



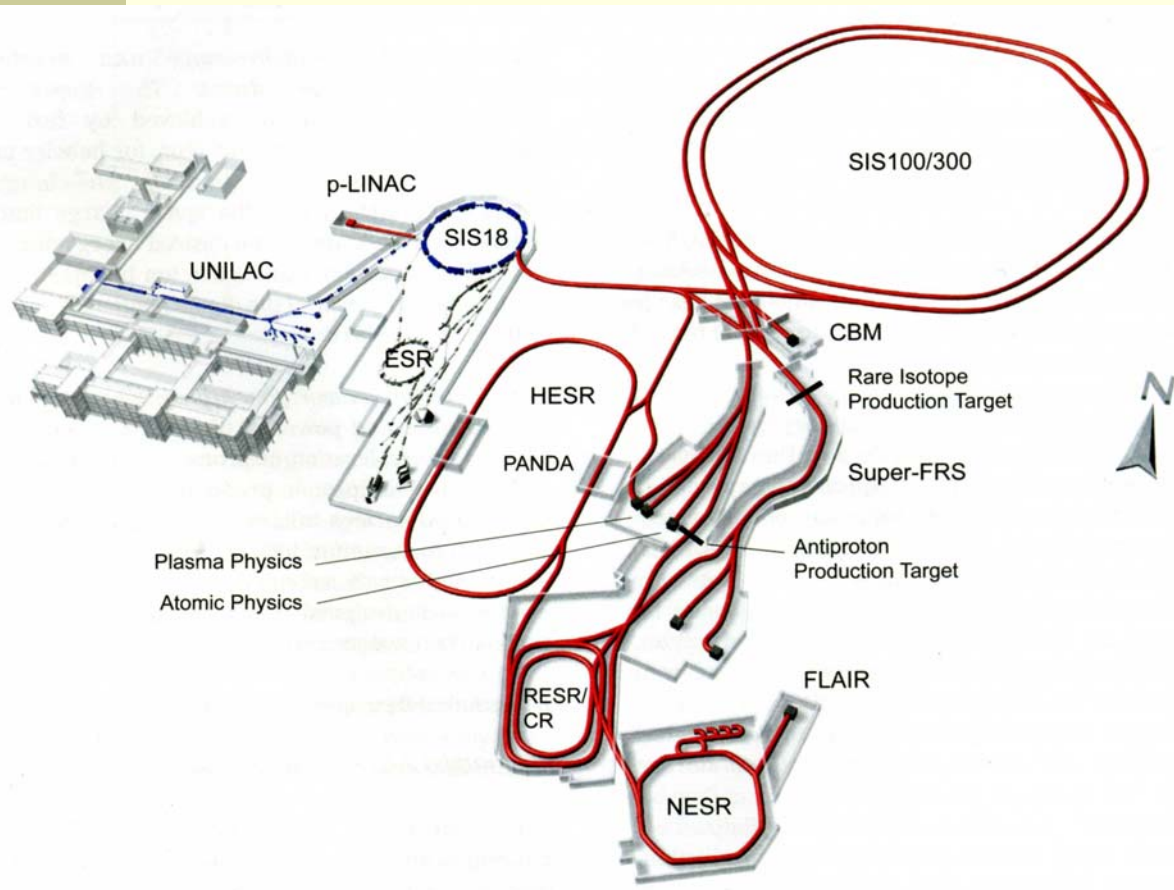
PANDA



AntiP Proton ANnihilation at DArmstadt

(Strong Interaction Studies with Antiprotons)

