

V.Kekelidze

Experiment NA48/2

**A Precision Measurement of Charged Kaon
Decay Parameters** (*CERN/SPSC 2000-003*)

Status Report *of November 5th, 2002*
(*SPSC-M-691*)

**CERN, Chicago, Dubna, Ferrara, Firenze,
Mainz, Northwestern, Perugia, Pisa, Saclay,
Siegen, Torino, Vienna** - *Collaboration*

Goals

- Direct CP violation** in $K^\pm \rightarrow \pi^\pm \pi^+ \pi^-$, $K^\pm \rightarrow \pi^\pm \pi^0 \pi^0$
 $\delta(A_g) \approx 10^{-4}$ (limited by statistics)
- K_{e4} π - π scattering length $\delta(a^0_0) < 1 \cdot 10^{-2}$

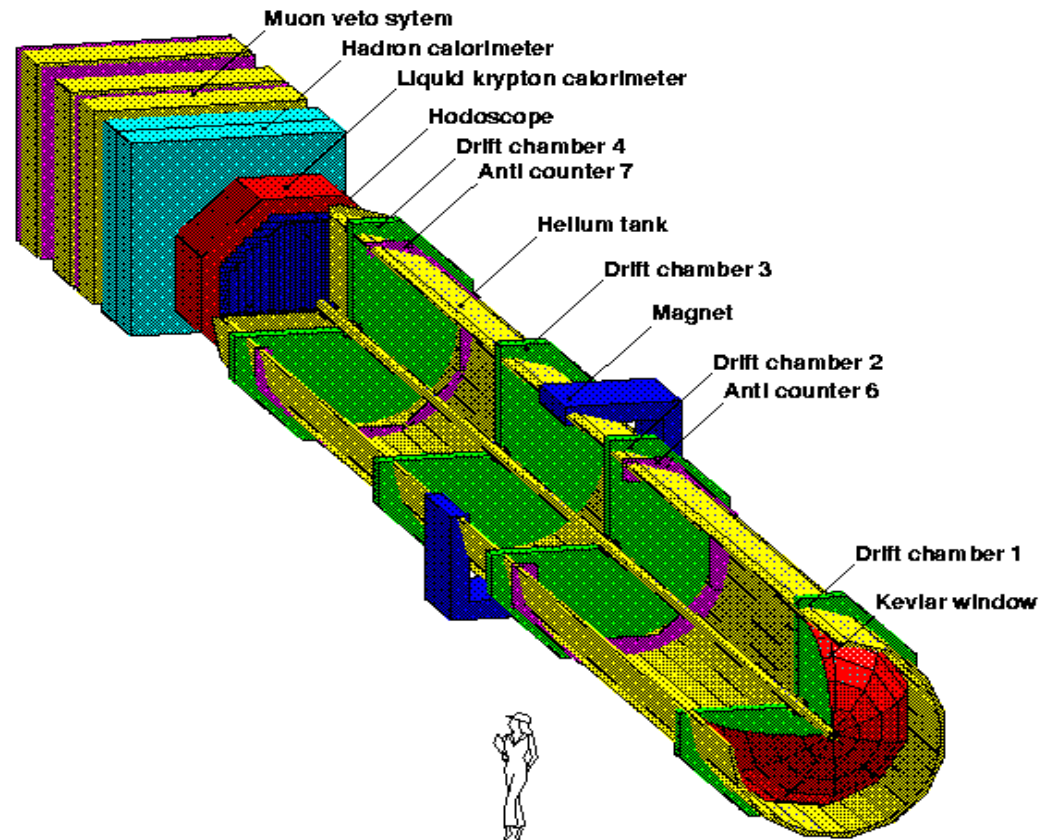
$> 10^6$	(430k)
expected (present) -statistics	
- Rare decays** to test χ PT & search for A_{Ch}

$K^\pm \rightarrow \pi^\pm \pi^0 \gamma_{IB}$	$\sim 7 \cdot 10^6$ ($2 \cdot 10^4$)
$K^\pm \rightarrow \pi^\pm \pi^0 \gamma_{DE}$	$\sim 2 \cdot 10^5$ (500)
$K^\pm \rightarrow \pi^\pm e^+ e^-$	$\sim 1 \cdot 10^4$ ($1 \cdot 10^4$)
$K^\pm \rightarrow \pi^\pm \mu^+ \mu^-$	$\sim 5 \cdot 10^3$ (400)
$K^\pm \rightarrow l^\pm \nu l^+ l^-$	$\sim 10^3 - 10^5$ (few)

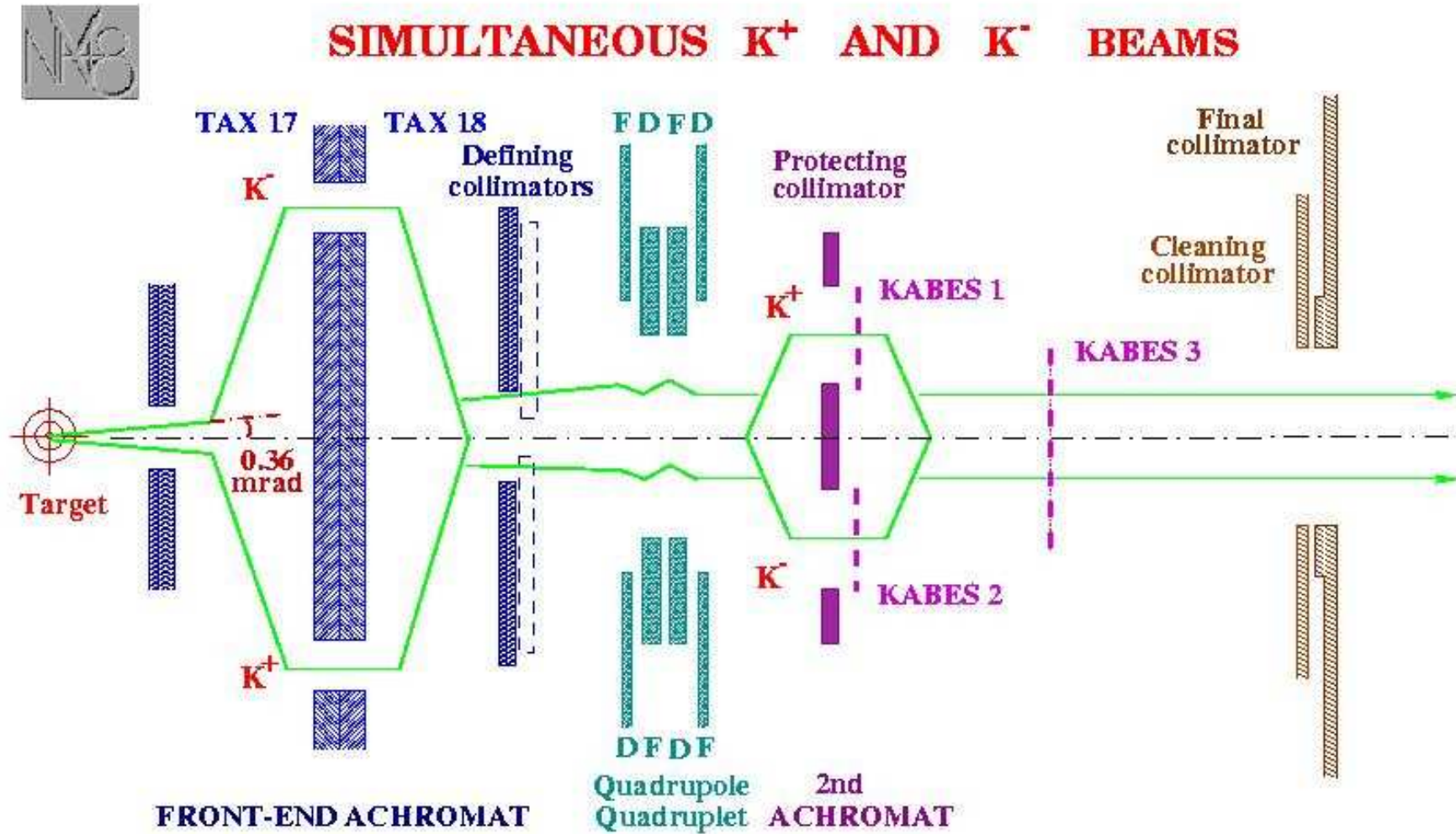
$K^\pm \rightarrow \pi^\pm \pi^0 \gamma\gamma$, $K^\pm \rightarrow \pi^\pm \pi^0 l^+ l^-$, ... etc.

