Status of the TOP calibration system

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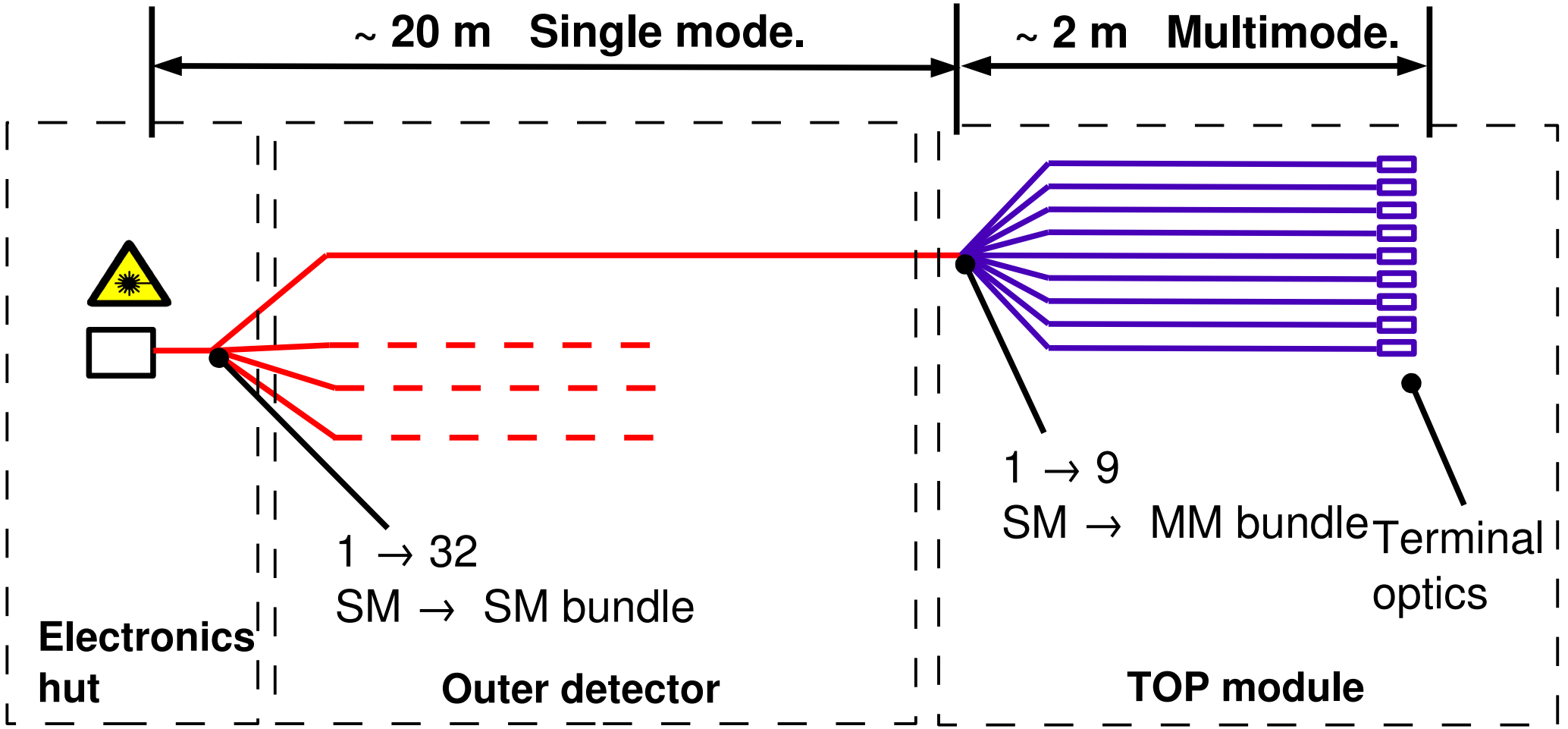
Second Belle II Italian collaboration meeting
Napoli, December 17th-18th, 2014

Light distribution

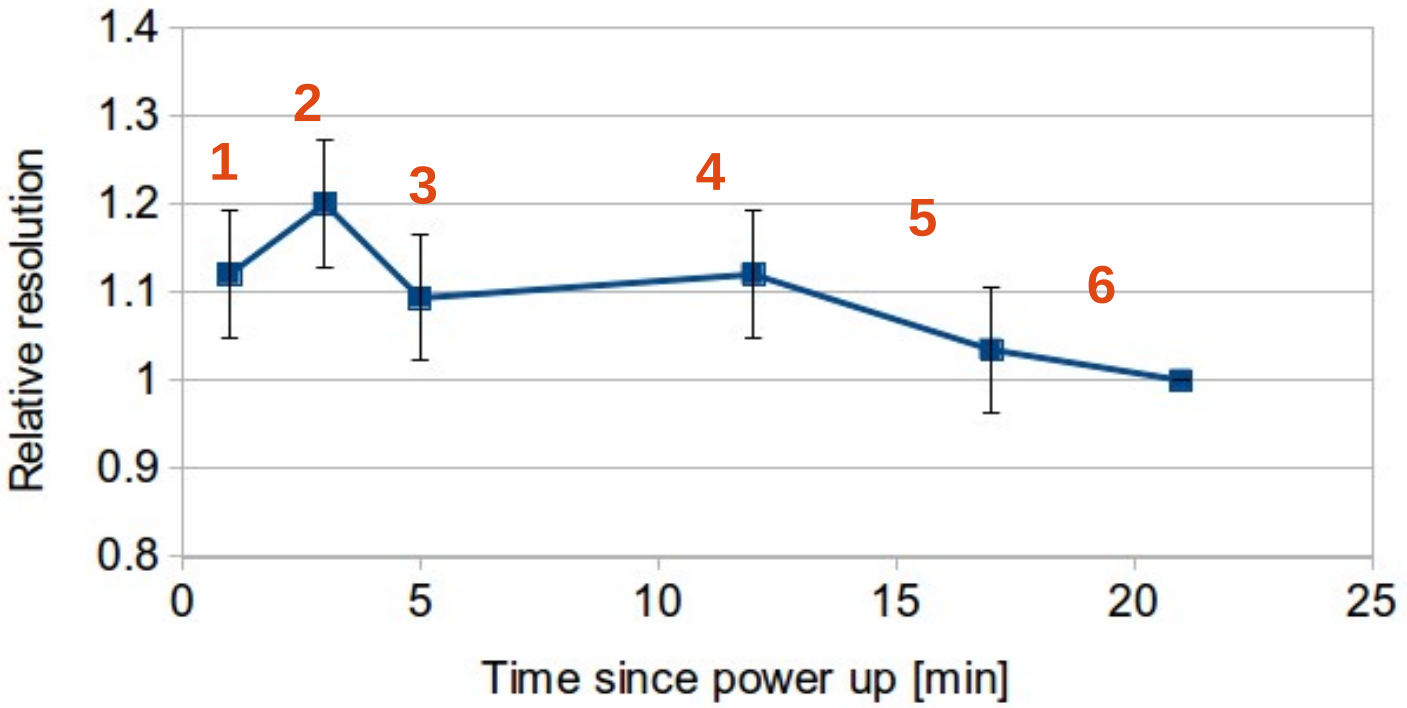


Progresses

→ Picolaser characterization
→ Module 1 assembly
→ Characterization of new MM fibers
→ Characterization of SM bundle
→ Mechanical integration in BelleII

Laser stability studies

Relative resolution = resolution / resolution after 21 min



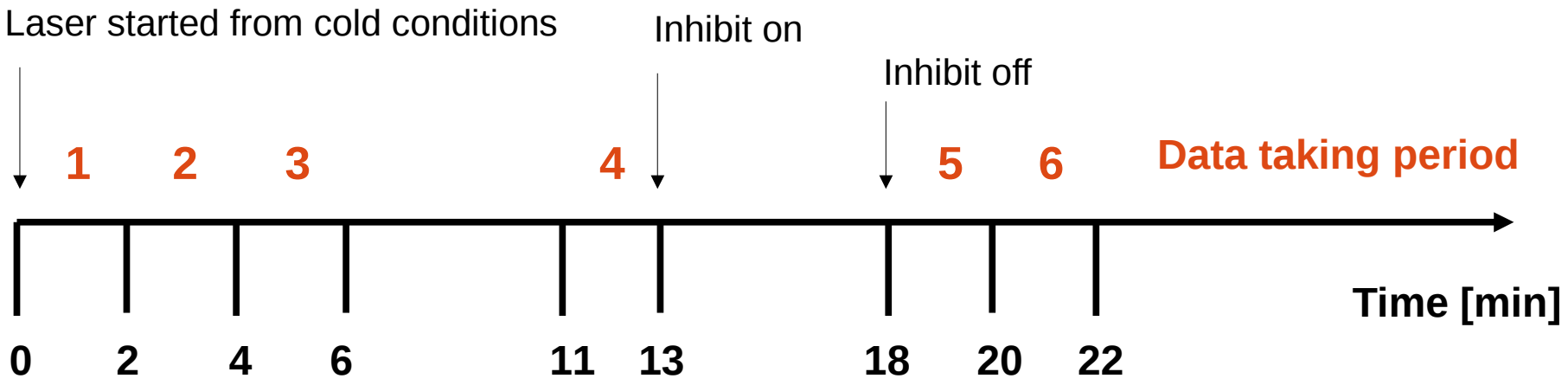
Stability within 10% (recommended warm up time = 5 min)

