Recent developments in Erlangen

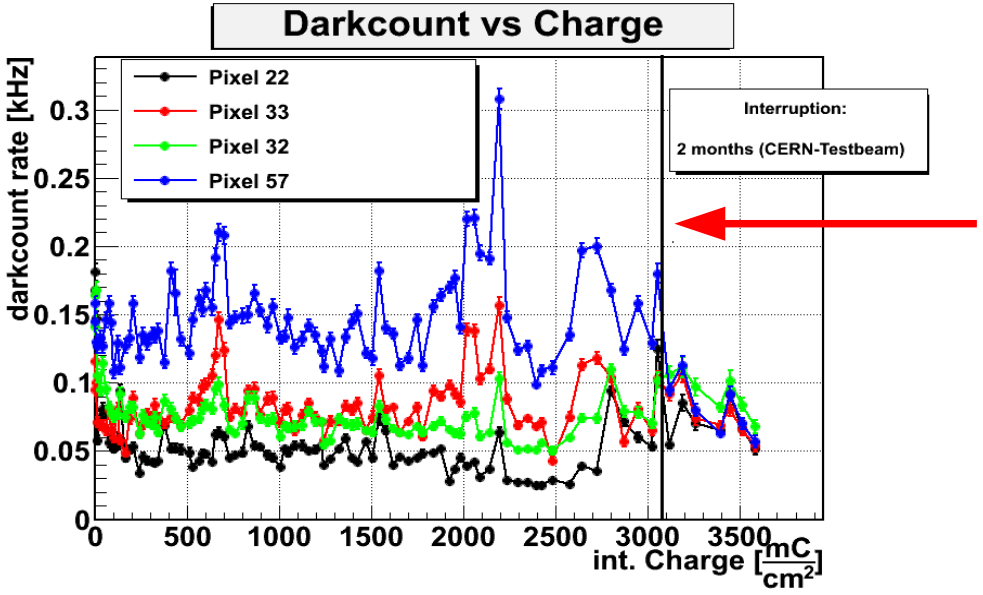
Alexander Britting, Wolfgang Eyrich, Albert Lehmann, Fred Uhlig

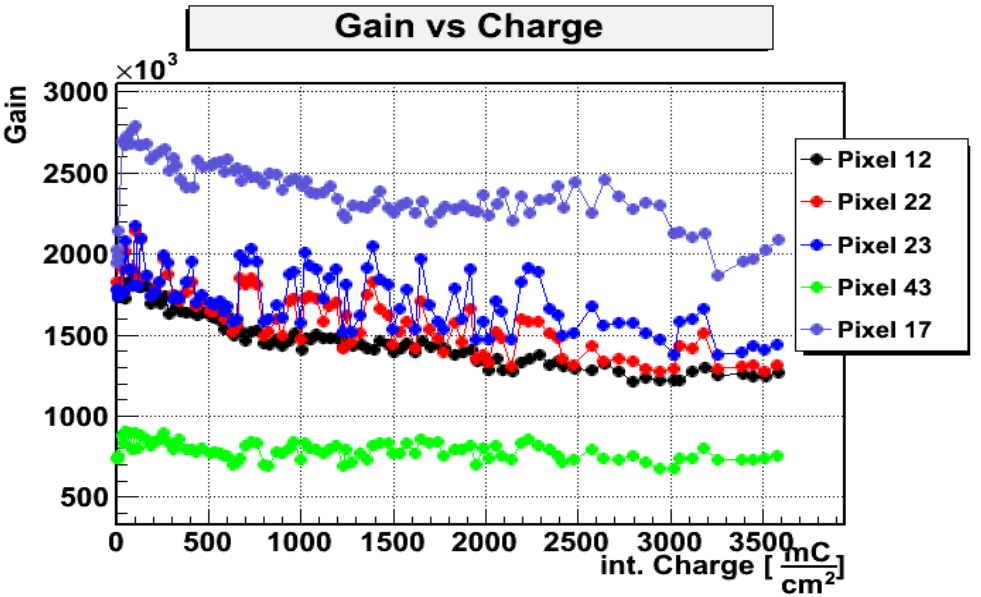
supported by BMBF and GSI

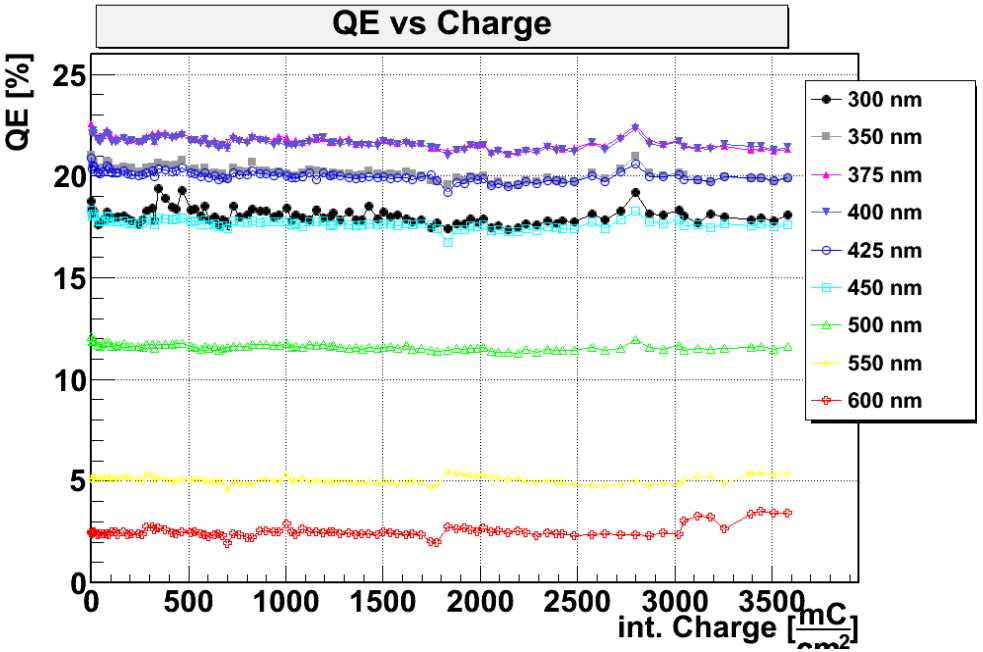
Overview

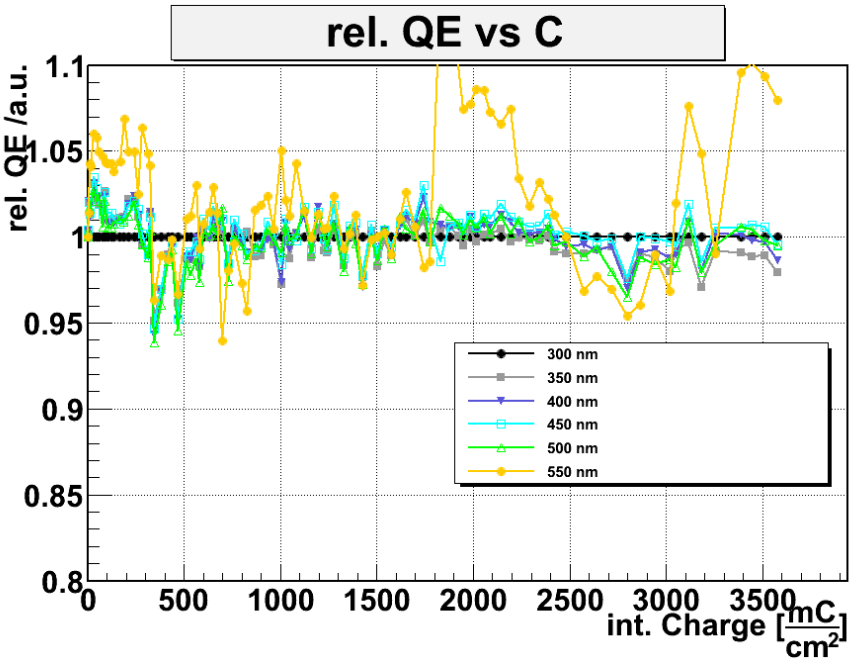
- Results of the latest lifetime measurements for XP85112:
  - QE surface scans
  - Gain measurements
  - QE measurements
- MCP-TOF for PID at testbeams facilities for PANDA DIRCs
  - Time walk correction
  - Time resolution and PID performance
  - Bottlenecks of current TRB2 DAQ and possible improvements
- Summary and outlook

