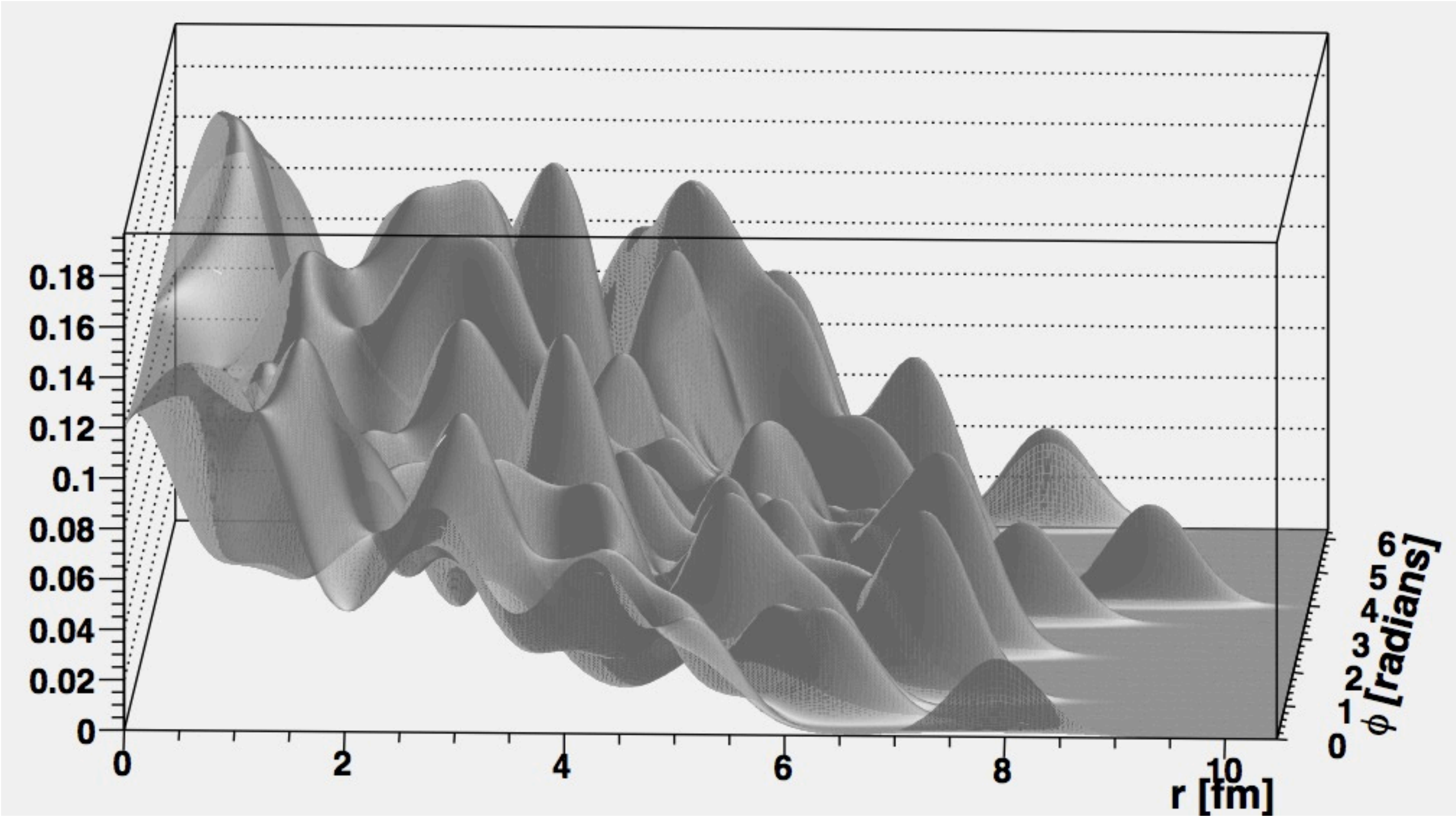
Update on XDVMP for eA



Going from ep to eA

ep:

