SET UP FOR GRADIENTS FIELD MEASUREMENT IN MRI

R. Lodato[1], S. Mancini[1], G. M. Contessa[2],V. Brugaletta[2], D. Andreuccetti[3], N.Zoppetti[3] and P. Rossi[2]

[1]ENEA, Rome, Italy,
[2]INAIL/ex ISPESL, Rome, Italy,
[3]Institute for Applied Physics "N. Carrara", CNR, Florence, Italy

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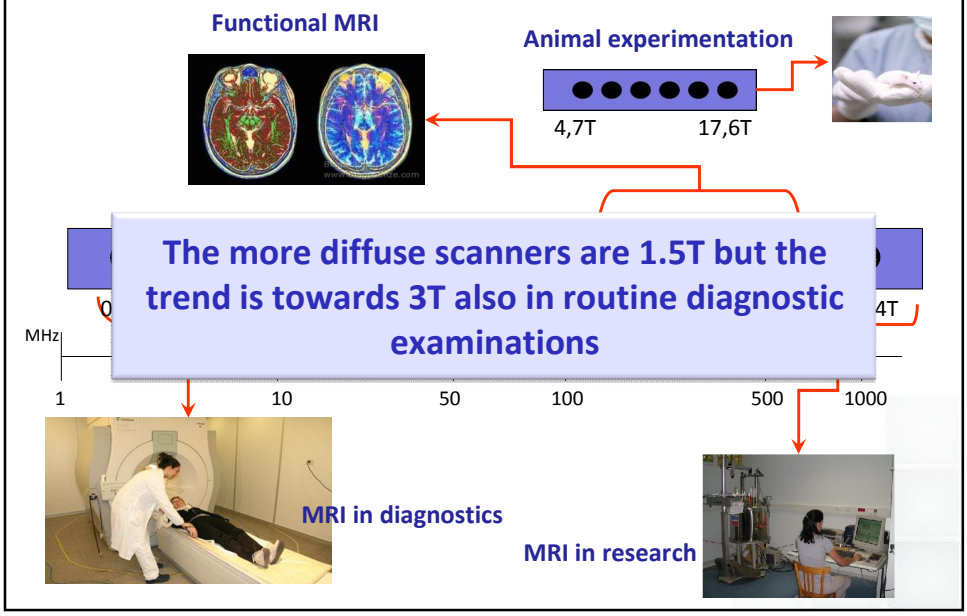
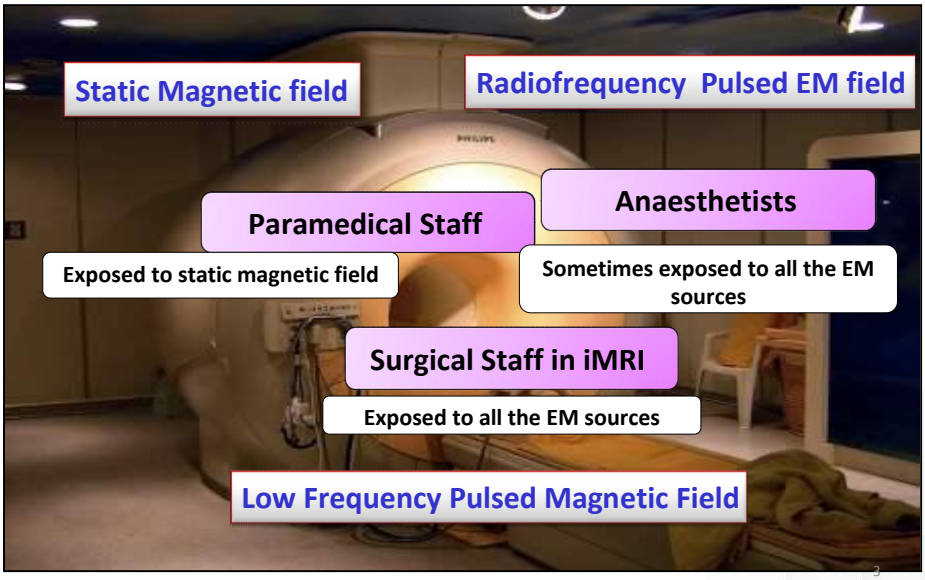
MRI Systems and Application



