CORSO DI LAUREA
TECNICHE DI RADIOLOGIA MEDICA, PER IMMAGINI E RADIOTERAPIA

CORSO INTEGRATO
«FISICA E APPARECCHIATURE TC E RM – RMX012»

ANNO ACCADEMICO 2023/2024

Gemelli

Insegnamento:
APPARECCHIATURE RISONANZA MAGNETICA
RMX054 - 13 ore MED/50 CFU 1

Formazione per l'eccellenza

apr. '24

2° anno I semestre

Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

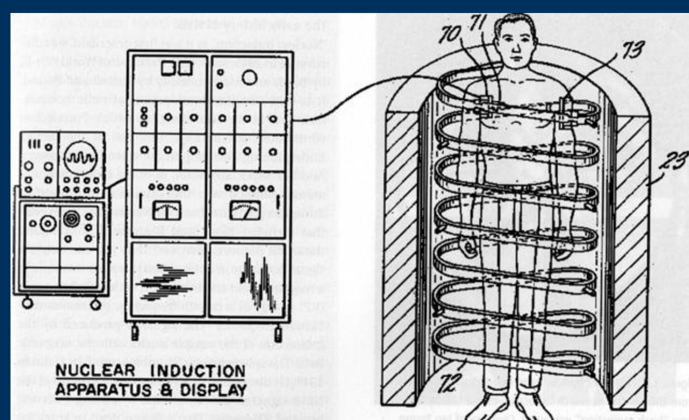
BEST HOSPITALS 2023 Newsweek statista
1° OSPEDALE IN ITALIA
POLICLINICO UNIVERSITARIO A. GEMELLI

Formazione per l'eccellenza

Insegnamento:
APPARECCHIATURE RISONANZA MAGNETICA
RMX054 - 13 ore MED/50 CFU 1

MRI – PASSATO, PRESENTE E FUTURO

Gemelli



apr. '24

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apr. '24

Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

Formazione per l'eccellenza

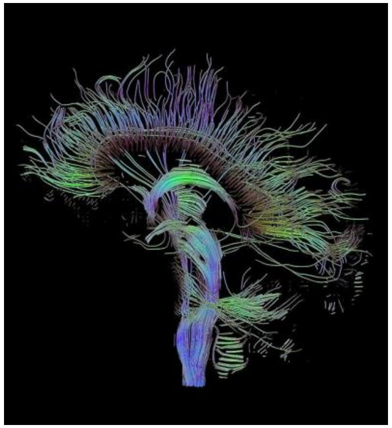
Argomenti del Corso

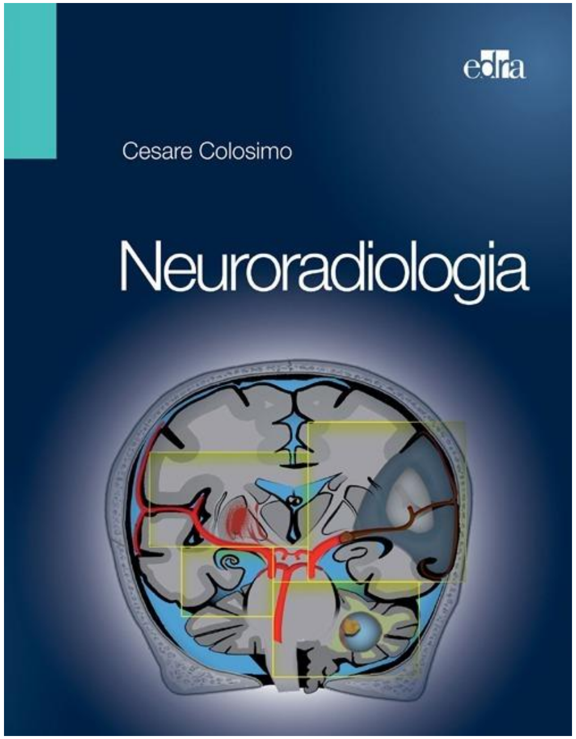
- Introduzione
- Sicurezza in RM
- MdC e sicurezza
- **Passato, presente e futuro della RM**
- Fenomeno «RM» e principi fisici di base
- Magnete e i vari componenti
- Radiofrequenza e Bobine
- Gradienti
- Generazione di un'immagine RM
- Tecniche di acquisizione – *Parallel Imaging*
- Intelligenza artificiale – *Deep Learning*
- Artefatti
- Esame RM
- Apparecchiature Fondazione

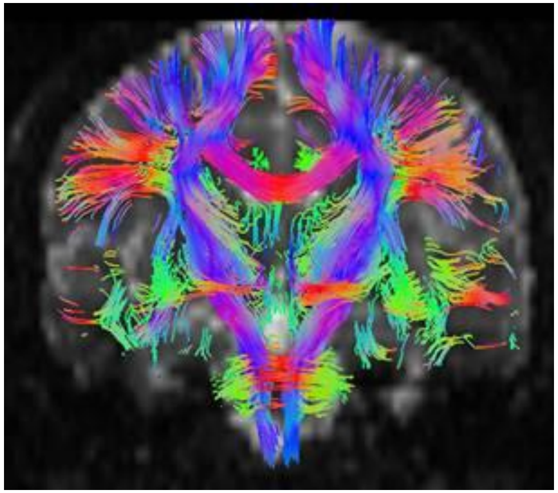
MRI


Istruzioni per l'uso
Risonanza Magnetica
MRI
Risonanza Magnetica
MRI

IRM – Imaging a Risonanza Magnetica







La **RM** è una metodica non invasiva che fornisce immagini di sezione multiplanari del corpo umano impiegando apparecchiature in grado di generare un potentissimo campo magnetico statico (B_0)...
... la RM sfrutta il fenomeno di risonanza per ottenere informazioni sui tessuti biologici ...

MRI

Interazione tra onde radio e nuclei di H^+ delle diverse strutture del corpo in presenza di un forte campo magnetico

CENNI DI STORIA

Formazione per l'eccellenza

La **Risonanza Magnetica Nucleare (RMN)** è un principio fisico che permette di misurare la precessione dello spin di alcuni nuclei atomici sottoposti ad un campo magnetico.

Scoperta indipendentemente nel 1946 dai fisici Felix Bloch ed Edward Purcell, per cui entrambi ricevettero il Premio Nobel per la fisica nel 1952, tra il 1950 e il 1970 venne utilizzata primariamente nell'analisi della chimica molecolare e della struttura dei materiali.

CENNI DI STORIA

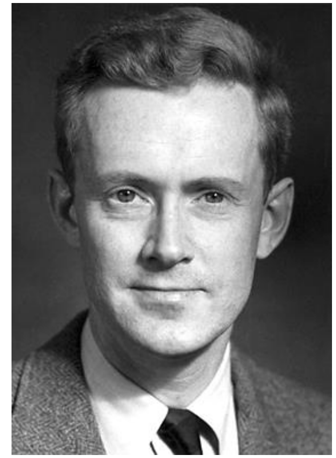
La **Risonanza Magnetica per Imaging (MRI)** è una tecnica utilizzata principalmente in campo medico per produrre immagini ad alta definizione dell'interno del corpo umano. L'MRI è basata sui principi della Risonanza Magnetica Nucleare (NMR), una tecnica spettroscopica usata dai ricercatori per ottenere informazioni di tipo microscopico, chimico e fisico, sulle molecole. La tecnica è stata chiamata "imaging mediante risonanza magnetica" piuttosto che "imaging mediante risonanza magnetica nucleare" a causa delle connotazioni negative associate negli ultimi anni '70 al termine "nucleare".

Quello che normalmente viene chiamato RMN in medicina è in realtà il Magnetic Resonance Imaging o MRI, ossia la visualizzazione di immagini tramite RM.

LA STORIA

Felix Bloch
Fisico
svizzero
23.10.1905-
10.9.1983

1946



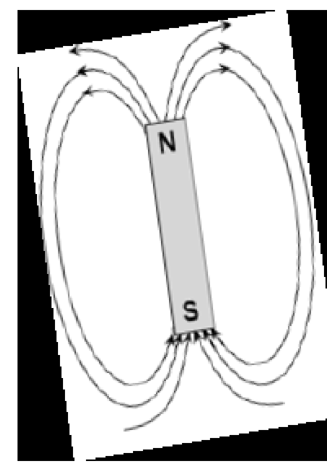
Edward Mills Purcell
Fisico
statunitense
30.8.1912 –
7.3.1997

Bloch e Purcell scoprirono il fenomeno della Risonanza Magnetica nel 1946 indipendentemente uno dall'altro

1952

Premio Nobel per la Fisica

Un nucleo si comporta come un magnete



Prize motivation: "for their development of new methods for nuclear magnetic precision measurements and discoveries in connection therewith"

Formazione per l'eccellenza

Paul Adrien Maurice Dirac (Bristol, 8 agosto 1902 – Tallahassee, 20 ottobre 1984) fisico e matematico britannico

1930

Meccanica quantistica -- momento angolare di spin caratterizzato da un numero quantico di spin, che è una proprietà intrinseca del nucleo

LA STORIA

Formazione per l'eccellenza

Rabi ⟨réibi⟩ Isaac Isidor (Rynranov, Galizia, 1898 - New York 1988)

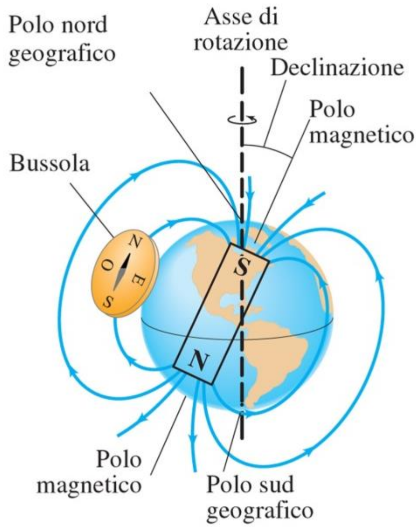
1937

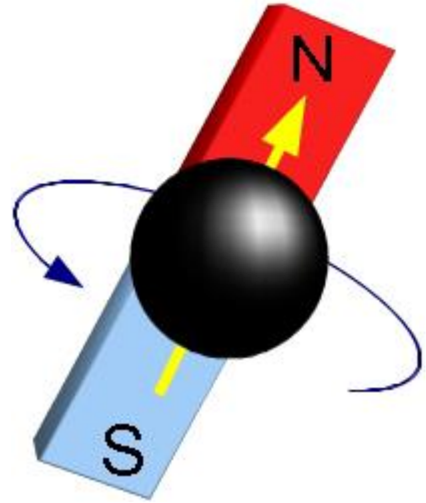
Storicamente il *primo esperimento di RMN* è stato quello dell'americano Rabi (v., 1937), effettuato su fasci atomici per la misura dei momenti magnetici di vari nuclei atomici.

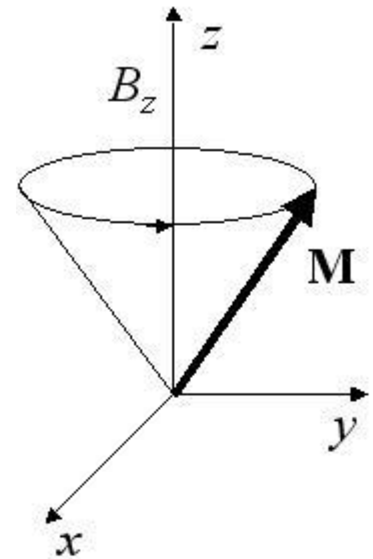
1944 Nobel per la fisica … "per il suo metodo della risonanza per la registrazione delle proprietà magnetiche dei nuclei atomici"

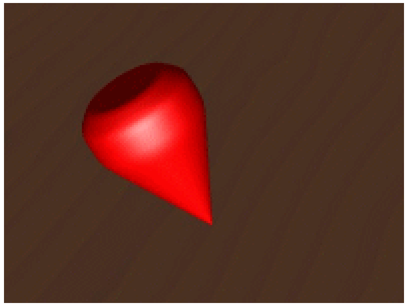
Equazioni di Bloch

Felix Bloch









Una particella carica, come un protone, che ruoti intorno al proprio asse genera un campo magnetico ("momento magnetico")

$$\frac{dM_{x'}}{dt} = (\omega_o - \omega)M_{y'} - \frac{M_{x'}}{T_2}$$

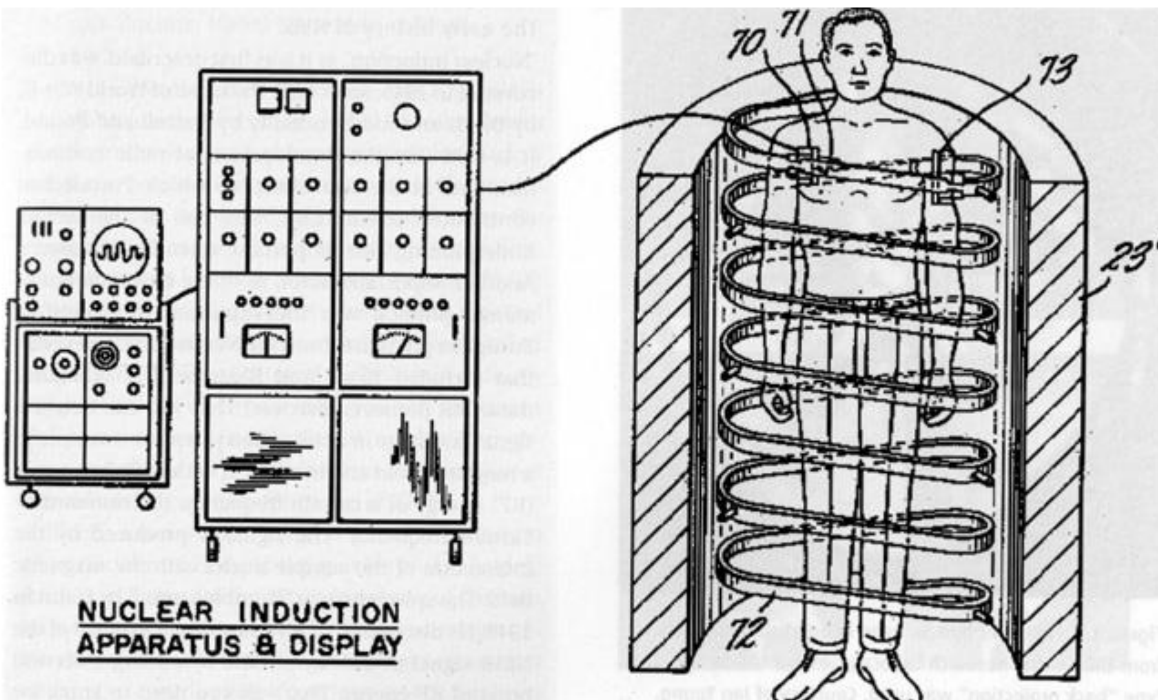
$$\frac{dM_{y'}}{dt} = -(\omega_o - \omega)M_{x'} + 2\pi\gamma B_1 M_z - \frac{M_{y'}}{T_2}$$