Facility for Antiproton and Ion Research

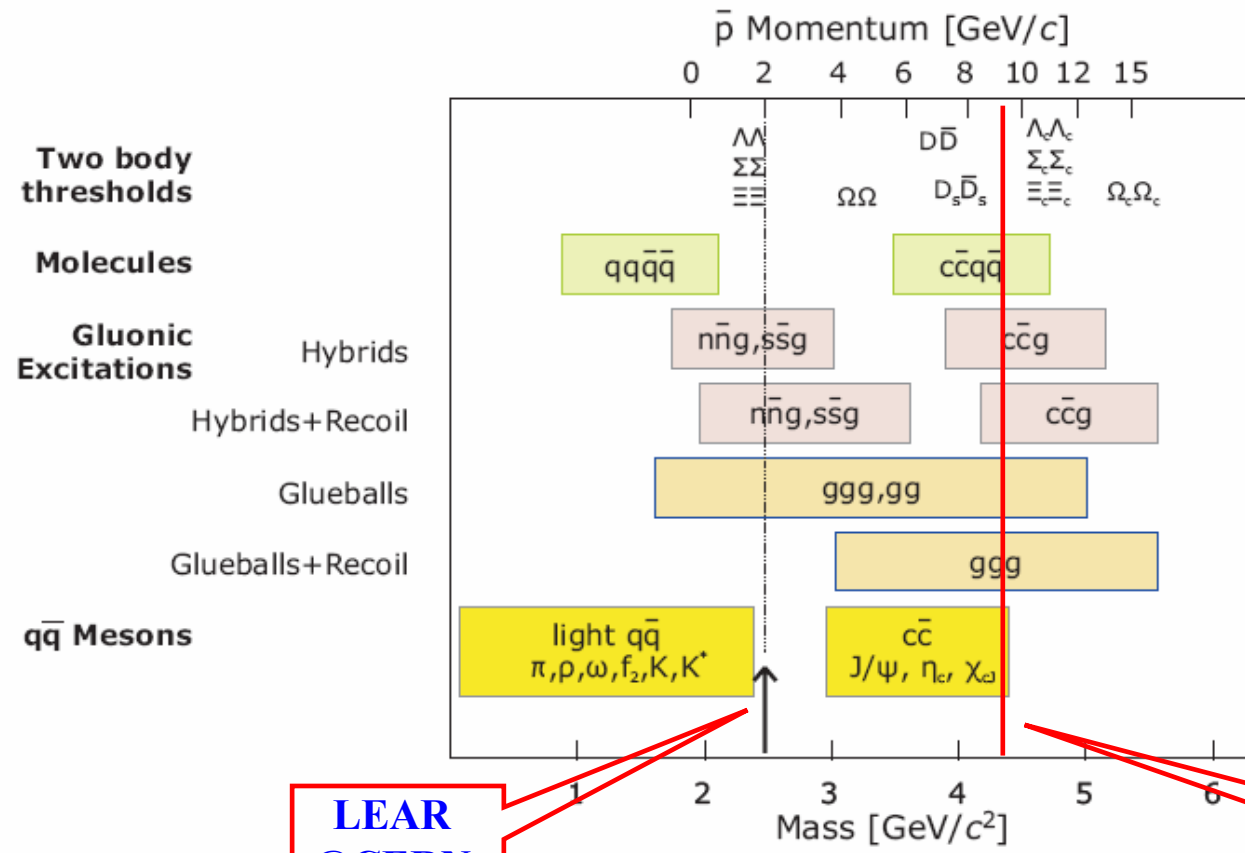


- Proton Linac
- $E_p = 29 \text{ GeV}$, $2 \cdot 10^{13}/\text{bunch}$
- p_{bar} target Ir 60mm, $\varnothing 3\text{mm}$
- P_{bar} yield $= 5 \cdot 10^{-6}$ per proton
- $E_{p\text{bar}} = 3 \text{ GeV}$, $10^8/\text{bunch}$
- $\Delta P/p \sim 0.03$
- P_{bar} collector & separator
- P_{bar} accumulation – RESR
- HESR $1.5 - 15 \text{ GeV}/c$
- High resolution mode
 - $\Delta P/P = 10^{-5}$
 - $L_{\text{max}} = 2 \cdot 10^{31} \text{ cm}^{-2} \text{ sec}^{-1}$
- High luminosity mode
 - $\Delta P/P = 10^{-4}$
 - $L_{\text{max}} = 2 \cdot 10^{32} \text{ cm}^{-2} \text{ sec}^{-1}$

Physics at PANDA



PANDA Physics Book (arXiv:0903.3905v1, March 2009)



LEAR
@CERN

E835
Fermilab

Charmonium spectroscopy

Gluonic excitations

Open Charm (**D^* mesons**)

