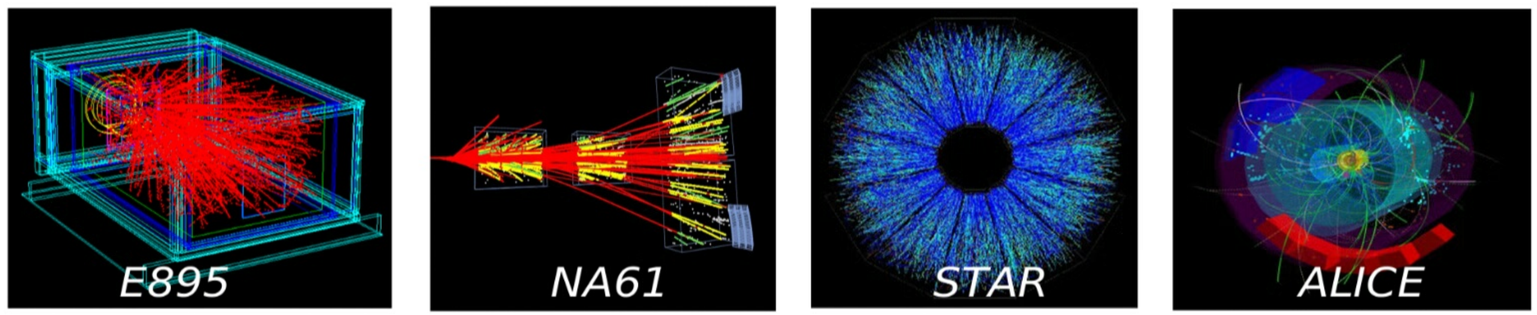
WHY STUDY FLUCTUATIONS IN HIGH ENERGY COLLISIONS

- EXPERIMENTAL STATUS
- WHY FLUCTUATIONS ?