Aging of XP85112

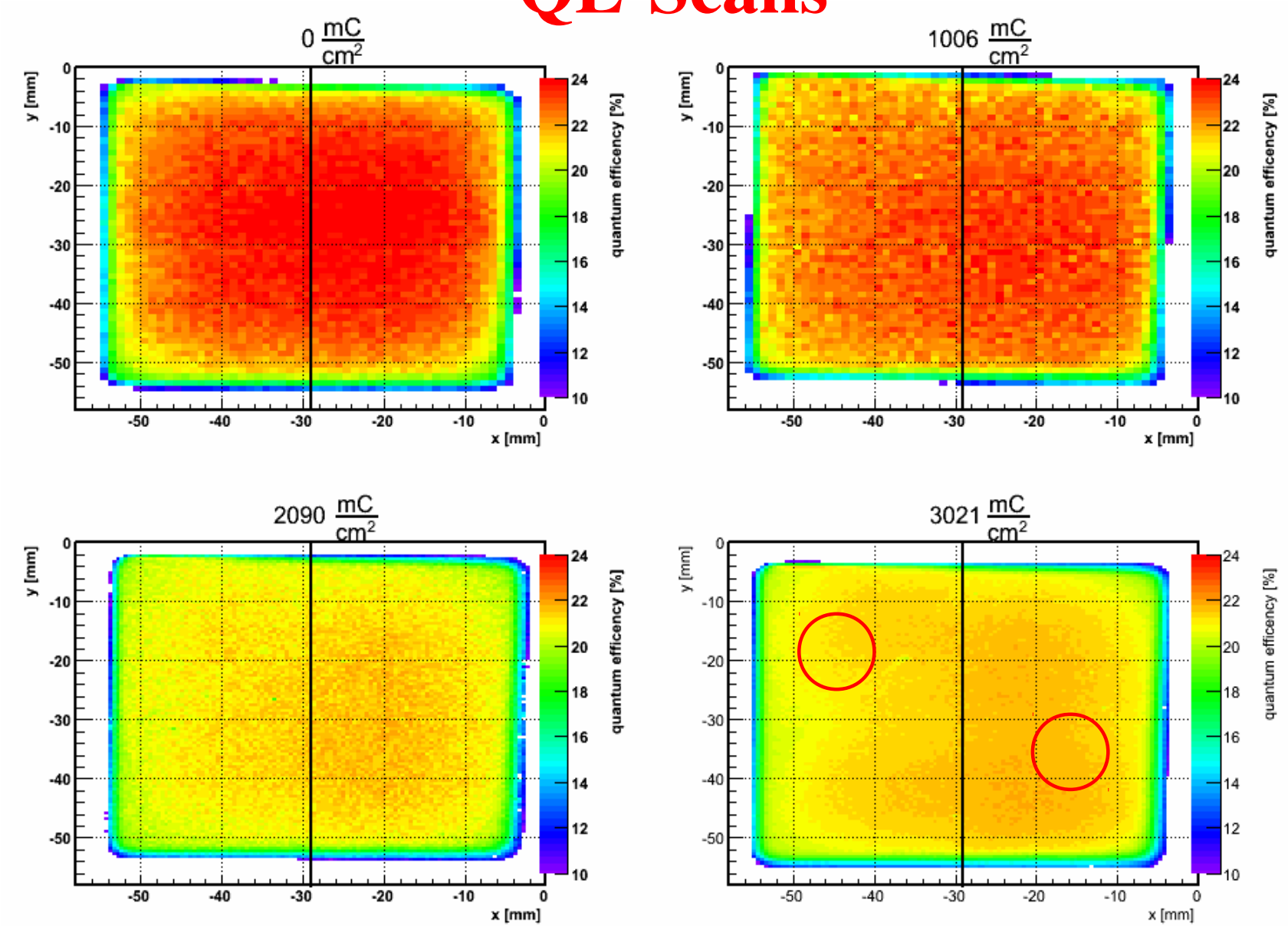






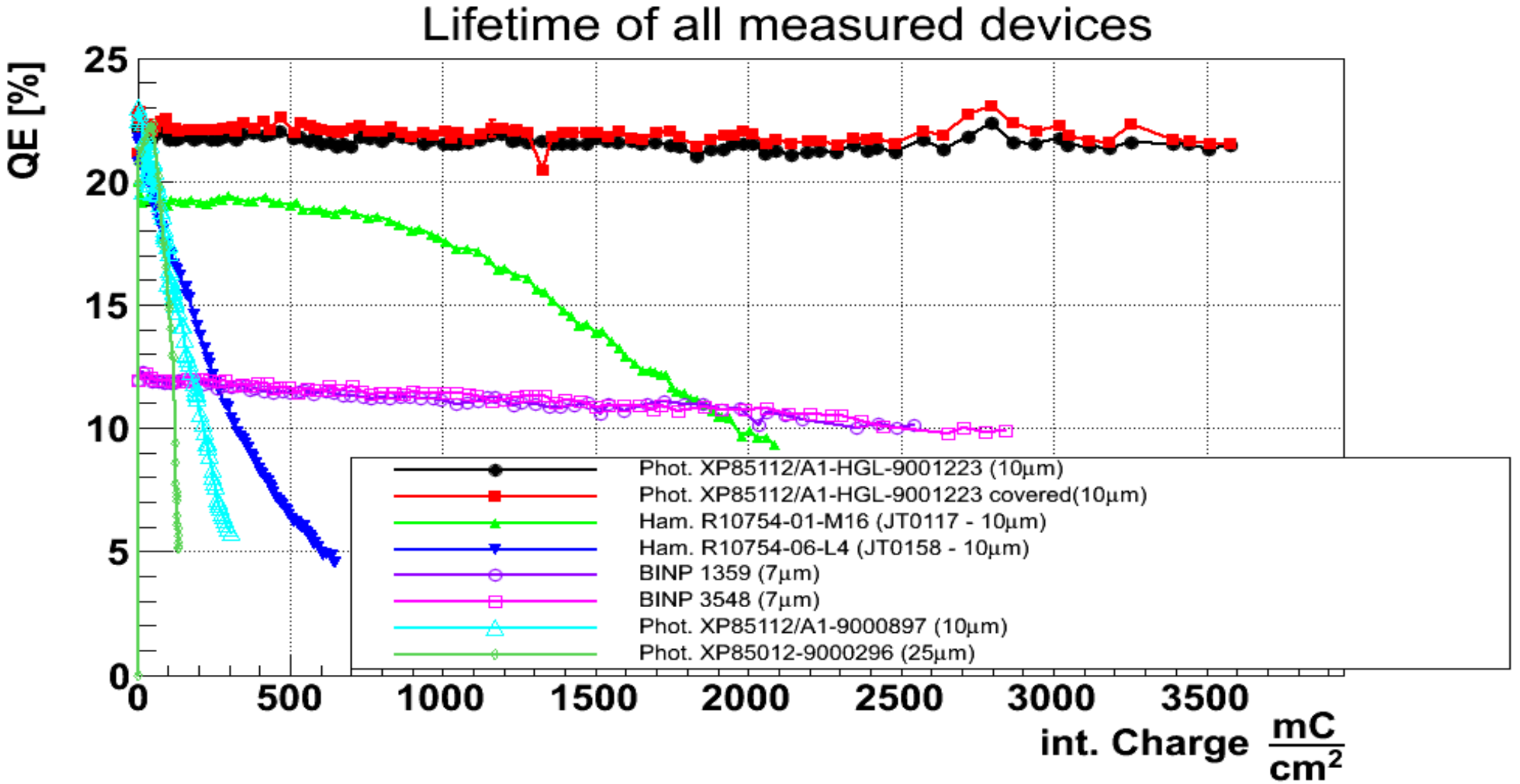


QE-Scans



- First hints for aging in illuminated area

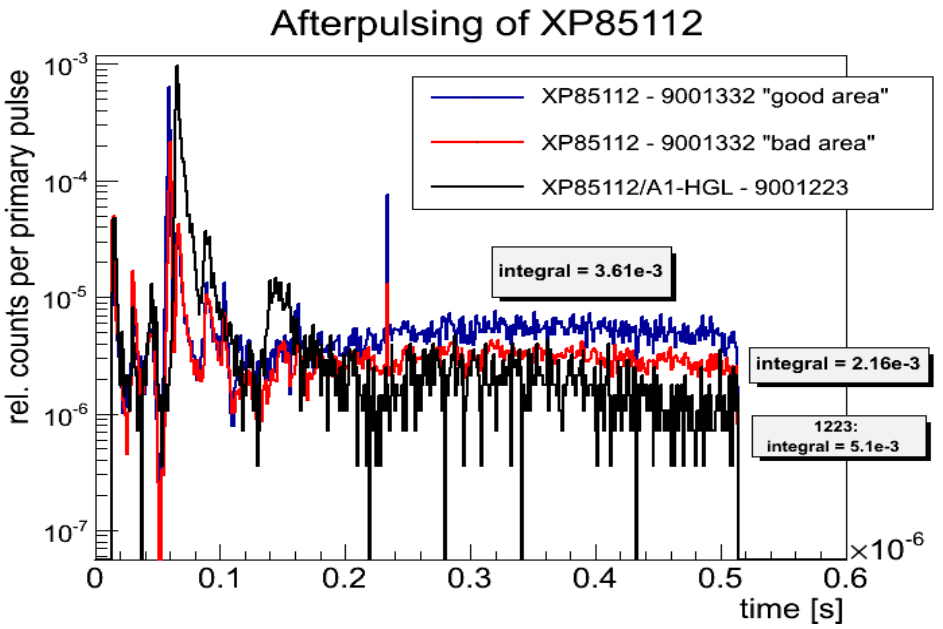
Comparison with older measurements

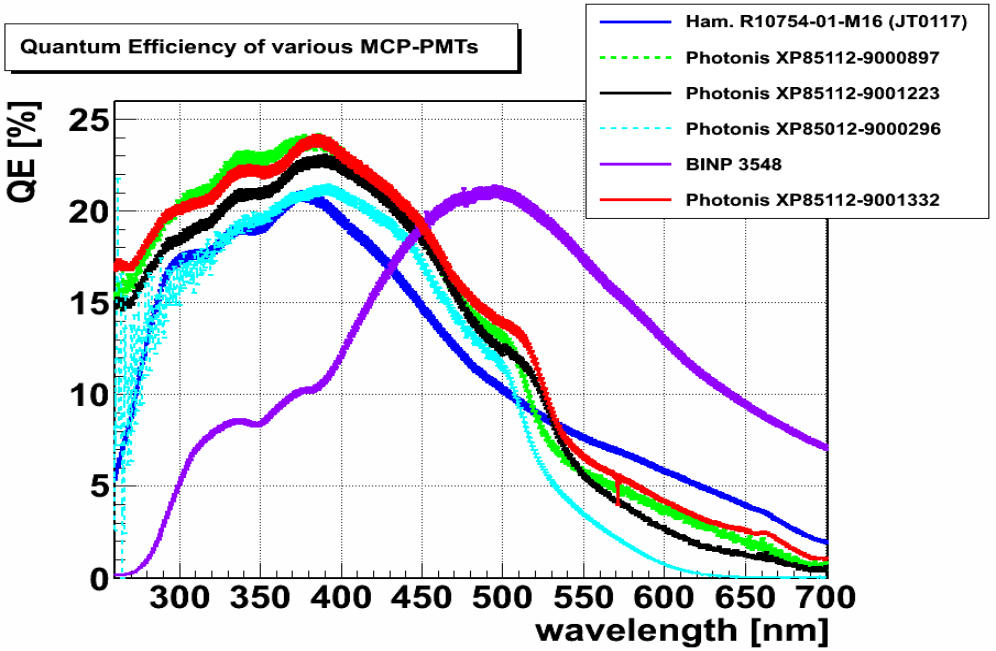


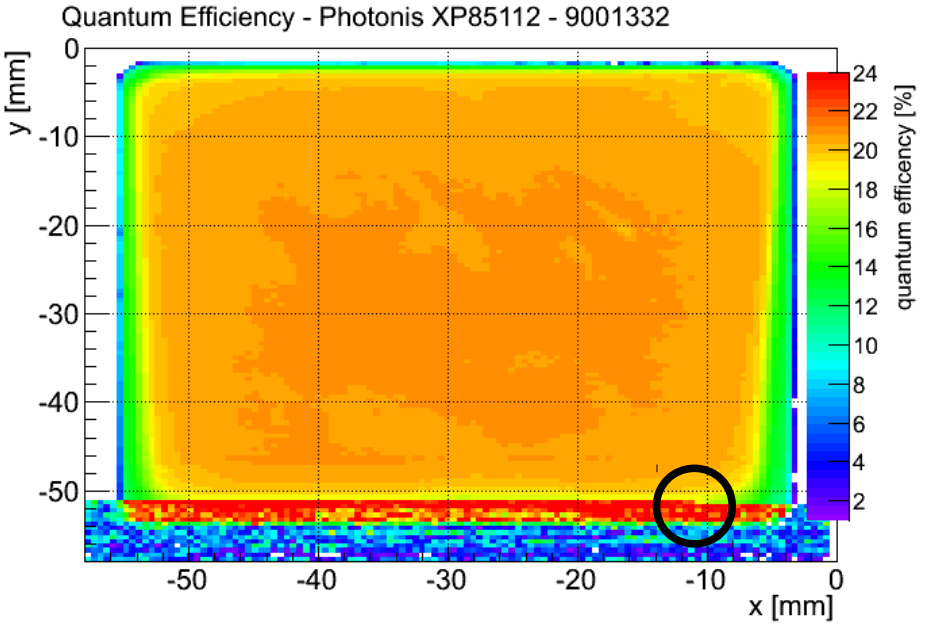
- Up to now (= 7 PANDA-years!), still almost no degradation for XP85112-9001223 → Lifetime has to be checked with another device (starts soon)
- Performance of BINPs is still good: QE: 12.3% → 9.7%

Behaviour of XP85112 - 9001332

