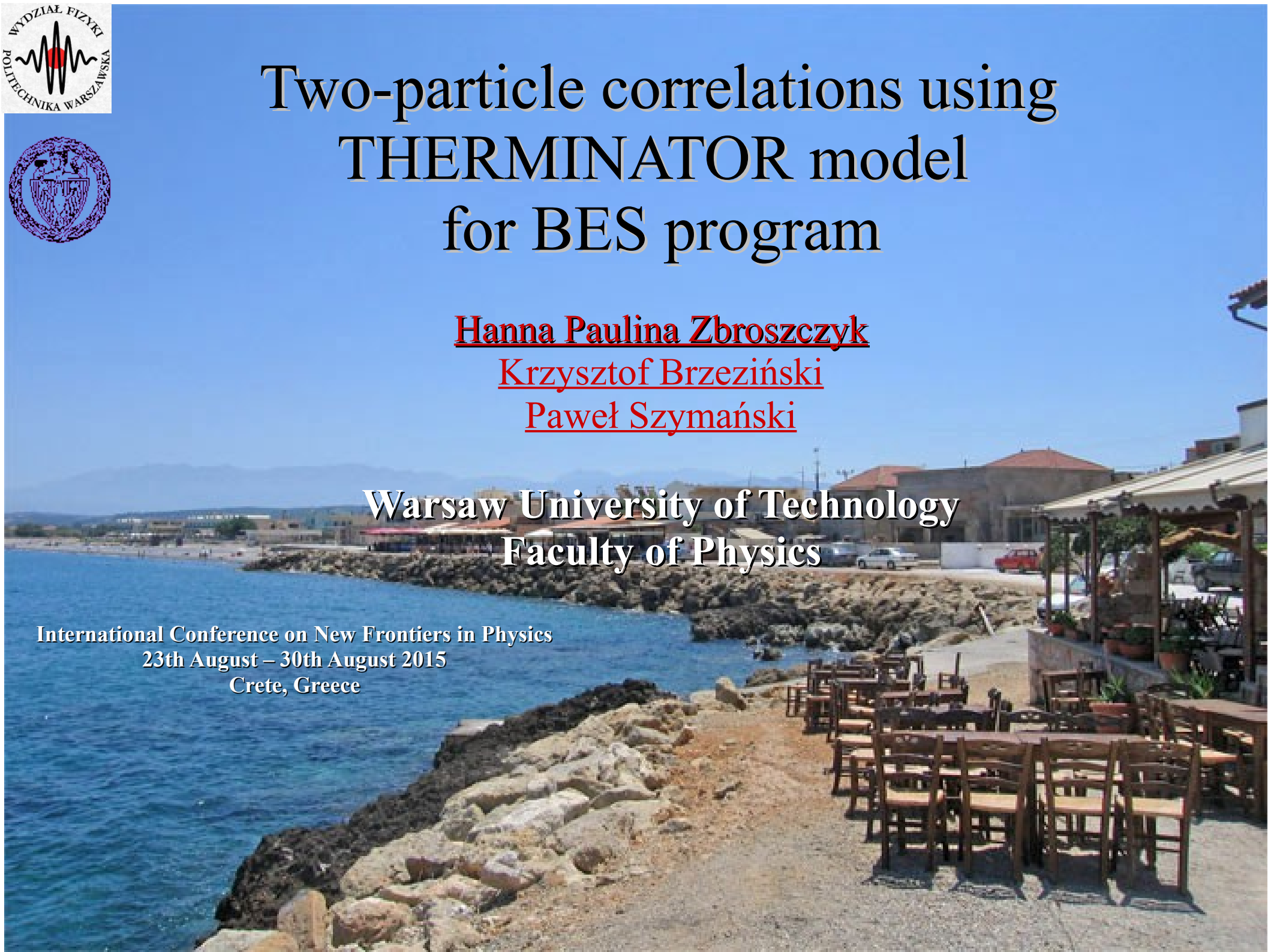

Two-particle correlations using THERMINATOR model for BES program

Hanna Paulina Zbroszczyk
Krzysztof Brzeziński
Paweł Szymański

Warsaw University of Technology
Faculty of Physics

International Conference on New Frontiers in Physics
23th August – 30th August 2015
Crete, Greece

Outline

1) Introduction to THERMINATOR generator

2) BES program

3) THERMINATOR for BES

3) Single particle distributions

4) Two-particle correlations

5) Summary and conclusions

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1) Introduction to THERMINATOR generator

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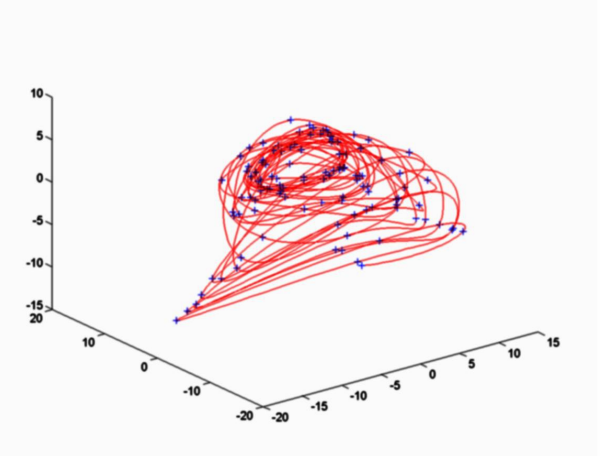
Phenomenological models

macroscopic

- No consideration of the dynamics of individual objects in detail
- Statistical description of multiparticulate system



Phenomenological models

microscopic

- Dynamic simulation of the collision process inspired by QCD
- Tracking of individual objects
- Propagation of individual particles through a cascade of collisions and decays

macroscopic

- No consideration of the dynamics of individual objects in detail
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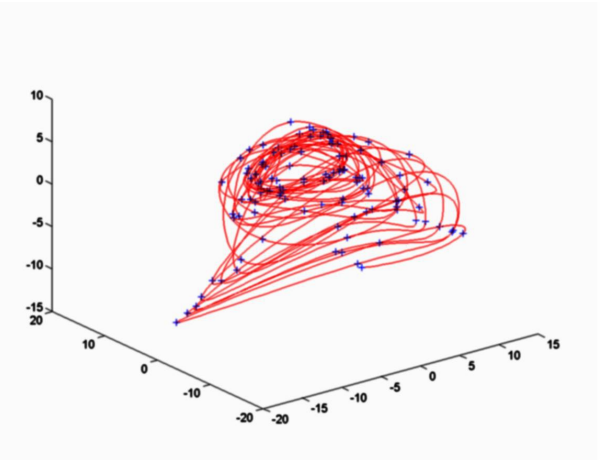

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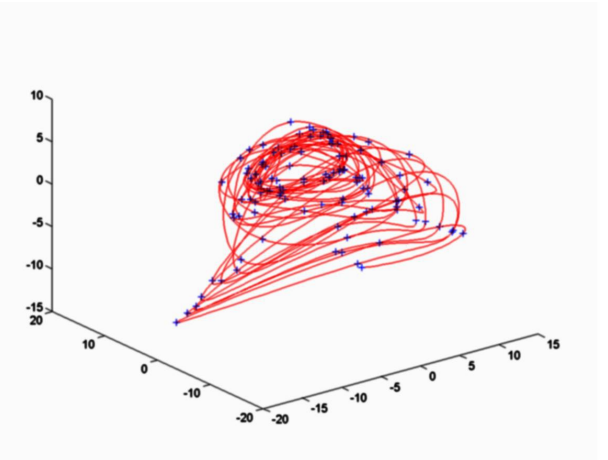

What about generators?

THERMINATOR generator

- Generates collisions of relativistic ions
- Uses Monte Carlo methods
- Implements thermal models of particle production with single freeze-out

THERMINATOR: THERMal heavy-IoN generATOR
A. Kisiel,T. Tałuć, W. Broniowski, W. Florkowski.
Comput.Phys.Commun. 174 (2006) 669-687

pszymanski@alix2:/data/users/pszymanski/THERMINATOR/Therminator

```
#* accessibile at: http://www.arxiv.org/nucl-th/0504047                      *
#*                                                                           *
#* Homepage: http://hirg.if.pw.edu.pl/en/therminator/                        *
#*                                                                           *
#* This code can be freely used and redistributed. However if you decide to  *
#* make modifications to the code, please contact the authors, especially    *
#* if you plan to publish the results obtained with such modified code.      *
#* Any publication of results obtained using this code must include the      *
#* reference to nucl-th/0504047 and the published version of it, when        *
#* available.                                                                *
#*                                                                           *
#*****************************************************************************

### This is the Therminator input file ###
# Therminator behaviour is controlled trough this file
# Please fill in all the neccessary values

# Number of events to generate
NumberOfEvents = 500

# Start each event with a new random seed taken from current time
Randomize = 1

# The type of input tables
# Now available:
# SHARE - input files from SHARE
TableType = SHARE

# Specify in which directory the SHARE input fils are
InputDirSHARE = ./share

# Name of the file to store the events in
EventOutputFile = event.out

# The model of freeze-out to use
# Now available:
# SingleFreezeOut
# BlastWaveVT
FreezeOutModel = BlastWaveVLinear

# Values of parameters of the BlastWave model
# used only when this FreezeOutModel is selected
# Flow velocity
BWVt = 1.23
BWA = -0.5

# Parameters common to both models
# proper time at freeze-out [fm]
Tau = 8.55
# maximum transverse radius [fm]
RhoMax = 5.7555
# Temperature [GeV]
Temperature = 0.161

# Chemical potentials for Isospin, Strangeness, Barion [GeV]
MiuI = -0.0009
MiuS = 0.0069
MiuB = 0.304

# Ranges of integration for z-variables
AlphaRange = 8.0
RapidityRange = 4.0

# Number of samples used in multiplicity and max. integrand determination
NumberOfIntegrateSamples = 1000000
```

pszymanski@alix2:/data/users/pszymanski/THERMINATOR/Therminator

```
#* accessibile at: http://www.arxiv.org/nucl-th/0504047                  *
#*                                                                       *
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```

Input file takes following information:

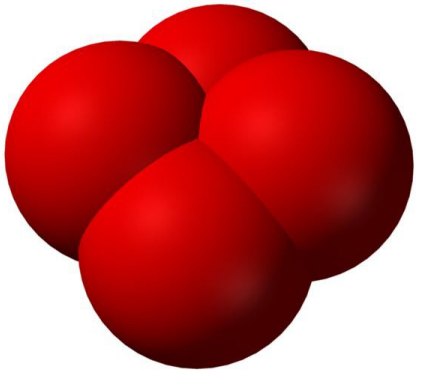
- The number of events
- Parameters:
  - Temperature [GeV]
  - μ_B, μ_S, μ_I [GeV]
  - BW V_t
  - τ, ρ_{max}

Therminator generator – input parameters

- Temperature (T) and chemical potentials:
  barion (μ_B), strangeness (μ_S), third component of isospin (μ_I) – thermodynamic parameters

- BWVt – a parameter specific to the Blast-Wave model, denoting velocity

- Tau, RhoMax – geometric parameters



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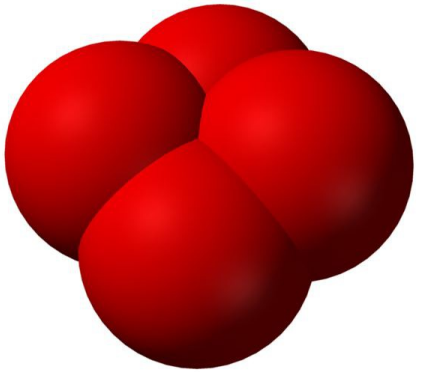

BWVt, Tau and RhoMax affect the produced particles

The relation between RhoMax and Tau is:

$$\rho_{max} \cdot \tau = V$$

V is the volume of the source

Therminator generator – output file

```
Therminator text output
all_particles_p_x
Therminator
1       5255    0.000   0.000
     0   5218      -1.659721e+00  -8.599909e-02  -8.989090e+00  9.414261e+00   2.250000e+00   -1.674057e+01  -8.735474e+00  -1.038539e+02  1.092653e+02
     1   8901      -1.365788e+00  -1.308702e+00  -9.974298e+00  1.035207e+01   2.025000e+00   -1.416694e+01  -2.056895e+01  -1.480015e+02  1.511954e+02
     2   119       4.258143e-01   1.658937e+00   -8.952060e+00  9.334289e+00   2.014000e+00   6.166333e+00   2.925372e+01   -1.211237e+02  1.244207e+02
     3   119       5.052830e-01   7.597097e-01   6.615291e-01   2.307875e+00   2.014000e+00   -9.244704e+00  1.526590e+00   1.099618e+01   4.024736e+01
     4   20225     8.952667e-01   9.118563e-01   5.929226e-01   2.455333e+00   2.011000e+00   2.588561e+01   1.480875e+01   3.867890e+00   2.875127e+01
     5   2118      -2.037936e+00  1.593500e-02   -4.241002e+00  5.093332e+00   1.950000e+00   -2.939204e+01  1.186835e+01   -5.618252e+01  6.257472e+01
     6   -67000    7.313909e-01   -1.093284e+00  3.687565e-01   2.380900e+00   1.950000e+00   1.890986e+01   -1.665551e+01  8.482258e+00   3.194812e+01
     7   -23114    -1.024778e+00  1.095195e+00   -4.763472e+00  5.357601e+00   1.940000e+00   -1.937354e+01  -1.537002e+00  -8.306537e+01  8.963512e+01
     8   -23214    -9.544941e-01  1.144178e+00   6.372825e+00   6.826178e+00   1.940000e+00   -2.333213e+01  1.075778e+01   4.539638e+01   5.472127e+01
     9   11116     1.047349e+00   -5.057926e-01  4.519443e+00   5.050052e+00   1.930000e+00   3.645622e+00   -1.312381e+01  9.131405e+01   9.837241e+01
    10   -11216    3.572342e-01   1.010360e+00   -2.074199e+00  3.029133e+00   1.930000e+00   1.053371e+01   2.620443e+01   -2.753442e+01  4.019270e+01
    11   -12126    9.490886e-01   -7.437465e-01  -1.335749e+00  2.638760e+00   1.930000e+00   3.013673e+01   -9.927932e+00  -1.051130e+01  2.947410e+01
    12   -12126    1.290726e+00   1.557681e+00   -7.139890e+00  7.667808e+00   1.930000e+00   6.156516e+00   9.234727e+00   -1.031000e+02  1.098288e+02
    13   22114     5.732440e-01   -7.823673e-01  -4.885746e-01  2.205859e+00   1.920000e+00   1.448873e+01   -5.920079e+00  -2.681964e+01  4.455212e+01
    14   22114     -3.901486e-01  -3.418125e-01  -2.949353e+00  3.557265e+00   1.920000e+00   -9.927925e+00  -1.163103e+01  -1.136871e+02  1.191771e+02
    15   13216     -1.223497e+00  8.021664e-01   3.098639e+00   3.925456e+00   1.915000e+00   -2.190540e+01  -4.760386e+00  6.497287e+01   7.251098e+01
    16   13226     -1.500176e+00  1.976538e+00   -1.267330e+00  3.380914e+00   1.915000e+00   -9.623184e+00  1.635853e+01   -2.144432e+01  4.012288e+01
    17   13226     4.513521e-01   -6.309102e-01  1.310972e+00   2.446965e+00   1.915000e+00   2.093106e+01   -1.106341e+01  2.353163e+01   3.936993e+01
    18   -13216    -6.016757e-01  1.139397e+00   -3.089999e+00  3.856884e+00   1.915000e+00   -2.473792e+01  3.177983e+00   -3.719694e+01  4.837667e+01
    19   22122     2.982088e-01   1.026156e+00   5.530477e+00   5.947790e+00   1.910000e+00   1.945088e+01   1.710184e+01   8.171901e+01   8.720815e+01
    20   1116      5.711217e-02   1.482624e-01   4.927869e-01   1.974109e+00   1.905000e+00   3.171281e+00   2.077467e+00   -1.133869e+01  4.302635e+01
    21   -1216     1.643320e-01   7.938368e-01   -1.232339e+00  2.409329e+00   1.905000e+00   -1.097657e+01  -1.204289e+00  -4.062362e+01  5.554419e+01
    22   23124     1.215571e-01   -7.914168e-02  -4.813670e+00  5.173447e+00   1.890000e+00   9.981600e+00   -2.262151e+01  -7.223383e+01  7.861991e+01
    23   23124     6.365846e-01   8.738308e-01   -6.834744e-01  2.282117e+00   1.890000e+00   2.176244e+01   2.129114e+01   -1.961878e+01  3.433536e+01
```

Therminator generator – output file

