PRAGUE

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Persistent Luminescence

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1st year PhD student

Team: ***Christophe Dujardin, Julien Houel, Gilles Ledoux, Benoît Mahler***

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Outline

I/ Team presentation
II/ Persistent Luminescence
- Definition
- Objective

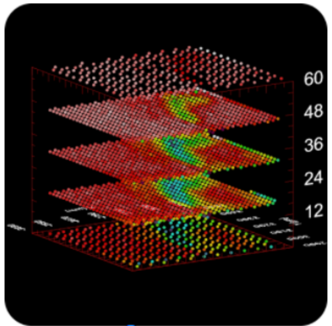
III/ Setups and Results
IV/ Conclusion & Prospects

I/ Team presentation

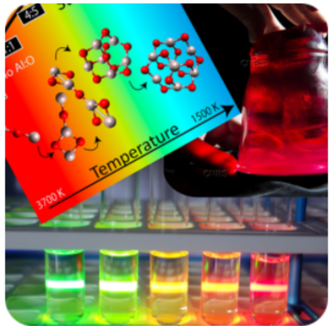
Luminescence

Head: Pr. Christophe DUJARDIN
Members: 41
Work developed through 6 topics:

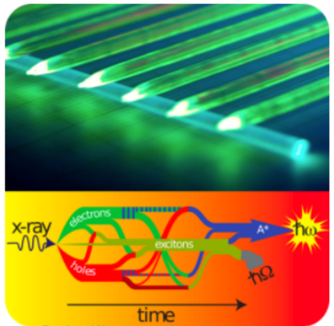
Nanostructures/Nano-optics
Head : Prof F. KULZER



