PMT and SiPM for PANDA TOF detector

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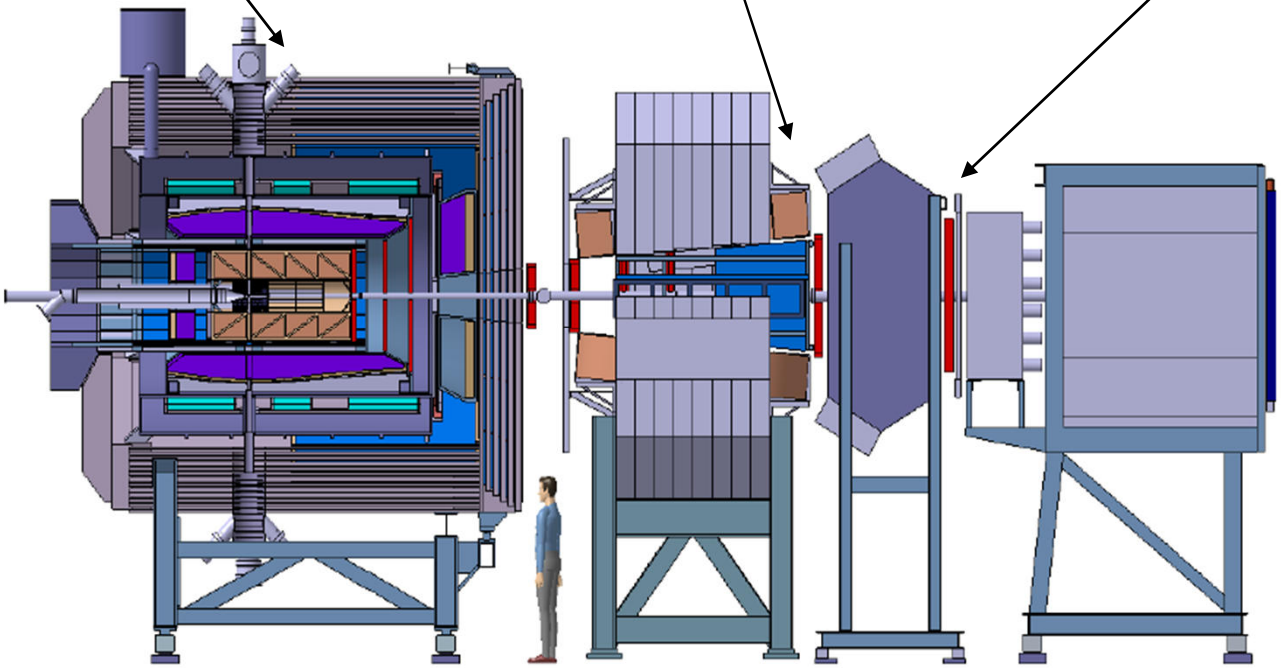
PNPI

PANDA detector

Barrel TOF (BTOF) SiPM

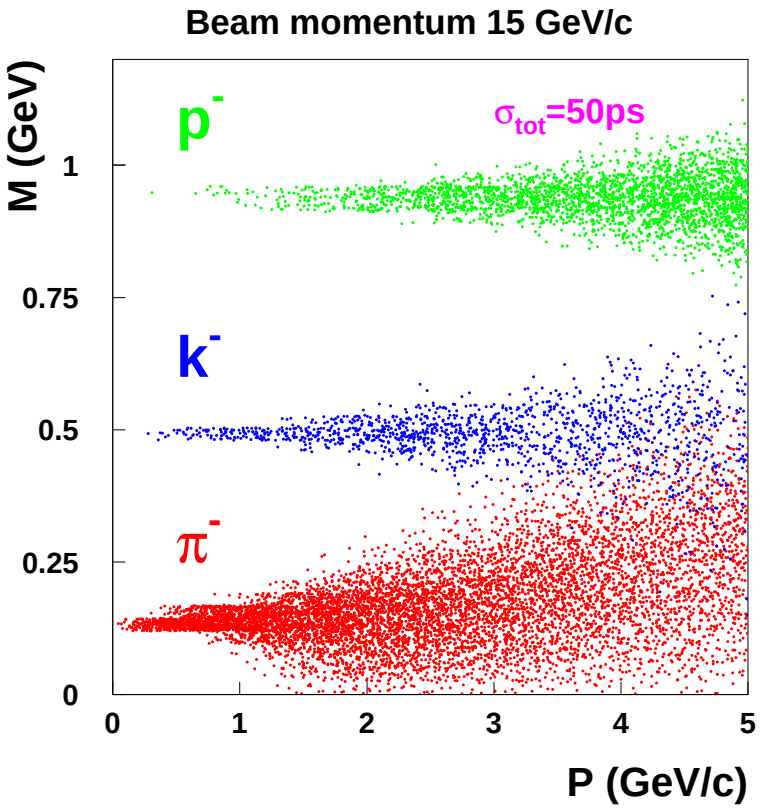
Side TOF walls in dipole Magnet SiPM

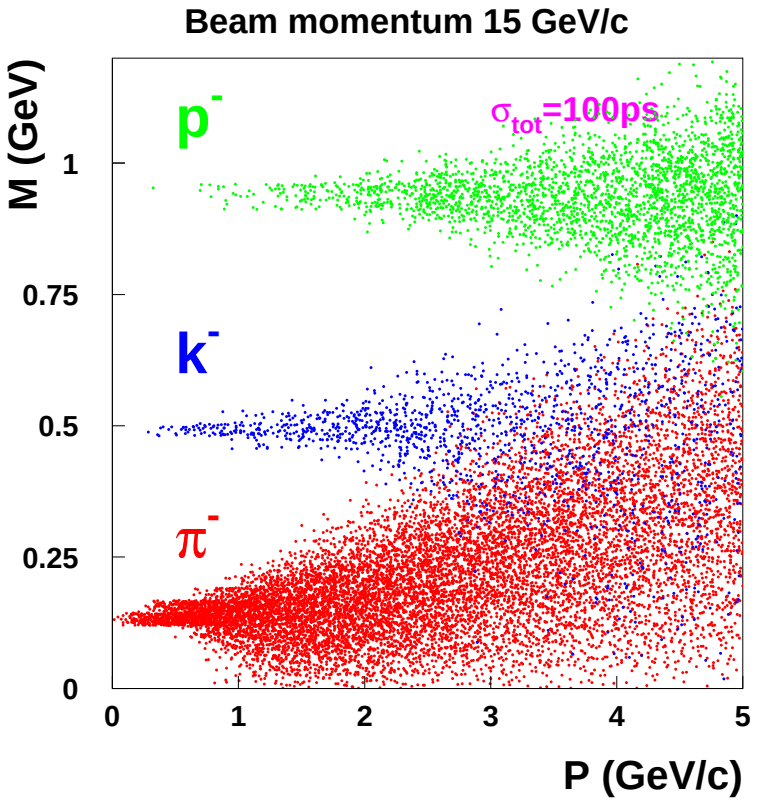
Forward TOF wall (FTOF) PMT or SiPM (?)