```
Therminator text output
all_particles_p_x
Therminator
1       5255    0.000   0.000
     0   5218      -1.659721e+00  -8.599909e-02  -8.989090e+00  9.414261e+00  2.250000e+00  -1.674057e+01  -8.735474e+00  -1.038539e+02  1.092653e+02
     1   8901      -1.365788e+00  -1.308702e+00  -9.974298e+00  1.035207e+01  2.025000e+00  -1.416694e+01  -2.056895e+01  -1.480015e+02  1.511954e+02
     2   119       4.258143e-01   1.658937e+00   -8.952060e+00  9.334289e+00  2.014000e+00  6.166333e+00   2.925372e+01   -1.211237e+02  1.244207e+02
     3   119       5.052830e-01   7.597097e-01   6.615291e-01   2.307875e+00  2.014000e+00  -9.244704e+00  1.526590e+00   1.099618e+01   4.024736e+01
     4   20225     8.952667e-01   9.118563e-01   5.929226e-01   2.455333e+00  2.011000e+00  2.588561e+01   1.480875e+01   3.867890e+00   2.875127e+01
     5   2118      -2.037936e+00  1.593500e-02   -4.241002e+00  5.093332e+00  1.950000e+00  -2.939204e+01  1.186835e+01   -5.618252e+01  6.257472e+01
     6   -67000    7.313909e-01   -1.093284e+00  3.687565e-01   2.380900e+00  1.950000e+00  1.890986e+01   -1.665551e+01  8.482258e+00   3.194812e+01
     7   -23114    -1.024778e+00  1.095195e+00   -4.763472e+00  5.357601e+00  1.940000e+00  -1.937354e+01  -1.537002e+00  -8.306537e+01  8.963512e+01
     8   -23214    -9.544941e-01  1.144178e+00   6.372825e+00   6.826178e+00  1.940000e+00  -2.333213e+01  1.075778e+01   4.539638e+01   5.472127e+01
     9   11116     1.047349e+00   -5.057926e-01  4.519443e+00   5.050052e+00  1.930000e+00  3.645622e+00   -1.312381e+01  9.131405e+01   9.837241e+01
    10   -11216    3.572342e-01   1.010360e+00   -2.074199e+00  3.029133e+00  1.930000e+00  1.053371e+01   2.620443e+01   -2.753442e+01  4.019270e+01
    11   -12126    9.490886e-01   -7.437465e-01  -1.335749e+00  2.638760e+00  1.930000e+00  3.013673e+01   -9.927932e+00  -1.051130e+01  2.947410e+01
    12   -12126    1.290726e+00   1.557681e+00   -7.139890e+00  7.667808e+00  1.930000e+00  6.156516e+00   9.234727e+00   -1.031000e+02  1.098288e+02
    13   22114     5.732440e-01   -7.823673e-01  -4.885746e-01  2.205859e+00  1.920000e+00  1.448873e+01   -5.920079e+00  -2.681964e+01  4.455212e+01
    14   22114     -3.901486e-01  -3.418125e-01  -2.949353e+00  3.557265e+00  1.920000e+00  -9.927925e+00  -1.163103e+01  -1.136871e+02  1.191771e+02
