

EMF exposure assessment through an online application: time and frequency domain data acquisition and processing

m.comelli@ifac.cnr.it

M. Comelli, N. Zoppetti

Institute of Applied Physics "Nello Carrara" (Italian National Research Council)

BRIC: 2017-2022

A collaborative research call

- Entrusted by INAIL (National Institute for Insurance against Accidents at Work)
- to CNR-IFAC ("Nello Carrara" Institute for Applied Physics of the Italian National Research Council)
- Italian National Institute of Health (ISS)
- "Scientific Hospitalization and Care Institute" Policlinico San Matteo
- Local Health Authority of Tuscany

INAIL

ISTITUTO NAZIONALE PER L'ASSICURAZIONE
CONTRO GLI INFORTUNI SUL LAVORO



BRIC: 2017-2022

A collaborative research call: 3° started in June 2023

Risk assessment and management deriving from exposure to new electromagnetic field sources for the protection of workers wearing active wearable and implantable medical devices

https://webnir.eu

The web portal

The screenshot shows the WebNIR web portal. At the top, there is a header with several logos: **IRFAC**, **SSI Azienda USL Toscana centro** (Servizio Sanitario della Toscana), **OSPITAL DI S. MARCO PAVIA**, **ISTITUTO SUPERIORE DI SANITA'**, **ARPALAZIO** (Agenzia Regionale per la Protezione dell'Ambiente della Toscana), **WebNIR** (Strumenti Web per la valutazione dell'esposizione occupazionale alle Radiazioni Non Ionizzanti), and **INAIL** (Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro). Below the logos, a blue banner contains the text: "Sito web sviluppato nell'ambito dei progetti INAIL ex bando Bric-2016 Strumenti web di ausilio alla valutazione del rischio da esposizione a campi elettromagnetici - anche in riferimento ai portatori di dispositivi medici impiantabili attivi - e a radiazioni ottiche artificiali e ex bando Bric-2019 Sviluppo di strumenti e metodi per la valutazione e la gestione del rischio derivante da esposizione a campi elettromagnetici per la tutela dei lavoratori portatori di dispositivi medici indossabili ed impiantabili". Below the banner, there is a navigation bar with "Ti trovi in: >Home" and a "Login" button with a green arrow. The main content area is divided into three columns: **Area CEM** (Campi Elettromagnetici), **Area DMIA** (Dispositivi Medici Impiantabili Attivi), and **Area ROA** (Radiazioni Ottiche Artificiali).

Ti trovi in: >Home

Login

Area CEM

Campi Elettromagnetici

Area DMIA

Dispositivi Medici Impiantabili Attivi

Area ROA

Radiazioni Ottiche Artificiali

Exposing different resources:

- Web tools
- Documents
- Procedures

<https://webnir.eu>

The web portal

3 main sections:

- Electromagnetic fields
- Artificial optical radiation
- Active implantable medical devices

<https://webnir.eu>

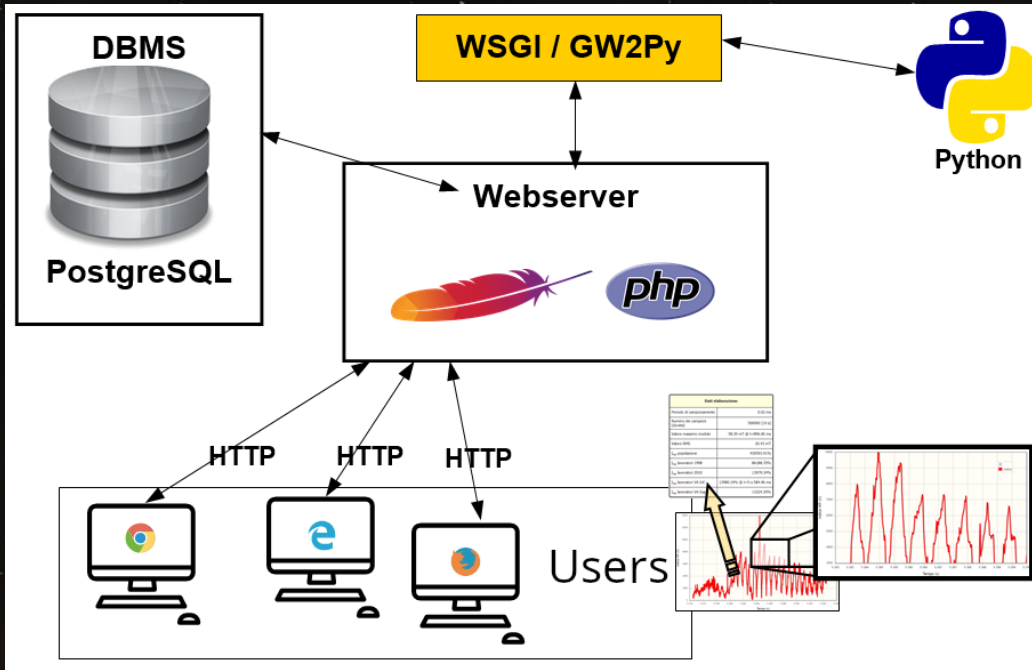
The web portal

Several EMF subsections:

- General aspects (regulatory limits...)
- Calculation of the distance of respect
- Characterization of sources in the external environment
- Applications to support reduction to compliance
- Processing data files from exposure measurements
- ...

<https://webnir.eu>

How does it work?



- **Web interface:** HTML, Javascript, jQuery
- **Server side:** PHP, Python
- **Gw2Py:** POST data to server, get data from server
- **DBMS:** PostgreSQL
- **JSON** as a standard data exchange format

<https://webnir.eu>

What shall we see?

- Consultation and comparison of regulatory limits
- Interpolation of index measurements and calculation of the distance of respect with determination of uncertainty
- Processing data files from exposure measurements
- Case study: assessment of the exposure to gradient magnetic fields generated by MRI tomographs

{json}

EMF web tools

General aspects: Consultation and comparison of regulatory limits

Elenco norme | Confronto norme | Filtro norme | Istruzioni

► ICNIRP GUIDELINES 1994 (STATIC MAGNETIC FIELDS)

► ICNIRP GUIDELINES 1998 (EMF UP TO 300 GHZ)

▼ ICNIRP GUIDELINES 2009 (STATIC MAGNETIC FIELDS)

ICNIRP. Guidelines on limits of exposure to static magnetic fields. Health Physics, Vol.96, N.4, April 2009, pp.504-514.

