RDH/nATT

Task 1:

why GNP amplify RT effects?

Task 2:

can we concentrate GNPs in cancer cells?

Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

Is it because more ROS is produced?

- Let us try and measure if/how much more ROS are produced when GNP are present in a PBS solution

- Measurements at Ospedale Mauriziano, Torino
  6 Mev photon beam

- How can we quantify the ROS production?
  We need a reliable oxygen quencher….

Task 1: why GNP amplify RT effects?

INFN
Istituto Nazionale di Fisica Nucleare

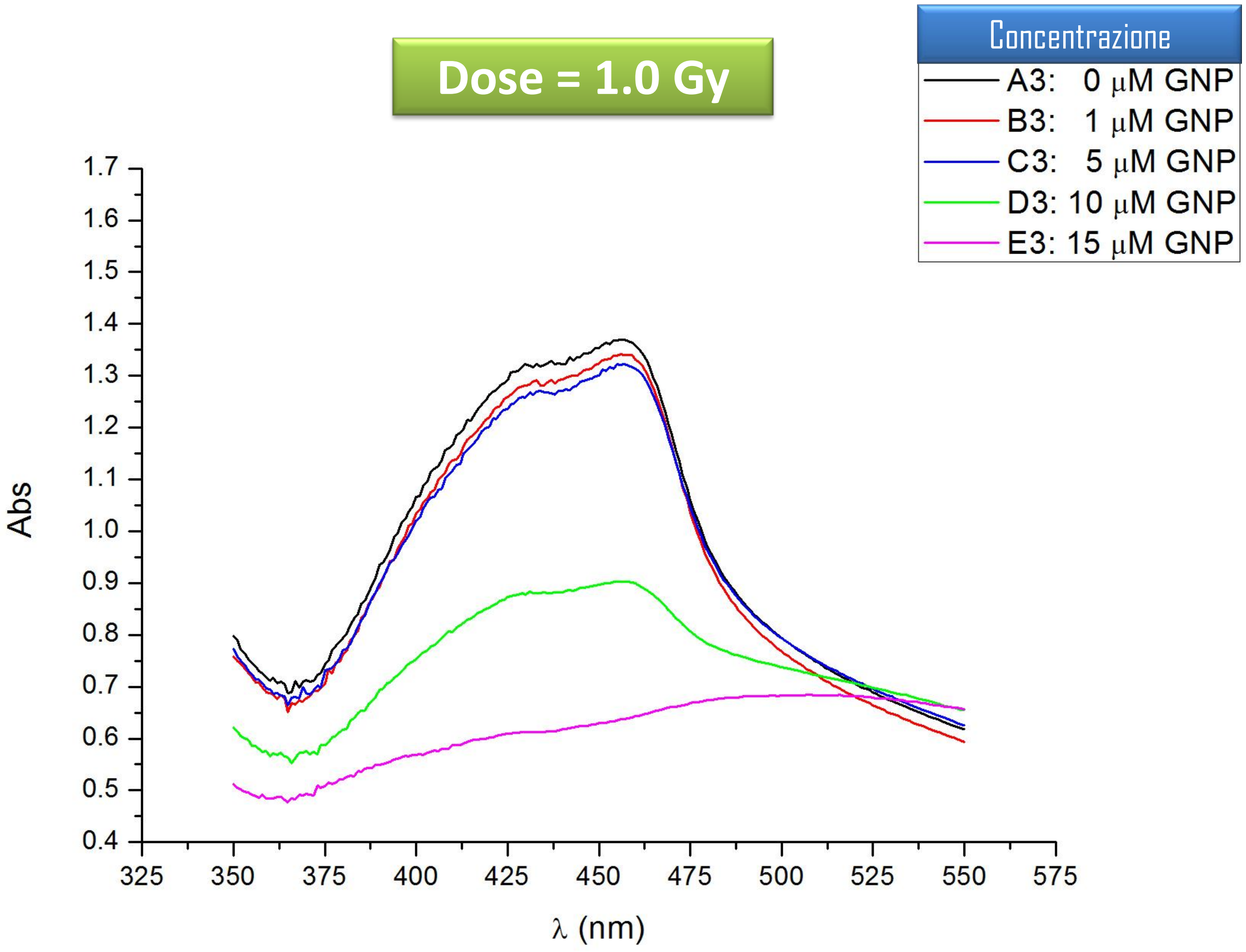
Risultati misure

02/10/2014

Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

DPBF/PBS measurements

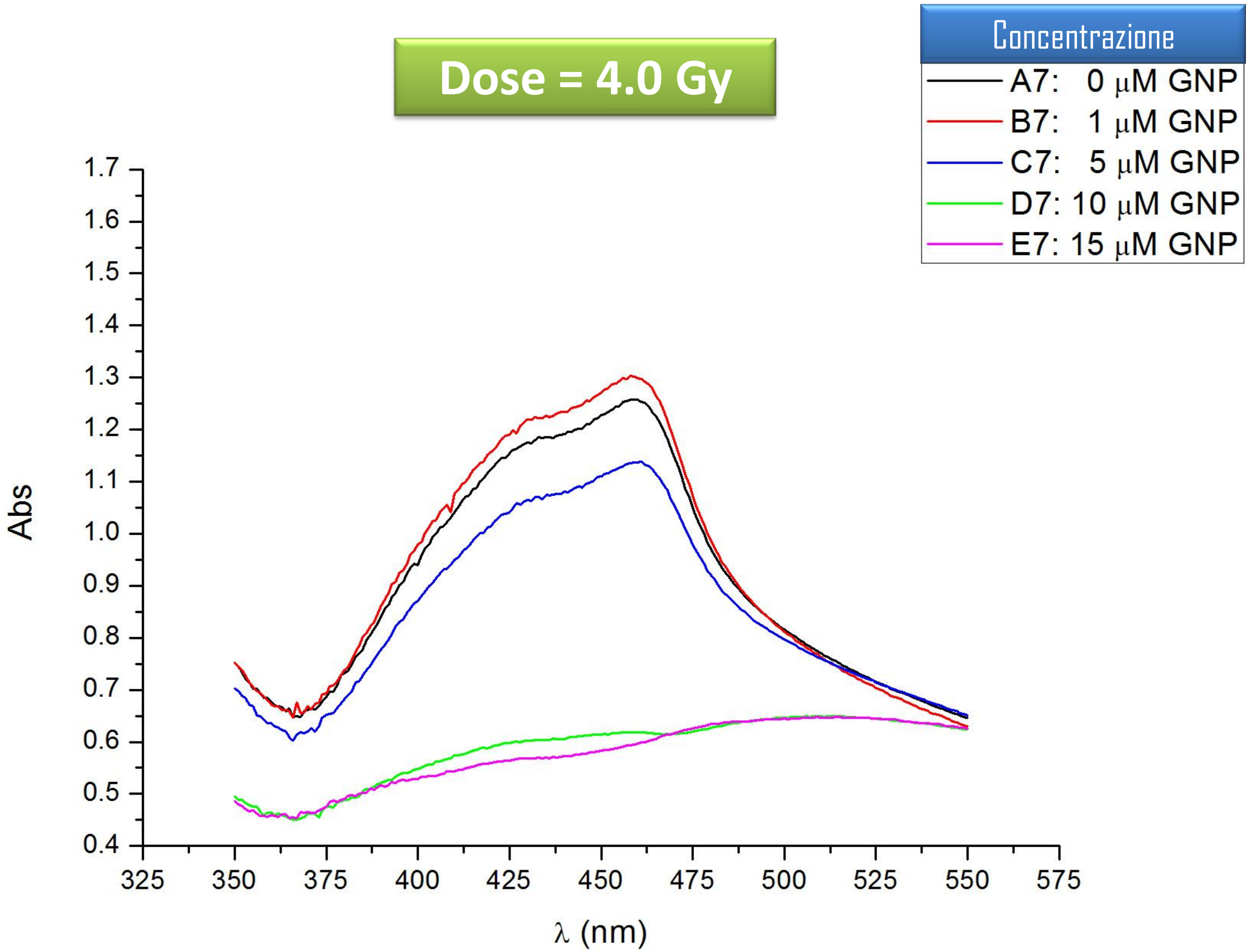


Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

DPBF/PBS measurements

Dose = 4.0 Gy

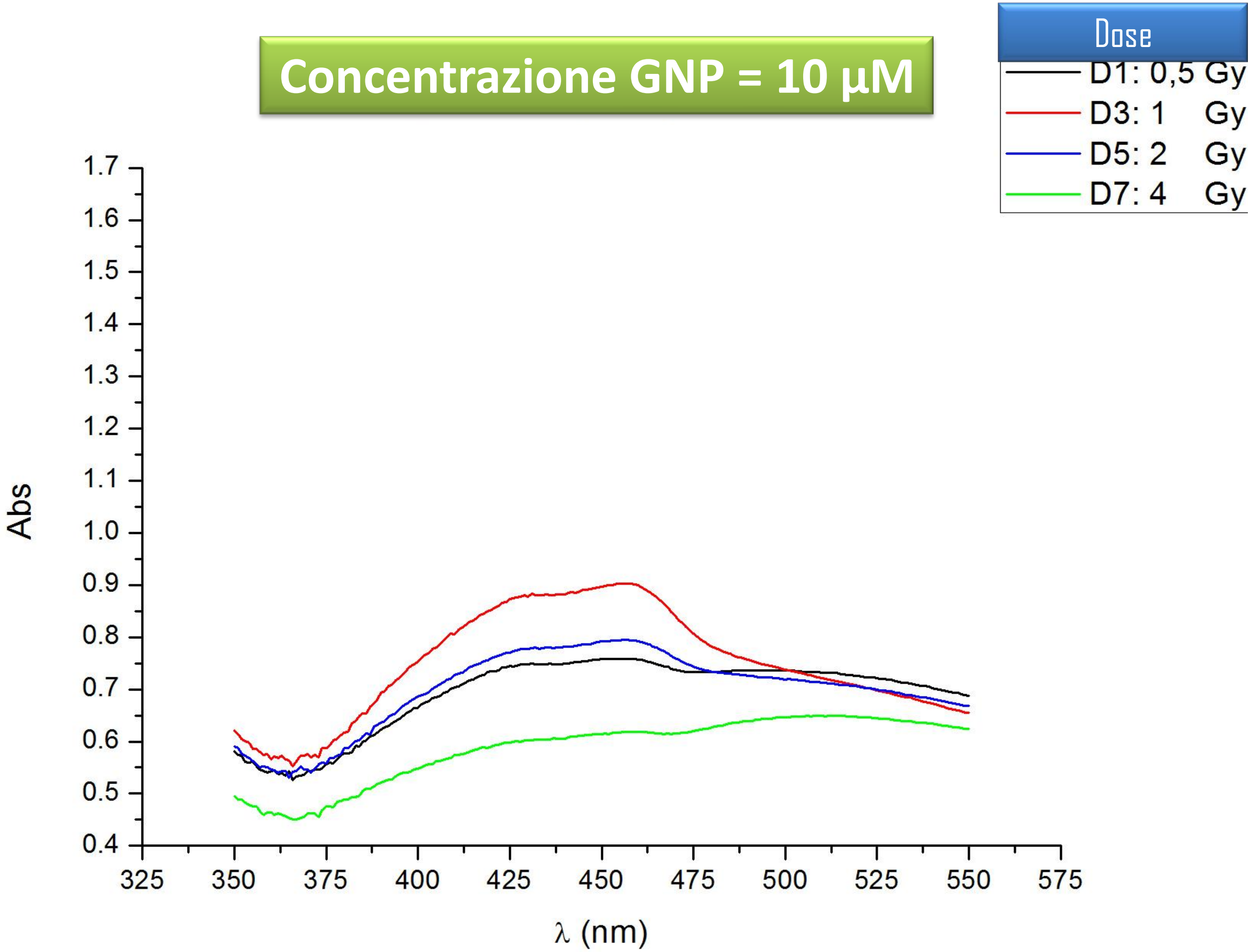


Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

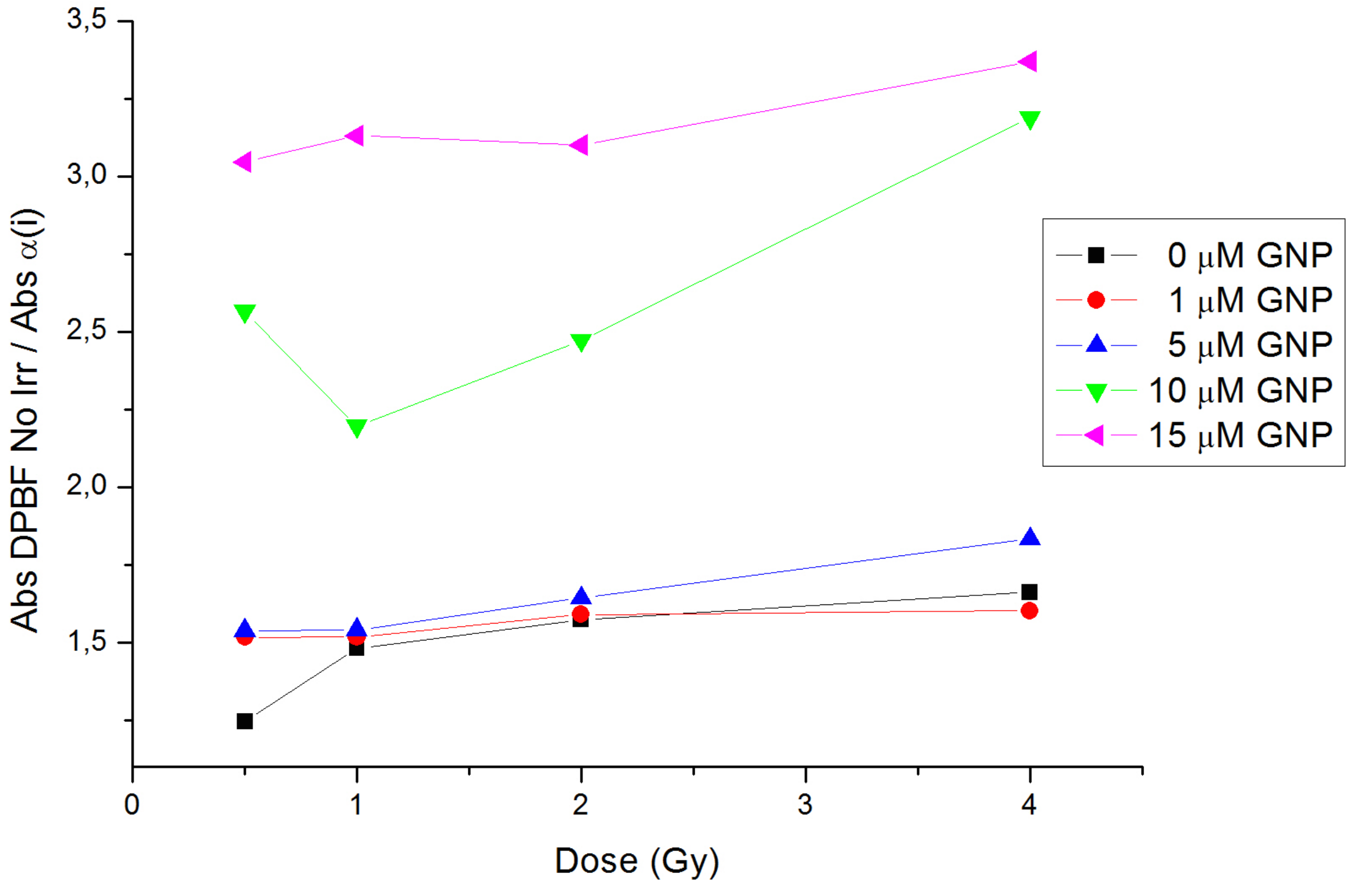
INFN Istituto Nazionale di Fisica Nucleare

DPBF/PBS measurements



Task 1: why GNP amplify RT effects?

