Protvino Diffractive group

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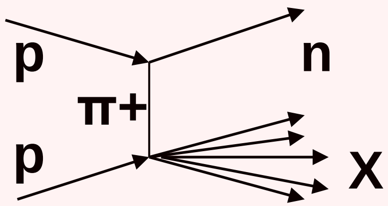
MONCHER
(MONte-Carlo for Charge Exchange Reactions)
v.1.0.0

Speaker: A.Sobol

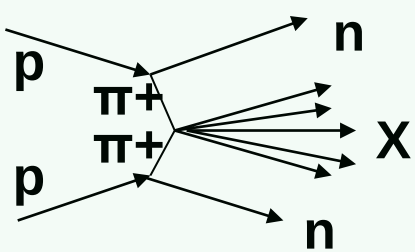
What are the CE and DCE?

Charge Exchange
or
Single Charge Exchange
or
Single Pion Exchange



pp → nX

Double Charge Exchange
or
Double Pion Exchange



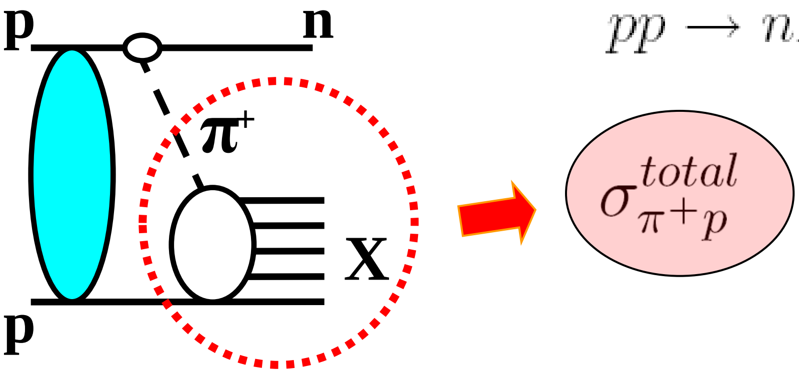
pp → nXn

Cross Sections in pp / √s = 7TeV

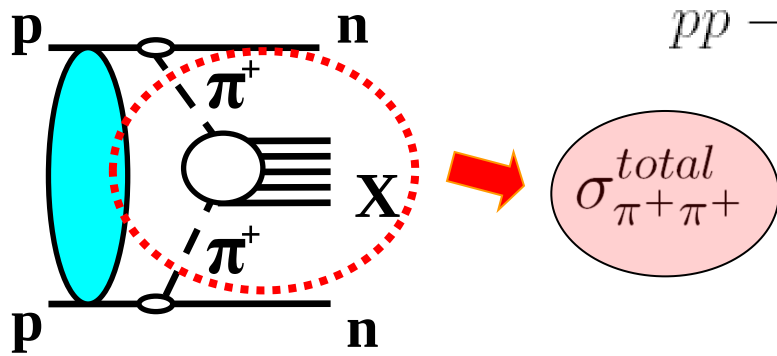
			PYTHIA 6.420
TOTAL		90.7 mb	100%
Minimum Bias	pp → X	48.4 mb	53.4%
Elastic Scattering	pp → pp	19.4 mb	21.4%
Single Diffraction	pp → pX	13.7 mb	18.1%
Double Diffraction	pp → XY	9.2 mb	10.1%
			MONCHER 1.0.0
Charge Exchange	pp → nX	1.3-1.9 mb	1.4-2.1%
Double Charge Exchange	pp → nXn	0.2-0.3 mb	0.2-0.3%

What we can study from CE and DCE?