Scarica PDF: [\[INT\]](#) [\[EXT\]](#)

Nome completo

Linee Guida ICNIRP 2009 - Limiti di esposizione per il campo magnetico statico Dettagli

Nome breve	ICNIRP-2009 B-Stat
Tipo	Limiti di esposizione
Grandezza fisica	Induzione magnetica
Metrica	Campo statico o valore in continua
Target	Popolazione e lavoratori
Effetto	Indifferenziato
Livello	Indifferenziato
Localizzazione	Esposizione a corpo intero
Frequenza minima	0 Hz
Frequenza massima	0 Hz
Documento di riferimento	ICNIRP Guidelines 2009 (Static magnetic fields)

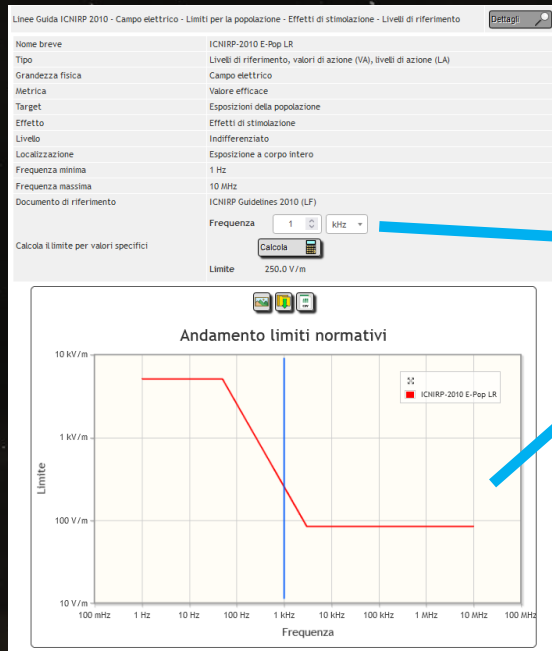
Limitazione	Valore
Esposizione occupazionale, piccolo spaziale nella testa o nel tronco	2 T
Esposizione occupazionale, applicazioni specifiche in ambiente controllato dove vengono implementate pratiche di lavoro appropriate per controllare gli effetti indotti dal movimento, piccolo spaziale	8 T
Esposizione occupazionale, piccolo spaziale per esposizione dei soli arti	8 T
Esposizione della popolazione, piccolo spaziale in qualunque parte del corpo	400 mT
Prevenzione dei potenziali effetti collaterali indiretti conseguenti all'esposizione di persone con dispositivi medici elettronici impiantati e con impianti contenenti materiali ferromagnetici, e dei pericoli derivanti da oggetti metallici volanti: possono essere opportuni livelli massimi molto più bassi, fino a	500 μ T

- Limits are stored in a Database
- One ICNIRP guideline (or other document) displayed in a tab
- Fixed limits displayed in a table



EMF web tools

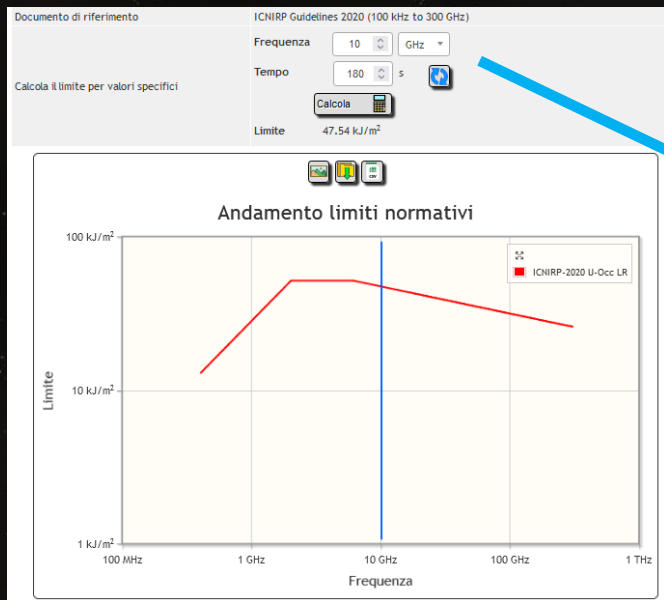
General aspects: Consultation and comparison of regulatory limits



- Limits are stored in a Database
- One ICNIRP guideline (or other document) displayed in a tab
- User can calculate limit depending on frequency
- Plot in function of frequency

EMF web tools

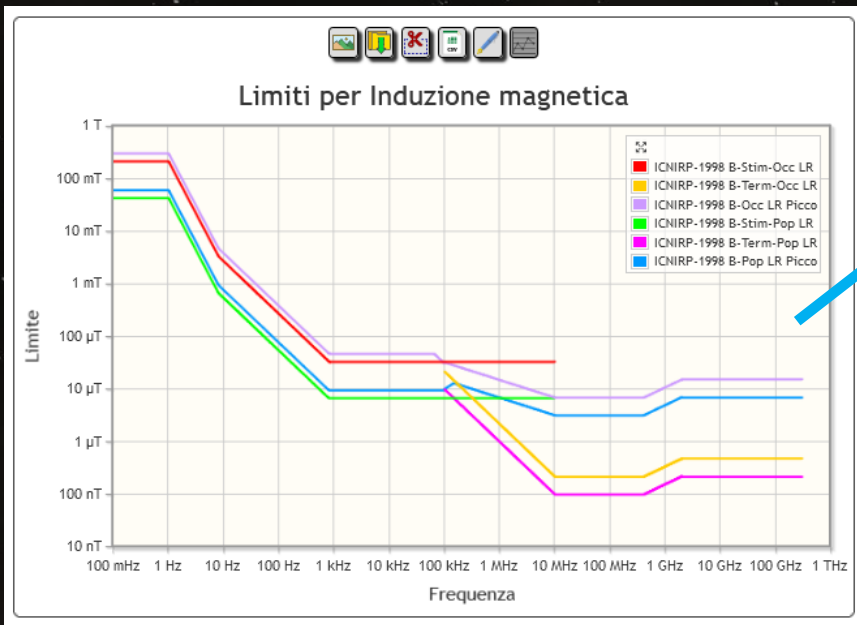
General aspects: Consultation and comparison of regulatory limits



- Limits are stored in a Database
- One ICNIRP guideline (or other document) displayed in a tab
- In ICNIRP guidelines 2020 limits depend both on time interval AND frequency value

EMF web tools

General aspects: Consultation and comparison of regulatory limits



Comparison of limits:

- User can select a set of limits to compare
- Plot all of them (one physical quantity per graph)

EMF web tools

Interpolation of index measurements and calculation of the distance of respect with determination of uncertainty

Presentazione **Inserimento dati** Risultati Istruzioni

Scegliere il file dati e inserire i dati richiesti

File dati lista_5_01.txt

Il file selezionato contiene dati disposti su 5 colonne.

