π^0 and η transition formfactors

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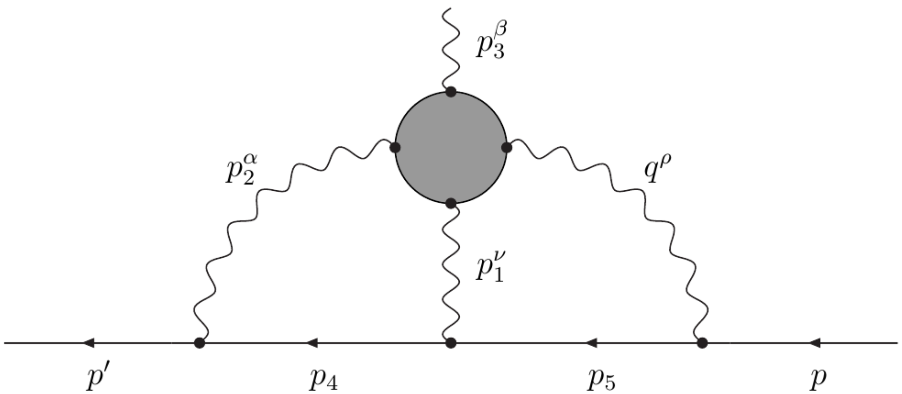
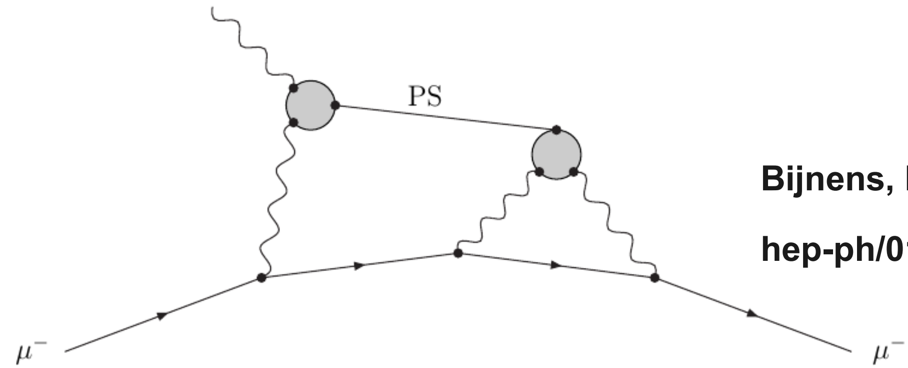
RMC WG Meeting Frascati, April 17, 2012

Outline





Bijnens, Persson

hep-ph/0106130

$$F_P\left((q_1+q_2)^2, q_1^2, q_2^2\right) =?$$

Experimental information on:

$\Gamma_{P\to\gamma\gamma}$ $\quad \left|F_P\left(q_1^2, q_2^2=0\right)\right|^2$ $\quad e^+e^- \to P\gamma$

$\left|F_P\left(q_1^2 \neq 0, q_2^2 \neq 0\right)\right|^2$

Workshop on Meson Transition Form Factors

May 29-30, 2012 in Cracow, Poland

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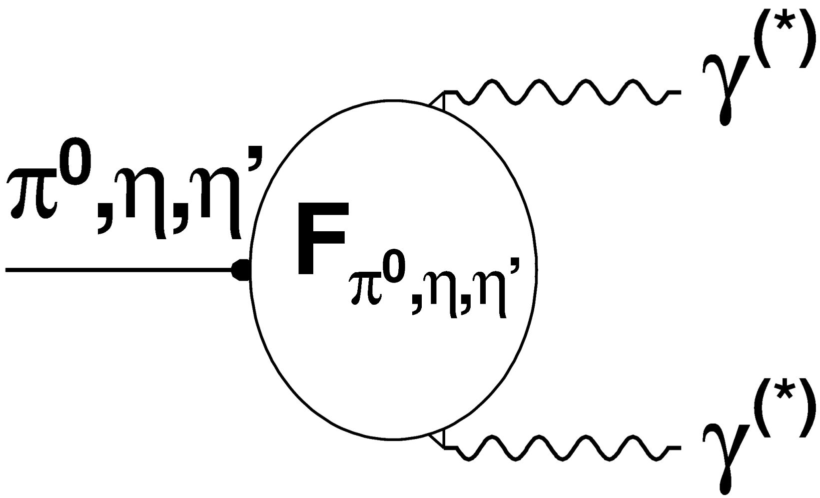
$$F_P\left((q_1+q_2)^2 = m_P^2, q_1^2, q_2^2\right) = F_P\left(q_1^2, q_2^2\right)$$

On shell PS TFF VMD



$$\boldsymbol{F_P(0,0) = 1}$$

$$F_P^{VMD}(q_1^2,q_2^2) = \frac{1}{N}\sum_V \sum_{V'} \frac{g_{PVV'}}{g_{V\gamma}g_{V'\gamma}} \frac{M_V^2}{D_V(q_1^2)} \frac{M_{V'}^2}{D_{V'}(q_2^2)}$$

$$D_V(q^2) = M_V^2 - q^2 - i\Gamma_V M_V$$

$$F_P^{VMD}(q^2,0) = \frac{1}{N}\sum_V \frac{g_{PV\gamma}}{2g_{V\gamma}} \frac{M_V^2}{D_V(q^2)}$$