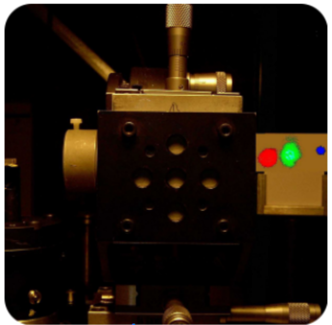
Sensors
Head : Dr. G. LEDOUX



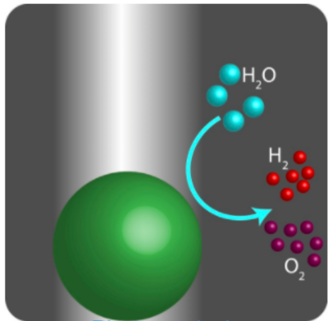
Synthesis and processing



Scintillators & phosphors
Head : Pr. C. Dujardin



Lasers
Head : Dr. A. BRENIER

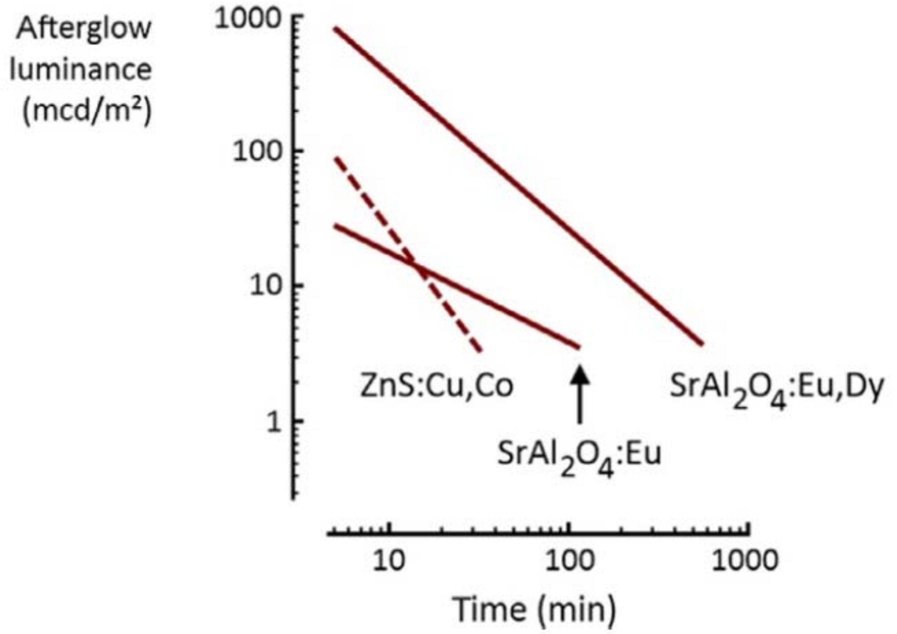


Photocatalysis
Head : G.Ledoux & B.Mahler

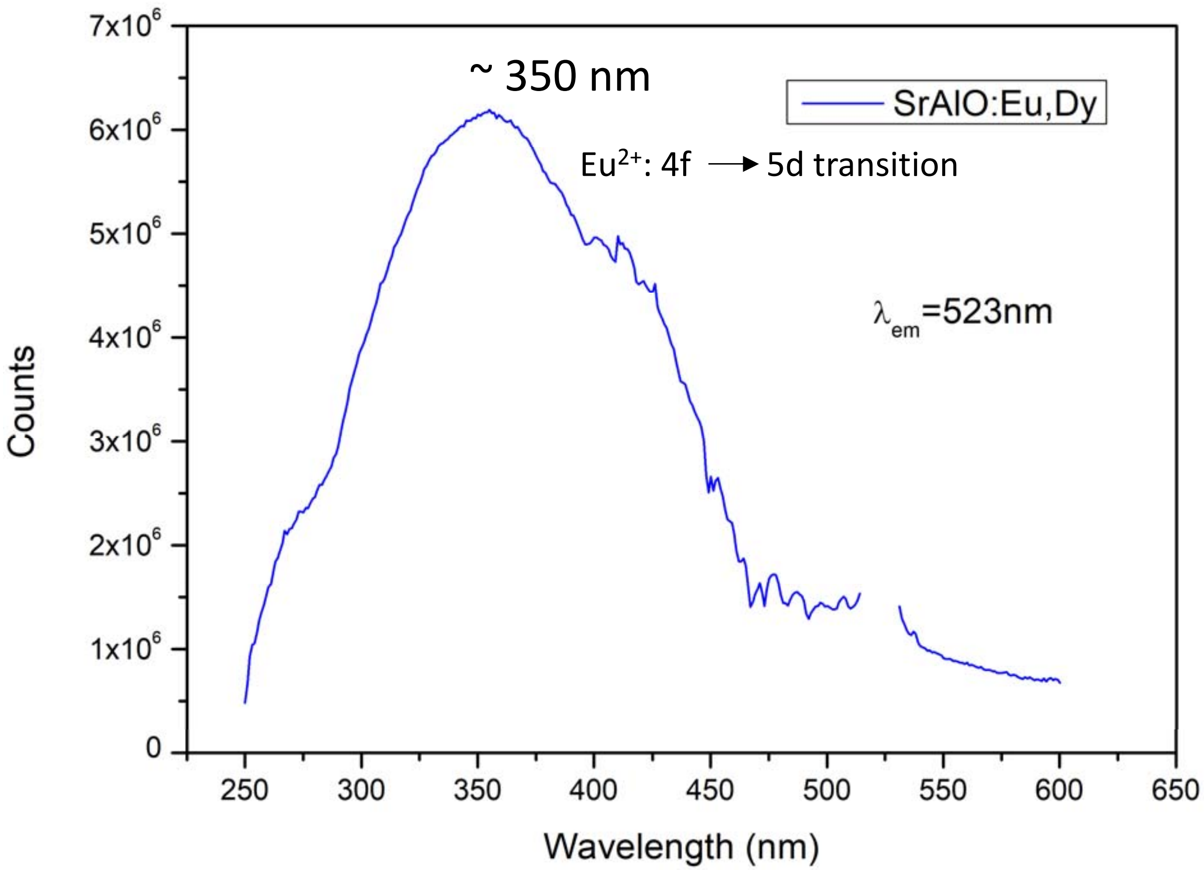
II/ Persistent Luminescence

o Definition

Optical phenomenon whereby a luminescent material keeps emitting light (from seconds to several hours) after the excitation has stopped.
→ Phosphorescence, afterglow, LLP (Long Lasting Phosphorescence)



Comparison of afterglow characteristics measured after 10 min exposure to 200 lx of D65 light.
A: $SrAl_2O_4:Eu^{2+}$; B: $SrAl_2O_4:Eu^{2+}-Dy^{3+}$; C: $SrAl_2O_4:Eu^{2+}-Nd^{3+}$; D: ZnS: Cu, Co



Excitation spectrum of $SrAl_2O_4$:Eu^{2+} -Dy^{3+} with λ_{em} = 523nm

o Objective

Efficient phosphors under LED excitation!

For what?

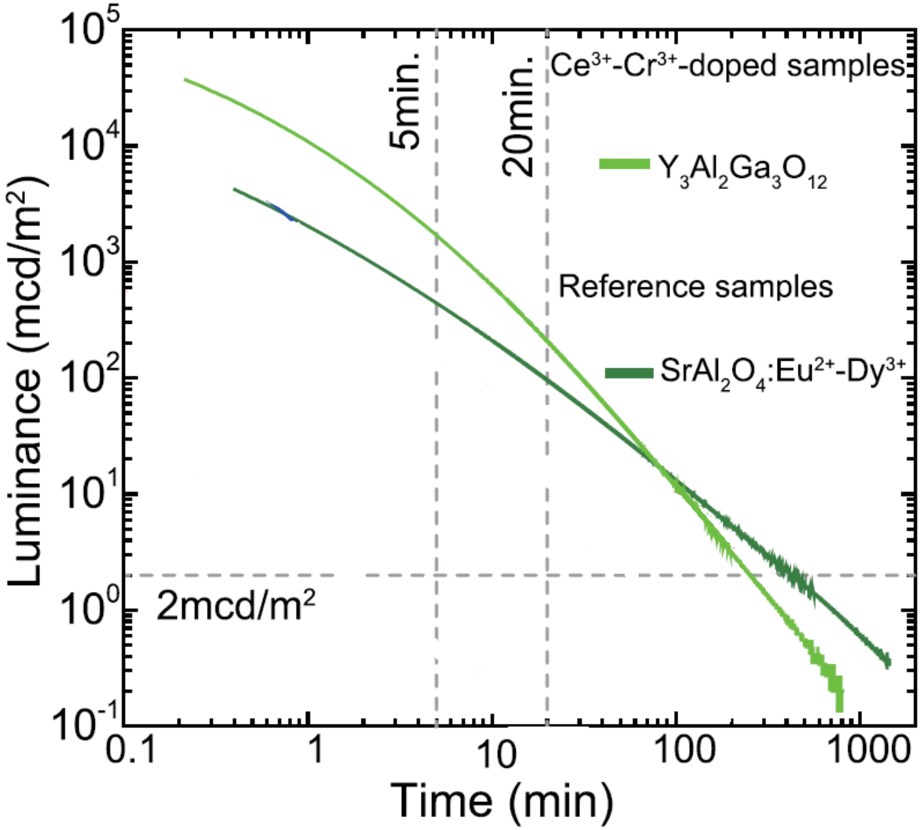
SECURITY purposes!