Mass reconstruction

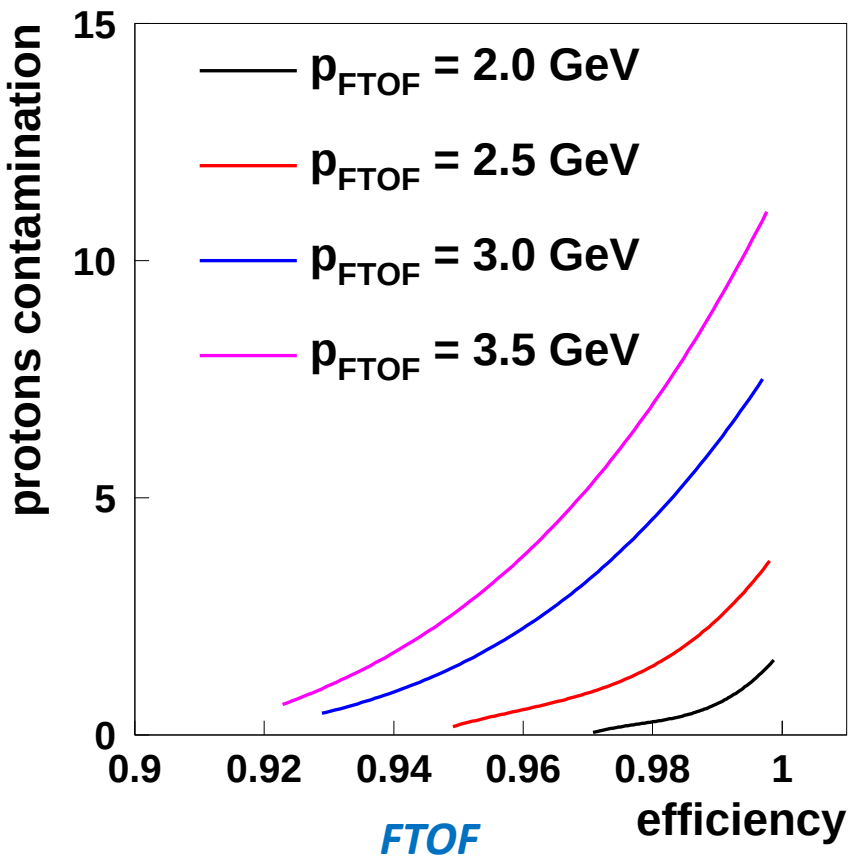
Hadrons identification



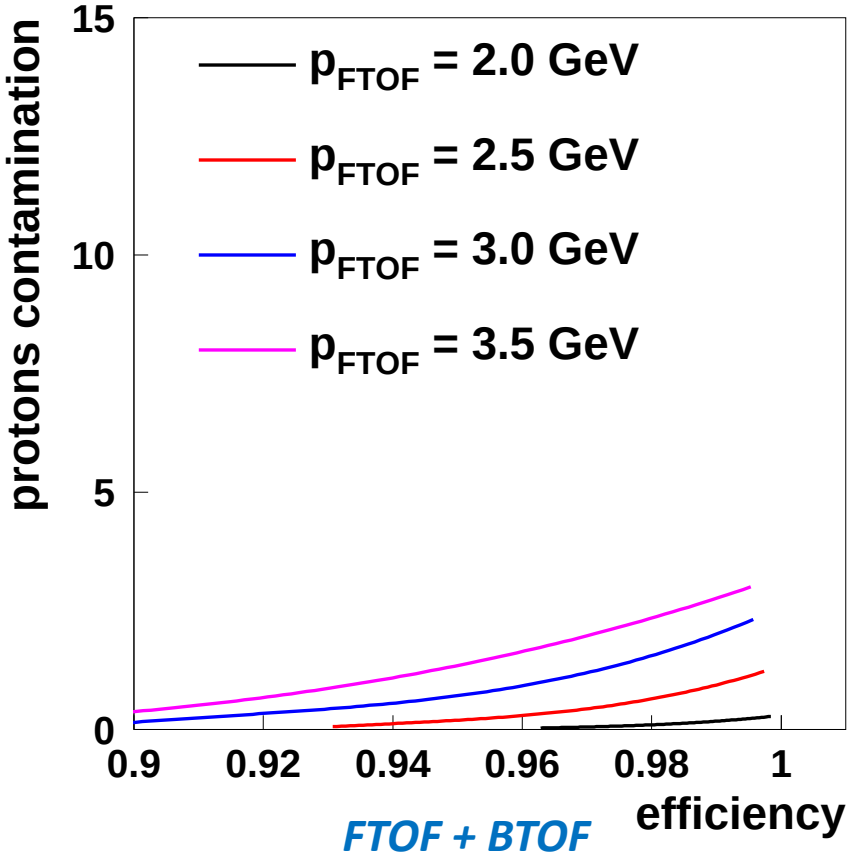


Effective π/K/p separation, e μ good event time reference

Comparison of proton-pion separation using FTOF + BTOF and FTOF only in "pion sample"



