

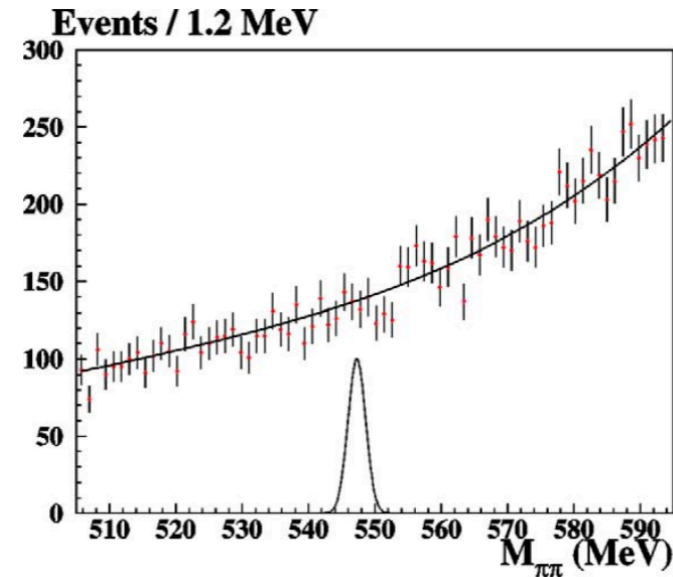
# Search for $\eta \rightarrow \pi^+ \pi^-$

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# Introduction

- $\eta \rightarrow \pi^+ \pi^-$  is P and CP violating process
- The Br prediction in SM  $\sim 10^{-27} \rightarrow$  proceed only via the CP-violating in weak interaction [[Phys. Scripta T99, 23 \(2002\)](#)]
- Any observation of larger branching ratio would indicate a new source of CP violation in the strong interaction
- The best limit  $\text{Br}(\eta \rightarrow \pi^+ \pi^-) < 1.3 \times 10^{-5}$  @ 90% C.L. by KLOE with  $\text{Lint} \sim 350 \text{ pb}^{-1}$  (efficiency is 16.6%)
- A recent limit  $\text{BR}(\eta \rightarrow \pi^+ \pi^-) < 1.6 \times 10^{-5}$  @ 90% CL from the LHCb

