

Il RICH di NA62

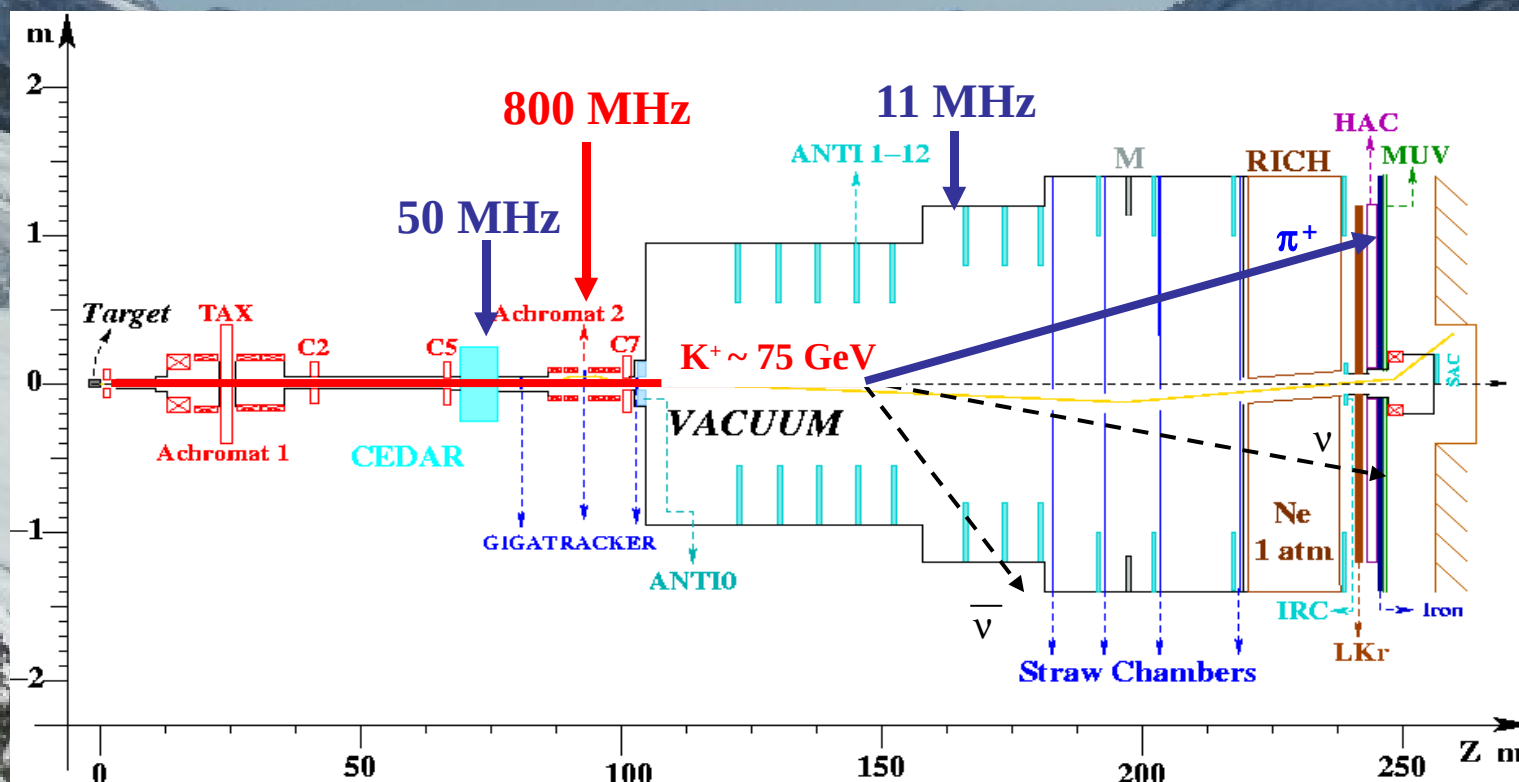
Antonino Sergi
Università e INFN Perugia

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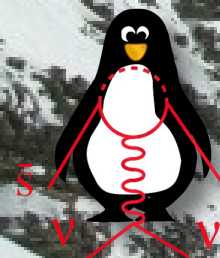
NA62: misura di $K^+ \rightarrow \pi^+ \nu \bar{\nu}$

- Previsione teorica molto pulita, sensibile a V_{td} , molto sensibile a nuova fisica (se misura al 10%: ~ 100 eventi)
- $BR(K^+ \rightarrow \pi^+ \nu \bar{\nu}) = (8.0 \pm 1.1) \times 10^{-11}$ SM @ NLO
- E787/949: $BR(K^+ \rightarrow \pi^+ \nu \bar{\nu}) = 1.47^{+1.30}_{-0.89} \times 10^{-10}$ (3 eventi)



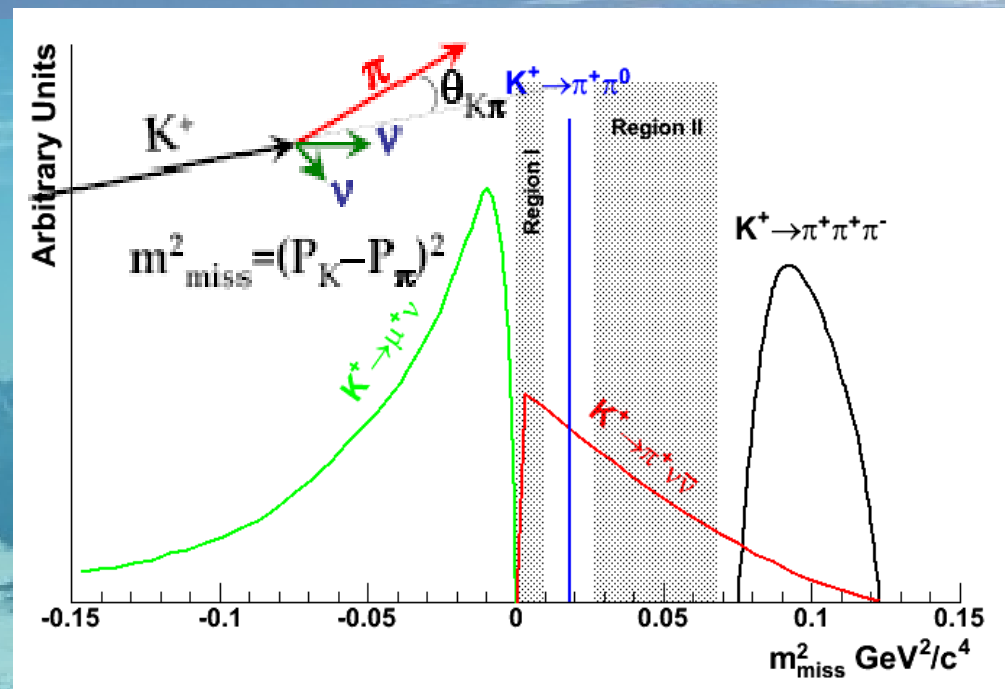
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Ruolo del RICH

- Fondo principale
 $K^+ \rightarrow \mu^+ \nu$ (BR $\sim 63\%$)
- Reiezione $\sim 10^{-12}$
 - Cinematica $\sim 10^{-5}$
 - Vetì $\sim 10^{-5}$
 - PID $\sim 5 \cdot 10^{-3} \Rightarrow$ RICH
- Tempo K- π
 - Risoluzione temporale $\sim 100\text{ps} \Rightarrow$ RICH

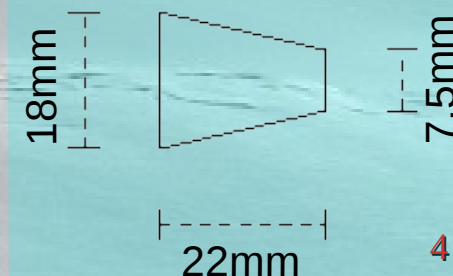
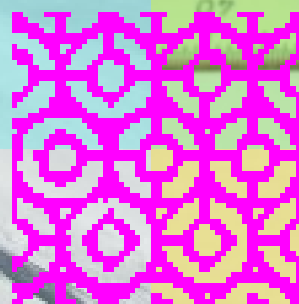


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II RICH

- Separazione π - μ a 3σ fino a $35\text{GeV}/c$
- Caratteristiche (basato su ToyMC di M.Lenti, INFN-FI):
 - Lunghezza focale $f \sim 17\text{m}$
 - Neon a 1 atm $\leftrightarrow P_\pi > 12\text{GeV}/c$
 - 2000 PM (Hamamatsu R7400U) granularità 18mm $\rightarrow$ Cono di Winston
 - $\sigma_t \leq 100\text{ps}$



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Prototipo 96 (autunno 2007)

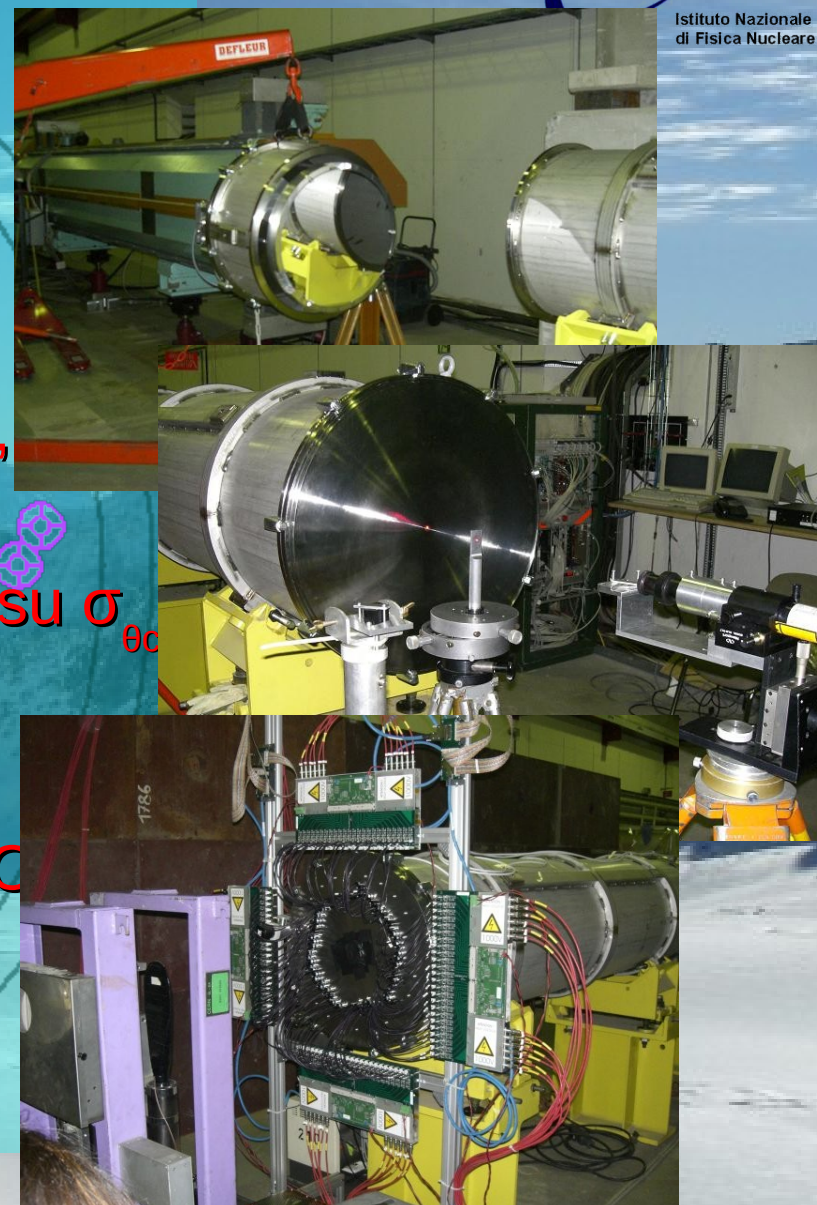
Perugia

INFN

Istituto Nazionale
di Fisica Nucleare

- **Scopo:**
 - Risoluzione temporale
 - Molteplicità PM
- **Caratteristiche:**
 - Specchio: $\Phi=50\text{cm}$, spessore=2.5cm, $f=17.01\text{m}$
 - 96 PM (Hamamatsu R-7400) $\Rightarrow$ Bias su σ_{θ_c}
- **Preparazione:**
 - Test PM e Front-End (basato su NINCO)
- **Setup del TestBeam:**
 - 96.2% π , 3.0% K, 0.8% p @200GeV