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VMD TFF

$$F_{\pi^0}^{VMD}(q_1^2, q_2^2) = \frac{1}{N}\left\{\frac{M_\rho^2}{D_\rho(q_1^2)}\frac{M_\omega^2}{D_\omega(q_2^2)} + \frac{M_\omega^2}{D_\omega(q_1^2)}\frac{M_\rho^2}{M_\rho(q_2^2)}\right\}$$

$$\begin{aligned} F_{\eta}^{VMD}(q_1^2, q_2^2) &= \frac{1}{N}\left\{\frac{g_{\eta\rho\rho}}{g_{\rho\gamma}^2}\frac{M_\rho^2}{D_\rho(q_1^2)}\frac{M_\rho^2}{D_\rho(q_2^2)} + \frac{g_{\eta\omega\omega}}{g_{\omega\gamma}^2}\frac{M_\omega^2}{D_\omega(q_1^2)}\frac{M_\omega^2}{D_\omega(q_2^2)}\right. \\ &+ \left.\frac{g_{\eta\phi\phi}}{g_{\phi\gamma}^2}\frac{M_\phi^2}{D_\phi(q_1^2)}\frac{M_\phi^2}{D_\phi(q_2^2)}\right\}. \end{aligned}$$

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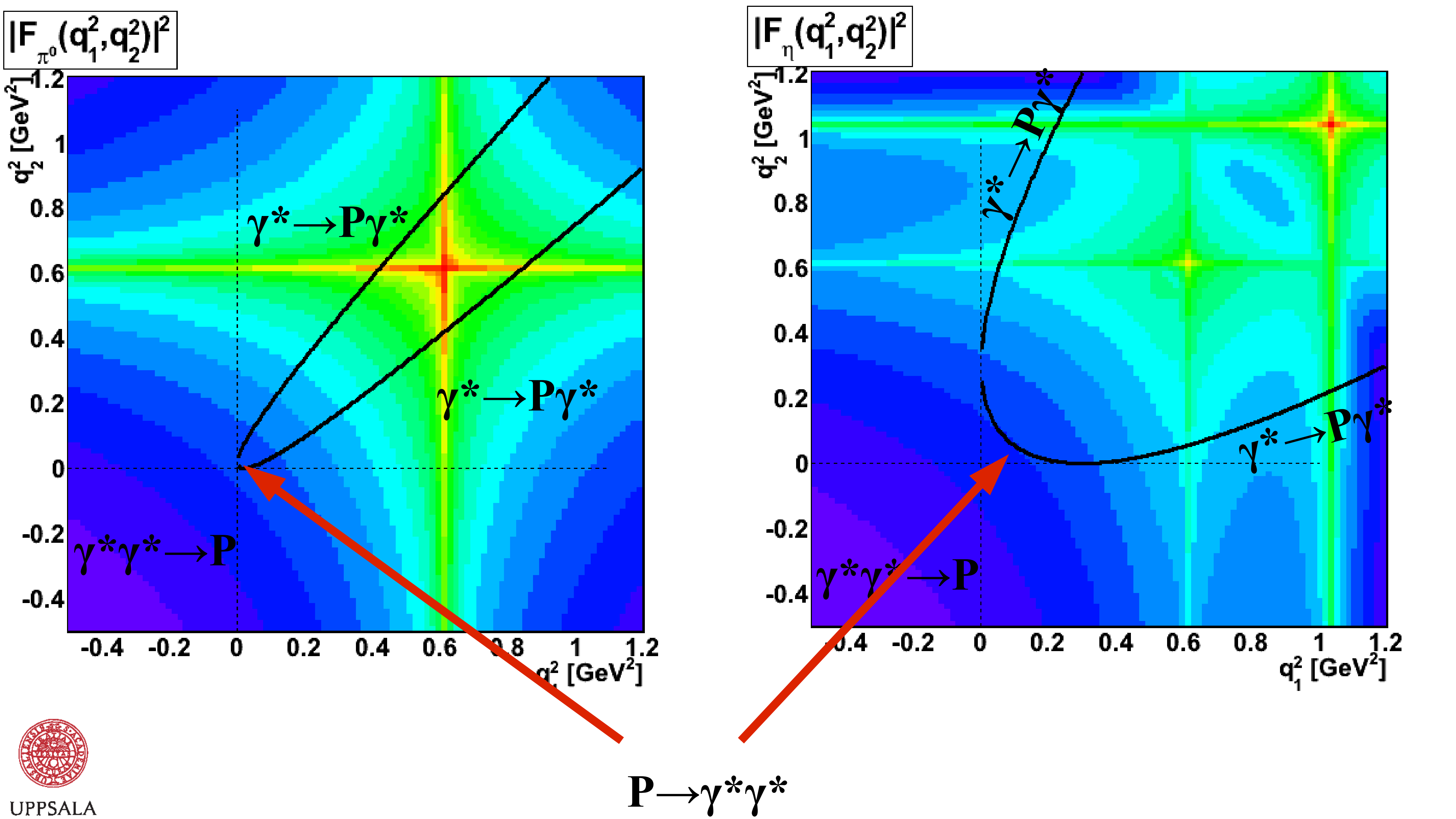
FF VMD