DPBF/PBS measurements



Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

Istituto Nazionale di Fisica Nucleare

DPBF in ETOH + PBS

Risultati misure

03/11/2014

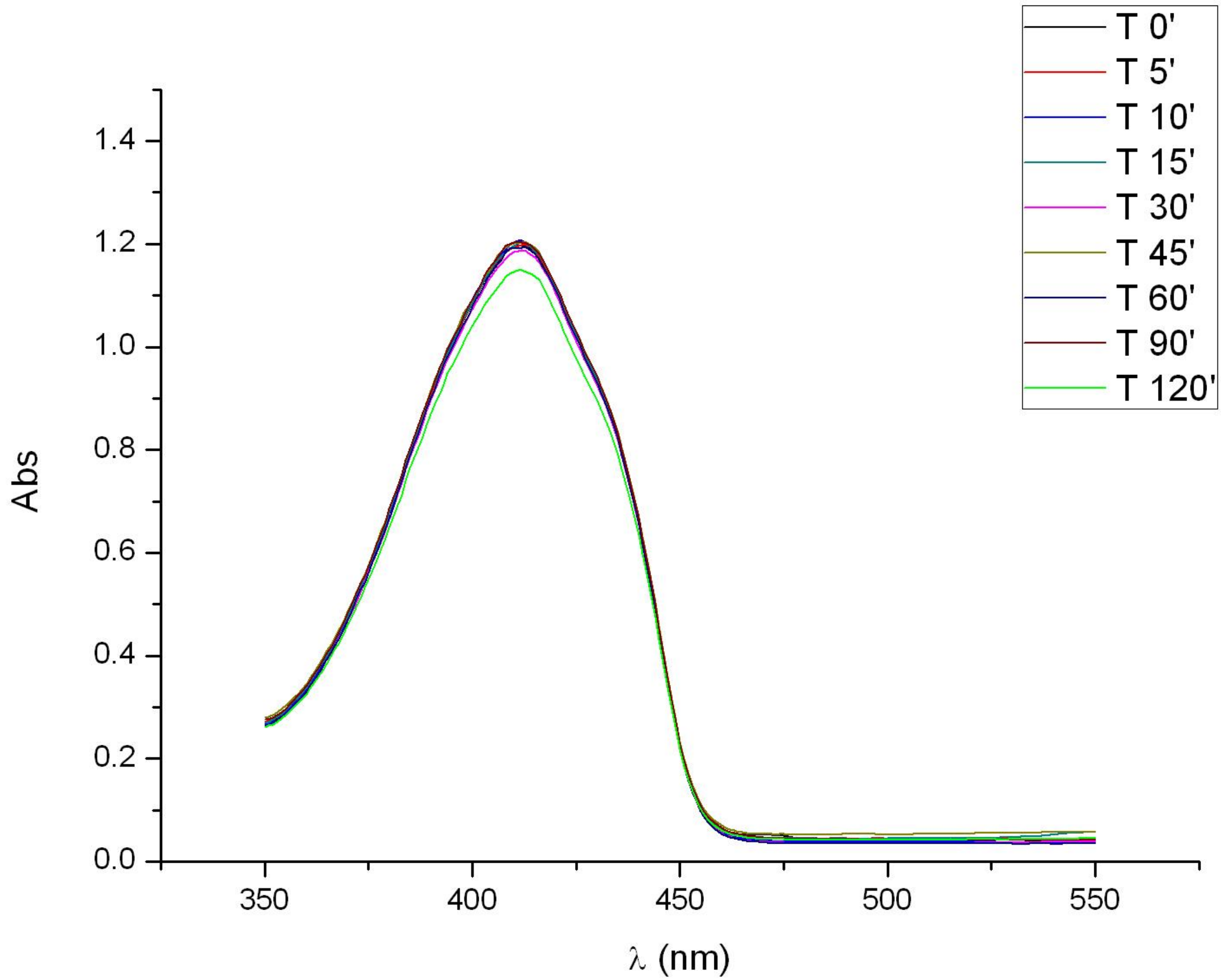
Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

INFN Istituto Nazionale di Fisica Nucleare

DPBF/PBS/EtOH measurements

DPBF 50% ETOH + 50% PBS



Task 1: why GNP amplify RT effects?

INFN Istituto Nazionale di Fisica Nucleare

TPA

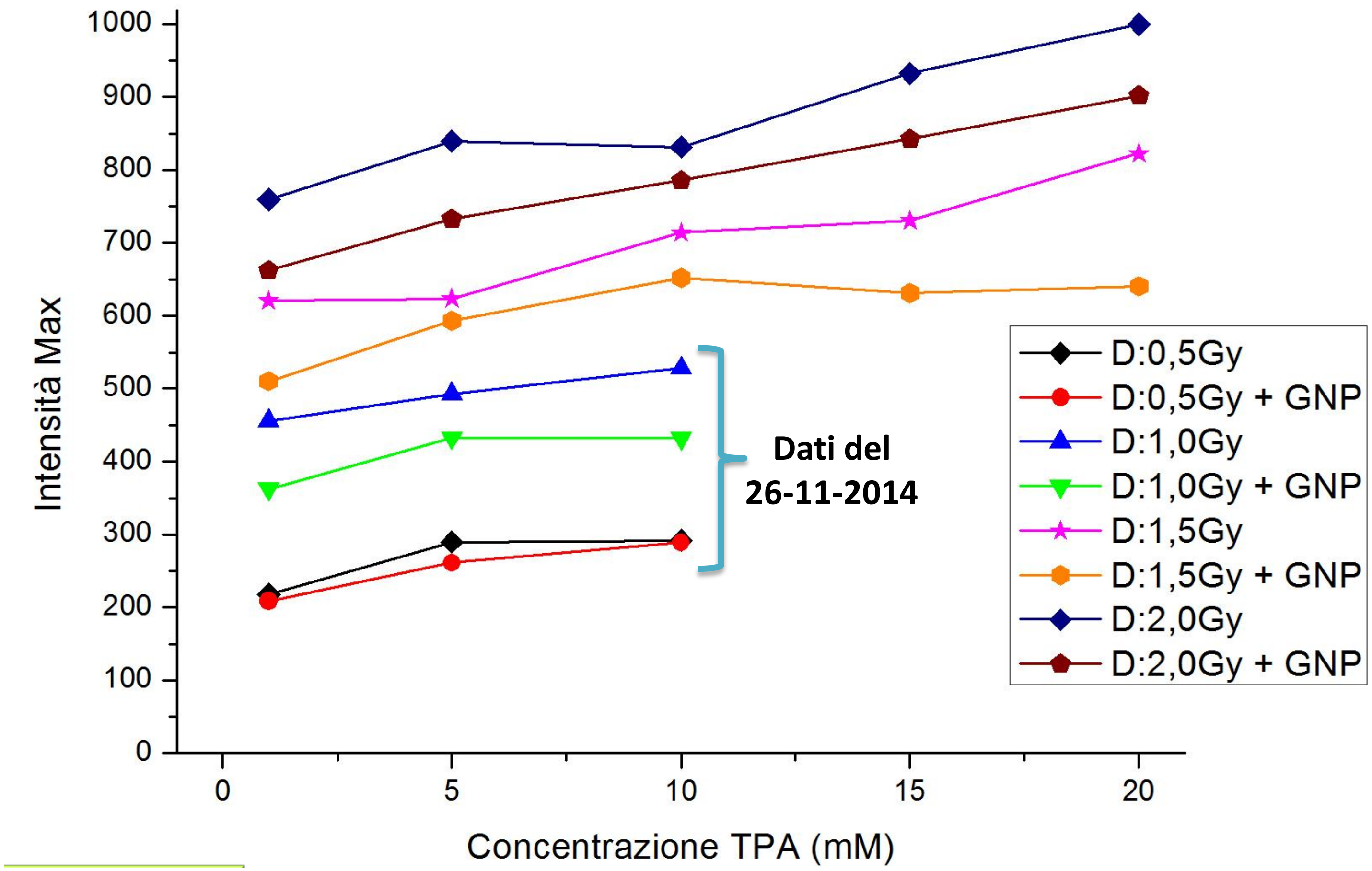
Risultati misure 11/12/2014

Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

TPA measurements

Intensità Max (424 nm)

