GSO study at low temperature in Pisa

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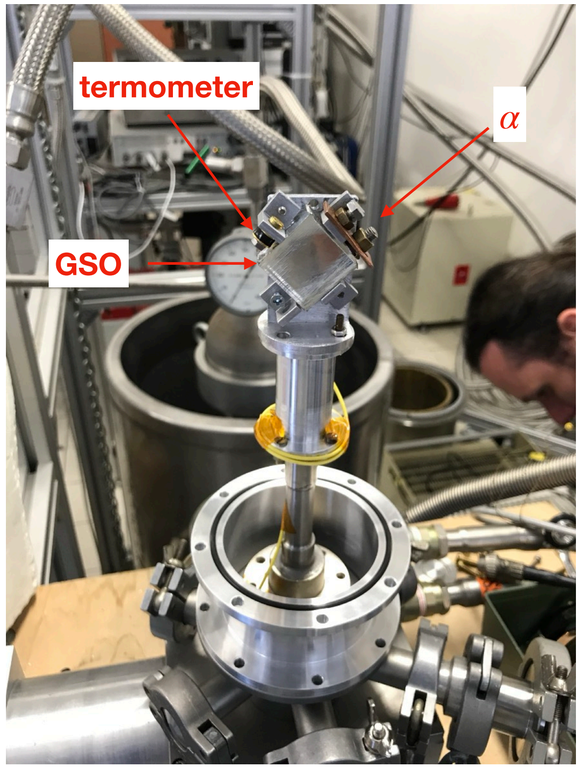
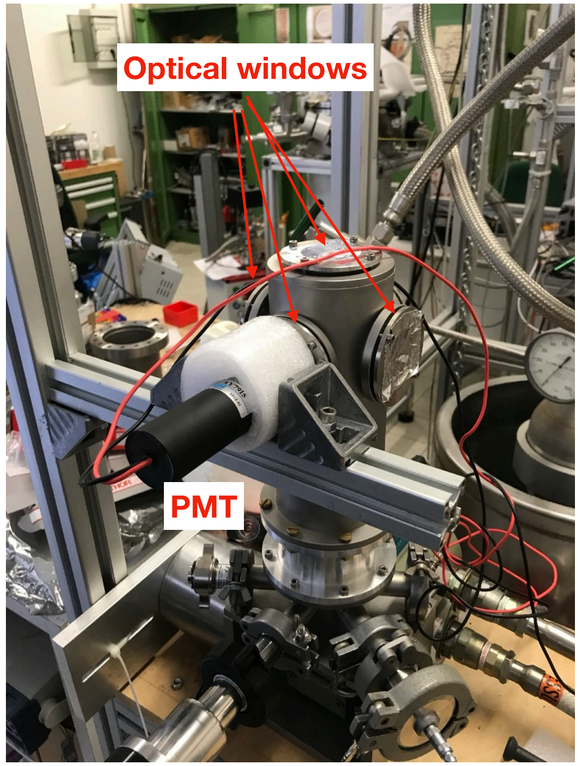
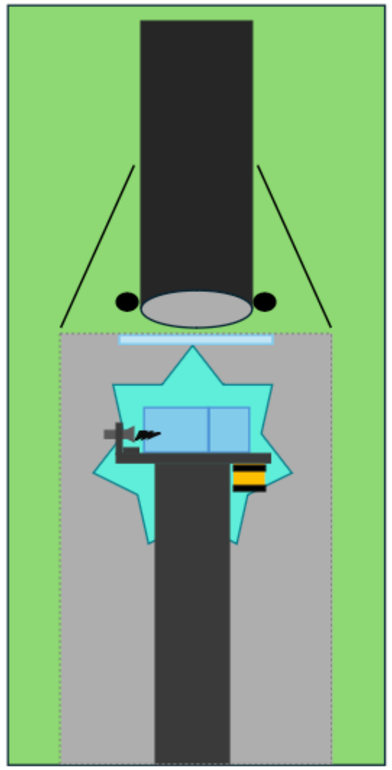
Tommaso Lari
tommaso.lari@phd.unipi.it

