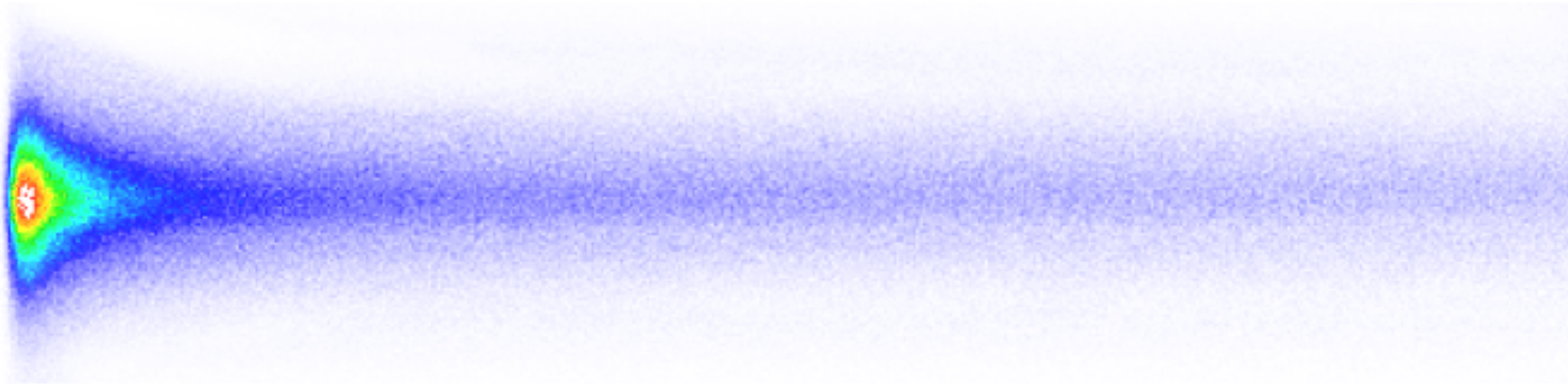




Nanocrystals as a driving force for ultrafast ionizing radiation detectors

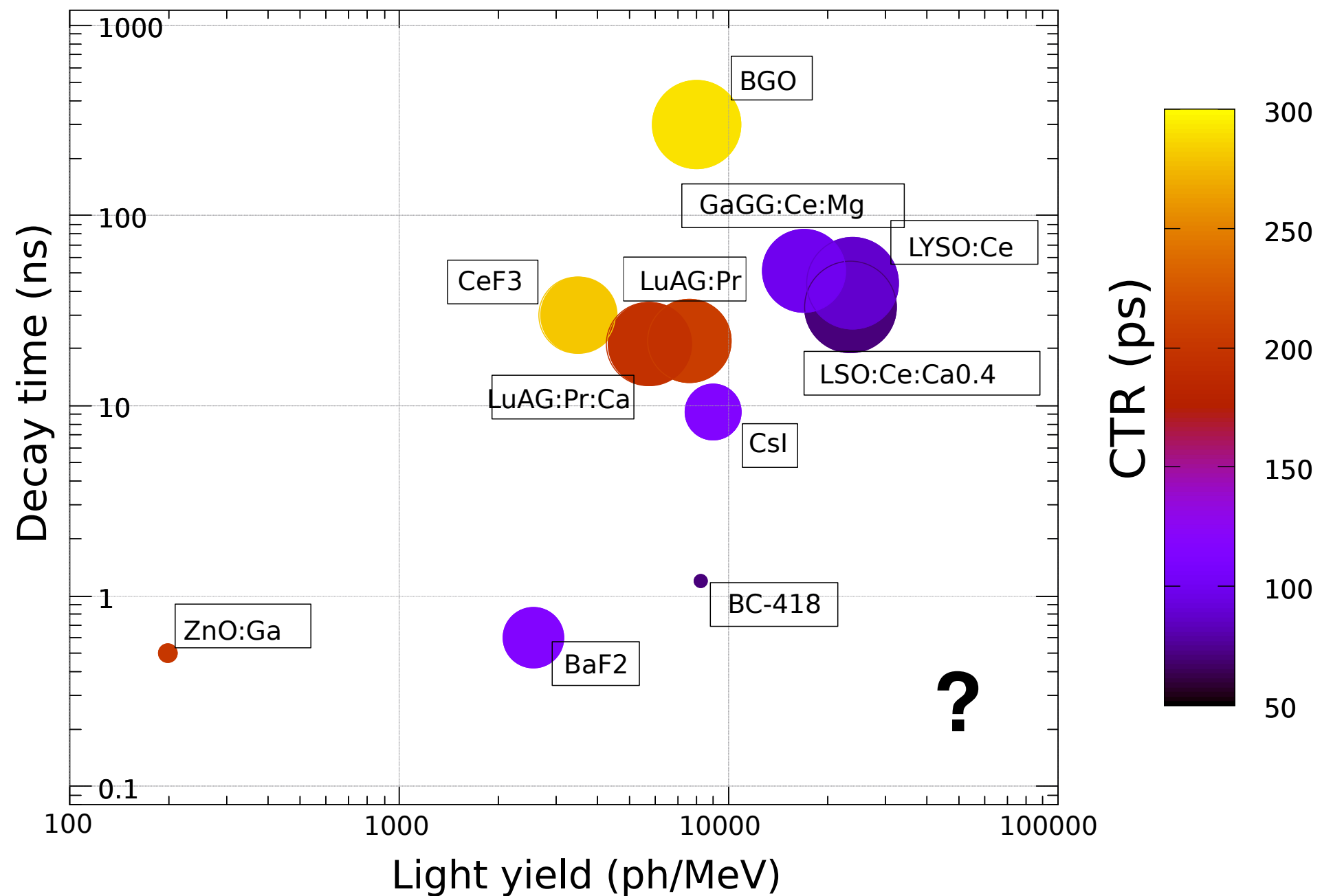
Rosana Martinez Turtós
on behalf of Lab27, CERN



