Molfetta, 25 settembre 2020

Verso il 5G: possibili rischi sanitari

Agostino Di Ciaula

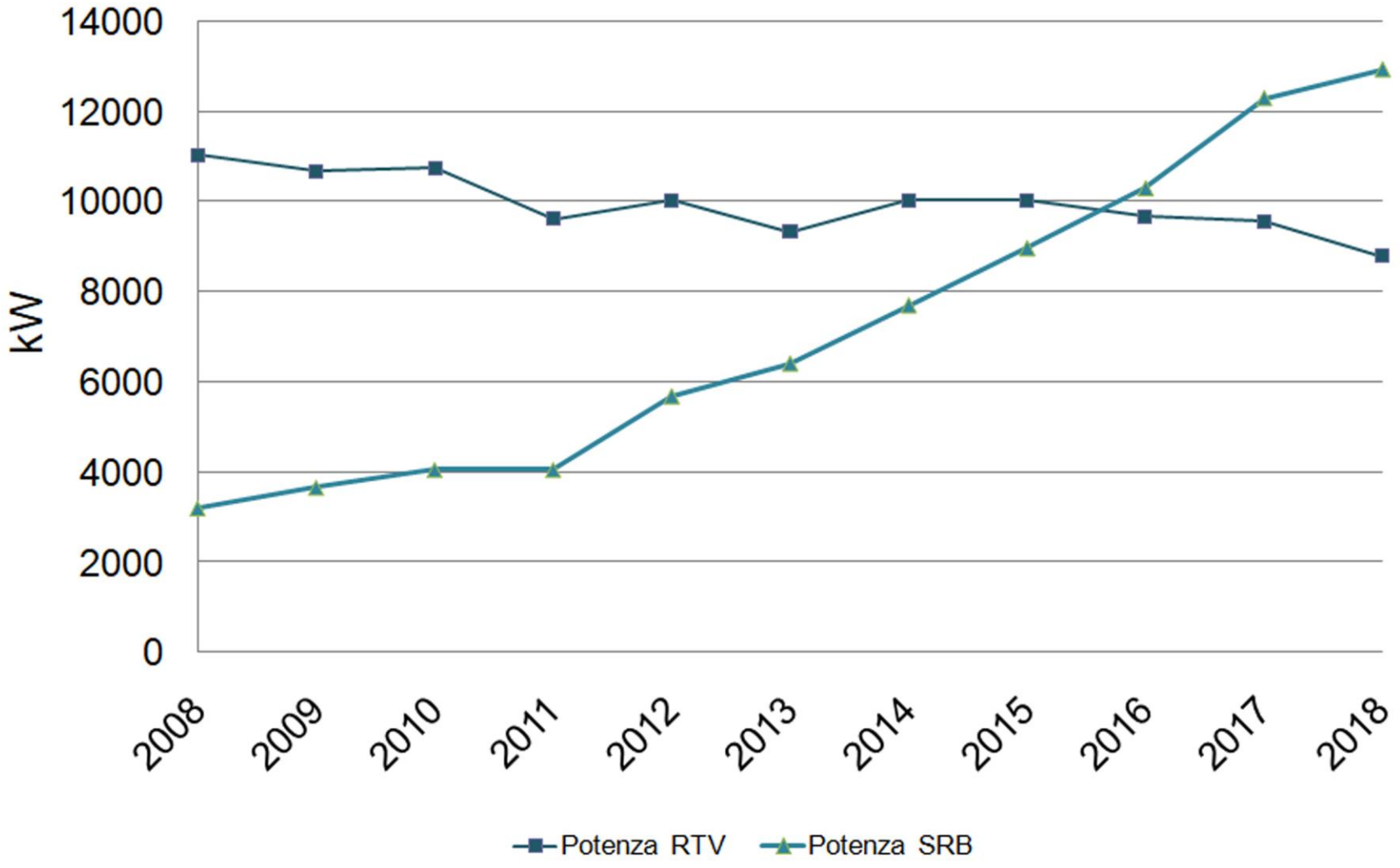
Presidente Comitato Scientifico ISDE

Le radiofrequenze sono innocue per la salute. Al massimo causano effetti termici (riscaldamento dei tessuti)

La normativa esistente ci tutela al meglio ed è una garanzia di sicurezza

L'introduzione del 5G garantirà vantaggi per tutti e non comporta rischi. Non ci sono studi che lascino immaginare in che modo possa essere pericolosa.

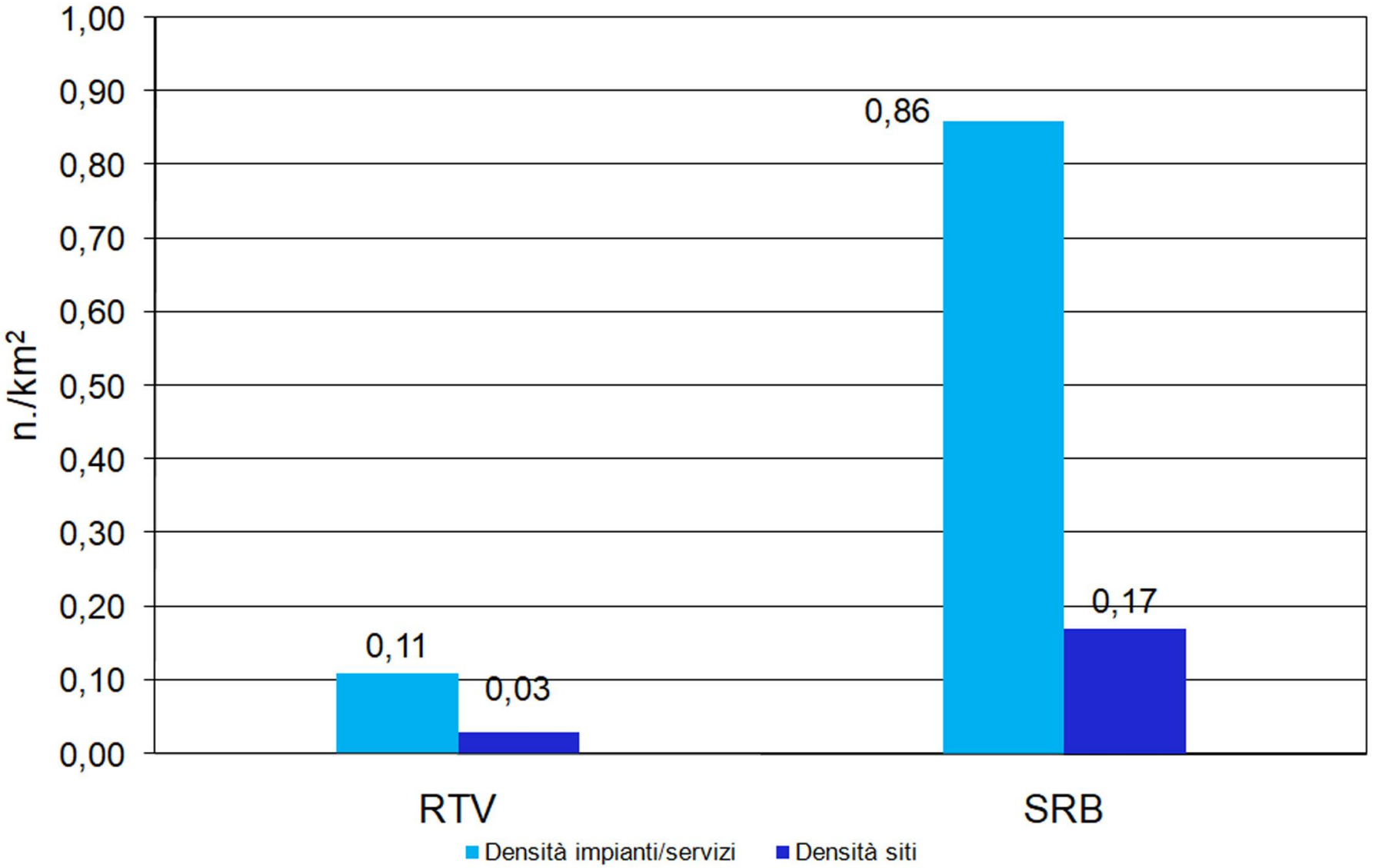
Dal 2008 al 2018 la potenza complessiva degli impianti SRB è aumentata del **305%**



Fonte: ISPRA

https://annuario.isprambiente.it/sys_ind/286

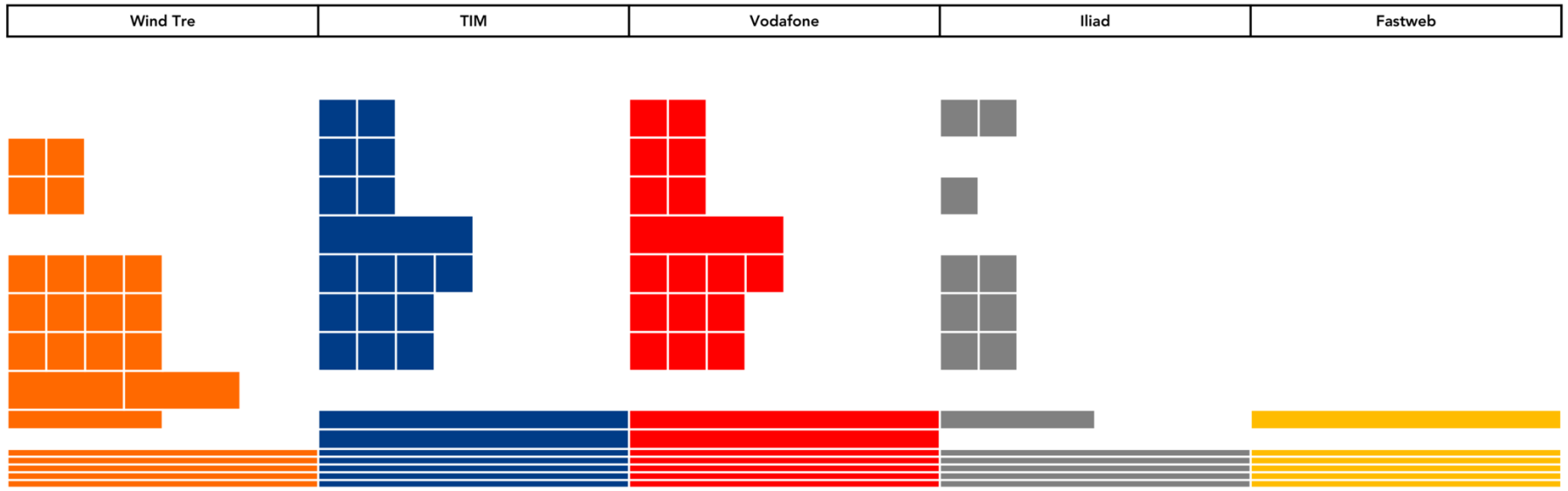
Densità impianti SRB: 0.86 per Km2



(ISPRA)

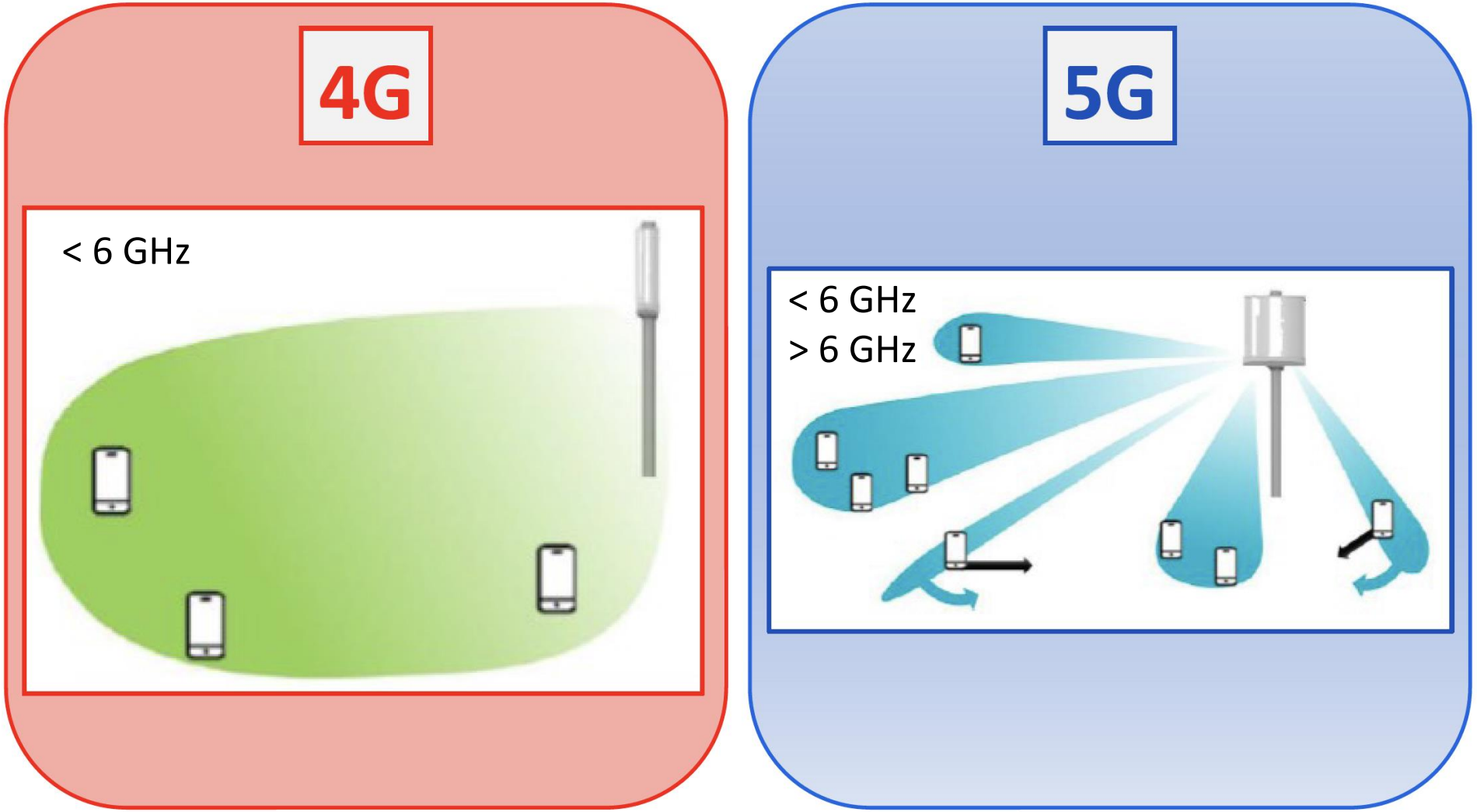
Il 5G in Italia

Bande di frequenza italiane				
Frequenza	Banda	Tecnologia	Rete	Ampiezza Blocchi
700 MHz	28	FDD	5G	5+5 MHz (down+up)
800 MHz	20	FDD	4G	5+5 MHz (down+up)
900 MHz	8	FDD	2G/3G	5+5 MHz (down+up)
1500 MHz	32	SDL	4G	20 MHz (down)
1800 MHz	3	FDD	2G/4G	5+5 MHz (down+up)
2100 MHz	1	FDD	3G/4G	5+5 MHz (down+up)
2600 MHz	7	FDD	4G	5+5 MHz (down+up)
2600 MHz	38	TDD	5G	15 MHz (down&up)
3700 MHz	77	TDD	5G	20→80 MHz (down&up)
26 GHz	258	TDD	5G	200 MHz (down&up)



