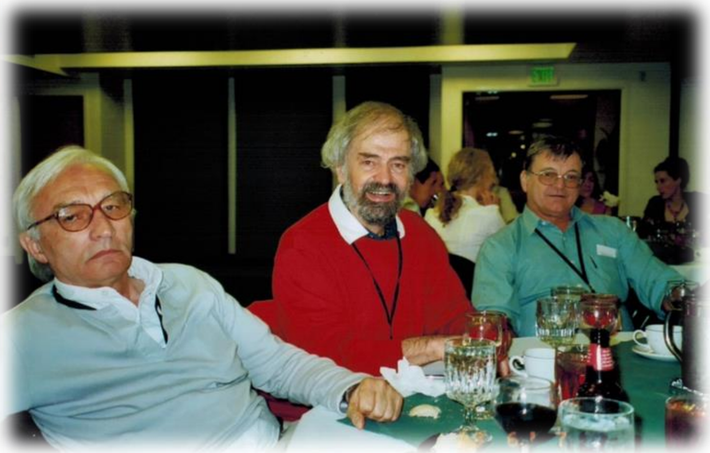
And now…Who is this famous FFF researcher: Q6

A : Mauricio Hoyos
B : Michel Martin
C : Marcus Myers

With Steve and Maciej …



With Francesco and Ron…

In Paris at the Observatory for G4F meeting

*Famous French FFF Researcher

And now…Who is this famous FFF researcher: Q6

A : Mauricio Hoyos
B : Michel Martin
C : Marcus Myers

With Lee Moore on the left of the picture…

And now…Who is this famous FFF researcher: Q6

A : Mauricio Hoyos

B : Michel Martin

C : Marcus Myers

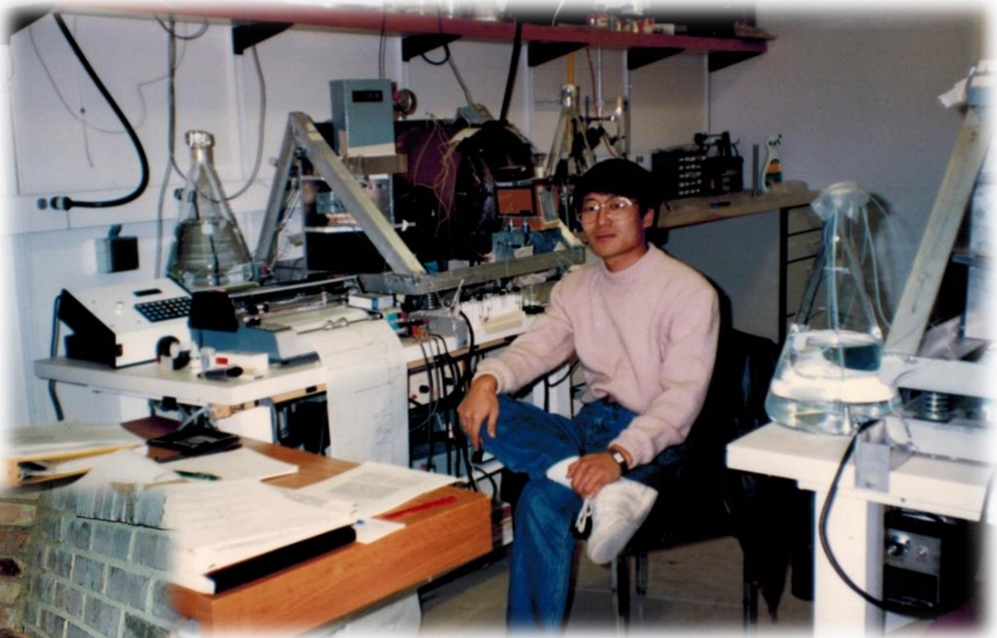
With Lee Moore on the left of the picture…

And now…the last but not the least…Who is this F FFF R: Q7

A : Mauricio Hoyos

B : Seungho Lee

C : Myeong Hee Moon



With Karen…

From the left with Ron, Philippe Cardot and George Karaiskakis…

The Korean Team with Francesco…

And now…the last but not the least…Who is this F FFF R: Q7

A : Mauricio Hoyos
B : Seungho Lee
C : Myeong Hee Moon

With Steve and Phil Wyatt…

With Lars Nielsen and Frédérique Violleau…

With Andrea Zattoni
and Luigi Reshiglian…

With Josef Chmelik…

And now…the last but not the least…Who is this F FFF R: Q7

A : Mauricio Hoyos

B : Seungho Lee

C : Myeong Hee Moon

From the left…
Mauricio, Michel, Bruce, Kim, Wenwan, Mohammed and Myeong Hee…

And now a special thanks also to MARCUS

From the left… Myeong Hee, Steve, Seungho, Luigi, Martin, MARCUS, Kim, Michel and Ron…

From the left… Steve, Martin, MARCUS, and Catia…

WHERE?

SEE PART 3 TO ANSWER...

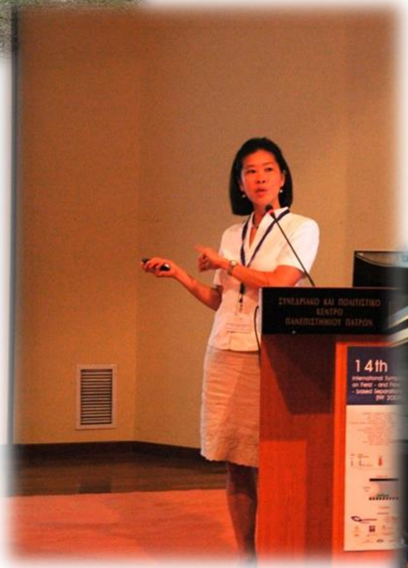
The place to be : Q1

A : Patras in 2009
B : Columbia in 2018
C : Brno in 2005

The place to be : Q1

A : Patras in 2009
B : Columbia in 2018
C : Brno in 2005



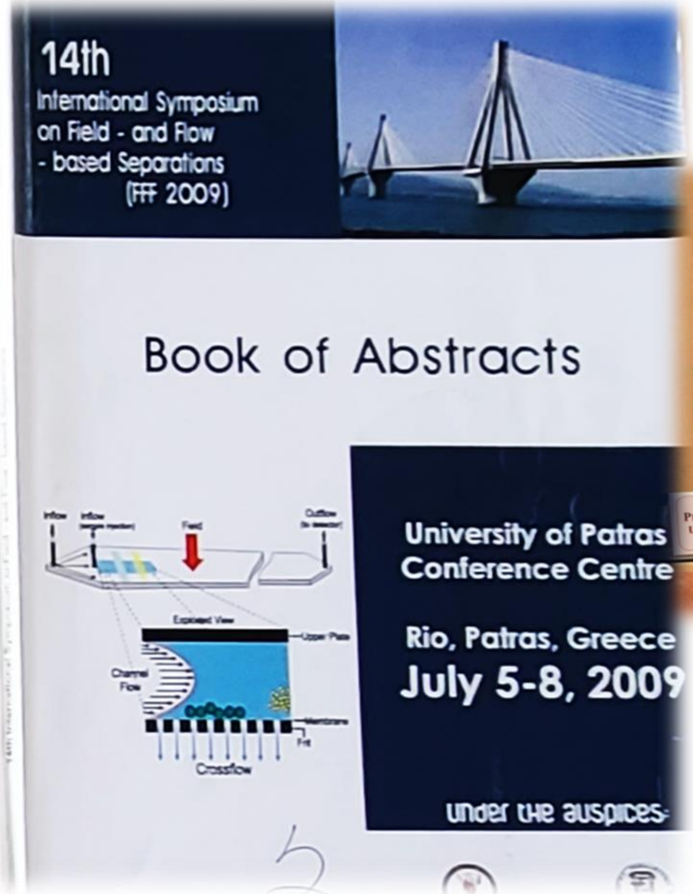



The place to be : Q1

A : Patras in 2009

B : Columbia in 2018

C : Brno in 2005



Chair : George Karaiskakis

The place to be : Q2

A : Vienna in 2020
B : Salt Lake City in 2014
C : Dresden in 2016



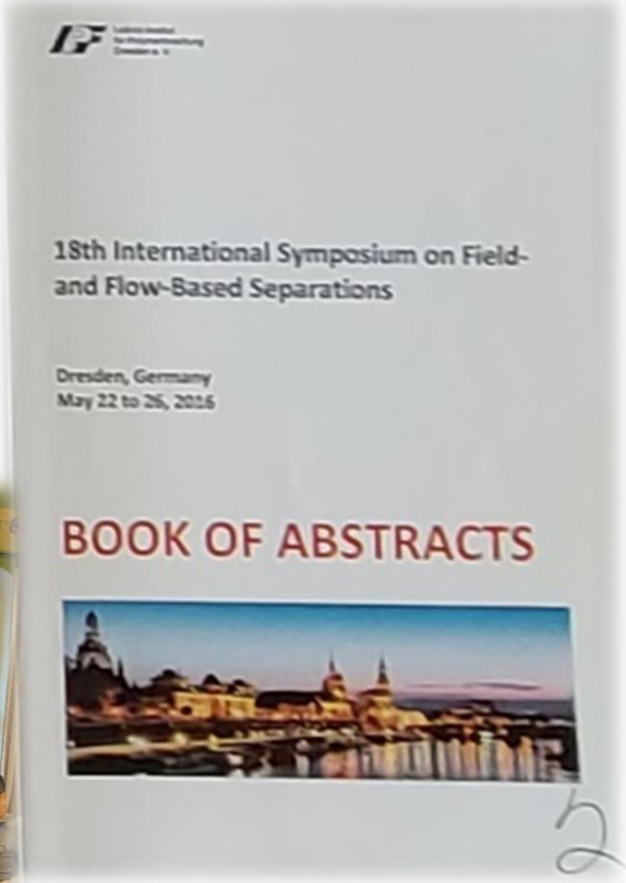



The place to be : Q2

A : Vienna in 2020

B : Salt Lake City in 2014

C : Dresden in 2016



Chair : Albena Lederer

The place to be : Q3

A : Salt Lake City in 2007
B : Salt Lake City in 2014
C : Pau in 2013

The place to be : Q3

A : Salt Lake City in 2007
B : Salt Lake City in 2014
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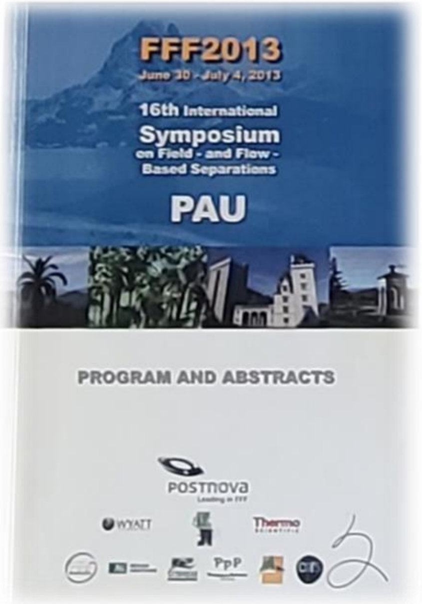
The place to be : Q3

