

Spettri di emissione, filtri e WLS

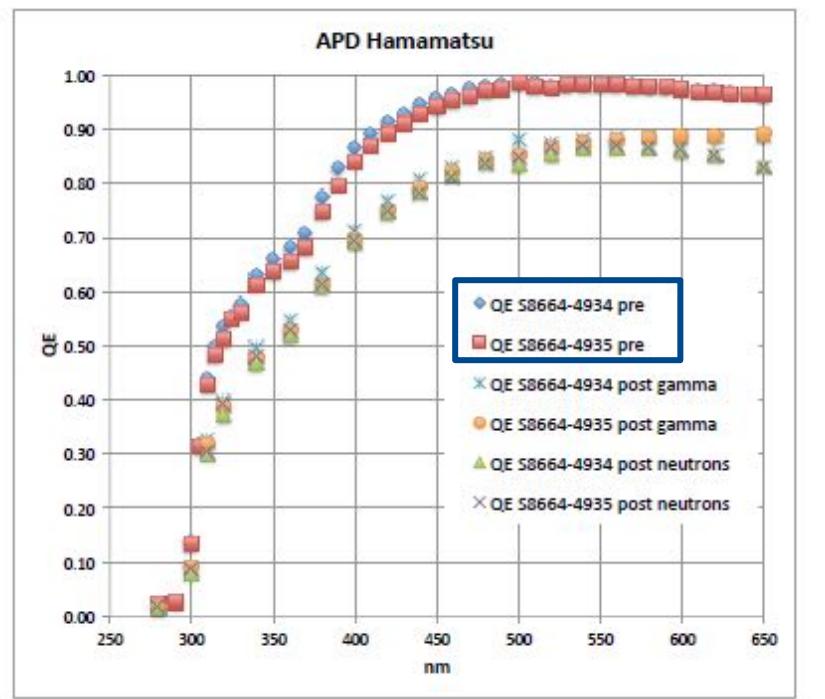
A. Rossi for the ECL group

Outline

- Studies on wavelength shifters to increase the light collection
 - Increase the S/N ratio
- Studies on the emission of the Pure CsI crystals
 - Optical properties
 - Time structure
- Optical filter to cut slow component(s)

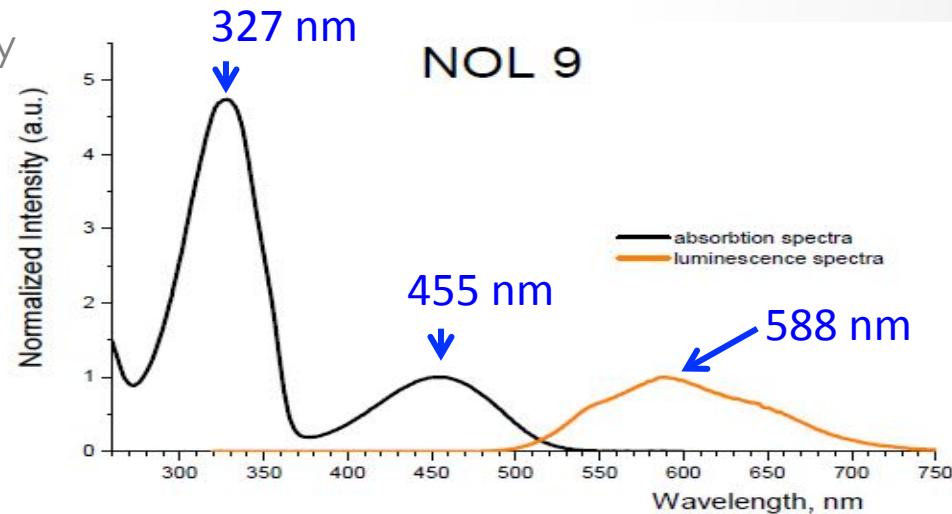
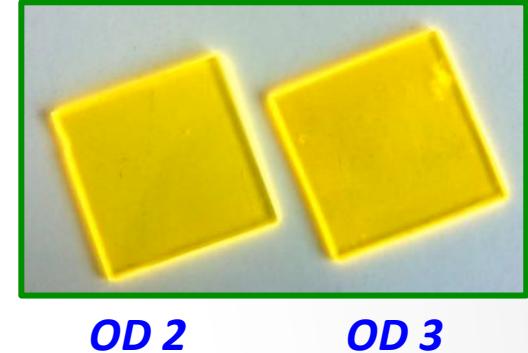
Wavelength shifter

- Pure CsI crystals have low light yield
- Fast emission on the 300/350 nm region
- Low APD QE on sub-400nm region
- Shift the fast component



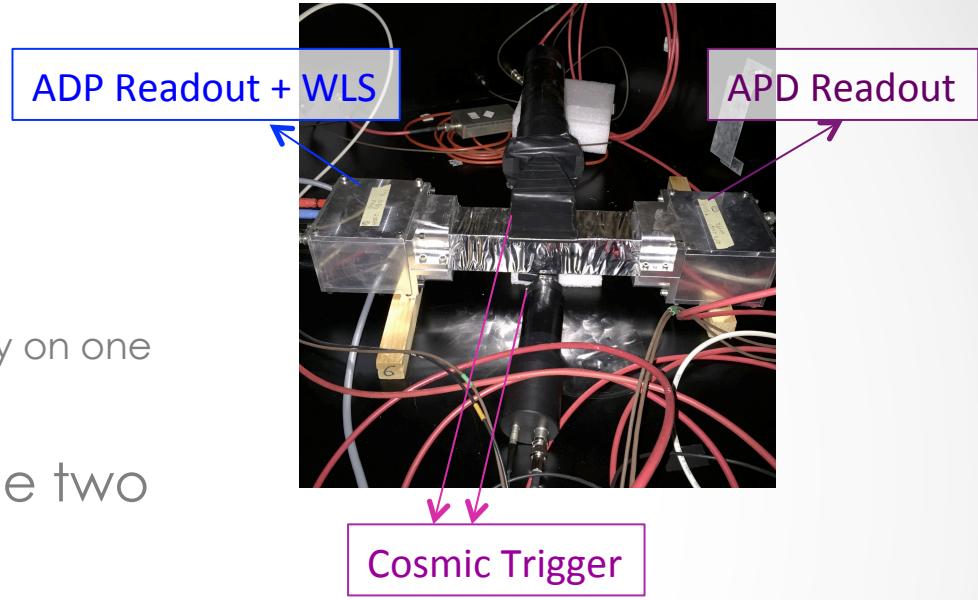
LumInno Tech. WLS

- Different type of Nanostructured Organosilicon Luminophores (NOLs) tested by Russian colleagues
- Best performance obtained with NOL9 sample
 - To be tested different optical density samples
- Shift to 588nm
 - APD QE @ 588nm ~95%

