

# The NLO PHOTON IMPACT FACTOR

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Low  $x$  2005, Romania

# Outline

- Few words on small  $x$  Physics
- About the Photon Impact Factor
- The NLO computation
- Conclusions

# pQCD in the small x limit

Large centre of mass energy  $\sqrt{s}$  and fixed (small) momentum transfer  $t$ .

$|t|$  and all the other scales  $\ll s$

$x=Q^2/s \rightarrow$  small

Physical Processes:

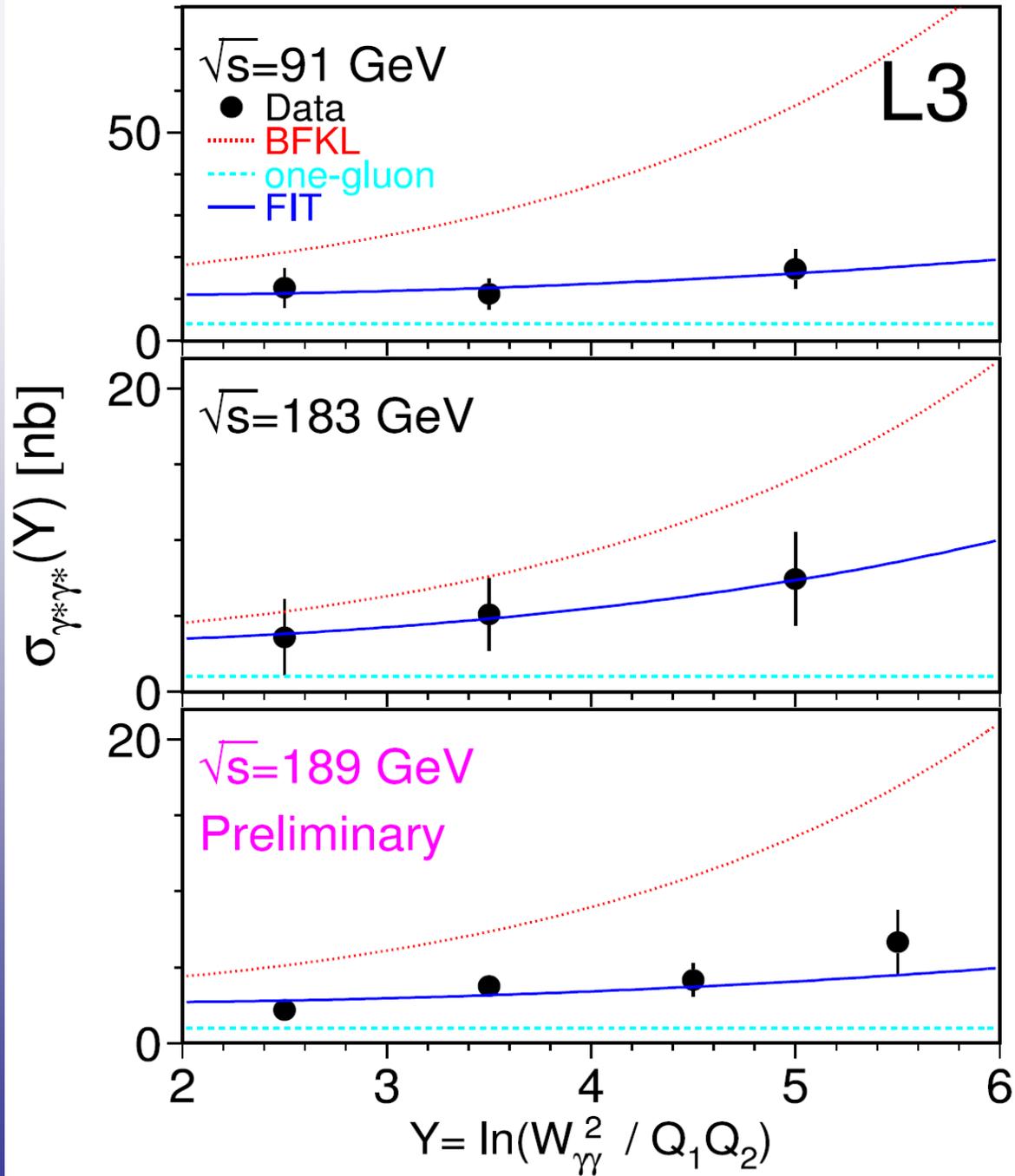
- Deep Inelastic Scattering (DIS)
- $\gamma^* \gamma^* \rightarrow \textit{hadrons}$

# The theoretical tool: **BFKL**

- High Energy scattering processes  $\implies$  BFKL dynamics

*Balitski-Fadin-Kuraev-Lipatov*

- Largest contribution to amplitudes comes from logarithms in  $s$ :  $lns$
- $\alpha_s$  small but  $lns$  large  $\implies (\alpha_s lns) \sim 1$
- Resum all  $(\alpha_s lns)^n$  terms up to arbitrary powers of  $n$



