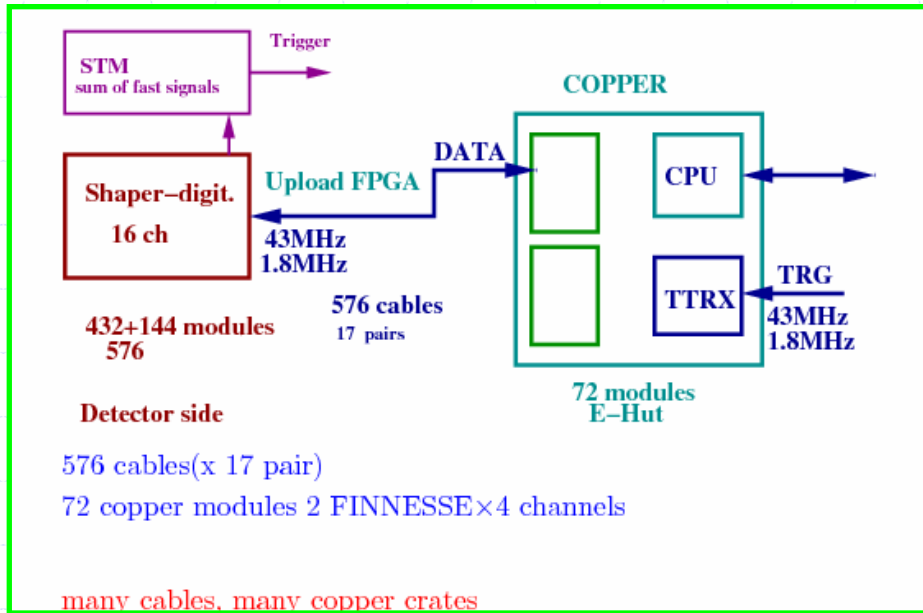# Results of the run with the new electronics

A.Kuzmin, Yu.Usov, V.Shebalin, B.Shwartz
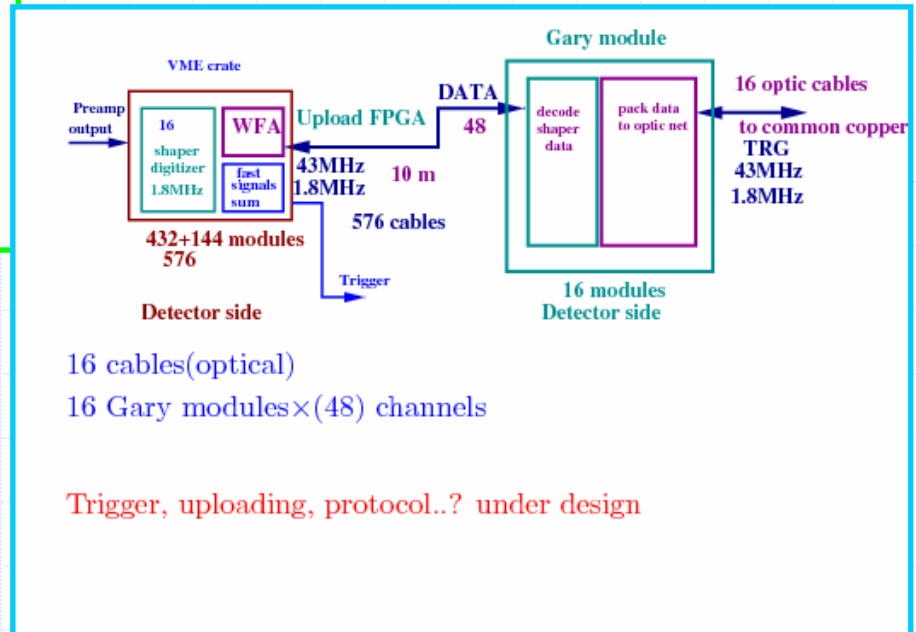
1. New electronics configuration

2. New electronics in the experiment

3. Results on the consistency, timing and noise reduction.

4. Operation without injection veto.
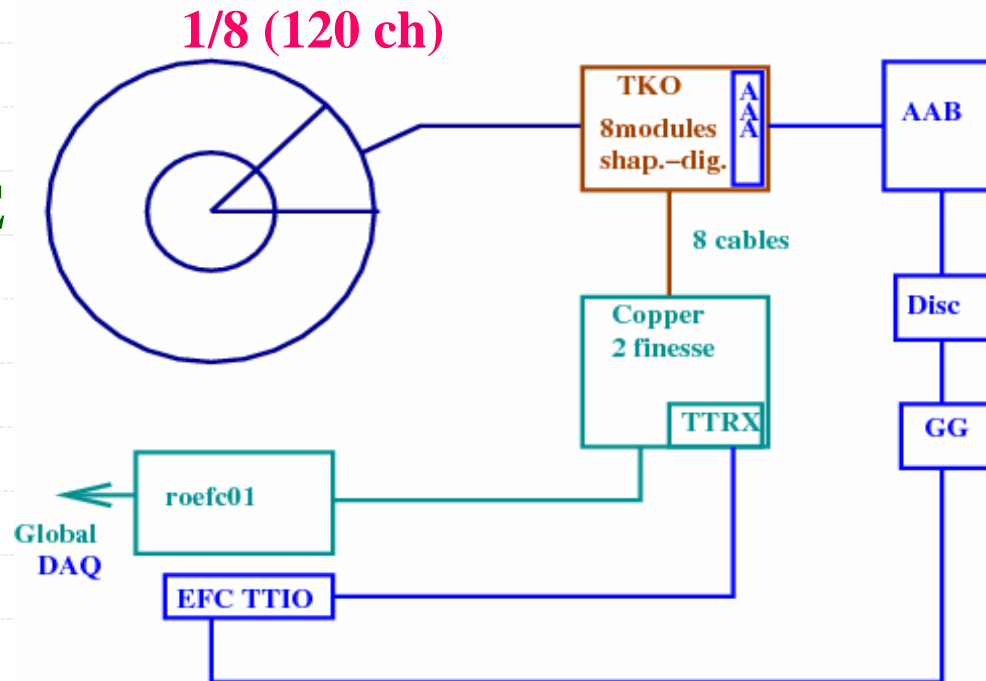
New+ ECL electronics

New electronics

STM sum of fast signals → Trigger

COPPER

Shaper–digit. 16 ch

DATA **Upload FPGA**

43MHz
1.8MHz

CPU

432+144 modules
576

576 cables
17 pairs

TTRX ← **TRG**
43MHz
1.8MHz

Detector side

72 modules
E–Hut

576 cables(x 17 pair)

72 copper modules 2 FINNESSE×4 channels

many cables, many copper crates

Very New electronics

VME crate

Gary module

Preamp output →

16 shaper digitizer 1.8MHz

WFA

fast signals sum

Upload FPGA

43MHz
1.8MHz

DATA
48

10 m

decode shaper data

pack data to optic net

16 optic cables

to common copper
TRG
43MHz
1.8MHz

432+144 modules
576

576 cables

Trigger

Detector side

16 modules
Detector side

16 cables(optical)