    15   13216     -1.223497e+00  8.021664e-01   3.098639e+00   3.925456e+00  1.915000e+00  -2.190540e+01  -4.760386e+00  6.497287e+01   7.251098e+01
    16   13226     -1.500176e+00  1.976538e+00   -1.267330e+00  3.380914e+00  1.915000e+00  -9.623184e+00  1.635853e+01   -2.144432e+01  4.012288e+01
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    19   22122     2.982088e-01   1.026156e+00   5.530477e+00   5.947790e+00  1.910000e+00  1.945088e+01   1.710184e+01   8.171901e+01   8.720815e+01
    20   1116      5.711217e-02   1.482624e-01   4.927869e-01   1.974109e+00  1.905000e+00  3.171281e+00   2.077467e+00   -1.133869e+01  4.302635e+01
    21   -1216     1.643320e-01   7.938368e-01   -1.232339e+00  2.409329e+00  1.905000e+00  -1.097657e+01  -1.204289e+00  -4.062362e+01  5.554419e+01
    22   23124     1.215571e-01   -7.914168e-02  -4.813670e+00  5.173447e+00  1.890000e+00  9.981600e+00   -2.262151e+01  -7.223383e+01  7.861991e+01
    23   23124     6.365846e-01   8.738308e-01   -6.834744e-01  2.282117e+00  1.890000e+00  2.176244e+01   2.129114e+01   -1.961878e+01  3.433536e+01
```

Output information:

- Type of particle (PDG number)
- Components of the momentum (p_x, p_y, p_z) [GeV/c]
- Energy E [GeV]
- Mass m [GeV/c^2]
- Space-time coordinates of creation (x,y,z) [fm], t [fm/c]

Outline

1) Introduction to THERMINATOR generator

2) BES program

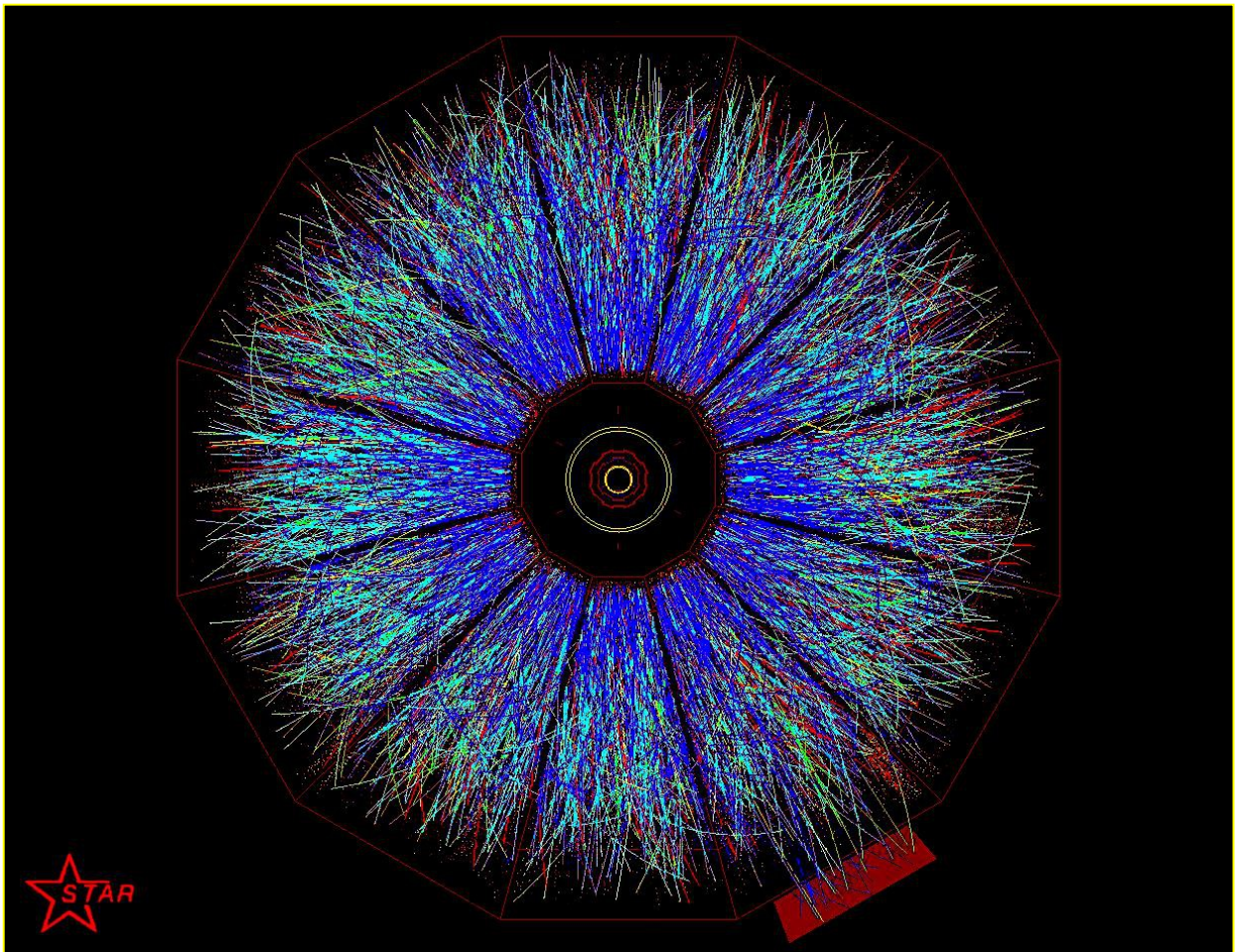
3) THERMINATOR for BES

3) Single particle distributions

4) Two-particle correlations

5) Summary and conclusions

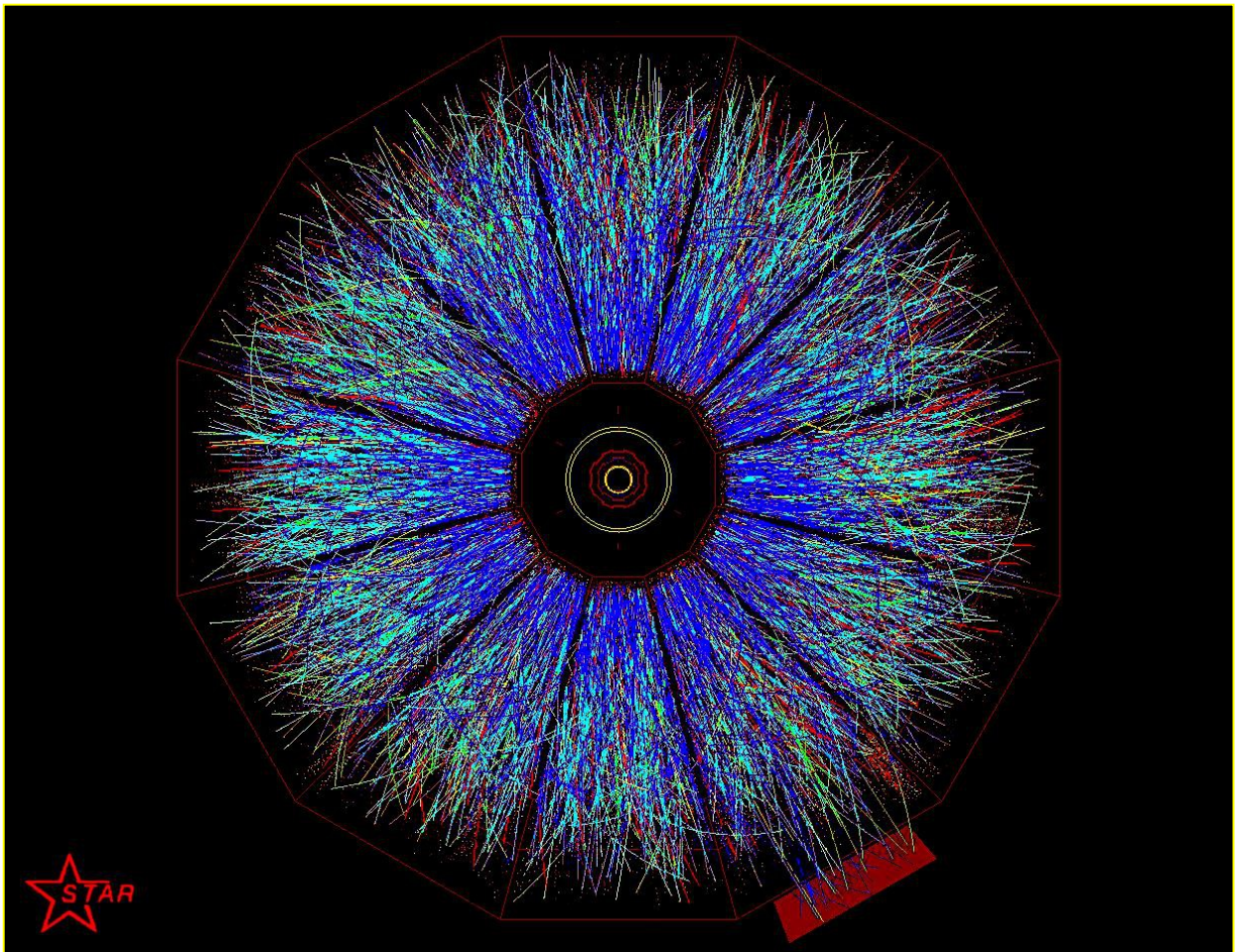
RHIC - What have we learned so far?



RHIC - What have we learned so far?

Goal of the RHIC Heavy Ion Program:

- search the QGP and measure its properties
- scan the QCD phase diagram



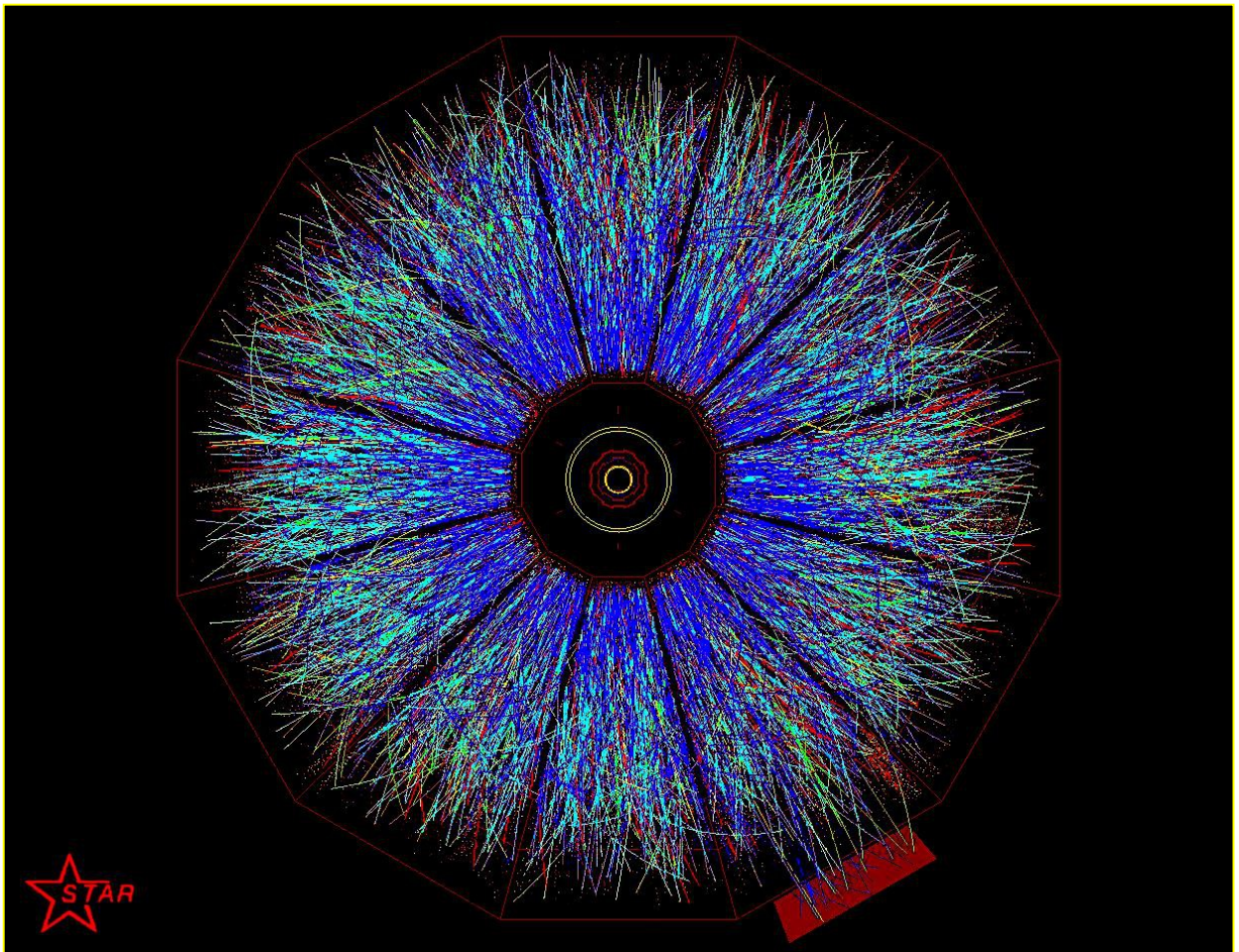
RHIC - What have we learned so far?

Goal of the RHIC Heavy Ion Program:

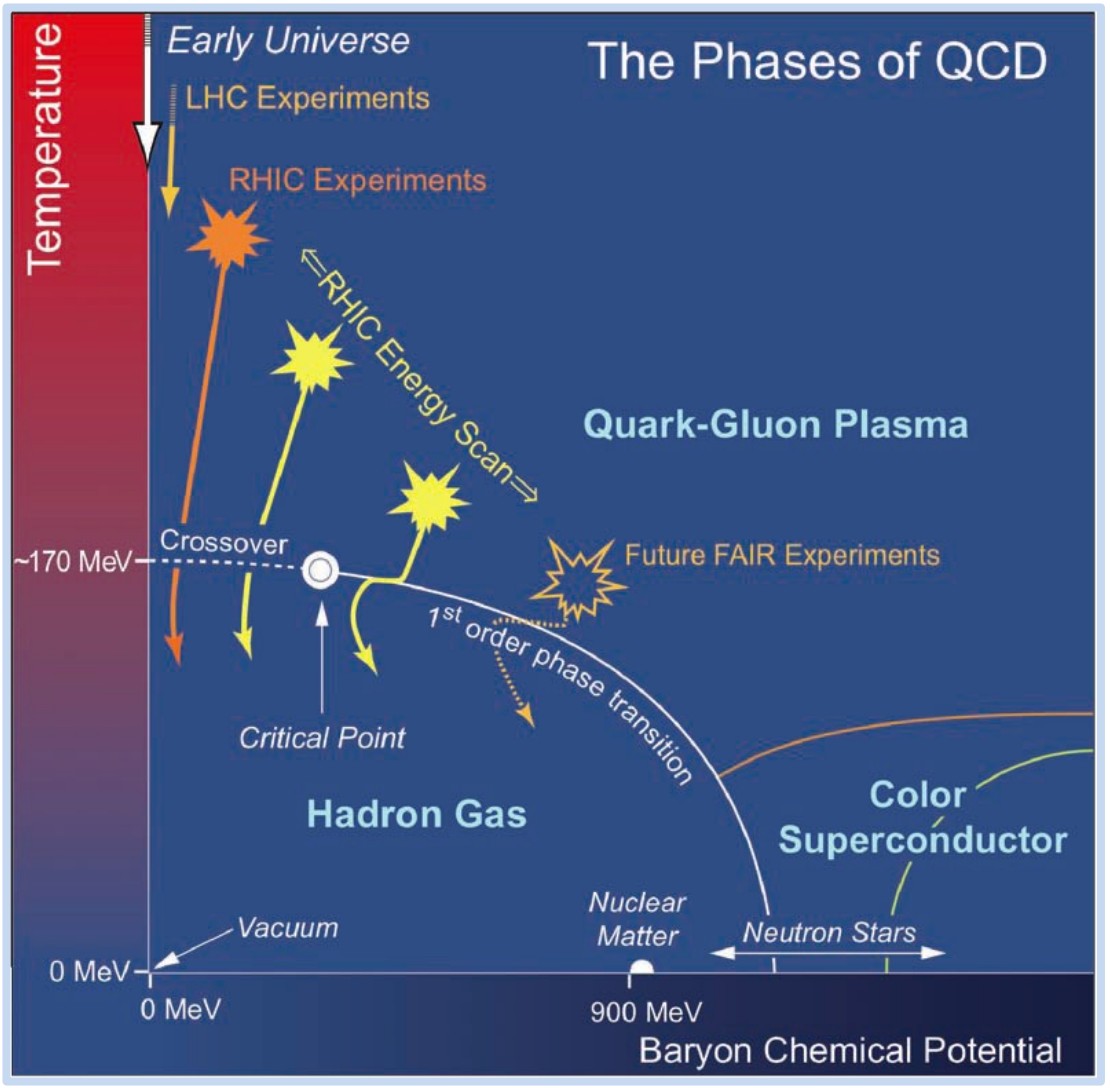
- search the QGP and measure its properties
- scan the QCD phase diagram

We learned about..

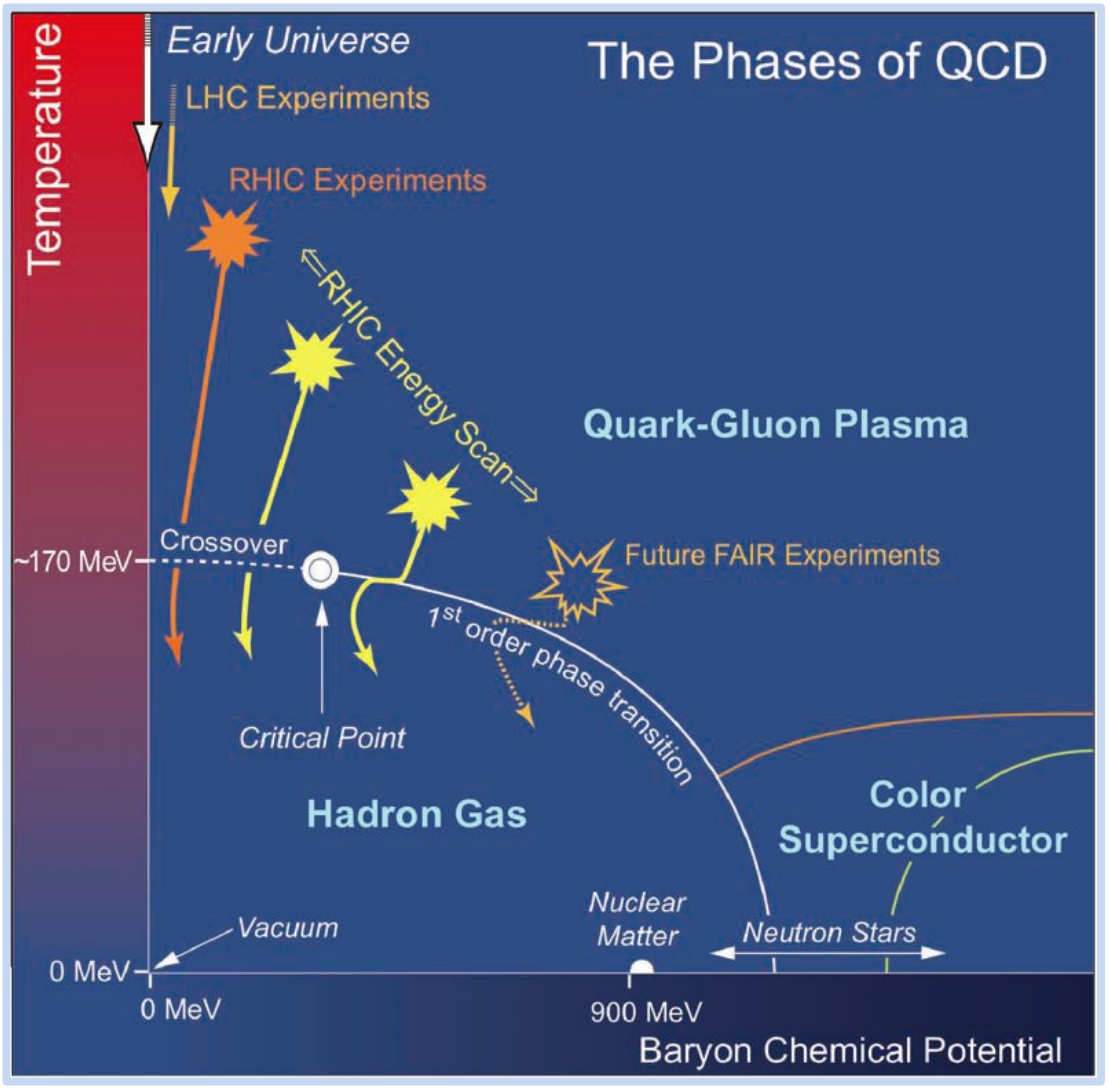
.. strongly interacting, hot, dense matter with partonic collectivity



Beam Energy Scan at RHIC



Beam Energy Scan at RHIC

