>>> Quark matter 2018 impressions
>>> and photos

Name: Evgeny Andronov[†] and Igor Altsybeev

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[†]evgeny.andronov@cern.ch

>>> Content

1. Photos
2. Talks summary
3. Brief news

>>> Impressions

This edition of Quark Matter took place in an extraordinary location!

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This edition of Quark Matter took place in an extraordinary location!

Palazzo del Cinema and Palazzo del Casino Lido di Venezia, where Venice International Film Festival takes place there every year

Can you find LUHEP team members?

>>> Impressions

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Machine learning cluster recognition is needed!

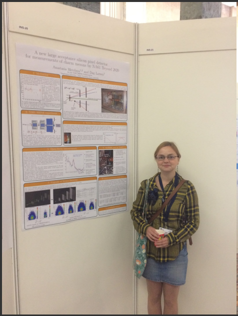
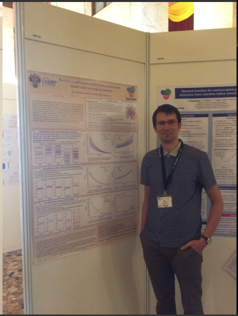
>>> Impressions

After application of magic machine learning techniques

\>>> Impressions

After application of magic machine learning techniques
Absolutely unsupervised learning!

>>> Impressions

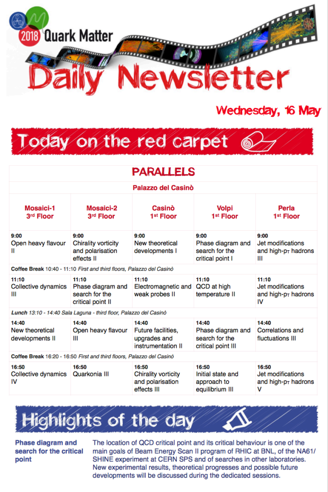


Significant contribution to the full program

280 talks, 400 posters in total

And hard work paid off

>>> Impressions



2018 Quark Matter

Daily Newsletter

Wednesday, 16 May

Today on the red carpet

PARALLELS

Palazzo del Casinò

Mosaici-1 3rd Floor	Mosaici-2 3rd Floor	Casinò 1st Floor	Volpi 1st Floor	Perla 1st Floor
9:00 Open heavy flavour II	9:00 Chirality vorticity and polarisation effects II	9:00 New theoretical developments I	9:00 Phase diagram and search for the critical point I	9:00 Jet modifications and high-p_T hadrons III
Coffee Break 10:40 - 11:10 *First and third floors, Palazzo del Casinò*				
11:10 Collective dynamics III	11:10 Phase diagram and search for the critical point II	11:10 Electromagnetic and weak probes II	11:10 QCD at high temperature II	11:10 Jet modifications and high-p_T hadrons IV
Lunch *13:10 - 14:40 Sala Laguna - third floor, Palazzo del Casinò*				
14:40 New theoretical developments II	14:40 Open heavy flavour III	14:40 Future facilities, upgrades and instrumentation II	14:40 Phase diagram and search for the critical point III	14:40 Correlations and fluctuations III
Coffee Break 16:20 - 16:50 *First and third floors, Palazzo del Casinò*				
16:50 Collective dynamics IV	16:50 Quarkonia III	16:50 Chirality vorticity and polarisation effects III	16:50 Initial state and approach to equilibrium III	16:50 Jet modifications and high-p_T hadrons V

Highlights of the day

Phase diagram and search for the critical point

The location of QCD critical point and its critical behaviour is one of the main goals of Beam Energy Scan II program of RHIC at BNL, of the NA61/SHINE experiment at CERN SPS and of searches in other laboratories. New experimental results, theoretical progresses and possible future developments will be discussed during the dedicated sessions.

EA NA61 talk announced in the daily newsletter-->high attendance

>>> Impressions



Significant contribution to the conference program

280 talks, 400 posters in total!

And hard work paid off

>>> Spoiler alert!

No major breakthroughs and discoveries were claimed.
In this presentation we will discuss only topics and ideas that we liked and understood to some extent.