$$\mathrm{Re}(S) = 1 - \mathcal{N}^{(p)}(x, r, \mathbf{b}) = 1 - \frac{1}{2}\frac{\mathrm{d}\sigma_{q\bar{q}}^{(p)}(x, r, \mathbf{b})}{\mathrm{d}^2\mathbf{b}}$$

eA:

$$1 - \mathcal{N}^{(A)} = \prod_{i=1}^{A}\left(1 - \mathcal{N}^{(p)}(x, r, |\mathbf{b} - \mathbf{b}_i|)\right)$$

Should follow the Wood-Saxon distribution

Technical Problem

$$\frac{\mathrm{d}\sigma^{(A)}{}_{q\bar{q}}(r,x,\mathbf{b})}{\mathrm{d}^2\mathbf{b}} = 2\left[1 - \prod_{i=1}^{A}\left(1 - \frac{1}{2}\frac{\mathrm{d}\sigma^{(p)}{}_{q\bar{q}}(r,x,|\mathbf{b}-\mathbf{b}_i|)}{\mathrm{d}^2\mathbf{b}}\right)\right]$$

Extremely slow!!!!

bSat:

$$\frac{\mathrm{d}\sigma^{A}_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}} = 2\left[1 - \exp\left(-\frac{\pi^2}{2N_c} r^2 \alpha_s(\mu^2) x g(x,\mu^2) \sum_{i=1}^{A} T_p(\mathbf{b}-\mathbf{b}_i)\right)\right]$$

Product becomes a sum over a function only dependent on b.

Not possible for bCGC!! Is abandoned for now.

Going from ep to eA

Another difference in eA:
The Nucleus can break up
into its colour neutral fragments!

When the nucleus breaks up, the scattering is called
incoherent

When the nucleus stays intact, the scattering is called
coherent

Total cross-section = incoherent + coherent

Incoherent Scattering

Nucleus dissociates ($f \neq i$): Good, Walker

$$\sigma_{\text{incoherent}} \propto \sum_{f \neq i} \langle i|\mathcal{A}|f\rangle^{\dagger} \langle f|\mathcal{A}|i\rangle$$

complete set

$$= \sum_{f} \langle i|\mathcal{A}\overbrace{|f\rangle^{\dagger} \langle f|}\mathcal{A}|i\rangle - \langle i|\mathcal{A}|i\rangle^{\dagger} \langle i|\mathcal{A}|i\rangle$$

$$= \left\langle i \left| |\mathcal{A}|^2 \right| i \right\rangle - |\langle i|\mathcal{A}|i\rangle|^2 = \left\langle |\mathcal{A}|^2 \right\rangle - |\langle \mathcal{A}\rangle|^2$$

The incoherent CS is the variance of the amplitude!!

$$\frac{d\sigma_{\text{total}}}{dt} = \frac{1}{16\pi} \left\langle |\mathcal{A}|^2 \right\rangle \qquad \frac{d\sigma_{\text{coherent}}}{dt} = \frac{1}{16\pi} |\langle \mathcal{A}\rangle|^2$$

Averaging over initial state

$$\frac{\mathrm{d}\sigma_{\mathrm{coherent}}}{\mathrm{d}t} = \frac{1}{16\pi}\left|\langle\mathcal{A}\rangle\right|^2$$

The average should be taken over initial nucleon configurations Ω within the nucleus (the nucleon configurations are not a QM observable).

$$\langle\mathcal{A}(\Delta)\rangle_\Omega = \int \mathrm{d}\Omega P(\Omega)\mathcal{A}(\Omega,\Delta) \approx \frac{1}{C_{\mathrm{max}}}\sum_{j=1}^{C_{\mathrm{max}}}\mathcal{A}(\Omega_j,\Delta)$$

