Estimations for the Higgs boson production with QCD and EW corrections in exclusive events at the LHC

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Outline

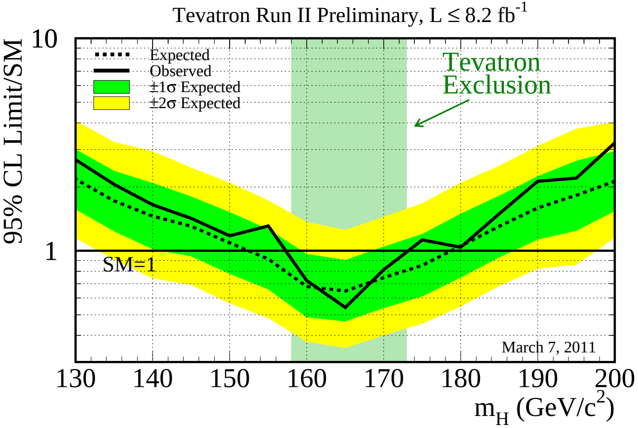
- Motivation
- Predictions for the diffractive Higgs boson production
- The Durham model
- Diffractive factorization
- The NLO accuracy
- Results: SD production
- Results: CED production
- Conclusions

Motivation

- LHC will allow to probe a new kinematical region:
  - CM *pp* energy: $\sqrt{s} = 7 - 14$ TeV;
  - Parton momentum fraction: $x \sim 10^{-5} - 10^{-6}$;
  - Wide pseudorapidity range: $\eta \sim \pm 12$.
  - Higgs physics: **the low luminosity regime is favorable to the Higgs boson production in diffractive processes**.
- The inclusive Higgs production by gluon fusion yields the highest production cross section: $\sigma \sim 55$ pb in NNLO+NNLL accuracy;
  - Serious problems with **backgrounds** and **pile up** in the LHC energy regime.
- Other production processes are under study to detect the Higgs in the LHC;
  - **DPE** allows the Higgs boson production through the leading *ggH* vertex in the mass range $M_H \sim 115 - 140$ GeV;
  - Higher-order corrections introduced through the **diffractive factorization**;
  - Background attenuation by **spin-parity selecting rules**.
- <u>New evidences</u>: we may explore the window mass 114.4 GeV $< M_H \lesssim$ 158 GeV.

New results from the Tevatron

- Excluded range[a]: 158 GeV $< M_H <$ 173 GeV
- Indirect constraints from EW data[b]: $M_H < 185$ GeV

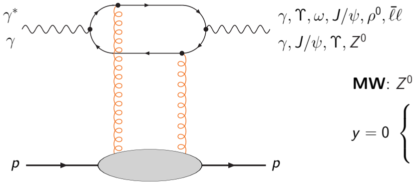


[a] The TEVNPH Working Group, arXiv:1103.3233[hep-ex]

[b] LEP-Tevatron-SLD Electroweak Working Group, arXiv:0811.4682[hep-ex]

Deeply Virtual Compton Scattering (DVCS)

- **1997**: Ji — PRD **55** (1997) 7114
  1999: Evanson and Forshaw — PRD **60** (1999) 034016
  - $\gamma^* p \longrightarrow \gamma p$ by **Pomeron exchange** in *ep* collisions.
- **2001**: Munier, Staśto and Mueller — NPB **603** (2001) 427
  - Vector meson production $\gamma^* p \longrightarrow Vp$ with **GBW model**.
- **2008**: Motyka and Watt — PRD **78** (2008) 014023
  2009: Cisek, Schafer and Szczurek — PRD **80** (2009) 074013
  2009: Kopeliovich, Schmidt and Siddikov — PRD **80** (2009) 054005
  2011: Cisek, Lebiedowicz, Schäfer and Szczurek — PRD **83** (2011) 114004
  - Vector particle production $\gamma p \longrightarrow Ep$ in **Ultraperipheral Collisions**.
- **2010**: Kopeliovich, Schmidt and Siddikov — PRD **82** (2010) 014017
  - Dilepton production in **Double Deeply Virtual Compton Scattering**.

