



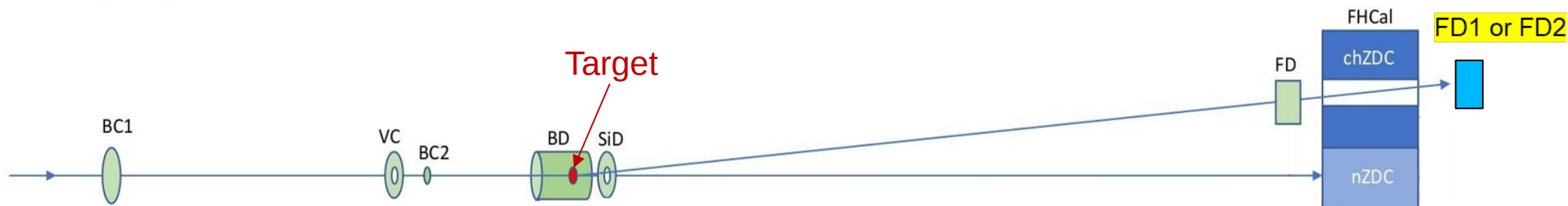
JOINT INSTITUTE
FOR NUCLEAR RESEARCH



FD1 and FD2 test counters from the BM@N run with a Xe beam

Valyo Velichkov

Overview of the trigger scheme

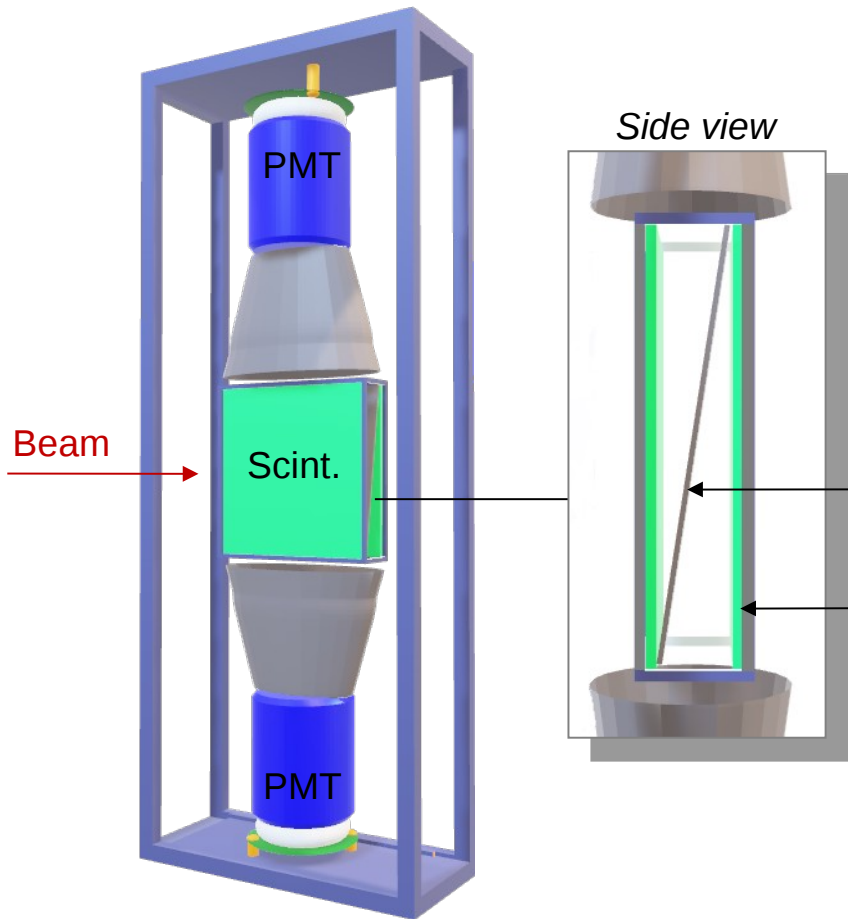


The trigger system for the BM@N includes the following detectors:

- beam counters in the vacuum transport line **BC1**, **BC2(T0)** and **VC**;
- multiplicity detectors in the target area **BD** and **SiD**;
- a detector of charged high-momentum fragments **FD**;
- a forward hadron calorimeter **FHCaI**;

Additional counters **FD1** and **FD2** are placed behind the FHCaI beam hole.

Design of FD1



FD1 has exactly the same PMTs and scintillator like in BC1.

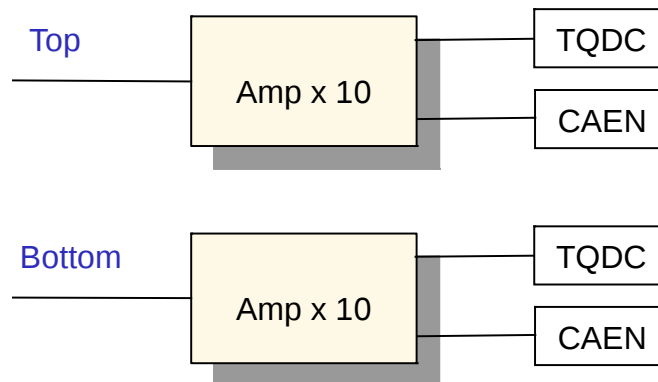
PMT	Radiator
Hamamatsu R2490-07	2 x Scint. BC400B 100x100x0.25mm ³

“Air”- lightguides from Al-mylar

An aluminum mylar is positioned between the scintillators, serving as a mirror.

Mirror from Al-mylar

Scintillators



Design of FD1

The housing is constructed using aluminum profiles.