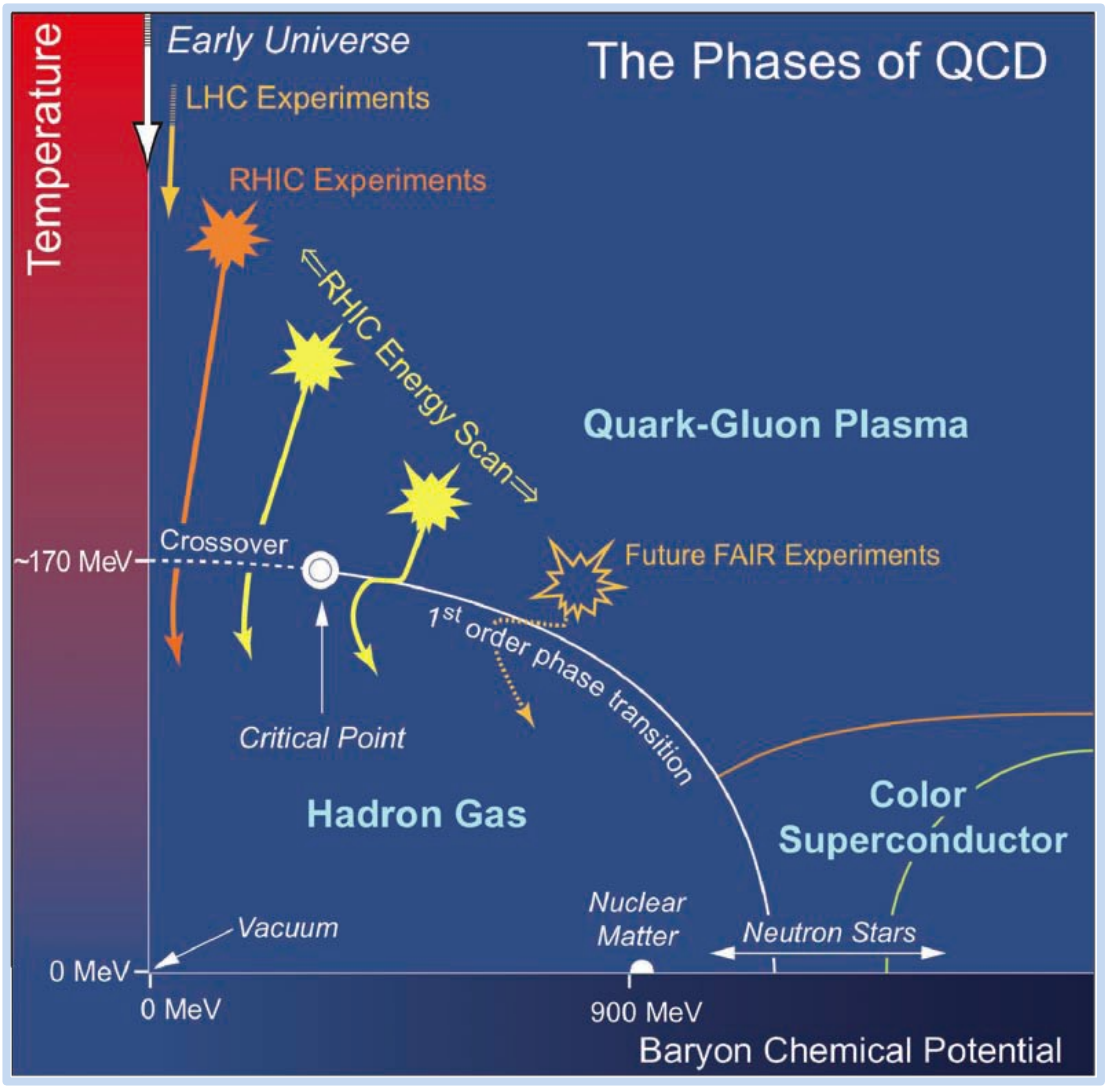


RHIC was built to find QGP.

QGP is new and complicated phase of matter

QGP exhibits unique and unexpected properties

Beam Energy Scan at RHIC



RHIC was built to find QGP.

QGP is new and complicated phase of matter

QGP exhibits unique and unexpected properties

Big progress in understanding its nature:
- high collision energy – cross over transition
- low collision energy – 1st order transition and the Critical Point

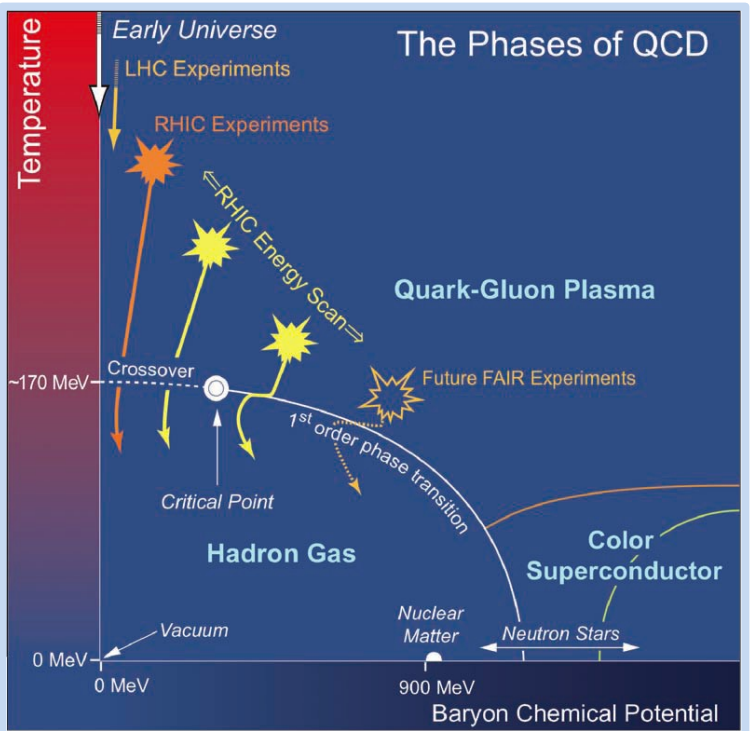
$\sqrt{s_{NN}} \sim 7.7 - 200$ GeV

$20 \text{ MeV} < \mu_B < 420 \text{ MeV}$

BES goals

1. Search for turn-off of sQGP signatures
2. Search for the QCD critical point
3. Search for the signals of phase transition/phase boundary

Where are we on the
QCD Phase Diagram ?



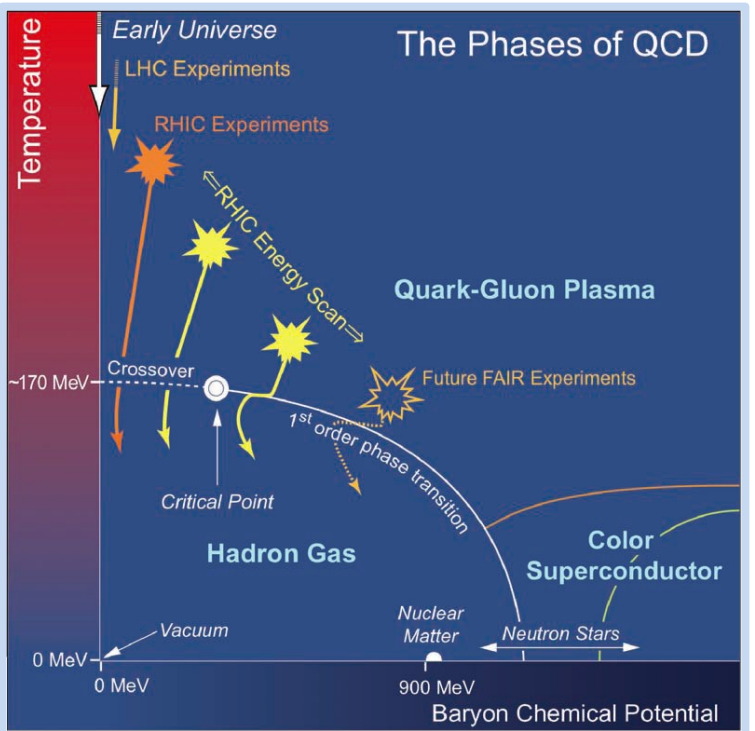
BES goals

1. Search for turn-off of sQGP signatures
2. Search for the QCD critical point
3. Search for the signals of phase transition/phase boundary

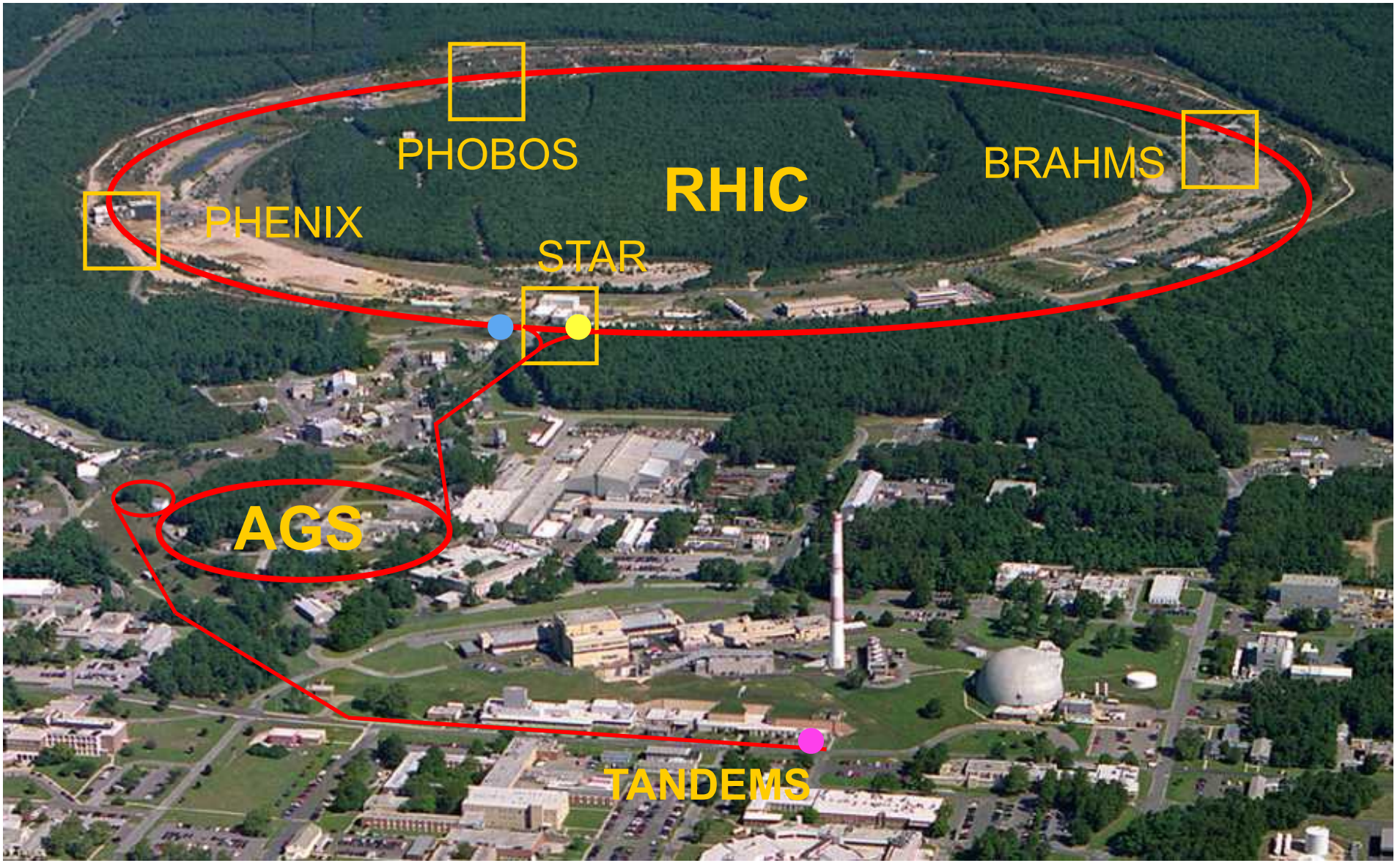
STAR: *http://drupal.star.bnl.gov/STAR/starnotes/public/sn0493, arXiv:1007.2613*

Year	$\sqrt{s_{NN}}$ (GeV)	μ_B (MeV)	Events (10^6)
2010	200	20	350
2010	62.4	70	67
2010	39	115	130
2011	27	155	70
2011	19.6	205	36
2014	14.5	260	20
2010	11.5	315	12
2010	7.7	420	4

Where are we on the QCD Phase Diagram ?



Relativistic **H**eavy **I**on **C**ollider (RHIC)
Brookhaven National Laboratory (BNL), New York



- 2 concentric rings of 1740 superconducting magnets
- 3.8 km circumference

Outline

1) Introduction to THERMINATOR generator

2) BES program

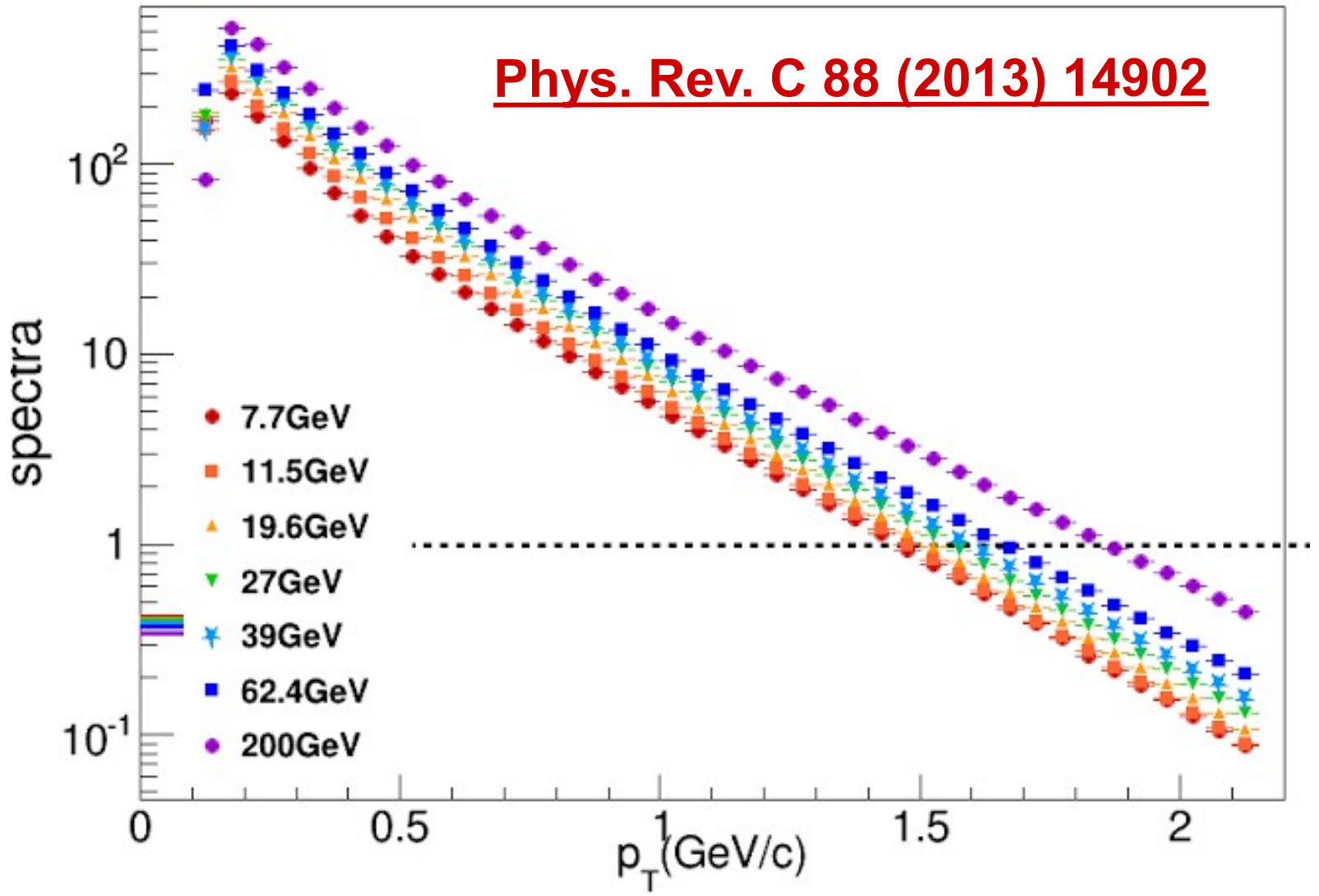
3) THERMINATOR for BES

3) Single particle distributions

4) Two-particle correlations

5) Summary and conclusions

Therminator model

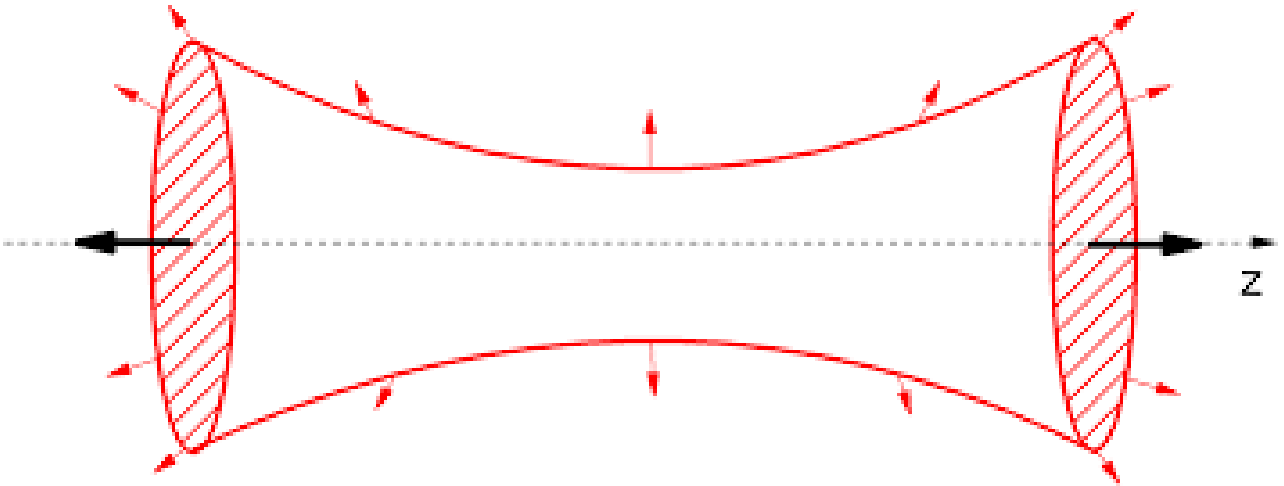


All charged hadrons

Therminator model

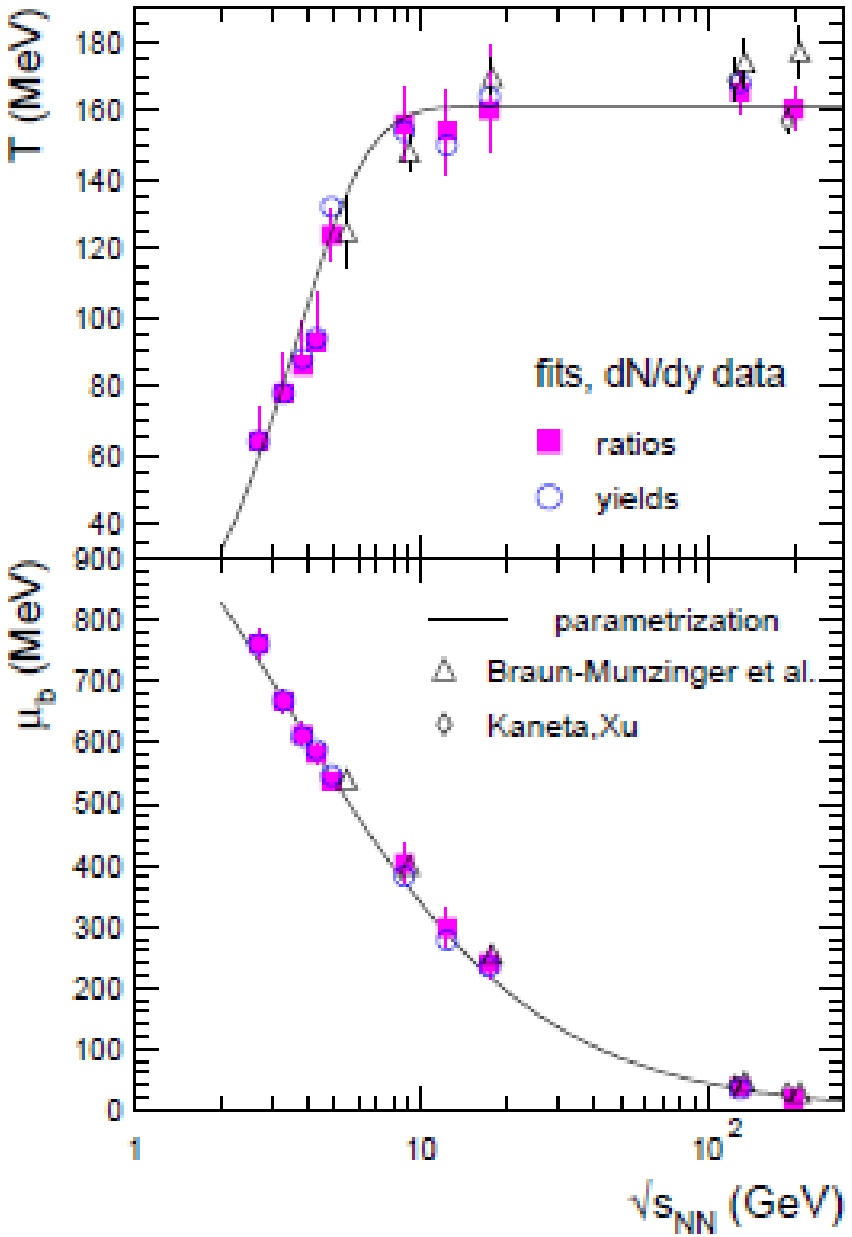
The parameters for collision energy $\sqrt{s_{NN}}$ = 200 GeV:

- T = 161 [MeV]
- μ_B = 28.5 [MeV]
- BWVt = 0.311
- Tau = 8.55 [fm]
- RhoMax = 8.92 [fm]



Comput.Phys.Commun. 174 (2006) 669-687

Therminator model

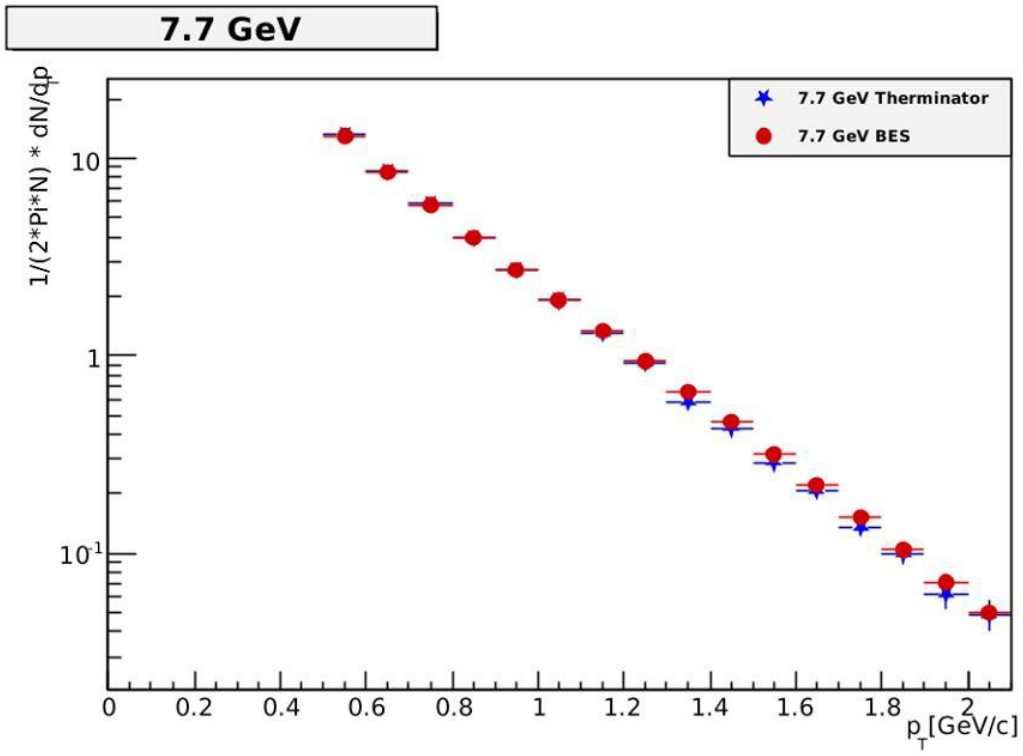


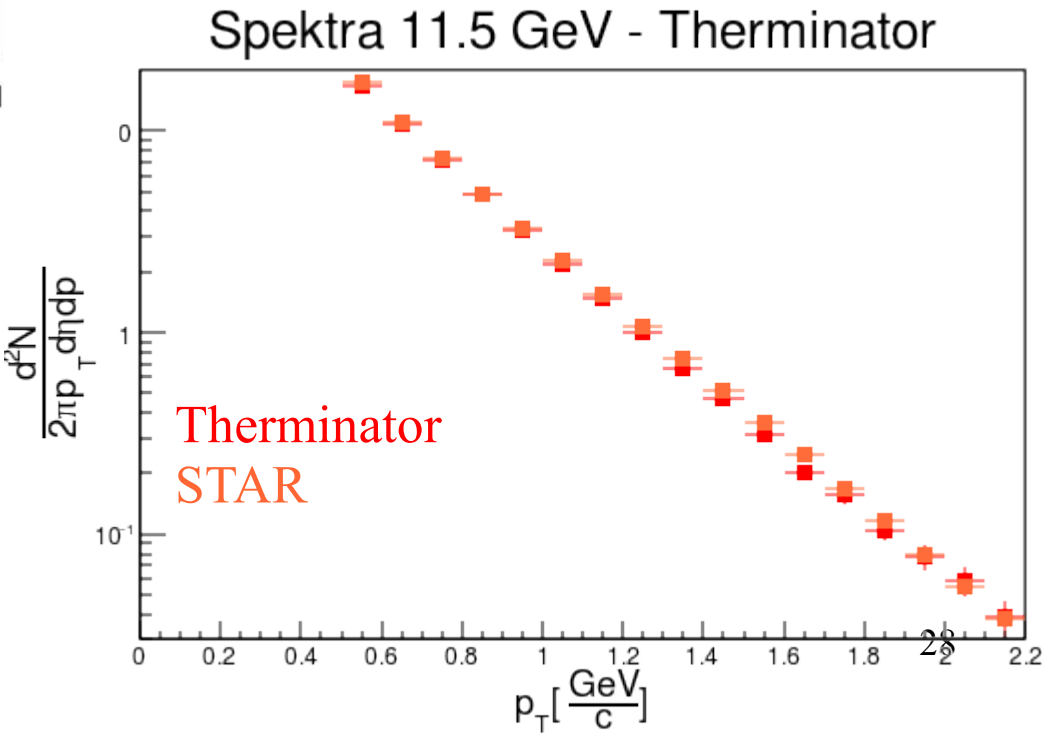
$$T = T_{\lim} \cdot \left[1 - \frac{1}{0.7 + \frac{e^{\sqrt{s_{NN}}} - 2.9}{1.5}}\right]$$

