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$H \rightarrow \mu\mu\mu\mu$ and $H \rightarrow ee\mu\mu$ Acceptance

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Abstract:

The loss of acceptance for Higgs events from a gap at $\eta = 0$ in the muon coverage is calculated.

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ABSTRACT

The loss of acceptance for Higgs events from a gap at $\eta = 0$ in the muon coverage is calculated.

It is proposed to make a gap in the muon system at $\eta = 0$ to allow for support and services. To estimate the effect of such a gap, a sample of 1000 $H \to \mu^+\mu^-\mu^+\mu^-$ events with $m_H = 800\,\mathrm{GeV}$ was generated with ISAJET 6.43, and the minimum and maximum $|\eta|$ for the muons were calculated. This is probably close to the worst case, since the Higgs is heavy and so centrally produced, and there are four muons to cause loss of acceptance.

Fig. 1 shows the distribution of the muon with the maximum $|\eta|$. No cut on the rapidities of the Z^0 bosons has been made. Fig. 2 shows the distribution for the minimum $|\eta|$, both inclusive and with a cut $|\eta_{\mathrm{max}}| < 2.5$. Fig. 3 shows the integral distribution normalized to events per SSC year as a function of the minimum $|\eta|$. A gap $\Delta\eta = \pm 0.1$ (two bins) reduces the number of accepted events from 9 to 7, a nontrivial loss.

Muons in the dead region need not be completely lost. There will be a crude momentum measurement in the tracking chamber and an isolated, minimum ionizing track in the calorimeter. This could be augmented by chambers outside the central membrane to identify a penetrating particle. If only one muon is lost, the background would have to have one real $Z^0 \to \mu^+\mu^-$, another isolated muon, and an isolated track which fakes a muon. This sounds unlikely, but calculating the background would require generating a large sample of Z + jet events and simulating them in some detail.

For $H \to ee\mu\mu$ the acceptance losses are smaller because the electron acceptance is presumably good to $\eta = 0$. Fig. 4–Fig. 6 show the corresponding curves for this mode.

Because of the way the events were generated, the cross section and rate are normalized to half the correct cross section. In these plots η_{max} refers to the maximum η for either e or μ, while η_{min} is the minimum for muons only.

For a lighter Higgs boson the production is less central, so the losses might be smaller. Fig. 7–Fig. 9 show the corresponding distributions for $H \to \mu\mu\mu\mu$ with $M_H = 400\,\mathrm{GeV}$. A gap $\Delta\eta = \pm 0.1$ reduces the number of events from about 59 to about 47. This loss is not much less as a percentage of the total, although it is less important for making a discovery.

It appears that a gap as large as $\Delta\eta = \pm 0.1$ will adversely affect the ability to study multimuon signals in GEM. We should try to keep the gap significantly smaller than this.