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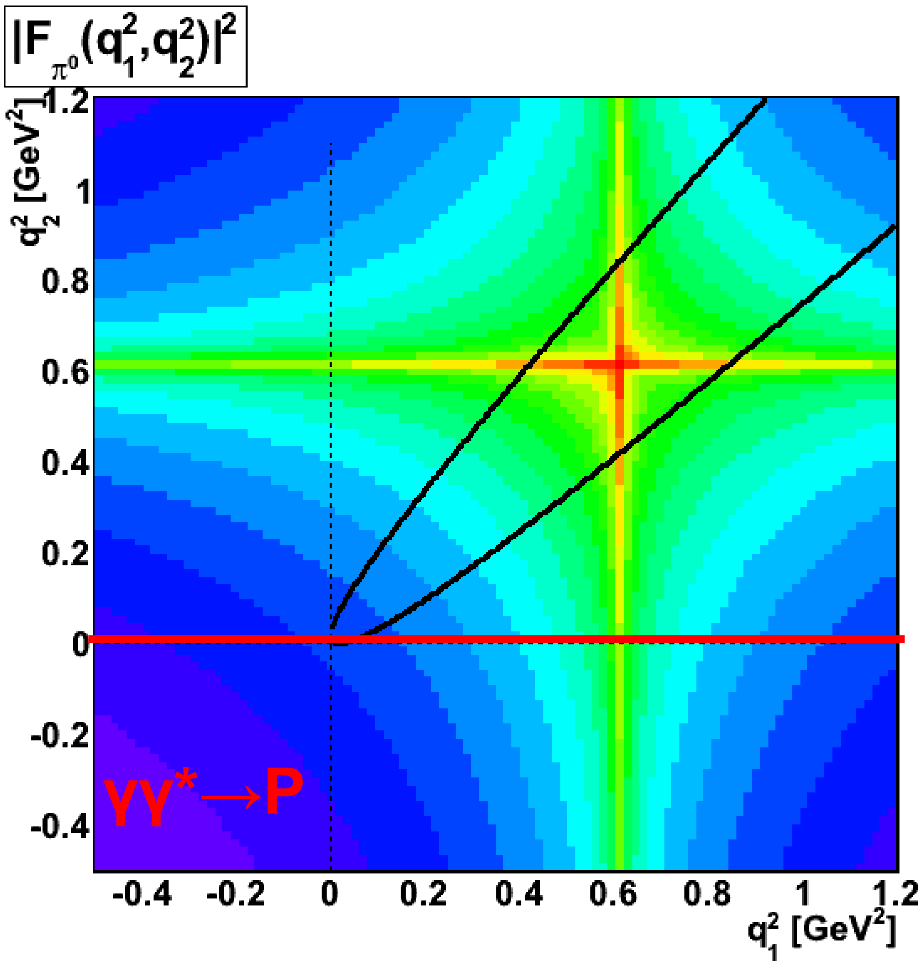
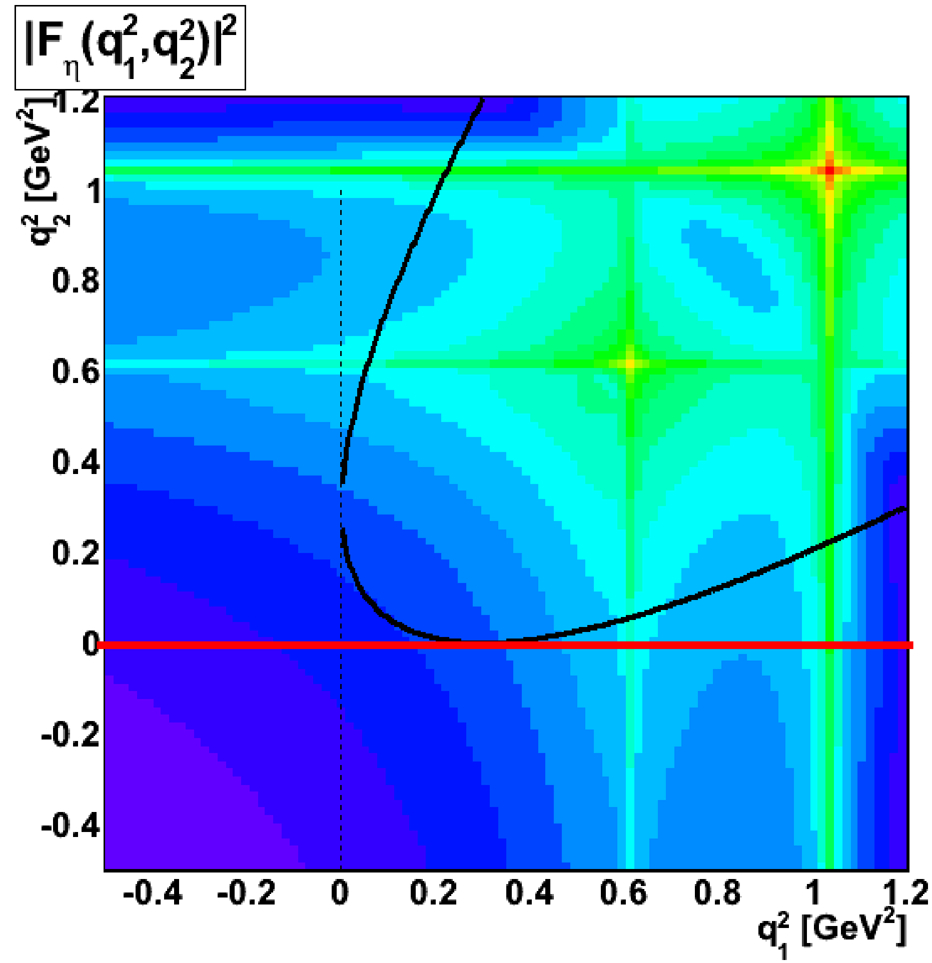
How to measure pi0 and eta TFF/ $\gamma\gamma$ decay width?