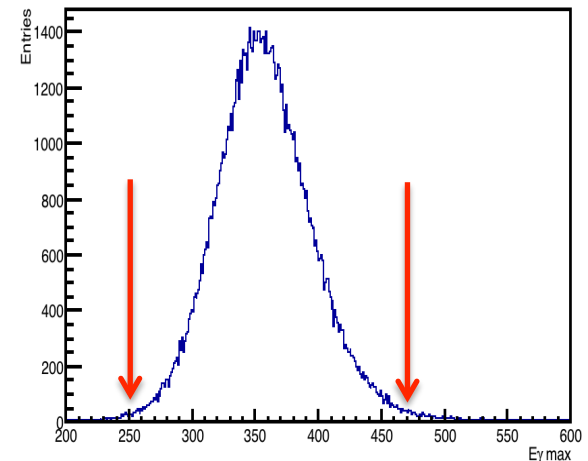


# Data Sets

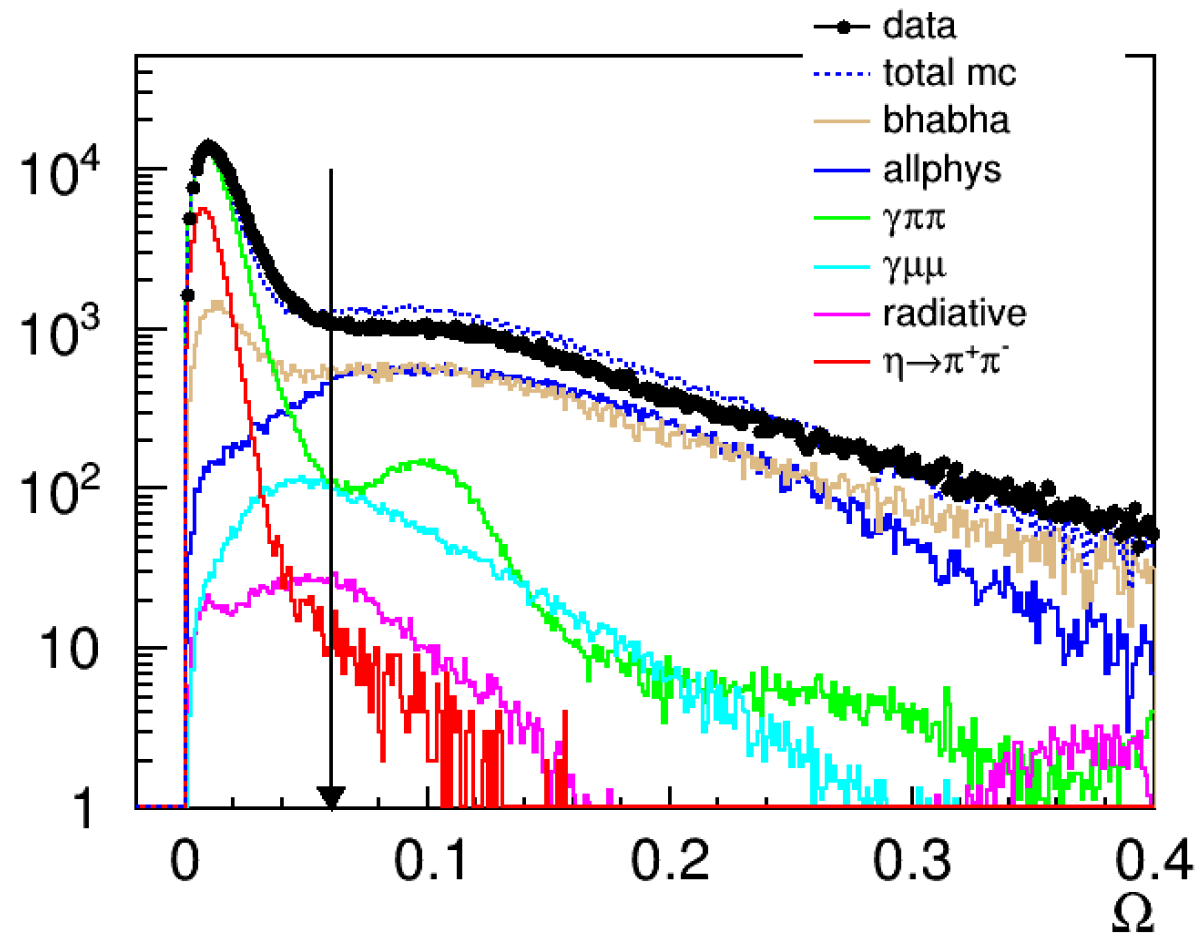
- 30300-41902 (all 2004/2005 data,  $L_{\text{int}} \sim 1.7 \text{ fb}^{-1}$ )
  - drc stream
  - version 26
- MC sample: (2004)
  - mrc stream (all\_phys, allrad, pho5mmg, ppgphok5)
  - radiative bhabha (eeg100)
  - private MC:  $\phi \rightarrow \gamma \eta$ ,  $\eta \rightarrow \pi^+ \pi^-$

# Event selection

- Charged tracks
  - one vertex with two opposite charged tracks
  - $R_V < 8$  cm,  $|Z_V| < 10$  cm
  - the two tracks are required to be at large angle  $45 < \theta_t < 135^\circ$
- Neutral clusters
  - one prompt photon in time:  $|T_{cl} - R_{cl}/c| < \min(5\sigma_t(E_{cl}), 2\text{ns})$
  - polar angle in  $(45, 135^\circ)$  to suppress background from  $\gamma\pi^+\pi^-$  (ISR)
  - $250 < E_\gamma < 470$  MeV



The angle  $\Omega$  between the direction of the  $\pi^+\pi^-$  missing momentum and the direction of the prompt photon is required to be less than 0.06 rad

