SAPIENZA UNIVERSITÀ DI ROMA

INFN Istituto Nazionale di Fisica Nucleare

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ISTITUTO ITALIANO DI TECNOLOGIA

Radio-guided surgery with β^- radiation

POLITECNICO MILANO

Gemelli

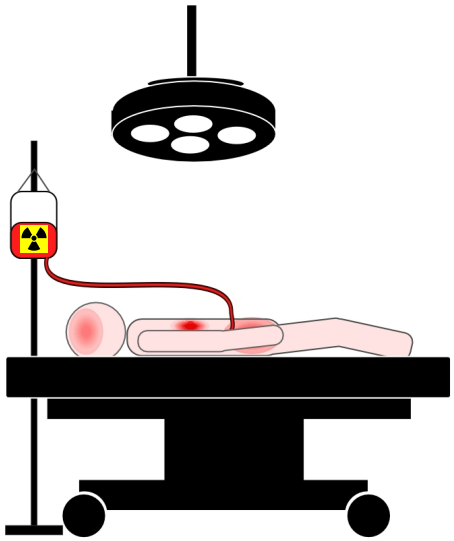
Istituto Europeo di Oncologia

SERVIZIO SANITARIO REGIONALE EMILIA-ROMAGNA
Azienda Ospedaliera di Reggio Emilia
Arcispedale S. Maria Nuova
Istituto in tecnologie avanzate e modelli assistenziali in oncologia
Istituto di Ricovero e Cura a Carattere Scientifico

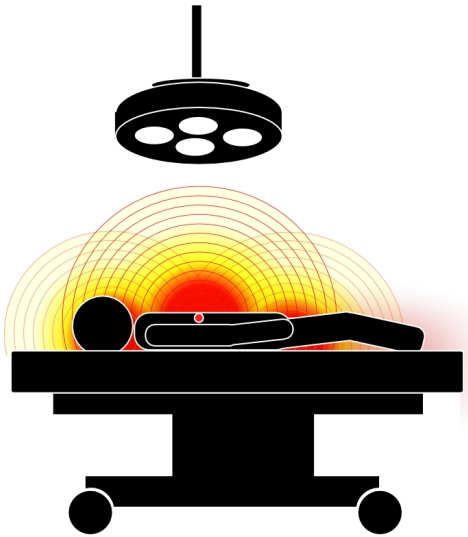
FONDAZIONE I.R.C.C.S. ISTITUTO NEUROLOGICO CARLO BESTA

Radio Guided Surgery

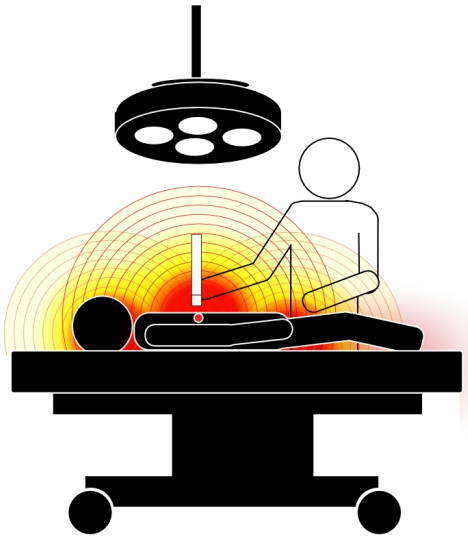
1. **Administration of the radiotracer**