EXPERIMENTAL STATUS

EXPERIMENTAL STUDY OF MULTI-PARTICLE IN HIGH ENERGY COLLISIONS LASTS FOR ABOUT 50 YEARS

BNL AGS → CERN SPS → BNL RHIC → CERN LHC

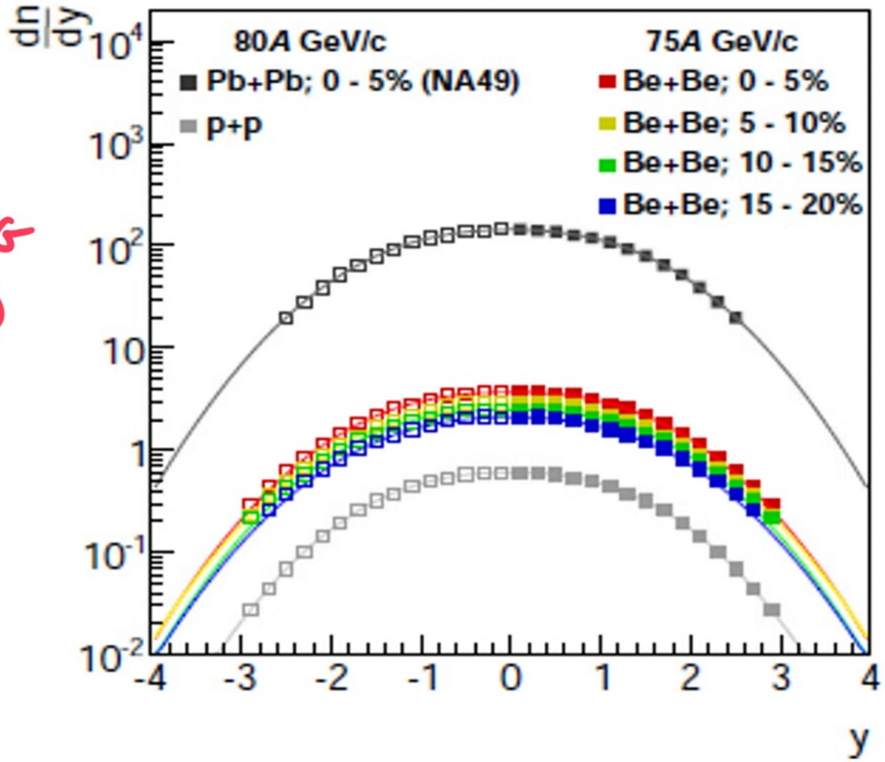


→ RICH DATA ON MEAN MULTIPLICITIES OF PRODUCED HADRONS ($\langle N \rangle$) AND THEIR MOMENTUM DISTRIBUTIONS (SINGLE PARTICLE SPECTRA, E.G. $d^2n/(dydp_T) \equiv d^2\langle N \rangle/(dydp_T)$)

→ BUT POOR DATA ON EVENT-BY-EVENT FLUCTUATIONS (SECOND AND HIGHER MOMENTS)
THIS IS MOSTLY DUE TO INCOMPLETE ACCEPTANCE OF MODERN DETECTORS

SINGLE PARTICLE SPECTRA ARE EASY TO MEASURE