A : Salt Lake City in 2007

B : Salt Lake City in 2014

C : Pau in 2013



Chair : Gaëtane Lespès

The place to be : **Q4**

A : Riverside in 2022

B : Salt Lake City in 2014

C : Columbia in 2018

The place to be : Q4

A : Riverside in 2022

B : Salt Lake City in 2014

C : Columbia in 2018

The place to be : Q4

A : Riverside in 2022

B : Salt Lake City in 2014

C : Columbia in 2018

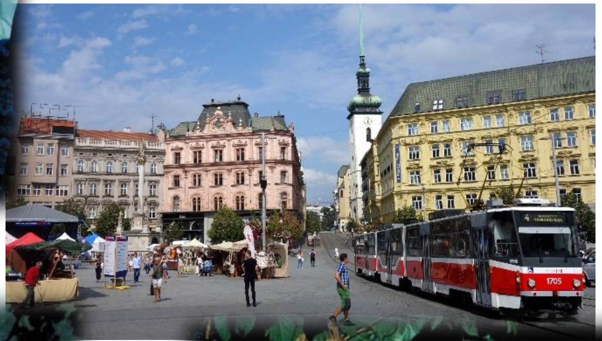
Chair : Mohammed Baalousha

The place to be : Q5

A : Patras in 2009
B : Salt Lake City in 2014
C : Brno in 2005

The place to be : **Q5**

A : Patras in 2009
B : Salt Lake City in 2014
C : Brno in 2005

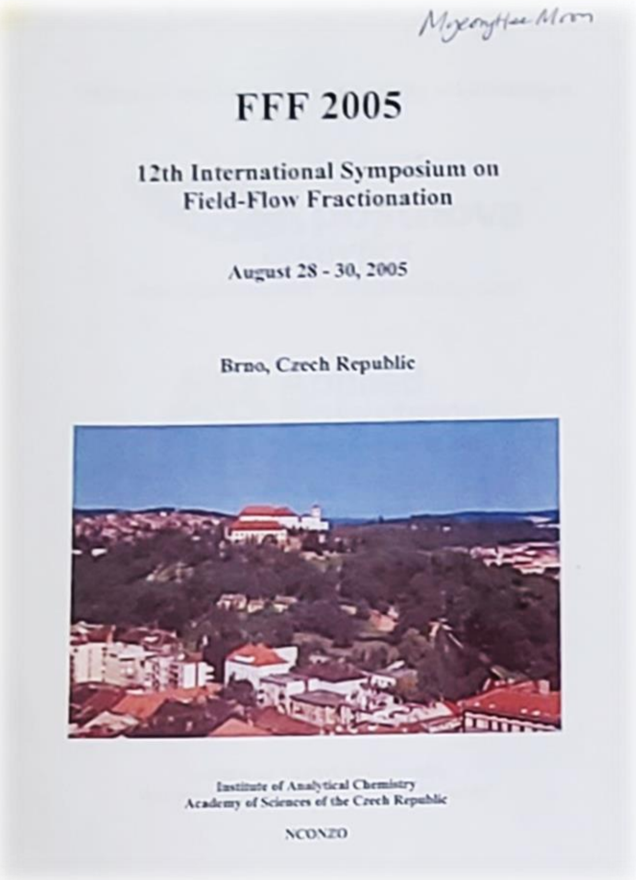


The place to be : Q5

A : Patras in 2009

B : Salt Lake City in 2014

C : Brno in 2005



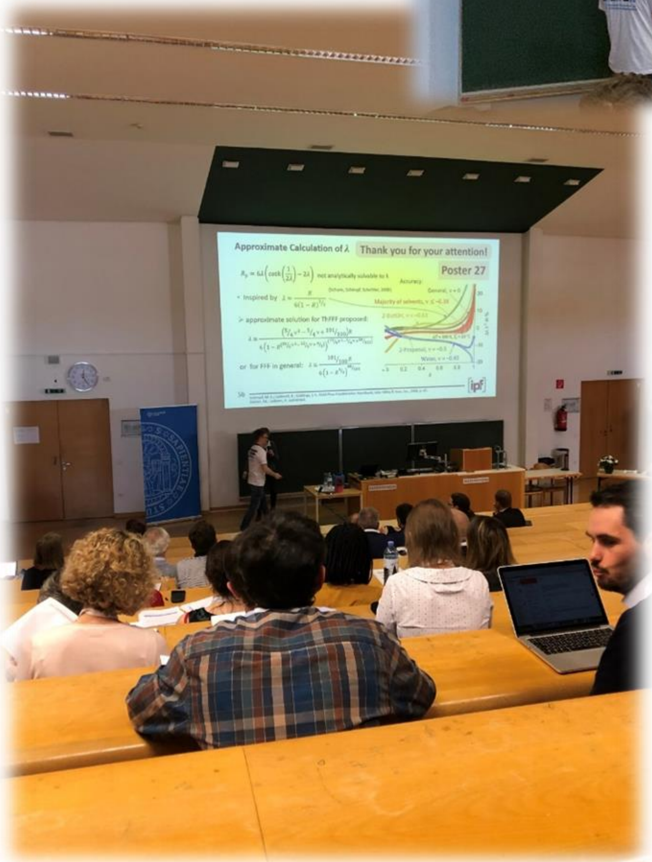
Chair : Josef Chmelik

The place to be : Q6

A : Amsterdam in 2002

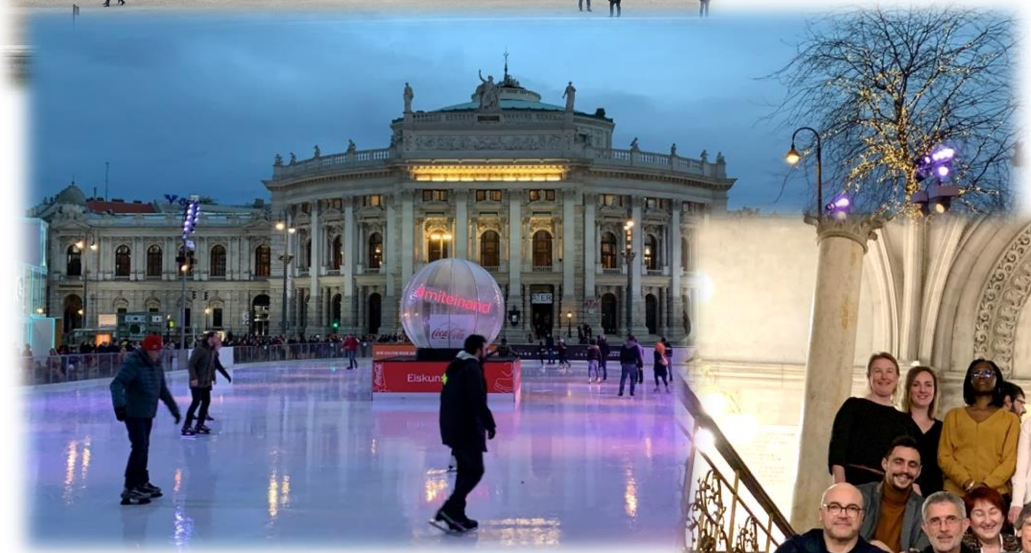
B : Vienna 2020

C : Columbia in 2018



The place to be : Q6

A : Amsterdam in 2002
B : Vienna 2020
C : Columbia in 2018



The place to be : Q6

A : Amsterdam in 2002

B : Vienna 2020

C : Columbia in 2018

Chair : Frank von der Kammer

FFF2020
20th International Symposium on Field- and Flow-Based Separations
23–27th February 2020
University of Vienna

The place to be : Q7

A : Salt Lake City in 2014
B : Salt Lake City in 2007
C : Paris in 1999

The place to be : **Q7**

A : Salt Lake City in 2014

B : Salt Lake City in 2007

C : Paris in 1999



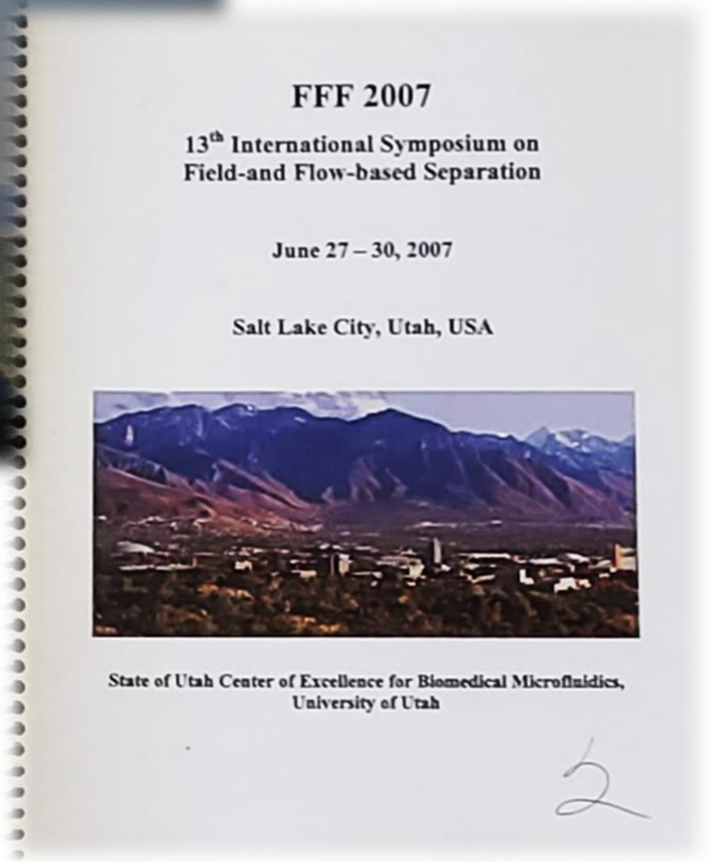



The place to be : Q7

A : Salt Lake City in 2014

B : Salt Lake City in 2007

C : Paris in 1999


FFF 2007

13th International Symposium on Field-and Flow-based Separation

June 27 – 30, 2007

Salt Lake City, Utah, USA

State of Utah Center of Excellence for Biomedical Microfluidics, University of Utah