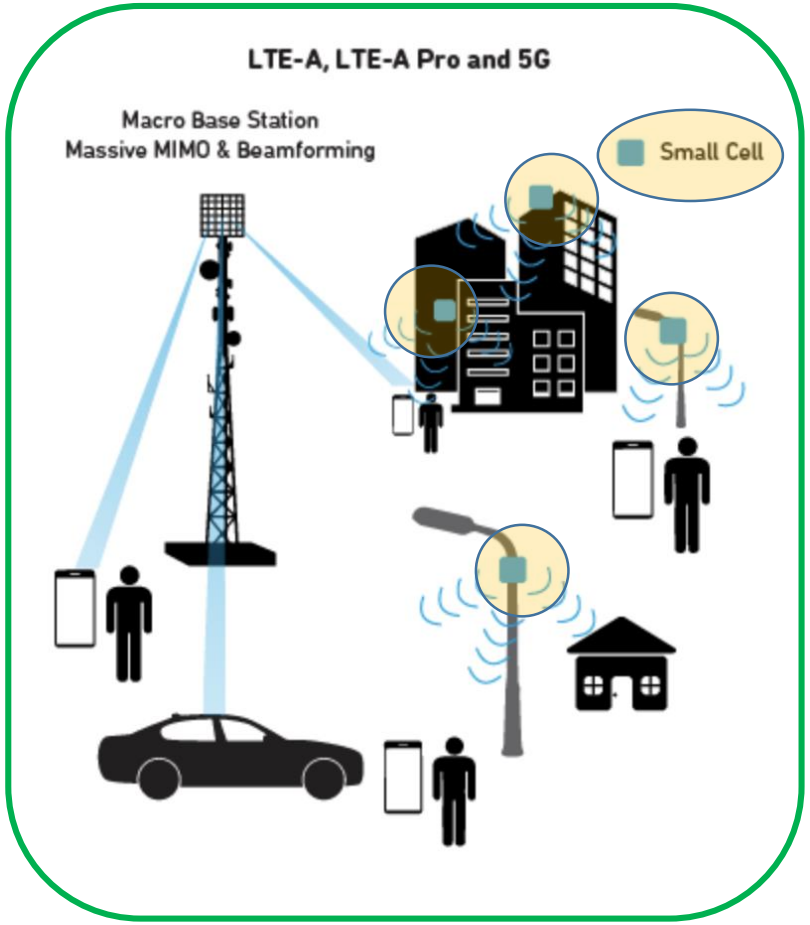
"bande pioniere" 5G" "prima di pervenire all'impiego … delle bande… identificate nelle gamme di frequenze più alte, … con particolare riferimento alle onde millimetriche… **nella gamma tra 24.25 e 86 GHz**" (*AGCOM, Action Plan 5G*)

Le antenne attive utilizzate per il 5G sono caratterizzate da **diagrammi di irraggiamento dinamici**, consentendo di ottimizzare la copertura della SRB

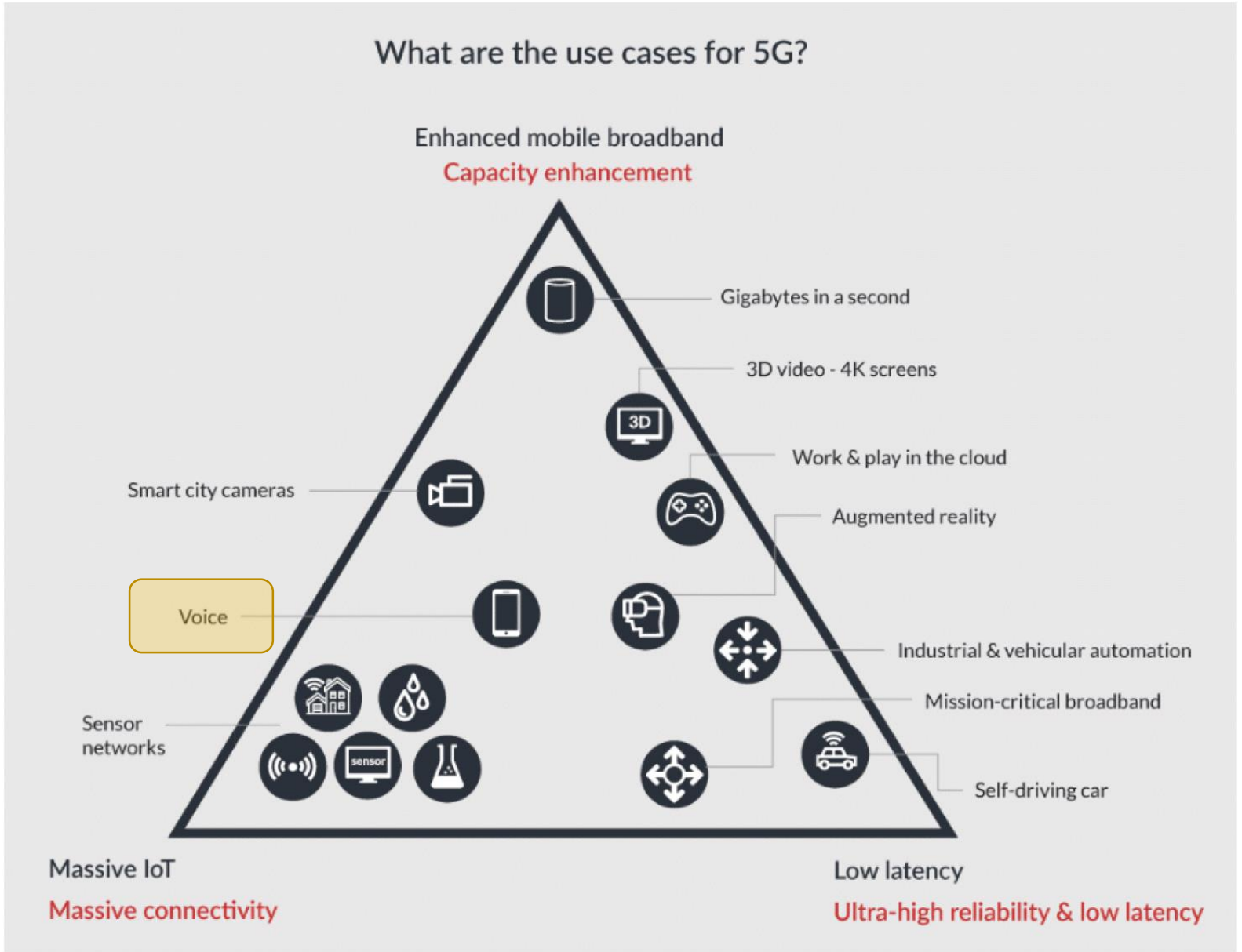


(modificata da slide ARPA Lazio)

5G: sommatoria copertura precedente + nuova rete ("irraggiamento dinamico" con connessione di dispositivi singoli)



Assenza di tecniche e standard validati per il monitoraggio


What are the use cases for 5G?
Enhanced mobile broadband
Capacity enhancement
Gigabytes in a second
3D video - 4K screens
3D
Work & play in the cloud
Smart city cameras
Augmented reality
Voice
Industrial & vehicular automation
Mission-critical broadband
Sensor networks
sensor
Self-driving car
Massive IoT
Massive connectivity
Low latency
Ultra-high reliability & low latency

AGCOM, 28 marzo 2017

Autorità per le Garanzie nelle Comunicazioni

INDAGINE CONOSCITIVA CONCERNENTE LE PROSPETTIVE DI SVILUPPO DEI SISTEMI WIRELESS E MOBILI VERSO LA QUINTA GENERAZIONE (5G) E L'UTILIZZO DI NUOVE PORZIONI DI SPETTRO AL DI SOPRA DEI 6 GHZ AI SENSI DELLA DELIBERA N. 557/16/CONS

65. Come osservato precedentemente, le reti 5G dovranno servire un numero elevato di clienti/apparati e connettere, secondo le ipotesi prevalenti alla base degli sviluppi di standardizzazione in corso, un ordine di 1 milione di *devices* per Km^2. Tale densità di apparati provocherà un incremento del traffico e la necessità di realizzare celle di dimensioni sempre più piccole per consentire di fornire idonee prestazioni di connettività, con conseguente aumento della densità di antenne installate. La

5G small cells

Cell Type	Output Power [W]	Cell Radius [km]	Users	Locations
Femto Cell	0.001 to 0.25	0.010 to 0.1	1 to 30	Indoor
Pico Cell	0.25 to 1	0.1 to 0.2	30 to 100	Indoor/Outdoor
Micro Cell	1 to 10	0.2 to 2.0	100 to 2000	Indoor/Outdoor
Macro Cell	10 to >50	8 to 30	>2000	Outdoor

2G, 3G→ 2 km (città) – 30 km (ambito rurale)
mmWave→ 20 - 200m (un'antenna ogni 20 metri)

Costi previsti:
119 miliardi

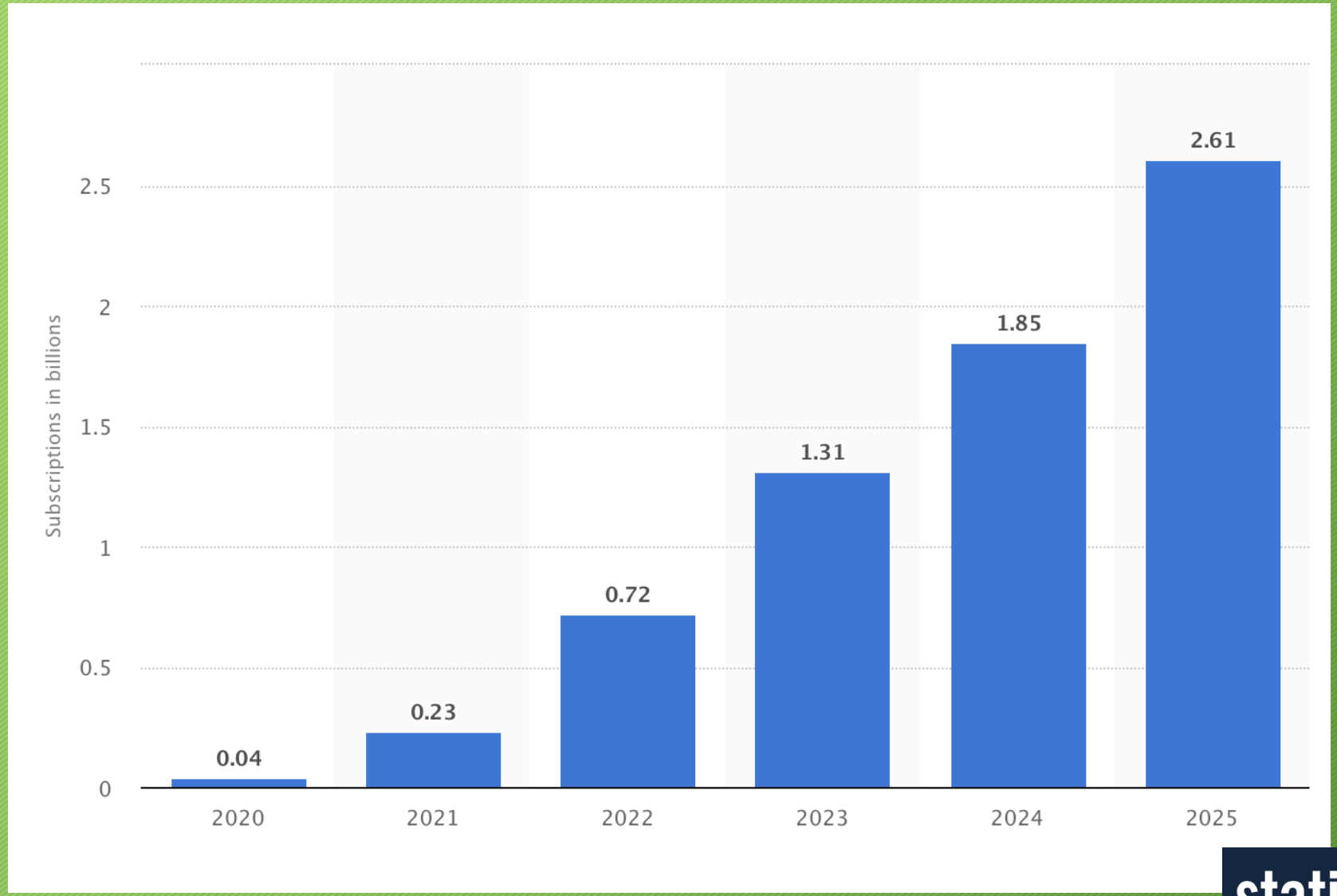
Oggi: circa una stazione radio-base/Km2
5G: 8-800 stazioni radio-base/Km2

Previsione realistica: 100 - 350 small cells/Km2

Abbiamo sulla terra abbastanza silicio, litio etc. per realizzare tutto questo?

(Scailquin H, 2020)

Forecast number of 5G subscriptions worldwide from 2020 to 2025 (in billions)



Il 5G nella città metropolitana di Bari

A partire da Luglio 2018 ad oggi sono state presentate ad ARPA Puglia 26 istanze per la sperimentazione 5G in diversi siti collocati per la maggior parte nel territorio di Bari. Il Servizio Agenti Fisici del Dipartimento di Bari ha utilizzato l'approccio statistico-conservativo precedentemente descritto per la modellizzazione.
L'analisi previsionale del campo elettrico generato, è stata effettuata, utilizzando un software sviluppato internamente all'Agenzia, considerando anche il contributo degli altri gestori eventualmente presenti nel raggio di 100 m (se si tratta di stazioni radio base) o di 200 m (se sono presenti anche impianti RTV) dal sito in esame. L'output del software consente di visualizzare tridimensionalmente l'isosuperficie a 6 V/m e di sovrapporla alla mappa 2D del territorio. In tal modo è possibile stabilire quali siano i siti a valenza radioprotezionistica per i quali è necessario valutare puntualmente il valore del campo elettrico.
In fig. 4 è mostrata l'isosuperficie (vista dall'alto e vista laterale) ottenuta da una modellizzazione effettuata per una SRB situata nel comune di Bari, senza il contributo 5G (sinistra) e con il contributo 5G per un solo settore (destra). E' evidente che l'introduzione del contributo 5G modifica la forma e l'estensione dell'isosuperficie andando ad incrementare il numero dei siti a valenza radioprotezionistica da «investigare». L'approccio seguito per la modellizzazione, sebbene conservativo, **ha consentito di accertare la conformità ai limiti vigenti dei progetti in quasi tutti i casi**.

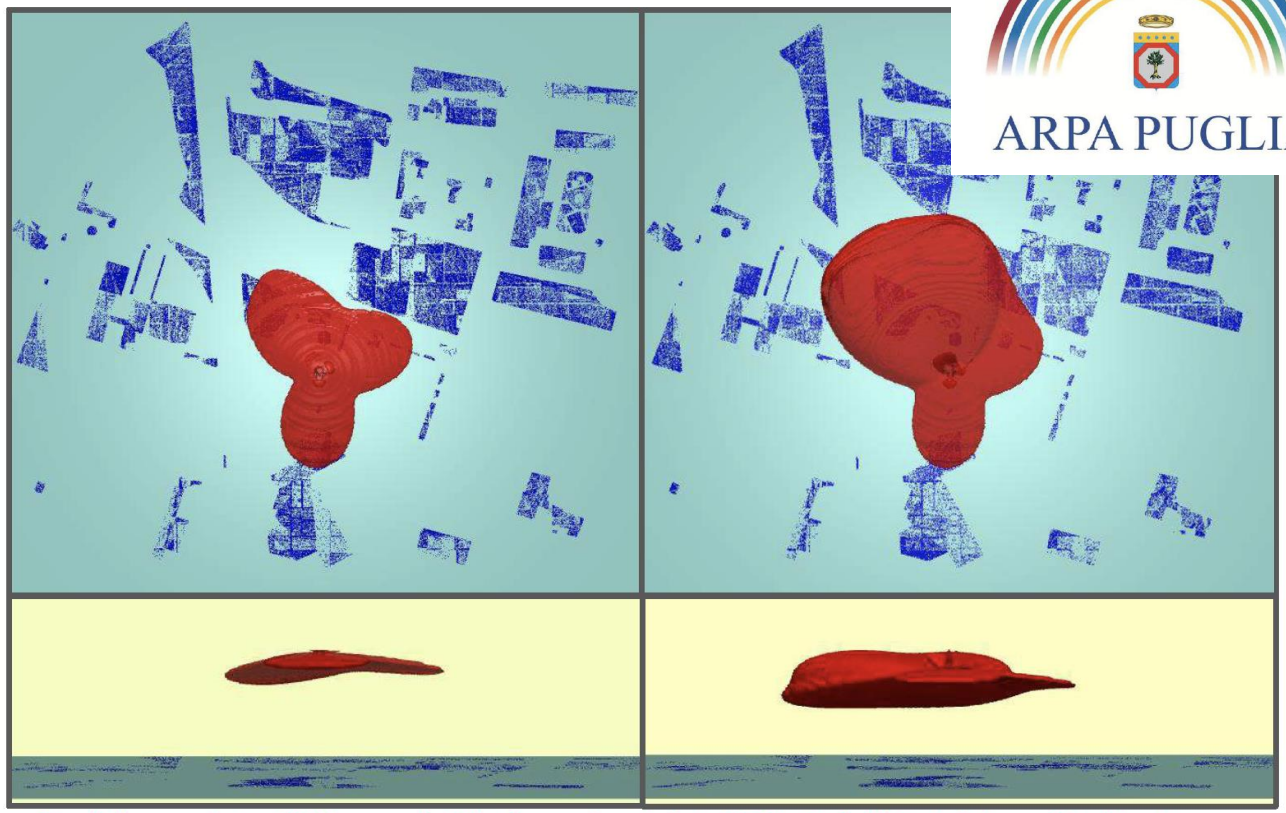


Fig. 3 Isosuperficie a 6 V/m senza (sinistra) e con il contributo 5G (destra). Vista dall'alto e vista laterale.