NA48/2 Set-Up

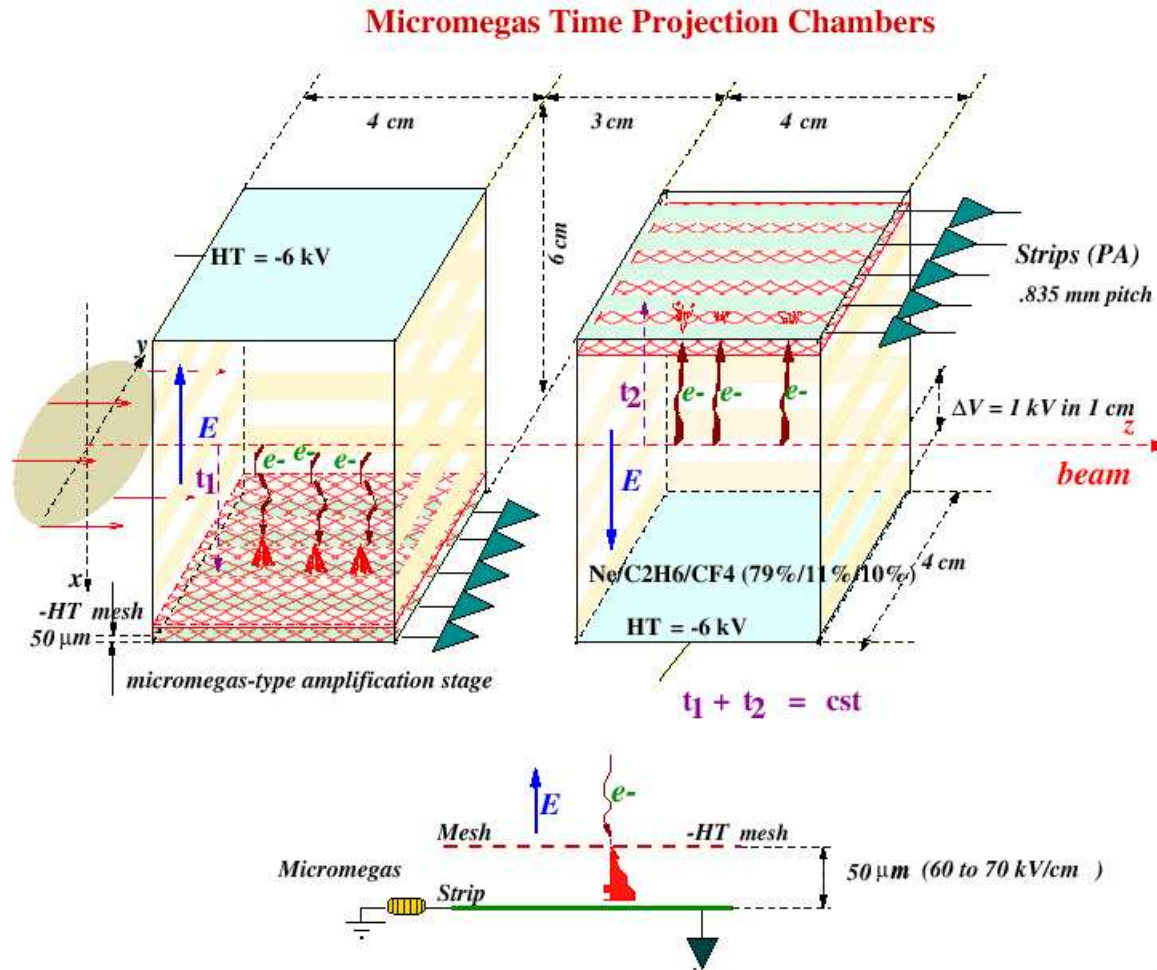
original NA48 Set-Up



New elements for NA48/2

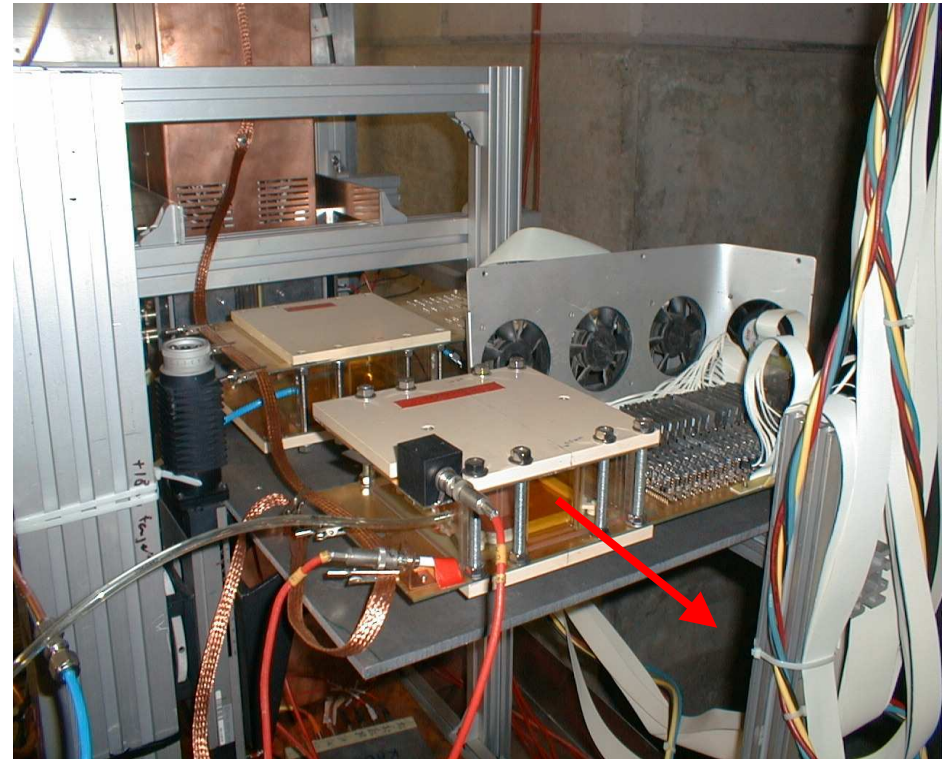
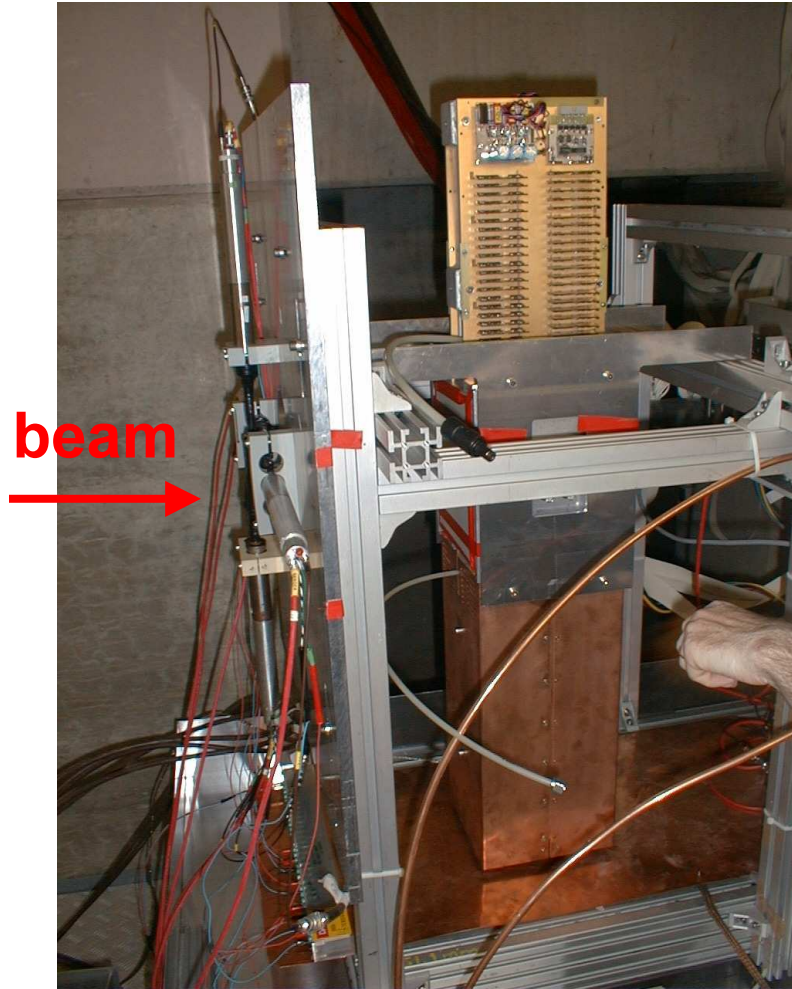


