

Persistent luminescence nanoparticles for bioimaging applications

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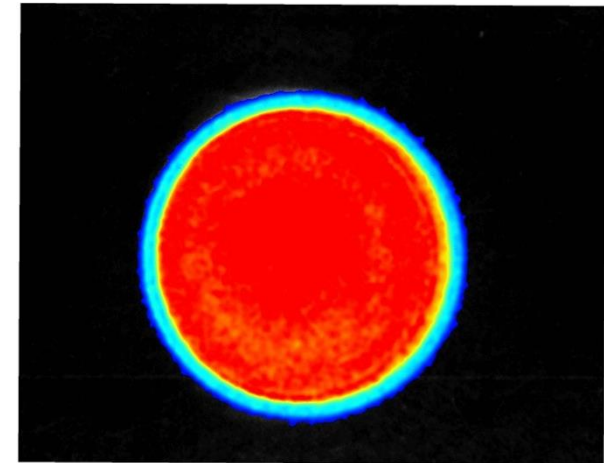
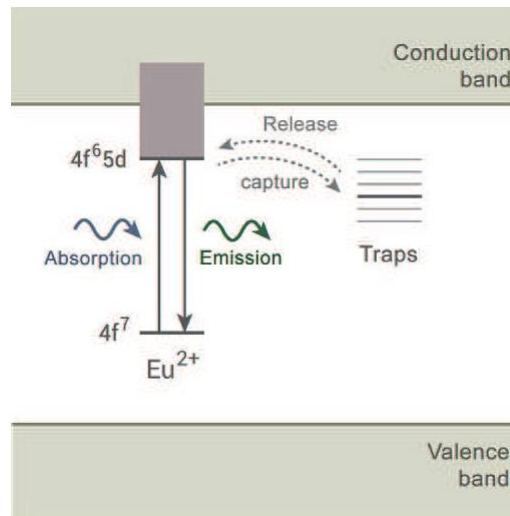
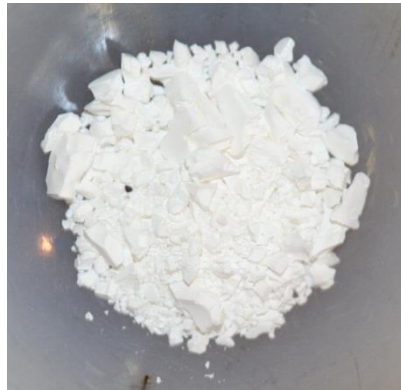
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Universidad
de Guanajuato

Persistent luminescence

Persistent luminescence is the ability of materials to store the excitation energy and to slowly **emit light** for **minutes to hours** after the stoppage of excitation.



Luminescence:
minutes hours

Main applications

Safety signages, watches, toys, paints, ...

$\text{SrAl}_2\text{O}_4:\text{Eu, Dy}$



<https://www.nemoto.co.jp>

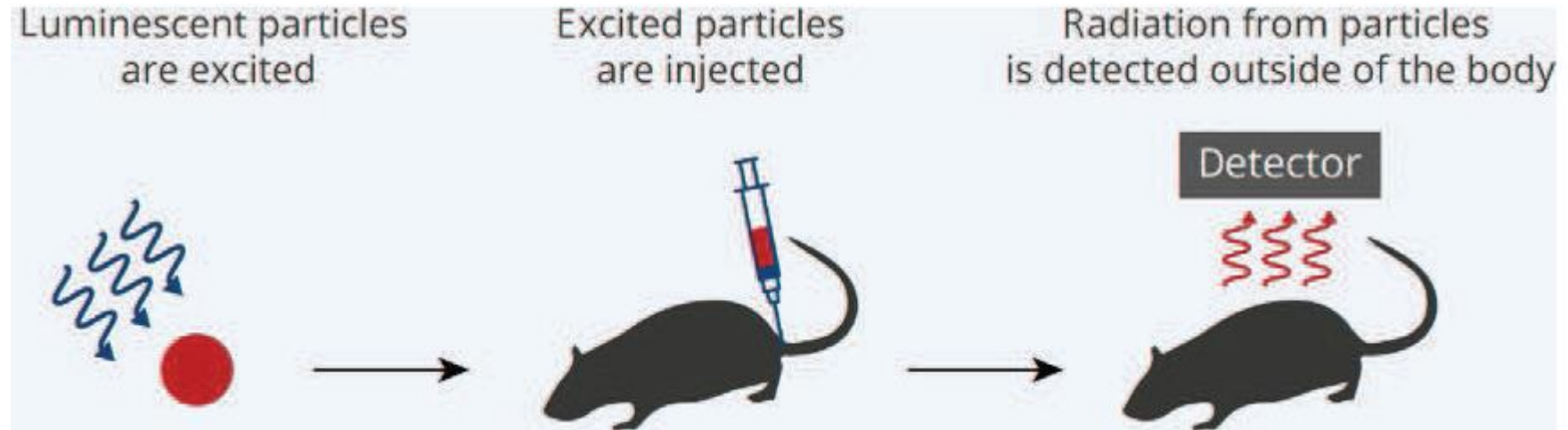


Nissan's luminescent car



Luminescent's road project in NL

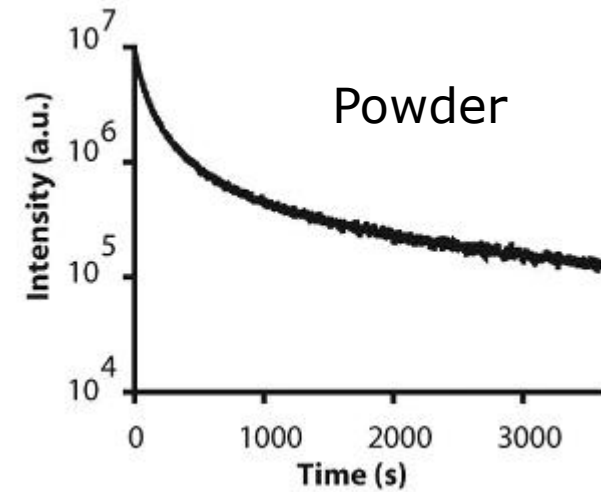
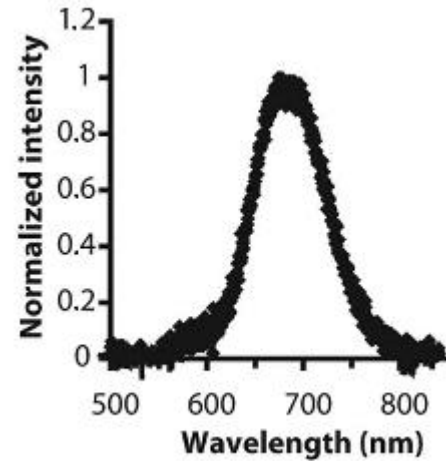
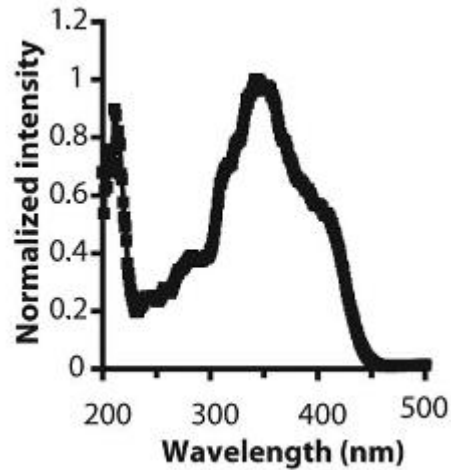
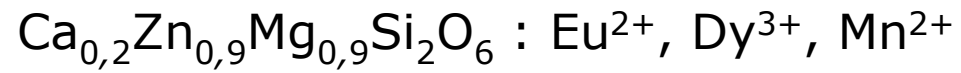
Principle of *in vivo* optical bioimaging with PLNPs