Hyperons $pp \rightarrow Y\bar{Y}$

Hyper nuclei

$\Xi^- (dss) + p(uud) \rightarrow \Lambda \Lambda (uds)$

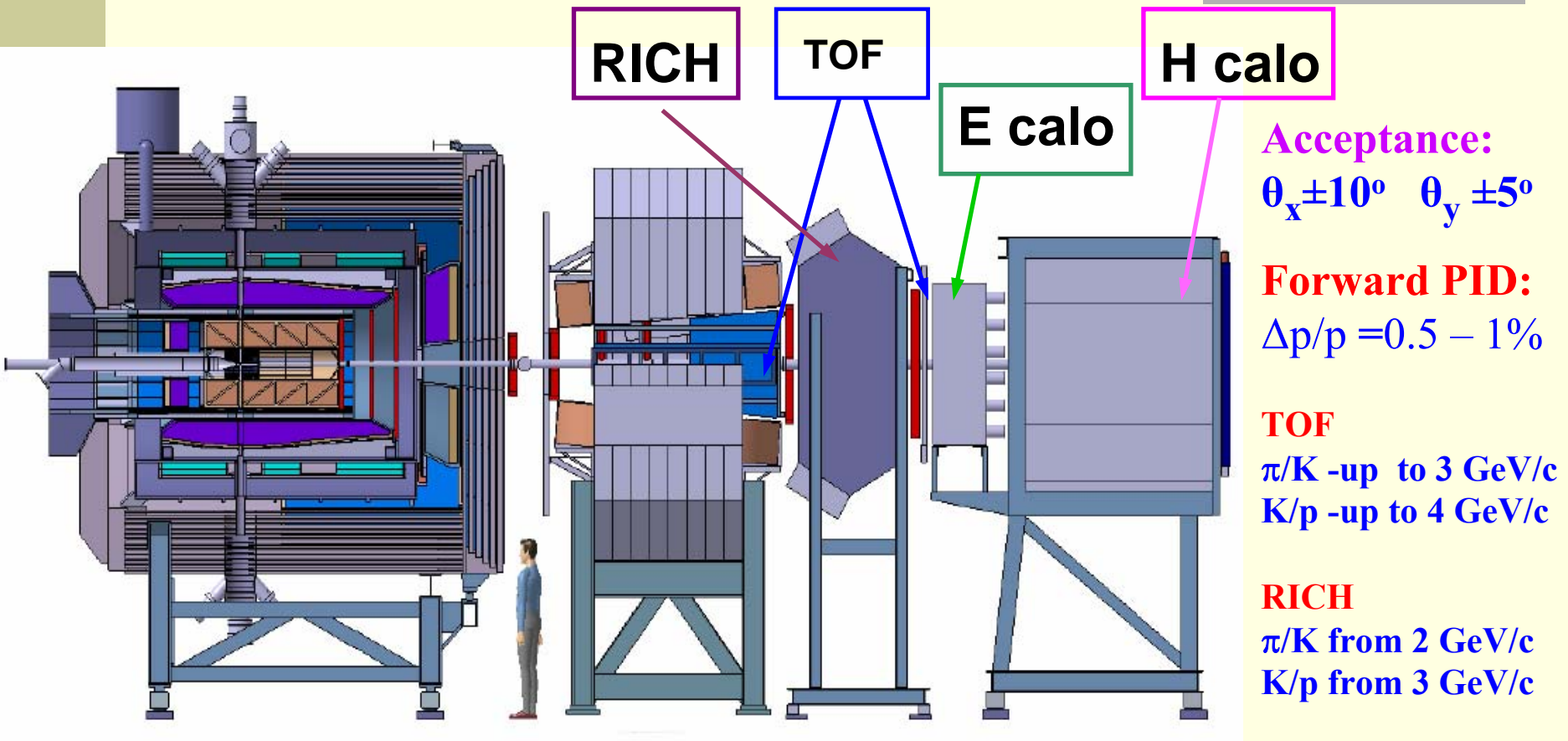
Charm in nuclei

$\bar{p} + A \rightarrow J/\psi + (A-1)$

Proton time-like FF

$\bar{p}p \rightarrow e^+e^-$

PANDA spectrometer



Geometry



TOF WALL

Plastic - BICRON 408

46 plates $140 \times 10 \times 2.5 \text{ cm}^3$

20 plates $140 \times 5 \times 2.5 \text{ cm}^3$

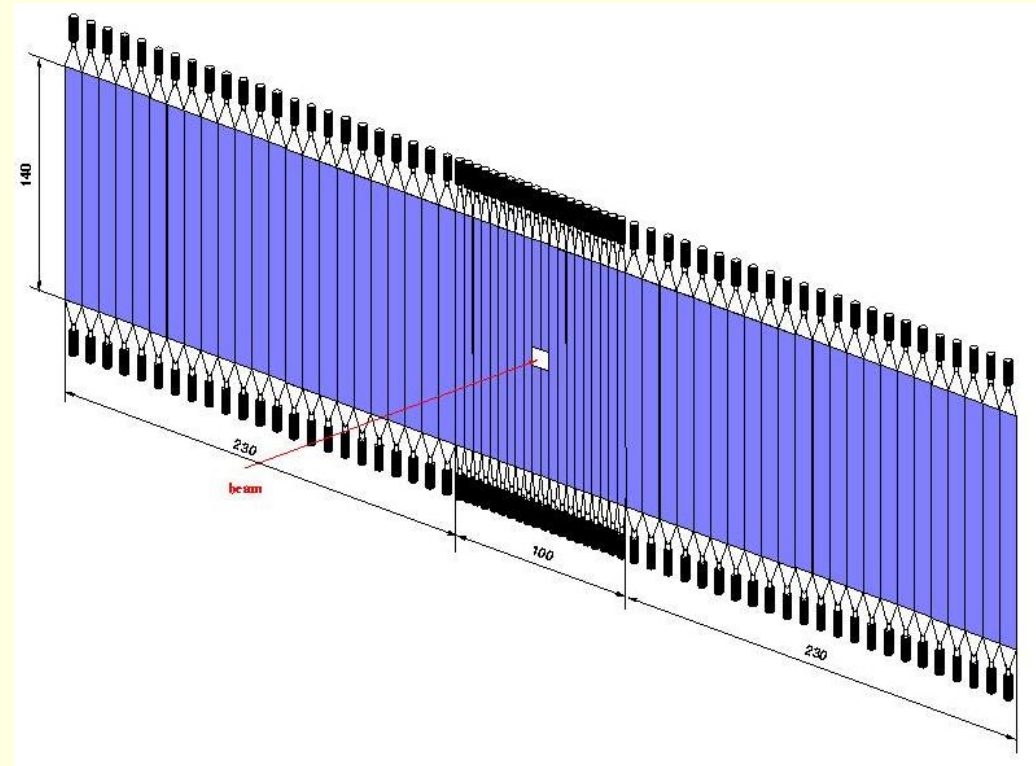
PMT:

Hamamatsu R2083, R4998

TOF Side

14 plates $100 \times 10 \times 2.5 \text{ cm}^3$

SiPM - as an option



MC: PYTHIA+Geant3 at 15 GeV/c $P_{\text{bar}}P$



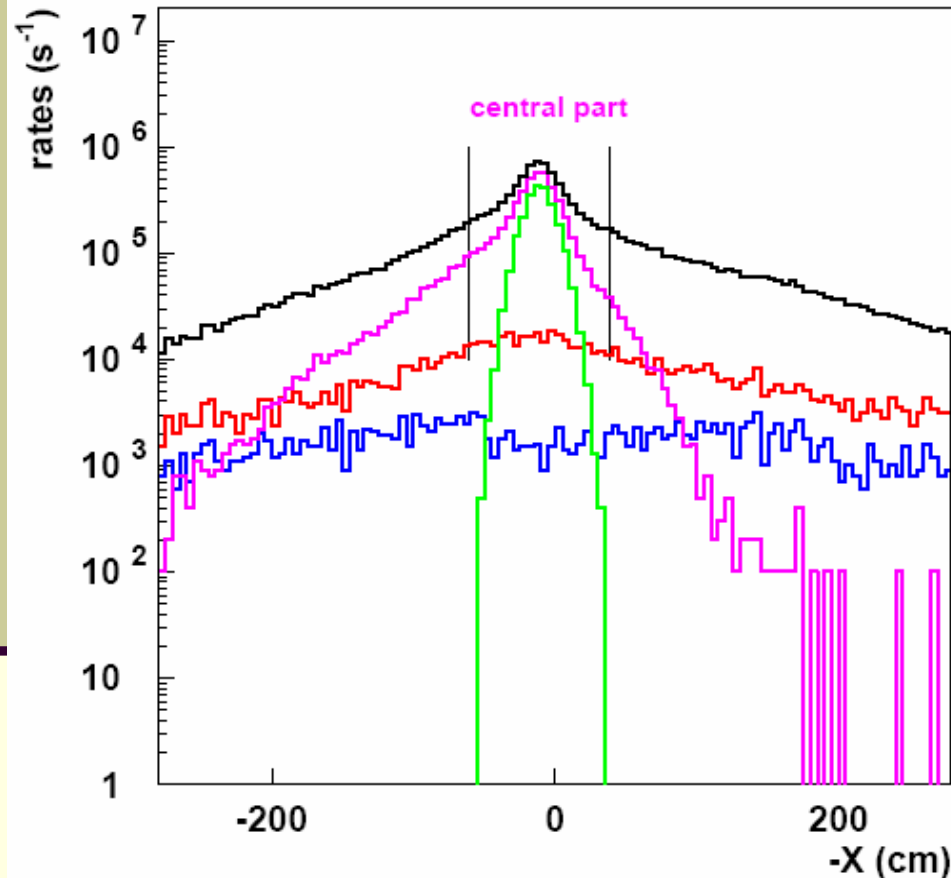
*Rates normalized on
 10^7 Interaction/s in the target*

- All charged particles
- P_{bar} elastic and inelastic
- P_{bar} elastic

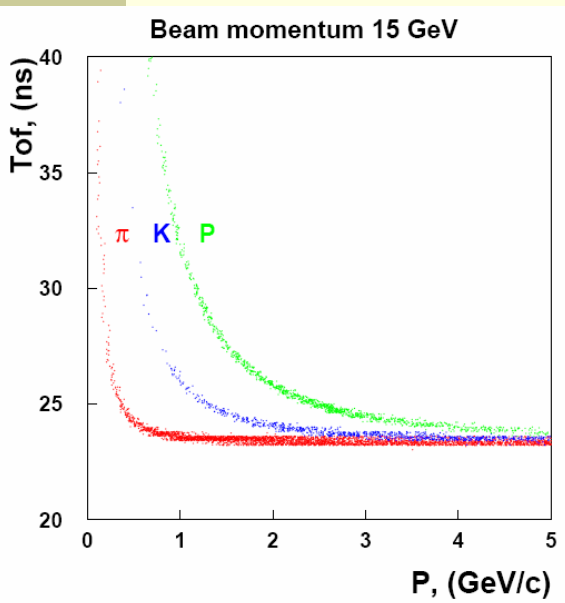
Secondary particles

- all charged from beam pipes
- e^+e^- pars from γ 's ($\pi^0 \rightarrow \gamma\gamma$)
produced on the beam pipes

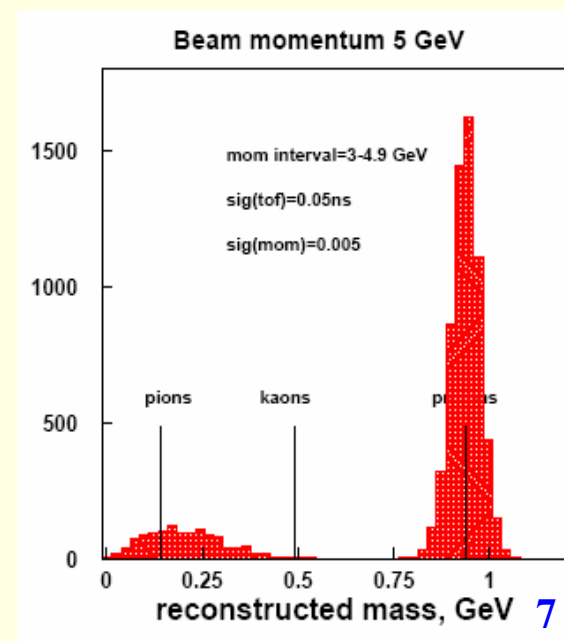
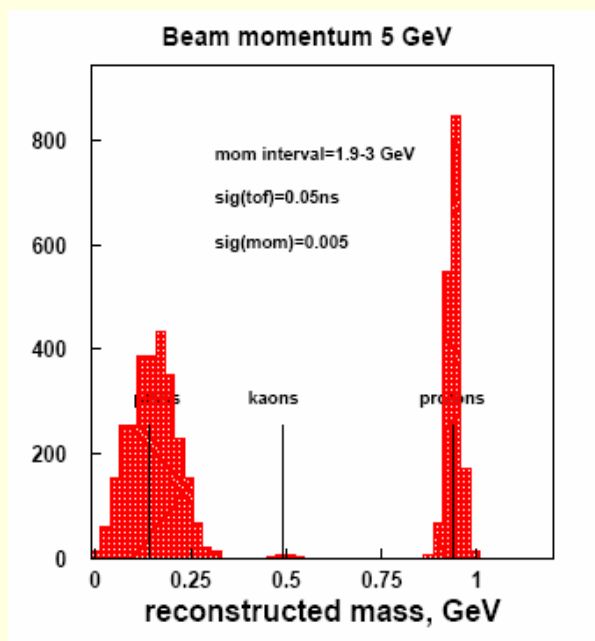
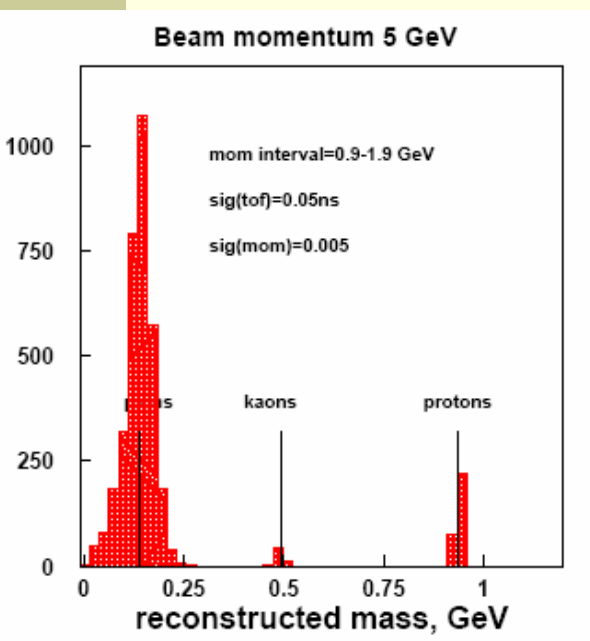
**bin = 5 cm - taken equal to
central strip width**