Chair : Bruce Gale

The place to be : Q8

A : Park City 1989

B : Salt Lake City in 2007

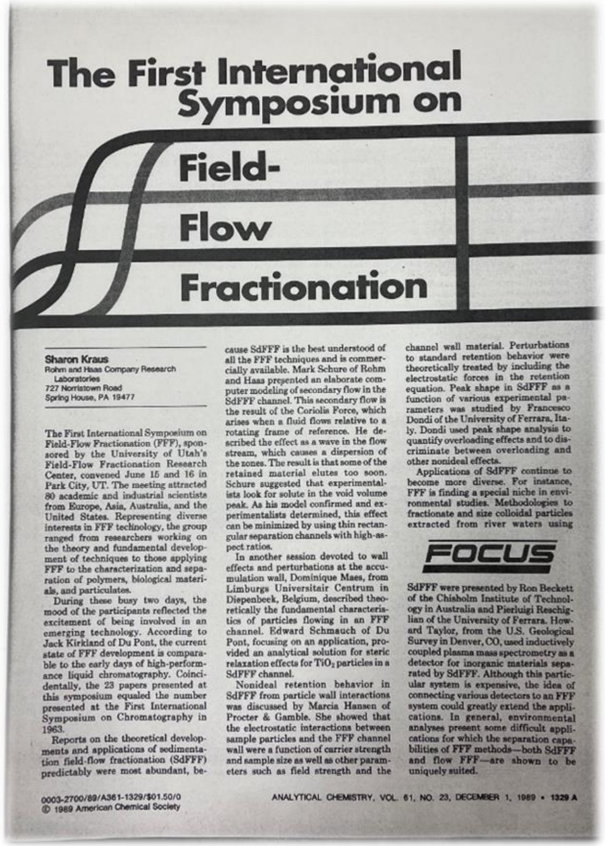
C : Ferrara in 1996

The place to be : Q8

A : Park City 1989

B : Salt Lake City in 2007

C : Ferrara in 1996



The First International Symposium on Field-Flow Fractionation

Sharon Kraus
Rohm and Haas Company Research Laboratories
727 Norristown Road
Spring House, PA 19477

The First International Symposium on Field-Flow Fractionation (FFF), sponsored by the University of Utah's Field-Flow Fractionation Research Center, convened June 15 and 16 in Park City, UT. The meeting attracted 80 academic and industrial scientists from Europe, Asia, Australia, and the United States. Representing diverse interests in FFF technology, the group ranged from researchers working on the theory and fundamental development of techniques to those applying FFF to the characterization and separation of polymers, biological materials, and particulates.

During these busy two days, the mood of the participants reflected the excitement of being involved in an emerging technology. According to Jack Kirkland of Du Pont, the current state of FFF development is comparable to the early days of high-performance liquid chromatography. Coincidentally, the 23 papers presented at this symposium equaled the number presented at the First International Symposium on Chromatography in 1963.

Reports on the theoretical developments and applications of sedimentation field-flow fractionation (SdFFF) predictably were most abundant, because SdFFF is the best understood of all the FFF techniques and is commercially available. Mark Schure of Rohm and Haas presented an elaborate computer modeling of secondary flow in the SdFFF channel. This secondary flow is the result of the Coriolis Force, which arises when a fluid flows relative to a rotating frame of reference. He described the effect as a wave in the flow stream, which causes a dispersion of the zones. The result is that some of the retained material elutes too soon. Schure suggested that experimentalists look for solute in the void volume peak. As his model confirmed and experimentalists determined, this effect can be minimized by using thin rectangular separation channels with high-aspect ratios.

In another session devoted to wall effects and perturbations at the accumulation wall, Dominique Maes, from Limburgs Universitair Centrum in Diepenbeek, Belgium, described theoretically the fundamental characteristics of particles flowing in an FFF channel. Edward Schmauch of Du Pont, focusing on an application, provided an analytical solution for steric relaxation effects for TiO_2 particles in a SdFFF channel.

Nonideal retention behavior in SdFFF from particle wall interactions was discussed by Marcia Hansen of Procter & Gamble. She showed that the electrostatic interactions between sample particles and the FFF channel wall were a function of carrier strength and sample size as well as other parameters such as field strength and the channel wall material. Perturbations to standard retention behavior were theoretically treated by including the electrostatic forces in the retention equation. Peak shape in SdFFF as a function of various experimental parameters was studied by Francesco Dondi of the University of Ferrara, Italy. Dondi used peak shape analysis to quantify overloading effects and to discriminate between overloading and other nonideal effects.

Applications of SdFFF continue to become more diverse. For instance, FFF is finding a special niche in environmental studies. Methodologies to fractionate and size colloidal particles extracted from river waters using

FOCUS

SdFFF were presented by Ron Beckett of the Chisholm Institute of Technology in Australia and Pierluigi Reschiglian of the University of Ferrara. Howard Taylor, from the U.S. Geological Survey in Denver, CO, used inductively coupled plasma mass spectrometry as a detector for inorganic materials separated by SdFFF. Although this particular system is expensive, the idea of connecting various detectors to an FFF system could greatly extend the applications. In general, environmental analyses present some difficult applications for which the separation capabilities of FFF methods—both SdFFF and flow FFF—are shown to be uniquely suited.

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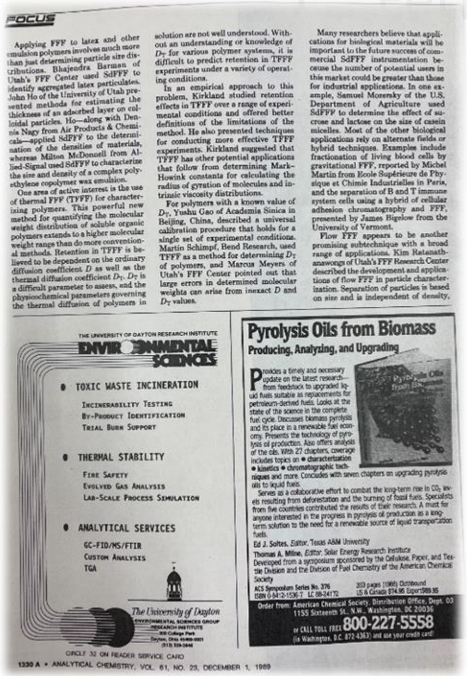


FOCUS

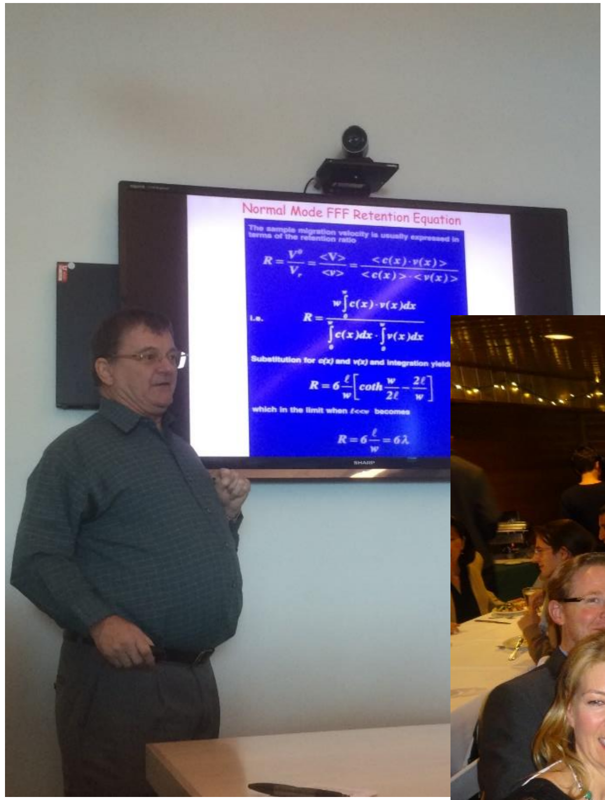
Chair : John Calvin Giddings

The place to be : Q9

A : Riverside in 2022

B : Salt Lake City in 2014

C : Columbia in 2018



The place to be : Q9

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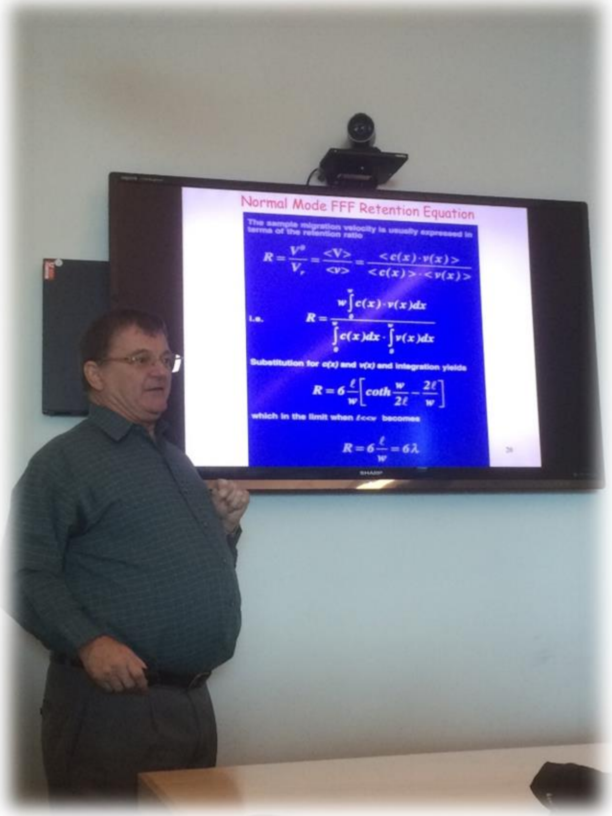


