Femtoscopy in $\sqrt{S_{NN}} = 7\ TeV$ p-p collisions with Pythia8

Sotarriva Álvarez Isaí Roberto

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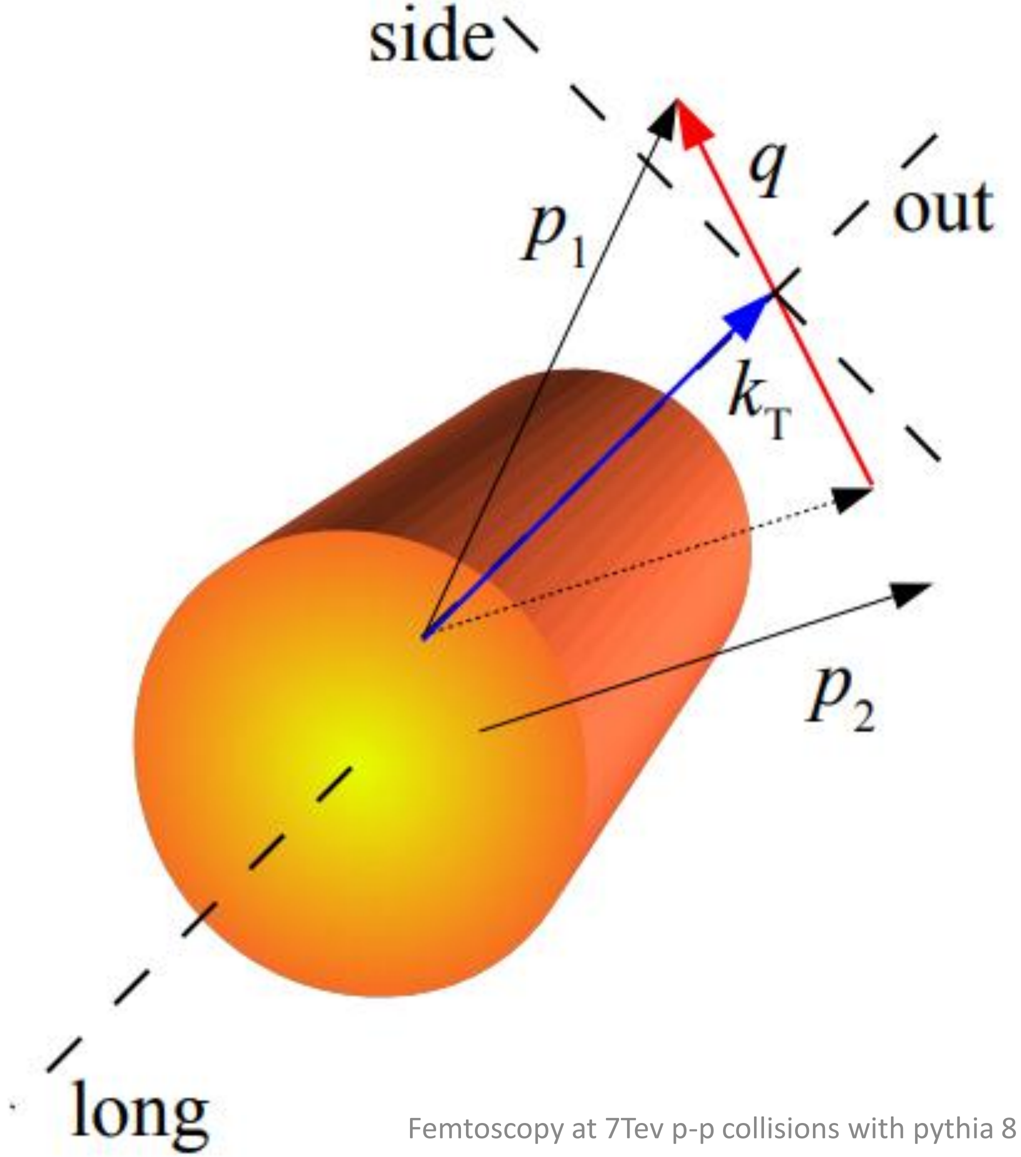
Instituto de Ciencias Nucleares UNAM

Motivation

- The HBT correlations play an important role in measuring the spatio-temporal scale of a reaction during a high energy collision.
- Reconstruct the size of the reaction using information both from the same event (correlated pairs) and different events (uncorrelated pairs) using the technic known as event mixing.
- Explore the kT dependence of the measured size of the reaction.

Physical meaning and motivation

- Q → Give us an idea of the overall size of the reaction
- Qout →The radius of the reaction (cylinder)
- Qlong →The length of the reaction (cylinder)
- Qside →perpendicular to both Qout and Qlong
- We can also use this information to extract the "temporal size" of the reaction.



HBT effect implementation on Pythia8

The Bose-Einstein effect is simulated by pythia using the BE_32 algorithm, which take place after the entire event is simulated. The process begins by cloning all the original particles marking them as decayed (isFinal=false) and their copies including the effect with positive status code (isFinal=true)

The algorithm first pull each pair of particles closer to each other to simulate the effect of interference (momentum is conserved, energy no). The second step of the algorithm is to push the particles apart in a way that restores the energy conservation.