Inspiration!

Jumpei Ueda *et al* Appl. Phys. Lett. **104**, 101904 (2014);
« Bright persistent ceramic phosphors of Ce^{3+}-Cr^{3+} codoped garnet able to store by blue light.»

Excitation source 460 nm blue LED
Excitation time: 15min

- Better afterglow results for the YAGG than the strontium aluminate under a 460 nm LED light during the first 100 minutes.
- The SAO has a higher luminance for longer observation times.
- Efficient carrier trap formation

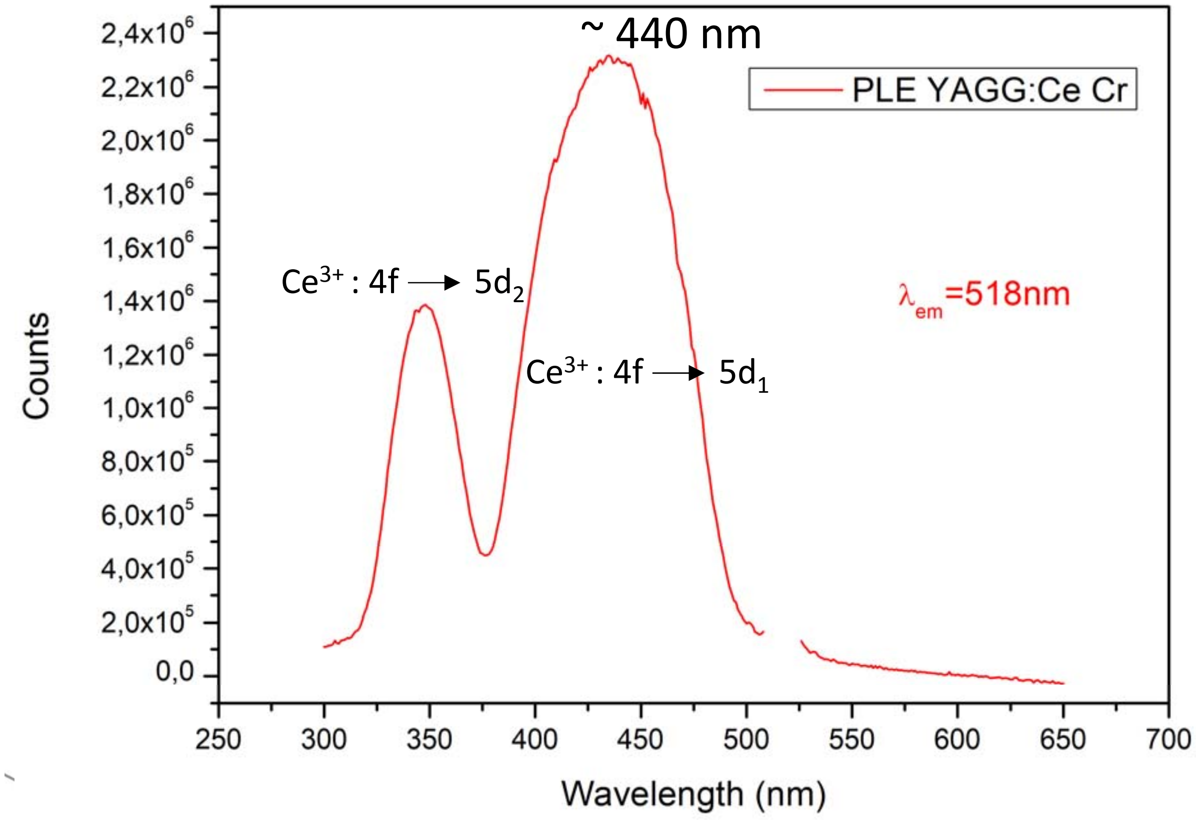


Persistent luminescence decay curves using 460 nm blue-light excitation of $Y_3Al_2Ga_3O_{12}$:Ce^{3+} - Cr^{3+} and $SrAl_2O_4$:Eu^{2+}-Dy^{3+}

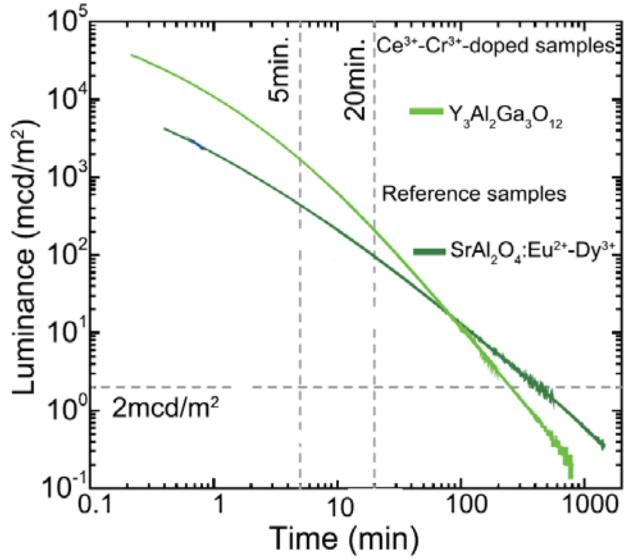
INSTITUT LUMIÈRE MATIÈRE

Inspiration!