Experimental flow observables

- Single particle distribution

Flow vector: $V_n = v_n e^{in\Phi_n}$

$$\frac{dN}{d\phi d\eta dp_T} = N(p_T,\eta)\left[1+2\sum_n v_n(p_T,\eta)\cos n\left(\phi-\Phi_n(p_T,\eta)\right)\right]$$

$$= N(p_T,\eta)\left[\sum_{n=-\infty}^{\infty} V_n(p_T,\eta)e^{in\phi}\right]$$

Radial flow

Anisotropic flow

- Two-particle correlation function

$$\left\langle \frac{dN_1}{d\phi d\eta dp_T}\frac{dN_2}{d\phi d\eta dp_T}\right\rangle \Rightarrow \left\langle V_n(p_{T1},\eta_1)V_n^*(p_{T2},\eta_2)\right\rangle$$

v_n from 2PC

- Multi-particle correlation function

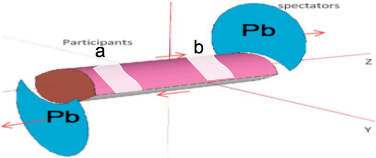
$$\left\langle \frac{dN_1}{d\phi d\eta dp_T}..\frac{dN_m}{d\phi d\eta dp_T}\right\rangle \Rightarrow \left\langle V_{n_1}V_{n_2}...V_{n_m}\right\rangle \quad n_1+n_2+...+n_m=0$$

$$\downarrow$$

$$p(v_n, v_m, ..., \Phi_n, \Phi_m, ...) = \frac{1}{N_{\rm evts}}\frac{dN_{\rm evts}}{dv_n dv_m...d\Phi_n d\Phi_m...}$$

How to measure flow? $V_n = v_n e^{in\Phi_n}$

By particle correlations!



Determine flow vector in one subevent:

$$\boldsymbol{q}_n = \frac{\Sigma_i e^{in\phi_i}}{\Sigma_i} = v_n e^{in\Phi_n} + \delta$$

Statistical noise

Noise uncorrelated between two subevents, average over events:

$$\left\langle \boldsymbol{q}_n^a \boldsymbol{q}_n^{b*} \right\rangle = \left\langle (v_n^a e^{in\Phi_n^a} + \delta^a)(v_n^b e^{-in\Phi_n^b} + \delta^{b*}) \right\rangle = \left\langle \boldsymbol{V}_n^a \boldsymbol{V}_n^{b*} \right\rangle$$

We often assume $p(v_n)$ independent of p_T and η, i.e. ignoring intra-event fluctuation $p(\boldsymbol{V}_n) = f(p_T,\eta)p(\bar{\boldsymbol{v}}_n)$

$$\left\langle \boldsymbol{V}_n^a \boldsymbol{V}_n^{b*} \right\rangle = f(p_T^a,\eta^a) f(p_T^b,\eta^b) \left\langle v_n^2 \right\rangle$$

Event-plane or scalar-product methods, e.g. measure flow in subevent **c** wrt symmetric subevents **a&b**:

$$f(p_T^a,\eta^a) = f(p_T^b,\eta^b)$$

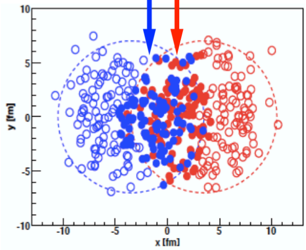
$$v_n^{meas} = \frac{\left\langle \boldsymbol{q}_n^c \boldsymbol{q}_n^{a*} \right\rangle}{\sqrt{\left\langle \boldsymbol{q}_n^a \boldsymbol{q}_n^{b*} \right\rangle}} = \frac{f(p_T^c,\eta^c)\cancel{f(p_T^a,\eta^a)}\left\langle \bar{v}_n^2 \right\rangle}{\sqrt{\cancel{f(p_T^a,\eta^a)}\,\cancel{f(p_T^b,\eta^b)}\left\langle \bar{v}_n^2 \right\rangle}} = f(p_T^c,\eta^c)\sqrt{\left\langle \bar{v}_n^2 \right\rangle} = \sqrt{\left\langle v_n^c v_n^c \right\rangle}$$

Lessons: 1) We often report RMS value of v_n, 2) relies on factorization assumption!