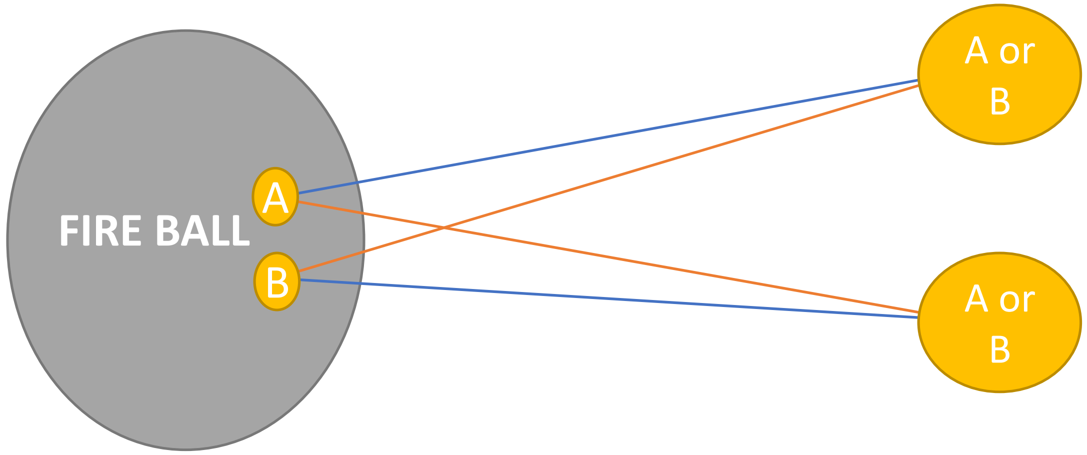
The algorithm intend to reproduce the next distribution:

$$f_2(Q) = (1 + \lambda \cdot \exp(-Q^2 R^2)) \cdot (1 + \alpha \cdot \lambda \cdot \exp(-Q^2 R^2/9) \cdot (1 - \exp(-Q^2 R^2/4)))$$

The simulation is driven by 3 main parameters: lambda, Qref and widthSep.

Introduction

- The theory is based on the HBT interference, originally the idea was conceived for light but an also be applied to particle collision and astrophysics.



$$C(p_1, p_2) = \frac{\frac{dN_{12}}{d^3p_1 d^3p_2}}{\frac{dN_1}{d^3p_1}\frac{dN_2}{d^3p_2}}$$

Bassically wath we are seeing here is the interference of two identical particles. On the upper side of the equation we have the expresion corresponding to the measurement of the function of both particles(incluiding both particles). On the bottom of the ecuation we have the terms related to evaluate the functions separatelly.

Introduction

$$C(q) = \frac{S(q)}{B(q)}$$

$$q = |pT_A - pT_B|$$

$$kT = \frac{pT_A + pT_B}{2}$$

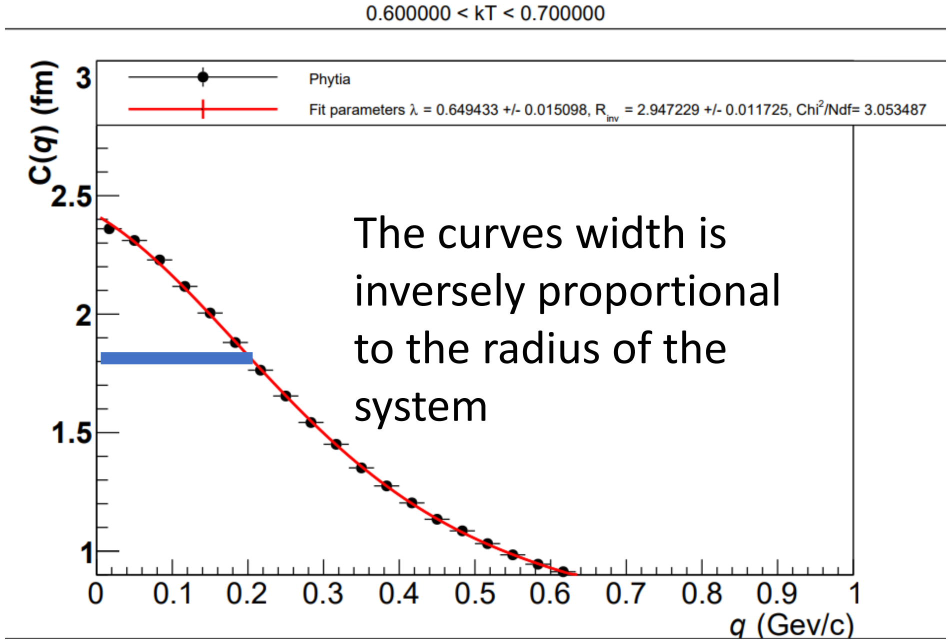
S(q) is the normalized signal from the event.

B(q) is the normalized background from the event.

