# The NA62 RICH detector

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# Outline

✔Motivation

✔NA62 Layout and background

✔Beam tests

✔Results

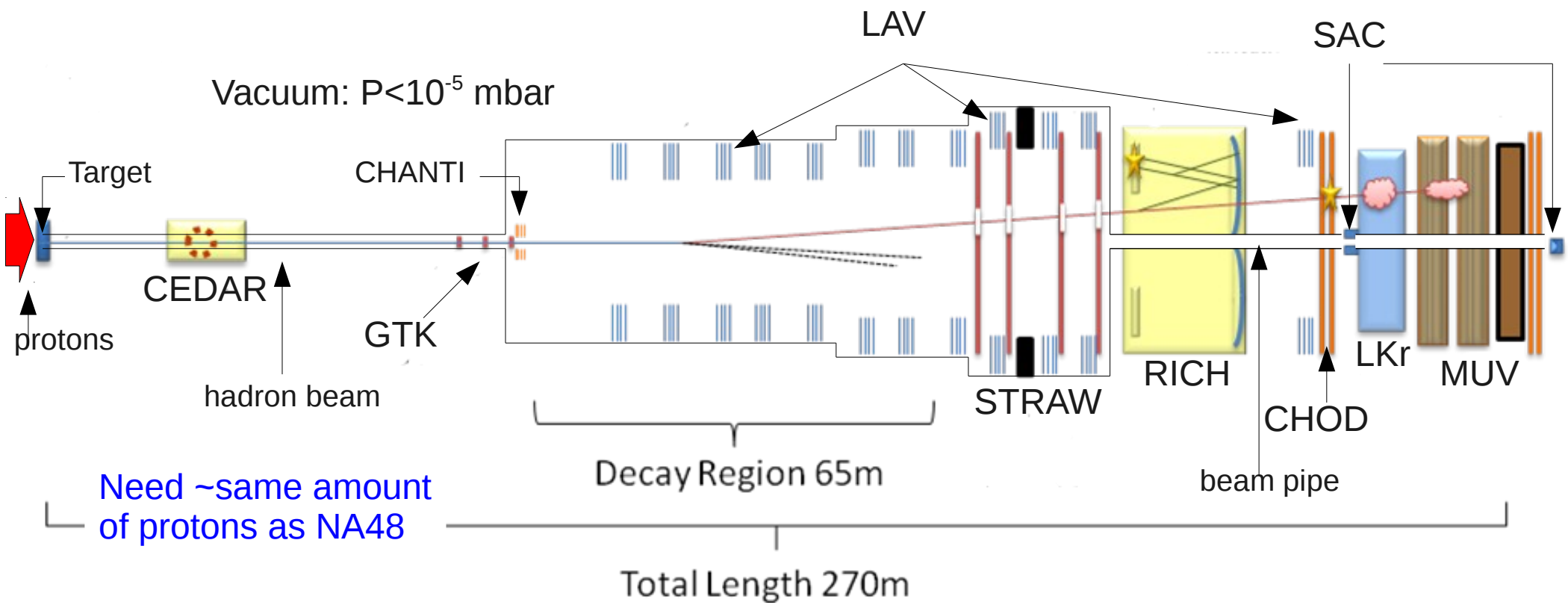
✔Conclusions

# Physical Motivations of NA62

- Measurement of the ($K^+ \rightarrow \pi^+ \nu\nu$)
- One of the cleanest channel in flavor physics
- BR($K^+ \rightarrow \pi^+ \nu\nu$) = (8.5 $\pm$1.1) x $10^{-11}$ SM @ NLO
- Present result BR = $(1.73^{+1.15}_{-1.05})$ x $\mathbf{10^{-10}}$
  (BNL E787/E949)

# NA62 Detector Layout

- SPS primary protons @ 400 GeV/c ⇨ Unseparated secondary charged beam
- 75 GeV/c ($\Delta P/P \sim 1\%$)
- $p/\pi/K$ (positron free, fraction of K ~6%)
- Area @ beam tracker 16 $cm^2$
- Integrated average rate @ beam tracker 750 MHz
- Kaon decays/year $4.8 \times 10^{12}$