$$\frac{dM_z}{dt} = -2\pi\gamma B_1 M_{y'} - \frac{(M_z - M_{z_o})}{T_1}$$

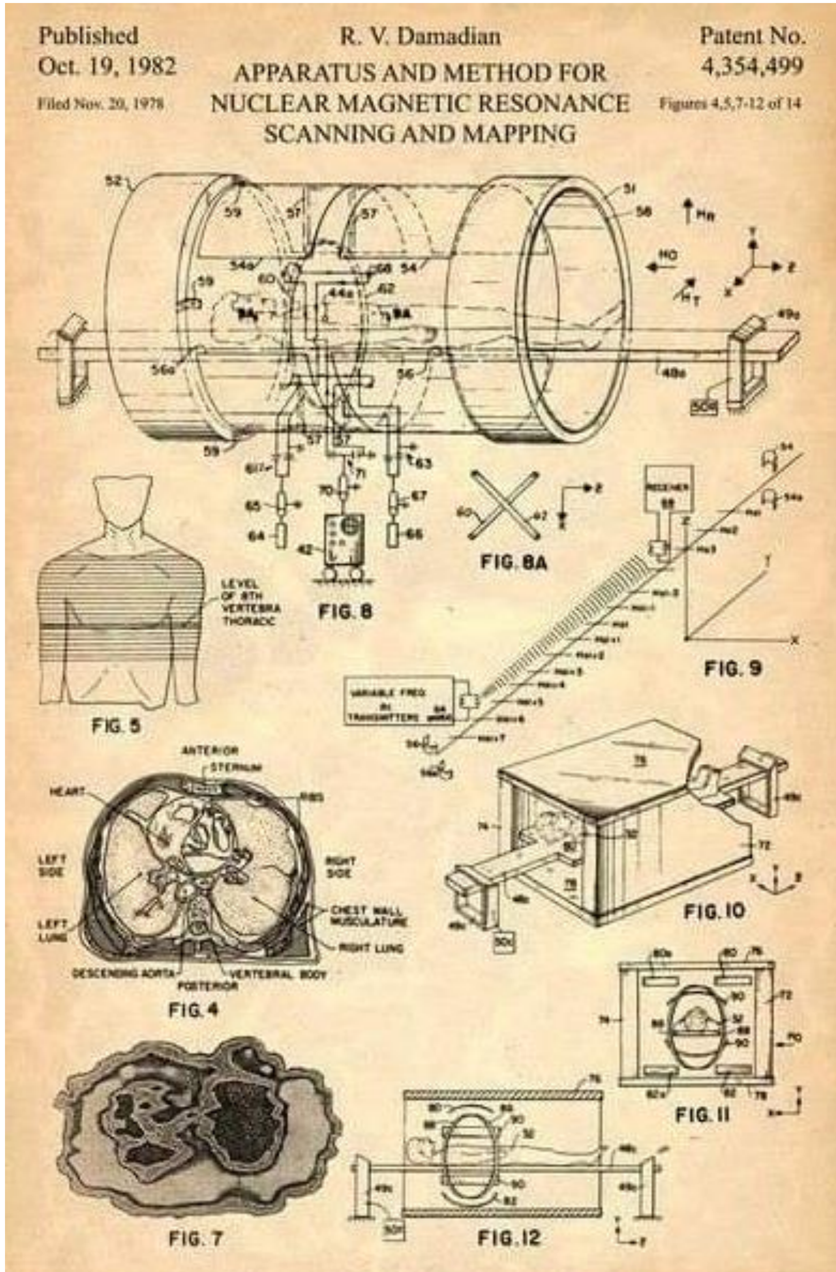
Raymond Vahan Damadian
USA 16 marzo 1936

1971

Fu Raymond Damadian nel 1971 a dimostrare, con esperimenti su cavie da laboratorio, che i tempi di rilassamento magnetico-nucleari dei tessuti sani erano differenti da quelli dei tessuti tumorali



LA STORIA


Published
Oct. 19, 1982
Filed Nov. 20, 1978
R. V. Damadian
APPARATUS AND METHOD FOR
NUCLEAR MAGNETIC RESONANCE
SCANNING AND MAPPING
Patent No.
4,354,499
Figures 4,5,7-12 of 14
FIG. 8A
FIG. 8
FIG. 5
FIG. 9
FIG. 10
FIG. 4
FIG. 11
FIG. 7
FIG. 12
LEVEL OF 8TH VERTEBRA THORACIC
ANTERIOR
STERNUM
HEART
RIBS
LEFT SIDE
RIGHT SIDE
LEFT LUNG
CHEST WALL MUSCULATURE
RIGHT LUNG
DESCENDING AORTA
VERTEBRAL BODY
POSTERIOR

Formazione per l'eccellenza

Image Formation by Induced Local Interactions: Examples Employing Nuclear Magnetic Resonance

nature.com

Paul Lauterbur
(1929-2007)

1973

16 March 1973 Image Formation by Induced Local Interactions: Examples Employing Nuclear Magnetic Resonance
P. C. LAUTERBUR
Nature 242, 190-191
doi:10.1038/242190a0

Formazione per l'eccellenza

Peter Mansfield

Londra 1933 -

1973

Il contributo di Mansfield consiste nell'aver mostrato come i segnali radio provenienti dalla MR possono essere matematicamente analizzati, trasformandoli in una immagine utile a fini diagnostici.

Inoltre Mansfield ha scoperto la tecnica di echo-planar imaging, in grado di rendere possibile l'ottenimento veloce di immagini dalla MR fino al punto da visualizzare immagini in movimento degli organi umani, come per esempio del cuore, e lo sviluppo della risonanza magnetica funzionale.

CENNI DI STORIA

Formazione per l'eccellenza

Paul Lauterbur (born 1929), Urbana, Illinois, USA, discovered the possibility to create a two-dimensional picture by introducing gradients in the magnetic field. By analysis of the characteristics of the emitted radio waves, he could determine their origin. This made it possible to build up two-dimensional pictures of structures that could not be visualized with other methods.

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…ency that is dependent on the strength of the magnetic field. Their energy can be increased if they absorb radio waves with the same frequency (resonance). When the atomic nuclei return to their previous energy level, radio waves are emitted. These discoveries were awarded the Nobel Prize in Physics in 1952. During the following decades, magnetic resonance was used mainly for studies of the chemical structure of substances. In the beginning of the 1970s, this year's Nobel Laureates made pioneering contributions, which later led to the applications of magnetic resonance in medical imaging.

Press Release

6 October 2003

The Nobel Assembly at Karolinska Institutet has today decided to award

The Nobel Prize

Paul C Lauterb

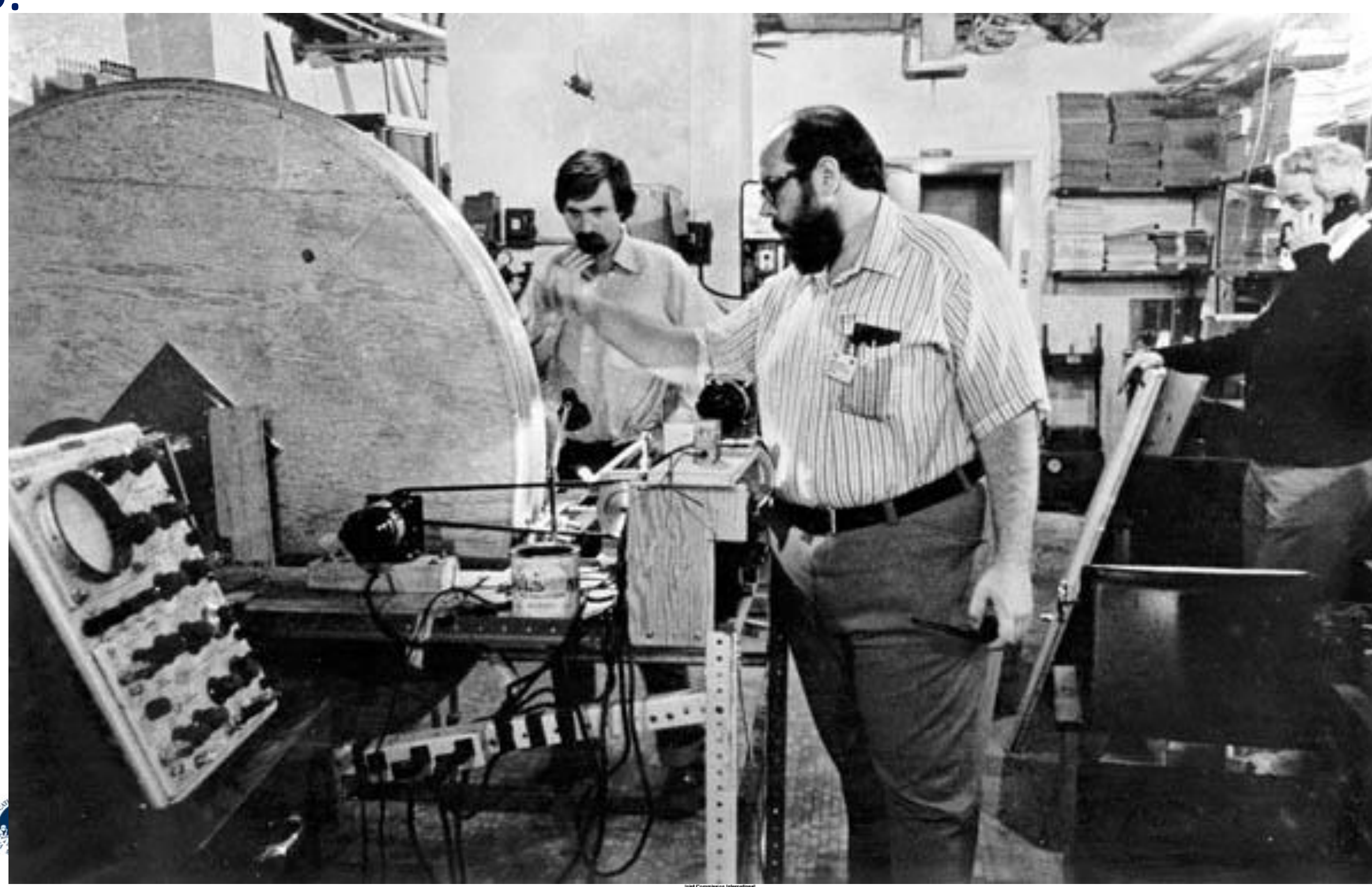
for their discov

Peter Mansfield (born 1933), Nottingham, England, further developed the utilization of gradients in the magnetic field. He showed how the signals could be mathematically analysed, which made it possible to develop a useful imaging technique. Mansfield also showed how extremely fast imaging could be achievable. This became technically possible within medicine a decade later.

http://www.nobelprize.or /laureates/2003/press.html

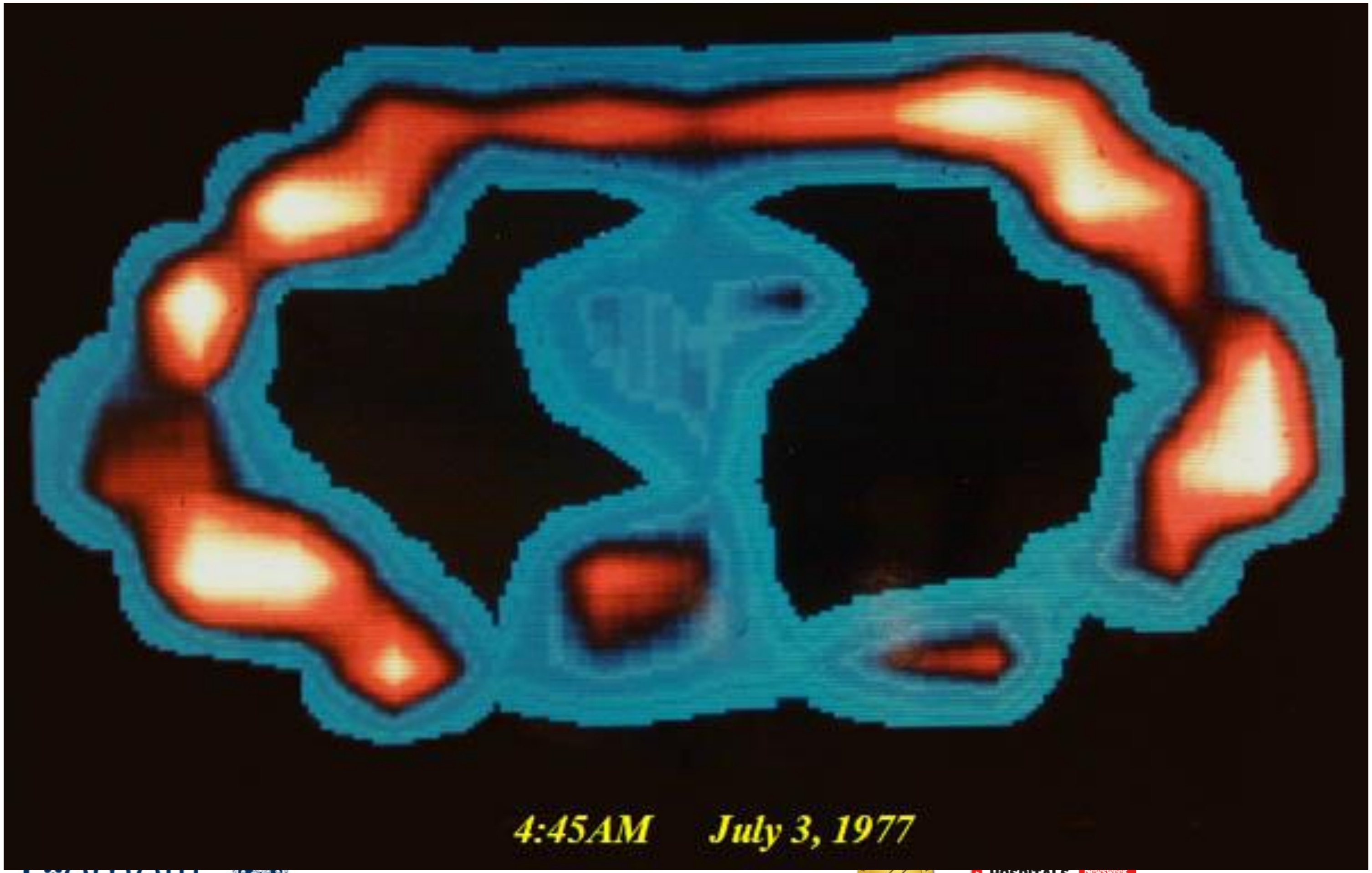
La prima MRI

Damadian went on to build the first MRI scanner by hand, assisted by his two post-doctoral students, Michael Goldsmith and Larry Minkoff at New York's Downstate Medical Center and achieved the first MRI scan of a ***healthy human body in 1977*** and a ***human body with cancer in 1978***.



