PNPI @ PANDA

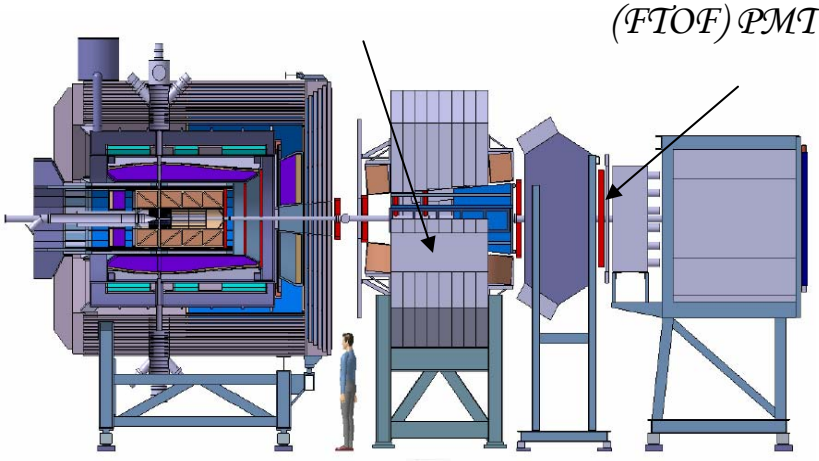
Anton A. Izotov,

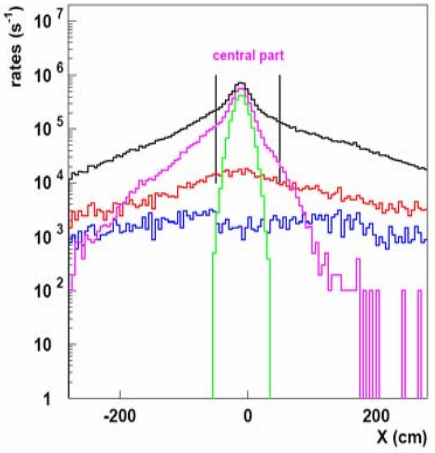
Gatchina 26.03.13

PANDA Forward TOF Walls.

Side TOF walls in dipole Magnet SiPM/PMT187

Forward TOF wall (FTOF) PMT's



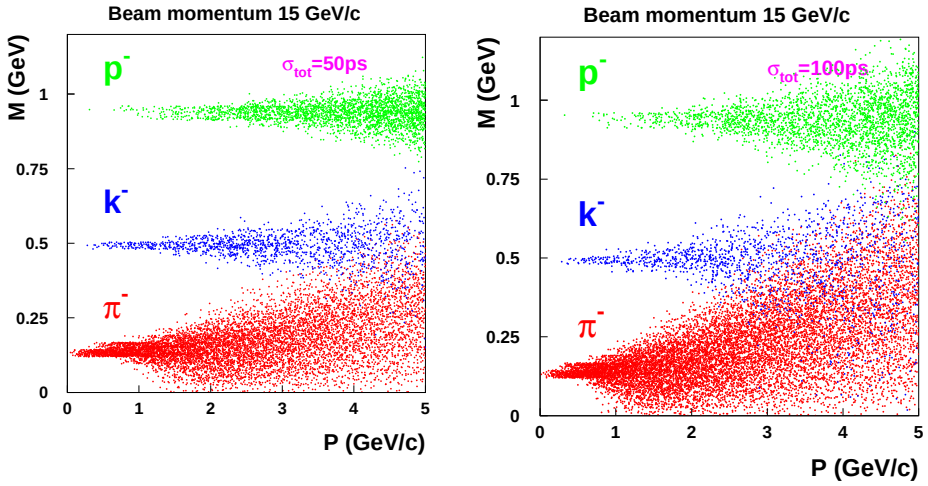


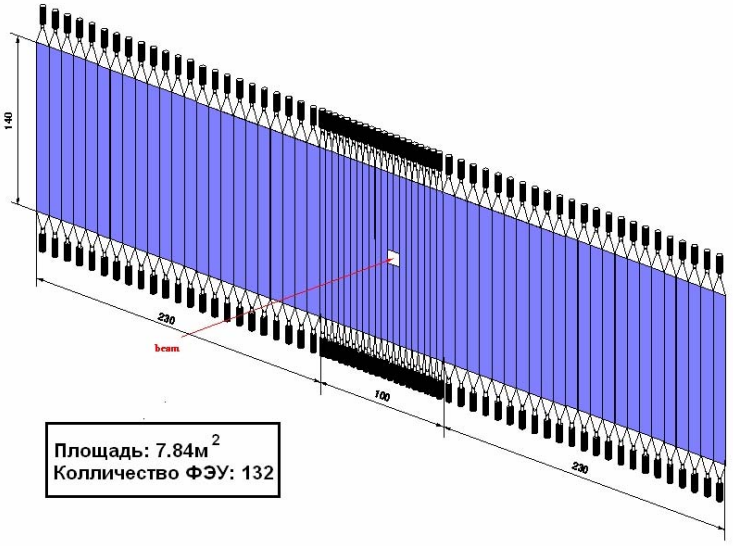
Forward Wall

Plastic: B408
*46x(140*10*2.5) cm³*
*20x(140*5*2.5) cm³*
high time resolution
PMs Hamamatsu
R4998, R2083,
(SiPM ??)