☒ Indici su base percentuale
☐ Indici su base unitaria

Unità di misura per la posizione (nel file-dati)

Errore assoluto sulla posizione

Errore assoluto sull'indice

Errore relativo sull'indice %

☒ Grafico con asse delle ordinate lineare
☐ Grafico con asse delle ordinate logaritmico

1) Select a text file:

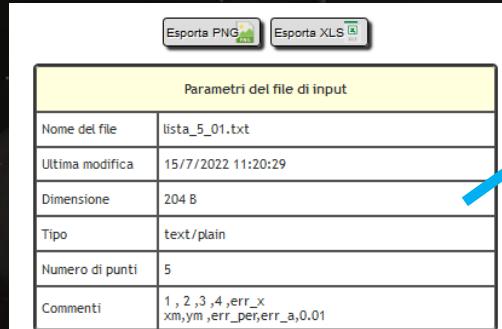
0.20,99.99
0.40,17.06
1.16,1.04
1.20,1.00
1.80,0.24

2) Insert distance unit and errors

3) Choose kind of graph (lin/log)

EMF web tools

Interpolation of index measurements and calculation of the distance of respect with determination of uncertainty



The screenshot shows a web interface with two buttons at the top: 'Esporta PNG' and 'Esporta XLS'. Below them is a table titled 'Parametri del file di input'. The table contains the following data:

Parametri del file di input	
Nome del file	lista_5_01.txt
Ultima modifica	15/7/2022 11:20:29
Dimensione	204 B
Tipo	text/plain
Numero di punti	5
Commenti	1, 2, 3, 4, err_x xm, ym, err_per, err_a, 0,01

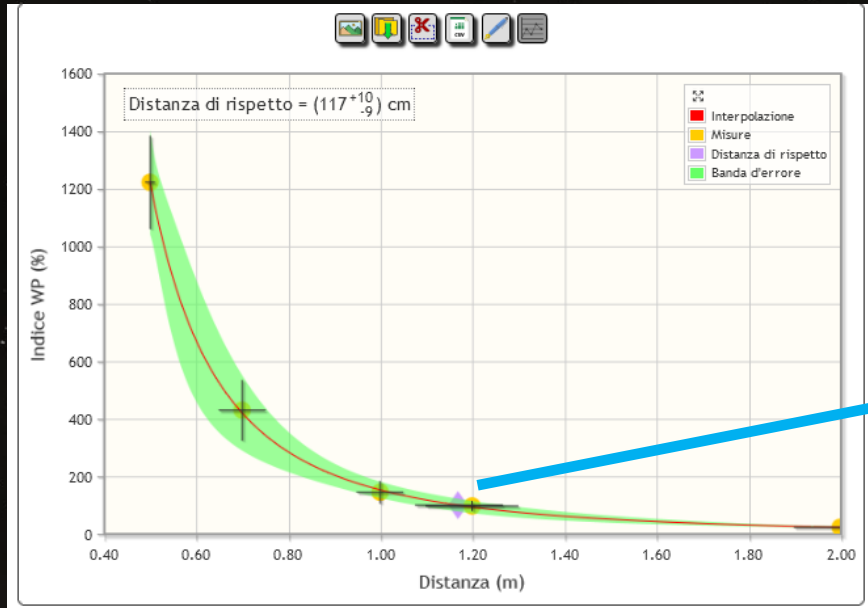
A blue arrow points from the 'Numero di punti' row to the text '1) Main data in a table'.

1) Main data in a table

2) Interpolation with error bars
and bands in a plot

EMF web tools

Interpolation of index measurements and calculation of the distance of respect with determination of uncertainty



1) Main data in a table

2) Interpolation with error bars and bands in a plot

Analysis of complex signals

Standard method

1. Compliance with the limit is given by this formula, in which an evaluation is made for each frequency component in relation to the limit referred to that frequency.
2. It is a very conservative approach, as it is not said that all the components have a maximum at the same instant (extremely improbable situation)

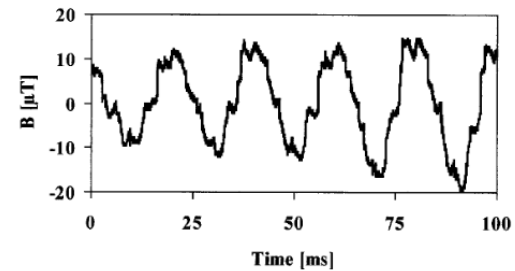
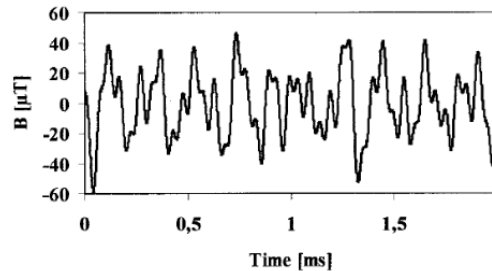
$$I_{MS} = \sum_{i=1}^N \frac{A_i}{L(f_i)} \leq 1$$

Analysis of complex signals

Weighted peak method (ICNIRP 2003-2010)

1. Differences in phases between different components are considered
2. Avoid overestimating the effect of the signal in an overly conservative manner
3. The approach can be shown to be valid for complex coherent and incoherent signals (complex non-sinusoidal waveforms, with or without phase coherence)

$$I_{WP} = \text{Max} \left| \sum_{i=1}^N \frac{A_i}{L(f_i)} \cos[2\pi f_i t + \vartheta_i + \varphi(f_i)] \right| \leq 1$$



EMF web tools

Processing data files from exposure measurements

Various tools have been developed and made publicly available on the WebNIR platform.

They allow to acquire signals measured with various instrumental chains, automatically calculate the trend of the weighted peak index, and carry out other important evaluations.

EMF web tools

Processing data files from exposure measurements

3 tools:

1. Movement in a static magnetic field: Processing of perceived magnetic field measurements (Detected with Narda-Metrolab THM1176 probe)
2. Calculation of the weighted peak indices for low and intermediate frequency magnetic field sources (Data acquired with Narda ELT-400 probe and Agilent U2351A acquisition system)
3. Loading, recognition and processing of data files of measurements in time or frequency domain

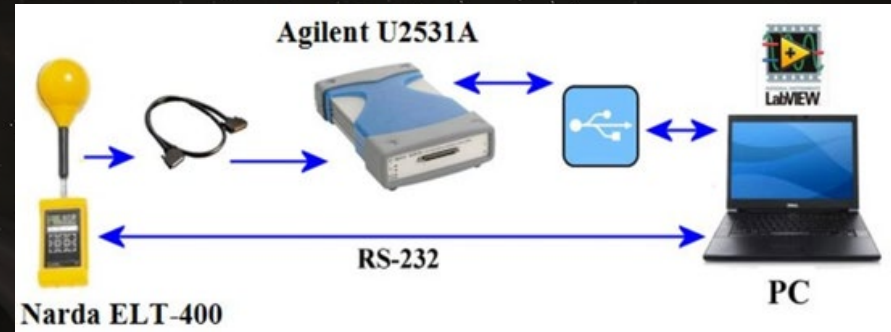


EMF web tools

Processing data files from exposure measurements

3 tools:

1. Movement in a static magnetic field: Processing of perceived magnetic field measurements (Detected with Narda-Metrolab THM1176 probe)
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3. Upload, detection and processing of measurements data files of in time or frequency domain



EMF web tools

Processing data files from exposure measurements

3 tools:

1. Movement in a static magnetic field: Processing of perceived magnetic field measurements (Detected with Narda-Metrolab THM1176 probe)
2. Calculation of the weighted peak indices for low and intermediate frequency magnetic field sources (Data acquired with Narda ELT-400 probe and Agilent U2351A acquisition system)
3. Upload, detection and processing of measurements data files in time or frequency domain (**ANY** measurement chain)

The screenshot displays the EMF web tools interface, which is divided into several sections for configuring data processing parameters.