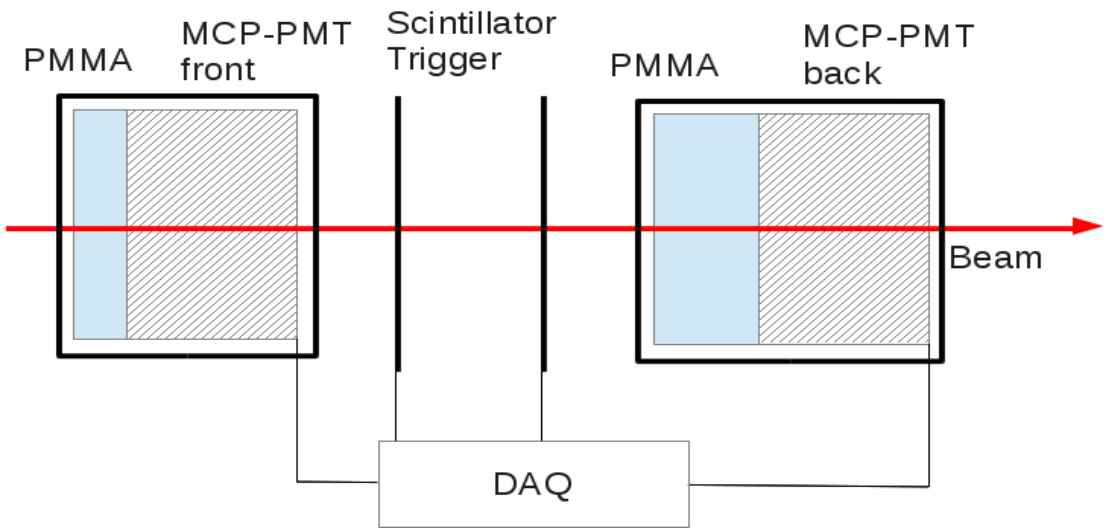
- QE rather homogenous and comparable to other devices
- Device reaches instable diode mode, if area is hitted → no return within several hours → power cycle
- Dead area not visible in photo counting mode
- Afterpulsing lower in both areas than 1223





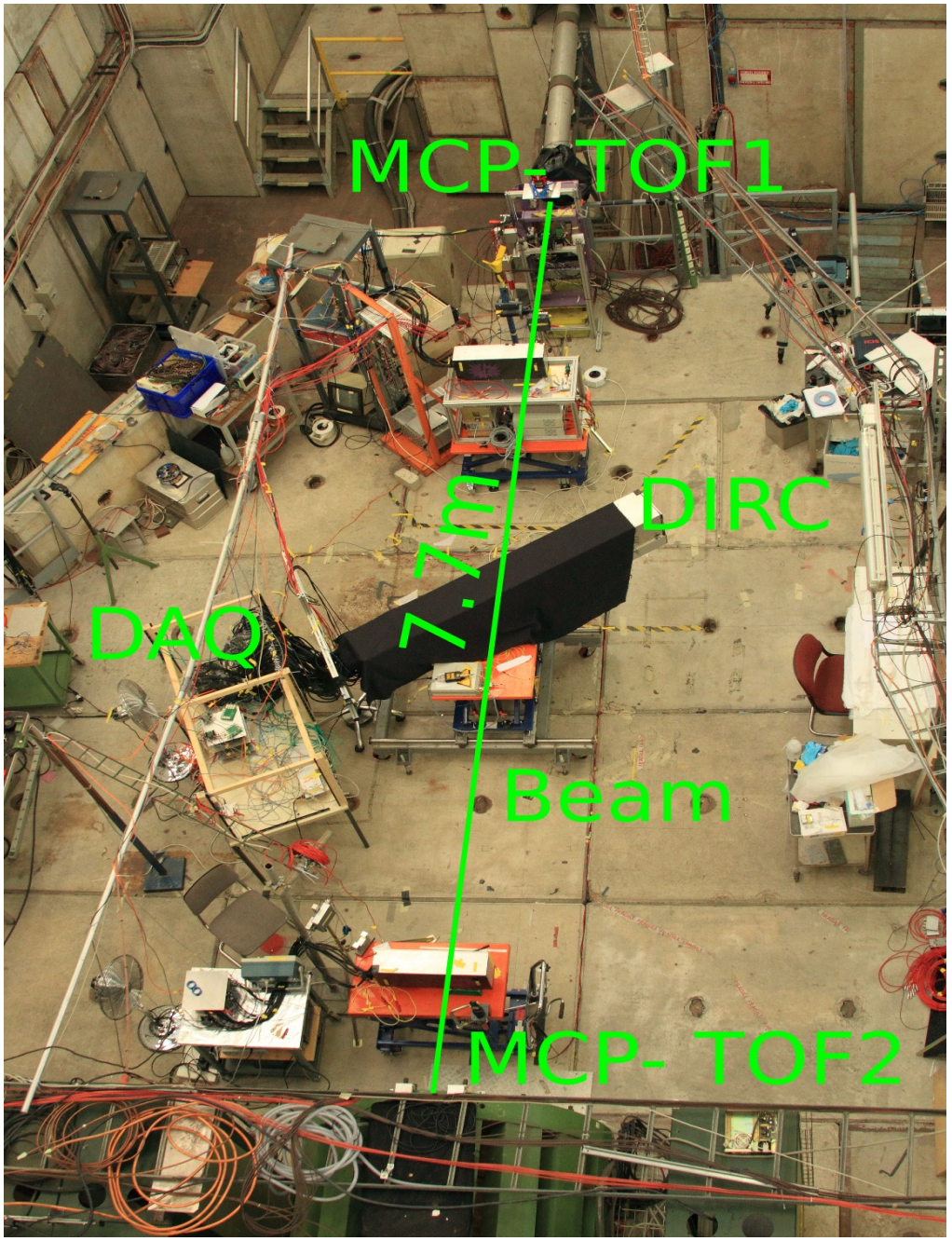


MCP-TOF Setup

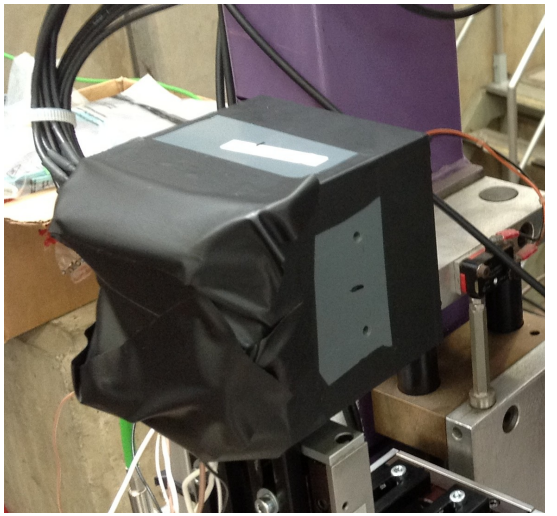


- 2 MCPs (Phot. XP85012-1D) with PMMA-Radiator (1cm TOF1, 2cm TOF2) coupled with BC-630
- Beam penetrates MCPs directly
- 16 channels (2x2 shortened) and MCP-Out for each sensor

