

Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria dell'energia

EFFETTO DEI CAMPI ELETTROMAGNETICI SU CELLULE TUMORALI ANALISI SPERIMENTALE

Tutor universitario: Ing. *Riccardo Torchio*

Laureando: *Marina Vitali*

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Tumor Treating Fields: At the Crossroads Between Physics and Biology for Cancer Treatment

Francesca A. Carrieri¹, Caleb Smack¹, Ismaeel Siddiqui¹, Lawrence R. Kleinberg¹ and Phuoc T. Tran^{1,2,3,4*}

Case Report: End-Stage Recurrent Glioblastoma Treated With a New Noninvasive Non-Contact Oncomagnetic Device

David S. Baskin^{1,2,3*}, Martyn A. Sharpe^{1,2}, Lisa Nguyen^{1,2} and Santosh A. Helekar^{1,2,3}

¹ Kenneth R. Peak Brain and Pituitary Tumor Treatment Center, Department of Neurosurgery, Houston Methodist Neurological Institute, Houston, TX, United States, ² Department of Neurosurgery, Houston Methodist Research Institute, Houston, TX, United States, ³ Department of Neurosurgery, Weill Cornell Medical College, New York, NY, United States

Tumor-Treating Fields: A Fourth Modality in Cancer Treatment

Elijah J. Mun¹, Hani M. Babiker², Uri Weinberg³, Eilon D. Kirson³, and Daniel D. Von Hoff^{4,5}

A Review on Tumor-Treating Fields (TTFields): Clinical Implications Inferred From Computational Modeling

Cornelia Wenger^{}, Pedro C. Miranda^{}, Ricardo Salvador^{}, Axel Thielscher, Zeev Bomzon, Moshe Giladi, Maciej M. Mrugala, and Anders R. Korshoej

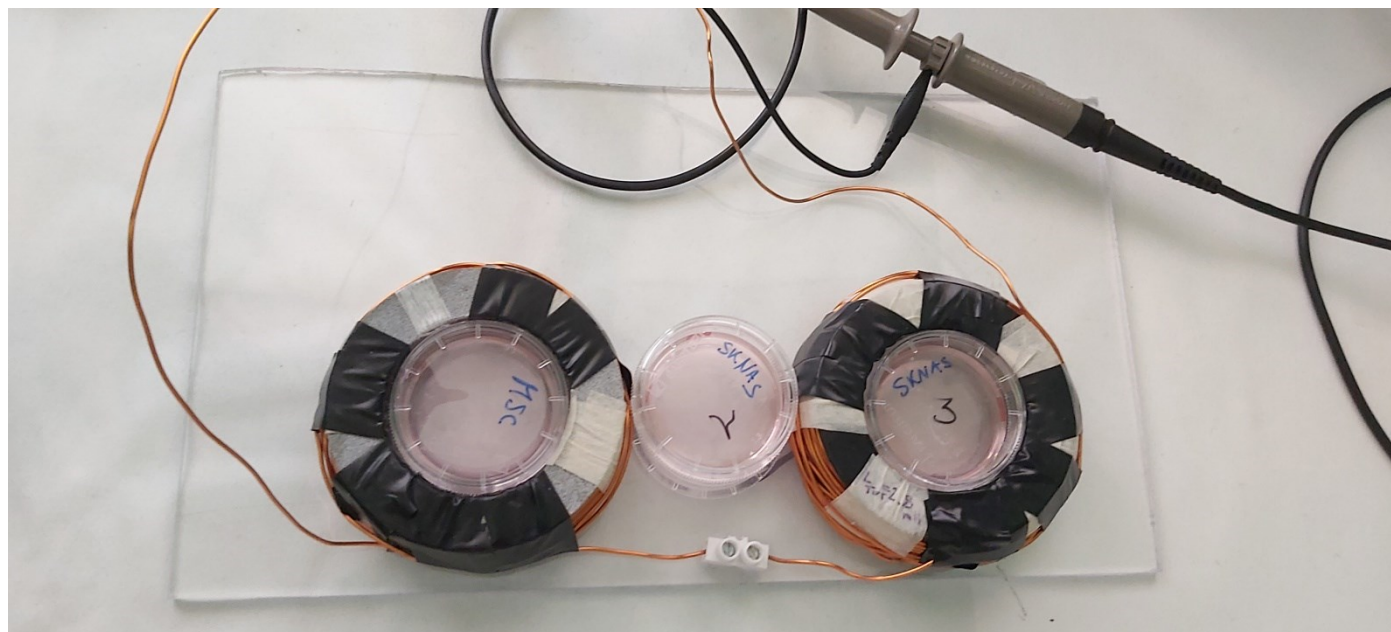
Selective induction of rapid cytotoxic effect in glioblastoma cells by oscillating magnetic fields

Santosh A. Helekar^{1,2,3,4}  · Shashank Hambarde^{1,2,3} · Omkar B. Ijare^{1,2,3} · Kumar Pichumani^{1,2,3,4} · David S. Baskin^{1,2,3,4} · Martyn A. Sharpe^{1,2,3}