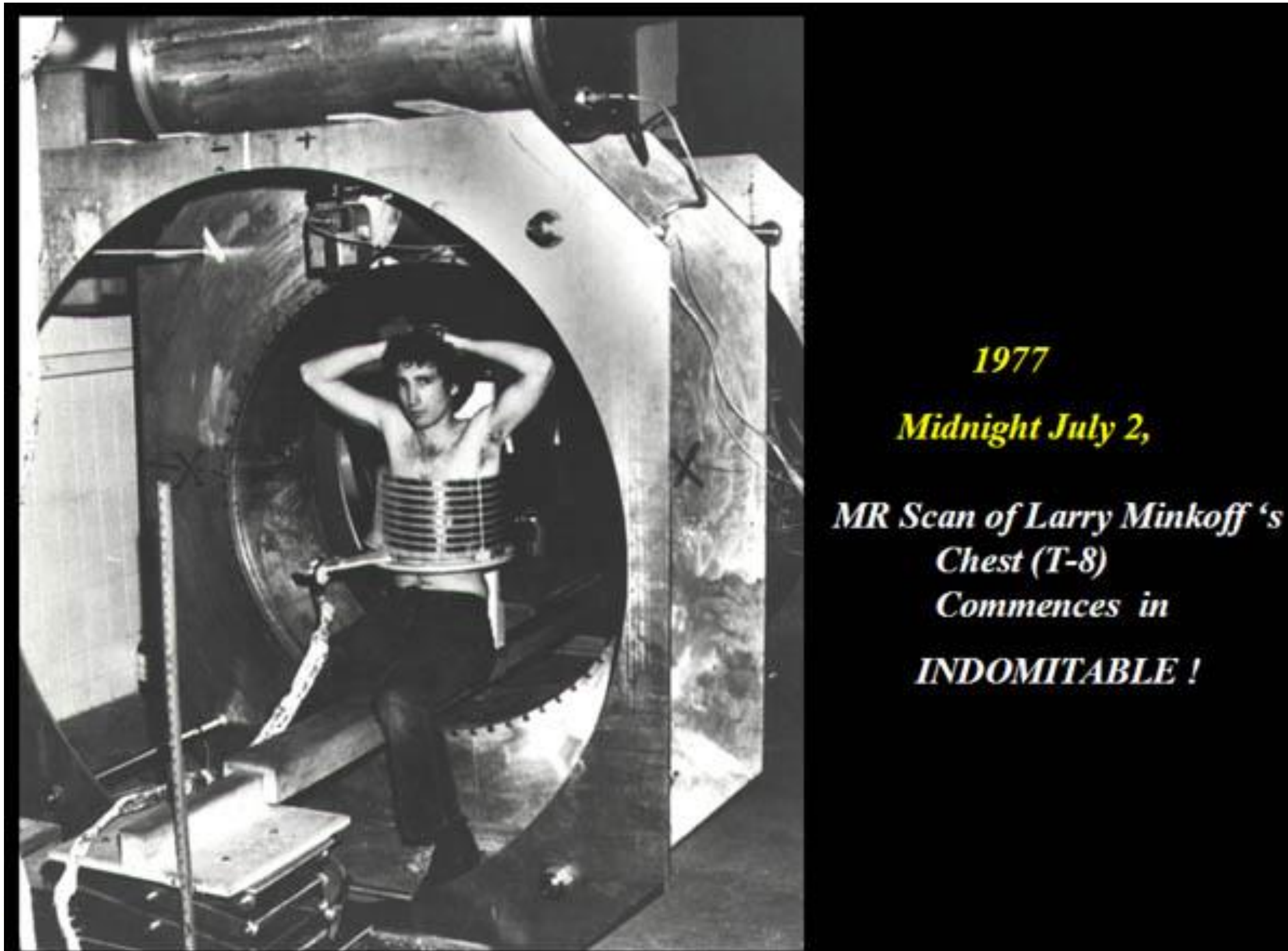
La prima MRI

Figura. The interpolated image of the Minkoff scan and the first ever MRI scan of a live human being (4:45 AM July 3, 1977).



La prima MRI

Figura. L. Minkoff in Indomitable with some "room to spare" inside the Goldsmith receiver coil.



Gemelli

Nel **1975 Richard Ernst** propose un processo di codifica di fase e di codifica in frequenza delle radiofrequenze e l'introduzione della trasformata di Fourier nell'analisi dei dati ottenuti.

Richard Robert Ernst (Winterthur, 14 agosto 1933) è un chimico svizzero

Nel 1980, Edelstein ed i suoi collaboratori sperimentarono l'imaging del corpo usando la tecnica di Ernst, grazie alla quale una singola immagine poteva essere acquisita in circa cinque minuti. Il tempo di imaging verrà drasticamente ridotto a circa cinque secondi, senza significativi cambiamenti della qualità dell'immagine, a partire dal 1986.

William A. Edelstein,
New York 1962 -

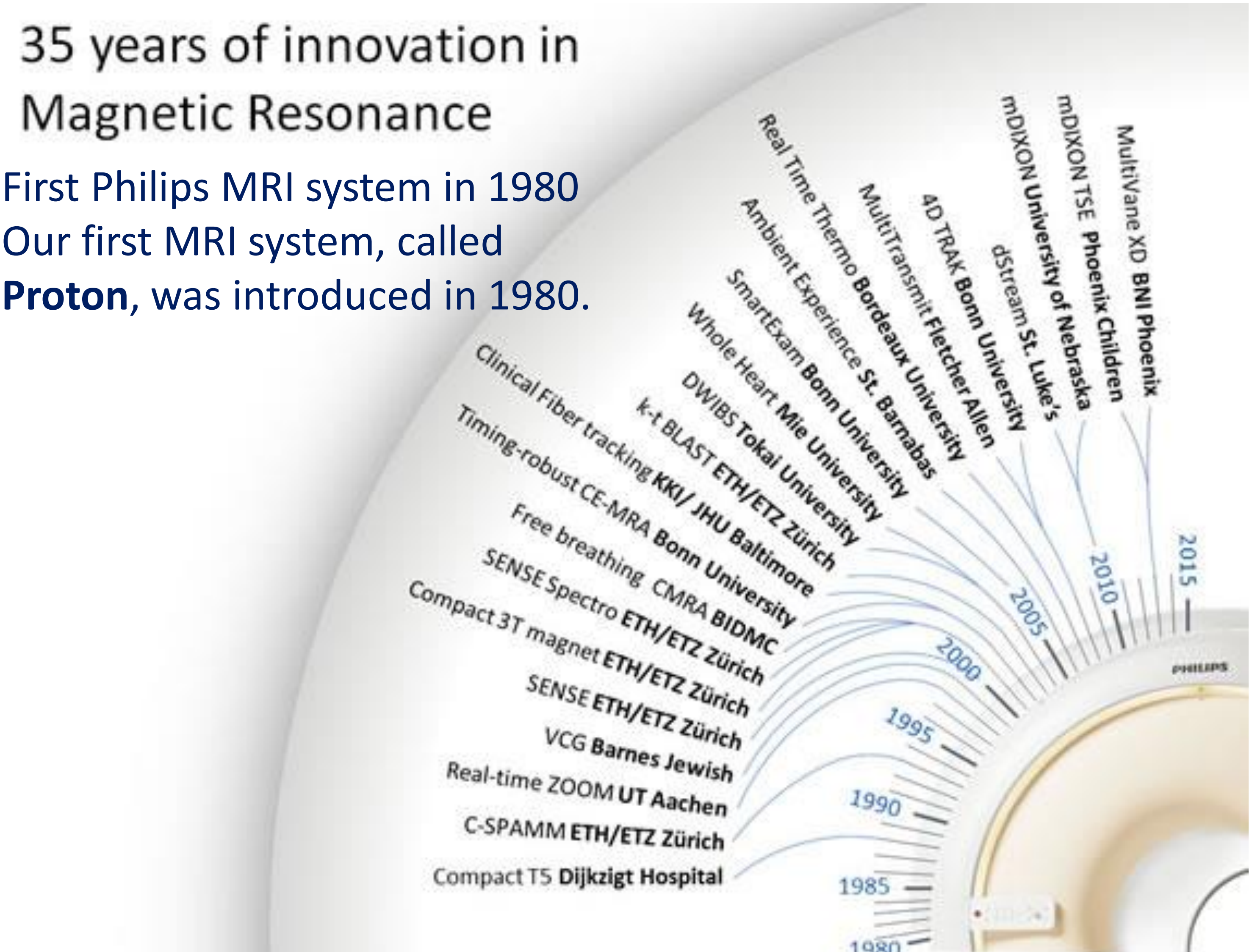
La prima MRI

FONAR The Inventor of MR Scanning™

Figura. Raymond Damadian, Larry Minkoff and Michael Goldsmith with "Indomitable" and its iced liquid helium and liquid nitrogen ports: the world's first supercooled, superconducting MR scanner and the world's first MRI machine.

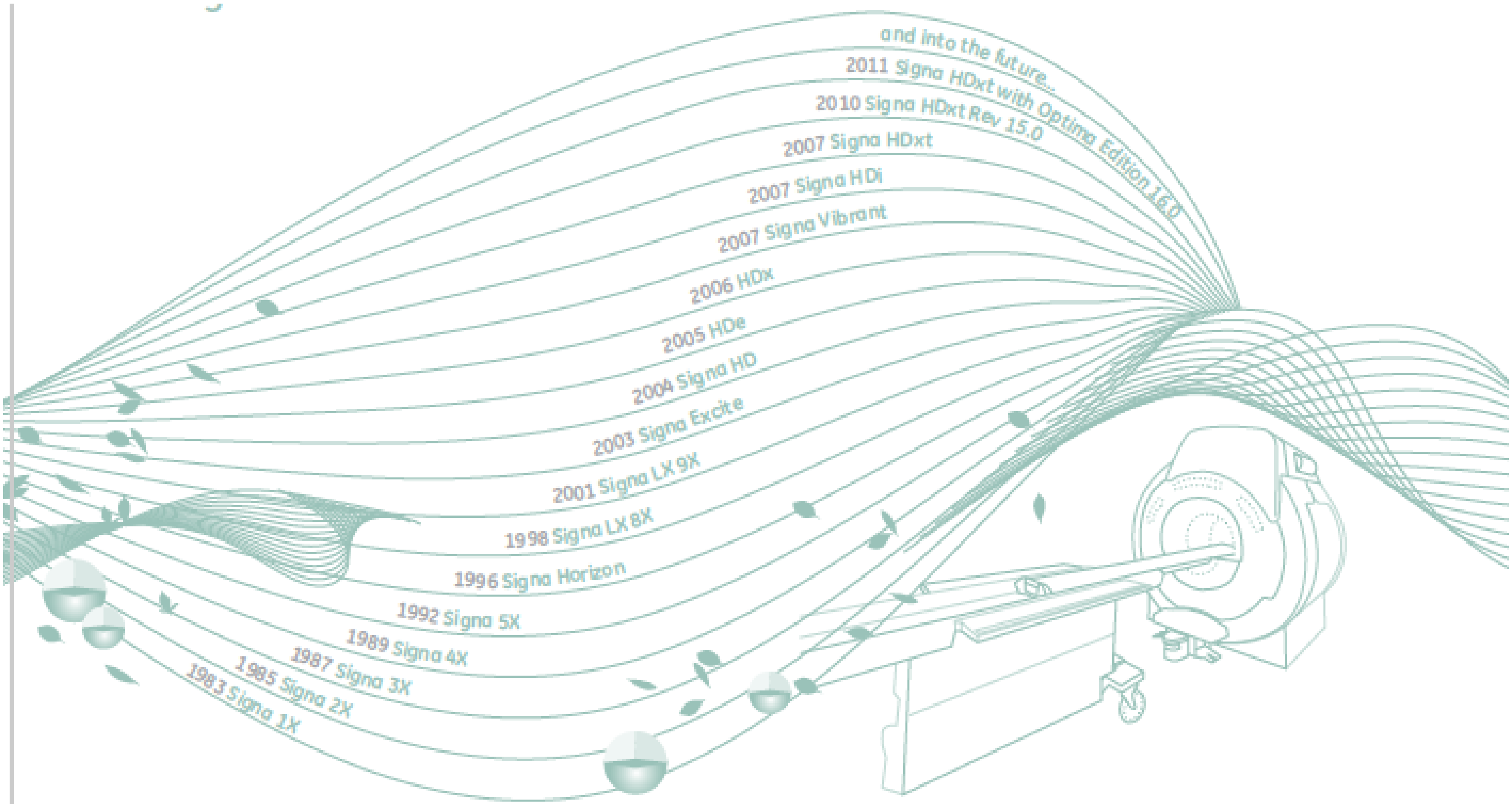
La prima MRI - Philips

First Philips MRI system in 1980
Our first MRI system, called **Proton**, was introduced in 1980.



GE

Formazione per l'eccellenza



RM e ISPESL (ora INAIL)

Formazione per l'eccellenza

1985 : arriva la Risonanza Magnetica

INAIL
ISTITUTO NAZIONALE PER L'ASSICURAZIONE CONTRO GLI INFORTUNI SUL LAVORO

Dipartimento Igiene del Lavoro - ex ISPESL

L'ISPESL si esprime sulle richieste di autorizzazione all'installazione presentate al Ministero della Sanità

RM PHILIPS

Classic magnet technology
~1,500 liters of liquid helium

BlueSeal micro-cooling technology
~7 liters of liquid helium

PHILIPS

BlueSeal magnet

RM PHILIPS

BlueSeal magnet design	
Field strength	1.5T
Magnet design	Ultra compact, lightweight and sealed
Magnet weight (with cryogen)	2,300 kg (5,071 lbs)
Minimum siting limitation	3,700 kg (8,157 lbs)
Open bore diameter	70 cm (incl. shim, gradient & QBC)
Maximum FOV	55 cm × 55 cm × 50 cm

BlueSeal micro-cooling system	
Type of cryogen	Liquid helium (~7 liters)
Micro-cooling technology	Yes
Cryogen boil-off rate	Not applicable, fully sealed
Cryogen refill interval	Not applicable, fully sealed

Vent-pipe requirements	Not applicable, fully sealed
BlueSeal adaptive-intelligence	
Type of magnet controller	Digital, adaptive-intelligent
Self ramp-up unit	Yes, digital
Self ramp-down unit	Yes, digital
BlueSeal EasySwitch	Yes, adaptive-intelligent
EasySwitch innovations	Yes, magnet UPS, air-cooled compressor and 24/7 monitored e-Alert

PHILIPS

BlueSeal magnet

RM CANON (EX TOSHIBA)

Formazione per l'eccellenza

Canon MR: Cenni di Storia & Portfolio Prodotti

Accettazione e Registrazione esame

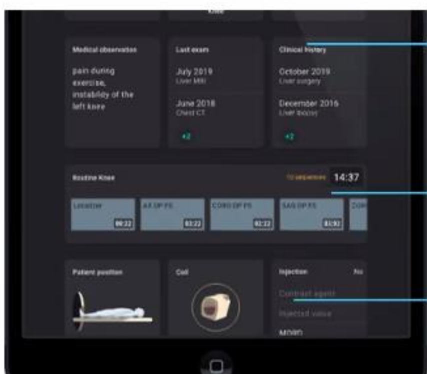
Sempre più vicini al paziente

WORKLIST PAZIENTE

Distretto esame, dati paziente.

AUTOVIEW

Visualizzazione immagini in acquisizione in tempo reale



STORICO ESAMI PAZIENTE

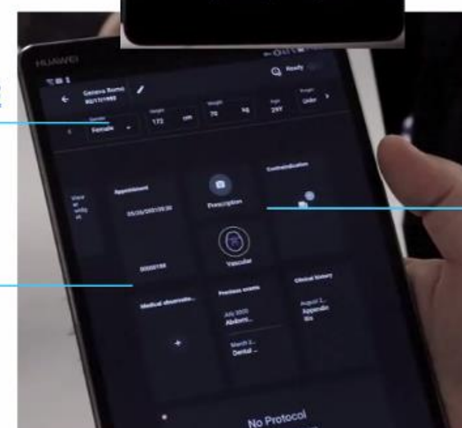
Visualizzazione esami precedenti

PROTOCOLLI

Selezione protocollo

STUDIO

Informazioni relative a bobine, posizione



DATI PAZIENTE

OSSERVAZIONI MEDICHE

Commenti e immagini

AREA COMMENTI

Configurablle

Formazione per l'eccellenza

Bobine

Al servizio del paziente e della clinica

Bobine per un elevato COMFORT PAZIENTE & un'elevata CONFIDENZA CLINICA

Bobine Dedicate

Bobine Flessibili

Formazione per l'eccellenza

Bobine

Al servizio del paziente e della clinica

Shape Coils: LEGGERE, FLESSIBILI & VERSATILI

Bobine Shape Coils

Pratica: RM presente e futuro

Formazione per l'eccellenza

https://www.nature.com/articles/d41586-018-07182-7

nature
International journal of science

NEWS FEATURE · 31 OCTOBER 2018

The world's strongest MRI machines are pushing human imaging to new limits

Researchers look to scanners with 10.5-tesla magnets and beyond for unprecedented detail about the brain.