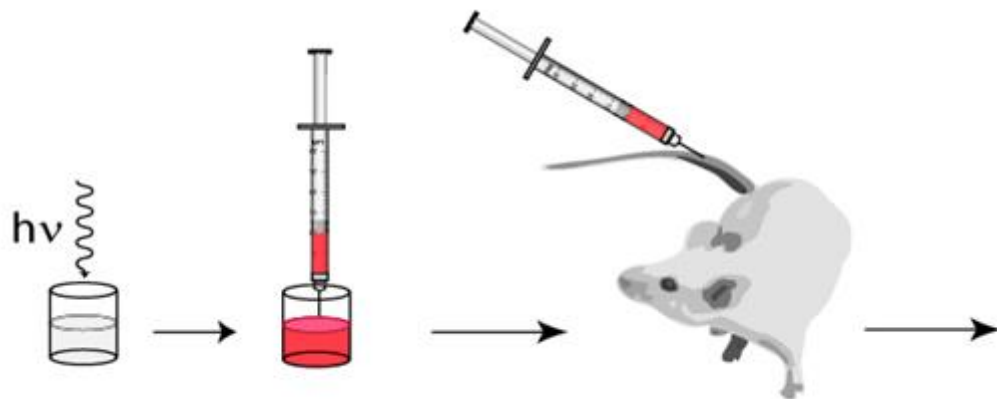
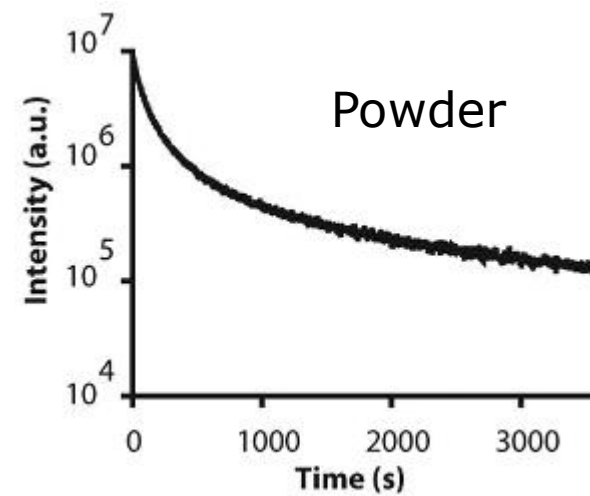
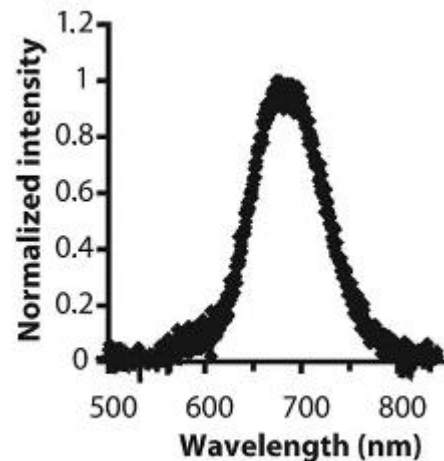
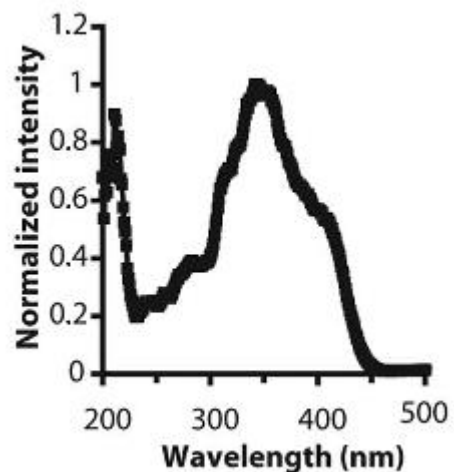
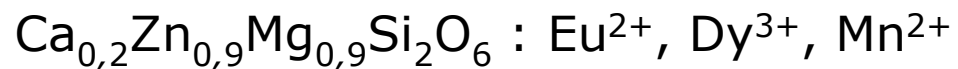
- ⇒ Advantage: signal **only** coming from the probe, **no autofluorescence**
- ⇒ Limit: nanoprobe should emit light in the biological window (> 650 nm)

Review : Theranostics 2016, 6, 2488-2524

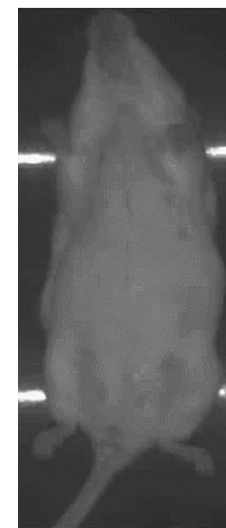
First generation of PLNPs: only UV excitable



First generation of PLNPs: only UV excitable

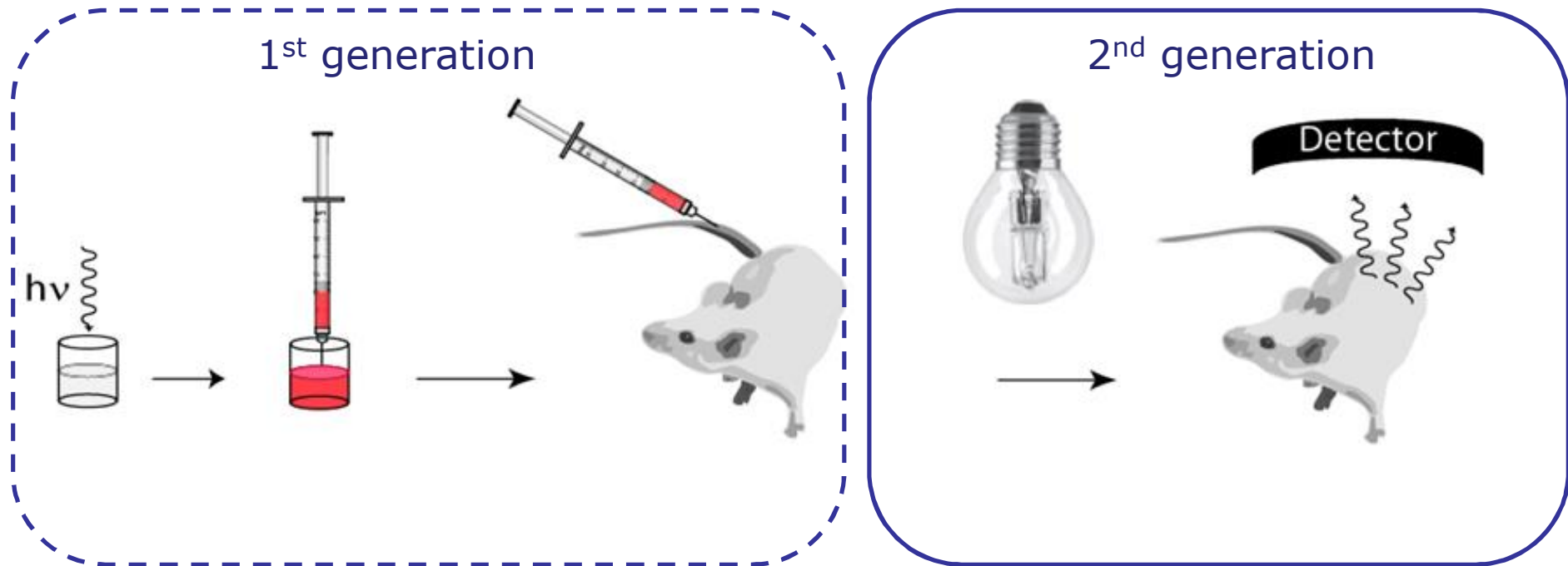


JACS 2011, 133, 11810-11815



Second generation of PLNPs: *in situ* excitable

Possible to re-excite PLNPs through animal tissues \Rightarrow long term imaging ?