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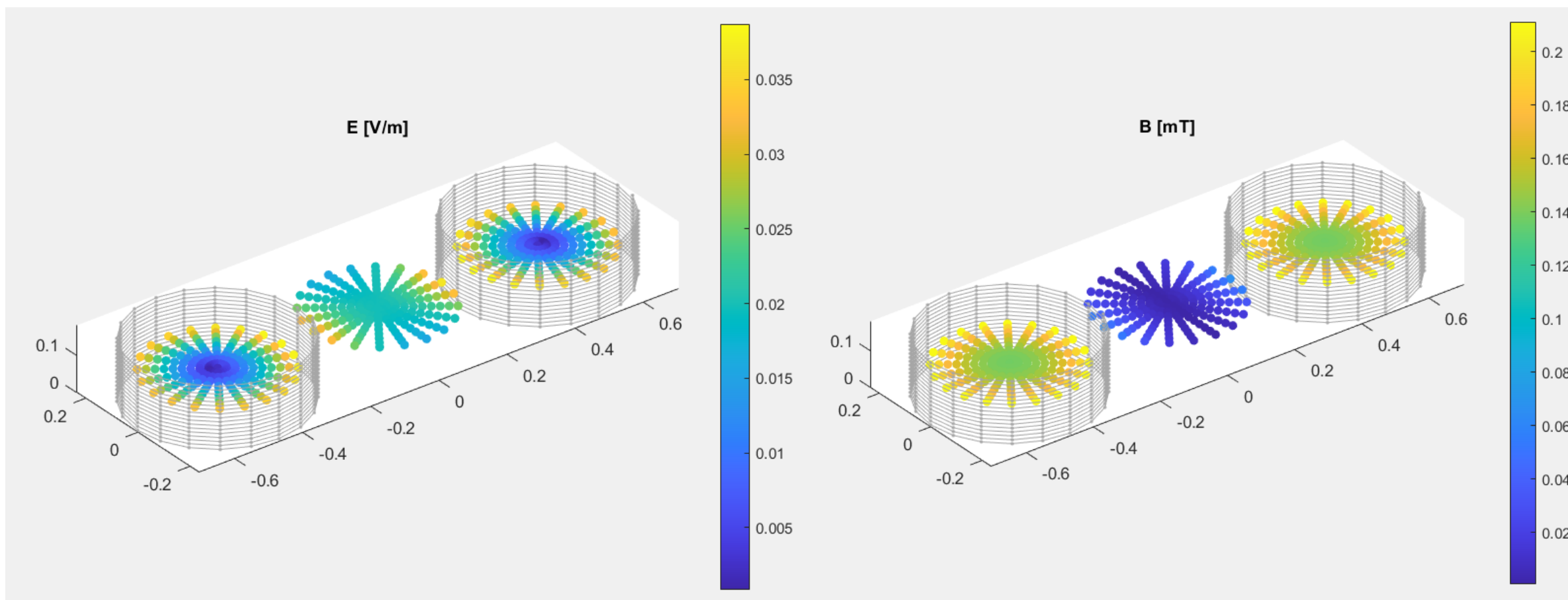
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- Generatore di tensione
- Amplificatore
- Due coil
- Sonde di tensione e di corrente
- Oscilloscopio



