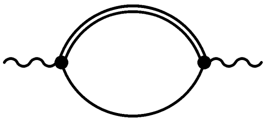
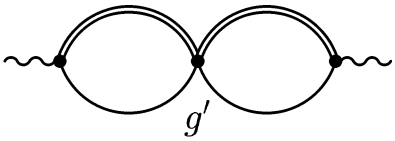
Off-shell pions in BUU:

Pion polarization function in the Δ-hole model:
(A.B. Larionov and U. Mosel, PRC **66**, 034902 (2002))

$-i\Pi(k) =$  $+$ 

$+ \ \ldots$

Pion spectral function: $A_\pi(k) = -\frac{1}{\pi}\mathrm{Im}\, G_\pi(k)$,
where $G_\pi(k) = (k^2 - m_\pi^2 - \Pi(k))^{-1}$.

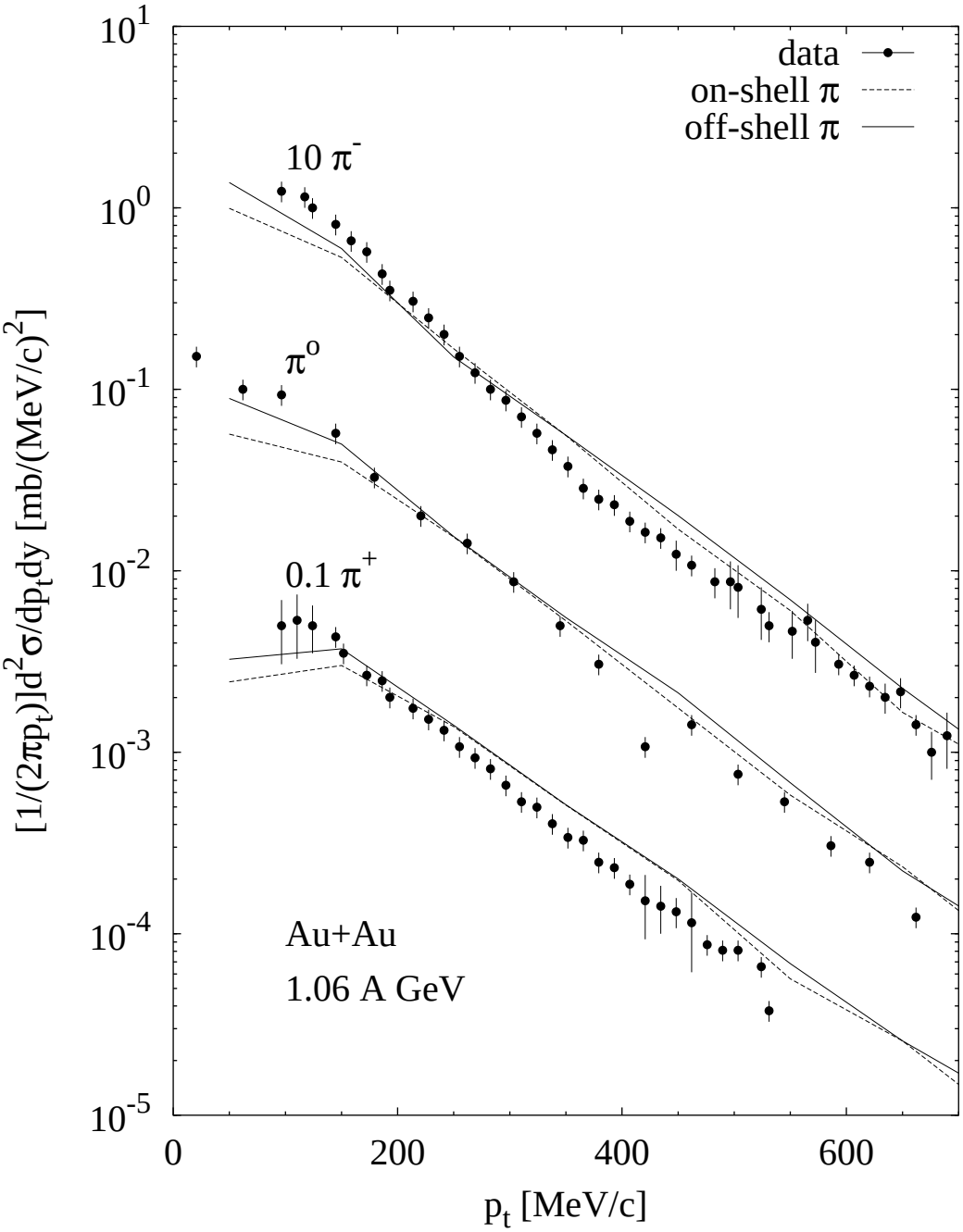
$R \to N\pi$, $NN \to NN\pi$: $W(M_\pi^2) \propto A_\pi(M_\pi^2, |\mathbf{k}|)$