$$\mu_B = \frac{a}{1 + b\sqrt{s_{NN}}}$$

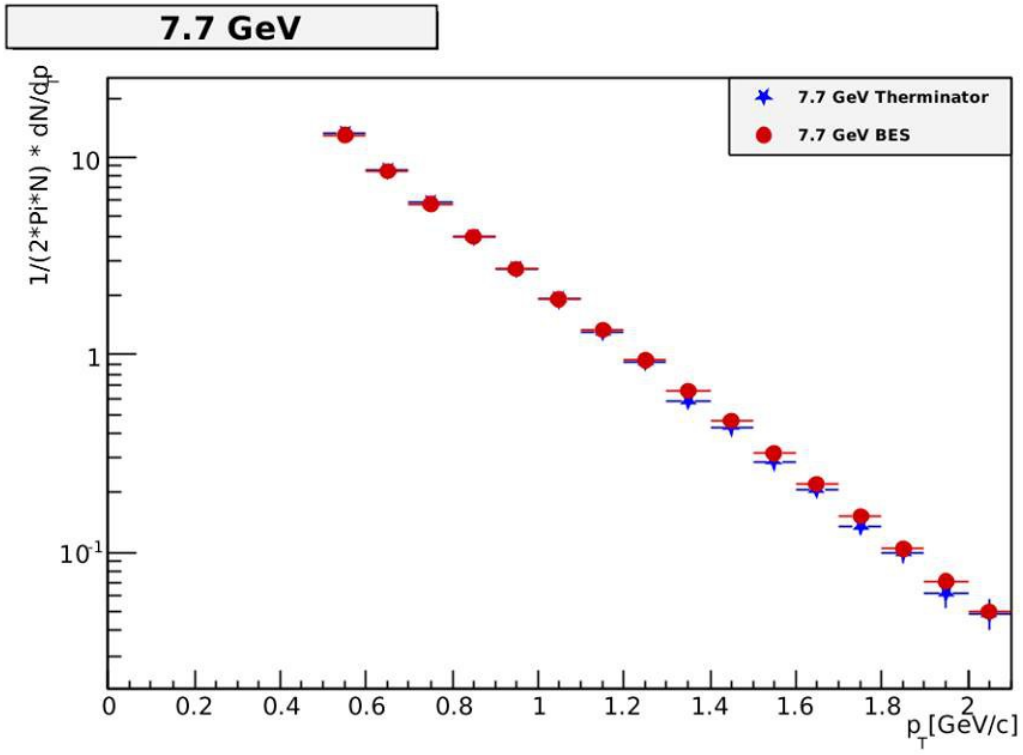
A. Andronic, P. Braun-Munzinger, J. Stachel,
arXiv:nucl-th/0511071v3

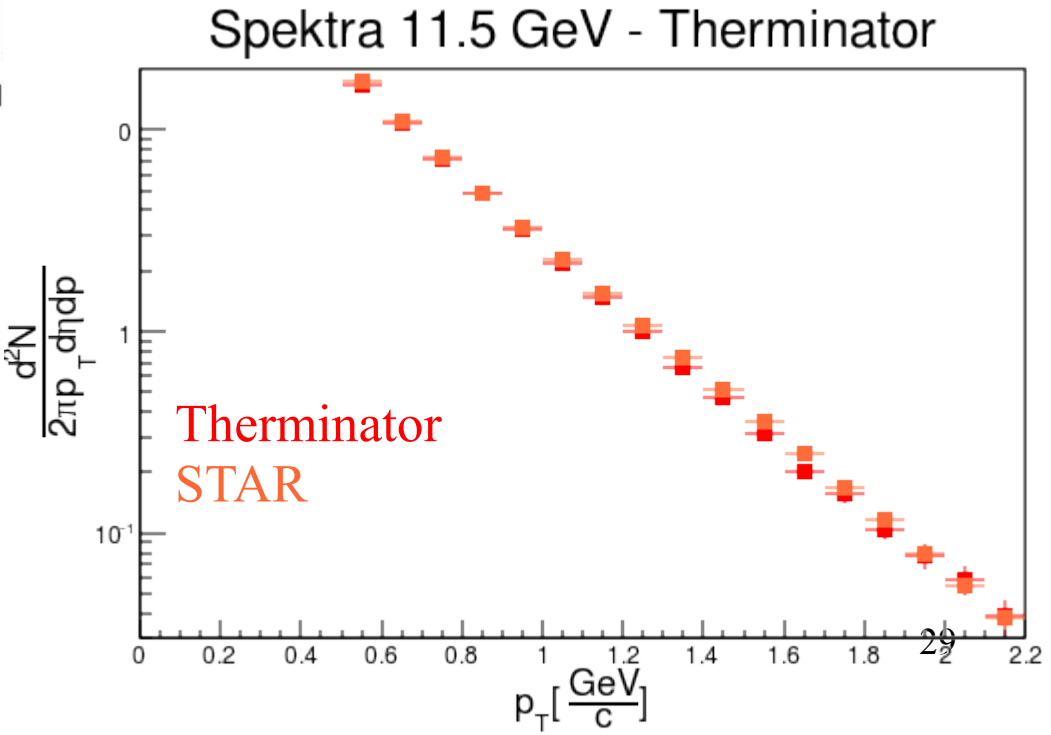
Therminator model





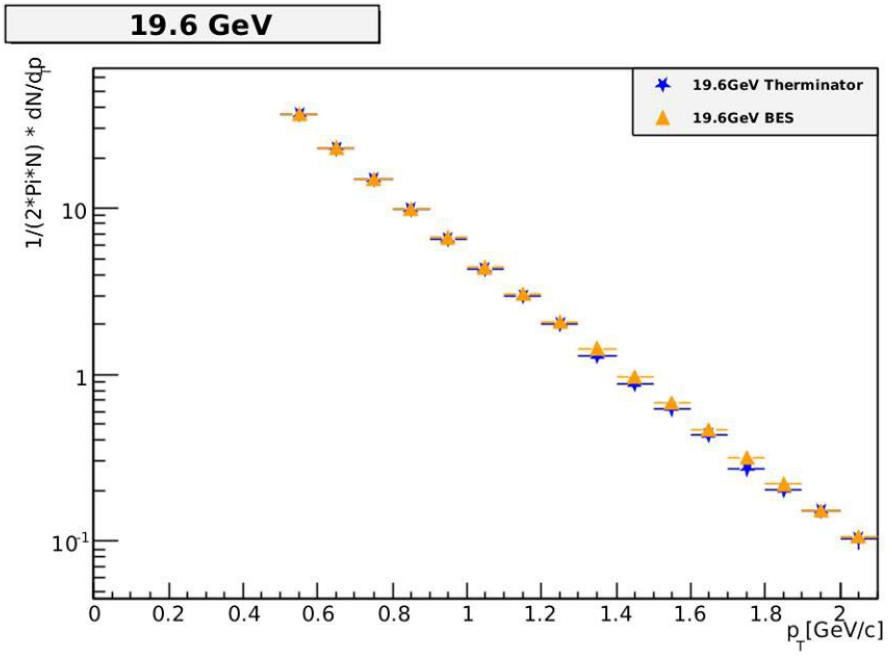
Therminator model

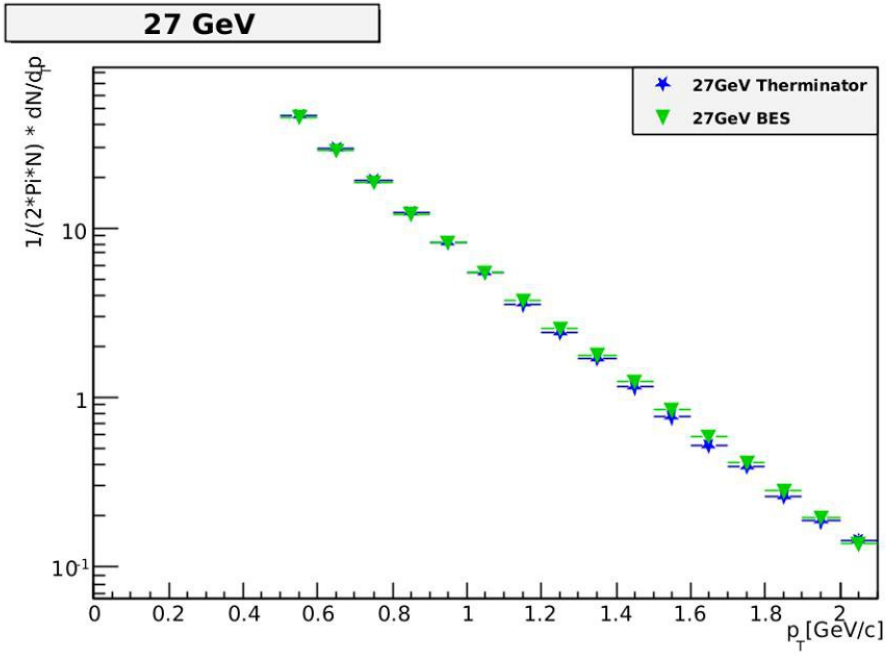




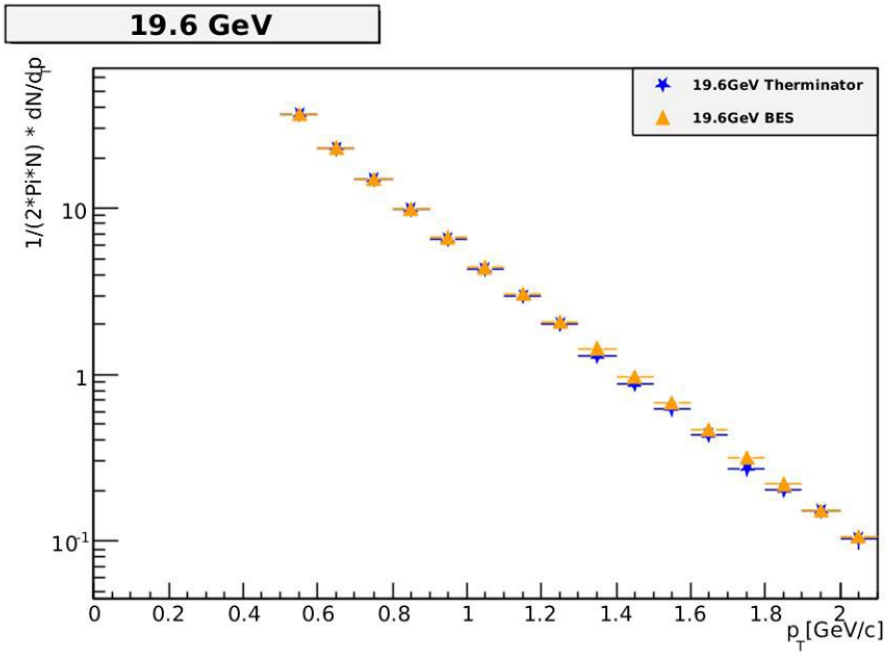
Good agremment between STAR data
THERMINATOR input
X^2 / NDF ≈ 1

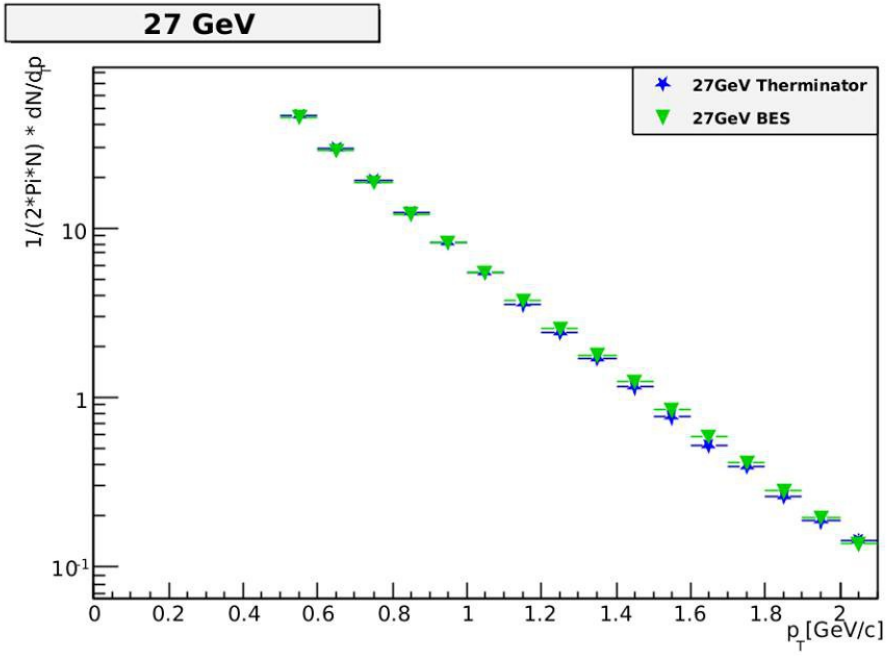
Therminator model

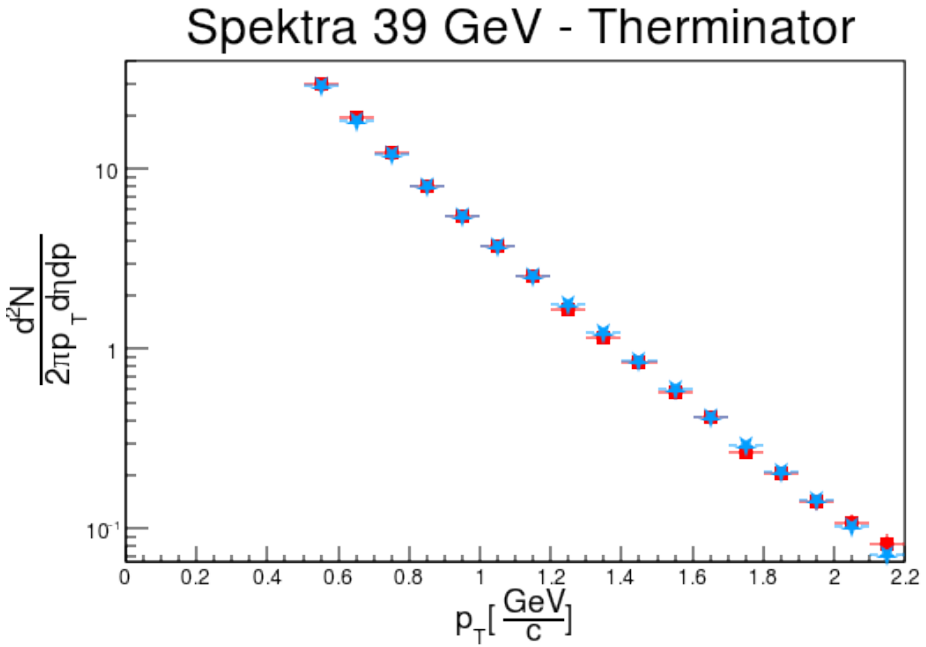


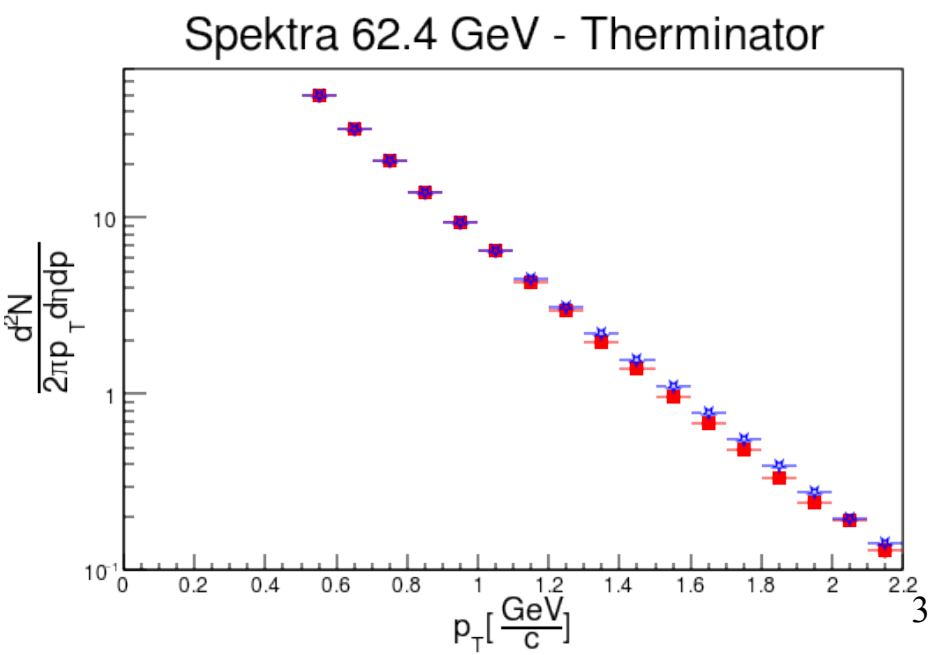


Therminator model









Therminator model

Tab. 1: Parametry Therminatora dla energii BES

Energia [GeV]	T [MeV]	μ_B [MeV]	τ [fm]	ρ_{max} [fm]	V_T
7.7	160.9	406.9	8.55	2.1	1.59
11.5	161	304	8.55	2.75	1.575
19.6	161	197.3	8.55	4.6	1.547
27	161	149.44	8.55	5.42	1.51
39	161	107	8.55	5.485	1.27
62.4	161	69.1	8.55	5.76	1.23

Therminator model

Nucl.Phys.A772:167-199,2006

$$T[MeV] = T_{lim}(1 - \frac{1}{0.7 + (e^{\sqrt{s_{NN}[GeV]}} - 2.9)/1.5})$$

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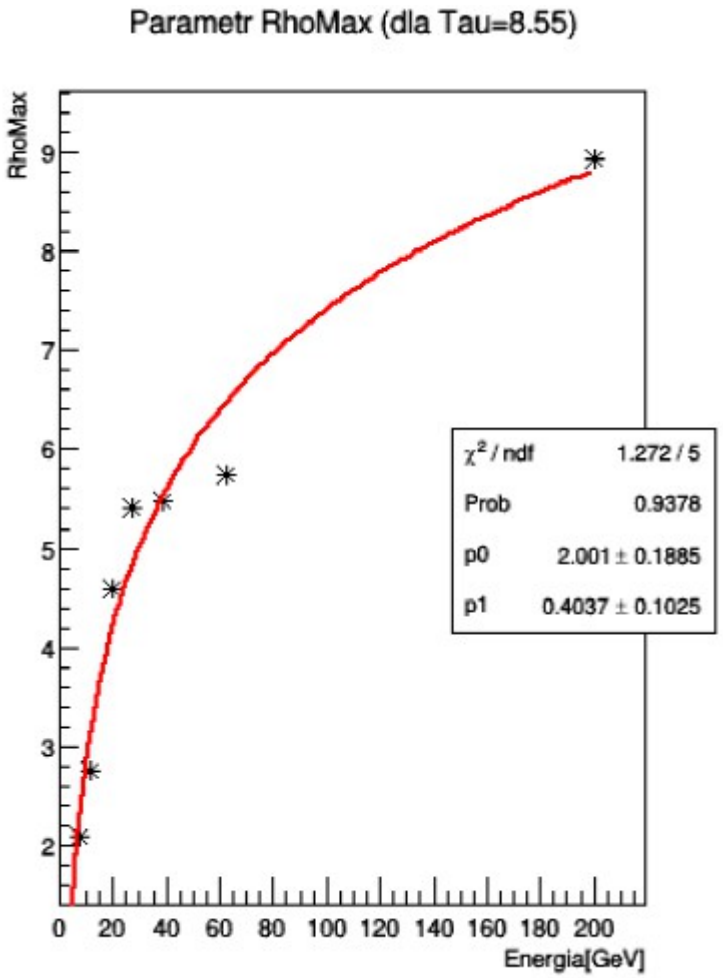

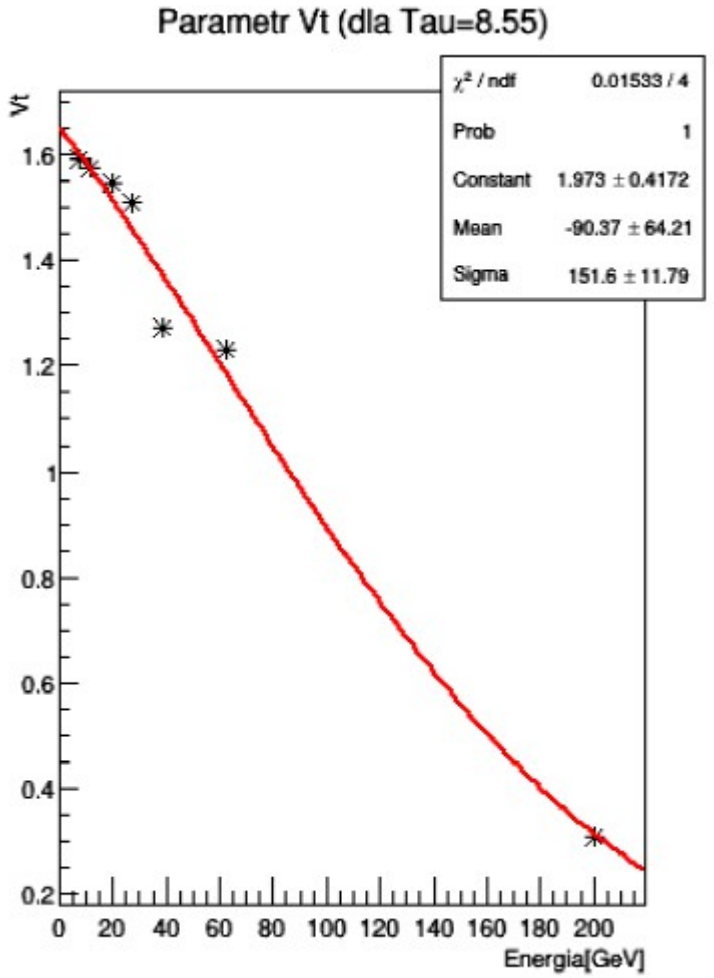

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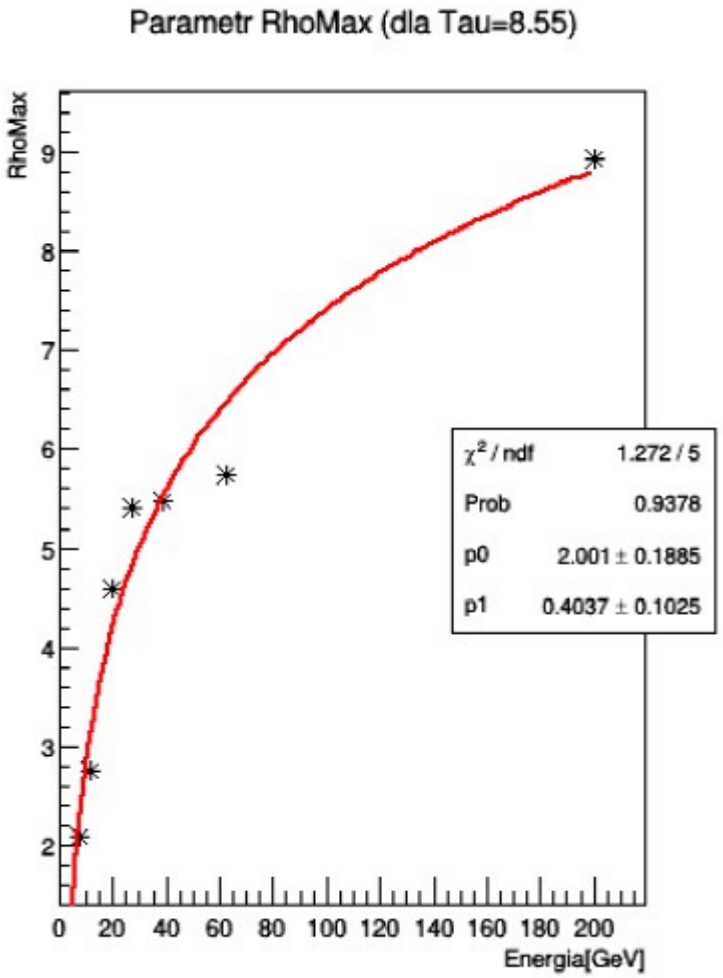

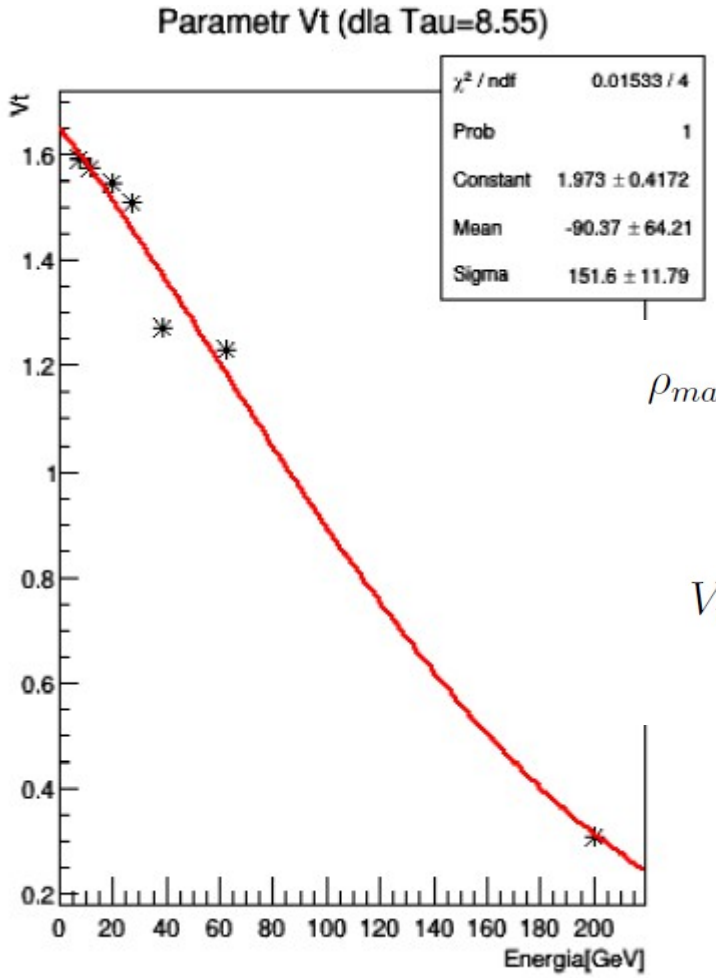

$$\rho_{max} = 2.001 \cdot ln(0.4037\sqrt{s_{NN}})$$

$$V_t = \frac{1}{151.6\sqrt{2\pi}} e^{\frac{-(\sqrt{s_{NN}}+90.37)^2}{45965,12}}$$

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1) Introduction to THERMINATOR generator

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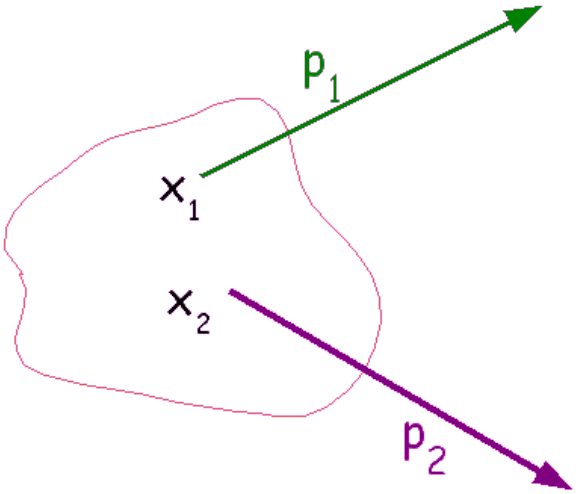
Femtoscopy

Single- and two- particle distributions

$$P_1(p) = E\frac{dN}{d^3p} = \int d^4x\, S(x,p)$$

S(x,p) – emission function: the distribution of source density probability of finding particle with x and p

$$P_2(p_1,p_2) = E_1 E_2 \frac{dN}{d^3p_1 d^3p_2} = \int d^4x_1 S(x_1,p_1) d^4x_2 S(x_2,p_2) \Phi(x_2,p_2|x_1,p_1)$$



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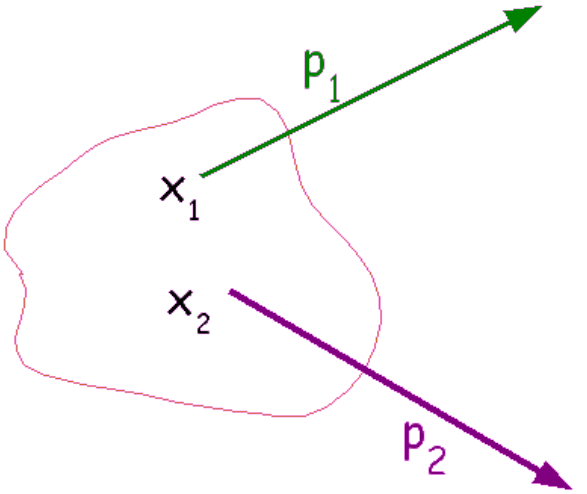
The correlation function

$$C(p_1,p_2) = \frac{P_2(p_1,p_2)}{P_1(p_1)P_1(p_2)}$$



Two – pion correlations

Number of analysed minimum bias Therminator events:

7 GeV (220 000 mln events)

11,5 GeV (200 000 mln events)