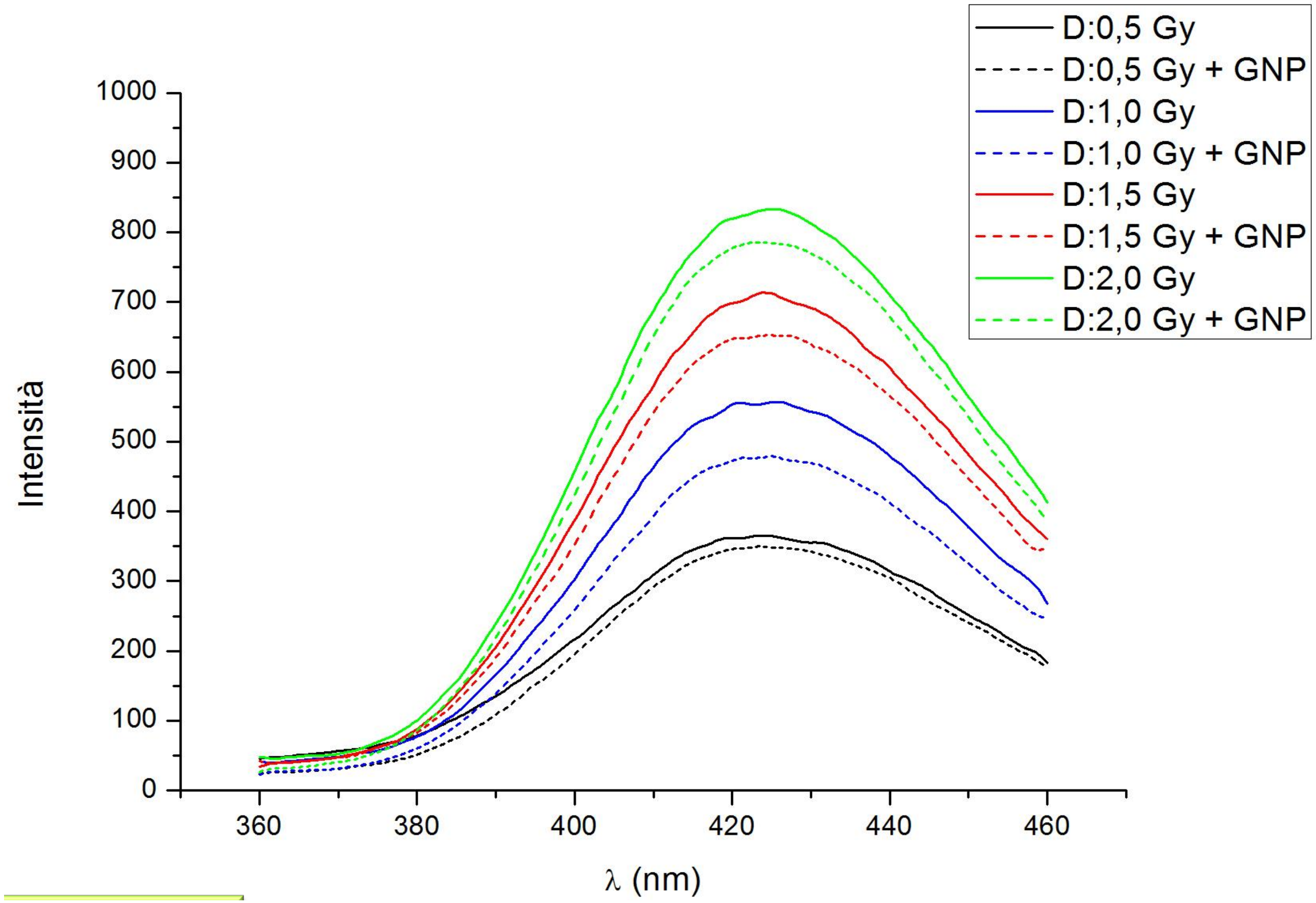


Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

TPA measurements

TPA (10 mM) Vs Dose



Piergiorgio Cerello (cerello@to.infn.it)

Task 1: why GNP amplify RT effects?

TPA measurements

GNP cause a reduction of fluorescence.
Why? Most likely absorption

Next steps

- we must measure the absorption coefficient of
  - PBS
  - PBS+GNP

at 424 nm

- We will simulate the absorption and correct the raw data

Task 2: can we concentrate GNPs in cancer cells?

In vivo measurements: protocol submitted to the Ministry of Health (Jul 2014). Authorisation received last week. We will start measuring next January.

