

SPICA 2008



ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



12th International
Symposium on
Preparative and
Industrial
Chromatography and
Allied Techniques

Congress Program

September 28 to October 1, 2008
ETH Zurich, Switzerland
www.spicazoo8.ethz.ch



Congress Partner

Program at a Glance

Sunday September 28, 2008	Monday September 29, 2008	Tuesday September 30, 2008	Wednesday October 1, 2008
		07:00 Young Scientist Buffet Breakfast G. J. Terfloth	
	08:15 Registration	Continuous Chromatography I	Continuous Chromatography II
	09:15 Opening Address	08:30 Keynote Lecture O. Werbitzky	08:30 Keynote Lecture F. Kjell
	Materials I	09:00 S. Katsuo	09:00 O. Ludemann-Homb.
	09:30 Keynote Lecture W. Lindner	09:15 M. Kaspereit	09:15 L. Aumann
	10:00 E. Francotte	09:30 J. P. B. Mota	09:30 M. Pennings
	10:15 S. R. Mukai	09:45 E. Valery	09:45 Y. Kawajiri
	10:30 Coffee Break	10:00 D. Schlinge	10:00 D. Horneman
		10:15 Coffee Break	10:15 Coffee Break
	Solide-Solute Interactions	Processes II	Manufacturing
	11:00 Keynote Lecture B. Sellaergren	10:45 Keynote Lecture W. Kuhne	10:45 Keynote Lecture L. Beaver
	11:30 C. Frech	11:15 T. M. Pabst	11:15 M. Degerman
	11:45 A. Jungbauer	11:30 B. K. Nfor	11:30 W. R. Leonard Jr.
	12:00 O. R. T. Thomas	11:45 P. A. J. Rosa	11:45 H. Hüttmann
	12:15 M. Salvalaglio	12:00 P. Wood	12:00 C. Langel
	12:30 Lunch Break	12:15 K. Kaczmarek	12:15 P. Franco
		12:30 Lunch Break	12:30 Closing Remarks
13:00 Registration open until 20:00			12:45 Lunch Break
Workshops	Materials II	Membranes	
14:00 Workshops 1, 2 & 3	14:00 Keynote Lecture M. Lohrmann	14:00 Keynote Lecture G. Belfort	14:00 Start of SFC 2008
	14:30 E. Ndocko	14:30 M. Kreuß	
	14:45 F. Oehme	14:45 P. van Beijeren	
	15:00 J. Souquet	15:00 C. Boi	
	15:15 E. Yilmaz	15:15 F. Sousa	
15:30 Coffee Break	15:30 Coffee Break	15:30 Coffee Break	
Workshops	Processes I	Special Symposium	
16:00 Workshops 4, 5 & 6	16:00 Keynote Lecture M. Lögers	16:00 Present and Future of Chromatography Purification Chair: A. Jungbauer	
	16:30 N. Mavroudis		
	16:45 C. Wenda		
	17:00 U. Emde		
	17:15 J. Priess		
17:30 Break	17:30 T. Fornstedt		
	17:45 D. Antos		
18:00 Welcome Reception Dozentenfoyer ETH Zentrum	18:00 Poster Session I with Drinks	18:00 Poster Session II with Drinks	
		20:00 Gala-Dinner	

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Welcome

The Scientific Committee cordially welcomes you in Zurich at the International Symposium on Preparative and Industrial Chromatography and Allied Techniques (SPICA).

SPICA 2008 is the 12th event in a series of symposia started in Paris in 1986. Since then, SPICA has become a regular appointment for scientists and practitioners involved in downstream processing of fine chemicals, natural products, drugs, food activities, flavors and aromas. Specifically, the focus of the symposium is on highly added-value products. Chemists, biotechnologists and engineers discuss various technologies including membranes, crystallization, filtration and extraction, with particular emphasis on chromatography. The considered topics range from modeling activities to the development of preparative and large scale separation and purification processes. The focus of SPICA will be both on small molecules and large molecules, which are of current interest in the development of new drugs, such as polypeptides and proteins.

For everyone involved in requirements on purity, yield and productivity, the SPICA 2008 symposium provides an ideal source of new ideas and of opportunities to interact with colleagues from academia and industry. SPICA 2008 offers a forum for the discussion of problems of common interest and for the establishment of new relations. The program includes oral technical and scientific communications, as well as poster presentations, with a proper balance between industry and academia. Issues related to new trends and future scope of separation science and technology as well as opportunities for supporting research and business activities are addressed within invited lectures and panel discussions. A matching exhibition will provide an up to date overview of current technologies in chromatographic separations, including stationary phases, equipment, products and software.



Massimo Morbidelli

Scientific Committee

- Jules Dingenen, Johnson & Johnson Pharmaceutical Research & Development, Beerse, Belgium
- Eric Francotte, Novartis AG, Basel, Switzerland
- Alois Jungbauer, University of Vienna, Austria
- Joachim Kinkel, Georg-Simon-Ohm University of Applied Sciences, Nuernberg, Germany
- Olivier Ludemann-Homburger, Novasep SAS, Pompey, France
- Marco Mazzotti, ETH Zurich, Switzerland
- Anton Middelberg, University of Queensland, Brisbane, Australia
- Massimo Morbidelli, ETH Zurich, Switzerland
- Owen Thomas, University of Birmingham, Edgbaston, United Kingdom
- Arvind Rajendran, Nanyang Technological University, Singapore
- Domingo Sanchez, Eka Chemicals, Bohus, Sweden
- Andreas Seidel-Morgenstern, University of Magdeburg and MPI for Dynamics of Complex Technical Systems, Magdeburg, Germany
- Jochen Strube, Technical University, Clausthal, Germany
- Gerarld Terfloth, GlaxoSmithKline, King of Prussia, USA

Organization

Organized by

ETH Zurich
Institute for Chemical and Bioengineering, ICB

Chairman

Massimo Morbidelli, ETH Zurich

Under the Auspices of

Schweizerische Chemische Gesellschaft (SCS)
Gesellschaft Deutscher Chemiker
Società Chimica Italiana
Société Française de Chimie
Europ. Federation of Biotechnology's Working Group on Downstream Processing
Contact Group for Research Matters KGF

Conference Offices

Conference office for scientific matters

ETH Zurich
Institute for Chemical and Bioengineering
Wolfgang-Pauli-Strasse 10 / HCI F131
8093 Zurich, Switzerland