$|F_P(q_1^2, q_2^1)|^2$ / $\Gamma(P \to \gamma\gamma)$ **can be measured in:**

- $P \to l^+l^-\gamma$ $\quad (4m_l^2 < q_1^2, q_2^2 = 0)$
- $P \to l^+l^-l^+l^-$ $\quad (4m_l^2 < q_1^2, q_2^2 < m_P^2)$
- $\gamma^*\gamma^* \to P$ $\quad (q_1^2, q_2^2 < 0)$ $\quad \Gamma(P \to \gamma\gamma)$
- $e^+e^- \to P\gamma$ $\quad (q_1^2 > m_P^2, q_2^2 = 0)$ $\quad \Gamma(P \to \gamma\gamma)$
- $e^+e^- \to Pl^+l^-$ $\quad (q_1^2 > (m_P + 2m_l)^2, q_2^2 > 4m_l^2)$

FF VMD





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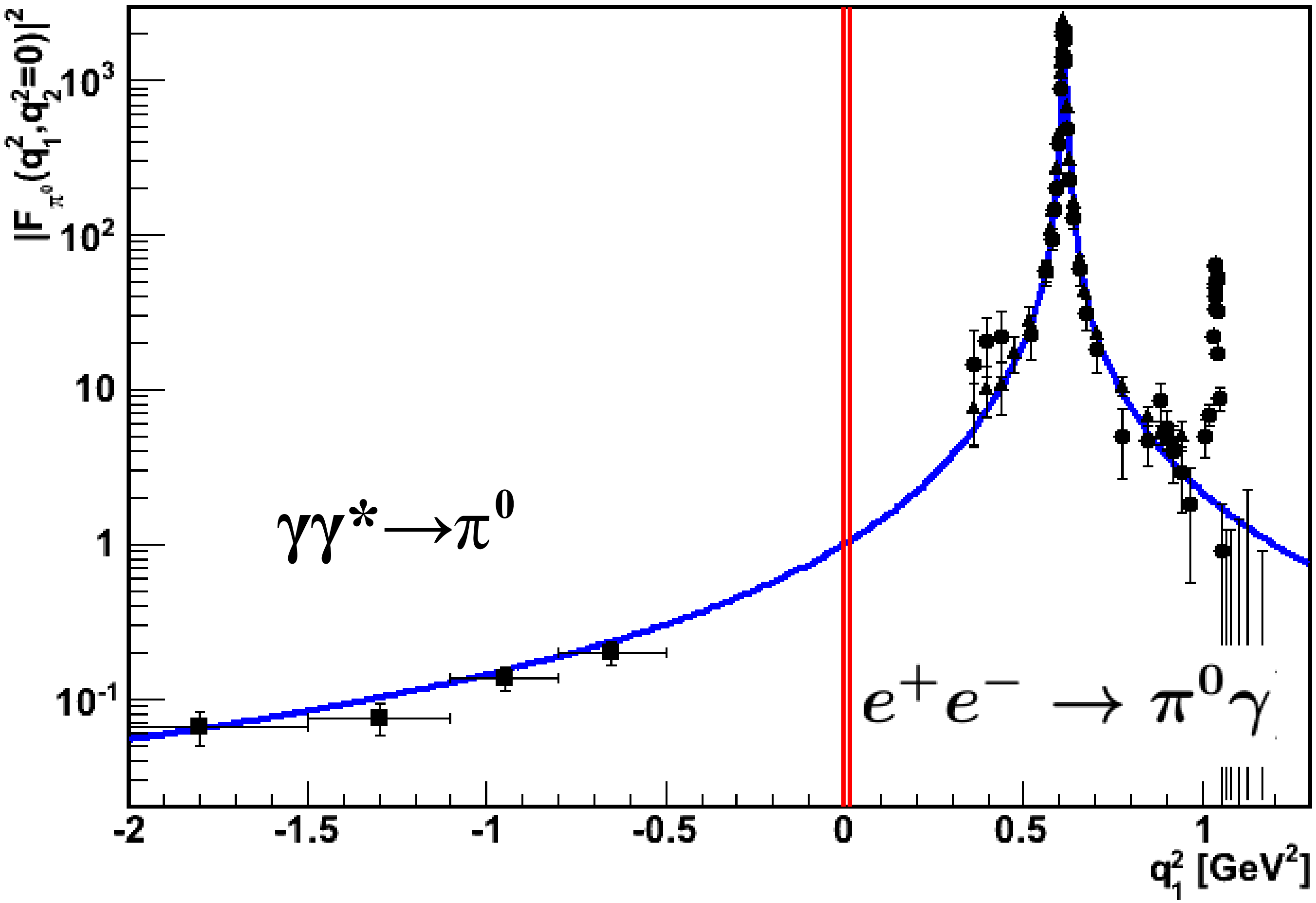

$$\sigma(e^+e^-\rightarrow\pi^0\gamma) = 4\pi\alpha\Gamma_{\gamma\gamma}\left(\frac{s-m_{\pi^0}^2}{sm_{\pi^0}}\right)^3|F_{\pi^0}(q^2=s,0)|^2$$