FAST COST Meeting
June 13th Prague, 2018

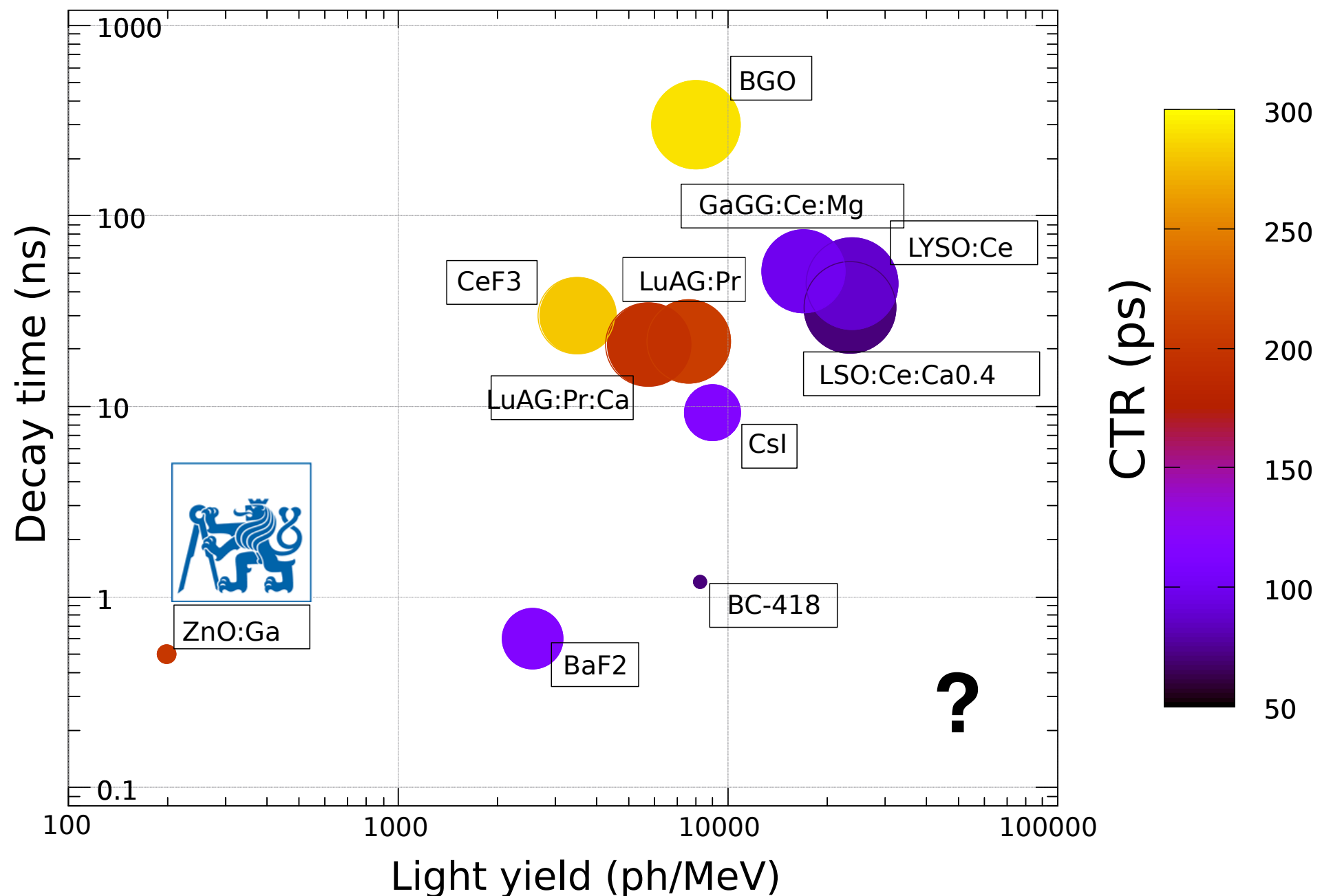


Next Generation of scintillating detectors



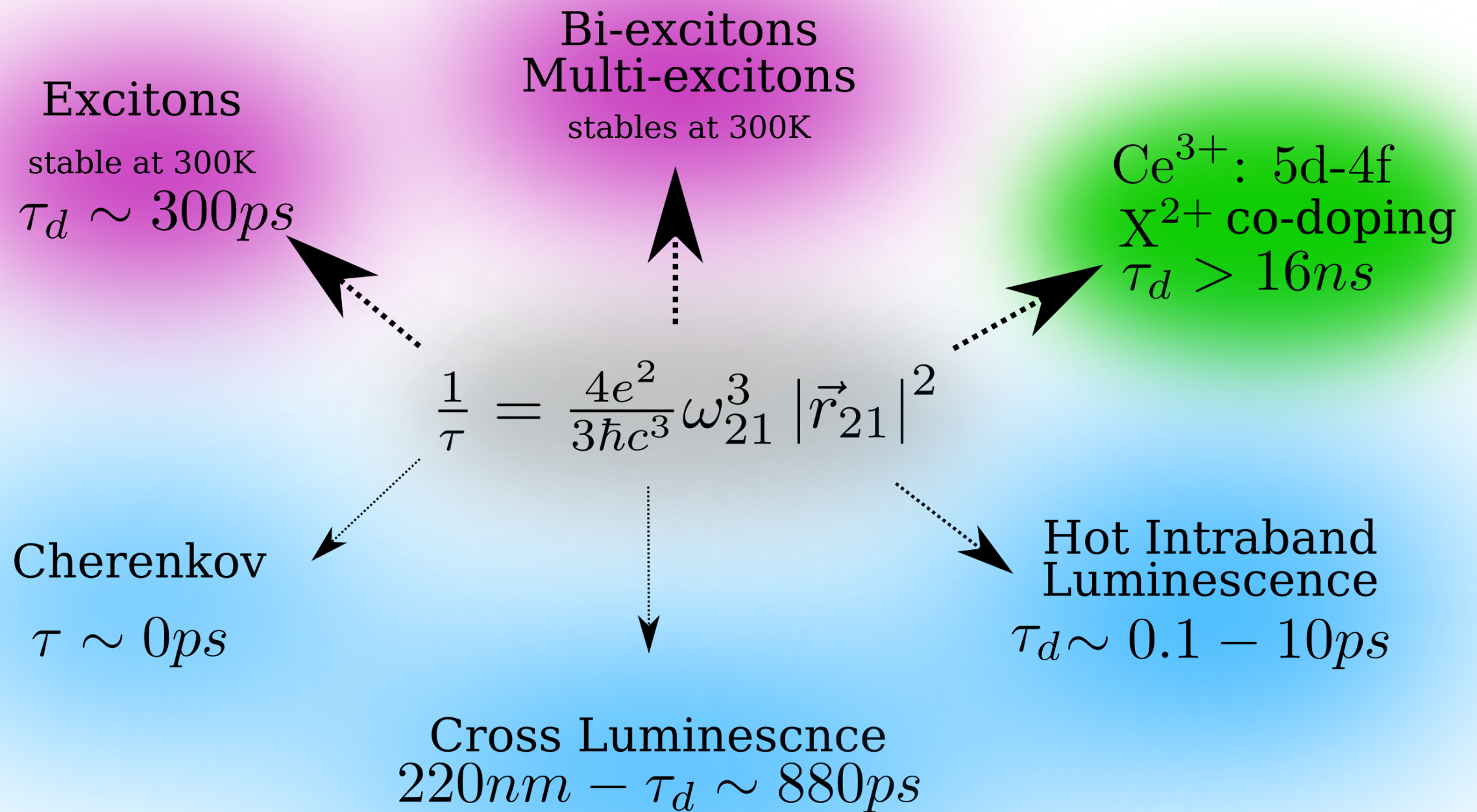
*Data measured by Stefan Gundacker in an optimised single channel readout configuration of scintillator coupled to SiPMs

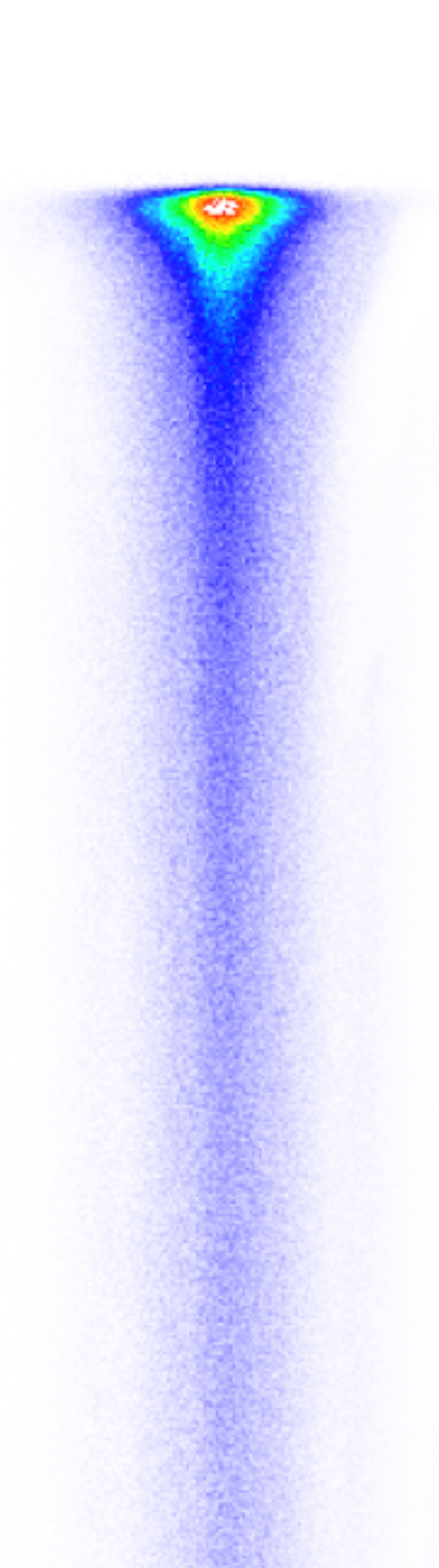
Next Generation of scintillating detectors



*Data measured by Stefan Gundacker in an optimised single channel readout configuration of scintillator coupled to SiPMs

Sub-1ns photon emission





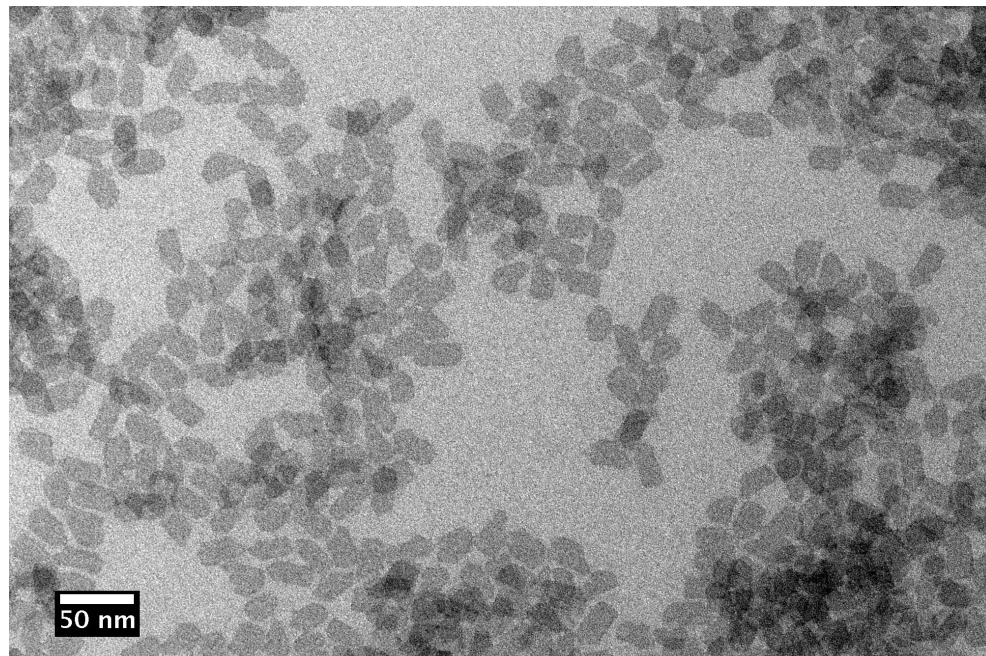
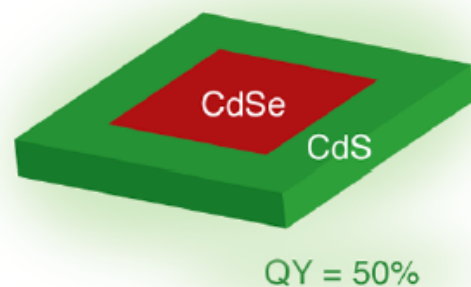
Outline

1. CdSe nanoplatelets on LYSO thin plates forming a sampled pixel.
2. InGaN/GaN multi-quantum wells nanostructure
3. CsPbBr₃ perovskites
4. New hybrid PMT TCSPC readout for radio-luminescent studies.

