Ergin Atalar
Ulusal Manyetik Rezonans Görüntüleme Merkezi
Bilkent Üniversitesi

Manyetik Rezonans Görüntüleme FİZİĞİ VE SON GELİŞMELER

KAPSAM

- MRG Fiziği
- Alıcı Anten Dizisi
- Verici Anten Dizisi
- Verici Anten Dizisi Uygulamaları
- Gradyan Dizi

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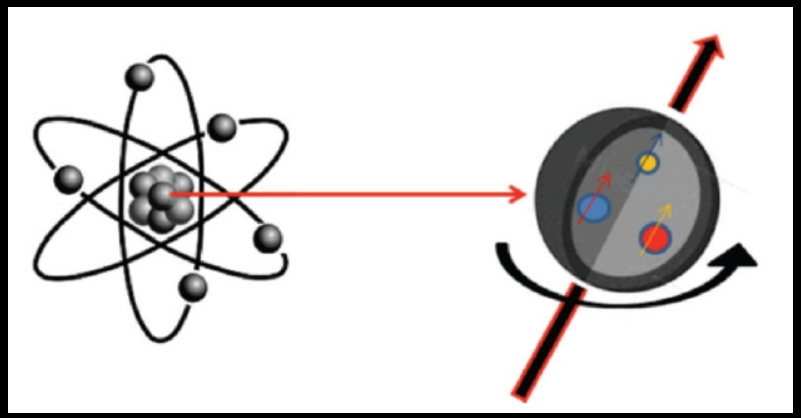
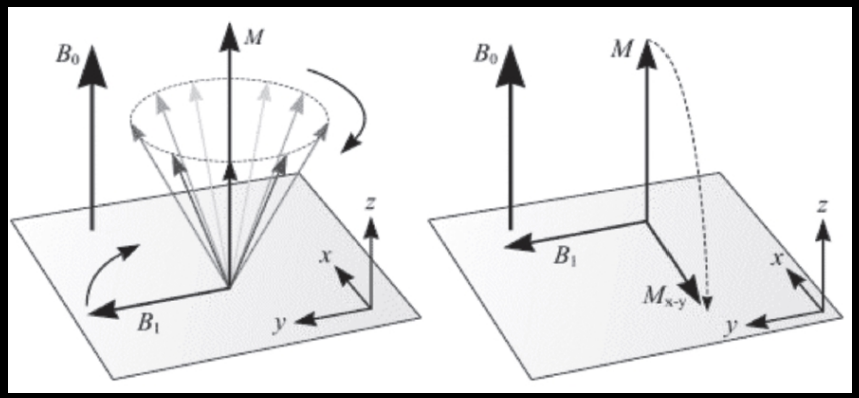
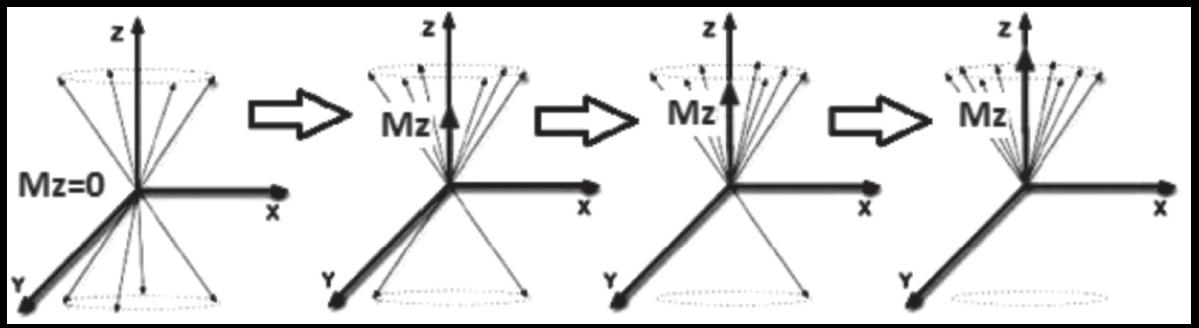
Nucleer Manyetik Rezonans

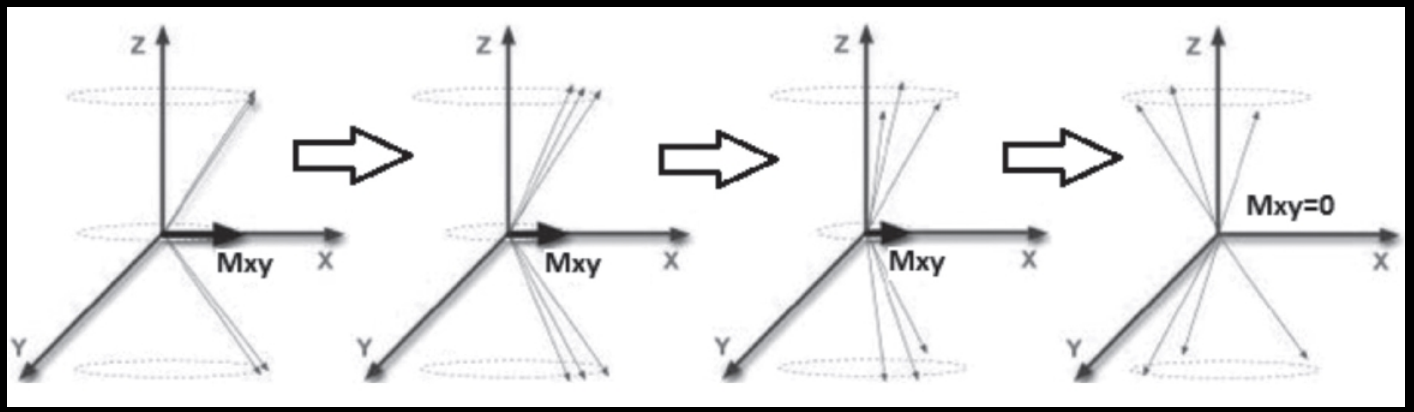


NMR ve veri toplama

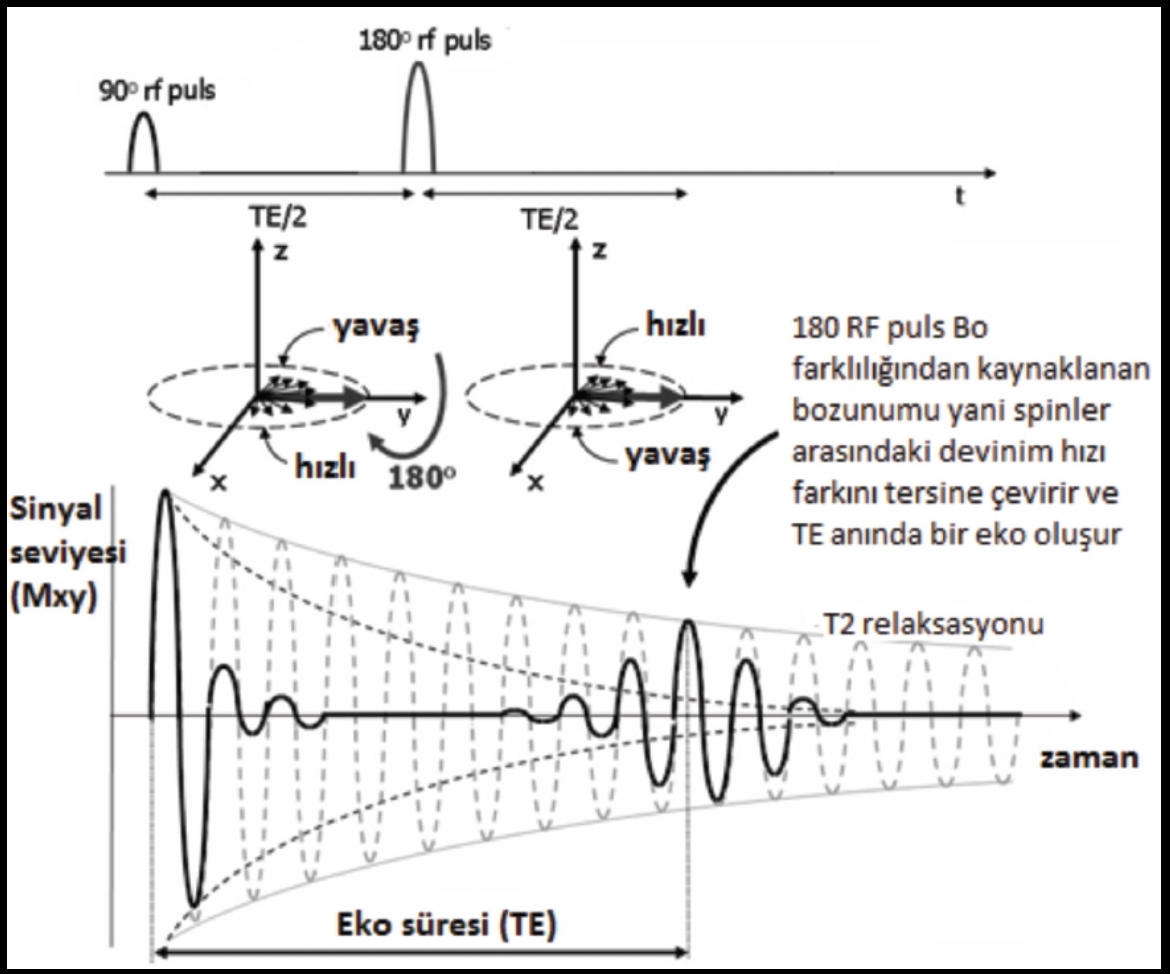


Relaksasyon

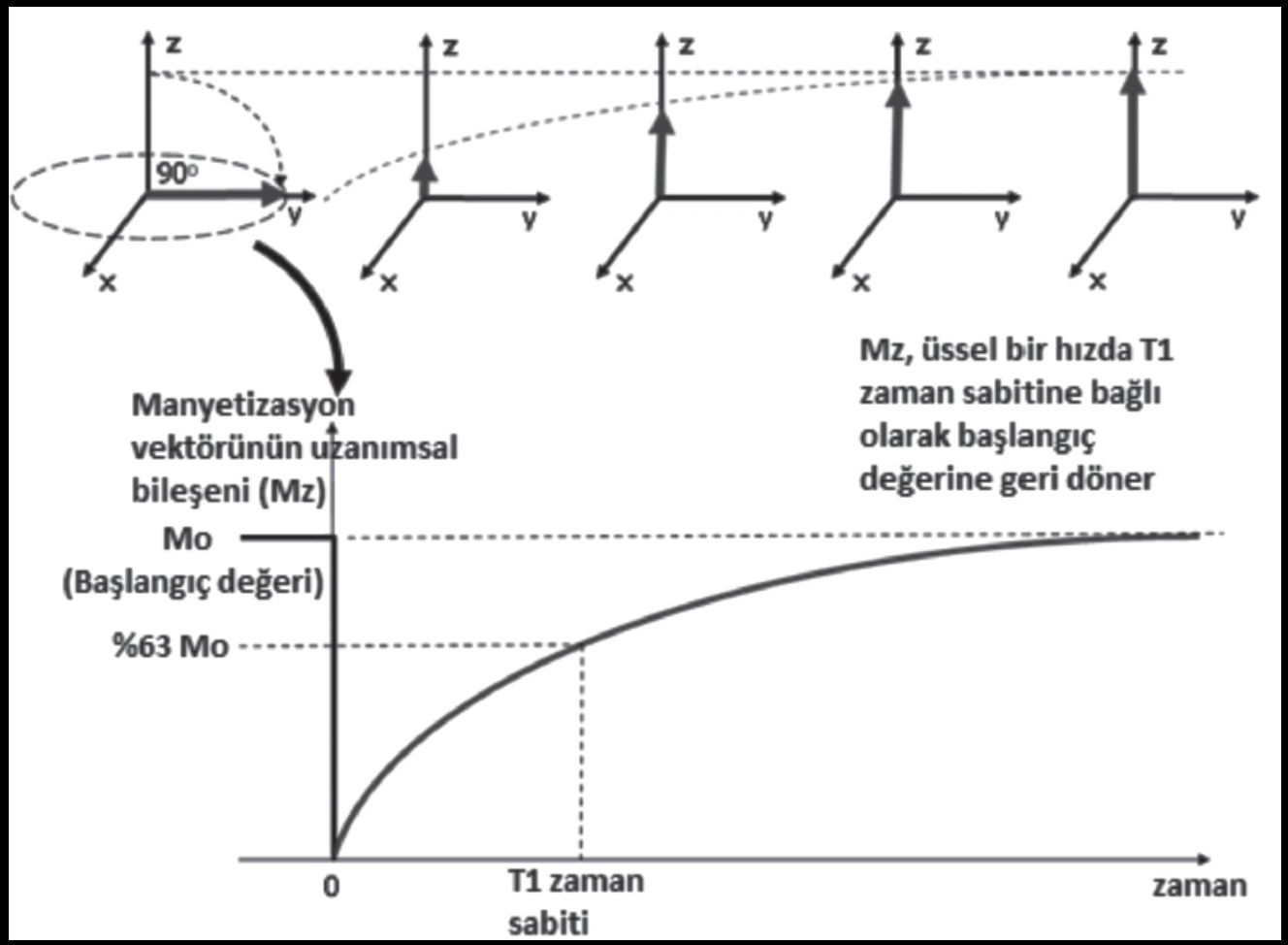




Spin Eko


180° rf puls
90° rf puls
t
TE/2
TE/2
z
z
yavaş
hızlı
y
y
hızlı
yavaş
x
x
180°
180 RF puls Bo farklılığından kaynaklanan bozunumu yani spinler arasındaki devinim hızı farkını tersine çevirir ve TE anında bir eko oluşur
Sinyal seviyesi (Mxy)
T2 relaksasyonu
zaman
Eko süresi (TE)

Relaksasyon – T1 sabiti



MR Görüntüleme

- Nükleer Manyetik Rezonans ilk olarak Felix Bloch ve Edward Purcell tarafından gösterildi. (1952 Nobel Ödülü)
- Paul Lauterbur, 1973 Nature (2003 Nobel Ödülü)