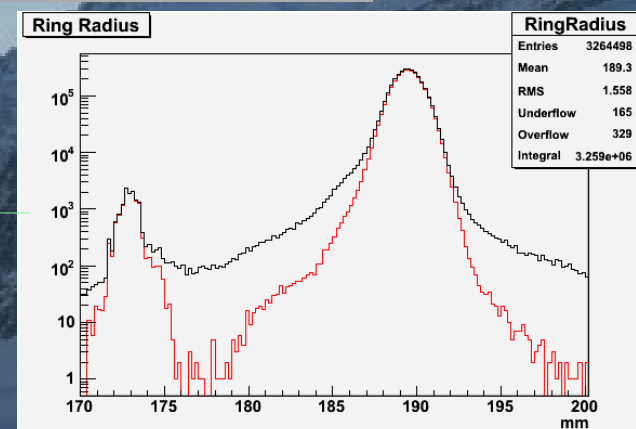
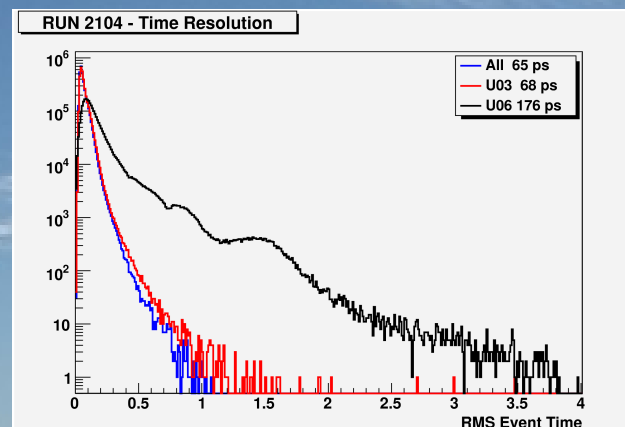
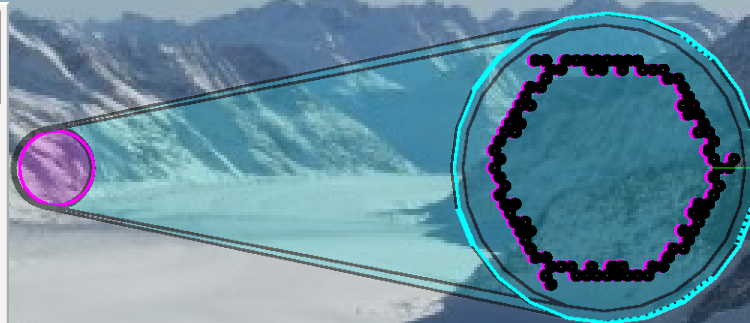
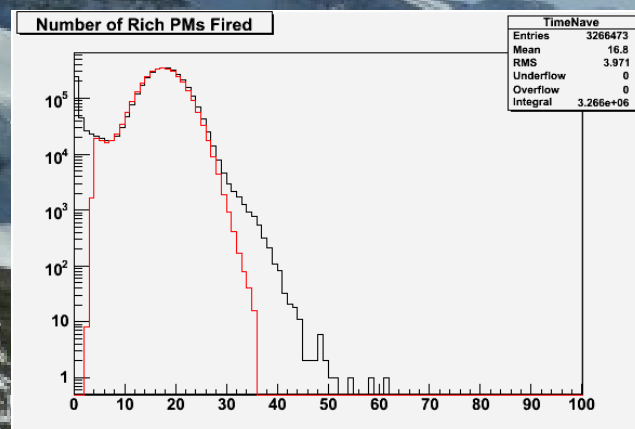
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Risultati del Test Beam

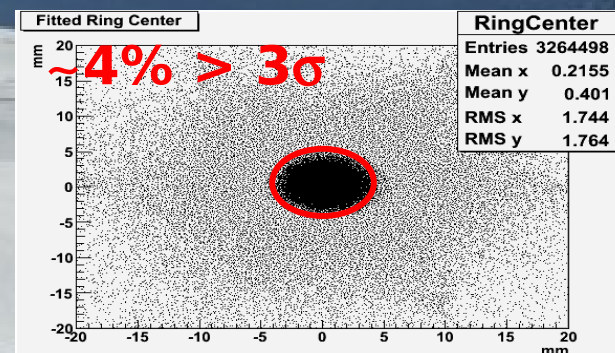
• Prestazioni:

- Risoluzione sul tempo dell'evento $\sim 65\text{ps}$
- $\sigma_{\theta c} \sim 50\mu\text{rad}$ (bias)



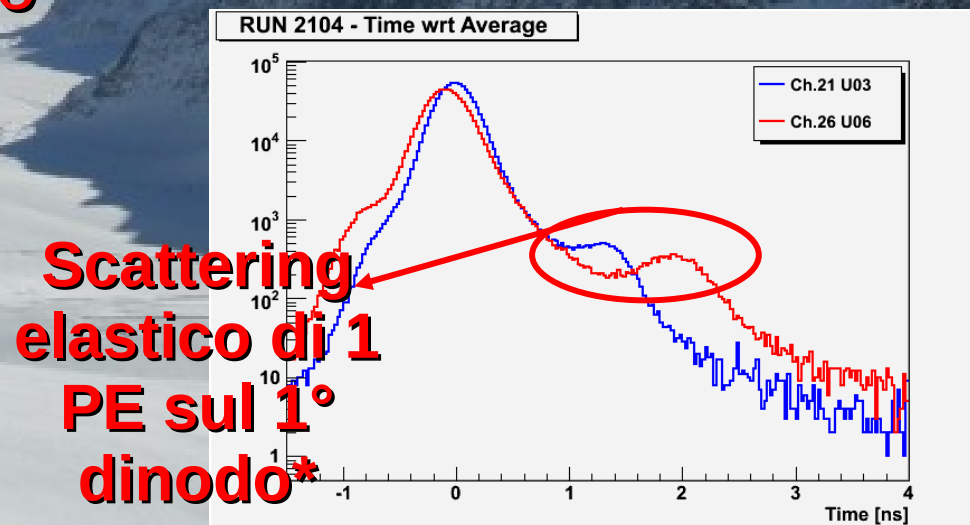
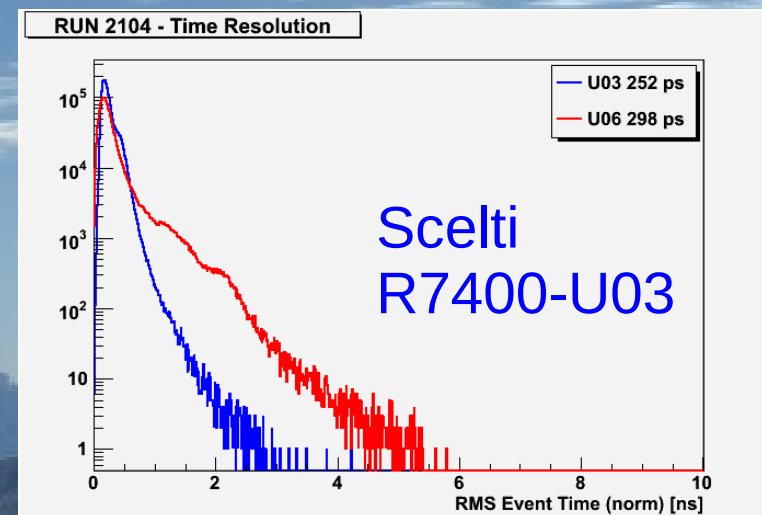
– Risoluzione angolare
NA62 sulla traccia $\sim 100\mu\text{rad}$

– Molteplicità PM ~ 17



Risultati del Test Beam (qualche dettaglio)

- Confronto PM U03/U06
- Risoluzione del singolo PM
- Diversi test di robustezza:
 - Contaminazione Neon fino all'1%
 - Variazioni di temperatura
 - Niente da segnalare

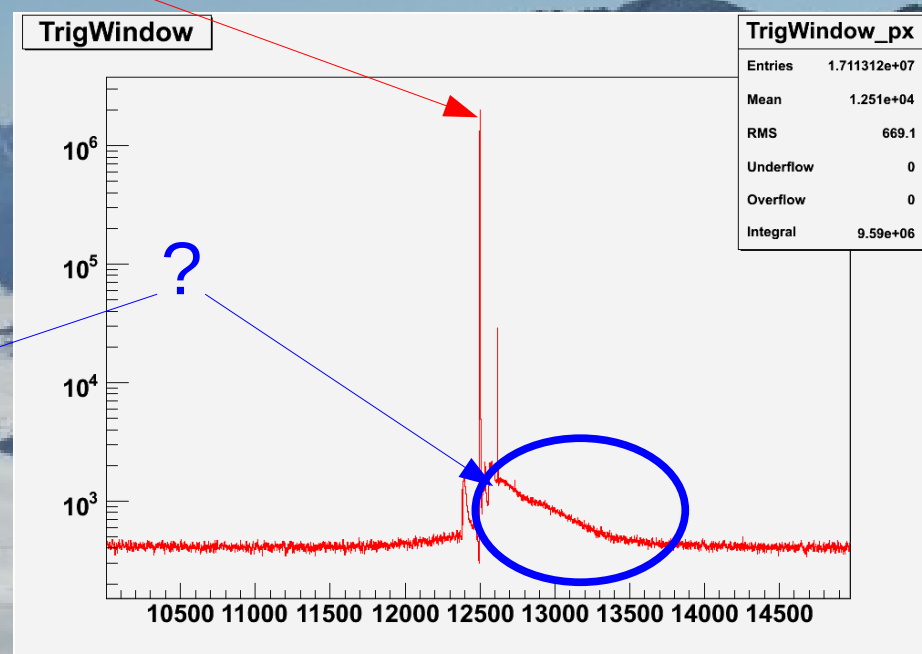
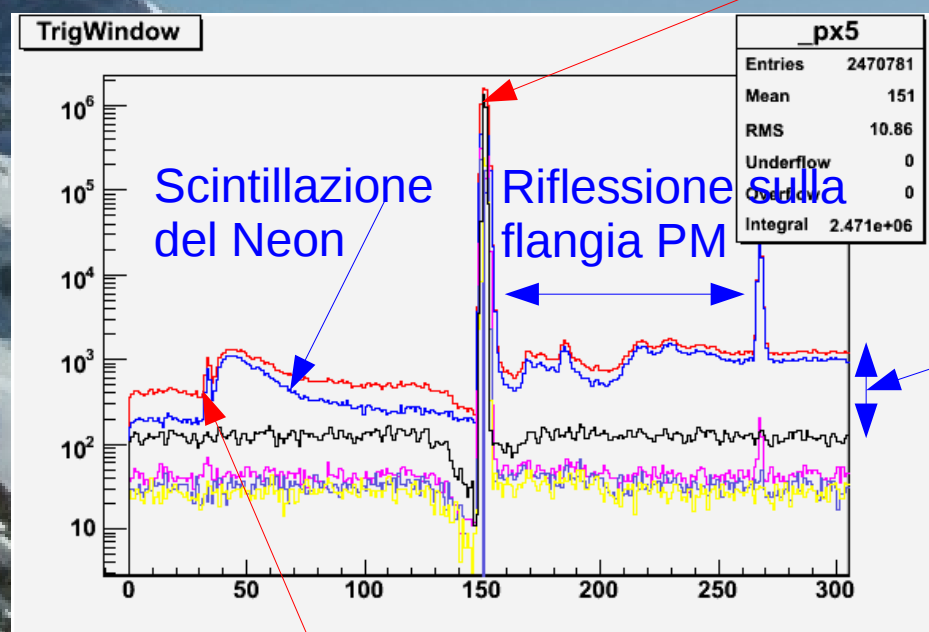