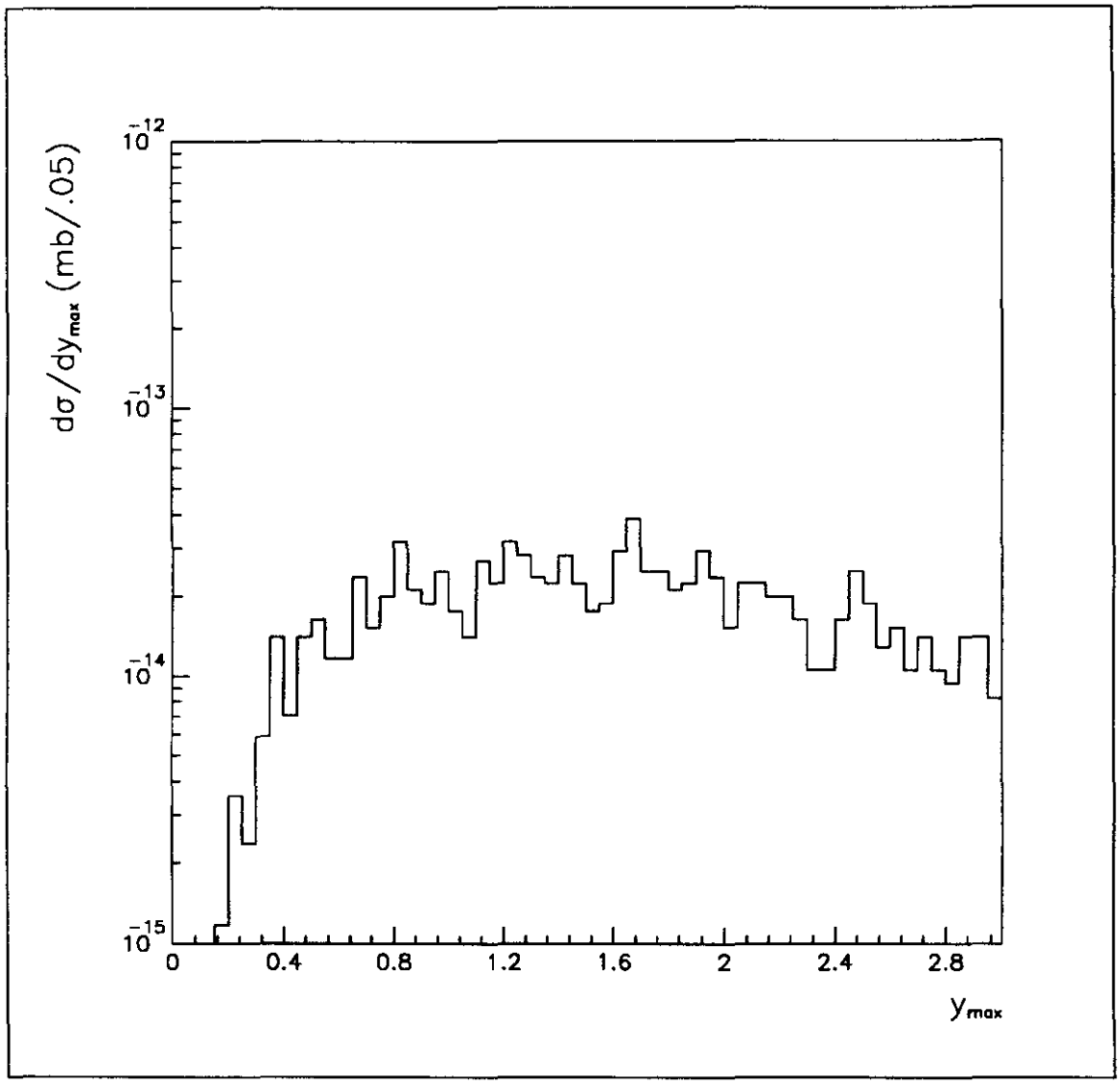

Figure 1: $|\eta_{\max}|$ distribution for $H \to 4\mu$ events.