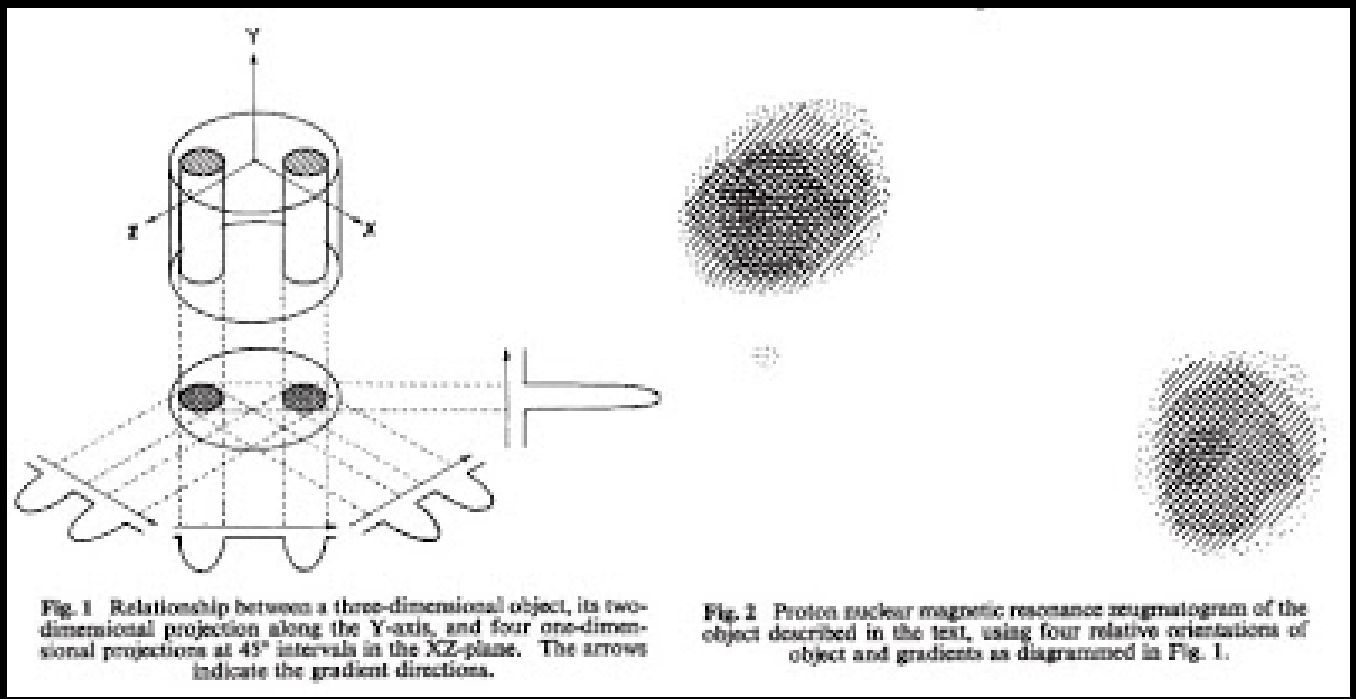
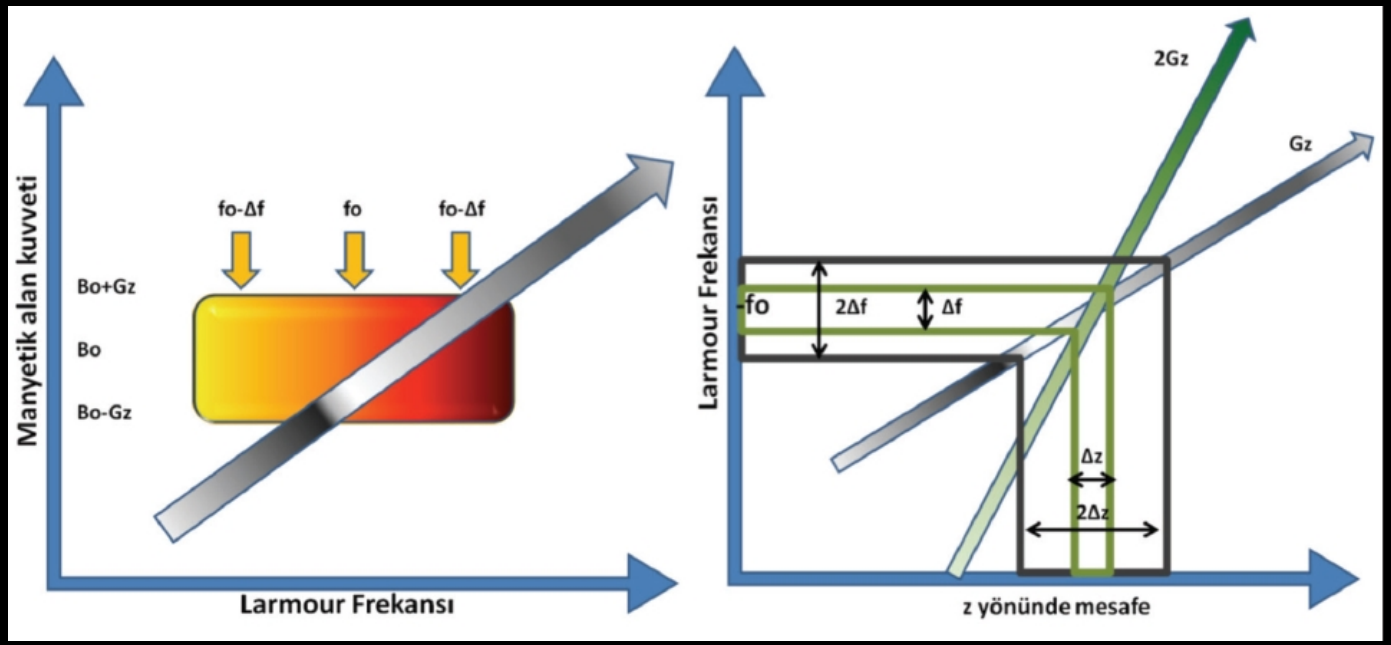


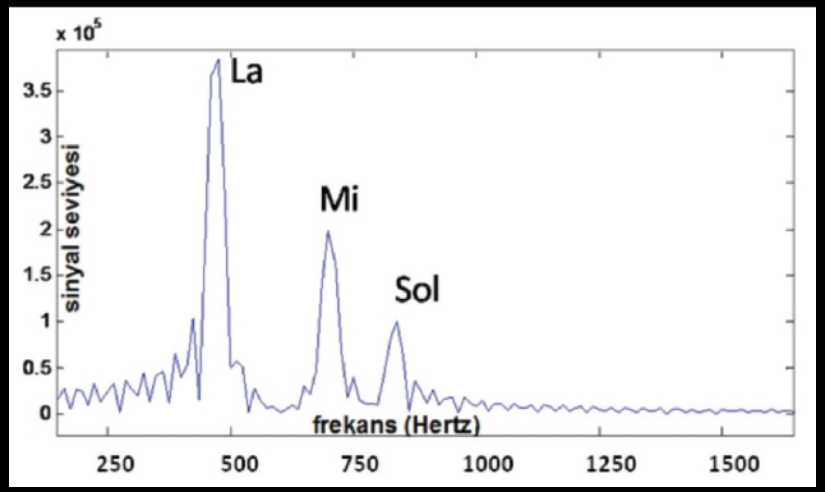
Fig. 1 Relationship between a three-dimensional object, its two-dimensional projection along the Y-axis, and four one-dimensional projections at 45° intervals in the XZ-plane. The arrows indicate the gradient directions.

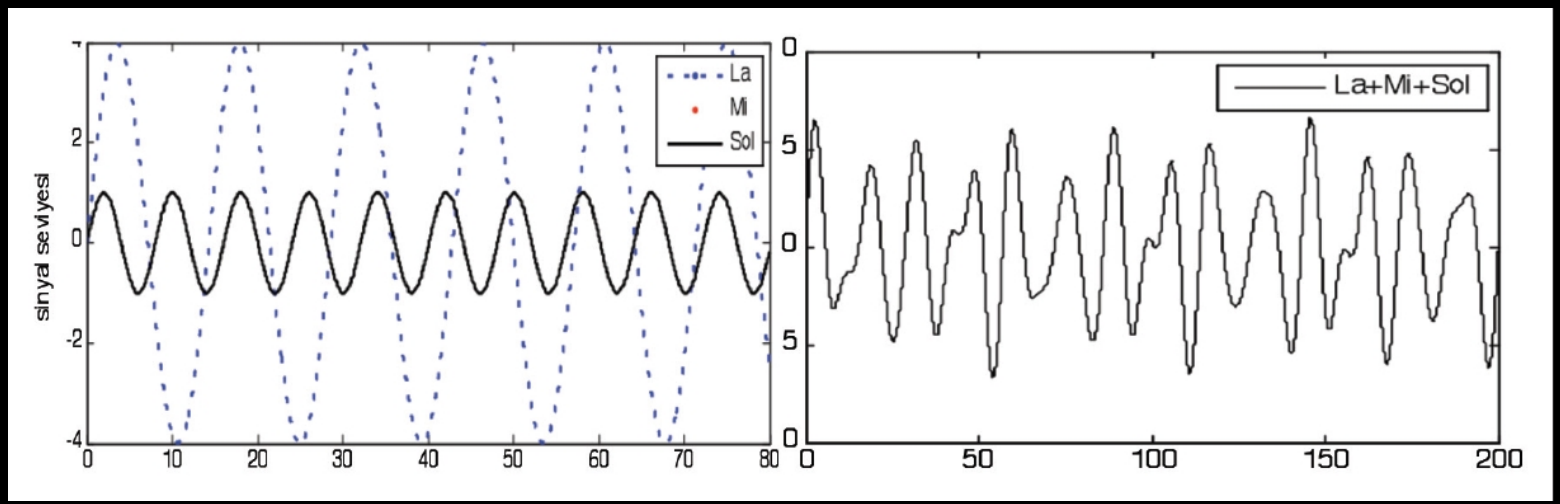
Fig. 2 Proton nuclear magnetic resonance zeugmatogram of the object described in the text, using four relative orientations of object and gradients as diagrammed in Fig. 1.