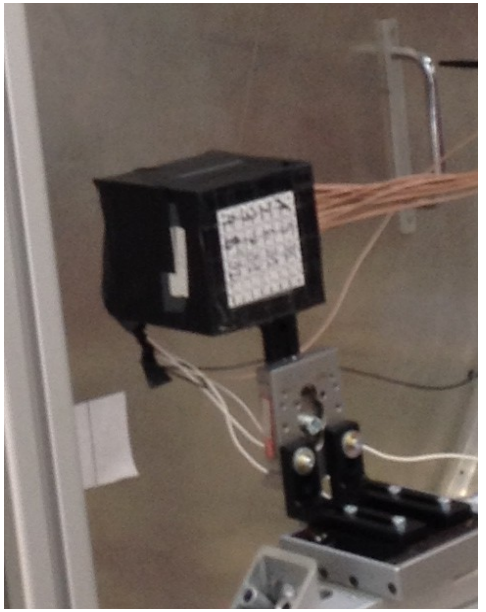
MCP-TOF at CERN



TOF1

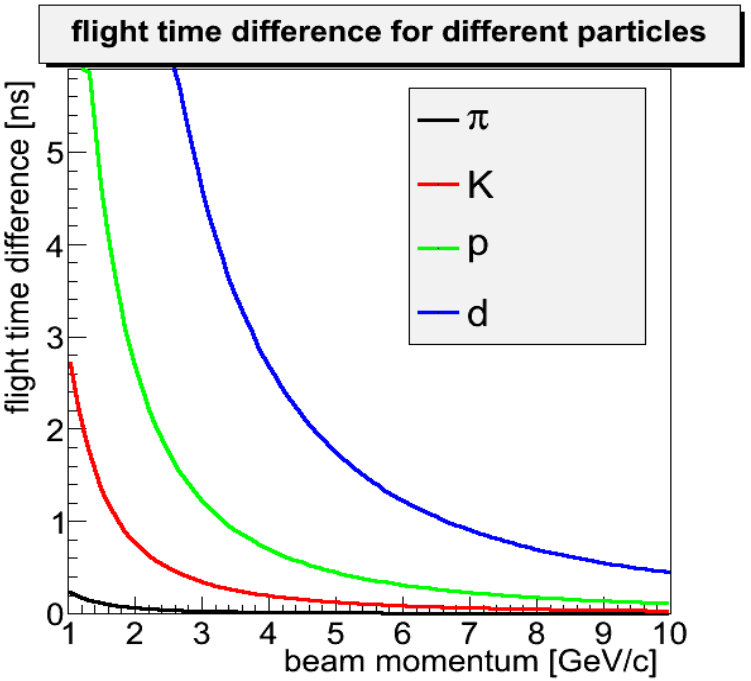


TOF2



MCP-TOF requirements for DIRC testbeams

- 47 ps for π/K separation up to 4GeV/c (7.7m path length, 3 σ)
- Spatial resolution for tracking
- Time walk correction necessary!
- Problems:
  - Kaon flux at T9 is very low! (π/K ~ 1000:1 for 2GeV/c)
  - High amount of electrons, even for hadronic head
  - Same TRB board needed so suppress clock jitter → long cables for TOF2 (~12m)



Time walk correction

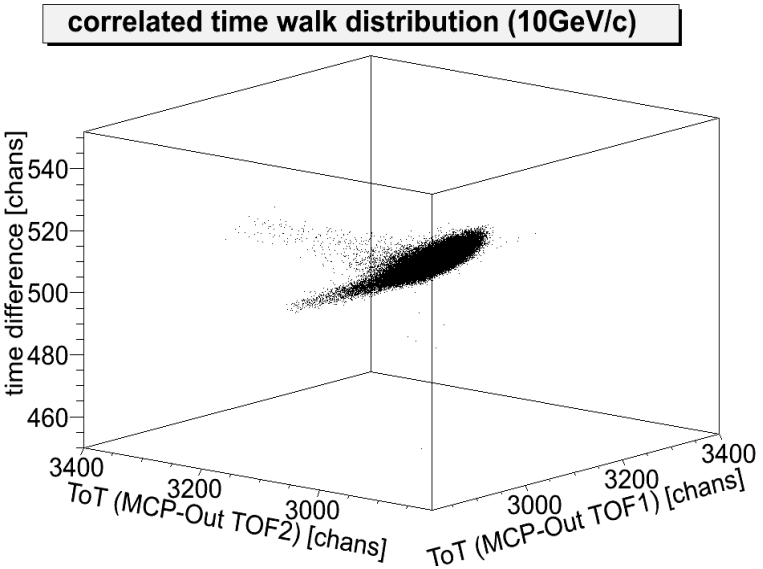
- Problem: Lack of well defined reference time

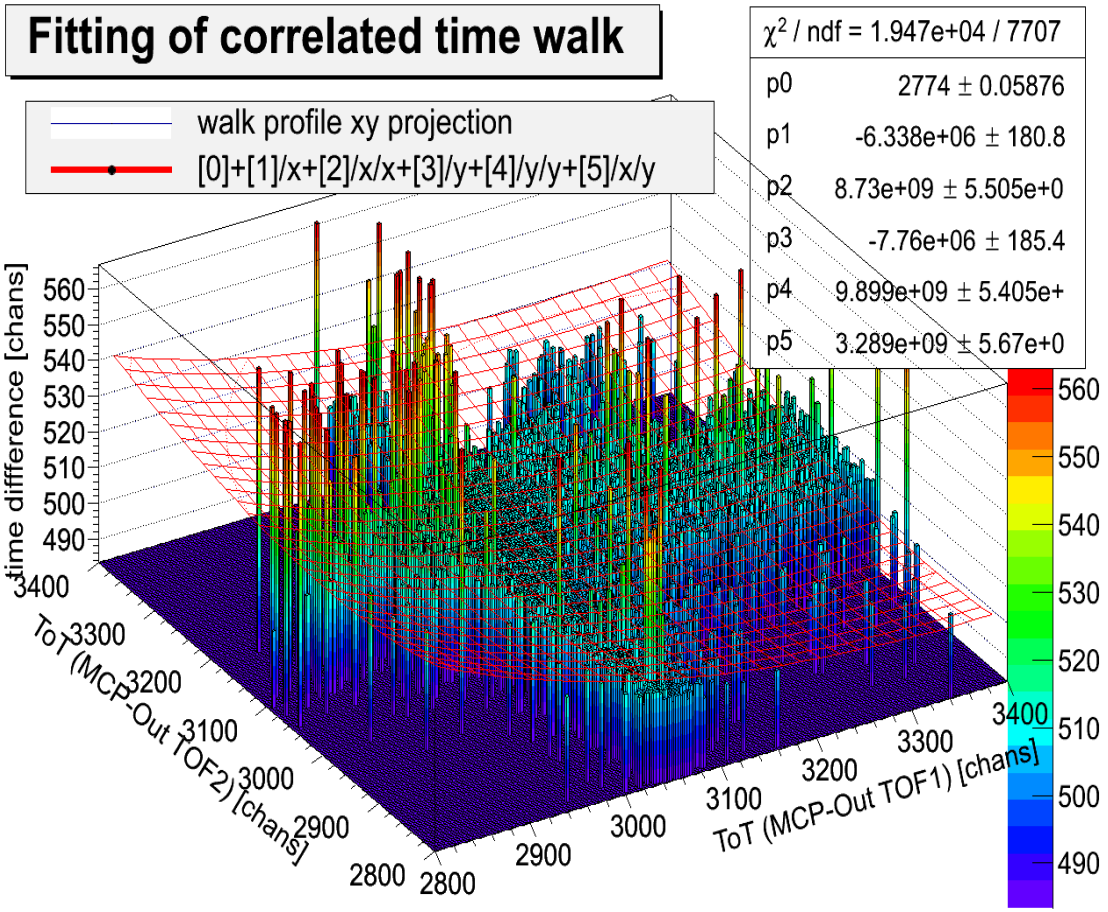
  → Time walk only possible for time difference of 2 channels (e.g. MCP-Outs)

- Solution: Correct $\Delta t = f(T_1, T_2)$ by fitting the mean values of Δt

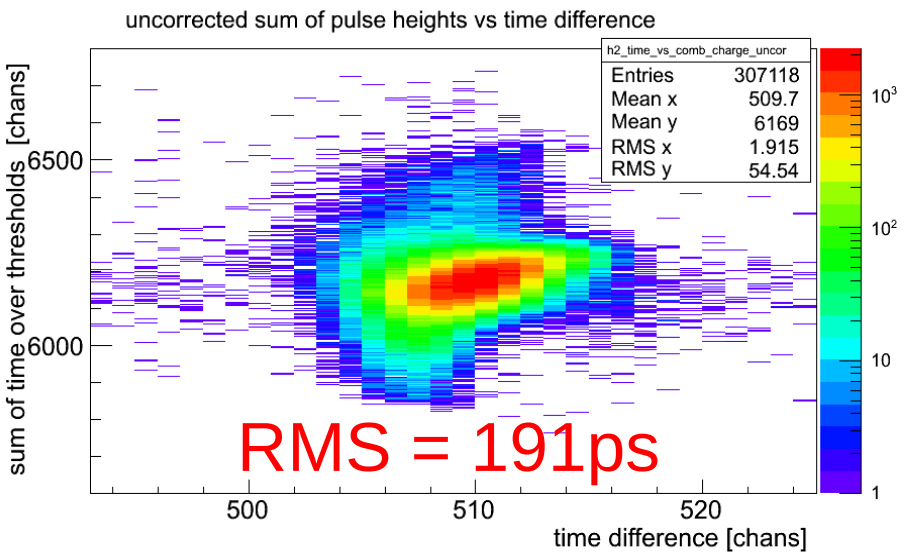
- Fitting function:

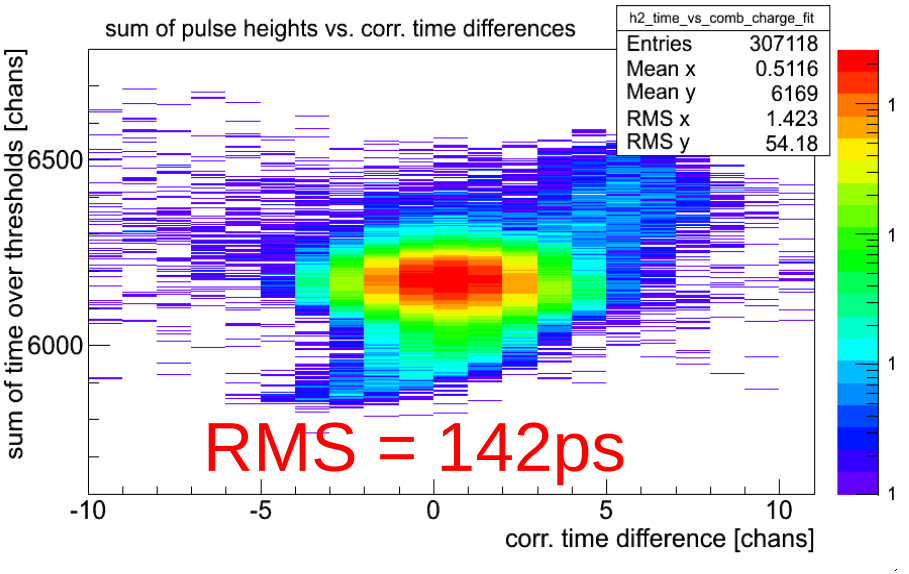
$$\Delta t = a + \frac{b}{T_1} + \frac{c}{T_1^2} + \frac{d}{T_2} + \frac{e}{T_2^2} + \frac{f}{T_1 \cdot T_2}$$



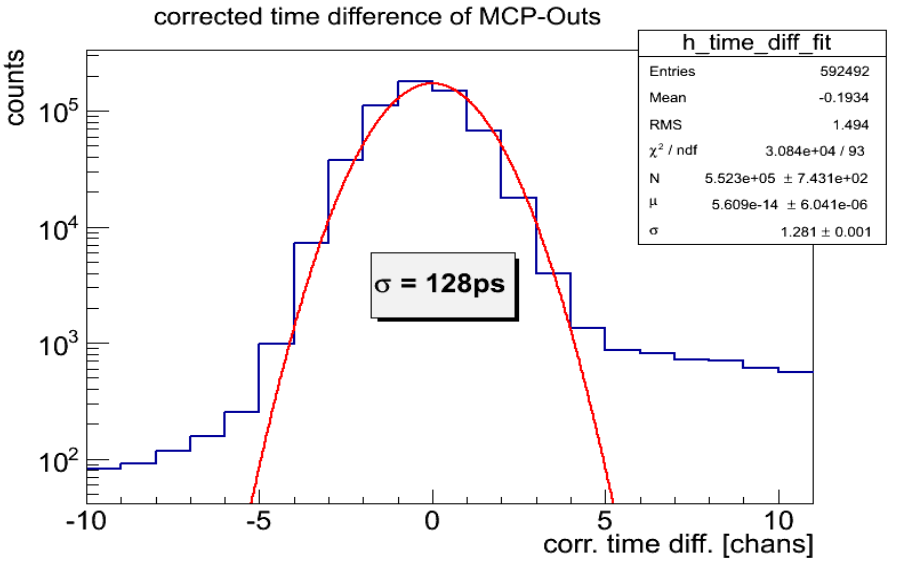


Time walk correction (2)



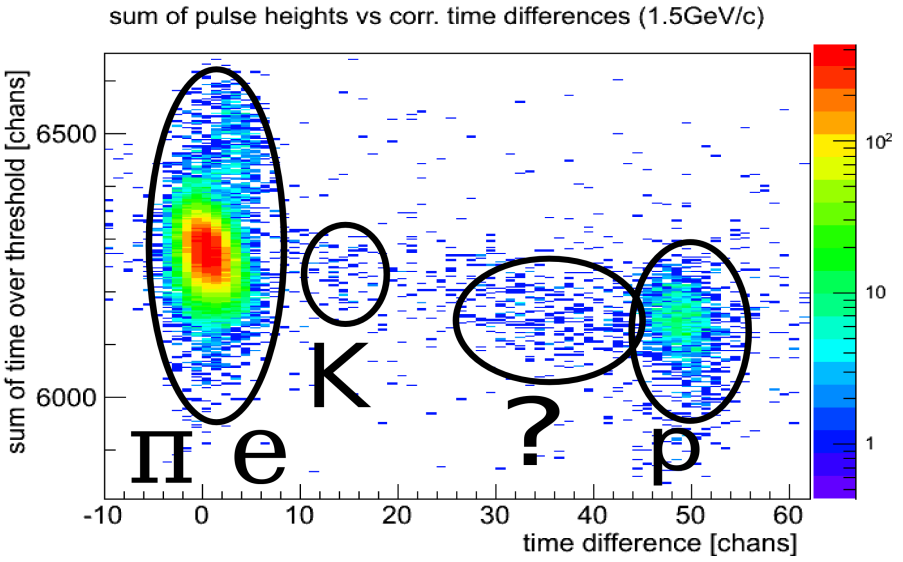


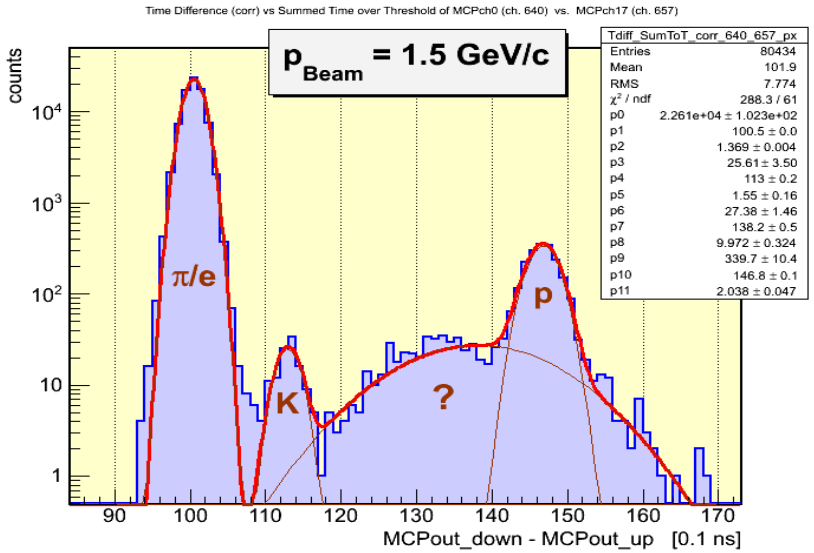
- Sum of pulse heights can be used to visualize goodness of fit
- Problem: Different particles, especially p, deteriorates fit → determine fitting parameters with 10GeV/c
- Time walk correction need to detect Kaons!

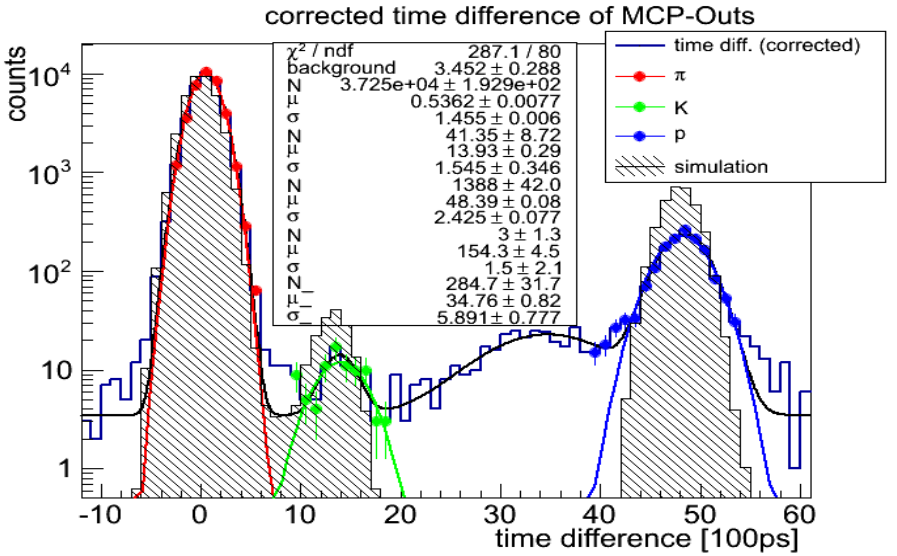


PID performance

- Light particles (π,μ,e) cannot be separated, even at lowest momenta (1.5GeV/c)
- Origin of cluster below p is unknown
- Simulation is in good agree-ment with data including:
  - Decay of Kaons
  - Momentum smearing
  - Beam divergence

