MEASURING FLUCTUATIONS: PROPERLY PUBLISHED RESULTS

- PROPERLY PUBLISHED RESULTS
- BAD AND GOOD EXAMPLES
- ON EVENT SELECTION IN A+A COLLISIONS

PROPERLY PUBLISHED RESULTS

NEW MEASURMENTS ARE MOTIVATED BY QUESTIONS AND PROBLEMS EMERGING FROM EXISTING DATA AND MODELS (THE SO-CALLED PROBLEM SITUATION).

IN ORDER TO RESOLVE A PROBLEM SITUATION ONE NEEDS NEW EXPERIMENTAL DATA, NEW MEASURMENTS.

MEASURMENTS FOR HEP ARE LONG-LASTING AND EXPENSIVE, DIFFICULT TO REPEAT. THEY ARE FINANCED BY PUBLIC, INTERNATIONAL FUNDS. THUS RESULTS ARE REQUESTED TO BE PUBLIC AND PRESERVED, TO BE USEFULL FOR "EVERYBODY FOREVER".

BEING USEFULL FOR "EVERYBODY FOREVER"
IN PRACTICE MEANS:

- ALL INFORMATION NEEDED TO QUANTITATIVELY CROSS-CHECK THE RESULTS IN OTHER EXPERIMENTS IS PUBLISHED TOGETHER WITH THE RESULTS

- ALL INFORMATION NEEDED TO QUANTITATIVEY COMPARE THE RESULTS WITH MODEL CALCULATIONS IS PUBLISHED TOGETHER WITH THE RESULTS

RESULTS USEFULL FOR "EVERYBODY FOREVER" ARE CALLED PROPERLY PUBLISHED RESULTS

MANY RESULTS ON EVENT-BY-EVENT FLUCTUATIONS
ARE NOT PROPERLY PUBLISHED RESULTS.

EXAMPLES:

POOR PRACTICE, TO BE AVOIDED

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Energy dependence of $K\pi$, $p\pi$, and Kp fluctuations in Au + Au collisions from $\sqrt{s_{NN}} = 7.7$ to 200 GeV

The data presented here for $K\pi$, $p\pi$, and Kp fluctuations were acquired by the STAR experiment [22] at RHIC in minimum bias (MB) Au + Au collisions at $\sqrt{s_{NN}} = 7.7, 11.5,$ 19.6, 27, 39, 62.4, and 200 GeV (3, 4, 15, 29, 10, 17, and 33 million events, respectively). The main particle tracking detector at STAR is the time projection chamber (TPC) [23].

DEFINITION OF MEASURED RESULTS

EVENT AND TRACK SELECTION

The position of the collision vertex along the beam line was restricted to the center of the TPC to $\pm$ 30 cm at $\sqrt{s_{NN}} = 19.6$ to 200 GeV, and $\pm$ 50 cm at $\sqrt{s_{NN}} = 7.7$ and 11.5 GeV. A distance of closest approach (DCA) of a track to the primary event vertex of less than 1.0 cm was required to reduce the number of particles not originating from the primary collision vertex. Each track was required to have at least 15 fit points in the TPC, and a ratio of the number of fit points to the maximum possible number of fit points greater than 0.51. Collision centrality is determined (at all energies) using TPC charged particle tracks from the primary vertex in the pseudorapidity range $|\eta| < 0.5$, with $p_T > 0.15$ GeV/c, and more than 10 fit points.

THE PAPER PRESENTS AS FINAL RESULTS :

- MEASURED (POORLY DEFINED) AND UNCORRECTED RESULTS

- A POSTERIORI SYSTEMATIC BIASES ARE GUESSED AND TREATED AS SYSTEMATIC UNCERTAINTIES

IMPROPERLY PUBLISHED RESULTS CANNOT BE COMPARE WITH MODEL PREDICTIONS AND OTHER MEASURMENTS WITHOUT ACCESS TO UNPUBLISHED INFORMATION AND SOFTWARE (MONTE CARLO AND RECONSTRUCTION)

THE RESULTS ARE NOT USEFULL FOR "EVERYBODY AND FOREVER"

EXAMPLE ON EVENT SELECTION:

~~possible number of fit points greater than 0.51~~. Collision centrality is determined (at all energies) using TPC charged particle tracks from the primary vertex in the pseudorapidity range $|\eta| < 0.5$, with $p_T > 0.15$ GeV/c, and more than 10 fit points.