FTOF

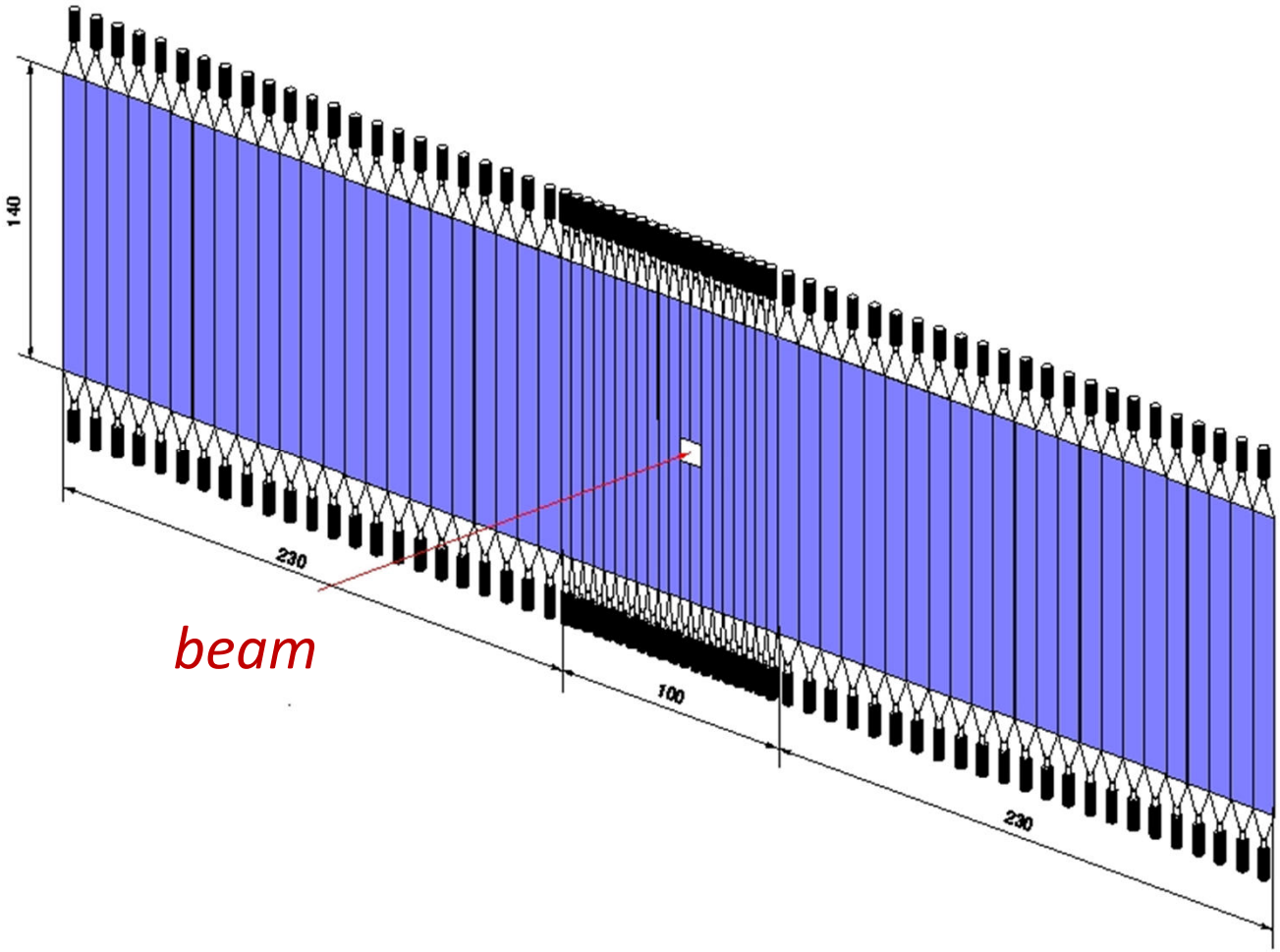


FTOF + BTOF

t_{res} = 100 ps

Forward and side TOF Walls

required TOF resolution σ = 50 - 100ps



Forward Wall

Plastic: B408

*46x(140*10* 1-2.5) cm^3*

*20x(140*5*1-2.5) cm^3*

high time resolution

PMs Hamamatsu 4998

(SiPM ??)