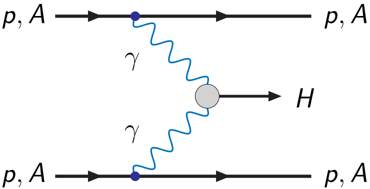


MW: Z^0 boson production

$$y = 0 \begin{cases} \sigma_{\gamma p} = \mathbf{4.2\ fb}\ , \text{Tevatron} \\ \sigma_{\gamma p} = \mathbf{37.\ fb}\ , \text{LHC} \end{cases}$$

Electromagnetic Higgs boson production

- **1990**: Cahn and Jackson — PRD **42** (1990) 3690
  Müller and Schramm — PRD **42** (1990) 3699
  - Ultraperipheral heavy-ion collision → $\gamma\gamma$ **annihilation**
- **2002**: Khoze, Martin and Ryskin — EPJC 23 (2002) 311
  2007: Miller — arXiv:0704.1985[hep-ph]
  2008: Levin and Miller — arXiv:0801.3593[hep-ph]
  - Contribution from **Electroweak boson loops** to the $\gamma\gamma \to H$.
- **2010**: D'Enterria and Lansberg — PRD **81** (2010) 014004
  - **Photon fluxes** and **Higgs effective Theory** in $\gamma\gamma$ processes.



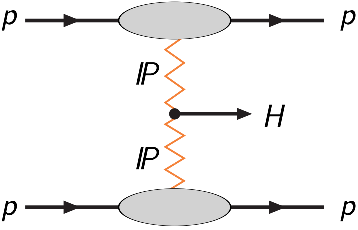
$M_H = 150$ GeV, $\sqrt{s} = 3.5$ TeV/A:
- **CJ**: $\sigma_{\rm PbPb} = 7.0$ pb
- **MS**: $\sigma_{\rm AA} \sim 100$ pb

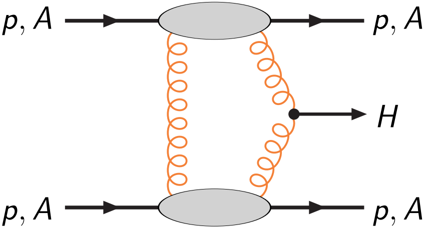
$M_H = 120$ GeV, $\sqrt{s} = 14$ TeV:
- **KMR/M**: $\sigma_{\rm pp} =$ **0.1 fb/0.12 fb**
- **LM**: $\sigma_{\rm pAu(AuAu)} =$ **0.6 pb (3.9 nb)**
- **DL**: $\sigma_{\rm pp} =$ **0.18 fb**

Diffractive Higgs production in *pp* and *AA* collisions

- **1991**: Bialas and Landshoff — PLB **256** (1991) 540
  - Regge Theory → **non-perturbative gluons**

- **1997**: Khoze, Martin and Ryskin — PLB **401** (1997) 330
  2007: Levin and Miller — arXiv:0801.3593[hep-ph]
  - QCD Pomeron → **hard-gluon exchange**





$M_H = 150$ GeV, $\sqrt{s} = 16$ TeV $\left\{ \textbf{BL} : \sigma_{\text{pp}} = 0.1 \text{ pb} \right.$

$M_H = 120$ GeV, $\sqrt{s} = 14/8.8(5.5)$ TeV/A $\left\{ \begin{array}{ll} \textbf{KMR}: & \sigma_{\text{pp}}^{\text{exc/inc}} \sim \mathbf{3\ fb}/300 \text{ fb} \\ \textbf{LM}: & \sigma_{\text{pA(AA)}} = \mathbf{0.1\ pb}\ (3.9 \text{ pb}) \end{array} \right.$

Diffractive factorization

- An alternative approach is the **Ingelman-Schlein model**[c], which considers the factorization of the total cross section

$$\sigma_{CED}(AB \to A + H + B) = \mathcal{F}_{a/IP/A}(x_{IP}, \beta, \mu_F^2) \otimes \sigma(ab \to H) \otimes \mathcal{F}_{b/IP/B}(x_{IP}, \beta, \mu_F^2)$$

being called the **diffractive factorization**;

- The Pomeron Structure Function is described by a two-step process

$$\mathcal{F}_{i/IP/A}(x_{IP}, \beta, \mu_F^2) = F_{i/IP}\left(\frac{x}{x_{IP}}, \mu_F^2\right) f_{IP/A}(x_{IP})$$

  1. Emission of a soft Pomeron from the colliding hadron, expressed by the Pomern flux $f_{IP/A}(x_{IP})$;
  2. Probability of find a parton a in the Pomeron, which is given by the structure function $F_{i/IP}\left(\beta, \mu_F^2\right)$.