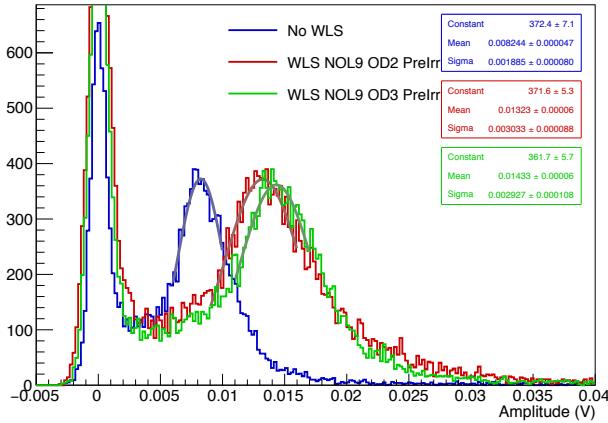


NOL9 test

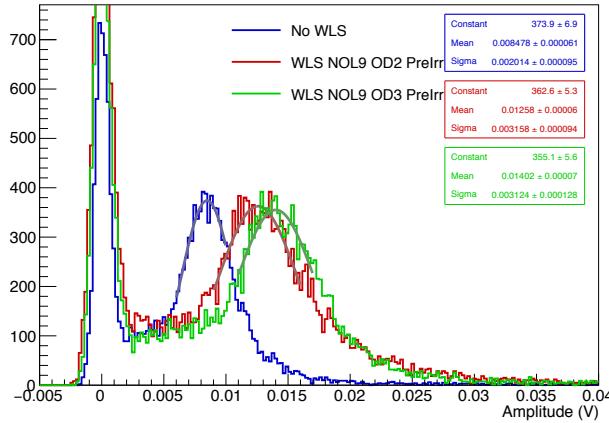
- Test WLS with cosmic rays
- Readout on both side
 - WLS only on one side
- Gain factor from WLS ~ 1.7
 - Can be higher with the readout only on one side
 - Russian group obtain a factor ~ 3
- Small difference between the two different optical density



Energy Distribution - APD 1

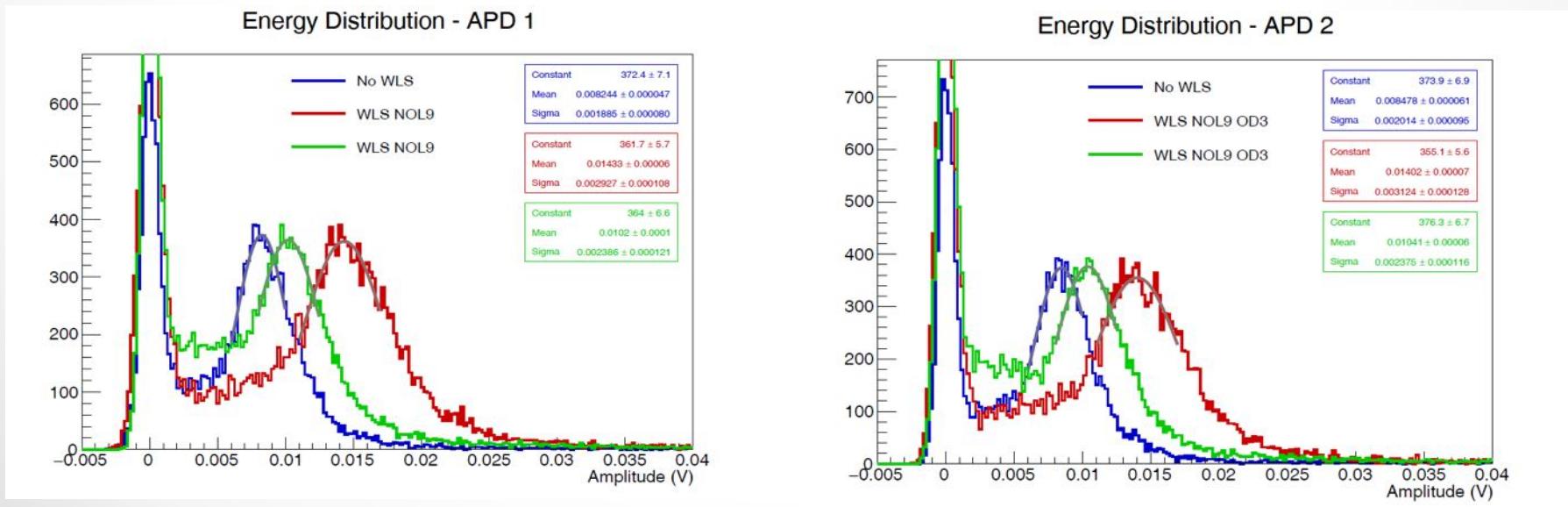


Energy Distribution - APD 2



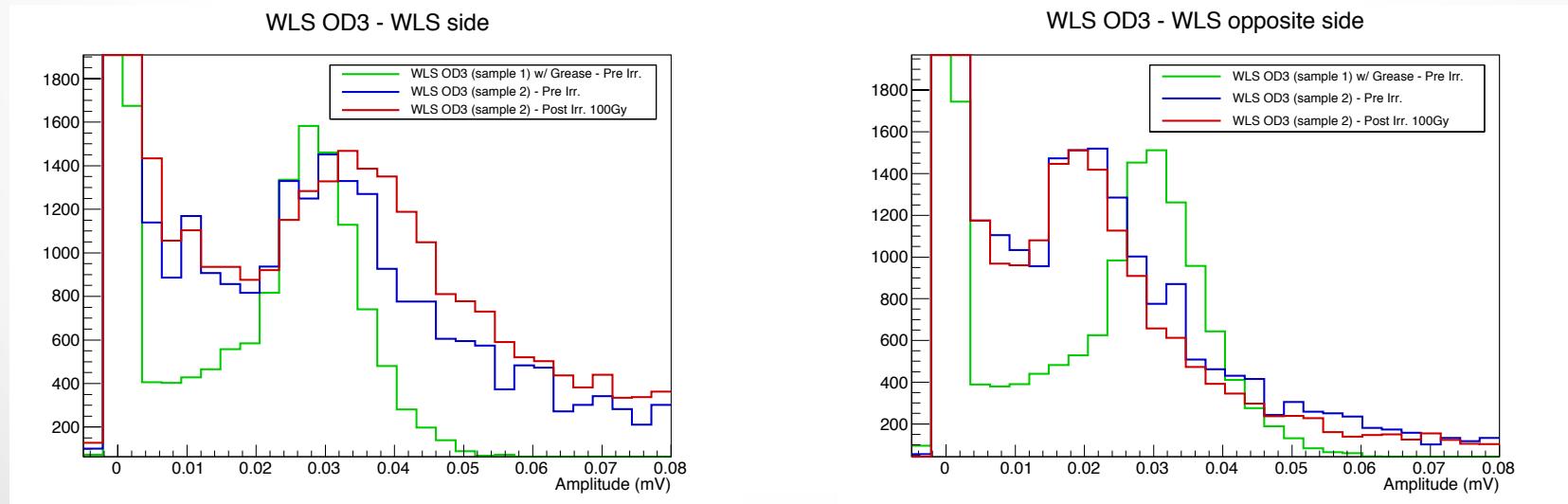
WLS stability

- NOLs WLS very delicate
 - After one use with optical grease they lost luminophores
 - Mechanically removed with optical grease
 - Lower gain (same effect observed by Russian)
- Absolut measurement of gain factor can be done only with brand new WLS