16 Gary modules×(48) channels

Trigger, uploading, protocol..? under design

Readout scheme

(was tested with cosmic ray runs during summer shutdown)

1/8 (120 ch)

ECL BE

| TKO |
| 8modules |
| shap.–dig. |

A A A

AAB

8 cables

Copper
2 finesse

Disc

TTRX

GG

roefc01
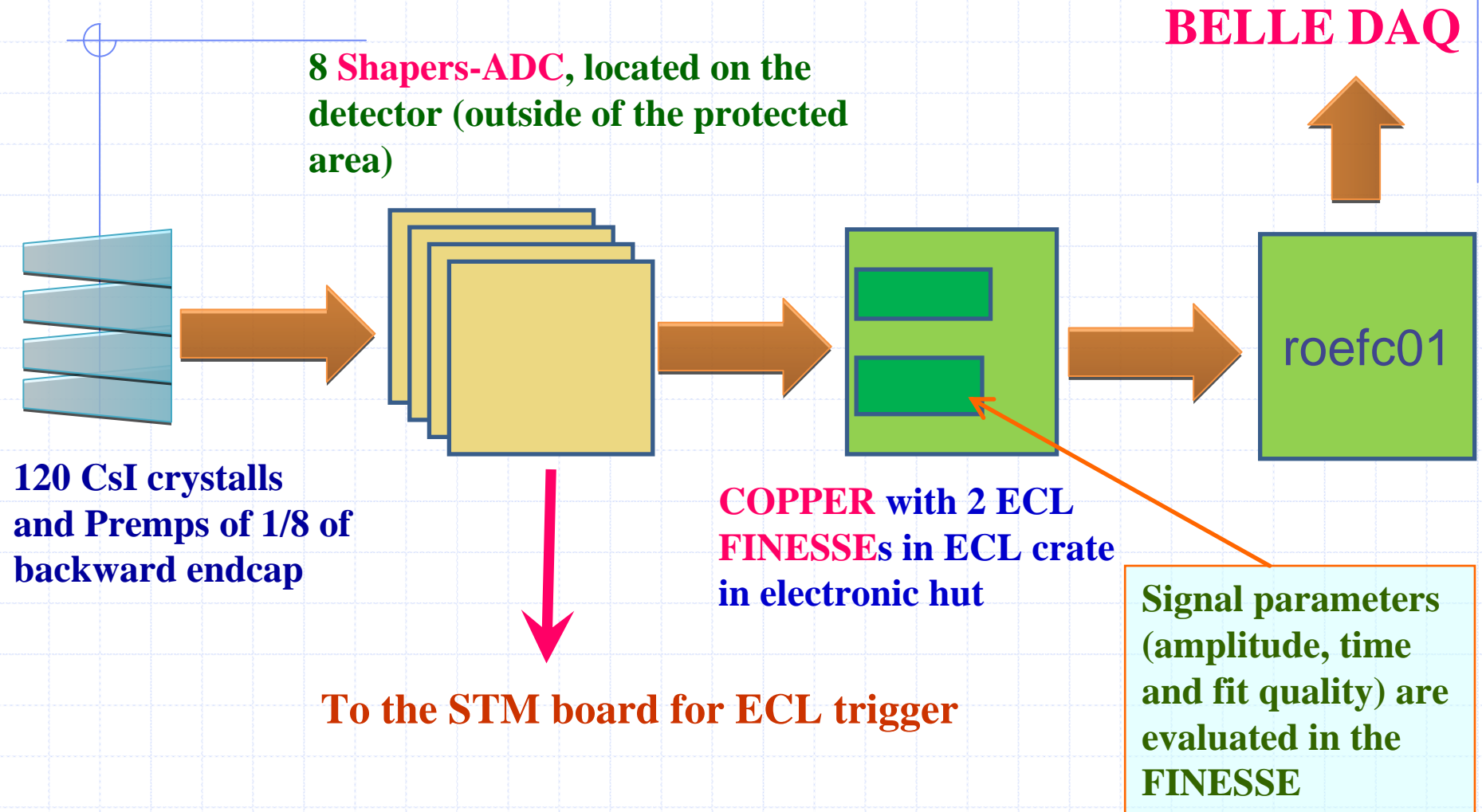
Global DAQ

EFC TTIO

8 Shaper digitizer were connected to ECL B3 sector (120 channels)
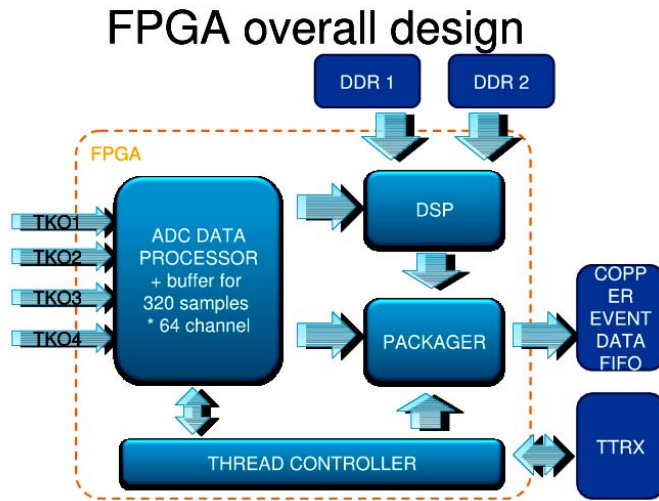**Copper module installed in the crate near FB rack**
The Copper is readout by EFC PC roefc01
Trigger: Normal cosmic trigger for global run.(or of all trigger cells)

New electronics channel

BELLE DAQ

8 Shapers-ADC, located on the detector (outside of the protected area)

roefc01

120 CsI crystalls and Premps of 1/8 of backward endcap

To the STM board for ECL trigger

COPPER with 2 ECL FINESSEs in ECL crate in electronic hut

Signal parameters (amplitude, time and fit quality) are evaluated in the FINESSE

Parameters determination

FPGA overall design

Algorithm details

$$\chi^2(A, p, t_0) = \sum_{i,j}(y_i - Af(t_i - t_0) - p)S_{ij}^{-1}(y_j - Af(t_j - t_0) - p) \to \min$$

$$S_{ij} = \overline{(y_i - \bar{y})(y_j - \bar{y})}$$

$f(t)$ − counter response
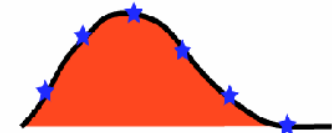
$$Af(t_i - t_1 - \Delta t) = Af(t_i - t_1) - A\Delta t f'(t_i - t_1) = Af(t_i - t_1) + Bf'(t_i - t_1)$$

where t_1 − initial time (trigger time)

$$\sum_{i,j} f_i S_{ij}^{-1}(y_j - Af_j - Bf'_j - p) = 0 \qquad A = \sum_i \alpha_i y_i$$

$$\sum_{i,j} f'_i S_{ij}^{-1}(y_j - Af_j - Bf'_j - p) = 0 \implies B = \sum_i \beta_i y_i \Rightarrow \Delta t = -B/A$$

$$\sum_{i,j} S_{ij}^{-1}(y_j - Af_j - Bf'_j - p) = 0 \qquad p = \sum_i \gamma_i y_i$$

FPGA are located at FINNESE module
The algorithm of energy and time reconstruction was implemented.