Side Walls

Plastic: B408
*14x(100*10*2.5) cm³*
SiPMs, PMT187

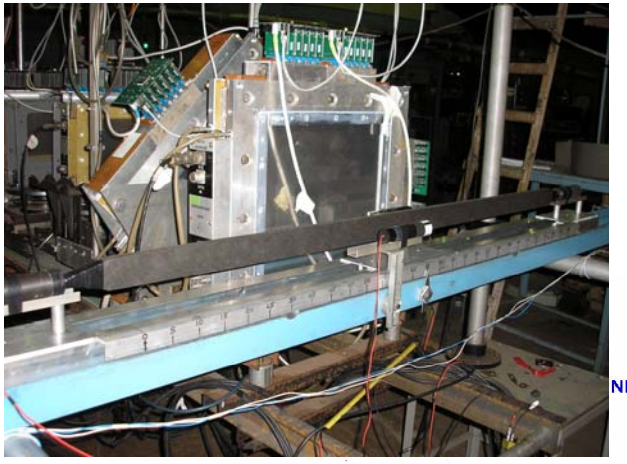


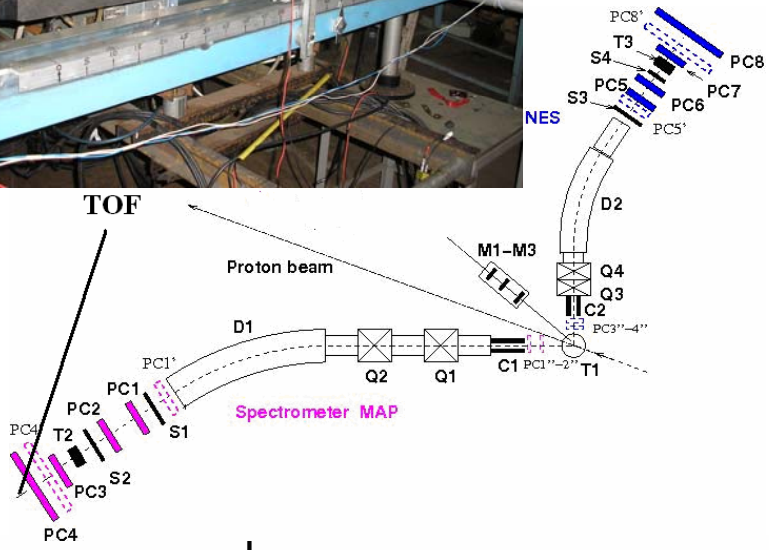


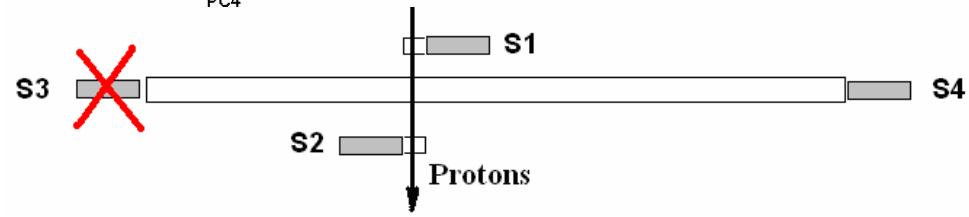
Done in Last Years:

- PMT test stand prototyping,
- PANDA prototype test @ PNPI-2009,
- Startless TOF reconstruction algorithm,
- SiPM test stand prototyping,
- SiPM radiation hardness test,
- SiPM's @ OLYMPUS,
- PANDA prototype MC simulation,
- PANDA prototype test @ PNPI-2012,
- PANDA prototype test @ COSY-2012.

Prototyping @ PNPI 2009 (Preprint PNPI 2833).







$$\Delta t = t_n - t_k - a - b(x-c) - d(q_n - e) + f(q_k - g), n \neq k = 1,2,4$$

Readout

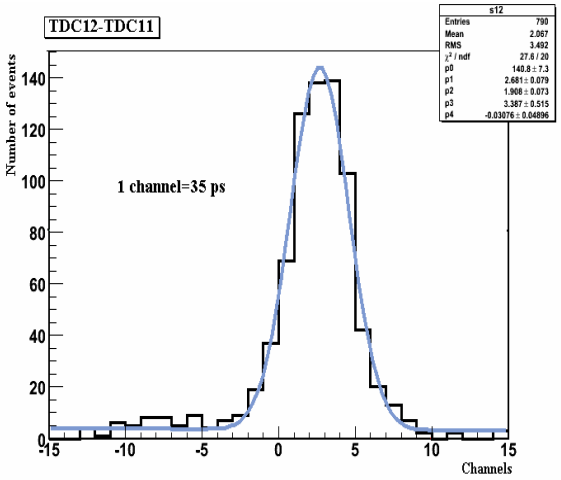
- TDC CAEN V775N (35 psec),
- QDC CAEN V792

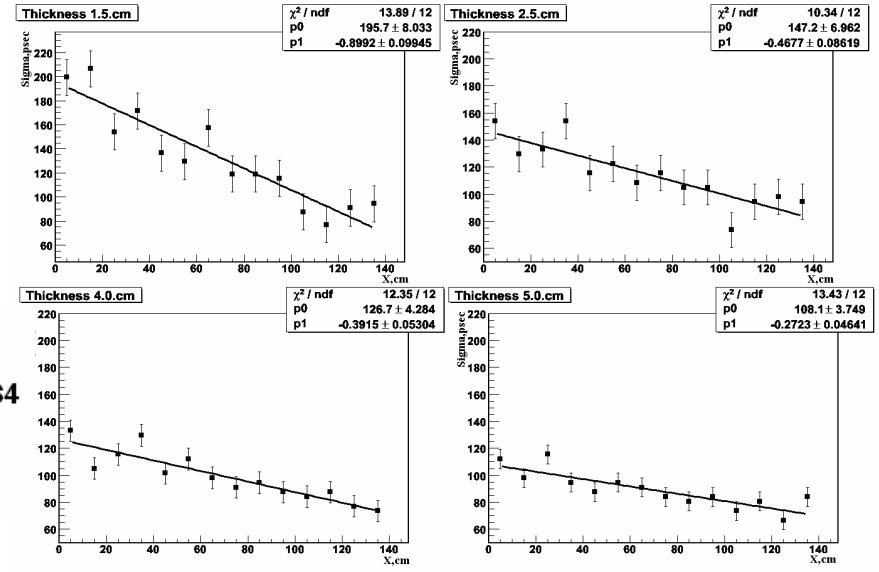
Beam

- Protons 730 MeV

Prototype

- Two 2x2x2 cm^3 B408, R4998,
- 140x5x1.5 cm^3, B408, R4998,
- Offline correction

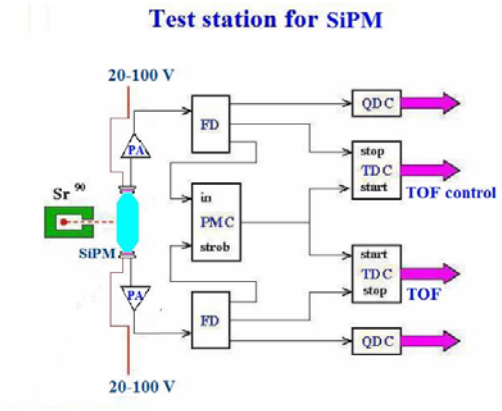


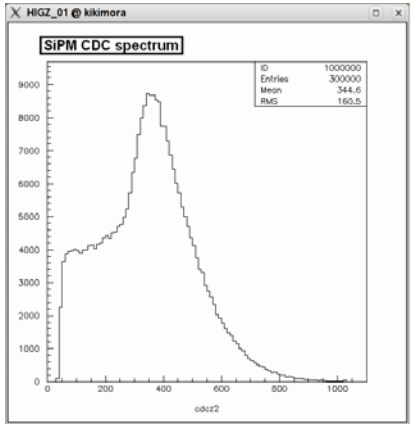


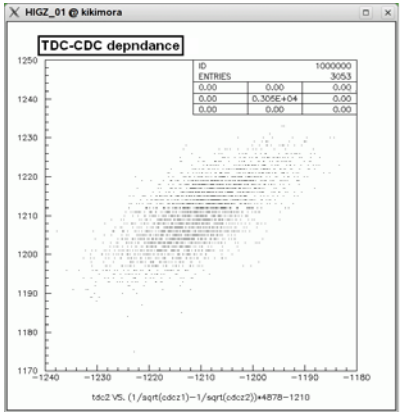
PMT R4998 & SiPM S10931-50p at the Test Stand.