2. **Major uptake by tumor**

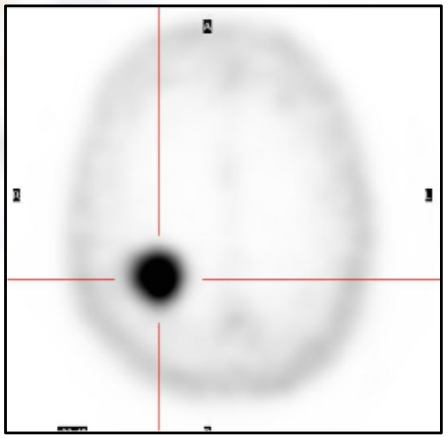


3. **Probe detects residuals**



Each tumor requires its own tracer

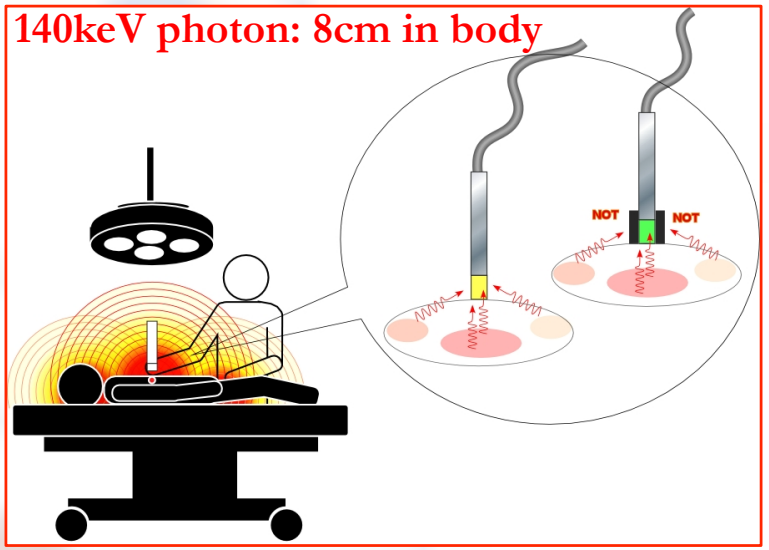
PET/SPECT scan to estimate receptivity and background



Limits of γ-RGS

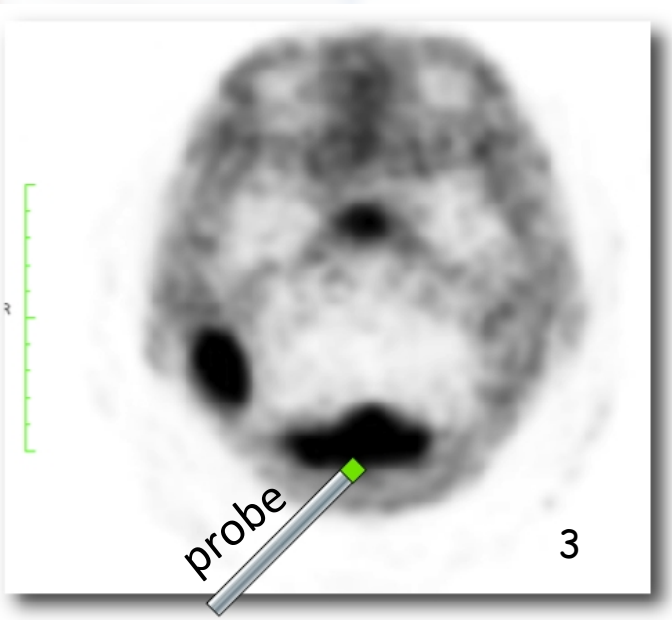
Long range of gamma's involves:

- Exposure of medical personnel
- Background from healthy organs around the lesion



Difficult to apply in:

- **Brain tumors**
- **Abdominal tumors**
- **Pediatric tumors**



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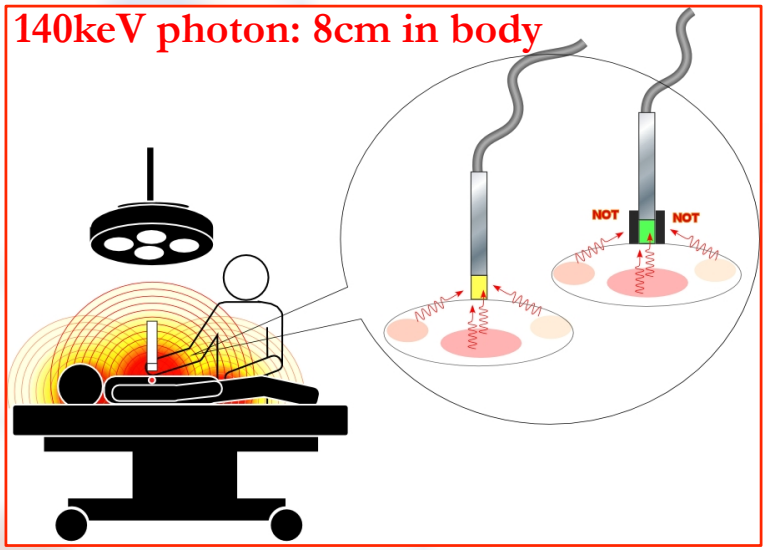