The online software allows:
- ✓ To set preliminary sparsification threshold (before FPGA processing);
- ✓ To set output sparsification threshold (after FPGA processing), before recording to
- ✓ COPPER buffer;
- ✓ To record amplitude, time and quality, reconstructed at FPGA;
- ✓ To save raw sample informatin (amplitudes of 16 points) for each or some fraction of events.
- ✓ According to simulation the algorithm works upto 50 kHz with occupancy < 1=3.

Electronics noise

Incoherent noises :
5.7 channels(330keV) (outer layers)
7.1 channels(410keV) (inner layers)
10% higher than expected

Obtained at the summer
tests with cosmic rays

Coherent noises :
1.2 channels(70 keV) for 16 channels (1 module)
0.6 channels(30keV) for 120 modules
On test bench we got 1.0 channel
Calibration module had given big noise and was
modied to have possibility to dissconect by relay.

The time resolution per counter is 17/√2=12ns as
expected for 35 MeV energy deposition

Test with new ECL electronics

Since beginning of this experiment (exp.67) up to Oct.23, morning, ECL was running with 120 channels (1/8 of the BE) connected to 8 new shaper-digitizer boards, read out by the copper module. Other ECL channels were in the usual status. In this configuration we collected about 965 pb^{-1} of the statistics.

From this data 4 runs with 26 pb^{-1} was recorded without injection veto.

On Oct.23, during the maintenance time, we replaced the new electronics with the old one. Nakamura-san analized the data from the local run performed after replacement and confirmed that all changed channels
are alive.

Examples of events

6

4

3

Shaded area – new electronics

ECL parallel session, Super B
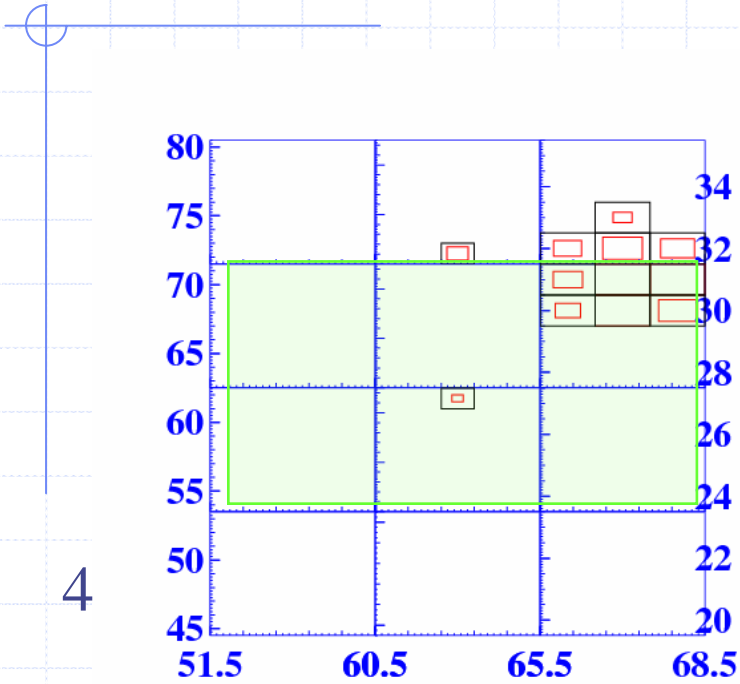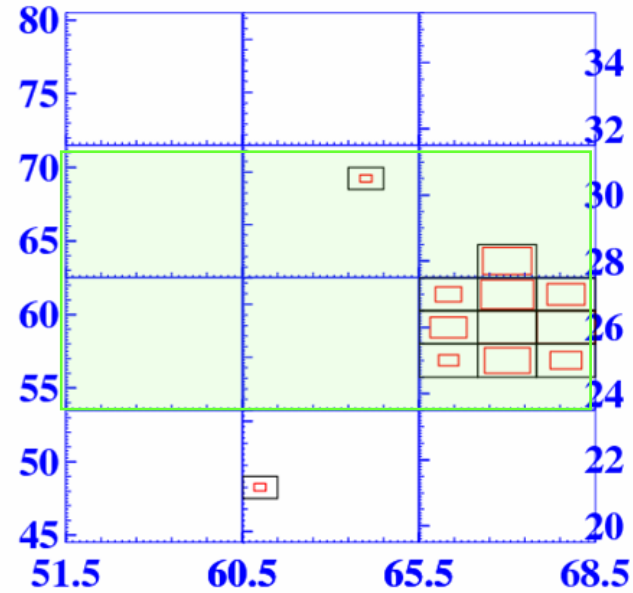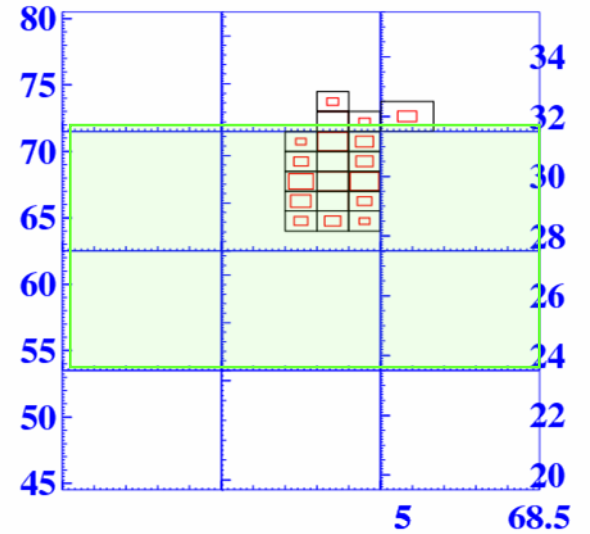
Energy deposition

