



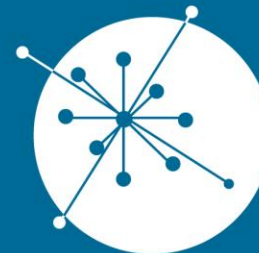
## Física Médica

Pesquisa, Inovação Tecnológica e Atividades em Ambiente Clínico



**Paulo Roberto Costa**

**Grupo de Dosimetria das  
Radiações e  
Física Médica**



**GRUPO DE  
DOSIMETRIA  
DAS RADIAÇÕES  
e FÍSICA MÉDICA**

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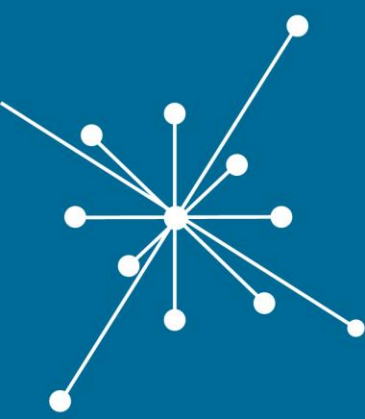
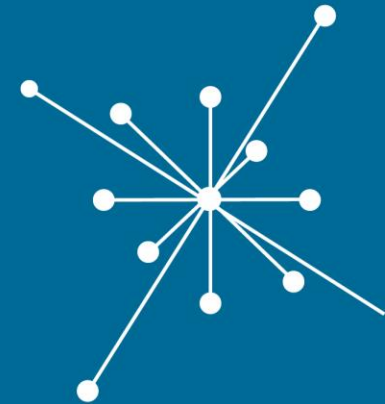
# Sumário



IFUSP - Instituto de Física da USP

- O que é Física Médica?
- Fronteiras na pesquisa e inovação
- Como é o trabalho em ambiente clínico?



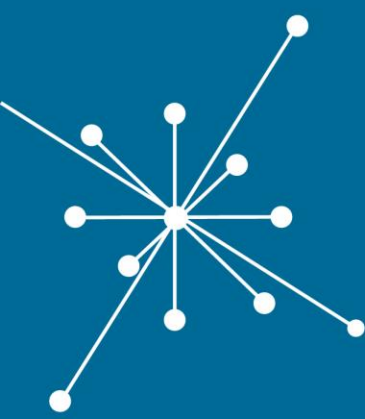
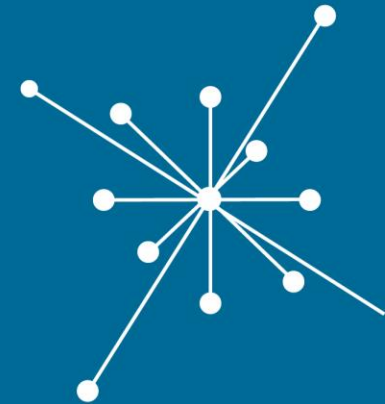


GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

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# O que é Física Médica?

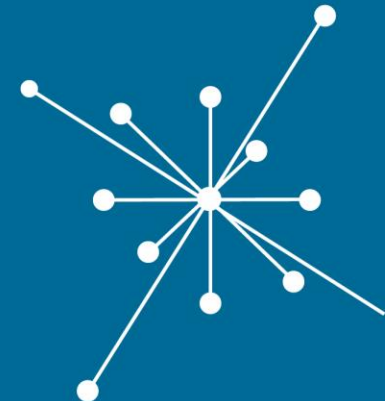


GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

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**A Física Médica é o ramo da Física que compreende a aplicação dos conceitos, leis, modelos, agentes e métodos da Física para a prevenção, diagnóstico e tratamento de doenças, desempenhando uma importante função na assistência médica, na pesquisa biomédica e na otimização da proteção radiológica.**



[www.iomp.org](http://www.iomp.org)



**GRUPO DE  
DOSIMETRIA  
DAS RADIAÇÕES  
e FÍSICA MÉDICA**

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# MEDICINA

DOENÇAS

CURA

DIAGNÓSTICO

TRATAMENTO

HOSPITAIS

# FÍSICA

NATUREZA

ENERGIA

EXPERIMENTOS

CÁLCULOS

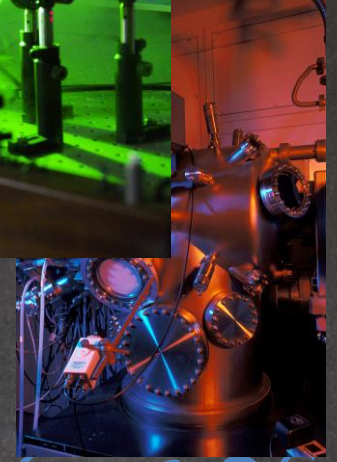
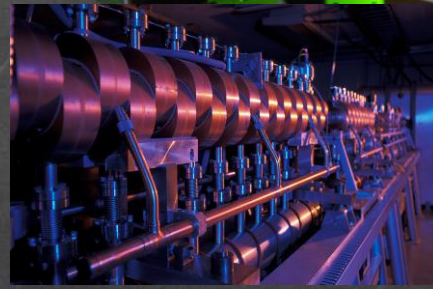
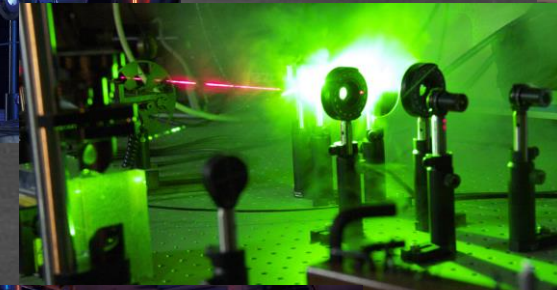
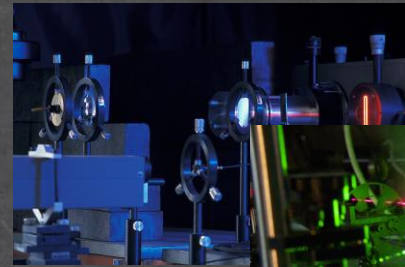
LABORATÓRIOS





# MEDICINA

# FÍSICA



# HOSPITAIS

# LABORATÓRIOS





# MEDICINA

# FÍSICA

DOENÇAS

CURA

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NATUREZA  
ENERGIA

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CÁLCULOS

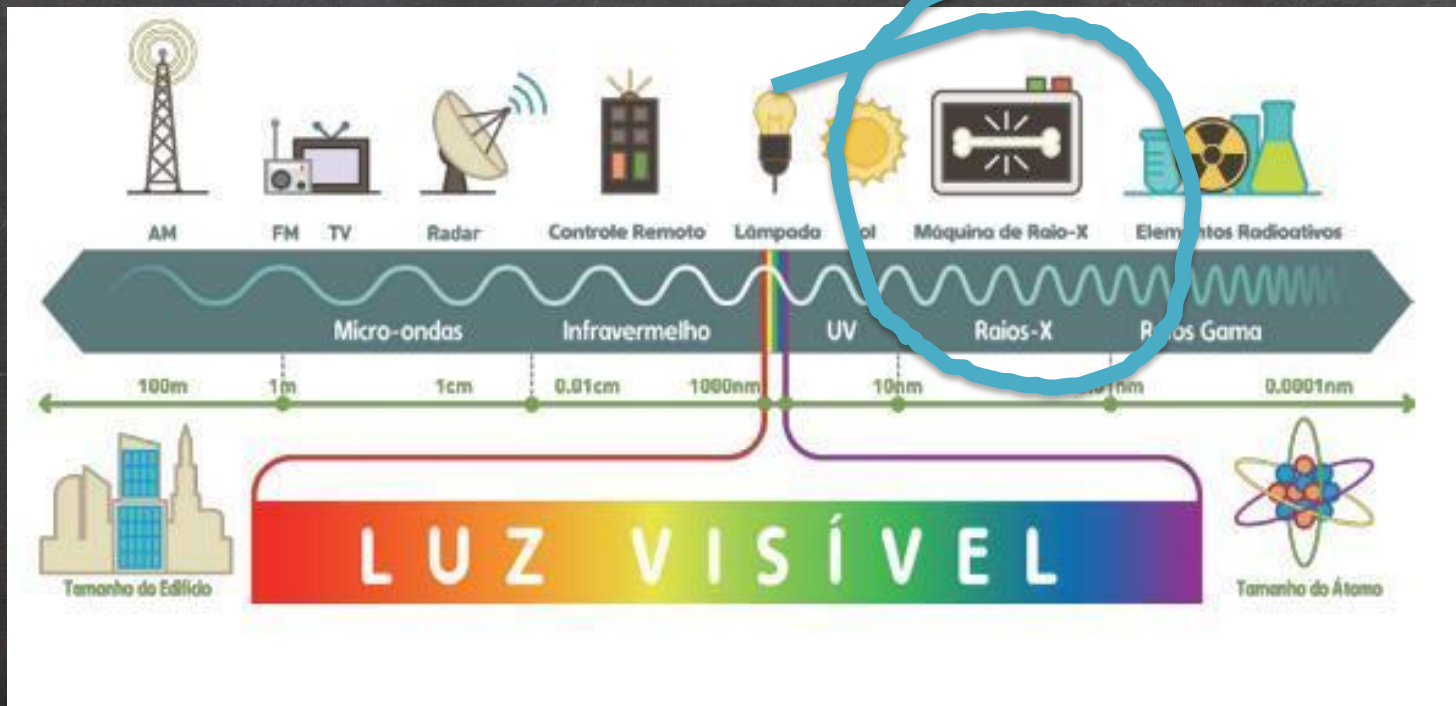
LABORATÓRIOS



FONTES DE

NA NATUREZA  
ENERGIA

# RADIAÇÃO ELETROMAGNÉTICA







# RAIOS X





# MEDICINA

# FÍSICA

DOENÇAS

CURA

DIAGNÓSTICO

TRATAMENTO

HOSPITAIS

NATUREZA

ENERGIA

EXPERIMENTOS

CÁLCULOS

LABORATÓRIOS







ODONTOLOGIA

RADIOLOGIA  
GERAL

MAMOGRAFIA

RAIOS X

TOMOGRFIA  
COMPUTADORIZADA

RADIOLOGIA  
INTERVENCIONISTA

ODONTOLOGIA

RADIOLOGIA  
GERAL

MAMMOGRAFIA





# RADIOLOGIA GERAL



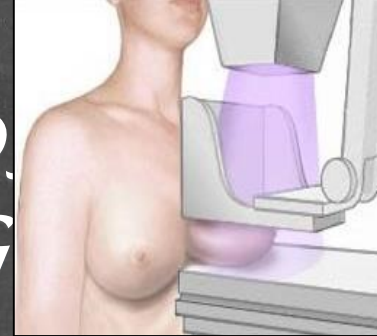
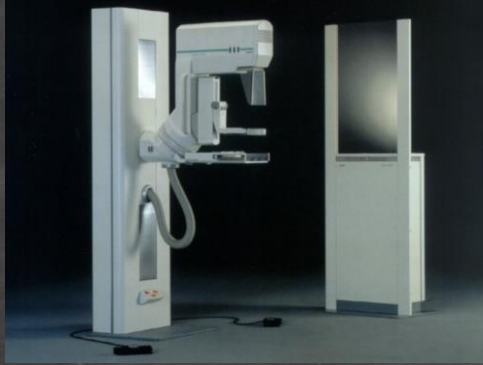
MAMMO



CON

DORIA

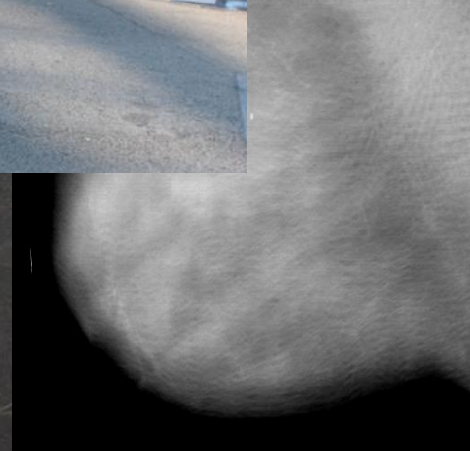
RADIOLOGIA GERAL



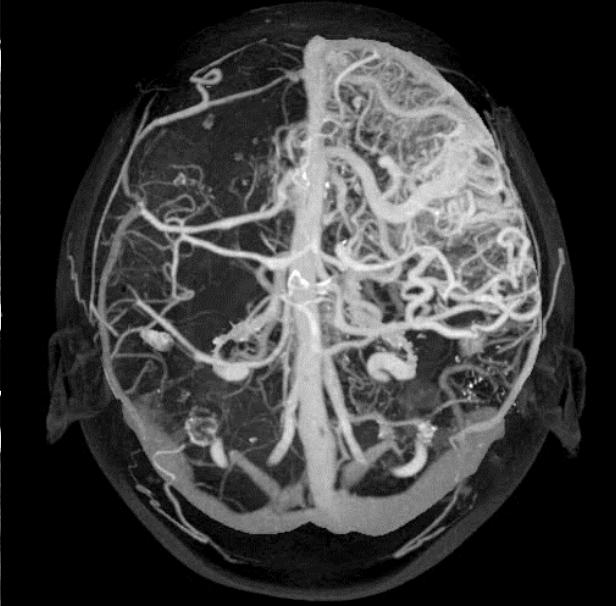
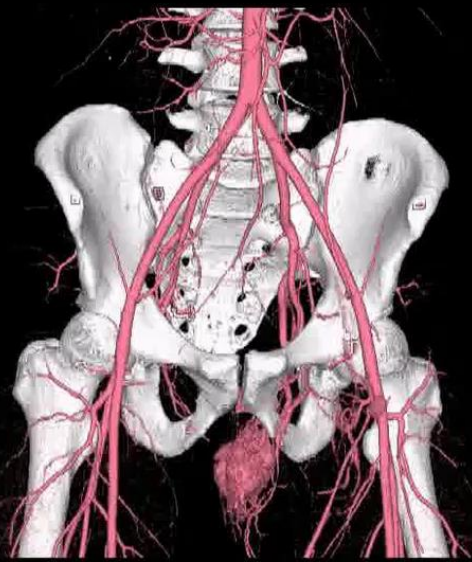
# MAMOGRAFIA



For  
*Outubro Rosa*

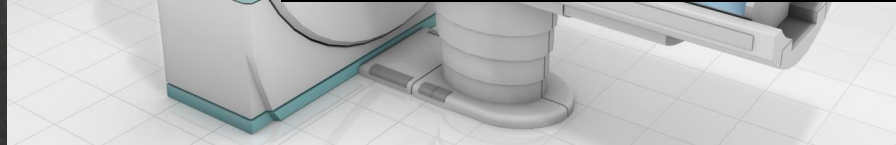






TOMOGRAFIA  
COMPUTADORIZADA

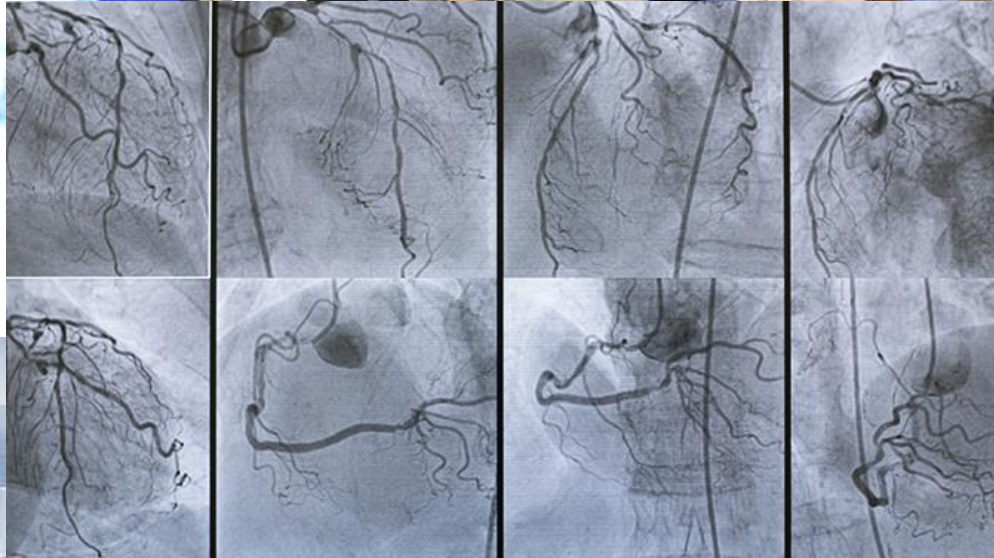
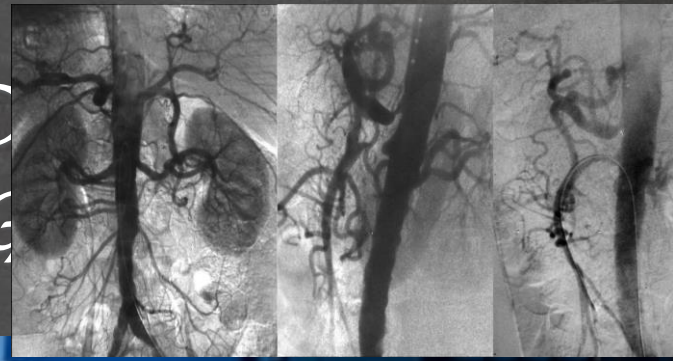
RAD  
INTER