B(q) is exactly equal to the signal S(q) except for the correlations

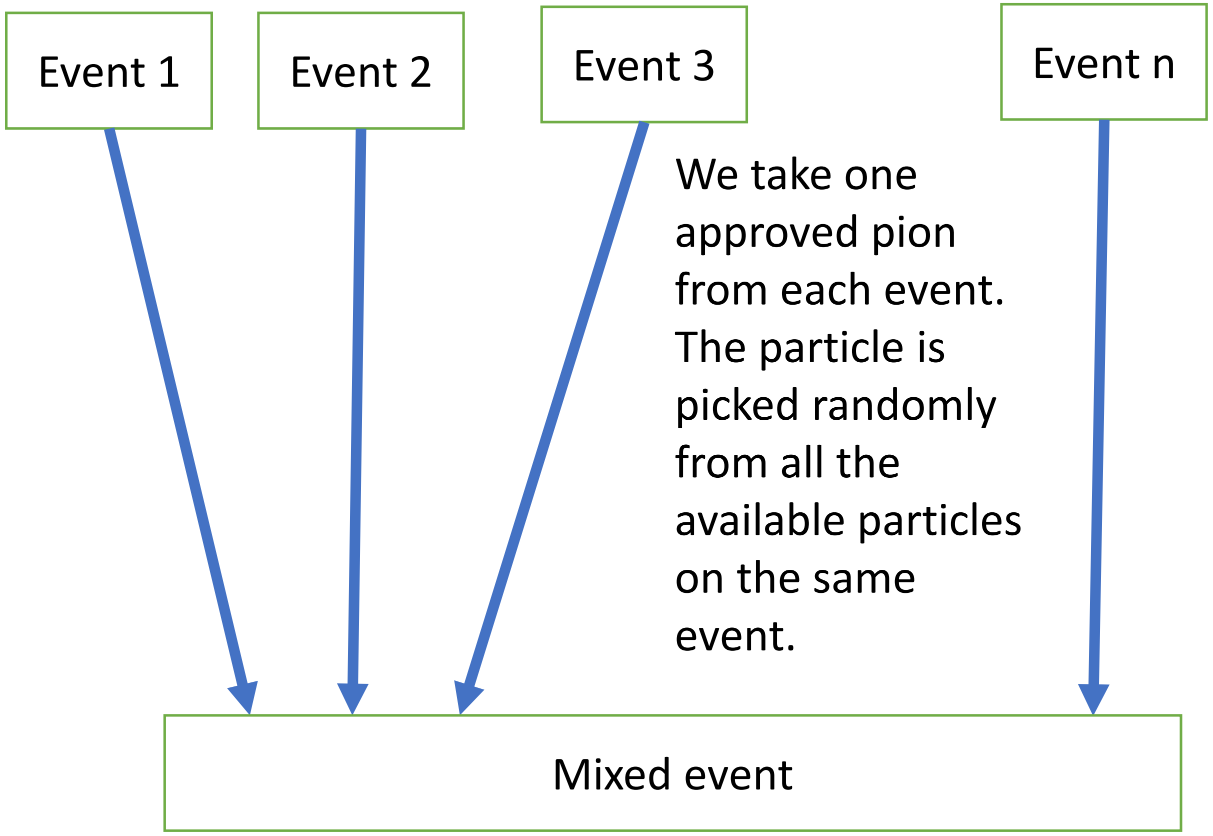
$$C(q) = \left(1 + \lambda e^{-(Rq)^2}\right) D(q)$$

D(q) is a polynomy, in theory it should be 1 but on the practice, the results are better modelled by D(q) a second degree polynomy.



The curves width is inversely proportional to the radius of the system

Mixed events (Background)



*An aproved pion have 0.14(GeV/c)<pT<2(Gev/c), $|\eta|<0.8$ and Pythia.isFinal=true

The number n of particles (approved pions) per mixed event follows the same probability distribution as the number of approved pions on a single event.

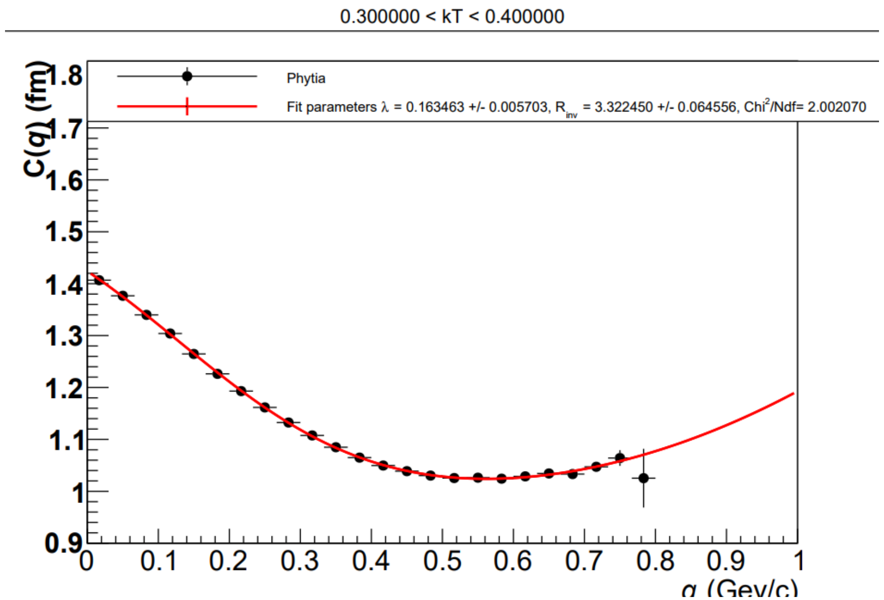
A mixed event resembles a normal event on every way except for one thing the particles are no correlated between them because they come from different events.