Kesit Seçimi

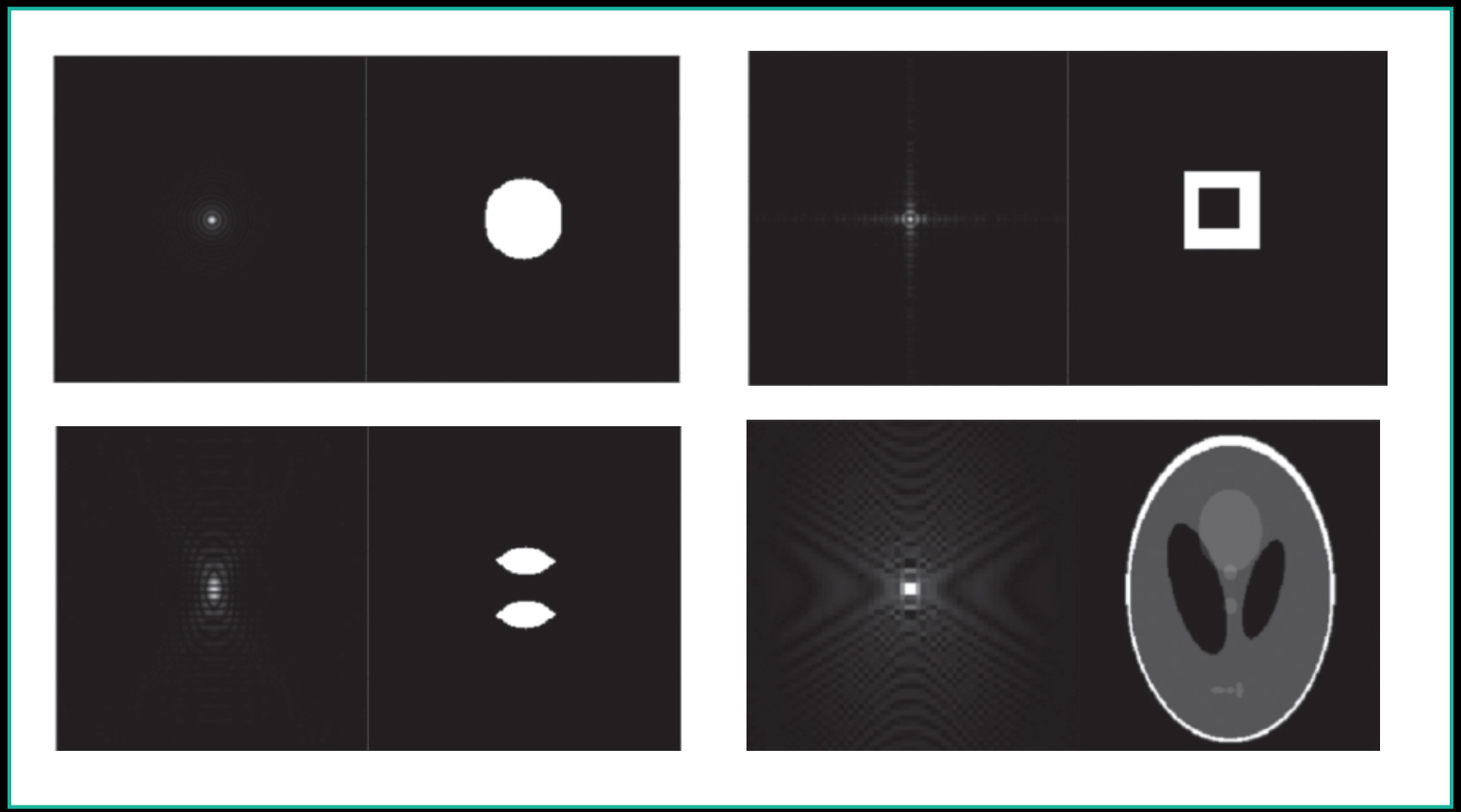


Zaman, Frekans ve Uzay İlişkisi

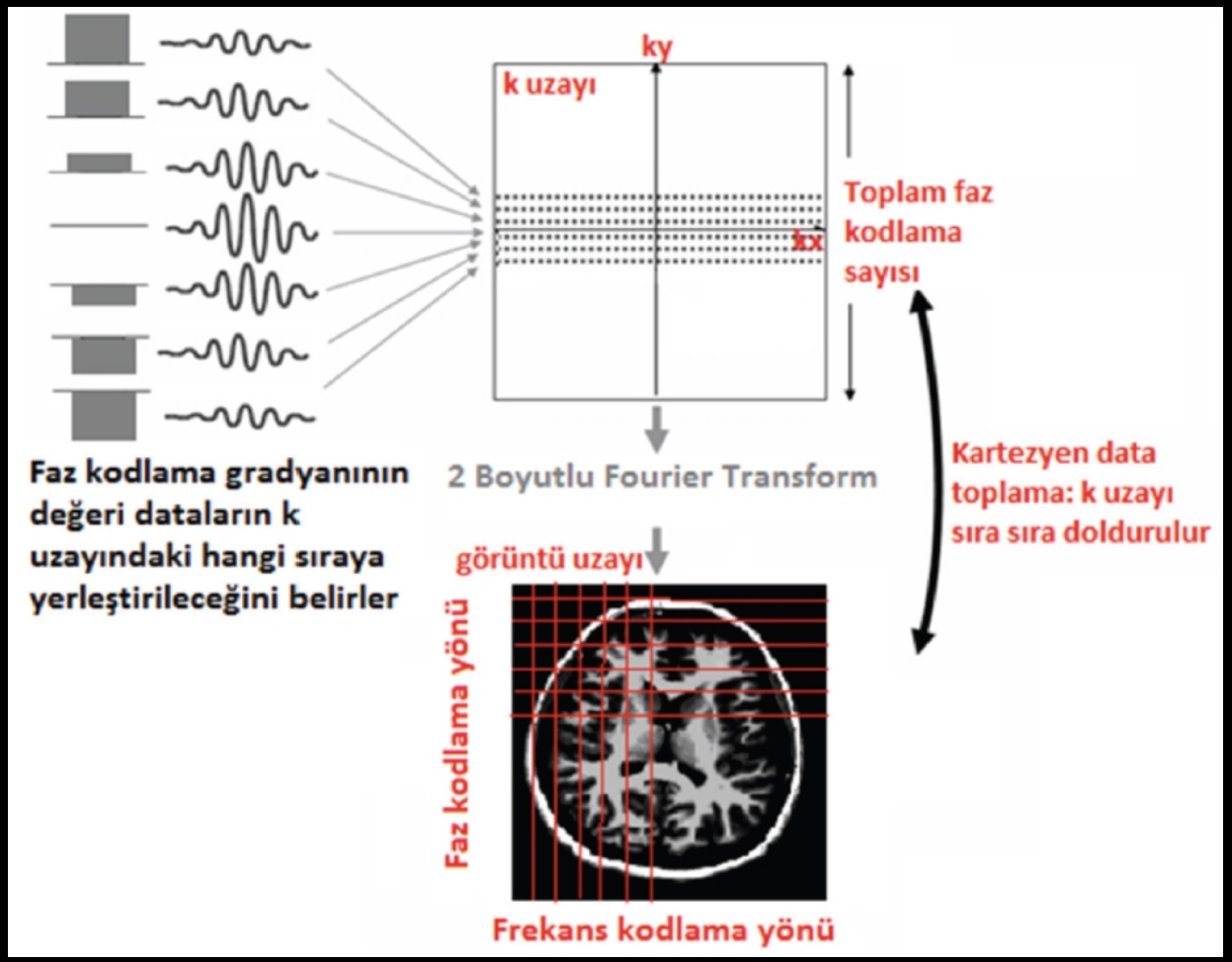




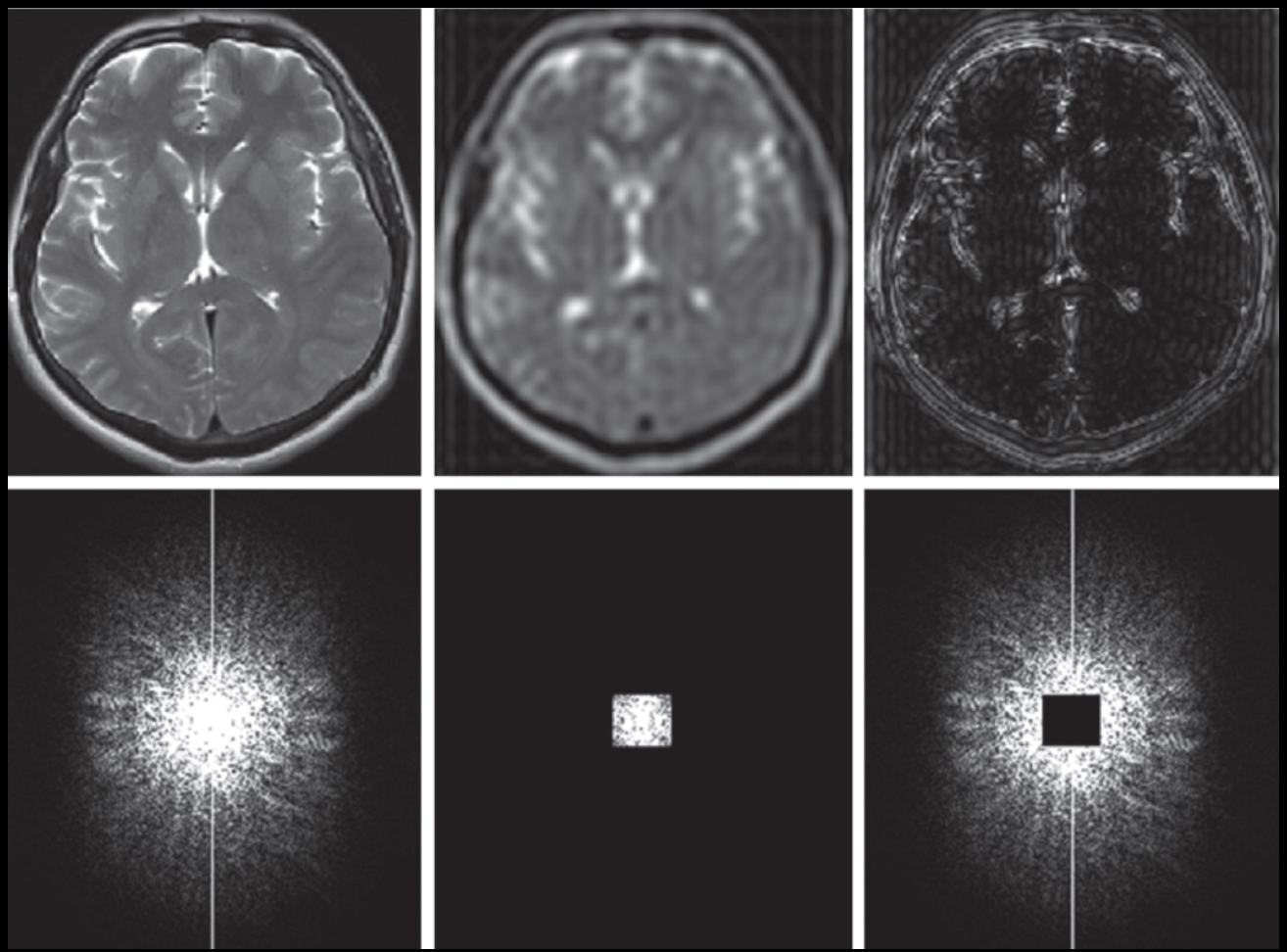
K-Uzayı ve Görüntü İlişkisi



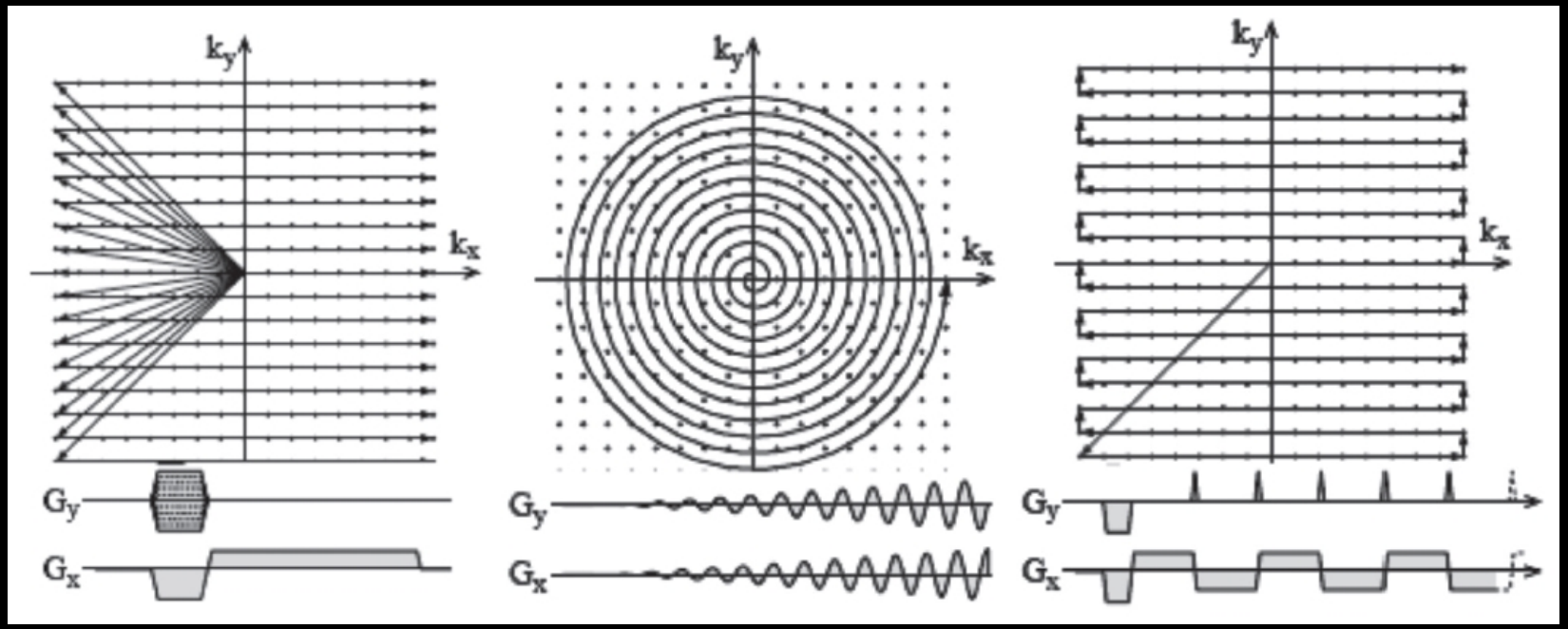
K-Uzayı ve Görüntü



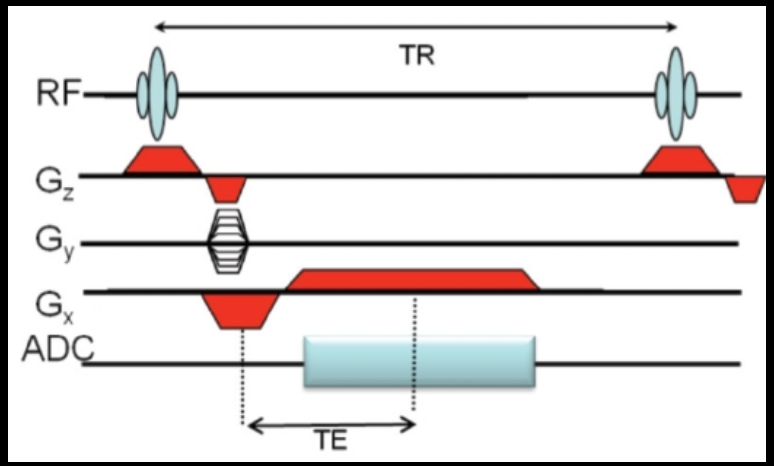
K-Uzayı ve Görüntü

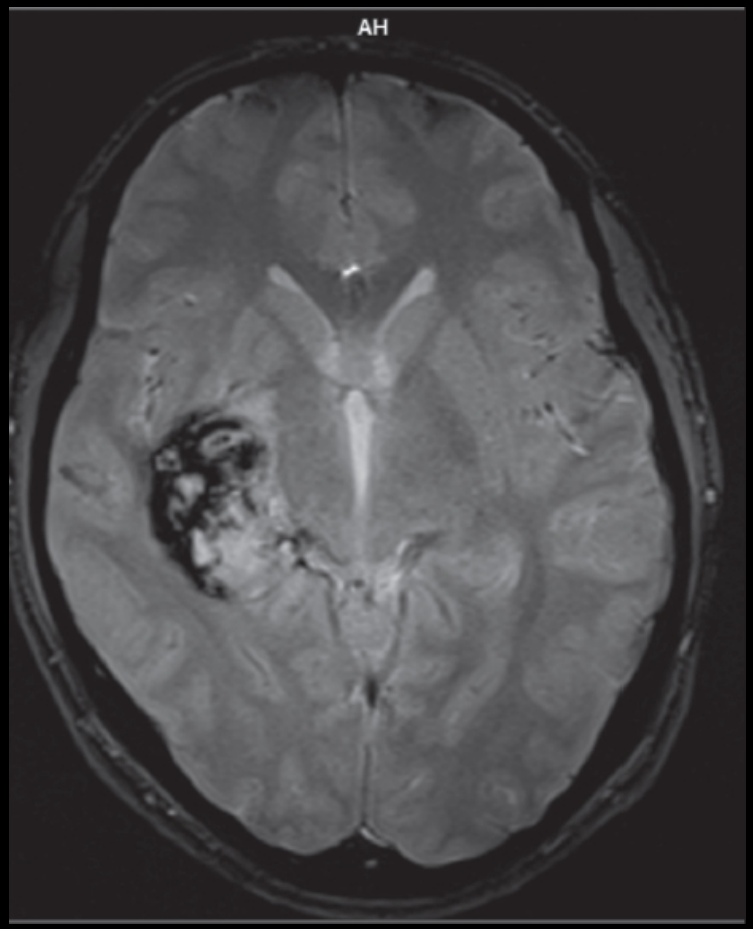


K-Uzayı Tarama Yöntemleri



MR Sekansları – Gradyan Eko





Mıknatıs

MR Görüntüleme Cihazı

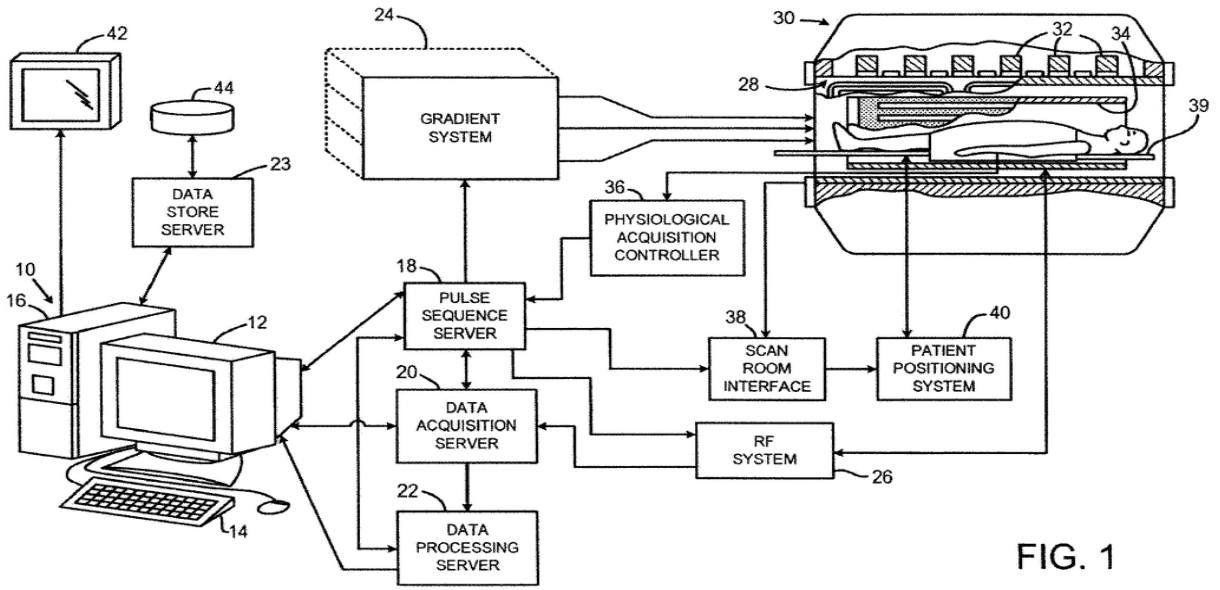
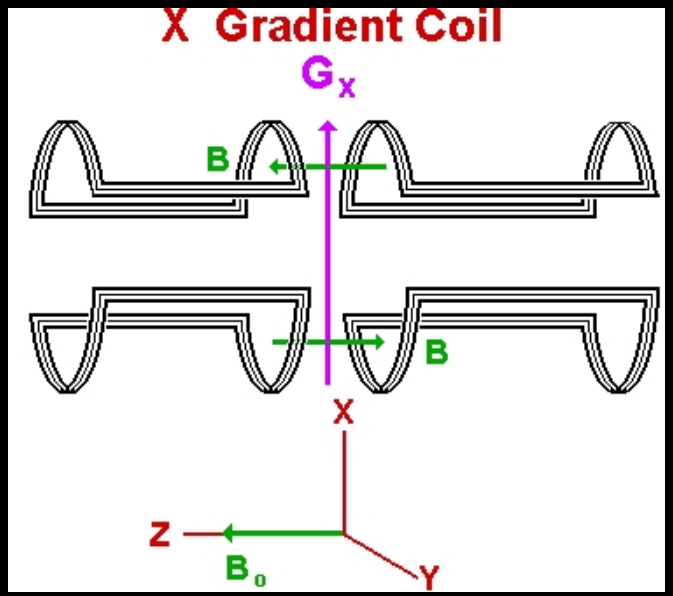


FIG. 1

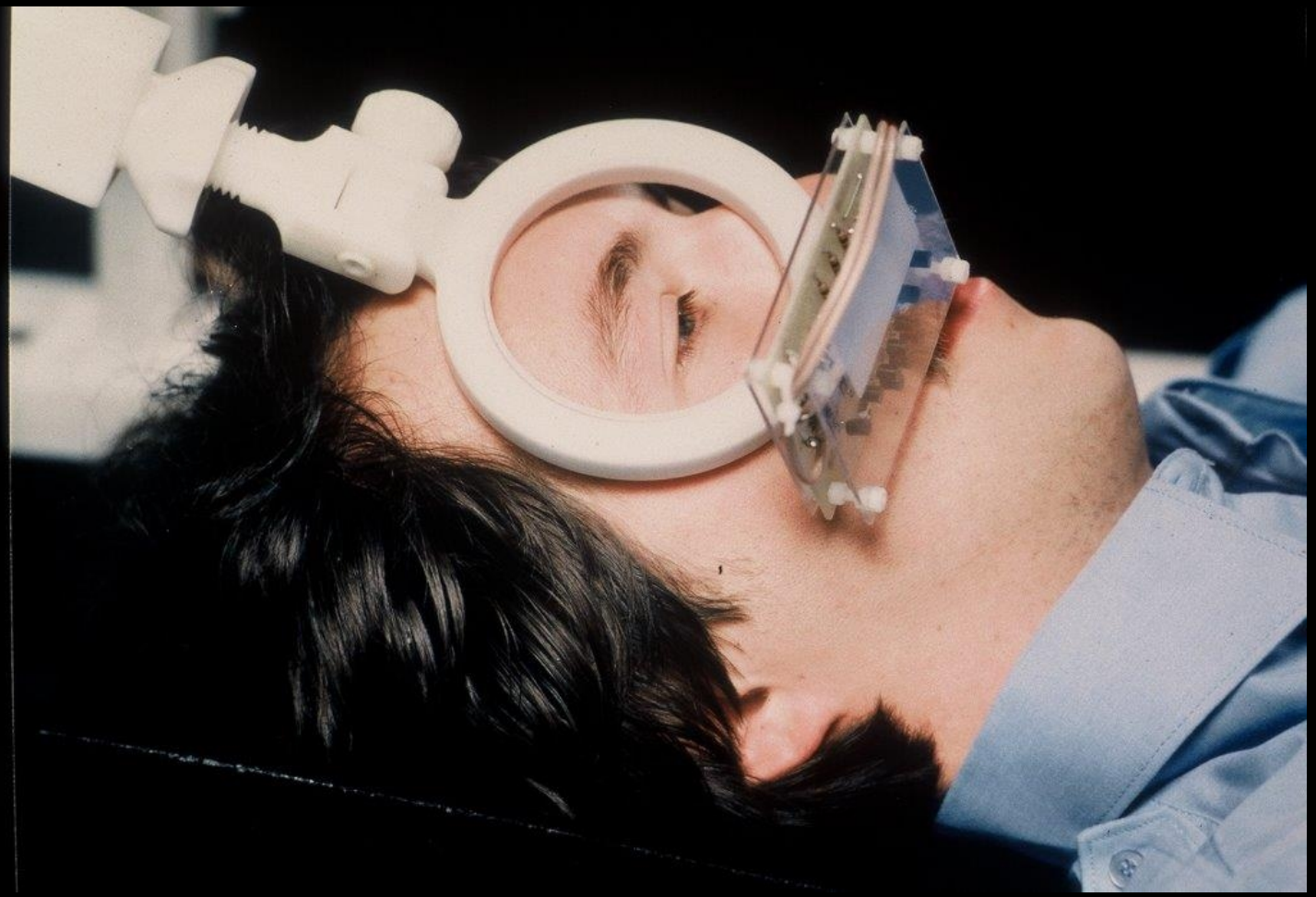
