Cascades on Lattice

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Introduction

$$\Xi^0(ssu) \qquad \Xi^-(ssd)$$

$$\Xi^{*0}(ssu) \qquad \Xi^{*-}(ssd)$$

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- Charge radii
- Magnetic Moments
- Magnetic Radii

Definitions

- Form Factor, $F(\vec{q}^2)$
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- Charge radii
  From Electric Form factor $\longrightarrow$ charge density
- Magnetic Moment
  Magnetic Form Factor at zero momentum transfer, $F(\vec{0})$.

Procedure

- Calculation of Form Factors
- Extraction of charge radii
- Extraction of Magnetic Moments
- Extraction of magnetic radii

- Form Factors

$$\overline{R}(\vec{q},\vec{0};\Gamma_4,4) = \mathcal{G}_E(q^2),$$
$$\overline{R}(\vec{q},\vec{0};\Gamma_j,k) = \frac{\mathcal{G}_M(q^2)\ |\epsilon_{ijk}q^i|}{(E_q+M)}$$

where

$$\Gamma_j = \frac{1}{2}\begin{pmatrix} \sigma_j & 0 \\ 0 & 0 \end{pmatrix} \quad ; \quad \Gamma_4 = \frac{1}{2}\begin{pmatrix} I & 0 \\ 0 & 0 \end{pmatrix}.$$

Calculate at the smallest finite q^2 available on our lattice,

$$\vec{q} = \frac{2\pi}{L}\hat{x}.$$

Electric Charge Radius

$$< r^2 > = -6 \frac{d}{dq^2} \mathcal{G}_E(q^2) \Big|_{q^2=0}$$

- Dipole approximation

$$\mathcal{G}_E(q^2) = \frac{\mathcal{G}_E(0)}{(1 + q^2/m^2)^2} \, , \; q^2 \geq 0 \, .$$

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$$\frac{< r^2 >}{\mathcal{G}_E(0)} = \frac{12}{q^2} \left[\left(\frac{\mathcal{G}_E(0)}{\mathcal{G}_E(q^2)} \right)^{1/2} - 1 \right] \, .$$

Magnetic Moments

$$\mu = \mathcal{G}_M(0) \left(\frac{e}{2M_N} \right)$$

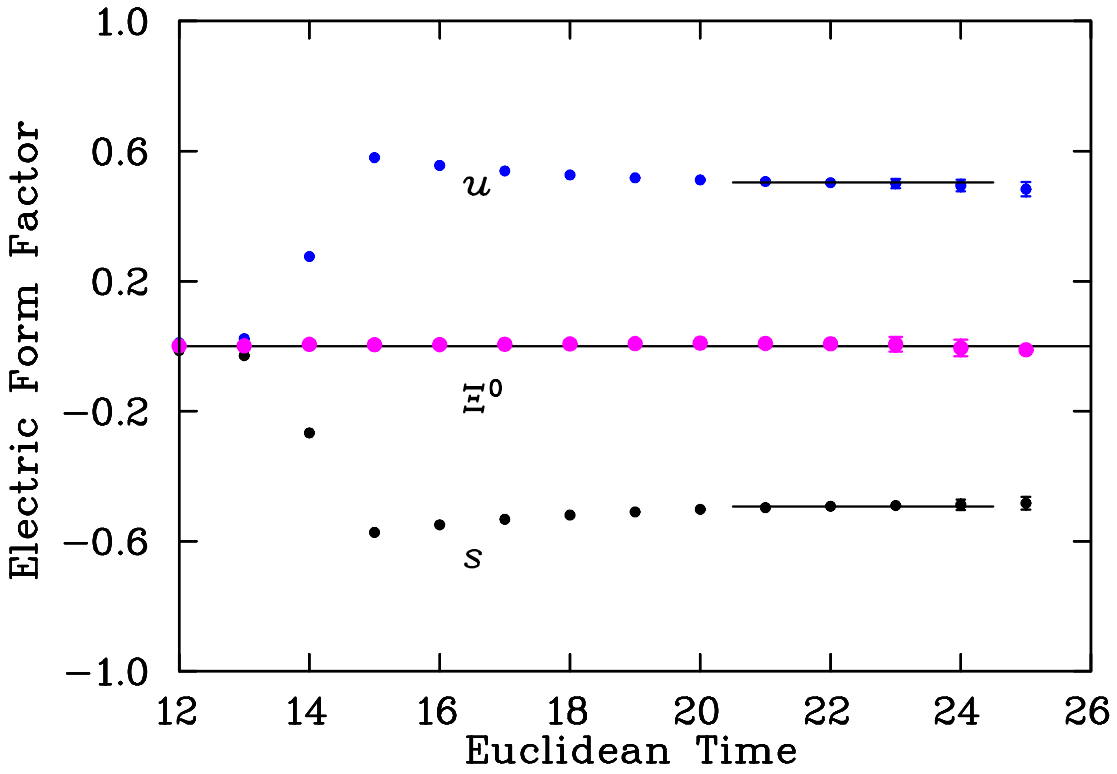
- Need $\mathcal{G}_M(0)$
- Assume a scaling of Electric and Magnetic form factors in q^2