RM SIEMENS 10.5T

RM SIEMENS 10.5T

The project was launched in 2008 with the aid of an $8 million grant from the U.S. National Institutes of Health (NIH). The magnet was built in the U.K. and shipped across the Atlantic Ocean and through the Great Lakes to Duluth, MN. It was then shipped over land on a specialized trailer to the CMRR building on the Twin Cities campus.

March 13, 2018 -- Researchers at the University of Minnesota's Center for Magnetic Resonance Research (CMRR) are breaking new ground by performing the first whole-body 10.5-tesla MRI scans on humans.

The scanner (Magnetom 10.5T, Siemens Healthineers) is able to image the entire body, but its main focus will be the brain.

RM SIEMENS 10.5T

Formazione per l'eccellenza

Magn Reson Med. 2019 Dec 17. doi: 10.1002/mrm.28131. [Epub ahead of print]

First in-vivo human imaging at 10.5T: Imaging the body at 447 MHz.

He X[1], Ertürk MA[1], Grant A[1], Wu X[1], Lagore RL[1], DelaBarre L[1], Eryaman Y[1], Adriany G[1], Auerbach EJ[1], Van de Moortele PF[1], Uğurbil K[1], Metzger GJ[1].

⊕ Author information

Abstract

PURPOSE: To investigate the feasibility of imaging the human torso and to evaluate the performance of several radiofrequency (RF) management strategies at 10.5T.

METHODS: Healthy volunteers were imaged on a 10.5T whole-body scanner in multiple target anatomies, including the prostate, hip, kidney, liver, and heart. Phase-only shimming and spoke pulses were used to demonstrate their performance in managing the $B_1^+|$ inhomogeneity present at 447 MHz. Imaging protocols included both qualitative and quantitative acquisitions to show the feasibility of imaging with different contrasts.

RESULTS: High-quality images were acquired and demonstrated excellent overall contrast and signal-to-noise ratio. The experimental results matched well with predictions and suggested good translational capabilities of the RF management strategies previously developed at 7T. Phase-only shimming provided increased efficiency, but showed pronounced limitations in homogeneity, demonstrating the need for the increased degrees of freedom made possible through single- and multispoke RF pulse design.

CONCLUSION: The first in-vivo human imaging was successfully performed at 10.5T using previously developed RF management strategies. Further improvement in RF coils, transmit chain, and full integration of parallel transmit functionality are needed to fully realize the benefits of 10.5T.

Doi: 10.1002/mrm.28131

RM SIEMENS MAGNETOM Free Max

Primo bore al mondo di 80 cm

High-V MRI…

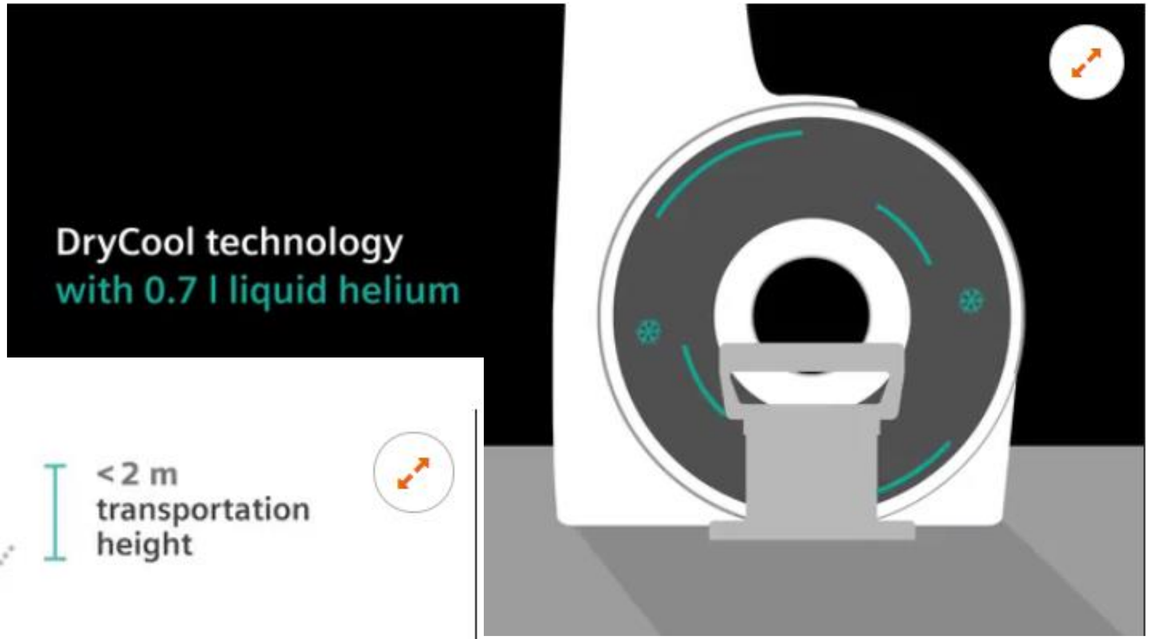
?

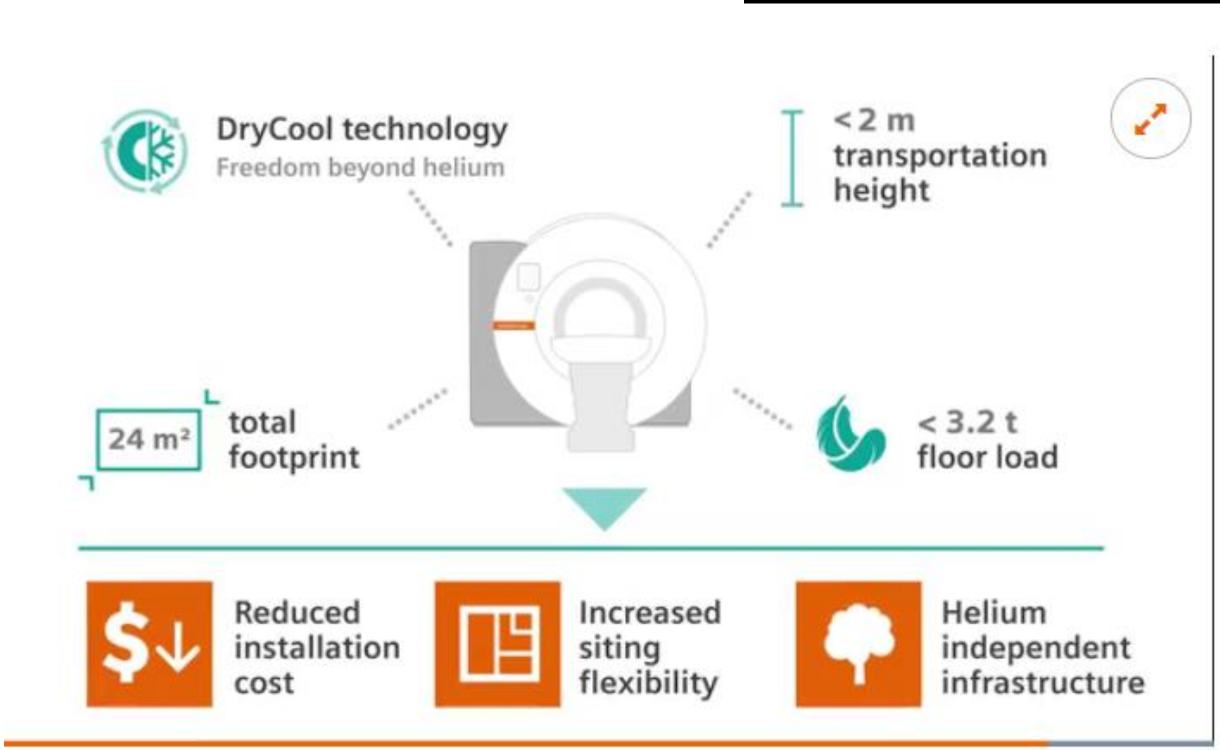
brand-new field strength of 0.55T…

RM SIEMENS MAGNETOM Free Max

Primo bore al mondo di 80 cm

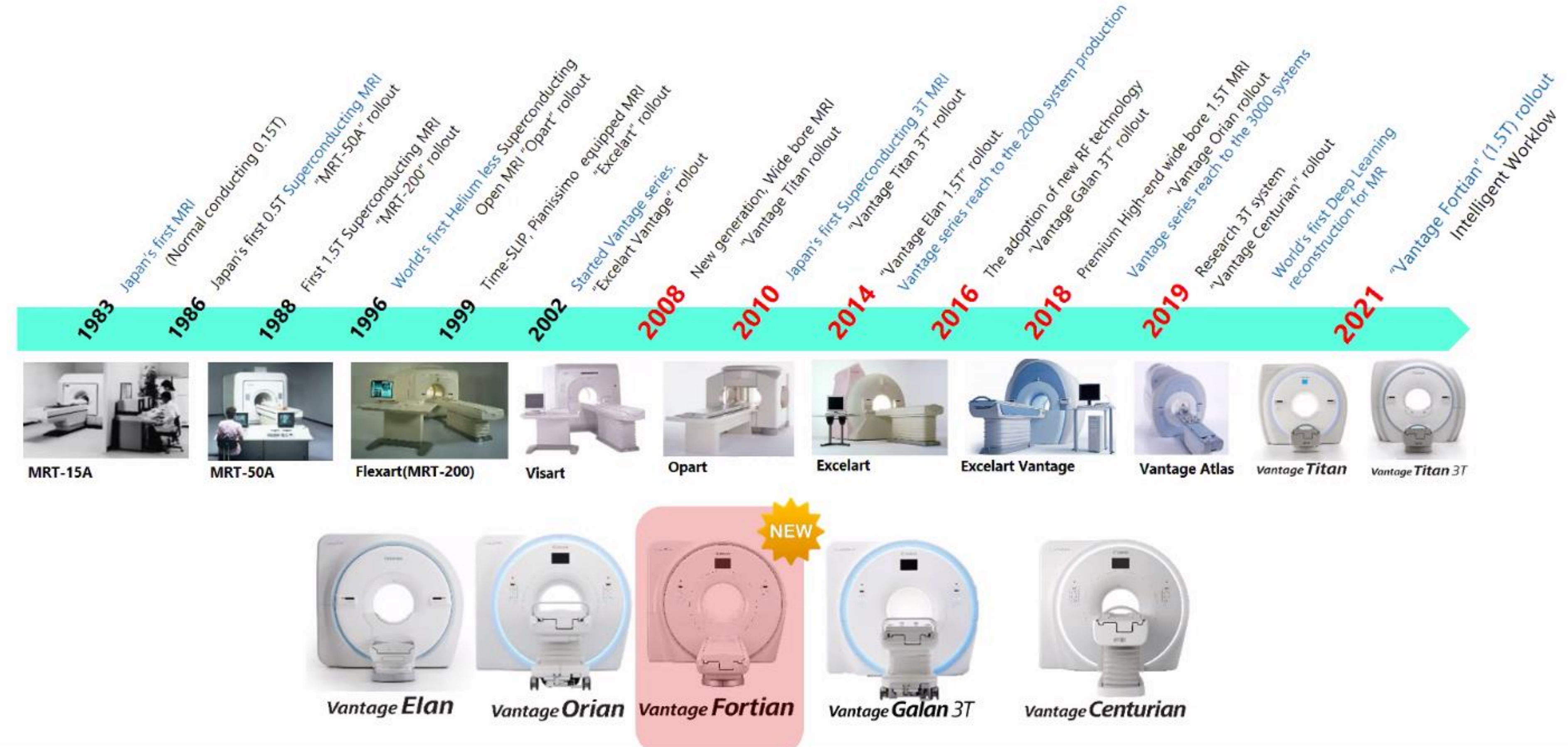
RM SIEMENS MAGNETOM Free Max





CANON (Ex Toshiba)

Canon MR: Cenni di Storia & Portfolio Prodotti



Bobine

Al servizio del paziente e della clinica

Bobine per un elevato COMFORT PAZIENTE & un'elevata CONFIDENZA CLINICA

Bobine Dedicate

Bobine Flessibili

Formazione per l'eccellenza

Bobine

Al servizio del paziente e della clinica

Shape Coils: LEGGERE, FLESSIBILI & VERSATILI

Bobine Shape Coils

RM portatile

https://hyperfine.io/

RM portatile

RM portatile

Specifications

Height: 55" (140cm)

Width: 34" (86cm)

Power: 15A, 110V

Weight: 1,400lbs (630kg)

RM portatile

RM portatile

Formazione per l'eccellenza

Gemelli

RM portatile

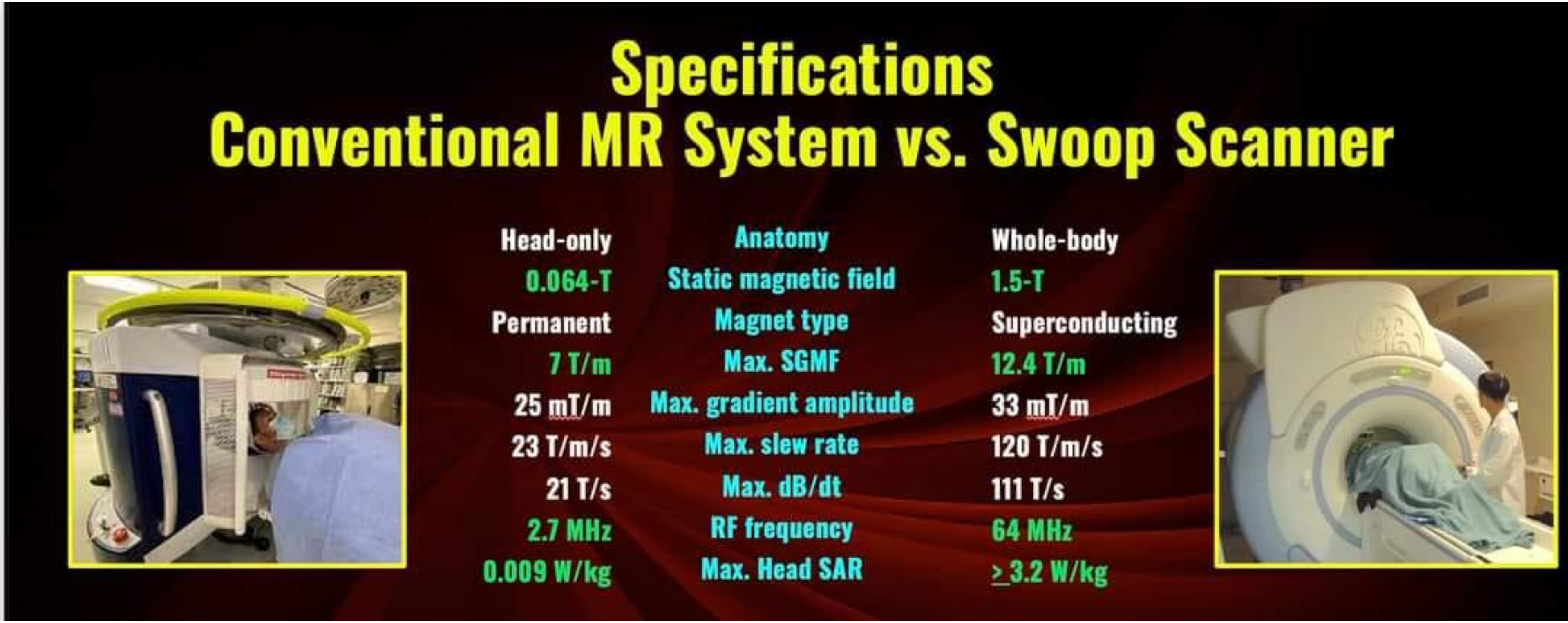
Formazione per l'eccellenza

An RSNA attendee undergoes an MRI brain scan on the expo floor using the Hyperfine Swoop head MRI system. It is self-shields with a low field 0.064 T. It uses a standard wall power outlet and can be wheeled through a standard 34-inch wide door frame. It weighs 1,400 pounds. Imaging sequences include T1, T2, FLAIR, and DWI (with ADC map) and its operational controls are all directed on an iPad interface.