$$E = -\frac{\partial A}{\partial t}$$

$$B = \frac{\mu_0 I}{2 \pi r}$$

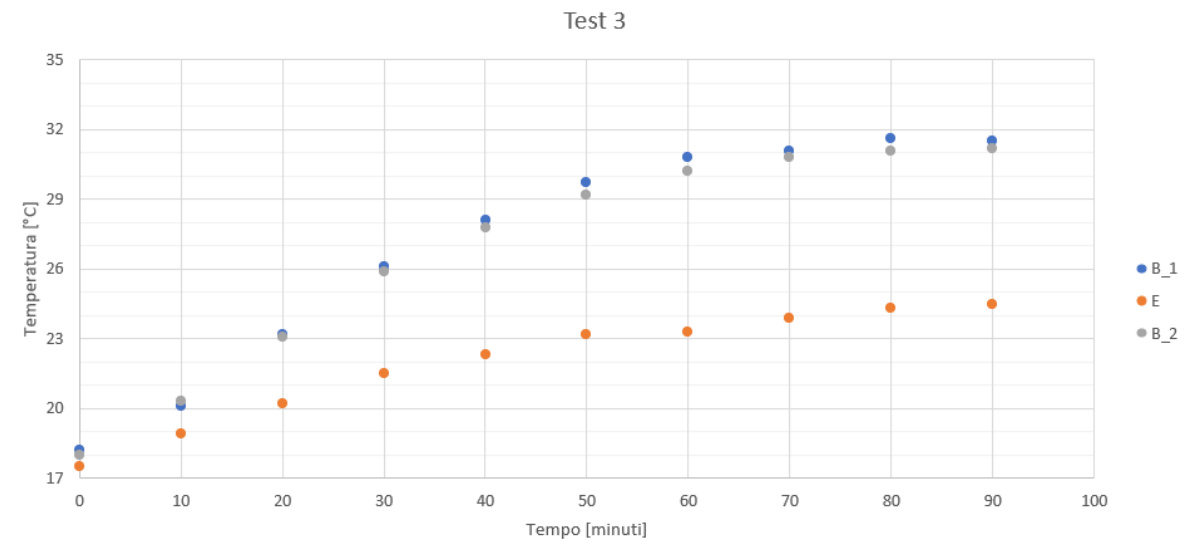
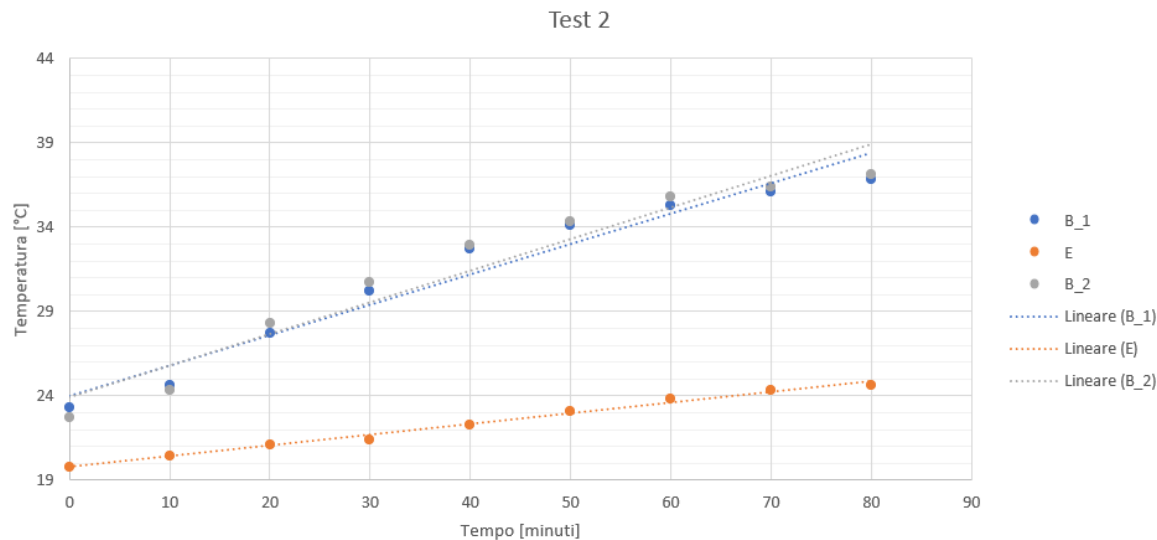


‘We exposed malignant and normal cells to OMF generated by oncoscillators [...] the cells were exposed to a peak-to-peak rotated magnetic field of 1–58 mT strength [...] OMF patterns in peak frequency (PF; 50–350 Hz) [...] total exposure time (ET; 2–4 h).’