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Risultati del Test Beam (dettagli ... di ordine superiore)

Tempo dell'evento
(offset arbitrario)



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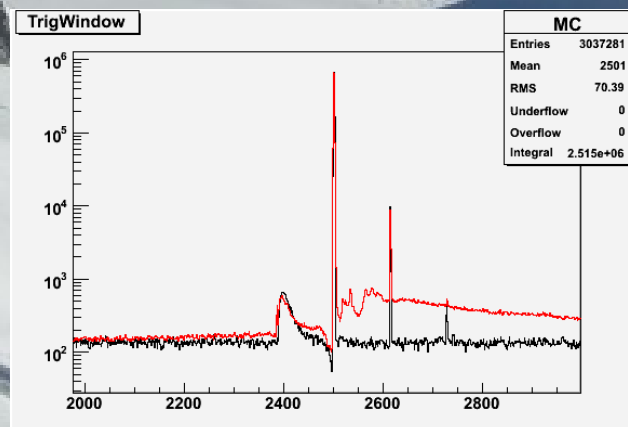
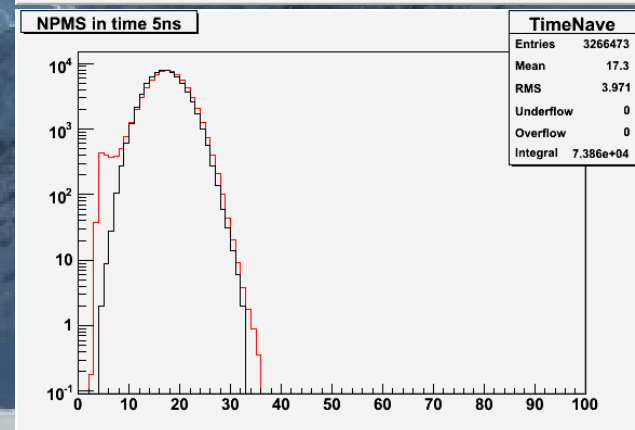
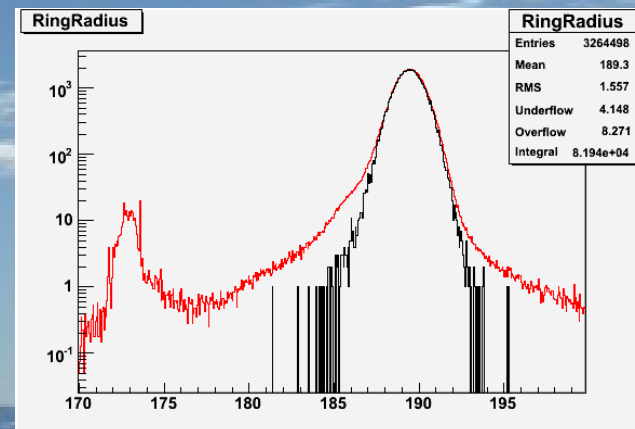
Delta ray

— all events
— 1 PM
— 2 PMs
— 3 PMs
— ≥ 4 PMs

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MonteCarlo (preliminary)

- Prestazioni Cerenkov sostanzialmente riprodotte (solo π nel MC)
- Effetti di ordine superiore ancora da mettere a punto



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Prototipo 384

• Scopo:

- Separazione π μ
15-35 GeV/c
- Raffinamento
meccanica
(raffreddamento)
- Test DAQ e Trigger
con TELL1 (HPTDC)

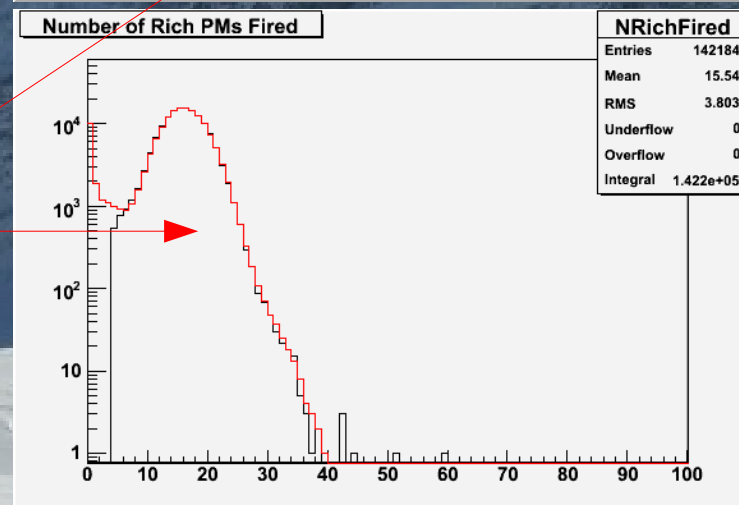
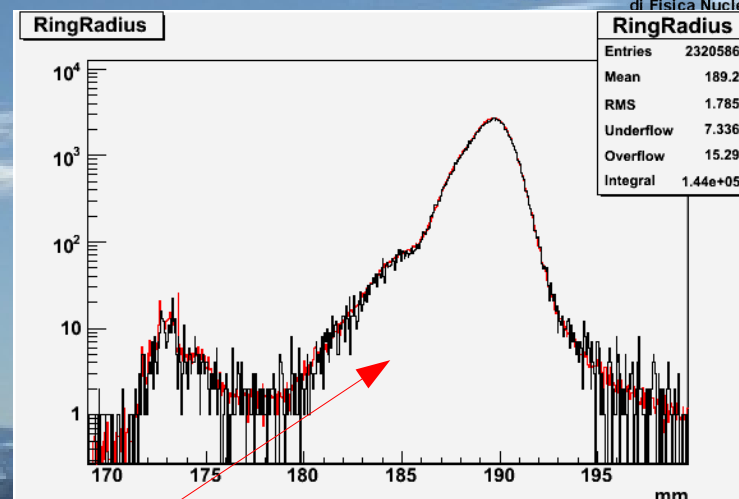
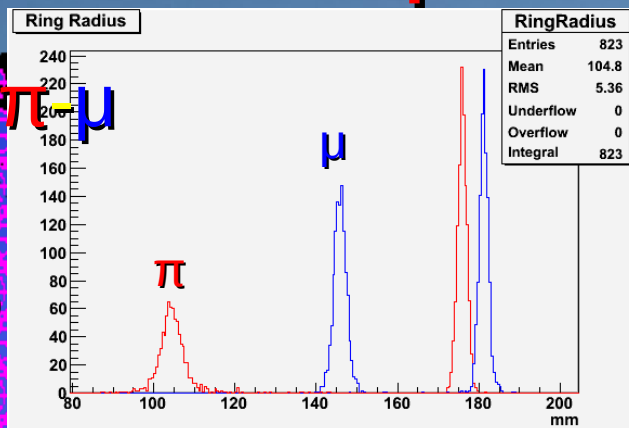
• Caratteristiche:

- Aggiunti 288PM

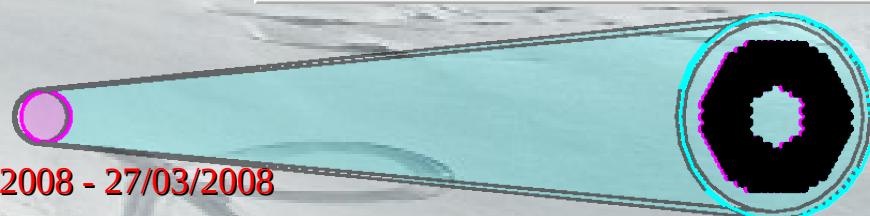
• Stato:

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Disegno quasi
finalizzato



Applicazione offline
algoritmo di trigger
ai dati del TestBeam
2007



Conclusioni

- Test del primo prototipo (96PM):
 - Buoni risultati
 - Strumento di validazione per il MC
- In autunno 2008 il test del secondo prototipo (384PM)

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SPARES

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PMT Hamamatsu R7400U

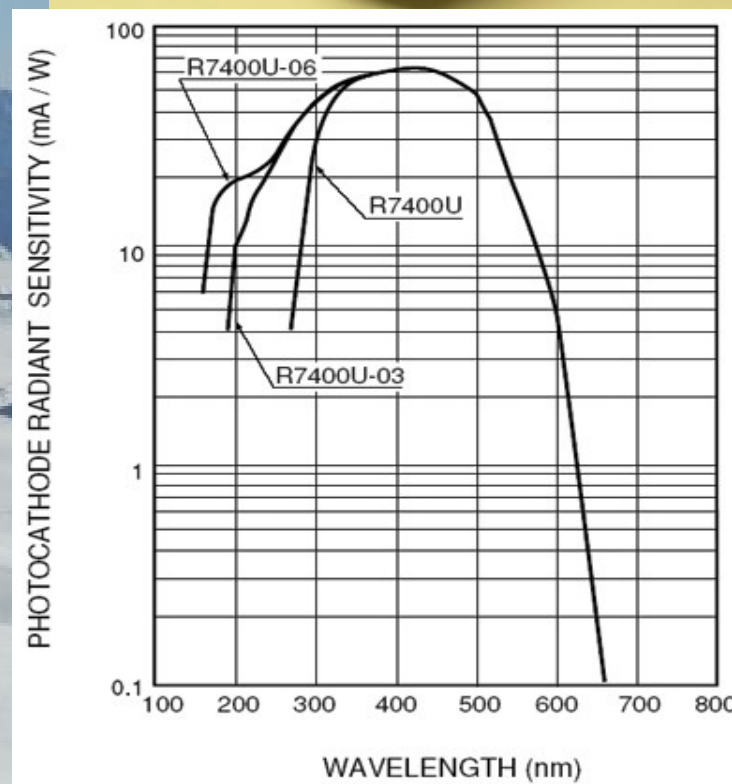
Hamamatsu R7400U PMT

- diameter 16 mm
- lenght 16 mm
- photocatode diameter 8 mm
- 8 stages
- Max HV 1000 V
- Gain@800V $\sim 5-7 \times 10^6$
- λ peak ~ 420 ns
- t.t.s. 280 ps