Flow fluctuation in longitudinal direction

Fluctuation of sources in two nuclei → fluctuation of transverse-shape

v_n^F, Ψ_n^F



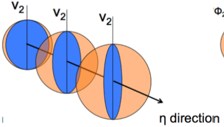
v_n^B, Ψ_n^B

Bozek et.al., arXiv:1011.3354

$$\boldsymbol{v}_n = v_n e^{in\Psi_n}$$

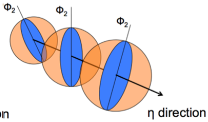
Consequences:

Asymmetry of a flow magnitude



$$v_n(\eta_1) \neq v_n(\eta_2)$$

Torque/twist of an event plane

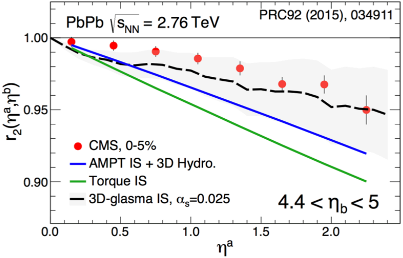


$$\Psi_n(\eta_1) \neq \Psi_n(\eta_2)$$

Flow fluctuation in longitudinal direction

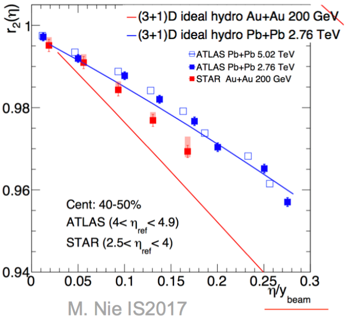
Observables: $$r_n^\eta = \frac{V_n(-\eta)V_n^*(\eta_{\mathrm{ref}})}{V_n(\eta)V_n^*(\eta_{\mathrm{ref}})} \sim \langle \cos n\left[\Phi_n(\eta) - \Phi_n(-\eta)\right]\rangle$$

Significant decorrelation, not described by any models



Wei Li QM2017

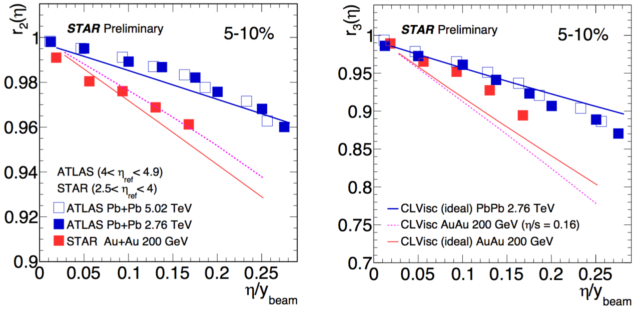
Can't be explained by beam-rapidity scaling, not described by hydro model



M. Nie IS2017

>>> Flow by STAR and ATLAS

Longitudinal Flow Decorrelation in 200 GeV Au+Au Collisions



$$r_n(\eta) = \frac{\langle v_n(-\eta) v_n(\eta_{\mathrm{ref}}) \cos n(\Psi_n(-\eta) - \Psi_n(\eta_{\mathrm{ref}}))\rangle}{\langle v_n(\eta) v_n(\eta_{\mathrm{ref}}) \cos n(\Psi_n(\eta) - \Psi_n(\eta_{\mathrm{ref}}))\rangle}$$

- Stronger longitudinal flow decorrelation at RHIC than at LHC
- Hydro calculations can not simultaneously describe LHC and RHIC data

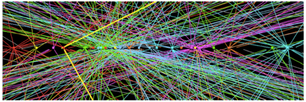
Maowu Nie
#332, May 15 19:10

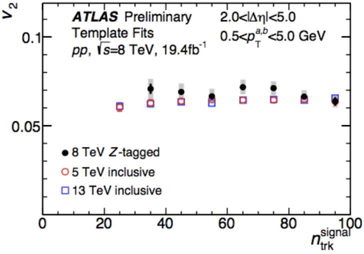
>>> Ridge with Z boson by ATLAS

RIDGE IN Z-TAGGED PP COLLISIONS

ATLAS-CONF-2017-068

- First attempt to control the impact parameter of pp by selecting a high-Q2 process
- 2PC for hadrons in events with Z bosons
- Analysis based on full 2012 pp data at 8 TeV with L=19.4 1/fb with 6.2M Z bosons
- Main challenge is high pileup: average μ is 20 (c.f. μ =1 in previous ATLAS ridge studies)
- **New technique** is **developed** to subtract the pileup contribution in 2PC (~20% correction)
- **v_2 is found to be 8±6% above that in the inclusive collisions at 13 TeV**