Characterization with Am source

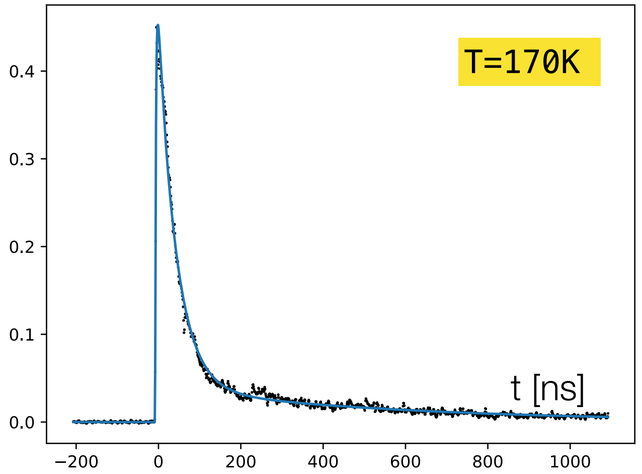
- Measurement of light yield and pulse shape of GSO stimulating the crystal with an α source.
  - Set-up :
    1. Small cryostat with optical windows and base temperature of 20 K.
    2. GSO stimulated with ^{241}Am α source (5.4 MeV α) placed close to the crystal.
    3. GSO light read out by a PMT placed outside the cryostat.
    4. PMT signal recorded with oscilloscope and analyzed with a MCA.