Exposure scenario in MRI environment



Project: MRI Occupational Exposure in Italy

S. Giovanni Calibita Hospital

Philips Achieva Nova 1,5T (whole body)

No interventional MRI

No staff exposure during scans

IRCCS - Santa Lucia

Siemens Magnetom Allegra 3T (head scanner)

No interventional MRI

No staff exposure during scans

Children's Hospital Bambino Gesù

Philips Achieva Nova 1,5T (whole body)

No interventional MRI

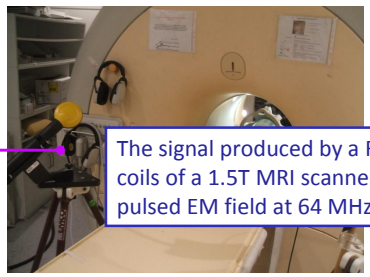
Anesthetist inside MRI room during controlled apneas exams

Radiofrequency field measurements (1/2)

Measurement Point

- 70 cm from the bore plane
- 60 cm from the couch axis
- 125 cm from the ground

Anaesthesia Equipment



The signal produced by a RF coils of a 1.5T MRI scanner is a pulsed EM field at 64 MHz

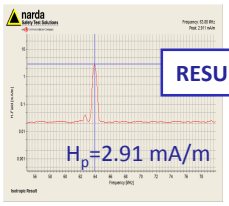
Spectrum Analyzer
Narda, SRM 3000
Bandwidth [100 kHz-3 GHz]

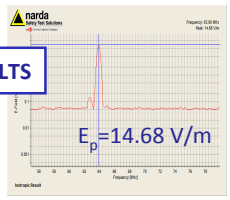
E-field Antenna
Bandwidth [100 kHz-300 MHz]

H-field Antenna
Bandwidth [100 kHz-300 MHz]

Radiofrequency field measurements (2/2)

The analyzer was set up in **max-hold modality** and the three components of the field were recorded





RESULTS

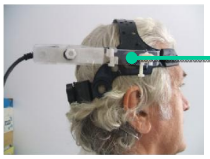
For frequencies exceeding 10 MHz it is suggested that the field strength does not exceed **32 times** the field strength exposure levels given in the table.

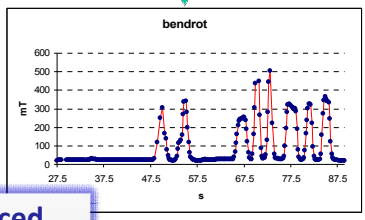
ICNIRP 98 Reference Levels

Frequency	*E-field strenght*	*H-field strenght*	*Eq. Plane wave power Density*
10-400 MHz	61 V/m	160 mA/m	10 W/m^2

Radiofrequency occupational exposure is not critical

Static Magnetic Field Measurement





3 axis Hall Magnetometer
Narda, Metrolab THM1176
Bandwidth [DC ÷ 1kHz]

The subject experienced a time varying magnetic field with a spectrum below 1Hz

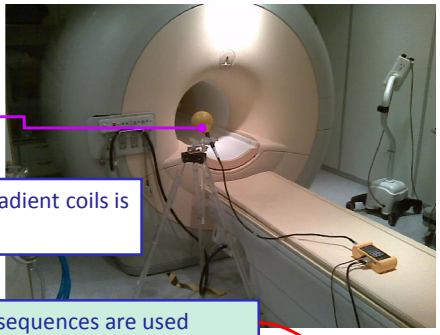
Numerical Dosimetry

The volunteer is bending forward several times, rotating his head to look into the bore.