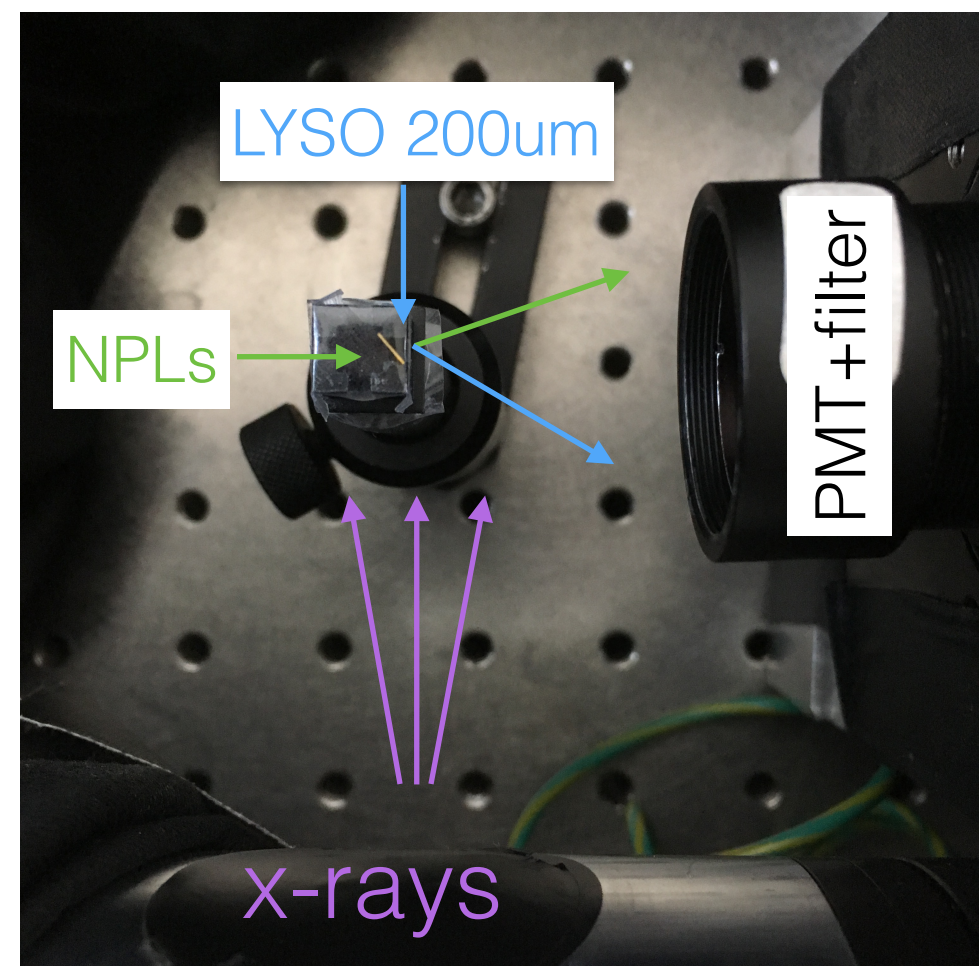
CdSe/CdS core crown nanoplatelets

In collaboration with B. Mahler and C. Dujardin@ILM, Lyon

a

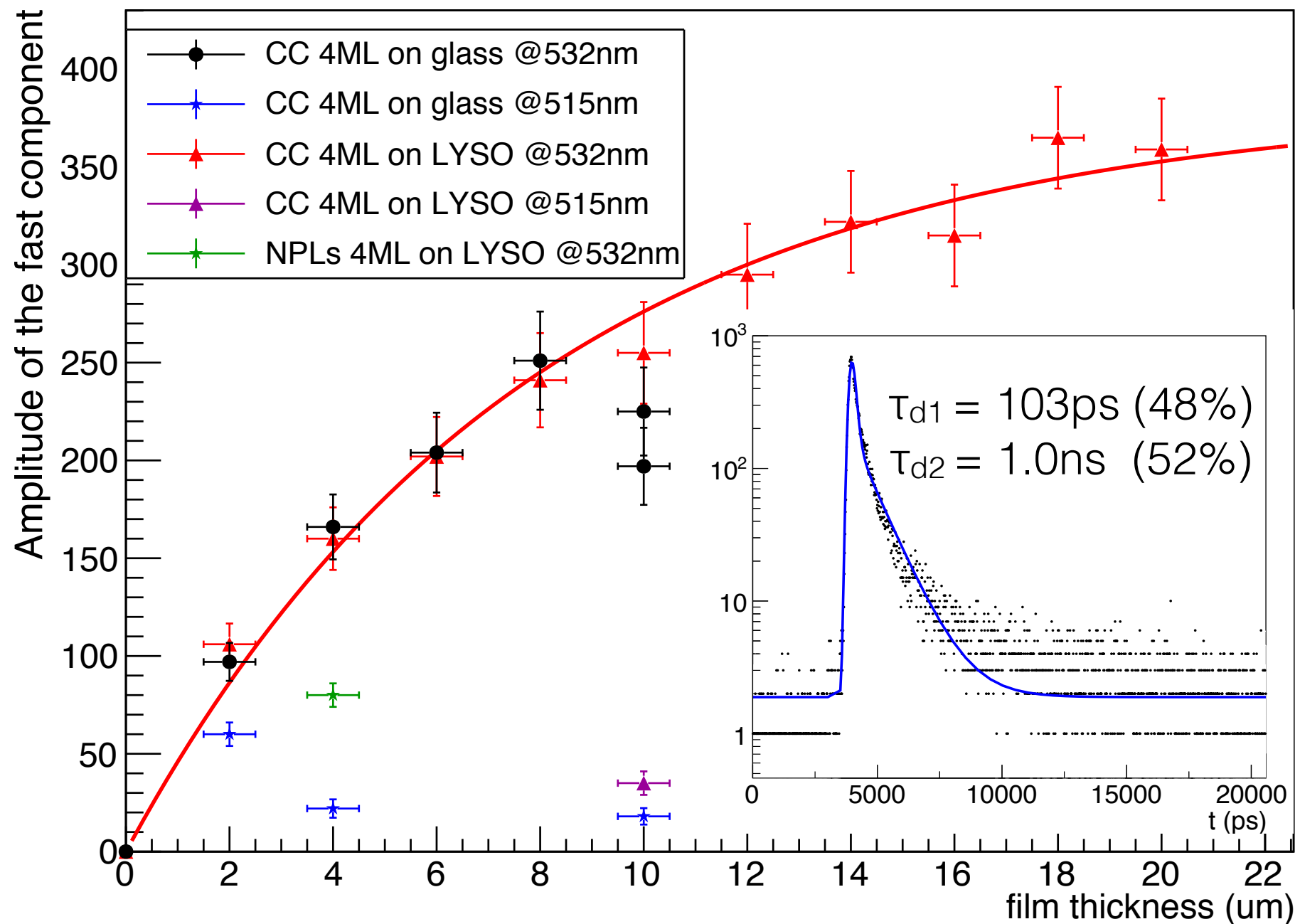