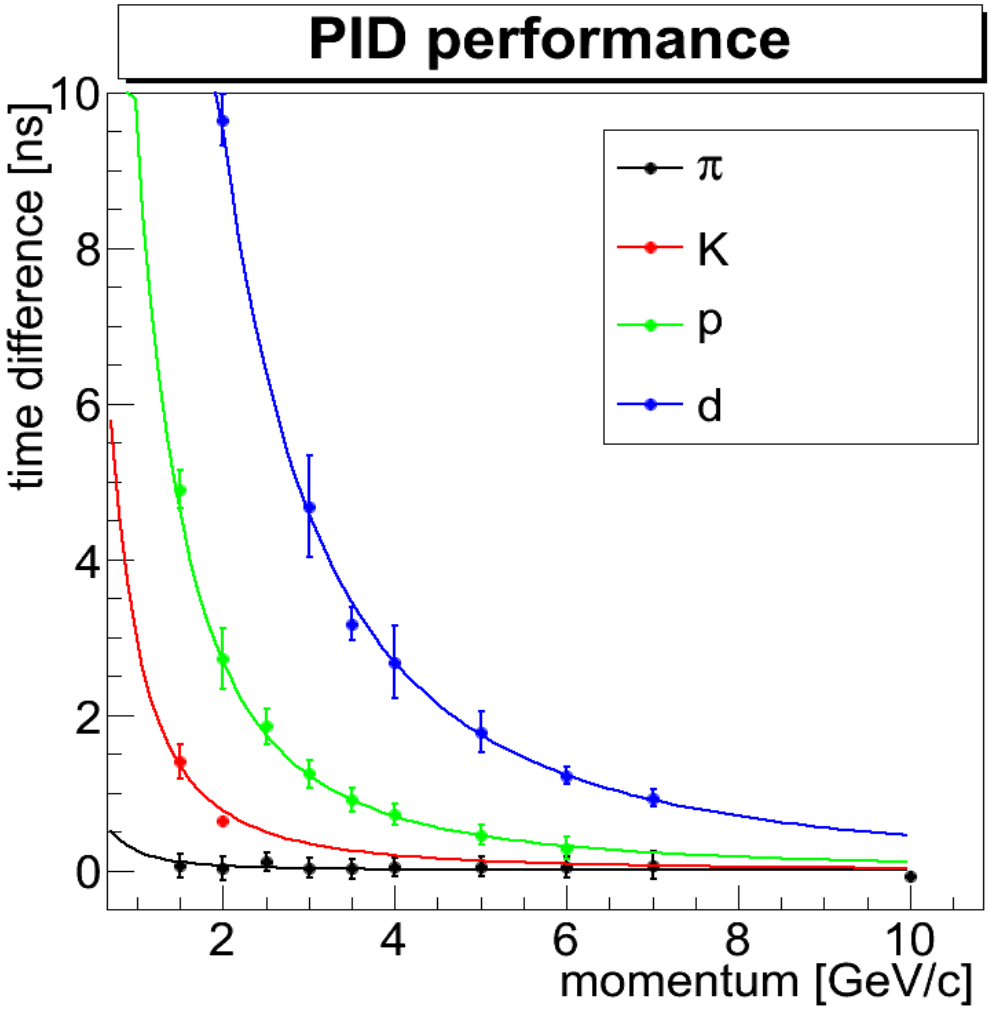






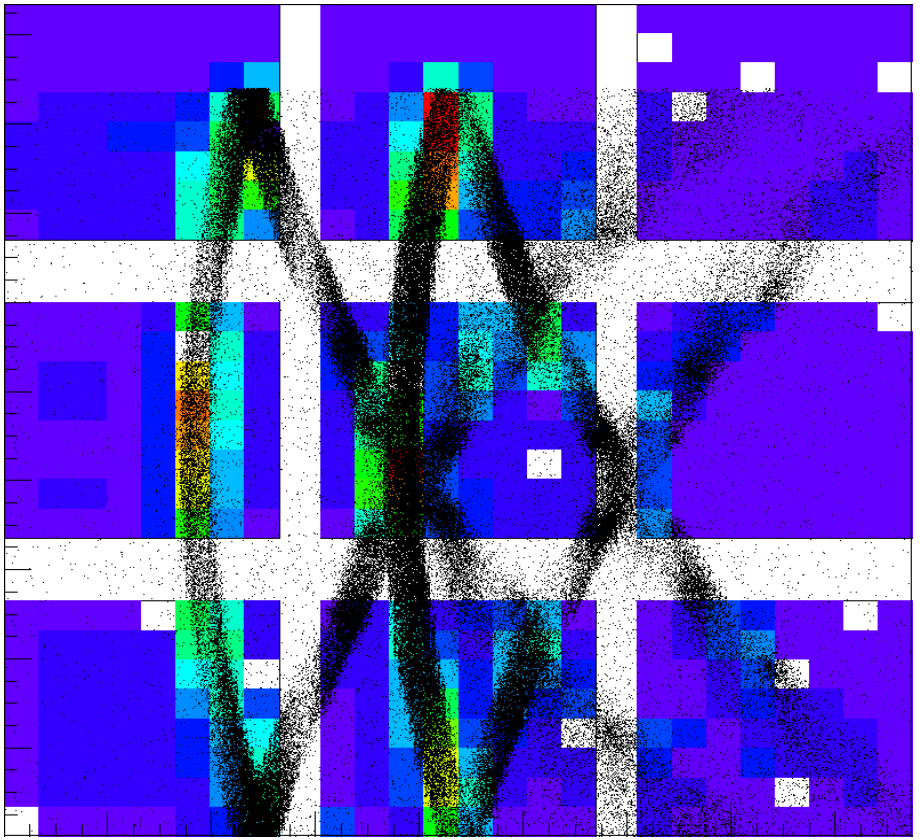
PID performance (2)

- Kaons can only be separated up to 2GeV/c
- p/π up to 6GeV/c
- Amount of deuterons is small, but signal is clear
  → d/π separation up to 7GeV/c

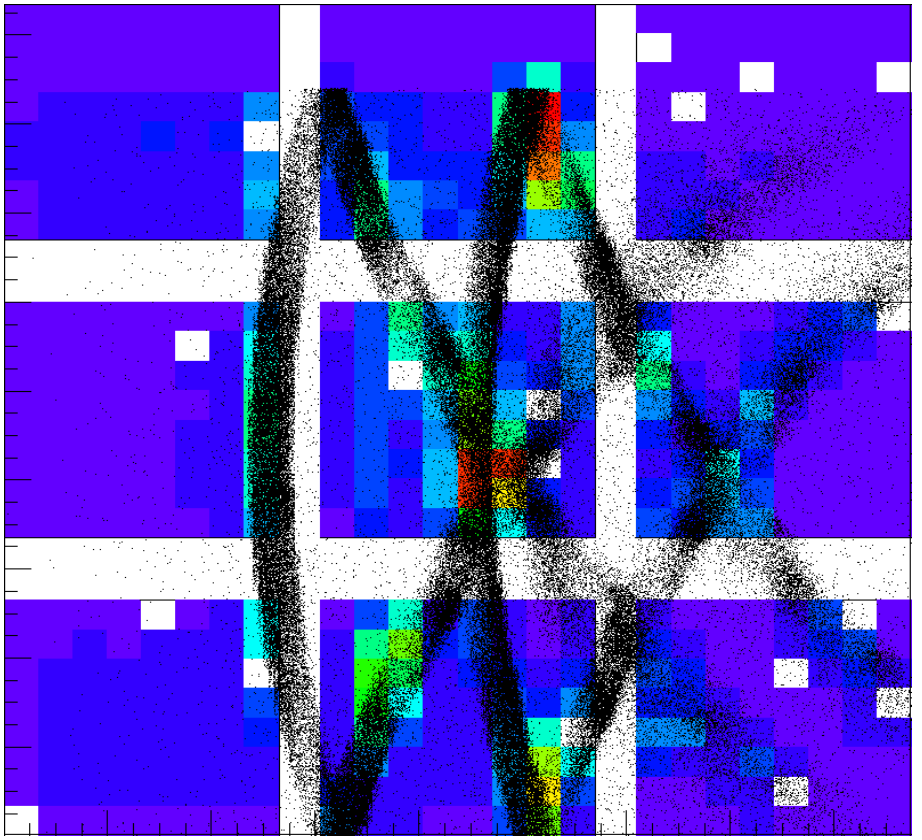


Comparison with DIRC at 3GeV/c

π



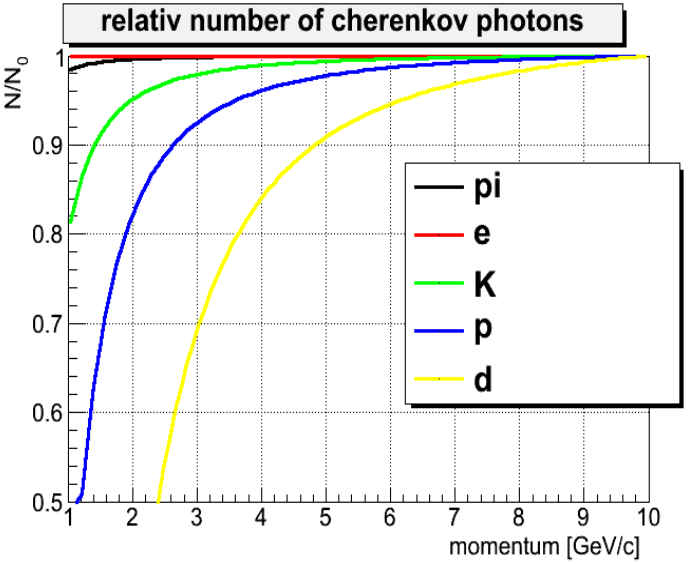
p

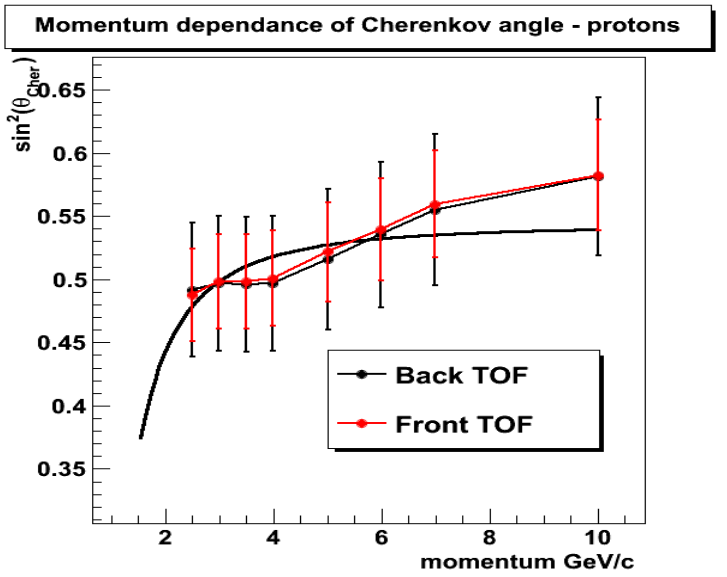


- Shift of fish is clearly visible
- Reconstruction fits with DIRC simulation (simulation by Grzegorz Kalicy – Dec 3th 2012)