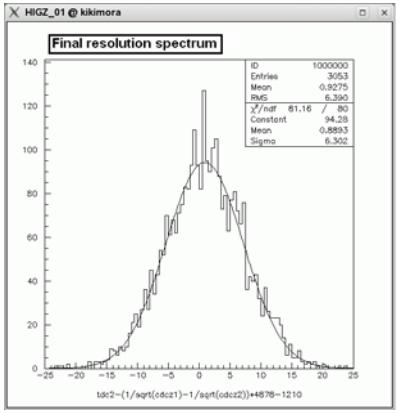
SiPM NxN matrixes!

$$\Delta t = \Delta t_0 - A\left(\frac{1}{\sqrt{q_1}} - \frac{1}{\sqrt{q_2}}\right) - b$$

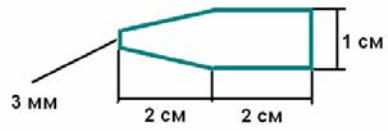


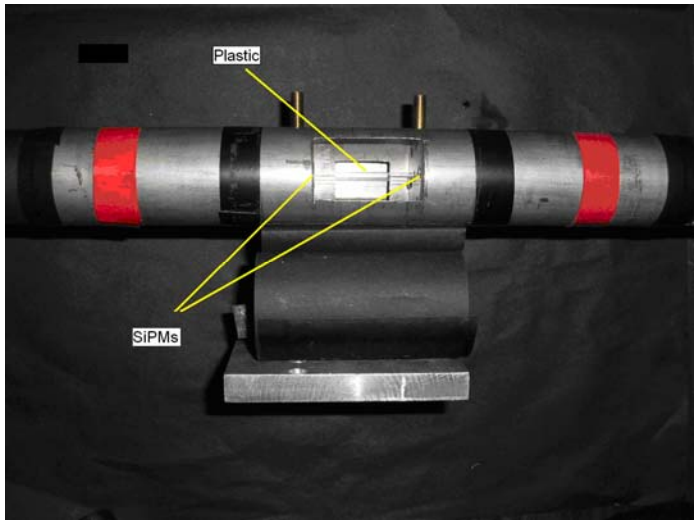






B408 – 3x3x40 mm³
TDC – 25 ps/chan
PA - ~8 times
Source - ^{90}Sr





R4998

Run	σ_0	σ_1	σ_2
40366	326	168	149
40367	497	170	142
40368	486	176	147

S10931-50p

Run	σ_0	σ_1	σ_2
40366	608	195	157
40367	543	199	151
40368	557	193	150

σ worse than 160 ns

SiPM Radiation Hardness Test @ 1GeV PNPI Proton Beam.

- **The absolute beam intensity was determined in a standard way by measuring induced radioactivity of irradiated aluminum foils.**
- **The beam intensity during the tests was varied in the range 1.3 - 2.1x10^{8} $cm^{-2}s^{-1}$.**
- **The SiPM sample was not powered!**
- **Radiation was exposed in 10 successive periods about 10 minutes each. The integrated number of protons passing through the sensitive surface of the SiPM sample with the cross-section of 3x3 mm^2 was 0.9*10^{11}. By our estimations, such dose corresponds approximately to irradiation to be collected by a similar SiPM installed on a central scintillation bar of the Forward wall during 10 years of continuous beam producing hadrons off the PANDA target.**
- **SiPM parameters (dark noise, amplitude and time characteristics for different values of high voltage) were measured before and after the radiation test using test station with ^{90}Sr electron source.**

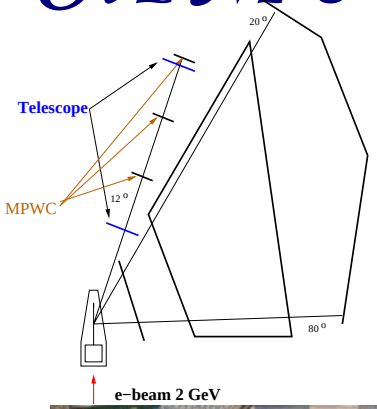
U,V	I, μA	A, mV	Noise	Noise+^{90}Sr
72.06	0.15	40	1550	8700
72.53	0.30	80	4230	18500
72.06	81.0	4	2800	6200
72.53	113.0	6	99000	102000

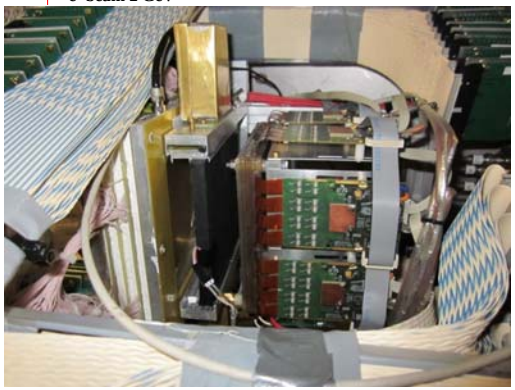
As it is seen from the table the SiPM was practically killed by this dose the value of which can be taken as upper limit,

- **Yet it is important to find out at which dose the sample start malfunctioning,**
- **It is also important to compare irradiation effect on unpowered and powered samples,**
- **All this will constitute our nearest experimental program with SiPM samples.**

$\Delta T = 0.056\ C^{o}$ *this is not heat!*

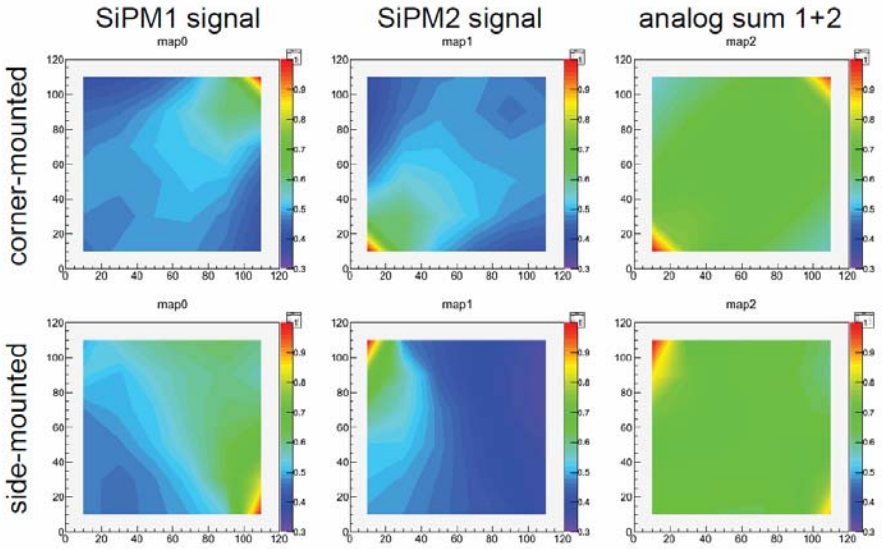
SiPM's @ OLYMPUS. DESY TB22.