New elements for NA48/2 Beam Spectrometer **KABES** (TPC micromegas)



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KABES prototype test run *in July 2002*

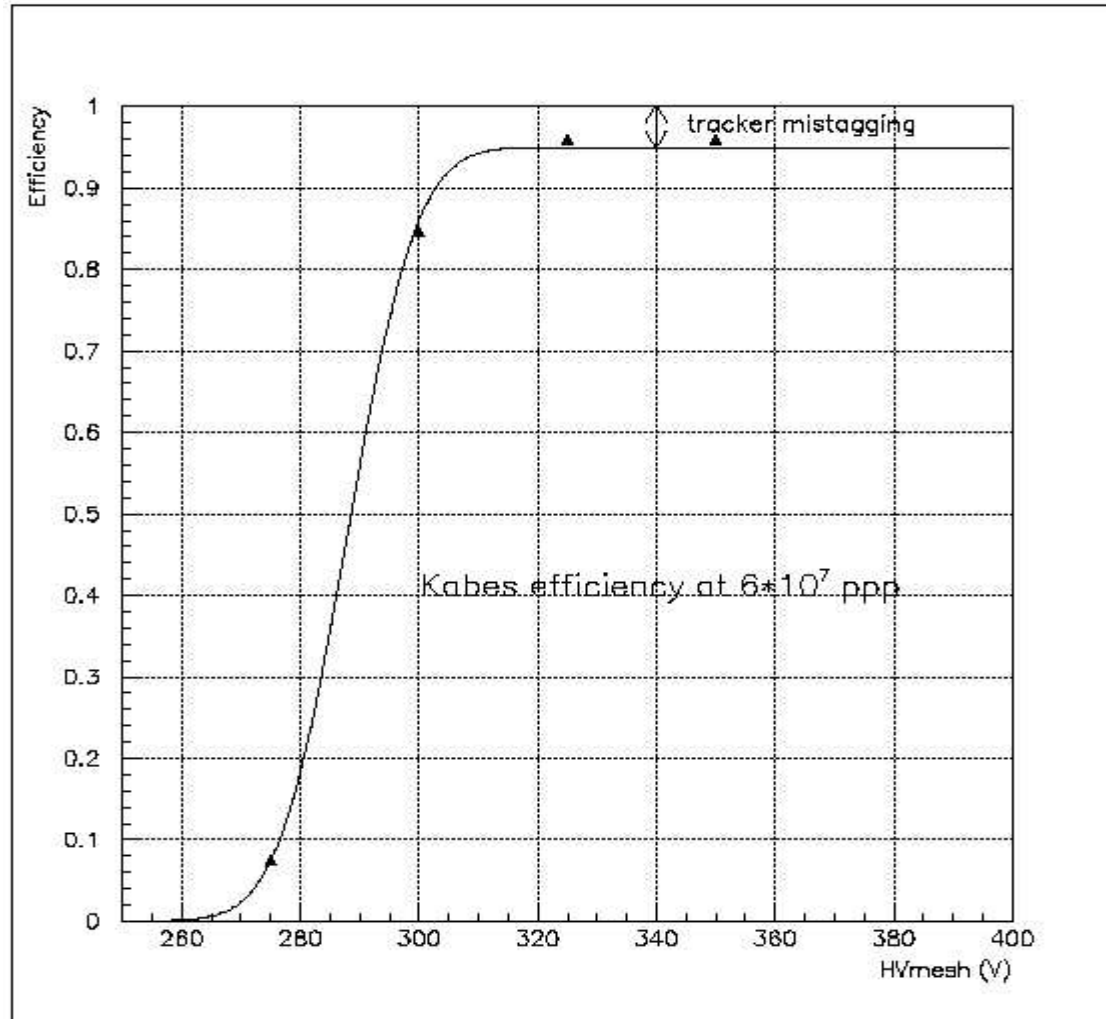


November 5, 2002

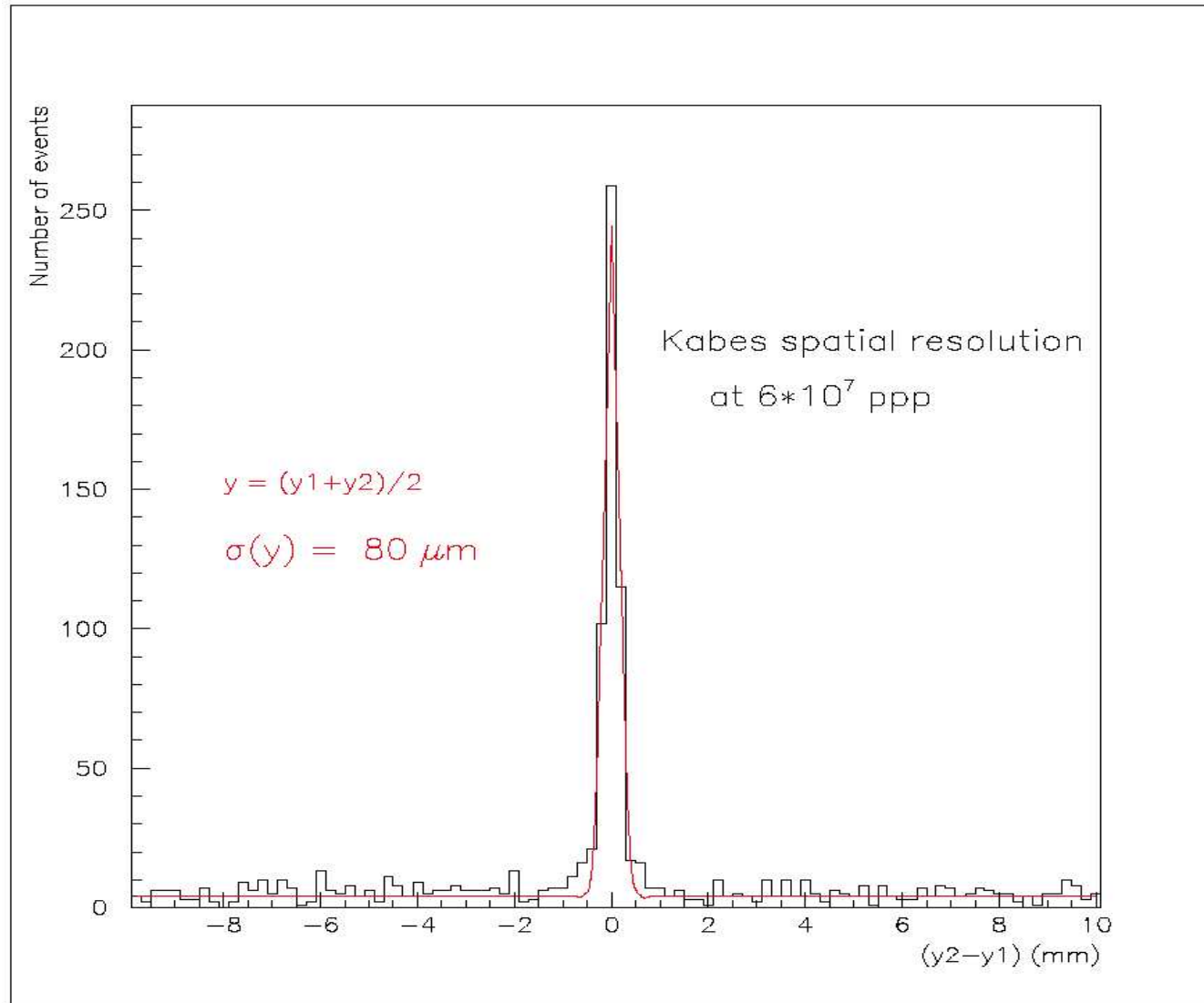
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6

