UNIVERSITY of York

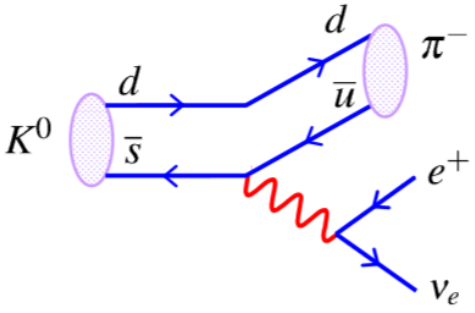
Additional physics potential with K_L beam

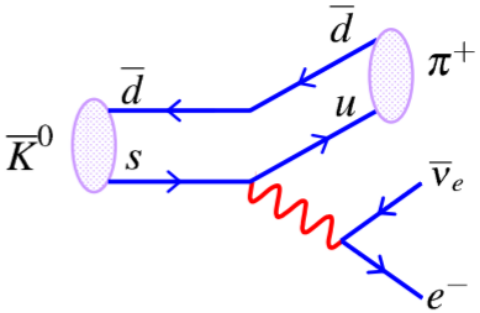
Mikhail Bashkanov

Outlook

- BEYOND KLF PROGRAM
  - CP-violation with Flux Monitor
  - K_L beta decay
  - Neutron absorption cross section

CP in K_L



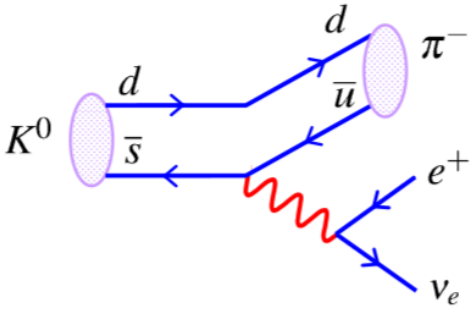


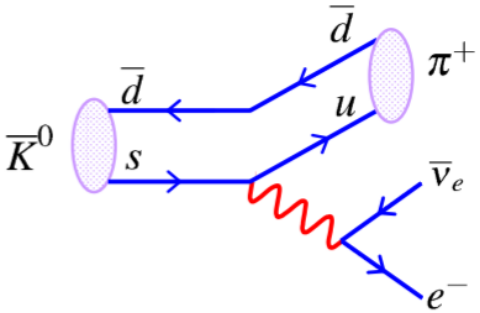
$$K^0 \rightarrow \pi^- e^+ \nu_e$$
$$\overline{K^0} \rightarrow \pi^+ e^- \bar{\nu}_e$$

$$K_L = \frac{1}{\sqrt{2(1+|\epsilon|^2)}}\left((1+\epsilon)K^0 - (1-\epsilon)\overline{K^0}\right)$$

$|\epsilon| \sim 10^{-3} \rightarrow$ CP is violated !

CP in K_L





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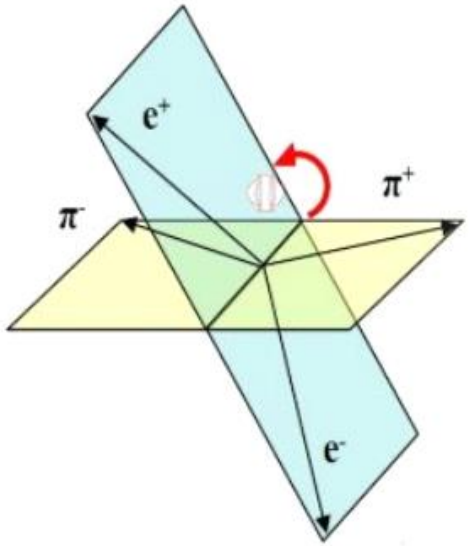
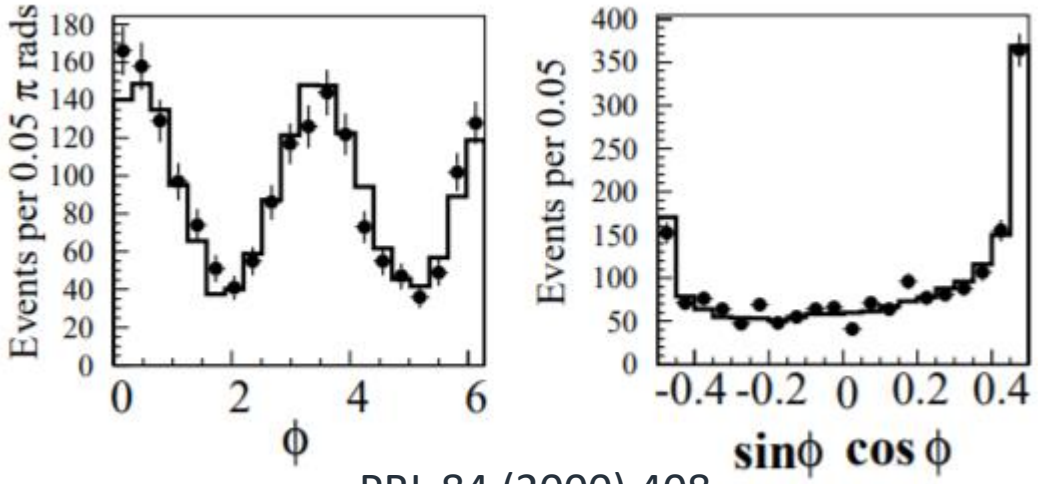
$$K_L = \frac{1}{\sqrt{2(1+|\epsilon|^2)}}\left((1+\epsilon)K^0 - (1-\epsilon)\overline{K^0}\right)$$