ONE CAN PARTLY FULLY CORRECT THEM FOR A LIMITED ACCEPTANCE USING ROTATIONAL AND FORWARD/BACKWARD SYMMETRIES. THEY ARE OBEYED BY PARTICLE SPECTRA AVEREGED OVER AN EVEN SAMPLE
→ MEASURMENTS IN FULL ACCEPTANCE ARE NOT NEEDED

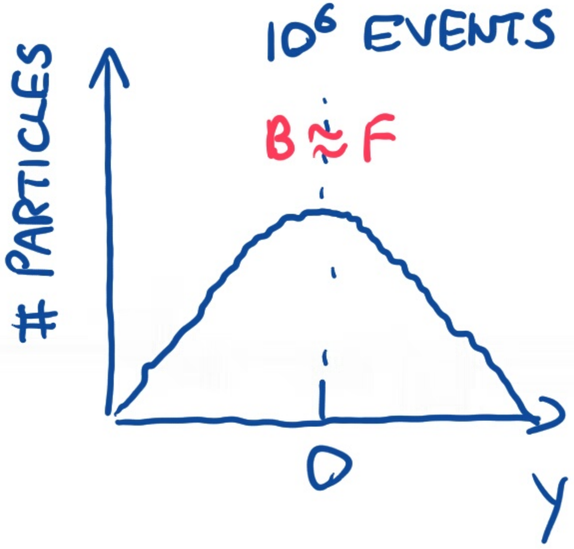
□ MEAN MULTIPLICITY RAPIDITY SPECTRA CALCULATED ASSUMING FORWARD/BACKWARD SYMMETRY OF EVENT SAMPLE



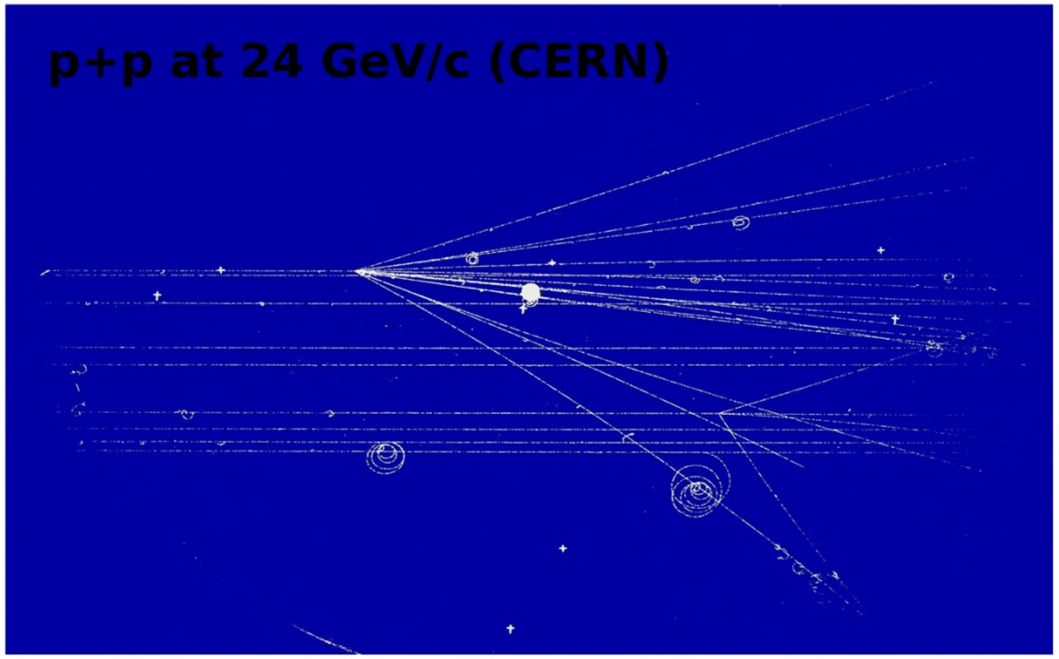
■ MEAN MULTIPLICITY RAPIDITY SPECTRA CALCULATED USING DATA IN LIMITED AZIMUTHAL ANGLE ACCEPTANCE AND ASSUMING ROTATIONAL SYMMETRY OF EVENT SAMPLE

