DY prediction is normalized to the data after subtracting other SM and QCD backgrounds in an invariant mass window from 76 to 106 GeV/$c^2$ for CC events and from 81 to 101 GeV/$c^2$ for CP events. Different mass windows are used because the QCD background in the CP events is higher than in the CC events and large uncertainty on QCD background estimation. We assign a 3.6% systematic uncertainty in the DY prediction to take into account the invariant-mass dependence of the $k$-factor [11] that is the difference between the leading and the next-to-next-to-leading order DY cross sections. The uncertainty in the DY prediction due to the choice of the parton distribution function set CTEQ6M [12] is evaluated using the Hessian method [13] and is found to be $3.7 - 6.4 - 13\%$ ($200 - 600 - 1,000$ GeV/$c^2$) depending on the invariant mass.

The QCD background estimation is determined from the experimental data. The estimate is obtained using the probability for a jet to be misidentified as an electron. We measure this probability with a jet-triggered data sample. We then apply the misidentification probability to each jet in events with one good electron candidate and one or more jets. To estimate the dijet background contribution, events with $W$ or $Z$ candidates are removed from the sample before applying the jet misidentification probability (MP). The events with $W$ candidate are identified with one good electron and a large missing transverse energy $E_T$ [14] and the events with $Z$ candidate are identified with two “loose electrons”. To estimate the $W$+jet background, events with $Z$ candidate are removed and events with $W$ candidate are retained. The dominant systematic uncertainty in the predicted QCD background is due to the 20% uncertainty in the jet MP.

Other SM contributions to the background are estimated with simulation samples generated with PYTHIA Tune A, except for the $W$+$\gamma$ process. The $W$+$\gamma$ process is generated with the matrix element generator Wgamma [15]. These simulated samples are normalized to the product of the theoretical cross sections and the integrated luminosity. The systematic uncertainty for these other SM backgrounds is dominated by the 6% uncertainty in the integrated luminosity measurement [16] and 8% uncertainty in the theoretical cross sections [17].

The QCD and other SM backgrounds are small compared to the DY rate. Fig. 1 shows the observed $e^+e^-$ invariant mass spectrum from 2.5 fb$^{-1}$ of data together with the expected backgrounds.

The dominant sources of systematic uncertainty in this analysis are the DY prediction, the luminosity, and the theoretical cross sections of other SM processes discussed above. Other systematic sources are the uncertainty on the scale factor of electron identification efficiency that comes from the difference between data and simulated events (1.3% for CC and 2.3% for CP events), the energy scale (1.0%), and the energy resolution (0.6% for CC and 0.3% for CP events), which affects the shape of the $e^+e^-$ invariant mass distribution. The uncertainty on the acceptance due to parton-distribution-function uncertainties is evaluated using the same method that was used for the DY prediction, and found to be 1.9% for CC and 0.6% for CP events.

The search for $e^+e^-$ resonances in the high-mass range of 150–1,000 GeV/$c^2$ uses an unbinned likelihood ratio statistic, $\lambda$, defined in Eqs. 1–3 [18]:

$$
\lambda = \frac{\text{max.} \mathcal{L}_b}{\text{max.} \mathcal{L}_{s+b}}, \quad 0 \leq \lambda \leq 1, \quad 0 \leq -2 \ln \lambda \leq \infty
$$

$$
\mathcal{L}_{s+b} = \frac{(n_s + n_b)^N e^{-(n_s+n_b)}}{N!} \prod_i^n (n_s S(x_i) \mu + n_b B(x_i))
$$

$$
\mathcal{L}_b = \frac{n_b^N e^{-n_b}}{N!} \prod_i^n B(x_i).
$$

where $\mathcal{L}_b$ is the likelihood for a null hypothesis that is described by the SM only, $\mathcal{L}_{s+b}$ is the likelihood for a test hypothesis that is described by physics beyond the SM together with the SM. The quantities $n_s$ and $n_b$ are the number of signal and background candidates which are determined by the fit and $N$ is the number of candidates observed in data, each represented by a vector $\{x_i\}$ of observables. The signal probability density function (PDF), $S(x|\mu)$, is a Gaussian with a floating mean $\mu$ and a fixed