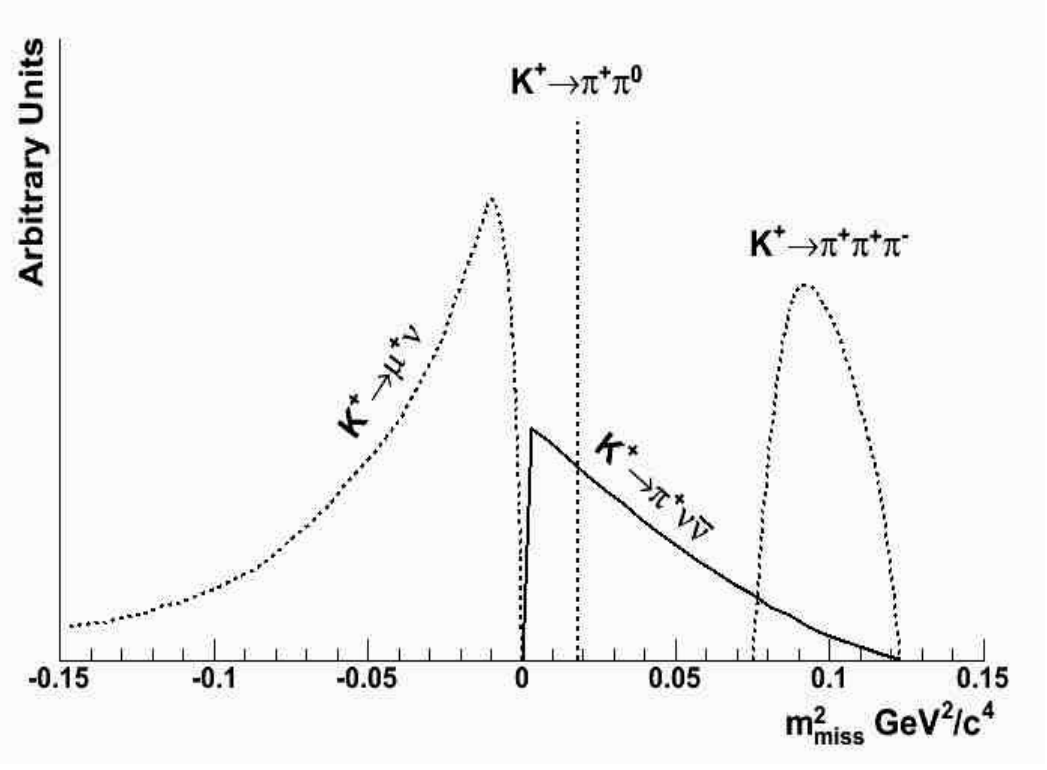


# Background: $K^+ \rightarrow \mu^+\nu$

The $K^+ \rightarrow \mu^+\nu$ process has a BR ~ 63%

Need a rejection of ~$10^{-12}$