$|\epsilon| \sim 6.6 \cdot 10^{-3} \rightarrow$ CP is violated !

T in $K_L \to \pi^+\pi^-e^+e^-$





PRL 84 (2000) 408

$$A = \frac{N_{\sin\phi\cos\phi\ >\ 0.0} - N_{\sin\phi\cos\phi\ <\ 0.0}}{N_{\sin\phi\cos\phi\ >\ 0.0} + N_{\sin\phi\cos\phi\ <\ 0.0}}$$

$A = 13.6\%$

~1 decay per hour with KLF FM

Rare decays

- Physics beyond SM
  - Rare final state
  - Precise calculations

Rare decays

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  - Precise calculations

K_L beta-decay

$$K_L \to K^+ e^- \overline{\nu_e}$$
$$K_L \to K^- e^+ \nu_e$$

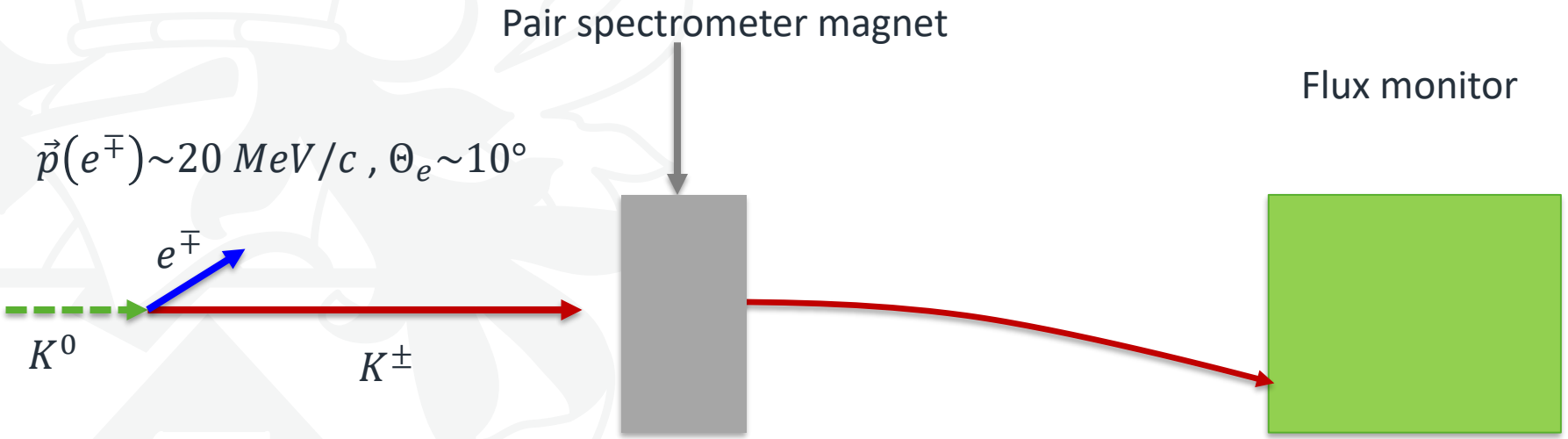
$$M(K_L) = 497.611\ MeV$$
$$M(K^{+/-}) = 493.696\ MeV$$
$$M(e^{+/-}) = 0.511\ MeV$$

Available Phase Space $\mathbf{3.4\ MeV}$

BUT!!!