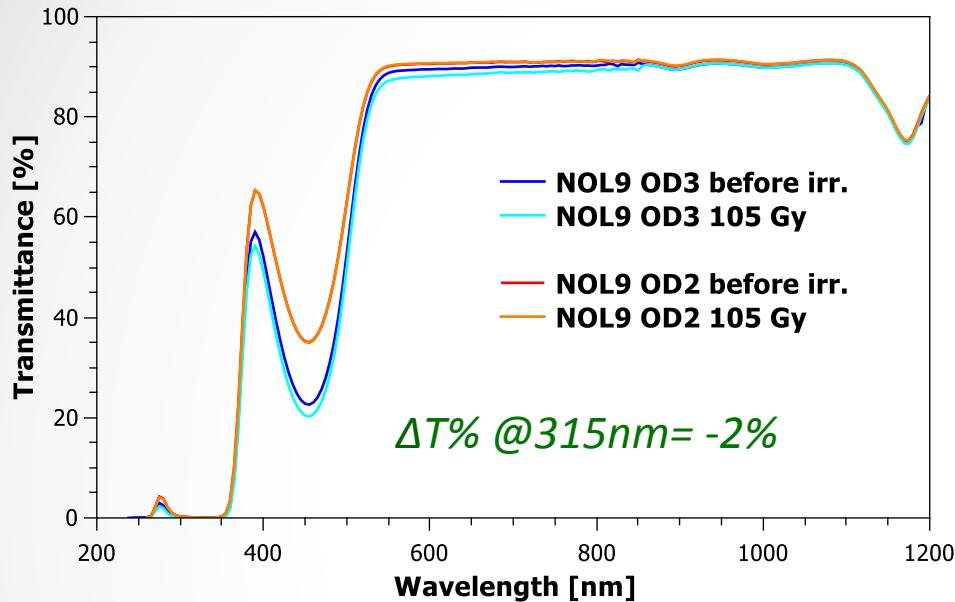


WLS Irradiation

- We tested the effect of gamma irradiation on WLS
- No optical grease used before and after irradiation in order to minimize the deterioration of the WLS
- WLS irradiated with $\sim 105\text{Gy}$ ($\times 2$ 10 years of BelleII operation)
- No deterioration has been observed

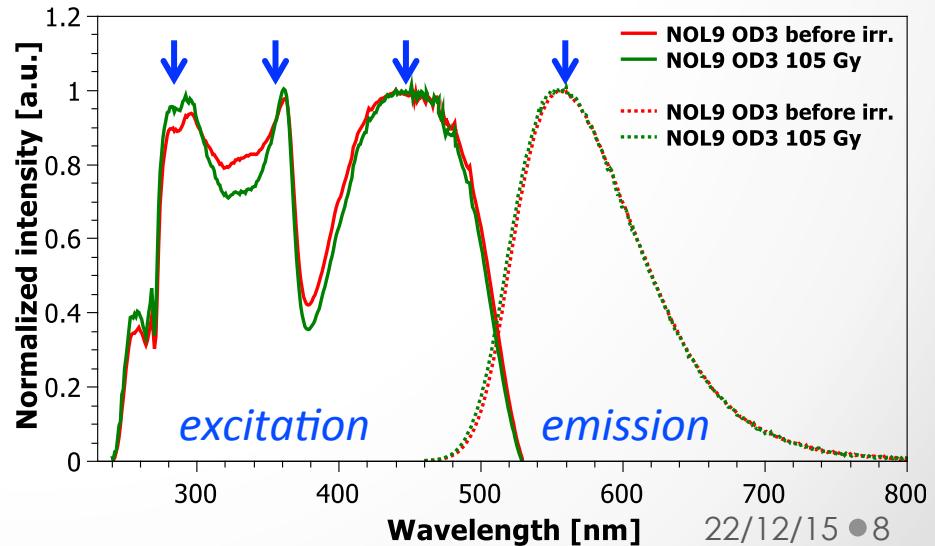


WLS Optical characterization

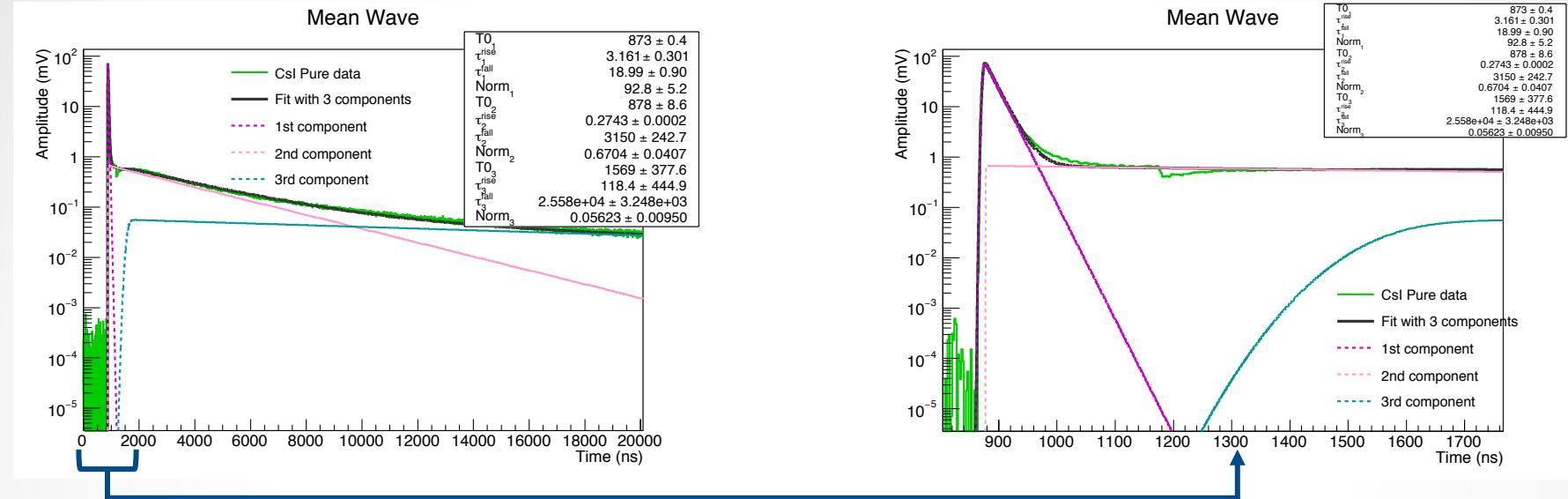


- Slight %T decrease for NOL9 OD3 after 105 Gy

- No irradiation effects on the excitation/emission peaks positions (up to 105 Gy)