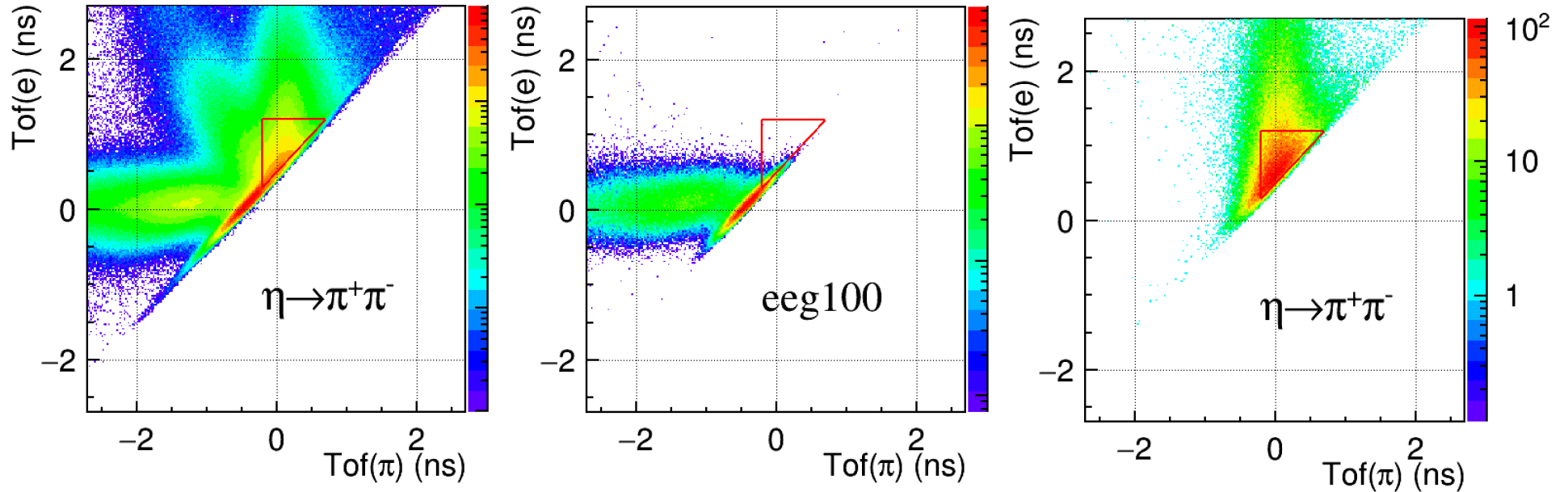


# Time of flight

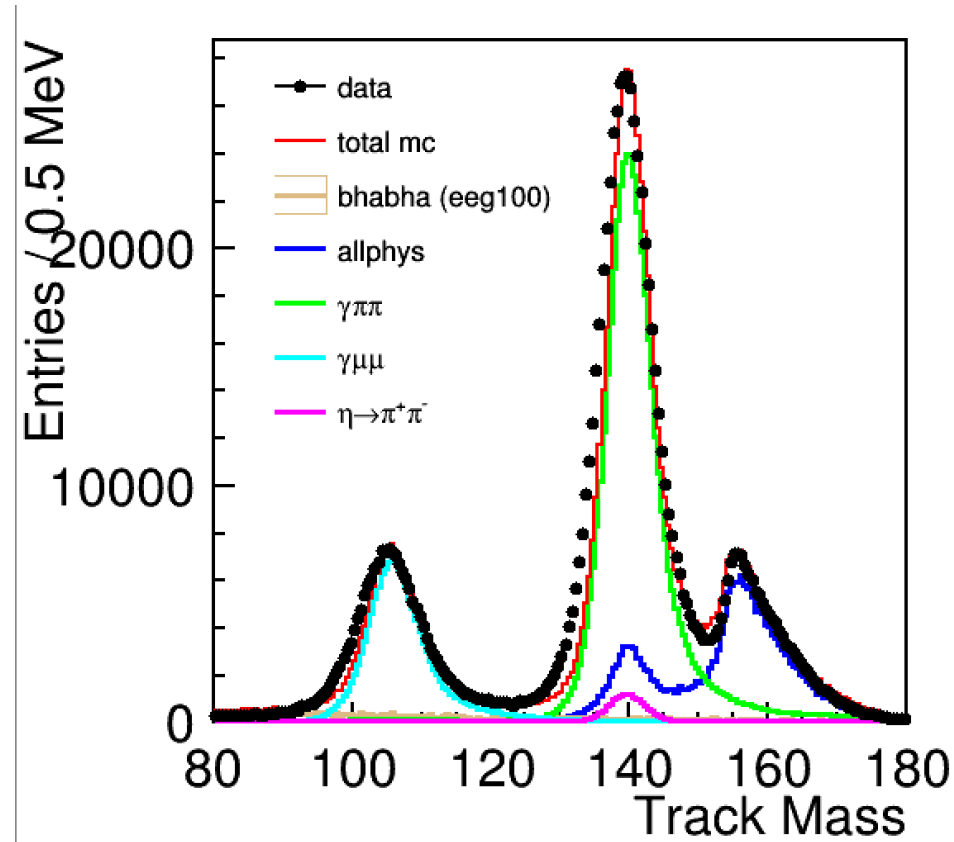
- Particle identification by the time of flight is used to reject the  $e^+e^- \rightarrow \gamma e^+e^-$

