Study of $K^+ \to \pi^+ e^+ e^-$ and $K^+ \to \pi^+ \mu^+ \mu^-$ decays in E865 at the AGS

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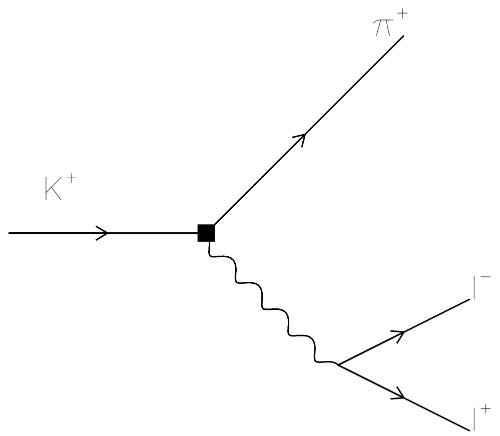
ICHEP 98, Vancouver

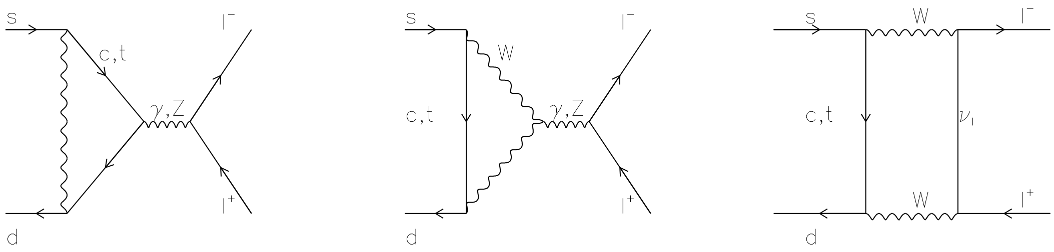
July 23, 1998



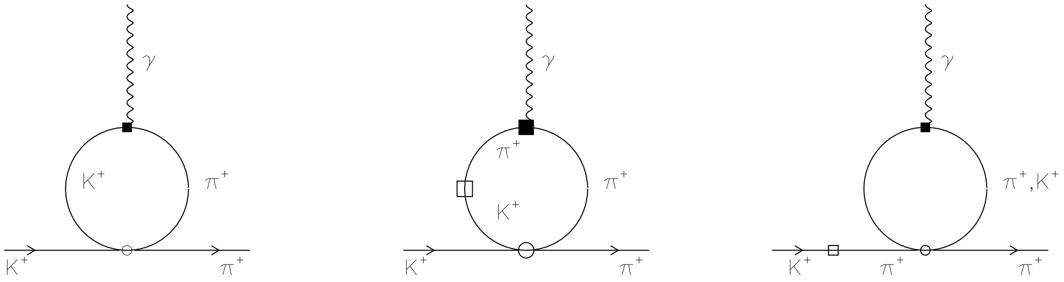
- Physics
- The detector
- Measurements.
- Summary

Theoretical models of $K^+ \to \pi^+ l^+ l^-$

- Short Distance Contributions:



- Chiral Perturbation Theory [$\mathcal{O}(p^4)$]



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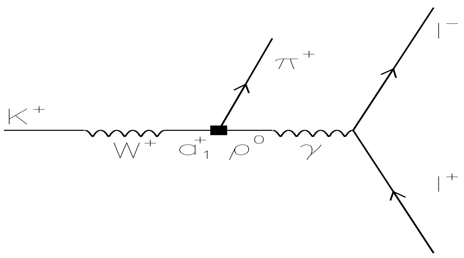
- Vector Meson Dominance Model