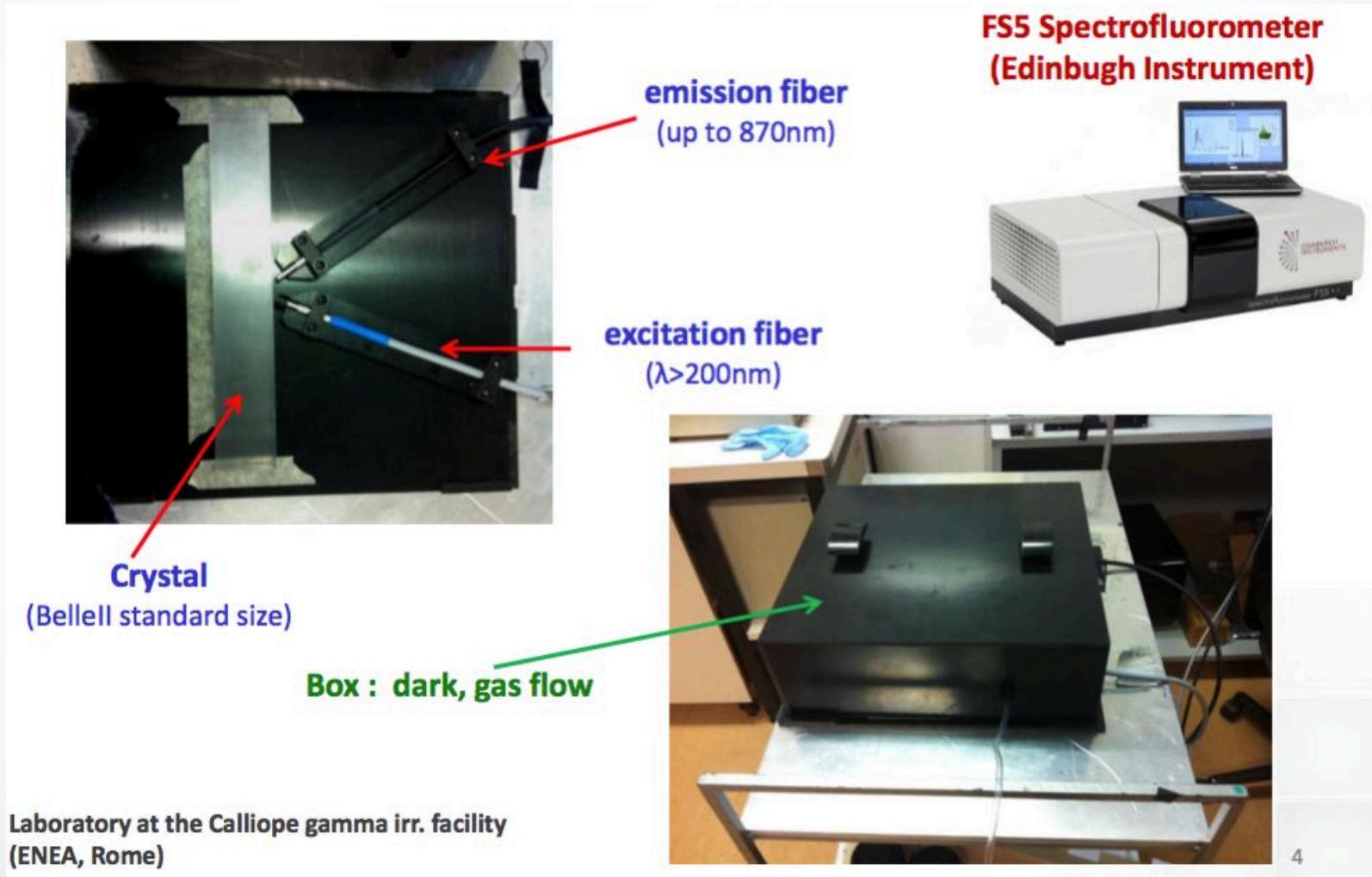
Studies on Pure CsI emission



- Crystal readout with standard PMT
 - Different QE wrt APD so ration between components are not the same as for APD
- 3 main components
 - Fast : ~20ns
 - Slow1 : ~3100ns
 - Slow2 : ~25 μ s
- Ratio between components 0.33/0.33/0.33 (with PMT)
- Slow components have a big impact on pileup
- A. Rossi - 4th Belle2 Italia meeting

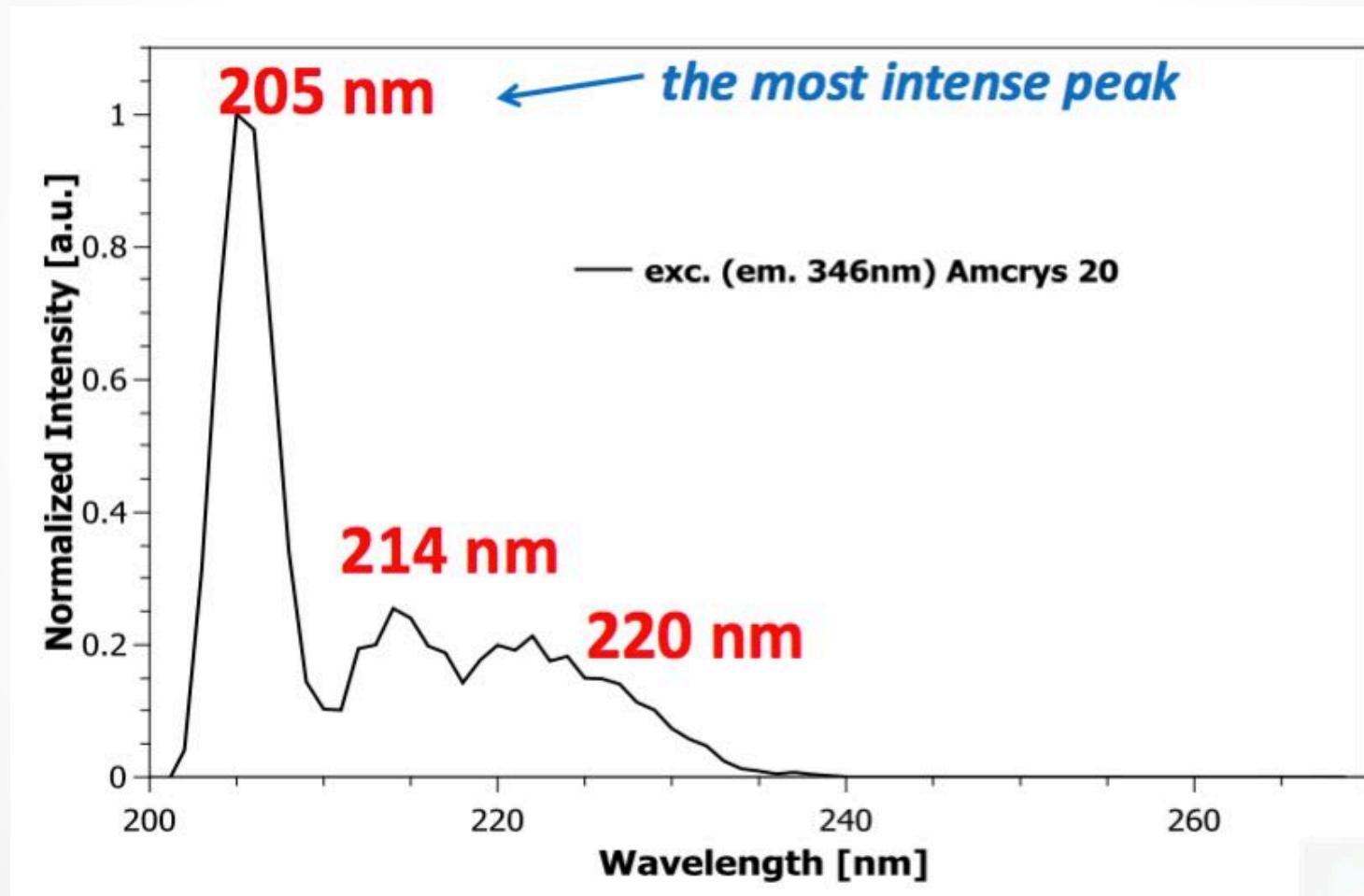
Photoluminescence measurement on Pure CsI