Riferimento dati relativi al dominio

- Seleziona il dominio: ☒ Colonna valori di tempo ☐ Δt (risoluzione temporale) ☐ Frequenza di campionamento
- Tempo: 1
- Formato valori di tempo: Numerico
- Unità: 0 s, 50 kHz
- Reset button

Parametri modalità di misura

- Fattore di conversione: 0.9375
- Offset in tensione (V): 0.02
- Unità di misura: s,mV,mV/mV

Catena da archivio | Struttura file | File utente | Istruzioni

Dettagli catena da archivio

Dopo aver selezionato un dominio, completate i campi in questa sezione se l'elaborazione viene effettuata a partire da file ottenuti da una catena presente in archivio. Se dovete definire dei parametri personalizzati per un file non conforme a quanto presente in archivio, passate alla scheda **Struttura file**.

Quindi, controllate i valori nel riquadro **Parametri modalità di misura** (in alto a destra), in particolare le unità di misura devono essere conformi con quelle memorizzate nel file.

Alla fine, caricate i vostri file nella sezione **File utente**.

Fabbricante: Narda

Catena di misura: ELT400 con sonda 3cm² e Picoscope 5442 B

Modalità di misura: Mode FS 80 mT Range High

Impostazioni catena: ELT 400 - Picoscope

Dettagli degli strumenti nella catena di misura (da database)

Fabbricante	Classe	Modello	Immagine	File tipo
Narda	Sonda di campo magnetico	2300/90,20		Scarica
Narda	Misuratore di induzione magnetica	ELT-400 BH2304/101		
Pico Technology	Oscilloscopio	Picoscope 5442 B		

EMF web tools

Upload, detection and processing of measurements data files

- Select measurement chain
- Select measurement mode
- Set sample frequency
- Select and order data files
- Upload files and process
- Output as tables and plots

Narda ELT-400 con sonda da 100 cm²

☐ Mode FS 320 μ T Range Low ☐ Mode FS 320 μ T Range High

☐ Mode FS 80 mT Range Low ☐ Mode FS 80 mT Range High

Narda ELT-400 con sonda da 3 cm²

☐ Mode FS 320 μ T Range Low ☐ Mode FS 320 μ T Range High

☐ Mode FS 80 mT Range Low ☒ Mode FS 80 mT Range High

Frequenza di campionamento: 50 kHz

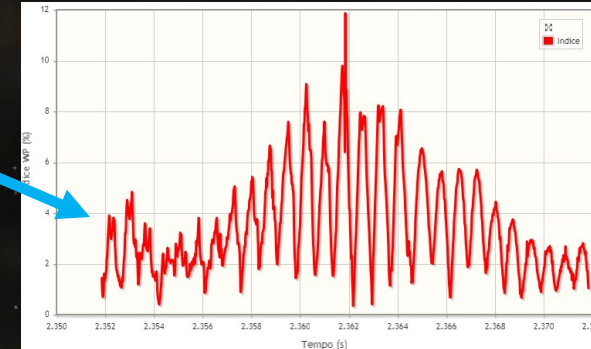
File dati: 

PuntoA_X0Y0Z1_1.txt
PuntoA_X0Y0Z1_2.txt
PuntoA_X0Y0Z1_3.txt
PuntoA_X0Y0Z1_4.txt
PuntoA_X0Y0Z1_5.txt
PuntoA_X0Y0Z1_6.txt
PuntoA_X0Y0Z1_7.txt
PuntoA_X0Y0Z1_8.txt
PuntoA_X0Y0Z1_9.txt
PuntoA_X0Y0Z1_10.txt

Dimensione totale dei file caricati: 33 MB

Elabora  Reset  Salva PNG 

Dati elaborazione	
Periodo di campionamento	0.02 ms
Numero dei campioni (durata)	500000 (10 s)
Valore massimo modulo	58.39 mT @ t=896.06 ms
Valore RMS	20.43 mT
I _{mp} popolazione	430593.91%
I _{mp} lavoratori 1998	86188.70%
I _{mp} lavoratori 2010	13979.34%
I _{mp} lavoratori VA Inf.	13980.19% @ t=5 s 584.46 ms
I _{mp} lavoratori VA Sup.	13224.30%



EMF web tools

Upload, detection and processing of measurements data files

- Select measurement mode
- Select measurement range
- Set sampling frequency
- Select and upload data files
- Upload files
- Output as tables and plots

Procedure dedicated to a specific instrumental chain

Narda ELT-400 con sonda da 100 cm²

☐ Mode FS 320 μ T Range Low ☐ Mode FS 320 μ T Range High

☐ Mode FS 80 mT Range Low ☐ Mode FS 80 mT Range High

Narda ELT-400 con sonda da 3 cm²

☐ Mode FS 320 μ T Range Low ☐ Mode FS 320 μ T Range High

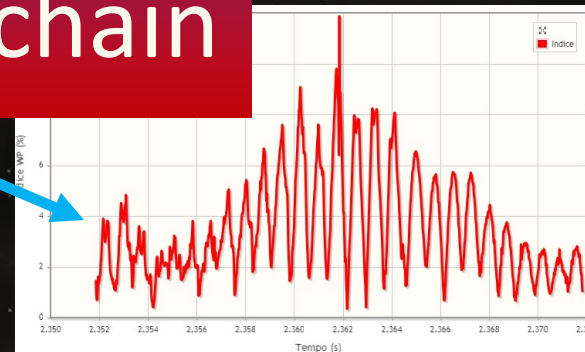
☐ Mode FS 80 mT Range Low ☐ Mode FS 80 mT Range High

Dati elaborazione	
Periodo di campionamento	0.02 ms
Numero dei campioni (durata)	500000 (10 s)
Valore massimo modulo	58.39 mT @ t=896.06 ms
Valore RMS	20.43 mT
Indice	430593.91%
1998	86188.70%
2010	13979.34%
VA Inf.	13980.19% @ t=5 s 584.46 ms
VA Sup.	13224.30%

PuntoA_X0Y0Z1_8.txt
PuntoA_X0Y0Z1_10.txt
PuntoA_X0Y0Z1_9.txt

Dimensione totale dei file caricati: 33 MB

Elabora  Reset  Salva PNG 



EMF web tools

Upload, detection and processing of measurements data files

General procedure: 3 options

1. Specific measurement chain procedure
2. Measurement chain present in our database, but no specific procedure: generalized data file acquisition system
3. Measurement chain not present in database: user must provide data file structure info