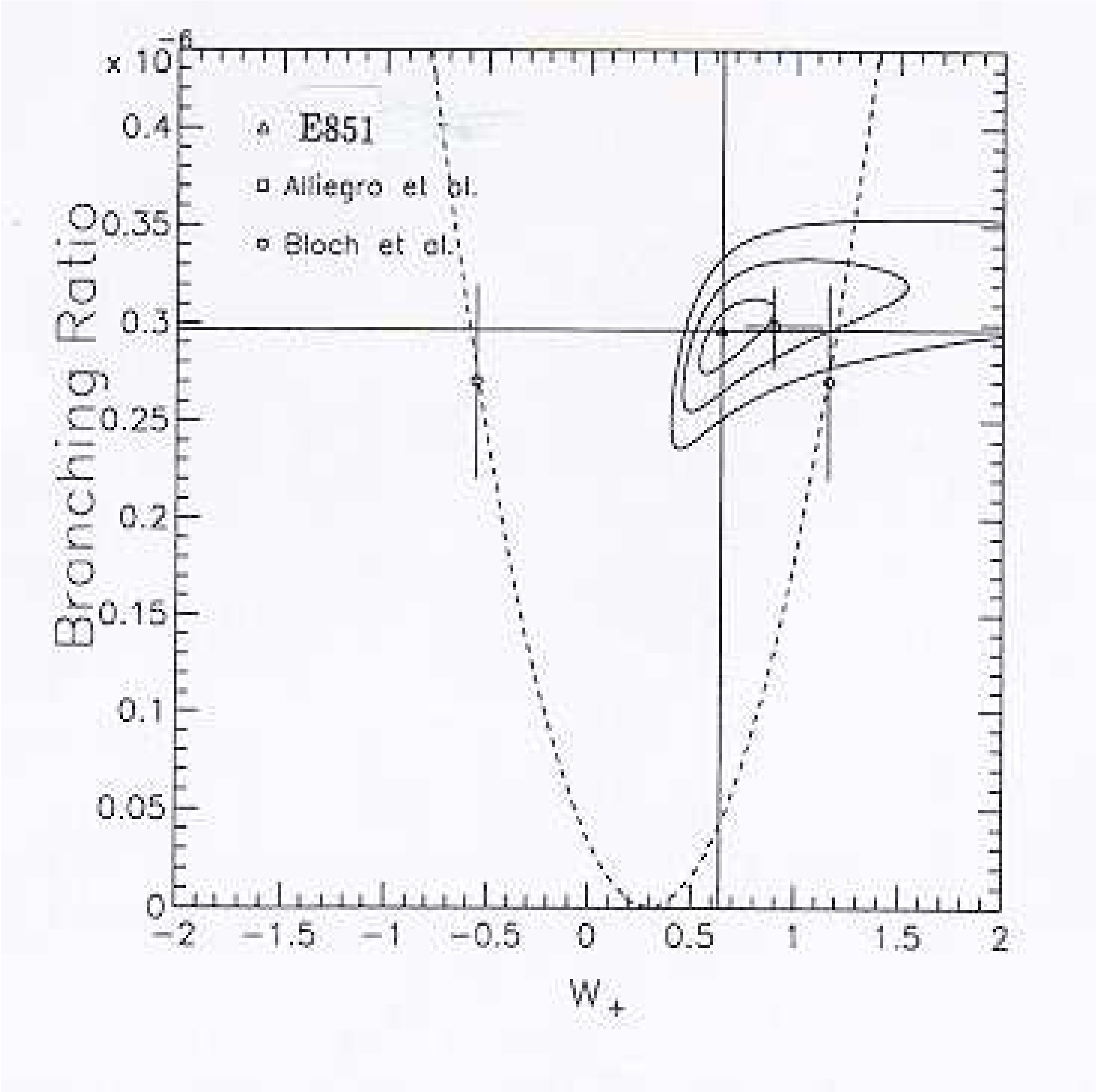


History of measurements of $K^+ \to \pi^+ e^+ e^-$ and $K^+ \to \pi^+ \mu^+ \mu^-$ decays

	$K^+ \to \pi^+ e^+ e^-$		$K^+ \to \pi^+ \mu^+ \mu^-$	
	Events	Br. Ratio $\times 10^{-7}$	Events	Br. Ratio $\times 10^{-8}$
1975 (Bloch)		2.7 ± 0.5		
1989 (E787)			3	< 23
1991 (E777)†	500	2.74 ± 0.23		
1995 (E851)† (unpublished)	800	2.87 ± 0.35		
1997 (E787)			200	5.0 ± 1.0
1998 (E865)	10,000		400	