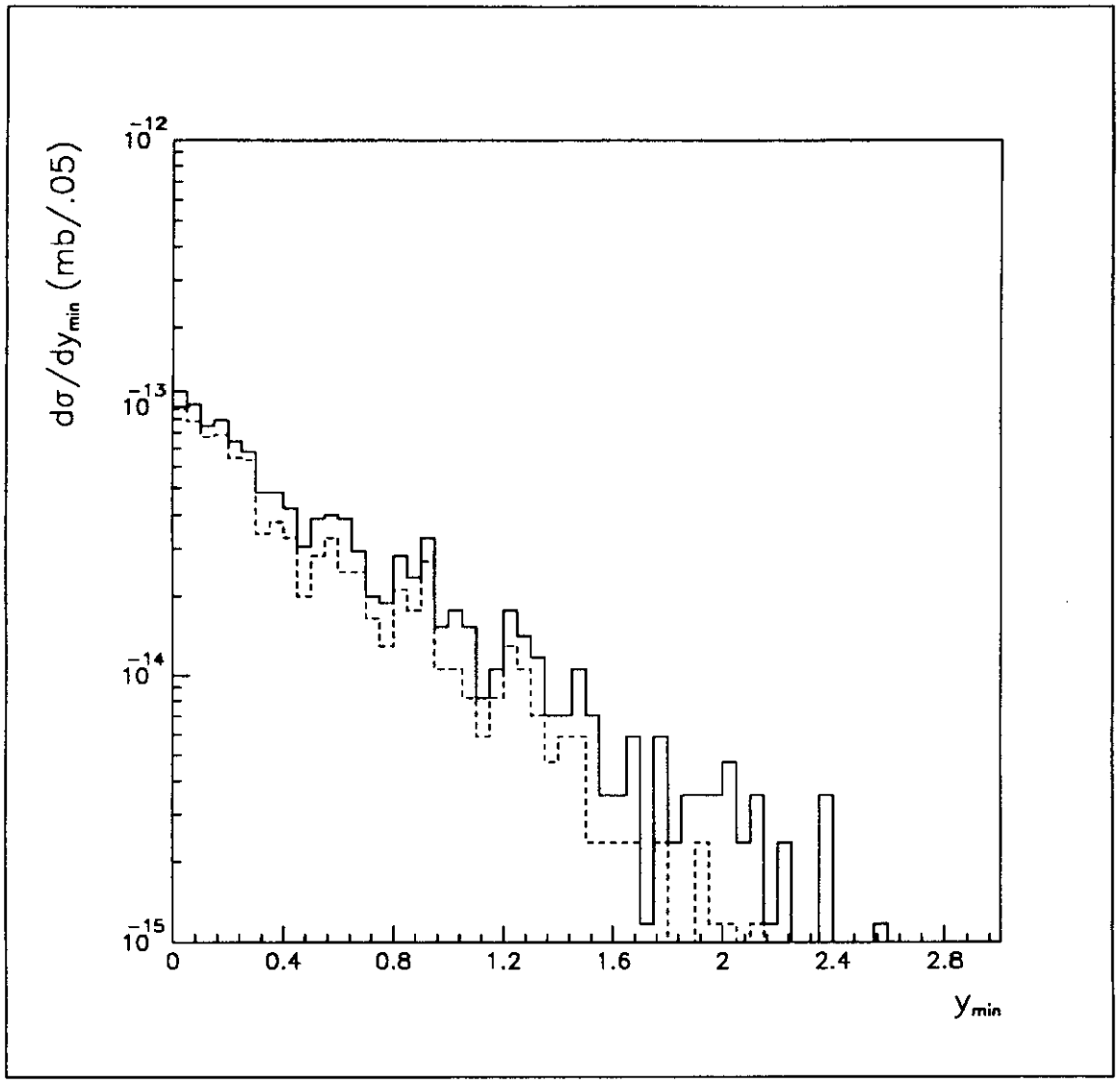

Figure 2: $|\eta_{\mathbf{min}}|$ distribution for $H \to 4\mu$ events. Solid: all events. Dashed: events with $|\eta_{\mathbf{max}}| < 2.5$.

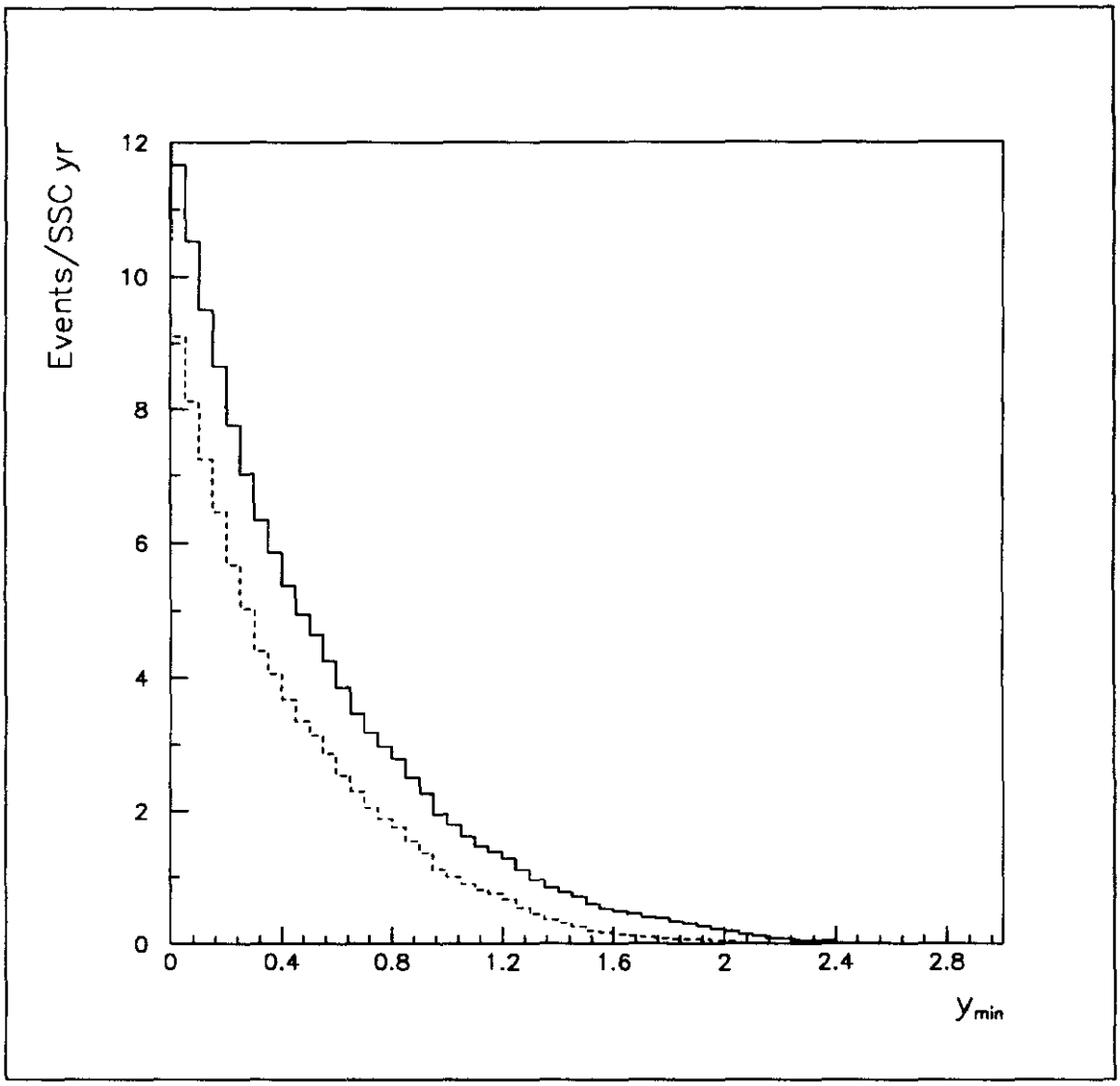

Figure 3: $H \rightarrow \mu\mu\mu\mu$ events per SSC year vs. $|\eta_{\rm min}|$. Solid: all events. Dashed: events with $|\eta_{\rm max}| < 2.5$.