Upload, detection and processing of measurements data files

Creating homogeneous format files

```

LabVIEW Measurement
Writer_Version 2
Reader_Version 2
Separator Tab
Decimal_Separator
Multi_Headings No
X_Columns Multi
Time_Freq Relativ
Operator BLMCMR
Date 2015/03/16
Time 16:24:32.3
***End of Header***
Channels 3
Samples 50000
Date 2015/03/16
Time 16:24:32.3
X_dimension Time
XS 0.0000000000000000
Delta_X 1.000000
***End of Header***
X_Value Untitled 0
0.000000 0.023028
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		1	Block	B	Bx	By	Bz	Units	Temperature	Timestamp	Serial No.	Comment
1	x	2	0	0.106400		0.027306		-0.069503	-0.075794	MT 36904	2016.09.21 16:25:25.413001461	0000303
2	sec	3	0	0.081320		0.067809		-0.042217	-0.015255	MT 36904	2016.09.21 16:25:25.513001461	0000303
3	+54	4	0	0.075802		-0.029535		-0.012355	-0.068710	MT 36904	2016.09.21 16:25:25.613001461	0000303
4	+54	5	0	0.087258		-0.061387		0.022770	-0.057681	MT 36904	2016.09.21 16:25:25.713001461	0000303
		6	0	0.085305		0.049478		-0.004054	-0.069345	MT 36904	2016.09.21 16:25:25.813001461	0000303

[illegible]

10	Limit: ICNIRF_general_public_P_1998						
11		Total	X	Y	Z	Limit	
12	Freq	V/m	V/m	V/m	V/m	V/m	
13	MHz						
14	0.00000	0.0017	0.0010	0.0010	0.0010	---	
15	0.0025	0.0017	0.0010	0.0010	0.0010	---	
16	0.0050	0.0017	0.0010	0.0010	0.0010	---	
17	0.0075	0.0017	0.0010	0.0010	0.0010	---	
18	0.0100	44.600	25.796	25.625	25.828	87.000	
19	0.0125	11.646	6.7344	6.7031	6.7344	87.000	
20	0.0150	1.1999	0.6875	0.7031	0.6875	87.000	
21	0.0175	0.1371	0.0938	0.0625	0.0781	87.000	
22	0.0200	0.1449	0.0781	0.0938	0.0781	87.000	
23	0.0225	0.1353	0.0781	0.0781	0.0781	87.000	
24	0.0250	0.1539	0.0938	0.0781	0.0938	87.000	
25	0.0275	0.1269	0.0781	0.0625	0.0781	87.000	
26	0.0300	0.1747	0.0938	0.0781	0.1250	87.000	
27	0.035	0.1747	1.094	0.781	1.193	87.000	
28	0.040	0.1747	1.094	0.781	1.193	87.000	

1	tipo	TD		
2	deltat	0.100046		
3	tini	1591.95		
4	grandezza	1	tipo	FD
5	colonne	3	grandezza	E
6	0.0001045	3	RBW	10000
7	6.19e-5	4.9	colonne	3
