Molecular Imaging, 7.5HP

190225-190326

Olof Dahlqvist Leinhard, PhD

Lecturer

Radiological Sciences/IMH

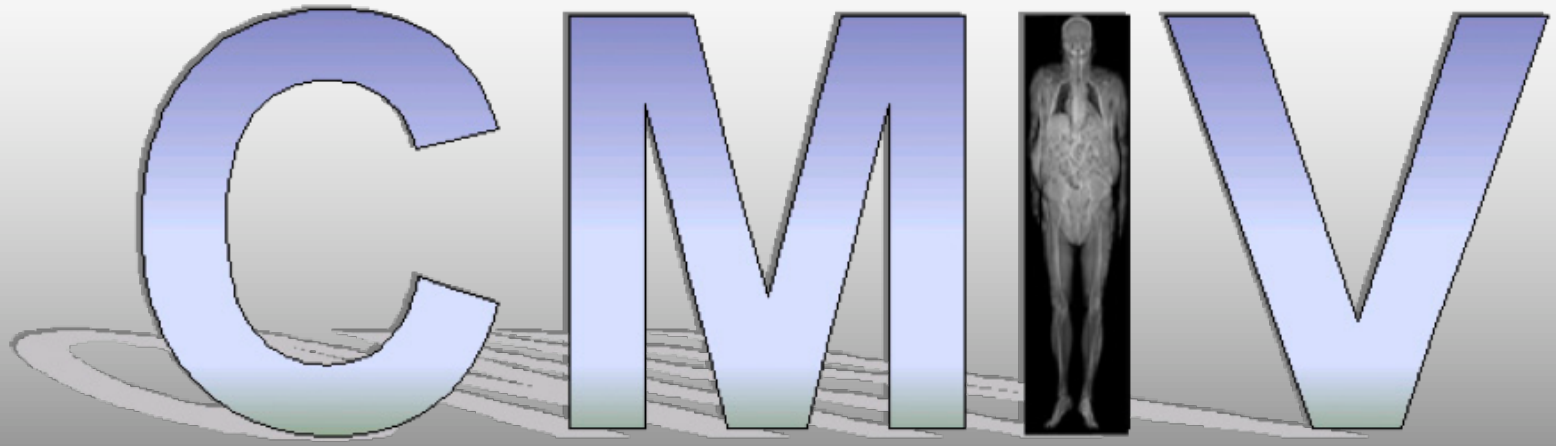
Linköping University

A little about me…

- Olof Dahlqvist Leinhard, PhD
- MRI Physicist
- 40 % University lecturer at LiU, IMH, CMIV
- 60 % Chief Scientific Officer and Founder at AMRA Medical AB
- Leading a hybrid academic/industrial research group in advanced body composition research

AMRA
PRECISION FOR DECISION

www.amramedical.com



Center for Medical Image Science and Visualization

Landstinget i Östergötland

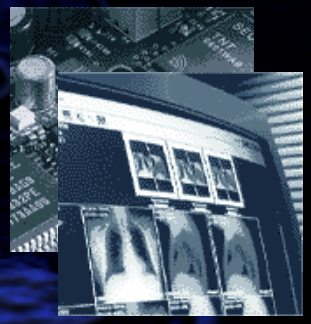
Linköpings Universitet

CMIV - Background

University
- Research
- Education

County council
- Clincal research
- Education

Private companies

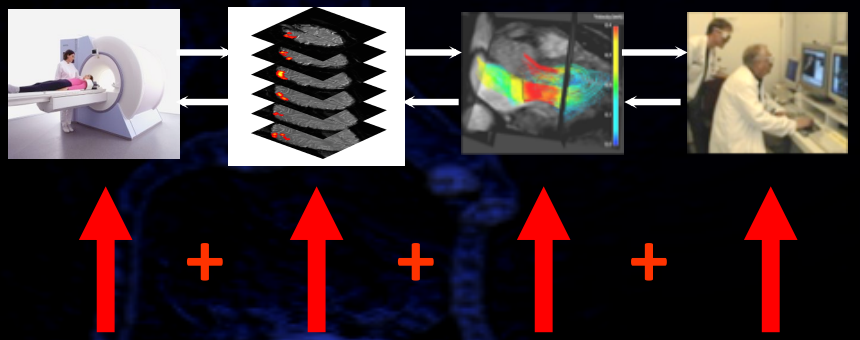


Goals:

- Conduct focused, world class research through interdisciplinary projects that leads to solutions for tomorrow's clinical questions.
- Provide graduate training for researchers with both medical and technical backgrounds in a single educational program.

Today:

- 80 researchers connected
- 32 PhD students
- Both medical and technical projects in a clinical environment



5 Spinoff Companies

Facilities

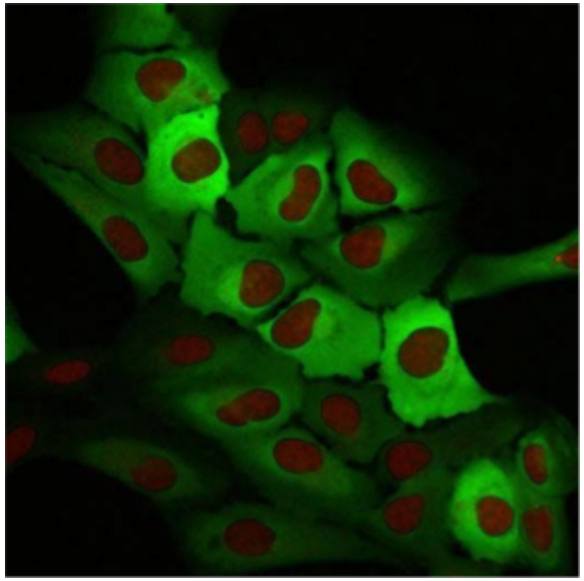
- CMIV – Lecture room
  - Wrannesalen
- CMIV – Conference rooms
  - Tesla
  - Voxel
- Laborative exercises at CMIV