old   new

N_{peak} = 2120
E_{peak} = 3.57 Gev

N_{peak} = 2160
E_{peak} = 3.46 Gev

lg(E(MeV))
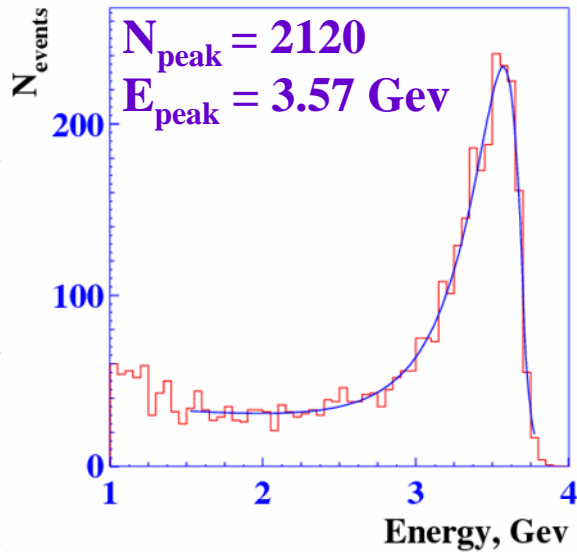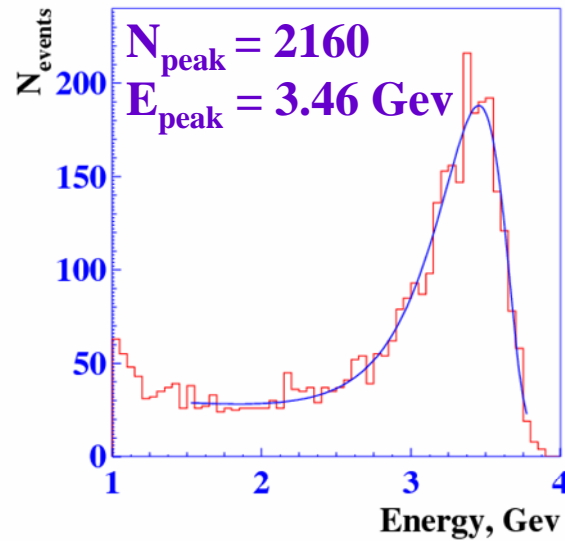
over 1/8 of backward endcap
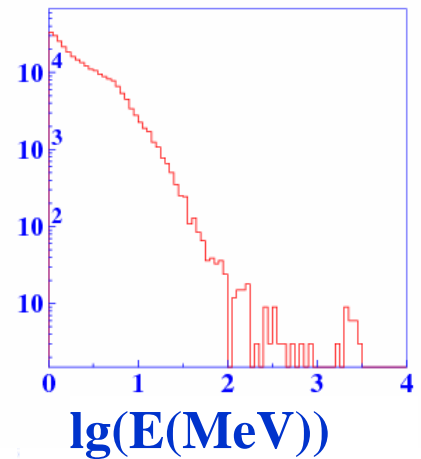
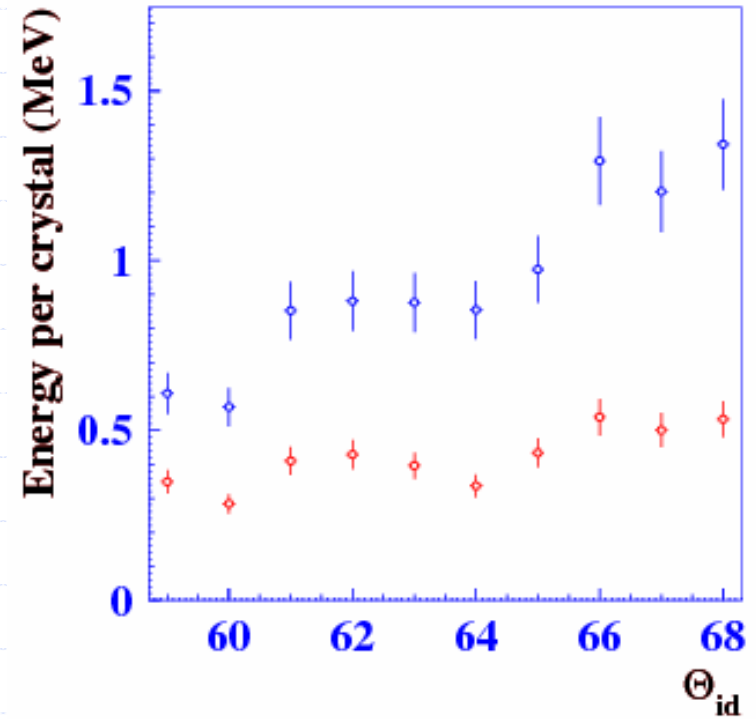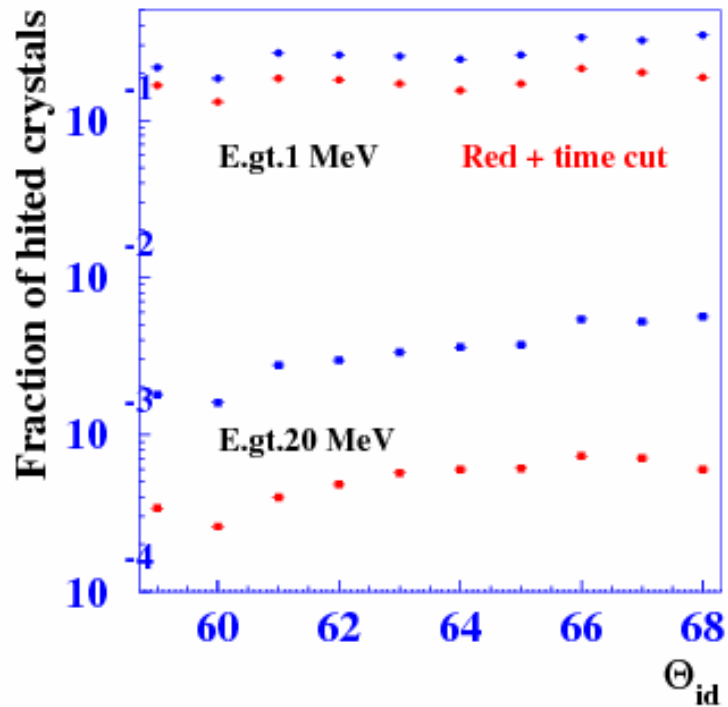Energy deposited in one crystal