EVENT-BY-EVENT FLUCTUATIONS ARE DIFFICULT TO MEASURE
ONE CANNOT CORRECT RESULTS FOR A LIMITED ACCEPTANCE USING SYMMETRIES OBEYED BY THE EVENT SAMPLE.
THEY ARE NOT OBEYED BY SINGLE EVENTS.

EXAMPLE FOR p+p INTERACTIONS:



THE ONLY PROPER RESULTS ON E-BY-E FLUCTUATIONS ARE ON FLUCTUATIONS OF CHARGED HADRON MULTIPLICITY IN p+p INTERACTIONS. THE MEASUREMENTS COME FROM BUBBLE AND STREAMER CHAMBER EXPERIMENTS PERFORMED MANY YEARS AGO.

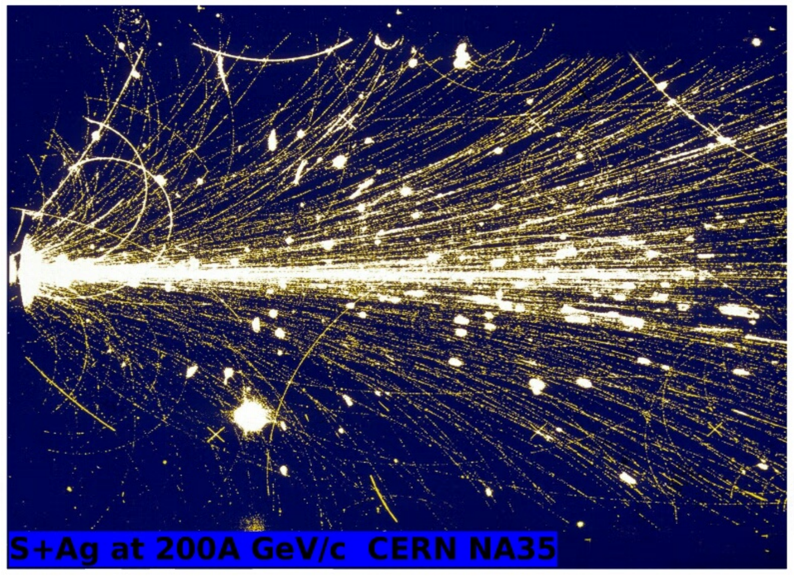


LIQUIDE HYDROGEN SERVES AS TARGET AND DETECTOR

⇒ + FULL ACCEPTANCE
+ LOW SYSTEMATIC BIASES

- PARTICLE MASS NOT MEASURED
- LOW STATISTICS
- WORKS ONLY FOR LOW MULTIPLICITY EVENTS

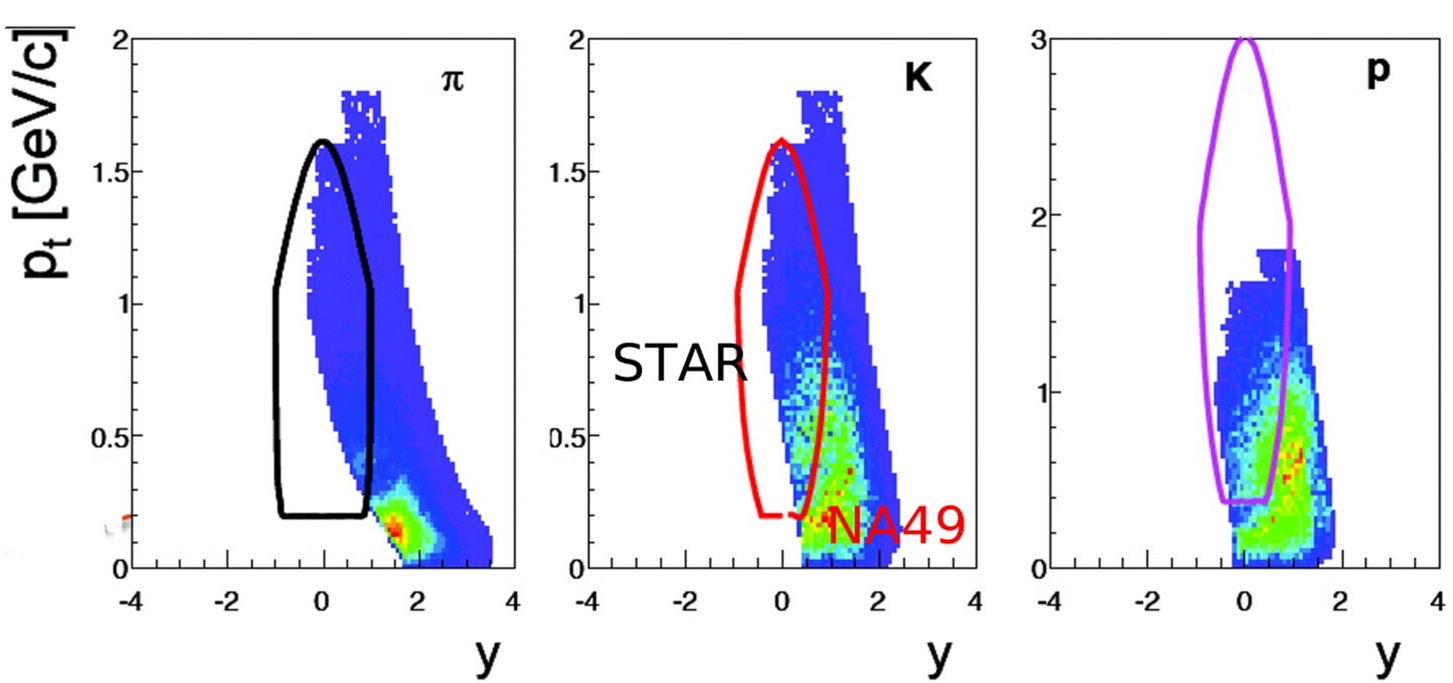
IN BUBBLE AND STREAMER CHAMBER EXPERIMENTS EVENTS WERE READ-OUT BY PROJECTING THEM ONTO 2D FILM PLANE. THE PROJECTED (3D→2D) TRACK DESITY IS SIGNIFICANTLY HIGHER THAN THE 3D ONE.