$$\frac{\mathcal{G}_M(q^2)}{\mathcal{G}_M(0)} \simeq \frac{\mathcal{G}_E(q^2)}{\mathcal{G}_E(0)} ,$$

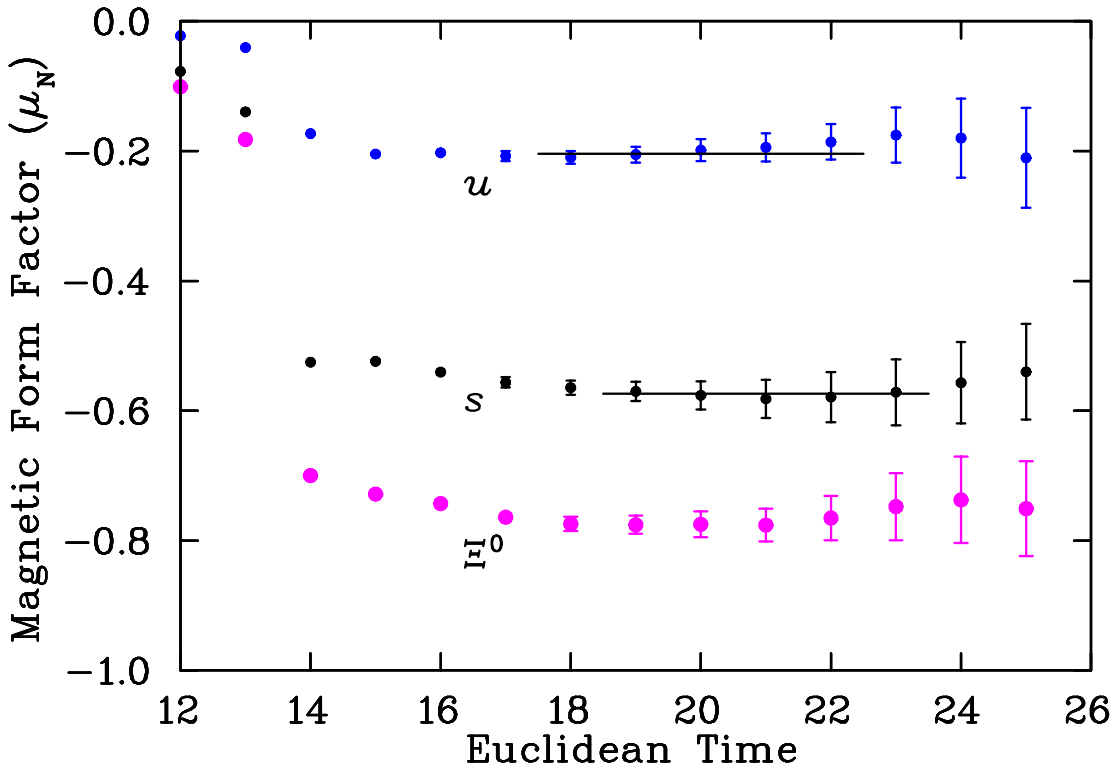
Lattice techniques

- Generate quenched gauge configurations on the lattice by the C-M psuedo-heat bath method.
- $20 \times 20 \times 20 \times 40$ lattice with spacing $a = 0.128 fm$
- FLIC fermion action
- Lowest quark mass is 300 MeV.

Electric Form factors



Magnetic Form factors



Power expansion

$$< r_E^2 > \;=\; \frac{1}{16\pi^2 f^2} \sum_X [5\beta \log\left(\frac{m_X^2}{\mu^2}\right) - ..... + C_0 + C_2 m_X^2 + ...]$$

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$$\beta \frac{m_N}{8\pi f_\pi^2} = \chi$$

χ are the Chiral coefficients calculated using loop integrals.