Cherenkov angle dependance

- Number of Cherenkov photons depend on β: $N_{Cher} = N_0^{'}\left(1-\frac{1}{\beta^2 n^2}\right)$
  → ToT depends on β
- Assuming linear rising and falling edges allows conversion of ToT into charge
  → $\bar{Q} \propto N_{pe}$





Reasons for testbeam at COSY

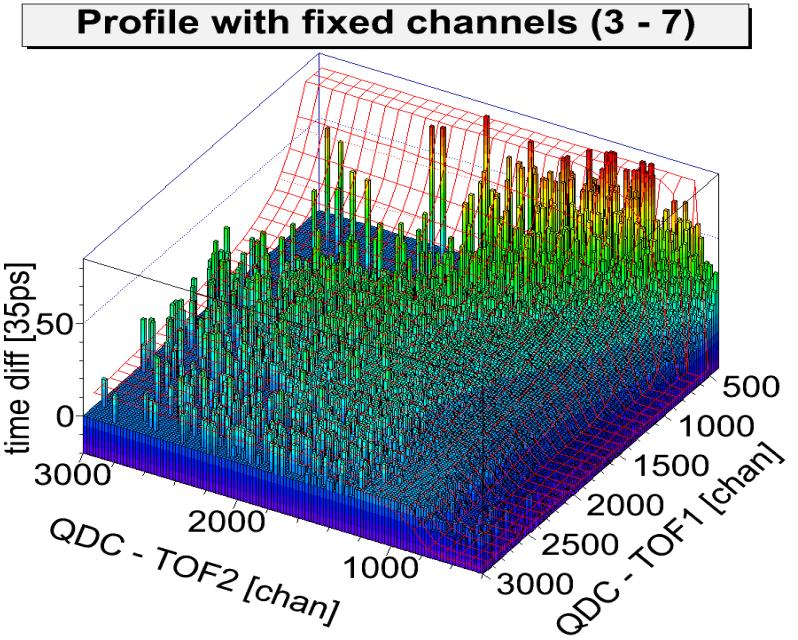
- Time resolution is could be better:
  - No charge data available, just ToT → QDC and TDC needed
  - Very long analog cables (~12m) disturbed TOF2, pixel resolution of TOF2: ~300ps (100ps TOF1) → short distance of MCPs ~20cm, shortest possible cables (~1.5m)
  - 'Real' time resolution of MCP-Out unknown (40-50ps just for single pixels with SPE)
- Resolution can be improved by requiring hitting of center pixels → very low statistics

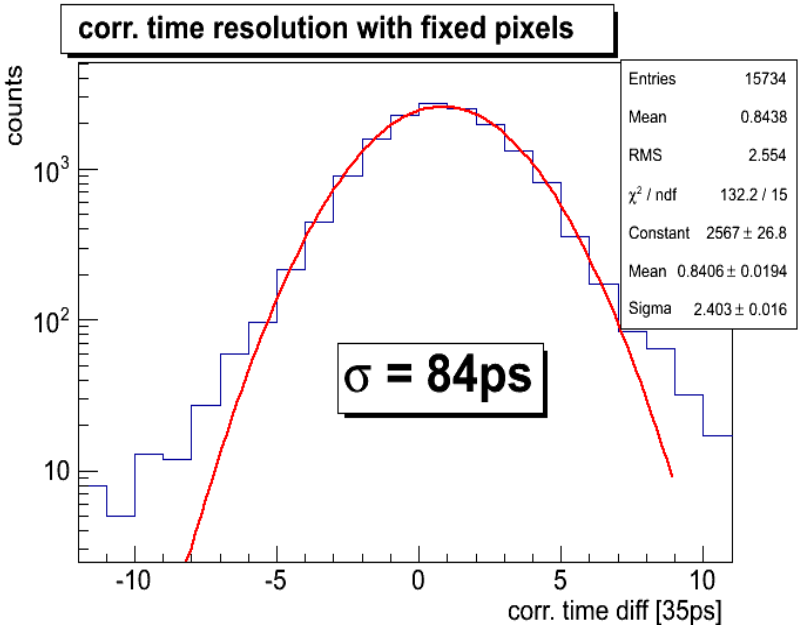
Improvements with different setup

- All signals amplified (10x, LeCroy 612a)
- QDC data allows better fitting
- With fixed fired pixels (1 per sensor) time resolution of MCP-Outs can be improved

  → path is less smeared

  → But: Loss of many events





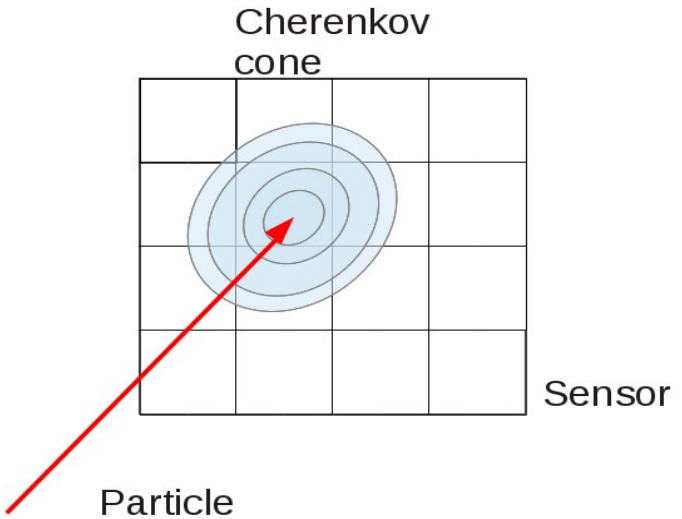
Charge resoluted time resolution

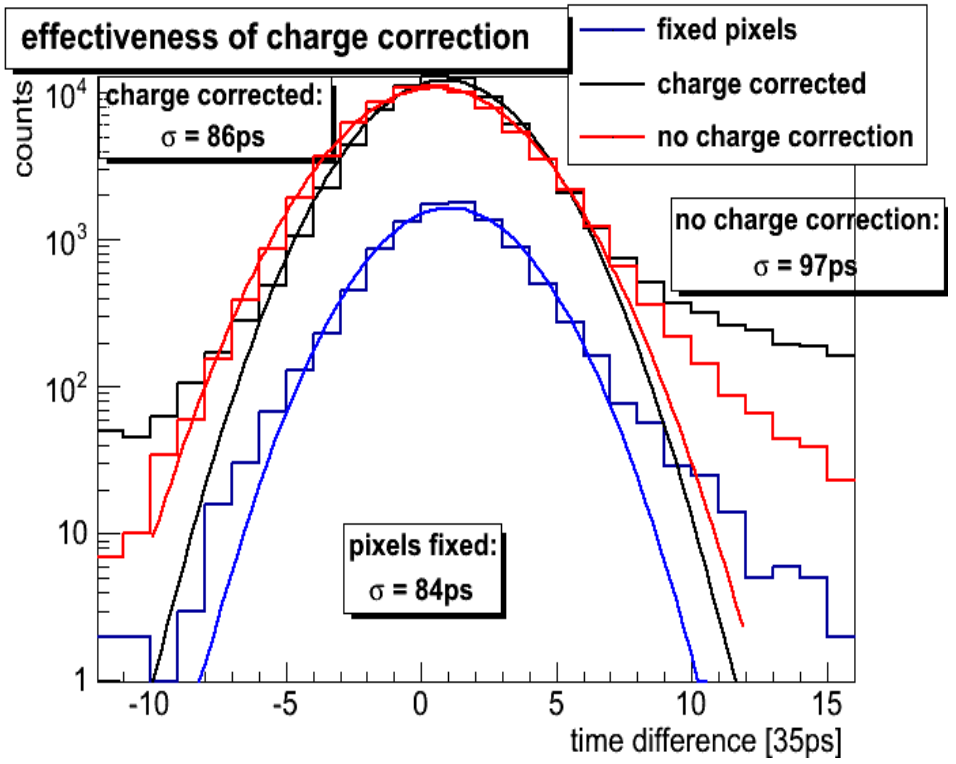
- Particle passes pixel with maximum charge

  → signal runtime along MCP can be compensated by using 'hitted' pixels per event

  → Not working for T9 data, ToT not sufficient (?)

- 'High resolution / High event' mode possible





Summary and Outlook

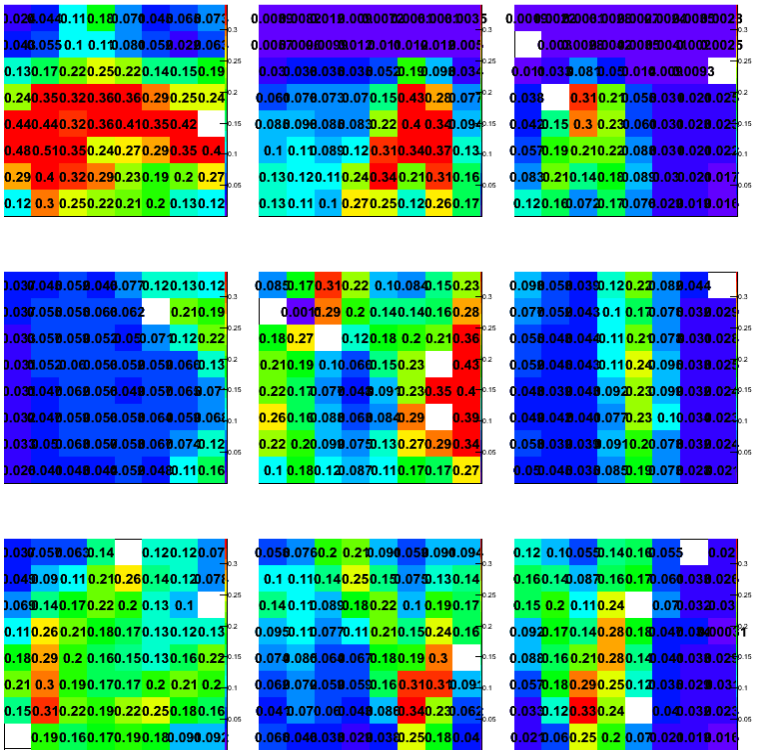
- Lifetime measurements ongoing:
  - Photonis XP85112-9001223 still almost unchanged after 3.6C/cm² (~ 7 PANDA-years!)
  - Origin of darkcount drop during shutdown is unknown
  - Illumination of XP85112-9001332 starts soon
- MCP-TOF:
  - separates π/p up to 6GeV/c (π/K 2GeV/c)
  - ADC obligatory to reach resolutions below 100ps
  - PID results seem consistend with DIRC prototype
  - Test with PiLas and semireflecting mirror planned to find time resolution bottlenecks (electronics, cables, etc.)