Used:

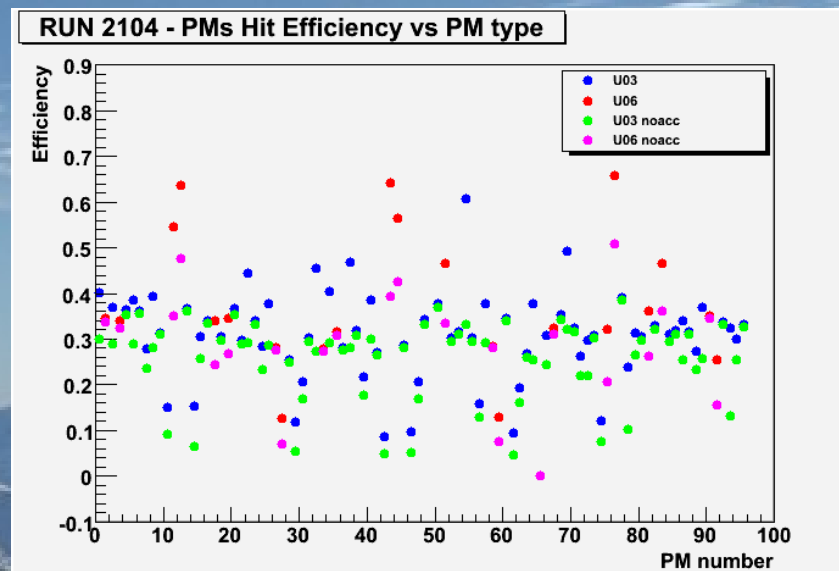
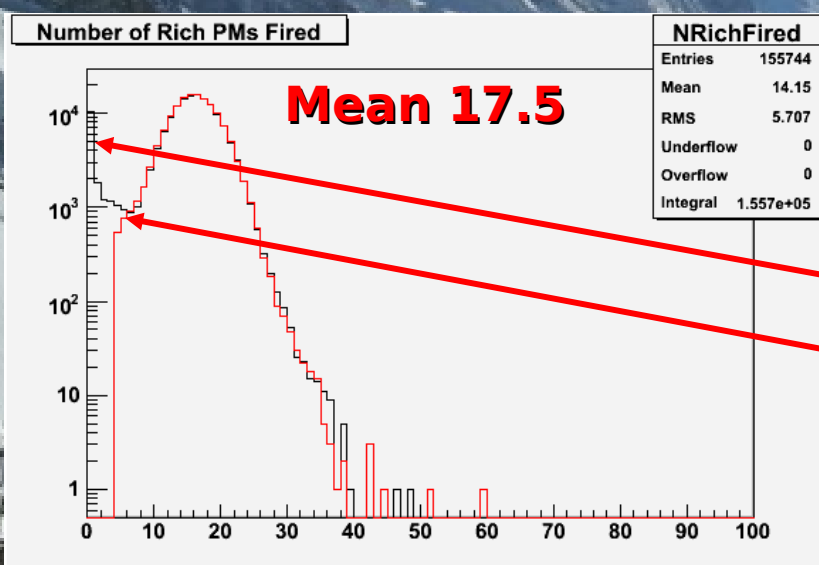
- R7400-U03: Bialkali, UV glass
- R7400-U06: Bialkali, quartz

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Efficiency

- PM "Efficiency" ~ 0.3 photoelectrons per PM
- Effect of Cuts
- $\lambda_1 \Rightarrow 0$ Hits (Prob ~ 7%)

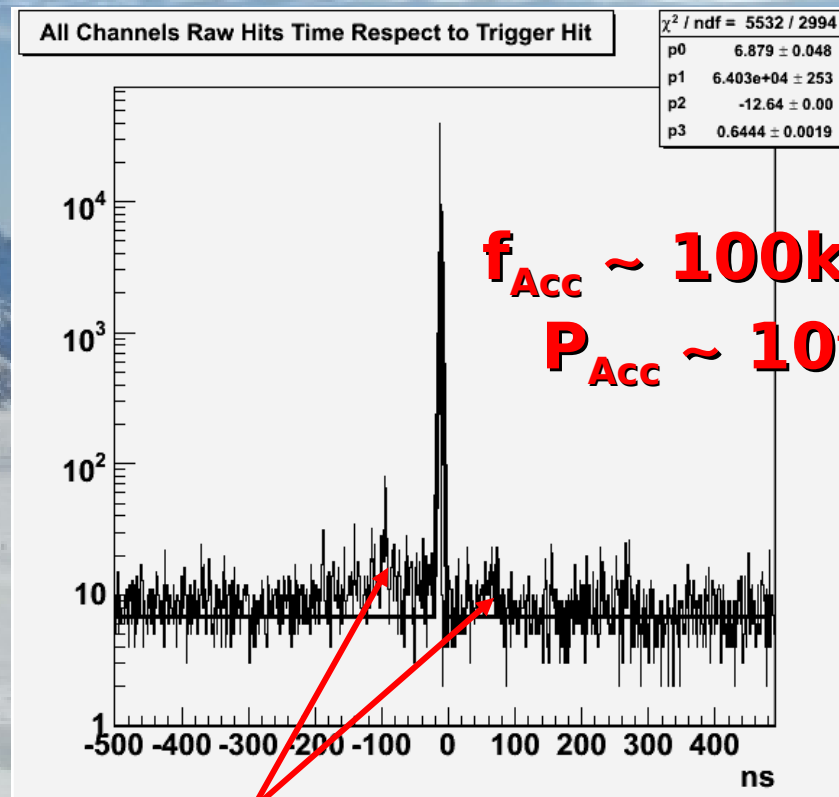
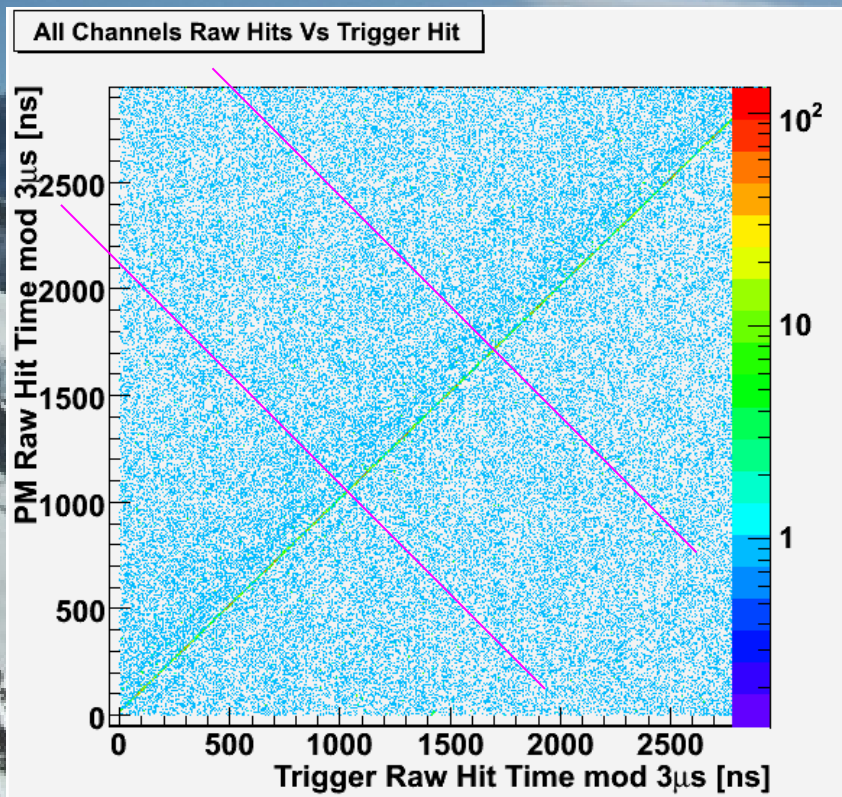
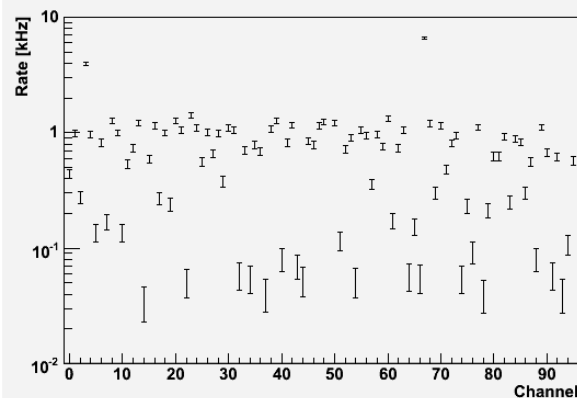


Cut / Run	Standard (2104)	Dx +500	Dx +100	Dy +500	Dy +1000
1 Trigger	.985	.985	.985	.984	.984
Trig Time Wind	.996	.996	.996	.996	.996
Nrich 2-35	.927	----	----	----	----
<Time> in 10ns	.996	.927	.884	.925	.885
≥4 PM in 1ns (Ring fit)	.984	.820	.259	.795	.255
Good fit	.999	.999	.988	.999	.986
Final	.891	.745	.222	.721	.218

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Accidentals

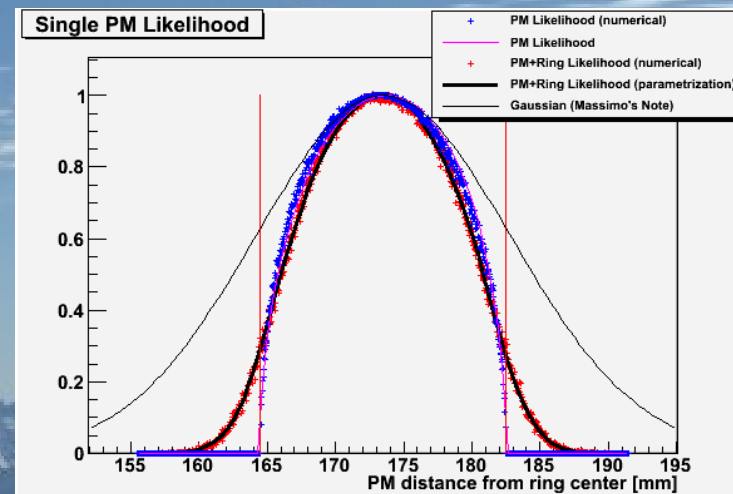
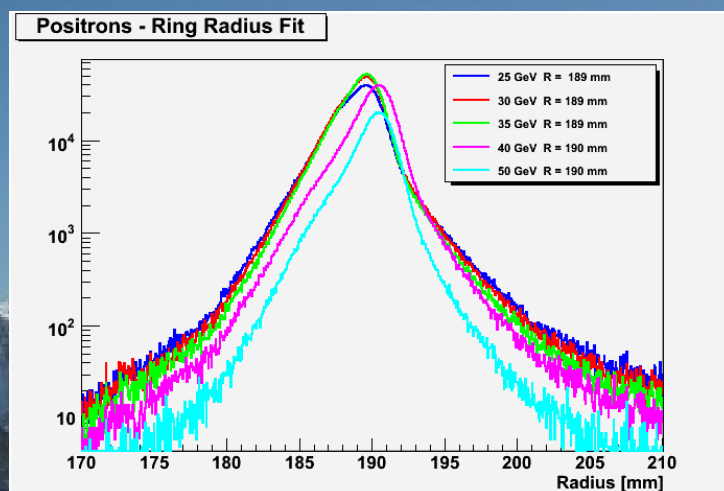