Massimo Morbidelli,
Email: massimo.morbidelli@chem.ethz.ch

Christine Missak,
Email: christine.missak@chem.ethz.ch

Phone: +41 44 632 30 33
Fax: +41 44 632 10 82

Conference office for logistic matters

Grass Roots Switzerland AG
Weinbergstrasse 11
8001 Zurich, Switzerland

Edith Wieland
Email: edith.wieland@grg.com

Phone: +41 44 252 50 30
Fax: +41 44 251 31 49

Topics

Materials

- Novel Stationary Phases and Membranes
- Surface Characterization and Transport Properties
- Packing and Flow in Chromatographic Columns and Membranes
- Design of Selective Ligands

Processes

- Theory, Modelling and Simulation of Separation Processes
- Purification Processes in Biotechnology
- Optimization and Integration of the Cascade of Units in Industrial Purification Processes (Crystallization, Membranes, Extraction and Chromatography)
- Development of Continuous Purification and Separation Processes
- Supercritical Separation Processes
- Chiral Separations

Manufacturing

- Separation of Active Pharmaceutical Ingredients (API) and their Intermediates
- Process Analytical Technologies (PAT)
- Impact of the Technology Choice on the Cost Structure of the Downstream Process
- Buffer and Solvent Recycling and Equipment Cleaning
- Purification of Peptides and Proteins

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Scientific Program

Sunday, September 28, 2008

13:00 – 20:00 Registration

Workshops 1, 2 & 3

14:00 – 15:30 *Preparative HPLC. Phase Screening, Method Optimization and Process Development*

M. Schulte, Merck KGaA, Darmstadt, Germany

Toolbox to Understand Simulated Moving Beds

M. Mazzotti¹ and A. Rajendran², ETH Zurich, Switzerland¹, Nanyang Technological University, Singapore²

From Leads to Production – How Chromatography is Scaled Up

J. Strube¹, R. Ditz², S. Boecker³, Clausthal University of Technology, Germany¹, Merck KGaA, Darmstadt, Germany², Bayer Technology Services GmbH, Leverkusen, Germany³

15:30 – 16:00 Coffee Break

Workshops 4, 5 & 6

16:00 – 17:30 *Supercritical Fluid Chromatography*

O. Ludemann – Hombourger¹, G. Terfloth², Novasep Process, Pompey, France¹, GlaxoSmithKline, King of Prussia, USA²

Bioseparation: Removal of Adventitious Agents, DNA and Endotoxins

A. Jungbauer, University of Natural Resources and Applied Life Sciences, Vienna, Austria

Continuous Chromatography of Biomolecules

M. Morbidelli¹, L. Aumann^{1,2}, G. Stroehlein^{1,2}, T. Mueller – Spaeth¹, ETH Zurich¹, Switzerland, ChromaCon AG, Zürich, Switzerland²

17:30 – 18:00 Break

Welcome Reception

18:00 – 20:00 Dozentenfoyer, ETH Zurich

Monday, September 29, 2008

08:15 – 09:15 Registration

09:15 – 09:30 Opening Address

Session – Materials I

09:30 – 10:00 (0126) **W. Lindner, University of Vienna, Austria**

Keynote Lecture: Chromatographic Selectivity as a Key Parameter to be Adjusted via the Stationary and Mobile Phases

10:00 – 10:15 (1117) **E. Francotte, P. Richert, G. Diehl, D. Huynh and J. Priess, Novartis, Basel, Switzerland**

A New Generation of Powerful Chiral Stationary Phases for HPLC, SFC, and SMB

10:15 – 10:30 (1012) **S. R. Mukai, S. Murata, K. Onodera, A. Eguchi, Y. Yao and T. Masuda, Hokkaido University, Sapporo, Japan**

Synthesis of Monolithic Columns Equipped with a Hierarchical Pore System of Micro/Mesopores and Macropores Using the Ice Template Method

10:30 – 11:00 Coffee Break

Session – Solid-Solute Interactions

11:00 – 11:30 (0142) **B. Sellergren, University of Dortmund, Germany**

Keynote Lecture: Affinity-based Separations Using Imprinted Polymers

11:30 – 11:45 (1134) **C. Frech¹, E. Todorova¹, H. Graalfs², A. Schwämmle² and M. Jöhnck², Hochschule Mannheim - University of Applied Sciences, Germany¹, Merck KGaA, Darmstadt, Germany²**

Direct Capture of Antibodies from Fermentation Broth Using a New Multi-modal High Salt Binding Ion Exchange Material

11:45 – 12:00 (1081) **T. Tarmann and A. Jungbauer, University of Natural Resources and Applied Life Sciences, Vienna, Austria**

Adsorption Properties of DNA on Charged Surfaces

12:00 – 12:15 (1087) **A.M. Liddy, G. Wynn-Jones, E. Theodosiou and O. R. T. Thomas, The University of Birmingham, Edgbaston, United Kingdom**
Bilayered SEC-IEC adsorbents for improved separation of bioparticulate nanoplex products

12:15 – 12:30 (1061) **M. Salvalaglio, V. Busini, L. Zamolo and C. Cavallotti, Politecnico di Milano, Italy**
Molecular Dynamic Investigation of the Interaction of Supported Affinity Ligands with Monoclonal Antibodies

12:30 – 14:00 Lunch Break

Session – Materials II

14:00 – 14:30 (0033) **S. Böcker and M. Lohrmann, Bayer Technology Services GmbH, Leverkusen, Germany**
Keynote Lecture: Challenges in Packing of Process Columns

14:30 – 14:45 (1036) **E. Ndocko¹, R. Ditz² and J. Strube³, Bayer Technology Services GmbH, Leverkusen, Germany¹, Merck KGaA, Darmstadt, Germany², Clausthal University of Technology, Germany³**
Material Design Strategy for Chromatographic Separation Steps in Bio-Recovery Downstream Processing

14:45 – 15:00 (1047) **F. Oehme, K. Kaiser, J. Lenz and J. Peters, Bayer HealthCare AG, Wuppertal, Germany**
“Mixed-mode” Chromatography Materials in Downstream Process Development

15:00 – 15:15 (1089) **J. Souquet¹, H. Liu¹, J. Liu¹, X. Fan¹, J. Liddell², P. Levison³, E. Theodosiou¹ and O. R. T. Thomas¹, The University of Birmingham, United Kingdom¹, Avecia Biologics Ltd, Billingham, United Kingdom², Pall Europe Ltd, Portsmouth, United Kingdom³**
Tracking the Movement of Individual Adsorbent Particles in Expanded Beds

15:15 – 15:30 (1075) **E. Yilmaz, C. Widstrand, A.-K. Wihlborg and A. Rees, MIP Technologies AB, Lund, Sweden**
Facilitated Extractions with Selective Resins - the Use of MIPs in Separations and Analysis