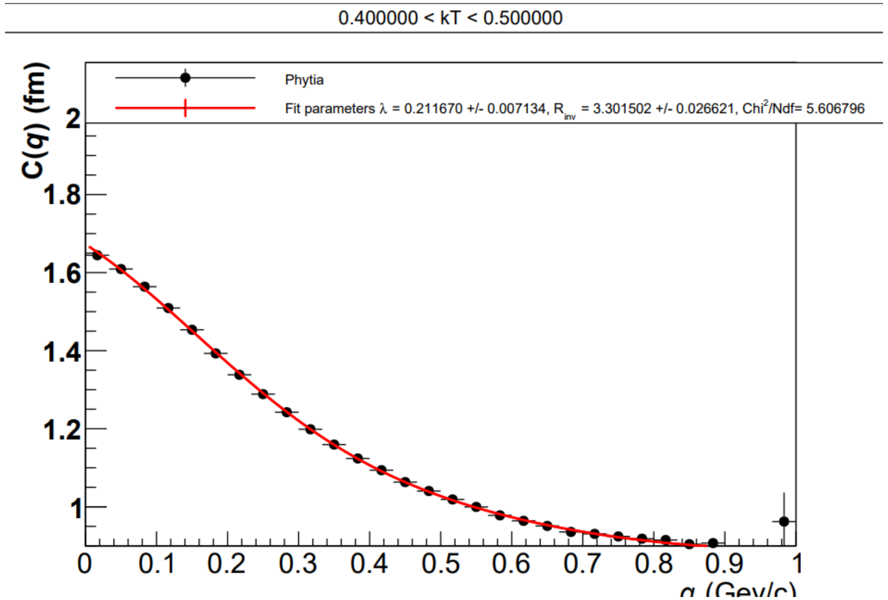
It works as background for HBT correlations.