			0017	0
			0.0017	0
			0.0017	0
			0.0017	0
			44.6	87
			11.646	87
			1.1999	87
			0.1371	87
16	7.1e-5	3.5	13	20000
17	9.62e-5	4.4	14	22500
			15	25000
			16	27500
			17	30000
			18	32500
			19	35000
			20	37500
			21	40000

Two homogeneous formats are created
(for time and frequency operating measurement chains)

EMF web tools

Upload, detection and processing of measurements data files

Data file

LABVIEW Measurement
Writer_Version 2
Reader_Version 2
Separator Tab
Decimal_Separator .
Multi_Headings No
X_Columns Multi
Time_Pref Relative
Operator BIONH4
Date 2015/03/16
Time 16:26:32.336661338061523437
end_of_reader

Channels 3
Samples 50000 50000 50000
Date 2015/03/16 2015/03/16 2015/03/16
Time 16:26:32.336661338061523437 16:26:32.336661338061523437 16:26:32.336661338061523437
X_Dimension Time Time Time
x0 0.000000000000000000E+0 0.000000000000000000E+0 0.000000000000000000E+0
Delta_X 1.000000 1.000000 1.000000

end_of_reader
X_Value Untitled (Extracted) X_Value Untitled 1 (Extracted) X_Value Untitled 2 (Extracted) Comment
0.000000 0.023041 0.000000 0.021973 0.000000 0.023651
1.000000 0.023193 1.000000 0.021973 1.000000 0.022888
2.000000 0.022888 2.000000 0.021942 2.000000 0.022796
3.000000 0.023193 3.000000 0.021820 3.000000 0.023193
4.000000 0.023193
5.000000 0.022888
6.000000 0.02414

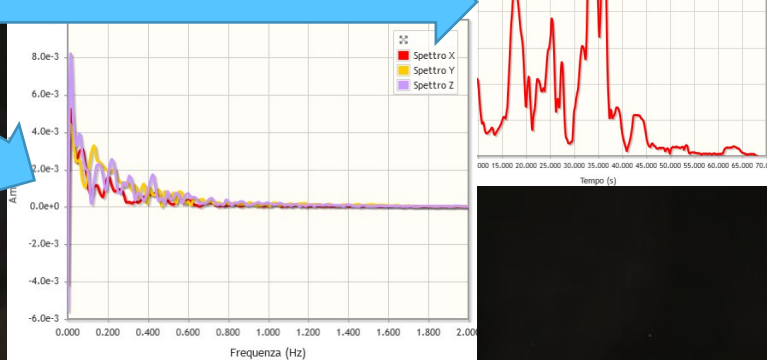
Cattura da archivio **Struttura file** File utente Istruzioni

Foglio di Excel 0 8
Numero di righe iniziali da saltare 13 8
O Salta righe fino a
Progressivo colonne da saltare 2,6
Grandezze fisiche f, Ex, Ey, Ez
Separatore tra i dati Spazio
Caratteri risultato non valido
Sostituisci risultato non valido
Numero di ripetizioni delle colonne di dati 1 8

JSON {
"taglio": "0",
"tag_sala_gher": "0",
"num_righe_iniziali": "13",
"sintassi_sala_gher": "",
"temp_col": "2,6",
"interpolazione": "f, Ex, Ey, Ez",
"formato_temper": "Time, Vime, Vime",
"Vime": "",
"tag_separatore": "f",
"non_valori": "1",
"tag_serie": "1",
"appellazione": "0",
"ripetizioni": "1",