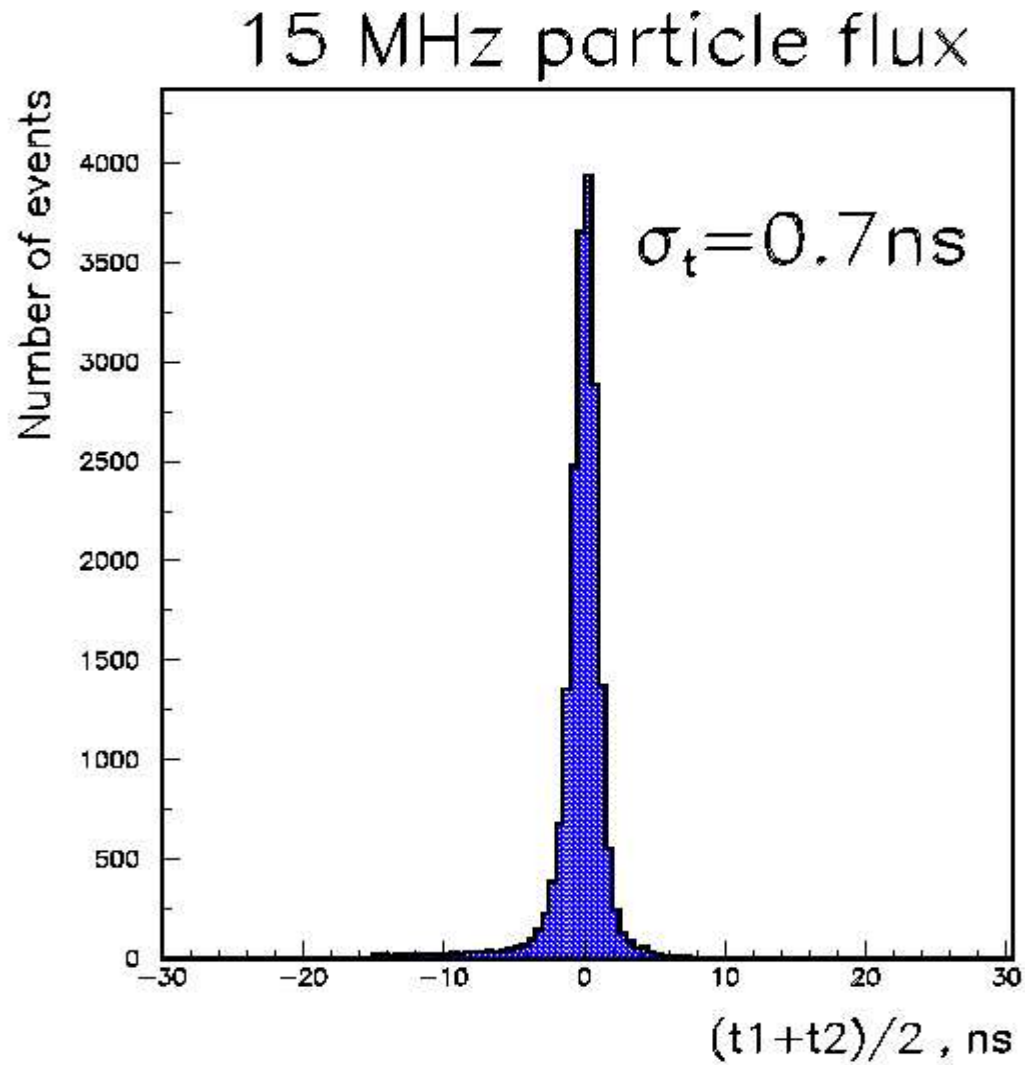
KABES prototype test results



KABES prototype test results



KABES prototype test results



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KABES prototype test results

- efficiency $\Rightarrow > 94\%$
- resolution in Y (*strips*) $\Rightarrow \sim 80 \mu\text{m}$
- resolution in X (*drift*) $\Rightarrow \sim 50 \mu\text{m}$
- time resolution $\Rightarrow \sim 0.7 \text{ ns}$
- $\langle \text{dead-time} \rangle$ /strip $\Rightarrow \sim 40 \text{ ns}$