Results

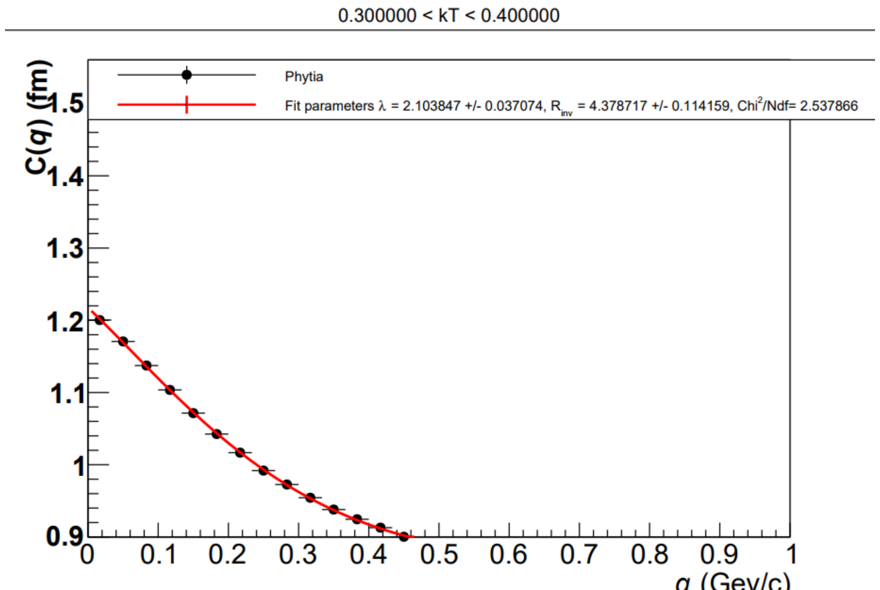
kT 0.3-0.4 GeV/c | **kT 0.4-0.5 GeV/c**

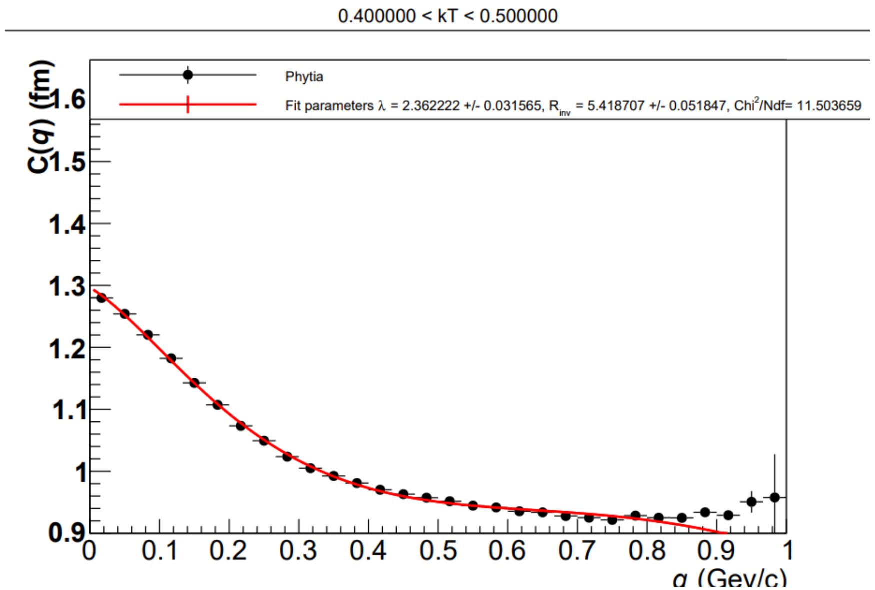
Qref=1





Qref=0.75



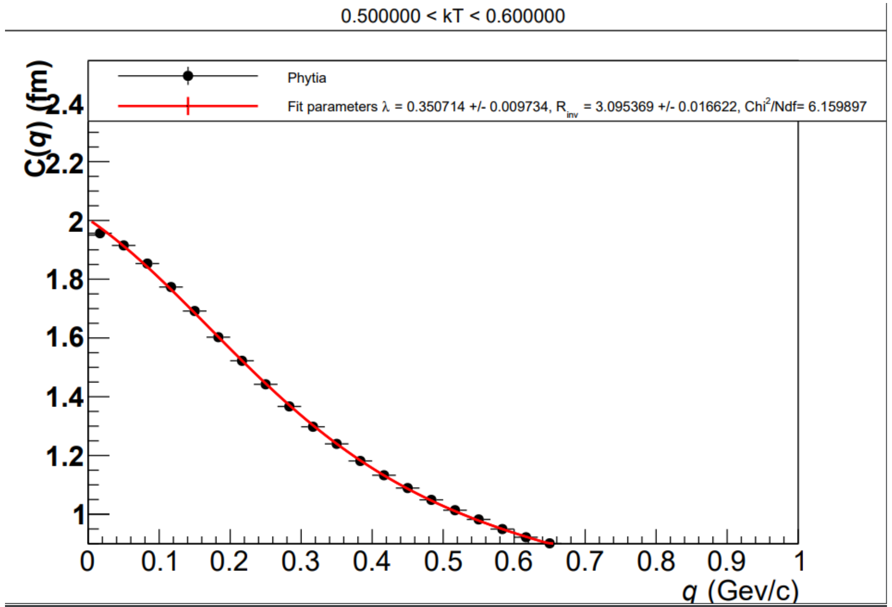


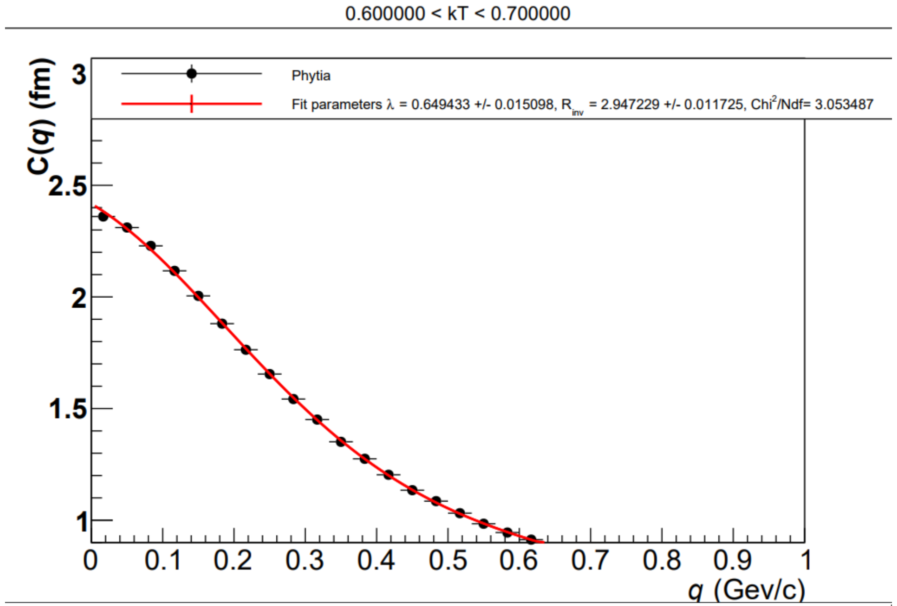