D  
G



Coil

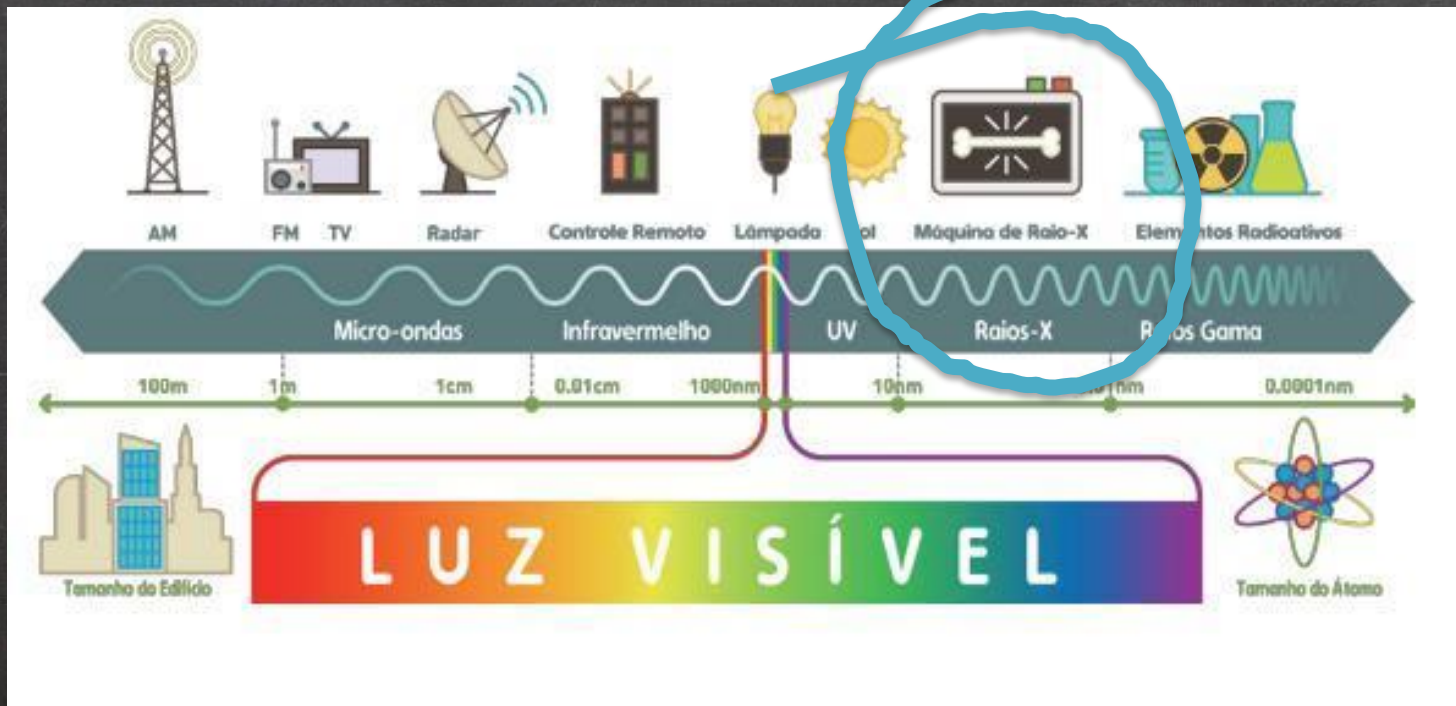


RIZADA

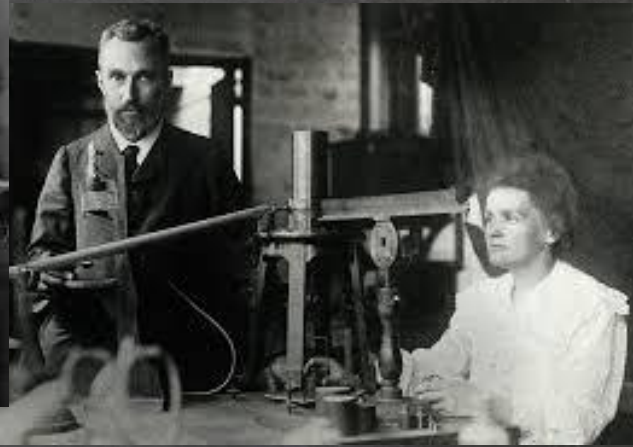
RADIOLOGIA  
INTERVENCIONISTA

# FONTES DE ENERGIA NA NATUREZA

## RADIAÇÃO ELETROMAGNÉTICA



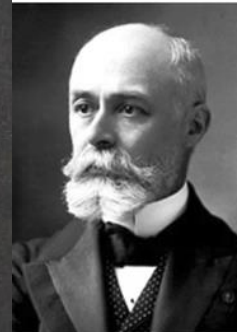




# RADIOISÓTOPOS



## The Nobel Prize in Physics 1903



Antoine Henri  
Becquerel  
Prize share: 1/2



Pierre Curie  
Prize share: 1/4



Marie Curie, née  
Skłodowska  
Prize share: 1/4

CINTILOGRAFIA

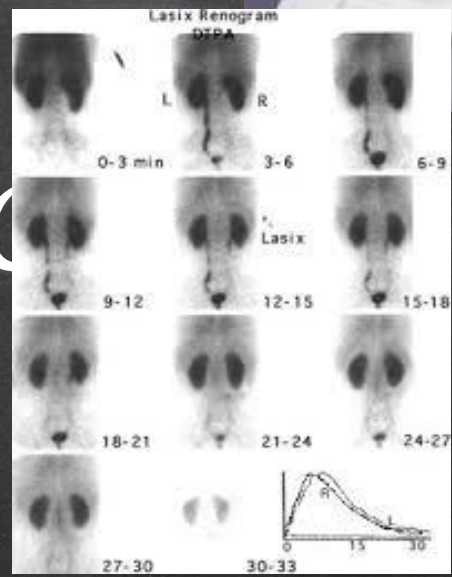
SPECT

RADIOISÓTOPOS

PET/CT



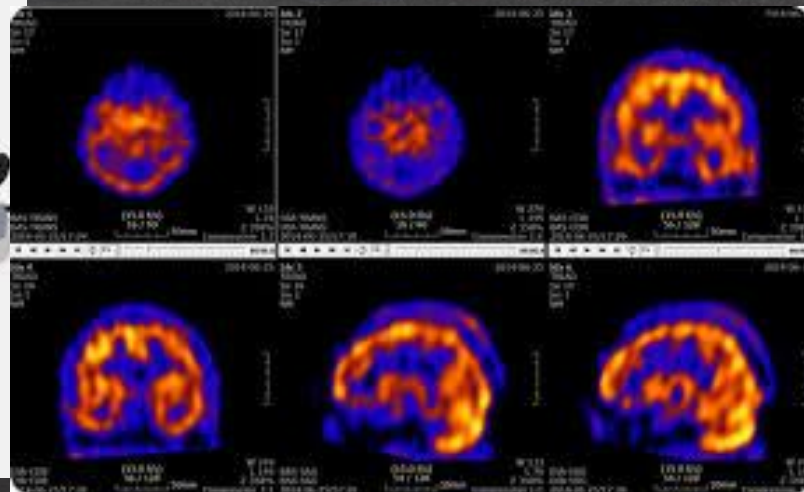
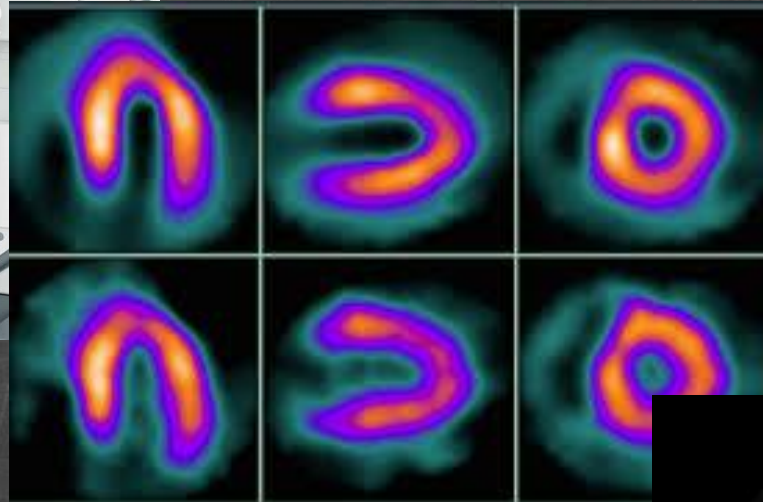
# CINTILOGRAFIA







*SPECT*



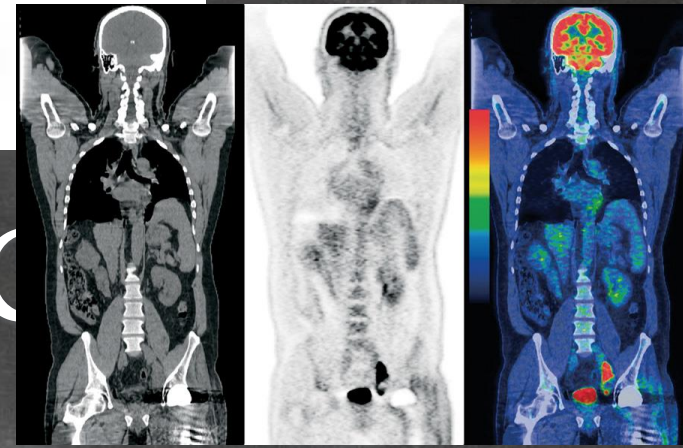
CINTILÓGRAFO



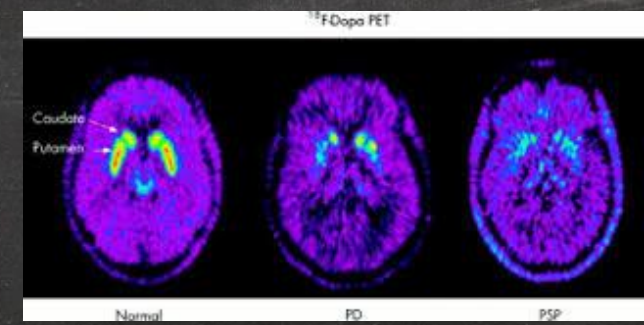
PECT



ISÓTOPO



PET/CT



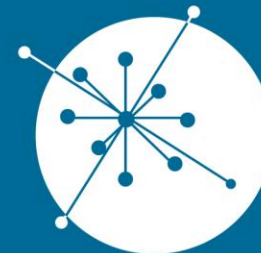
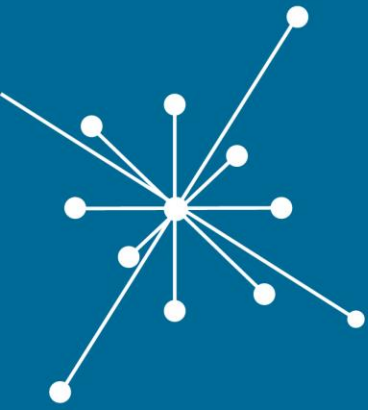
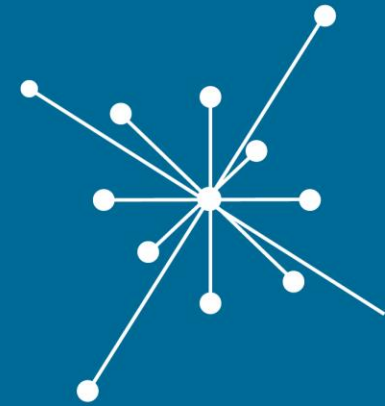


# HISTÓRIA DA TOMOGRAFIA COMPUTADORIZADA

<https://youtu.be/RSyR8BIEz60>

# DOS RAIOS X AO PETCT

<https://youtu.be/6XZOR7xJ1gs>



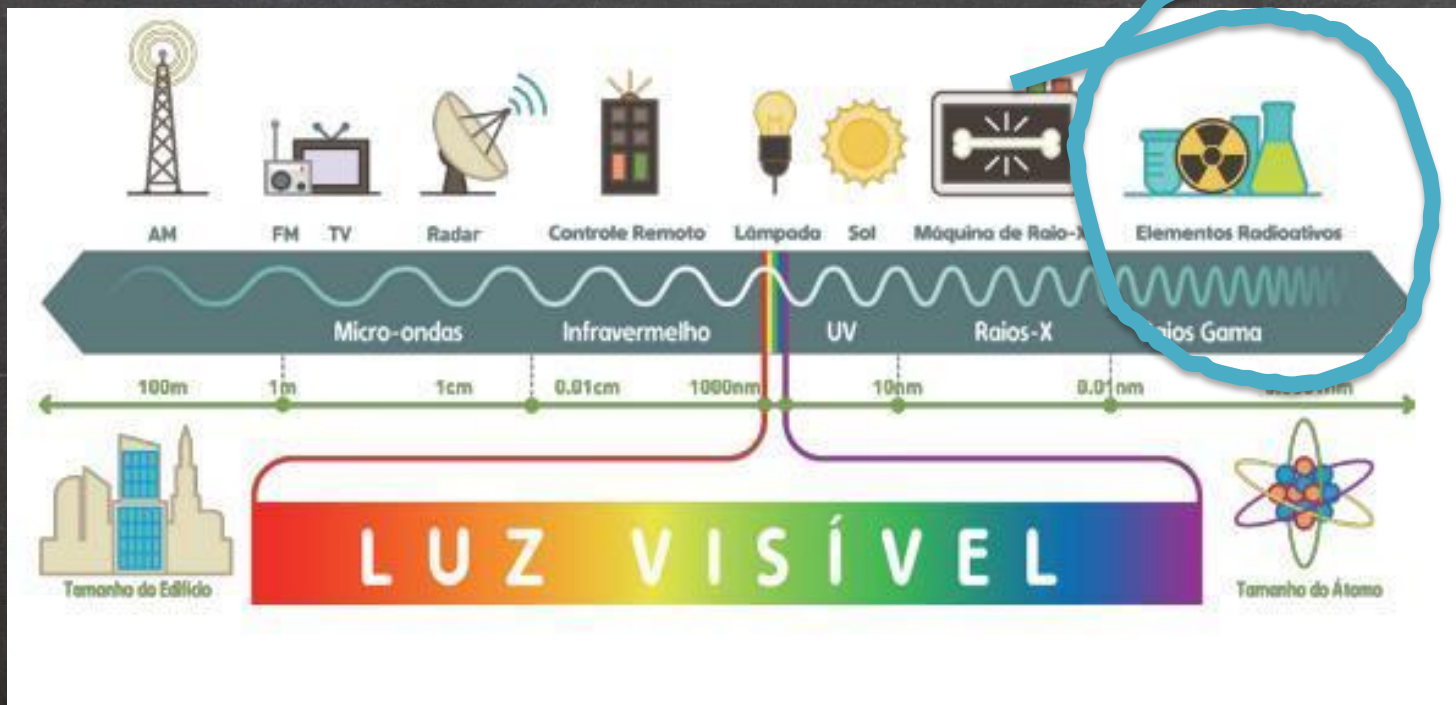
GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

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# FONTES DE ENERGIA NA NATUREZA