Jumpei Ueda *et al* Appl. Phys. Lett. **104**, 101904 (2014);
« Bright persistent ceramic phosphors of Ce^{3+}-Cr^{3+} codoped garnet able to store by blue light.»



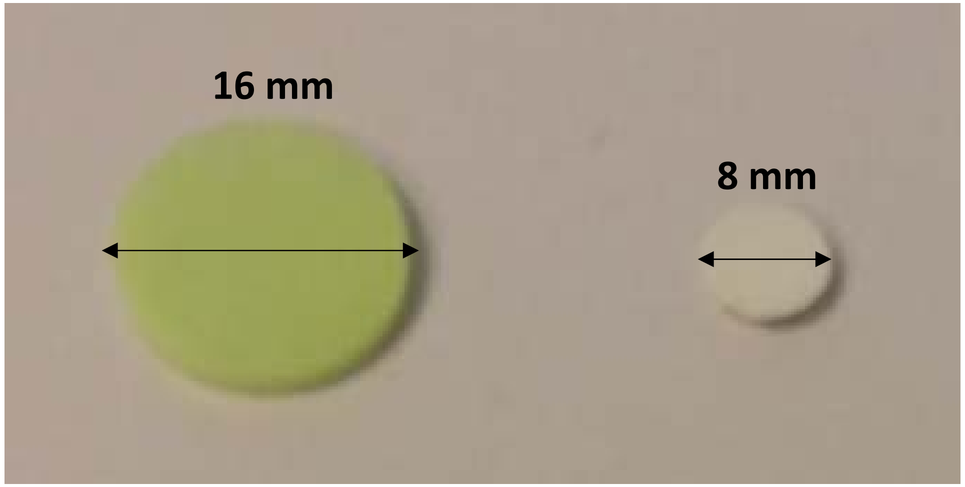
Excitation spectrum of $Y_3Al_2Ga_3O_{12}:Ce^{3+}$ - Cr^{3+} with λ_{em} = 518nm



Persistent luminescence decay curves using 460 nm blue-light excitation of $Y_3Al_2Ga_3O_{12}:Ce^{3+}$ - Cr^{3+} and $SrAl_2O_4:Eu^{2+}$-Dy^{3+}

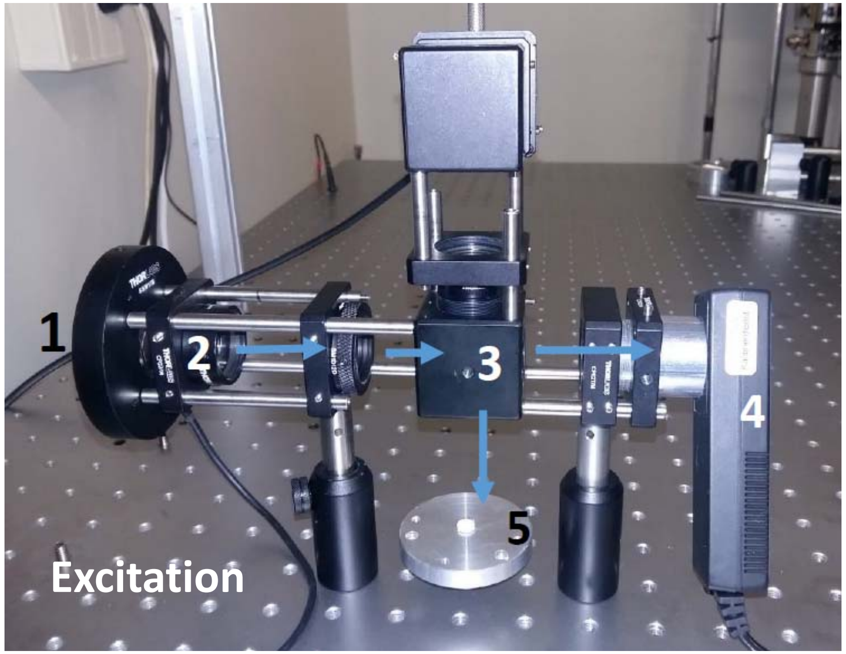
- Excitation under blue light more efficient for the YAGG than UV.
- Bright and long persistent luminescence is achieved by electron trap creation by Cr^{3+}-codoping

