行政院國家科學委員會專題研究計畫 期中進度報告

超高極性氙氣 129 鼠肺之磁振造影影像研究(2/3)
期中進度報告(精簡版)

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計 畫 主 持 人：張允中
共 同 主 持 人：劉尚斌、陳志宏

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行政院國家科學委員會補助專題研究計畫□ 成 果 報 告
■期中進度報告

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計畫主持人：張允中
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成果報告類型(依經費核定清單規定繳交)：■精簡報告　□完整報告

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執行單位：台大醫學院 放射線科

中　華　民　國　96 年　5　月　28 日

中文摘要

本研計畫之目的在發展超高極化氙氣（Hyperpolarized Xenon-129）之鼠肺影像平台。在第一年計畫中已獲得高品質之氙氣 129 產生，並建立一個具有磁場屏障而能保持超高極化狀態之移動式運送氙氣裝置，對於產生之超高極化氙氣之弛緩時間（relaxation time）已有實際測量之資訊及並已獲得仿體影像。今年本研究團隊已將單一環裝線圈之敏感度最佳化，並製造一個鞍型線圈(saddle coil)與一個具有氫及氙振動頻率之雙頻線圈(dual frequencies coil for proton and xenon)，可以獲得氫原子及氙氣之融合影像(fusion image)。同時我們並改善一個螺旋冷凝彎管及玻璃腔室，能夠使超高極化氙氣進氣與 MRI 之截取影像協調。此部份之硬體改善可以有助於高度極化氙氣影像平台之運作。目前超高極化氙氣在世界上僅有少數研究單位具有研發能力，本研究為本土研究團隊自行設計硬體，製造並加以測試，所獲得之成果。

關鍵詞：磁振造影影像、肺臟、氙氣、超高極性。

Abstract:

The aim of this project is to develop imaging platform for hyperpolarized (HP) Xenon129 (^{129}Xe) for rat lung. In the first year of this project, the production of high quality HP ^{129}Xe was obtained and capable to deliver to MR lab with a successfully implemented mobile transport system with magnetic shield. We also implemented a single loop MR coil tune to the frequency of Xe, and obtained data of HP ^{129}Xe relaxation times as well as phantom images. In this second year, we have optimized the sensitivity of the single loop radiofrequency (RF) coils and implemented a saddle coil and double-tuned coil for both proton and Xe nuclei for the anatomic localization and correlation which may facilitate the fusion image of HP ^{129}Xe and proton MR study. As for the production of HP 129Xe gas, we implemented a special design for HP^{129}Xe storage and delivery, which consists of a storage chamber made up of a spiral freeze trap and a glass chamber, which can be synchronized to the ventilation of animal as well as the acquisition sequences of the MRI scanner. The hardware improvement of this project will be beneficial to HP Xenon imaging platform. Currently, there are only limited research centers capable of producing HP ^{129}Xe for ventilation MR lung imaging. Our research team designed and implemented hardware and software to image HP ^{129}Xe in this project.

Keywords: magnetic resonance imaging, lung, xenon, hyperpolarization.

前言：**Introduction**

MRI has exhibited its powerful capability of diagnosing soft tissue disease since 1970s [1]. The development of hyperpolarized (HP) noble gas isotopes ^{129}Xe has drawn much attention for a variety of NMR applications in the past decade owing to its highly enhanced polarization by several orders of magnitude. Recently, it has been further demonstrated that HP ^{129}Xe gas, once inhaled, is capable of providing intense MR signals and images in the pulmonary airspaces that are inaccessible by conventional methods using proton (^{1}H) MRI [2]. HP noble gas isotope has no inherent radiation exposure and capable to explore the physical function of ventilation [3-5]. Furthermore, unlike HP helium3, HP ^{129}Xe may dissolve in tissue which is more interesting to probe the related physiologic phenomenon.

HP ^{129}Xe is commonly produced by an indirect polarization method mostly involving spin exchange between optically pumped Rb vapor and Xe noble gas. During these processes, nitrogen and helium are typically added as buffer gases to achieve a higher polarization for HP ^{129}Xe, which represents only a small fraction of the original gas mixture [3]. As such, proper freezing and thawing schemes become inevitable for mass production and subsequent usage of HP ^{129}Xe gas. Furthermore, its delivery to target medium of interest

without significant loss in spin polarization is also an important issue in MRI-related applications.

研究目的：**Purpose:**

The goals of this project are to establish related techniques and hardware for HP noble gas MRI as well as their applications for pulmonary function imaging of small animals and model studies. The project includes development of radiofrequency coils (bird-cage, solenoid, surface and saddle coils), optimization of radiofrequency pulses, storage and delivery of hyperpolarized (HP) noble gas, mechanical ventilation for noble gas MR imaging, and exploration of dynamic and diffusion capability of HP noble gas ventilation MRI, lung imaging of small animal and the pulmonary model studies. In the past year, we focused on the design and construct storage/delivery system for transportation of HP Xe gas to a remote MRI scanner with significant polarization loss (ISMRM May 8-12, 2006. A delivery system for hyperpolarized ^{129}Xe MRI of small animal lungs. Shing-Jong Huang SJ, Hsieh CH, Chen JH, Liu SB, Chang YC) [6]. This system highly benefits HP ^{129} Xe gas signal intensity as well as spatial resolution of acquired MRI images. Furthermore the amount of HP ^{129}Xe gas delivered at the outlet is

synchronized to the ventilation of animal and the acquisition sequences of the MRI Scanner. Using self-developed coil tuned to Xenon frequency to obtain spectrum and phantom image of naturally abundant Xenon. We also tested the tubing for delivering HP129Xe to the phantom in the 3T MR system.

研究方法：**Methods:**

During this year, we designed and implemented RF coils for HP Xenon study, including optimization for the image sensitivity, and also for better anatomic correlation, as saddle coil and double-tuned coil were developed. As we know, in the biomedical application, conventional 1H MRI is used for planning and localizing the region of interest (ROI), or for combination with fMRI or perfusion imaging. Thus, the use of these multinuclear imaging modalities could provide more function indexes, such as for lungs and for diagnostic studies for pulmonary diseases. In this project, we designed a prototype of the 1H-129Xe dual surface coil (Figure 5), which was capable to image CuSO4 solution (proton image) within a cylinder tube, and HP 129Xe gas within a spiral storage chamber sequentially (Figure 6-8). As for the production of HP 129Xe gas, we have demonstrated a special design for HP 129Xe storage and delivery, which consists of a storage chamber made up of a spiral freeze trap

and a glass chamber, which can be synchronized to the ventilation of animal as well as the acquisition sequences of the MRI scanner [7,8].