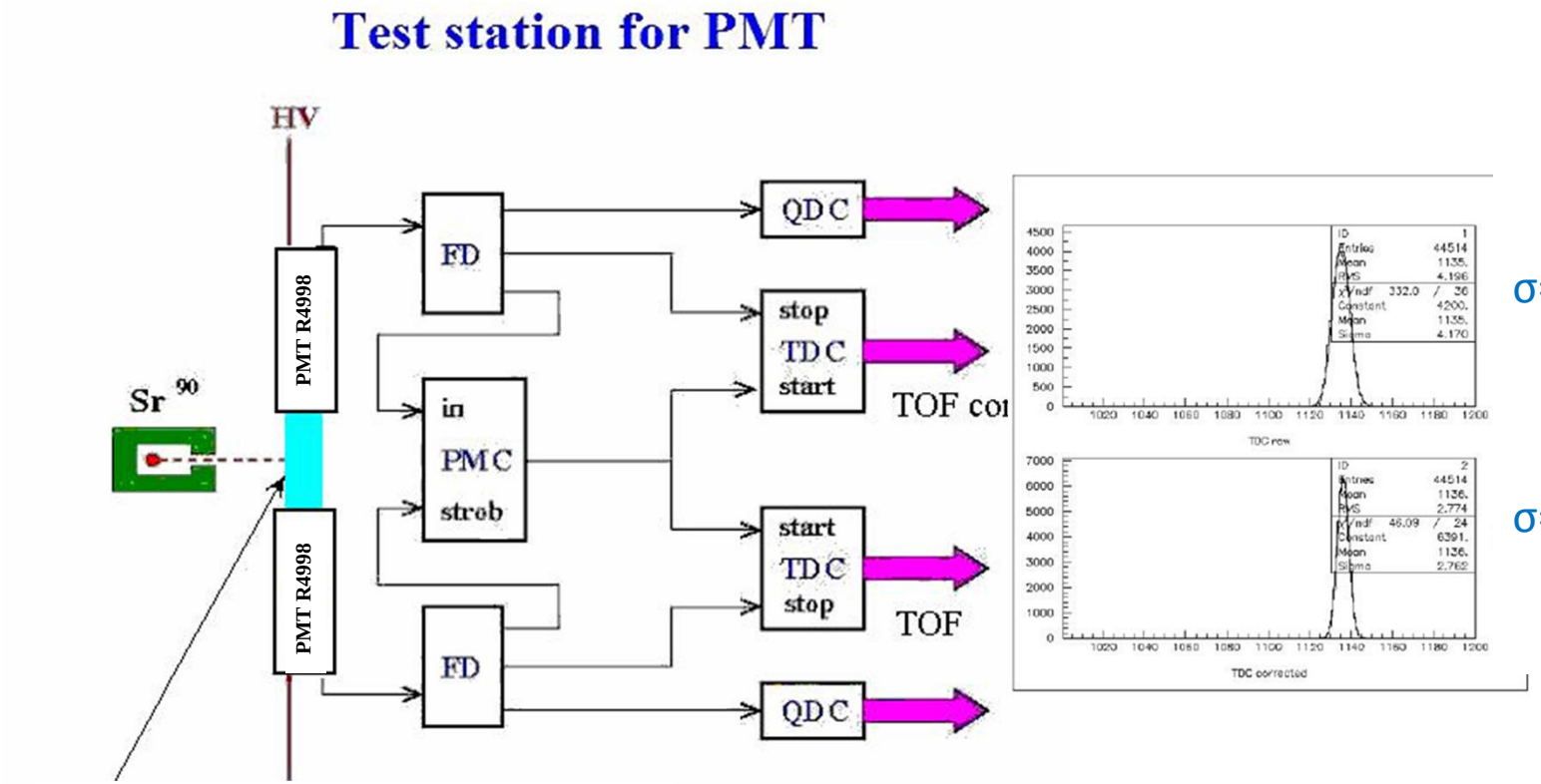
Side Walls

Plastic: B408

*14x(100*10*2.5) cm3*

SiPMs

Test station to study standard PMT



σ=103 ps without correction

σ= 70 ps with amplitude correction

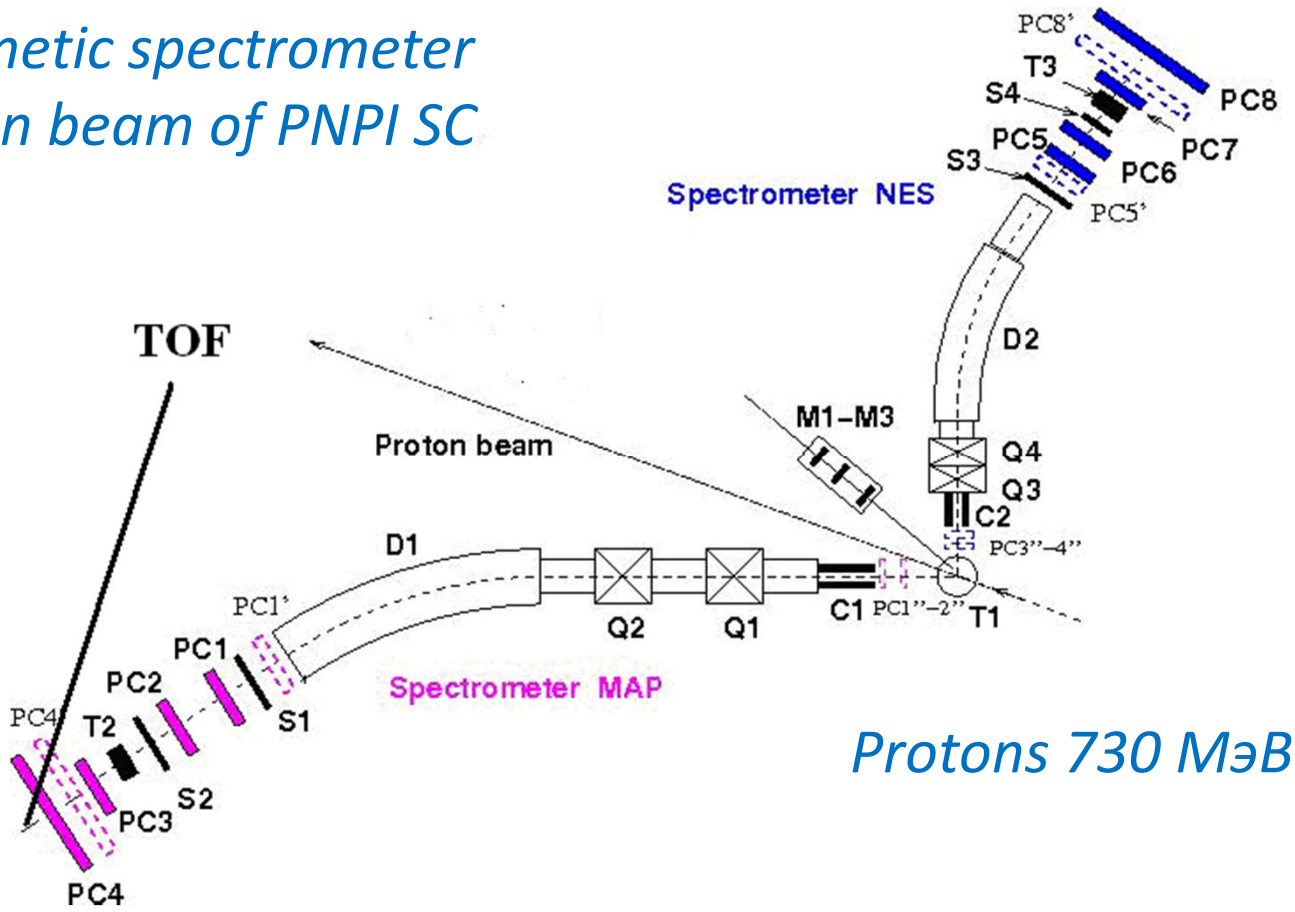
Scintillator B408

20x20x20 mm^3

2 PMT Hamamatsu 4998

Prototyping @ PNPI beam (Preprint PNPI 2833).