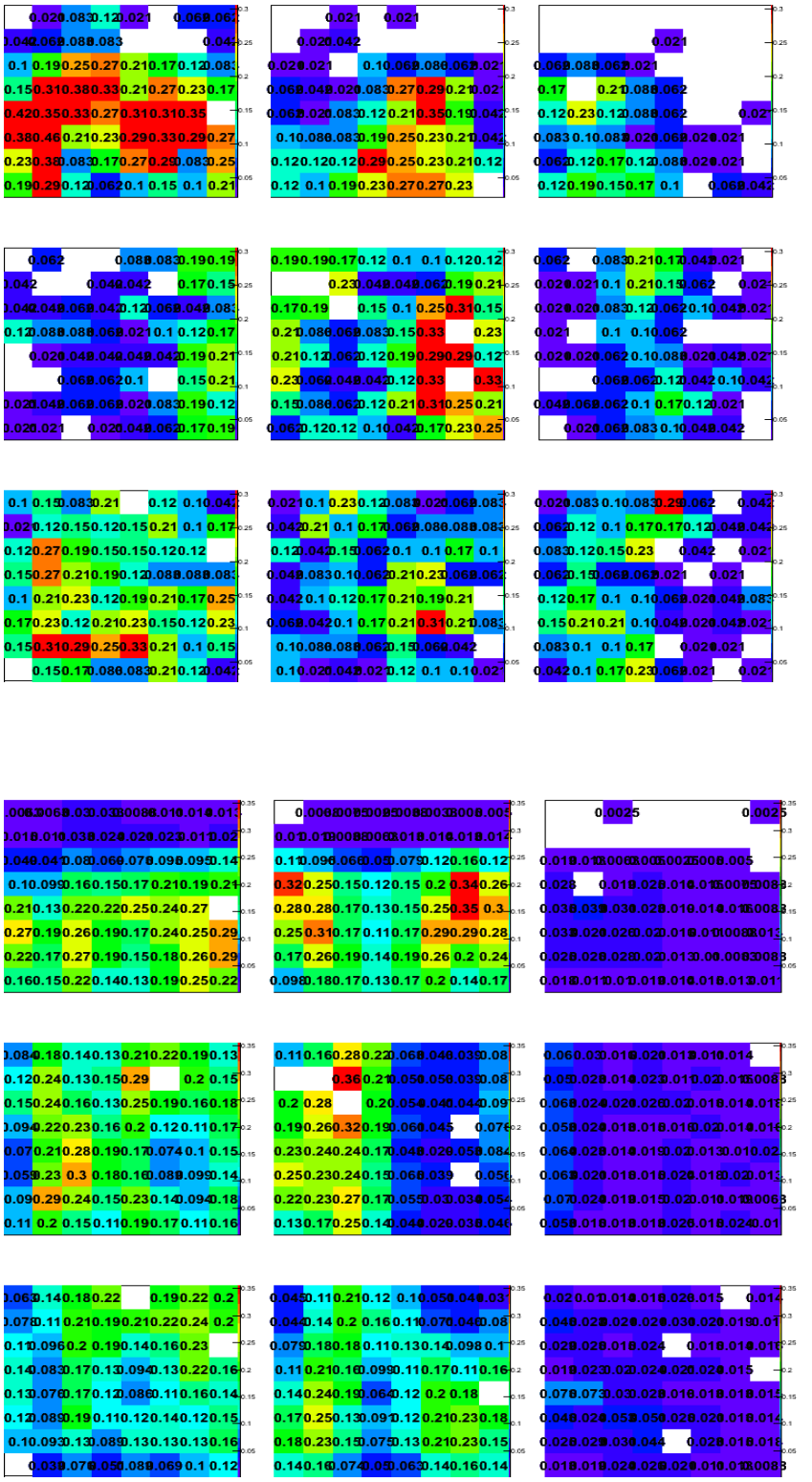
Comparison with DIRC at 2GeV/c

π

K

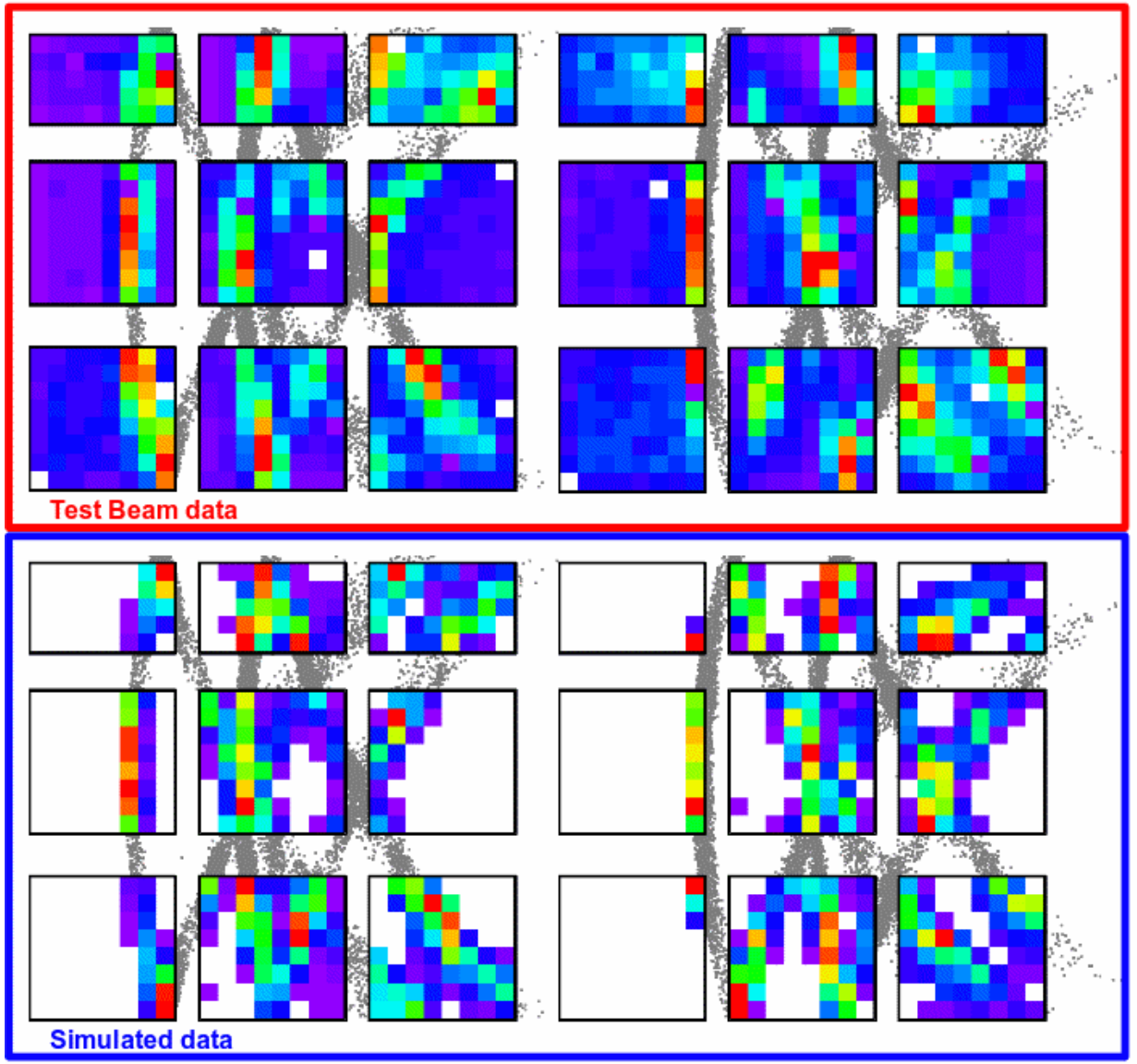
p





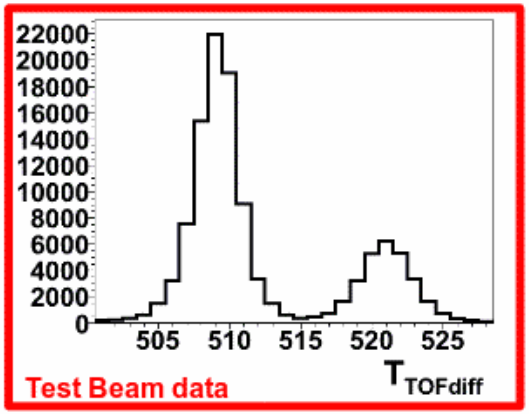
- Shift of fish is clearly visible
- Check with DIRC PID and simulation has to be done

Simulation results

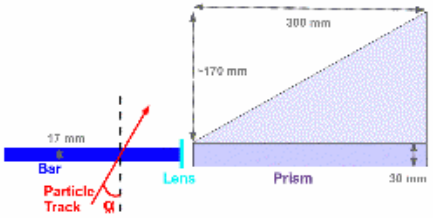


Momentum = 3 GeV/c

Ce12237081030



32.5º, UV lens, 3.2 mm AG,
11.2 mm step,
540.3 mm hitZ



Simulation by Kalicy, Grzegorz – Dec 3th 2012