Laser settings

$\lambda = 405 \pm 2$ nm

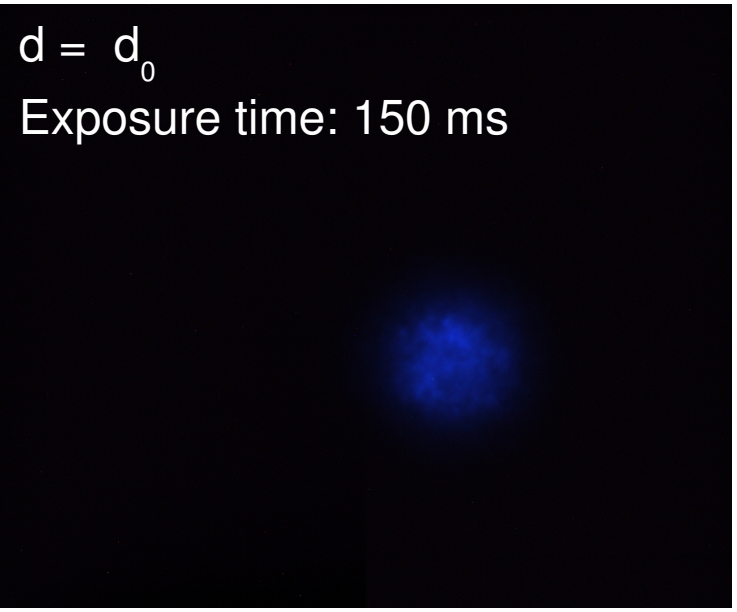
Nominal time jitter = 23 ps

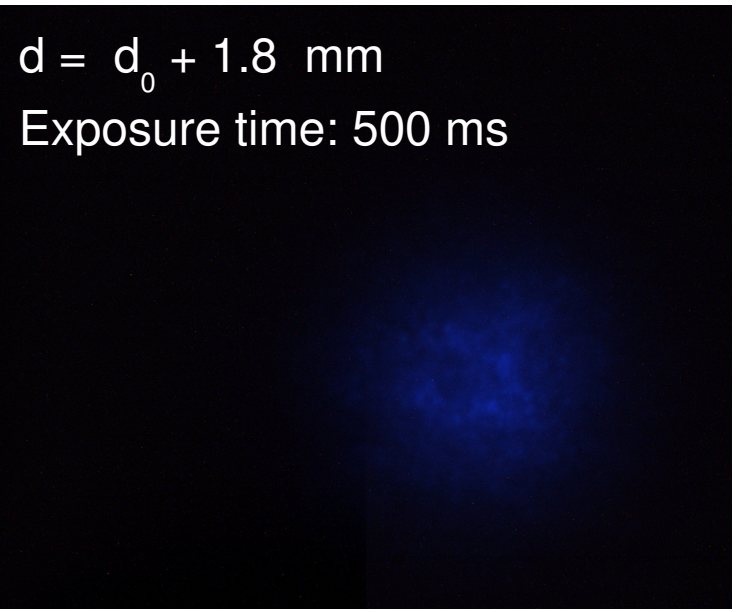
Pulse energy 14 pJ



Laser beam profile

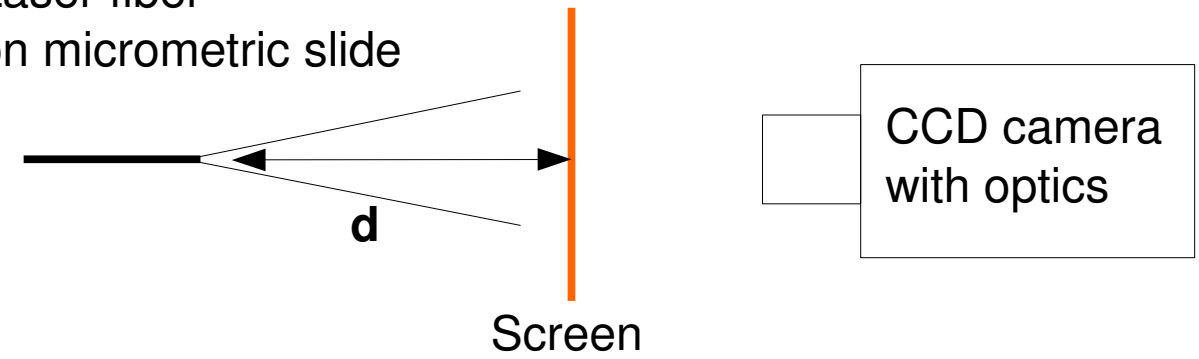
In collaboration with
Alessandro Re (Univ. Torino)

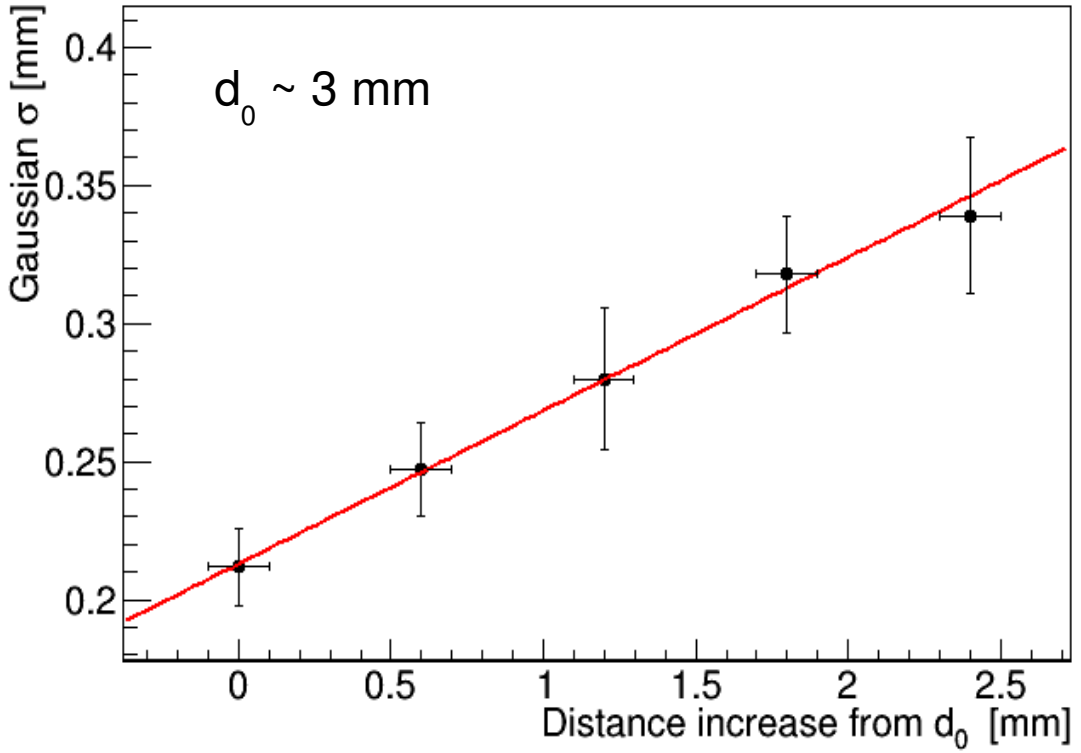




2.90 mm

3.47 mm





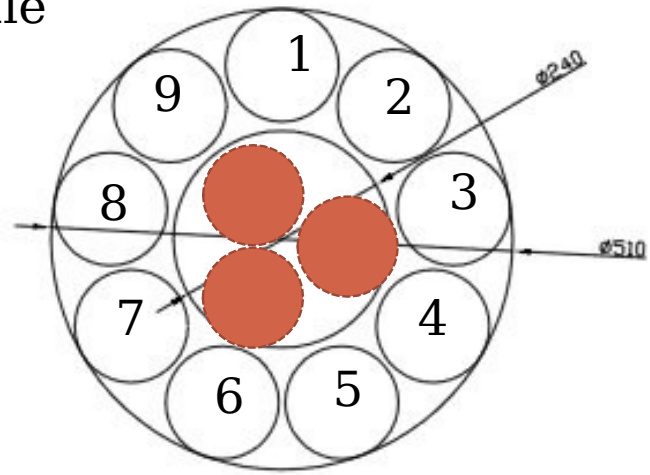
From the linear fit:

tan(Θ/2) = 0.056 ± 0.014

Θ = 0.11 ± 0.02 rad

Module 1: Multimode bundle

Multimode fiber bundle with 9 fibers 2 meters long ended with SMA ferrule

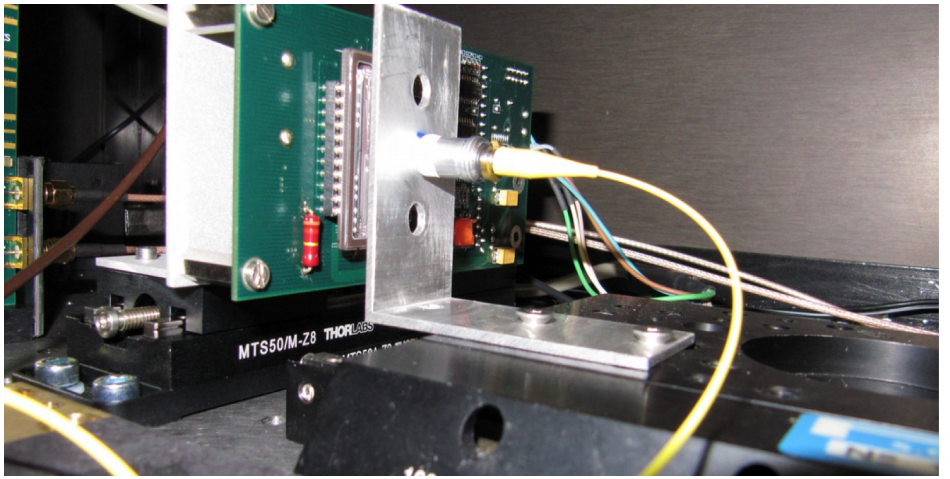


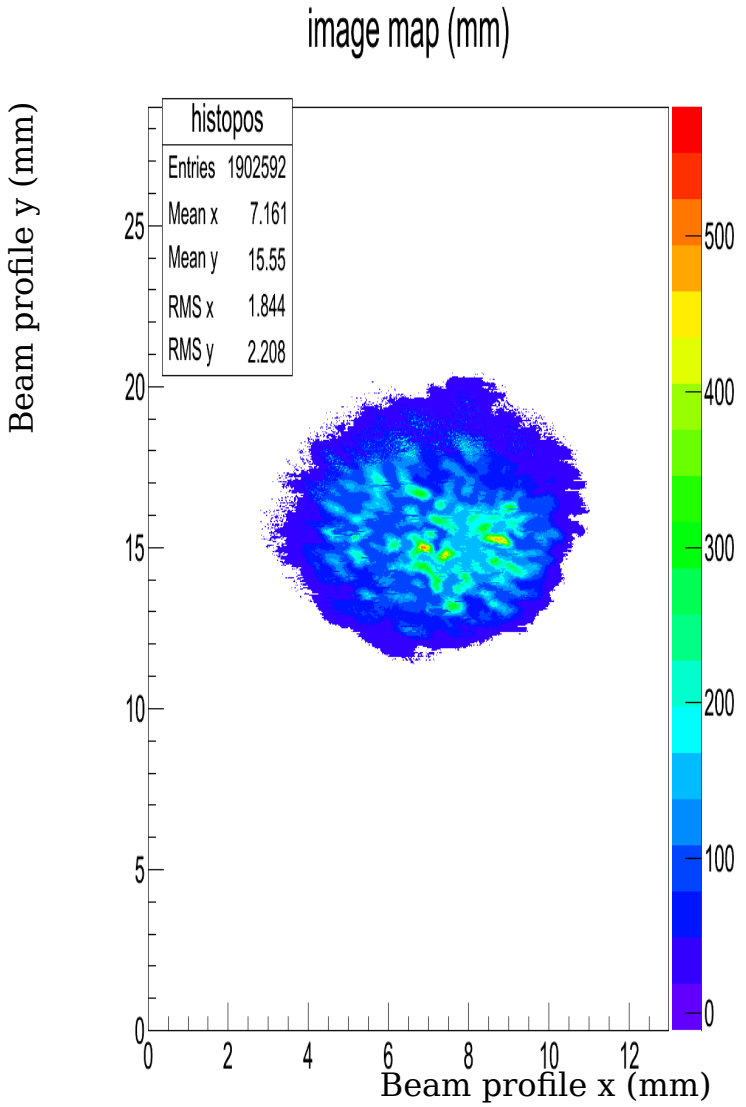
Bundle prototype (installed on module 1)
Step index
Cladding = 240 µ m
Core = 105 µ m
Single fiber efficiency (SFE) = $(105 / 510)^2 = 4.2\ \%$

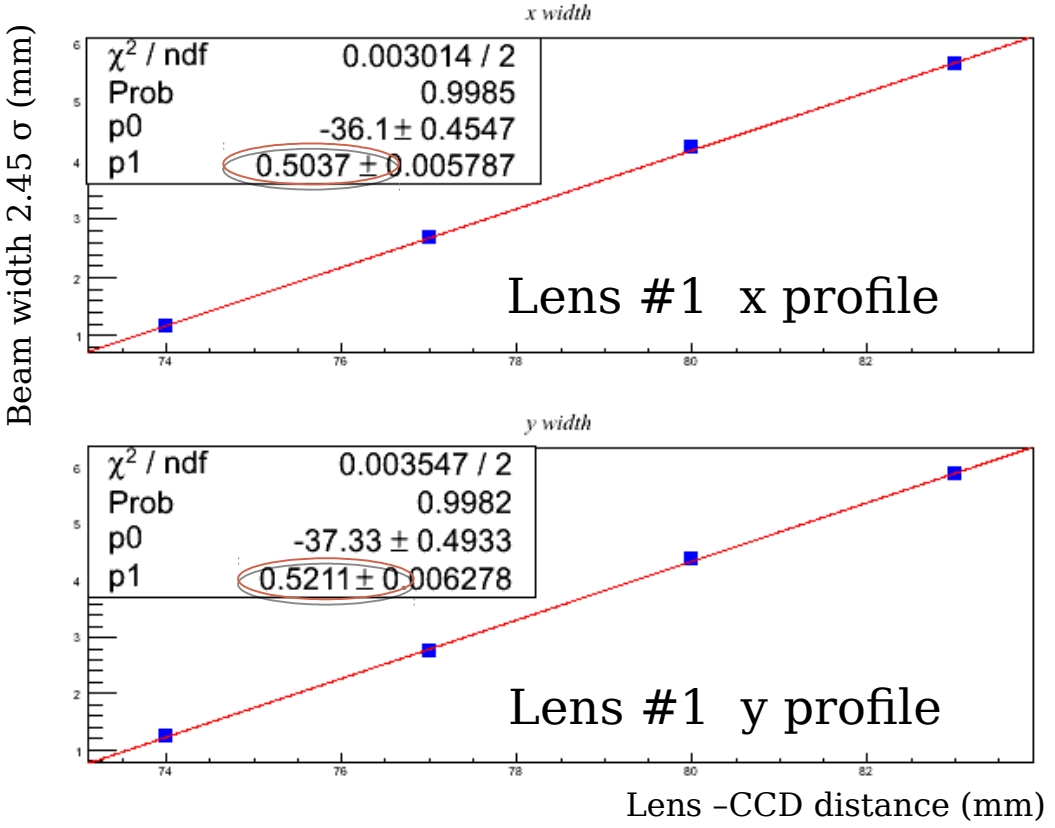
New bundles (do be installed on future modules)
Graded Index
Cladding = 240 µ m
Core = 65 µ m
SFE = 1.6%