15:30 – 16:00 Coffee Break

Session – Processes I

16:00 – 16:30 (0145) **J.B. Lenfers and M. Lögers, Bayer Schering Pharma, Wuppertal, Germany**

Keynote Lecture: Present and Future Technology Trends in API Development

16:30 – 16:45 (1131) **N. Mavroudis¹, P. Bongers¹, J. Koek¹, S. Dubbelman¹ and M. Mazzotti², Unilever Food and Health Research Institute, Vlaardingen, the Netherlands¹, ETH Zurich, Switzerland²**

Retention of Amino-Acids in Ion Exchange/Exclusion Chromatography

16:45 – 17:00 (1039) **C. Wenda, A. Rajendran and M. Amanullah, Nanyang Technological University, Singapore**

Optimized Preparative Supercritical Fluid Chromatography: Enantioseparation of Flurbiprofen

17:00 – 17:15 (1022) **U. Emde, M. Dietz, H. Reubold and H. Pflug, Merck KGaA, Darmstadt, Germany**

Sample Solubility - Important Parameter for Successful Preparative Chiral Chromatography

17:15 – 17:30 (1016) **J. Priess and E. Francotte, Novartis, Basel, Switzerland**

A Versatile Solubility Screening Platform for Preparative Chromatography: Methodology and Applications

17:30 – 17:45 (1071) **T. Fornstedt¹, P. Forssén¹, R. Arnell², M. Kaspereit³ and A. Seidel-Morgenstern^{3,4}, Uppsala University, Sweden¹, AstraZeneca AB, Södertälje, Sweden², Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany³, Otto-von-Guericke-University, Magdeburg, Germany⁴**

Utilisation of Peak Shape Tuning to Optimize Preparative Batch Chromatography

17:45 – 18:00 (1018) **Kramarz, W. Piatkowski and D. Antos, Rzeszów University of Technology, Poland**

Altering Efficiency of Hydrophobic Interaction Chromatography by Combined Salt and Temperature Effects

Poster Session I

18:00 – 20:00 Poster Presentations

(2002) **N. Bian¹, N. Soice¹, C. Wang¹, K. S. Cheng¹, S. Ramaswamy¹, and K. Beyzavi², Millipore Corporation, Bedford, USA¹, Millipore Corporation, Consett, United Kingdom²**

Resin Optimization for Affinity Chromatography Media

(2008) **R. M. Dias and C. C. Santana, State University of Campinas, Brazil**

Chiral Chromatographic Separation of o,p'-Dichlorodiphenyldichloroethane (Mitotane) in Semi-preparative Columns of o,o'-bis[4-Tert-butylbenzoyl]-n,n'-diallyl-l-tartadamide and Separation Regions for a Simulated Moving Bed

(2013) **K. Hallman, B. Kofoed-Hansen and D. Börjesson, Eka Chemicals AB, Bohus, Sweden**

Important Aspects when Designing Chiral Preparative Separations Using Coated Polysaccharide Stationary Phases

(2019) **J. Nowak¹, I. Poplewska², D. Antos² and A. Seidel-Morgenstern^{1,3}, Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany¹, Rzeszów University of Technology, Poland², Otto-von-Guericke-University, Magdeburg, Germany³**

Adsorption Behavior of Sugars versus their Activity in Single and Multicomponent Liquid Solutions

(2020) **F. Torrens¹ and G. Castellano², Universitat de València, Spain¹, Universidad Católica de Valencia San Vicente Mártir, València, Spain²**

Binding of Water-Soluble, Globular Proteins to Anionic Model Membranes

(2023) **T. Keller¹, N. Forrer² and L. Jelinek¹, Zeochem AG, Uetikon, Switzerland¹, ETH Zurich, Switzerland²**

A New Silica Gel from Zeochem AG for Preparative HPLC: ZEOsphere

(2027) **M. M. H. El-Sayed and H. A. Chase, University of Cambridge, United Kingdom**

Cation-exchange Adsorption of the two Major Whey Proteins

(2029) **J. Li and H. A. Chase, University of Cambridge, United Kingdom**

Characterization and Evaluation of Amberlite XAD7HP for Use in the Expanded Bed Adsorption of Flavonoids

- (2030) **J. Li and H. A. Chase, University of Cambridge, United Kingdom**
The Use of Expanded Bed Adsorption (EBA) to Purify Flavonoids from Ginkgo Biloba L.
- (2032) **V. Brochier, T. Robin, V. Ravault and A. Schapman, Pall BioSeptra, Cergy, France**
Lab-scale Optimization and Scale-up of two Purification Steps Using a Mixed-mode and a Novel Ion Exchange Sorbent
- (2034) **K. Morishita¹, T. Matsutomi¹, J. Kadoya¹ and G. Krautz², Daiso Co., Ltd., Osaka, Japan¹, Daiso Fine Chem GmbH, Düsseldorf, Germany²**
New Process Scale Stationary Phase for Peptide Purification
- (2040) **C. Wenda and A. Rajendran, Nanyang Technological University, Singapore**
Supercritical Fluid Chromatography Enantioseparation of Flurbiprofen: Determination of Non-linear Isotherms
- (2042) **C. Boi¹, S. Dimartino¹, G. C. Sarti¹, S. Hofer² and W. Lindner², Università di Bologna, Italy¹, University of Vienna, Austria²**
Influence of Different Spacer Arms on A2P Affinity Membranes for Human IgG Capture
- (2044) **L. Joron¹, J. Fisher², A. Gehris² and J. Maikner², Rohm and Haas-Advanced Biosciences, Chauny, France¹, Rohm and Haas-Advanced Biosciences, Philadelphia, USA²**
An Economical Approach to Upstream Decolorization
- (2046) **L. Joron¹, J. Fisher², A. Gehris² and J. Maikner², Rohm and Haas-Advanced Biosciences, Chauny, France¹, Rohm and Haas-Advanced Biosciences, Philadelphia, USA²**
Rapid Removal of Detergents from Protein Solutions Using Polymeric Reversed Phase Resins
- (2051) **S. Katsuo, O. Kartachova and M. Mazzotti, ETH Zurich, Switzerland**
Measurement of Adsorption Isotherms of Träger's Base Enantiomers for Chromatography-Crystallization Combined Process Design

(2052) **K. Wrzosek, M. Gramblicka and M. Polakovic, Slovak University of Technology, Bratislava, Slovakia**

Equilibrium and Kinetics of IgG Adsorption on a Strong Cation-exchanger

(2053) **I. Tatárová¹, M. Polakovic¹ and R. Fáber², Slovak University of Technology, Bratislava, Slovakia¹, Sartorius Stedim Biotech, Göttingen, Germany²**