TCSPC setup@Lyon $\rightarrow$ IRF ~ 330 ps

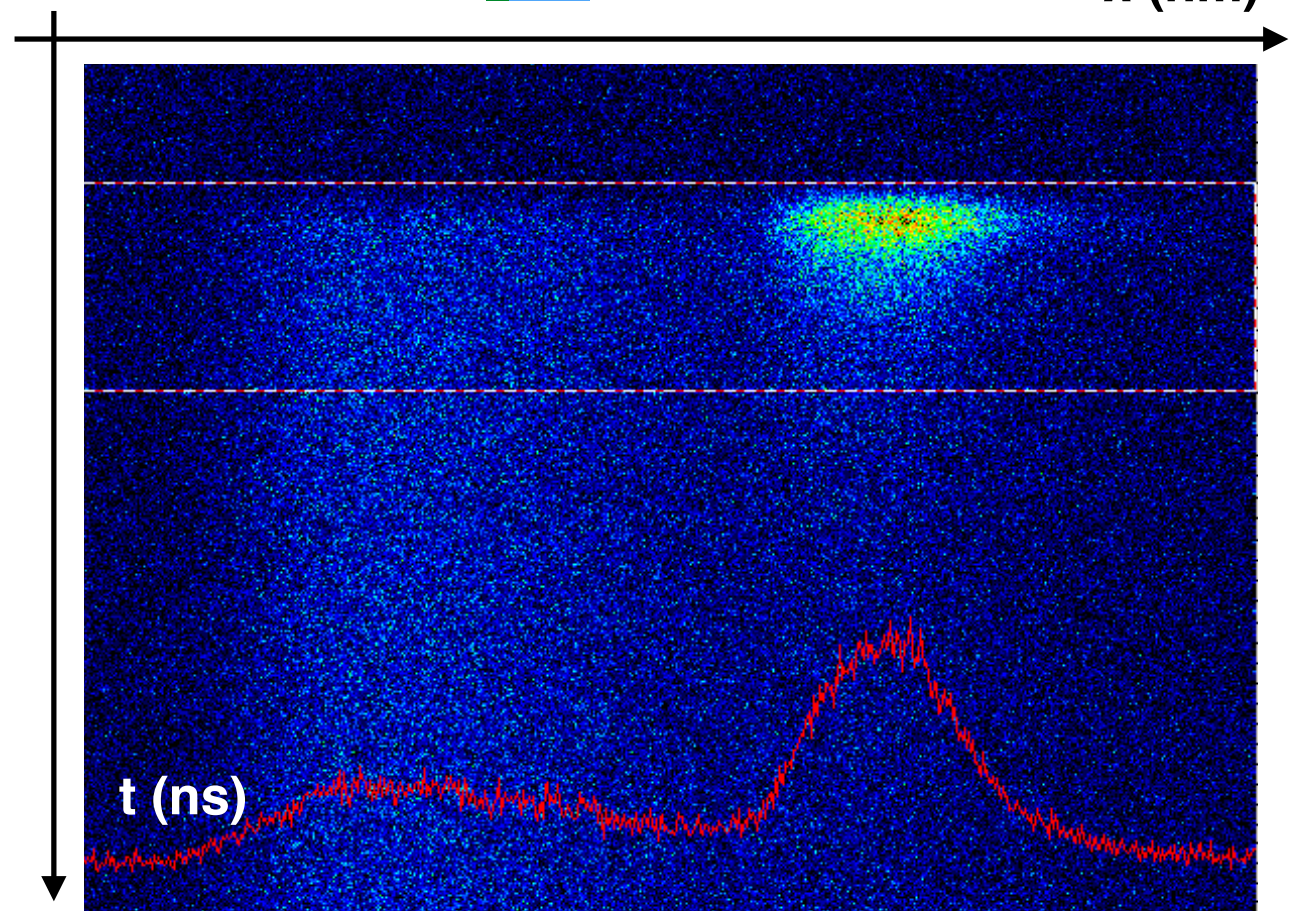
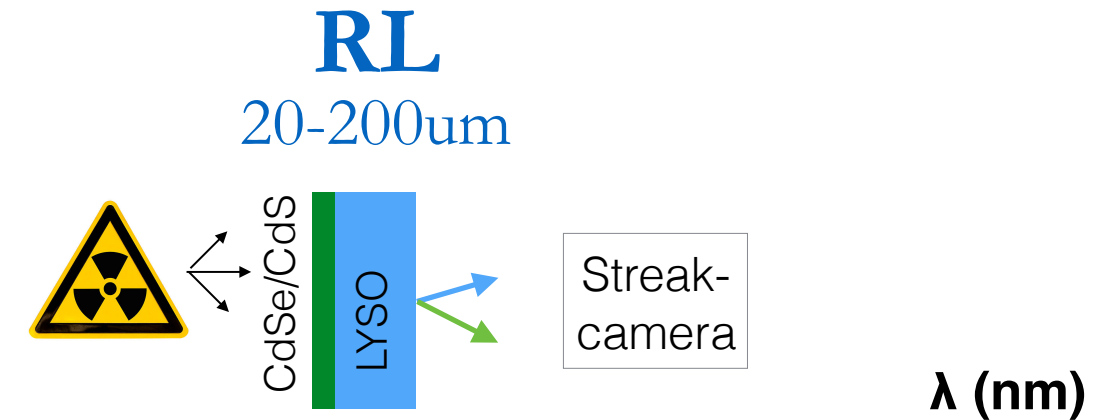
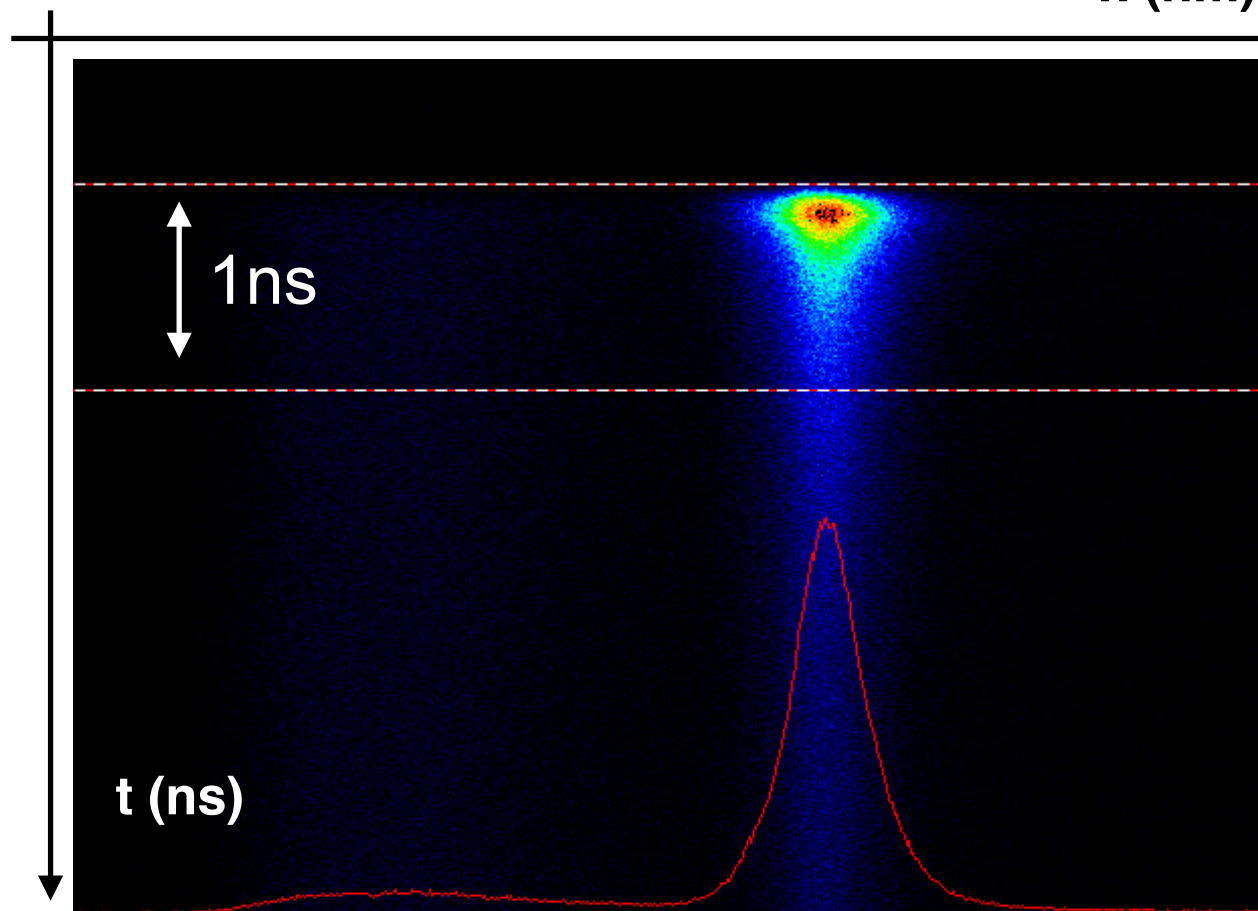
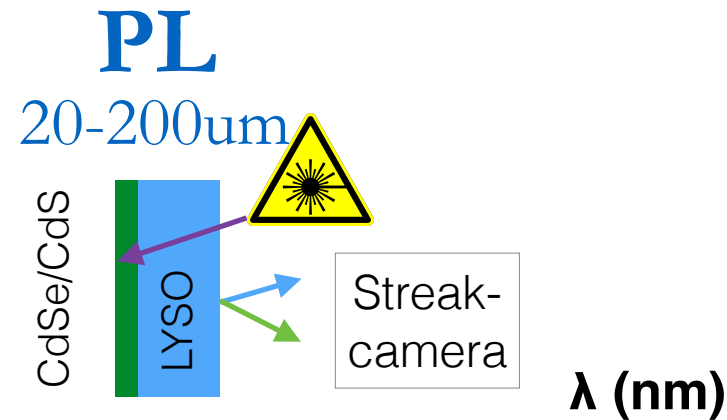


