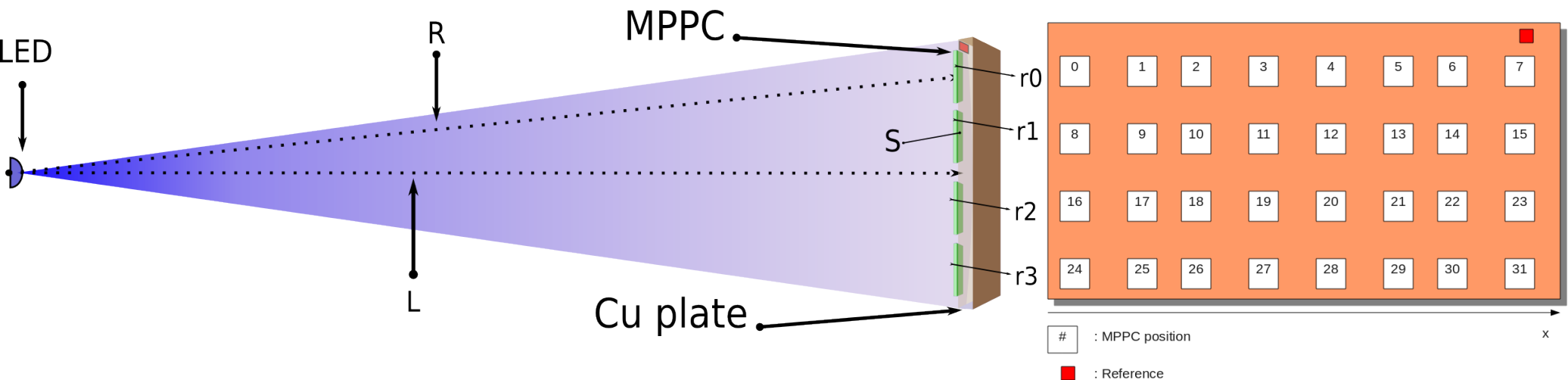# PDE estimation on stage 3

Orlando Soto

Basis

- LED's light is uniform
- Incident light is proportional to the solid angle from led.

- R   : Distance from led to MPPC.
- L   : Distance from led to Cu plate middle point.
- S   : Sensible Surface of mppc (average).
- r0-r3   : row 0 to row 3.

Function estructure.

Intensity of light (<N ph.e>).

$$I = k \cdot \Omega, \qquad k: \quad constant$$

Solid Angle.

$$\Omega = \frac{s}{R^2} = \frac{s^2}{L^2 + c \cdot (x - x_0)^2}, \qquad c: \quad constant$$