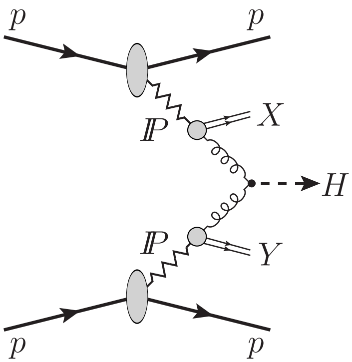
- DPDF and Pomeron flux provided by the analyses of HERA data[d].

[c] Ingelman and Schlein, Phys. Lett. **B152** (1985) 256

[d] H1 Collaboration, Eur. Phys. J. **C48** (2006) 749; Eur. Phys. J. **C48** (2006) 715

Diffractive processes

Central Exclusive Diffractive



Purpose: **reduce the uncertainties related to the Higgs boson predictions in the CED production**

NLO corrections

- The corrections to the $gg \to H$ processes are represented by the processes

$$gg \to H(g) \quad qg \to Hq \quad q\bar{q} \to Hg$$

- The NLO inclusive cross section for $pp \to pHp$ can be computed by[e]

$$\sigma_{NLO} = \frac{\mathrm{d}\mathcal{L}^{ij}}{\mathrm{d}\tau_H}\sigma_0\tau_H\left[1+\alpha_s(\mu_R^2)\frac{\mathcal{C}}{\pi}\right] + \Delta\sigma_{gg} + \Delta\sigma_{gq} + \Delta\sigma_{q\bar{q}}$$

being the functions definied in the **heavy-quark mass limit** $\tau_Q = M_H^2/4M_t^2$

  - $\mathrm{d}\mathcal{L}^{ij}/\,\mathrm{d}\tau$ the parton-parton luminosity;
  - $\tau_H = M_H^2/s$ is the Drell-Yan variable;
  - $\sigma_0 = G_f\alpha_s(\mu_R^2)\left|\frac{3}{4}\,2[\tau_Q + (\tau_Q - 1)\arcsin^2\sqrt{\tau_Q}]/\tau_Q^2\right|^2/288\pi\sqrt{2}.$

- The singular virtual corrections are included in the factor $\mathcal{C}$, and the non-singular ones in the $\Delta\sigma_{ij}$ ones.

[e] Spira et al., Nucl. Phys. **B453** (1995) 17

Parton-parton luminosities

- The **modified** parton-parton luminosity for the **CED** process reads

$$\frac{d\mathcal{L}^{ij}_{\rm CED}}{d\tau} = \int_{\tau}^{1}\frac{dx}{x}\int_{x}^{0.05}\frac{dx^{1}_{IP}}{x^{1}_{IP}}F_{i/IP/p}\left(x^{1}_{IP},\frac{x}{x^{1}_{IP}},\mu_F^2\right) \times \int_{\tau/x}^{0.05}\frac{dx^{2}_{IP}}{x^{2}_{IP}}F_{j/IP/p}\left(x^{2}_{IP},\frac{\tau}{x^{2}_{IP}x},\mu_F^2\right).$$

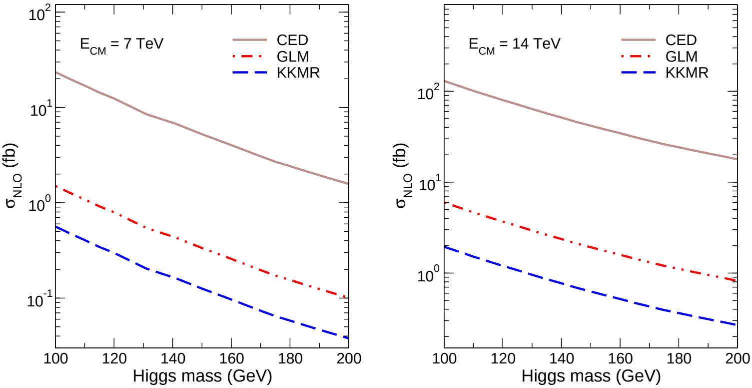
- The Pomeron Structure Function $F_{i/IP/p}$ relates the **Pomeron flux** and the **DPDF**[f]

$$F_{i/IP/p}(x,Q^2,x_{IP},t) = F_{i/IP}(\beta,Q^2)f_{IP/p}(x_{IP},t).$$

- The **factorization breaking** will be overcome with the use of the GSP.

