

Novel ultrafast halide nanoscintillators

Ascimat workshop

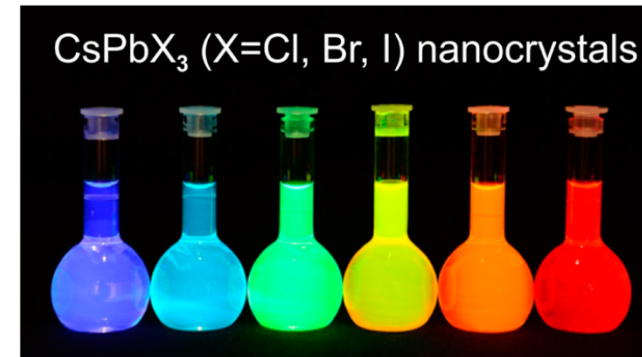
13th April 2018

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CsPbX₃ nanocrystals



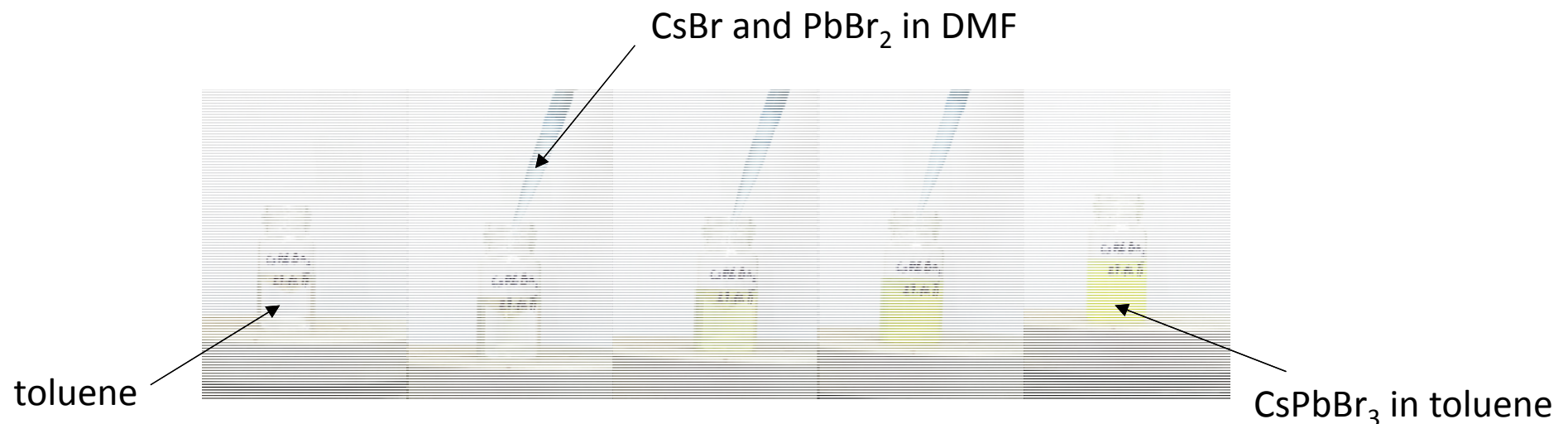
Protesescu et al., 2015

- X = Cl, Br, I
- Cubic perovskite crystal structure
- Excellent photoluminescence properties:
 - High quantum yield (up to 90 %)
 - Narrow emission line widths
 - Short radiative lifetimes (1 – 29 ns)
- Emission spectra are tunable over the entire visible spectral region
- Optoelectronic applications (LEDs, displays, photovoltaics)

