Progress

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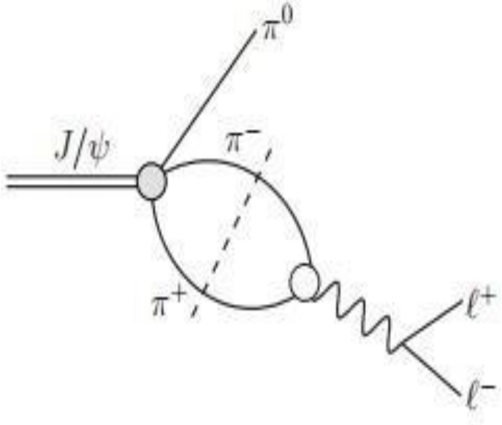
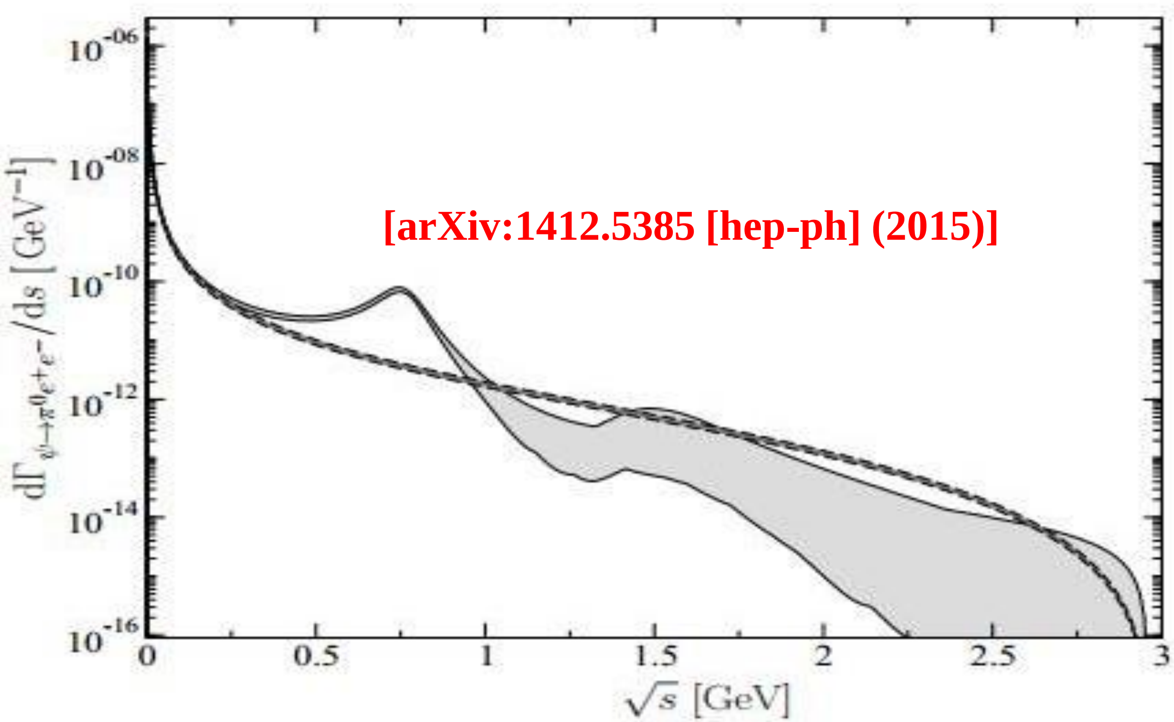
Motivation

$J/\psi \to e^+e^-\pi^0$ decay





[arXiv:1412.5385 [hep-ph] (2015)]

	Exp. data	this work	VMD prediction [13]
$\psi \to \pi^0 e^+ e^-$	0.0756 ± 0.0141	0.1191 ± 0.0138	$0.0389^{+0.0037}_{-0.0033}$
$\psi \to \eta e^+ e^-$	1.16 ± 0.09	1.16 ± 0.08	1.21 ± 0.04
$\psi \to \eta' e^+ e^-$	5.81 ± 0.35	5.76 ± 0.16	5.66 ± 0.16

[arXiv:1411.1159 [hep-ph] (2014)]

Event reconstruction and selection

- Select the events of interests with exactly two charged tracks and at least two photons.

