

Report on DPEMC generator

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- What is DPEMC?
- QCD inclusive and exclusive models
- Survival probability correction
- QED $\gamma\gamma$ models
- Conclusion

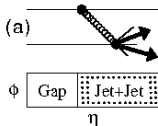
DPEMC - Double Pomeron Exchange Monte Carlo

Main objectives:

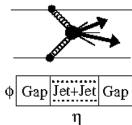
- Purpose: have a convenient interface containing many models to perform various analysis of Tevatron, and LHC diff. data
- Intended to be an extension to POMWIG MC
- Today: standalone program, many features and models included
- Modified Herwig, hadronization and process codes like in HERWIG
- Authors: M. Boonekamp et al.
- Download: [http : //boonekam.home.ch/boonekam/dpemc.htm](http://boonekam.home.ch/boonekam/dpemc.htm)

Content

- Single diffraction (at the Tevatron/LHC but also at HERA)

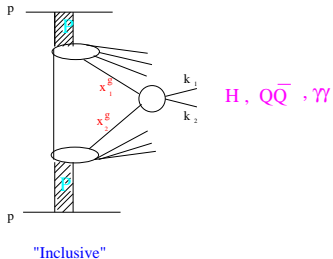
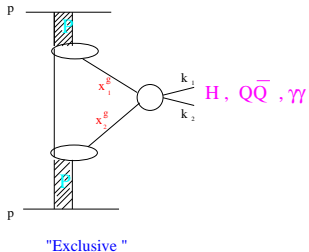
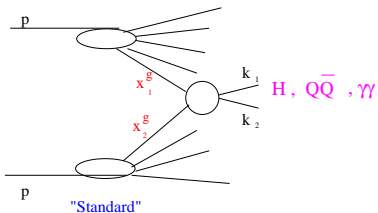


- Double pomeron exchange - inclusive + exclusive models
- Exclusive χ_b, χ_c



- QED $\gamma\gamma$ interactions of protons or heavy ions

Inclusive vs. exclusive DPE



Implementation of diffractive processes

- Diffractive process usually viewed as:
 $p \rightarrow p' + \mathbb{P}$, followed by $\mathbb{P} \rightarrow g + X$
- Technically: simulation of ee interactions transformed into pp (ep) collisions

$$\begin{aligned} e^+ + e^- &\rightarrow e^+ + \gamma + \gamma + e^- \\ \bar{p} + p &\rightarrow \bar{p} + \mathbb{P} + \mathbb{P} + p \end{aligned}$$

- Reweighting of photon flux to the Pomeron flux
- Appropriate choice of Pomeron structure functions

$$\sigma^{inc} = \sum_{ij} \int dx_1 dx_2 d\xi_1 d\xi_2 \mathbf{F}_{\mathbb{P}}(\xi_1) \mathbf{F}_{\mathbb{P}}(\xi_2) f_i(x_1) f_j(x_2) \hat{\sigma}(ij \rightarrow M)$$

- Pomeron flux and Pomeron structure functions measured at HERA
- In DPEMC various PDF included

Parameters of MC

PART1	'E-'
PART2	'E+'
TYPEPR	'INC'/'EXC'
TYPINT	'QCD'/'QED'
NFLUX	9/10/11/...
IPROC	process to study
IFITPDF	PDF

- Parameters set via Format free cards, no need to recompile the code to run with new settings

Available models - QCD processes

QCD inclusive

- **"Factorized model"** (FM)
exchange of perturbative pomerons (Reggeons)
factorization brake-up only up to the survival probability factor
(code adopted from POMWIG)
- **Bialas-Landshoff inclusive model** (BL inc, BPR model, Saclay model)
non-perturbative approach, inclusive extension of BL exclusive model

To select particular model use NFLUX

NFLUX	
9	Factorized model, Pomeron flux
10	Factorized model, Reggeon flux
11	Bialas-Landshoff inclusive model

DPE partonic sub-processes

Final state	IPROC	TYPINT/TYPEPR	NFLUX
Higgs	11600+ID	QCD/INC	9, 10, 11
Dijets	11500	QCD/INC	9, 10, 11
Lepton pairs	11350+IL	QCD/INC	9, 10, 11
Photon pairs	12200	QCD/INC	9, 10, 11