Grin Lens numerical aperture

Setup for NA measurement with CCD
Multimode fiber with
grin lens NA=0.6

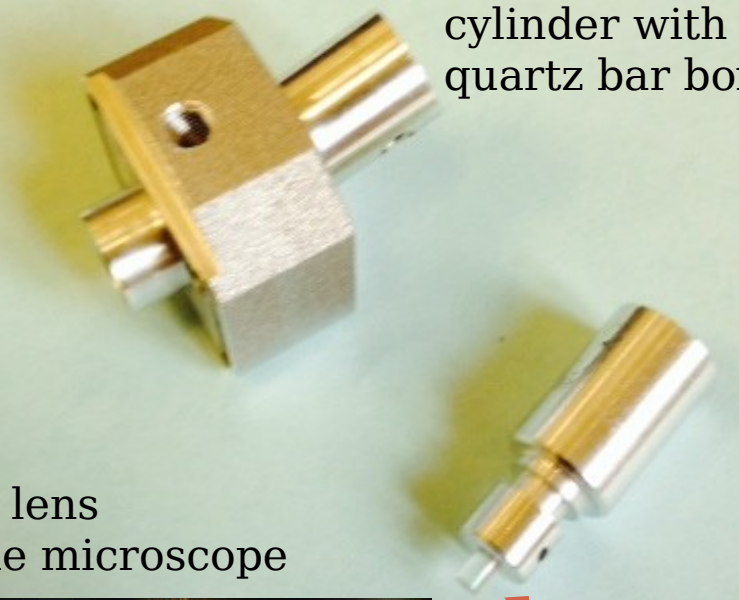






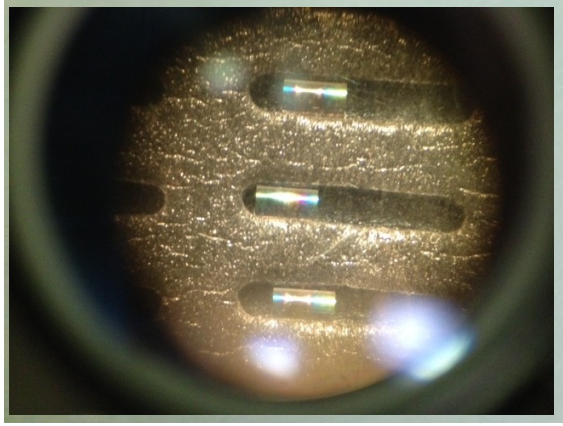
Module 1: Terminal optics

Spread the light with a grin lens implemented at the end the fiber



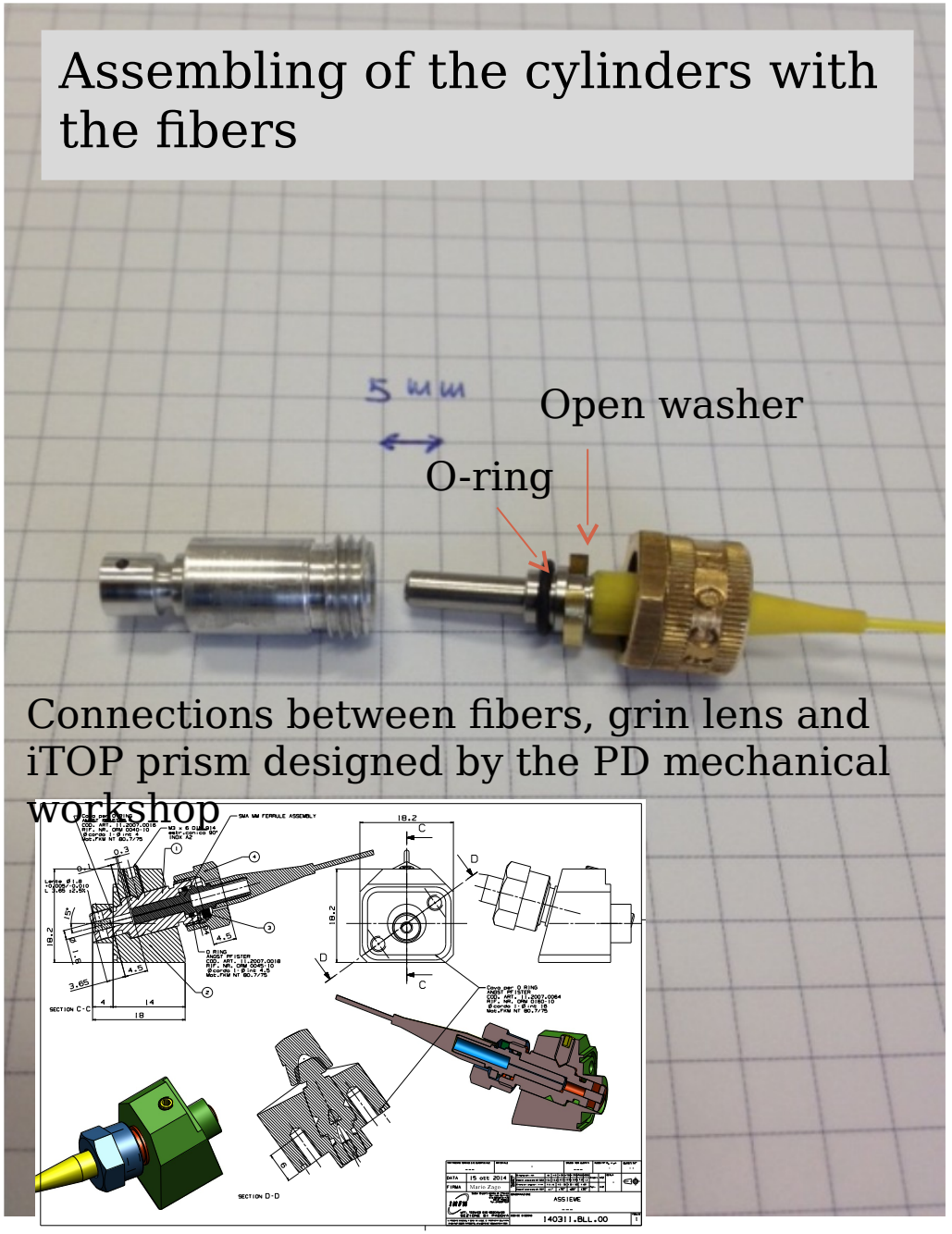
Block to integrate cylinder with the quartz bar box

Grin lens at the microscope



Grin lens

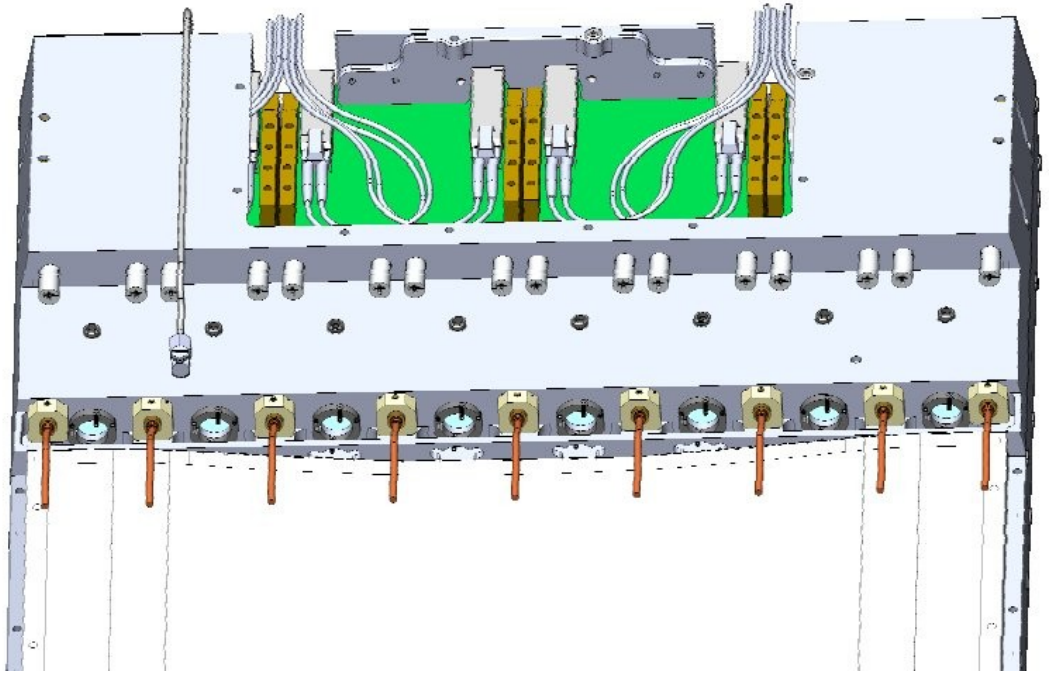
Assembling of the cylinders with the fibers



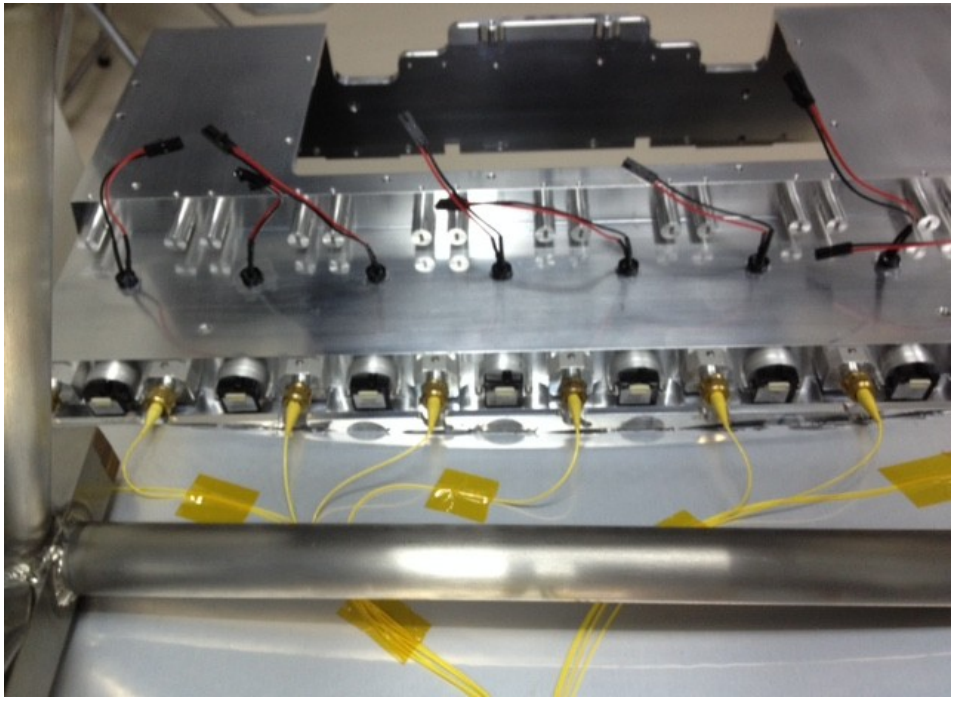
Connections between fibers, grin lens and iTOP prism designed by the PD mechanical workshop

