BBC status report

A.V.Tishevsky on behalf of JINR-MEPhI BBC

VII SPD Collaboration Meeting

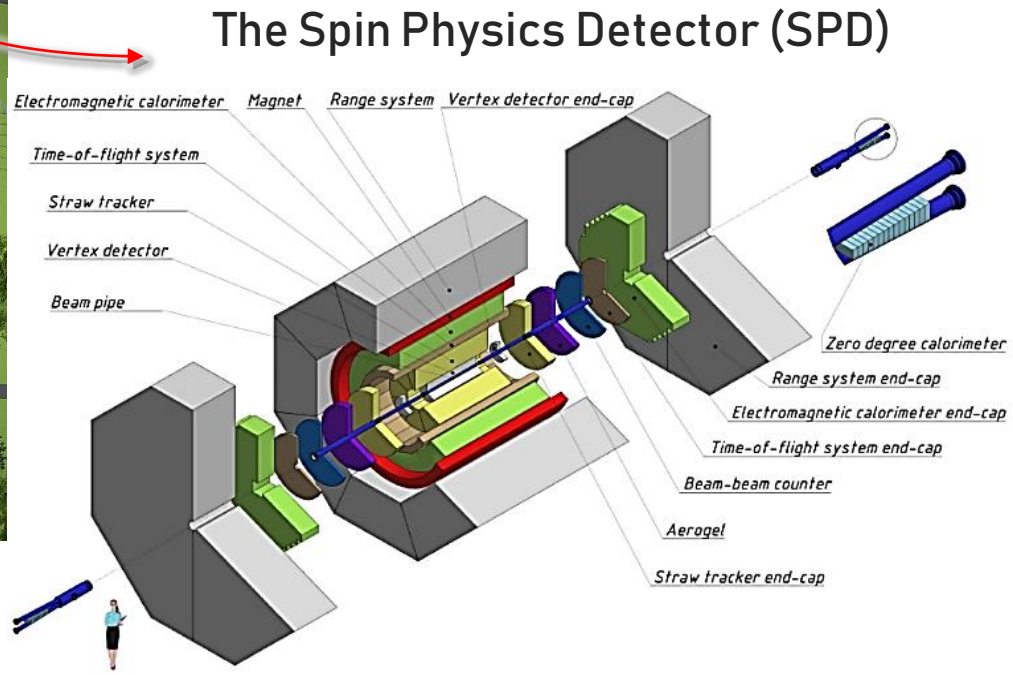
21 May 2024

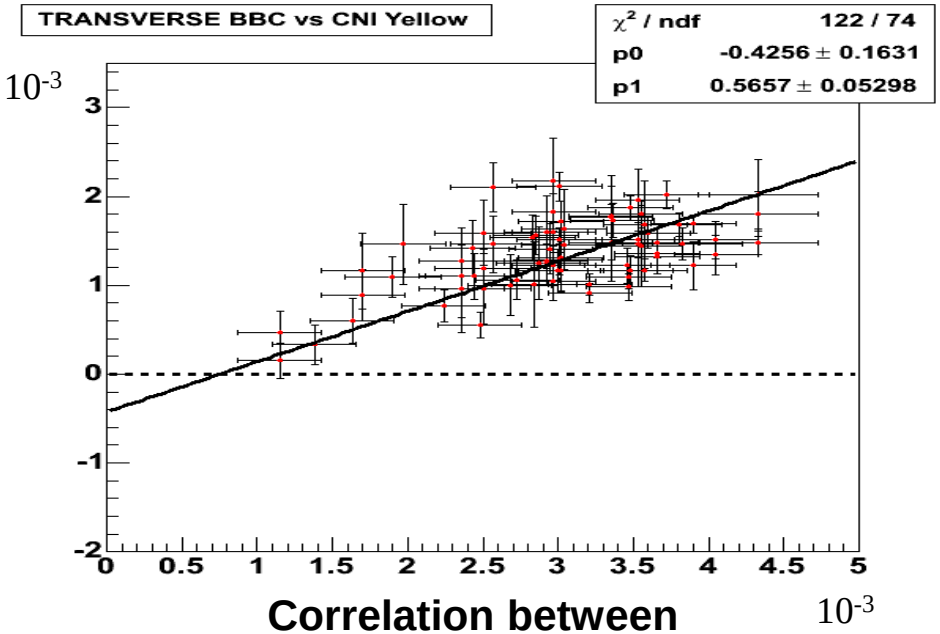
OUTLINE

- Introduction
- Simulation
- R & D
  - The hardware of BBC tests part
  - Materials selection test part
  - Prototype assembling test part (preliminary)
- Results
- Plans
- Conclusions

Introduction

General





Correlation between CNI polarimeter and STAR BBC asymmetries.

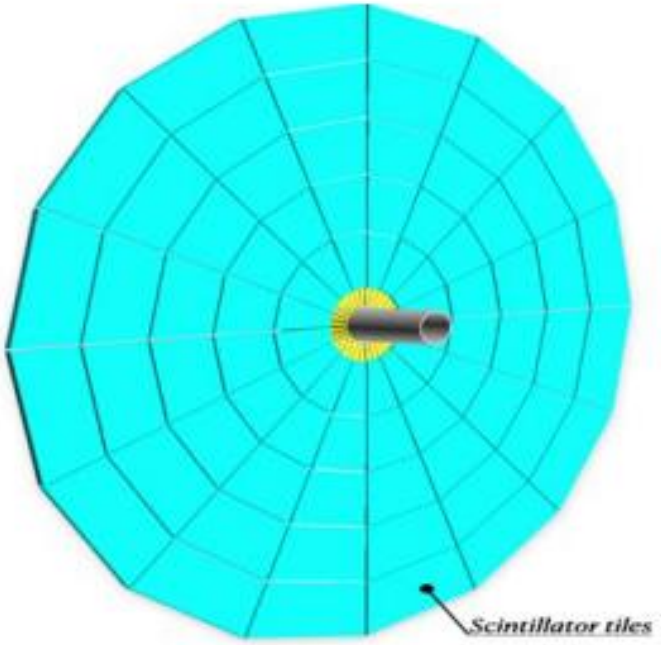
The Beam-Beam Counters (BBC) for SPD

The main purpose of BBC is the permanent monitoring of the beam polarization using the azimuthal asymmetry of the inclusive charged particles yield.

+ event plane detector for HI physics.

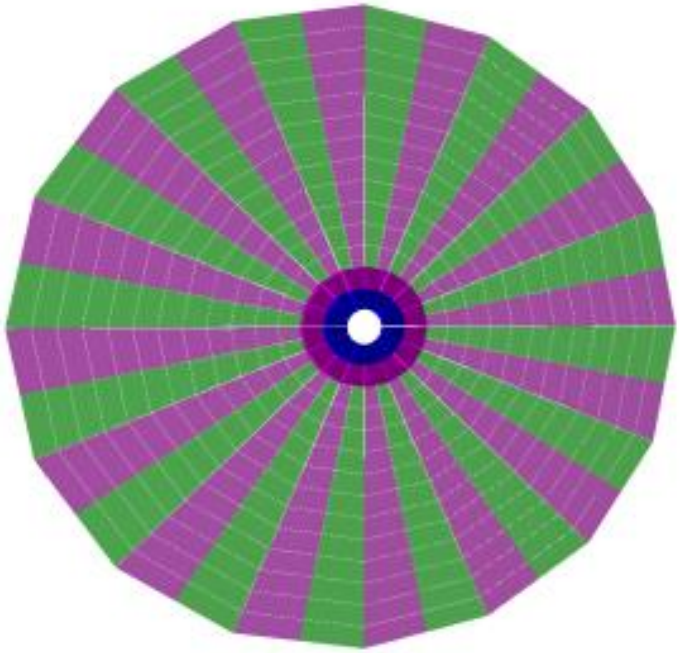
- **Scintillator tiles part at the distance ~1.7 m**

TDR version of BBC



TDR 2022
96 tiles

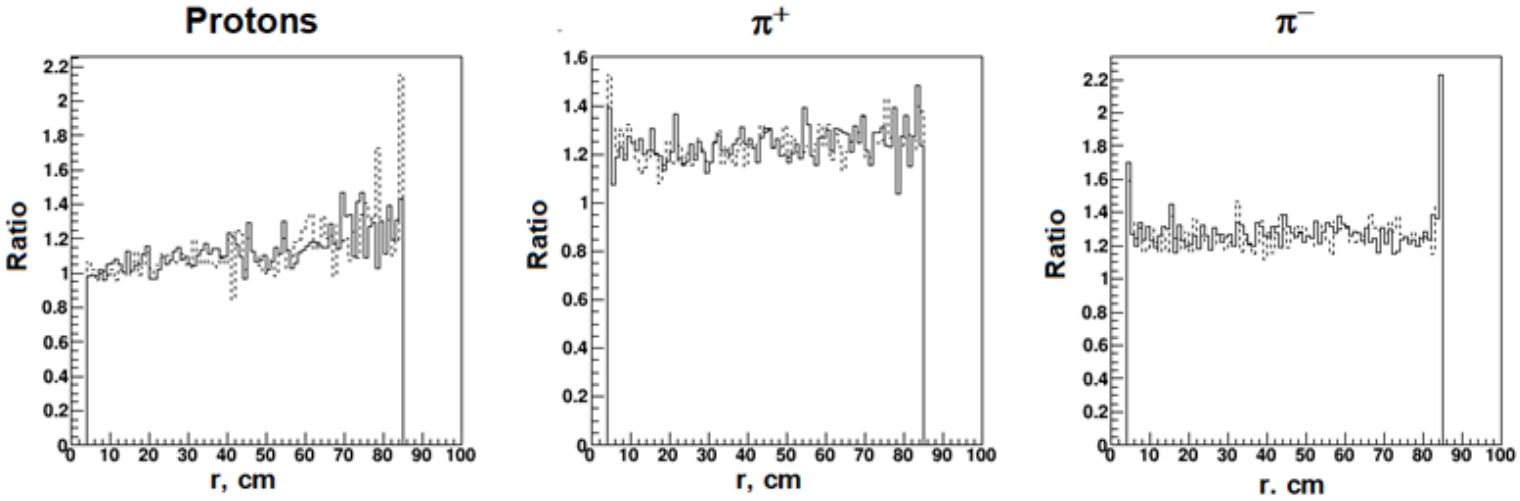
- **local polarimetry**



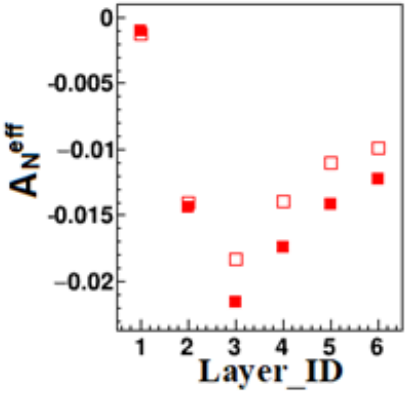
TDR 2023
400 tiles

- **local polarimetry**
- **event plane determination**

The influence of the magnetic field on the BBC load has been estimated by the simulation of the pp-interaction in the SPDRoot framework. It presence **increases the BBC load**. This is especially observed for π^+, and π^-. For protons the influence of the magnetic field is observed in the range of the big radiuses.

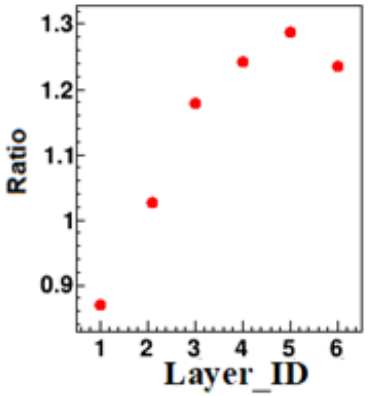


The ratio of the loads at B=1T and B=0T for first (solid line) and second (dashed line) BBC



□ ***B*** = 1T

■ ***B*** = 0T



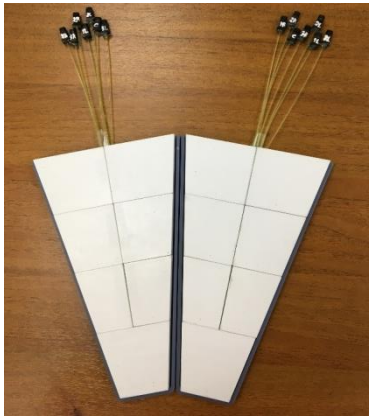
The analyzing powers A_N^{eff} for inclusive reaction have been calculated for case when the *B*=0 and *B*=1T. The presence of the magnetic field leads to a change of the A_N^{eff} up to 22%.

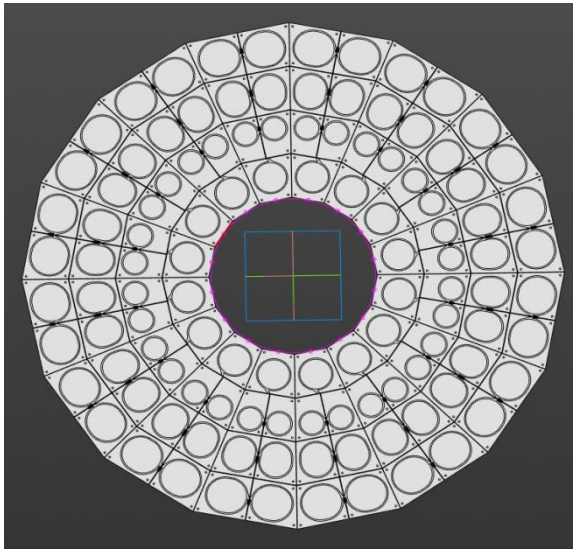
Simulation of the pp-scattering in BBC in the magnetic field (**A.Terekhin**)

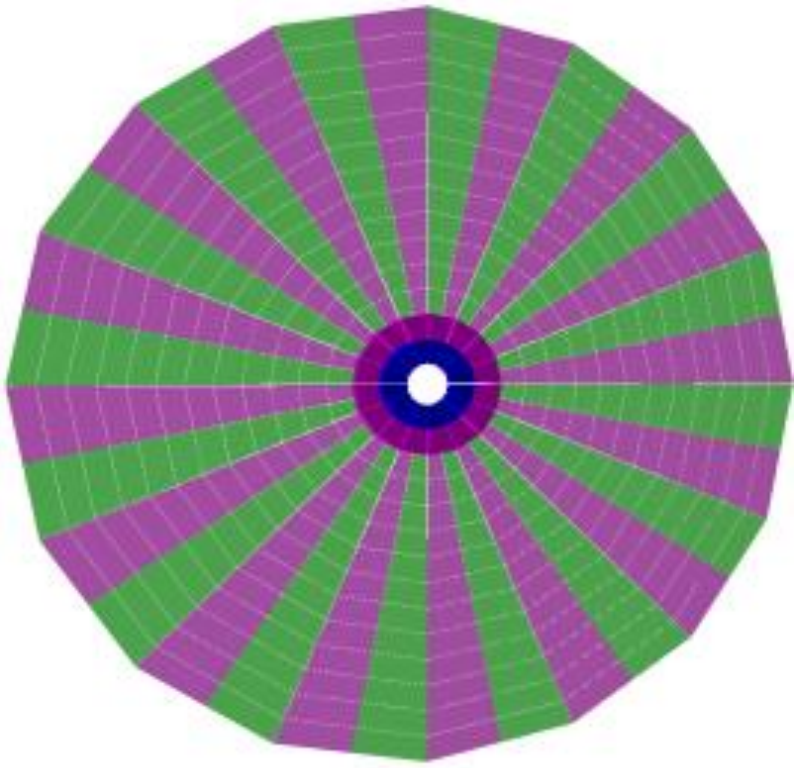
see talk (Friday 24/05)

Stages of detector production

Materials selection tests







1-st Stage
14 tiles (16?)

2-nd Stage
2 wheels with 112 tiles each (128?)

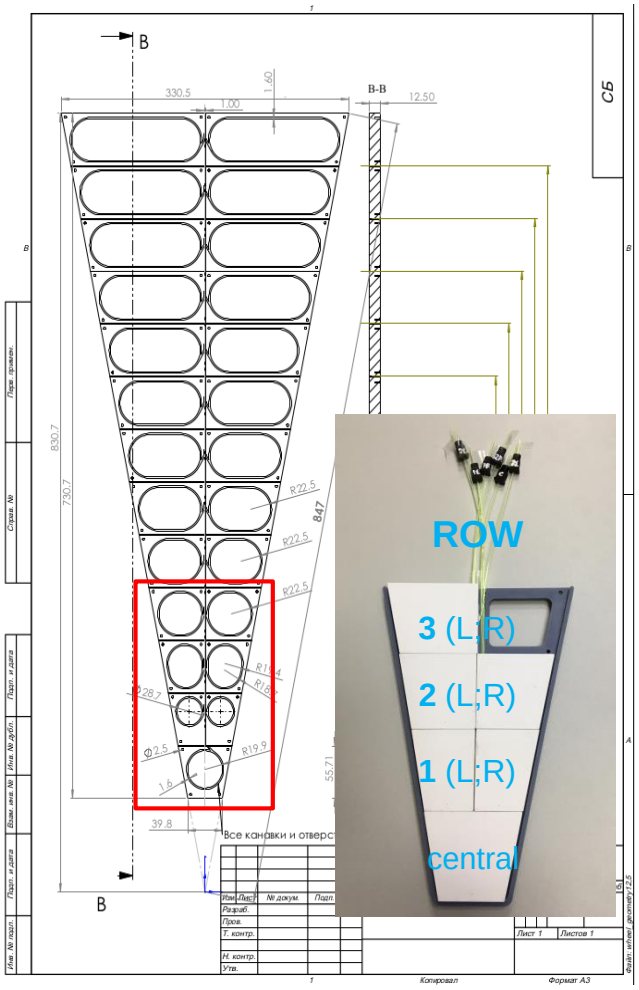
3-rd Stage (final)
2 wheels with 400 tiles each (416?)

Phase 0

Phases: 1-st & 2-nd

Proposal for prototype BBC design

Tile height 55.7 mm
25 tiles in sector (similar to STAR EPD)



The BBC prototype options:

Readout system: ✓**CAEN FERS-5200**

Materials selection tests

Scintillator: **chemical mating**

vs

polished (Tyvek or Mylar covered)

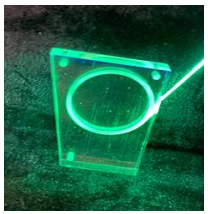
Optical cement: **OK-72 vs CKTN Med (mark E or B)**

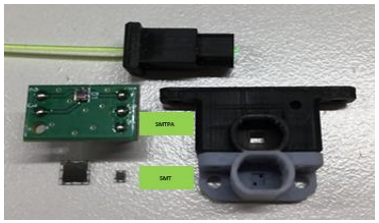
Fibers: **Saint-Gobain Crystals (SG92S)**

vs

KURARAY (Y-11) for Phase 1

SiPMs: ✓**SensL 1x1 mm^2 (main option 2023)**

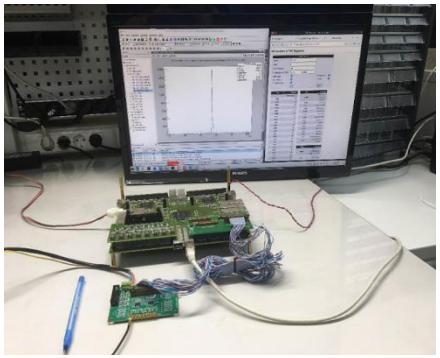




The hardware of BBC tests part

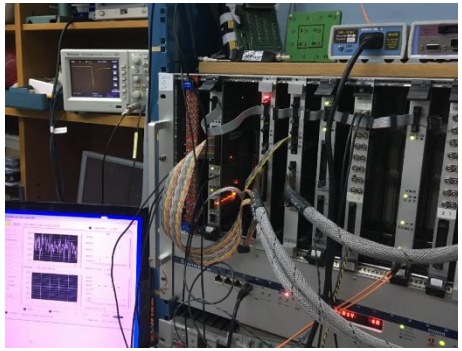
Stand for BBC measurements

TRB-3 (10 ps)



Together with **V.Chmil (JINR), S.Morozov, E.Usenko (INR)**

The VME based DAQ



Isupov A.Yu. // EPJ Web Conf. 2019. V.10003. P.204

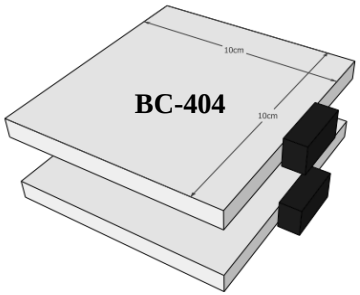
CAEN FERS 5200

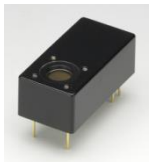
DT5202 (citiroc 1A chip)

DT5203 (picoTDC chip)

DT5215 (Concentrator)

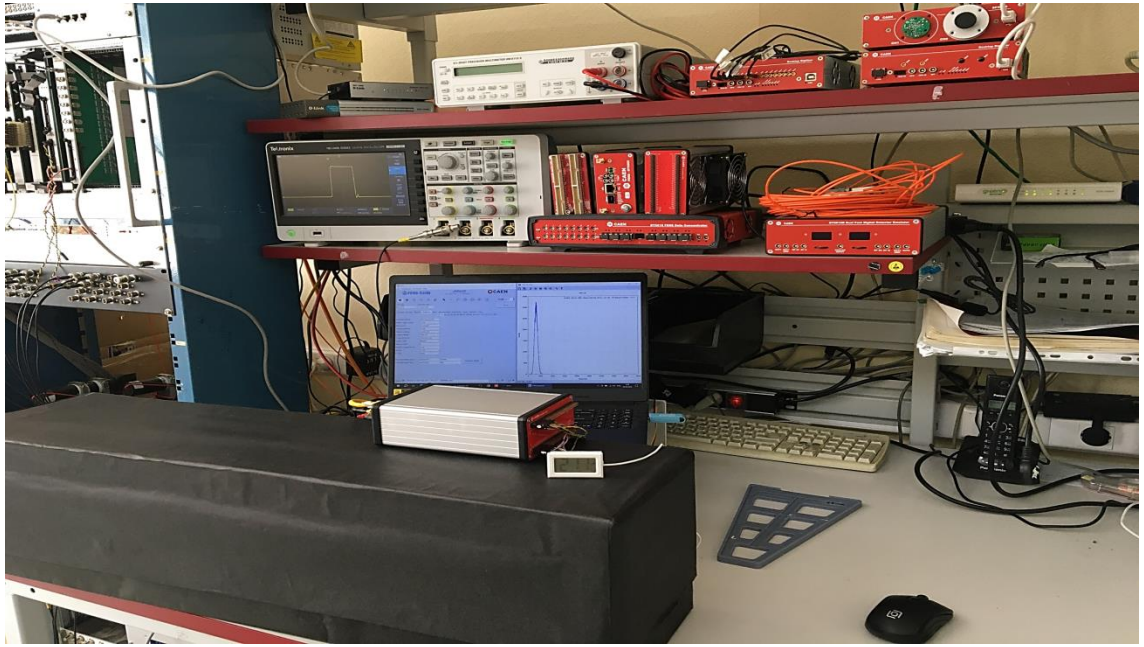
External trigger by coincidence of two scintillators with PMTs readout