- Setup for Pure CsI excitation and emission spectra



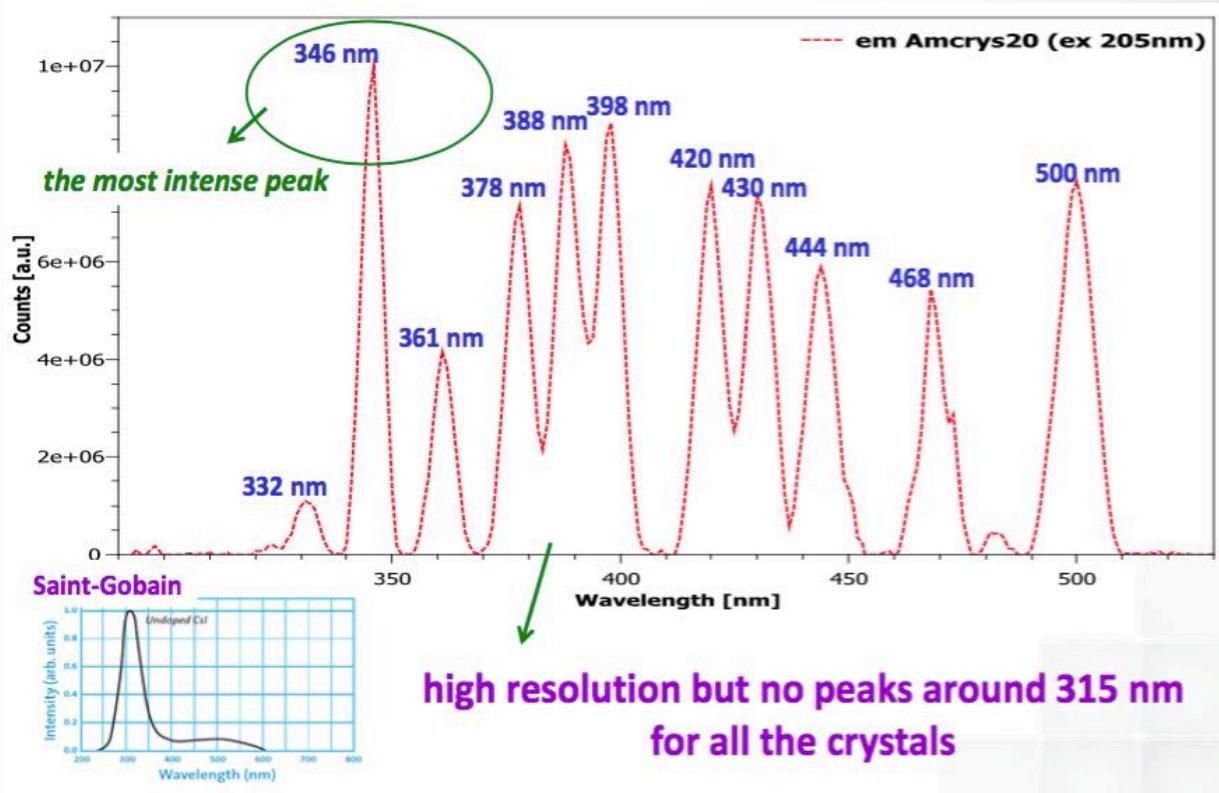
Excitation Spectrum

- Excitation spectrum of Pure CsI crystals



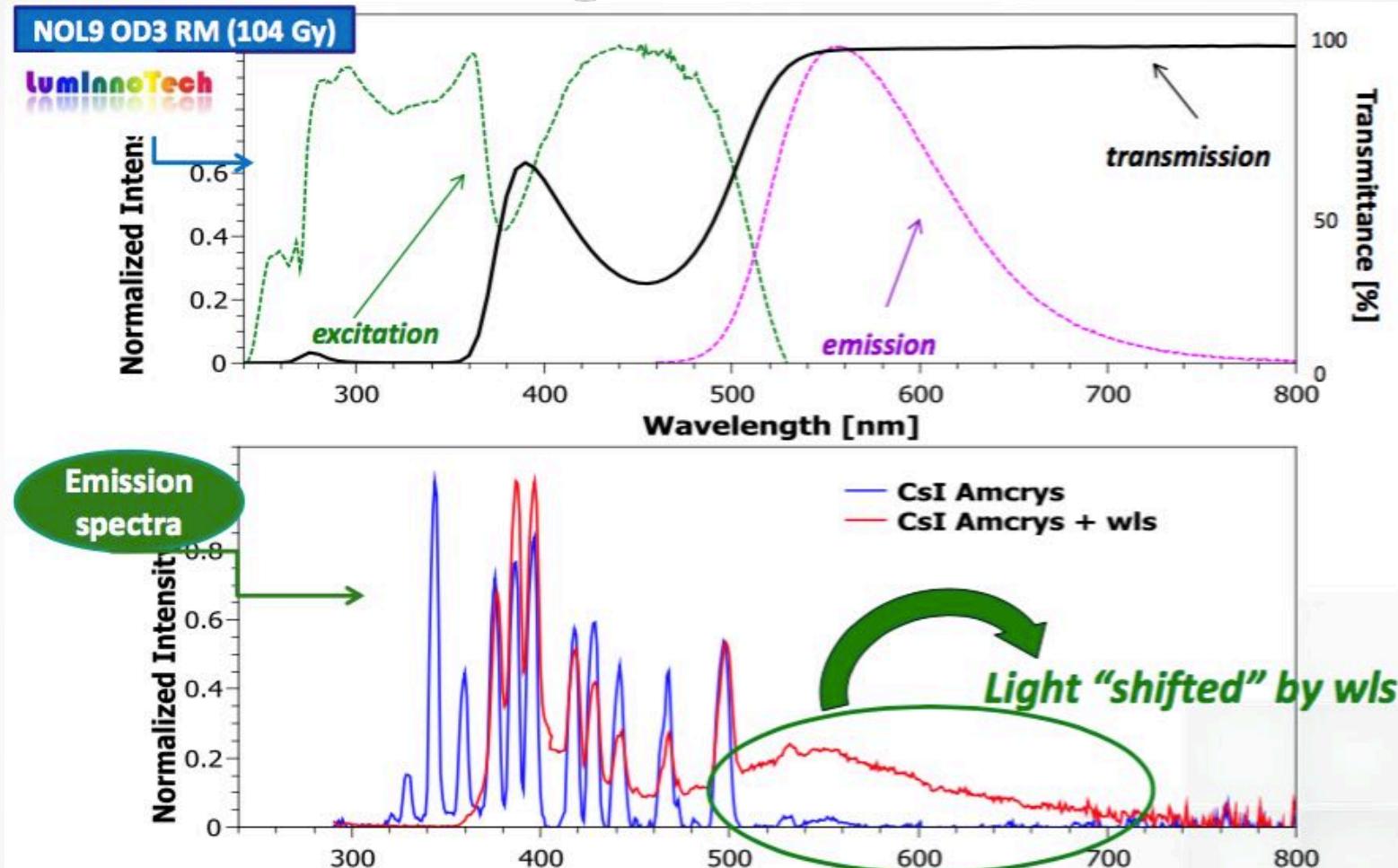
Emission Spectrum

- Emission spectrum shows multiple structure
- No peak at 315nm as expected
- This can be due to the materials and technique used for crystal growing