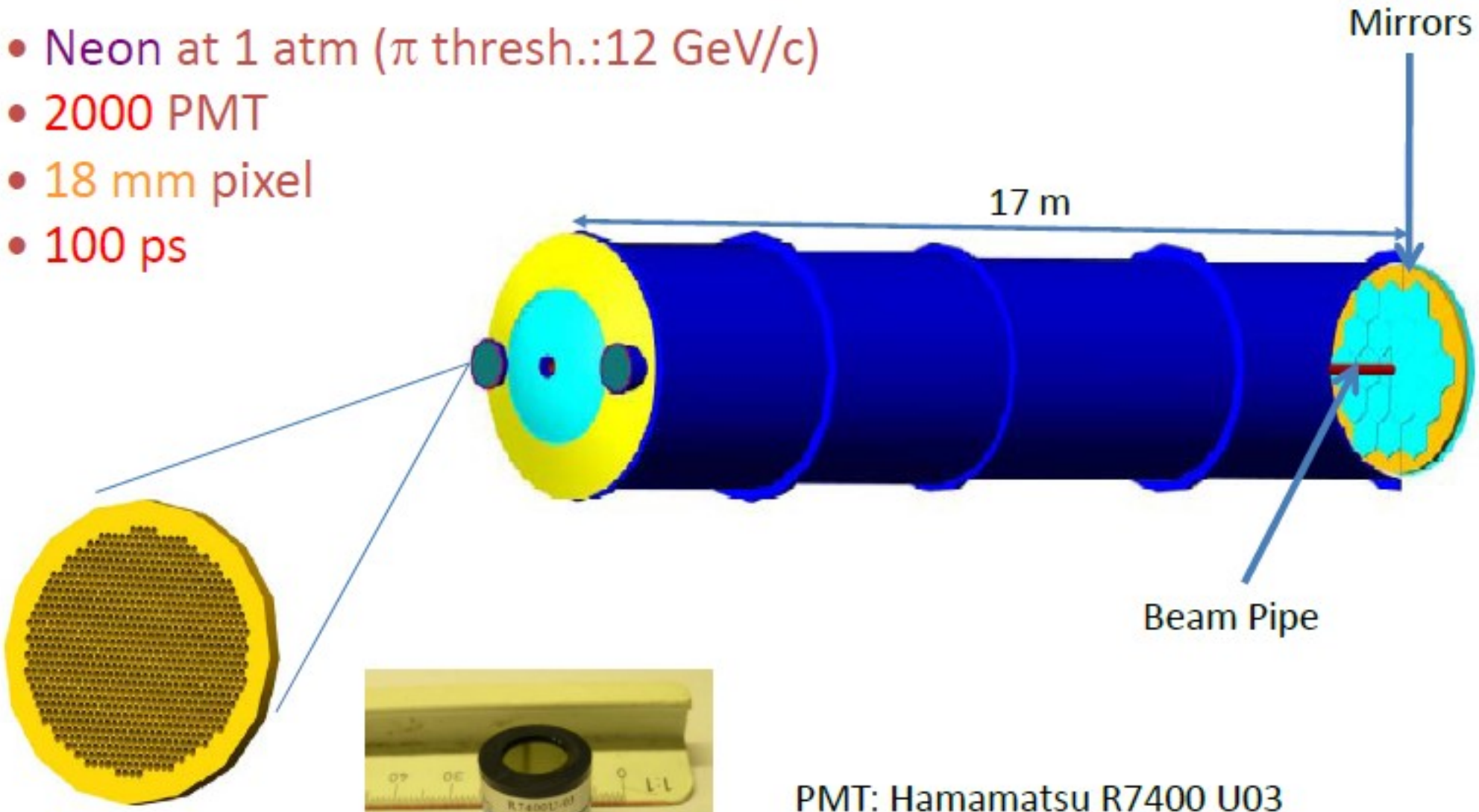
- Kinematics: ~ $10^{-5}$ → STRAW+GTK
- Muon veto: ~ $10^{-5}$ → MUV
- Particle ID: ~ $10^{-2}$ → RICH