PMT Hamamatsu H10720-110

The stand for BBC

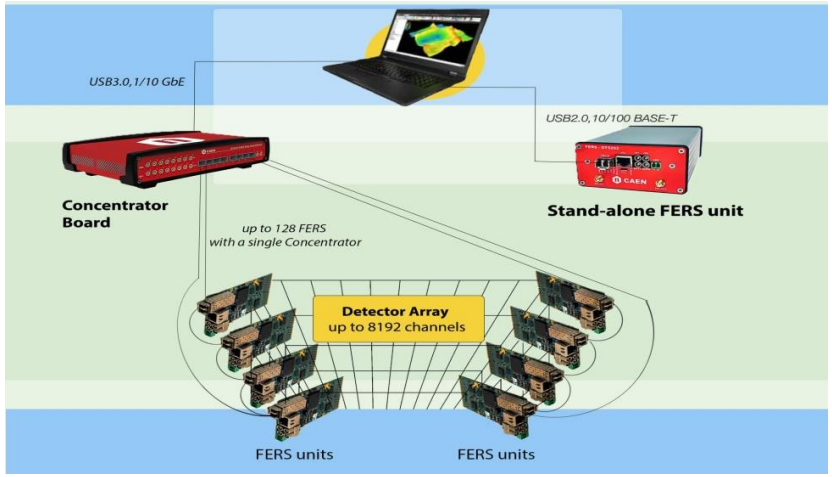


The hardware of BBC tests part

CAEN DT5202

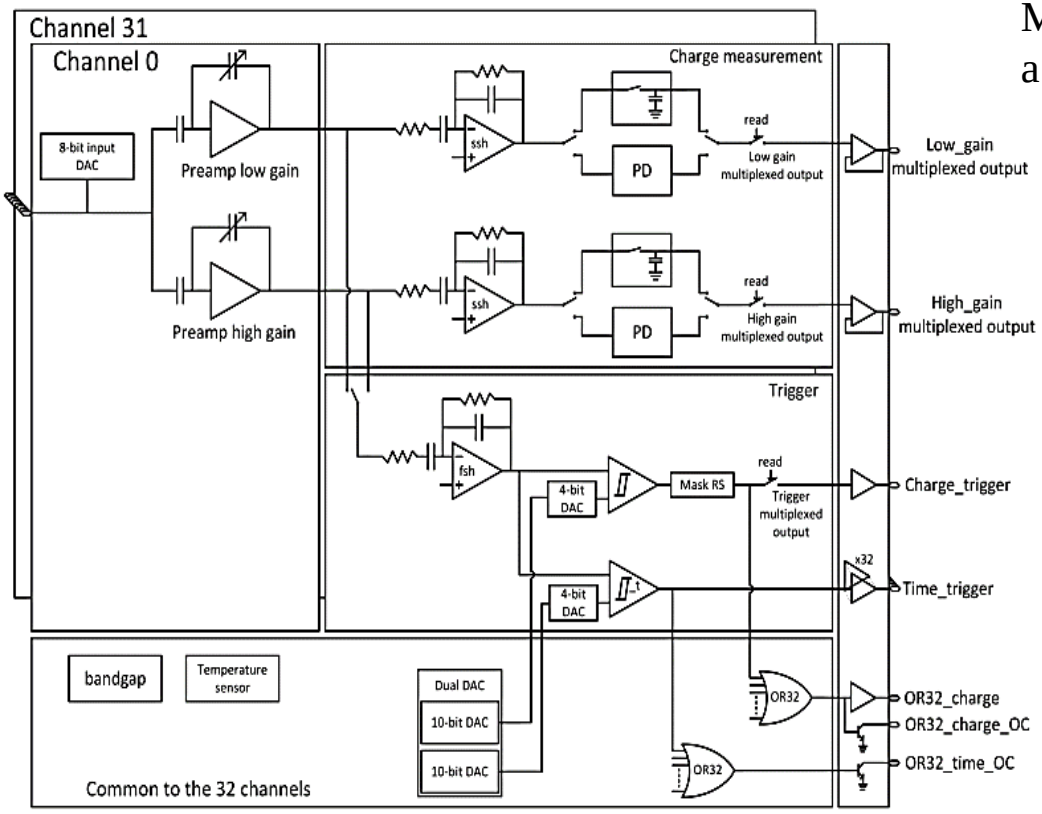
FERS-5200 is an extendable high speed front-end readout system.

- Concentrator DT5215 for the possibility of expanding the number of channels to 8192.
- DT5203 (with picoTDC chip) for high-resolution multi-hit time measurements.
- **DT5202 (**with Citiroc 1A chip) based on the 64-channel module **for SiPM**.



Fine for testbeam and Phase 0 experiments.

Citiroc 1A allows triggering down to 1/3 p.e. and provides the charge measurement with a **good noise rejection**. Moreover, Citiroc 1A outputs the 32-channel triggers with a **high resolution timing** (better than 100 ps).



Each channel has low **(LG)** and high **(HG)** gain preamplifiers providing a wide dynamic range.

Main Acquisition Modes:

- SPECTROSCOPY → (for collibration)
- SPECT_TIMING → (for tests)

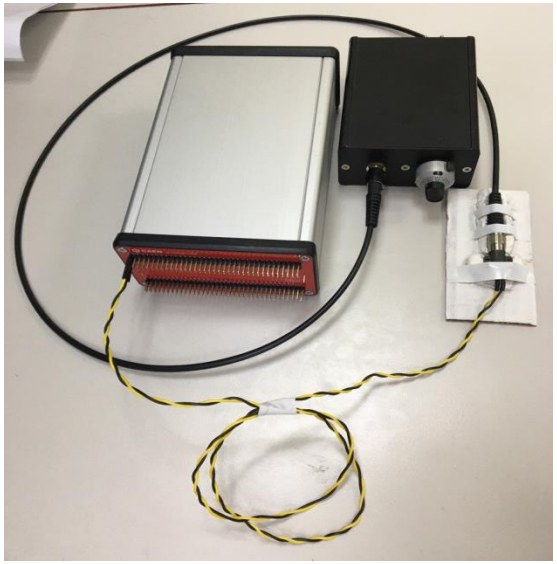
(the Spectroscopy + Timing)

- TIMING → (for the free-streaming mode)

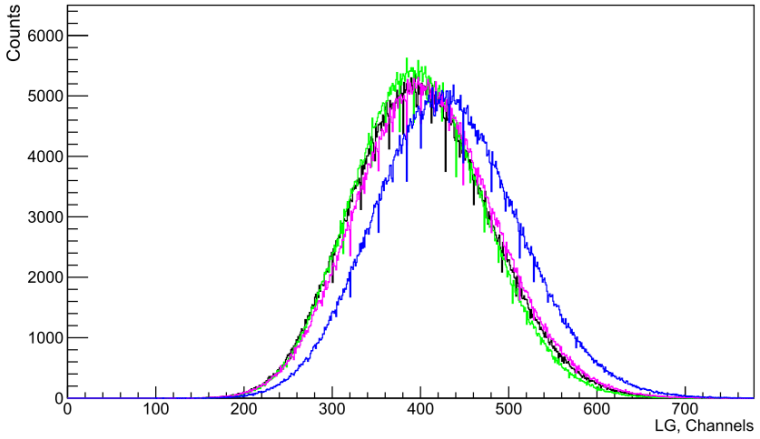
FEE studies results

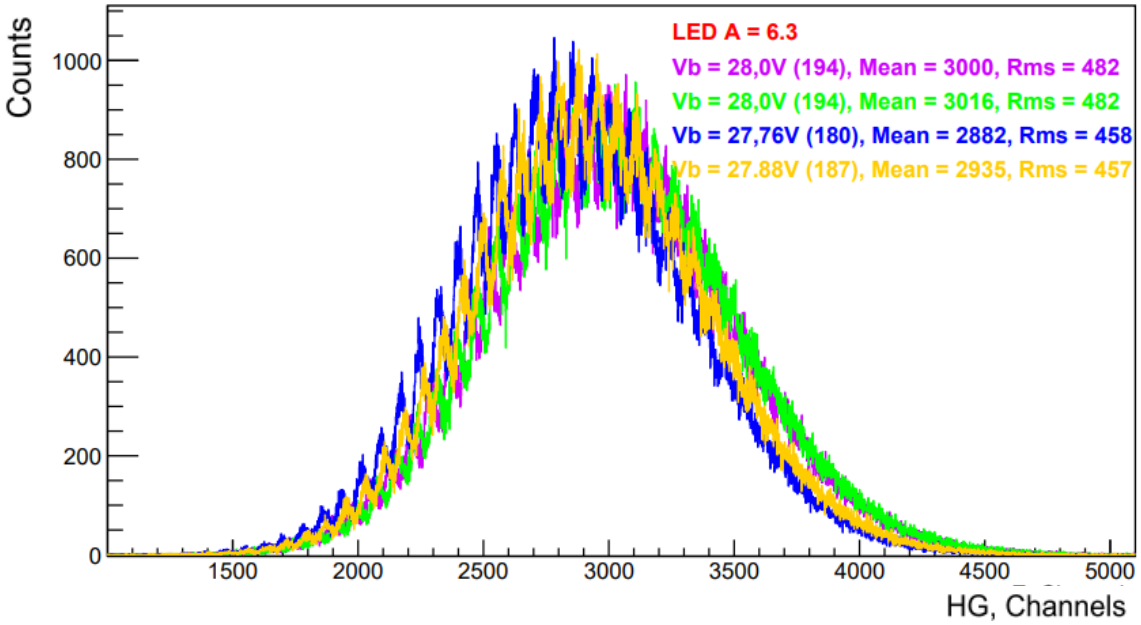
Calibration method (Led source)

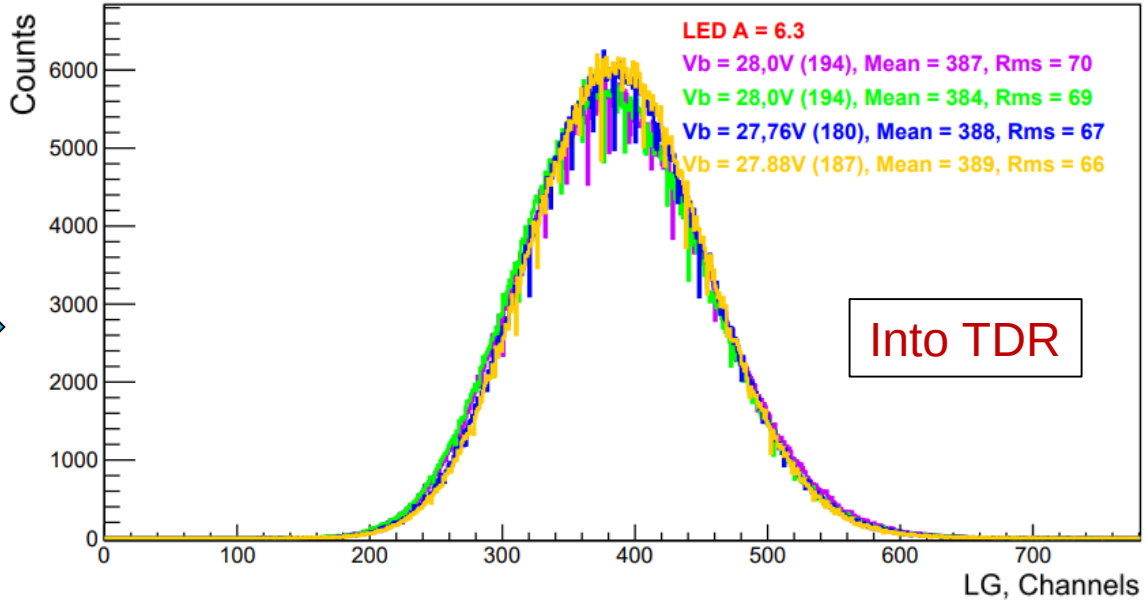
DT5202 with CAEN LED Driver (SP5601)



Not calibrated

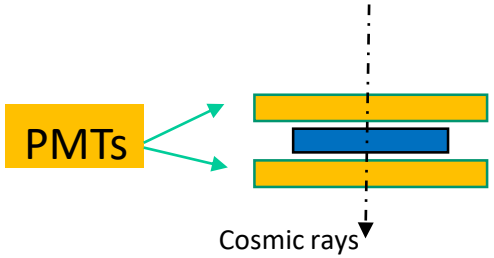






Materials selection test part

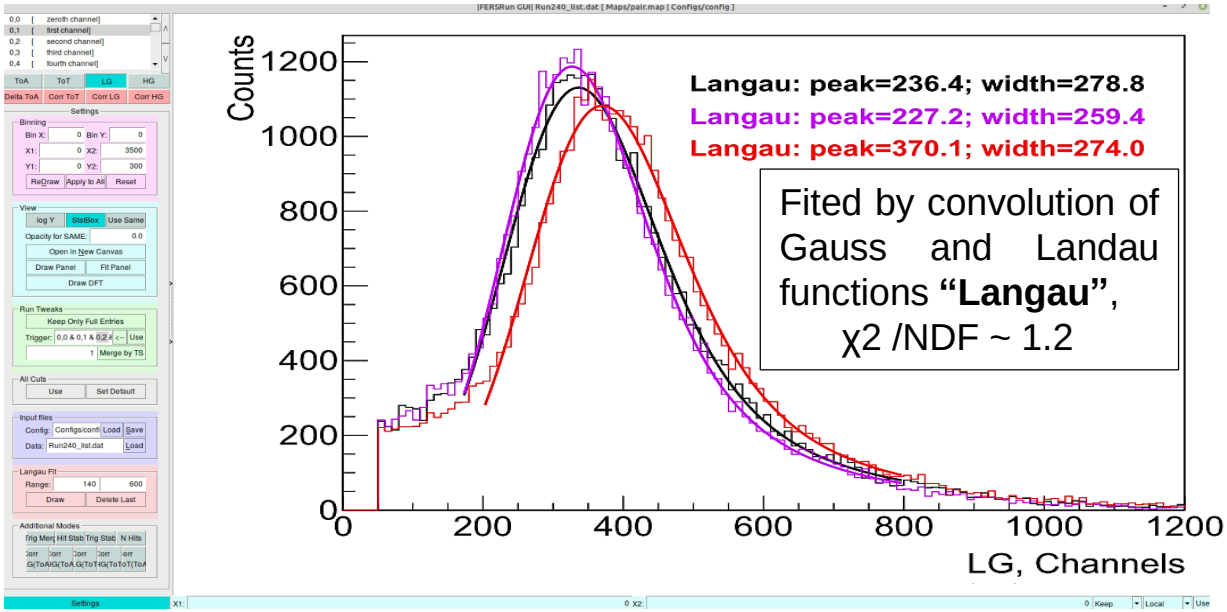
Scintillator cover



Matted
or
Mylar
or
Tyvek

SensL SiPM (27.34 V.)
S.G. (WLS)
CKTN (opt. cement)

The "FersRun" framework have been designed.

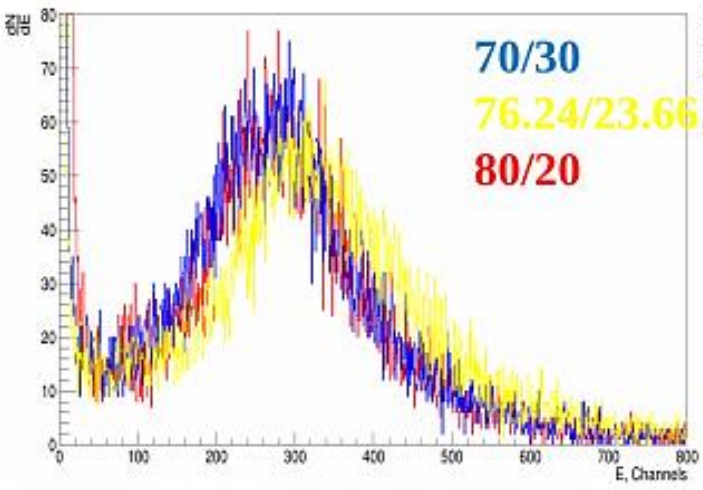


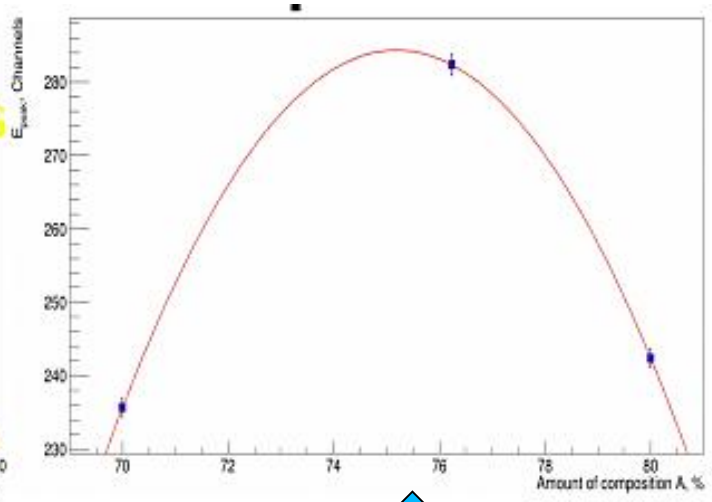
The amplitude spectra of the BBC prototype scintillation tile coated with **Mylar** or **Tyvek**, as well as covered with **Matted** options.

- The option with **matted tiles** is more priority.

Optical cement (compositions comparison)

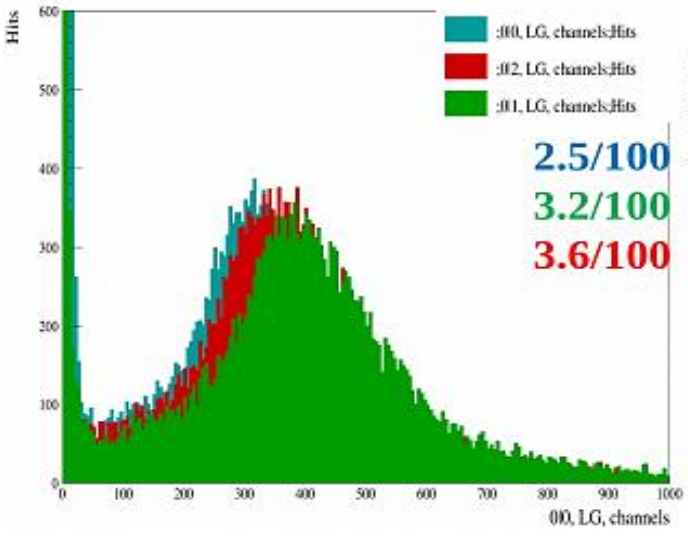
OK-72

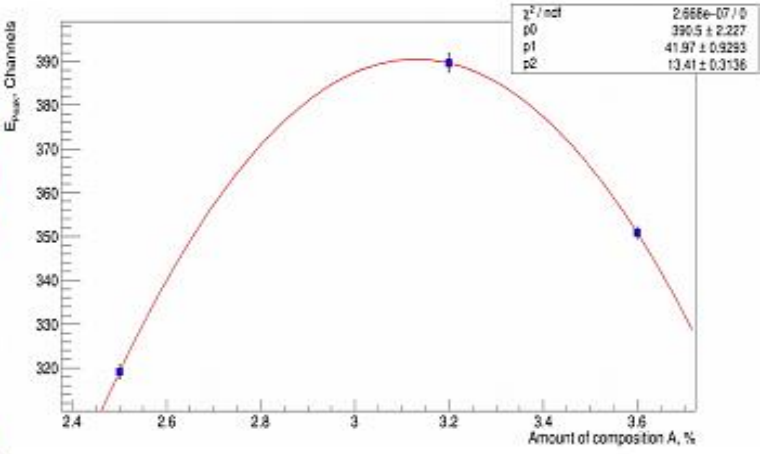




Light collection peak position on dependence of A component amount for optical cement.

CKTN



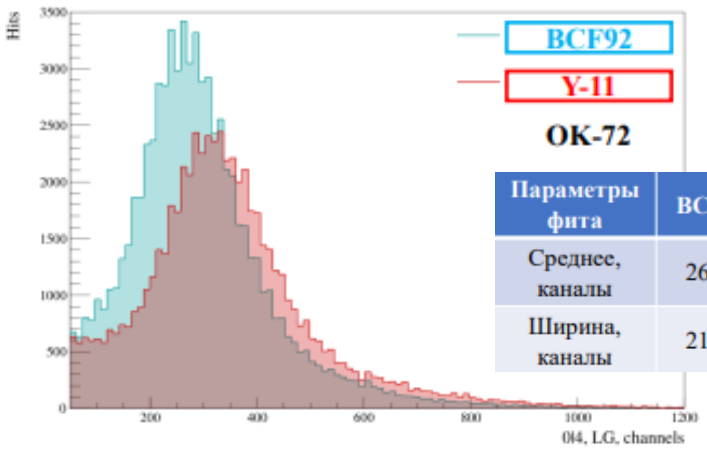


The choice of optical cement is also important. The candidates were OK-72 and CKTN. From the point of view of mass production, the ratio of components and their influence is important.

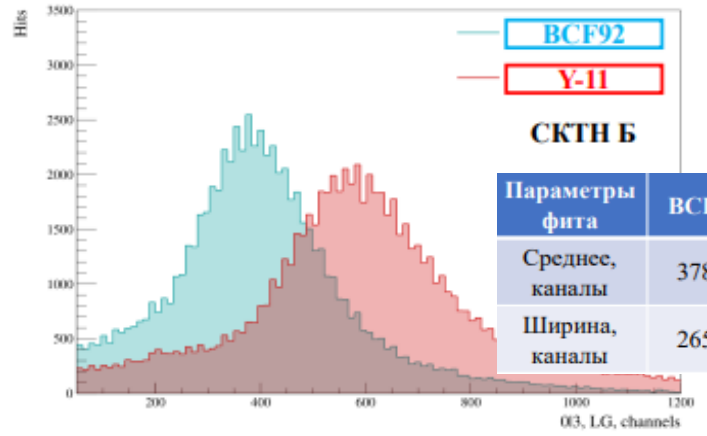
- This influence is showed. Datasheet ratio will be used and closely monitored.

