Misure NA lenti e simulazione laser

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TOP Italian Meeting,
Torino, 1 October 2015

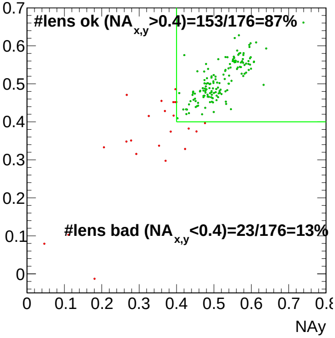
Outline

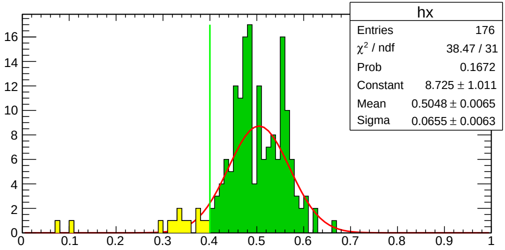
Intro

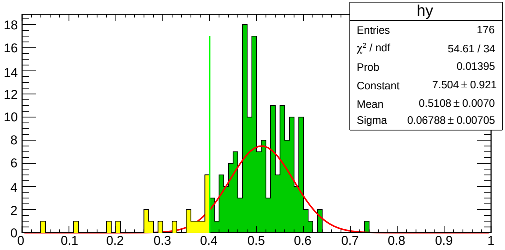
- Results on NA measurement of GRIN lens
  - most of the measurements done by Alessandro;
  - all lens measured;
- Preliminary study of time distribution for calibration system using BelleII simulation
  - Idea is to try to compare results from module 1 test at Fuji-hall with what is expected from simulation;
    - do we understand what we see?
    - is the simulation proper?
    - how can we extract calibration constant from measurements?

NA along x and y for all lens

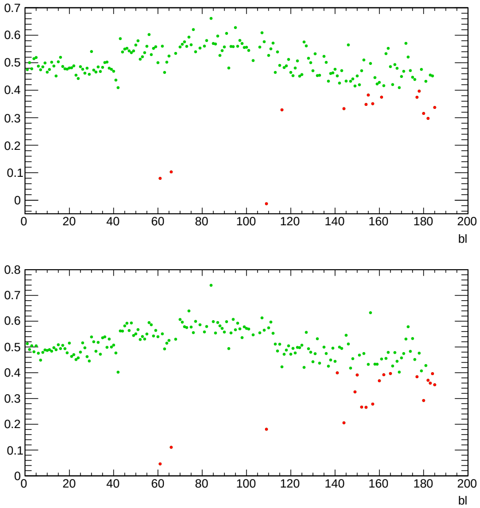
Total	176 lens
Needed	$9 \cdot 16 = 144$
avg	$\langle NA \rangle = 0.51$
bad	$NA < 0.4$: **23**
good	$NA > 0.4$: **153**





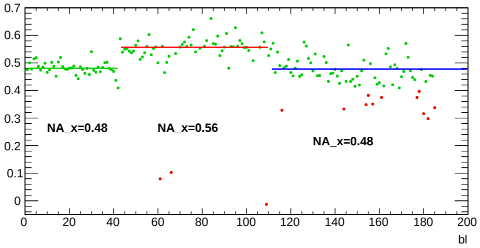


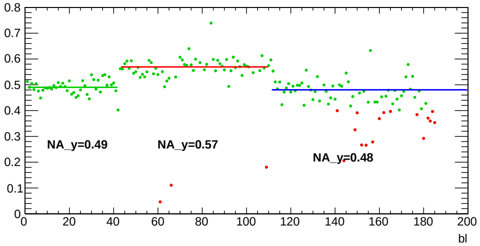
NA vs block number (time)



- NA clearly not uniform
- Most of the bad lens are from last batch
- Three separate populations are visible