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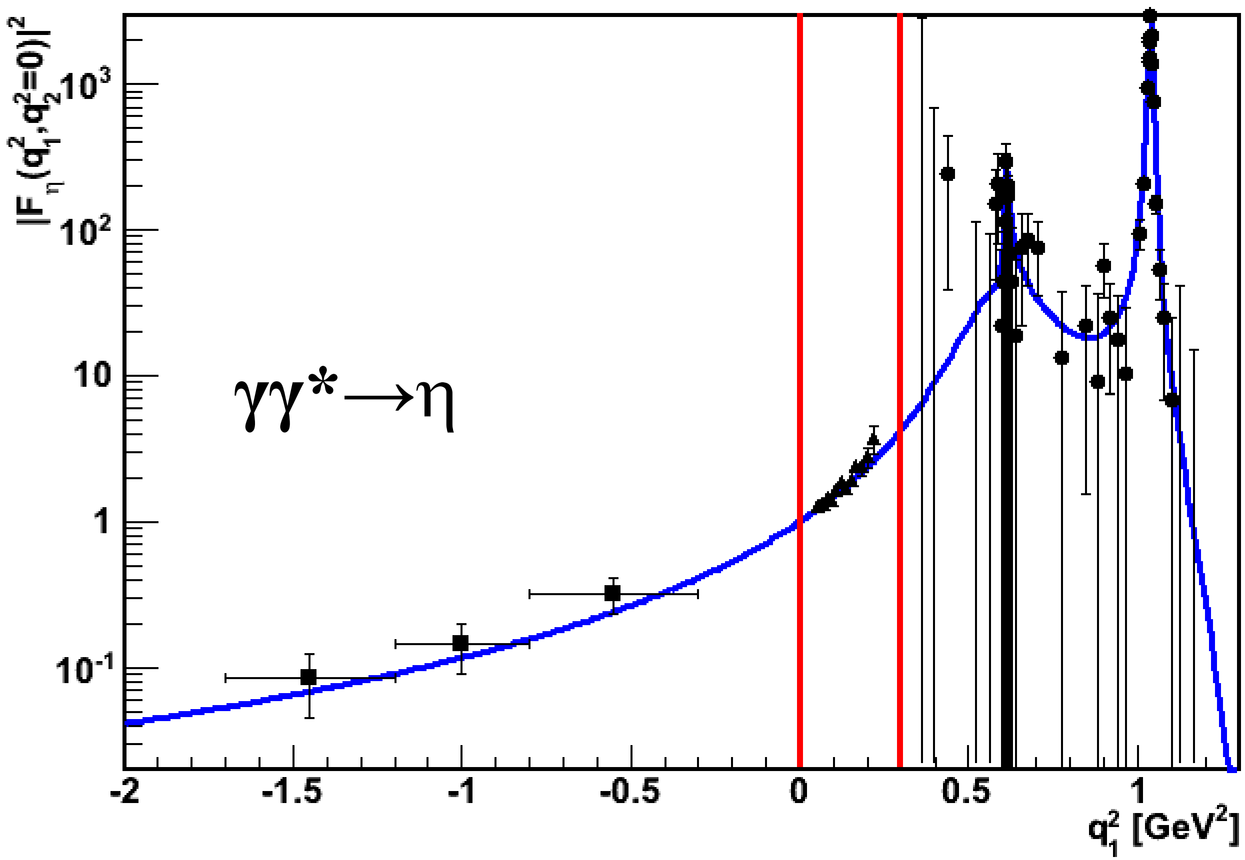
Squares: CELLO e+e-->π^0e+e-; Circles: CMD-2: e+e- $\rightarrow \pi^0\gamma$

Eta form factor



Triangles: NA60 $\eta \rightarrow \mu^+\mu^-\gamma$**; Circles: CMD-2: e+e- → eta g**
Squares: CELLO

