Institute for High Energy Physics (IHEP), Protvino, Russia

Exclusive Double Diffractive Events at LHC.

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Contents

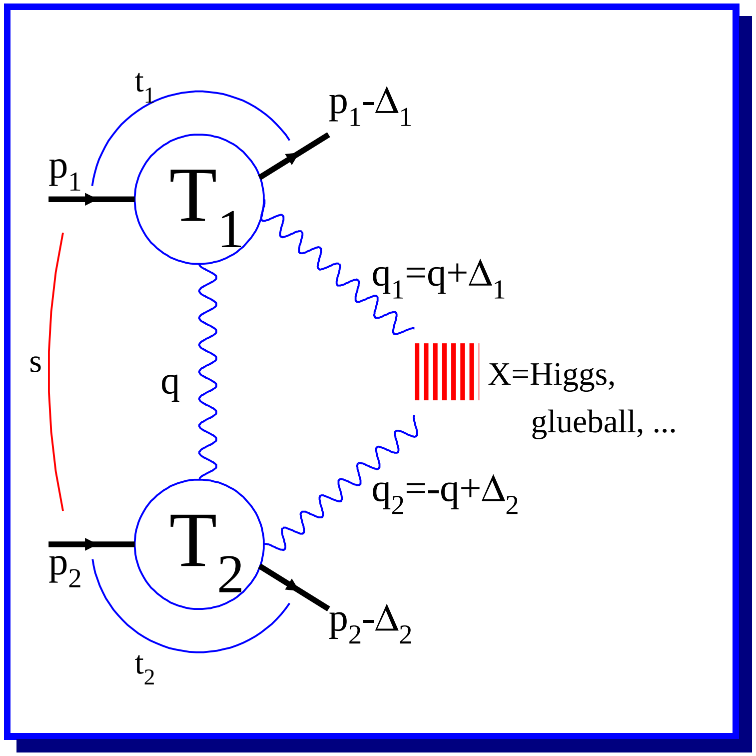
- Physical motivations for the EDDE.
- Process. Kinematics. Corrections.
- Results for the St. Model Higgs.
- RS1 model. Results.
- Other processes in the EDDE.
- Low mass particles. Spin-parity analyser.
- Plans.

Motivations

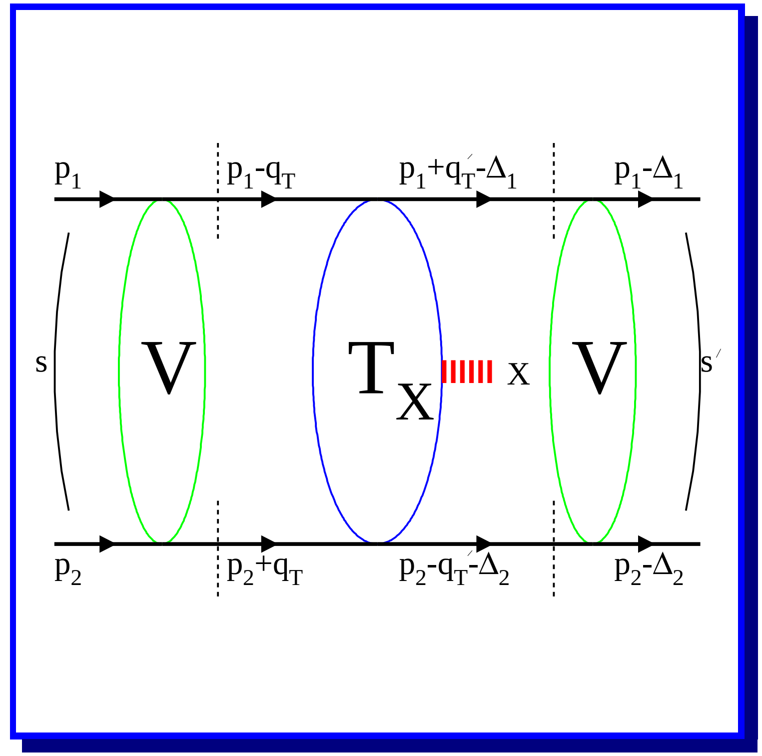
- Clear signature. Two rapidity gaps with final protons and two jets ($M_X > 100\ GeV$).
- It is possible to reconstruct the event exactly by measurements of final protons. "Missing mass" method can improve much the accuracy of the central mass measurements.
- Background is strongly suppressed.
- Spin-Parity analysis of the central particle is possible.
- Measurements of the diffractive pattern of the interaction in the presence of the "hard" scale.

