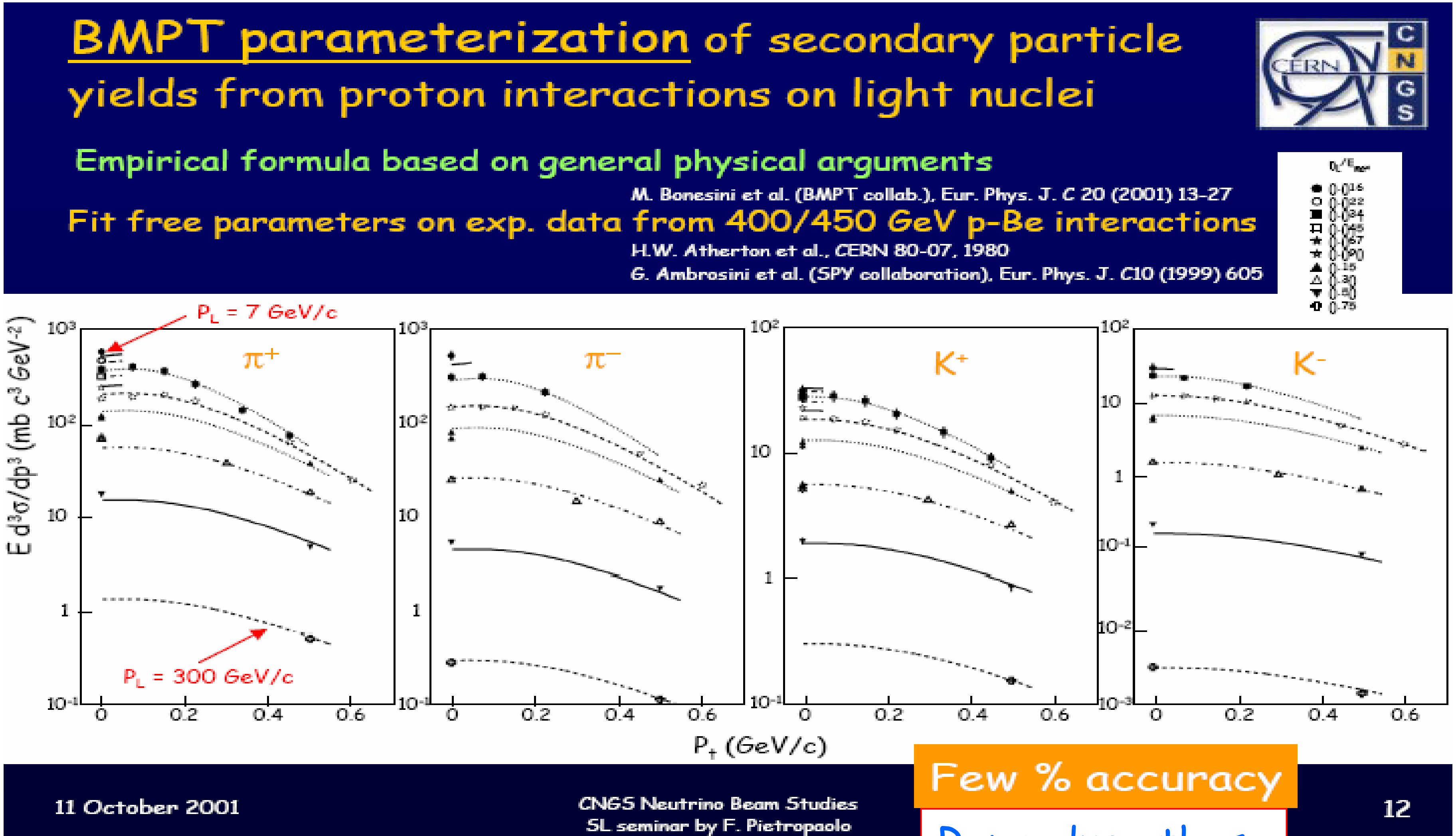
Proton On Target

G4 v7.0p1

Fluka 2003.1b

Physical case: see M. Bonesini et al.
hep-ph/0101163 published in EPJC

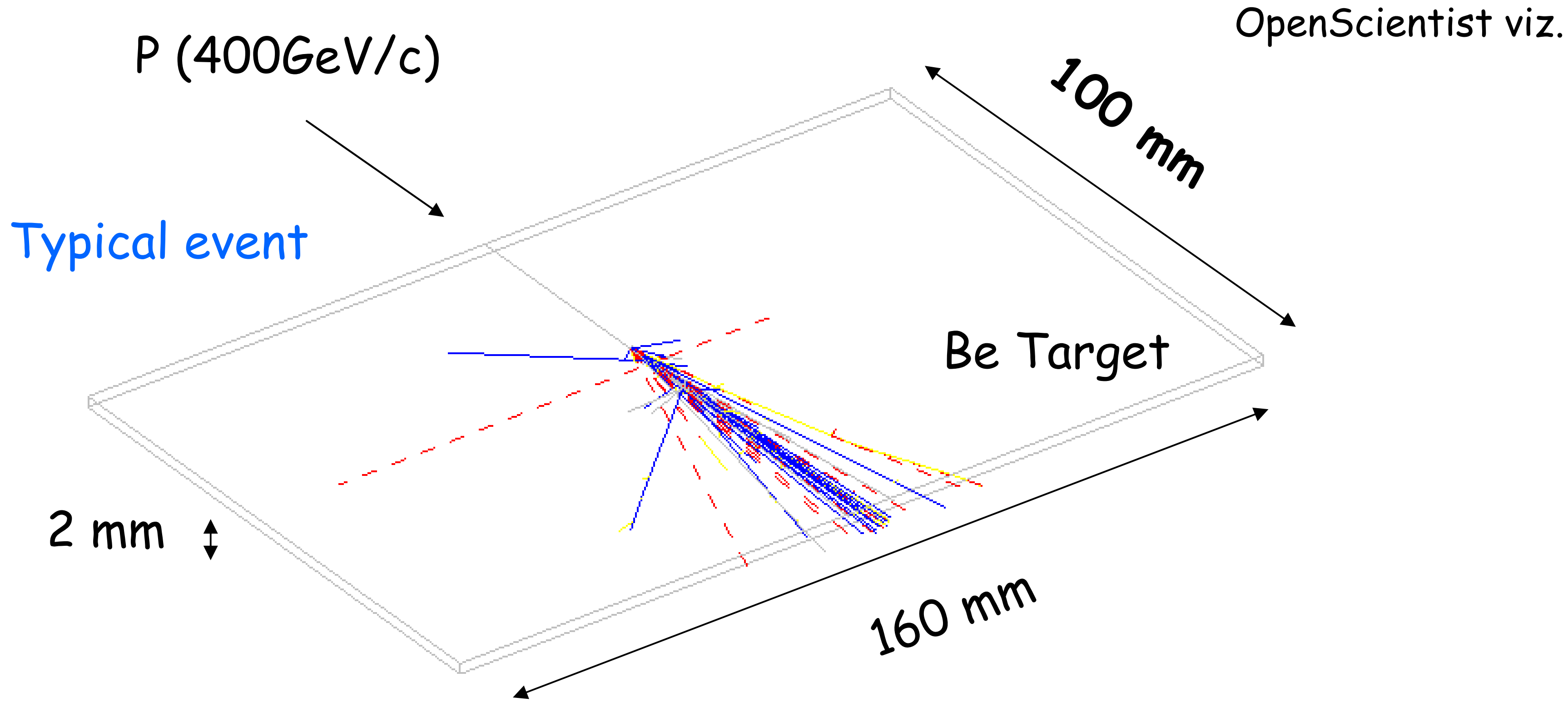
The goal: from F. Pietropaolo SL seminar



Few % accuracy

Reproduce these distributions

The target & beam (SPY-like)



For Geant4 use QGSP physics list (cf. Hans-Peter Wellisch)
http://www.geant4.com/hadronics/GHAD/HomePage/

Analysis (simple)