"tag_dominio": "2",
"col_temper": "1",
"formato_temper": "0",
"col_frequenza": "1"
}

Standard file

1	tipo	TD
2	deltat	0.100046
3	tini	1591.95
4	grandezza	B
5		3
6		0.045 2.51e-5 -5.48e-5
7		6.19e-5 4.98e-5 -0.0001193
8		1.26e-5 2.3e-5 -5.4e-5
9		8.18e-5 4.62e-5 -7.83e-5
10		6.99e-5 8.01e-5 -8.53e-5
11		2.85e-5 7.96e-5 -2.08e-5
12		7.62e-5 4.49e-5 -4.3e-5
13		9.12e-5 8.51e-5 1.81e-5
14		0.0001071 8.58e-5 -4.3e-5
15		8.0e-7 7.67e-5 8.0e-7
16		7.1e-5 3.52e-5 3.34e-5
17		9.62e-5 4.43e-5 -1.25e-5

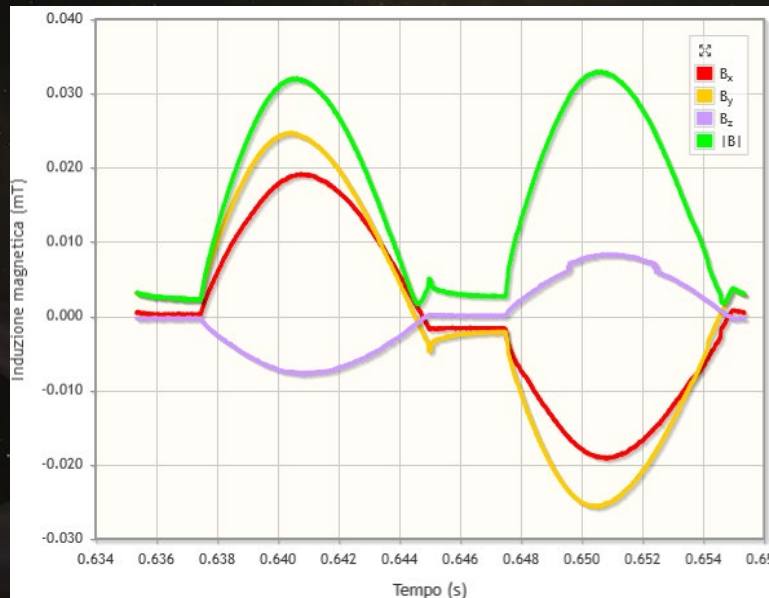
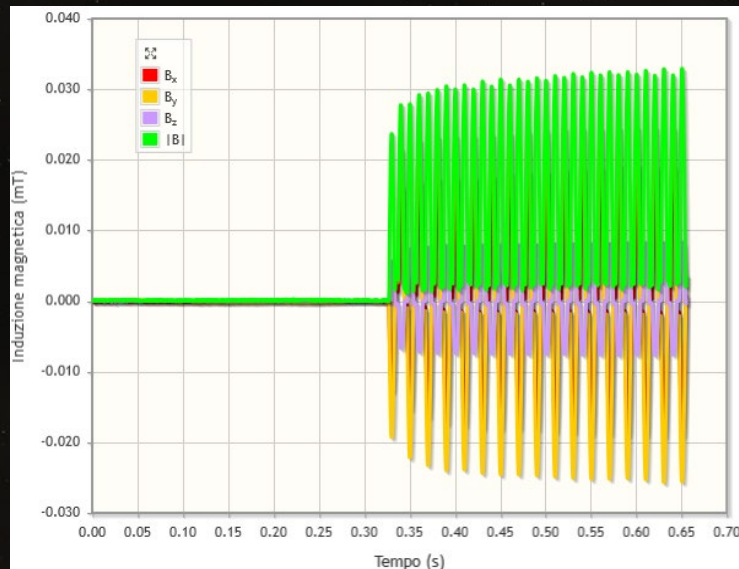


Information on file structure

EMF web tools

Upload, detection and processing of measurements data files

Data output: components and module of H/B/E fields (condensed or all-data modes)

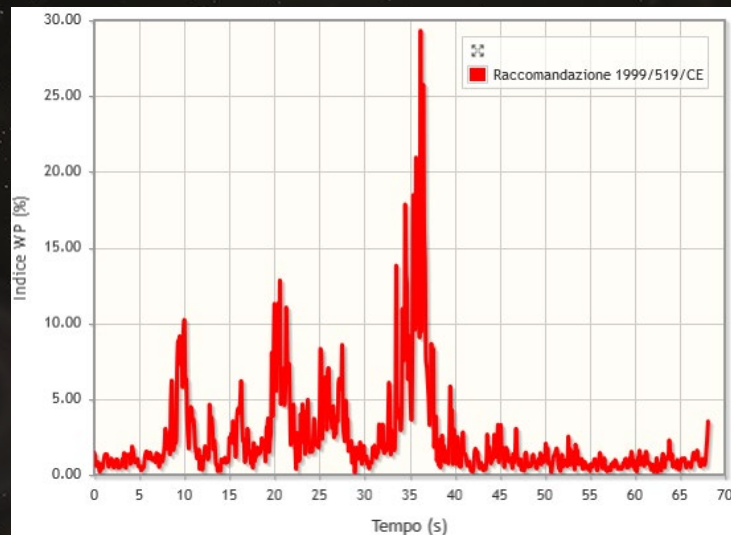


EMF web tools

Upload, detection and processing of measurements data files

Data output: wheighted peak indices, according to different regulations

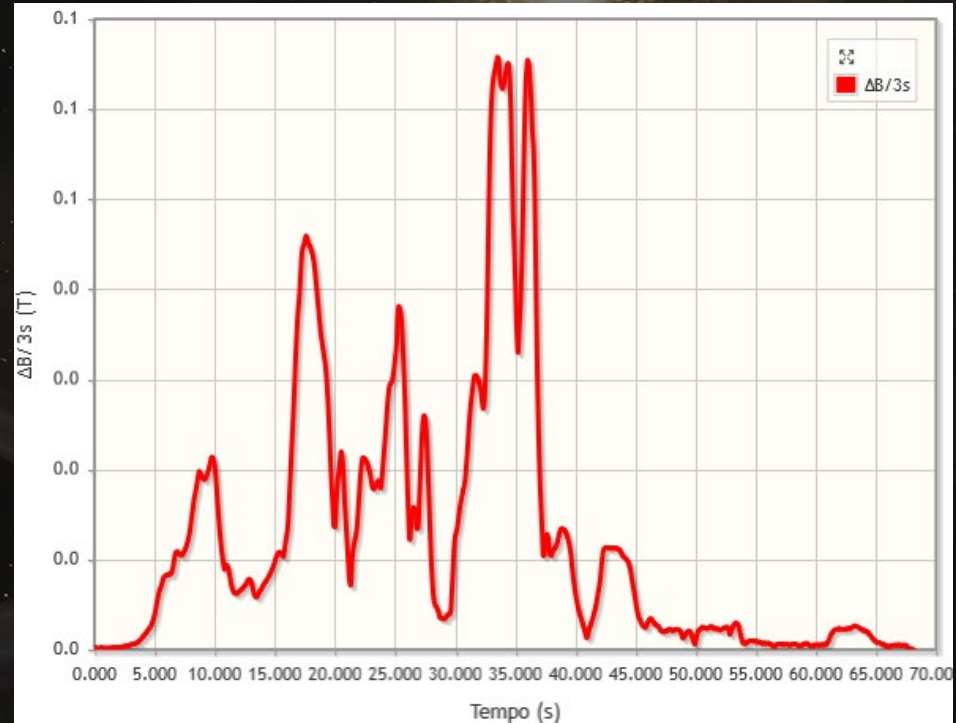
Indici WP 	
Raccomandazione 1999/519/CE	29.3%
ICNIRP 1998 Lavoratori	5.8%
ICNIRP 2010 Lavoratori	5.8%
D.Lgs. 159/2016 VA inferiori	7.6%
D.Lgs. 159/2016 VA superiori	3.7%
D.Lgs. 159/2016 VA negli arti	1.2%



EMF web tools

Upload, detection and processing of measurements data files

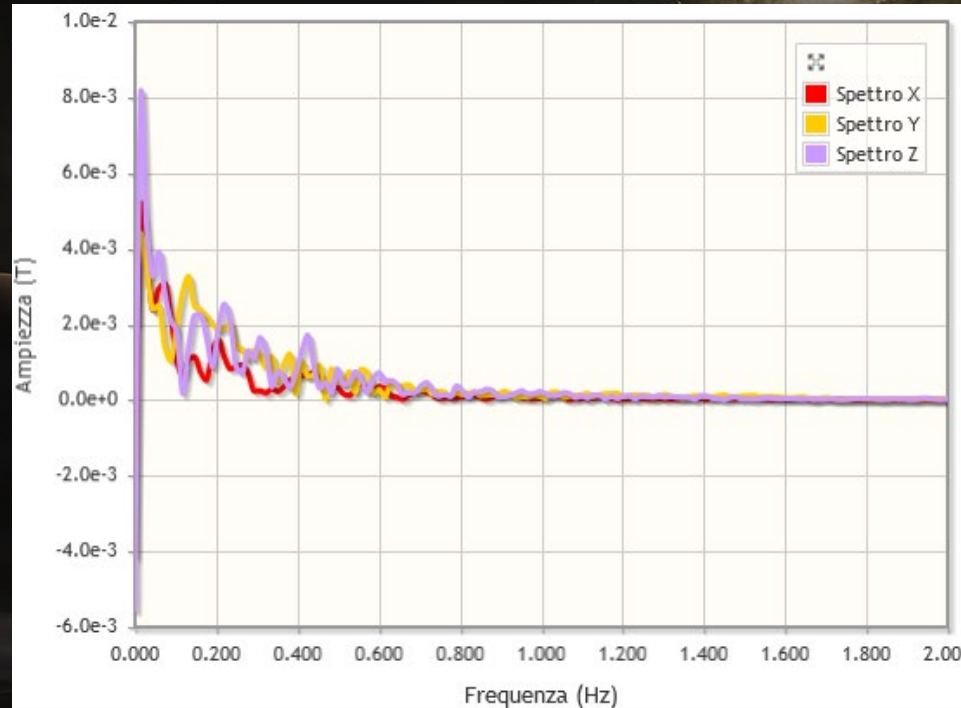
Data output: Max $\Delta B/3s$ and its trend over time



EMF web tools

Upload, detection and processing of measurements data files

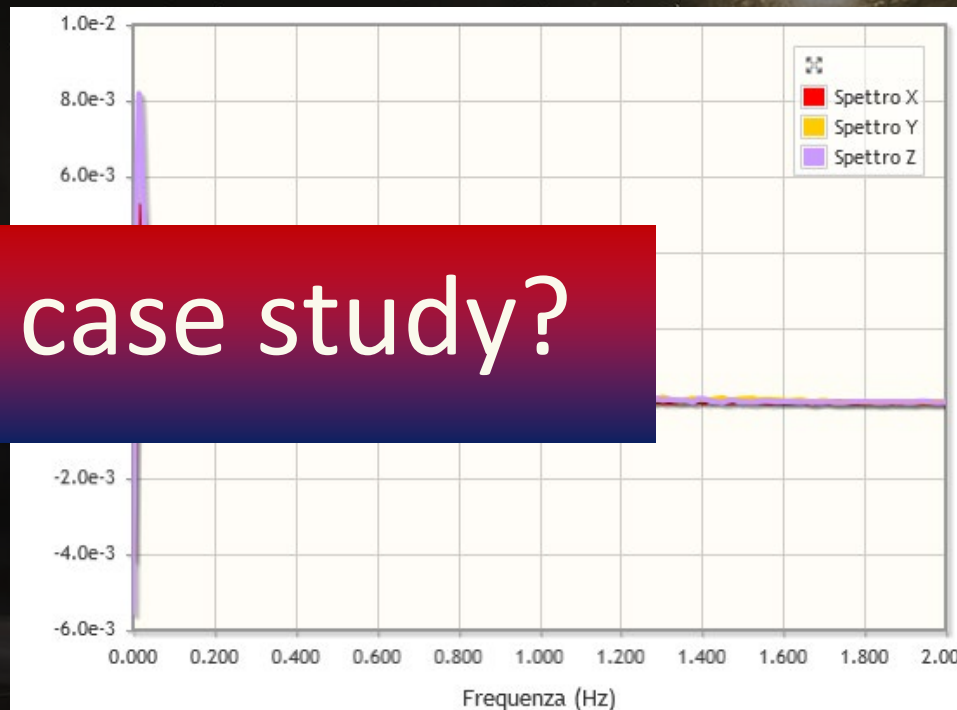
Data output: spectrum in continuous/discrete format



EMF web tools

Upload, detection and processing of measurements data files

Data output: spectrum in continuous/discrete format

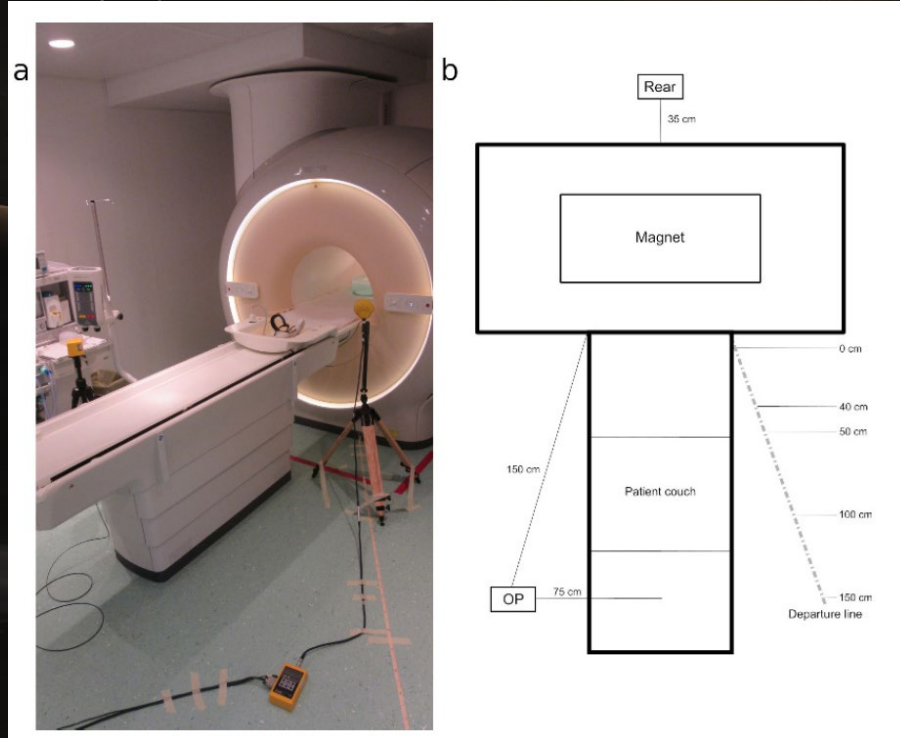


Any case study?

EMF web tools

Assessment of the exposure to gradient magnetic fields generated by MRI tomographs

- Tests carried out on different tomographs (1 and 1.5 T)

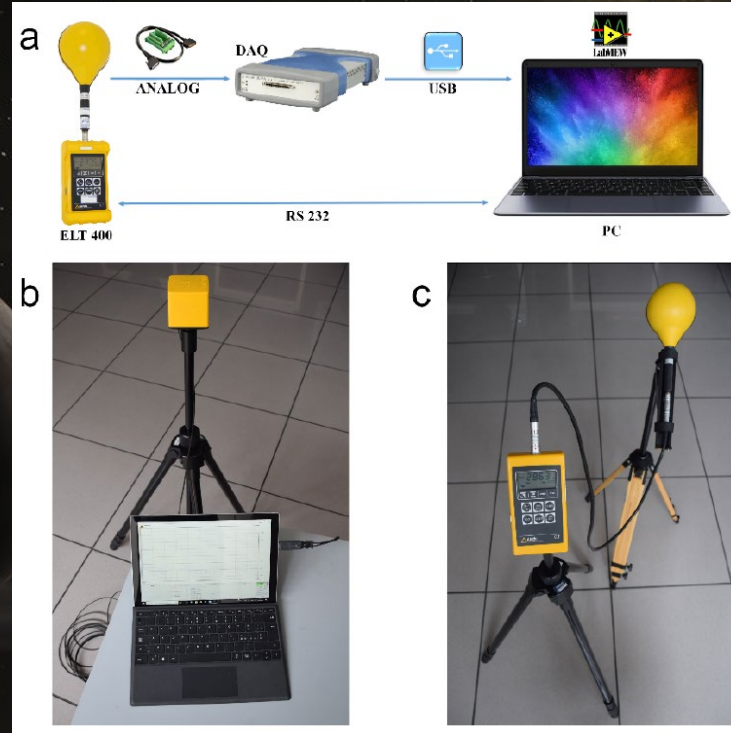


EMF web tools

Assessment of the exposure to gradient magnetic fields generated by MRI tomographs