結果：Results:

1. **Imaging of HP ^{129}Xe gas in delivery chamber with RF saddle coil**

Figs. 1 and 2 show MRI images of HP ^{129}Xe gas in the spiral tube with matrix size of 64*64 using a saddle RF coil. The setting parameters are described as below:

Figure 1

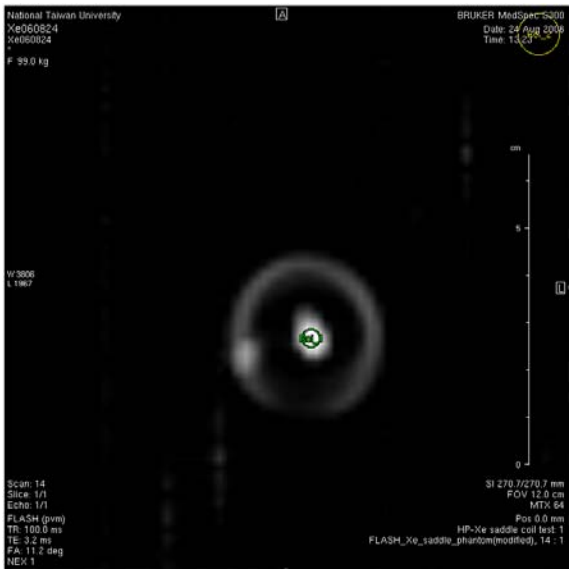

Fig. 1 The HP-^{129}Xe solenoid tube axial image using saddle RF coil: matrix size 64*64

Setting Parameters (Fig. 1):BF1: 34.6 M Hz ; Pulse sequence: FLASH (modified); TE: 3.2 ms; TR: 100 ms; Numbers of average: 1; Matrix size: 64*64; Slice thickness: 10 mm; FOV: 12.0/12.0 cm; Flip angle: 11.2 degree;

TX0: 13.4 dB; SNR: 258; Pulse length: 5 μs; Time of one slice: 6.4s.
HP-129Xe gas Parameter: 6% 129Xe; Flow rate: 140 scc/min; Time : 2 min; Volume: 16.8 c.c

Figure 2

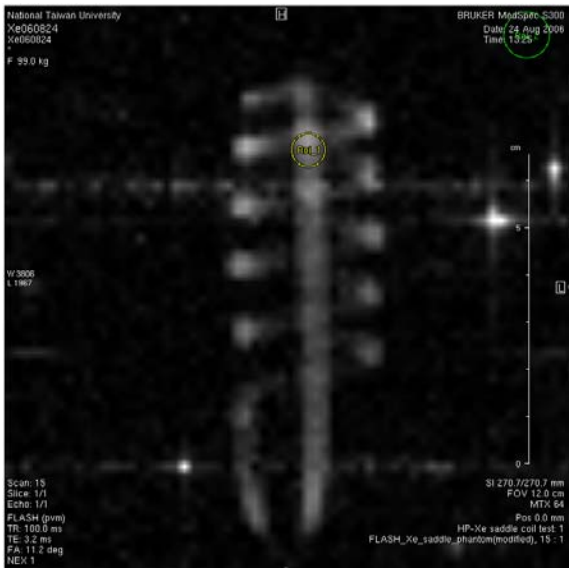	Fig. 2 The HP-^{129}Xe solenoid tube coronal image using saddle RF coil: matrix size 64*64
Setting Parameters:BF1: 34.6 M Hz ; Pulse sequence: FLASH (modified); TE: 3.2 ms; TR: 100 ms; Numbers of average: 1; Matrix size: 64*64; Slice thickness: 10 mm; FOV: 12.0/12.0 cm; Flip angle: 11.2 degree; TX0: 13.4 dB; SNR: 19; Pulse length: 5 μs; Time of one slice: 6.4s	
HP-129Xe gas Parameter: 6% 129Xe; Flow rate: 140 scc/min; Time : 2 min; Volume: 16.8 c.c	

Figure 3

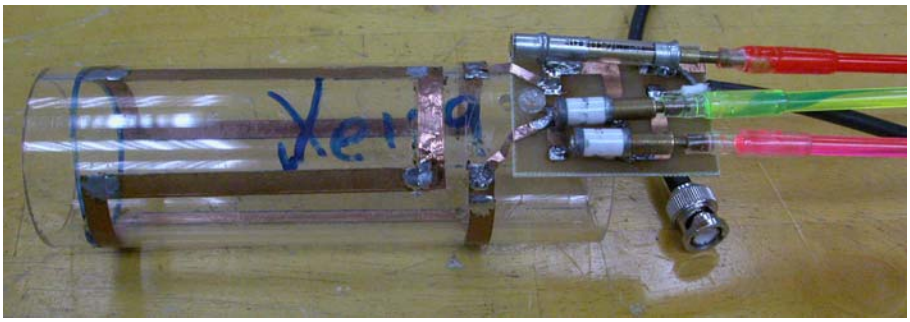

Photo of 129Xe RF saddle coil

2. ^{1}H-^{129}Xe dual surface coil

A prototype of the 1H-129Xe dual surface coil was implemented and tested with ^{1}H and ^{129}Xe phantoms filled with $CuSO_4$ solution and HP ^{129}Xe gas, respectively. The inner diameter of $CuSO_{4(aq)}$ cylinder tube was 1.5 cm and the outer diameter of HP 129Xe spiral storage chamber was 3 cm. The phantoms are placed superior and inferior of the coil with the axis of the cylinders placed horizontally. The photo is shown in Fig. 4. Figures 6 and 7 show the HP ^{129}Xe image of the spiral storage chamber and 1H image of $CuSO_{4(aq)}$ cylinder tube, respectively; both were acquired easier and just switched the RF cable connectors. Thus, it may be concluded that multinuclear spectroscopic imaging for HP ^{129}Xe and ^{1}H could be applied to small animal lungs and related disease diagnosis studies more convenient.