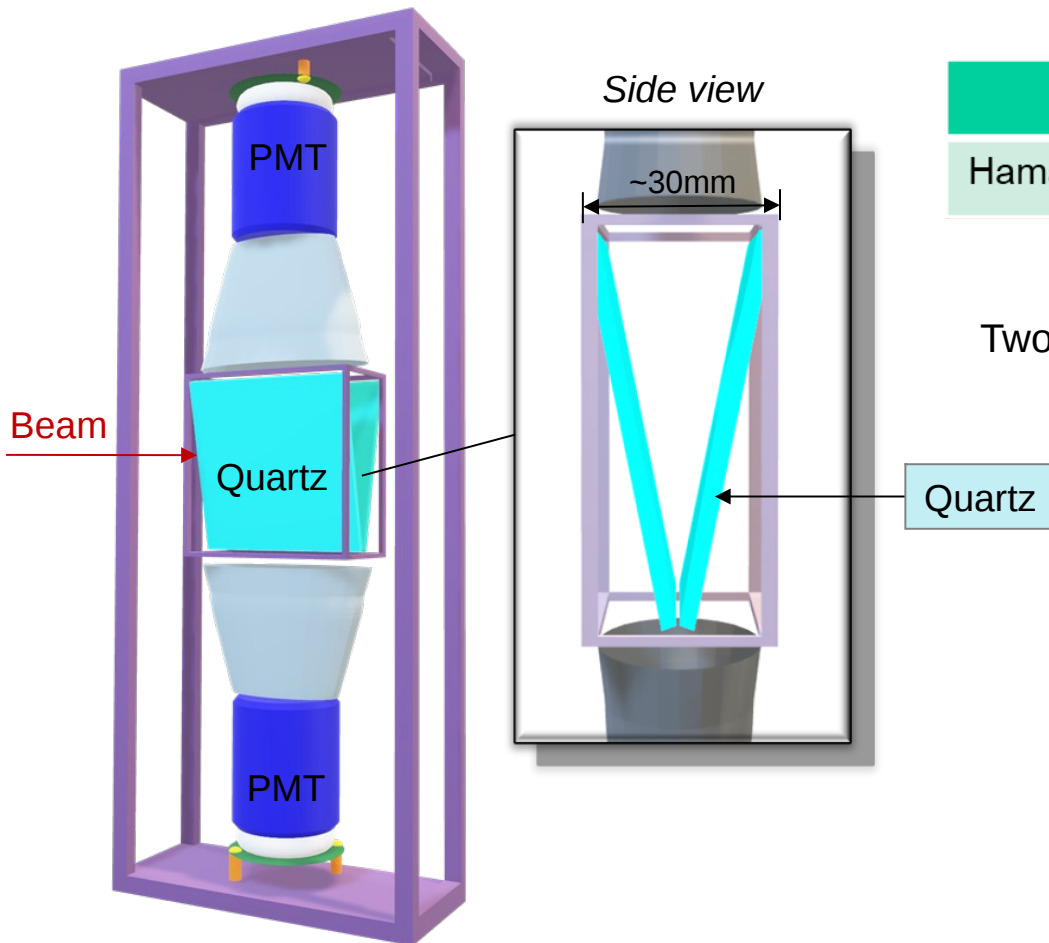
The dimensions of FD1 are: 225x500x75mm.

HV and output signals



Black paper covers the detector to prevent light leaks.

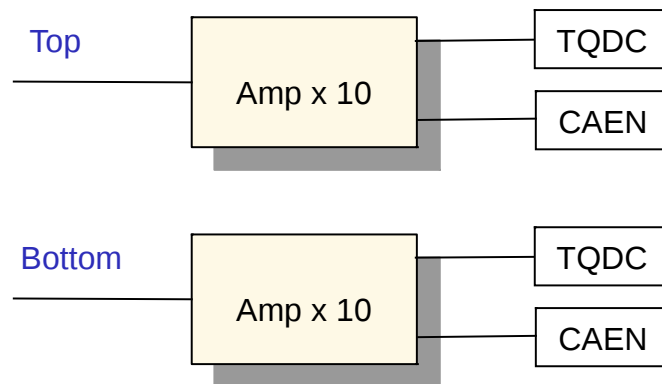
Design of FD2



PMT	Radiator
Hamamatsu R2490-07	2 x Quartz glasses 120x70x0.3mm ³

"Air"- lightguides from Al-mylar

Two quartz glasses positioned at an angle to each other.

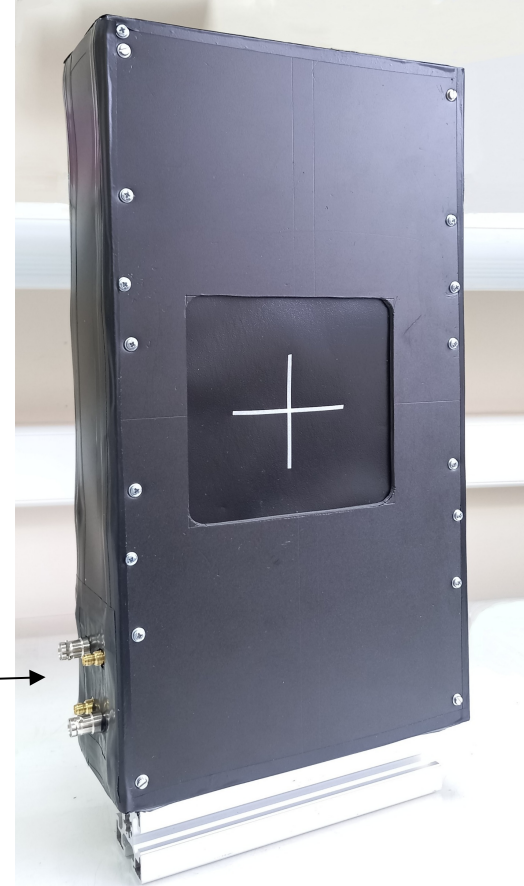


Design of FD2

The dimensions of FD2 are: 225x400x80mm.

FD2 has plastic panels with openings around the radiator glasses. This setup allows us to dismantle and repair it easily when needed. In this way, it also reduces material in the beam path.