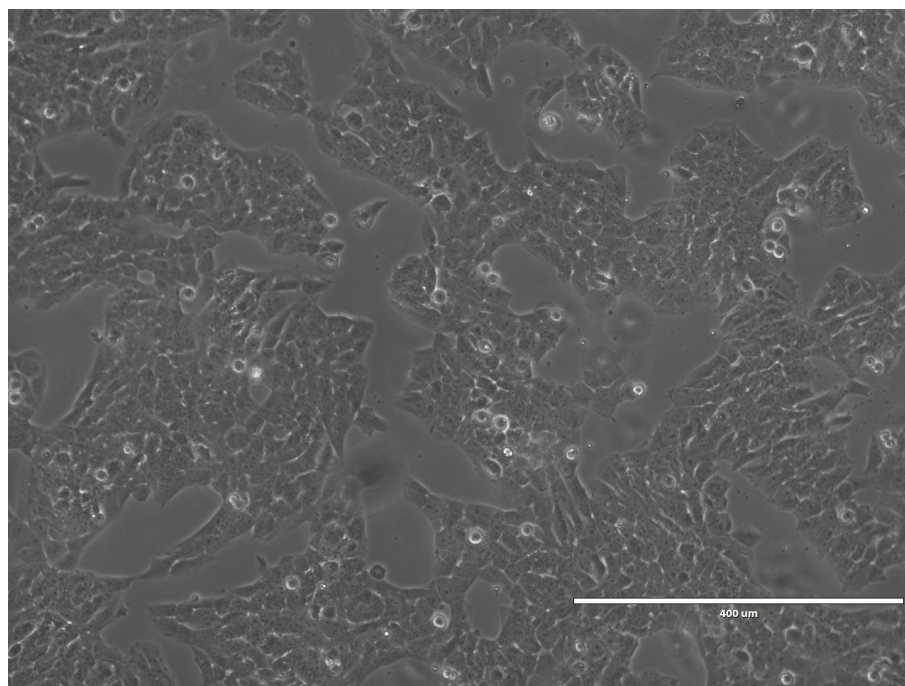
Frequenza fissa: 350 Hz

Durata: 3h

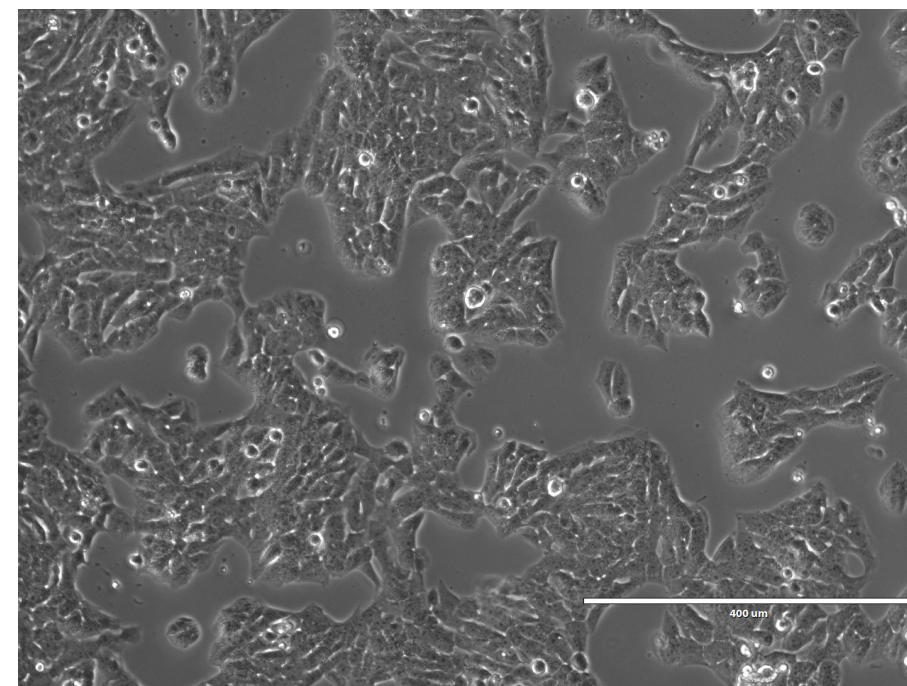
	Frequenza [Hz]	Tensione [V]	Corrente [A]
Test 1	300	12,87	2,10
Test 2	350	24,51	4,00
Test 3	350	20,00	3,26



