



Tests of the light attenuation in a long scintillator strips

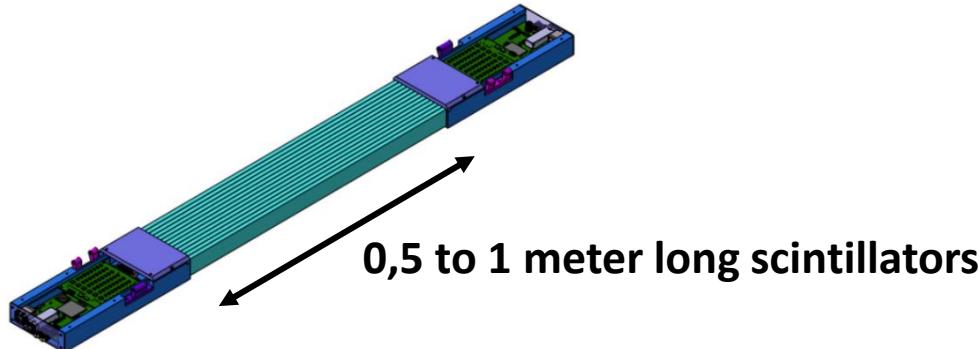
Łukasz Kaplon

Faculty of Physics, Astronomy and Applied Computer Science
Jagiellonian University

10.09.2018

Motivation

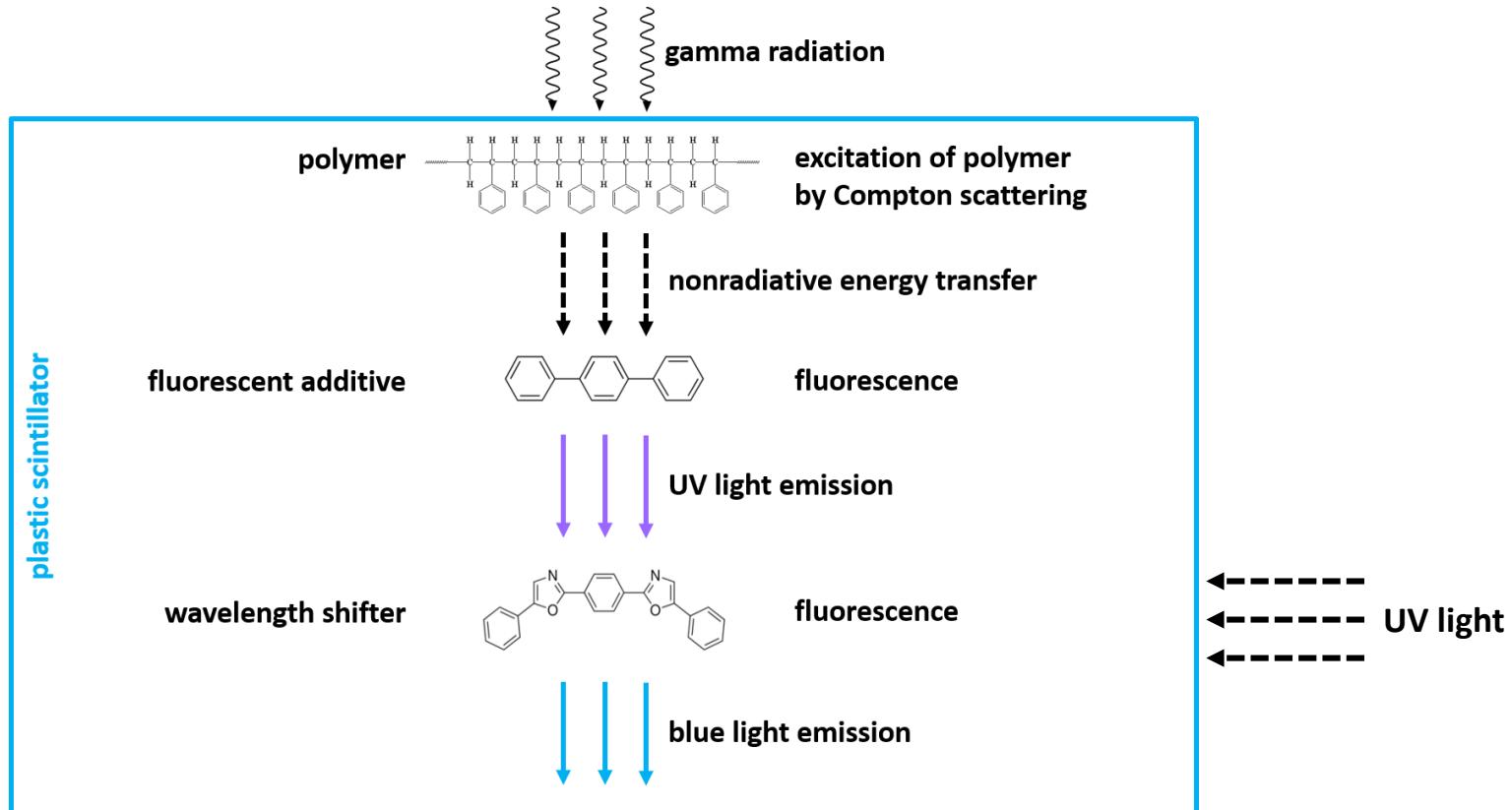
- The aim of this measurement was to determine technical light attenuation length of plastic scintillator strips used for J-PET modules construction.
- The technical attenuation length (TAL) of a plastic scintillator bar is defined as the length of scintillator reducing the light signal by a factor of e and depending upon bulk transmission of the scintillator, its thickness, shape and reflective properties of the surfaces.



