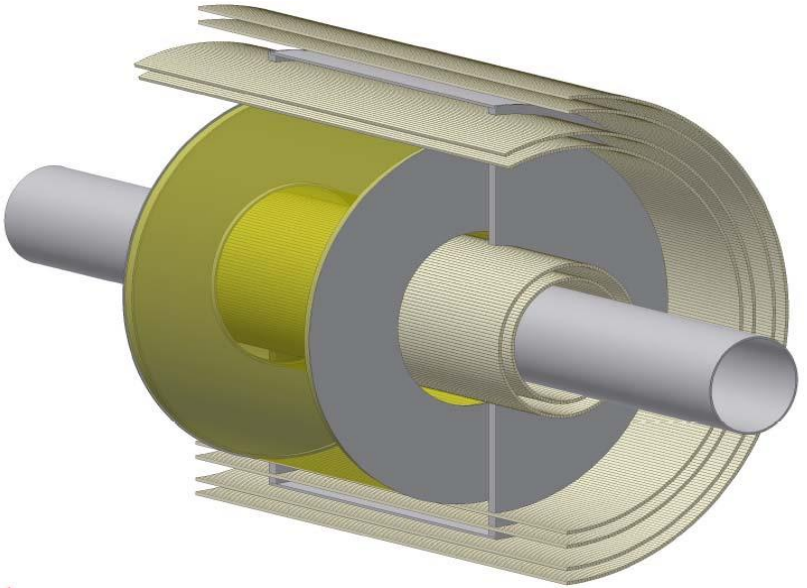
WP28 activity at LNF-INFN:

SiPM used in a trigger system with scintillating fibers

results and future plans



A. Scordo (LNF-INFN)

WP28 meeting (Wien, 16 February 2013)

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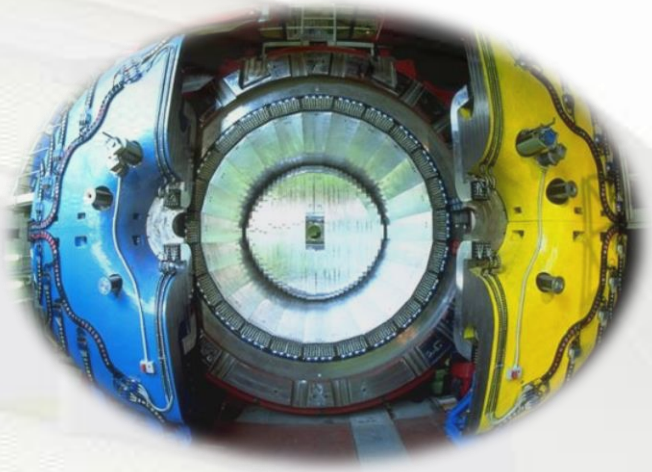
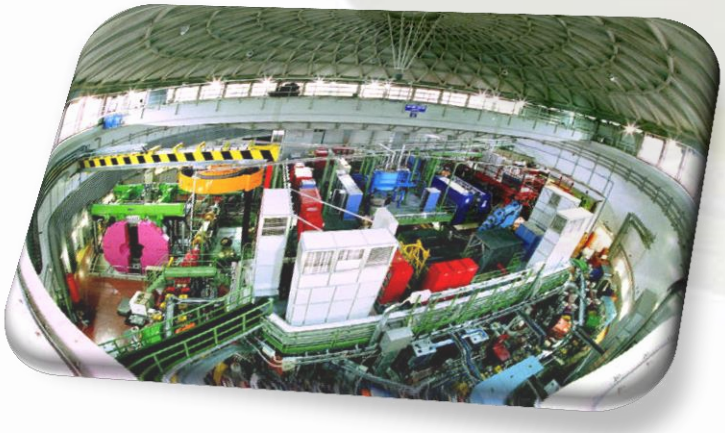
The AMADEUS experiment: a brief introduction

ANTIKAONIC MATTER AT DAΦNE: AN EXPERIMENT WITH UNRAVELING SPECTROSCOPY



KLOE

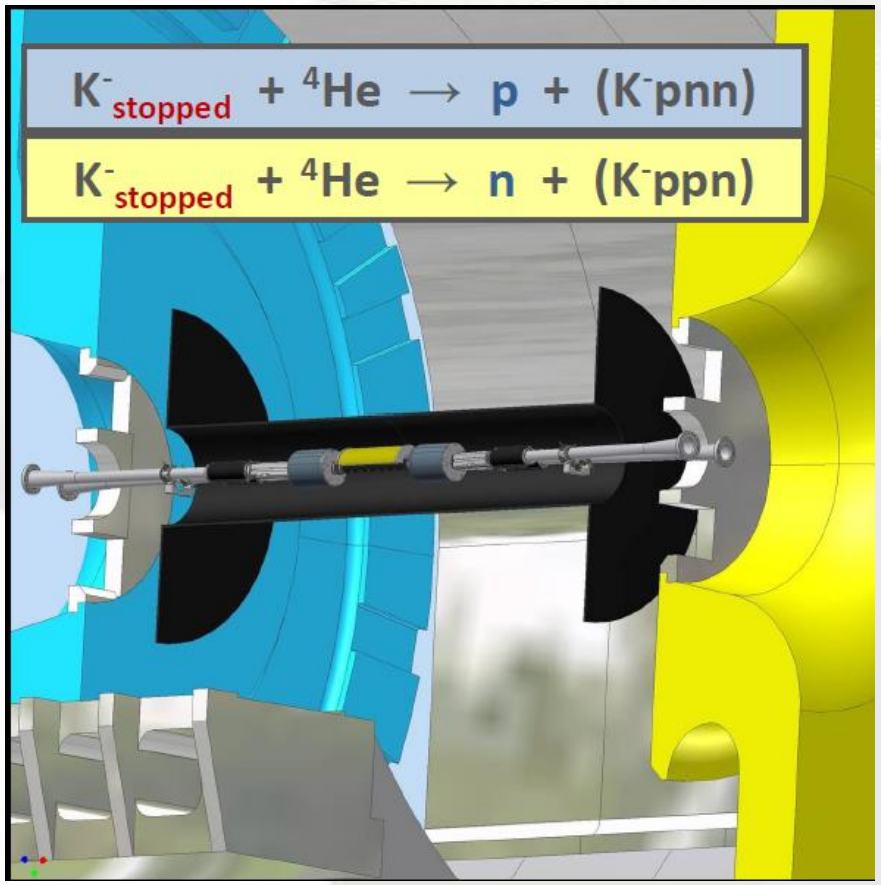
DAΦNE

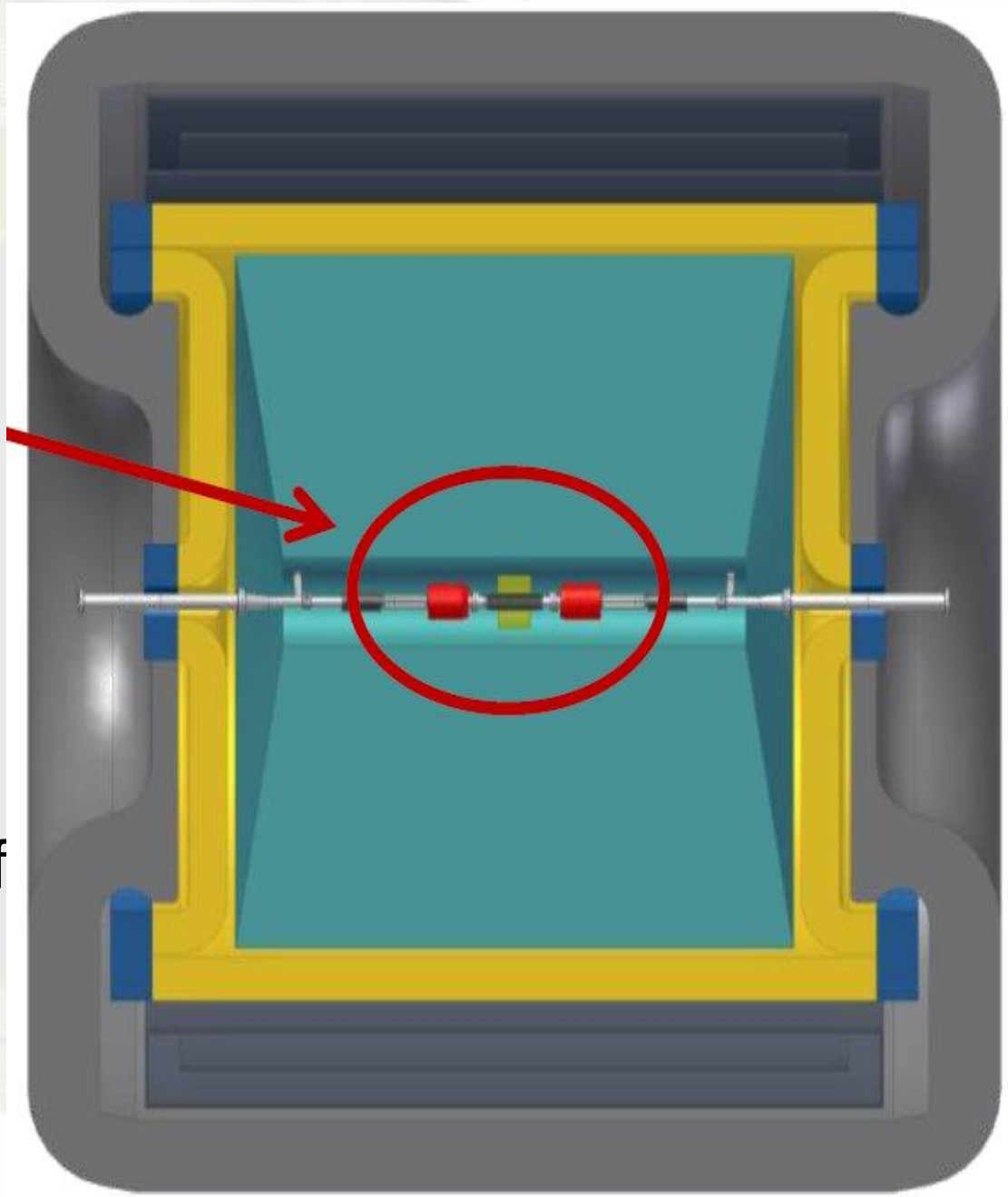


- The main aim of AMADEUS is to confirm or deny the existance of Kaonic Clusters,

- **EXTENDED PROGRAM**: Low-energy interactions, cross sections in light nuclei, decay of resonance states and exotic channels in nuclear medium will be studied

The AMADEUS experiment: a brief introduction



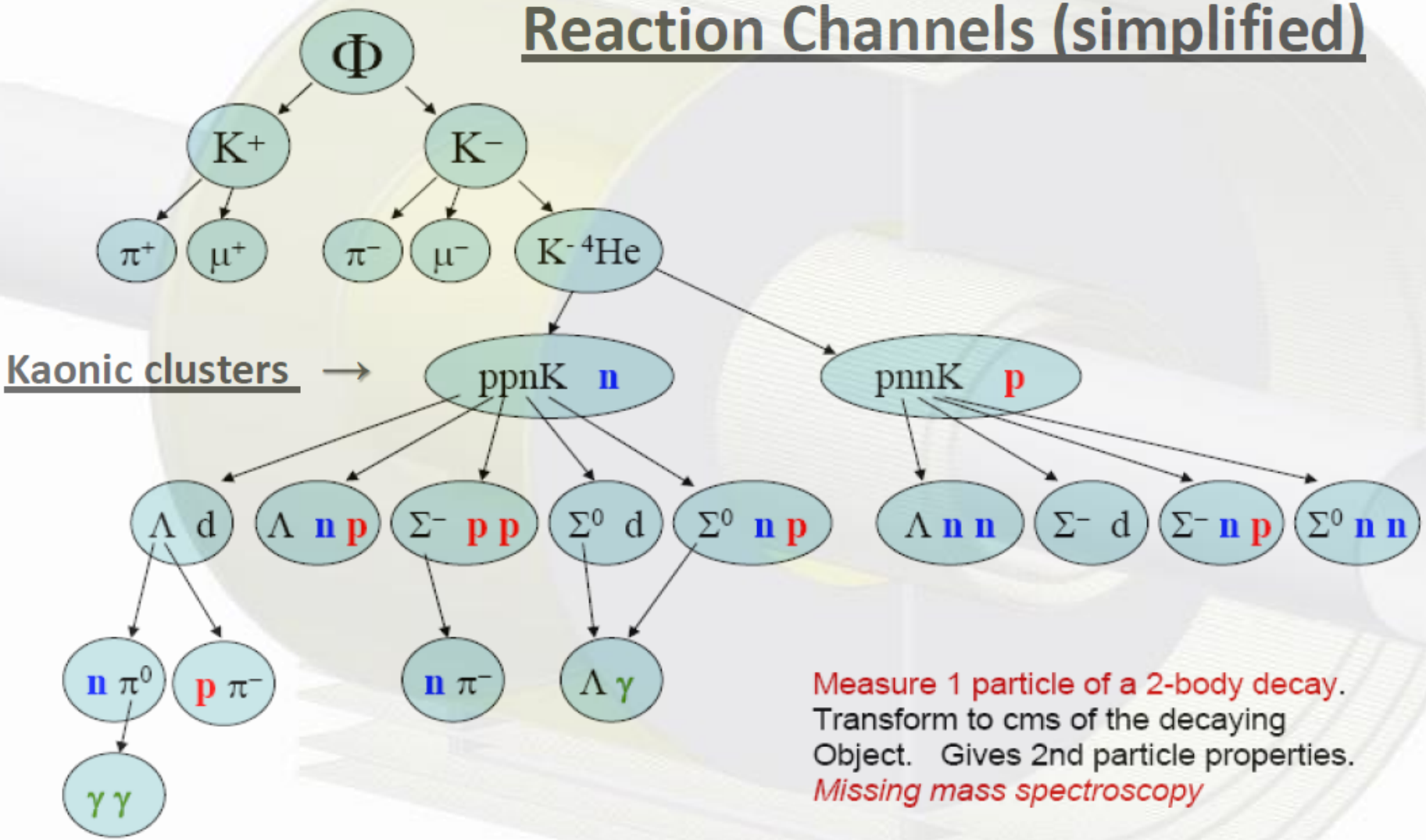


Target: A gaseous He target f

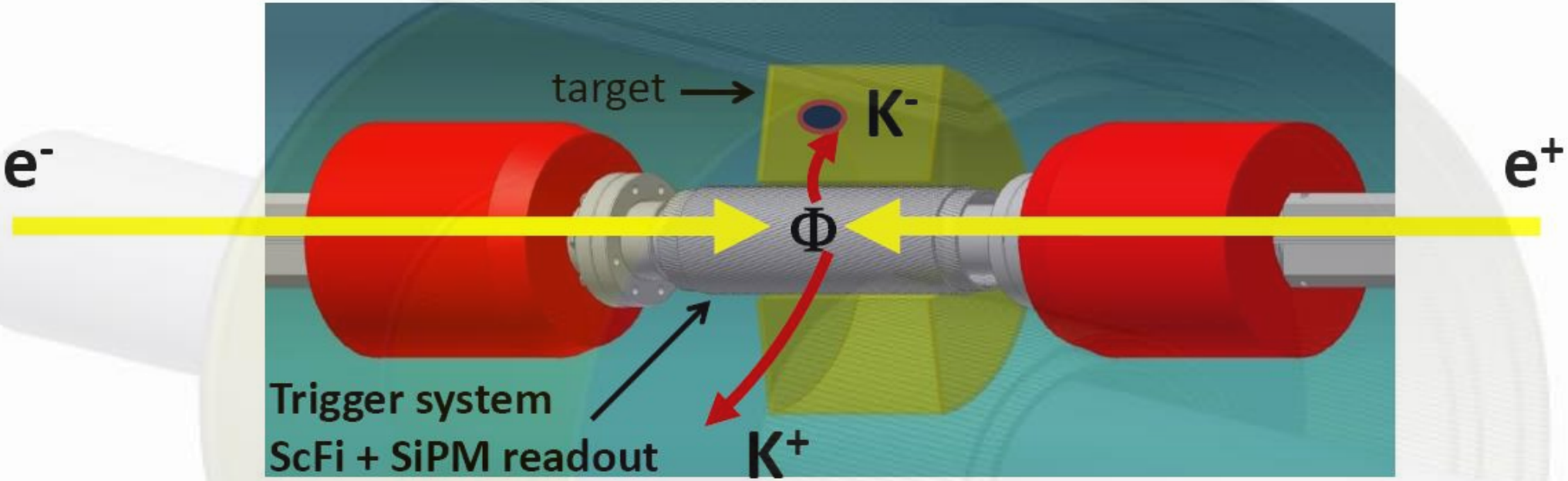
a first phase of study

First 4π fully dedicated setup!