Roll call

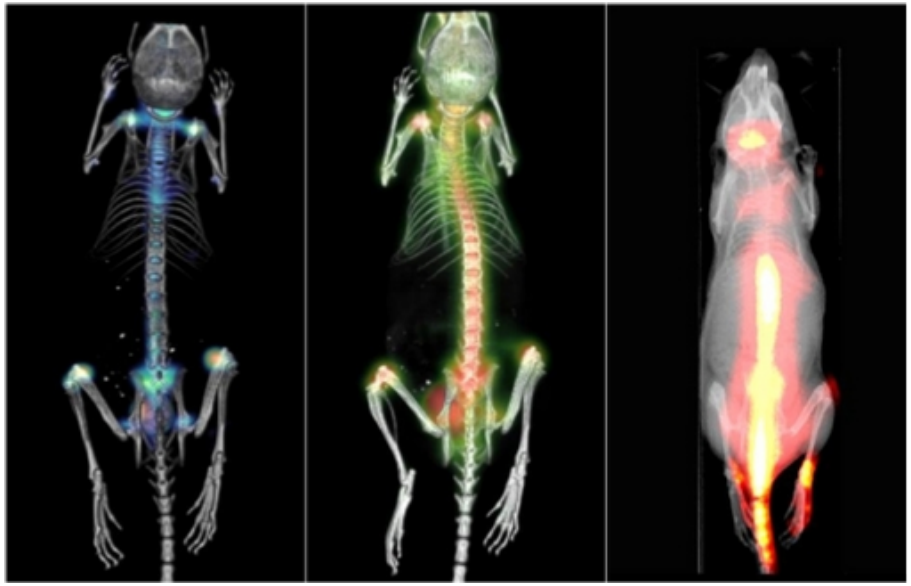
Student	Mail	Kommentar
Ibikari Allwell-Brown	ibial055@student.liu.se	
Cao Siyuwei	siyca218@student.liu.se	
Xiaohe Liu	xiali313@student.liu.se	
Double Degree		
Lekha Pezhumkattil	lekpe490@student.liu.se	
Fristående studenter		
Ali Sheikholvaezin	alish663@student.liu.se	
Lan Yin	carolylan@hotmail.com	
Zacharias Mahrs	Zacharias.lindgren@hotmail.se	
Marie Peterson	linneamarie.p@gmail.com	