This is the second year the vendor has performed free MRIs on the show floor. The system is safe to operate outside a shielded room and around ferrous objects because of its built in shielding and low power magnet.

#RSNA22 RSNA

RM portatile



Specifications
Conventional MR System vs. Swoop Scanner

Swoop Scanner		Conventional MR System
Head-only	Anatomy	Whole-body
0.064-T	Static magnetic field	1.5-T
Permanent	Magnet type	Superconducting
7 T/m	Max. SGMF	12.4 T/m
25 mT/m	Max. gradient amplitude	33 mT/m
23 T/m/s	Max. slew rate	120 T/m/s
21 T/s	Max. dB/dt	111 T/s
2.7 MHz	RF frequency	64 MHz
0.009 W/kg	Max. Head SAR	≥ 3.2 W/kg

RM 11.7T

Formazione per l'eccellenza

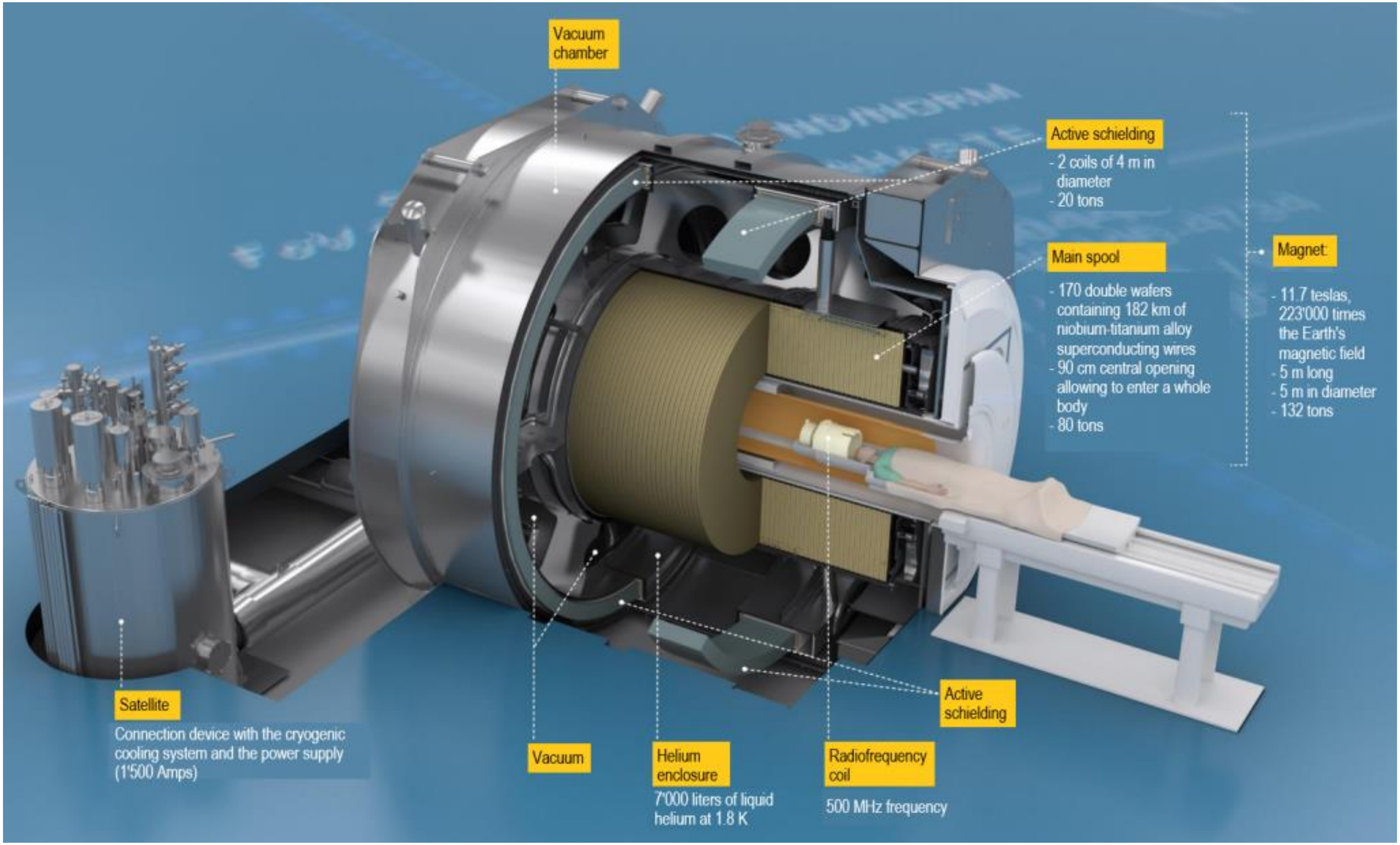
METROlab
Magnetic precision has a name

https://www.metrolab.com/it/gigantic-11-7-t-mri-magnet-iseult-a-discussion-with-lionel-quettier/

RM 11.7T

Metrolab
Magnetic precision has a name

Formazione per l'eccellenza



Metrolab: What is the significance of the 90 cm opening?

Dr. Quettier: The MRI scanner is much more than just a magnet. The larger aperture gives more room for equipment to be positioned inside the bore but situated away from the field of interest: this reduces the risk of interference. For example, we need gradient coils to generate pulsed fields and to measure the Nuclear Magnetic Resonance (NMR). The gradient coils need to be far away from the magnet coils to limit magnetic coupling, which would corrupt the results. Other projects in Korea and the United States, which are also operating at 11.7 T, have a central bore of only 68 cm. The larger bore opens the possibility to image not only the brain but also any other part of the body.

Metrolab
Magnetic precision has a name

Formazione per l'eccellenza

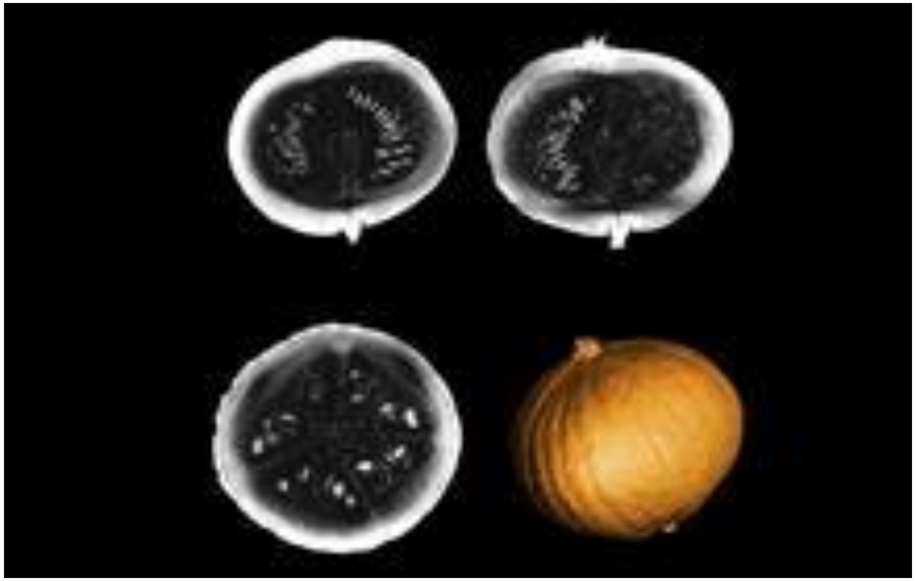
Figure: Front view of the magnet after installation in Saclay, France. © Francis Rhodes/CEA

Metrolab
Magnetic precision has a name

September 2021, the 11.7 Tesla MRI of the Iseult project, the most powerful in the world for human imaging, has just unveiled its first images. They validate the entire process that has enabled, thanks to multiple technological breakthroughs, the transformation of an « outstanding » magnet, delivered in 2017 to the CEA-Paris-Saclay site, into an « imager ». This MRI, designed by CEA engineers and researchers together with Siemens Healthineers, will enable major advances in fundamental research, cognitive sciences and in understanding brain pathologies.

RM 11.7T – LA ZUCCA …

The most powerful MRI scanner in the world delivers its first images!



September 2021

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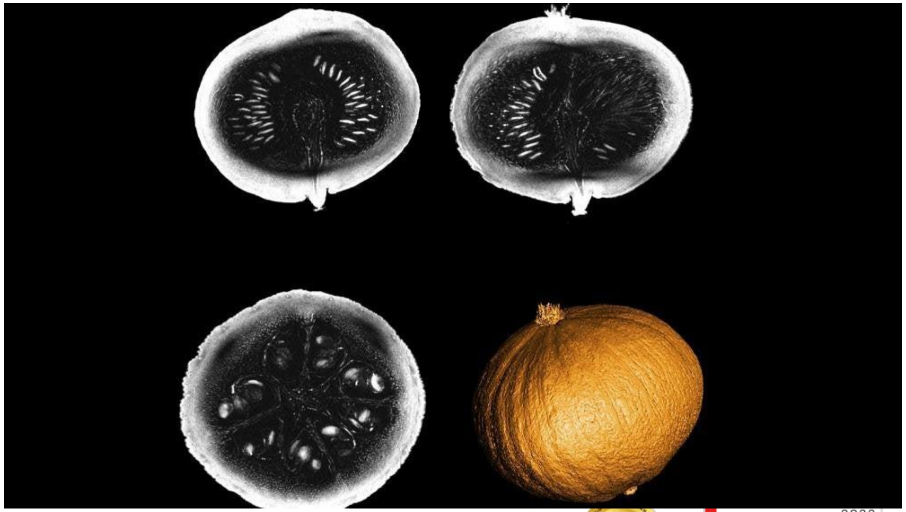
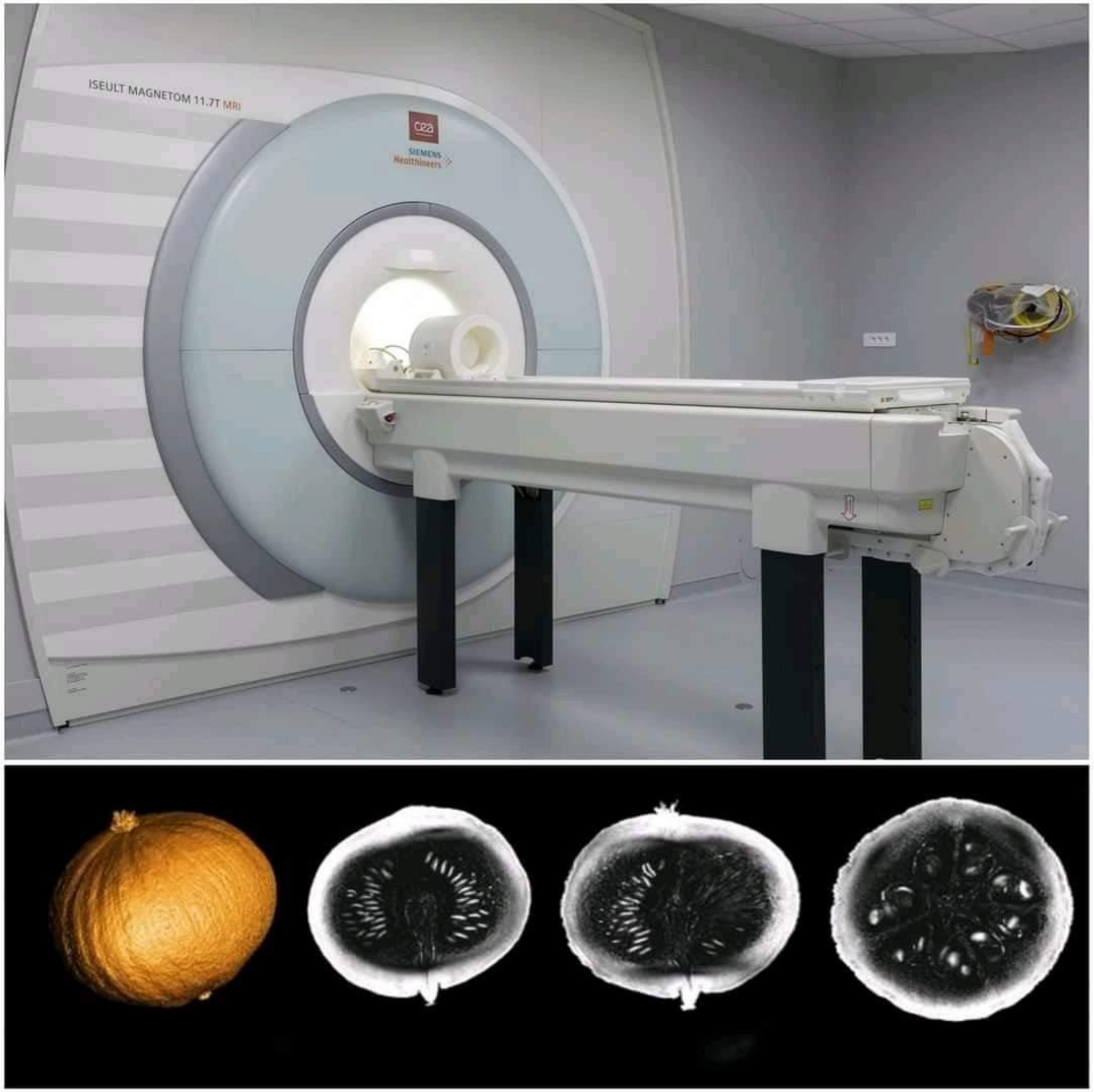
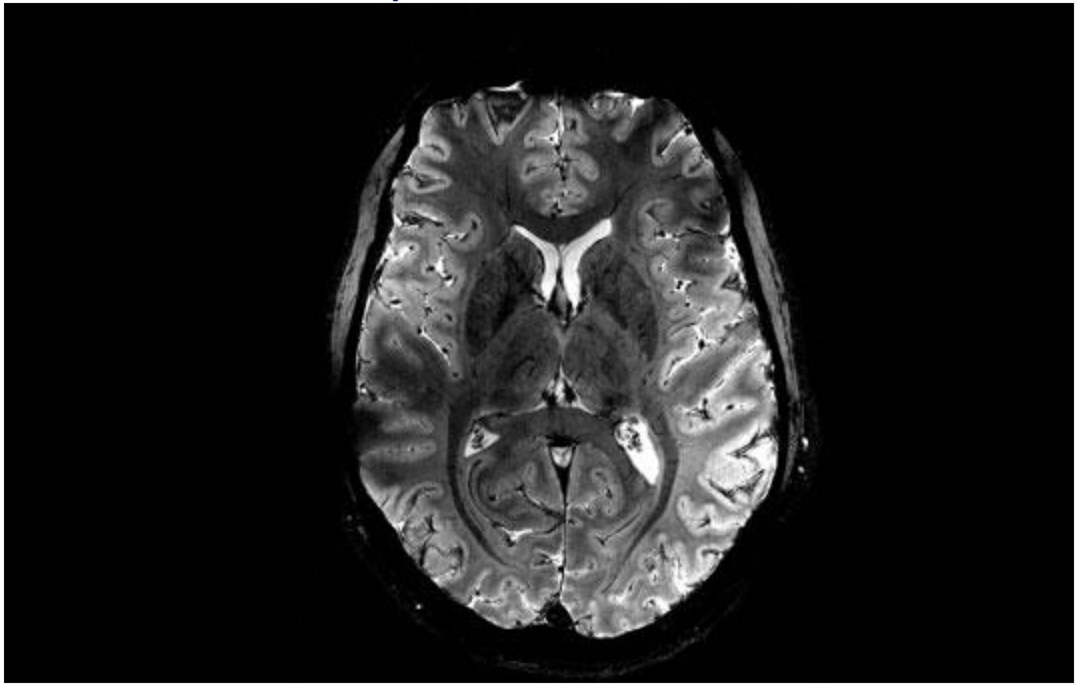
A **pumpkin**: this unusual object was chosen for its multiple textures by CEA engineers and researchers to make the first images with the world's most powerful 11.7 T human whole-body MRI of the Iseult project, installed at NeuroSpin at CEA-Paris-Saclay.