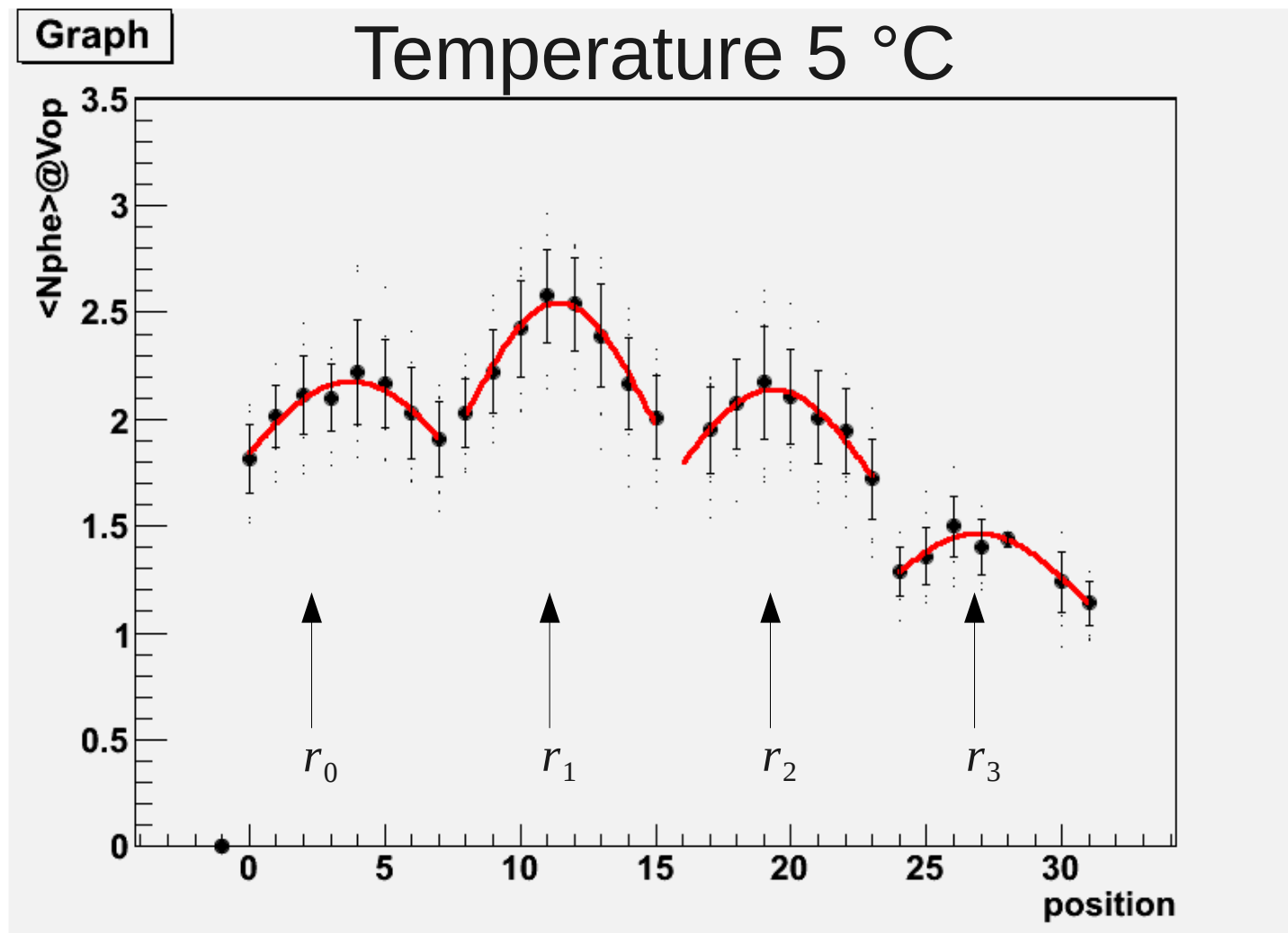## Prototipe function to fit, one function per row.