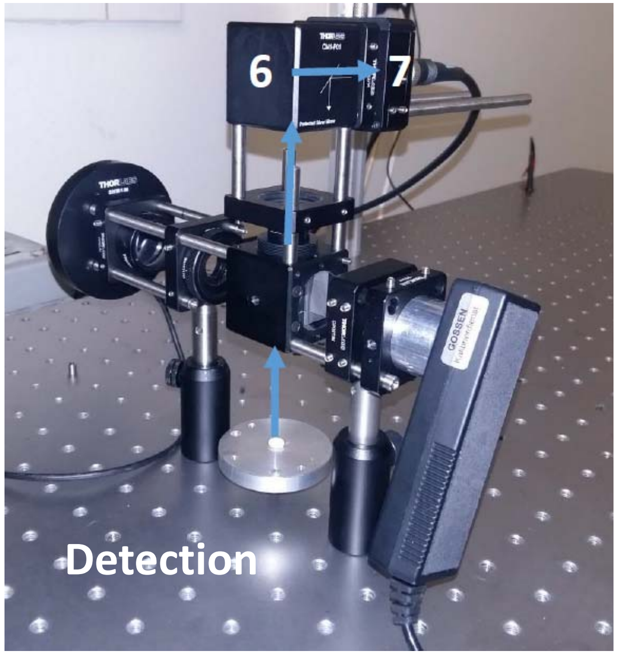
o The samples

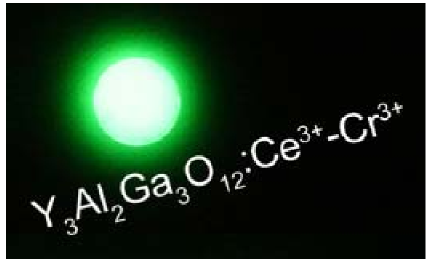


Samples. Transluscent ceramic of YAGG:Ce^{3+}, Cr^{3+} (left), compact powder of $SrAl_2O_4$: Eu^{2+}, Dy^{3+} (right)

III/ Setups and results

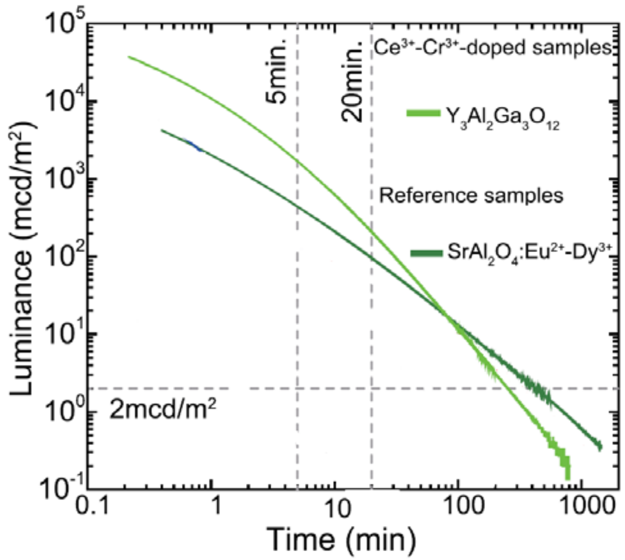


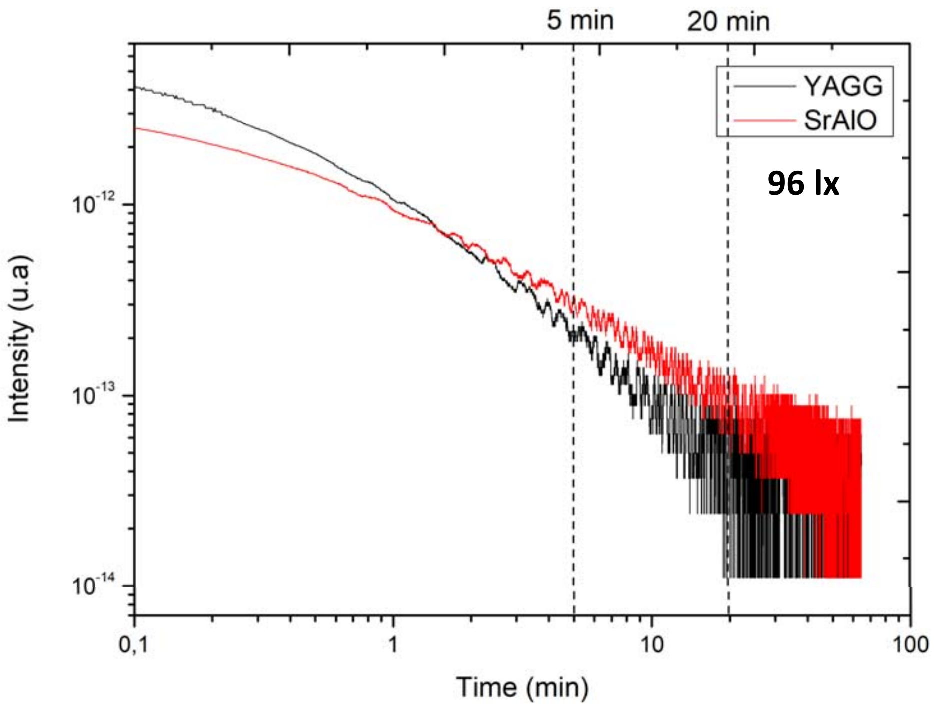




Experimental Parameters:

- Excitation source: 455nm blue LED
- Excitation time: 15mn
- Samples: $Y_3Al_2Ga_3O_{12}:Ce^{3+}- Cr^{3+}$ & $SrAl_2O_4: Eu^{2+}-Dy^{3+}$