Run $N_{pot}=10^6$ protons mono-energetic and pencil-like beam on target

Register $\pi^\pm, K^\pm$ particles that exit the target

Compute the production cross-section:

Assume symmetry around the beam axis

Number of particles at i^{th} p_T bin and j^{th} p_L bin

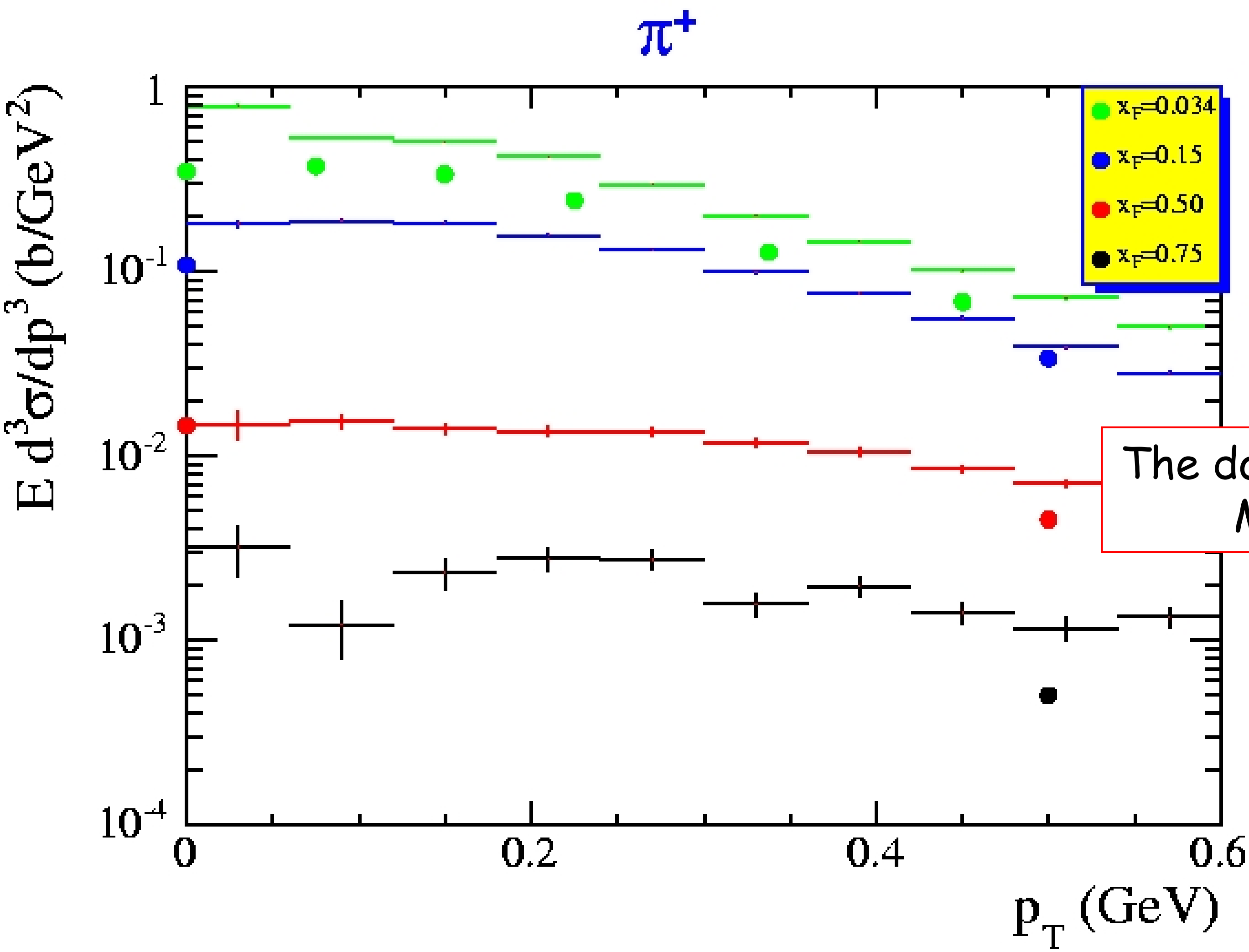
$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi}\frac{E}{p_T}\frac{A}{N_{pot}\,\rho N_A L_{equ}}\frac{n_{ij}}{\left(\Delta p_{T_i}\right)\left(\Delta p_{L_j}\right)}$$