Calibration test with a phantom: let's take a look at the results

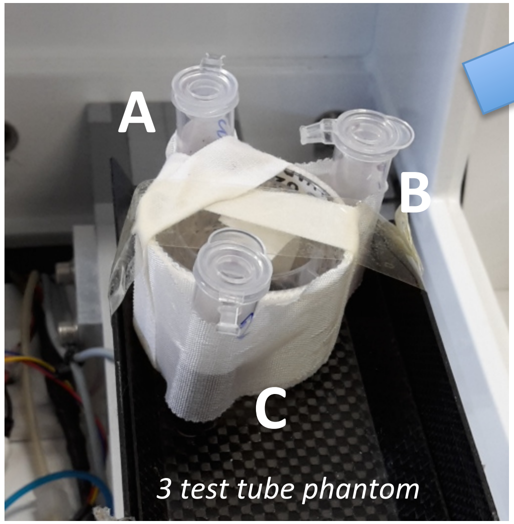
Piergiorgio Cerello (cerello@to.infn.it)

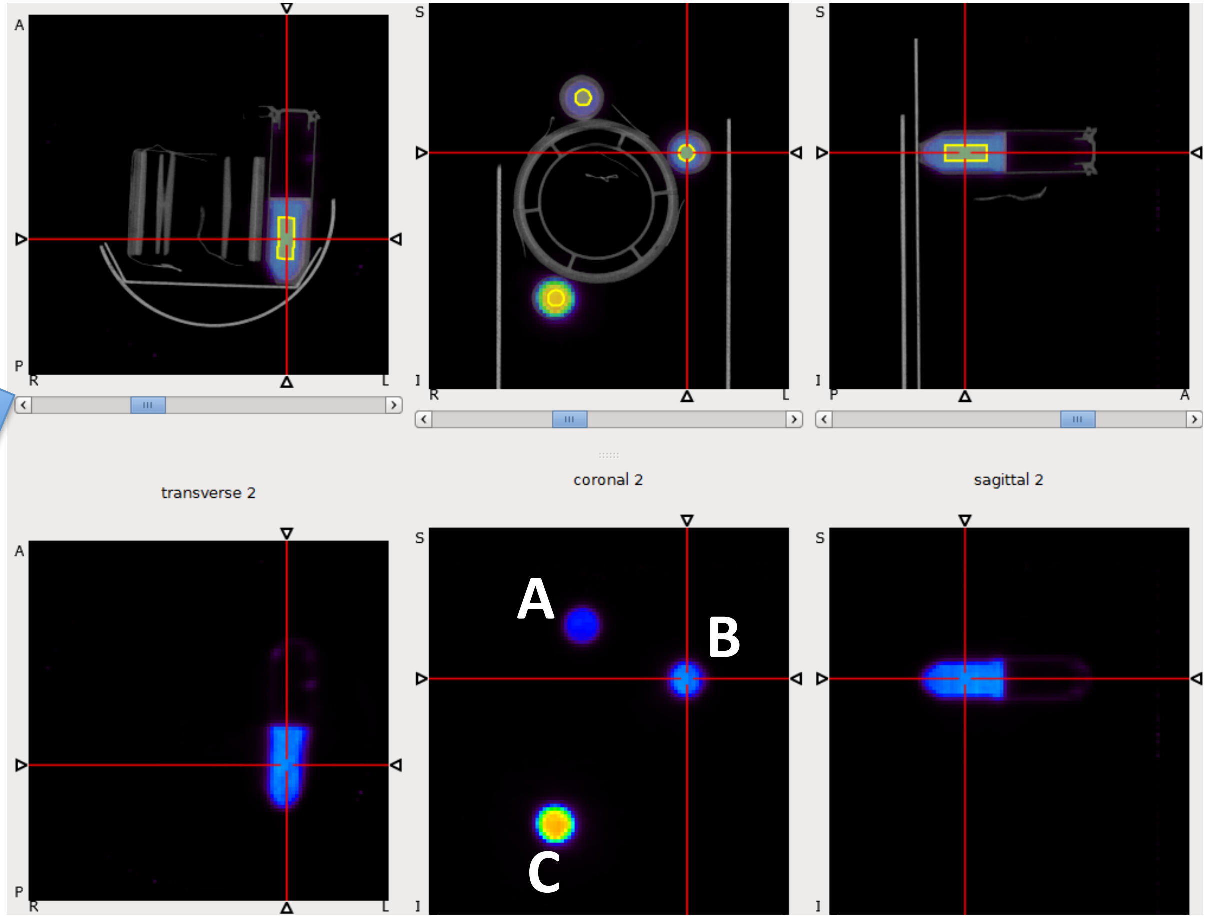
Phantom experiments with F18-labeled NP-Au

- **Goal: correlating PET image values with Au content using known dilutions of F18-labeled NP-Au in water**
- Test tubes mimic the size (< 1 cm^3) of a typical tumor in experimental model (mouse)
- Small ROI's -> attenuate partial volume artifacts

PET Scan time: 30' (6x 5')
PET Reconstruction:
3D-OSEM, 6 subs, 8 iter
Voxel size: 0.855 mm isotropic
Range of act. conc. in phantoms:
0.5 – 12 MBq/ml

CT Scan time: 20 s
CT Reconstruction:
Cone beam FBP (FDK),
Voxel size: 0.16 mm isotropic





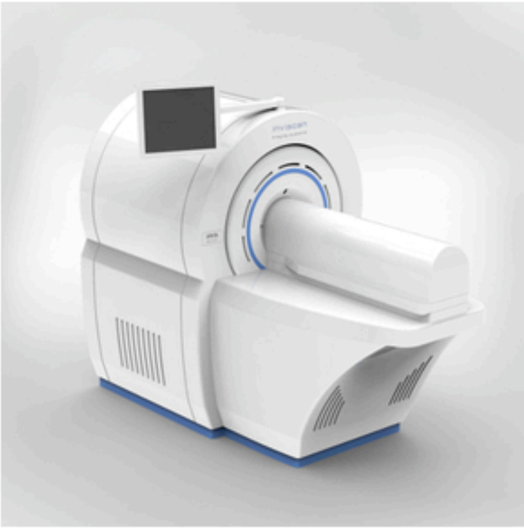
Piergiorgio Cerello (cerello@to.infn.it)