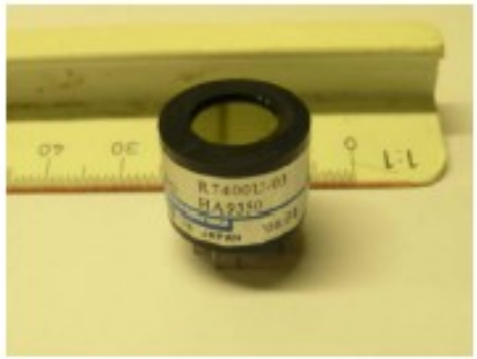


# The NA62 RICH

## 3 σ π-μ separation (15-35 GeV/c)

- Neon at 1 atm (π thresh.:12 GeV/c)
- 2000 PMT
- 18 mm pixel
- 100 ps

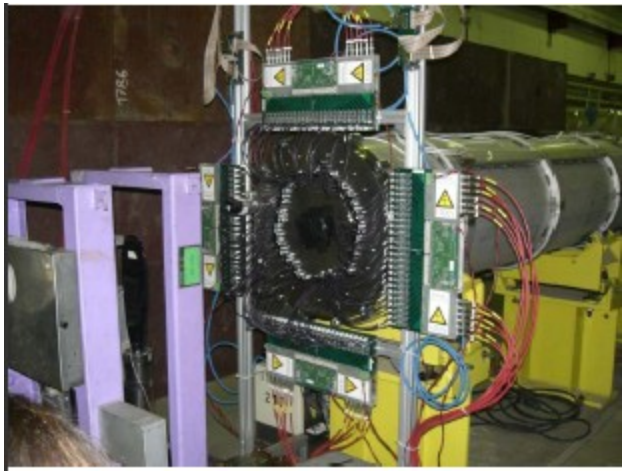


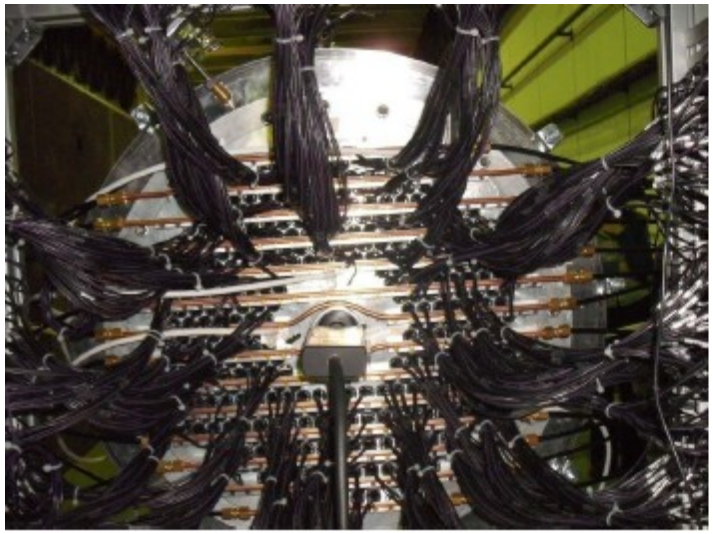
PMT: Hamamatsu R7400 U03

# Test Beams

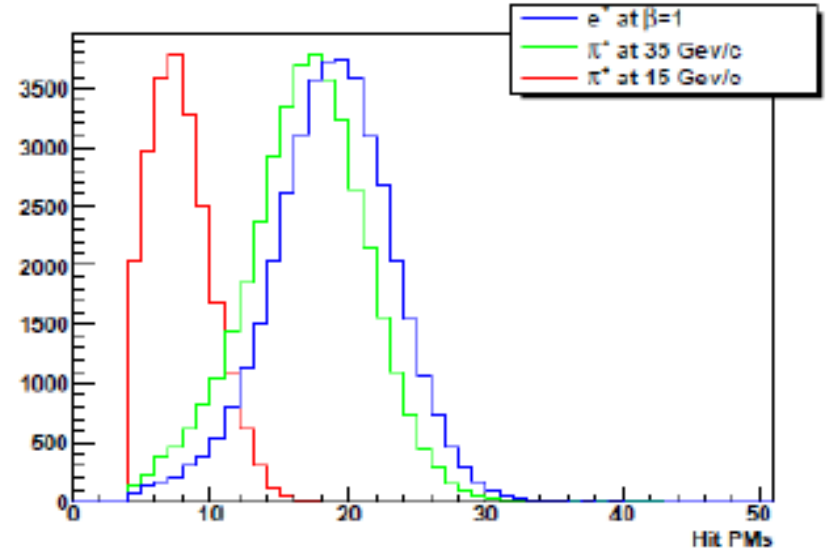
2007 test beam: RICH prototype with 96 PM
(time resolution, n of p.e., …)