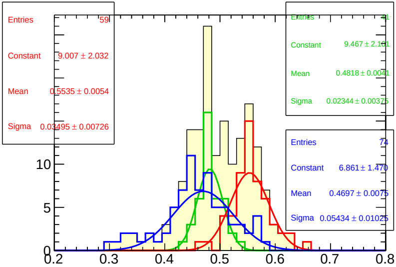
NA vs block number (time)

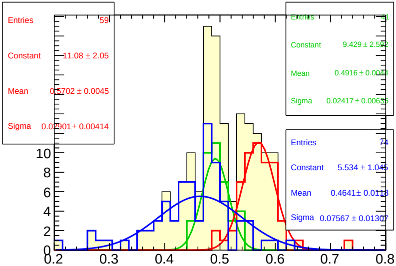


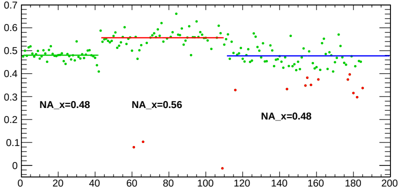


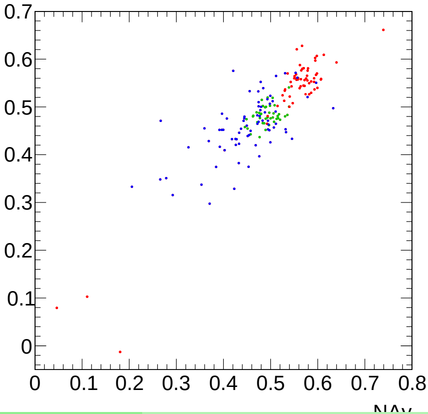
- NA clearly not uniform
- Most of the bad lens are from last batch
- Three separate populations are visible

