# Quark Matter 2017

The 26th International Conference
on Ultrarelativistic Nucleus-Nucleus Collisions

February 6-11, 2017, Chicago

## Some impressions about the conference

28.03.2017

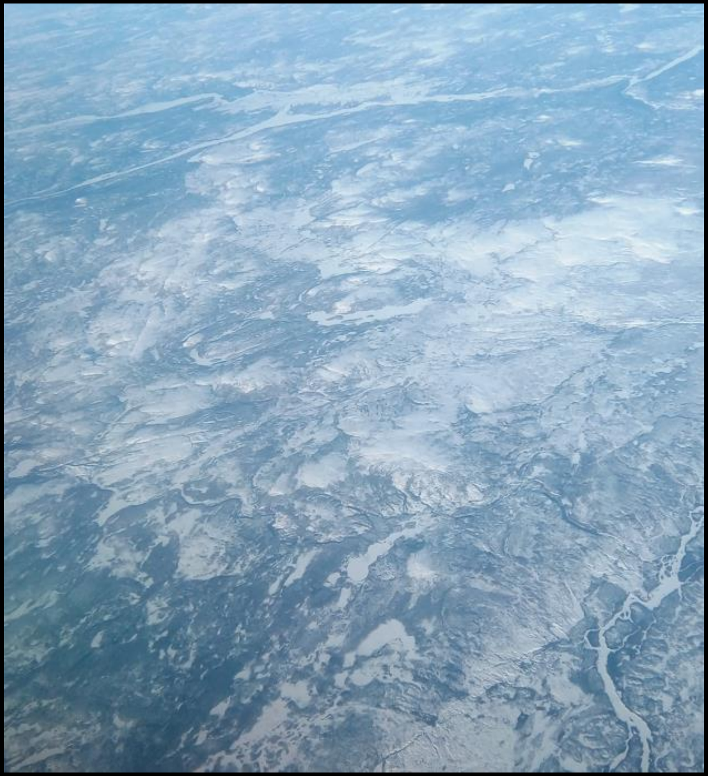
- QCD at high temperature
- Baryon-rich QCD matter
- QGP in small systems
- Initial state physics and approach to thermal equilibrium
- Collective dynamics
- Correlations and fluctuations
- Jets and jet quenching
- Heavy flavor and quarkonium
- Electroweak probes
- Strongly coupled systems
- New theoretical developments
- Future facilities and new instrumentation

## Participant List

716 participants


UBS


Chicago
Frankfurt




DEMISIA !
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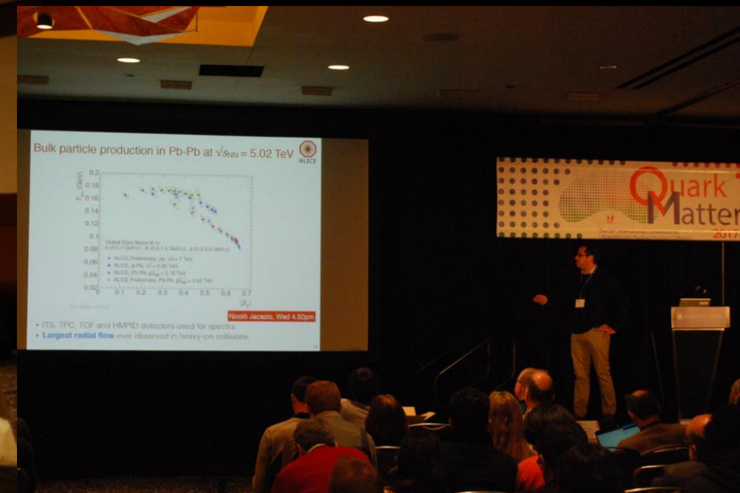
DEMISIA !


estimated arrivals
1:25
O'Hare
Wells/Lake
200W-200N
Clark/Lake
CHICAGO PUBLIC LIBRARY
FREE HOMEWORK HELP
eyelove
Danger - Keep Off Tracks
High Voltage


cta
Rail ('L') System
Midway
Pulaski
Kedzie
Western
35th/Archer
Ashland
Halsted
54th/Cermak
Forest Park
Harlem/Lake
Ashland/63rd
King Drive
Cottage Grove
See Loop Detail


Welcome to Quark Matter 2017!
Enjoy the program, discussions, fellowship, and
CHICAGO


