FEVA

Final state radiation for MC EVA

G. Pancheri, O. Shekhovtsova,
G. Venanzoni

EVA

MC $e^+ e^- \rightarrow \pi^+ \pi^- \gamma$

large angle kinematics (only)

Born level, method SF

sQED*VMD for FSR

S.Binner, H.Kuhn, K.Melnikov

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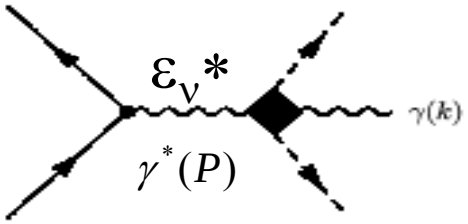
Pion FF

- Kuhn Santamaria (8 parameters)
- Gounaris Sakurai (9 parameters)
- PSV (our) (8 parameters)

FSR

- sQED (M_{sQED})
- beyond sQED (RPT) (M_{RPT})
- $f_0 + \sigma$ (M_{ϕ})
- $\gamma \to \phi \to \rho\pi \to \pi\pi\gamma$ ($M_{\phi\rho\pi}$)
- $\gamma \to \rho\pi \to \pi\pi\gamma$ ($M_{\gamma\rho\pi}$)



$$M_F^{\mu\nu} = f_1\tau_1^{\mu\nu} + f_2\tau_2^{\mu\nu} + f_3\tau_3^{\mu\nu}$$

C* ---> 1 0=initial state radiation only 0 1=fsr only 1 1=interference isr+fsr

KIND 0 1

C* Model for the Pion form factor --> KS GS SV

FPKIND 3

C*FSR---> sqed bsqed f0 VMD rhotopig

rhokind 0 0 1 0 0

C*f0KIND phi decay model

f0KIND 5

C*--------> Parameters of the Pion Form factor

C*PSV*MRHO GAMMARHO MRHOL GRHOL MOMEGA GOMEGA pi_rho FV

C*KS*MRHO GAMMARHO MRHOL GRHOL MOMEGA GOMEGA AL BE

C*GS*MRHO GAMMARHO MRHOL GRHOL MOMEGA GOMEGA AL BE arg(AL)

C*--------> Parameters of Scalar contribution (f0,f0+sigma) in FSR

C*F0 Gf0_k+k- Gf0_p+p- Gphi_k+k- phase(deg) f0MASS msigma gsigpp gsigkk Cf0sig

C*F0+SIGMA Gf0_k+k- Gf0_p+p- Gphi_k+k- phase(deg) f0MASS msigma gsigpp gsigkk Cf0sig

C*f0phase F0+SIGMA m0k m2k LambdaK b0p b1p b2p Lambdap

C*--------> Parameters of VMD contribution in FSR g_rhopig g_phirpi

C*VMDPAR g_rhopig g_phirpi prhores beta_bro beta_wphi

C* ---> histo output file

ENES 1.039202865 EMIN 0.02

QMIN 0.9 GMIN 0.02 ACUT 1. 179. 0. 180.