EDDE. $p + p \to p + X + p$.

Amplitude T_X for the EDDE.



Absorbtive corrections.



Kinematical cuts for the EDDE:

$$0.01\ GeV^2 \le |t_i| \le 1\ GeV^2\ ,\ \xi_{Min} \simeq \frac{M_H^2}{s\xi_{Max}} \le \xi_i \le \xi_{Max} = 0.1$$

Roman Ryutin

Absorbtive corrections

$$T_X^{Unitarized}(p_1\ ,\ p_2\ ,\ \Delta_1\ ,\ \Delta_2) = \frac{1}{16ss'}\int \frac{d^2\mathbf{q_T}}{(2\pi)^2}\frac{d^2\mathbf{q'_T}}{(2\pi)^2} V(s\ ,\ \mathbf{q_T}) \times$$

$$\times\ T_X(p_1-q_T, p_2+q_T, \Delta_{1T}, \Delta_{2T})\ \times\ V(s'\ ,\ \mathbf{q'_T})\ ,$$

$$\Delta_{1T} = \Delta_1 - q_T - q'_T\ ,\ \Delta_{2T} = \Delta_2 + q_T + q'_T\ ,$$

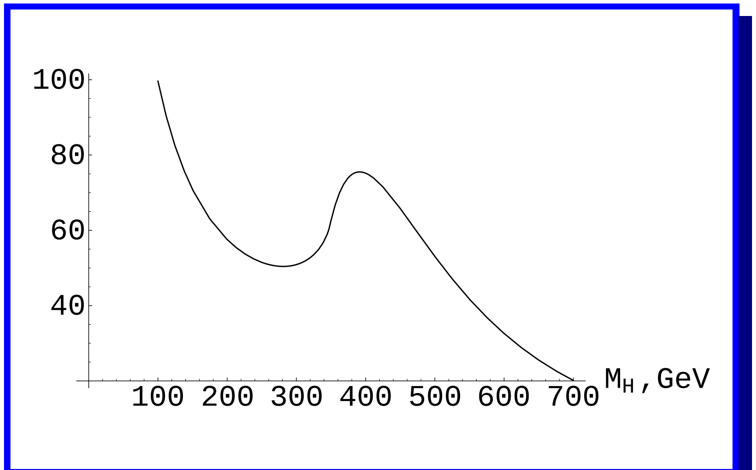
$$V(s\ ,\ \mathbf{q_T}) = 4s(2\pi)^2\delta^2(\mathbf{q_T}) + 4s\int d\mathbf{b} e^{i\mathbf{q_T}\mathbf{b}}\left[e^{i\delta}-1\right]$$

Eikonal function δ can be found in [hep-ph/0105209]

All the available data on $p+p(\bar{p})\to p+p(\bar{p})$ are well described.

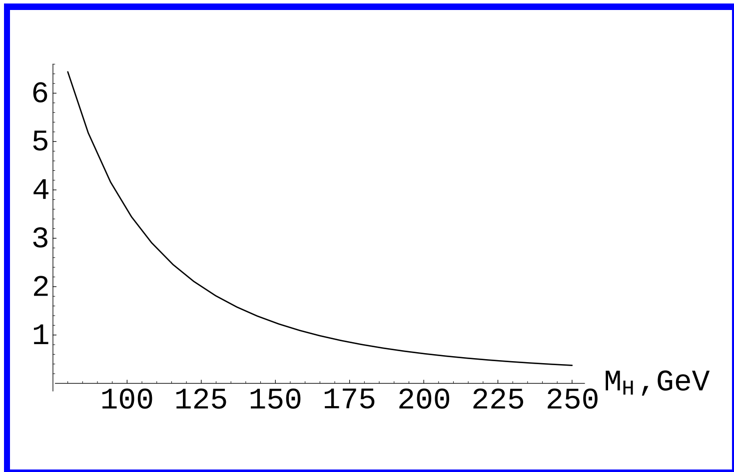
St. Model Higgs. Results.