Light output of different NPLs synthesis and film thickness

CdSe_CdS Core Crown (CC) NPLs

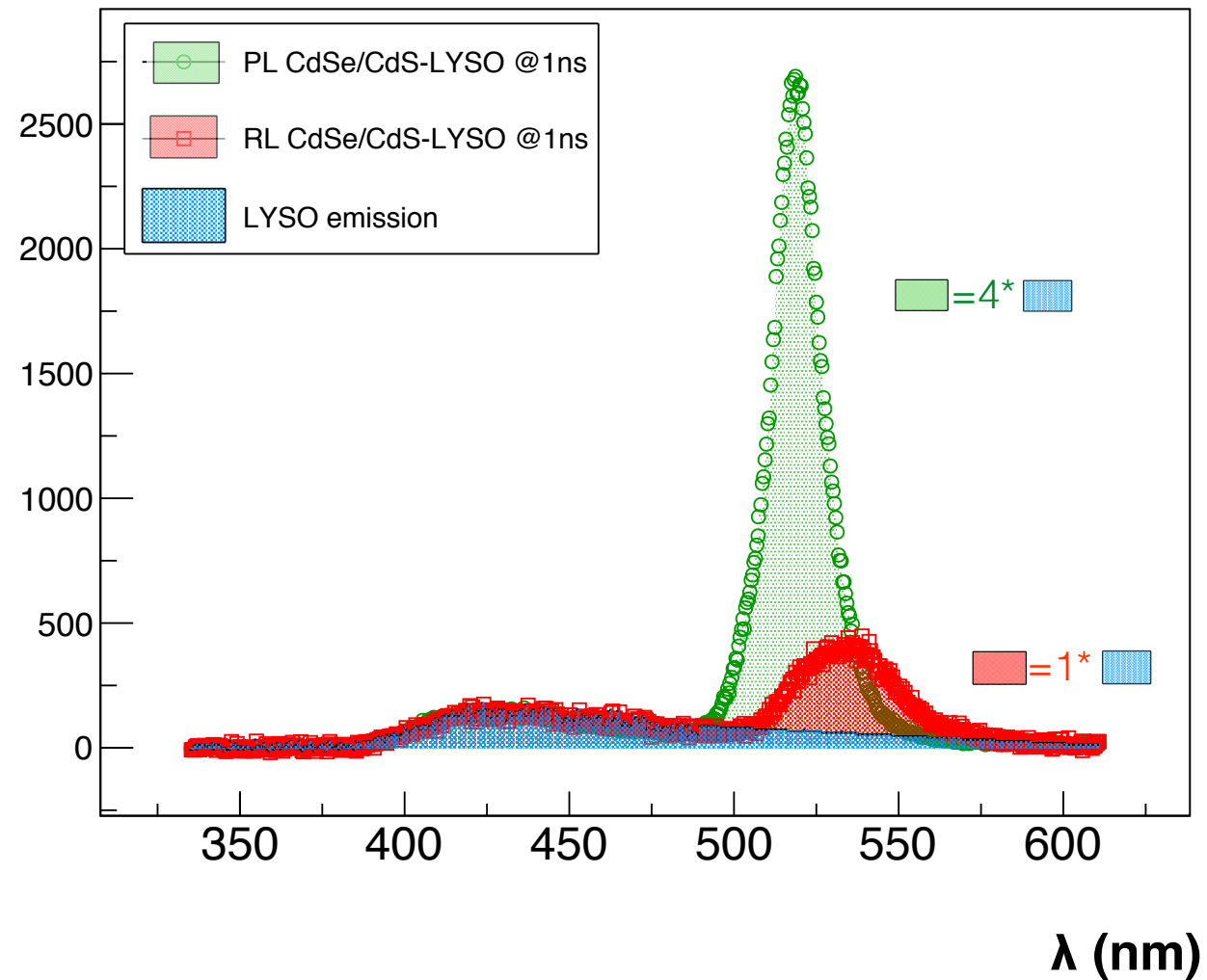


Spectroscopy of CdSe/CdS-LYSO plate

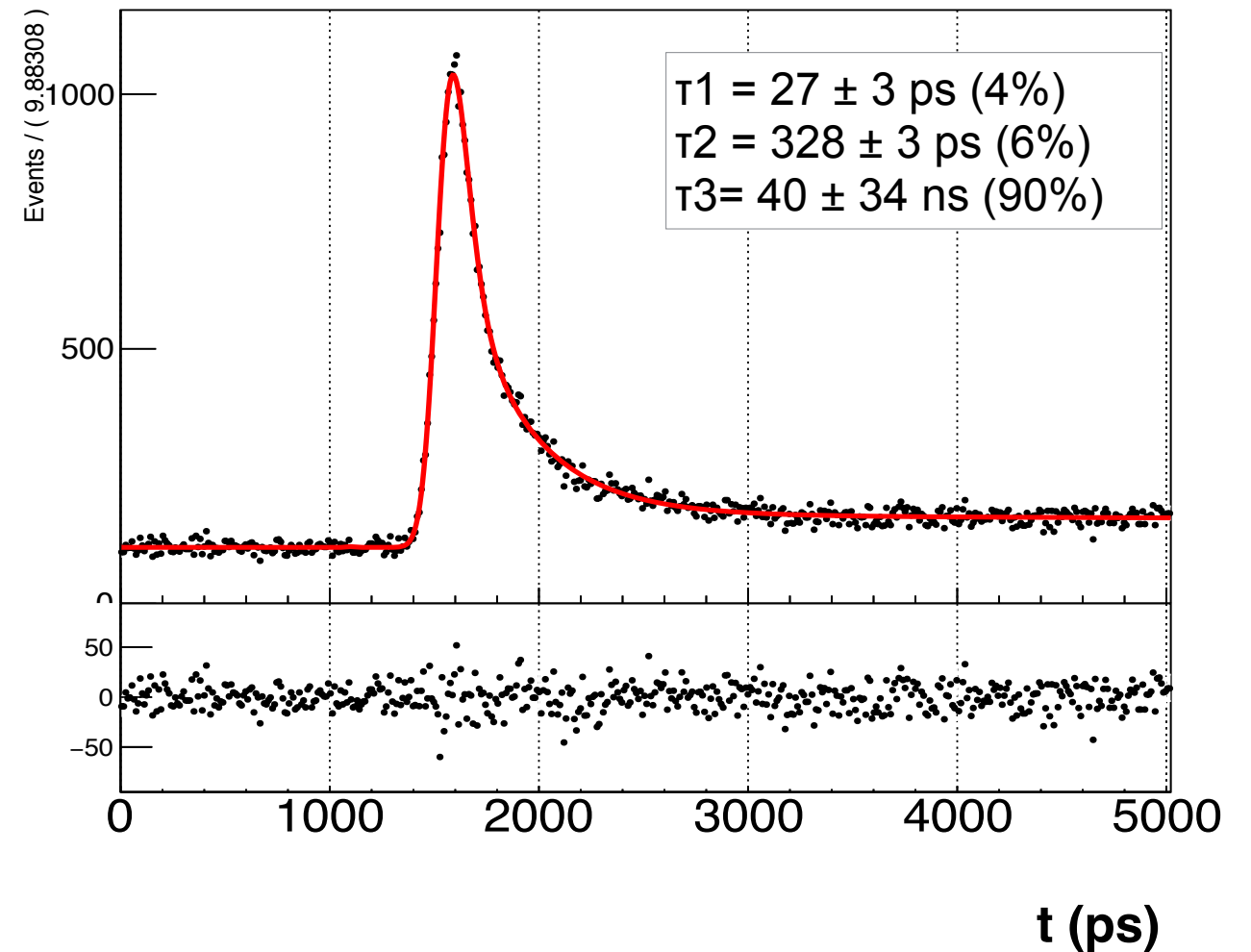


Spectroscopy of CdSe/CdS-LYSO plate

PL & RL spectra @1ns

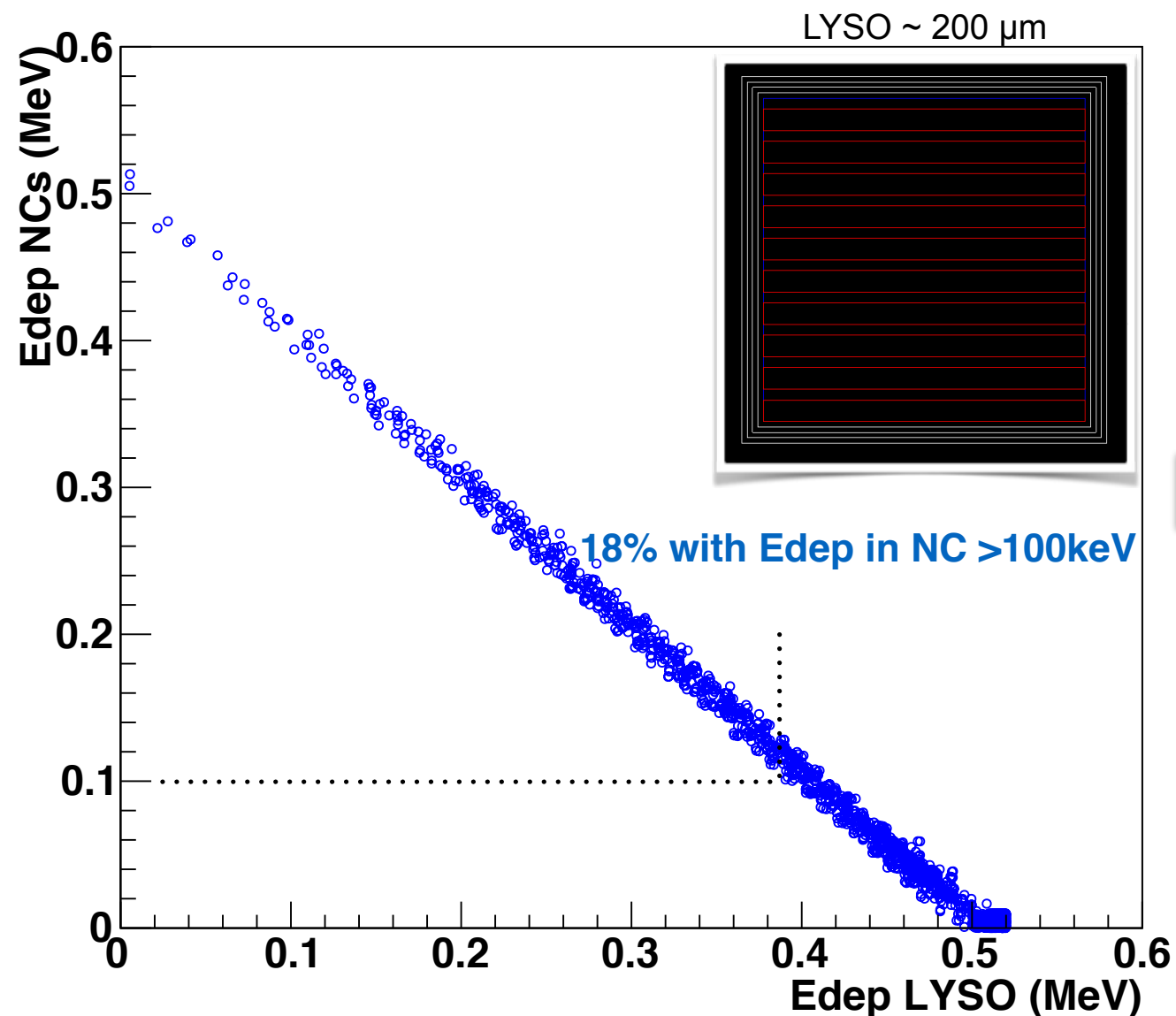


RL decay profile @530nm

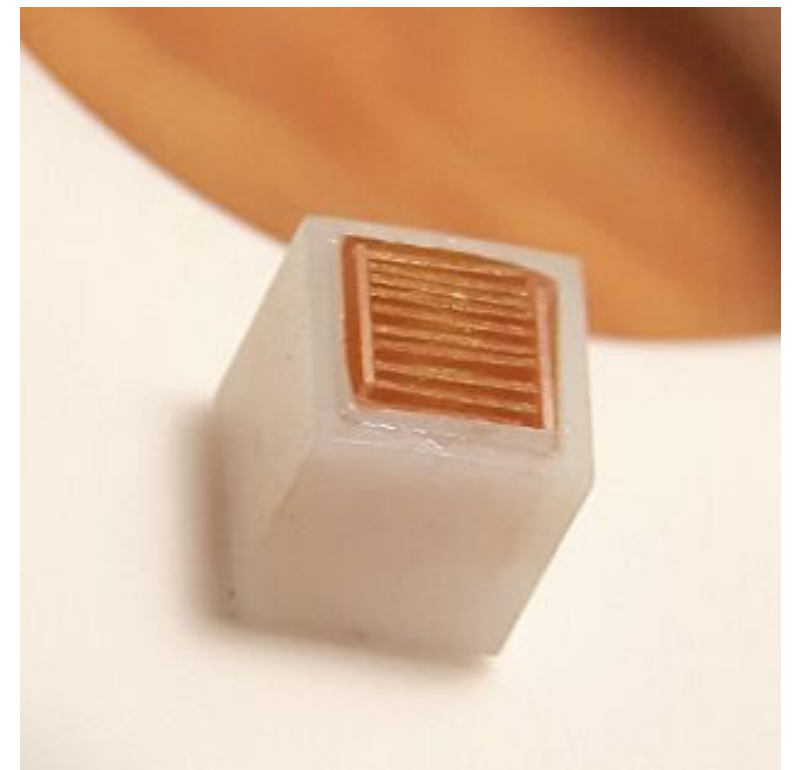


Energy leakage of a 511keV gamma in a CdSe/CdS-LYSO sampled pixel