19,6 GeV (50 000 mln events)

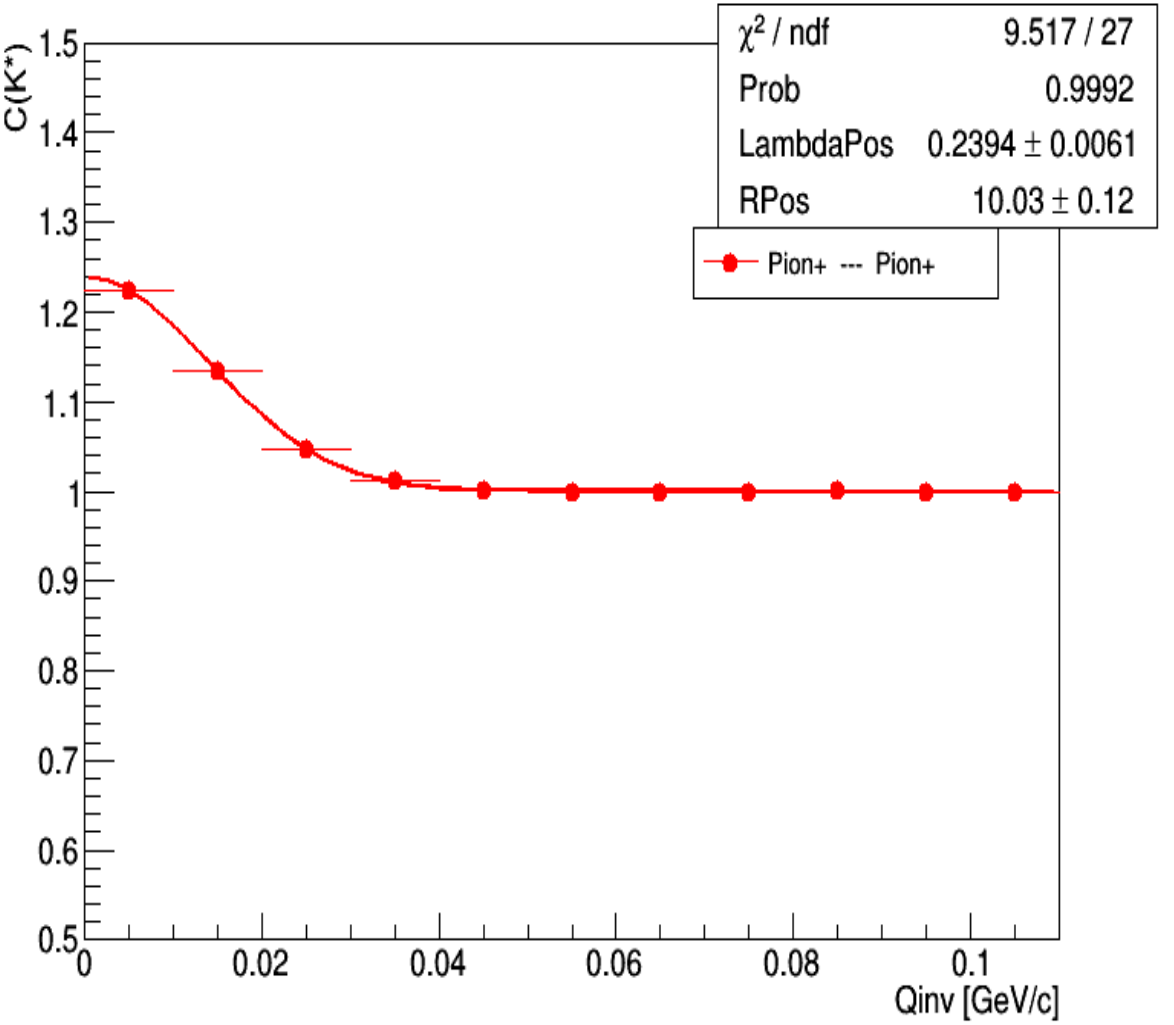
27 GeV (5 000 mln events)

39 GeV (25 000 mln events)

62,4 GeV (5 000 mln events)

Two – pion correlations

$$CF(q) = 1 + \lambda \exp\left(-q^2 R^2\right)$$



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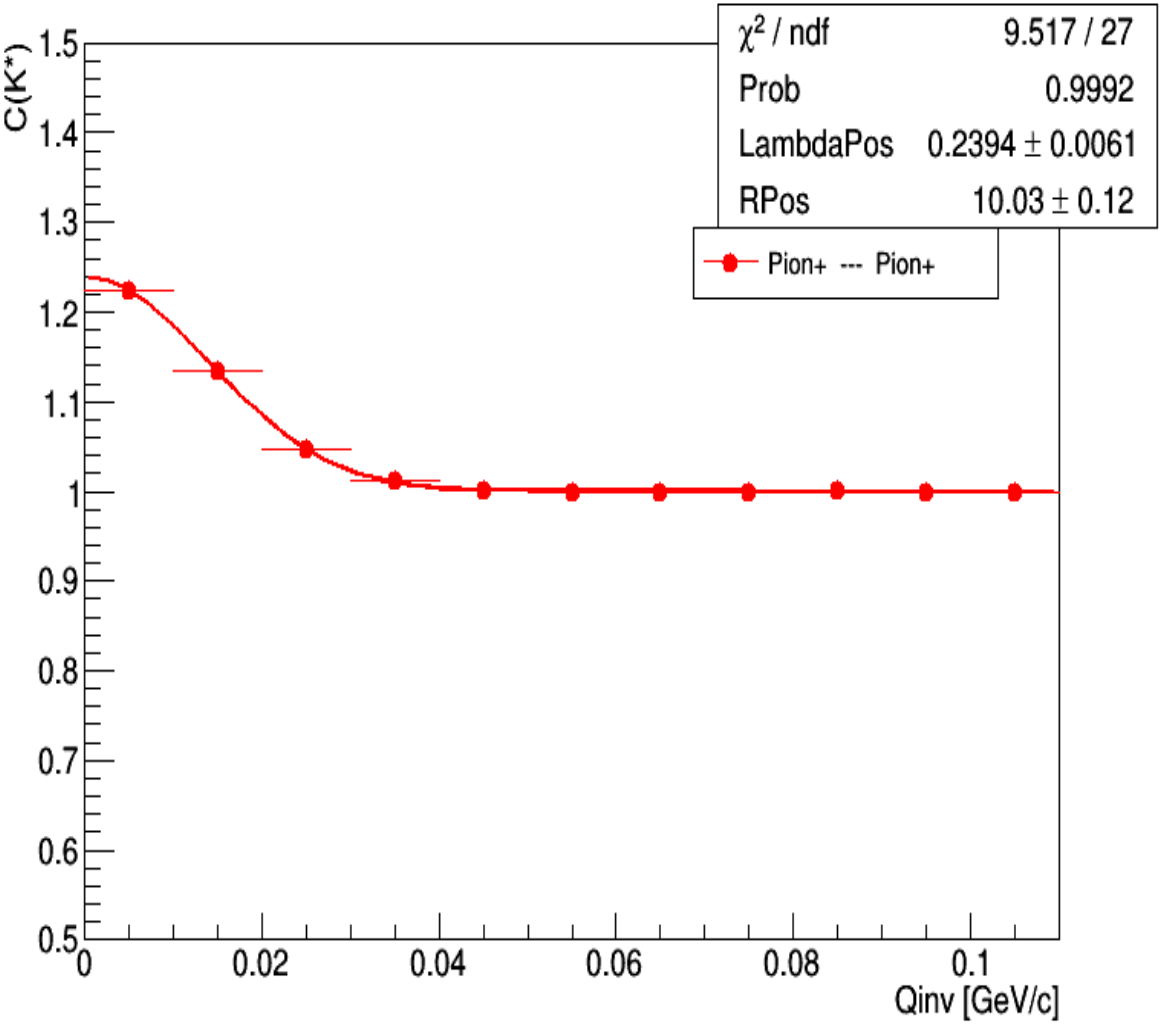
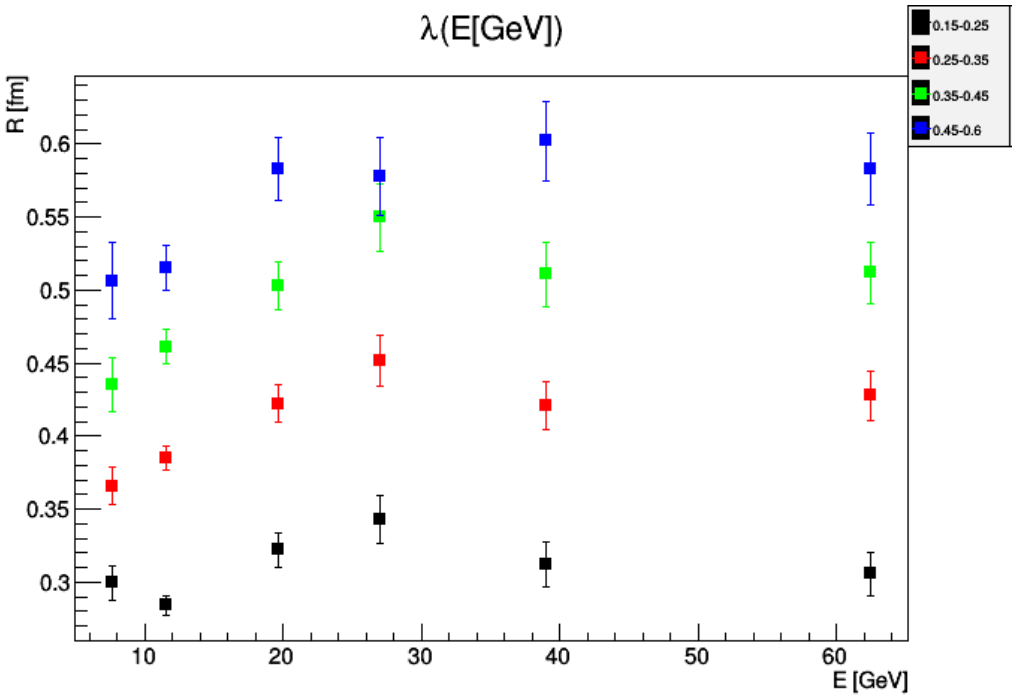
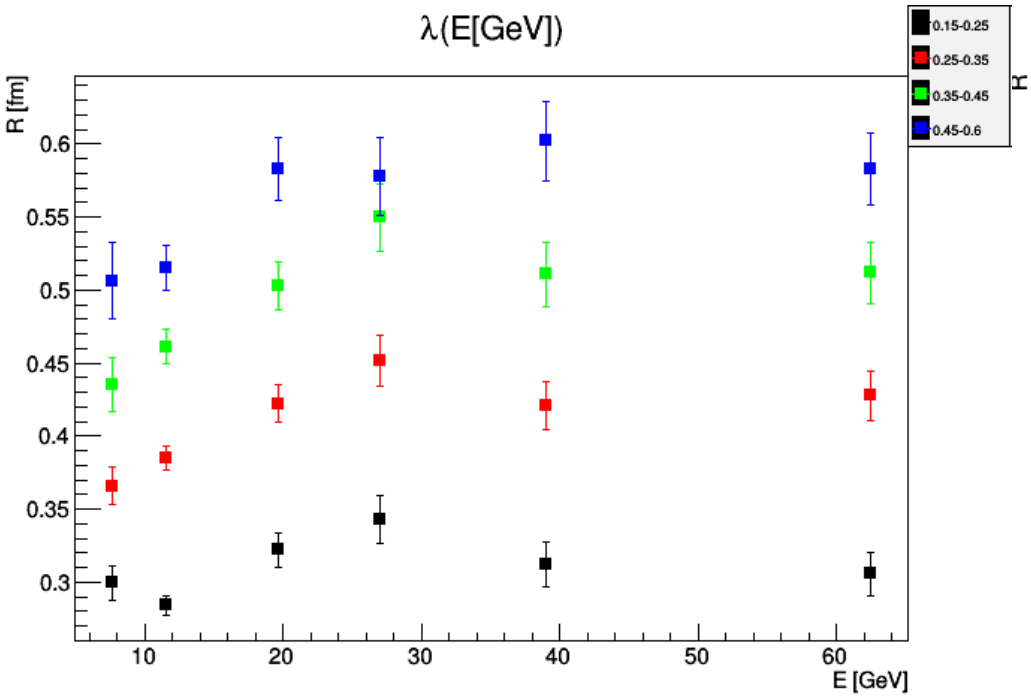
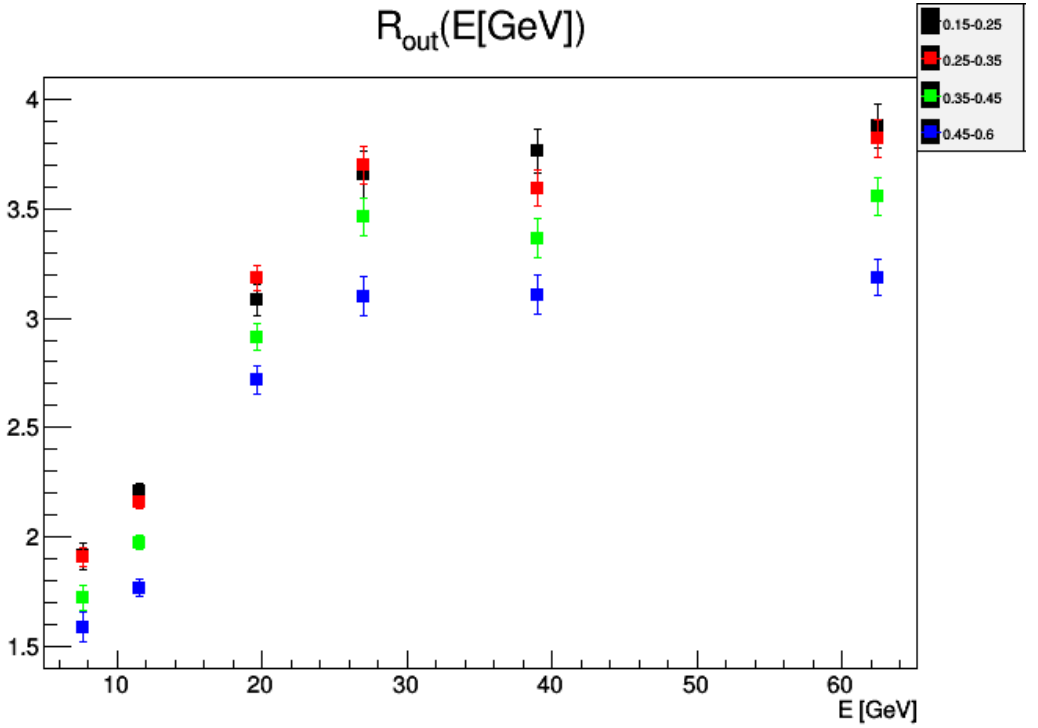
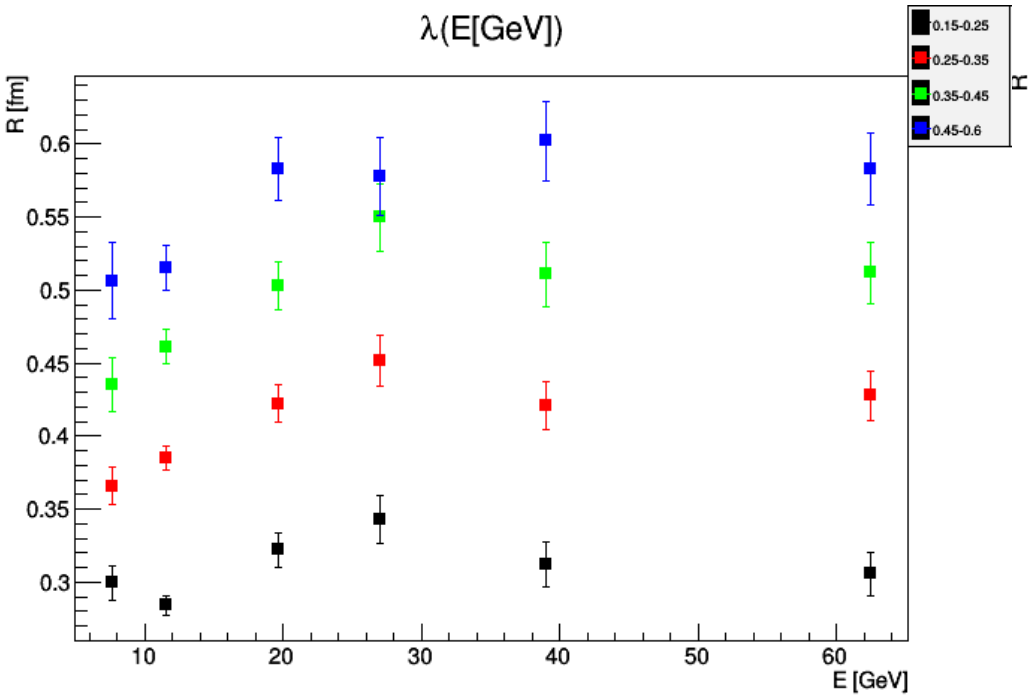


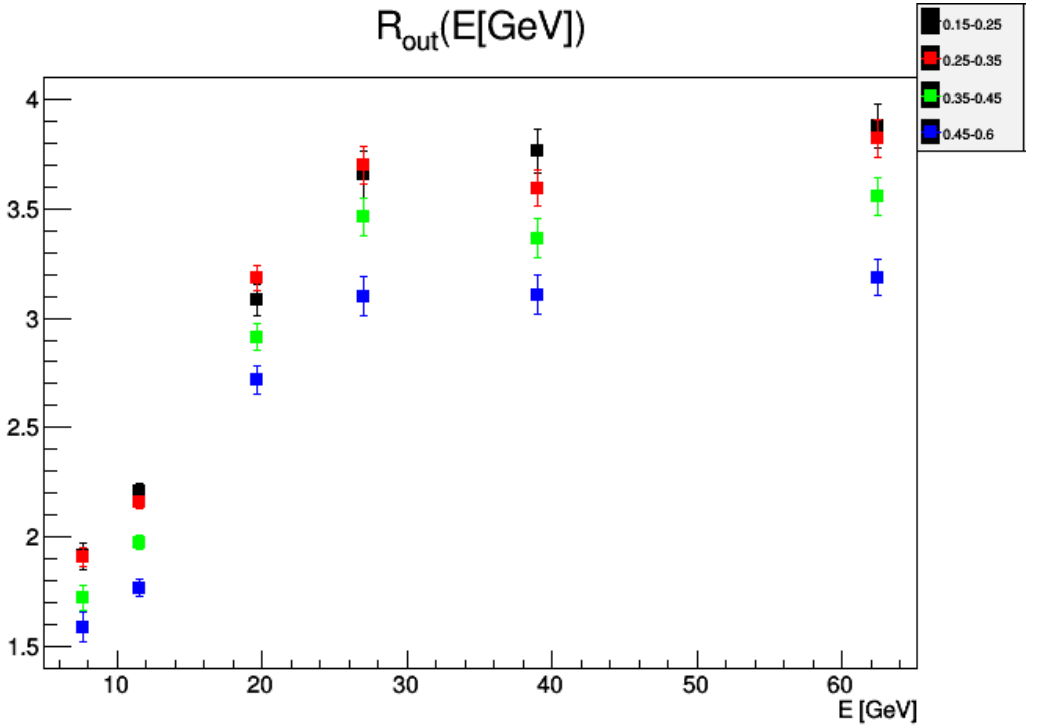
$$CF(q_o, q_s, q_l) = 1 + \lambda \exp(-q_o^2 R_o^2 - q_s^2 R_s^2 - q_l^2 R_l^2)$$

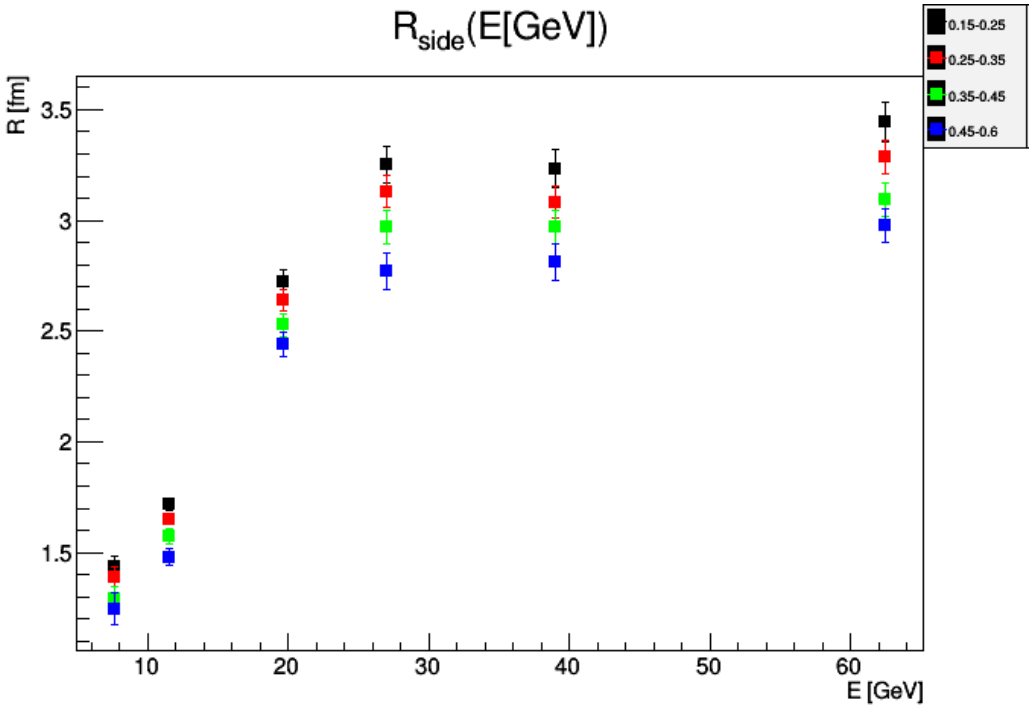

λ(E[GeV])
R [fm]
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6
0.6
0.55
0.5
0.45
0.4
0.35
0.3
10
20
30
40
50
60

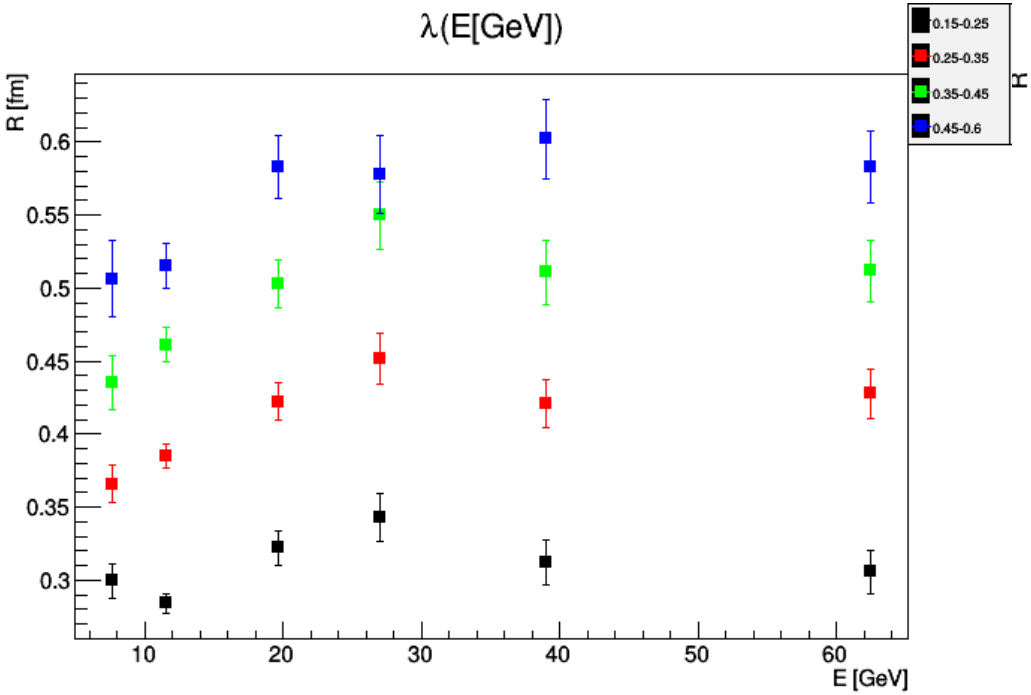

λ(E[GeV])
R [fm]
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6

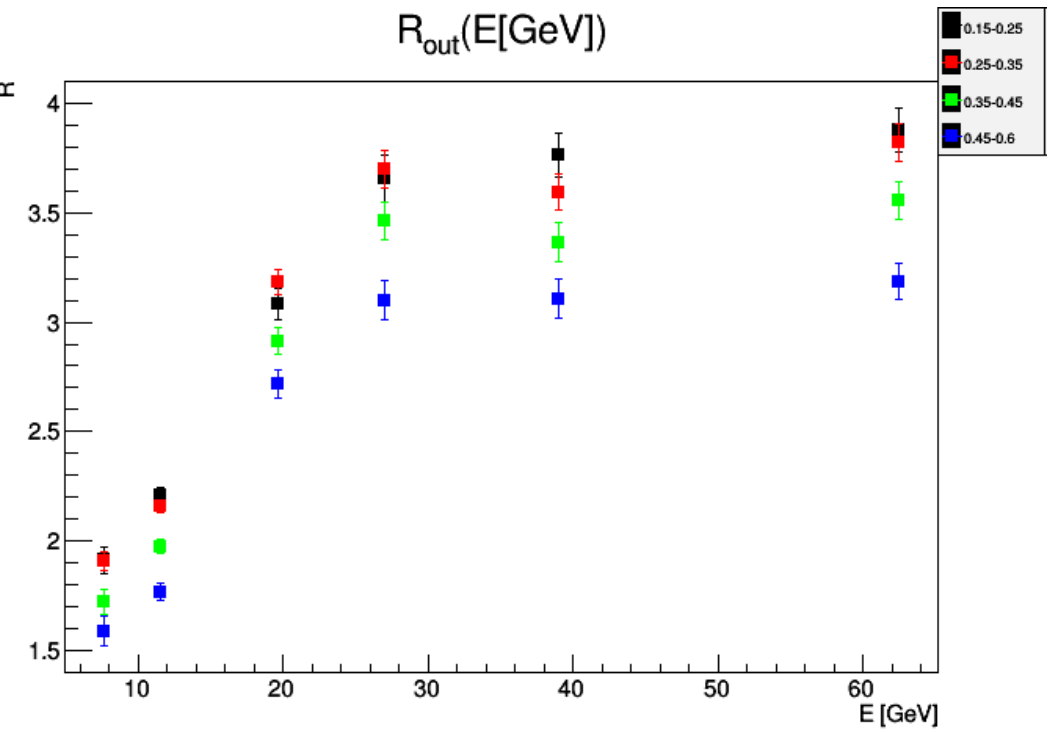

R_out(E[GeV])
R
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6

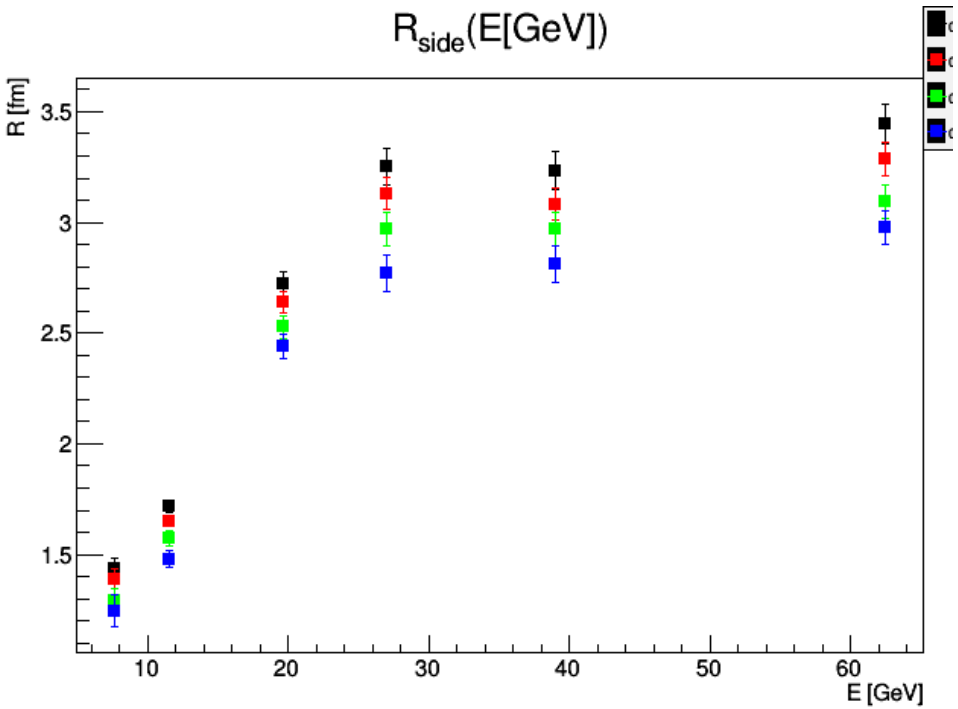

λ(E[GeV])
R [fm]
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6

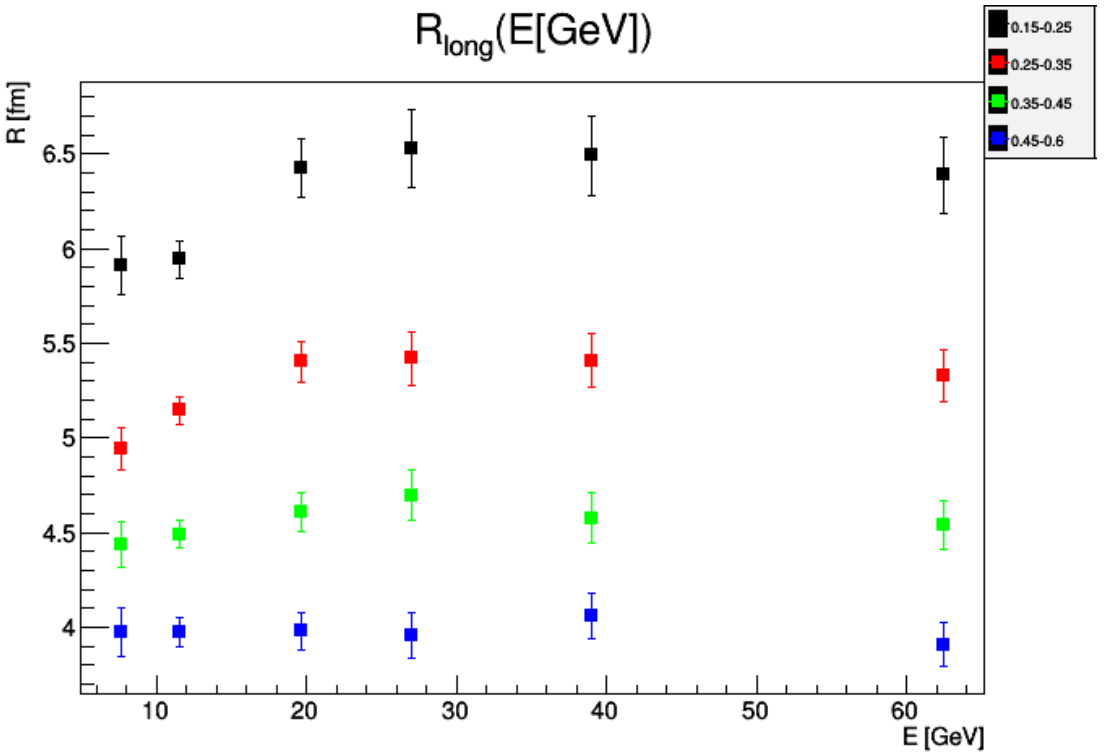

R_out(E[GeV])
R
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6

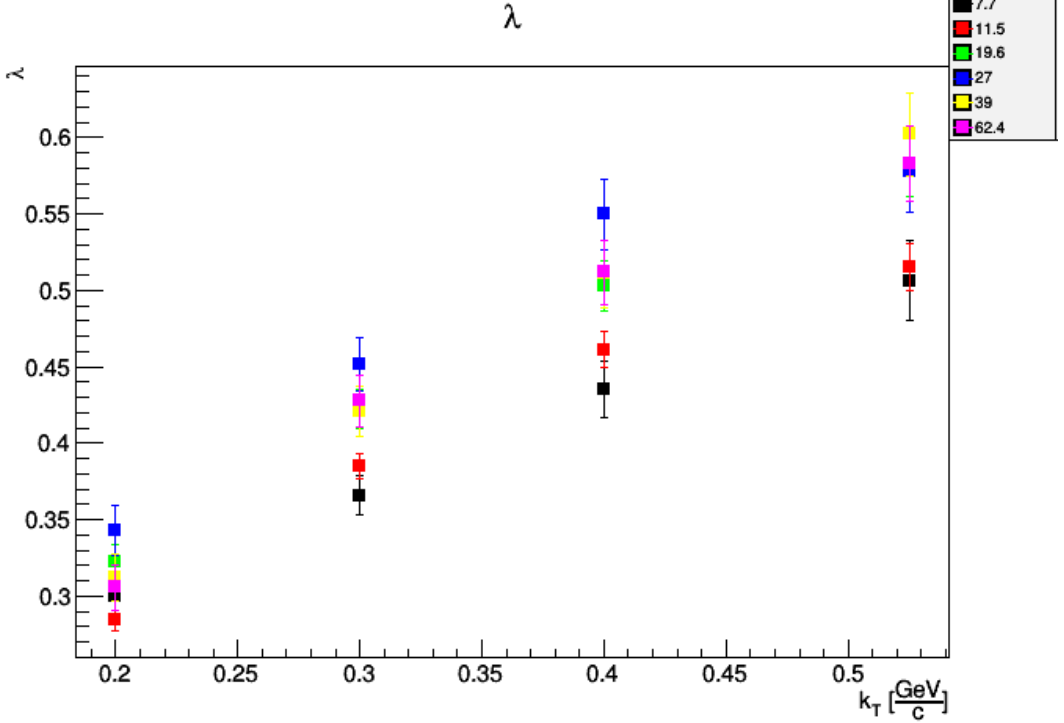

R_side(E[GeV])
R [fm]
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6

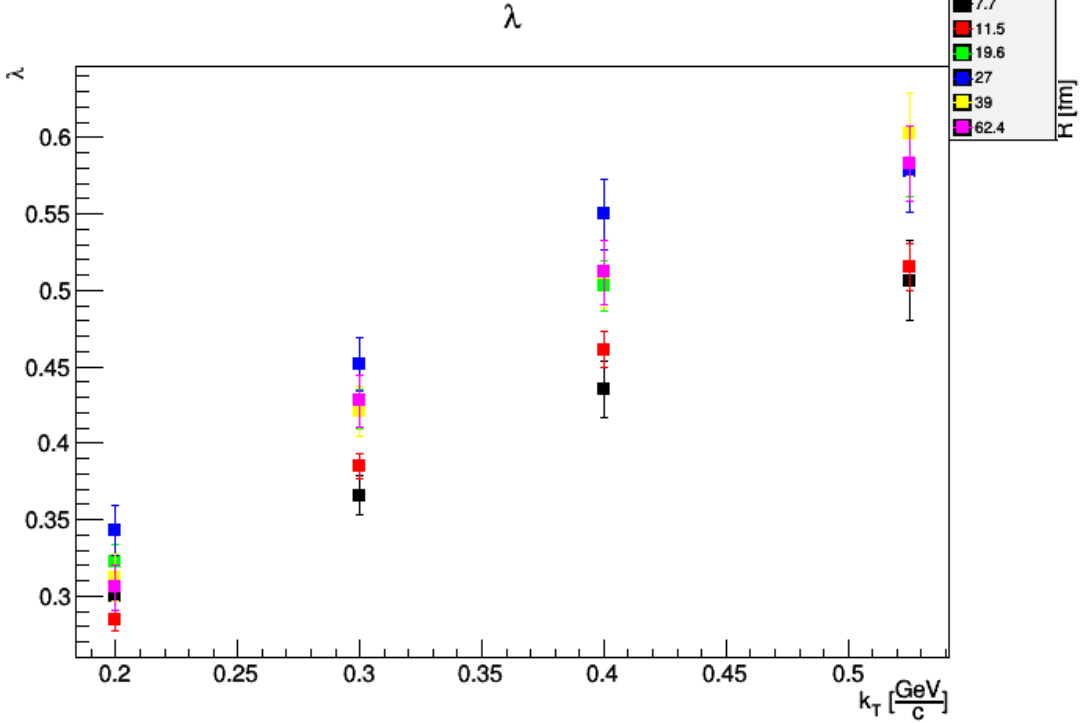

λ(E[GeV])
R [fm]
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6


R_out(E[GeV])
R
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6


R_side(E[GeV])
R [fm]
E [GeV]


R_long(E[GeV])
R [fm]
E [GeV]
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.6


λ
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4


λ
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
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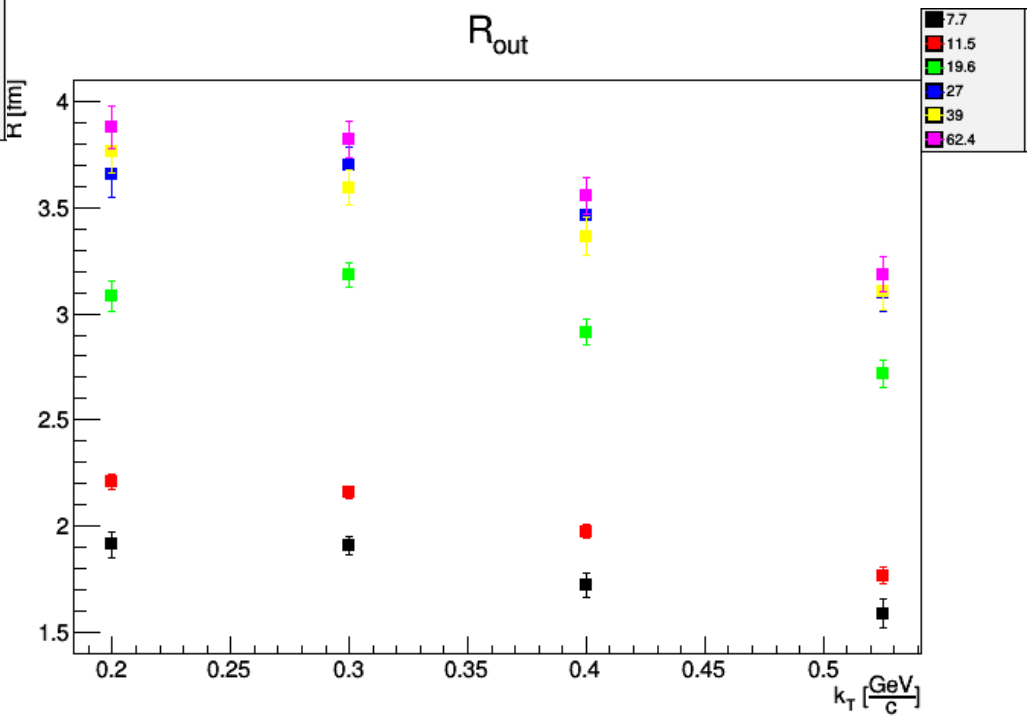
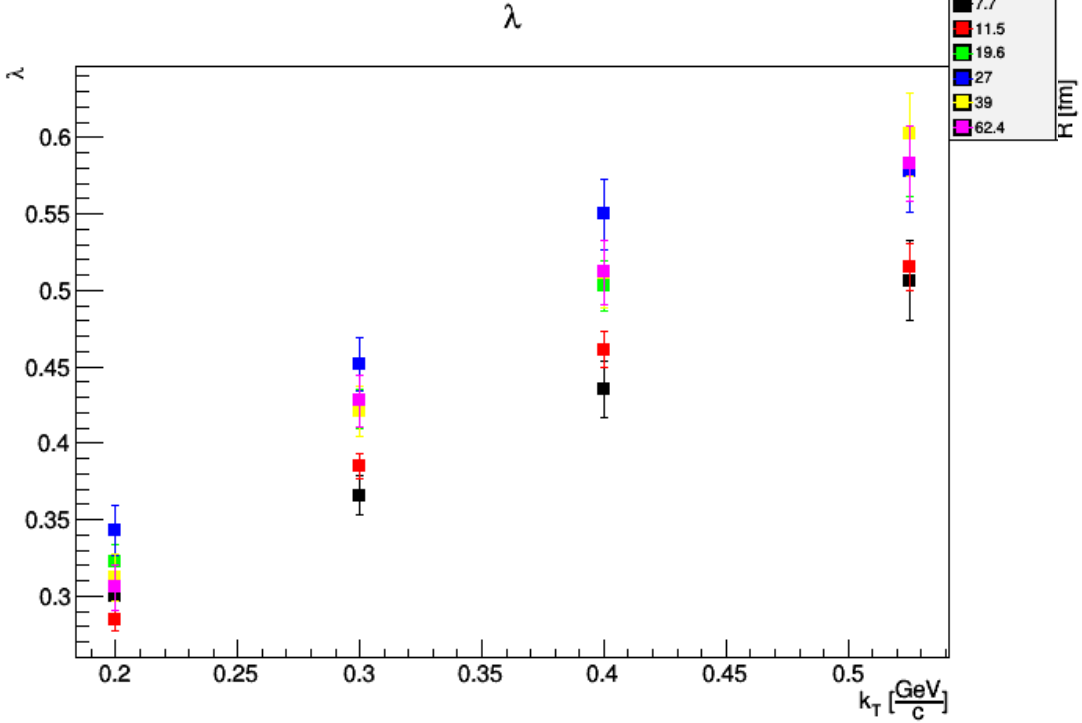
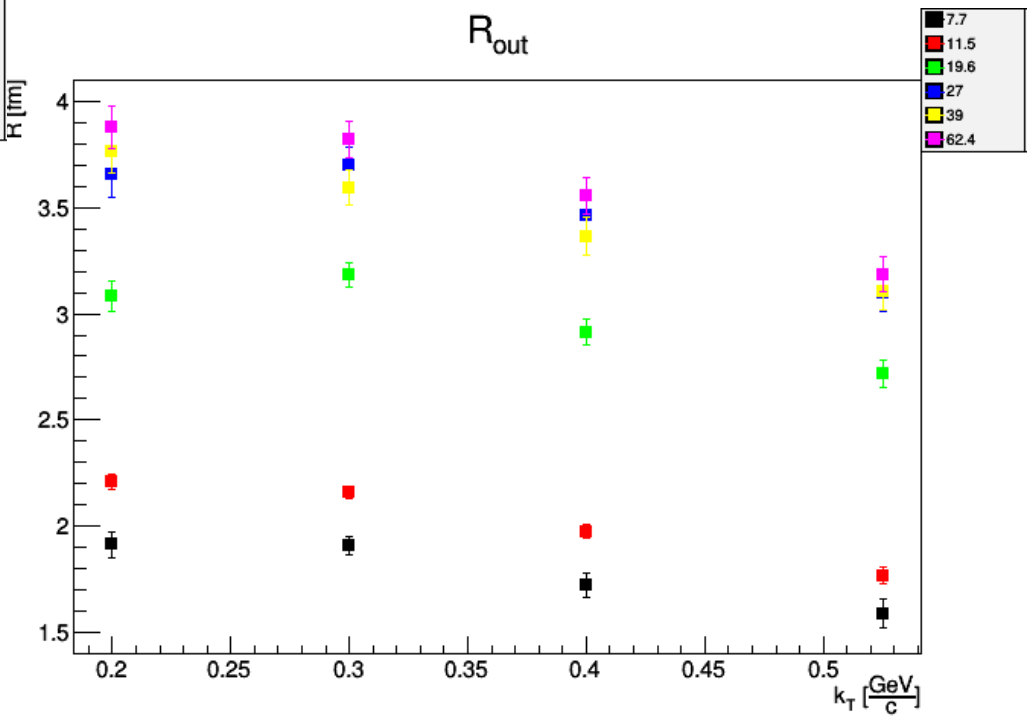
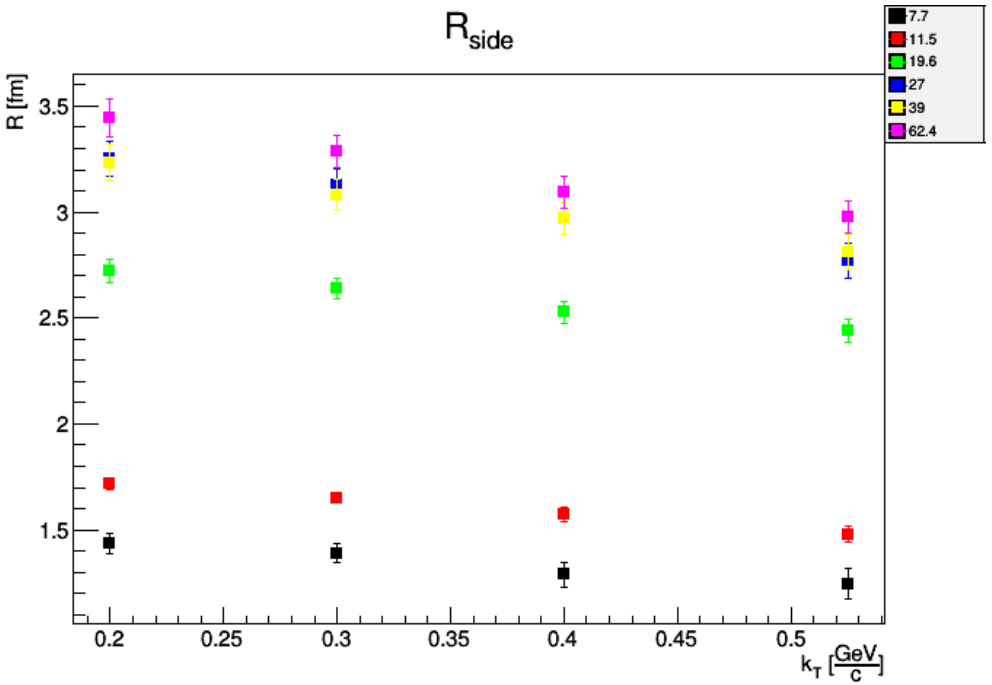
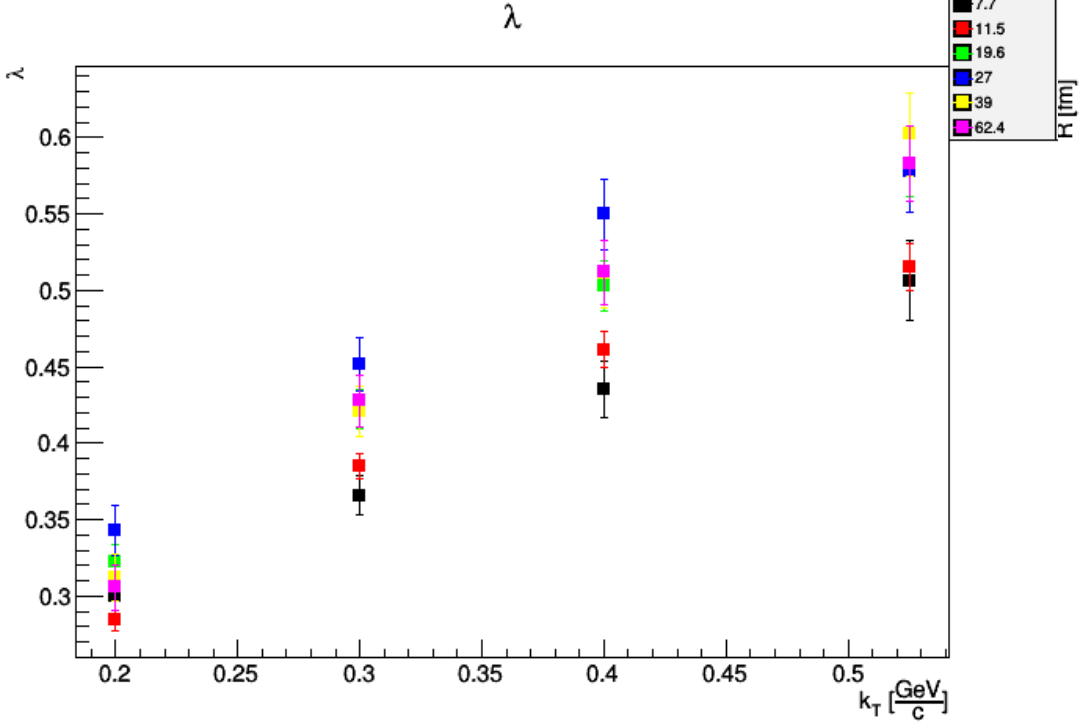
39
62.4

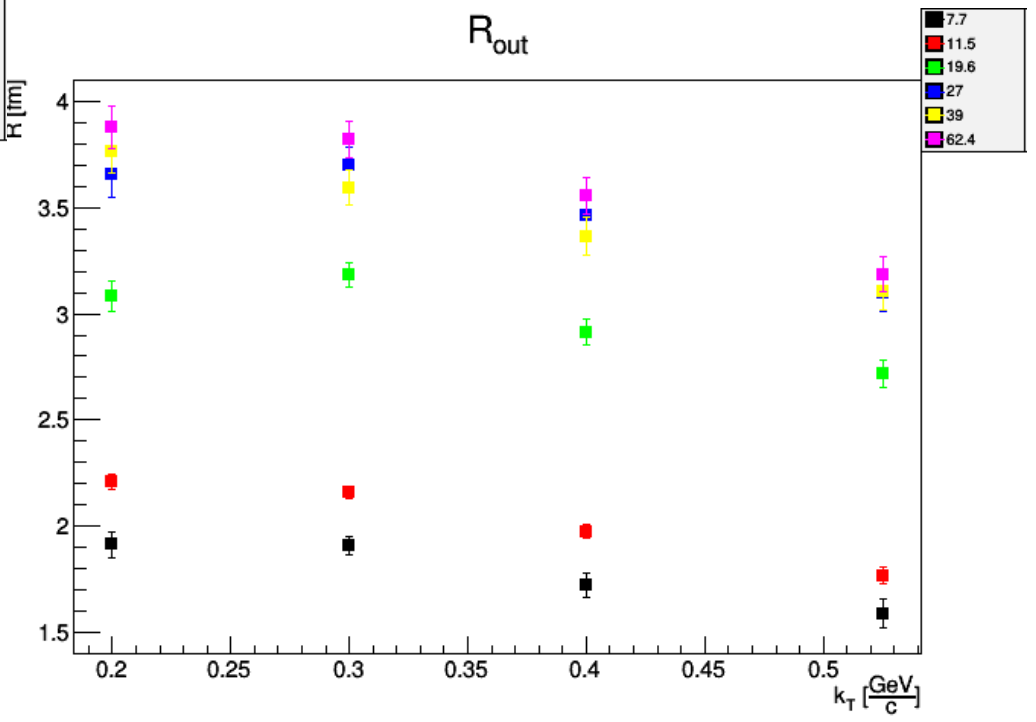

R_out
R [fm]
4
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

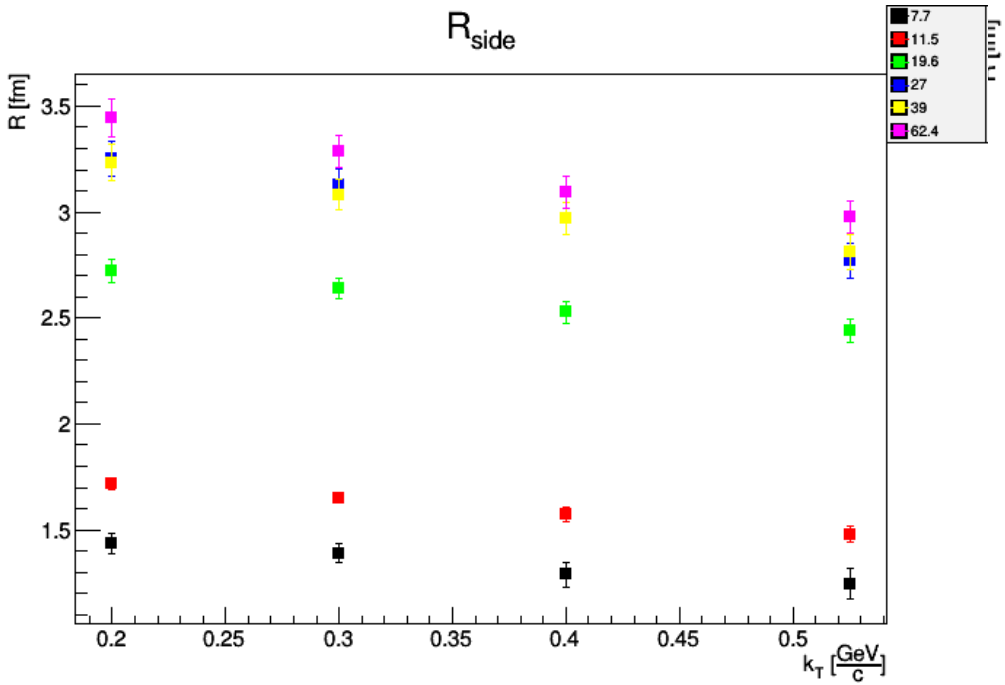

λ
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

