August 19-23, 2019, in Lund, Sweden

Topics and tentative abstracts

Topic 1: In what way does the initial state and stages of a collision imprint itself on the final state observables? And how can we distinguish different models of the stages of evolution in nuclear collisions?

Christian Bierlich	Secretary	
Christopher Plumberg	Secretary	
Andreas Morsch	Convenor	
Mark Mace	Convenor	Only synopsis.
Piotr Bozek		
Christine Rasmussen	PhD (TH)	No poster.

Link to synopsis:
https://indico.lucas.lu.se/event/1214/material/0/3.pdf

Abstracts:

Christian Bierlich: Proton substructure with Mueller dipoles
Following the lessons from flow measurements in heavy ion physics, it seems reasonable to believe that the spatial structure of protons, when probed at small x, has a role to play for collective effects in pp collisions. In this poster a new implementation of a Monte Carlo cascade built on Mueller dipoles is presented, along with implications for flow measurements in small systems. It is emphasized that the model essentially has no free parameters tunable to flow measurements, but is fixed to total and semi-inclusive cross sections from pp and ep collisions.

Andreas Morsch: Constraints on matter distribution inside the proton
In multiple parton interaction based models like PYTHIA static proton radial matter profiles with impact dependent pp overlap successfully describe observables like multiplicity fluctuations and the jet pedestal effect. Surprisingly, combined with a Glauber model, it also reproduces well certain aspects of soft-hard particle correlations in p-Pb and peripheral Pb-Pb. Other data like elliptic flow in pp and incoherent ep diffractive scattering are best described by a fluctuating gluon distribution inside the proton. How are the two models related ? Can the jet pedestal

effect and particle multiplicity distribution further constrain the fluctuating matter distribution? How would the PYTHIA pp overlap plus spatial fluctuations perform?

Christopher Plumberg: Particle Interferometry from Hydrodynamics and Event Generators

Particle interferometry - also known as Hanbury Brown-Twiss (HBT) interferometry - is a measurement technique which allows one to study the space-time evolution of femtoscopic collision systems. In particular, HBT interferometry provides valuable insight into both the coordinate-space and momentum-space properties of these collisions. In this work, I describe some recent and ongoing efforts to connect the techniques of HBT interferometry with the question of QGP medium formation in heavy-ion collisions and high multiplicity hadron-hadron collisions. Specifically, I will show how hydrodynamic predictions for the space-time evolution can be tested using HBT, and I will discuss some current work to enable similar predictions to be made using the MC event generator formalism of Pythia/Angantyr for the modeling of both small and large high-energy collision systems.

Piotr Bozek: Small collision systems on polarized targets

Tuning the initial deformation of the fireball using a polarized light nucleus target is possible. Signatures of collective flow with respect to the polarization axis should be measured.

Topic 2: In what way are QGP like effects in small systems related to each other?

Alice Ohlson	Secretary	
Aleksas Mazeliauskas	Convenor	
Anthony Timmins	Convenor	Only synopsis.
Antonio Ortiz		
Vytautas Vislavicius		
Gösta Gustafson		
Dong Jo Kim		
Jonatan Adolfsson	PhD (EXP)	
Marius Utheim	PhD (TH)	
Wenbin Zhao	PhD (TH)	
Robin Törnkvist	PhD (TH)	No poster.

Link to synopsis:
https://indico.lucas.lu.se/event/1214/material/0/2.pdf

Abstracts:

Alice Ohlson: Short-range correlations and jet-like effects in small systems
Two-particle correlation studies in azimuthal angle and pseudorapidity have yielded surprising results in small collision systems, showing the presence of correlations between particles over large ranges in pseudorapidity in high-multiplicity pp and p–Pb collisions. These correlations are reminiscent of features observed in heavy-ion collisions where they are commonly attributed to anisotropic flow (v_n). However, in order to quantify long-range correlations, a detailed understanding of short-range (mini-)jet correlations is required. The multiplicity and transverse momentum dependence of the nearside jet peak in pp collisions will be shown in this contribution, and the implications for the study of collective behavior will be discussed.