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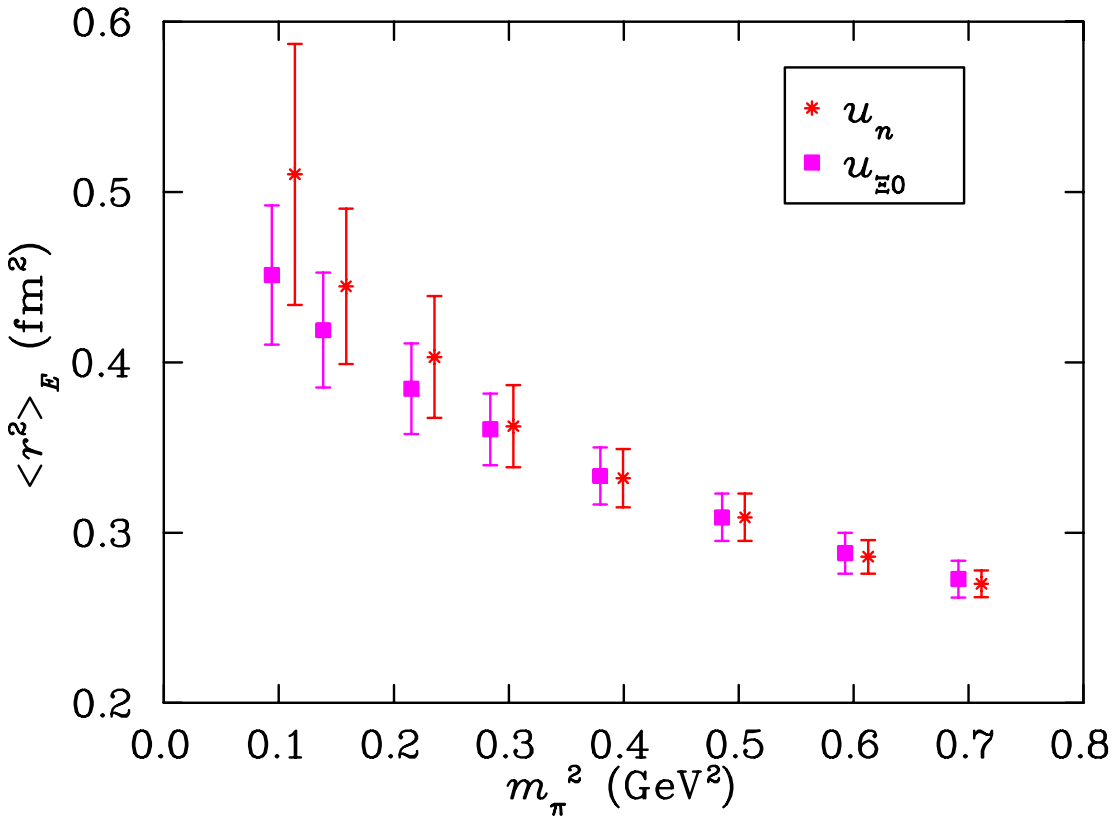
$$\mu_B = a_0^B + a_2^B m_\pi^2 + a_4^B m_\pi^4 + ... \chi_B m_\pi + ...$$

Chiral Coefficients

q	Int	Total	Quenched Valence
u_{Ξ^0}	$\Xi\pi$	-0.29	0
	ΛK	0	-0.40
s_{Ξ^0}	ΛK	-0.40	$+0.40$
	ΣK	-10.3	-3.43
Ξ^0	$\Xi\pi$	-0.29	0
	ΛK	0	-0.40
Ξ^-	$\Xi\pi$	$+0.29$	0
	ΛK	$+0.40$	0