[f] H1 Collaboration, Eur. Phys. J. **C48** (2006) 715; Eur. Phys. J. **C48** (2006) 749

Results: CED production

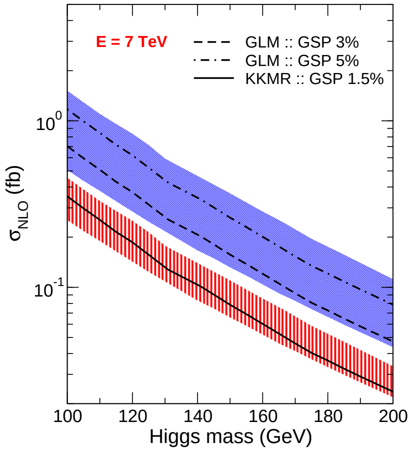


- KKMR[g]: 2-channel model with enhanced diagrams $\langle S^2 \rangle = 2.6\%(1.5\%)$;
- GLM[h]: 3-channel model with N=4 SYM and QCD $\langle S^2 \rangle = 3 - 5\%$.

[g] Khoze, Martin and Ryskin, Eur. Phys. J. **C60** (2009) 265; **C71** (2011) 1617

[h] Gotsman, Levin and Maor, arXiv:1101.5816 [hep-ph]

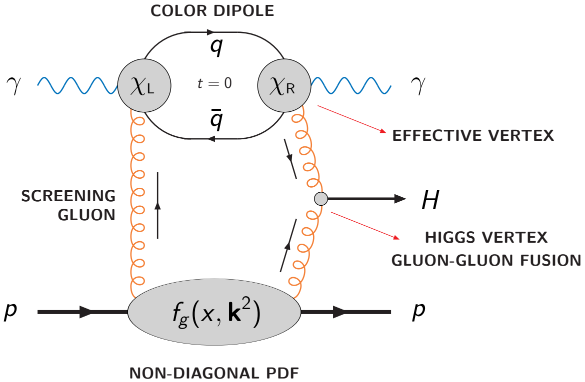
Results: Uncertainties



- The bands represent the scales in the range $0.5M_H < \mu_F, \mu_R < 4M_H$;

Diffractive Higgs photoproduction

- **Proposal**: γp process by **DPE** in pp collisions[i];



- The dipole amplitude is computed in the **Impact Factor Formalism**;
- Possibility of Higgs production via intrinsic heavy flavors[j] and in large x_F[k].

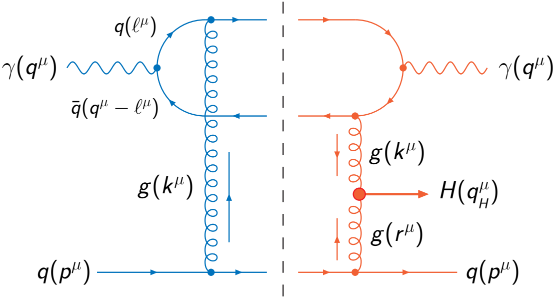
[i] Gay Ducati and Silveira, Phys. Rev. **D78** (2008) 113005

[j] Brodsky, Goldhaber, Kopeliovich, Schmidt and Soffer, Phys. Rev. **D73** (2006) 113005

[k] Brodsky, Goldhaber, Kopeliovich and Schmidt, Nucl. Phys. **B807** (2009) 334; **D80** (2009) 054005

Scattering amplitude

- The amplitude is computed for the **partonic process** $\gamma q \to \gamma + H + q$



- The **Cutkosky rules** are employed to obtain the imaginary part of the amplitude

$$\Im\mathcal{A} = \frac{1}{2}\int \mathrm{d}(PS)_3\ \mathcal{A}_{(left)}\ \mathcal{A}_{(right)}$$

- Similar to the direct photon production via Color Dipole approach[I].