Presentation of participants

Molecular imaging (MI)
Visualization of molecular processes in vivo



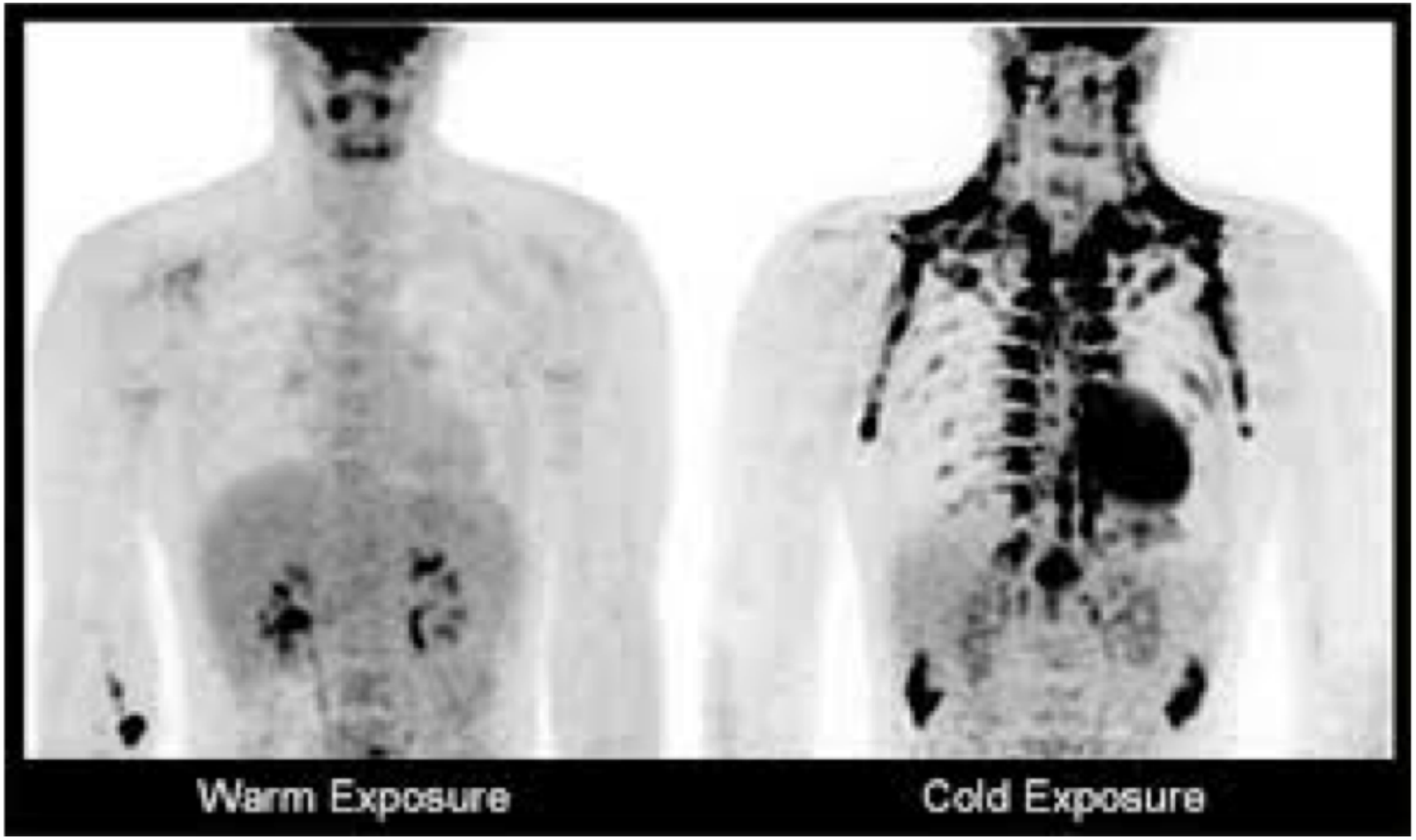
Cell imaging



Small animal imaging

Clinical imaging

Molecular imaging (MI)
Visualization of molecular processes in vivo

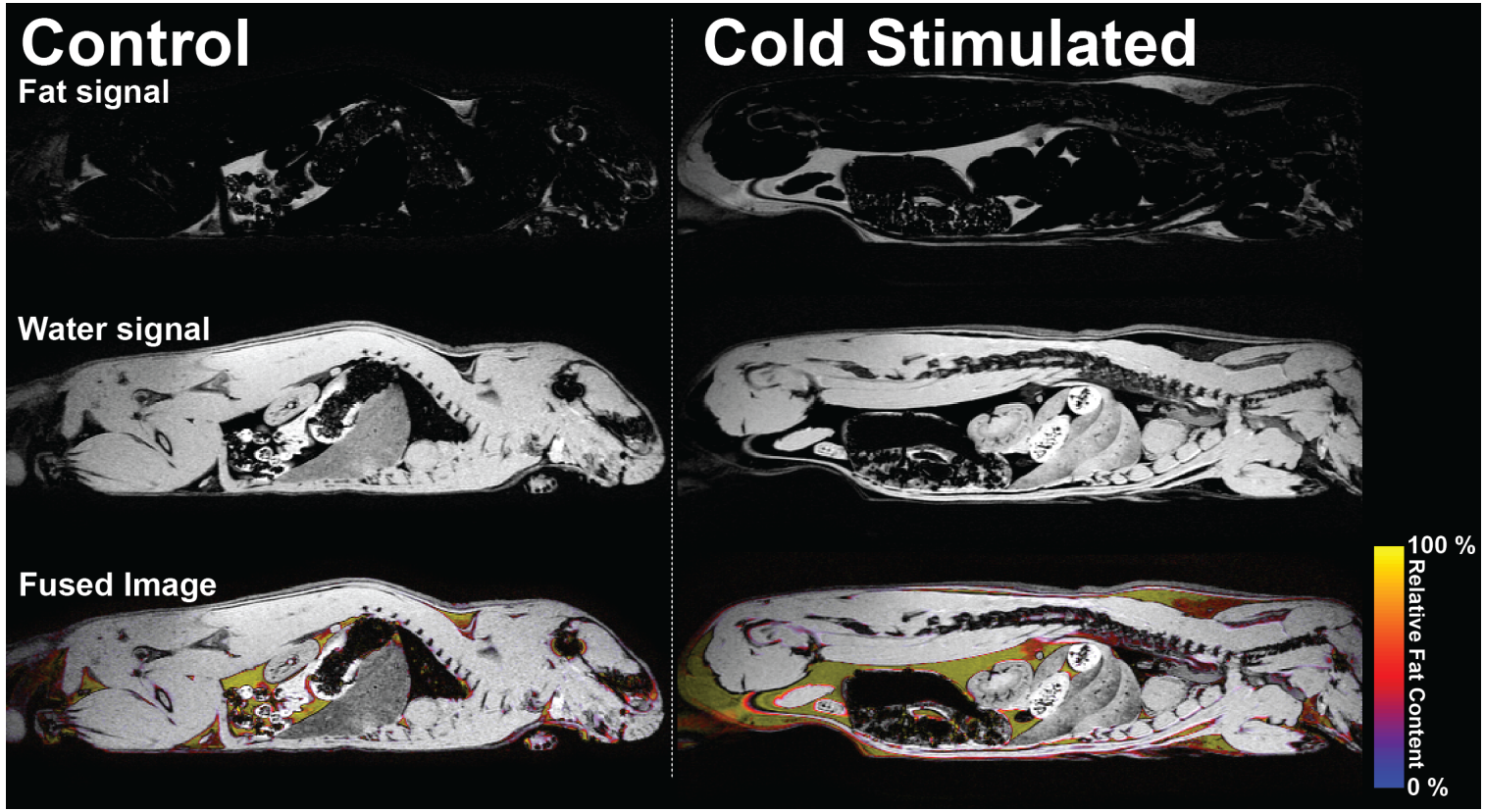


How do we see molecular processes in vivo?

- Different MI techniques
- Choice of techniques
- CT, MRI, PET, SPECT, EPR, Ultrasound, optical methods, and Electron microscopy

How do we know where it happens?