Light attenuation lengths

	Bulk attenuation length (BAL)	Technical attenuation length (TAL)
Depends on:	<ul style="list-style-type: none">bulk transmission of the scintillator material	<ul style="list-style-type: none">bulk transmission of the scintillator material;reflective properties of the surfaces;thickness and shape of strips;use of reflectors
Relation	$I(x) = C_1 * e^{\left(-\frac{x}{\lambda_1}\right)}$	$I(x) = C_1 * e^{\left(-\frac{x}{\lambda_1}\right)} + C_2 * e^{\left(-\frac{x}{\lambda_2}\right)}$
Example		

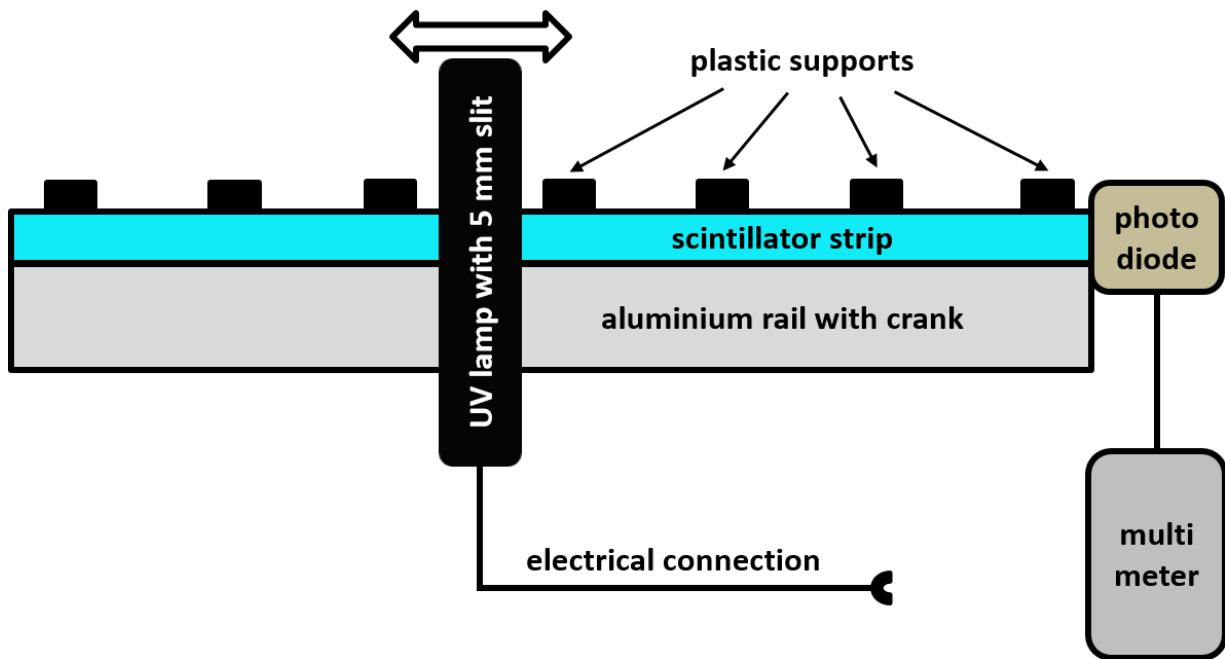
Mechanism of energy transfer in plastic scintillators