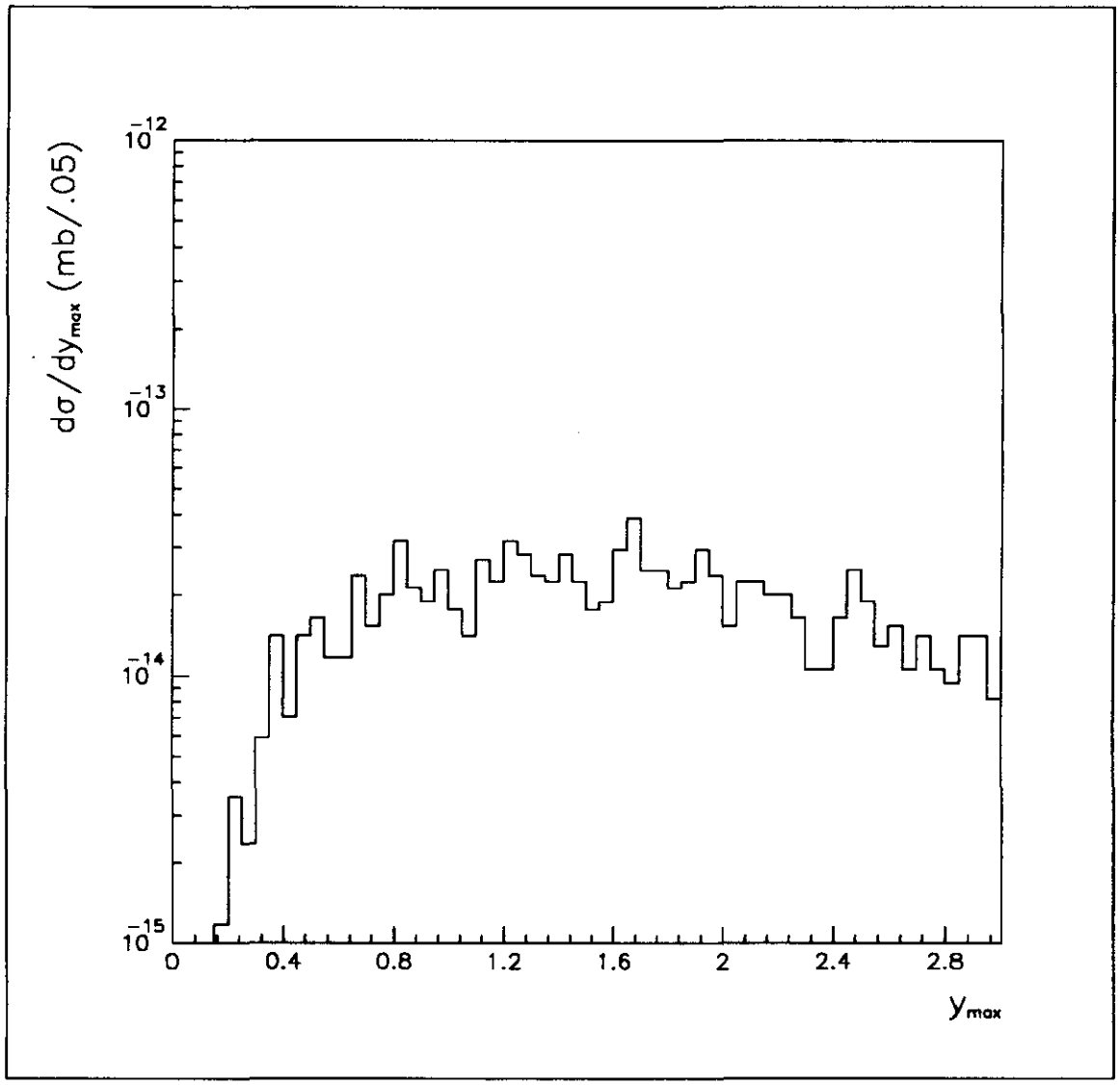

Figure 4: $|\eta_{\mathbf{max}}|$ distribution for $H \to ee\mu\mu$ events, normalized to half the total rate.