[I] Kopeliovich, Rezaiaen, Pirner and Schmidt, Phys. Lett. **B653** (2007) 210

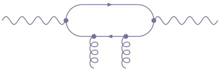
Applying the rules

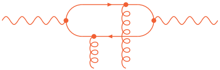
- Performing the product of the two sides of the cut one gets

$$
\mathcal{A}_L\mathcal{A}_R \;=\; (4\pi)^3\,\alpha_s^2\,\alpha\left(\sum_q e_q^2\right)\left(\frac{\epsilon_\mu\epsilon_\nu^*}{k^6}\right)\overbrace{\frac{V^{ba}_{\sigma\eta}}{N_c}}^{\text{ggH}}\left(t^b t^a\right)\overbrace{4p_\lambda p^\sigma}^{\text{eikonal}}
$$

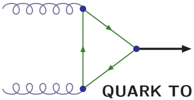
$$
\times\quad 2\left\{\frac{\mathrm{Tr}\left[(\not q-\not l)\gamma^\mu\not l\gamma^\lambda(\not k+\not l)\gamma^\eta\not l\gamma^\nu\right]}{l^4}+\frac{\mathrm{Tr}\left[(\not q-\not l)\gamma^\lambda(\not k+\not l-\not q)\gamma^\mu(\not k+\not l)\gamma^\eta\not l\gamma^\nu\right]}{l^2(k+l+q)^2}\right\}
$$

OTHER POSSIBILITIES





- For a **not so heavy Higgs** ($M_H \lesssim 200$ GeV), the ggH vertex reads[m]



QUARK TOP LOOP

$$
V^{ab}_{\mu\nu} \approx \frac{2}{3}\frac{M_H^2\alpha_s}{4\pi v}\left(g_{\mu\nu}-\frac{k_{2\mu}k_{1\nu}}{k_1\cdot k_2}\right)\delta^{ab}
$$

[m] Plehn, arXiv:0910.4182[hep-ph]

The amplitude in parton level

- The imaginary part of the amplitude has the form

$$\mathrm{Im}\,\mathcal{A} = -\frac{s}{6}\frac{M_H^2}{\pi v}\frac{\alpha_s}{N_c}\left(\frac{\alpha_s C_F}{\pi}\right)\int \Phi^T_{\gamma\gamma}(\mathbf{k}^2, Q^2)\,\frac{d\mathbf{k}^2}{\mathbf{k}^6}$$

  with the $\gamma\gamma$ impact factor given by

$$\Phi^T_{\gamma\gamma}(\mathbf{k}^2, Q^2) = 4\pi\alpha_s\alpha\sum_q e_q^2\int_0^1 d\tau\, d\rho\,\frac{\mathbf{k}^2\,[\tau^2+(1-\tau)^2]\,[\rho^2+(1-\rho)^2]}{Q^2\rho(1-\rho)+\mathbf{k}^2\tau(1-\tau)}.$$

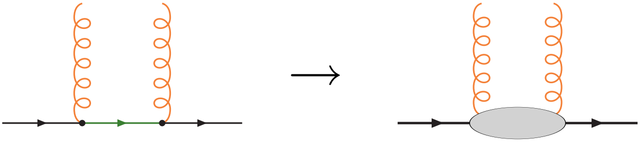
- **First remark**: dependence on $\mathbf{k}^{-6}$ due to the presence of the color dipole.

- Computing the event rate in central rapidity

$$\frac{d\sigma}{dy_H\,d\mathbf{q}^2} = \frac{\alpha_s^4 K_{NLO}}{288\pi^5 B}\left(\frac{M_H^2}{N_c v}\right)^2\left[\int \frac{\alpha_s C_F}{\pi}\,\Phi^T_{\gamma\gamma}(\mathbf{k}^2, Q^2)\frac{d\mathbf{k}^2}{\mathbf{k}^6}\right]^2.$$

- γp: replace the quark contribution to the parton content into the proton.

Parton → Hadron



- The hadron coupling is represented by a **non-diagonal** PDF[n]

$$\frac{\alpha_s C_F}{\pi} \quad \longrightarrow \quad f_g(x, \mathbf{k}^2) = \mathcal{K} \frac{\partial [x g(x, \mathbf{k}^2)]}{\partial \ln \mathbf{k}^2}$$

- The non-diagonality is approximated by a multiplicative factor[o]

$$\mathcal{K} = (1.2) \exp(-B \mathbf{p}^2/2)$$

where $B = 5.5$ GeV^{-2} is the slope of the gluon-proton form factor.

- To correctly compute the pomeron coupling to the proton: $x \sim 0.01$.