## RADIAÇÃO ELETROMAGNÉTICA



Felix Bloch e Edward Mills Purcell



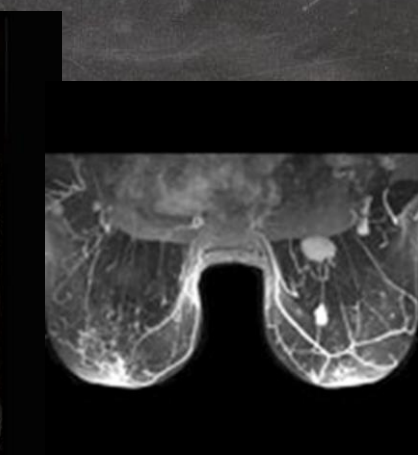
# CAMPOS MAGNÉTICO E RADIOFREQÜÊNCIAS







# CAMPOS MAGNÉTICO E RADIOFREQÜÊNCIAS





# E O QUE MÉDICOS E FÍSICOS FAZEM NA PRÁTICA NA ÁREA DE DIAGNÓSTICO MÉDICO?

ANAMINESE

PRESCRIÇÃO

PRODUÇÃO DE  
RADIOISÓTOPOS

CONTROLE DE  
QUALIDADE  
DAS IMAGENS



DIAGNÓSTICO

ENCAMINHAMENTO  
PARA TRATAMENTO



PROJETOS DE  
BLINDAGEM

PROTEÇÃO  
RADIOLÓGICA

# MEDICINA

# FÍSICA

DOENÇAS

CURA

DIAGNÓSTICO

TRATAMENTO

HOSPITAIS

NATUREZA

ENERGIA

EXPERIMENTOS

CÁLCULOS

LABORATÓRIOS

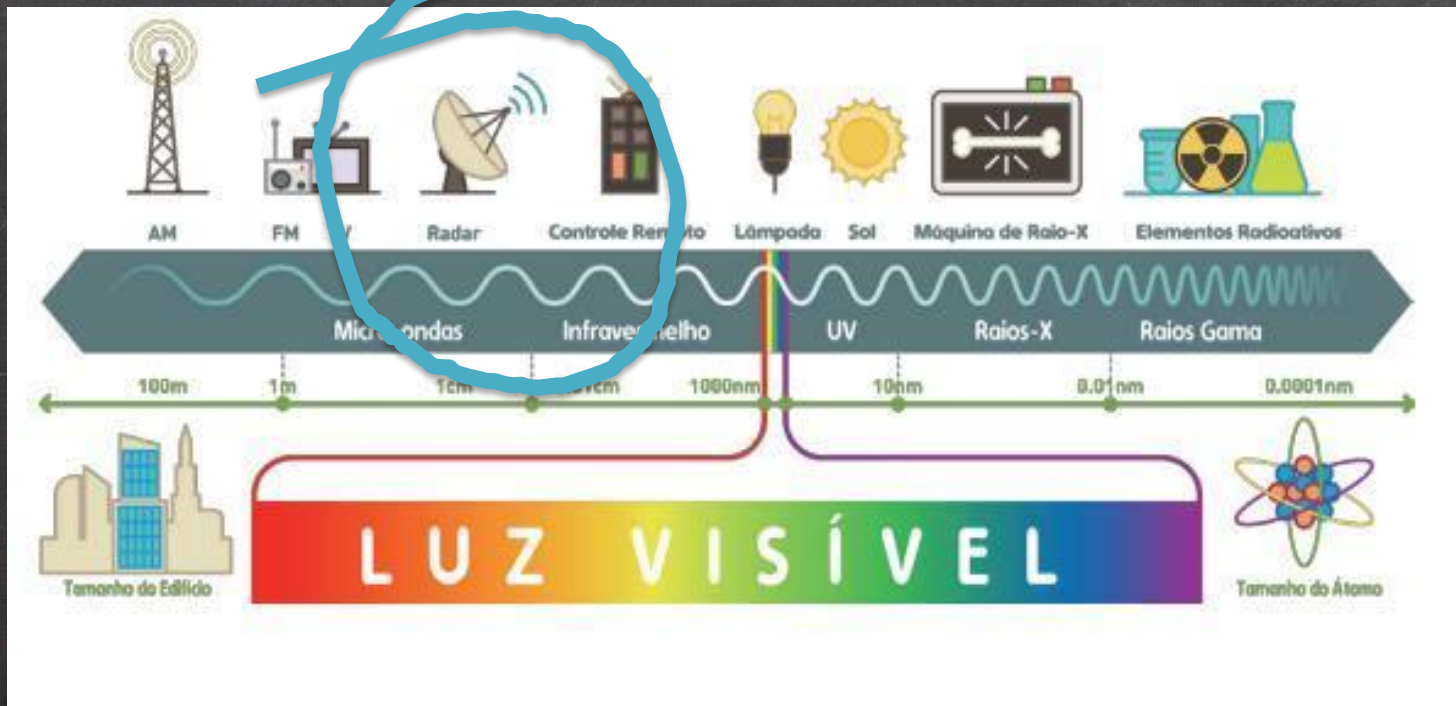




# FONTES DE ENERGIA NA NATUREZA

E também algumas  
partículas, como elétrons

## RADIAÇÃO prótons, etc ELETROMAGNÉTICA



BRAQUITERAPIA

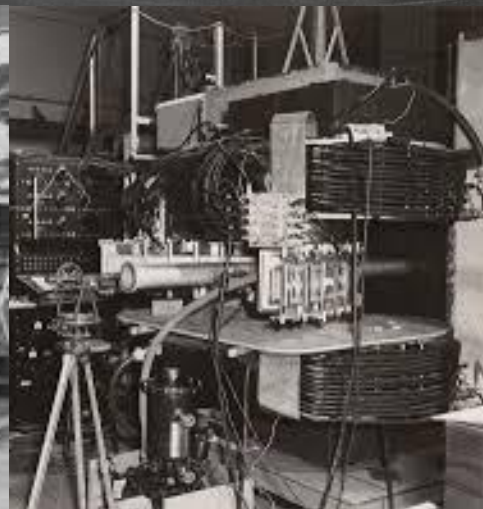
IMRT/IGRT

# RADIOTERAPIA

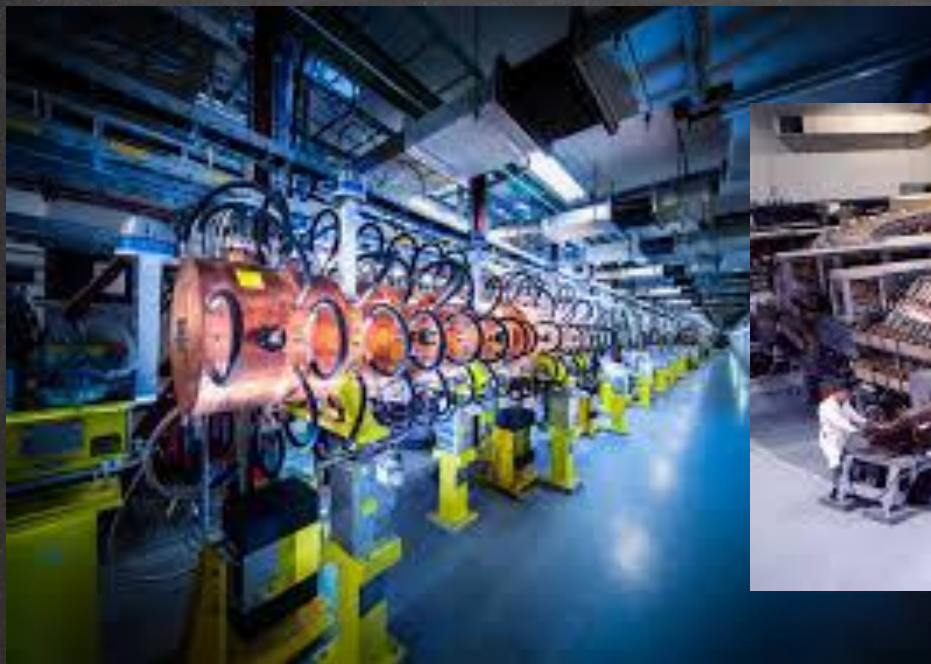
PROTONTERAPIA  
IONS PESADOS

IODOTERAPIA

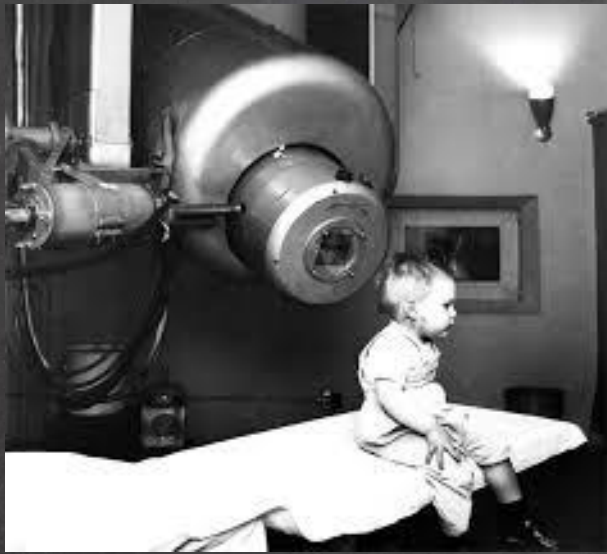




# RADIOTERAPIA



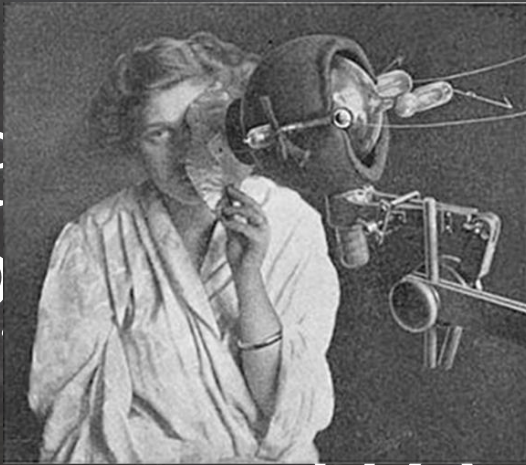




RAPIA

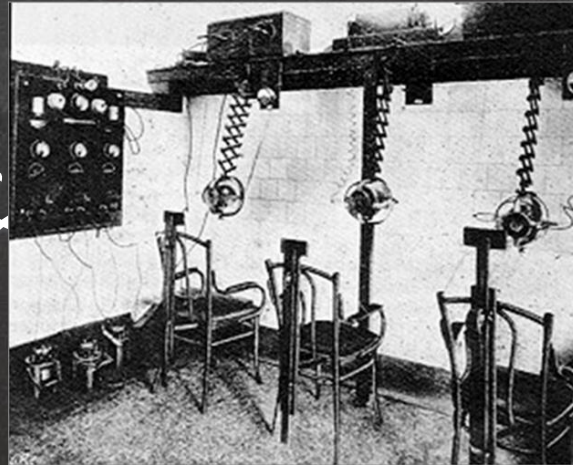


# RADIOTHERAPIA



PR  
IO

PI  
DOS



ERAPIA



# BRAQUITERAPIA



R

PP



191

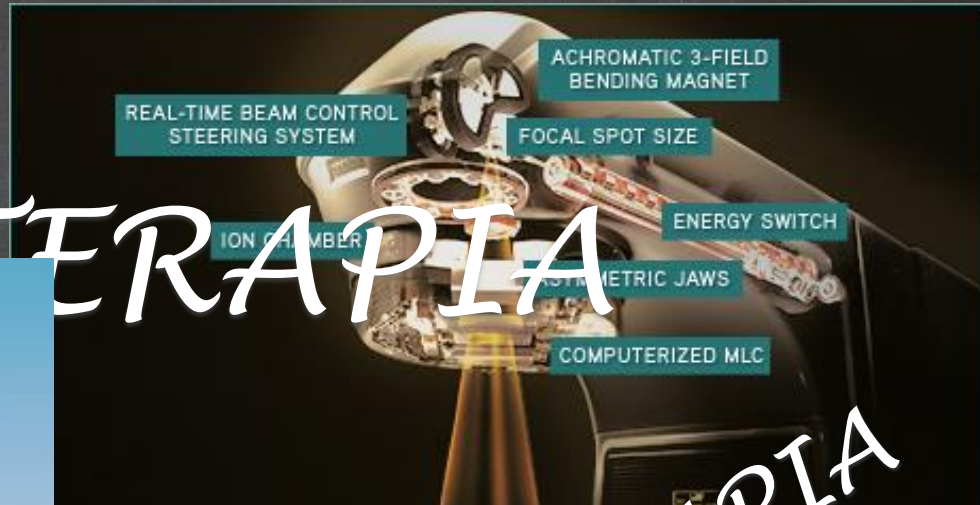




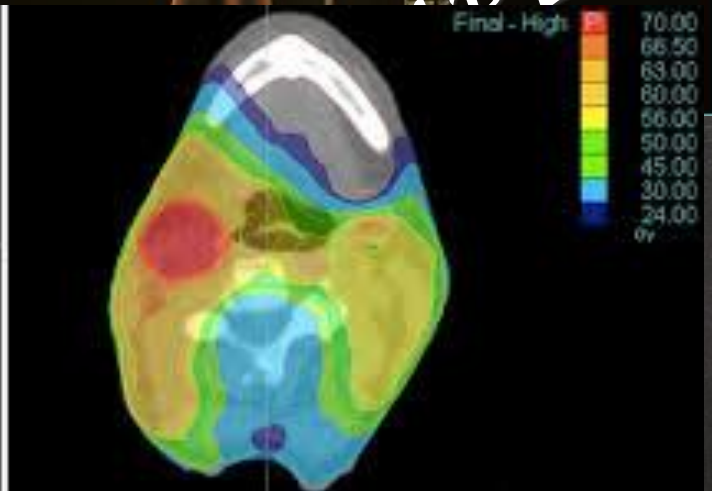
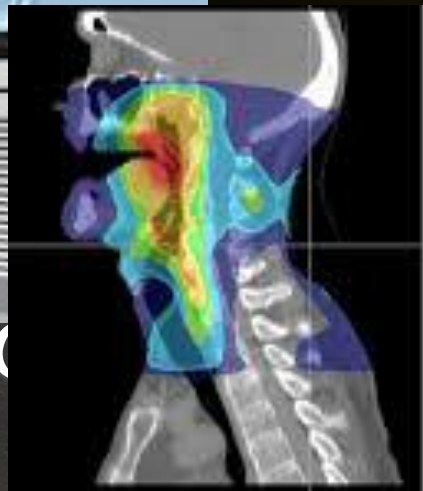
IA

IMRT/IGRT

# RADIOTHERAPY



RIA

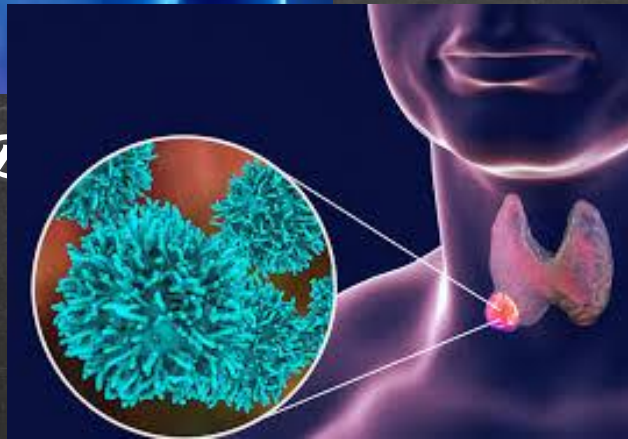






OTERAPIA

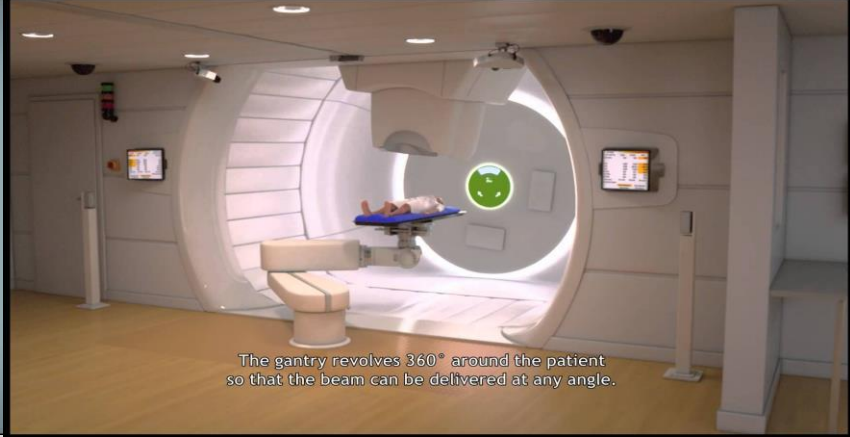
ONS &



IODOTERAPIA  
(+  $^{90}\text{Y}$ ,  $^{153}\text{Sm}$ ,  $^{89}\text{Sr}$ ...)

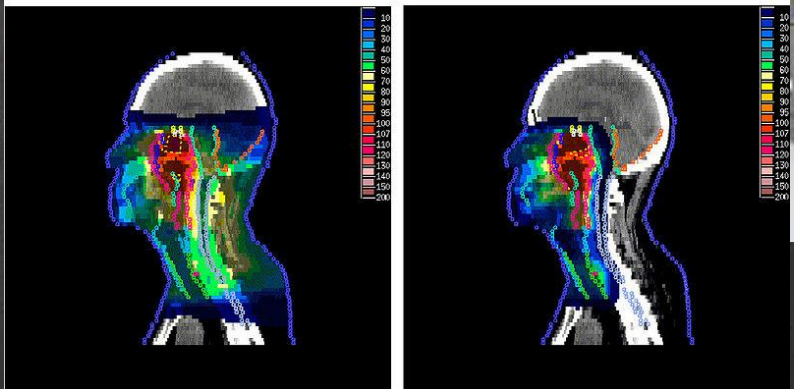
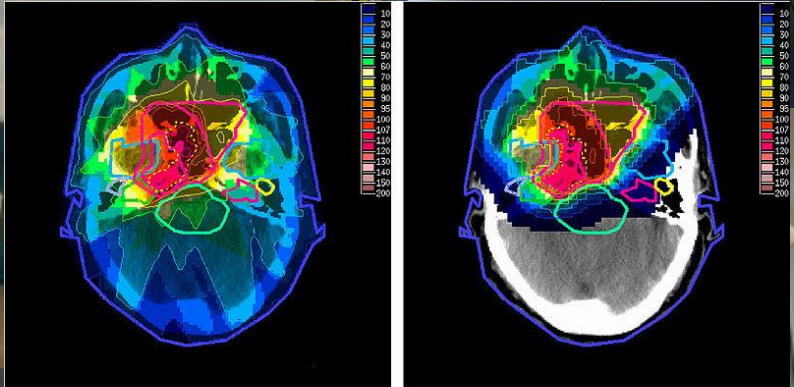
1 Cyclotron  
Using magnetic fields, the cyclotron can accelerate ions to high speeds.

4 Nozzle  
A zoomed-in magnet guides the beam.



The gantry revolves 360° around the patient so that the beam can be delivered at any angle.