† Form Factor Measured

Chiral Perturbation Theory of $\mathcal{O}(p^4)$ and Previous Data

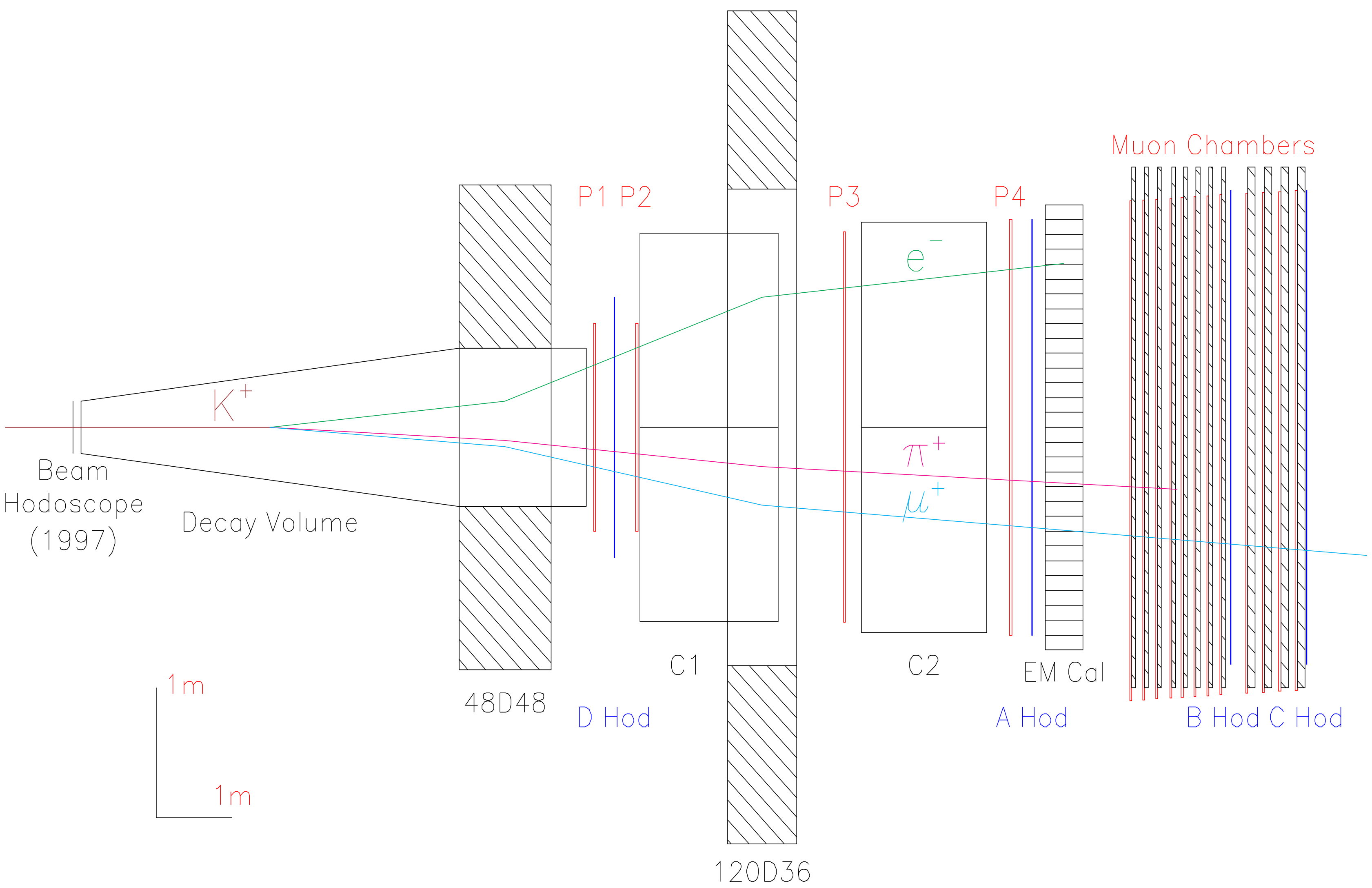


$$\frac{d\Gamma}{dM_{ee}} = 16 M_{ee} \bar{\Gamma} p_\pi^3 |\Phi_+(M_{ee})|^2 / M_K^5$$

$$\Phi_+(M_{ee}) = (\Phi_K(M_{ee}) + \Phi_\pi(M_{ee}) + w_+)$$

(Ecker, Pich and de Rafeal, Nucl Phys B291(1987)692)