Three lens batches

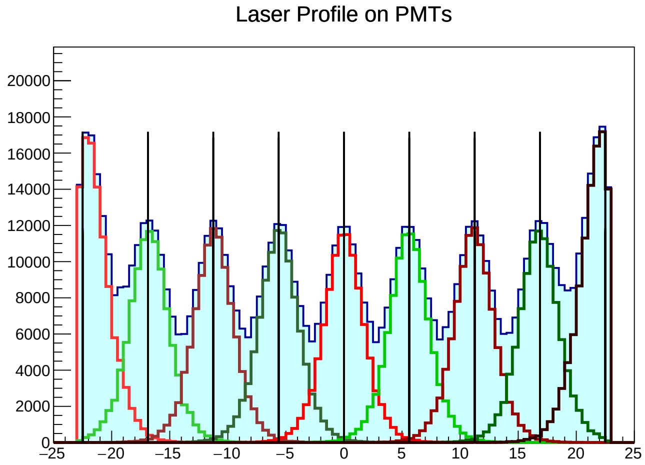






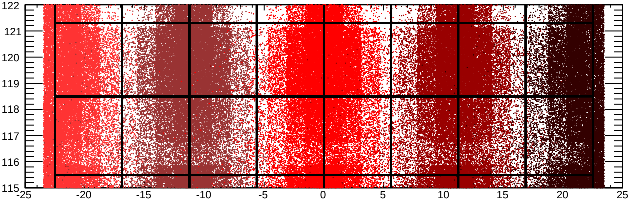


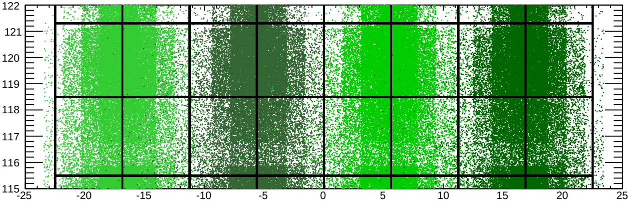
Laser light profile on PMT



Each PMT is illuminated by two laser sources

Laser light profile on PMT

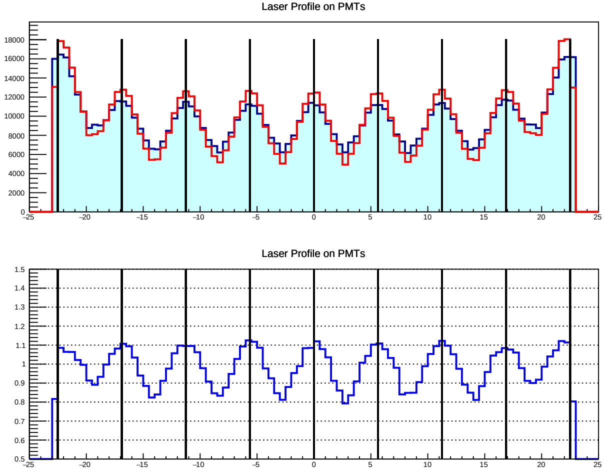




Each PMT is illuminated by two laser sources

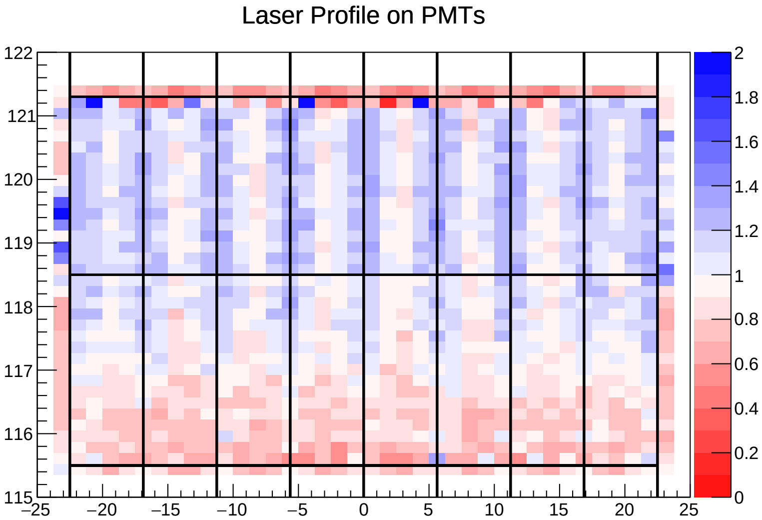
What if NA is lower than expected?

NA=0.55, NA=0.47



Ratio light (NA=0.47/NA=0.55) $\in [+10\%, -15\%]$

What if NA is lower than expected?



a bit worse in the lower PMT: down to -40%

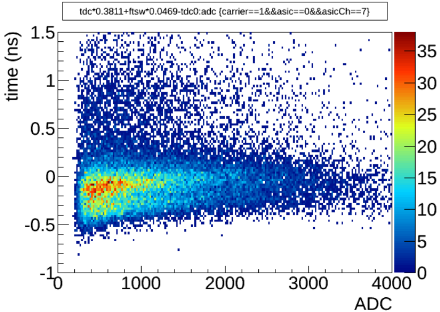
CRT timing resolution analysis

- Circulated by Matsuoka-san in iTOP CRT list on 24/9/2015 link
- using run 00298-00318
- three peaks structure seen for time distribution
- Different for different channels
- attributed to different photon path: direct, 1 reflection, 2 reflections
- Time resolution seen ~ 80 *ps*

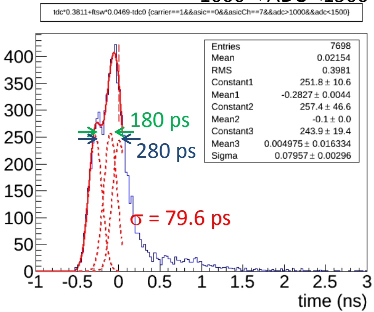
- Can we see that on simulation?
- Test both data and simulation.