# LL and NLL **BFKL** equation

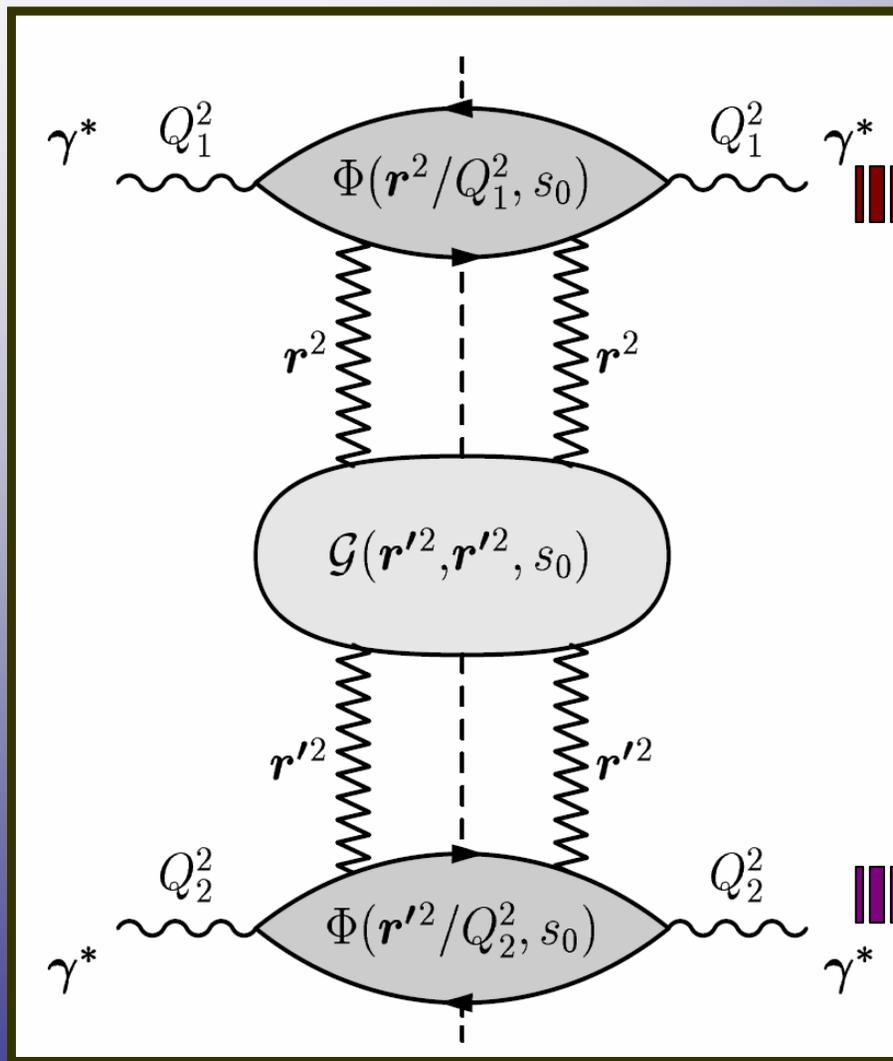
- LL:  $(\alpha_s \ln s)^n$
- NLL:  $\alpha_s (\alpha_s \ln s)^n$
- Forward case (zero momentum transfer)

$$\omega f_\omega(\mathbf{k}_a, \mathbf{k}_b) = \delta^{(2)}(\mathbf{k}_a - \mathbf{k}_b) + \int d^2\mathbf{k} \mathcal{K}(\mathbf{k}_a, \mathbf{k}) f_\omega(\mathbf{k}, \mathbf{k}_b)$$

- Factorization

$$\sigma_{\gamma^*\gamma^*} = \int \frac{d^2\mathbf{k}_a}{\mathbf{k}_a^2} \int \frac{d^2\mathbf{k}_b}{\mathbf{k}_b^2} \Phi_A(\mathbf{k}_a, \mathbf{Q}_1, s_0) f(\mathbf{k}_a, \mathbf{k}_b, s_0) \Phi_B(\mathbf{k}_b, \mathbf{Q}_2, s_0)$$