Bulk particle production in Pb-Pb at √sNN = 5.02 TeV
Nicolò Jacazio, Wed 4.50pm
ITS, TPC, TOF and HMPID detectors used for spectra
Largest radial flow ever observed in heavy ion collisions
Quark Matter 2017


Quark Matter 2017
NA61/SHINE at CERN SPS


Wilke van der Schee, MIT/Utrecht
STANDARD MODEL OF HEAVY ION COLLISIONS
Initial stage goes from weak to strong coupling
• Hydrodynamisation: the process of far-from-equilibrium → hydro
• Rapid longitudinal expansion means much later isotropisation
• Much progress on timescale: weak (kinetic) and at finite coupling
• Also important: resulting temperature profile and pre-flow
η/s
1/λ
See talk by Jacopo Ghiglieri (Tuesday, 2:00pm)
2/17
L. Keegan, A. Kurkela, P. Romatschke, WS and Y. Zhu, Weak and strong coupling equilibration in nonabelian gauge theories (2015)
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STAIRS
pepsi

US LUA



HYATT REGENCY


ORIGINS OF COLLECTIVITY
1. Final state correlations:
Particles acquire momentum space correlations via final state interactions (conversion of spatial structure into momentum correlations e.g. via hydrodynamic flow)
2. Initial state correlations:
Particles are produced with their momentum space correlations
3
Björn Schenke, BNL
Quark Matter
2017
HYATT REGENCY


Quark
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201
HYATT REGENCY


RESERVED


HYATT REGENCY
Rethinking The Skyscraper:
Rethinking Cities
Antony Wood

| | | | | |
| --- | --- | --- | --- | --- |
| 09:00 | **Opening Ceremony** | | *Hyatt Regency Chicago* | 09:00 - 09:20 |
| | **Status of the field and key open questions before QM2017** | *Jürgen Schukraft* | *Hyatt Regency Chicago* | 09:20 - 10:00 |
| 10:00 | **STAR** | *Alexander Schmah* | *Hyatt Regency Chicago* | 10:00 - 10:20 |
| | **PHENIX** | *Darren McGlinchey* | *Hyatt Regency Chicago* | 10:20 - 10:40 |
| | **HADES** | *Manuel Lorenz* | *Hyatt Regency Chicago* | 10:40 - 10:55 |
| 11:00 | **NA61** | *Antoni Aduszkiewicz* | *Hyatt Regency Chicago* | 10:55 - 11:10 |
| | **Coffee Break** | | *Hyatt Regency Chicago* | 11:10 - 11:30 |
| | **ALICE** | *Anthony Robert Timmins* | *Hyatt Regency Chicago* | 11:30 - 11:50 |
| 12:00 | **ATLAS** | *Jiangyong Jia* | *Hyatt Regency Chicago* | 11:50 - 12:10 |
| | **CMS** | *Yen-Jie Lee* | *Hyatt Regency Chicago* | 12:10 - 12:30 |
| | **LHCb** | *Patrick Robbe* | *Hyatt Regency Chicago* | 12:30 - 12:45 |
| | **Lunch Break** | | | |

| | | | |
|---|---|---|---|
| 14:00 | **Collective flow from pp to AA** | *Wei Li* | |
| | *Hyatt Regency Chicago* | | 14:00 - 14:30 |
| | **Determination of QGP parameters from global Bayesian analysis** | *Prof. Steffen A. Bass* | |
| | *Hyatt Regency Chicago* | | 14:30 - 15:00 |
| 15:00 | **Equilibration and hydrodynamics at strong and weak coupling** | *Wilke van der Schee* | |
| | *Hyatt Regency Chicago* | | 15:00 - 15:30 |
| | **Jet energy loss and equilibration** | *Korinna Christine Zapp* | |
| | *Hyatt Regency Chicago* | | 15:30 - 16:00 |
| 16:00 | **Poster Session** | | |

Bayessian analysis

Multiparticle cumulants

Charge asymmetry, ESE, chiral magnetic effect

Blast wave fits (Wed, 16.50)

Onset of fluid-dynamical behaviour (Wed, 16.30)

Locally equilibrated QGP?.. Romatschke

Fluctuating proton (dennis perepelitsa, Thu)

Quarkonium production in AA: suppression (enrico, Fri) arXiv:1605.03954

# Applying Bayesian parameter estimation to relativistic heavy-ion collisions: simultaneous characterization of the initial state and quark-gluon plasma medium

Jonah E. Bernhard, J. Scott Moreland, and Steffen A. Bass
*Department of Physics, Duke University, Durham, NC 27708-0305*