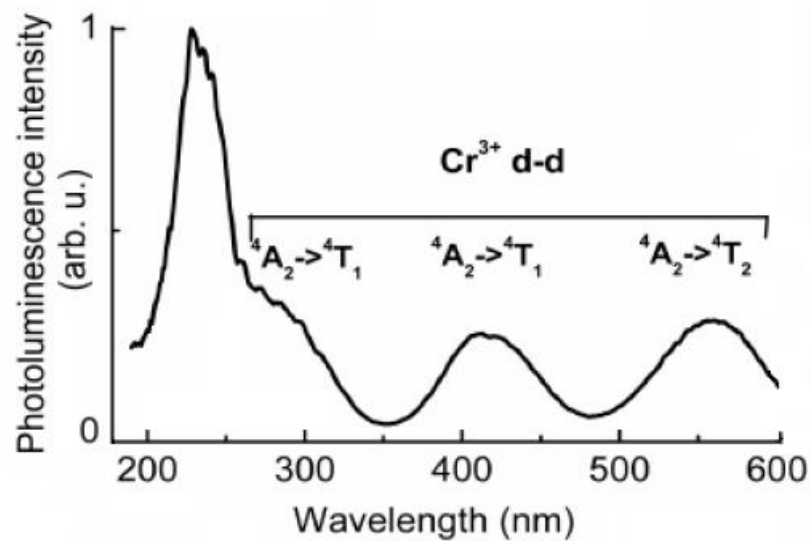


PCT Int. Appl. (2013), WO 2013113721

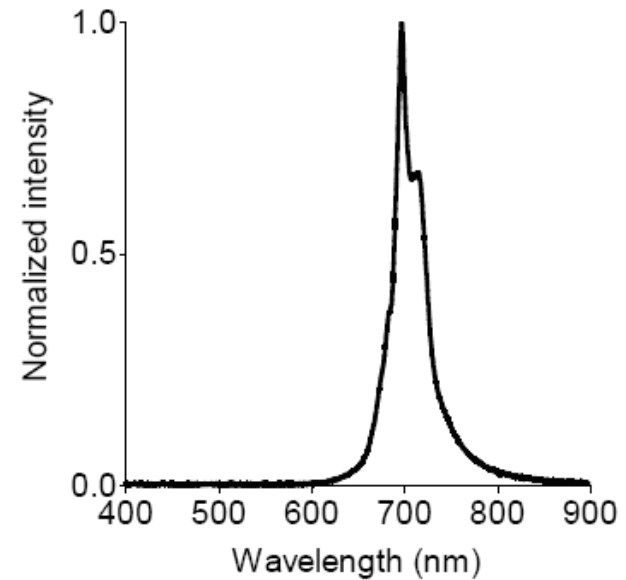
Zinc gallium oxide

$\text{ZnGa}_2\text{O}_4:\text{Cr}^{3+}$: a new red long-lasting phosphor with high brightness