Coherent

$$\frac{\mathrm{d}\sigma_{\mathrm{coherent}}}{\mathrm{d}t} = \frac{1}{16\pi}\left|\frac{1}{C_{\max}}\sum_{j=1}^{C_{\max}} \mathcal{A}(\Omega_j)\right|^2$$

$$\langle\mathcal{A}\rangle_\Omega = \left\langle \int \mathrm{d}r \int \frac{\mathrm{d}z}{4\pi} \int \mathrm{d}^2\mathbf{b}(\Psi_V^*\Psi)(r,z)2\pi r b J_0([1-z]r\Delta) \right.$$

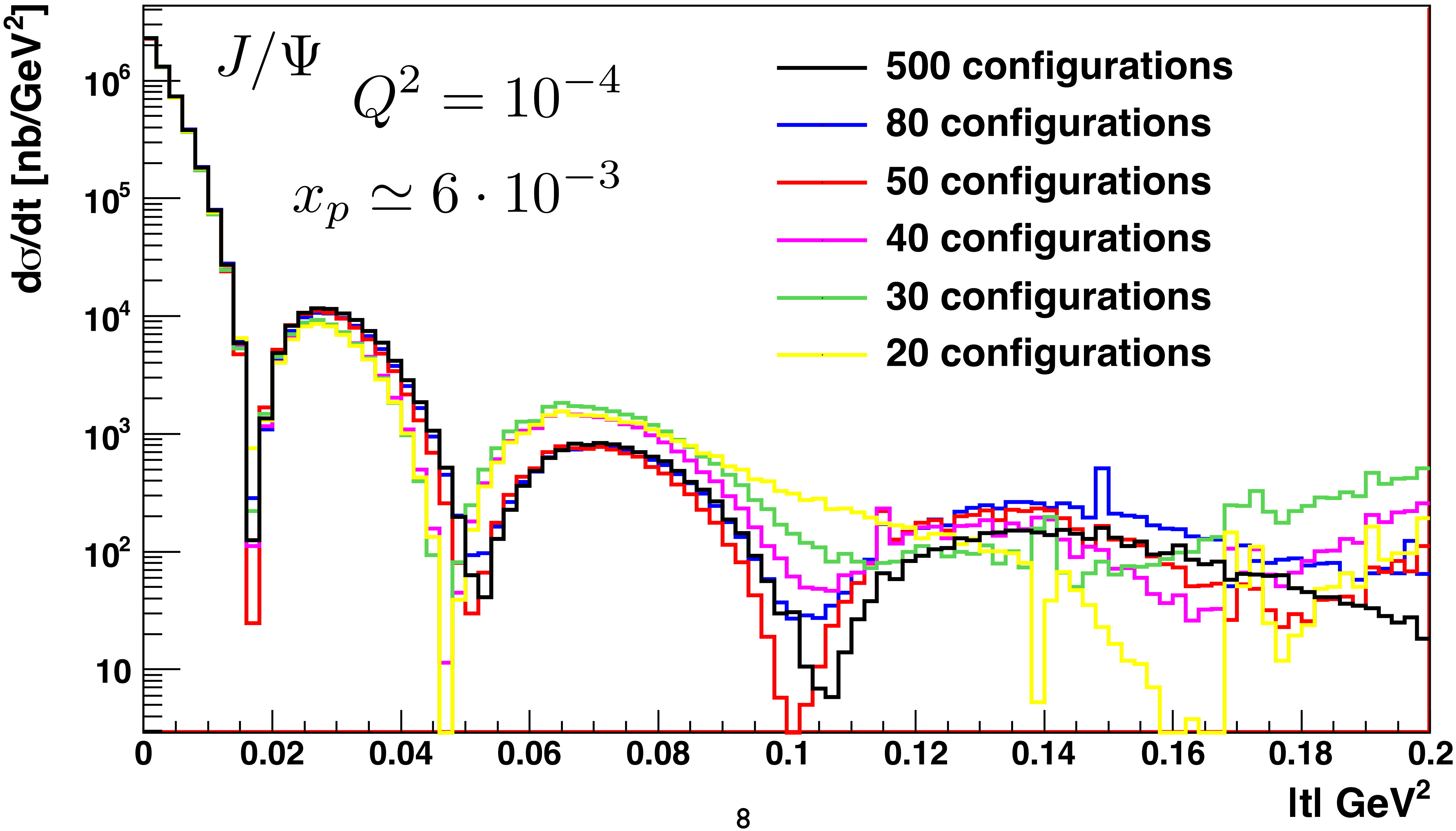
$$t \equiv -\Delta^2 \qquad \left. e^{-i\mathbf{b}\cdot\mathbf{\Delta}} \frac{\mathrm{d}\sigma_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}}(x,r,\mathbf{b},\Omega) \right\rangle_\Omega$$