$$f_{rx}(x) = p_0 \cdot \frac{s^2}{p_3^2 + p_1 \cdot (x - p_2)^2}, \qquad f_{rx} \in \{f_{r0}, f_{r1}, f_{r2}, f_{r3}\}$$
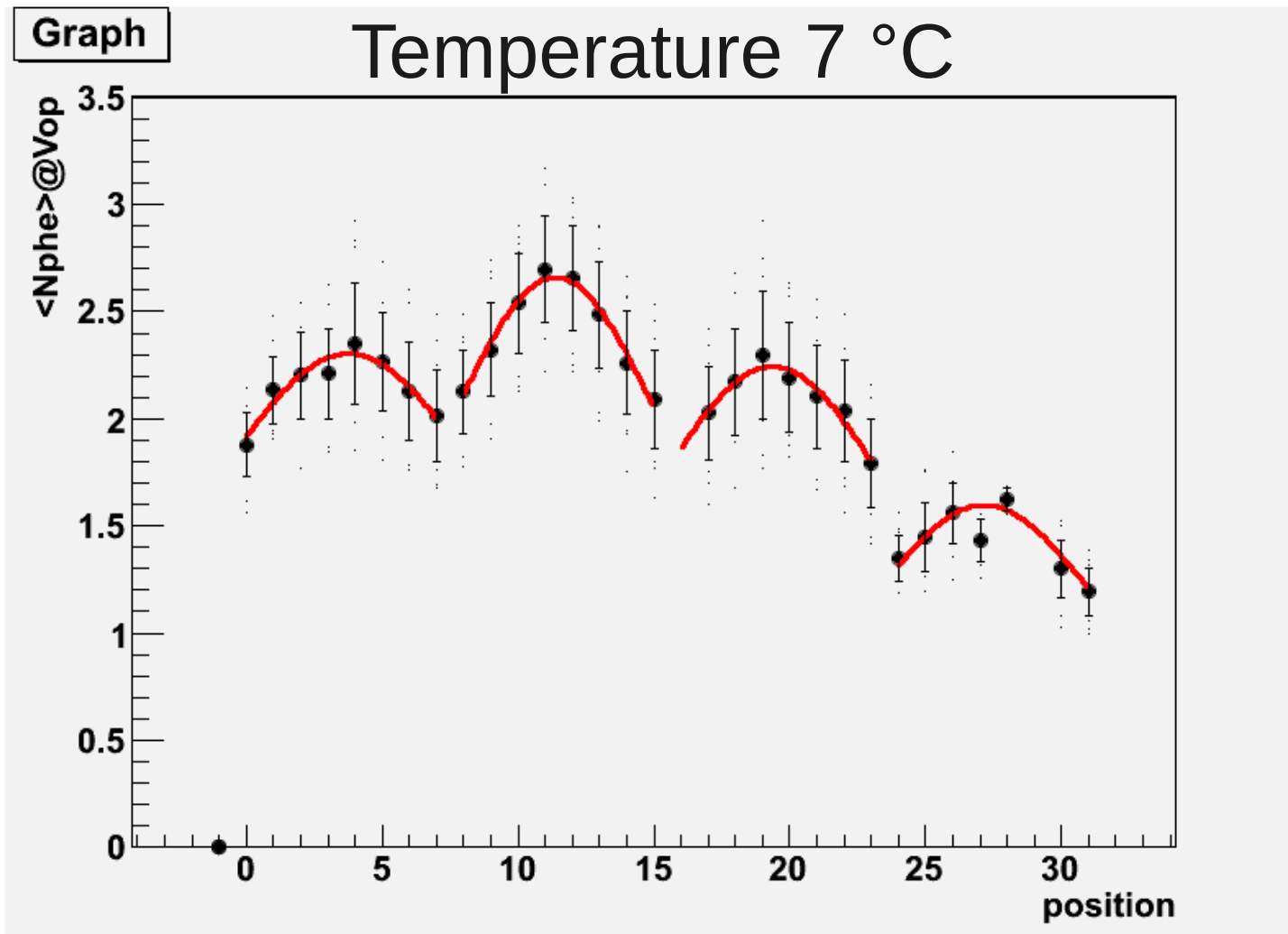
$p_0, \ p_1, \ p_2, \ p_3 : \quad constants$

$p_3 \quad$ was fix

Fiting over data (1)

The fit was done for all measurements (~400 mppc), for each temperature.

Fiting over data (2)