The AMADEUS experiment: a brief introduction



Trigger system

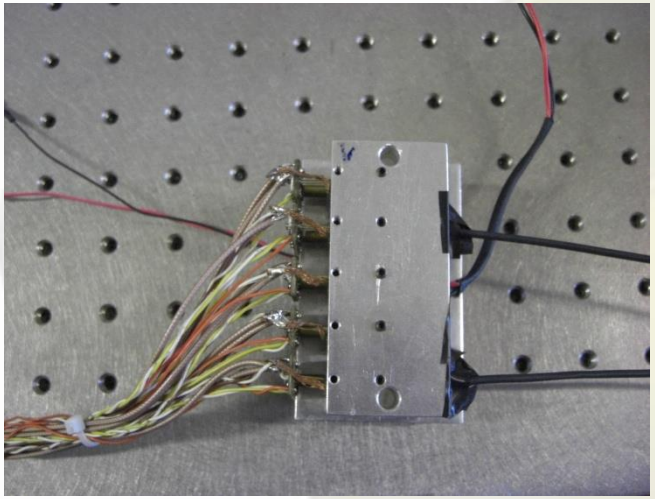


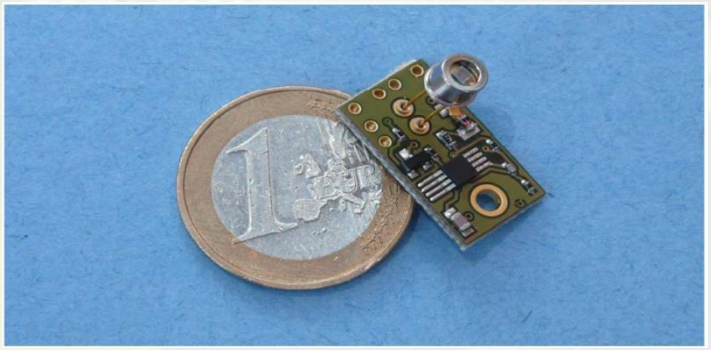
1) Small dimensions ✓
2) Working in magnetic field ✓
3) Working at room temperature
4) Very good time resolution (σ ~ 300 ps)
5) High efficiency

→ Multi Pixel Photon Counters (MPPC)

First prototype and MPPC characterization

Pre-Amplifiers (X 100)

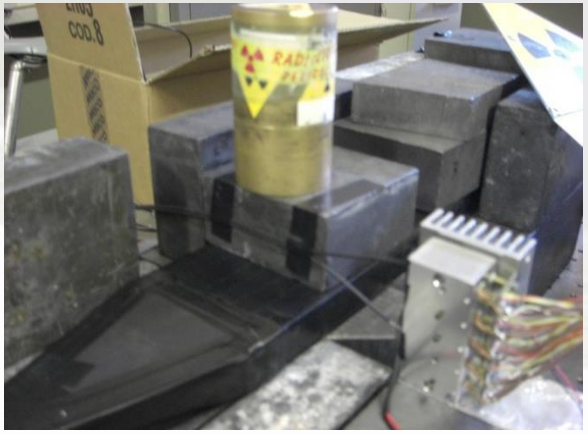




5 Channles HV power supply (stability better than 10 mV)

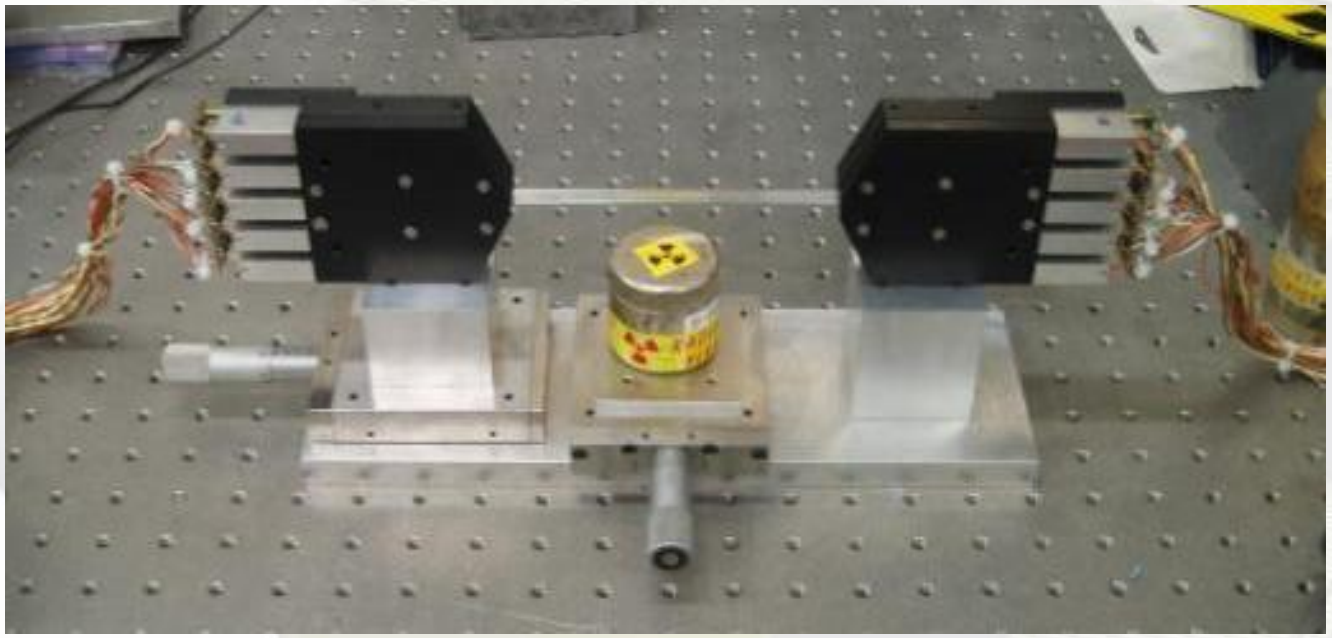
Scintillating fibers
Bicron BCF-10 (blue)

SiPM (HAMAMATSU U50) (400 pixels)
Operating voltage ~70V



- Sr90 beta source (37 MBq)

First prototype and MPPC characterization

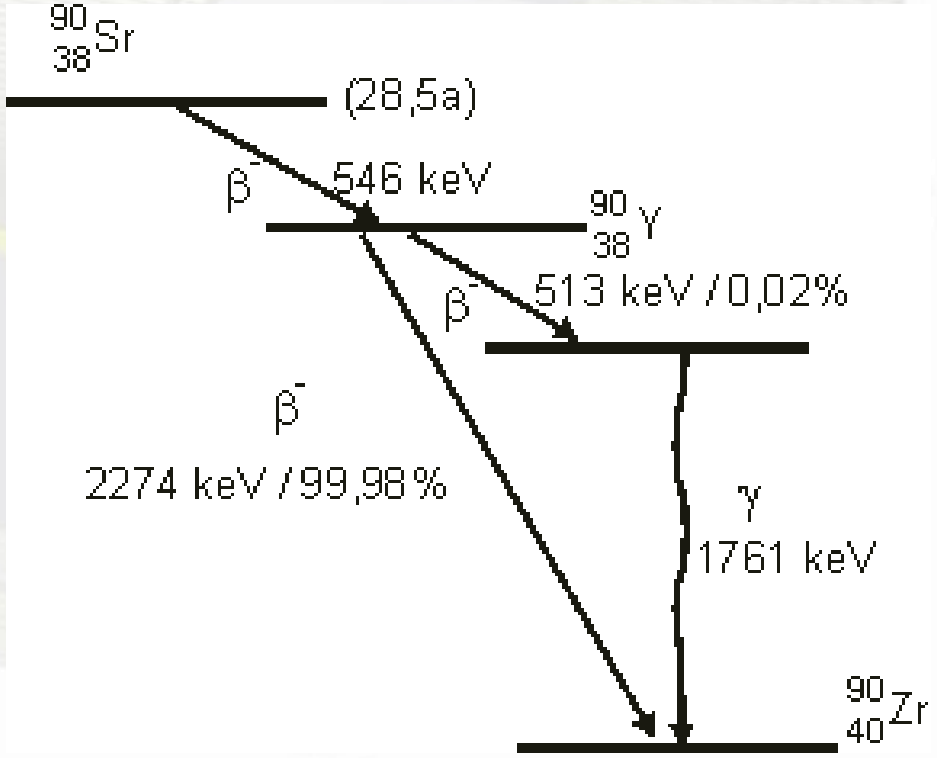


Is cooling needed ?

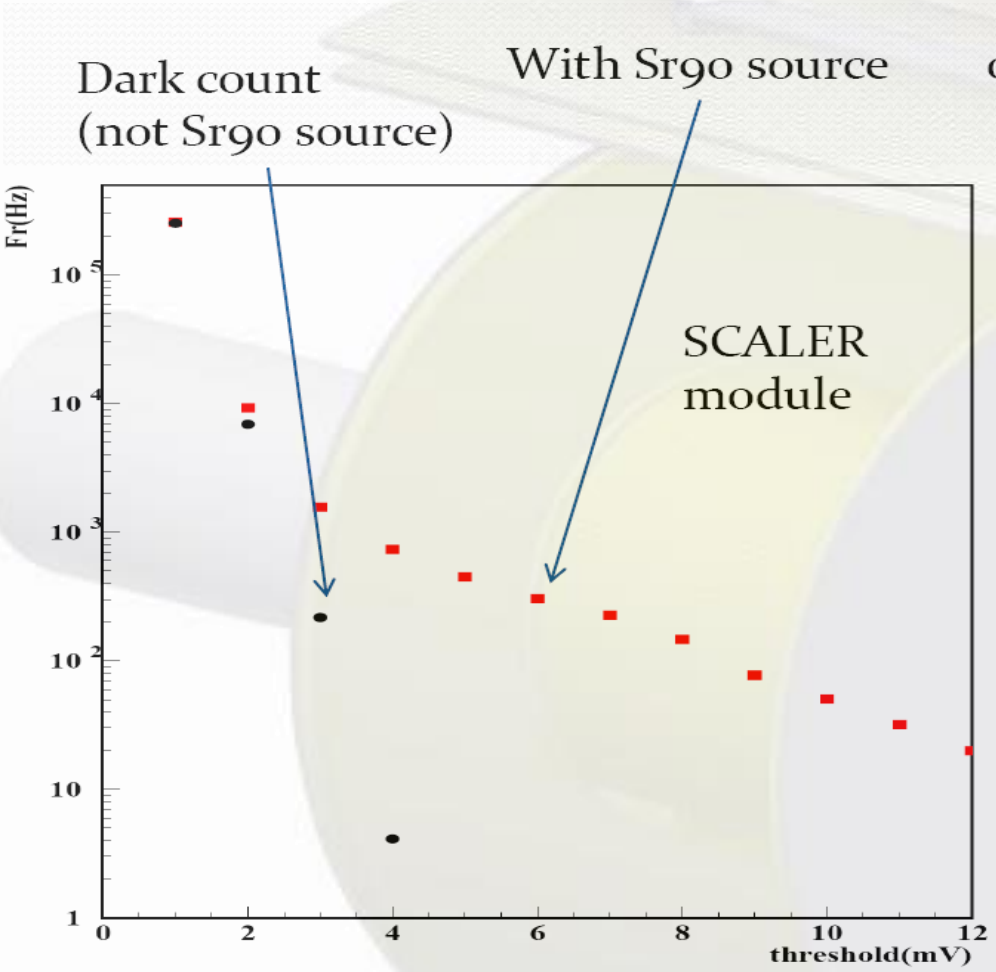
A scintillating fiber is activated by a beta Sr90 source

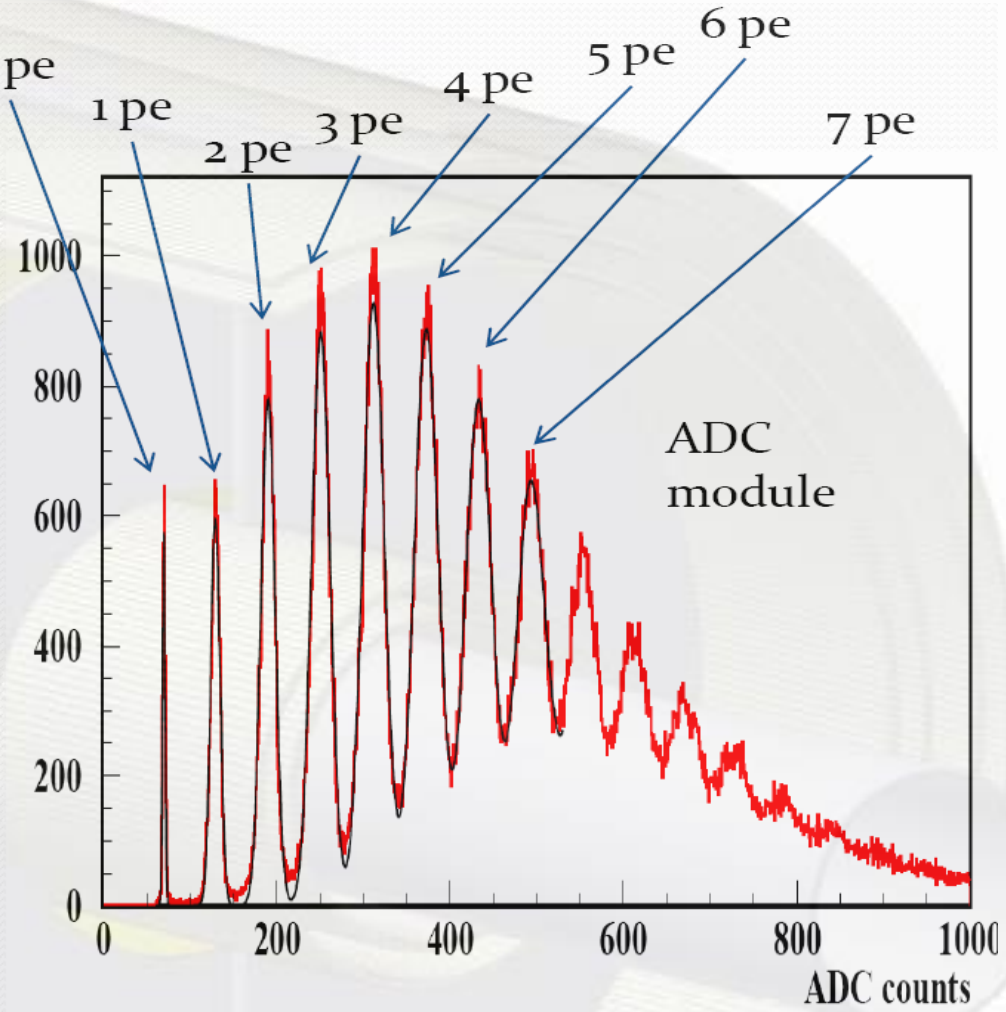
Both ends are coupled to detectors;

