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sense and simplicity

Innovationsmanagement dreidimensionaler Bildgebung aus Sicht der Industrie

APT Seminar, München 15./16. Juni, 2012

Philips Healthcare
Rolf Behling, Sr. Director Tube and Generator Technology Management

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Innovation auf 4 Säulen

- **Mitarbeiter**
  - 84% aller Mitarbeiter sind stolz, für das Unternehmen zu arbeiten
  - Kunde im Mittelpunkt
- **Führung**
  - Kultur der Differenzierung. Gewinnen wollen
  - Abbau struktureller Schranken
  - Roadmaping
- **Netzwerk**
  - Forschungslabore Hamburg, Eindhoven, …
  - globale Partner, offene Innovation
  - klinische Forschung
  - System- und Komponenten-Vorentwicklung
- **Finanzielle Stärke**
  - + 300 M€ für Innovation
  - öffentliche Förderung

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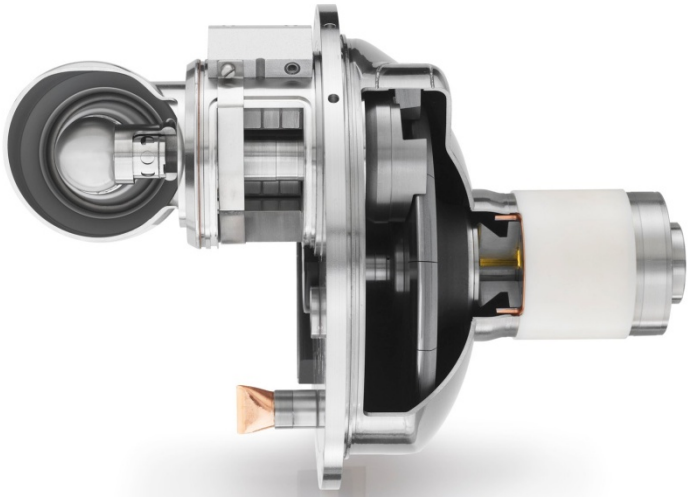
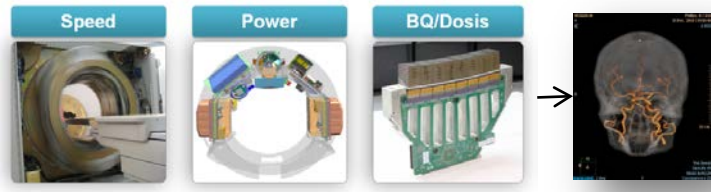
Den Beweis liefern

Brilliance iCT TVI - Total Vascular Imaging

- 120kW - iMRC Röhre
  - 130-150% Leistung pro Brennfleckgröße
  - Brennfleckablenkung gegen Artefakte
  - zuverlässig durch Flüssigkeitslager
- 0,27 Sek./Rot.
  - luftgelagerte Gantry
- 8cm Abdeckung
  - 2D-AntiScatter Grid (Dosis)
  - 1-Kanal: Keine Kreuz-Einstreuung (Dosis)
  - sphärischer Aufbau (Bildqualität)
- iDose^4 (Dosis, adipöse Patienten)
- Dual Energy
- Step&Shoot complete
- Brain Perfusion
- Jog Mode
- Langer Scanbereich



Philips iMRC-Röhre



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In Führung bleiben. Beispiel Röntgenröhren

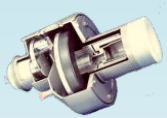
X-rays

Inonen-röhre

Nr 1, 2, …

1896 ff

Key Technologies

1975	1980	1985	1990	1995	2000	2005	2010
reliable	work flow	work flow	No wait, dose down	No wait	Compact	Cardiac CT Less artifacts	Less artifacts
							
SRM 1st metal center	**SRC** 1st ceramics 1st ceramics rotor	**SRC CT** 1st ceramics CT tube	**MRC CV** 1st liquid bearing 1st 200 mm anode 1st noise-free	**MRC CT** 1st liquid bearing in CT 1st $30MHU_{eff}$	**MRC 160** 1st high speed liquid bearing	**iMRC** 1st liquid 32+g bearing 1st 120 kW top-flux & flex beam	**Simplicity /zMRC** 1st zDFS @ mid tier