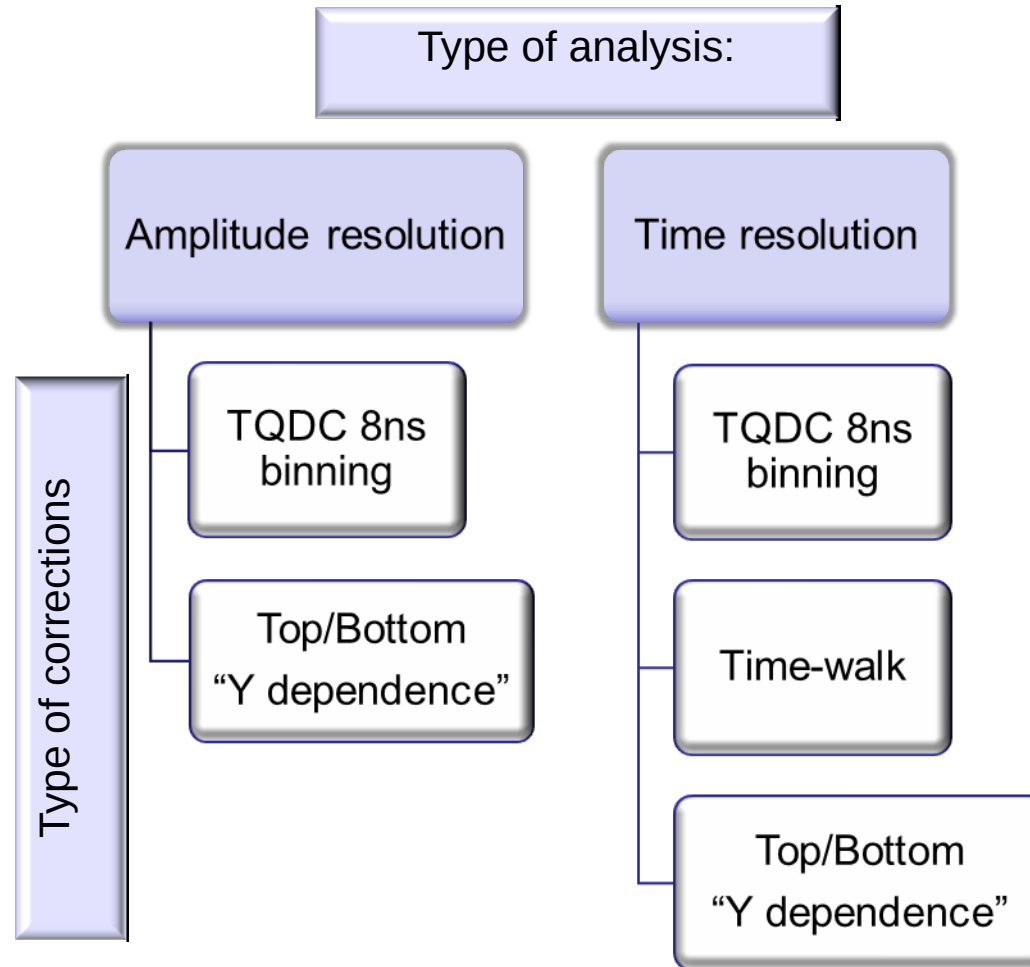
HV and output signals



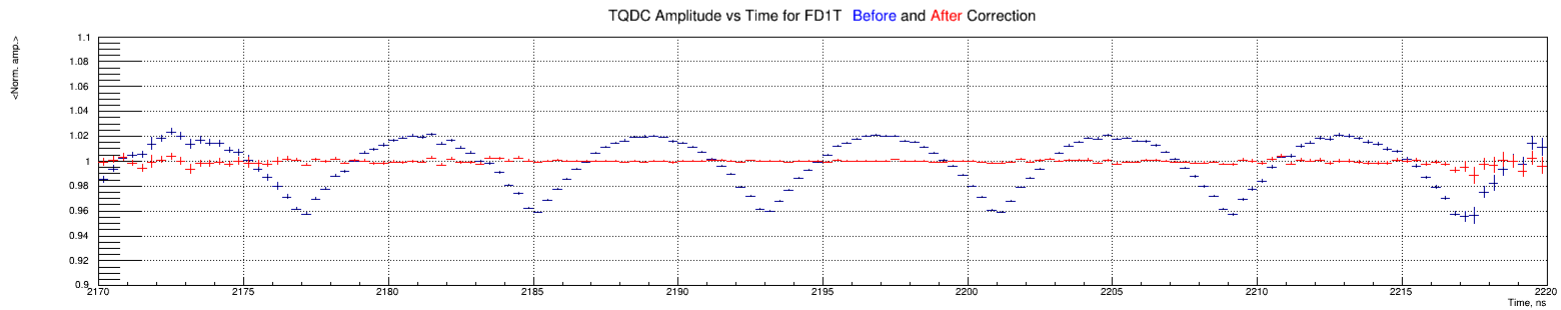
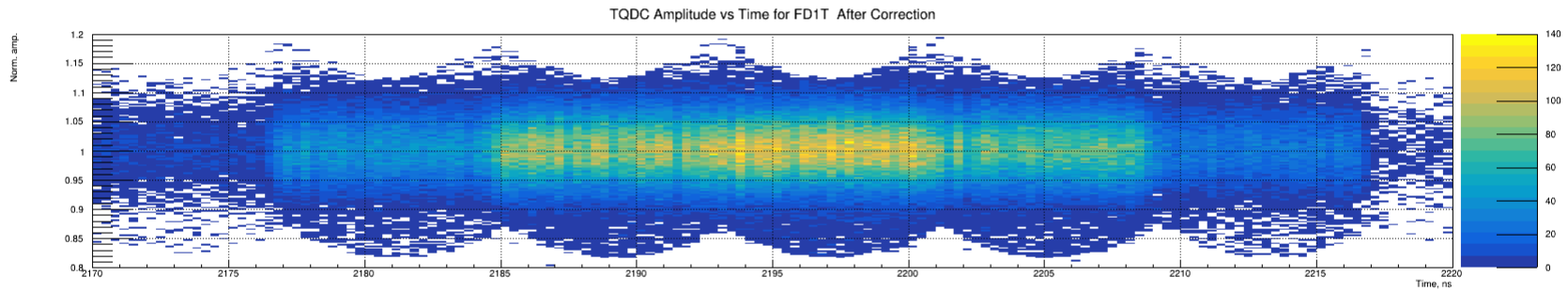
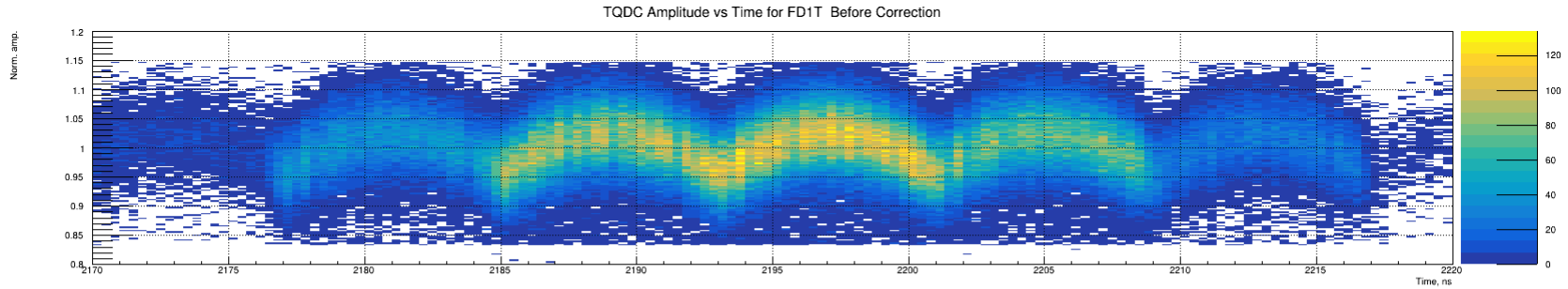
Goals of the tests