2D Energy deposition for 511keV gammas

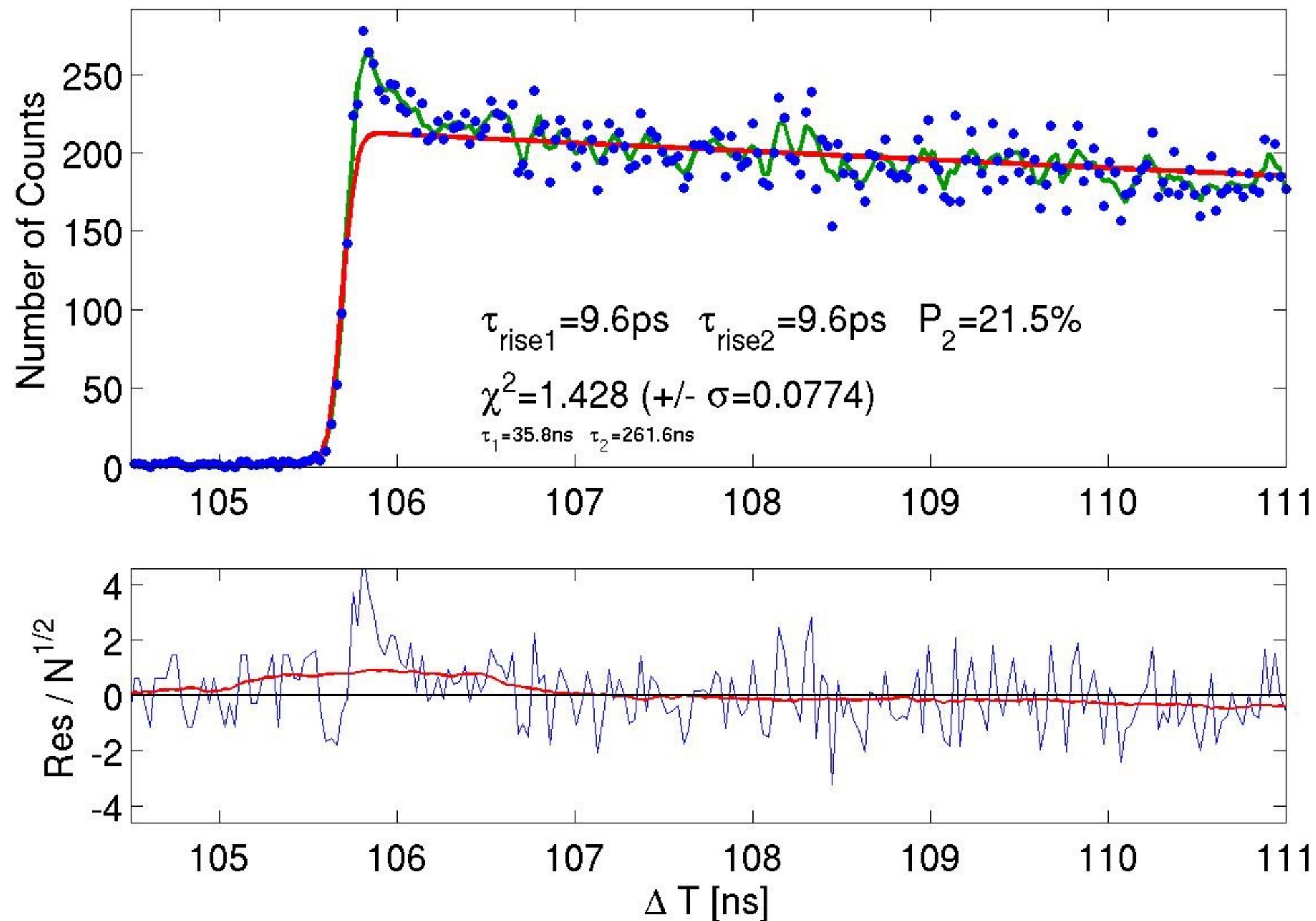


3mm^3 sampled cube



Rise time of CdSe/CdS-LYSO sampled pixel

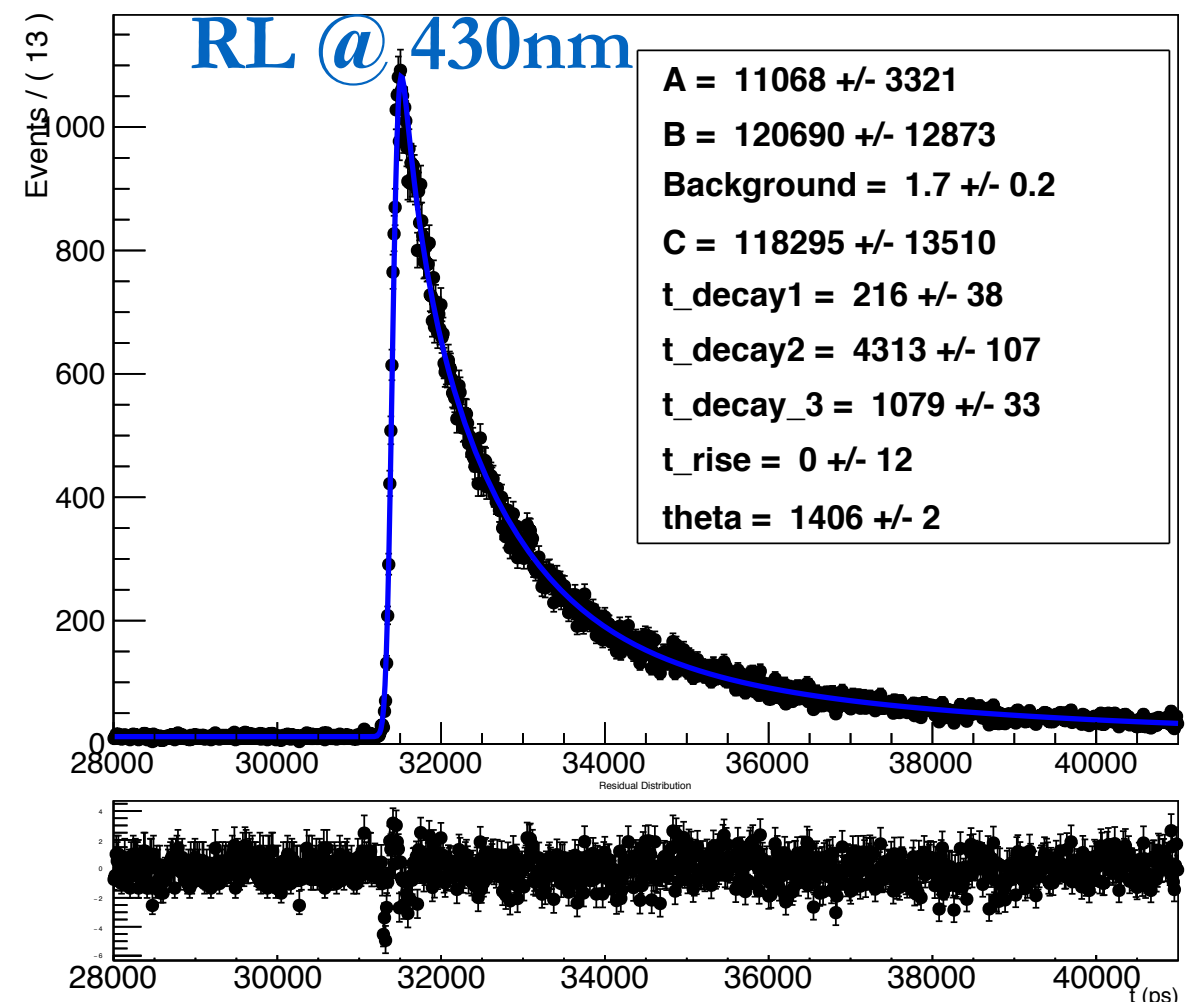
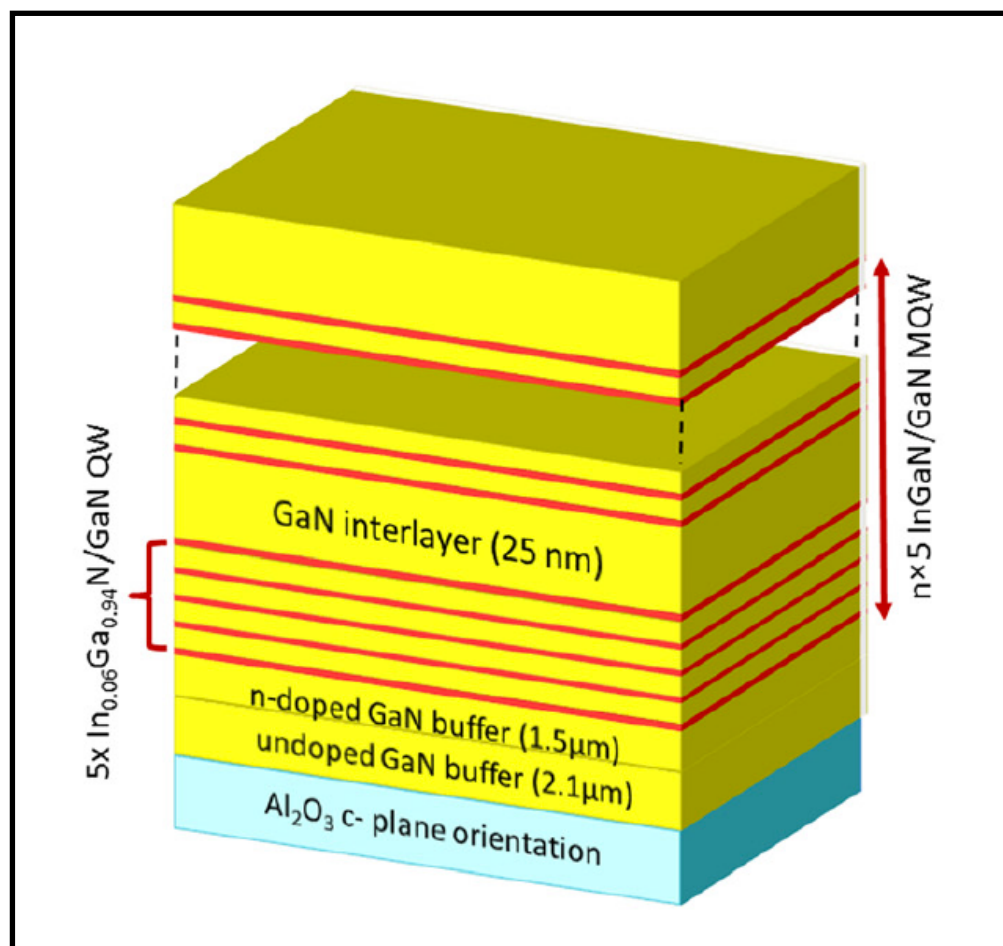
Experimental confirmation of energy leakage to the nano-phase



InGaN/GaN multi-quantum wells

In collaboration with Tomáš Hubáček@FZÚ, Prague