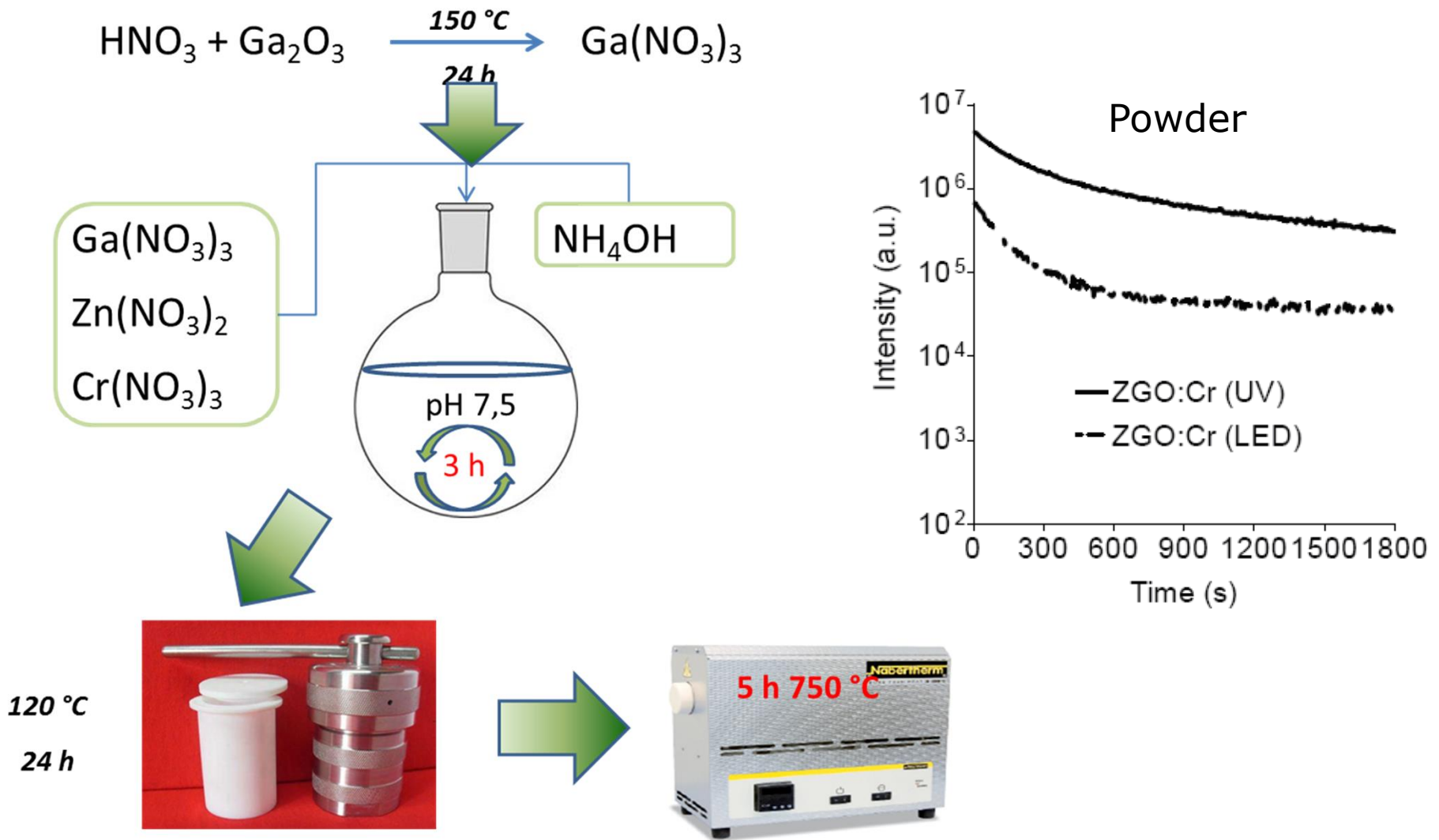
Excitation spectrum



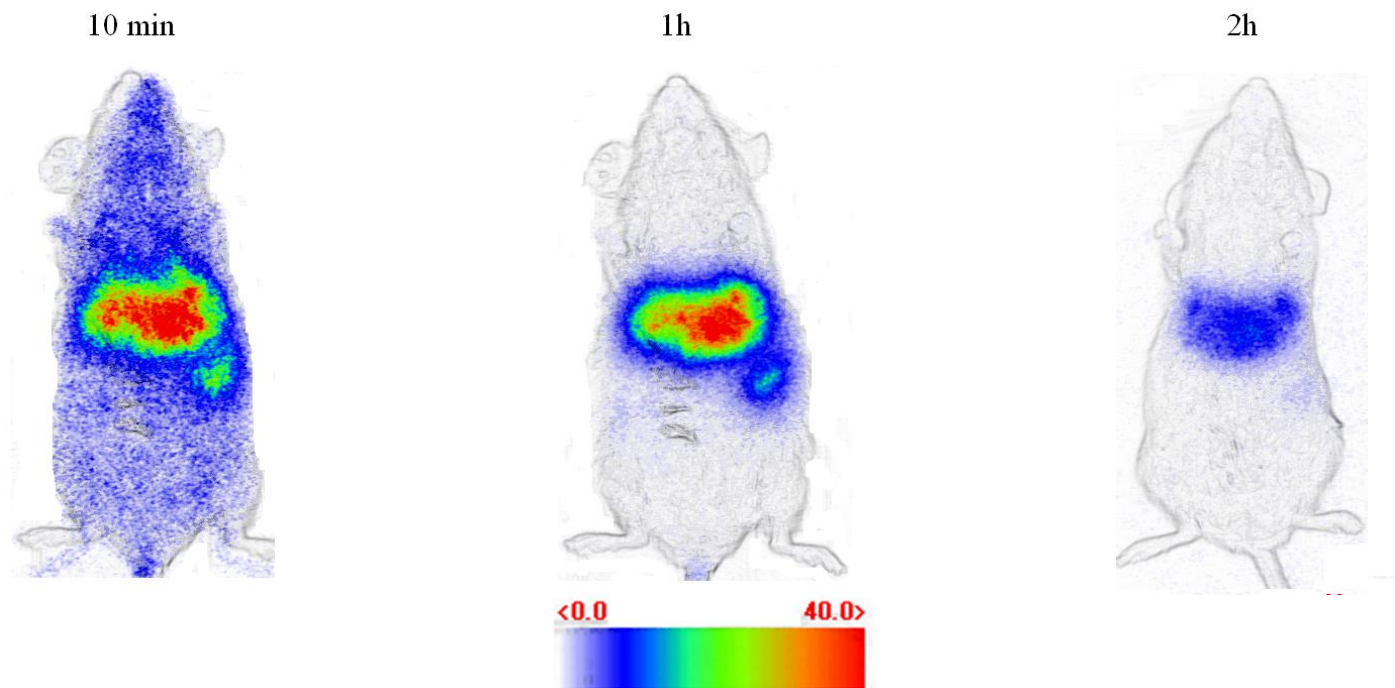
Emission spectrum



Synthesis of $\text{ZnGa}_2\text{O}_4:\text{Cr}$

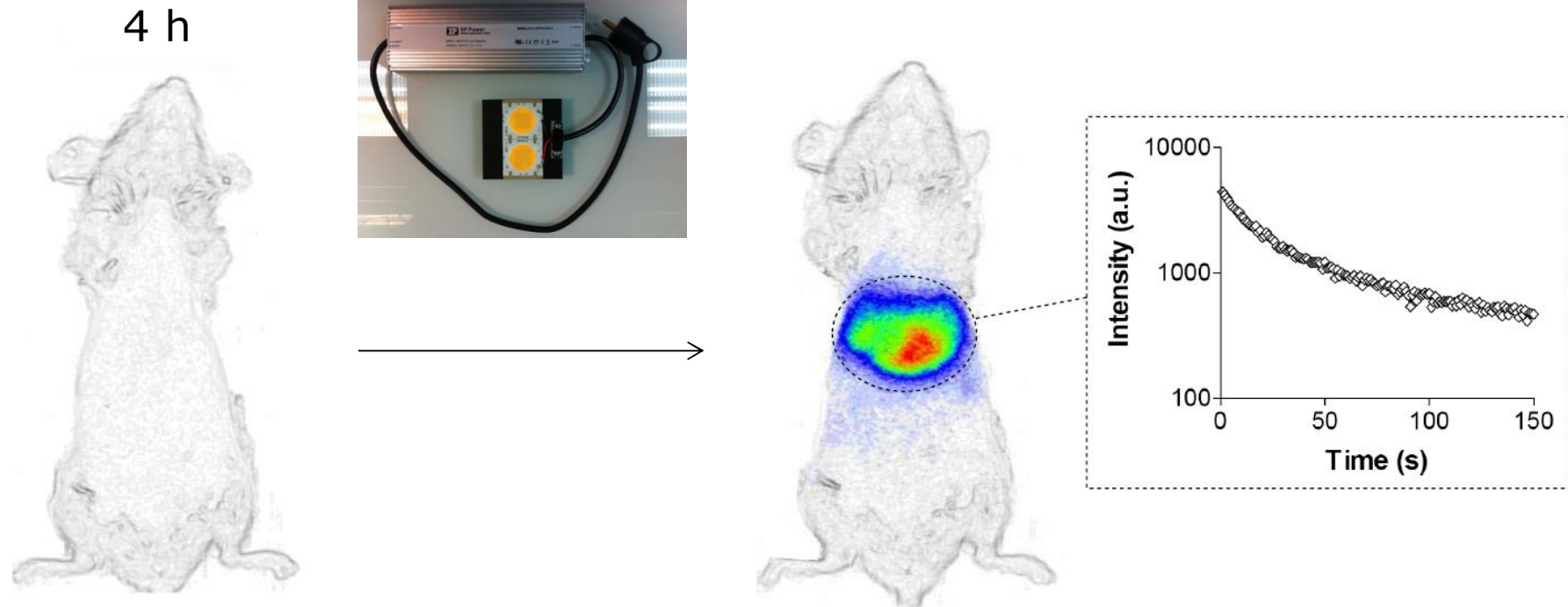