Figure 4

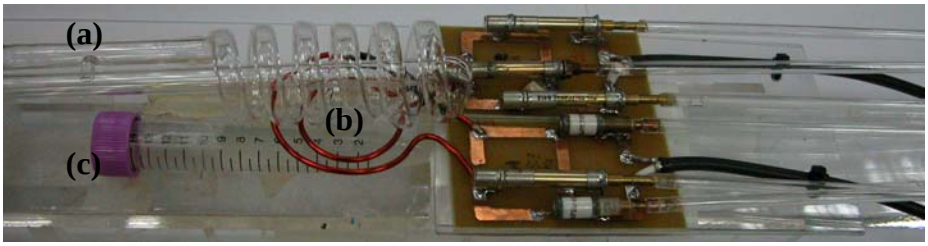

Fig.4 Photos of home-built ^{1}H -^{129}Xe dual surface coil with HP ^{129}Xe and ^{1}H phantoms. (a) HP ^{129}Xe spiral storage chamber; (b) ^{1}H-^{129}Xe dual surface coil; (c) $CuSO_4$ solution cylinder tube.

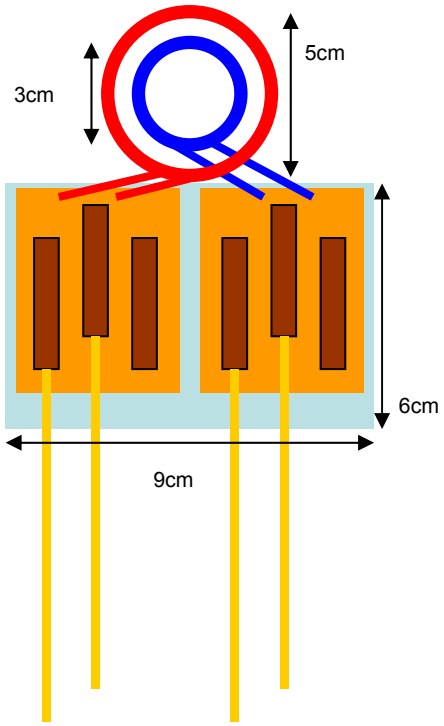

Fig.5 Schematic diagram of ^{1}H -^{129}Xe dual surface coil: ^{1}H (in red) and ^{129}Xe (in blue) surface coil diameters are 5 cm, and 3 cm, respectively.

The schematic diagram of ^{1}H-^{129}Xe dual surface coil is shown in Fig. 5.

2D FLASH and 2D RARE were used in the following experiments.

Figure 6.

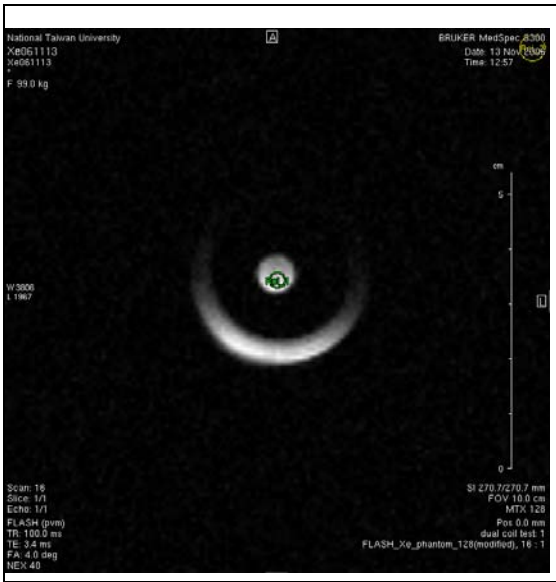

Fig.6 HP ^{129}Xe image: spiral storage chamber in axial view, experimental parameters as below: 2D FLASH, 128X128, FOV 10.0/10.0 cm, Flip angle: 4^{o}, TR = 100 ms, TE = 3.4 ms, SNR: 48, and numbers of average: 40

Figure 7

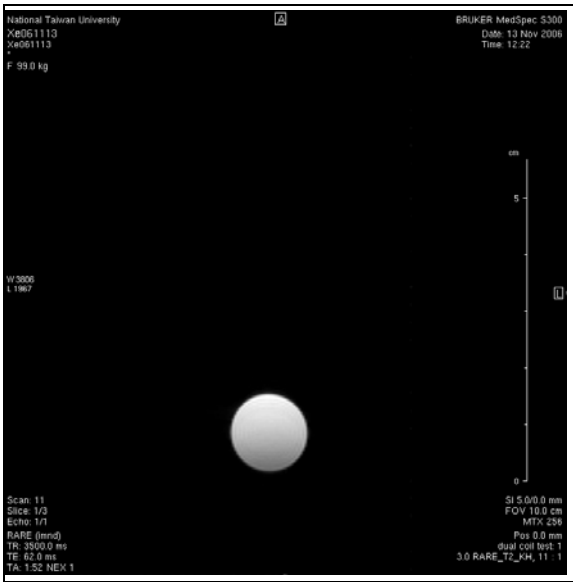

Fig.7 ^{1}H MRI images: $CuSO_{4(aq)}$ cylinder tube in axial view. Experimental parameters: 2D RARE, 256X256, FOV 10.0/10.0 cm, TR = 3500 ms, TE = 62

ms, and numbers of average: 1.

Figure 8

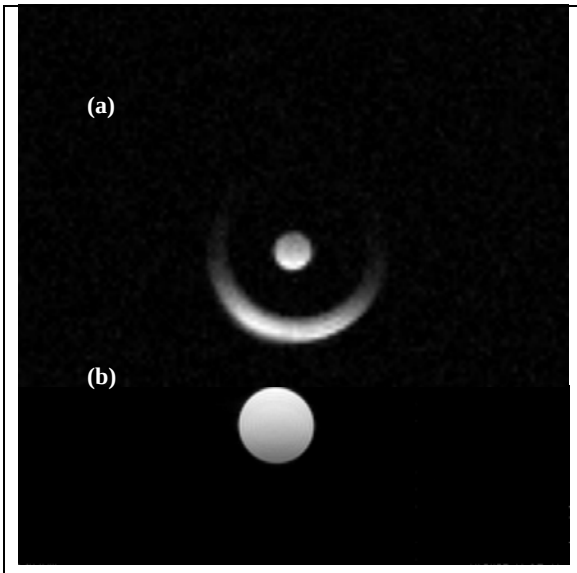

Fig.8 The merged picture: (a) HP ^{129}Xe MRI image; (b) ^{1}H MRI image

討論：**Discussion:**

The implement of ^{129}Xe RF saddle coil provided an image of high signal to noise ratio (SNR), compared with surface coil. As shown on Fg.1 and Fig.6, there was better signal intensity of saddle coil than surface coil, and the SNR of saddle coil is about 258 during one acquisition, then, the SNR of surface coil is about 48 during forty averaged acquisitions. However, the saddle coil generated more RF power than surface coil, and HP ^{129}Xe relaxation became

faster for saddle coil. It means that higher HP ^{129}Xe gas density and the larger amount of HP ^{129}Xe gas will be utilized for saddle coil than surface coil.