$\mathcal{A}$ is a Fourier transform of b. This means that small variations in b will be seen at large t and vice versa

The question is how many configuration is needed to be averaged over for the cross-section to converge.

Coherent

$$\frac{d\sigma_{\text{coherent}}}{dt} = \frac{1}{16\pi}\left|\frac{1}{C_{\max}}\sum_{j=1}^{C_{\max}}\mathcal{A}(\Omega_j)\right|^2$$



Incoherent/Total

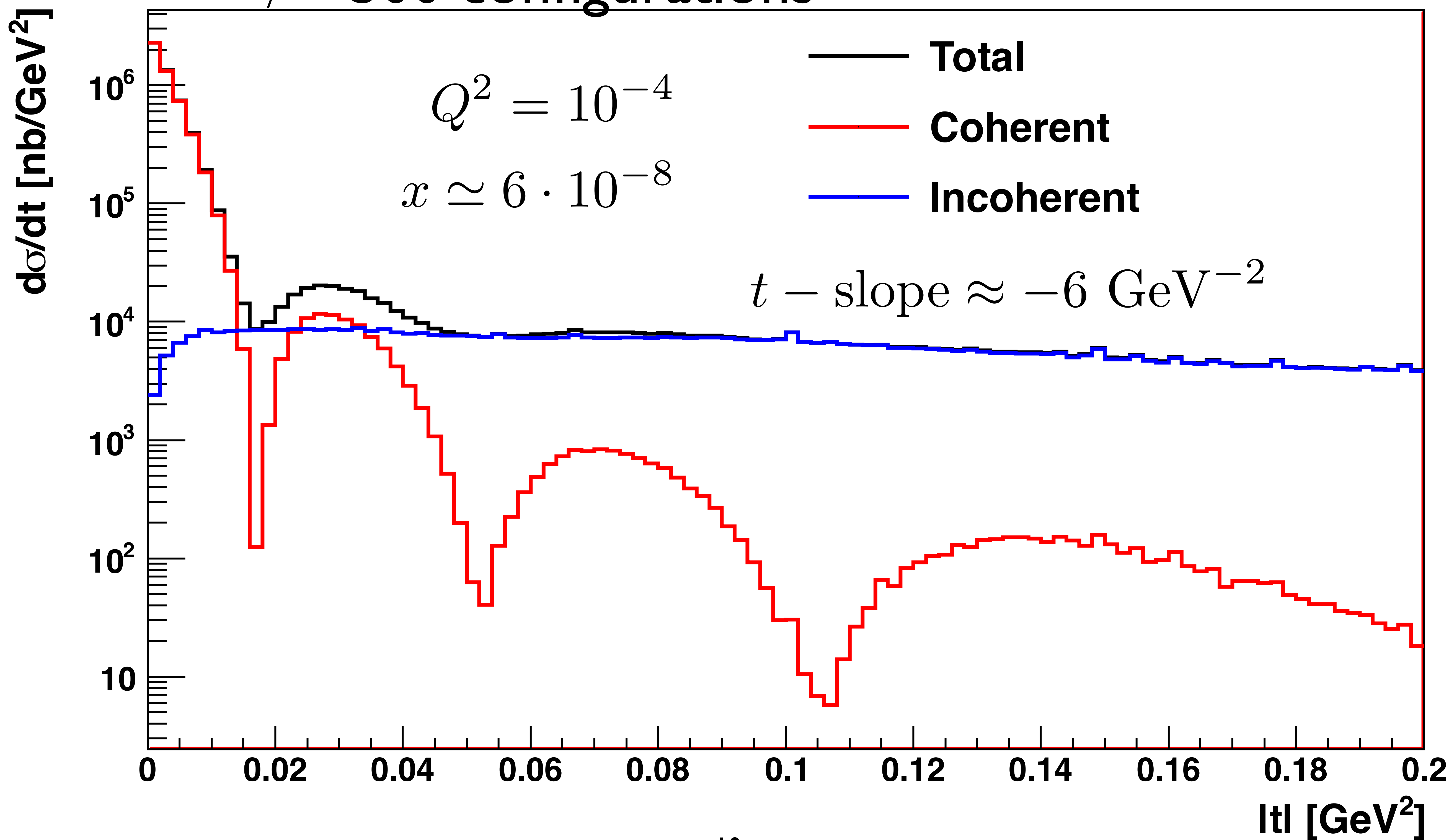
$$\frac{\mathrm{d}\sigma_{\mathrm{total}}}{\mathrm{d}t} = \frac{1}{16\pi} \frac{1}{C_{\mathrm{max}}} \sum_{j=1}^{C_{\mathrm{max}}} |\mathcal{A}(\Omega_j)|^2$$