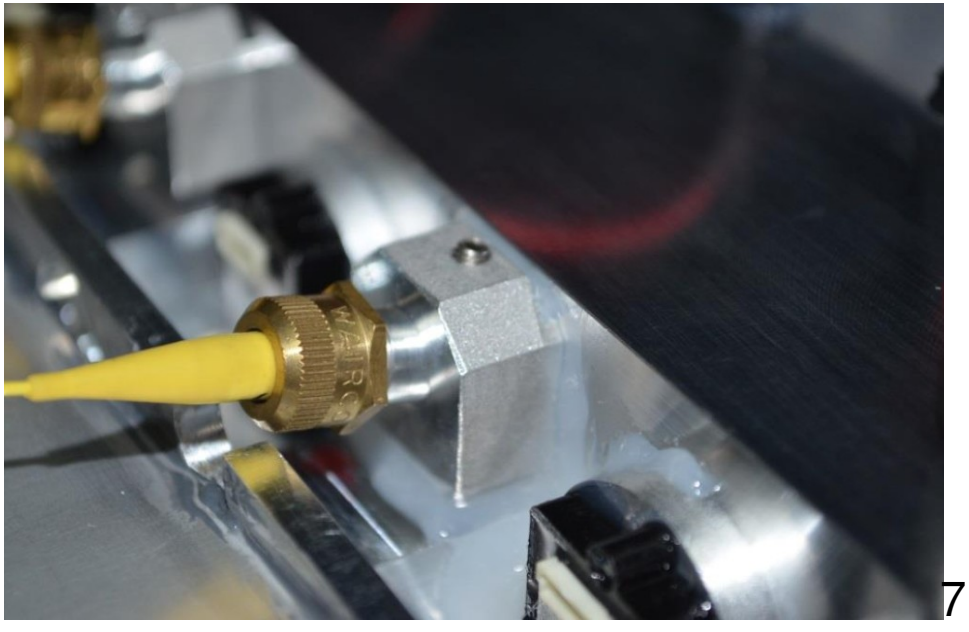
Module 1 integration

CAD design



Module 1





Problems:

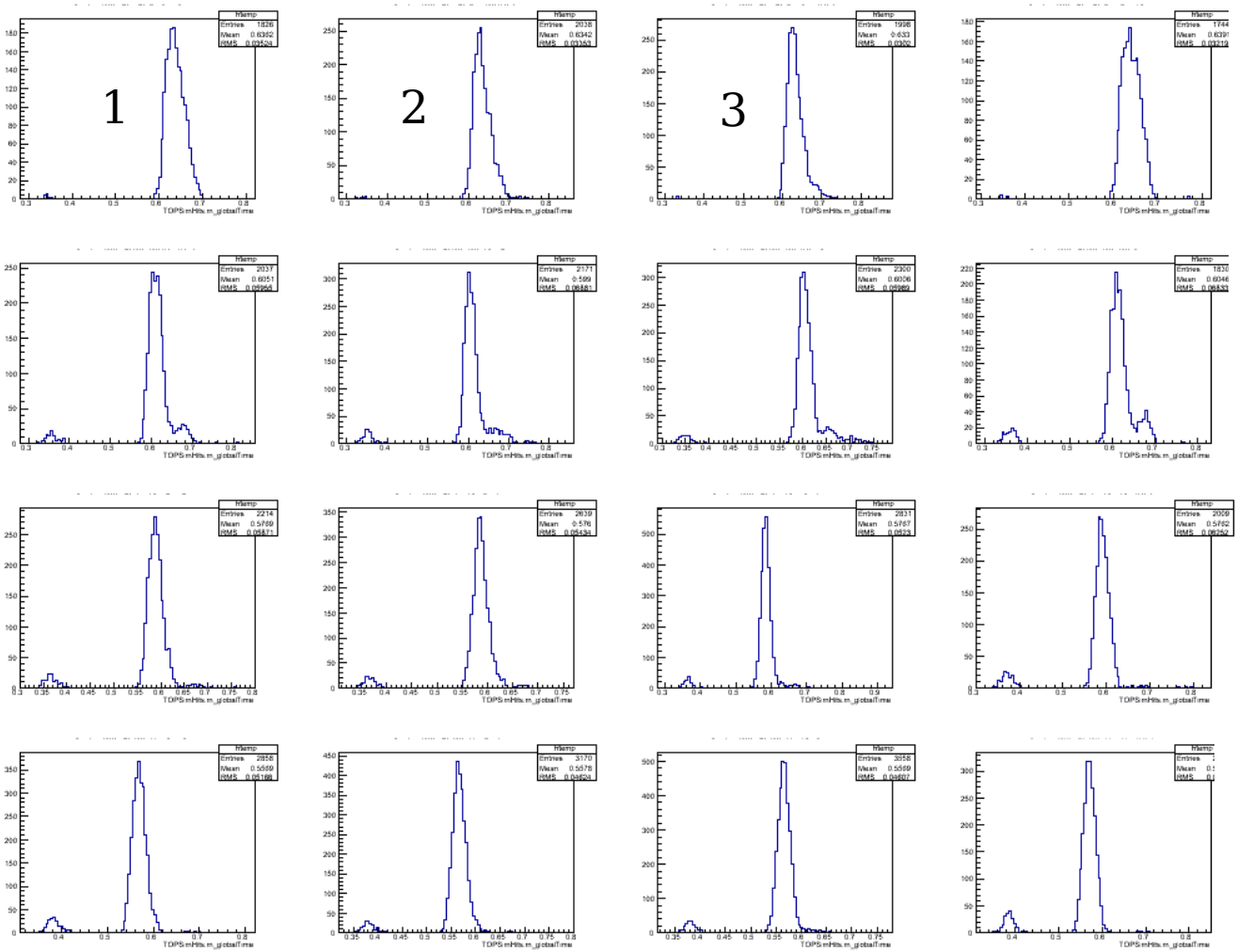
Mechanical interference between
the supports and the honeycomb
→ change injection angle from 15° to 17°

Gas leakage due to defective O-ring
→ sealed with silicon rubber on Module 1
→ O-ring changed in in the supports

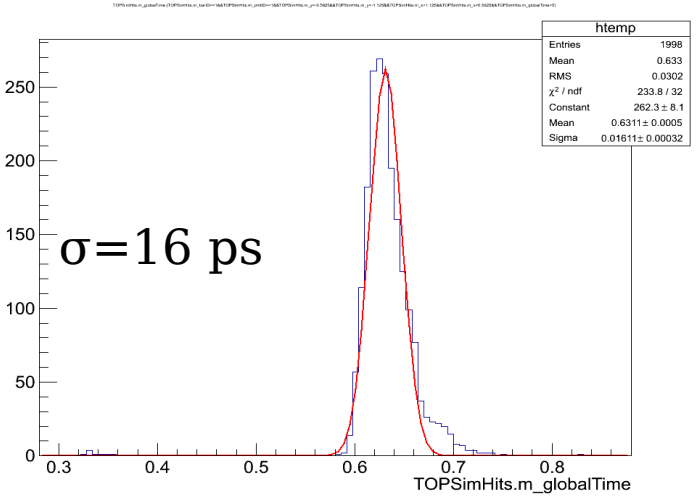
MC simulation for module 1

- Light input angle 17 degree
- Realistic gaussian angular distribution of each light point

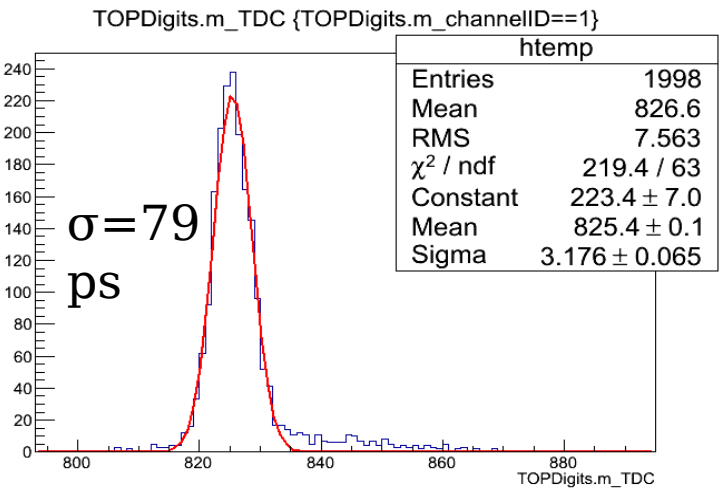
16- channel PMT response



Fit Simhit channel 3



Fit Rechit TDC count



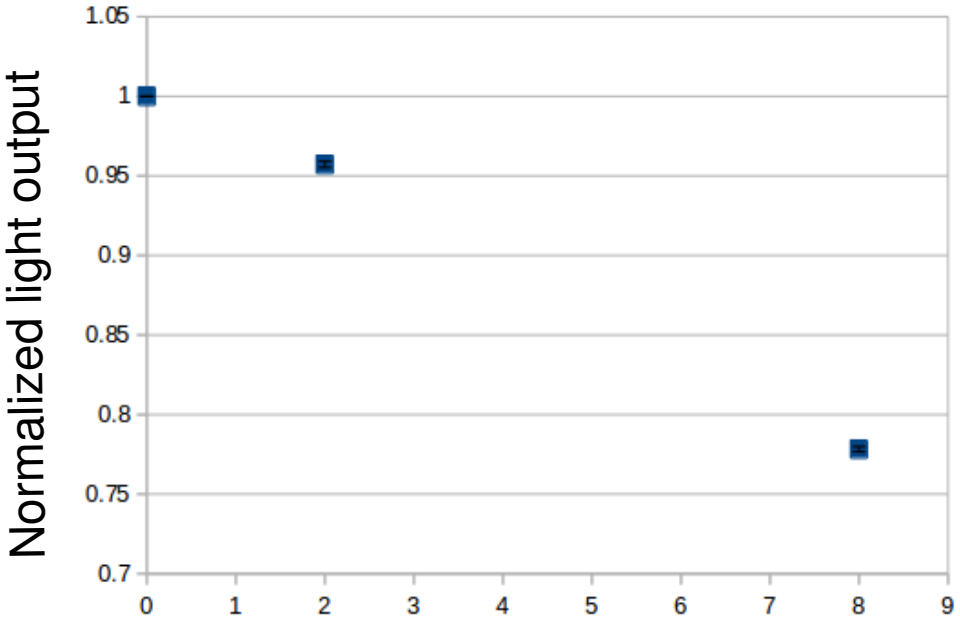
Attenuation in graded index fibers

New multimode fibers

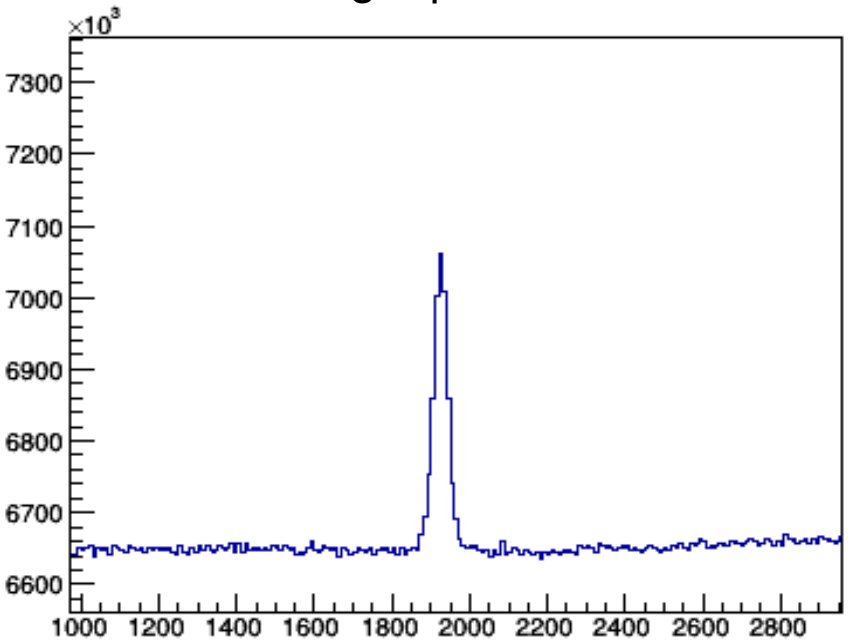
Graded Index
Cladding = 240 µ m
Core = 65 µ m
SFE = 1.6%