Timing and background
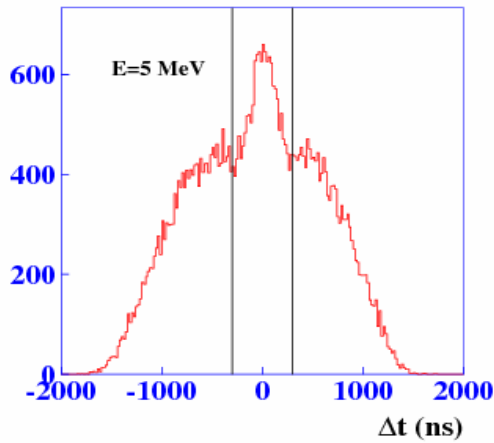
One channel time distribution
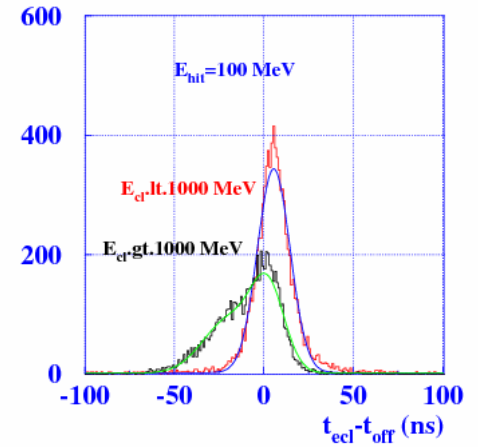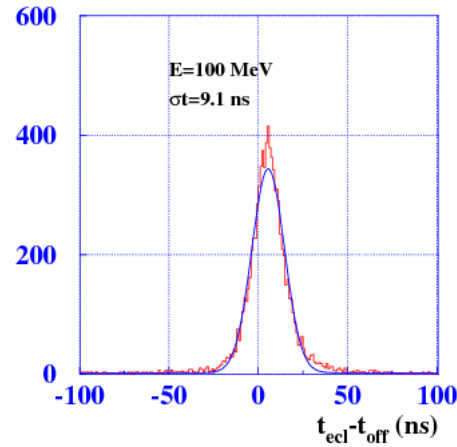
Low energy hits for high energy clusters
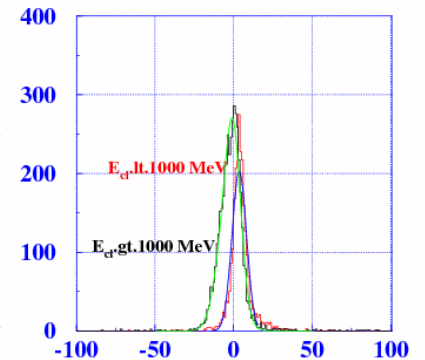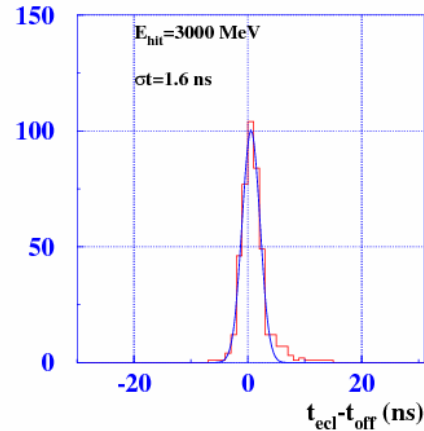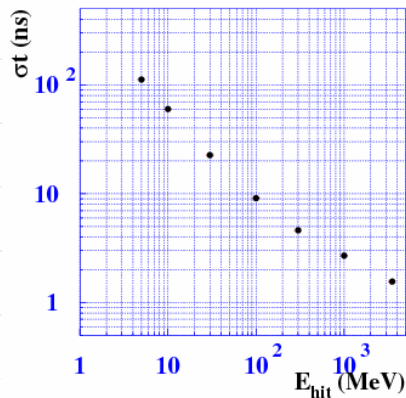
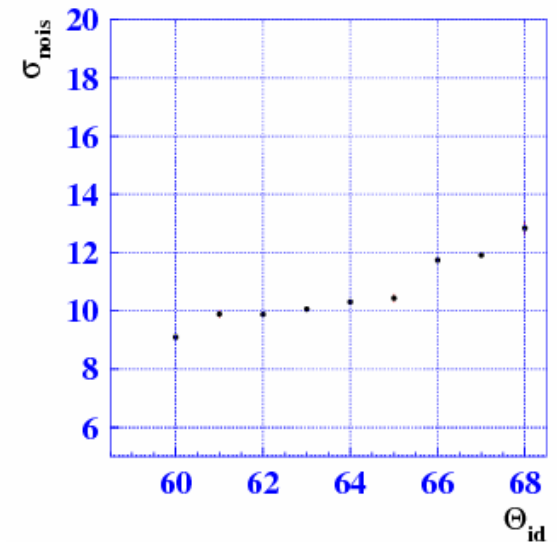# Background reduction
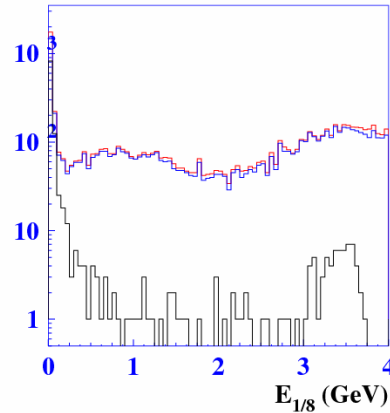
Noise measurement
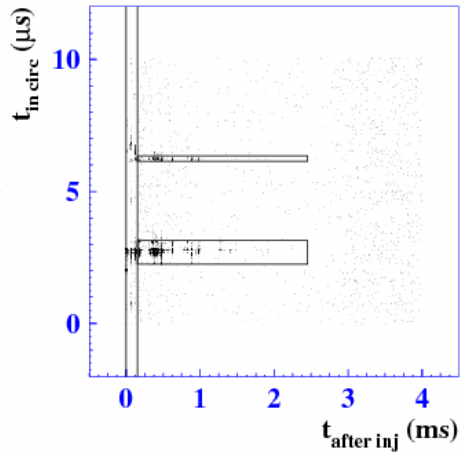
new electronics
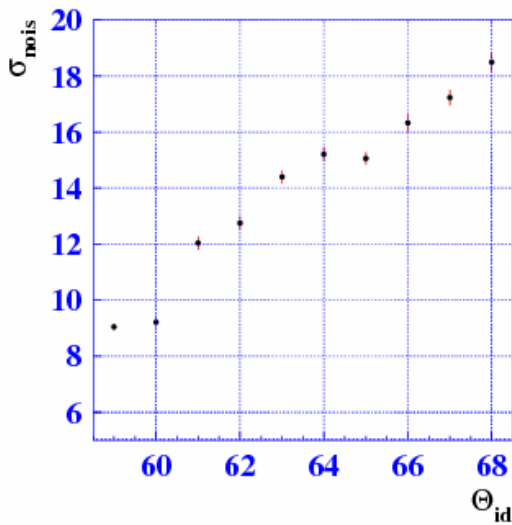
old electronics

Run 70
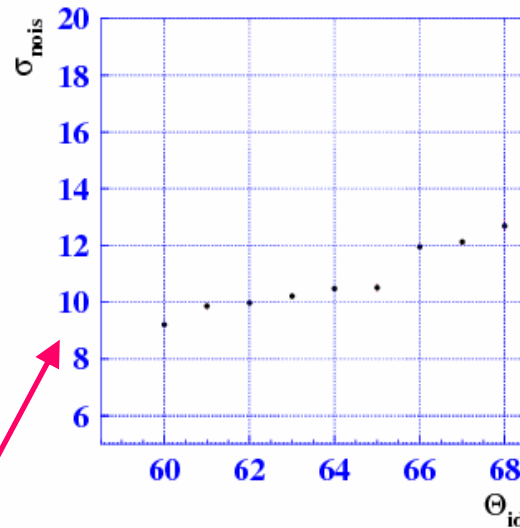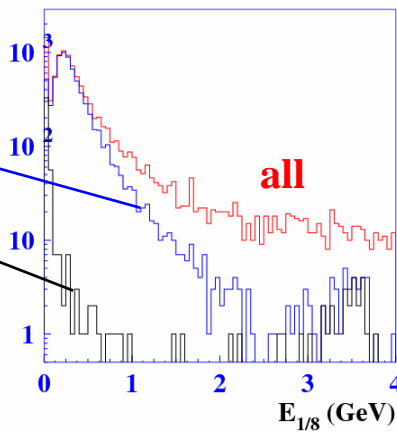
Run 90