- Sub-1ns blue shifted decay component depends on the nanostructure thickness. For the fastest sample, the sub-1ns decay components represent the 50% of the emission.
- Delayed excitonic-related emission $\sim \mu\text{s}$.
- Silicon doping works as a solution to mitigate the defect band.

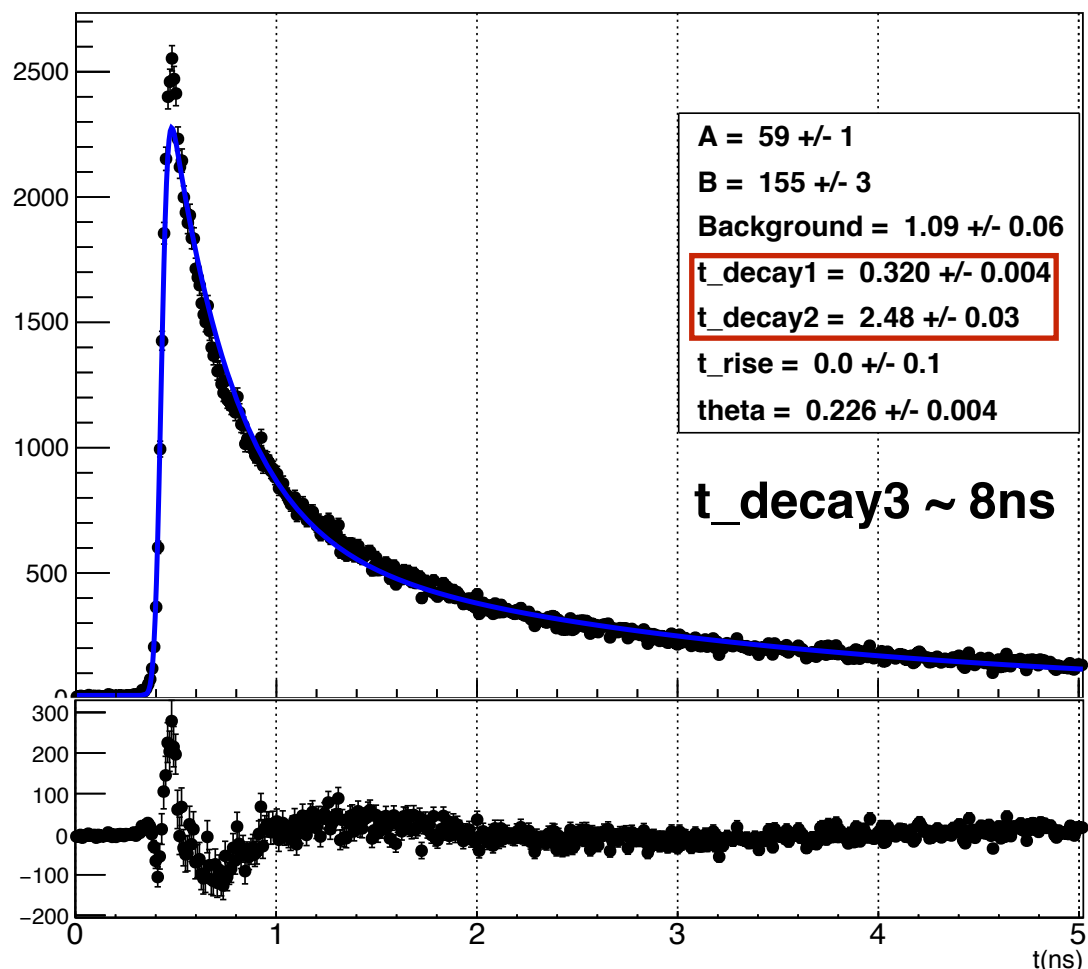


CsPbBr₃ perovskites, first characterisation using laser excitation

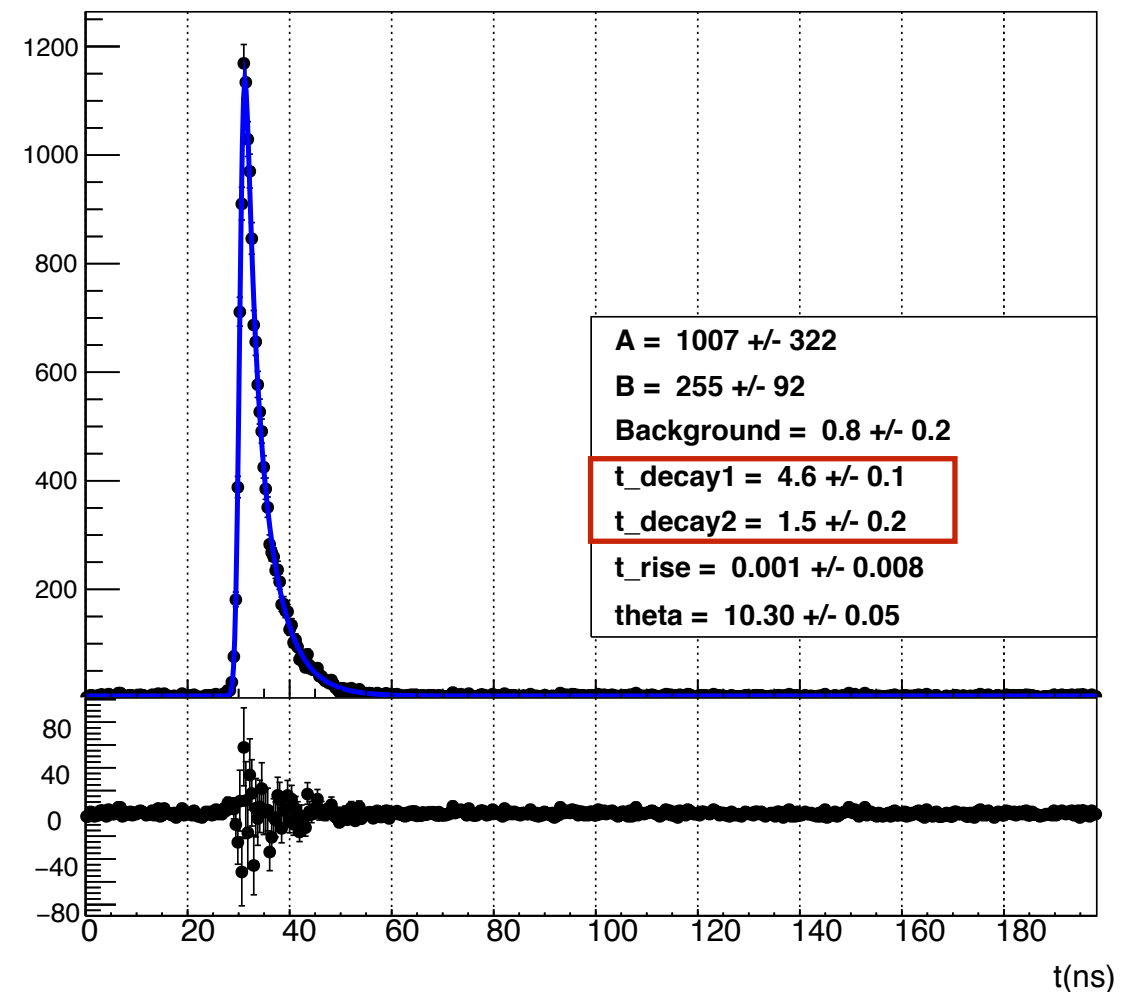
In collaboration with Czech Technical University in Prague