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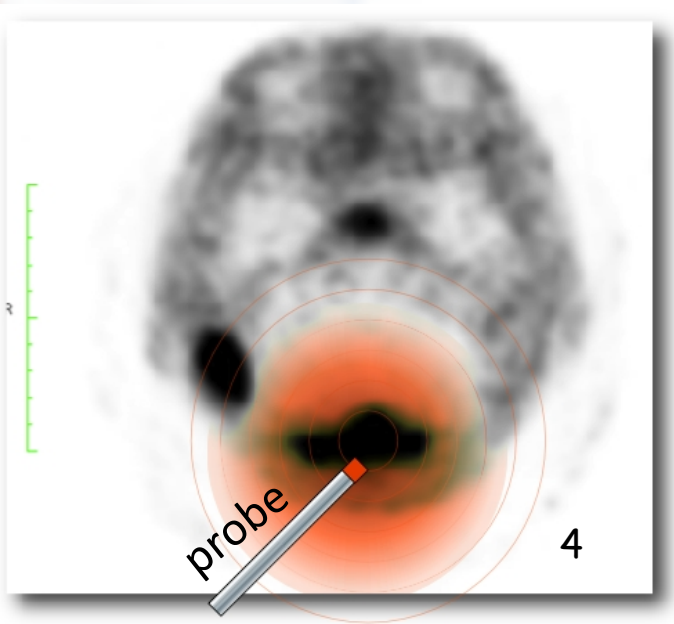

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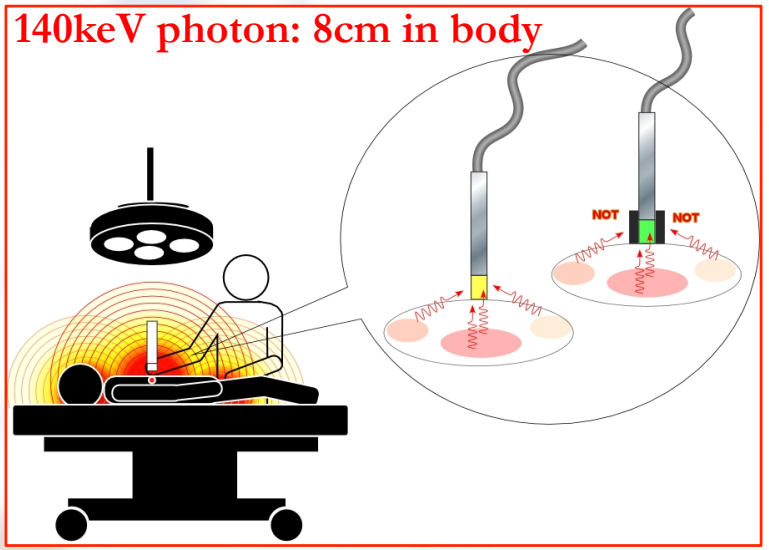