1H-129Xe dual surface coil could be used complementarily for demonstrating the anatomic localization of high signal HP Xenon gas. By simple switch of the RF cable connectors, and sequential acquisition of images from two different nuclei was obtained. The coil dimension determines the depth of image. As a rule, the larger the dimension, the deeper the area is observed. However, there is limitation for coil dimension due to the available space of gradient coil chamber. In order to cover more image area, the dual coil should be modified from surface coil to saddle or volume coil in the future.

In summary, implementation of coil technology for xenon requires an interdisciplinary collaboration. Our results demonstrated the capability of self-made facility to image HP Xenon. The results of our research will benefit ventilation MR images with HP Xenon in live animals.

參考文獻: **References:**

1. Lauterbur PC. Nature 1973; 242: 190-191.
2. Albert MS, et al., Nature 1994; 370: 199–201.
3. De Lange EE, Murgler JP, Brookeman JR, et al. Lung air spaces: MR

imaging evaluation with hyperpolarized ^{3}He gas. *Radiology 1999;210:851-857.*

4. Mugler JP, Driehuys B, Brookeman JR. et al. MR imaging and spectroscopy using hyperpolarized ^{129}Xe gas: preliminary human results. *MRM 1997;37:809-815.*
5. Wagshul ME, Button TM, Li HF, et al. In vivo MR imaging and spectroscopy using hyperpolarized ^{129}Xe. *MRM 1996;36:183-191.*
6. Huang S.J. et al., “A delivery system for hyperpolarized (HP) 129Xe MRI of small animal lungs”, Proc ISMRM Ann Meeting, Seattle, U.S.A, 2006.
7. Chao-Hsien Hsieh, Shing-Jong Huang, Jyh-Horng Chen, Shang-Bin Liu, Yeun-Chung Chang. Hyperpolarized xenon-129 MRI platform: the design of gas delivery. Ann Meeting Biomedical Engineering, 2006.
8. Chao-Hsien Hsieh, Shing-Jong Huang, Jyh-Horng Chen, Shang-Bin Liu, Yeun-Chung Chang. Hyperpolarized Xenon-129 MRI Platform: the Design of Gas Delivery System. Annual Meeting of RSROC, 2007.

行政院所屬各機關出國報告

The 3rd International Workshop of Pulmonary Functional Imaging

服務機關：台大醫院影像醫學部

職　　稱：助理教授

姓　　名：張允中

出國地區：德國，海德堡

出國期間:2006/10/05-2006/10/07

報告日期：2005/10/27

一、摘要

本報告主要為參加The 3rd International Workshop of Pulmonary Functional Imaging, DKFZ, Germany之紀錄。肺臟功能影像（pulmonary functional imaging）為結合肺臟影像及功能分析；使用最多之影像工具包含CT、MRI、PET等，由於影像檢查不僅提供良好之解晰度，更提供各種具生理意義之功能分析，此為未來像檢查之趨勢。本次參加之會議，參加之人數約 230 人左右，但由於大會主題明確，受邀之演講者均為世界知名學者，因此整體內容具有十分廣泛及深之之主題。例如在肺臟疾病如呼吸道疾病、肺氣腫、肺動脈高壓症、急性呼吸窘迫症、腫瘤之血管新生及急性肺栓塞等均包含在內，並有許多有關於超高極化鈍氣（hyperpolarized noble gas）之氦氣-3 及氙氣-129 MRI研究，肺癌之MRI及CT血管新生性之研究、及 3D、4D MDCT或MRI之相關研究報告。在世界上使用 Hyperpolarized Xe^{129} 研究MRI氣體影像並不多，是屬於尖端科技，由於 Hyperpolarized Xe之生產儲存通常需要許多設備及人力配合。

本研討會有助於本團隊目前進行之Hyperpolarized Xe^{129} MRI之研究計劃，使本團隊之研究者得以更瞭解世界各地研究成果，以及未來研究方向及可能成果。此外更使我們瞭解各種不同影像工具如MDCT、MRI在臨床應用及基礎研究上所可能扮演之角色，此對於國內之肺臟功能影像之研究將有所幫助。

二、目次

三、正文（包含目的、過程（包含每天課程重點）、心得、建議及其它相關事項（如會議主題、期間、地點、主辦單位、協辦單位、參加國家及展望等）

目的：參加 The 3rd International Workshop of Pulmonary Functional Imaging 以增進對肺臟功能影像研究之知識與未來發展方向。

過程：本人在 10 月 3 日由台北出發經過香港轉機前往法蘭克福（Frankfurt）機場，再轉巴士前往德國海德堡（Heidelberg）參加The 3rd International Workshop of Pulmonary Functional Imaging。會議會場是位於海德堡世界知名之德國癌症研究中心（German Cancer Research Center, DKFZ）。本次國際研討會期間由 10/5 ~ 10/7，主要之目的為探討幾個使用不同image modality來研究肺功能影像之重要議題，包含airway disease, emphysema, pulmonary hypertension, exercise testing and biomechanic, protective ventilation, ARDS, experimental techniques, bronchoscopy, ultrasound, tumor angiogenesis, acute pulmonary hypertension及最近研究之壁報展示，主要使用來研究之工具包含多層切面電腦斷層（Multi-Detector Computed Tomography，簡稱MDCT）、磁振造影（Magnetic Resonance Image，簡稱MRI）等。與會人士主要為德國及其它歐洲之學者、一些美國學者、少數日韓學者及 1 位台灣參加者，共計約 230 人之小型國際會議，但包含了目前國際上研究肺功能影像之著名專家。三天研討會之詳細內容如附件一，可以歸納為下列幾點：

（一） 呼吸道疾病（airway disease）：使用 MDCT 進行 automated measurement of airway wall thickness、airtrapping 等研究、使用 hyperpolarized helium-3 MRI of lung 來研究呼吸道疾病之功能性變化。

（二） 肺氣腫（pulmonary emphysema）：使用 hyperpolarized helium-3、hyperpolarized xenon-129、oxygen-enhanced MRI 及 MDCT 來進行肺氣腫或肺臟內定量氣體交換之研究。

（三） 肺高壓症（pulmonary hypertension）：包含肺高壓症之基因表現型態、治療及追蹤、外科治療及影像診斷。使用 contrast-enhanced MRI 等方式來評估 chronic thrombo-embolic pulmonary hypertension 等。