$$\frac{\mathrm{d}\sigma_{\mathrm{coherent}}}{\mathrm{d}t} = \frac{1}{16\pi} \left| \frac{1}{C_{\mathrm{max}}} \sum_{j=1}^{C_{\mathrm{max}}} \mathcal{A}(\Omega_j) \right|^2$$

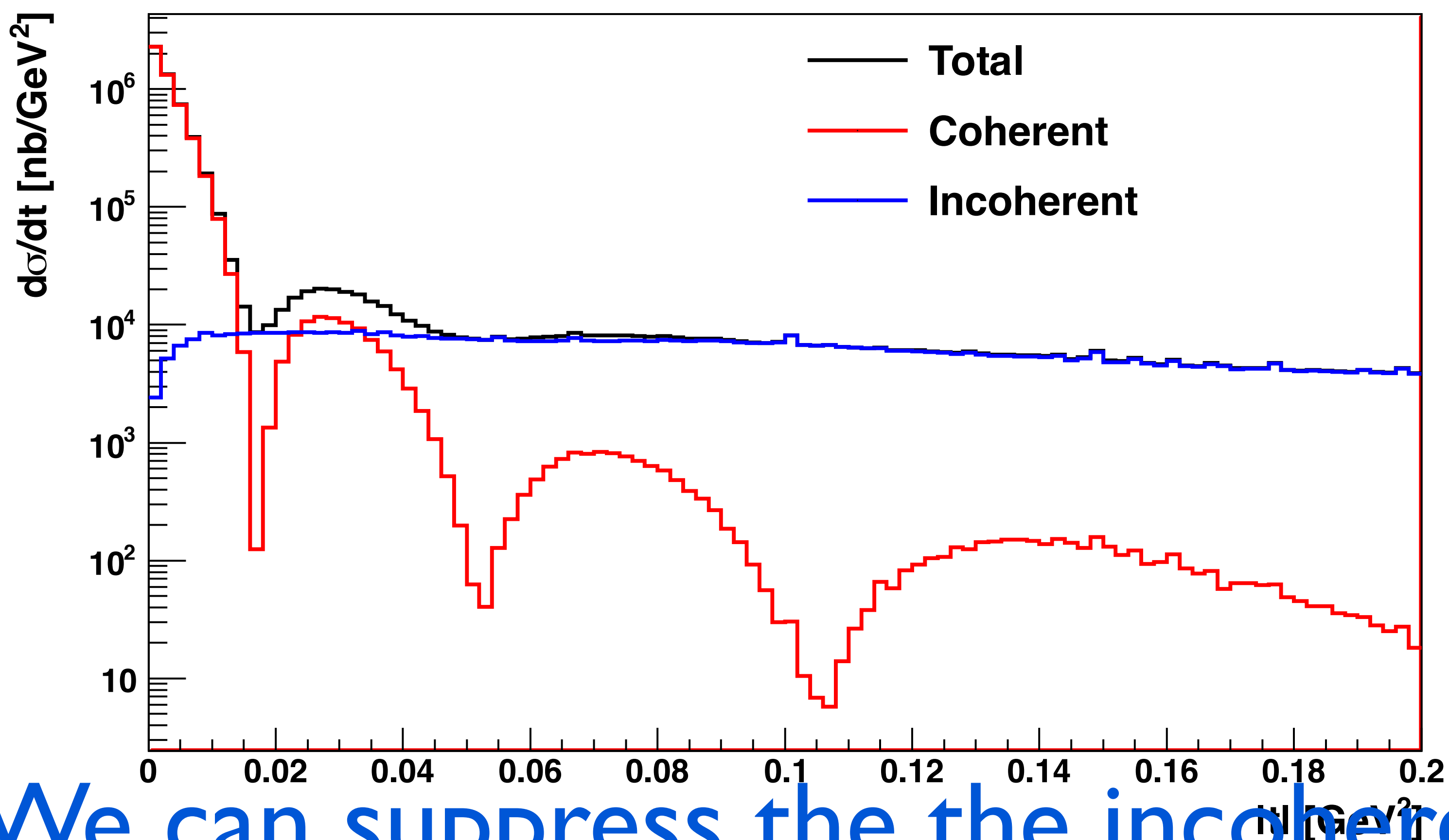
$$\frac{\mathrm{d}\sigma_{\mathrm{incoherent}}}{\mathrm{d}t} = \frac{\mathrm{d}\sigma_{\mathrm{total}}}{\mathrm{d}t} - \frac{\mathrm{d}\sigma_{\mathrm{coherent}}}{\mathrm{d}t}$$