Conclusioni

L'esperienza di ARPA Puglia in questa prima fase della sperimentazione 5G ha evidenziato:

- La necessità di **convergere urgentemente verso norme tecniche specifiche per l'emergente tecnologia 5G** sia in ambito modellistico che di misura;
- La necessità di **rivedere il quadro normativo italiano di settore per consentire un uso ottimizzato e più consapevole dello spazio elettromagnetico**: i pareri ARPA vengono dati basandosi sui dati tecnici dell'impianto fra i quali la "potenza fornita al connettore d'antenna", pertanto non si basano sulle potenze effettivamente erogate, che, molto spesso, sono inferiori a quelle richieste e successivamente autorizzate. Inoltre, i Gestori non ricorrono spesso all'uso dei fattori di riduzione della potenza da applicare nelle stime previsionali per tener conto della variabilità temporale dell'emissione degli impianti nell'arco delle 24 h.

Adverse Impacts of 5G Downlinks on Human Body

Imtiaz Nasim and Seungmo Kim
Electrical and Computer Engineering Department
Georgia Southern University

2019

- AP copriranno piccole aree, dunque saranno più vicini al corpo umano
- L'altro numero di AP utilizzati aumenterà le possibilità di esposizione, soprattutto in downlink (emissioni "concentrate" sul target)

possibly carcinogenic to humans [25]. We will show later in this paper that the amount of exposure from 5G networks can generate EMFs that go beyond the guidelines provided by FCC or ICNIRP when human users are located close to the APs.

One problem is that the literature on the impact of cellular

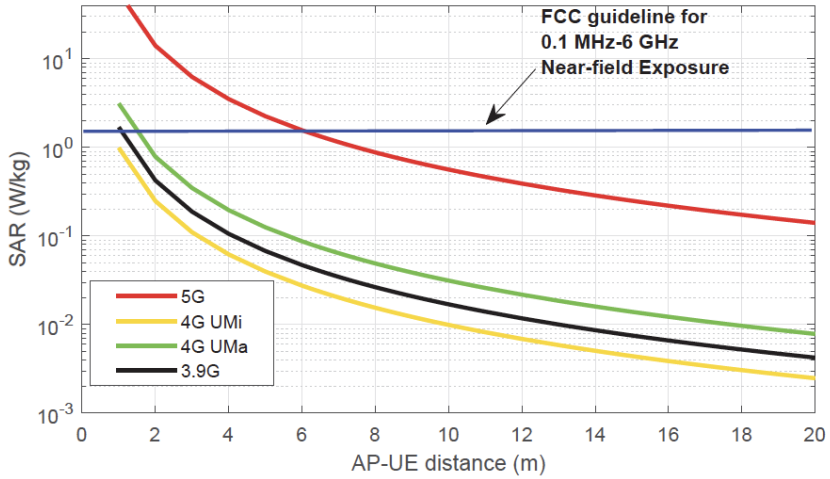


Fig. 5. SAR versus AP-UE distance (zoomed in view)

B. Human EMF Exposure

Now we show that even considering such shallow penetration depth due to high frequencies, a 5G downlink EMF emission can cause higher exposure than the concurrent 4G or 3.9G systems. Figs. 2 and 3 show the comparison in terms of

effect on the human body in far-field. But our results suggest that the human users in 5G can be exposed to higher SAR than the present systems at every point in a network. Even the available near field SAR exposure guideline can be violated

(SAR non considerato sino ad ora per le SRB)

DOI: 10.1109/SoutheastCon42311.2019.9020454

RAPPORTI ISTISAN 19|11

ISSN: 1123-3117 (cartaceo) • 2384-8936 (online)

Radiazioni a radiofrequenze e tumori: sintesi delle evidenze scientifiche

S. Lagorio, L. Anglesio, G. d'Amore, C. Marino, M.R. Scarfì

"*In base alle caratteristiche previste per i sistemi radianti utilizzati, al fine di valutare correttamente l'esposizione, occorrerà pertanto considerare* ***non solo i valori medi*** *di campo elettromagnetico,* ***ma anche i valori massimi raggiunti per brevi periodi di esposizione****. Tale aspetto richiederà un* ***adeguamento della normativa nazionale*** *che, ad oggi, non considera esposizioni di breve durata ma solo esposizioni continuative*".

ci sarà un "***incremento notevole del numero di impianti*** *installati sul territorio*"

"*L'introduzione della tecnologia 5G potrà portare a* ***scenari di esposizione molto complessi****, con livelli di campo elettromagnetico fortemente variabili nel tempo, nello spazio e nell'uso delle risorse delle bande di frequenza*"

"*al momento,* ***non è possibile formulare una previsione*** *sui livelli di campo elettromagnetico ambientale dovuti allo sviluppo delle reti 5G*" e che "*sarà dunque necessaria una* ***revisione della normativa nazionale***".

27 | Sviluppo Reti 5G

Adeguare i livelli di emissione elettromagnetica in Italia ai valori europei, oggi circa 3 volte più alti e radicalmente inferiori ai livelli di soglia di rischio, per accelerare lo sviluppo delle reti 5G. Escludere opponibilità locale se protocolli nazionali sono rispettati.

Contesto

- Le reti a banda ultra larga 5G consentiranno alte velocità e ridotte latenze, rendendo possibili nelle aree coperte servizi ubiqui e istantanei per imprese (ad es. Robotica e Industria 4.0, logistica e distribuzione, manutenzione) e famiglie (ad es. *multiparty applications* e accesso banda larga wireless).
- Gli alti costi delle frequenze in Italia sono ulteriormente aggravati da una normativa specifica italiana sulle emissioni radiomagnetiche. Tale normativa impone limiti (pari a 20Volt/metro e 6Volt/metro nelle zone ad alta presenza umana) molto più restrittivi di quelli in vigore nella maggior parte degli altri paesi Europei, a loro volta molto al di sotto dei limiti di nocività ipotizzati. Poiché il 5G si basa su frequenze più elevate (che si propagano a minor distanza) il mantenimento degli attuali limiti implica che una completa copertura 5G richiederà un numero molto più elevato di stazioni radio di quello attualmente in uso per 3/4G, con implicazioni di costo e ambientali estremamente sfavorevoli e un lento sviluppo del servizio

Azioni specifiche

a. Riportare i limiti massimi di emissione elettromagnetica in Italia alle linee guida europee/in linea con i livelli richiesti dagli altri stati membri UE
b. Valori limite di campo elettrico (per frequenze 3.6-3.8 GHz):
   - Linee guida ICNIRP[1]: 61 V/m
   - Francia, Germania, Regno Unito, Spagna: 61 V/m
   - Grecia: 47 V/m
   - Belgio: 31 V/m
   - Italia: 20 V/m

1. International Commission on Non-Ionizing Radiation Protection

Logiche e fonti di funding: Principalmente Pubblico | **Principalmente Privato** | No funding

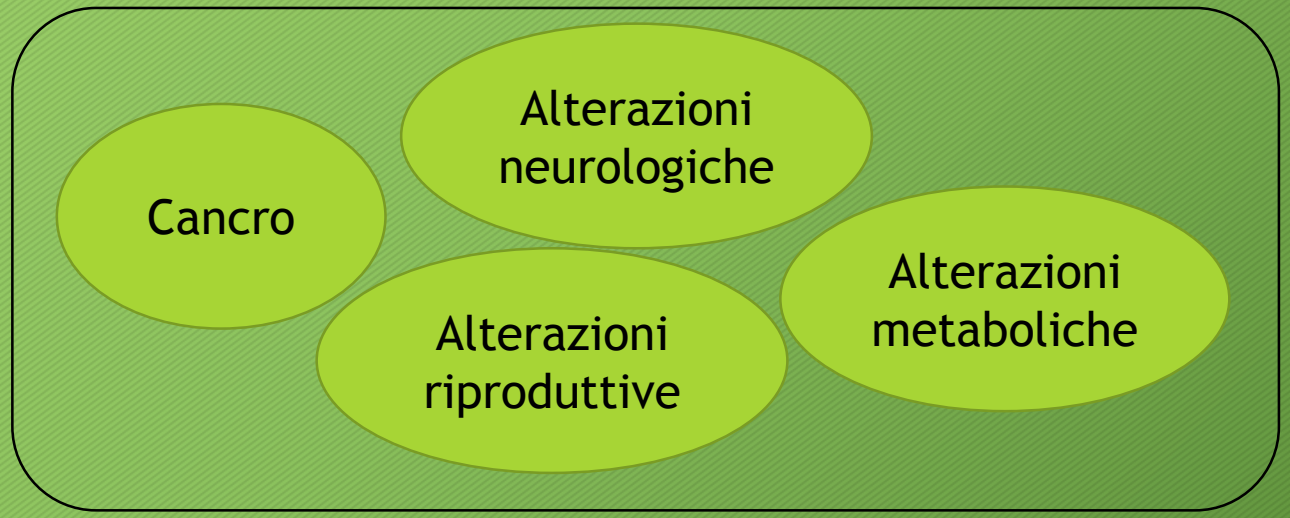
Tempistiche per lancio iniziativa: **Attuare subito** | Finalizzare | Strutturare

La prime "novità" del 5G:

- Frequenze (MMW) e esposizioni mai impiegate prima su così larga scala
- Numero di dispositivi elevatissimo, senza precedenti e in crescita costante
- Sommatoria del "nuovo" con il "vecchio"
- Implementazione rete già in corso, con normativa ancora inadeguata e, probabilmente, ancora meno protettiva in futuro

RF-EMF: Effetti biologici e sanitari

Effetti sanitari da esposizione a RF-EMF
(studi epidemiologici, studi in vitro e su modelli animali



Studio meccanismi fisiopatologici

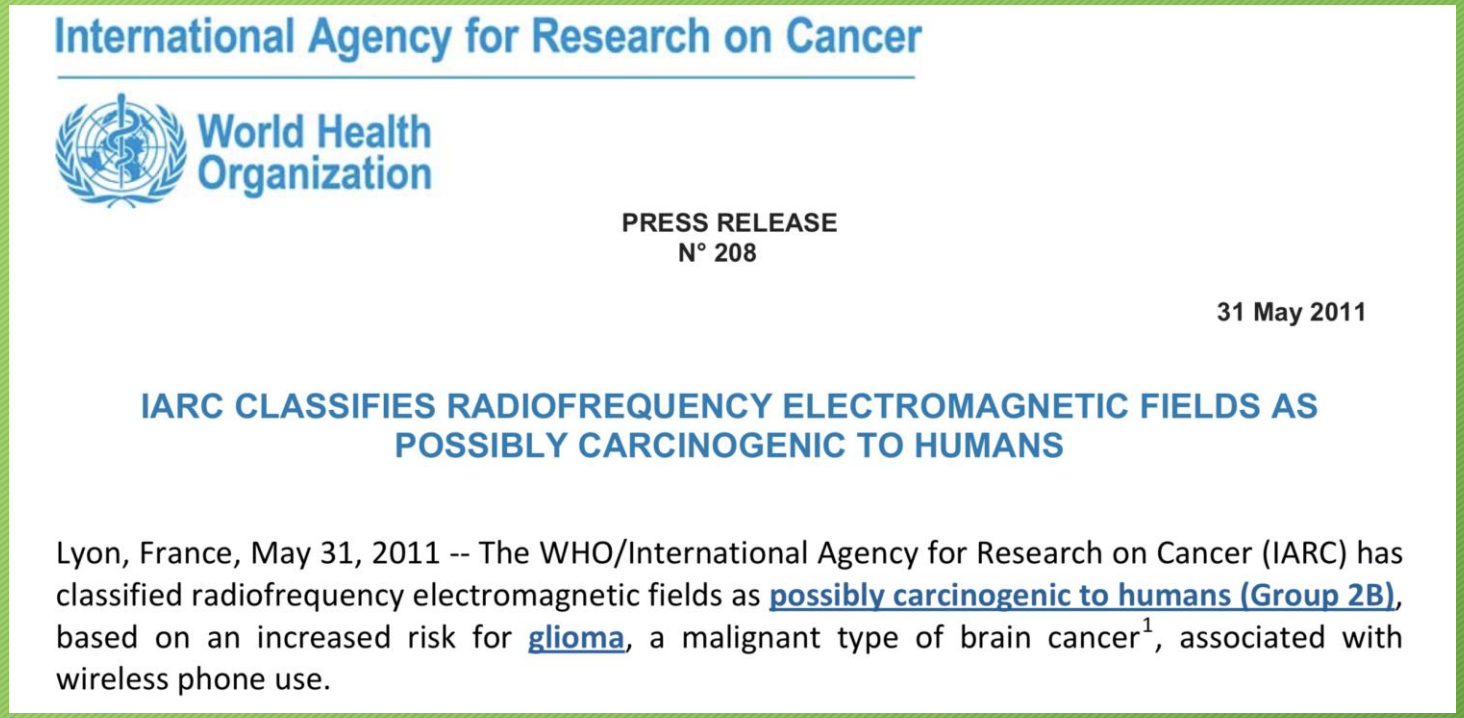
Identificazione soglie

??

ALARA

(As Low As Reasonably Achievable)

IARC Group 2B, anno 2011



International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

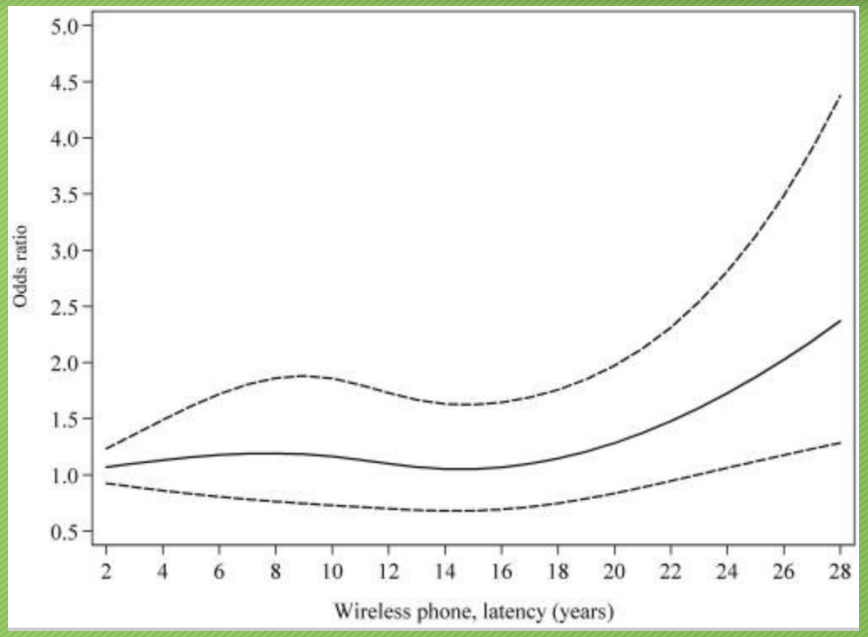
Lyon, France, May 31, 2011 -- The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

"The conclusion means that there could be some risk, and therefore we need to keep *a close watch for a link between cell phones and cancer risk*."