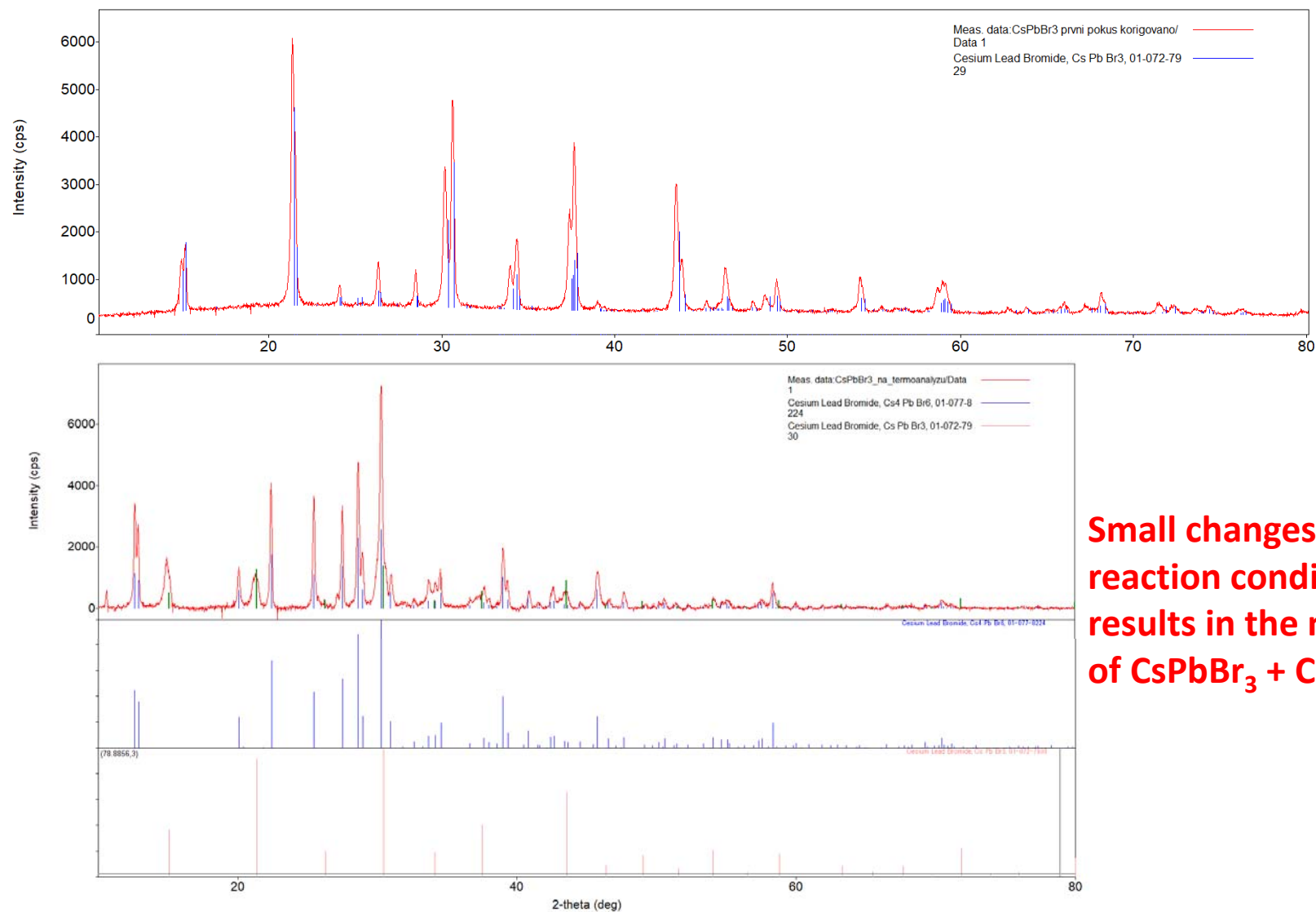
Ref.: L. Protesescu, et al., 2015, *Nano Lett.* **15**, 3692–3696, DOI: 10.1021/nl5048779

Method - CsPbBr_3

- Supersaturated recrystallization at room temperature (alternative to hot injection method) – Liu et al., 2016
- Solution of CsBr and PbBr_2 in DMF (dimethylformamide) with ligands (oleic acid, oleylamine) added dropwise into toluene