Bin widths

For Beryllium: A = 9g/mol, $\rho = 1.85$ g/cm^3, N_A = 6 10^{23}/mol

$L_{equ} = \lambda_p f(L=100\text{mm})$ = 82mm with f(L) Eq.7 Ambrosini et al. CERN-EP/99-19

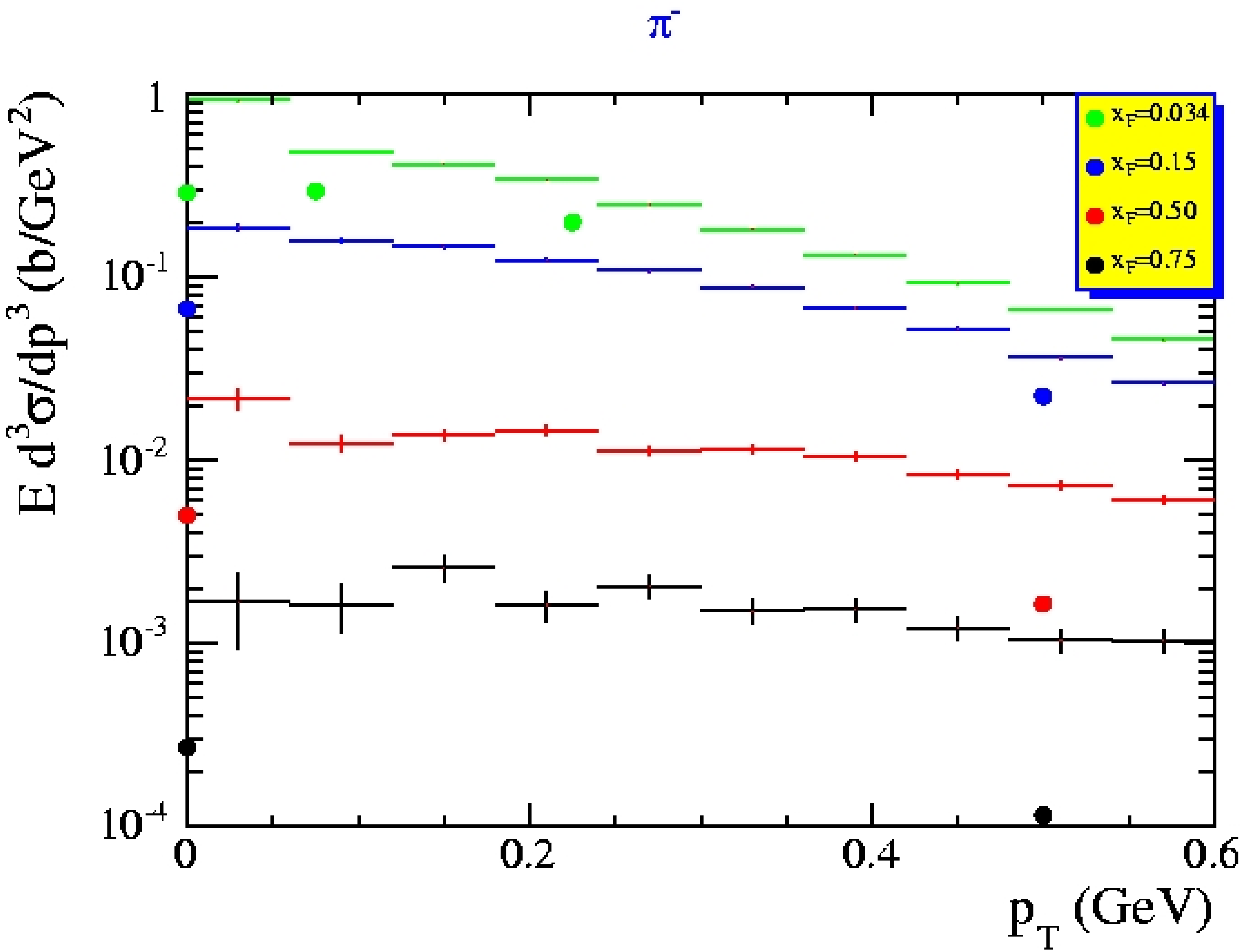
Results with G4



$x_F = p/p_{Beam}$

The dots are from Tab. 1 of M. Bonesini et al.