$$\delta t(m_X) = t_{cl} - \frac{L}{c\beta(m_X)}$$

- $-0.2 < \text{Tof}(p) < 0.7$  &&  $0.3 < \text{Tof}(e) < 1.2$  &&  $\text{Tof}(e) > \text{Tof}(p)$



# Track mass distribution

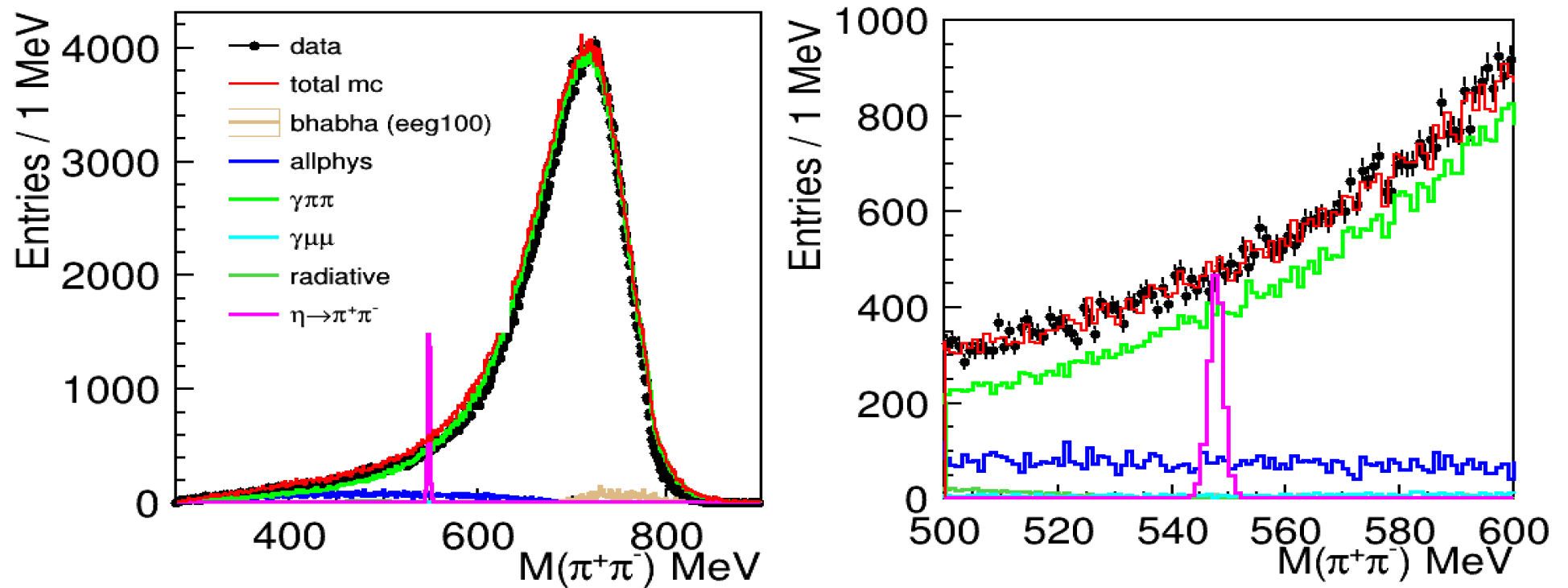


- The track mass ( $M_{\text{trk}}$ ) is mass value that satisfies the equation:

$$|\vec{p}_\phi - \vec{p}_1 - \vec{p}_2| = E_\phi - \sqrt{p_1^2 + T_M^2} - \sqrt{p_2^2 + T_M^2}$$