Plastic scintillator strips to measure

	EJ-200	BC-404	EJ-230
Dimensions [mm³]	6x24x1000	6x24x500	7x19x500
Used in J-PET prototype	1m long with WLS and SiPMs	312 strips modular PET with SiPMs	192 strips big barrel with PMTs
Data from manufacturers			
Decay time [ns]	2.1	1.8	1.5
Light output [% of anthracene]	64	68	64
Wavelength of maximum emission [nm]	425	408	391
Light attenuation length [cm]	380	160	120

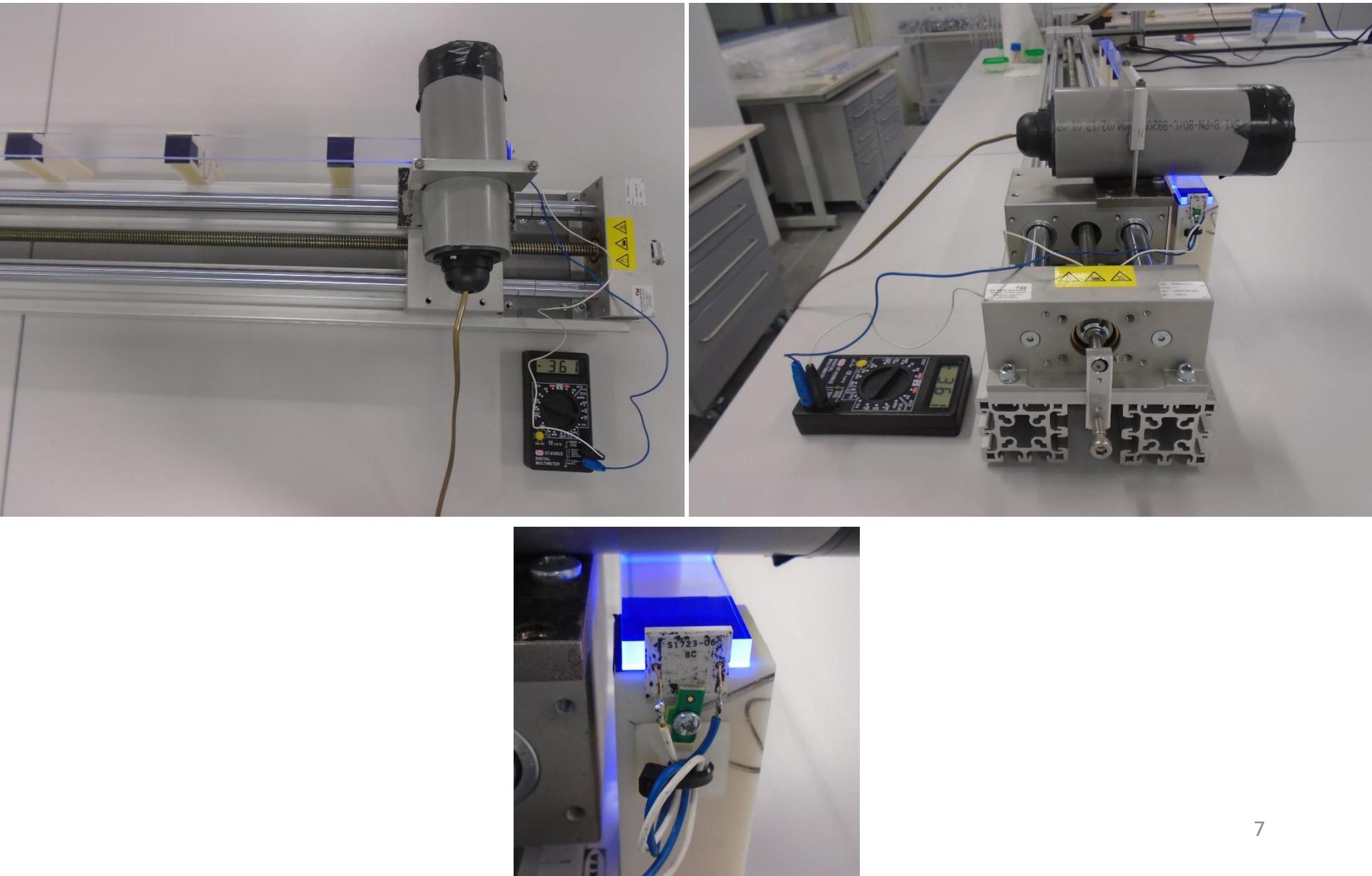
Setup for TAL measurements



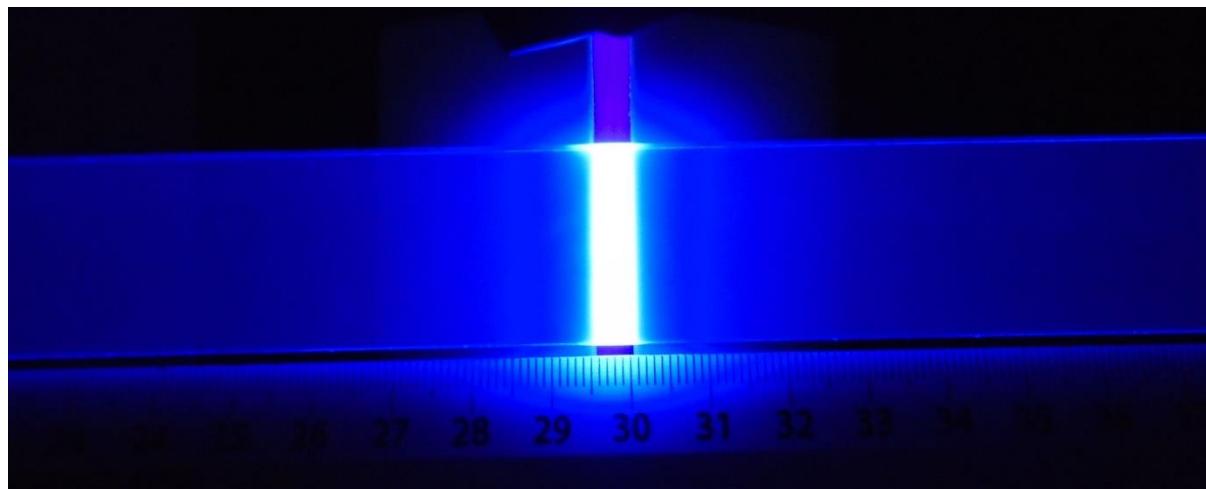
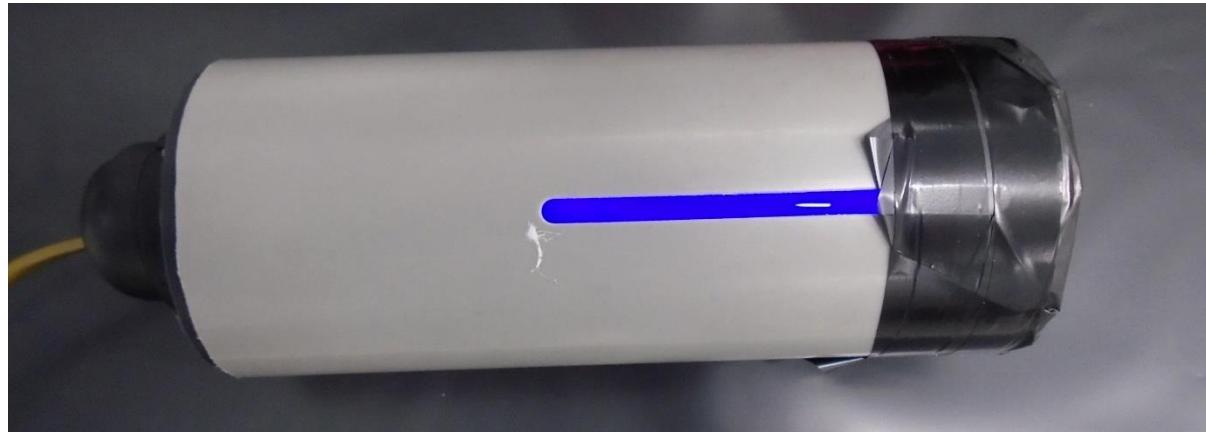
In measurement following equipment was used:

- UV lamp with 365 nm wavelength of maximum emission, BeamZ 25W/E-27;
- silicon PIN photodiode S3590-06 from Hamamatsu with 9x9 mm² active area;
- digital voltage multimeter DT-830BUZ;
- aluminium rail with crank.