[n] Khoze, Martin and Ryskin, Phys. Lett. **B401** (1997) 330

[o] Shuvaev et al., Phys. Rev. **D60** (1999) 014015

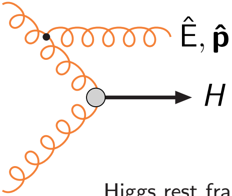
Phenomenology inside

Gluon Radiation at DLLA[p]

- The real gluon emission from the ggH vertex needs to be **suppressed**.
  - Sum the virtual graphs that include terms like $\ln(M_H/\mathbf{k}^2)$.
- The emission probability of 1-gluon is computed by **Sudakov form factors**

$$S(\mathbf{k}^2,\mu^2) = \frac{N_c}{\pi}\int_{\mathbf{k}^2}^{\mu^2}\frac{\alpha_s(\hat{\mathbf{p}}^2)}{\hat{\mathbf{p}}^2}\,\mathrm{d}\hat{\mathbf{p}}^2\int_{\hat{\mathbf{p}}}^{M_H/2}\frac{\mathrm{d}\hat{\mathrm{E}}}{\hat{\mathrm{E}}} = \frac{3\alpha_s}{4\pi}\ln^2\frac{\mu^2}{\mathbf{k}^2}$$

- Real emissions are **not suppressed** if the gluon color neutralization **fails**.
- Suppressing many gluons emission:
  - It is included a factor e^{-S} to the cross section.
    - Emissions below $\mathbf{k}^2$ are **forbidden**.
  - As $\mathbf{k}^2 \to 0$ the non-emission probability goes to zero **faster** than any power of $\mathbf{k}$, like $\mathbf{k}^{-6}$.



Higgs rest frame

[p] Khoze, Martin and Ryskin, PLB **650** (2007) 41

Phenomenology inside

Gluon Radiation at LLA[q]

- Possibility of **quark** emissions from the production vertex.
  - There will be contributions of single logarithms.
- The **Sudakov form factors** are rewritten as[r]

$$T(\mathbf{k}^2,\mu^2) = \int_{\mathbf{k}^2}^{\mu^2} \frac{\alpha_s(\hat{\mathbf{p}}^2)}{2\pi}\frac{\mathrm{d}\hat{\mathbf{p}}^2}{\hat{\mathbf{p}}^2}\int^{1-\Delta}\mathrm{d}z\left[zP_{gg}(z)+\sum_q P_{qg}(z)\right]$$

  - The P_{ij} are the DGLAP splitting functions;
  - In this work, $\mu = M_H/2$.
- In order to correctly include these contributions to the amplitude, the unintegrated distribution is written as[s]

$$\tilde{f}(x,\mathbf{k}^2,\mu^2) = \mathcal{K}\frac{\partial}{\partial\ln\mathbf{k}^2}\left[\sqrt{T(\mathbf{k}^2,\mu^2)}\,xg(x,\mathbf{k}^2)\right]$$

[q] Khoze, Martin and Ryskin, PLB **650** (2007) 41

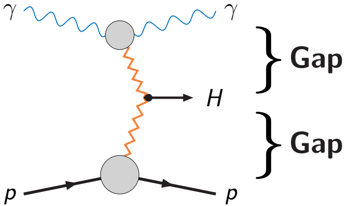
[r] Khoze, Martin and Ryskin, EPJ **C14** (2000) 525

[s] Dokshitzer, Diakonov and Troian, Phys. Rept. **58** (1980) 269

Phenomenology inside

Survival factor

- The **Rapidity Gap Survival Probability** is calculated by the use of two models:
  - KKMR[t]: 2-channel model with enhanced diagrams $\langle S^2 \rangle = 2.6\%(1.5\%)$;
  - GLM[u]: 3-channel model with N=4 SYM and QCD $\langle S^2 \rangle = 3 - 5\%$.
- Central dijet production at HERA: diffractive ratio of **10%**.[v]
- Some data suggests that the QCD factorization may be **broken** in certain kinematical regimes[w];
- Applying the GSP to the Ingelman-Schlein approach is suggested[x] to **correct** the predictions in those regimes.