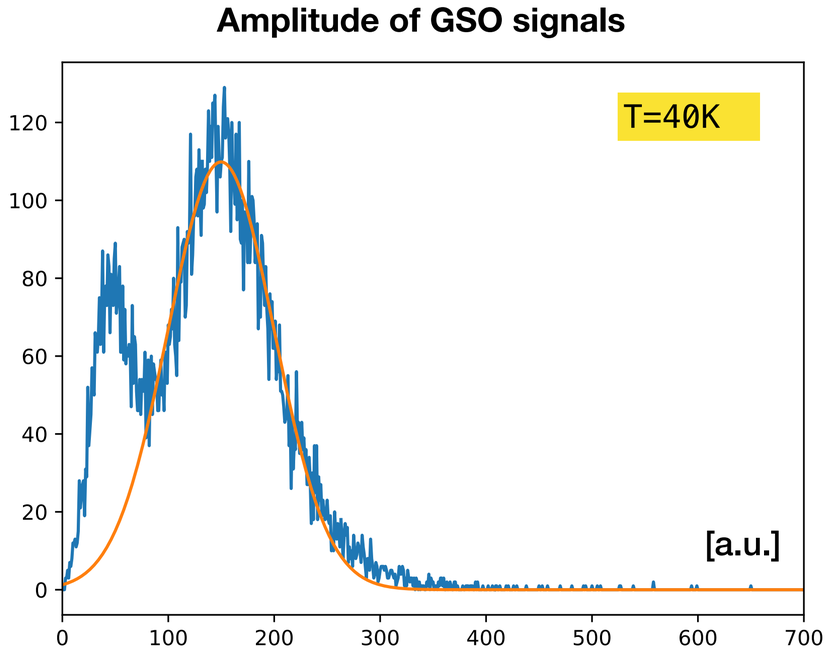
GSO scintillation signal

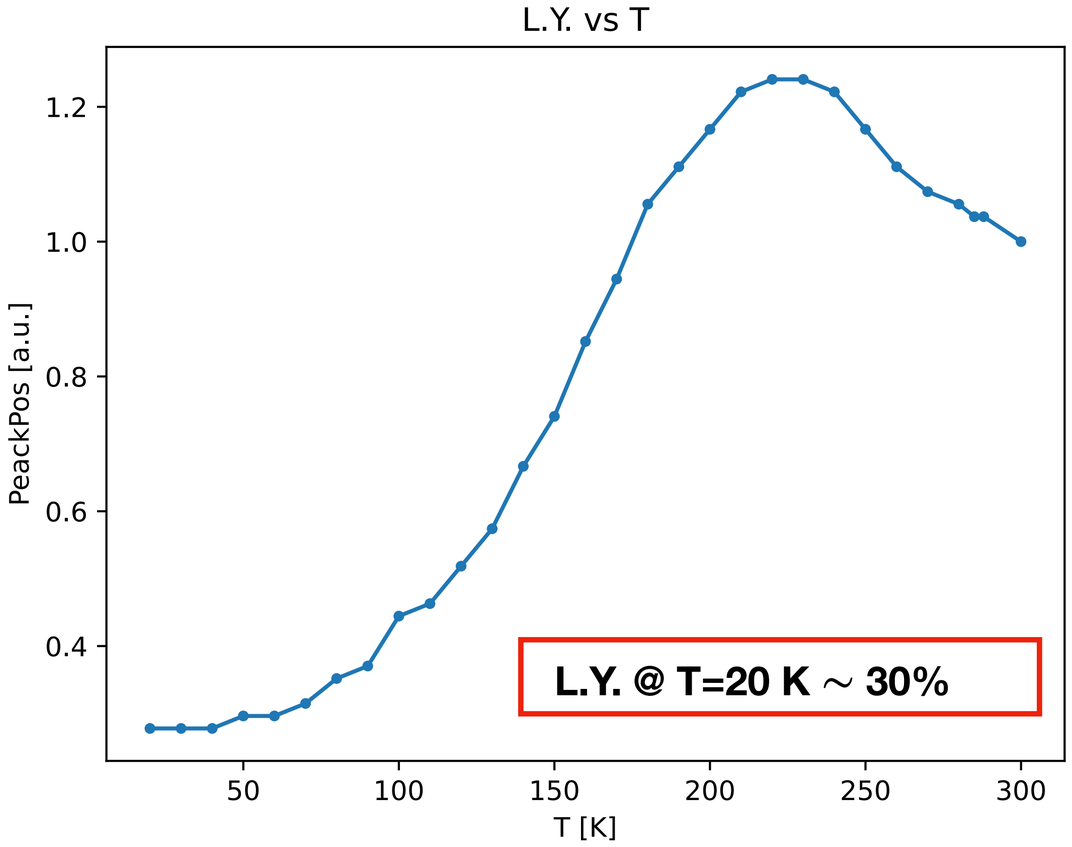


(Picture of preliminary tests. Actually the Crystal and the PMT have been moved to use the top window which allows a better light collection)

Characterization with Am source: Light Yield

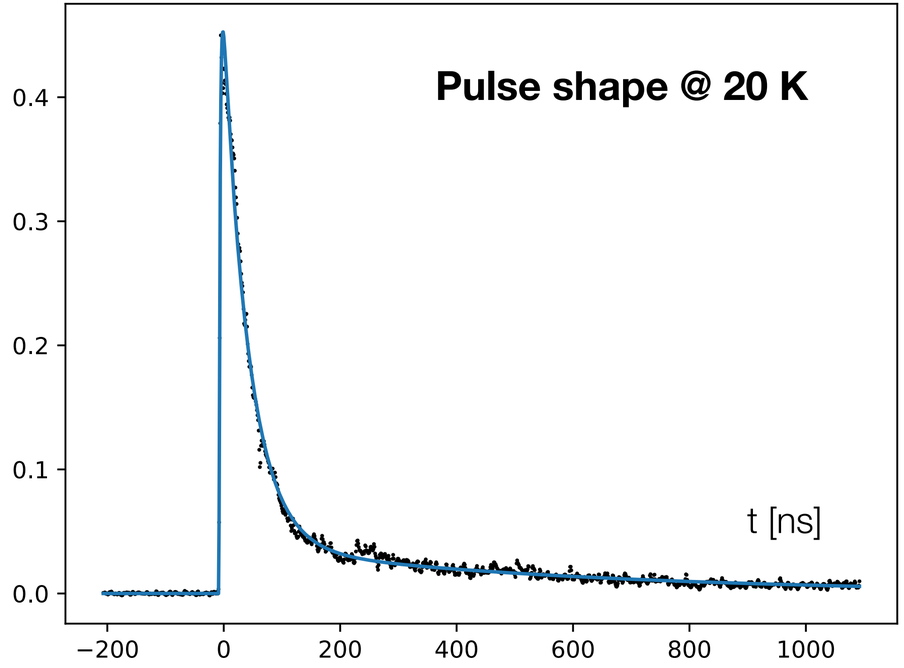
1.Spectrum of GSO signal amplitudes measured using MCA
2.Fit with a gaussian function to the alpha peack to estimate its central value.
3.Procedure repeated varying the temperature 20K - 300 K
4.Relative Light Yield: L.Y.= peack mean (T)/peak mean (T=300K)

