OUTLINE

- MOTIVATION
- ANALYSIS
  - SOFTWARE
  - DATA SELECTION
  - RESULTS
- SUMMARY
MOTIVATION

• ACCESS TO INFORMATION ABOUT SPATIOTEMPORAL STRUCTURE OF THE EVENT

\[ CF(q) = \frac{N(q)}{D(q)} \]

\[ q = p_1 - p_2 \]
SOFTWARE

• URQMD 3.4 FOR SIMULATION OF MC-DATA
• MPDROOT (MAY 2018 VERSION) FOR SIMULATION OF DETECTOR RESPONSE
• NICAFEMTO
  • CALCULATION OF CF
  • FITTING CF
DATA

- 3.6 M AU+AU EVENTS
- ENERGY: $\sqrt{S_{NN}} = 11 \text{ GeV}$
- CENTRALITY 0-5% (IMPACT PARAMETER <3.5 FM)
DATA

- SIMULATED WITH STANDARD MACROS
- COLLISION POSITION FIXED AT (0,0,0)
DATA SELECTION

- I focused on $\pi^+\pi^+$ correlations, therefore I should select
  - primary pions
  - relatively well reconstructed
TRACK CUTS
DATA SELECTION

• TRACK CUTS
  • $DCA_{XY} < 1.25 \text{ CM}$
  • $|DCA_{Z}| < 0.75 \text{ CM}$
  • NHITS > 29
  • $|\eta| < 1.2$
  • $|\text{PION N-SIGMA}| < 2$
  • $0.3 < m^2 < 0.15 \text{ GEV}^2/\text{C}^4 \text{ IF } P > 0.5 \text{ GEV}/\text{C}$
CORRELATION FUNCTION

• „RAW FUNCTION” – NO FEMTOSCOPIC WEIGHTS, NO TWO-PARTICLE CUTS:
  • CF=1 – EXPECTED
  • CF<1 – MERGING (RECONSTRUCTION OF A PAIR AS A SINGLE PARTICLE)
  • CF>1 – SPLITTING (RECONSTRUCTION OF A PARTICLE AS A PAIR OF THE PARTICLES)
„RAW” CORRELATION FUNCTION
NOMINAL TPC ENTRANCE $> 2$ cm

FRACTION OF SHARED HITS = 0
„SECOND” CORRELATION FUNCTION
„SECOND” CORRELATION FUNCTION

• „PSEUDOSPLITTING PROBLEM”
  • ALL STANDARD ANTI-SPLITTING CUTS DO NOT WORK
  • REMOVING TRACKS WITH THE SAME MC PARENT DOES NOT HELP
„SECOND” CORRELATION FUNCTION
„SECOND” CORRELATION FUNCTION
„SECOND” CORRELATION FUNCTION
„FINAL” CF
1-D CORRELATION FUNCTION
SIMULATION PARAMETERS

- INCOHERENCE FACTOR ($\lambda$) SET TO 0.5
- RADII TAKEN FROM STAR DATA ($\sqrt{s_{NN}} = 11.5 \text{ GeV}$)
- 3D GAUSSIAN IN LCMS ASSUMED
FITTING

• 1D GAUSSIAN SOURCE ASSUMED
• MOMENTUM SMEARING TAKEN INTO ACCOUNT ($C_{\text{gaussian}}(q, r) \rightarrow C_{\text{smeared}}(q, R)$)
• FITTING FUNCTION:

$$C(q, r) = NC_{BCKG}(q)\{\lambda[(C_{\text{smeared}}(q, R) - 1)C_{\text{purity}}(q)] + 1\}$$
FITTING

- THE "PSEUDOSPLITTING" WAS PARAMETRIZED BY A LINEAR FUNCTION
  - $C_{BCKG}(q) = 1 + a + bq$ IF $aq > 0$
  - $C_{BCKG}(q) = 1$ IF $a + bq < 0$
$C_{\text{purity}}(q) = C - B \exp(-qA)$
\[ C_{\text{PERF}} = \frac{N_{\text{weighted}}}{N_{\text{unweighted}}} \]
RESULTS

• STATIC UNCERTAINTY WAS NEGLIGIBLE

• THE SYSTEMATIC UNCERTAINTY:
  • 6.2-19.3 % FOR RADII (DEPENDS ON K$_T$)
  • 46.9-63.3 % FOR LAMBDA (DEPENDS ON K$_T$)

• MAIN SOURCES OF UNCERTAINTY:
  • FITTING RANGE
  • BACKGROUND CORRECTION FUNCTION
3-D CORRELATION FUNCTIONS
3D STUDIES

• THE SAME CUTS WERE APPLIED ON THE SAME DATA

• MAIN DIFFERENCES IN FITTING PROCEDURE:
  • DUE TO COMPUTING RESOURCES MOMENTUM RESOLUTION CORRECTION WAS NOT APPLIED – ONLY SYSTEMATIC UNCERTAINTY WAS ESTIMATED (AS A DIFFERENCE BETWEEN DATA FITTED WITH AND WITHOUT SMEARED MOMENTUM)
  • BOWLER-SINYUKOV USED (INSTEAD OF FUNCTION DIRECTLY FROM LEDNICKY’S CODE)
  • BACKGROUND FUNCTION DESCRIBED NUMERICALLY (CALCULATED FROM π⁻π⁻ PAIRS)
3D STUDIES

• STATISTIC UNCERTAINTY NEGLIGIBLE (<0.3%)
• TOTAL SYSTEMATIC UNCERTAINTY OF RADII
  • 14-17% FOR "OUT"
  • 11-15% FOR "SIDE"
  • 5 – 6% FOR "LONG"
  • 22-24% FOR "LAMBDA"

• MAIN SOURCE OF UNCERTAINTIES: TWO PARTICLE CUTS, COWBOY-SAILOR CUT, BOWLER-SINYUKOV PROCEDURE, MOMENTUM RESOLUTION CORRECTION
SUMMARY

• STUDIES OF PION CORRELATION IN ONE AND THREE DIMENSIONS WERE PERFORMED
• THE „PSEUDOSPLITTING” EFFECT WAS OBSERVED (BUT NOT EXPLAINED!)
• BASIC TOOLS FOR FITTING WERE DEVELOPED AND TESTED
• SYSTEMATIC UNCERTAINTIES WERE ESTIMATED
PLANS FOR THE FUTURE

• GENERATION OF DATA WITH NEWER SOFTWARE
• IMPROVEMENTS IN FITTING PROCEDURES (ESPECIALLY FOR 3D CF)
• STUDY OF KAONS AND PROTONS (REQUIRE MUCH MORE STATISTICS)
THANK YOU FOR YOUR ATTENTION
BACKUP SLIDES

[Graphs showing data with and without bin optimization]