Results

kT 0.5-0.6 GeV/c

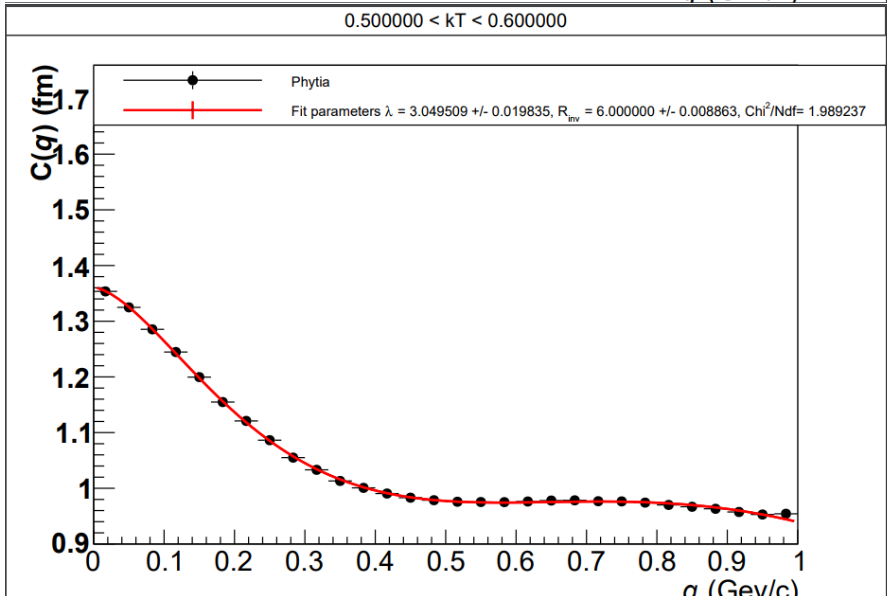
kT 0.6-0.7 GeV/c

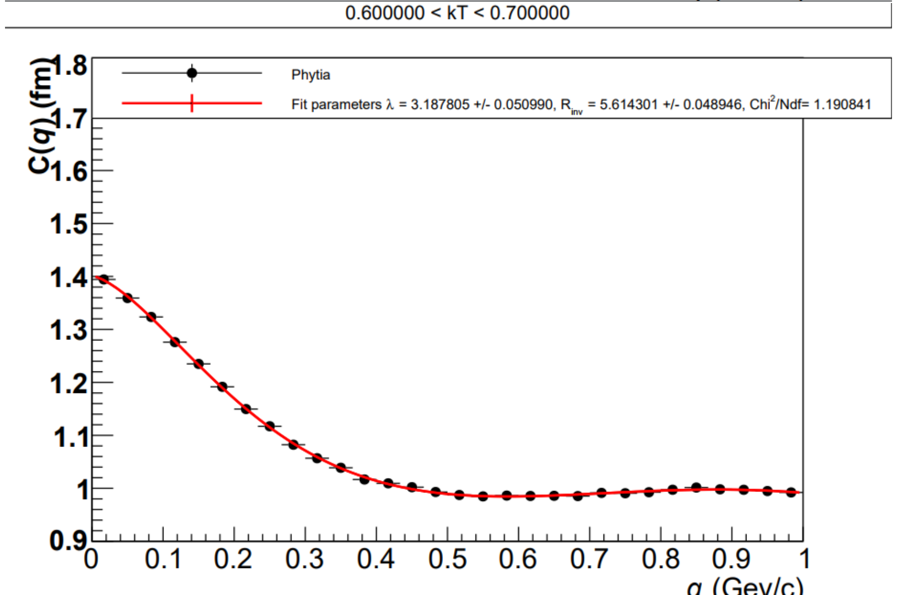
Qref=1





Qref=0.75

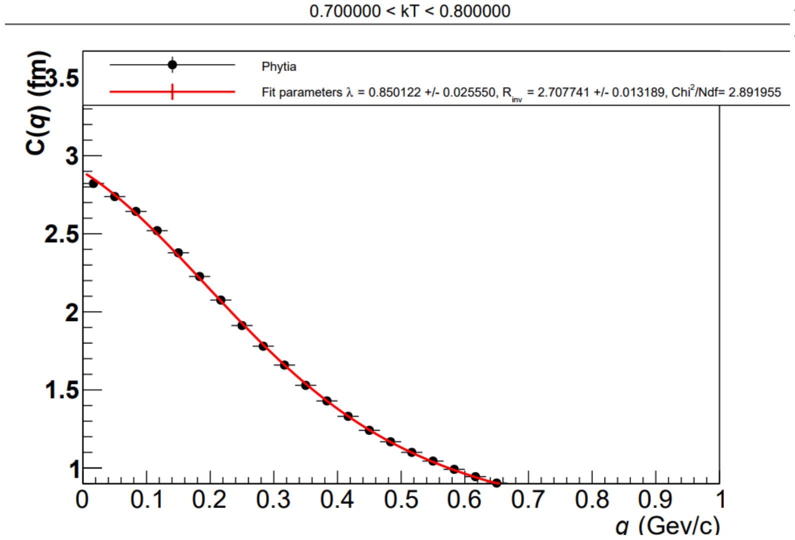


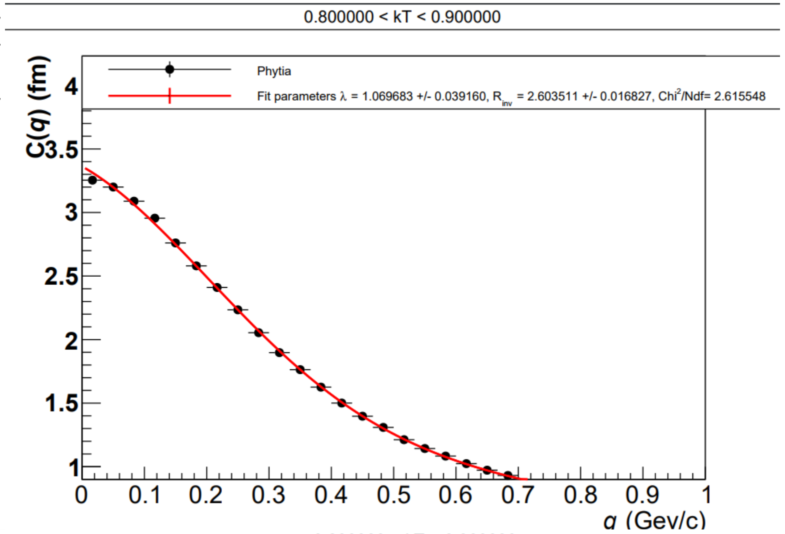