- Spatial encoding techniques
- Combination with other imaging techniques
- Visualization



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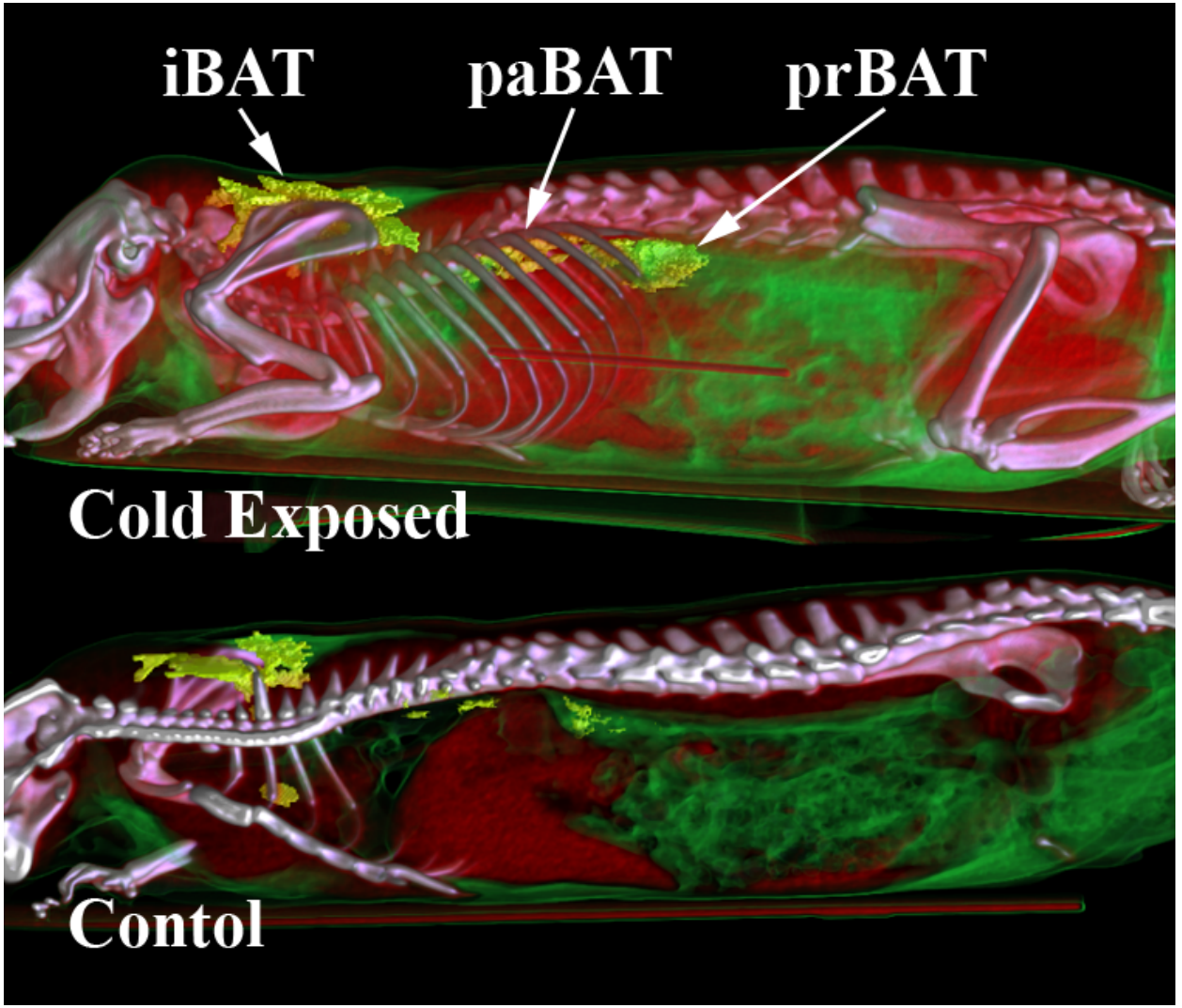
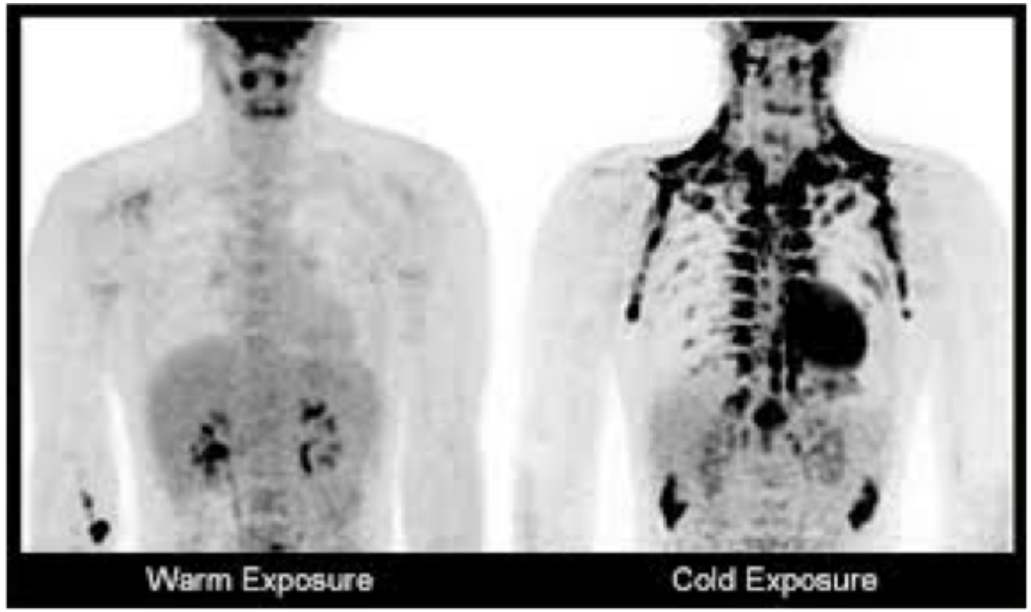