Electric Charge radii



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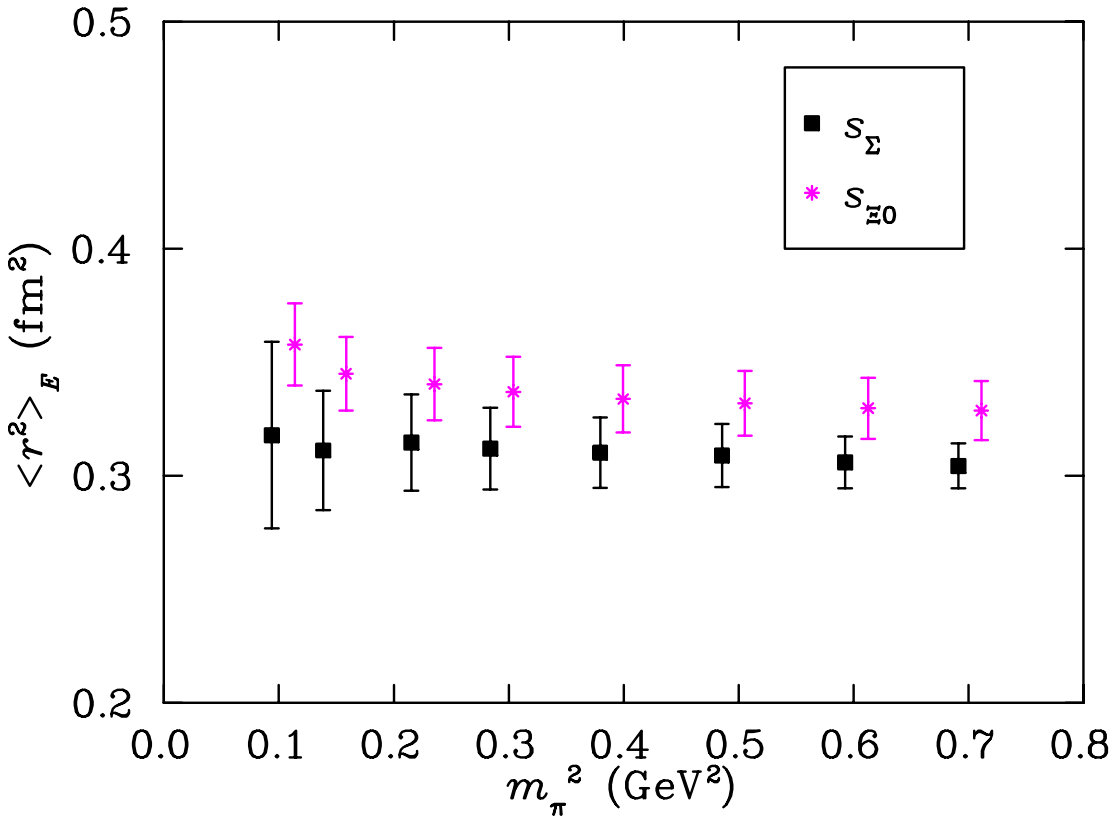