Micro-PET/CT imaging system

IRIS PET / CT

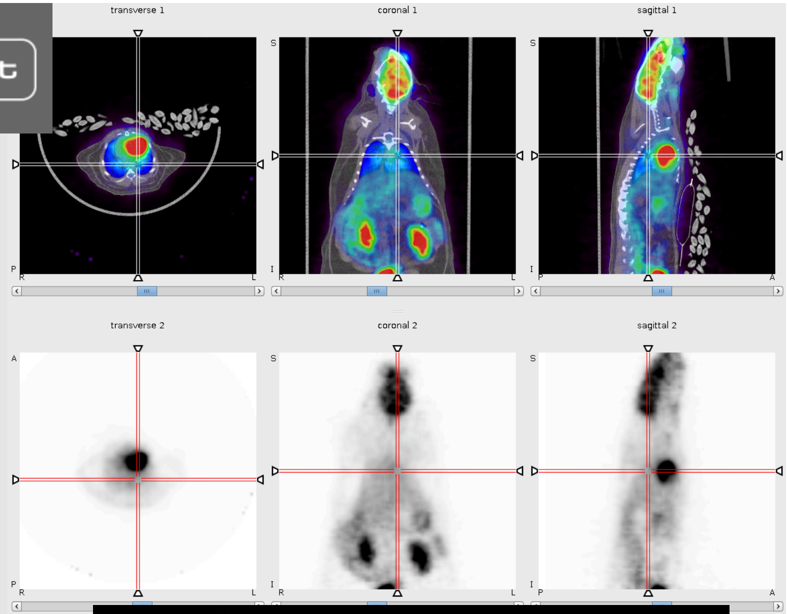
combined PET and CT scanner for mice

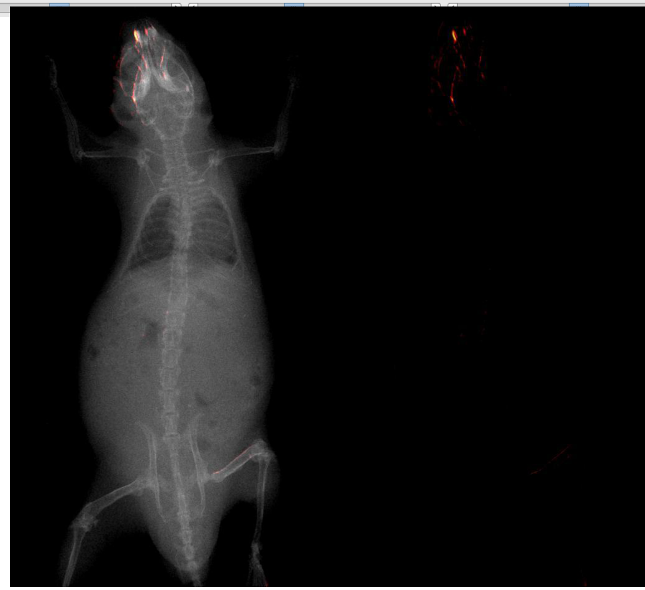
2014



Applications

PET/CT Oncology
Cardiac imaging
Brain imaging
New tracer development
Inflammation
Dynamic imaging
Gated imaging





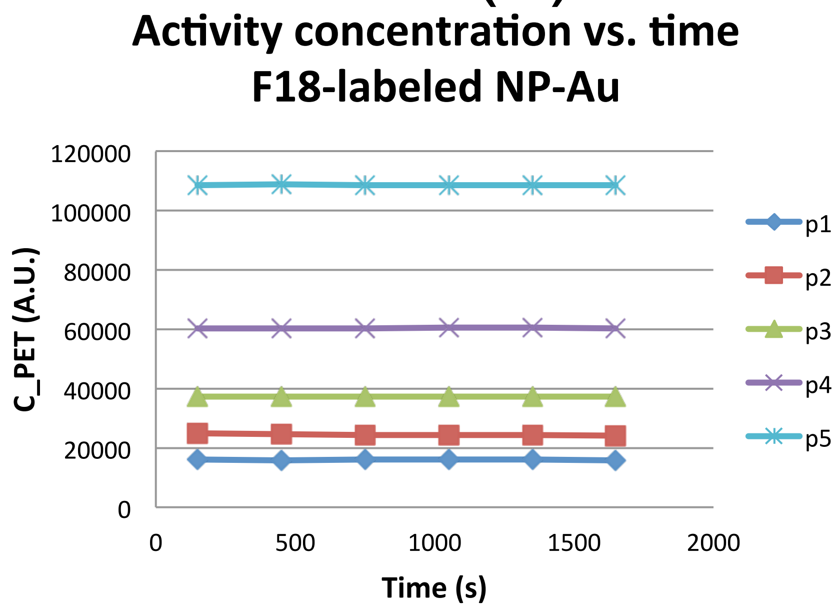
Specifications PET:
Sensitivity = 9.8% [250 keV - 750 keV]
Spatial resolution = 1.1 mm (MLEM)
Axial FOV = 94 mm
Trans-axial FOV = 80 mm
Energy resolution = 14%
Timing resolution = 1.4 ns

Specifications CT:
Fast scan time = 20 sec.
Low dose = 20 mGy
Resolution = 5 lp/mm
Axial FOV = 90 mm
High resolution scan time = 1 min.
Max rate = 86 fps