Results with G4 (cont'ed)



M. Bonesini et al. parameterization (BMPT)

$$(E \times \frac{d^3\sigma}{dp^3}) = A(1 - x_R)^\alpha (1 + B x_R) x_R^{-\beta} \times$$
$$(1 + a'(x_R) p_T + b'(x_R) p_T^2) e^{-a'(x_R) p_T}$$

where $a'(x_R) = a/x_R^\gamma$ and $b'(x_R) = a^2/2x_R^\delta$. π^+, K^+

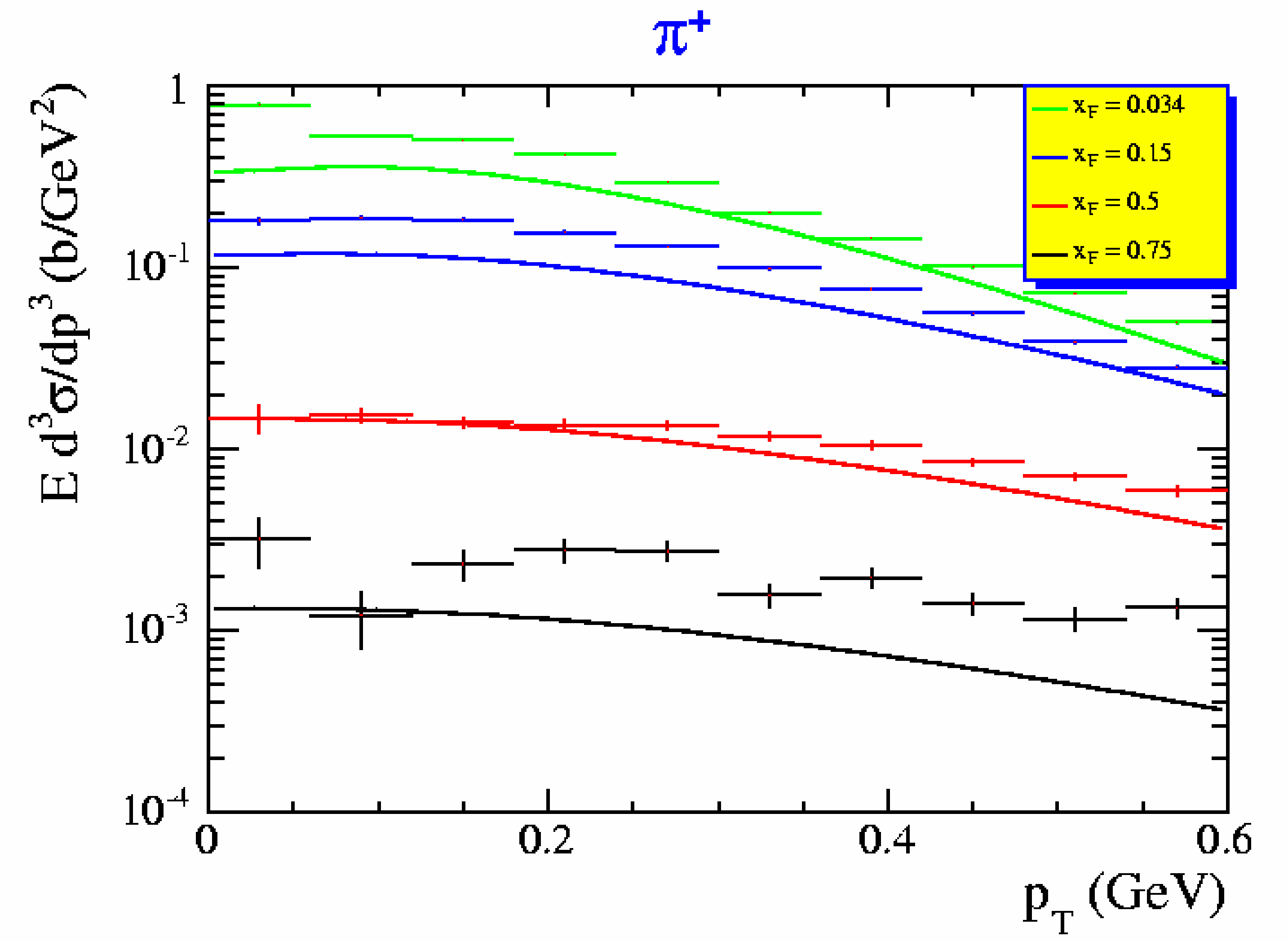