1. Measuring the time resolution of BC1 and BC2.
2. FD1 as modification for FD or BC1.
 - Compare amplitude resolution with FD.
 - Compare amplitude resolution with BC1.
3. FD2 as simplest quartz prototype for FD and BC2.
 - Compare amplitude resolution with FD.
 - Compare amplitude and time resolution with BC2.

Data analysis of BC1, BC2, FD1 and FD2



TQDC "8ns binning" correction for FD1T

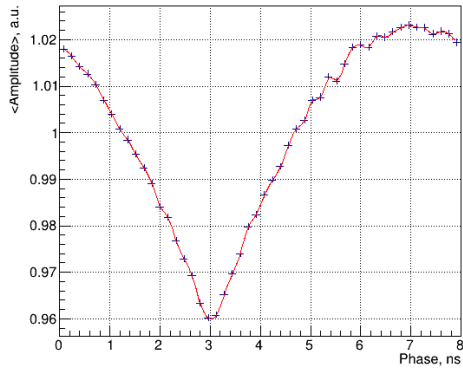


Correction factors based on "phase in 8ns bin"

BC1



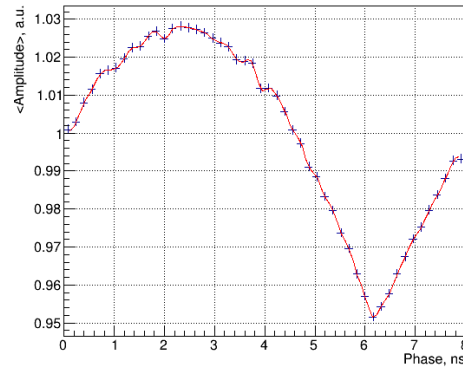
TQDC Mean Amplitude of BC1T



BC2



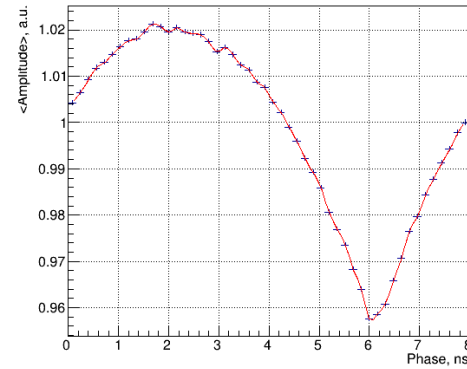