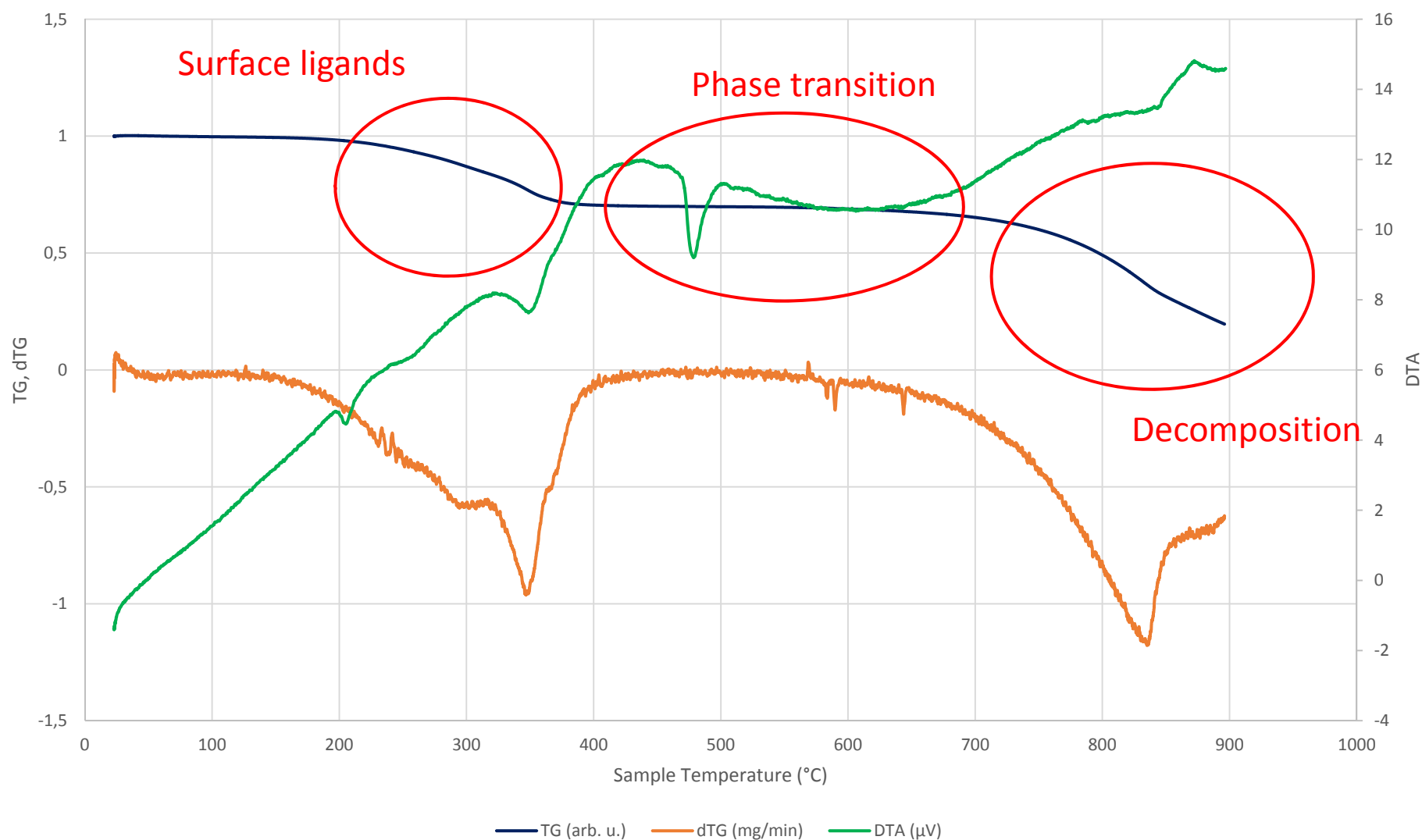


First experiments – results (XRD)



**Small changes in
reaction conditions
results in the mixture
of CsPbBr₃ + Cs₄PbBr₆**

First experiments – results (TG,DTA)