Gradient field Measurements

Measurement Point

- 70 cm from the bore plane
- 60 cm from the couch axis
- 125 cm from the ground



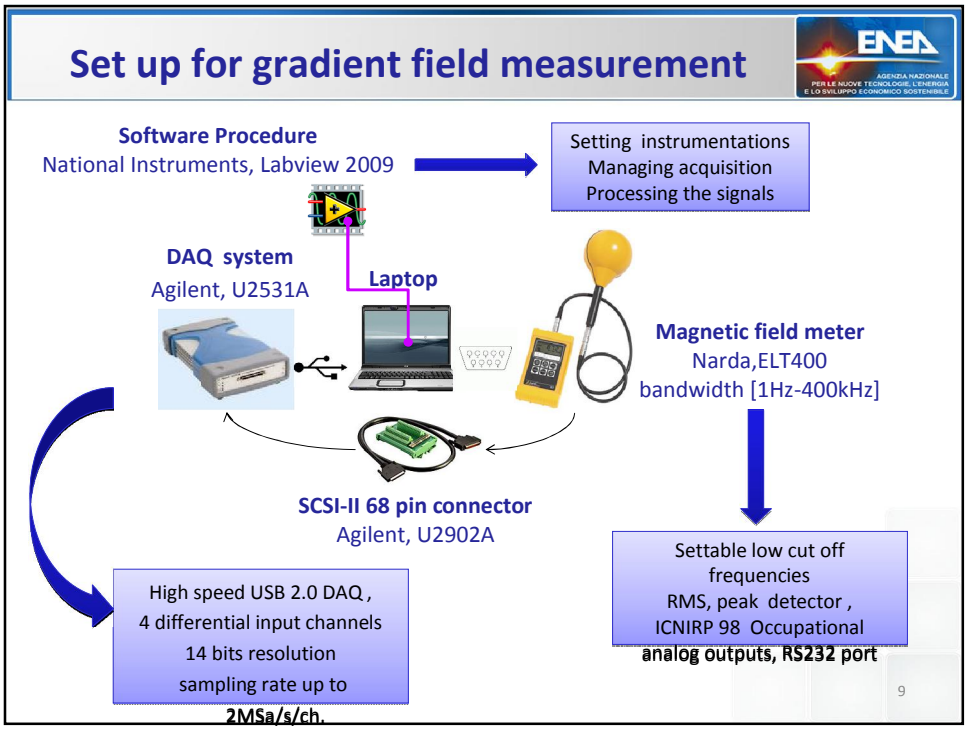
The magnetic field produced by a gradient coils is pulsed complex signal.

Several clinical sequences are used

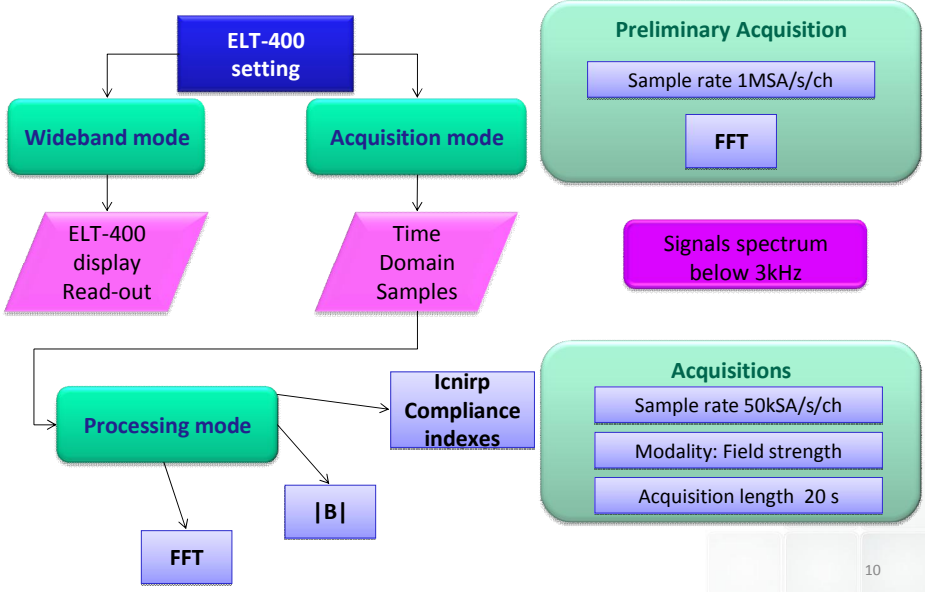
Different sequences waveforms = Different effects