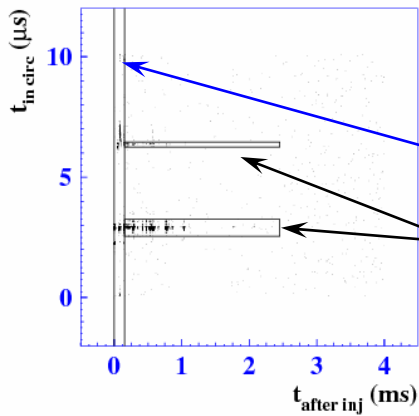**ADC bins @ 0.05 MeV/bin**

Injection study

HER

HER
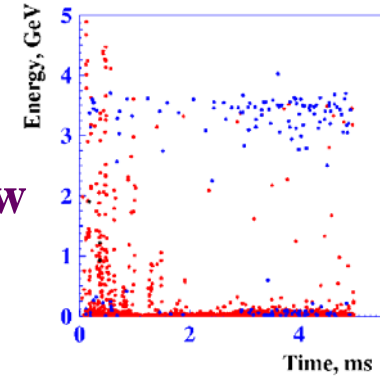
new

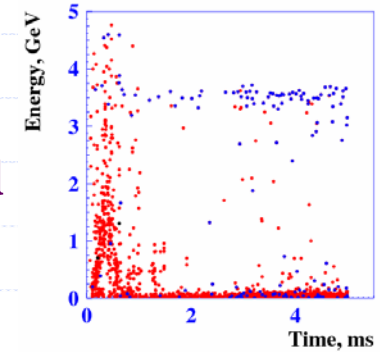**all events**

FE.and.BE

LER

bad inj.time

all

old

Summary of the new electronics tests and plans

❖ **System works and allows to record data from COPPER**

❖ **The data evaluated by FINNESSE are consistent with that taken by the old electronics**

❖ **The recorded data shows parameters close to expected.**

❖ **Data quality vs. injection time are studied. A decrease of veto gate looks to be possible.**

Plans:

❖ **Further study pile-up noise suppression**

❖ **To analyse data with sampling storage to get information about time noise correlation, as well as fit procedure and hardware reliability.**

❖ **To analyse run without injection veto.**

❖ **Implementation of the data from the new electronics to the standard data processing procedures: cluster reconstruction, Bhabha calibration etc.**

New shaper-digitizer
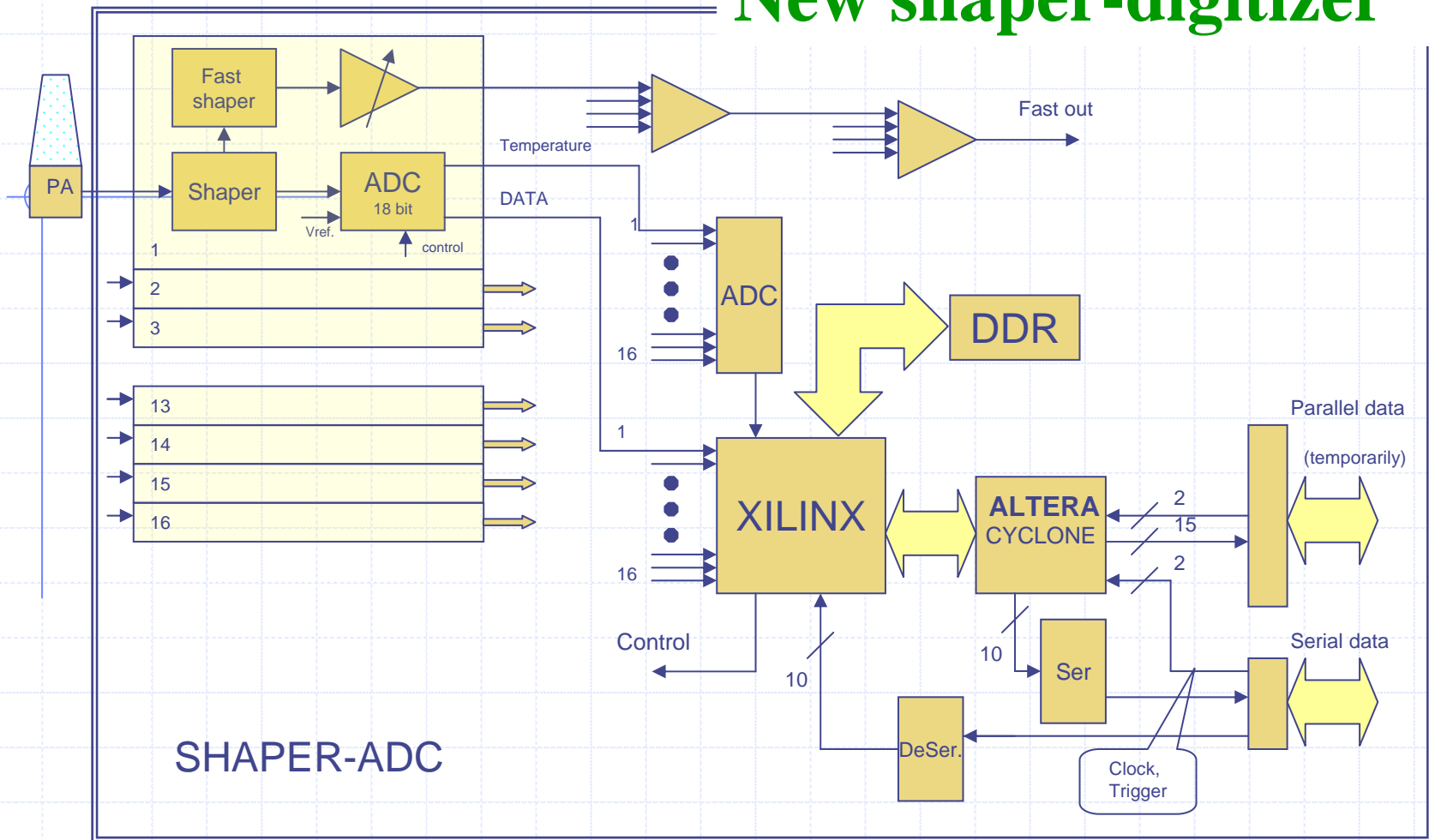
Status: the board design has been completed and agreed (Yu.Usov) with the manufacturer-company. Now the formal contract is needed to start the production of the 2 first version boards.
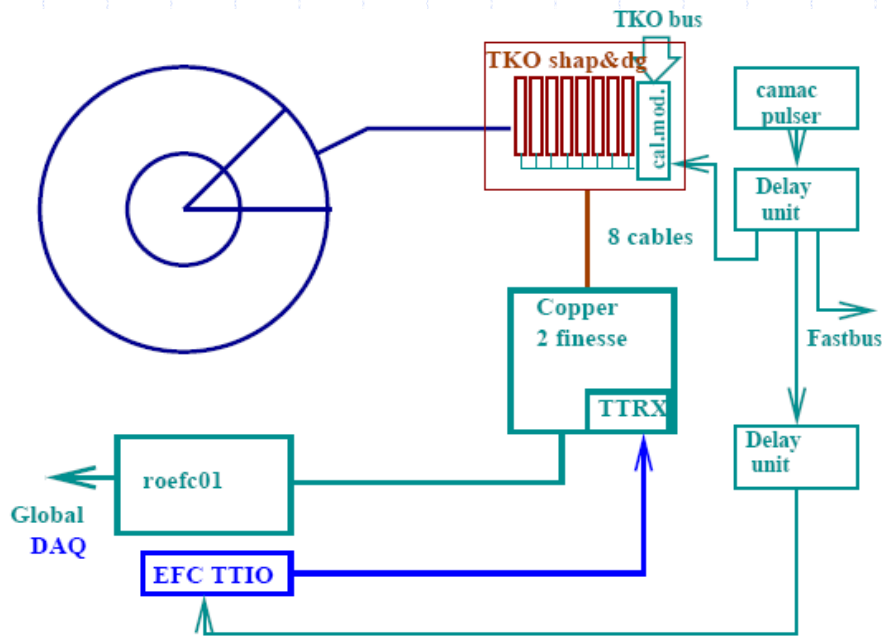
Back up slides

Local run

For FASTBUS ECL electronics we perform local runs to monitor pedestals ant gain.