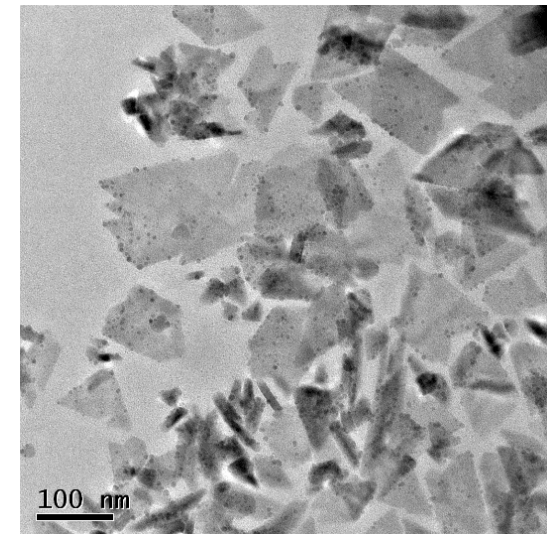
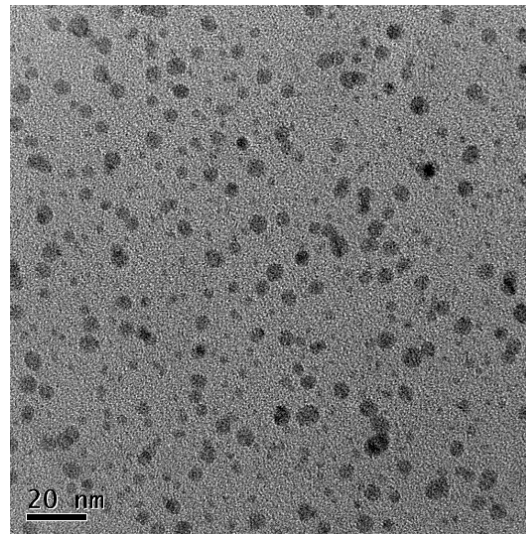
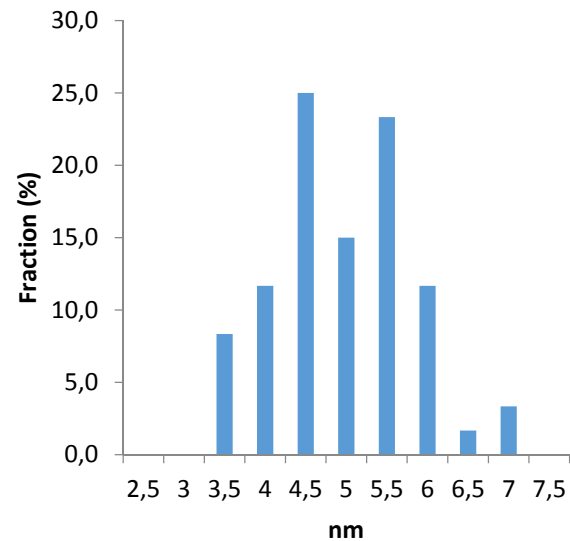
First experiments – results (TEM)