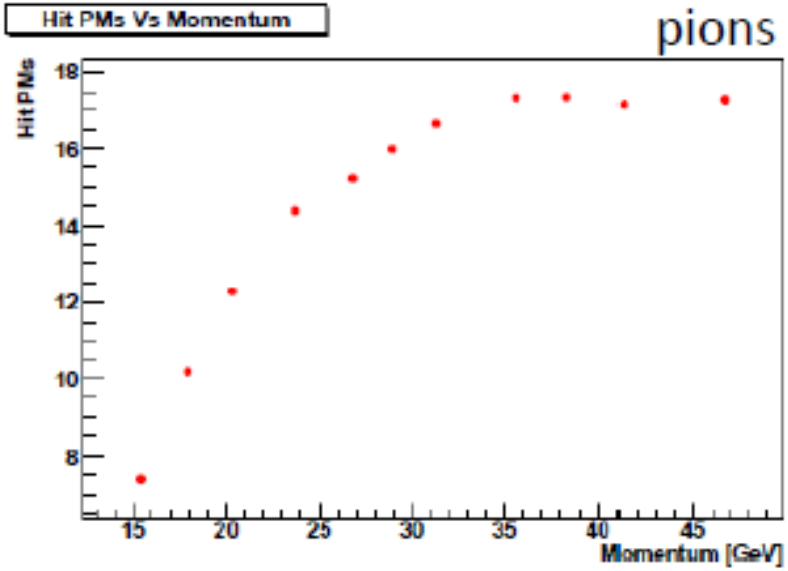


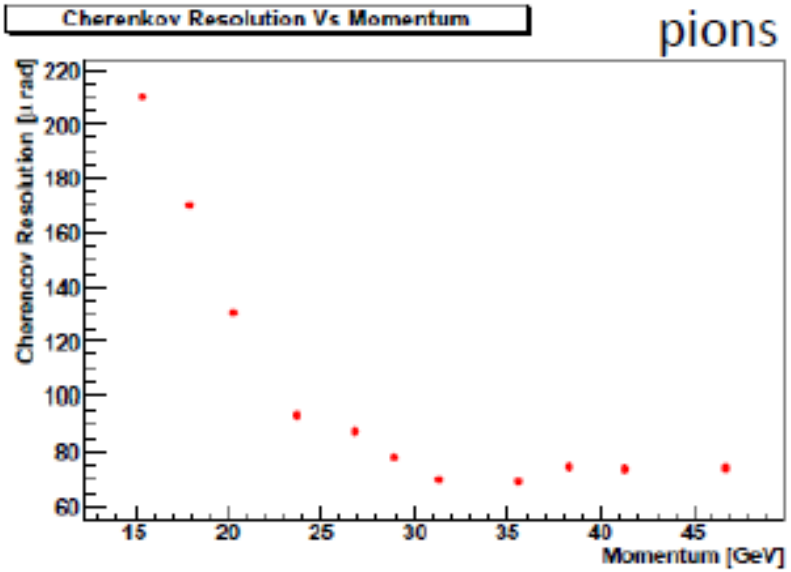
2009 test beam: RICH prototype with 414 PM
(3 σ π-μ separation, n. of p.e., cooling, DAQ, ...)