Frequenza:	350 Hz
Tensione:	20 V
Corrente:	3,2 A
Durata:	3 ore

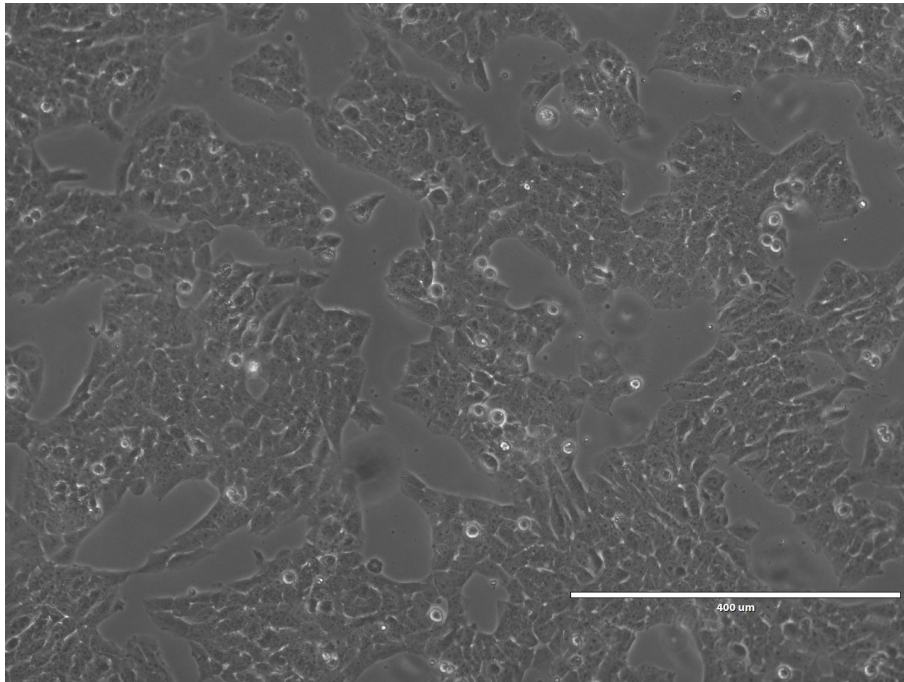


Cellule tumorali, pre-trattamento, 10x

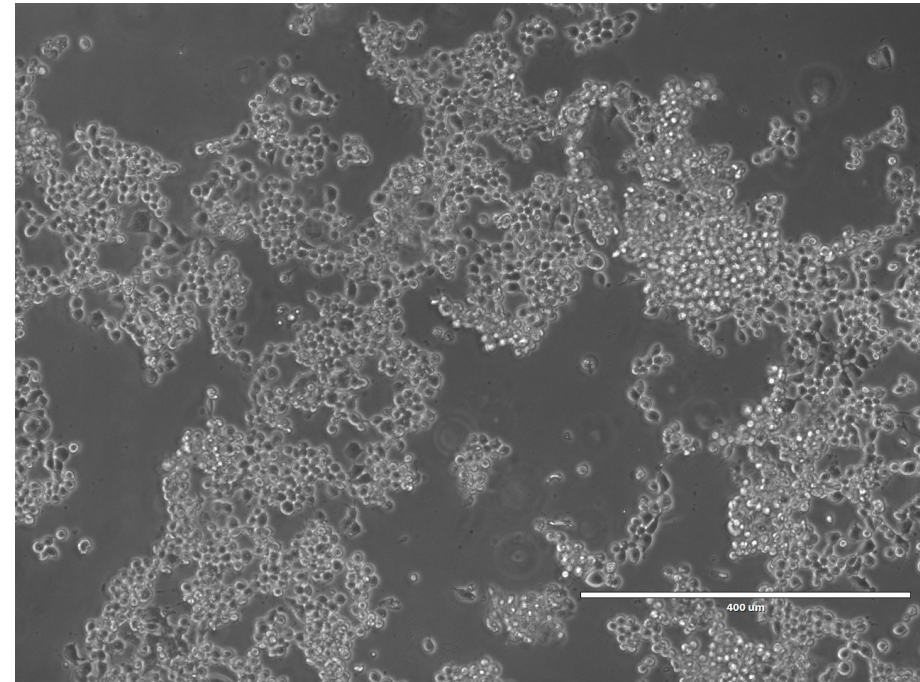


Cellule tumorali sottoposte al campo elettrico, 10 x

Frequenza:	350 Hz
Tensione:	20 V
Corrente:	3,2 A
Durata:	3 ore

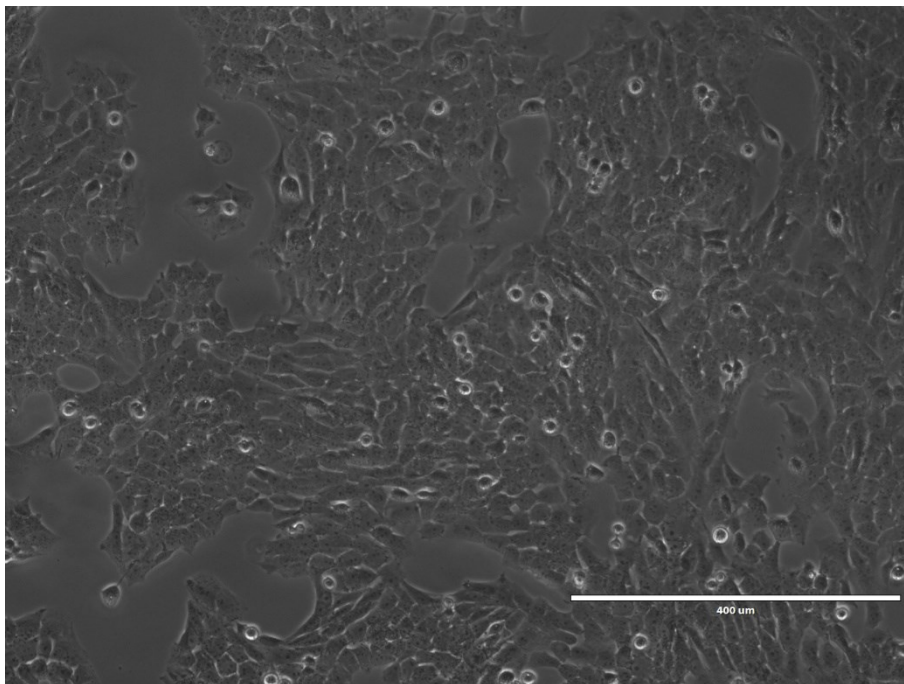