$x_R \sim p/p_{proton}$

$$r(\pi) = r_0 \cdot (1 + x_R)^{r_1}$$
$$r(K) = r_0 \cdot (1 - x_R)^{r_1}$$

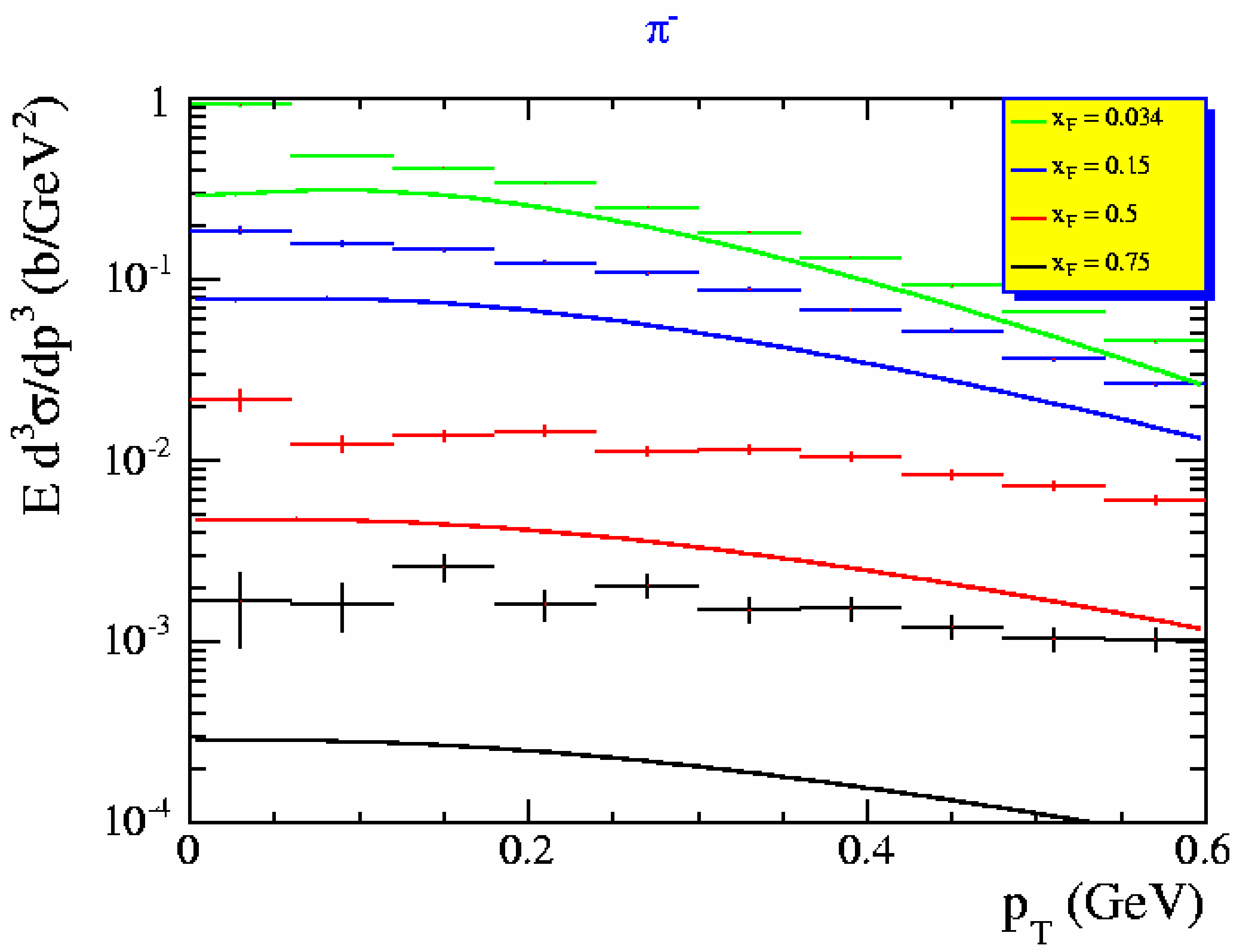
π^-/π^+, K^-/K^+

Parameters fit on SPY & Na20 data and then allows one to extrapolate to other use cases: diff. proton energy, diff. target material.

Geant4/QGSP vs BMPT



Geant4/QGSP vs BMPT (cont'ed)