With a resolution of 400 microns in three dimensions, the images of the cucurbit prefigure the prowess that the scientific and technical teams of the CEA and their partners will be able to achieve in order to probe the human brain, for the benefit of fundamental research, cognitive sciences and in understanding brain pathologies. These first acquisitions validate the entire process that has made it possible, thanks to multiple technological breakthroughs, to transform an "outstanding" magnet into an MRI machine.



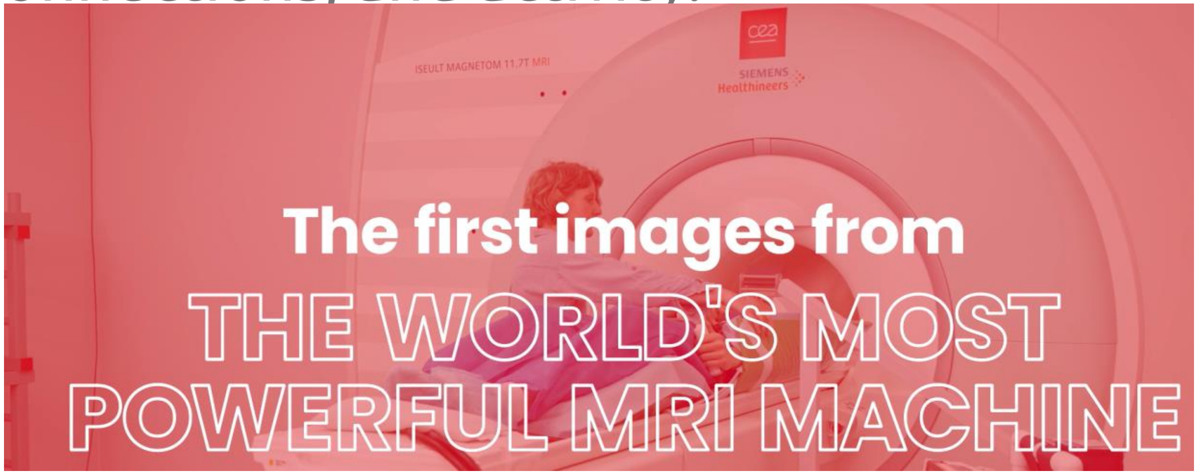

ISEULT MAGNETOM 11.7T MRI
cea
SIEMENS Healthineers

https://www.cea.fr/english/Pages/News/world-premiere-living-brain-imaged-with-unrivaled-clarity-thanks-to-world-most-powerful-MRI-machine.aspx



A world premiere: the living brain imaged with unrivaled clarity thanks to the world's most powerful MRI machine

The CEA is revealing a series of in vivo human brain images acquired with the Iseult MRI machine and its unmatched 11.7 teslas magnetic field strength. This success is the fruit of more than 20 years of R&D as part of the Iseult project, with one pillar goal being to design and build the world's most powerful MRI machine. Its ambition is to study healthy and diseased human brains with an unprecedented resolution, allowing us to discover new details relating to the brain's anatomy, connections, and activity.



RM 11.7T

Aprile 2024

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Magnetic precision has a name

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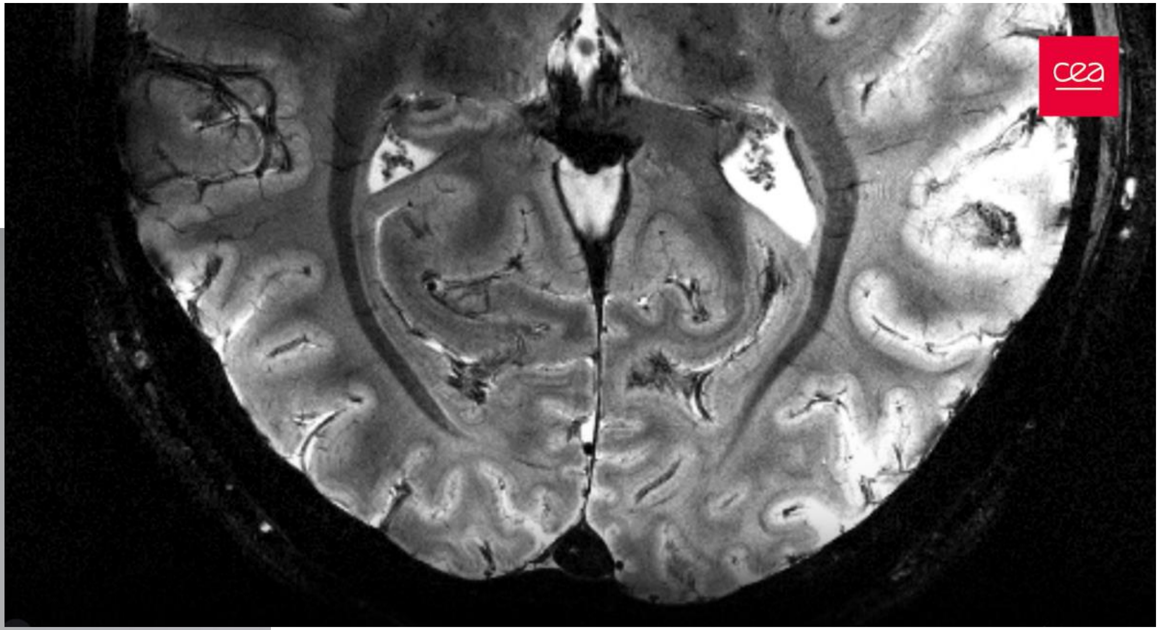
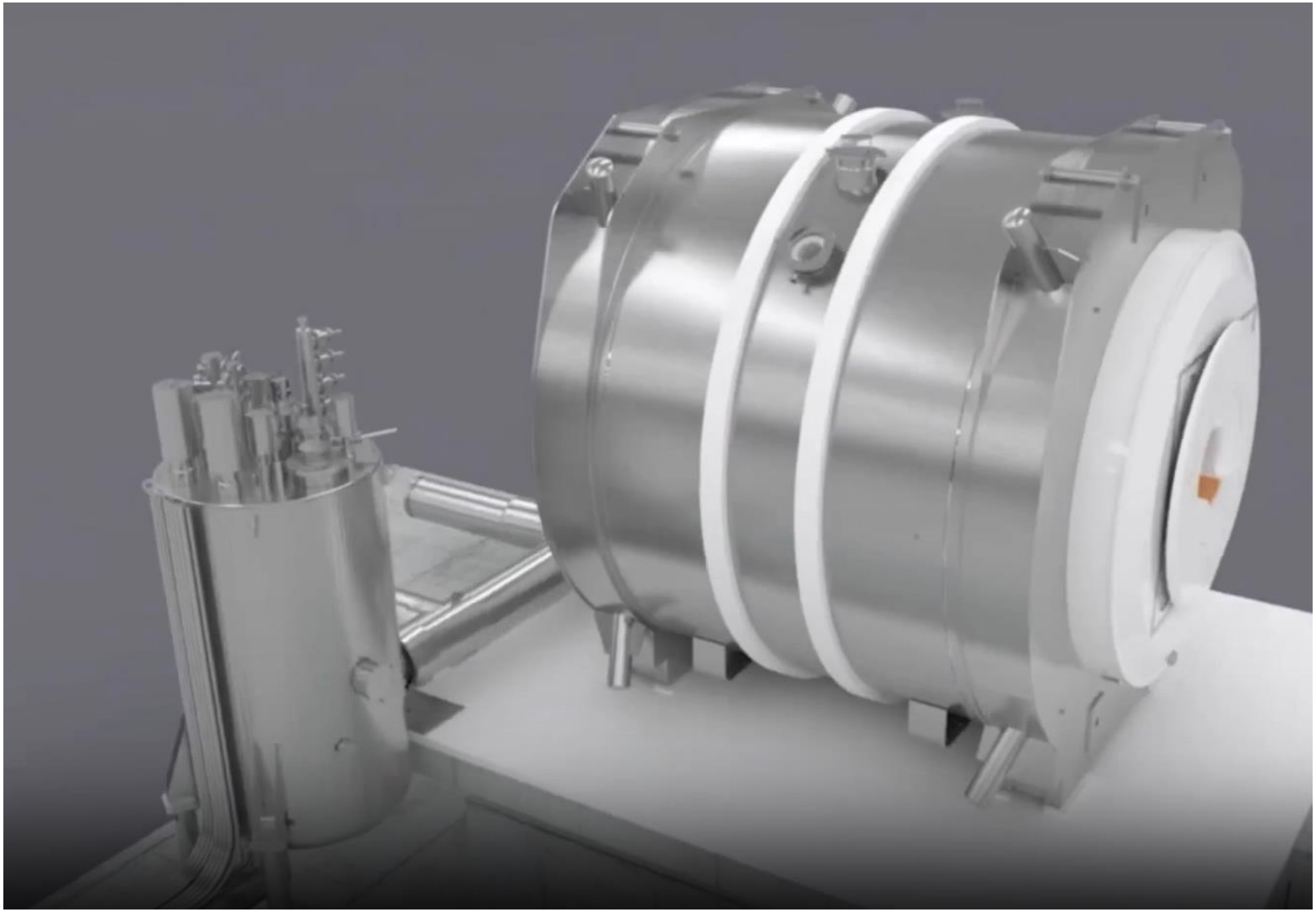


Gemelli

BEST HOSPITALS 2023 Newsweek
1° OSPEDALE IN ITALIA
statista
POLICLINICO UNIVERSITARIO A. GEMELLI



RM 11.7T Aprile 2024

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RM 11.7T

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1,7T MRI

Key figures

- 11,7 teslas (T) magnetic field strength (vs 1.5 and 3 T for conventional MRI machines in hospitals)
- 132 tons, 5 m long and 5 m wide
- 182 km of superconducting wires
- 1 500 amperes running through the coil
- -271.35 °C: the temperature at which the magnet is cooled by using 7 500 litres of liquid helium
- 90 cm of central opening

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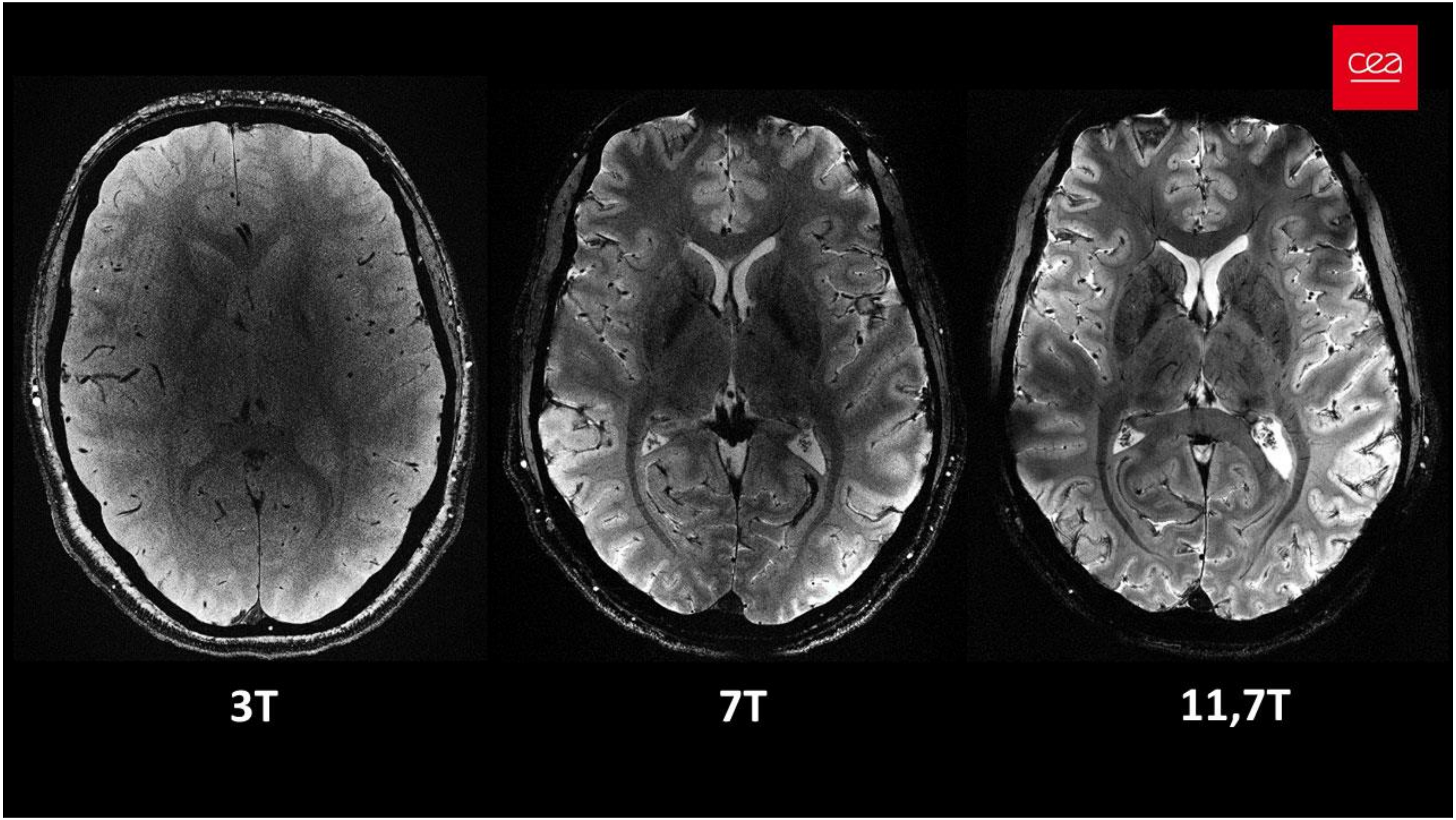
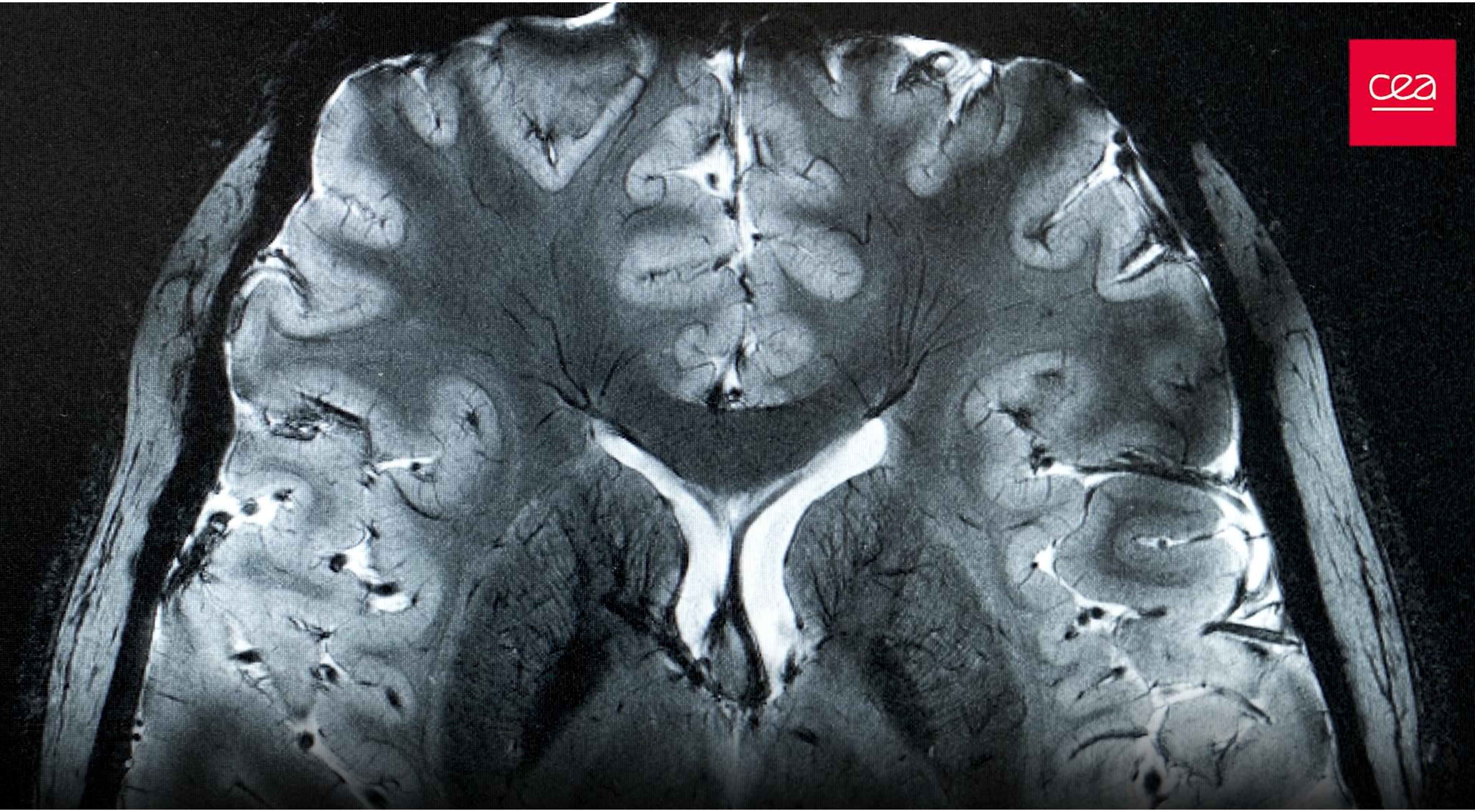