@ highest flux of **15** MHz

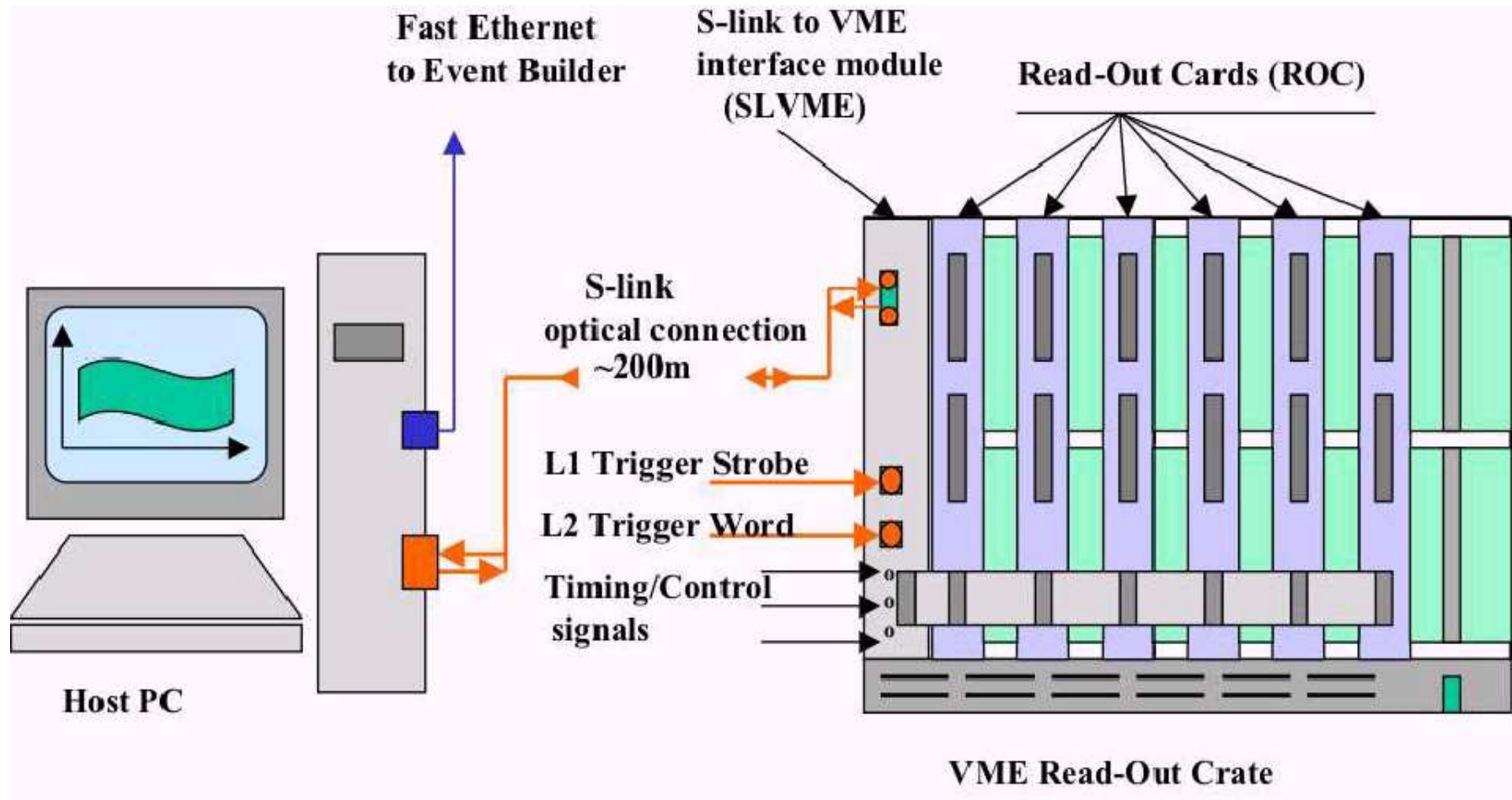
@ highest rate of **2** MHz /strip

$$\sigma(\Delta p/p) < \mathbf{0.5} \%$$

Read-Out Main Features

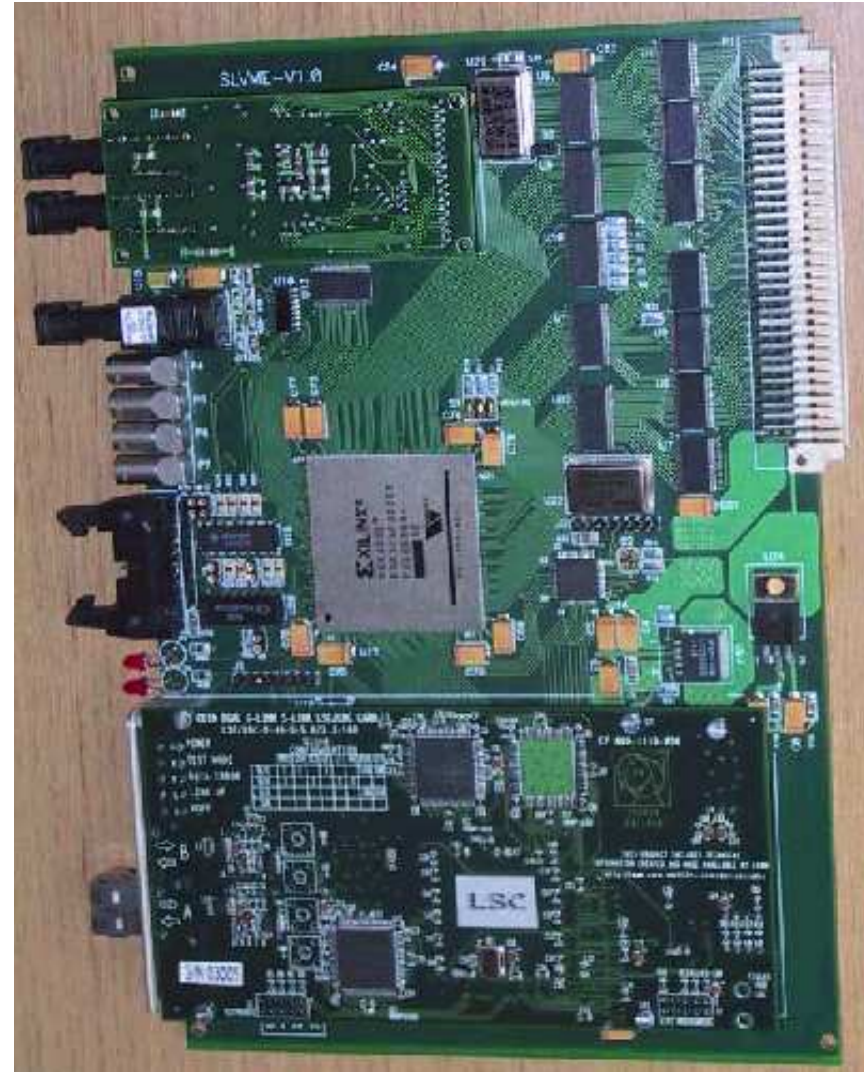
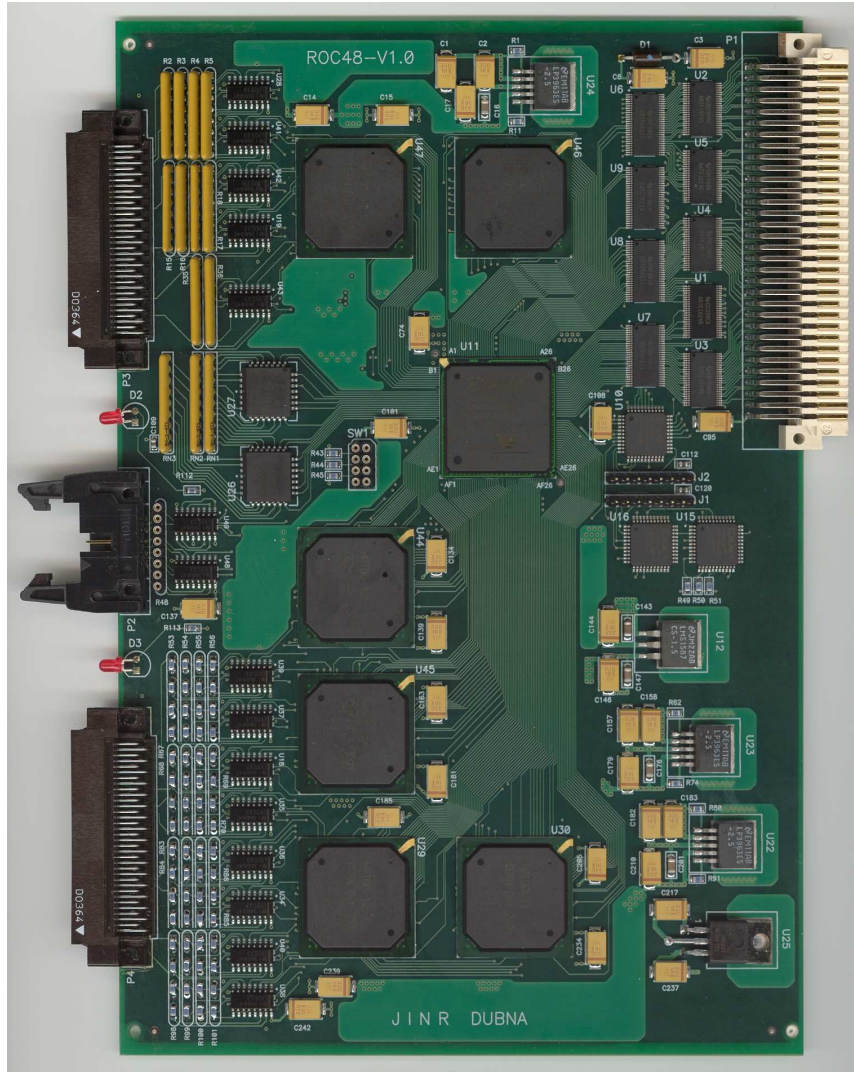
Particle flux	40	Mp/s
Hit rate /strip	8	Mhit/s
Peak hits / strip	8hits/0.5 μ s	
Average strip multiplicity	1.75	
Strip data size	2 x 4	Bytes
Data/s/chamber	960	MB/s
Time window	0.5	μ s
Number of TDC channels	288	
L1 Trigger rate	100	KHz
L1 Trigger Latency	5.5	μ s
L1 ring memory size per chamber	64	KB
L2 Trigger rate	20	KHz
Event size	2	KB
Output bandwidth	40	MB/s
Data/5sec burst	160	MB
Data after reduction	80	MB

KABES Read-Out Architecture



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ROC & SLVME interface modules