Two arm magnetic spectrometer
at 1 Gev proton beam of PNPI SC

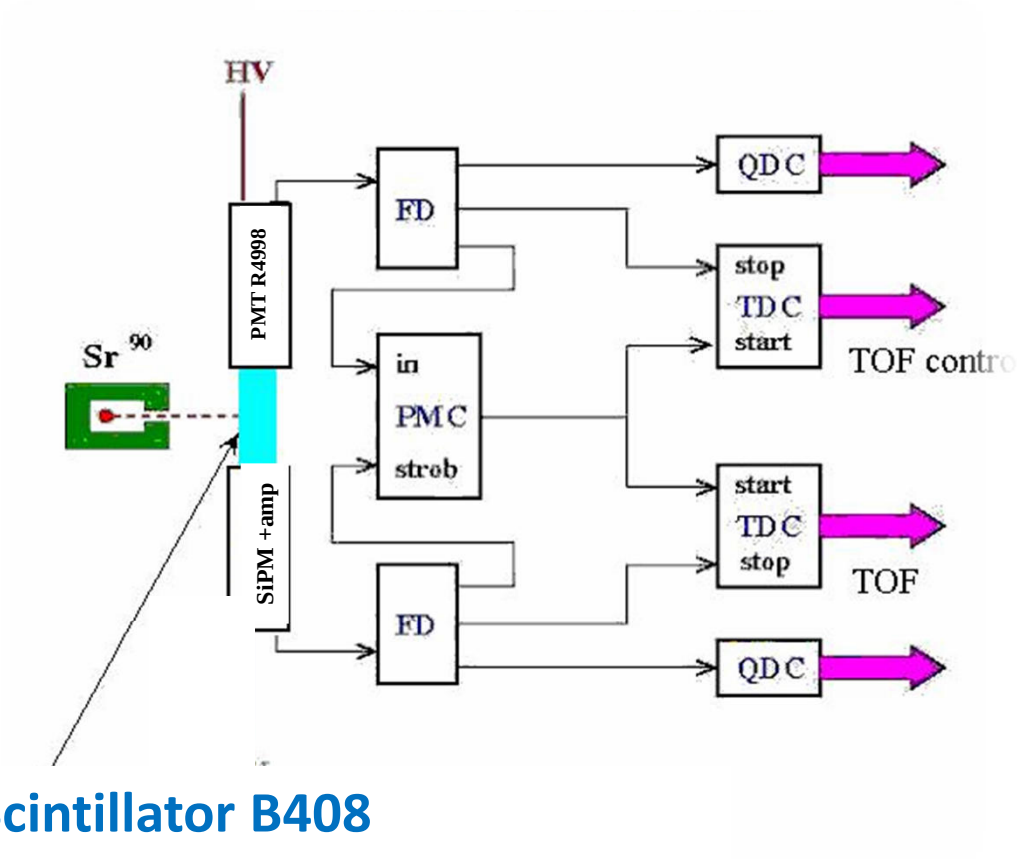


Protons 730 МэВ

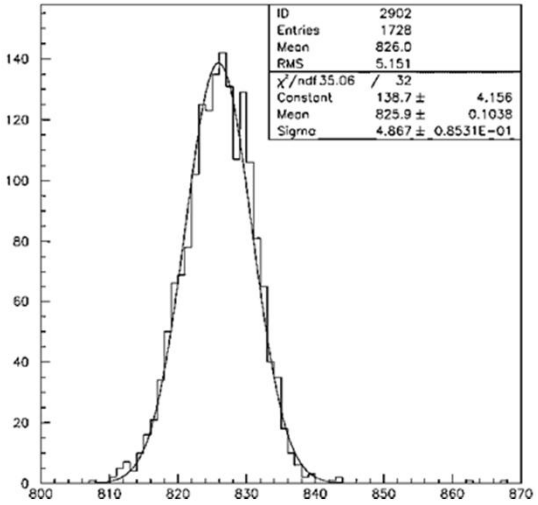
Experimentally obtained σ_o= 70 ps

Prototyping with PMT's is practically finished

Test station to study SiPM's

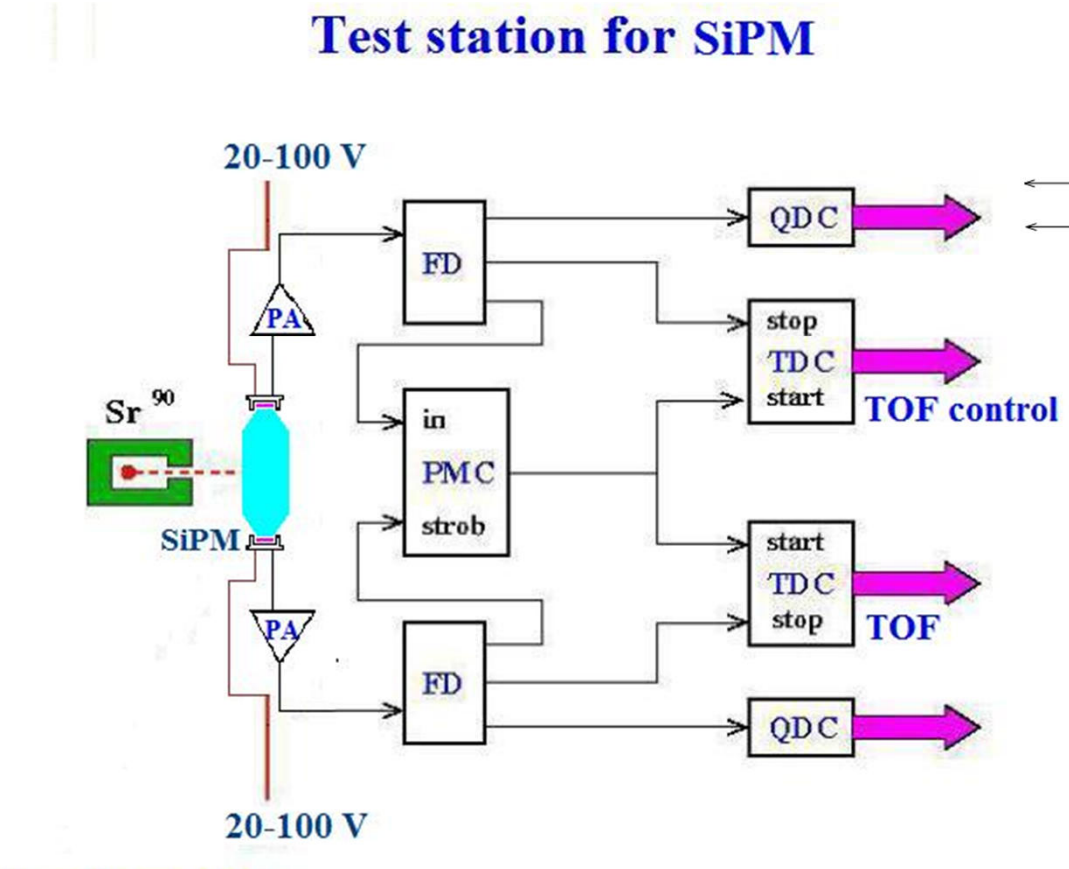


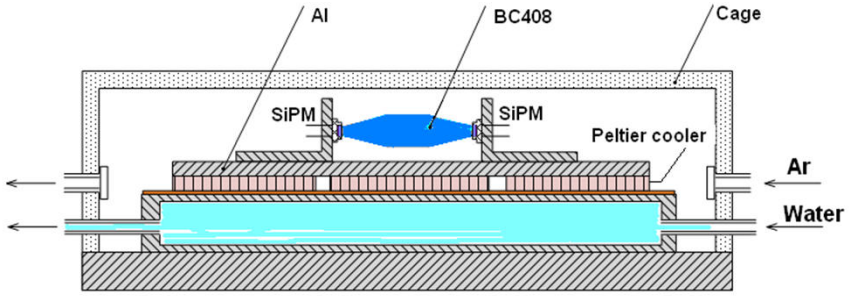
σ=147 ps 2 PMT's
σ=120 ps PMT + SiPm without correction
σ= 65 ps with correction for SiPM