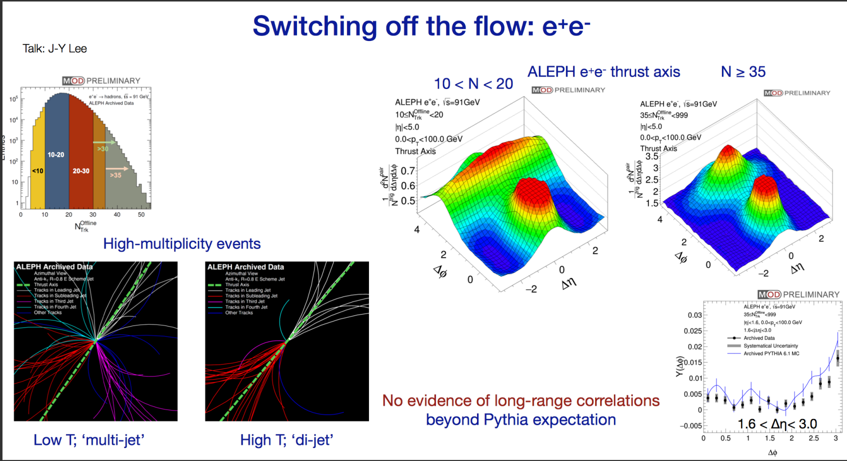




Talk by B.Cole on Tue 15:40

Poster by A.Milov

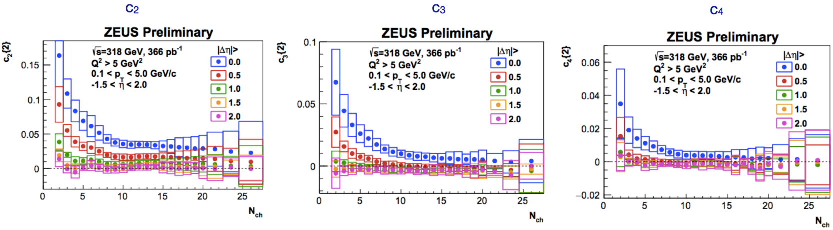
>>> Ridge in ALEPH and ZEUS?



>>> Ridge in ALEPH and ZEUS?

Cumulants from in e-p data from ZEUS

J Onderwaater



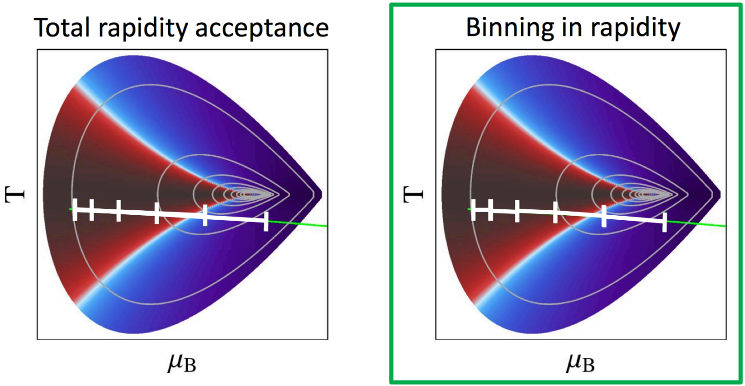
Familiar behaviour: non-flow dominates at small multiplicity and without eta-gap

No flow-like signal seen in high-multiplicity, large eta gap for c_2, c_3, c_4

No flow with 'single string' ⇒ Need multiple interactions to set up initial geometry