Total cross-section for the process $p + p \to p + H + p$ (in fb).



Normalized to $\gamma + p \to J/\Psi + p$ data from HERA. Without Sudakov-like suppression.

Total cross-section for the process $p + p \to p + H + p$ (in fb).



Normalized to the data from CDF on $p+p \to p+jet+jet+p$. Sudakov-like suppression is taken into account.[hep-ph/0311024]

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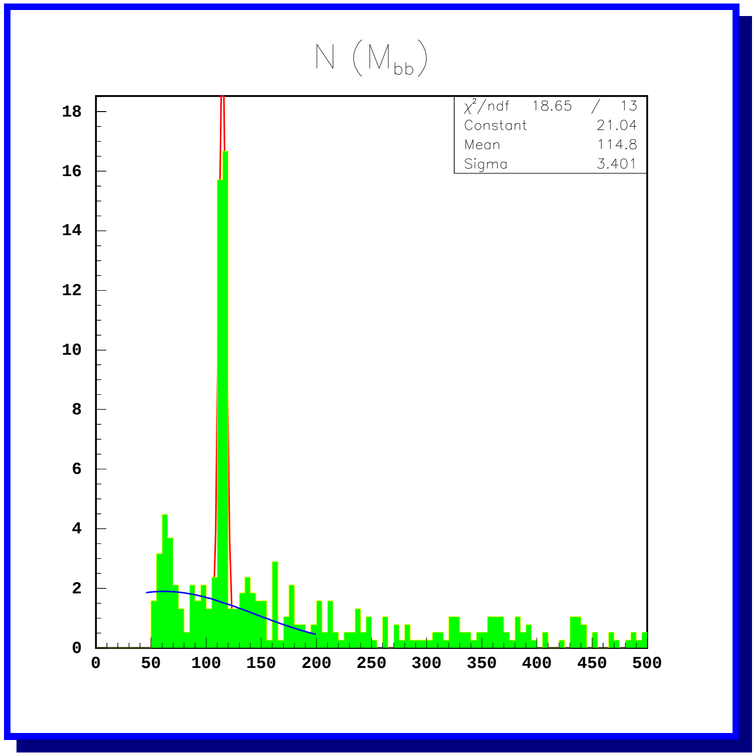
St. Model Higgs. Results.

Generator for EDDE. Fast M.-C. (PYTHIA, CMSJET, CMKIN).



Mass reconstruction for Higgs boson mass 115 GeV. Signal + $b\bar{b}$ background.

- Integrated luminocity 30 fb^{-1}
- $E_{T,jet} > 50\ GeV$ (∼50% of signal events)
- b-tagging 50%
- efficiency of final protons registration ∼50% ($M_H = 115$ GeV)
- mass resolution (if "missing mass" method is applied!) ∼1%