（四） 運動測試及生物機轉：主要研究使用快速 MRI，可以針對動態呼吸運動及肺臟體積變化進行研究，此研究之方式在臨床上可以使放射線治療時更集中。

（五） 急性呼吸窘迫症（ARDS）之相關研究：由生理及臨床研究出發，使用一些模型及不同方法如 MRI、liquid-liquid system、intravital microscopy、MDCT、electrical impedance tomography 等方式。其中 intravital microscopy 可以觀察到活體動物肺臟表面細胞活動血流運動等之實際狀況，令人印象深刻。

（六） 動物實驗：如老鼠肺氣腫之影像、MRI、HP Xe-129、HP He-3 MRI 等之研究。

（七） 氣管鏡及超音波：使用 Navigation system 有輔助功能。

（八） 腫瘤之血管新生（Tumor Angiogenesis）：使用 MDCT 及 MRI 在 3D 或 4D mode 下來研究 lung cancer 之 angiogenesis 或放射治療之 target volume。

（九） 急性肺栓塞之臨床基礎至最近進展包含 CT、MR、CAD 等之研究。

心得與建議：

歐洲、美國在肺功能影像之研究投入大量人力及研究經費，確實居肺臟功能影像之世界領導地位。近年來亞洲國家如日本及韓國亦開始進行此方面研究，雖然在規模及研究深度及廣度上尚不及歐洲國家或美國來得顯著，但在某些題目上，確也能有令人注意之成果，例如日本 Kyto University 之 O2-enhanced MRI 之研究，及韓 Asan Medical Center 使用 MDCT 在全國多中心之研究氣喘及肺氣腫病患，十分令人注目。

目前國內有關肺臟功能影像之研究十分零散，我們之研究團隊使用 XP Xenon-129 進行 MRI 影像之研究亦歷經許多困難。目前國內對肺功能影像尚未十分重視，但此主題為活體功能性之研究，對於瞭解生理、病理之變化極有幫助。在國內之學術單位若能整合研究資源及人力，可能才有機會有國際水準之表現。

附件：

program schedule

3rd International Workshop of Pulmonary Functional Imaging

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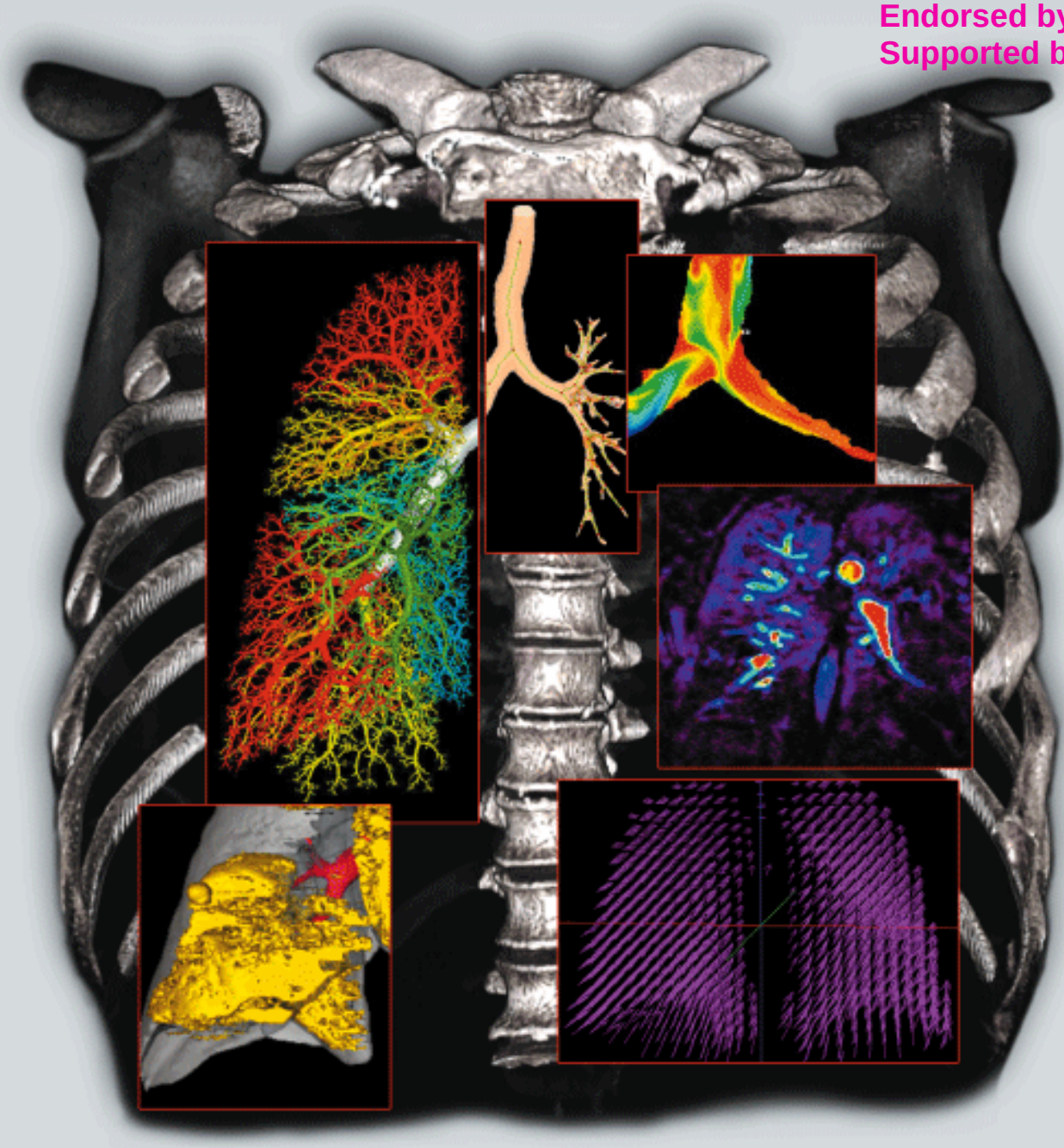

Heidelberg, Germany
October 5-7, 2006
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Program at a Glance