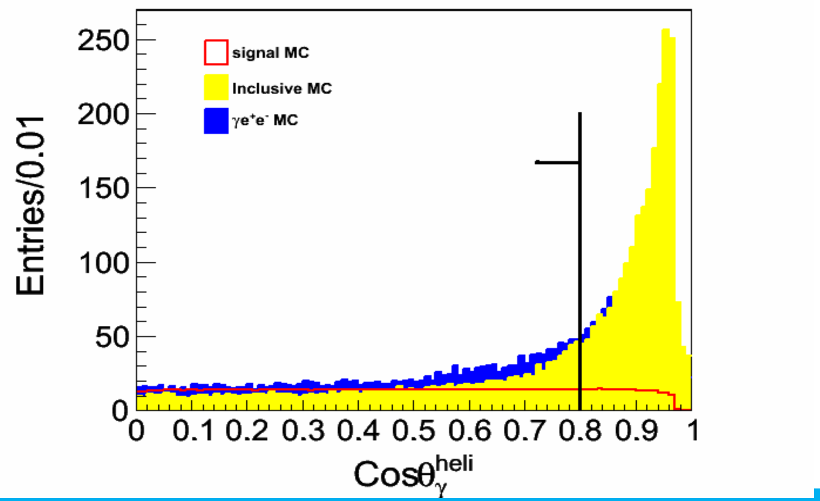
Good charged tracks

$|V_r| < 1.0$ cm, $|V_z| < 10$ cm and $|\cos\theta| \leq 0.93$

Good photons

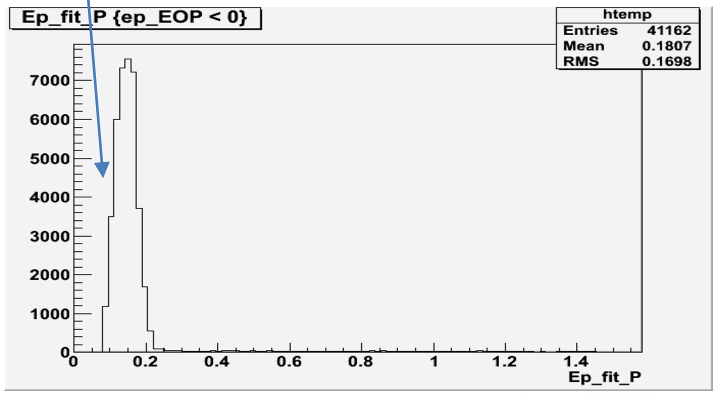
Barrel region ($\cos\theta_\gamma < 0.8$): $E_\gamma > 25$ MeV
End-cap region ($0.86 < \cos\theta_\gamma < 0.92$): $E_\gamma > 50$ MeV
EMC timing: [0,14]×(50) ns, $\theta_{\gamma,x}\pm > 10$ degrees.

- Perform a 4C kinematic fit with two charged tracks and at least two good photon candidates.
- The χ^2 from 4C kinematic fit is required to be less than 100.
- The two charged tracks are required to be identified as electrons using the PID based on dE/dx, TOF and EMC
  - prob of e^- > prob of π^-
  - Prob of e^- > prob of K^-
- $\delta_{xy} < 2$ cm
- $\cos\theta_{heli} < 0.8$