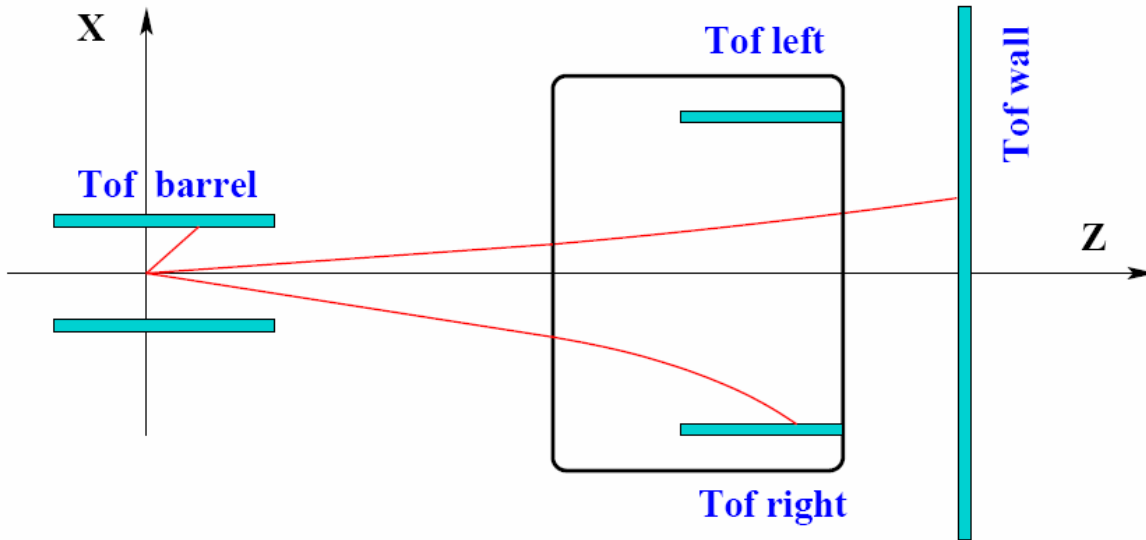
Tof wall, mass reconstruction assuming T_0



$$m_{\text{wall}} = \frac{P_{\text{wall}}}{c} \sqrt{\frac{c^2 \text{tof}_{\text{wall}}^2}{L_{\text{wall}}^2} - 1}$$



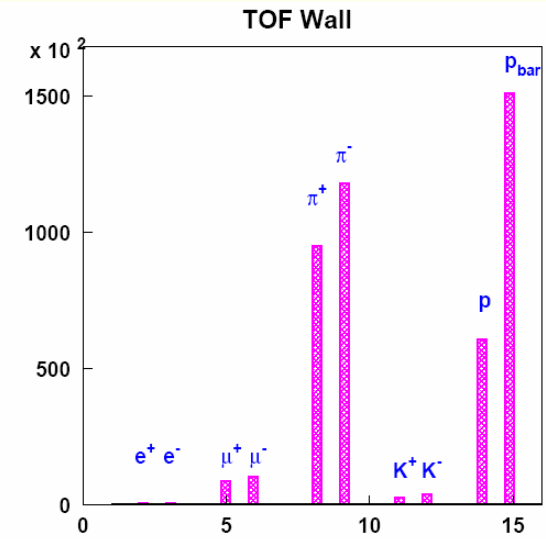
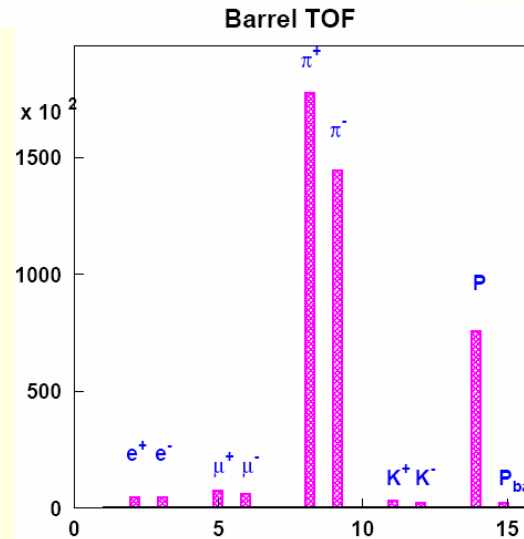
Relative TOF and PID