Investigation of Bimodal Pore Structure of Sartobind Q Membrane Adsorbent Using Different Experimental Techniques

(2067) **R. Marti¹, S. Höck¹ and M. Juza², ZHAW Zürcher Hochschule für Angewandte Wissenschaften, Winterthur, Switzerland¹, Siegfried Ltd., Zofingen, Switzerland²**

Chromatographic Purification of Reference Standards – a Case Study

(2068) **H. Gumm¹, M. Hamdan² and W.-R. Jueterbock¹, Sepiatec GmbH, Berlin, Germany¹, GlaxoSmithKline SpA, Verona, Italy²**

Implementation of a New Strategy for Rapid Enantiomer Screening

(2078) **K. Vanková, M. Gramblicka and M. Polakovic, Slovak University of Technology, Bratislava, Slovakia**

Adsorption Equilibria of Fructose, Glucose, Sucrose and Fructooligosaccharides on a Cation-exchange Resin

(2079) **A. Damtew¹ and A. Seidel-Morgenstern^{1,2}, Otto-von-Guericke-University Magdeburg, Germany¹, Max Planck Institute Dynamics of Complex Technical Systems, Magdeburg, Germany²**

Analysis of the Optimal Shape of Gradients for Systems Characterized by Complex Adsorption Isotherms

(2083) **P. Dimitrova and H-J. Bart, TU Kaiserslautern, Germany**

Modified Ligand Exchange Chromatography for Amino Acids Separation

(2084) **M. A. Snyder, Bio-Rad Laboratories, Hercules, USA**

Rapid, Efficient Packing Methodologies for Ceramic Hydroxyapatite

(2085) **L. J. Cummings, Bio-Rad Laboratories, Hercules, USA**

Managing pH Excursions in Hydroxyapatite Columns Associated with Changes in NaCl Concentration Mobile Phase Concentration

(2088) **H. Liu, E. Theodosiou and O. R. T. Thomas, The University of Birmingham, Edgbaston, United Kingdom**

Chromatographic Materials Displaying "Smart" New Functions.

(2091) **J. Horak and W. Lindner, University of Vienna, Austria**

Introduction of a Fast and Widely Applicable Analytical Screening Method for the Design of New Materials for Antibody Purification

(2092) **H. St-Laurent, L. Tremblay, P. Couture, G. Gingras and F. Béland, SiliCycle Inc., Quebec, Canada**

Novel Fluorous Phase for the Separation of Organic Compounds

(2093) **A. Rajendran, Nanyang Technological University, Singapore**

Direct Estimation of Competitive Langmuir Isotherm Parameters from Overlapping Bands of Binary Injections

(2098) **A. Tarafder and M. Morbidelli, ETH Zurich, Switzerland**

Effect of Multiple Acidic Buffers on the Retention of Ionogenic Molecules

(2099) **B. Bloedorn², M. Omote¹, K. Morishita¹, N. Shoji¹, and N. Kuriyama¹, YMC Co. Ltd., Ishikawa, Japan¹, YMC Europe GmbH, Dinslaken, Germany²**

Newly Developed High Strength and Chemically Stable Silica Gel Based Preparative Reversed Phase Packing Materials

(2102) **B. Bloedorn², M. Omote¹, K. Morishita¹, N. Shoji¹, and N. Kuriyama¹, YMC Co. Ltd., Ishikawa, Japan¹, YMC Europe GmbH, Dinslaken, Germany²**

New Generation of Semi Prep column by YMC

(2112) **A. Törnecrona, J. Ekeröth, B. Kofoed-Hansen and S. Winkel-Pettersson, Eka Chemicals AB, Bohus, Sweden**

Optimization of Silica Based RPLC Materials for Peptide Purification

(2114) **J. N. Kinkel¹, A. Zucker² and P. Koepfel¹, Ohm-University of Applied Sciences, Nürnberg, Germany¹, Biontis GmbH, Geesthacht, Germany²**

New Polar Phases for Preparative HILIC Applications

(2116) **B. Gutiérrez^{1,2} and C. Minguillón^{1,2}**, Institute for Research in Biomedicine, Barcelona, Spain¹, University of Barcelona, Spain²

Enantioselective Membranes Containing L-Proline-derived Chiral Carriers

(2118) **L. Charles and T. Kaiser**, Fuji Silysia Chemical S.A., Le Mont-sur-Lausanne, Switzerland

Orlistat – a Successful Approach to an Efficient Preparative Liquid Chromatography Purification Method

(2120) **J. Saar¹, R. T. Nguyen² and B. Denoulet³**, Grace Davison Discovery Sciences, Worms, Germany¹, Grace Davison Discovery Sciences, Hesperia, USA², Grace Davison Discovery Sciences, Lokeren, Belgium³

Optimize the Performance of Denali RP Media for Preparative Purification by Using MODcol SpringColumn and MultiPacker Technology

(2122) **J. Saar¹, R. T. Nguyen², S. Anderson³, W. Luo³ and B. Denoulet⁴**, Grace Davison Discovery Sciences, Worms, Germany¹, Grace Davison Discovery Sciences, Hesperia, USA², Grace Davison Discovery Sciences, Deerfield, USA³, Grace Davison Discovery Sciences, Lokeren, Belgium⁴

Vydac MS RP-HPLC Columns Provide Unique Selectivity and High Recovery for Peptide and Protein Separations

(2124) **A. Sousa¹, F. Sousa¹, D. M. F. Prazeres² and J. A. Queiroz¹**, Universidade da Beira Interior, Covilhã, Portugal¹, Instituto Superior Técnico, Lisboa, Portugal²

Histidine Affinity Chromatography of Homo-oligonucleotides: The Role of Multiple Interactions on Retention

(2137) **J. Priess, C. Valente, G. Diehl and E. Francotte**, Novartis Institutes for Biomedical Research, Basel, Switzerland

Evaluation of Chiral Stationary Phase Packed AXIA HPLC Columns

Tuesday, September 30, 2008

Young Scientist Buffet Breakfast

07:00 – 08:15 (0149) **G. J. Terfloth, GlaxoSmithKline, King of Prussia, USA**

How to Work in Industry

Session – Continuous Chromatography I

08:30 – 09:00 (0141) **O. Werbitzky, U. Altenhöner and F. Quattrini, Lonza, Visp, Switzerland,**

Keynote Lecture: *Large Column Operation, Challenges in the Downstream Processing of APIs*

09:00 – 09:15 (1050) **S. Katsuo and M. Mazzotti, ETH Zurich, Switzerland**

Comparison of Performance between Improved and Conventional Simulated Moving Bed (SMB) Process