RA  
PROTON THERAPY  
IONS PESADOS  
(HADRON THERAPY)





# E O QUE MÉDICOS E FÍSICOS FAZEM NA PRÁTICA NA ÁREA DE TERAPIA MÉDICA?

AValiação  
CLÍNICA

PLANEJAMENTO  
DO PROCEDIMENTO

VOLUME E  
NÚMERO DE  
SESSÕES

MONITORAMENTO  
DA RESPOSTA



CONTROLE DE  
QUALIDADE  
E CALIBRAÇÃO

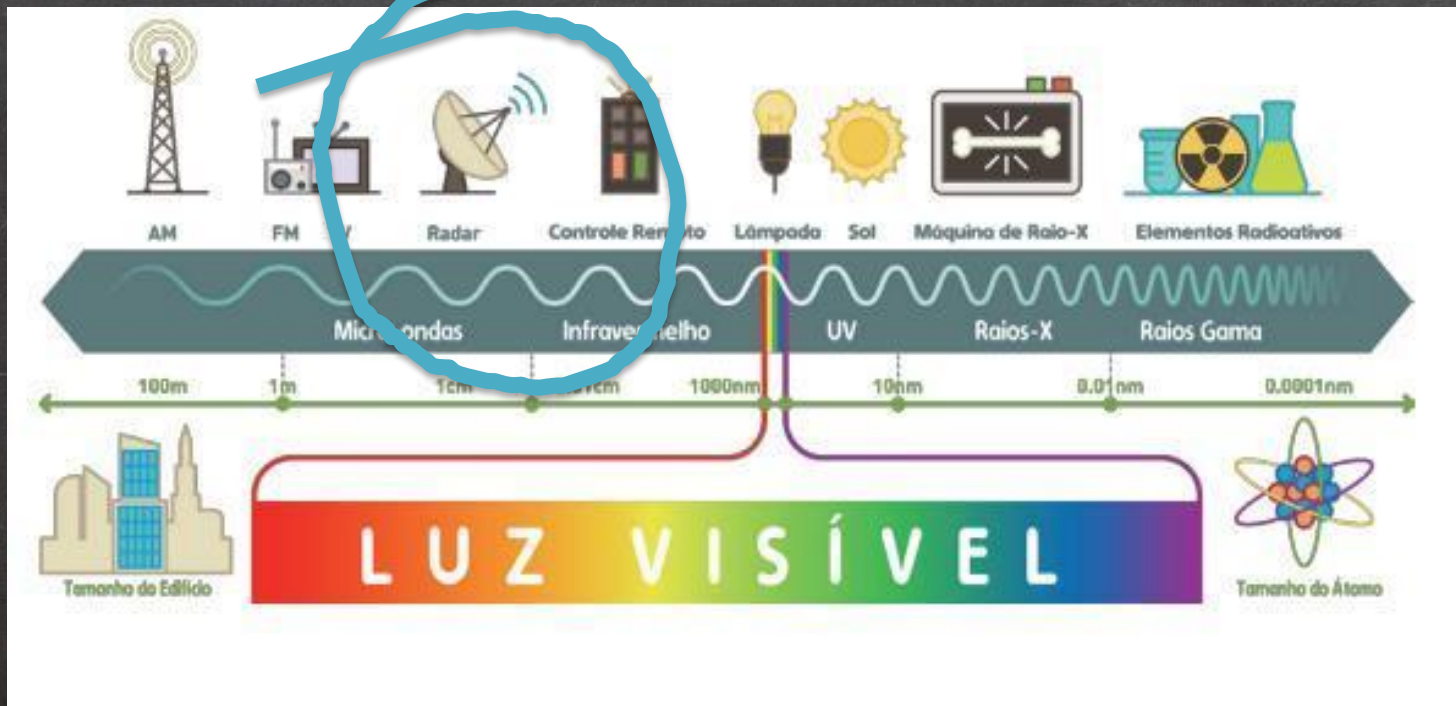
PLANEJAMENTO  
DO TRATAMENTO

ANÁLISE DO  
FEIXE DE RADIAÇÃO



# FONTES DE ENERGIA NA NATUREZA

## RADIAÇÃO ELETROMAGNÉTICA







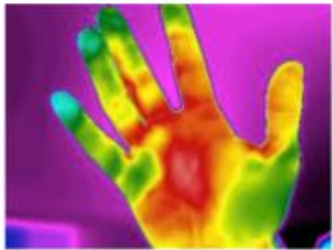
# BioPhotonics

BioPhotonics: interaction of living cells (bio) with electronic control or detection of light (photonics)

Initial ABP Focus

## Imaging

2D & 3D examination of cells, tissue, and organs



example : *IR thermography*

## Biometrics

noninvasive biophysical parameter measurement



example : *blood oxygen sensor*

## Therapeutics

photonic treatment of injured or diseased cells



example : *ABP phototherapy*

## Detection

detecting the presence of injury, disease & distress



example : *UIUC cancer detection*

## Surgery

laser cutting, ablation, removal of cells & tissue



example : *laser hand-piece scalpel*



# Física para todos

## A FANTÁSTICA FÁBRICA CELULAR E COMO PROGRAMÁ-LA PARA PRODUZIR REMÉDIOS

- Palestrante: Marcelo Victor Pires de Sousa, Bright Smart Photomedicine.



A fantástica FÁBRICA CELULAR e como programá-la para produzir remédios

**A FANTÁSTICA FÁBRICA CELULAR**

e como programá-la para produzir remédios

DR. MARCELO VICTOR P. DE SOUSA  
BRIGHT PHOTOMEDICINE

Física para Todos | MAI 2021

Assistir no  YouTube

Assistir no  YouTube

Compartilh...

<https://youtu.be/EYuppYP68HU>

# Óptica biomédica



IFUSP - Instituto de Física da USP



<https://youtu.be/VtCLIKsehok>

Fonte: Mesquita, R. – IFGW/Unicamp



# E AS OUTRAS DE ENERGIA NA NATUREZA

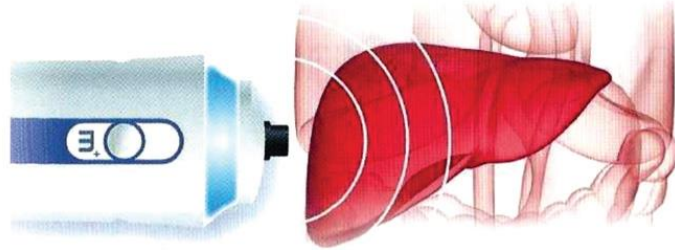
?????

## EXEMPLOS: RADIAÇÃO ELETROMAGNÉTICA



A rigidez hepática determina o estado patológico

Fígado macio = normal



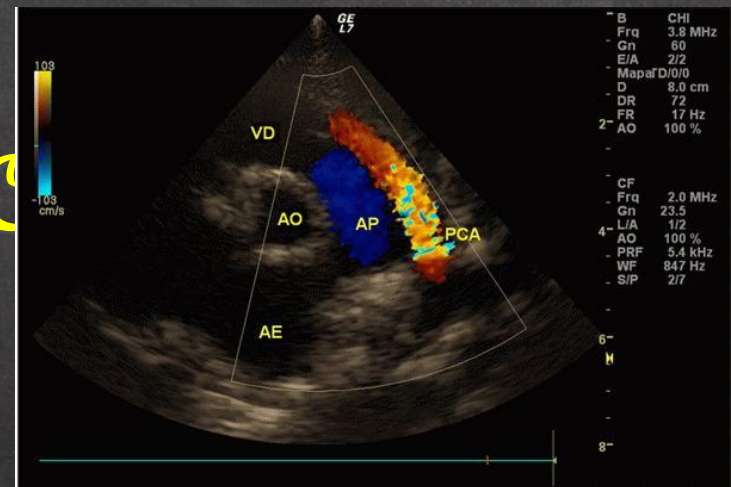
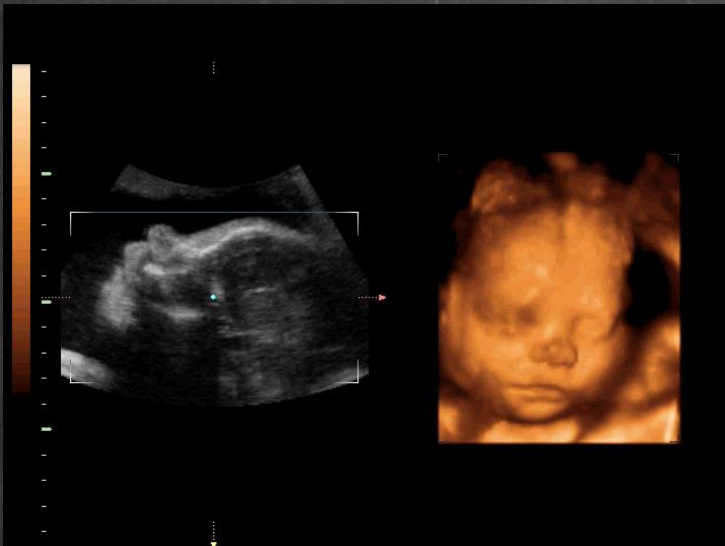
Fígado rígido = estado patológico

FibroScan® mede a rigidez hepática que é sujeita a variação devido a inflamação e grau de fibrose. Quanto mais fibrose presente, mais rígido o fígado fica.

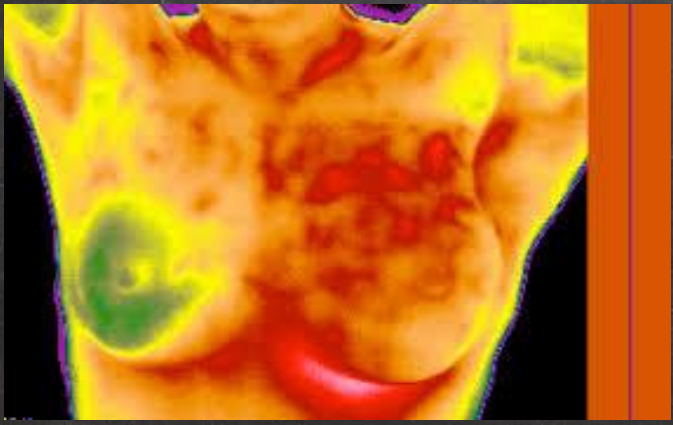
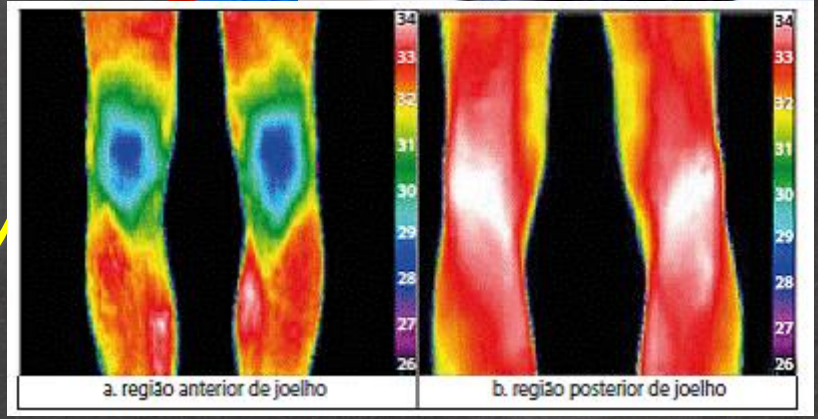
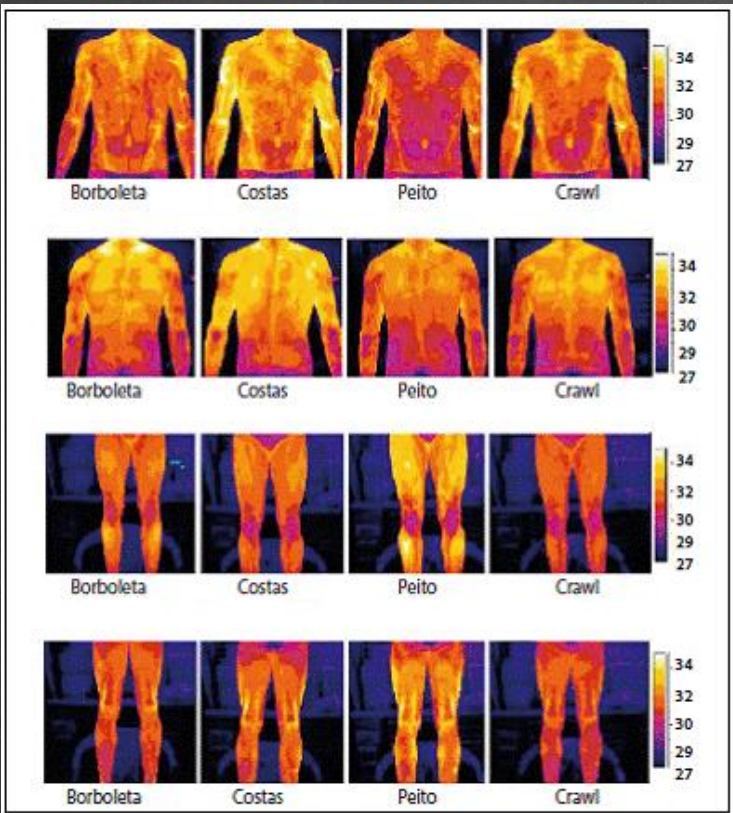


SOM

CALC





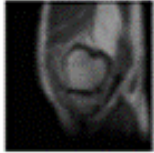
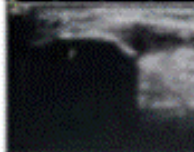
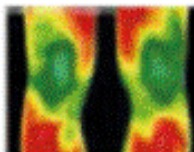


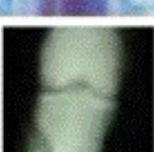
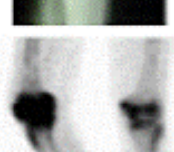


SOM

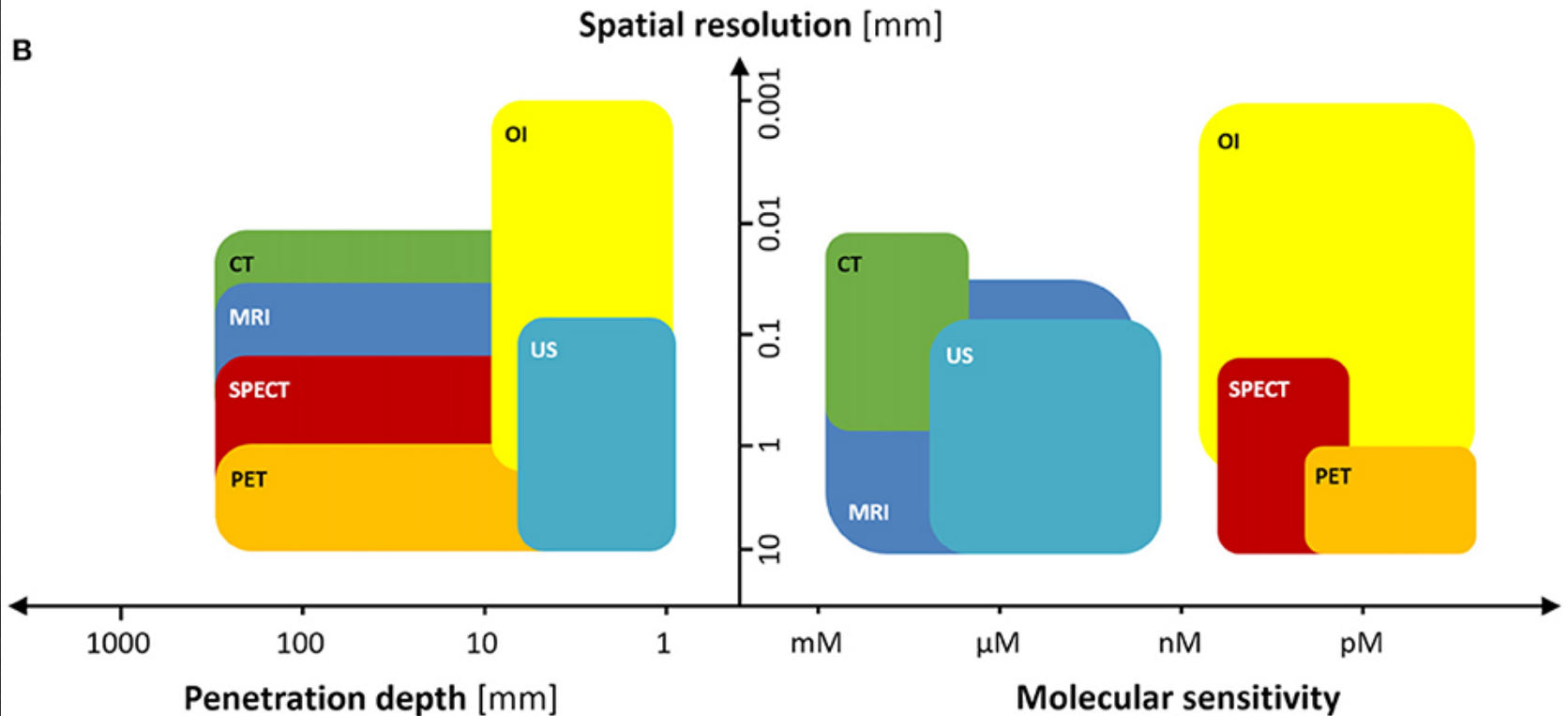
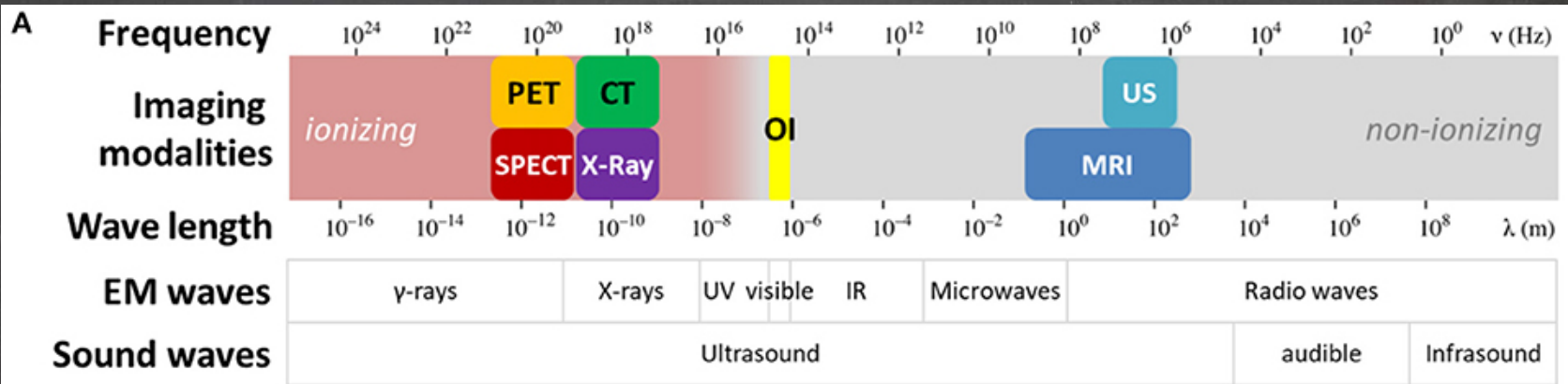
CALOR