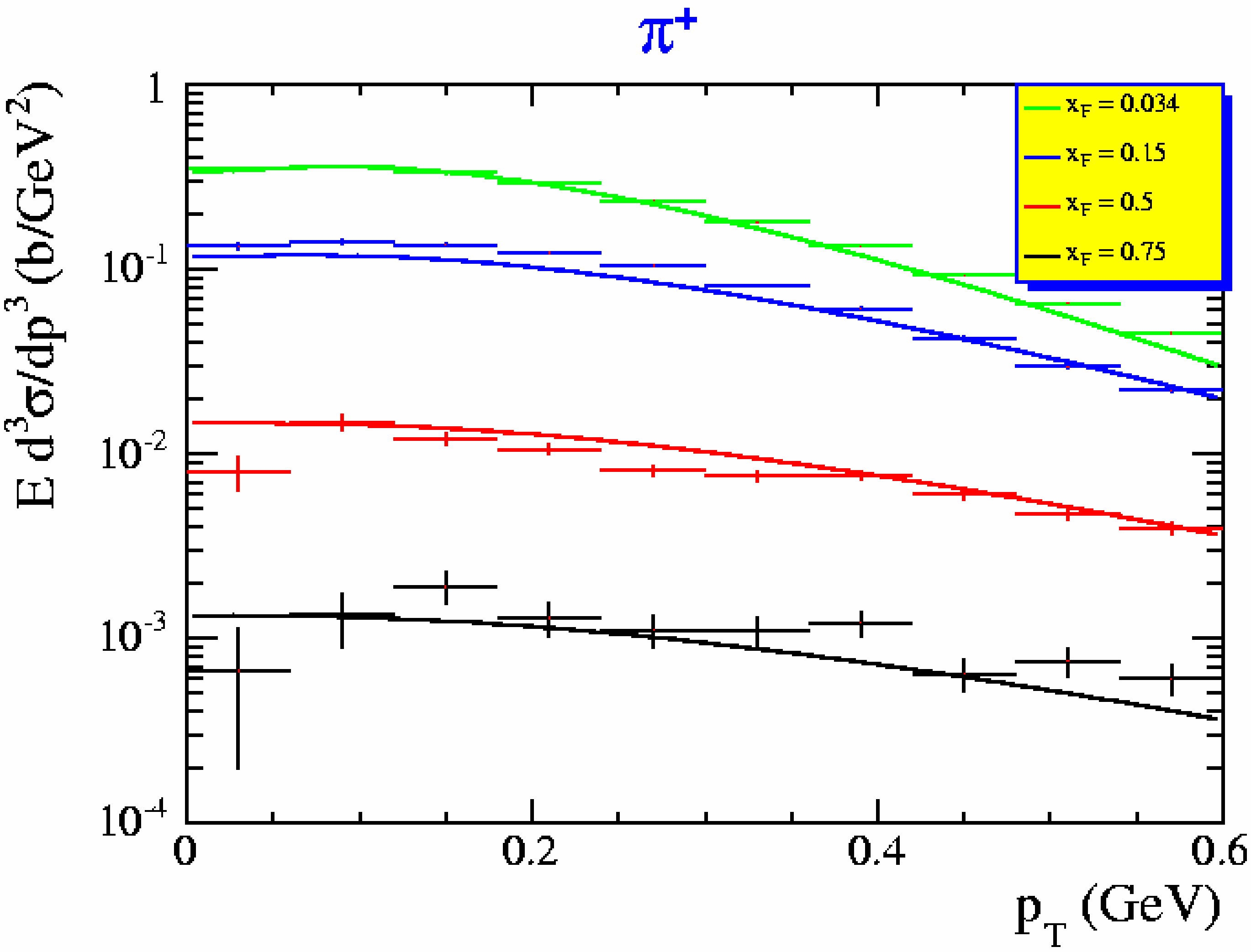


Fluka vs BMPT ?

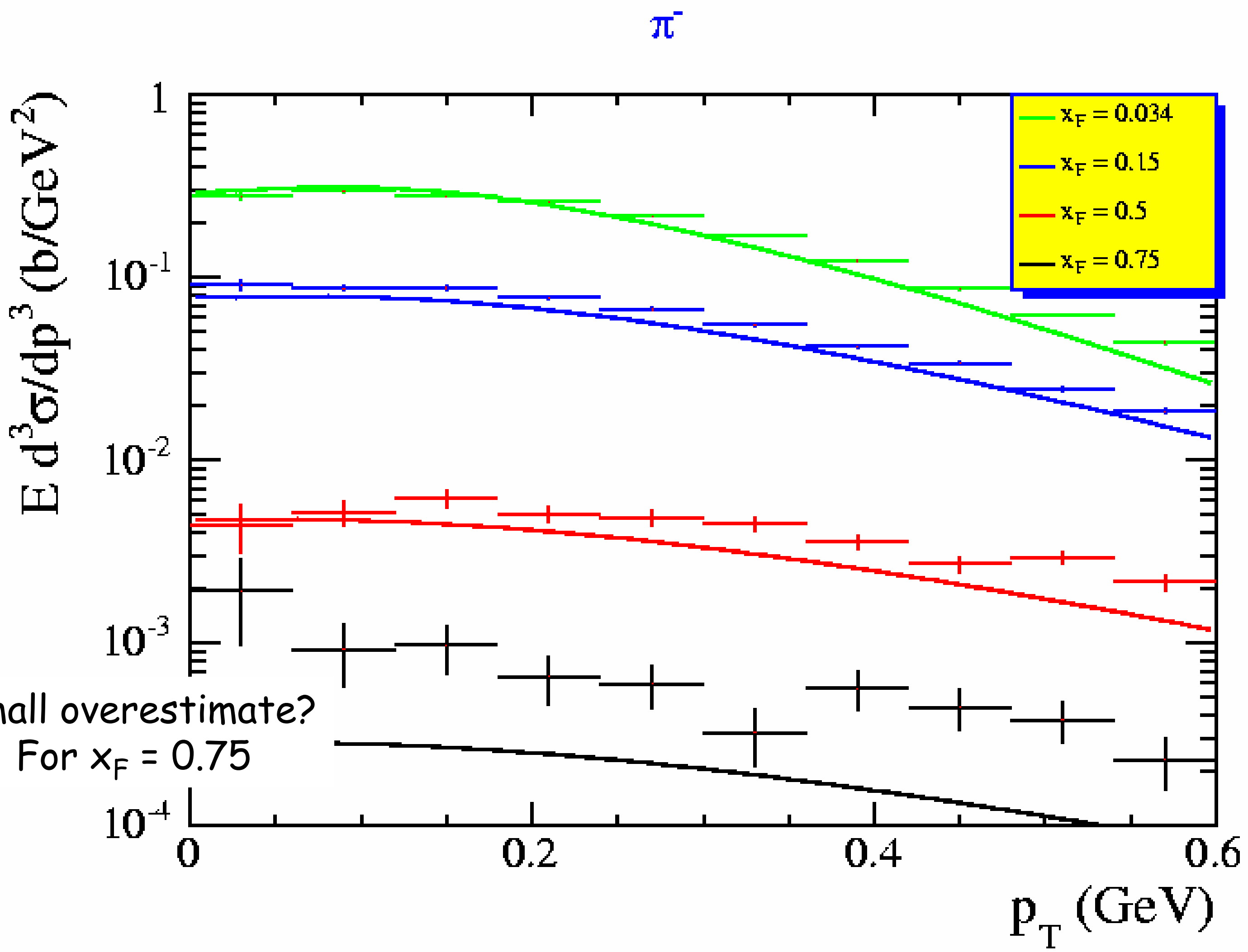
As there is a significant disagreement between G4/QGSP and SPY data and also BMPT parameterization, one can question the cross-section computation.

Use Fluka in the same beam & target conditions and compute the cross-section exactly as previously.