Patent Application Publication Jul. 28, 2011 Sheet 1 of 4 US 2011/0184273 A1

Gradyan Sargı



Yüzey Sargısı (Göz Sargısı)

Eddy Boskamp, 1986



Kuşkafesi tasarım

- Cecil Hayes, 1985 and Gary Grover, 1985.

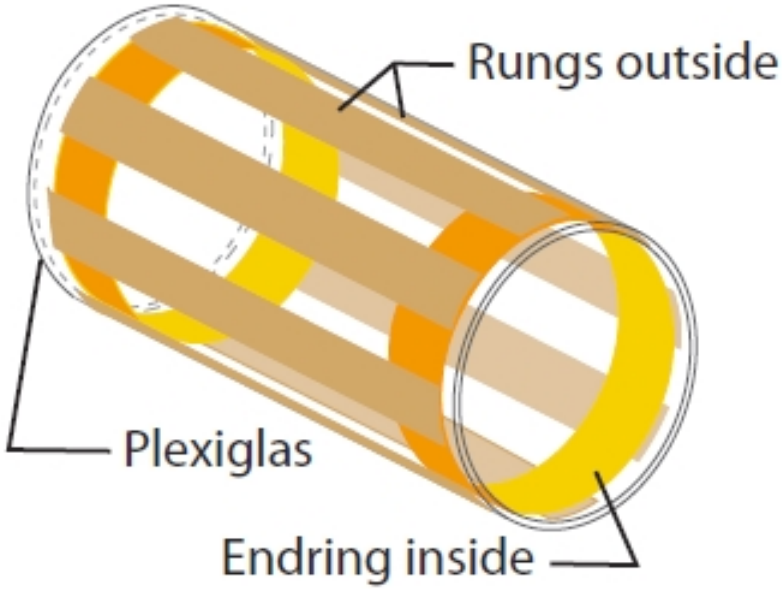


Figure 2. The first birdcage resonator built.

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Alıcı Anten Dizisi

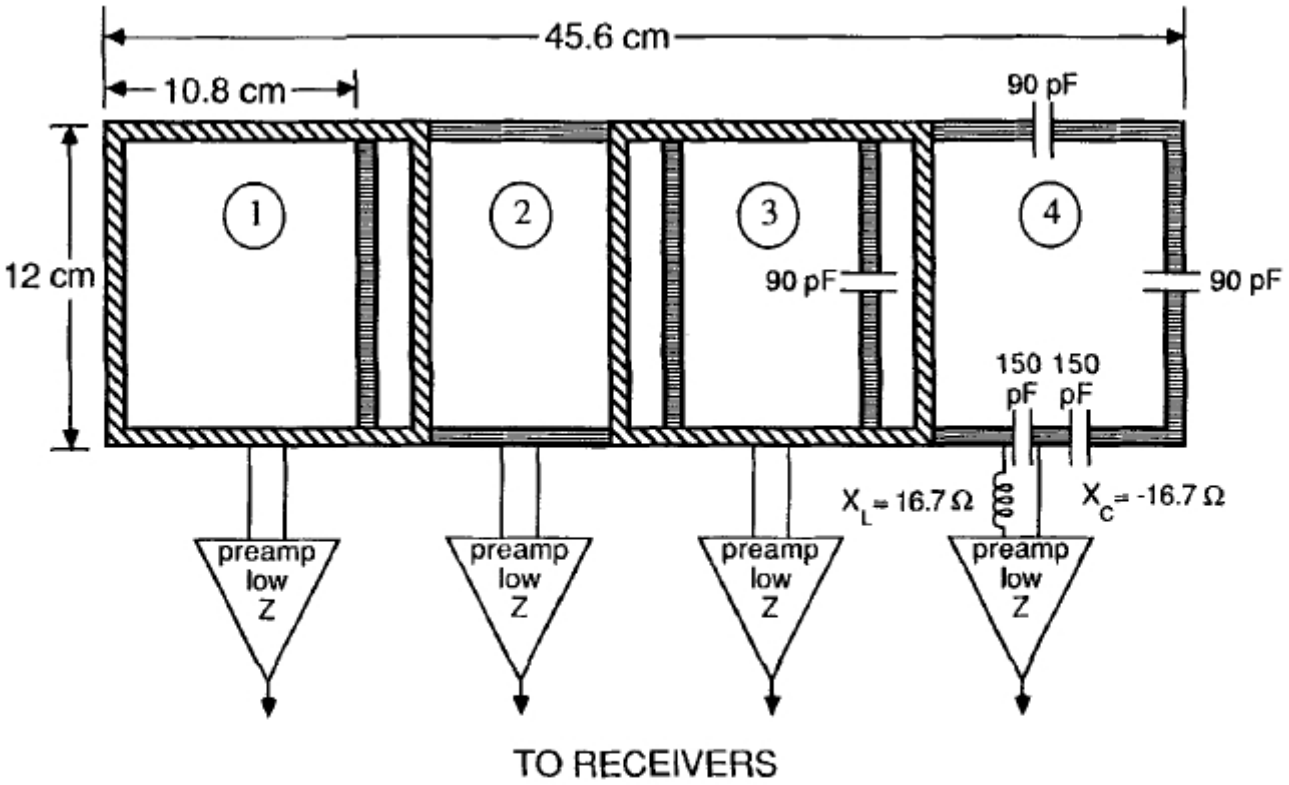


FIG. 3. Four element linear spine coil. Nearest neighbor interactions are eliminated by overlap. Next nearest neighbor and more distant coil interactions are reduced to negligible levels by connection to low input impedance preamplifiers.