Temperature 7 °C

Fiting over data (3)
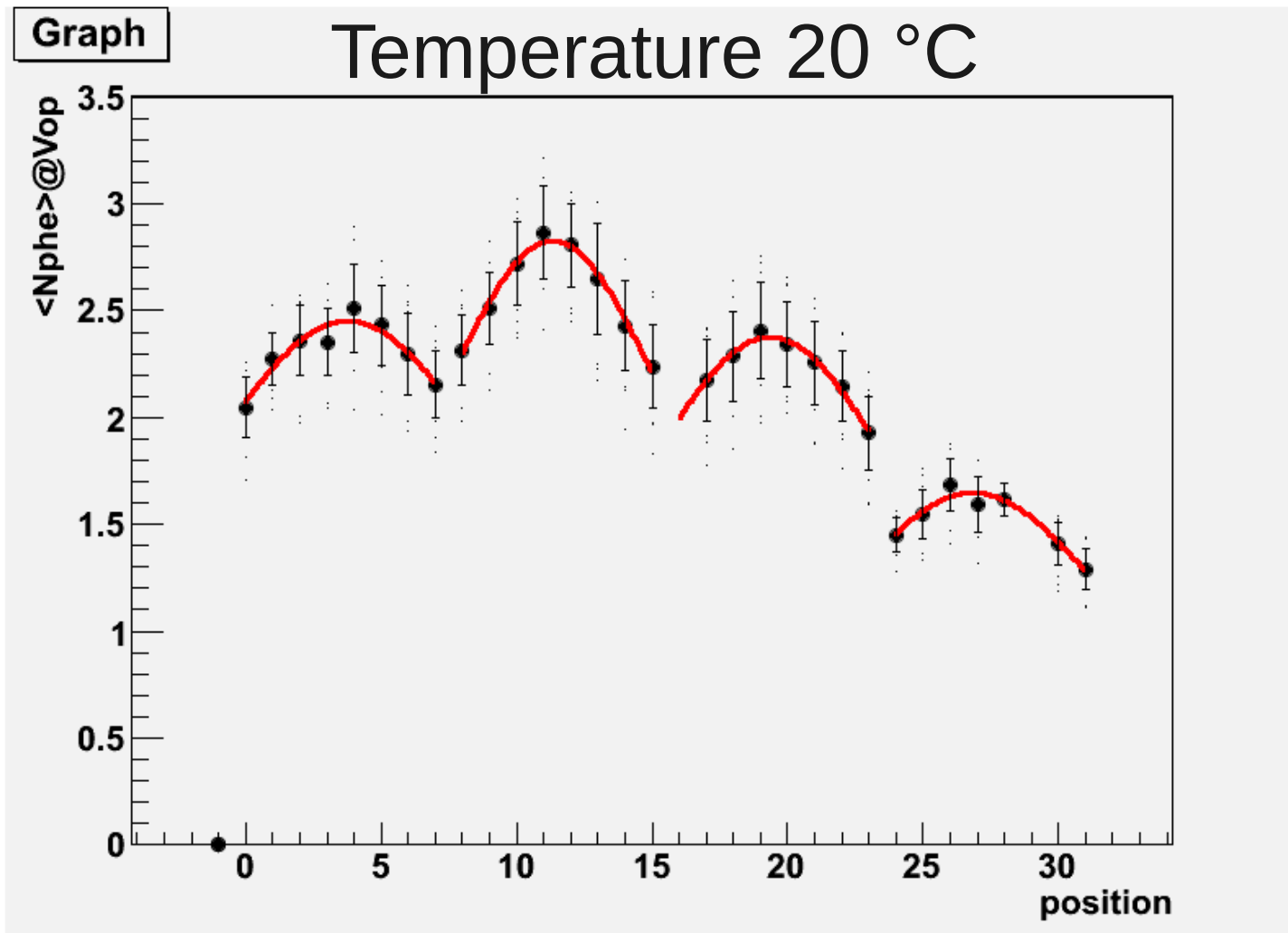
Parameters summary

row	Temp	p0	p1	p2	p3	p0_err	p1_err	p2_err	Chisqrt
0	5	30737.7	29962.7	3.75282	2.27723e+06	1496.03	17975.8	0.597446	0.303126
0	7	32518.8	32744	3.76974	2.27723e+06	1782.67	19859.8	0.606654	0.348786
0	20	34607.5	29287.8	3.76975	2.27723e+06	1383.22	14411.6	0.479806	0.51462
1	5	35554.5	50391.4	11.4146	2.25302e+06	1777.32	19866.3	0.371895	0.144812
1	7	37150	50803.4	11.3867	2.25302e+06	1979.78	22197.7	0.406684	0.134386
1	20	39484.9	46623.3	11.3327	2.25302e+06	1677.4	17185.7	0.34559	0.133847
2	5	29886.5	39396.1	19.3356	2.25302e+06	1879.69	30542.3	0.747618	0.095688
2	7	31338.3	41291.4	19.3564	2.25302e+06	2150.7	32814	0.757055	0.12517
2	20	33188.1	38290.3	19.3578	2.25302e+06	1690.29	25014.4	0.642275	0.0735226
3	5	20696.5	39043.8	26.8899	2.27723e+06	559.96	14908.7	0.485019	0.423711
3	7	22547	49332.5	27.1562	2.27723e+06	705.389	16107.4	0.395846	3.71771
3	20	23267	37554.2	26.8418	2.27723e+06	851.906	13642.7	0.388671	0.414602

PDE estimation

In each run we have some mppcs with pde measured on stage 2. In order to estimate pde for each mppc with several points, we try to get a relationship between the row functions.

We try two aproximation to pde estimation.