run00298-00318

TDC distribution



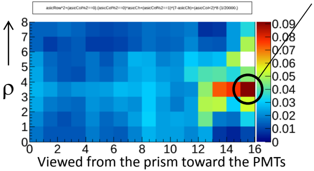
1000 < ADC <1500

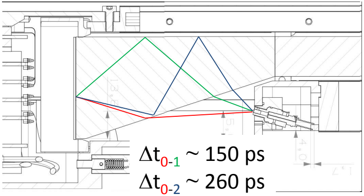


Probably three peaks by direct photons and those reflected once and twice

Board stack #1

This channel

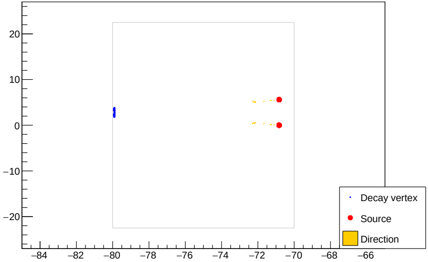


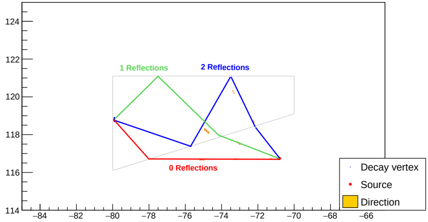


Simulation setup: central channel

- Simulate only two laser sources;
- Select 3 different emitting angles, with narrow width (2°)
  - relative light yield included
- illuminating the same PMT in 2 channels;
  - direct PMT illumination
  - one reflection
  - two reflection
- look at MC γ time-of-decay;
- look at TDC (1 TDC = 25 ps);
- ADC not simulated in MC!;
- Use two lasers:

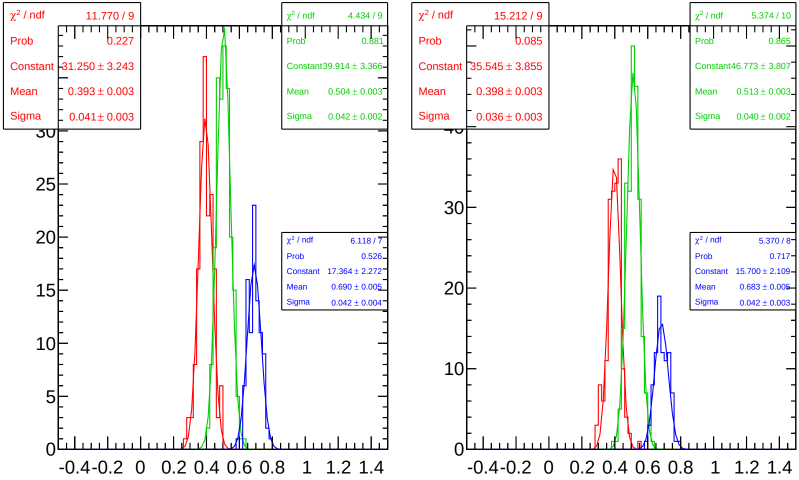
40 ps used in CRT
25 ps used in BelleII





SimHit γ time-of-decay: central PMT, $\sigma_t = 40\ ps$

Two different PMT channels

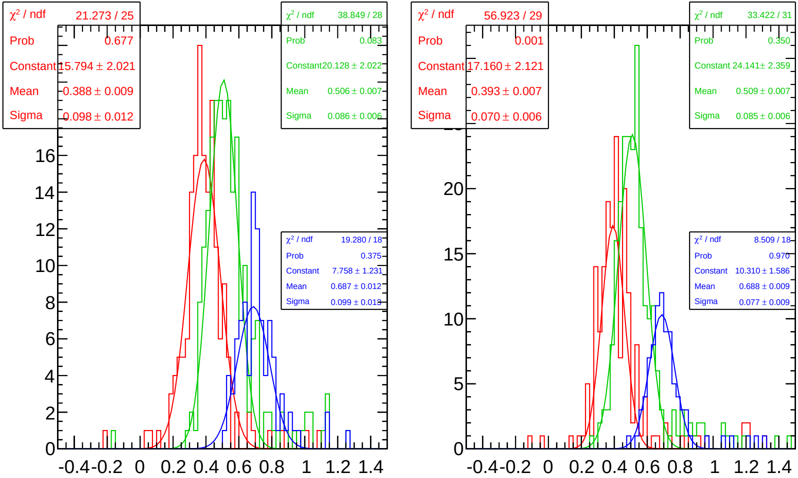


$\Delta t(0-1) = 111/115\ ps$; $\Delta t(0-2) = 296/285\ ps$; $\Delta t(1-2) = 186/171\ ps$