[t] Khoze, Martin and Ryskin, Eur. Phys. J. **C60** (2009) 265; **C71** (2011) 1617

[u] Gotsman, Levin and Maor, arXiv:1101.5816 [hep-ph]

[v] Kaidalov, Khoze, Martin, and Ryskin, PLB **567** (2003) 61

[w] Kopeliovich, Nemchik, Potashnikova, Johnson, and Schmidt, Phys. Rev. **C72** (2005) 054606

[x] CDF Collaboration, Phys. Rev. Lett. **85** (2000) 4215

Cross section for central rapidity

- The cross section is calculated for central rapidity ($y_H = 0$)

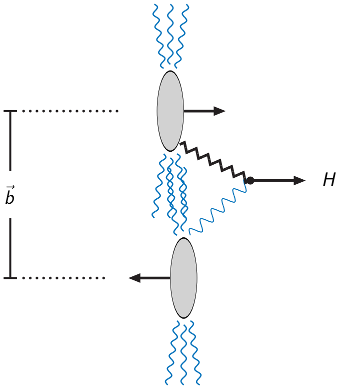
$$\left.\frac{d\sigma}{dy_H\, dt}\right|_{y_H,t=0} = \langle S^2 \rangle \frac{K_{NLO}}{288\pi^5 B}\, \alpha_s^4 \left(\frac{M_H^2}{N_c v}\right)^2 \left[\int_{\mathbf{k}_0^2}^{\mu^2} \frac{d\mathbf{k}^2}{\mathbf{k}^6}\, \tilde{f}_g(x,\mathbf{k}^2,\mu^2)\, \Phi_{\gamma\gamma}^T(\mathbf{k}^2,Q^2)\right]^2$$

- Proton content[a]: $\alpha_s C_F/\pi \;\; \rightarrow \;\; f_g(x,\mathbf{k}^2) = \mathcal{K}\, \partial_{(\ln\, \mathbf{k}^2)} \left[\sqrt{T} x g(x,\mathbf{k}^2)\right]$
- Sudakov form factor[b]: $T(\mathbf{k}^2,\mu^2) = \left[\alpha_s(\mathbf{k}^2)/\alpha_s(\mu^2)\right] e^{-S}$, $S \sim \ln^2(\mu^2/\mathbf{k}^2)$[c]
- Gap Survival Probability[d]: $S^2_{gap} \rightarrow$ 3% and 10% for LHC
- Cutoff $\mathbf{k}_0^2$ to regulate the infrared divergences: $\mathbf{k}_0^2 = 0.3$ GeV^2.
- Electroweak vacuum expectation value: $v = 246$ GeV
- Gluon-proton form factor: $B = 5.5$ GeV^{-2}

[a] Khoze, Martin and Ryskin, EPJC **14** (2000) 525
[b] Forshaw, hep-ph/0508274 (2005)
[c] Gay Ducati and Silveira, PRD **78** (2008) 113005
[d] Khoze, Martin and Ryskin, EPJC **18** (2000) 167

Higgs boson production in UPC

- The γp process is a subprocess in **Ultraperipheral collisions**.



- **Impact parameter**: $|\vec{b}| > 2R \rightarrow$ **NO STRONG INTERACTION!**
- Only **EM force** acts in the second proton $\rightarrow$ **REAL PHOTONS**

Hadronic cross section

- For pp collisions, $\sigma_{\gamma p}$ is convoluted with the photon flux

$$\sigma_{tot} = 2\int_{\omega_{min}}^{\omega_{max}} d\omega\, \frac{dn_i}{d\omega}\, \sigma_{\gamma p}(\omega, M_H),$$

with $\omega_{min} = M_H^2/2x\sqrt{s_{NN}}$ and $\omega_{max} = \sqrt{Q^2\gamma_L^2\beta_L^2}$. The photon flux is

$$\frac{dn_p}{d\omega} = \frac{\alpha_{em}}{2\pi\omega}\left[1+\left(1-\frac{2\omega}{\sqrt{s}}\right)^2\right]\left(\ln\mu_p - \frac{11}{6} + \frac{3}{\mu_p} - \frac{3}{2\mu_p^2} + \frac{1}{3\mu_p^2}\right).$$

for protons[e], with $\mu_p \simeq 1 + (0.71\ \text{GeV}^{-2})\sqrt{s}/2\omega^2$, and

$$\frac{dn_A}{d\omega} = \frac{2Z^2\,\alpha_{em}}{\pi\omega}\left[\mu_A K_0(\mu_A)K_1(\mu_A) - \frac{\mu_A^2}{2}[K_1^2(\mu_A) - K_0^2(\mu_A)]\right].$$

for nuclei[f], with $\mu_A = 2R_A\omega/\gamma_L$.