Materials selection test part

Optical cement and WLS

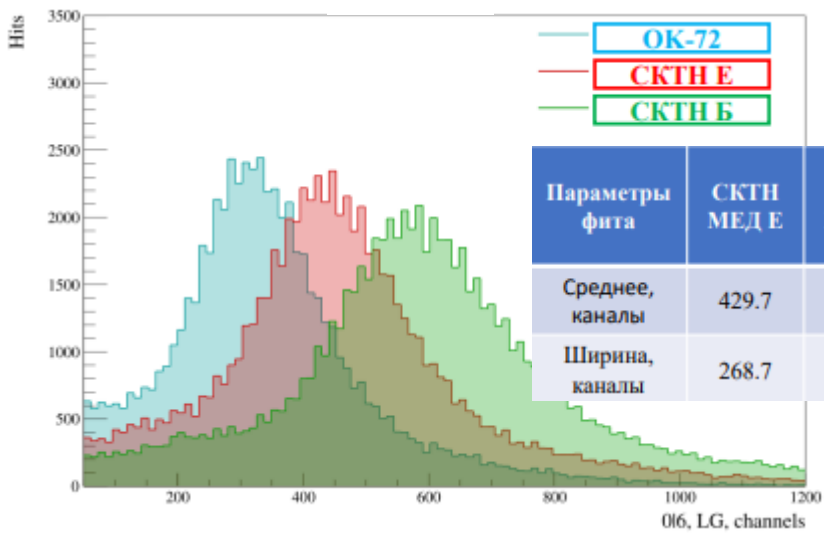


Параметры фита	BCF92	Y-11
Среднее, каналы	263.7	312.8
Ширина, каналы	212.6	228.2



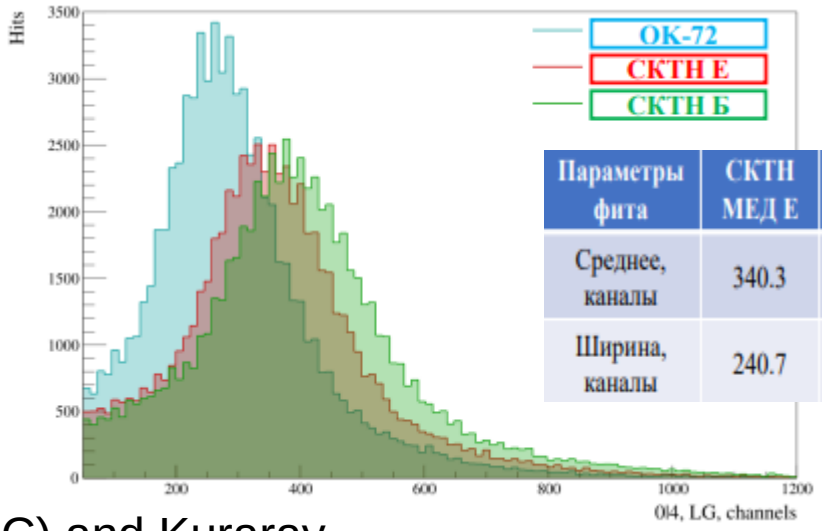
Параметры фита	BCF92	Y-11
Среднее, каналы	378.4	569.1
Ширина, каналы	265.4	324.9

Kuraray Y-11



Параметры фита	СКТН МЕД Е	СКТН МЕД Б	ОК-72
Среднее, каналы	429.7	569.1	312.8
Ширина, каналы	268.7	324.9	228.2

SGC BCF92



Параметры фита	СКТН МЕД Е	СКТН МЕД Б	ОК-72
Среднее, каналы	340.3	378.4	263.7
Ширина, каналы	240.7	265.4	212.6

The results of tests of Saint-Gobain Crystals (SGC) and Kuraray WLS fibers with different types of cement are presented.

- ❑ CKTN mark B paired with SGC fiber are the most appropriate candidates for prototype assembly.

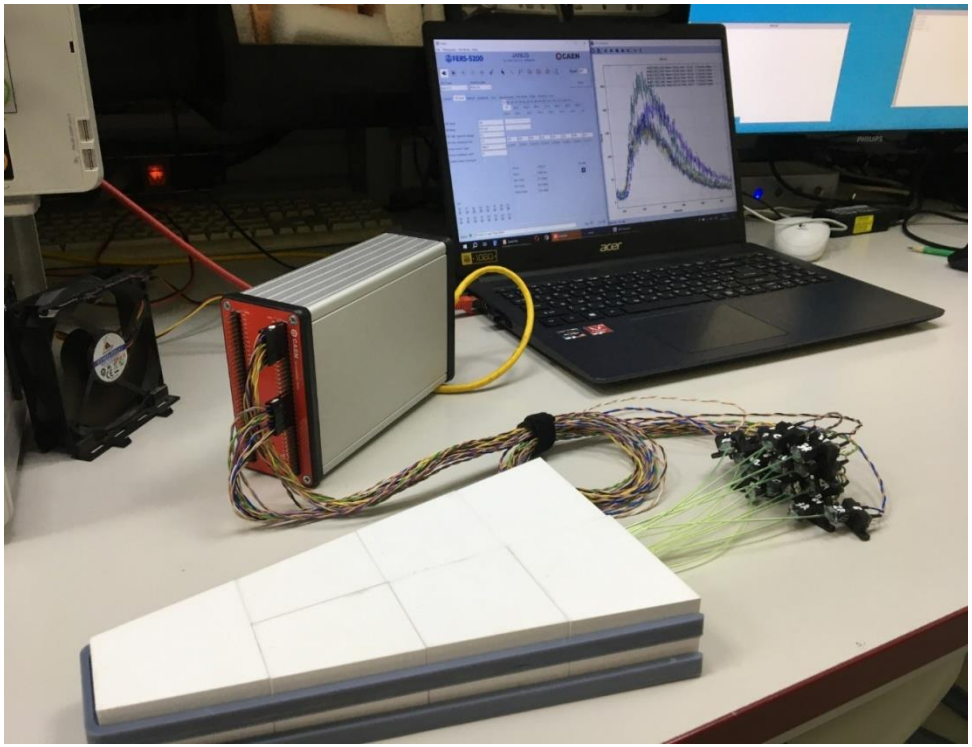
More detail (**P.Teterin**)

Prototype assembling test part

View of two sectors

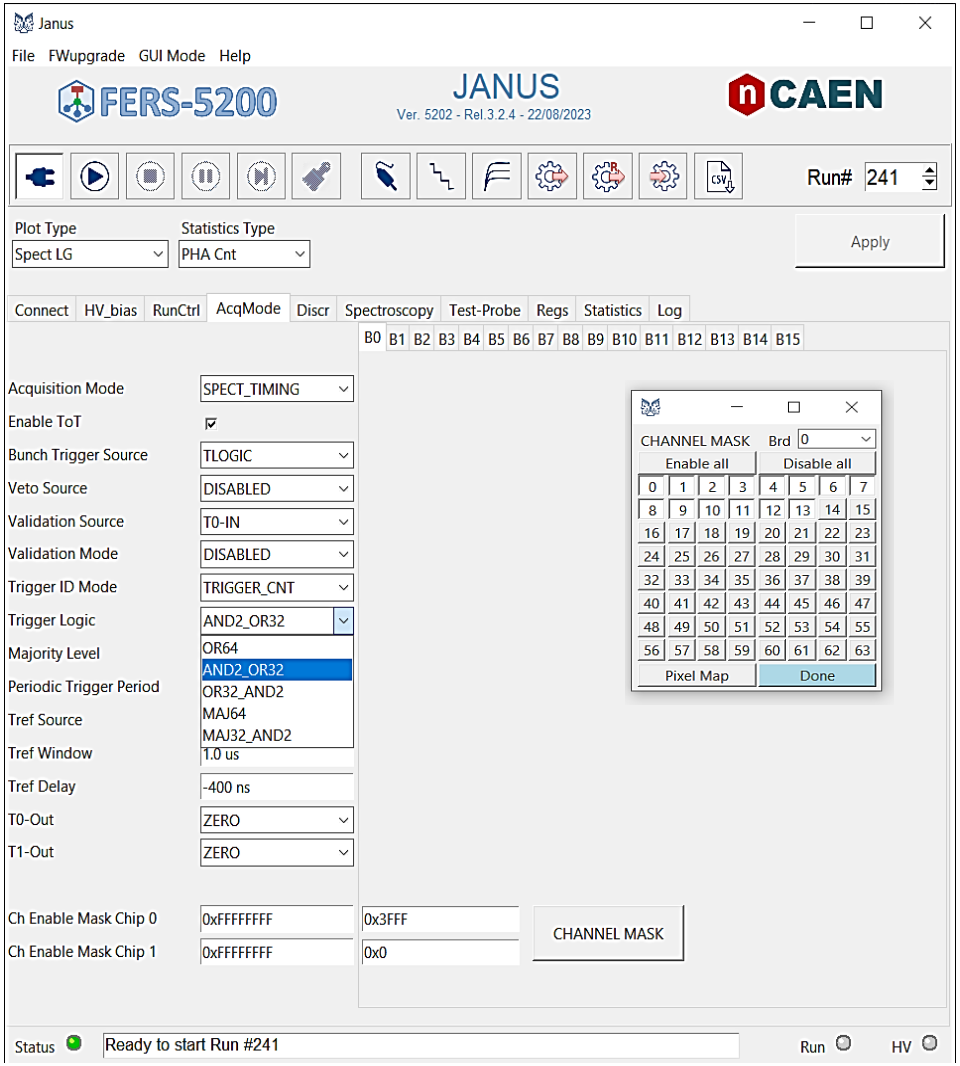
Selected options:

Scintillator:	**Uniplast-Vladimir (chemical mating)**
Optical cement:	**CKTN Med mark B**
Fibers:	**Saint-Gobain Crystals (SG92S)**
SiPMs:	**SensL 1x1 mm^2 (tests temperature ≤ 25.3 °C)**



Prototype assembling test part

Trigger logic parameters for DAQ

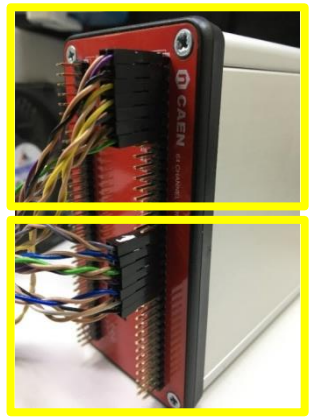


The tests were performed in **self-triggering mode**. The 2 trigger logic options were tested. 1 chip was used for the first case, for the other case the channels were allocated to two chips.

1-st Citiroc 1A was used

AND2_OR32
Parameter

Both Citiroc 1A were used



OR32_AND2
Parameter

1 our of working

Time Stamp	3600.860 s
Trigger-ID	6884
Trg Rate	2.717 cps
Trg Reject	0.51%
Tot Lost Trg	35
Event Build	0.00%
Readout Rat	245.409 B/s
T-OR Rate	0.000 cps

~3.8k counts/channel

Time Stamp	3600.410 s
Trigger-ID	7332
Trg Rate	2.867 cps
Trg Reject	0.05%
Tot Lost Trg	4
Event Build	0.00%
Readout Rat	258.667 B/s
T-OR Rate	0.000 cps

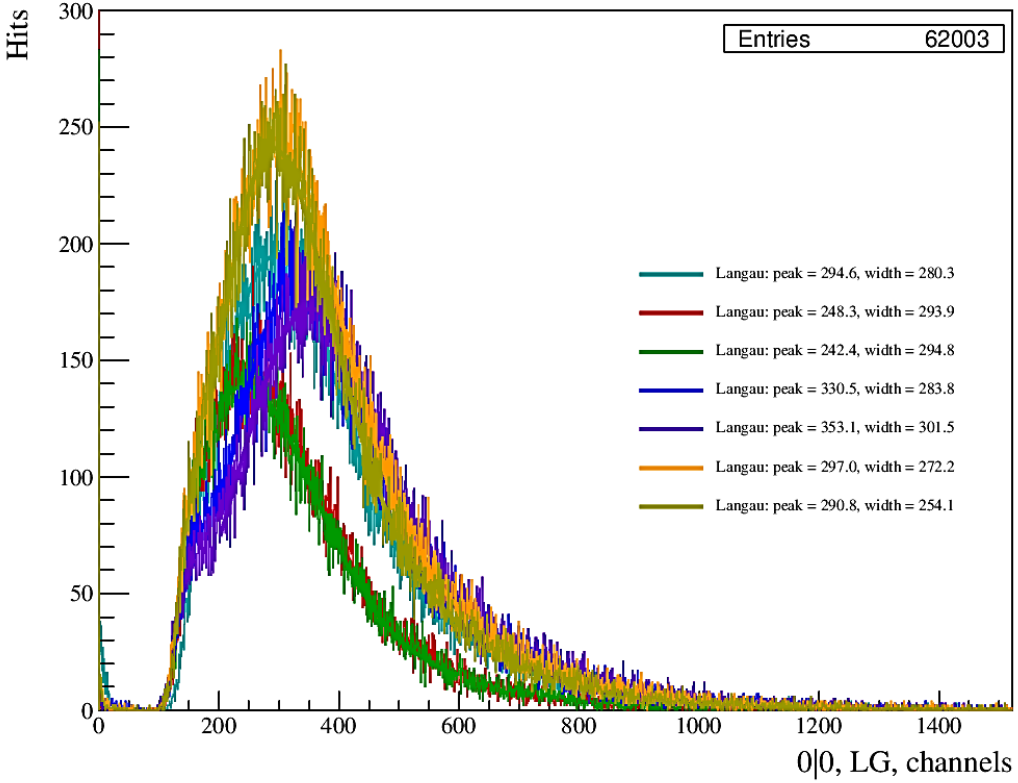
~4.1k counts/channel

The first case, a more hard trigger, used to demonstrate the following results.

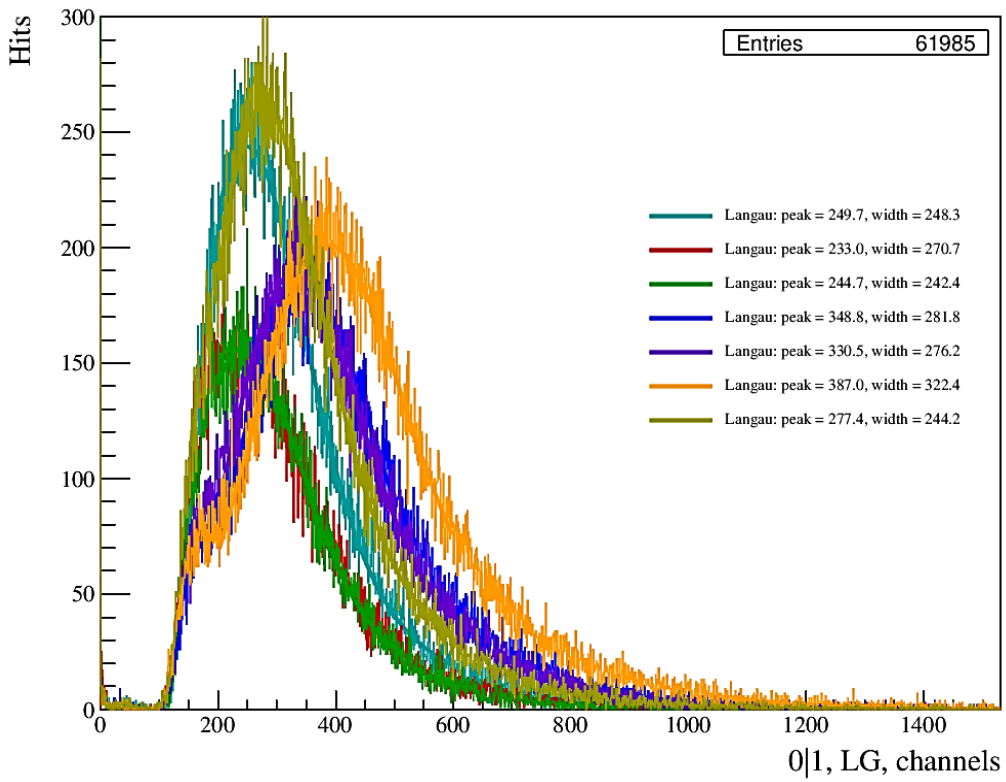
Prototype assembling test part

Amplitude spectra of two sectors (AND2_OR32)

1-st sector



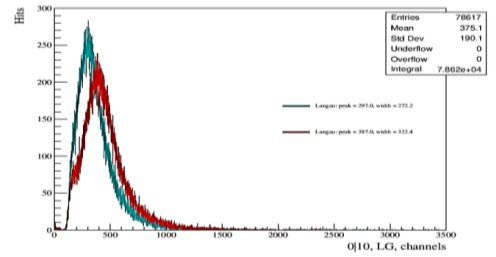
2-nd sector



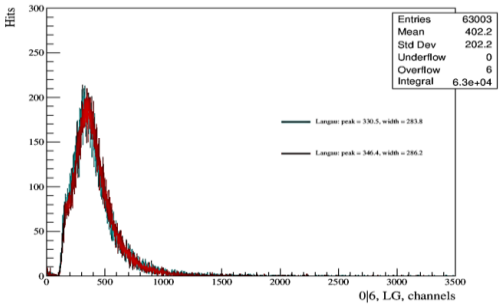
- the amplitude spectra from seven tiles for each prototype.

Comparison of sector pairs

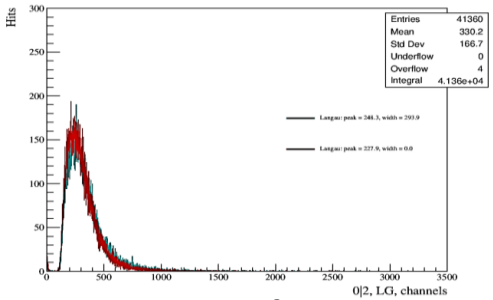
The radius dependence



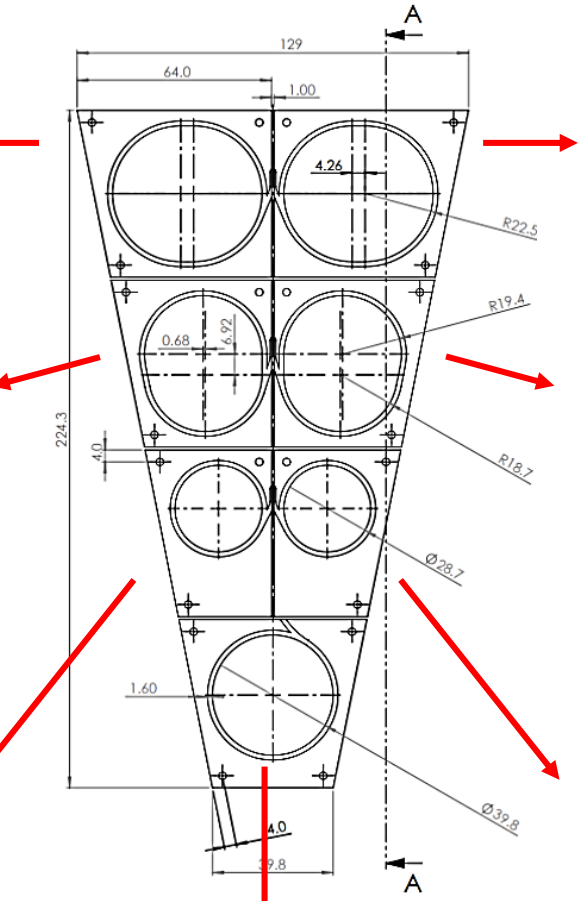
3 Left

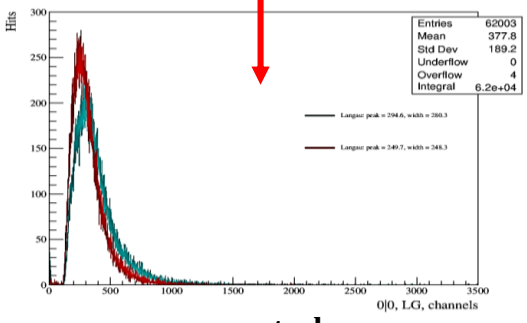


2 Left

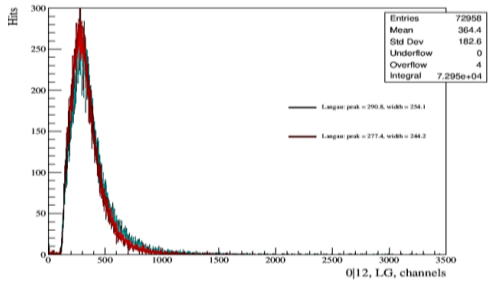


1 Left

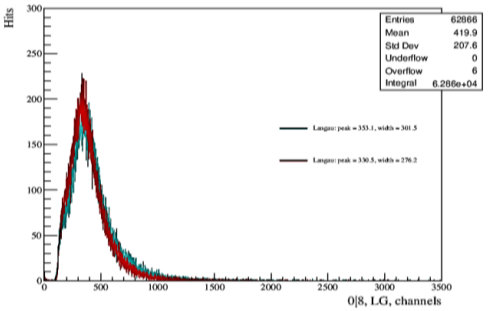




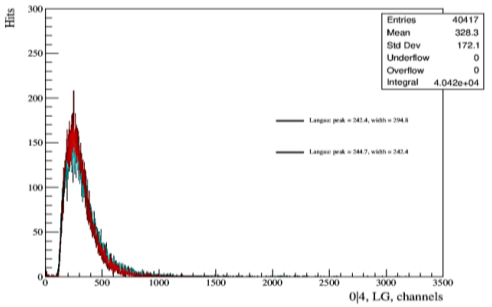
central



3 Right



2 Right



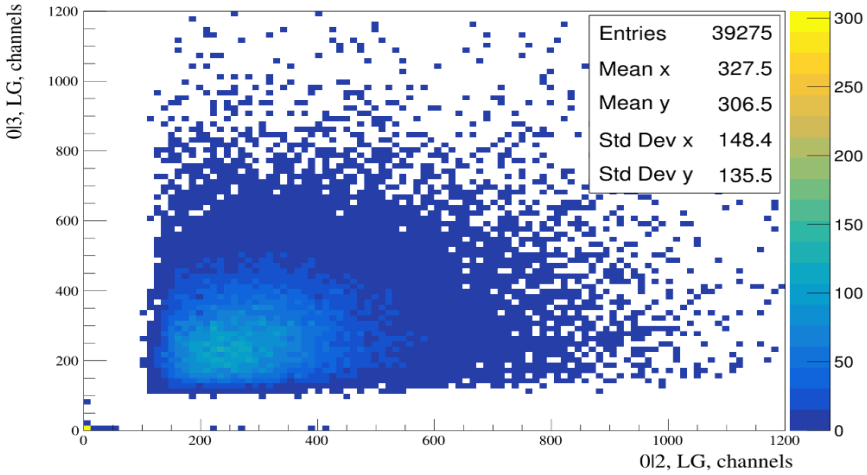
1 Right

The amplitude increases with increasing radius. There are 2 unusual channels, but the debugging process of mass production continues.

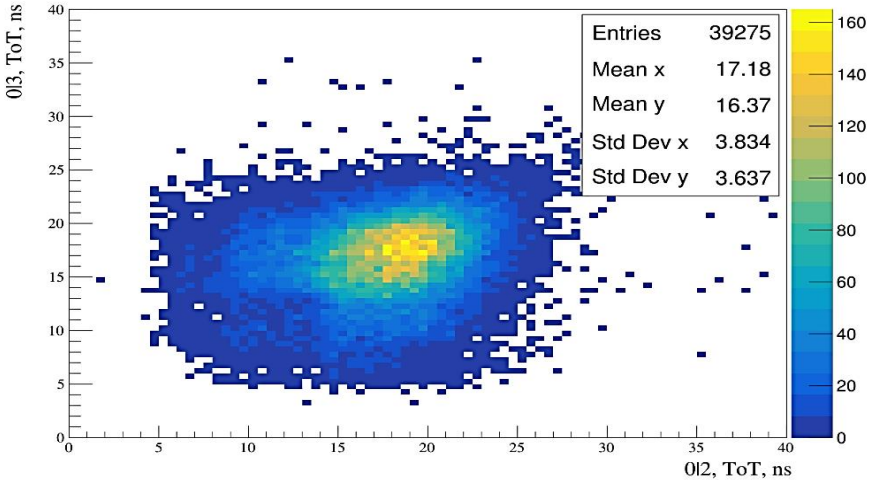
In addition, the use of multi-channel connectors should exclude the possible problems of single connectors.