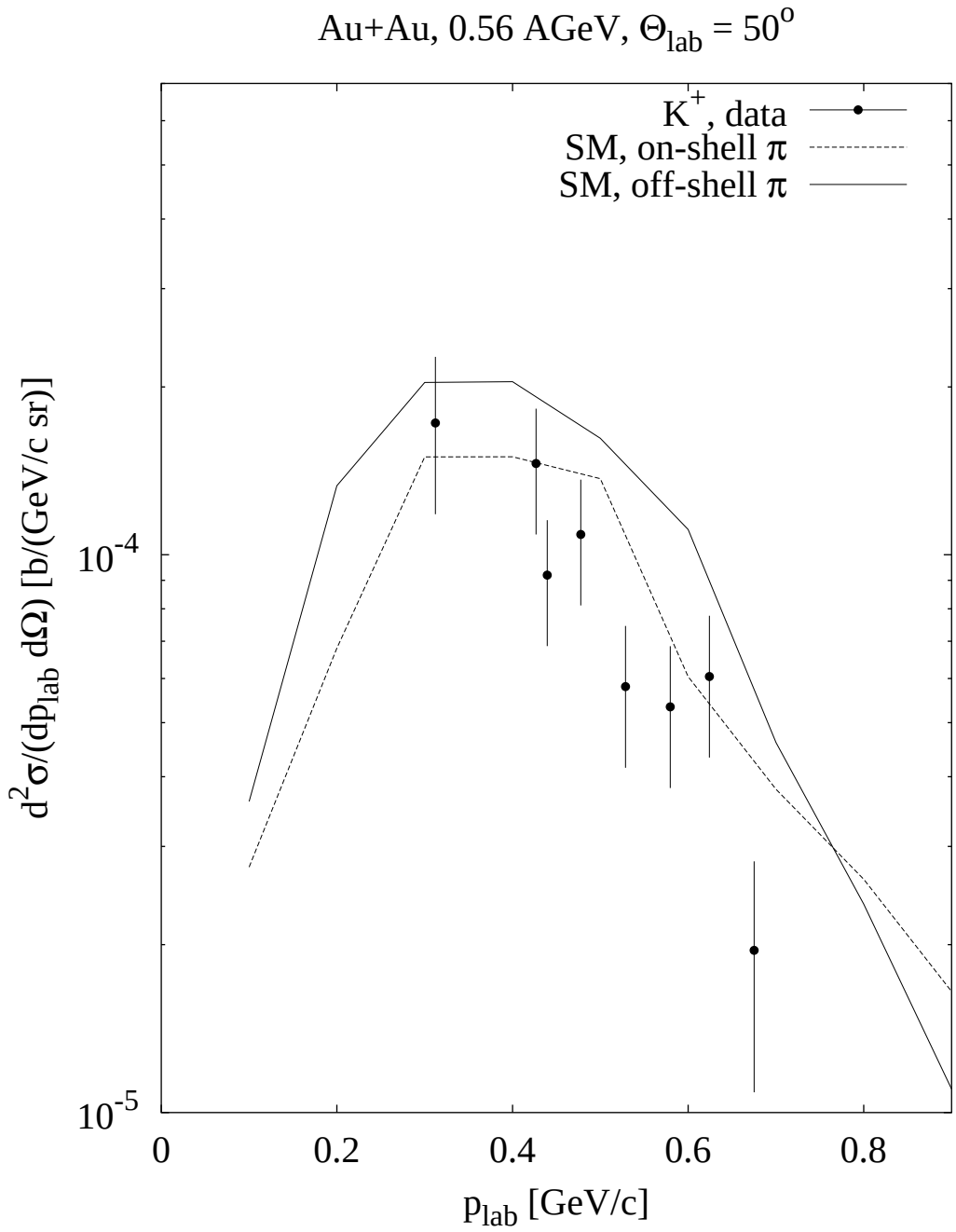
Propagation:

$$
\begin{aligned}
s_\pi(\mathbf{r}(t), t) &= \frac{M_\pi(t_{cr}) - m_\pi}{\rho_N(\mathbf{r}(t_{cr}), t_{cr})}\rho_N(\mathbf{r}(t), t) \ , \\
M_\pi(t) &= m_\pi + s_\pi(\mathbf{r}(t), t) \ , \\
H_{off-shell} &= \sqrt{\mathbf{k}^2 + M_\pi^2(t)}
\end{aligned}
$$

Hamiltonian equations of motion:

$$
\begin{aligned}
\dot{\mathbf{r}} &= \frac{\partial H_{off-shell}}{\partial \mathbf{k}} \ , \\
\dot{\mathbf{k}} &= -\frac{\partial H_{off-shell}}{\partial \mathbf{r}} \ .
\end{aligned}
$$


data
on-shell π
off-shell π
10 π-
π0
0.1 π+
Au+Au
1.06 A GeV
[1/(2πpt)]d2σ/dptdy [mb/(MeV/c)2]
pt [MeV/c]
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0
200
400
600


Au+Au, 0.56 AGeV, Θlab = 50o
K+, data
SM, on-shell π
SM, off-shell π
d2σ/(dplab dΩ) [b/(GeV/c sr)]
10-4
10-5
0
0.2
0.4
0.6
0.8
plab [GeV/c]