$$\gamma^* \gamma^* \rightarrow \textit{hadrons}$$



Photon Impact Factor

$$\Phi_A$$

Impact factor: coupling  
to external projectile

Photon Impact Factor

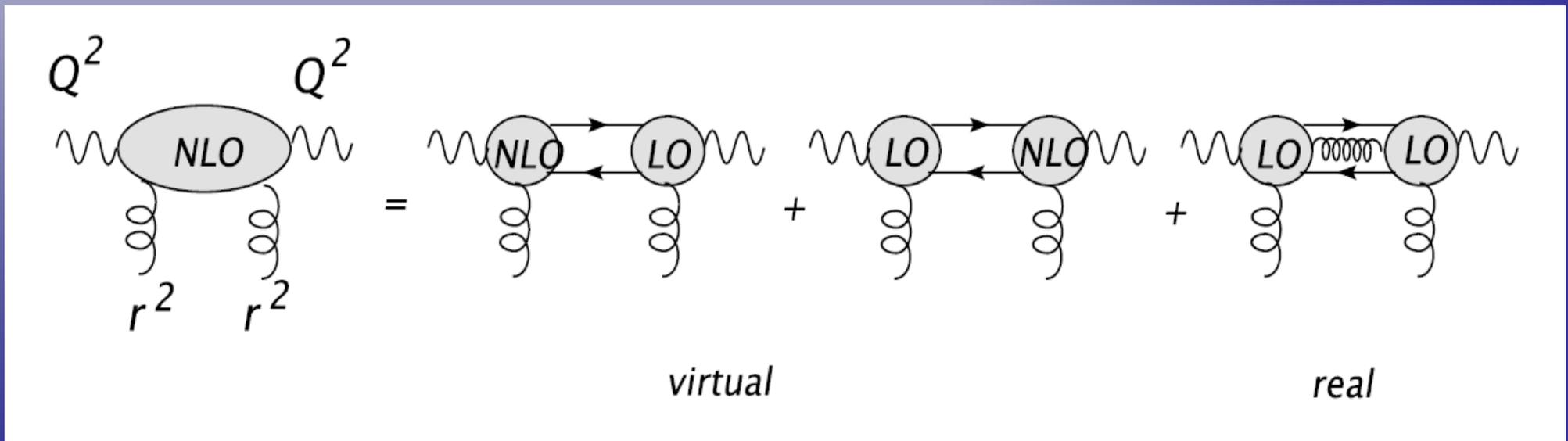
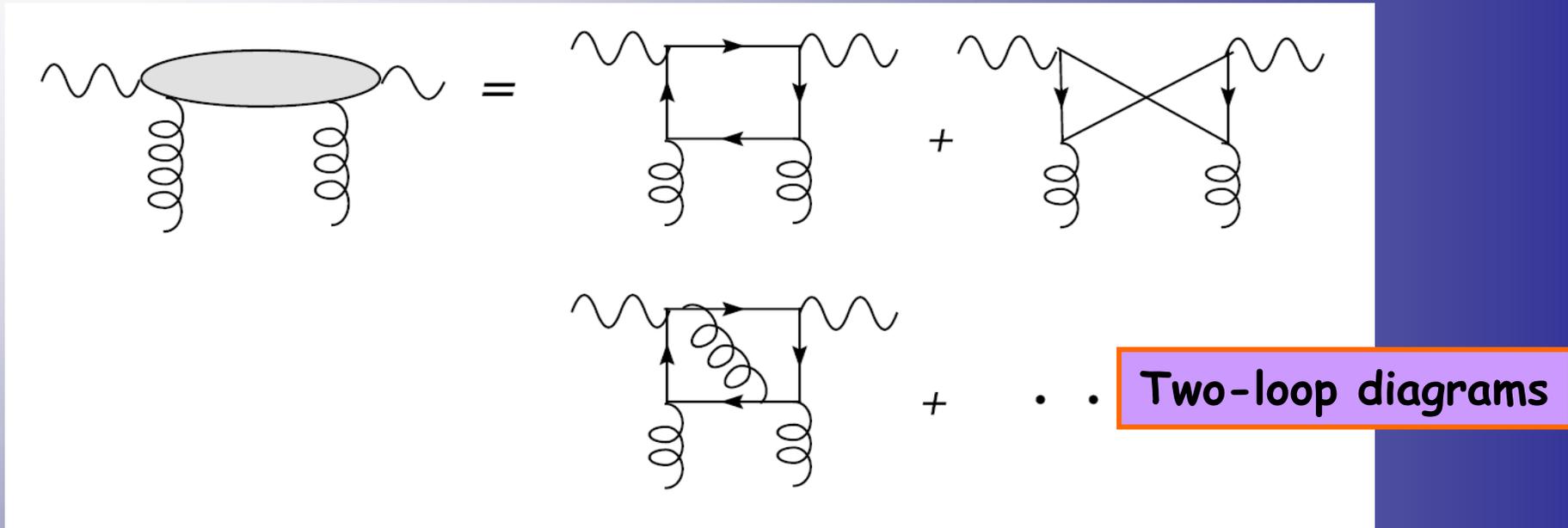
$$\Phi_B$$