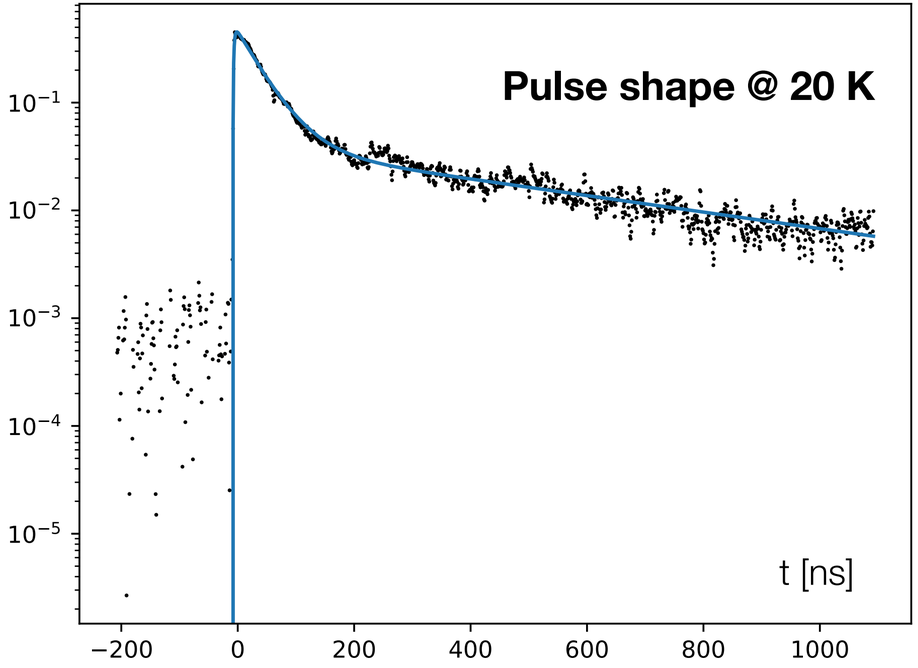




Characterization with Am source: Pulse shape

1. Average of $\sim 250 - 350$ signals.
2. Fit using two exponential decay component function.
3. Amplitudes and time constant of the fast and slow component as a function of temperature (very preliminary results).