FROM THIS IMPRECISE DEFINITION ONE CAN GUESS THE FOLLOWING!

- MEASURED (UNCORRECTED) MULTIPLICITY OF CHARGED PARTICLES FITTED A PRIMARY VERTEX WAS DETERMINED EVENT-BY-EVENT.

  IT IS BIASED BY LOSSES OF PRIMARY TRACKS AND A CONTRIBUTION OF SECONDARY TRACKS (WEAK DECAYS, SECONDARY INTERACTIONS).

A TRACK ACCEPTANCE DEFINITION INCLUDES A CUT ON THE NUMBER OF FITTED POINTS WHICH CANNOT BE REPRODUCED WITHOUT MC AND RECO CHAINS (UNPUBLISHED).

- THE MULTIPLICITY DISTRIBUTION WAS PROBABLY CORRECTED FOR EVENT LOSSES DUE TO ON-LINE AND OFF-LINE EVENT SELECTION CUTS (UNSPECIFIED) TO ALL INELASTIC (PROBABLY) Au+Au COLLISIONS.
IT WAS PROBABLY CORRECTED FOR A CONTAMINATION OF UNWANTED EVENTS.

- "COLLISION CENTRALITY" FOR AN EVENT WAS PROBABLY DETERMINE AS A FRACTION OF EVENTS WITH MULTIPLICITY HIGHER THAN THE MEASURED EVENT MULTIPLICITY WITH RESPECT TO ALL INELASTIC Au+Au COLLISIONS.

RECOMMENDED EXAMPLE
(BUT STILL IMPERFECT ☹)

Multiplicity and transverse momentum fluctuations in inelastic proton-proton interactions at the CERN Super Proton Synchrotron

NA61/SHINE Collaboration (A Aduszkiewicz (Warsaw U.) *et al.*) *Show all 132 authors*

Oct 1, 2015 - 16 pages

CERN-PH-EP-2015-273
e-Print: arXiv:1510.00163 [hep-ex] | PDF
Experiment: CERN-NA-061

Abstract Measurements of multiplicity and transverse momentum fluctuations of charged particles were performed in inelastic p+p interactions at 20, 31, 40, 80 and 158 GeV/c beam momentum. Results for the scaled variance of the multiplicity distribution and for three strongly intensive measures of multiplicity and transverse momentum fluctuations $\Delta[P_T,N]$, $\Sigma[P_T,N]$ and Φ_{p_T} are presented. For the first time the results on fluctuations are fully corrected for experimental biases.

The final results refer to charged hadrons produced in the analysis acceptance in inelastic proton-proton interactions at 20, 31, 40, 80, and 158 GeV/c beam momenta. Products of electromagnetic decays are included. Products of weak decays and secondary interactions among the tracks satisfying the selection criteria are corrected for. The result is referred to as *accepted primary* hadrons.

5.3 Determination of the analysis acceptance

The detection and reconstruction inefficiencies were corrected using the simulation. However, in order to limit the impact of possible inaccuracies of this simulation, only regions were accepted where the reconstruction efficiency (defined as the ratio of the number of reconstructed and matched Monte Carlo tracks passing the track selection criteria to the number of generated tracks) is greater than 90%. These regions were identified using a separate, statistically independent simulation in three dimensional bins of rapidity, azimuthal angle and transverse momentum. The result is stored in the form of three dimensional tables Ref. [20] where zeroes signal bins excluded from the acceptance and ones those that are included. The population of charged particles within this acceptance is shown in Fig. 2 for 20 GeV/c and 158 GeV/c p+p interactions.