E865, Plan Diagram, Search for $K^+ \rightarrow \pi^+\mu^+e^-$



The E865 Collaboration

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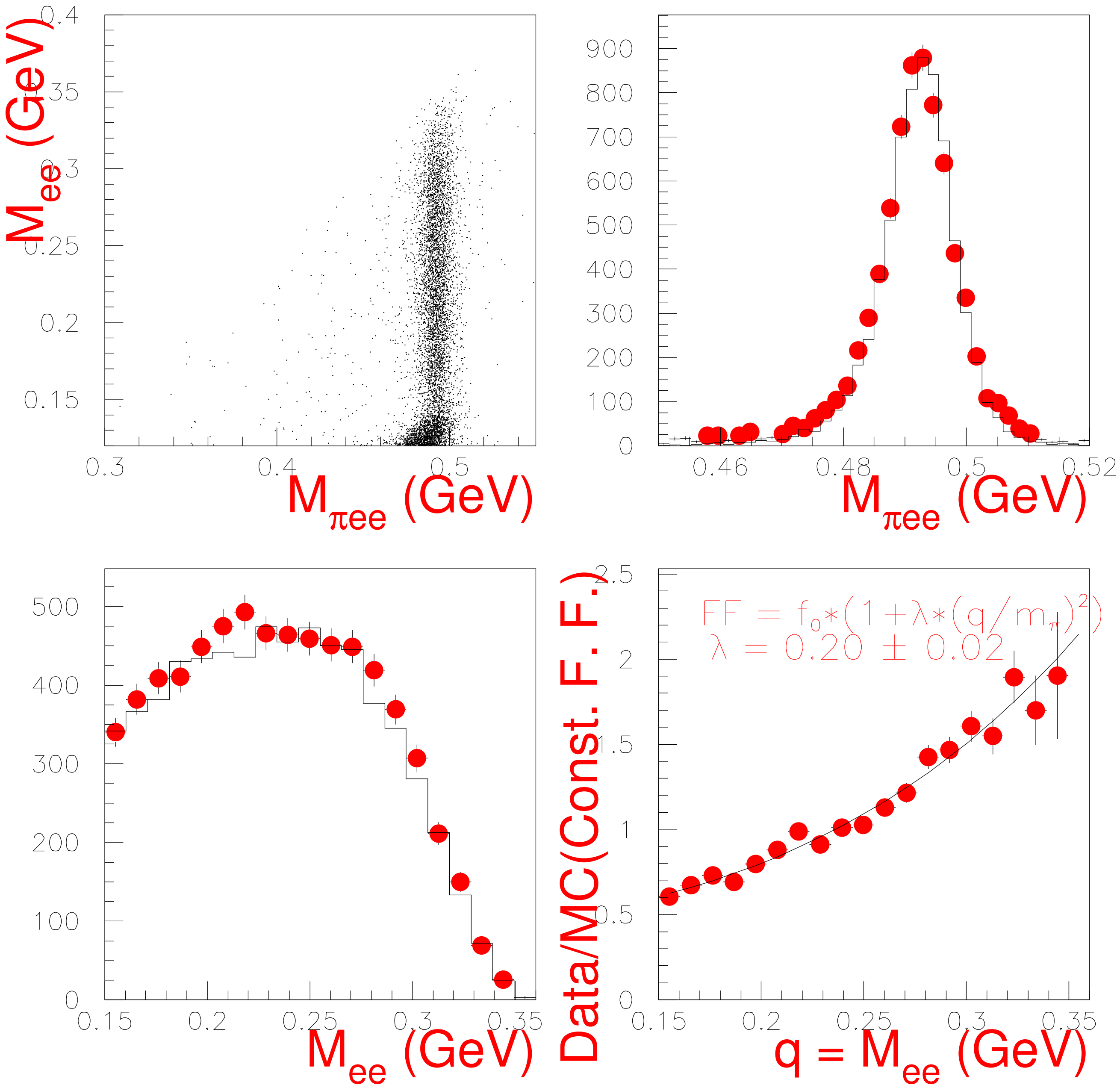
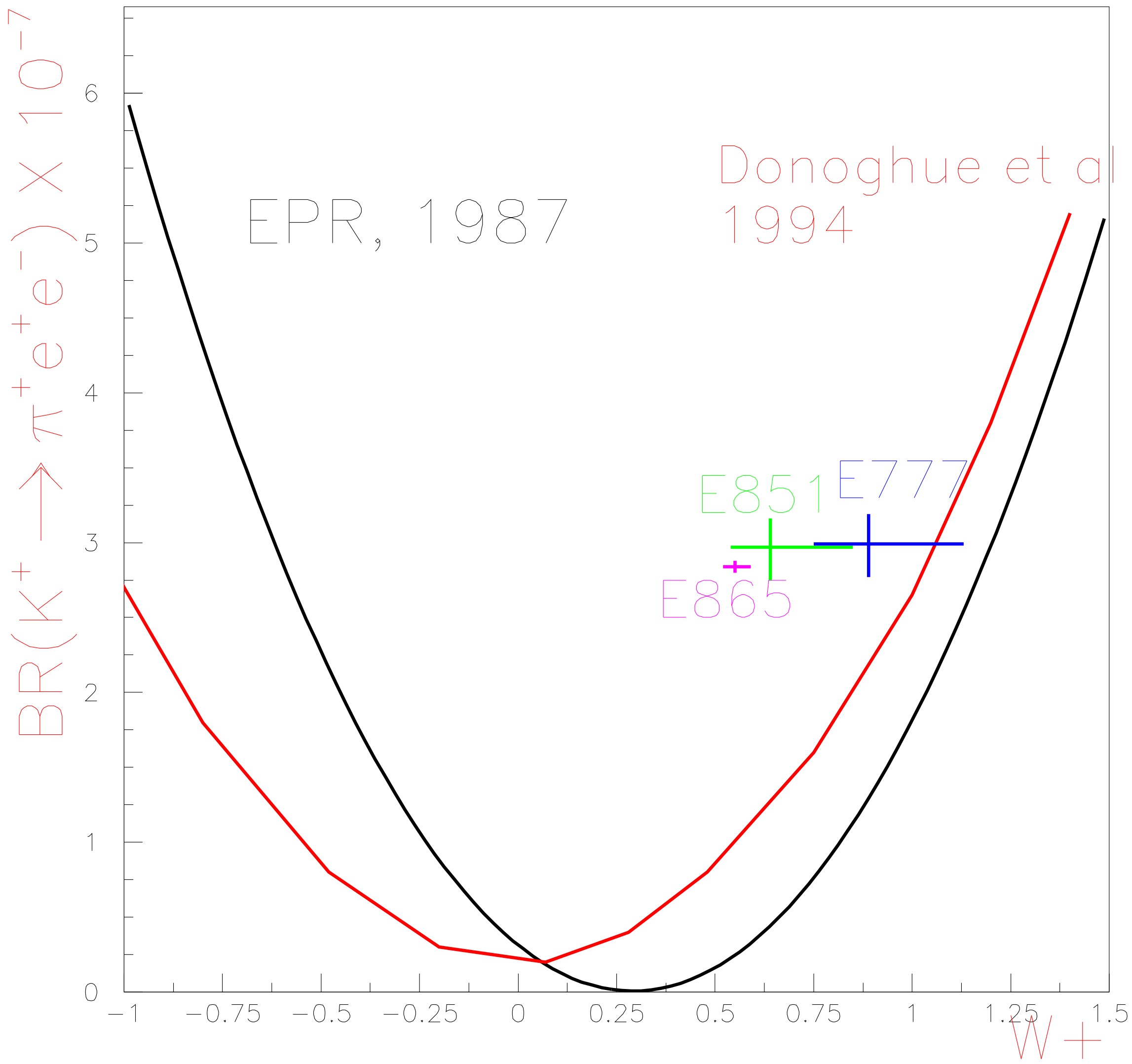
$K^+ \rightarrow \pi^+ e^+ e^-$



Chiral Perturbation Theory of $\mathcal{O}(p^4)$ and Present $K^+ \to \pi^+ e^+ e^-$ Data



The E865 $K^+ \to \pi^+ e^+ e^-$ data is inconsistent with the $\mathcal{O}(p^4)$chiral perturbation theory calculation.