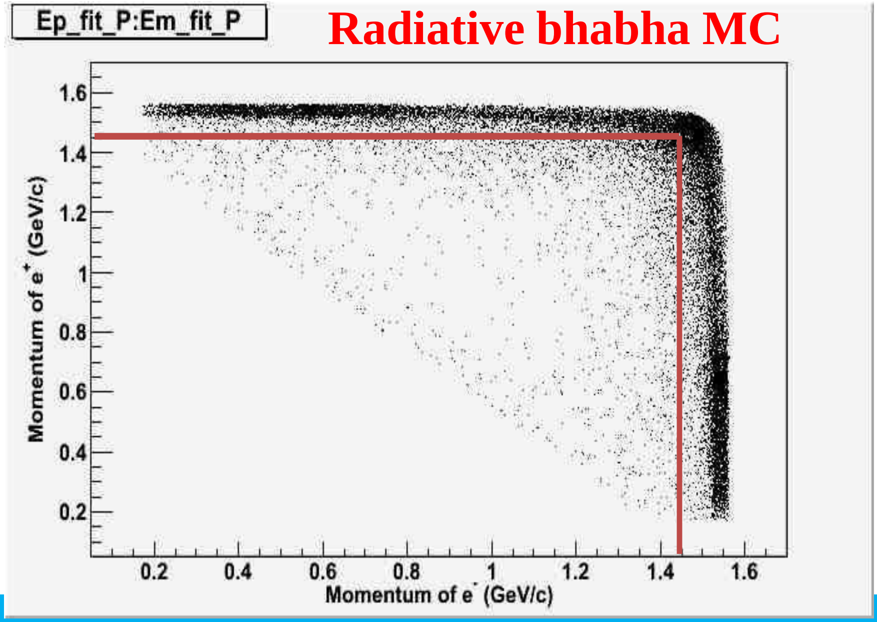
Event selection

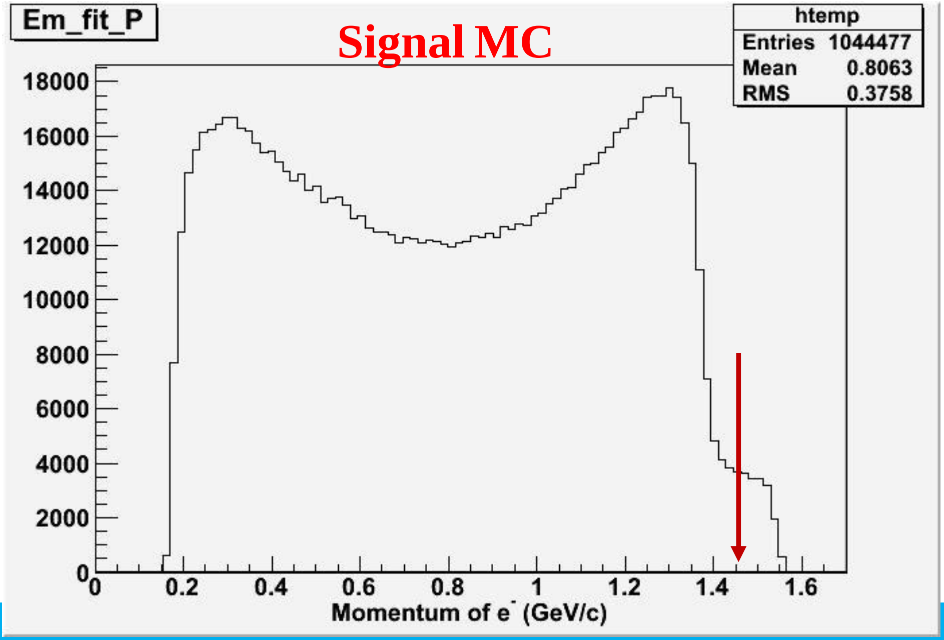
- Improve further the purity of electrons while requiring the E/p distributions of both the tracks to be greater than 0.8c for $e^{\pm}$ momentum to be greater than 0.25 GeV/c.



- No m_{ee} cut.

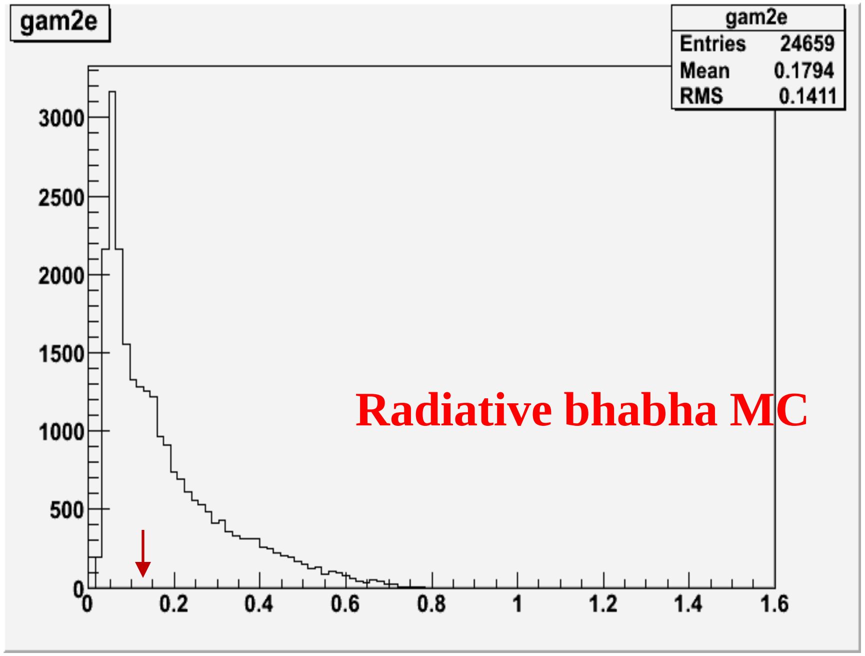
- Radiative bhabha related events are suppressed while requiring the momentum of both the tracks to be less than 1.45 GeV/c