TQDC Mean Amplitude of BC2AT



FD1

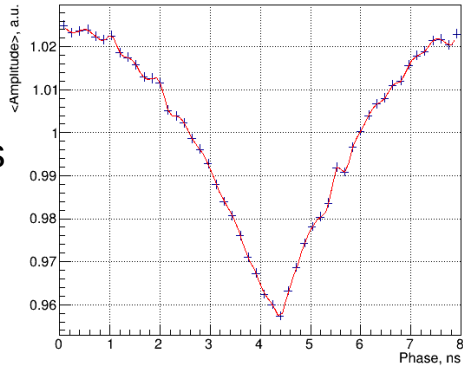


TQDC Mean Amplitude of FD1T

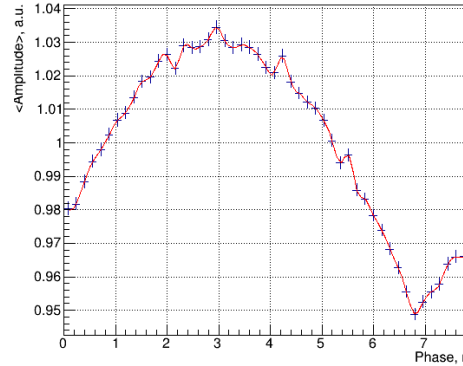


Top signals

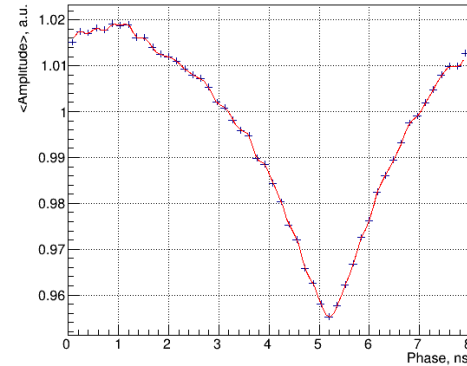
TQDC Mean Amplitude of BC1B



TQDC Mean Amplitude of BC2AB



TQDC Mean Amplitude of FD1B

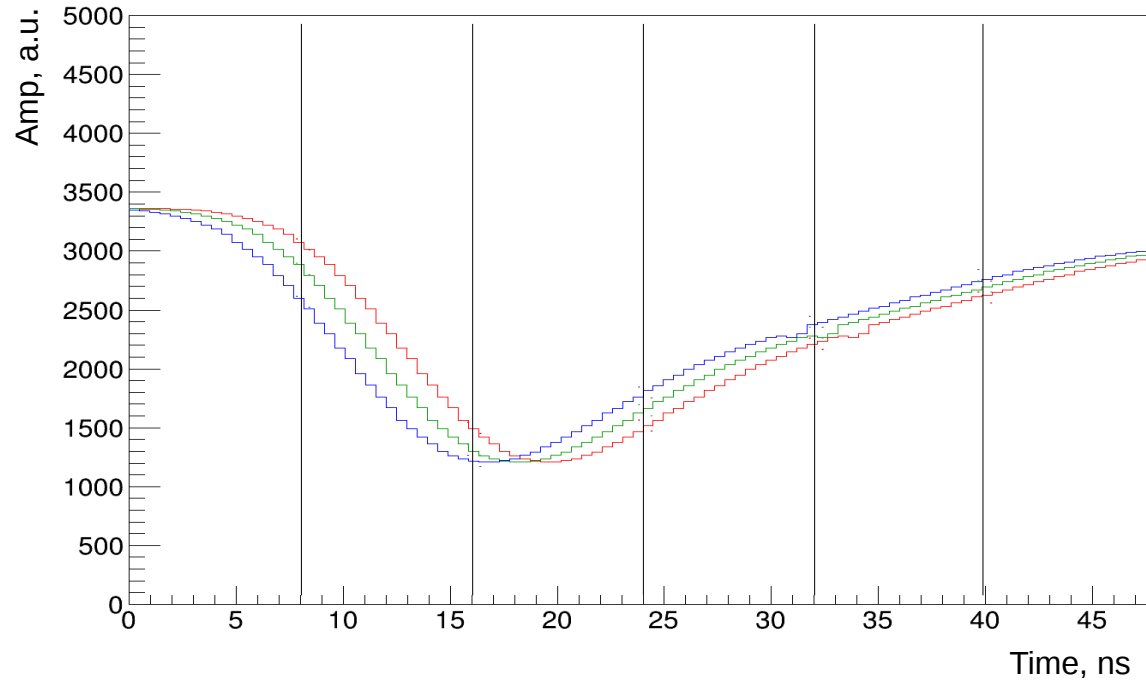


Bottom signals

Dependence on the position of the pulse

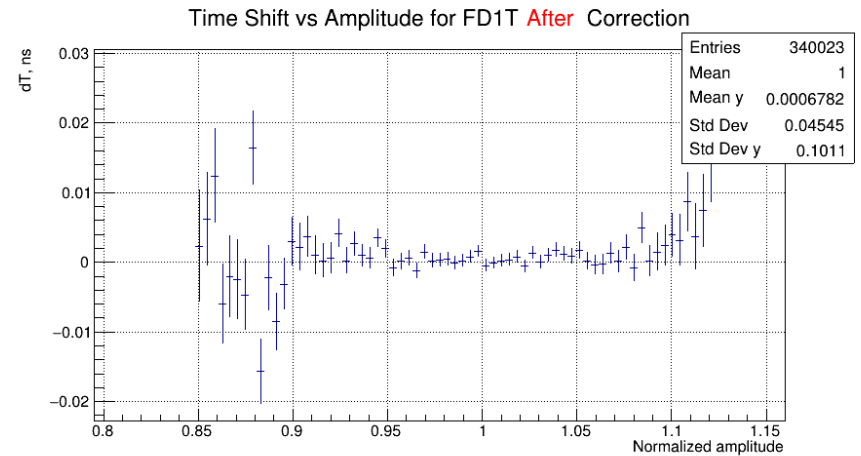
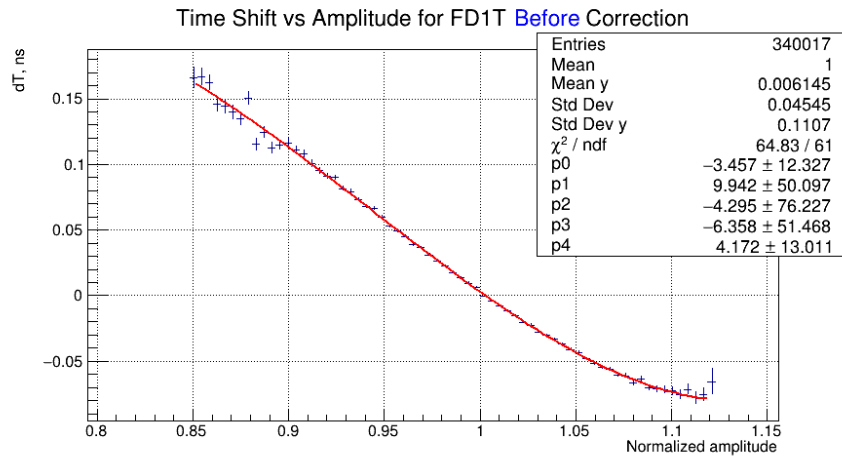
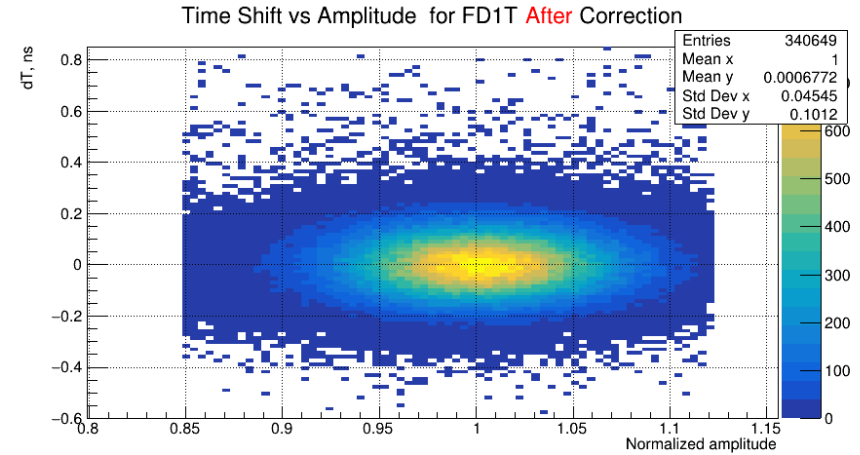
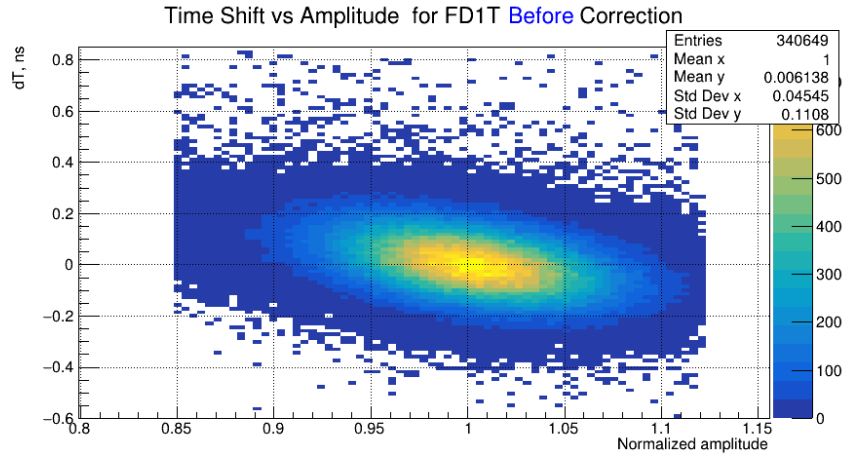
Red, green and blue – the same pulse, shifted by a few nanoseconds.