FFF 2014
October 12-16, 2014

17th International
Symposium On
Field- and Flow- Based Separations

Salt Lake City, Utah, USA

Program and Abstracts

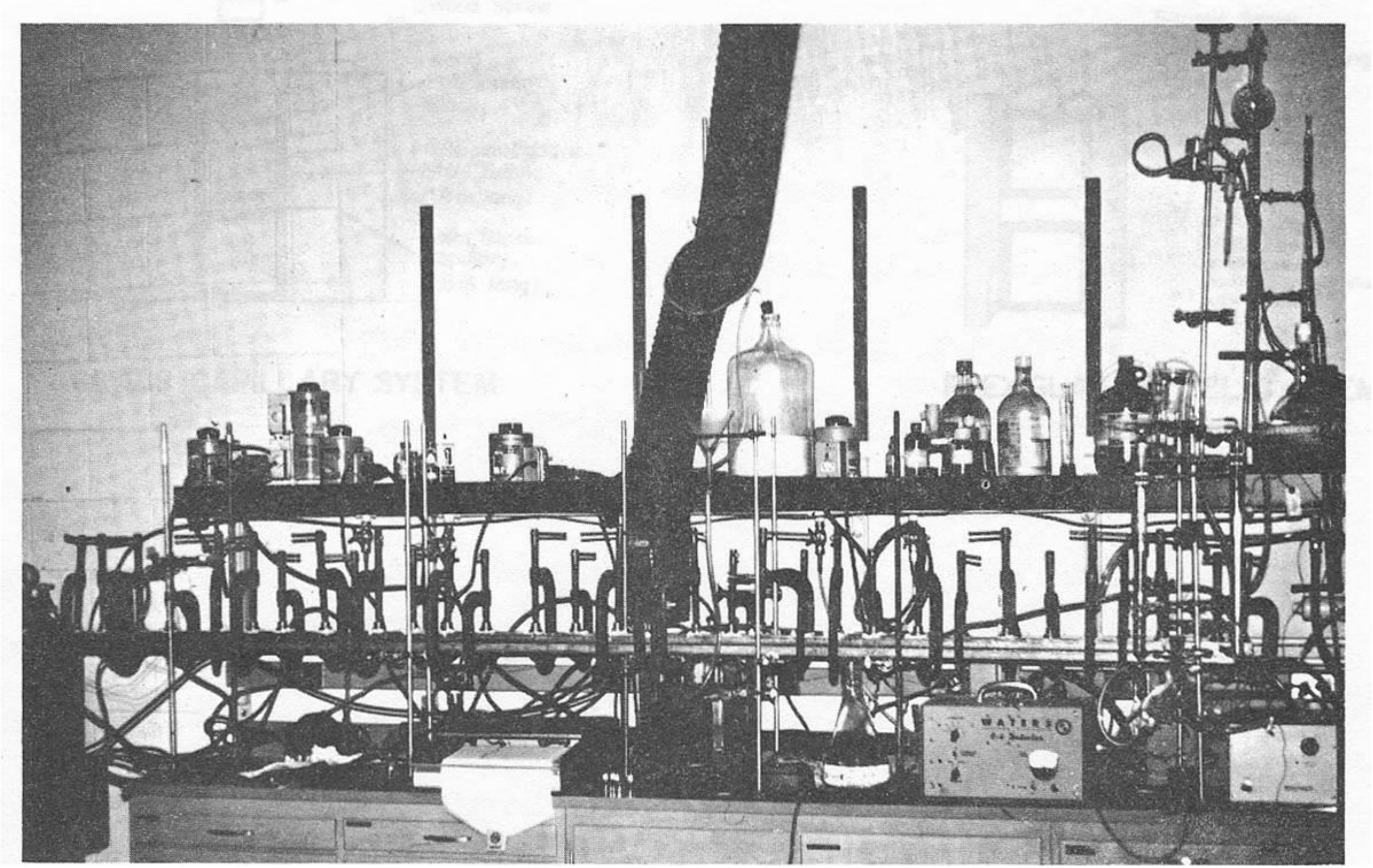
Chair : Bruce Gale

HISTORY

SEE PART 1 TO ANSWER...