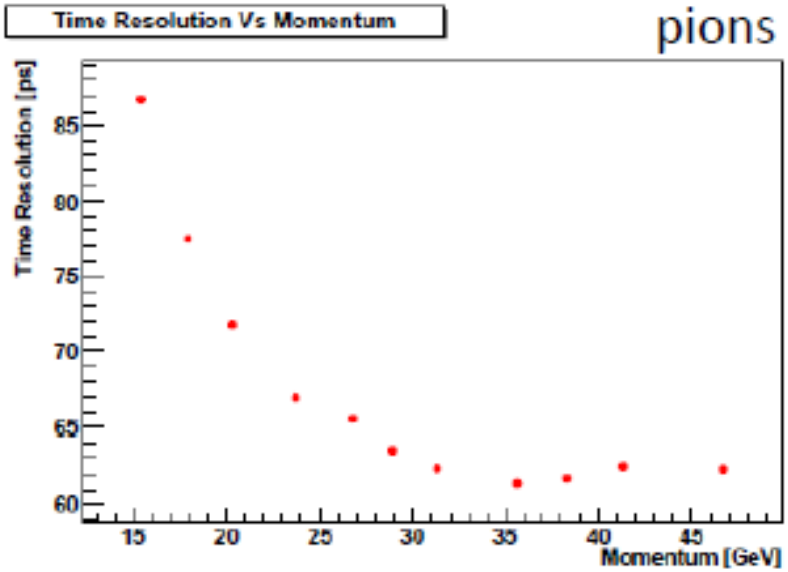


# RICH 400: Performaces



# RICH 400: π-μ separation (1)

- Easier to have a pion beam with respect a muon one
- For each energy point, 2 runs:

➔ One at the same nominal energy

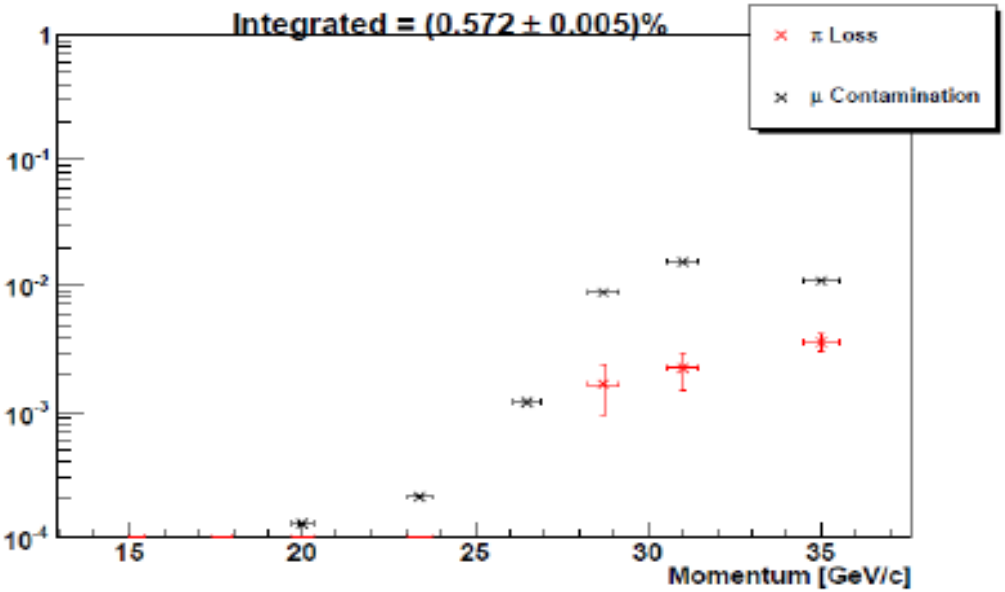
➔ One at energy · $(m_\pi/m_\mu)$ [pion velocity equal to muon velocity at nominal energy]

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\pi$ | 15.2 | 17.7 | 20.0 | 23.4 | 26.5 | 28.7 | 31.0 | 35.0 |
| "$\mu$" | 20.0 | 23.4 | 26.5 | 31.0 | 35.0 | 38.0 | 41.0 | 46.3 |