"Given the potential consequences for public health … *it is important that additional research be conducted into the long-term*"

Dopo il 2011…

Rischi oncologici



Restricted cubic spline plot of the relationship between latency of wireless phones and malignant brain tumours. The solid line indicates the OR estimate, the broken lines represent 95% CI. Adjustment was made for age at diagnosis, gender, SEI-code and year of diagnosis.

A case-control study has documented an increased risk of brain tumor in mobile phone users or after cordless phone use (latency >15-20 years) (Hardell et al, 2013).

Dopo il 2011…

Rischi oncologici

International Journal of Occupational Medicine and Environmental Health 2017;30(1):27–43
https://doi.org/10.13075/ijomeh.1896.00802

MOBILE PHONE USE AND RISK FOR INTRACRANIAL TUMORS AND SALIVARY GLAND TUMORS – A META-ANALYSIS

ALICJA BORTKIEWICZ[1], ELŻBIETA GADZICKA[1], and WIESŁAW SZYMCZAK[2]

[1]Nofer Institute of Occupational Medicine, Łódź, Poland
Department of Work Physiology and Ergonomics
[2]University of Lodz, Łódź, Poland
Faculty of Educational Sciences, Institute of Psychology, Chair of Psychological Research Methodology and Statistics

A meta-analysis exploring papers published until the end of March 2014 (24 studies, 26,846 cases, 50,013 controls) reported a higher risk of intracranial tumor (mobile phone use over 10 years) and for the ipsilateral location (Bortkiewicz et al., 2017)

Dopo il 2011…

Rischi oncologici

A re-analysis (correcting for possible biases) of Canadian data from the multinational INTERPHONE study demonstrated ***an odds ratio of 2.2 for glioma***, and an ***increased risk of meningioma, acoustic neurinoma and parotid gland tumors*** in relation to mobile phone use (Momoli 2017)

Table 5. Conditional Logistic and Bias-Adjusted Odds Ratios for Phone Use by Tumor Type, Interphone Study, Montréal, Ottawa, and Vancouver, Canada, 2001–2004

Tumor Type and Exposure Metric	No. of Cases	No. of Controls	OR[a]	95% CI	Bias Modeling Adjustment					
					Bias Due to Recall Error[b]		Selection Bias[b]		Recall and Selection Biases, With Random Error	
					OR	95% Limits	OR	95% Limits	OR	95% Limits
Glioma										
Reference level[c]	89	339	1.0	Referent	1.0	Referent	1.0	Referent	1.0	Referent
Regular use	81	314	1.0	0.7, 1.5	NA[d]	NA	1.1	1.0, 1.2	1.1	0.7, 1.6
Cumulative no. of hours										
<40	14	77	0.9	0.4, 1.7	0.8	0.7, 0.9	1.0	0.7, 1.3	0.9	0.4, 1.8
40–558	35	163	0.7	0.4, 1.2	0.7	0.6, 0.8	0.8	0.6, 1.0	0.8	0.4, 1.4
>558	32	74	2.0	1.2, 3.4	2.0	1.8, 2.1	2.3	1.9, 2.8	2.2	1.3, 4.1

Dopo il 2011…

Rischi oncologici

ELSEVIER

Environmental Research
Volume 182, March 2020, 109013

Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut

Jiajun Luo [a], Hang Li [b], Nicole C. Deziel [a], Huang Huang [a], Nan Zhao [c], Shuangge Ma [d], Xin Ni [e, f], Robert Udelsman [g], Yawei Zhang [a, h]

Source of funding: This research was supported by the American Cancer Society (ACS) grants RSGM-10-038-01-CCE and 127509-MRSG-15-147-01-CNE, the National Institutes of Health (NIH) grant R01ES020361 and CA204120, and the Ministry of Science and Technology of the People's Republic of China grant 2016YFC1302500.

The IRB approval is displayed as below:

Yale University

PROTOCOL REVIEW COMMITTEE
Mario Sznol, M.D., Chair
Diane Miranda, PRC Coordinator
P.O. Box 208028
New Haven, Connecticut 06519-1717

Campus address:
2 Church St. So, Suite 113
Telephone: 203-785-5191
Fax: 203-785-2234
diane.miranda@yale.edu

- 440 thyroid cancer cases
- 465 population-based controls

HIGHLIGHT

- The interaction between cell phone use and genetic variants on thyroid cancer was investigated in this study.
- When some genetic variants were present, cell phone use was significantly associated with thyroid cancer.
- The association increased when cell phone use duration and frequency increased.
- Genetic susceptibility may modify the association between cell phone use and thyroid cancer.

Dopo il 2011…

Rischi oncologici

Table 2
Long-term bioassay on 1.8 GHz base station RFR, administered at various doses to male (M) and female (F) Sprague-Dawley rats (Experiment BT 1CEMRF): results on pre-neoplastic and neoplastic lesions of the heart.

Group No.	Dose GSM-RFR	Animals		Hyperplasia Schwann cells		Endocardial Schwannoma		Intramural Schwannoma		Total Schwannoma	
	1.8 GHz (V/m)	Sex	No.	No.	%	No.	%	No.	%	No.	%
I	0	M	412	3	0.7	0	0.0	0	0.0	0	0.0
	(control)	F	405	2	0.5	0	0.0	4	1.0	4	1.0
		M+F	817	5	0.6	0	0.0	4	0.5	4	0.5
II	5	M	401	2	0.5	2	0.5	1	0.2	3	0.7
		F	410	0	0.0	2	0.5	7	1.7	9	2.2
		M+F	811	2	0.2	4	0.5	8	1.0	12	1.5
III	25	M	209	1	0.5	1	0.5	0	0.0	1	0.5
		F	202	0	0.0	0	0.0	1	0.5	1	0.5
		M+F	411	1	0.2	1	0.2	1	0.2	2	0.5
IV	50	M	207	5	2.4	2	1.0	1	0.5	3	1.4*
		F	202	2	1.0	1	0.5	1	0.5	2	1.0
		M+F	409	7	1.7	3	0.7	2	0.5	5	1.2

* Statistically significant $p < .05$ using Fisher exact test.

A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m)
(Falcioni et al, 2018).

Dopo il 2011…

Rischi oncologici

National Toxicology Program
U.S. Department of Health and Human Services

High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats

News Release

Archive - New Contact Information

For more information about this archival news release, please contact Christine Flowers, Director, Office of Communications & Public Liaison at (919) 541-3665.

FOR IMMEDIATE RELEASE
Thursday, November 1, 2018, 10:00 a.m. EDT

Contact: Virginia Guidry, NIEHS
919-541-1993

What did the studies find?

The NTP studies found that high exposure to RFR used by cell phones was associated with:

- **Clear evidence of tumors in the hearts of male rats.** The tumors were malignant schwannomas.
- **Some evidence of tumors in the brains of male rats.** The tumors were malignant gliomas.
- **Some evidence of tumors in the adrenal glands of male rats.** The tumors were benign, malignant, or complex combined pheochromocytoma.

Dopo il 2011…

Rischi sanitari non-oncologici

Alterazioni Riproduttive

- ✓ Alterata morfometria e funzionalità spermatica
- ✓ Alterazioni testicolari
- ✓ Alterazioni ovociti
- ✓ Alterata follicologenesi
- ✓ Alterazioni ormonali

Alterazioni Neurologiche

- ✓ Astrogliosi
- ✓ Alterata maturazione neuronale
- ✓ Alterato flusso cerebrale
- ✓ Demielinizzazione neuroni corticali
- ✓ Alterazioni comportamentali
- ✓ Alterazioni della memoria
- ✓ Danno neuronale
- ✓ Riduzione neuroni dopaminergici
- ✓ Alterazioni vescicole sinaptiche
- ✓ …

Alterazioni Metaboliche

- ✓ Alterata espressione geni regolatori trasporto di glucosio
- ✓ Effetti su metabolismo del glucosio e sull'insulina
- ✓ Alterazioni lipidiche
- ✓ Alterata proliferazione cellule staminali derivate da adipociti
- ✓ Alterazioni epatiche e pancreatiche

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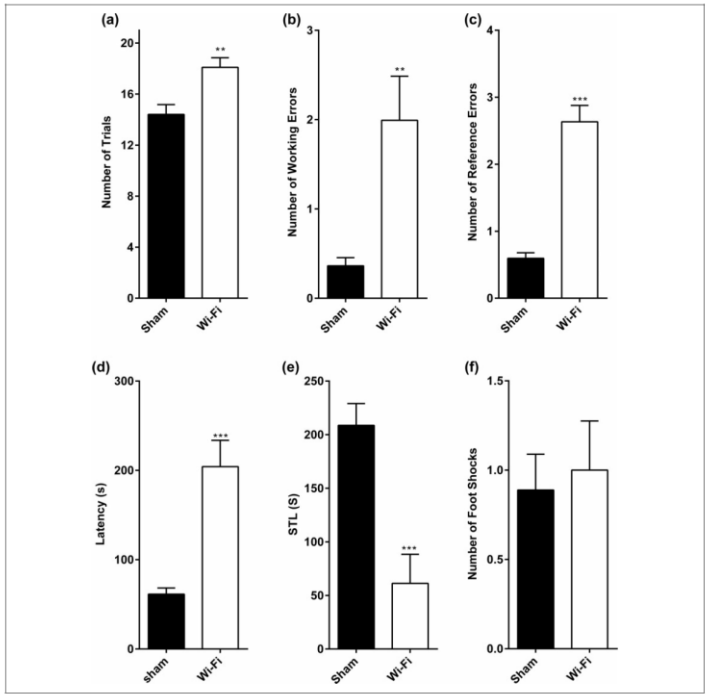
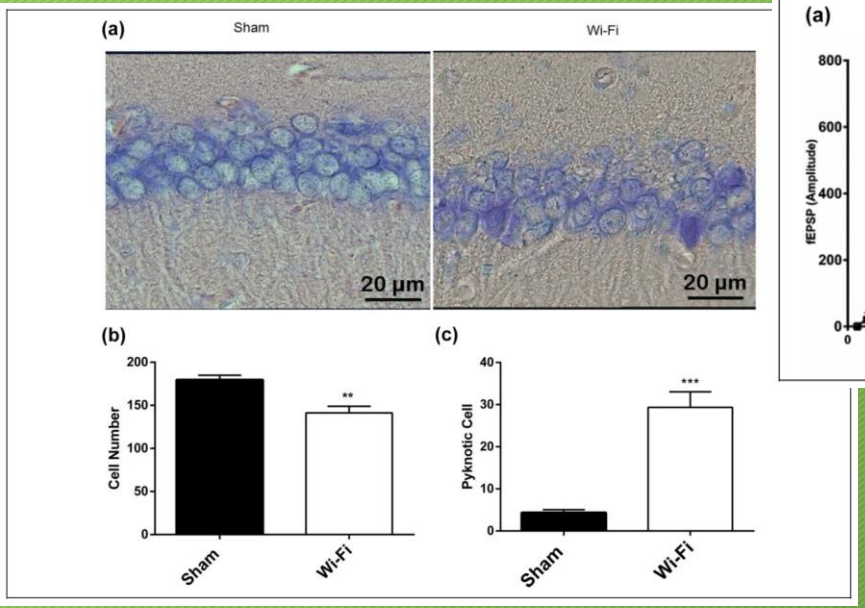
National Institutes of Health

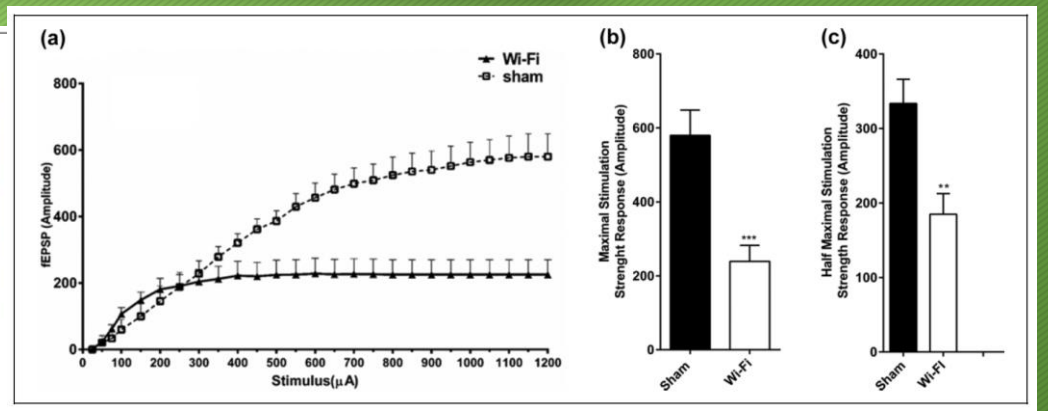
Ratti esposti a un access point (2,45 GHz) collocato a 25 cm dalle loro gabbie per 2 hr/giorno per 40 giorni



Ridotte capacità di apprendimento e di memoria



Ridotto numero di neuroni nell'ippocampo

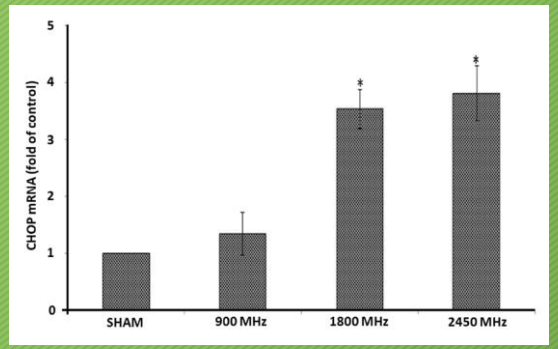


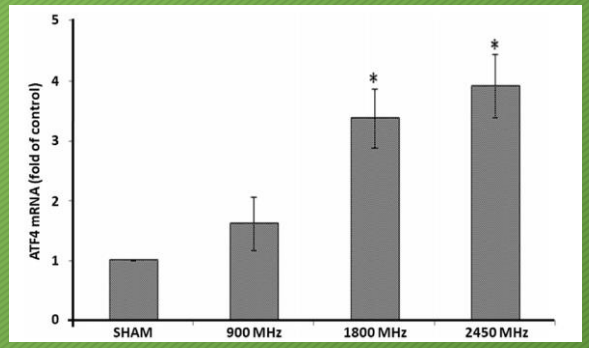
Ridotta eccitabilità sinaptica dei neuroni piramidali

Karimi et al, Toxicology and Industrial Health 2018
doi: 10.1177/0748233718798976

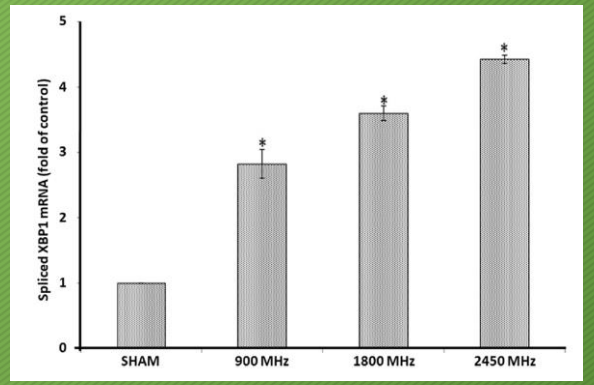
RF-EMF, alterazioni cognitive e mnesiche