Time spread < 1 ps / m
Lower piping efficiency (smaller core)
Never tested for 405 nm light

Attenuation measurements done with CCD setup in Torino



Light profile



Piping efficiency

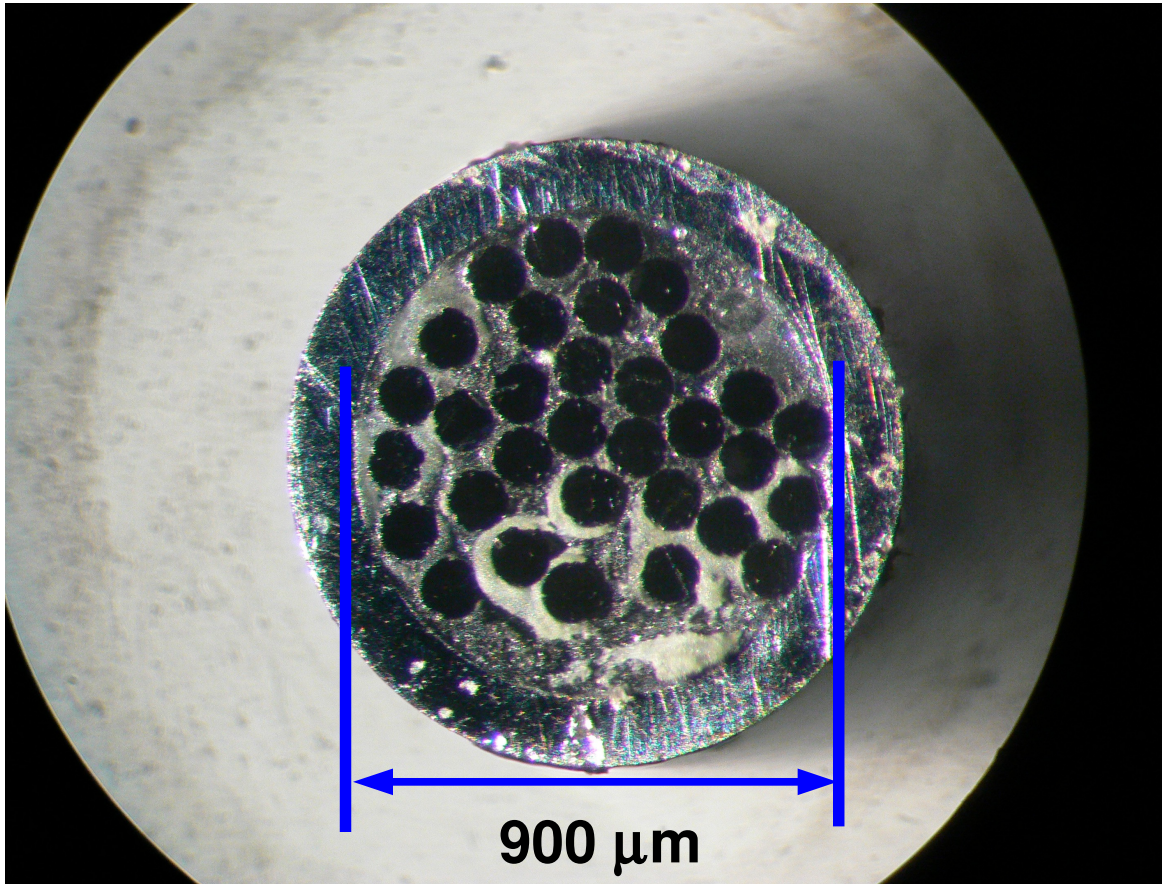
Optimal laser operation point: 14 pJ/pulse, 100kHz (lifetime > 5 yr)
→ 10 kHz max in order to copy with the DAQ limitation

Piping efficiency of each light source

$\varepsilon = SFE_{SM} \times SFE_{MM} \times attenuation = 2 \times 10^{-5} \times 1.6 \times 10^{-2} \times 0.95 = 3 \times 10^{-7}$

$N\gamma/pulse = 2.8 \times 10^{7}$

→ **~ 9 photons/(pulse x source)**
→ **~0.15 photons/(pulse x channel)**



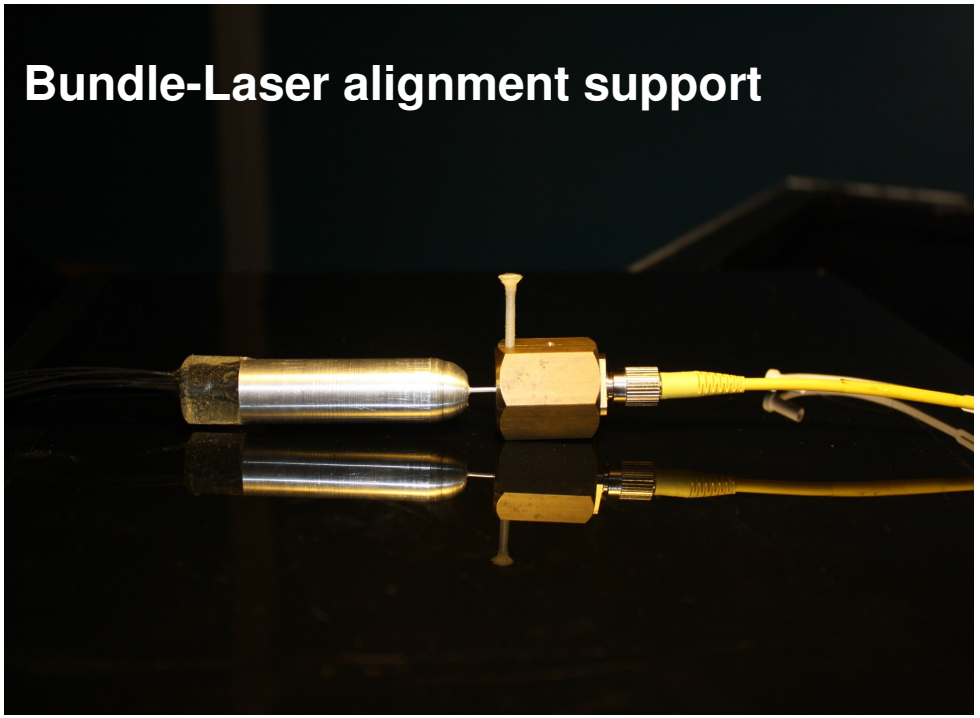
Actions that can be taken:

→ **increase fiber core**

→ **SM bundle with cores only**

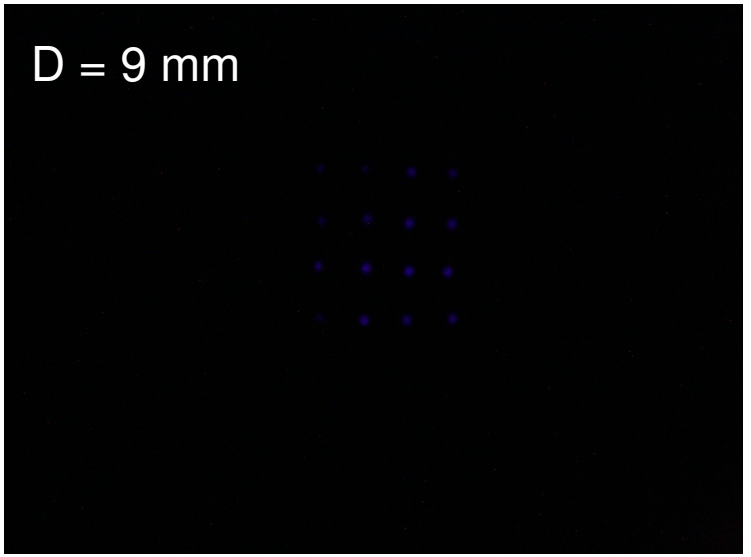
→ **reduce the size of the SM bundle**
→ 1 spare every two modules
→ minimize dead areas

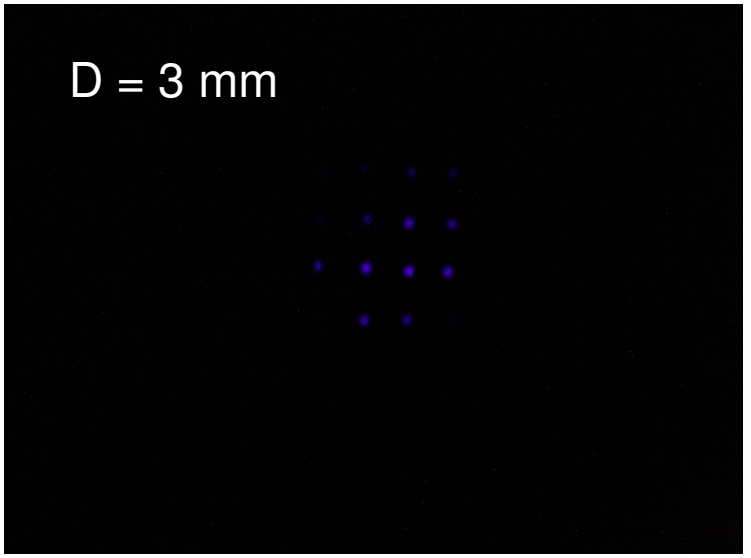
Towards precise SFE_{SM} measurement



Grants alignment allowing to adjust the bundle-fibre disance at 0.1 mm level

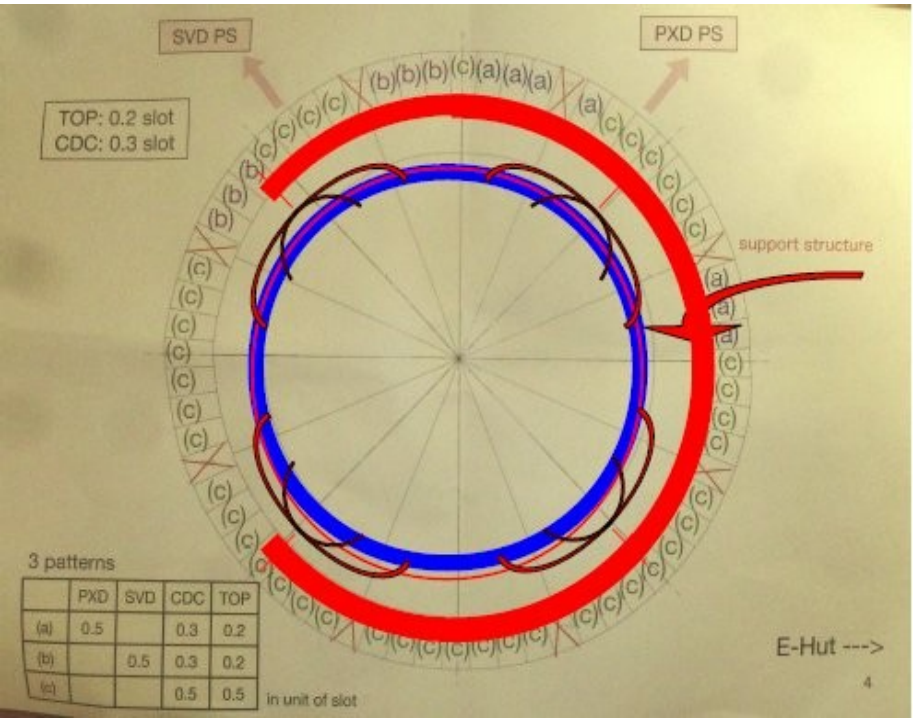
Analysis of light distribution and piping efficiency ongoing



