Diffractive central Higgs production in ion collisions

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Summary

Motivations

The Higgs Search:

A process to measure a reliable signal of the Higgs boson

- Central particle production: in high energy regime to produce the central system $\Rightarrow$ in Higgs case[1] limits of mass: $113\,\mathrm{GeV} < m_H < 200\,\mathrm{GeV}$;
- Rapidity gaps events: easy identification; diffractive *IPIP* scattering or photon-photon ($\gamma\gamma$) interactions;
- Very low background; precise measurements of Higgs proprieties (spin, mass);

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- f_g: proton off-diagonal unintegrated gluon density

$$f_g(x, x', Q_T^2, \mu^2) = R_g \frac{\partial}{\partial \ln Q_T^2}\left[\sqrt{T(Q_T,\mu)}\, xg(x, Q_T^2)\right] \tag{2}$$

where R_g is the ratio of off-diagonal and conventional distr. ($R_g \simeq 1.2$); $g(x, Q_T^2)$, integrated gluon distr. (CTEQ);

KMR model: probability survivals

- T is the survival probability of *hard* gluons (Sudakov factor):

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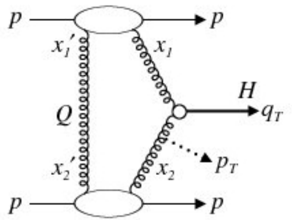

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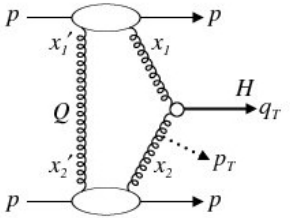

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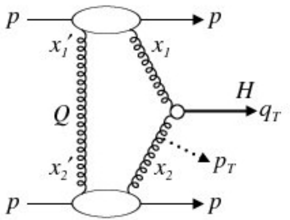

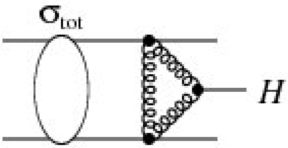

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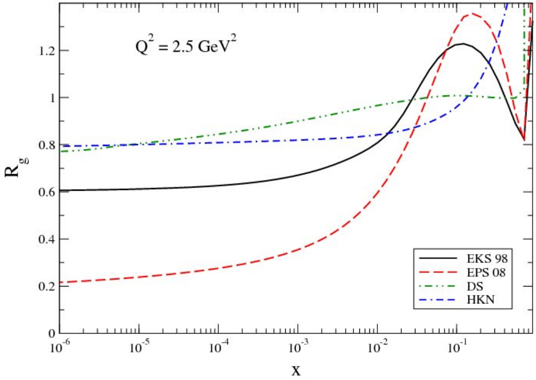

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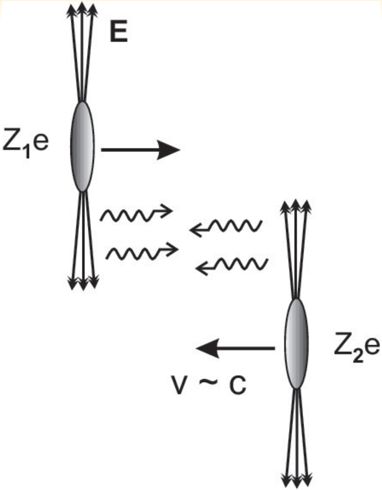

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where $\sigma_{\gamma\gamma H}$ is the hard c.s. for $\gamma\gamma \to H$ and F is a "folded" photon spectra:

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$$\begin{aligned} F(\omega_A, \omega_B) &= 2\pi \int_{R_A}^\infty b_1 db_1 \int_{R_B}^\infty b_2 db_2 \int_0^{2\pi} d\phi \, N_A(\omega_A, b_1) N_B(\omega_B, b_2) \\ &\quad \times \Theta(b - R_A - R_B), \end{aligned}$$

with $b^2 = b_1^2 + b_2^2 - 2 b_1 b_2 \cos\phi$; $R_{A,B}$, the particles radii.

E.P.A. (cont.)