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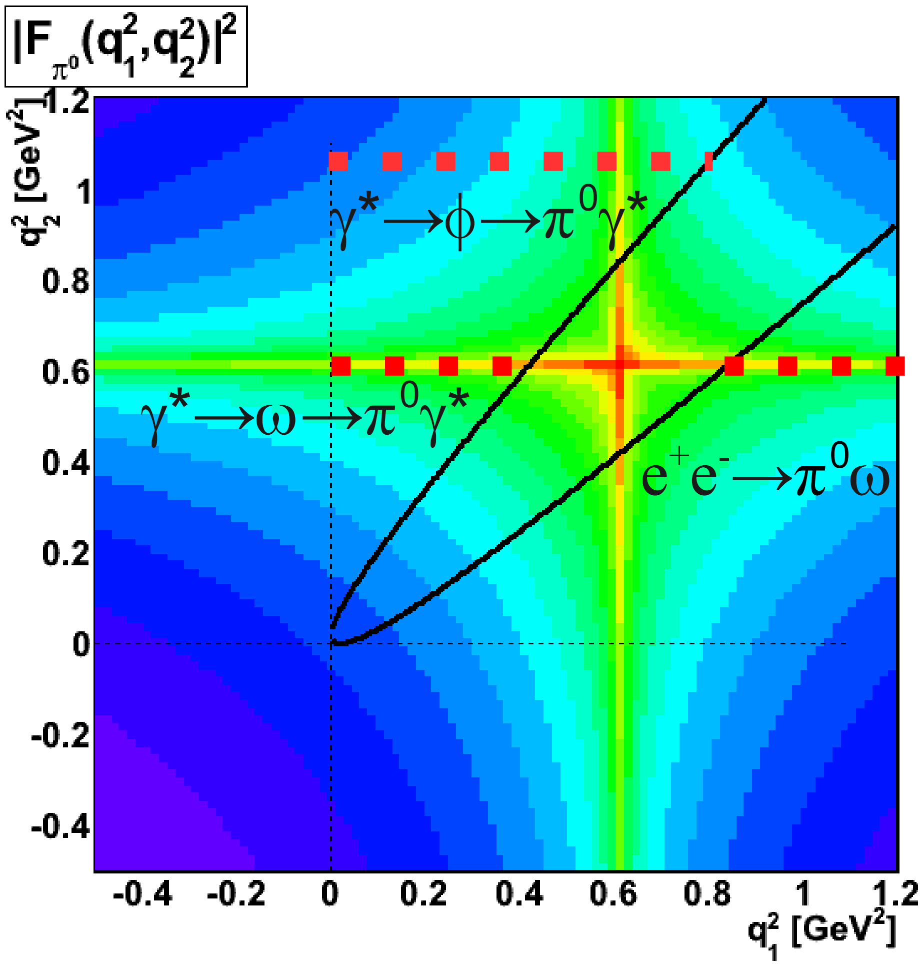
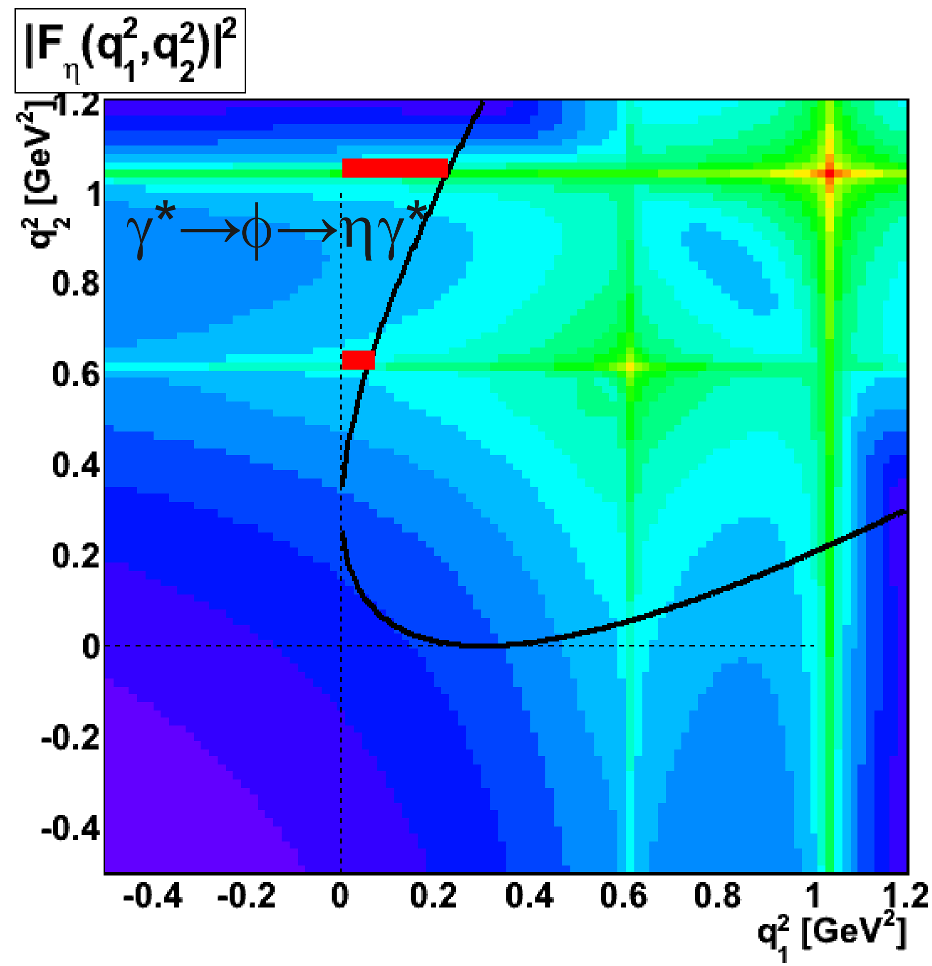
$V \to P\gamma^*$ and e+e- → PV processes