# NLO computation so far

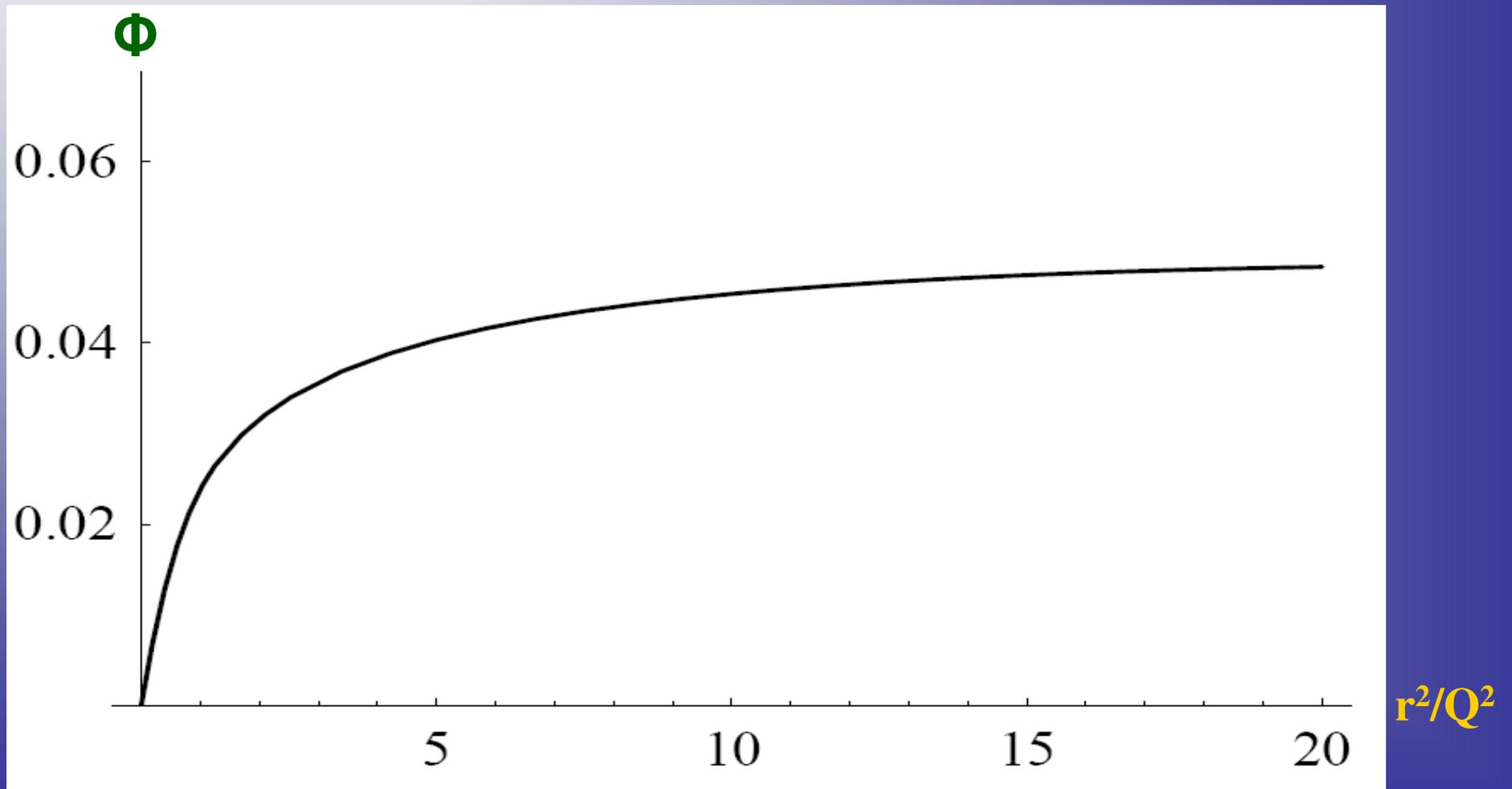
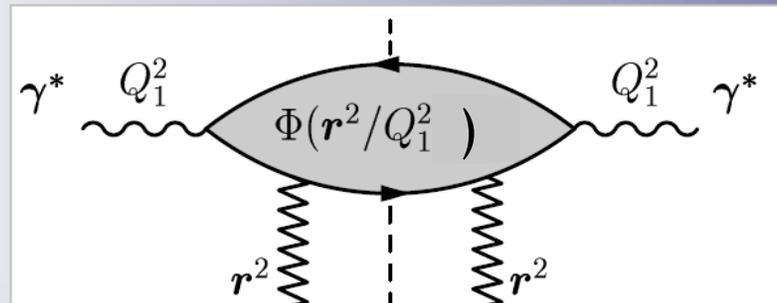
- Virtual corrections **Bartels, Gieseke, Qiao**
- Real corrections **Bartels, Gieseke, Kyrieleis**
- Cancellation of divergences  
**Bartels, Colferai, Gieseke, Kyrieleis**
- Integration over phase space-Real part  
**Bartels, Kyrieleis**
- Integration over phase space-Virtual part  
**Bartels, G.C. (in progress)**

- **Photon Impact Factor** **Fadin, Ivanov, Kotsky**
- **Photon to Light Vector Meson** **Ivanov, Kotsky, Papa**