What is it? **Q1**

A : M. C. Escher artwork
B : FFF instrument
C : Lab storage bench

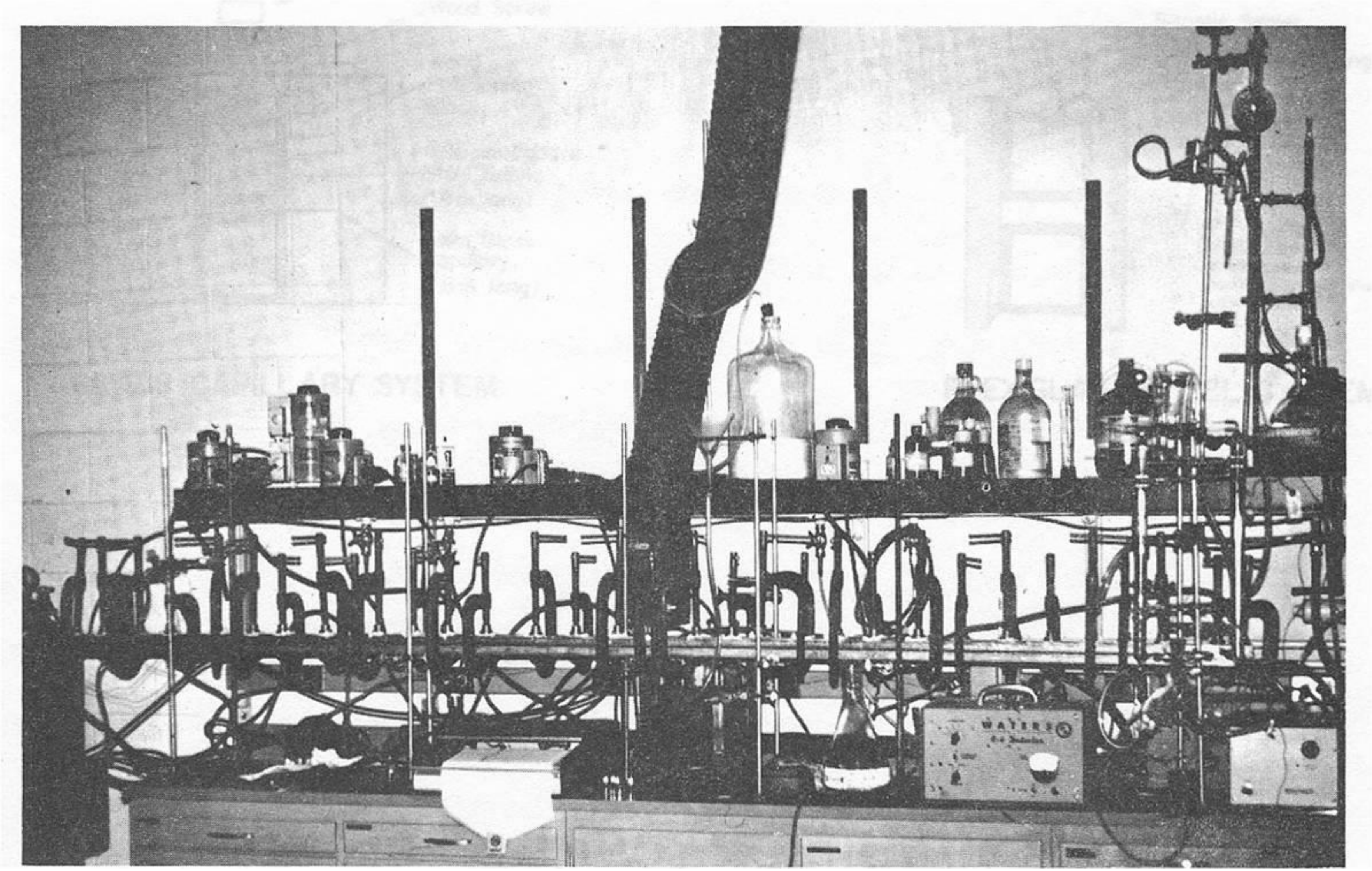


What is it? Q1

A : M. C. Escher artwork

B : FFF instrument

C : Lab storage bench



What is it? Q1

A : M. C. Escher artwork

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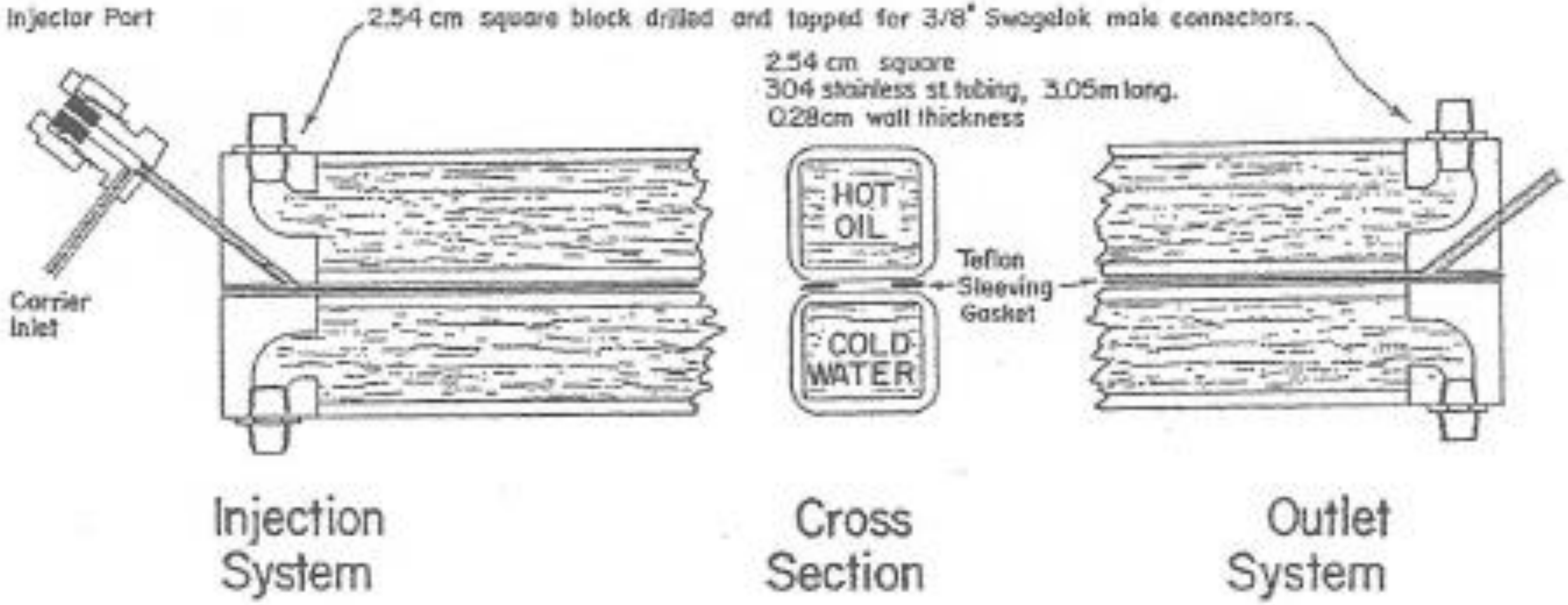
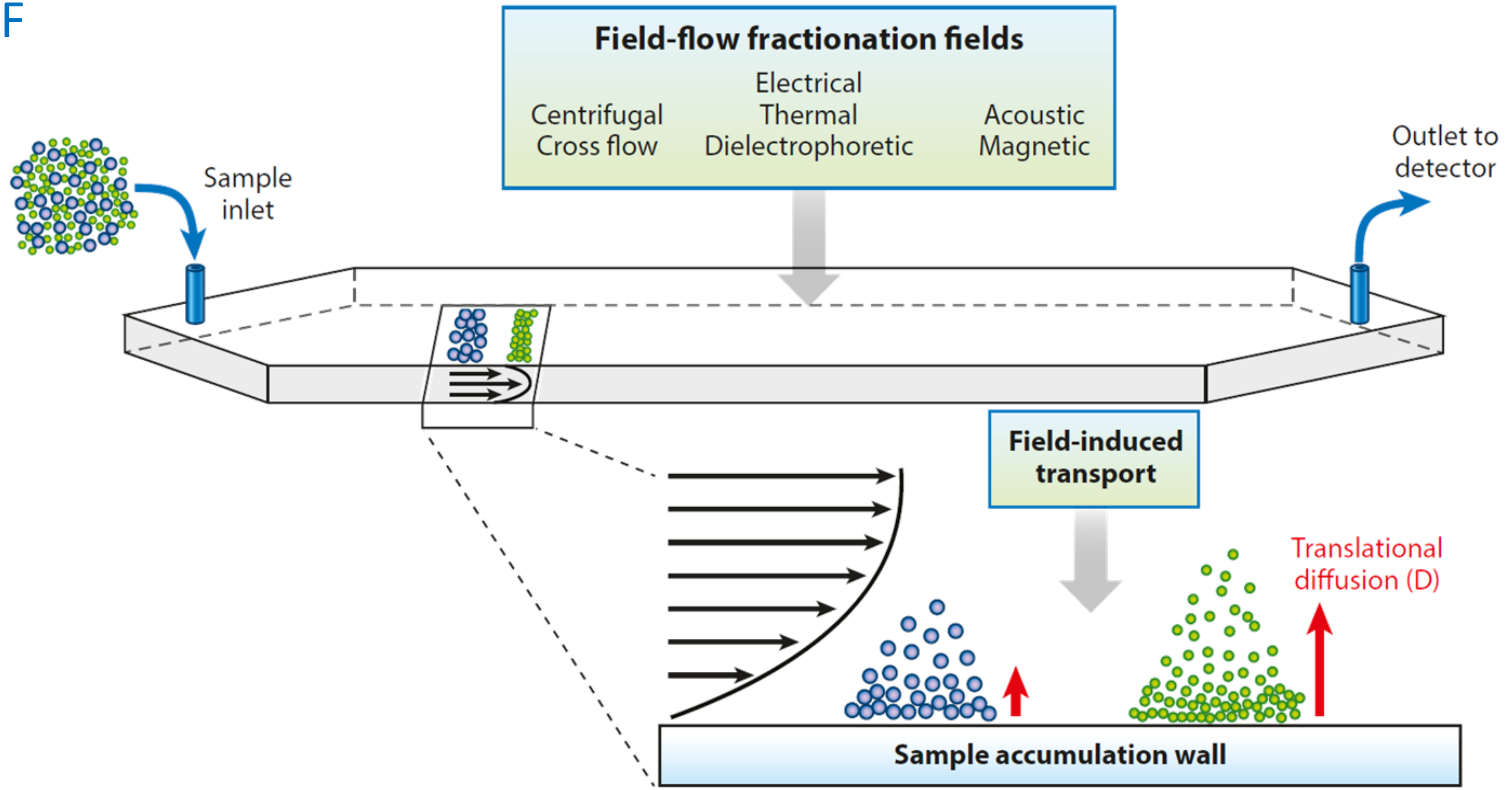


Figure 2. Diagram of the rectilinear channel system

ANALYTICAL CHEMISTRY

Which FFF technique produced the first experimental results? Q2

A : Flow FFF
B : Centrifugal or SdFFF
C : Thermal FFF
D : Dielectrophoretic
E : Magnetic
F : Acoustic



Which FFF technique produced the first experimental results? Q2

A : Flow FFF

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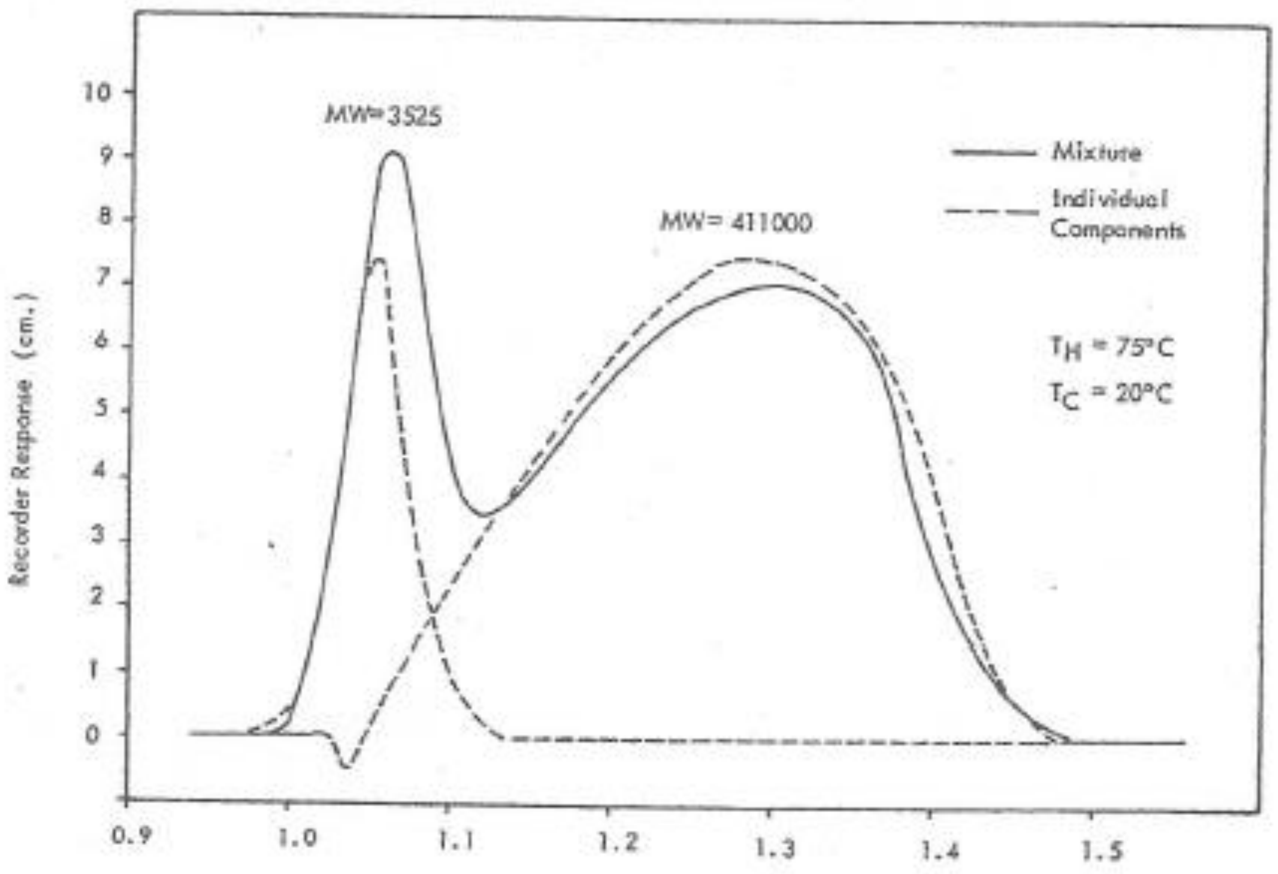


Thompson, Myers, Giddings, Sep Sci, 2, 797 (1967).

a mixture.

International Symposium on Field- and Flow-based Separations
iSFFF Nantes 2024 JUNE 3-6 2024

The origins of AF4

1332 Anal. Chem. 1987, 59, 1332–1339

Properties of an Asymmetrical Flow Field-Flow Fractionation Channel Having One Permeable Wall

Karl-Gustav Wahlund[1] and J. Calvin Giddings*

Department of Chemistry, University of Utah, Salt Lake City, Utah 84112

We describe here a flow field-flow fractionation channel having only a single permeable wall. This wall, serving as the accumulation wall, consists of a membrane/frit bilayer permeable to the carrier flow but impermeable to the sample. The opposite wall, impermeable to flow, is made of a glass plate, which renders the channel contents visible. In operation the channel has one incoming flowstream and two outgoing streams, one being the diffuse stream permeating the membrane. This design is technically simpler than conventional, more symmetrical designs where the upper wall is also permeable to flow. It is shown that the new design creates both longitudinal and transverse flow velocity gradients but retention, if sufficiently strong, can be interpreted in much the same way as with conventional channels. Theoretical expressions are obtained for velocity gradients, retention, and relaxation and focusing times. A fractionation of a mixture of proteins is shown in order to illustrate the potential for macromolecular separations.

Resolution in flow FFF, unlike that in other FFF subtechniques, has been well below what theory predicts (4). This indicates that phenomena causing excessive zone broadening are operative in the channel. These might be associated with distorted flow profiles for axial and transverse flow and/or sample immobilization (e.g., by adsorption) at the accumulation wall. It is essential to develop new methodologies and concepts to help understand and overcome this deficiency.

This paper presents a new design of the flow FFF channel which makes its construction technically simpler. The porous upper wall of the channel is replaced by a solid wall made of a glass plate. Thus the upper wall is impermeable to the carrier flow and the channel is left with only one source of carrier flow. This source is the channel inlet, located at one end of the channel. The carrier will exit the channel as two separate flowstreams, one a thin stream emerging from the outlet at the other channel end, and the other a diffuse stream passing through the accumulation wall.

This new "asymmetrical" design eliminates technical difficulties associated with the possible heterogeneity and uneven

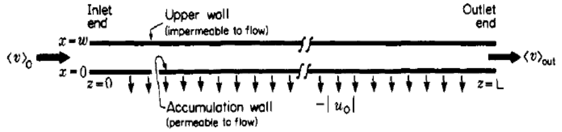


Figure 1. Schematic illustration of asymmetrical channel for flow field-flow fractionation. Flow velocities at designated locations are shown as $\langle v \rangle_0$, $\langle v \rangle_{out}$, and u_0 where the first two are the longitudinal flow velocities at the inlet and outlet ends, respectively, and u_0 is the crossflow velocity at the accumulation wall.