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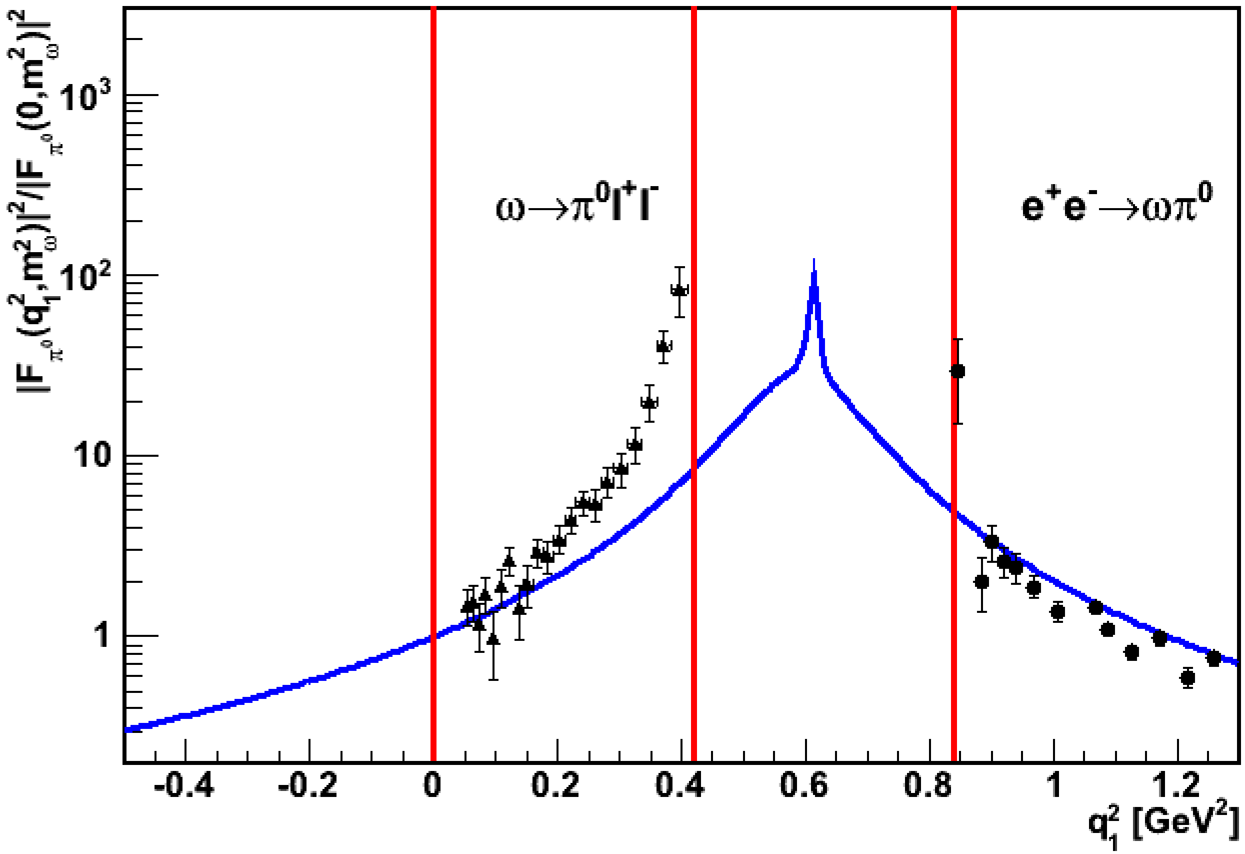
$\omega\pi^0$ transition form factor



$$\frac{|F_{\pi^0}(q_1^2, m_\omega^2)|^2}{|F_{\pi^0}(0, m_\omega^2)|^2}$$

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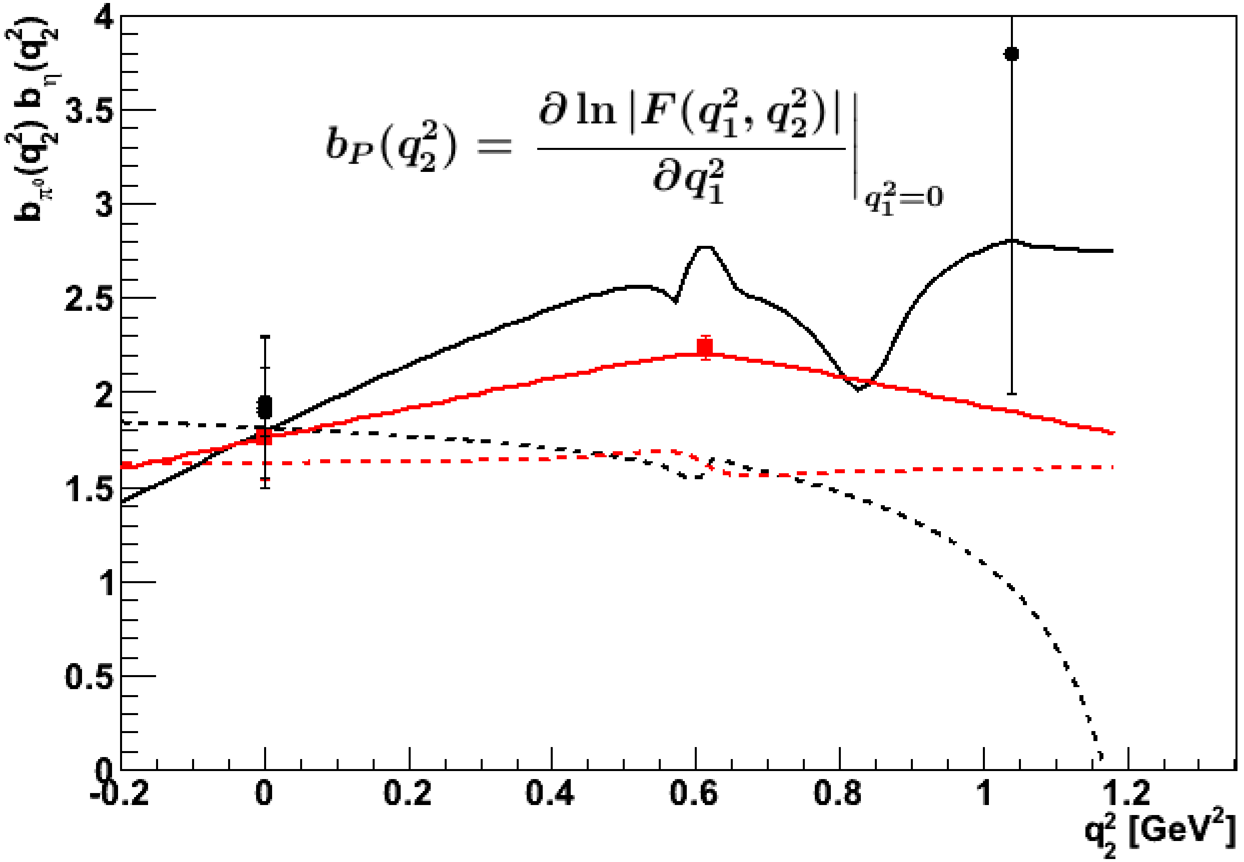
Slopes of pi0 eta form factors from naive VMD