With actual instrument we can't measured the time constant of each emission peak

WLS effect on emission spectrum

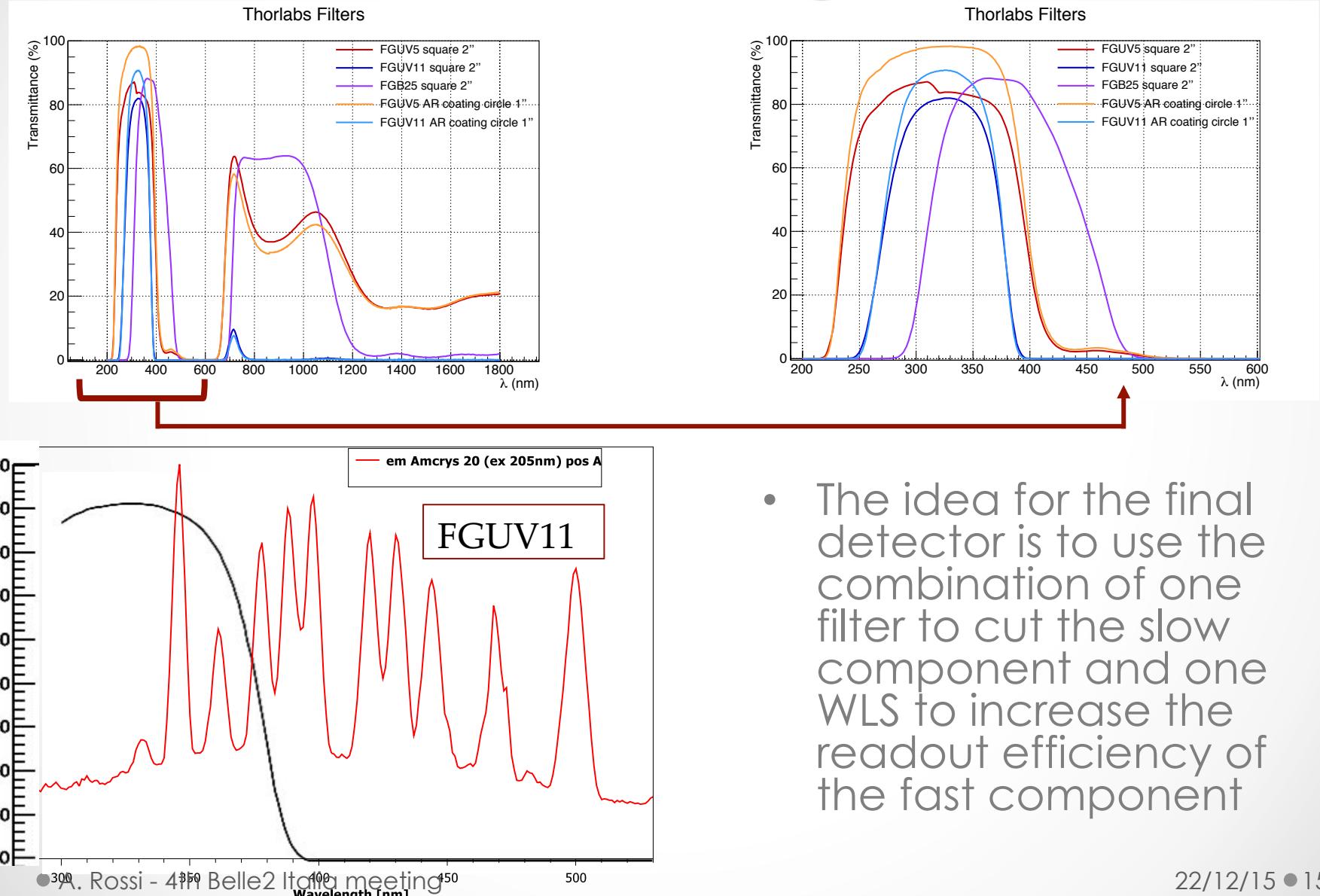


- Almost all light emitted below 370nm shifted to higher wavelength

Filter

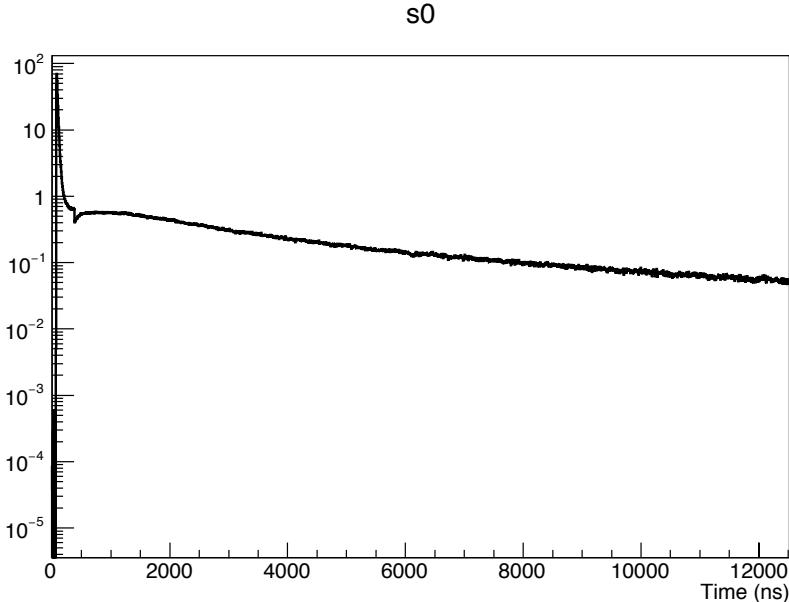
- In order to remove slow components we can use optical filter
- To do that we need to understand which wavelength correspond to the fast emission of the crystal (the one we want to use)
- No instrument available to perform this measurement
- Possible solution:
 - Use different filter to select different regions of the emission spectrum and compare the time structure of the signal with PMT readout