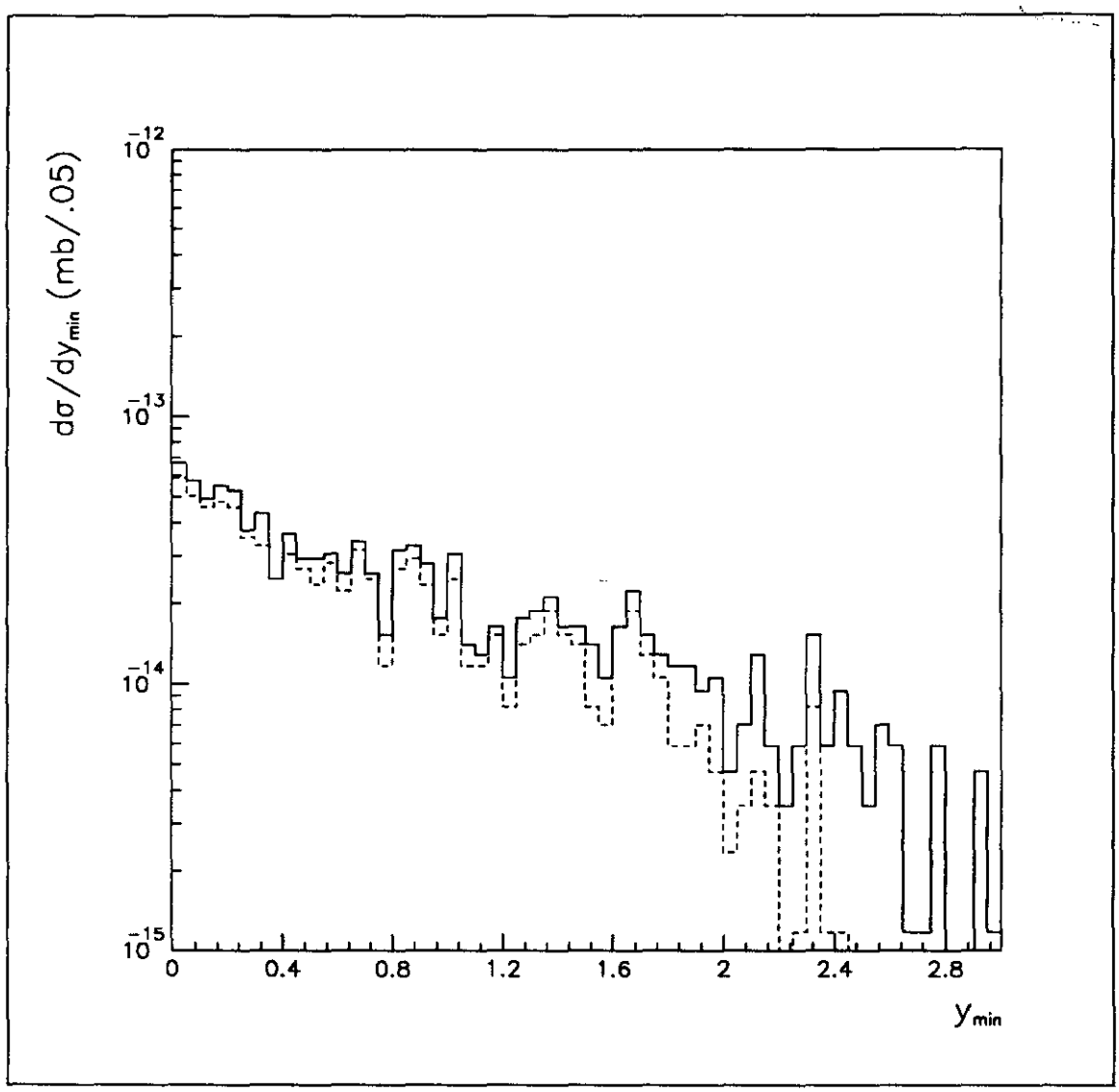

Figure 5: $|\eta_{\mathbf{min}}|$ distribution for $H \to ee\mu\mu$ events, normalized to half the total rate. Solid: all events. Dashed: events with $|\eta_{\mathbf{max}}| < 2.5$.