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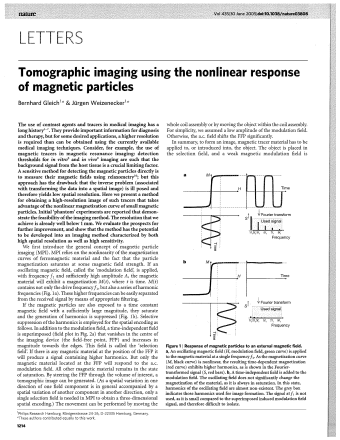
Zukunft sehen

- Weitere Dosis-Reduzierung
- Diagnostische Sicherheit
    - Höhere Bildqualität
    - Geringere Artefakte
    - Spektral-CT / Quantitative CT
- Vernetzung der Bildinformation
- Neue Modalität MPI in der Forschung



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LETTERS

Tomographic imaging using the nonlinear response of magnetic particles

Bernhard Gleich[1*] & Jürgen Weizenecker[1*]

The use of contrast agents and tracers in medical imaging has a long history[1,2]. They provide important information for diagnosis and therapy, but for some desired applications, a higher resolution is required than can be obtained using the currently available medical imaging techniques. Consider, for example, the use of magnetic particles as tracers for cardiovascular imaging. The spatial thresholds for *in vitro*[3] and *in vivo*[4] imaging are such that the background signal from the host tissue is a crucial limiting factor. A sensitive method for detecting the magnetic particles directly is to measure their magnetic fields using relaxometry[5]; but this method has low spatial resolution. The alternative approach, starting with transforming the data into a spatial image, is ill-posed and therefore yields low spatial resolution. Here we present a method for obtaining a high-resolution image of such tracers that takes advantage of the nonlinear magnetization curve of small magnetic particles. We derive a theoretical description of the method and prove the feasibility of the imaging principle. The resolution that we achieve is already well below 1 mm. We evaluate the prospects for further improvement, and show that the method has the potential to be developed into an imaging method characterized by both high spatial resolution as well as high sensitivity.

We first introduce the general concept of magnetic particle imaging (MPI). We then derive a theoretical description of the nonlinear curve of ferromagnetic material and the fact that the particle magnetization saturates at some magnetic field strength. If an oscillating magnetic field, called the 'modulation field' is applied, with frequency f_1 and sufficiently high amplitude A, the magnetic material in the field-free region (FFR) will respond to the field and saturate and with the drive frequency f_1 but also a series of harmonic frequencies (Fig. 1a). These higher frequencies can be easily separated from the received signal by means of appropriate filtering.

If the magnetic particles are also exposed to a time constant magnetic field with a sufficiently large magnitude, then saturate and the generation of harmonics is suppressed (Fig. 1b). Selective imaging of the particles is accomplished by the following principle. As follows, in addition to the modulation field, a time-independent field is superimposed (bold plot in Fig. 2a) that variables in the centre of the imaging device (the field-free point, FFP) and increases in magnitude towards the edges. This field is called the 'selection field'. The magnetic material outside the field-free point (FFP) will produce a signal containing higher harmonics. But only the magnetic material located at the FFP will respond to the a.c. modulation field. All other magnetic material remains in the state of saturation. By moving the FFP through the volume of interest, a tomographic image can be generated. (As a spatial variation in one direction of one field component is in general accompanied by a change in the other field components, a second, homogeneous, time-independent field is needed in MPI to obtain a three-dimensional spatial encoding.) The movement can be performed by moving the whole coil assembly or by moving the object within the coil assembly. For simplicity, we assumed a free amplitude of the modulation field. Otherwise, the a.c. field shifts the FFP significantly.

In summary, to form an image, magnetic tracer material has to be applied to, or introduced into, the object. The object is placed in the selection field, and a weak magnetic modulation field is

Figure 1: Response of magnetic particles to an external magnetic field. The magnetization curve (bold plot) of a ferromagnetic material is exposed to a field in the magnetic material at a single frequency f_1. As the magnetization curve (M, black curve) is nonlinear, the resulting time-dependent magnetization (red curve) exhibits higher harmonics, as is shown in the Fourier-transformed signal (A, red bars). **b**, A time-independent field is added to the modulation field. The magnitude of the field is sufficiently large to saturate the magnetization of the material, as it is shown in saturation. In this case, harmonics of the oscillating field are almost non existent. The grey bars represent the frequency spectrum of the used generator. The signal at f_1 is not used, as it is small compared to the superimposed induced modulation field signal, and therefore difficult to isolate.