$\sigma_t(0) = 41/36\ ps$; $\sigma_t(1) = 42/40\ ps$; $\sigma_t(2) = 42/42\ ps$

TDC γ: central PMT. Laser $\sigma_t = 40$ ps

Two different PMT channels

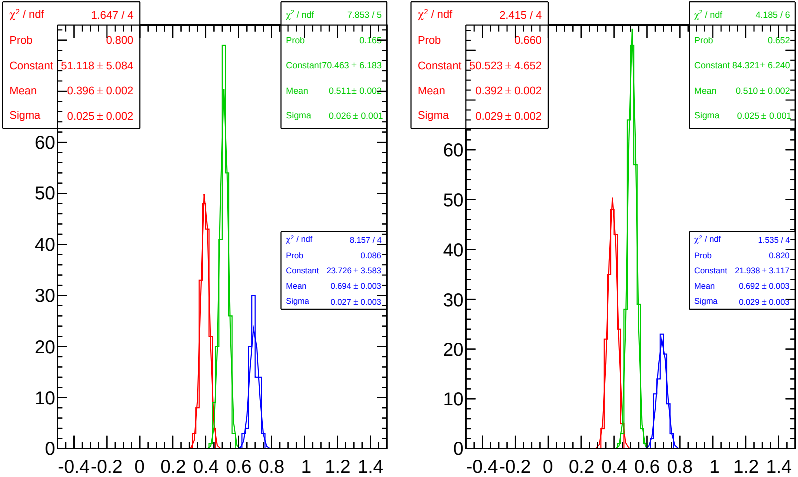


$\Delta t(0-1) = 118/117$ ps; $\Delta t(0-2) = 299/296$ ps; $\Delta t(1-2) = 181/179$ ps

$\sigma_t(0) = 98/69.9$ ps; $\sigma_t(1) = 86/85.1$ ps; $\sigma_t(2) = 99/77.5$ ps

SimHit γ time-of-decay: central PMT, $\sigma_t = 27\ ps$

Two different PMT channels

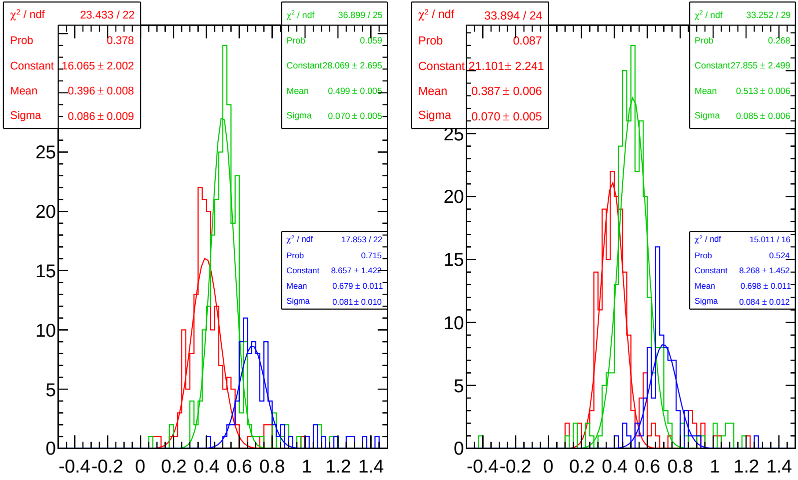


$\Delta t(0-1) = 111/115\ ps$; $\Delta t(0-2) = 296/285\ ps$; $\Delta t(1-2) = 186/171\ ps$