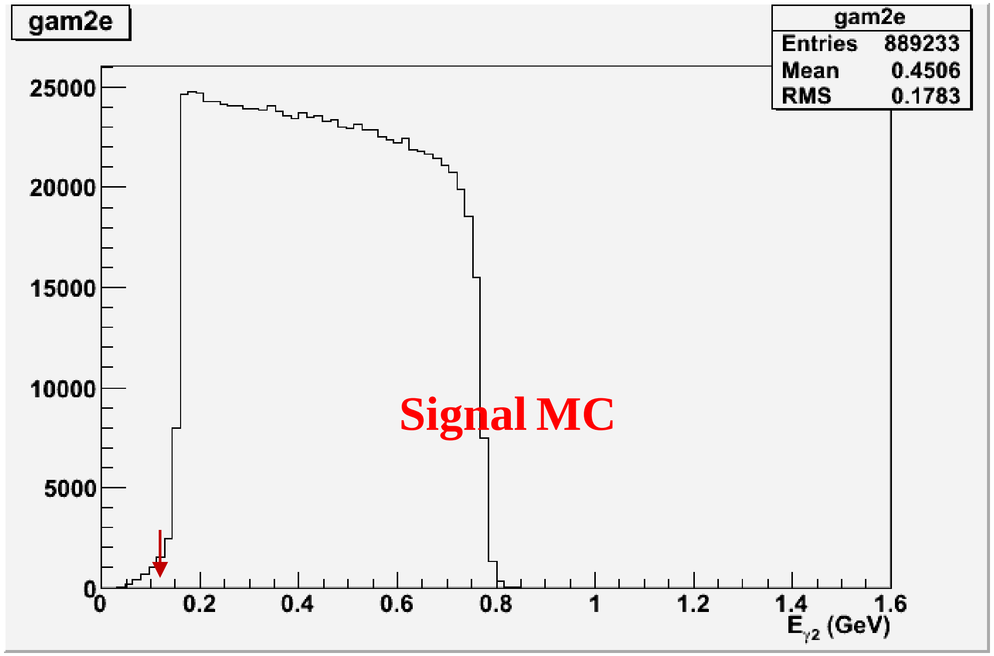




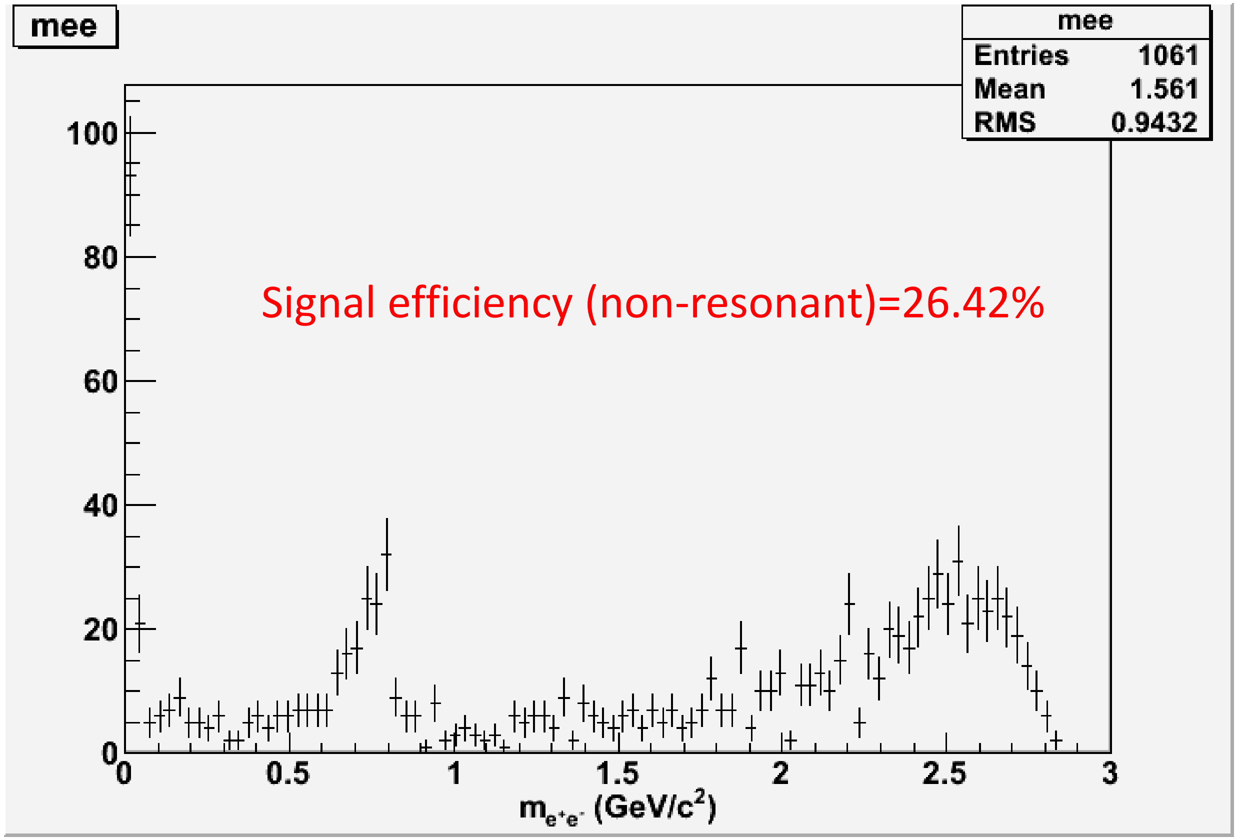
Event selection

➢ Energy of second photon used for $\pi^0 \to \gamma\gamma$ is required to be larger than 0.14 GeV.





Di-electron invariant mass distribution



Peaking backgrounds:

- $J/\psi \to \pi^+\pi^-\pi^0$ (78.29 events determined using exclusive MC sample)
- $J/\psi \to \gamma\pi^0$ (2.37 event determined using exclusive MC sample)