Correlations

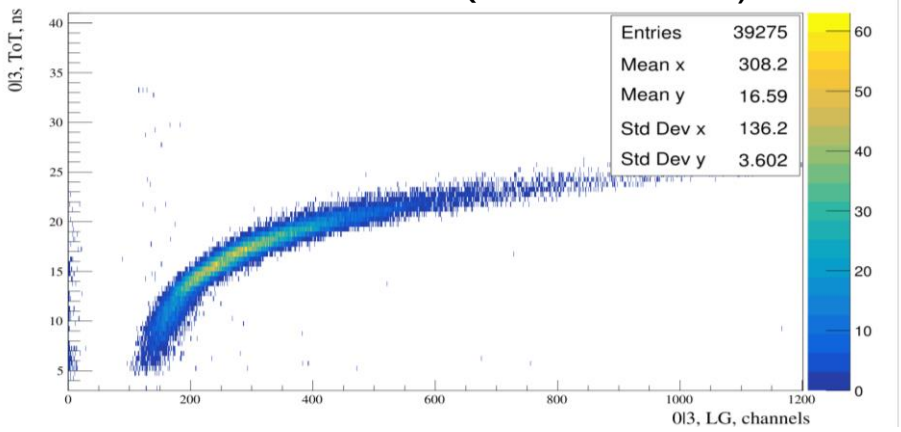
LG correlations



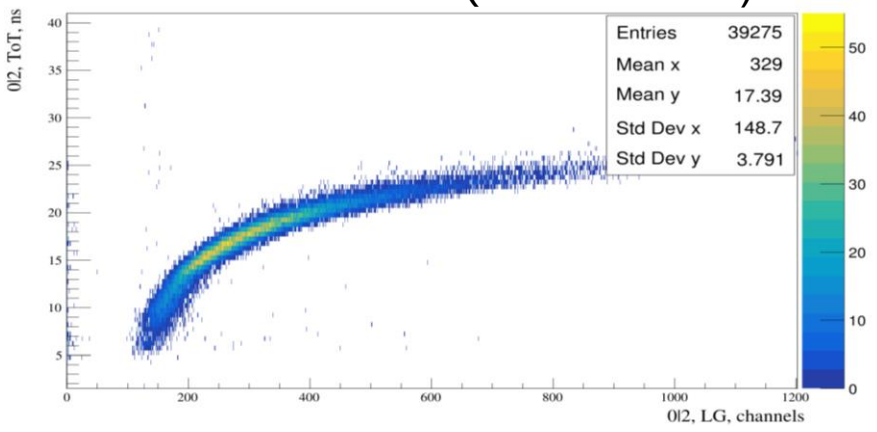
ToT correlations



LG vs ToT (channel №3)



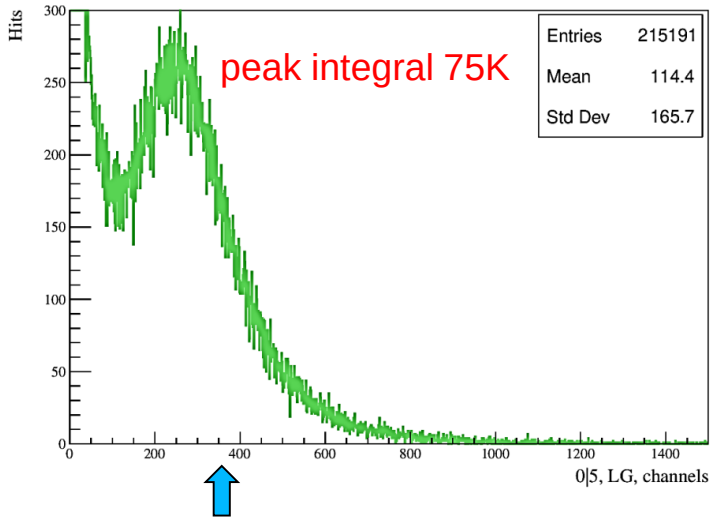
LG vs ToT (channel №2)

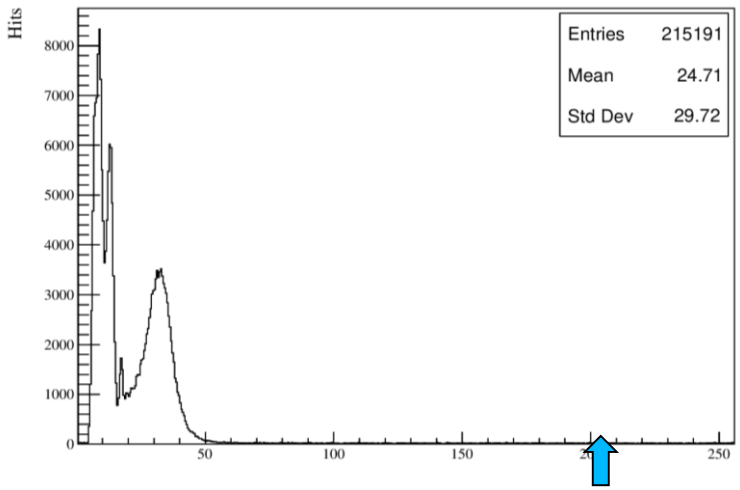


- Offline software for the data from FERS5200 (n*DT5202->DT5215) is developped
- Correlation of energy deposition for 2 channels, as well as the time information for this channels. ToT for the free-streaming mode of DAQ
- The collibration of ToT is required

FERS DT5202 working options. Data rate (different thresholds)

T-Discriminator Threshold = 200 (for **HG)** 3.27 Gb/hour



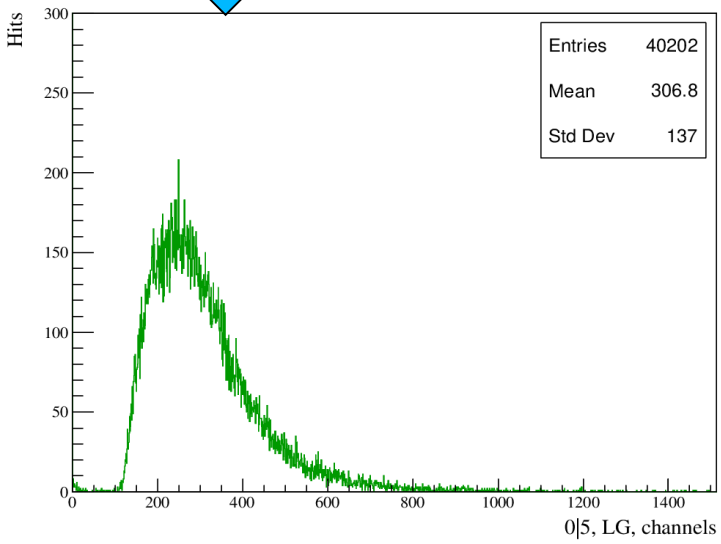


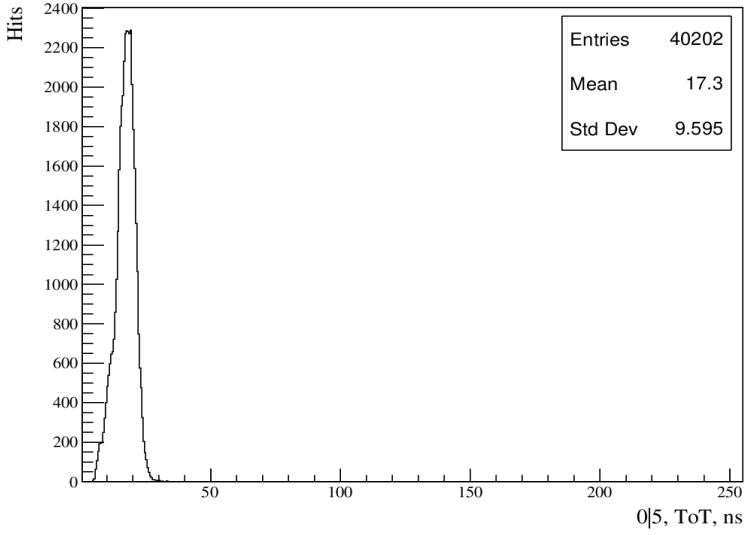
The comparison of the amplitudes and ToT histograms depending on the T-Discriminator thresholds.

LG

ToT

T-Discriminator Threshold = 200 (for **LG**) <1 Mb/hour



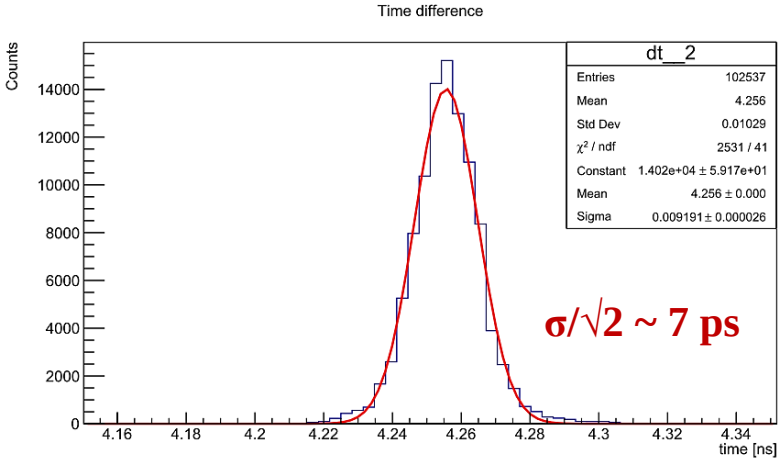


- Calibration of the energy channels of DT5202 is **required**
- determining the optimal thresholds for DT5202 is **required**

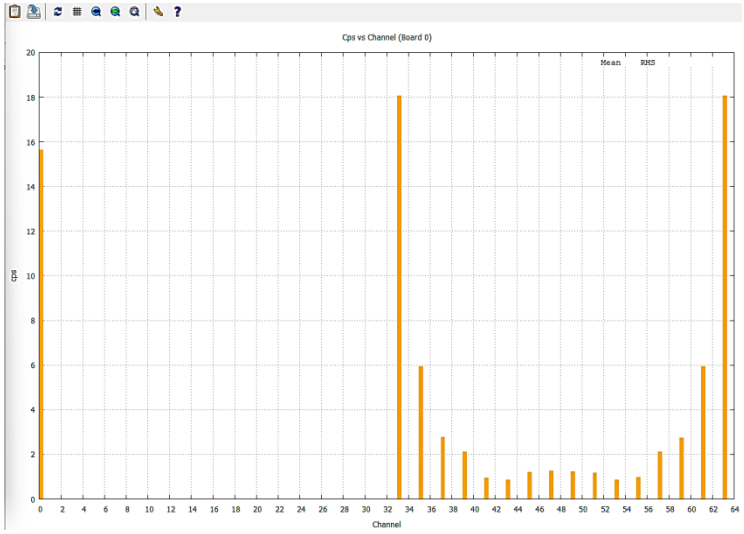
FEE studies

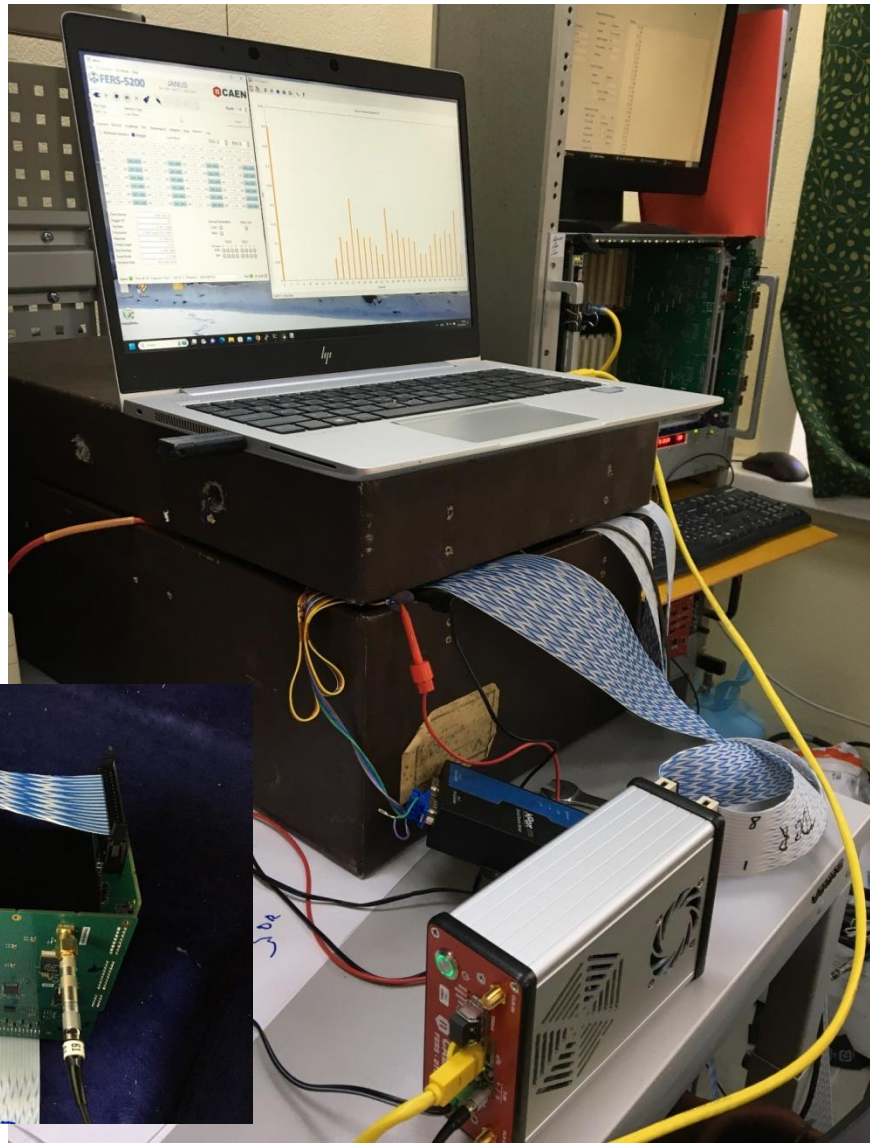
DT 5203 (picoTDC chip)

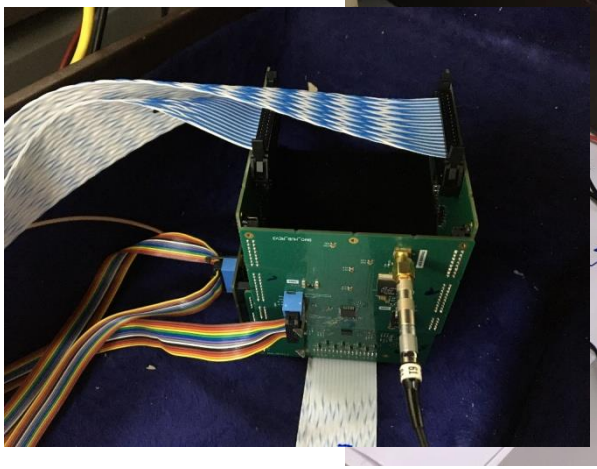
The generator tests



The ToT signals (cosmic rays tests)







Together with **M. Buryakov (JINR),**
S. Buzin (JINR),
A. Dmitriev (JINR)

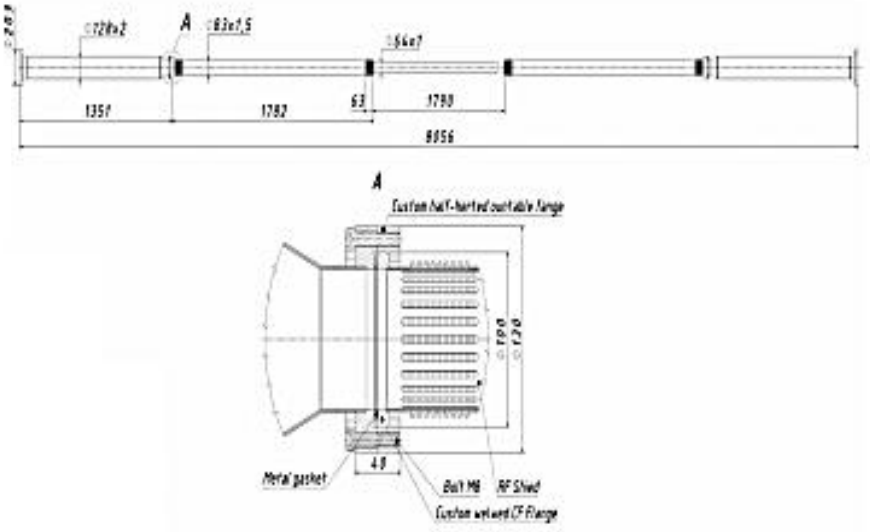
Current status

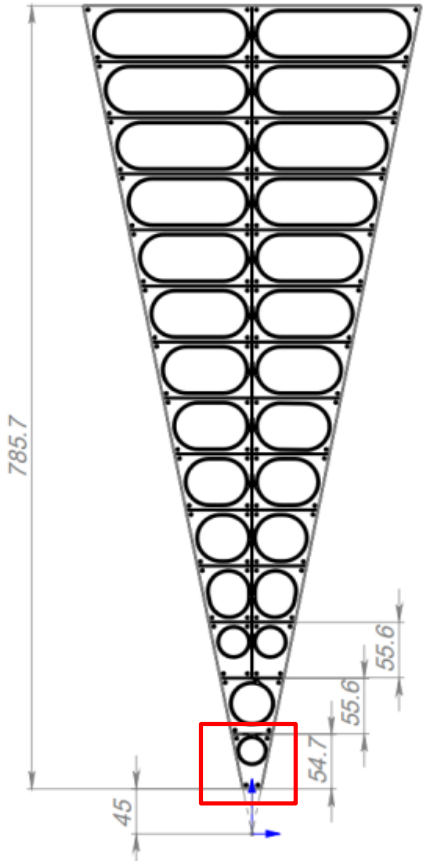
1. New geometry of the outer part of BBC is **defined**.
2. Prototype materials are **selected**
    - Scintillators manufacturer (Uniplast-Vladimir).
    - Scintillator cover, optical cement, and WLS types.
3. Two 7-tiles prototypes designed, manufactured and **carrying out testing**
4. FEE and digitizer option for Phase0 and Phase1 (possibly) are **selected**.
5. Software for the data analysis and simulation is **developed**.

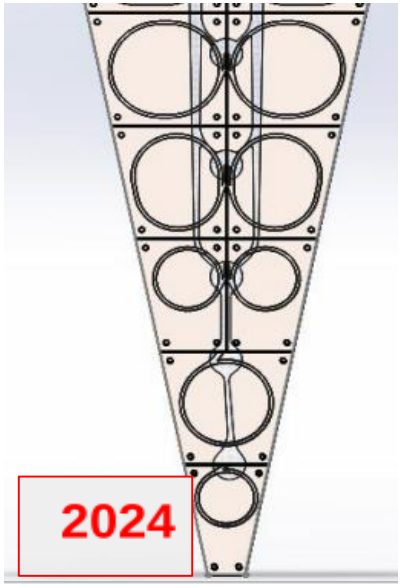
Extended design

Additional tile for sector. The 8-tiles prototype.

Now : 124 mm diameter
Need: 83 mm diameter







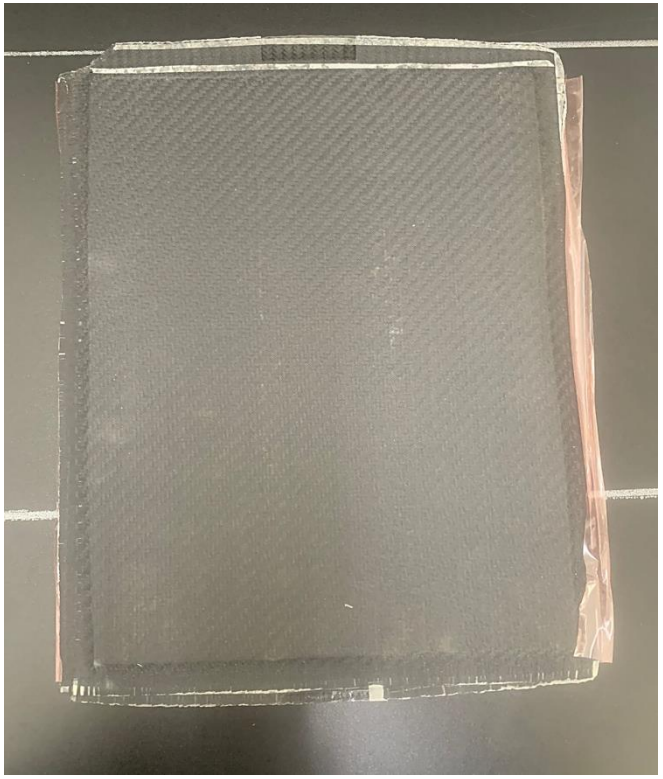
We get the opportunity to use an additional tile due to the diameter decreases of the beam pipe.

- One of the plans for this year is to assemble and test 8-channel prototypes with new mechanics.

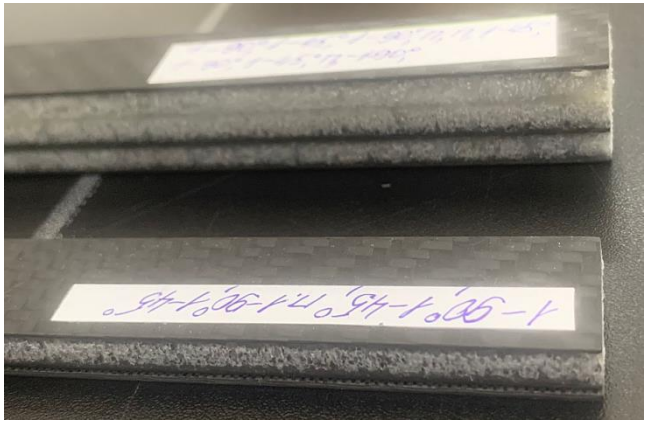
Extended design

The 8-tiles prototype

Sandwich support:
Carbon fiber+foam plastic
3 layers for prototypes
5 layers for detector



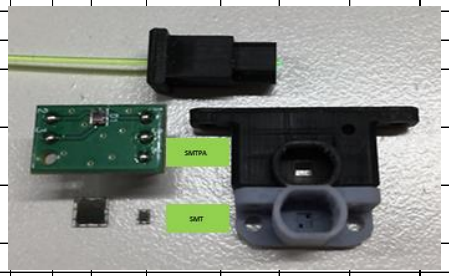
The trapezoids have already been done



Schedule of works

The manpower involved

№	Наименование	2024 year										2025 year												2026 year					
		1-st quarter	2-nd quarter			3-rd quarter			4-th quarter			1-st quarter			2-nd quarter			3-rd quarter			4-th quarter			1-st quarter			2-nd quarter		
		March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
1	Estimation of light loss on fiber bending																												
2	Manufacturing and testing of samples with various optical cement options																												
3	Selection of final assembly components																												
4	Production of a three-layer base for a prototype																												
5	Assessment of the strength of the base																												
6	**Development of 2 sector prototypes [2*7 tiles]**																												
6.1	Astimation tests																												
6.2	Calibration of the energy scale of DT5202																												
6.3	Determining the optimal thresholds for DT5202																												
6.4	Determination of temperature dependence and its consideration in tests																												
6.5	Prototype testing									1	2																		
6.6	Data processing and interpretation of results																												
7	Tests with Hamamatsu SiPM (1.3x1.3 mm^2)																												
8	Development of the inner part of the detector (the space between the tube and the proposed BBC concept)																												
9	Development of mapping_a for the BBC subsystem																												
10	**Development of 2 detector prototype wheels [2*(8*16) =256 tiles]**																												
10.1	Production of the prototype frame																												
10.2	Production of a five-layer base for a prototype																												
10.3	Implementation of composite sleeves for fixings, and milling																												
10.4	Installing the base into the frame																												
10.5	Development and manufacture of optical connector modules (WLS <-> transparent fiber)																												
10.6	Development and manufacture of connectors (transparent fiber <-> SiPM)																												
10.7	Development and manufacture of a printed circuit board (PCB) for SiPM																												
10.8	Checking the performance of connectors and PCB																												
10.9	Prototype testing (test beam)																												
10.10	Data processing and interpretation of results																												
11	Coordinating the output of detector cables to the BBC control room																												
12	**Assembly of 2 rings of a full-scale detector**																												
12.1	Manufacturing of the frame (2 parts)																												
12.2	Manufacturing of a five-layer base for the detector																												
12.3	Implementation of composite sleeves for fixings, and milling																												
12.4	Installing the base into the frame																												
12.5	Full camera testing																												
12.6	Data processing and interpretation of results																												
13	Dismounting of detectors																												
14	Transferring detectors to SPD																												
15	Installation of detectors																												
16	Cross check and tests																												



BBC group:

VBLHEP : 7+1 (HI simulations)

DLNP : 2 (simulations)

MEPhI : about 10

★ *Not JINR : ?*

Conclusions

Risks

I. The R&D phase for the scintillation tiles is almost finished.

II. The main task for 2024 is to produce and to test the 8 tiles prototypes.

III. The manufacture of 2 small BBC wheels (128 tiles each) for SPD Phase 0 is planned for the end of 2024.

Risks 2024-2025:

- FERS5200 CAEN availability. We have only 3 DT5202 boards.
- Radiation conditions for HI collisions. Simulation for beam pipe& small BBCs& Bi+Bi is required.