Male Wistar rats exposed to microwave radiation for 30 days at 900 MHz, 1800 MHz, and 2450 MHz frequencies





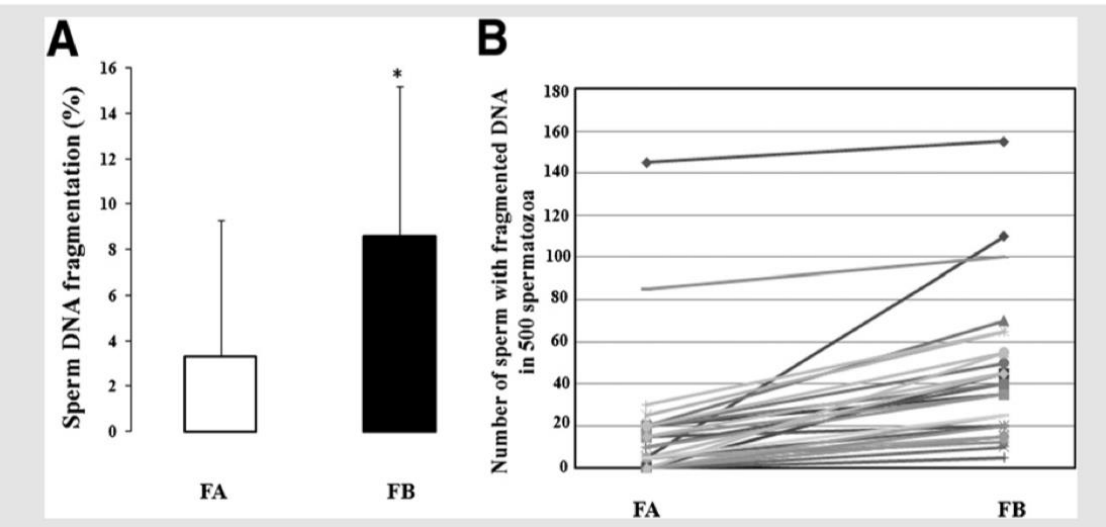
Altered mRNA expression of transcription factors ATF4, CHOP, and XBP1 with increasing microwave frequency

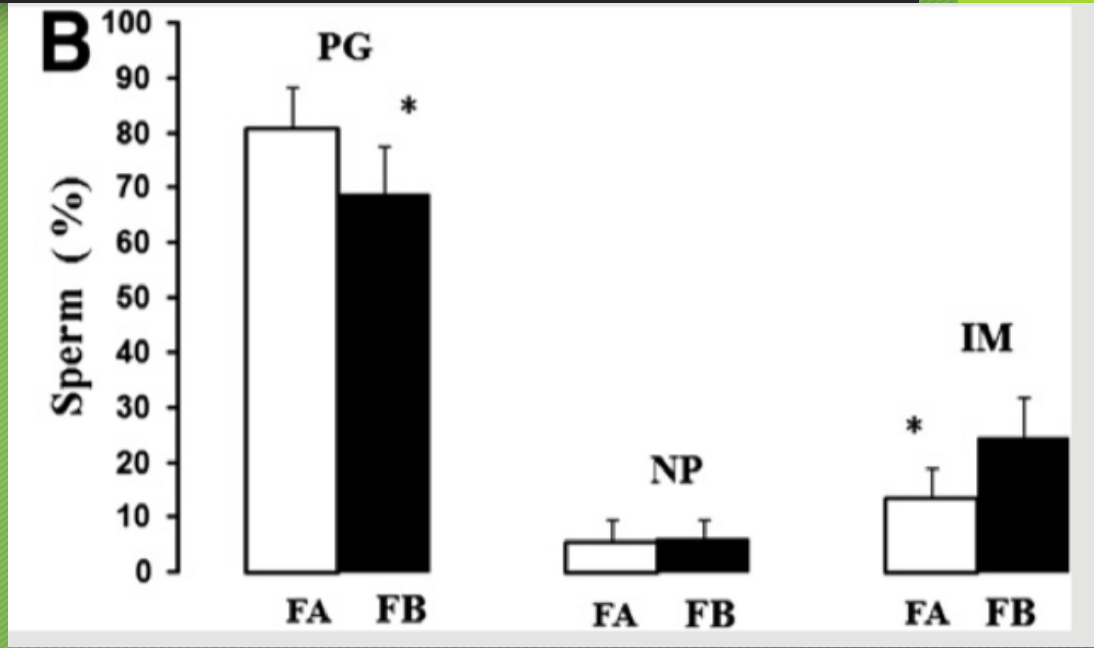


"alterations … might be the possible cause for cognitive impairment and memory dysfunction"

(Kumar et al, 2019)

Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation (Avendano C et al, Fertil Steril 2012).





L'esposizione di campioni di sperma per 4 ore a intensità di molto inferiori ai 6V/m della normativa vigente riduce la motilità degli spermatozoi e aumenta la frammentazione del DNA

DOI 10.1016/j.fertnstert.2011.10.012

Gli studi sulle “nuove” frequenze

Bioelectromagnetics 19:393–413 (1998)

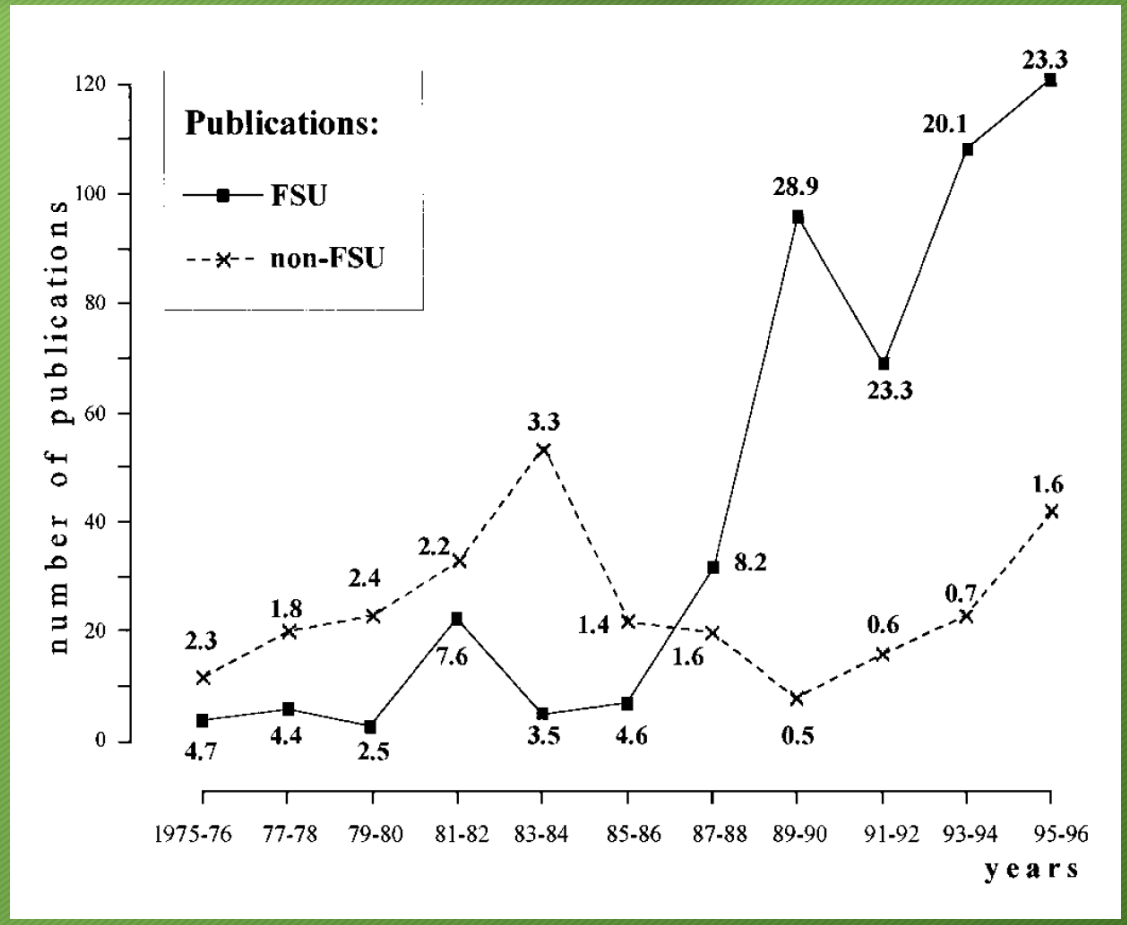
Review Article

Current State and Implications of Research on Biological Effects of Millimeter Waves: A Review of the Literature

Andrei G. Pakhomov,[1]* Yahya Akyel,[1] Olga N. Pakhomova,[1] Bruce E. Stuck,[2] and Michael R. Murphy[3]

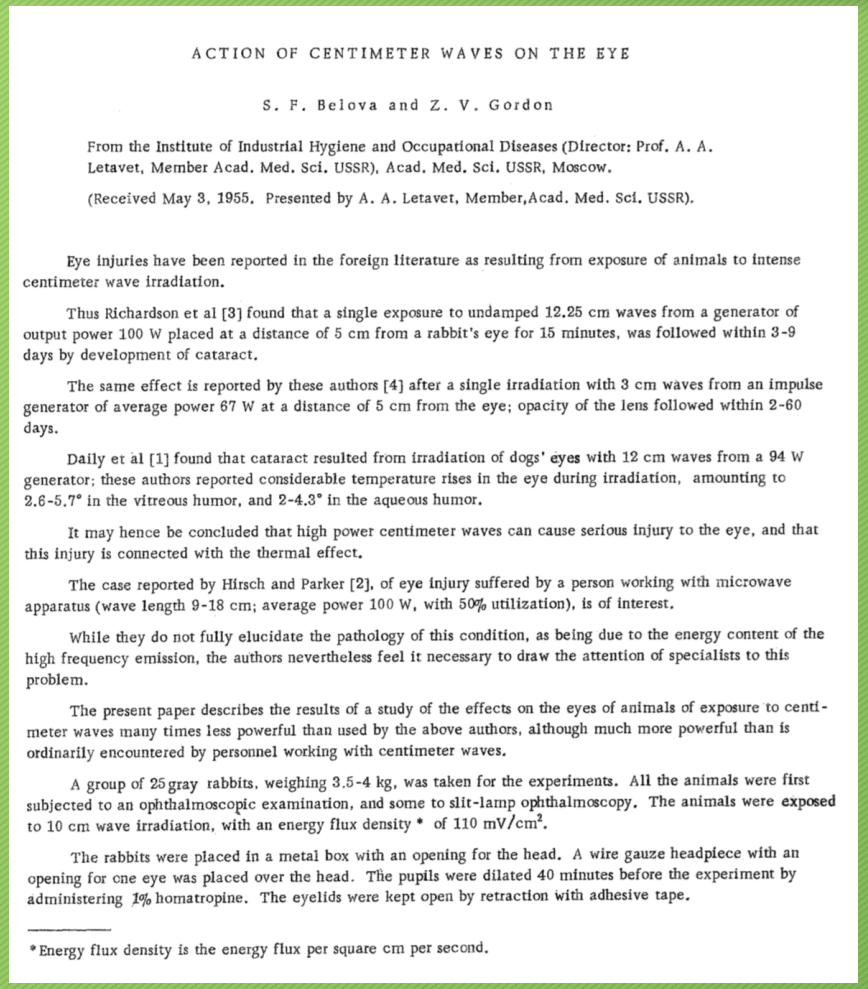
[1]McKesson BioServices, Brooks Air Force Base, San Antonio, Texas
[2]U.S. Army Medical Research Detachment of the Walter Reed Army Institute of Research, Brooks Air Force Base, San Antonio, Texas
[3]Directed Energy Bioeffects Division, Human Effectiveness Directorate, Air Force Research Laboratory, Brooks Air Force Base, San Antonio, Texas

In recent years, research into biological and medical effects of millimeter waves (MMW) has expanded greatly. This paper analyzes general trends in the area and briefly reviews the most significant publications, proceeding from cell-free systems, dosimetry, and spectroscopy issues through cultured cells and isolated organs to animals and humans. The studies reviewed demonstrate effects of low-intensity MMW (10 mW/cm^2 and less) on cell growth and proliferation, activity of enzymes, state of cell genetic apparatus, function of excitable membranes, peripheral receptors, and other biological systems. In animals and humans, local MMW exposure stimulated tissue repair and regeneration, alleviated stress reactions, and facilitated recovery in a wide range of diseases (MMW therapy). Many reported MMW effects could not be readily explained by temperature changes during irradiation. The paper outlines some problems and uncertainties in the MMW research area, identifies tasks for future studies, and discusses possible implications for development of exposure safety criteria and guidelines.
Bioelectromagnetics 19:393–413, 1998.



Gli studi sulle “nuove” frequenze

Le onde centimetriche



ACTION OF CENTIMETER WAVES ON THE EYE

S. F. Belova and Z. V. Gordon

From the Institute of Industrial Hygiene and Occupational Diseases (Director: Prof. A. A. Letavet, Member Acad. Med. Sci. USSR), Acad. Med. Sci. USSR, Moscow.

(Received May 3, 1955. Presented by A. A. Letavet, Member, Acad. Med. Sci. USSR).

Eye injuries have been reported in the foreign literature as resulting from exposure of animals to intense centimeter wave irradiation.

Thus Richardson et al [3] found that a single exposure to undamped 12.25 cm waves from a generator of output power 100 W placed at a distance of 5 cm from a rabbit's eye for 15 minutes, was followed within 3-9 days by development of cataract.

The same effect is reported by these authors [4] after a single irradiation with 3 cm waves from an impulse generator of average power 67 W at a distance of 5 cm from the eye; opacity of the lens followed within 2-60 days.

Daily et al [1] found that cataract resulted from irradiation of dogs' eyes with 12 cm waves from a 94 W generator; these authors reported considerable temperature rises in the eye during irradiation, amounting to 2.6-5.7° in the vitreous humor, and 2-4.3° in the aqueous humor.

It may hence be concluded that high power centimeter waves can cause serious injury to the eye, and that this injury is connected with the thermal effect.

The case reported by Hirsch and Parker [2], of eye injury suffered by a person working with microwave apparatus (wave length 9-18 cm; average power 100 W, with 50% utilization), is of interest.

While they do not fully elucidate the pathology of this condition, as being due to the energy content of the high frequency emission, the authors nevertheless feel it necessary to draw the attention of specialists to this problem.

The present paper describes the results of a study of the effects on the eyes of animals of exposure to centimeter waves many times less powerful than used by the above authors, although much more powerful than is ordinarily encountered by personnel working with centimeter waves.

A group of 25 gray rabbits, weighing 3.5-4 kg, was taken for the experiments. All the animals were first subjected to an ophthalmoscopic examination, and some to slit-lamp ophthalmoscopy. The animals were exposed to 10 cm wave irradiation, with an energy flux density * of 110 mV/cm².

The rabbits were placed in a metal box with an opening for the head. A wire gauze headpiece with an opening for one eye was placed over the head. The pupils were dilated 40 minutes before the experiment by administering 1% homatropine. The eyelids were kept open by retraction with adhesive tape.

*Energy flux density is the energy flux per square cm per second.