cards_feva.dat

Final State radiation

The matrix element for $e^+e^- \rightarrow \pi^+\pi^-\gamma$ for **DAFNE**

$$d\sigma_T \sim |M_{ISR} + M_{FSR}|^2 = d\sigma_I + d\sigma_F + d\sigma_{IF}$$

$$d\sigma_I \sim |M_{ISR}|^2$$

$$d\sigma_F \sim |M_{RPT} + M_\phi + M_{\phi\rho\pi} + M_{\gamma\rho\pi}|^2$$

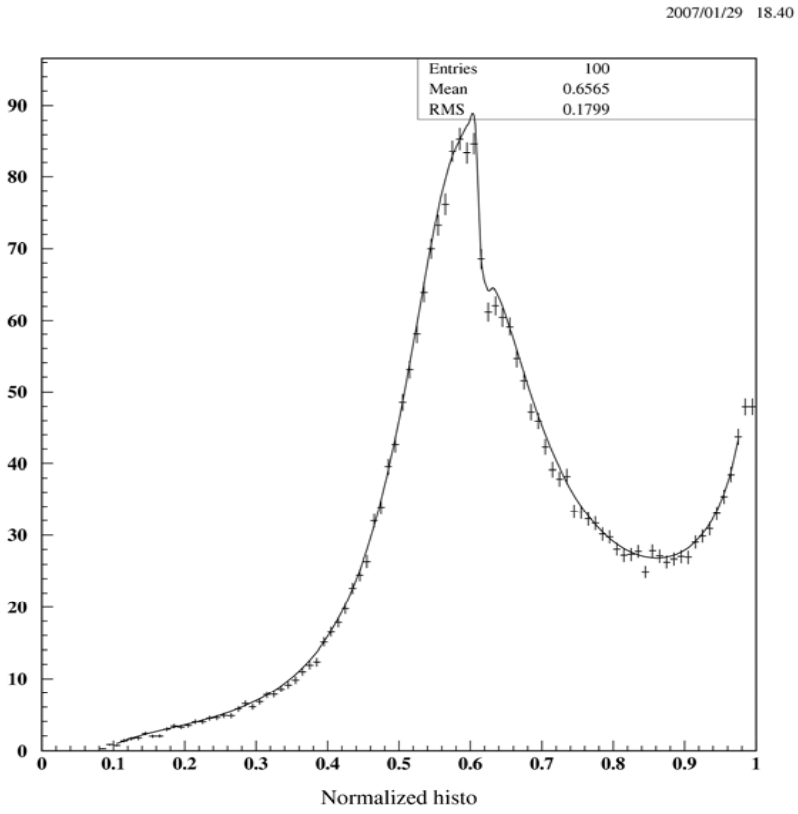
$$d\sigma_{IF} \sim 2Re(M_{ISR} \cdot (M_{RPT} + M_\phi + M_{\phi\rho\pi} + M_{\gamma\rho\pi})^*)$$

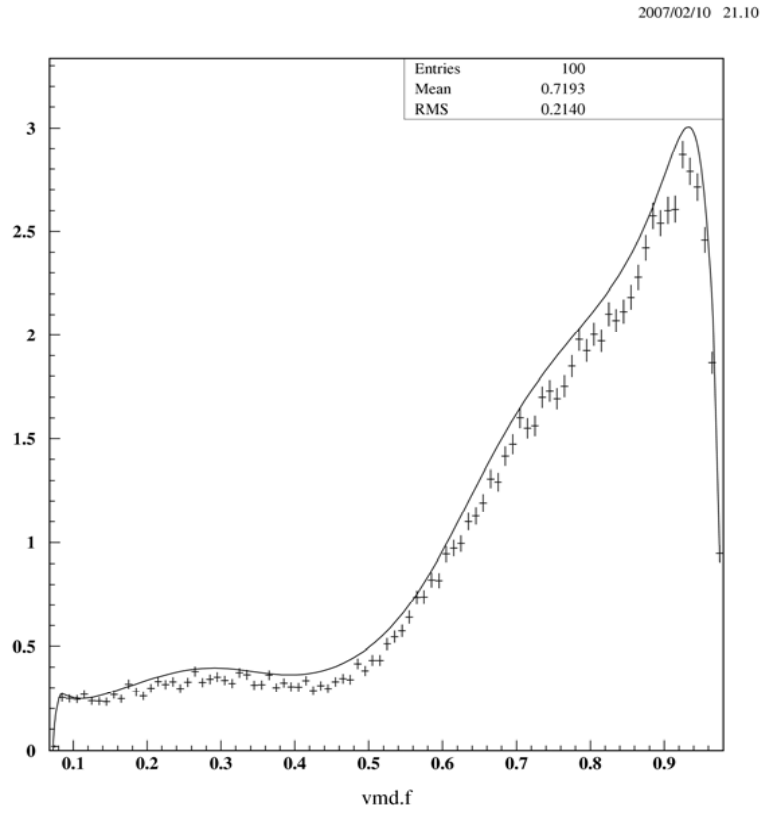
S. Binner et al.
Phys. Lett. B 459 (1999)

- *Our MC is based on EVA MC structure*, with **our amplitude for all FSR contributions (i.e. M_{FSR})**
- Interference term $d\sigma_{IF}=0$ for symmetric cuts on θ_π