Fonte: Côrte, Ana Carolina Ramos e, & Hernandez, Arnaldo José. (2016). TERMOGRAFIA MÉDICA INFRAVERMELHA APLICADA À MEDICINA DO ESPORTE. *Revista Brasileira de Medicina do Esporte*, 22(4), 315-319



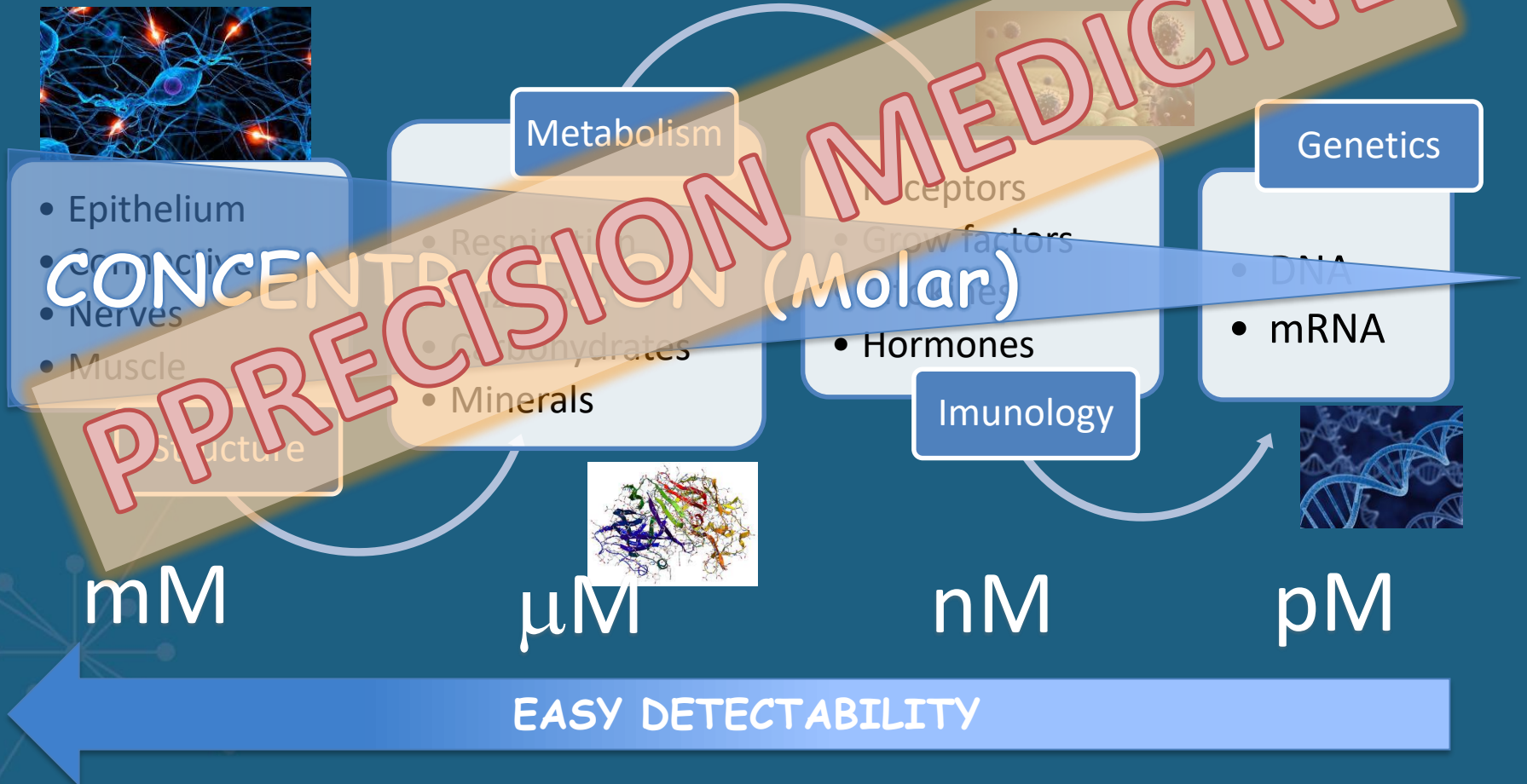
	Comprimento de onda em metros		Modalidade de Imagem	Informações medidas
Baixa energia	Ondas de rádio $10^3$		Imagem por RM	Anatomia Edema, fluxo Composição química
	Micro-ondas $10^{-2}$		Ultrassom	Anatomia Características, fluxos da estrutura tecidual
	Infravermelho $10^{-5}$		Imagem por infravermelho	Anatomia e fisiologia Temperatura da superfície
	Luz visível $10^{-6}$		Artroscopia	Anatomia Estrutura intra-articular, infamação
	Ultravioleta $10^{-5}$		Radiação UV	Cicatrização/terapia Pele, inflamação crônica
	Raios X $10^{-10}$		Raios X	Anatomia Lesões ósseas
	Raios gama $10^{-12}$		Cintilografia	Fisiologia Inflamação, metabolismo do osso
Alta energia				





# Desafios: novos agentes de contraste

POTENTIAL INCREASE OF SPECIFICITY





MEDICINA

FÍSICA

DOENÇAS

CURA

NATUREZA

ENERGIA

DIAGNÓSTICO

EXPERIMENTOS

FRATAMENTO

CALCULO

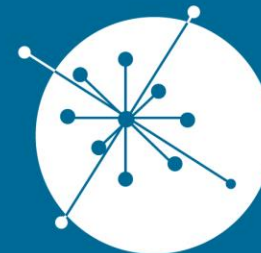
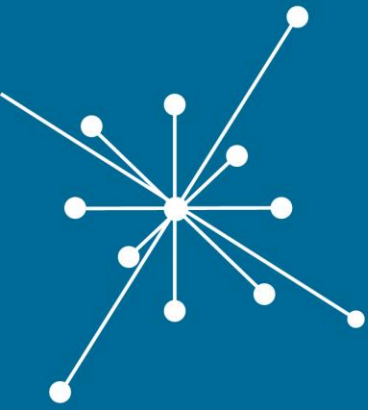
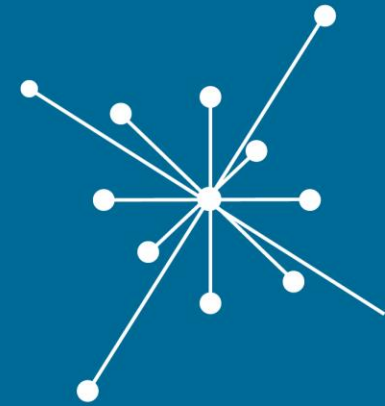
HOSPITAIS

LABORATÓRIOS

ESTAS SÃO SOMENTE  
AS TÉCNICAS MAIS COMUNS  
TEM MUUUUUUITO MAIS!!



# Fronteiras na pesquisa e inovação



GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

---

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tem  
Novidade!



## The linear quadratic model: usage, interpretation and challenges

Stephen Joseph McMahon 2019 *Phys. Med. Biol.* 64 01TR01

## The physics of proton therapy

Wayne D Newhauser and Rui Zhang 2015 *Phys. Med. Biol.* 60 R155

## The silicon photomultiplier: fundamentals and applications of a modern solid-state photon detector

Stefan Gundacker and Arjan Heering 2020 *Phys. Med. Biol.* 65 17TR01

## Tissue mimicking materials for imaging and therapy phantoms: a review

Conor K McGarry *et al* 2020 *Phys. Med. Biol.* 65 23TR01

## Quantitative PET in the 2020s: a roadmap

Steven R Meikle *et al* 2021 *Phys. Med. Biol.* 66 06RM01

## Physics in Biology and Medicine

Fifth Edition



Paul Davidovits



MAIS  
LIDOS

## Physics and technology of time-of-flight PET detectors

Dennis R Schaart 2021 *Phys. Med. Biol.* 66 09TR01

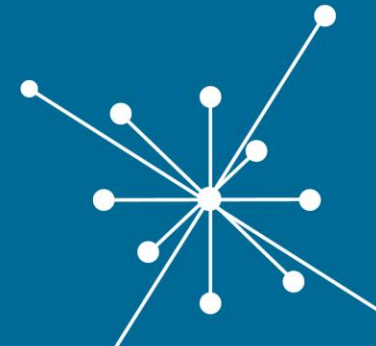
GRUPO DE  
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Generating synthesized computed tomography (CT) from cone-beam computed tomography (CBCT) using CycleGAN for adaptive radiation therapy

Xiao Liang *et al* 2019 *Phys. Med. Biol.* **64** 125002



Real-time intrafraction motion monitoring in external beam radiotherapy

Jenny Bertholet *et al* 2019 *Phys. Med. Biol.* **64** 15TR01

Experimental time resolution limits of modern SiPMs and TOF-PET detectors exploring different scintillators and Cherenkov emission

Stefan Gundacker *et al* 2020 *Phys. Med. Biol.* **65** 025001

A computational model of radiolytic oxygen depletion during FLASH irradiation and its effect on the oxygen enhancement ratio

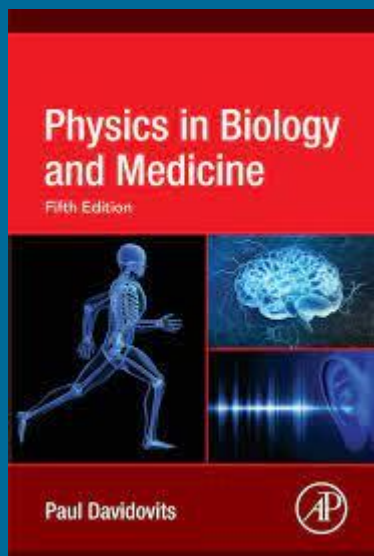
Guillem Pratx and Daniel S Kapp 2019 *Phys. Med. Biol.* **64** 185005

Experimental comparison of proton CT and dual energy x-ray CT for relative stopping power estimation in proton therapy

George Dedes *et al* 2019 *Phys. Med. Biol.* **64** 165002



GRUPO DE  
**DOSIMETRIA**  
DE  
**RADIACÖES**  
MÉDICA



**MAIS  
CITADOS**



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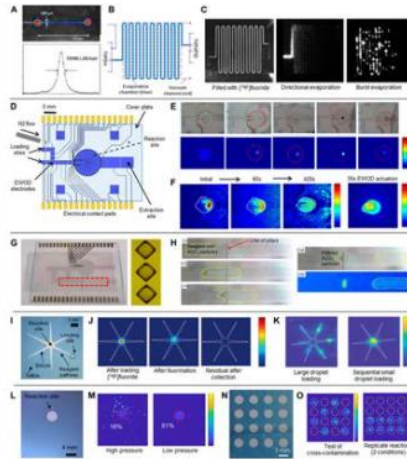
### EM Estimation of the Spectrum With a Generalized Optimal Step-Wedge Phantom

### Constructing Customized Multimodal Phantoms Through 3D Printing: A Preliminary Evaluation

Jianfeng Qiu, Kun Hou, Brandon Jyh-Cheng Chen, Liting Shi, Yong Longchun Xu, Huihui Zhao, Zhen Tiao Chen, Minghui Li, Fuquan Zhang, Haozhao Zhang and Yi Rong

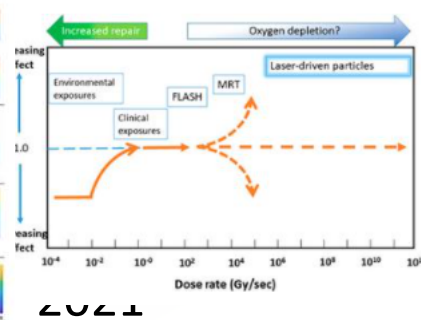
### Cerenkov Luminescence Imaging in the Development and Production of Radiopharmaceuticals

R. Michael van Dam and Arion F. Chatziioannou



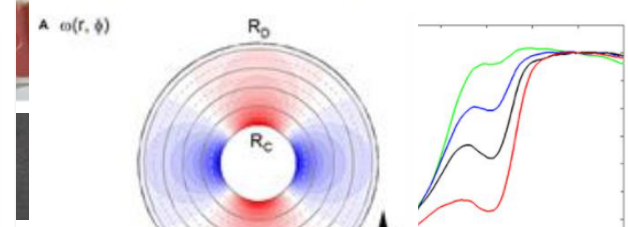
### Radiobiology Experiments with Ultra-high Dose Rate Laser-Driven Protons: Methodology and State-of-the-Art

Ankaj Chaudhary, Giuliana Milluzzo, Ahmad Ahmed, Boris Odlozilik, Aaron Murray, Kevin M. Prise and Marco Cerchiesi



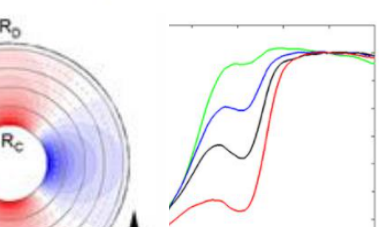
### Electrostatic Validity Criteria Numerical Approximation in a Cylindrical Tissue Model

Lukas T. Rotkopf, Eckhard Wehrse, Heinz-Peter Schlemmer and Christian H. Ziener



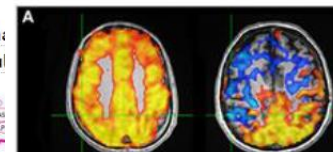
### Measuring Tumor Microenvironment pH During Radiotherapy Using a Novel Cerenkov Emission Optical Probe

Essam Al-Snayyan, Roy Clarke, Alnawaz Essam El Naqa



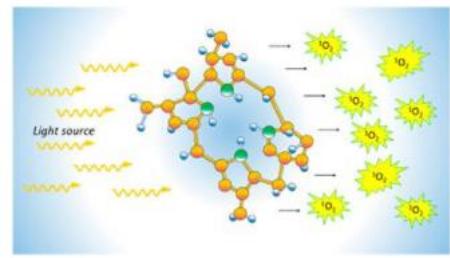
### Relationship Between Cerebrovascular Reactivity: Implications for Task-Based fMRI

Rebecca J. Williams, M. Ethan MacDonald, Erin L. Mazerolle and G. Bruce Pike



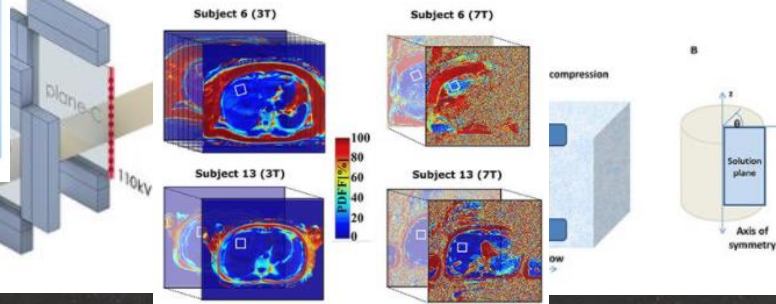
### Photodynamic Therapy Using Cerenkov and Radioluminescence Light

Antonello E. Spinelli and Federico Boschi



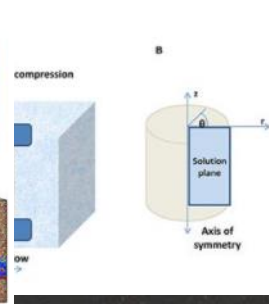
### Feasibility of Hepatic Fat Quantification Using Proton Density Fat Fraction by Multi-Echo Chemical-Shift-Encoded MRI at 7T

Radim Kořinek, Lorenz Pflieger, Korbinian Eckstein, Hannes Beiglböck, Simon Daniel Robinson, Michael Krebs, Siegfried Trattinig, Zenon Starčuk and Martin Krššák



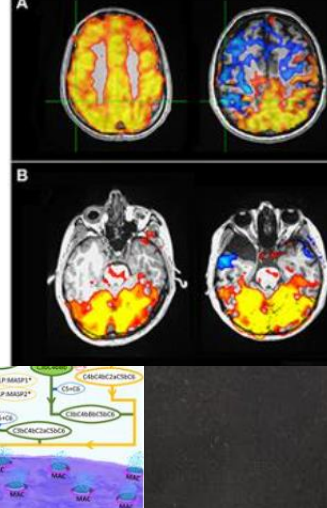
### Comparative Strain Relaxation for Ultrasound Tissue Characterization

Jeremie Fromageau, Jozsef Zsuzsanna and Jeffrey C.