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13

KABES Read-Out

production, test, integration & put in operation schedule

Very **tight** in time schedule:

first test at CERN in **November 2002**

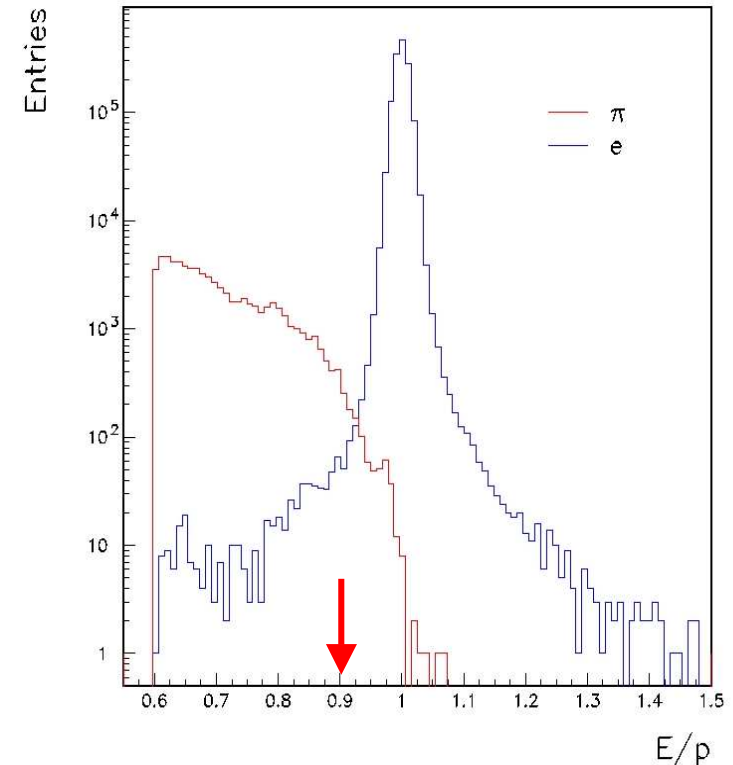
ready by **April 2003**

#	Item	2002												2003			
		February	March	April	May	June	July	August	September	October	November	December	January	February	March		
1	XILINX foundation software	█	█														
2	VME 64x crate + PC's: order & delivery (O&D)		█	█													
3	HPTDC evaluation board: D&P			█	█	█	█										
4	components for prototype and KABES emulator: O&D		█	█	█	█	█	█									
5	KABES emulator: design & manufacture (D&M)			█	█	█	█	█	█								
6	prototype controller and ROC: D&M				█	█	█	█	█	█							
7	prototype: debugging									█	█						
8	host PC: O&D										█						
9	test of the prototype with NA48 setup											█					
10	all components for read-out: O&D												█	█			
11	ROC's: manufacture & debugging													█	█	█	
12	the read-out: assembly and adjustment																█

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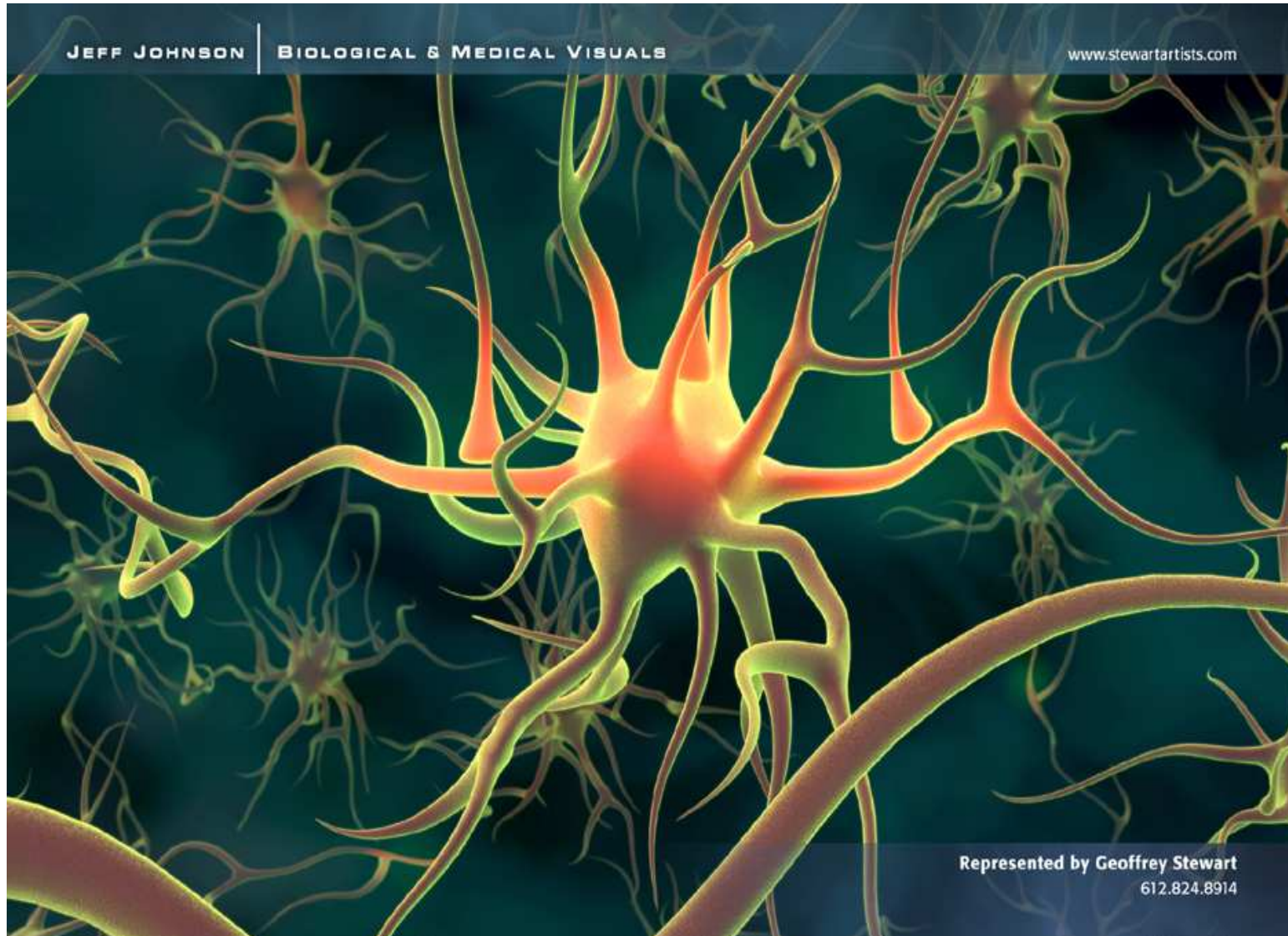
Selection of K_{e4} $K^\pm \rightarrow \pi^\pm \pi^\mp e^\pm \nu(\bar{\nu})$

- conventional e / π separation:
E/p > 0.9 \Rightarrow π rejection factor \sim **150**
 e – selection efficiency \sim 98%
- major background of $K^\pm \rightarrow \pi^\pm \pi^+ \pi^-$
 \sim **4%**
- additional rejection power needed
 \Rightarrow **NN** method



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Neural Network



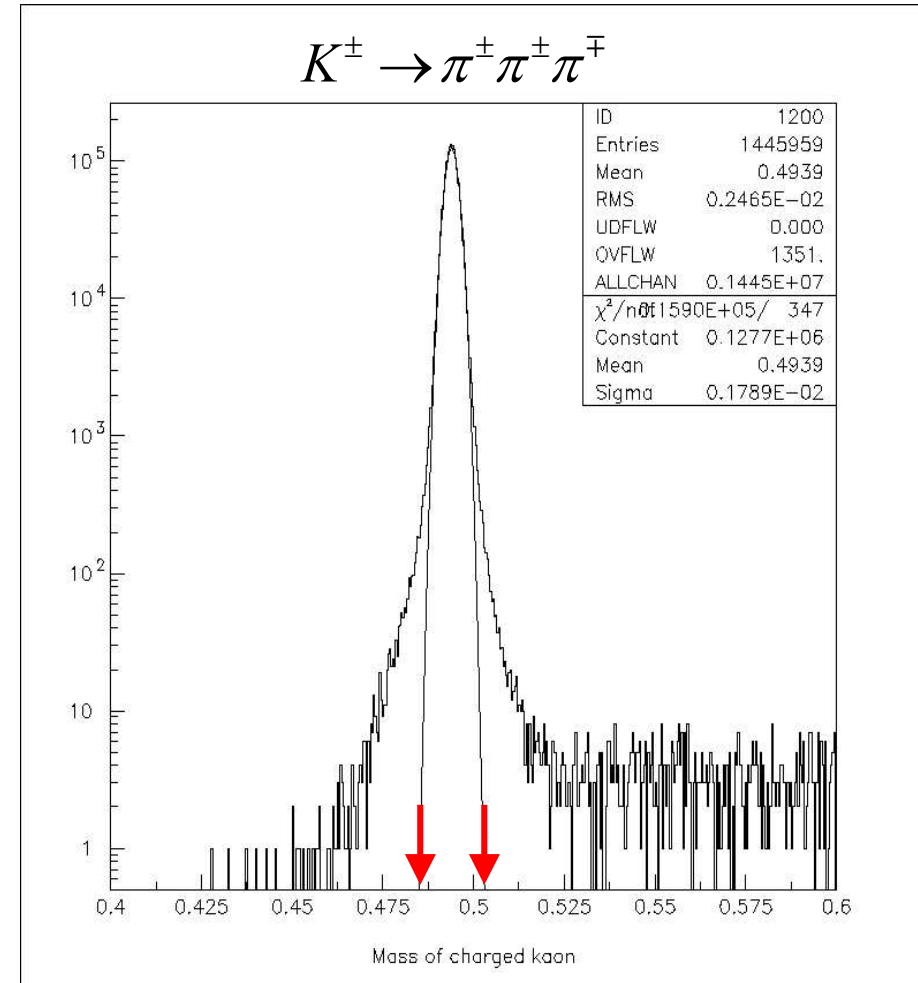
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pure π sample from $K^\pm \rightarrow \pi^\pm \pi^+ \pi^-$