Counters: 8mm/2SiPM's, 4mm/2SiPM's (corners), 4mm/2SiPM's (sides),
Readout: 25x preamp (electronics workshop, KPH Mainz)

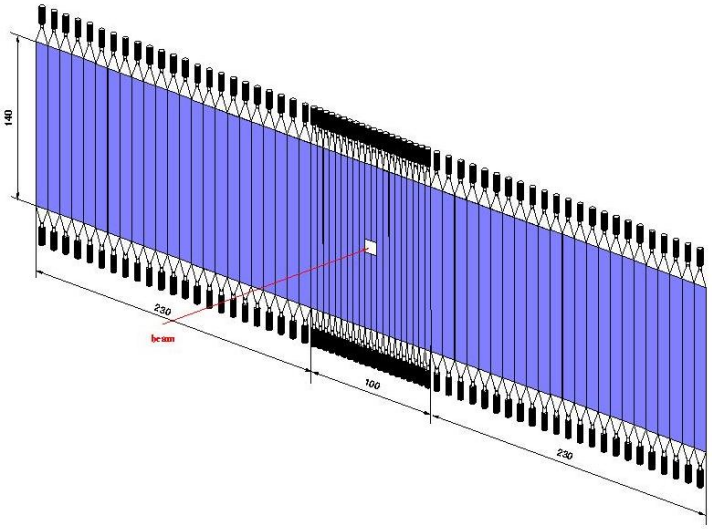
- *QDC spectra to see light yield,*
- *QDC spectra with prescaled baseline triger mixed into determine gain for each spectrum,*
- *Triple coincidence from beam trigger finger conciliators (2 with PMT's, 1 with SiPM)*
- *Quadruple coincidence (3 PMT's, 1 SiPM and single SiPM*
  - *efficiency scan,*
  - *maximum efficiency reachable with single SiPM*



- *Both side-mounting and corner-mounting, counters have similar yields,*
- *Blind spots exist in both configurations,*
- *Side-mounting is easier,*
- *Trigger scan shows, that even one SiPM is enough with proper threshold*

Prototype MC Simulation.

- Simulation of optical processes in GEANT4.
- MC studies. Time distributions.
- First estimations for time resolution.



TOF WALL

BICRON 408

46 plates 140*10*2.5 cm³

20 plates 140* 5*2.5 cm³

PMT:

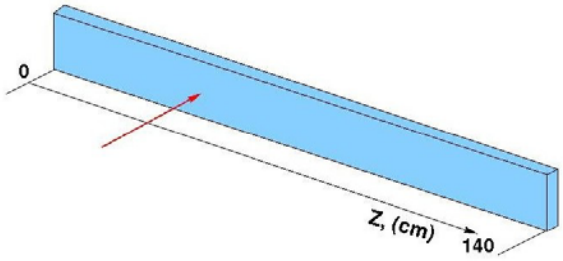
Hamamatsu R2083, R4998

TOF Side

14 plates 100*10*2.5 cm³

SiPM

Scintillator BC 408

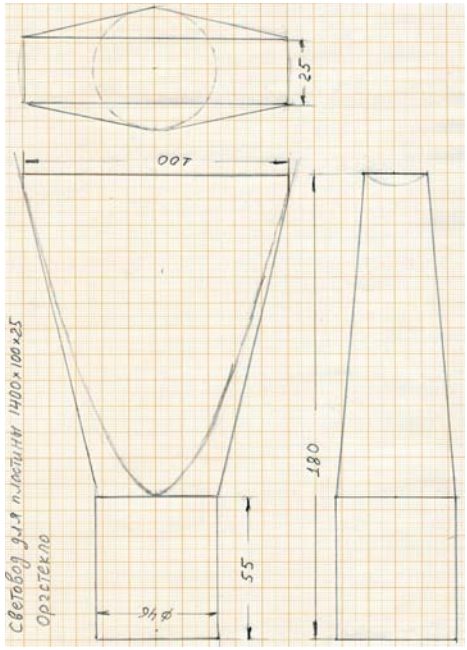


with light guides

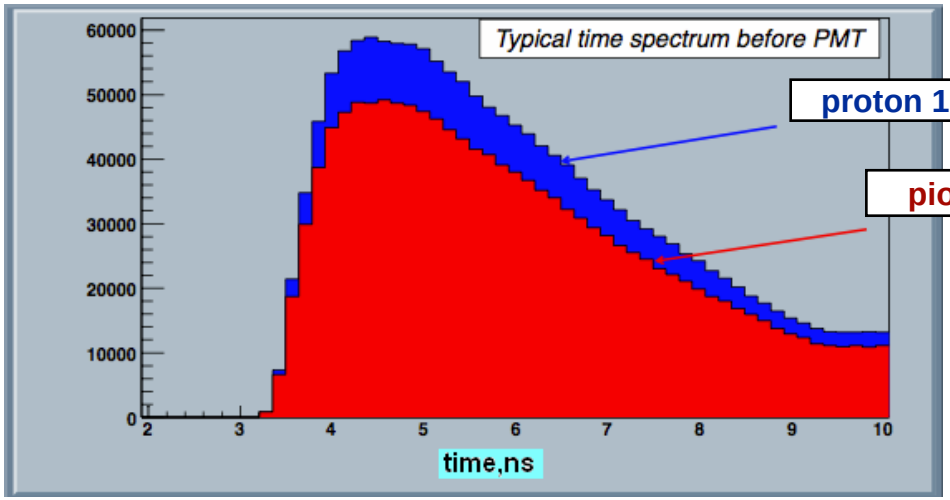
for 2” PMT (46 mm diameter)