S+Ag COLLISION AT 200A GeV/c SEEN BY THE NA35 STREMER CHAMBER

IN HEAVY ION COLLISIONS AND/OR AT VERY HIGH ENERGIES TRACK MULTIPLICITY IS TOO HIGH TO USE DETECTORS PROJECTING 3D SPACE ONTO 2D PLANE

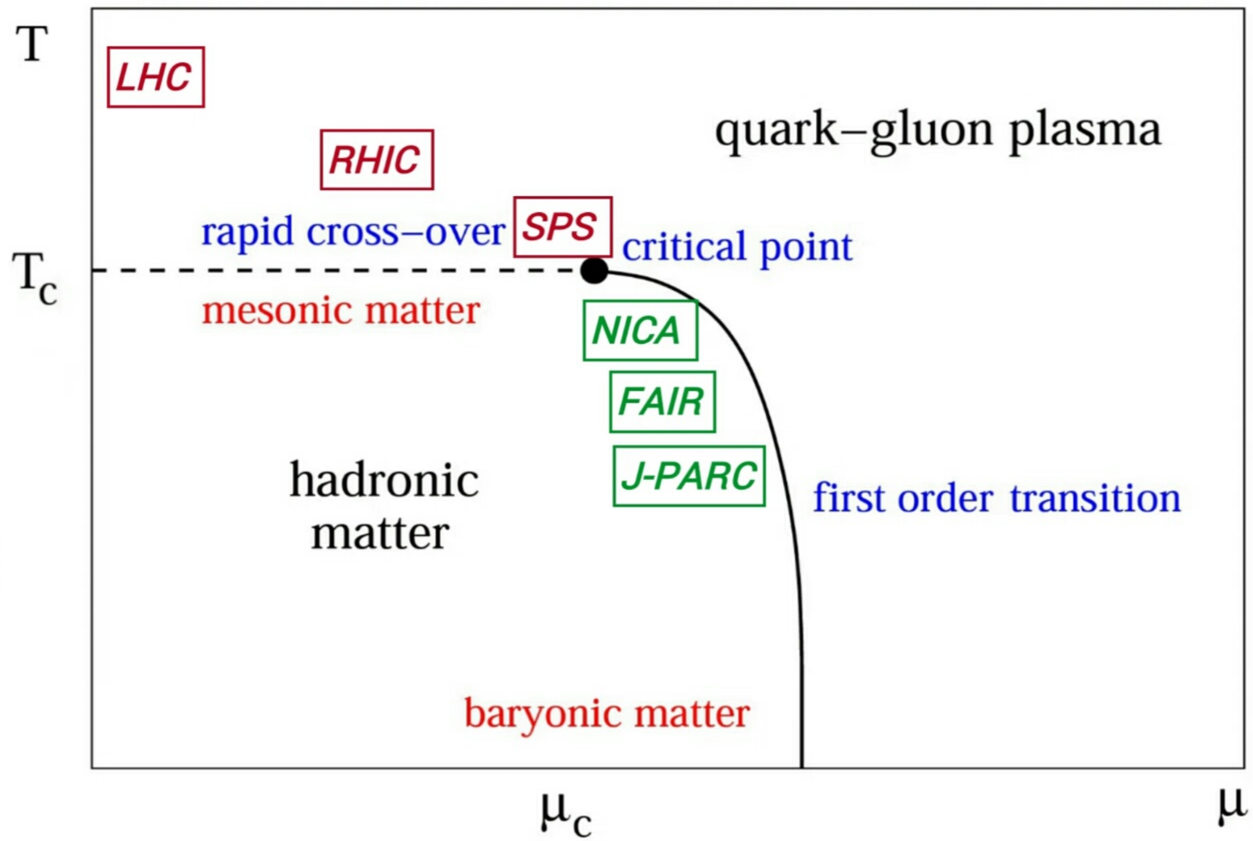
IN ORDER TO OVERCOME THIS PROBLEM MODERN EXPERIMENTS USE TIME PROCECTION CHAMBERS OR SILICON PIXEL DETECTORS FOR PARTICLE TRACKING.
MOREOVER, MANY RUN IN THE COLLIDER MODE AT VERY HIGH ENERGIES.
THE PRICE IS A LIMITED OR VERY LIMITED ACCEPTANCE AND CONSEQUENTLY POOR DATA ON E-BY-E FLUCTUATIONS.