Risks >2024:

- New electronics (localized in RF) is needed: FEE, digitization, L1.

Thank you for the attention!

Backup

T-Discriminator Threshold = 200 (for **HG)**

Time Stamp	3599.318 s
Trigger-ID	48792418
Trg Rate	5.862 kcps
Trg Reject	56.77%
Tot Lost Trg	27697364
Event Build	0.00%
Readout Rat	926.554 kB/s
T-OR Rate	0.084 cps

3.27 Gb/hour

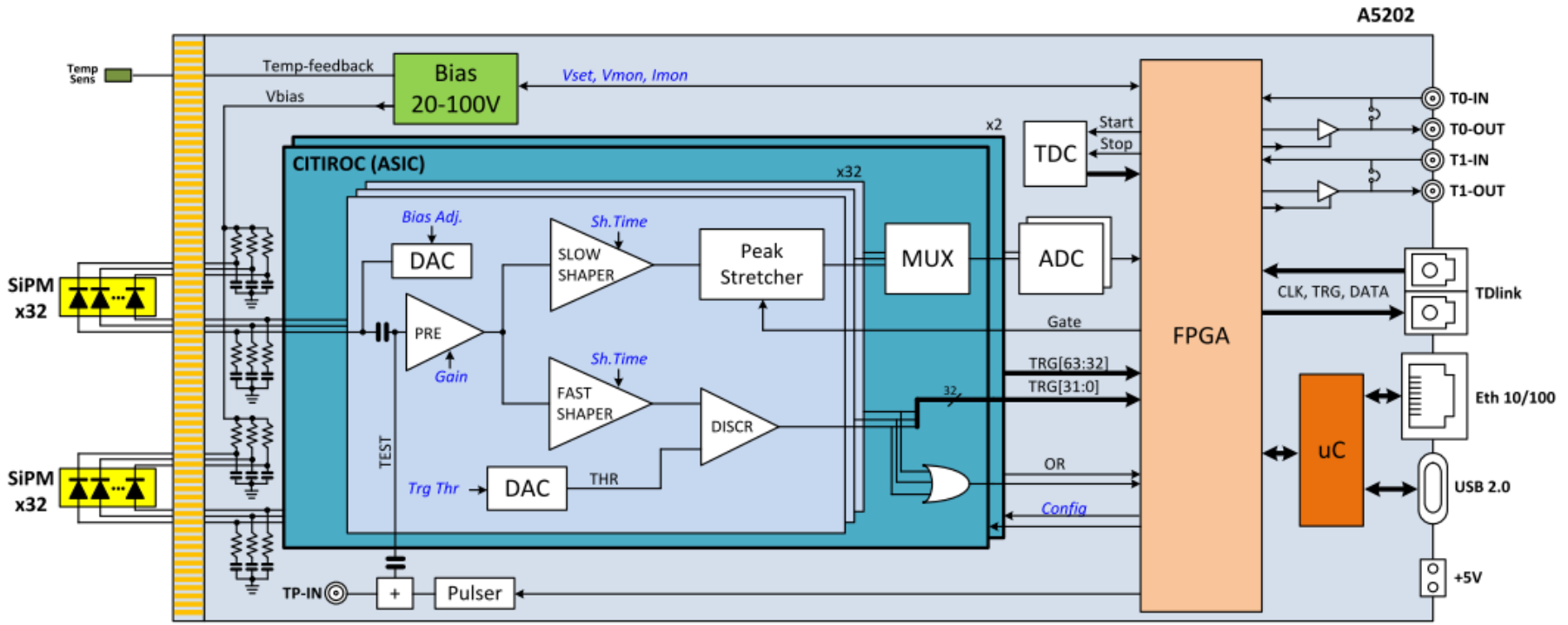
T-Discriminator Threshold = 200 (for **LG**)

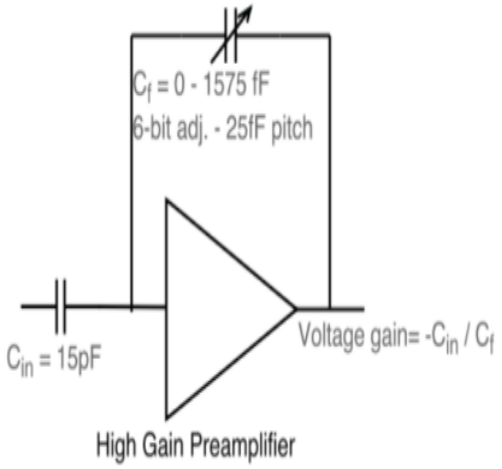
Time Stamp	3600.860 s
Trigger-ID	6884
Trg Rate	2.717 cps
Trg Reject	0.51%
Tot Lost Trg	35
Event Build	0.00%
Readout Rat	245.409 B/s
T-OR Rate	0.000 cps

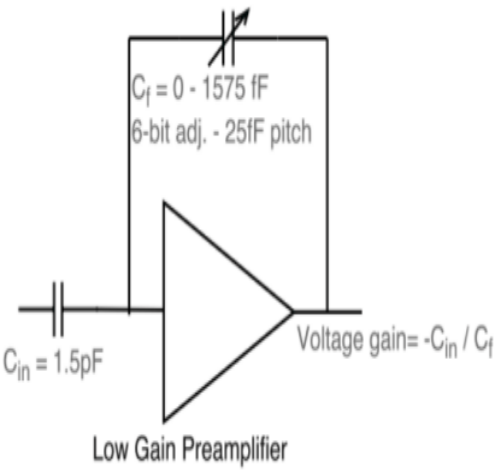
<1 Mb/hour

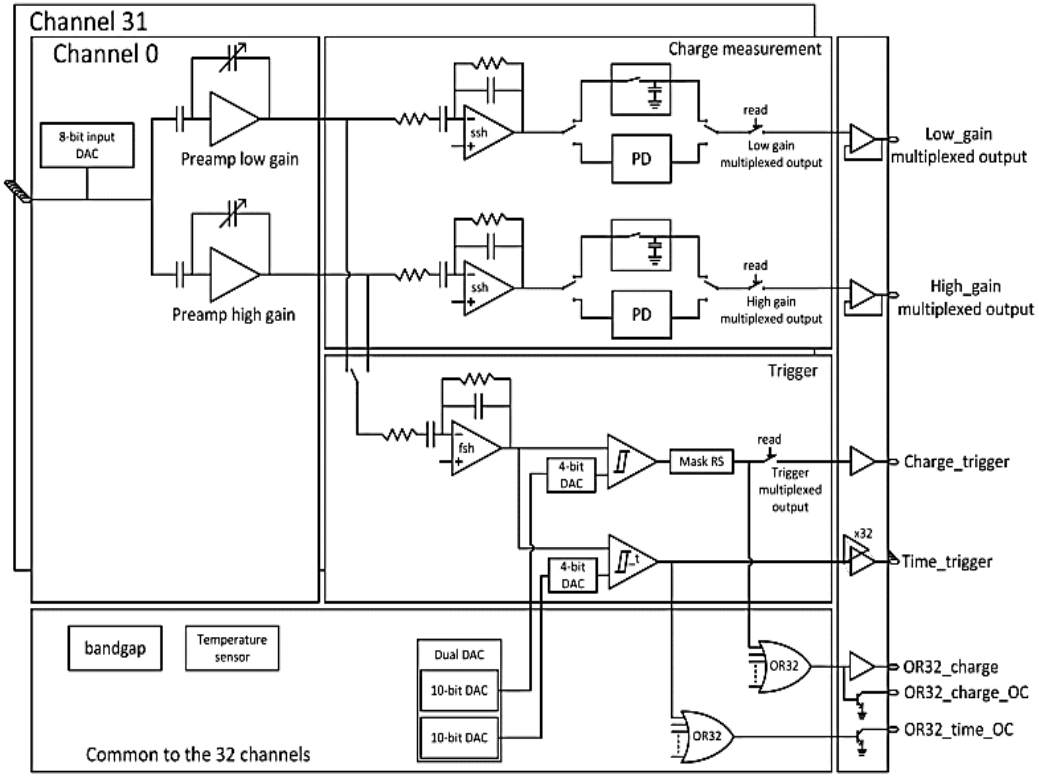
- Triggers of consecutive channels are sent to an AND logic operator (e.g. CH0&CH1, CH2&CH3, etc.). The 32 outputs are then sent to an OR logic operator.

- OR32_AND2: Triggers of each Citiroc-1A (32 channels each) are sent to an OR logic operator. The 2 output signals (one for each Citiroc-1A) are then sent to a logic AND operator.


A5202
Temp Sens
Temp-feedback
Vbias
Bias
20-100V
Vset, Vmon, Imon
CITIROC (ASIC)
x2
x32
TDC
Start
Stop
Bias Adj.
DAC
Sh.Time
SLOW SHAPER
Peak Stretcher
MUX
ADC
SiPM x32
PRE
Gain
Sh.Time
FAST SHAPER
DISCR
TEST
Trg Thr
DAC
THR
Gate
TRG[63:32]
TRG[31:0]
32
OR
Config
FPGA
T0-IN
T0-OUT
T1-IN
T1-OUT
CLK, TRG, DATA
TDlink
Eth 10/100
uC
USB 2.0
+5V
TP-IN
+
Pulser


C_f = 0 - 1575 fF
6-bit adj. - 25fF pitch
C_{in} = 15pF
Voltage gain= -C_{in} / C_f
High Gain Preamplifier


C_f = 0 - 1575 fF
6-bit adj. - 25fF pitch
C_{in} = 1.5pF
Voltage gain= -C_{in} / C_f
Low Gain Preamplifier


Channel 31
Channel 0
Charge measurement
8-bit input DAC
Preamp low gain
Preamp high gain
ssh
PD
read
Low gain multiplexed output
High gain multiplexed output
Low_gain multiplexed output
High_gain multiplexed output
Trigger
fsh
4-bit DAC
Mask RS
Trigger multiplexed output
Charge_trigger
Time_trigger
x32
bandgap
Temperature sensor
Dual DAC
10-bit DAC
10-bit DAC
OR32
OR32_charge
OR32_charge_OC
OR32_time_OC
Common to the 32 channels

```
//*************************************************
// File Format Version 3.1
// Janus Release 2.2.10
// Acquisition Mode: Spect_Timing
// Energy Histogram Channels: 4096
// ToA/ToT LSB: 0.5 ns
// Run start time: Thu May 12 12:34:25 2022 UTC
//*************************************************
```

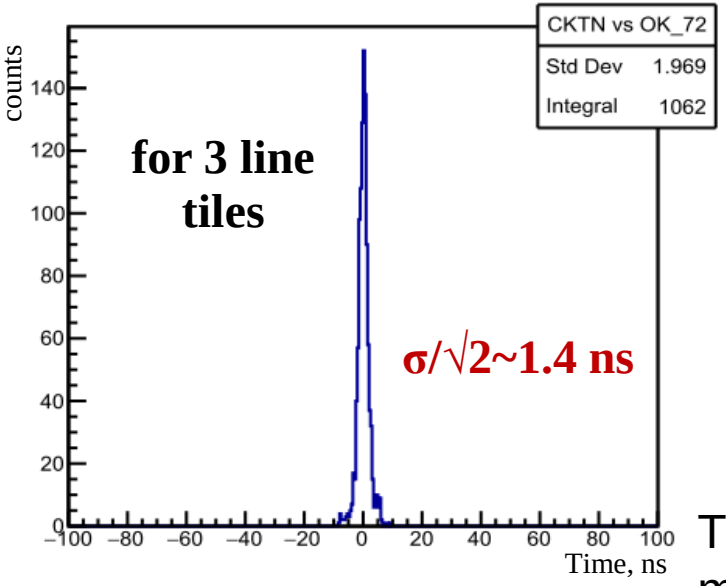
Tstamp_us	TrgID	Brd	Ch	LG	HG	ToA_ns	ToT_ns
2.080	0	00	00	39	39	-	-
		00	01	36	35	-	-
		00	02	36	20	919.0	8.0
		00	03	42	55	-	-
		00	04	30	9	-	-
		00	05	40	41	-	-
		00	06	36	12	-	-
		00	07	38	69	-	-
		00	08	33	13	-	-
		00	09	31	32766	955.0	5.5
		00	10	38	160	140.0	14.0
		00	11	37	282	74.0	20.0
		00	12	45	141	-	-
		00	13	105	785	71.0	28.0
		00	14	35	14	-	-
		00	15	105	768	71.0	28.5
		00	16	35	69	-	-
		00	17	36	101	855.0	8.5
		00	18	38	100	-	-
		00	19	117	861	71.0	29.5
		00	20	35	32	-	-
		00	21	44	236	83.5	8.5
		00	22	38	25	-	-
		00	23	57	240	83.0	9.0
		00	24	36	32767	-	-
		00	25	32	12	-	-
		00	26	39	53	-	-
		00	27	33	49	-	-

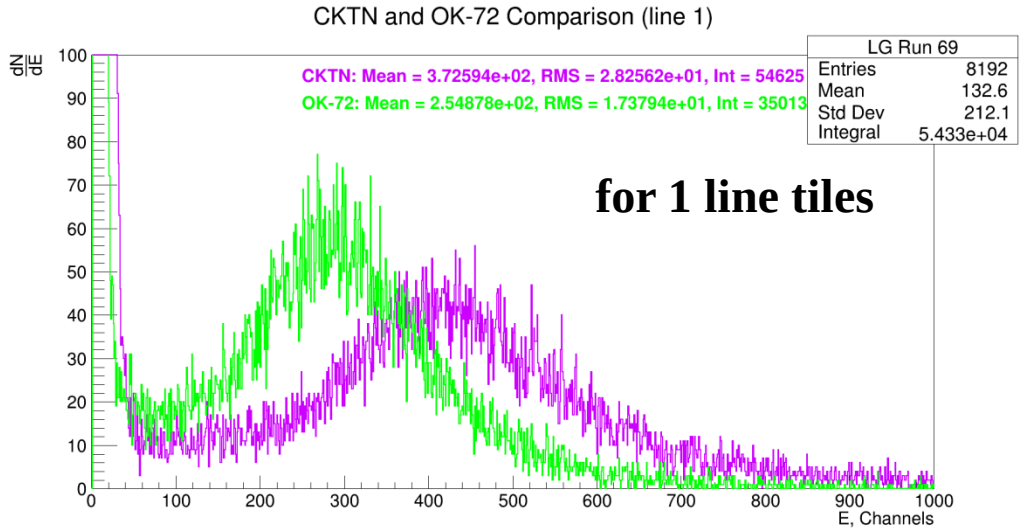
Fig. 3.36: Event List example in Spectroscopy + Timing Mode (Ascii format), where ToA and ToT are expressed in ns.

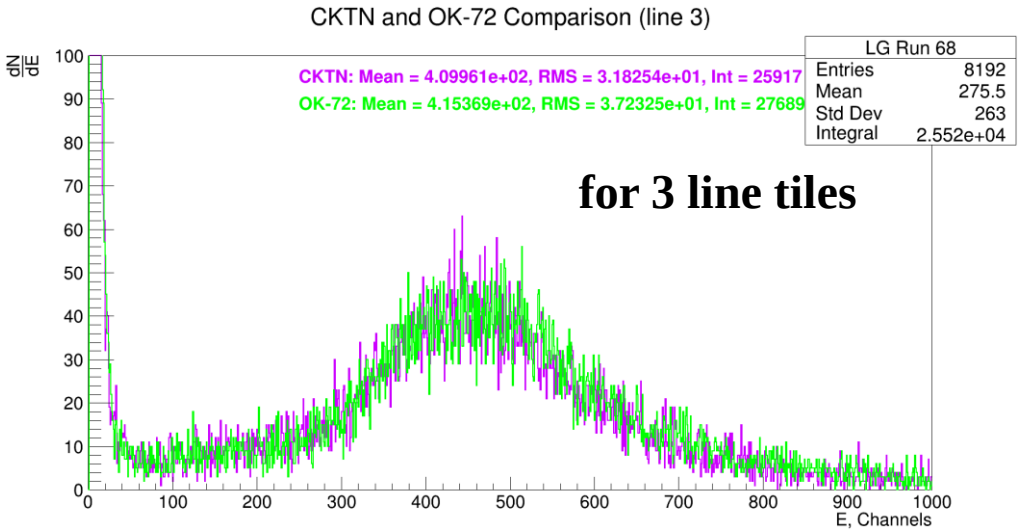
FEE studies results

CKTN Med and OK-72 difference

Trigger time resolution ~650 ps



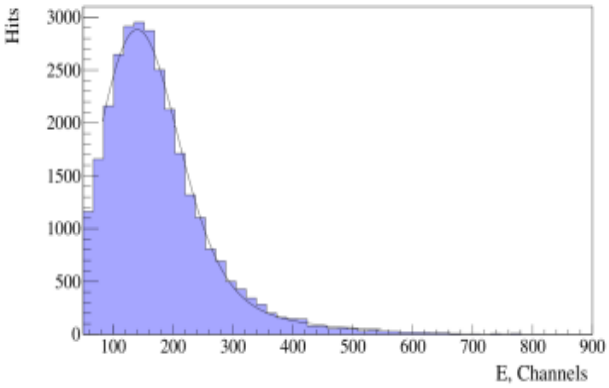




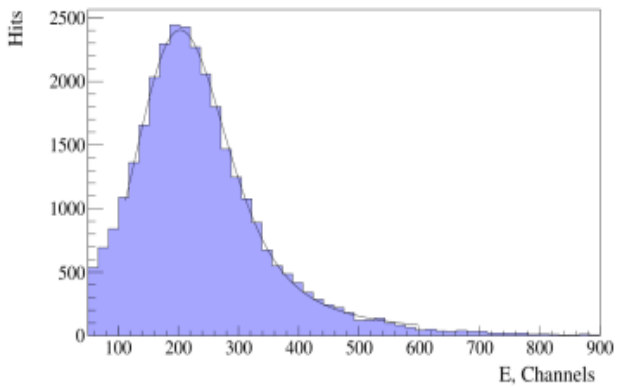
There is uncertainty with optical cement, so additional measurements are important.

The efficiency of single channel output tiles

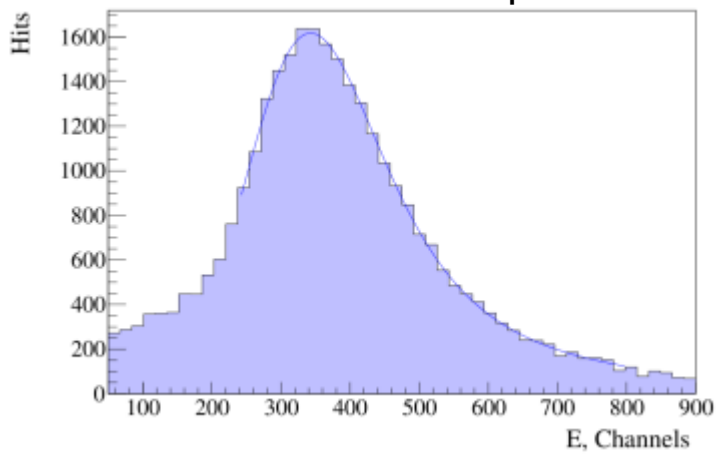
1-st WLS output

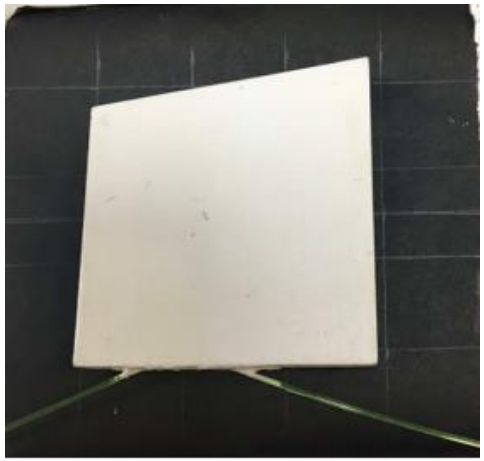


2-nd WLS output

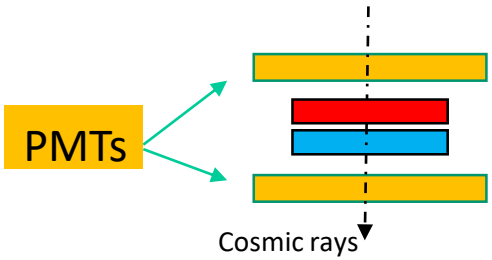


Sum of WLS outputs

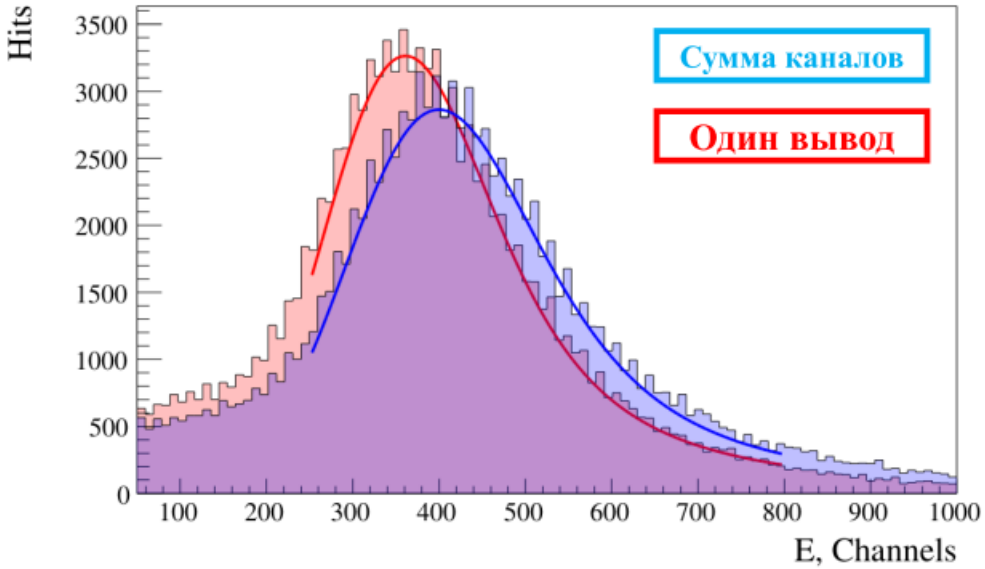




S.G. (WLS)
CKTN (opt. cement)
SensL SiPMs (~27.34 V.)