Aleksas Mazeliauskas: Equilibration of QGP in small systems
QCD kinetic theory provides a systematic framework of describing different aspects of QGP equilibration. Within this framework, we review

how different QGP effects, like hydrodynamization, chemical equilibration and thermalization are related and how incomplete equilibration of QGP might manifest itself in small systems.

Antonio Ortiz: Where does the pT come in small systems?
In this contribution, I will show MC results on angular correlations between leading charged particles and associated charged particles (within different pT ranges). Average charged-particle multiplicity and average pT are studied as a function of R ($\sqrt{\Delta\phi^{2}+\Delta\eta^{2}}$). Results are presented for identified and unidentified associated charged particles. Contributions from different UE processes are studied as a function of the number of multi partonic interactions and mid-pseudorapidity charged-particle multiplicity. Recent results of ALICE for pp collisions as a function of multiplicity are discussed within this context.

Vytautas Vislavicius: Measuring the underlying probability density function of v_{2}
Measurements of flow coefficients $v_{\rm n}$ have been used as a tool to probe the initial conditions and transport properties of a strongly interacting matter produced in heavy-ion collisions. In this poster we report on the measurements of $p_{\rm T}$-differential charged-hadron $v_{\rm 2} and $v_{\rm 3}$ coefficients, measured using two- and multi-particle cumulants in Pb-Pb collisions at $\sqrt{s_{\rm NN} = 5.02{\rm TeV}}$ and Xe-Xe collisions at $\sqrt{s_{\rm NN}} = 5.44{\rm TeV}$. In order to discuss the non-flow effects, the presented results are obtained using a novel 2-subevent technique. We observe that the $v_{\rm 2}{\rm 6}$ and $v_{\rm 2}{\rm 8}$ deviate from $v_{\rm 2}{\rm 4}$, indicating that the underlying PDF is not well-described by the Bessel-Gaussian distribution. The non-trivial evolution of $v_{\rm 2}{\rm 6}/v_{\rm 2}{\rm 4}$ and $v_{\rm 2}{\rm 8}/v_{\rm 2}{\rm 4}$ suggest that $v_{2}\propto\epsiulon_{2}$ scaling breaks down at above $p_{\rm T} \gtrsim 2\,{\rm GeV}/c$. Finally, we calculate the skewness and kurtosis of the undelying $v_{\rm 2}$ PDF as a function of transverse momenta and centrality.

Gösta Gustafson: flow-like effects in small systems

I will describe how an enhanced pressure can give flow like effects without a hot thermalized medium.

Dong Jo Kim: Long and short range correlations in high multiplicity events in small systems

I will discuss the following two topics,

1. the ridge study in ALICE
https://indico.cern.ch/event/577856/contributions/342419
and the relations to hard scattering. The ALICE results will be compared to the Shoving configuration in Pythia model developed by Christian Bierlich.
2. Jet transverse momentum distributions in pPb high multiplicity events
https://jyx.jyu.fi/handle/123456789/64412
measured separately for showering and hadronization parts to address the jet quenching for small systems.

Jonatan Adolfsson: Xi-hadron correlations in pp collisions

There are theoretical indications that there may be enhanced correlations between the multistrange Xi baryon and other strange particles, such as kaons. If this is the case, it may give a clue to the origin of strangeness enhancement in small systems. In this work, I show simulation results of angular correlations between Xi-pi, Xi-K, Xi-p, and Xi-Lambda in pp collisions at 13 TeV, as well as how the spectra of these associated hadrons change when triggering on a Xi baryon. These methods may be used to test the predictions in data.

Marius Utheim: Hadronic rescattering in Pythia

I have been developing a framework for hadronic rescattering in Pythia. One of the most important questions we are interested in, is to what degree such rescattering can account for QGP-like effects such as flow.

Wenbin Zhao: Probing the partonic degree of freedom in high multiplicity p-Pb at $\sqrt{s}$ = 5.02 TeV collisions.