In vivo imaging using the 2nd generation PLNPs



In vivo activation of persistent luminescence

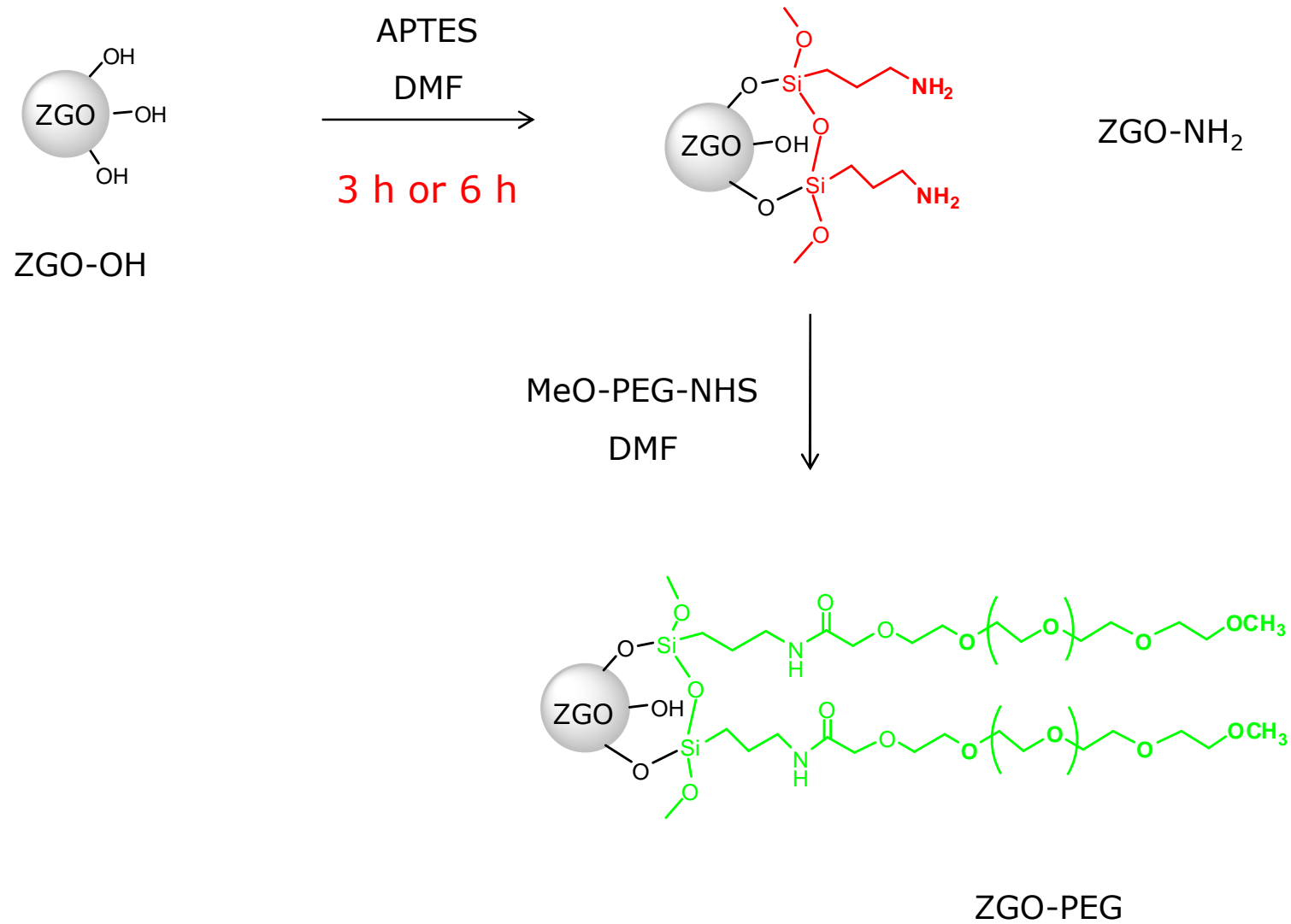
In situ excitation



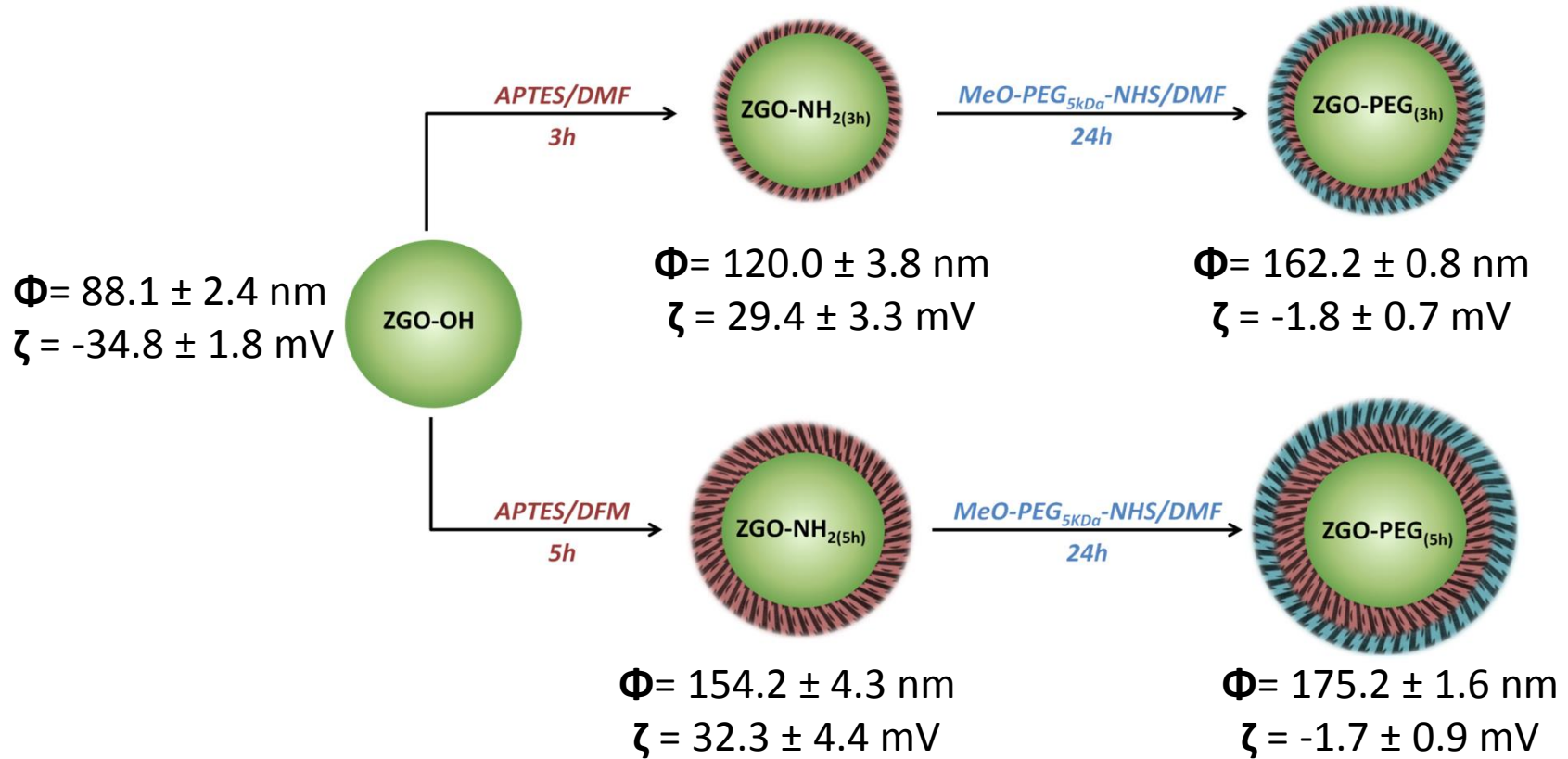
- ⇒ Excitation through tissues is possible
- ⇒ No more time limit