Comparison MC with analytical functions

$s=m_{\phi}^{2}$

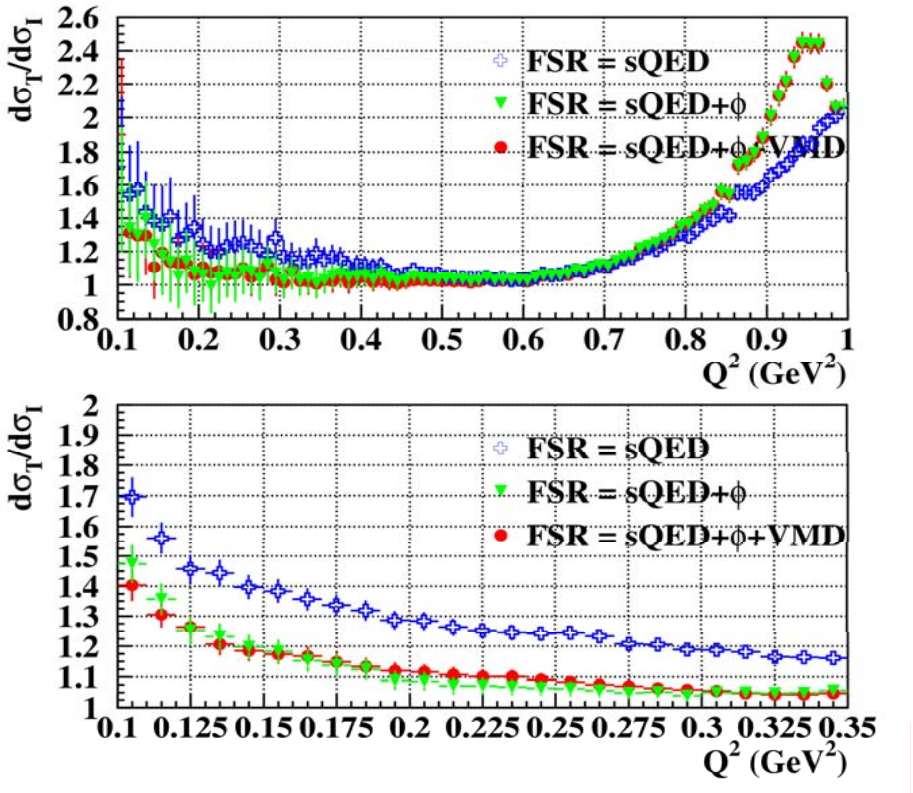


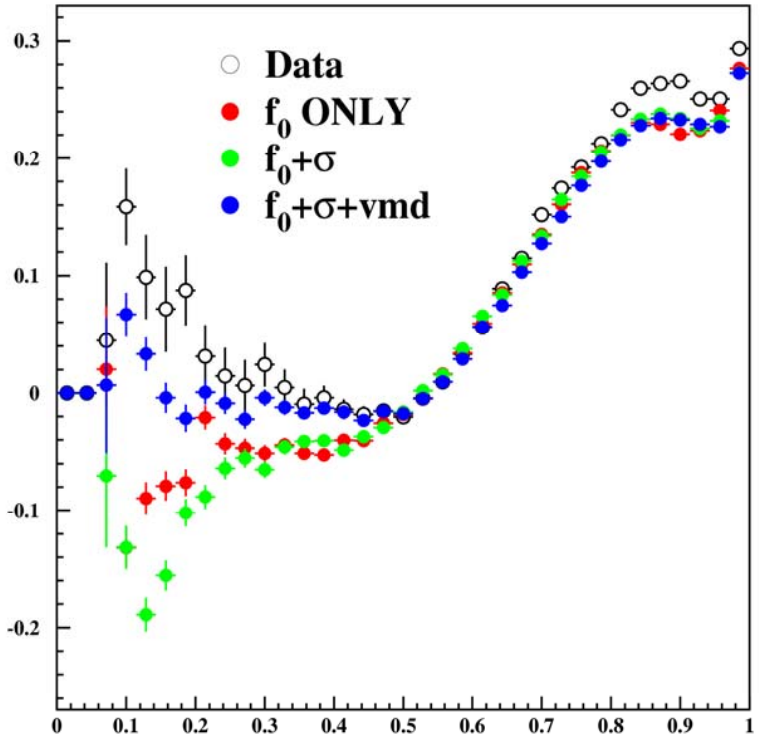


ISR

FSR (ϕ decay+VMD)