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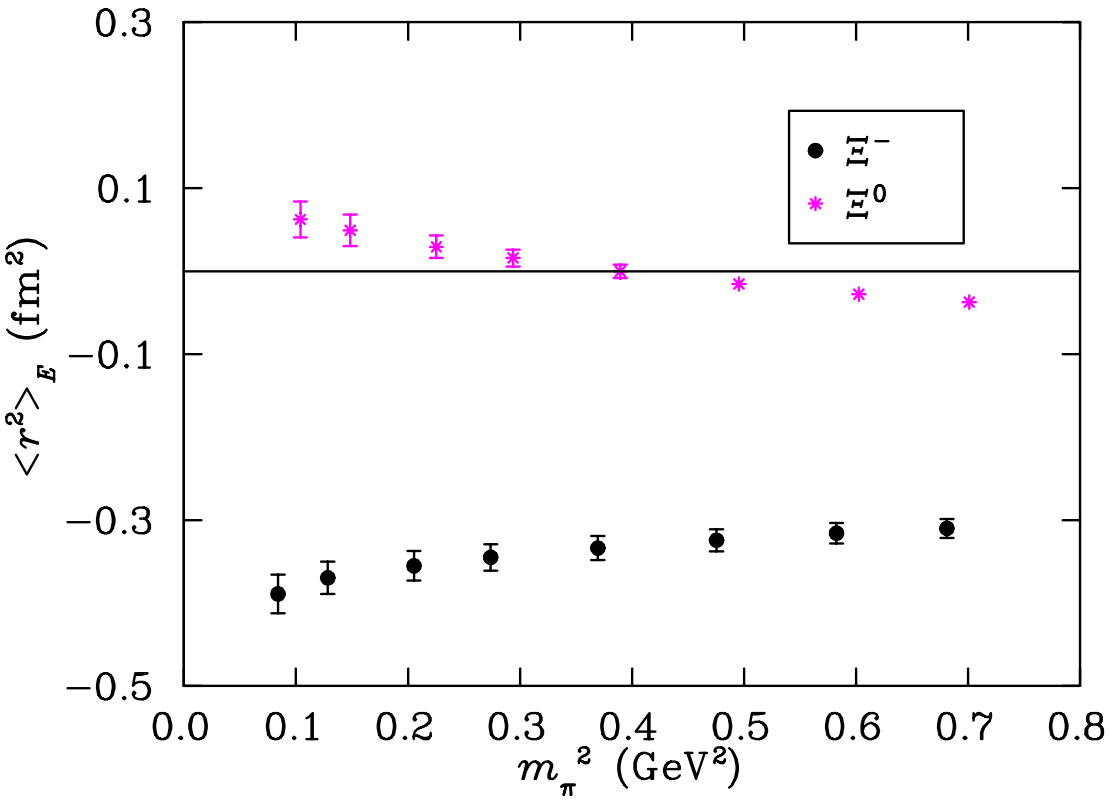
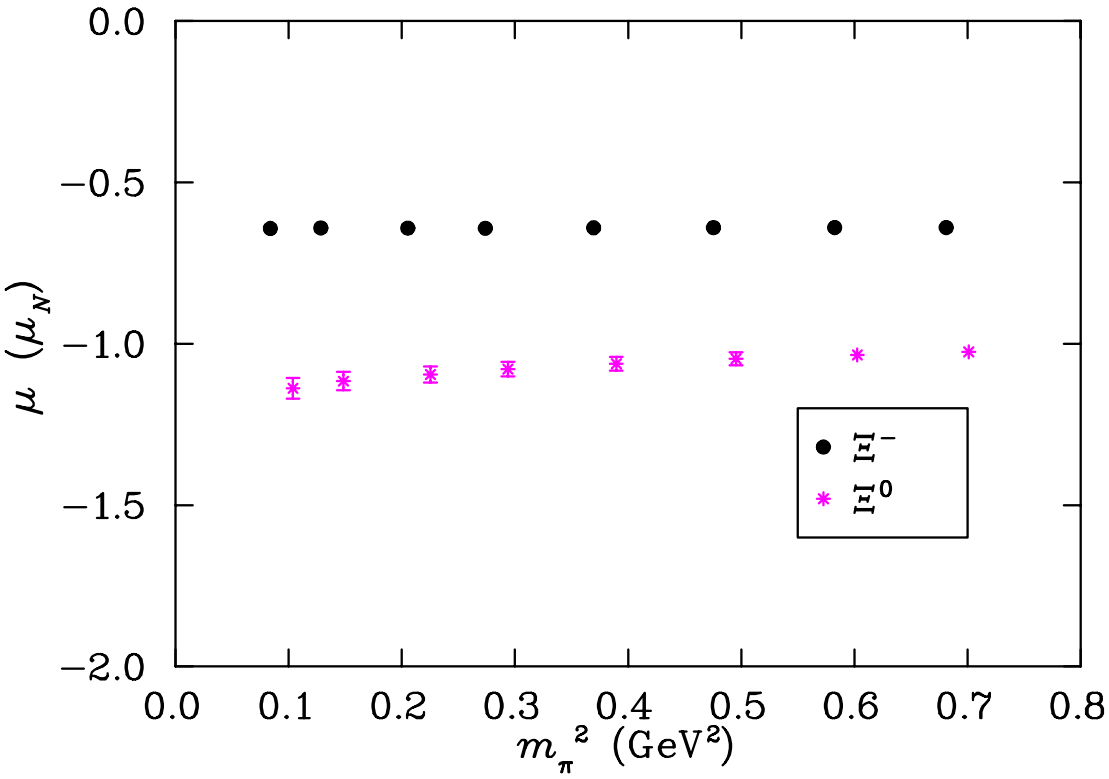