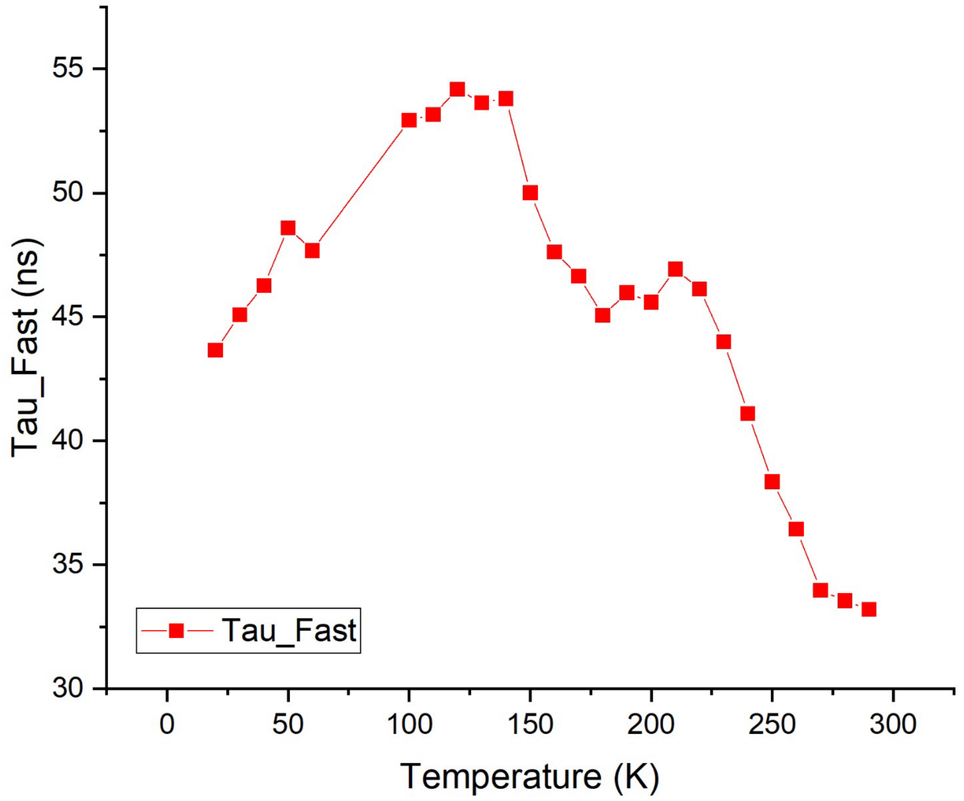
$$f(t) = \theta(t - t_0)\left[a_1 e^{-(t-t_0)/\tau_1} + a_2 e^{-(t-t_0)/\tau_2} - (a_1 + a_2) e^{(t-t_0)/\tau_3}\right]$$

T=20K

Fast component:	Slow component:
tau1 [ns]= 43.66 ± 0.35	tau2 [ns]= 567 ± 2
a1 = (92.6±0.5)%	a2 = (7.30±0.20)%