First

$$pde(x_i) \cdot \lambda_0(x_i) = \lambda_m(x_i)$$

$$c_i \cdot f_{rx}(x_i) = \lambda_0(x_i) = \frac{\lambda_m(x_i)}{pde(x_i)}$$

$$pde(x) = \frac{\lambda_m(x)}{\lambda_0(x)} = \frac{\lambda_m(x)}{c_i f_{rx}(x)} \quad (1)$$

Second

$$g_{rx}(x) = f_{rx}(x) + \lambda_m(x_i) - f_{rx}(x_i)$$

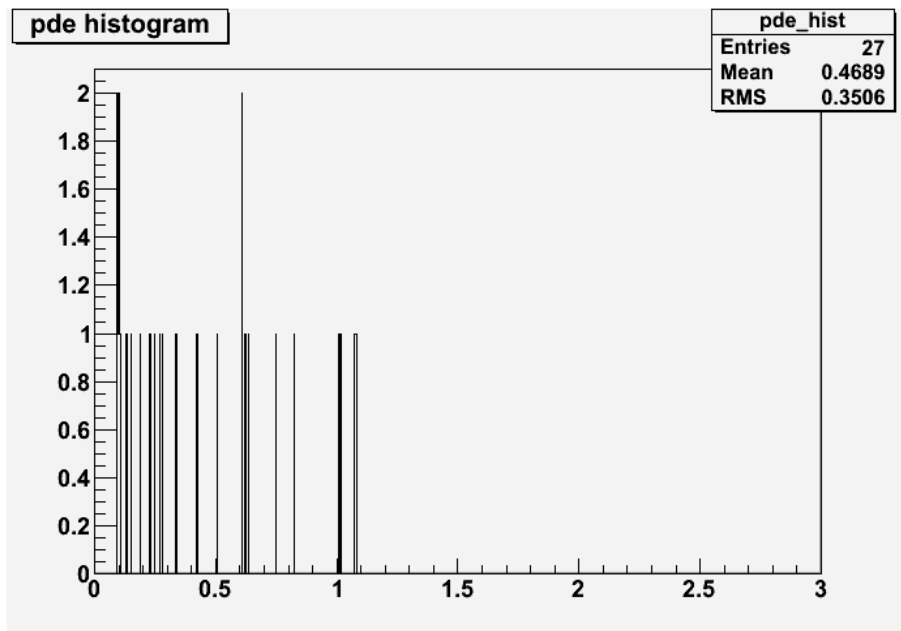$$pde(x) = \frac{\lambda_m(x) \cdot pde(x_i)}{g_{rx}(x)} \quad (2)$$

$$\lambda_0(x): \quad \textit{incident light}$$
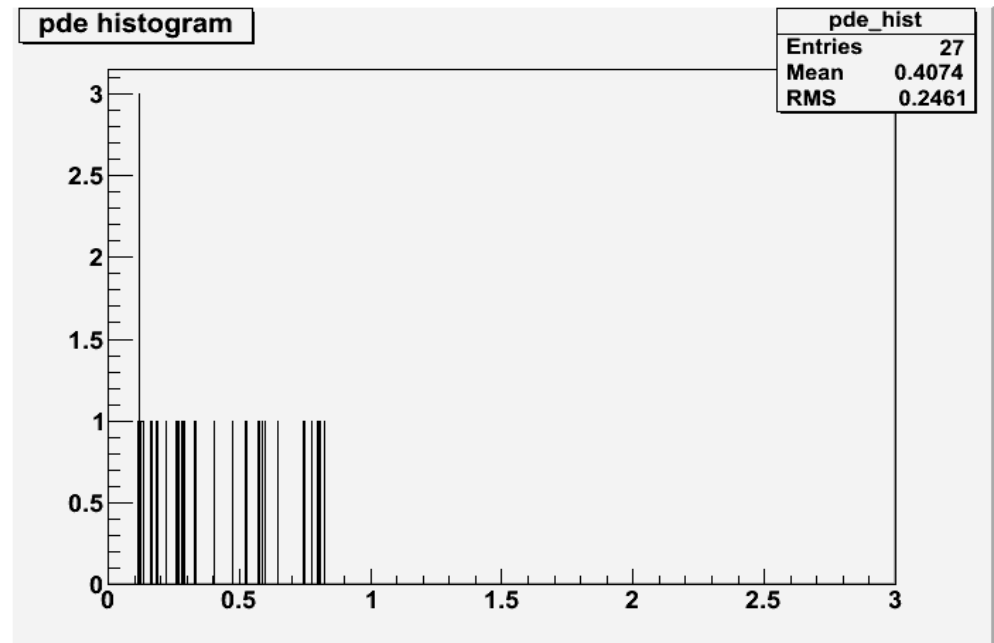$$\lambda_m(x): \quad \textit{measured light}$$