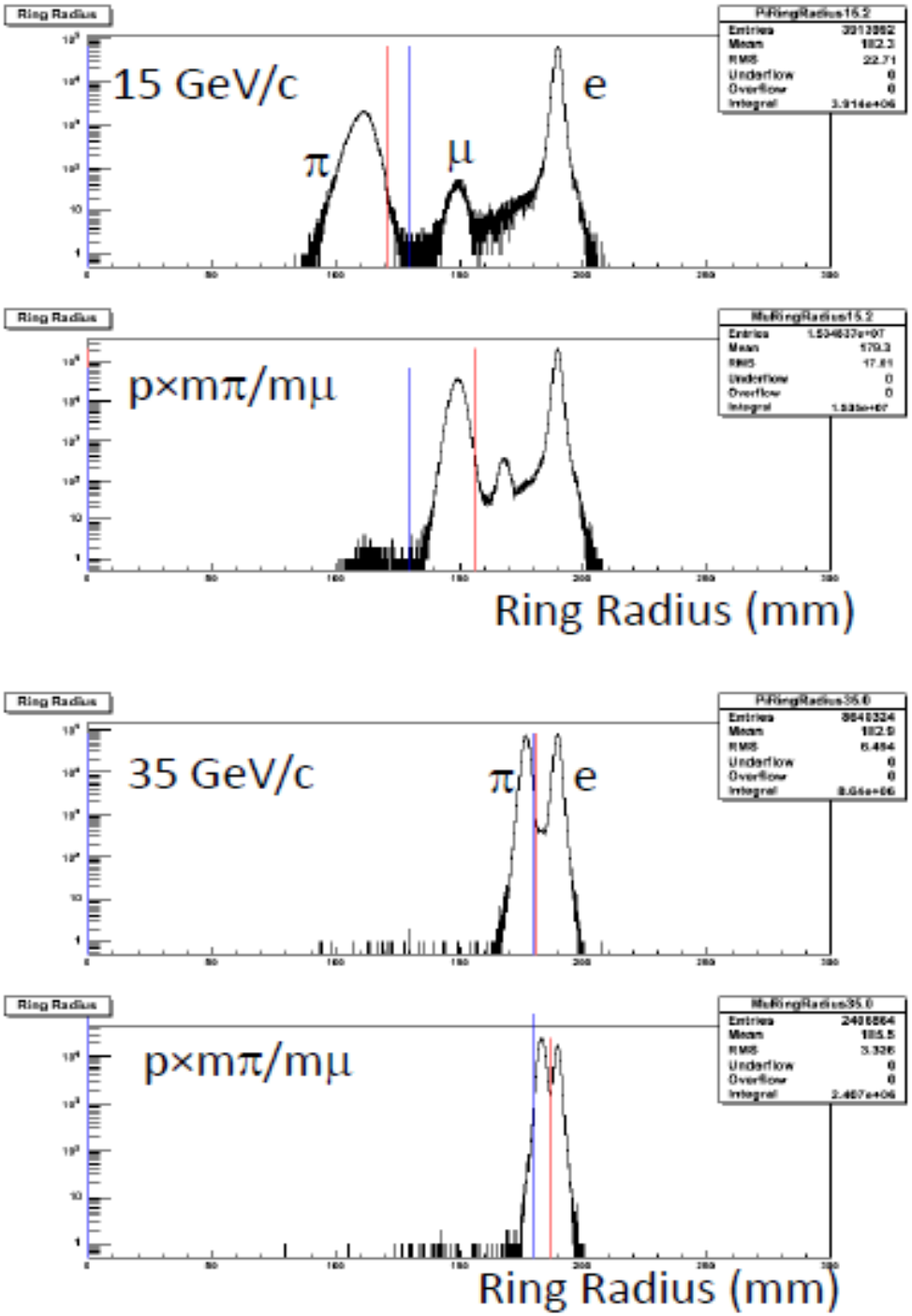
GeV/c

➔ Compare the two distribution of the fitted Cherenkov rings

# RICH 400: π-μ separation (2)




Muon suppression (15-35 GeV/c): 0.7%



# Conclusions

- The 2 beam tests have confirmed the expectations
- Work in progress to construct the final detector to be ready in 2012-2013