Jia Liu and Ulrich Heinz
*Department of Physics, The Ohio State University, Columbus, OH 43210-1117*
(Dated: August 22, 2016)

### A. Model parameters and observables

We choose a set of nine model parameters for estimation. Four control the parametric initial state:

1. the overall normalization factor,
2. entropy deposition parameter $p$ from the generalized mean ansatz Eq. (14),
3. gamma shape parameter $k$, which sets nucleon multiplicity fluctuations in Eq. (12), and
4. Gaussian nucleon width $w$ from Eq. (11), which determines initial-state granularity;

the remaining five are related to the QGP medium:

5–7. the three parameters ($\eta/s$ hrg, min, and slope) in Eq. (4) that set the temperature dependence of the specific shear viscosity,

8. normalization prefactor for the temperature dependence of bulk viscosity Eq. (5), and
9. particlization temperature $T_{\text{switch}}$.

TABLE I. Input parameter ranges for the initial condition and hydrodynamic models.

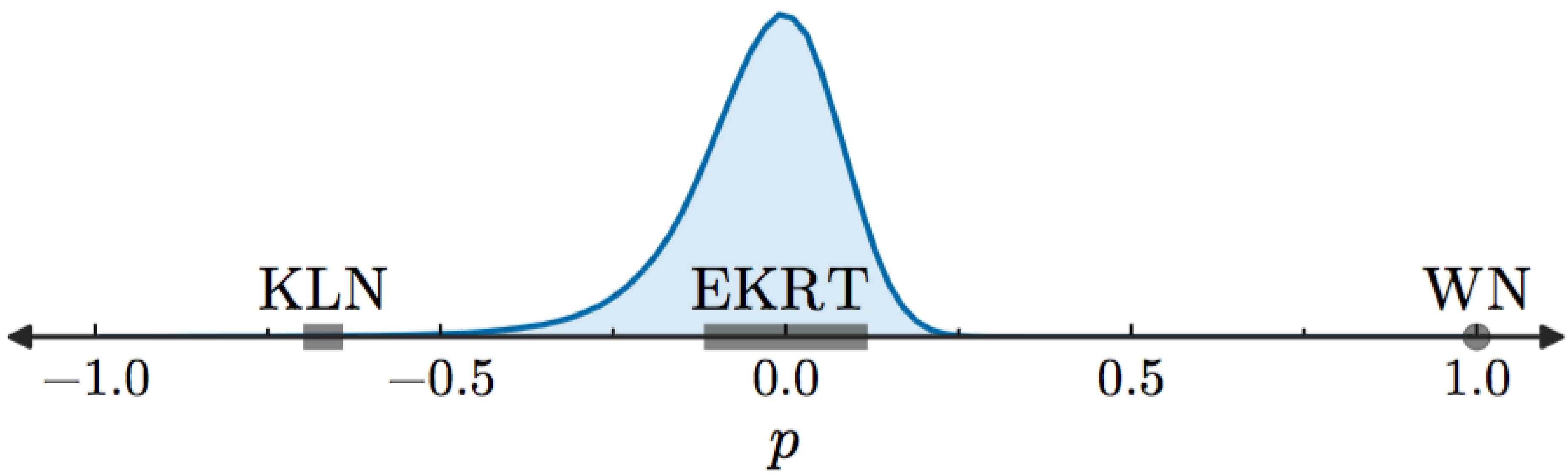
| Parameter | Description | Range |
| --- | --- | --- |
| Norm | Overall normalization | 100–250 |
| $p$ | Entropy deposition parameter | $-1$ to $+1$ |
| $k$ | Multiplicity fluct. shape | 0.8–2.2 |
| $w$ | Gaussian nucleon width | 0.4–1.0 fm |
| $\eta/s$ hrg | Const. shear viscosity, $T < T_c$ | 0.3–1.0 |
| $\eta/s$ min | Shear viscosity at $T_c$ | 0–0.3 |
| $\eta/s$ slope | Slope above $T_c$ | 0–2 $\mathrm{GeV}^{-1}$ |
| $\zeta/s$ norm | Prefactor for $(\zeta/s)(T)$ | 0–2 |
| $T_{\mathrm{switch}}$ | Particlization temperature | 135–165 MeV |

TABLE II. Experimental data to be compared with model calculations.