Fusion of MRI and CT
images of Brown adipose tissue (BAT)
in rats

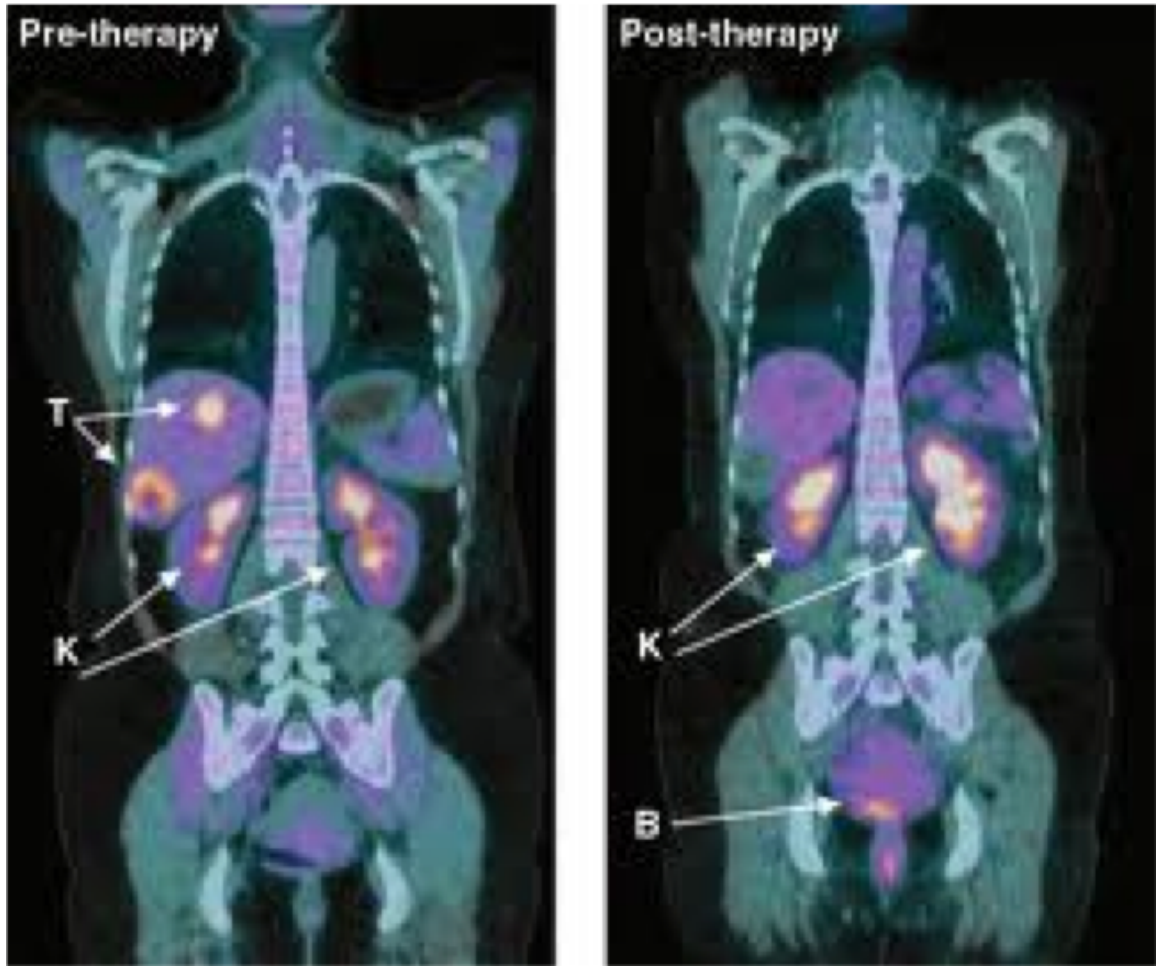
How do we increase the sensitivity and how much activity is it?

- How much activity must be there before we see something?
- Signal quantification



MI applications

- MI in the clinic
- MI in drug development
- MI in pre-clinical and clinical research