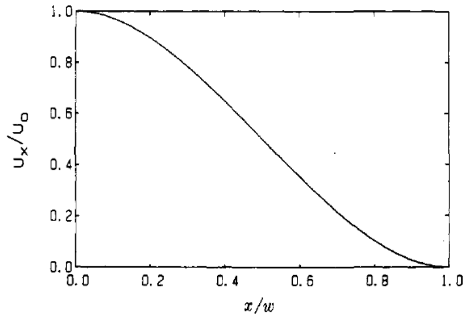


Figure 2. Crossflow velocity profile according to eq 1.

than the average longitudinal flow velocity, resulting in parabolic flow along the channel. Also the pressure drop along the channel is required to be much smaller than that across the accumulation wall in order to ensure a homogeneous permeation of the carrier. The transverse (crossflow) velocity distribution for our system according to this theory is

$$u_x = -|u_0|\left(1 - \frac{3x^2}{w^2} + \frac{2x^3}{w^3}\right) \qquad (1)$$

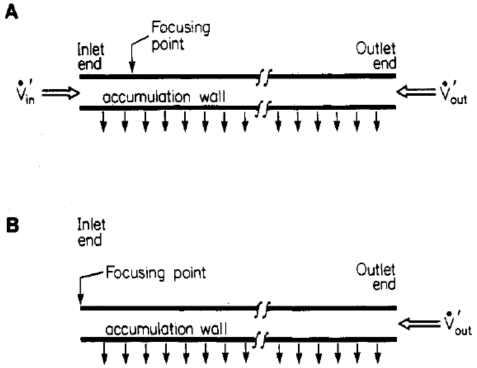


Figure 5. Schematic illustration of flow directions and focusing points for the two sample relaxation procedures. Part A illustrates opposing flow relaxation and B reverse flow relaxation.

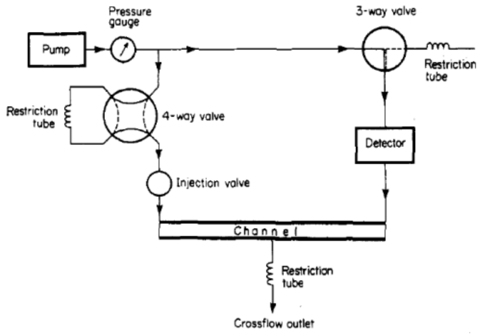


Figure 6. Illustration of flow system. The indicated flow direction and valve positions are for opposing flow relaxation and focusing. Dotted lines indicate valve positions during elution.

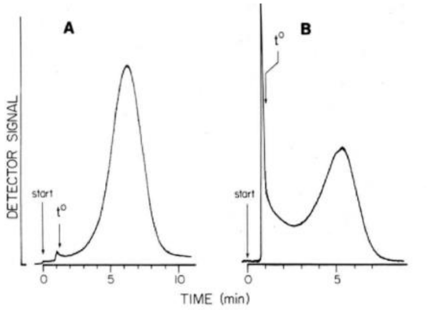
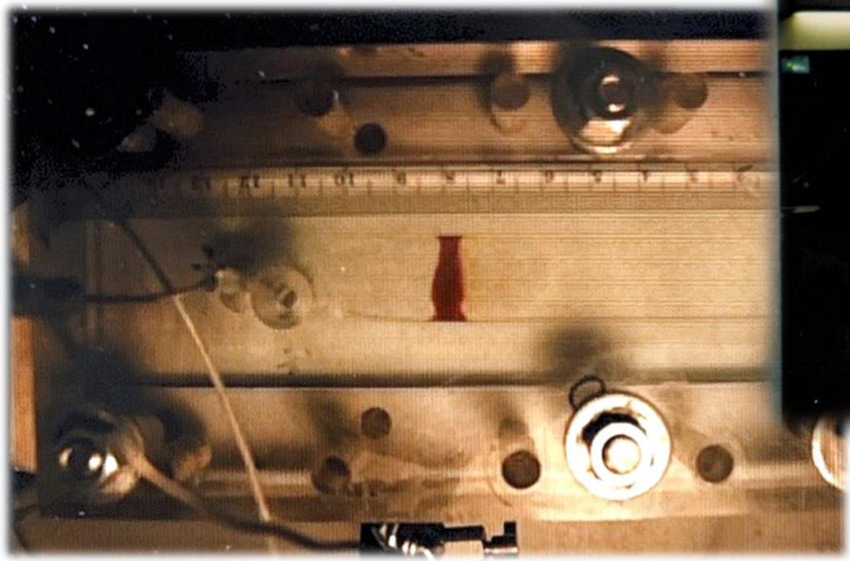
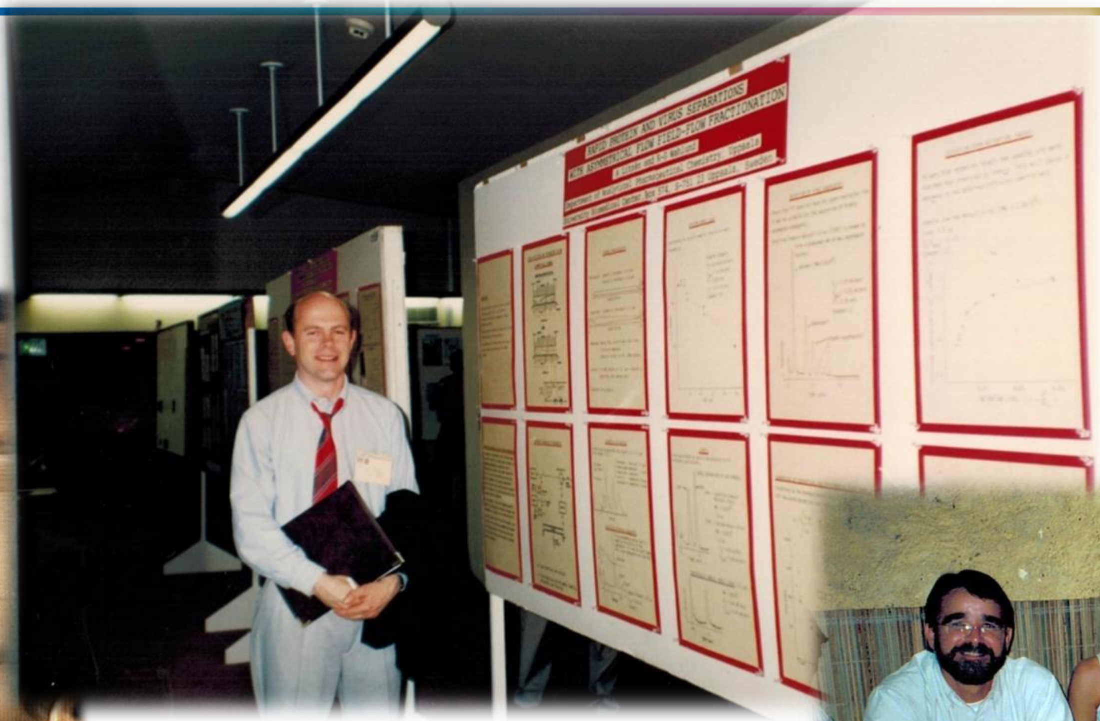


Figure 8. Comparison of cytochrome c peaks obtained with two sample relaxation methods. Flowrates during elution are as follows: $\dot{V}_{in}$ = 4.9 mL/min (23 psi); $\dot{V}_c$ = 3.19 mL/min; $\dot{V}_{out}$ = 1.75 mL/min. (A) Opposing flow relaxation with z' = 4.1 cm and cross flowrate ($\dot{V}_{in}'$ + $\dot{V}_{out}'$) = 3.4 mL/min (21 psi); relaxation/focusing time (preceding "start"), 17 min (τ(95%) = 10 min). (B) Reverse flow relaxation using cross flowrate = 4.9 mL/min (36 psi) and relaxation/focusing time = 19 min (τ(95%) = 6 min).

- First paper: Anal. Chem., 59, 1332 – 1339 (1987).

The origins of AF4





From the left, Enrica Alasonatti, Martin Schimpf…. **Lars Nilson** and Mauricio Hoyos

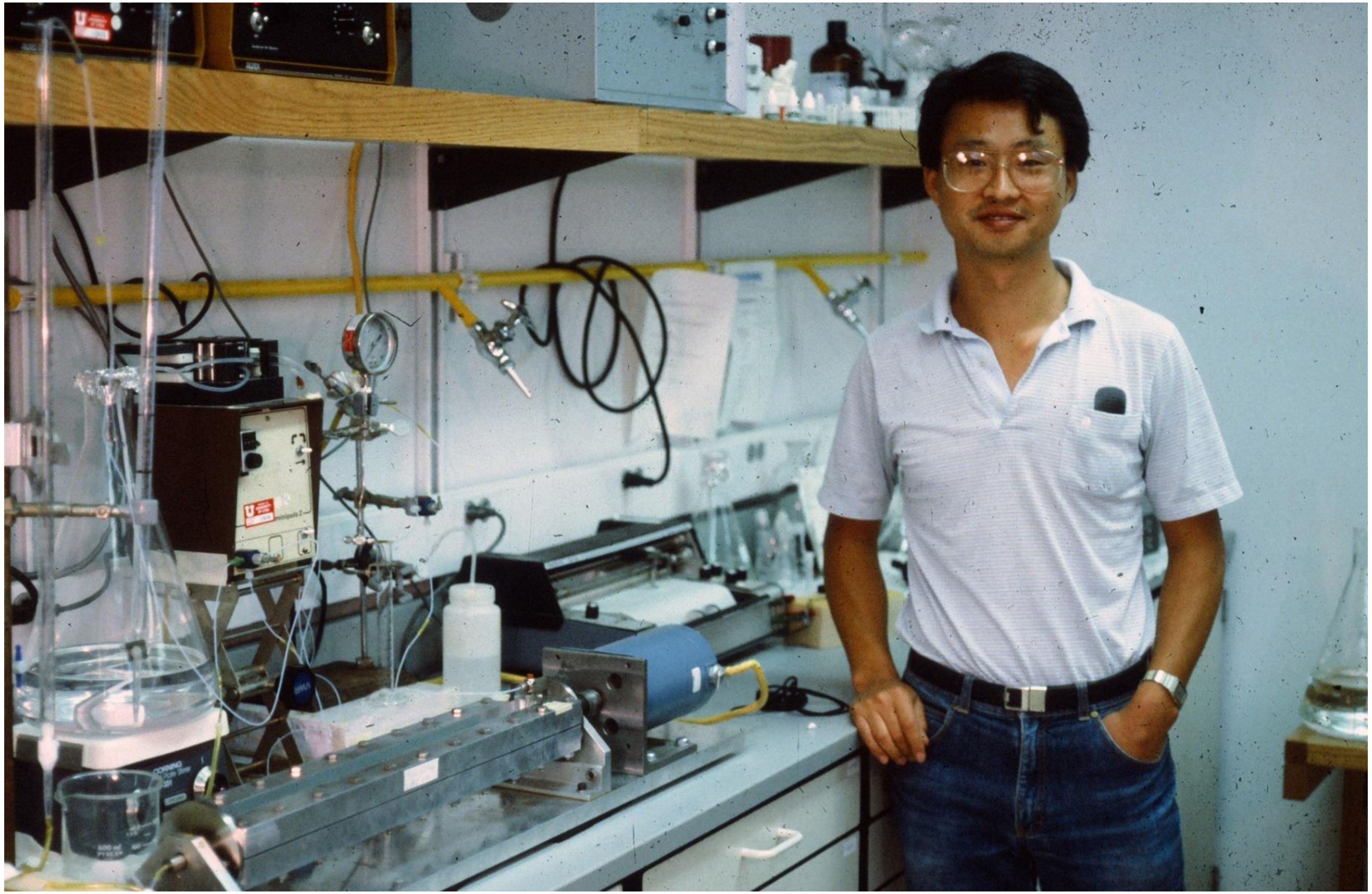
And don't forget KG’s students who did marvelous work over many years in Lund: Anne Litzen, Bengt Wittgren, Michael Nilsson, Mats Andersson, Cecilia Arfvidsson, Mats Leeman, Gustaf Modig, Lars Nilson, ….