Cellule tumorali, pre-trattamento, 10x

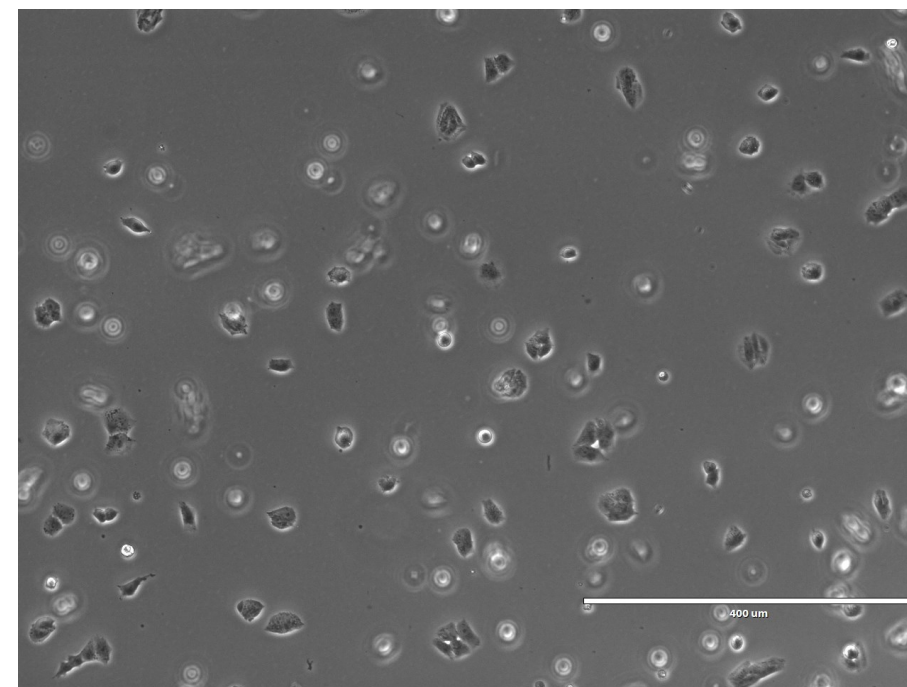


Cellule tumorali sottoposte al campo magnetico, 10 x

Frequenza:	350 Hz
Tensione:	17 V
Corrente:	2,8 A
Durata:	3 ore

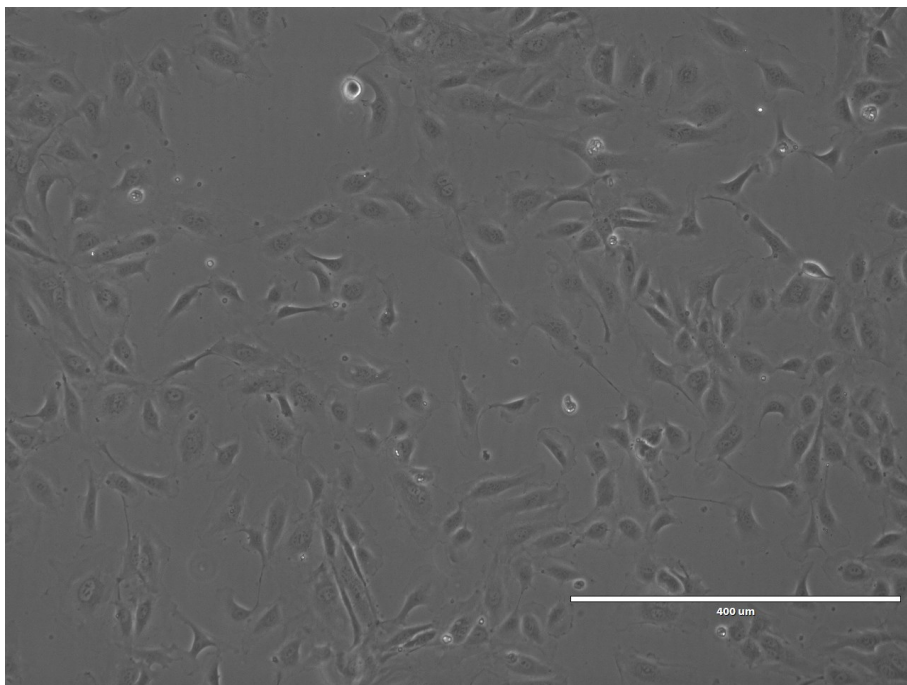


Cellule tumorali, pre-trattamento, 10x

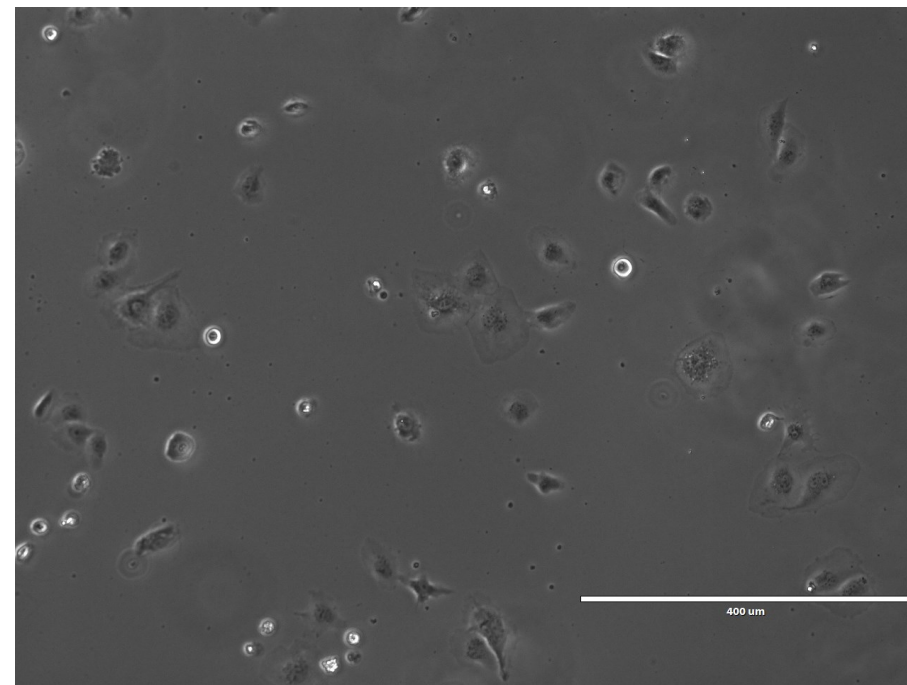


Cellule tumorali sottoposte al campo magnetico, 10 x