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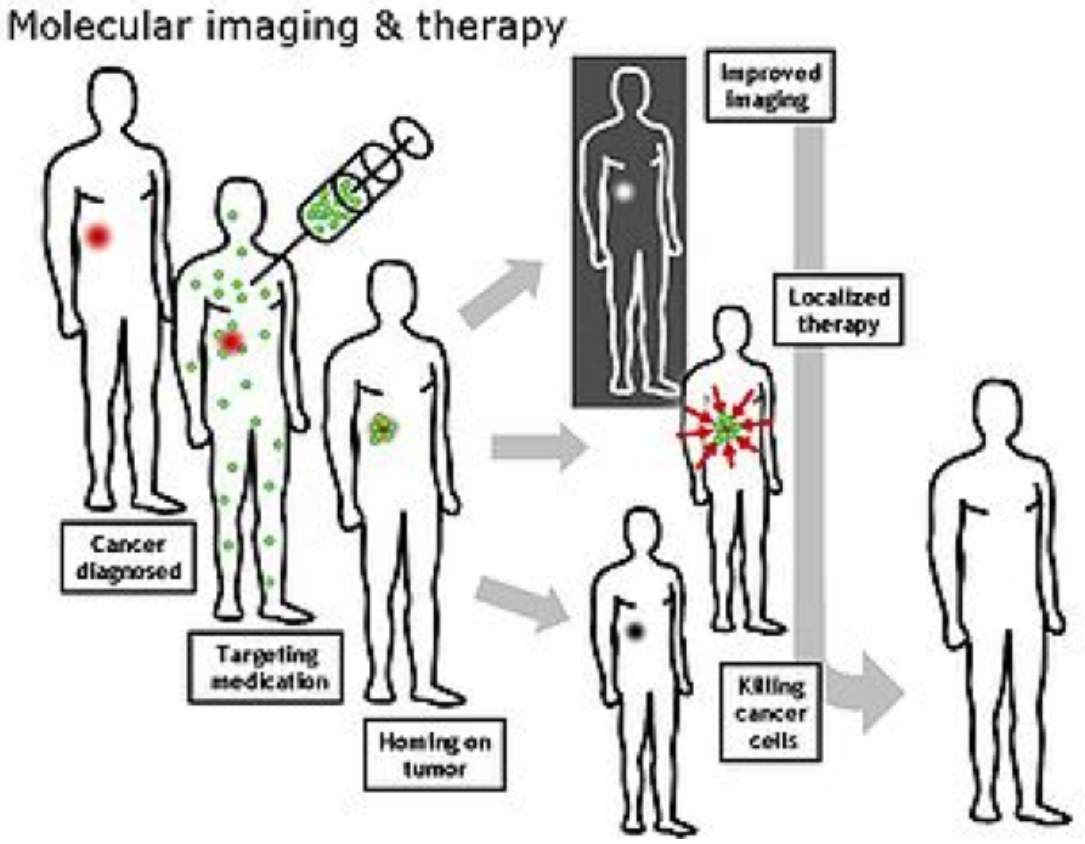
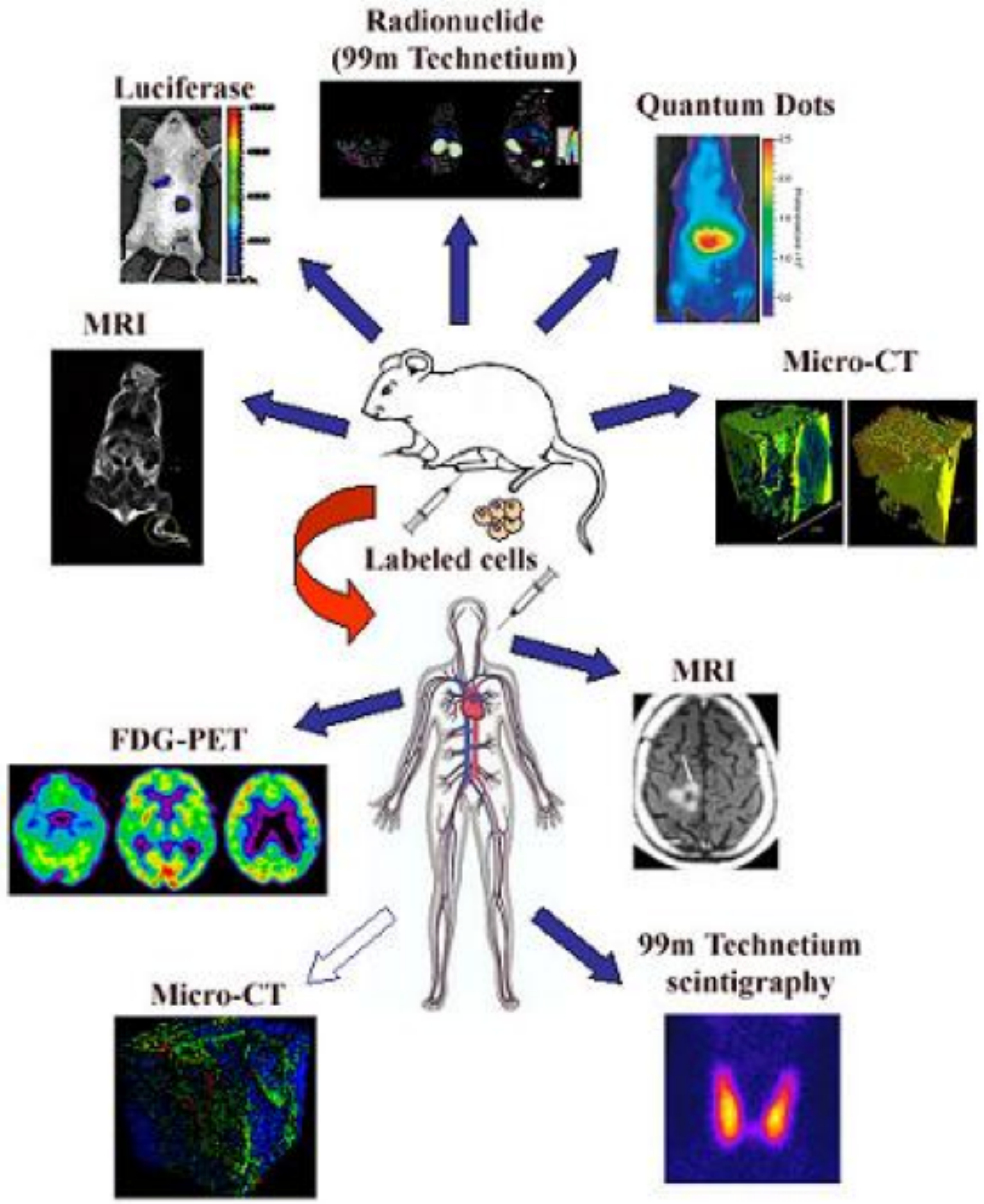


Why?