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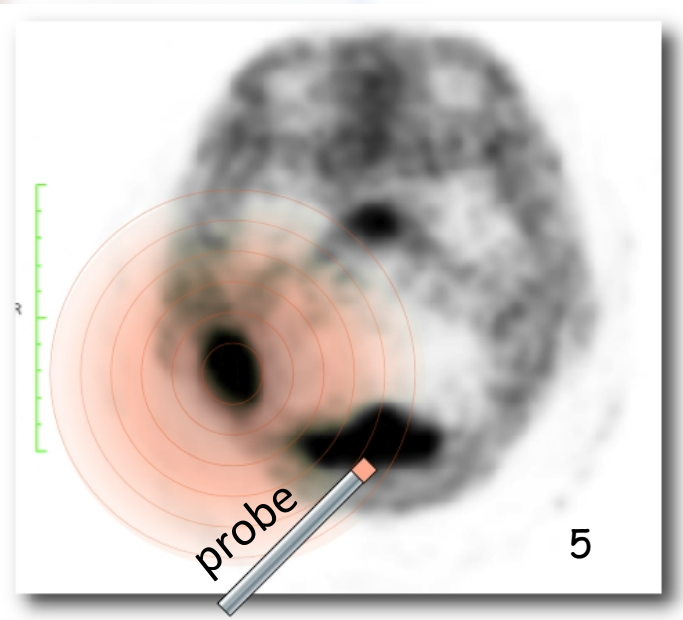

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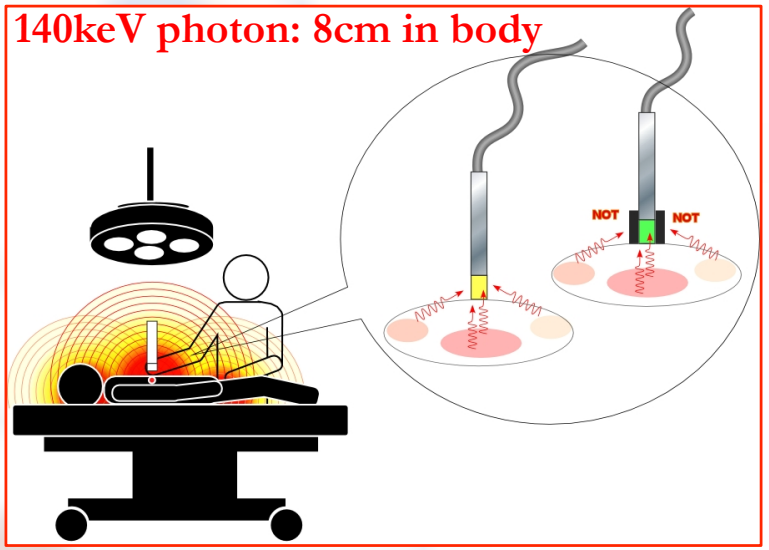

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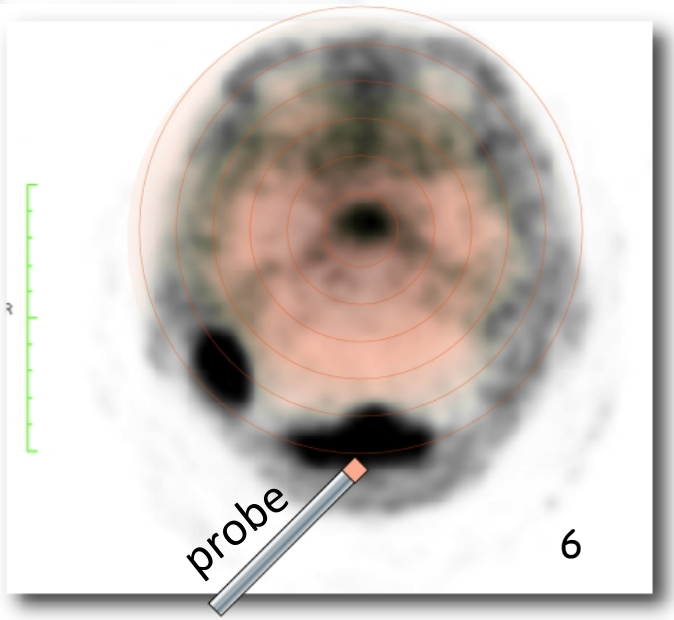