Coincidence:
 Tof wall - Tof barrel
 Tof wall - Tof left
 Tof wall - Tof right
 Tof wall - Tof wall

Relative Tof

$$d_{\text{tof}} = \text{Tof}_{\text{wall}} - \text{Tof}_{\text{barrel}}$$



Tof wall mass reconstruction

using particles detected by barrel TOF



From the reconstructed event we know:

- particle's charge $(C_{\text{wall}}, C_{\text{barrel}})$
- momentum $(P_{\text{wall}}, P_{\text{barrel}})$
- track length $(L_{\text{wall}}, L_{\text{barrel}})$

$\overline{d_{\text{tof}}} = d_{\text{tof}}$ with smearing ($\sigma_{\text{tof}} = 100 \text{ ps.}$)

This we used for PID

$$\text{tof}_{\text{barrel}}^{\text{calc}}(\pi) = \frac{L_{\text{barrel}}}{c} \sqrt{1 + \left(\frac{m_{\pi}}{p_{\text{barrel}}} \right)^2}$$

We assume

$$\overline{\text{Tof}}_{\text{wall}} = \overline{d_{\text{tof}}} + \text{tof}_{\text{barrel}}^{\text{calc}}(\pi)$$

$$m_{\text{wall}} = \frac{P_{\text{wall}}}{c} \sqrt{\frac{c^2 \text{tof}_{\text{wall}}^2}{L_{\text{wall}}^2} - 1}$$