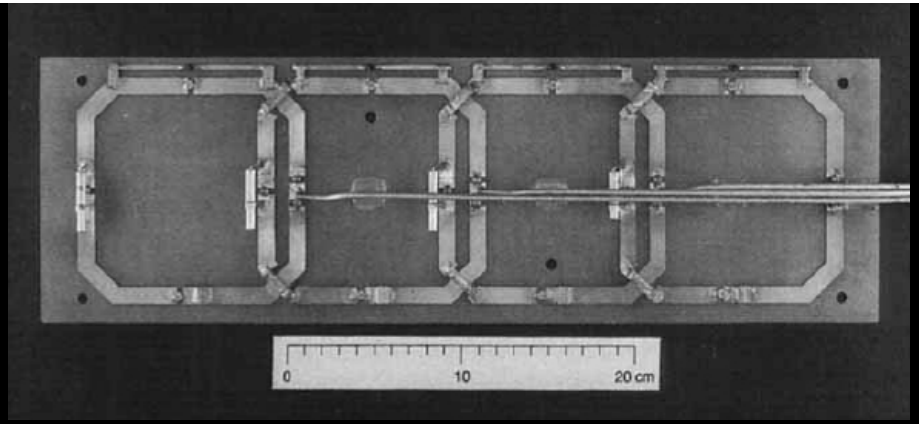
Alıcı Anten Dizisi

MAGNETIC RESONANCE IN MEDICINE **16,** 192–225 (1990)

The NMR Phased Array

P. B. ROEMER,* W. A. EDELSTEIN,* C. E. HAYES,† S. P. SOUZA,* AND O. M. MUELLER*

**GE Corporate Research and Development Center, Schenectady, New York 12301;*
†GE Medical Systems, Milwaukee, Wisconsin 53201



En çok sinyal gürültü oranı

Ultimate Intrinsic Signal-to-Noise Ratio in MRI

Ogan Ocali, Ergin Atalar

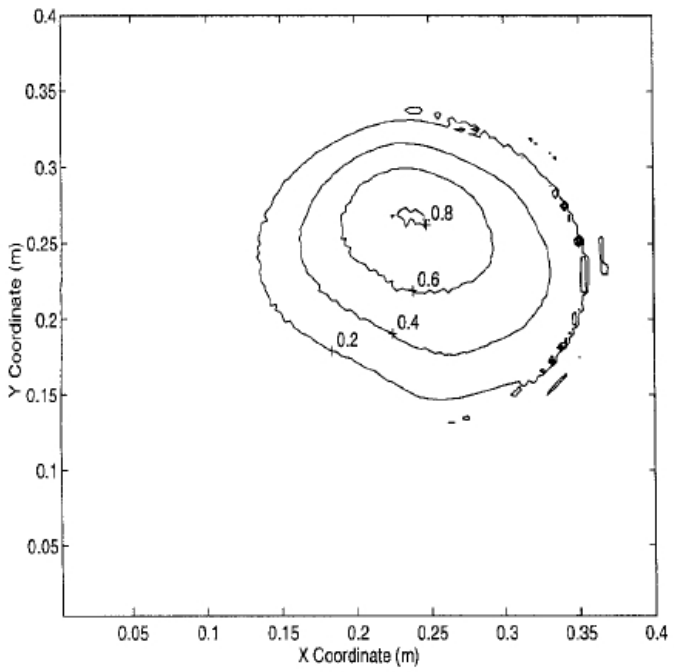


FIG. 15. CPM of cardiac phased array.

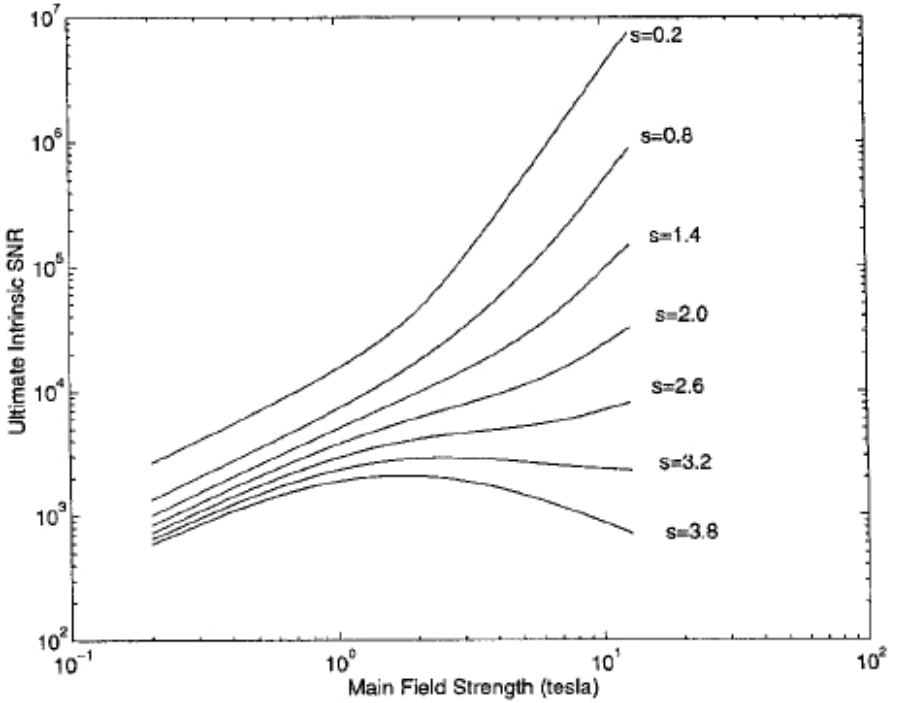
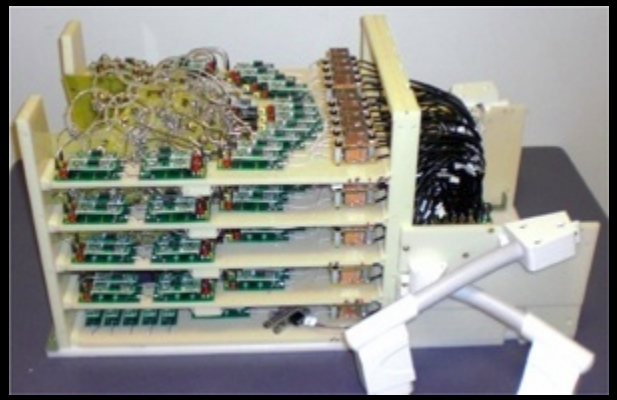
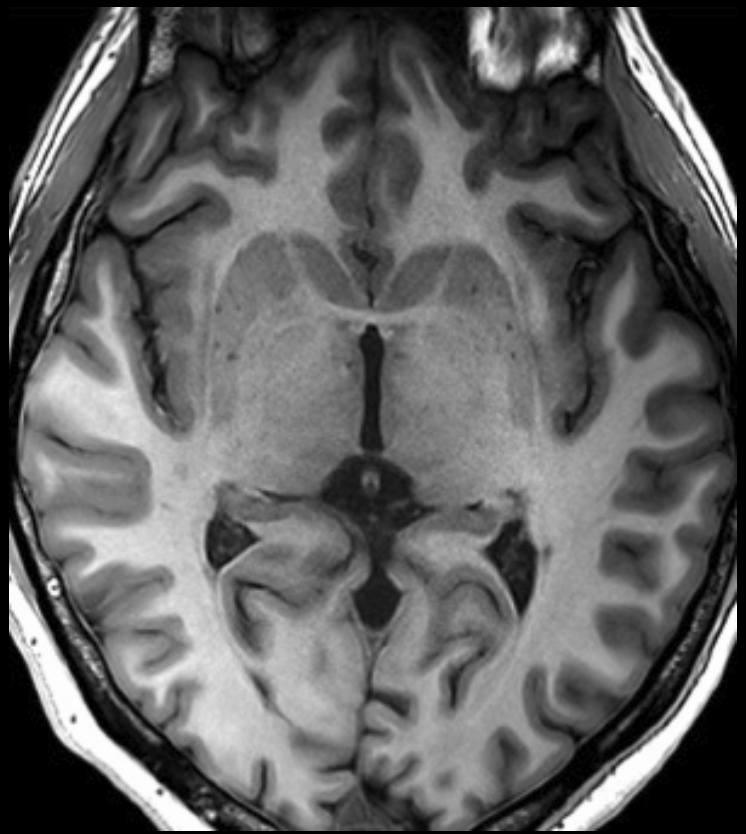


FIG. 16. Ultimate intrinsic SNR versus main field strength at the center of the human torso model for different values of effective conductance *s*.