● The dots show the values of 8ns samples.

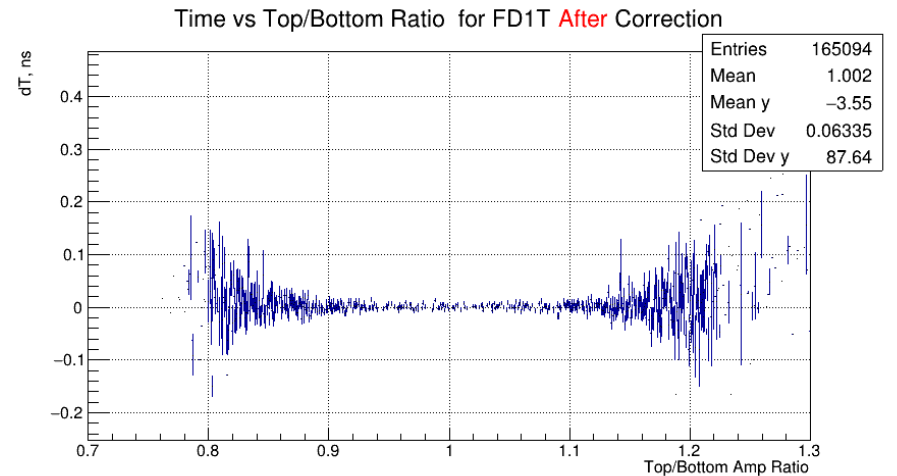
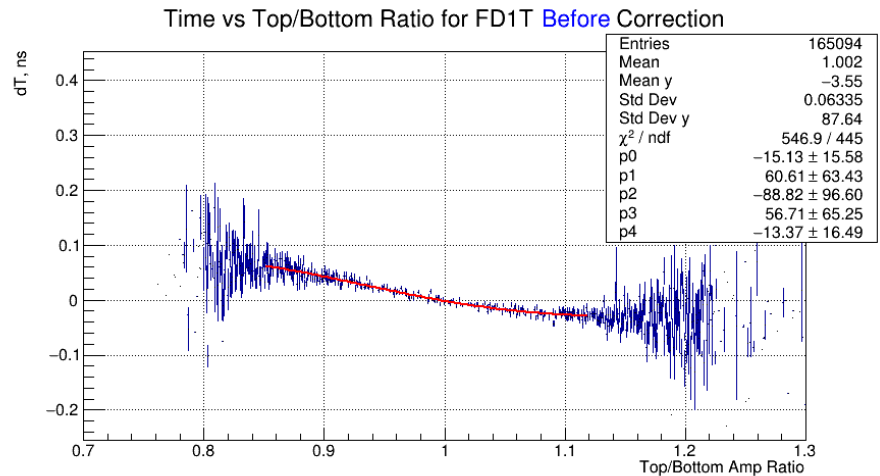
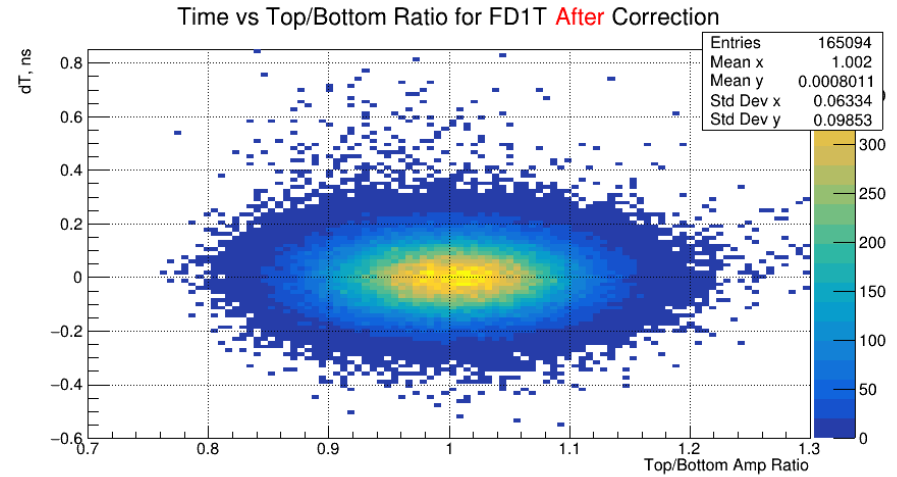
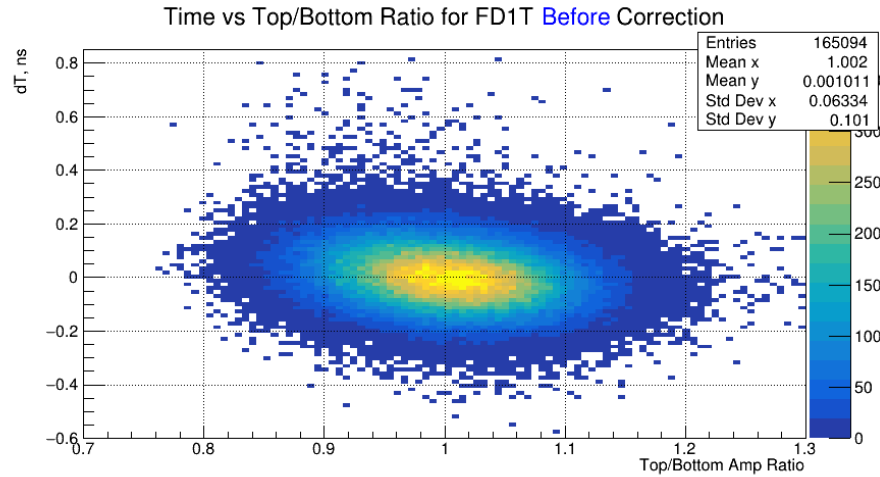