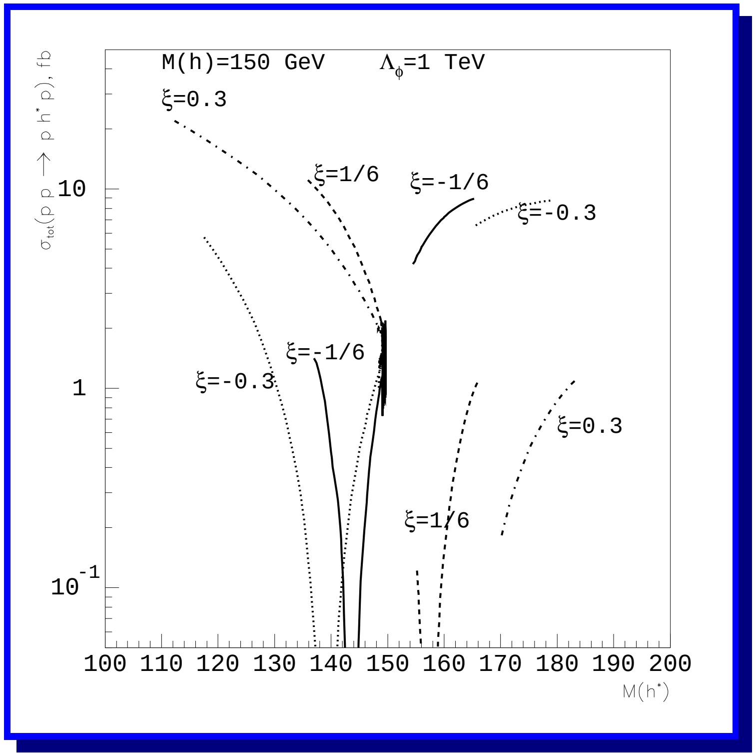
total efficiency is about 10 %

Significance estimations

$$\frac{N_S}{\sqrt{N_S + N_B}} \simeq 3.5$$

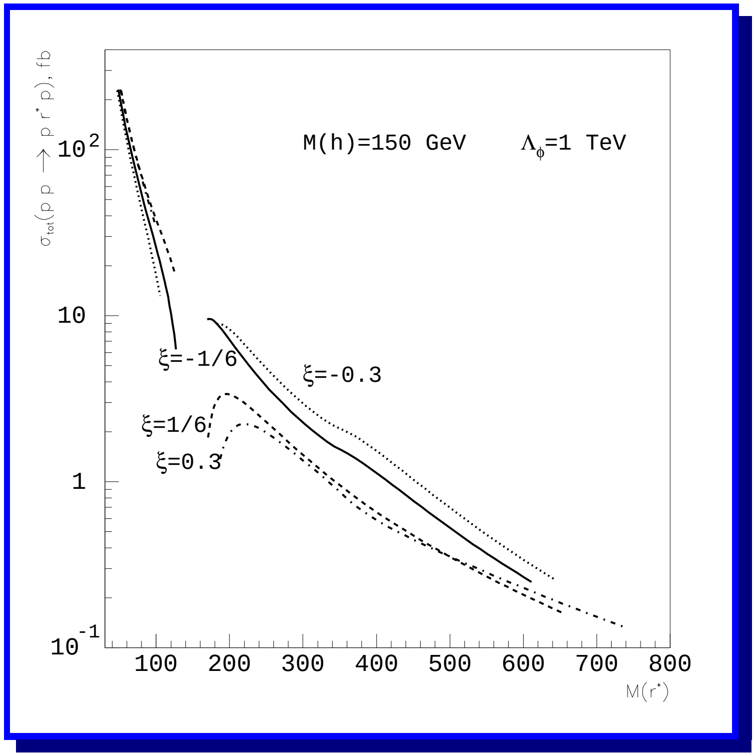
RS1 model. Results.

Total cross-section for the process
$p + p \to p + h^* + p$ (in fb).



h^* and r^* are observable mass eigenstates.

Total cross-section for the process
$p + p \to p + r^* + p$ (in fb).



Λ_ϕ is the vacuum expect. value of the radion field and ξ is the mixing parameter.[hep-ph/0002178]

RS1 model. Results.

Estimations for the significance of higgs and radion production at LHC (for the integrated luminocity 30 fb^{-1}):

$M(h) = 150$ GeV, $\Lambda_\phi = 1$ TeV

$\xi = 1/6$

M(h*) GeV	Signif.	M(r*) GeV	Signif.
$115 \to 138$	$4.7 \to 4\ \sigma$	$60 \to 100$	$4 \to 4.5\ \sigma$
$138 \to 147$	$4 \to 3\ \sigma$	$200 \to 250$	$\sim 3\ \sigma$

$\xi = -1/6$

M(h*) GeV	Signif.
$155 \to 165$	$> 5\ \sigma$
M(r*) GeV	
$170 \to 210$	$> 5\ \sigma$
$210 \to 245$	$5 \to 4\ \sigma$
$245 \to 300$	$4 \to 3\ \sigma$

Other processes.