20. T. Czopowicz. Acceptance used in the paper
https://edms.cern.ch/document/1549298/1.

5 Analysis procedure

The analysis procedures consisted of the following steps:

(i) applying event and track selection criteria,
(ii) evaluation of the moments of distributions of quantities needed to calculate fluctuations (Eqs. 1,2,3,4),
(iii) evaluation of corrections to the moments based on experimental data and simulations,
(iv) calculation of the corrected fluctuations.

Corrections for the following biases were evaluated and applied:

(i) contribution of off-target interactions,
(ii) losses of inelastic p+p interactions due to the trigger and the event and track selection criteria,
(iii) contribution of particles other than primary charged hadrons,
(iv) losses of primary charged hadrons due to the track selection criteria.

STATISTICAL (SUBSAMPLES) AND SYSTEMATIC (A PRIORI AND A POSTERIORI) ERORRS ARE PRESENTED.

THESE ARE PROPERLY PUBLISHED RESULTS

BUT THERE IS STILL A SIGNIFICANT ROOM FOR IMPROVEMENTS:

- CORRECTIONS WERE APPLIED USING BIN WEIGHTING INSTEAD OF UNFOLDING (3D CASE, ROOUNFOLD DOES NOT WORK)

– 5.8 Systematic uncertainties

Systematic uncertainties were estimated by changing:

(i) event selection criteria,
(ii) track selection criteria and

A POSTERIORI SYSTEMATIC UNCERTANTIES INSTEAD OF A PRIORI ONES.

ON EVENT SELECTION IN A+A COLLISIONS

RESULTS ON A+A INTERACTIONS ARE USUALLY GIVEN FOR CENTRAL EVENTS

THE DEFINITION OF CENTRAL EVENTS IS USUALLY:

- DETECTOR DEPENDENT
  (E.G. 10% OF EVENTS WITH THE SMALLEST E_F)
- MODEL DEPENDENT
  (E.G. EVENTS WITH $b < 3$ fm)

- DIFFICULT TO COMPARE EXPERIMENTAL DATA
- DIFFICULT TO COMPARE DATA WITH MODELS

CAN WE IMPROVE THE A+A SELECTION BASED ON THE p+p EXAMPLE ?

EVENT SELECTION FOR p+p INTERACTIONS

(A) GIVE PRECISE, MODEL AND DETECTOR INDEPENDENT, DEFINITION OF A TRUE EVENT SELECTION

(p+p: ALL INELASTIC INTERACTIONS)

(B) ADJUST SELECTION OF MEASURED DATA TO BE CLOSE TO THE TRUE ONE

(p+p INTERACTIONS WITH ZERO SIGNAL IN A FORWARD Sci.)

(C) CORRECT DATA FOR DIFFERENCES BETWEEN THE TRUE AND MEASURMENT SELECTIONS (USING MC OR DATA)

(CORRECT RESULTS FOR THE TRIGGER BIAS; LOSSES OF INELASTIC, UNWANTED ELASTIC INTERACTIONS)

IMPROVED EVENT SELECTION FOR A+A COLLISIONS

(A) EXAMPLE OF THE TRUE EVENT SELECTION

10% OF EVENTS WITH THE SMALLEST ENERGY INSIDE THE PROJECTILE SPHERE: $\vec{p}^{*} < \vec{p}^{*}_{MAX}$

PROJECTILE SPHERE ≡ SPHERE IN MOMENTUM SPACE IN THE PROJECTILE REST SYSTEM, $\vec{p}^{*}$, CENTERED AT $\vec{p}^{*} = 0$

(B) MEASUREMENT EVENT SELECTION

10% OF EVENTS WITH THE SMALLEST ENERGY IN A GIVEN SET OF PSD MODULES

THE SET OF PSD MODULES IS SELECTED TO KEEP THE CORRECTION SMALL.

(C) CORRECT MEASURED RESULTS

CALCULATE THE CORRECTION USING UNFOLDING

CORRECT MEASURED DATA

HAPPY STUDY OF EVENT-BY-EVENT FLUCTUATIONS !