| Observable | Particle species | Kinematic cuts | Centrality classes | Ref. |
|---|---|---|---|---|
| Yields $dN/dy$ | $\pi^{\pm}$, $K^{\pm}$, $p\bar{p}$ | $\lvert y\rvert < 0.5$ | 0–5, 5–10, 10–20, . . . , 60–70 | [108] |
| Mean transverse momentum $\langle p_T \rangle$ | $\pi^{\pm}$, $K^{\pm}$, $p\bar{p}$ | $\lvert y\rvert < 0.5$ | 0–5, 5–10, 10–20, . . . , 60–70 | [108] |
| Two-particle flow cumulants $v_n\{2\}$ $n = 2, 3, 4$ | all charged | $\lvert\eta\rvert < 1$ $0.2 < p_T < 5.0$ GeV | 0–5, 5–10, 10–20, . . . , 40–50 $n = 2$ only: 50–60, 60–70 | [109] |

TABLE III. Estimated parameter values (medians) and uncertainties (90% credible intervals) from the posterior distributions calibrated to identified and charged particle yields (middle and right columns, respectively). The distribution for $T_{\mathrm{switch}}$ based on charged particles is essentially flat, so we do not report a quantitative estimate.

| | Calibrated to: | |
|---|---|---|
| Parameter | Identified | Charged |
| Normalization | $120.^{+8.}_{-8.}$ | $132.^{+11.}_{-11.}$ |
| $p$ | $-0.02^{+0.16}_{-0.18}$ | $0.03^{+0.16}_{-0.17}$ |
| $k$ | $1.7^{+0.5}_{-0.5}$ | $1.6^{+0.6}_{-0.5}$ |
| $w$ [fm] | $0.48^{+0.10}_{-0.07}$ | $0.51^{+0.10}_{-0.09}$ |
| $\eta/s$ min | $0.07^{+0.05}_{-0.04}$ | $0.08^{+0.05}_{-0.05}$ |
| $\eta/s$ slope [GeV$^{-1}$] | $0.93^{+0.65}_{-0.92}$ | $0.65^{+0.77}_{-0.65}$ |
| $\zeta/s$ norm | $1.2^{+0.2}_{-0.3}$ | $1.1^{+0.5}_{-0.5}$ |
| $T_{\mathrm{switch}}$ [GeV] | $0.148^{+0.002}_{-0.002}$ | — |