- Size distribution
- Bohr diameter ~ 7 nm

Colloidal part

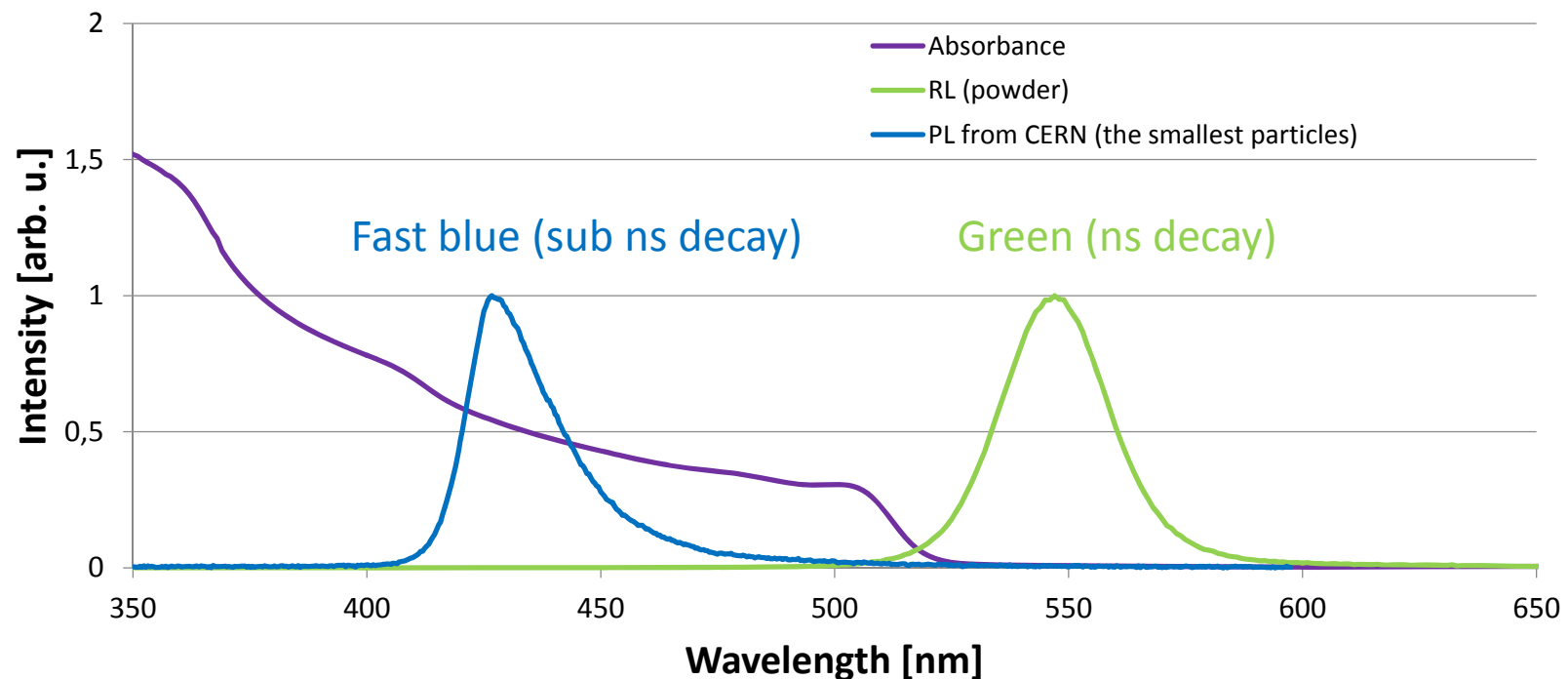


Mixed sample



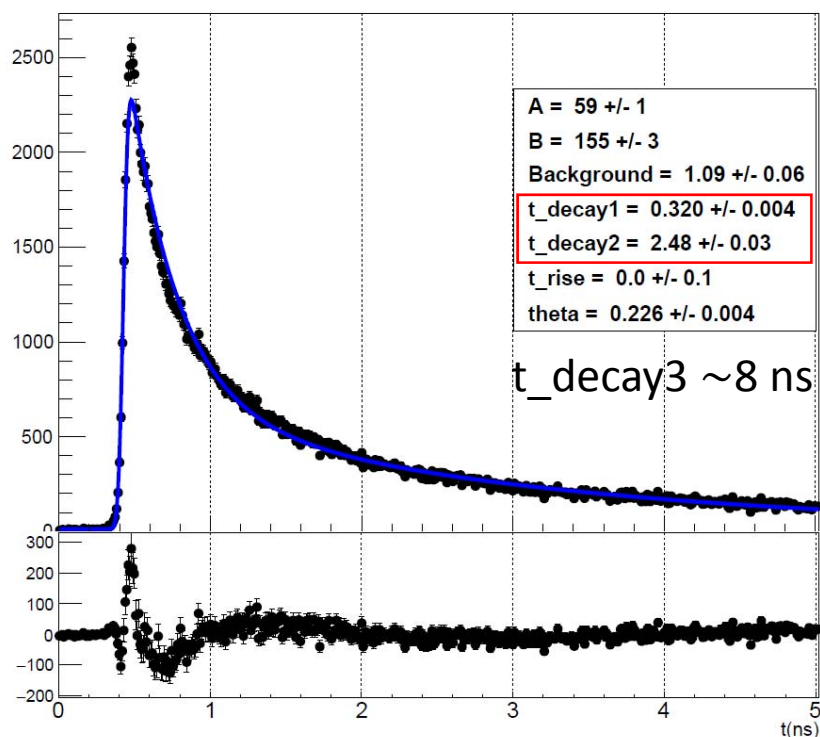
First experiments – results (RL, PL)