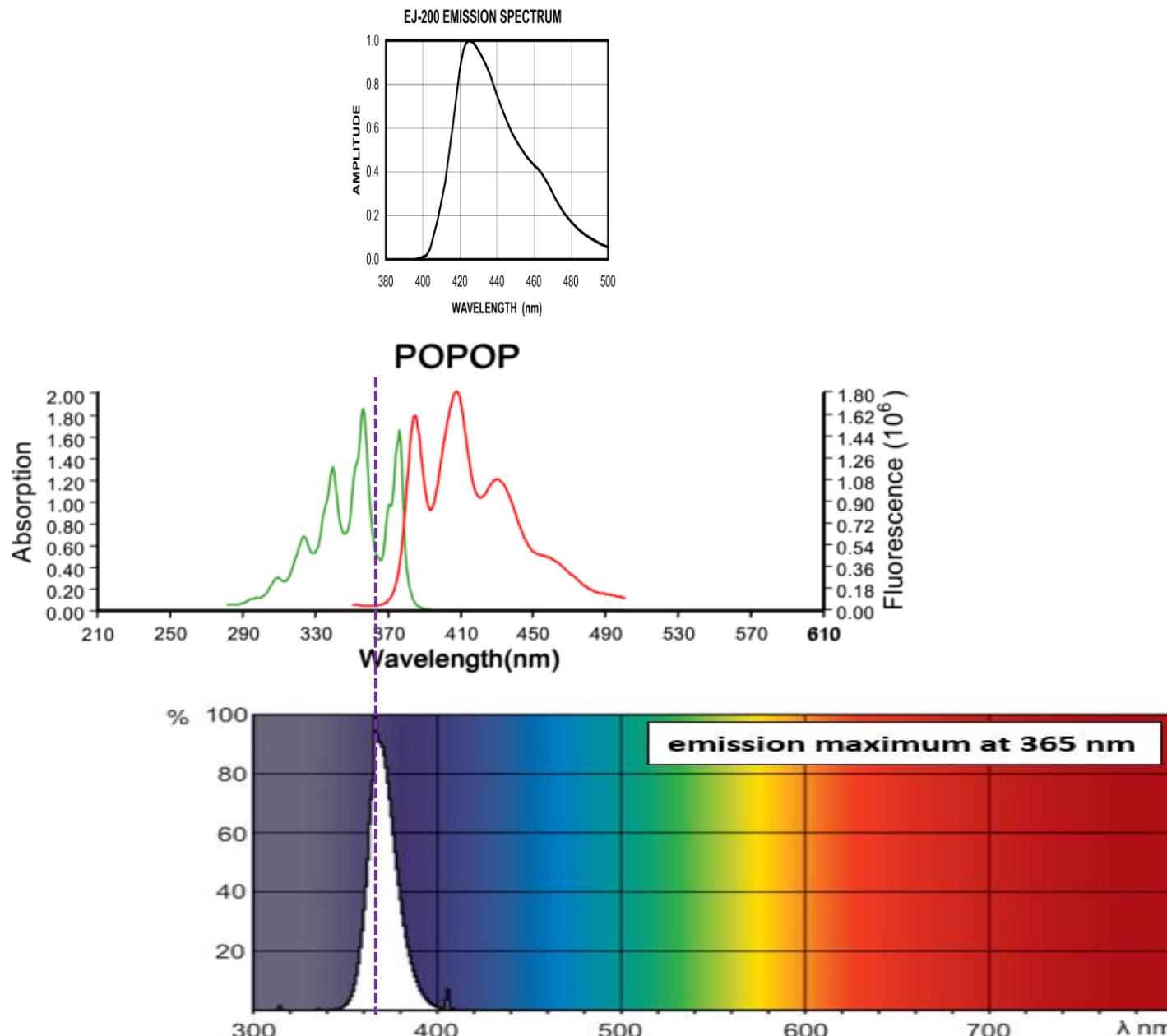
Setup for TAL measurements



365 nm UV lamp



Overlapping of 365 nm UV lamp emission spectra and scintillator absorption

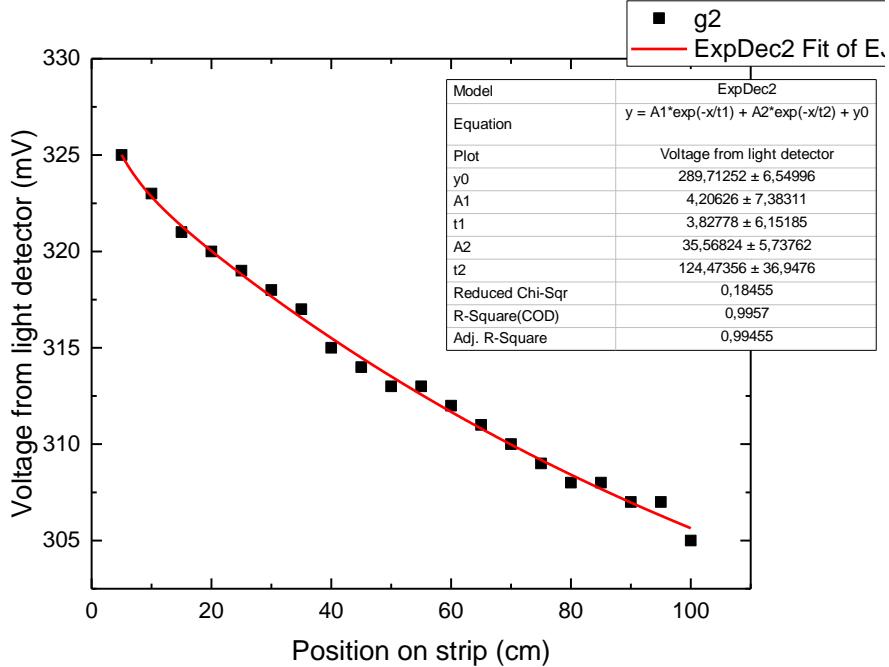