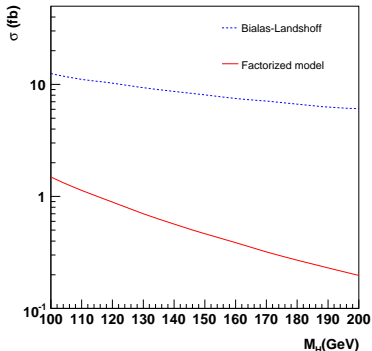
ID... specifies decay into $q\bar{q}$, l^+l^- , W^+W^- , ZZ , all decay modes

IL... selects type of leptons

DPE inclusive Higgs production at the LHC

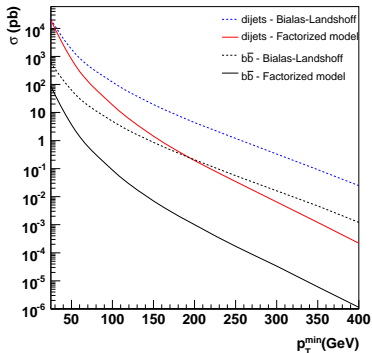
IPROC=11699: Higgs in all decay modes

NFLUX: 9=Factorized model 11=BL inclusive



M_{Higgs} (GeV)	σ^{FM} (fb)	σ^{BLinc} (fb)
120	0.89	10.3
140	0.57	8.7
160	0.39	7.5
200	0.20	6.1

DPE inclusive $\gamma\gamma, l^+l^-$, dijet production at the LHC



IPROC	Process
11500	dijets
11705	$b\bar{b}$
12200	$\gamma\gamma$
11350	l^+l^-

Available models - QCD processes(2)

QCD exclusive DPE

- **Bialas-Landshoff exclusive model** (BL exc)
exchange of two non-perturbative gluons
- **Khoze, Martin, Ryskin model** (KMR)
exchange of two gluons directly coupled to the protons

NFLUX	
11	Bialas-Landshoff exclusive model
16	KMR model

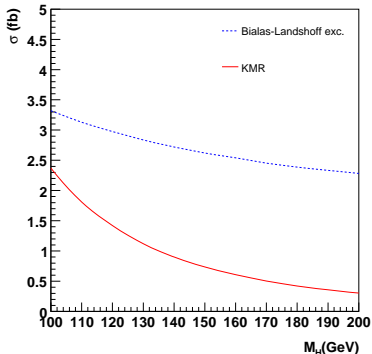
Final state	IPROC	TYPINT/TYPEPR
Higgs	19900+ID	QCD/EXC
Dijets	16000+ID	QCD/EXC

- ID... decay modes for Higgs / parton sub-processes for dijets (for details see manual)
- **Diphoton production** possible exclusively (through quark loop), but **not implemented!**

Exclusive Higgs production

IPROC=19999: **Higgs production** (all decay modes)

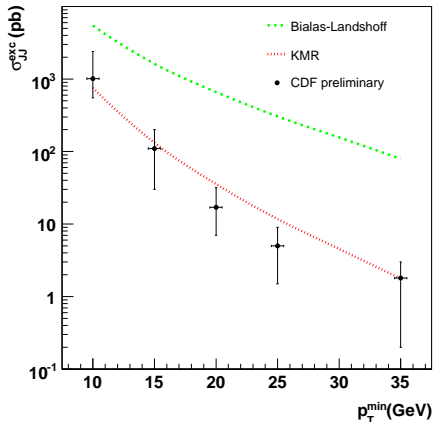
NFLUX: 11=BL exclusive model 16=KMR model



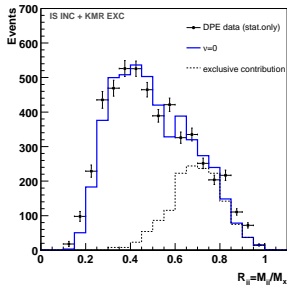
M_{Higgs} (GeV)	σ^{KMR} (fb)	σ^{BLexc} (fb)
120	1.42	3.1
140	0.90	2.7
160	0.61	2.5
200	0.31	2.3