$s=m_\phi^2$





cross section

asymmetry

FEVA

Final state radiation for MC EVA

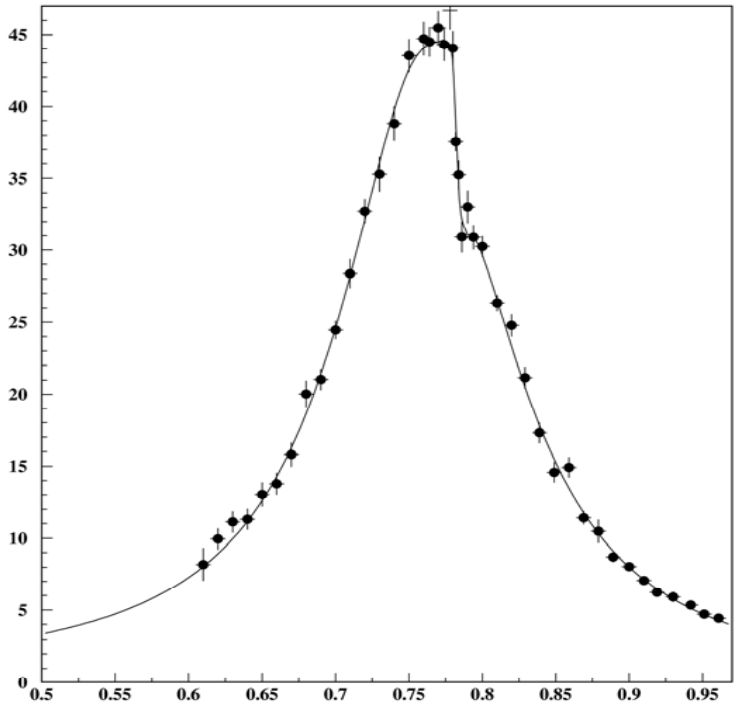
- **Final State Radiation**
  - block structure $\Rightarrow$ can be modified easy
  - the most important contributions are included
- **Cross section and asymmetry calculation**

To include

- full phase space
- $\pi^0\,\pi^0$ final state; multipion final state
- two photon emission

Back-up

Pion Form Factor with ρ-ω mixing



$$F_\pi(q^2) = 1 + \frac{F_V G_V}{f_\pi^2} F_\rho(q^2)\left(1 - \frac{\Pi_{\rho\omega}}{3q^2} F_\omega(q^2)\right)$$

$$+ \sum_i \frac{F_{V_i} G_{V_i}}{f_\pi^2} F_{\rho_i}(q^2)$$

$$F_{res}(q^2) = \frac{q^2}{m_{res}^2 - q^2 - i m_{res} \Gamma_{res}(q^2)}$$

$$\Gamma_{res}(q^2) = \Gamma \sqrt{\frac{m_{res}^2}{q^2}} \left(\frac{q^2 - m_{res}^2}{m_{res}^2 - 4m_\pi^2}\right)^{3/2} \Theta(q^2 - m_\pi^2),$$

$$\Gamma_\omega = 8.68\,\text{MeV}, \quad m_\omega = 782.7\,\text{MeV}$$

Our fit Novosibirsk CMD-2 data gives us

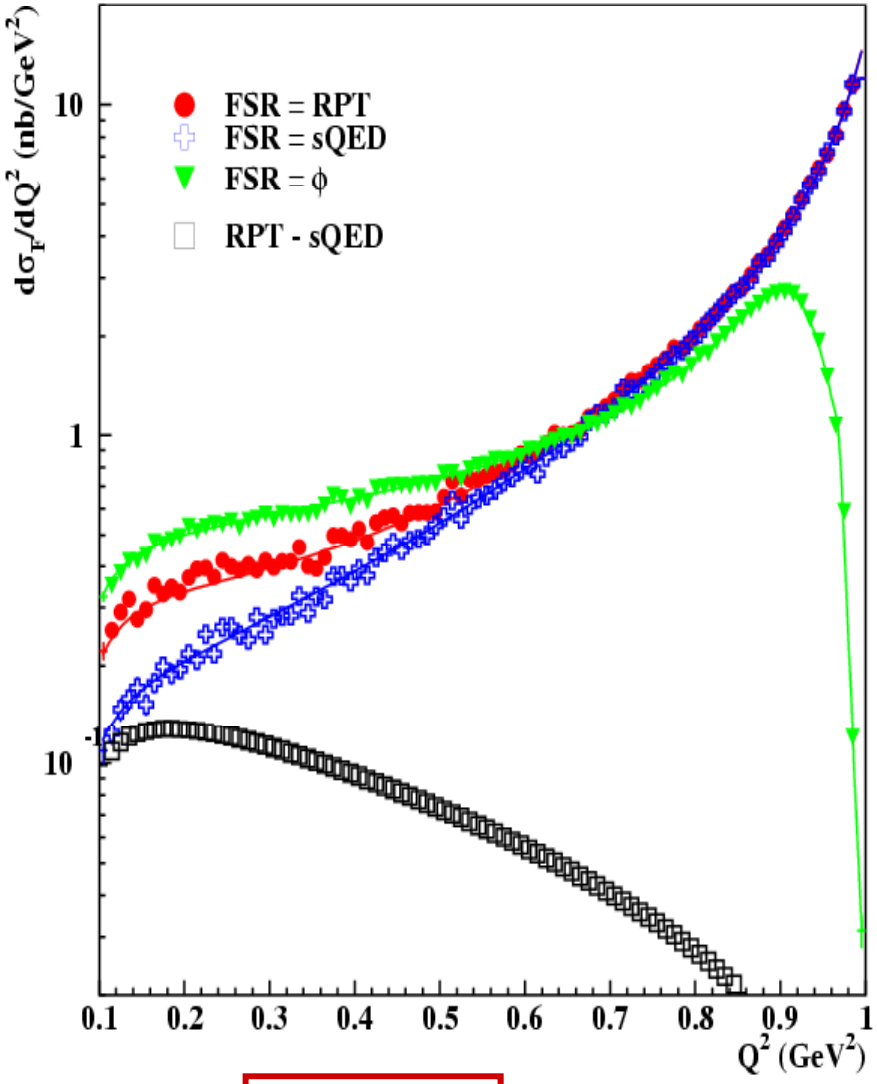
$m_\rho = 774.97 \pm 1.4$ MeV, $F_V = 154.22 \pm 0.5$ MeV