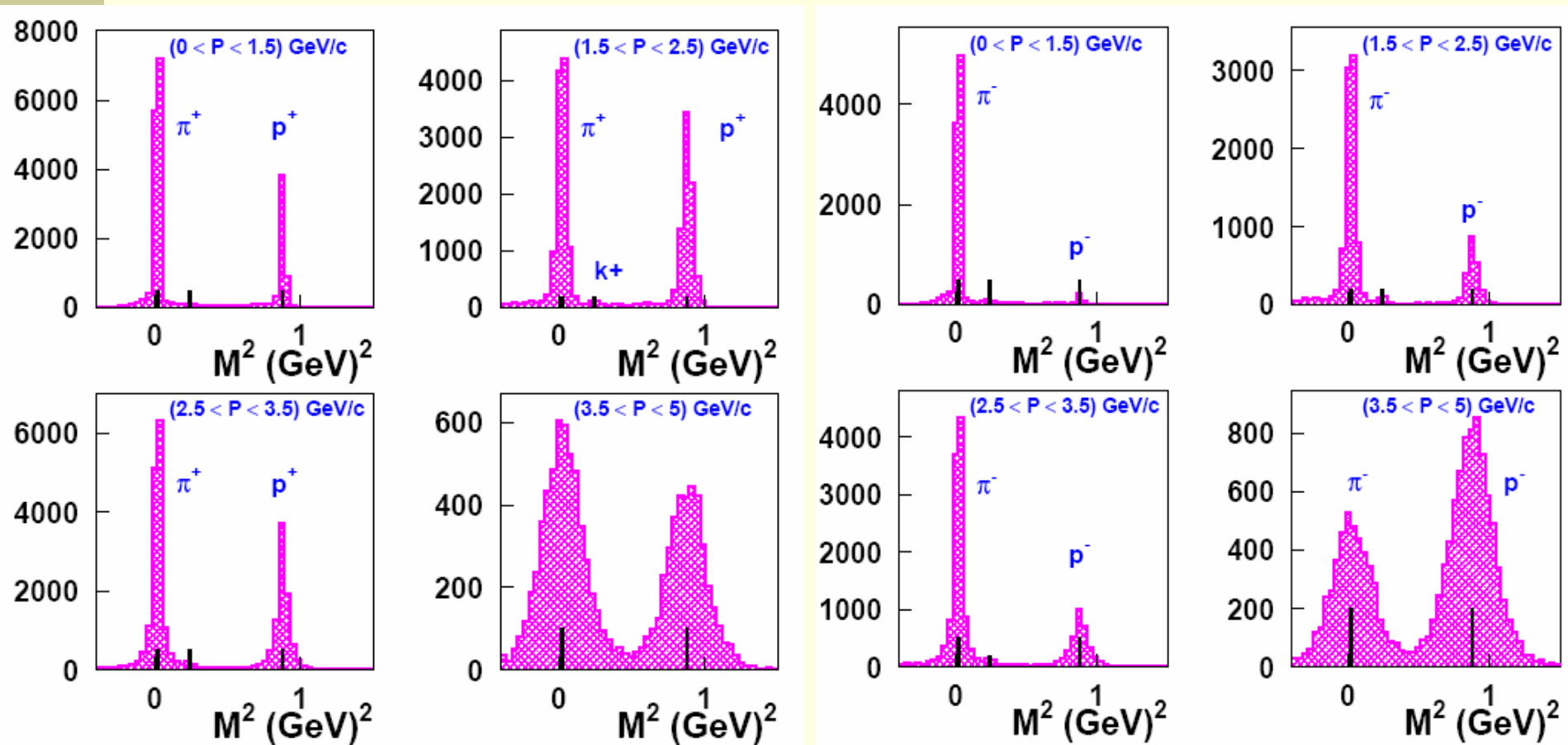
Tof wall particle's mass reconstruction

in case of π^- accepted by barrel TOF

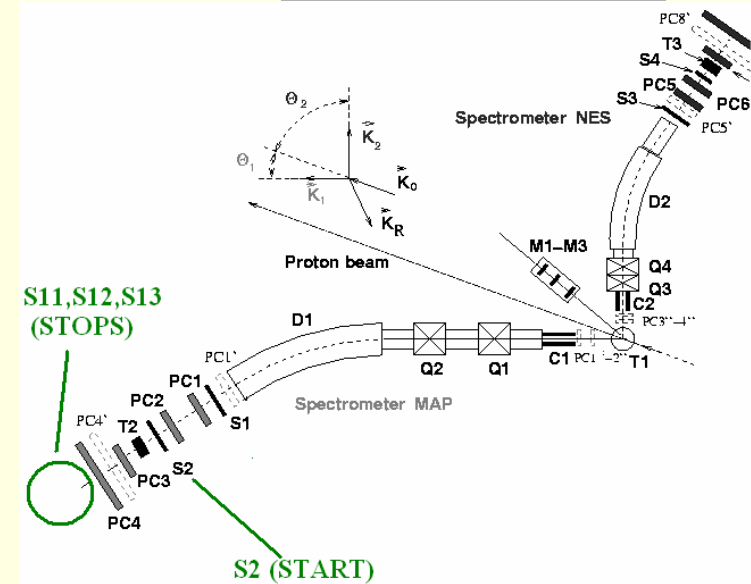
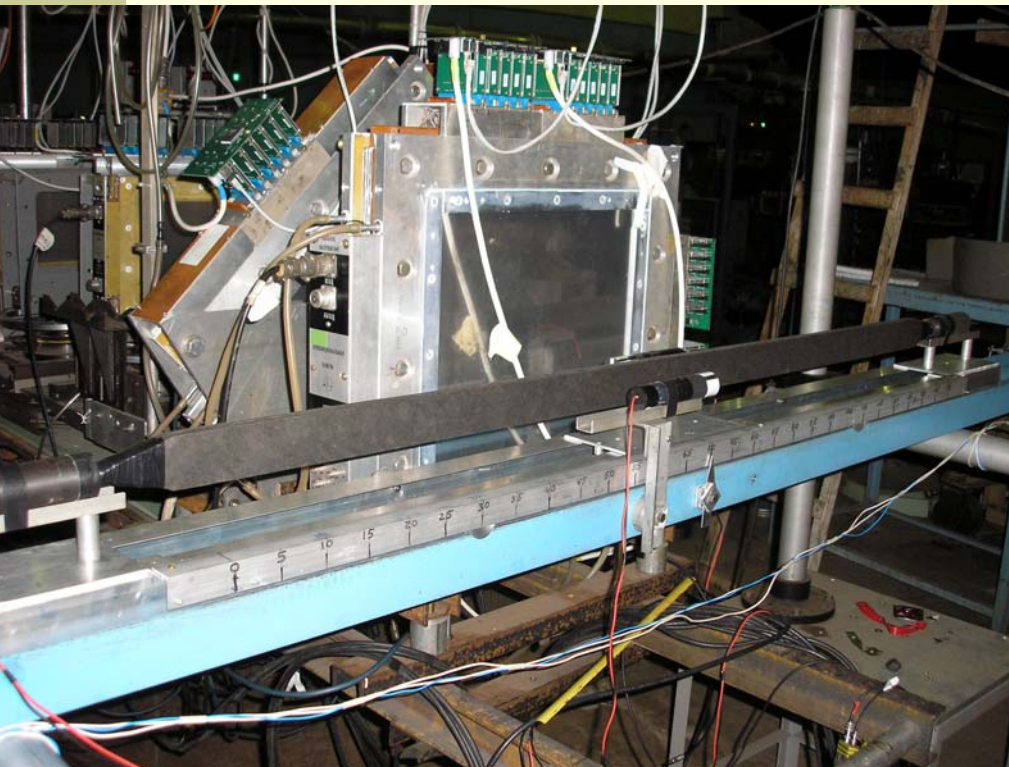