- PL was measured on a drop-casted film of the colloidal solution (the smallest particles)
- RL measured on the powder (the biggest particles) – setup for RL measurement of colloids is prepared for next samples

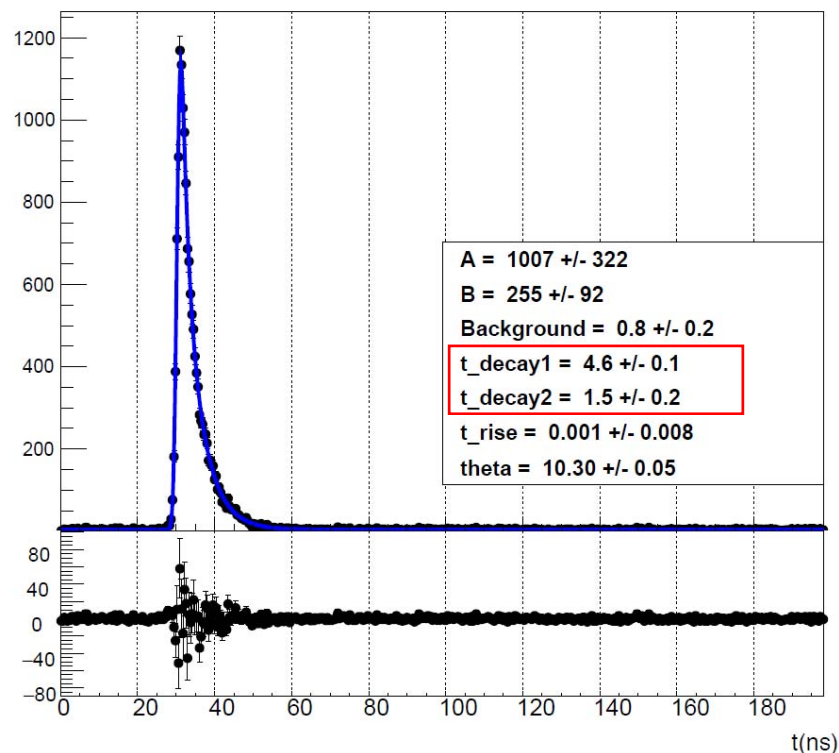


First experiments – results (PL decay)

- Photoluminescence under laser excitation (372 nm)
- Measured at CERN by Rosana Martinez Turtos
- Blue vs. green emission (blue: fast component – 320 ps!)