TQDC_Digit → GetPeak() will return different values, depending on the pulse phase with respect to the 8ns binning grid.

Before and after time-walk correction for FD1T

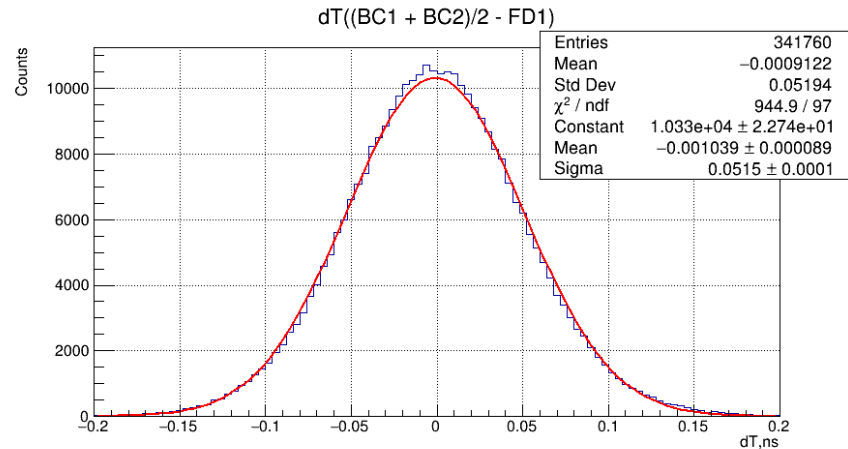
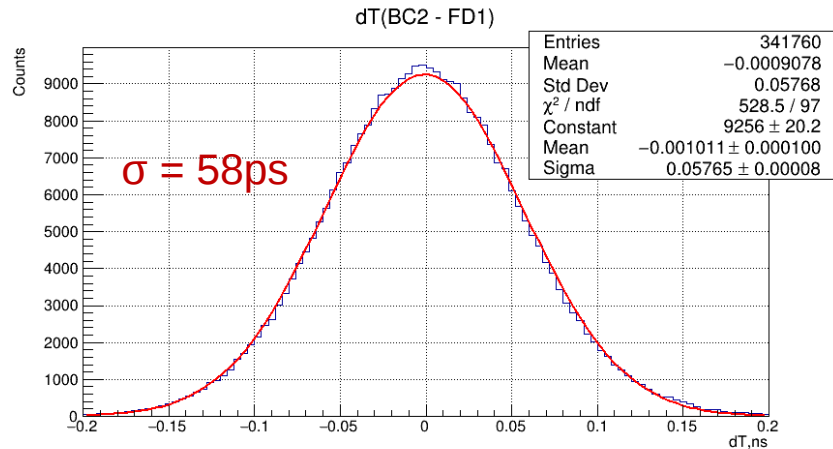
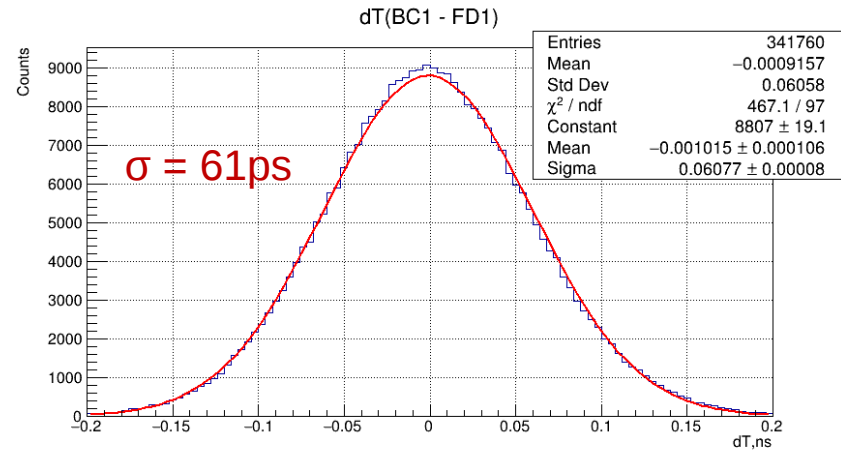
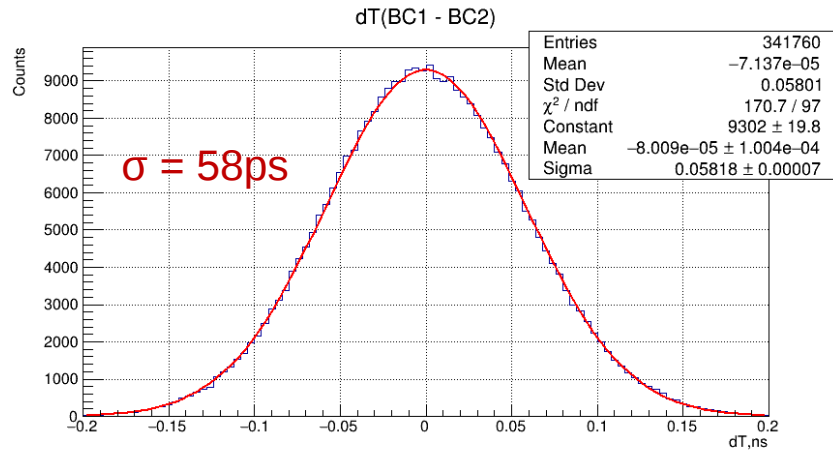