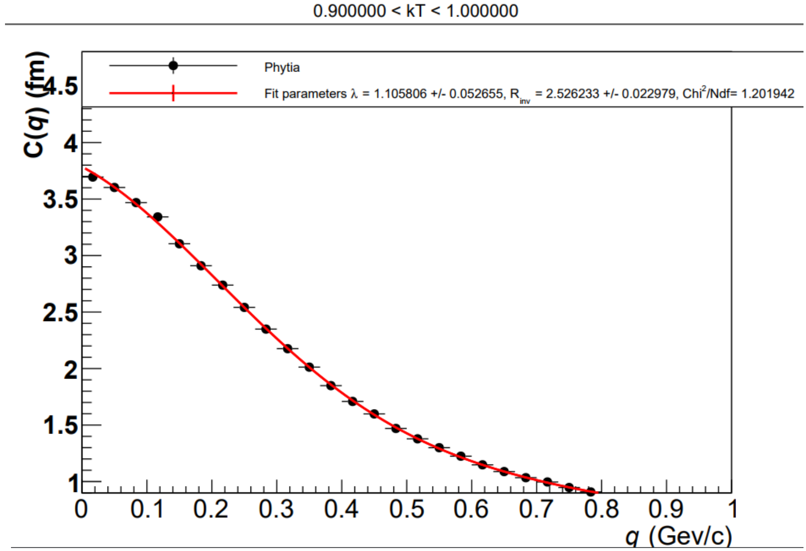
Results

kT 0.7-0.8 GeV/c | **kT 0.8-0.9 GeV/c** | **kT 0.9-1.0 GeV/c**

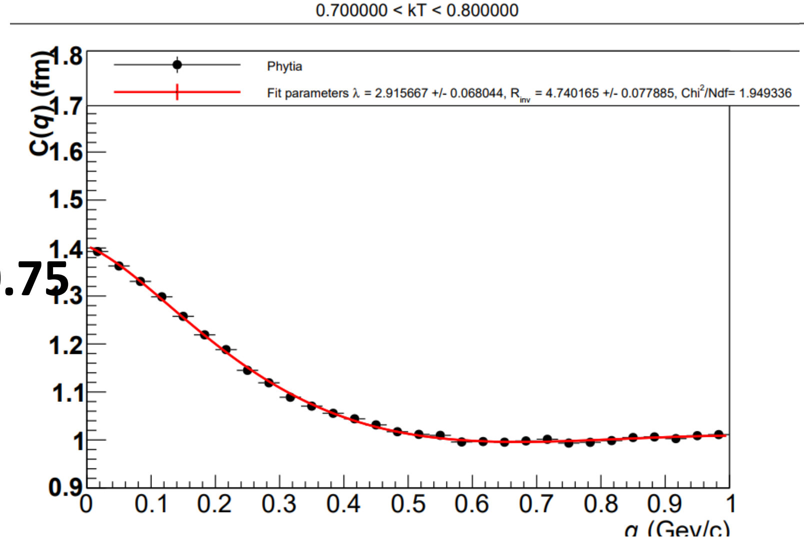
Qref=1

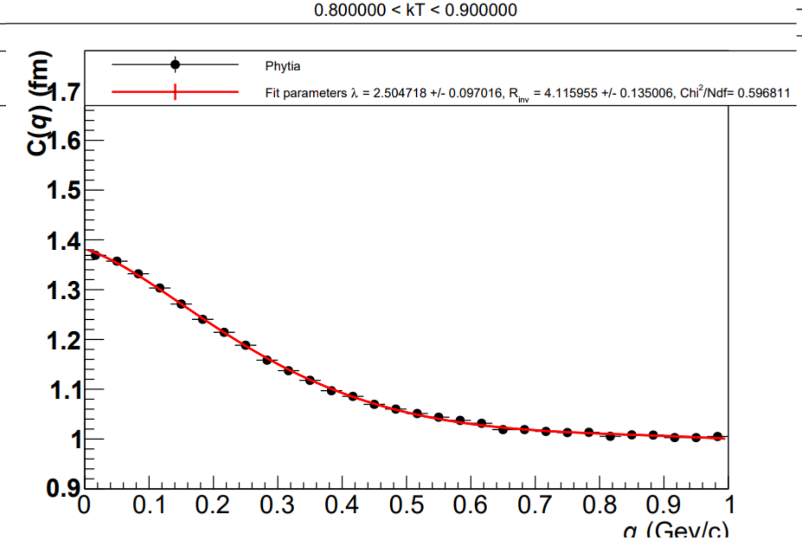


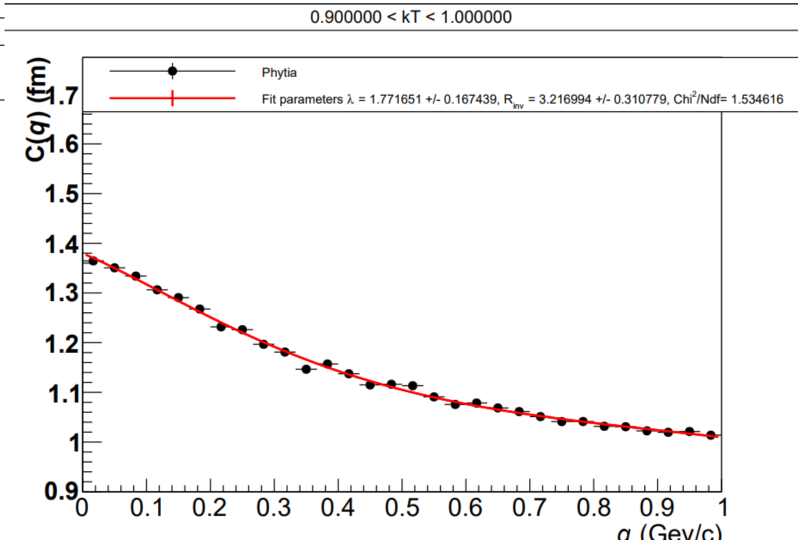