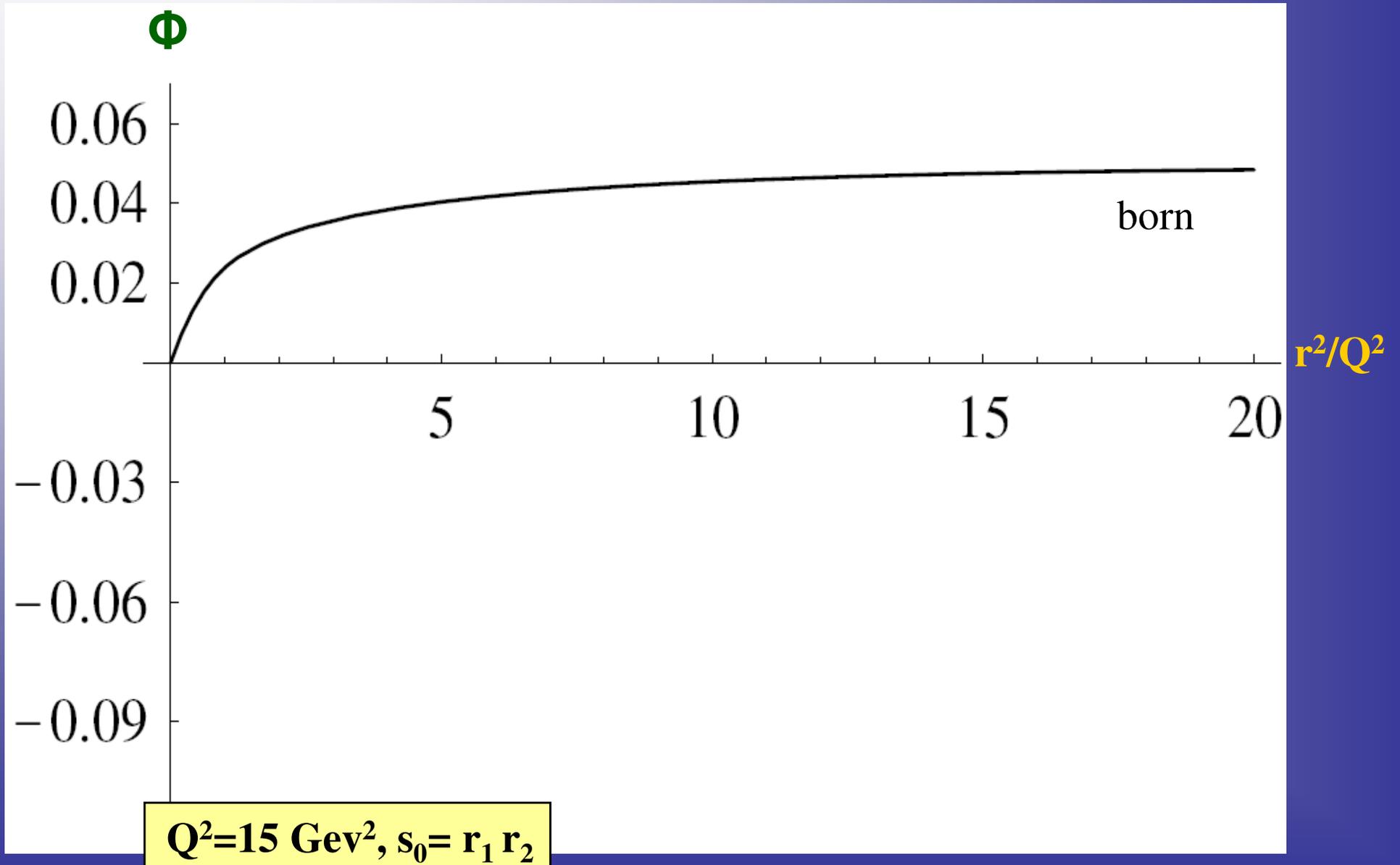
# Born plus NLO corrections



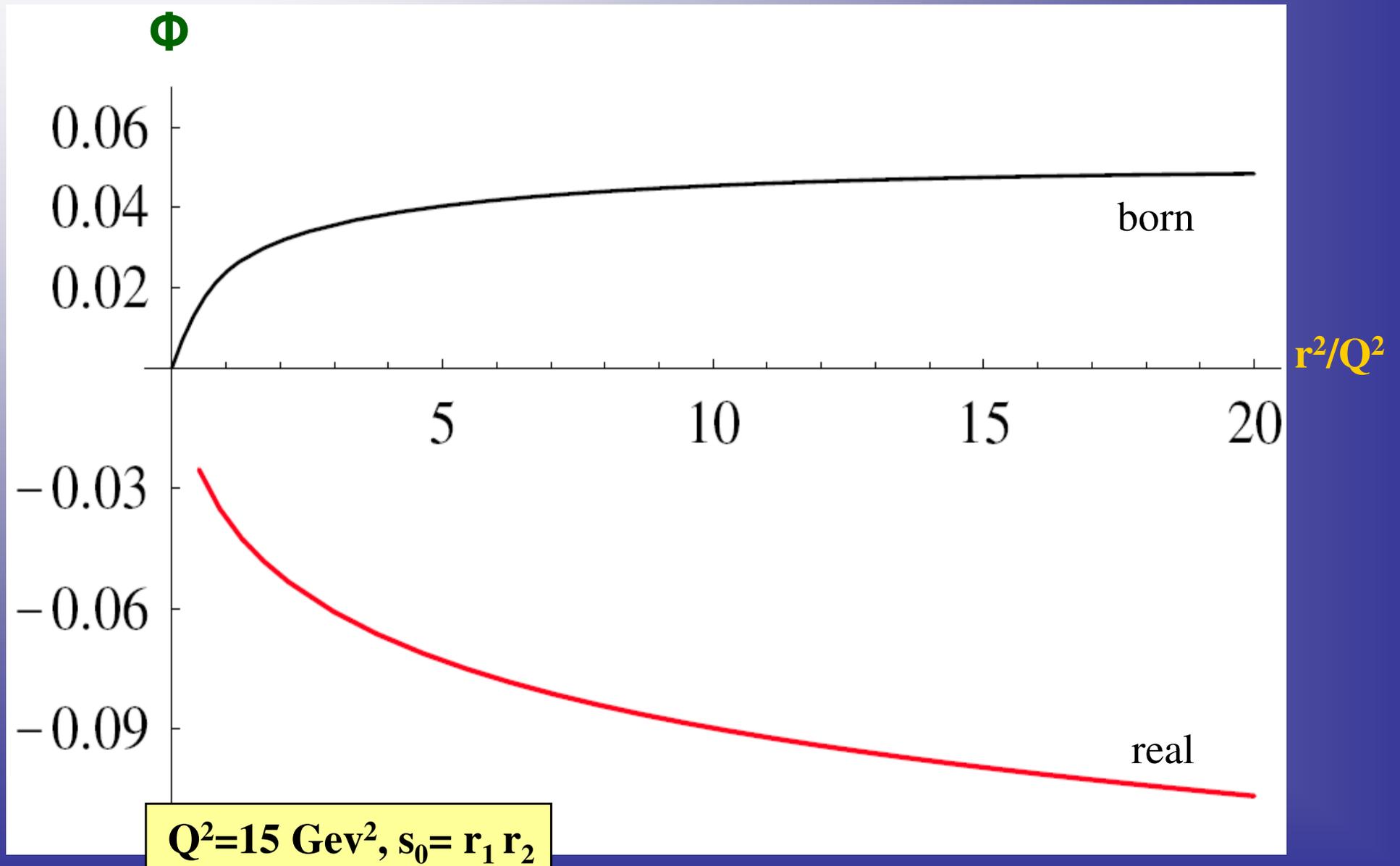
# BORN



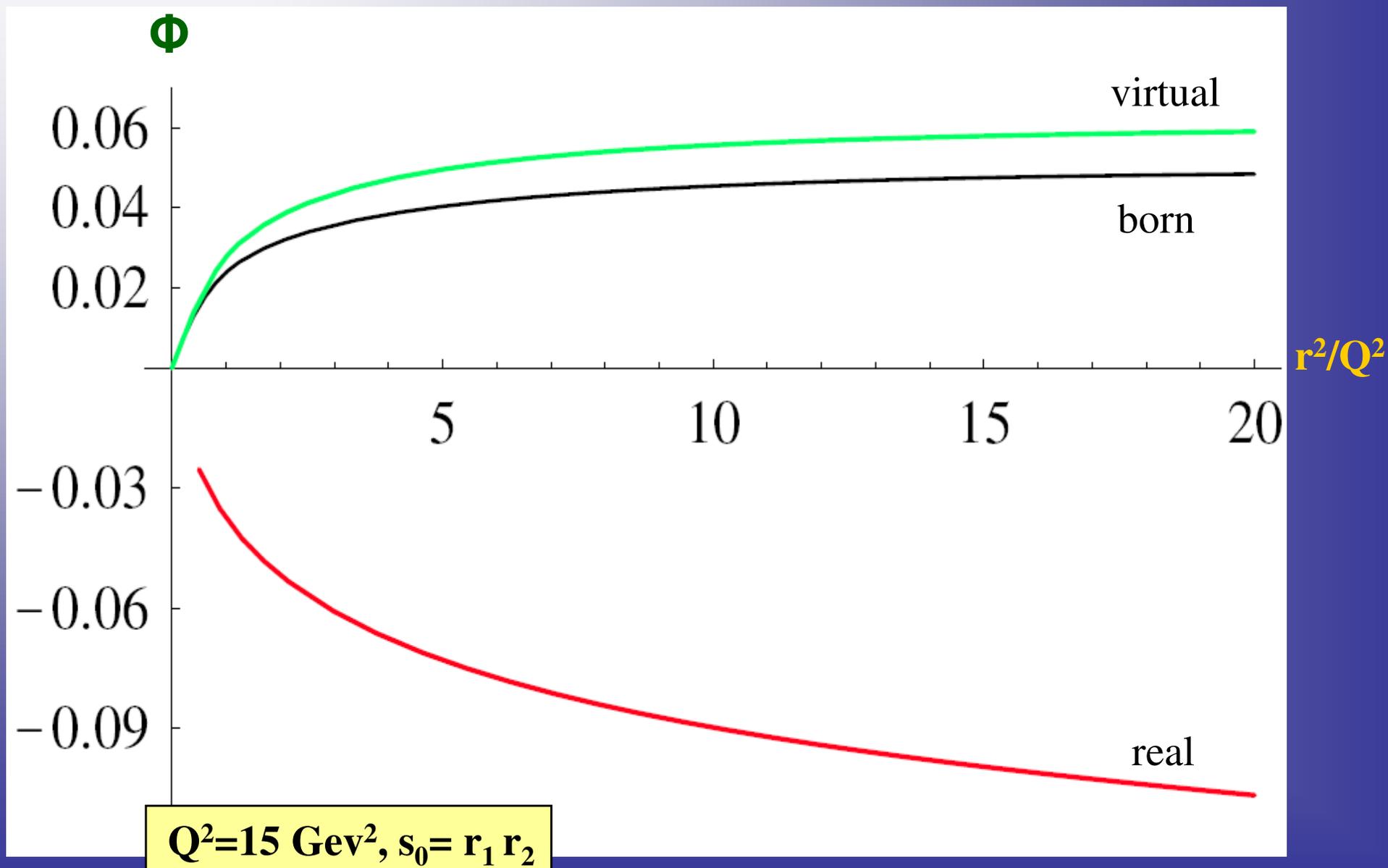