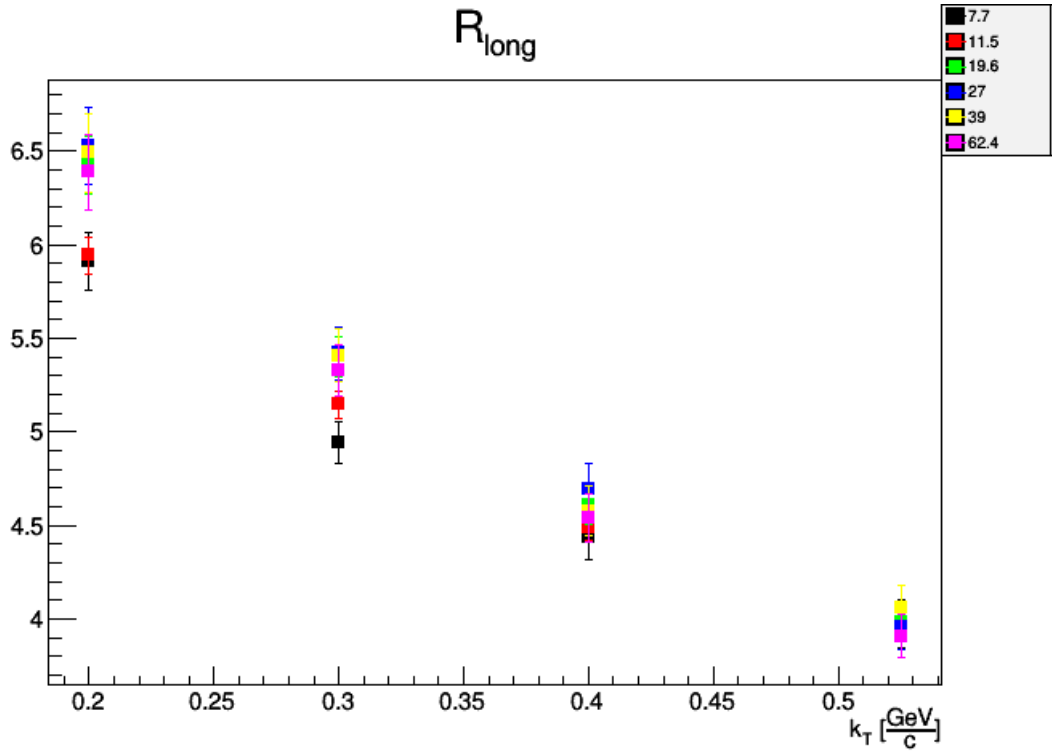

R_{out}
R [fm]
4
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

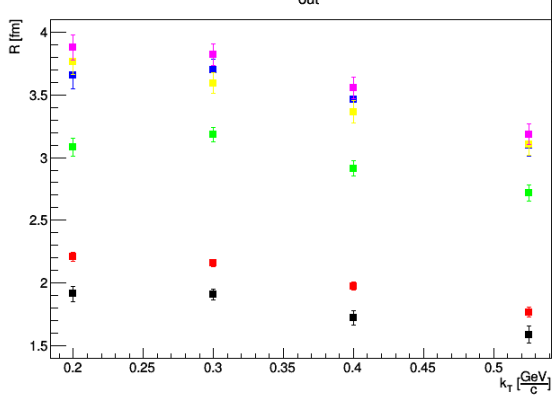

R_{side}
R [fm]
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

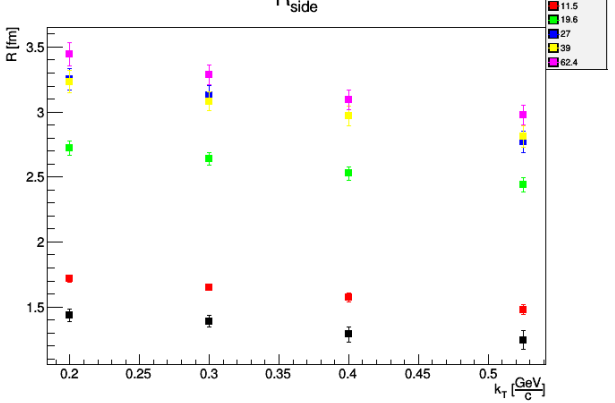

λ
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

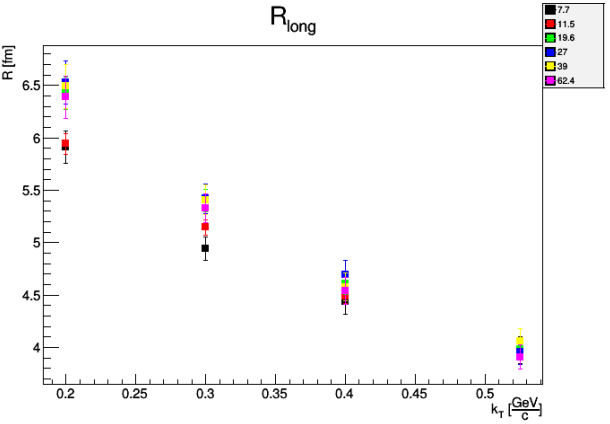

R_out
R [fm]
4
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

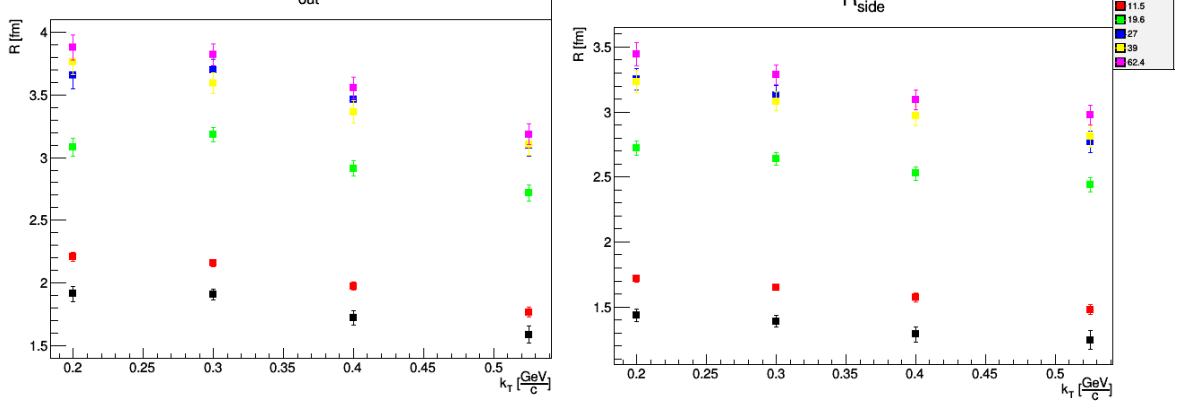

R_side
R [fm]
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4

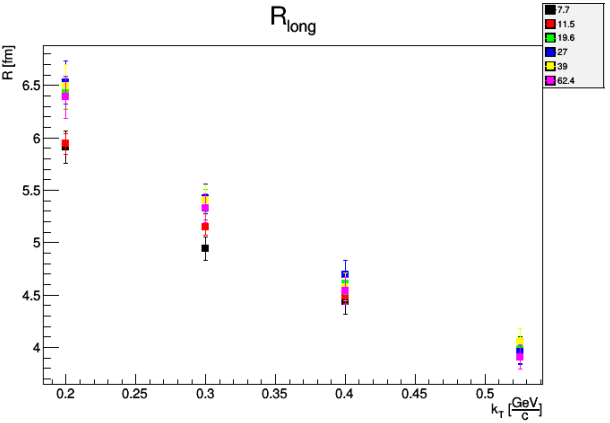

R_long
6.5
6
5.5
5
4.5
4
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4


R [fm]
4
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]


R_side
R [fm]
3.5
3
2.5
2
1.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
11.5
19.6
27
39
62.4


R_long
R [fm]
6.5
6
5.5
5
4.5
4
0.2
0.25
0.3
0.35
0.4
0.45
0.5
k_T [GeV/c]
7.7
11.5
19.6
27
39
62.4





Results from THERMINATOR:

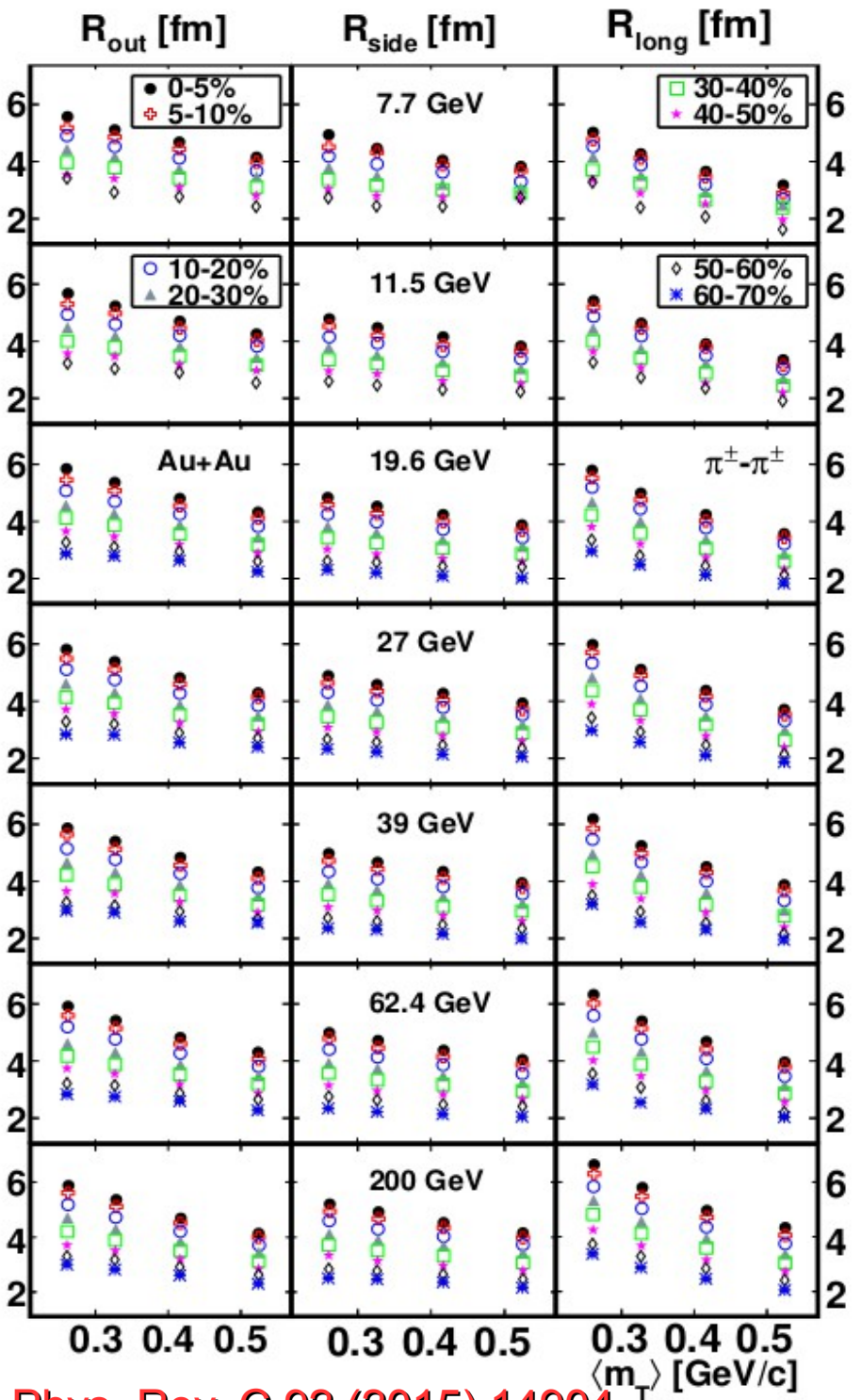
R_{out}, R_{side}: 1.5 – 3.5 fm

R_{long} : 5,0 – 6,5 fm

Bigger dependencies on energy than in STAR

R_{long} bigger than others

R_{out}, R_{side} – smaller than STAR



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Outline

1) Introduction to THERMINATOR generator

2) BES program

3) THERMINATOR for BES

3) Single particle distributions

4) Two-particle correlations

5) Summary and conclusions

Summary

- THERMINATOR generator considered

- taken energies: $\sqrt{s_{NN}}$ = 7.7, 11.5, 19.6, 27, 39, 62.4 GeV

- pion – pion femtoscopic correlations checked

Summary

- THERMINATOR generator considered

- taken energies: $\sqrt{s_{NN}}$ = 7.7, 11.5, 19.6, 27, 39, 62.4 GeV

- pion – pion femtoscopic correlations checked

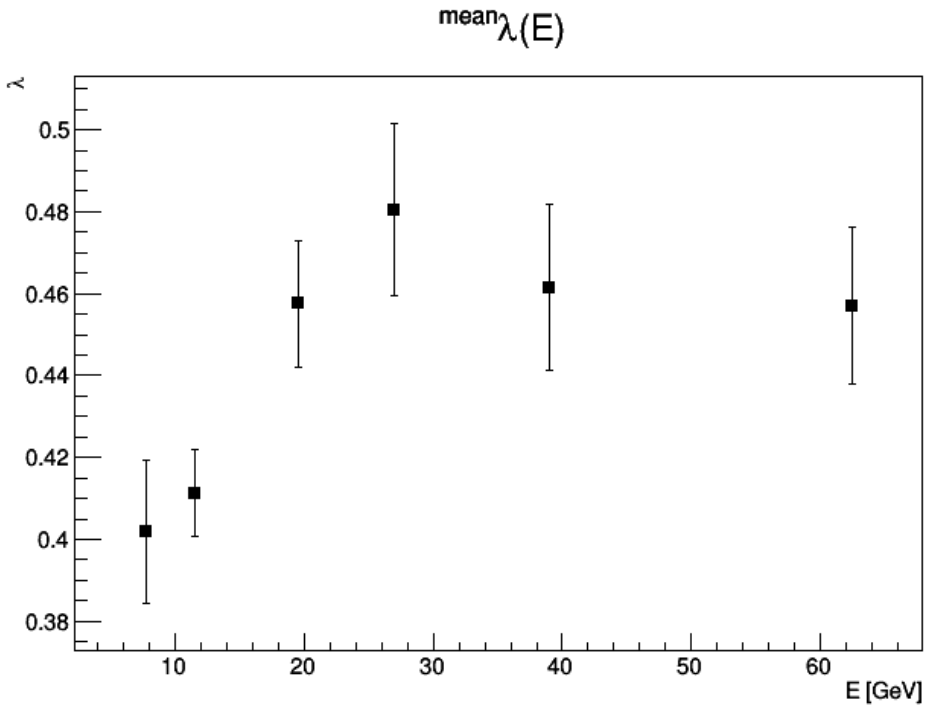
Conclusions:

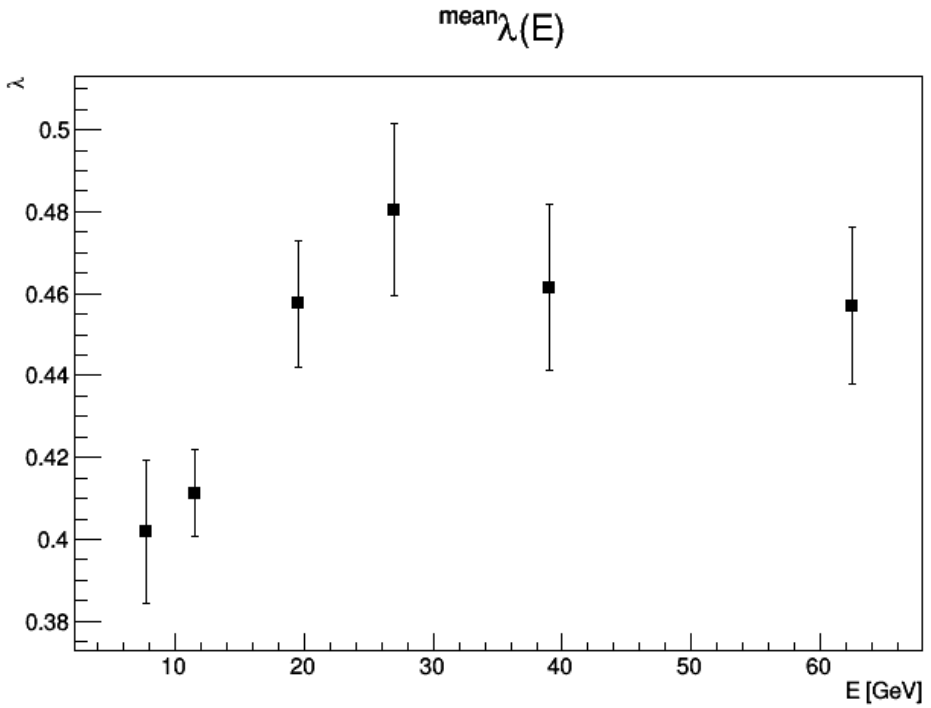
- Generator parameters estimated

- Bigger energetic dependencies in THERMINATOR than in STAR

- Ro, Rs underestimated in THERMINATOR at least ~ 30%

Thank you for your attention!


mean λ(E)
λ
0.5
0.48
0.46
0.44
0.42
0.4
0.38
10
20
30
40
50
60
E [GeV]


mean λ(E)
λ
0.5
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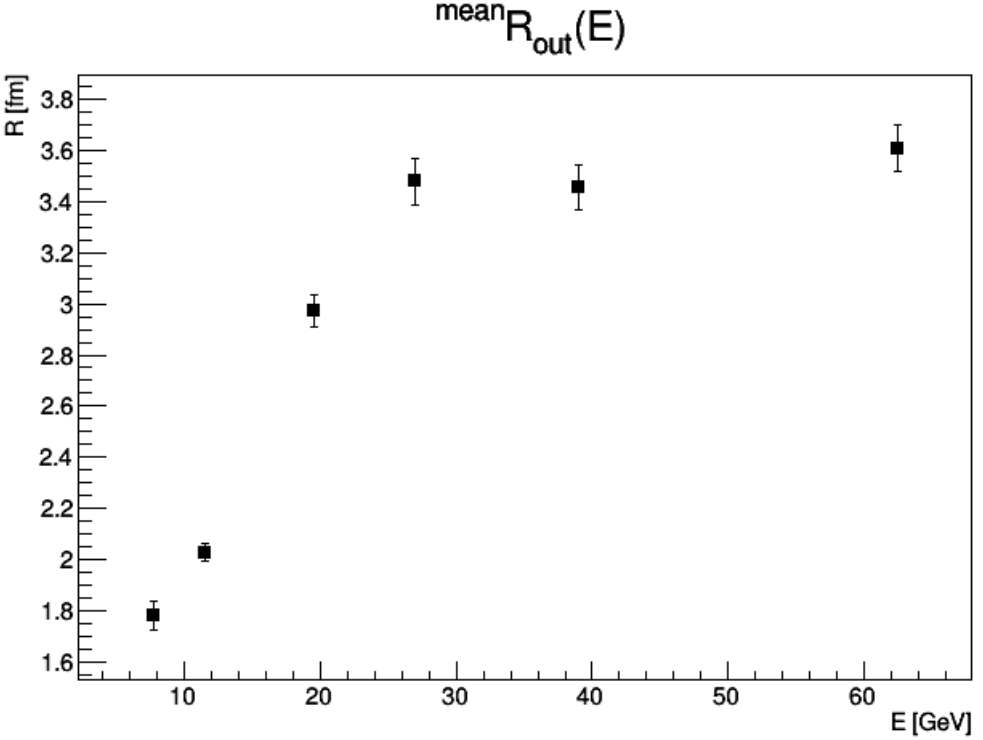
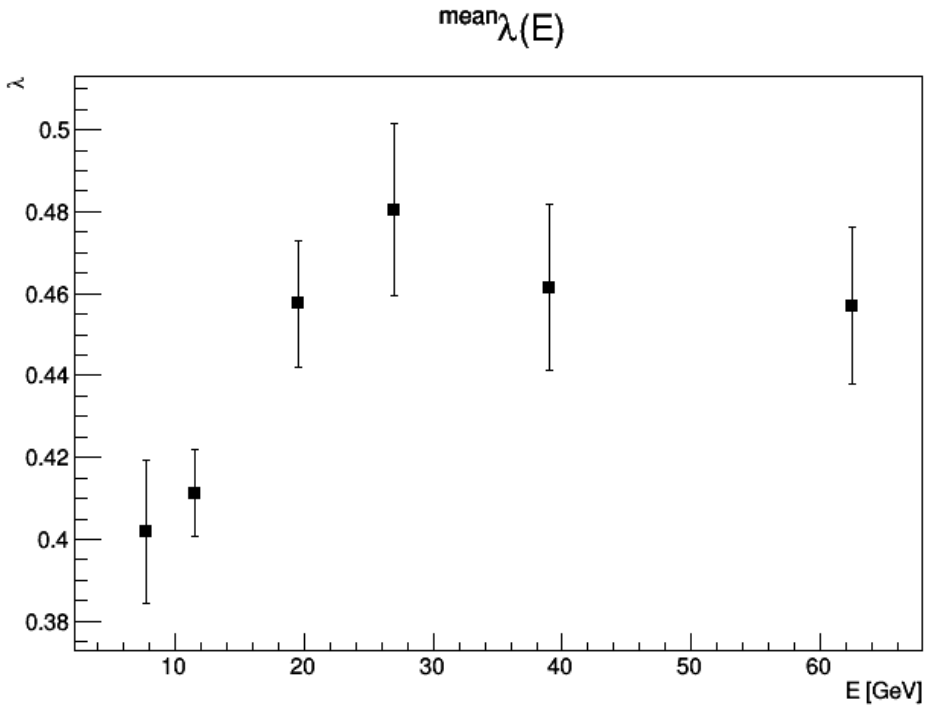