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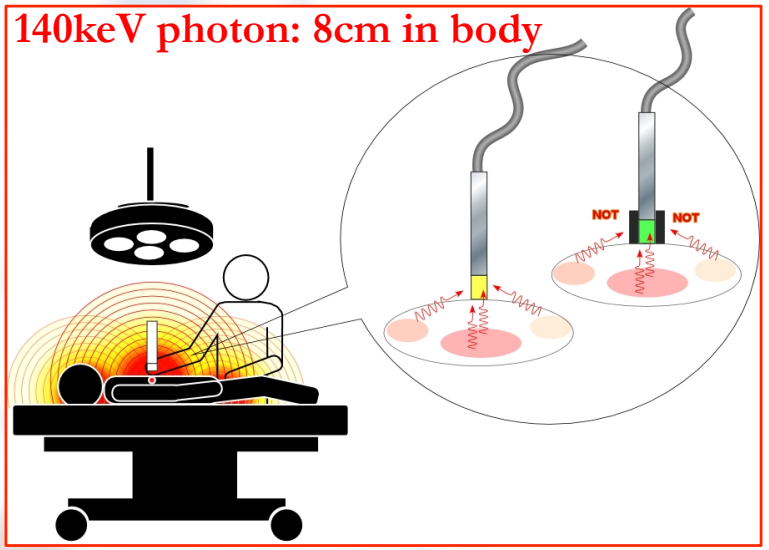

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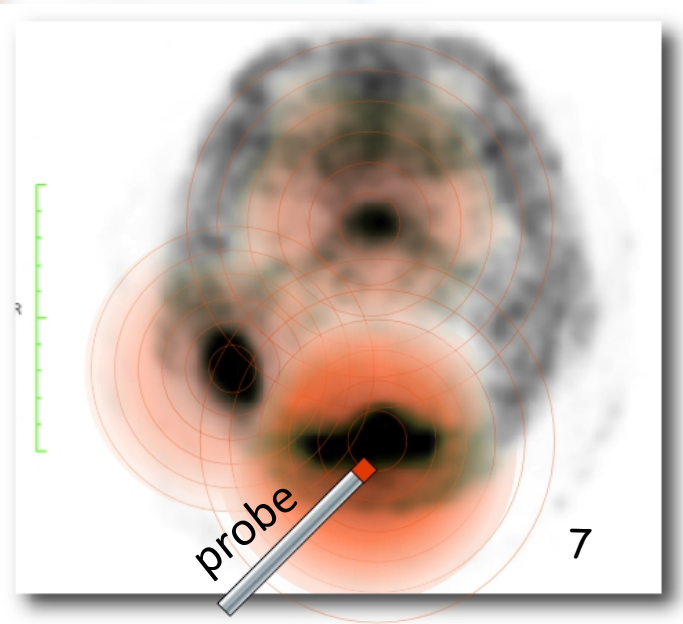
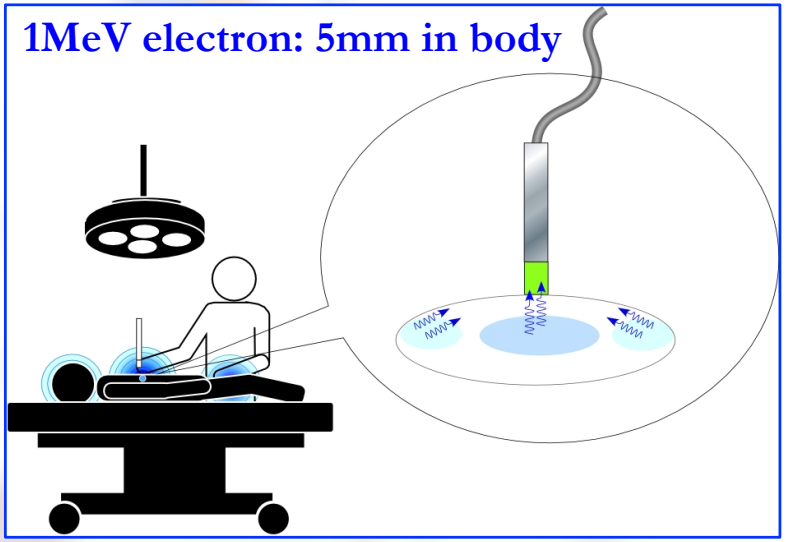