Incoherent/Total

J/Ψ 500 configurations



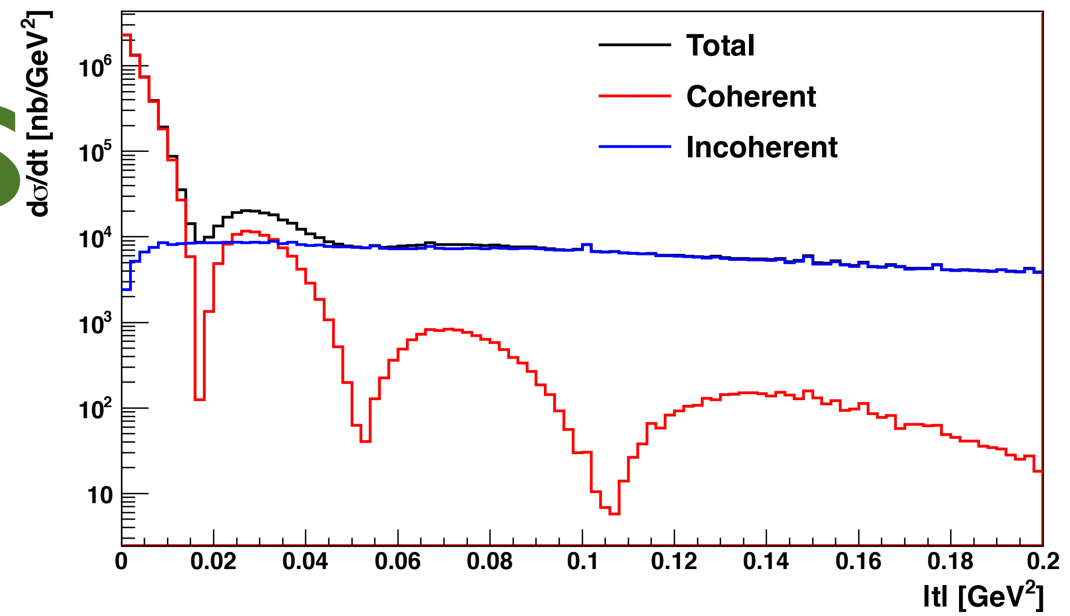
Incoherent/Total



We can suppress the the incoherent background by 90-99.9%
(See Thomas' talk b4 xmas)

This result means that it will be possible to measure the first 3 coherent bumps and access the spatial gluon distribution at an EIC!!

Generating events



Generate t, Q^2 and W^2 from total Xsection:

$$\frac{\partial^3\sigma_{\mathrm{total}}}{\partial Q^2\partial W^2\partial t}(Q^2,W^2,t)=\sum_{T,L} f^{\gamma^*}_{T,L}(Q^2,W^2)\left\langle\left|\mathcal{A}^{\gamma^* A\to VA'}_{T,L}(Q^2,W^2,t,\Omega)\right|^2\right\rangle_\Omega$$

Break up if:

$$\frac{\dfrac{\partial^3\sigma_{\mathrm{total}}}{\partial Q^2\partial W^2\partial t}-\dfrac{\partial^3\sigma_{\mathrm{coherent}}}{\partial Q^2\partial W^2\partial t}}{\dfrac{\partial^3\sigma_{\mathrm{total}}}{\partial Q^2\partial W^2\partial t}}>R$$

Ongoing

- Nuclear Break-up (Thomas)
- INT proceedings/paper almost done
- DVCS - as always
- Inclusive Diffraction

  $$eA \to eA' M_X$$

  Doesn't seem too complicated at the moment, should be implemented soon

  Before DIS?