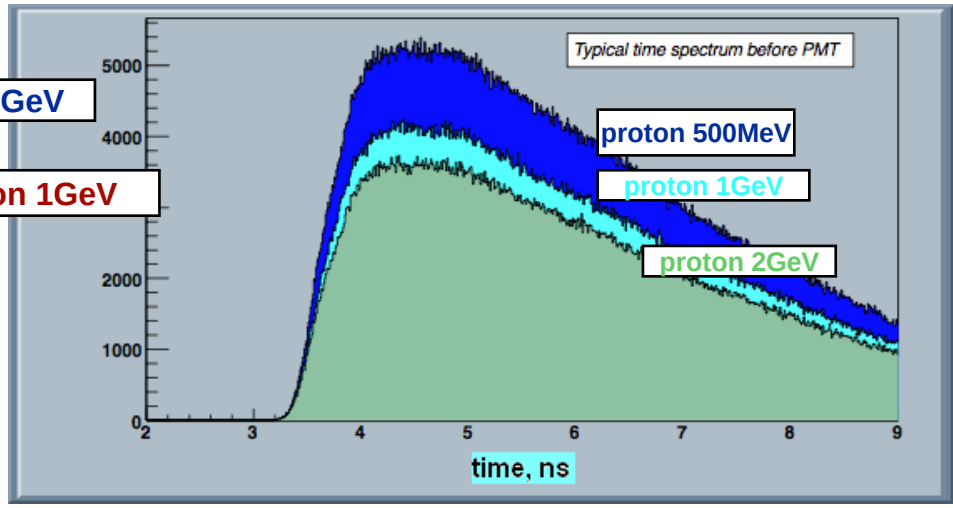
Plexiglass

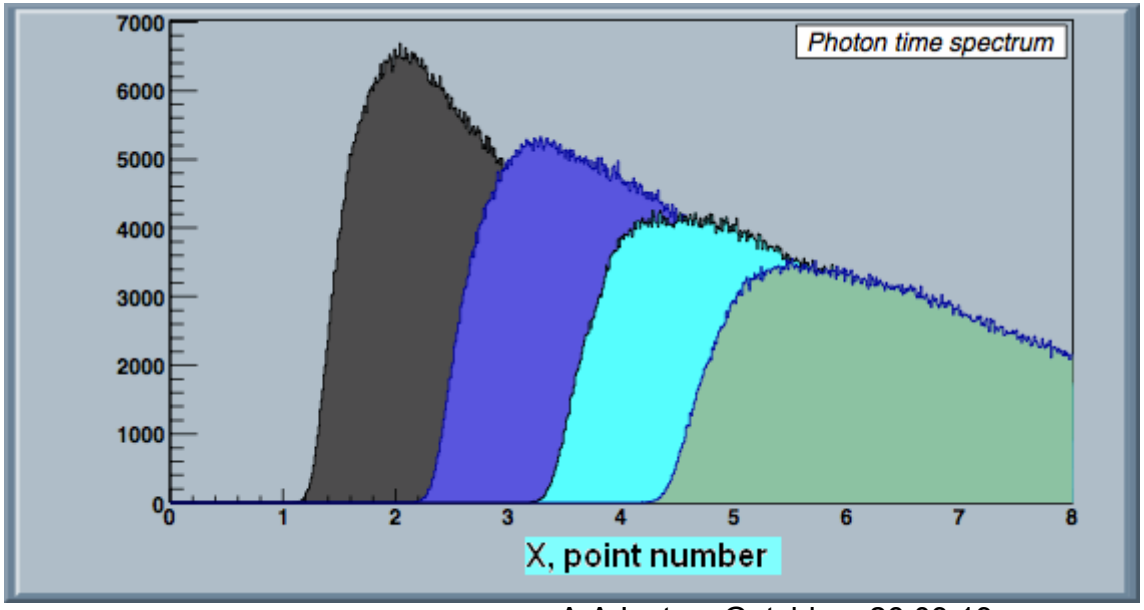
Mylar wrapping

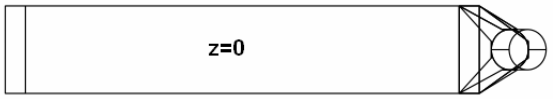


Photon Yield Time Distributions.