Characterization with Am source: Pulse shape

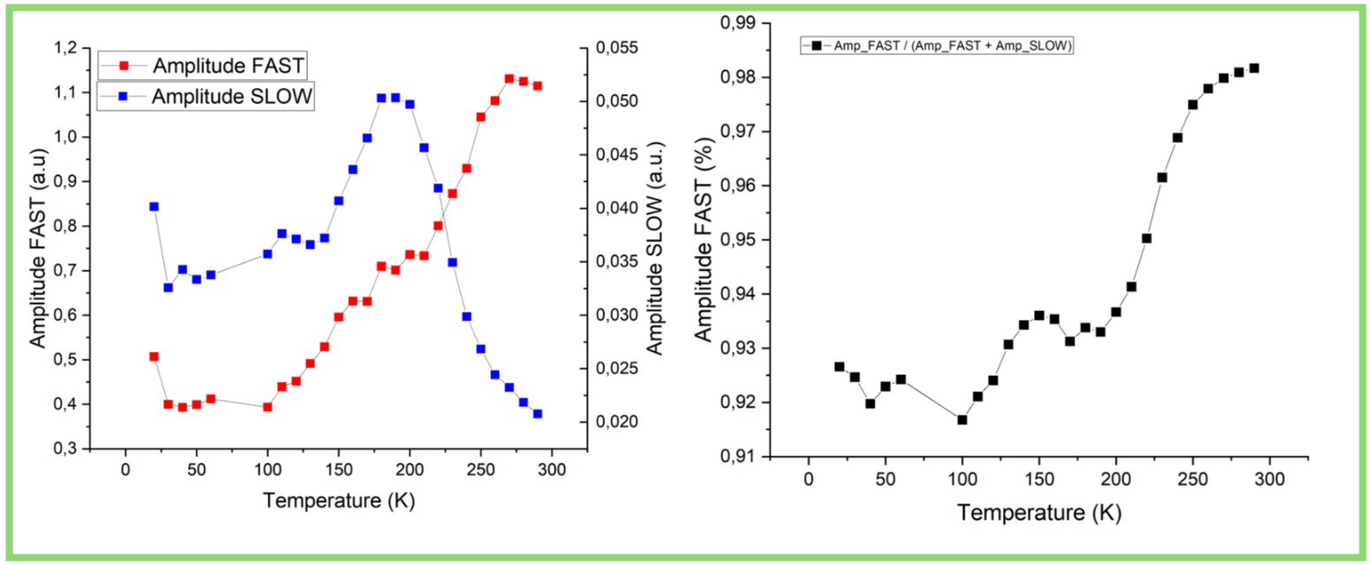
Decay Time constant of Fast component



Amplitude of fast and slow component

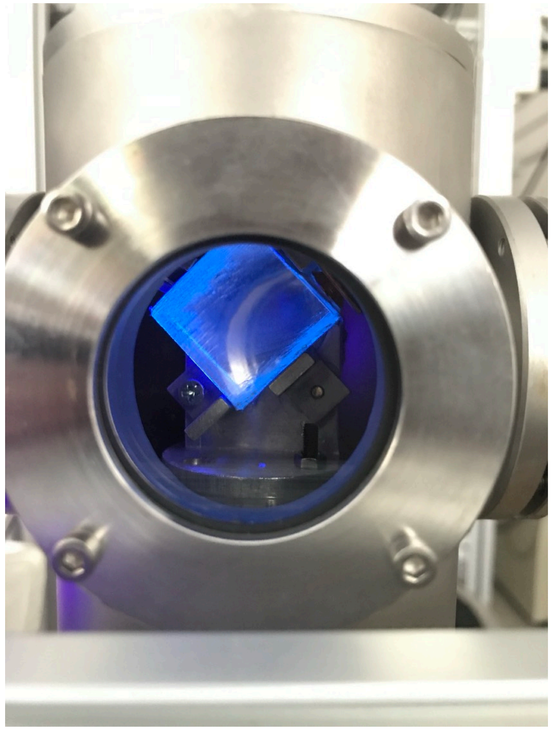
Pulse analysis: two components

Fixed $\tau_{slow} = 566\ ns$ (20K fit)