Fluka vs BMPT



Fluka vs BMPT



Small overestimate?
For x_F = 0.75

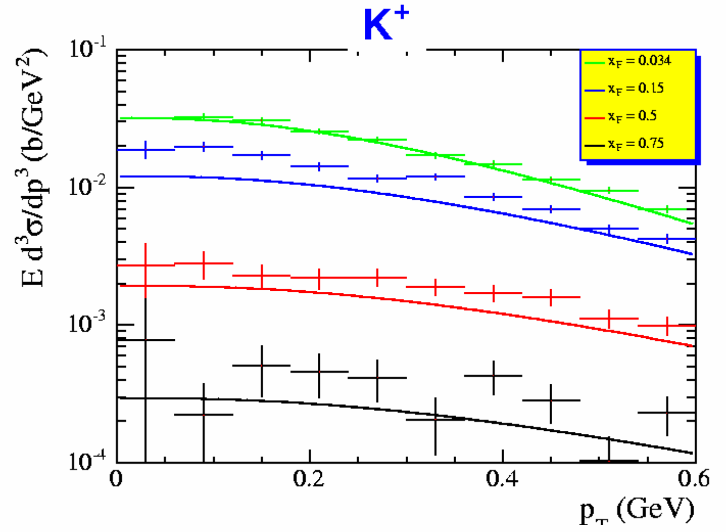
Preliminary conclusions

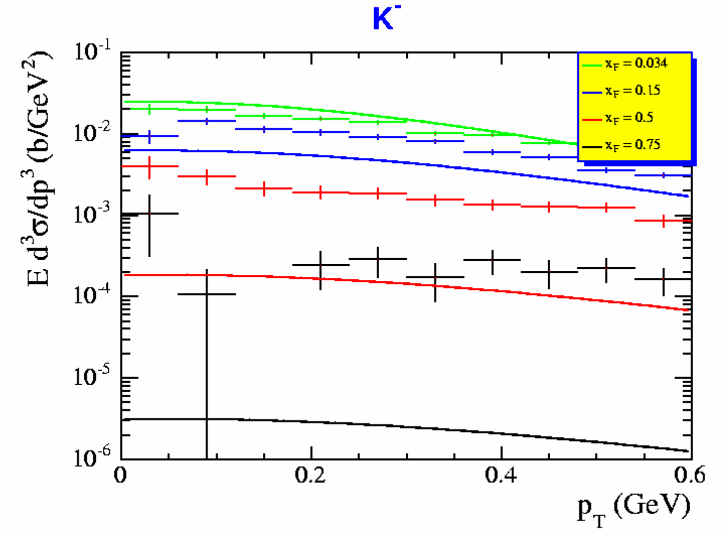
1. The computation of the cross-section is correct;
2. Fluka 2003.1b reproduces quite well the SPY-BMPT parameterization;
   - One may wander if Fluka is using the BMPT parameterization in some way?
3. Geant4/QGSP fails:
   - Need some expertise from G4 Team to see if I do not make a misuse of G4 and/or QGSP.

Extra

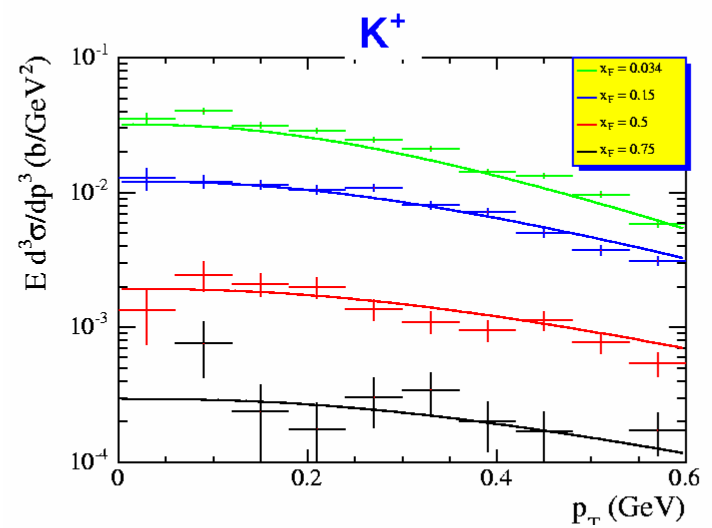
Kaons
(SPY use case)