- MI is a new scientific field with major importance
  - Basic science
  - Diagnostics
  - Targeted treatment
- MI is important in translational medicine
- Provides information about where in the living organism things happen.



Int. J. Mol. Sci. 2010, 11(3), 1070-1081; doi:10.3390/ijms11031070

Course overview

- Part 1: Imaging basics, overview of the different techniques
  - 8 Lectures
  - Laboratory exercise MR & CT
- Part 2: Quantification, fusion of techniques, image analysis, visualization.
  - 4 Lectures
  - Laboratory exercise Visualization and Quantification
  - Laboratory exercise fMRI
- Part 3: Clinical applications, selection of techniques.
  - Tutorial groups/literature seminars
- Examination
  - Written exam at end of course
    - Grading: Fail lower than 60%, Pass, at least 60% Pass with distinction 80%, (70% if pass with distinction on lab reports and presentation)
  - 2 Written lab reports and 1 oral presentation
  - Tutorial group work/literature seminars

Final points:

- Course given in CMIV facilities – multi disciplinary research environment
- Labs conducted on modern MRI and CT scanners, visualization table
- Individualized course content based on interest of the participants
- Access to experts within the field, radiologists, physicists, basic researchers, clinicians

Course overview

- Part 1: Imaging basics, overview of the different techniques
  - Lectures
    - MRI
    - CT
    - MRS
    - DECT
    - Contrast agents MR & CT
    - Optical methods
    - PET and SPECT
    - PET and SPECT Tracers
  - Laboratory exersize MR & CT part 1
- Part 2: Quantification, fusion of techniques, image analysis, visualization.
  - Lectures
    - Fat and water imaging, BAT imaging, Visualization techniques 1&2
    - Image analysis
  - Laboratory exersize part 2
  - FMRI lecture
  - Laboratory exersize fMRI
- Part 3: Clinical applications, selection of techniques.
  - Tutorial groups
    - MRI/MRS – clinical application
    - SPECT/PET – Clinical application
    - Contrast agent safety
    - BAT and body composition imaging
    - MI using microbubbles and ultrasound

Learning outcomes

To gain knowledge about and understand:

- **Account for what kind of biological, physiological and pathophysiological processes that can be studied with different molecular imaging techniques.**
  - Describe the sensitivity and on what physical scale the imaging techniques depict the imaged physiological processes.
  - Describe potential interaction between the molecular imaging probes, imaging techniques and physiological processes.

- **Describe the contrast mechanisms in different molecular imaging modalities.**
  - Briefly describe how different imaging modalities work technically
  - Briefly describe the physical phenomena causing the image signal and factors that determines the signal strength and contrast between different tissues.

- **Describe methods for quantification in molecular imaging and how they relate to studied biological or physiological process**
  - Describe the relationship of the measured signal and the magnitude of the studied process
  - Describe how image analysis techniques can be used to quantify physiological processes and properties in an image volume.

- **Describe different visualization techniques in molecular imaging**
  - Understanding the concepts of transfer function and volume rendering
  - Describe image fusion techniques and its application to fuse images within modalities, between different subjects and between different modalities.

- **Account for how different molecular imaging techniques and other imaging techniques are combined to improve the interpretation of molecular imaging**

Learning outcomes

Competence and skills:

- **Use image analysis and visualization software to interpret and visualize the result from a molecular imaging experiment**

Judgement and approach:

- **Evaluate advantages and disadvantages of different molecular imaging techniques when applied in different clinical and pre-clinical situations**
  - Read, interpret and review scientific articles where molecular imaging techniques are used.
  - Discus advantages and disadvantages of different imaging techniques in respect to a research question.

In the course the following imaging techniques specifically are covered

- Positron Emission Tomography (PET), and Single Photon Emission Computed Tomography (SPECT),
- Magnet Resonance (MR), MR-spectroscopy, and Hyperpolarized MR,
- Electron Paramagnetic Resonance Imaging (EPR),
- Computed Tomography (CT),
- Ultrasound Imaging (US),
- Optical methods including optical coherence tomography, optical spectroscopy, and photo acoustic imaging
- (Electron microscopy)

Course literature

- Molecular Imaging, Weissleder, Ralph Ross, Brian D. Rehemtulla, Alnawaz e. ISBN: 9781607951230 pISBN: 9781607950059 Dewey Decimal Number: 616.07/54 OCLC-nummer: 680621303

- Molecular Imaging in Oncology, Otmar Schober, Burkhard Riemann. Springer, ISSN 0080-0015 ISBN 978-3-642-10852-5 ISBN 978-3-642-10853-2 (eBook) DOI 10.1007/978-3-642-10853-2

- Both books are available as e-books via the Linköping University library homepage
-
- Articles covering topics related to specific lectures or tutorial groups will be sent out via LISAM.

Lectures

- Suggested reading available in shedule on Lisam (will be updated during the course)
  - Course literature
  - Scientific articles
  - Book chapters
- Most powerpoint presentations will be made available on Lisam
- Send an email to me if you cannot attend a lecture.