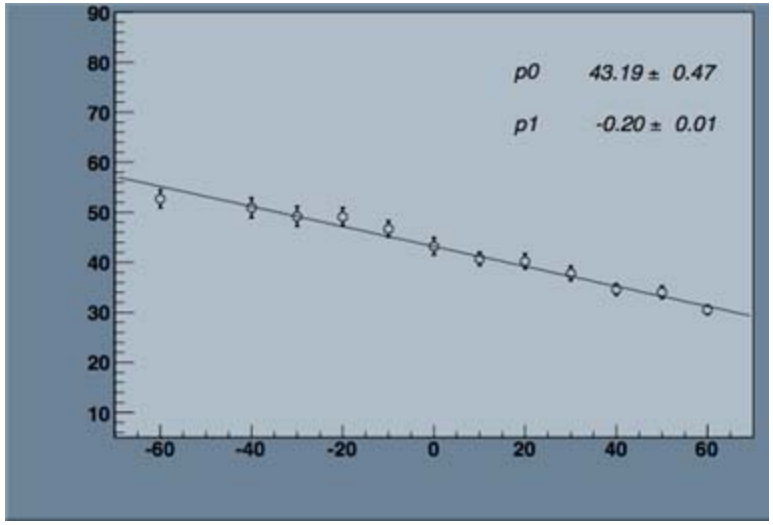


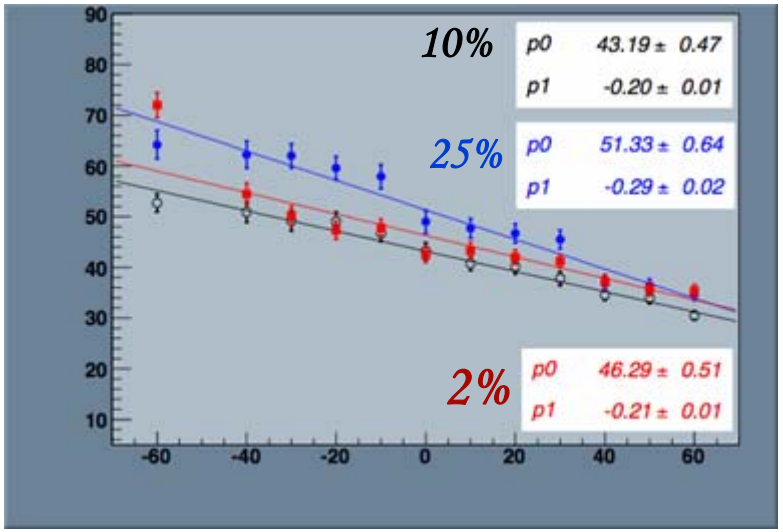


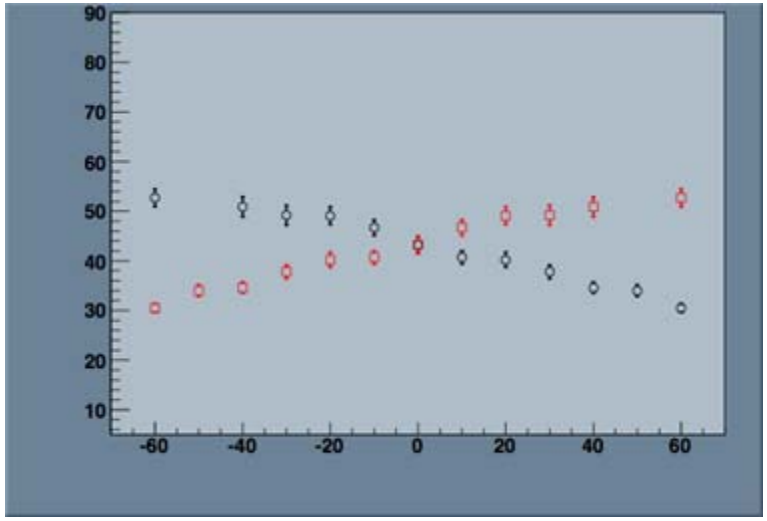


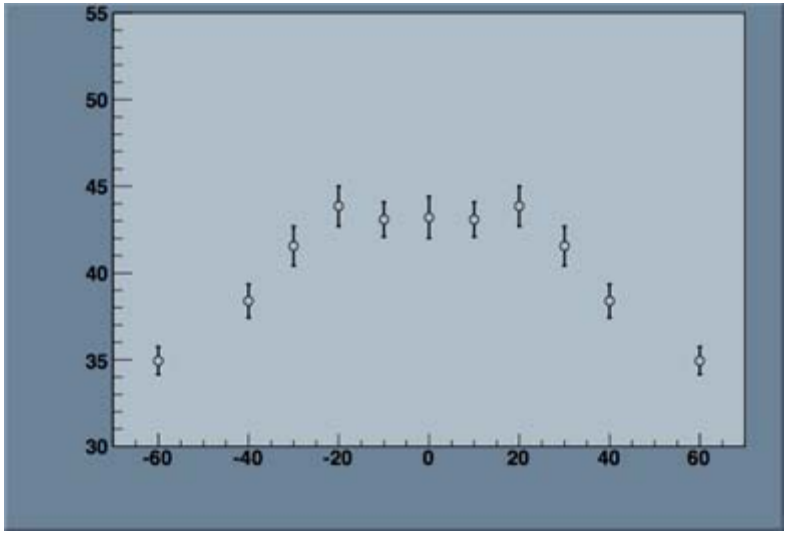


MC Time Resolutions.

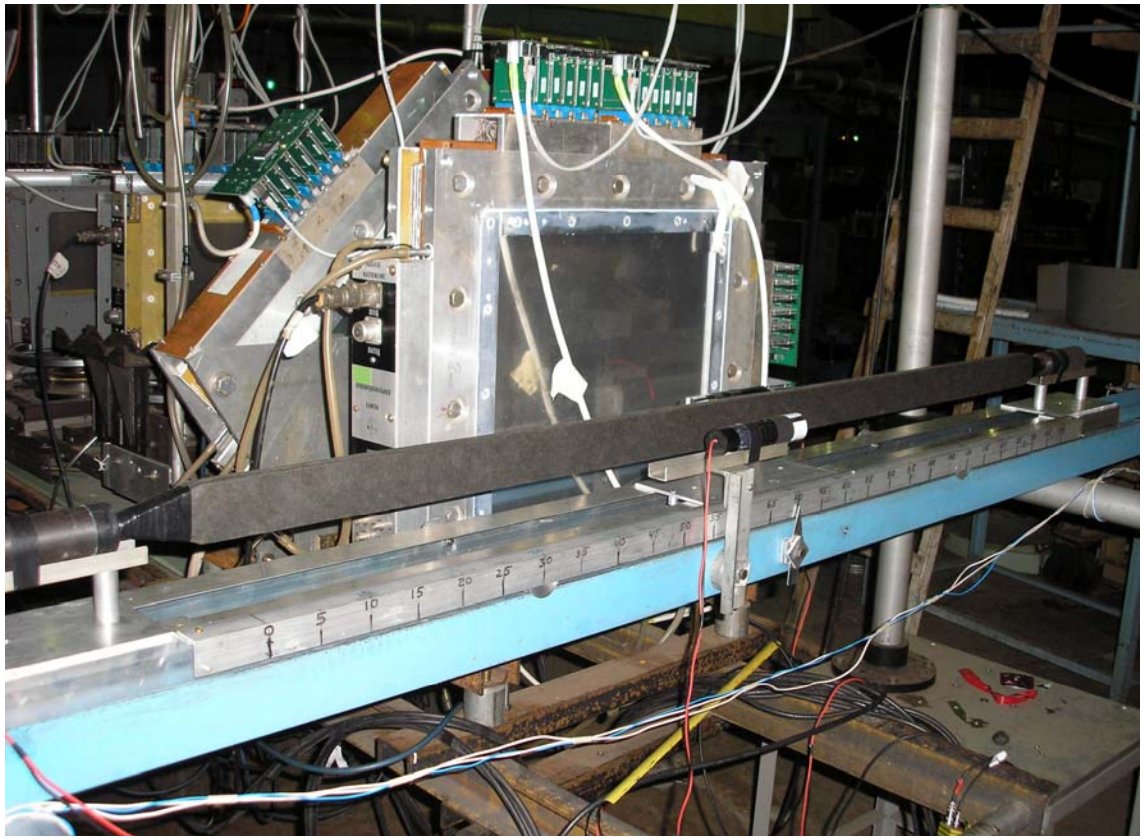




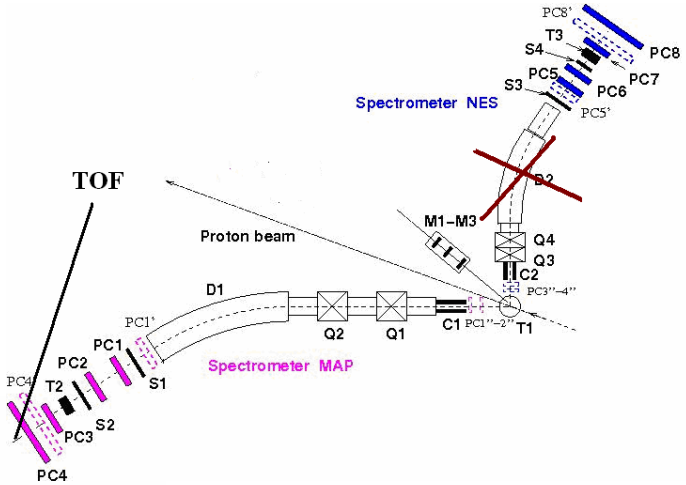


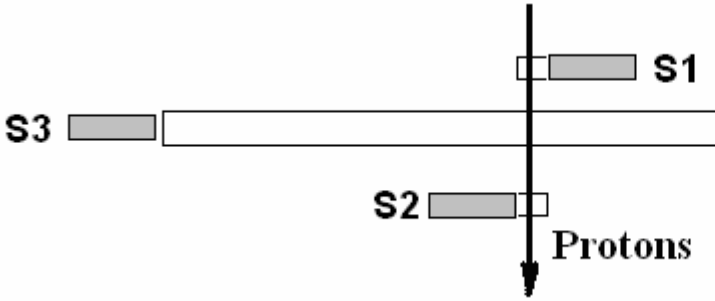


PNPI-2012 Prototyping.