one is used as trigger



First prototype and MPPC characterization





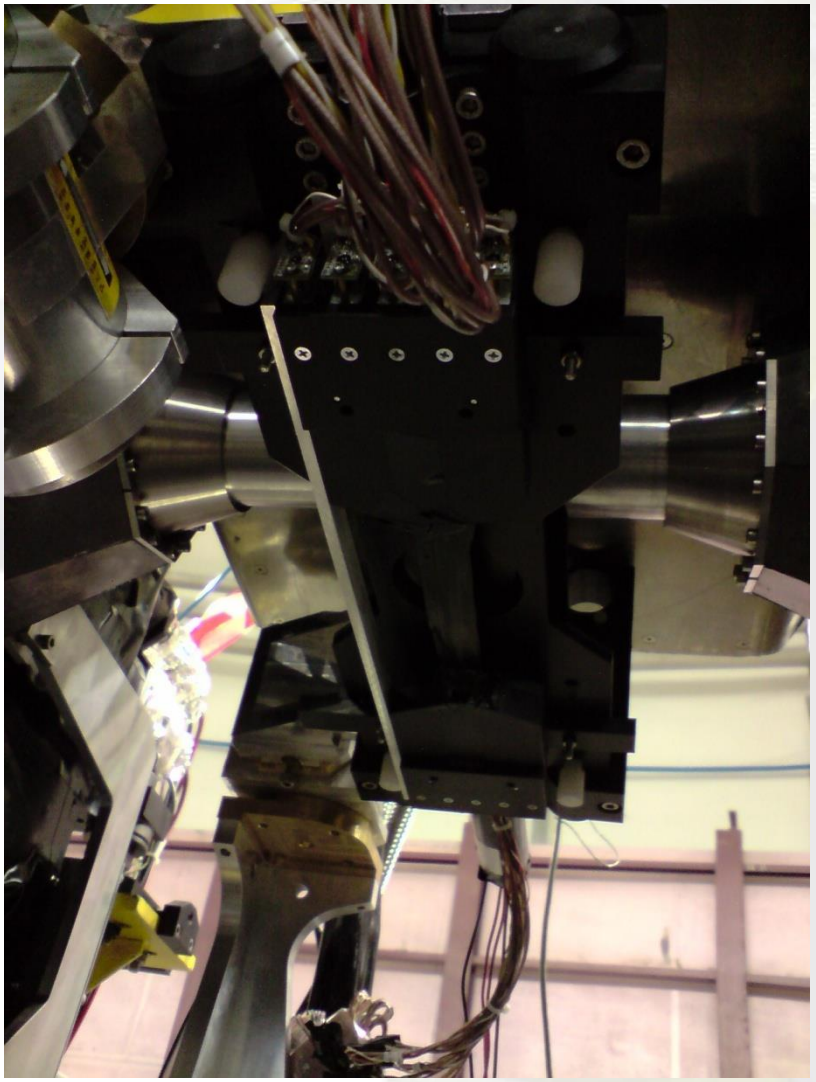
Studying rates with and without the beta source, it turned out that starting from the 4th p.e. peak, dark count contribute is negligible

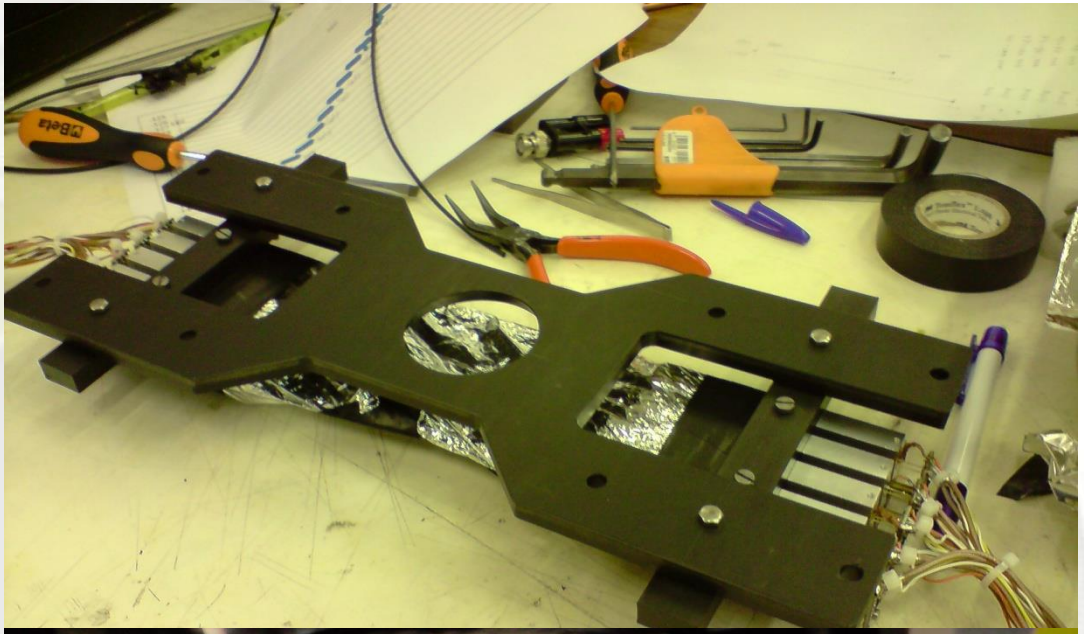
This means that non cooling is needed in this case!!!!

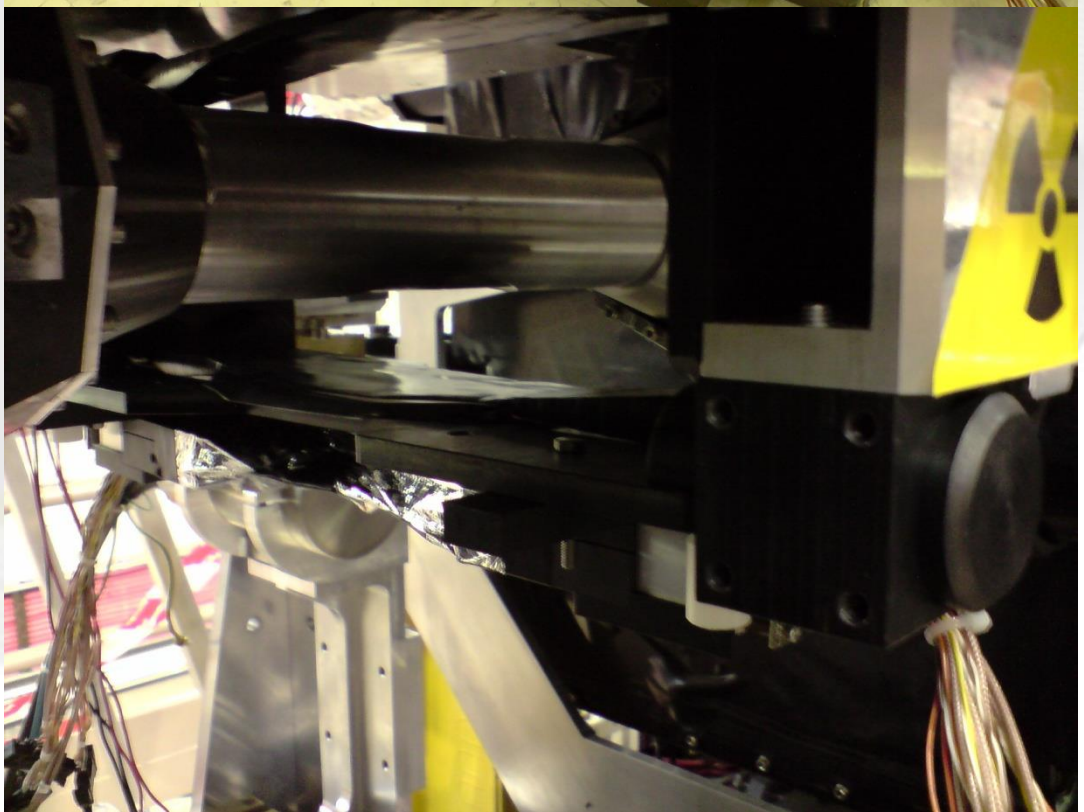
Requirements

1) Small dimensions ✓
2) Working in magnetic field ✓
3) Working at room temperature ✓
4) Very good time resolution ($\sigma \sim 300$ ps)
5) High efficiency

Results of tests on DAΦNE

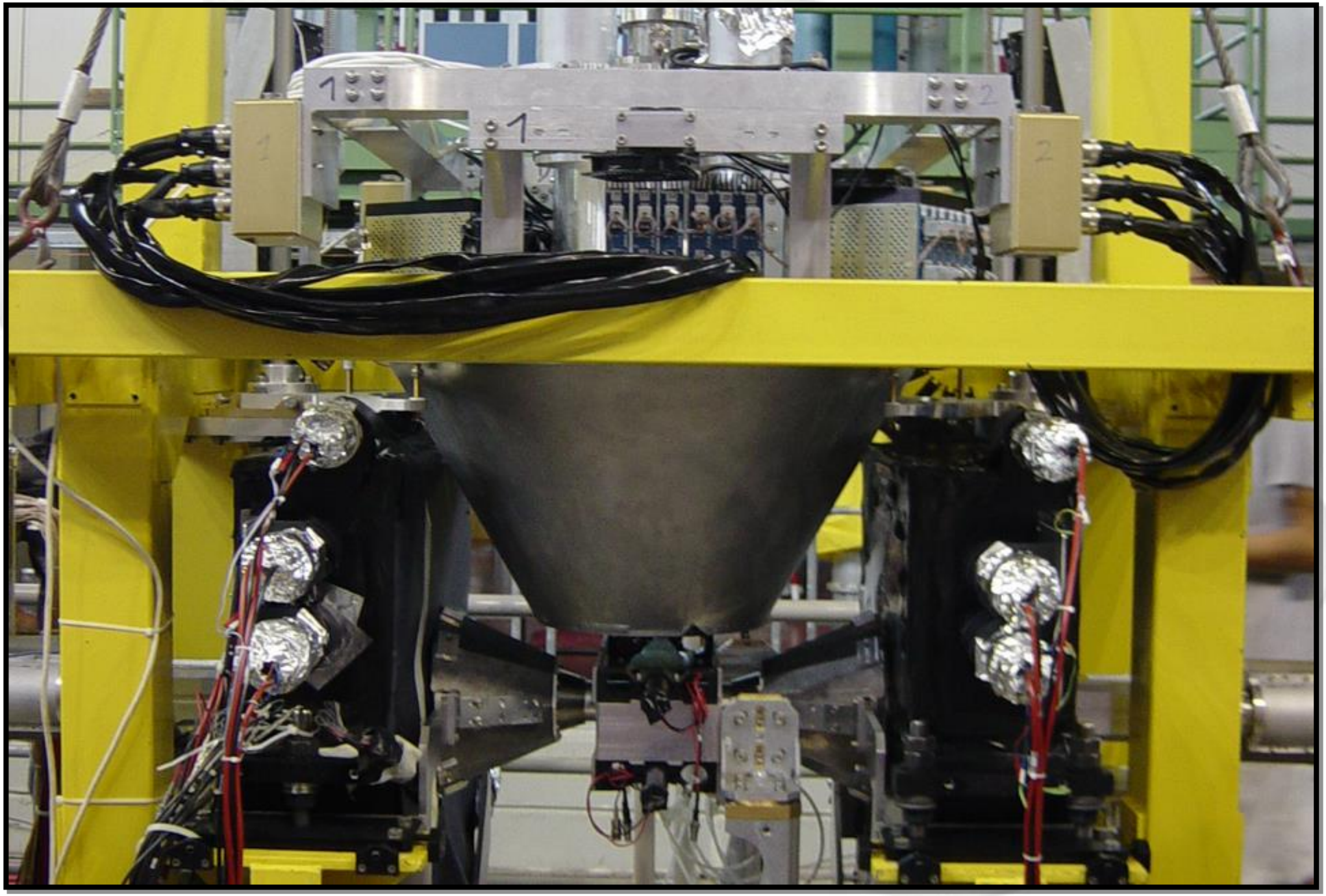




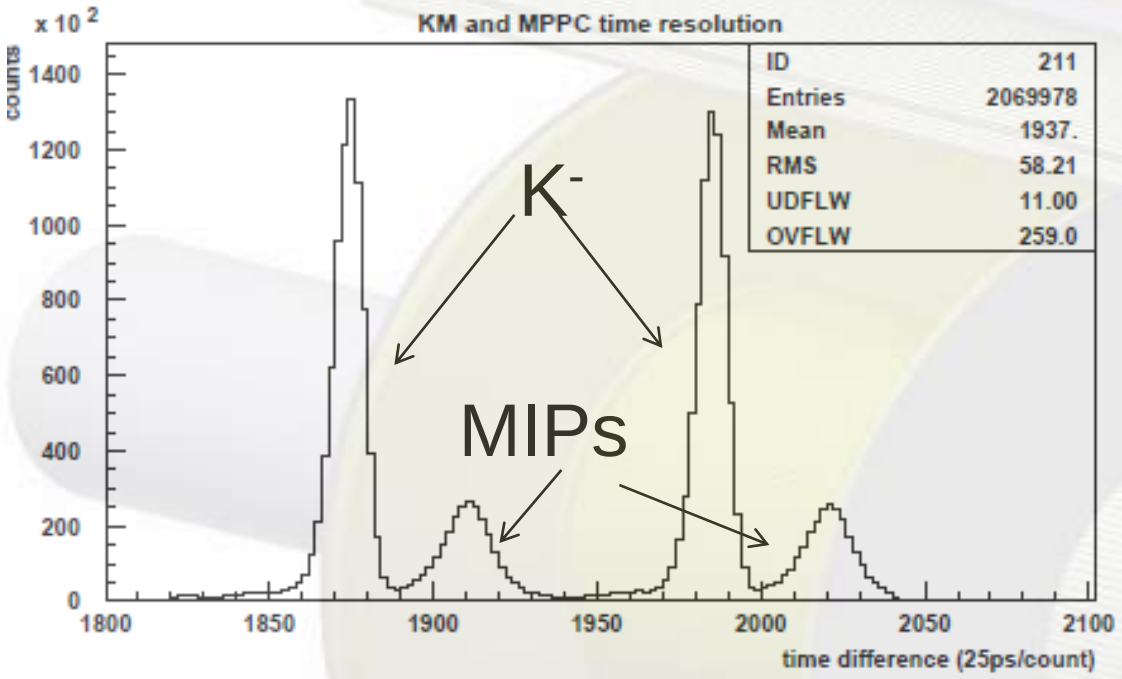


22-24 January 2009

Results of tests on DAΦNE



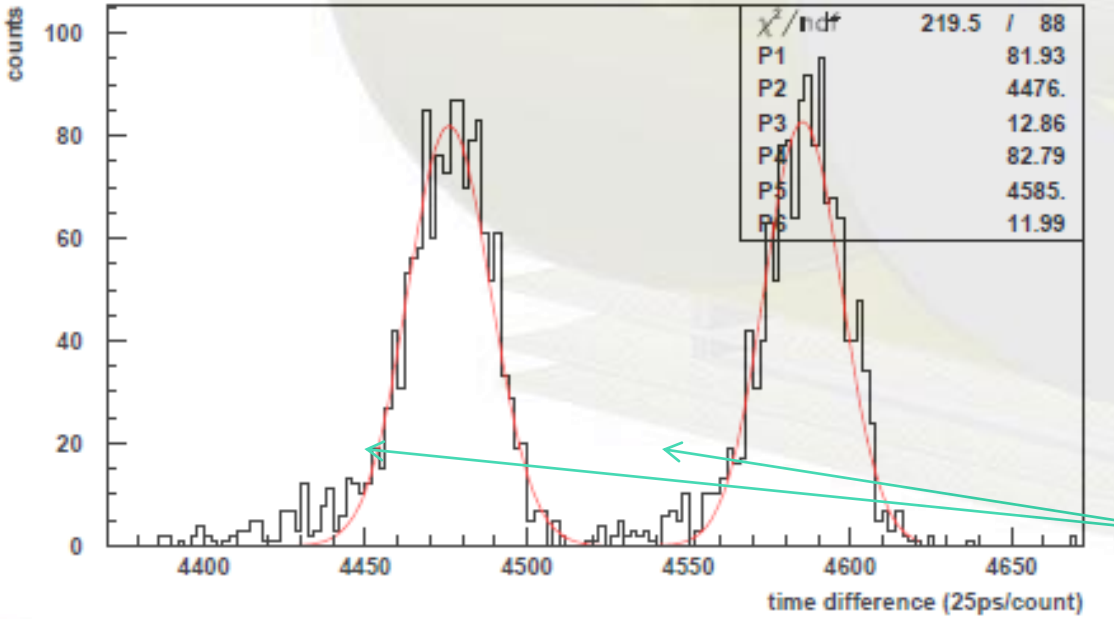
Results of tests on DAΦNE



Kaon Monitor TDC
(upper/lower coincidence)