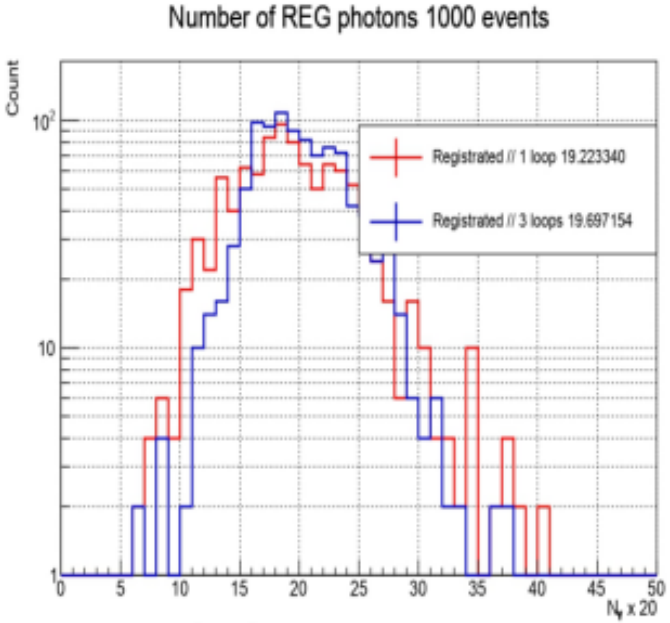
Single WLS Tile
Double WLS Tile



The efficiency estimate is about 90%.

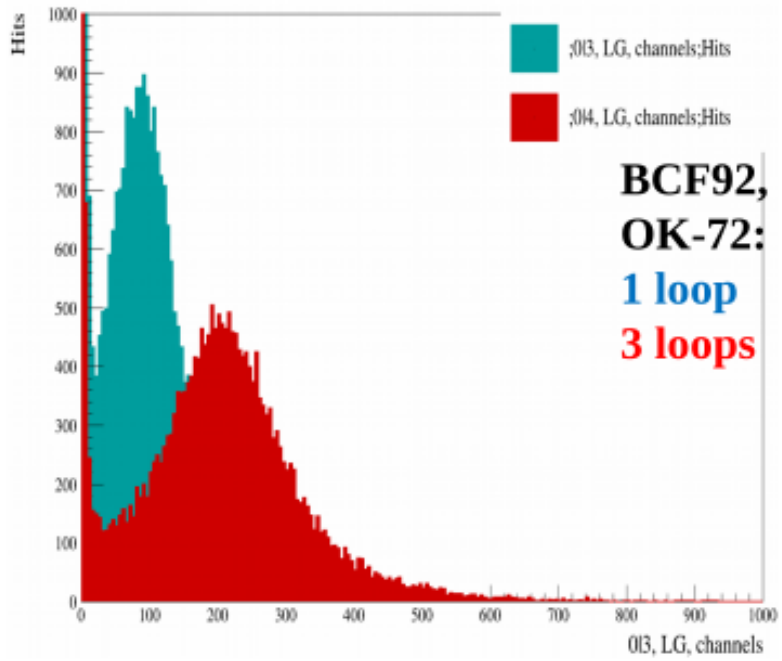
Ways to reduce the cost of the BBC

Amount of fiber loops



For more details, see https://indico.particle.mephi.ru/event/389/contributions/3829/attachments/2283/4212/-12--.pdf

Fit Params	1 row	3 rows
Mean, Channels	86.7	202.6

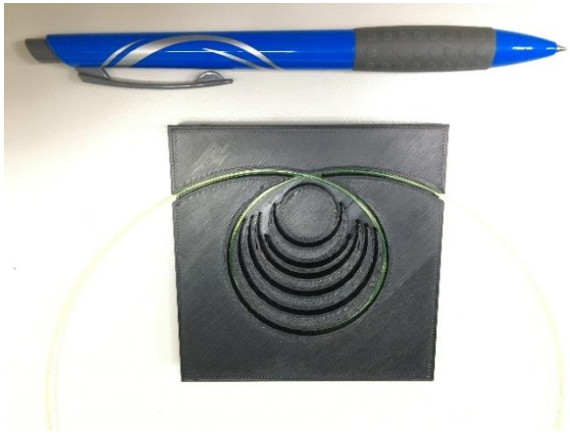


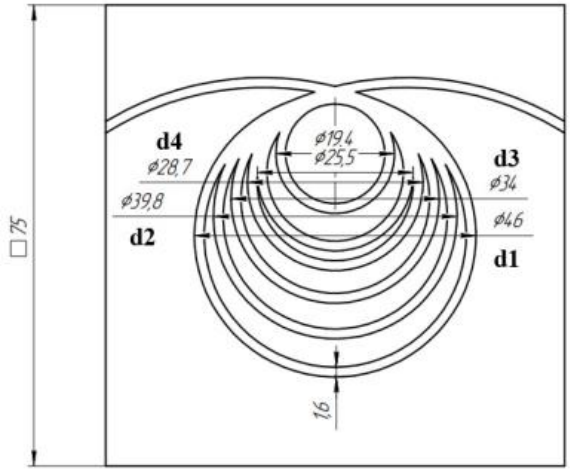
Experimental data: Light collection of second row tiles with SG BCF92 and OK-72, but: 1 (blue) and 3 (red) rows of WLS fiber, starting from the same depth

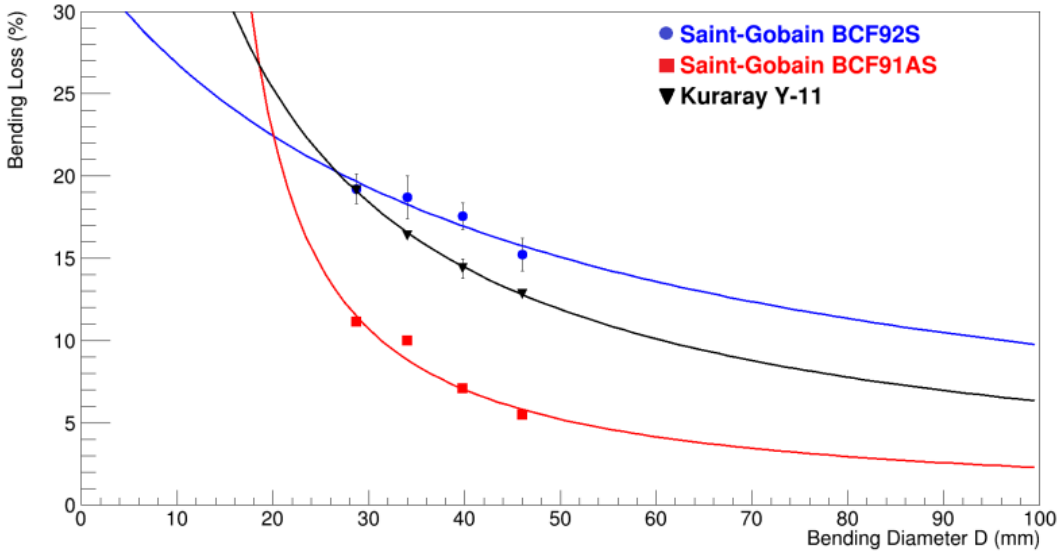
FEE studies results

Fibers bending loss

Tool for bending loss tests







PRELIMINARY

Difference between d1 and d4 diameters:

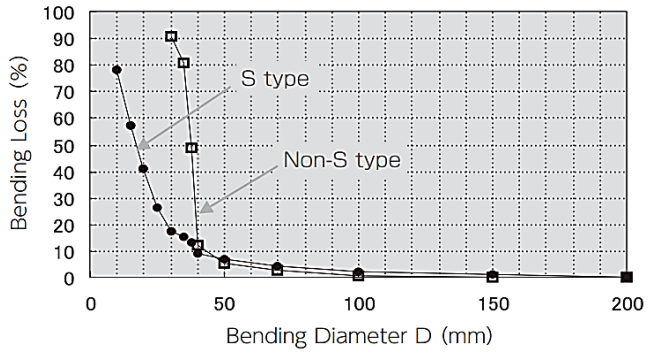
SG BCF91AS – 6.0%

SG BCF92S – 4.7%

Kuraray Y-11 – 8.5%

for 1 rotation (inside the tiles is 3)

Kuraray (datasheet)



FEE studies results

Saint-Gobain Crystals vs KURARAY fibers difference. (CKTN optical cement)

Saint-Gobain Crystals fibers

Specific Properties of Standard Formulations				
Fiber	**Emission Color**	**Emission Peak, nm**	**Decay Time, ns**	**# of Photons per MeV****
BCF-10	blue	432	2.7	~8000
BCF-12	blue	435	3.2	~8000
BCF-20	green	492	2.7	~8000
BCF-60	green	530	7	~7100
BCF-91A	green	494	12	n/a
BCF-92	green	492	2.7	n/a
BCF-98	n/a	n/a	n/a	n/a

** For Minimum Ionizing Particle (MIP), corrected for PMT sensitivity

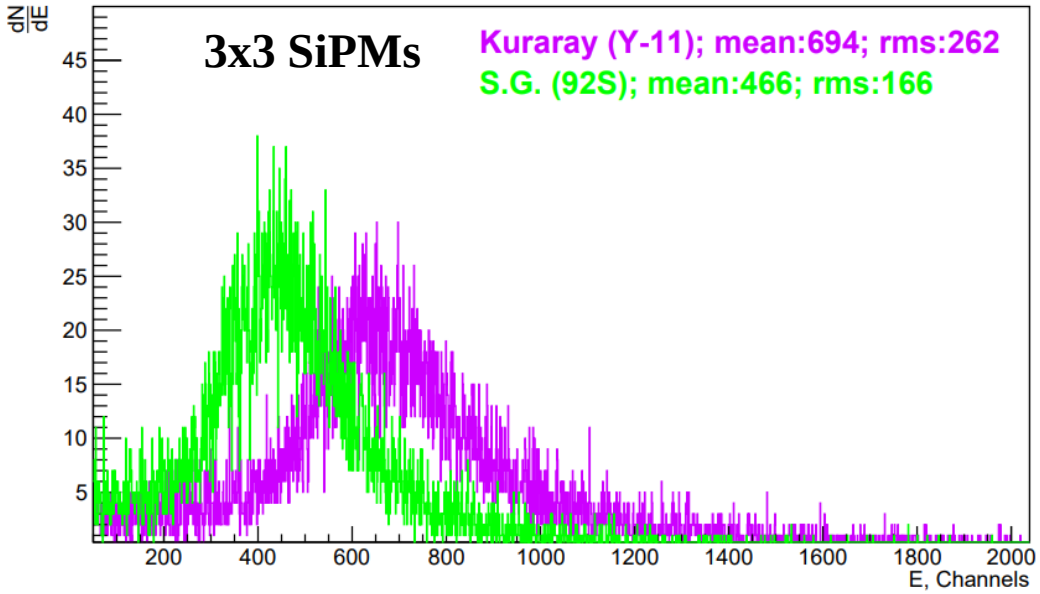
Table 1. Optical cements and their parameters

Brand	Viscosity, cPs	Operating temperature range	Spectral characteristics	Refractive index
EJ-500	800	From -65 to +105 °C	60-95% at 300-350 nm 95-100% at 350-600 nm	1.574
CKTN MED Mark E	$15 \cdot 10^3$	—	92-96% 500 nm	1.606
OK-72	—	From -60 to +60 °C	99% at 400-2700 nm	1.587

KURARAY fibers

Description	Emission			Absorption Peak[nm]	Att.Leng.[2] [m]	Characteristics
	Color	Spectra	Peak[nm]			
Y-7(100)	green	See the following figure	490	439	>2.8	Blue to Green Shifter
Y-8(100)	green		511	455	>3.0	Blue to Green Shifter
Y-11(200)	green		476	430	>3.5	Blue to Green Shifter (K-27 formulation) Long Attenuation Length and High Light Yield
B-2(200)	blue		437	375	>3.5	UV to Blue shifter
B-3(200)	blue		450	351	>4.0	UV to Blue shifter

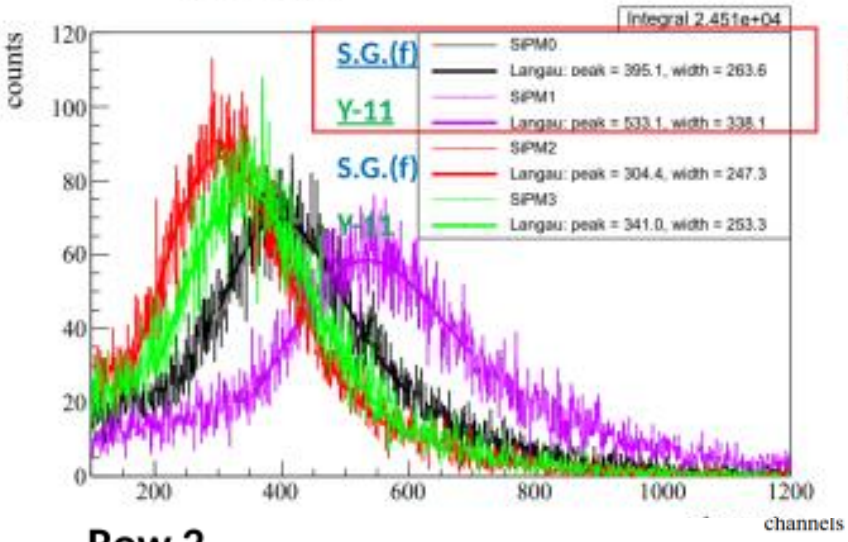
Kuraray Y-11 fiber collects more photons.



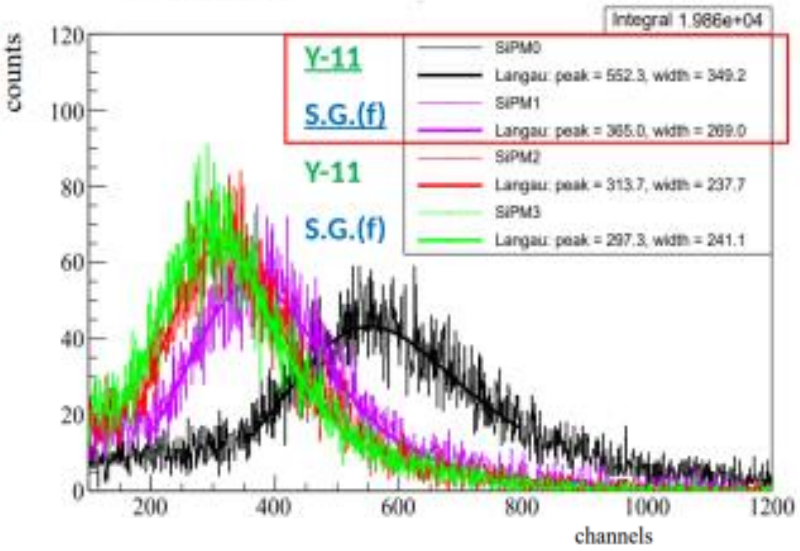
FEE studies results

Material selection: Optical cement

Run138



Run 139

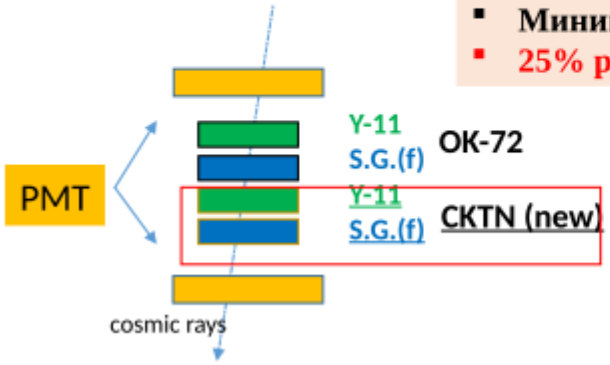


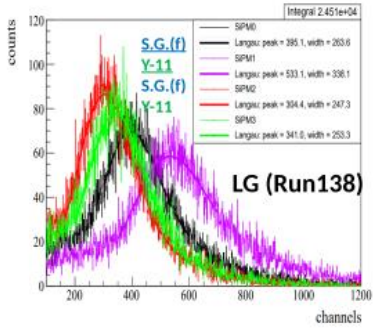
Row 2

1x1 mm² SMTPA SiPM

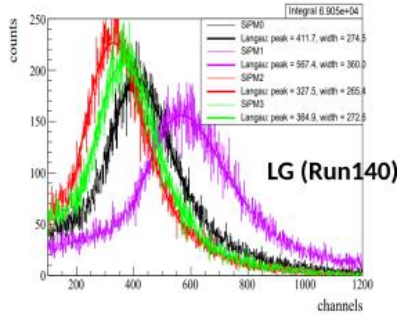
Vbias~27,37V calibration for all

- Отсутствие влияния SiPMs
- Минимальное различие сигнала для различного в
- 25% различие сигнала для различного волокна (п

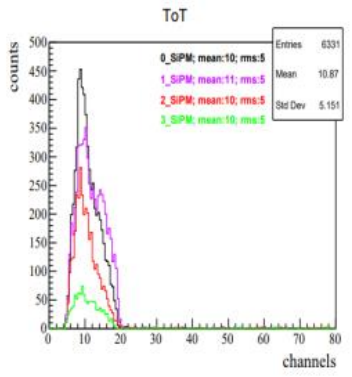


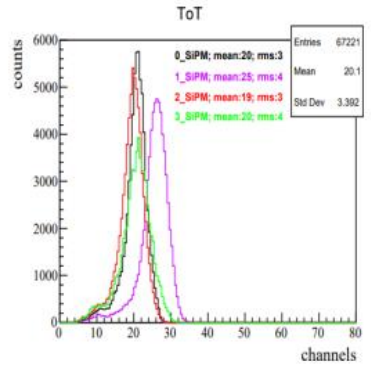


T-Threshold = **300**

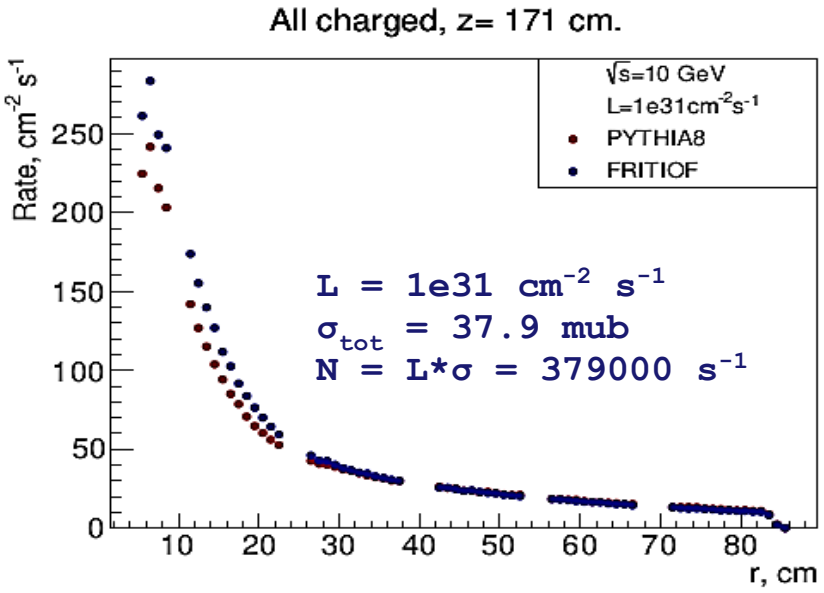


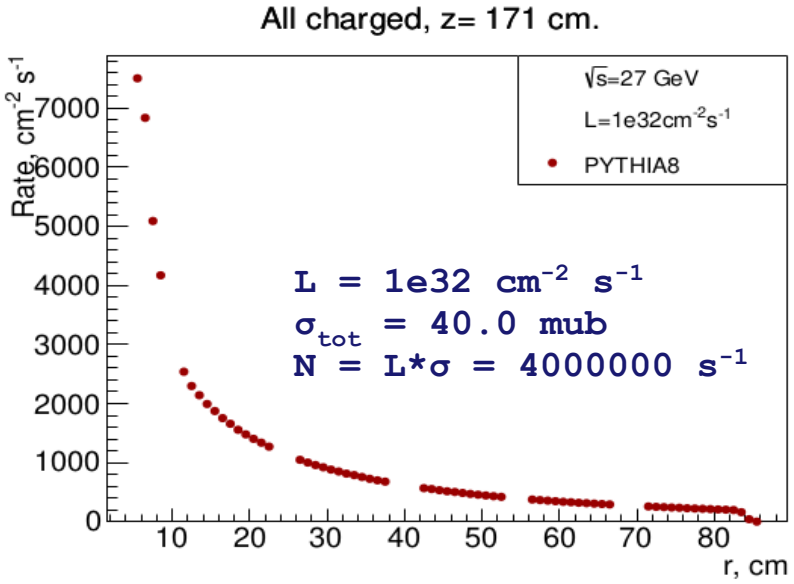
T-Theshold = **200**





$\sqrt{s}$ = 10 and 27 GeV

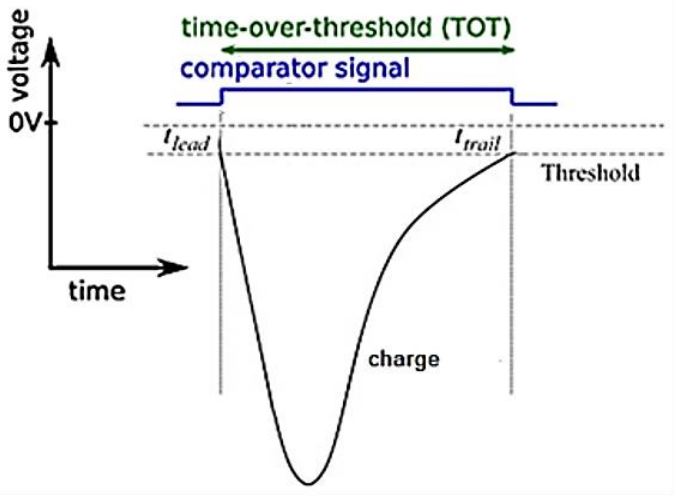




Z.Kurmanaliyev (JINR)

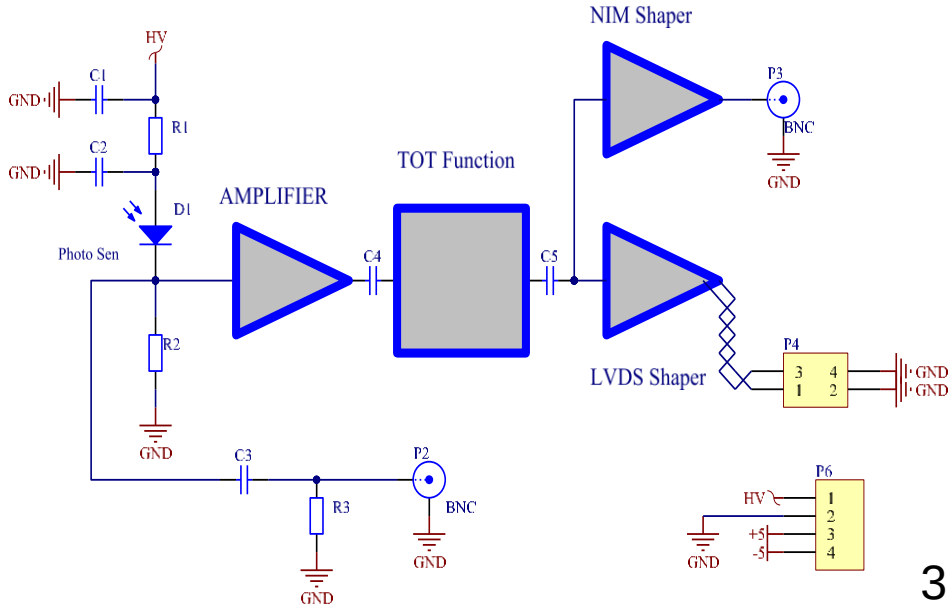
The result of this simulations shows that the in principle accepted for the internal part of this design works at the high luminosity of SPD.