Exclusive dijet production at the Tevatron

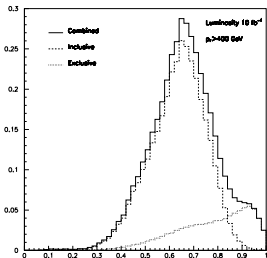
- Exclusive cross section compared to the preliminary CDF data
CDF note 8493, (2006)
- IPROC: 16013=dijets ($gg \rightarrow gg + q\bar{q}$ all flavors)
- NFLUX: 11=BL exclusive model 16=KMR model



Dijet mass fraction at the Tevatron and LHC



- Tevatron
- $p_T > 10$ GeV
- IPROC=11500: dijets
- NFLUX=9: Factorized model
- NFLUX=16: KMR exclusive model



- LHC
- $p_T > 400$ GeV

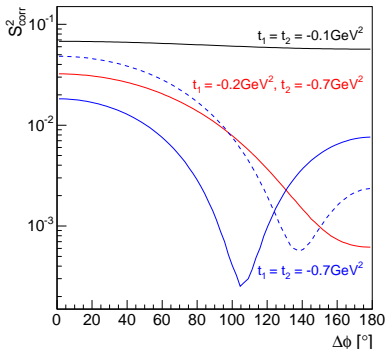
Inclusive + exclusive χ_c, χ_b production

- Inclusive and exclusive production extended for low mass states
- $M^2 = s\xi_1\xi_2$ does not hold for low M (~ 3 GeV)
- The kinematics treated correctly in that limit, special version
- hep-ph/0612297

Final state	IPROC	TYPINT/TYPEPR	NFLUX
χ_c	19601	QCD/INC	9, 10, 11
χ_c	19601	QCD/EXC	11, 16

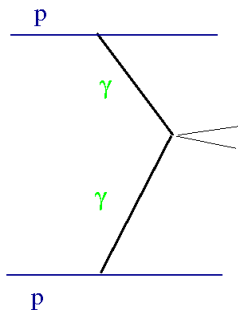
Survival probability

- **Survival probability**: probability that there is no additional soft interaction that would spoil the diffractive process and destroy the proton
- For the Tevatron 0.1, for the LHC 0.03, ISOFTM=1
- **Strongly $\Delta\Phi$ -dependent**, $\Delta\Phi$ is the difference in the azimuthal angle between p and \bar{p}
- Implemented: ISOFTM=2



Available models - QED processes

QED fluxes

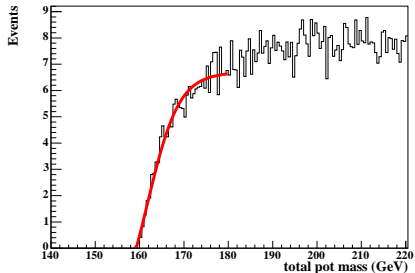
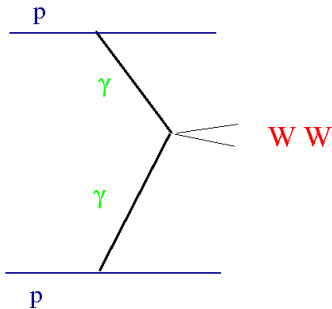


Final state	IPROC	TYPINT/TYPEPR
Higgs	19900+ID	QED/EXC
Dijets	16000+ID	QED/EXC
Lepton pairs	16006+IL	QED/EXC
WW	16010	QED/EXC

NFLUX	Flux description
12	QED flux from Cahn, Jackson; $R \sim 1.2A^{1/3}$
13	QED flux from Drees et al., valid for heavy ions only
14	QED flux in pp collisions, from Papageorgiou
15	QED flux in pp collisions, from Budnev et al.

WW QED production

- NFLUX=10
- IPROC=16010



- All energy is used for production, well known process, $\sigma \sim 56$ fb
- WW produced for $M > 2M_W$
- Turn-on fits: **fit missing mass distribution at the threshold**
- Alternative M_W measurement
- **Anomalous γ coupling to W** can be studied

Conclusion

- DPEMC is a collection of different models
- It is a flexible interface to study:
SD, DPE processes, exclusive χ_c, χ_b and $\gamma\gamma$ interactions between protons or heavy nuclei
- Production of dijets, dileptons, WW , Z , diphotons, SUSY particles ...
- Interfaced with ATLAS full simulation ATHENA
- New version v2.8 is about to be published in the Comput.Phys.Commun.
- Download: <http://boonekam.home.ch/boonekam/dpemc.htm>