Single peak resolution
Is ~ 100 ps

MIP/K separation ~ 1 ns



MPPC tdc spectra

Single peak resolution
Is ~ 300 ps

Missing MIPs

Requirements

1) Small dimensions ✓
2) Working in magnetic field ✓
3) Working at room temperature ✓
4) Very good time resolution ($\sigma \sim 300$ ps) ✓
5) High efficiency

M. Bazzi et al., Experimental tests of the trigger prototype for the AMADEUS experiment based on
Sci-Fi read by MPPC, Nucl. Instr. and Meth. in Pyhis. Res. A 671 (2012) 125.

New electronics and 64 channels prototype

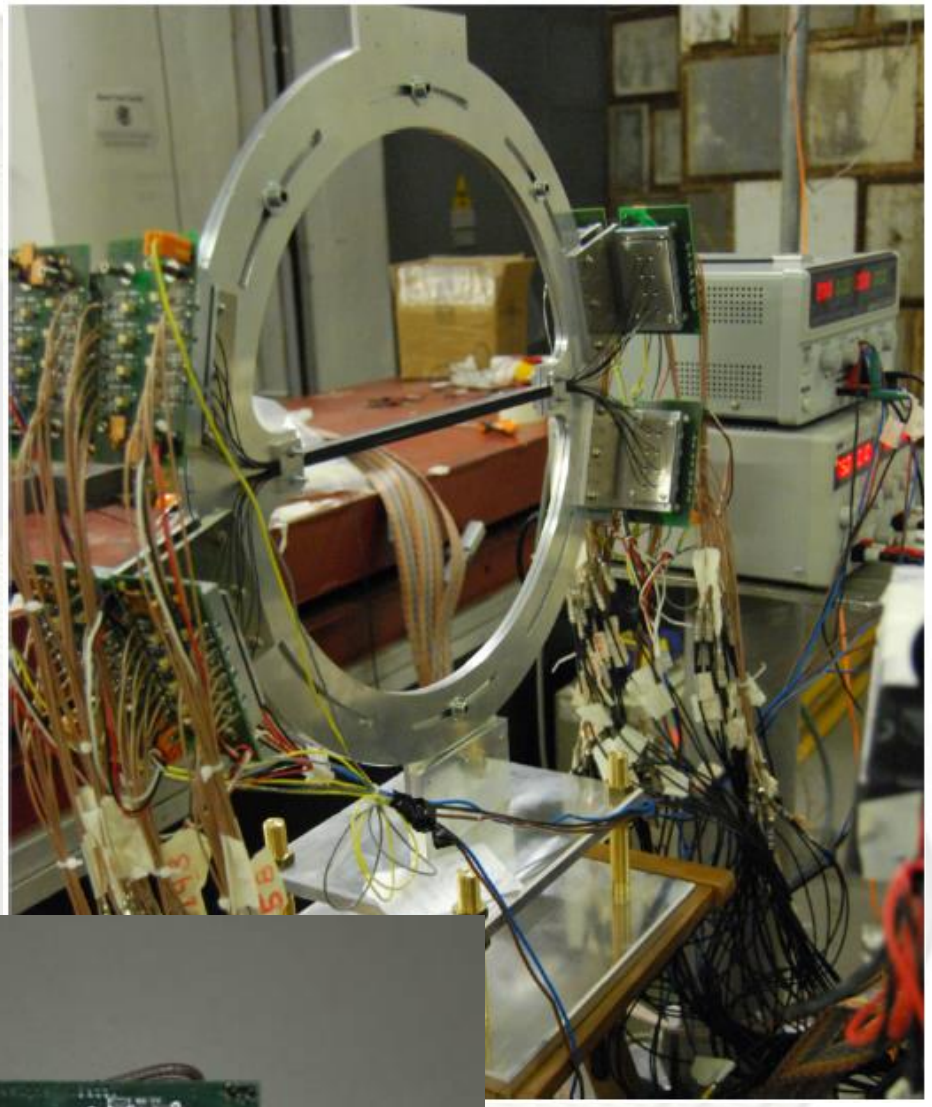
32 Sci-Fi read at both sides

2 indipendent double layers with adjustable angle

Amplification of a factor 10

64 Constant Fraction Discr.

Logic OR of all detectors



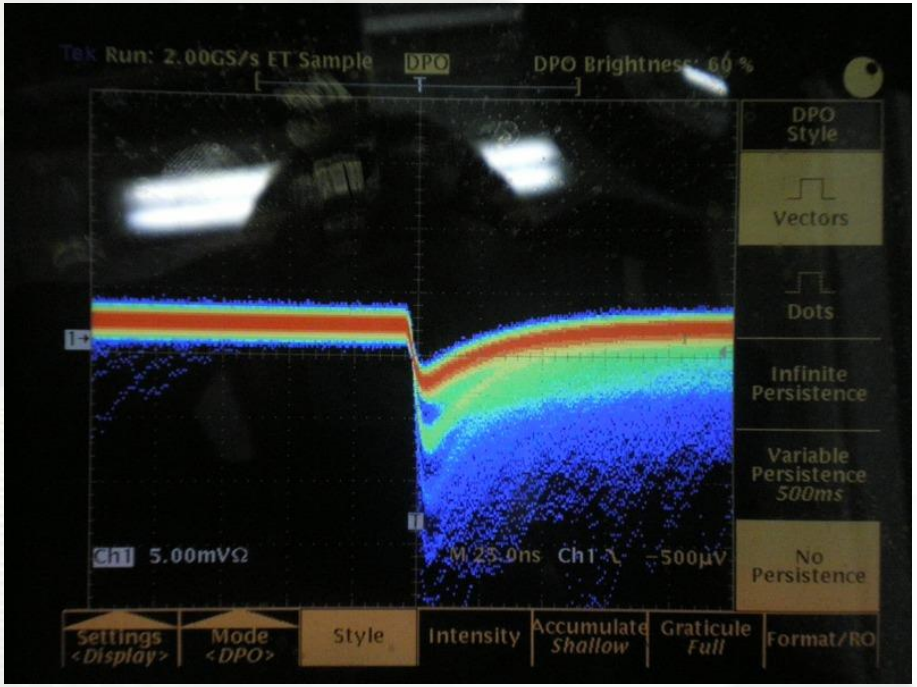
Preamplifier Board

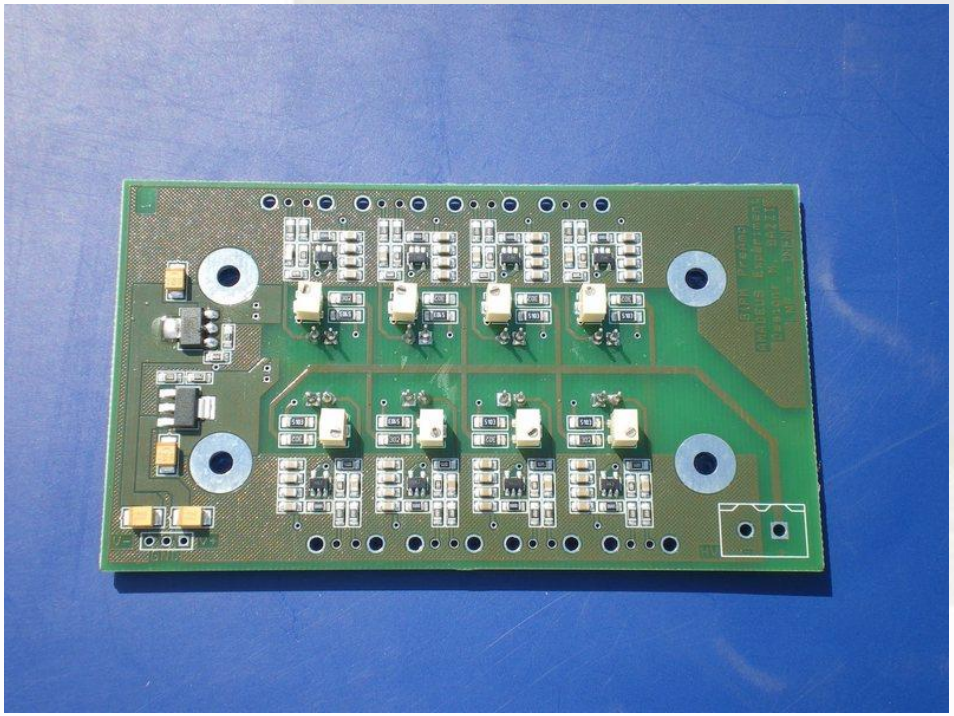
- A dedicated preamplifier board has been developed for the experimental set-up. Main Characteristics are:

- 8 SiPM channels
- Independent and 10% tunable HV supply for each channel
- LV stability below 0.1%
- Ultra fast amplifiers
- Dual output signal per channel
- Transipedance amplifier (Gain = 1KOhm)

Preamplifier Board

- Fast response, 5ns rise time
- 5-10mV per fired pixel
- Quenching time 60ns
- 100uA of photocurrent corresponds to 100mV output (Gain 1KOhm)
- QDC correct lecture tested





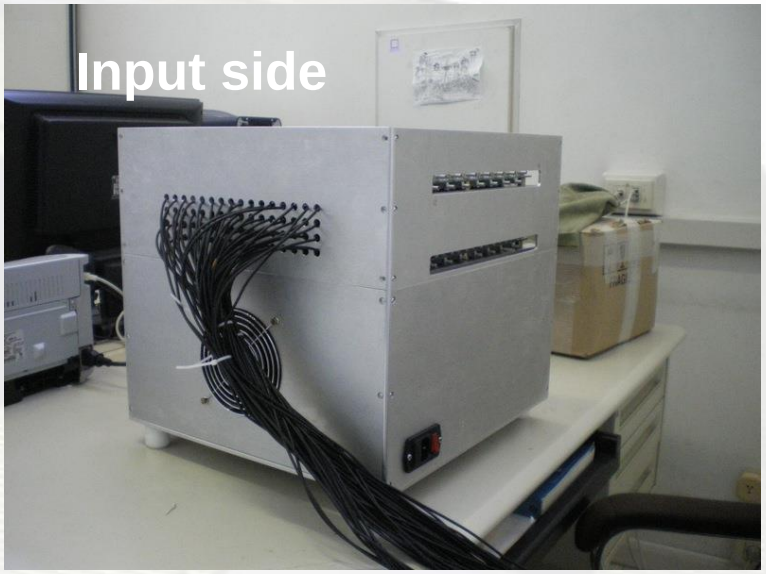
QDC spectra consist in a set of peaks whose x-axis position corresponds to the number of fired pixels

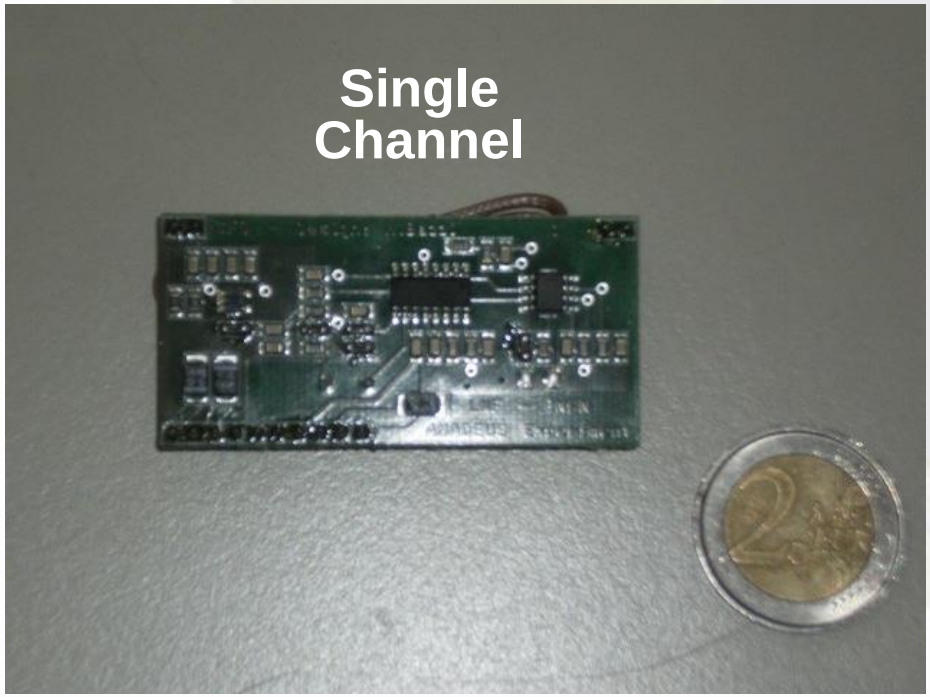
Constant Fraction Discriminator

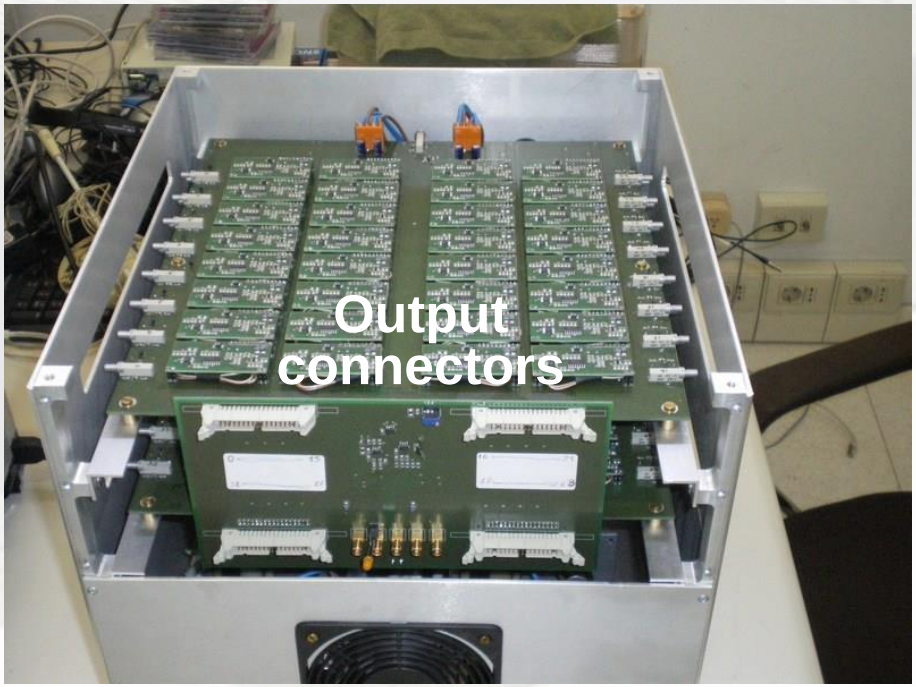
- A constant fraction discriminator has been developed for a large number of channels and to dispose of the correct output data format for TDC.
  - Main characteristic are:
- 64 input channels (50Ohm terminated)
- Negative input
- Selectable threshold 10-1000mV
- Differential ECL output
- Minimum input amplitude signal 10mV
- Minimum input pulse width 10ns
- Jitter skew below 10ps
- 230VAC power supply