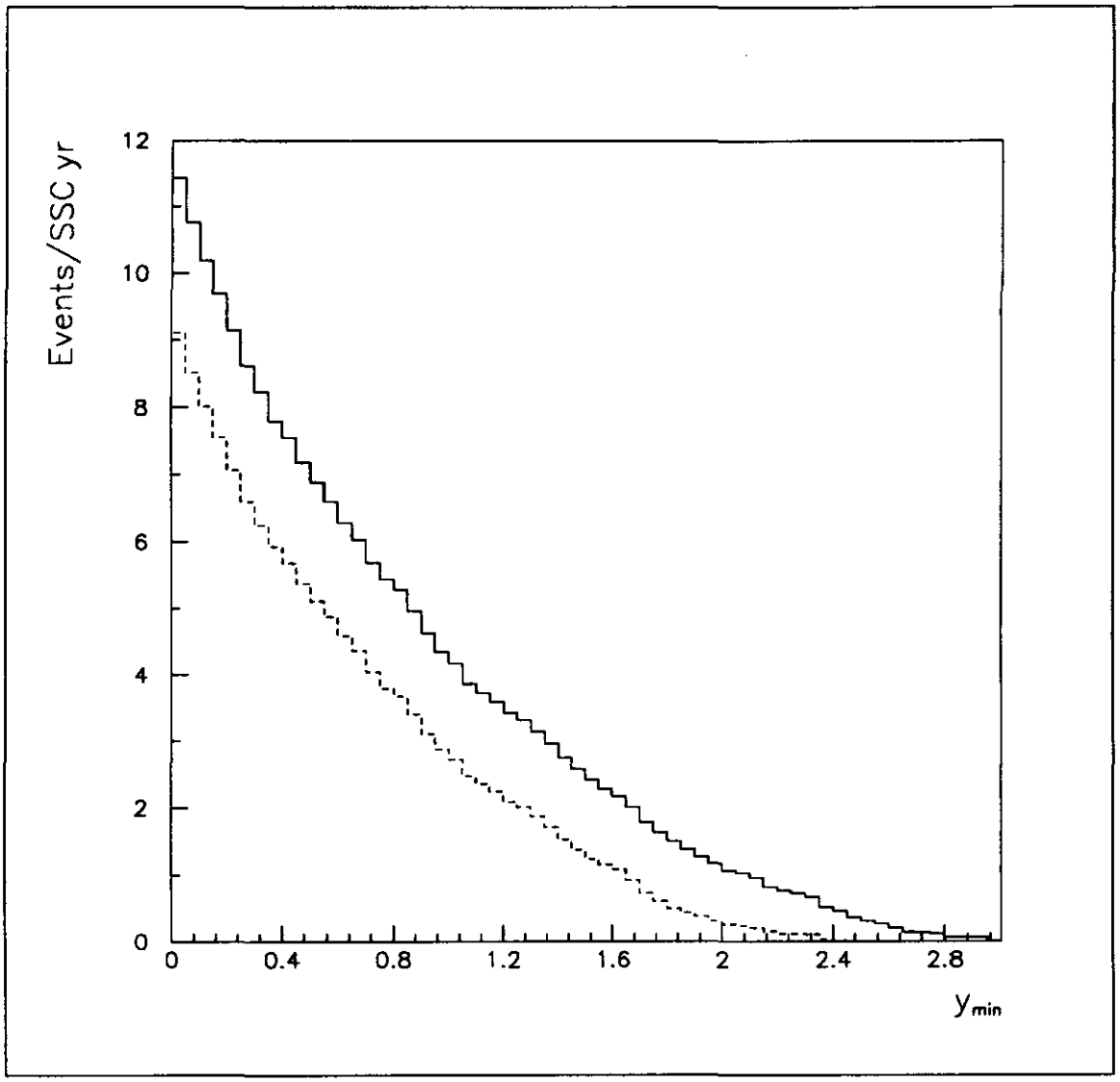

Figure 6: $H \to ee\mu\mu$ events per SSC year vs. $|\eta_{\rm min}|$, normalized to half the total rate. Solid: all events. Dashed: events with $|\eta_{\rm max}| < 2.5$.