Frequenza:	350 Hz
Tensione:	17 V
Corrente:	2,8 A
Durata:	3 ore

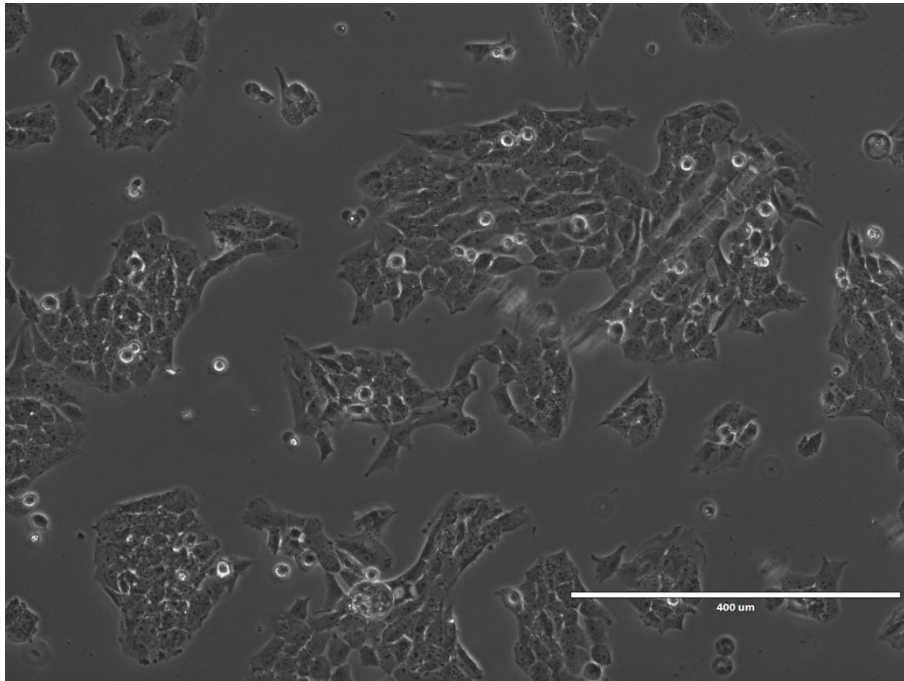


HUVEC, pre-trattamento, 10x

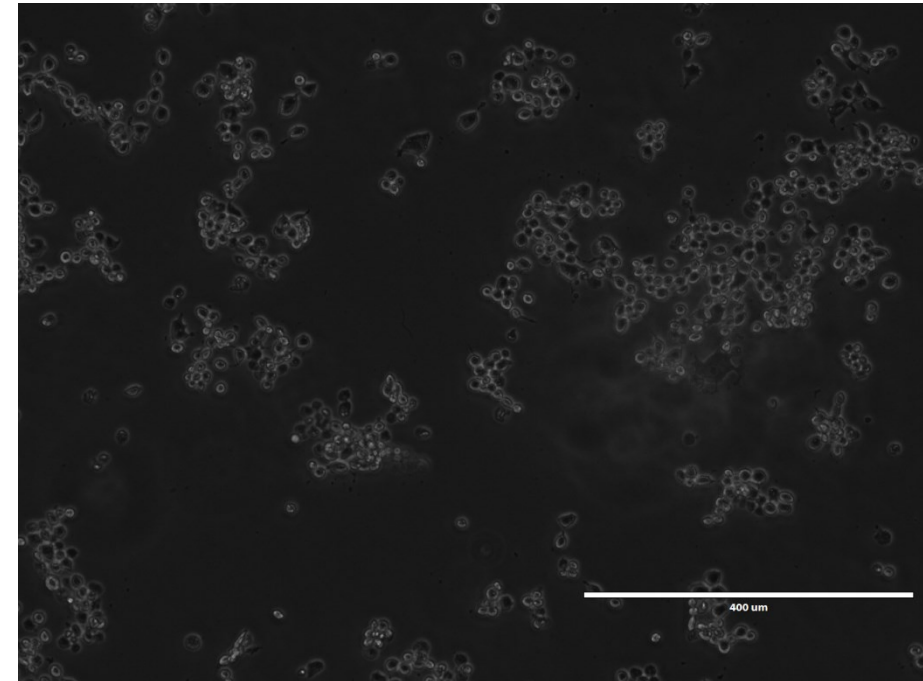


HUVEC sottoposte al campo magnetico, 10 x

	terzo esperimento	quarto esperimento
Frequenza:	350 Hz	350 Hz
Tensione:	19 V	20 V
Corrente:	3,1 A	3,2 A
Durata:	3 ore	2 ore