Magnetic moments



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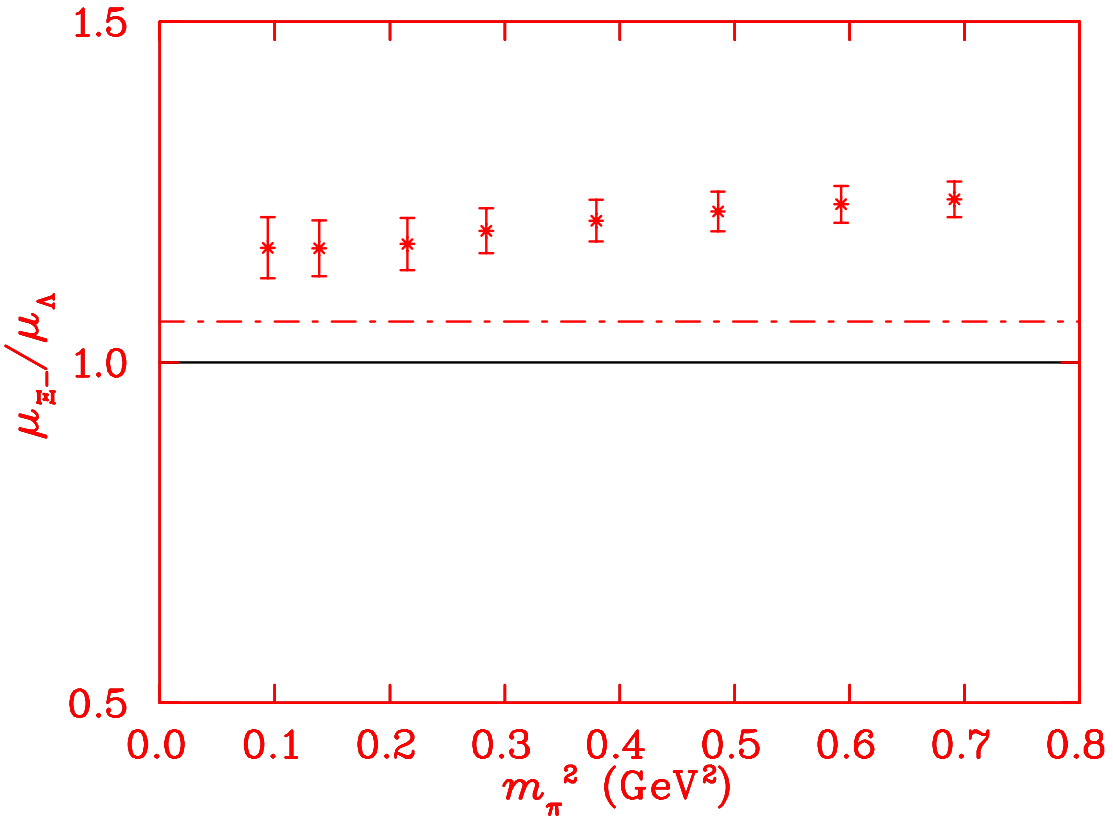