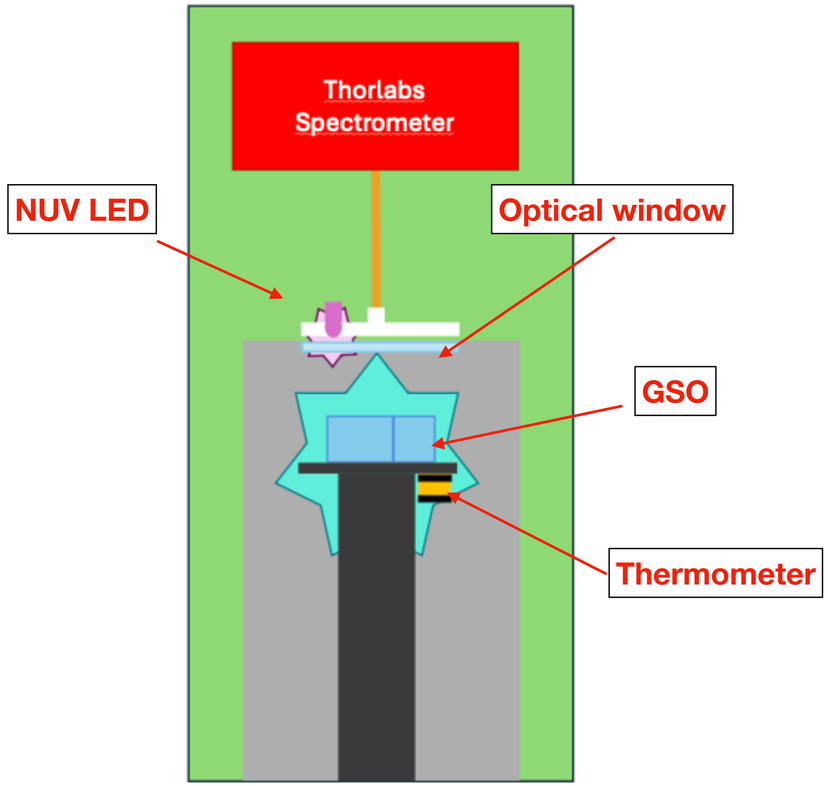


Characterization with UV LED

- Measurement of light yield and emission spectrum of GSO stimulating the crystal with an UV LED
- Set-up :
  1. Small cryostat with optical windows and base temperature of 20 K
  2. GSO stimulated with UV LED placed outside the cryostat through one optical window
  3. GSO light read out using a Spectrometer

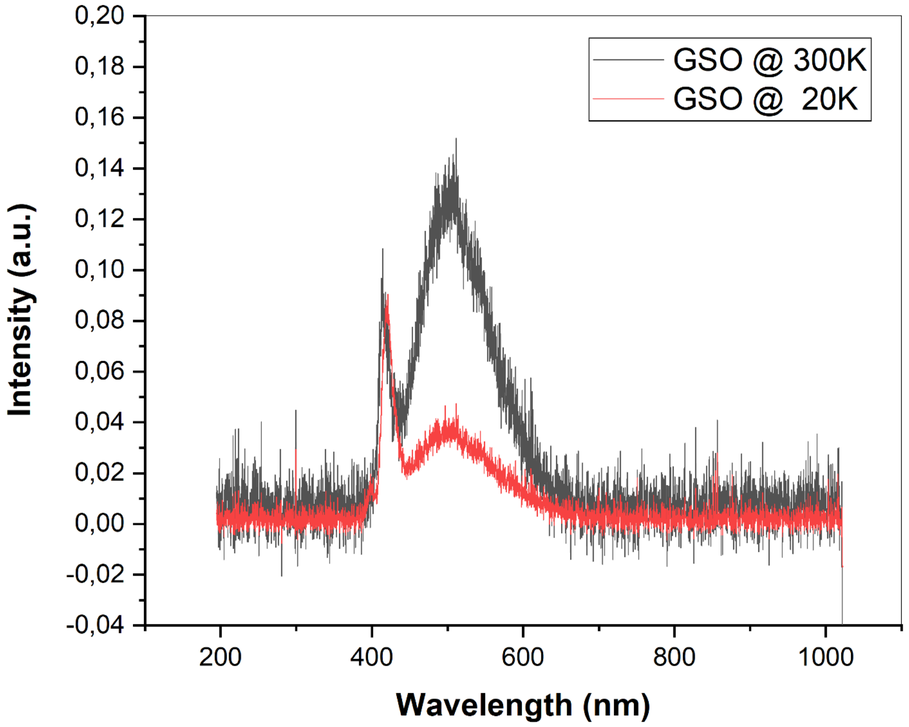


(Picture of preliminary tests. Actually the Crystal has been moved to use the top window which allows a better light collection)