- The photon virtuality can be written in terms of the ω and $\mathbf{q}_\perp$

$$Q^2 = -\omega^2/(\gamma_L^2\beta_L^2) - q_\perp^2 \leq \frac{1}{R^2}$$

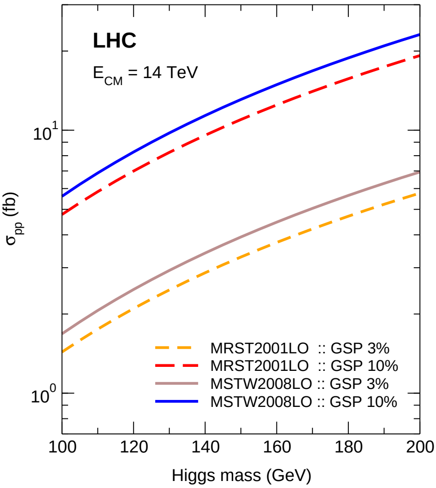
with $\gamma_L = (1-\beta_L^2)^{-1/2} = \sqrt{s}/2m_N$.

[e] Drees and Zeppenfeld, Phys. Rev. **D39** (1989) 2536

[f] Klein and Nystrand, Phys. Rev. **C60** (1999) 014903

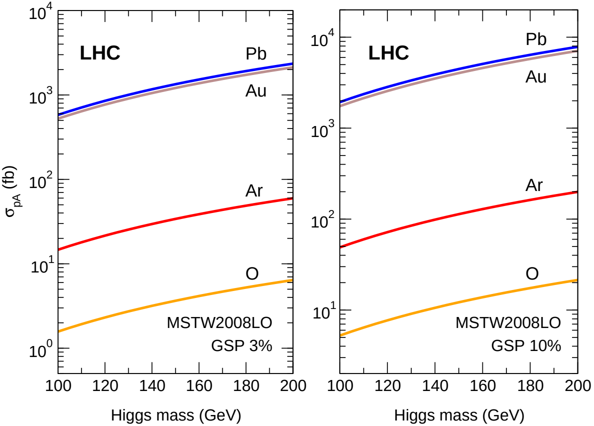
Results: Higgs boson in Ultraperipheral *pp* collisions

- σ_{pp}: one order higher than the results from $\gamma\gamma$ processes (0.1-0.18 fb).
- An optimistic approach for the GSP provides a cross section of **6 fb**.



Results: pA collisions

- $\sigma_{pAu} \sim 800$ fb: competitive with the $\gamma\gamma$ process[g];
- σ_{pPb}: **4x** higher than the approach with an **Effective Field Theory**[h].



[g] Levin and Miller, arXiv:0801.3593 [hep-ph] (2008)

[h] D'Enterria and Lansberg, Phys. Rev. **D81** (2010) 014004

Gap Survival Probability

- The predicted cross section is competitive with other approaches;
- The Rapidity Gap Survival Probability (GSP) **is not** computed for the Higgs boson production in γp processes;
  - Based on previous evidences from HERA: $\langle S^2 \rangle = \mathbf{10\%}$.

Subprocess	GSP (%)	σ_{pp} (fb)
$I\!PI\!P$	2.6[i]	3.00[j]
$I\!PI\!P$	0.4[k]	0.47
$I\!PI\!P^{gg}$	4.6[l]	3.68
$\gamma\gamma$	100.	0.1-0.2
γp	3.0	**1.77**
γp	10.	**5.92**

- The γp process may provide a good way to look for the Higgs boson in pp and pA collisions at the LHC.

[i] Khoze, Martin, Ryskin, JHEP **05** (2006) 36

[j] Khoze, Martin, Ryskin, Eur. Phys. J. **C23** (2002) 311

[k] Miller, Eur. Phys. J. **C56** (2008) 39

[l] Gotsman, Levin and Maor, arXiv:1101.5816 [hep-ph] (2011)

Conclusions

- We have computed the production cross section for the **Higgs boson** in UPC at the LHC:

$$\sigma_{\rm pp} \sim 2 - 6 \text{ fb} \qquad \sigma_{\rm pA} \sim 0.8 - 2.0 \text{ pb}$$

- Applying the diffractive factorization is a useful tool to compute higher-order corrections in CED processes;
- Correct predictions can be obtained with the use of the GSP;
- The *pA* collisions provide a clean process to discover the Higgs boson at the LHC;
  - The luminosity and pile-up in such processes will be favorable for the Higgs boson detection in LHC;
  - A reasonably event rate predicted for future *pA* runs in LHC.
- Taking the specific GSP for the photoproduction processes, the predictions may be **higher** than the ones from other approaches;