# Control and Optimization Problems in Mechanics

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Progress Report Meeting

Special Radon Semester, RICAM, Linz

December 12, 2005

1. Workshops

2. Seminars

3. Outlook

## Workshop 1

**Workshop on "Control of complex fluids"**

October 10 - 13, 2005

organized by R. Griesse, K. Kunisch, B. Vexler, E. Sachs

Main topics:

Modelling and control in magnetohydrodynamics

Fluid flow control

Efficient numerical solvers for PDE constraints

## Workshop 1 cont'd

**Participants**

Marek Behr (RWTH Aachen and Rice University)
Martin Berggren (Uppsala University)
Thomas Bewley (UCSD)
Malte Braack (University of Heidelberg)
Nicolas Gauger (DLR Braunschweig and HU Berlin)
Omar Ghattas (University of Texas at Austin)
George Haller (MIT)
Matthias Heinkenschloss (Rice University)
Amnon Meir (Auburn University)
Volker Schulz (University of Trier)
Nicholas Zabaras (Cornell University)

## Workshop 2

**Workshop on "Efficient methods for time-dependent optimal control: preconditioning, reduced order modelling and feedback control"**

November 21 - 24, 2005

organized by R. Griesse, K. Kunisch, B. Vexler, E. Sachs

Main topics:

Optimization of time-dependent systems

New developments in reduced order model for optimal control

Preconditioning techniques for PDE contrained optimization

## Workshop 2 cont'd

**Participants**

Peter Benner (Univ. Chemnitz)
George Biros (Univ. of Pennsylvania)
John Burns (Virginia Tech)
Fariba Fahroo (AFOSR)
Michael Hinze (Techn. Univ. Dresden)
Angela Kunoth (Univ. Bonn)
Rainer Tichatschke (Univ. Trier)
Michael Ulbrich (Univ. Hamburg)
Stefan Ulbrich (Techn. Univ. Darmstadt)
Stefan Volkwein (Techn. Univ. Graz)
Andy Wathen (Oxford Univ.)
Karen Willcox (Mass. Inst. Technol.)
Local Participants: M. Burger, A. Roesch, B. Vexler, W. Zulehner (Linz),
F. Leibfritz (Trier), L. Grasedyck (Leipzig)

## Seminar on Preconditioning of KKT Systems

Organizers: U. Langer, E. Sachs, W. Zulehner

02.11.2005 (09:00) Walter Zulehner
*"Uzawa-type and Projection-type Methods for Block-structured Indefinite Linear Systems"*

02.11.2005 (10:30) Ekkehard Sachs
*"Preconditioning for Optimization Problems"*

16.11.2005 (13:00) Rene Simon
*"Multigrid in Optimal Control: Theory and Numerics"*

25.11.2005 (09:00) Roman Stainko
*"Phase-Field Relaxation of Topology Optimization with Local Stress Constraints and an Optimal KKT-Solver"*
*"About KKT-Systems Arising from the Minimal Compliance Problem"*

## Seminar on Preconditioning of KKT Systems, continued

Organizers: U. Langer, E. Sachs, W. Zulehner

30.11.2005 (13:00) Rene Simon
*"Preconditioning of KKT-Systems"*

30.11.2005 (14:30) Ekkehard Sachs
*"Preconditioner for Elliptic Control Problems"*

09.12.2005 (09:00) Marco Discacciati and Roland Griesse
*"On a Stokes-MHD Problem"*

## Seminar on Optimization and Optimal Control

Organizers: K. Kunisch, E. Sachs

18.10.2005 (16:00) Samuel Amstutz
*"Introduction to the topological derivative"*

25.10.2005 (16:00) Friedemann Leibfritz
*"Nonlinear semidefinite programs arising in feedback control design for PDE systems"*

16.11.2005 (16:30) Takeo Takahashi
*"Model for the motion of a robotic fish into a viscous incompressible fluid"*

29.11.2005 (16:00) Jan Maruhn
*"Parabolic PDE Constrained Optimization Problems Arising in Robust Static Hedging"*

## Future Projects

**F. Leibfritz (Oct. 05):**

Impact RICAM lectures:

H-matrix techniques in NSDP (Nonlinear Semi-Definite Programming)
Solution of linear systems (Lyapunov equns, large scale)
cooperation with L. Grasedyck (Leipzig)

Impact RICAM workshops:

Numerical design of feedback control laws for large scale problems
Use of balanced truncation and POD for unstable systems
Cooperation with Benner (Chemnitz)

Impact RICAM seminars:

Preconditioning for linear system solvers in NSDP
Cooperation Leibfritz, EWS, RICAM-Group

## Future Projects

**J. Maruhn (Oct. - Dec. 05):**

Impact RICAM seminars:

Parameter identification problems in finance, here Heston model
Exchange with RICAM group

Application of PDE constrained optimization:
Static hedging of barrier options
Cooperation with Albrecher (Graz)

Impact RICAM workshops:

Solution of robust optimization problem in hedging of barrier options by
NSDP techniques

J. Maruhn, F. Leibfritz
A successive SDP-NSDP approach to a robust optimization problem in
finance, RICAM report

## Future Projects

**EWS (Oct. - Dec. 05):**

Impact RICAM seminars:

Preconditioning KKT systems
cooperation with RICAM group
Griesse, Langer, EWS, Simon, Stainko, Zulehner

Trust region management in PDE constrained optimization
POD: EWS, Kunisch
Adaptivity: EWS, Vexler

Impact RICAM lectures:

H-matrices and reduced Hessian

## Future Activities

Special Issue **Mathematical Programming**

Editors: J. A. Burns, E. W. Sachs

Title: Optimization with PDE constraints

completed by May 2006

**Minisymposium** Proposal
"Preconditioners for PDE-Constrained Optimization"

Joint GAMM-SIAM Conference on Applied Linear Algebra (ALA 2006)

Duesseldorf, Germany, July 24-27, 2006