For COPPER elctronics the pedestals are obtained from the t.

We need the TP calibration to monitor gain.

ECL local run has complicated structure and we use simplied procedure.

The delay of start signal was adjusted to have the same time for global and TP run.

The calibration signal shape agrees with the shape of the real signal within 10%.

The procedure to take local run was:
- start EFC in local mode
- perform usual ECL local run
- stop EFC
- analyzed the data from EFC

Summer time - goals of the test

In the last summer shutdown 120 channels of the ECL BE were connected to the new shaper-digitizer boards. The goals of the test were:

- Measurement of the noise and coherent noises at detector
- Test of reliability of the readout at high rates
- Test of calibration procedure
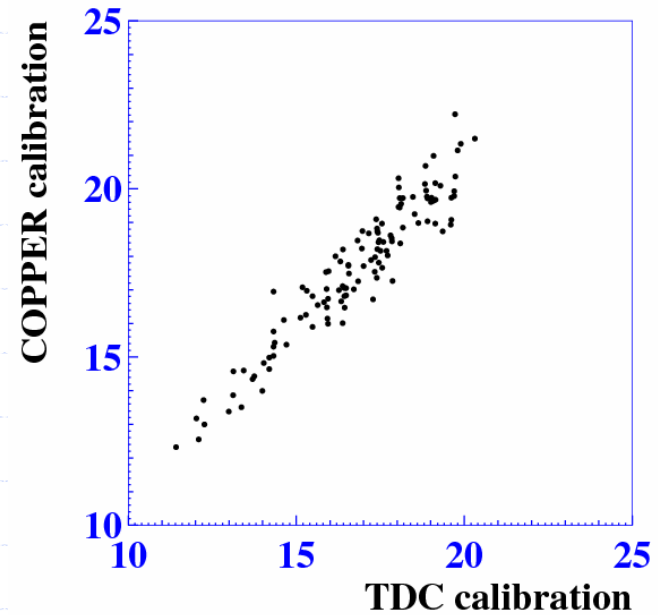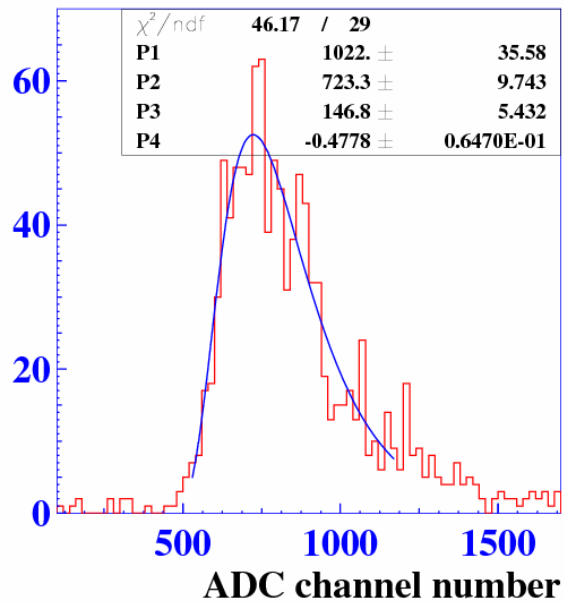- Long term test of the FPGA logic

Signal shape
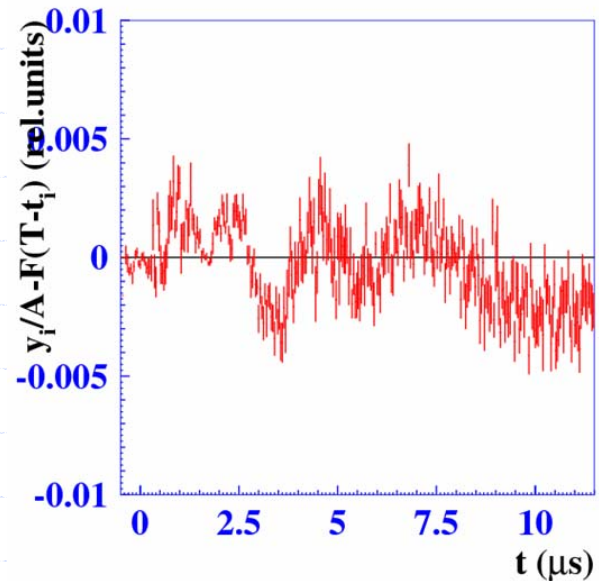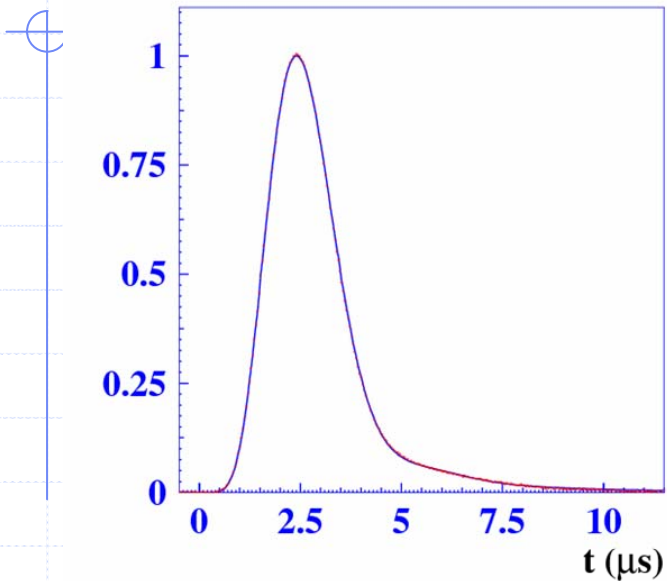
The signal shape was measured with cosmic rays
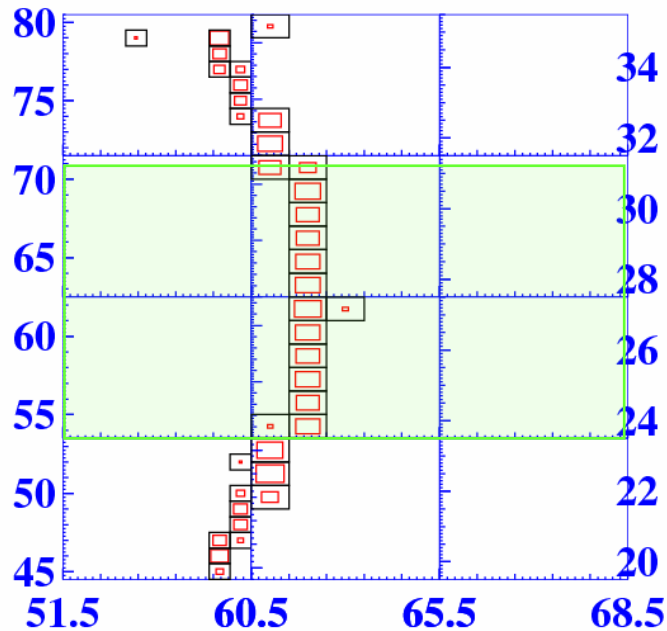
Software was installed at roefc01