- In flight decay (boosted)
- Can build dedicated detector
- Br$(K^0 \to K^{\pm} e^{\mp}\ \nu) \sim 10^{-9}$ (N.N. Shishov, Yad. Fyz. 82, 86, (2019))
- ~50 decays per beamtime

Rare decays



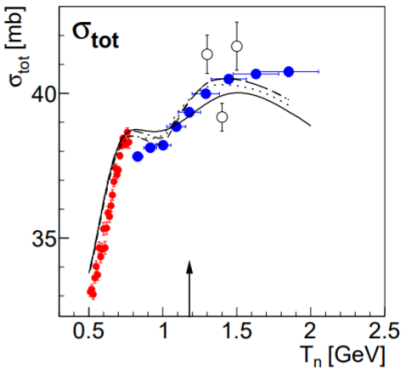
$\vec{p}(K^0) = \vec{p}(K^{\pm})$

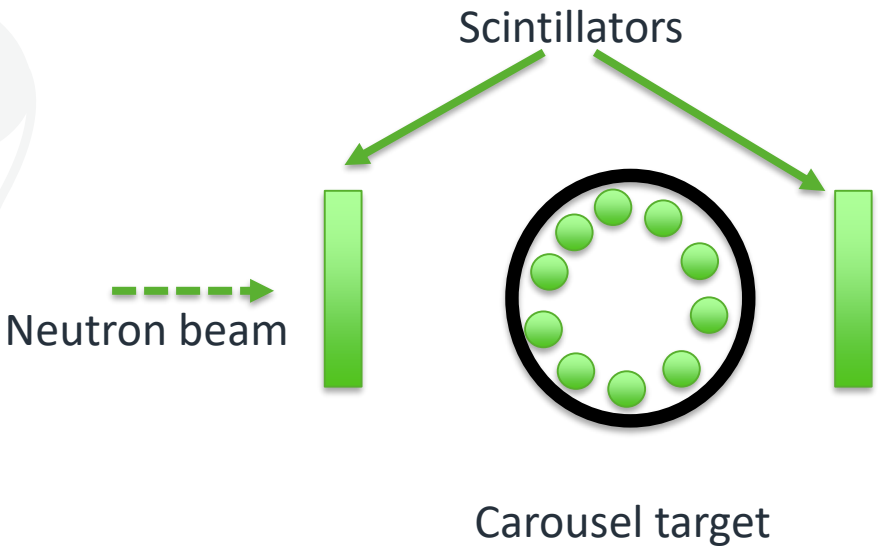
BUT!!!

- In flight decay (boosted)
- Can build dedicated detector
- Br$\left(K^0 \rightarrow K^{\pm} e^{\mp} \nu\right)$~$10^{-9}$
- ~50 decays per beamtime

Beam dump station

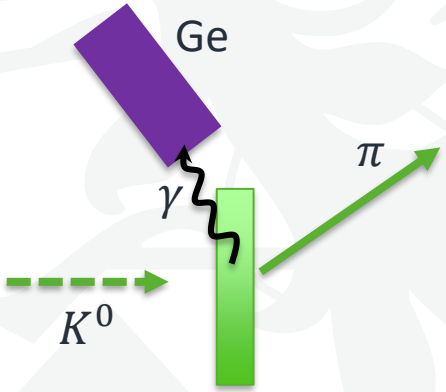
- Neutron absorption cross section measurement
  - Over large range
  - Various materials
  - One beam (no relative normalisation issues)

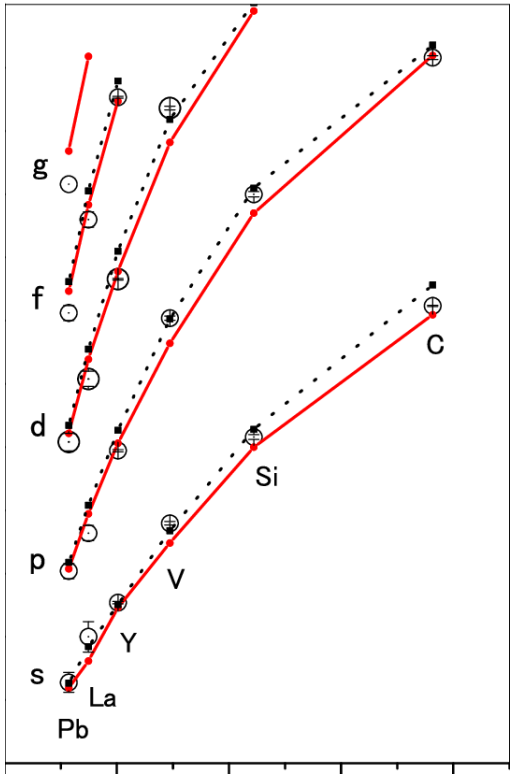




- Neutrino physics
- Cosmic rays
- Dark matter searches
- Space science

Hypernuclei?





Conclusion

- What else can we do?
- Do we need any modifications to perform better?
- New equipment for side projects?