Pde distribution on stage 3

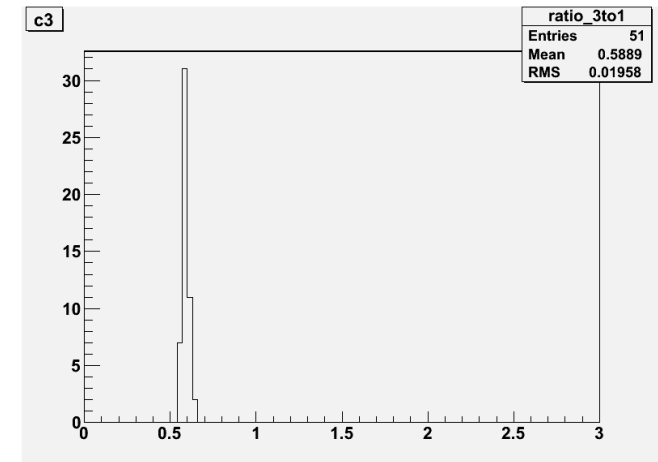We test the method in a box with the all the mppc with known pde (from stage 2).

first
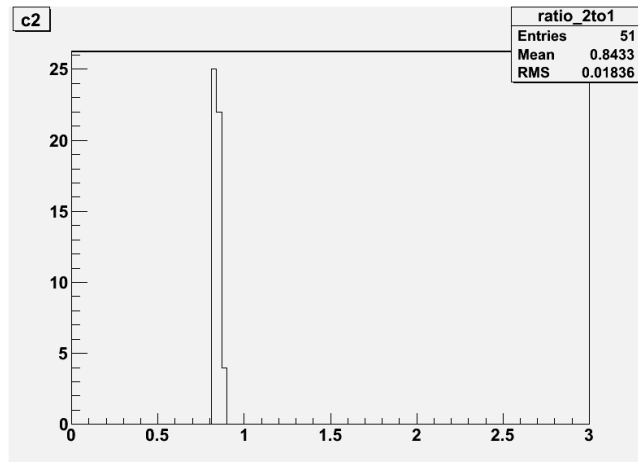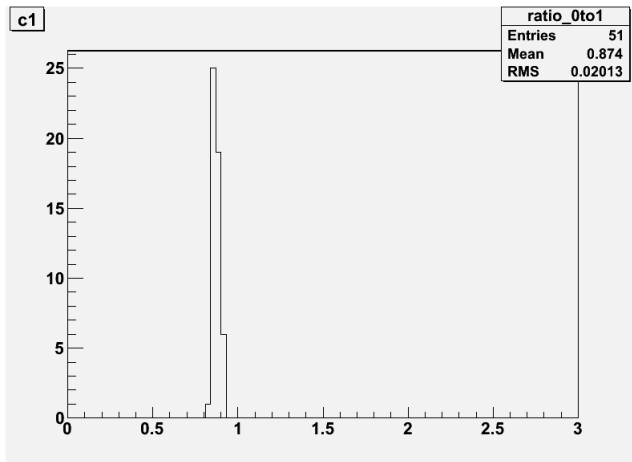
second

The results were not good.

Function relationship

$$\frac{f_{r0}}{r_{0to1}} = \frac{f_{r2}}{r_{2to1}} = \frac{f_{r3}}{r_{3to1}} = f_{r1}, \qquad r_{0to1}, \ r_{2to1}, \ r_{3to1} : constants.$$