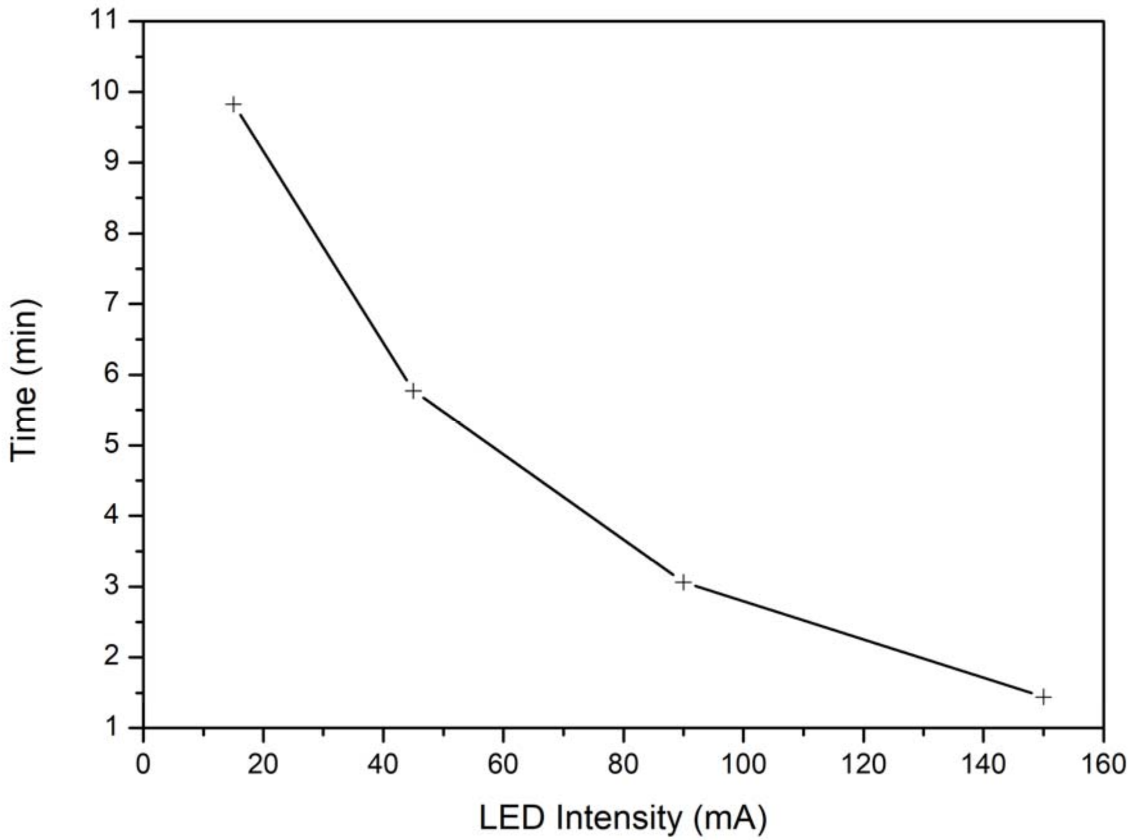




Persistent luminescence decay curves using 455 nm blue-light excitation of $Y_3Al_2Ga_3O_{12}:Ce^{3+}$ - Cr^{3+} and $SrAl_2O_4:Eu^{2+}$ -Dy^{3+}

Junction 1 min after the excitation has stopped

Evolution in time of the cross point as a function of the LED intensity



Experimental Parameters:

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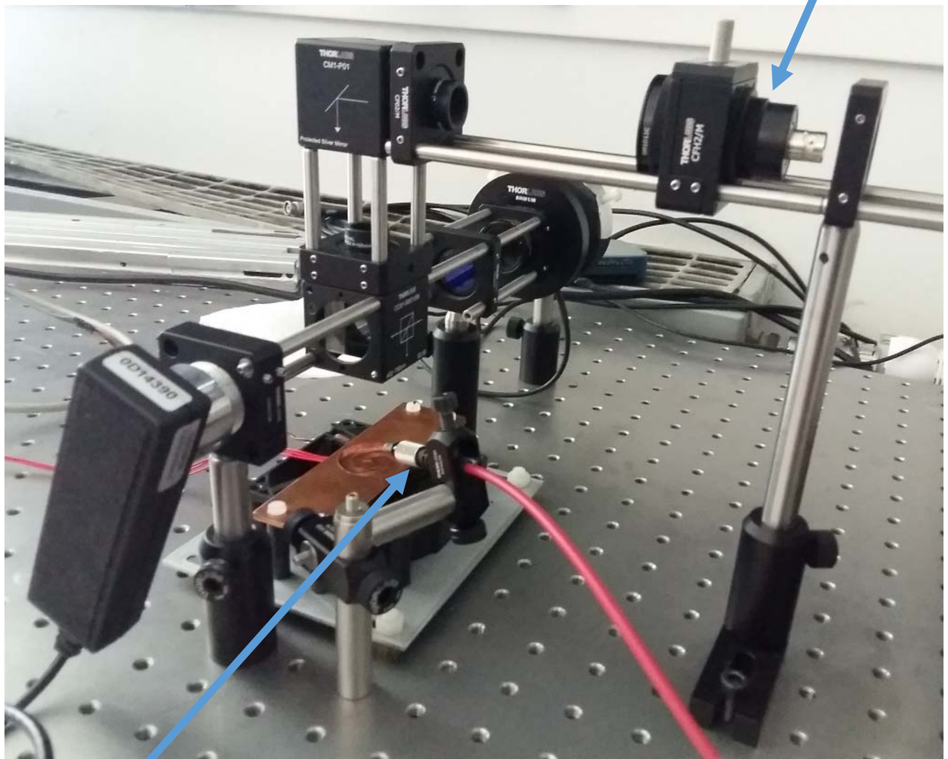
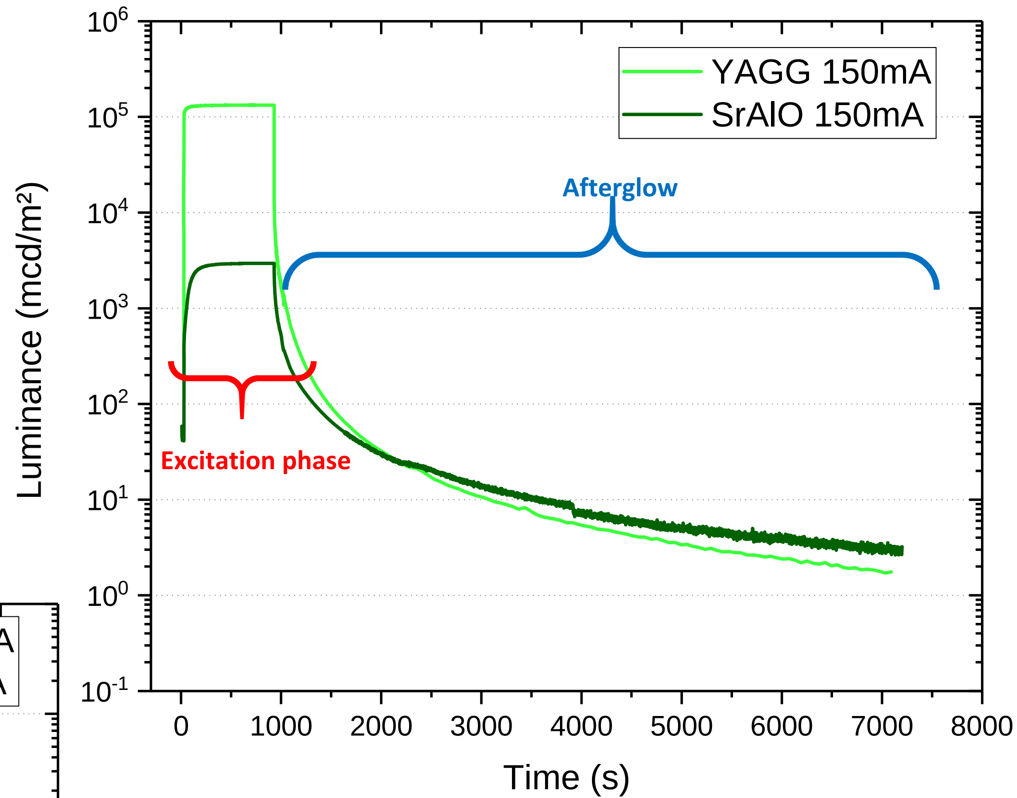
Photodiode