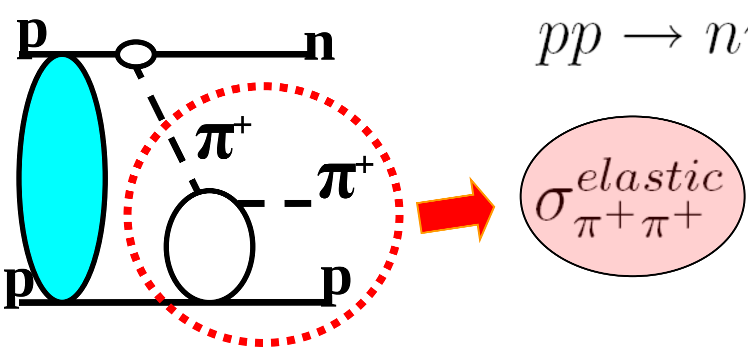
$pp \to nX$



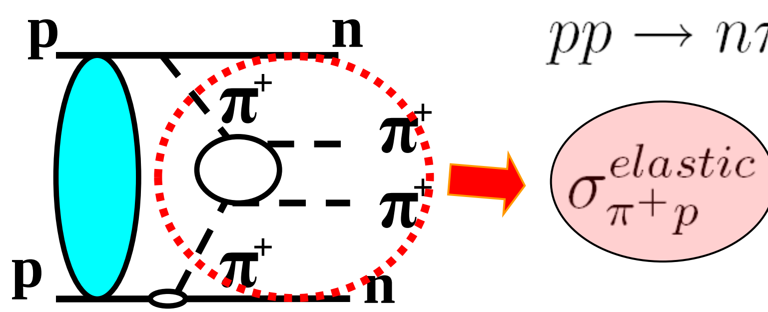
$pp \to nXn$



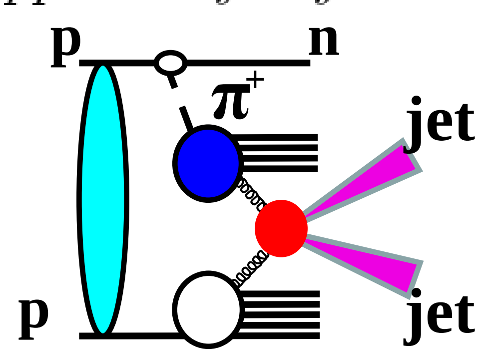
$pp \to n\pi^+p$



$pp \to n\pi^+\pi^+n$



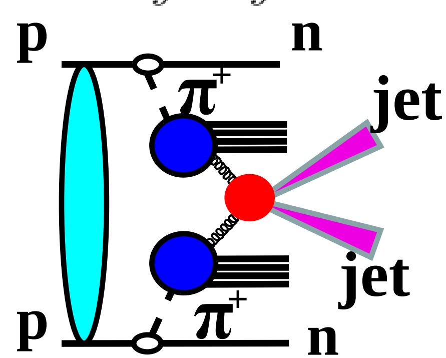
$pp \to n\ jet\ jet\ X$



Hard πp and ππ scattering

gives access to a
- parton distributions in a pion in a still unexplored domain of Q^2 and x
- possible extraction of effective strangeness, charm, and beauty content of the pion
- study of the d-u asymmetry in the pion

$pp \to n\ jet\ jet\ X\ n$



$$\frac{d\sigma_{\mathrm{S}\pi\mathrm{E}}}{d\xi dt} = F_0(\xi,t)\, S(s/s_0,\xi,t)\, \sigma_{\pi^+p}(\xi s)$$

$$0.01 < |t| < 0.5$$
$$\xi < 0.4$$

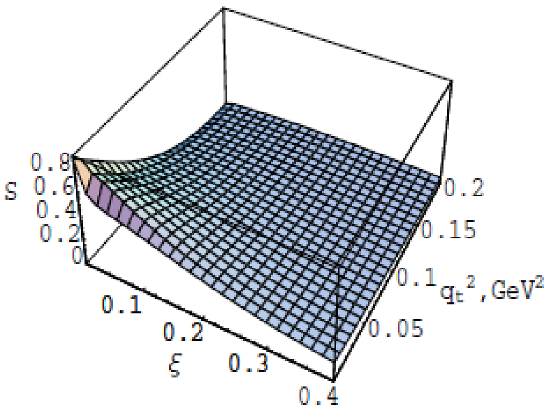
$$F_0(\xi,t) = \frac{G^2_{\pi^+pn}}{16\pi^2}\frac{-t}{(t-m_\pi^2)^2}\mathrm{e}^{2bt}\xi^{1-2\alpha_\pi(t)}$$

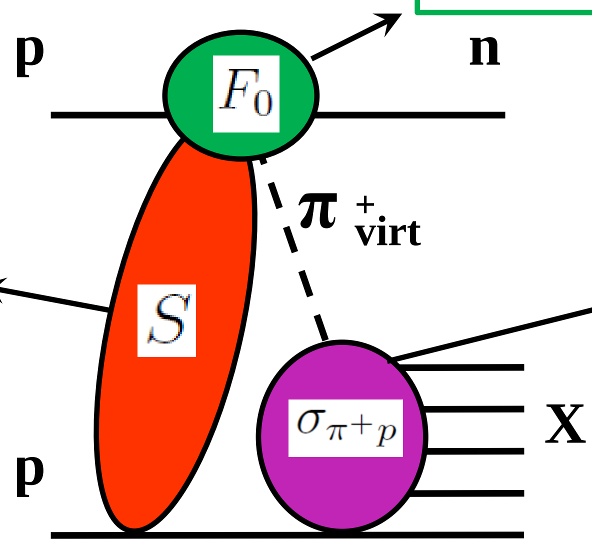
$$G^2_{\pi^+pn}/(8\pi) = 13.75$$

$$\alpha_\pi(t) \simeq 0.9(t-m_\pi^2),\ b \sim 0.3\ \mathrm{GeV}^{-2}$$

S – absorptive or rescattering corrections:

1. Petrov-Prokudin





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σ_{π^+p} parameterization:

1. Donnachie-Landshoff
2. COMPETE
3. Bourrely-Soffer-Wu
4. Petrov-Godizov

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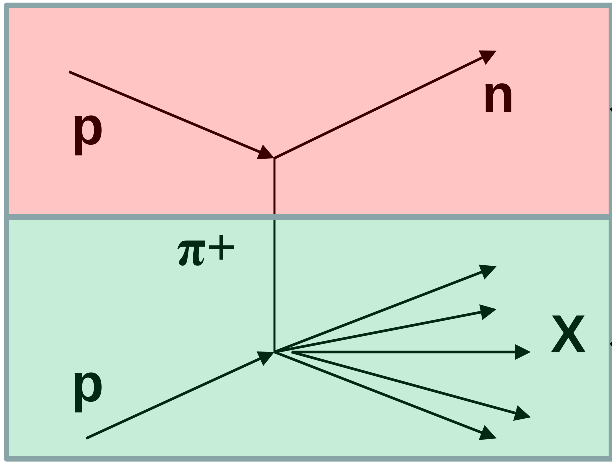
How it is implemented to MONCHER?



1. *MONCHER CODE*
   CALL CEEVE → (P_neutron, P_π+_virtual)

2. *PYTHIA CODE*
   P_π+_virtual → /PYJETS/
   CALL PYINIT(“5MOM”, “PI+”, “P”, 0.0)
   CALL PYEVNT → P_X

3. (P_neutron, P_X) → /PYJETS/

```
PROGRAM  MAIN
    IMPLICIT DOUBLE PRECISION(A-H, O-Z)
    IMPLICIT INTEGER(I-N)
c-...global MONCHER parameters
    INTEGER MXGLPAR
    REAL GENPAR
    PARAMETER   (MXGLPAR=200)
    COMMON /MONCHERGLPAR/ GENPAR(MXGLPAR)
c-- initialization
    CALL MONCHERINI
    NTOT=GENPAR(1)
    KLHE=GENPAR(2)
c-- generation
    DO NEV=1,NTOT
     CALL MONCHEREVE
     IF(KLHE.EQ.1) CALL MONCHER_PYUPEV_ST
     IF(NEV.LE.3)  CALL PYLIST(1)
    ENDDO
C...Final statistics.
    CALL PYSTAT(1)
C...Produce final Les Houches Event File.
    IF(KLHE.EQ.1) CALL PYLHEF
    STOP
    END
```

Initialization
- read MONCHER control keys and PYTHIA parameters
- set default PYTHIA parameters
- read parameters for dσ/dξdt of neutron
- or CALL PYINIT(“CMS”,”P”,”P”,ECM)
- open temporary files for LHE saving

Generation
- CALL CEEVE
- or CALL DCEEVE
- or CALL PYEVNT

Output
here in LHE file

MONCHER control keys

Control keys are defined in *moncher.par*

MONCHER control

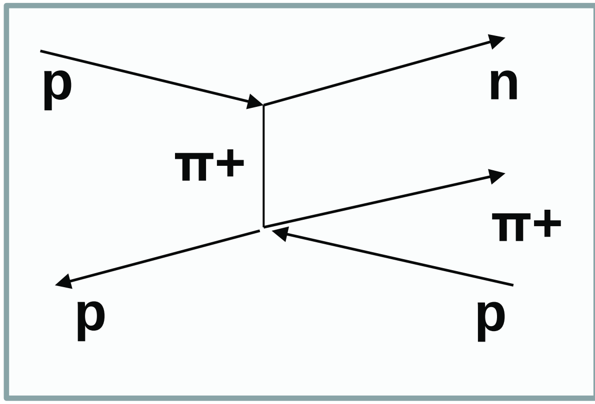
- GENPAR(1) → N events to be generated
- GENPAR(2) → LHE output
  [1 - yes, 0 - no]
- GENPAR(3) → pp cms energy
  [900 →1400 GeV]
- GENPAR(4) → Model for pR and RR
  [1 - Donnachie-Landshoff (default)]
  [2 - COMPETE (PDG)]
  [3 - Bourreli-Sopfer-Wu]
  [4 - Godizov-Petrov]
- GENPAR(5) → Model for absorption
  [1 – Petrov-Prokudin 3 IP eikonal model]
- GENPAR(6) → Type of the exchange Reggeon
  [1 - pi+(default)]
  [2 - rho+, 3 - a2+]
- GENPAR(7) → CE generation
  [1 - yes, 0 - no]
- GENPAR(8) → DCE generation
  [1 - yes, 0 - no]