# Born



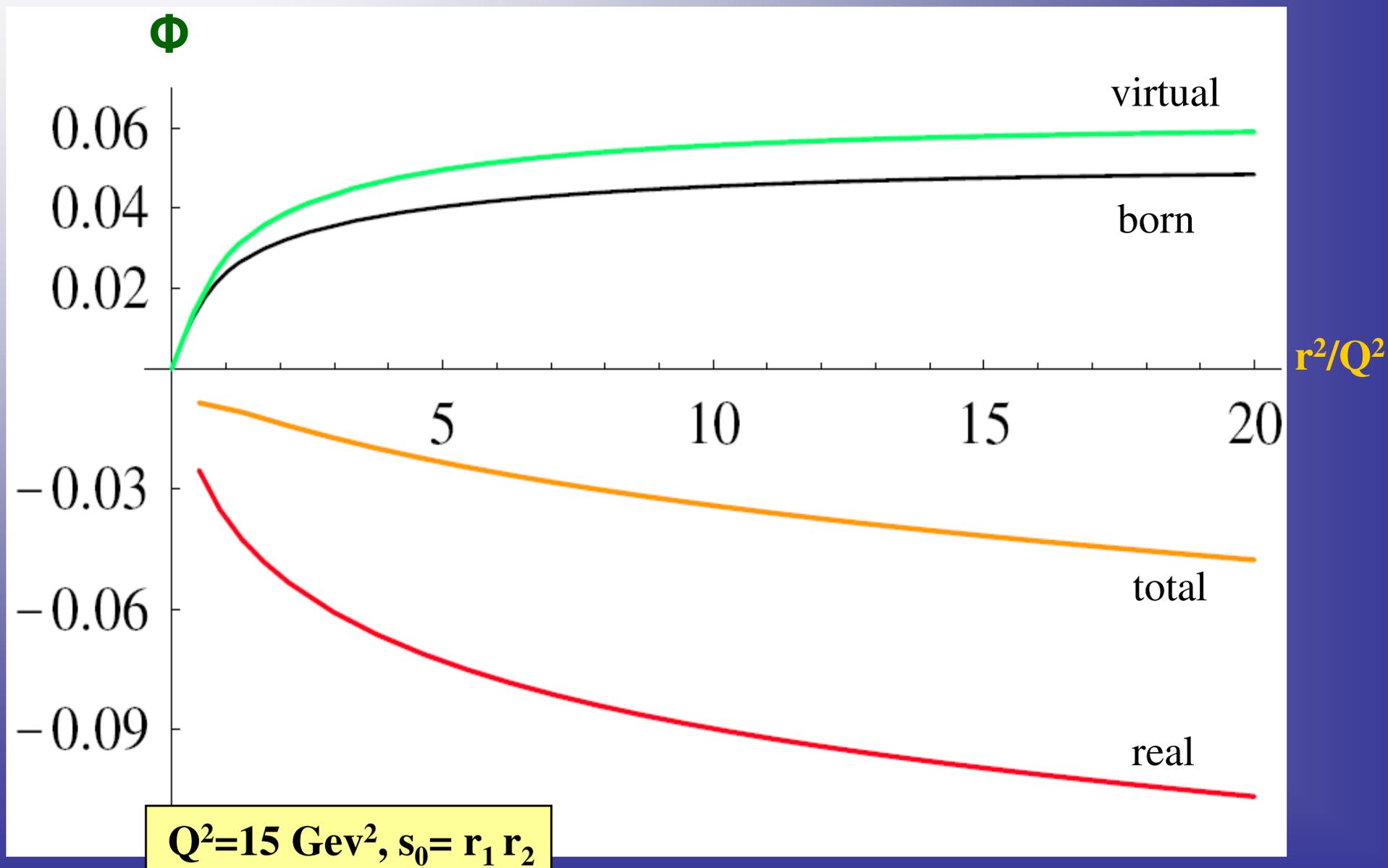
# Real Corrections



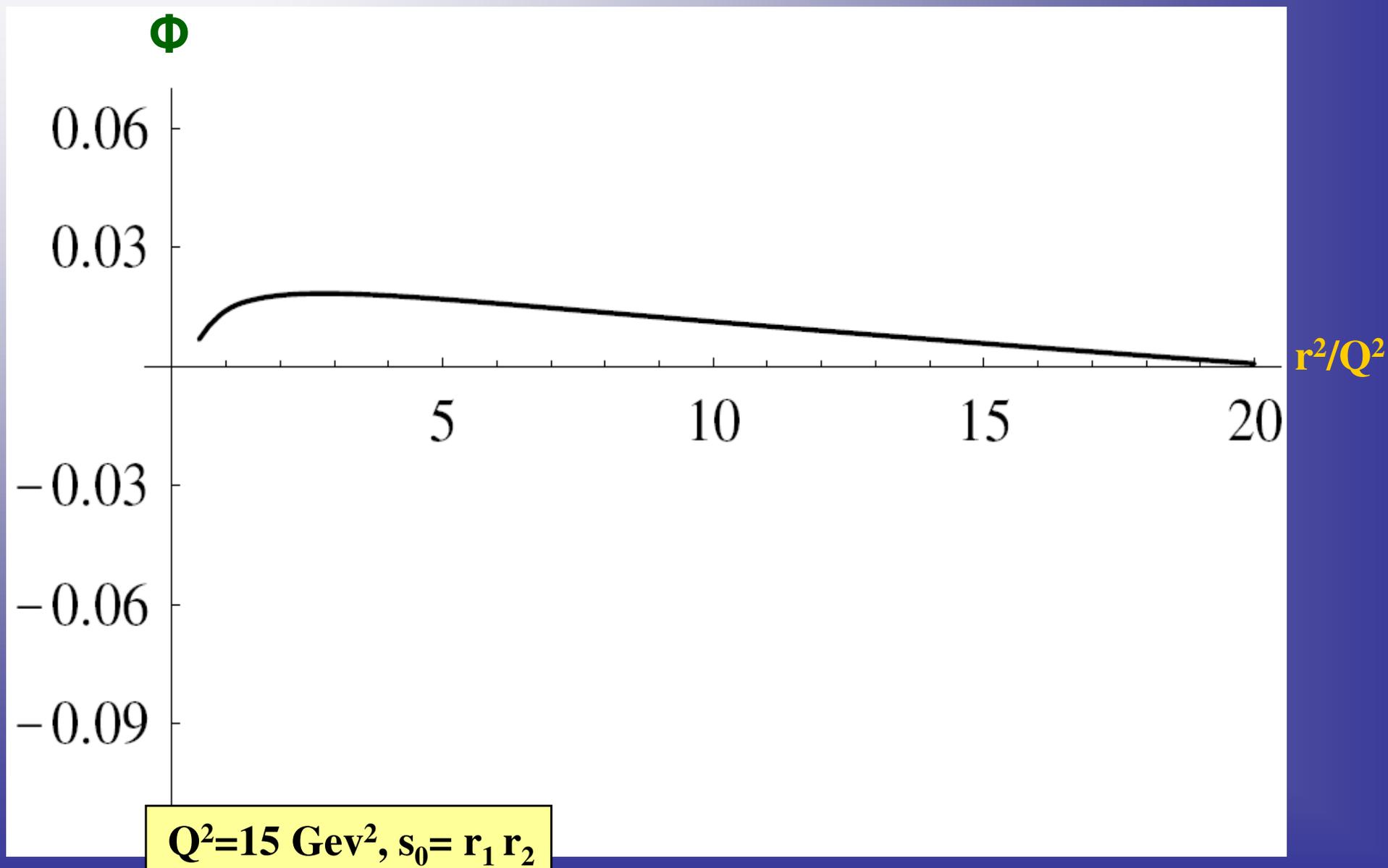
# Virtual corrections



# Total Corrections



# Full Photon Impact Factor



# Conclusions

- Further checks to be done, ongoing analysis
- Corrections are negative
- Corrections are large
- Next step: Convolution with NLO BFKL Green's function  $\rightarrow \gamma^* \gamma^*$  total cross section