Constant Fraction Discriminator

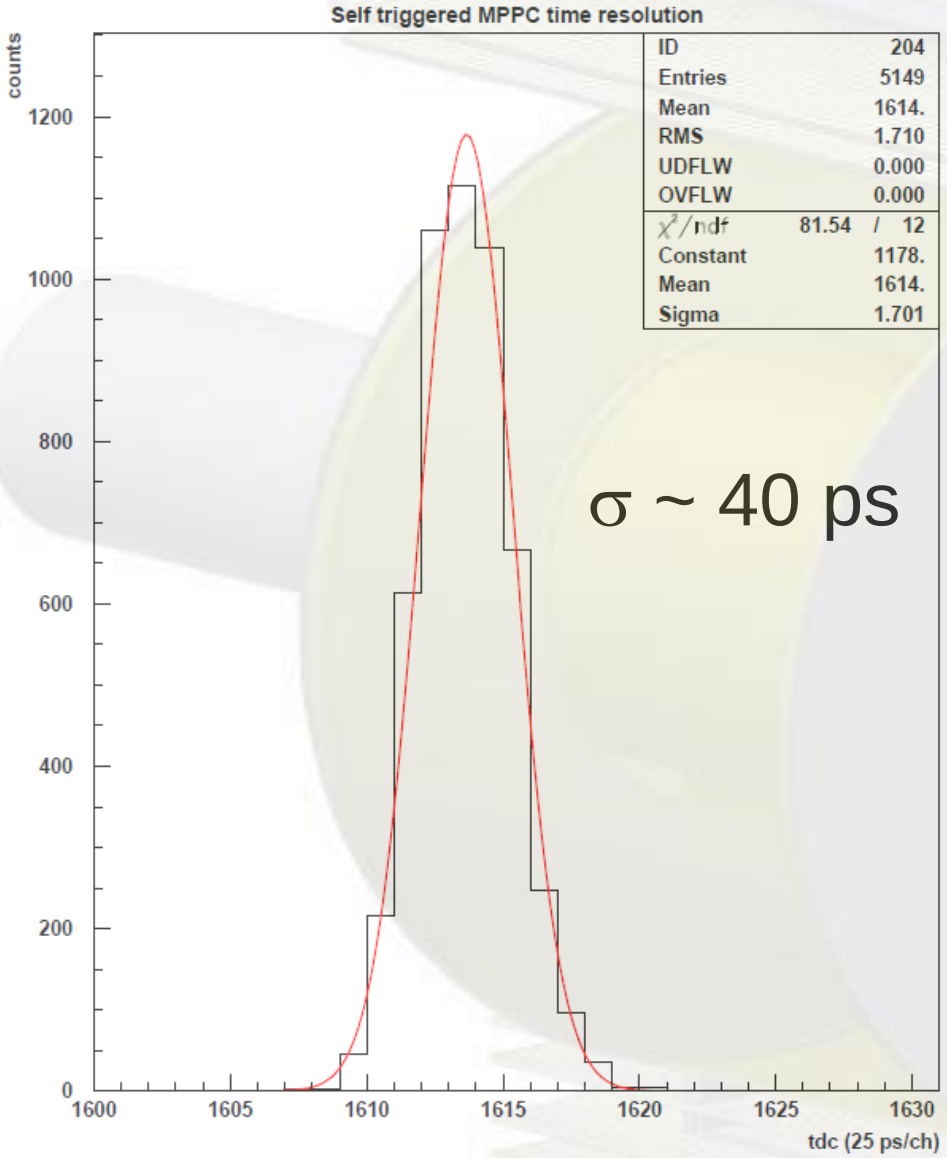
- Piggyback board technique
- Flat twisted cable output connector
- Box provides NIM format GATE signal to TDC & QDC
- Performances compatible with CFDs available on market

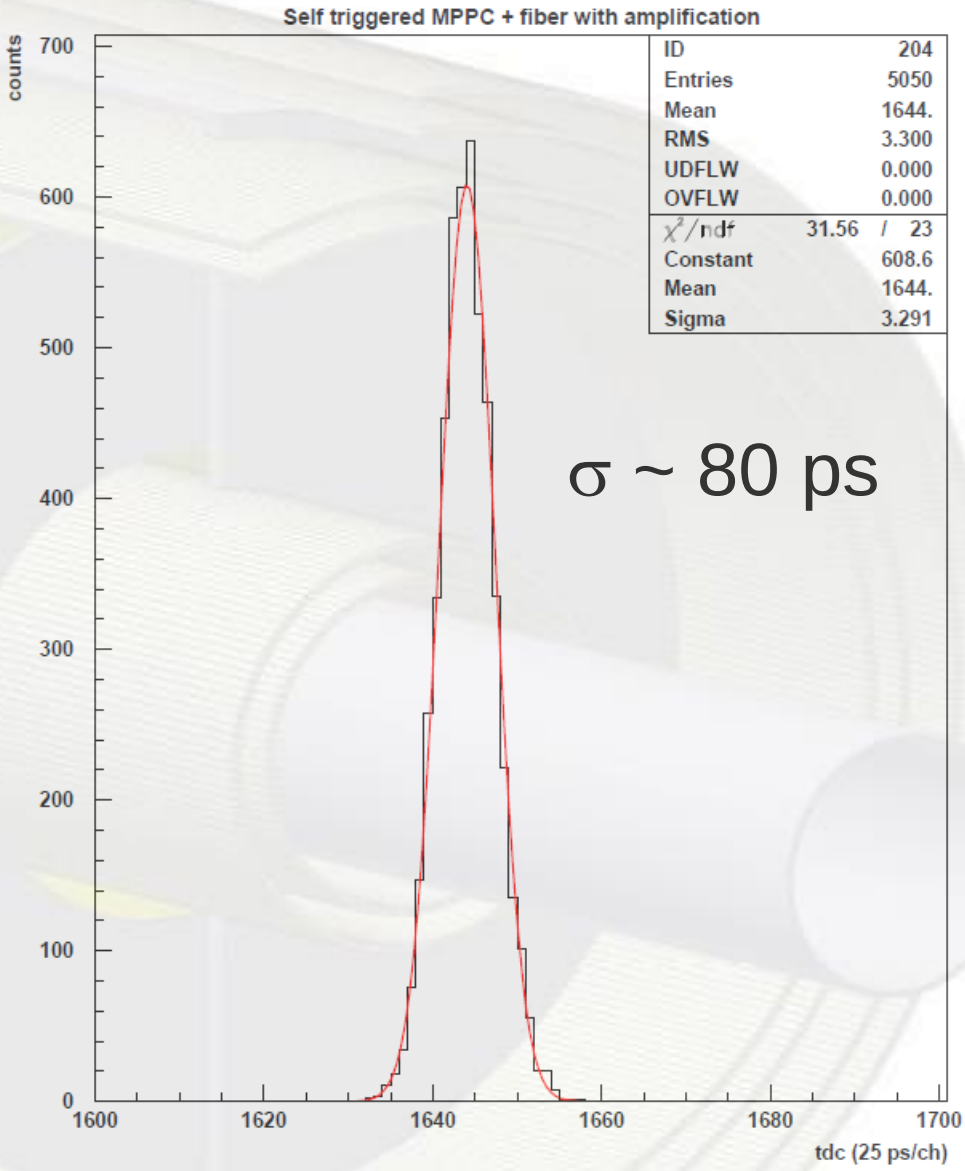






New electronics and 64 channels prototype





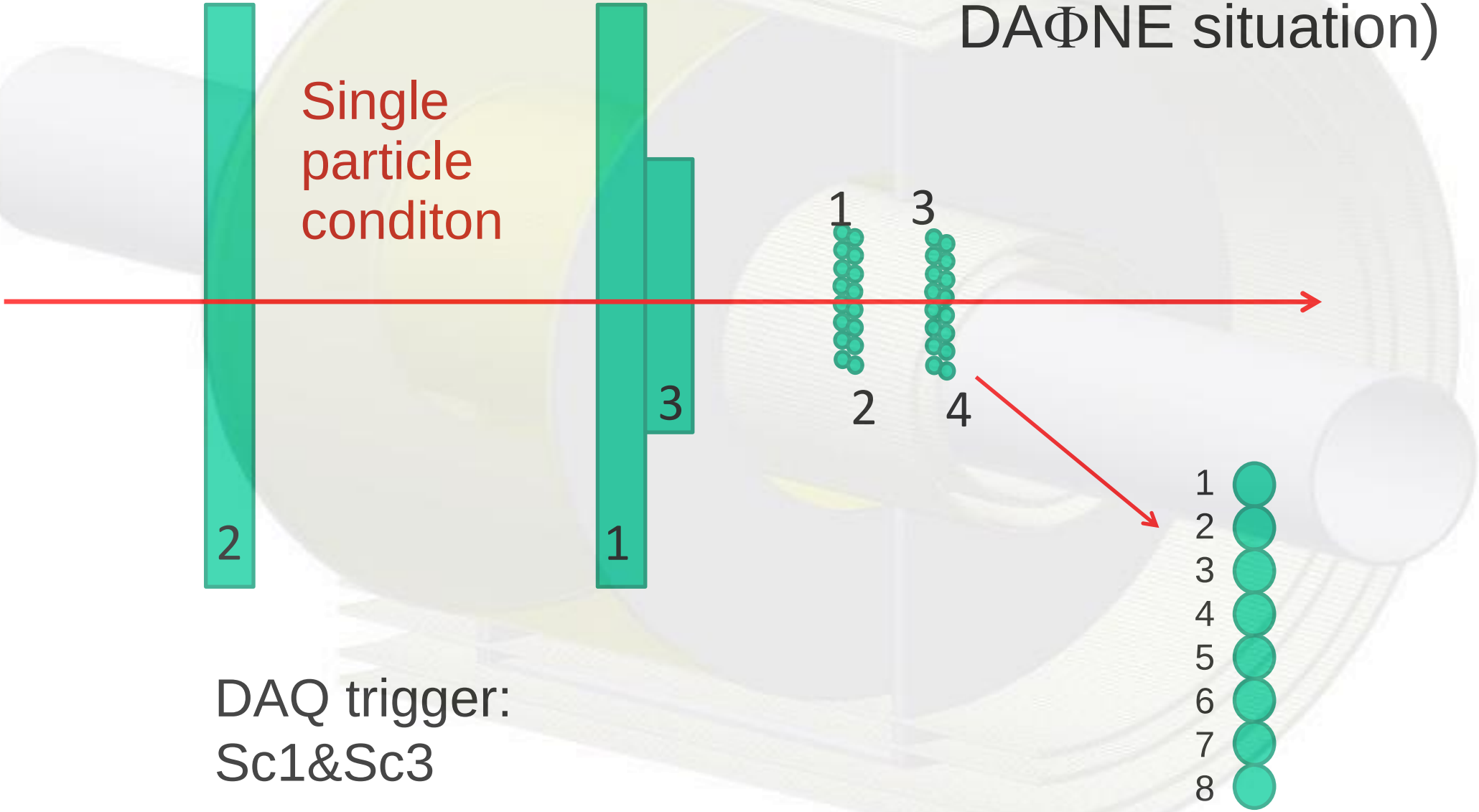
Direct laser on MPPC

MPPC + Sci-Fi

Tests on hadronic beam

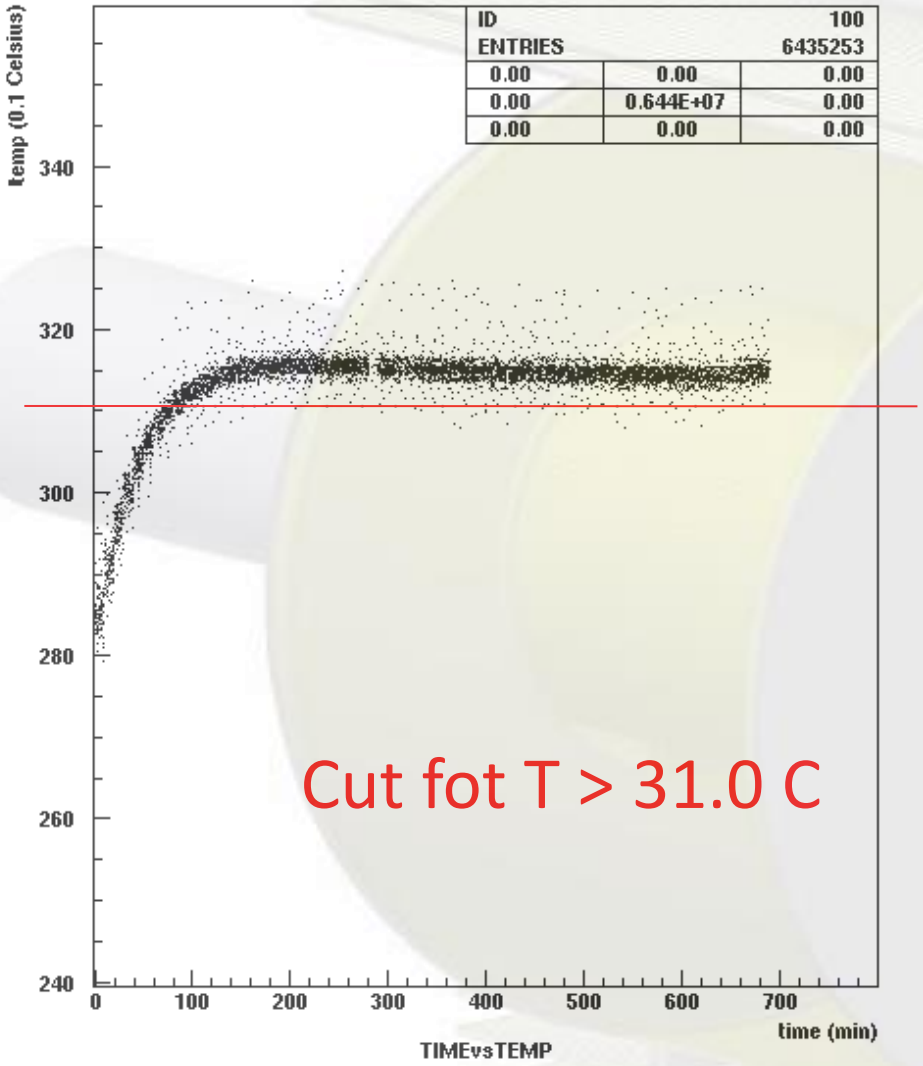
πM-1 beam at
Paul Scherrer Institute (PSI, Zurich)