09:15 – 09:30 (1054) **M. Kaspereit¹, R. Arnell², P. Forssén³, A. Seidel-Morgenstern^{1,4}, T. Fornstedt³ and A. Kienle^{1,4}, Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany¹, AstraZeneca AB, Södertälje, Sweden², Uppsala University, Sweden³, Otto-von-Guericke-University, Magdeburg, Germany⁴**

Theoretical Analysis of Continuous Chromatography with Adsorbing Additives

09:30 – 09:45 (1049) **J. M. M. Araújo, R. R. C. R. Rodrigues and J. P. B. Mota, Universidade Nova de Lisboa, Portugal**

Automated Iterative Refinement of Adsorption Isotherm Models for Simulated Moving Bed Operation Based on Cyclic Steady State Data

09:45 – 10:00 (1060) **E. Valery, W. Majeswsky and C. Morey, Novasep SAS, Pompey, France**

Making Multi Columns Chromatography Simpler and Faster

10:00 – 10:15 (1065) **P. Scherpian, D. Schlinge and G. Schembecker, Technische Universität Dortmund, Germany**

Design Method for Closed-Loop and Steady-State Recycling Chromatography

10:15 – 10:45 Coffee Break

Session – Processes II

- 10:45 – 11:15 (O144) **W. Kuhne, Roche Diagnostics GmbH, Penzberg, Germany**
Keynote Lecture: New Perspectives in the Downstream Processing of Large Molecules
- 11:15 – 11:30 (1119) **T. M. Pabst¹, G. Carta¹, A. Hunter² and N. Ramasubramanian², University of Virginia, Charlottesville, USA¹, Pfizer Inc., St. Louis, USA²**
Advances in Chromatofocusing with Unretained Buffers for Challenging Preparative Protein Separations
- 11:30 – 11:45 (1004) **B. K. Nfor¹, T. Ahamed¹, G. W. K. van Dedem¹, L. A. M. van der Wielen¹, E. J. A. X. van de Sandt², M. H. M. Eppink³ and M. Ottens¹, Delft University of Technology, the Netherlands¹, DSM Anti-Infectives B.V., Delft, the Netherlands², Biotechnology Operations N.V. Oss, the Netherlands³**
Modeling-based Rational Protein Purification Process Synthesis Methodology
- 11:45 – 12:00 (1057) **P. A. J. Rosa, A. M. Azevedo, I. F. Ferreira and M. R. Aires-Barros, CEBQ Instituto Superior Técnico, Lisbon, Portugal**
Optimisation of Affinity-enhanced Purification of Antibodies Using Aqueous Two-Phase Extraction
- 12:00 – 12:15 (1127) **P. Wood¹, L. Janaway¹, P. Hewitson², S. Ignatova² and I. Sutherland², Dynamic Extractions Ltd, Berkshire, United Kingdom¹, Brunel University, Uxbridge, United Kingdom²**
An 18 Litre Process Scale High Performance Counter-current Chromatography Centrifuge
- 12:15 – 12:30 (1135) **K. Kaczmariski¹ and G. Guiochon^{2,3}, Rzeszów University of Technology, Poland¹, The University of Tennessee, Knoxville, USA², Oak Ridge National Laboratory, USA³**
Preparative Extraction by Chromatography of Organic Pollutants from Water Streams
- 12:30 – 14:00 Lunch Break

Session – Membranes

- 14:00 – 14:30 (0146) **G. Belfort, Rensselaer Polytechnic Institute, Troy, USA**
Keynote Lecture: Synthetic Membrane Filtration: Breakthroughs and Needs
- 14:30 – 14:45 (1003) **M. Kreuß and U. Kulozik, Technische Universität München, Freising-Weihenstephan, Germany**
Development of a Preparative Ion Exchange Process for the Separation of Individual Fractions of Caseinomacropptide Using Membrane Adsorption Chromatography
- 14:45 – 15:00 (1066) **P. van Beijeren, D. Plassmann and P. Kreis, Technische Universität Dortmund, Germany**
IEX Membrane Adsorbers for Capturing of Proteins: Model Development, Model Validation and Scale up
- 15:00 – 15:15 (1041) **C. Boi¹, V. Busini², C. Cavallotti² and G. C. Sarti¹, Università di Bologna, Italy¹, Politecnico di Milano, Italy²**
Understanding Ligand-Protein Interactions in Affinity Membrane Chromatography for Antibody Purification
- 15:15 – 15:30 (1125) **F. Sousa¹, D. M. F. Prazeres², J. A. Queiroz¹, Universidade da Beira Interior, Covilhã, Portugal¹, Instituto Superior Técnico, Lisboa, Portugal²**
A New Amino Acid-based Affinity Chromatography Approach to Supercoiled Plasmid DNA Purification on Arginine-agarose
- 15:30 – 16:00 Coffee Break

Special Symposium

"Present and Future of Chromatography Purification", Chair: A. Jungbauer

16:00 – 18:00 (0143) **K. Larson, AstraZeneca AB, Södertälje, Sweden**

The Comination of SMB Chromatography, Slurry Wash and Batch Chromatography for the Resolution and Purification of a Racemate

(0140) **E. Freund, CarboGen-Amcis, Aarau, Switzerland**

SMB: A Flexible and Quick Tool for Chiral Separations in Early Development - A Case Study

(0148) **B. Schenkel, Novartis Pharma AG, Basel, Switzerland**

Peptides and Macrolides

(0147) **F. Vix, F. Hoffmann-La Roche AG, Basel, Switzerland**

Process Optimization for Peptide Purification

(0129) **O. Lyngberg, Bristol-Myers Squibb, New Brunswick, USA**

Development Challenges for Chromatographic Purification Process of an early development 11-Aminoacid polypeptide program

(0110) **J. Davies, Lonza Biologics, Slough, United Kingdom**

Does Chromatography have a place in the Future of the Manufacture of Monoclonal Antibodies?