RM 11.7T

Aprile 2024



RM 11.7T Aprile 2024

Metrolab — Magnetic precision has a name

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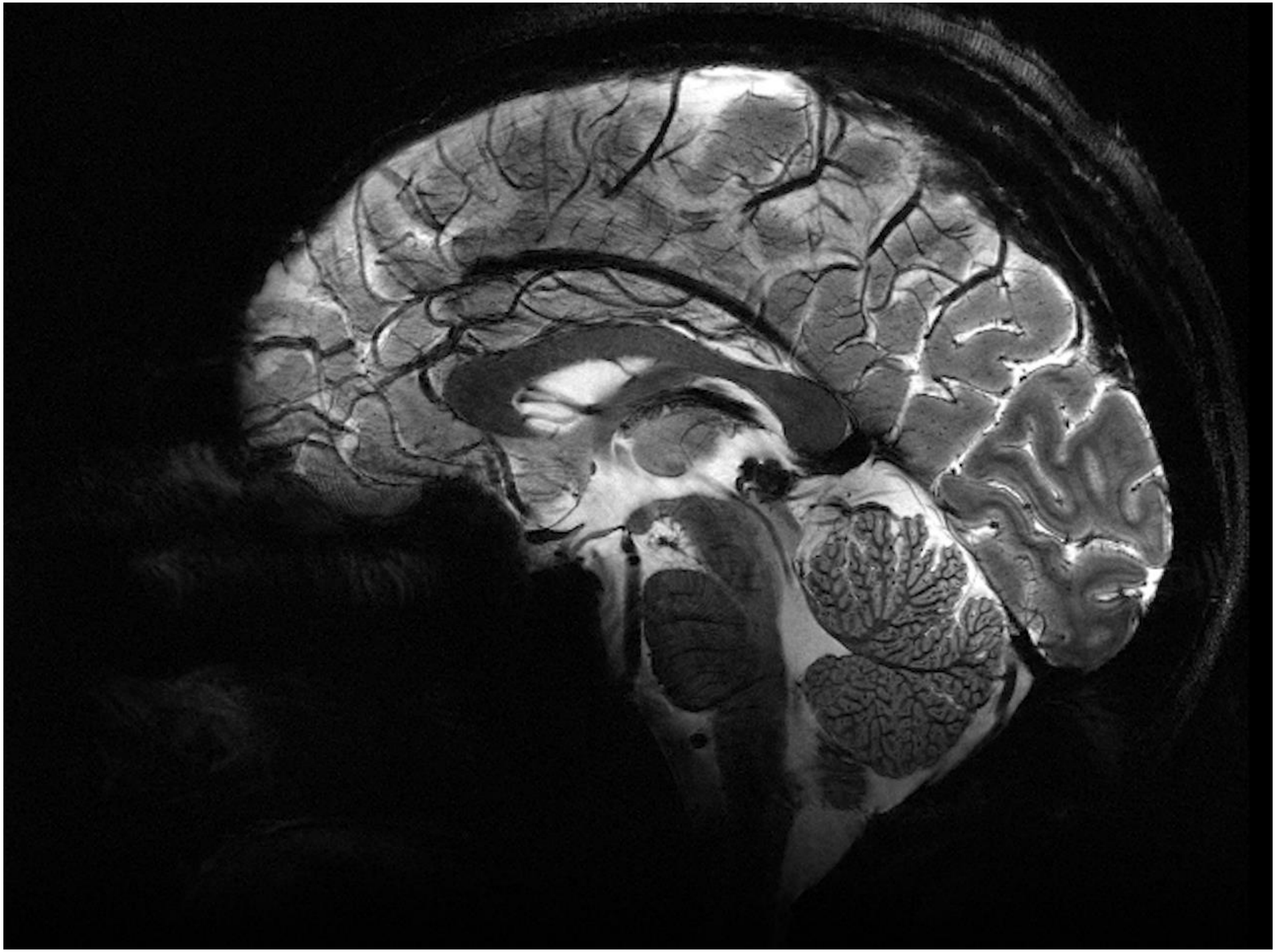

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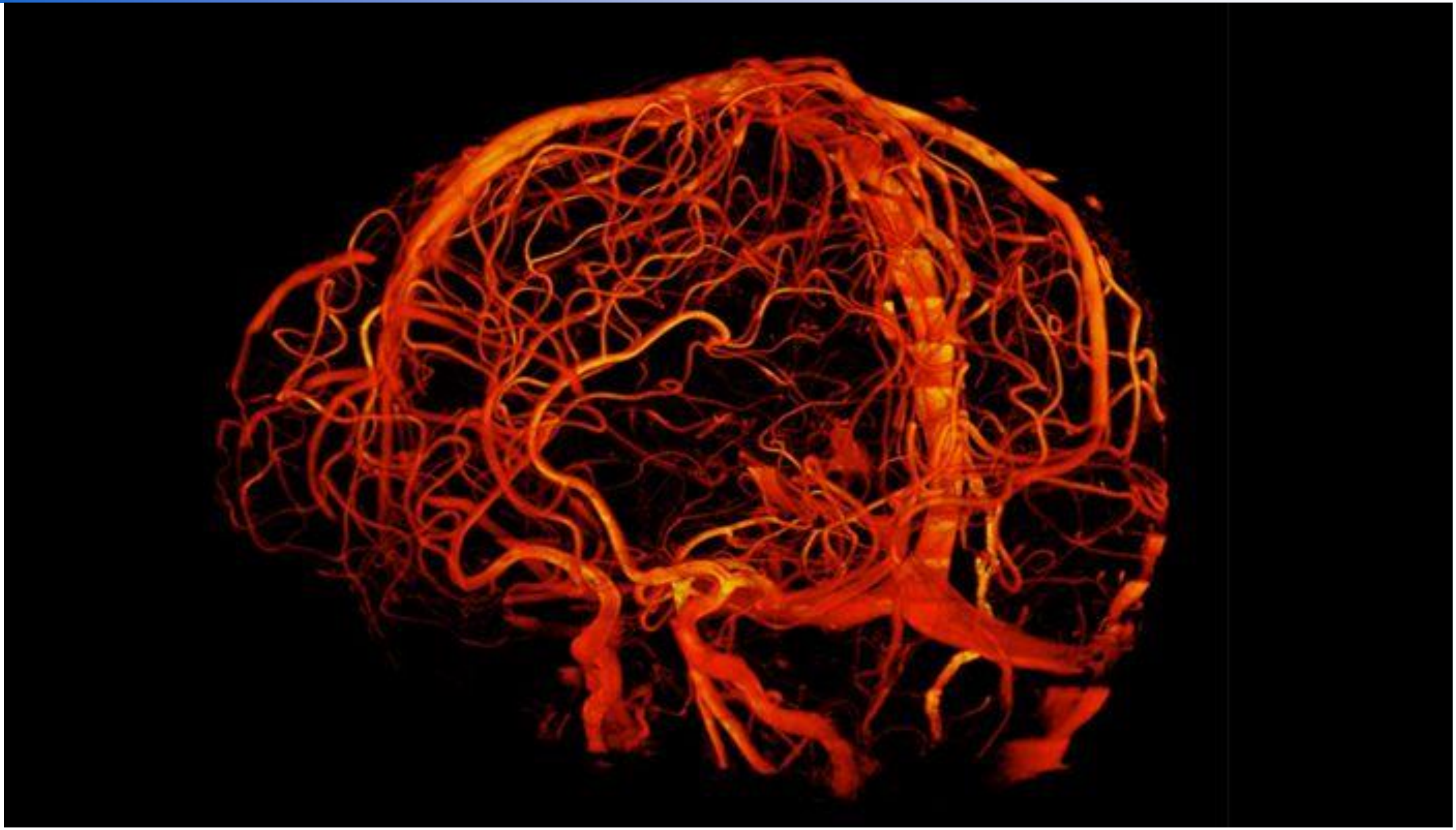
Pratica: RM presente e futuro

https://www.nature.com/articles/d41586-018-07182-7

The amount of heating generated by such machines could be even more problematic. Some researchers have speculated that scanners operating above 14 T could also cause nerve conductance to slow down, stimulate peripheral nerves or damage DNA, although Schepkin says he has seen none of these effects so far in animals, even at 21.1 T. Still, Scheffler thinks that at some point there will be a limit to field strength beyond which we can't go without damaging the body: "I don't think we can go higher and higher forever."

Pratica: RM 7T

Formazione per l'eccellenza

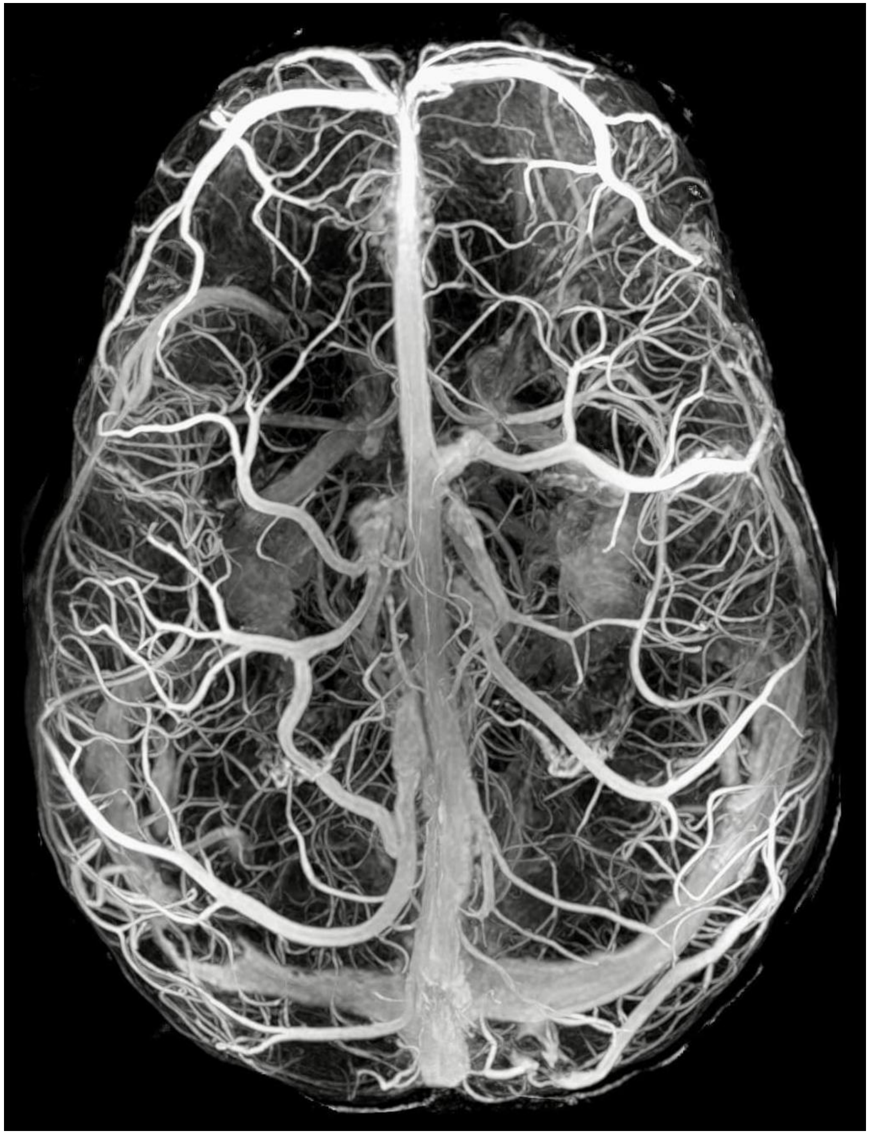


Cerebral blood vessels glow orange in this picture, generated by a 7-tesla magnetic resonance imaging scanner at The University of Queensland in Australia. Credit: Centre for Advanced Imaging, The University of Queensland

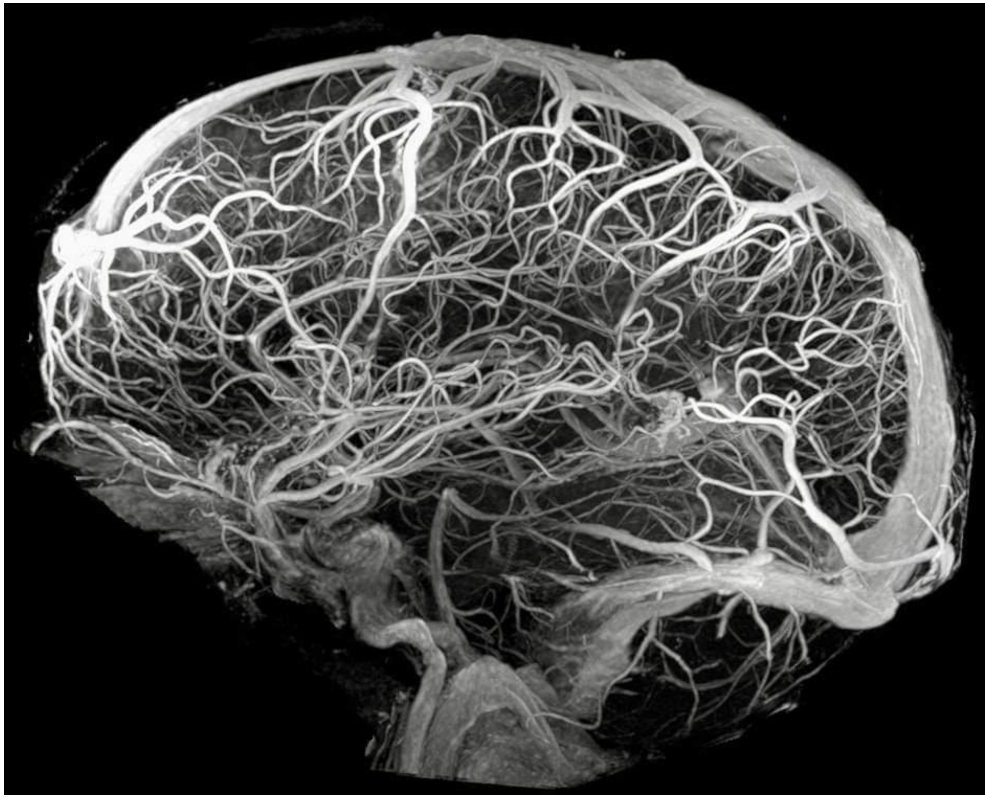
CE-MRV 7T

Contrast-Enhanced Magnetic Resonance Venography (CE-MRV) of the brain at 7T, Siemens MAGNETOM Terra.