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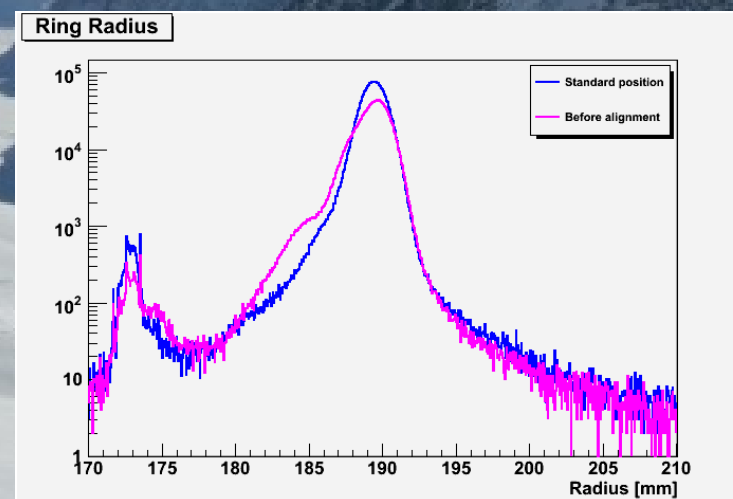


Trigger (Low) Quality

Ring Fit



- Positrons Run: Single Peak
- Bump in "Kaon Region" **removed**: Geometry/Fit artifact

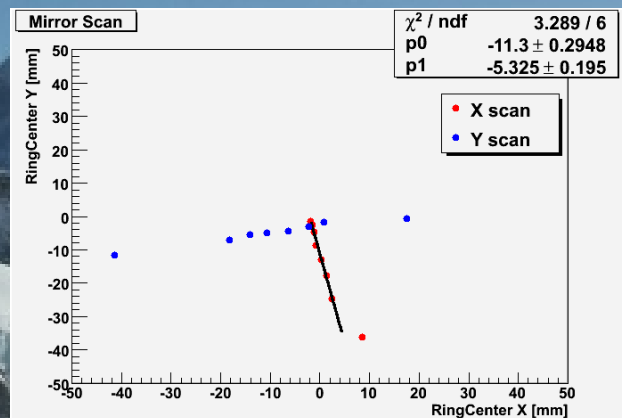


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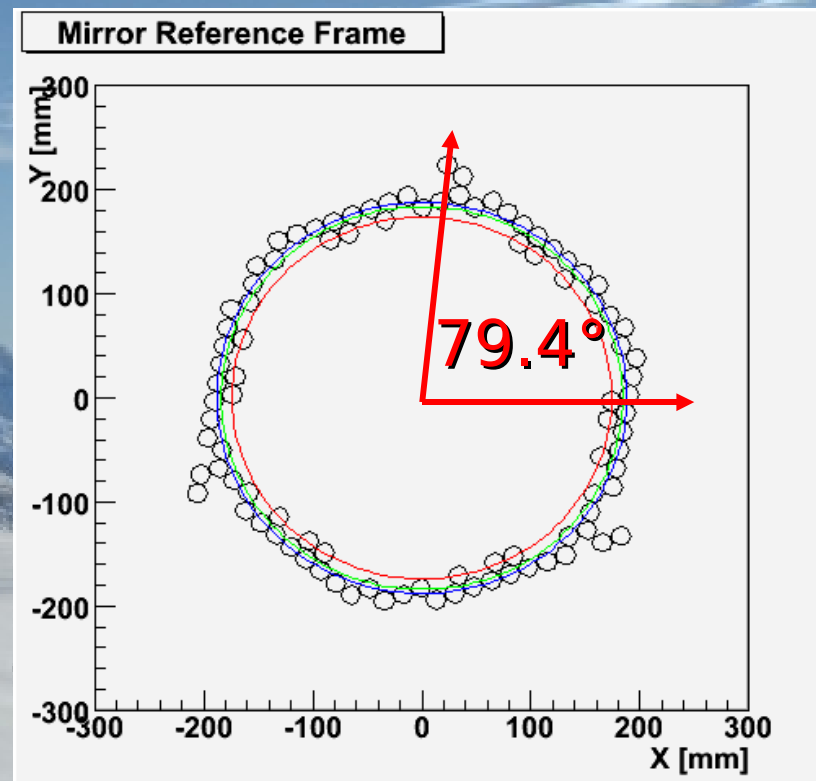


Mirror Movements

- Mirror orientation reproducibility



- Rotation angle between Mirror and PMs XY reference

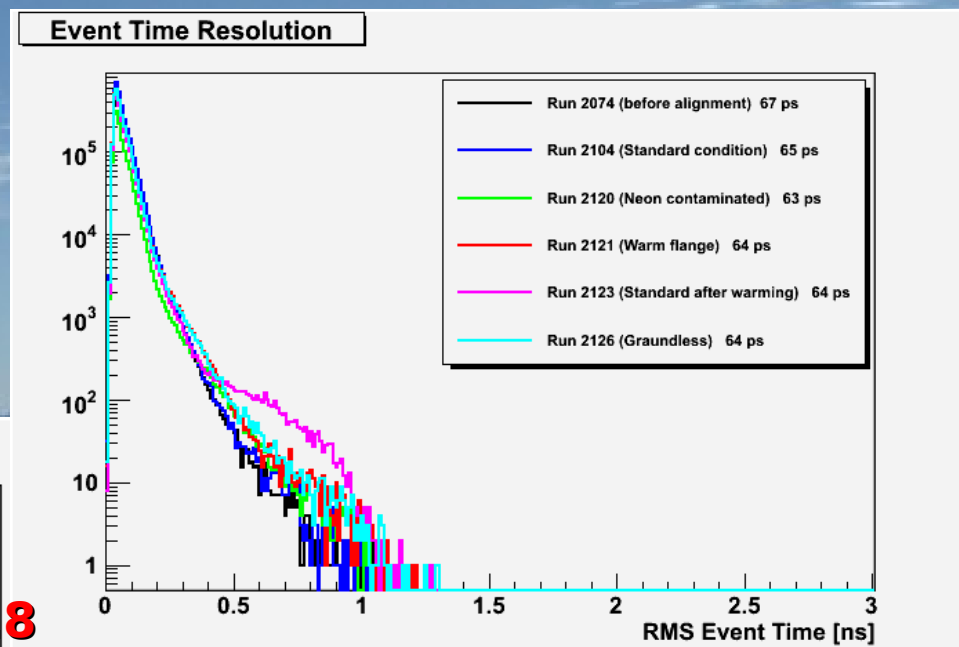
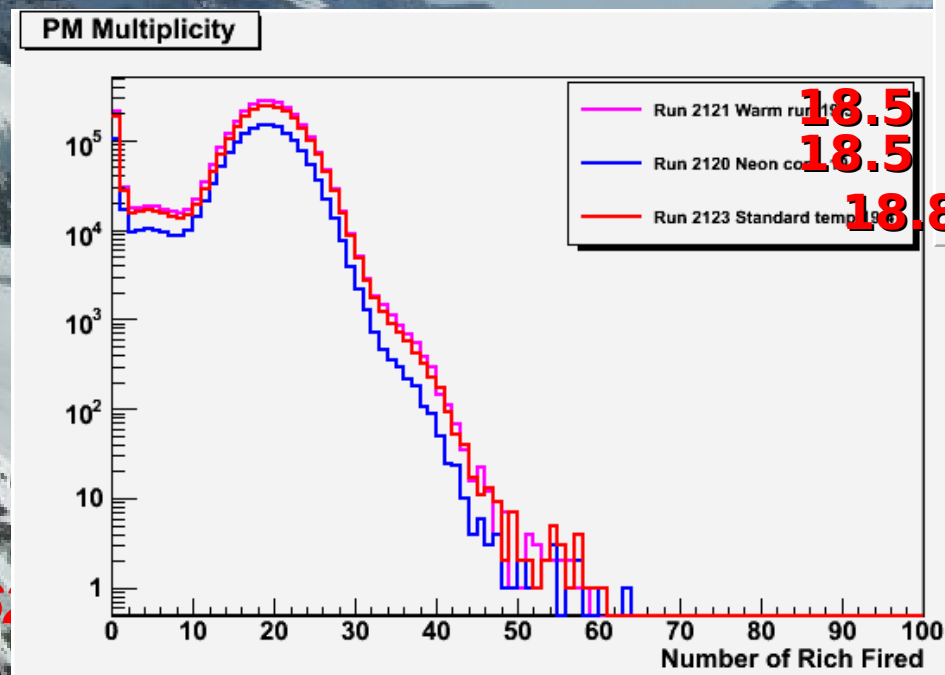


NA62 (~80°)



Robustness Tests

- Temperature
No visible effect on
“Cerenkov side”



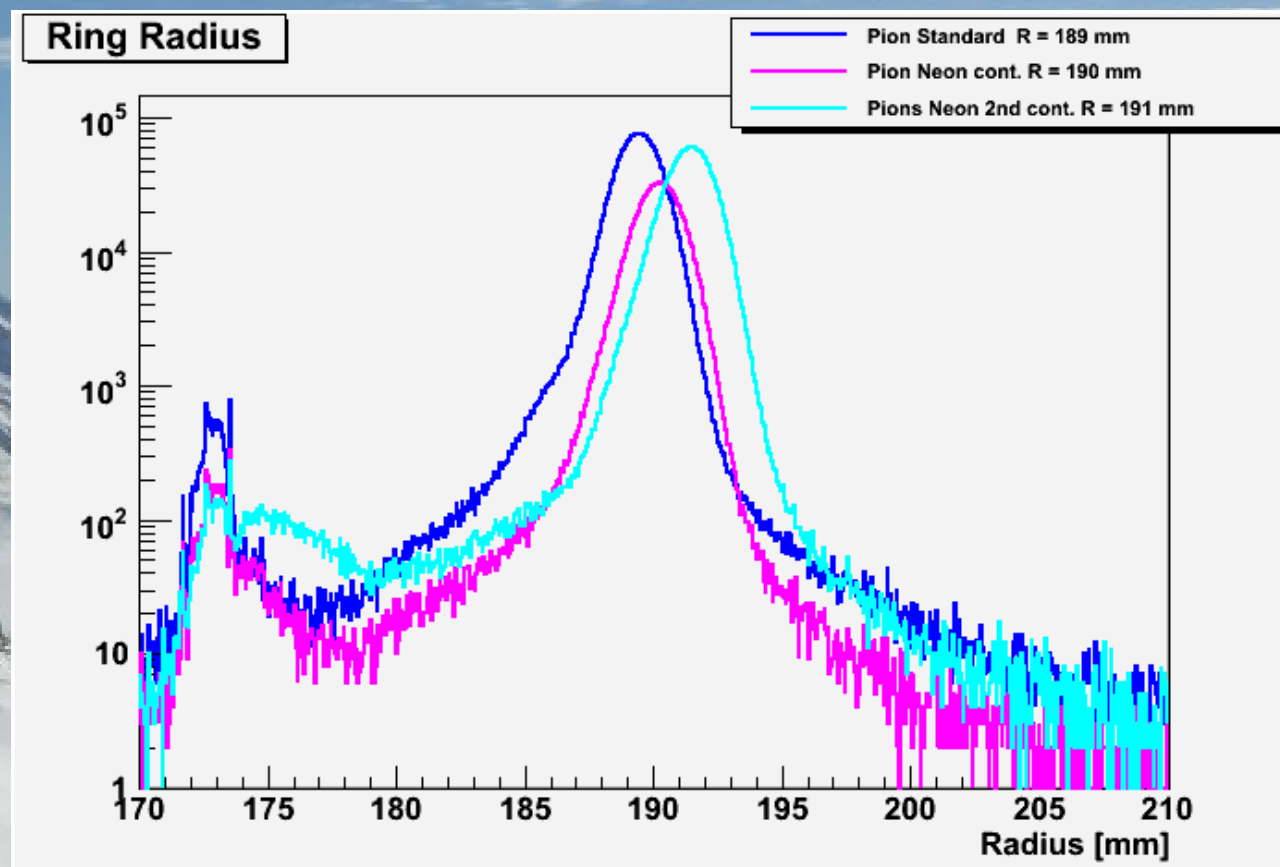
Neither on Time
Resolution

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Robustness Tests (2)