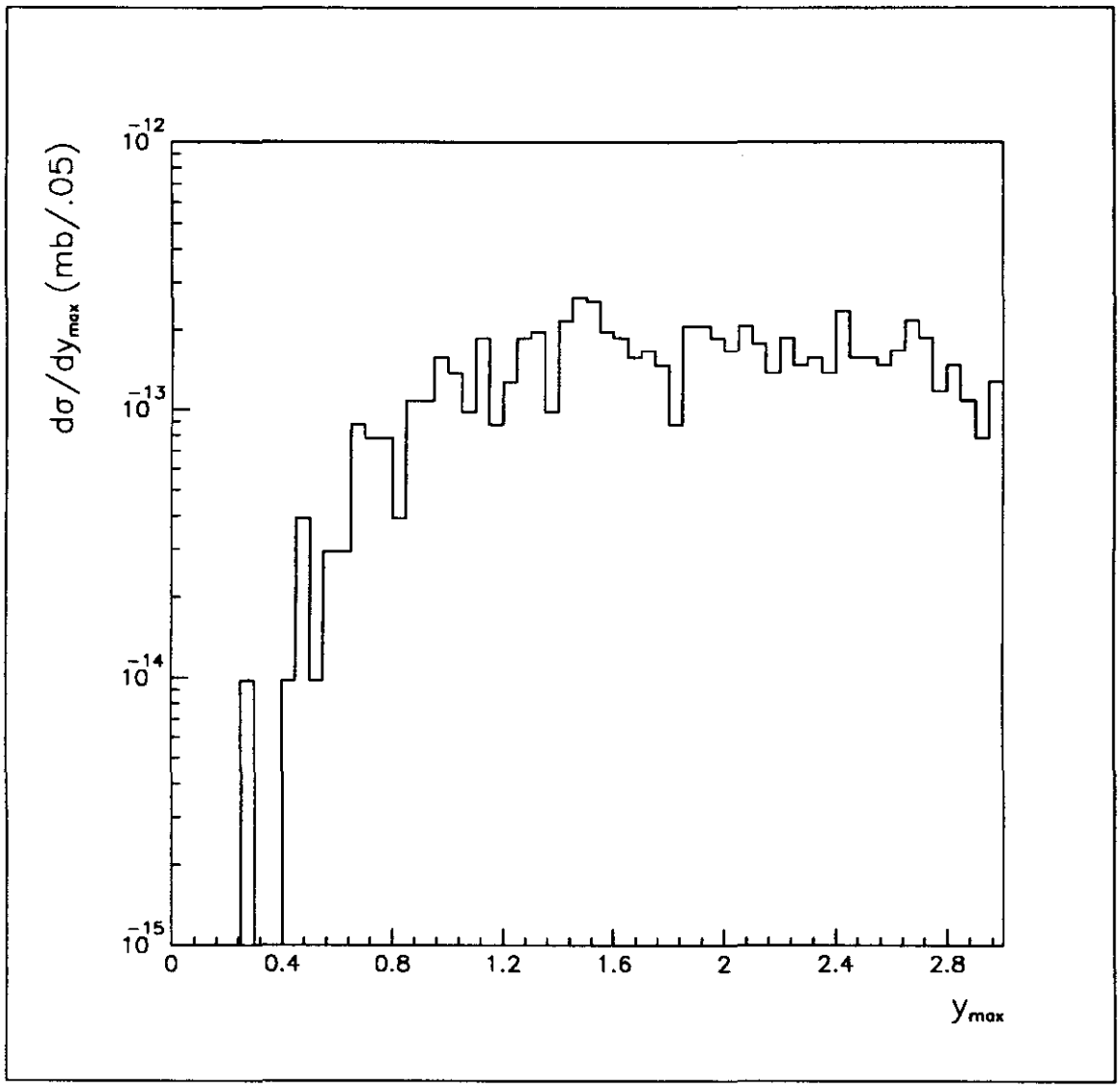

Figure 7: $|\eta_{\max}|$ distribution for $H \to \mu\mu\mu\mu$ events with $M_H = 400\,\mathrm{GeV}$.