PCT Int. Appl. 2013, WO 2013113721

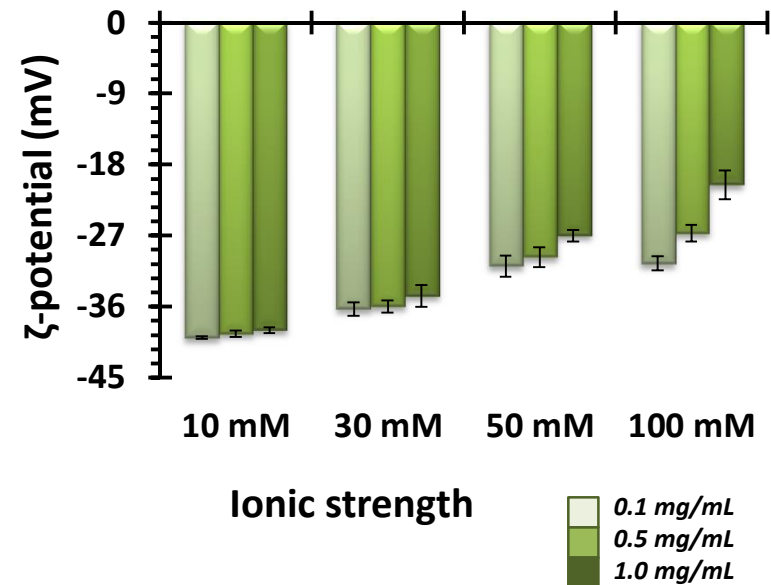
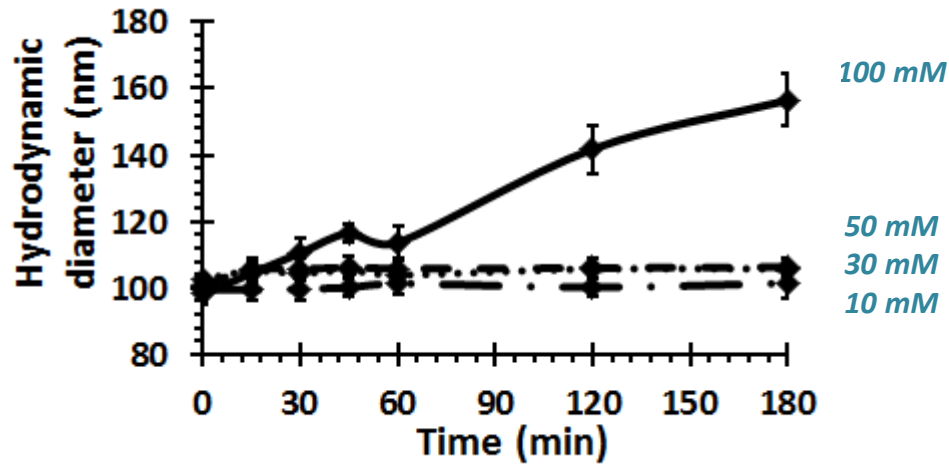
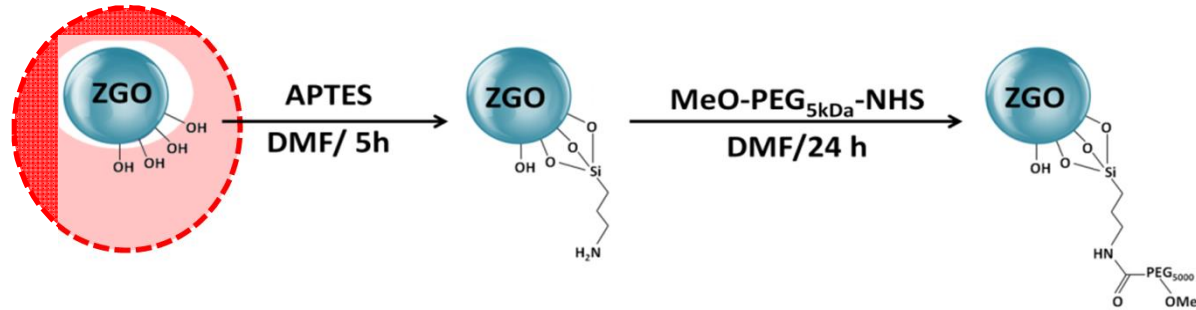
Surface functionalization of ZGO



Nanoparticles characterization

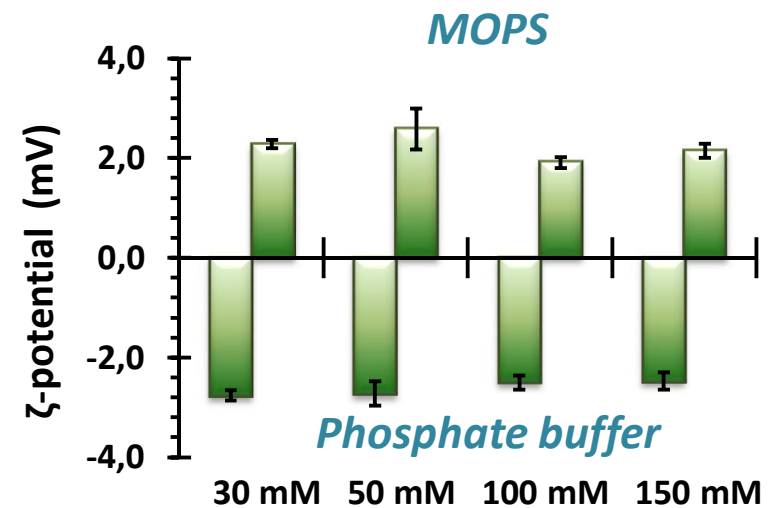
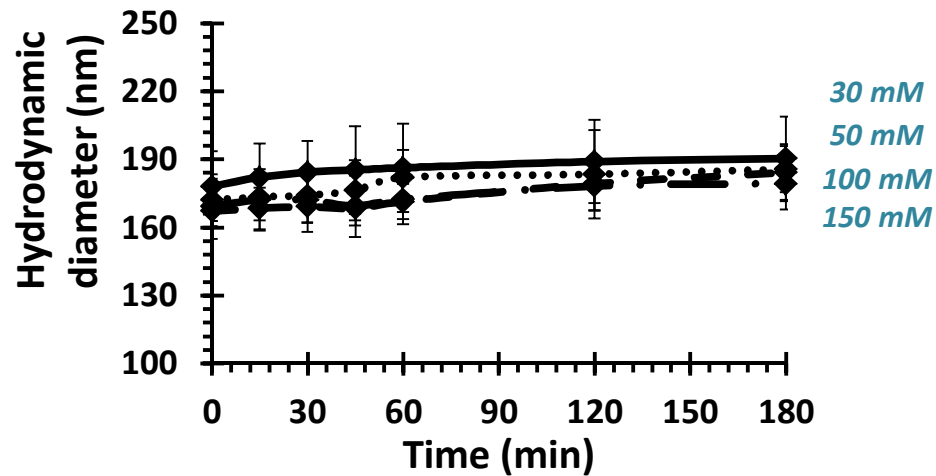
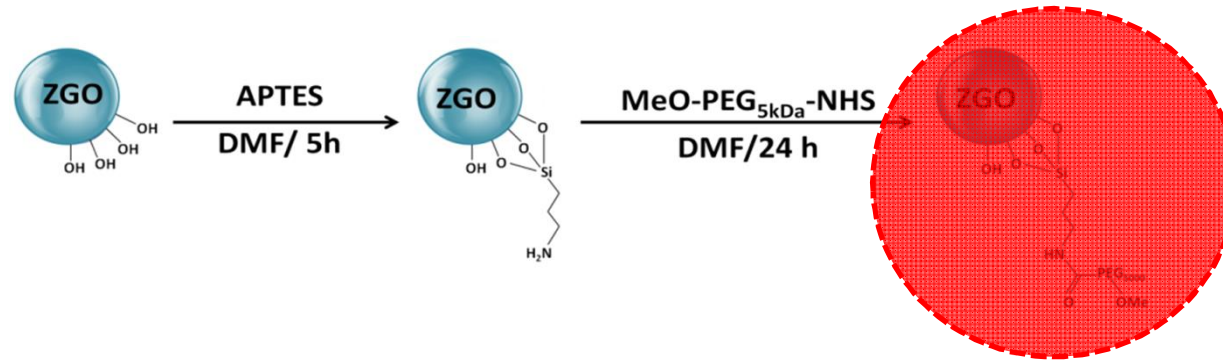