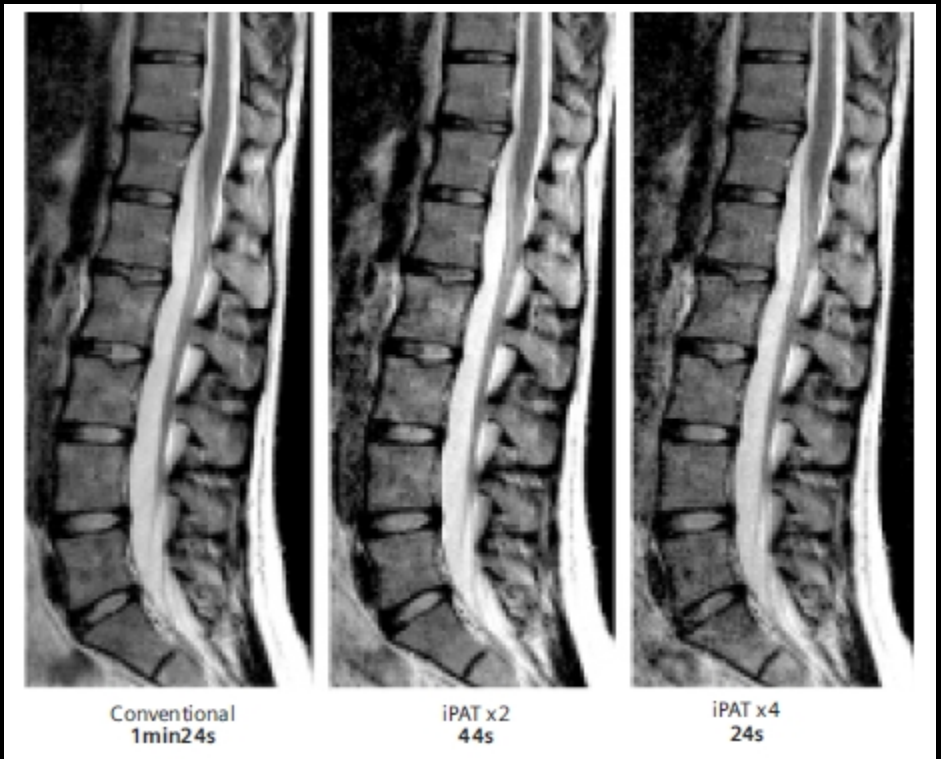
96 Kanal Alıcı Anten Dizisi

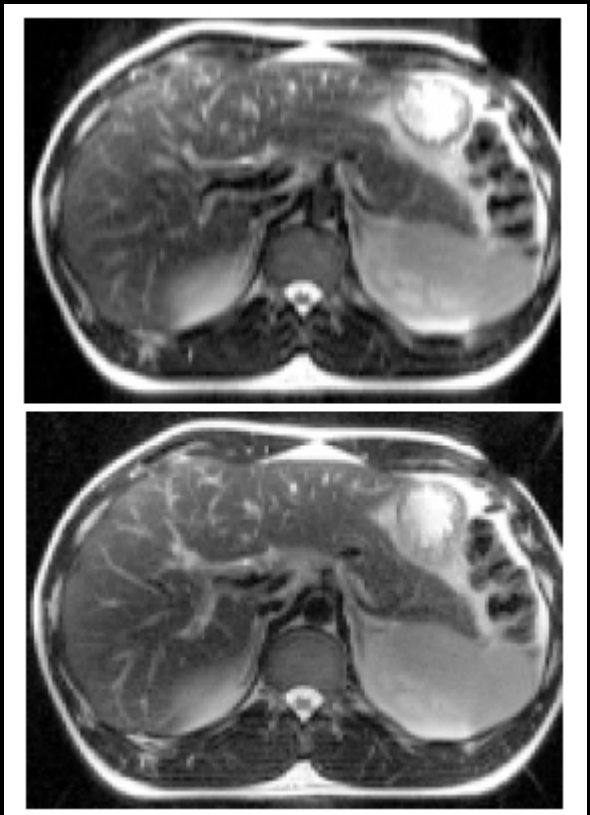




Paralel Görüntüleme

SMASH, SENSE,GRAPPA





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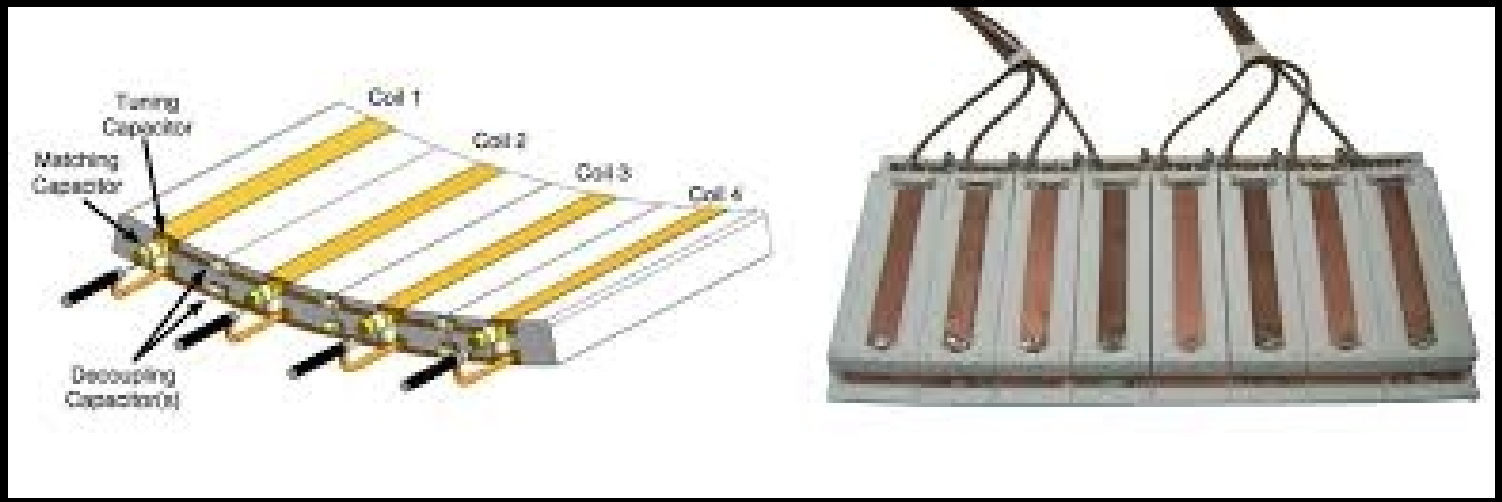
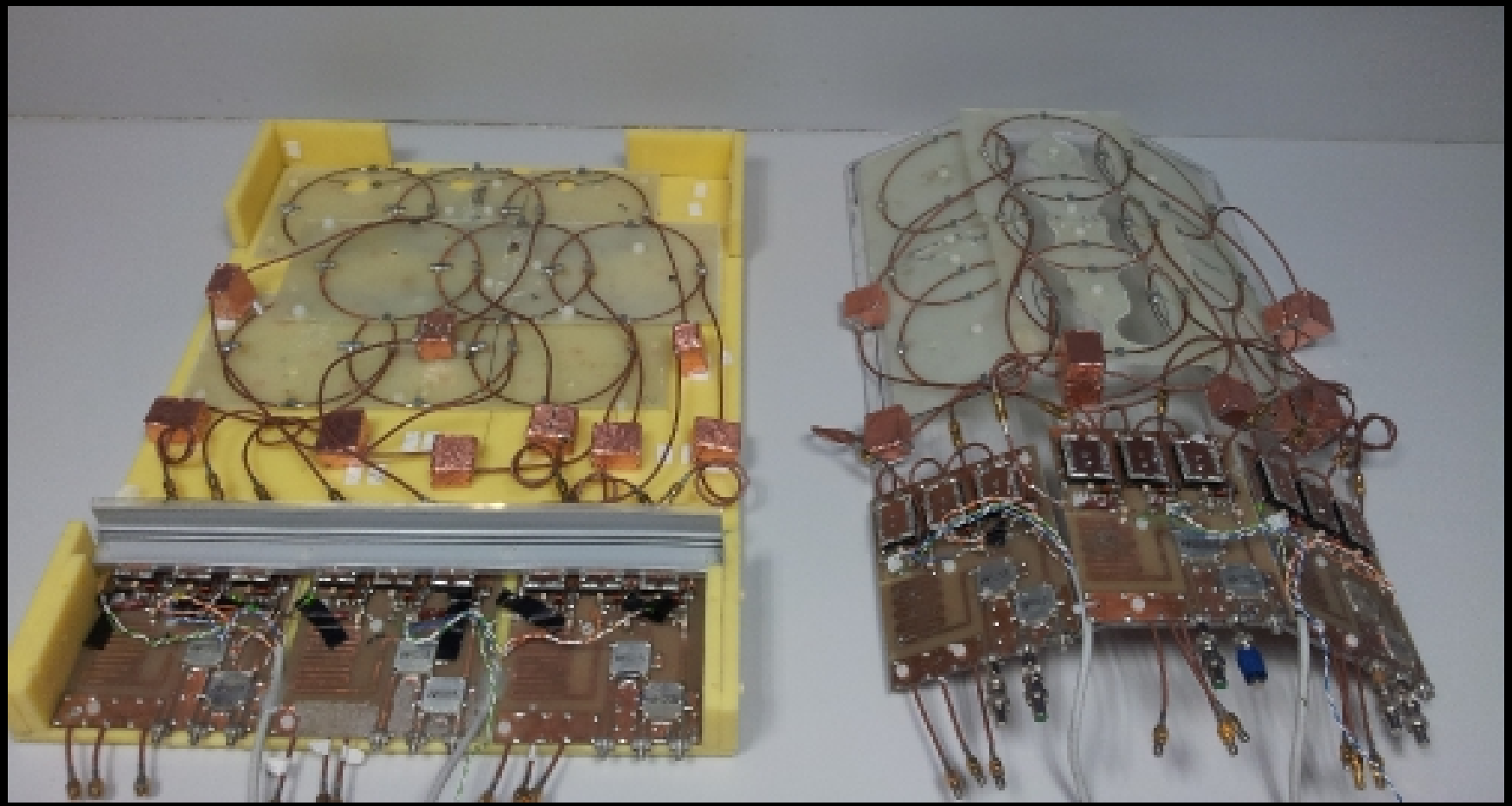
Verici Anten Dizisi



University of Minessota

Verici Dizisi Tasarımı



4. Taner Demir, Esra A. Turk and Ergin Atalar, *Mode Matrix Transceiver Surface Coil*, ISMRM, Melbourne, Australia, 2012

En az SAR

- RF darbe açısı ile SAR arasında bağlantı vardır.
- Homojen darbe açısı elde ederken SAR önemli bir sorun

BIOMEDICAL
RESEARCH - Full Papers

Magnetic Resonance in Medicine 66:846–858 (2011)

Analytic Expressions for the Ultimate Intrinsic Signal-to-Noise Ratio and Ultimate Intrinsic Specific Absorption Rate in MRI

E. Kopanoglu,[1,2] V. B. Erturk,[1] and E. Atalar[1,2]*

$$\mathrm{UISAR} = \frac{\sigma B_0^2 r^5}{m_{\mathrm{sample}} \mathcal{S}_{\max}^2}.$$

$$\mathcal{S}_{\max}^{\mathrm{cyl}} = 0.953\sqrt{1 + (0.723/d)^5}$$

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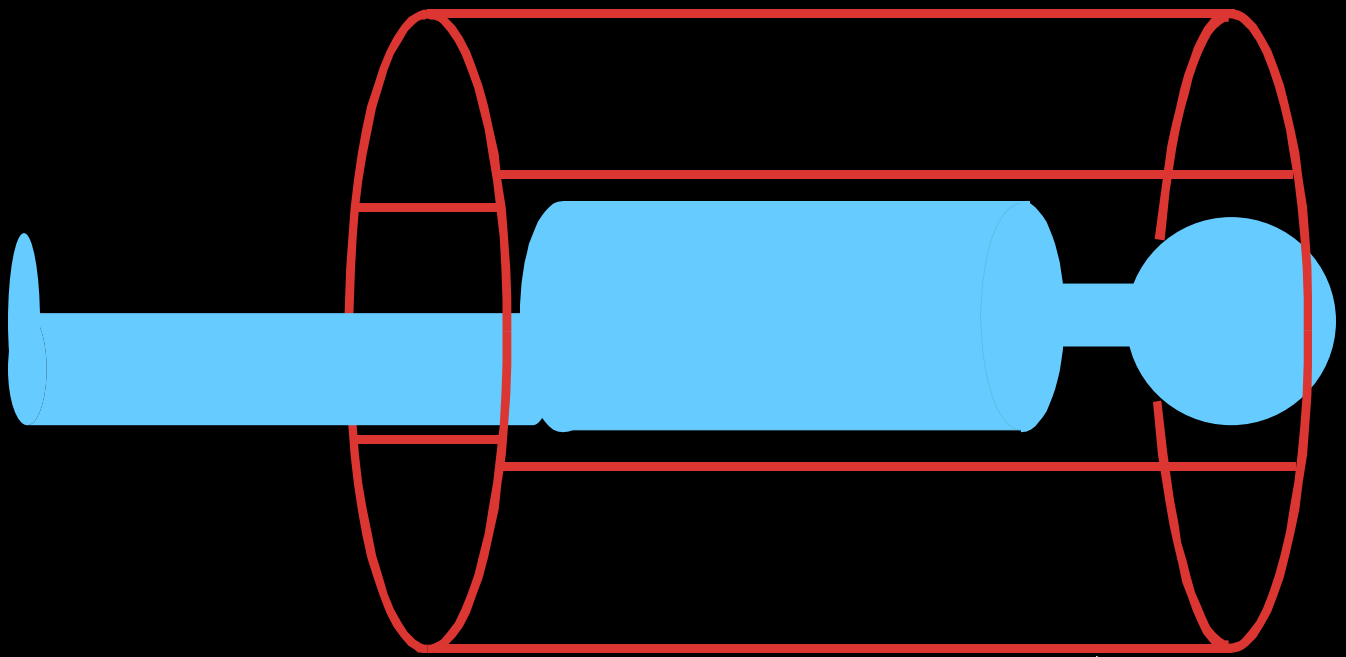
- Gradyan Dizi

Ergin Atalar, UMRAM Bilkent Üniversitesi
Ahmet Kırlılar, TTD-GYTM REHİS ASELSAN
Bülent Şen, TTD-GYTM REHİS ASELSAN

VerİCİ DİZİSİ Kullanarak İmplant Uyumlu MR Görüntüleme cihazI

RF Isınma

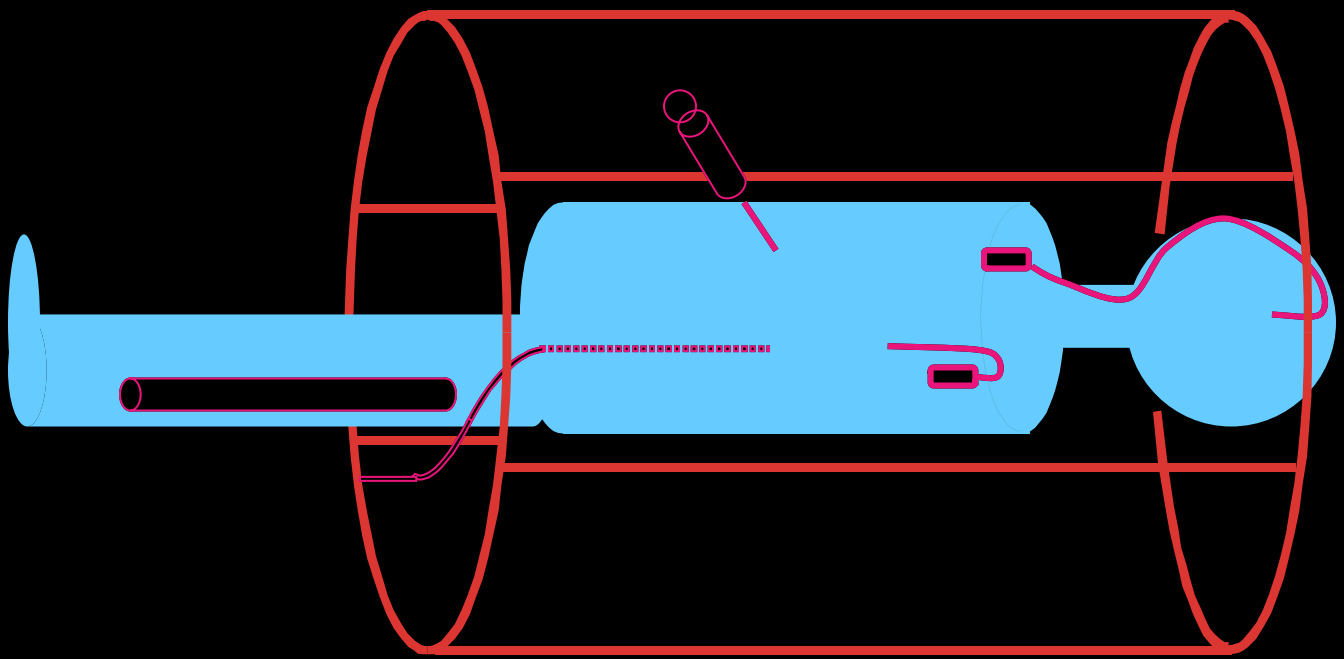
- MRG sırasında RF enerji emilir ve obje ısınır.



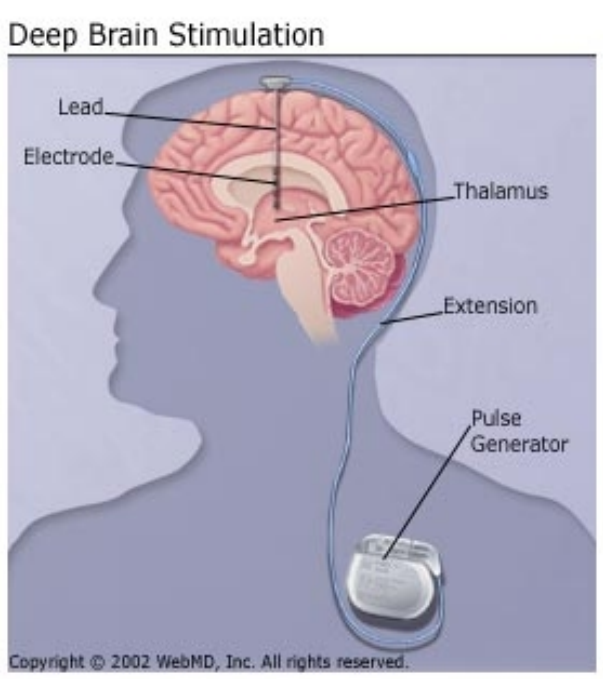
RF verici
(Vücut sargısı)

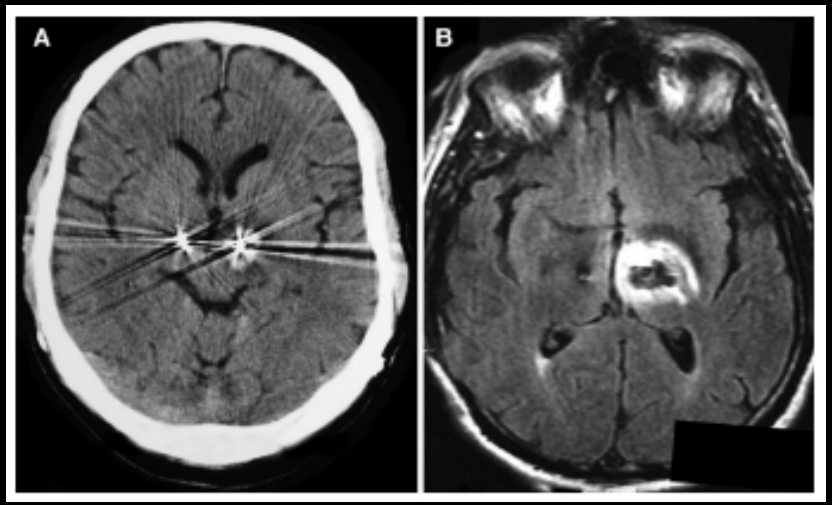
Mikrodalga fırın

MRG içinde kullanılan metalik cihazlar



Problem





Henderson, J.M., et al., *Permanent neurological deficit related to magnetic resonance imaging in a patient with implanted deep brain stimulation electrodes for Parkinson's disease: case report.* Neurosurgery, 2005. **57**(5): p. E1063.

NOVEL SAR REDUCTION METHODS FOR MAGNETIC RESONANCE IMAGING

Yiğitcan Eryaman

Supervisor: Prof. Ergin Atalar

National Magnetic Resonance Research Center, Ankara, Turkey

Elektrik alanını implanttan uzaklaştırma

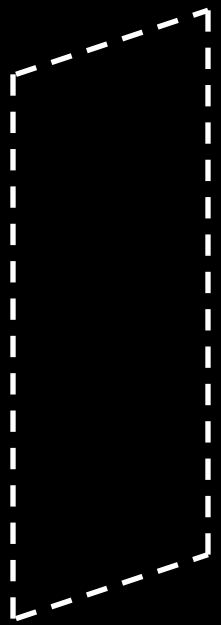
2. Yigitcan Eryaman, Burak Akin and Ergin Atalar, Reduction of implant RF heating through modification of transmit coil electric field. in *Magn Reson Med* **2011**, 65:1305--1313.