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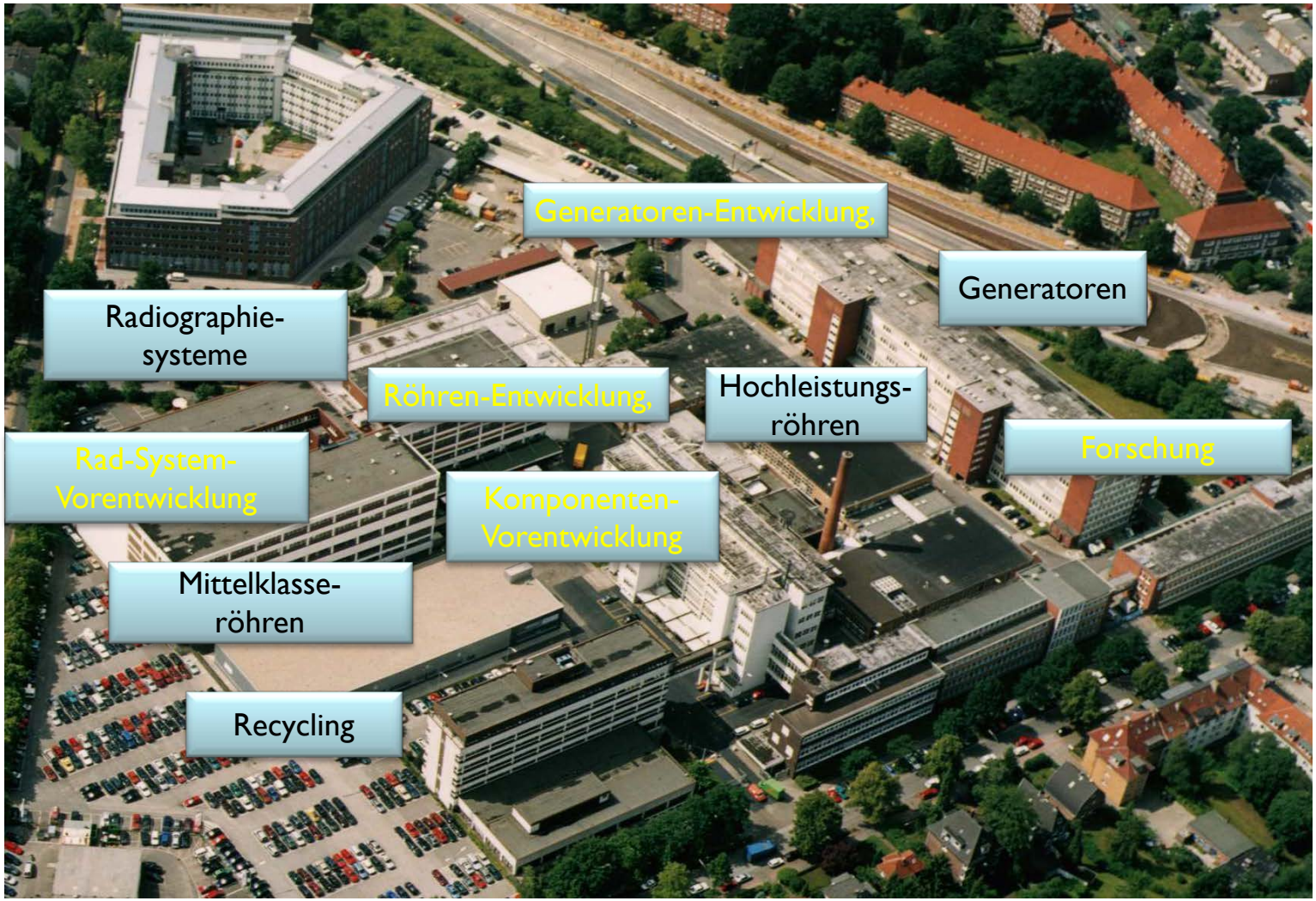
Ökosystem Hamburg



Best, NL

Aurora, USA