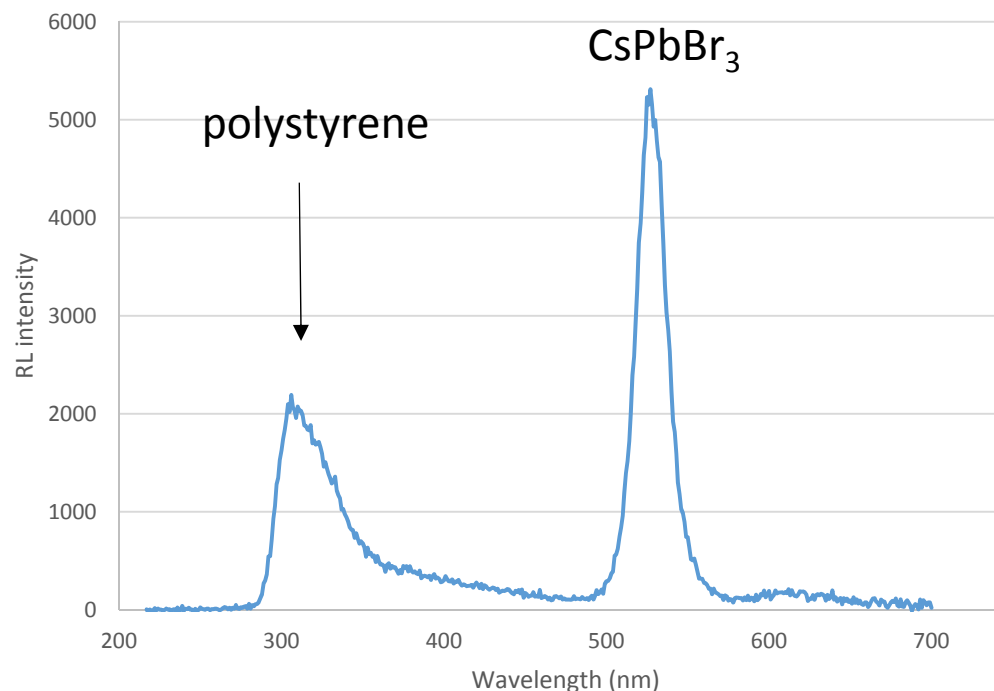
Blue



Green

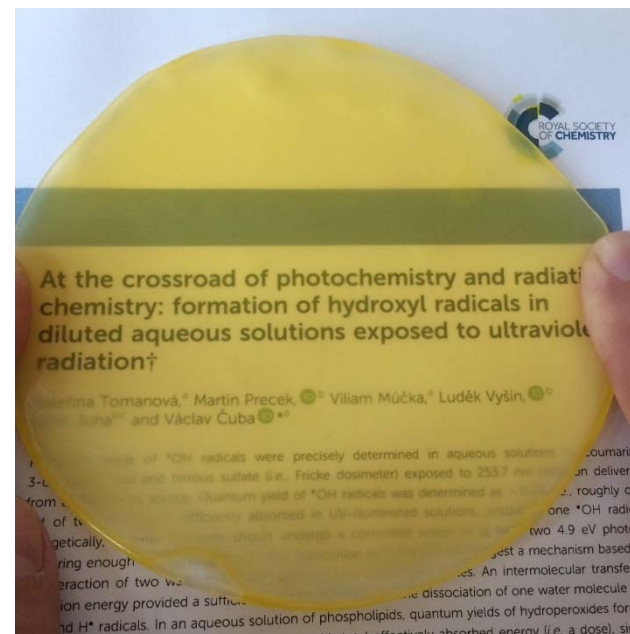
Embedding in polystyrene

- Embedding in polystyrene via polymerization of colloidal solution of CsPbBr_3 in styrene
- Stripping of surface ligands quenched the RL intensity
- PL decay times are a mixture of several components, 1.6 ns up to 450 ns (measured by Rosana Martinez Turtos at Lyon – ILM, Christoph Dujardin)

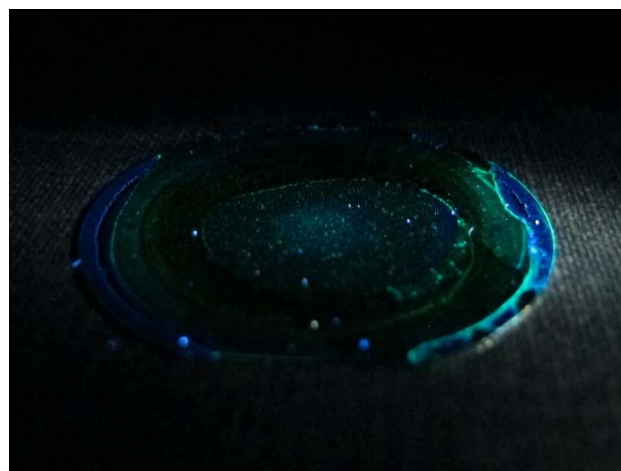


Outlooks

- Disadvantages:
 - CsPbBr_3 is soluble in water
 - Sensitive to air
 - Colloidal solution unstable
- How to solve them:
 - Core-shell – either silica coating or embedding in polymer matrix
 - Thin films



Mixed sample
embedded in polystyrene



Thin film
of the colloidal sample
(UV excitation)

Conclusions

- CsPbBr₃ are prospectively excellent nanoscintillators
- The fastest component has decay time of **320 ps** (first set of experiments)
- Next generation of samples – to concentrate on preparation of the blue emitting smallest particles
- After separation of the blue emission – stabilization of the particles (polystyrene, SiO₂ core-shell, thin films)