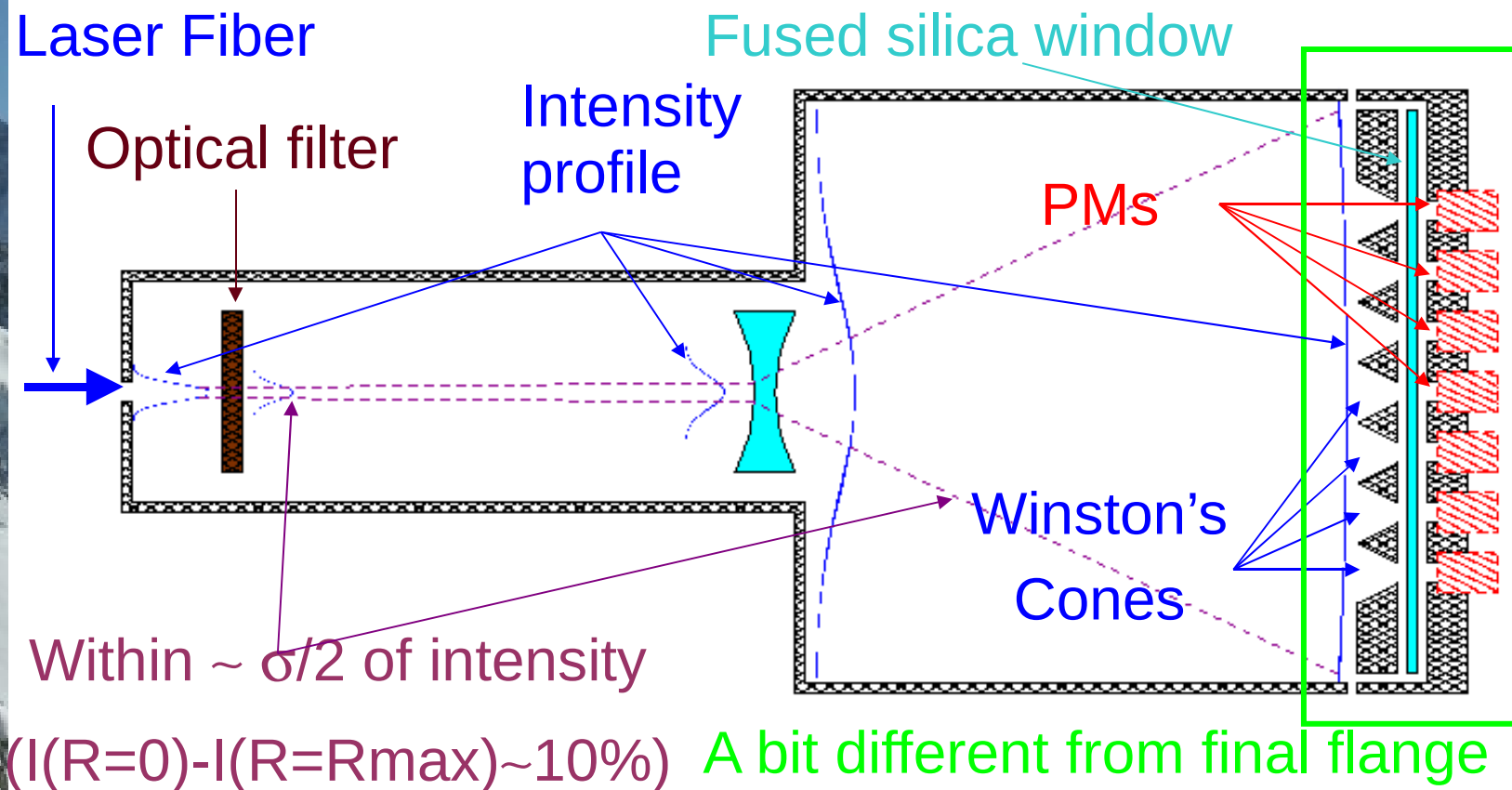
- Neon Contamination (N_2 0.5%+0.5%)



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Test Optics

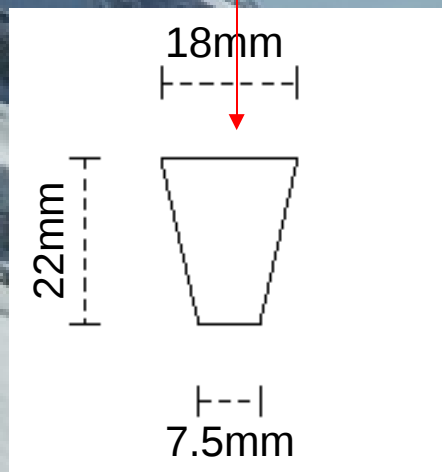


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Flanges

Within $\sim 1^\circ$
from axis
max $\sim 3\text{mm}$ gap
without loosing
efficiency



Fused silica window(s)

PMs

Winston's
Cones

$\sim 7\text{mm}$ gap
($\sim 40\%$ loss)

$\sim 1.5\text{ mm}$ gap

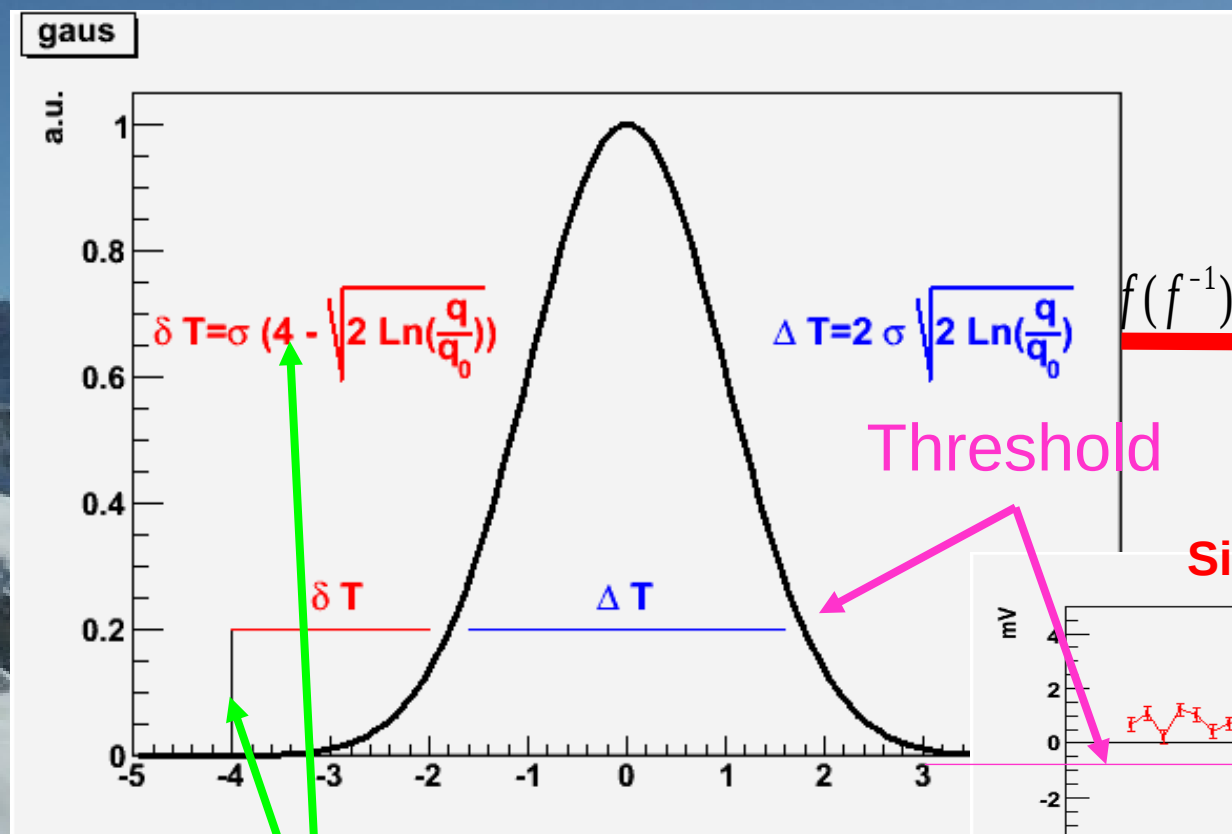
Perugia Lab

RICH Test

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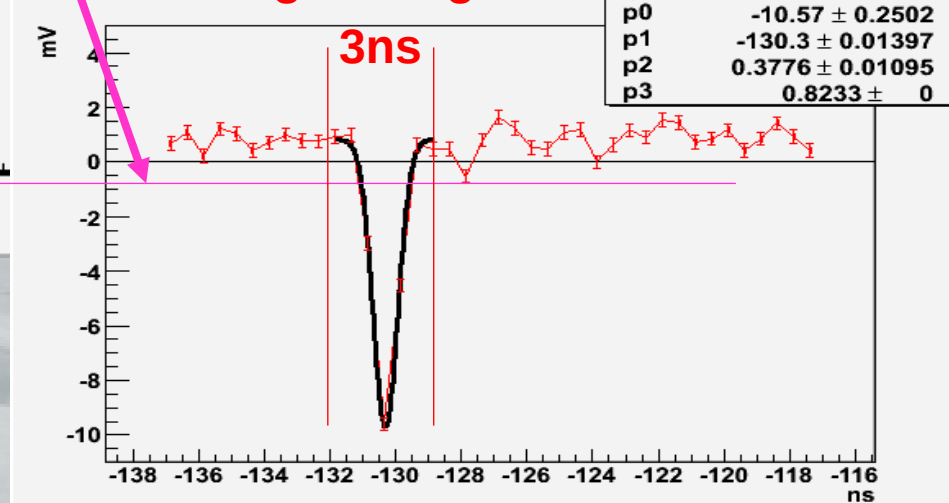
Analog signal parametrization