Filter examples

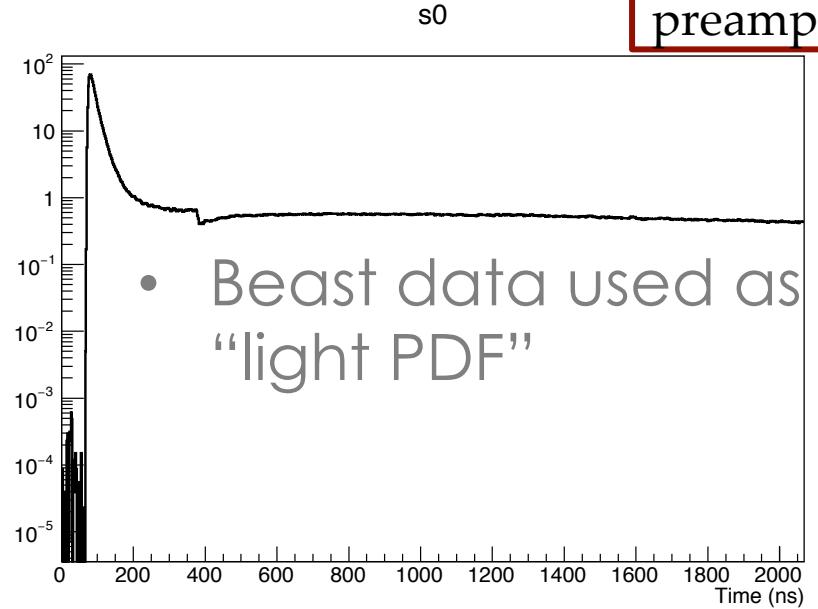
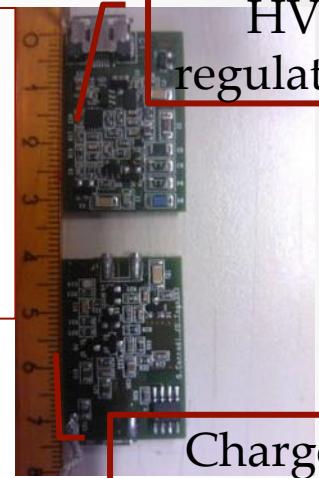


Studies on fast electronics

- Studies on the custom readout electronics
- Main purpose
 - Understand how to correctly put the electronic inside the BelleII simulation
 - We have to start from crystal light output or we can sum the output signal of the preamp

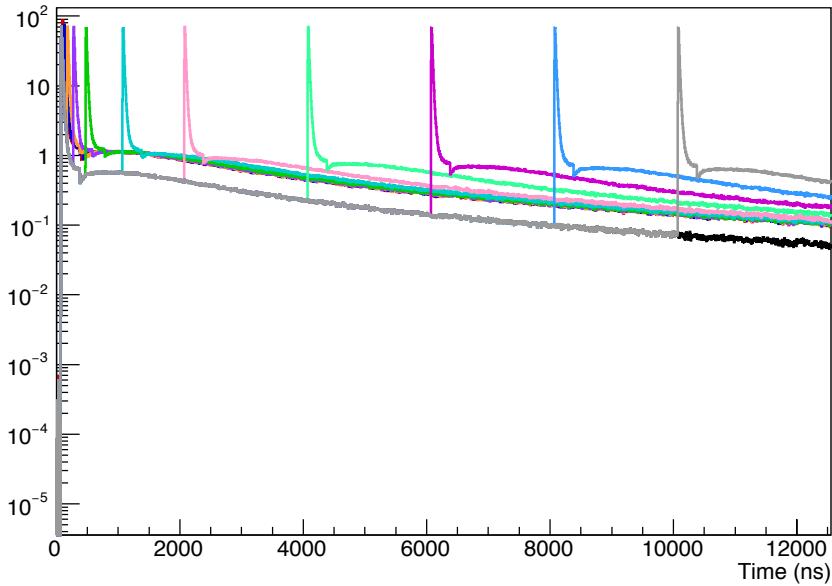


Charge – Preamplifier
Custom discrete
amplifier at BJT
transistor.
Gain = 1.4V/pC
Dynamic Range 2.2V
 $\text{Tau IN} = 40\text{ns}$



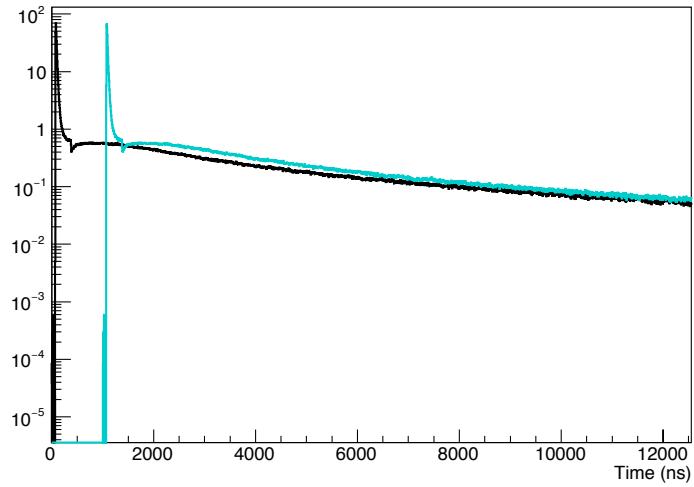
Light Sum

s0



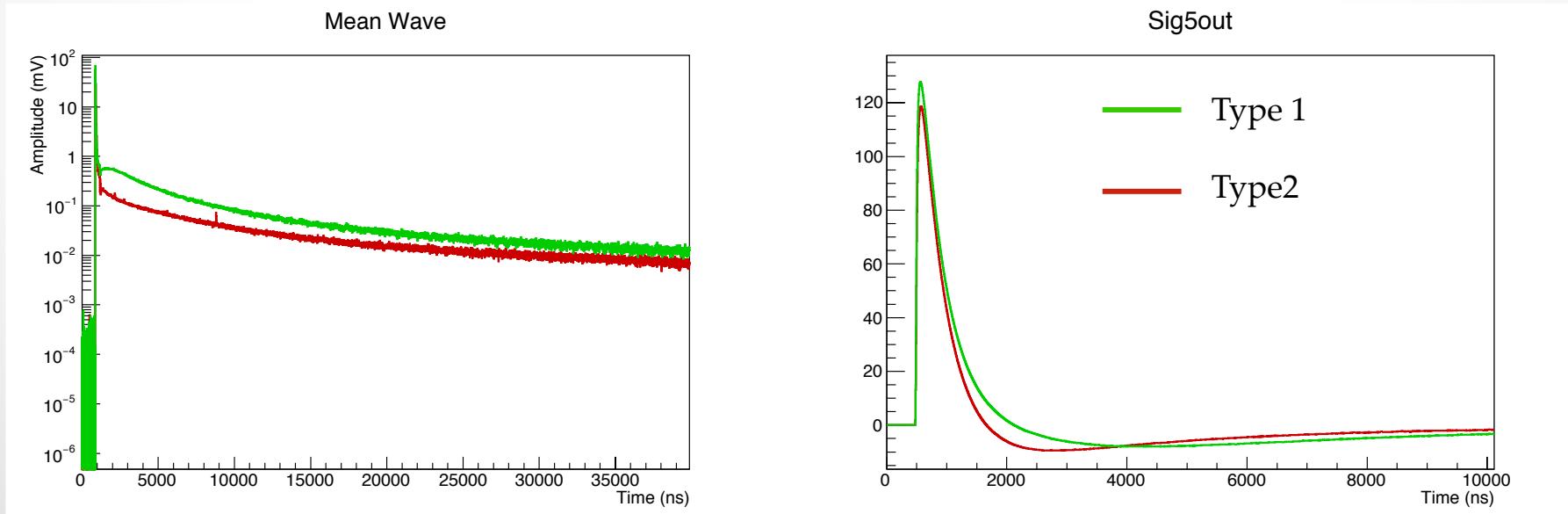
- Sum 2 identical signal at different DeltaT