Estimations of the total cross-sections for $p+p \to p+X+p$ processes. Kinematical cuts:

$$M_X^2/s < \xi_i < 0.1\ ,\ 0.01 < |t_i| < 1\ GeV^2$$

$X = jet + jet$

$E_T >$ 10 GeV, $\sigma_{tot} \simeq$ 5 nb

$E_T >$ 25 GeV, $\sigma_{tot} \simeq$ 100 pb

$E_T >$ 50 GeV, $\sigma_{tot} \simeq$ 6 pb

$X = \chi_{c0}$

$\sigma_{tot} \simeq$ 6.3 pb

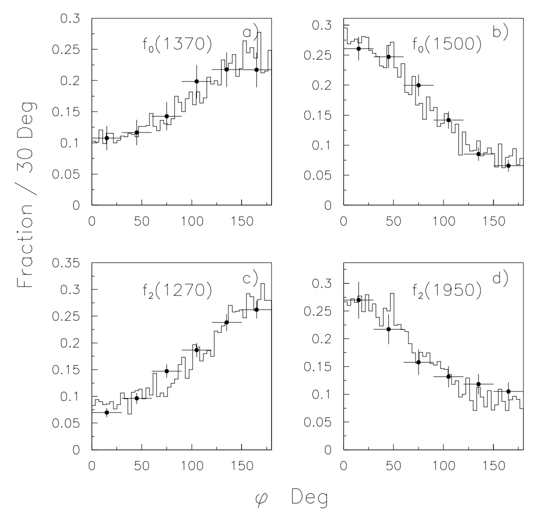
$X = \chi_{b0}$

$\sigma_{tot} \simeq$ 160 fb

Low luminocity measurements are possible

Low mass particles. S.-P. analyser.

Results of the WA102 experiment. 0^{++} and 2^{++} sectors.



ϕ distributions for the a)$f_0(1370)$, b)$f_0(1500)$, c)$f_2(1270)$ and d)$f_2(1950)$.

$$dP_t^2 = (\sqrt{|t_1|} - \sqrt{|t_2|})^2 + 4\sqrt{t_1 t_2}\sin^2\frac{\phi}{2}\ ,$$

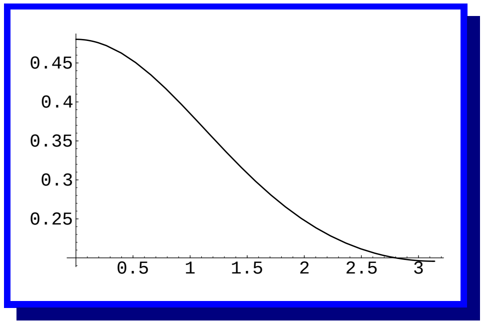
ϕ is the azimuthal angle between outgoing protons.

$$\frac{d\sigma}{d\phi} \sim \left(1 + \frac{\sqrt{t_1 t_2}}{A}\cos\phi\right)^2 \quad [F.Close]$$

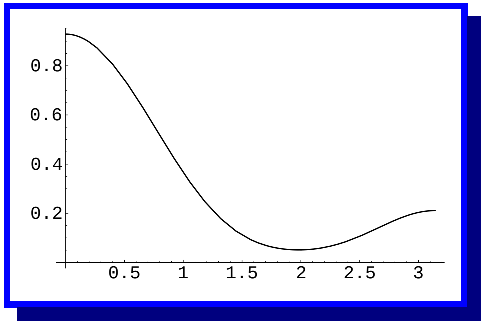
$f_0(1370)$: $A = -0.5\ GeV^2$,
$f_2(1270)$: $A = -0.4\ GeV^2$,
$f_0(1500)$, $f_2(1950)$: $A = 0.7\ GeV^2$ (glueball candidates)
$dP_t < 0.2\ GeV$ - glueballs survive, $q\bar{q}$ states are suppressed.
dP_t is the natural theoretical variable.

Low mass particles. S.-P. analyser.

Absorbtive corrections (unitarization) affect the ϕ distribution $d\sigma/d\phi/\sigma$.



$|t_i| < 0.3\ GeV^2$. $\phi \sim 0 \rightarrow$ small dP_t



$|t_i| > 0.8\ GeV^2$. $\phi \sim \pi \rightarrow$ large dP_t

- glueballs have large cross-sections for observations at rather low luminocities, when we can measure ϕ-distributions. Spin-parity analysis is possible (as in WA102 experiment).
- dP_t filter for glueballs.
- ϕ-distributions is a very powerful tool to separate different models for soft diffraction.

Plans for the nearest future.

- Cross-sections for the EDD-production of other possible states in the St. model and beyond.
- Generators for the considered processes and backgrounds.

All the information will be available on

http://sirius.ihep.su/∼ryutin/diff.html