CURRENT AND PLANED ACCELERATORS AND EXPERIMENTS

energy (GeV)	accelerator/exps accelerator/exps
~1	SIS-18/HADES SIS-100/HADES-CBM
~10	SPS/NA61 NICA/MPD AFTER@LHC
~100	RHIC/STAR,PHENIX
~1000	LHC/ALICE,ATLAS,CMS

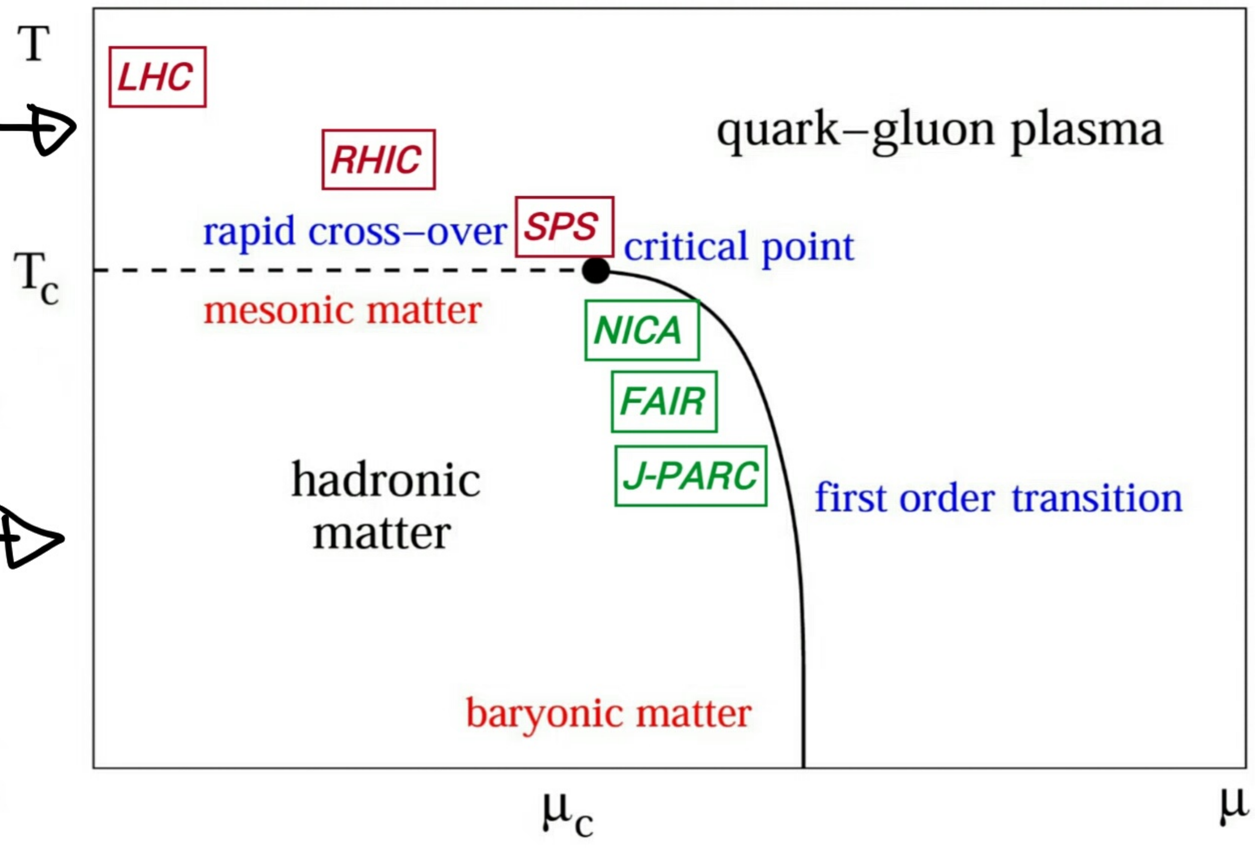
IN THE LANDSCAPE OF THE MOST POPULAR PHASE DIAGRAM OF STRONGLY INTERACTING MATTER