The collective flow and the possible formation of the Quark-Gluon Plasma (QGP) in the small colliding systems are hot research topics in the heavy-ion community. Recently, ALICE, ATLAS and CMS collaborations have measured the elliptic flow and the related number of constituent quark (NCQ) scaling of identified hadrons in p+Pb collisions at $\sqrt{s}$ = 5.02 TeV, which are important observables to probe the partonic degree of freedom in the created small system.   In this talk, we focus on the coalescence model calculations for the NCQ scaling of at intermediate for the high multiplicity p+Pb collisions, which includes thermal-thermal, thermal-jet and jet-jet partons recombinations, using the thermal partons from hydrodynamics and jet partons after the energy loss of the Linear Boltzmann Transport (LBT) model. Such coalescence model calculations have also been smoothly connected with the low hydrodynamic calculation and high jet fragmentation. Within such combined framework, we present a nice description of the spectra and elliptic flow over the p_T range from 0 to 6 GeV, and obtain the approximately NCQ scaling at intermediate as measured in experiment. We also switch off the coalescence process of partons and find that without such coalescence, one can not describe the differential elliptic flow and related NCQ scaling at intermediate . Such comparison calculations also demonstrate the importance of the partonic degree of freedom and indicate the possible formation of QGP in the high multiplicity p+Pb collisions.

Topic 3: Is there jet quenching in small systems, and can we measure and calculate it?

Leif Lönnblad	Secretary	
Peter Jacobs	Convenor	Will do synopsis poster together.
Urs Achim Wiedemann	Convenor	
Guy Paic		
Dennis Pereplitsa		
Korinna Zapp		
Anders Oskarsson		No poster
Smita Chakraborty	PhD (TH)	
Omar Vazquez Rueda	PhD (EXP)	

Link to synopsis:
https://indico.lucas.lu.se/event/1214/material/0/4.pdf

Abstracts:

Leif Lönnblad: What, where and when is the medium
Jet quenching is typically discussed in terms of the jet interacting with "the medium". This medium is often thought of as some uniform soup of thermalised quark gluon plasma, which may be a reasonable approximation in central AA collisions. But what does it look like in smaller systems? With Pythia8 we can generate somewhat realistic partonic states for the early stages of pp, pA and AA collisions. What does these tell us about "the medium"?

Peter Jacobs: Jet quenching in small systems: what can we know?
What do we know experimentally and theoretically about jet quenching in small systems, and what is achievable in the foreseeable future?

Urs Achim Wiedemann: The inner workings of the QGP
I plan to participate in the discussion of strategies that exploit the system size dependence of collective effects and of jet quenching to learn about

non-hydrodynamic properties of the matter produced in nucleus-nucleus collisions.

Guy Paic: Do we see parton energy loss in pp collisions

We will present simulations with Pythia that indicate that at very high multiplicities in pp collisions we do see effects that can be interpreted as energy loss of partons wit a subsequent increase in multiplicity and a increased slope of the corresponding spectra. The results for the jetty part and underlying event part will be shown

Dennis Pereplitsa: Multiplicity selection effects on intra-event jet quenching observables

Attempts to observe jet quenching in small systems through some of the traditional methods used in large system suffer from potential biases introduced by high-multiplicity event selections. In particular, it is well-known that precise measurements of hard process rates (nuclear modification factors) are difficult due to biases in the multiplicity-based geometric classification. Thus, there has been a focus on searching for jet quenching through intra-event correlations (high-pT v2, boson+jet pT balance, etc.). However, there may still be subtle ways in which these observables are sensitive to such selection effects. For example, a high-multiplicity selection preferencing boson+multijet topologies which may appear as energy loss in some boson + (single) jet observables. To get a sense of the specific magnitudes of these kinds of effects, I would like to study them in some modern event generators such as Pythia, Hijing, etc. This way we can better understand which measurements are less affected by multiplicity selection effects and thus may be more sensitive to measurements of energy loss.