- $N_{A,B}$ is the Weizsäcker-Williams equivalent photon flux,

$$N(\omega, b) = \frac{Z^2 \alpha_{em}}{\pi^2} \left(\frac{\omega}{\gamma v^2} \right)^2 \left[K_1^2(x) + \frac{K_0^2(x)}{\gamma^2} \right], \quad x = \frac{\omega b}{\gamma v} \qquad (6)$$

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- Performing a approximation in the luminosities (Cahn/Jackson)

$$\sigma_{AA \to AHA} = \frac{8\pi^2}{m_H^3} \Gamma_{H \to \gamma\gamma} \left[\tau \frac{d\mathcal{L}}{d\tau} \right] \qquad (8)$$

$$\left[\tau \frac{d\mathcal{L}}{d\tau} \right]_{AA} = \frac{16 Z^4 \alpha_{em}^2}{3\pi^2} \sum_{j=1}^{3} A_j e^{-b_j z}, \quad z = \frac{m_H R}{\gamma}, \qquad (9)$$

$$\Gamma_{H \to \gamma\gamma} \simeq 3\,\mathrm{keV}\, (m_H / 100\,\mathrm{GeV})^3 \,. \qquad (10)$$

Present calculation

- Choice of parameters in KMR: $Q_{\mathrm{min}} = 0.3\,\mathrm{GeV}$, $N_c = 3$, $N_f = 4$, $\Lambda_{\mathrm{QCD}} = 160\,\mathrm{MeV}$, $\mathcal{V}_{\mathrm{NLO}} = \sqrt{1.5}$.

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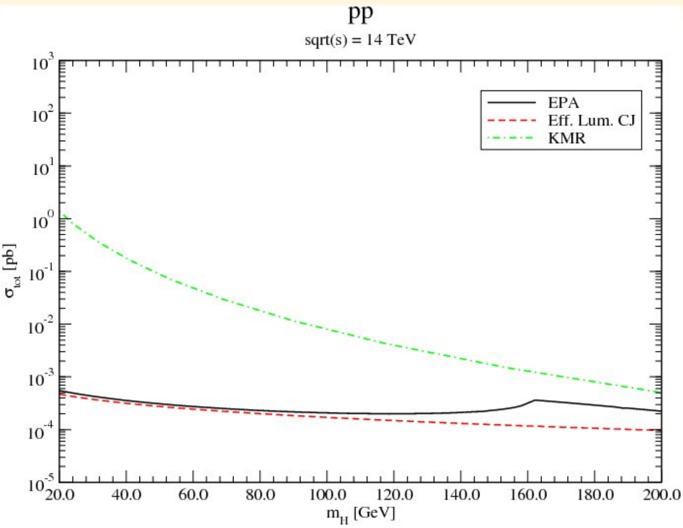
- Luminosities in EPA: in "full" calculation, $R_p \simeq 0.7\,\mathrm{fm}$, $R_A \simeq 1.2\,\mathrm{fm}A^{1/3}$; in "effective" calculation, pp are Ohnemus, Walsh and Zerwas result:

$$\left[\tau \frac{d\mathcal{L}}{d\tau}\right]_{pp} = \frac{16}{3}\left(\frac{\alpha_{\mathrm{em}}}{\pi}\right)^2 \log^3\left(\frac{\sqrt{s}}{m_H}\right) \quad (11)$$

LHC Predictions: pp



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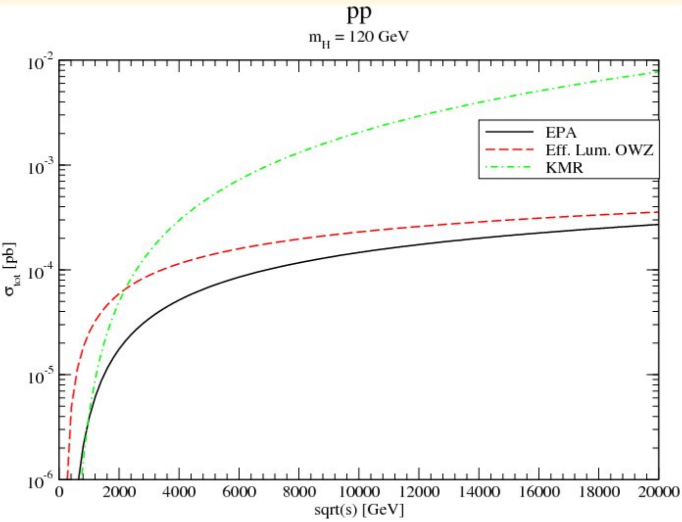