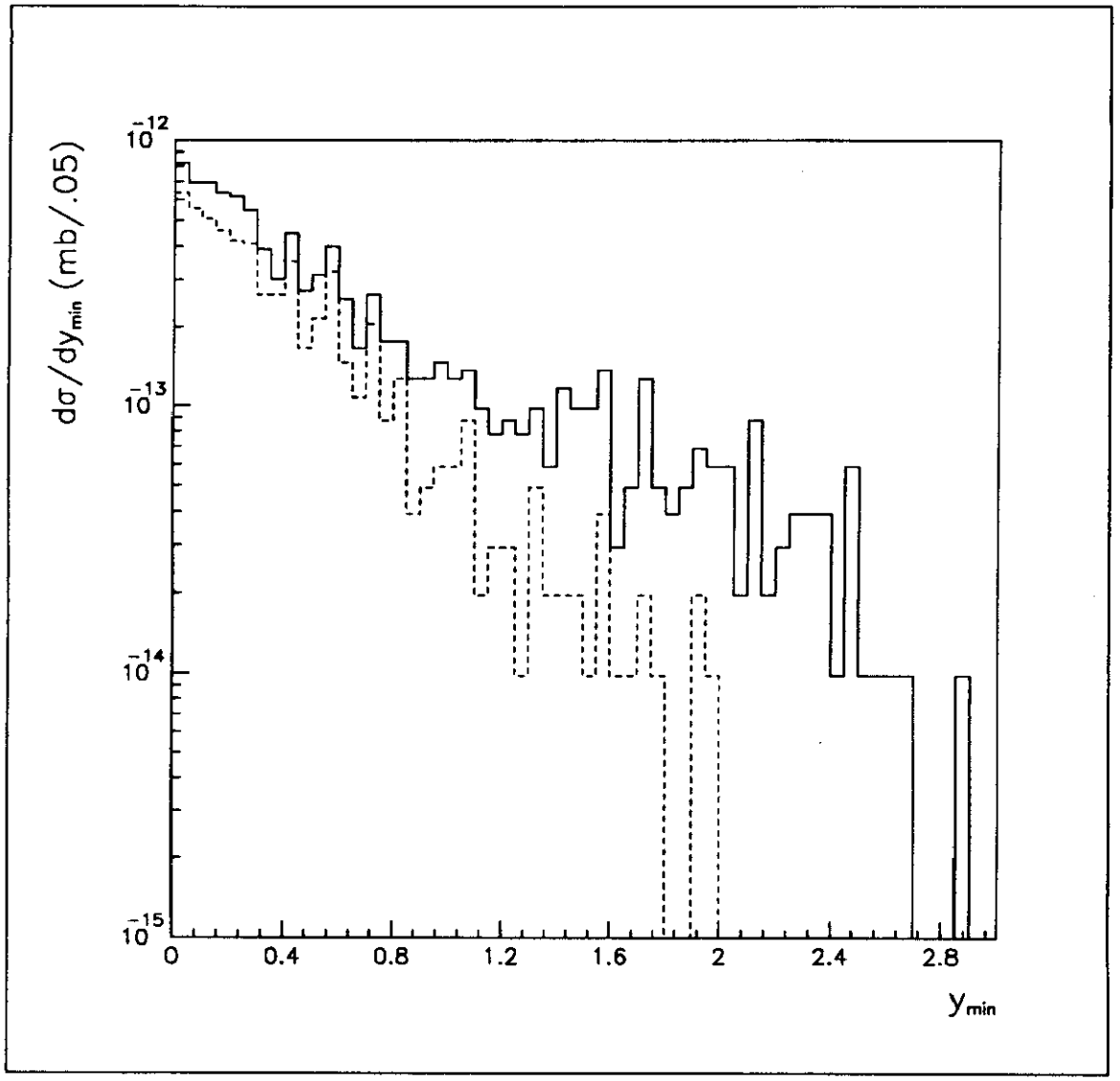

Figure 8: $|\eta_{\mathbf{min}}|$ distribution for $H \to \mu\mu\mu\mu$ events with $M_H = 400\,\mathrm{GeV}$. Solid: all events. Dashed: events with $|\eta_{\mathbf{max}}| < 2.5$.

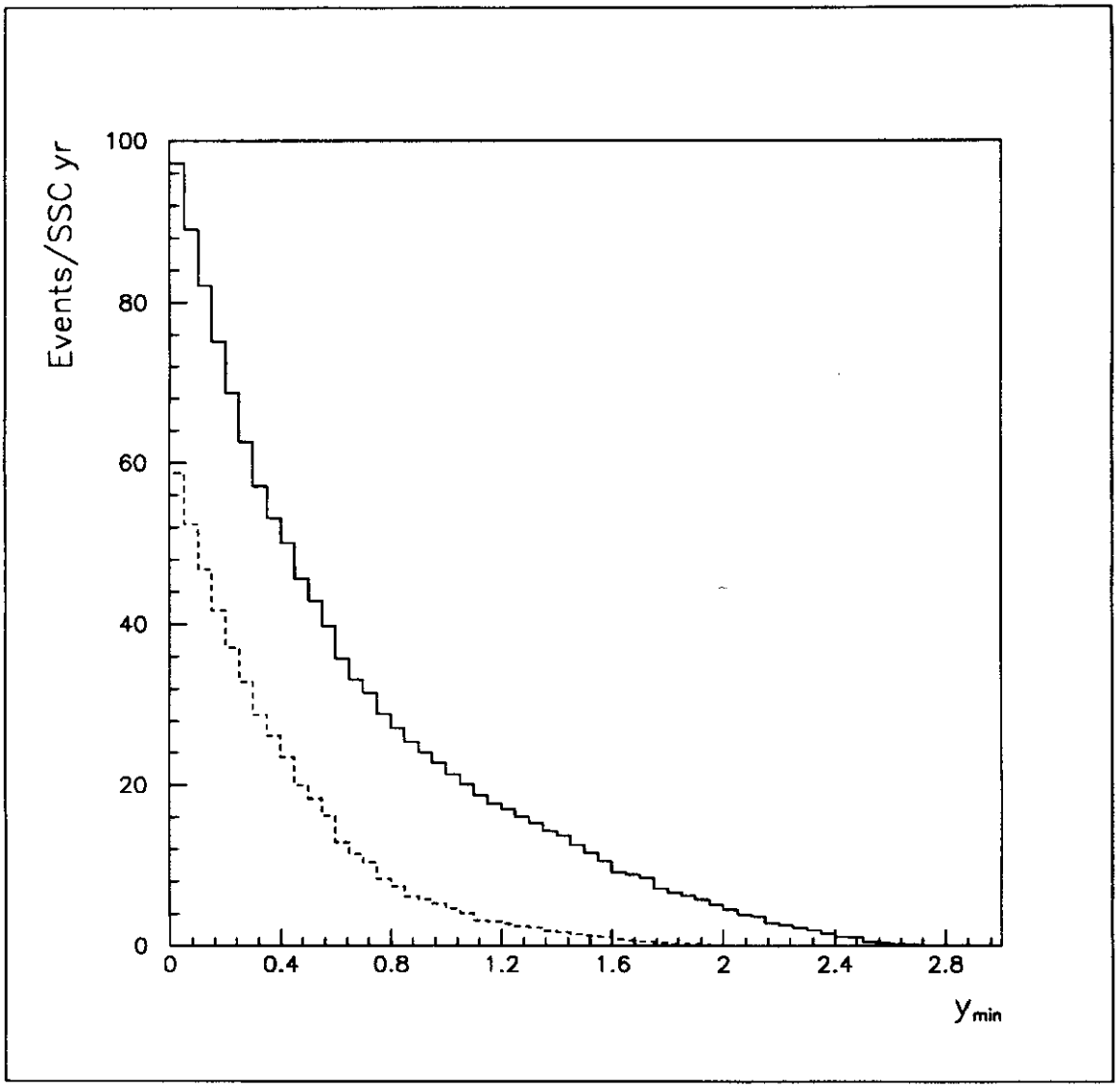

Figure 9: $H \to \mu\mu\mu\mu$ events per SSC year vs. $|\eta_{\rm min}|$ with $M_H = 400\,{\rm GeV}$. Solid: all events. Dashed: events with $|\eta_{\rm max}| < 2.5$.