3 maggio 1955

“…Centimeter waves can cause serious injury to the eye…”

Gli studi sulle “nuove” frequenze

Le onde centimetriche

JPRS 57209

10 October 1972

HYGIENIC PROBLEMS OF THE EFFECT OF MICROWAVE ELECTROMAGNETIC FIELDS ON THE BODY

By

M. P. Troyanskiy

JOINT PUBLICATIONS RESEARCH SERVICE

Investigations into the effect of a microwave field on the human body and animals primarily confirm the fact that microwave radiations possess a high biological effectiveness over a wide range of wavelengths. The nature

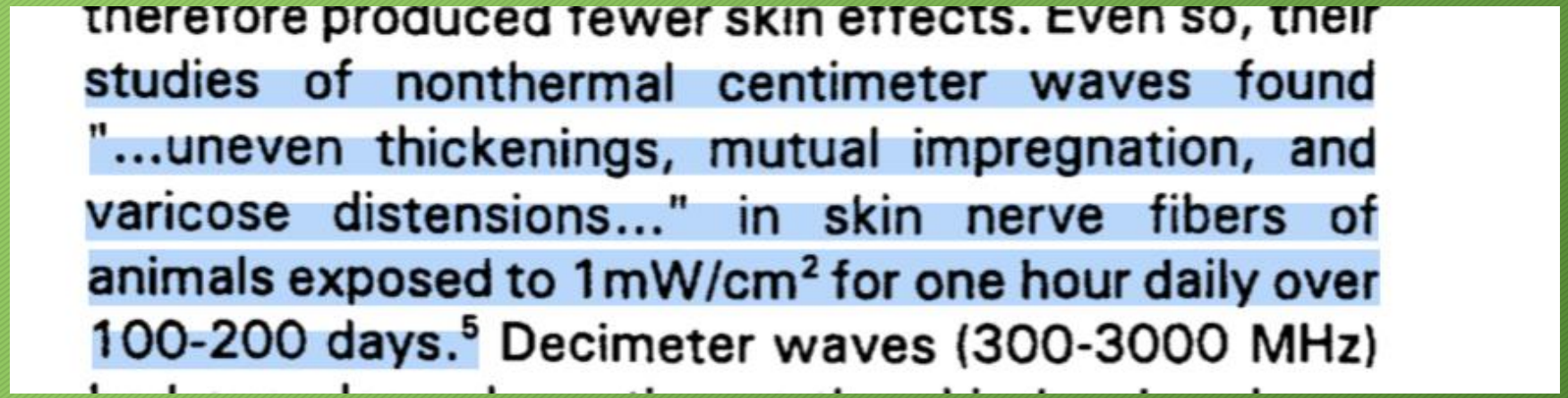
continuous, in a fixed beam or rotating antenna mode, and so on). The greatest interest as well as the most practical value lies in data on non-thermal -- specific -- microwave field effects*. In its most general form, the specific effect of a microwave field appears in functional changes in the nervous, cardiovascular, and other systems. This is confirmed in an experiment on animals using conditioned reflex procedures, electroencephalo-

Data obtained by studying volunteers is of great value. An analysis of the body changes under the influence of microwave irradiation indicates that the damage pattern is primarily determined by the changes in the nervous system. It is therefore natural that the attention of researchers,

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Letavet, A.A. and Z.V. Gordon, eds. The Biological Action of Ultrahigh Frequencies. USSR: Academy of Medical Sciences, 1960.



therefore produced fewer skin effects. Even so, their studies of nonthermal centimeter waves found "...uneven thickenings, mutual impregnation, and varicose distensions..." in skin nerve fibers of animals exposed to 1 mW/cm^2 for one hour daily over 100-200 days.[5] Decimeter waves (300-3000 MHz)

Gli studi sulle “nuove” frequenze

Le onde centimetriche

1970

79. Prevention of the pathogenic effects of centrimetric radiation

PEPERSACK J. P., *Belgium*

The centrimetric radiation emitted by radar apparatus may have thermal and biological effects on the human organism. Beyond a certain threshold these effects may become dangerous, particularly to the eyes, testicles, lungs, bladder and digestive tract.

Accordingly, preventive measures are necessary. Operators must be protected as much as possible from the harmful radiations by using screens and special materials.

Their working conditions should be accurately examined. Periodical medical examination is necessary in order to detect any damage that may nevertheless occur.

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Jan 1980

Soviet and Eastern European Research on Biological Effects of Microwave Radiation

DONALD I. MCREE

TABLE II

SOME RESULTS OF EXPERIMENTAL STUDIES ON THE BIOLOGICAL EFFECTS OF VERY LOW INTENSITY MICROWAVES (UP TO 150 $\mu W/cm^2$) [6]

Investigated Function	Radiation intensity $\mu W/cm^2$	Character of Changes	Investigator
Body Weight	150	Lag in weight (chronic experiment)	V. V. Markov
Arterial Pressure	150	Biphasic course with marked hypotension (chronic experiment)	V. V. Markov
Reproductive Function	150	Decreased fertility, decreased litter size, increased number of defective progeny, increased embryonic mortality etc. (chronic experiment)	A. N. Bereznitskaya *et al.*
Central nervous system	10–20 and higher	1) EEG changes with predominant synchronization (acute experiment)	Z. V. Gvozdikcova *et al.*
	150	2) Bivariant shifts with predominance of activation (acute experiment)	
	150	3) Bivariant shifts in the subcortical-basal structures (chronic experiment)	
Electromyography	150	Increased electrical activity of active unit	V. V. Markov
Hypothalamus-adrenal cortex system	150	1) Weight change of endocrine glands hypophysis adrenals)	N. K. Demokidova
		2) Change in the neurosecretory function of the hypothalamus	
		3) Tendency for increased levels of norepinephrine in the adrenals	
Metabolism	150	Changes in water and electrolyte metabolism (Na, K, water, and total nitrogen excretion)	N. K. Demokidova
Immunology	150	Inhibition of neutrophils phagocytic activity	A. P. Vokova and V. V. Markov

Gli studi sulle “nuove” frequenze

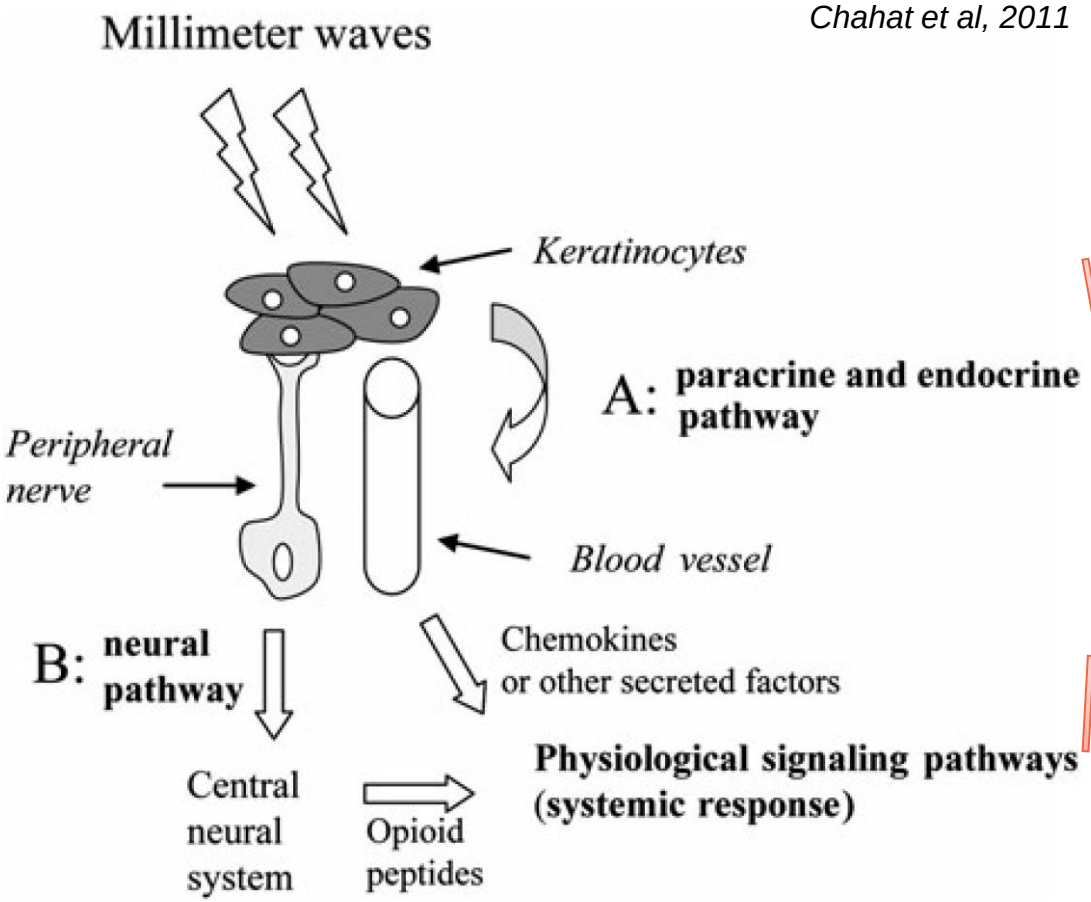
Anni ‘50-’80:

Risultati derivati da osservazioni cliniche / anatomo-fisiologiche e non biologico-molecolari ma concordanti su due punti fondamentali:

- ✓ Presenza di effetti biologici anche INDIPENDENTI dall’effetto termico (l’unico valutato da ICNIRP)
- ✓ Effetti SISTEMICI

Gli studi sulle “nuove” frequenze

Le onde millimetriche



Chahat et al, 2011

Effetti locali

Effetti sistemici

THE RADIATION SAFETY JOURNAL
HEALTH PHYSICS

Sep. 2018
doi 10.1097/HP.0000000000000930

SYSTEMATIC DERIVATION OF SAFETY LIMITS FOR TIME-VARYING 5G RADIOFREQUENCY EXPOSURE BASED ON ANALYTICAL MODELS AND THERMAL DOSE

Esra Neufeld[1] and Niels Kuster[1,2]

The recommendations in the ICNIRP guidelines limit the power density during short pulses to 1,000 times the limit for the time-averaged incident power density. The IEEE standard limits the radiant exposure (energy absorption per unit area) during any 100 ms to one-fifth of the total radiant exposure for the whole averaging time. The physical or biological rationales for these limits, however, are not provided.

CONCLUSION

Transient exposure with high PAR can lead to large temperature oscillations, with peak temperature increases in the skin reaching tens of degrees, thus exceeding tissue damage thresholds after short exposure durations. Thresholds for fluence alone do not guarantee safety. In this paper, a 10 ms to allow for rapidly modulated signals. Another conclusion of this study is that the current ICNIRP (1998) and IEEE (2005, 2010) guidelines urgently need to be revised, as the duty cycle of 1,000 currently tolerated can produce unacceptable temperature increases that may result in permanent tissue damage.

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Electromagnetic Biology and Medicine, 31(3): 223–232, 2012

ISSN: 1536-8378 print / 1536-8386 online
DOI: 10.3109/15368378.2012.700293

informa
healthcare

2012

Impact of Microwave at X-Band in the aetiology of male infertility

Sanjay Kumar[1,2], J. Behari[1] & Rashmi Sisodia[2]

[1]*Bioelectromagnetic Laboratory, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India, and* [2]*Department of Zoology, Neurobiology Laboratory, University of Rajasthan, Jaipur, India*

Reports of declining male fertility have renewed interest in assessing the role of environmental and occupational exposures to electromagnetic fields (EMFs) in the aetiology of human infertility. Testicular functions are particularly susceptible to electromagnetic fields. The aim of the present work was to investigate the effect of 10-GHz EMF on male albino rat's reproductive system and to investigate the possible causative factor for such effect of exposure. The study was carried out in two groups of 70-day old adult male albino rats: a sham-exposed and a 10-GHz-exposed group (2 h a day for 45 days). Immediately after completion of the exposure, animals were sacrificed and sperms were extracted from the cauda and caput part of testis for the analysis of MDA, melatonin, and creatine kinase. Creatine kinase results revealed an increased level of phosphorylation that converts creatine to creatine phosphate in sperms after EMF exposure. EMF exposure also reduced the level of melatonin and MDA. It is concluded that microwave exposure could adversely affect male fertility by reducing availability of the above parameters. These results are indications of deleterious effects of these radiations on reproductive pattern of male rats.

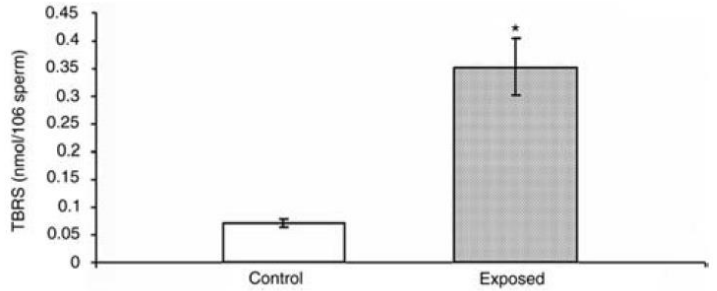


FIGURE 2 Effects of electromagnetic field on MDA production in sperm. Data were presented as mean ± SEM. *significantly different form the control ($P < 0.05$).

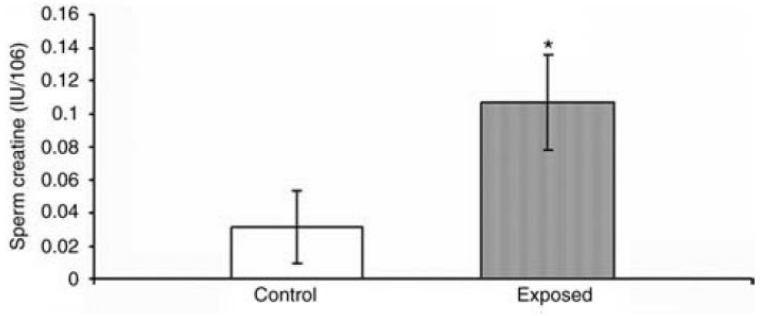


FIGURE 4 Creatine kinase activity in sperm fractions of control and 10 GHz-exposed group. Results expressed as IU/106 spermatozoa ± standard deviation. *Significantly different form the control ($P < 0.05$).

Gli studi sulle “nuove” frequenze

Le onde centimetriche

Journal of Radiation Research, 2015, 56, 261–268
doi: 10.1093/jrr/rru097 Advance Access Publication 30 October 2014

Effects of fetal microwave radiation exposure on offspring behavior in mice

Yanchun ZHANG, Zhihui LI, Yan GAO* and Chenggang ZHANG

2015

Topi esposti in utero a 9.4 GHz durante la gravidanza:

- aumento comportamenti di tipo ansioso
- riduzione apprendimento e memoria (maschi)

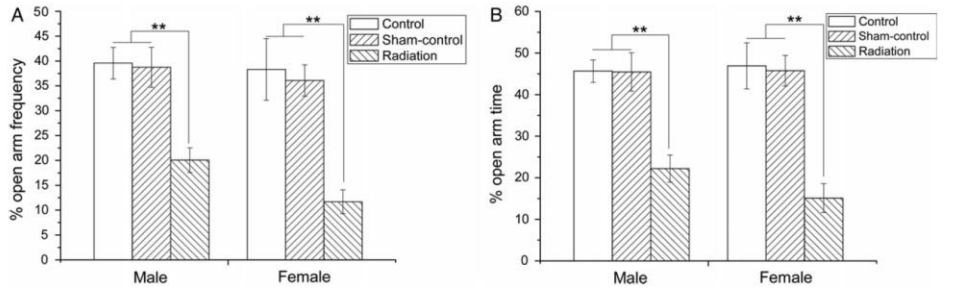


Fig. 2. The effect of fetal microwave exposure on anxiety as determined using EPM. Compared with the Control and Sham-control mice, the offspring of exposed mice had a lower percent open arm frequency (**A**) and percent open arm time (**B**), suggesting anxiety-related behavior, in accordance with the OFT. Data are means ± SEM, 12 animals per group; $^{**}P < 0.01$, vs corresponding values in Control and Sham-control groups.