The Time-over-Threshold (ToT) method



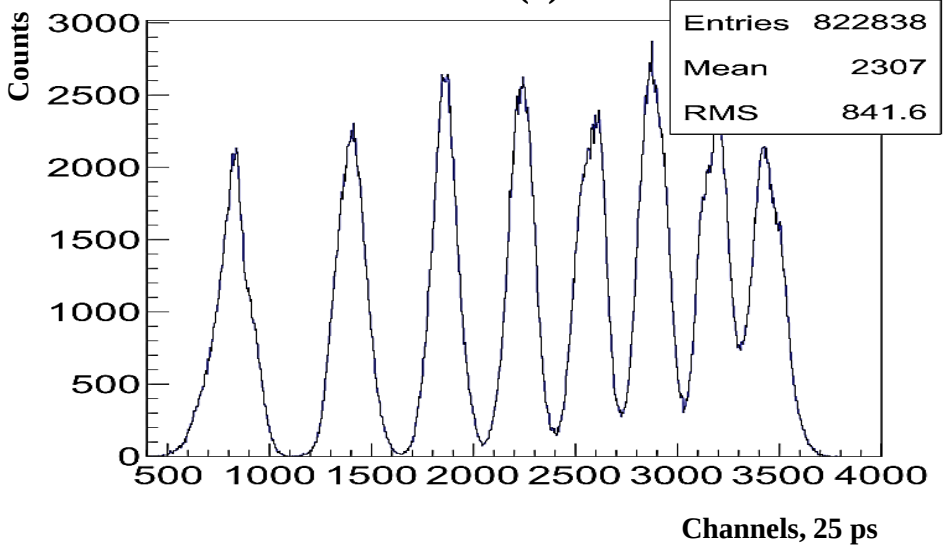
The ToT is a well-known method which allows to measure the energy deposited in the material.

Front-end electronics with ToT technique

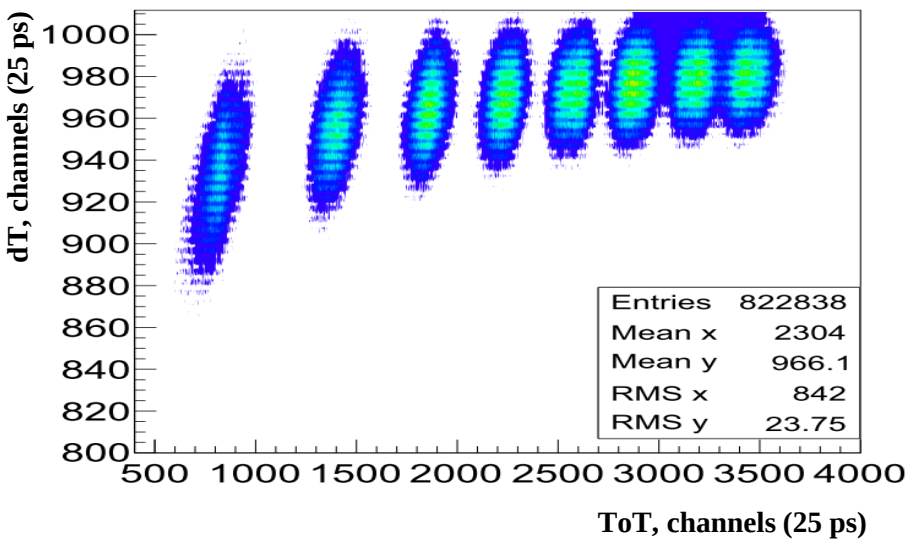


Extracting correction parameters FEE ToT (version №1)

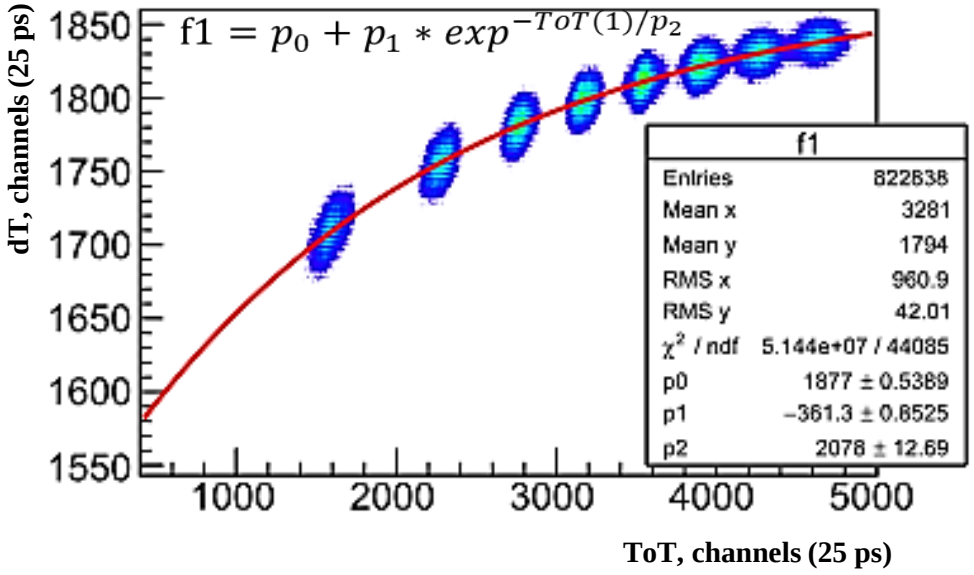
ToT(2)



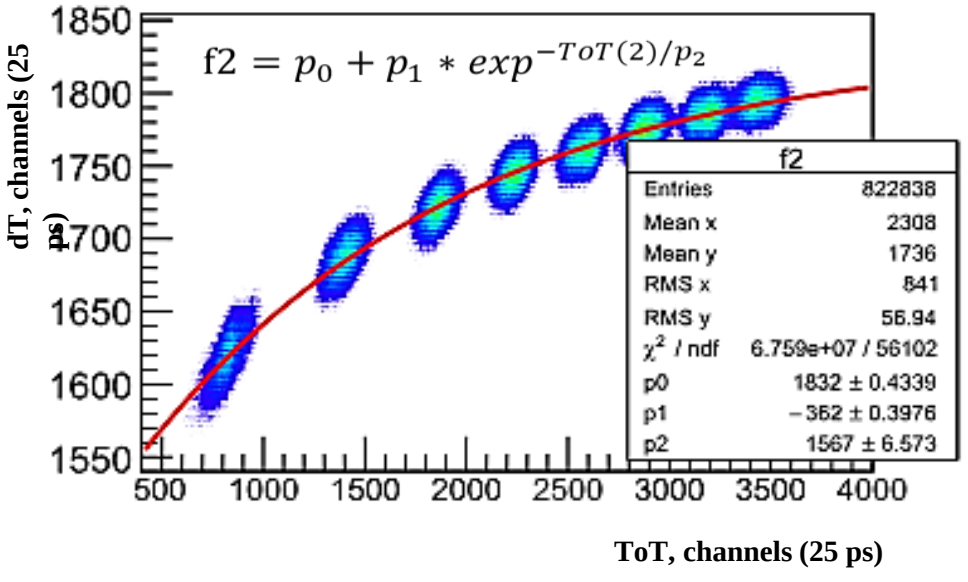
dT(SiPM1-SiPM2) vs ToT(2)



dT(trig-SiPM1) vs ToT(1)

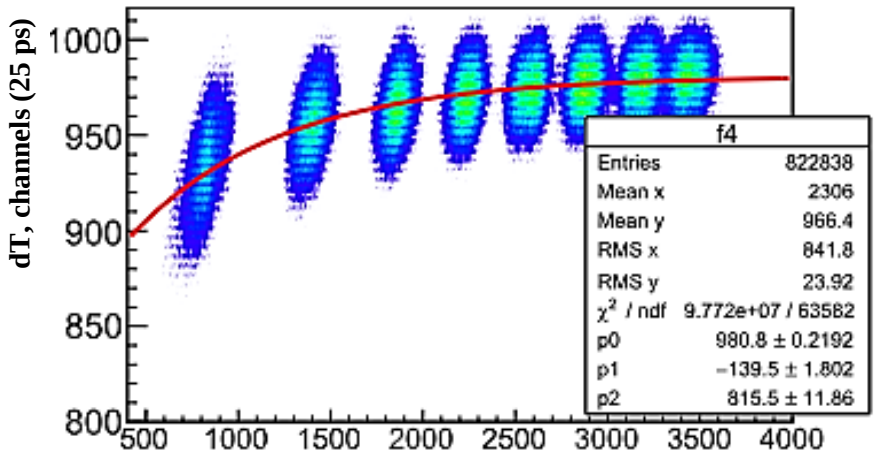


dT(trig-SiPM2) vs ToT(2)

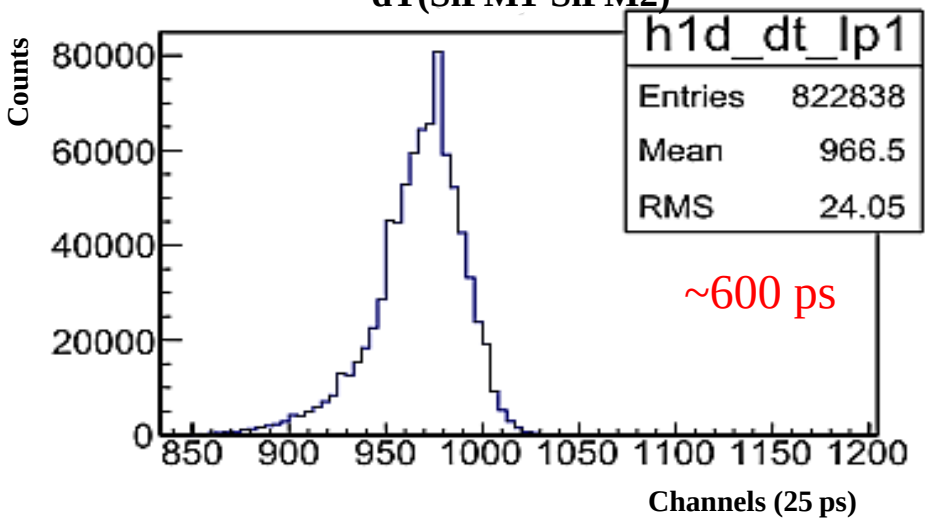


The time difference histogram FEE ToT (version №1)

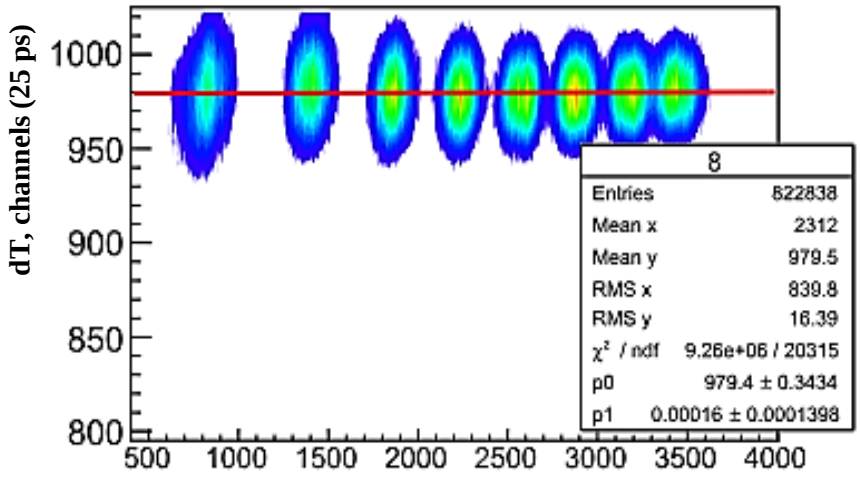
dT(SiPM1-SiPM2) vs ToT(2)



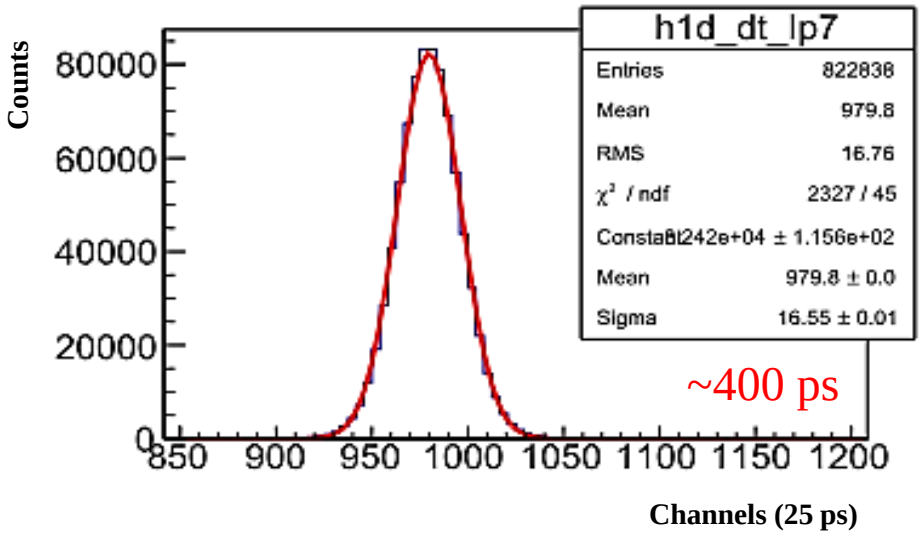
dT(SiPM1-SiPM2)



Corrected dT(SiPM1-SiPM2) vs ToT(2)



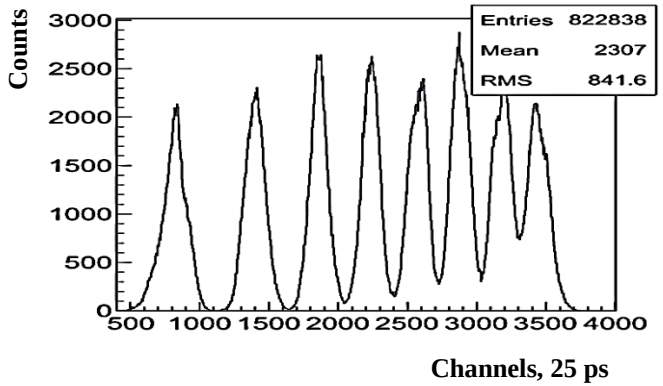
Corrected dT(SiPM1-SiPM2)



A.V. Tishevskiy et al., J.Phys.Conf.Ser, V.1690, 012051 (2020)

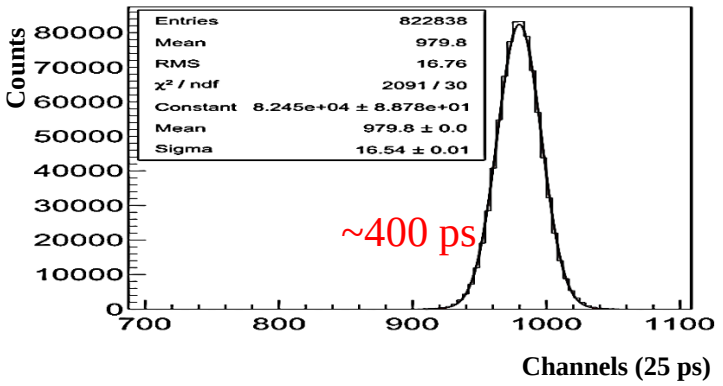
Comparison of FEE ToT versions

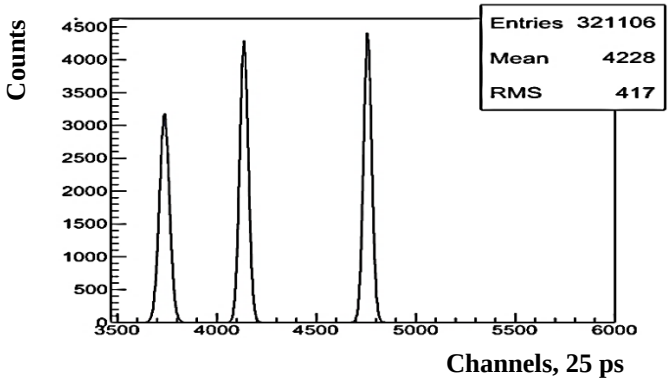
ToT



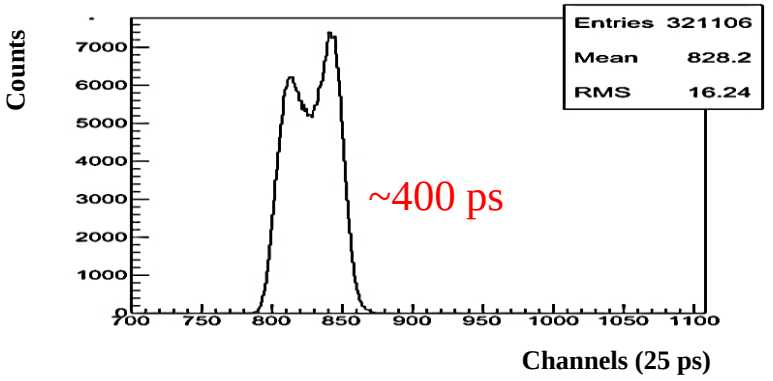
v.1

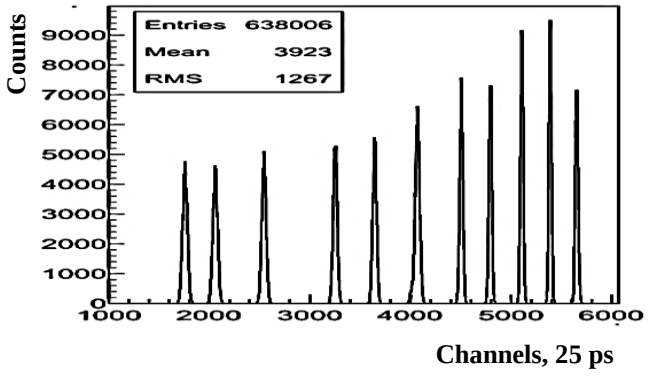
Corrected dT(SiPM1-SiPM2)