### Systems Biology Modeling of the Complement System Under Immune Susceptibility Pathogens

Nehemiah T. Zewde, Rohit Dimitrios Morikis and Giulio





# IOMP E IAEA



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<https://www.iomp.org/iomp-school-webinars/>  
IOMP WEBINARS 2021



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[TOPICS](#) [SERVICES](#) [RESOURCES](#) [NEWS & EVENTS](#) [ABOUT US](#)

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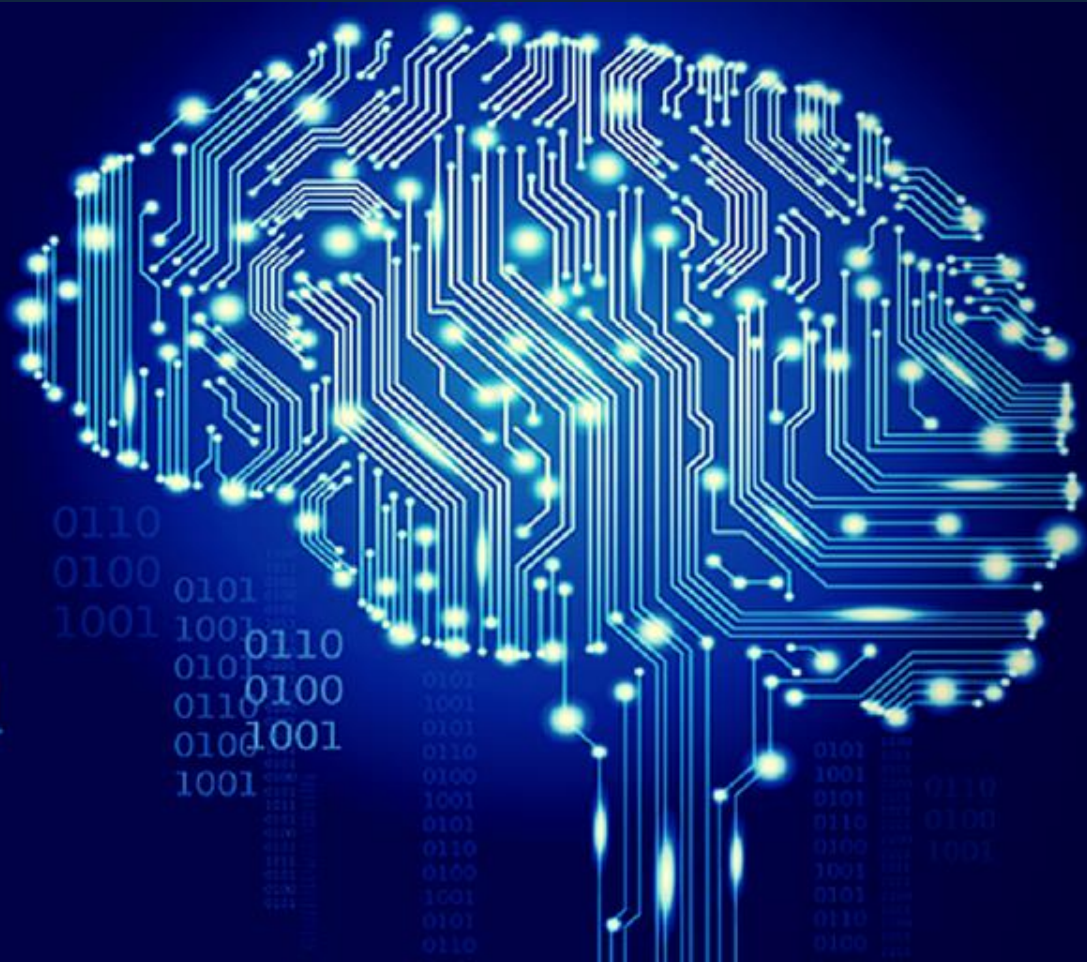
[Home](#) / [Resources](#) / [NUCLEUS information resources](#) / [Radiation Protection of Patients](#)



Radiation Protection of Patients (RPOP)

# A.I.

Inteligencia Artificial





RadVid-19

# AUXÍLIO AO DIAGNÓSTICO

A Inteligência Artificial a serviço da saúde!

REGISTRE-SE

ACESSAR

inova  
iHC

# Projeto RadVid19

# Proposta da plataforma







49

Cadastro de Centros de Diagnósticos e Hospitais



24.065

Imagens Armazenadas



9

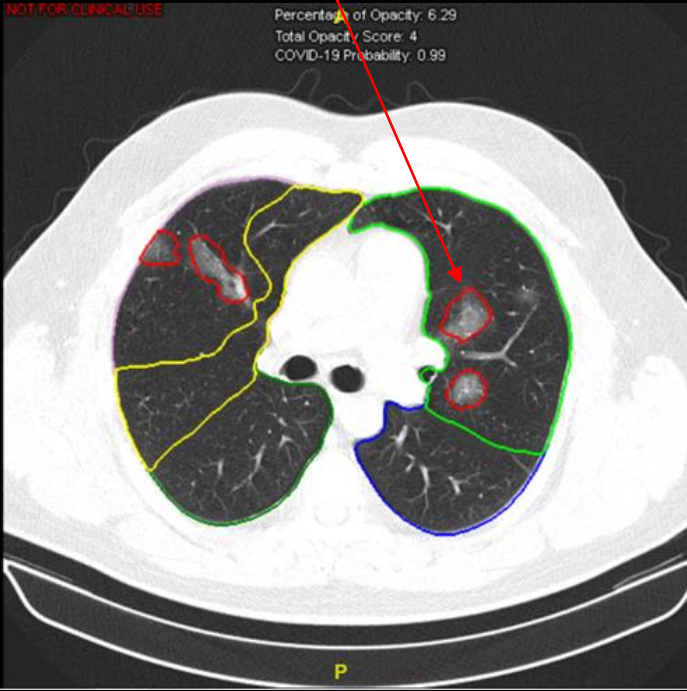
Empresas Parceiras

DAS RADIAÇÕES  
e FÍSICA MÉDICA

IFUSP - Instituto de Física da USP

Cortesia: M. Sawamura – INRAD/HCFMUSP

Indicação de localização das lesões (estrutura contornada em vermelho)



anonymous, radvid19, Age: 33y Sex: M  
 Patient ID: RDL0030-5507  
 ACC: 010057670193001  
 DOB: 11-Jun-1987  
 Thorax\*#TORAX\_ROTINA\_2020 (Adult)  
 AI-Rad Companion Research Results  
 PNEUMONIA ANALYSIS, V2.0  
 AIRC Research CT Pneumonia Analysis Results **IR CLINICAL USE**  
 Study Date: 06-Jul-2020  
 Study Time: 17:48:32

Se: 2

Lung Opacity	Both Lungs	Left Lung	Right Lung
Affected	YES	YES	YES
Opacity score	4	2	2
Volume total (ml)	7151.16	3335.84	3815.32
Volume of opacity (ml)	449.83	399.37	50.26
Percentage of opacity (%)	6.29	11.97	1.32
Volume of high opacity* (ml)	12.47	11.83	6.84
Percentage of high opacity* (%)	0.17	0.35	0.02
Mean HU total	-837.78	-820.43	-852.94
Mean HU of opacity	-654.26	-447.01	-711.88
Standard dev. total	175.43	191.07	158.97
Standard dev. of opacity	174.48	174.38	164.29

COVID-19 Probability: 0.99  
 Total Opacity Score: 4  
 Percentage of Opacity: 6.29  
 Opacity Index: [Color scale]

LUNG LOBES OPACITY	Left Upper	Left Lower	Right Upper	Right Middle	Right Lower
Affected	YES	YES	YES	YES	NO
Opacity score	1	1	1	1	0
Volume total (ml)	1576.27	1759.56	910.81	812.25	2092.46
Volume of opacity (ml)	122.16	277.21	19.44	16.35	14.47
Percentage of opacity (%)	7.75	15.75	2.13	2.01	0.69
Volume of high opacity* (ml)	3.10	8.53	0.39	0.26	0.19
Percentage of high opacity* (%)	0.20	0.48	0.04	0.03	0.01
Mean HU total	-836.78	-805.81	-847.74	-874.36	-845.89
Mean HU of opacity	-639.27	-650.41	-710.04	-693.44	-735.17
Standard dev. total	168.86	207.89	146.15	131.51	172.75
Standard dev. of opacity	175.95	173.57	174.63	168.91	152.73

\* High Opacity Threshold: -200 HU

To interpret the results, please refer to the user documentation.

Probabilidade de ser Covid

Percentual de acometimento pulmonar



<https://youtu.be/Vhhe92-tTWw>

**radvid19.com.br**

**radvid19.inrad@hc.fm.usp.br**



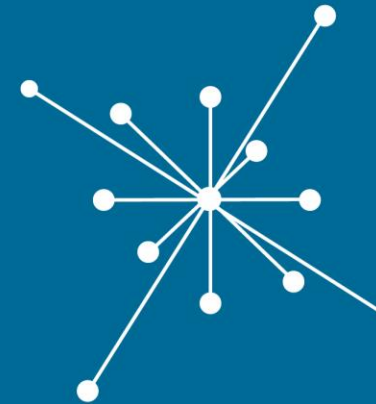
# Ainda falando de IA



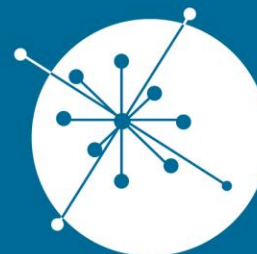
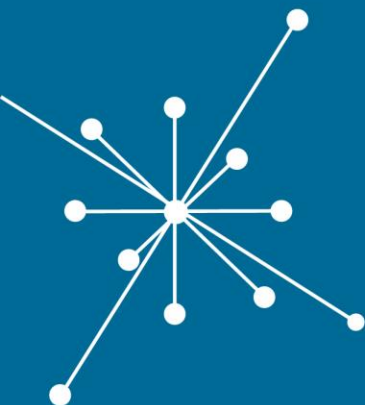
Article collection about artificial intelligence in  
medical physics is **FREELY** available now:

[https://www.physicamedica.com/artificial-intelligence-medical-physics?fbclid=IwAR0Mqr4QmwaQxhHRcVb4Wl2y7uDBq6B7C5KvsyUs0VvjM\\_9dEbUJ8dFbCrY](https://www.physicamedica.com/artificial-intelligence-medical-physics?fbclid=IwAR0Mqr4QmwaQxhHRcVb4Wl2y7uDBq6B7C5KvsyUs0VvjM_9dEbUJ8dFbCrY)





# Método Monte Carlo para Estudo de doses de radiação (só um exemplo... Tem muito mais)



GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

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# Simulações Monte Carlo em multiescala para técnicas avançadas de imageamento da mama: estudos dosimétricos

RODRIGO T. MASSERA\*<sup>1</sup>, ALESSANDRA TOMAL<sup>1</sup>, ROWAN M. THOMSON<sup>2</sup>

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<sup>1</sup>UNIVERSIDADE ESTADUAL DE CAMPINAS, BRASIL

<sup>2</sup>CARLETON UNIVERSITY, CANADA

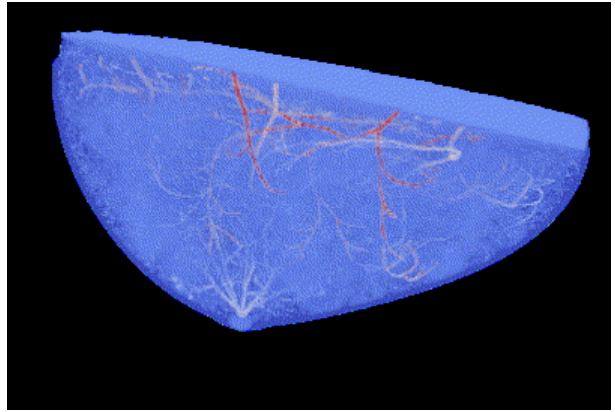


# METODOLOGIA

## Modalidades (espectros)

- BCT (W/Al 49 kV; W/Cu 80 kV)
  - Mamografia (W/Rh 28 kV)
  - DBT (W/Al 32 kV)
  - CEDM (W/Cu 49 kV)

Modelo de mama

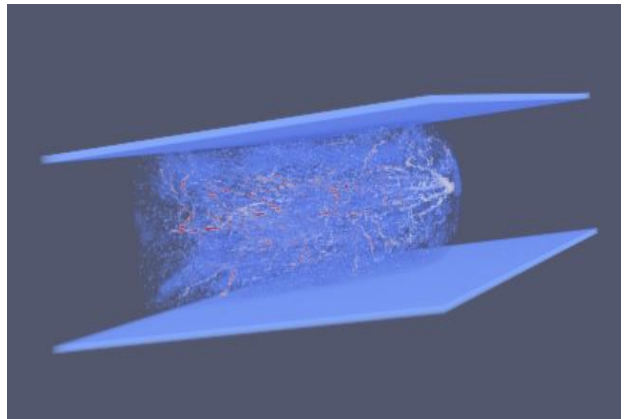


Graff 2016

≈20% glandular (em massa)

## Códigos Monte Carlo

- MC-GPU (v. 1.5 b) Badal 2009
- PENELOPE (v. 2014) + penEasy (v. 2015) Salvat 2015, Sempau 2011
- EGSnrc (egs\_brachy) Kawrakow 2017, Chamberland 2016

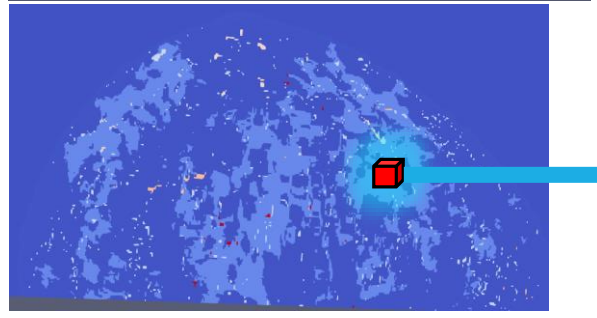
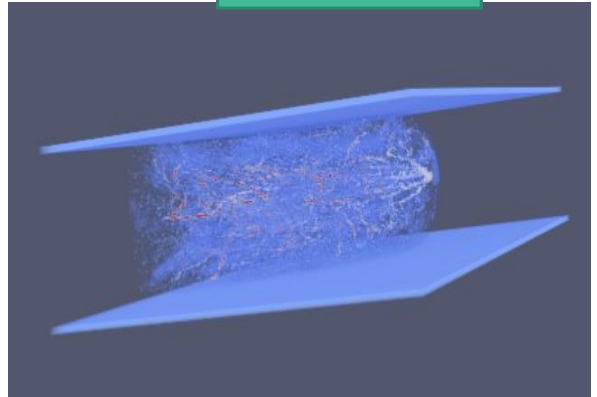
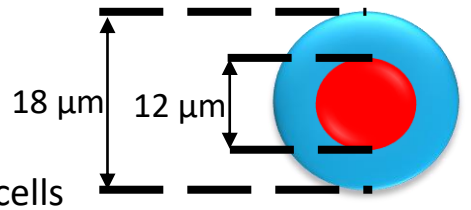


Resolução de 0.5 mm    Espessura da mama: 5 cm

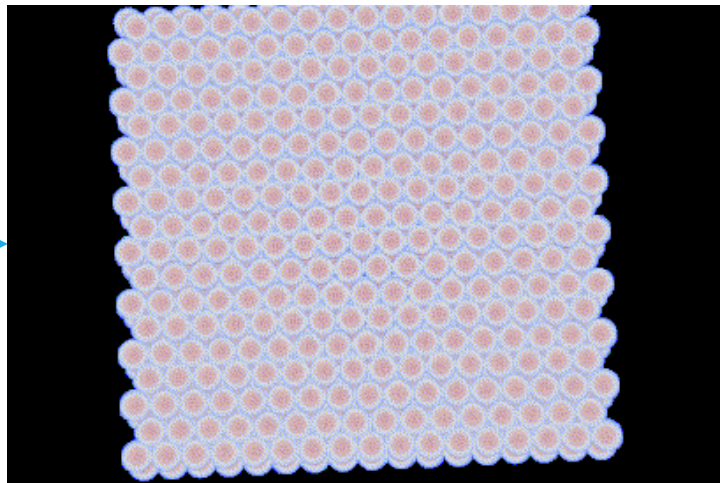
# METODOLOGIA – Simulações Monte Carlo multiescala

MC-GPU

PENELOPE



Phase Space Files



$(500)^3 \mu\text{m}^3$  cube

Martinov 2020

Distribuição da dose glandular

Energia específica (z)