Nanoparticles characterization



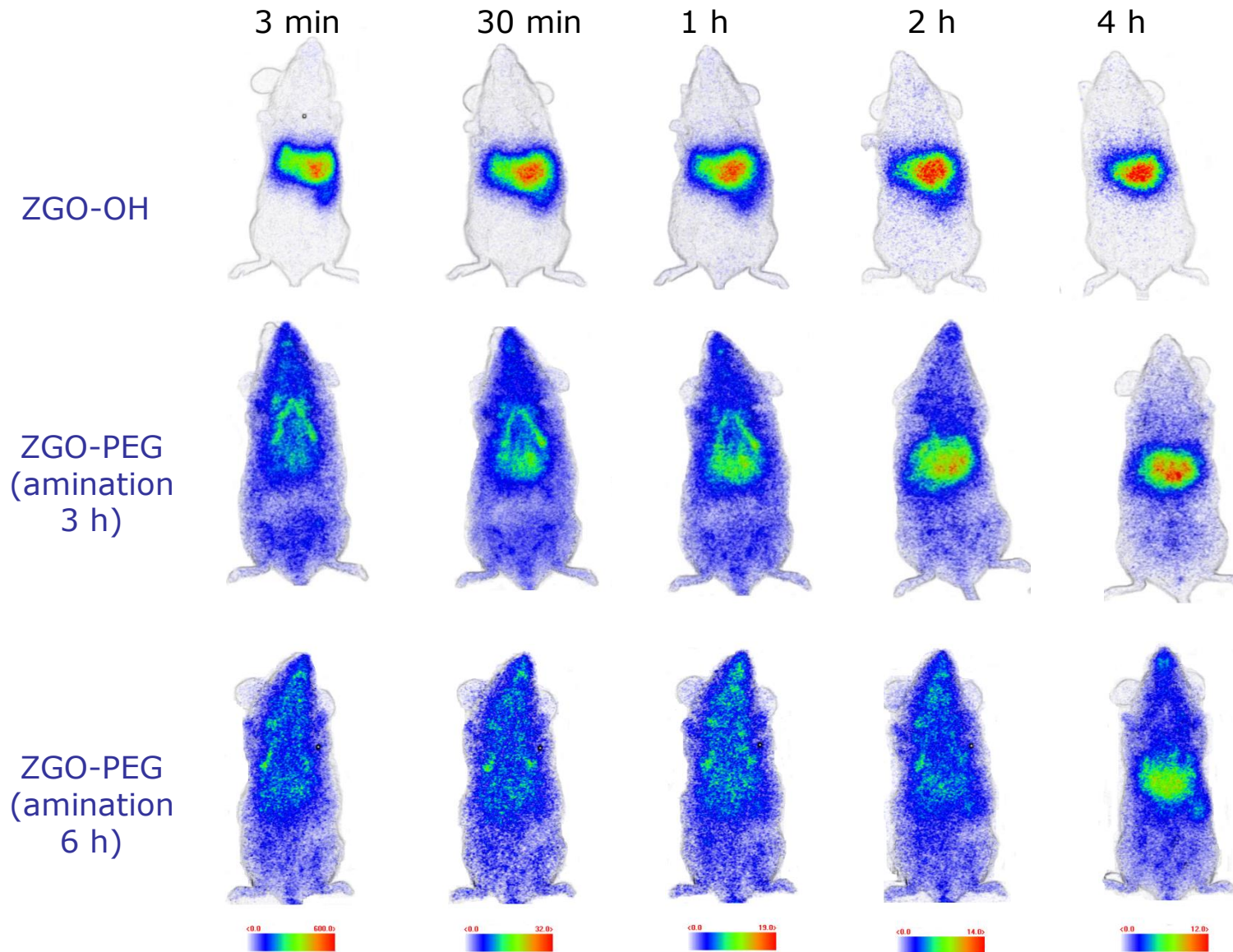
Increase of ionic strength causes increase in ζ -potential and NPs aggregation.

Nanoparticles characterization

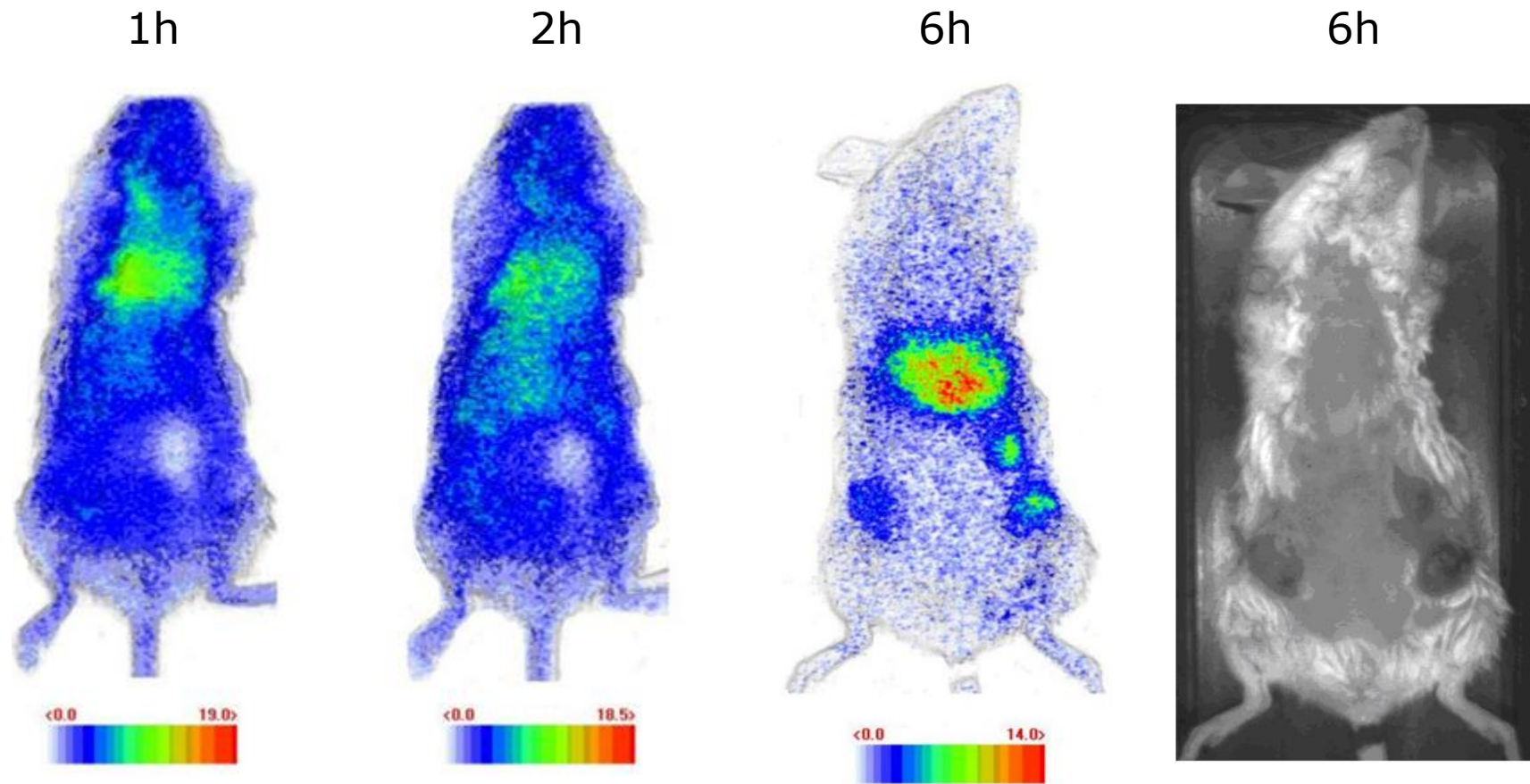


The ionic strength of the solutions does not affect the ZGO-PEG colloidal stability in the range of 0-150 mM.