$\sigma_t(0) = 41/36\ ps$; $\sigma_t(1) = 42/40\ ps$; $\sigma_t(2) = 42/42\ ps$

TDC γ: central PMT. Laser $\sigma_t = 27$ *ps*

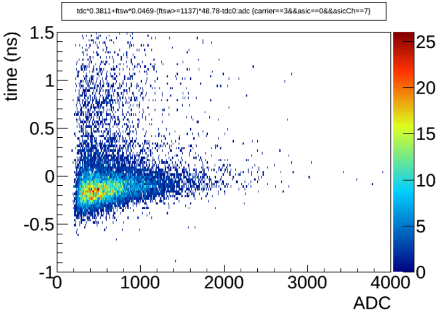
Two different PMT channels



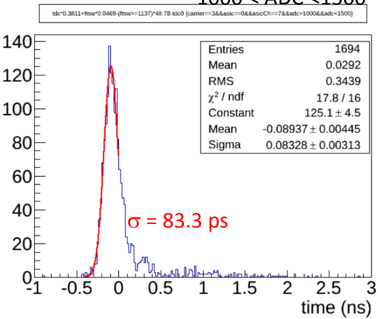
$\Delta t(0-1) = 102/126$ *ps*; $\Delta t(0-2) = 283/311$ *ps*; $\Delta t(1-2) = 180/185$ *ps*

$\sigma_t(0) = 86/70$ *ps*; $\sigma_t(1) = 70/85$ *ps*; $\sigma_t(2) = 81/84$ *ps*

TDC distribution



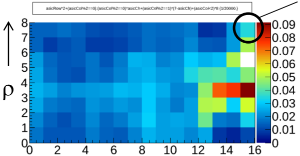
1000 < ADC <1500



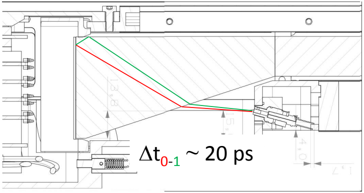
Cannot distinguish direct photons and those reflected once in this channel

Board stack #1

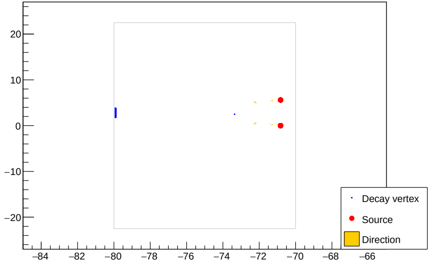
This channel

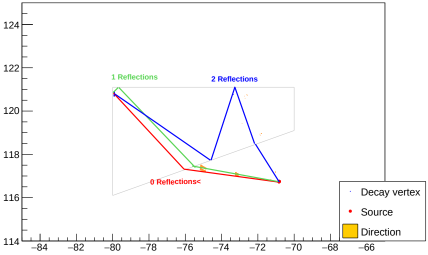


Viewed from the prism toward the PMTs



Simulation setup: Border channel

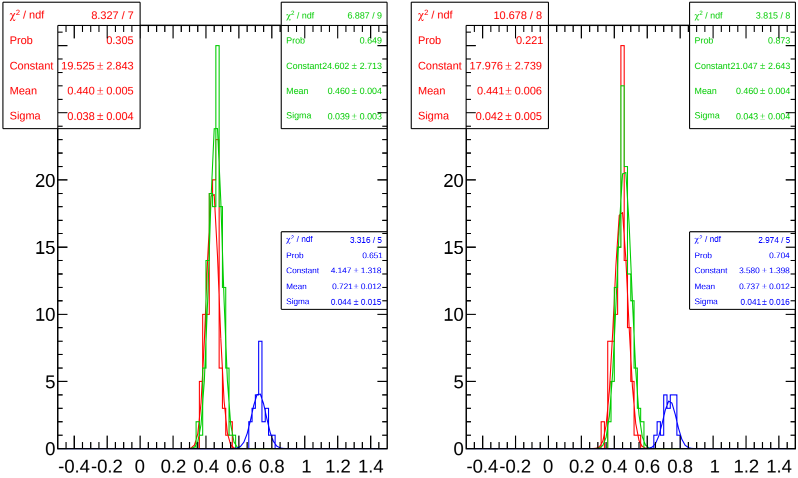




- Same as before, but selecting a PMT on the border of Expansion Box;
- Select 3 different emitting angles, with narrow width (2°)
- illuminating the same PMT in 2 channels;
  - direct PMT illumination
  - one reflection
  - two reflection
- NB: relative light yield not simulated (yet)