(0138) **H. Kornmann, Merck-Serono Biotech Center, Fenil-sur-Corsier, Switzerland**

Evaluation of Alternative Technologies for the Capture of a Recombinant Protein

Poster Session II

18:00 – 20:00 Poster Presentations

(2005) **F. Hassaine-Sadi, L. Sadoun and H. Bouchabou, University of Sciences and Technology Houari Boumediene, Algiers, Algeria**

Treatment of Wastewater Containing Toxic (Chromium) and Heavy (Cadmium) Metals: Extraction with Oxyde tri-n-octyl Phosphine

(2010) **M. Zandian and A. Jungbauer, University of Natural Resources and Applied Life Sciences, Vienna, Austria**

Engineering of a scFv Affinity Column for Separation of Cytokines

(2011) **J. Nti-Gyabaah, M. J. Iammarino and D. J. Roush, Merck and Co. Inc., Rahway, USA**

A Potential Paradigm Shift in Downstream Chromatographic Purification of Monoclonal Antibodies

(2014) **E. Freund¹, J. Lill¹ and M. Juza², CarboGen-Amcis, Aarau, Switzerland¹, Siegfried Ltd., Zofingen, Switzerland²**

The Chromatographic Isolation of Reference Standards – a Case Study

(2017) **J. García Palacios¹, M. Kaspereit¹ and A. Kienle^{1,2}, Max-Planck-Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany¹, Otto-von-Guericke University, Magdeburg, Germany²**

Systematic Study of Production Processes Integrating Chromatographic Separation and Isomerisation Reactions

(2021) **M.-H. Chuang and M. Johannsen, Hamburg University of Technology, Germany**

Sub-/Supercritical Fluid Chromatography with Propane

(2024) **M. Onsberg, M. Degerman and B. Nilsson, Lund University, Sweden**

Determining Optimal Operating Conditions for Preparative Purifications with Varying Feed Composition

(2026) **K. Westerberg, M. Degerman and B. Nilsson, Lund University, Sweden**

Determination of Robust Pooling in Preparative Chromatography

(2028) **J. Sempere, R. Nomen, E. Serra, K. Cuevas, O. Pou, J. Menacho and S. Martínez, Institut Químic de Sarrià, Barcelona, Spain**

Simulation and Optimization of two and three Components SMB Separations

(2031) **K. Eriksson, K. Lacki and H. J. Johansson, GE Healthcare, Uppsala, Sweden**

Rapid Development of Monoclonal Antibody Downstream Processes for Production of Clinical Phase I/II Material: a Case Study

(2035) **A. Rajendran, Nanyang Technological University, Singapore**

Equilibrium Theory Based Design of Simulated Moving Bed Processes under Reduced Purity Requirements: Linear Isotherms

(2037) **R. C. R. Rodrigues, J. M. M. Araújo and J. P. B. Mota, Universidade Nova de Lisboa, Portugal**

Robust Design and Operation of two- and three-Column Compact SMB Process for Binary and Ternary Separations

(2038) **C. Grossmann¹, G. Ströhlein^{1,2}, M. Morbidelli¹ and M. Morari¹, ETH Zurich, Switzerland¹, ChromaCon AG, Zürich, Switzerland²**

Development of a 'Cycle to Cycle' Control for the MCSGP-Process for a Monoclonal Antibody Variant Separation

(2043) **J. Nowak¹, D. Antos², Y. Kawajiri^{1,3} and A. Seidel-Morgenstern^{1,4}, Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany¹, Rzeszów University of Technology, Poland², Georgia Institute of Technology, Atlanta, USA³, Otto-von-Guericke-University, Magdeburg, Germany⁴**

Theoretical Investigation of Separation of a Ternary Mixture by Simulated Moving Bed Chromatography

(2045) **J. M. M. Araújo, R. C. R. Rodrigues and J. P. B. Mota, Universidade Nova de Lisboa, Portugal**

A Streamlined Two-Column SMB Process for Chiral Separation

(2048) **C. Langel, C. Grossmann, M. Mazzotti, M. Morari and M. Morbidelli, ETH Zurich, Switzerland**

Implementation of an Automated Online HPLC Monitoring System for SMB Processes

(2056) **C. Frerick¹, P. Kreis² and A. Górak², Bayer Technology Services GmbH, Leverkusen, Germany¹, Technische Universität Dortmund, Germany²**

Dynamic Discrete Event Modelling and Mixed Integer Optimisation of Protein Downstream Processes

(2059) **J. Bléhaut, E. Lang and E. Valéry, Novasep SAS, Pompey, France**

Preconceived Ideas about Preparative Chromatography

(2062) **C. Morey¹, E. Valéry¹, C. Bobier¹ and M. Bailly², Novasep SAS, Pompey, France¹, Laboratoire des Sciences du Génie Chimique, Nancy Cedex, France²**

Integration of PAT (Process Analytical Technologies) in Continuous Chromatographic Processes: the Advanced Control System

(2063) **M. Amanullah¹, S. Katsuo² and M. Mazzotti², Nanyang Technological University, Singapore¹, ETH Zurich, Switzerland²**

Design and Optimization of a Chromatographic-Crystallization Hybrid Process for the Separation of Träger's Base Enantiomers

(2064) **P. Scherpian, D. Schlinge and G. Schembecker, Technische Universität Dortmund, Germany**

Choice of Process Concept in Preparative Chromatography

(2070) **J.-L. Wu^{1,2}, M. Minceva¹, Q.-J. Peng² and W. Arlt¹, University of Erlangen-Nuremberg, Germany¹, Jiangnan University, Wuxi, China²**

Design and Optimization of a Pilot Scale Simulated Moving Bed Unit for Citric Acid Separation from Fermentation Broth

(2074) **F. Grote¹, R. Ditz² and J. Strube¹, Clausthal University of Technology, Germany¹, Merck KGaA, Darmstadt, Germany²**

Integrated and Model-based Bioprocess Development from Upstream to Downstream - and Beyond

(2077) **T. Hellenkamp¹, P. Balling², M. Günther² and G. Schembecker¹, Technische Universität Dortmund, Germany¹, Inosim GmbH, Ammersbek, Germany²**

Systematic Design of Downstream Processes – Modeling and Simulation

(2094) **M. Bechtold, M. Füreder S. Makart and S. Panke, ETH Zurich, Switzerland**
Integrated Operation of SMB, Biocatalysis and Cross-flow Filtration for the Production of Fine Chemicals

(2095) **M. Bechtold, M. Füreder and S. Panke, ETH Zurich, Switzerland**
SMB Design for Chiral Stationary Phases Showing an Analyte-related Memory Effect

(2097) **R. Herry¹, J. Stevens², M. Crawford² and L. Roenneburg², Gilson International B.V. Den Haag, The Netherlands¹, Gilson, Inc., Middleton, USA²**
Automated Fraction Trapping of Purified Compounds from Preparative Chromatography

(2101) **T. K. Tran, L. H. Phung, S. N. Xuan and V. T. Pham, Hanoi University of Technology, Vietnam**
Dynamic Model for the Ultrasonic-assisted Extraction Process of Curcumin from Curcuma Longa L.