Third estimation

For each run, we take the same function estimated from all measurements and we translate it to the point of incident light without changing the shape.
To do that we introduce an extra parameter.
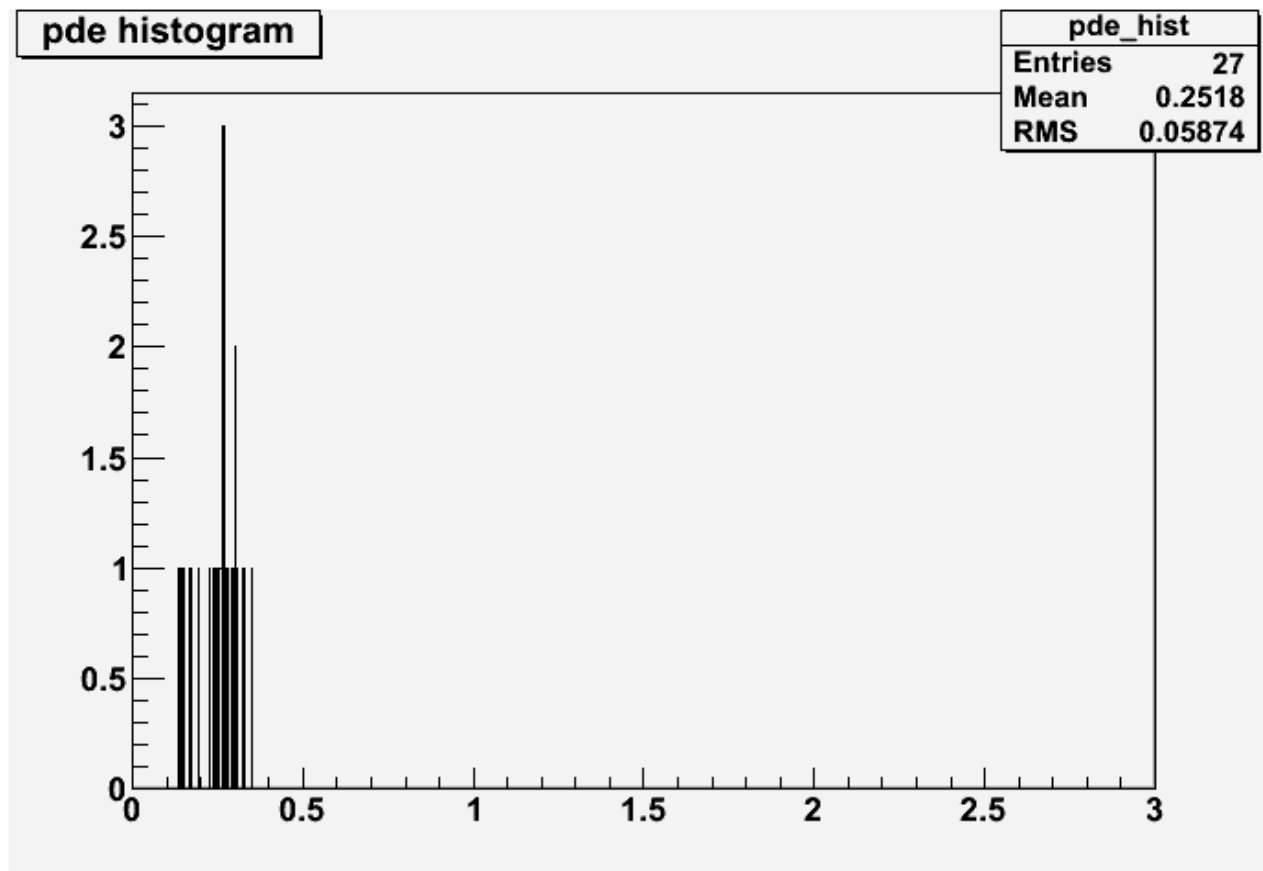
$$g_{rx}(x) = f_{rx}(x) + k_4^{rx}$$

We relate the row functions by this extra parameter and estimate the PDE

$$\lambda_0(x) = g_{rx}(x) + \frac{\lambda_m(x_i)}{pde(x_i)} - g_{rx}(x_i)$$

$$pde(x) = \frac{\lambda_m(x)}{\lambda_0(x)} \qquad (1)$$

Last results

The result are better but not enough.

Summary table

#MPPC_ID	stage2	stage3
2165	0.208845	0.237316
2167	0.229646	0.269089
2168	0.248664	0.290653
2169	0.221583	0.274011
2170	0.228071	0.305376
2171	0.245754	0.302095
2172	0.237595	0.266823
2173	0.247844	0.264371
2175	0.23072	0.293522
2176	0.243676	0.329884
2178	0.211588	0.349372
2179	0.222157	0.326352
2181	0.230036	0.30265
2182	0.229823	0.269153
2183	0.227066	0.251677
2184	0.243162	0.2566
2185	0.238864	0.281316
2186	0.23739	0.266559
2187	0.216328	0.259422
2188	0.223193	0.236515
2189	0.23434	0.227746
2190	0.219952	0.194623
2191	0.22145	0.144895
2192	0.22289	0.151779
2193	0.236724	0.170678
2196	0.220284	0.140533
2197	0.227516	0.136025

Conclusion

The estimation on stage 3 is not good enough, we can improve this, but for now and considering time, we will take PDE estimation from stage 2 for all mppcs.