SESSION 1: IMPROVING QUALITY of LIFE

PANEL 1.1B: Human health

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METALLIC NANOPARTICLES: PROMISING TOOLS TO ENHANCE EFFICACY AND DOSIMETRY IN RADIOTHERAPY

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Radiotherapy a major treatment for cancer
- 50% of cancer patients received RX
- 20% of cancer are radiation-resistant

Radiotherapy road map improvements
- better target the tumor
- total dose split
- higher dose per session
- higher dose rate

Main challenges
- increase radiation efficacy, while preserving healthy tissues
- overcome resistance and/or tumor relapse?
- intratumoral radiation dosimetry rather than calculation of the delivered radiation dose
  - is the dose currently delivered to the tumor the expected one? …
  - prevent accident during the time course of radiotherapy
Metallic nanoparticles for radiotherapy enhancement and intratumoral radiation dosimetry

Transversal skills and technical innovations in astrophysics, biology and chemistry

Astrophysics

Detector X-ray

Chemistry Gold NPs

Dosimetry

Biology Cancer response

Nanoparticles synthesized LCP and finely characterized for each lot
Tailles et recouvrements à façon
Principle effects of radiotherapy on cancer cells

Direct effects

Indirect effects

H₂O → °OH + e⁻

ROS

Living cancer cells

Resistant tumor

Sensitive tumor

Dead cells

Dead cells and living resistant cells
Nanoparticles: enhancement of radiotherapy

Direct effects
- Fluorescent emission
- Campton scattering
- Auger electrons
- Pair production: positron & electron
- Electromagnetic scattering

Indirect effects
- ROS
- Additive indirect effects
- RO5

Living cancer cells
- Sensitive and Resistant tumor
- Dead cells
Nanoparticles enhancement of radiotherapy

DarkField microscopy

Nanoparticles internalisation

Cancer cells

Number of cells

Mortality (%)

irradiation

Irradiation + AuNP

MDAMB231 0µg/mL

MDAMB231 50µg/mL
Nanoparticles: intratumoral radiation dosimetry

Photon detector

Strictly proportional to the dose

Fluorescent emission

Electromagnetic scattering

Campton scattering

Auger electrons

Pair production positron & electron

High z metal

Photon detector

Nanoparticles: intratumoral radiation dosimetry

Fluorescent emission

Campton scattering

Auger electrons

Pair production positron & electron

Electromagnetic scattering

Photon detector

Nanoparticles: intratumoral radiation dosimetry

Fluorescent emission

Campton scattering

Auger electrons

Pair production positron & electron

Electromagnetic scattering

Photon detector
Fluorescence detection of irradiated nanoparticles intratumoral radiotherapy dosimetry

Sensitivity: 50 µg

In vivo: 1 à 10 mg/kg (intra-tumoral)
- 20g mouse => 20-200 µg d’or
- 60 kg women => 60-600 mg d’or
Conclusions

Main results

- Improve efficacy of radiotherapy by killing resistant cancer cells — **Better cure**
- Real time measurement of radiation dose delivered into the tumor — **Better cure and increased safety**

*First attempts of XRF tomographic reconstruction for adjustment of NP exposure*

Combine transversal skills ans knowledge
Disruptive technologies are only possible through multidisciplinary approaches

Still a lot of work to get to the patient, but all proofs of concept are there
Thank you for your attention

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