Korinna Zapp: some news on medium response in JEWEL

No details.

Smita Chakraborty: String shoving in heavy ion collisions:PYTHIA8 Angantyr

We explain the string shoving mechanism in PYTHIA8 in this poster. We also describe how this will influence the final-state jets in heavy ion collisions.

Omar Vazquez Rueda: Fractional momentum loss in heavy-ion collisions

No details.

Topic 4: How does the hadronization process depend on the properties of the hadronizing system?

Peter Christiansen	Secretary	
Rainer Fries	Convenor	
David Dobrigkeit Chinellato	Convenor	
Torbjörn Sjöstrand		No poster
Roberto Preghenella		
Adrian Nassirpour	PhD (EXP)	
André Vieira da Silva	PhD	

Link to synopsis:
https://indico.lucas.lu.se/event/1214/material/0/0.pdf

Abstracts:

Peter Christiansen: Hadronization
Something about strangeness and quantum number correlations.

Rainer Fries: Hadronization in Small and Large Systems
We investigate string fragmentation and quark recombination and their possible relation in the hadronization of partons. We discuss various systems, from e+e- to AA collisions, and potential constraints that experimental data from these experiments can provide on the hadronization mechanism.

David Dobrigkeit Chinellato: Hadronization from low to high densities
One of the most challenging problems when comparing different collision systems, such as pp, p-Pb and Pb-Pb, is to understand how hadronization may be altered in each of these systems because of the varying conditions at hadronization time. Recently, several measurements have provided further information on this fundamental topic, but no definite conclusion has been reached so far. In this work, we discuss experimental and phenomenological ideas that may help in characterizing the

formation of hadrons and therefore are crucial for inferring conditions prior to their formation.

Roberto Preghenella: Are strange quarks already there or are they born at hadronisation?

It has been pointed out already several times that the phi meson has a big potential to help us understand how hadronization works and from where the observed strangeness enhancement builds up. I unfortunately did not have much time to think about this before writing it here, but I write it anyway. Suppose I have a hadronisation picture where strage quarks are born in the breaking of the string. I break one string twice and create a phi meson. I break another string twice and create another phi meson. The probability to create two phi mesons is the product of the probabilities. Suppose I have a quark soup with some strange quarks in it and my hadrons are created starting from those quarks. The probability to form a phi meson will depend from the strange quark density. The probability to form a second phi meson should be lower than the product of the probabilities. While I don't know whether all this makes sense, I wonder whether studying the production yield of a given strage hadron A conditional to the production of another strange hadron B in the same event can give us some hints of the existence of a potential source of strange quarks from where we hadronise. I would naively expect that in a string-fragmentation picture and at sufficiently high Nch, the probability of production a (for instance) phi meson does not depend on whether in that given event we have already produced a Omega baryon.

Adrian Nassirpour: Event Shape Engineering of Phi Meson (1020) Production to Pin Down QGP-like Effects in Small Systems

Recent measurements of proton-proton (pp) collisions at ALICE have indicated signs of multiplicity dependent collective-like behavior. Collective behaviour was previously observed in larger collision systems (p-Pb, Pb-Pb), and believed to be a signature of a strongly interacting medium, Quark-Gluon Plasma (QGP). Due to the limited phase-space of pp collisions, and the theorized lack of a QGP, it is now important to pin-down the sources of collective behaviour in small systems. Event-Shape engineering is used to further investigate the sources behind the collective behaviour in small system. This is done by isolate events that are dominated by soft physics (small momentum transfers) and hard physics (large momentum transfers). Transverse Spherocity and the rT of an event are used as tools to effectively isolate the two different physics. The Phi meson is an especially important particle in this context, as it consists of a s-sbar pair. In pQCD models such as PYTHIA, it can only be produced by a double-string breaking, heavily suppressing the phi meson production. In other statistical models, the phi-meson is produced at a rate according to its mass (similar to that of a proton). Simulation studies of the Phi meson production as a function of different event shape estimators and charged particle multiplicities will be presented.