- $129 < M_{\text{trk}} < 149$  MeV is required to reject the  $\mu^+\mu^-\gamma$  background

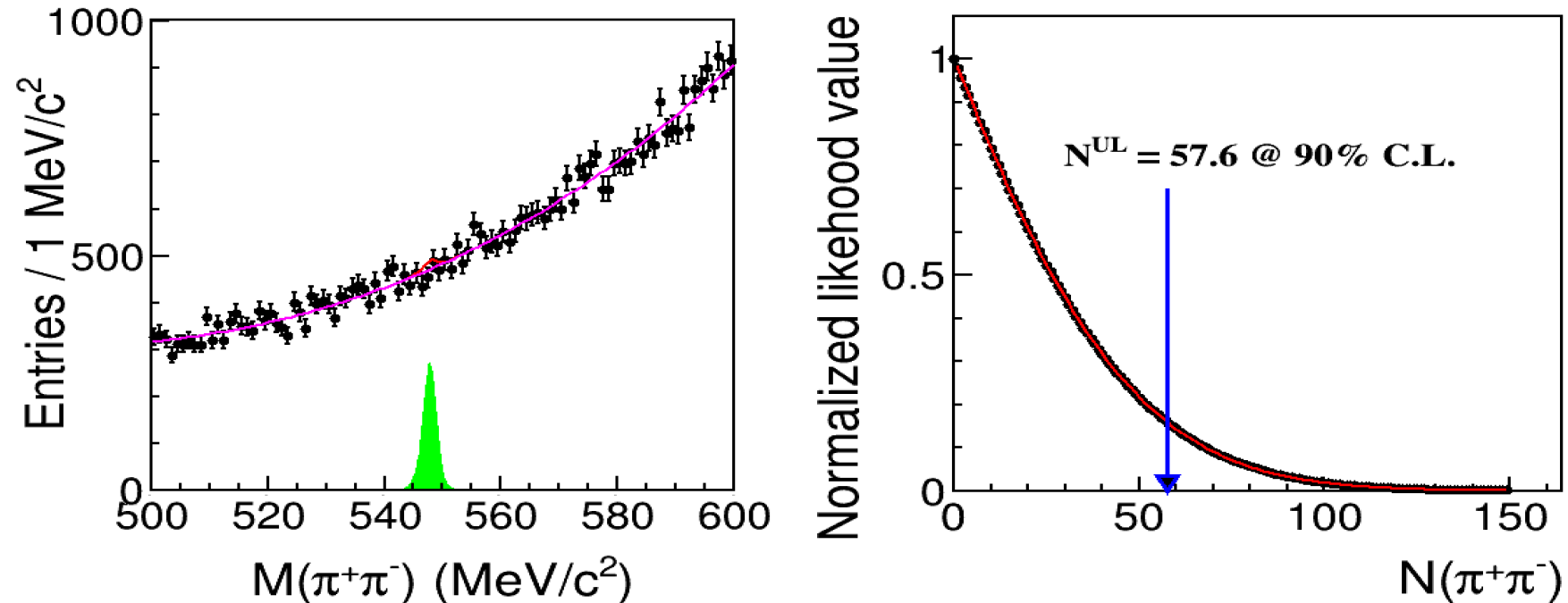
# $M(\pi\pi)$ distribution



The remain backgrounds are mainly from  $\gamma\pi\pi$  and  $\rho\pi$  (allphys)



# Preliminary upper limit



- $\text{Lint} \sim 1.7 \text{ fb}^{-1}$
- After all the cuts, efficiency  $\sim (13.7 \pm 0.05)\%$
- Fit with 3<sup>rd</sup> polynomial function + MC signal shape
- $N^{\text{UL}} = 57.6$  at 90% C.L.  $\rightarrow \text{BR} = 6.3 \times 10^{-6}$  @ 90% C.L.

# Summary and plans...

- The procedure is established and preliminary upper limit with 2004/2005 data is obtained
- Systematic uncertainties study is ongoing
  - alternative fits will be performed
    - fitting (fitting range, background shape, signal shape)
    - efficiency ( $M_{\text{Trk}}$  cut, TOF cut)
  - associated with tracks and photon  $\rightarrow$  momentum-dependent correction
- A first test of KLOE-2 data is ongoing

**Thank you!!!**