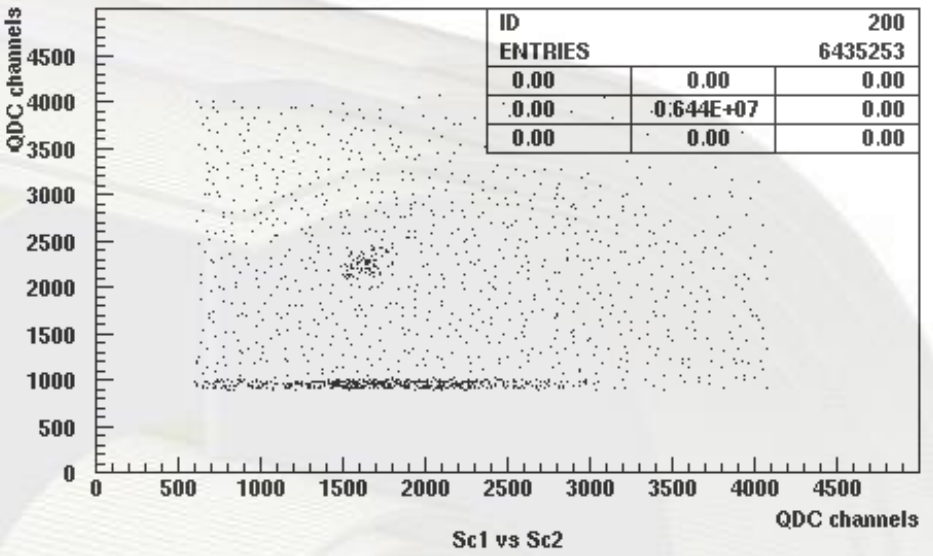
π,μ,e⁻,p beam
(similar to
DAΦNE situation)

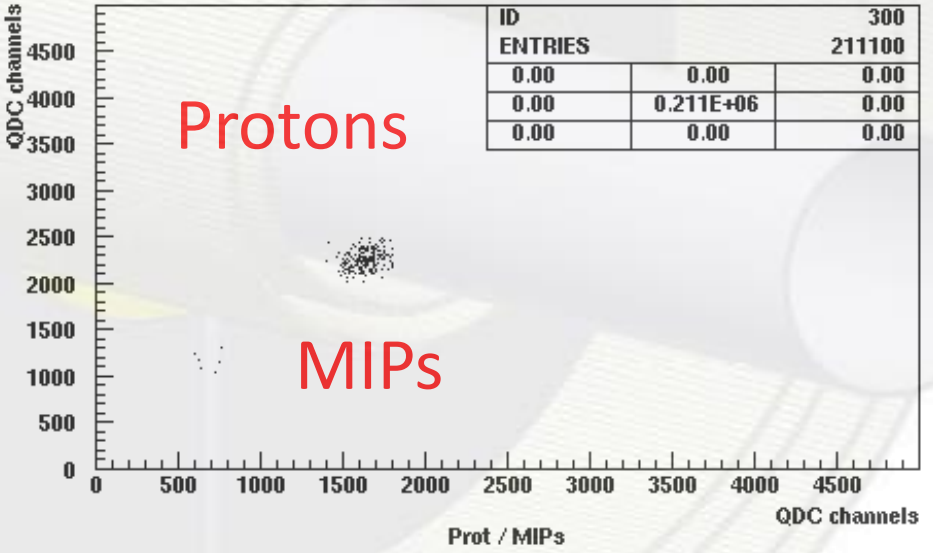


DAQ trigger:
Sc1&Sc3

Tests on hadronic beam

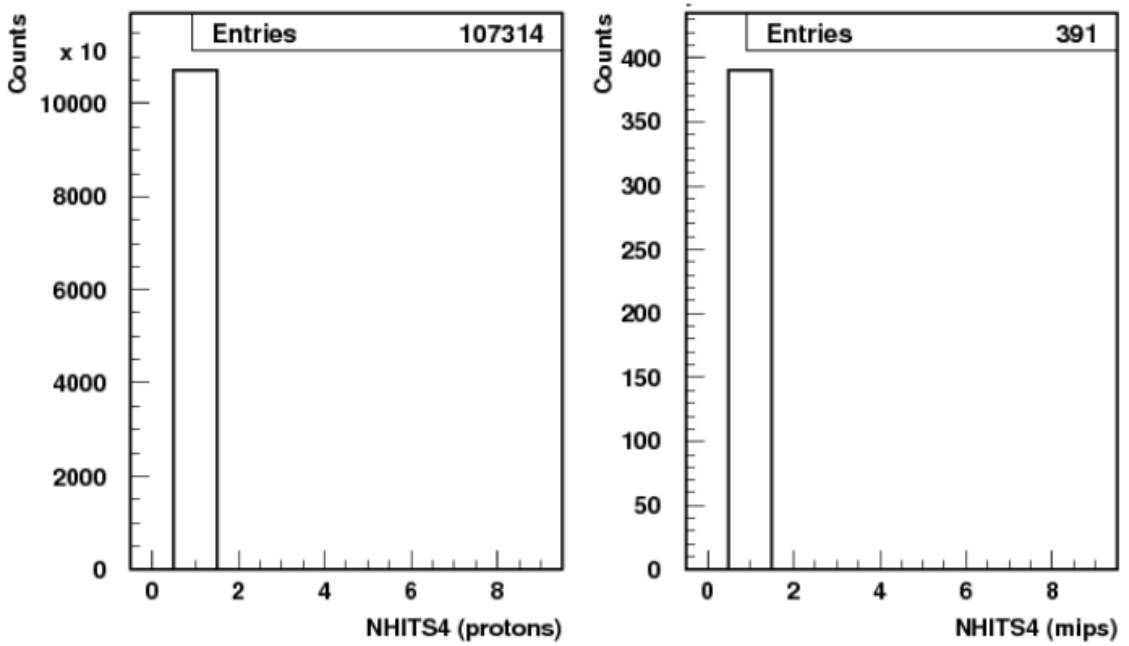


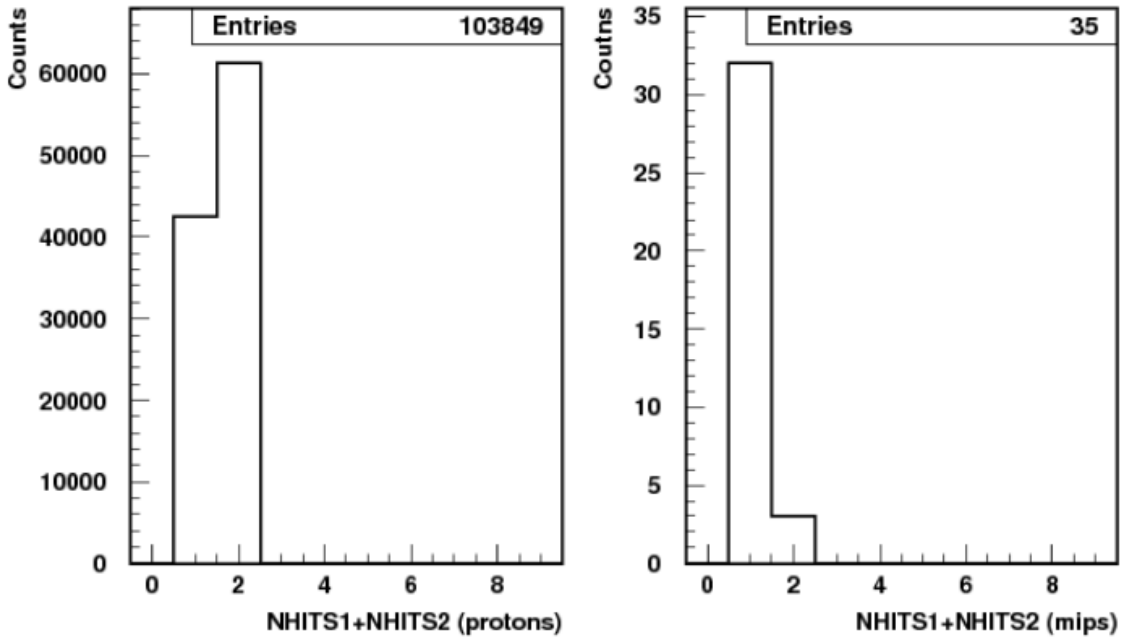




Common cuts for the whole analysis

Tests on hadronic beam: efficiency





$$Eff_{1+2} = \frac{Entr(1 \leq NHITS1 + NHITS2 \leq 2)}{Entr(NHITS4 = 1)}$$

$$Eff_{1+2}^{prot} = (96.8 \pm 0.4(stat))\%$$

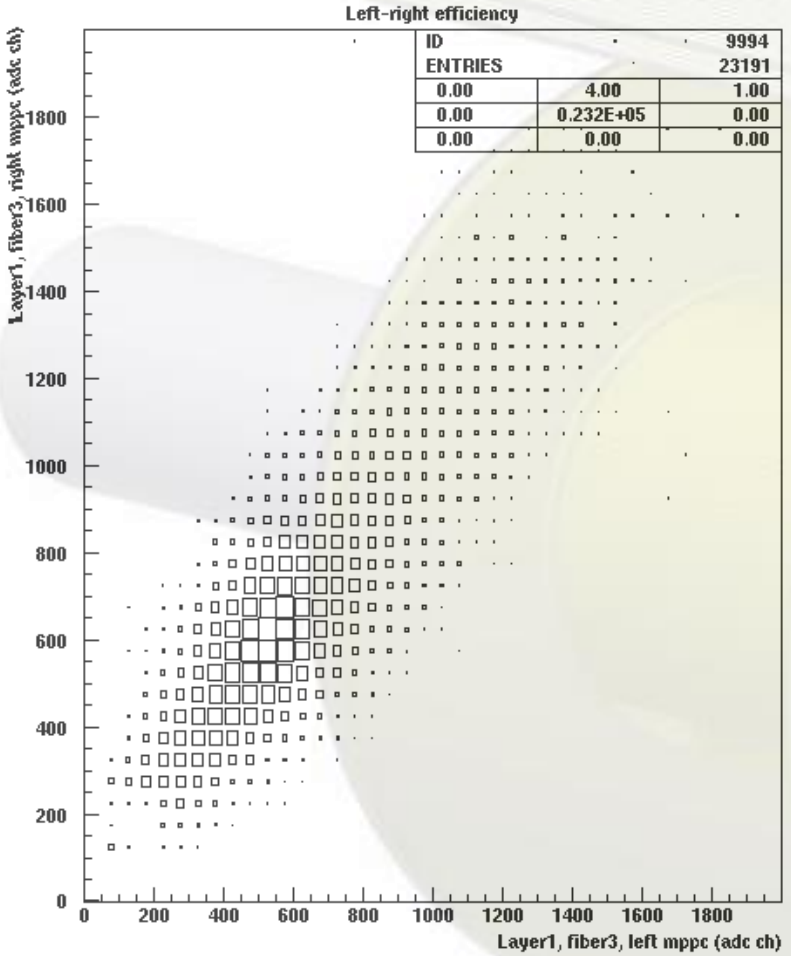
$$Eff_{1+2}^{MIPs} = (8.9 \pm 1.5(stat))\%$$

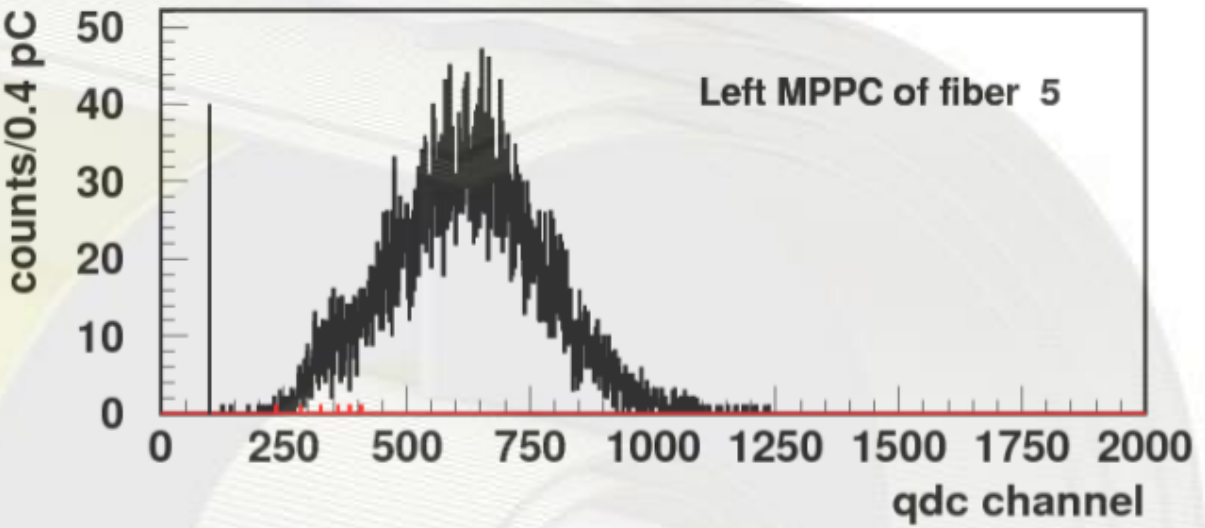
Triggering on 1 fiber:

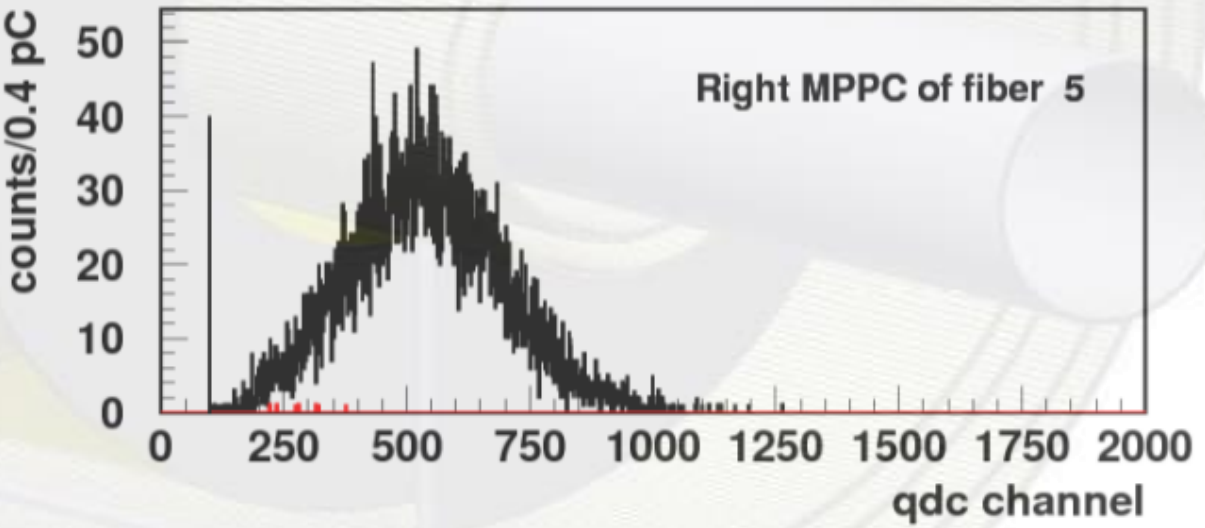
Triggering fiber in L4	Efficiency of (L1+L2) (%)
1	91.1 ± 1.3
2	98.3 ± 1.3
3	97.2 ± 1.3
4	97.5 ± 1.3
5	99.1 ± 1.1
6	99.6 ± 1.6
7	98.8 ± 1.0
8	93.2 ± 1.0