Reduction of RF Heating of Metallic Devices in MRI

$$E_z = \frac{-H_f w m_0 r}{2} e^{jf}$$

$$E_f = o$$

$$E_\rho = 0$$



6)Eryaman Y., Akin B. and Atalar E., Reduction of implant RF heating through modification of transmit coil electric field. Magnetic Resonance in Medicine, n/a. doi: 10.1002/mrm.22724

Reduction of RF Heating of Metallic Devices in MRI

$$E_z = -H_f \, j\omega\mu_0 r \sin\phi$$

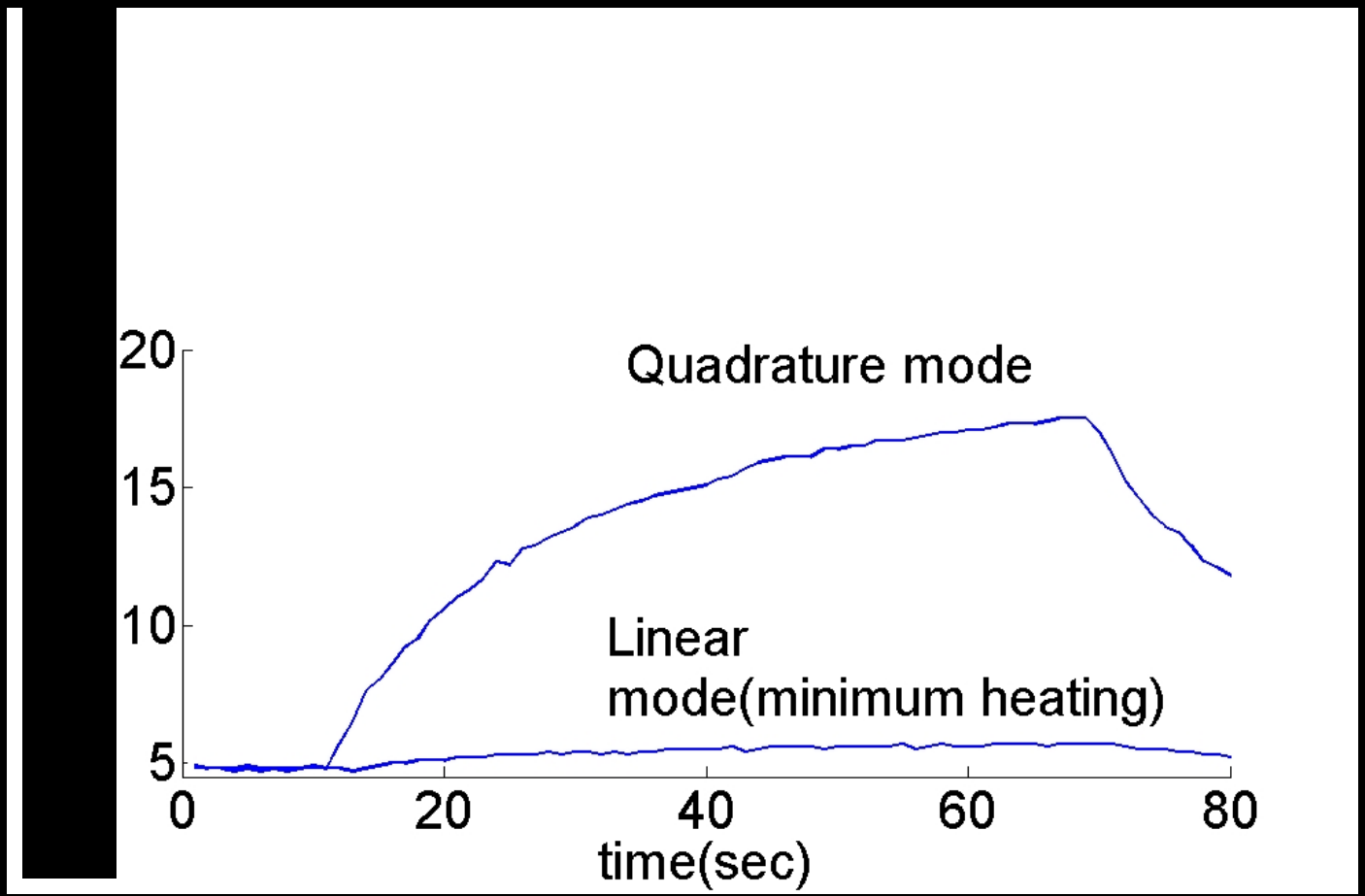
$$E_f = 0$$

$$E_\rho = 0$$

6)Eryaman Y., Akin B. and Atalar E. , Reduction of implant RF heating through modification of transmit coil electric field. Magnetic Resonance in Medicine, n/a. doi: 10.1002/mrm.22724

Reduction of RF Heating of Metallic Devices in MRI

Fiber 2 .4 2 % %

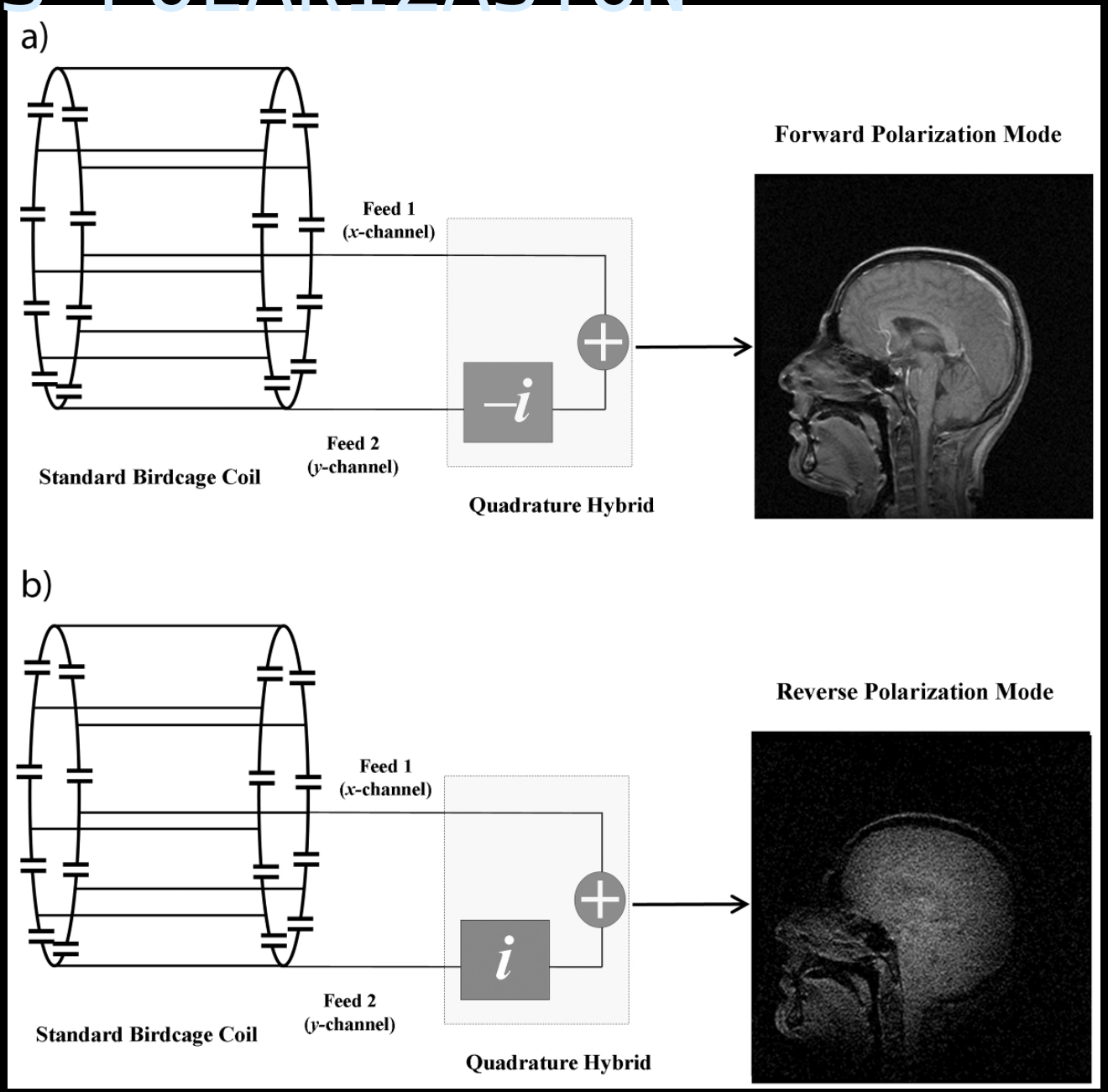


Reduction of RF Heating of Metallic Devices in MRI

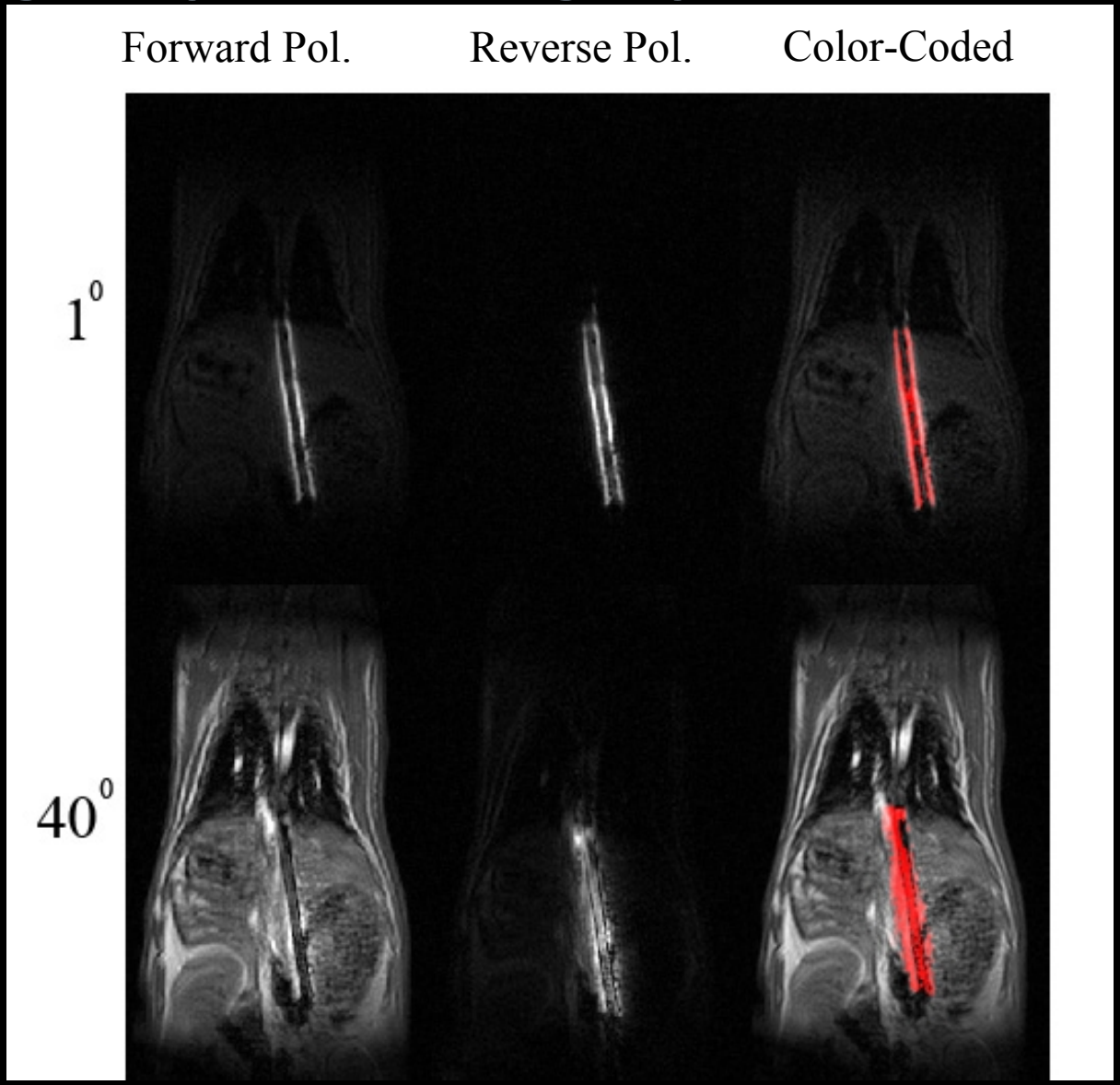
Reduction of RF Heating of Metallic Devices in MRI