A change in paradigm: use of β^- tracers

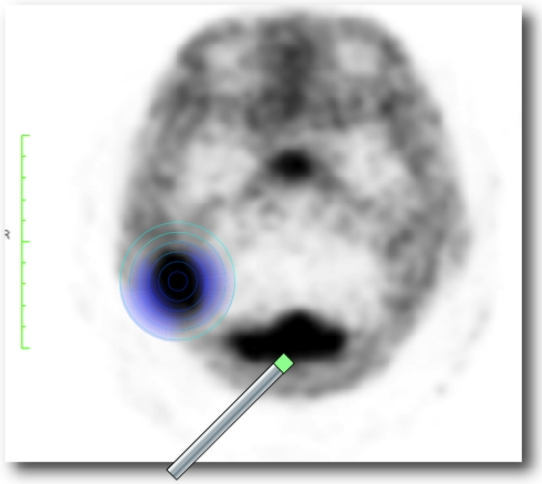
Tracers with ^{90}Y can be used
(already used for Molecular RT)

- Electrons travel ~100 times less than photons
- No background from gamma



- Reduced effect of nearby healthy tissues
- Smaller administered activity necessary
- Compact and more versatile detector
- Reduced dose to medical staff

APPLIABLE TO MORE CLINICAL CASES



E. Solfaroli Camillocci et al, Sci. Repts. 4,4401 (2014)

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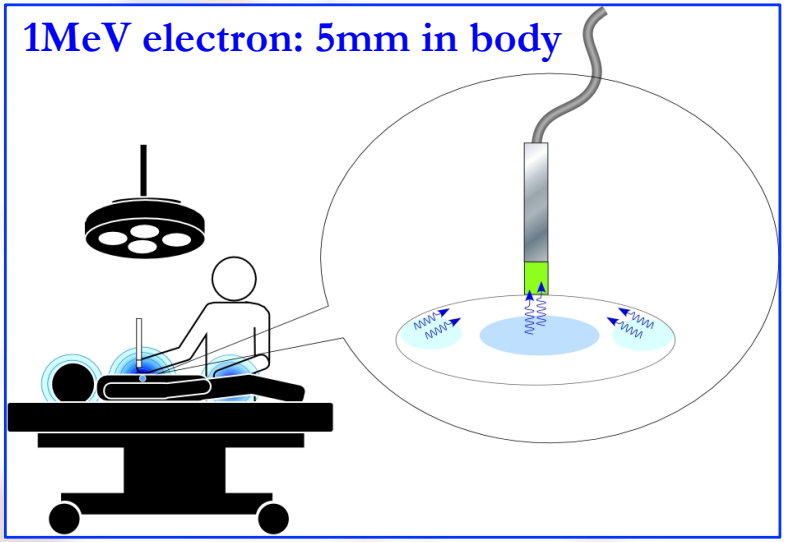

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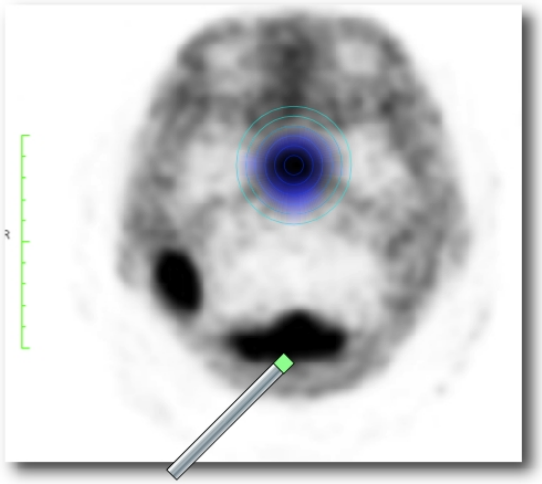