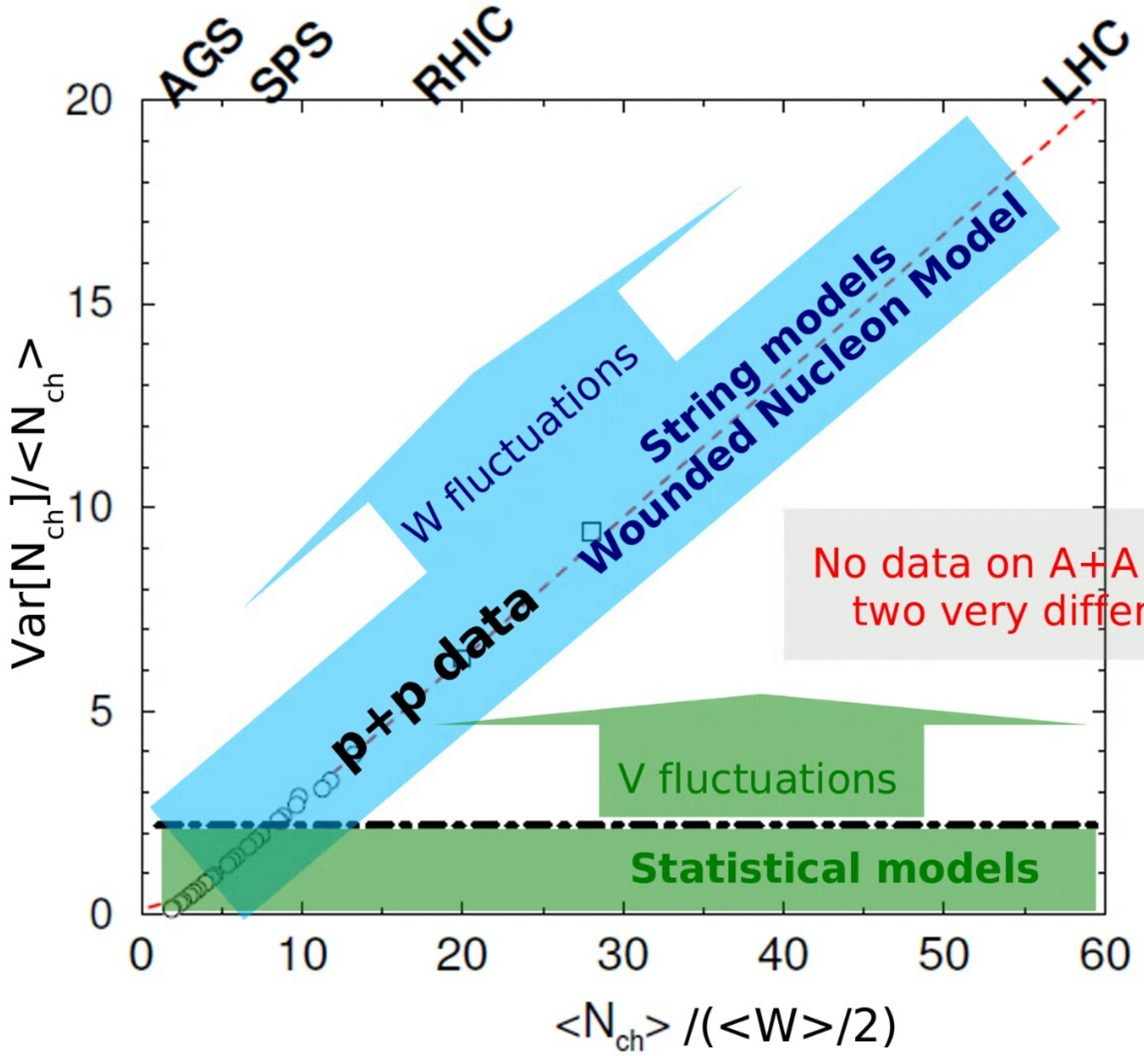
WHY EVENT-BY-EVENT FLUCTUATIONS ?