	Thursday, Oct. 5, 2006	Friday, Oct. 6, 2006	Saturday, Oct. 7, 2006
07:30 - 08:30		Continental Breakfast	Continental Breakfast
08:30 - 10:00		Pulmonary Hypertension	Bronchoscopy and Ultrasound
10:00- 10:30		Break	Break
10:30 - 12:30		Exercise Testing and Biomechanics	Tumor Angiogenesis
12:30 - 14:00	Lunch Reception Registration	Toshiba Lunch Symposium	Siemens Lunch Symposium
14:00 - 16:00	Welcome + Introduction Airway Disease	Protective Ventilation and ARDS	Acute Pulmonary Embolism
16:00 - 16.30	Break	Break	Adjourn
16:30 - 18:30	Emphysema	Parallel Sessions: Experimental Poster Sessions: Airway Disease + Emphysema Vasculature and Oncology	
18:30 - 20:30	Get together Party		
19:30		Workshop Dinner	

Scientific Program

Thursday, October 5

12:30 Lunch Reception and Registration

14:00 Welcome + Introduction: H.-U. Kauczor (D-Heidelberg), H. Hatabu (US-Boston)
G.W. Kauffmann (D-Heidelberg)

14:30 Airway Disease

Moderators P. Schnyder (CH-Lausanne), C.P. Heussel (D-Heidelberg)

Keynote Lectures

14:30	H. Magnussen (D-Hamburg)	Pulmonary function tests in COPD
14:45	P. Grenier (F-Paris)	Imaging of airway disease
15:00	F.M. Müller (D-Heidelberg)	Functional diagnostics in CF

Scientific Presentations

15:15	N. Woodhouse (UK-Sheffield)	Hyperpolarised Helium-3 Regional Volumetry Pre and Post Physiotherapy in Cystic Fibrosis: Preliminary Experiences
15:25	Y.S. Tzeng (US-Boston)	Quantification of Ventilation Heterogeneity Changes in Asthmatic and Non-Asthmatic Lungs Using Hyperpolarized 3He MRI
15:35	S.H. Park (ROK-Seoul)	Automatic measurement of airway dimension and index of air trapping at volumetric CT in asthma: Correlation with clinical parameters.
15:45	T. Achenbach (D-Mainz)	Influence of Image Matrix and an Integral Based Method on Bronchial-Wall Quantification.
15:55	N. Sverzellati (I-Parma)	How much do GOLD stages reflect CT abnormalities in COPD patients?

16:00 Break

16:30 Emphysema

Moderators H. Magnussen (D-Hamburg), P. Grenier (F-Paris)

Keynote Lectures

16:30	M. Mishima (J-Kyoto)	Discrimination and phenotyping of COPD using CT
16:45	E. Hoffman (US-Iowa)	Functional imaging of emphysema using CT
17:00	E. van Beek (US-Iowa)	Imaging of emphysema using 3He MRI
17:15	Y. Ohno (J-Kobe)	Oxygen-enhanced MRI

Scientific Presentations

17:30	F. Molinari (I-Rome)	Oxygen-enhanced MRI vs. Quantitative Multidetector-Row CT in Smoking-Related Pulmonary Emphysema.
17:40	K. Ruppert (US-Philadelphia)	Detecting Emphysema with Functional Lung Imaging Using Hyperpolarized Xe-129
17:50	S. Patz (US-Boston)	Quantitative surface/volume and Gas Exchange Imaging in Humans with Hyperpolarized 129Xe
18:00	A. Evans (CDN-London)	Hyperpolarized Helium 3 Magnetic Resonance Imaging of Severe and Moderate COPD: Reproducibility of ADC and Ventilation Volumes

18:30-20:30 Get together Party

Friday, October 6

07:30 Continental Breakfast

08:30 Pulmonary Hypertension

Moderators C. Fink (D-Munich), D. Kiely (UK-Sheffield)

Keynote Lectures

08:30	E. Gruenig (D-Heidelberg)	Genetics and clinical presentation of PH
08:45	D. Kiely (UK-Sheffield)	Therapy and monitoring of PH
09:00	E. Mayer (D-Mainz)	Surgical Treatment of PH
09:15	S. Ley (D-Heidelberg)	Imaging in PH

Scientific Presentations

09:30	N. Woodhouse (UK-Sheffield)	Intra-Individual Comparison of 0.5 & 1.0M Contrast Agents in the Evaluation of Chronic Thrombo-Embolic Pulmonary Hypertension
09:40	P. Kunz (D-Mainz)	Mean pulmonary arterial pressure estimation by means of high temporal resolution phase-contrast MRI in patients with CTEPH
09:50	M. Nogami (J-Kobe)	Myocardial Glucose Uptake on Whole-body 18F-FDG PET/CT in Patients with Suspected Malignancy: Correlation with Right Ventricle Function and/or Pulmonary Vascular Resistance

10:00 Break

10:30 Exercise Testing and Biomechanics

Moderators H. Hatabu (US-Boston), M. Paiva (B-Brussels)

Keynote Lectures

10:30	P. Baertsch (D-Heidelberg)	Lung function and PA pressure in hypoxia
10:45	J. Gee (US-Philadelphia)	Image-based vector analysis of lung motion
11:00	D. Levin (US-Rochester)	Imaging during and after exercise testing
11:15	M. Paiva (B-Brussels)	Dedicated lung function tests

Scientific Presentations

11:30	M. Nishino (US-Boston)	Volumetric Expiratory High-Resolution CT of the Lung: Clinical applications
11:40	J. T. Marcus (NL-Amsterdam)	MRI estimation of dynamic regional lung ventilation, derived from pulmonary density changes during respiration
11:50	M. Eichinger (D-Heidelberg)	Visualisation of Lung Function using Real-Time MRI
12:00	A. Swift (UK-Sheffield)	Rapid lung volumetry with ultrafast dynamic MRI during forced vital capacity manoeuvre – correlation with Spirometry
12:10	N. Nurpeissov (D-Heidelberg)	Lung parenchyma motion analysis: Comparison of MRI techniques

Friday, October 6

12:30 Toshiba Lunch Symposium

Moderator K. Sugimura (J-Kobe)

12:30	H. Dogan (NL-Leiden)	Systolic Right Ventricular Function in Acute Pulmonary Embolism using MDCT
12:55	J. Ley-Zaporozhan (D-Heidelberg)	Insights in pulmonary mechanics and ventilation using 4D CT
13:20	H. Hatabu (US-Boston)	Lung Multicenter Trial for dose reduction in CT

14:00 Protective Ventilation and ARDS

Moderators G. Hedenstierna (S-Uppsala), H.-U. Kauczor (D-Heidelberg)