Backup

Cross-Sections

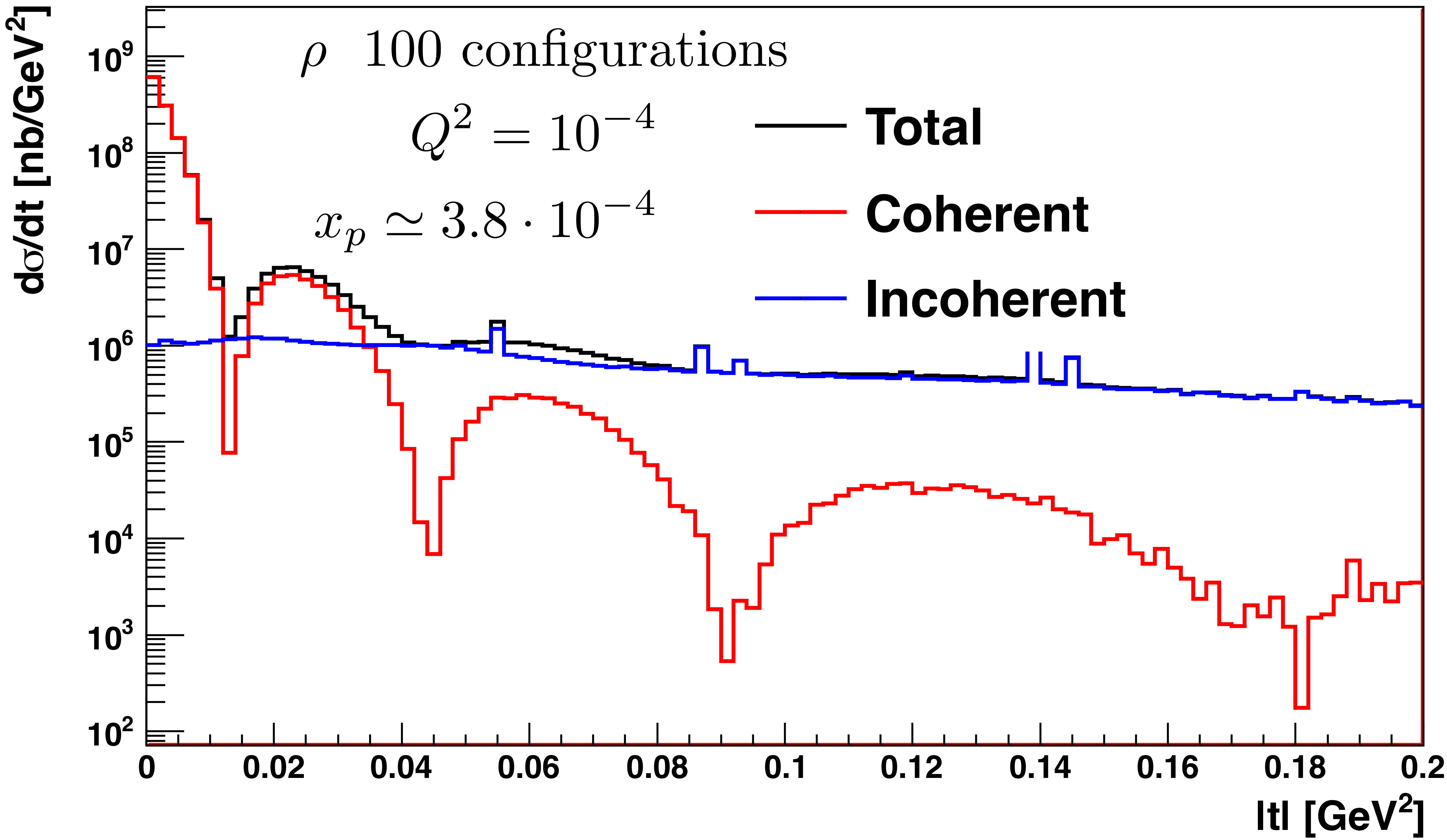
$$Im(\mathcal{A}) = \int_0^{r_{\max}} \mathrm{d}r \int_0^1 \mathrm{d}z \int_0^{b_{\max}} \mathrm{d}b \int_0^{2\pi} \mathrm{d}\phi_{b\Delta}$$
$$\frac{1}{2} r \left(\Psi_V^* \Psi\right)(r, z) J_0([1-z]r\Delta) b \cos(b\Delta \cos\phi_{b\Delta}) \frac{\mathrm{d}^2\sigma_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}}(x, r, b, \phi_{b\Delta}, \Omega)$$

$$Re(\mathcal{A}) = \int_0^{r_{\max}} \mathrm{d}r \int_0^1 \mathrm{d}z \int_0^{b_{\max}} \mathrm{d}b \int_0^{2\pi} \mathrm{d}\phi_{b\Delta}$$
$$\frac{1}{2} r \left(\Psi_V^* \Psi\right)(r, z) J_0([1-z]r\Delta) b \sin(b\Delta \cos\phi_{b\Delta}) \frac{\mathrm{d}^2\sigma_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}}(x, r, b, \phi_{b\Delta}, \Omega)$$

Coherent:
$$|\langle\mathcal{A}\rangle_\Omega|^2 = \left|\frac{1}{C_{\max}} \sum_{j=1}^{C_{\max}} iIm(\mathcal{A}(\Omega_j))\right|^2 + \left|\frac{1}{C_{\max}} \sum_{j=1}^{C_{\max}} Re(\mathcal{A}(\Omega_j))\right|^2$$

Total: $$\left\langle|\mathcal{A}|^2\right\rangle_\Omega = \frac{1}{C_{\max}} \sum_{j=1}^{C_{\max}} \left(|iIm(\mathcal{A}(\Omega_j))|^2 + |Re(\mathcal{A}(\Omega_j))|^2\right)$$

Incoherent/Total



Incoherent/Total