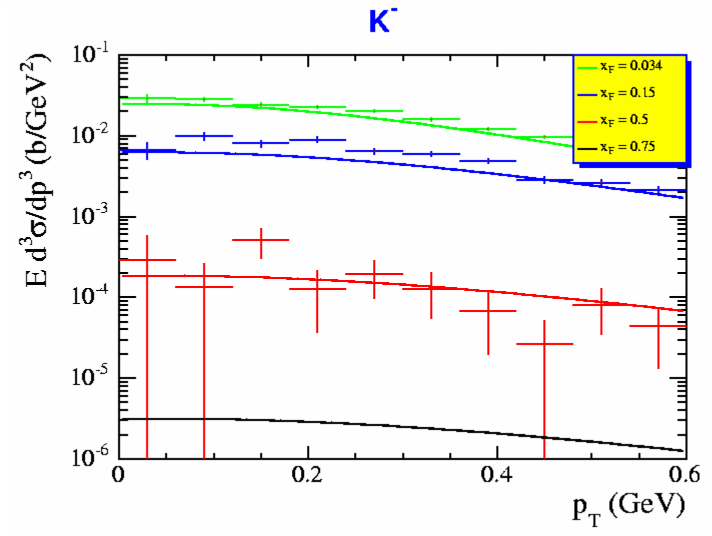
G4/QGSP



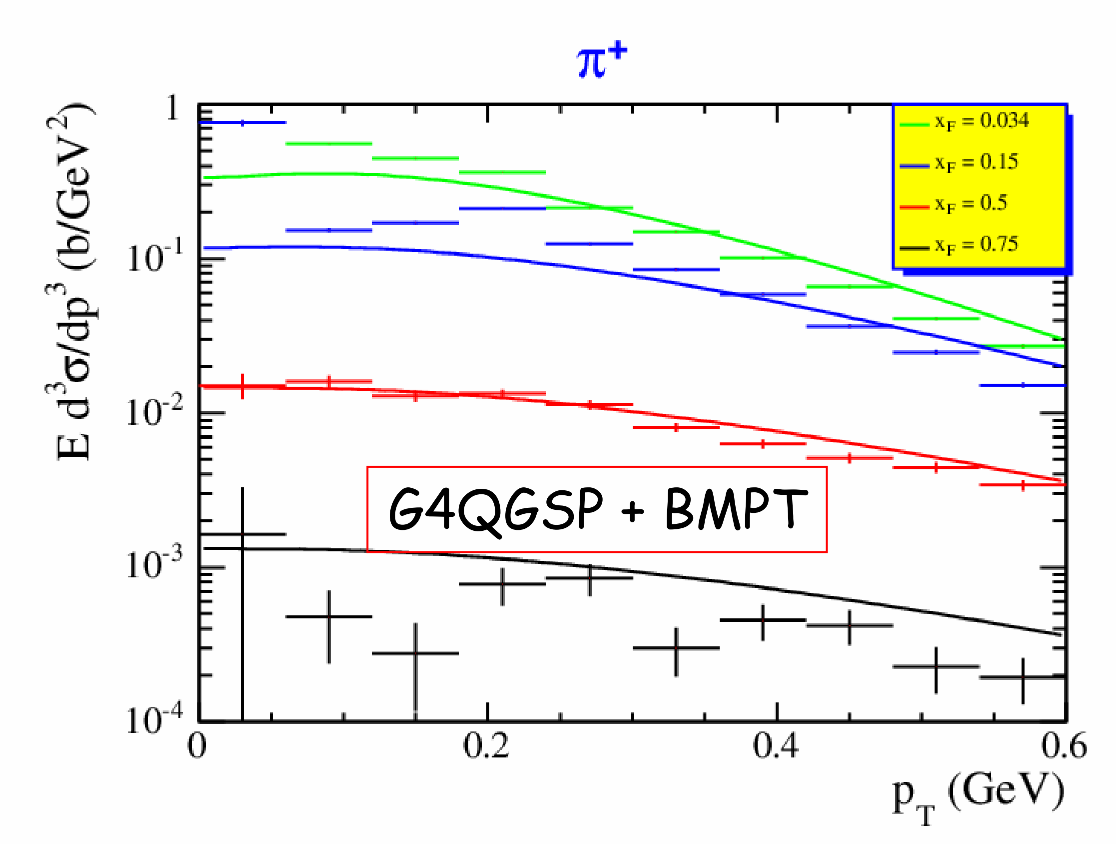


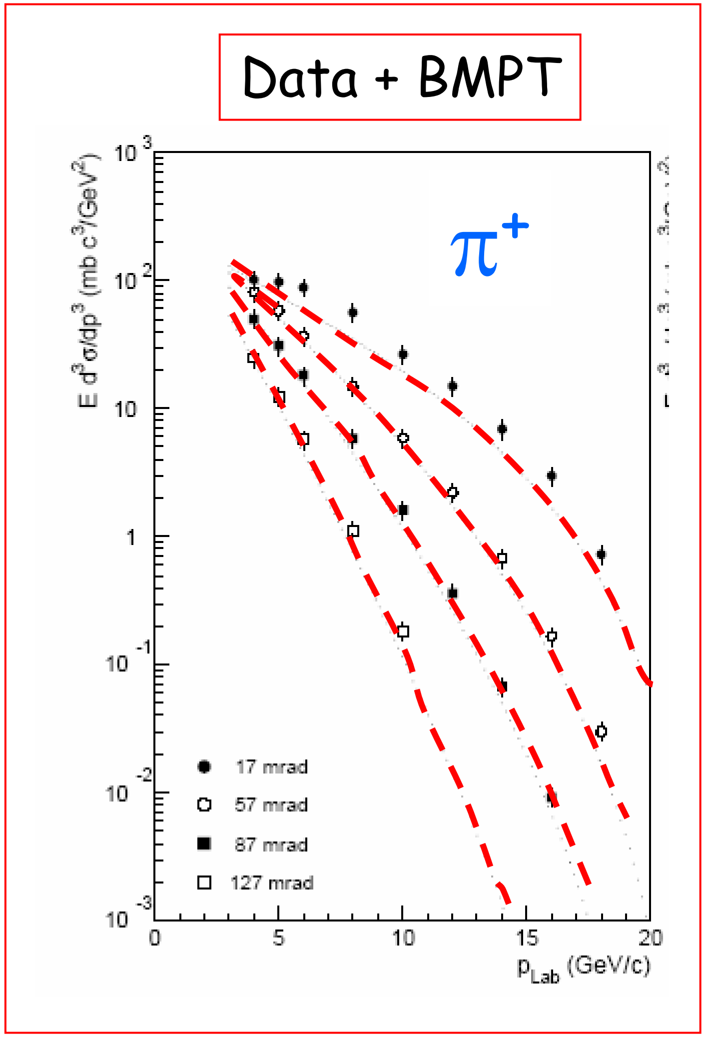
Fluka





p(24 GeV/c) → Be
(Eichten et al. NP B44(92)333.)





p(24 GeV/c) → Be (cont'ed)

G4QGSP + BMTP