PYTHIA control

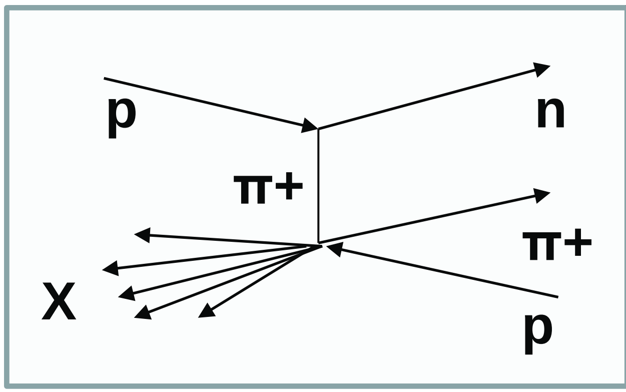
```
MSEL =0               ! full user control
c MSUB(11)=1          ! f + f' -> f + f' (QCD) ',
c MSUB(12)=1          ! f + fbar -> f' + fbar' ',
c MSUB(13)=1          ! f + fbar -> g + g',
c MSUB(28)=1          ! f + g -> f + g ',
c MSUB(53)=1          ! g + g -> f + fbar',
c MSUB(68)=1          ! g + g -> g + g',
MSUB(91)=1            ! Elastic scattering',
c MSUB(92)=1          ! Single diffractive (AX)',
c MSUB(93)=1          ! Single diffractive (XB)',
c MSUB(94)=1          ! Double  diffractive',
c MSUB(95)=1          ! Low-pT scattering',
c
c MSEL =1             ! mb
c MSEL =2             ! mb+sd+dd+elastic+lowpt
c
MRPY(1)=12031967      ! random number generator
c  ….. any others
```

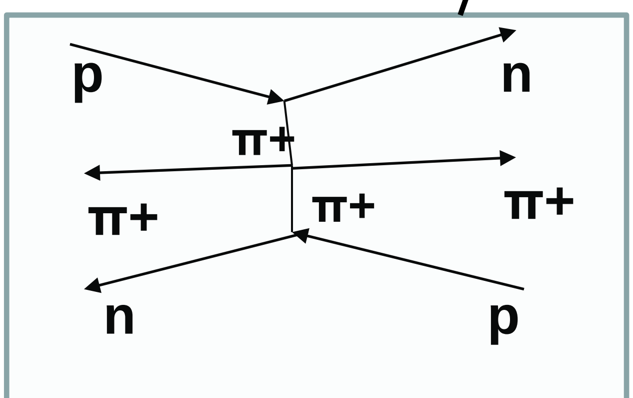
If GENPAR(7)=0.and.GENPAR(8)=0 then PYTHIA processes are generating
If GENPAR(7)≠0.or.GENPAR(8)≠0   then PYTHIA parameters control π+p / π+π+ interactions

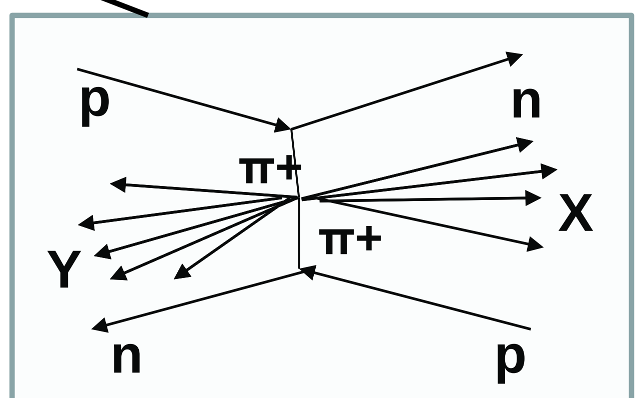
Some processes which can be generated with MONCHER