Keynote Lectures

14:00	G. Hedenstierna (S-Uppsala)	Concepts for protective ventilation in ARDS
14:15	K. Markstaller (CH-Berne)	Image-based support for protective ventilation in ARDS
14:30	W. Schröder (D-Aachen)	Flow simulation for protective ventilation

Scientific Presentations

14:45	K. Adler (D-Freiberg)	Investigation of Dynamic Flow Patterns in a Realistic 3D Model of the Tracheobronchial-Tree
14:55	W. Kilian (D-Berlin)	MR velocimetry of hyperpolarized rare gases for non-invasive in vivo gas-flow measurements
15:05	K Schirrmann (D-Berlin)	A Liquid-Liquid-System as a Blood Model Fluid in a Capillary Network
15:15	U. Wolf (D-Mainz)	19F-MRI of a wash-out of C4F8 during HFOV: initial results
15:25	A. Tabuchi (D-Berlin)	Intravital microscopy of the pulmonary microcirculation in ventilated mice
15:35	M.G. Papi (I-Rome)	MDCT quantitative and qualitative findings in ARF and ARDS patients at different PEEP ventilation pattern: cut-off value of PEEP
15:45	I. Frerichs (D-Kiel)	Quantification and reproducibility of PEEP-induced redistribution of regional lung ventilation determined by functional electrical impedance tomography

16:00 Break

Friday, October 6

16:30 Parallel Sessions

16:30 Experimental

Moderators Y. Cremillieux (F-Villeurbanne), H. Schulz (D-Munich)

Keynote Lecture

16:30	M. Takahashi (US-Boston)	Emphysema imaging in mice

Scientific Presentations

16:45	I. Bolle (D-Munich)	Does lack of the Cftr gene result in a lung function phenotype?
16:55	M. Mall (D-Heidelberg)	Airway surface liquid (ASL) dehydration produces a novel animal model for CF and COPD
17:05	F.X. Ble (CH-Basel)	MRI as a non-invasive tool to characterize a murine model of allergic pulmonary inflammation
17:15	D. Rudersdorf (D-Mainz)	Bimodal imaging of Elastase induced emphysema in rats
17:25	J. Mata (US-Charlottesville)	Evaluation of Emphysema Severity and Progression in a Rabbit Model: A Comparison of Hyperpolarized He-3 and Xe-129 ADC with Morphometry
17:35	J. Perez-Sanchez (ES-Madrid)	Pressure dependence, isotropy, and reproducibility of in-vivo 3He-MRI ADC measurements in the rat lung at 0.5T
17:45	M. Mertens (D-Berlin)	Respiratory changes in lung volume of the ventilated mouse are attributable to alveolar distension rather than recruitment
17:55	S.I. Mund (CH-Berne)	Local Capillary Duplications at the Basis of Newly Forming Septa Allow Late Alveolarization of Juvenile and Young Adults Lung
18:05	F.W. Hersman (US-Durham)	Large-scale polarization of 129Xenon

Friday, October 6

16:30 Poster Session 1: Airway Disease and Emphysema

Moderators J. Biederer (D-Kiel/Heidelberg), S. Murayama (J-Ryukyus)

P01	J.B. Seo (ROK-Seoul)	Quantitative assessment of emphysema and airway dimension at volumetric CT in chronic obstructive lung disease (COPD): correlation with pulmonary function test (PFT) and clinical parameters
P02	M. Nieber (NL-Leiden)	Airflow Limitation in COPD: Differentiation between the Effects of Parenchymal and Bronchial Disease by measuring Lung Density and Bronchial Dimensions in CT
P03	M. Nishino (US-Boston)	Volumetric Expiratory High-Resolution CT of the Lung: Basics and technical considerations
P04	N. Kim (ROK-Seoul)	Optimal binning and ROI size of the automatic classification system for differentiation between obstructive lung diseases on the basis of texture features at HRCT
P05	S.H. Park (ROK-Seoul)	An automated classification system for differentiation between obstructive lung diseases on the basis of texture features at HRCT: Improvement of performance by adding shape features
P06	H. Koyama (J-Kobe)	Quantitative Analysis of Isotropic Thin-section Volumetric MSCT in Pulmonary Emphysema Patients: Correlation with Pulmonary Function Test and NETT Score for Determination of Feasible Threshold Value
P07	J.-M. Kuhnigk (D-Bremen)	Functional analysis of lungs, lobes and bronchopulmonary segmens based n CT data
P08	N. Kim (ROK-Seoul)	Automatic measurement of oblique-oriented airway dimension at volumetric CT: Effect of imaging parameters and obliquity of airway on physical phantom.
P09	N. Kim (ROK-Seoul)	Influence of CT imaging parameters on automatic measurement of airway wall thickness with FWHM method using a physical phantom.
P10	G. Edula (S-Lund)	Measuring airway changes and emphysema in COPD patients for patient stratification and disease progression - findings from cross-sectional study
P11	J.B. Seo (ROK-Seoul)	Quantitative perfusion MR in patients with COPD: Correlation of perfusion parameters with pulmonary function test and quantitative CT
P12	M. Doebrich (D-Mainz)	Deconvolution analysis in rapid hyperpolarized 3He MRI
P13	J.M. Wild (UK-Sheffield)	Changes in dynamic lung ventilation in asthmatics in response to broncho-dilator treatment demonstrated with radial projection 3He MRI
P14	E. Bannier (F-Villeurbanne)	Lung ventilation MRI using polarised He3 – sequence validations and preliminary results on a clinical scanner
P15	N. Woodhouse (UK-Sheffield)	Comparison of Hyperpolarised 3-He Administration Methods in Healthy and Diseased Subjects
P16	R. Failo (NL-Rotterdam)	Ultra-short TR/TE 2D Steady State Free Precession (SSFP) MRI: is this a feasible method to evaluate the lungs in CF patients?
P17	M. Oechsner (D-Wuerzburg)	Optimised FLASH sequences for examinations of the human lung at 0.2 T
P18	F. Giesel (D-Heidelberg)	Regional brain matter loss in chronic obstructive pulmonary disease
P19	W. Möller (D-Gauting)	Left to right asymmetry of lung deposition after shallow aerosol bolus inhalation is an effect of lung ventilation

Friday, October 6

16:30 Poster Session 2: Vasculature and Oncology

Moderators D. Levin (US-Rochester), L. Bonomo (I-Rome)