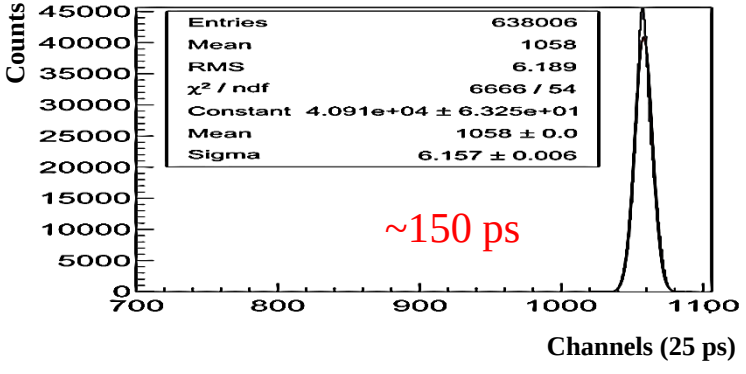


v.2



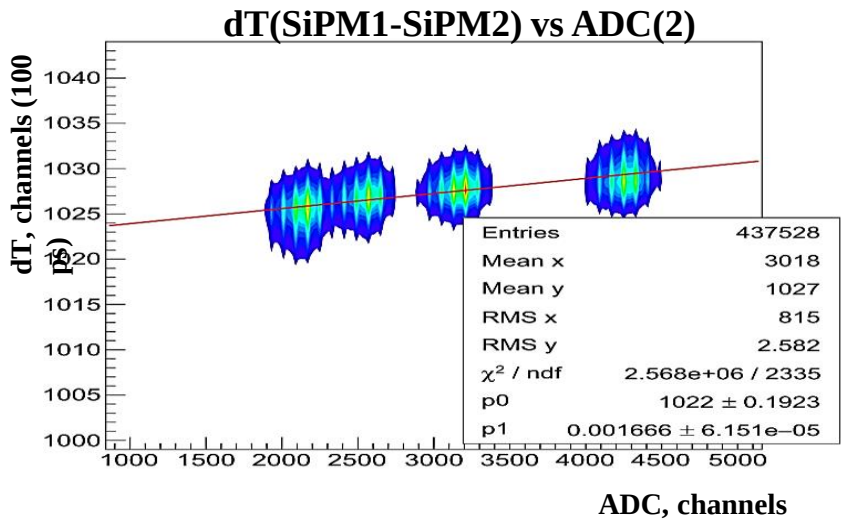


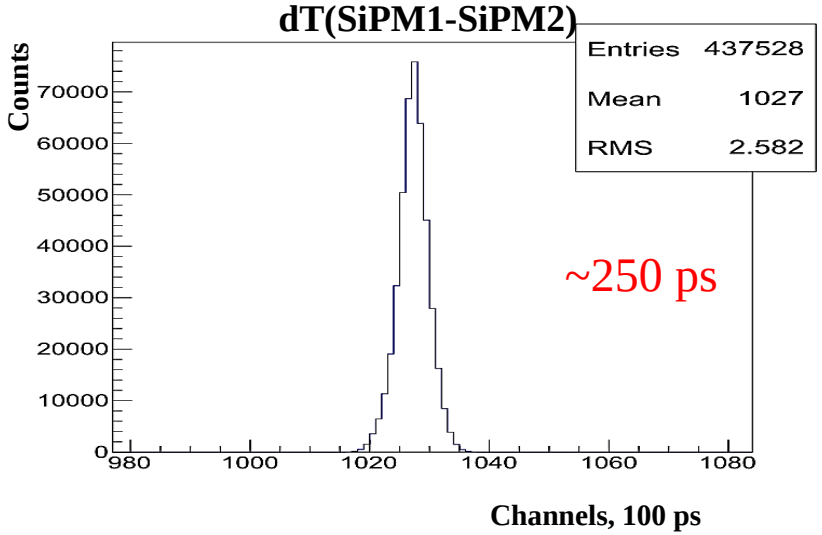
v.3

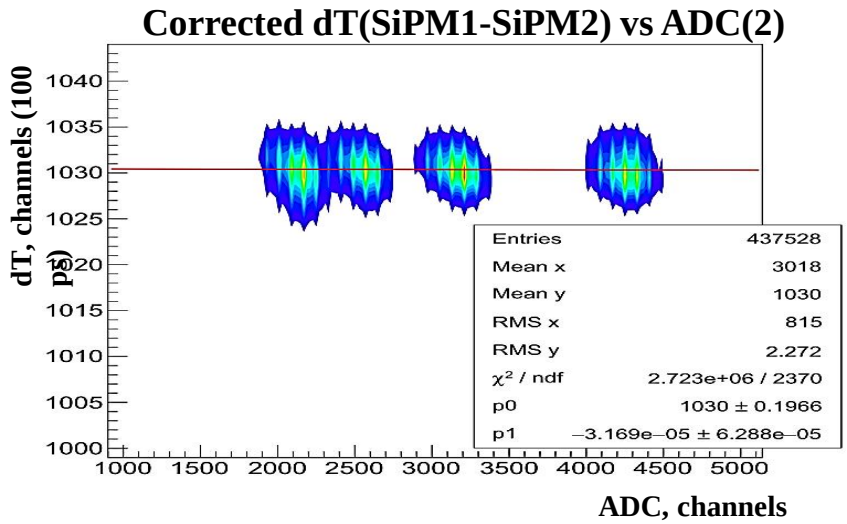


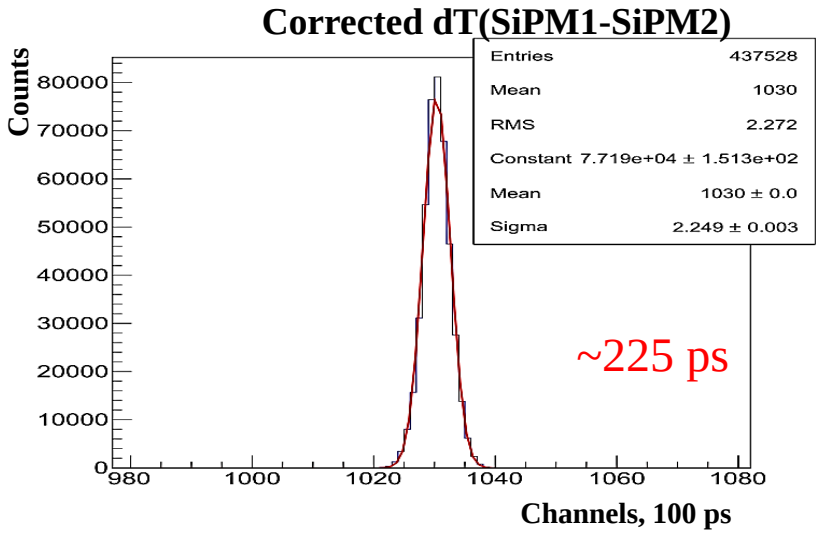
FEE studies results

The time difference histogram for FEE DANSS









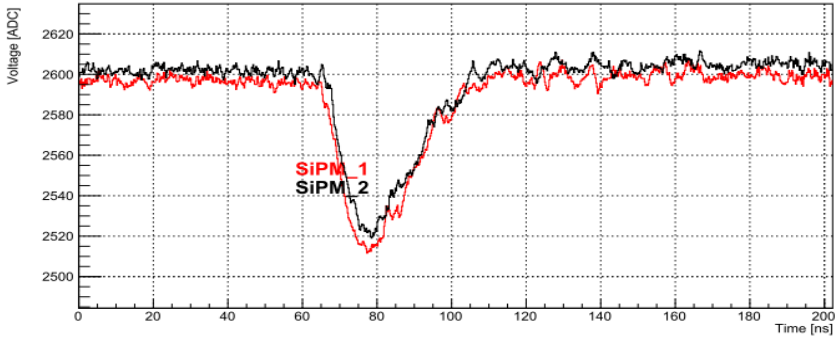
Phys.Atom.Nucl., DOI:10.1134/S1063778822090381 (2022)

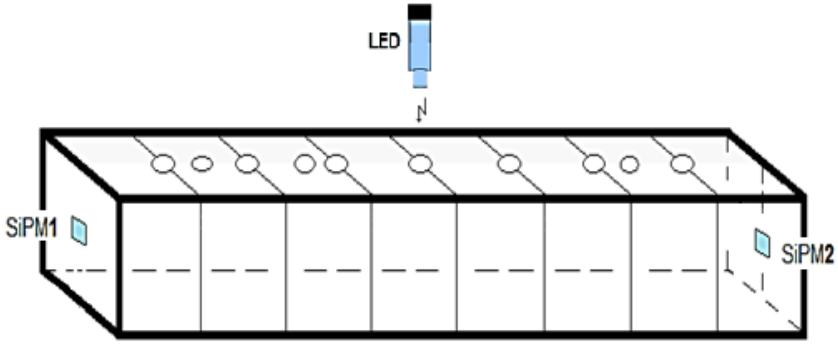
FEE studies results

CAEN digitizer DT5742 (16ch)

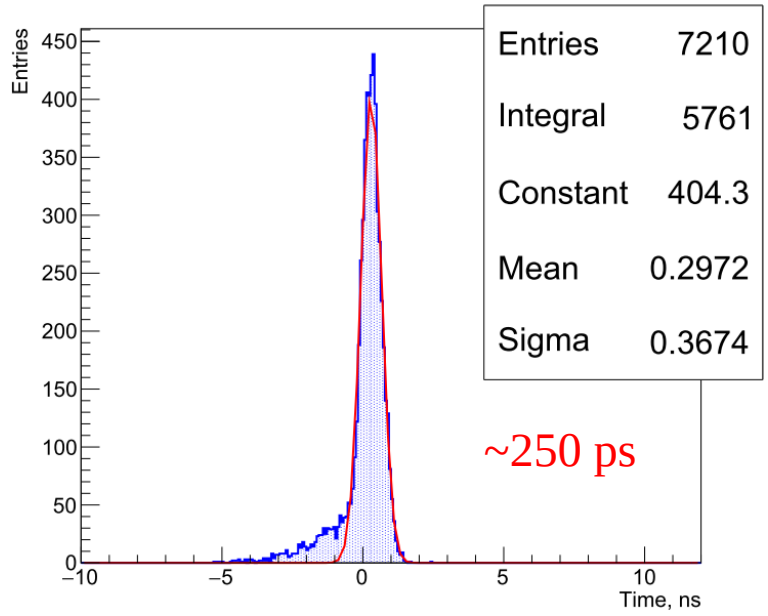
16+1 Channel 12 bit 5 GS/s
Switched Capacitor Digitizer

based on the DRS4 a Switched Capacitor Array. This technology relies on a set of capacitors that continuously sample the analog input signals. As soon as the trigger is issued, capacitors are decoupled from the input signals with a time interval from each other that is the sampling period.



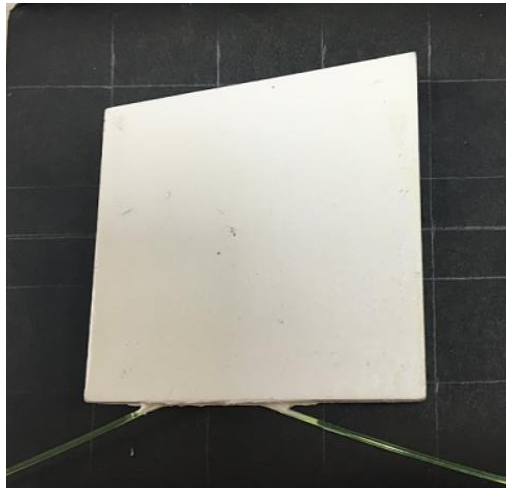


- Hamamatsu SiPM (S12572-010P)
- FEE of DANSS experiment

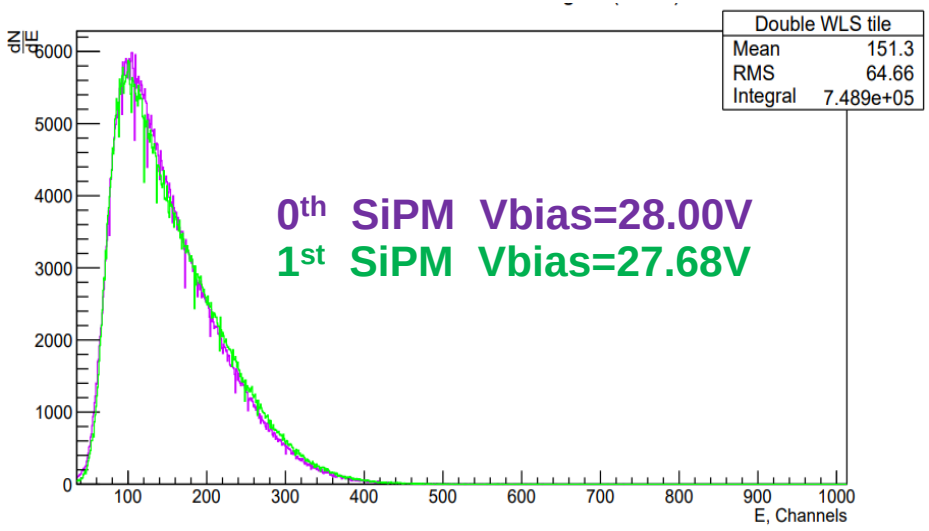


The first steps at the work with FERS and tiles tests

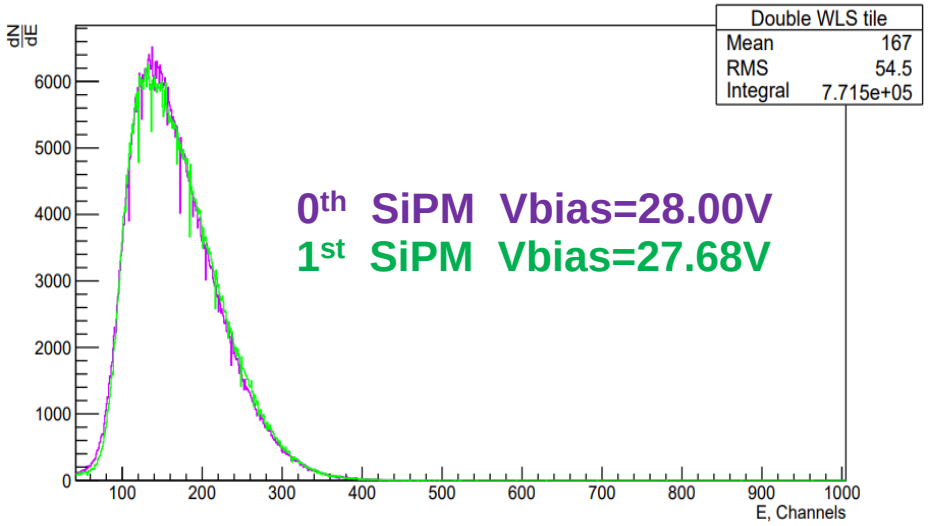
Tile with **two WLS outputs of single fiber** for tests and in particular for SiPM calibration with radioactive sources were used.



1x1 mm² SiPM



3x3 mm² SiPM

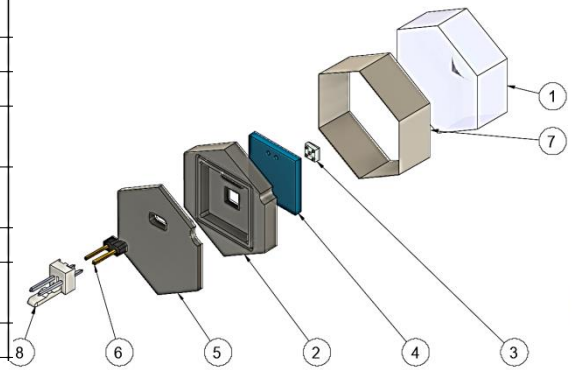


The amplitude histograms for both SiPM sizes with the chosen voltage are shown. This is not a bad result, but we preferred **another the way of calibration**.

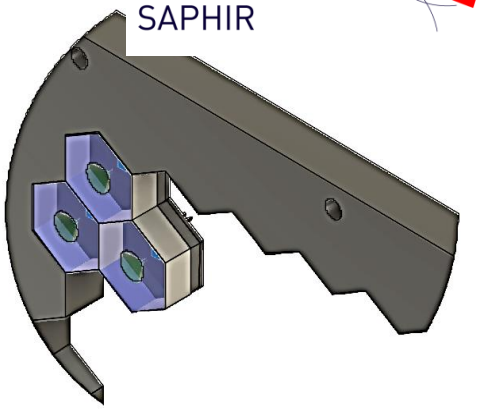
Tests at Lab201- VBLHEP

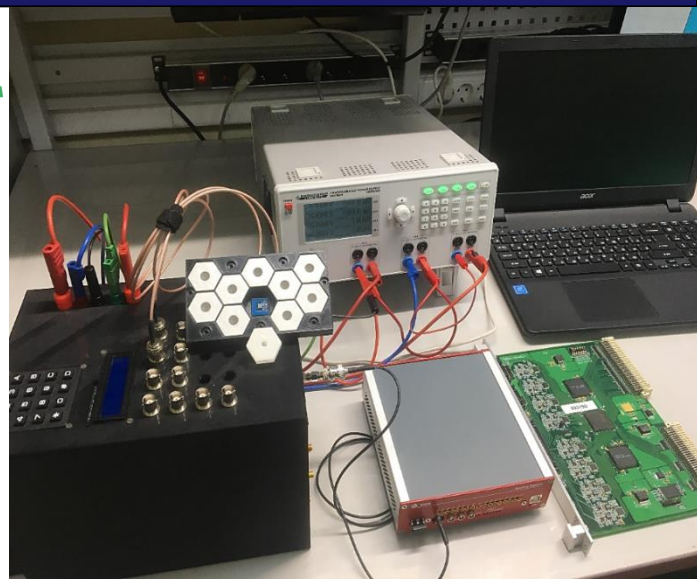
Hexagonal granularity detector

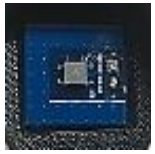
8	Male connector 0022272021
7	Mylar
6	RA conn
5	Tapa hexagon right cavity
4	MPPC PCB and support
3	S14160-3050HS
2	Housing mppc right cavity
1	Single Hexagon



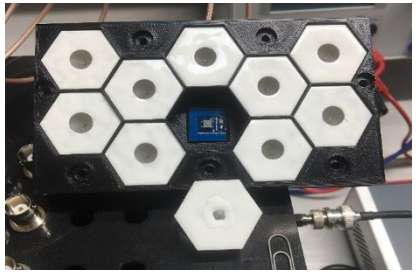
MILLENNIUM INSTITUTE FOR SUBATOMIC PHYSICS AT HIGH-ENERGY FRONTIER
SAPHIR





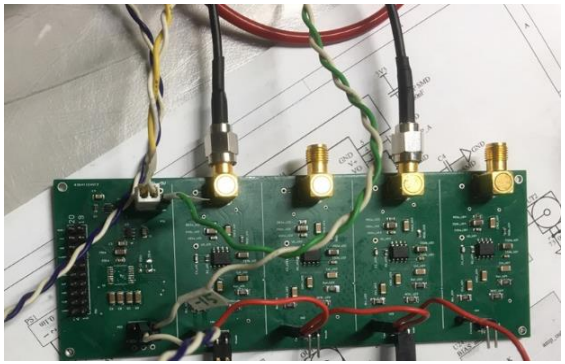


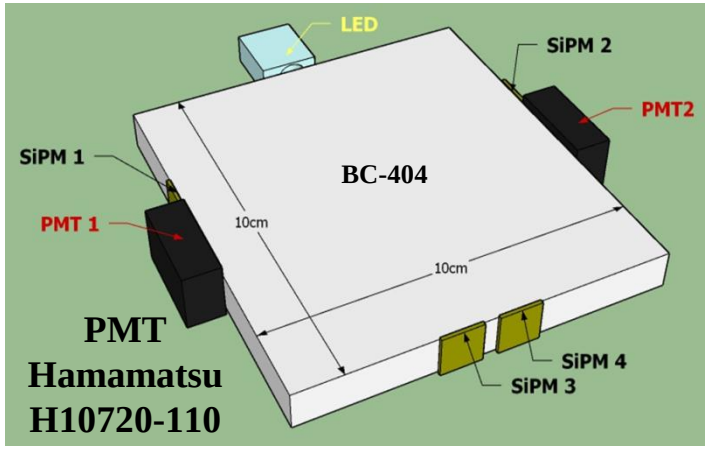
Hamamatsu SiPM S14160-3050HS
(3x3 mm^2, 50 µm/cell)



10 honey-comb scintillators and SiPMs,
FEE boards,
micro PC control.

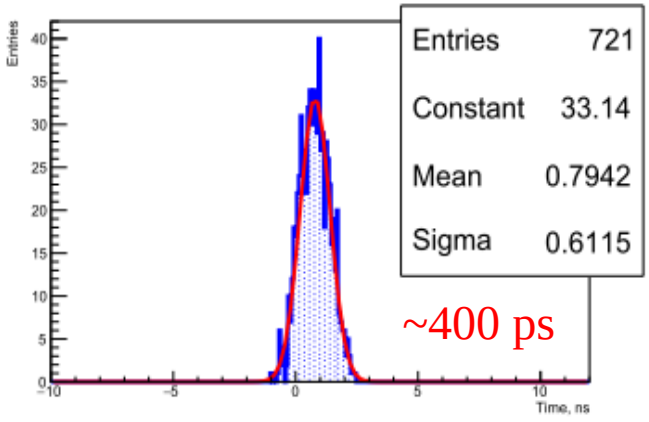
CAEN Digitizer DT5742
(16+1 Channel 12 bit 5 GS/s)





PMT Hamamatsu H10720-110

COSMIC RAYS

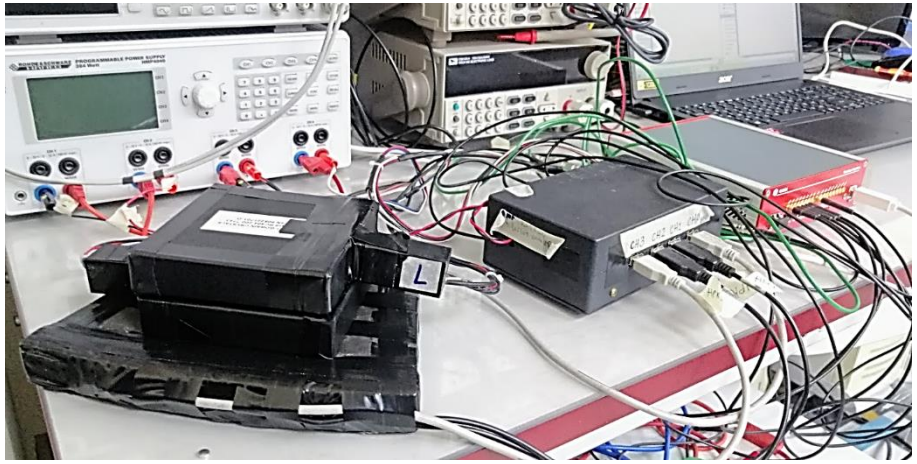


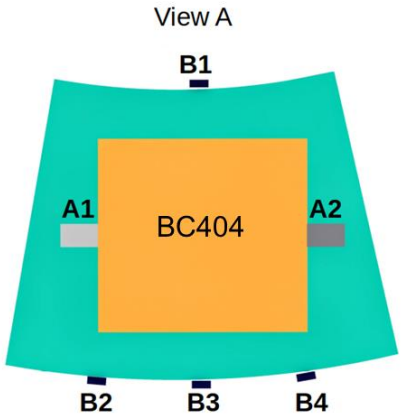
CTEPP-UNAB FEE (Chile) + SiPM

Together with **E.R. Rozas-Calderon (CTEPP-UNAB)**

Tests at Lab201- VBLHEP

SAPHIR-UNAB and Cinvestav Teams





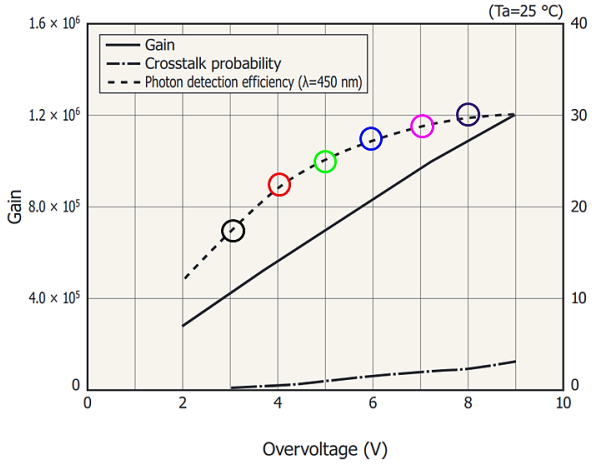
Light from prototype (BC404) is detected by four SiPM (B1-B4)

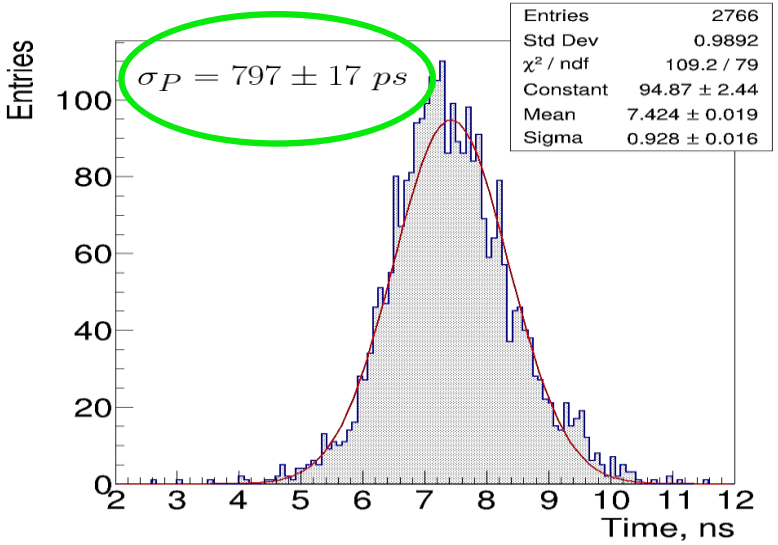
Different Vbias were explored (55.5, 56.5, 57.5, 58.5, 59.5, 60.5 V).

DAQ based on **(16 ch) CAEN digitizer DT5742** was launched

Hamamatsu SiPM (S13360-3050CS, 3x3 mm^2, 50 μm/cell)

The prototype (in blue) was placed below the trigger counters (in yellow), which provided the start signal for data readout. Each trigger counter was made of a BC404 scintillator plate (10x10x2 cm^3) and one Hamamatsu (H5783) PMT (A1, A2).





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