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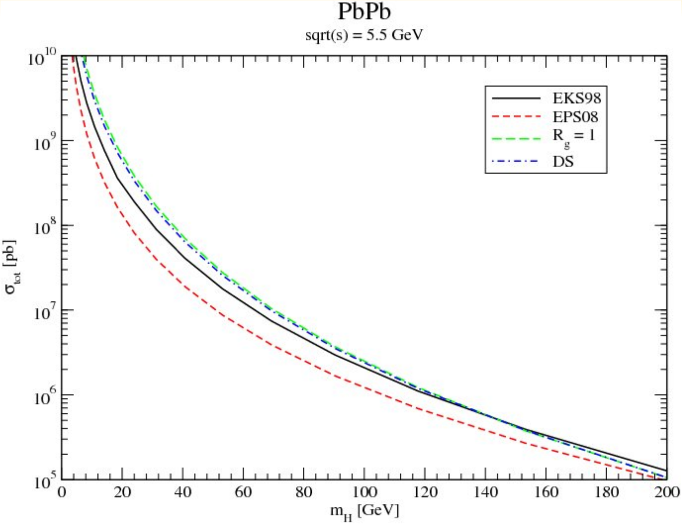

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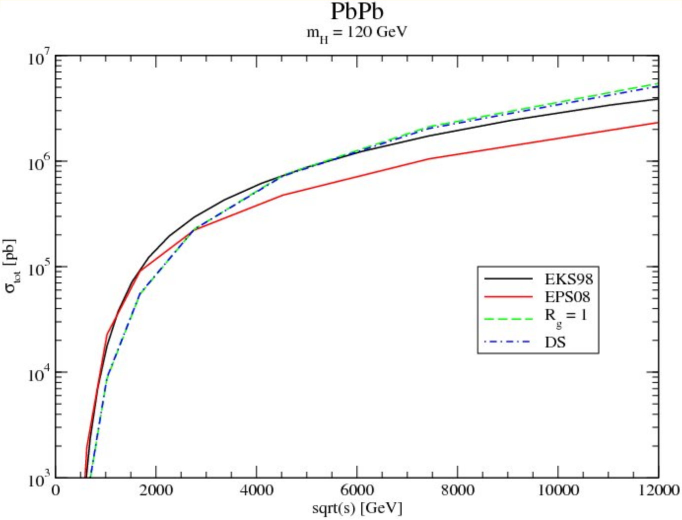

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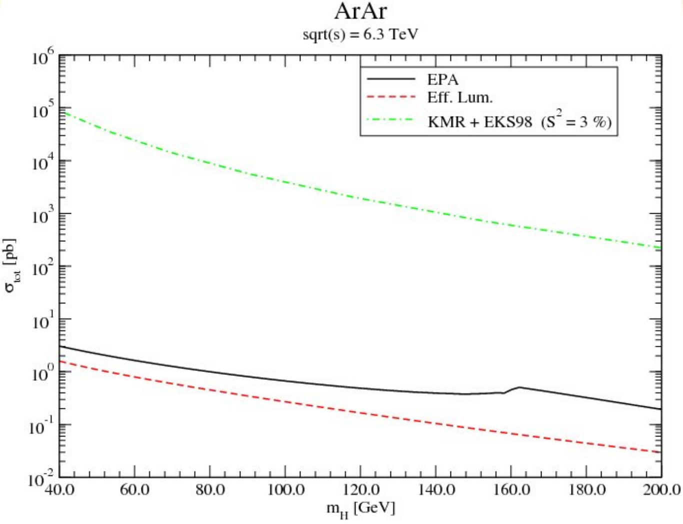