Biodistribution of ZGO in healthy mice



Biodistribution of PEG-ZGO in tumor bearing mice

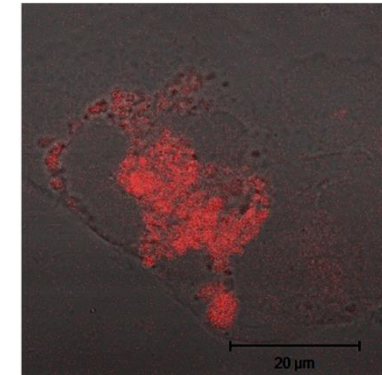
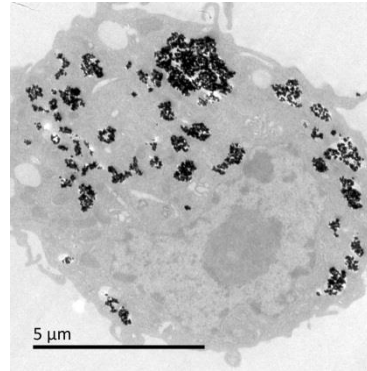
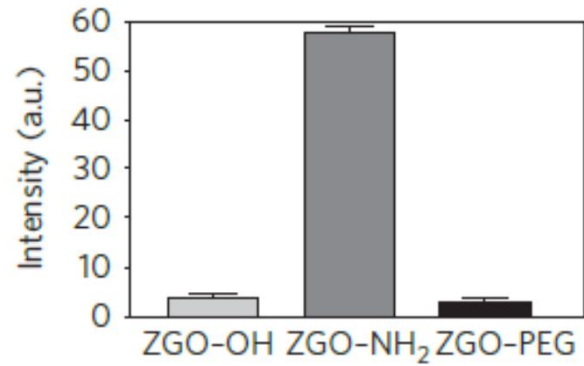


UV pre-excitation

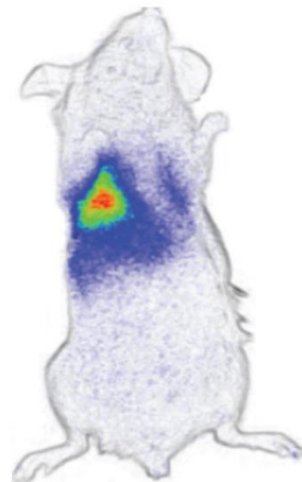
In situ activation

Nature Materials 2014, 13, 418-426

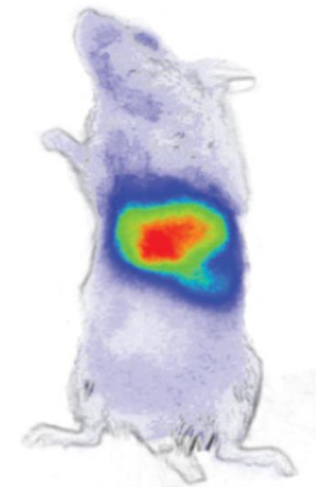
Cell labelling and tracking



Labelled cells

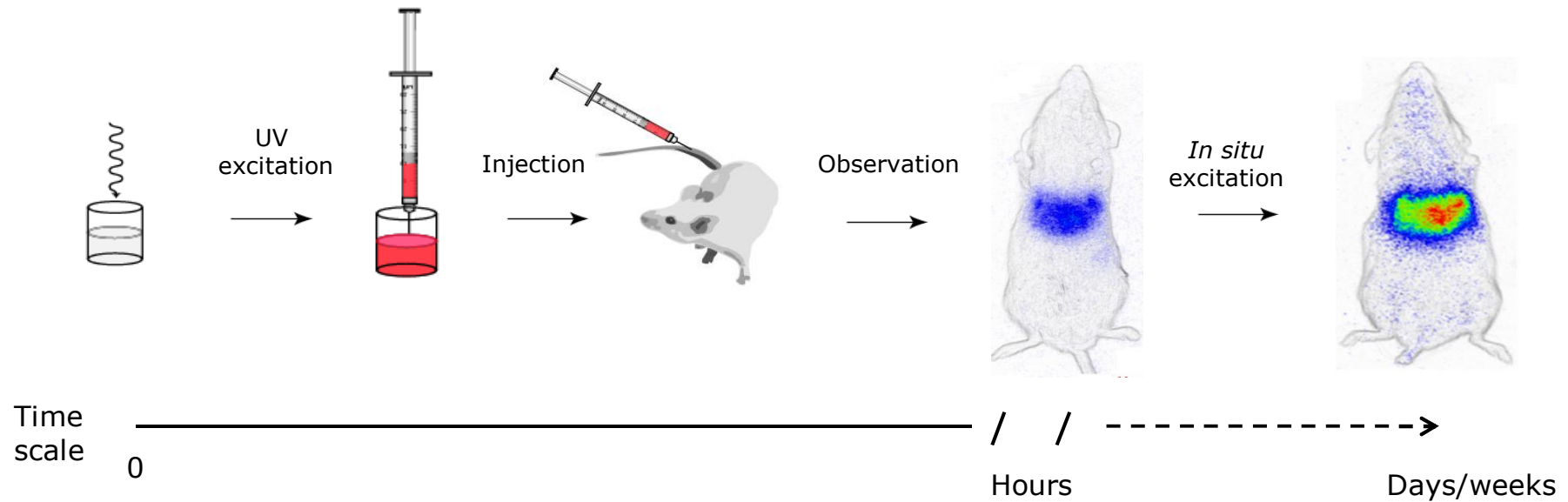


Free nanoparticles



Conclusion

Persistent luminescence nanoparticles are smart tools for *in vivo* imaging



- Real-time imaging without any time limit (2nd generation)
- Signals with high target to background ratio
- Surface modification for biodistribution and targeting

Acknowledgements

PhD students

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Collaborators

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Bruno Viana, Aurélie Bessière, Didier Gourier, Corinne Chanéac (LCMCP, Paris)

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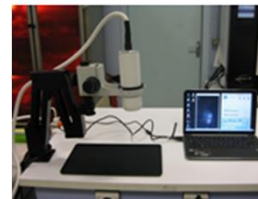


- “ High-sensitivity optical molecular imaging (bioluminescence and fluorescence)
- “ Co-registration with digital X-rays
- “ In vivo anatomical localization of molecular and cellular biomarkers
- “ Biodistribution studies of nanoparticles
- “ Characterization of tumor models
- “ Gene therapy: Evaluation of gene transfer
- “ bi-modal imagery with MRI

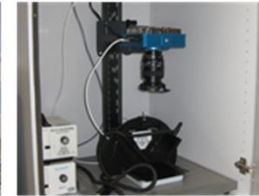
PhotonIMAGER™
Biospace



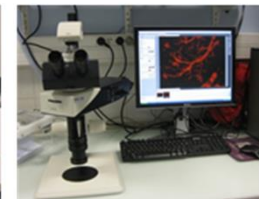
Fluobeam
portable system



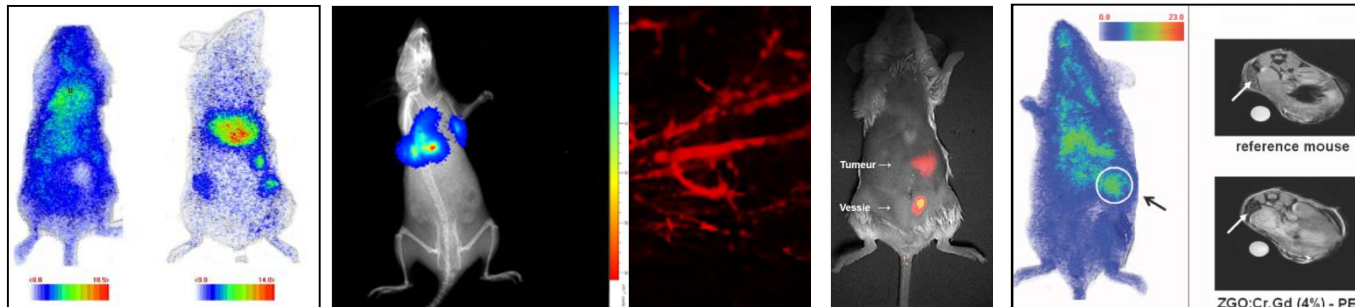
Apogée Alta U47
camera



Leica Z6 APO
MacroFluo



Micro MRI 7
Tesla



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