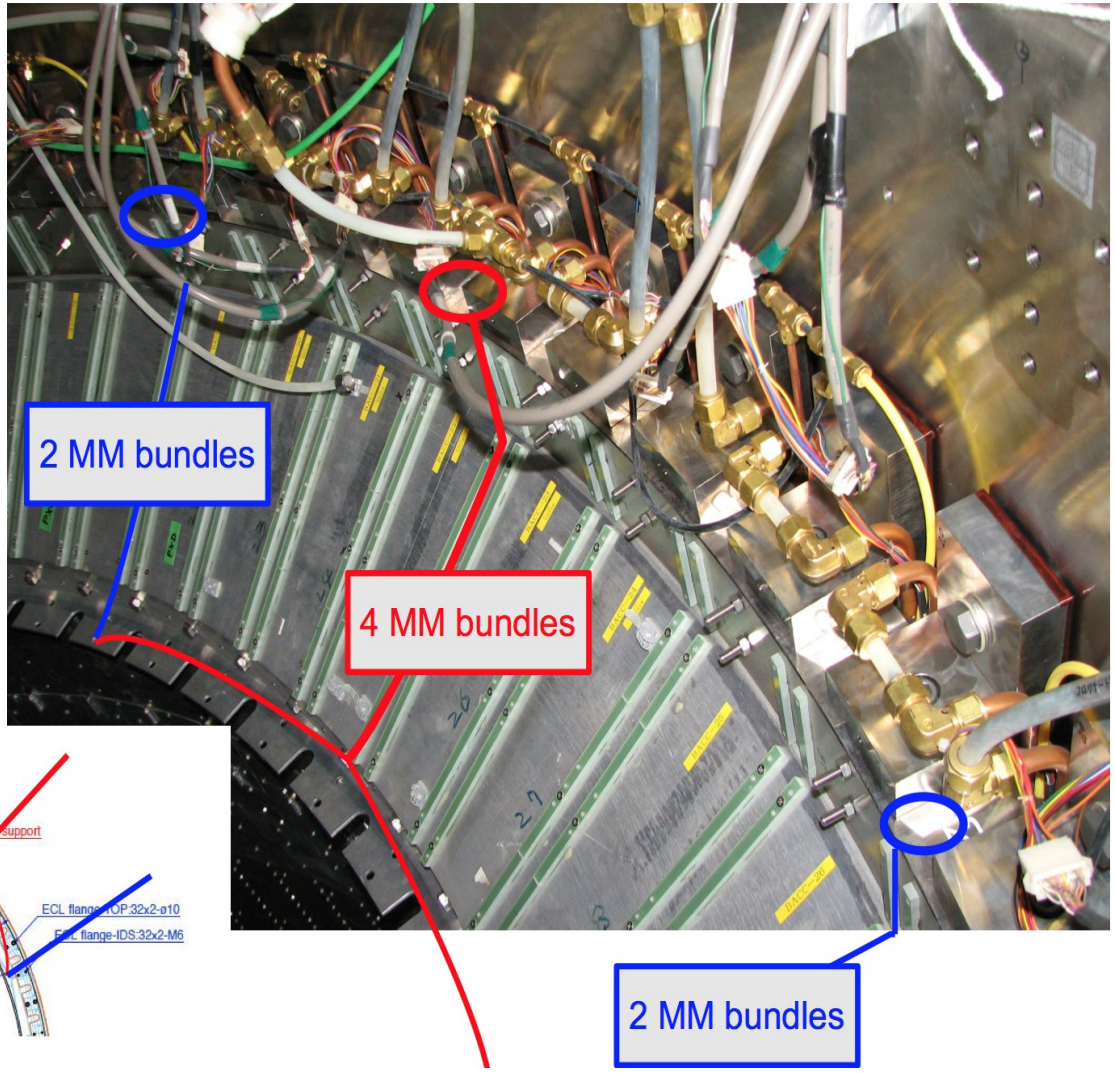


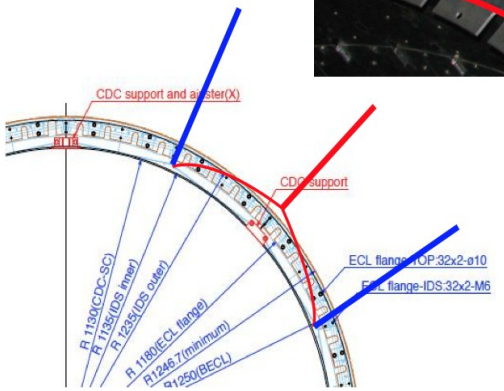
Light output form 16 fibers randomly distributed in the bundles

Fiber routing on the detector



	PXD	SVD	CDC	TOP
(a)	0.5		0.3	0.2
(b)		0.5	0.3	0.2
(c)			0.5	0.5





Studies for mechanical support for the MM bundle connectors are ongoing

Conclusions

Done:

The MM bundle prototype has been successfully integrated in the Module 1

Attenuation in the new MM fibers has been measured

The setup for the GRIN lens numerical aperture is ready and working

The setup for study of the piping efficiency on the SM bundle is ready and working

Plans:

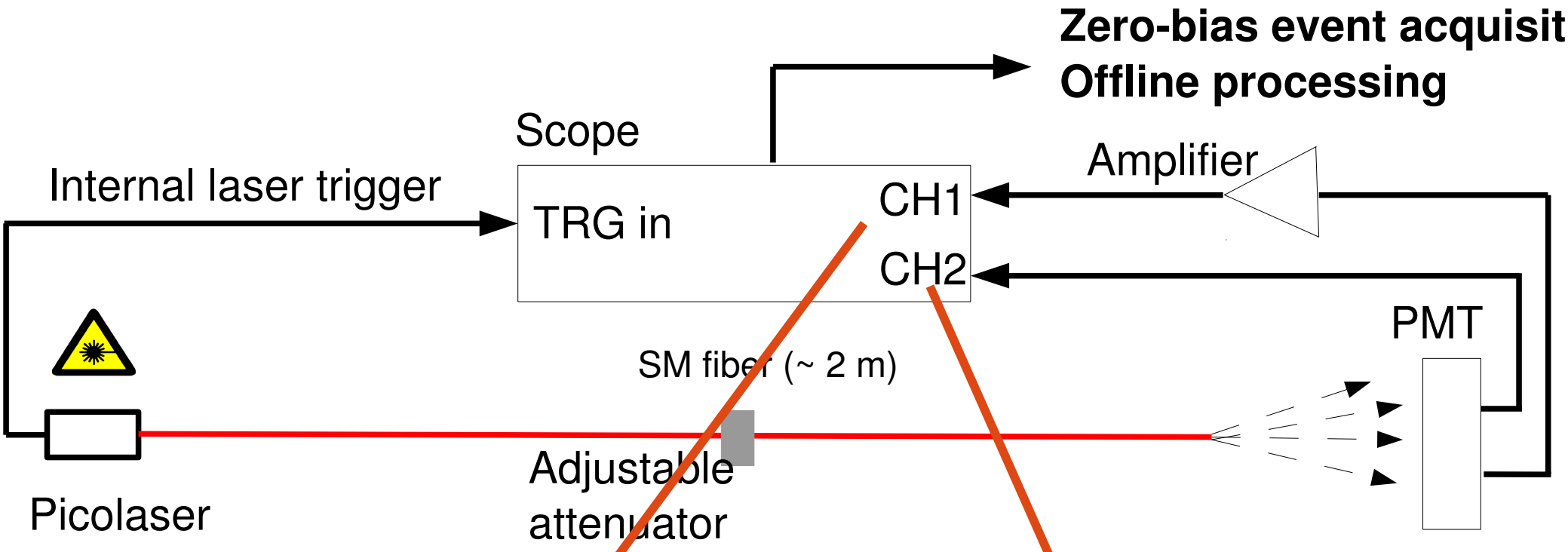
Irradiation studies at Legnaro
→ tricky for SM fibers due to connectors

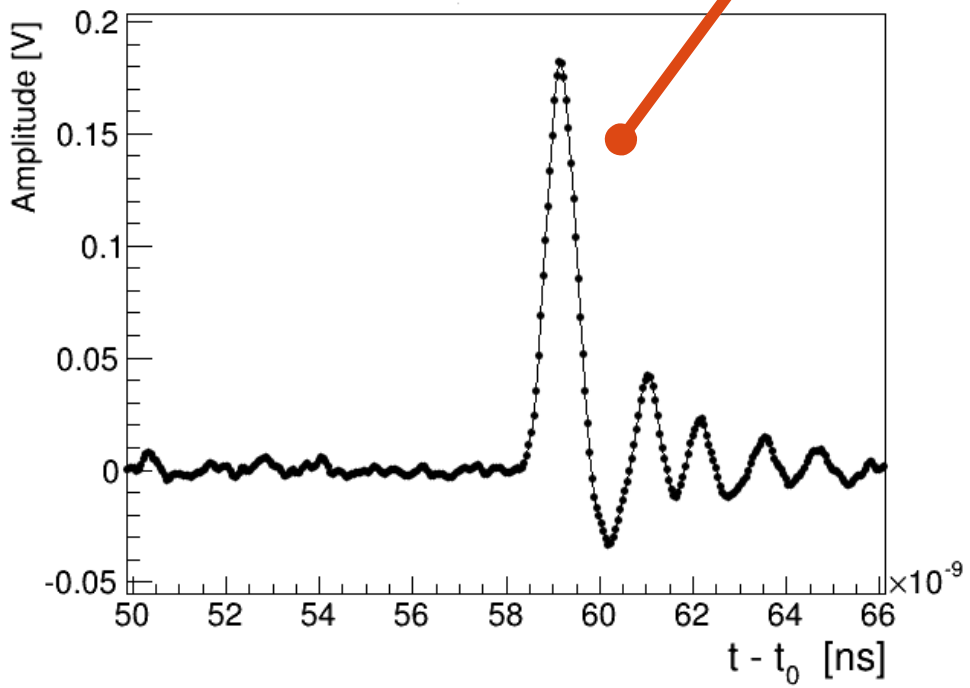
Complete laser characterization

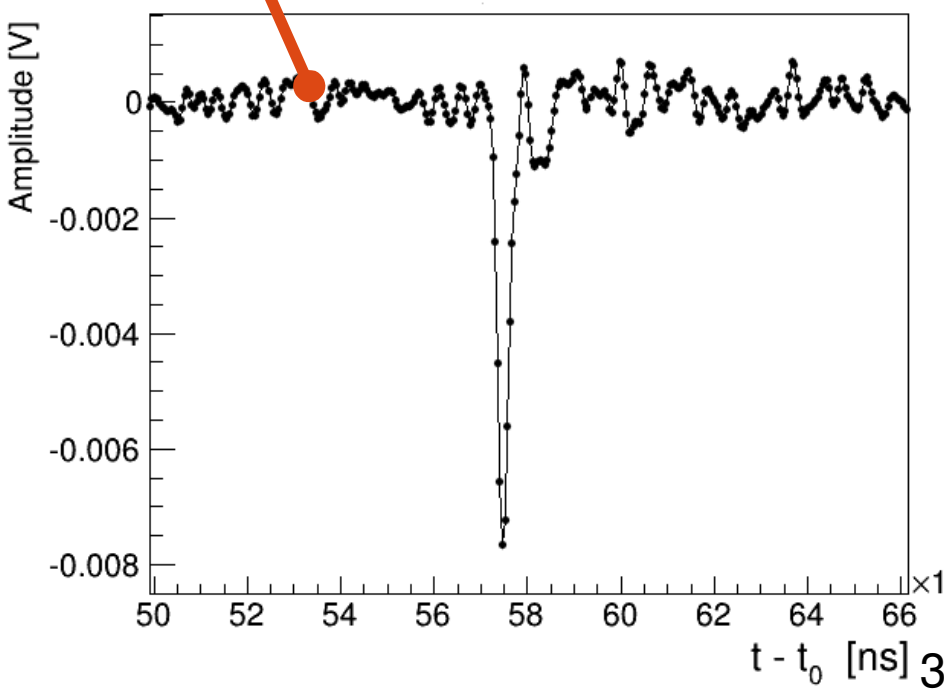
Produce a new SM bundle prototype with smaller radius