Protons: 900 MeV
Plastic: B408
140x5x2.5 см
140x10x2.5 см
PMT's: R4998, R2083
TDC: CAEN V775N
QDC: PNPI 8CDC
Preamps: Y/N

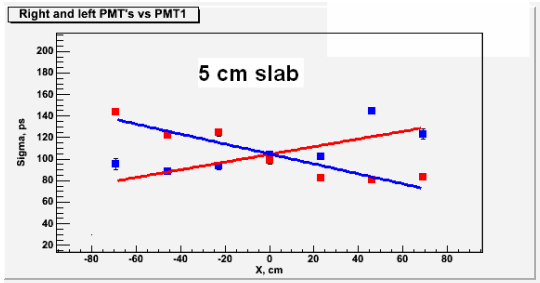


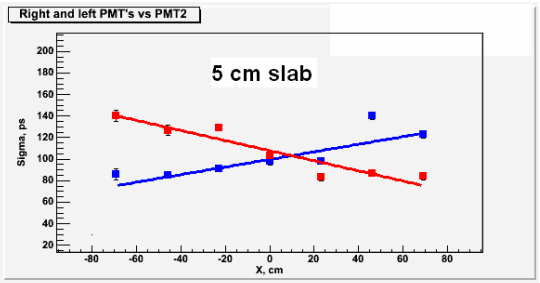


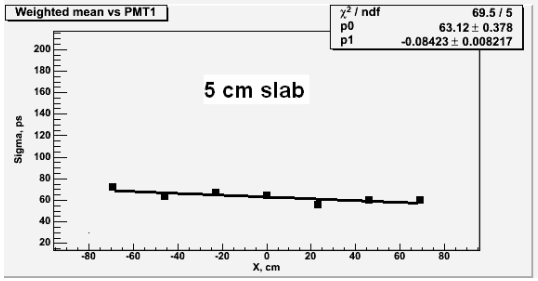
$$\Delta t = t_n - t_k - a\left(\frac{1}{\sqrt{q_n}} - \frac{1}{\sqrt{q_k}}\right) - bx - c, n \neq k = 1,2,3,4$$

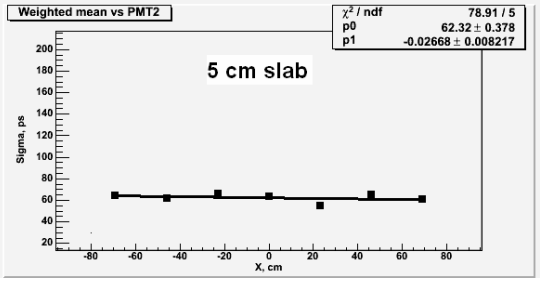
5&10 cm Wide Slab Resolutions.

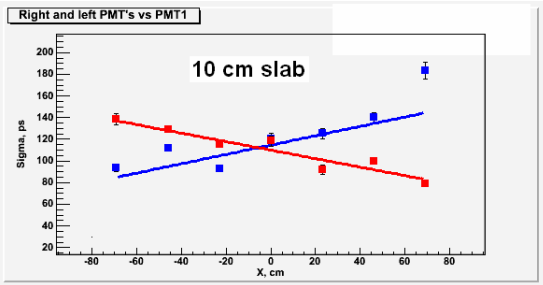
σ_{12}=63 ps

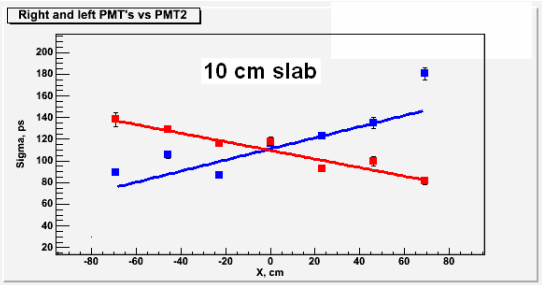


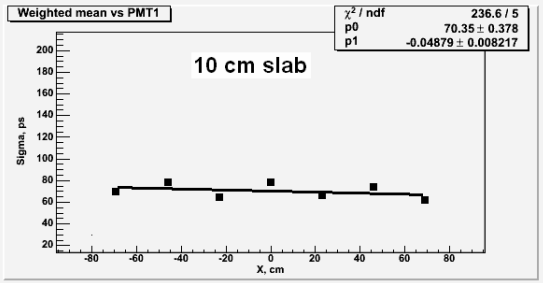


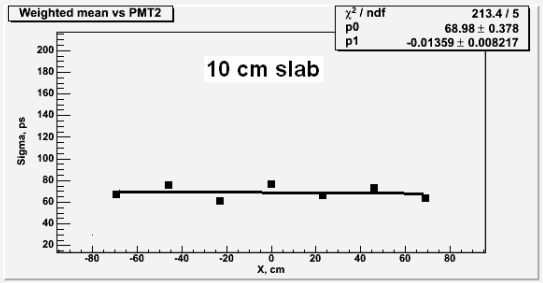








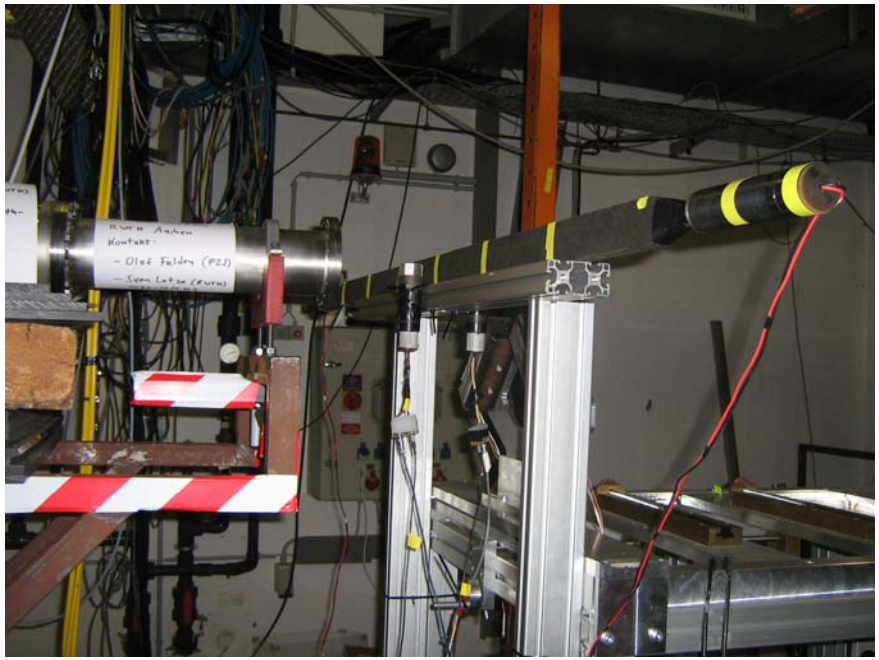


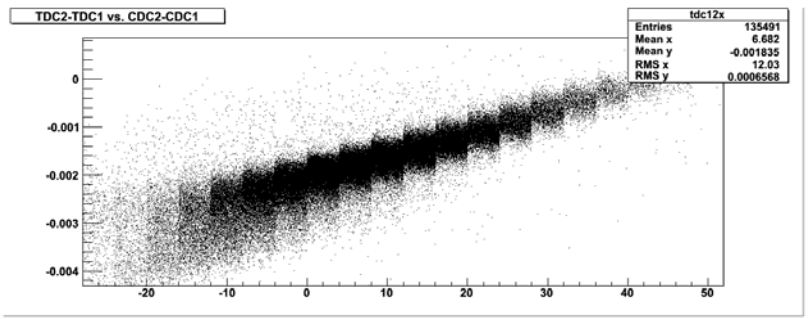


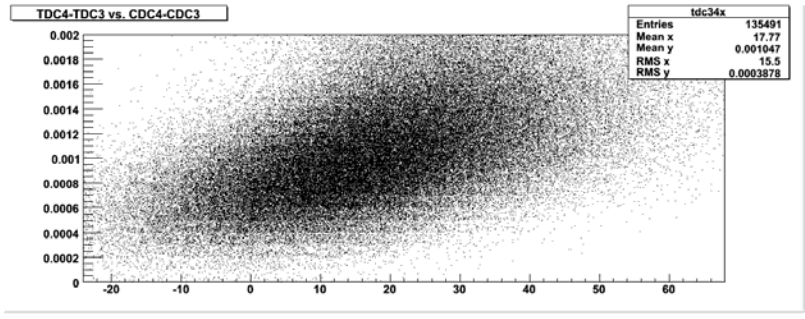
Prototyping @ COSY.