$$\delta T \propto \Delta T$$

$$\sigma \approx \text{const}$$

Signal Region

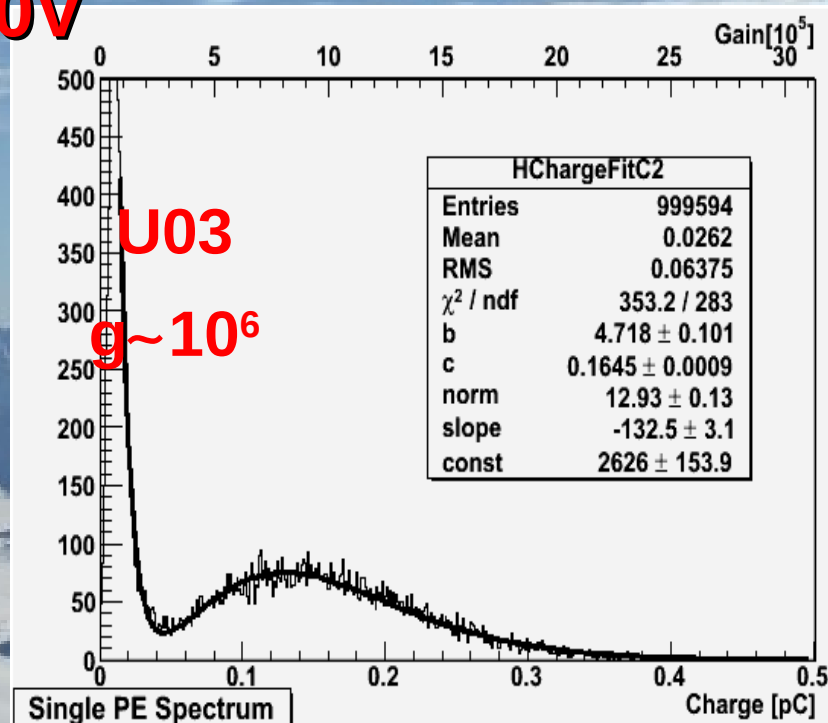
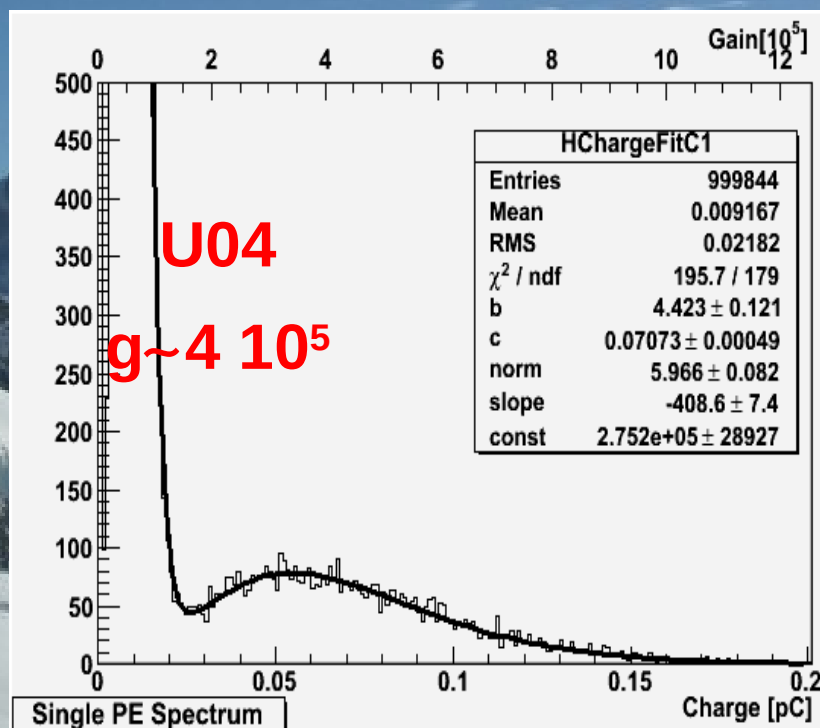


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Single PE measurements

900V

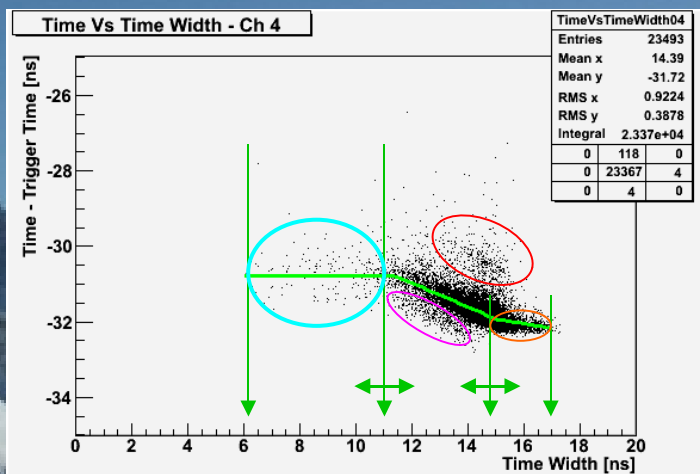


$$f(q) = \frac{\left(\frac{b}{c}q\right)^b e^{-\frac{b}{c}q}}{x \Gamma(b)}$$

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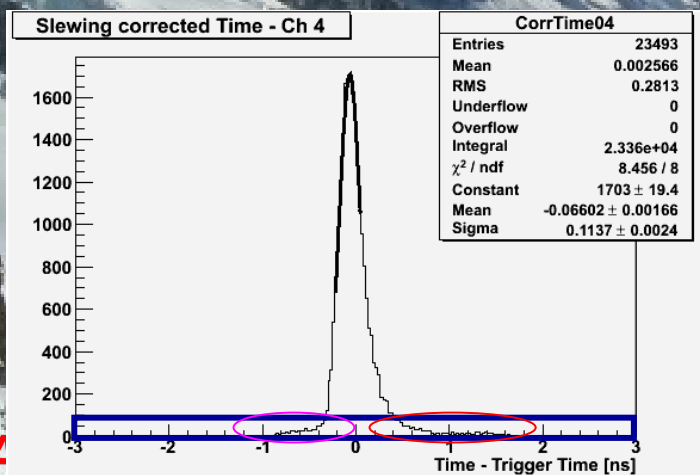
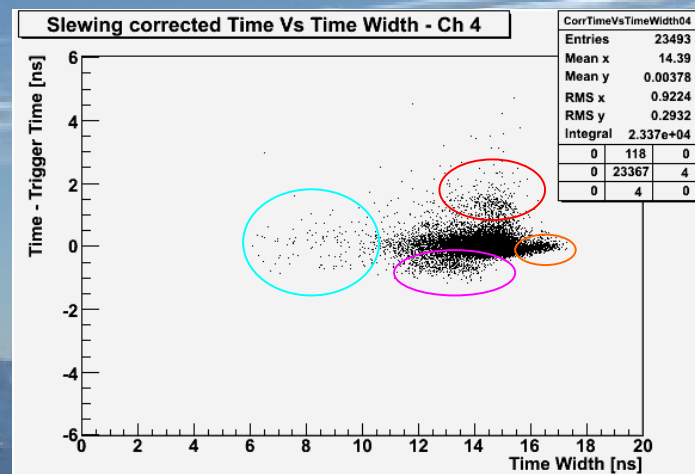


Time resolution understandings



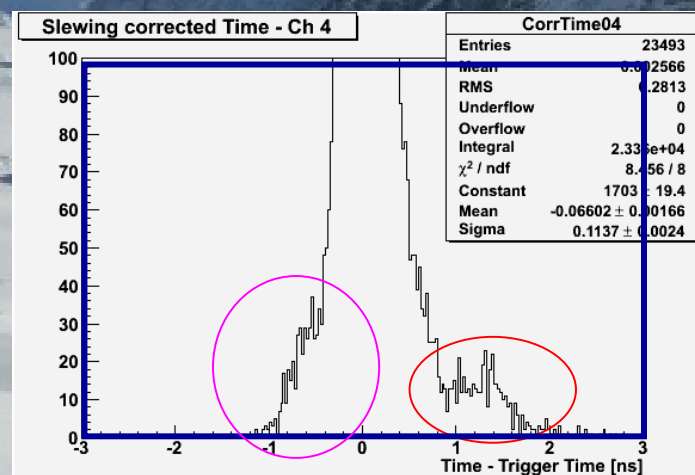
Laser
specs?

NINO
stretch
ineff



Restarts

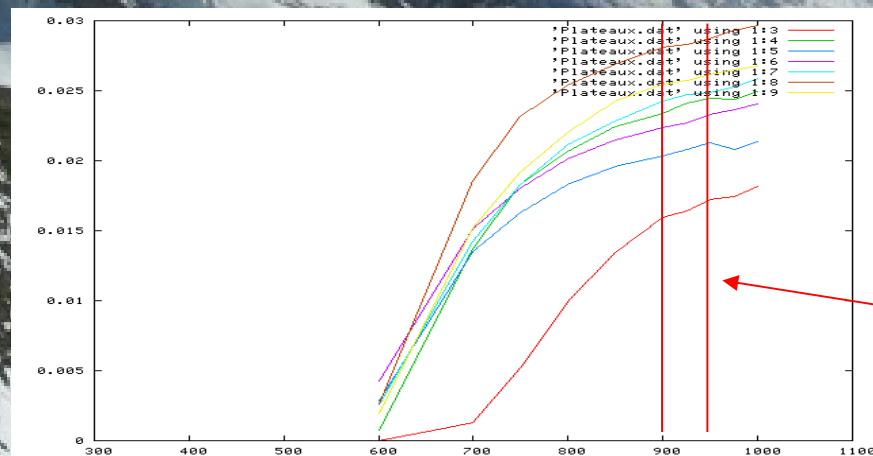
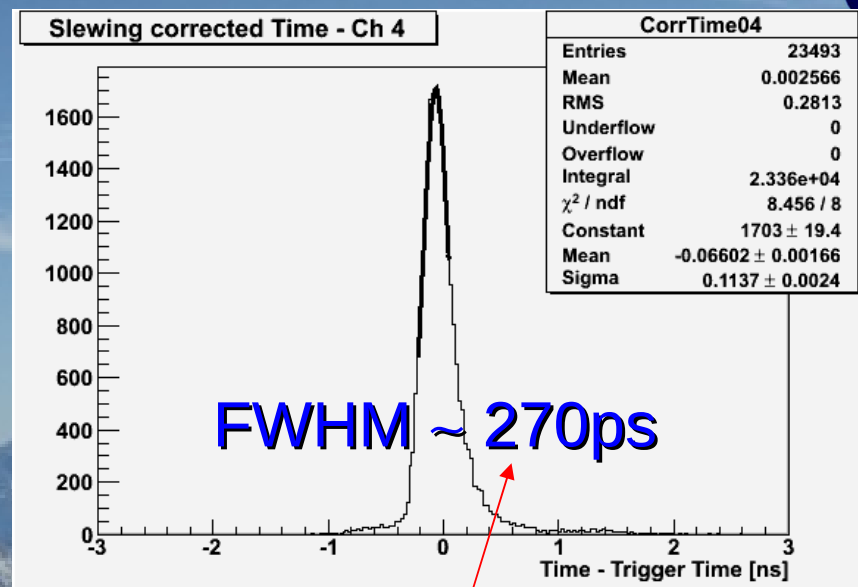
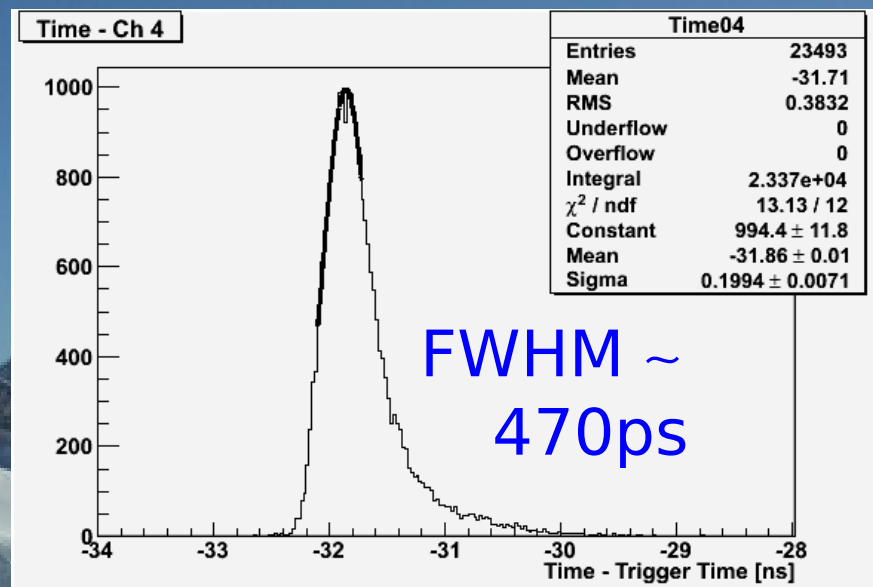
?