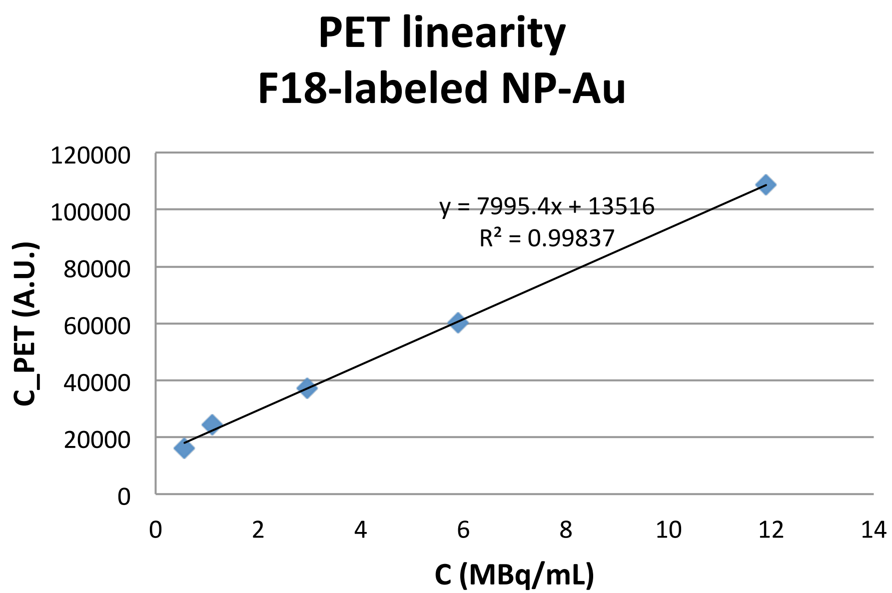
http://www.raytest.de/preclinical-imaging/positron-emission-tomography/iris-petct.html

NP-Au quantification with PET (1)

- Decay-corrected Time Activity Curves (TACs) were plotted for repeated experiments (5 different activity concentrations).
- Good flatness (< 1%) of the TACs indicates linear behavior of the imaging system at selected points of the field of view (FOV).



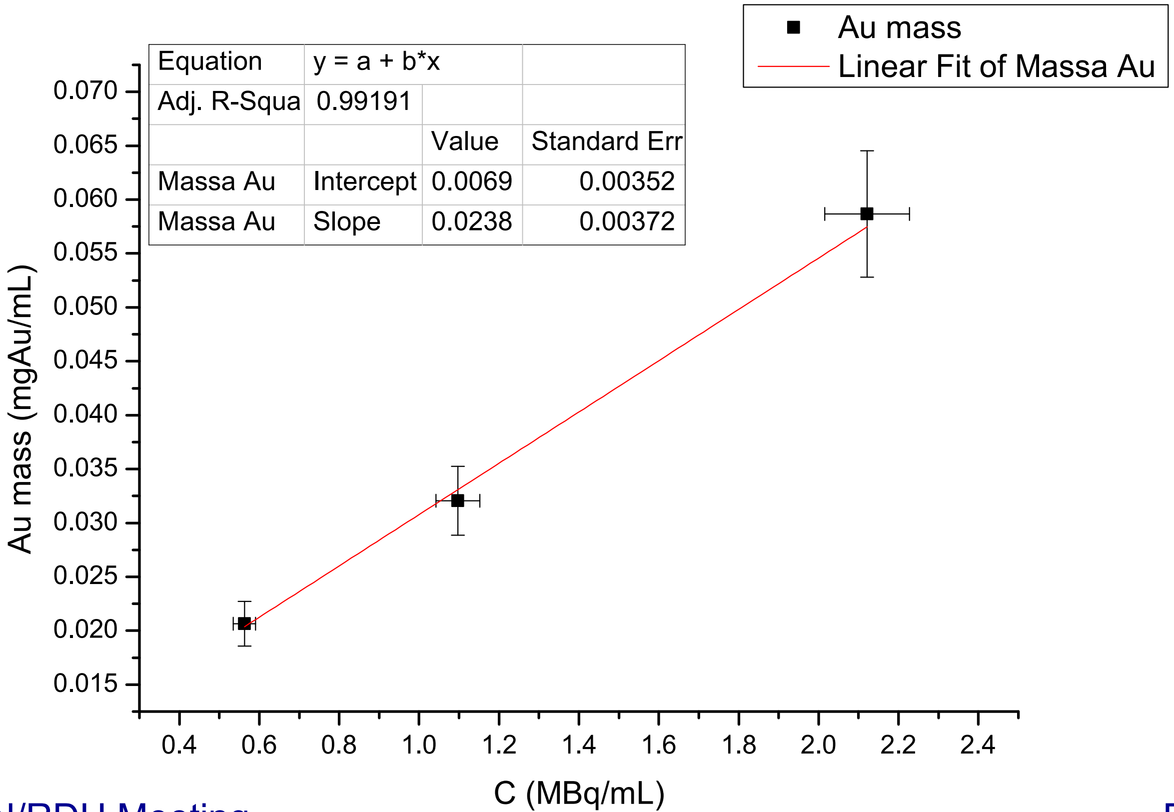
- Time-averaged raw values (A.U.) on each ROI were plotted against corresponding calibrated activity concentration values (AtomLab 300, Biodex, NY – USA).
- Non-linearity at very low activity concentration (<500 kBq/cc) can be associated to increasing relative contribution of the LYSO background for this imaging system.



Piergiorgio Cerello (cerello@to.infn.it)

NP-Au quantification with PET (2)

- Au concentration was measured in 3 out of the 5 samples used to test the PET linearity with F18-labeled NP-Au using Inductively-Coupled Plasma Mass Spectrometry (ICP-MS).
- Sample handling and ICP-MS parameters have been optimized to achieve the required accuracy for the direct Au quantification in NPs suspensions(*).
- This calibration will be applied to PET data (mice) to obtain parametric images of Au concentration to be used in Monte Carlo treatment planning.
- Further experiments are needed to estimate the fraction of free F18 (not bound to NP-Au) in-vivo (authorization for animal experiment is pending).



(*) We are grateful to Dr. Giovanni Signore (Center for Nanotechnology Innovation@NEST, Pisa, Italy) for advice and support with ICP-MS analysis.

Piergiorgio Cerello (cerello@to.infn.it)

Summary

We are well on track with:

- ROS measurements
- in vivo measurements
- simulations

If the idea works:

- ready to publish early next year
- start in-vitro measurements
- plan a pre-clinical trial

There is a clear interest by researchers in RT and NM

Piergiorgio Cerello (cerello@to.infn.it)