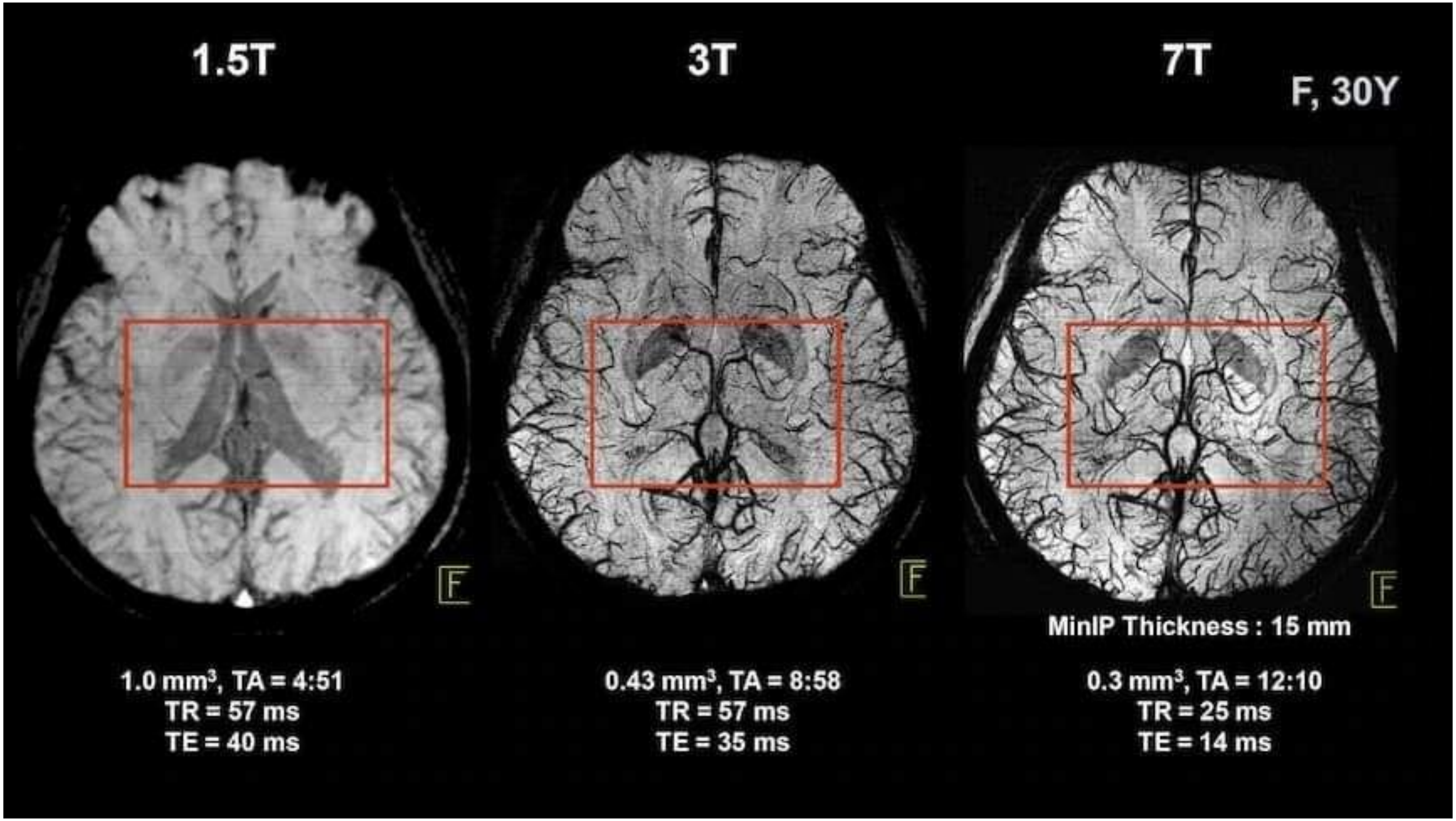
300 micron isotropic resolution!



CE-MRV 7T



SWI


1.5T
3T
7T
F, 30Y
MinIP Thickness : 15 mm
1.0 mm³, TA = 4:51
TR = 57 ms
TE = 40 ms
0.43 mm³, TA = 8:58
TR = 57 ms
TE = 35 ms
0.3 mm³, TA = 12:10
TR = 25 ms
TE = 14 ms

UNITED IMAGING

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Shanghai United Imaging Healthcare Co., Ltd.

Formazione per l'eccellenza

UNITED IMAGING

5.0T MRI

UNITED IMAGING 3.0T

uMR Omega

uMR 790

uMR 780

uMR 770

UNITED IMAGING

UNITED IMAGING 1.5T

uMR 680

uMR 670

uMR 588

uMR 580

uMR 570

UNITED IMAGING

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https://www.bruker.com/it/products-and-solutions/preclinical-imaging/mri/ultra-high-field-magnetic-resonance-imaging.html

BRUKER

Ultra High-Field Magnetic Resonance Imaging

Overview

Currently, most clinical MRI systems operate at moderate field strengths of 1.5 Tesla and 3 Tesla. For small animal imaging, resolutions need to be significantly increased in order to visualize similar structures as in humans. Since the sensitivity increases with the field strength, field strengths of 7 Tesla and 9.4 Tesla are therefore standard in the preclinical field. Beyond this, preclinical UHF systems ranging from 11.7 Tesla to 21 Tesla address specific applications, which demand the highest sensitivity. Even the most demanding applications become feasible when ultra high field strengths are combined with optimal coil setups, such as receive-only arrays, the sensitivity of which increases super-linearly with magnetic field strength, or MRI CryoProbes, which provide an even additional sensitivity boost.

BRUKER

The advantages of UHF MRI go beyond the sensitivity gain itself. UHF MRI facilitates a range of imaging methods and applications. Increased chemical shift, increased Blood Oxygenation Level Dependent (BOLD) contrast, altered relaxation times, and increased susceptibility effects make it predestinated for several MRI methods such as MR Spectroscopy (MRS), BOLD Functional MRI (fMRI), Chemical Exchange Saturation Transfer (CEST), Susceptibility weighted Imaging (SWI), and Quantitative Susceptibility Mapping (QSM). Taken together UHF MRI can open up completely new avenues in the understanding of biological processes.

BioSpec 152/11

BioSpec 117/22

BioSpec 117/16

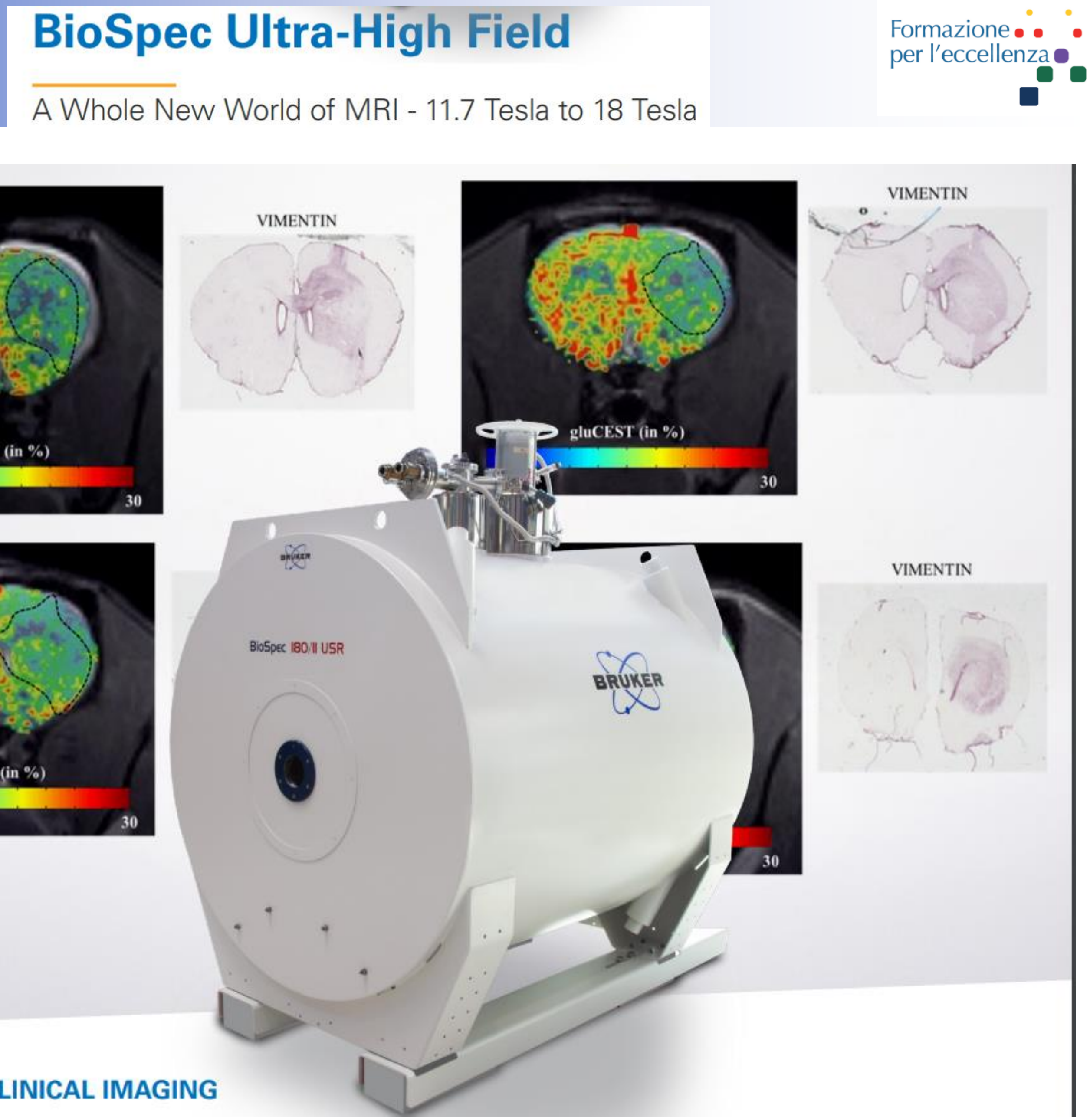
BRUKER

Bruker 9.4T MRI animal scanner

9.4T MRI technical specifications

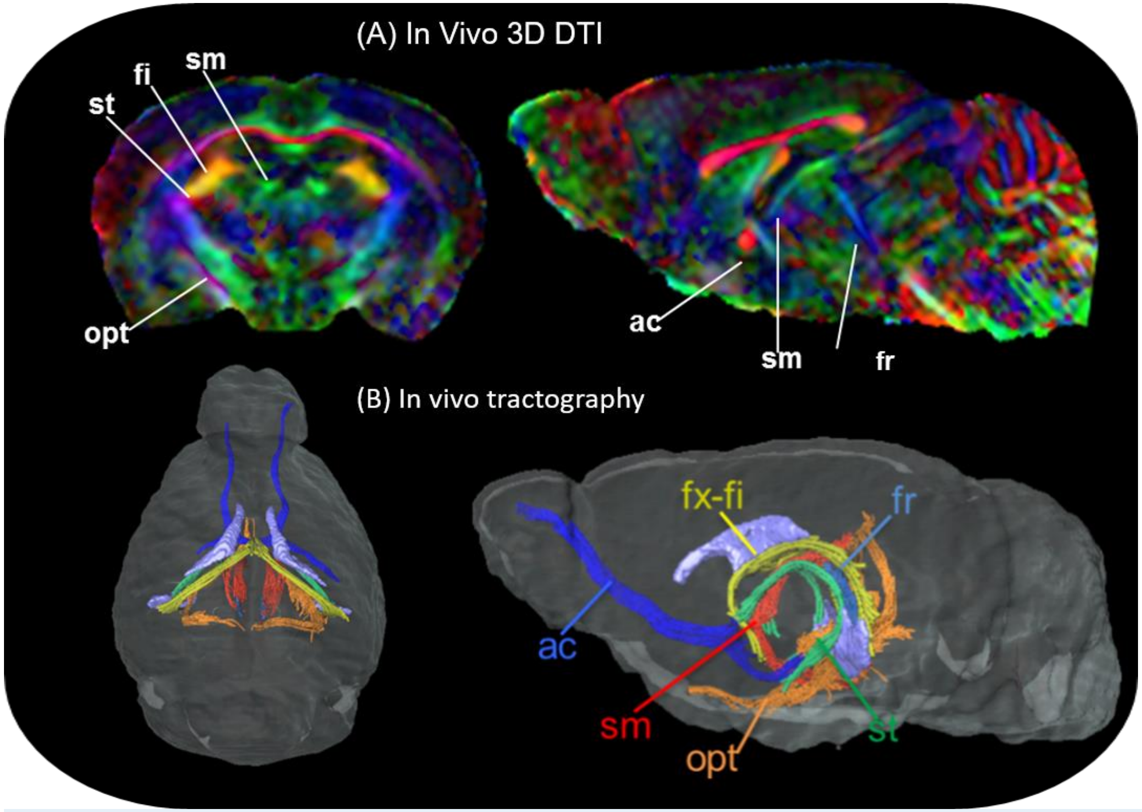
- Dual gradient coils
- Mouse and rat head array and surface coils for brain imaging
- Mouse and rat cardiac array coils for heart imaging
- Array coil for marmoset brain imaging
- 40mm 19F/1H dual channel fluorine imaging coil for mouse or samples
- 35mm volume coil for high-resolution mouse head/body or sample imaging
- 72mm volume coil for rat body or sample imaging
- 90mm and 86mm radio frequency transmit and receive coils
- Suitable isoflurane anaesthesia and animal monitoring system and heater to maintain animal temperature during the scan
- Full range of beds to cater for most species and samples

UHF MRI


BioSpec Ultra-High Field
A Whole New World of MRI - 11.7 Tesla to 18 Tesla
VIMENTIN
VIMENTIN
VIMENTIN
gluCEST (in %)
0
30
gluCEST (in %)
30
gluCEST (in %)
0
30
30
BioSpec 180/II USR
BRUKER
PRECLINICAL IMAGING

UHF MRI

Cardiac FLASH MRI provides superior spatial and temporal resolution with visualization of all four heart chambers and aorta with 9 frames per heartbeat



The anterior commissure (ac), optical track (opt), fornix-fimbria (fx-fi), stria medullaris (sm), stria terminalis (st), and fasciculus retroflexus (fr) can be seen in DTI Courtesy: P. van Zijl, Kennedy Krieger Institute and Johns Hopkins University, Baltimore, USA