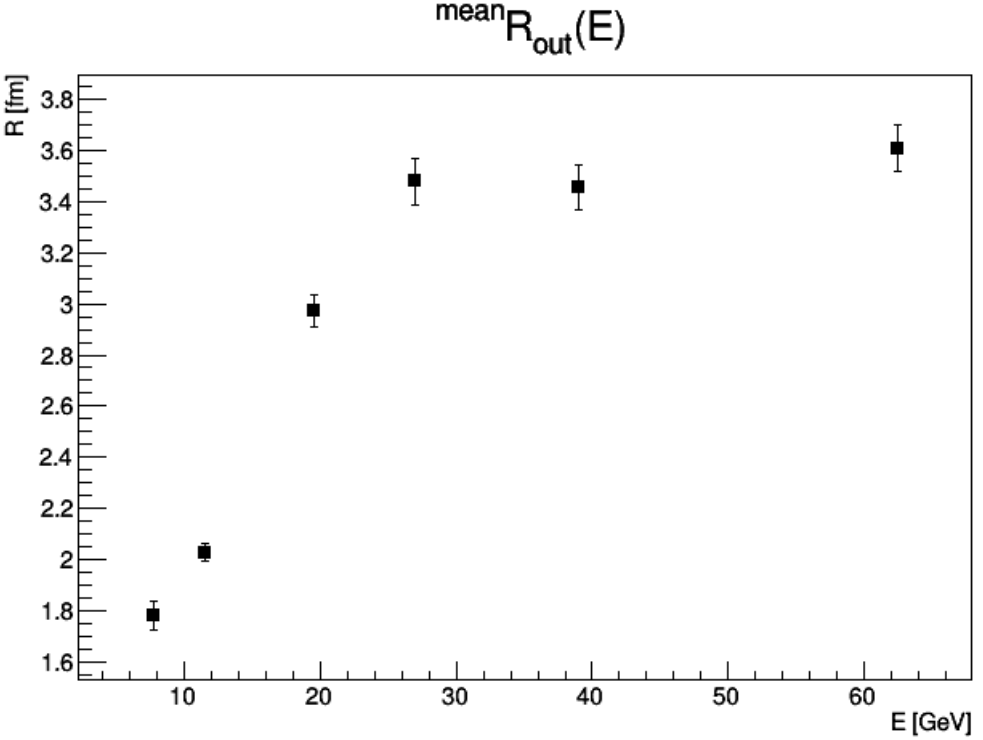
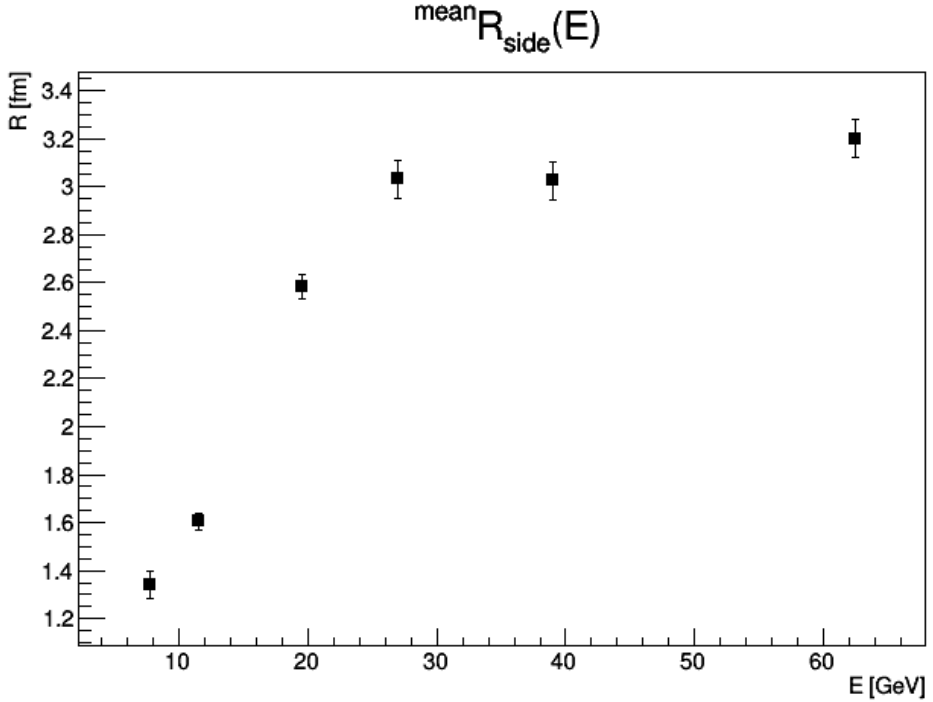
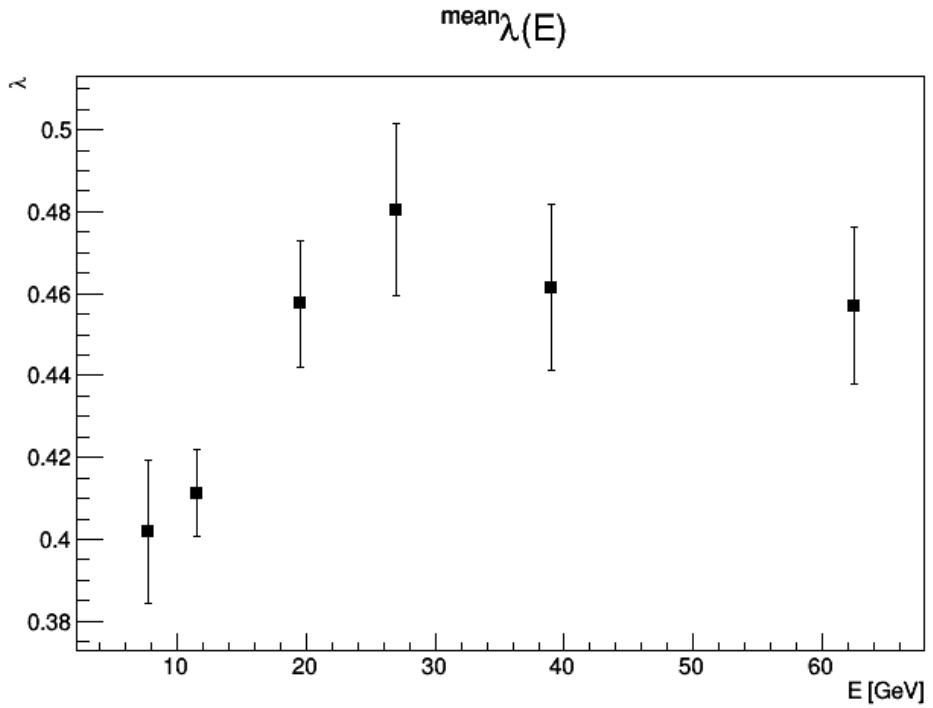
0.46
0.44
0.42
0.4
0.38
10
20
30
40
50
60
E [GeV]

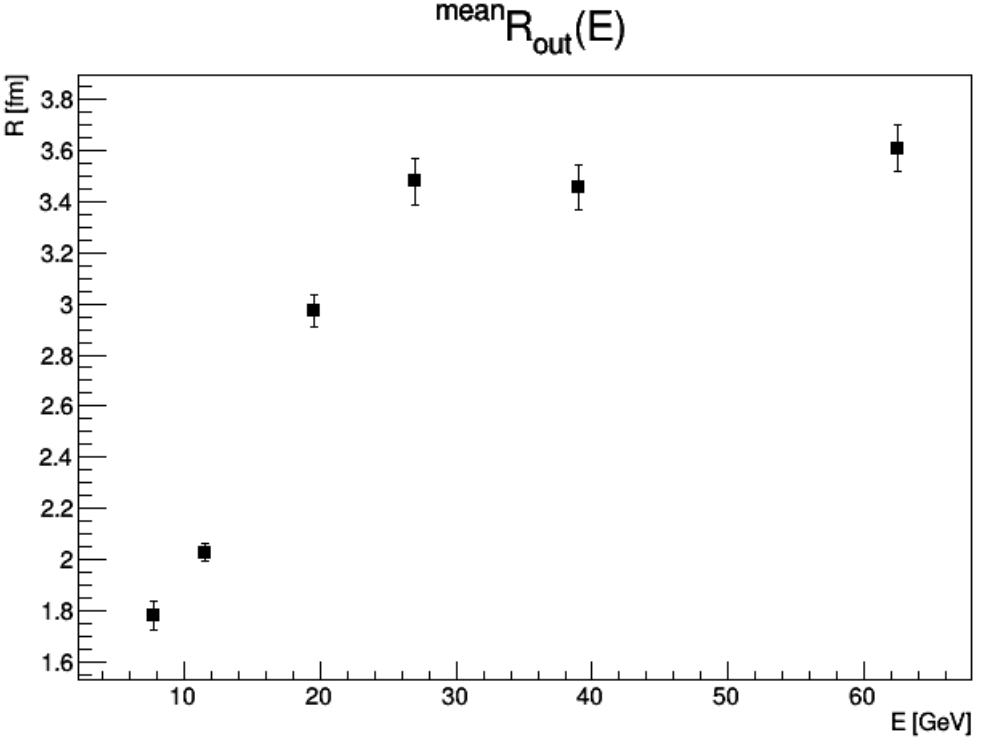

mean R_out(E)
R [fm]
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
10
20
30
40
50
60
E [GeV]

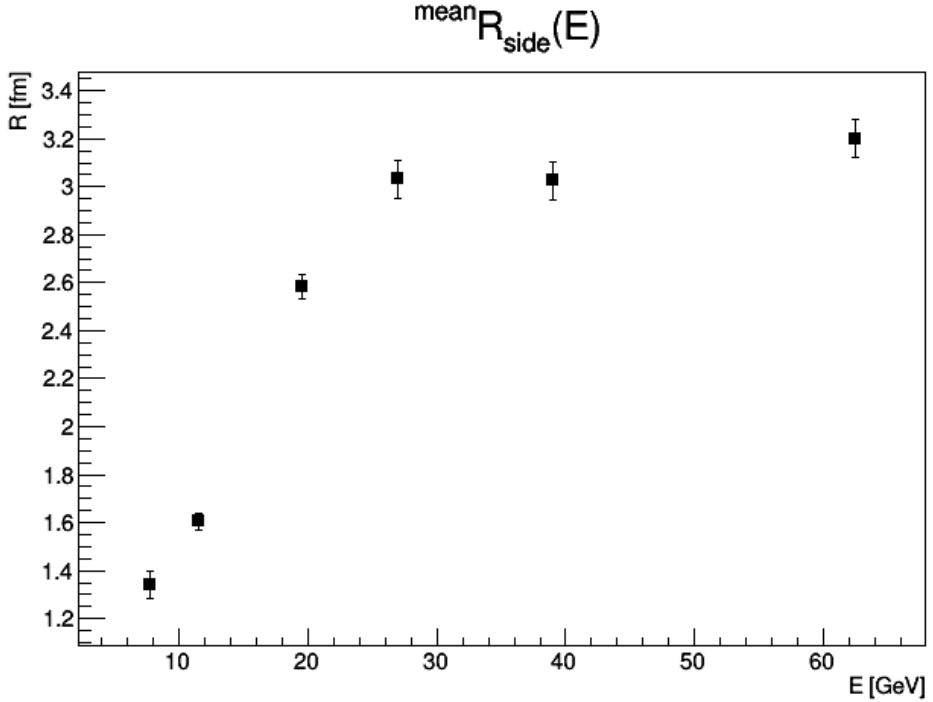

mean λ(E)
λ
0.5
0.48
0.46
0.44
0.42
0.4
0.38
10
20
30
40
50
60
E [GeV]

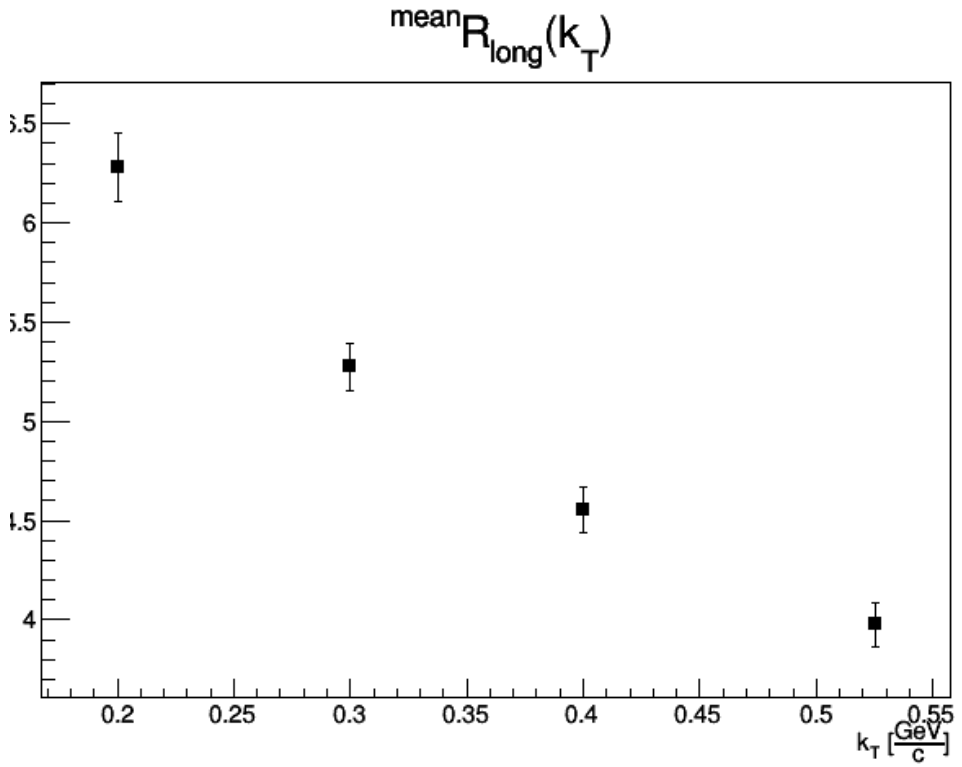

mean R_out(E)
R [fm]
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
10
20
30
40
50
60
E [GeV]

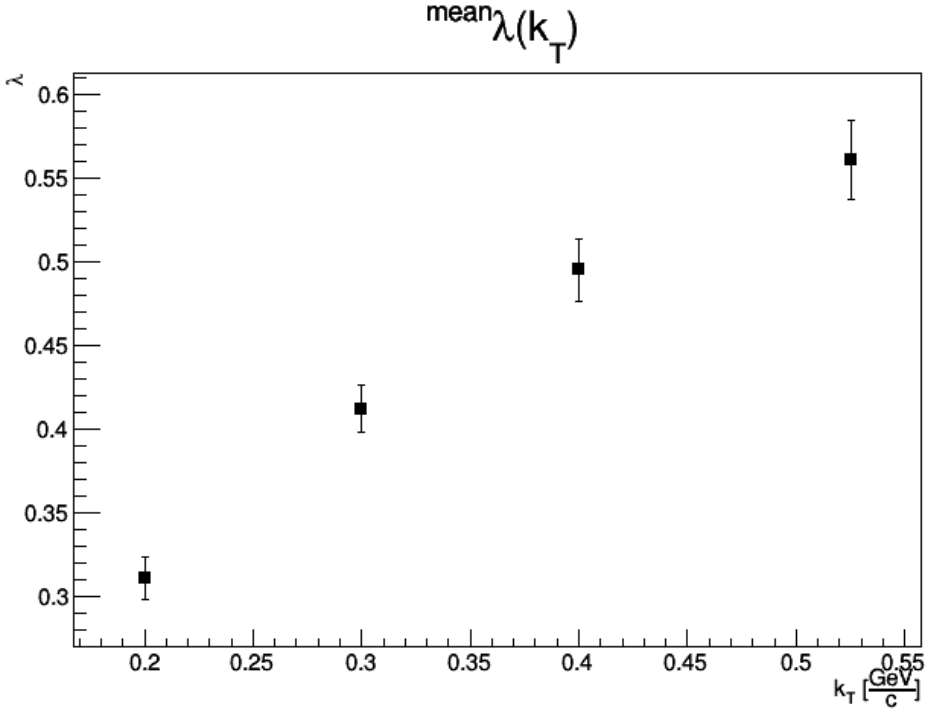

mean R_side(E)
R [fm]
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
10
20
30
40
50
60
E [GeV]

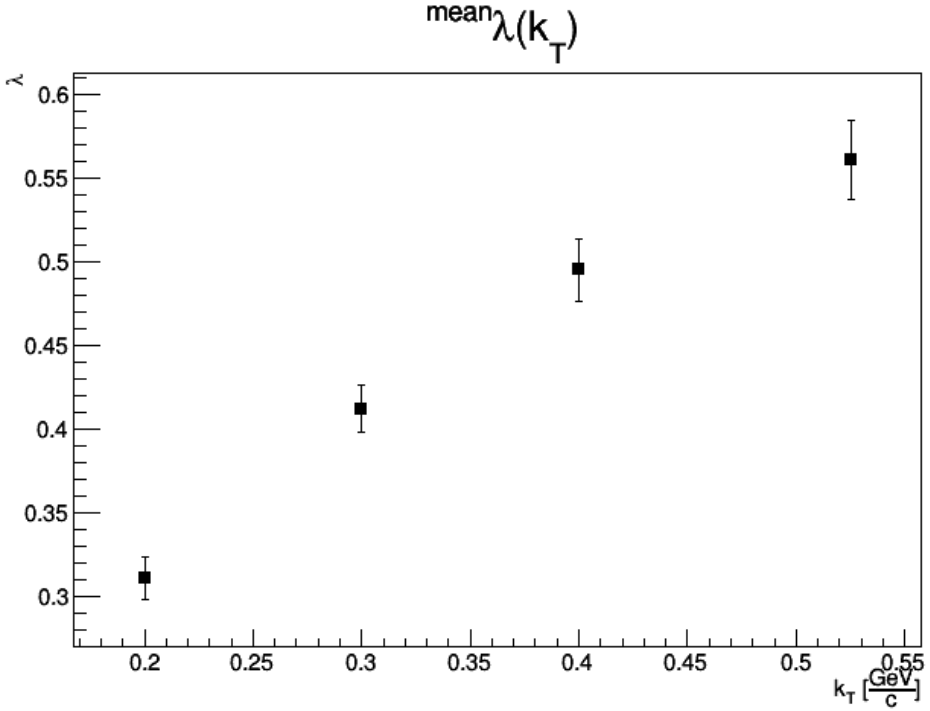

mean λ(E)
λ
0.5
0.48
0.46
0.44
0.42
0.4
0.38
10
20
30
40
50
60
E [GeV]

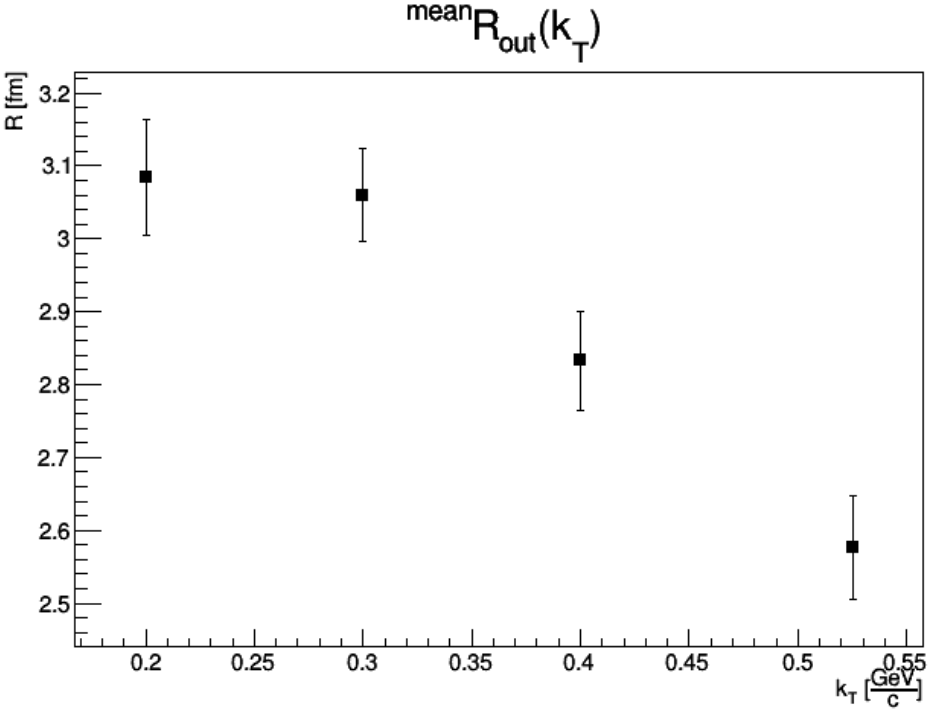

mean R_out(E)
R [fm]
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
10
20
30
40
50
60
E [GeV]

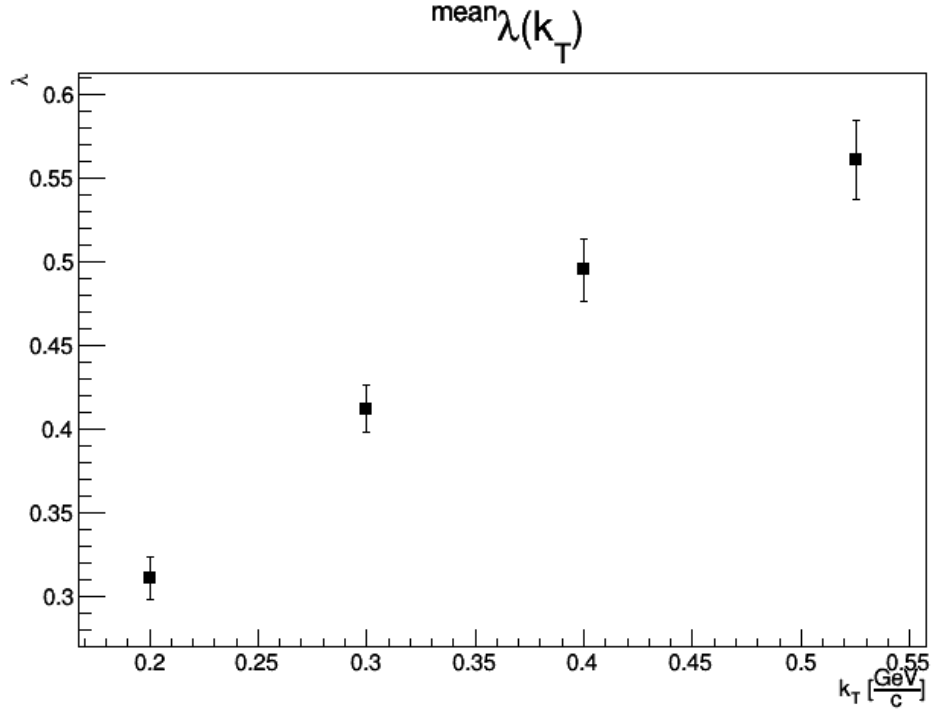

mean R_side(E)
R [fm]
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
10
20
30
40
50
60
E [GeV]

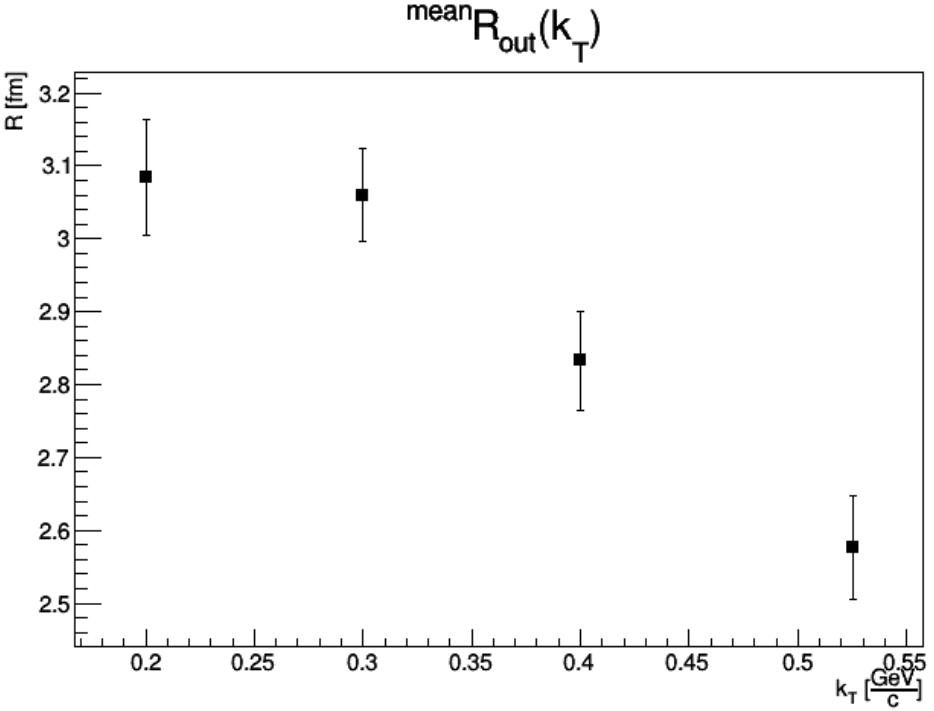

mean R_long(k_T)
6.5
6
5.5
5
4.5
4
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]

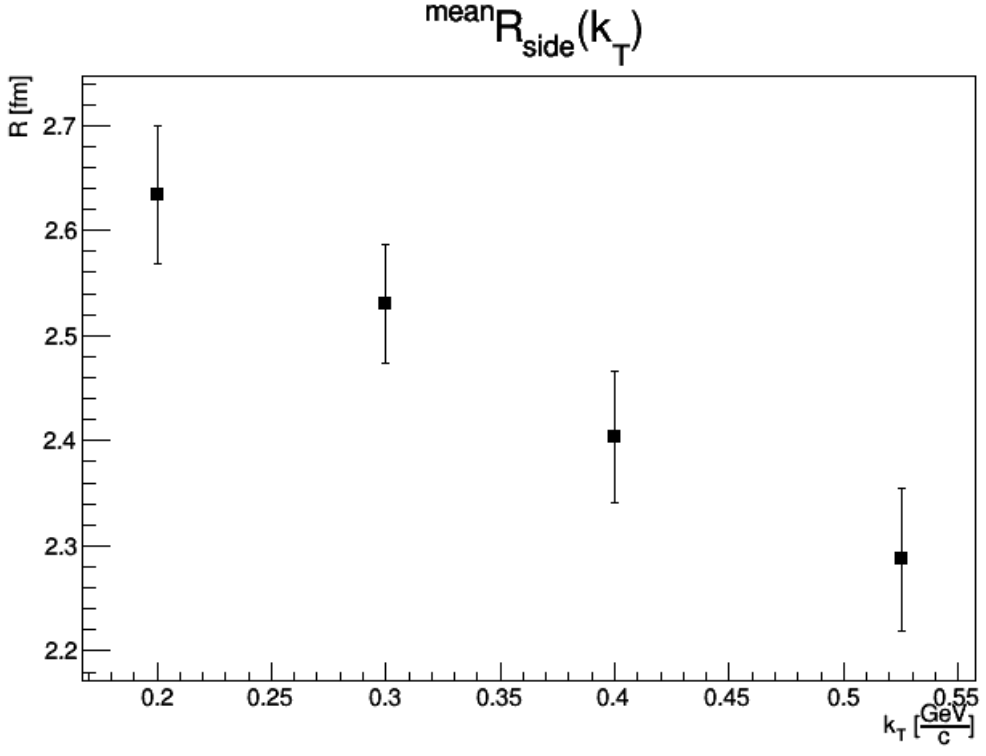

mean λ(k_T)
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]

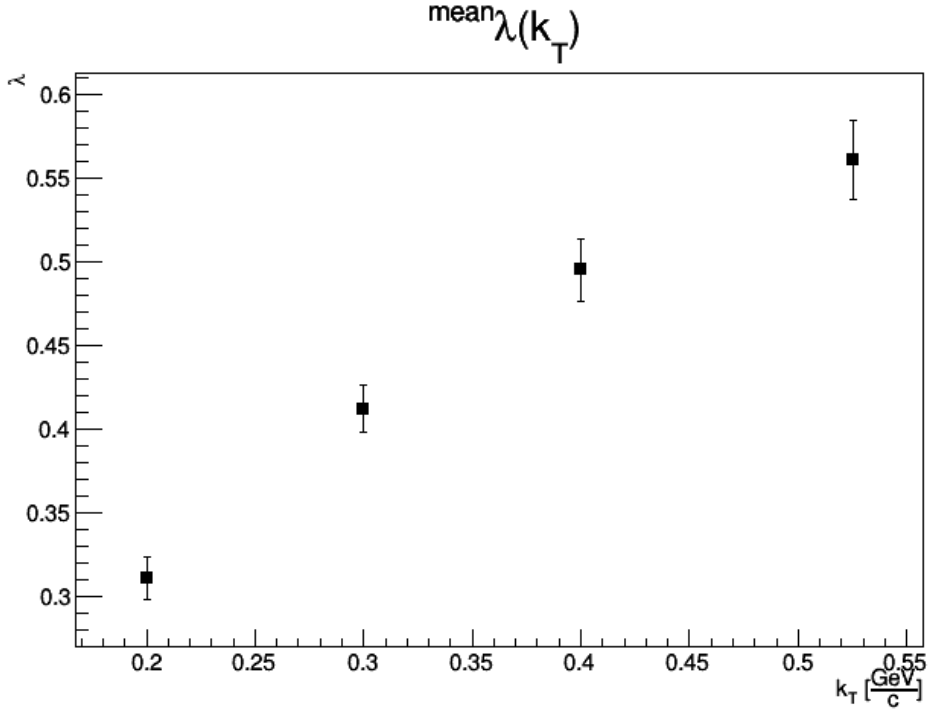

mean λ(k_T)
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]

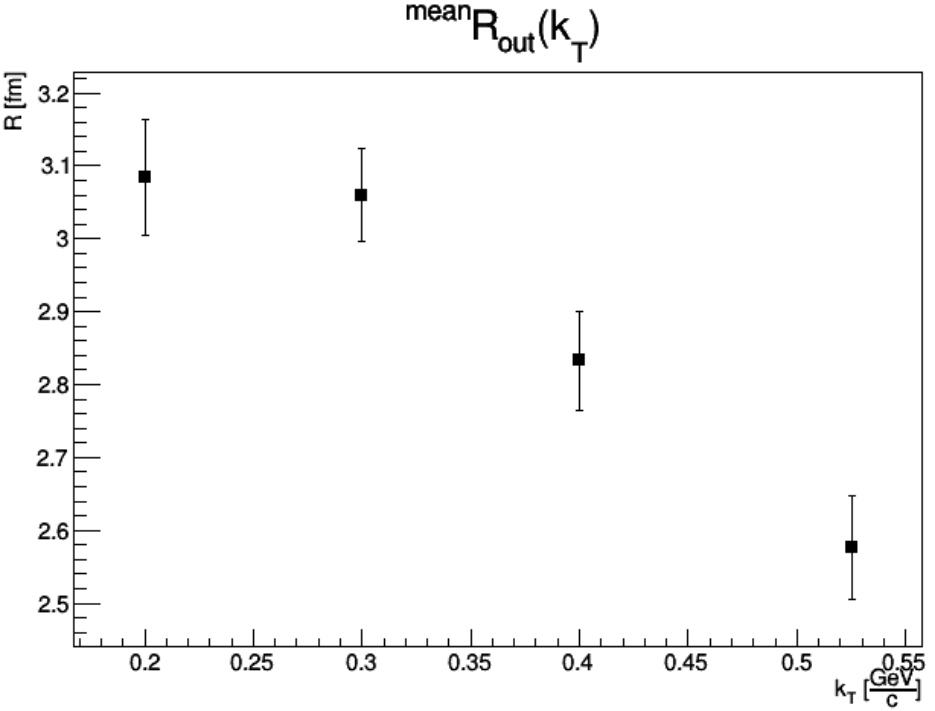

mean R_out(k_T)
R [fm]
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]

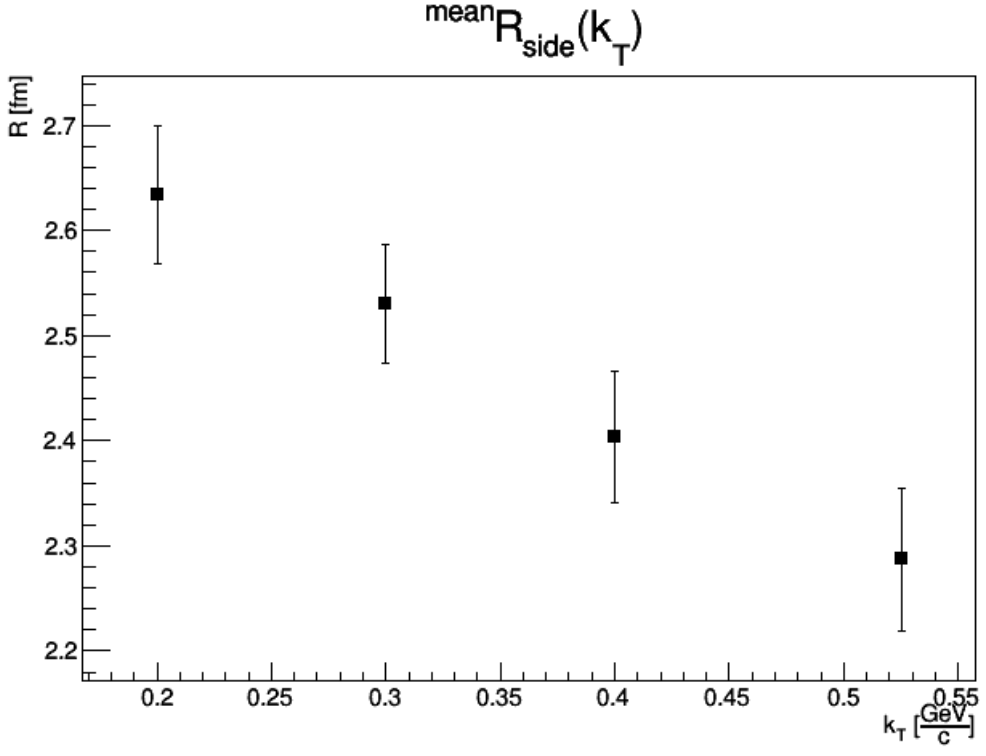

mean λ(k_T)
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]

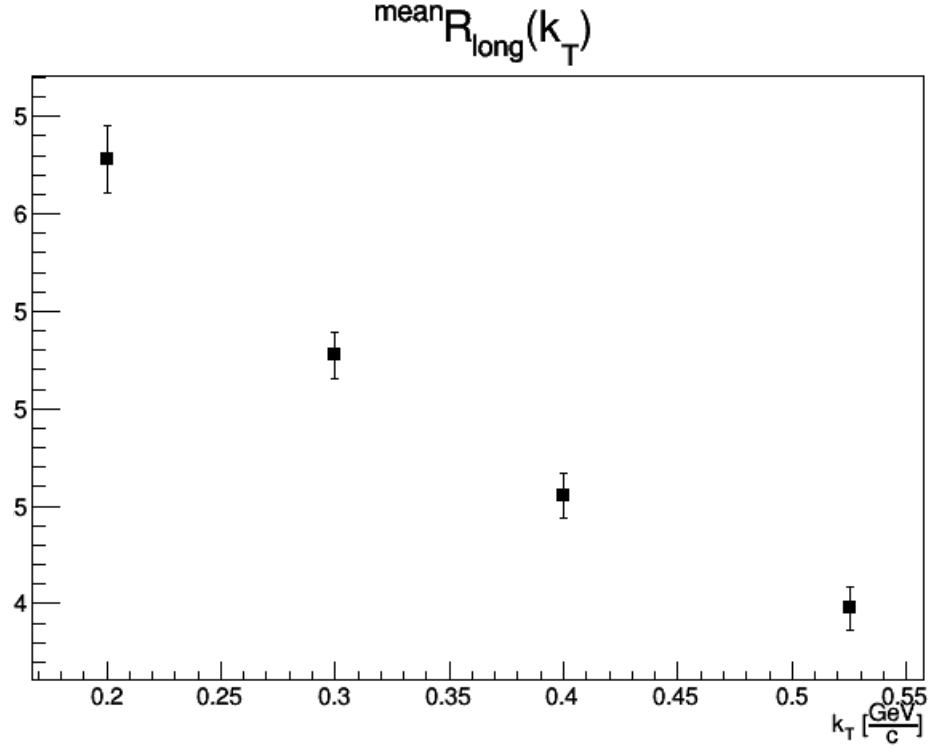

mean R_out(k_T)
R [fm]
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]


mean R_side(k_T)
R [fm]
2.7
2.6
2.5
2.4
2.3
2.2
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]


mean λ(k_T)
λ
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]


mean R_out(k_T)
R [fm]
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]


mean R_side(k_T)
R [fm]
2.7
2.6
2.5
2.4
2.3
2.2
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]


mean R_long(k_T)
6
5
5
5
4
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
k_T [GeV/c]