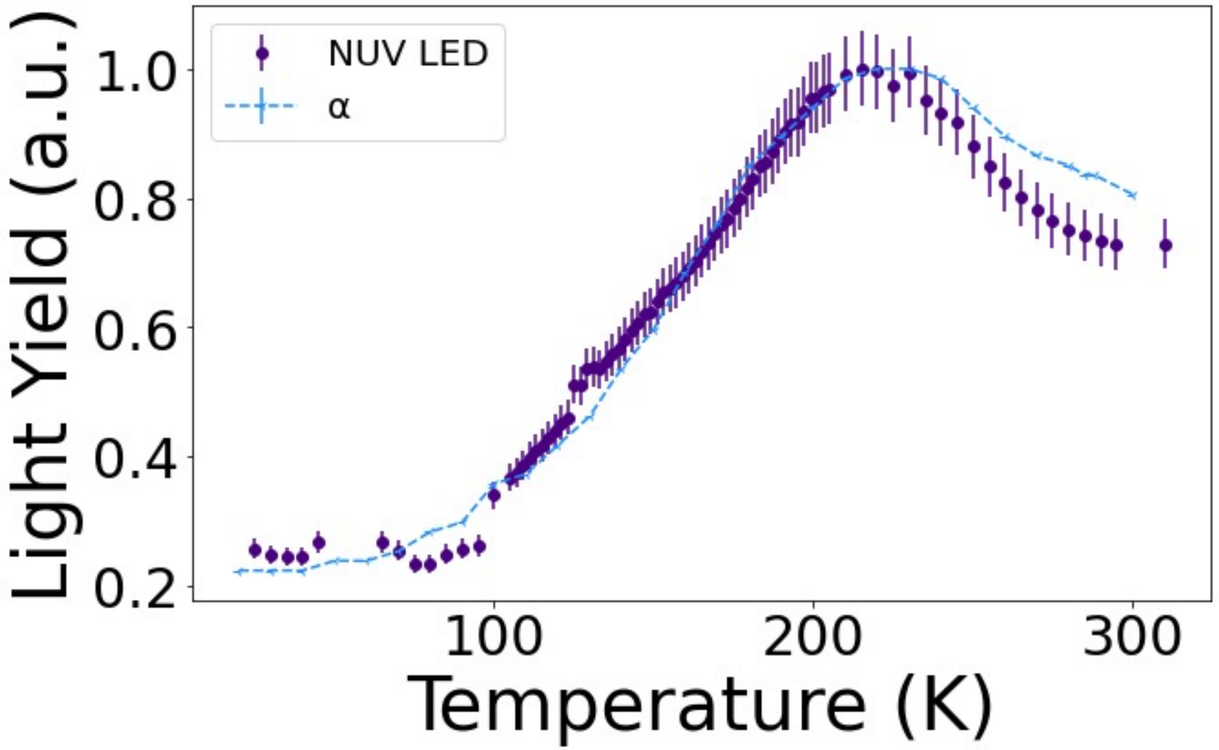


Characterization with UV LED

1. Small peak on the left -> LED. Large peak -> GSO emission.
2. Emission spectrum largely unchanged between 300 k and 20 K.Procedure repeated varying the temperature 20K - 300 K
3. Emission intensity (amplitude of GSO emission peak) measured as a function of temperature.
4. Emission intensity profile consistent with L.Y. measured with Am α



GSO emission spectrum



GSO emission intensity as a function of temperature (purple) and Light Yield measured with α (blue)

Possible crystal solutions

Crystal	Formula	L.Y. [ph/MeV]	Decay time [ns]	Density [g/cm3]
GSO	$Gd_2SiO_5(Ce)$	7510	30-35	6.7
GSOZ	$Gd_2SiO_5(Zr, Ce)$	9000	30-35	6.7
GAGG	$Gd_3Al_2Ga_3O_{12}(Ce)$	30-54 k	50-150	6.6
BGO	$Bi_4Ge_3O_{12}$	8500	320	7.13
YAG	$Y_3Al_5O_{12}(Ce)$	14000	75	4.56
YAP	$YAlO_3$	18000	25	5.4

Conclusions

1. Measured light yeld at 20 K is smaller (30 %) compared to the value at room temperature but scintillation light is still emittet.

2. The scintillation signal of GSO is fast at 20 K. The fast component, which constitutes the 93 % of the signal, has a decay time constant tau$\sim$ 40 ns at 20 K

3. The emission spectrum of GSO is largely unchanged at low temperature

4. We have developed a set-up and a procedure suitable to test other crystals for the veto

5. Exploring different crystals to buy for the test

6. Assesed stray magnetic field of GSO (< 0.03 G @ 300 K)