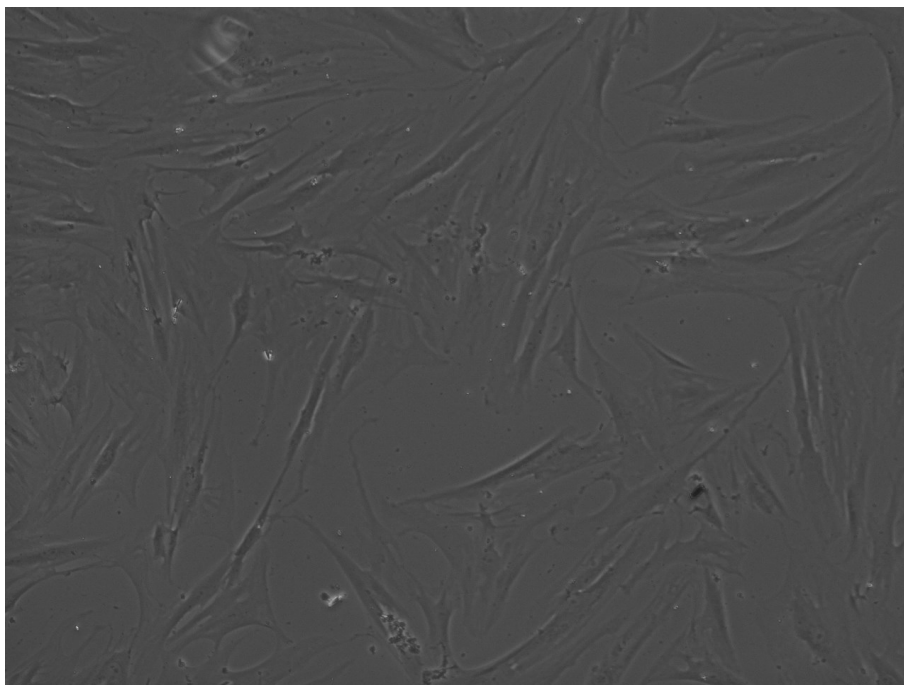


SKNAS, pre-trattamento, 10x

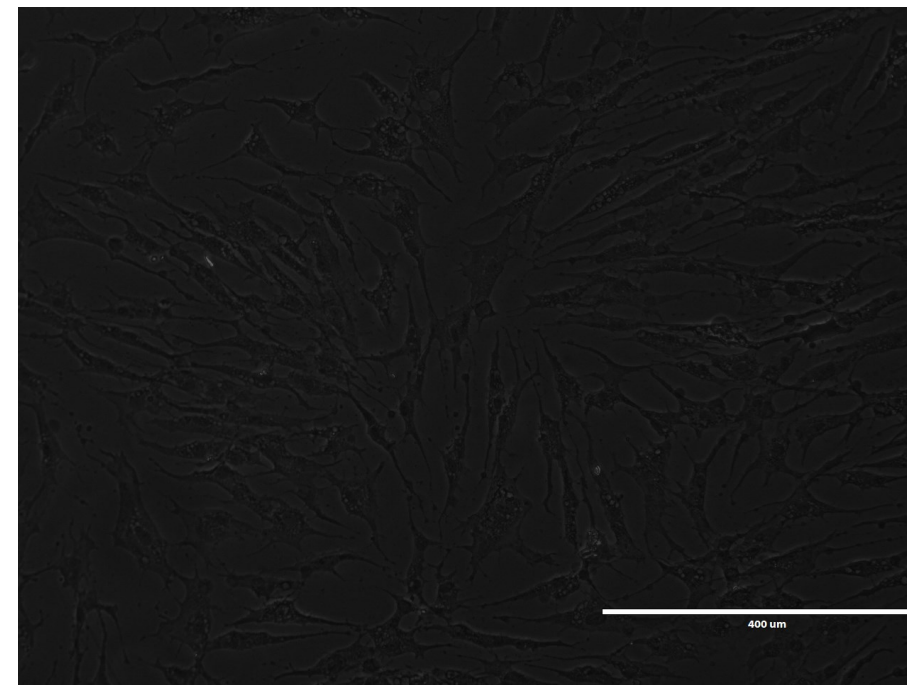


SKNAS, sottoposte al campo magnetico dopo 3h, 10 x

	terzo esperimento	quarto esperimento
Frequenza:	350 Hz	350 Hz
Tensione:	19 V	20 V
Corrente:	3,1 A	3,2 A
Durata:	3 ore	2 ore



MSC, pre-trattamento, 10x



MSC, sottoposte al campo magnetico dopo 2h, 10 x

V	I	Tipologia cellula	Effetto campo elettrico	Effetto campo magnetico
17 V	2,8 A	HUVEC	Vive	Diminuite
		Tumoriali	Vive	Alcune morte
19 V	3,1 A	MSC	Vive	Vive in pessime condizioni
		SKNAS	Vive	Morte
20 V	3,2 A	MSC	Vive	Vive in pessime condizioni
		SKNAS	Vive	Morte
		Tumoriali	Vive	Morte