$\Gamma_\rho = 145.21 \pm 2.6$ MeV, $\Pi_{\rho\omega} = -2774 \pm 291.2$ MeV^2

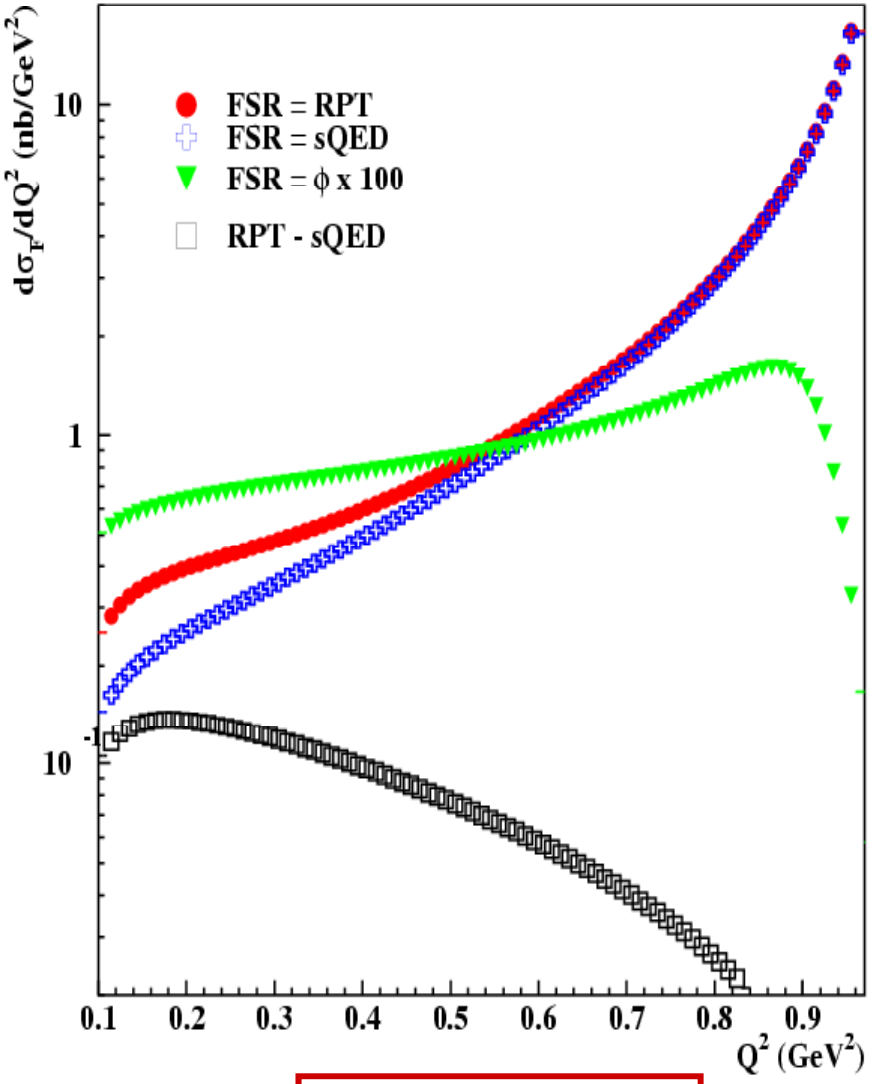
$m_{\rho'} = 1.2 \pm 0.2$ GeV, $\Gamma_{\rho'} = 400 \pm 200$ MeV

χ^2=0.853

Comparison MC with analytical functions



$s=m_\phi^2$



$s=1GeV^2$