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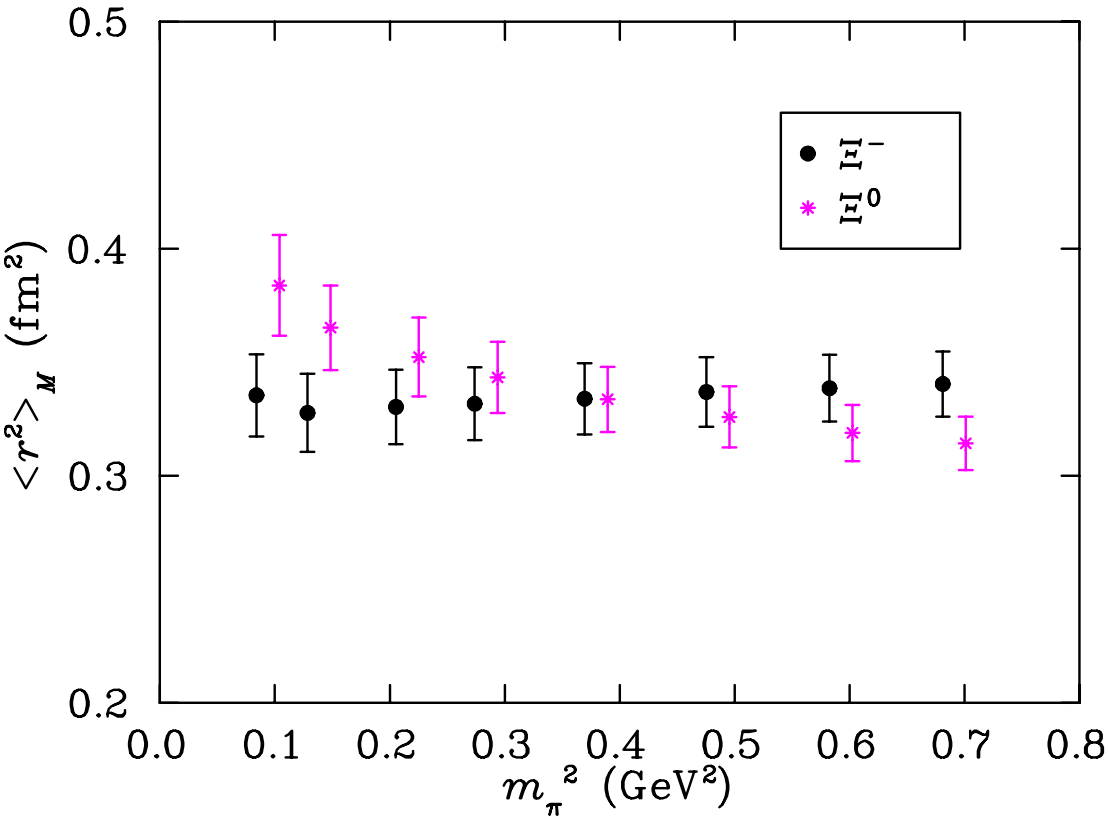
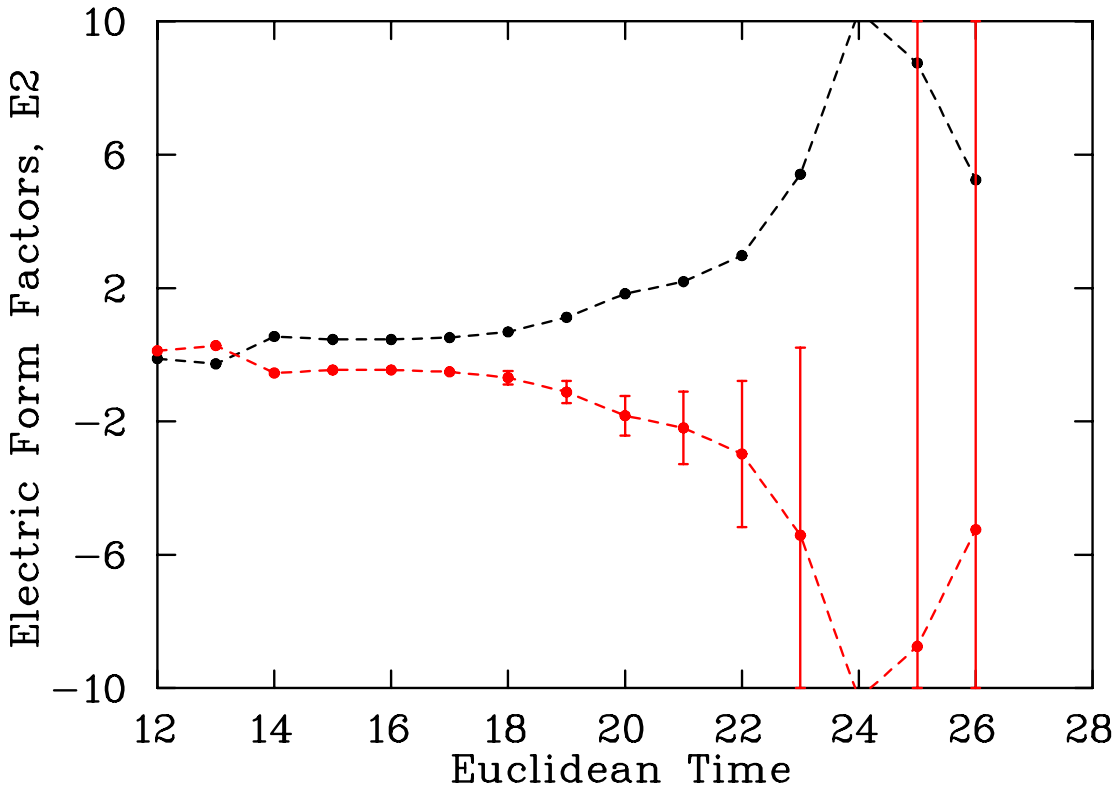


Conclusions

- Environment sensitivity established
- Consistent with experimental values.
- Consistent with Quenched Chiral Perturbation theory.

Electric Form factors



Magnetic Form factors