ML fit to di-electron invariant mass distribution

Gounaris-Sakurai lineshape PDF

$$GS(m\,;m_0,\Gamma_0,J,R) = \frac{(1+d.\Gamma_0/m_0)^2}{(m^2-m_0^2-f(m^2))^2+m_0^2\Gamma^2(m)},$$

where

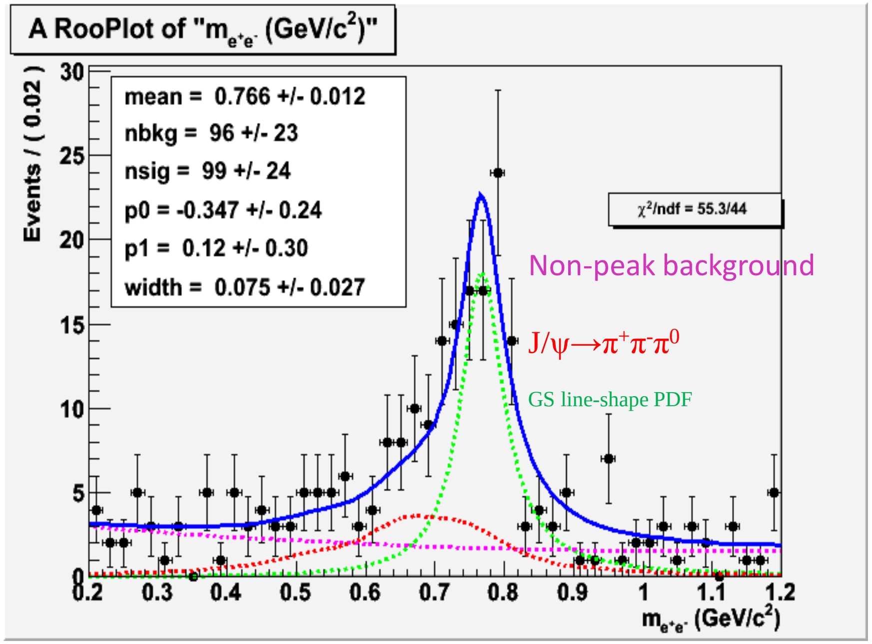
$$f(s) = \Gamma_0\frac{m_0^2}{k^3(m_0)}\left[k^2(m)[h(s)-h(m_0^2)]+(m_0^2-s)k^2(m_0)dh/ds|_{s=m_0^2}\right],$$

$$h(s) = \frac{2k(m)}{\pi\sqrt{(s)}}\ln\left(\frac{\sqrt{s}+2k(m)}{2m_\pi}\right),$$