Black Fη
Red Fπ
bη strong variation?...

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Today QNP2012: KLOE preliminary result on bη(m^2_ϕ) $\phi \to \eta\gamma^*$

Summary and outlook

- $\Gamma\gamma\gamma$ and/or TFF measurements
  e+e- $\rightarrow$ Pγ ?
- Processes for $q_1^2, q_2^2 \neq 0$ TFF:

  V $\rightarrow$ Pγ* TFF

  γ* $\rightarrow$ Pγ* slopes

Required large L /ISR(?)

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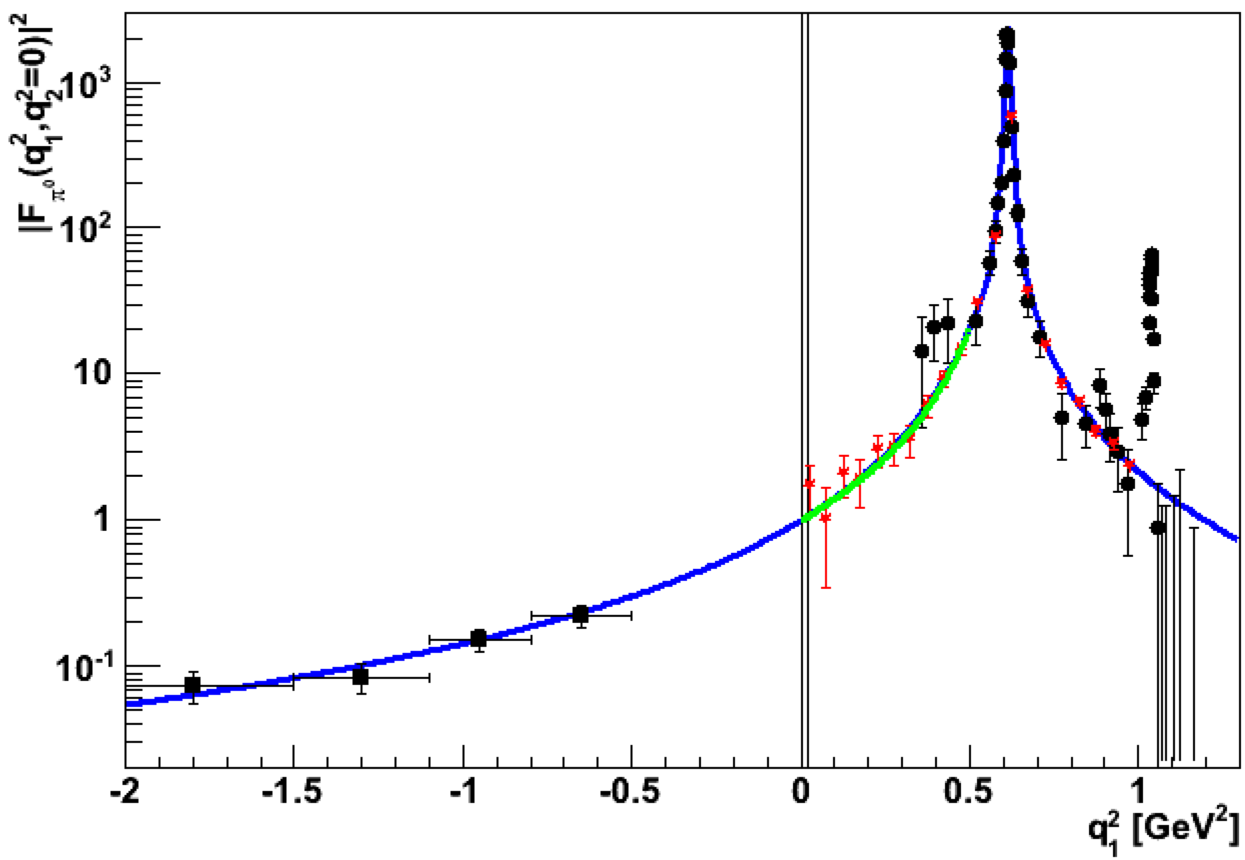
Pi0 form factor



Black squares: CELLO e+e → π0e+e-; black circles: CMD-2: e+e- → π0 g
Red stars rough estimate of ISR ≈1GeV 2.5 fb^{-1} 35<θ<145 acc 10%