The new calculation by Donoghue and Gabbiani includes some corrections.

$K^+ \to \pi^+\mu^+\mu^-$ Event Selection.

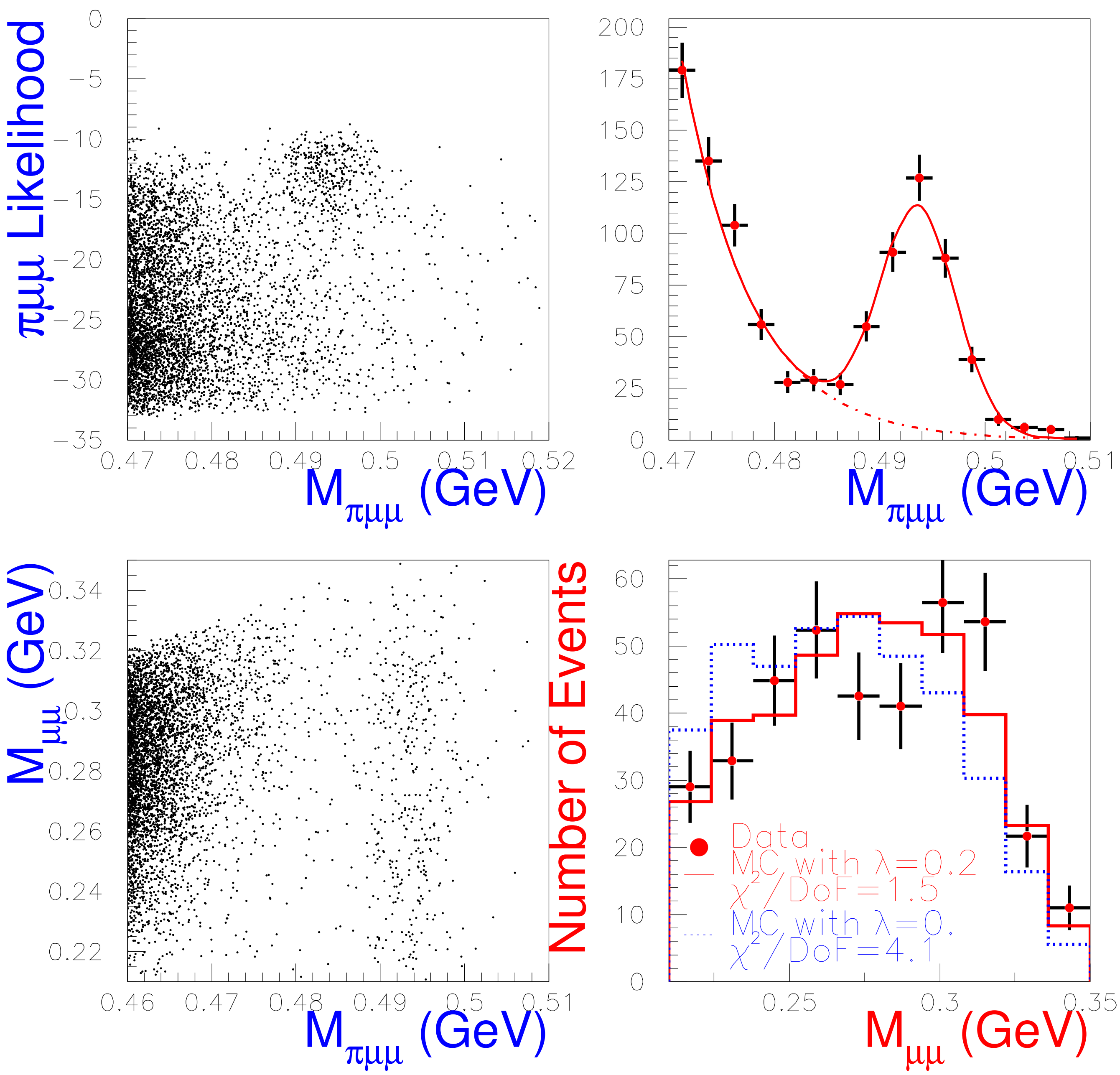
- Trigger requirement:
  Three charged clusters in calorimeter
  One muon on each side of the muon system.