DİĞER UYGULAMALAR

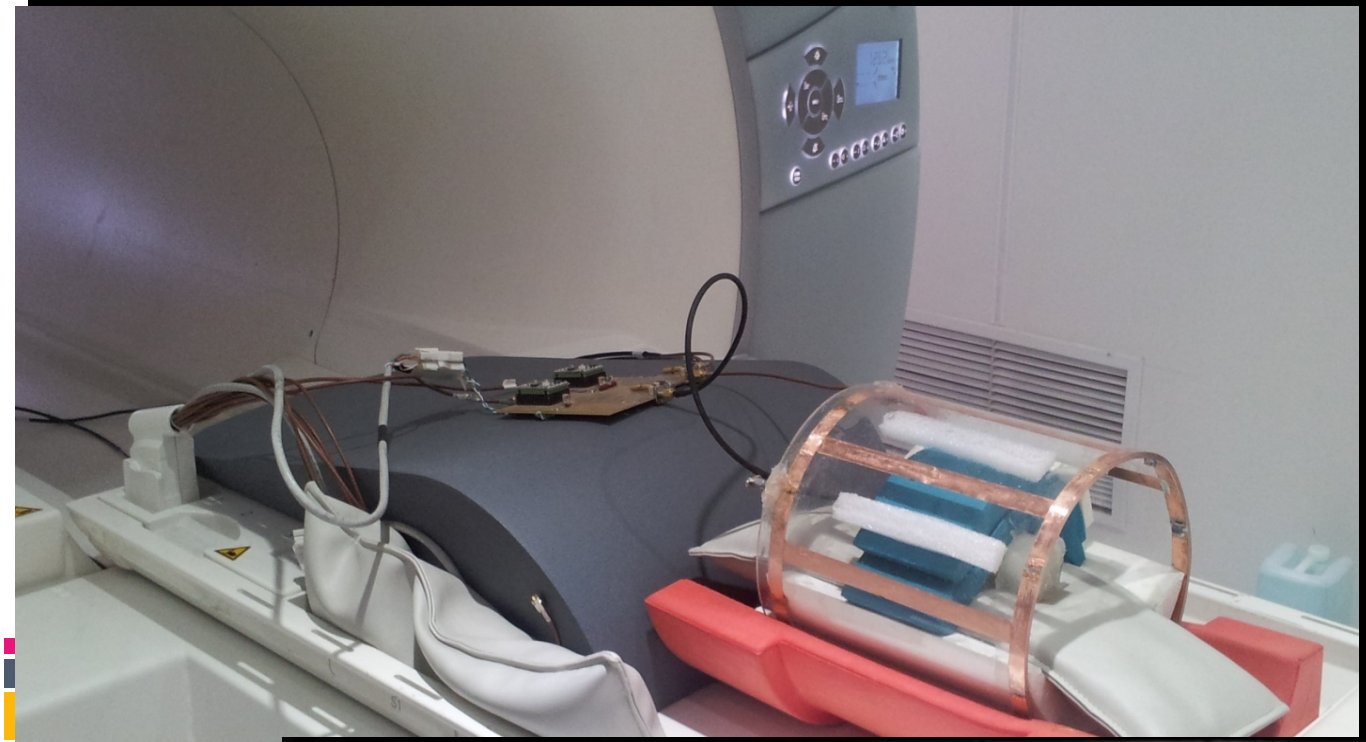
TERS POLARIZASYON



TERS POLARİZASYON



RF ile silindirik kodlama



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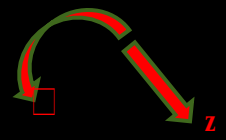

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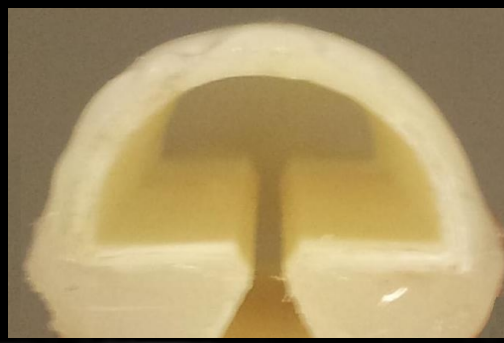
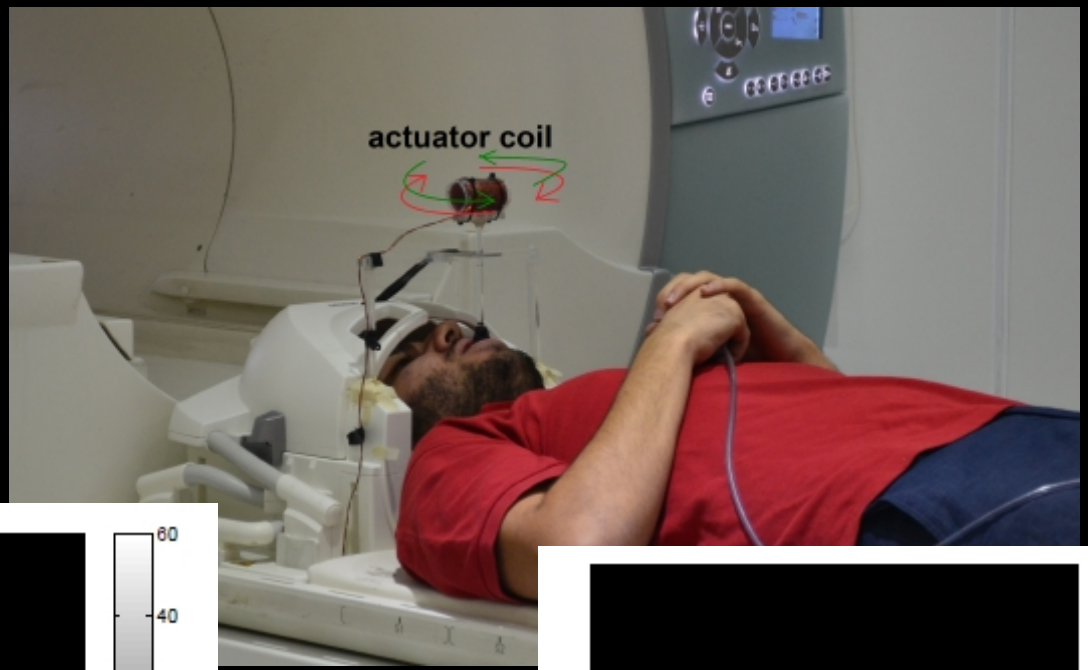
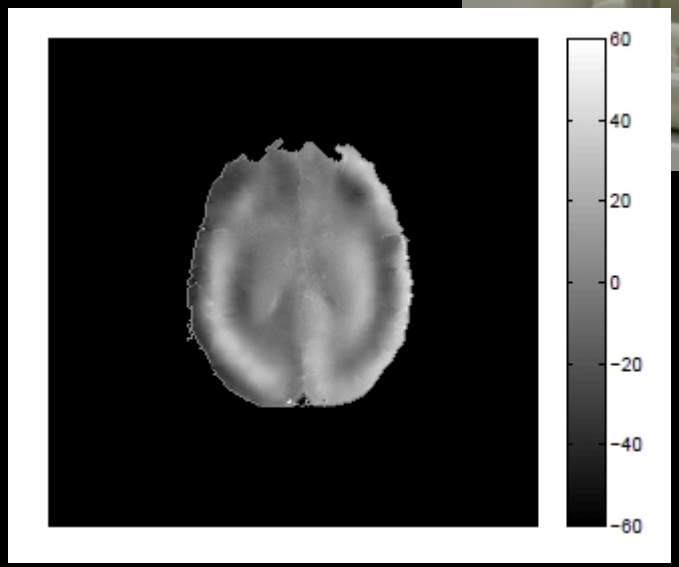
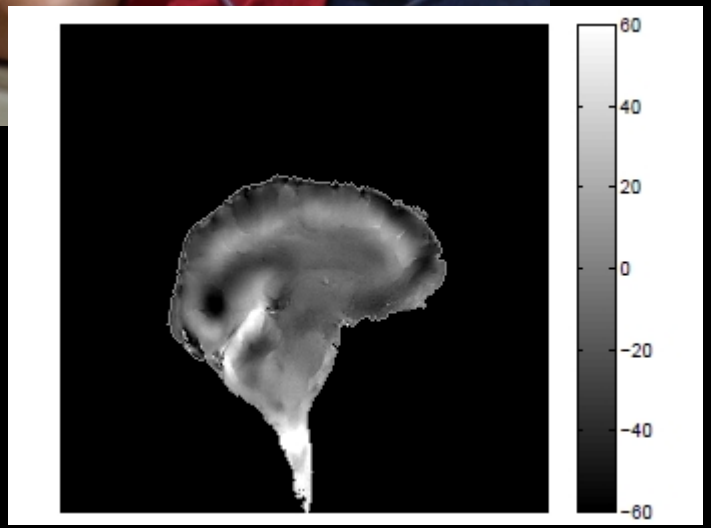


MR ile beyin elastografisi



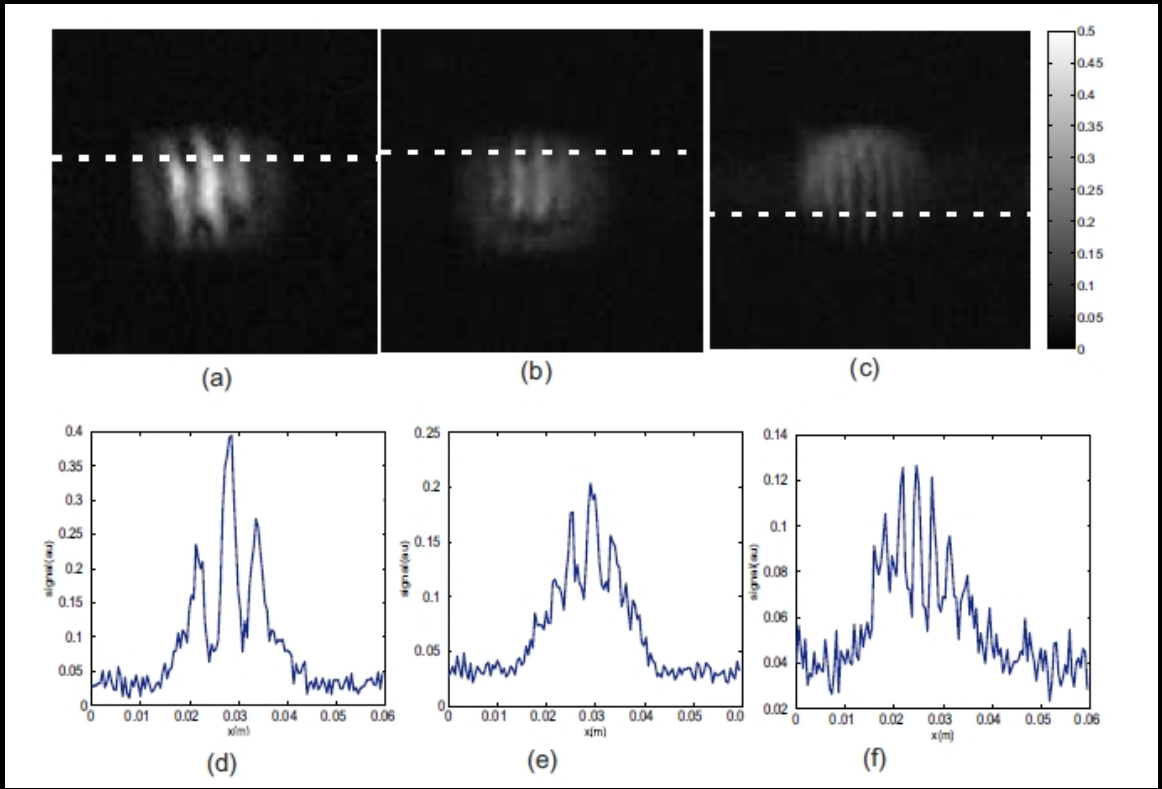




B1 gradyanı ile elastografi

Shear Wave Imaging using B_1 gradients

Esra Abaci Turk[1,2], Cemre Ariyurek[1,2], Yusuf Ziya Ider[2], Arif Sanli Ergun[3], and Ergin Atalar[1,2]



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- Verici Anten Dizisi Uygulamaları
- Gradyan Dizi

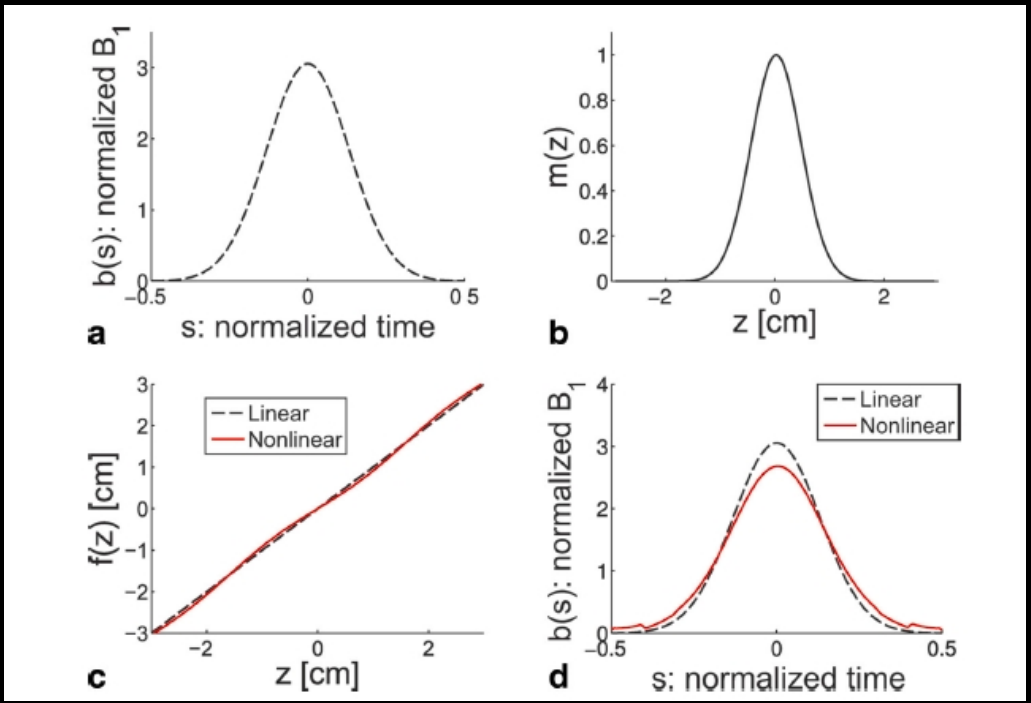
Doğrusal olmayan gradyanlar

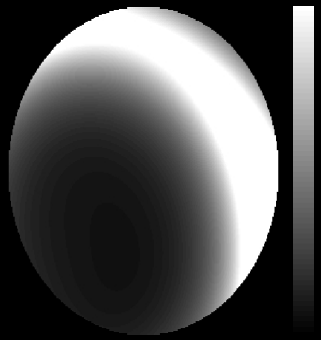
- Doğrusal gradyanlar
  - $B_z(t) = Bo + G_x x + G_y y + G_z z$
- Doğrusal olmayan gradyanlar
  - $B_z(t) = G_{xx} x^2 + G_{yy} y^2 + G_{zz} z^2 + G_{xy} xy + \ldots$

Doğrusal olmayan gradyanlar kullanarak SAR azaltma

Specific Absorption Rate Reduction Using Nonlinear Gradient Fields

Emre Kopanoglu,[1,2] Ugur Yilmaz,[1,2] Yildiray Gokhalk,[1] and Ergin Atalar[1,2*]





Simultaneous Use of Linear and Nonlinear Gradients as Indepedent K-Space Variables for RF Excitation

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Doğrusal ve Doğrusal Olmayan Gradyan Alanların Birlikte Kulalnımı