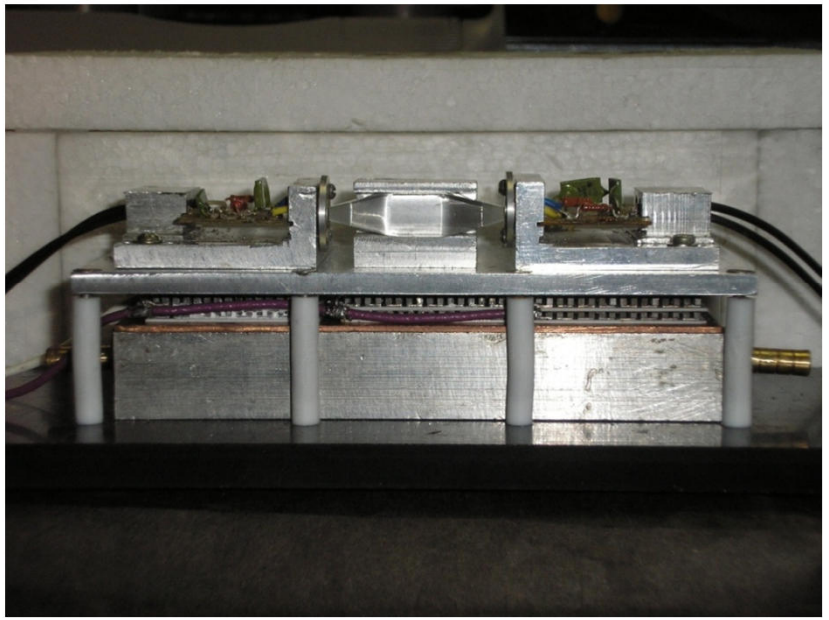


Scintillator B408
3x3x40 mm³
PMT Hamamatsu 4998
SiPM Hamamatsu S10931-50p

In progress





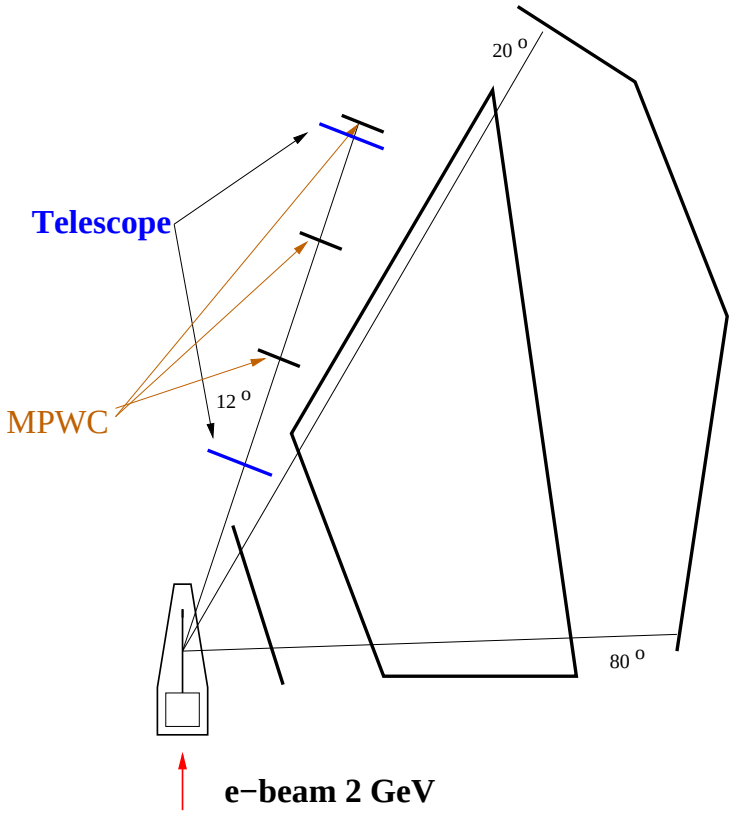


Scintillator B408

40x10x10 cm^3

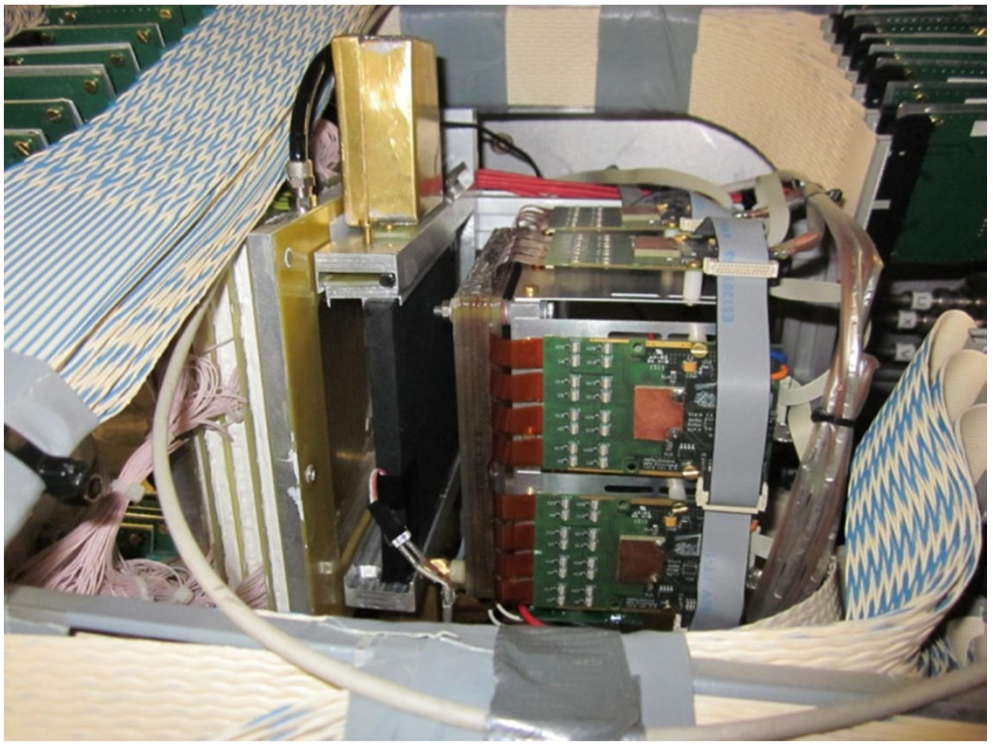
2 SiPM Hamamatsu S10931-50p

Telescope with SiPM in OLYMPUS experiment



Very limited environment in the detector and strong magnetic field

SiPM Hamamatsu S10931-50p



Plastic scintillators
12 x 12 x 0.5 cm
12 x 12 x 1.0 cm

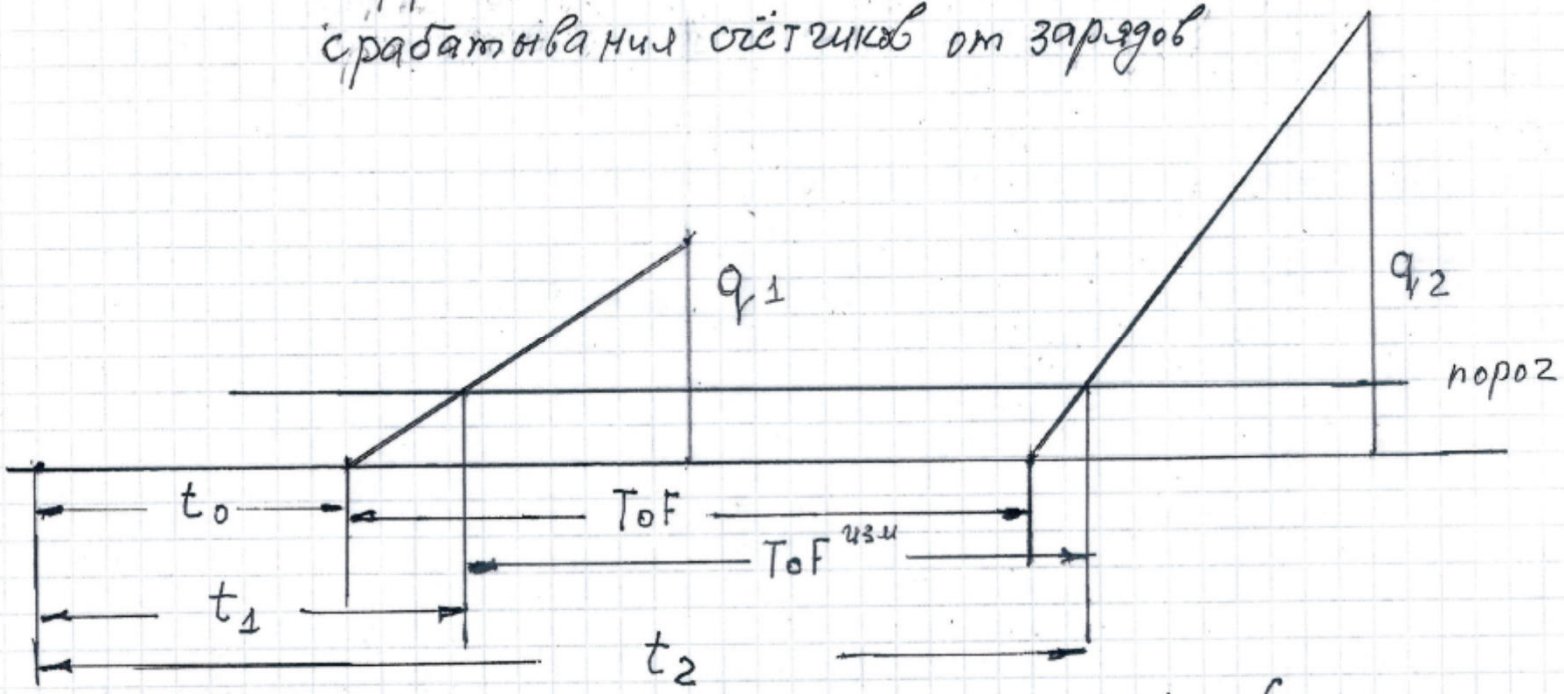
Current results

- *SiPM Hamamatsu S10931-50p have been tested at PNPI. Time resolution of the SiPM under study is found to be 65ps which is better then for the PMT for same amount of collected light.*
- *For temperature dependence of SiPM operation, there was produced test station with the Pelitier elements*
- *Two plastic panels 120x120x10 mm3 with 2 SiPM in the opposite diagonal corners are installed in the OLYMPUS experiment. The amplitude of signal is 6 mV including about 2 mV (accelerator + inherent noise) for these scintillator counters. For the plastic paddles 60x60x10 mm3 the amplitude of signal was 3 times larger about 18 mV (amplitude of signal for the stick 3x3x40 mm3 was 60 mV.*

Outlook

- *Continuation of investigations using test station in PNPI*
- *Commissioning of SiPM telescopes in OLYMPUS experiment*
- *Preparation for Jeulich PANDA test run, study of SiPM vs PMT for large plastic paddles*
- *Study of radiation hardness (aging) at electron and proton accelerators*