- track momentum > 3 GeV
- $| M(3 \pi) - M_K | < 7.5$ MeV
- a **track** is chosen randomly
& $E/p < 0.8$ for **two** others



930 000 π selected

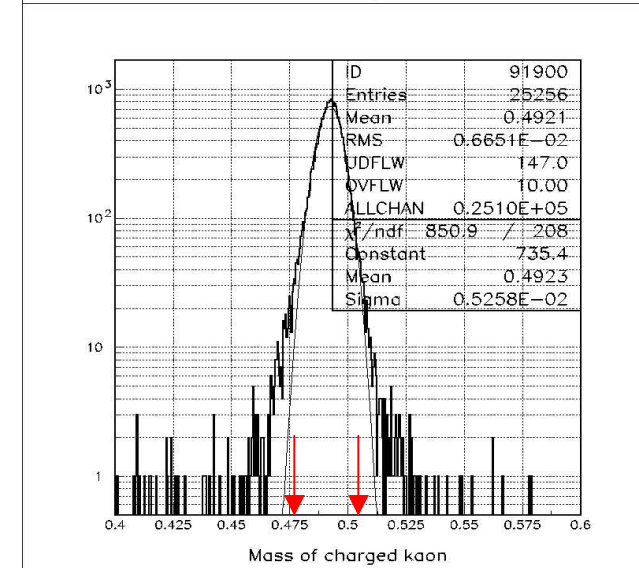
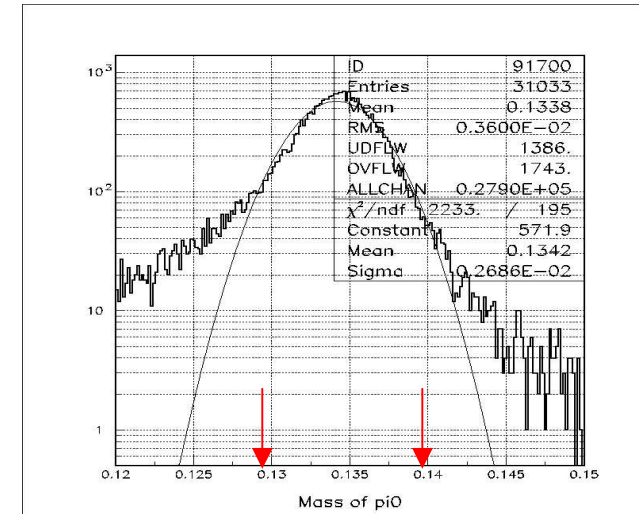


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pure **e** sample from $K^{\pm} \rightarrow \pi^{\pm} \pi^0_D \rightarrow \pi^{\pm} \gamma e^+ e^-$

- 3 tracks:
 - \Rightarrow tot charge ± 1 , CDA < 3 cm
 - additional γ in LKr
 - 3 tracks, γ in LKr
 - \Rightarrow separated by > 25 cm
 - $M(\gamma e^+ e^-)$: 128 – 140 MeV / c^2
 - $M(\pi^{\pm} \gamma e^+ e^-)$: 482 – 505 MeV / c^2
- a **track** is chosen randomly
- others: **e** ($E/p > 0.9$), **π** ($E/p < 0.8$)

20 000 **e** selected



NN variables

Difference in e.m. \Leftrightarrow hadronic showers \Rightarrow lateral development

10 input variables:

➤ $p, E/p$

➤ shower effective radius & projections:

RMS_R, RMS_X, RMS_Y

➤ track entry point \Leftrightarrow associated shower:

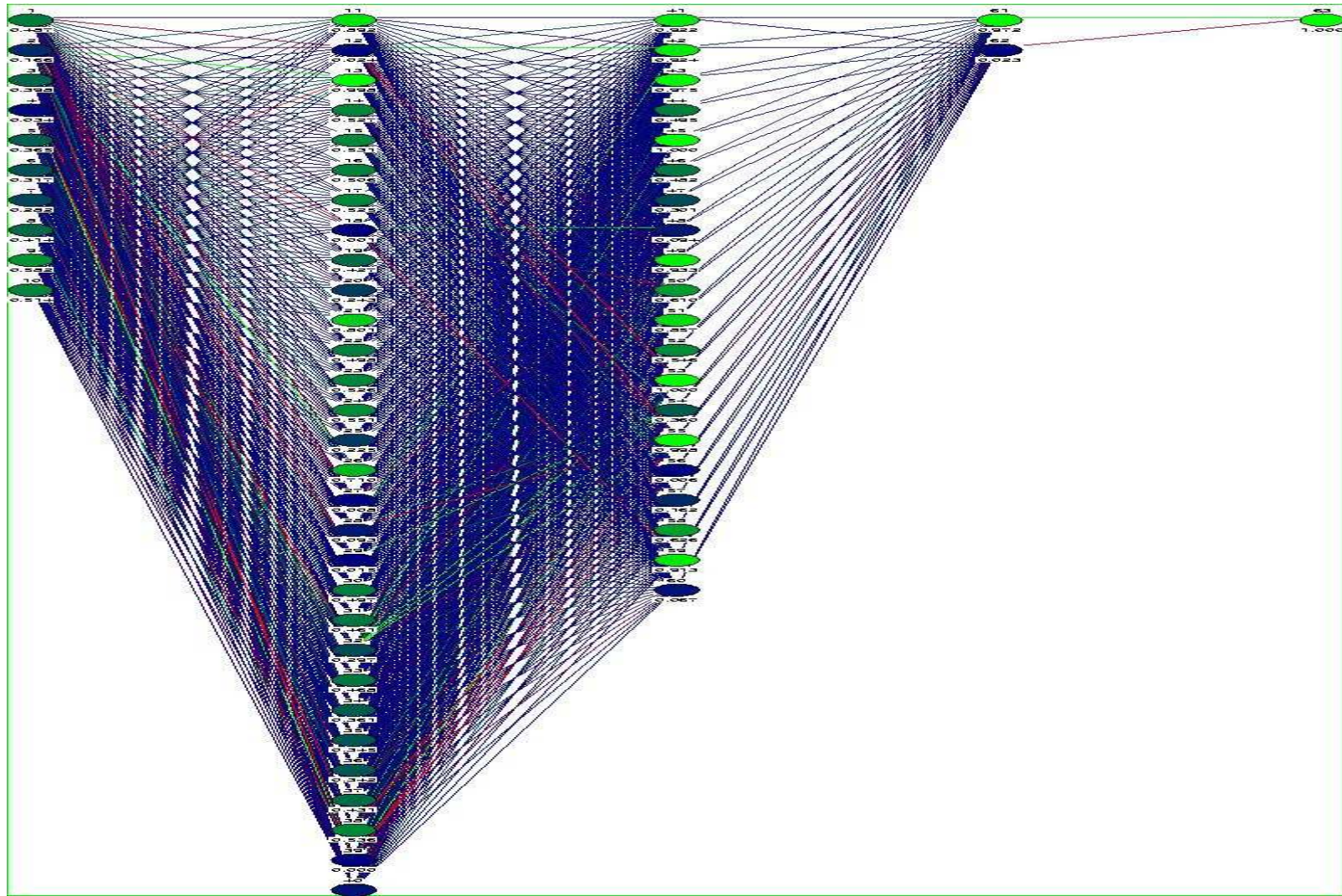
$DIST, DIST_X, DIST_Y$

➤ track impact vectors:

$dx/dz, dy/dz$

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NN 10-30-20-2-1



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20

NN output

$X_{NN} > 0.9$:

overall:

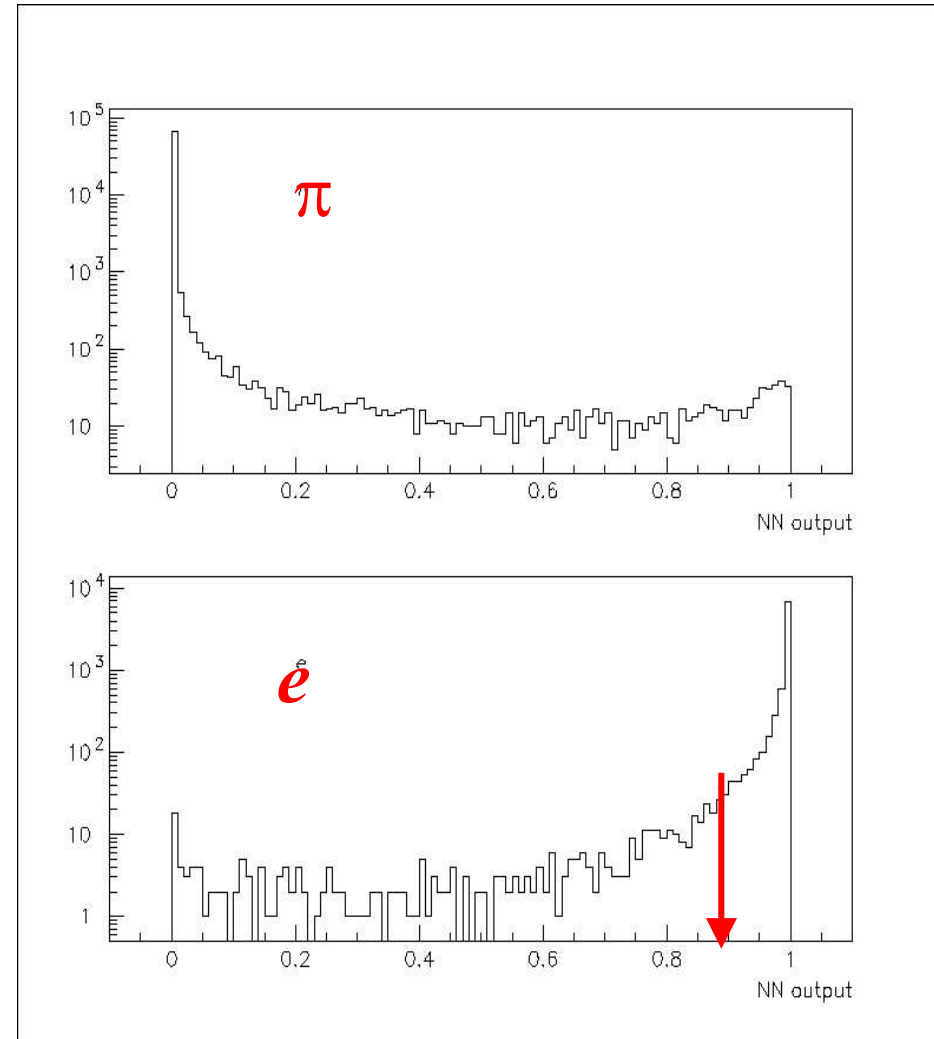
π rejection factor ~ 3600

e selection $\sim 94\%$

additional to $E/p > 0.9$:

π rejection factor ~ 30

e selection $\sim 96\%$



Selection of K_{e4}

K_{e4} events ~ 1500

background $< 1\%$

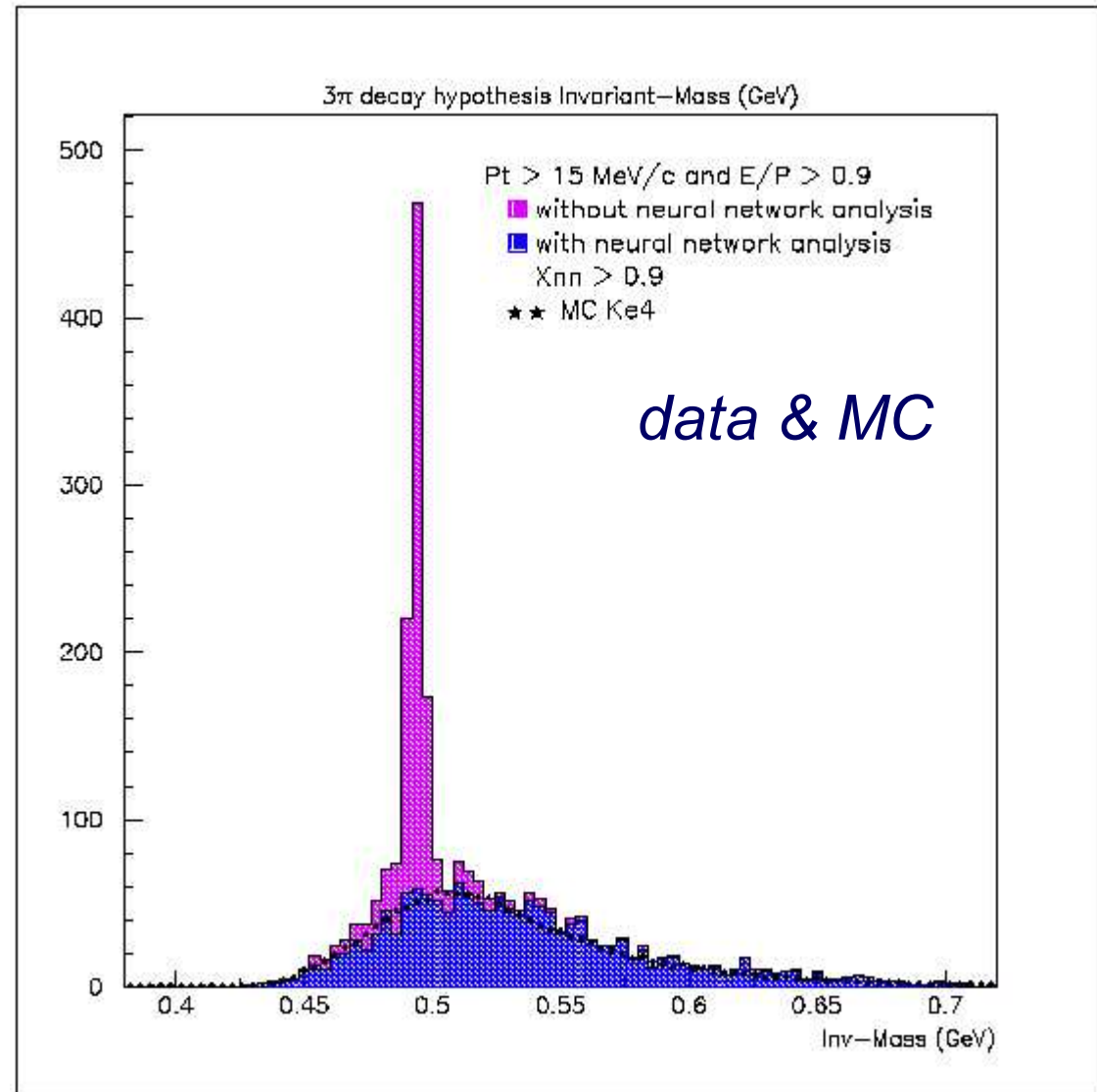
loss of K_{e4} $\sim 5\%$



satisfactory performance



TRD - not needed



Beam Request for 2003

- *Proposal:* **120** days
of 400 GeV protons
1·10¹² ppp on T10
- *SPS proton run in 2003:* **~ 98** days
=105 days – ~7 days of MD
(+ 1 week of *25 ns beam structure*)
- *Request:* **full** proton run
special structure run at the **beginning**