P20	M. Nogami (J-Kobe)	Phase Contrast MR Imaging: Utility for Assessment of Influence on Cardiac Function and Disease Severity of the Lungs in Pulmonary Emphysema
P21	K.O. Choe (ROK-Seoul)	Role of thin section CT in the patients with Eisenmenger syndrome determining operability
P22	K.O. Choe (ROK-Seoul)	PA/PV ratio related with cross-sectional area of systemic-pulmonary collateral vessels by CT in patients with congenital heart defects and decreased pulmonary blood flow
P23	M. Oechsner (D-Wuerzburg)	Quantitative contrast-enhanced perfusion measurements of the human lung
P24	D. Takenaka (J-Kobe)	Adiabatic Inversion Recovery HASTE Sequence: Determination of the Influence of Slice-selectivity to Oxygen-enhanced MRI-Preliminary Results
P25	H. Karmouty (CH-Basel)	Experimental pulmonary disease assessed by proton MRI
P26	C. Otto (US-Philadelphia)	Regional and Temporal Distribution of Chemokines in a Model of Acute Lung Injury
P27	R. Tetzlaff (D-Heidelberg)	Lung motion of animal lung explants in a MR-compatible chest phantom - Interpolation from landmarks in CT-scans at distinct inspiratory levels
P28	C. Plathow (D-Tuebingen)	Monitoring of lung motion in patients with malignant pleural mesothelioma using 2D and 3D dynamic MRI: Comparison with Spirometry
P29	F. Giesel (D-Heidelberg)	Non-invasive analysis of malignant epithelioid mesothelioma using DCE-MRI: a feasibility study
P30	C. Hintze (D-Heidelberg)	MR based lung cancer perfusion measurement: Quantitative and qualitative assessment of time intensity curves of a hybrid breath hold and navigator triggered 3D MR sequence
P31	C. Plathow (D-Tuebingen)	Comparison of whole body MRI and whole body PET-CT for staging of advanced bronchial carcinoma - initial results

19:30 Workshop Dinner

Saturday, October 7

07:30 Continental Breakfast

08:30 Bronchoscopy and Ultrasound

Moderators L. Bonomo (I-Rome), F. Herth (D-Heidelberg)

Keynote Lectures

08:30	A. Ernst (US-Boston)	Imaging requirements for the central airways
08:45	F. Herth (D-Heidelberg)	Imaging requirements for the peripheral airways
09:00	C.P. Heussel (D-Heidelberg)	CT and MRI to support endobronchial therapy

Scientific Presentations

09:15	I. Wegner (D-Heidelberg)	Development of a Navigation System for Bronchoscopy inside Human Lungs
09:25	W. Harms (D-Heidelberg)	Prospective Clinical Trial on Safety and Feasibility of Electromagnetically Navigated Brachytherapy as a new Treatment Option for Peripheral Lung Cancer
09:35	R. Eberhardt (D-Heidelberg)	EBUS-TBNA for Mediastinal Restaging
09:45	R. Eberhardt (D-Heidelberg)	Electromagnetic Navigation – a new approach in diagnosing peripheral lung lesions: Evaluation of the learning curve

10:00 Break

10:30 Tumor Angiogenesis

Moderators Y. Ohno (J-Kobe), H. Augustin (D-Mannheim/Heidelberg)

Keynote Lectures

10:30	H. Augustin (D-Mannheim)	Role of angiogenesis in lung cancer
10:45	N. Reinmuth (D-Heidelberg)	Role of anti-angiogenic treatment in lung cancer
11:00	V. Goh (UK-Northwood)	CT imaging of angiogenesis in lung cancer
11:15	H. Hatabu (US-Boston)	MRI perfusion of nodules

Scientific Presentations

11:30	J. Arnold (D-Wuerzburg)	Target volume definition in patients with non-small cell lung cancer using magnetization transfer MRI
11:40	R. Ireland (UK-Sheffield)	Optimisation of lung cancer radiotherapy treatment with hyperpolarised He-3 MRI
11:50	G. Remmert (D-Heidelberg)	Retrospectively gated MRI – 4D imaging of porcine lung phantom
12:00	C. Plathow (D-Tuebingen)	Quantification of lung tumor volume and rotation during respiration using 3D dynamic parallel MRI with view sharing – preliminary results
12:10	H. Bolte (D-Kiel)	Computer aided volumetry of ex-vivo pulmonary nodules: does respiratory gated helical CT (4D-CT) affect reproducibility?
12:20	A. vanBaardwijk (NL-Maastricht)	PET-CT scan as a way to come to the “Dynamic Biological Target Volume” (D-BTV) in non-small cell lung cancer (NSCLC) patients.

Saturday, October 7

12:30 Siemens Lunch Symposium

SIEMENS

Moderator J. Biederer (D-Heidelberg)

12:30	T. Rupprecht (D-Erlangen)	MR alveolar ventilation imaging (AVI) - a breakthrough for lung imaging and functional assessment? Results of a phantom study and a clinical trial in 85 patients
13:00	C. Fink (D-München	Whole-body MRI with parallel imaging: potential for lung imaging
13:30	J. Biederer (D-Heidelberg)	Respiratory gated helical CT: Evaluating regional lung motion and tumor displacement for concepts of motion-adapted radiotherapy

14:00 Acute Pulmonary Embolism

Moderators M. Miniati (I-Florence), E. van Beek (US-Iowa)

Keynote Lectures

14:00	M. Miniati (I-Florence)	Clinical evaluation of pulmonary embolism
14:15	M. Remy-Jardin (F-Lille)	CT of pulmonary embolism
14:30	H. Roberts (CDN-Toronto)	Computer-assisted diagnosis for CT of pulmonary embolism
14:45	C. Fink (D-Munich)	MRI of pulmonary embolism

Scientific Presentations

14:55	C. Engelke (D-Munich)	Multislice CT of acute pulmonary embolism: prediction of short-term patient survival from morphological embolus burden
15:05	L. Ketai (US-Albuquerque)	The Impact of Non-occlusive Pulmonary Emboli on Local Pulmonary Blood Flow
15:15	C. Engelke (D-Munich)	Multislice CT of acute pulmonary embolism: prognostic value of morphological cardiac parameters
15:25	C. Engelke (D-Munich)	Acute pulmonary embolism on multislice CT: one-year survival of treated and untreated patients
15:35	A. Kluge (D-Bad Nauheim)	MRI in clinical routine for acute pulmonary embolism and deep vein thrombosis
15:45	E. Pracht (D-Wuerzburg)	Single-Shot Perfusion Imaging of the Human Lung
15:55	C. Fink (D-Munich)	Blood pool MR contrast agents: new perspectives for the assessment of pulmonary embolism?

16:15 Adjourn