Double layer efficiency

Tests on hadronic beam







Perfect correlation and coupling

High trigger capability
(MIPs rejection)

Conclusion

1) Small dimensions ✓
2) Working in magnetic field ✓
3) Working at room temperature ✓
4) Very good time resolution ($\sigma \sim 300$ ps) ✓
5) High efficiency ✓

Characterization of a scintillating fibers read by MPPC detectors trigger prototype for the AMADEUS experiment

arXiv:1301.7268v1 [physics.ins-det] 30 Jan 2013

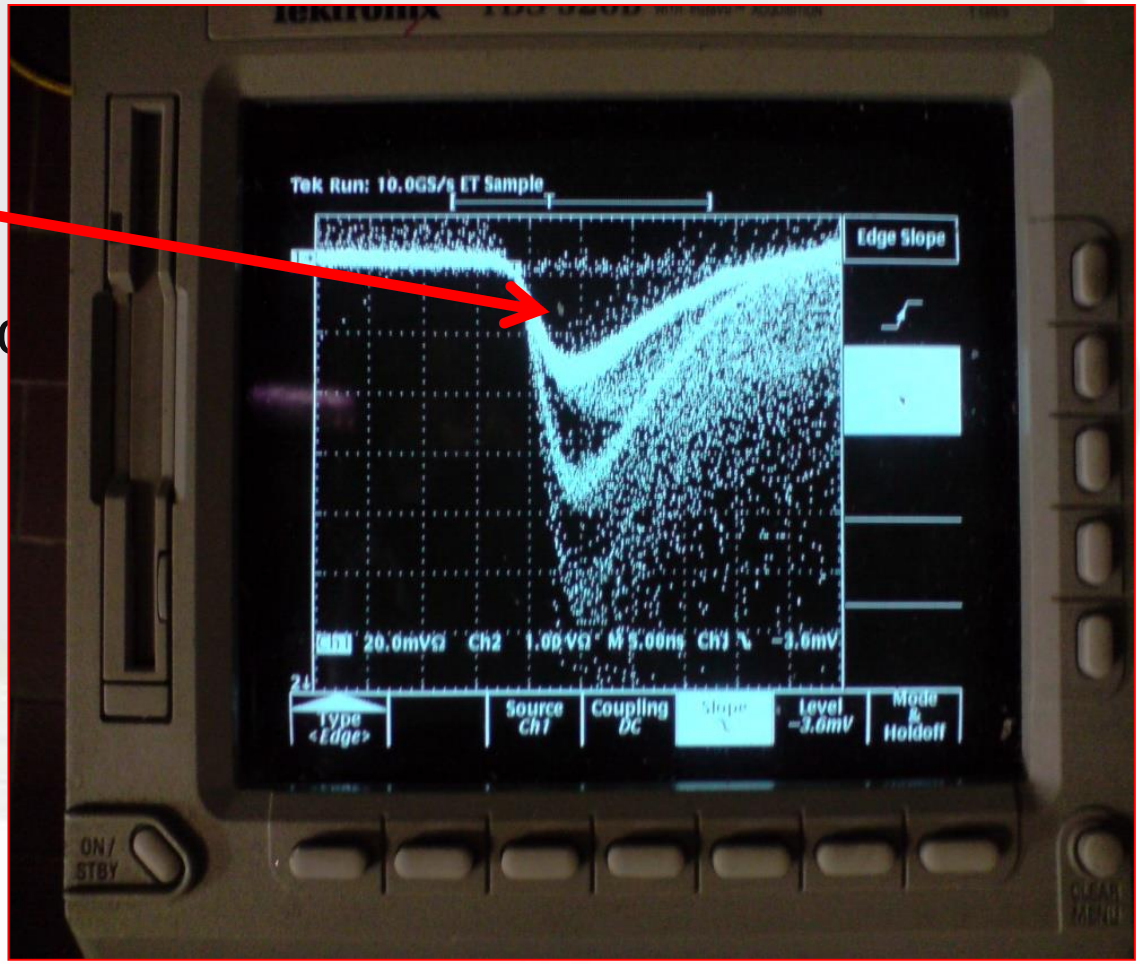
Spare slides

MPPC : working principle

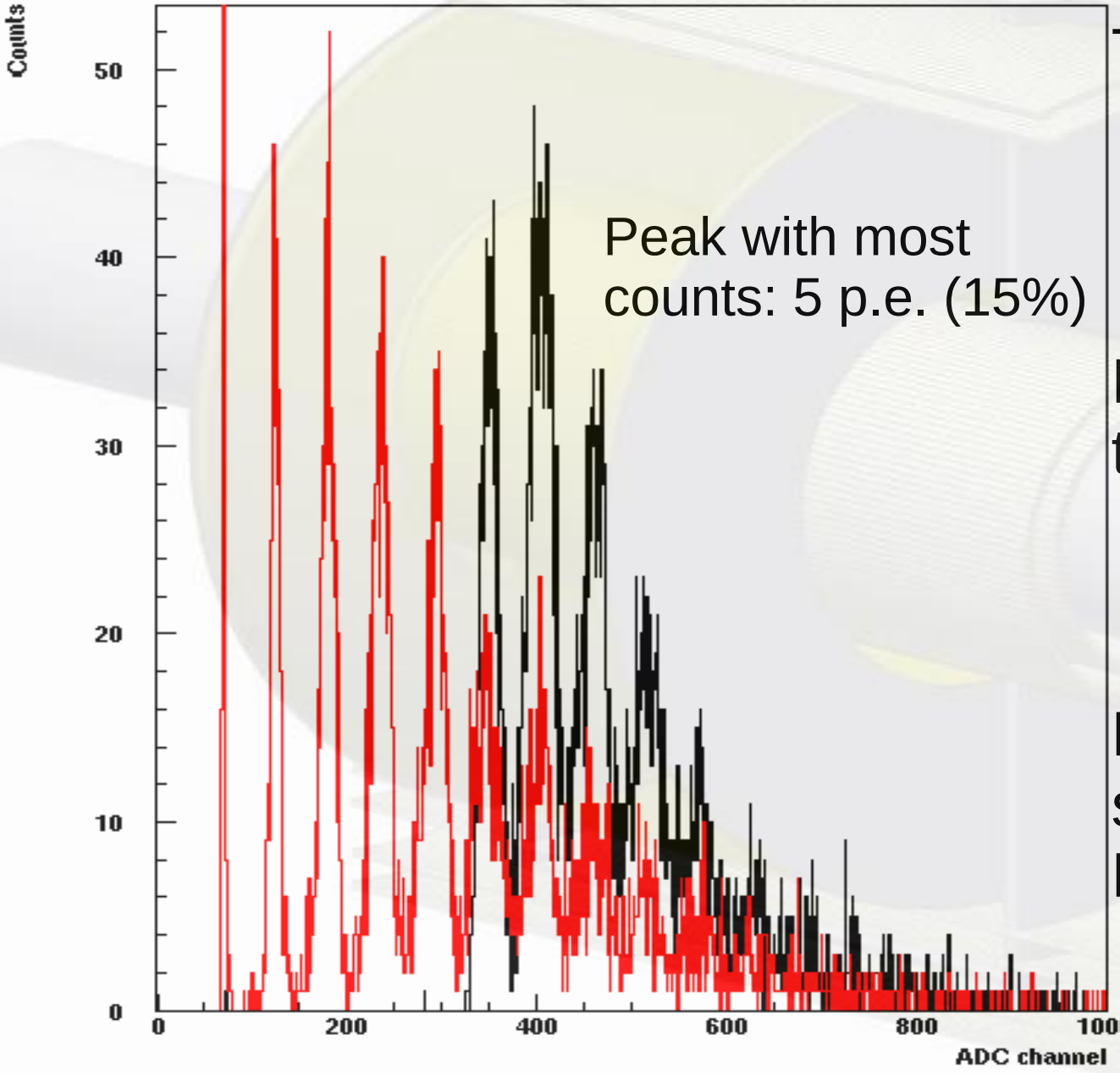
Thermally generated electrons can activate the avalanche process in some pixel, with a high rate of 10^5-10^6 Hz (dark current)

The main contribute is a peak corresponding to 1 pixel (photoeletron)

Luminescence of carriers can also be absorbed by another pixel giving a noise signal



First prototype and MPPC characterization



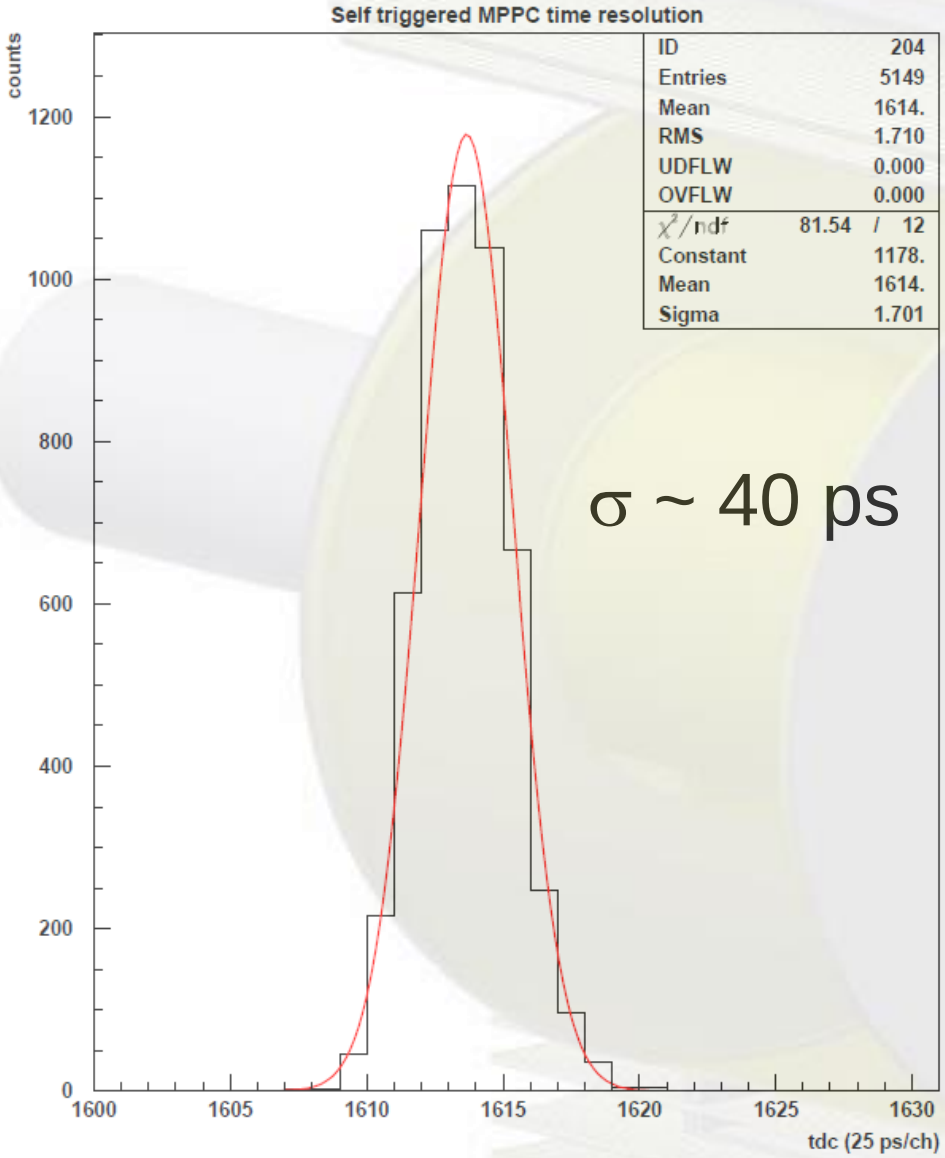
Peak with most counts: 5 p.e. (15%)

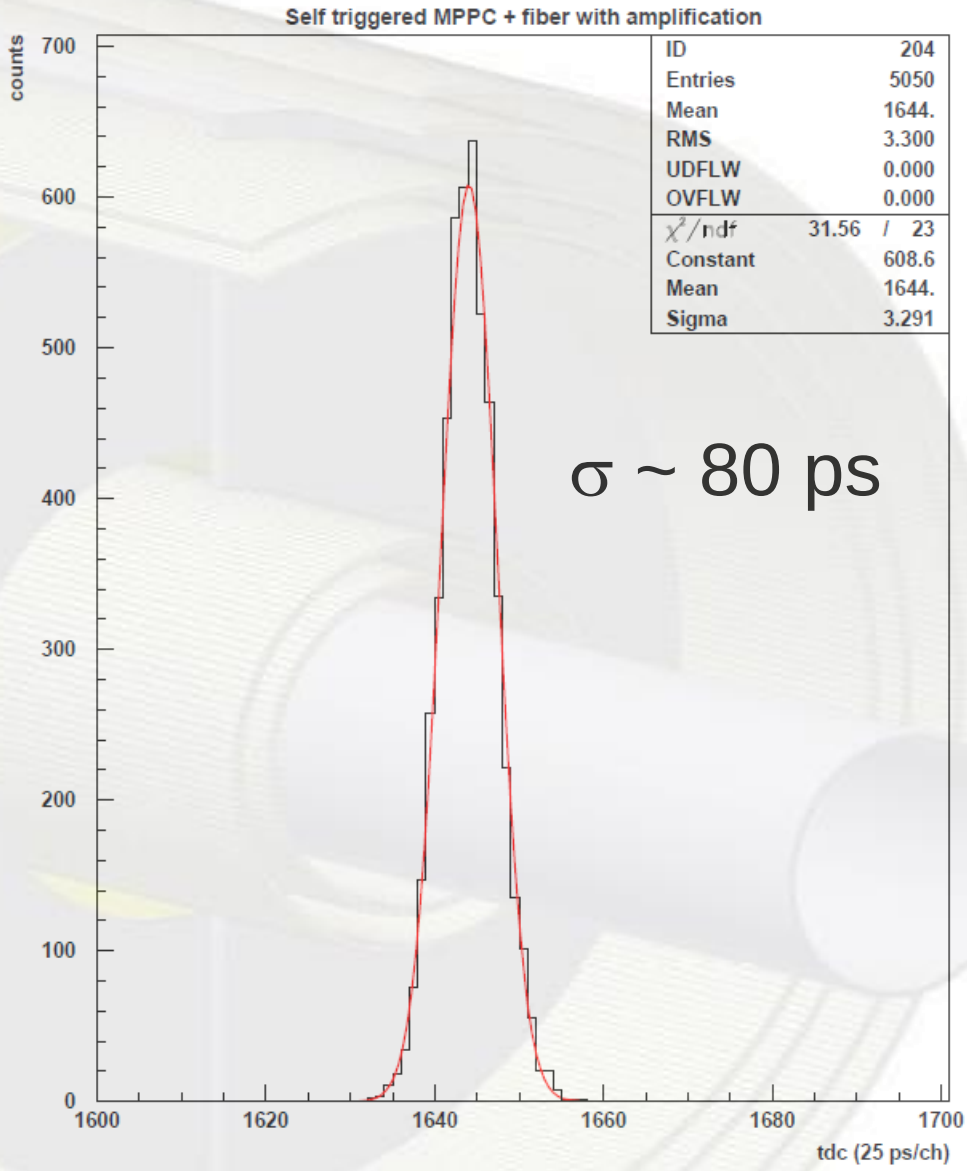
Threshold at 5 p.e.