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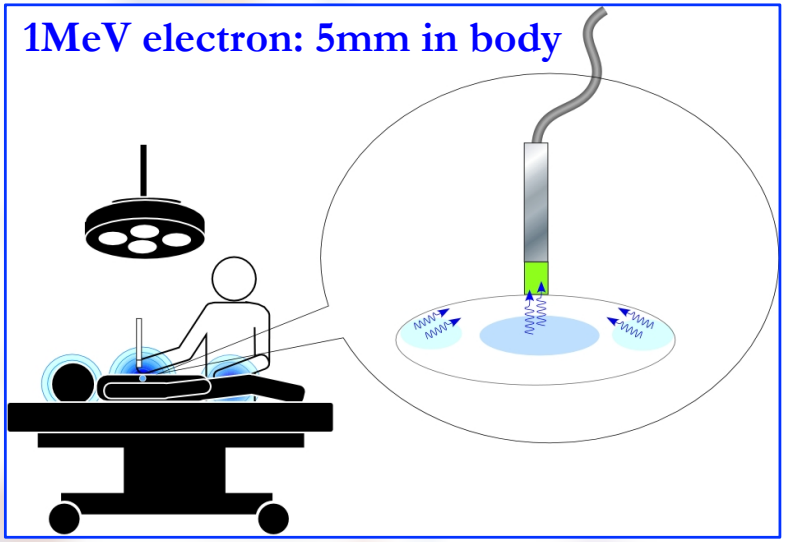

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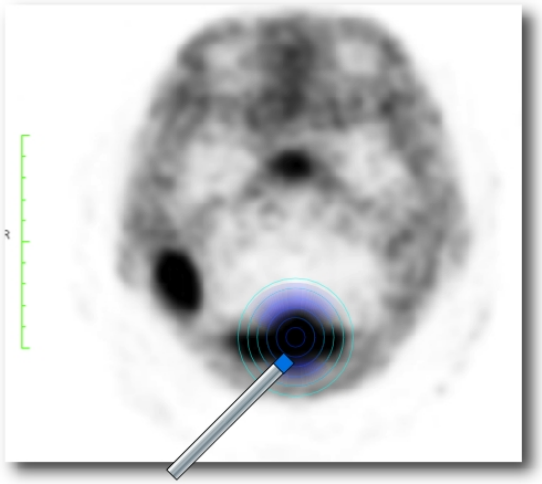

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The probe prototype

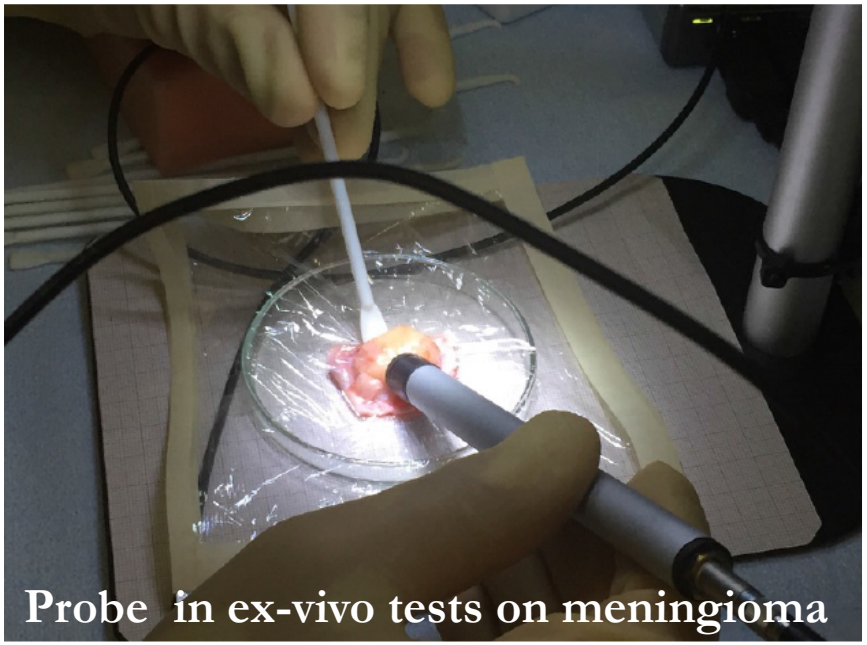
Compact, easy to handle, local measurement, simple technology:

- scintillating crystal + light sensor (SiPM)

Most stringent constraints for medical tool (mechanics, electrical safety, sterilization).