Different instrumental chains:

- Narda ELT-400 probe, data acquired via Agilent ADC
- Narda ELT-400, stand alone setup
- Narda EHP-50F

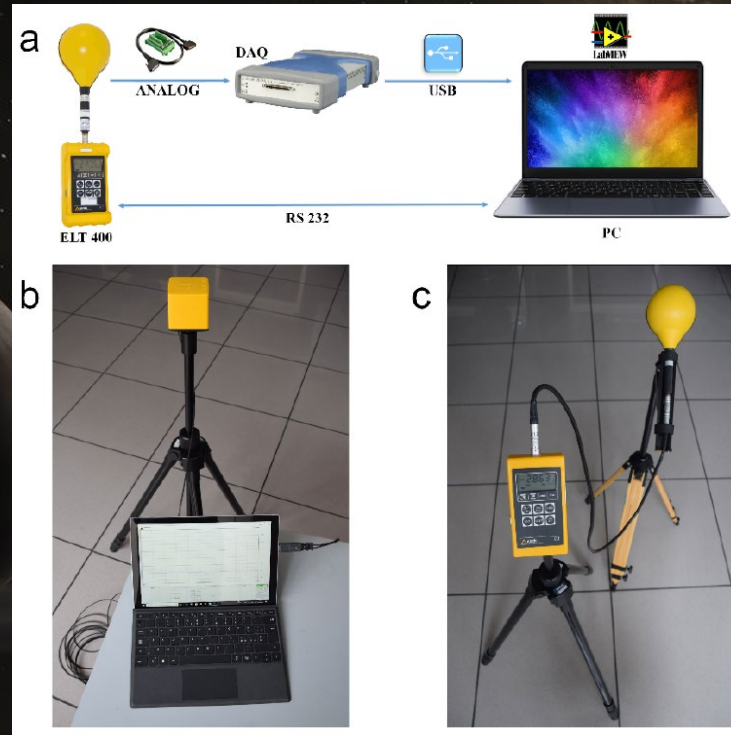


EMF web tools

Assessment of the exposure to gradient magnetic fields generated by MRI tomographs

Different instrumental chains:

- Narda ELT-400 probe, data acquired via Agilent ADC: provides raw data (analog output), skilled personnel required for data analysis
- Narda EHP-50F: Provides indexes, but no further analysis is possible



EMF web tools

Assessment of the exposure to gradient magnetic fields generated by MRI tomographs

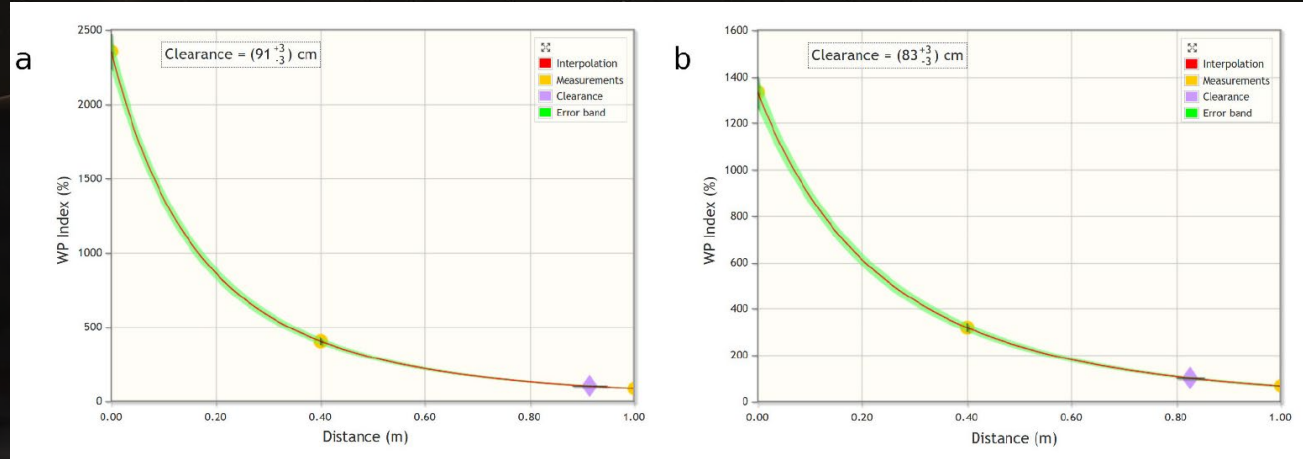
- I_{WP} calculated at every distance

Sequence	Distance (cm)	Height (cm)	RLs 1999/519/EC	Low ALs 2013/35/EU	High ALs 2013/35/EU
B1	0	100	1389%	45.0%	45.6%
	OP		22.5%	0.70%	0.60%
B2	0	100	2356%	76.0%	72.5%
	40		401%	13.0%	12.0%
	100		83%	2.50%	2.10%
	OP		51%	1.57%	1.25%
	0		1332%	40.1%	40.8%
	40	160	317%	9.70%	9.17%
	100		66%	2.00%	1.65%

EMF web tools

Assessment of the exposure to gradient magnetic fields generated by MRI tomographs

- Interpolation of indices to get a compliance area



<https://webnir.eu>

What else?

A few open problems:

1. Website in Italian language only
2. Not responsive
3. Some important features are missing
4. ...

<https://webnir.eu>

What else?

Solution (almost done):

1. Developing a portal creation system
2. Based on Bootstrap (responsivity)
3. Search tool
4. Multilanguage
5. Authentication system

<https://webnir.eu>

What else?

And:

Using the same infrastructure on other topics
(Ionizing radiations, middle-age manuscripts db
management, air pollution...)

Anyone interested in joining a new project?

The background of the slide is a deep black space filled with numerous small, distant stars. On the right side, a large, detailed Earth is visible, showing continents and clouds. On the left side, a smaller, grey, cratered Moon is visible.

Thanks

m.comelli@ifac.cnr.it