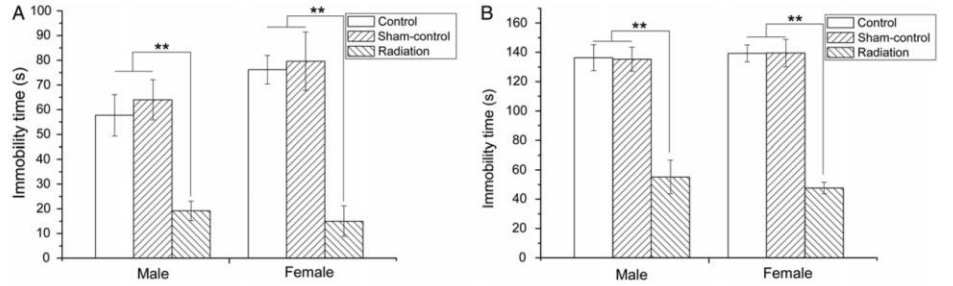


Fig. 3. The effect of fetal microwave exposure on depression based on the TST and FST. Radiation exposure decreased the immobility time compared with the Control and Sham-control mice in TST (**A**) and FST (**B**), illustrating the decreased depression-related behavior. Data are means ± SEM, 12 animals per group; $^{**}P < 0.01$, versus corresponding values in Control and Sham-Control groups.

Gli studi sulle “nuove” frequenze

Le onde millimetriche

Pubblicazioni ultimo decennio

- Alterazioni dell’espressione genica
- Incremento della temperatura cutanea
- Stimolazione proliferazione cellulare
- Alterazione funzionalità membrana cellulare
- Alterazioni neuro-muscolari

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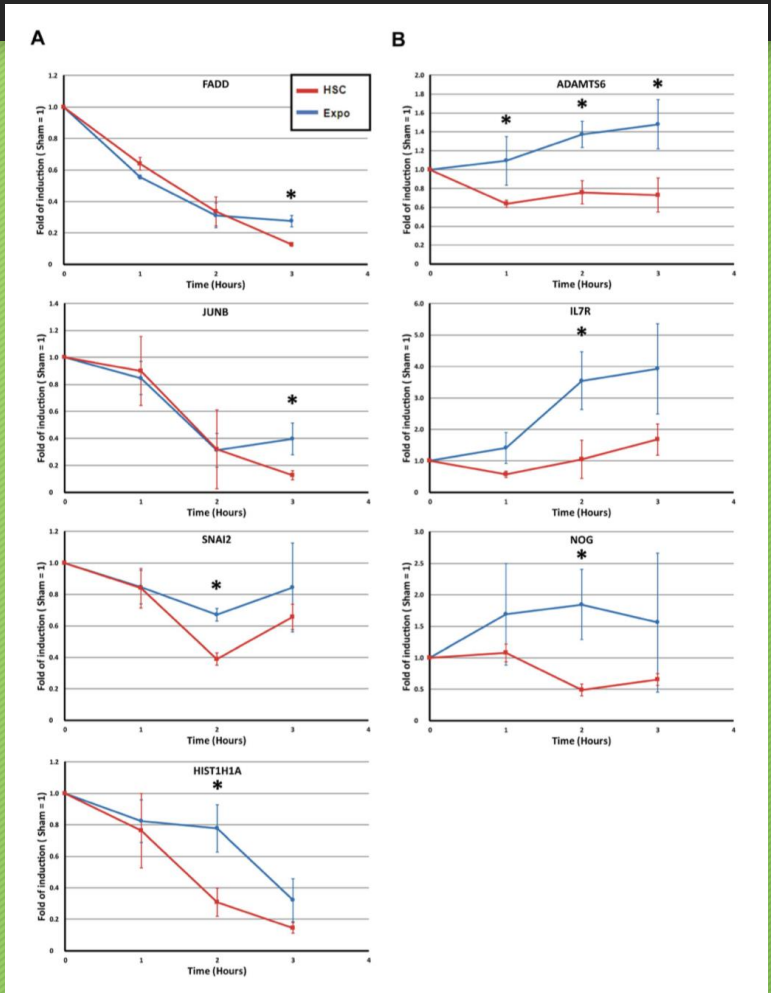
Gli studi sulle “nuove” frequenze

Le onde millimetriche



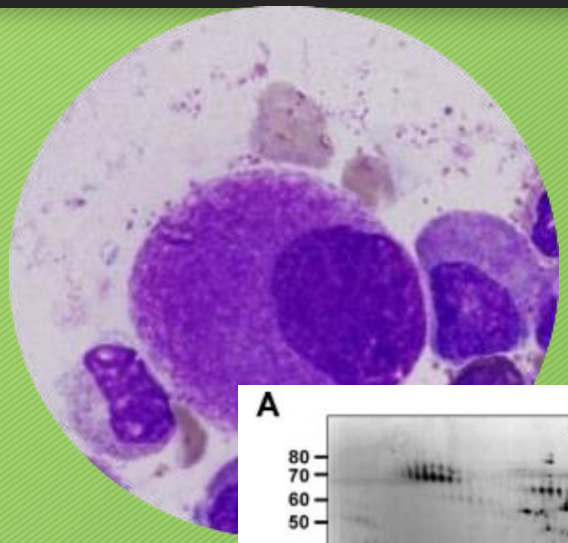
In cheratinociti umani le MMW

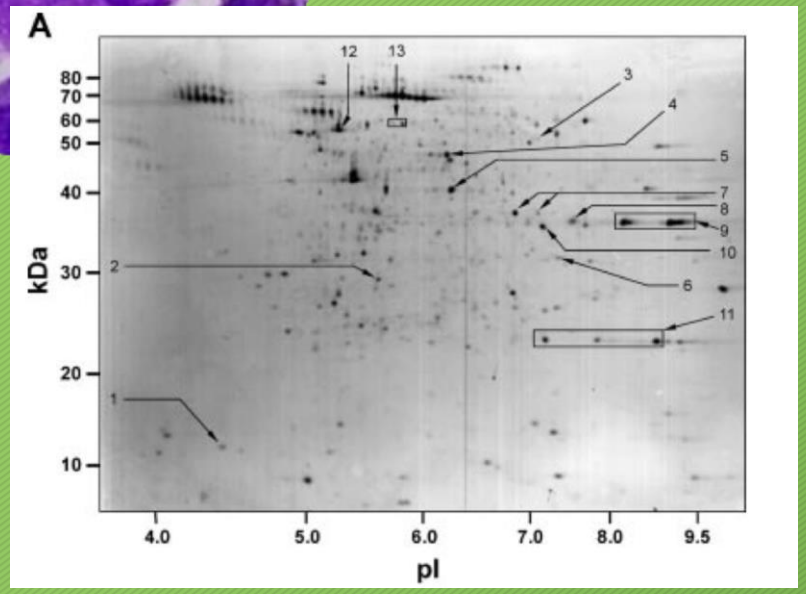
- alterano l’espressione di 7 geni (ADAMTS6, NOG, IL7R, FADD, JUNB, SNAI2, HIST1H1A)
- 3 di questi geni (ADAMTS6, NOG, IL7R) codificano l’espressione di proteine specificamente indotte da MMW e coinvolte nella sintesi proteica e nell’omeostasi del reticolo endoplasmico

Habauzit et al, 2014

Gli studi sulle “nuove” frequenze

Le onde millimetriche



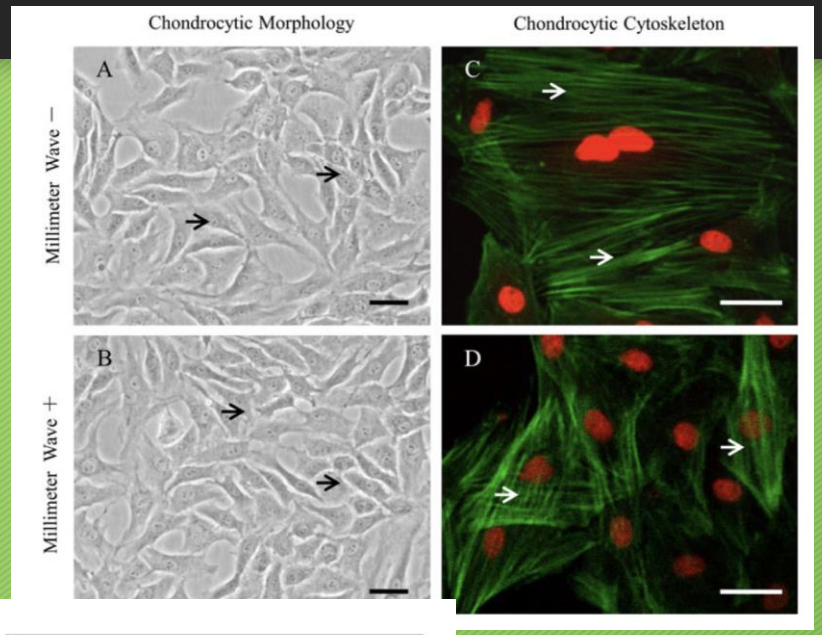


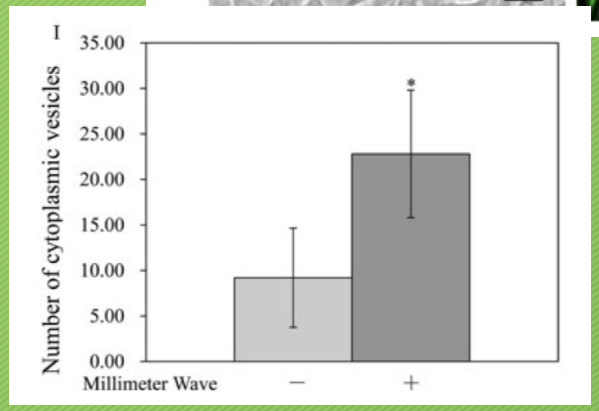
I macrofagi di ratti esposti a MMW (35 GHz) mostrano aumentata espressione genica di 11 proteine e alterazioni strutturali in 3 proteine coinvolte in processi infiammatori, stress ossidativo e metabolismo energetico

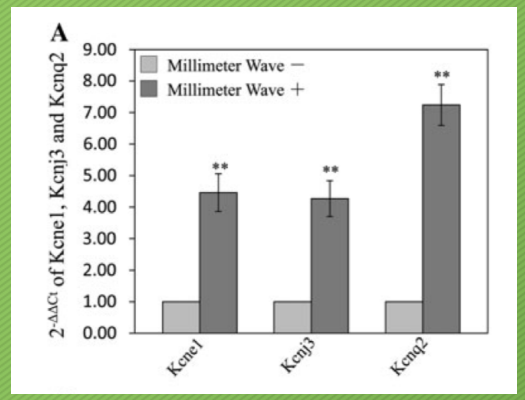
Sypniewska et al, 2010

Gli studi sulle “nuove” frequenze

Le onde millimetriche







Le MMW stimolano la proliferazione cellulare di condrociti (alterati morfologicamente per espansione dei mitocondri e del RER) e la sintesi di matrice extracellulare regolando l’attività dei canali del K+

Effetti espressione dell’alterata omeostasi del metabolismo energetico

Li X et al 2013

5G: Rischi biologici (non-termici) delle onde millimetriche

doi.org/10.1038/s41598-019-45662-6

Untargeted metabolomics unveil alterations of biomembranes permeability in human HaCaT keratinocytes upon 60 GHz millimeter-wave exposure

Pierre Le Pogam[1], Yann Le Page[2], Denis Habauzit[2], Mickael Doué[1], Maxim Zhadobov[1], Ronan Sauleau[1], Yves Le Dréan[2] & David Rondeau[1,3]

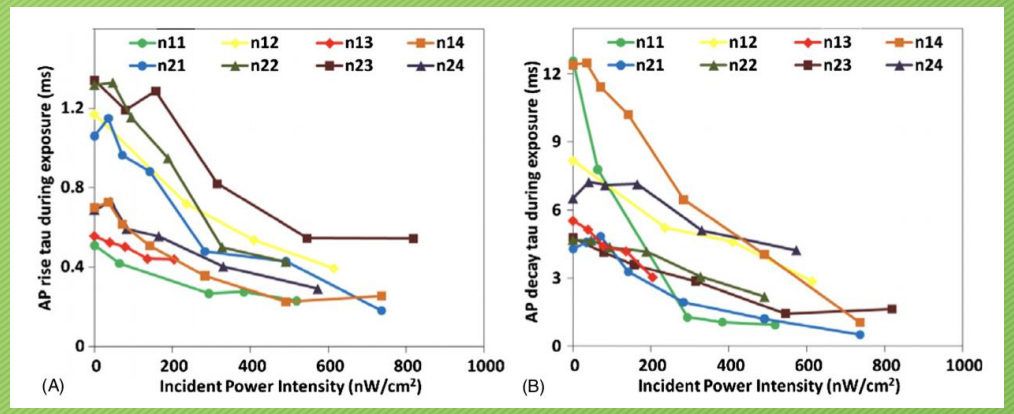
Finally, we can conclude that our model, purely *in vitro*, haven't to be lead to a direct extrapolation of our results at the organism level. In the future, further studies will be necessary to assess MMW bioeffects on animal models and to investigate potential dysregulations induced by lower IPD values prior to the wide-scale deployment of technologies based on these specific frequencies.

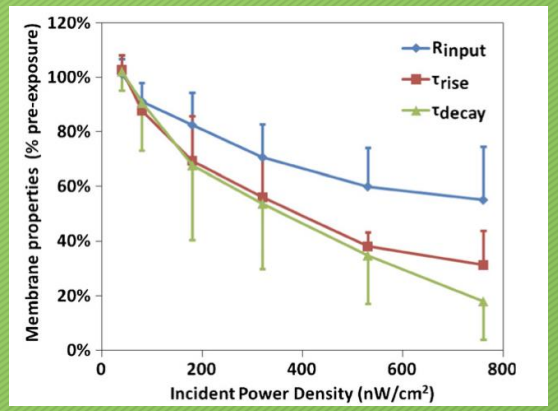
Conclusion

As far as can be ascertained, this report represents the first metabolomic investigation focusing on the effects of MMW. To get as wide an insight into cellular processes as possible, a joint metabolomic and lipidomic profiling strategy was designed and the extra and intracellular contents were discriminated. It appeared that all lipidomic sequences and intracellular metabolomic profiles were slightly affected by MMW but drastic changes in extracellular metabolomic sequences could be evidenced. During these experiments, we put great emphasis on

Gli studi sulle “nuove” frequenze

Le onde millimetriche





In neuroni corticali piramidali l’applicazione di MMW a livelli di intensità molto inferiori ai limiti di legge alterano la funzionalità neuronale e le proprietà di membrana.

L’effetto non è spiegabile con il solo aumento di temperatura ed è legato all’assorbimento delle MMW da parte del tessuto nervoso, attraverso interazioni dirette con la membrana plasmatica neuronale

Pikov V et al, 2010

Gli studi sulle “nuove” frequenze

Le onde millimetriche

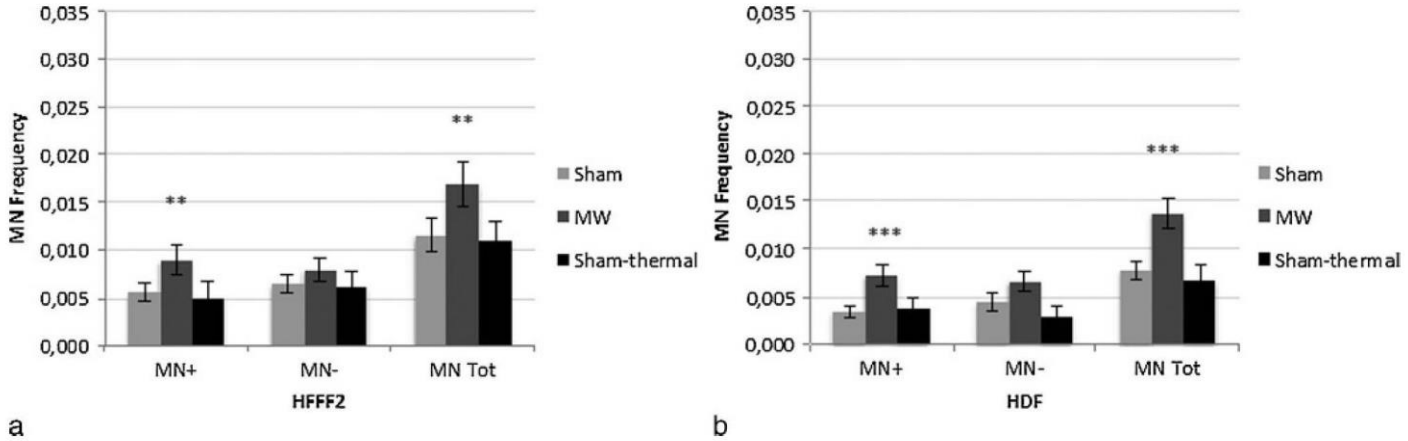


Fig. 6. CREST analysis. A significant increase in MN+ and MN total (Tot) in irradiated samples was observed in (a) fetal and (b) adult fibroblasts. Data are representative of four independent experiments and bars denote SE, $**p < 0.01$, $***p < 0.001$.