TEST MODELS (STAT. VS DYN.) OF STRONG INTERACTIONS

STUDY PROPERTIES OF THE PHASE TRANSITION

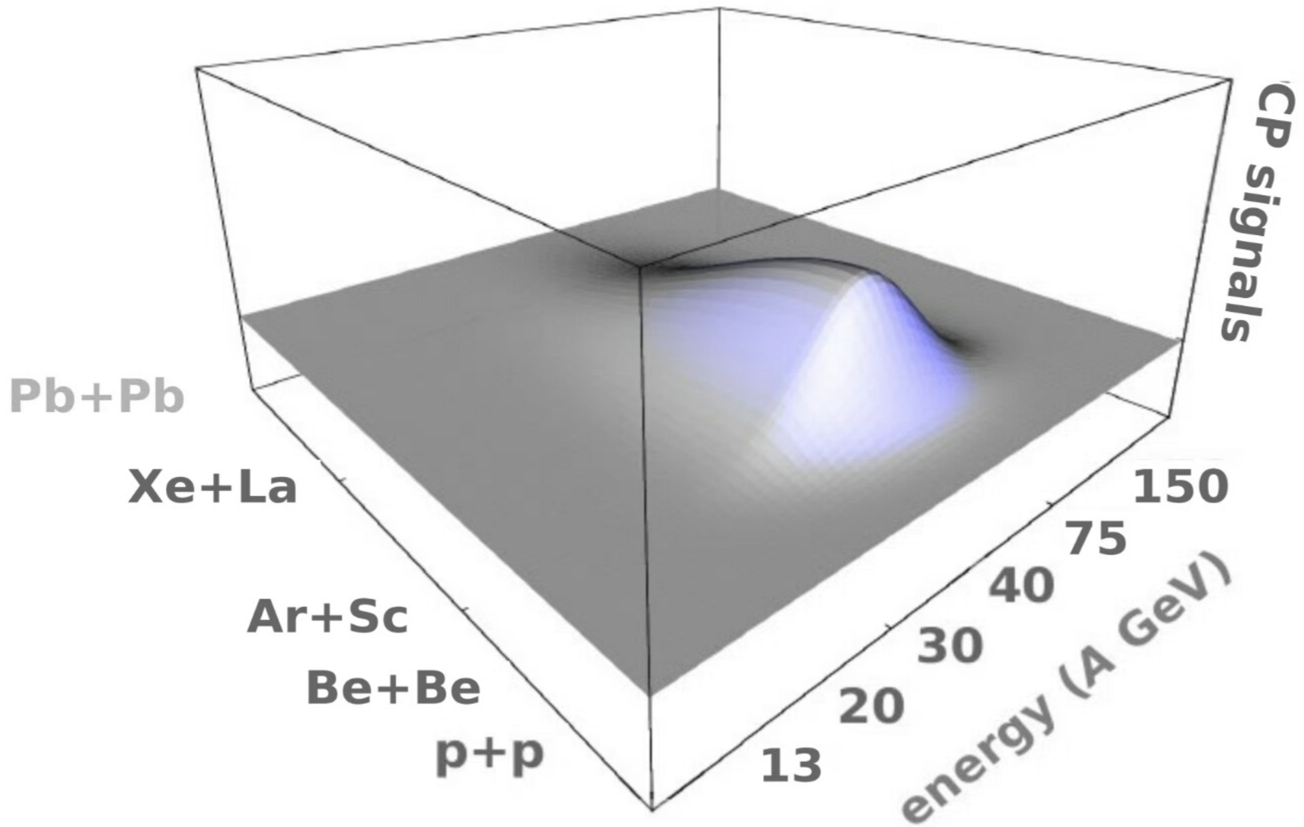


TEST MODELS OF STRONG INTERACTIONS: STATISTICAL VS DYNAMICAL



THIS KEY PLOT WILL BE EXPLANED IN THE FOLLOWING LECTURES

STUDY PROPERTIES OF THE PHASE TRANSITION



FLUCTUATIONS ARE EXPECTED TO SIGNAL THE CRITICAL POINT