What is Seungho Lee doing? Q3

A : Taking a break

B : Watching a soccer match

C : Creating new FFF techniques



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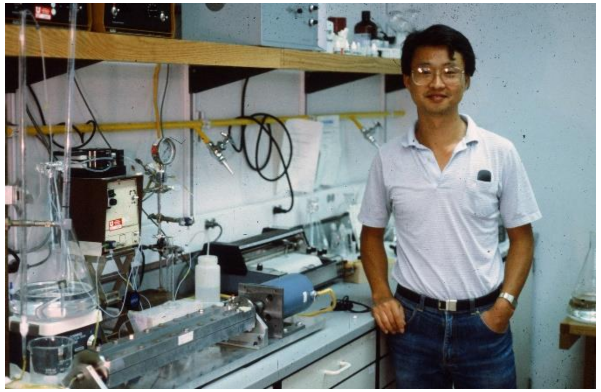
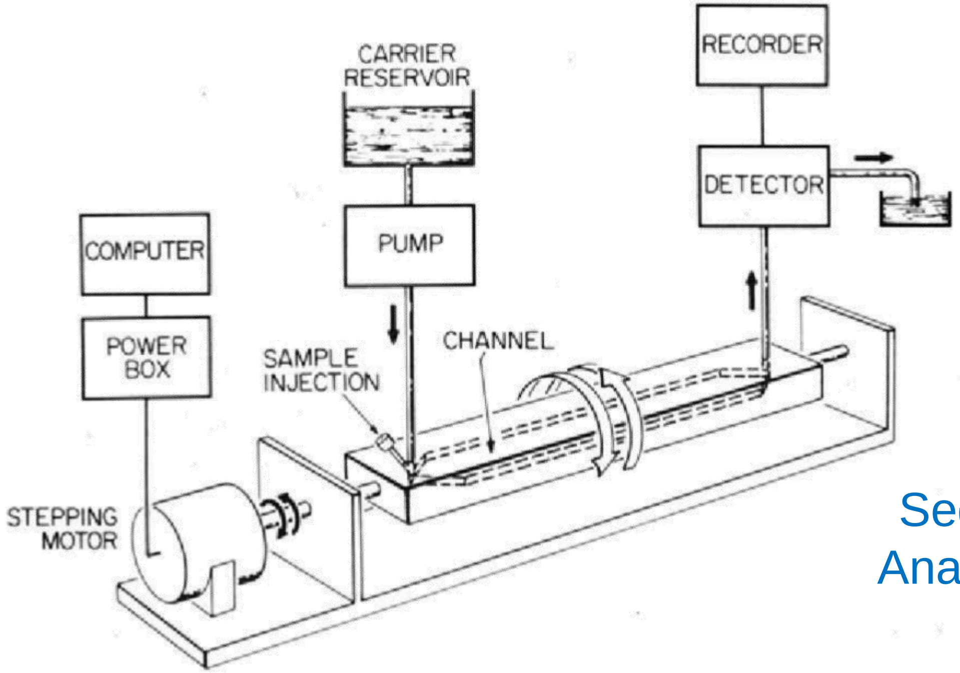
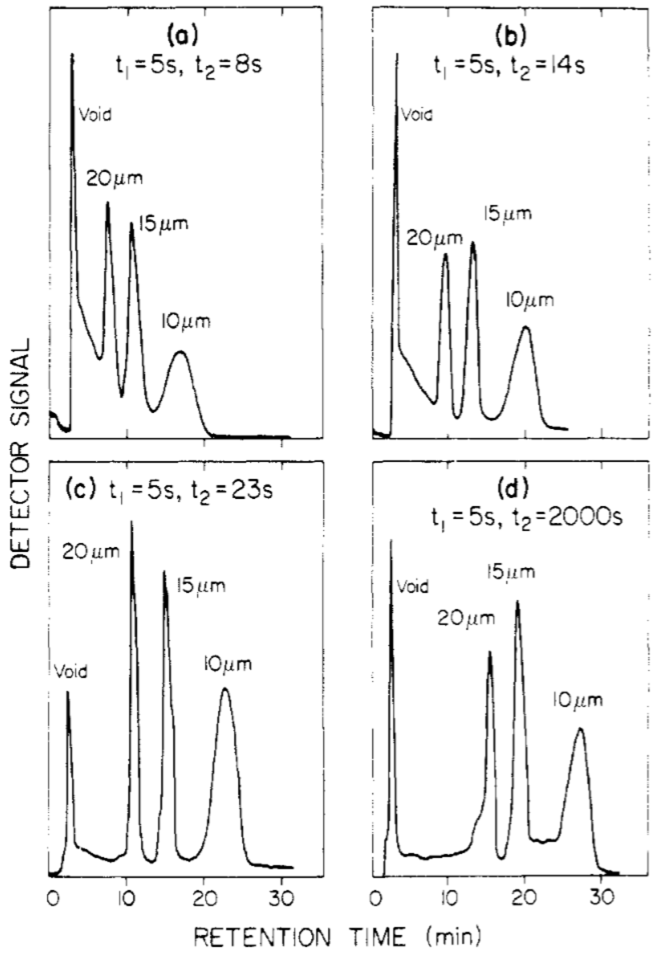




Sedimentation/Cyclical FFF
Anal. Chem., 60, 1129 – 1135 (1988).



iSFFF Nantes 2024
International Symposium on Field- and Flow-based Separations
JUNE 3-6 2024

What is it? Q4

A : FFF instrument controller box

B : White board with sticky notes

C : Box of unknown origin found in Kim Williams research lab

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“Icki” box created by Dale Heisler (with Marcus Myers), University of Utah.

When were commercial FFF instruments first shown at Pittcon? Q5

A : 1978
B : 1988
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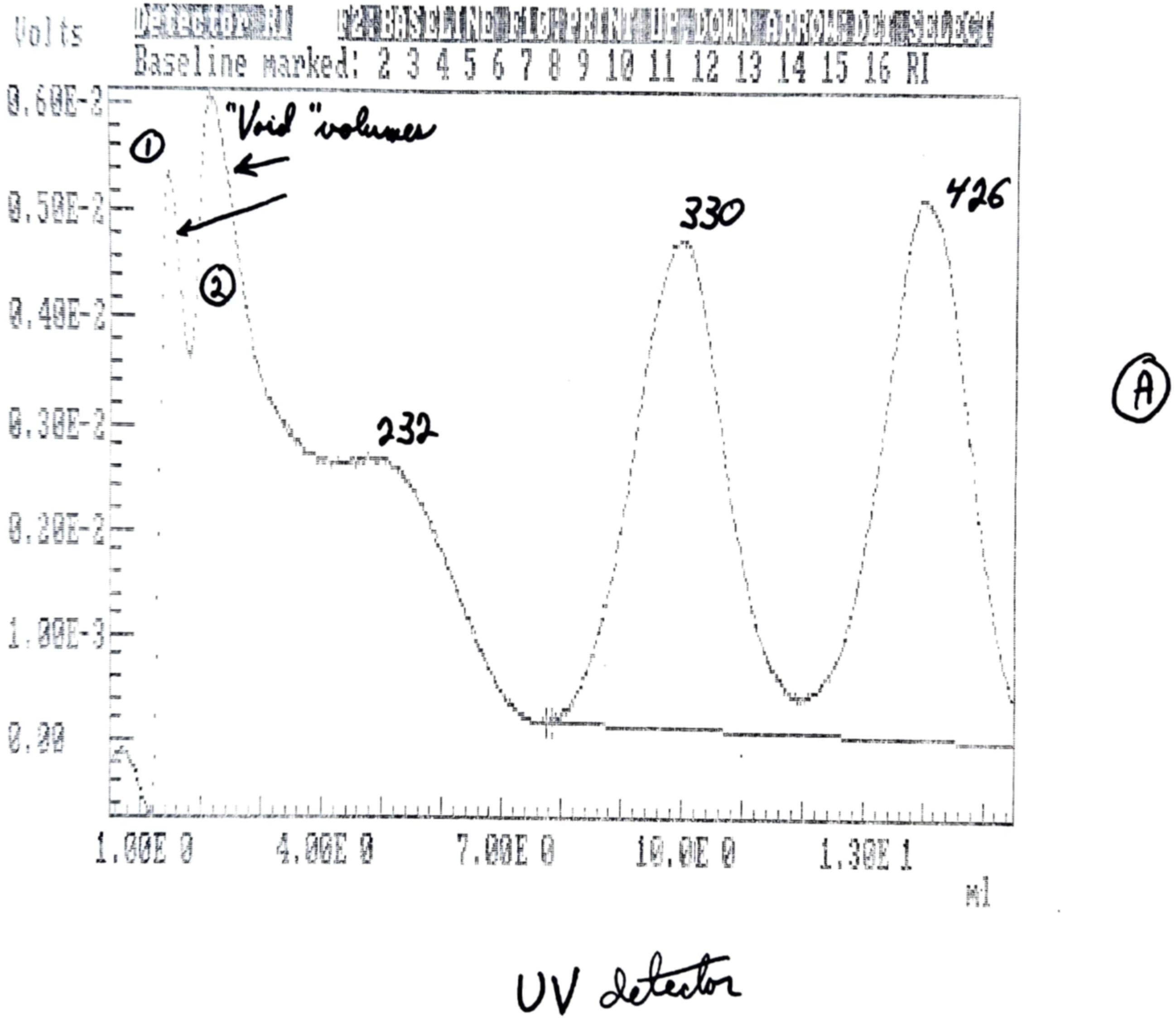
When was FFF first coupled to MALS? **Q6**

