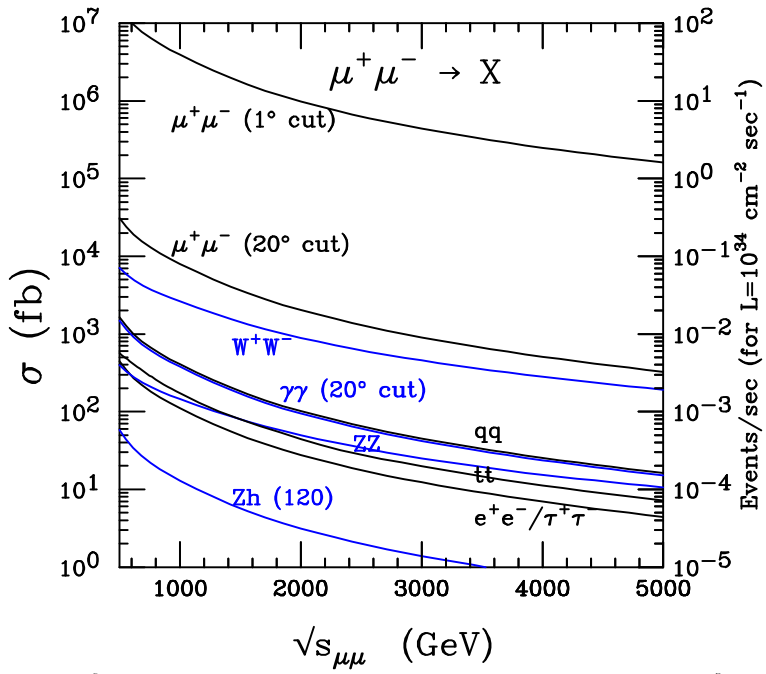
Benchmark Processes for a High-Energy Muon Collider

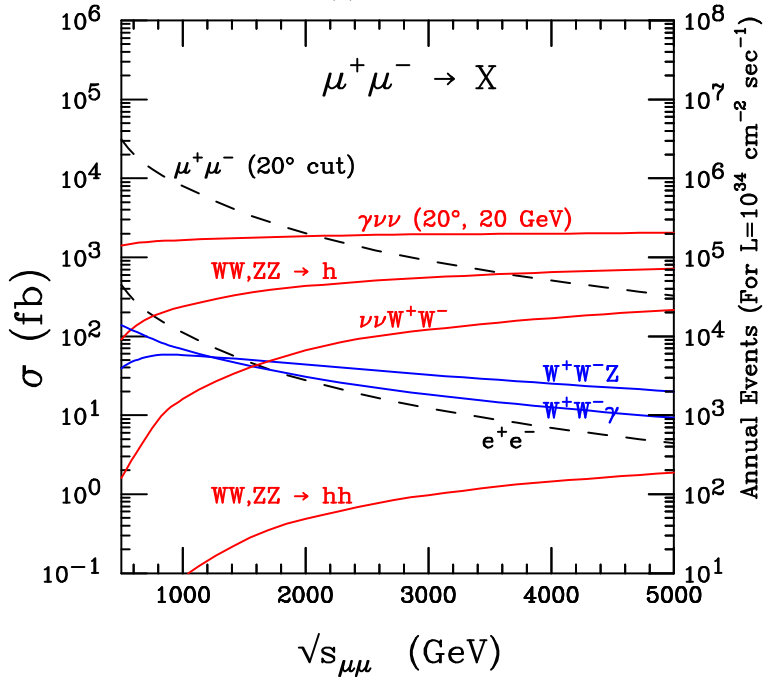
Abstract

We discuss some typical processes that may serve for benchmark studies at a muon collider in the energy range of $1.5 - 5$ TeV. We motivate these processes from the experimental point of view in a relatively model-independent way, although they cover a board spectrum of new physics scenarios beyond the standard model.

Final states	Exp. considerations	Theo. considerations
$\ell^+\ell^-, \quad \ell = e,\ \mu,\ \tau$	Ecal, μ-chamber; τ-tagging at HE	Contact interaction
$q\bar{q}, \quad q = u,\ c,\ s,\ b$	Hcal, b-tagging at HE	Contact interaction
$\gamma\gamma$	Ecal	QED
$\gamma + \not{E}$	Ecal, missing energy	missing mass/dark matter
$W^+W^- \to q\bar{q}', q\bar{q}'$	Hcal: M_W-reconstruct	New resonances
$W^+W^- \to \ell\bar{\nu}, q\bar{q}'$	$\not{E}$, M_W-reconstruct	New resonances
$ZZ \to q\bar{q}, q\bar{q}$	Hcal: M_Z-reconstruct	New resonances
$ZZ \to \ell^+\ell^-, \nu\bar{\nu}$	Ecal; $\not{E}$	New resonances
$t\bar{t} \to bW^+\ \bar{b}W^+$	E,Hcal, b-tagging, mass reconstruct	New heavy quarks
ZHH	multiple $b\bar{b}$	Higgs self coupling
$W^+W^- \to HH$	multiple $b\bar{b}$	Higgs self coupling
$\nu\bar{\nu}W^+W^- \to 4j + \not{E}$	Hcal: M_W-reconstruct	WW scattering
$\nu\bar{\nu}ZZ \to 4j + \not{E}$	Hcal: M_Z-reconstruct	WW scattering
$\nu\bar{\nu}t\bar{t}$	Hcal: m_t-reconstruct	$WW \to t\bar{t}$
$\tilde{\chi}_i\tilde{\chi}_j$	leptons, jets+$\not{E}$	SUSY
$\tilde{\ell}_i\tilde{\ell}_j$	leptons+$\not{E}$	SUSY
$\tilde{q}_i\tilde{q}_j$	jets+$\not{E}$	SUSY

TABLE I. Benchmark processes in $\mu^-\mu^+$ collisions, relevant to a high energy muon collider of $\sqrt{s} = 1.5 - 5$ TeV.


$\mu^+\mu^- \to X$
$\mu^+\mu^-$ (1° cut)
$\mu^+\mu^-$ (20° cut)
W^+W^-
$\gamma\gamma$ (20° cut)
ZZ
qq
tt
$e^+e^-/\tau^+\tau^-$
Zh (120)
σ (fb)
Events/sec (for L=10^{34} cm^{-2} sec^{-1})
$\sqrt{s}_{\mu\mu}$ (GeV)


$\mu^+\mu^- \to X$
$\mu^+\mu^-$ (20° cut)
$\gamma\nu\nu$ (20°, 20 GeV)
WW,ZZ → h
$\nu\nu W^+W^-$
W^+W^-Z
$W^+W^-\gamma$
e^+e^-
WW,ZZ → hh
σ (fb)
Annual Events (For L=10^{34} cm^{-2} sec^{-1})
$\sqrt{s}_{\mu\mu}$ (GeV)