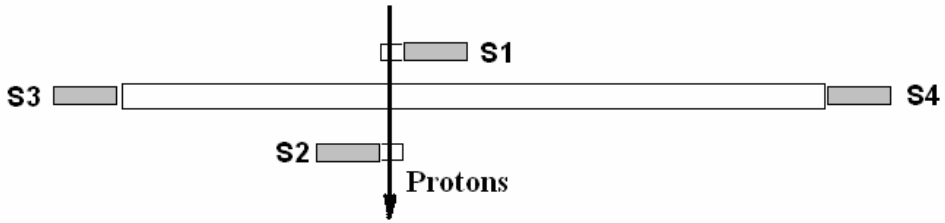
- Beam: protons E=2GeV, d=3cm,
- Collimator 0.2x3 cm,
- Counter: B408, 140x5x1.5 cm^3, R4998X2,
- Two counters: B408, 1x1x1 cm^3, PMT-187,
- Flash QDC 24 ps/ch

(Marek Palka, Jagellonian University, Krakow),





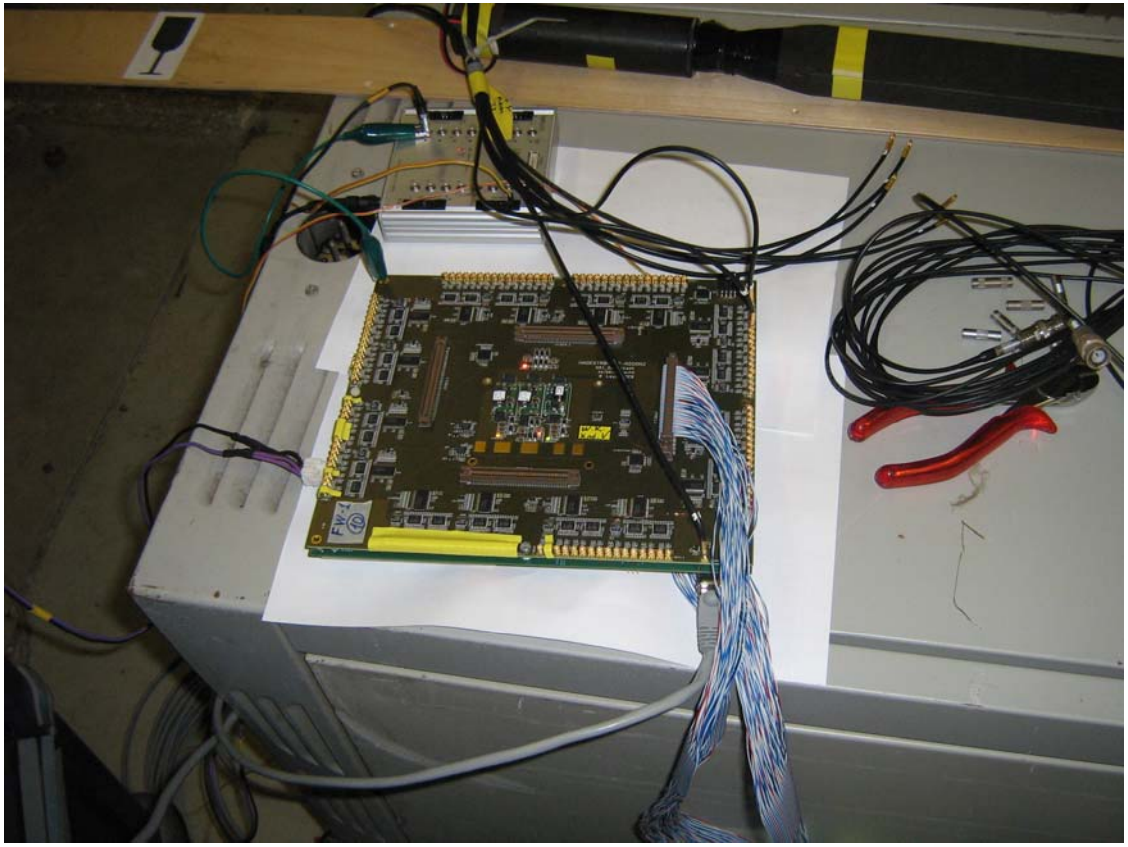




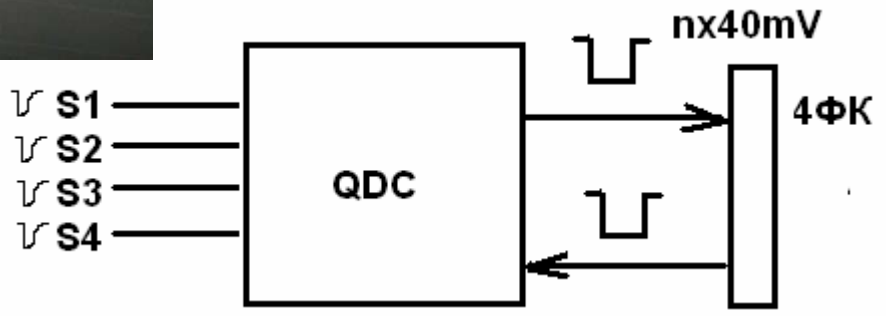
$\sigma_{PMT\text{-}187} \leq 70\ ps$

$\sigma_{slab} > 200\ ps$

Readout and Preliminary Results.



- *Real PANDA readout prototype,*
- *2009 results confirmed – 1.5cm is not enough,*
- *2PMT187 difference resolution better 100 ps, or ~70ps per PMT*



Plans:

- SiPM – NxN matrixes?
- MC development (prototypes, physics),
- Side TOF Wall prototype (to be done and tested),
- TDR.

Yet another approach to the ToF-based PID at PANDA.

→ consider all N tracks in a given event at once, that's clear

→ assume each track can be pion/kaon/proton

evaluate all 3^N $\{m_1,\ldots,m_N\}$ mass configurations separately, one by one

→ obtain their χ^2 weights (and t_S offsets)

→ reject (reweight) some, using external PID input

→ compare various mass configurations

→ select the "most probable" one(s)

→ obtain the significance estimate