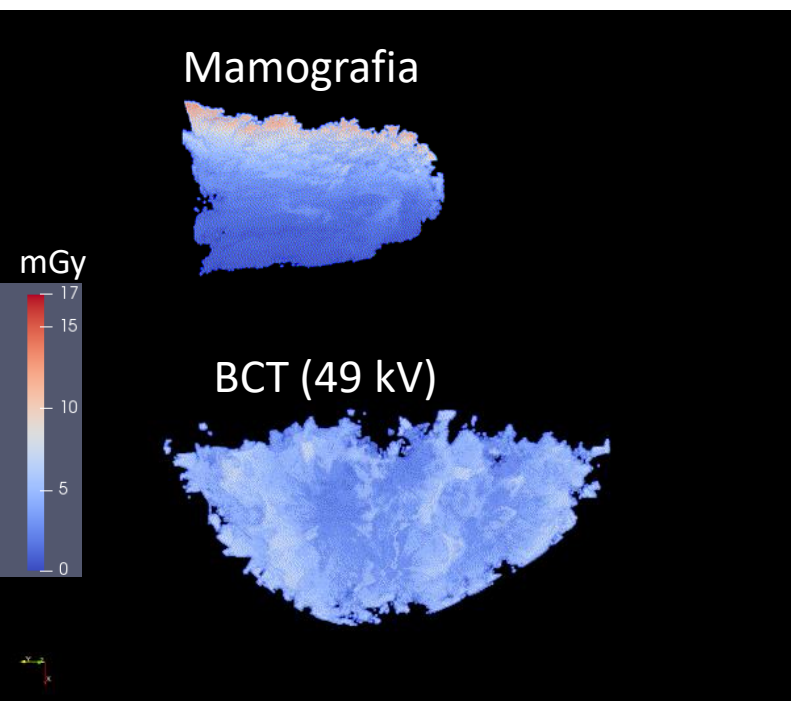
simulando  $e^-$



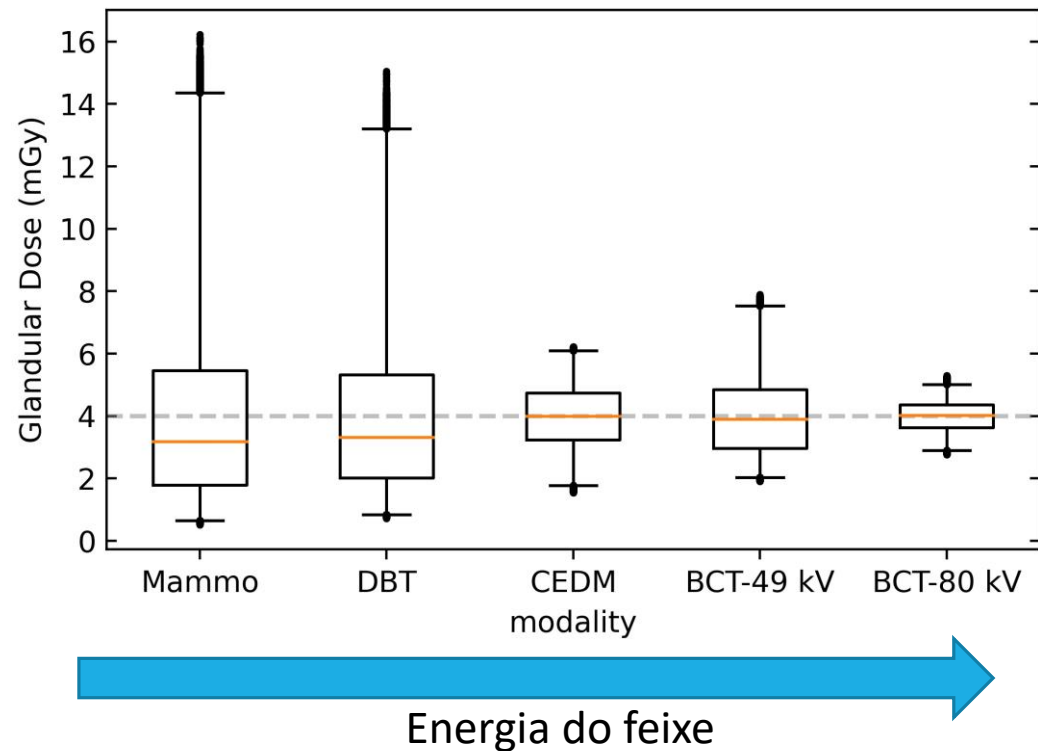
# RESULTADOS – DISTRIBUIÇÃO DA DOSE GLANDULAR

Distribuição 3D

MGD = 4 mGy

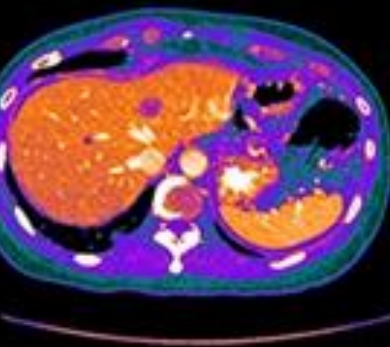
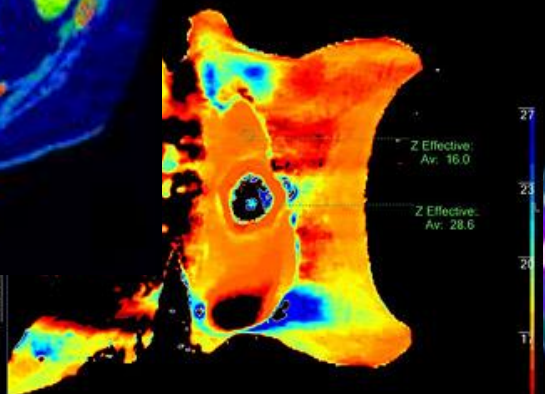
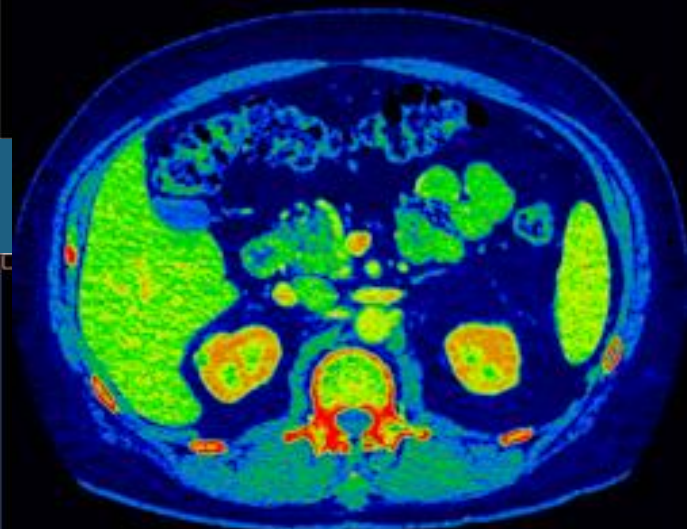
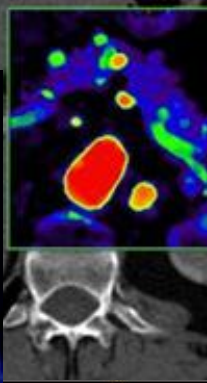
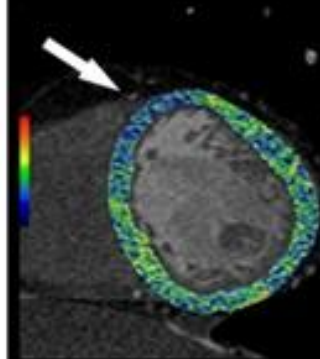
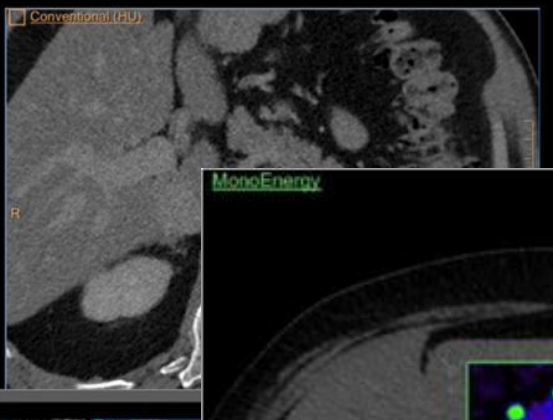


Distribuição da dose glandular



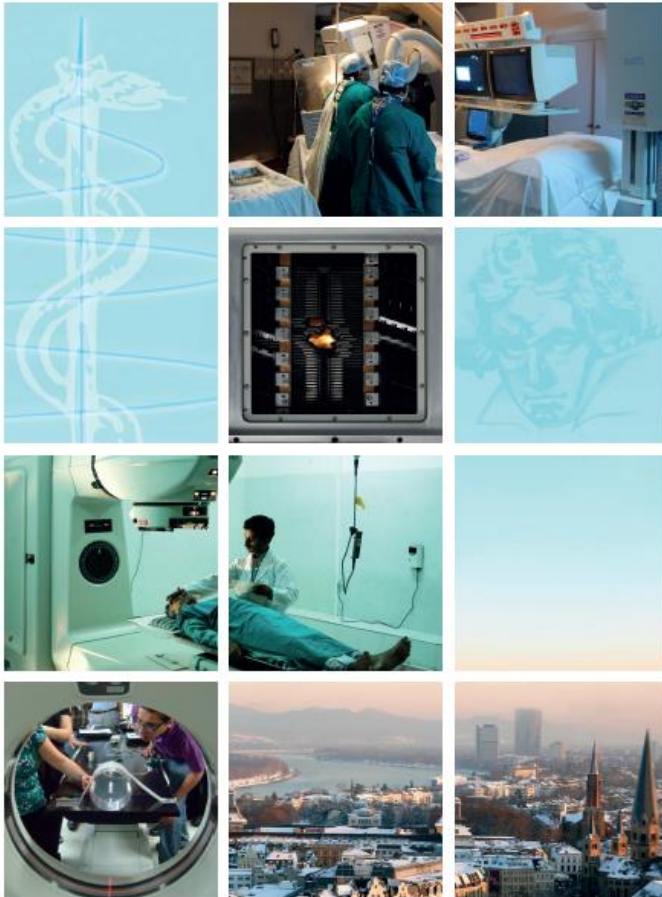
# IQon Spectral CT

Abdomen without and with IV contrast and Virtual Non Cc  
110 sec scan delay between acquisitions





# Nossos desafios



## BONA: CHAMADA PARA A AÇÃO

10 Ações para a melhoria da proteção radiológica em medicina na próxima década

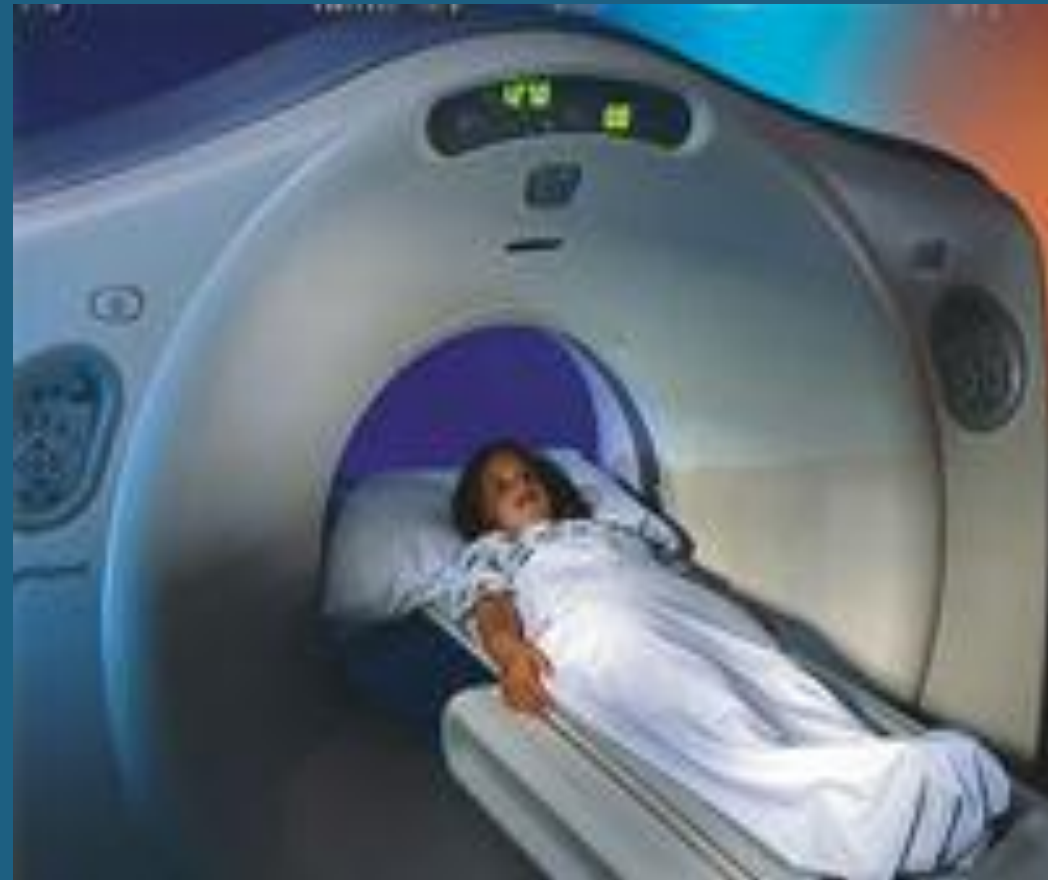
[https://www.iaea.org/sites/default/files/17/12/bonn-call-for-action\\_por.pdf](https://www.iaea.org/sites/default/files/17/12/bonn-call-for-action_por.pdf)  
<https://cbr.org.br/brasil-call-actions/>

SPECTRAL  
RADIOGRAPHY  
IMAGING TOMOGRAPHY  
SPECT-CT  
INTERVENTIONISM TABOLT-LAU  
MOLECULAR IMAGES  
TOMOSYNTHESIS PET-CT CEBCT PAEDIATRIC  
DUAL-ENERGY  
EMISSION MAMMOGRAPHY DECT  
INOVATIONS ENHANCED  
PCCT PHASE CT MRI ASSESSMENT  
DOSE POWER CONTRAST RELATIVE  
PRE-TREATMENT HYBRID ORGAN-SPECIFIC  
STOPPING SPECT CT/DR  
PRECISION PROTON  
MEDICINE PET-MRI DOSIMETRY  
ULTRA-LOW  
PATIENT-SPECIFIC



# Perspectivas

## Redução de doses em pediatria



# Protocolos Pediátricos

## Protocolos de TC e Dose Administrada:

Devem ser adaptados ao tamanho, idade e necessidades clínicas dos pacientes de acordo com...



## Image Gently: “One size does not fit all”

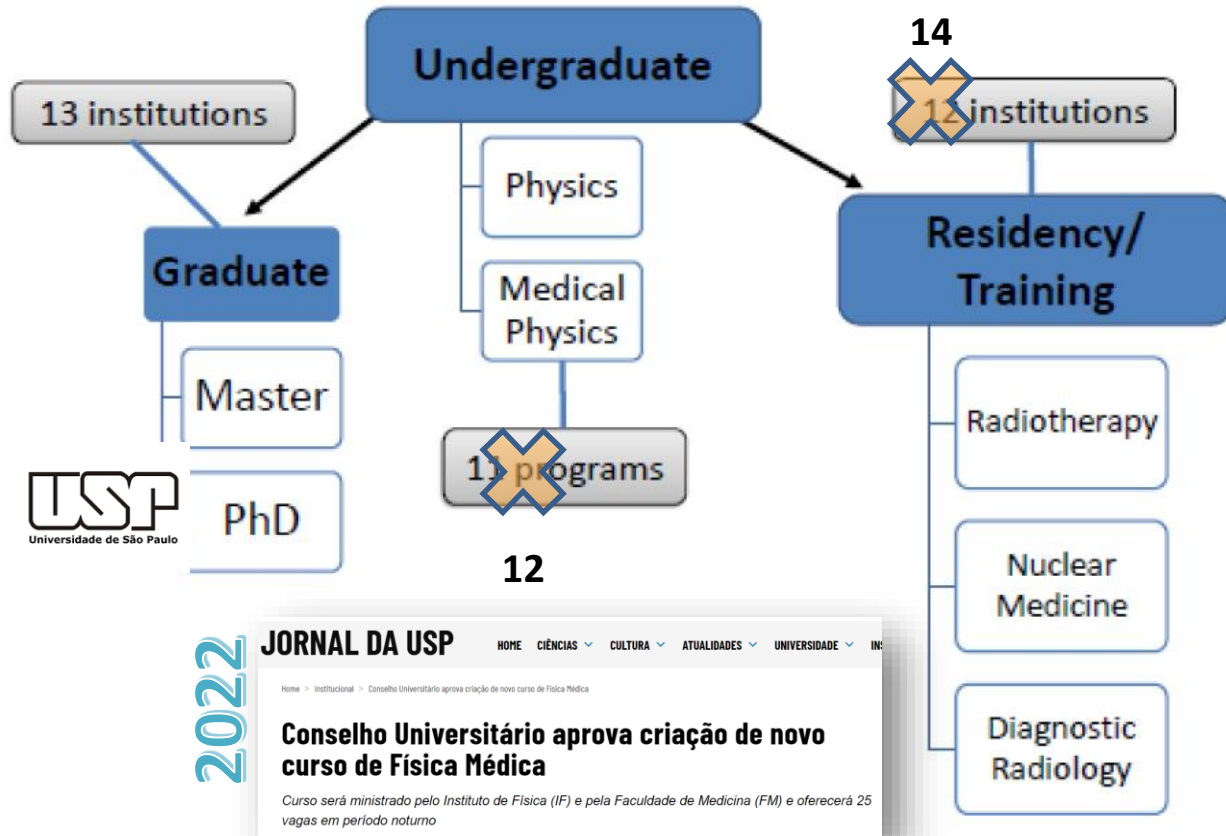






Hummm... Gostei!!  
Como é que eu faço  
pra virar um físico  
médico???