SimHit γ time-of-decay: Border PMT, $\sigma_t = 40\ ps$

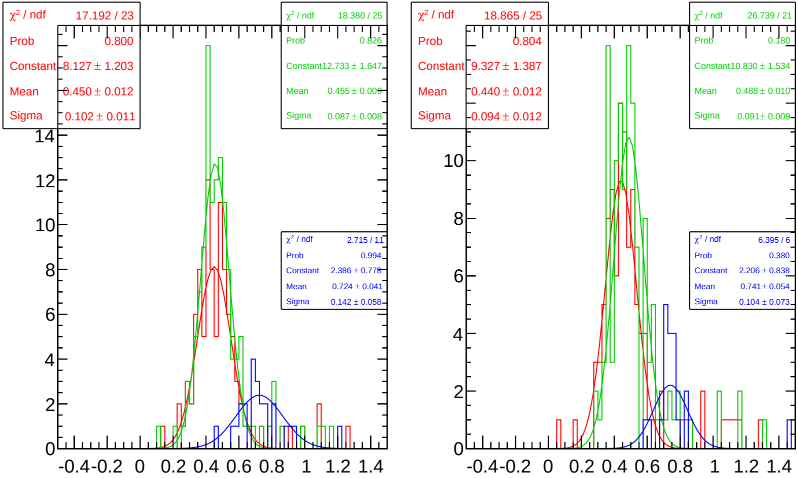
Two different PMT channels



$\Delta t(0-1) = 19.7/19.6\ ps$ $\Delta t(0-2) = 281/296\ ps$ $\Delta t(1-2) = 261/276\ ps$
$\sigma_t(0) = 38/42\ ps$ $\sigma_t(1) = 39/43\ ps$ $\sigma_t(2) = 44/41\ ps$

TDC γ time-of-decay: Border PMT, $\sigma_t = 40\ ps$

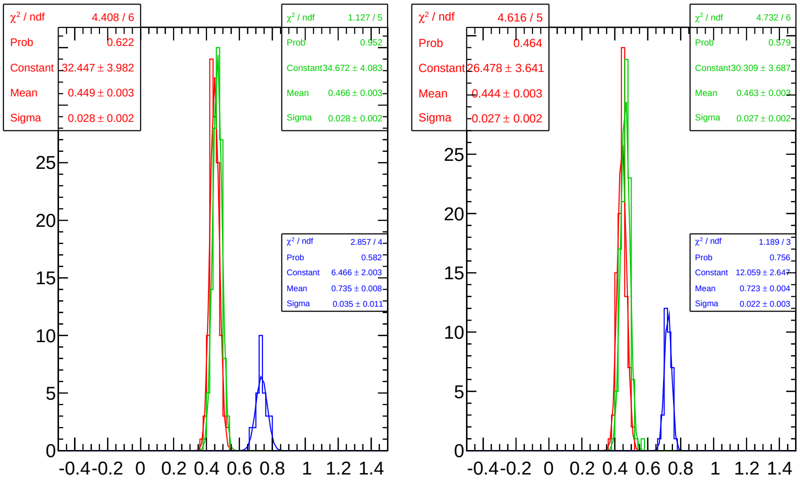
Two different PMT channels



$\Delta t(0-1) = 5.58/47.\ ps$; $\Delta t(0-2) = 274/301\ ps$; $\Delta t(1-2) = 269/253\ ps$
$\sigma_t(0) = 100/94\ ps\ ps$; $\sigma_t(1) = 87/91\ ps\ ps$; $\sigma_t(2) = 140/100\ ps$