Trigger was taken from 1 TKO crate and store several local runs

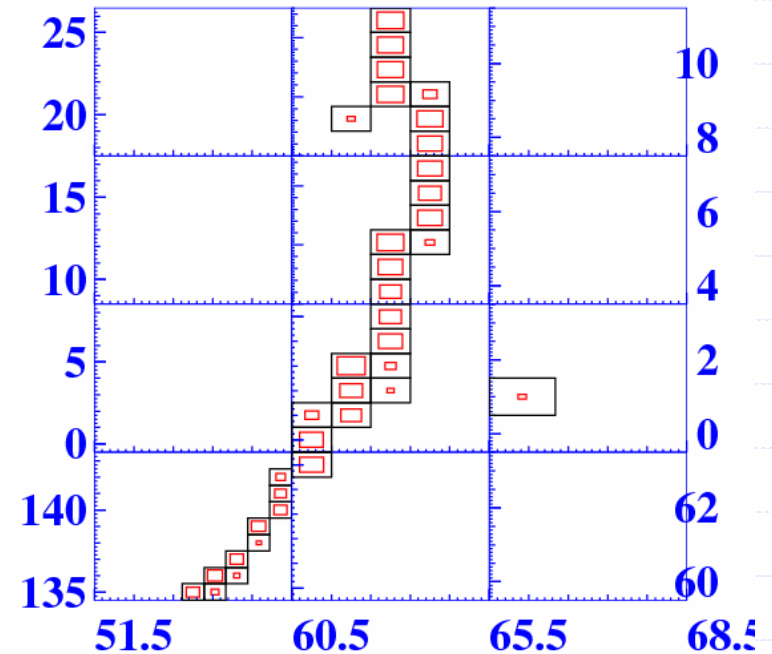Using stored data we fit time shape of the signals ans prepare DSP les for FINNESSE

Calibration with cosmic rays

Consistency

Shaded area – new electronics

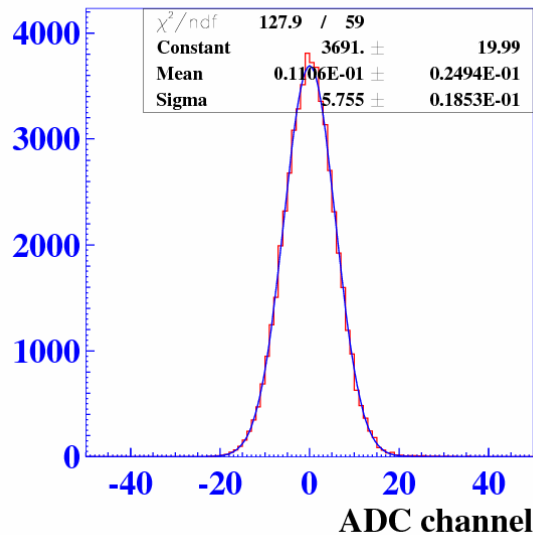We searched for possible events with some inconsistence in FASTBUS and COPPER data

Electronics noise

Incoherent noises :
5.7 channels(330keV) (outer layers)
7.1 channels(410keV) (inner layers)
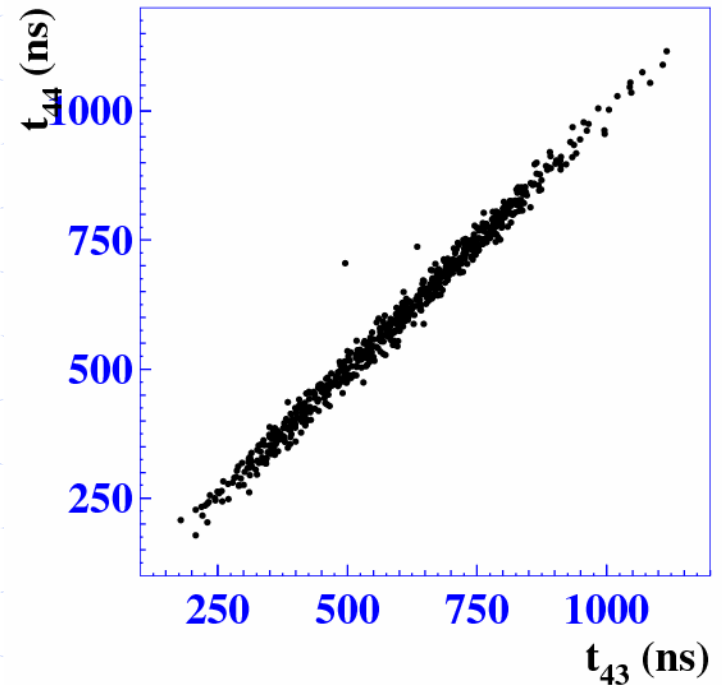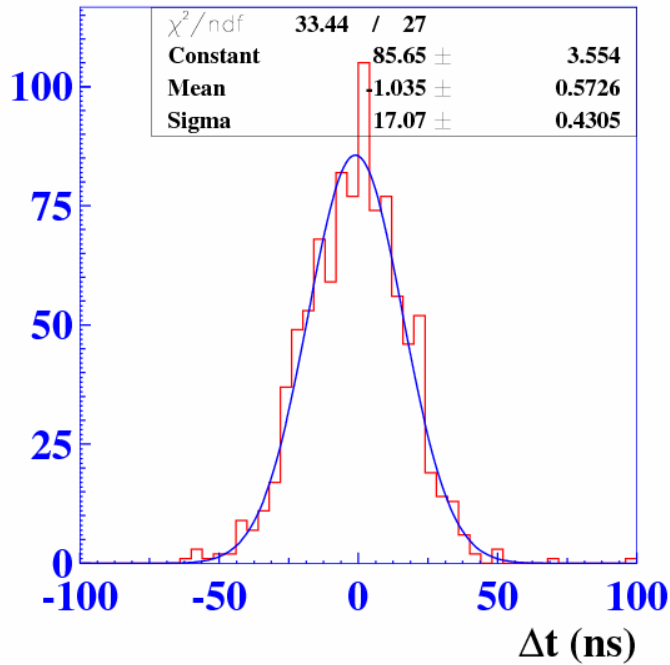10% higher than expected

Coherent noises :
1.2 channels(70 keV) for 16 channels (1 module)
0.6 channels(30keV) for 120 modules
On test bench we got 1.0 channel
Calibration module had given big noise and was
modied to have possibility to dissconect by relay.

Timing

The time resolution per counter is $17/\sqrt{2}=12$ns as expected for 35 MeV energy deposition

ECL parallel session, Super B