(2104) **J. Hoogendoorn and D. Stadermann, Solvay Pharmaceuticals B.V., Weesp, the Netherlands**
Comparison Batch vs SMB/Varicol for a Racemic Mixture and for a Complex Mixture

(2105) **R. Chen and P. Ridgeway, Thar Instruments Inc., Pittsburgh, USA**
Separation and Purification of Polar, Basic Pharmaceutical Relevant Compounds by MS Directed Preparative Supercritical Fluid Chromatography (SFC)

(2106) **N. A. Vaidya, ChiroSolve Inc., San Jose, USA**
Chiral Resolution for Full Spectrum of Racemates

(2111) **H. J. Johansson, H. Tenglidén and A. Grönberg, GE Healthcare Bio-Sciences, Uppsala, Sweden**
Rapid Development of Cleaning-In-Place Protocols for Affinity Media

(2113) **C. Birkner¹, U. Haering¹, J. N. Kinkel² and T. Gubbey², Roche, Diagnostics Division, Penzberg, Germany¹, Ohm-University of Applied Sciences, Nürnberg, Germany²**
Batch and Continuous Liquid-liquid Partition Chromatography of Biopolymers in Aqueous/Ionic Liquid two Phase Systems

(2115) **J. N. Kinkel, Ohm-University of Applied Sciences, Nürnberg, Germany**
LLPC /SMB: The Continuous Separation of Biopolymers on Polyacrylamide Silica

(2121) **J. Saar¹, K. Vind² and B. Denoulet³, Grace Davison Discovery Sciences, Worms, Germany¹, Peak Biotech, Kvistgaard, Denmark², Grace Davison Discovery Sciences, Lokeren, Belgium³**
The Use of High Quality Silica Media in Pilot and Process Scale Chromatography Using Custom Designed High Pressure Process LC Columns and Systems

(2123) **M. Gramblicka and M. Polakovic, Slovak University of Technology, Bratislava, Slovakia**
A Rational Approach to Modelling of Uptake Rate of Large Proteins by Porous Chromatographic Materials

(2130) **M. Mazzotti, ETH Zurich, Switzerland**
Non-classical Composition Fronts in Nonlinear Chromatography

(2136) **S. Seraman, S. Ayothiraman, A. Rajendran and V. Thangavelu, Annamalai University, Tamilnadu, India**
*Optimization of Lovastatin Production by *Monascus Purpureus* MTCC 369 Using Plackett-Burman and Central Composite Statistical Experimental Design*

20:00 – 24:00 Gala-Dinner

Wednesday, October 01, 2008

Session – Continuous Chromatography II

08:30 – 09:00 (0139) **F. Kjell, Siemens, Ninove, Belgium**

Keynote Lecture: PAT Application and Architecture in Pharmaceutical Process Development

09:00 – 09:15 (1058) **O. Ludemann-Hombourger, M. Holzer, L. David, H. Osuna-Sanchez and E. Valery, Novasep SAS, Pompey, France**

Sequential Multi-Column Chromatography: New Disruptive Continuous Purification Technology for Downstream Processing

09:15 – 09:30 (1076) **L. Aumann^{1,2}, T. Müller-Späth¹, G. Ströhlein^{1,2} and M. Morbidelli¹, ETH Zurich, Switzerland¹, ChromaCon AG, Zürich, Switzerland²**

Continuous Downstream Processing of Monoclonal Antibodies Using MCSGP with Cation-exchange Resins

09:30 – 09:45 (1108) **M. Pennings¹, M. Bisschops², T. Ransohoff² and S. Fulton³, Xendo Manufacturing B.V., Leiden, the Netherlands¹, Tarpon Biosystems Inc., Marlborough, USA², Biosystem Development, Middleton, USA³**

BioSMB™, Continuous Chromatographic Purification with Disposable Columns and Membrane Adsorbers

09:45 – 10:00 (1096) **Y. Kawajiri^{1,2} and A. Seidel-Morgenstern^{2,3}, Georgia Institute of Technology, Atlanta, USA¹, Max Planck Institute of Dynamics of Complex Technical Systems, Magdeburg, Germany², Otto-von-Guericke-University, Magdeburg, Germany³**

Optimization of 8-Zone Simulated Moving Bed Chromatography for Ternary Separation with Recycle Stream Enrichment

10:00 – 10:15 (1107) **D. Horneman¹, M. Bisschops¹ and M. Guiseppin², Xendo Manufacturing B.V., Leiden, the Netherlands¹, Solanic B.V., Veendam, the Netherlands²**

Continuous Recovery of Proteins Using Large-scale Multicolumn EBA Chromatography Technology

10:15 – 10:45 Coffee Break

Session – Manufacturing

- 10:45 – 11:15 **L. Beaver, Food and Drug Administration, Washington, USA**
Keynote Lecture: Pharmaceutical Process Design Considerations
- 11:15 – 11:30 (1025) **M. Degerman, K. Westerberg and B. Nilsson, Lund University, Sweden**
Robust Design and Process Validation of Preparative Chromatography
- 11:30 – 11:45 (1073) **W. R. Leonard Jr., P. Sajonz and C. J. Welch, Merck & Co. Rahway, USA**
Advances and Case Studies in the Use of Chiral Chromatography in Pharmaceutical Process Research
- 11:45 – 12:00 (1109) **H. Hüttmann¹, A. Jungbauer², S. Zich² and M. Berkemeyer¹, Boehringer Ingelheim Austria GmbH, Vienna, Austria¹, University of Natural Resources and Applied Life Sciences, Vienna, Austria²**
Industrial Crystallization of Recombinant Biopharmaceutical Proteins
- 12:00 – 12:15 (2133) **C. Langel, C. Grossmann, M. Mazzotti, M. Morari and M. Morbidelli, ETH Zurich, Switzerland**
'Cycle to Cycle' Optimizing Control of Simulated Moving Beds – Experimental Implementation for a Nonlinear Chiral Separation
- 12:15 – 12:30 (1055) **T. Zhang, D. Colantuono, D. Robin, J.-M. Heym, V. Briand, M. Schaeffer and P. Franco, Chiral Technologies Europe, Illkirch, France**
Efficient Combination of HPLC and SFC at Preparative Scale for the Separation of Enantiomers: Timings and Productivity
- 12:30 – 12:45 Closing Remarks
- 12:45 – 14:00 Lunch
- 14:00 Start of SFC 2008

General Information about the Congress

Book of Abstracts

A book of abstracts of all contributions (oral and poster) presented at SPICA 2008, will be distributed to each participant.

Special Issue of the Journal of Chromatography A

The contributions to SPICA 2008, when desired by the authors, will be published in a special issue of the Journal of Chromatography A. Elsevier sends out detailed instructions to all authors how to submit online. The deadline for submission of the manuscripts will be November 1st, 2008.