Top/Bottom correction for time resolution analysis



Time resolution between detectors

$$T_{det} = (T_{top} + T_{bottom})/2$$



Time resolution of BC1, BC2 and FD1

$$\Delta t_{ij} = t_i - t_j$$

$$\sigma_{ij}^2 = \sigma_i^2 + \sigma_j^2$$

i, j : BC1, BC2, FD1

Detectors	σ_{ij} , ps
BC1 – BC2	58
BC1 – FD1	61
BC2 – FD1	58
(BC1&BC2) - FD1	52

Data from Run 8317

Each counters have ≤ 45 ps resolution.

Comparison: before and after corrections	
Detectors	σ_i , ps
BC1	54 -> 43
BC2	57 -> 39
FD1	63 -> 43

Time resolution of BC1, BC2 and FD2

$$\Delta t_{ij} = t_i - t_j$$

$$\sigma_{ij}^2 = \sigma_i^2 + \sigma_j^2$$

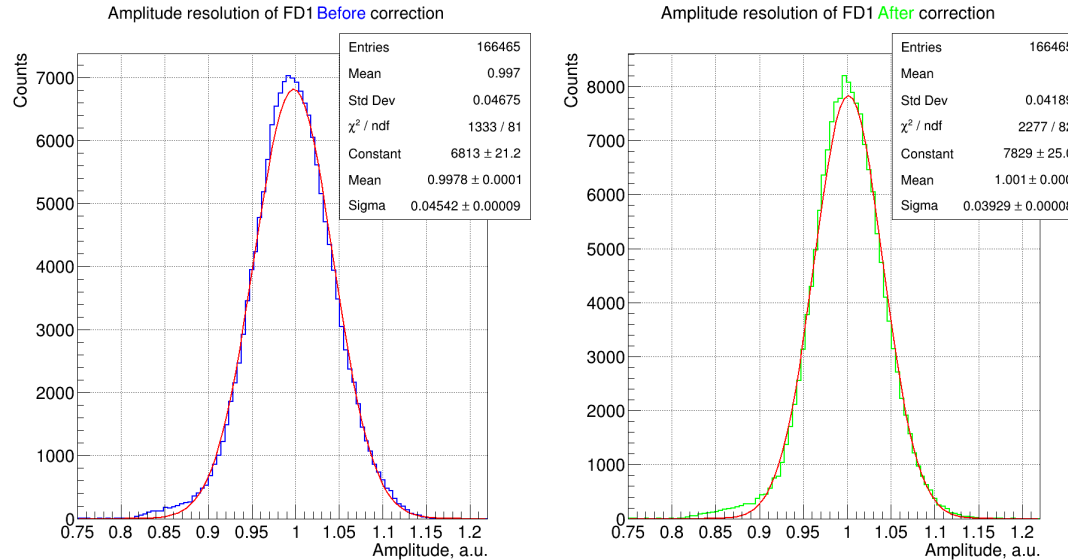
i, j : BC1, BC2, FD2

Data from Run 8406

Detectors	σ_{ij} , ps
BC1 – BC2	58
BC1 – FD2	67
BC2 – FD2	65
(BC1&BC2) – FD2	59

Comparison: before and after corrections	
Detectors	σ_i , ps
BC1	53 -> 43
BC2	59 -> 39
FD2	75 -> 52

Amplitude resolution before and after amplitude corrections



Detectors	Radiator	Radiator thickness	$\sigma / \langle A \rangle$ (%)
FD1	Scintillator	2x0.25mm	4.5 -> 3.9
BC1	Scintillator	1x0.25mm	5.4 -> 4.8
FD	Scintillator	1x0.5mm	5.3
FD2	Quartz	2x0.3mm	8.6 -> 8.2
BC2	Scintillator	1x0.15mm	8.0 -> 7.5
FD	Quartz	1x1mm	12 *)

*) with a unstable BNC signal

Summary and outlook

FD1 and FD2 have been prepared and tested during the BM@N run with Xe beam.

The completed tasks and the results are as follows:

- the time resolution of BC1 and BC2 have been measured;
- the structure and the mechanics have proved to be suitable for these purposes;
- FD1 has time and amplitude resolution almost the same as BC1;
- FD2 time resolution of 50 ps is considerably worse than BC2 (about 40ps).

Tasks for the next run:

- make FD1 ready for similar test of time resolution;
- prepare different prototypes for Cherenkov radiators;
- maybe at test counter with SiPMs.

Thank you for your attention!