positive

negative



TOF prototype test @ 1 GeV proton beam



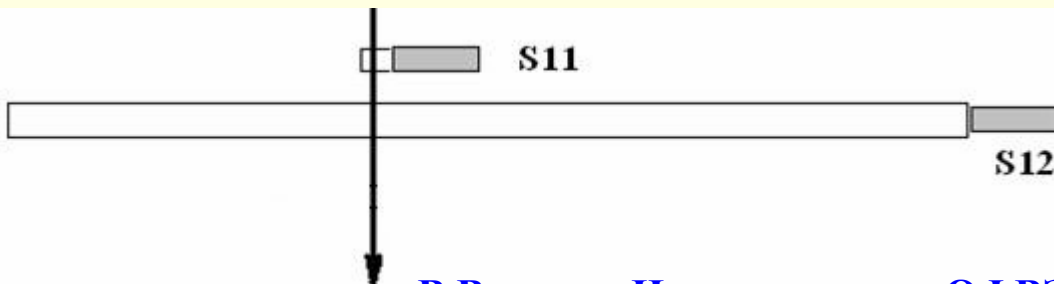
730MeV protons

Prototype: $140 \times 5 \times 1.5 \text{ cm}^3$

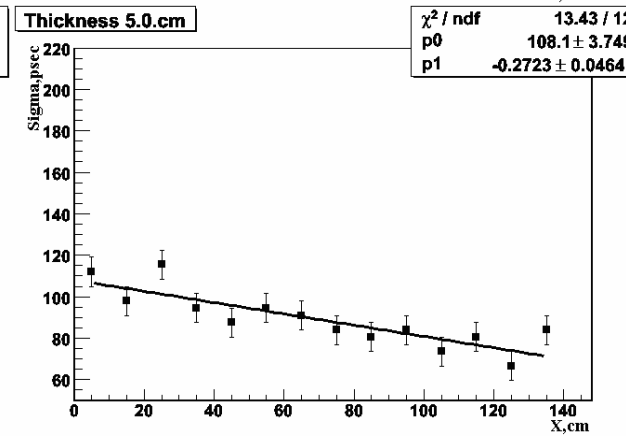
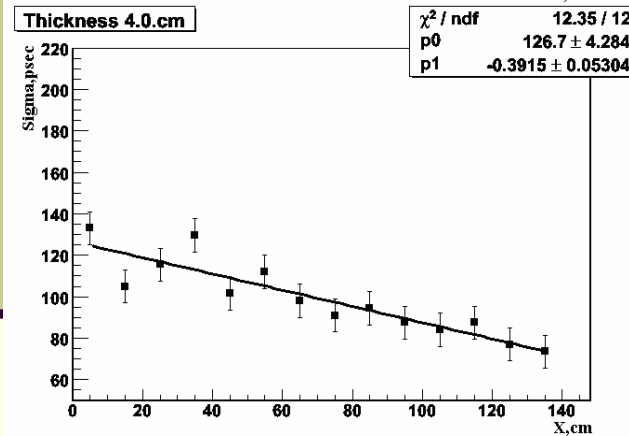
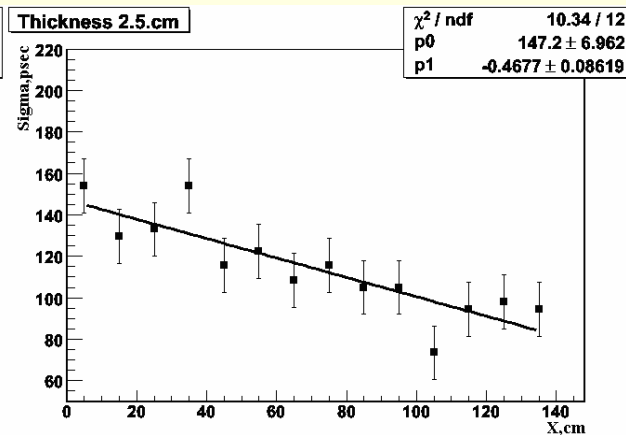
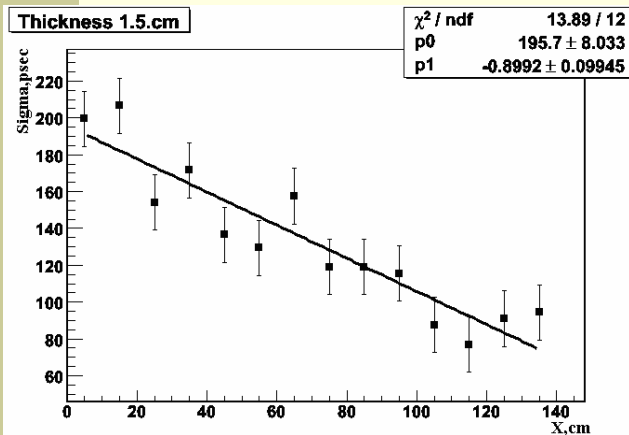
Small counters S11(12) $2 \times 2 \times 2 \text{ cm}^3$

Plastic: Bicron 408

PMT's: Hamamatsu R4998



$\sigma_{\text{tof}} (S_{11} + S_{12})$ vs coordinate (cm)



Пластик и ФЭУ –
подарены Дж. Ритманом
FZ, Juelich
VME crate – ЛНИ
TDC, QDC... -
DESY, Giessen, Frascati

Есть резервы для
улучшения
разрешения!

Публикации / ПЛАНЫ - 2010



- Physics Performance Report [arXiv:0903.3905v1](https://arxiv.org/abs/0903.3905v1)
 - Magnets Technical Design Report
 - Результаты работы доложены на 4-х митингах коллаборации ПАНДА
 - По результатам обработки тестового эксперимента готовится к публикации препринт ПИЯФ
-
- Конструирование корпусов ФЭУ, поддерживающей системы с учетом интегрирования ВПД в детектор ПАНДА;
 - изготовить и испытать на пучке протонов новый прототип с толщиной пластика 2.5 см;
 - продолжить Монте Карло моделирование
 - идентификации частиц с помощью ВПД с использованием пакета программ PANDAROOT.
 - процессов рождения и распада гиперонных пар, включая тяжелые гипероны. Исследовать возможность измерения поперечной поляризации гиперонов. Исследовать другие реакции на анти-протонном пучке
 - ($p\bar{p} \rightarrow e^-e^+$, форм-фактор протона во времени-подобной области)
 - подготовить TDR (technical Design Report) по ВПД.