Коррекция ToF на зависимость времени срабатывания счётчиков от зарядов



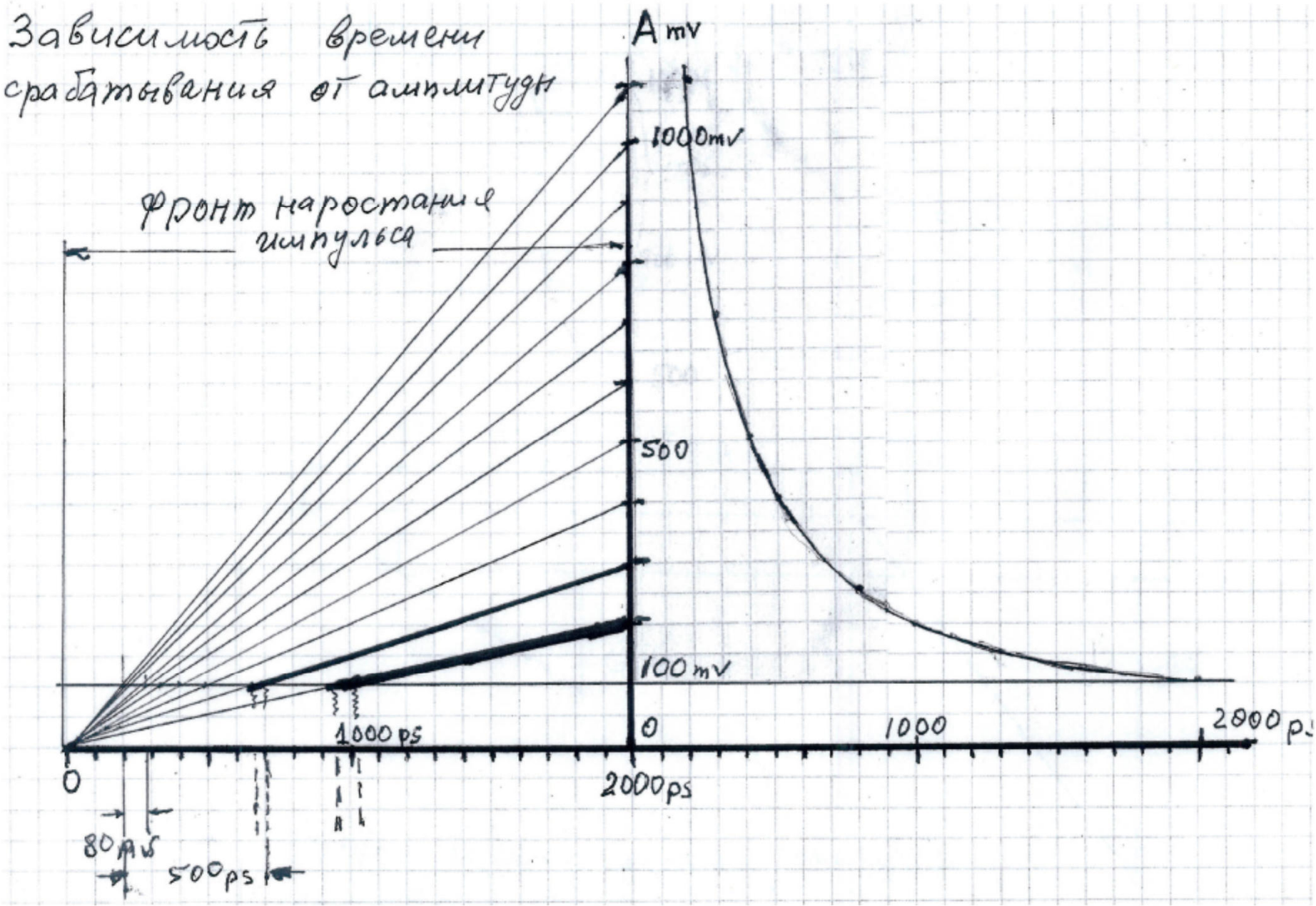
$$ToF^{изм} = t_2 - t_1$$

$$t_1 = t_0 + \frac{c}{\sqrt{q_1}}$$

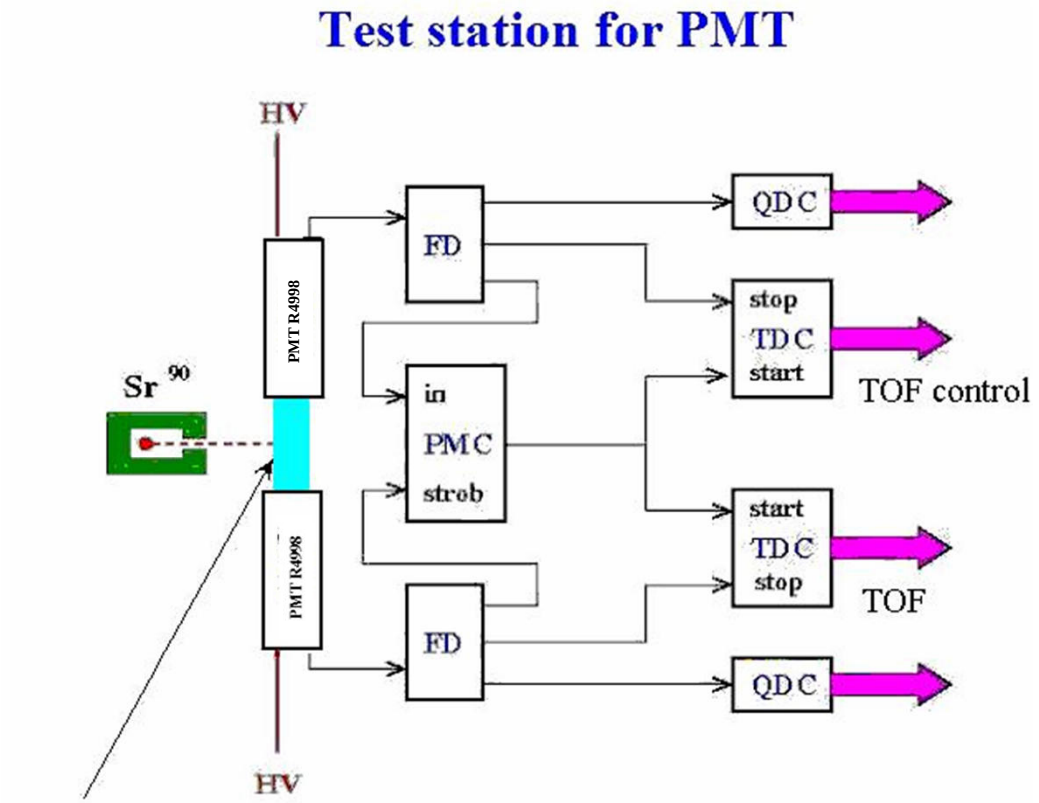
$$t_2 = t_0 + ToF + \frac{c}{\sqrt{q_2}}$$

$$ToF^{изм} = \frac{c}{\sqrt{q_2}} + ToF - \frac{c}{\sqrt{q_1}}$$

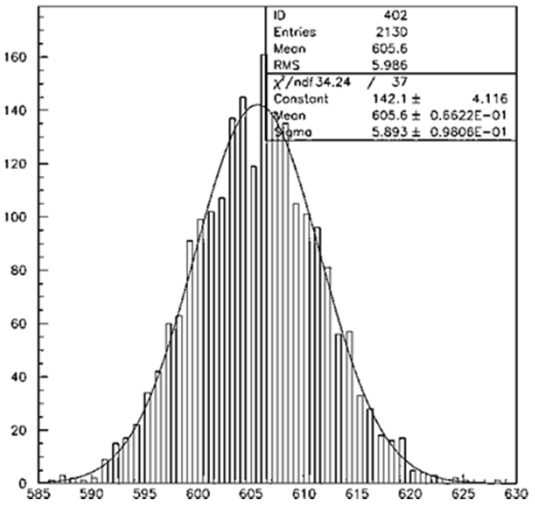
$$ToF = ToF^{изм} + c\left(\frac{1}{\sqrt{q_1}} - \frac{1}{\sqrt{q_2}}\right)$$


Зависимость времени срабатывания от амплитуды
A mV
1000mV
Фронт нарастания импульса
500
100 mV
1000 ps
0
1000
2000 ps
0
2000ps
80 ns
500ps