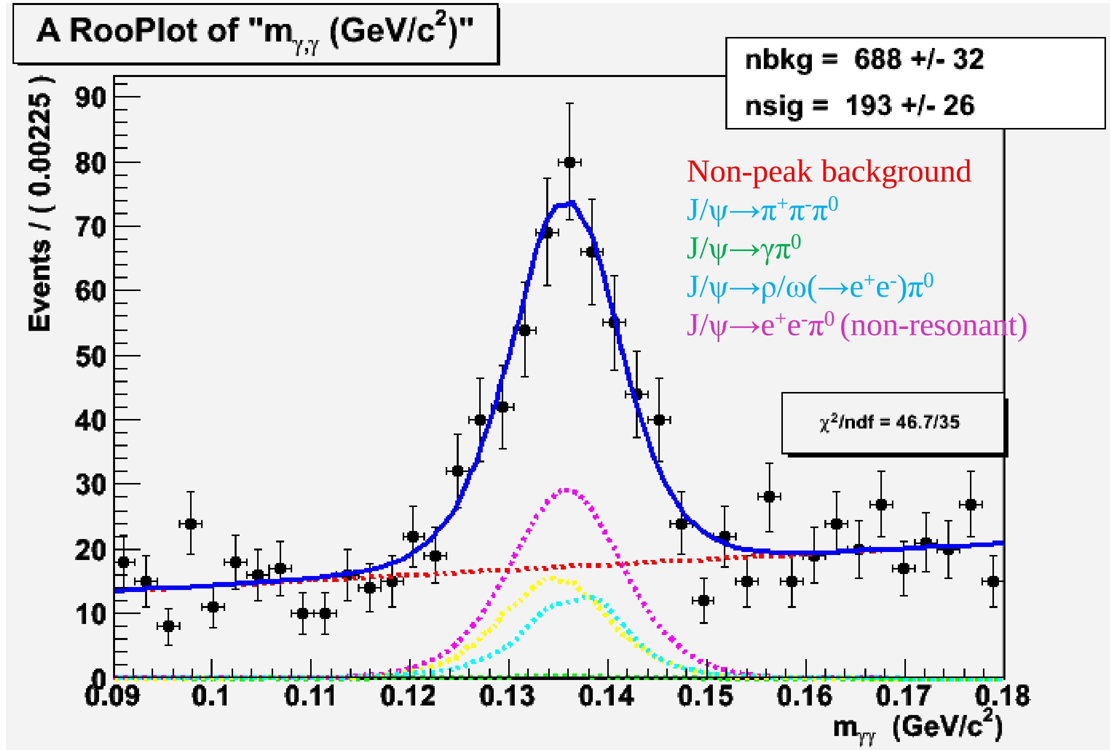
$$dh/ds|_{s=m_0^2} = h(m_0^2)\left[(8k^2(m_0))^{-1}-(2m_0^2)^{-1}\right]+(2\pi m_0^2)^{-1},$$

$$d = \frac{3m_\pi^2}{\pi k^2(m_0)}\ln\left(\frac{m_0+2k(m_0)}{2m_\pi}\right)+\frac{m_0}{2\pi k(m_0)}-\frac{m_\pi^2 m_0}{\pi k^3(m_0)},$$

$$\Gamma(m) = \Gamma_0\frac{m_0}{m}\left(\frac{k(m)}{k(m_0)}\right)^{2J+1},$$



ML fit to di-photon invariant mass distribution



$Br(J/\psi \to e^+e^-\pi^0)$ (non-resonant) = $(5.64 \pm 0.76) \times 10^{-7}$

To do list:

- Will generate the MC sample for resonant + non-resonant contributions of $J/\psi \to e^+e^-\pi^0$ to compute the final branching fraction number.
- Will finalize the systematic uncertainties.
- Will produce a memo for a review.