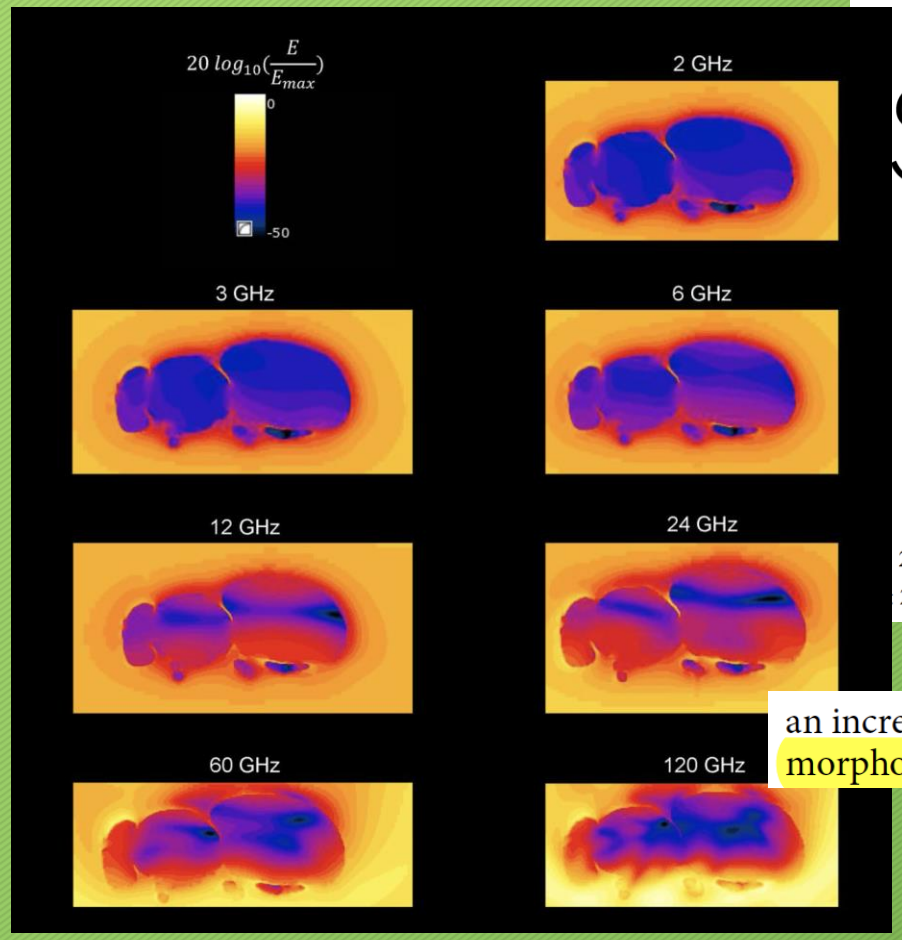
L’esposizione di fibroblasti umani (adulti e fetali) a 25 GHz per 20 minuti determina effetti sui cromosomi (aneuploidia) ben noti come predisponenti al cancro

“The increased number of aneuploid cells seems to predispose cells to malignant transformation”

Considering everyone’s constant daily exposure to MW radiation, the results … obtained in this study could contribute to the evaluation of the risks for human health”

Franchini V et al, 2018

5G: Effetti possibili sulle api



www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz

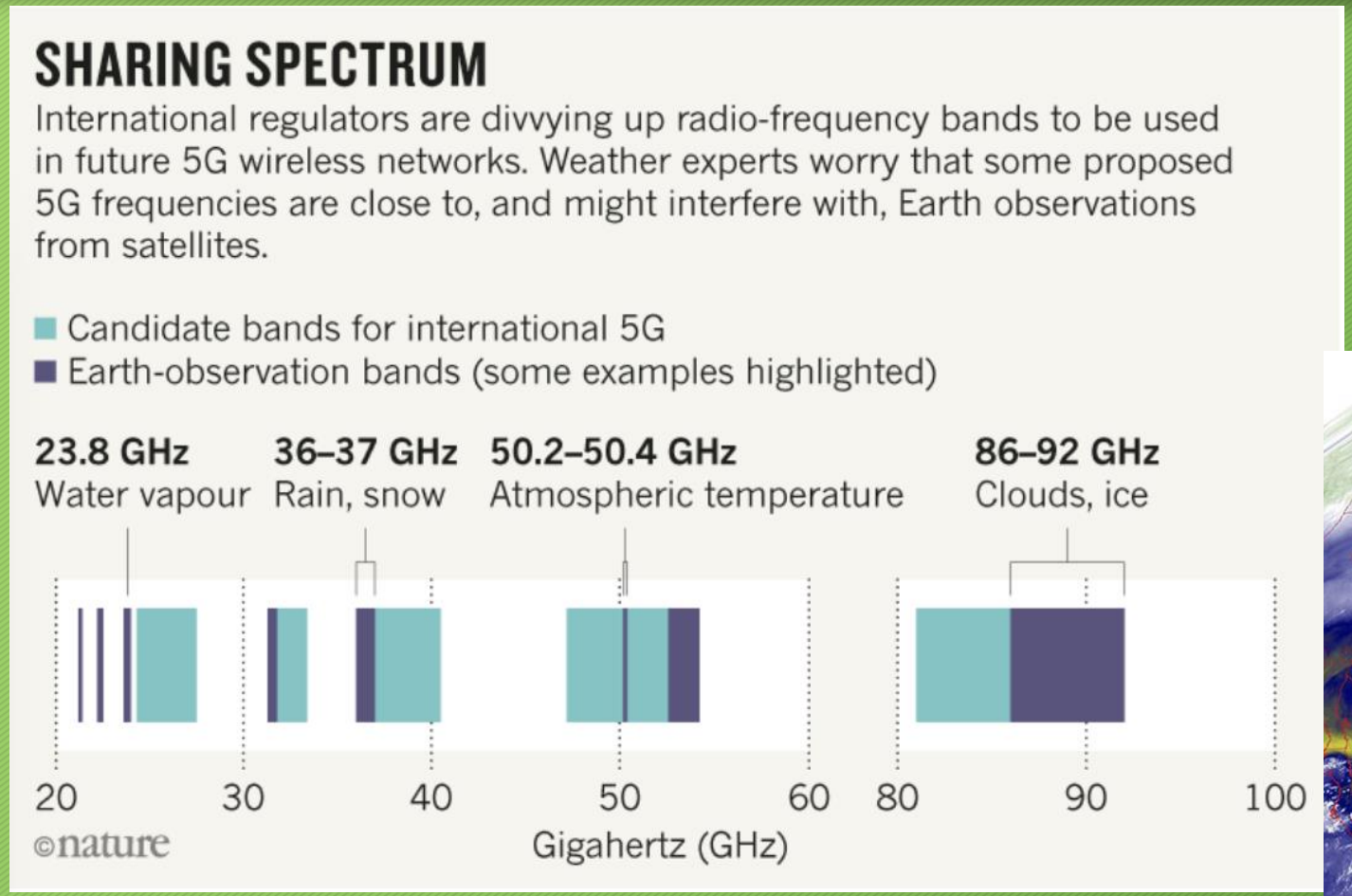
27 September 2017
20 February 2018

Arno Thielens[1,2], Duncan Bell[3], David B. Mortimore[4], Mark K. Greco[5], Luc Martens[1] & Wout Joseph[1]

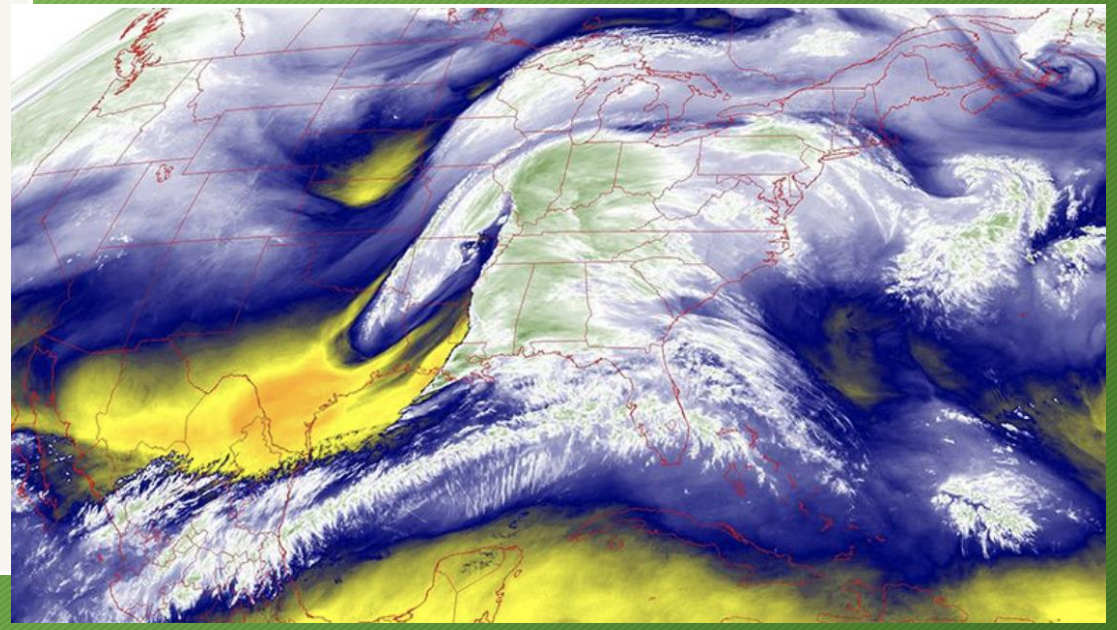
an increase in absorbed power between 3–370%. This could lead to changes in insect behaviour, physiology, and morphology over time due to an increase in body temperatures, from dielectric heating. The studied insects that

DOI:10.1038/s41598-018-22271-3

Gli altri rischi del 5G.
La “tempesta perfetta”…



nature
International journal of science



Gli altri rischi del 5G.
La “sicurezza nazionale”…

AUDIZIONE DI VECCHIONE (DIS)

Sicurezza: la mappa degli 007 sui rischi del 5G

di Marco Ludovico

(thodonal - stock.adobe.com)

3' di lettura

«Il 5G è un’opportunità straordinaria di sviluppare il fatturato per tutti gli operatori economici di settore. Ma è potenzialmente foriero di rischi per la sicurezza nazionale». Gennaro Vecchione, direttore del Dis (dipartimento informazioni e sicurezza) nell’audizione di ieri, mercoledì 12 giugno in commissione Trasporti alla Camera ha tracciato il quadro delle criticità. Sono molte, ampie e rischiose: «Occorre intervenire al più presto con misure efficaci», ha spiegato.

Il Sole 24 ORE
Italia

5G e RF-EMF: rischio sanitario e ambientale emergente

European Commission

Scientific Committee on Health, Environmental and Emerging Risks

SCHEER

Statement on emerging health and environmental issues (2018)

Topic	**Potential effects on wildlife of increases in electromagnetic radiation**
Initiator(s)	Marian Scott
Sources	2
Causative factors	e
(see section 2section 2 of this document)	"On the horizon, a new generation of even shorter high frequency 5G wavelengths is being proposed to power the Internet of Things (IoT). The IoT promises us convenient and easy lifestyles with a massive 5G interconnected telecommunications network. However, the expansion of broadband with shorter wavelength radiofrequency radiation highlights the concern that health and safety issues remain unknown. Controversy

Background including reliability of data, a key reference if possible any other reasons for concern.	5G networks will soon be rolled out for mobile phone and smart device users. How exposure to electromagnetic fields could affect humans remains a controversial area, and studies have not yielded clear evidence of the impact on mammals, birds or insects. The lack of clear evidence to inform the development of exposure guidelines to 5G technology leaves open the possibility of unintended biological consequences.

THURSDAY, 04 APRIL 2019

THE BRUSSELS TIMES

Radiation concerns halt Brussels 5G development, for now

Monday, 01 April 2019 10:54

© Belga

Plans for a pilot project to provide high-speed 5G wireless internet in Brussels have been halted due to fears for the health of citizens, according to reports.

"I cittadini di Bruxelles non sono cavie la cui salute possa essere venduta per profitto".

Céline Fremault, Ministro per l'Ambiente, Belgio

FINANCIAL TIMES

February 12, 2020

Switzerland halts rollout of 5G over health concerns

The country's environment agency has called time on the use of all new towers

© AFP via Getty Images

Sam Jones in Zurich FEBRUARY 12 2020

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"Switzerland, one of the world's leaders in the rollout of 5G mobile technology, has placed an indefinite moratorium on the use of its new network because of health concerns".

Conclusioni (1)

Le evidenze sugli effetti biologici dei RF-EMF si stanno progressivamente accumulando e, nonostante la presenza di aspetti ancora da chiarire, dimostrano l'esistenza di interazioni a più livelli tra RF-EMF e sistemi biologici e la possibilità di effetti oncologici e non oncologici (soprattutto riproduttivi, metabolici, neurologici)

L'introduzione del 5G determinerà un incremento dell'esposizione e l'utilizzo di frequenze / tecnologie per le quali non abbiamo ancora normative e tecniche di monitoraggio validate e affidabili

Conclusioni (2)

Particolari preoccupazioni derivano dalla maggiore vulnerabilità in età pediatrica e dagli effetti a livello cellulare e molecolare (stress ossidativo, danno al DNA, alterazioni dell'espressione genica, influenza sulla riproduzione cellulare)

Nonostante siano necessari ulteriori studi, sottostimare i risultati già disponibili non appare eticamente giustificabile, perché significherebbe accettare che un pericolo potenziale possa essere verificato solo a posteriori, dopo che gli effetti dei campi RF-EMF avranno avuto tempo e modo di generare danni

Conclusioni (3)

I risultati già disponibili sono sufficienti ad invocare il principio di precauzione, anche considerato l'elevato numero di soggetti esposti e vulnerabili e le possibili interazioni con sorgenti inquinanti di altro tipo

Il rispetto del principio OMS "health in all policies" dovrebbe imporre, prima dell'avvio del 5G su larga scala:

- Un adeguato approfondimento dei possibili effetti sanitari ancora in discussione
- L'adeguamento della normativa vigente
- L'adozione di tutte le misure utili a ridurre l'esposizione e ad adottare misure di prevenzione primaria

Conclusioni (4)

La maggior parte di noi NON ha la necessità impellente del 5G e, con ogni evidenza, questa necessità appare essere impellente solo per l'industria

Indipendentemente dal possibile impatto sanitario, ci sarà certamente una maggiore necessità di estrazione di materie prime (soprattutto metalli), una maggiore richiesta di energia, maggiori necessità di smaltimento di sostanze pericolose e un cospicuo investimento economico che potrebbe essere impiegato per rendere le attuali tecnologie più sostenibili

5G: scelta rischiosa, prematura, insostenibile

Grazie per l'attenzione

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