# Caminhos para formação



<https://jornal.usp.br/institucional/conselho-universitario-aprova-criacao-de-novo-curso-de-fisica-medica/>



After 30 years  
of negotiations!!



# Graduação, pós-graduação e residência



Instituto  
University of

[https://youtu.be/TReR8\\_OE2Lc](https://youtu.be/TReR8_OE2Lc)



<https://youtu.be/wDYIfXo-U0E>



## Residence, Ms and PhD programs



# Programa de Residência em Física Médica

- 6 residentes ingressando por ano – 2 RD e 2 RT

80 %

Práticas  
(INRAD e  
ICESP)

Residência

20 %

Aulas  
teóricas  
(INRAD e  
IFUSP)

Monografia

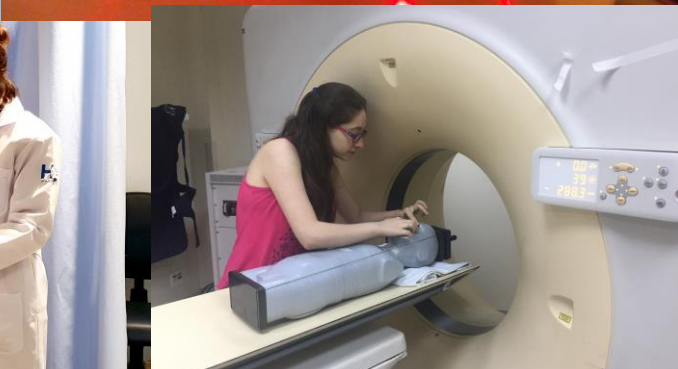
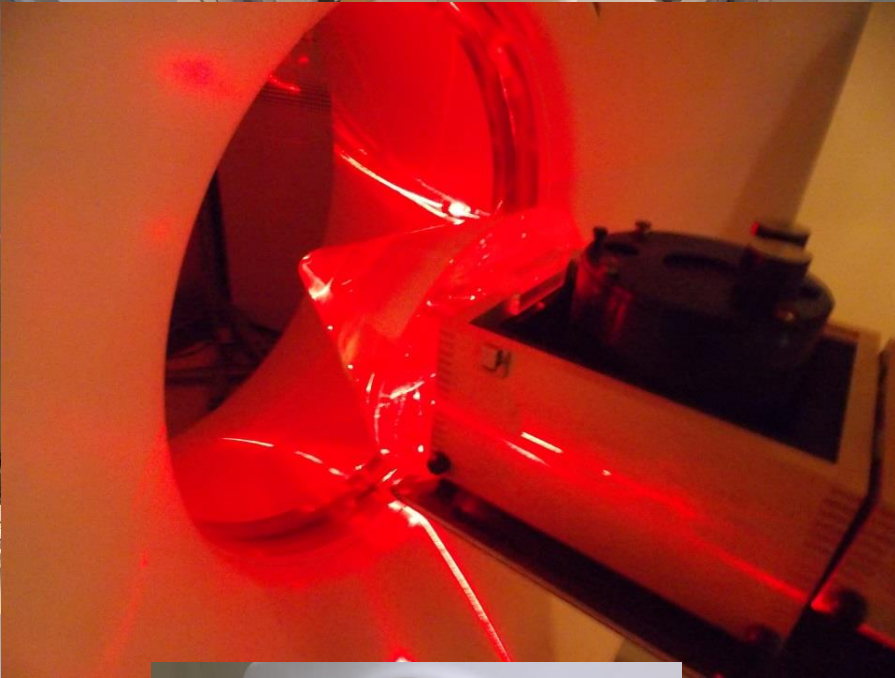
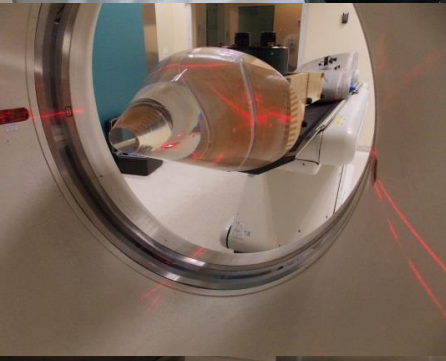
2 anos

5760 horas

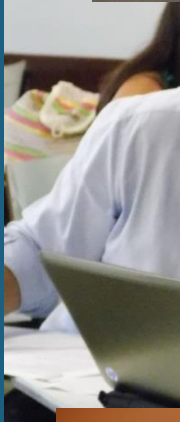
60 h/sem













# Nosso time



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# SUGESTÃO



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The screenshot shows the website <https://jornal.usp.br/universidade/carreira-de-fisico-medico-tem-muitas-oportunidades-com-tecnologias/>. The page features the 'Jornal da USP' header with navigation links for 'PORTAL DA USP', 'WEBMAIL USP', 'SERVIÇOS', 'SISTEMAS USP', and 'TRANSPARÊNCIA'. The main article is titled 'Carreira de físico médico tem muitas oportunidades com tecnologias' and is dated 22/02/2018. It is categorized under 'Universidade' and 'Tecnologia'. The article text mentions that the 'Abraça uma Carreira' program from Rádio USP discusses the field of medical physics, with guests including Professor Paulo Costa from the Department of Nuclear Physics at IFUSP, Professor Elizabeth Yoshimura, and Homero Lavieri Martins from the Instituto do Câncer de São Paulo. The page also includes social media sharing options and a search bar.

<https://jornal.usp.br/universidade/carreira-de-fisico-medico-tem-muitas-oportunidades-com-tecnologias/>





PESQUISA | INOVAÇÃO

# ALGUNS EXEMPLOS DE NOSSO GRUPO

AMBIENTE  
CLÍNICO



GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

---

IFUSP - Instituto de Física da USP

# Produção de phantoms



IFUSP - Instituto de Física da USP

TEMÁTICO  
P&D&I EM METROLOGIA  
DAS RADIAÇÕES NA  
ÁREA DA SAÚDE  
Em andamento  
Coord. Linda Caldas - IPEN



Código 2.1 - Pedido de Patente ou Certificado de Adição de Invenção  
depositado  
(22) 18/11/2020  
(71) UNIVERSIDADE DE SÃO PAULO - USP (BR/SP)

(21) BR 10 2020 023580-0

**patente**

PTDE  
DE  
APL  
R  
EQU  
MENTES A TECIDOS  
HUMANOS E DE OBJETOS  
SIMULADORES

Em fase de submissão  
Coord. Andrew Frimaio

**Start-up  
DXL**





# Contribuições potenciais

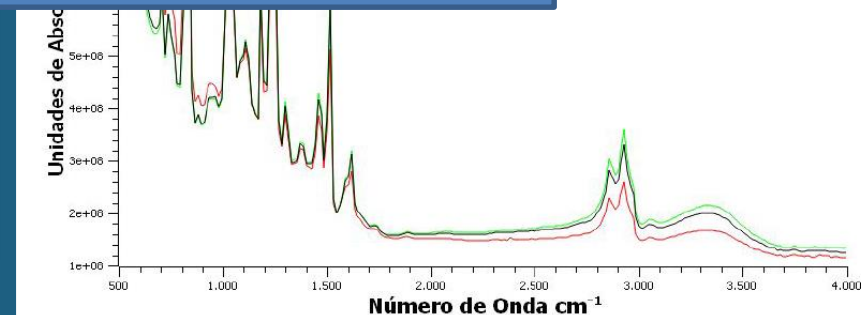


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TEMÁTICO  
P&D&I EM METROLOGIA  
DAS RADIAÇÕES  
ÁREA DA SAÚDE  
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PIPE/FAS  
DESENVOLVIMENTO  
APLICAÇÕES DE  
RADIOLOGIA  
EQUIVALENTES A TECIDOS  
HUMANOS E DE OBJETOS  
SIMULADORES  
Em fase de submissão  
Coord. Andrew Frimaio

**Novos materiais:**  
**Pulmão**  
**Pele**  
**Osso**



# Contribuições potenciais

## TEMÁTICO

P&D&I EM METROLOGIA  
DAS RADIAÇÕES NA  
ÁREA DA SAÚDE

Em andamento

Coord. Linda Caldas - IPEN

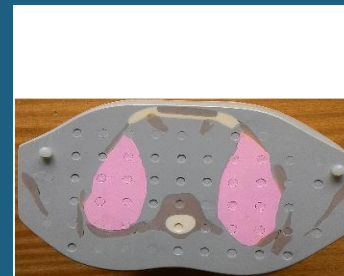


## PIPE/FASE 2

DESENVOLVIMENTO E  
APLICAÇÕES DE MATERIAIS  
RADIOLOGICAMENTE  
EQUIVALENTES A TECIDOS  
HUMANOS E DE OBJETOS  
SIMULADORES

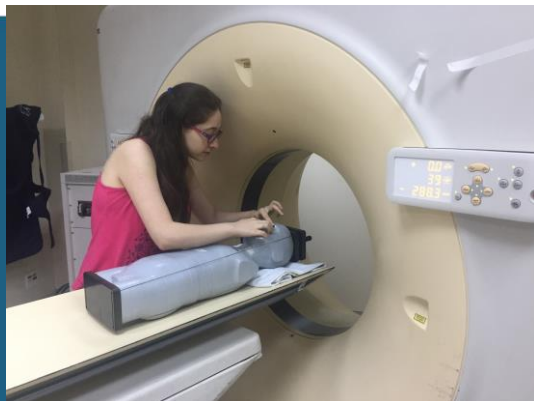
Em fase de submissão

Coord. Andrew Frimaio





# Otimização em CT pediátrico



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Physica Medica

journal homepage: [www.elsevier.com/locate/ejmp](http://www.elsevier.com/locate/ejmp)



Original paper

Developing and implementing a multi-modality imaging optimization study in paediatric radiology: Experience and recommendations from an IAEA coordinated research project

Physica Medica 82 (2021) 255–265

H. Delis<sup>a,\*</sup>, P. Homolka<sup>b</sup>, C.L. Chapple<sup>c</sup>, P.R. Costa<sup>d</sup>, E. Attalla<sup>e</sup>, L.E. Lubis<sup>f</sup>, T.A. Sackey<sup>g</sup>,  
F. Fahev<sup>h</sup>, M. Lassmann<sup>i</sup>, G.L. Poli<sup>a</sup>

WILEY

Original Article

Revista Brasileira de Física Médica. 2019;13(1):138-144.

## Pediatric computed tomography dose optimization in a general hospital

Otimização de dose em tomografia computadorizada pediátrica em hospital geral

Vivian Heidorne Guerra<sup>1</sup>, Denise Yanikian Nersissian<sup>1</sup>, Camila S Melo<sup>1</sup>,  
Caio Eduardo C. E. C. Vasconcellos<sup>1</sup>, Rebeca Gonçalves Freitas<sup>3</sup>,  
Marcio V. Y. Sawamura<sup>2</sup>, Eloisa M. M. S. Gebrim<sup>2</sup>, Paulo R. Costa<sup>1</sup>

DOI: 10.1002/acm2.12505

MEDICAL IMAGING

## Organ doses evaluation for chest computed tomography procedures with TL dosimeters: Comparison with Monte Carlo simulations

Louise Giansante<sup>1</sup> | Juliana C. Martins<sup>1,2</sup> | Denise Y. Nersissian<sup>1</sup> | Karen C. Kiers<sup>1,3</sup> |  
Fernando U. Kay<sup>4</sup> | Marcio V. Y. Sawamura<sup>4</sup> | Choonsik Lee<sup>5</sup> | Eloisa M. M. S.  
Gebrim<sup>4</sup> | Paulo R. Costa<sup>1</sup>

# Otimização em CT para casos de pacientes com COVID-19

ORIGINAL RESEARCH • THORACIC IMAGING

Specific CT Protocol for COVID-19

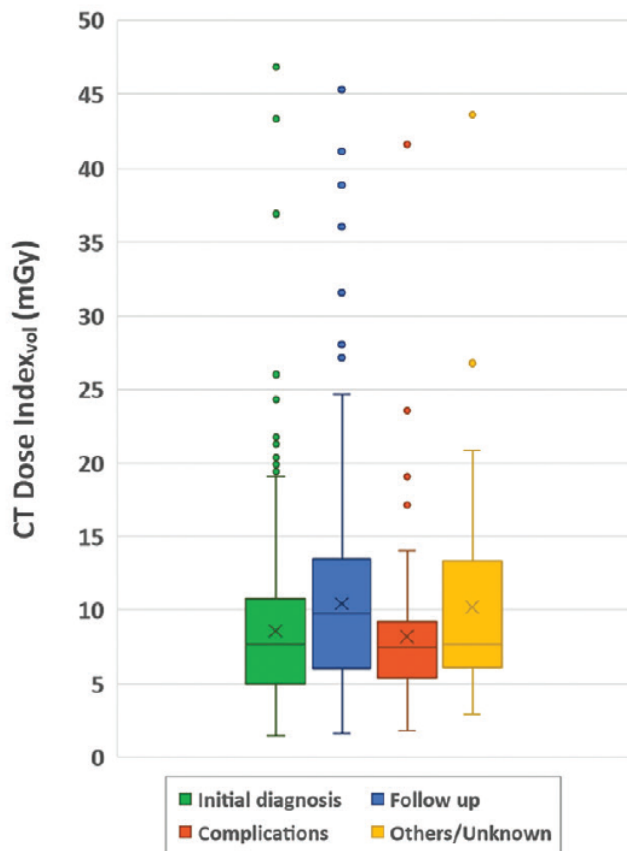
Radiology

Variations in C in COVID-19 F in the IAEA Stuc

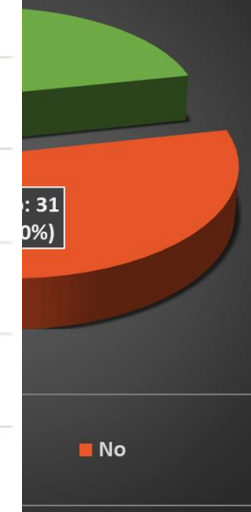
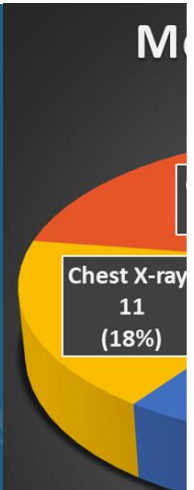
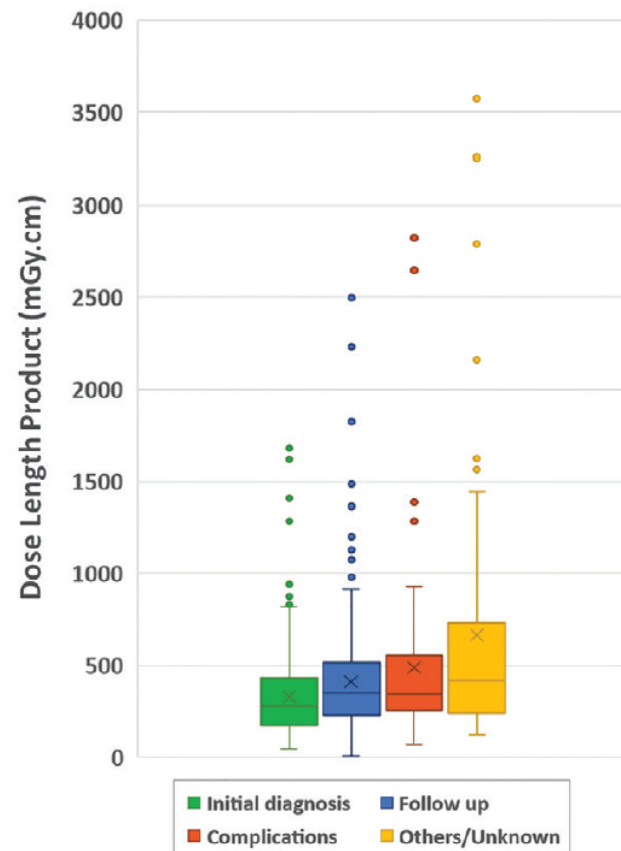
Fatemeh Homayounieh, MD • Algidas Basevičius, MD • Pau Pilvi Ives, MD, PhD • Desisl Osvaldo Rampado, DMP • N Tájana Turk, MD • Claire Va

Radiology 2021; 2

CTDI<sub>vol</sub> for different indications



DLP for different indications



- Antibody
- RT-PCR
- Chest X-ray
- CT-scan

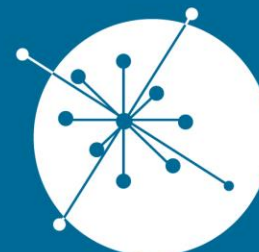
- Never (0%)
- Rarely (1-25%)
- Frequently (25-50%)
- Commonly (51-75%)
- Always (>75%)





Obrigado

[pcosta@if.usp.br](mailto:pcosta@if.usp.br)



GRUPO DE  
**DOSIMETRIA  
DAS RADIAÇÕES**  
e FÍSICA MÉDICA

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