The exposure assessment is a very critical issue

Set up for gradient field measurement



Measurement Procedure

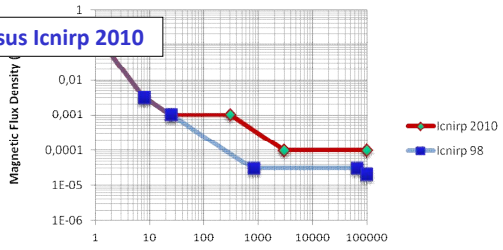


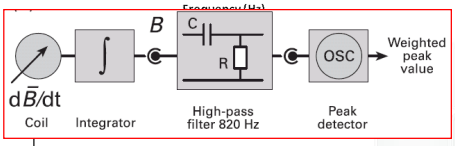
Weighted Peak Method

To assess exposure is to weight the external magnetic fields, with a filter function which is related to the basic restriction or reference level

SIMULTANEOUS EXPOSURE TO MULTIPLE FREQUENCY FIELDS

Icnirp 1998 versus Icnirp 2010

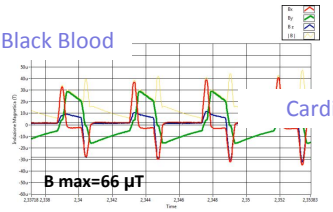




$$WP = \left| \sum_i \frac{A_i}{EL_i} \cos(2\pi f_i t + \theta_i + \varphi_i) \right| \leq 1$$

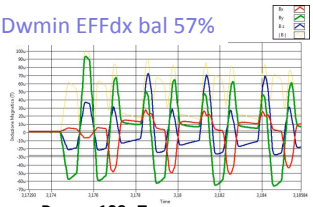
Results (1/2)

Cardiological Black Blood



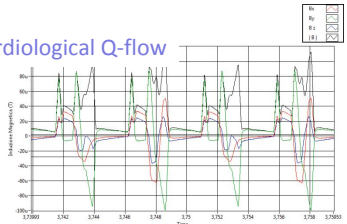
B max=66 μT

Cardiologica Dwmin EFFdx bal 57%



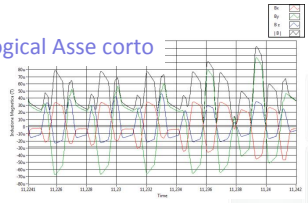
B max=109μT

Cardiological Q-flow



B max=116 μT

Cardiological Asse corto



B max=112 μT

Results (2/2)

SEQUENCE	B (T)	WP03 workers	WP03 pubblic	WP10 workers	WP10 pubblic
DWmin EPI axial	1.10E-04	2.407	11.871	0.409	1.549
DWmin EPI coronal	6.53E-05	1.125	5.555	0.210	0.786
Dwmin EPI sagittal	1.02E-04	1.260	6.231	0.234	0.902
DTI 6 directions	3.31E-06	0.039	0.194	0.006	0.025
Double Echo DPT2	1.10E-06	0.017	0.085	0.003	0.013
Cardiological Black Blood	6.40E-05	0.906	4.499	0.143	0.570
Cardiological EFF dx	1.10E-04	1.575	7.849	0.212	0.860
Cardiological Q-flow	1.18E-04	1.555	7.720	0.235	0.915
Cardiological “short axis”	1.13E-04	1.454	7.263	0.191	0.789

Conclusions

- Most gradient sequences are not compliant with Icnirp 1998

- The same sequences processed according Icnirp 2010 standard don’t exceed