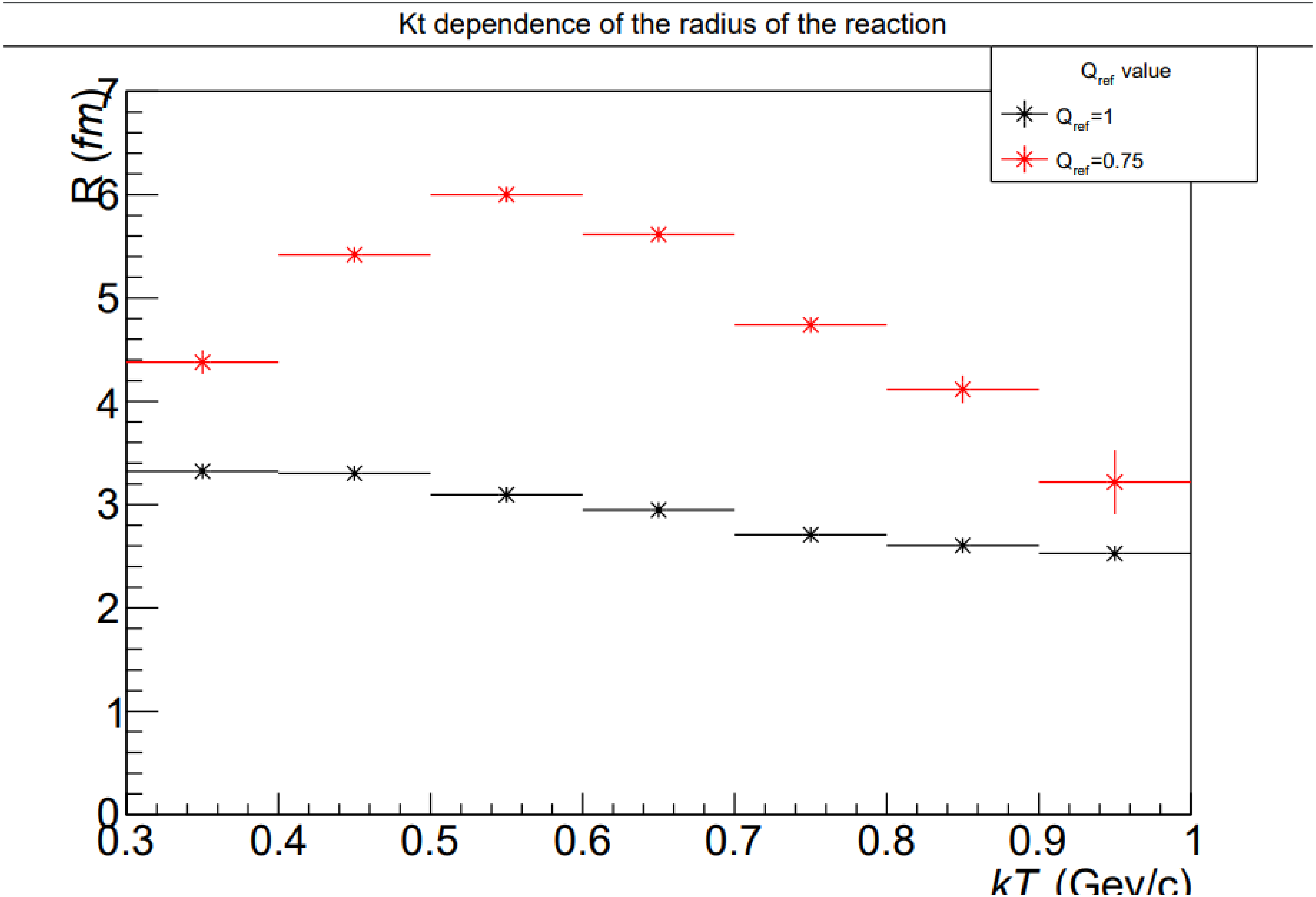
Qref=0.75







Results



Kt dependence of the radius of the reaction
Qref value
Qref=1
Qref=0.75
R (fm)
0
1
2
3
4
5
6
7
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
kT (Gev/c)