- Event Reconstruction:
  Three charged tracks with a good vertex
  $\pi^+\mu^+\mu^-$ particle ID
  Total Likelihood based on track χ^2, vertex quality, and beam phase space.

- Background:
  $K^+ \to \pi^+\pi^+\pi^-$ with $\pi^\pm \to \mu^\pm\nu$
  Background estimated by extrapolating from below Kaon mass. Signal/Background > 10

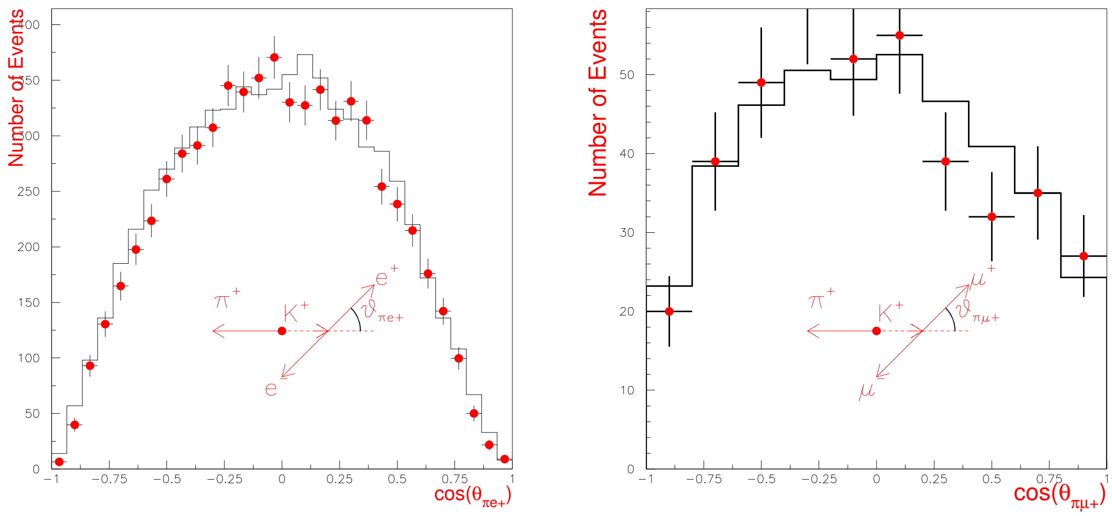
- Check muon acceptance with $K^+ \to \pi^0\mu^+\nu$.

$K^+ \to \pi^+ \mu^+ \mu^-$



A form factor with $\lambda = 0.2$ is favored.

E865: Angular distribution of $K^+ \to \pi^+ l^+ l^-$



$cos(\theta)$ distribution compared to MC of pure vector coupling for $K^+ \to \pi^+ e^+ e^-$ (left) and $K^+ \to \pi^+ \mu^+ \mu^-$ (right)

- For vector interaction:

$$\frac{d^2N}{dE_\pi dcos\theta} \sim p_\pi^3 \left(1 - \frac{4m_l^2}{m_{ll}^2}\right)^{1/2} \left[1 - \left(1 - \frac{4m_l^2}{m_{ll}^2}\right) cos^2\theta\right] |f(\frac{m_{ll}^2}{M_K^2})|^2$$

- Constraint on scalar and tensor interactions.

Summary

- E865 at the AGS has collected a sample of $\sim$ 10000 $K^+ \to \pi^+ e^+ e^-$ and 400 $K^+ \to \pi^+ \mu^+ \mu^-$ events.

- The preliminary analysis shows that the decays can be described by a vector interaction. The q^2 dependence of the form factor is large, $\lambda = 0.20 \pm 0.02$.

- The Chiral Perturbation Theory of $\mathcal{O}(p^4)$can not fit both the branching ratio and lepton pair mass spectrum simultaneously.

- An analysis of combining $K^+ \to \pi^+ e^+ e^-$ and $K^+ \to \pi^+ \mu^+ \mu^-$ is under way.