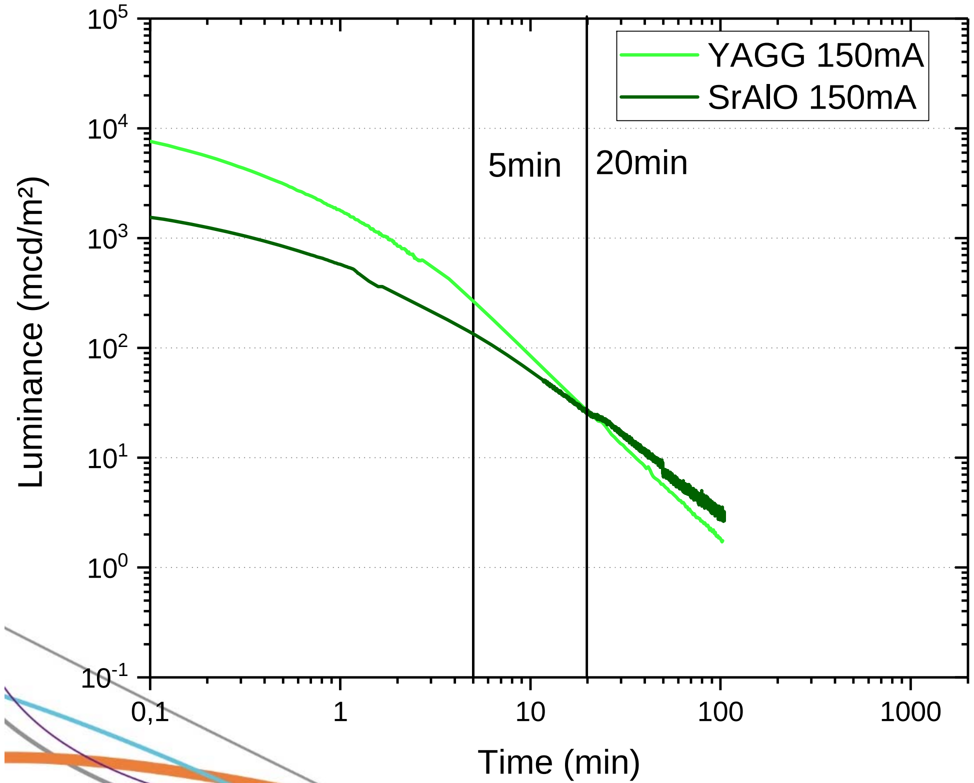


Afterglow measurement setup

Optical fiber
connected to PM

LED 96 lx

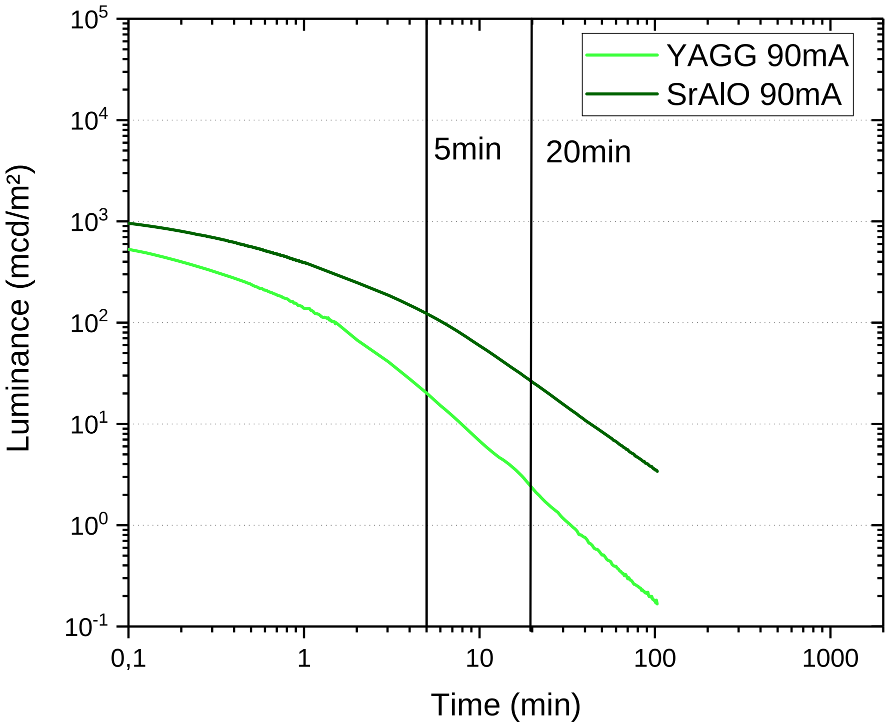




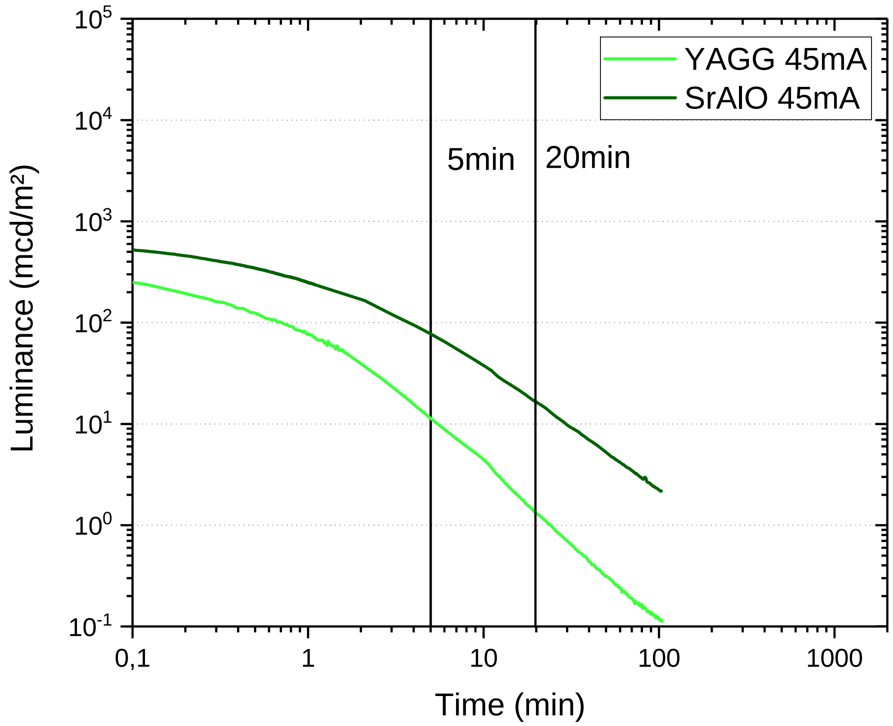
The two curves join **20 min** after the excitation has stopped

Lower LED intensities . . .

60 lx



40 lx



- No intersection between the YAGG curve and the SAO curve.
- SAO shows a higher luminance than the YAGG

Higher LED intensities . . . ?

To be continued …

III/ Conclusion & Prospects

- ✓ Study of luminescent materials under blue light excitation
- ✓ The YAGG:Ce, Cr exhibits higher fluorescence than the $SrAl_2O_4$: Eu^{2+}-Dy^{3+}
- ✓ Under low light intensities the strontium aluminate exhibits higher luminance during afterglow
- ➢ The right experimental parameters still need to be investigated

Thank you for your attention