Black spectra are the trigger-used MPPC

Red spectra are the signal outputs of the NON trigger MPPC

New electronics and 64 channels prototyp

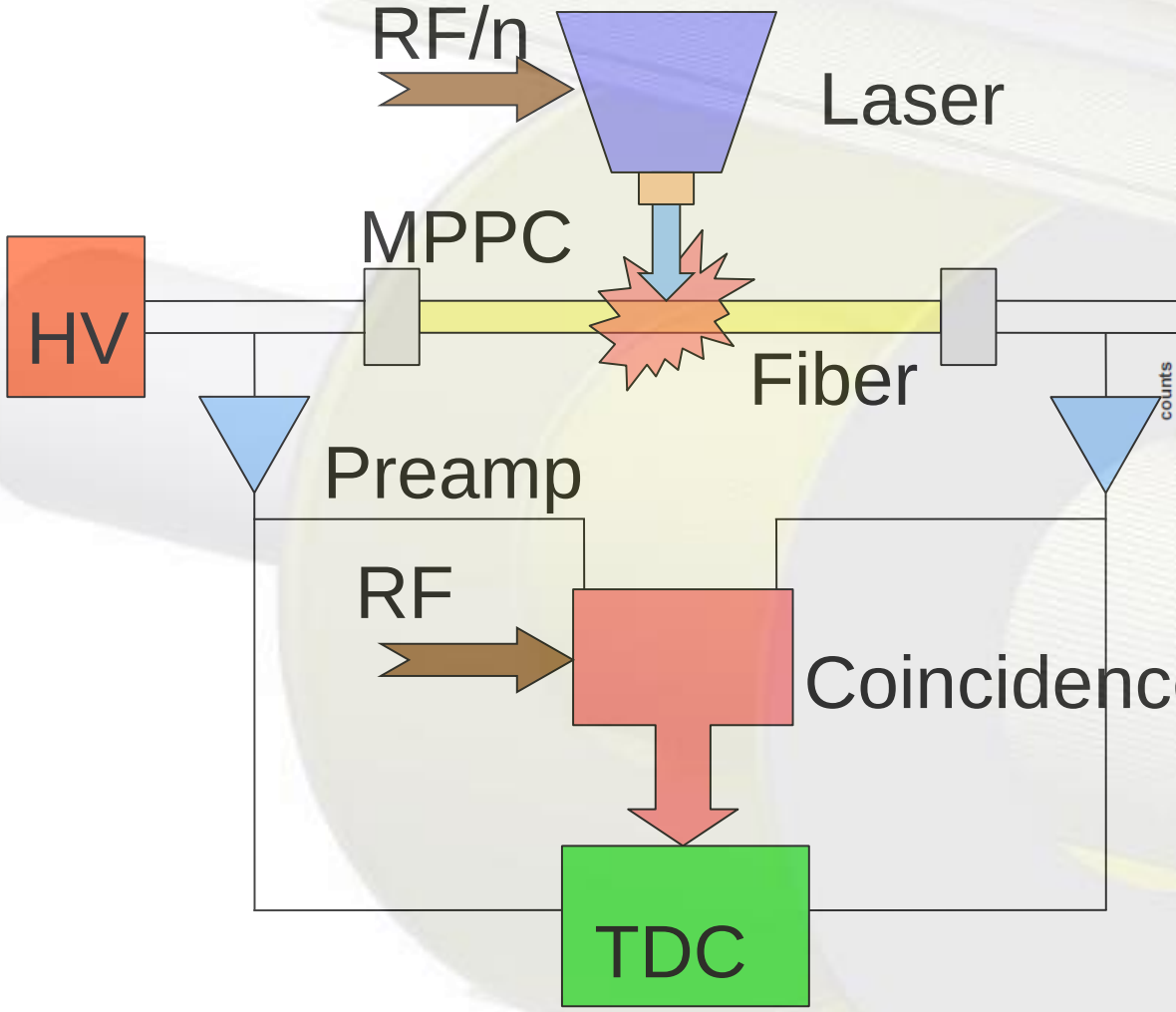




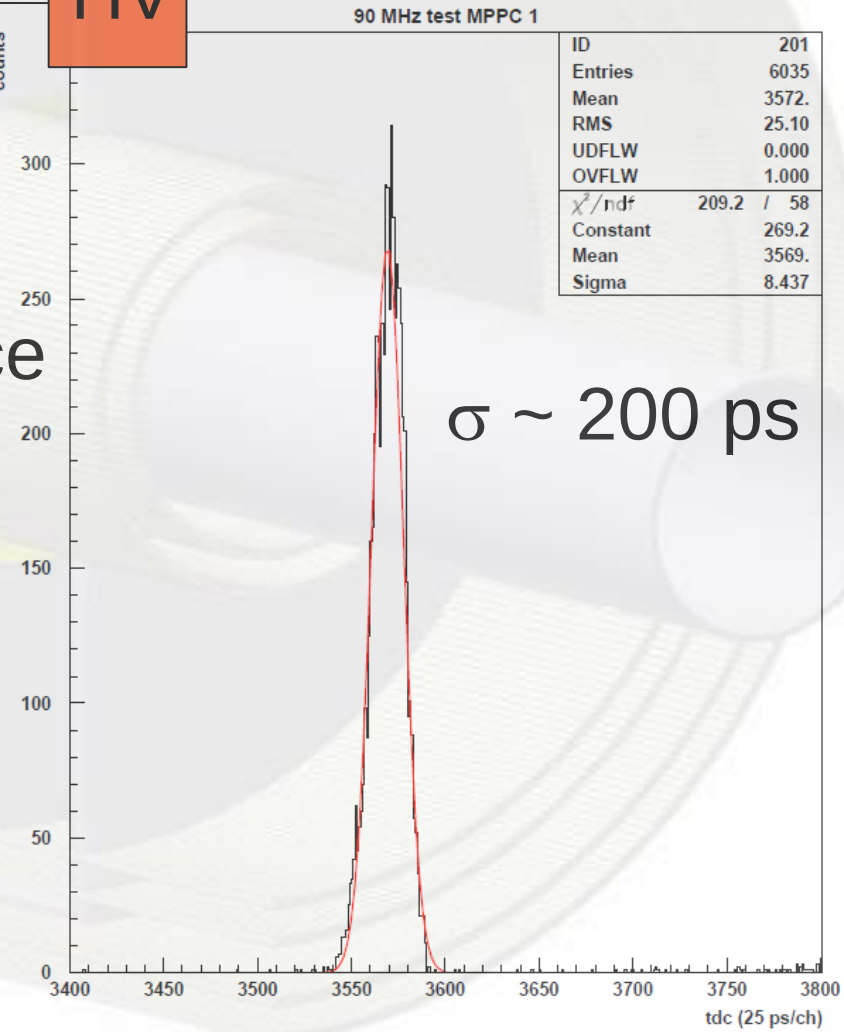
Direct laser on MPPC

MPPC + Sci-Fi

New electronics and 64 channels prototyp



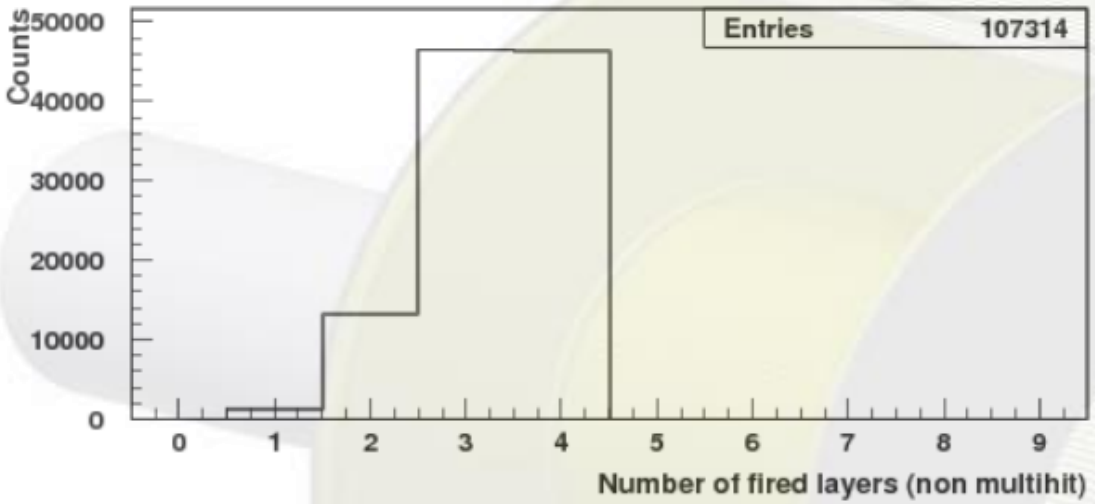
RF=90 MHz (≈ RF/4)
n ≈ 10000

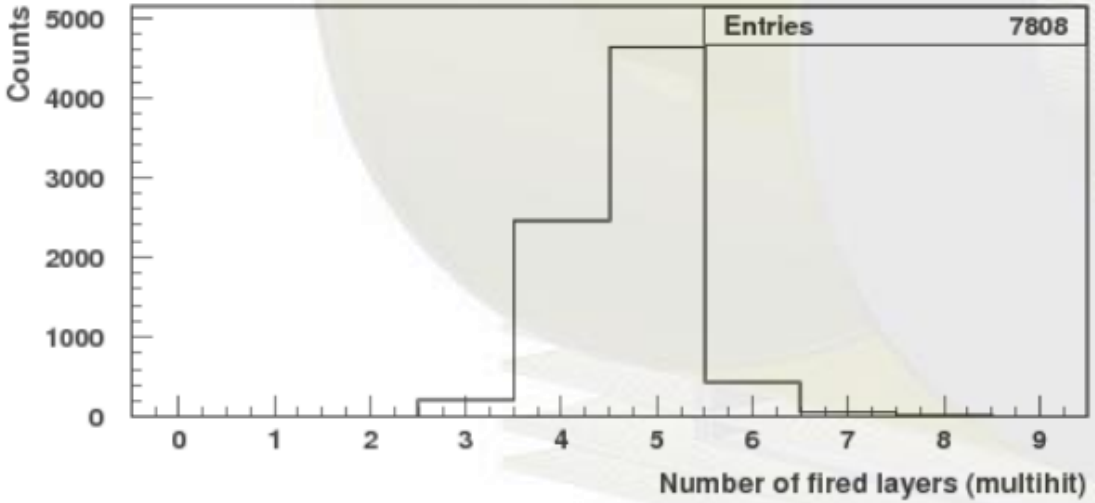


σ ~ 200 ps

No jitter from photon generation
(to be considered)

Tests on hadronic beam: “relative” efficiency





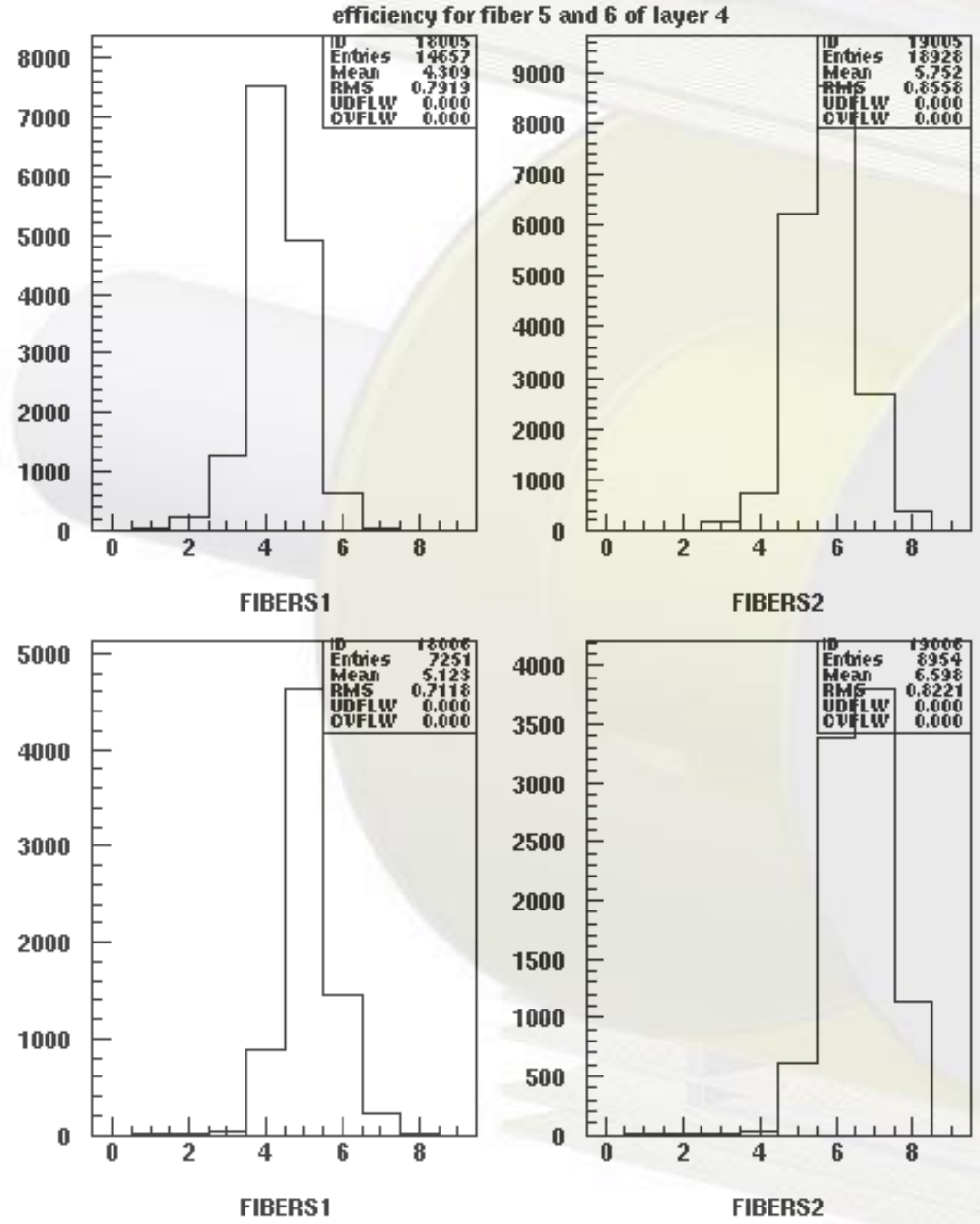
Non Multihit events = 107314

Multihit events = 7808

Multihit/total = 0.068

Single particle configuration !

Tests on hadronic beam



Selecting a single fiber of the last layer, a geometrical correlation is clearly visible with the fibers of the first 2 layers.

This, together on the request of single hit on each fiber, confirms that we are working in single particle condition

Geometrical correlation