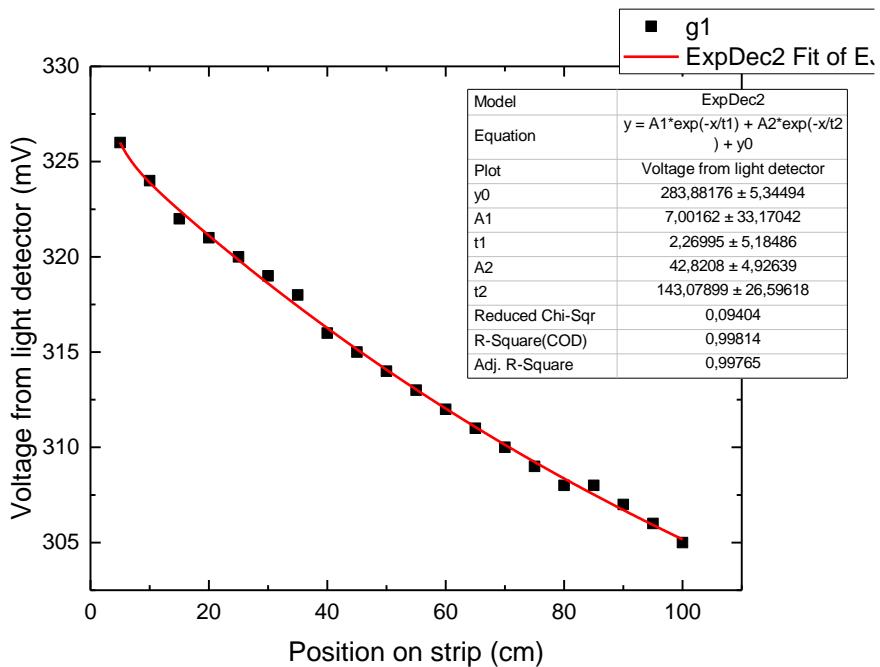


- The intensity of light traveling through plastic scintillator $I(x)$ follows a relation of the form of sum of two exponential functions given by the formula:

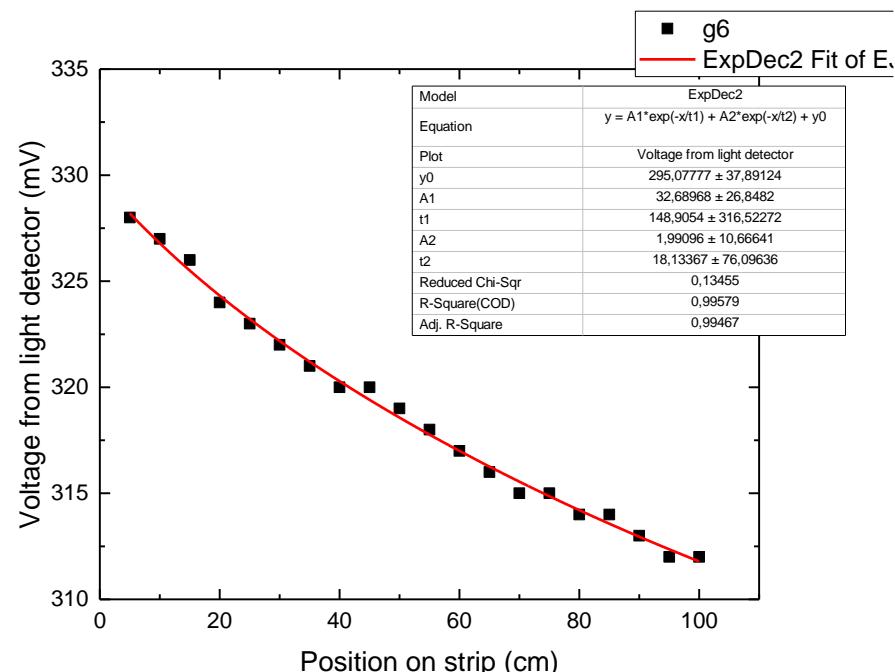
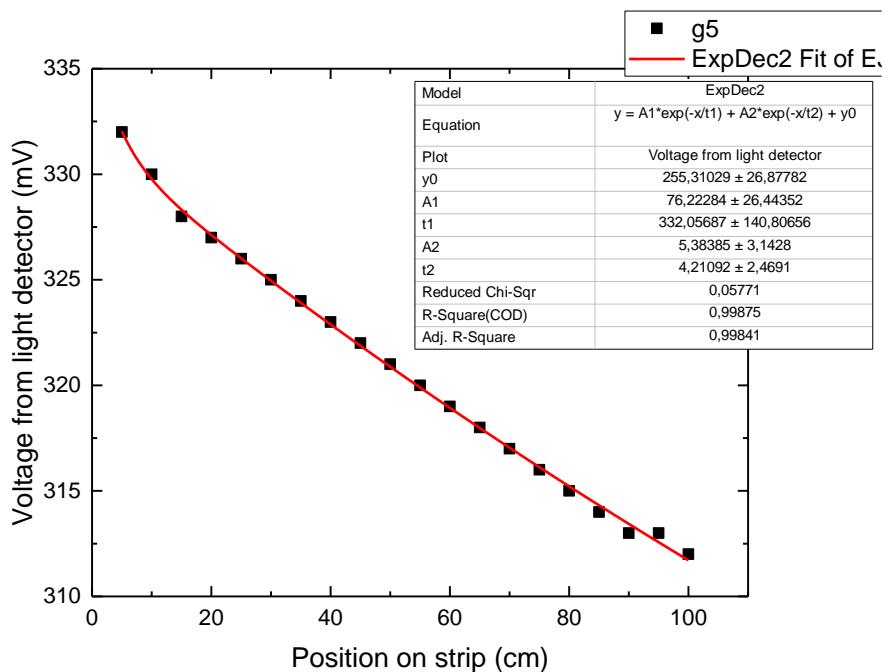
$$I(x) = C_1 * e^{\left(-\frac{x}{\lambda_1}\right)} + C_2 * e^{\left(-\frac{x}{\lambda_2}\right)}$$

where λ_1 and λ_2 are long and short components of light attenuation lengths, respectively.

Results for EJ-200 6x24x1000 mm³ strip no 1



Results for EJ-200 6x24x1000 mm³ strip no 2



Measured plastic scintillator strips

Scintillator	EJ-200	BC-404	EJ-230
Dimensions [mm ³]	6x24x1000	6x24x500	7x19x500
Used in J-PET prototype	1m long with WLS and SiPMs	312 strips modular PET with SiPMs	192 strips big barrel with PMTs
Data from manufacturers			
Decay time [ns]	2.1	1.8	1.5
Light output [% of anthracene]	64	68	64
Wavelength of maximum emission [nm]	425	408	391
Light attenuation length [cm]	380	160	120
Data from measurements			
Light attenuation length [cm]	124-332	32-84	30-78

Thank you