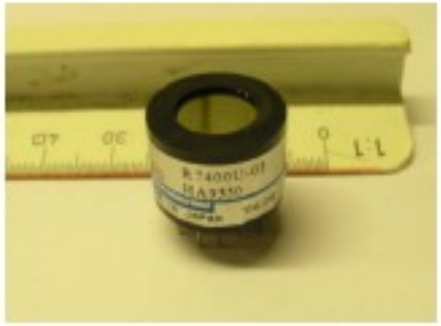
# Spares

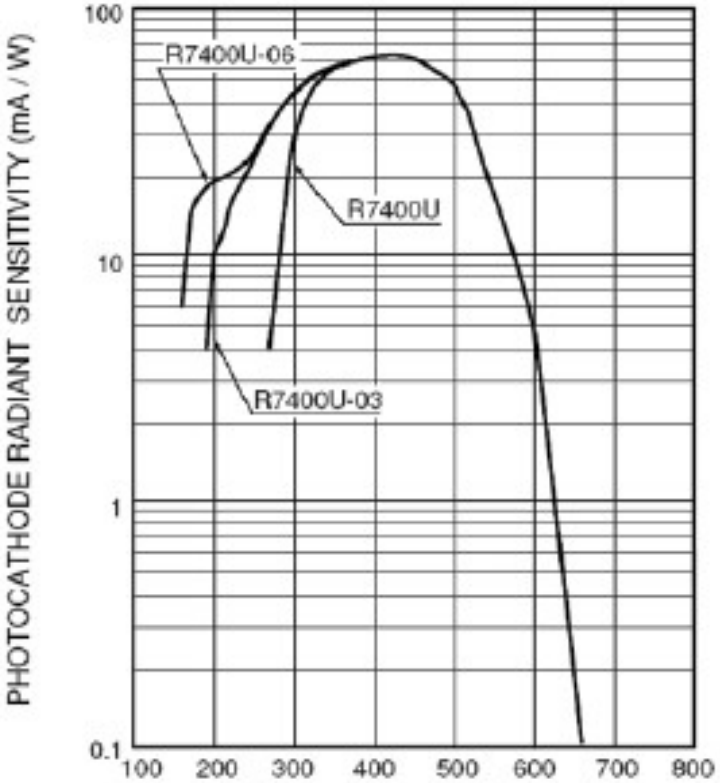
# The mirror system

- 20 mirror pieces
- 18 hexagonal
- 2 semi-hex + pipe hole
- 700 mm wide, 25 mm thick glass
- 17 m focal lenght,

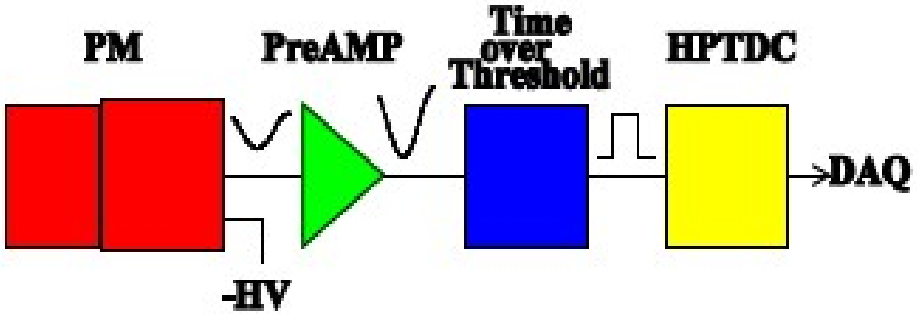
# The photomultipliers

- Hamamatsu R7400U-03
- UV-glass, bialkali, 8 dyn
- 16 mm wide (8 mm active)
- Gain 1.5 $10^{+6}$ @900 V
- 280 ps time jitter (FWHM)
- 185-650 nm response (420 nm peak)
- Q.E. around 20% on peak
- PM output (1 p.e.): 240 fC, peak at 200 μA or -10 mV (50 Ω)
- Rise time: 0.78 ns, fall time~1.6 ns





# The Front-end and DAQ




FE+DAQ contribution < 50 ps

- NINO ASIC (from ALICE) as fast discriminator operated in Time over Threshold
- HPTDC (developed at CERN) embedded on TELL1 (from LHCb)
- Possible use of the RICH as main charged trigger of NA62