A : 1979
B : 1989
C : 1999
D : 2009



Who did this work? **Q7**

A : Myeong hee Moon
B : Phil Wyatt
C : Marcus Myers
D : Torsten Walter

Except from letter

A : 1979
B : 1989
C : 1999
D : 2009

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December 18, 1989

Professor Calvin Giddings
Chemistry Department
Henry Eyring Building, Room 2532
University of Utah
Salt Lake City, UT 84112

5. Finally, some results of my recent studies concerning Moon's measurements on SFFF of three latex "standards" of nominal diameter 232, 330, and 426 nm. Graph A presents the UV detector output and the designations of the peaks by Moon. On this basis, I normalized the detectors using the full Lorenz-Mie theory for the 330 nm results. The normalization coefficients were generated by comparing the measured results for 3 different slices in the peak at the scattering angles listed in Exhibit **B**. The lowest and highest angles (4.25° and 143.77°) were dropped. All numbers were relative to the values at 90°. The Lorenz data are shown attached to **B** also. Exhibit **C** lists the revised normalization coefficients for these experiments. Note that the booster amplifier gains had been set by me to 1X for detectors 3 through 9, and 21X for detectors 10 through 15.

WYATT TECHNOLOGY CORPORATION

Phil

Philip J. Wyatt
President
PJW:hmb
Enclosures

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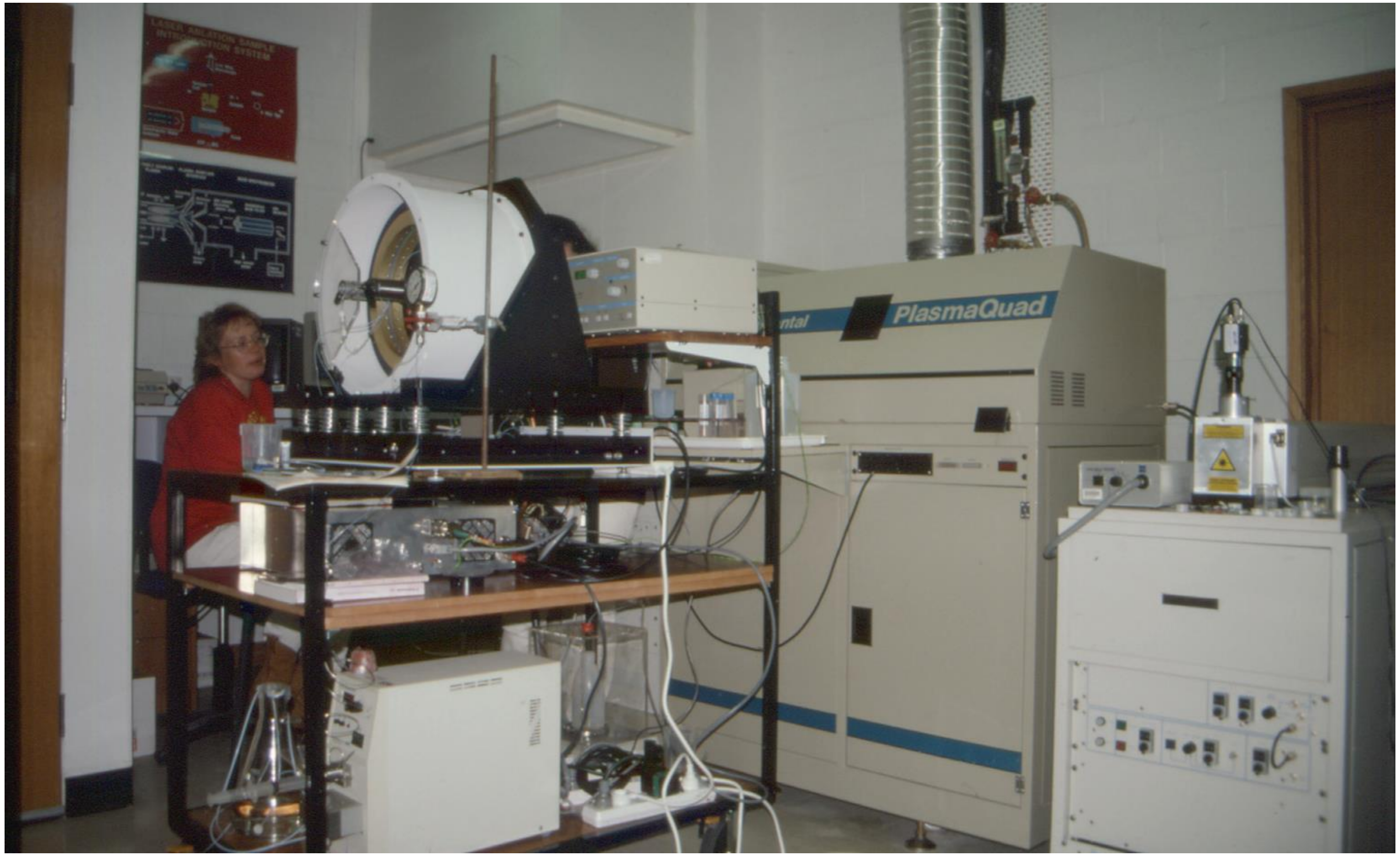
When was FFF first coupled to ICP? Q8

A : 1970s
B: 1980s
C: 1990s
D: 2000s

Who did this work? Q9

A : Deidre Murphy
B: Ron Beckett
C: Atitaya Siripinyanond
D: Raymond Barnes, Univ of Massachussetts



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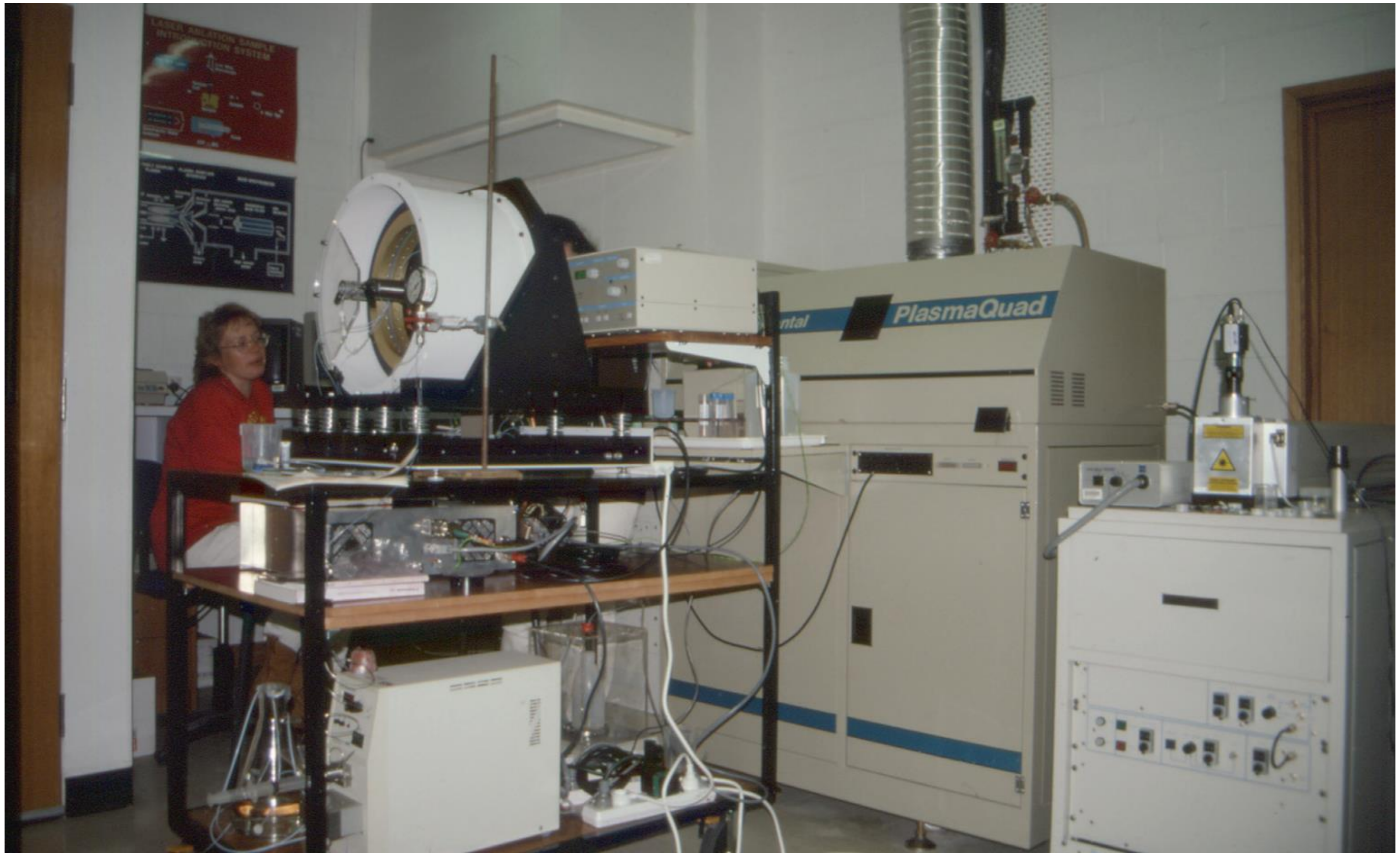

D.M. Murphy, et al., J. Chromatogr. 642, 459-467 (1993).

How many times has France hosted the FFF symposium? **Q10**

A : One

B : Two

C : Three

D : Too many to remember

How many times has France hosted the FFF symposium? Q10

A : One
B : Two
C : Three
D : Too many to remember