>>> Rapidity dependence of fluctuations

There are several different ways to look at the rapidity dependence

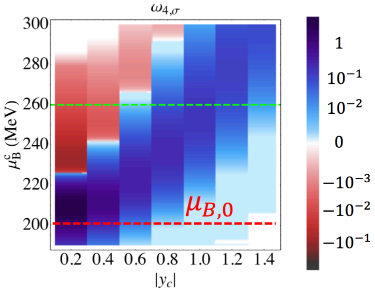


More crisp picture of the critical region

ne Brewer (MIT)

>>> Rapidity dependence of fluctuations

Whether cumulants binned in rapidity increase or decrease as a function of rapidity **switches** when a critical point is passed



Independent test of critical behavior from $\sqrt{s}$-dependence of cumulants

>>> Balance function by ALICE

General Balance Function Measurement

ALICE

$$B(\Delta y) = \frac{1}{2}\left[C_2^{+-} - C_2^{++} + C_2^{-+} - C_2^{--}\right]$$

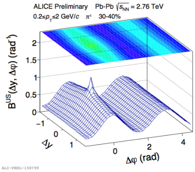
Bass, Danielewicz, Pratt PRL. 85, 2689 *(2000)*

$$C_2^{a,b}(\Delta y) = \frac{\langle N^{a,b}(\Delta y)\rangle}{\langle N^{a}(y_1)\rangle} \qquad a,b \in \{+,-\}$$

same for $\Delta\varphi$ and Δp_T

General charges:
- e: (±)electric charge
- S: (anti)strangeness
- B: (anti)baryon number

$$B^{US}(\Delta y) = \frac{1}{2}\left[C_2^{+-} + C_2^{-+}\right]$$



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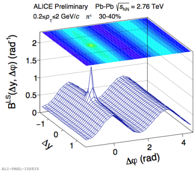
$$B^{LS}(\Delta y) = \frac{1}{2}\left[C_2^{++} + C_2^{--}\right]$$



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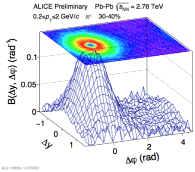
$$B(\Delta y) = B^{US}(\Delta y) - B^{LS}(\Delta y)$$



✧ Remove charge independent effects

✧ Keep effects related to balancing pairs

Experiment Method 1: $R_2^{a,b}(\Delta y) = \frac{\langle N^{a,b}(\Delta y)\rangle}{\langle N^{a}(y_1)\rangle\langle N^{b}(y_2)\rangle} - 1$ → $B(\Delta y) = \frac{1}{2}\frac{dN}{dy(N_{ev})}\left[R_2^{+-} - R_2^{++} + R_2^{-+} - R_2^{--}\right]$

Experiment Method 2: Directly measure $B(\Delta y) = \frac{1}{2}\left[C_2^{+-} - C_2^{++} + C_2^{-+} - C_2^{--}\right]$

✧ mixed events technique
-> detector acceptance and inefficiency correction

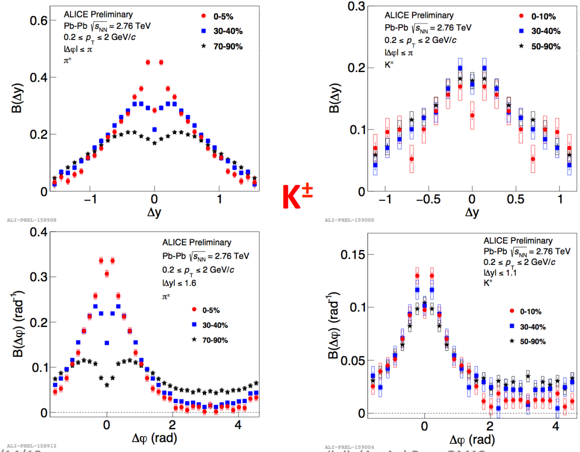
>>> Balance function by ALICE

Balance Function Projections (Pb-Pb @ 2.76 TeV)

ALICE

$\pi^{\pm}$

$K^{\pm}$



BF changes with centrality:

- ✧ $\pi^{\pm}$ shape & magnitude change
- ✧ $K^{\pm}$ no shape & magnitude change

5/14/18 Jinjin(Au-Au) Pan QM18 17

>>> Brief news

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Fin