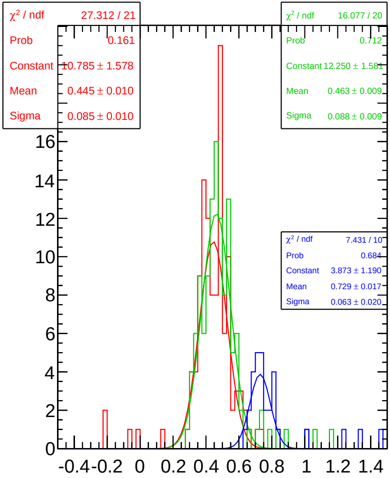
SimHit γ time-of-decay: Border PMT, $\sigma_t = 27$ *ps*

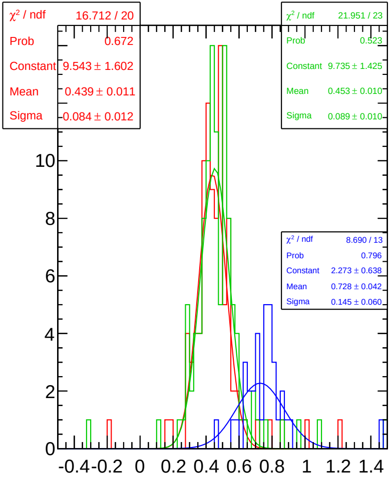
Two different PMT channels



$\Delta t(0-1) = 17.3/19.7$ *ps*; $\Delta t(0-2) = 286/280$ *ps*; $\Delta t(1-2) = 268/260$ *ps*
$\sigma_t(0) = 28/27$ *ps*; $\sigma_t(1) = 28/27$ *ps*; $\sigma_t(2) = 35/22$ *ps*

TDC γ time-of-decay: Border PMT, $\sigma_t = 27\ ps$
Two different PMT channels





$\Delta t(0-1) = 17.7/14.7\ ps$ $\Delta t(0-2) = 284/290\ ps$ $\Delta t(1-2) = 266/275\ ps$
$\sigma_t(0) = 85/84\ \ ps$ $\sigma_t(1) = 88/89\ \ ps$ $\sigma_t(2) = 63/140\ ps$

Summary: TDC

Central PMT

(ps)	$\sigma_t^L = 40$	$\sigma_t^L = 27$
Δt_{0-1}	118	114
Δt_{0-2}	297	295
Δt_{1-2}	180	182
$\sigma_t(0)$	85	78
$\sigma_t(1)$	85	78
$\sigma_t(2)$	88	82

Border PMT

(ps)	$\sigma_t^L = 40$	$\sigma_t^L = 27$
Δt_{0-1}	22	16
Δt_{0-2}	287	288
Δt_{1-2}	260	270
$\sigma_t(0)$	97	85
$\sigma_t(1)$	88	88
$\sigma_t(2)$	120	100

Electronic timing resolution

In simulation: $\sqrt{\sigma_t^2 - {\sigma_t^L}^2}$: $\sigma_t^L = 40\ ps$: $\sim 75\ ps$; $\sigma_t^L = 27\ ps$: $\sim 73\ ps$
From Matsuoka-san numbers it seems a bit better: $\sigma_t \sim 73\ ps$, $\sim 60\ ps$
Is this reasonable?

Conclusion I

Lens NA

- All lens measured
- $\sim 13\%$ bad NA
- $\langle NA \rangle = 0.51$
- but in three subpopulation with
  - $NA \sim 0.48$
  - $NA \sim 0.56$
  - $NA \sim 0.48$

Conclusion II

Time distribution simulation

- Simulation reproduce reasonable well results shown in CRT analysis;
  - Direct, 1-reflection, 2-reflections photons produce signals separated in time for some of the channels;
  - fit signal with 3-gaussian model taking into account different contribution could separate the three signals, recovering optimal time resolution;
  - As the separation of the three signal depends on light-path, possible to estimate *a priori* Δt to reduce free parameters in the fit;
- Selection based on ADC signal (done in CRT) not possible since not simulated
- Is the simulated electronic σ_t correct?