Name	Process	σ(mb) at 7 TeV
SπE_mb	pp $\to$ n X	1.13
SπE_es	pp $\to$ n πp	0.26
SπE_dd	pp $\to$ n XY	0.20
SπE_sd1	pp $\to$ n πX	0.17
SπE_sd2	pp $\to$ n pX	0.15
DπE_mb	pp $\to$ n X n	0.19
DπE_es	pp $\to$ n ππ n	0.04
DπE_sd	pp $\to$ n πX n	0.05
DπE_dd	pp $\to$ n XY n	0.03







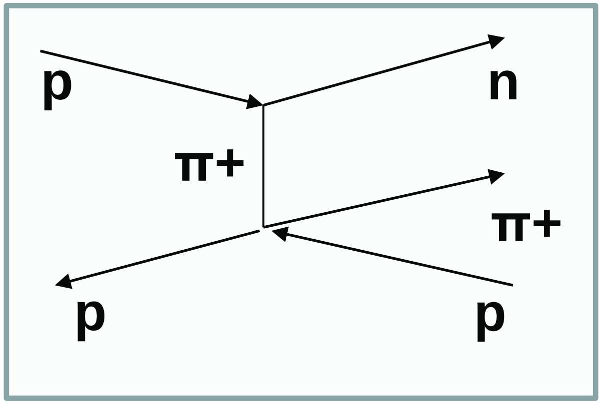
Example

SπE with π+p elastic scattering

pp → n π+ p

100 events / at 7 TeV

LHE output / BSW model




```
c ---------------------------------- MONCHER v.1.0.0 card file
GENPAR(1)=100        ! number of events to generate
GENPAR(2)=1          ! key for Les Houches data
GENPAR(3)=7000       ! pp centre mass energy in GeV
GENPAR(4)=3          ! Model for pR and RR interaction
c                    =3 -> Bourreli-Sopfer-Wu model
GENPAR(5)=1          ! Model for absorption
c                    =1 - >3 IP eikonal model (default)
GENPAR(6)=1          ! Type of Reggeon
c                     (1-pi+, 2-rho+, 3-a2+)
GENPAR(7)=1          ! CE
GENPAR(8)=0          ! DCE
c----------------------------------------- PYTHIA control keys
MSEL =0              ! full user control
MSUB(91)=1           ! Elastic scattering
```

PYTHIA's event listing of the 1st event

Event listing (summary)

particle/jet	KS	KF	orig	p_x	p_y	p_z	E	m
1 !p+!	21	2212	0	0.000	0.000	3500.000	3500.000	0.938
2 !p+!	21	2212	0	0.000	0.000	-3500.000	3500.000	0.938
3 n0	1	2112	2	0.114	0.216	-2296.198	2296.198	0.940
4 !pi+!	21	211	2	-0.114	-0.216	-1203.802	1203.802	0.140
5 !p+!	21	2212	3	-0.019	-0.001	3500.000	3500.000	0.938
6 !pi+!	21	211	4	-0.095	-0.215	-1203.802	1203.802	0.140
7 p+	1	2212	5	-0.019	-0.001	3500.000	3500.000	0.938
8 pi+	1	211	6	-0.095	-0.215	-1203.802	1203.802	0.140
sum:	2.00			0.000	0.000	0.000	7000.000	7000.000

Known problems

Problem:
PYTHIA is crushed if one uses initialization subroutine for the virtual beam particles
CALL PYINIT("5MOM", "PI+", "P", 0.0) and start to generate diffractive processes:
MSEL=0 and (MSUB(93)=1 or MSUB(94)=1 or MSUB(95)=1) or MSEL=2 including diffraction
Solution:
One can use PYINIT("3MOM","PI+","P",0.0) for real beam particles. It's a good approach because mass of π is small.

Problem:
We have differential and total cross sections calculated for two other exchange Reggeons: ρ+ and a2+. But in PYTHIA there are no such beam particles.
Solution:
No solution yet. If GENPAR(4)=2 or 3, MONCHER gives correct total and differential cross section, but it generates π+p intermediate interactions.

Problem:
For LHE output we can save only stable particles. Resulting *moncher.lhe* can be read well by standalone PYTHA, but CMSSW is crushed sometimes by long MONCHER LHE events.
Solution:
This problem can be solved easy by integrating of MONCHER to CMSSW as "generator".
But we need approval from "generator group" for it.

Plans:
Implementing of new models for absorptive corrections

Generator location: ***http://rioutine.web.cern.ch/rioutine/***