Blue emission

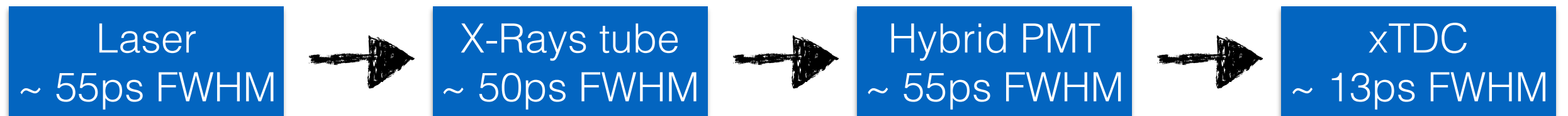


Green emission



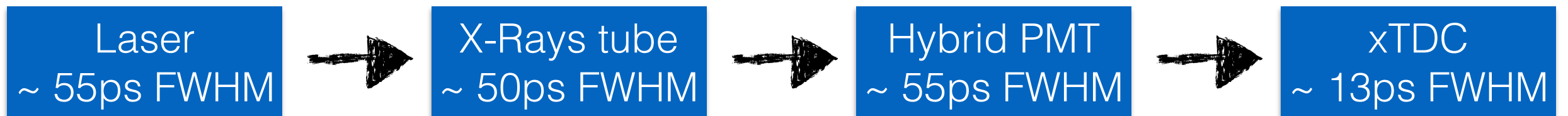
New TCSPC readout

In collaboration with Sergey Omelkov@Tartu University, Estonia

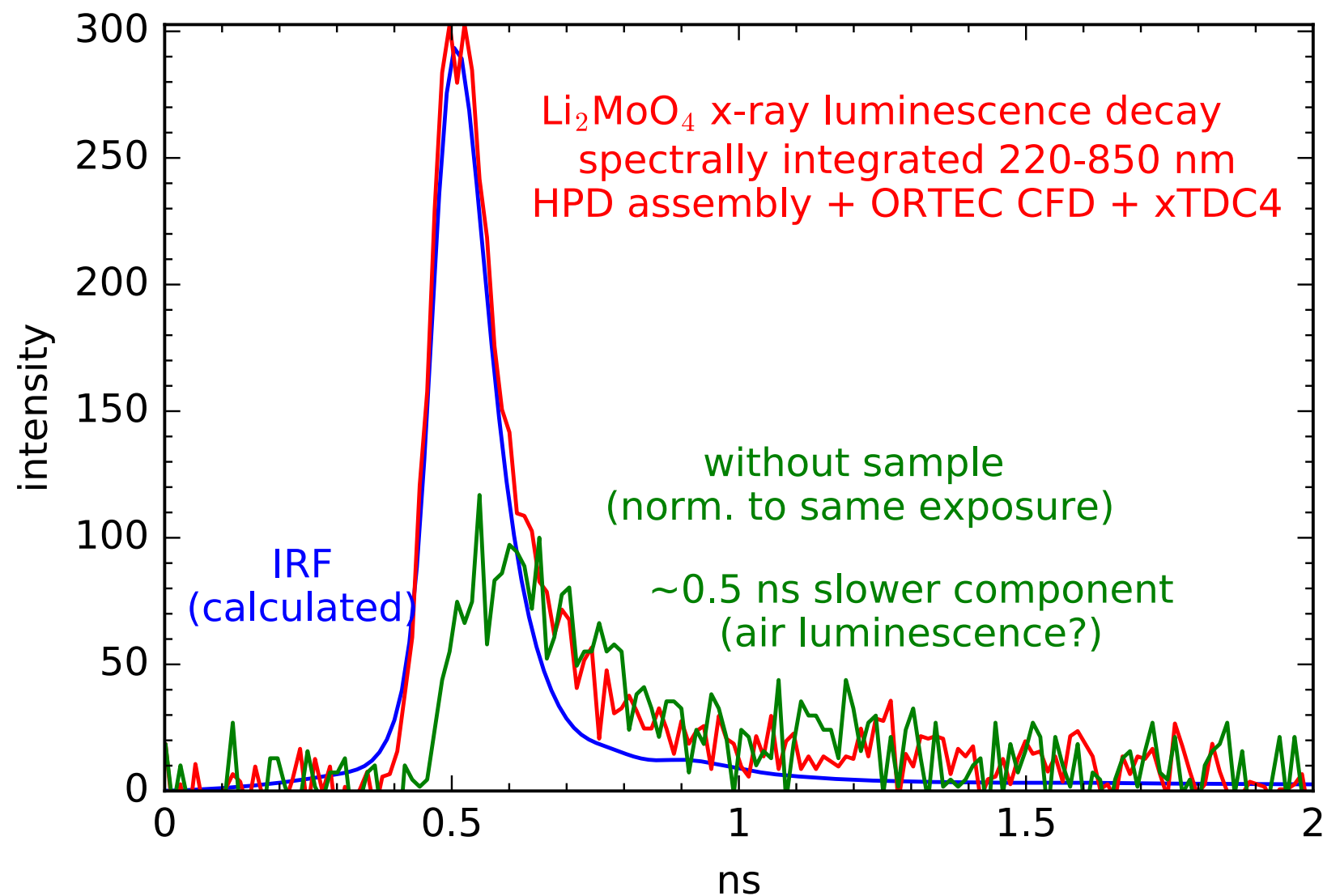


New TCSPC readout

In collaboration with Sergey Omelkov@Tartu University, Estonia

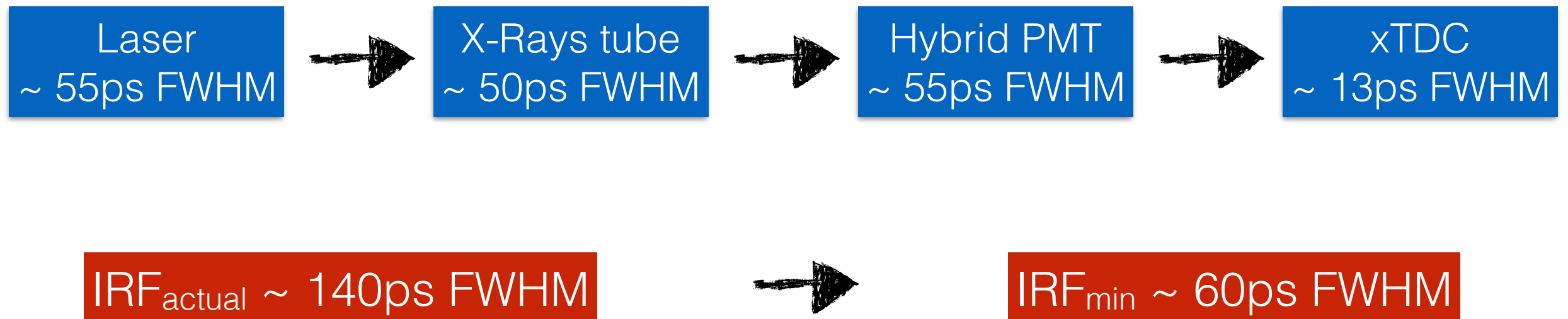


First experimental IBL confirmation with the TCSPC setup@CERN



New TCSPC readout

In collaboration with Sergey Omelkov@Tartu University, Estonia



- Fast characterisation of prompt/bright scintillating materials
- Allows for comparative light output studies from sample to sample if they maintain the same geometry/index of refraction/polishing state.
- Spectral resolution of the setup to be implemented.

Perspectives

- Optically “isolating” the nano-phase from the conventional scintillating material.
- Build a sampled pixel using ZnO:Ga and perovskites.
- Energy reconstruction algorithm for a sampled pixel with two active detectors.
- Finding an embedding procedure of nanocrystals in a host that allows for efficient non-radiative energy transfer between nanocrystals and matrix.
- Increase the thickness of the active layer in InGaN/GaN 2D nanostructures.