Backup

Experimental setup in Torino

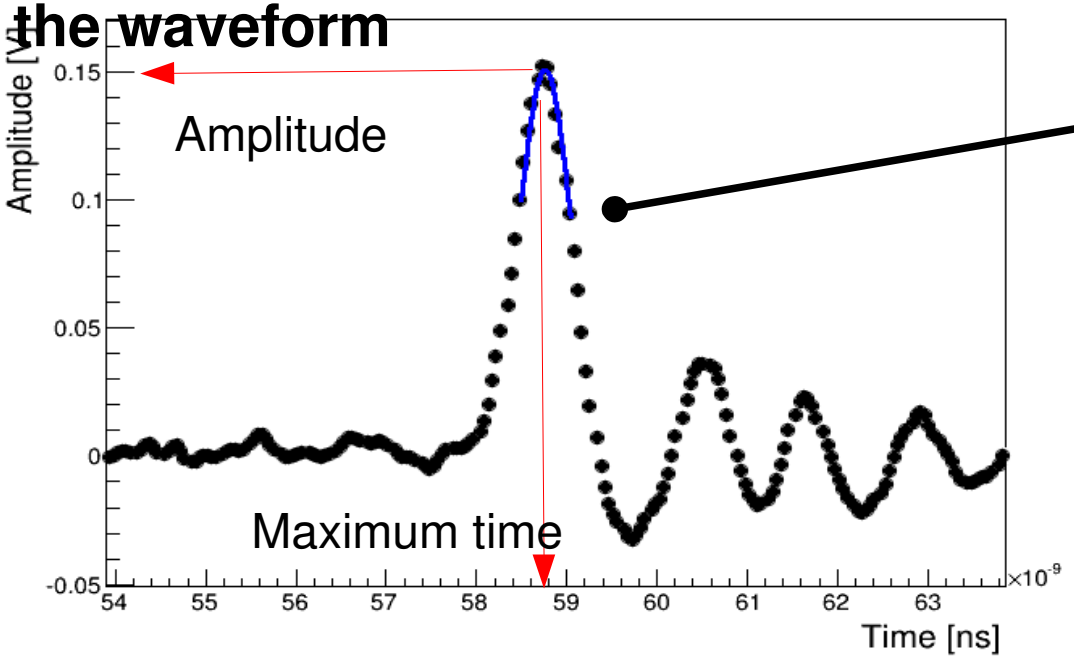






Signal processing – I

DC offset is subtracted fitting the first points of the waveform

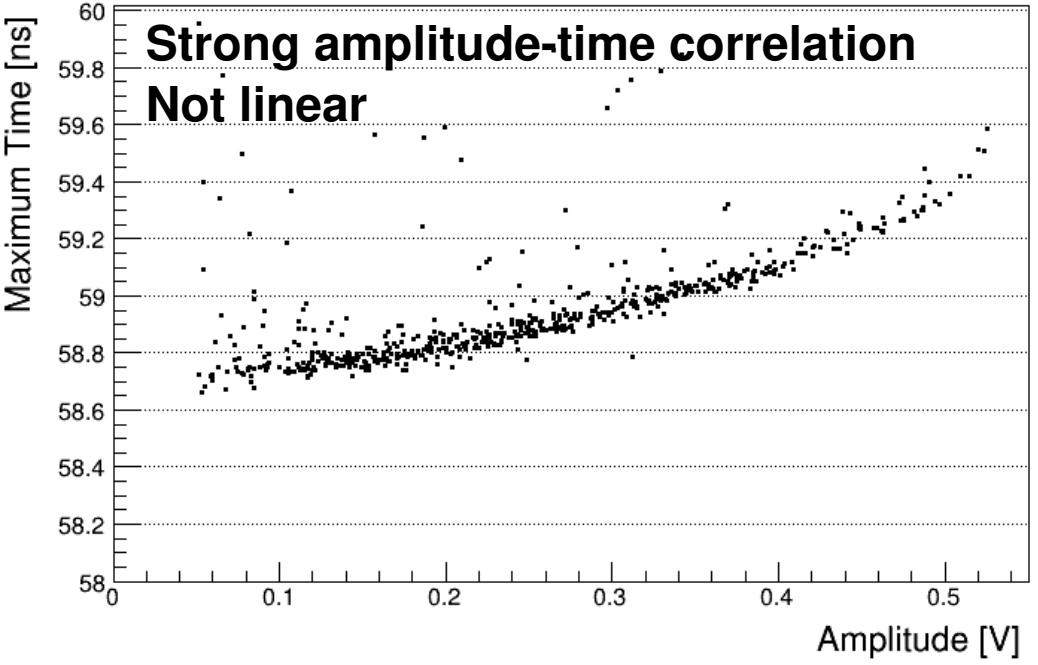


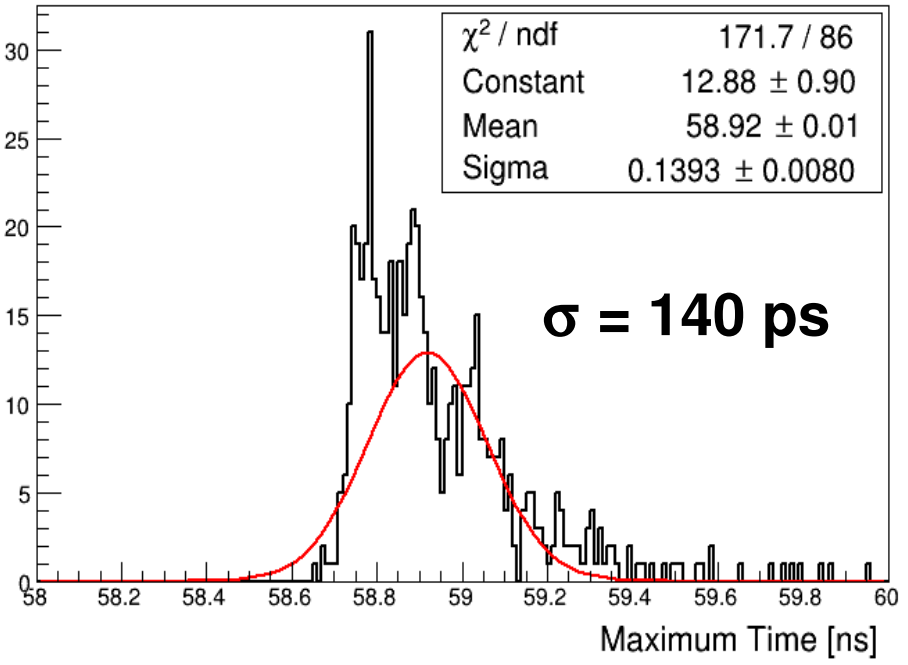
Gaussian fit around the maximum Point.

Determination of:

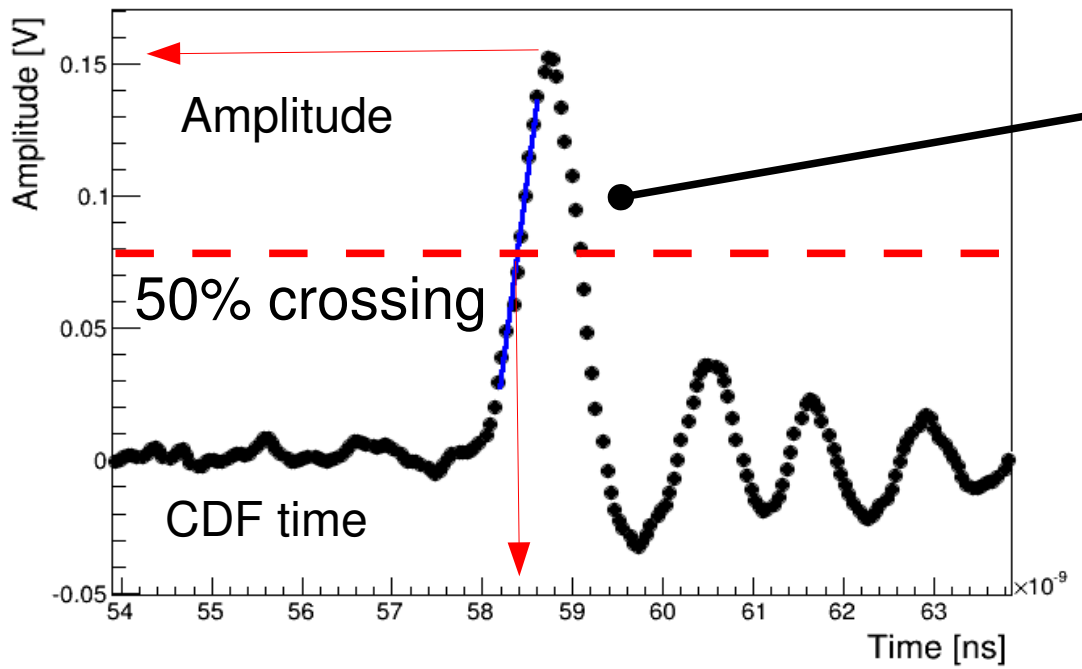
→ Signal amplitude

→ Maximum time



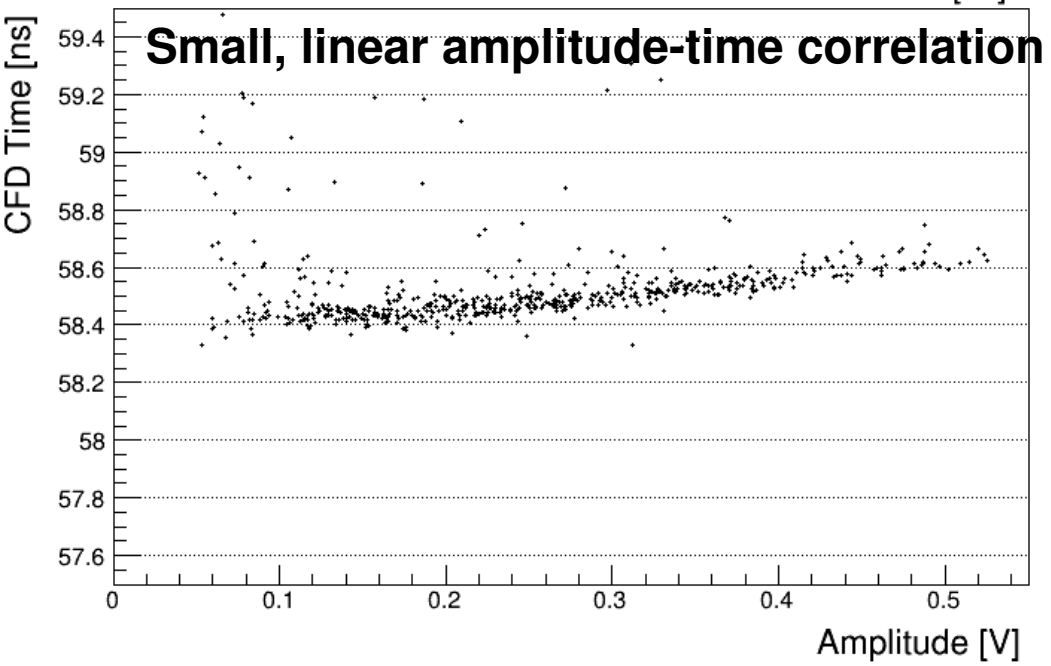


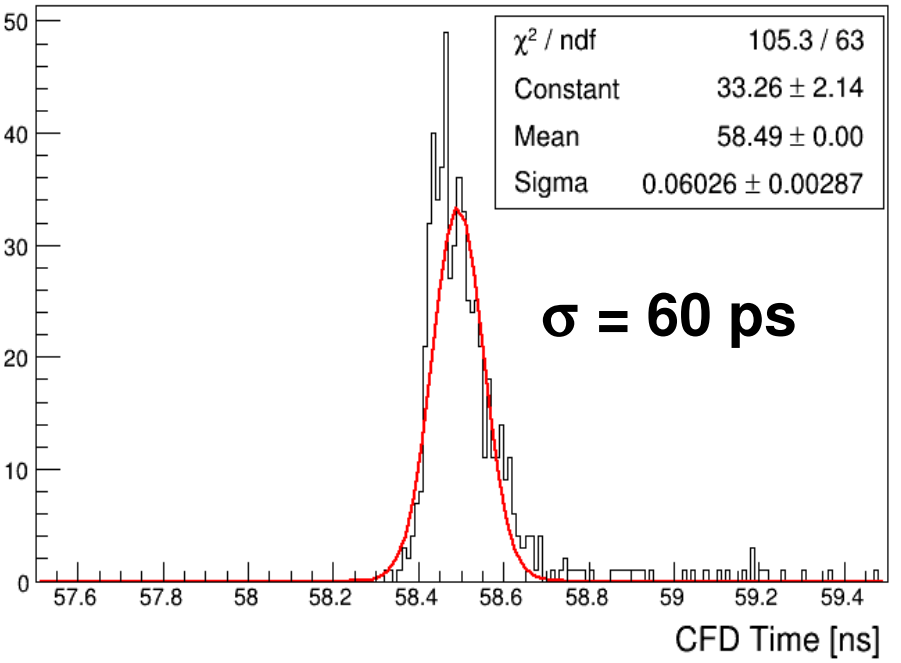
Signal processing – II



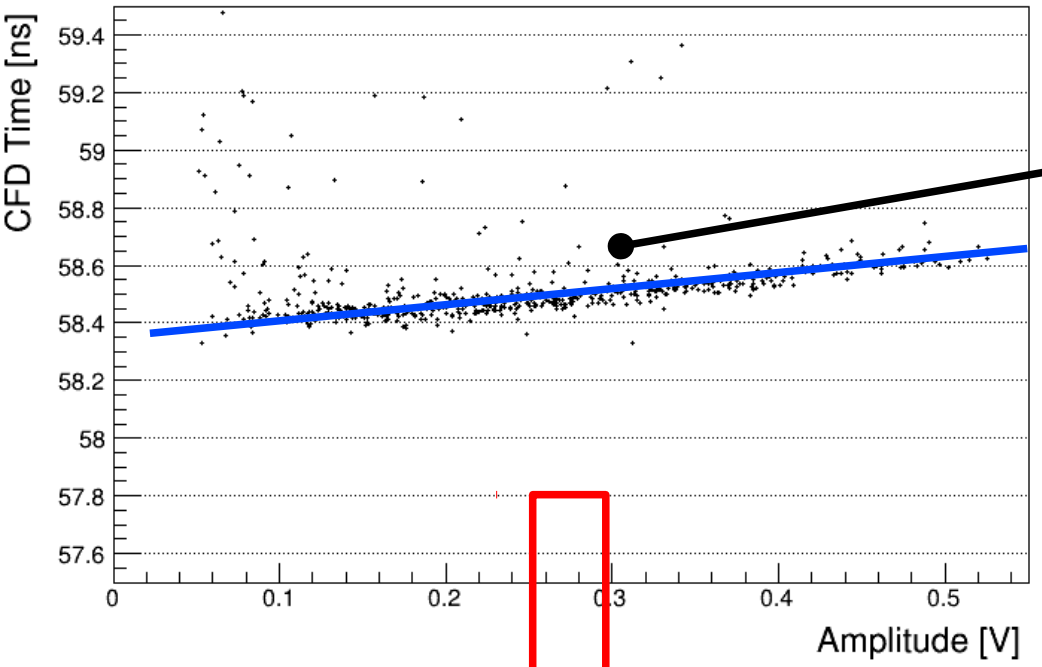
Linear fit around the 50% crossing

Determination of:
→ 50% crossing time (CFD time)





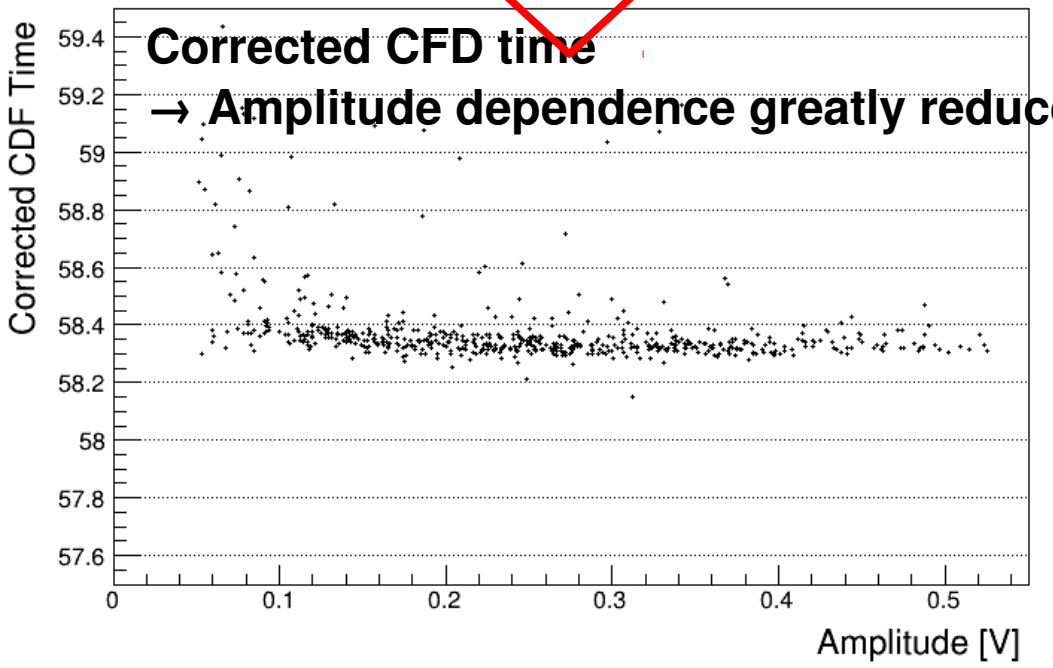
Signal processing – III

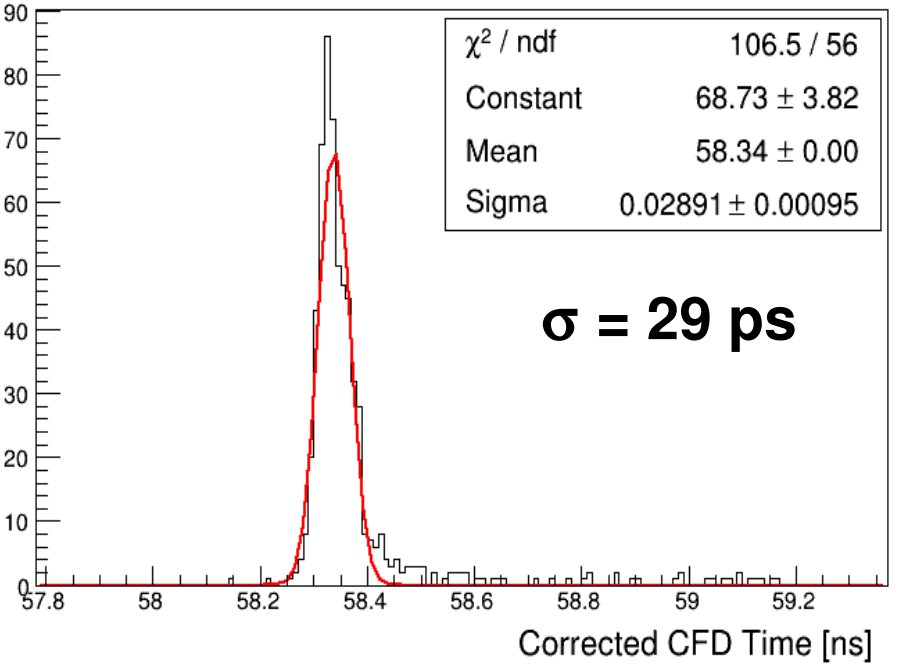


Linear fit of the Amplitude VS CFD time Distribution

Determination of:
→ corrected CFD time

Corrected CFD time
→ Amplitude dependence greatly reduced



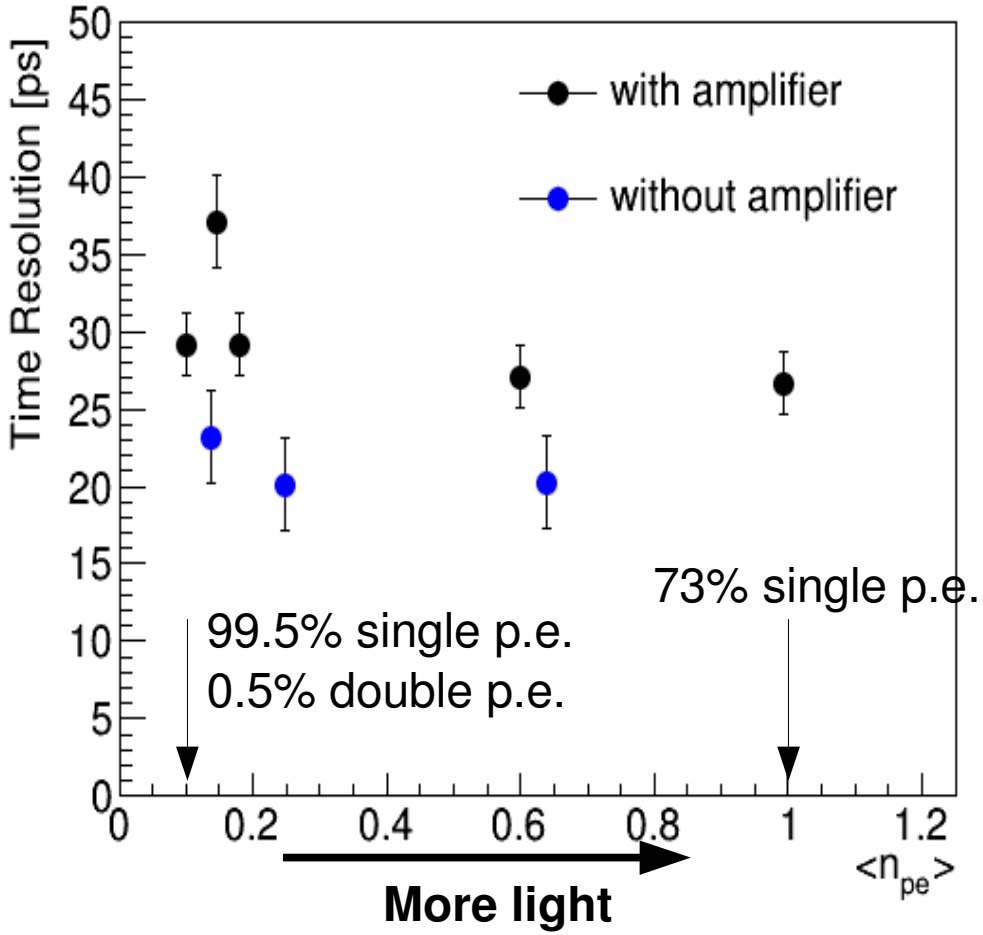


σ = 29 ps

Results

Time resolution study repeated for different laser tunings and different HV value

From <n_pe> the contamination from > 1 photoelectron events can be calculated



Results

Time resolution study repeated for different laser tunings and different HV value

Resolution is expected to drop with reduced
→ only one study is available so far
→ confirmation is highly desired