Exhibition

During the entire Symposium an exhibition will take place in the hall of the ETH Zurich main building. The program will provide ample opportunities to the participants to meet most of the world's leading suppliers of chromatography instrumentation, including packing, equipment, simulation software and separation units. The following companies will exhibit at SPICA 2008.

Exhibitor's Name	Booth-Nr.
AKZO / Eka Chemical.....	27
Bio-Rad Laboratories AG	28
Büchi Labortechnik AG.....	24
CAMAG.....	16
Carbogen Amcis AG	19
Chiral Technologies Europe	2
ChromaCon AG	10
Dynamic Extractions Ltd.....	11
ECSA Emanuele Centonze SA.....	6
Grace Davison Discovery Sciences	20
Kiralya SAS	29
Knauer GmbH.....	7
Labomatic	13
Mallinckrodt Baker B.V.....	26
Merck KGaA.....	9
NOVASEP SAS	8
Pall Life Science.....	17+18
Phenomenex.....	21
PIC Solution	4+5
Regis Technologies, Inc.....	22
Rohm and Haas Europe Services	14
Sepiatec GmbH.....	25
Thar Instruments, Inc	1
Varian AG (Polymer).....	12
VWR International GmbH	3
YMC Europe GmbH	23
Zeochem AG.....	15

Social Program

Welcome Reception

Sunday, September 28, 2008, 6 pm

The Welcome Reception will be held at the Dozentenfoyer. This is the lecturers restaurant on the top floor, with a splendid view over the city of Zurich. The Dozentenfoyer is located in the same building as the conference is taking place.

Gala Dinner

Tuesday, September 30, 2008, 8 pm

The Gala Dinner will be served in the guildhall "Zur Meisen", an extraordinary place with an exquisite cuisine in the old town of Zurich. Built during Zurich's Golden Age, it is ranking as Zurich's most impressive guildhall. The Guild has a history of drawing celebrities to its handsome precincts. Swiss author Gottfried Keller and the country's foremost painter Ferdinand Hodler were among the famous persons who have dined in this guildhall. A typical meal from Zurich and local wine will give you an impression of our fine Swiss cuisine.



To reach the guildhall, cross the river Limmat at Grossmünster (the church with the two towers) over Münster Bridge (tram station: Helmhaus). The guildhall "Zur Meise" is the first building on your right after the bridge.

Excursions

Zurich and Switzerland offer great experiences. Take the chance to see more than only the conference site, you have a wide variety of trips or tours to choose from. You can book directly under the website www.spica2008.ethz.ch/socialevents.html. Three classical options are:

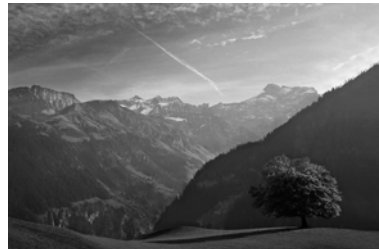
Swiss Mountain Passes

CHF 95.00

Coach journey over the Brünig Pass (1008 m) to the Bernese Oberland. Here we visit the impressive Aare Gorges. Walk through the gorges on a secure footbridge. This is an unforgettable nature adventure.

June to September 2008, Monday, Saturday and Sunday. Departure: 10.30 am, duration: 9 hours

Departure point: Bus parking near Zurich Main Train Station. Stop: Sihlquai, Streetcar: 4 / 13.



Titlis from Zurich – Eternal Snow at 10'000 feet

CHF 147.00

Coach journey via Albis Pass and along the shores of Lake Lucerne to Lucerne. Short City Tour with main sights and visit of the Lion Monument. Approx. 1 hour at leisure. We continue to Engelberg, where the breath-taking journey upwards begins, surrounded by high alpine glaciers. Spectacular sight of the glacier's deep crevasses and gigantic ice boulders from the revolving cable car. At the top, magnificent views of the Alps await you. Restaurants, a sun terrace, Ice Grotto are further attractions. By IceFlyer you go close to the crevasses and enjoy the FunLift in the snow! Entire tour with multi-lingual guide.



daily, departure: 09:30 am , duration: 9 1/2 hours.

The Best of Zurich – 2 ¼ hours City Tour

CHF 33.00

Discover this unique city, winner of the award "City of Best quality of life" in a comfortable air-conditioned bus! See the castle-like National Museum, the shopping and business centre on Bahnhofstrasse, the Limmatquai with its medieval Old Town and view to the Lindenhof, where the brave women of Zurich saved the city from the invaders, the largest church clock-face of Europe on St. Peter, the patriarchal Guild Houses, the Opera house with its famous June-Festivals, the lake (picture stop).



The tour ends after a short walk through the Old Town. Live guided: English Spanish, German

daily 10:30 am or 01.00 p.m., departure: from Zurich Sihlquai, Duration 2 1/4 hours.

ETH Zurich

Consistently ranked the top university in continental Europe, ETH Zurich, is a leading player in research and education in Switzerland and worldwide.

ETH Zurich has 16 departments, offering Bachelor, Master and Doctoral programs in engineering and natural sciences. The language of instruction in the Bachelor programs is German, whereas English is the lingua franca on the graduate level. All degree programs provide a solid scientific foundation combined with outstanding all-round skills, equipping ETH graduates with the abilities and flexibility needed for a career in industry, business or the public sector, as entrepreneur or scientist.

The international outlook – close to 60% of the professors have been recruited from abroad – and the excellent teaching and research infrastructure make ETH Zurich the ideal place for creative personalities. The links with business and industry are very close, because the Greater Zurich area is being the economic center of Switzerland and home to numerous international companies. Beyond world-class education, Zurich also offers many other quality-of-life highlights. Zurich has a metropolitan flair, excellent sports facilities, an extensive range of cultural and recreational offerings and a very vibrant nightlife.

Education and research areas:

- **Construction Sciences:**
Architecture, Civil, Environmental and Geomatic engineering.
- **Engineering Sciences:**
Computer Science, Information Technology and Electrical Engineering, Materials Science, Mechanical and Process Engineering
- **Natural Sciences and Mathematics:**
Biology, Chemistry, Chemical Engineering and Biotechnology, Computational Science and Engineering, Human Movement Sciences and Sport, Mathematics, Physics, Pharmaceutical Sciences
- **System-oriented Sciences:**
Agricultural and Food Sciences, Earth Sciences, Environmental Sciences
- **Management and Social Sciences:**
Management, Technology and Economics, Professional Officer (Swiss Armed Forces), Comparative and International Studies