On-going R&D:

- Improvement of sensitivity
- Laparoscopic application:
  - shape optimization
  - 3D-sensitivity



Probe in ex-vivo tests on meningioma

Possible applications: known radiotracers

The most detectable radiation is ^{90}Y.

This restricts the use to

- DOTAXXX or PSMA (marked with ^{90}Y) for general administration
  - →need tumors with correct receptors
  - →Ongoing ex-vivo tests on meningioma
  - →Known effectiveness with glioma and NETs
- ^{90}Y microspheres or colloid for local administration → possibility to trace routes, channels, …

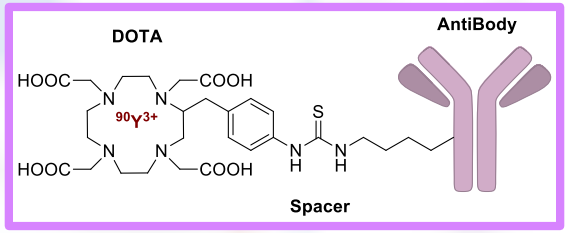
Extension to other tumors: new radiotracers

Synthesis of new tracers with ^{90}Y or other β^- emitters.

Examples of ongoing studies:

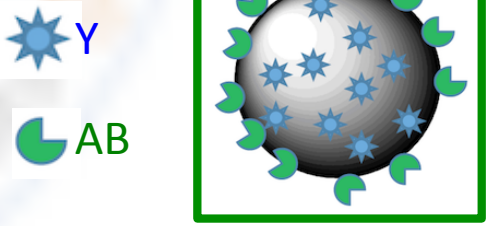
Monoclonal antibodies

NIMOTUZUMAB for EGFR receptors



MIBG

Nano-scale carriers composed of polymers, antibody and yttrium



Industrial Partnership

- A major boost to the clinical tests requires certification (for research purposes) of the prototypes to be used in the surgical room
- Industrial partnership is needed to:
  - Certify existing prototypes
  - Engineer new prototypes
  - Support clinical tests

Cost of components is small.

Core investment is in man-power + part of costs of clinical trials.


Probe Devel
Simulation
New Fronteers
Prototipization
Multi-Channel/imaging
Lower E-threshold (e.g. CMOS)
Endoscopic (miniat.)
P-terf. procurement
Certification
Phys
Chem.
Med.
Eng./ industry
GLOBAL PLAN
Clinical cases
New RadioTracer
Known Radio-tracer
Synthesis
Preclinical Tests
Radio-isotope Production
Clinical tests on NET
Clinical tests on Meningioma/Glioma

Summary

A NOVEL RADIO-GUIDED SURGERY WITH β^- DECAYS

No background from gamma allows for

- **Shorter time to have a response**
- **A smaller and more versatile detector**
- **Reduced background from nearby healthy organs**
- **Reduced dose to medical staff**

A translational research involving physics, chemistry, nuclear medicine, oncology and engineering…

…we still have a long way to go!

Info & contacts

- Solfaroli Camillocci E et al. "A novel radioguided surgery technique exploiting β^- decays." Sci.Rep. 4: 4401 (2014)
- Solfaroli Camillocci E et al. "Polycrystalline para-terphenyl scintillator adopted in a β^- detecting probe for radio-guided surgery."J. Phys. Conf. Ser. 620 012009 (2015)
- Collamati F et al "Toward Radioguided Surgery with β^- Decays: Uptake of a Somatostatin Analogue, DOTATOC, in Meningioma and High-Grade Glioma."J. Nucl. Med. 56:3-8 (2015)
- Collamati F et al "Time evolution of DOTATOC uptake in neuroendocrine tumors in view of a possible application of radioguided surgery with β^- decay" J. Nucl. Med. 56:1501-6 (2015)

http://arpg-serv.ing2.uniroma1.it/arpg-site/

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