s0

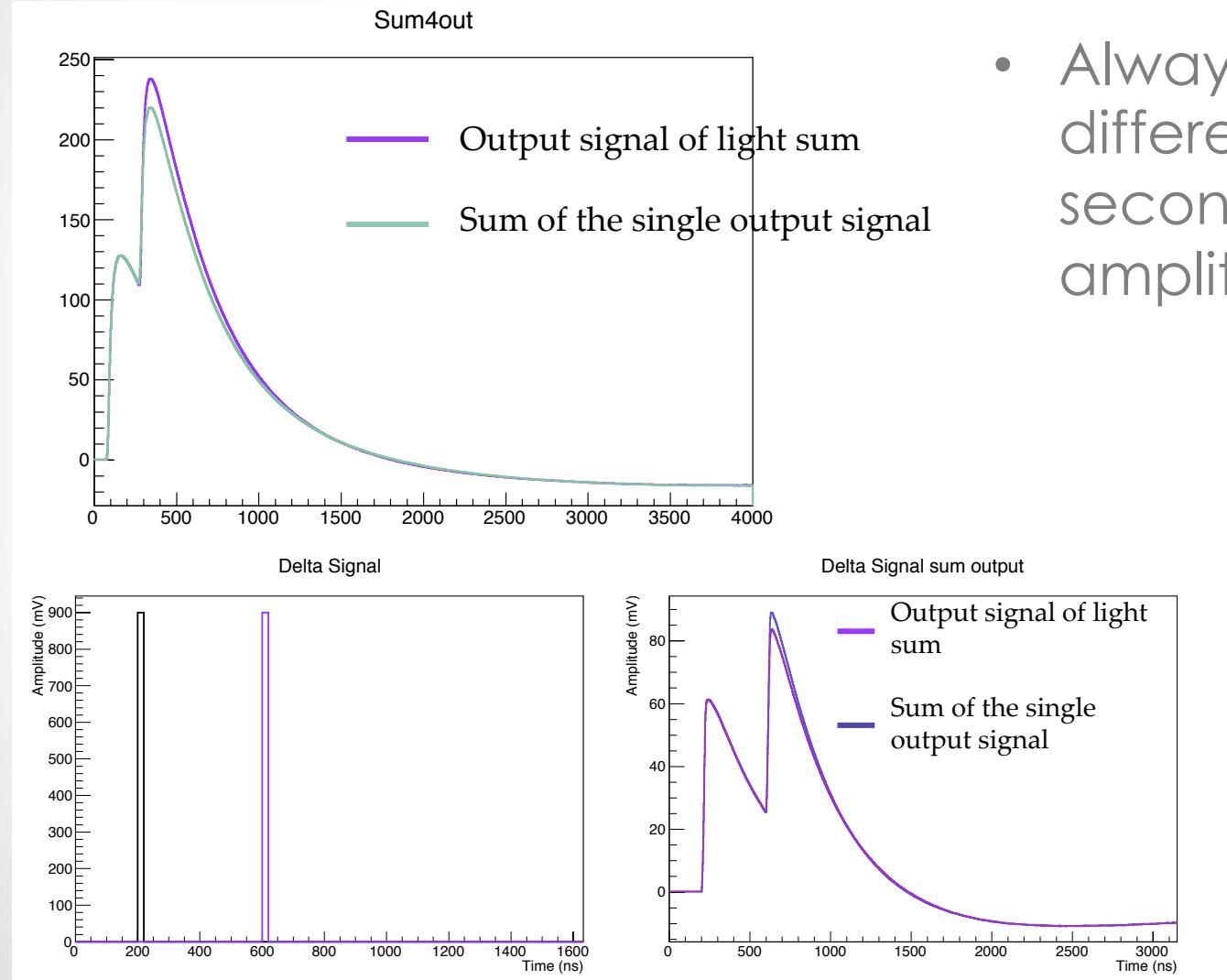


Electronic simulation

- Simulation with spice
 - Simulate Preamp output with light summed
 - Simulate Preamp output of single light events with different T0
 - Comparison between the two results

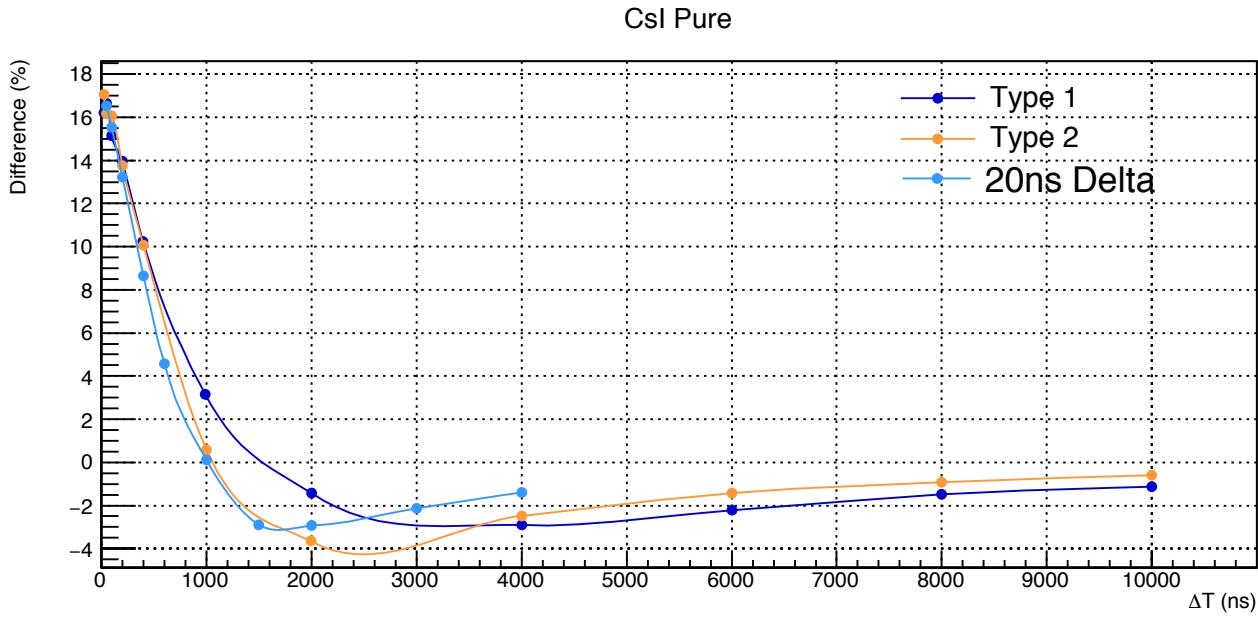


Coparison



- Always a difference on the secondo peak amplitude
- Same test repeated with delta function as input
 - No pileup
- About the same behavior

Difference vs DeltaT



- Reflect output signal shape
- Studies are going on to understand the source of this behavior
 - Test bench to perform the same studies with HW

Conclusions

- Shifting the crystal emission wavelength from 340nm to 580nm give a significant increase on the S/N ration ($\sim \times 3$)
- NOLs WLS from LumInno Tech. have good performance
 - Very delicate. Use with optical grease degrade the performance.
- Emission/Excitation spectra of Pure CsI
 - Difference with the expected emission spectrum
 - No emission at 315nm, smallest WL 346nm
- CsI emission with 3 different time constants
 - 20ns, 3100ns and $25\mu s$
- Slow components have a big impact on pileup
- Optical Filters can be used to study the time constant of each emission peak and to cut the slow components before the WLS.