NA



Time resolution for O(1-2) PE

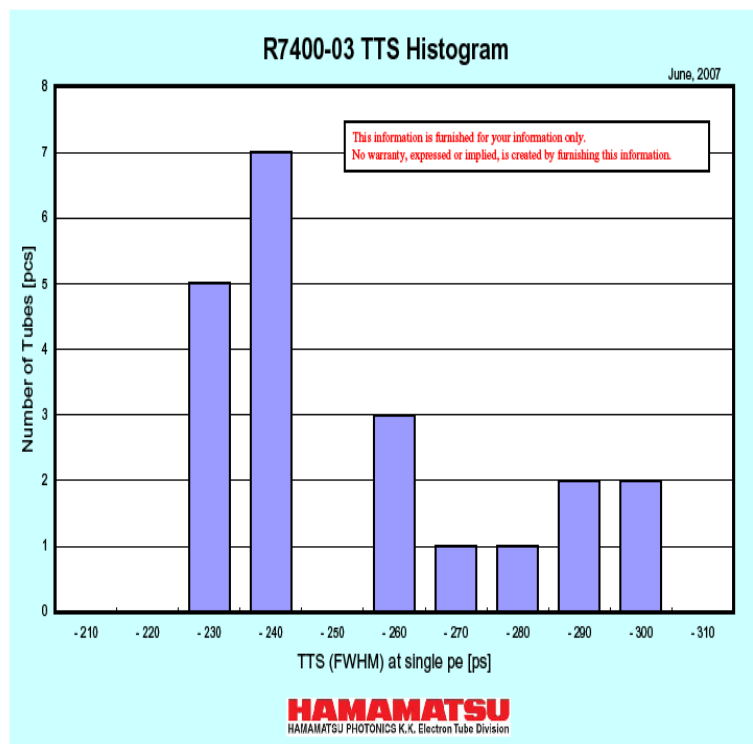


Electronics Contribution
~ 120ps

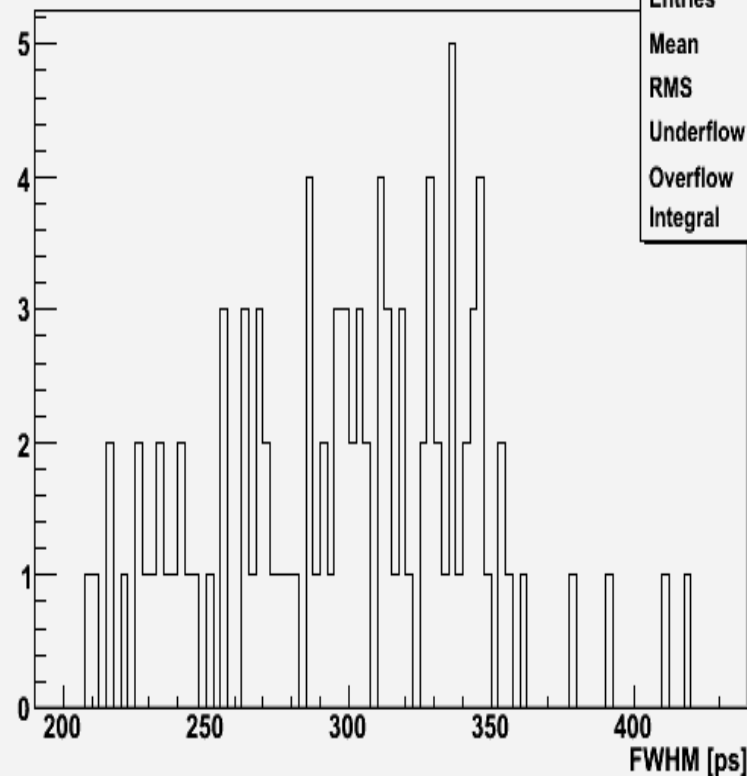
Suggested Working Voltage
900-950V



Time resolution for O(1-2) PE Results



Single Photoelectron Time Resolution @ 900V



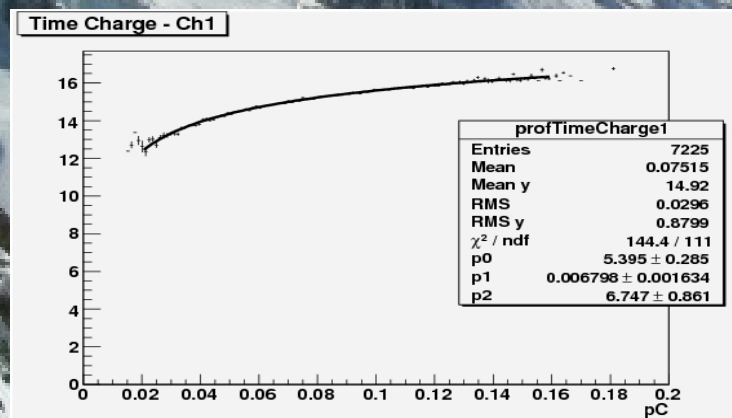
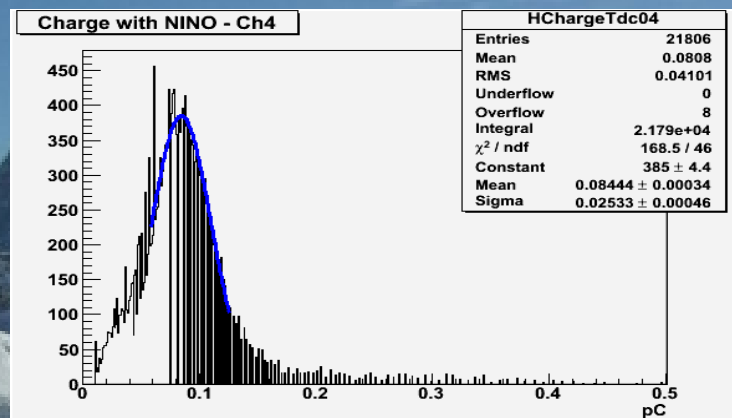
htemp	
Entries	100
Mean	298.8
RMS	44.65
Underflow	0
Overflow	0
Integral	100

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Charge Calibration Results

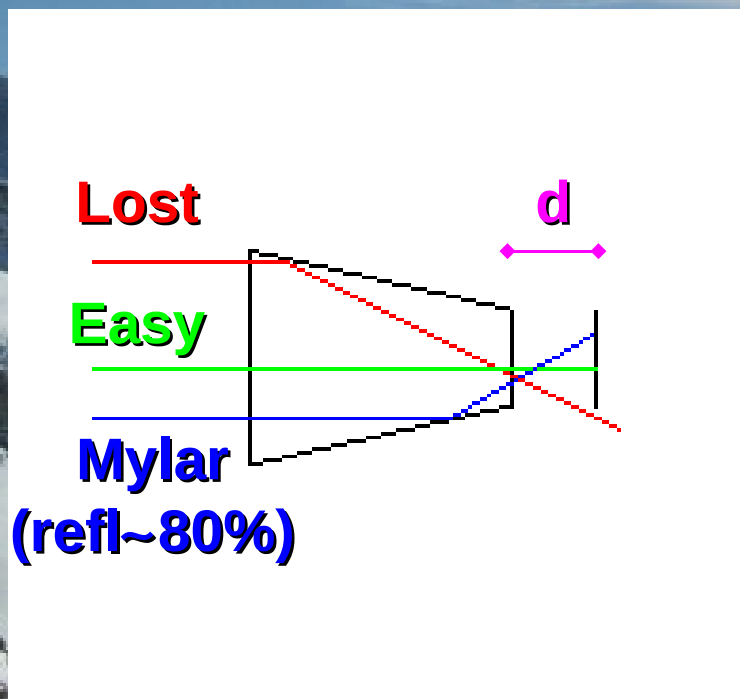
- Channel by channel
- Needs very clean input signal
- Gain estimate accuracy $\sim 10\%$
- Pulse height estimate without further electronics



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Winston's cones

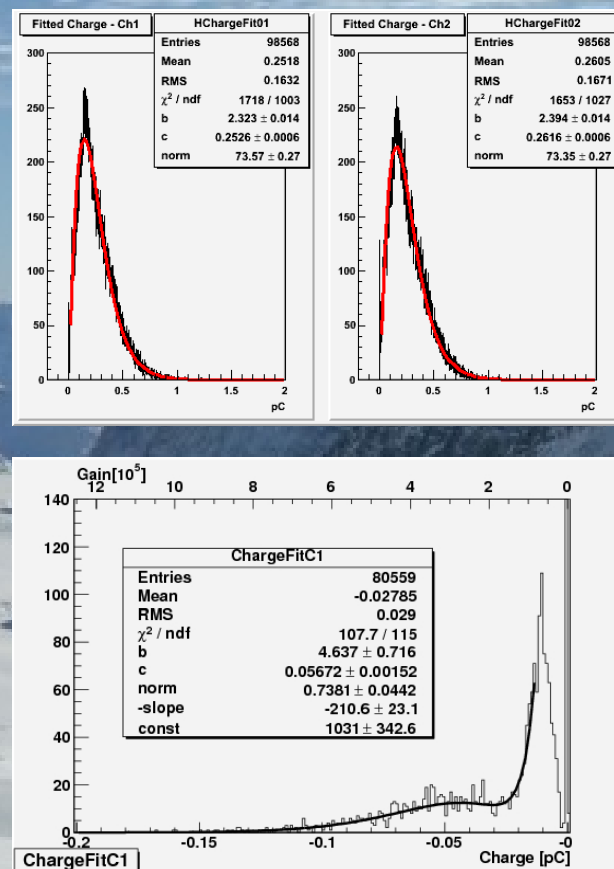


- If $d < 3\text{mm} \Rightarrow 0\% \text{ Lost}$
- In tests $d = 7\text{mm} \Rightarrow 40\% \text{ Lost}$
- In the prototype $d < 2\text{mm}$
- Gain should be ~ 5
- Seen ~ 3 in tests (compatible with $40\% \text{ Lost}$)

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Charge analysis backup



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