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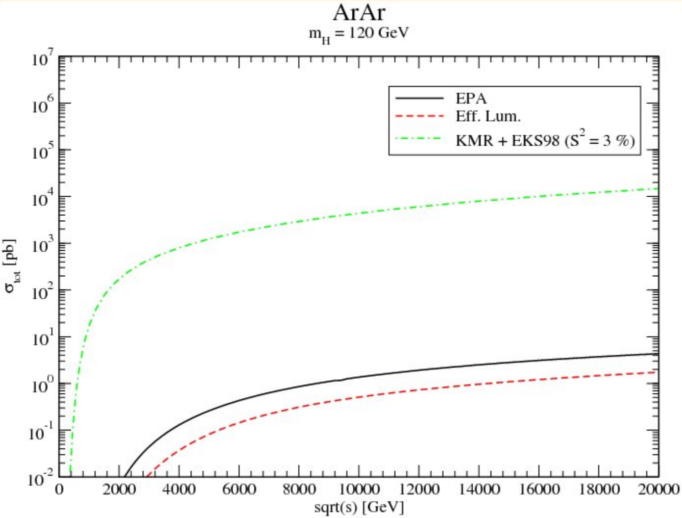

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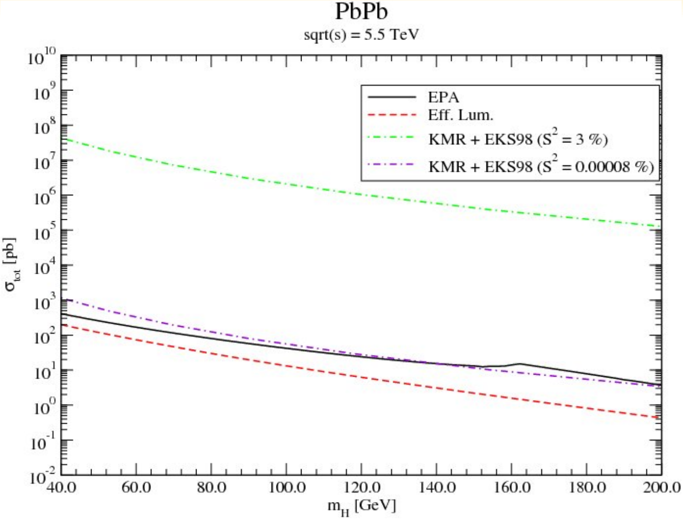

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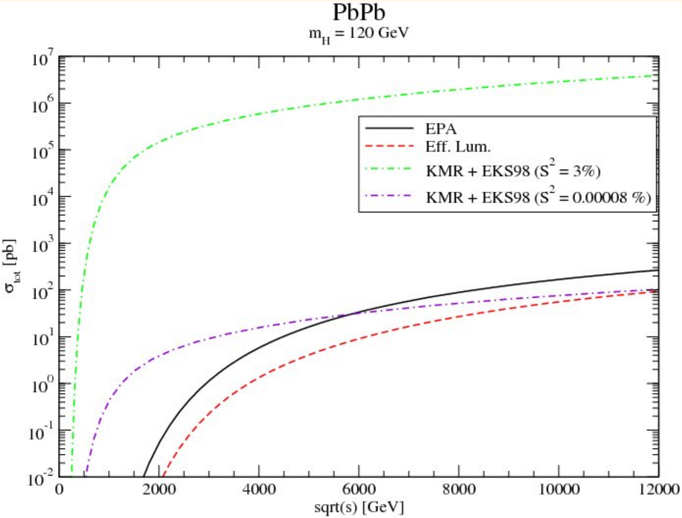

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- Dominant mechanism: depend on the mechanism and the S^2 $\Rightarrow$ open question;
- Change in nuclear c.s. due the different behavior of the nuclear distributions: shadowing, screening, etc.

Conclusions

- The proposed process can be used to observe the Higgs boson;
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- *pA* process; calculation of S^2 in the nuclear case (medium effects);
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