Laboratory exersizes

- Exercise 1 part 1 – MR & CT data acquisition
- Exercise 1 part 2 – PACS & Visualization table
  - Written report (3 pages excluding images) and oral presentation
- Exercise 2 – functional magnetic resonance imaging
  - Written report (2 pages excluding images)

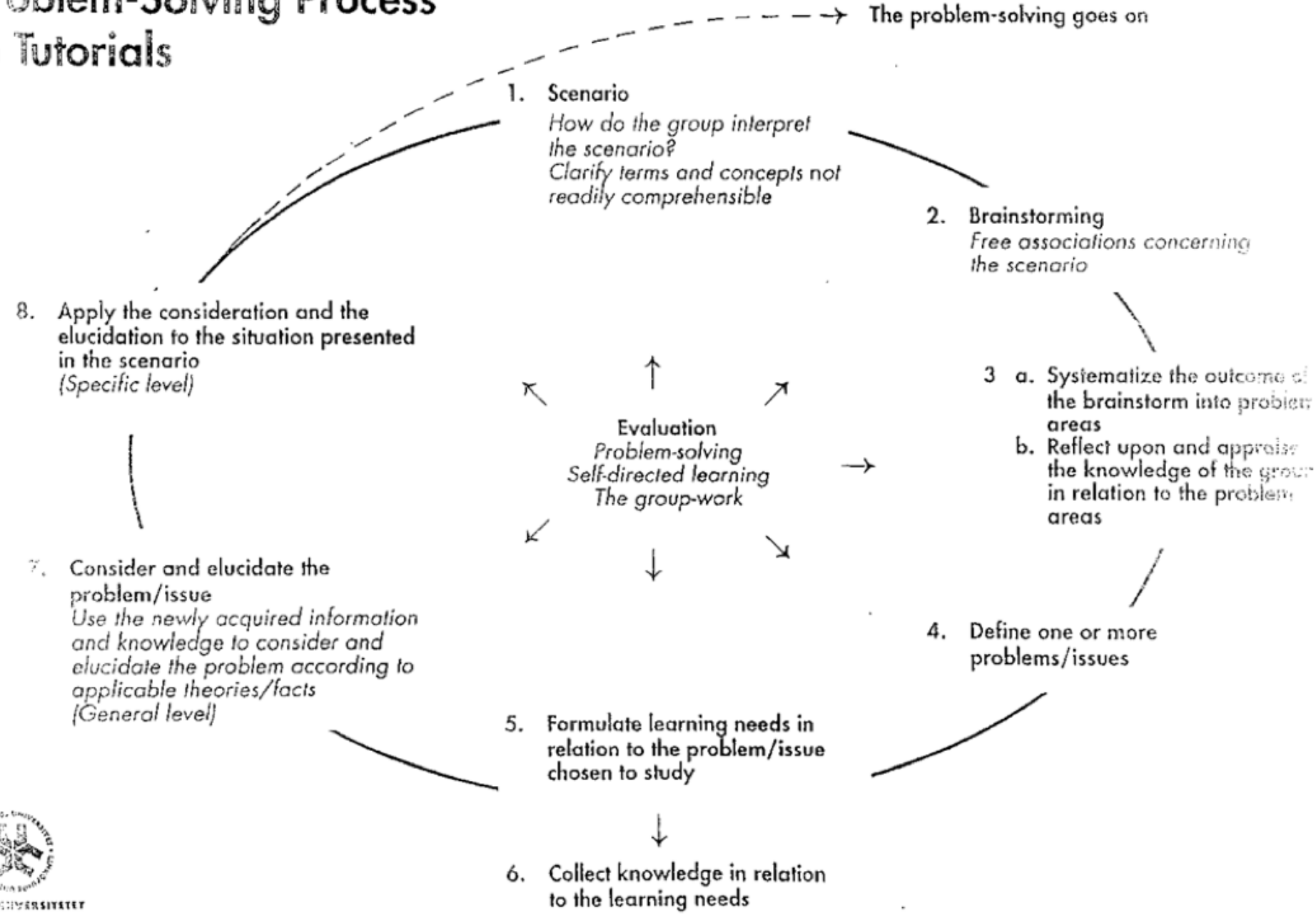
- Grade fail, pass or pass with distinction, pass with distinction gives 10 % lower level for pass with distinction on the written examination.

- Important
  - Patient confidentiality
  - MR-scanner safety, the magnetic field is always active.

Tutorial groups

- 2 Literature seminars
  - Arterosclerosis tuesday
  - Diagnosis & treatment using the same compound and microdosing
- 5 tutorial groups
  - Case 1, Neuroimaging in oncology
  - Case 2, MI in neurodegenerative disesases
  - Case 3, Contrast agent safety
  - Case 4, MI using ultrasound and microbubbles
  - Case 5, Imaging of brown adipose tissue and body composition
- Compulsory attendance, email tutor if you cannot participate, compensation for absence is agreed together with examiner.
- One or two tutorial groups

Problem-Solving Process in Tutorials



Student's representative

- Communicate possible issues during the course.
- Provide comments to the course evaluation.

- Course evaluation:
  - Written comments anytime via mail
  - Oral evaluation at the first tutorial group meeting each week.

Course evaluation 2018

- 1)Overall comment:
- The consensus is that the courses are very interesting and to some people, it is new and eye-opening. However, some people have mentioned that the lectures are still very physics based.

- Actions this year: MRI lectures updated, lecturers informed

- 2)Positive aspects
- The lectures were interesting, especially with the CT, MRI and fMRI. The course also provides a better understanding to image analysis.

- 3)Negative aspects
- Schedule wise, most people agree that it should be done to a minimum as it can become infuriating, especially when lectures have to be rescheduled till the last minute on the last week. The lectures didn't always follow suit with the PBLs, confusing some students.

- 4)improvements
- Most students agree the need to further simplify and dumb down physic related contents. Also, a better need for scheduling lectures is needed.

Written examination

- March 25, 8.00-12.00
- Remember to register for the exam.
- Reexamination April 26, 8.00-12.00

- Grading
  - Fail lower than 60%
  - Pass, at least 60%
  - Pass with distinction 80%, (70% if pass with distinction on lab reports and presentation)