KLN
EKRT
WN
−1.0
−0.5
0.0
0.5
1.0
p

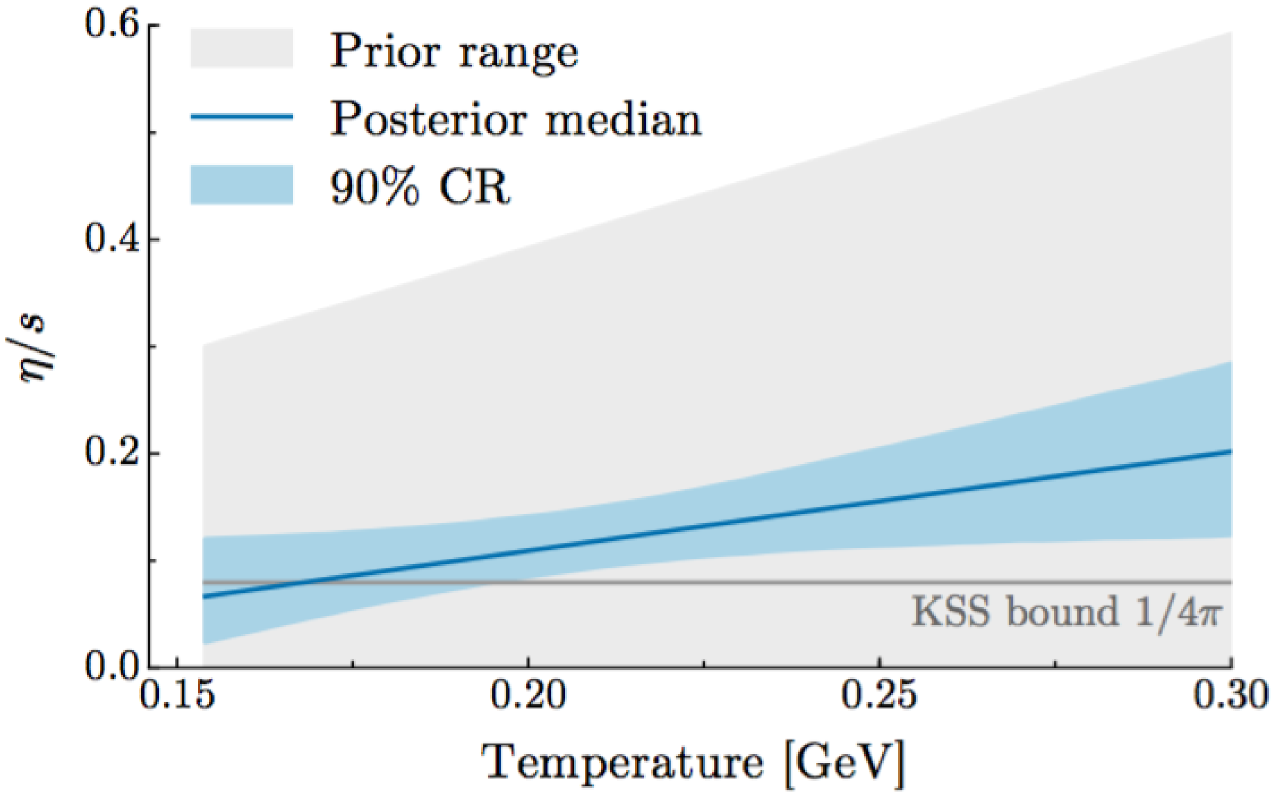
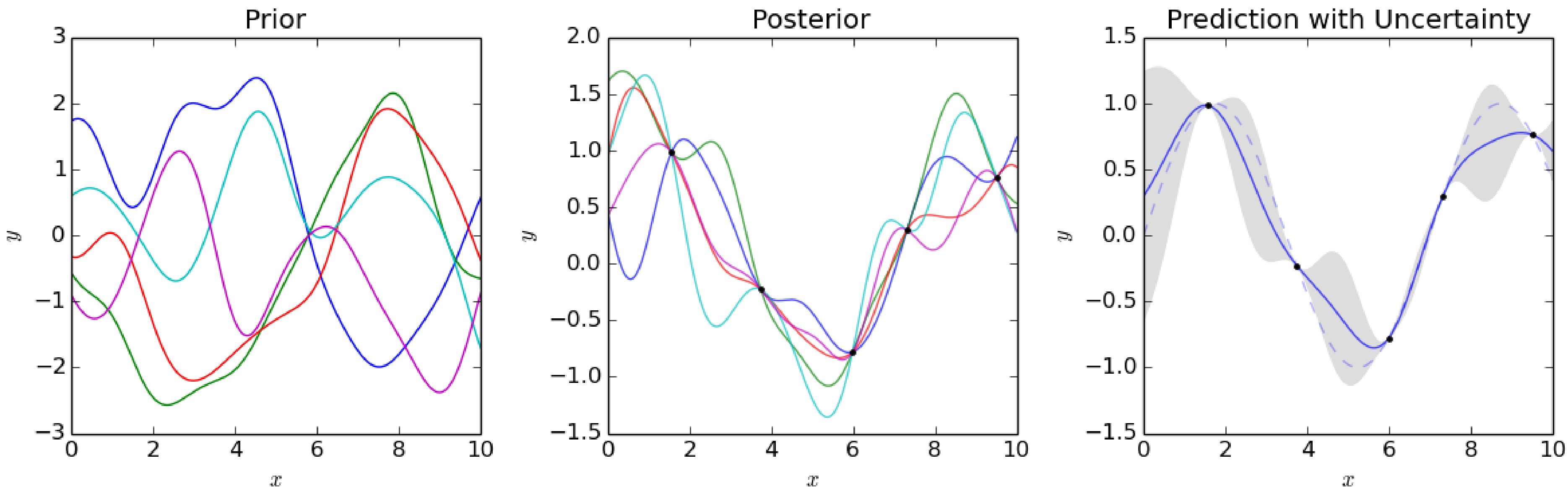



FIG. 10. Estimated temperature dependence of the shear viscosity $(\eta/s)(T)$ for $T > T_c = 0.154$ GeV. The gray shaded region indicates the prior range for the linear $(\eta/s)(T)$ parametrization Eq. (31), the blue line is the median from the posterior distribution, and the blue band is a 90% credible region. The horizontal gray line indicates the KSS bound $\eta/s \geq 1/4\pi$ [12–14].


Prior
Posterior
Prediction with Uncertainty
x
y

https://indico.cern.ch/event/595059/contributions/2522194/attachments/1432097/2200299/R-tutorial.pdf