Test station using radioactive source

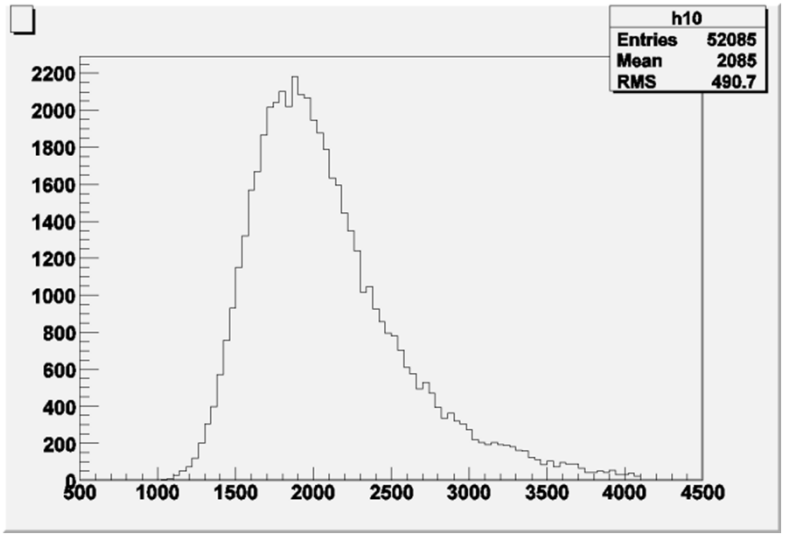


147 ps without correction



Scintillator BC408
10x3x30 cm^3

CDC spectrum



Test stand with:

radioactive source Sr90

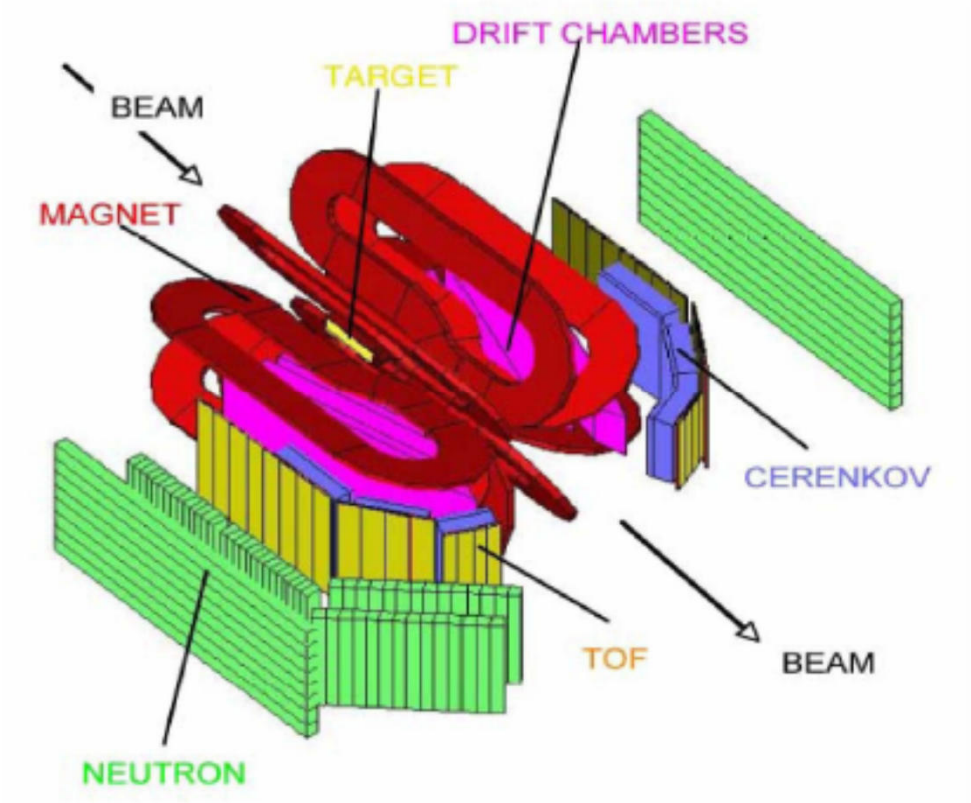
QDC LeCroy 1182 VME

SiPM Hamamatsu S10931-50p

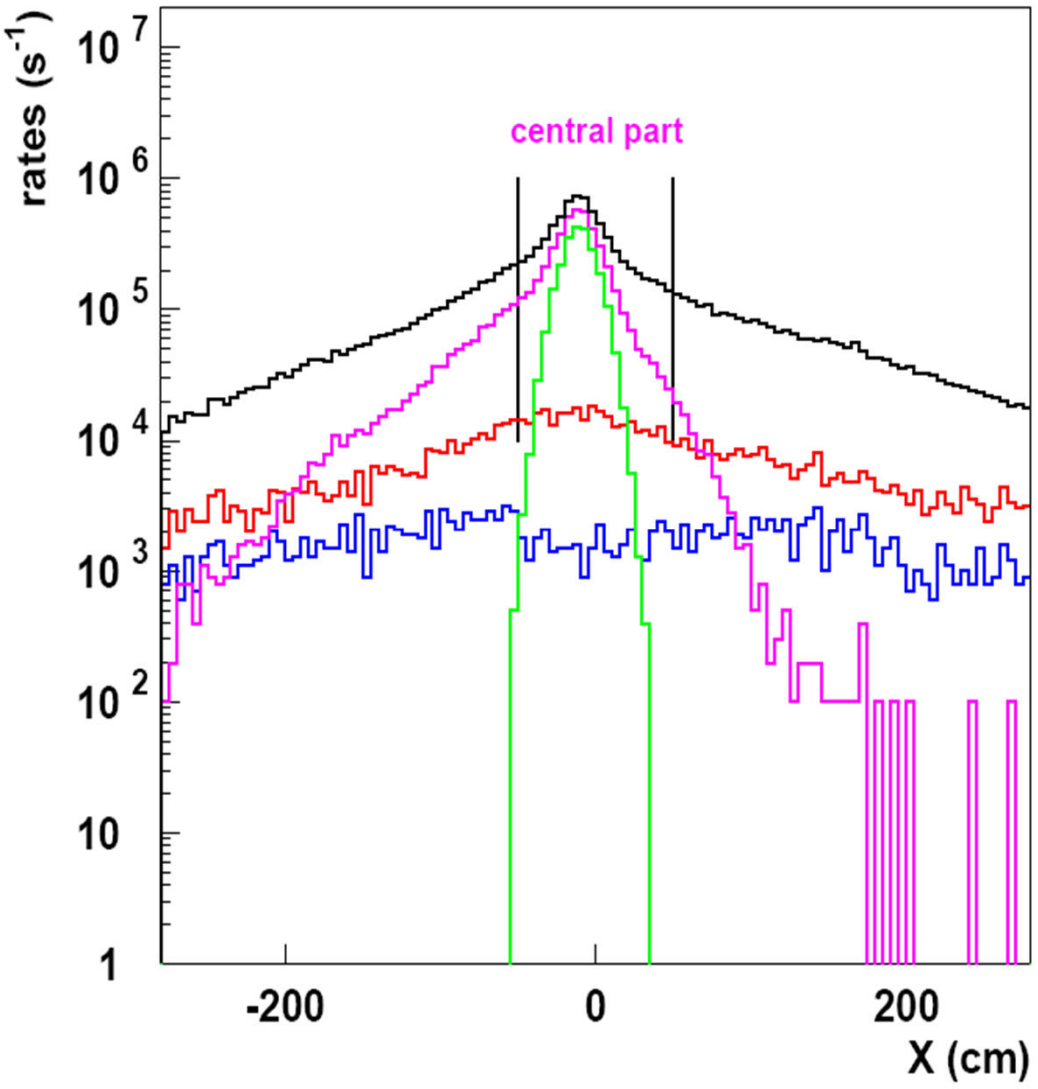
Naïve estimation give 50 photons hits the SiPM surface

OLYMPUS experiment

Study of two-photon exchange contribution to elastic ep cross-section



Forward Tof Wall rates (backgrounds) at 15 GeV/c P_{bar} beam.



Rates normalized on 10^7 Interaction/s in the target

---- **All charged particles from target**

---- **P_{bar} elastic and inelastic**

---- **P_{bar} elastic**

Secondary particles

---- **all charged from beam pipes**

---- **e^+e^- pairs from γ's ($\pi^0 \rightarrow \gamma\gamma$) from beam pipes**

bin = 5 cm strip width taken in central part of TOF wall