André Vieira da Silva: Studying the effect of the hadronic phase in nuclear collisions

The main goal in the physics of ultra-relativistic heavy-ion collisions is to study the properties of strongly interacting matter under extreme conditions. In these collisions, large energy densities are expected to be achieved and a state of matter where quarks and gluons are no longer confined in to hadrons, the quark-gluon plasma (QGP), is formed. The presence of such a system leads to some experimental signatures such as collective behaviour and the suppression of high momentum particles that are expected and measured in the experiments at the LHC. These signatures are only measured indirectly after hadronization take place and the system evolution in which inelastic and elastic interactions may still happen. Therefore, understanding the effects of this hadronic phase is of paramount importance to infer on the properties of the QGP. In this work, we couple the PYTHIA Angantyr event generator for heavy-ion collisions at LHC energies with the hadronic cascade simulator UrQMD to study the effect of the hadronic phase on observables such as charged-particle multiplicity densities, transverse momentum spectra, identified particle ratios, nuclear modification factor and anisotropic flow. In addition, the fact that PYTHIA is a perturbative QCD-inspired model that does not assume a thermalized QGP phase also makes these results a crucial baseline for hydrid models that include a QGP phase.

Topic 5: What is the role of heavy quarks in establishing the underlying physics mechanisms in small or large systems?

David Silvermyr	Secretary	
Ralf Rapp	Convenor	
Anton Andronic	Convenor	
Hendrik van Hees		
Andrea Rossi		
Ingvar Otterlund		No poster
Oliver Matonoha	PhD (EXP)	No poster.

Link to synopsis:
https://indico.lucas.lu.se/event/1214/material/0/1.pdf

Abstracts:

David Silvermyr: Future heavy quark measurements with the upgraded ALICE detector
Discussion re. which are the most interesting and important measurements that should be done?

Ralf Rapp: Issues in Heavy Flavor Physics in Nuclear Collisions
A critical assessment of the various model components for heavy-flavor production in nuclear collisions will be made.

Anton Andronic: Statistical hadronization of heavy quarks
Production of hadrons in nucleus-nucleus collisions exhibits in its bulk aspects clear statistical features, over a broad range of collision energy. At the LHC production of heavy-quark hadrons, and in particular charmonium, also exhibits statistical features, indicating hadronization at the QCD phase (crossover) boundary. I will discuss these aspects and contrast them to production in pp (and pA) collisions.

Hendrik van Hees: Relativistic Langevin simulations for heavy-quark diffusion and quarkonia formation

We study relativistic Langevin simulation for the diffusion of heavy quarks and anti-quarks in the QGP formed in relativistic heavy-ion collisions with applications to the spectra (RAA and v2) of open-heavy-flavor mesons as well as the formation of quarkonium bound states in a classical potential model.

Andrea Rossi: Heavy-flavour baryon production at colliders

Recent measurements at the LHC indicate that the Lc/D0 and Lb/B baryon-to-meson ratios in pp and p-Pb collisions are significantly higher than in e+e- and ep collisions and higher than expectations from several Monte Carlo generators. These results suggest that, even in small collision systems, heavy-quark hadronisation is sensitive to the surrounding hadronic environment. The role of colour-reconnection effects and of the feed-down from higher-mass states has to be further investigated. In nucleus-nucleus collisions an enhancement of baryon-to-meson ratio is expected in case charm and beauty quark hadronise via coalescence with light-flavour quarks from the Quark-Gluon Plasma. Models including such process can better describe the Lc/D0 ratios, as well as the D-meson flow and RAA, measured at RHIC and at the LHC. A model based on statistical hadronisation can also describe the Lc/D0 ratio in Pb-Pb collisions. In this poster, the main experimental results will be reported and compared to model expectations with the goal of identifying new possible measurements, among which multiplicity-differential studies and the measurement of different baryonic states, that could provide further insight on heavy-quark hadronisation in hadronic collisions and on possible connections across different collision systems.